42D CONGRESS, 3d Session. | HOUSE OF REPRESENTATIVES. | Ex. Doc. No. 240.

REPORT OF THE SUPERINTENDENT

OF THE

UNITED STATES COAST SURVEY,

SHOWING

THE PROGRESS OF THE SURVEY

DURING

THE YEAR 1872.

WASHINGTON:
GOVERNMENT PRINTING OFFICE,
1875.

National Oceanic and Atmospheric Administration

Annual Report of the Superintendent of the Coast Survey

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LETTER

FROM

THE SECRETARY OF THE TREASURY,

TRANSMITTING

REPORT OF THE SUPERINTENDENT OF THE COAST SURVEY.

TREASURY DEPARTMENT, *February* 15, 1873.

SIR: I have the honor to transmit, for the information of the House of Representatives, a report made to this Department by Prof. Benjamin Peirce, Superintendent of the Coast Survey, stating the operations and progress in the survey of the coast during the year ending with October, 1872.

I have the honor to be, very respectfully,

GEO. S. BOUTWELL,
Secretary of the Treasury.

Hon. JAMES G. BLAINE,
Speaker of the House of Representatives.

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ALPHABETICAL INDEX.

REPORT.

COAST SURVEY OFFICE,
Washington, D. C., January 16, 1873.

SIR: I have the honor to report herewith the progress made in the survey of the Atlantic, Gulf, and Pacific coasts of the United States during the surveying-year 1871-'72, which comprises, on both sides of the continent, a working-season in northern sections, and another on southern parts of the coast, where all the field and hydrographic parties are now engaged, as well on the Atlantic as on the Pacific seaboard. For convenient reference, the notices of operations will close, as heretofore, with the transfer of parties for the winter-surveys, which transfer occurs in general about the 1st of November of each year.

The past year, though extremely unfavorable for surveying operations along the coast, will ever be memorable in the annals of our work. It included the voyage of the steamer Hassler from Boston to San Francisco through the Strait of Magellan; the temporary occupation of points on the Rocky Mountains for special scientific purposes, which will be stated in detail in the body of this report under the head of "Interior;" and an expedition for determining the exact difference of longitude between Washington, D.C., and Greenwich. In each of these undertakings, the Survey, without encroaching on appropriations made by Congress for developing the coast, has enabled distinguished *savans* who volunteered their services to accomplish near results in several important branches of knowledge.

The steamer Hassler is now engaged in the regular hydrographic service, for which that vessel was destined, on the coast of California. In the course of the voyage, the observations made by Professor Agassiz, and his conclusions from them, were communicated to me from time to time, and have been made known to the public through the columns of the popular press. It is gratifying to myself, and doubtless is so to many others, that the facts recently brought to light by that great naturalist confirm the views which he had adopted after many years of thoughtful research. These being well known through his published letters, only a general narrative of the voyage of the Hassler, (Appendix No. 11,) written, at my request, by L. F. Pourtales, assistant Coast Survey, will accompany this report.

The steady advance of work in the geodetic connection between the Atlantic and Pacific coasts, with the proviso for determining points in States of the Union which make suitable provision for their own geological and topographical surveys, will, it is hoped, prove to be of great service to the country. In the interior, the indirect benefit of the development of the coast is easily overlooked. Thought, consideration, and argument are requisite for the conviction that operations upon the seaboard are valuable to States which have no coast-lines. But every facility in the avenues of commerce, by diminishing rates of insurance and in other ways lowering the prices of foreign products, may be just as important to citizens of Iowa, Kentucky, and Arkansas as to those of Massachusetts, South Carolina, and Louisiana. The safe transportation of three thousand millions of domestic commerce, which make up the annual coast-trade of the Union, the produce and property of interior States, is more important to the farmer than to the merchant; yet, removed from the sight of the owners, the safeguards of transit cannot command their immediate attention.

The moderate outlay proposed for the geodetic connection between the coasts is directly applicable to all the States of the interior. Points used in the survey of the coast will suffice for the most elaborate surveys that may be undertaken hereafter by the seaboard States. In like manner, points determined in the geodetic connection will serve for future surveys of the interior States. The existing maps are imperfect, but no outlay for their improvement would be warrantable without the essential groundwork of triangulation. In prosecuting the geodetic connection, primary points are determined as far from each other as the nature of the country will permit, or as far as signals can be seen. The combination of these forms a system of large triangles, by which all the general positions of the country are bound together in exact relative position, and the whole constitutes what is known as a geodetic survey. Such a system of points applied to an imperfect map reveals the errors that exist near the points. For final topographical surveys intermediate points are determined between the distant stations. The primary triangulation requires perfect instruments, and observers of known ability and of the greatest experience. All such work is subject to direct tests as to its validity, and frequent scrutiny has shown that the geodetic work of the Coast Survey has been done by observers especially qualified for this duty.

In secondary and tertiary triangulation, such extreme precision is not indispensable; the determination of nearer points being checked, controlled, and corrected by those made at the primary stations. The secondary work in the States can, therefore, be safely intrusted to the hands of scientific citizens or residents connected with engineering or other educational institutions, who might in annual vacations much advance the interests of the State by determining intermediate points. It is beyond doubt that in many instances the principals, when qualified in the use of instruments, could enlist suitable aids from the classes under their charge. In this way, the survey will be efficiently associated with leading scientific men in all parts of the country; the work may have the benefit of their advice and co-operation, and be subject to their criticism. This form of organization has been approved by many able minds, and has been tried with admirable success in the State of New Hampshire, where Professor Quimby, of Dartmouth College, has, during successive vacations, carried on the triangulation of the State. His field-work during the summer will be noticed under the head of section I in this report. Without such co-operation, any surveys for developing the industrial capacities of the several States must necessarily be vague, inaccurate, and unsatisfactory.

The plan here suggested, besides giving opportunity for instruction in the most important problems of surveying, would gradually accomplish, with the utmost economy, a reliable survey of the entire Union. The annual appropriation requisite to carry on operations simultaneously in every State of the Union is estimated not to exceed $150,000; but several years must elapse before the interest, now very active and pressing in some of the States, becomes general. The interests of all require that the co-operative plan, which enlists so much exact knowledge in local geography, and which is thereby made speedily effective in field-work, should be fostered to the utmost. My attention, therefore, will be given to every appeal additional to such as have been already made for the determination of geographical points in the several States of the interior.

LONGITUDE.

The exact determination of the longitude of some point in the triangulation of the Coast Survey from the principal observatories of Europe forms one of the most important problems of the work, and all the various means known to science have been successively brought to bear on its solution. The Coast Survey Reports from 1848 to 1866 show that the methods of moon-culminations, of chronometer-transportation, and of lunar occultations have each in turn received a large share of attention. The latter method has not yet yielded the full results that may be expected of it, in consequence of the infrequency with which corresponding observations are obtained in Europe and America, owing to the parallactic displacement of the moon; it cannot be doubted however, that, with a suitably-organized system of observation, this method will in time give results of extreme exactness.

Upon the successful completion of the Atlantic telegraph from Ireland to Newfoundland, measures were at once taken to make use of that means for the determination of the longitude between the two continents. The results of these operations, conducted by Dr. B. A. Gould, have been given at length in the Report for 1867. Although far more certain than the previous results, the value thus obtained still left a larger margin of doubt as to its precision than is desirable to admit in so fundamental a determination. This uncertainty, which probably does not exceed a quarter of a second of time, is owing in part to the number of intermediate stations that were necessarily employed, and in part to the fact that, though we can measure the total time of transmission of signals through the cable and back again, we are unable to separate the duration in opposite directions, and are obliged to assume it equal—an assumption which may not be exact within a sensible fraction of a second.

When the laying of the French cable from Brest, in France, to Duxbury, in Massachusetts, afforded an independent means of verifying the former result by observations under entirely different conditions, the opportunity was promptly seized, and the longitude between Brest and Duxbury determined by Assistant G. W. Dean, as set forth in the Report for 1870. At that time, no cable was yet in operation between Brest and England, so that Mr. Dean was unable to carry his determination direct to the observatory at Greenwich. Such a cable having since been laid, this wanting link in the chain of longitudes was supplied during the past summer by Assistant J. E. Hilgard, who temporarily gave up the charge of the Coast Survey Office in order to bring this much-desired operation to a satisfactory conclusion. In re-occupying Brest for that purpose, it appeared in every way advisable that the experiments through the French cable should be repeated, this time with an intermediate station at Saint Pierre, where the long cable makes a landing. That part of the operations which connected Saint Pierre with Cambridge was under the immediate direction of Assistant G. W. Dean, and will be further noticed, under Section I, in the body of this report.

The general plan of operations was to unite at Brest signals from America, from Greenwich, and from Paris, sent nearly at the same time and compared by means of the Brest chronograph, and to determine the personal equations of the several observers through one of them, who should observe successively with all the rest. This was done by Subassistant F. Blake, jr., who ably assisted Mr. Hilgard in the detailed operations.

Through the kindness and assistance of Sir George B. Airy, the astronomer-royal of England, and of M. Delaunay, the distinguished director of the Paris observatory, whose lamented death occurred while the operations were in progress, and through the generous courtesy of the French Atlantic Telegraph Company and of the Submarine Telegraph Company, the work was brought to a successful conclusion in September. The results will be found in Appendix No. 14.

As part of the record of the year, I here insert the brief statement of progress and remarks on estimates, which were transmitted to the Department on the 30th of September: In the estimates submitted for continuing the survey of the coast of the United States during the fiscal year 1873–'74, the increase in the items for regular work on the Atlantic and Pacific coasts arises partly from the absorption of the pay and rations of engineers for steamers, which previously stood as a separate item, and partly from increase in the wages demanded by field-hands on some parts of the coast. The difficulty of engaging laborers at ordinary rates has not been general, though it has affected the operations of parties on both sides of the continent. It may be added that the two hydrographic parties, which went into operation within the present year with new steam-vessels, one on the Atlantic side and one on the western coast, will somewhat increase the outlay for the next fiscal year; hence, also, the necessity for a small increase in the estimate for he repair of vessels.

The addition of $14,000 in the item for transcontinental triangulation is required to carry on the plan which was previously laid out. This includes the determination in the interior of points in exact geographical relation to the coast. The requirements of the General Land-Office in that respect have been already met in several instances. It is again confidently submitted that a timely moderate outlay for that object is needful to prevent confusion and waste of means in the joining and adjustment of future surveys of the interior.

From these explanations, it will be seen that, although a decided increase in comparative results may be expected from the operations of the fiscal year 1873–'74, the estimates do not contemplate any enlargement of the organization or of the plans for work.

In further illustration of the detailed estimates, an abstract is here given, mentioning the sites which have been occupied by surveying-parties in the field or afloat since the 1st of November, 1871. In the northern sections of our Atlantic and western coasts, the field and hydrographic operations are yet in progress, and, as usual, will be continued until the approach of winter, when transfers will be made, as heretofore, for continuing work in the southern sections.

Surveying-parties are now engaged, either in triangulation, topography, or hydrography, on the coast of Maine, at Bass Harbor, Mount Desert Island; at Blue Hill Bay; on the islands between it and Isle au Haut Bay; and in the vicinity of Castine, for the survey of the east side of Penobscot Bay; on the west side of that bay above and below Belfast; and in Penobscot Bay north of Islesboro; on the western side of the Kennebec, in Maine, for the determination of geographical points; and or like service in New Hampshire. Special astronomical observations have been made at Cambridge, Mass., to determine the precise relation in longitude between points in the United States and points in Europe. One of the parties in that service occupied a station on Saint Pierre, Miquelon Island. The magnetic elements have been determined at stations on the coast of Massachusetts.

Special examinations have been made to verify the sailing-directions for harbor-charts of the coast of New England. The tides have been recorded constantly during the year at North Haven, in Penobscot Bay, and at the Charlestown navy-yard. A hydrographic party is now at work near the Monomoy Shoals; and offshore soun dings have been continued along the northern sections of the coast. The plane-table survey of the coast of Rhode Island is in progress near Perrysville, west of Point Judith, and also the detailed survey of New Haven Harbor. Views have been drawn for the charts of several harbors between Portland and New York. Special hydrographic investigations are in progress in New York Harbor and in the adjacent waters, and the tides have been steadily recorded at Governor's Island. A field-party is engaged in the survey of Lake Champlain, and others are sounding its northern branches.

Triangulation is in progress near Barnegat, and plane table work and hydrography near Little Egg Harbor, on the coast of New Jersey. Points have been determined for the construction of a comparative chart of the Schuylkill River at Philadelphia, for which the soundings were made last winter; and the magnetic elements have been determined in that vicinity, and also at Washington City.

The tides have been regularly recorded at Old Point Comfort, Va. Geodetic reconnaissance is in progress near Harper's Ferry. The detailed survey of the James River, Virginia, has been extended upward to Warwick River; that of Pamplico River, at Washington, N.C., has been completed. and also that of the lower part of Pungo River, and of the vicinity of Cedar Island, in the lower part of Pamplico Sound. In that sound, the main triangulation has been extended, and progress has been made in the soundings. Cape Hatteras has been included in a resurvey, which revealed changes in contour; and recent soundings develop the dangers to navigation at the Hatteras Shoals. Plane-table work has been completed at Bear Inlet and Brown's Inlet on the coast of North Carolina; and the several channels leading into Cape Fear River have been sounded, Little River entrance, near the boundary-line of South Carolina, has been examined, and much of the coast-line traced southward to connect with a detailed survey; which now includes the shores of Winyah Bay. The survey of the Sea-islands and channels between Coosaw River and Broad River, South Carolina, has been well advanced toward completion; and the sea-water channels inside of Saint Simon's Island, on the coast of Georgia, and between Talbot Island and Saint John's River, have been sounded. Latitude, azimuth, and the magnetic elements were determined at a station on Saint Simon's Island. The measurement of a primary base-line near Atlanta, Ga., and the determination of points in geodetic connection with the line are now in progress.

Along the eastern coast of Florida, the survey south of Matanzas Inlet, including the branches of Matanzas River, is well advanced toward Mosquito Inlet. Below Cape Canaveral, a shoal has been developed near Indian River Inlet. Soundings have been continued in the approaches to the Florida Reef and in the Gulf of Mexico; and the inshore hydrography has been completed at the eastern approach of Saint George's Sound, as, also, the survey of the Gulf coast between Saint Andrew's and Mobile entrance, including Choctawhatchee Bay. The hydrography has also developed the approaches from deep water to the Mississippi Delta, and the vicinity of Trinity Shoal off the coast of Louisiana. In the Mississippi River, the survey has advanced from Magnolia upward to Jesuit Bend, including determinations for latitude and azimuth. On the coast of Texas, the hydrography has been continued in San Antonio and the adjacent bays; and the longitude of Austin has been determined.

Sherman Station, in Wyoming Territory, and Verdi, on the Union Pacific Railroad in Nevada, have been occupied as points in the geodetic connection between the Atlantic and Pacific coasts; and collateral observations of much interest have been recorded.

On the western coast of the United States, the following sites have been, or will be, occupied in prosecuting the field and hydrographic operations now in progress, in accordance with the plan of work for the season. The parties are all in the field, and will, as heretofore, report their results at the end of October.

Progress has been made in the hydrographic reconnaissance between Panama and San Diego. The station near Cape San Lucas, at which the transit of Venus was observed in 1769, will be determined in latitude and longitude. At San Diego, the tides have been constantly recorded. The survey of the coast of California will be resumed at San Pedro Bay; that of the Santa Barbara Islands has been continued; and the crest-line of the mountains which range along the Santa Barbara Channel has been traced; reconnaissance has determined suitable points for the triangulation between Santa Barbara and Monterey; the survey of the coast is well advanced between Point Conception and Point Arguello; also south of San Luis Obispo toward Point Sal, and south of San Simeon; and the latitude and azimuth will be determined, if practicable, at both sites of work before the close of the season. In the operations of the year are included the survey of the South Farallon Island, and the outline of sand-drift on the San Francisco Peninsula; the contour of Table Mountain north of the Golden Gate; comparative soundings at San Francisco entrance; and the tides of the year at that port. Cordell's Bank will be developed by soundings in the course of the season; at Mendocino Bay, latitude and azimuth will be determined, and the survey in progress in that vicinity will be extended northward. Magnetic observations will be made generally at stations which may be occupied by the astronomical party. Soundings have been made to develop a bank off Cape Mendocino; the survey of the coast below Shelter Cove is in progress; latitude and azimuth will be determined there, and longitude at Eureka when the telegraph reaches that place. Soundings are in progress along the coast of California, between Shelter Cove and Rocky Point; the survey is extending south of the False Klamath River, California, and along the coast of Oregon north of Chetko River. At Astoria, the tides of the year have been recorded; and longitude will be determined when telegraphic facilities reach that port. The survey of both shores of the Columbia River has been continued, and that of Shoalwater Bay in Washington Territory. At False Dungeness, the astronomical station has been connected with the triangulation of the Strait of Fuca; and Smith's Island has been occupied for completing the main triangulation, which embraces the waters of Washington Sound. The plan for this season includes also determinations of latitude and azimuth at Steilacoom and Dwamish Bay; the selection of a site for a base-line on Whidbey Island; and triangulation for extending the survey in Puget Sound.

On the coast of Alaska, good progress has been made in the hydrographic reconnaissance. Observations of much importance have been made on the tides and currents, and a number of geographical points have been determined.

The office-operations in drawing and engraving have been kept up with the results in field-work and hydrography. Twenty new charts have been published, and nine others which show extensive additions in comparison with their first issue. Fifty charts, of which thirteen were commenced within the year, have been in hand in the Drawing Division. Of the engraved charts, 11,500 copies have been printed and distributed. Ninety of the manuscript-maps on file in the archives have been copied within the year, to meet calls for information. As these usually pertain to places near the more important ports, a few of the topographical sheets showing much variety in details have been reproduced by lithography. The process is cheap, and its extension is under advisement, as affording means of special usefulness in the inception of local improvements, in which success must depend on accurate information in regard to the surface-contour.

Tide-tables for the ensuing year have been prepared, and published as heretofore.

ESTIMATES IN DETAIL.

For general expenses of all the sections, namely: Rent, fuel, materials for drawing, engraving, and map-printing; and for transportation of instruments, maps, and charts; for miscellaneous office-expenses; and for the purchase of new instruments, books, maps, and charts, will require $25,000

SECTION I. *Coast of Maine, New Hampshire, Massachusetts, and Rhode Island.* FIELD-WORK.—To complete the triangulation of the vicinity of the northeastern boundary of the United States; to continue the topography of the western shore of Saint Croix River; to determine the heights of the principal trigonometrical points in the section; to complete the survey of Mount Desert Island and of the adjacent bays and harbors; to extend the plane-table work on Penobscot River above Castine, Me., and the hydrography of the bay eastward along the coast; to supply subsidiary points on the coast of Maine for the topographical and hydrographic parties; to continue the offshore hydrography of this section, and make special examination for the sailing-lines for charts; to continue the tidal observations; and to make such astronomical and magnetic observations as may be required. OFFICE-WORK.—To complete results from the field-observations; to commence the drawing of charts No. 1 and No. 2, showing the approaches to the coast of Maine between Passamaquoddy entrance and Petit Manan light-house; to continue drawing and engraving for charts No. 3, No. 4, and No. 6, which include Frenchman's Bay, Blue Hill Bay, the approaches of the Penobscot, and the coast between Kennebec entrance and Saco; also for local charts of the vicinity of Mount Desert Island, Eggemoggin Reach, Penobscot Bay west, Saco River entrance, and the vicinity of Monomoy Shoals, will require $80,000

SECTION II. *Coast of Connecticut, New York, New Jersey, Pennsylvania, and part of Delaware.* FIELD-WORK.—To determine points and complete the topography of the coast of Rhode Island near Watch Hill; to complete the survey of New Haven Harbor; for special observations bearing on the hydrography of New York Harbor; to continue observations on the tides and currents; to extend the plane-table survey of Hudson River above Haverstraw; to make the requisite astronomical observations; to measure a base of verification and complete the shore-line survey and soundings in Lake Champlain; to connect the triangulation of New Jersey with the coast series at Barnegat; and to complete the topography of the coast near Pleasant Bay. OFFICE-WORK.—To make the computations and reductions; to commence the drawing and engraving of a chart of New Haven Harbor; to continue the engraving of chart No. 21, showing the coast between Sandy Hook and Barnegat Inlet; and drawing and engraving for No. 22 and No. 23 between Barnegat and Cape May; and for the chart of Little Egg Harbor, will require 20,000

SECTION III. *Coast of part of Delaware, and that of Maryland and part of Virginia.* FIELD-WORK.—To connect the Atlantic-coast triangulation with that of Chesapeake Bay near the boundary-line between Maryland and Virginia; to extend the detailed survey of the James River, Virginia, above Jamestown Island, including the hydrography, and commence the plane-table survey of the Potomac River; to continue southward the main triangulation along the Blue Ridge parallel with the coast, including astronomical and magnetic observations; to complete the supplementary hydrography required in this section; and to continue the tidal observations. OFFICE-WORK.—To compute results from the records of field-observations; to continue the drawing and engraving of the chart of James River below City Point; and to make additions to the charts and sketches of the section, will require.................. 40,000

SECTION IV. *Coast of part of Virginia and part of North Carolina.* FIELD-WORK.—To complete the triangulation of Currituck Sound, North Carolina, and continue that of Pamplico Sound, and the topography of its western shores between the Roanoke Marshes and Pungo River; to measure a base of verification and determine azimuth for the coast-triangulation south of Cape Lookout; to make the astronomical and magnetic observations requisite; to continue the offshore hydrography of the section, and that of Pamplico Sound and its rivers. OFFICE-WORK.—To make computations from the field-data; to continue the drawing and engraving of charts No. 37, No. 39, No. 42, No. 43, No. 44, No. 45, No. 46, and No. 47, showing parts of the Atlantic coast between Cape Henry und Cape Lookout, and also of chart of Hatteras Inlet and Beaufort Harbor, North Carolina, will require............... 40,000

SECTION V. *Coast of South Carolina and Georgia.* FIELD-WORK.—To complete the triangulation and topography of the coast between Cape Fear and Winyah Bay; to extend the topographical survey southward of Winyah entrance; to determine azimuth for the triangulation of the coast of South Carolina; and to complete the detailed survey of the sea-islands and water-passages between Charleston and Savannah. OFFICE-WORK.—To make computations and reductions, and additions to the charts and sketches, will require........ $40, 000

SECTION VI. *Coast, Keys, and Reefs of Florida.* FIELD-WORK.—To extend southward, from Mosquito Inlet, the triangulation, topography, and hydrography of the sea-water channels adjacent to the eastern coast of the Florida Peninsula; to make astronomical observations and determine the azimuth north of Cape Canaveral; to continue the offshore hydrography of the Florida Peninsula, and observations on the Gulf Stream; and to complete soundings in the vicinity of the reefs and keys. OFFICE-WORK.—To reduce and compute from the field-records; to continue the drawing and engraving of chart No. 58, showing Cumberland Sound and Saint John's River, Florida; and to make additions to the chart of the section, will require...... 45, 000

SECTION VII. *Gulf coast of the Florida Peninsula north of Tampa, and coast of Western Florida.* FIELD-WORK.—To make the astronomical and magnetic observations requisite in this section; to continue the triangulation and topography of the western coast of the peninsula between Cedar Keys and Appalachee Bay; to run lines of soundings in the Gulf of Mexico and develop the hydrography of the Gulf coast included in the field-operations. OFFICE-WORK.—To compute from the astronomical and field records; to continue the drawing and engraving of charts No. 79, No. 82, No. 83, No. 86, and No. 87, showing parts of the Gulf coast between Chassahowitzka River and Pensacola entrance; and of the chart of Saint Andrew's Bay, will require 35, 000

SECTION VIII. *Coast of Alabama, Mississippi, and part of Louisiana.* FIELD-WORK.—To connect the survey of the Mississippi River at New Orleans with the triangulation of Lake Pontchartrain; to determine geographical positions, and make the astronomical and magnetic observations required in this section; to extend the triangulation and topography westward of the Mississippi Delta, and continue the hydrography of the Gulf of Mexico. OFFICE-WORK.—To make the computations required; to continue the drawing and engraving of charts No. 91, No. 92, No. 93, No. 94, and No. 95, showing Lake Borgne, Lake Pontchartrain, Isle au Breton Sound, and the Mississippi River between New Orleans and the Gulf of Mexico, will require...... 50, 000

SECTION IX. *Coast of part of Louisiana, and coast of Texas.* FIELD-WORK.—To extend the triangulation and topography of the coast of Texas eastward from Galveston Bay, and south of Corpus Christi; to measure a base of verification and make the astronomical and magnetic observations requisite in this section. OFFICE-WORK.—To compute results from observations recorded in the field; to continue the drawing and engraving for charts No. 108 and No. 109, showing Pass Cavallo, San Antonio Bay, Aransas Bay, and Copano Bay, will require........ 35, 000

Total for the Atlantic coast and Gulf of Mexico........ 410, 000

The estimate for the survey of the western coast of the United States is intended to provide for the following progress:

SECTION X. *Coast of California.* FIELD-WORK.—To make the requisite observations for latitude, longitude, azimuth, and the magnetic elements at stations along the Pacific coast of the United States; to continue the hydrographic reconnaissance between Panama and San Diego, and continue tidal observations at the last-named port; to extend the coast triangulation and topography between San Juan Capistrano and Anaheim Landing, and that of the Santa Barbara Islands; to continue the detailed survey of the coast from Gaviota Pass to Point Conception and Point Arguello; to extend the triangulation and topography between Point Sal and San Luis Obispo, and northward from Piedras Blancas; to continue reconnaissance for the main triangulation between Santa Barbara and Monterey; to continue the hydrography of the western part of Santa Barbara Channel, and make soundings between the islands; to develop the Falmouth Shoal and the hydrographic changes in San Francisco Bay and its approaches; to continue tidal observations at the Golden Gate; to make observations on the ocean-current along the coast of California, and complete the hydrographic survey of Cordell's Bank; to continue the triangulation, topography, and hydrography of the coast northward, the detailed survey south from Shelter Cove and Bear Harbor, and the hydrography of the Pacific coast between Humboldt Bay and Rocky Point; to extend the detailed survey from the last-named point to the Klamath River, and complete the hydrography of Crescent City Reef. OFFICE-WORK.—To make computations from the observations recorded in the field, and additions to the general and local charts of the section; also, for the operations in—

SECTION XI. *Coast of Oregon and of Washington Territory.* FIELD-WORK.—To continue the triangulation and topography of the coast of Oregon from Mack's Arch northward toward Cape San Sebastian and Port Orford; to determine the latitude, longitude, and azimuth at stations on the coast of this section; to complete the survey between Tillamook Head and Cape Adams; to continue the survey of the Columbia River and tidal observations at Astoria; to extend the triangulation and topography from Cape Disappointment northward to Shoalwater Bay, and the detailed survey from thence along the coast of Washington Territory to Gray's Bay; to measure a base-line and continue the triangulation of the Strait of Fuca, Puget Sound, and Washington Sound, and to develop the hydrography of harbors in Puget Sound. OFFICE-WORK.—To make the requisite computations, and to draw and engrave the results of field-work as additions to the charts and sketches of the section; also, for the operations in—

SECTION XII. *Coast of Alaska.* FIELD-WORK.—To make the requisite astronomical and magnetic observations, and to continue hydrographic researches in the vicinity of the Aleutian Islands, the Choumagins, and near the Kodiak group, with observations on the tides and currents. OFFICE-WORK.—To compute results from the recorded observations, and to draw and engrave the shore-line and soundings derived from the reconnaissance, will require $260,000

For extending the triangulation of the Coast Survey, to form a geodetic connection between the Atlantic and Pacific coasts of the United States, and assisting in the State surveys 50,000

For repairs and maintenance of the complement of vessels used in the Coast Survey 50,000

For continuing the publication of observations made in the progress of the Coast Survey 10,000

The annexed table shows, in parallel columns, the appropriations made for the fiscal year 1872-'73, and the estimates herein submitted for the fiscal year 1873-'74.

Objects.	Estimated for fiscal year 1873–'74.	Appropriated for fiscal year 1872–'73.
For continuing the survey of the Atlantic and Gulf coasts of the United States, including compensation of civilians engaged in the work, and pay and rations of engineers for the steamers used in the coast-survey, per acts of March 3, 1843, and June 12, 1858....	$410, 000	$401, 000
For continuing the survey of the western coast of the United States, including compensation of civilians, and pay and rations of engineers for the steamers used in the work, per act of September 30, 1850	260, 000	240, 000
For extending the triangulation of the coast-survey to form a geodetic connection between the Atlantic and the Pacific coasts of the United States, and assisting in the State surveys, including compensation of civilians engaged in the work, per act of March 3, 1871	50, 000	36, 000
For repairs and maintenance of the complement of vessels used in the coast-survey, per act of August 18, 1856	50, 000	45, 000
For continuing the publication of observations made in the progress of the coast-survey, including compensation of civilians engaged in the work, the publication to be made at the Government Printing-Office, per act of March 3, 1869	10, 000	10, 000
Total	780, 000	732, 000

PART II.

In this part of the report will be found, in geographical order, notices of the work done in the course of the season by each of the surveying-parties. A general view of their distribution on the Atlantic, Gulf, and Pacific coasts is given in Appendix No. 1.

In addition to tours of inspection, which I made personally, several of the parties engaged in secondary triangulation have been visited in the field by Assistant Richard D. Cutts, to whom I am indebted for his continued care of the details pertaining to that branch of the work. Special duty, in which Mr. Cutts was engaged during the summer at Sherman station, in the interior, will be mentioned in the body of the report.

Assistant H. L. Whiting, in charge of details relating to the topography, visited most of the parties, and in the course of the year inspected the mode of work in the field. His reports give increased confidence in regard to the accuracy of returns made on the topographical sheets.

The hydrographic inspector, Capt. C. P. Patterson, in addition to the oversight of matters pertaining to the issue of charts, among which are sailing-directions and other notes requisite for navigation, has met the difficult duty of maintaining the means of transportation for field-work that cannot be conducted without vessels. The provision made by Congress at the present session will relieve much of the embarrassment which has attended the use of vessels worn out, but yet of necessity retained in the service until they can be replaced by safe means of transit from place to place along the coast.

The progress made in the survey of the western coast will be stated under Sections X, XI, and XII, after which will be given a general summary of the work done during the past year in the Coast Survey Office.

SECTION I.

ATLANTIC COAST OF MAINE, NEW HAMPSHIRE, MASSACHUSETTS, AND RHODE ISLAND, INCLUDING SEA-PORTS, BAYS, AND RIVERS, (SKETCHES NOS. 2 AND 3.)

Topography and hydrography of Placentia Bay, (Mount Desert Island,) Maine.—The survey of Mount Desert Island was resumed by Assistant J. W. Donn after midsummer, with a party working as heretofore with the schooner Scoresby. The topography of the season covers the southwestern part of the island from Bass Harbor to Pretty Marsh, and includes the entire area between the western margin of the previous season and Placentia Bay, which is bounded by outlying islands. Many interesting details are shown on the plane-table sheets, among them the Western and Beech Mountains, Seal Cove Pond, and Great Pond. Soundings made in the last show that the bottom of that lake is 51 feet below the level of the sea.

The hydrographic work of the party developed by the 25th of October the waters of Placentia Bay, and is in continuation of the survey of last year, the limit then being between Bass Head and Gott's Island. The greatest depth found in soundings is 56 fathoms in Placentia Bay.

Assistant Donn was aided by Messrs. S. N. Ogden and F. C. Donn. The statistics of work are:

Shore-line surveyed, (miles)	29½
Roads, (miles)	44½
Water-courses and lake-shores, (miles)	52
Area of topography, (square miles)	36
Miles run in sounding	325
Angles measured	2,392
Number of soundings	9,916

Since his return from the coast of Maine, Assistant Donn has resumed work in Section III, where he was engaged in the beginning of the present year.

Topography of Eggemoggin Reach and Isle au Haut, Maine.—Early in July, a party was organized to work in this vicinity under the direction of Assistant Charles Hosmer, who had been previously engaged in Section V. On the west side, the plane-table survey was joined at Orcutt's Harbor with the detailed work of another party, and from that limit was extended along the north shore of Eggemoggin Reach as far eastward as Sedgwick, at the head of Benjamin River. Mr. Hosmer mapped also Little Deer Island, and farther eastward traced the north shore-line of Deer Isle to Gray's Cove.

Under the general direction of Assistant Hosmer, Subassistant J. N. McClintock traced the shore-line of Isle au Haut and of the adjacent smaller islands, joining at the north with the plane-table sheet of Assistant Dennis. Part of the north end of Isle au Haut was mapped in detail, and also the island adjacent to it. Field-work was continued until the 25th of October. The report of Mr. Hosmer mentions that the season has been unusually unfavorable for topographical work; the operations during August and September being interrupted very frequently by rain or fog. He was aided in the field by Mr. R. B. Palfrey, and for transportation had the use of the schooner G. M. Bache. The statistics of work are:

Shore-line traced, (miles)	100
Roads, (miles)	22
Area of topography (square miles)	20½

Assistant Hosmer has resumed service in Section V. Subassistant McClintock, who was previously employed in duty which will be noticed under the head of Section VII, is now engaged in Section VI.

Topography of Deer Isle and vicinity.—Field-work was commenced on Deer Isle on the 15th of July by the plane-table party of Assistant W. H. Dennis, and was continued until the 1st of November.

"The shore-line, being very irregular and rocky, required much time. The low-water line, moreover, being a marked feature, was requisite, and could be surveyed only at low tide. One hundred and fifty detached ledges were developed at that stage of water, and are shown on the topographical sheet."

The southern half of Deer Isle was included in this survey by Mr. Dennis, with the indentations known as Crockett's Cove, Burnt Cove, Webb's Cove, Deer Isle Thoroughfare, and all the outlying islands of the neighborhood. The surface in general is rough and rocky, with but little artificial detail.

Mr. A. P. Barnard aided in the field-work, and during part of the season mapped the details of some of the islands with a separate plane-table. The statistics are:

Shore-line surveyed, (miles)	64
Roads, (miles)	55
Area of topography, (square miles)	26

Assistant Dennis had been previously engaged in Section V, and has now resumed field service in the same section.

Triangulation near Cape Rosier and Castine, Maine.—In order to provide for the plane-table survey of the vicinity of Castine, and of the shores of Baggaduce River and Eggemoggin Reach, Mr. W. H. Stearns was detailed in July to interpolate points between stations which had been occupied in the secondary triangulation of the coast of Maine.

The Baggaduce River, which takes in what is known as Castine Harbor, is of irregular width, being wide and deep at its mouth. From there, after expanding eastward into a bay two miles across, the river stretches to the northward into branches known as North Bay and South Bay. The water is of good depth through South Bay, though in some places the channel is narrow and the current very rapid.

Mr. Stearns closed field-work in this section on the 21st of September, and then engaged in duty near Atlanta, Ga. The statistics of his work near Castine are:

Signals erected	20
Stations occupied	9
Angles measured	112
Number of observations	1,536

Twenty-two points were determined for plane-table purposes, within an area of seventy square miles.

Under Section VI notice will be taken of field-service in which Mr. Stearns was engaged during the winter and spring.

Topography of Cape Rosier, Maine.—The party of Assistant A. W. Longfellow left Portland on the 19th of July in the schooner Meredith, and as soon as practicable commenced plane-table work on Cape Rosier. Owing to the prevalence of fogs and frequent heavy rains, the progress of parties on the coast of this section was much impeded. Every favorable opportunity was improved by Mr Longfellow until the 26th of November, when operations were closed for the season.

The topographical sheet includes the peninsula and harbor of Castine, with that part of Brookville which extends south from Castine Harbor to Eggemoggin Reach, called the Cape Rosier district, a rocky region, with wooded hills and intervening swamps. Within these limits the shore-lines were traced, including Holbrook's Island and Nautilus Island, and the shores of Lawrence Bay, to the eastward of which some of the details were filled in, as also along the western side of Cape Rosier. The general statistics are:

Shore-line surveyed, (miles)	72
Roads, (miles)	7
Area of topography, (square miles)	14

All the ledges within the plane-table limits were determined and marked in position on the sheet.

Subassistant H. M. De Wees was attached to this plane-table party.

At the close of the season, the schooner Meredith, which had been used for transportation, was laid up in Portland Harbor.

Coast pilot.—The review of hydrography and of other features needful in the compilation of general sailing-directions for the coast of New England was resumed by Assistant J. S. Bradford on the 21st of July with a party in the schooner Joseph Henry. Mr. W. B. McMurtrie accompanied the party, and made drawings of such views of the approaches to Casco Bay and Damariscotta River as were deemed requisite for the charts of those waters.

Assistant Bradford developed and marked on the chart a rocky shoal in the Damariscotta below Hodgden's Mills, and otherwise revised the chart of the channel. He then sailed for Eastport, and, though much hindered by fogs, made a thorough general examination, with reference to sailing-directions, of Passamaquoddy Bay, the Saint Croix River entrance, Cobscook River, and of the harbor of Eastport. After eleven days' detention at that port by continuous fog in August, the revenue-cutter Mosswood arrived, and by the courtesy of Captain Hodgden the schooner in charge of Assistant Bradford was towed out to sea. In the report made at the end of the season it is noted as evidence of the exceptional weather of last summer, that the light-keeper at Petit Manan Island kept the fog-trumpet in blast during twenty-four consecutive days of the month of August. Mr. Bradford, nevertheless, succeeded in observations that suffice for describing, with the exception of a few small harbors, the coast of Maine as far westward as Penobscot entrance. As yet, but few charts exist of this region, the detailed hydrography being now in progress, but well advanced from the westward toward Mount Desert. Forty-one places in all were included in the detailed descriptions turned in by Mr. Bradford, the last being Belfast Harbor in Penobscot Bay. Many of the harbors in the list are important as places of refuge in heavy weather; and it is desirable that their character and accessibility should be known even in advance of their development by soundings. In reference to their number, Assistant Bradford remarks, "The coast of Maine between Eastport and Penobscot Bay is so indented by harbors and rivers that it would be almost impossible for a mariner with a good coast-pilot in hand to fail in making secure anchorage, if the approaches to the many places of refuge were properly buoyed."

The views of Assistant Bradford in regard to sea-marks proper for this part of the coast were presented in a separate report, and are now on file in the office of the hydrographic inspector.

At the end of October, the party in the schooner Joseph Henry proceeded to Portland, where the vessel was laid up.

Assistant Bradford is now engaged in examining the harbors of Chesapeake Bay, with a view to the preparation of final sailing-directions. He was aided during part of the season, on the coast of Maine, by Mr. R. R. Steedman.

Hydrography of Belfast Bay, Maine.—This work was taken up in the middle of July by a party in charge of Assistant Horace Anderson, working with the schooner Silliman and the small steam-launch Sagadahoc. The two hydrographic sheets include Belfast Bay and the waters of the Penobscot to the eastward as far as the peninsula in the vicinity of Castine. Searsport and Stockton Harbors are within the limits of work, and both were sounded out, and dangerous ledges in the neighborhood of Belfast were marked by stone monuments, so as to make the water-approach to that town safe and easy.

All the soundings were referred to the low-water level by means of tidal observations at Simpson's wharf in Belfast, and a permanent bench-mark was established.

Assistant Anderson was aided in the hydrography by Messrs. F. H. North, E. H. King, and W. S. Bond. Operations in the Penobscot were closed for the season on the 27th of October, when arrangements were made for resuming duty in Section VII.

The following are statistics of the work done near Belfast:

Miles run in sounding	756
Angles measured	5,552
Number of soundings	32,828

The previous service of this party will be mentioned under the head of Section VII.

Topography of Searsport Harbor and Stockton, Penobscot River, Maine.—In continuation of his work of last season, Assistant C. T. Iardella resumed work with the plane-table on the 13th of July, above Belfast, Me., and extended the survey northward to include Stockton and all intervening details on the west side of the Penobscot. Among these are Long Cove and the adjacent peninsula, known as Sears' Island, Searsport Harbor, and the details of the shore to a breadth conformable with the work previously done in the vicinity of Belfast. Nine signals were erected and determined in position as points for the topographical survey. Within the limits of field-work, contour-lines were carefully traced to represent surface-features, the most prominent of which is Randall's Hill, 560 feet high, in the neighborhood of Stockton.

Assistant Iardella remained in the field until the middle of November, and then returned to Section IV, where he had been engaged in the early part of the year. He was aided in both sections by Mr. W. C. Hodgkins. The statistics of the work of his party on the Penobscot are:

Shore-line surveyed, (miles)	17
Roads, (miles)	49
Streams, (miles)	37
Area of topography, (square miles)	17

Topography near Belfast, Me.—The detailed survey of the western shore of Penobscot Bay, below Belfast, has been completed by Assistant F. W. Dorr. Resuming, in the middle of July, at Knight's Pond, near Northport, the topography was extended northward to a junction with work previously done in the environs of Belfast. In this course were included, among other details, Saturday Cove, Brown's Corner, Little River, and other streams, and the intervening roads.

"The continual rains, for which the past summer and fall will be memorable, retarded field-work, but the allotted area was mapped in a period but little exceeding that which had been estimated as requisite."

"Commencing at Knight's Point, the upper headland of Duck Trap Harbor, the shore-line was traced as far as a small battery, which had been erected about a mile below Belfast for the protection of the town during the late war. There a junction was made with the previous work of Assistant Iardella. Much of the shore-line is abrupt bluff, but varied by gradual slopes about the small coves that indent the bay. At the southwestern extremity of the sheet, the rough and rocky peaks of the Camden and Lincolnville Mountains give place to a series of irregular, detached hills, and lose their character as a coast-range until we reach Little River, where a gently-sloping country opens, and follows the shore of Penobscot Bay for several miles."

Mr. W. E. McClintock aided in the topographical work, the statistics of which are thus reported:

Shore-line traced, (miles)	10¼
Rivers and creeks, (miles)	47
Roads, (miles)	60
Area of topography, (square miles)	18

Assistant Dorr closed plane-table work on the 10th of October, and then made a reconnaissance of the Penobscot River to the head of navigation, with a view of estimating the amount of topography remaining to be done. The detailed report has been received, and will be valuable as a basis for projecting sheets to receive the details which yet remain to be surveyed. Mention will be made under the head of Section IV of work done by the party of Assistant Dorr in the early part of the year; and under Section II notice will be taken of a survey made at the close of the present season.

Triangulation near Augusta, Me.—For properly connecting the survey of the Kennebec River with the primary triangulation of the coast of Maine, it was found necessary to occupy two secondary stations in the vicinity of Augusta. Assistant G. A. Fairfield took up this duty on the 18th of July. Signals were set up at six stations; of these, the structure at Burnt Hill, near the town, was made 60 feet high, in order to bring into view the signal at Sebattis. After occupying the last-named station, Mr. Fairfield occupied "Blin," and completed the requisite angular measurements on the 14th of October. The longest of the three lines included in the triangle is twenty-eight miles in length. Eight angles in all were determined by 1,548 observations with the theodolite.

While the work was in progress at Blin, one of the party made a record of the tides, through a half-lunation, at Bowdoinham.

The height of the primary station Sebattis was determined by the aid in the party, Mr. Walter B. Fairfied. A line of levels was run over the most direct road between the mountain and tide-water at Bowdoinham on the Cathance River, at a point about two miles from its mouth in Merrymeeting Bay. The road being hilly, many stations were requisite in leveling. The aggregate of the lines was forty miles. Assistant Fairfield found for the height of the primary station 799.71 feet, to which is to be applied a correction for ordinary instrumental errors.

The previous service of the party of Assistant Fairfield will be stated under the head of Section IV.

Assistant H. L. Whiting inspected the plane-table work of most of the parties engaged in northern sections, and found the organization and the progress and method in details entirely satisfactory.

Geodetic connection.—The triangulation across New Hampshire, which was commenced last year, has been continued during the present season by Prof. E. T. Quimby. As before stated, the main object of this work is to connect the survey of Lake Champlain with that of the coast, and incidentally to supply points as sanctioned by Congress for the geological and topographical operations that may be undertaken in future by the State. The last-mentioned part of the service has been greatly simplified by the wise and liberal action of the State legislature. Mention was made in my last annual report of a plan proposed for inducing the several towns in New Hampshire to erect, at their own expense, the tertiary signals requisite for the local survey. Recently, that plan has been much enlarged. Through the representations of Professor Quimby, showing the value of numerous well-established geographical positions for the future construction of a map of the State, the legislature passed an act, which was approved by the governor July 3, 1872, authorizing the assistant in charge of triangulation on the part of the Coast Survey "to set such signals as may be necessary, at an expense not to exceed $20, in any town or city of the State, and to draw upon the State treasurer for the sums so expended."

This prompt acceptance of the policy of Congress, on foresight of the benefit which must follow as well to each State of the Union as to the public service and its economical administration, will serve as an example to induce other States to co-operate with the General Government in a work of such vast importance as laying in time the sure foundation for an accurate map of our country.

Professor Quimby resumed field-work on the 1st of May, and devoted some weeks to reconnaissance and to the erection of signals for the extension of quadrilaterals in the direction of Lake Champlain, and of others to include important points in the State.

The measurement of angles was commenced on the 1st of June at Monadnock, one of the primary stations which was occupied in the survey of the coast. Work was continued at all favorable intervals. In regard to progress at that time, Professor Quimby reports, "The month of June was very unfavorable, with scarcely more than a day in a week of good observing-weather. In July and August, the weather was more favorable; but still the rainy days were about equal in number to the fair ones."

Field-work was continued until the 1st of September. The following statistics result from operations conducted while occupying as stations Monadnock, Unkonoomuc, Rattlesnake, Stewart's Peak, and Mount Kearsarge. Angular measurements were made with a ten-inch and with a twenty-four-inch theodolite.

Angles observed	32
Vertical angles measured	77
Directions noted by theodolite	123
Number of observations	4,150

Forty-one stations were determined in position. The expense of erecting twenty-one tertiary signals was paid by the State of New Hampshire.

Hydrography of George's Bank.—Commander John A. Howell, U. S. N., Assistant Coast Survey, after the completion of hydrographic service, which will be mentioned under the head of Section VI, and of repairs requisite on the steamer A. D. Bache, took up soundings in this section in August. The following are extracts from his report at the end of the season:

"On the 22d of August, we anchored in 8 fathoms on George's Shoal, off the coast of Massachusetts, intending to observe the currents, a thick fog preventing other operations."

"The hand-log (a large grating) was thrown every half-hour, the ship's head being at each time noted. In twelve hours and a half, the vessel had swung once about her anchor. During this time, there was no slack water, the velocity of the tide being not less than one knot. The motion of the ship's head was uniform, passing from east through south to west, north, and east again. At intervals, unequal tide-rips moved up against the current, and these passing slowly from aft forward temporarily augmented the velocity of the current sometimes to 2¼ knots, and as a consequence the vessel would shear about. The rips passed ahead, disappeared gradually, and the current again diminished. Several tide-rips were frequently in sight at the same time, the appearance being like that of a gentle swell breaking in very shallow water. The surface of the sea was white and broken, and the noise, like that of breakers, was audible at a great distance."

"On the 29th of August, lines of soundings were run to develop the Cultivator Shoal, the position of which, as determined by observation, is latitude 41° 38′ north, longitude 68° 11′ 30″ west. The least water found on the shoal was 3½ fathoms."

"On the 12th of September, soundings were taken up off Cape Sable, and continued on a line toward the assigned position of Hope Bank. At one hundred miles from the cape, the depth was 1,000 fathoms; but farther on and at the assigned position no bottom was found with 1,800 fathoms of line. The position having been determined by good observations, it would hardly seem possible that any bank could be in the immediate vicinity. We ran to the westward, sounding at intervals, but found no bottom till nearing George's Bank."

At the request of Prof. Spencer F. Baird, the commissioner authorized by Congress to institute investigations in regard to the habits of fish that frequent the coast of the Atlantic States, quarters for two special observers, Messrs. Smith and Hager, were provided on the steamer by Commander Howell. Dredgings made in the vicinity of Halifax, Nova Scotia, to which point the vessel was driven by stress of weather, and others about Cultivator Shoal and George's Bank, were conducted by the special observers.

The steamer Bache is yet engaged in soundings off the coast of New England, but will soon return to service near the Florida Reef. Commander Howell is assisted in hydrographic operations by Lieuts. W. H. Jacques, E. S. Jacob, Richard Rush, and W. L. Field, United States Navy.

Hydrographic changes at Monomoy Shoals and Nantucket, Mass.—The causes which have resulted in changes of depth at the turning point of the coast of New England having been noted for observation, Henry Mitchell, esq., Assistant, has, under my direction, collected data bearing upon the question. In order to facilitate his researches, Subassistant F. D. Granger was instructed to follow, in revising the soundings, such methods as might be suggested by Mr. Mitchell. Mr. Granger, with a party, in the steamer Endeavor, commenced on the 14th of August, and continued work until the 25th of October.

"The soundings taken represent the following shoals and channels: Broken part Pollock Rip; Pollock Rip; Bearse's Shoal; part of Stone Horse Shoal; the channel between Broken part and Pollock Rip; and the main ship-channel from the Handkerchief light-vessel out, passing Shovelful Shoal and the Pollock Rip light-vessels."

"Because of the uneven bottom, the dangerous character of the shoals, and the importance of this survey, the work was prosecuted only when the sea was smooth and the atmosphere free of haze, so as to insure the soundings and angles."

"Comparison of the soundings with previous surveys shows great changes in depth and in the contour of the shoals. The Broken part Pollock Rip is now in three parts, separated by deep channels. The eastern part has on it at one place 13 feet of water; the part near by has only 11 feet; and 16 feet depth is found on the third part, which is a narrow spit nearly half a mile in length. This spit extends east and west, and is detached from the second by a channel over a mile wide, in which channel the depth is 20 feet."

"The passage between the second and third parts has been used by coasters commonly, and frequently by steamers within the past year. The course through from the Pollock Rip light-vessel is NE. by N. ¼ N. by compass. Steering ENE. from Red Buoy No. 4, on the southeast end of Pollock Rip, will carry through vessels drawing 22 feet."

"The northern part of Pollock Rip has advanced westward, connecting with Bearse's Shoal within the three-fathom curve. Formerly the intervening channel had 21 feet, but it has shoaled to 15, and several spots with only 10 and 12 feet were found in the survey of this season. It is believed that within a century Pollock Rip was a dry sand-reef. On Bearse's Shoal, the least water at this time is 5½ feet."

All the shoals and channels in the vicinity of Monomoy Point are described in detail in the report of Subassistant Granger.

For reference in sounding, the tides were observed at Powder-Hole wharf, and also at northwest point Powder-Hole. The tide-gauge at the latter place, though fixed where the depth at low tide was 3 feet, served only a short period, as, by the frequent and rapid shifting of the sands, the gauge was soon left bare at low water. "A box-gauge, with copper float, was then secured to a piece of scantling, which was driven well into the sand off the west beach, about half a mile south-southwest from the northwest point of Powder Hole, and a temporary wharf was built out to it. But in westerly winds at high water, (spring-tides,) the sea broke over the beach, rendering it impossible to record the observations. Night and day tides were, however, recorded at Powder Hole wharf; and, from observations there during one lunar month, the mean low-water level was deduced."

Subassistant Granger made also a resurvey of Nantucket Upper Harbor from Coatue Point to the head of the bay. A tide-staff was observed at Commercial wharf, Nantucket, for referring the soundings. Messrs. D. B. Wainwright and D. C. Hanson efficiently aided in the hydrographic operations.

After the 18th of September, a member of the party remained on board of the Handkerchief light-vessel to record positions while soundings were in progress, that vessel being used occasionally as one of the points for determining the position of the soundings. The aggregate statistics of the work are:

Miles run in sounding	448½
Angles measured	3,711
Number of soundings	15,328

The soundings develop a water-area of fifty-five square miles.

The party of Subassistant Granger had been previously in service in Section VIII, and will be there engaged during the approaching winter and spring.

In the autumn of 1871, my attention was called to the opening of a new inlet through the Nantucket Beach, and the ravages of the sea upon the mainland at Chatham. I visited the locality, and made arrangements for recording the progress of the changes from time to time. Mr. Mitchell, to whom the work was assigned, as making part of the physical history of the coast, has since made his first report on the subject. This, given in Appendix No. 18, traces the history with tolerable continuity back to the voyage of Poitrincourt, one of Champlain's officers, who made a map of Chatham and its neighborhood in the year 1606.

Tidal observations.—At North Haven, on one of the Fox Islands in Penobscot Bay, the self registering tide-gauge in charge of Mr. J. C. Spaulding has recorded the tides of the year. The decided regularity of the curves traced by the apparatus shows that the station was well chosen. Owing to the accumulation of ice around the pier at North Haven, the continuity of the series was several times endangered; but, notwithstanding several short stoppages, the care and patience of the observer secured the record of all the high and low waters.

In place of the old one, a new gauge has been substituted at this station, the construction of which includes the latest device for meeting the difficulties that arise from the formation of ice around the moving parts of the self-registering apparatus.

A full series of meteorological observations was recorded at North Haven.

At the Charlestown navy-yard, (Boston,) Mr. H. Howland has continued the series of tidal and meteorological observations. During the severe cold of last winter, the old self-registering gauge, hitherto relied on for maintaining the series, frequently stopped. At such times, the record was continued with the glycerine-gauge, at the same station; but this, being less sensitive under the rise and fall of the water, gives a result only approximately correct. To guard against the great liability to stoppages and consequent breaks in the record at Charlestown, heating-apparatus has been attached to the old gauge, similar to the device found necessary for maintaining the regularity of the tidal series in Penobscot Bay.

Early in May, a tide gauge, of the improved plan of construction, was lent to the city of Providence, R. I. This will be used by the engineer of the city water-works for a year or more in determining the proper level for the termini of the sewer-pipes, and for other municipal purposes. As a remuneration for its use, the city will return to the Coast Survey Office, with the apparatus, the record of tidal observations made at Providence.

As usual, in prosecuting hydrography, several short series of tidal observations have been made by parties in this section in the course of the year. These, apart from their utility in the adjustment of soundings, yield valuable results by comparison with the records made at the permanent stations.

Longitude of Cambridge, Mass., and of Washington, D. C.—Under favorable circumstances, notwithstanding untoward incidents which attended the prosecution of the plan of operations, the difference in longitude between Greenwich, England, and the observatories at Cambridge and Washington, in the United States, has been well determined within the season.

The general plan of operations was prepared by Assistant J. E. Hilgard, who conducted the observations requisite in Europe. Those made at the western end of the French Atlantic cable were directed by Assistant George W. Dean.

Professor Joseph Winlock, director of the Cambridge observatory, co-operated with the Coast Survey observers; and, under the direction of Rear-Admiral Sands Superintendent, Professor William Harkness, of the United States Naval Observatory at Washington, interchanged signals for longitude with the observers at Cambridge.

At the outset, the general plan was to place Coast Survey observers at two astronomical stations, one at Duxbury, Mass., and the other at Saint Pierre, Miquelon, where the French telegraph-cable first touches American ground.

Assistant Edward Goodfellow reached Saint Pierre on the 22d of May, and was received with marked kindness by the French government officials, who unremittingly afforded every facility possible for the work requisite at the western end of the telegraphic line. Unfortunately, the link which passes from Saint Pierre to Duxbury was broken on the 29th of May, and in consequence a change became necessary in the plan, arrangements having been made previously for recording upon chronographs at Cambridge and Washington the longitude-signals which passed from the east through the station at Duxbury. At the request of Assistant Dean, the use of land-wires to communicate with Miquelon was conceded, free of charge, by General Thomas T. Eckert, superintendent of the Western Union lines, and by H. H. Ward, esq., superintendent of the New York, Newfoundland and London Telegraph. The same officers, as in previous instances, co-operated in our work by the detail of operators at the several stations.

As the Western Union Company use the "*closed telegraph-circuit*," while the London Company operators use only the "*open circuit*," the local managers, at the instance of Mr. Dean, made the arrangements requisite for success in the desired interchange of signals through the telegraphic wires. Some delay occurred in consequence of a defect in the main French cable near Brest; but several series of signals for longitude-difference were successfully exchanged between Subassistant F. Blake, jr., at Brest, on the coast of France, and Mr. Goodfellow, at Saint Pierre, on the night of the 9th of July, and on each subsequent night favorable for observing stars, making seven nights in all, preceding the 24th of July. In recording longitude-signals, "personal and instrumental retardations" were carefully noted by Assistant Goodfellow and Subassistant Blake. The length of the telegraphic cable between Brest and Saint Pierre is about 2,590 geographical or 2,980 statute miles. For difference of longitude between the extremities of the main cable, the result found from the observations is, in time, $3^h\ 26^m\ 45^s.2$ right ascension.

On the 21st of July, clock-signals were successfully exchanged by telegraph between Saint Pierre, Cambridge, and Washington, and by the 9th of August the observers at the three stations had satisfactorily interchanged signals on eight nights. The aggregate length of telegraph line used in these operations is about 1,575 miles, of which 220 miles are under water in passing from Saint Pierre to North Sidney, on Cape Breton Island. In the exchanges between Cambridge and Saint Pierre, two "*telegraph-repeaters*" were in the circuit, one at North Sidney and one at Saint John, New Brunswick. An additional repeater was used at Boston in exchanging between Miquelon and Washington. For difference of longitude between Saint Pierre and Cambridge, the result found is, in time, $59^m\ 48^s.8$ right ascension.

At Saint Pierre, Mr. Goodfellow recorded 510 transits of 97 zenith and circumpolar stars with the 45-inch transit-instrument. The magnetic elements were at intervals determined there by his aid, Mr. A. H. Scott. While these observations were in progress auroras were frequent, and decidedly influenced the suspended magnets.

Assistant Goodfellow specially acknowledges obligations for the facilities afforded to him by John Gott, esq., superintendent of the French cable station at Saint Pierre, and by his assistant, Mr. George G. Ward; also, for the kindness of A. M. Mackay, esq., superintendent of the Newfoundland Telegraph, and for the assistance rendered by the operators at Saint Pierre and at points in the British provinces. By the courtesy of Admiral Surville, of the French Navy, commander of the fleet of the Antilles, Mr. Goodfellow and his aid, with the instruments and equipments used in the observations, were taken from Saint Pierre in the flag-ship, and were landed at New York. The astronomical station at Saint Pierre was carefully marked by a cut-granite post, in the top of which was inserted a copper bolt. By geodetic measurements, the station was also referred to Galentry Head light-house.

In order to provide facilities for determining the personal equations of all the observers engaged in this work, and for ascertaining whether the collimation of the instruments was in any way affected by flexure of their transit-axes, Assistant Dean erected, by permission of the Director, a temporary station in the grounds of the Harvard College observatory. Its exact position is 39 feet north, or in latitude equal to 0″.39, and 73.5 feet, or equal to 0″.98, or 0s.07, longitude, west of the great meridian-circle of the observatory. At the temporary station, a 46-inch transit-instrument was firmly adjusted on granite piers, and 504 observations on the transits of 97 zenith and circumpolar stars were recorded by the observer, Mr. Edwin Smith, of the Coast Survey, under the direction of Professor Winlock. When signals for longitude were exchanged, the clock-corrections were also carefully determined by the assistant observer in Cambridge observatory, Prof. W. A. Rogers.

For determining the personal equation of the several observers, the transit-instruments which had been used at Brest and Saint Pierre were brought to Cambridge, and carefully adjusted on brick piers in a line north and south with the transit used in the temporary observatory. The three instruments were alike in size and construction. Early in September, Professor Harkness, of the United States Naval Observatory, joined Messrs. Goodfellow and Rogers. Observations were conducted through several nights; each astronomer determining the correction of the same clock by observing the same stars, and also by noting the transit of the same star upon alternate tallies or groups of five lines. The meridian-circle of the Cambridge observatory and alternately one ot the three 46-inch transit-instruments of the Coast Survey were used in these observations. About 90 transits were noted by each of the observers for personal equation. Subsequently, Assistant Goodfellow, Subassistant Blake, and Mr. Smith each made independent determinations of the clock-correction with the three similar transit-instruments, using the same stars, and recording upon the same chronograph by the same clock. The results found for their personal equations were very satisfactory. As a further check, Messrs. Blake and Smith observed the transits of 82 stars on four nights by noting times upon the alternate tallies. The absolute personal equation of each observer was also well determined by noting with apparatus devised by Professor Rogers the transits of an artificial star.

All the records of observations for longitude have been duplicated, and are now in the archives of the Coast Survey Office.

SECTION II.

ATLANTIC COAST AND SEA-PORTS OF CONNECTICUT, NEW YORK, NEW JERSEY, PENNSYLVANIA, AND DELAWARE, INCLUDING BAYS AND RIVERS, (SKETCHES NOS. 4 AND 5.)

Topography west of Point Judith.—Assistant A. M. Harrison resumed work with the plane-table at a point about four miles westward of Point Judith on the 20th of August. The survey was continued until the 19th of October, at which time the following summary was given of the results:

"The plane-table sheet has for its eastern limit the old post-road which runs from Sugar Loaf Hill near Wakefield to the northern end of the Weeden road. From thence the survey was extended south about six miles along the limit of the previous sheet, and westward nearly half a mile beyond Cross's Mills, or Charlestown. Inland the details were mapped to include the post-road and other features within two and a half miles of the coast."

"The character of the country is somewhat similar to that noticed last year. Large shallow lagoons occur, separated from the ocean by narrow strips of low sand-ridges. Back of these the surface undulates with a gradual upward slope, broken by a few hills. There are few streams, and the large ponds which connect with the sea by sandy and shifting outlets are not navigable."

"Care was taken to represent the numerous inclosed depressions, which are marked features upon the slopes and hills."

Mr. Bion Bradbury served in the topographical party as aid during the season. The following is a summary of statistics:

Shore-line traced, (miles)	31½
Marsh-line, (miles)	30½
Roads, (miles)	54
Area of topography, (square miles)	13½

The party of Assistant Harrison was previously engaged in Section VI, and is now about to resume operations in that section.

Station-marks.—In the course of the season, Assistant John Farley visited some of the primary stations in this section, and made careful examination at each with reference to the preservation of the marks which had been placed for the identification of the points. His report gives in detail the present condition of the stations at McSparran, Spencer, Brown, or Indian Hill, Beacon Hill, in Rhode Island, and Prospect Hill, on Fisher's Island, Connecticut. The report now in the archives is accompanied by drawings and views of the vicinity of each of the points, and by others showing the vertical contour of each of the stations. The ranges and other particulars furnished by Assistant Farley are of special value for reference in any case that may call for local surveys near the station-points.

Survey of New Haven Harbor, Connecticut.—Field-work was resumed by Assistant R. M. Bache at New Haven on the 8th of May, and was continued until the 26th of October.

"The low-water line, owing to the sloping character of the shores, presenting extensive and sometimes intricate flats, had to be determined by a special operation. The survey at first looked no further than to the determination of the high and low water lines of the harbor, and the making of soundings therein; but, to make the shores recognizable with relation to the hydrography, a fringe of topography was found necessary, varying in width from 200 to 600 meters."

Soundings were made within the shore-lines determined this season, and also beyond the mouth of the harbor into Long Island Sound; the lines in that direction extending to an even depth.

"The season, except for the excessive heats of midsummer, was favorable enough for the topography, although exhausting to the field-operators, but peculiarly unfavorable for the hydrography, for it was unprecedentedly hazy and foggy, rendering impossible on some days the very shortest sights, and therefore causing the loss of many days to the sounding-party."

The statistics of the work at New Haven Habor are:

Harbor shore-line traced, (miles)	26¼
Area of topography, (square miles)	4½
Number of soundings	12,990

This survey comprises an area of 18¾ square miles. Assistant Bache is now engaged in the office-work and other details connected with the survey.

Shoal off New Haven Harbor entrance.—At the instance of General G. K. Warren, in July, Assistant F. H. Gerdes connected with Capt. George Townsend, and was by him referred to a shoal spot in the southeast approach to New Haven Harbor. The locality was developed by 536 casts of the lead. Tidal observations were at the same time recorded at New Haven light-house. Assistant Gerdes found the least depth to be 19 feet at mean low water. The results of this survey will appear on subsequent issues of the chart of Long Island Sound.

Service performed by the party of Assistant Gerdes between July and the middle of November in the vicinity of New York will be referred to before closing notices of work in this section.

Physical survey of New York Harbor.—This work has made considerable progress during the past season under the conduct of Mr. Henry Mitchell, who is charged with this kind of work in the Coast Survey. Although it is only part of a general study of the physical history of the coast, the practical importance of the information gathered has naturally made this a special point in our researches.

The work of the past season has comprised the gauging of the East and North Rivers, besides surveys for comparison on the Jersey Flats, and in Gowanus Bay, West Bank Channel, and Sandy Hook Bay. In these operations, Assistants F. F. Nes and H. L. Marindin and Mr. E. B. Pleasants have co-operated with surveying-parties in the steamer Arago and the schooner Bowditch. Mr.

J. B. Weir was also engaged in the service with the schooner Hassler. The other observers relied on were students from the scientific schools, who volunteered for the service during their vacations.

Incidentally, a few special surveys were made at the suggestion of the board of commissioners of pilots and the department of docks of the city of New York. Among these was the examination of the anchorage in the lower bay after the grounding of the Spanish frigate Numancia, which vessel, as it proved, had been placed beyond the best mooring-ground. Mr. Mitchell wrote an official report concerning the matter, in which he showed from surveys by Mr. Nes and others that there was ample room for fourteen such vessels as the Numancia to anchor in safety in the lower bay without fear of touching bottom under any circumstances. In a communication from General George B. McClellan, written in behalf of the department of docks of the city of New York, dated the 20th of June, I was requested to designate proper places for depositing material dredged from the city-slips. The commissioners of pilots, having in view the preservation of the harbor, had refused to sanction further deposits of this kind within the harbor-limits, because, from the tenor of my report of last year upon the increase of the Jersey Flats, they feared that no place could be found where these deposits would not be, directly or indirectly, injurious to the port. In advance, however, having no doubt that there were localities where these deposits would be harmless, I had requested Captain Patterson, hydrographic inspector, and Mr. Mitchell, chief of physical hydrography, to select suitable sites. These were promptly pointed out to the engineer in chief of the department of docks, and were approved by the board of pilot commissioners.—(Appendix No. 15.)

The site ultimately preferred is on the eastern shore of Staten Island, and the survey since made seems to justify the selection. The only doubtful point in the West Bank Channel, which skirts the shore of Staten Island, is the 'Bulkhead' at the upper end, near the Narrows, where it joins the main channel. A very close survey was made here, so that the least change could hereafter be detected.

The department of docks furnished steamers and men for the examination of the dumping-ground, and defrayed expenditures incurred by the party engaged in the special investigation.

From the results of the physical survey, valuable information has been furnished to the United States commissioners in reference to proper pier-lines for Brooklyn, and that board has paid part of the expenses of the season.

Mr. Nes is now preparing to resume duty in Section IV, where he had been engaged in the preceding winter.

Shore-line survey of Gowanus Bay.—This survey was made by Assistant F. W. Dorr early in November, in order to facilitate the progress of the hydrographic party of Assistant Nes, who was then sounding in the adjacent parts of New York Harbor. Many docks had been built within the past fifteen years, and so much of the marsh and flats filled up that it was found impracticable to plot the desired soundings without a correct shore-line.

The resurvey by Mr. Dorr and his aid, Mr. W. E. McClintock, represents the shore of Gowanus Bay as it now is, from the south end of the old Atlantic dock pier, at Red Hook, to Hunt's wharf, or for a distance of about two miles. Outside of the limits named, the changes have been slight. Extensive alterations have been made, however, between Red Hook and the Brooklyn Canal, especially by the Erie Dock Company, the Brooklyn Canal Company, and, most of all, by the projected improvements of the Erie Basin Company. The resurvey shows the exact condition of the water-margin and soundings in Gowanus Bay as they are at this time.

After defining the structures by which changes had been occasioned, Assistant Dorr thus remarks, in reference to the contour of parts of New York Harbor not yet so altered in outline: "The absolute identity between the resurvey and parts of the survey made for the harbor commissioners some years ago, and along which no alterations have yet been artificially made, would not be matter of surprise to any one who knew that careful accuracy always distinguished the work of the assistant by whom the first-mentioned survey was made—the late General Samuel A. Gilbert. Such exact coincidence in surveys, made at long intervals of time and based on different triangulation-points, is always a matter of satisfaction, although only what ought to be expected."

The aggregate of shore-line, docks, and piers traced by the party of Assistant Dorr was thirteen miles.

Survey of Newark Bay, Hackensack River, and Raritan River, New Jersey.—In the latter part of August, Assistant Gerdes inspected and revised in several places the hydrography of Newark Bay.

Along the lower part of Hackensack River, all the termini of railroads that pass to the ferries and the recently-erected bridges were added to the working-sheet of last year. The plane-table survey of the Hackensack was extended to the head of navigation; a fringe of topography as usual marking the banks. The river was developed by close soundings.

Similar work was intended to include the navigable part of the Passaic River, but the use of the plane-table was found to be impracticable along its wooded bank without the previous determination of points by a triangulation-party. Provision will be made for that service hereafter. Of the Raritan River, Mr. Gerdes made a plane-table and hydrographic survey, showing the shores and the depths of water between Amboy and the brick-yards and factories which are about five miles above New Brunswick.

The soundings which appear on the returned charts of Assistant Gerdes were adjusted by about 2,500 tidal observations in the aggregate, made at two stations in Newark Bay, at one in the Hackensack, and at a station in Raritan Bay. The general statistics are:

Shore-line surveyed, (miles)	33
Signals determined	64
Miles run in sounding	241
Angles measured	3,440
Casts of the lead	19,140

The party erected 35 signals and occupied 40 shore-stations with the theodolite. Assistant Gerdes continued work in the field until the 15th of November. Subassistant C. P. Dillaway was attached to his party, and he was aided also by Messrs. C. A. Ives and H. Gerdes. The schooner Dana used in the service here noticed, was sent to Baltimore when operations closed for the season.

Triangulation of Lake Champlain.—This work has been completed by two parties, who had been elsewhere engaged during part of the season, as will be specified in closing this notice of their operations.

Assistant S. C. McCorkle resumed the triangulation of Lake Champlain on the 1st of June by occupying stations near Burlington, Vt., and on the opposite or New York side at Ligonier Point. Thence on going southward he occupied successive points, and extended the triangulation to Crown Point. In the course of his work, Mr. McCorkle determined approximately the positions of Mount Mansfield, Camel's Hump, Peare's Mountain, and Snake Mountain, in Vermont, and Boquet Mountain, in New York. On the east side of the lake, he selected points for the secondary triangulation at intervals quite to the elevated ground back of Saint Albans; and like points, accessible without difficulty, were selected on the New York side. The longest line observed in the triangulation is fifteen miles.

After completing the angular measurements, Assistant McCorkle repaired to Crown Point, and assisted in determining the length of the base-line, which was measured there by Assistant R. E. Halter between the 21st and 25th of September. Mr. McCorkle occupied three stations near Crown Point, and after connecting the base-line with his triangulation discharged his party.

The triangulation of the southern end of the lake was taken up at Crown Point by Assistant Halter, and was extended to Whitehall. He was aided in the field by Messrs. B. A. Colonna and D. S. Wolcott. Assistant McCorkle was aided in the work between Crown Point and Burlington by Mr. R. P. Maynard. The statistics of the two parties are:

Signals erected	74
Stations occupied	37
Angles determined	836
Number of observations	8,382

The base-line measured at Crown Point is about three miles in length.

Assistant Halter had been previously engaged in Section VIII, and Assistant McCorkle in Section II. The former is now in service in Section IV, and Mr. McCorkle in Section IX.

Topography of Plattsburgh, N. Y., and of Burlington, Vt.—To complete the survey of the upper part of Lake Champlain, a party was assigned in the summer to map the topographical details around Burlington and the surface-features of the shores of Cumberland Bay, including the town of Plattsburg.

Field-operations were commenced in this section by the party of Assistant H. G. Ogden on the 13th of July, and closed on the 18th of October. Preparations have since been made for resuming topographical service on the coast of the Gulf of Mexico.

At Burlington, Mr. Ogden extended his survey to about a mile north of the city, and southward to about two miles beyond the corporate limits.

Mr. Andrew Braid, the aid in the party, worked with a separate plane-table in the survey of Plattsburg, but rejoined Assistant Ogden for tracing the contour-lines belonging to the two sheets of work. These detailed surveys will doubtless suffice for a long period to meet any ordinary local purpose that may come into view. The statistics of the work are:

Shore-line traced, (miles)	12¼
Creeks, (miles)	9¼
Roads, (miles)	98
Area of topography, (square miles)	19

The previous work of this party will be noticed under the head of Section VII.

Hydrography of Lake Champlain.—Soundings in the northern, and by much the larger, part of Lake Champlain have been nearly completed within the season.

Three hydrographic sheets returned by Subassistant L. B. Wright show, in the northwest arm of the lake, characteristic soundings between Cumberland Head and the north end of Isle la Motte; and, in the northeast part of the lake, soundings from Burlington northward to the upper end of Butler's Island.

At the upper limit named in the northwest arm, soundings were taken up by Assistant Charles Junken, and were extended northward so as to develop the lake-waters within the United States boundary.

The soundings adjacent to the shores of the lake, in the vicinity of Saint Albans Bay, Mallet's Bay, and on the west side north of Cumberland Head, were made by a boat-party in charge of Mr. Joseph Hergesheimer. Depths were determined at intervals on lines making, in the aggregate, 805 miles. This work was closed on the 19th of October.

The steamer Fathomer was employed by the party of Mr. Wright, whose statistics of work are thus reported:

Miles run in sounding	1,125
Angles	7,948
Number of soundings	31,918

The statistics reported by Assistant Junken are:

Miles run in sounding	481
Angles	5,937
Number of soundings	37,350

Messrs. T. J. Lowry, F. W. Ring, and M. M. Defrees served as aids in prosecuting the hydrography. Subassistant Wright is now engaged in Section IX, and Mr. Hergesheimer in Section VIII.

Triangulation near Barnegat, N. J.—Early in July, Subassistant F. W. Perkins and his aid, Mr. J. F. Pratt, restored the two principal signals near Mount Holly, and without delay resumed angular measurements for extending the triangulation toward Barnegat. Four primary stations were occupied with the theodolite. The additional statistics are:

Points determined	5
Objects observed on	13
Angles measured	41
Number of observations	3,108

One of the tripods, 60 feet in height, erected in the preceding season, having been wantonly burned in the course of last winter, the erection of another caused delay in the measurement of angles. During the summer of next year, it is hoped that the work may be closed by geodetic connection with Barnegat light-house, and with a station south of it on the coast of New Jersey.

Mr. Perkins kept the field in this section until the middle of November. His previous occupation will be detailed under the head of Section VII.

Topography of the coast near Tuckerton, N. J.—In accordance with instructions, Assistant C. M. Bache resumed work with the plane-table on the 6th of July. The region surveyed lies along the coast between Tuckerton and Manahawken; the road between the two towns being the limit of topography on the western side. On the east, the work extends to the ocean-beach, and includes the intervening bay and part of the recently-constructed Tuckerton Railroad. In all, an area of fifty-five square miles is represented by the plane-table sheet. Some details to the southward of Tuckerton remain to be mapped in order to complete the survey of the coast of New Jersey between Barnegat and Great Bay.

Subassistant H. W. Bache was attached to this topographical party. Mr. G. D. Rand served as aid. Field-work was continued until the close of November, when the statistics reported were:

Shore-line surveyed, (miles)	190
Roads, (miles)	47
Area of topography, (square miles)	43

Under Section IV, mention will be made of the work performed by this party during the preceding winter and spring.

Hydrography between Little Egg Harbor and Absecom Bay, New Jersey.—The party of Subassistant W. I. Vinal erected signals in July, and early in the following month took up soundings with the schooner Bailey. Great Bay had been sounded by the late Subassistant Harding. Mr. Vinal extended the hydrography of that vicinity to include the navigable part of Mullica River at the head of Great Bay, and also the seaward approaches to New Inlet, southward of Little Egg Harbor light-house. Soundings were continued southward and westward along the coast of New Jersey to a point about four miles below Absecom Inlet. Inside of the shore-line, all the intervening waters were developed. These are known as Grassy Bay, Little Bay, Reed's Bay, and Absecom Bay. All are, however, connected by sea-water channels. The soundings were all reduced to the plane of mean low water from tidal observations recorded for the purpose on a tide-gauge near Atlantic City, and on two others within the hydrographic limits. The party erected twenty-four signals on shore, and twenty-seven stations were occupied with the theodolite. Thirty-five signals were determined in position. The general statistics of the work are:

Miles run in sounding	379
Angles measured	3,226
Number of soundings	71,221

Twelve buoys were determined in position. The records of the work and the four resulting hydrographic sheets are now on file in the office.

Messrs. J. J. Evans and L. A. Bailey served as aids, and accompanied Subassistant Vinal to Section V, where the party was engaged in the preceding winter, as will be stated further on in this report.

Triangulation of Schuylkill River, Pennsylvania.—Field-work pertaining to the hydrographic survey made last winter of the Schuylkill River at Philadelphia was completed in May by Assistant S. C. McCorkle. Eighteen points were determined, to include about eight miles of the course of the river, between League Island and Fairmount. The statistics are:

Signals erected	7
Stations occupied	9
Observations with theodolite	612

The hydrographic survey having preceded, the data furnished by Assistant McCorkle were applied in plotting the soundings made by the party of Assistant Nes. The chart of this work is now complete.

Assistant McCorkle was occupied during the summer on the shores of Lake Champlain, as already stated.

Tidal observations.—The self-registering tide-gauge at Governor's Island, in New York Harbor, has been kept running as usual by Mr. R. T. Bassett, who also makes, for purposes of comparison, day-observations on the tides with a box-gauge, at Hamilton avenue ferry, in Brooklyn. These series have been kept up, with occasional interruptions, for a number of years, and, as mentioned in previous reports, have furnished data of much local importance. For the improvements now in progress in the vicinity of New York City, the results given by the recorded series of tidal observations are of vital consequence.

In order to determine the relations of the tides of the inner harbor to those of the connected waters, it will be necessary to have simultaneous observations at other points. With this requirement in view, two tide-gauges have been made on a new plan, with single cylinders. One of these instruments will be put up at Sandy Hook and the other on the wharf-line at New York City.

SECTION III.

ATLANTIC COAST, AND BAYS OF MARYLAND AND VIRGINIA, INCLUDING SEA-PORTS AND RIVERS. (SKETCH No. 6.)

Topography and hydrography of James River, Virginia.—The detailed survey of the James River was commenced near Newport News on the 12th of December, 1871, by the party of Assistant J. W. Donn.

"Because of the severity of the winter, it was necessary, for the safety of the vessel and for ordinary comfort, to occupy the earlier part of the season in work on the estuaries of the river. Pagan Creek and its branches, and a margin along the south shore of the James River for several miles above and below the mouth of the creek, together with the hydrography of the immediate vicinity, were surveyed before the close of the winter. As soon as practicable, the work was resumed and continued without serious interruption until the approach of summer. Frequent gales of wind prevented rapid progress, as did also the occasionally violent currents in the river."

Mr. Donn's survey includes both banks of the James River, and soundings within the river-course for about fifteen miles above Newport News. His operations for the season in this section closed with the survey of Warwick River and part of Mulberry Island, which separates it from the main stream. The statistics are:

Shore-line surveyed, (miles)	175
Roads, (miles)	96
Area of topography, (square miles)	65
Miles run in sounding	1,003
Angles determined	8,064
Casts of the lead	65,272

Assistant Donn was aided in this section and in Section I by Messrs. S. N. Ogden and F. C. Donn. The party is now again at work on the James River.

Hydrography of Elizabeth River, Virginia.—On the last return of the steamer Bibb to Norfolk, after being in service on the Hatteras Shoals, as will be mentioned under the head of Section IV, the vessel was found to be no longer sea-worthy. In order, therefore, to complete the working-season for which the crew had been engaged, Acting Master Robert Platt was directed to sound out the main channel and the estuaries of Elizabeth River. This service occupied the party during November and December, and the hydrography is yet in progress. Acting Master Platt, aided by Mr. J. B. Adamson, determined points along the shores to guide in the soundings. Arrangements have been made for the shore-line survey this winter, to include the river and its branches. The hydrography now includes the following statistics:

Miles run in sounding	
Angles measured	
Number of soundings	

The present winter has been unusually severe; Norfolk harbor being at times obstructed by ice.

Geodetic connection.—Reconnaissance has been made for extending the primary triangulation from the Blue Ridge westward toward the Ohio River as part of the geodetic connection between the Atlantic coast and the Pacific coast of the United States. Assistant A. T. Mosman took the field in this section on the 1st of September, and between that date and the 10th of November made a thorough reconnaissance of the region between the Blue Ridge and the Monongahela River, including parts of Maryland, Pennsylvania, Virginia, and West Virginia. He presented a scheme for the geodetic series, on which are included also secondary points for the local State surveys and bases for extending the triangulation north and south of the main chain, the base of which is the line joining Maryland Heights and Mount Marshall. Mr. Mosman reports that it is practicable to carry the main triangulation through to the Ohio River along the fortieth parallel, but suggests the examination of the country along the thirty-ninth parallel previous to the determination of points in the geodetic connection.

Mr. Mosman had been previously engaged in Section V, where he is now in the field. Mention of his occupation during the early part of the year will be made under that head.

Tidal observations.—The series of tidal observations, with a self-registering gauge, at Old Point Comfort, Va., has been continued by Mr. W. J. Bodell. Few interruptions have occurred within the year; though in former seasons the series was broken by causes which have been mentioned in preceding reports. The apparatus is good; but, owing to the decay of the parts of the wharf leading to the pier on which the gauge is placed, it will soon become necessary to move the instrument to the steamboat-wharf. The order of General Barry provides for the future accommodation of the gauge in a building belonging to the Quartermaster's Department at Fortress Monroe.

SECTION IV.

ATLANTIC COAST AND SOUNDS OF NORTH CAROLINA, INCLUDING SEA-PORTS AND RIVERS, (SKETCH No. 7.)

Triangulation of Pamplico Sound, North Carolina.—In continuation of field-work in this section, Assistant G. A. Fairfield reached Newbern in the middle of December, 1871, and without delay fitted out the steamer Hitchcock for the use of his party. The first duty was to furnish points for the topographical party of Assistant Iardella, who had been directed to survey the vicinity of Cedar Island. At one of the southern lines of the triangulation of Pamplico Sound Mr. Fairfield started, and at intervals determined stations as far southward as Hall's Point. The intention was to push the triangulation so as to connect with stations on Core Sound; but, owing to very stormy weather and the necessity of providing points for another party in Pamplico Sound, the connection was impracticable. The triangulation desired will be made by an advance from the southward. After computing the positions determined along Cedar Island, Mr. Fairfield took up the triangulation of Pungo River, and extended that work to the head of navigation at Leechville, where the party closed operations on the 1st of May. The remainder of that month was occupied by Assistant Fairfield in reconnaissance for further extending the triangulation so as to include the main body of Pamplico Sound. All the records and computations due from the party have been received at the Office. The statistics of field-work are:

Signals erected	28
Stations occupied	22
Points determined	30
Angles measured	150
Number of observations	3,816

Mr. B. A. Colonna, the aid in the party, erected most of the signals, and took part also in the angular measurements until the 25th of May, when he was assigned to duty in the party of Assistant Cutts.

Assistant Fairfield is now prosecuting the general triangulation of Pamplico Sound. During the summer he was engaged in field-duty in Section I.

Topography of Washington, N. C.—Assistant F. W. Dorr reached Washington, N. C., on the 12th of December, 1871, and without delay organized his party for topographical service, using, as heretofore, the hulk of the old steamer Hetzel for transportation.

"In order to represent properly the approaches to the city and its intricate wharf-line, as well as the numerous obstructions, natural and artificial, in the river, the sheet was projected on a scale larger than those representing the main part of Pamplico River. This provision was fortunate, as, when the work was nearly complete, application was made by the mayor, R. S. Myers, esq., for a copy of the survey, official action being then in progress for dredging some of the shoals in the channel."

Mr. Dorr's survey was extended about two miles above the city, to the junction of Tar River and Tranter's Creek, which form the Pamplico River. The lines of fortification erected at Washington in the recent war are yet generally in good preservation. Such as remain were carefully marked on the plane-table sheet. The detailed survey was completed on the 7th of March, after which date the party was engaged at another site of work in this section. A synopsis is appended of the topographical details in the approaches to Washington:

Shore-line surveyed, (miles)	9
Creeks, (miles)	111
Roads, (miles)	126
Fortifications, (miles)	2¼
Area of topography, (square miles)	25

The plane-table survey of Pamplico River and its branches is now complete.

Topography of Pungo River, North Carolina.—The party of Assistant Dorr, in the Hetzel, the hulk having been towed by the Arago, reached the mouth of Pungo River on the 12th of March. Unfavorable weather, which had some time prevailed, impeded work with the plane-table during several successive weeks, but the lower sheet of Pungo River was finished early in May. The detailed survey includes the banks of the main stream and its branches as far up as Pungo Creek, on the west side, and Duran's Point on the eastern side.

"Pungo River is nearly 3 miles wide at its mouth, and nowhere less than 2 miles in width as far up as Duran's Point, a distance of about 8 miles. Although long shoals make out from the various points along the river, the channel is wide, and 3 fathoms can be carried as far up as the mouth of Pungo Creek, beyond which the work will be extended in the course of next season."

After closing work, the return of the party was delayed by calms; but, on the arrival of the revenue-cutter Stevens, Captain Abbey kindly took the Hetzel in tow. The hulk was laid up as usual at Washington, N. C.

Mr. W. E. McClintock served as aid in the party of Mr. Dorr in this section, and also in Section I, during the summer. The statistics of the survey of the Pungo are:

Shore-line traced, (miles)	97
Streams, (miles)	108
Roads, (miles)	122
Area, including river, (square miles)	60

The party is now at work on the upper part of Pungo River.

Topography of Cape Hatteras, North Carolina.—Assistant C. T. Iardella commenced on the coast about four miles north of Cape Hatteras on the 16th of January, and prosecuted field-work until the middle of February. Heavy gales then setting in made it impracticable to continue the survey. His party was consequently transferred to another intended site of work, the details of which will be mentioned presently. Field-service was resumed near the cape on the 17th of April, and was closed on the 3d of May. The returned topographical sheet shows Hatteras Inlet, Cape Hatteras, and the intervening coast. In reference to changes in the shore-line, Assistant Iardella reports, "On the outer beach, at the extreme end of the cape, the shore has been washed away 612 meters, while the cove has filled up 250 meters."

"At East Inlet, land has made out 770 meters, but nearly the whole of Fort Hatteras has been washed away within the year. Where the Commissary was recently, there is now a depth of 9 feet of water. But little change has taken place at West Inlet. The southern point has made out 300 meters since the previous survey, and the north and south points have shifted eastward to about the same distance."

Mr. Iardella determined, and marked on his plane-table sheet, the positions of the ten buoys which mark the sailing-course from sea, through Hatteras Inlet, into Pamplico Sound. The general statistics of this work are:

Signals erected and determined	9
Shore-line surveyed, (miles)	44
Roads and water-courses, (miles)	30
Area of topography, (square miles)	15

In the interval, during which the survey of Cape Hatteras was interrupted, the survey noticed under the next head was commenced by the same party.

Topography of Cedar Island Bay.—In February and March, Assistant Iardella, with the schooner Bowditch, moved into Pamplico Sound, and prosecuted the survey from Point of Marsh eastward to the shore of Core Sound. The topographical sheet represents the south branch of Pamplico Sound, known as Cedar Island Bay. Several small bays setting in on the west side of Core Sound were also embraced in the detailed survey. During part of the month of April, the party was engaged at Cape Hatteras, but resumed and extended work to include all the branches of Cedar Island Bay.

Assistant Iardella was aided in field and office work by Mr. W. C. Hodgkins. The statistics are:

Signals erected	19
Shore-line traced, (miles)	170
Roads, (miles)	5½
Area of topography, (square miles)	68

This party was subsequently employed in work which has been noticed under the head of Section I. Mr. Iardella is now engaged in prosecuting the survey along the west side of Core Sound.

Hydrography of Pamplico Sound and its Rivers.—Assistant F. F. Nes took command of the steamer Arago on the 20th of January. After a short trial-trip, to prove the engine, the vessel was started from Baltimore, but was detained some days by ice, and did not reach Newbern until the 17th day of February. In the course of the season, three sites of work were occupied by the party. Assistant Dorr having furnished a tracing from his survey of the lower part of Pungo River, soundings were commenced without delay, and were continued until the Arago was driven from her anchorage by a heavy gale that occurred early in March. On his arrival at Washington, N. C., Assistant Nes was informed of the call mentioned in the preceding notice, relative to the hydrography of the upper part of Pamplico River, which, being included in the plan of work for the year, was at once undertaken. Mr. Nes established a tide-gauge and erected signals, and, after conferring with a committee of the business-men of Washington, N. C., sounded out the channel of Pamplico River from Cedar Point upward to the junction of the Tar River. Five unusually cold days were employed in this work, which was pressed at the request of the city-authorities, though the weather at the time was unfit for sounding. The hydrography of the lower part of the Pamplico River had been previously completed. Taking the hulk of the Hetzel in tow, the Arago returned to Pungo River, and finished soundings in the main stream and branches within the plane-table limits occupied this season by Assistant Dorr. Hydrographic work in that river was closed on the 13th of April.

As soon as practicable, the hydrography of Pamplico Sound was resumed. The part developed this year lies between Royal Shoal light-house and Brant Island, and everywhere, except along the north side of the chart, the recent soundings connect with soundings made in former seasons,

Bell's Bay, one of the branches of Pamplico Sound, near the entrance of Pamplico River, was also sounded out by the party of Assistant Nes by means of points used in the survey of the last-named river. The shore-line of Bell's Bay yet remains to be traced.

The steamer Arago returned to Baltimore on the 20th of May. Assistant Nes was engaged during the summer in Section II, as already stated. In Pamplico Sound, Subassistant C. P. Dillaway served in his party. The statistics of that work are:

Miles run in sounding	659
Angles measured	4,013
Number of soundings	46,803

All the buoys within the hydrographic limits were determined in position. Tides were observed at four stations. Soundings were adjusted in position by seventy-three signals put up on shore by the party. Sixty points on shore were occupied with the theodolite.

Assistant Nes is now prosecuting the hydrography of the main body of Pamplico Sound.

Hydrography of Hatteras Shoals.—After repairs needed in order to keep the steamer Bibb afloat for the remainder of the season, the hydrographic party of Acting Master Robert Platt left Norfolk with that vessel on the 2d of July to complete soundings in the vicinity of the Hatteras Shoals. Several days were occupied in resetting signals to be used along the coast, and in establishing a tidal station. Every favorable opportunity was employed until the 26th of August in sounding around the shoals known as the Inner and Outer Diamond. "Beginning with the south point of Cape Hatteras beach, the bottom is very uneven. Between the pitch of the cape and the Inner Diamond, there are many lumps with only 6 and 8 feet of water in them. In the inner slough, several places were found with only 14 and 18 feet water. On the Inner Diamond there is as little as 4 feet, but this shoal may not be considered dangerous, as it nearly always shows itself by breakers, and is near the land. Many spots north and east of that shoal have only 18 feet of water on them. The buoys have all disappeared from the inner slough, and that passage should not be attempted unless the navigator is well acquainted with the vicinity of Hatteras Shoals. Between the Inner and Outer Diamond is a passage, now buoyed, known as the Outer Slough. This is perfectly safe for vessels drawing less than 14 feet. The Outer Diamond has 5 feet, and on the north side is very steep; the deep water on that side running close to the shoal. On the south side, however, and on the southeast side, the water shoals gradually, making the approach safe while the lead is going. The Outer Diamond shows at all times by breakers, except in calms of several days duration."

"East of the Outer Diamond, and two and a half miles from it, is a dangerous shoal SE. ¾ S. (magnetic) and eight and a third nautical miles from Hatteras light-house. This shoal has 11 feet water, and 10 fathoms within a quarter of a mile to the eastward."

Acting Master Platt recommends that in passing the Hatteras Shoals, heavy-draught vessels should in day-time keep the white part of the light-house barely in view on the horizon; and, at night, that such vessels, unless very sure of position, should not keep in less than 10 fathoms.

Only one vessel has been available for the hydrographic survey off Cape Hatteras; but the distance from land of some of the dangers in that vicinity makes an additional vessel expedient, to serve as a stationary object in the determination of angles of position. In the absence of such facilities, Hatteras light-house was used by the party as a theodolite-station. The tides were recorded at Hatteras Inlet for adjusting the hydrography of the shoals. A synopsis in the records of the work shows:

Miles run in sounding	520
Angles measured	2,997
Number of soundings	18,093

Messrs. J. B. Adamson and C. L. Gardner aided in the hydrography and in office-work pertaining to it. The party in the steamer Bibb was subsequently engaged in Section III.

Topography of Bear's Inlet and Brown's Inlet, North Carolina.—In continuation of the detailed survey of the coast of North Carolina below Bogue Inlet, Assistant C. M. Bache reached Swansboro' on the 12th day of February, and there joined with the previous work of Assistant Adams, who had filled in details from Beaufort to Bogue Inlet, and traced the coast-line as low down as New Inlet. The topography back of that shore-line was filled by the party of Assistant Bache. Subassistant H. M. De Wees and H. W. Bache assisted in the work. An area of twenty square miles is represented by the plane-table sheet. The party returned early in May, and took up service in Section II.

Assistant Whiting inspected the plane-table work while it was in progress on the coast of North Carolina, and found it correct in plan and details. The season being exceptionally cold, the party of Assistant Bache suffered in passing from Beaufort to their working-ground, and were much hindered afterward by inclement weather.

SECTION V.

ATLANTIC COAST AND SEA-WATER CHANNELS OF SOUTH CAROLINA AND GEORGIA, INCLUDING SOUNDS, HARBORS, AND RIVERS, (SKETCH NO. 8.)

Hydrography of the Cape Fear entrances.—With a party in the schooner Bailey, the hydrography of the Cape Fear entrances was taken up at the end of December, 1871, by Subassistant W. I. Vinal. Major Craighill, of the United States Engineers, having under consideration the improvement of the channels, signals were erected and soundings were made in accordance with the wishes of that officer. The work was inspected in February by Assistant Henry Mitchell, who advised with the party in regard to observations on the currents. Profiles and cross-sections were also made of the narrow strip of land at the northern end of Smith's Island. Mr. Vinal reports that the shore-line of that island is changing rapidly in the vicinity of Bald Head Point and near New Inlet. He carefully traced the water-line in both places as it now exists. The party was engaged in sounding the Cape Fear channels until the 7th of June. Among the developments made are the following: A new channel, with 9 feet of water, at the western entrance; a channel, now in use at New Inlet, that of 1866 being no longer used.

The hydrographic sheet shows the crib-work constructed at the head of Smith's Island by the Corps of Engineers; the catch-sand fences, intended for preserving the littoral cordon; and the ground which efforts will be made to keep from rapid degradation by the cultivation of grass.

Each of the current-stations was occupied during thirteen hours, and records were made at each of the rate at and under the surface of the water. While the party was sounding at the western entrance, assistance was rendered by Captain Carson with the revenue-cutter Seward on several occasions.

Mr. J. J. Evans aided in the service afloat and also in the field and office work. The general statistics are:

Signals erected	59
Miles of shore-line traced	13½
Miles run in sounding	448
Angles measured	3,221
Number of soundings	54,950

Seventeen buoys were determined in position, and the working-sheets mark the places of as many wrecks.

The schooner Bailey, after repairs at Baltimore, was subsequently in service with the party, as mentioned under the head of Section II. Subassistant Vinal is now engaged in the hydrography of Cape Fear River.

Survey between Little River entrance and Winyah entrance, South Carolina.—Subassistant O. H. Tittmann commenced on the 1st of January with a view of developing a stretch of the coast-line of about 60 miles, along which triangulation by ordinary means is impracticable. Two triangulation-points on the upper side of Winyah Bay furnishing a base and azimuth, other stations in connection with them were occupied in the usual way with the theodolite to cross the North Inlet marshes, beyond which no natural facilities for triangulation are found along the beach. In going northward, the beach was measured in the longest lines practicable by means of a steel tape, and the adjacent topography was sketched in as the measurement advanced.

The first opening which interrupts the continuity of the beach is Butler's Inlet. On the adjacent island, several houses were determined in position, and as points they will be useful in prosecuting offshore hydrography; the uniform outline of the woods which back the view from sea on the low flat coast making it extremely difficult to distinguish any other objects. The beach of Debidue Island, moreover, is subject to great changes of outline under the influence of northeast storms. While Mr. Tittmann was there at work, an old house near the high-water line was washed away, and also some of the posts set to guide in the beach-measurement.

Midway Inlet, at the head of Pawley's Island, is like Butler's Inlet, too shallow to admit any except row-boats; but Murrell's Inlet, 5 miles to the northward, though it has but little water on the bar, has much more water, and was the refuge of small blockade-runners in the late war. Thence on, the coast-line tends to the eastward and becomes more stable, as Subassistant Tittmann observed by the remains of structures for making salt at and below the high-water line.

The topography of the region is simple, consisting mainly of pine-woods. About Murrell's Inlet, but seldom above it, the woods are traversed by roads. The waters of the neighboring swamps percolate through the soil, and re-appear on the beach as stagnant, malaria-generating ponds. Subassistant Tittmann, his aid, Mr. Bryant Goodwin, and every hand in the party, were prostrated by the unhealthy condition of the air. Work was pushed until the end of August in the effort to develop the coast-line as far as Little River; but the party being at that time entirely disabled, was recalled.

Mr. Tittmann had previously made an examination of Little River entrance, which, as being the only navigable opening in a long stretch of coast, has some trade. The channels were sounded, and observations were made for the positions of buoys. A sketch of the entrance, made at the request of underwriters in New York and of traders at Little River, was at once furnished for the information of the Light-House Board.

Subassistant Tittmann, though much impaired in health by protracting his stay through the summer below Little River, has now resumed work in the hope of completing the topography between that entrance and Winyah Bay.

Topography of Winyah Bay, South Carolina.—The detailed survey of the shores of Winyah Bay was taken up by Assistant W. H. Dennis, on the 7th of December, with a party working in the schooner Caswell.

"The sheet on which the work was laid down includes the whole of Winyah Bay and North Inlet, and parts of the Sampit, Pedee, and Waccamaw Rivers. The main shore-line of the bay, traced by Assistant Whiting in 1857, having changed very slightly, was transferred to the sheet of this year, on which the topography was filled in. This includes the vicinity of Georgetown, and the rice-plantations which line the rivers and the western side of the bay."

Field-work was closed on the 9th of May. After the return of the vessel to Baltimore, Assistant Dennis organized a party for service, which has been mentioned under the head of Section I. The statistics of the survey of Winyah Bay are:

Shore-line, (miles)	126
Marsh and rice banks, (miles)	144
Roads, (miles)	142
Area of topography, (square miles)	84½

Mr. A. P. Barnard was attached to the plane-table party as aid. Assistant Dennis is now extending the topography below Winyah entrance.

Topography of Saint Helena Island, Ladies Island, and Port Royal Island, South Carolina.—The work done this season by Assistant Charles Hosmer and his aid, Mr. R. B. Palfrey, with a party in the schooner G. M. Bache, is comprised on three sheets, two of which, in connection, show the water-passages between Saint Helena Island and Ladies Island, together with the adjacent roads and natural surface-features. The third sheet represents part of Port Royal Island between the railroad and Broad River. Field-work was commenced on the 19th of December, 1871. As the plane-table survey advanced, the water-courses included in it were sounded out. The general statistics are:

Shore-line surveyed, (miles)	79
Creeks and marsh-outline, (miles)	239
Roads, (miles)	182
Area of topography, (square miles)	81¼
Miles run in sounding	58
Angles measured	121
Number of casts of the lead	8,185

Assistant Hosmer closed operations in this section on the 4th of May, and was afterward engaged in Section I. He is now at work with his party on the outstanding topography of the sea-islands of South Carolina.

Latitude and azimuth at Saint Simon's Island, Georgia.—In the plan of work for the season, three stations were to be occupied for azimuth between Savannah and Fernandina. Early in February, Assistant A. T. Mosman sought at the desired points, but found identifying marks at only one station; the ground at other stations having been disturbed in the course of the war. Fortunately, on Saint Simon's Island the point found was well situated for the application of azimuth. Assistant Mosman and his aid, Mr. Edwin Smith, occupied the station in March, but the weather was extremely unfavorable. Observations were, however, completed by the 16th of April. Before closing, the magnetic elements were determined, and horizontal angles were measured for connecting the station with other known points in this section.

For latitude on Saint Simon's Island, 16 pairs of stars were observed on ten nights; for time and instrumental corrections, 66 stars, on thirteen nights; azimuth was determined by 14 sets of 12 repetitions on six nights; and for the magnetic elements, observations made in the usual way were continued through four days. The duplicate records and field-computations were turned in promptly at the Office. Mr. Mosman then engaged in astronomical observations at Salt Lake City and at Sherman Station, mention of which will be made further on in this report. While his party was on duty on the coast of Georgia, Assistant Webber afforded needful facilities by transporting the observers and instruments in the steamer Endeavor. Mr. Mosman has resumed field-service in Section V.

Hydrography of sea-island channels between Doboy Sound and Saint Simon's Sound, Georgia.—Part of the service this season of the hydrographic party of Assistant F. P. Webber in the steamer Endeavor consisted in sounding out the inland water-passages behind Saint Simon's Island and Wolf Island. The main channel is known as the South Branch of Altamaha River. The upper part of Altamaha Sound was also developed, and the water-courses in connection with that body of water. Assistant Webber commenced the work in the middle of January and closed on the 18th of March. He was aided by Messrs. D. B. Wainwright and D. C. Hanson. The statistics of the work will be included with that of a similar development, to be noticed under the head of Section VI.

SECTION VI.

ATLANTIC AND GULF COAST OF THE FLORIDA PENINSULA, INCLUDING THE REEFS AND KEYS AND THE SEA-PORTS AND RIVERS, (SKETCH No. 9.)

Hydrography of Fort George Inlet, Florida, including the adjacent sea-island channels.—The work done in this vicinity was for the immediate use of the United States Engineer Department. Having, in a previous season, sounded along the coast adjoining Fort George Inlet, Assistant Webber joined on the 21st of March, and extended lines so as to include the branches of the inlet and Sister Creek, which connects the head of the inlet with Saint John's River. This work was closed in the middle of April. After completing soundings in a space left in the outside work of a preceding season between Saint Simon's and Saint Andrew's Sounds, the party in the Endeavor sailed for Baltimore, and arrived at that port early in May.

For the work included under this and the preceding head, tidal observations were recorded at five stations. The general hydrographic statistics here given include the soundings made along the coast of Georgia:

Miles run in sounding	771
Angles measured	5,673
Number of soundings	62,803

During the summer, the aids of this party were employed in Section I. Assistant Webber at the same time was engaged in field-service, which will be mentioned under the head of Section VII.

Triangulation, topography, and hydrography south of Matanzas River, Florida.—For continuing the survey of the eastern coast of Florida south of the head of Matanzas River, Assistant A. M. Harrison organized his party early in December, 1871. The sloop Steadfast was assigned for transportation, and was passed to her working-ground through the series of sea-water channels which, along the southern coast, permit the transfer of vessels that would be endangered by an outside coast-voyage.

Commencing at points which had been determined in a previous season near Matanzas Inlet, Assistant Harrison, in going southward, occupied others in succession along the coast, and thus secured a basis for the topography, and for sounding the channel at the head of Matanzas River. There the Barrier was encountered, which is thus described in the field-report: "This consists, for the most part, of a wet and densely-wooded tract called Graham's Swamp. The growth is principally live-oak, cypress, water-oak, poplar, bay, myrtle, hard pine, willow, palmetto, and cedar, and the trees are interlaced with vines of various kinds. The Barrier is part of the inland forest which comes to the sea, where the waters of the Halifax River going southward separate from the waters of Matanzas River, the course of which is north."

For occupying stations in this region, the party of Mr. Harrison cut lines through the tangled growth of the Barrier to admit of observing with the theodolite. Stations were determined as far south as practicable with reference to the rate of progress of the detailed survey.

"The topographical work was taken up at the southern extremity of the plane-table sheet of 1869, made by Assistant C. M. Bache, and was carried southward to and over the Barrier, and about three-quarters of a mile beyond the last triangulation-point. During February, March, and April, the party was engaged in mapping the details within a stretch of about sixteen miles long and three and a half miles wide."

"While engaged in the topography, points were determined along the outer beach near Matanzas Inlet, and along the shores of the river and its branches, and at these signals were set up to guide in sounding the channels. A tide-gauge was established near the head of the river, and observations were recorded while the triangulation and topography were in progress." The soundings made are on two sheets of large scale; one showing the vicinity of Matanzas Inlet, and the other the river.

Assistant Harrison specially commends his aids, Messrs. W. H. Stearns and Bion Bradbury, jr., for perseverance in overcoming obstacles met at the Barrier. Frequently, they were waist-deep in water when engaged with the hands of the party in cutting lines of sight. The statistics of the work are:

Stations occupied	19
Angles observed	521
Number of observations	3,587
Shore-line surveyed, (miles)	61
Creeks and marsh-line, (miles)	171
Roads, (miles)	37
Area of topography, (square miles)	56

The Matanzas and its branches were sounded out, making in the aggregate, fourteen square miles.

During the summer, Mr. Harrison was engaged in field-work in Section II. He is now prosecuting the survey of the coast of Florida in the vicinity of Halifax River.

Hydrography of the Gulf of Mexico.—At the request of the International Ocean Telegraph Company, the first service of the hydrographic party, in the steamer Bibb, under command of Acting Master Robert Platt, was rendered in February, by sounding Guadiana Bay, near the western end of Cuba; that place having been indicated as a desirable shore-station for the telegraph-cable intended to connect with the coast of Yucatan. The examination made showed, however, that the cable landed anywhere in Guadiana Bay would be subjected to great risk. Acting Master Platt reported on the general features, and specified defects in the existing Spanish charts, through which doubtless the managers had been misled. The variable currents in the vicinity of Cape San Antonio were observed and reported on, and a site near San Antonio light-house, inside of Cape Cajon, was suggested as the most suitable place in the vicinity for a shore-end of the Gulf cable. From that station, a line of soundings was run to Mugres Island, on the coast of Yucatan, and a favorable place on the island was indicated for landing the western end of the telegraphic line. The greatest depth of water found by sounding was 1,164 fathoms. Doctor Stimpson, since deceased, was on board of the Bibb, and, though then ill, prosecuted researches in regard to the forms of animal life brought up by the dredge from the bottom of the Gulf. A few rare shells were detected, but generally the bottom was found barren, and wanting in many forms which the dredge brings up in profusion elsewhere. Off Chorrera, the dredge brought up, from a depth of 250 fathoms, a beautiful specimen of *Pentacrinus*. It was alive, and about a foot in length. At great depths on the course to Yucatan, the thermometers indicated a temperture of 39½ degrees; the surface-temperature being at the same time and place 81 degrees. The strongest current observed at nine stations on the course was two knots per hour, and the direction was generally northward. On the chart, deep-sea soundings are marked at twenty-six places, and many others were taken in less than 50 fathoms.

The results obtained by the hydrographic party were communicated, at the end of February, to General W. F. Smith, president of the International Ocean Telegraph Company.

Acting Master Platt was aided in this section, as also in duty which has been mentioned under the head of Sections III and IV, by Messrs. J. B. Adamson and C. L. Gardner.

While the steamer Bibb was passing to the southward in January, Acting Master Platt found and developed a shoal off the coast of Florida, between Indian River Inlet and Saint Lucie Inlet. Soundings on the shoal show a depth of only 17 feet, at a position about five miles from the coast of Florida.

After completing work in the Gulf of Mexico, the steamer Bibb returned to Norfolk, Va., and arrived at that port on the 28th of May.

Doctor Stimpson's labors in the vicinity of the Florida Reef were undertaken in a great measure for the recovery of the types of Molluscs and Crustacea collected in previous years by Assistant L. F. Pourtales, and lost in the great Chicago fire while in the care of Doctor Stimpson for description. His expenses in the cruise were borne by Professor Agassiz personally. The specimens have been received, but the state of Doctor Stimpson's health was such during the voyage that he was unable to write any notes to accompany them. Seven casts of the dredge were taken in the Straits of Yucatan, the deepest in 1,002 fathoms, where the usual *Globigerina* bottom was found, with shells and corals, in small quantities. In the neighborhood of Key West, off the Florida Reef, thirty-six casts were taken, mostly on the rich plateau, in from 100 to 200 fathoms; and there many types of the lost collection were brought up. Mr. Pourtales had successfully dredged in the same vicinity in the year 1868, and, as might be expected, not many unknown forms were added to the collection.

Deep-sea soundings, Gulf of Mexico.—It was stated in my last annual report that Commander John A. Howell, United States Navy, assistant Coast Survey, had his party organized for service in the steamer A. D. Bache. The following is a transcript from the report of that officer:

"Our work consisted in running four lines of soundings off the west coast of Florida, and in dredging along these lines and off Sombrero and Sand Key. Operations were commenced on the 17th of February, but, owing to unfavorable weather, little was effected till the 19th of April, between which time and the 16th of May nearly all the soundings were made."

"The first line was on the parallel 27° 8′ north, off Sarasota Bay. It commenced in 5 fathoms and terminated in 1,612 fathoms. Eighty soundings were made and two successful dredgings for specimens of the bottom of the Gulf of Mexico."

"The second line, on the parallel of 26° 16′ north, off Oyster Bay, commenced in 1,708 fathoms, but 1,821 fathoms were found before reaching the 5-fathom curve. On this line, 106 soundings were made and 5 dredgings."

"On a third line, on the parallel of 25° 3′ north, west from Cape Sable, 128 soundings and 7 dredgings were made in depths between 9½ and 1,664 fathoms."

"The fourth line, on a course southwest from Tortugas, gave a depth of 1,694 fathoms between the extremes of 8½ and 1,199 fathoms; 33 soundings were made and 5 dredgings."

"Temperatures were recorded at the surface and at the bottom for each sounding. In the latter discrepancies appeared in the record by two instruments, due perhaps to unavoidable jarring of the thermometers while reeling in the line. The lowest bottom-temperature was 39°; the surface being at 81°."

"The dredgings on these lines, and in March and April off Sand Key and Sombrero Key, were done partly under the direction of the late Dr. William Stimpson, who took charge of the specimens brought up. The energies of that able man of science, though greatly wearied by disease, were then in full exercise. His valuable life closed soon after the completion of the work here noticed."

Commander Howell, with the steamer under his command, reached New York on the 23d of May, and was subsequently engaged in hydrographic service, as was mentioned under the head of Section I. In both sections, the party had the able assistance of Lieutenants W. H. Jacques, E. S. Jacob, Richard Rush, and W. L. Field, of the United States Navy.

On the western coast of Florida, 20 casts were made with the dredge, and specimens were obtained in depths varying from 15 to 100 fathoms. This region had not been previously explored. It is, therefore, of particular interest for comparison with the deep-sea fauna bordering on the coral reef, where the bottom is entirely calcareous, whereas along the Gulf coast, where the specimens were taken, the bottom is siliceous.

Tidal observations.—At the instance of Col. F. E. de Bille, governor of the island of Saint Thomas, in the West Indies, a self-registering tide-gauge, in complete working-order, was committed to Captain Thulstrup, of the royal Danish engineers. It is expected that the record of observations to be made with this instrument at a station distant from our coast-line, and in the track of the tidal waves which reach the coast of the United States, will throw much light on the character and magnitude of the waves, and the changes they undergo. As in similar cases, the record of observations will pass into the archives of the Coast Survey.

SECTION VII.

GULF-COAST AND SOUNDS OF WESTERN FLORIDA, INCLUDING THE PORTS AND RIVERS, (SKETCH No. 10.)

Hydrography of Saint George's Sound, Florida.—The outstanding hydrography at the eastern approach of Saint George's Sound was completed in the course of the present season by the party of Assistant Horace Anderson. Owing to a succession of gales, the schooner Silliman could not reach Apalachicola until the 2d of January. After that date, the work was prosecuted steadily until the 20th of May. The lines run are comprised between Dog Island light-house and the light-house on Peninsula Point, and were extended broad off into the Gulf of Mexico. In regard to the development, Assistant Anderson says:

"On the eastern side of the entrance, near Southwest Cape, a channel was found with a depth of 20 feet water. This channel has not been used, and was not before known to exist. A channel of 15 feet was developed by soundings near the east end of Dog Island."

"Offshore soundings were made extending seaward eight miles and a half from a line joining East Pass and Southwest Cape, which are distant about twenty-three miles."

"A tide-gauge was established at the east end of Dog Island, and observations on the rise and fall were recorded from 6 a. m. until 6 p. m. during the season."

Assistant Anderson was aided by Messrs. F. H. North and E. H. King. The statistics of work are:

Miles run in sounding	773
Angles measured	1,891
Number of soundings	29,667

During the summer, this party was employed in duty which has been described under the head of Section I.

Survey of the Gulf coast westward of Saint Andrew's Bay, Florida.—In this section, as in Section VI, the two embracing the peninsula of Florida, the absence of elevations, combined with an almost tropical growth and impassable swamps, has been a serious impediment to progress in the coast-triangulation. Where triangulation has not been possible without heavy cutting to open lines, an expensive and slow operation, a direct measurement of the coast has been made along the beach. This has been done in several places; the direction of the measured lines in all cases being checked so as to insure confidence in the results. Much work of this character remains at other places along the Gulf coast; but it is gratifying to be able to report that good progress has been made on parts of the coast of the peninsula of Florida not available for the ordinary process of triangulation. An important link has been included within the present surveying-year.

Immediately after the opening of the present year, Subassistant F. W. Perkins took the field in this section. After verifying the measurement of the base-line at Saint Andrew's Bay, he made a direct measurement of the Gulf coast between it and Choctawhatchee Bay, filling in also the intervening topography, and connecting with the survey of Assistant Ogden.

The work of Mr. Perkins, lying upon a nearly straight stretch of open sand-beach, backed by an uninhabited and almost impassable country, distant from any harbors that can be entered during gales, the transportation of means for prosecuting this survey was a matter of much difficulty. Exposure and many hardships were endured by the members of the party. Subassistant J. N. McClintock assisted in the measurement, which was made with a wire of sixty meters, and also sketched the topography. Mr. L. F. Chew served as aid in the party.

Of the Gulf coast, thirty-six miles in length were defined and mapped on three sheets. The statistics are:

Test-bases measured with bars	6
Stations occupied with the theodolite	34
Angles measured	76
Number of observations	1,572
Coast-line surveyed, (miles)	36
Creeks and bayou, (miles)	82
Roads, (miles,)	10
Topography, (square miles)	48

The schooner Torrey was used by the party for transportation.

Mr. Perkins closed in this section early in May, and was subsequently engaged in Section II. He is now under instructions to resume duty on the Gulf coast.

Subassistant McClintock was employed during the summer in Section I, and is about to resume work for the winter in Section VI.

The work done on the Gulf coast completes the survey between Saint Andrew's Bay and Pensacola.

Triangulation, topography, and hydrography of Choctawhatchee Bay, Florida.—Assistant H. G. Ogden, with his party, left Mobile on the 29th of December, 1871, in the schooner Agassiz; but, owing to adverse winds in the Gulf, the vessel was delayed in the passage to Choctawhatchee entrance. Field-work was resumed there on the 8th of January, and was prosecuted until May, when a junction was made with the coast-measurement, of which notice was taken under the last head.

Taking up the triangulation at the eastern end of Santa Rosa Sound, where it was left off last year, Mr. Ogden extended it to the head of Choctawhatchee Bay through a scheme which includes six quadrilaterals and two triangles. The longest line in the scheme is about nine miles.

The survey of the bay is comprised on two plane-table sheets, of which the details were filled by Mr. Andrew Braid, the aid in the party. The fringe of topography was carried back about a mile from the shores, and includes also the delta of the Choctawhatchee River. On the north side of the bay the land is generally high, and covered with pines and a few live-oak trees; but the south shore is low and wet. The shores of the upper half of the bay are lined with a broad growth of cane, through which boats must be forced in order to effect a landing.

The hydrography includes the entire bay and its branches. Assistant Ogden found the greatest depth to be seven fathoms. Generally, the 6-foot and 12-foot curves follow the contour of the shores. The bayous, very generally, have two or three fathoms of water, but some have less. The Choctawhatchee River empties into the head of the bay through four mouths, all of which are obstructed by bars.

Tidal observations were made by the party during two months at East Pass, and subsequently at the head of the bay. The general statistics of the work are:

Signals erected	40
Stations occupied	16
Angles measured	168
Number of observations	3,390
Shore-line surveyed, (miles)	237
Roads and marsh, (miles)	103
Miles run in sounding	872
Angles determined	4,638
Casts of the lead	48,375

Mr. J. F. Pratt served as aid in this party. Assistant Ogden was engaged during the summer in Section II, as already stated.

Reconnaissance.—To provide for the future determination of points for connecting the triangulation of the Atlantic coast with the triangulation of the Pacific, Assistant J. A. Sullivan was directed to examine the region of country between the uplands of Georgia and the Mississippi River. He took the field early in the spring, and conferred with Assistant Boutelle, who was then engaged in similar duty, with a view of extending southward the primary triangulation which now rests at stations in the upper part of the Blue Ridge. The result was a selection of a site for a base-line to connect with that work, and to serve also as a base for a system of points between the Atlantic coast and the Mississippi River. Mr. Sullivan continued the reconnaissance in that direction, and at the end of the season made a comprehensive report on the facilities and obstacles to be met with in prosecuting the geodetic connection. A party has since been detailed, and is now engaged in the determination of points within the region included in the reconnaissance. Assistant Sullivan is yet in the field, and in the course of the winter will select, for large triangles, stations known to be intervisible, so that, in advancing from Atlanta, stations on the Mississippi may be reached by the least number of well-determined points.

Measurement of a primary base-line near Atlanta, Ga.—The site for a base-line in the vicinity of Doraville, about fifteen miles from Atlanta, Ga., having been selected to meet requirements in the field-work of Assistant C. O. Boutelle, I visited the station early in the season, and personally inspected the plan for connecting the line with triangulation, to be advanced from it westward toward the Mississippi. The proposed arrangements were approved, and the grading of the line went on during the summer, under charge of the aids of the party, Messrs. H. W. Blair and Habersham Barnwell; Assistant Boutelle being part of the time prostrated by serious illness. He was able, however, to rejoin his party in October, and completed the measurement of the base-line in November. In his absence from the field, an experienced aid, Mr. W. H. Stearns, was detailed to re-enforce the party; Assistant Webber, in that interval, taking charge of the details.

Before and after the measurement of the base-line, the bars used for determining its length were carefully compared with the standard length-measure at the Office. Mr. Boutelle is now making angular measurements for connecting the base-line with the nearest triangulation-points. (See Sketch No. 11.)

Geodetic connection.—In order to make available without delay the results derived from the measurement of the base-line near Doraville, Ga., Assistant F. P. Webber was assigned to conduct the triangulation of the vicinity. His party reached the site of the base early in August. As soon as practicable, a transit-instrument and zenith-telescope were mounted. Observations for latitude and time were made at favorable intervals, and were completed by Mr. Webber by the end of September. The charge of all the field-work intended in the vicinity having devolved on him during the illness of Assistant Boutelle, Assistant Webber conducted both parties, and was aided in his special observations and computations by Messrs. Blair and Barnwell. Near the middle of October, he was joined by Mr. Stearns. Later in that month, Assistant Webber and Mr. Stearns determined the magnetic elements at a station near the base-line.

After assisting in the measurement of the line, Mr. Webber selected stations for extending triangulation from it in the direction toward Chattanooga, applying for that purpose the scheme which had resulted from the reconnaissance previously made by Assistant Sullivan. At the station nearest to the base, a tripod and observing-scaffold have been put up, and a primary signal on Stone Mountain. These points will be occupied in the course of the winter, and such others as may be found practicable for the intended triangulation. (See Sketch No. 11.)

Under the heads of Section V and Section VI mention has been made of the previous work of Assistant Webber.

SECTION VIII.

GULF COAST AND BAYS OF ALABAMA, AND THE SOUNDS OF MISSISSIPPI AND OF LOUISIANA TO VERMILION BAY, INCLUDING THE PORTS AND RIVERS, (SKETCH No. 12.)

Triangulation, topography, and hydrography of the Mississippi River.—The party of Assistant C. H. Boyd resumed the survey of the Mississippi on the 11th of January. Very soon after, the chief, aids, and most of the hands on board of the schooner James Hall were prostrated by sickness, owing to peculiarities of the season, though all had been accustomed to service in this section. Fortunately, Dr. T. C. Hilgard, then engaged in special field-service near New Orleans, visited the disabled party, and treated the sick with such good effect that Mr. Boyd was enabled to resume operations before the close of the month. Thence on, the detailed survey was prosecuted until the 1st of June, when the work rested for the season at Jesuit Bend.

In the previous year, Assistant Boyd selected a base of verification for the work already done, intending to measure the line this season. It joined in the scheme, became one of the triangle-sides in passing upward from Magnolia Plantation, and when measured at the end of January was found to be 3614.7 meters in length. The ends of the base were securely marked as usual by copper bolts inserted into granite posts, which were bedded in the ground with masses of béton. As facilities for future identification, iron screw-piles were placed in the ground at intermediate measured distances. Subassistant William Eimbeck joined Mr. Boyd, and assisted in measuring the Magnolia base previous to determining azimuth for the triangulation.

The detailed survey of the banks and soundings in the Mississippi was extended in the direction to New Orleans, and, as before stated, rested at Jesuit Bend, where Mr. Boyd is now about to resume work. In the interval, his party was employed in the vicinity of Saint Louis. While prosecuting the survey below New Orleans, tidal observations were recorded daily at the quarantine-station.

Assistant Boyd was aided during the winter by Messrs. C. H. Van Orden and Joseph Hergesheimer. The statistics of work are:

Signals erected	17
Stations occupied	17
Angles measured	172
Number of observations	2,940
Shore-line surveyed, (miles)	110
Roads, levee, canal, &c., (miles)	220
Area of topography, (square miles)	85
Miles run in sounding	83
Angles determined	609
Number of soundings	2,449

Twelve of the lines of triangulation requisite for defining the outline of the Mississippi this season required cutting through the forest in order to admit of using the theodolite. The currents of the river were determined at three stations while the soundings were in progress. In addition to the sheets showing the advance of work on the Mississippi, Mr. Boyd turned in a sketch of the shore-line and soundings for about seven miles of the course of the river Aux Chênes.

Geodetic connection.—Assistant R. E. Halter kept the field in the triangulation near Saint Louis until the 10th of November, 1871. Cold weather setting in immediately after, the camp-equipage of his party was with difficulty stored for the season in Saint Louis. Subassistant William Eimbeck, who was then observing for azimuth at a station near the city, completed the determination, and then joined the party of Assistant Boyd below New Orleans. Subassistant O. H. Tittman at the same time took up duty on the Atlantic coast, as stated under the head of Section V. Subassistant Eimbeck, when the season closed, was assigned to duty on the western coast.

Assistant Boyd took up field-work near Saint Louis, in August last, after recovery from serious illness, contracted in the course of the season in prosecuting duty below New Orleans. The great heat of September in the region about Saint Louis caused much sickness in the party; but the details of triangulation were urged as far as practicable. Mr. Boyd selected a site for a base-line about eight miles to the eastward of the city, and proved its fitness for connecting properly with the triangulation-points, which have been already occupied. The base-site intended for measurement on the American Bottom is about four and a half miles in length. In October, the weather was favorable, but, as in the preceding month, immense volumes of smoke interfered with lines of sight along that part of the Mississippi Valley. Two stations near the city were occupied, both of them connecting by angles with the proposed base. Late in October, the line was measured with six-meter bars under favorable circumstances, and the ends were carefully marked for identification, as in all similar cases. A line of levels run from the site about fifteen miles, and terminating at the city directory in Saint Louis, gave, for the height of the base-line on the American Bottom above the level of mean tide in the Gulf of Mexico, about 480 feet. Until the 21st of November, angular measurements were continued at all favorable intervals at the ends of the base, but further observations will be recorded in the coming season. The approximate length of the base-line is 7266.86 meters. Five stations were occupied in all. Without the hindrance from smoke, the triangulation might have been well advanced to the westward of the Mississippi.

The aid in the party, Mr. C. H. Van Orden, conducted the field-operations near Saint Louis during the illness of Assistant Boyd. Since closing work, the party has resumed the survey of the Mississippi in the vicinity of New Orleans.

Hydrography of the Gulf of Mexico near the Mississippi Delta.—Subassistant F. D. Granger reached New Orleans on the 20th of December, 1871, and as soon as practicable fitted for service in the Gulf hydrography the schooner Varina and the steam-launch Barataria. His party was organized at once, and by the middle of January lines of soundings were commenced to develop the approaches from the southeastward of the Mississippi Delta. Between Pass à Loutre and South Pass the soundings were extended from land to a distance of fifteen miles in the Gulf, and terminated generally in about forty-five fathoms. It was observed that off the South Pass the water deepens, the 100-fathom curve being only twelve miles from land. Fourteen miles SE. by E. ½ E. by compass from Pass à Loutre, the gully, of 80 fathoms depth, was partially sounded, and depths of only 68 fathoms were found about two miles seaward of the gully. The place seems to be well known as a resort for fish of several kinds. Soundings in the vicinity of the delta occupied the party until the 10th of March. By the courtesy of Capt. Robert Boyd, light-house inspector at New Orleans, the steamer Geranium was then placed at the disposal of Subassistant Granger for the hydrographic survey of Trinity Shoal and Tiger Shoal off the entrance to Vermilion Bay westward of the Mississippi Delta. Mr. E. B. Pleasants accompanied as aid in this service. The other aid of the party, Mr. F. W. Ring, remained in charge of the Varina, and prosecuted soundings in the Mississippi River above and below Fort Jackson; at the upper limit joining with the work done by Assistant Boyd.

The tides were observed at Pass à Loutre for the hydrography of the adjacent waters of the Gulf. For the development of Trinity Shoal and Tiger Shoal, observations were recorded at Southwest Reef light-house, and by them the soundings made were reduced to low water. Tides were observed at Fort Jackson while soundings were in progress in the Mississippi River. The operations of the party in this section were closed on the 6th of May, when the vessels used in the service were laid up at the Head of the Passes. A synopsis of the statistics of hydrographic work is appended.

Miles run in sounding	797
Angles measured	1,171
Number of soundings	12,398

The results of the survey of Trinity Shoal were forwarded to the Light-House Board in April. The report of Mr. Granger states that he was ably seconded in that work by Capt. Henry Coop, of the light-house steamer Geranium.

The party of Subassistant Granger was employed in Section I during the summer. Since the close of the season there, hydrographic work has been resumed in the vicinity of the delta.

SECTION IX.

GULF COAST OF WESTERN LOUISIANA AND OF TEXAS, INCLUDING BAYS AND RIVERS, (SKETCH No. 13.)

Hydrography of Matagorda Bay, Texas.—Soundings have been completed within the season in Matagorda Bay by a party working with the schooner M. L. Stevens, in charge of Subassistant L. B. Wright. As in several other instances, the basis for this work was established just previous to the rebellion; but in the lapse of time, during which the ground could not be occupied by a surveying-party, the triangulation-points were obliterated. Mr. Wright found it necessary to make a plane-table triangulation through a distance of forty-two miles, or from Half Moon Reef light-house to the head of the bay. There he fortunately identified one of the stations which had been occupied in the triangulation, and to that he joined his work with good success. He was aided by Mr. T. J. Lowry. The statistics of the work, exclusive of operations with the plane-table, are as follows:

Miles run in sounding	285
Angles	1,085
Casts of the lead	16,630

This work occupied the party during winter and spring. After midsummer, Mr. Wright was occupied in service which has been stated under the head of Section II. He is now about to resume hydrographic duty on the coast of Texas.

Latitude and longitude of Austin, Tex.—Much interest having been manifested within the past two years by the city authorities, in regard to the exact geographical position of Austin, the earliest opportunity has been taken to meet their wishes, as expressed in the application.

In the plan of work for last spring, astronomical observations on the Mississippi below New Orleans were included, as already mentioned. The occasion was then taken for determining latitude and longitude at a station in the city of Austin, and Subassistant William Eimbeck was instructed accordingly. Prof. S. P. Langley, of the Allegheny observatory, Pennsylvania, kindly offered to co-operate with the instruments under his charge; the geographical position of that observatory having been ascertained in a previous year by similar co-operation.

Assistant G. W. Dean made the needful arrangements for telegraphic exchanges of time-signals between the observers at Allegheny and Austin. In the spirit of liberality which has been invariably manifested at the requests of the survey in past years, Col. John Van Horne, general superintendent of the Western Union Telegraph lines at the South, afforded the free use of the wires for the requisite exchanges. Between Mr. Eimbeck at Austin and Professor Langley at Allegheny, signals were recorded with success on the nights of the 23d, 24th, and 25th of April, under favorable circumstances. The astronomical clock at Allegheny, being in the telegraph-circuit, its time was recorded there upon a Bond chronograph-register, and simultaneously upon a Morse fillet at Austin. Each series of signals consisted of twenty-five exchanges between the observers, made alternately, and at intervals as nearly as practicable of five seconds each. All the signals being recorded at both stations, the double-transmission time was obtained by comparing the times recorded on the respective chronographs. •

The several wire-circuits between Allegheny and Austin make in the aggregate about one thousand five hundred and fifty miles. Four "telegraph-repeaters" were used at intervals in that distance while signals were passing to determine longitude.

Before leaving the station at Austin, Subassistant Eimbeck recorded observations made by the usual method for determining the latitude, and others, also, for the magnetic elements.

INTERIOR.

Astronomical observations at Sherman, Wyoming Territory.—At the last session of Congress, a small appropriation was approved, "to enable the Superintendent of the Coast Survey to cause astronomical observations to be made at one of the highest points on the line of the Pacific Railroad."

The observations here referred to were recommended by a committee of the American Association for the Advancement of Science, and were authorized by Congress with a view to ascertain the advantage of noting celestial phenomena with the telescope at an elevation quite above the least transparent portion of the atmosphere. In view of ulterior purposes, the memorial of the association was properly met by the action of Congress; all general operations in the survey being of necessity conducted under the known disadvantage of observing with portable instruments at stations near the sea-level.

The station selected for the observations and tests desired by the memorialists was Sherman, on the summit of the most eastern range of the Rocky Mountains, and at the highest elevation on the line of the Union Pacific Railway. That station is about 8,268 feet above the level of the sea. Under the general charge of Assistant Richard D. Cutts, of the Coast Survey, and his aid, Mr. B. A. Colonna, the observing-party was Prof. C. A. Young, of Dartmouth College, well known by successful researches with the spectroscope; and his assistant, Prof. C. F. Emerson. The excellent 12-foot equatorial and other apparatus requisite for the observations were furnished by the trustees of Dartmouth College. For collateral operations, Assistant A. T. Mosman, of the Coast Survey, was stationed at Salt Lake City, to co-operate in determining the true longitude of Sherman station.

Three temporary observatories were put up at Sherman in June: one for the transit and latitude instruments, including also the telegraph and chronograph apparatus; another for the meteorological instruments; and the third for the equatorial telescope. The respective observations were commenced in each early in July, and were continued until the 16th of August. Professor Young has, with my sanction, made known the special results in leading scientific publications of our country, and they have been read with much interest by European observers.

To guard against molestation by roving Indians, the observing-party was attended, in accordance with orders from the War Department, by a sergeant and ten men of the United States Army. Four of the latter, instructed by Assistant Cutts, recorded meteorological observations for sixty days. The registers show that, during June, July, and part of August, the weather was unfavorable for astronomical work, a condition said to be exceptional in that region. When, however, the sky was clear, the brilliancy of the firmament was startling by the unusual number of stars visible to the unaided eye; and their apparent proximity demonstrated at a glance the transparency and steadiness of atmosphere gained by elevation. Instrumental comparisons confirmed the correctness of the eye-impression. From the results obtained, it may be stated that the value of observations at an elevation of 8,000 feet is from 20 to 25 per cent. greater than at the sea-level. As a single illustration of increased power apparently given to the telescope when used above the dense and more perturbed strata of the atmosphere, Professor Young reports, in reference to the spectrum of the chromosphere, that, at Dartmouth College, he had succeeded in making out a list, in all, of 103 lines reversed; but that, during the six weeks at Sherman, he added 170 new lines to the catalogue.

Among the observations were included careful determinations of the latitude and longitude of the station, and the magnetic declination, force, and inclination. The details, with the conclusions drawn by each observer in regard to the transparency of the air due to elevation, are given in Appendix No. 8.

Considering the short period employed by the party at Sherman, and the cloudy weather which prevailed, the results reported are of interest and value. They clearly warrant the continuance of special observations tending to the advancement of astronomical science, and not less directly to the credit of the Government and the repute of our country among nations.

For the astronomical observations needful at Salt Lake City, Governor Brigham Young placed his own observatory in Temple Square at the disposal of Assistant Mosman. Time-observations were made with the transit-instrument belonging to the governor, who added to this courtesy every facility desirable for the observations. On the 26th of June, the governor's observatory was connected with the Deseret Telegraph Company's wires, going to Ogden by a loop; and by the line, from Ogden to Sherman by the wires of the Pacific and Atlantic Telegraph Company. Signals for longitude were exchanged with the observer at Sherman on the night of the 28th of June, and on seven other nights preceding the 23d of July. That month being very favorable at Salt Lake, Mr. Mosman recorded time-observations on twenty-five nights in the course of less than a month. He rejoined Assistant Cutts on the 27th of July, and determined the latitude of the point occupied for the special observations at Sherman station. Assistant Mosman returned to the Atlantic coast early in August, and engaged in computations previous to resuming work, on which he is now engaged in Section V. His field-report specially mentions the cordial assistance rendered by Governor Young, of Utah, and by Superintendent Musser, of the Deseret Telegraph, in furthering the operations needful at Salt Lake for determining the true position of Sherman station.

Observations at Summit station and at Verdi, Nev.—On his return to the western coast, Assistant George Davidson occupied a station on the Central Pacific Railroad near Summit, in the pass of the Sierra Nevada, at an elevation of 7,200 feet above the sea. His plan for testing the advantage of a great elevation included observations with instruments which he had used for years, and the noting of objects entirely familiar to him as an astronomical observer in the Coast Survey. His previous experience on the Pacific Coast Mountains had been limited to elevations of somewhat less than 3,500 feet. Subsequently, Mr. Davidson occupied several weeks in making transit, azimuth, and latitude observations at Verdi, about twenty-five miles east of Summit station, with a view of connecting points with the one hundred and twentieth meridian of longitude from Greenwich, for the determination of which request had been made, for the uses of another department. The station occupied at Verdi is about 4,870 feet above sea-level, and not favorable for steadiness of atmosphere. In observing upon Polaris, Assistant Davidson reports, that "every night the companion of Polaris was distinctly visible to every member of the party." The planet Saturn and the attendant rings were better defined than had ever been previously observed. All features in the aspect of the moon were seen with unusual distinctness; and Mr. Davidson suggests that photographic pictures taken of the moon from places above atmospheric perturbation would be remarkably effective. His observations on the outline and general features of spots on the sun revealed what could not be seen with the same instruments at the sea-level. The report of Assistant Davidson, given in Appendix No. 9, also warrants the conclusion that the value of observations on celestial phenomena and objects is much increased by the use of ordinary instruments at great elevations.

On the south side of the railroad, near Verdi Bluff, Mr. Davidson measured a short base, and made a triangulation of the vicinity. While occupying stations with the theodolite, angular measurements were made to determine approximately the positions of all the mountain-peaks in view that could be identified by local names. Records of the observations for latitude, longitude and azimuth were sent to the Office, and promptly reduced and computed. The results are now on file in the archives.

In August, Assistant Davidson passed on to San Francisco, and occupied the season in field-duties, which are yet in operation. Abstracts of the work done by his own party, and by others under his general direction, will be given under the next head.

The longitude of Verdi station was determined in April by the exchange of clock-signals between the aid at that station, Mr. S. R. Throckmorton, and Assistant Davidson at San Francisco, through the lines of the Pacific and Atlantic Telegraph Company. Mr. Throckmorton recorded 145 transits of 44 stars in the course of eleven nights, using the meridian-instrument No. 1, a Frodsham break-circuit chronometer, and Hipp's field-chronograph.

Mr. Davidson subsequently determined the latitude of Verdi by 163 observations on 88 stars, arranged in 45 pairs; recording at the same time notes on their relative magnitude. For time, 83 transits of 37 stars were observed on nine nights, with the meridian-instrument and sidereal chronometer.

Mr. H. I. Willey recorded at Verdi barometrical observations simultaneous with others observed by Assistant Davidson at San Francisco, for comparing the derived difference of level with results given by the levelling-instrument.

Azimuth was determined by Assistant Davidson's observations on B. A. C. 4165 at western elongation, and on Polaris at eastern elongation, in connection with a station of his triangulation as an azimuth-mark. The base-line, half a mile in length, was carefully measured twice with steel tape. Six stations were occupied with the theodolite, and seventeen positions were determined, as well as the height of each above the level of the sea.

The aids of the party determined at Verdi the magnetic variation and dip. Mr. Davidson added to the records a series of observations for the absolute horizontal intensity of magnetism at the station.

With reference to a geodetic connection by stations across the continent, Mr. Davidson, before returning to San Francisco, made a short reconnaissance along the crest of the Sierra Nevada to note where a large triangulation might cross that chain of mountains. Views were taken from elevations of nine and ten thousand feet; but smoke in the Sacramento Valley hid from sight the Coast Range of Mountains along the Pacific. The earliest opportunity will be taken for completing this reconnaissance.

SECTION X.

COAST OF CALIFORNIA, INCLUDING THE BAYS, HARBORS, AND RIVERS, (SKETCHES NOS. 14 AND 15.)

In the abstracts which follow under this and subsequent heads, the sites of work will be mentioned in geographical order, beginning with the most southern on the coast of California, and terminating with a general notice of operations on the coast of Alaska. Most of the parties on the western coast are now in the field. Assistant George Davidson, in presenting results on the several sites of work which he had selected, remarks that the weather has been unusually bad, but the returns show a good average in the progress of the field-work. When his own field-duties permitted, Mr. Davidson has, from time to time, inspected the operations under way in other parties, and, as heretofore, carefully examined the records and maps before sending them to the office. Abstracts of his own field-work will be given in their proper order. Mr. Davidson has, as usual, met the calls made on the western coast for charts, tracings, and information generally, when needed for public use, and, as occasion offered, has added materials for a subsequent edition of the Coast Pilot, which describes all known dangers in navigating between San Diego and the Aleutian Islands, as well as sea-marks, capes, light-houses, and intervening harbors. Intimacy of relation with the Light-House Board has been kept up. Assistant Davidson has furnished promptly to the light-house inspector the ascertained positions of lights and buoys, and, as hitherto, has reported upon the location and character of ad ditional aids for navigation on the Pacific coast.

Hydrographic reconnaissance between San Diego and Panama.—Commander Philip C. Johnson, U. S. N., Assistant Coast Survey, has entered upon this service with his hydrographic party in the steamer Hassler. Special examination was made under favorable circumstances at the site of a supposed rock off San Diego, in latitude 31° 00′ north, and longitude 119° 24′ west, but only deep water was found. The steamer was of necessity refitted at San Francisco after the voyage by the Strait of Magellan, but is now in effective condition for service in the hydrographic reconnaissance along the sailing-line below San Diego.

In September, Assistant Davidson lent to Dr. David Walker a few instruments suitable for making observations on a projected passage from San Francisco to Guaymas, Mexico, and return passage to San Francisco. The results received comprise temperatures, recorded at intervals of four hours, of the water and air; notes on the currents; errors in the position of certain parts of the coast of Mexico; and notice in regard to a reef off the island of Geronimo, not laid down on any chart. This reef was referred to the attention of Assistant Davidson by Captain Metzgar, who discovered it.

Commander Johnson is assisted in the operations of the hydrographic party by Lieut. Commander C. W. Kennedy, and by Lieuts. M. S. Day, H. B. Mansfield, and E. W. Remy, U. S. N.

Triangulation and topography.—East of the San Gabriel River and toward the Anaheim Landng on the coast of California, the topographical survey and requisite triangulation were continued during part of the winter and spring by Assistant A. W. Chase. Points for the plane-table work were determined near the base on the Los Angeles Plains, and other points connecting with them were established at intervals toward the landing. The improvements in the vicinity, including the railroad and jettee and the town of Wilmington, were added to the topographical sheet, with which that of the present year connects. Most of the ground represented is low, and cut up by lagoons bordered by marsh. The shore is low, and marked by sand-dunes.

Mr. Chase returns the following synopsis of statistics:

Signals erected	20
Stations occupied	20
Angles measured	75
Number of observations	900

The topographical work fills two sheets and part of a third, which was used in the field until the opening of the season for work on the coast of Oregon. Nine miles of shore-lines were traced; the details fill an area of about eighteen square miles.

Part of the winter of 1871 was employed by Assistant Chase in reducing his field-observations and completing the topographical sheets. The records and results of the work have been received, and placed in the Office. Further mention of the field-work of Mr. Chase will be made under the head of Section XI.

Triangulation and topography of the Santa Barbara Islands, California.—Subassistant Stehman Forney, during the winter of 1871, inked his plane-table sheets of San Miguel Island, duplicated the records, and forwarded his results of the previous season to the Office. In April, he took the field, and, after connecting San Miguel with Santa Rosa Island by angular measurements, started with the detailed survey of the last-named island. Field-work was somewhat impeded by recurring fogs, but the progress reported is satisfactory.

Santa Rosa Island, in the outer range of the Santa Barbara group, is eighteen miles long, and has a shore-line of about forty-eight miles. Parts of it are elevated more than 1,200 feet. As a well-defined sea-mark, the outline will in due time be generalized, and the main features of the topography will also be defined for the charts of the vicinity. The report of Mr. Forney for the present season includes a general description of the island. He is now prosecuting the survey, and will, if practicable, continue field-work during the winter. The statistics at the end of October were:

Signals erected	23
Stations occupied	6
Objects observed on	7
Angular measurements	155
Shore-line surveyed, (miles)	41
Roads, &c., (miles)	21
Area of topography, (square miles)	41

Triangulation of the mainland of Santa Barbara Channel.—During the winter of 1871, Assistant W. E. Greenwell was engaged in office-work pertaining to the field-operations of his party in the preceding season. In the spring, he resumed the triangulation of the main coast of California at the western limit of previous work, and extended work so as to connect with the astronomical station near Point Conception. Dense fogs and strong winds are mentioned in the field-report as causes affecting the intended progress. The statistics are:

Signals erected	52
Stations occupied	49
Angles measured	238
Number of observations	7,240

Mr. Greenwell rendered assistance to the party of Assistant Davidson on its start in reconnaissance for the primary triangulation of the coast of California, northward of Gaviota Mountain.

The records of the field-work of Assistant Greenwell have been duplicated, and the computation of results is now in hand.

Main triangulation north of Santa Barbara Channel.—In October, Assistant Davidson detailed a few hands from his party to serve in charge of Subassistant William Eimbeck, on reconnaissance for the selection of stations to connect the survey of the Santa Barbara Channel with that of Monterey Bay. The part of the coast included presents many difficulties; but at the close of the season Mr. Eimbeck had made good progress in laying out points for the desired triangulation. In order to find intervisible stations, mountains elevated as much as 5,700 feet above the sea were traversed by the party engaged in this reconnaissance.

Triangulation and topography of the coast near San Luis Obispo, Cal.—Assistant L. A. Sengteller inked his plane-table sheets of the previous season, and duplicated the records of his field-work in the course of the winter of 1871. These, with the computations, have been received at the Office.

In February, Mr. Sengteller resumed the topographical survey of the coast of California, about three miles to the northward of Point San Luis Obispo, and extended the detailed work farther in the same direction. The triangulation was advanced about eight miles along the coast, and nearly half of the stretch so defined was included in the plane-table survey previous to the transfer of the party to a station south of San Luis Obispo. Going southward, the topography of the coast was pushed about three miles beyond the limit of work in the preceding season. The statistics of the work north and south of San Luis Obispo are:

Signals erected	16
Stations occupied	12
Angles measured	81
Number of observations	1,539
Shore-line surveyed, (miles)	5½
Roads, (miles)	10
Area of topography, (square miles)	5

Early in May, the party of Assistant Sengteller was transferred to a site of work in the vicinity of Mendocino Bay, of which mention will be made before closing notices of the work in this section.

Triangulation and topography northward of San Simeon Bay, California.—Assistant Cleveland Rockwell passed the winter of 1871 at San Francisco, where he inked his five topographical sheets of the preceding season, and completed the office-work pertaining to them. Sheets were projected for the work of his party in Oregon before taking the field near San Simeon Bay. The season there was generally unfavorable, but advance was made in the triangulation and topography northward of Piedras Blancas. On the 20th of April operations were closed, and the party was sent to continue the survey of Columbia River, as will be further noticed under the head of Section XI. The statistics of field-work near San Simeon Bay are:

Signals erected	5
Stations occupied	7
Angles measured	22
Points determined	16
Number of observations	392

The fringe of topography, mapped by Mr. Rockwell and his aid, Mr. G. H. Wilson, comprises the details adjacent to about four miles of the ocean shore-line.

Topography of Table Mountain and of the Southeast Farallon.—Field-work was completed at Table Mountain by Assistant A. F. Rodgers in the course of the winter of 1871. This important landfall at the entrance of San Francisco Bay presents three summits in a range nearly east and west; the highest being twenty-six hundred feet above water-level in the Golden Gate. The north and south sides of the mountain are cut by deep gulches, between which are steep rocky slopes covered with chaparral.

Part of the winter was occupied by Mr. Rodgers in computations and other office-work connected with the operations of the preceding year. Before the completion of these details, the aid of the party, Mr. E. F. Dickins, was sent to the Southeast Farallon to make the final survey of that island. Points were determined by triangulation in the usual manner, and on that basis Mr. Dickins sketched in the topography. After depositing the sheet at San Francisco, the party of Assistant Rodgers took up field-work at another site in this section, as will be noticed presently.

Longitude-observations at San Francisco.—At the outset of the present surveying-year, request was pending for the determination of the one hundred and twentieth meridian of longitude on the Union Pacific Railroad, as stated in my annual report. Assistant George Davidson, who passed part of the winter of 1871 on the Atlantic coast, took charge of the service desired, and made arrangements for its performance on his overland return to San Francisco in the spring of the present year. On his application, the lines of the Pacific and Atlantic Telegraph Company were assigned for the use of his party, and every facility needful was afforded by Governor Stanford and by Messrs. Vanderburg and Foley. Assistant Davidson occupied the station at Washington Square, San Francisco, with transit No. 3, Kessel's clock 1440, and with a chronograph; Verdi station, in Nevada, near the one hundred and twentieth meridian of longitude west from Greenwich, was occupied, as already mentioned, by the aids of his party, Messrs. S. R. Throckmorton and H. I. Willey. Observations by means of the telegraph were commenced on the 1st of June, and clock-signals were satisfactorily exchanged each way between Assistant Davidson and his aids on six nights. For the instrumental and clock corrections at San Francisco, Mr. Davidson recorded 120 transits of 35 stars on six nights; and, for the personal equation between himself and Mr. Throckmorton, sixty-six observations were made in the course of five nights on 35 stars. When the determination for longitude was complete, Assistant Davidson went eastward and determined the latitude and azimuth at Verdi station, as stated under a preceding head.

In the winter of 1871, Mr. Throckmorton, under special instruction of Assistant Davidson, made a series of magnetic observations at Presidio station, with a view of determining the yearly increase of magnetic declination on the Pacific coast. The observations were repeated at the same station in October, 1872; and results of much value are expected from a discussion of the observations, which will be made without delay.

Observations were made by Assistant Davidson in 1859 at Ross Mountain and Bodega Head, with the intention of determining then the co-efficient of refraction. The records, including registers of the meteorological conditions under which the observations were made, remained incomplete during the war, when Assistant Davidson was on the Atlantic coast. Last winter, however, the requisite lines for level were run by the aids of his party, and the means for the desired determination are now complete. The records and field-computations of this work are on file in the Office.

Hydrography of San Francisco Bay.—During the winter of 1871, Assistant Gershom Bradford, with his party, in the schooner Marcy, conducted current-observations, and from time to time extended soundings in the Golden Gate approaches, and also between Fort Alcatraz and Point Avisadera, in order to furnish the means for comparing with the existing chart any future surveys of San Francisco Bay. The observations on currents were continued during three days at each of the fifteen stations. Assistant Bradford's report was accompanied by plotted diagrams showing the results graphically. Connected cylinders with conical ends were used for determining sub-currents, one of them being at the bottom, with two or more at distances above it varying with the depth of water. For the surface-current, the apparatus was so arranged as to give the flow as exerted upon vessels of average draught. The statistics of hydrographic work are:

Signals erected	9
Stations occupied	13
Angles measured	2, 970
Miles run in sounding	289
Number of soundings	9, 449

On the 5th of April, the party, in the schooner Marcy, made arrangements for resuming work in the northern part of the section, as will be noticed hereafter.

While the steamer Hassler was at the navy-yard refitting for sea-duty, Commander Philip C. Johnson, with his party, sounded in the Mare Island Straits, and in the vicinity of the navy-yard, and made a chart for future reference or for comparison with previous surveys.

Topography and hydrography of Mendocino Bay and vicinity.—In May, Assistant L. A. Sengteller transferred his party from San Luis Obispo to Little River, near Mendocino Bay, and resumed the survey of the coast at the northern limit of his work of the preceding year. The stretch now included presents a very narrow margin of cleared country along the water-line, which is bordered by broken bluffs of moderate height, backed by heavily-timbered ridges. Hence the triangulation was advanced with difficulty, and, as in other sites of work, the season was marked by heavy fogs and strong winds.

On the topographical sheets are included several "landings," or points of shipment, for lumber and produce, and the streams known as Navarro River, Salmon Creek or Big River, and Russian Gulch. Lumber is shot into the vessels by structures that stretch from the top of the bluff nearly to the deck, the vessels when loading being moored below. These landings afford no shelter from the heavy gales of winter; but by position they are protected from prevailing summer-winds and from the swell of the ocean.

For the determination of points on which to base the plane-table work, Mr. Sengteller erected thirty signals along the coast, and occupied three stations with the theodolite. The topographical statistics are:

Shore-line of ocean, (miles)	29½
Rivers, (miles)	12
Roads, (miles)	30
Area of topography, (square miles)	12½

Before leaving the vicinity, Mr. Sengteller, aided during part of the season by Mr. H. I. Willey, of the party of Assistant Davidson, made a hydrographic survey of Mendocino Bay and its approaches, recording 1,135 soundings. In this general examination, the bottom of the bay was found to be very irregular and broken. Special examination was made in the vicinity of a supposed rock off the south point of Mendocino Bay, but no obstacle to navigation was developed by the soundings.

Triangulation and topography south of Shelter Cove.—In July, Assistant A. F. Rodgers transferred his party to the vicinity of Shelter Cove on the coast of California, and resumed field-work from the limit of the preceding year. The site of operations presented many difficulties. The beach is impassable, except at extreme low water. Back of the water-line, the country is rugged, and covered in part with dense chapparral and partly with heavy red-wood timber. The high ground affords no feed for animals nor any water. Some of the heights occupied by the party for the measurement of horizontal angles are three thousand feet above the sea. The general statistics are:

Signals erected	25
Stations occupied	27
Angles measured	392
Number of observations	11,980
Ocean shore-line, (miles)	9
Area of topography, (square miles)	7

Assistant Rodgers was aided by Mr. E. F. Dickins. The party is yet in the field, and will continue work as long as the weather will permit. Earlier in the season progress was much hindered by fogs and by the smoke of burning forests.

Hydrography off Cape Mendocino.—In the latter part of April, Assistant Gershom Bradford engaged one of the steam-tugs, with a competent pilot of Humboldt Bar, and determined in position nearly all the sunken rocks which were discovered by Assistant Davidson in 1869. Two other rocks, not then known, were found to the northward. The survey indicates a passage about a mile and a half wide between the sunken rocks inside of Blunt's Reef and the sunken rocks of the Sugarloaf at the cape. But this channel cannot be used in thick weather. The course by the passage referred to is, moreover, only about a mile less in distance, as compared with the ordinary course of vessels outside of Blunt's Reef.

When these special developments were complete, the steam-tug was returned to her owners, and the hydrographic survey of Trinidad Bay was taken up by Mr. Bradford with his party in the schooner Marcy. Foggy weather, however, greatly interfered with lines intended to develope the offshore soundings. While the party was engaged at sea, tidal observations were recorded at Trinidad and at Humboldt Bay. In Trinidad Harbor, two rocks, heretofore unknown, were discovered near the anchorage. The currents of the vicinity were observed and recorded. The hydrographic statistics are:

Signals erected	33
Stations occupied	22
Angles measured	4,685
Miles run in soundings	548
Number of soundings	9,682

Assistant Bradford was aided by Mr. Frederick Westdahl. As already mentioned, this party was occupied during the winter in the vicinity of San Francisco.

Under the direction of Assistant Davidson, Subassistant G. Farquhar, though in impaired health, accomplished in the course of the winter and spring a large amount of office-work pertaining to the hydrography of the western coast. These details include tracings of the survey of Humboldt Bay, projections for the work between Rocky Point and Shelter Cove, plottings of the current observations, and drawings of previous work requisite for the field-operations of Assistant Davidson.

Triangulation south of False Klamath River entrance, California.—Assistant A. W. Chase took up this work late in September; his party having been previously engaged near Cape San Sebastian, on the coast of Oregon, as will be presently noticed.

After signals had been erected for field-work south of the Klamath, a dense fog set in and prevailed until the middle of October. This was followed by a short period of clear weather, during which stations were determined by angular measurement for service in the plane-table survey. The statistics of the triangulation are:

Signals erected	9
Stations occupied	8
Angles measured	29
Number of observations	228

The field-report includes a general description of the Klamath River. Fauntleroy Rock, developed in the hydrographic survey of Crescent City Harbor, has been marked, in the operations of the Light-House Board, by an iron spindle. While in that vicinity, Mr. Chase occupied shore-stations with the theodolite, and determined the exact position of the spindle.

Tidal observations.—Maj. G. H. Mendell, United States Engineers, has continued his acceptable supervision of the tidal operations at the permanent stations on the western coast.

The self-registering tide-gauge, heretofore in use at San Diego, was kept at work by the observer, Mr. William Knapp, until the structure on which the instrument was placed gave out. As a large expenditure would have been required to replace the structure, it was deemed best to close observations at this station; the series of nineteen years duration being nearly complete. The tide-gauge accordingly has been transferred to Port Townshend, Washington Territory, where similar observations are much needed.

The self-registering gauge at Fort Point, near San Francisco, has been in the care of Mr. E. Gray. Good records have been received at the Office, and the prospect is good for the continuity of the series.

As usual, meteorological observations have been registered at both stations on the coast of California. The observers have also tabulated from the tidal records the readings of high and low waters, using for the purpose the new glass scales.

SECTION XI.

COAST OF OREGON AND OF WASHINGTON TERRITORY, INCLUDING THE INTERIOR BAYS, PORTS, AND RIVERS, (SKETCH No. 16.)

Triangulation and topography near Mack's Arch, coast of Oregon.—As mentioned under the head of Section X, the party of Assistant Chase passed the early part of the year in work on the southern part of the coast of California. In April, the office-work was completed; and before the end of that month the party reached Crescent City, and, as soon as practicable, resumed field-work on the coast of Oregon, south of Mack's Arch. The triangulation and shore-line survey were extended to Mack's Reef, from a point about sixteen miles southward and eastward, where the operations closed in the preceding season. Two plane-table sheets, joining at Whale's Head, were projected to include the limits of work. The shore-line is complete on both, and the final topography on the sheet north of Whale's Head, which represents a rough, broken coast, covered with forest and dense undergrowth, The cliffs in many places are precipitous. Nine miles of coast, with the usual margin of topography, are included in the detailed survey. Twenty-two signals were erected by the party, and as many stations were occupied with the theodolite. The records of the triangulation, and the field-computations resulting from it, have been filed in the Office.

Hydrography of Chetko Bay, Oregon.—In the course of the summer, Assistant Chase sounded the anchorage abreast of the mouth of Chetko River, and found six fathoms over sandy bottom, with good shelter from the northwest wind and from the ocean-swell. His report is accompanied by a sketch, showing the soundings made at the anchorage.

Topography of the Columbia River.—In May, Assistant Cleveland Rockwell transferred his party from a site of work on the coast of California, and resumed the detailed survey of the shores of the Columbia River. East and west of Cathlamet, the triangulation and topography were advanced so as to include the whole of Puget Island and both banks of the river as far up as Westport. The topographical features are much the same as were found nearer the mouth. There is properly no valley to the river, but between the steep walls of the original channel of the river lie timbered low-lands and timbered and marshy islands. The banks of the Columbia are basaltic, and are covered with spruce of great size.

Good progress has been made in this survey, notwithstanding impediments arising from freshets fogs during the season, and smoke from the adjacent forests. Mr. George H. Wilson served as aid in the field-party. The detailed work of the season includes the following:

Shore-line surveyed, (miles)	35
Creeks and sloughs, (miles)	67
Roads, (miles)	8
Area of topography, (square miles)	24

The previous occupation of the party of Assistant Rockwell has been mentioned under the head of Section X.

Triangulation and topography of Shoalwater Bay, Washington Territory.—This work was continued by Subassistant J. J. Gilbert several weeks after my annual report of last year was closed. Some shoals and islands within the limits of two of the plane-table sheets were added before the field-operations were discontinued for the winter. Mr. Gilbert then engaged in office-work at Olympia, and completed the records and computations pertaining to the previous triangulation, and inked the plane-table sheets. His party resumed field service early in March, and extended the triangulation and topography of Shoalwater Bay down to the ocean-beach, and there joined with the coast-triangulation.

Shoalwater Bay is filled with extensive flats. Along the shores, the forest generally comes down to the water-line. By taking advantage of the state of the tides, Mr. Gilbert has made good progress in this survey. His work of the season includes:

Signals erected	52
Angles measured	193
Number of observations	5, 648
Shore-line surveyed, (miles)	78
Sloughs, (miles)	93
Area of topography, (square miles)	27

The survey of Shoalwater Bay and vicinity is yet in progress, and will be continued until the severity of weather makes it expedient to close work for the season.

Triangulation and topography of Puget Sound, Washington Territory.—The office-work of last year was brought up by Assistant J. S. Lawson, in the course of the winter of 1871, at Olympia. These details comprise the triangulation-records, duplicates, and computations, the completion of the plane-table sheets of that year, and tracings from them, to guard against possible loss in the transmission of the originals.

Assistant Lawson resumed field-work in April, and extended the topographical survey on both sides of Admiralty Inlet from Lagoon Point and Oak Cove to the north side of Dwamish Bay and Point Restoration; and up Possession Sound to Point Elliott, where the operations connect with the previous survey of Port Ludlow, Hood's Canal, and Madison Harbor.

In August, the party commenced the triangulation of Budd's Inlet, at the head of Puget Sound This is the proposed temporary terminus of the North Pacific Railroad. A base was measured on the north side of the inlet, and the triangulation connected with it now includes the entire course of the channel. Some progress was made in the plane-table survey, but the season was well advanced before the triangulation was complete. Details in the vicinity of Olympia and New Market will be mapped in the course of the winter. The work now done is on eight sheets, of which the statistics are, with those of the triangulation:

Signals erected	56
Stations occupied	22
Angles measured	139
Number of observations	3, 248
Shore-line of sound, (miles)	86
Sloughs and lagoons, (miles)	30
Roads, (miles)	5½
Area of topography, (square miles)	48

Two plane-tables were used in the party of Assistant Lawson: one of them at intervals by himself, when not engaged in the triangulation; the other was used during the season by Subassistant Eugene Ellicott. Mr. F. A. Lawson was attached to the party as aid. The brig Fauntleroy, as heretofore, was employed for transportation.

Tidal observations.—The self-registering tide-gauge at Astoria, Washington Territory, has been removed to a new wharf not far from the old station, and is well attended, as heretofore, by Mr. L. Wilson. The series are excellent of both tidal and meteorological observations at Astoria. Mr. Wilson has also tabulated from the tidal sheets the readings of high and low waters.

As stated under the head of Section X, a series of observations with a self-registering tide-gauge will be commenced near Port Townshend, Washington Territory. The three permanent tidal stations on the western coast remain under the able supervision of Maj. G. H. Mendell, United States Engineers, who has full knowledge of the conditions requisite for the successful working of the tide-gauges.

SECTION XII.

PACIFIC COAST—ALASKA TERRITORY, (SKETCH No. 17.)

Geographical reconnaissance of the coast of Alaska.—In August, 1871, as stated in my last annual report, Assistant W. H. Dall sailed from San Francisco with his party, in the schooner Humboldt, for reconnaissance at the Aleutian Islands. On the trip to Unalaska, the opportunity was taken to determine the general direction of the ocean-currents. The observations as reported confirm the deductions published in my report for the year 1867, with other conclusions then presented by Assistant Davidson.

Before laying up the Humboldt for the winter at Ilioulionk, Mr. Dall established a self-registering tide-gauge, and kept up a continuous series of observations. In the Akutan Pass, a rock was occupied by an observer for a period sufficient to determine the range of the tide. In geographical development, the party surveyed and sounded out the harbor of Ilioulionk on Unalaska Island, and the passage through to Captain's Harbor.

Between Unalaska and Kadiak, careful observations were made on the currents in April. Coal Harbor, on Unga Island, was surveyed and sounded; and the latitude of a station there was determined by M. W. Harrington, esq., who accompanied the party as astronomical observer. The magnetic elements were determined at both of the islands.

In June, Assistant Dall made a reconnaissance of the Shumagin group of islands. The shores of Popoff Strait were traced, and that passage was sounded. At Sanborn Harbor, on Nagai Island, the latitude was determined; the shore-line was traced, and soundings were made to develop the anchorage. Several of the adjacent islands were fixed in position by angular measurements, and sketches were made of the nearest harbors. Northeast Harbor on Little Koniushi Island and a harbor on Simeonoff Island were likewise traced in outline and brought into connection with others by a determination for latitude and by observations for position. The currents and tides were recorded at the Shumagins, and views were drawn of fifteen conspicuous headlands and harbor-entrances. Fourteen harbors or anchorages, and ten islets or rocks not marked on any previous chart, were noted by the party, and determined in approximate position.

While the schooner Humboldt was on her course for Kadiak, Mr. Dall discovered a shoal-bank on which his party caught, in abundance, halibut and codfish. The bank has a depth of 22 fathoms, and its approximate position, as determined by the observations of Mr. Harrington, is latitude 56° 13′ north, and longitude 153° 39′ west.

From Kadiak, the Humboldt sailed for San Francisco on the 9th of September. The ocean-currents were observed on the passage, and observations for temperature were recorded. On the arrival of the vessel, experiments were made with the magnets for comparison with the results found by observations in high latitudes.

The registers containing the observations made at various points on the coast of Alaska are now at San Francisco. Mr. Dall's detailed report of operations in conducting the reconnaissance will be found in Appendix No. 10.

Tidal observations.—The tide-gauge sent last year to Alaska was established by Assistant Dall, at Ilioulionk, on the Aleutian Islands, and has furnished satisfactory records. These will be compared with the short series registered at the same place in 1867.

Early in the summer, a self-registering gauge was sent to Capt. Charles Bryant, agent of the United States Treasury Department at Saint Paul, one of the seal-islands in Behring Sea. Should the instrument reach its destination in safety, an interesting series of tidal observations may be expected, from the known zeal and ability of Captain Bryant in prosecuting useful researches.

COAST SURVEY OFFICE.

The charge of the office has remained, as in former years, with Assistant J. E. Hilgard, on whose departure for Europe, in April, the duty of directing the office-operations was temporarily assigned to Assistant C. S. Peirce. The organization of the different divisions of the Office has remained unchanged.

In the *Hydrographic Division*, under the immediate direction of C. P. Patterson, inspector of hydrography, the hydrographic charts have been plotted and drawn from the field-notes by E. Willenbücher and J. Sprandel. The former also framed sailing-directions for charts, and prepared the needful matter relative to lights, buoys, and sailing-lines for the charts in progress of publication, and for others when changes had become necessary. Similar service was performed during part of the year by Subassistant C. Junken.

Computing Division.—The computing division of the Survey has remained in charge of Assistant Charles A. Schott, with the same organization as in the preceding year, excepting the increase of force by one geodetic computer during the last three months of the year. The temporary assistance of two astronomical computers was afforded to the division, the same as last year. The current work required by the office and field parties was promptly kept up, and the adjustment of the secondary triangulation, old and new, has been pushed forward. These computations, aiming at and securing greater consistency and accuracy in the work, require now more frequent application since the triangulation is approaching completion. The time of one computer was almost wholly given to the revision of the latitude-computations, and to the introduction of improved catelogue-places of stars, which in all cases proved the great accuracy attainable in the measures by the zenith-telescope.

Besides arranging the work for the computers, and giving detailed instructions, examining and reporting results, Mr. Schott was engaged, in November last, in attending to and giving necessary information for the magnetic survey of the steamer Hassler. In June, he made the usual annual determination of the magnetic declination, dip, and intensity at Washington, and rediscussed and prepared for publication accounts of the lengths of the primary base-lines measured at Dauphine Island, at Bodie's Island, at Edisto Island, at Key Biscayne, and at Cape Sable. Some trial-measures with the Rutherford micrometer-screw were made to ascertain whether there was any noticeable effect of wear. Mr. Schott also made an addition to the professional papers of the Survey by preparing an account of the measurements of terrestial magnetism in sufficient detail to enable an experienced observer to make magnetic observations, without further instructions, and to secure uniformity in methods and treatment in operations, which have hitherto proved troublesome to many. He also constructed and presented to the Survey a sketch of a hypsometric chart of the United States by means of contour-lines of definite elevations, thus enabling us at a glance to ascertain the general physical features of the country relating to elevations. The chart is specially interesting to the meteorologist. Assistant T. W. Werner, Dr. G. Rumpf, and Mr. E. H. Courtenay have performed the computations of triangulation and their verification and adjustment, aided, since the 1st of July, by Dr. F. Kampf. Messrs. James Main, R. Keith, and F. Hudson have been engaged upon the reductions of astronomical observations; the revision of the several computations, and the introduction of the best available star-places, being altogether assigned to Mr. Main.

Drawing Division.—The work in this division has been under the charge of Mr. W. T. Bright. The drawings for engraved charts and tracings for photolithographs of maps have been made by Messrs. A. Lindenkohl, H. Lindenkohl, L. Karcher, F. Smith, P. Erichson, and F. Fairfax. Miscellaneous tracings have been made by W. Fairfax and E. J. Sommer, and corrections on printed charts by H. Eichholtz. A detailed summary of the work of the division during the year is given in Appendix No. 4.

Engraving Division.—The work of this division has continued under the able direction of Assistant E. Hergesheimer. During the year, Mr. W. H. Knight has been added to the force of the division, which has been employed as follows: Messrs. J. Enthoffer, H. C. Evans, A. Sengteller,

A. M. Maedel, and W. A. Thompson, as topographical engravers; J. Knight, E. A. Maedel, and A. Petersen, as letter-engravers; H. S. Barnard, J. C. Kondrup, R. F. Bartle, H. M. Knight, J. G. Thompson, F. W. Benner, E. H. Sipe, W. H. Davis, and W. H. Knight, as miscellaneous engravers. Views of entrances to harbors have been engraved by Mr. George McCoy on contract. Mr. E. Molkow has continued the reduction of outlines on copper from tracings of original sheets by means of the pantograph. The clerical duties of the division have been performed by Mr. G. W. Morrison. A statement in detail of the work on each plate in hand during the year is given in Appendix No. 5.

Tidal Division.—Mr. R. S. Avery has continued in charge of this division during the year. He arranged and supervised the computations and other work; inspected the observations when received; attended to the correspondence relating to tides, with the observers and others; and labored to improve the tables and methods. He improved the tide-gauges and apparatus for reading off observations from the sheets, and supervised their construction. He also supplied many tide-tables for charts, data for use in field and office work, and some tidal predictions for almanacs. The computations were made by Messrs. J. Downes, A. Gottheil, C. Ferguson, and Miss M. Thomas. Appendix No. 6 will show the work in detail performed during the year.

Division of Charts and Instruments.—This division, comprising the map-printing, distribution of charts and reports, and the mechanicians' and carpenter shops, has continued under the direction of Mr. John T. Hoover.

The registration and filing of the original maps and charts and records of field-observations have remained with Mr. A. Zumbrock.

Mr. Nissen performed the duty of backing on muslin sheets required for field-work; and the map-room continued in charge of Mr. Thomas McDonnell. The supervision of work in the instrument-shop continued with Mr. John Clark, with J. Foller, William Jacobi, Charles Würdemann, and E. Eshleman, as mechanicians. The work in the carpenter-shop was performed by Mr. A. Yeatman, assisted by Mr. F. E. Lackey.

Mr. V. E. King continued in the performance of the clerical duties of the Office, assisted by Mr. F. W. Clancy. The duties of writer in the hydrographic office were performed by Mr. C. A. Hoover.

In the office of disbursing-agent, Samuel Hein, esq., the duties of book-keeper were discharged by Mr. R. L. Hawkins; and Mr. W. A. Herbert and W. I. Flenner acted as writers.

The assistant in charge of the Office, J. E. Hilgard, esq., was temporarily absent from Washington during the summer. While conducting, on the eastern coast of Europe, the operations for determining transatlantic longitude, of which mention was made in the introduction to this report, he was called, through the French legation and Department of State, to take part as representative of the United States in the International Commission on Weights and Measures. I am specially gratified in saying that, at the conference of the commission at Paris, in September, and in intimate relations with the most distinguished astronomers and geodesists of Europe, Mr. Hilgard ably sustained the reputation of our country by his extensive knowledge of the subject before the commission. As an experienced officer of the Coast Survey, and cognizant of its advances in field and office operations, he was, in that relation also, recognized as in close scientific harmony by the most eminent members of the international commission.

In closing this report, I take great pleasure in recording the continued services of the disbursing-agent of the Survey, Samuel Hein, esq., which have been maintained with inflexible regard to the best interests of the work; and also the services of Assistant W. W. Cooper, in the discharge of office-duties under my immediate direction.

Respectfully submitted.

BENJAMIN PEIRCE,
Superintendent United States Coast Survey.

Hon. GEORGE S. BOUTWELL,
Secretary of the Treasury.

APPENDIX.

APPENDIX No. 1.

Distribution of surveying parties upon the Atlantic, Gulf, and Pacific coasts of the United States during the surveying-season of 1871–'72.

Coast-sections.	Parties	Operations.	Persons conducting operations.	Localities of work.
SECTION I.				
Atlantic coast of Maine, New Hampshire, Massachusetts, and Rhode Island, including seaports, bays, and rivers.	No. 1	Topography and hydrography.	J. W. Donn, assistant; S. N. Ogden and F. C. Donn, aids.	Plane-table survey of the southwestern part of Mount Desert Island and hydrography of Placentia Bay, Me. (See also Section III.)
	2	Topography	Charles Hosmer, assistant; J. N. McClintock, subassistant; R. B. Palfrey, aid.	Topography of the eastern part of Eggemoggin Reach and of the northern part of Isle au Haut, Me. (See also Sections V and VII.)
	3	Topography	W. H. Dennis, assistant; A. P. Barnard, aid.	Detailed survey of the southern part of Deer Isle and of adjacent islands and ledges on the coast of Maine. (See also Section V.)
	4	Triangulation ...	W. H. Stearns	Interpolation of points near Castine, Me., and Cape Rosier, for the plane-table survey. (See also Section VI.)
	5	Topography	A. W. Longfellow, assistant; H. M. De Wees, subassistant.	Topographical survey, including the vicinity of Cape Rosier, Me. (See also Section IV.)
	6	Hydrography	J. S. Bradford, assistant; R. R. Steedman, aid.	Coast-description and sailing-directions for navigating the coast of Maine and entering harbors between Eastport and Penobscot Bay.
	7	Hydrography	Horace Anderson, assistant; F. H. North, E. H. King, and W. S. Bond, aids.	Hydrography of Belfast Bay, Me., and soundings extended eastward across Penobscot River to the vicinity of Castine. (See also Section VII.)
	8	Topography	C. T. Iardella, assistant; W. C. Hodgkins, aid.	Detailed survey of the western shore of the Penobscot, including Searsport Harbor and Stockton, Me. (See also Section IV.)
	9	Topography	F. W. Dorr, assistant; W. E. McClintock, aid.	Topography of the west shore of Penobscot Bay completed in the vicinity of Northport, and connected with the survey of Belfast Bay. (See also Sections II and IV.)
	10	Triangulation.....	G. A. Fairfield, assistant; W. B. Fairfield, aid.	Stations occupied near Augusta, Me., for connecting the survey of the Kennebec with the primary triangulation; determination of the height of station Sebattis. (See also Section IV.)
	11	Triangulation	Prof. E. T. Quimby................	Points determined in New Hampshire by observations from Monadnock, Unkonoonuc, Rattlesnake Stewart's Peak, and Mount Kearsarge.
	12	Longitude	J. E. Hilgard, assistant; G. W. Dean and Edward Goodfellow, assistants; Prof. Joseph Winlock; F. Blake, jr., subassistant; A. H. Scott and Edwin Smith, aids.	Astronomical observations at Brest on the coast of France, at Saint Pierre on Miquelon Island, and at Cambridge, Mass., for determining difference of longitude between Paris and Greenwich and the observatory at Washington, D. C.
	13	Hydrography	Commander J. A. Howell, United States Navy; Lieutenants W. H. Jacques, E. S. Jacob, Richard Rush, and W. L. Field, United States Navy.	Hydrographic development of Cultivator Shoal, and determination of the currents on George's Bank off the coast of Massachusetts. (See also Section VI.)
	14	Hydrography	H. Mitchell, assistant; F. D. Granger, subassistant; D. B. Wainwright and D. C. Hanson, aids.	Hydrography of the vicinity of Monomoy Shoals, and near Nantucket, developing changes in the depth of water. (See also Section VIII.)

Distribution of surveying-parties upon the Atlantic, Gulf, and Pacific coasts, &c.—Continued.

Coast-sections.	Parties.	Operations.	Persons conducting operations.	Localities of work.
SECTION I—Continued.	....	Tidal observations.	J. G. Spaulding; H. Howland	Observations with self-registering gauge continued at North Haven, on the Fox Islands, in Penobscot Bay, and at the Charlestown navy-yard, near Boston, Mass.; series of observations commenced at Providence, R. I.
SECTION II.				
Atlantic coast and seaports of Connecticut, New York, New Jersey, Pennsylvania, and Delaware, including bays and rivers, and also Lake Champlain.	No. 1	Topography	A. M. Harrison, assistant; Bion Bradbury, aid.	Plane-table survey of the coast of Connecticut extended near Charlestown, west of Point Judith. (See also Section VI.)
	2	Reconnaissance...	John Farley, assistant	Examination of station-marks of the coast-triangulation of Rhode Island and Connecticut.
	3	Topography and hydrography.	R. M. Bache, assistant	Plane-table survey of the shores and hydrographic survey of New Haven Harbor, Conn.
	4	Hydrography	F. H. Gerdes, assistant; C. P. Dillaway, subassistant; C. A. Ives, aid.	Development of a shoal in Long Island Sound, southeast of New Haven light-house.
	5	Hydrography	H. Mitchell, assistant; F. F. Nes and H. L. Marindin, assistants; E. B. Pleasants and J. B. Weir, aids.	Soundings and current-observations in New York Harbor, including East River, Gowanus Bay, Jersey Flats, and the anchorage in Sandy Hook roadstead. (See also Section I.)
	6	Topography	F. W. Dorr, assistant; W. E. McClintock, aid.	Gowanus Bay (New York Harbor) traced in outline, and alterations surveyed in detail. (See also Sections I and IV.)
	7	Topography and hydrography.	F. H. Gerdes, assistant; C. P. Dillaway, subassistant; C. A. Ives and H. Gerdes, aids.	Topographical survey and sounding of Hackensack River and Raritan River to the head of navigation, and completion of hydrography in Newark Bay, N. J.
	8	Triangulation.....	S. C. McCorkle, assistant, R. P. Maynard, aid.	Triangulation of Lake Champlain from Burlington, Vt., southward to Crown Point.
	9	Triangulation.....	R. E. Halter, assistant; B. A. Colonna and D. S. Wolcott, aids.	Measurement of base-line and triangulation of Lake Champlain from Crown Point southward to White Hall.
	10	Topography	H. G. Ogden, assistant; Andrew Braid, aid.	Plane-table survey of the vicinity of Burlington, Vt., and of the shores of Cumberland Bay, including Plattsburgh, N. Y. (See also Section VII.)
	11	Hydrography.....	Charles Junken, assistant; L. B. Wright, subassistant; Jos. Hergesheimer, aid; T. J. Lowry, F. W. Ring, and M. M. Defrees, aids.	Soundings completed in the western part of Lake Champlain, from Burlington, Vt., and Cumberland Head northward to the United States boundary, and in the eastern arm to Butler's Island. (See also Sections VIII and IX.)
	12	Triangulation	F. W. Perkins, subassistant; J. F. Pratt, aid.	Triangulation between Mount Holly, N. J., and Barnegat light-house. (See also Section VII.)
	13	Topography	C. M. Bache, assistant; H. W. Bache, subassistant; George D. Rand, aid.	Topography of the coast of New Jersey completed between Barnegat and Great Bay, including Manahawken and Tuckerton. (See also Section IV.)
	14	Hydrography......	W. I. Vinal, subassistant; J. J. Evans and L. A. Bailey, aids.	Soundings completed along the coast of New Jersey, between Little Egg Harbor light-house and Absecom, including the sea-water channels inside of the coast-line. (See also section V.)
	15	Triangulation.....	S. C. McCorkle, assistant..........	Points determined between League Island and Fairmount for the hydrographic survey of the Schuylkill River at Philadelphia.
		Tidal observations.	R. T. Bassett	Series of observations continued at Governor's Island in New York Harbor, and at Brooklyn, N. Y.
SECTION III.				
Atlantic coast and bays of Maryland and Virginia, including seaports and rivers.	1	Topography and hydrography.	J. W. Donn, assistant; S. N. Ogden and F. C. Donn, aids.	Detailed topography and hydrography of the James River, Va., from Newport News Point upward, and including Warwick River. (See also Section I.)

Distribution of surveying-parties upon the Atlantic, Gulf, and Pacific coasts, &c.—Continued.

Coast-sections.	Parties.	Operations.	Persons conducting operations.	Localities of work.
SECTION III—Continued..	No. 2	Hydrography.....	Acting Master Robert Platt, U. S. N.; J. B. Adamson and C. L. Gardner, aids.	Hydrography of Elizabeth River, Va. (See also Sections IV and VI.)
	3	Reconnaissance...	A. T. Mosman, assistant..........	Reconnaissance westward from Harper's Ferry, Va., for geodetic connection between the Atlantic and Pacific coasts. (See also Section V and Interior.)
		Tidal observations	W. J. Bodell....................	Series continued with self-registering tide-gauge at Old Point Comfort, Va.
SECTION IV. Atlantic coast and sounds of North Carolina, including sea-ports and rivers.	1	Triangulation.....	G. A. Fairfield, assistant; B. A. Colonna, aid.	Triangulation of the upper part of Pungo River, and of the vicinity of Cedar Island and Bay, Pamplico Sound, N. C. (See also Section I.)
	2	Topography	F. W. Dorr, assistant; W. E. McClintock, aid.	Topography of the approaches to Washington, N. C., and detailed survey of the shores of Pungo River and its branches as far up as Pungo Creek and Durand's Point. (See also Sections I and II.)
	3	Topography	C. T. Iardella, assistant; W. C. Hodgkins, aid.	Plane-table survey of Cape Hatteras and vicinity, including Hatteras Inlet. Topography of Cedar Island Bay and adjacent branches of Pamplico Sound. (See also Section I.)
	4	Hydrography.....	F. F. Nes, assistant; C. P. Dillaway, subassistant.	Hydrography extended in Pamplico Sound, and completed in Bell's Bay and in Pamplico River; soundings in Pungo River from its mouth upward to Leachville. (See also Section II.)
	5	Hydrography.....	Acting Master Robert Platt, U. S. N.; J. B. Adamson and C. L. Gardner, aids.	Hydrography of the outer shoals off Cape Hatteras. (See also Sections III and VI.)
	6	Topography	C. M. Bache, assistant; H. M. De Wees and H. W. Bache, subassistants.	Detailed survey of the coast of North Carolina between Bogue Inlet and New Inlet. (See also Section II.)
SECTION V. Atlantic coast and sea-water channels of South Carolina and Georgia, including sounds, harbors, and rivers.		Shore-line and hydrography.	W. I. Vinal, subassistant; J. J. Evans, aid.	Shore-line survey of Smith's Island, and hydrographic development of the entrances to Cape Fear River, N. C. (See also Section II.)
	2	Topography	O. H. Tittman, subassistant; Bryant Godwin, aid.	Development of Little River entrance and reconnaissance of the coast of South Carolina southward toward Winyah Bay.
	3	Topography	W. H. Dennis, assistant; A. P. Barnard, aid.	Plane-table survey of the shores of Winyah Bay, including parts of the Sampit, Pedee, and Waccamaw Rivers, and the vicinity of Georgetown, S. C. (See also Section I.)
	4	Topography and hydrography.	Charles Hosmer, assistant; R. B. Palfrey, aid.	Detailed survey of sea-island water-passages, including adjacent parts of Saint Helena Island and Ladies Island with soundings, and survey of part of Port Royal Island, S. C. (See also Section I.)
	5	Astronomical observations.	A. T. Mosman, assistant; Edwin Smith, aid.	Latitude, azimuth, and the magnetic elements determined at Butler station on Saint Simon's Island, Ga. (See also Interior.)
	6	Hydrography.....	F. P. Webber, assistant; D. B. Wainwright and D. C. Hanson, aids.	Sounding of the sea-island channels between Doboy Sound and Saint Simon's Sound, Ga. (See also Sections VI and VII.)
SECTION VI. Atlantic and Gulf coast of the Florida Peninsula, including reefs and keys, and the sea-ports and rivers.	1	Hydrography.....	F. P. Webber, assistant; D. B. Wainwright and D. C. Hanson, aids.	Hydrography of Fort George Inlet, Fla., and of the sea-island channels connecting it with Saint John's River. (See also Sections V and VII.)
	2	Triangulation, topography, and hydrography.	A. M. Harrison, assistant; W. H. Stearns and Bion Bradbury, aids.	Detailed survey of the eastern coast of Florida, including the southern part of Matanzas River. (See also Section II.)

Distribution of surveying-parties upon the Atlantic, Gulf, and Pacific coasts, &c.—Continued.

Coast-sections.	Parties.	Operations.	Persons conducting operations.	Localities of work.
SECTION IV—Continued..	No. 3	Hydrography	Acting Master Robert Platt, U. S. N.; J. B. Adamson and C. L. Gardner, aids.	Development of a shoal off the coast of Florida near Indian River Inlet; deep-sea soundings between Cape San Antonio and Mugres Island on the coast of Yucatan. (See also Sections III and IV.)
	4	Hydrography	Commander J. A. Howell, U. S. N.; Lieutenant W. H. Jacques, E. S. Jacob, Richard Rush, and W. L. Field, U. S. N.	Soundings in the Gulf of Mexico off the western coast of Florida, and hydrography of the vicinity of Sand Key and Sombrero Key. (See also Section I.)
		Tidal observations.	....	Series of observations commenced with self-registering tide-gauge at Saint Thomas, West Indies.
SECTION VII.				
Gulf coast and sounds of Western Florida, including the ports and rivers.	1	Hydrography	Horace Anderson, assistant; F. H. North and E. H. King, aids.	Hydrography of the eastern entrance to Saint George's Sound, Fla., between Dog Island and South West Cape. (See also Section I.)
	2	Triangulation and topography.	F. W. Perkins, subassistant; J. N. McClintock, subassistant; L. F. Chew, aid.	Coast measurement and survey between Saint Andrew's Bay and Choctawhatchee Bay, Fla. (See also Section II.)
	3	Triangulation, topography, and hydrography.	H. G. Ogden, assistant; Andrew Braid and J. F. Pratt, aids.	Detailed survey of the shores and development of the waters of Choctawhatchee Bay, Fla. (See also Section II.)
	4	Reconnaissance ...	J. A. Sullivan, assistant	Reconnaissance for base-line and triangulation to determine points in Georgia.
	5	Geodetic operations.	C. O. Boutelle, assistant; H. W. Blair and Barnwell Habersham, aids.	Measurement of a primary base-line near Atlanta, Ga.
	6	Triangulation.....	F. P. Webber, assistant; W. H. Stearns, aid.	Triangulation in the vicinity of primary base near Atlanta, Ga. (See also Sections V and VI.)
SECTION VIII.				
Gulf coast and bays of Alabama, and the sounds of Mississippi and Louisiana to Vermilion Bay, including the ports and rivers.	1	Triangulation, topography, and hydrography.	C. H. Boyd, assistant; William Eimbeck, subassistant; Joseph Hergesheimer, aid, (part of season;) C. H. Van Orden, aid.	Detailed survey of the shores and development of the channel of the Mississippi River, from Magnolia upward to Jesuit Bend. (See also Section II.) Measurement of a base-line on "American Bottom," and triangulation continued in the vicinity of Saint Louis, Mo.
	2	Hydrography	F. D. Granger, subassistant; F. W. Ring, and E. B. Pleasants, aids.	Soundings in the southeastern approaches of the Mississippi Delta and in Mississippi River above and below Fort Jackson; hydrography of Trinity Shoal and Tiger Shoal off the entrance to Vermilion Bay, La. (See also Section I.)
SECTION IX.				
Gulf coast of western Louisiana and of Texas, including bays and rivers.	1	Hydrography	L. B. Wright, subassistant; T. J. Lowry, aid.	Hydrography of Matagorda Bay, Tex., completed by soundings in the northeastern arm. (See also Section II.)
	2	Astronomical observations.	William Eimbeck, subassistant ...	Determination of latitude, longitude, and the magnetic elements at Austin, Tex. (See also Section X.)
INTERIOR	1	Astronomical observations.	Richard D. Cutts, assistant; Professors C. A. Young and C. F. Emerson; A. T. Mosman, assistant; B. A. Colonna, aid.	Special observations on the sun and stars at Sherman, Wyoming Territory, above ordinary atmospheric perturbations; latitude and longitude of the station determined. (See also Sections II, III, and V.)
	2	Astronomical and magnetic observations.	George Davidson, assistant; S. R. Throckmorton and H. I. Willey, aids.	Latitude, longitude, triangulation, and the magnetic elements determined at Verdi, Nevada; special observations recorded with instruments greatly elevated above the ocean-level. (See also Section X.)

Distribution of surveying-parties upon the Atlantic, Gulf, and Pacific coasts, &c.—Continued.

Coast-sections.	Parties.	Operations.	Persons conducting operations.	Localities of work.
SECTION X.				
Coast of California, including the bays, harbors, and rivers.	No. 1	Hydrography	Commander Philip C. Johnson, U. S. N.; Lieut. Commander C. W. Kennedy, U. S. N.; Lieutenants M. S. Day, H. B. Mansfield, and E. W. Remy, U. S. N.	Hydrographic reconnaissance of part of the sailing-route between San Diego, Cal., and Panama.
	2	Triangulation and topography.	A. W. Chase, assistant............	Triangulation and detailed survey of the coast between San Gabriel River and Anaheim Landing, Cal. (See also Section XI.)
	3	Triangulation and topography.	Stehman Forney, subassistant	Triangulation and topography of the shores of Santa Rosa Island, Santa Barbara Channel.
	4	Triangulation.....	W. E. Greenwell, assistant........	Triangulation of the coast of California in the vicinity of Point Conception.
	5	Reconnaissance...	W. Eimbeck, subassistant	Selection of stations for connecting the survey of Santa Barbara Channel with that of Monterey Bay.
	6	Triangulation and topography.	L. A. Sengteller, assistant	Detailed survey of the coast of California north and south of San Luis Obispo.
	7	Triangulation and topography.	Cleveland Rockwell, assistant; G. H. Wilson, aid.	Triangulation and topography of the coast north of Piedras Blancas, Cal. (See also Section XI.)
	8	Triangulation and topography.	A. F. Rodgers, assistant; E. F. Dickins, aid.	Detailed survey of Table Mountain, (San Francisco entrance,) and of the Southeast Farallon.
	9	Astronomical observations.	George Davidson, assistant; S. R. Throckmorton and H. I. Willey, aids.	Longitude-observations at San Francisco for determining the one hundred and twentieth meridian; magnetic observations and determination of the co-efficient of refraction. (See also *Interior.*)
	10	Hydrography	Gershom Bradford, assistant; F. Westdahl, aid.	Special observations on the currents of San Francisco Bay and soundings in the approaches to the Golden Gate.
	11	Hydrography	Commander P. C. Johnson, U. S. N.; Lieut. Commander C. W. Kennedy, U. S. N.; Lieutenants M. S. Day, H. B. Mansfield, and E. W. Remy, U. S. N.	Hydrographic survey of Mare Island Strait, including the vicinity of the United States navy-yard.
	12	Topography and hydrography.	L. A. Sengteller, assistant; H. I. Willey, aid, (part of the season.)	Detailed survey of the coast of California north and south of Mendocino Bay, and hydrography of the bay.
	13	Triangulation and topography.	A. F. Rodgers, assistant; E. F. Dickins, aid.	Topography of the coast of California south of Shelter Cove.
	14	Hydrography	Gershom Bradford, assistant; F. Westdahl, aid.	Soundings off Cape Mendocino and development of the vicinity of Blunt's Reef; hydrography of Trinidad Harbor.
	15	Triangulation.....	A. W. Chase, assistant	Triangulation of the coast of California south of False Klamath River. (See also Section XI.)
		Tidal observations	Maj. G. H. Mendell, United States Engineers; William Knapp and E. Gray, observers.	Tidal observations completed at San Diego, Cal.; series continued at Fort Point, near San Francisco. (See also Section XI.)
SECTION XI.				
Coast of Oregon and of Washington Territory, including the interior bays, ports, and rivers.	1	Triangulation and topography.	A. W. Chase, assistant	Detailed survey of the coast of Oregon near Mack's Arch; soundings to develop the anchorage at Chetko River entrance. (See also Section X.)
	2	Triangulation and topography.	Cleveland Rockwell, assistant; G. H. Wilson, aid.	Topography of the shores of the Columbia River, including Puget Sound and others near Cathlamet and Westport. (See also Section X.)
	3	Triangulation and topography.	J. J. Gilbert, subassistant	Triangulation and survey of the shores of Shoalwater Bay, Washington Territory.

Distribution of surveying-parties upon the Atlantic, Gulf, and Pacific coasts, &c.—Continued.

Coast-sections.	Parties.	Operations.	Persons conducting operations.	Localities of work.
SECTION XI—Continued..	No. 4	Triangulation and topography.	James S. Lawson, assistant; Eugene Ellicott, subassistant; F. A. Lawson, aid.	Survey of the shores of Admiralty Inlet and of the eastern shore of Possession Sound; shore-line survey of Budd's Inlet, at the head of Puget Sound.
		Tidal observations	Maj. G. H. Mendell, United States Engineers; L. Wilson, observer.	Tidal observations continued at Astoria, Oreg.; series of observations commenced at Port Townshend, Washington Territory. (See also Section X.)
SECTION XII.				
Coast of Alaska Territory	1	Astronomical observations, shore-line, and hydrography.	W. H. Dall, assistant; M. W. Harrington, assistant.	Geographical and hydrographic development of various harbors among the Aleutians and the Shumagin group of islands off the coast of Alaska, with observations on the tides, currents, and magnetic elements.
		Tidal observations	W. H. Dall, assistant; Capt. Charles Bryant.	Series continued with self-registering tide-gauge at Iliouliouk on the Aleutian Islands, Alaska; series of tidal observations commenced at Saint Paul Island in Behring Sea.

APPENDIX No. 2.

Statistics of field and office work of the United States Coast Survey during the years—

	Previous to 1865.	1865.	1866.	1867	1868.	1869.	1870.	1871.	Total.
RECONNAISSANCE.									
Area in square miles	63, 136	59	588	413	32	1, 125	320	4, 173	69, 846
Parties, number of, n each year	38	3	1	1	2	3	3	3	54
BASE-LINES.									
Primary, number of	10	....	....	....	....	1	1	....	12
Secondary, number of	58	....	3	6	3	3	6	5	84
Length of, in miles	167	....	2	$40\frac{1}{4}$	$3\frac{1}{3}$	$7\frac{1}{4}$	$11\frac{2}{3}$	$3\frac{1}{4}$	$234\frac{1}{2}$
TRIANGULATION.									
Area in square miles	56, 615	59	588	653	100	269	1, 355	1, 033	60, 672
Extent of general coast in miles	4, 793	....	70	150	....	....	....	....	....
Extent of shore-line in miles, including bays, sounds, islands, and rivers	23, 960	....	440	100	....	....	....	....	....
Horizontal-angle stations occupied	5, 545	72	122	218	114	205	314	402	6, 992
Geographical positions determined	10, 476	132	391	363	244	364	480	650	13, 100
Vertical angle stations occupied	344	2	3	....	....	2	19	12	382
Elevations determined, number of	732	....	3	1	....	5	29	28	798
Parties, number of, in each year	132	6	11	12	10	14	14	28	227
ASTRONOMICAL OPERATIONS.									
Stations occupied for azimuth	86	1	4	....	2	7	4	11	115
Stations occupied for latitude	140	15	5	5	1	13	6	11	196
Stations occupied for longitude	95	13	108	7	....	16	5	6	250
Permanent longitude-stations	42	....	....	....	....	....	....	....	42
Parties, number of, in each year	31	2	....	2	3	10	8	9	65
Magnetic stations occupied, number of	253	16	13	7	2	9	11	13	324
Parties, number of, in each year	33	4	3	3	3	3	6	7	62
TOPOGRAPHY.									
Area surveyed, square miles	17, 904	501	144	403	429	682	942	721	21, 726
Length of general coast in miles	4, 232	29	71	219	55	242	229	211	5, 288
Length of shore-line in miles, including rivers, creeks, and ponds	45, 260	1, 372	598	1, 208	1, 935	1, 901	5, 993	2, 264	60, 531
Length of roads in miles	28, 459	559	310	428	453	602	1, 134	483	32, 428
Parties, number of, in each year	149	22	22	23	20	21	27	28	312
HYDROGRAPHY.									
Parties, number of, in each year	78	12	18	24	17	21	20	32	222
Number of miles run while sounding	184, 769	4, 825	8, 064	9, 392	11, 071	7, 386	7, 755	12, 022	245, 284
Area sounded out in square miles	47, 615	334	454	819	2, 551	1, 191	1, 324	1, 988	56, 276
Miles run additional, of outside or deep-sea soundings	30, 340	....	....	80	....	318	....	....	30, 738
Soundings, number of	7, 288, 789	299, 597	397, 914	530, 415	606, 101	496, 047	442, 922	638, 846	10, 700, 631
Soundings in Gulf Stream for temperature	4, 072	....	....	....	....	....	....	....	4, 072
Tidal stations, permanent	119	7	7	7	7	7	7	7	168
Tidal stations occupied temporarily	1, 107	11	41	41	35	30	30	40	1, 335
Tidal parties, number of, in each year	100	6	20	21	19	21	17	22	226
Current-stations occupied	1, 012	6	20	27	1	6	....	....	....
Current-parties, number of, in each year	21	1	2	6	1	3	3	....	....
Specimens of bottom, number of	8, 454	....	58	511	250	153	61	122	9, 609
RECORDS.									
Triangulation, originals, number of volumes	1, 229	13	23	27	23	40	45	64	1, 464
Astronomical observations, originals, number of volumes	648	2	17	10	12	63	29	45	826
Magnetic observations, originals, number of volumes	196	49	8	6	4	4	5	12	284

Statistics of field and office work of the United States Coast Survey, &c.—Continued.

	Previous to 1865.	1865.	1866.	1867.	1868.	1869.	1870.	1871.	Total.
RECORDS—Continued.									
Duplicates of the above, number of volumes...	1, 481	16	42	45	32	82	82	111	1, 891
Computations, number of volumes............	1, 331	101	69	41	44	69	58	92	1, 805
Hydrographic soundings and angles, originals, volumes	3, 749	135	179	272	271	446	143	254	5, 449[1]
Hydrographic soundings and angles, duplicates, volumes	292	12	15	19	....	37	28	....	403
Tidal and current observations, originals, volumes	1, 829	16	62	62	53	107	44	56	2, 229
Tidal and current observations, duplicates, volumes	1, 578	12	32	31	25	24	19	23	1, 744
Sheets from self-registering tide-gauges, number of........................	1, 330	84	84	84	90	84	95	96	1, 947
Tidal reductions, number of volumes	1, 179	36	38	39	38	40	37	41	1, 448
Total number of volumes of records	13, 504	356	447	531	511	877	559	578	17, 363
MAPS AND CHARTS.									
Topographical maps, originals..................	973	44	20	33	25	37	56	50	1, 238
Hydrographic charts, originals.................	872	22	25	32	47	40	54	47	1, 139
Reductions from original sheets................	602	29	20	13	9	12	11	13	709
Total number of manuscript maps and charts..	2, 370	29	20	13	9	12	11	13	2, 477
Number of sketches made in field and Office...	2, 346	60	26	48	22	36	51	44	2, 633
ENGRAVING AND PRINTING.									
Engraved plates of finished charts, number of..	111	8	11	9	11	8	3	4	165
Engraved plates of preliminary charts, sketches, and diagrams for the Coast Survey reports, number of	435	18	16	13	12	17	16	20	547
Electrotype plates made in each year	785	24	28	22	18	24	34	30	965
Finished charts published in each year	104	9	8	3	6	7	6	11	154
Preliminary charts and hydrographic sketches published........................	415	10	6	2	2	2	7	11	455
Printed sheets of maps and charts distributed.	191, 709	22, 556	10, 900	9, 703	13, 900	12, 843	11, 420	5, 041	278, 031
Printed sheets of maps and charts deposited with sale-agents........................	63, 219	5, 426	4, 007	4, 420	7, 545	4, 623	4, 633	5, 242	99, 115
LIBRARY.									
Number of volumes	4, 005	161	178	239	162	136	94	231	5, 206
INSTRUMENTS.									
Cost of........................	$55, 374. 63	$1, 500. 00	$2, 511. 50	$3, 150. 74	$2, 639. 85	$3, 182. 15	$2, 844. 56	$5, 774. 23	$76, 977. 66

GENERAL NOTE.

Triangulation.—The extent of general coast is measured in outline, including Delaware and Chesapeake, as well as all open bays, but omitting the minor indentations of the sea-coast. The extent of shore-line is also measured in general outline, and includes such rivers only as have been triangulated.

Topography.—The length of general coast is measured similarly to that under triangulation; but the shore-line under topography represents the whole water-line surveyed, including all the minor indentations, as represented on the plane-table sheets.

Engraved plates.—Progress-sketches (averaging twelve yearly) are not counted.

It is to be remarked that the numbers appearing in the column of this table for the year immediately preceding that of its compilation are in some cases subject to be changed, more or less, in the succeeding report, owing to data not being, at the time of compilation, fully turned into the Office from the distant parties in the field.

APPENDIX No. 3.

Information furnished from the Coast Survey Office, by tracings from original sheets, &c., in reply to special calls during the year ending November, 1872.

Date.		Names.	Data furnished.
1871.			
November	6	Col. George H. Thom, United States Corps of Engineers.	Hydrographic approaches to Seal Harbor, coast of Maine, showing south breaker.
December	15	Col. J. H. Simpson, United States Corps of Engineers.	Hydrographic survey of Santa Rosa Sound, from Deer Point to Choctawhatchee Pass, Fla.
	29	Enoch Cousins, esq	Topographical survey, vicinity of Kennebunk Port, Me.
	29	Jacob M. Clarke, civil engineer	Hydrographic survey of the entrance to Raritan River, N. J.
	30	H. L. Whiting, assistant Coast Survey	Topographical survey of Point Gammon, Mass.
	30	........do	Topographical survey of part of Cape Ann, vicinity of Gloucester, Mass.
	30	Dr. Howland, Washington, D. C	Hydrographic survey of Potomac River, Fort Washington to Marshall's Point.
1872.			
January	16	Committee on District of Columbia, House of Representatives.	Hydrographic survey of the Potomac River, from Aqueduct to Anacostia bridge.
	23	Board of public works, District of Columbia	Hydrographic survey of the Potomac River, from Aqueduct to Anacostia bridge.
February	9	G. H. Thomson, esq., assistant engineer New Orleans, M. and T. R. R.	Hydrographic survey of the Rigolets, La.
	16	New York pilot-commissioners	Comparative chart of New York Harbor, from surveys of 1855 and 1871.
	19	E. A. Marshall, esq	Hydrographic and topographical surveys of Wimbee Creek, S. C.
	19	Hon. F. T. Frelinghuysen	Comparative chart of New York Harbor, showing changes between surveys of 1855 and 1871.
arch	7	General Q. A. Gillmore, United States Corps of Engineers.	Hydrographic survey of Inside Passage, from near Fernandina, towards the Saint John's River, Fla.
	5	Daniel T. Van Buren, esq	Hydrographic survey of the west side of the Hudson River, from Knickerbocker Pier to Tyler's Point.
	11	Maj. George H. Elliot, United States Corps of Engineers.	Topographical survey of Anacapa Island, off coast of California.
	15	Maj. G. K. Warren, United States Corps of Engineers.	Hydrographic survey of entrance to Saugatuck River, Conn.
	26	United States Corps of Engineers	Hydrographic survey of main channel and bar of Cedar Keys, Fla.
April	3	Committee on Ways and Means, House of Representatives.	Estimated coast-line of the Atlantic, Gulf, and Pacific States, with that of Alaska.
	8	George H. Bagwell, esq	Topographical survey of the inner shore of Chincoteague Island and Marsh Islands, in Chincoteague Bay, Va.
	9	United States Light-House Board	Topographical survey of the southeast end of Mare Island, Cal.
	9	Theodore W. Dimon, esq	Hydrographic approaches to Dix Island, Me.
	10	David Pennell, esq	Hydrographic survey of Wills Straits, Me.
	17	Rumford Chemical Works, Providence, R. I	Hydrographic and topographical survey of the Seekonk River, R. I.
	29	Hon. James Buffinton, Massachusetts	Hydrographic and topographical survey of Fall River, Mass., and vicinity.
May	2	Bvt. Maj. Gen. W. H. Emory, U. S. A	Hydrographic survey of Dry Tortugas Keys, Fla.
	2	Prof. N. S. Shaler, State geologist of Massachusetts	Plan and sections in Narragansett Bay, R. I.
	3	Edward Dodge, esq	Hydrographic survey of the outer edge of the Jersey Flats, from Jersey City to Rollin's Reef light.
	3	........do	Topographical survey of west side of Newark Bay, from Newark Neck to Maple Island Creek.
	4	G. S. Green, esq	Hydrographic survey of Barnegat Inlet and a portion of the bar southward.
	4	........do	Topographical survey, coast of New Jersey, south of Barnegat Inlet.
	20	Col. W. P. Craighill, United States Corps of Engineers	Hydrographic survey of the western entrance to Cape Fear River, N. C.
	27	Hon. Lucius Armstrong, chairman committee of sewers, city of Newark, N. J.	Hydrographic survey of Passaic River and part of Newark Bay.
	31	Prof. N. S. Shaler, State geologist of Massachusetts	Topographical survey of the southeast portion of Boston Harbor, including the islands, from Weymouth Fore River to Point Allerton, Mass.

Information furnished from the Coast Survey Office, &c.—Continued.

Date.		Names.	Data furnished.
1872.			
May	31	Prof. N. S. Shaler, State geologist of Massachusetts	Topographical survey of the southern portion of Boston Bay, from Cohasset Harbor to Point Allerton, Mass.
June	14	Admiral G. H. Richards, royal navy	Line of deep-sea soundings from Cuba to Yucatan.
	21	Department of Docks, New York	Hydrographic survey of Gowanus Bay, New York Harbor.
	21	William R. Hutton, esq	Topographical and hydrographic surveys of Drum Point, Patuxent River, Md.
	25	Maj. Geo. H. Elliot, United States Corps of Engineers	Hydrographic survey of Trinity Shoals, coast of Louisiana.
	27	G. H. Bagwell, esq	Topographical survey of northern portion of Chincoteague Island, Md.
	28	Prof. N. S. Shaler, State geologist of Massachusetts.	Complete topographical survey of Martha's Vineyard, Mass.
July	6	Maj. G. K. Warren, United States Corps of Engineers	Hydrographic survey of Providence River and Wickford Harbor, R. I.
	8	Maj. W. P. Craighill, United States Corps of Engineers	Hydrographic survey of Edenton Harbor, N. C.
	8	......do	Hydrographic survey of Mackey's Creek, N. C.
	8	......do	Hydrographic survey of part of Eastern Bay and Chester River, by way of Kent Island Narrows, Md.
	8	......do	Hydrographic survey of Nomini Bay and Creek, Va.
	8	Hydrographic Bureau, Navy Department	Topographical survey of Cape Mendocino and portion of Blunt's Reef, Cal.
	13	Maj. George H. Elliot, United States Corps of Engineers.	Tracing of hydrographic and topographical surveys of Wood End, Cape Cod, Mass.
	18	......do	Topographical survey of coast of New Jersey, vicinity of Hereford Inlet
	18	Col. J. H. Simpson, United States Corps of Engineers	Hydrographic survey of Saint George's Sound, Fla.
	20	Maj. Geo. H. Elliot, United States Corps of Engineers	Topographical survey of Point Fennin, Cal.
	22	......do	Topographical survey of Point Hueneme, Cal.
	24	G. S. Green, jr., esq	Topographical survey of Morrisania and vicinity, N. Y.
	29	Maj. Geo. H. Elliot, United States Corps of Engineers	Topographical survey of coast of North Carolina, south of Cape Henry.
	29	Maj. William P. Craighill, United States Corps of Engineers.	Hydrographic survey of New Inlet, Cape Fear River, N. C.
August	3	Maj. Henry M. Robert, United States Corps of Engineers.	Hydrographic survey of Port Orford, or Ewing Harbor, Oreg.
	7	H. Rosenberg, president of the board of harbor-improvements.	Hydrographic survey of Galveston entrance and harbor, Tex.
	8	Lieut. Col. C. S. Stewart, United States Corps of Engineers.	Hydrographic survey of Rincon Rock, San Francisco Harbor, Cal.
	14	Lieut. Col. G. H. Thom, United States Corps of Engineers.	Hydrographic survey of Kennebec River, vicinity of Swan Island, Me.
	14	......do	Hydrographic survey of Camden Harbor, Me.
	21	H. H. Dodge, esq	Hydrographic and topographical surveys of the Upper Potomac River, from Aqueduct Bridge to Chain Bridge.
	30	Maj. William P. Craighill, United States Corps of Engineers.	Hydrographic survey of Washington Harbor, N. C.
	31	G. S. Green, jr., esq	Topographical survey of coast of New Jersey, below Barnegat Inlet.
	31	Department of public parks, New York	Hydrographic survey of east side of Hudson River, from Spuyten Duyvil Creek to Yonkers.
September	3	George W. Parsons, esq., Salisbury, Md	Hydrographic survey of Crisfield Harbor, Md.
	3	Lieut. Col. G. H. Thom, United States Corps of Engineers.	Hydrographic survey of Salem Harbor, Mass.
	3	Col. J. D. Kurtz, United States Corps of Engineers.	Hydrographic survey of Cohansey Creek, N. J.
	3	......do	Topographical survey of Billingsport, N. J.
	3	......do	Hydrographic survey of entrance to Chincoteague, Va.
	3	Delaware and Raritan Canal Company	Valley of the Raritan River, from New Brunswick to Perth Amboy, N. J.
	21	Marsh-Land Company, New York	Hydrographic and topographical surveys of Flushing Bay, N. Y.
	26	Dr. T. F. Cherry, Baltimore, Md	Topographical survey of Paramore's Island, Va.
October	16	Col. John G. Stevens, New Jersey	Topographical and hydrographic surveys of Newark Bay, N. J.
	21	Harbor-improvement committee	Hydrographic and topographical surveys of New Haven Harbor and vicinity, Conn.
	26	H. R. Thomas, esq	Hydrographic survey of Plattsburgh, city, (front,) N. Y.
	28	Col. J. D. Kurtz, United States Corps of Engineers.	Topographical survey of coast of Maryland, vicinity of Isle of Wight Bay.
	28	Captain C. W. Howell, United States Corps of Engineers.	Hydrographic survey of Galveston Bay, Texas, from surveys of 1852 and 1867.

APPENDIX No. 4.

DRAWING DIVISION.

Charts completed or in progress during the year ending November 1, 1872.

1. Hydrography. 2. Topography. 3. Drawing for photographic reduction. 4. Details on photographic outlines. 5. Verification. 6. Lettering.

Titles of charts.	Scale.	Draughtsmen.	Remarks.
Moose-a-bec Reach, Me	1-40,000	1. H. Lindenkohl.	
Some's Sound and Southwest Harbor, Me	1-40,000	1, 2. L. Karcher	Preliminary edition; completed.
Coast chart No. 3, Petit Manan Light to Naskeag Point, Me	1-80,000	3. F. Smith. 4. H. Lindenkohl.	
Coast chart No. 4, Naskeag Head to White Head light, Me	1-80,000	3. F. Smith. 4. H. Lindenkohl.	
Penobscot Bay, Me., (western part)	1-40,000	1. H. Lindenkohl. 1. A. Lindenkohl.	
Coast chart No. 6, Seguin Island to Wood Island light, Me	1-80,000	1. A. Lindenkohl. 2. H. Lindenkohl	Completed.
Saint George's River and Muscle Ridge Channel, Me	1-40,000	1. H. Lindenkohl.	
Casco Bay, Me	1-40,000	1. A. Lindenkohl	Additions.
General coast chart No. I, Quoddy Head to Cape Cod, Mass	1-400,000	1. A. Lindenkohl. 2. H. Lindenkohl	Additions.
Coast chart No. 7, Seguin Island to Cape Porpoise, Me	1-80,000	1. A. Lindenkohl. 3. F. Smith	Additions.
Plymouth, Duxbury, and Kingston Harbors, Mass	1-40,000	1, 2. H. Lindenkohl	Completed.
Coast chart No. 10, Cape Cod Bay, Mass	1-80,000	1. A. Lindenkohl	Additions; completed.
Coast chart No. 11, Monomoy and Nantucket Shoals, Mass	1-80,000	1, 2. A. Lindenkohl	Additions; completed.
Narragansett Bay, (upper sheet)	1-40,000	2. P. Erichsen.	
Narragansett Bay, (lower sheet)	1-40,000	2. H. Lindenkohl.	
Coast chart No. 13, Narragansett Bay, R. I	1-80,000	1. A. Lindenkohl. 3. F. Smith.	
Burlington Harbor, Vt., (photolithograph)	1-16,000	1. F. Fairfax. 2. P. Erichsen.	
Lake Champlain, Vt. and N. Y	1-40,000	2. L. Karcher.	
Coast chart No. 26, off Philadelphia	1-80,000	1. A. Lindenkohl	Additions; completed.
Coast chart No. 27, Cape May to Isle of Wight, Del	1-80,000	1. A. Lindenkohl	Additions; completed.
Coast chart No. 30, Hog Island to Cape Henry, Va	1-80,000	1, 2. A. Lindenkohl.	
Coast chart No. 31, Entrance to Chesapeake, Hampton Roads, &c.	1-80,000	1, 2. A. Lindenkohl	Additions; completed.
Coast chart No. 32, York River to Pocomoke Sound	1-80,000	1, 2. A. Lindenkohl	Additions; completed.
Coast chart No. 33, Pocomoke Sound to York River	1-80,000	1, 2. A. Lindenkohl	Additions; completed.
Coast chart No. 34, Potomac River to Choptank River	1-80,000	1, 2. A. Lindenkohl	Additions; completed.
Coast chart No. 35, Choptank River to Magothy River	1-80,000	1, 2. A. Lindenkohl	Additions; completed.
Coast chart No. 36, Magothy River to Head of Bay	1-80,000	1, 2. A. Lindenkohl. 1. H. Lindenkohl	Additions; completed.
Coast chart No. 42, part of Pamplico Sound, N. C	1-80,000	2. F. Fairfax.	
Coast chart No. 43, Pamplico Sound, N. C	1-80,000	2. H. Lindenkohl.	
Coast chart No. 44, Pamplico and Neuse Rivers	1-80,000	1, 2. A. Lindenkohl. 2. H. Lindenkohl.	
Bull and Combahee Rivers, S. C., (lithographic)	1-40,000	1, 2. H. Lindenkohl. 2. F. Fairfax	Completed.
Savannah River and Wassaw Sound, Ga	1-40,000	2. E. J. Sommer	Additions; completed.
Coast chart No. 55, Hunting Island to Ossabaw Sound, including Savannah River.	1-80,000	1, 2. H. Lindenkohl	Additions; completed.
General coast chart No. VII, Cape Roman to Cumberland Sound, Fla.	1-400,000	1, 2. A. Lindenkohl	Additions.
Inside Passage between Coosaw River and Broad River, S. C	1-40,000	1. A. Lindenkohl. 2. L. Karcher.	
Saint Andrew's Sound, Ga	1-40,000	1. F. Fairfax.	
General coast chart No. X, Straits of Florida	1-400,000	1. A. Lindenkohl	Additions.
Coast chart No. 86, Choctawhatchee Entrance to Pensacola, Fla	1-80,000	1. A. Lindenkohl. 1. H. Lindenkohl. 2. P. Erichsen.	Additions.
Coast chart No. 87, Pensacola to Mobile Bay, Fla	1-80,000	2. H. Lindenkohl.	
Coast chart No. 91, Lakes Borgne and Pontchartrain, La	1-80,000	1. H. Lindenkohl.	
Coast chart No. 93, Mississippi River and Delta, La	1-80,000	1. A. Lindenkohl.	
General coast chart No. XIII, Pensacola to Mississippi Delta, La.	1-400,000	1, 2. A. Lindenkohl	Additions.
Coast chart No. 107, Matagorda and Lavacca Bays	1-80,000	1, 2. H. Linderkohl.	
General coast chart No. XVI, Galveston to Rio Grande, Tex	1-400,000	2. H. Lindenkohl	Additions; completed.
Sailing-chart, Gulf of Mexico	1-1,200,000	1. A. Lindenkohl	Additions; completed.
Western coast No. 7, Mendocino City to Humboldt Bay	1-200,000	1, 2. A. Lindenkohl.	
Columbia River, Oregon, (sheet No. 2)	1-40,000	1, 2. L. Karcher.	
Washington Sound, Washington Territory	1-200,000	1. A. Lindenkohl	Additions; completed.

Charts completed or in progress during the year ending November 1, 1872—Continued.

Titles of charts.	Scale.	Draughtsmen.	Remarks.
MISCELLANEOUS.			
Progress-sketches for 1869		A. Lindenkohl	Completed.
Beaufort Harbor, N. C., (lithographic)	1-20,000	H. Lindenkohl	Completed.
Diagrams illustrating eclipses of 1869 and 1870		L. Karcher, A. Schott	Completed.
Coloring lights and buoys on charts		H. Eichholtz.	
Duplicating geographical positions		M. E. Nesbitt.	
Copper-plate projections		A. Lindenkohl.	
Numbering tidal cylinders		H. Lindenkohl, F. Smith.	
Autographic maps of Narragansett Bay, R. I	1-10,000	F. Smith, P. Erichsen, E. J. Sommer.	
Plotting stars on celestial globe		L. Karcher	Completed.
Duplicating plane-table sheets		P. Erichsen.	
Field-projections		L. Karcher.	
Sketch of Sherman station, Wyoming Territory		E. J. Sommer.	
Hypsometric chart, (engraving on stone)		H. Lindenkohl	Completed.

APPENDIX No. 5.

ENGRAVING DIVISION.

Plates completed, continued, or commenced during the year 1872.

1. Outlines. 2. Topography. 3. Sanding. 4. Lettering.

Titles of plates.	Scale.	Engravers.
COMPLETED.		
Coast charts:		
No. 10, Cape Cod Bay	80, 000	3. F. W. Benner. 4. E. A. Maedel and J. Knight.
No. 54, Charleston to Saint Helena Sound	80, 000	2. A. Sengteller. 4. A. Petersen.
Damariscotta and Medomak Rivers, (preliminary edition)	40, 000	2 and 3. H. M. Knight. 4. A. Petersen and J. G. Thompson.
Burlington Harbor, (preliminary edition)	10, 000	1 and 2. J. C. Kondrup. 4. E. H. Sipe.
Bull and Combahee Rivers	40, 000	1. J. C. Kondrup. 2. J. G. Thompson. 3. W. H. Davis. 4. J. G. Thompson, W. H. Davis, and E. H. Sipe.
Doboy and Altamaha Sounds	40, 000	3. F. W. Benner. 4. J. G. Thompson and E. H. Sipe.
Suisun Bay	40, 000	2. A. Sengteller and R. F. Bartle. 3. F. W. Benner.
CONTINUED.		
General coast charts:		
No. II, Cape Ann to Gay Head	400, 000	4. J. Knight.
No. IV, Cape May to Cape Henry	400, 000	1 and 2. A. M. Maedel. 3. F. W. Benner.
No. XIII, Pensacola to Southwest Pass	400, 000	2. A. M. Maedel. 4. E. A. Maedel.
Coast charts:		
No. 3, Frenchman's and Blue Hill Bays	80, 000	1 and 2. J. Enthoffer.
No. 4, Penobscot Bay	80, 000	1. J. Enthoffer.
No. 5, Penobscot Bay to Kennebec Entrance	80, 000	3. H. S. Barnard. 4. J. Knight and E. A. Maedel.
No. 6, Kennebec Entrance to Saco River	80, 000	1 and 2. J. Enthoffer. 4. E. A. Maedel.
No. 7, Kennebec Entrance to Cape Porpoise	80, 000	1 and 2. J. Enthoffer. 4. A. Petersen.
No. 29, Chincoteague Inlet to Hog Island light	80, 000	1 and 2. H. C. Evans. 4. A. Petersen and J. G. Thompson.
No. 30, Hog Island light to Cape Henry	80, 000	1 and 2. H. C. Evans. 4. A. Petersen.
No. 31, Entrance to Chesapeake, Hampton Roads, (new edition)	80, 000	3. F. W. Benner. 4. A. Petersen.
No. 32, York River to Pocomoke Sound, (new edition)	80, 000	3. F. W. Benner. 4. J. Knight.
No. 33, Pocomoke Sound to Potomac River, (new edition)	80, 000	2. A. Sengteller.
No. 36, Magothy River to head of bay	80, 000	3. F. W. Benner.
No. 50, Cape Fear and approaches	80, 000	4. J. Knight.
No. 55, Hunting Island to Ossabaw Sound	80, 000	2. A. Sengteller. 3. H. S. Barnard. 4. E. A. Maedel.
No. 56, Savannah to Sapelo light	80, 000	3. H. S. Barnard. 4. E. A. Maedel.
No. 57, Sapelo light to Fernandina	80, 000	1 and 2. A. Sengteller.
No. 94, Passes of the Mississippi	80, 000	3. H. M. Knight. 4. J. Knight.
No. 107, Matagorda Bay	80, 000	2. J. C. Kondrup. 3. R. F. Bartle. 4. A. Petersen.
Saint George's River and Muscle Ridge Channel	40, 000	1. J. C. Kondrup. 3. F. W. Benner. 4. E. A. Maedel and A. Petersen.
Penobscot Bay, (west)	40, 000	1. E. Molkow and J. C. Kondrup.
Narragansett Bay, (upper)	40, 000	1. E. Molkow and R. F. Bartle. 2. R. F. Bartle and W. A. Thompson.
Narragansett Bay, (lower)	40, 000	1. W. A. Thompson. 2. H. C. Evans and W. A. Thompson. 4. A. Petersen.
New York Bay and Harbor, (upper)	40, 000	1. R. F. Bartle. 2. R. F. Bartle and W. A. Thompson. 3. H. M. Knight. 4. E. A. Maedel.
New York Bay and Harbor, (lower)	40, 000	2. R. F. Bartle. 3. H. M. Knight.
Beaufort River, &c	40, 000	2. A. M. Maedel and R. F. Bartle.
Savannah River and Wassaw Sound	40, 000	1 and 2. A. M. Maedel and E. H. Sipe.
Cape Orford and reef	40, 000	2. W. A. Thompson. 3. F. W. Benner.

Plates completed, continued, or commenced, &c.—Continued.

Titles of plates.	Scale.	Engineers.
COMMENCED.		
Southwest Harbor and Somes Sound	40,000	1, 3, and 4. W. H. Knight.
Moose-a-bec Reach	40,000	1. W. H. Davis.
Penobscot Bay, (east)	40,000	1. E. Molkow.
Mount Desert, (east)	40,000	1. E. Molkow and J. C. Kondrup.
Duxbury and Plymouth Harbors	40,000	1 and 4. J. G. Thompson.
Burlington Harbor	10,000	1 and 2. J. C. Kondrup. 3. E. H. Sipe. 4. J. G. Thompson and E. H. Sipe.
Neuse River	80,000	1. H. M. Knight. 4. A. Petersen.
Pamplico River	80,000	1. J. C. Kondrup, R. F. Bartle, and J. G. Thompson.
Bull and Combahee Rivers	40,000	1. J. C. Kondrup. 2. J. G. Thompson. 3. W. H. Davis. 4. J. G. Thompson, W. H. Davis, and E. H. Sipe.

APPENDIX No. 6.

FIELD AND OFFICE WORK RELATING TO THE TIDES.

Field-work.—The following stations have been occupied during the year, for long or permanent series of observations, to be used for general purposes and theoretical investigations: North Haven, Me.; Boston, Mass.; Governor's Island, N. Y.; Old Point Comfort, Va.; San Diego, and Fort Point near San Francisco, Cal.; and Astoria, Oreg. Some short series of observations have also been made by hydrographic parties for use in reducing soundings, but which, when reduced by the tidal division, have furnished valuable constants for improving the tide-tables.

The tidal observations received from the North Haven station have been excellent, with but few exceptions. The pier on which the tide-house stands is large and strongly built, with a well in the center, an arrangement which gives great protection from waves and ice; and a self-registering gauge was furnished. Some parts of this having become so much worn as to endanger the continuity of the series, a new gauge has been made, and sent to take its place. This is made on a new plan devised by me, which, it is hoped, will avoid some of the imperfections of the older gauges. The heating-apparatus, by which a circulation of warm water is kept up around the moving parts to prevent the formation of ice, has continued to work admirably when in use, and the experiments of the observer during the past winter have shown that it cannot be dispensed with until ice disappears in the spring. This appears to be a very good place for making a long series of observations. A series of meteorological observations is also kept up here. A part of the wharf leading to the tide-house had to be rebuilt recently.

The ordinary self-registering gauge at the Boston navy-yard has worked well except in winter, when it was stopped much of the time by ice. The glycerine-gauge near it was stopped but little, and then not by ice; but, as the curve traced by it was never quite satisfactory, it has been discontinued, and the other gauge is being fitted up with heating-apparatus similar to that which has done so well at North Haven. We may, therefore, reasonably expect better work in winter than we have yet had at this station. The series of meteorological observations at this place is kept up.

A new self-registering gauge, on the plan of that sent to North Haven, has been made and loaned to the city of Providence, to be used there for a year or more by the engineer of the Providence water-works; the observations to be finally sent to the Coast Survey Office for reduction and preservation. A good set of observations at this point was much needed, not only for use on the improvements going on there, but for the general purposes of the Coast Survey. Without them, the work relating to Narragansett Bay would not be complete.

The self-registering gauge at Governor's Island has run well except in winter, when some tides were lost, and many stoppages occasioned by ice. To secure a perfect record in winter, some improvements in the apparatus will be required. Occasional day-observations are made at Brooklyn with a box-gauge for comparison with those of the above self-registering gauge; but the fine floating ice, ground up by the numerous steamers and ferry-boats, appears to be sometimes drawn into the float-boxes of the gauges, and obstructs them; hence, this gauge cannot be relied upon during the coldest weather.

Two new self-recording gauges have been made, similar to the North Haven one, which will be first used in connection with the surveys going on around New York. One of these will be located at Sandy Hook, and the other at some other suitable point, to enable us to study the relations of the tides of the inner harbor registered at Governor's Island to those of the bays and other waters connecting with it.

The record of the self-registering gauge at Old Point Comfort has generally been good; but as the wharf leading to it has been nearly destroyed by worms and storms, it has been deemed best to move the gauge to the steamboat-wharf near it, where it will always be accessible. Accordingly, a room has been prepared for it there in the new building erected by the Quartermaster's Department, and it will soon be placed there. We are indebted to General Barry for these accommodations.

The porcelain tidal staff-gauges put up at the principal stations on the eastern coast have continued to give satisfaction, and seem to be far more durable and convenient to read than the wooden ones previously used, as the glazing put on over the divisions and figures protects them, while the dirt is easily cleaned off.

A self-registering gauge has been sent to the island of Saint Thomas, in the West Indies, in accordance with an arrangement made by the Coast Survey Office with Col. F. E. de Bille, governor of the island. It is expected that the observations made there will be of great use in clearing up certain difficulties connected with the tidal waves, which, coming from the South Atlantic, pass this island, and finally reach our coasts.

The self-registering gauge at San Diego continued to give good work until the supports to the house gave way; and then, as it was not considered best to incur the large expense required for replacing them, the series having been continued nearly nineteen years, or about as long as had been contemplated, it was stopped. The gauge was also wanted at Port Townshend, where a good series of observations with a self-registering gauge is much needed. The self-registering gauges at Fort Point and Astoria have been kept going. The one at Fort Point, however, had to be refitted on new piles adjoining the wharf, which had become too much decayed to yield a firm support, and the Astoria gauge was removed to a new wharf built near the old one. At all three of these stations, good meteorological observations have been regularly made. G. H. Mendell, major of engineers, brevet-colonel, U. S. A., has continued his very efficient supervision of these stations, and carried out the plans sent from the Office.

No observations have yet been received from the self-registering tide-gauge sent last year to Ilioulionk, Aleutian Islands, but it is presumed to be in operation. It is very desirable that a good set of observations be secured there.

One of our self-registering gauges was taken a few months ago to the island of Saint Paul, the largest of the seal-islands in Behring Sea, by Capt. Charles Bryant, an officer acting under the Treasury Department. He appeared to be well qualified for the supervision of it, and we are confident that he will cause a good series of observations to be made with it.

The old self-registering gauge that has been used at North Haven will be returned to the Office soon for repairs, when it will probably be sent to Fernandina, Fla., as it is very desirable that a permanent tidal station should be established there.

We have no gauges yet that can be spared for the Gulf coast or the coast of Alaska, though observations on both are very desirable. The few observations we have just received from Saint Thomas indicate a close relation between the tides there and those of the Gulf of Mexico, and it would be interesting to have simultaneous observations from these places.

A self-registering tide-gauge was sent, in August, 1862, to Mr. Pease, surveyor on the Sandwhich Islands, by Lieut. George H. Elliott, by direction of Professor Bache, together with a description, full instructions, and a supply of paper, but we have no evidence that it was ever set up; and, on the death of Mr. Pease, it was sold among his effects; but Mr. W. D. Alexander, the present superintendent of the Hawaiian government survey, heard of it, and, after considerable trouble, succeeded in recovering it, and having it repaired and put in operation at Hilo on the island of Hawaii. He has another self-recording gauge at Honolulu. The plan of Professor Bache for securing series of observations at these islands, to compare with those made on our western coast, is, therefore, after a lapse of ten years, in a fair way of being carried out. The tides at these islands are found to be of the same type as those on the coast of California. The tides of the North Pacific seem to be everywhere of the same general type; but the study of them cannot be very complete until we have gauges on the coast of Alaska.

In the following table I give a brief recapitulation of the tidal observations received at this Office since November 1, 1871, and not before reported, omitting those made by hydrographic parties specially for their own use in reducing soundings, but which are generally reduced by the tidal division:

Section.	Name of station.	Name of observer.	Kind of gauge.	Station, permanent or temporary.	Time of occupation. From—	Time of occupation. To—	Total days.
I	North Haven, Me	J. G. Spaulding	S. R	Permanent	Nov. 1, 1871	Oct. 1, 1872	335
I	Boston navy-yard, Mass	H. Howland	S. R	do	Nov. 1, 1871	Oct. 1, 1872	335
I	do	do	S. R., glycerine	Temporary	Nov. 1, 1871	June 21, 1872	173
II	Governor's Island, N. Y	R. T. Bassett	S. R	Permanent	Nov. 1, 1871	Oct. 1, 1872	335
II	Brooklyn, N. Y	do	Box	do	Nov. 1, 1871	Oct. 1, 1872	335
III	Old Point Comfort, Va	W. J. Bodell	S. R	do	Nov. 1, 1871	Oct. 1, 1872	335
	Saint Thomas, West Indies	W. Thülstrüp	S. R	Temporary	Oct. 3, 1872	Oct. 23, 1872	10
X	San Diego, Cal	William Knapp	S. R	Permanent	Nov. 1, 1871	Sept. 1, 1872	245
X	San Francisco, Cal	F. P. Thompson	S. R	do	Nov. 1, 1871	Oct. 1, 1872	335
XI	Astoria, Oreg	L. Wilson	S. R	do	Nov. 1, 1871	Sept. 1, 1872	305

NOTE.—Day-tides only were observed at Brooklyn for comparison with those of Governor's Island.

Office-work.—The times and heights of both high and low waters have been tabulated soon after the observations were received at the Office, and, in general, the primary reductions have also been made in order to enable us to give any information that might be asked for relating to the tides on any part of our coasts, whether for surveying, engineering, or other purposes. Such information is now very frequently asked for, and the importance of possessing an accurate knowledge of the tides seems to be so generally recognized that greater attention to the subject will no doubt be given. We have, for some time, allowed the observers on the western coast to tabulate the high and low waters from their own tide-rolls, and this mode of working has succeeded well. We think the character of the observations has been bettered thereby, as there has been more attention paid to the time and the staff-readings. The new glass scales used for this purpose work admirably. The four new-style gauges, just sent to North Haven, Providence, and New York, have all been furnished with triangular reading-scales, some of them with reading-boxes; and it is expected that the observers will tabulate the high and low waters and also the hourly readings on blank forms furnished, as it can be done better and more accurately before the sheets are removed from the cylinders than ever afterward.

The tabulation of the hourly readings for the long series of observations at Fort Point, Cal., has been brought within a few months of the present time. The work on this series has been greatly increased by the imperfections in the observations, and sometimes by the loss of them. Two or three months were wholly lost on the way to the Office. It will require a considerable amount of work still to set these hourly readings in proper order for discussion. A portion of the commencement of the series has been found to be so defective as to call for its rejection, and a continuance of the observations enough longer to complete a set of good ones for a period of the required length. Copies of about three years of these hourly readings were sent to Sir William Thomson, of England, for trying his new methods of discussion on them; and the results which have been received seem to be good considering the shortness of the series. But to carry out such methods perfectly would seem to require more frequent readings.

Considerable time has been spent in making the necessary preparations for tabulating the hourly readings for the San Diego series in the best manner. As this series is now terminated, it is very desirable that this should be done. A large part of the series was good; and probably the imperfections which exist in it can be so far remedied as not to very seriously affect any results that may be deduced from it; but some of the reductions required cannot be made in the best manner until the whole series has been tabulated.

Some progress has been made during the year in tabulating hourly readings for North Haven, Boston, and Governor's Island, for the last of which the work is now going on.

Two pamphlets, containing the predicted times and heights of the tides for 1873, one for the eastern coast and one for the western coast and called "Tide-Tables," have been computed under the supervision of Mr. Avery, and published. They give values for the high waters for about twenty of the principal ports of the United States, and for low waters also for such of them as have large diurnal inequality. The modes of prediction and the formulæ used were the same as were used for 1872; but some of the tables used have been considerably improved. No new tables or methods have been substituted for older ones until they had been properly tested. The Table of Constants, appended to the published predictions, have been extended and improved, and embody results from many volumes of observations. These give the means of deducing from the tides of the principal ports those for a great number of others, embracing nearly all places of any note on our coasts.

The persons employed on the office-work of this division were R. S. Avery, J. Downs, A. Gottheil, C. Ferguson, and M. Thomas.

Mr. R. S. Avery remained in charge of the division, arranged and supervised the computations and other work, inspected the observations when received, and attended to the tidal correspondence with the observers and others, and labored to improve the tables and methods. He improved the tide-gauges and apparatus for reading off observations from the sheets, and supervised their construction. He also supplied many tide-tables for charts, data for use in field and office work, and some tidal predictions for almanacs.

APPENDIX No. 7.

MAXIMA AND MINIMA OF TIDES ON THE COAST OF NEW ENGLAND FOR 1873, BY WILLIAM FERREL.

CAMBRIDGE, MASS., *September* 2, 1872.

DEAR SIR: Having been instructed by you to compute the maxima and minima of the tides and the times of their occurrence for the year 1873, from the tidal formulæ and tables obtained from the discussion of the tidal observations of Boston Harbor, and contained in a former report, I have the honor to submit the following results:

Date.	A	B	C	Date.	A	B	C
	Feet.		*Feet.*		*Feet.*		*Feet.*
Jan. 1	6.53	1.335	−0.40	July 3	3.74	0.764	−0.15
9	4.53	0.925	+0.58	13	6.04	1.233	−0.39
13	4.76	0.973	+0.71	20	4.65	0.948	+0.69
21	3.89	0.794	−0.27	23	4.82	0.984	+0.72
30	6.60	1.349	−0.35	Aug. 2	3.87	0.791	−0.42
Feb. 7	4.10	0.837	+0.61	10	6.53	1.334	−0.36
12	4.77	0.973	+0.42	18	4.22	0.861	+0.67
20	4.02	0.820	−0.46	23	4.78	0.975	+0.39
27	6.83	1.393	−0.14	Sept. 1	3.90	0.796	−0.56
Mar. 8	3.79	0.774	+0.57	8	6.88	1.405	−0.09
15	4.93	1.007	−0.06	15	3.91	0.798	+0.54
21	4.19	0.855	−0.54	22	4.87	0.995	0.00
28	6.71	1.371	−0.02	30	3.99	0.815	−0.54
Apr. 6	3.61	0.736	+0.47	Oct. 7	6.89	1.406	+0.20
15	5.17	1.054	−0.39	14	3.73	0.762	+0.42
20	4.37	0.891	−0.47	24	5.00	1.021	−0.46
26	6.45	1.318	−0.26	29	4.26	0.869	−0.40
May 5	3.51	0.716	+0.35	Nov. 6	6.58	1.343	−0.55
14	5.43	1.109	−0.54	13	3.68	0.752	+0.15
19	4.67	0.953	−0.26	22	5.15	1.052	−0.61
25	5.80	1.183	+0.49	27	4.63	0.946	−0.26
June 4	3.51	0.716	+0.05	Dec. 4	5.93	1.211	+0.72
13	5.63	1.148	−0.58	12	3.67	0.750	−0.02
19	5.08	1.038	+0.27	22	5.47	1.117	−0.65
23	5.19	1.059	+0.64	28	5.03	1.028	+0.31

In this table of results—

A is the co-efficient of the semi-diurnal tide or height of high water above the mean level;

B is the ratio of this co-efficient to that of the mean tide;

C is the effect of the diurnal tide upon the height of high water, near the time of upper transit of the moon.

The sign of C must be reversed for high water occurring near the time of lower transit.

The height of the maximum and minimum tides only are given, and the days on which they occur; but several tides preceding and following do not generally differ much from these in height. Of the two high waters occurring on the same day, the one near the time of upper transit is the greater when C is positive, but the reverse when C is negative. The highest tide of the year will be the tide occurring near the time of upper transit on the 7th of October. The next highest will be on the 27th of February, near the time of lower transit, since C, in this case, is negative.

On account of the smallness of the solar tide, and the unusually large effect of the lunar parallactic inequality, the maxima and minima of the Boston tides, and of the New England coast generally, are much more irregular than those of European ports. While in the latter there are two maxima and two minima each month, which do not differ very much in magnitude, and occur generally within one or two days after the syzygies and quadratures, in the former it is seen that during some parts of the year, when the moon's perigee happens near the time of new or full moon, the one maximum is almost entirely destroyed, and is frequently less than the mean tide, as may be readily seen from the column B. For the same reason, the intervals between the maxima and minima in the Boston tides are also very irregular, being in some cases ten days, while in others, as in the latter part of July, only three days.

Although the absolute heights of the tides may differ very much in different ports, yet, as the type of the tides is probably very nearly the same from Cape Cod northward along the New England coast, the preceding dates of the maxima and minima, and the ratios expressed in the column B, are very nearly correct for all of this coast, and approximately so for the whole Atlantic coast.

It should be borne in mind that the preceding results may be materially modified by the effects of meteorological causes. A fall of one inch of the mercury in the barometer below the mean, causes the height of high or low water to be about seven inches greater in Boston Harbor, and the reverse for a rise of one inch of the mercury; and proportional effects belong to other ranges of the mercury. Also northeast and contiguous winds cause a considerable increase of the height of high or low water, while southwest and contiguous winds depress the height of the tides.

The preceding results are not only useful to navigators, but also to farmers who have hay to make near the level of tide-water. In July and August of this year, very high tides occur on the 13th and the 10th respectively, after which it may be seen from the column B that there will be no tides for nearly a month which come up to the mean tide, expressed by unity.

WM. FERREL.

Prof. BENJAMIN PEIRCE,
Superintendent United States Coast Survey.

APPENDIX No. 8.

REPORT OF THE ASTRONOMICAL AND METEOROLOGICAL OBSERVATIONS MADE AT SHERMAN, WYOMING TERRITORY, BY RICHARD D. CUTTS, ASSISTANT UNITED STATES COAST SURVEY, AND CHARLES A. YOUNG, PROFESSOR OF ASTRONOMY IN DARTMOUTH COLLEGE, NEW HAMPSHIRE, UNDER THE ACT OF CONGRESS OF JUNE 10, 1872.

PART I.—REPORT OF ASSISTANT RICHARD D. CUTTS.

WASHINGTON CITY, *March* 29, 1873.

DEAR SIR: I beg leave to submit the following report of the astronomical and meteorological observations made at Sherman, Wyoming Territory, in conformity with your written and verbal instructions of April and May last. Those instructions directed me to determine the latitude and longitude of Sherman for the geodetic connection between the Atlantic and Pacific coasts, and placed under my general charge the class of observations called for in the following paragraph of the appropriation bill approved by the President June 10, 1872: "To enable the Superintendent of the Coast Survey to cause astronomical observations to be made at one of the highest points on the line of the Pacific Railroad, two thousand dollars."

The character of the observations to be made was inferred from the resolutions passed by the American Association for the Advancement of Science, at their meetings held, respectively, at Chicago, in 1868, and at Troy, in 1870; and especially from the memorial of J. E. Hilgard, United States Coast Survey, Prof. Joseph Henry, Smithsonian Institution, and Prof. J. H. Coffin, of Lafayette College, a committee appointed by the association to represent to Congress "the importance of establishing an observatory and maintaining a scientific corps, for one year or more, at one of the highest points of the Pacific Railroad, and particularly at the eastern rim of the Utah basin." The principal desiderata mentioned in the memorial were the occupation of the highest point attainable, and the employment of the best optical means which could be provided, "in order that the celestial phenomena observed with the telescope, noted by photography, or analyzed by the spectroscope," could be compared with similar observations made near the sea-level, with a view to determine the advantages to be gained for the advancement of astronomical science, by an elevation of the instruments above nearly one-third, and certainly the densest strata, of the atmosphere.

The sum appropriated by Congress was altogether insufficient to carry out the extensive programme laid out in the memorial. The erection of an observatory of sufficient strength to protect the instruments during the violent storms which prevail during winter on the summits of the Rocky Mountains would alone have consumed the greater part of the appropriation. Being thus limited as to means, and, consequently, in regard to time, prompt action was necessary in order to secure the months most favorable in respect to weather; and, depending on the interest very generally felt in the proposed investigations, outside aid was invoked, and was indispensable, even for partial results. The Coast Survey contributed all that it could under the law and the regulations which govern it. An able expert in the science of spectrum-analysis offered his services on acceptable conditions, and carried with him; through the liberality of the trustees of Dartmouth College, the splendid 12-foot equatorial and spectroscopic apparatus belonging to that institution. The Army supplied a guard, from which were drawn subordinate observers for the meteorological department; and free passes for the party and the free use of the telegraph-line were given in two instances, to be mentioned hereafter.

The party reached Sherman on the 6th of June, and consisted, at that date, of myself, B. A. Colonna, esq., aid, and Mr. Werner Suess, electrician and mechanician. On the 10th, a guard, composed of a sergeant and ten men, authorized by the honorable Secretary of War, and selected for their inteligence and good character by the commandant at Fort D. A. Russell, reported for duty. Within a week afterward, Assistant A. T. Mosman arrived, and, on the 21st, left for Salt Lake City, to co-operate in determining the telegraphic difference of longitude between the two observatories, distant one from the other about 6° 30′, on the mean parallel of 41° north; and, on the 6th of July, Professors C. A. Young and C. F. Emerson joined the party, to make the astronomical and spectroscopic observations, according to the plan arranged.

The instruments carried out were as follows: Time and latitude instrument, No. 13, by Würdemann, of Washington; sidereal chronometer Hutton 202, with break-circuit, by Bond, of Boston; pocket-chronometer, mean time, by Jurgensen; Hipp chronograph, fillets, keys, &c.; battery, repeaters, and sundries for telegraphic purposes; 10-inch Gambey theodolite and vertical circle; reconnoitering-telescope, 2¼ inches aperture, by Dollond; sextant and artificial horizon; gradienter, &c.; magnetic apparatus, including theodolite, magnetometer, dip-circle, &c.; 3 cistern-barometers; 3 sets of psychrometers; 3 detached thermometers; 1 aneroid barometer; 1 anemometer; 1 self-registering maximum-thermometer; 1 self-registering minimum-thermometer; 2 black bulbs for solar radiation; 2 hypsometers; 1 atmospheric electrometer; besides microscopes, scales, clock, complete set of tools for the repairing of instruments, &c.; and, for Assistant Mosman, at Salt Lake City, time and latitude instrument, No. 7, by Würdemann; sidereal chronometer, with break-circuit, by Bond; Hipp chronograph, battery, repeaters, keys, &c.

With the exception of the meteorological instruments, which were purchased for the occasion from Green, of New York, all on the above list belonged to the United States Coast Survey; some having been made at its shops attached to the Office in Washington. They were packed in 28 boxes, and reached Sherman, June 6, in good condition. On the 27th, 8 additional boxes arrived; containing the equatorial and spectroscopic apparatus from Dartmouth College.

Sherman, the locality selected for the observations, is situated on the summit of the Black Hills, the easternmost range of the Rocky Mountains, and at the highest elevation crossed by the Union Pacific Railroad; the track being at that point, as determined by the engineers, 8,325 feet above the sea-level. The summit is a plateau, the ascent to which, from the Missouri River, at Omaha, a distance of over five hundred miles, is so gradual that the traveler looks in vain for the "Hills." Even when the summit is reached, the snow-capped mountains to the westward, as seen across the southern terminus of Laramie Valley, are so prominent, and apparently high, as to keep up, in a measure, the illusion that the observer is still on the so-called "Plains." Among the characteristic features of the plateau are the isolated piles of granite, which, layer upon layer, stand up like immense ruins, and are, in fact, the remains of a still higher summit; the number of huge masses of the same rock, generally rounded, but frequently weather-worn into fantastic shapes, which are so delicately poised, one upon the other, as to require apparently but a touch to throw them down; and, as the result of this extensive disintegration from atmospheric agencies, the reddish glittering appearance of the soil, composed, to a considerable depth, of an accumulation of crystals of feldspar and quartz. Sherman is a railroad-station, and, in addition to the ticket and telegraph office, contains eight or ten small frame-houses, and about thirty inhabitants. A few stunted pines are scattered over the plateau; but lower down, on the eastern and western slopes, the cañons supply not only firewood in abundance but lumber for building-purposes.

The necessity of being in close vicinity to the depot and telegraph-wires enabled me to decide, on the same evening I arrived, upon a site for the observatories. This site was an elevation about 650 feet south of, and 33 feet above, the railroad-track, and commanded a full horizon.

Three observatories were erected: one for the transit, battery, chronograph, and telegraphic apparatus; another for the meteorological instruments and observers; and a third for the 12-foot equatorial. The roof of this last building was divided into four panels of seasoned plank, each of which could be unclamped and slid off on trestles placed in continuation of the inclination of the roof, either singly or together, as the occasion required. It was erected under the supervision of Mr. Colonna, and, with the exception of the floor, the exact height of which could not be adjusted until the equatorial was mounted, was completed by the 25th of June.

The accompanying topographical sketch of Sherman and its vicinity (see sketch No. 18) will show the position of the observatories in relation to the railroad-track and telegraph-wires. The survey was made by Mr. Colonna. A base $420^{m}.05$ in length was measured on a part of the track found to be straight and level; and, after a re-determination of the length of the measuring-wire by recomparisons with a meter-scale brought for the purpose, the line was remeasured, the two results agreeing within 0.001 of a meter. Starting from this base, a series of triangles and quadrilaterals, with sides gradually increasing in length from 500^m to 5,000^m, was laid off, covering the plateau. The horizontal angles and differences of altitude were measured partly by the gradienter, and, in the case of the more distant points, by the 10-inch Gambey theodolite and vertical circle. The transit, the meridian-mark, and eccentric station were observed upon and introduced in the scheme, by which means the necessary data were obtained for computing the azimuth of each line and the latitude and longitude of each station. The topographical features and minor details were determined with a plane-table, improvised for the occasion by Mr. Colonna.

The eccentric station above referred to was established as an additional mark for the preservation of the point at which the latitude and longitude observations were made. It is distant 22.4 feet, and bears north 89° 08′ west, true, from the center of the block on which the transit was mounted, and is marked by a hole drilled in the rock, *in situ*, 10 inches deep and 2 inches in diameter, and filled with lead.

LATITUDE AND LONGITUDE OF SHERMAN.

The longitude of the astronomical station at Sherman was determined by telegraphic exchange of clock-beats with Salt Lake City; the interdistance, following the line of the wire, being about five hundred miles. The observatory at Salt Lake City was the same as that used in the longitude-campaign of 1869, during which the difference of longitude between Cambridge, on the Atlantic, and San Francisco, on the Pacific, was determined, including two intermediate stations, Omaha, on the Missouri River, and Salt Lake City, in Utah Territory.

By the night of the 25th June, the transit-instrument, chronograph, and telegraph-apparatus were mounted and adjusted at the Sherman observatory, and the poles and wires were put up to connect the Sherman clock, by means of the telegraph-line of the Union Pacific Railroad Company, with the clock at Salt Lake City. In the mean time, Assistant Mosman had reached the city; and, finding the transit of Governor Brigham Young mounted at the old observatory and in good condition, proceeded at once to put it in complete adjustment, and to connect the observatory with the telegraph-station.

By the 28th of June, both observatories were prepared for the interchange of time-signals; but, in consequence of cloudy weather at Sherman and derangements in the circuit, the exchange did not commence until July 3. Between that date and the 24th, there were seven nights at Sherman on which a sufficient number of star-transits were obtained for the determination of the local time. The usual course pursued was to observe ten or twelve stars for time and instrumental corrections, equally divided between clamp E and clamp W, before the exchange of clock-beats; and a similar series after the exchange.

The general result is as follows:

	h.	*m.*	*s.*	*s.*
Longitude of Salt Lake City observatory west of Greenwich	7	27	35.16	± 0.08
Difference between Salt Lake City observatory and Sherman observatory		26	00.93	± 0.05
Longitude of Sherman observatory	7	01	34.23	± 0.09
	or 105°	23′	33″.55	± 1″.35

Being too unwell to observe at the time of Assistant Mosman's return to Sherman, and the weather being clear, I requested him to remain and make the observations for latitude. Between the 30th of July and August 7, one hundred and ten measurements, on nineteen pairs of stars, were taken for difference of zenith-distance, and two sets each for the value of the divisions of the micrometer-screw and level. The instrument used was No. 13; the same as employed at Sherman for the star-transits.

Latitude of the astronomical station ....41° 07′ 49″.55 ± 0″.10

TERRESTRIAL MAGNETISM.

The measurement of the terrestrial magnetism at Sherman was made with unifilar magnetometer No. 3, Gauss's construction, and dip-circle No. 8. The observations were started by Assistant A. T. Mosman and carried on and finished by Mr. Werner Suess. The measurements for declination were commenced July 30, and completed on August 3; for horizontal intensity on the 3d and 5th, and for dip on the 6th of August. The magnetic observatory was situated 216.5 feet (66^m) nearly due west of the astronomical station and about 19.7 feet (6^m) below it. The observations were conducted and the results computed according to the methods and formulæ adopted in the Survey, and as fully explained and illustrated in the valuable paper on the subject by Assistant Ch. A. Schott.

The results are presented in the following table, with the remark that the intensity is expressed in English units, as usual in the Survey.

Terrestrial magnetism, Sherman.

Date.	Declination, east.			Horizontal and total intensity.			Magnetic dip.		
	Daily range.	Daily mean.	Mean of all.	First set.	Second set.	Mean.	Needle 1, positions 1, 2, and 3.	Needle 2, positions 1, 2, and 3.	Mean.
1872.	′	° ′	° ′				° ′	° ′	° ′
July 31....	11.5	15 52.5							
August 1..	14.9	51.2	15 52.6						
August 2..	13.3	54.0							
August 3..				4.732					
August 4..						4.729			
August 5..					4.725	13.130			
August 6..							68 52.5	68 54.2	68 53.3

Mr. Suess reports that, at 10^h 45^m, on Saturday, August 3, he suspended magnet C_{17}; using magnet C_6 for deflections. At 11^h 30^m, the magnet was in a continued state of agitation; and, in consequence of the large differences, the set of observations then made for deflection, as well as the tosion-readings, could not be used for the normal intensity. The magnet C_{17} was, from time to time, deflected out of the field.

At 8 a. m. on August 5, the observations for deflection were resumed; and on that occasion, also, the magnet was disturbed, so much so that it was deemed advisable to reject the first set and to take a second, commencing at 8^h 35^m a. m.

Professor Young, in his report, refers to these two instances of observed magnetic disturbances at Sherman; and as they coincided in time with the solar eruptions observed by him, he is clearly of opinion that the former were in a great measure a mere response to the latter.

METEOROLOGY.

The meteorological observatory was a frame-building erected close to the astronomical observatory, and sufficiently large to accommodate both instruments and observers. The building faced to the north, and to this, the highest side, and immediately in front of a small window, the usual latticed frame was bolted on, within which were suspended, at a height of 10 feet above the ground, two detached thermometers, two sets of psychrometers, and the maximum and minimum thermometers, the two last in a nearly horizontal position. The barometers, two cistern and one aneroid, were hung up inside, and so placed as to secure, both for adjustment and reading, the proper degree of light from panes of glass inserted for the purpose in the side of the building; and, finally, to insure that the eye of the observer should be on the same level with the divisions on the scales, a platform, regulated to the proper height, occupied the interior front of the observatory; and here the observer had his seat and desk, and recorded the readings.

The wind-vane, elevated 6 feet above the roof, at the northwest angle of the building, was so arranged that the direction of the wind could be read by the observer without leaving the platform inside. In the case, however, of the anemometer, which was set up over the northeast angle, it was necessary that the observer should go outside and ascend a set of steps in order to read the hourly record of velocity.

The observations and observers were placed under the special charge of Mr. Colonna. The twenty-four hours were divided at first into four and finally into three watches, for each of which there was a separate observer; and the observers, with a single temporary exception, were enlisted men selected from the guard supplied by the Army. These were carefully trained by Mr. Colonna, and their readings were tested more than once on each day during the progress of the work. As a further security, and with a view to obtain some idea of the personal equation of the observers, twelve sets of comparison were made at different dates, the results of which are exhibited in Table I. Each set consisted of an adjustment of the cistern and reading of the barometer, and, also, of the different thermometers, first by Mr. Colonna and then by the others, one succeeding the other as rapidly as possible. As the attached thermometer, read always after the adjustment of the cistern, was generally higher toward the close of the set, the height of the column was reduced to 32° F. before instituting the comparisons. Adopting Mr. Colonna's readings as the standard for the purpose of this comparison, the mean of the differences from that standard, as given at the foot of the table, may be considered as the approximate personal error of the different observers.

TABLE I.—*Showing the differences in reading by the principal observers.*

Date.	Colonna.			Soberg.			Courtney.			Andrit.		
	Barometer.	Dry bulb.	Wet bulb.	Barometer.	Dry bulb.	Wet bulb.	Barometer.	Dry bulb.	Wet bulb.	Barometer.	Dry bulb.	Wet bulb
		°	°		°	°		°	°		°	°
July 8	.000	0.0	0.0	−.002	+0.1	+0.2	+.003	−0.3	−0.9	+.006	−1.0	−0.9
9	.000	0.0	0.0	+.002	−0.7	+0.2	+.001	+0.3	+0.3	+.003	−1.1	−0.4
10	.000	0.0	0.0	.000	−0.2	−0.2	+.006	+0.3	0.0	+.007	+0.3	+0.1
11	.000	0.0	0.0	.000	0.0	−0.3	.000	−0.1	−0.2	−.003	0.0	0.0
12	.000	0.0	0.0	−.003	0.0	−0.2	+.004	+0.1	+0.1	+.002	+0.1	+0.1
13	.000	0.0	0.0	.000	−0.4	−0.6	.000	−0.6	−0.8	+.001	−0.7	−0.8
15	.000	0.0	0.0	+.002	−0.2	−0.1	+.005	+0.2	0.0	+.001	−0.1	+0.1
16	.000	0.0	0.0	−.006	−0.2	+0.1	−.008	+0.5	−0.1	+.008	−0.4	0.2
18	.000	0.0	0.0	−.001	−0.4	−0.7	+.006	−1.3	−0.7	+.001	−1.2	−1.3
20	.000	0.0	0.0	−.001	−0.2	−0.1	+.005	0.0	0.0	+.001	0.0	0.0
Aug. 6	.000	0.0	0.0	+.002	+0.3	−0.2	+.002	+0.8	−0.6	+.005	+1.0	−0.7
15	.000	0.0	6.0	−.001	0.0	0.0	.000	+0.1	−0.3	+.002	0.0	−0.2
				−.001	−0.16	−0.16	+.002	0.0	−0.27	+.003	−0.26	−0.35

From a careful examination of the records of the comparisons, it would appear that the above differences are due, in part, to changes in the pressure and temperature which occurred during the period, say, from ten to fifteen minutes, required by the four observers to make their respective adjustments and readings.

The barometers 1936 and 1937 were made by Green of New York, were corrected for capillarity, and set to standard. The diameter of the tubes was 0.25 of an inch. The attached and detached thermometers were compared, and found to be correct. The two sets of psychrometers, 1807 and 1816, were also compared with the standard, with the following results:

Standard.	Dry bulb—1807—	Wet bulb.	Dry bulb—1816—	Wet bulb.
62°	62°	62°	62°	62°
92°	91°.8	91°.8	92°	91°.8

Barometer 1936 and psychrometer 1807 were adopted for the hourly observations. The other two sets of instruments were observed, at equal intervals, four times each day.

The height of the barometric column is in all cases reduced to the freezing-point.

The observations were commenced on the 17th of June, and continued, without interruption, to August 15 inclusive, extending through sixty days and nights.

The full meteorological record is given below.

The number of hourly observations amounted to 1,440. Of these, 60 were taken by Colonna, 86 by Shanks, 363 by Soberg, 446 by Audrit, and 485 by Courtney, and with such variation of hours that the errors of adjusting and reading peculiar to each observer were, in a great measure, neutralized in the daily and hourly means.

Table II presents a condensed statement of the results arranged according to daily means, and will show at a glance the principal atmospheric phenomena and the relation of one to the other. Each day represents the mean of the twenty-four hours, except in the case of the velocity of the wind, and in this the total velocity of the day is given.

The elastic force of vapor and the relative humidity were computed from Williamson's tables.

The mean direction of the wind and of the lower clouds is the mean or the leading direction of the 24 hourly observations.

The sky, when entirely overcast, is represented by 10, and, when entirely clear, by zero. The mean cloudiness was deduced by dividing the total amount by the number of hours for which any degree of cloudiness was entered in the journal.

The curves require but little explanation. They show considerable and rapid oscillations in the condition of the atmosphere, and the generally prompt response of the barometric column to the varying temperature, amount of aqueous vapor in the air, and direction and velocity of the wind, the combination of which, that is, of the observed and unobserved phenomena, determine the changes in the atmospheric pressure. The unobserved phenomena are included, as those observed cannot account for all the barometric indications. For instance, on June 20 and 21 and on July 3, the high barometers of those dates were preceded by violent winds from the westward, a low temperature, and comparatively dry air. The cloudiness did not extend beyond 5. But, on the 10th and 11th of July, there was another high barometer, preceded, accompanied, and followed by an average temperature, unusual amount of moisture, and a velocity of wind below the mean, a condition of the atmosphere which did not authorize such high barometer; and we must, therefore, look elsewhere for the cause. The meteorological journal states that, on the 9th, 10th, and 11th of July, the sky was almost entirely overcast, and that there were frequent showers, accompanied by thunder and lightning. In consequence of this envelope of clouds, the radiation was obstructed, and the observed temperature of the air at the station was specially high, and not characteristic of the column of air, the weight of which was represented by the observed barometer. The southerly wind at the station and the movement of the upper clouds from a nearly opposite direction, as recorded on the 10th, show the character of the two currents, and that we observed the maximum temperature of the lower and warmer stratum.

TABLE II.—*Daily means, compiled from Appendix A.*

Date.	Barometer at 32° Fahrenheit.	Temperature, air.	Wet bulb.	Force of vapor.	Relative humidity.	Wind.		Cloudiness.		Aneroid barometer.	Difference, cistern and aneroid.
						Velocity, sum.	Mean direct'n.	No. of hours.	Mean amount.		
1872.	*Inches.*	°	°	*Inches.*		*Miles.*				*Inches.*	*Inches.*
June 17	22.033	59.0	48.7	0.243	.504	....	S. W.	9	9	21.913	.120
18	.099	47.6	37.5	.143	.432	672.7	S. W.	13	5	21.996	.103
19	.263	44.0	34.9	.130	.472	627.7	W. by N.	18	4½	22.182	.081
20	.468	52.9	42.5	.183	.474	224.3	S. by W.	24	4	.347	.121
21	.488	53.4	42.8	.183	.534	236.3	N. by E.	23	5	.373	.115
22	.395	60.2	43.6	.161	.349	326.4	W. S. W.	21	3	.275	.120
23	.265	64.1	46.4	.179	.316	364.1	W. by N.	24	5	.124	.141
24	.232	63.9	48.1	.203	.351	251.9	S. W. by W.	24	7	.095	.137
25	.242	53.9	47.2	.253	.628	509.2	W. by S.	24	7	.126	.116
26	.304	56.3	45.8	.212	.528	339.5	W. S. W.	24	4	.182	.122
27	.218	55.8	45.2	.205	.479	293.1	W. S. W.	24	8	.099	.119

DIAGRAM I.

Curves of the daily variations.

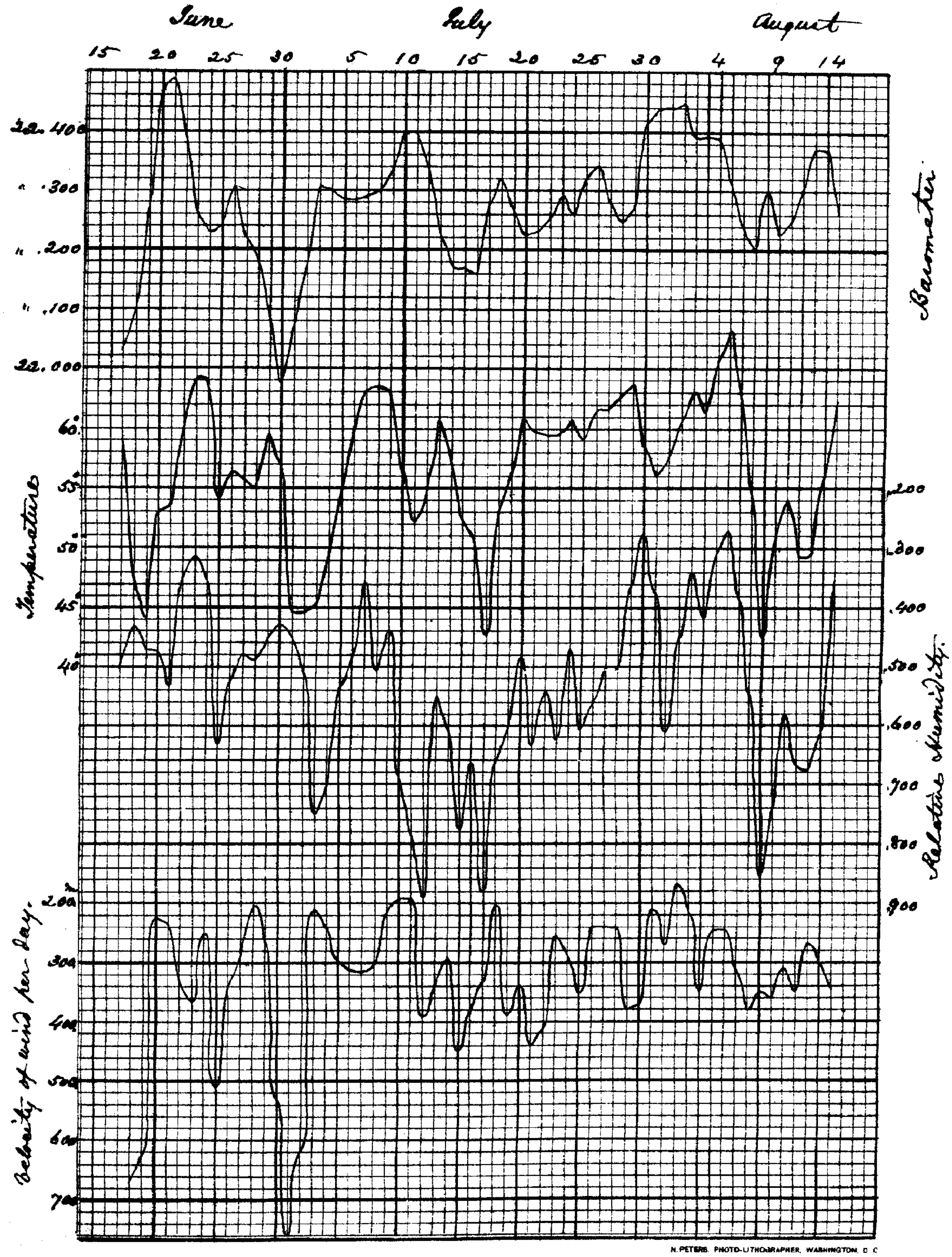


TABLE II.—*Daily means, compiled from Appendix A*—Continued.

Date.	Barometer at 32° Fahrenheit.	Temperature, air.	Wet bulb.	Force of vapor.	Relative humidity.	Wind. Velocity, sums.	Wind. Mean direct'n.	Cloudiness. No. of hours.	Cloudiness. Mean amount.	Aneroid barometer.	Difference, cistern and aneroid.
1872.	*Inches.*	°	°	*Inches.*		*Miles.*				*Inches.*	*Inches.*
June 28	22.185	54.9	44.8	0.204	.488	204.0	S. W.	24	7	22.066	.119
29	.096	59.5	46.9	.210	.449	258.3	S. by E.	24	5	21.972	.124
30	21.977	57.2	44.6	.189	.432	533.7	S. by W.	24	7	.852	.125
July 1	22.066	44.8	34.8	.124	.449	759.7	S. W.	23	4	.960	.106
2	.176	44.8	36.4	.145	.507	621.2	W.	21	4	22.065	.111
3	.306	45.3	41.0	.212	.748	211.2	S. S. E.	22	5	.190	.116
4	.302	49.0	44.1	.237	.705	242.3	S.	24	6	.180	.122
5	.288	54.4	44.6	.204	.541	295.7	N. W.	24	3	.156	.132
6	.287	60.0	47.7	.219	.484	312.8	S.	23	5	.139	.148
7	.293	62.9	47.2	.195	.358	317.7	W. by N.	24	5	.137	.156
8	.299	63.3	51.3	.259	.502	305.4	W. N. W.	24	5	.141	.158
9	.336	63.1	50.4	.214	.440	216.7	N. N. W.	24	5	.177	.159
10	.397	56.6	50.9	.308	.681	197.5	S. by E.	24	7	.252	.145
11	.397	52.2	48.7	.302	.779	195.6	S. E.	24	9	.266	.131
12	.340	54.3	52.7	.377	.891	390.2	S. S. E.	24	9	.212	.128
13	.228	60.7	51.5	.282	.551	342.8	W.	24	6	.083	.145
14	.174	58.1	50.7	.288	.609	294.0	W. N. W.	24	5	.028	.146
15	.172	52.4	48.7	.300	.777	418.6	S. S. E.	20	6	.037	.135
16	.159	50.7	44.7	.233	.666	379.6	W. by N.	20	4	.025	.134
17	.278	42.7	41.6	.250	.879	334.8	S. S. E.	24	10	.156	.122
18	.319	53.1	46.5	.247	.662	206.6	S. W.	19	4	.178	.141
19	.268	55.9	48.3	.259	.602	392.8	W. N. W.	24	5	.121	.147
20	.226	60.8	51.5	.282	.486	341.6	S. W. by W.	24	3	.065	.161
21	.231	59.8	52.3	.307	.637	441.6	S. W. by W.	18	7	.069	.162
22	.256	59.5	50.4	.270	.543	414.6	W. by N.	24	7½	.092	.164
23	.290	59.5	51.6	.295	.626	256.1	S.	24	5	.121	.169
24	.259	60.7	51.5	.282	.474	287.1	W.	23	6	.094	.165
25	.323	59.2	51.3	.292	.606	351.0	S.	24	3	.152	.171
26	.339	61.5	51.6	.278	.561	240.7	S.	24	5	.168	.171
27	.283	61.5	50.9	.265	.499	241.1	N. W.	24	4½	.114	.169
28	.247	62.7	51.9	.275	.500	241.2	E. S. E.	24	3½	.076	.171
29	.278	63.7	48.7	.213	.364	379.2	W.	24	2	.101	.177
30	.409	58.8	41.1	.137	.281	374.4	W.	15	1	.231	.178
31	.439	55.9	44.4	.193	.375	209.7	E. by N.	21	2	.265	.174
Aug. 1	.439	57.5	49.5	.270	.609	272.0	S.	19	4	.271	.168
2	.448	60.4	48.1	.223	.453	167.9	S. E.	23	4	.271	.177
3	.394	63.1	46.1	.179	.339	215.2	N. W. by N.	24	4	.212	.182
4	.396	61.4	48.0	.216	.415	347.6	S. E.	24	4	.212	.184
5	.390	65.8	46.5	.172	.309	248.0	W. N. W.	19	3	.193	.197
6	.317	68.2	47.4	.175	.277	246.3	W. N. W.	24	3½	.106	.211
7	.239	62.4	47.5	.202	.384	312.6	N. W.	24	6½	.044	.195
8	.201	54.4	46.9	.244	.544	381.5	W. by N.	21	8	.029	.172
9	.300	42.6	41.2	.243	.854	353.1	E.	8	10	.151	.149
10	.226	51.2	47.3	.281	.741	360.8	S. by E.	14	6	.062	.164
11	.249	53.9	45.7	.226	.582	310.4	W.	22	6	.078	.171
12	.303	49.3	44.3	.238	.666	351.5	N.W. by W.	21	6½	.139	.164
13	.371	49.5	43.7	.225	.677	267.4	N. W.	24	4	.204	.167
14	.369	55.6	47.7	.250	.611	302.9	S. S. E.	22	3	.187	.182
15	.262	62.2	45.5	.175	.353	347.7	W.	24	3	.072	.190
	22.2806	56.47	45.56	0.230	.534	332.	....	21.8	5.2	22.1314	.1492

Table III shows the tropical hours for the season, and the hours of minimum and maximum temperature and relative humidity, as deduced from the sixty-days set of observations; and Table IV, similar results from the same observations, divided into four parts. The division is made in order to determine how close any fifteen days will show the horary oscillations of the barometer at the particular locality and season of the year. The comparisons prove that the hours of the morning maximum and of the afternoon minimum were as clearly established by any one of the parts as by the whole, while the night maximum and minimum oscillated from the mean hour by very small quantities. The abnormal variations, it will be seen, increased with singular regularity, the increase of pressure being uniform at the rate of .031 for every fifteen days.

The hours of least and highest temperature are about as clearly defined by any one of the fifteen-days set as by the entire series.

In regard to relative humidity, while there is a general decrease from sunrise to noon, and increase from noon to midnight, the hours of maximum and minimum are not uniform for the parts of the series, nor could this, or regularity in the hours of high or low temperature, be expected for such short periods, so much depending on the condition of the sky and the force and direction of the wind.

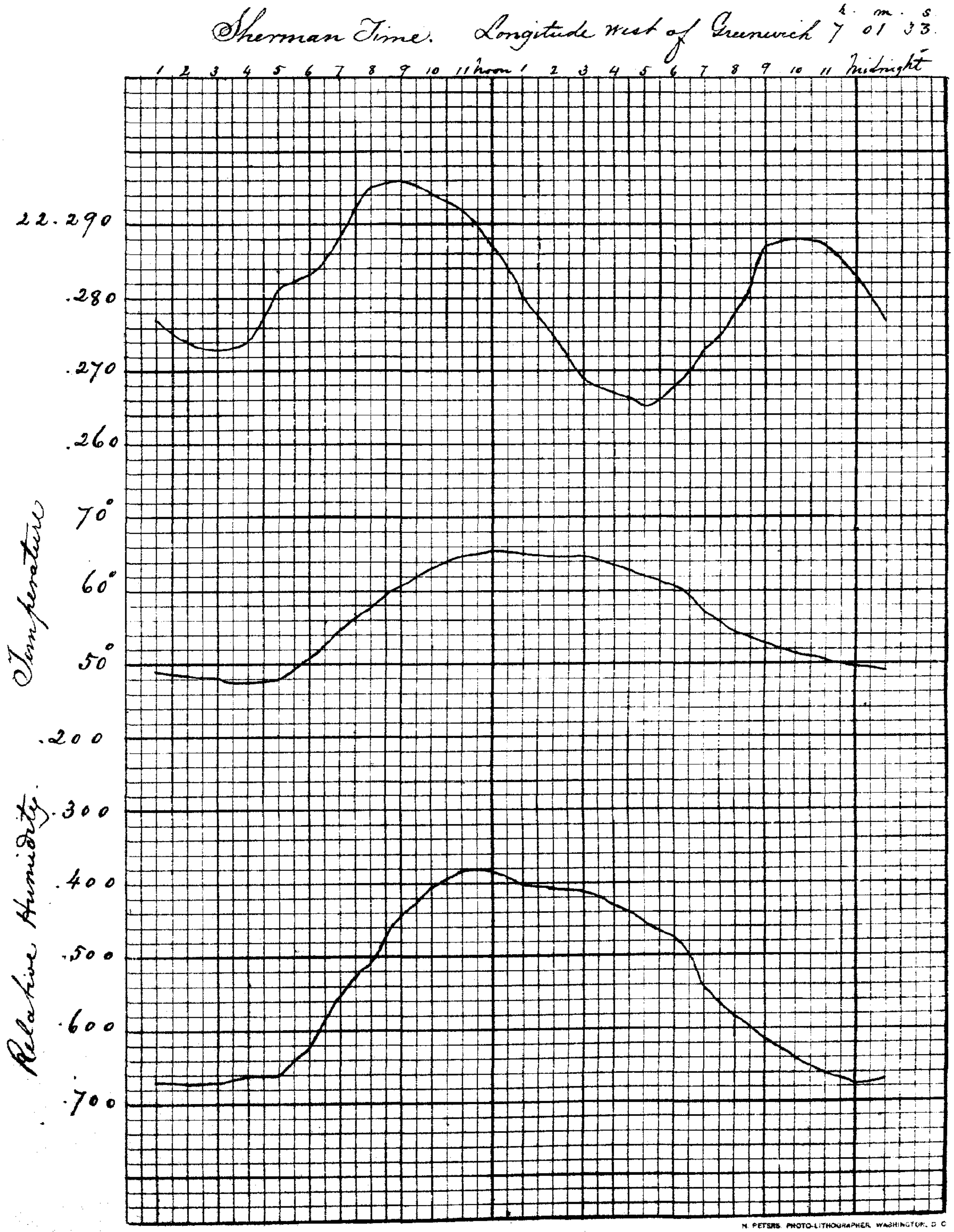
Diagram II (omitted) illustrates the mean of the hourly variations in the pressure, temperature, and relative humidity of the atmosphere from June 17 to August 15, inclusive.

TABLE III.—*Hourly means, compiled from Appendix A.*

Hour of the day.	June 17 to August 15; mean of sixty days.										
	Barometer at 32° Fahrenheit.	Hourly oscillation.		Air; thermometer, Fahrenheit.	Difference from mean.		Relative humidity.	Difference from mean.	Tropical hours for the season.	Hours of minimum and maximum temperature.	Hours of minimum and maximum relative humidity.
		Inches.	Millimeters.		Fahrenheit.	Centigrade.					
1 a. m.	22.277	+ .004	+0.10	49.0	+ 7.5	+ 4.16	.669	− .129	....	....	....
2 a. m.	.274	+ .007	+ .18	48.6	+ 7.9	+ 4.34	.673	− .133	....	....	....
3 a. m.	.273	+ .008	+ .20	48.2	+ 8.3	+ 4.61	.672	− .132	Minimum	....	....
4 a. m.	.274	+ .007	+ .18	47.8	+ 8.7	+ 4.83	.663	− .123	....	Minimum	....
5 a. m.	.281	.000	.00	47.9	+ 8.6	+ 4.78	.663	− .123	....	....	....
6 a. m.	.283	− .002	− .05	50.8	+ 5.7	+ 3.16	.628	− .088	....	....	....
7 a. m.	.288	− .007	− .18	54.5	+ 2.0	+ 1.11	.557	− .017	....	....	....
8 a. m.	.295	− .014	− .36	57.6	− 1.1	− 0.61	.512	+ .028	....	....	....
9 a. m.	.296	− .015	− .38	60.5	− 4.0	− 2.22	.448	+ .102	Maximum	....	....
10 a. m.	.294	− .013	− .33	63.0	− 6.5	− 3.61	.407	+ .133	....	....	....
11 a. m.	.292	− .011	− .28	64.7	− 8.2	− 4.55	.384	+ .156	....	....	....
Noon	.287	− .006	− .15	65.4	− 8.9	− 4.94	.384	+ .156	....	Maximum	Minimum.
1 p. m.	.280	+ .001	+ .03	65.1	− 8.6	− 4.78	.401	+ .139	....	....	....
2 p. m.	.275	+ .006	+ .15	64.7	− 8.2	− 4.55	.408	+ .132	....	....	....
3 p. m.	.269	+ .012	+ .30	64.8	− 8.3	− 4.61	.413	+ .127	....	....	....
4 p. m.	.267	+ .014	+ .36	63.7	− 7.2	− 4.00	.432	+ .108	....	....	....
5 p. m.	.265	+ .016	+ .41	62.1	− 5.6	− 3.11	.454	+ .086	Minimum	....	....
6 p. m.	.268	+ .013	+ .33	60.8	− 4.3	− 2.37	.475	+ .065	....	....	....
7 p. m.	.273	+ .008	+ .20	57.3	− 0.8	− 0.50	.544	− .004	....	....	....
8 p. m.	.278	+ .003	+ .08	54.4	+ 2.1	+ 1.16	.584	− .044	....	....	....
9 p. m.	.287	− .006	− .15	52.9	+ 3.6	+ 2.00	.618	− .078	....	....	....
10 p. m.	.288	− .007	− .18	51.6	+ 4.9	+ 2.72	.641	− .101	Maximum	....	....
11 p. m.	.287	− .006	− .15	50.6	+ 5.9	+ 3.28	.661	− .121	....	....	....
Midnight	.283	− .002	− .05	49.6	+ 6.9	+ 3.83	.677	− .137	....	....	Maximum.
24 Hours	22.281	....	....	56.5	....	....	.540	....	....	....	....

DIAGRAM II.

Curves of the hourly oscillations.



N. PETERS, PHOTO-LITHOGRAPHER, WASHINGTON, D. C.

TABLE IV.—*Hourly means, compiled from Appendix A.*

Hour.	June 17 to 30, 14 days.			July 1 to 16, 16 days.			July 17 to 31, 15 days.			August 1 to 15, 15 days.		
	Barometer, 32°.	Temperature of air.	Relative humidity.	Barometer, 32°.	Temperature of air.	Relative humidity.	Barometer, 32°.	Temperature of air.	Relative humidity.	Barometer, 32°.	Temperature of air.	Relative humidity.
		°			°			°			°	
1 a. m	22.243	48.1	.580	22.250	47.4	.720	22.285	51.1	.654	22.330	49.2	.705
2 a. m	.237	47.1	.590	.246	47.5	.705	.284	50.6	.709	.328	49.2	.680
3 a. m	.233	46.5	.576	.247	47.0	.723	.285	50.2	.721	.326	49.1	.658
4 a. m	.236	45.8	.587	.251	46.6	.720	.286	49.8	.672	.323	48.7	.665
5 a. m	.245	46.3	.591	.256	46.9	.734	.290	49.6	.664	.332	48.8	.654
6 a. m	.235	50.4	.519	.260	49.7	.720	.296	52.0	.653	.338	51.0	.607
7 a. m	.240	54.7	.477	.266	53.0	.607	.309	56.3	.565	.343	54.1	.572
8 a. m	.253	57.6	.438	.272	55.7	.560	.307	59.9	.528	.346	57.2	.516
9 a. m	.255	60.8	.374	.272	58.5	.506	.308	62.3	.459	.346	60.7	.443
10 a. m	.247	63.3	.337	.272	60.3	.492	.310	64.8	.405	.346	63.7	.381
11 a. m	.243	64.9	.323	.274	61.2	.466	.308	67.2	.391	.341	65.8	.349
Noon	.234	66.1	.308	.276	61.5	.490	.302	67.9	.384	.334	66.5	.342
1 p. m	.227	65.6	.326	.266	61.9	.477	.299	67.6	.396	.328	65.7	.394
2 p. m	.219	65.4	.332	.260	61.8	.465	.298	66.1	.416	.321	65.6	.388
3 p. m	.214	64.9	.342	.256	61.9	.488	.294	65.4	.452	.310	67.0	.361
4 p. m	.214	62.5	.384	.256	61.0	.499	.286	65.9	.444	.309	65.5	.393
5 p. m	.214	60.9	.390	.253	59.5	.533	.286	64.2	.468	.305	63.9	.416
6 p. m	.219	60.0	.396	.258	58.8	.538	.286	62.8	.482	.307	61.7	.476
7 p. m	.223	57.2	.464	.263	56.3	.585	.292	58.9	.540	.310	57.1	.580
8 p. m	.230	53.9	.508	.267	52.9	.644	.296	55.9	.592	.318	54.9	.585
9 p. m	.232	52.2	.536	.280	51.9	.665	.304	54.4	.643	.330	53.3	.622
10 p. m	.238	50.8	.547	.279	50.4	.698	.305	53.4	.660	.329	51.9	.649
11 p. m	.236	49.2	.577	.276	49.3	.724	.307	52.8	.674	.328	51.0	.661
Midnight	.232	47.7	.572	.274	48.3	.744	.302	52.0	.703	.321	50.2	.676
Twenty-four hours	22.233	55.9	.461	22.264	54.6	.605	22.296½	58.4	.553	22.327	57.2	.532

ANEROID BAROMETER.

The aneroid was subjected to different pressures from 20.5 inches upward, and was compared with, and adjusted to, the standard at 73° and 32°, before it was forwarded to me in May last by Green of New York. From an examination of the journal, or of Table II, it will be seen that the aneroid when at Sherman was always lower than the cistern-barometer, and that the difference varied from 0.149 inch at 42°.6 to 0.211 inch at 68°.2. This divergency from the mercurial barometer would appear to increase, as a general rule, with the rise in temperature. The disagreement at the coldest hours was equivalent to about .080 at the freezing-point, and this quantity may be considered as the index-error for the high station. Besides this error, however, the observations show that there was another, resulting from imperfect compensation, amounting to .003 for every degree in the increase of temperature.

After being used at Sherman, the aneroid was sent back with the other instruments to the Office in Washington, reaching the city in September; and between November 19, 1872, and February 27, 1873, a series of comparisons was made between the same barometers, with a view to ascertain whether the agreement, which existed previous to their transportation to an elevation of 8,000 feet, would be renewed on their return to the level of the sea. In all such comparisons, it must be borne in mind that, while the cistern-barometer can be read to .002, the scale of the aneroid will not admit of a closer reading than .020; and even this reading is subject to an error from parallax arising from the distance between the index and the scale-divisions. The mercurial barometer was reduced, as usual, to the freezing-point.

During the ordinary changes in the atmospheric pressure, the differences between the readings of the two barometers were always less than .01, or within the probable error of reading. During great and rapid changes in the pressure, the differences were as high as .02; one of the barometers showing the changes sooner than the other. During the intensely cold weather of December, the aneroid was cooled to 16° F., when it was .023 lower than the other; and, on the same day, the aneroid was placed before the hot-air furnace and heated certainly to 100° F., when it was .08 lower. For seven days following the exposure of the aneroid to these extremes of temperature, the differences between the two were quite irregular, varying from .00 to .04; but, after the seventh day, the agreement was as good as before the exposure. These recomparisons, for which I am indebted to Dr. A. Zumbrock, of the Coast Survey Office, show that the apparatus for compensation of temperature was in a better condition at 29.9 than at 22.3.

SOLAR RADIATION.

The three solar maximum radiation thermometers, numbered in the record 1, 2, and 3, were constructed according to the suggestions of Sir John Herschel, and, being those now generally adopted to obtain the heat of the sun's rays free from the influence of vapor and of passing currents of air, are too well known to require description. Each rested in a bracket fastened to the top of a stand four feet in height and firmly planted in the ground. They were placed in a nearly horizontal position, with their bulbs to the south, and secured in position by movable buttons.

The observations were made hourly from 4 a. m. to 8 p. m., including the moments of sunrise and sunset, and without regard to the condition of the sky. The record, however, (Appendix B, which it is not necessary to print in full,) shows at what hours the sun was more or less obscured, as well as the hours when the bulbs received the full heat of the sun's rays. When the temperature was rising, the thermometers were read before setting, and, when it was falling, they were read immediately after the setting. The setting consisted in taking the thermometer from its bracket and moving it up and down until the mercury in the tube reached the lowest point permitted by the temperature of the mercury in the blackened bulb and stem. It was then replaced, as before. During the morning, the observation, for instance, at 10 o'clock represented the maximum temperature which had occurred during the preceding hour, while, in the afternoon, the reading gave the radiation as it existed at the particular moment for which it was recorded. It would have been better, perhaps, to have observed in the morning in the same manner as was done later in the day, for the reason that in the dry, cold atmosphere of the station, the temperature of the air was immediately affected by a cloud-shadow, and, when such occurred at any morning hour, the air-thermo meter showed a minimum for that moment, while the radiation-thermometers expressed the maximum, which may have taken place thirty minutes previous. The observations made under these circumstances have been excluded, as far as possible, in making up the results.

It will be seen that the three thermometers differed always, and, at times, very largely and without uniformity. The want of regularity in the differences may be due, in part, to carelessness in reading Nos. 2 and 3, as No. 1, made by Casella, London, was looked upon as the best at a very early date, and the observer was directed to be specially careful in setting and reading it. Thermometer No. 1 was, and has been, adopted as the most reliable, from the fact that it recorded a higher temperature; showing that the vacuum in which it was confined was more perfect than that of either of the two others.

The observations were extended through a period of fifty-one days, and have been divided into three sets of seventeen days, for each of which the mean time of sunrise and sunset and the mean altitude of the sun at noon have been computed.

Table V, compiled from Appendix B, shows the excess of the readings of the black bulb *in vacuo* over those of the ordinary air-thermometer protected from the sun; and Table VI, the same results in a more condensed form, including a special column containing the mean of the observations taken on the nine days of clearest weather, viz, July 1, 2, 5, 20, 29, 30, and 31, and August 5 and 14. Adopting the last column as best expressive of the relative value of the results, we find that the amount of solar radiation was not excessive; that it was the greatest at noon; that it decreased with the daily decreasing altitude of the sun; and that there was less cloudy weather and fewer passing clouds in the forenoon than during the afternoon.

TABLE V.—*Amount of solar radiation, being the excess of the readings of the black bulb in vacuo over the temperature of the air in shade.*

Date.	4 a. m.	Sunrise.	5 a. m.	6 a. m.	7 a. m.	8 a. m.	9 a. m.	10 a. m.	11 a. m.	Noon.	1 p. m.	2 p. m.	3 p. m.	4 p. m.	5 p. m.	6 p. m.	7 p. m.	Sunset.	8 p. m.
June 26	−1.5	7.4	17.0	38.7	51.1	57.9	61.2	63.0	65.7	61.2	74.9	73.5			54.0	28.8		−0.3	−1.5
June 27	−1.7	0.6					64.9	72.1	68.7	63.9						21.6		−0.4	−2.2
June 28	−3.7			41.2	47.6	56.3	62.6	64.0	72.9	80.0								−2.8	−2.0
June 29	−2.3		20.7	42.2	50.5	56.5	58.5	60.9	64.8	71.8	73.7	74.5	58.9					−0.1	−2.8
June 30	−3.4			43.5	48.2	58.9	58.1	67.2	68.1										
July 1	−1.5	13.4	30.5	48.3	58.4	60.9	69.3	68.6	74.2	75.6	68.3	65.5	64.8		46.2	39.2	25.6	1.3	−0.8
July 2	−1.7	8.4	29.3	51.3	57.4	64.9	69.0	75.6	75.5	79.7			58.6	55.0	42.9	33.8	5.5	4.9	−1.6
July 3	−1.3																26.6	7.9	−1.5
July 4	−3.8		17.4		47.0	58.9	60.5	62.9	70.9	77.7	76.2	69.2					30.7	−2.7	−5.7
July 5	−3.5	2.9	12.7		52.4	58.9	61.6	64.9	66.5	68.7	68.5	68.5	70.7	50.2	46.1	41.7	28.1	0.5	−2.8
July 6		1.4	13.5		50.0	57.3	65.8	65.1	71.4	70.3	75.4	71.0	72.6					2.3	−2.6
July 7	−1.5	11.7	16.1		50.1	58.6	63.3	65.2	73.1							32.7			−1.9
July 8	−1.7	0.4			48.7	54.1	59.8	62.1	64.7	73.1									−0.4
July 9	−2.4					53.7	58.0	64.2	73.8		69.9	70.1	54.2	51.5	54.4				−2.1
July 10	−0.4	0.5	2.7		52.2	58.1	66.6												−0.2
July 11	−1.5	−1.8	1.4																
July 12	−0.5	−1.2																	
	−2.0	4.0	16.1	44.2	51.1	58.1	62.8	65.8	70.0	72.2	72.4	70.3	63.3	52.2	48.7	32.9	23.3	1.1	−2.0
July 13	−2.8	−1.9			52.3	57.7	59.4	64.3	69.7										
July 14	−0.9	−0.8	6.7		48.1	52.7	57.0	62.1	67.5	73.4	74.4		60.0						
July 15										70.8	68.6	69.9	67.1						
July 16	−1.5	1.7	9.0	31.1	51.0	56.5	59.6	66.2				70.0							
July 17	−0.6																		
July 18	−2.1	−3.1	7.1	31.4	51.1	57.7	61.3	62.4	62.7	63.1	67.6	74.7							
July 19	−4.2	−4.6	13.8	35.0	47.3	55.4	57.8												
July 20	−1.0	−2.0	17.8	34.9	49.6	54.0	57.1	60.0	63.2	70.2	69.1	64.9	62.3	54.6	46.6	35.1	10.3	−3.4	−2.9
July 21	−1.5	−1.4			49.4	61.6		60.2	75.6										
July 22	−2.0	−0.7	−0.7			41.1		61.8	67.7	73.9									
July 23	−5.5	−3.7	−0.3	23.7			59.6	58.7	62.3	60.9	65.6	63.5	60.4	50.0	46.1	32.6			
July 24	−2.3	−2.5	8.0		48.6		63.2	65.0	65.1	63.8			63.6			35.6			−2.0
July 25	−2.4	−2.1	3.3	22.4	49.1	54.7	58.1	58.9	62.0	65.3				50.2		44.6			−1.9
July 26	−0.3	−1.4	8.2				59.1	61.3	61.3	62.0	62.3								
		5 a. m.	Sun-rise.																
July 27	−2.8	0.0	5.0	16.5	49.1	53.2	57.7	60.2	58.6					55.0	51.8	34.6			−1.0
July 28	−3.2	−2.2	3.6	17.6	45.9	51.9	54.9	58.8	61.1	62.7				57.0					
July 29	−5.2	−2.0	4.5	21.6	48.3	54.4	57.7	59.6	61.2	65.2	70.5	66.9	66.0	56.0	48.3	19.5	2.6	1.2	−2.8
	−2.4	−0.6	5.4	26.0	49.1	54.5	58.6	61.4	64.5	66.5	68.3	68.3	63.2	53.8	48.2	33.7	6.4	−1.1	−2.1
		5 a. m.	Sun-rise.																
July 30	−2.3	−1.7		33.5	57.1	58.8	61.7	62.9	63.7	63.4	62.7	62.4	60.6	56.2	49.2	38.3	18.2	0.1	−2.7
July 31	−4.1	−2.4		23.4	51.0	58.5	63.0	63.5	61.1	64.0	64.2	63.1	60.4	55.7	36.5	31.8	4.5	1.8	−2.2
August 1	−0.9	−1.2			49.5	54.7	58.7	59.0	67.9				65.9	53.1	46.7	29.3	9.3	−3.2	−4.0
August 2	−3.7	−4.7		16.2	48.0	54.1	58.9	58.3	66.5						38.4	29.4	12.8	−2.5	−3.4
August 3	−8.3	−9.7		17.1	49.7	53.3	58.1	60.0	60.8	64.0	68.2								
August 4	−2.5				49.7	54.9	57.0	57.9	58.9	59.7	59.9				45.4	34.5			−1.4
August 5	−1.6	−1.0		18.5	46.4	54.9	58.9	60.3	61.1	61.3	60.6	61.3	63.4	55.2	50.5	35.5	15.3	−4.4	−5.5
August 6	−4.3	−3.0		18.5	39.2	55.0	57.8	59.7	60.9	65.2					51.3	34.5			−4.0
August 7	−2.5	−1.5		12.7	48.5		59.7	62.8											
August 8	−1.2	−0.8																	
August 9																			
August 10	−1.5							61.7	66.1										
August 11	−5.0	−4.8		11.4	48.3	61.1	60.7	63.7	68.2										
August 12	−2.0	−2.6		9.9	48.1		61.0	65.3	69.9										
August 13	−3.5	−2.2		15.0	47.2		59.1	62.4	63.9	63.2	64.8			57.1	46.7				−4.8
August 14	−2.8	−1.7		9.4	46.1	53.8	58.1	59.2	63.1	63.0	64.9	67.7	64.0	54.1	44.0				−2.2
August 15	−2.9	−3.1		9.3	36.2	55.2	58.9	60.7	62.0	64.9				53.0	47.2	40.6			−1.8
	−3.1	−2.9		16.4	47.5	55.7	59.4	61.2	63.9	63.2	63.6	63.6	62.9	54.9	45.6	34.2	11.6	−1.6	−3.2

The blank spaces indicate that the sun was obscured at those hours.

TABLE VI.—*Solar radiation, altitude of sun, and number of observations for each hour.*

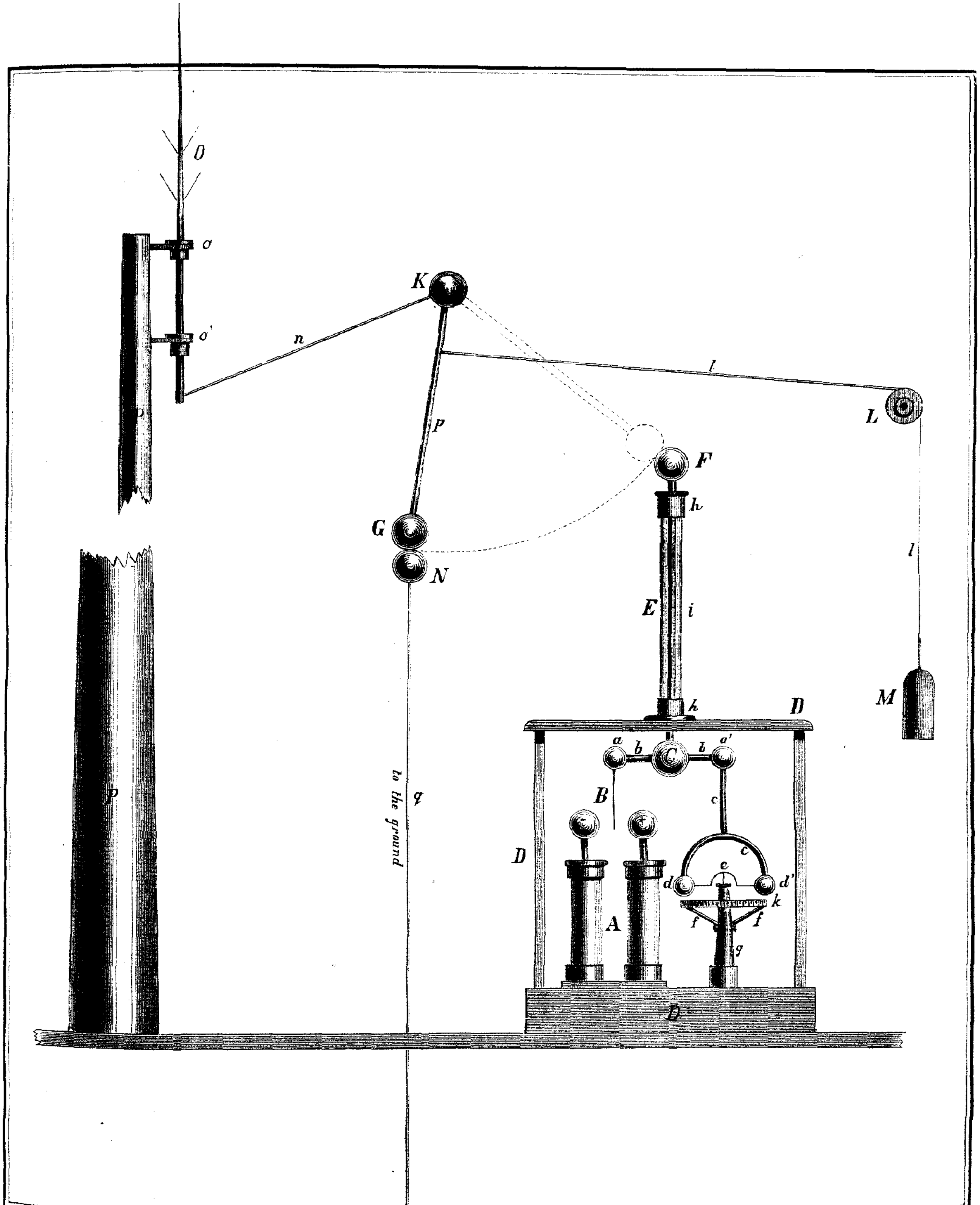
Hour.	June 26 to July 12, 17 days.			July 13 to July 29, 17 days.			July 30 to August 15, 17 days.			June 26 to August 15, 51 days.			Nine selected days.
	Number of observations.	Solar radiation.	Altitude of sun.	Number of observations.	Solar radiation.	Altitude of sun.	Number of observations.	Solar radiation.	Altitude of sun.	Number of observations.	Solar radiation.	Altitude of sun.	Solar radiation.
		°	° ′		°	° ′		°	° ′		°	° ′	°
4 a. m	16	− 2.0		16	− 2.4		16	− 3.1		48	− 2.5		
4.38, sunrise	11	4.0	0										
4.50, sunrise				15	− 0.6	0						0	
5 a. m	10	16.1		13	5.4		14	− 2.9		37	5.2		
5.06, sunrise									0				
6 a. m	6	44.2		9	26.0		12	16.4		27	25.8		30.1
7 a. m	12	51.1		12	49.1		14	47.5		38	49.1		51.9
8 a. m	13	58.1		12	54.5		11	55.7		36	56.2		57.7
9 a. m	14	62.8		13	58.6		14	59.4		41	60.3		61.8
10 a. m	13	65.8		14	61.4		15	61.2		42	62.7		63.8
11 a. m	13	70.0		13	64.5		14	63.9		40	66.1		65.5
Noon	10	72.2	71 41	11	66.5	69 12	9	63.2	65 04	30	67.4	69 12	67.9
1 p. m	7	72.4		7	68.3		7	63.6		21	68.1		66.1
2 p. m	7	70.3		6	68.3		4	63.6		17	68.0		65.0
3 p. m	6	63.3		6	63.2		5	62.9		17	63.1		63.4
4 p. m	3	52.2		6	53.8		7	54.9		16	54.0		54.6
5 p. m	5	48.7		4	48.2		10	45.6		19	47.0		45.6
6 p. m	6	32.9		6	33.7		8	34.2		20	33.7		34.4
7 p. m	5	23.3		2	6.4		5	11.6		12	15.6		
7.04, sunset							5	− 1.6	0				
7.21, sunset				2	− 1.1	0						0	
7.30, sunset	10	1.1	0										
8 p. m	14	− 2.2		5	− 2.1		10	−3.20		29	− 2.5		

ATMOSPHERIC ELECTRICITY.

Observations for atmospheric electricity were made between 8 a. m. and 9 p. m. on twenty-five days, commencing July 10 and ending August 12; and, although incomplete in some respects, they are presented with the hope that the unusual altitude at which they were taken would give to them an interest not authorized by so short a series. The electrometer was made for the occasion by Mr. Werner Suess, of the Coast Survey Office, a mechanician of great skill and an expert in electrical science, and the field observations were placed under his special charge. In his report he gives a drawing, (here omitted,) and the following description of the apparatus:

(A) represents a dry battery made of disks of common silver paper, covered on the paper side with oxide of manganese and inclosed in two glass tubes. In one of the tubes, the manganese side of the paper is up and the ball is marked +. In the other, the silver side is on top, and the ball is marked —. Between these two balls, a piece of very thin gold-leaf, ¼ inch wide, (B,) is suspended, and fastened to the small ball (*a*) with a little glue. The other small ball (a^1) carries a fork of brass wire, (*c*,) provided with the disks (*d*, d^1.) The letters (*b*, *b*) show the wire-connections with the larger ball, (C). The glass tube (E) with the brass end-pieces (*h*, *h*) carries the ball, (F.) The wire (*i*) in the glass tube (E) completed the metallic connection between C and F. The stand (*g*) carries on its upper end an agate center, on which the point of the fine steel-wire needle (*e*) is playing. The ends of this slightly-magnetized needle are resting against the disks, (*d*, *d*.) The whole is inclosed in the framed box (D) provided with windows on the four vertical sides.

(K) is a hinge. The movable arm (*p*) with ball (G) can be moved to the ball (F) by means of the string (*l*,) as shown by the dotted lines. (M) is a weight equalizing the weight of (*p*, G,) All the parts already described are adjusted inside of the observatory.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g
D'

Outside of the building, and at a distance of 60 feet from it, a mast, (P,) 40 feet in height, was erected. To the upper end is fastened, by means of glass insulators, (o, o^1,) the lightning-rod point (O.) An insulated wire, (n,) fastened to the lower end of (O,) leads through the wall of the observing-room direct to hinge (K.)

The drawing shows the movable ball (G) in contact with ball (N) of the ground-connection. To make observations, the observer has to bring ball (G,) by means of the string (l,) in slight contact with ball (F.) If there is any atmospheric electricity, it will be communicated to ball (F) and charge the gold-leaf (B) and the disks (d, d) with the same. For example, we will obtain + electricity when the gold-leaf will be attracted toward the + ball. To prevent erroneous readings, the balls are marked with the electricity of the leaf. At the same moment, the disks (d, d) are charged with plus electricity, and, by contact, the needle (e.) Two conductors, charged with the same electricity, are repulsive in proportion to the power of the latter, and the angle of the declination may be read on the divided circle (k) fastened to the stand (g) by the arms (f, f.) After each observation, the ball (G) has to be removed to (N) again. By this arrangement, not only very feeble degrees of electricity may be observed, but the apparatus can be used during the heaviest thunder-storms without danger. In cases of the latter character, the ball (G) is removed only one-fourth of an inch from the ball (N), allowing the sparks to pass to the ground during the prevalence of the storm, and at the same time permitting, by communication, the quality and quantity of the electricity to be marked on the apparatus. A distance of two feet, from F to N, was found sufficient during two months' observations, with occasional very heavy thunder-storms. The whole arrangement worked admirably, but is, of course, subject to improvement.

Table VIII presents the results, with the omission of more than thirty observations, made day and night, but principally at 8 a. m., during clear weather, when no trace of electricity was discovered. From this record, it would appear that electricity existed, or was only collected during the prevalence of great commotions in the atmosphere, and that the kind and intensity followed no general law. The entire absence of electricity during comparatively serene days may be due partly to the cold, dry atmosphere of the station, and, in some measure, to the incapacity of the electrometer to detect slight amounts. To provide against such a contingency in the future at elevations similar to that of Sherman, Mr. Suess suggests that the collectors of atmospheric electricity should command a more extended area; and that, for this purpose, instead of one, four masts should be erected, about 400 feet apart; and that, in place of the lightning-rod point, there should be substituted a ball of thin copper or brass, from 10 to 12 inches in diameter, to be fastened to an iron bar raised about 18 inches above the top of each mast, and secured to it by insulators.

It was a source of regret that, owing to other more important duties devolving on Mr. Suess, it was not possible for him to take a more regular and extended series of hourly observations.

TABLE VIII.—*Atmospheric electricity.*

Date.	Hour.	Atmospheric electricity. + or −.	Atmospheric electricity. Deflection.	Atmospheric electricity. ¼-inch sparks per minute.	Remarks.	Date.	Hour.	Atmospheric electricity. + or −.	Atmospheric electricity. Deflection.	Atmospheric electricity. ¼-inch sparks per minute.	Remarks.
July 10	8 a. m.	+			Cloudy.	July 19	11 a. m.	+	25°		Distant thunder.
10	Noon	+			Thunder, lightning.	20	8 a. m.	0			Clear.
10	4 p. m.	0			Cloudy.	20	4 p. m.	0			Do.
10	6 p. m.	0			Do.	21	4 p. m.	Traces			Cloudy.
11	6 p. m.	0			Raining.	22	8 a. m.	0			Do.
12	2 p. m.	−	35°		Distant thunder.	22	Noon	−			Do.
12	9 p. m.	−	40°		Distant thunder and rain.	23	8 a. m.	0			Clear.
12	10 p. m.	−	75°		Distant thunder.	23	6 p. m.	−	10°		Distant thunder.
13	8 a. m.	0			Clear.	25	8 a. m.	0			Partially clear.
13	Noon	+			Lightning and thunder.	25	Noon	−		60	Light sprinkle.
13	1 p. m.	−	35°	90	Rain.	25	5 p. m.	−		300	Lightning and thunder.
14	11 a. m.	+			Distant thunder.	26	8 a. m.	0			Cloudy.
14	Noon	−	35°		Raining.	26	6 p. m.	+			Do.
14	4 p. m.	+	25°		Distant thunder.	27	8 a. m.	0			Clear.
14	6 p. m.	+	30°		Raining.	27	Noon	+	20°	200	Distant thunder.
15	6 a. m.	0			Fog.	27	3 p. m.	−		300	Hail-storm.
15	11 a. m.	0			Cloudy.	28	2 p. m.	−	10°	300	Distant thunder.
16	11 a. m.	+	30°	160	Thunder, distant; rain.	29	8 a. m.	0			Clear in zenith.
16	Noon	+			Distant thunder.	29	Noon	0			Do.
16	2 p. m.	+	10°		Thunder and lightning.	30	8 a. m.	0			Do.
16	3 p. m.	+		(*)	Do.	Aug. 4	2 p. m.	−	10°	60	Light shower.
16	4 p. m.	−			Distant thunder.	7	Noon	−	25°	220	Distant thunder.
17	8 a. m.	0			Fog.	7	1 p. m.	−	20°		Do.
17	4 p. m.	0			Fog and light rain.	7	4 p. m.	0			Light sprinkle.
18	8 a. m.	0			Clear.	8	8 a. m.	0			Cloudy.
18	9 a. m.	0			Do.	8	1 p. m.	−			Hail and rain.
18	4 p. m.	0			Cloudy and light rain.	10	8 a. m.	0			Fog.
19	8 a. m.	+			Clear.	12	8 a. m.	0			Clear.
19	10 a. m.	+			Distant thunder.						

* Sparks too continuous to be estimated.

ALTITUDE OF THE ASTRONOMICAL STATION.

SPIRIT-LEVEL.

The height above the sea-level of the railroad-track at Sherman, as given by the engineers who constructed the road, is 8,235 feet. The astronomical and meteorological station was 33 feet above the track, and, hence, 8,268 feet above the sea. This result, however, cannot be accepted as conclusive. Its reliability is affected by the probable errors committed in the leveling, especially when conducted by the ordinary method, of a series of lines amounting in the aggregate to over 2,000 miles in length, and by errors in the graduation of the leveling-rods. Of the first uncertainty, no estimate of its value can be made, and we will, therefore, assume that the plus compensated for the minus errors. In regard to the second, we have only to suppose that the foot-divisions of the rod were inaccurate to the extent of $\frac{1}{20}$ of an inch, which is very generally the case, and adopting the given altitude of Omaha, 966 feet, as critically correct, we have for the line from Omaha to Sherman, a distance of 549 miles, with a gradual rise of 7,270 feet, a probable error of $\pm$ 30 feet. The height of the station, from the spirit-leveling operations may be, therefore, stated to be 8,268 feet $\pm$ 30.

BAROMETER.

In order to compare the altitude given by the railroad-company with that which could be deduced from the barometric observations at the station in connection with corresponding observations at other points whose height above the sea was accurately determined, application was made to Dr. G. Engelmann, of Saint Louis, for a transcript of those taken by him during June, July, and August, and also to General Albert Myer, Chief-Signal Officer, U. S. A., for those of a like date made under his direction at the Signal-Office in Washington; and I take pleasure in acknowledging the courtesy and promptness with which both complied with my request.

Besides these two series of corresponding observations, the mean barometer for the period, as established by more than one year's observations at Saint Louis, Girard College, Sacramento, San Francisco, and Astoria, has been introduced for similar comparisons; and for the purpose of showing and of throwing out, if necessary, any special discrepancy which might be found to exist, the sixty-days' set has been divided into four periods of fifteen days each, as exhibited in Tables IX, X, and XI.

Saint Louis (1).—This station, the present residence of Dr. Engelmann, is about two miles west of Saint Louis; the cistern of the barometer being 549 feet above the Gulf of Mexico. The observations were made at the hours of 7 a. m. and 2 and 9 p. m., representing the mean of the twenty-four. The wet bulb was not observed.

Washington.—The observations at the Signal-Office were made hourly, and, besides the usual corrections for instrumental error and temperature, were reduced to the sea-level.

Saint Louis (2).—The data in this case, the mean of the years 1860, 1861, and 1862, are derived from the meteorological tables published by Dr. Engelmann in the Transactions of the Academy of Science of Saint Louis. During these years, Dr. Engelmann resided in the city; the cistern of the barometer being 481 feet above the Gulf of Mexico.

Girard College, Philadelphia.—The results in the table are the mean of the period during the five years' series taken in 1840, 1841, 1842, 1843, and 1844, under the direction of Prof. A. D. Bache.

Sacramento, San Francisco, and Astoria.—The data for these stations were obtained from the ten-days' observations in each month for two successive years, as published by Col. R. S. Williamson, Corps of Engineers, U. S. A., in his paper "On the use of the barometer."

The relative humidity and elastic force of vapor for Sherman were computed, as heretofore stated, from Williamson's tables.

The formulæ and tables used in the computations of the difference of height between Sherman and the other stations were those of Dr. Richard Ruhlmann, professor in the Polytechnic School at Carlsruhe, published at Leipsic in 1870.

The cistern of the barometer at the astronomical station was eight feet above the ground, and this quantity must be, therefore, deducted from any computed difference of height from the Sherman observations.

The correction for relative humidity, or the elastic force of vapor, has not, in any case, been applied.

Table XI shows that the first period of fifteen days gives results much higher, in every case, than the three other periods. This fact points to Sherman as the cause. Upon examination of the record and of Diagram I, we find that between the 21st of June and the 1st of July, dates embraced within the above period, the barometer at Sherman fell over half an inch. Of course, it could hardly be expected that this great change in the atmospheric pressure would be felt, during the summer-season, at so great a distance as the meridian of Saint Louis, and still less of Washington; nor do we find at those stations any response, either following or preceding, to this exceptionally low barometer at Sherman. The pressure is never the same, except under unusually favorable circumstances, beyond a radius of fifteen miles, so that, unless the two stations were situated within that area, simultaneous observations for a short period give only approximate results; the uncertainty increasing with the distance. When, however, that distance is from 15° to 30° of longitude, the very best observations cease to be corresponding, and the mean of the period for any year or series of years would afford results equally reliable, and especially between a station of high elevation in the interior and those situated in such an entirely different climate as the valley of the Mississippi and the Atlantic seaboard.

Rejecting, therefore, the first period as evidently exceptional, and adopting the other three as representing the true mean barometer for the station and dates, we find that the results from the four stations to the eastward are sufficiently harmonious to entitle them to considerable weight in the discussion of the altitude; and the same may be said of the heights deduced from the three stations to the westward, notwithstanding the two sets of results differ more than 100 feet.

The observations on the Pacific coast were taken on only ten days of the month, and are not, therefore, strictly entitled to the same weight as the full series on the Atlantic coast. In view, however, of all the facts, the mean of the two sets, 8,312 feet, has been taken to represent the height of the station as deduced from the barometrical observations; and, assigning to this mean an equal weight with the spirit-leveling, the mean of the two shows the altitude of the astronomical station at Sherman to be 8,290 feet above the sea-level.

TABLE IX.

Barometer-station.	Latitude north.	Longitude west of Greenwich.	Period.	Number of days.	Barometer at 32°, mean.	Air, temperature, mean.	Force of vapor, mean.	Relative humidity, mean.	Station above sea-level.
	° ′	° ′				°	*Inch.*		*Feet.*
Sherman	41 08	105 23	June 17 to July 2	15	22.222	55.2	0.188	.459	8,290
			July 2 to July 17	15	.277	55.2	0.254	.616	8,290
			July 17 to August 1	15	.296	58.4	0.257	.540	8,290
			August 1 to August 16	15	.326	57.2	0.221	.521	8,290
Saint Louis (1)	38 37	90 15	June 17 to July 2	15	29.482	78.5	....	....	549
			July 2 to July 17	15	.407	78.7	....	....	549
			July 17 to August 1	15	.431	78.4	....	....	549
			August 1 to August 16	15	.490	77.3	....	....	549
Washington	38 54	77 03	June 17 to July 2	15	30.055	80.2	0.656	.637	0
			July 2 to July 17	15	29.986	82.8	0.708	.641	0
			July 17 to August 1	15	29.953	80.1	0.561	.548	0
			August 1 to August 16	15	30.051	80.3	0.674	.652	0
Saint Louis (2)	38 37	90 18	June 17 to July 2	15	29.463	76.6	0.580	.645	481
			July 2 to July 17	15	.469	78.8	0.613	.633	481
			July 17 to August 1	15	.480	79.5	0.629	.634	481
			August 1 to August 16	15	.494	78.9	0.628	.648	481
Girard College	39 38	75 11	June 17 to July 2	15	28.896	69.8	0.376	.521	112.3
			July 2 to July 17	15	.908	71.8	0.412	.528	112.3
			July 17 to August 1	15	.921	72.5	0.426	.533	112.3
			August 1 to August 16	15	.935	71.8	0.417	.534	112.3

TABLE X.

Barometer-station.	Latitude north.	Longitude west of Greenwich.	Period.	Number of days.	Barometer at 32°, mean.	Air, temperature, mean.	Force of vapor, mean.	Relative humidity, mean.	Station above sea-level.
	° ′	° ′				°			*Feet.*
Sacramento	38 34	121 19	June 17 to July 2	15	29.883	69.8	....	....	81
			July 2 to July 17	15	.874	71.3	....	....	81
			July 17 to August 1	15	.868	71.8	....	....	81
			August 1 to August 16	15	.868	71.4	....	....	81
San Francisco	37 48	122 23	June 17 to July 2	15	29.989	59.3	....	....	22
			July 2 to July 17	15	.986	59.2	....	....	22
			July 17 to August 1	15	.984	59.2	....	....	22
			August 1 to August 16	15	.984	59.3	....	....	22
Astoria	46 11	123 50	June 17 to July 2	15	30.028	57.2	....	....	53
			July 2 to July 17	15	.048	58.5	....	....	53
			July 17 to August 1	15	.044	59.8	....	....	53
			August 1 to August 16	15	.017	61.0	....	....	53

TABLE XI.

Barometer-station.	1st period, 15 days.	2d period, 15 days.	3d period, 15 days.	4th period, 15 days.	Mean of 2d, 3d, and 4th periods.	
ATLANTIC COAST.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Meters.*
Saint Louis (1)	8, 505. 0	8, 364. 8	8, 385. 8	8, 385. 8	8, 378. 8	2, 553. 8
Washington	8, 509. 7	8, 394. 9	8, 345. 7	8, 392. 0	8, 354. 2	2, 546. 3
Saint Louis (2)	8, 404. 8	8, 357. 2	8, 372. 0	8, 333. 5	8, 377. 4	2, 553. 4
Girard College	8, 391. 5	8, 349. 3	8, 366. 4	8, 327. 9	8, 347. 9	2, 544. 4
Mean	8, 452. 8	8, 366. 4	8, 367. 5	8, 359. 8	8, 364. 6	2, 549. 5
PACIFIC COAST.						
Sacramento	8, 348. 8	8, 282. 4	8, 281. 1	8, 231. 5	8, 265. 0	2, 519. 2
San Francisco	8, 304. 0	8, 232. 8	8, 231. 3	8, 185. 5	8, 216. 5	2, 504. 4
Astoria	8, 351. 5	8, 312. 2	8, 319. 3	8, 257. 0	8, 296. 2	2, 528. 7
Mean	8, 334. 8	8, 275. 8	8, 277. 2	8, 224. 7	8, 259. 2	2, 516. 8

BOILING POINT APPARATUS.

The temperature of the vapor of boiling water was determined by one of Casella's hypsometers, No. 9776. Sixteen mean results, obtained on twelve days in July and August, show that the boiling-point, at the altitude of Sherman, ranged from 197°.02 F. to 197°.70 F.; the variations following the fluctuations in the atmospheric pressure.

The results are given in Table XII. The mean temperature of the boiling-point was 197°.32, and the observed height of the barometric column for the same hours and series was 22.305. Now, if we adopt 197°.32 as correct, and compute, by means of the Smithsonian tables, what the pressure should have been for that temperature, we find that the barometer should have read 22.179, or 0.127 lower than was actually observed; or, if the barometer was correct, the theoretical temperature should have been 197°.59, or 0°.27 higher than observed.

With a view to test the accuracy of the scale of the Casella thermometer at 212°, the temperature at which it was standarded, a series of careful comparisons were made at my request, under the special direction of Prof. J. E. Hilgard, assistant, in charge of the Office, the results of which are given in Table XIII. The comparisons show that, at a mean pressure of 29.967, the boiling-point stood at 212°.087; being almost identically the same as that deduced from the same pressure by means of Moritz's revision of Regnault's tables. It is, therefore, believed that the thermometer was correct, and that its scale had not changed since it was made; and, as it is not probable that so great an error as 0.127 could have been committed by the different observers in adjusting and reading the Sherman barometer, the discrepancy must be referred to the tables and to possible mistakes, amounting to one-quarter of a degree of Fahrenheit in the field-determinations.

It should be stated in this connection that the hypsometer was observed at a point about .030 of the barometric column below the cistern at the astronomical station; and, also, that the aneroid and boiling-point apparatus were in excellent accordance.

Adopting, for the sake of illustration, the observed temperature of 197°.32 as correct, we find 22.178 in the table as the corresponding atmospheric pressure, from which must be subtracted the quantity .030 to reduce it to the upper station. With these new values, 22.148 for the barometer and 60°.2 for the temperature of the air, the height of the astronomical station would be about 8,416 feet above the sea-level, a result showing that the thermometrical measurement could not be depended on in this case within about 126 feet of what may be assumed as the true altitude.

TABLE XII.—*Temperature of the boiling point of water at Sherman.*

Date.	Hour.	Observed. Boiling-point.	Observed. Barometer at 32°.	Observed. Air, temperature.	Computed barometer from observed boiling-point.	Difference between observed and computed barometer.	Computed boiling-point from observed barometer.	Difference between observed and computed boiling-point.
		°		°			°	°
July 15	6 a. m.	197.18	22.246	42.6	22.116	+0.130	197.46	—0.28
17	4 p. m.	.23	.305	44.0	.139	.166	.59	.36
18	9 a. m.	.40	.360	55.4	.218	.142	.70	.30
18	4 p. m.	.30	.342	60.6	.172	.170	.67	.37
20	8 a. m.	.19	.240	61.5	.120	.120	.45	.26
22	8 a. m.	.29	.285	60.4	.166	.119	.54	.25
23	8 a. m.	.40	.351	60.7	.218	.133	.69	.29
23	6 p. m.	.38	.288	65.0	.209	.079	.55	.17
26	8 a. m.	.60	.393	62.4	.311	.082	.77	.17
27	8 a. m.	.40	.336	64.8	.218	.118	.65	.25
29	8 a. m.	.20	.272	64.2	.125	.147	.52	.32
29	Noon.	.39	.296	73.2	.213	.083	.57	.18
30	8 a. m.	.70	.465	55.2	.358	.107	.93	.23
Aug. 7	1 p. m.	.19	.260	68.4	.120	.140	.49	.30
7	4 p. m.	.17	.244	68.4	.111	.133	.46	.29
8	7 a. m.	.02	.205	56.1	.042	.163	.37	.35
		197.32	22.305	60.2	22.178	+0.127	197.59	—0.27

TABLE XIII.—*Observations made at the United States Coast Survey Observatory, with Casella thermometer No. 9776, to ascertain the boiling-point of water.*

Elevation above mean half-tide level of the Potomac, 52.5 feet.

Date.	Hour.	Barometer, Green No. 1936.	Attached thermometer.	Reduction to 32° Fahrenheit.	Corrected pressure.	Boiling-point.	Observer.
1873.			°			°	
Mar. 24	2.15 p. m.	30.016	45.8	—.047	29.969	212.12	W. Suess.
24	3 p. m....	.016	45.0	.044	.972	.10	Do.
25	9 a. m....	29.976	37.0	.023	.953	.05	Do.
25	11.10 a. m.	.997	38.0	.026	.971	.10	J. H. Lane.
25	11.35 a. m.	.995	38.4	.027	.968	.10	Do.
25	12 m	.994	37.9	.026	.968	.08	W. Suess.
25	2.30 p. m.	.990	37.0	—.023	.967	.06	Do.
		29.998	39.9	—.031	29.967	212.087	

HEIGHT OF LONG'S PEAK, ETC.

After the triangulation of the plateau was completed, the longest lines were used as bases for determining the position and altitude of some of the prominent and distant mountain-peaks in view from the station. In consequence, however, of the short length of the bases in comparison with the long lines to be determined, and of the absence of signals on the summits and of any distinguishing mark which could be pointed at with equal certainty at all the stations, the angles at the mountain-peaks were very small, averaging 3°, and their determination merely approximate.

The double zenith-distances of Medicine Bow and Mount Agassiz were observed at 6 p. m., August 7; the barometer standing at 22.239, and the dry and wet bulbs, respectively, at 63°.3 and 51° Fahrenheit. The observations on Long's Peak were made the next afternoon at the same hour, when the barometer showed 22.216 and the dry and wet bulbs 49°.3 and 46°.3. The highest part of Medicine Bow range, the summit observed upon, and Long's Peak, are always covered with snow. With the above data and Struve's formula, the co-efficient of the normal refraction was computed for each line:

$$K = \left(0.07238 + \frac{.1298}{A} \right) \frac{B}{736.586} 1.011838^{(20 - T)}$$

in which—

K = the mean height of the ray above the ground, in *meters*;
B = height of barometer in millimeters, reduced to freezing-point; and
T = the temperature of the air in centesimal degrees.

The co-efficient for Medicine Bow was .05791; for Mount Agassiz, .058.1; and for Long's Peak, .05595; but, as the refraction increases slowly, and then more rapidly after the midday hours, the above values do not represent the co-efficients at the hour of observation. In the absence of a reliable table of the hourly rates of increase and decrease for altitudes similar to that of Sherman, we have assumed one-fifth of the normal refraction as the increase from 4 to 6 p. m. The results, with their probable errors, principally of distance, are given in the following table, and are based upon the latitude, longitude, and height of the astronomical station, as given in the preceding pages:

Mountain-summits.	From observations at astronomical station.			Latitude.	Longitude west of Greenwich.	Above Sherman.	Height above sea.	
	Azimuth.	Distance.	Zenith-distance.					
	° ′ ″	*Meters.*	° ′ ″	° ′ ″	° ′ ″	*Feet.*	*Feet.*	*Meters.*
Medicine Bow	108 22 55	61, 140	89 33 28	41 21 26	106 18 46	3, 517	11, 807	3, 598
Mount Agassiz	85 47 13	48, 726	89 41 52	41 05 48	105 58 16	1, 373	9, 663	2, 945
Long's Peak	10 46 55	101, 097	89 20 42	40 14 09	105 36 54	6, 081	14, 370	4, 380

SHERMAN, ITS ATMOSPHERE AND CLIMATE.

The advantages which follow an elevation of the telescope above the denser strata of the atmosphere are a lower and more uniform temperature, a proportional dryness or decrease of aqueous vapor, less refraction, increased darkness of the interstellar spaces in consequence of there being so much less atmosphere to produce color, and, for the same reason, the comparative absence of interfering lines in the spectra of the heavenly bodies, and, as the general result, an improved brightness, definition, and steadiness of the stars and degree of accuracy with which celestial phenomena can be noted. As the advantages theoretically belonging to the altitude are modified by the atmospheric conditions dependent on the locality, the results of the meteorological observations made during our stay at Sherman become of the first importance in considering the availability of the position for a permanent observatory.

A description of the locality and of the wide plains to the eastward and mountain-ranges to the westward has been already given. In regard to the safe transportation of instruments, accessibility at all times, and supplies, Sherman possesses advantages not equaled by any similar altitude in Europe or America. In respect to weather, it may be generally stated that the 72 days spent there during June, July, and August were characterized by excessive cloudiness; by high winds from the westward; by the various directions in which the cloud-strata would be moving at the same time; by the suddenness with which the sky would be overcast and then become clear again; and, as a consequence, by a great uncertainty in regard to the duration of favorable hours for astronomical observations. This condition of the atmosphere, resulting from the juxtaposition of the station to the snow-covered ranges to the westward and the heated air over the plains, would appear to indicate that the altitude was somewhat too great, being within the region of the lower clouds or mist-formations; and the same objection could be urged against the occupation of any of the higher altitudes situated within view to the westward and from forty to seventy miles distant. In no instance were clouds observed to hang on the mountain-side; but when any existed and were visible from Sherman, they enveloped the summit. It frequently occurred that there was bright, clear weather at Laramie, twenty-four miles west and 1,000 feet lower, and at Cheyenne, thirty-three miles to the eastward and 2,000 feet lower. Assistant Mosman had clear weather, night after night, at Salt Lake City, when it was the worst at Sherman.

The mean temperature during the sixty days of observation, or season, when the day-temperature would be the highest and the extremes the greatest, was 56°.5 F.; the range being from the minimum, 47°.8, just before day-break, to the maximum, 65°.4, at noon. There were twenty-two days on which the temperature of the warmest hour reached or exceeded 70°, and only one when the mercury showed as high as 80°. Fires were generally necessary after sun-down, and acceptable for half the time during the day, especially when the wind was strong.

The absolute quantity of aqueous vapor in the air was about 50 per cent. less than is recorded for Saint Louis; and yet it was, no doubt, exceptionally large for the season, in consequence of the amount of snow remaining on the mountain-slopes from the excessive fall of the previous winter. The dryness of the air was further illustrated by rapid evaporation; by unusual and almost immediate shrinkage of newly-cut lumber; and by the fact that there was no perspiration, no animal putrefaction, and no mold. Dew was never seen; the dew-point being invariably lower than the temperature of the air. The mean evaporation of water exposed for twenty-four hours on the roof of the meteorological observatory was, for eleven days of careful comparison and measurement, sixfold greater than within the building.

The total quantity of rain and melted hail and snow which fell during the sixty days amounted to 2.55 inches.

The wind was at times very strong, and frequently continued so day and night, constituting dry gales. The velocity ranged from 2 to 43.7 miles per hour; there being very few occasions on which it was entirely calm. The velocity per day varied from 167 to 760 miles; the average being 332 miles. The general direction of the wind was from the mountains to the plains, or from the quarter between the northwest and southwest; the proportion from this direction was 53 per cent.; from southwest to southeast, 25 per cent.; from southeast to northeast, 12 per cent.; and from northeast to northwest, 10 per cent. The direction of the upper winds, as determined by the movements of the upper clouds, was, as a general rule, from northwest to southwest.

Notwithstanding the prevalence of cloudy weather, we had opportunities of making all of the observations which we had proposed, and of fully realizing the advantages of the altitude for astronomical purposes. When the sky was entirely free from clouds, the firmament was indescribably brilliant from the appearance of a host of stars of the sixth and seventh magnitudes, rarely, if ever, seen near the sea-level by the unassisted eye. Stars of the fifth magnitude were observed for some time before sunset with the telescope of the small portable transit; and the companion to Polaris, a star of the ninth magnitude, appeared, always distinct and only slightly quivering, with a 2¼-inch object-glass and a power of 45. The increased steadiness and definition of the 60 time-stars observed by me were readily recognized. Those of the first magnitude, such as Antares, were too large and brilliant for precise transits. The number of telescopic stars was increased by two or three magnitudes.

The special observations, however, to determine the value of the elevation in the observing of celestial phenomena were made by Prof. C. A. Young. It will suffice here to state that his telescope and spectroscopic apparatus were the largest and most powerful ever mounted at so high an altitude; and being the same instruments which he had employed for so many years, and with such distinguished success, at Dartmouth College, he was enabled to make direct comparisons of the most interesting and decisive character. In his report, which will accompany this, he gives it as his deliberate opinion that the elevation of 8,000 feet made his 9.4-inch object-glass equal in power to a 12-inch glass at the sea-level.

Before closing this report, I beg to acknowledge the assistance given to the expedition by the detail of a guard supplied by General E. O. C. Ord, under the authority of the Secretary of War, and made doubly efficient by the care with which the men were selected by the commandant at Fort

D. A. Russell, General John A. King; also, the courtesy of Col. Thomas A. Scott, president of the Pennsylvania Central Railroad Company, for free passes for each member of the party, from Harrisburg to Chicago; and, finally, the liberality and promptness with which the superintendent of the Atlantic and Pacific Telegraph Company, Col. I. I. Dickey, erected a branch from the main line to our observatory, at their expense, and gave us the free use of the wires between Sherman and Salt Lake City, "from a desire, on the part of the company, to advance the interests of science."

I am, respectfully, yours,

RICHD. D. CUTTS.

Prof. BENJAMIN PEIRCE,
Superintendent of the United States Coast Survey.

METEOROLOGICAL JOURNAL.—SHERMAN, WYOMING TERRITORY.

SHERMAN, JUNE 17, 1872.

Hour.	Barometer at 32° Fahrenheit.	Dry bulb.	Wet bulb.	Relative humidity.	WIND.		LOWER CLOUDS.		UPPER CLOUDS.			Amount of rain and melted snow.	Aneroid barometer.	Remarks.
					Direction.	Velocity per hour.	Kind.	Amount.	Kind.	Amount.	Moving from—			
1 a. m.	22.131	54.2	43.7	.456	......	......	......	...	......	...	......	......	21.960	
2 a. m.	.136	52.9	43.4	.488	......	......	......	...	......	...	......	......	.962	
3 a. m.	.129	53.8	43.4	.450	......	......	......	...	......	...	......	......	.958	
4 a. m.	.125	53.9	43.9	.473	......	......	......	...	......	...	......	......	.959	
5 a. m.	.147	53.8	44.5	.498	......	......	......	...	......	...	......	......	.953	
6 a. m.	.057	59.8	48.9	.469	......	......	......	...	......	...	......	......	.970	
7 a. m.	.058	64.4	51.7	.430	......	......	......	...	......	...	......	......	.965	
8 a. m.	.106	65.8	52.1	.404	......	......	......	...	......	...	......	......	.960	
9 a. m.	.091	69.6	54.7	.387	......	......	......	...	......	...	......	......	.948	
10 a. m.	.038	70.1	52.2	.317	S. W. by S.	31.2	......	...	Cu. St.	9	S. W. by S.	......	.925	
11 a. m.	.047	69.0	52.1	.335	S. W. by S.	18.0	......	...	Cu. St.	10	S. W. by S.	......	.925	
12 m ...	.038	62.2	50.9	.464	W.	26.4	......	...	Cu. St.	10	S. W. by S.	......	.924	Slight sprinkle of rain.
1 p. m.	.024	66.9	53.5	.416	W. by S.	8.4	......	...	Cu. St.	7	S. W. by S.	......	.910	
2 p. m.	21.983	72.5	54.2	.317	S. S. E.	22.8	......	...	Cu. St.	5	S. by E.	......	.868	
3 p. m.	.986	66.5	52.1	.388	S. E.	24.0	......	...	Cu. St.	9	S. S. E.	......	.820	Forked lightning to
4 p. m.	.981	55.0	52.2	.819	W.	12.0	......	...	Cu. St.	9	W.	......	.875	westward.
5 p. m.	.934	57.9	50.8	.608	N.W. by W.	27.6	Cir.	3	Cu. St.	9	N. W.	......	.850	At 3.30 p. m., squall with
6 p. m.	.934	57.0	50.7	.640	W.	28.8	Cir.	3	Cu. St.	9	S. W.	......	.850	lightning.
7 p. m.	.951	53.0	50.4	.826	W.	19.2	......	...	......	...	......	......	.857	
8 p. m.	.937	54.7	49.5	.686	W.	14.4	......	...	......	...	......	......	.856	
9 p. m.	.953	55.0	48.4	.620	W.	26.4	......	...	......	...	......	......	.870	
10 p. m.	.979	53.1	45.7	.575	W.	30.0	......	...	......	...	......	......	.899	
11 p. m.	22.003	51.5	42.8	.510	W.	30.0	......	...	......	...	......	......	.920	
12 p. m.	.021	44.7	37.0	.519	W.	31.2	......	...	......	...	......	......	.924	
	22.033	59.0	48.7	.504	......	360.4	......	...	......	...	......	......	21.913	

METEOROLOGICAL JOURNAL.—SHERMAN, WYOMING TERRITORY—Continued.

SHERMAN, JUNE 18, 1872.

Hour.	Barometer at 32° Fahrenheit.	Dry bulb.	Wet bulb.	Relative humidity.	WIND.		LOWER CLOUDS.		UPPER CLOUDS.			Amount of rain and melted snow.	Aneroid barometer.	Remarks.
					Direction.	Velocity per hour.	Kind.	Amount.	Kind.	Amount.	Moving from—			
1 a. m.	22.033	43.9	35.5	.481	....	36.0	....	....	....	...	....	......	21.925	
2 a. m.	.062	41.8	33.6	.475	....	32.4	....	....	....	...	....	......	.932	
3 a. m.	.069	39.6	32.3	.502	....	30.0	....	....	....	...	....	......	.945	
4 a. m.	.067	38.9	31.4	.486	....	39.6	....	....	....	...	....	......	.954	
5 a. m.	.080	39.0	31.9	.507	....	34.8	....	....	....	...	....	......	.960	
6 a. m.	.141	40.7	33.5	.517	....	21.6	....	....	....	...	....	......	.974	
7 a. m.	.062	43.6	35.2	.479	W. S. W.	34.2	Cir. St.	1	....	...	....	......	.985	
8 a. m.	.072	45.8	36.9	.470	S. W.	35.0	Cir. St.	1	....	...	....	......	.990	Wind blow'g in squalls.
9 a. m.	.092	49.1	39.4	.457	S. W. by W.	34.3	Cir. St.	1	....	...	....	......	22.010	
10 a. m.	.101	52.9	41.8	.428	W. by S.	20.4	Cir. St.	1	....	...	....	......	.020	
11 a. m.	.100	54.4	42.3	.403	W. by S.	20.4	Cir. St.	1	....	...	....	......	.004	
12 m ...	.082	61.3	43.8	.292	S. W.	24.0	Cir. St.	2	....	...	....	......	21.979	
1 p. m.	.068	62.7	43.0	.252	S. W. by S.	26.4	....	....	Cu.	2	S. W.	......	.960	
2 p. m.	.068	62.3	44.5	.290	S.	20.4	....	....	Cu. St.	8	S.	......	.959	
3 p. m.	.080	57.6	41.2	.299	S.	27.6	....	....	Cir. Cu.	9	S.	......	.975	
4 p. m.	.085	58.3	42.8	.327	S.	24.0	....	....	Cir. Cu.	10	S.	......	.970	
5 p. m.	.109	51.7	39.2	.373	S.	21.6	....	....	Cir. Cu.	10	S.	......	22.000	
6 p. m.	.121	50.0	38.0	.378	S. W.	27.6	....	....	Cir. Cu.	10	S. W.	......	.005	
7 p. m.	.142	48.2	38.2	.439	S. W.	25.2	....	....	Cir. Cu.	9	....	......	.040	
8 p. m.	.143	42.7	37.9	.662	S. W.	28.0	....	....	....	...	....	......	.041	
9 p. m.	.138	41.8	36.0	.599	W.	32.4	....	....	....	...	....	......	.041	
10 p. m.	.157	39.5	34.8	.650	W.	22.8	....	....	....	...	....	......	.070	
11 p. m.	.160	38.7	34.5	.677	W.	26.4	....	....	....	...	....	......	.079	
12 p. m.	.164	37.5	32.5	.614	W.	27.6	....	....	....	...	....	......	.080	
	22.099	47.6	37.5	.461	....	672.7	....	....	....	...	....	......	21.996	

METEOROLOGICAL JOURNAL.—SHERMAN, WYOMING TERRITORY—Continued.

SHERMAN, JUNE 19, 1872.

Hour.	Barometer at 32° Fahrenheit.	Dry bulb.	Wet bulb.	Relative humidity.	Wind. Direction.	Wind. Velocity per hour.	Lower clouds. Kind.	Lower clouds. Amount.	Upper clouds. Kind.	Upper clouds. Amount.	Upper clouds. Moving from—	Amount of rain and melted snow.	Aneroid barometer.	Remarks.
1 a. m.	22.151	37.5	31.8	.572	W.	36.0	......	......	......	......	......	......	22.092	
2 a. m.	.157	35.8	31.2	.621	W.	25.2	......	......	......	......	......	......	.098	
3 a. m.	.158	35.0	30.8	.636	W.	22.8	......	......	......	......	......	......	.102	
4 a. m.	.164	35.7	31.3	.633	W.	27.6	......	......	......	......	......	......	.102	
5 a. m.	.165	34.5	30.5	.639	W.	25.2	......	......	......	......	......	......	.110	
6 a. m.	.134	36.9	31.8	.601	W.	26.5	......	......	......	......	......	......	.113	
7 a. m.	.212	40.0	33.9	.569	W.	34.8	......	......	Cu.	1	W.	......	.135	
8 a. m.	.238	42.8	34.9	.497	N. N. W.	30.0	......	......	Cir. St.	5	N. W.	......	.160	
9 a. m.	.230	43.9	35.2	.468	W. N. W.	31.8	......	......	Cir. St.	3	W.	......	.159	
10 a. m.	.225	46.1	36.0	.423	W. by N.	36.0	......	......	Cir. St.	2	W.	......	.140	
11 a. m.	.245	48.8	37.1	.380	W. by N.	35.4	Cir.	1	Cu.	6	W. by N.	......	.159	
12 m.	.249	51.8	38.7	.355	W. N. W.	34.2	......	......	Cir. St.	5	W. by S.	......	.160	
1 p. m.	.270	50.4	37.9	.364	W. N. W.	30.6	......	......	Cu.	8	W.	......	.170	
2 p. m.	.274	52.5	38.9	.344	W.	33.6	......	......	Cu.	6	W.	......	.172	
3 p. m.	.276	53.0	38.3	.315	W.	26.4	......	......	Cu.	5	W.	......	.175	
4 p. m.	.286	50.9	36.8	.318	W.	37.2	......	......	Cu.	8	W.	......	.185	
5 p. m.	.302	51.4	37.2	.318	W.	25.2	......	......	Cu.	6	W.	......	.195	
6 p. m.	.311	50.2	36.4	.322	W.	26.4	......	......	Cu.	5	W.	......	.210	
7 p. m.	.332	49.8	37.8	.377	W.	22.8	......	......	Cu.	4	W.	......	.230	
8 p. m.	.352	45.7	36.5	.457	W.	14.4	......	......	Cu.	3	W.	......	.260	
9 p. m.	.379	42.5	34.6	.495	W.	13.2	......	......	Cu.	4	W.	......	.278	
10 p. m.	.398	41.8	34.5	.519	W.	13.2	......	......	Cu.	4	W.	......	.298	
11 p. m.	.402	39.7	33.5	.563	W.	9.6	......	......	Cu.	3	W.	......	.318	
12 p. m.	.413	39.3	33.0	.554	W.	9.6	......	......	Cu.	2	W.	......	.330	
	22.263	44.0	34.9	.472	......	627.7	......	......	......	......	......	......	22.182	

METEOROLOGICAL JOURNAL.—SHERMAN, WYOMING TERRITORY—Continued.

SHERMAN, JUNE 20, 1872.

Hour.	Barometer at 32° Fahrenheit.	Dry bulb.	Wet bulb.	Relative humidity.	WIND.		LOWER CLOUDS.		UPPER CLOUDS.			Amount of rain and melted snow.	Aneroid barometer.	Remarks.
					Direction.	Velocity per hour.	Kind.	Amount.	Kind.	Amount.	Moving from—			
1 a. m.	22.461	39.2	32.9	.553	W.	9.7	St.	3	......	...	......	......	22.332	
2 a. m.	.466	38.5	32.8	.581	W.	4.8	Cu. St.	5	......	...	......	......	.332	
3 a. m.	.470	37.8	32.3	.586	W.	7.2	Cu.	5	......	...	......	......	.337	
4 a. m.	.468	37.0	32.3	.629	W.	3.6	Cir. St.	5	......	...	......	......	.352	
5 a. m.	.453	39.3	33.2	.564	W.	6.0	Cir. St.	5	......	...	......	......	.357	
6 a. m.	.444	45.7	37.5	.501	W.	2.4	Cir. St.	5	......	...	......	......	.363	
7 a. m.	.466	52.3	42.2	.460	S. W. by S.	6.6	......	...	Cir. St.	1	......	......	.365	At 7 a.m., began reading the actual distance measured by the anemometer in one hour instead of making an average of the distance passed in five minutes.
8 a. m.	.471	53.9	44.1	.480	S.	14.4	......	...	Cir. St.	1	S. by W.	......	.368	
9 a. m.	.515	54.9	44.1	.449	S. by E.	24.6	......	...	Cir. St.	2	S.	......	.360	
10 a. m.	.473	56.8	45.1	.428	S.	7.1	......	...	Cir. St.	4	S. by W.	......	.360	
11 a. m.	.468	60.3	47.0	.394	S. by W.	14.2	Cir. St.	1	Cir. St.	8	S. W.	......	.359	
12 m...	.467	61.3	48.0	.398	S.	15.4	......	...	Cir. St.	5	S. W.	......	.345	
1 p. m.	.452	63.2	48.5	.367	S. E.	26.3	Cu.St.& Cu.	5	Cu.	3	N. W.	......	.325	
2 p. m.	.450	64.8	49.6	.360	S. E.	8.7	Cu.& Cu.St.	4	......	...	......	......	.320	
3 p. m.	.451	64.9	49.4	.353	S. E.	9.7	Cir. St. & Cu. St.	5	......	...	......	......	.318	A slight sprinkle of rain at 3.30 p. m.
4 p. m.	.448	62.5	46.4	.329	S. E.	12.1	Cu. St. & Cir. St.	4	......	...	......	......	.318	
5 p. m.	.450	64.8	47.6	.312	W.	8.4	Cu.	3	......	...	......	......	.318	
6 p. m.	.453	67.8	49.5	.301	W.	4.6	Cu. St.	3	......	...	......	......	.320	
7 p. m.	.460	62.4	49.0	.400	S. E.	3.3	Cu.	5	......	...	......	......	.330	
8 p. m.	.478	55.7	45.0	.457	N. E.	6.3	Cu. St.	5	......	...	......	......	.357	From 8 to 10 p. m., lightning seen from N. E. to S. E.
9 p. m.	.492	51.5	43.1	.523	N. E.	5.6	Cir. St.	3	......	...	......	......	.370	
10 p. m.	.493	47.3	41.1	.605	N. E.	9.7	Cir. St.	2	......	...	......	......	.377	
11 p. m.	.492	45.3	39.8	.634	S. E.	7.3	St.	1	......	...	......	......	.380	
12 p. m.	.484	44.6	40.5	.711	N. E.	6.3	St.	1	......	...	......	......	.377	
	22.468	52.9	42.5	.474	......	224.3	......	...	......	...	......	......	22.347	

METEOROLOGICAL JOURNAL.—SHERMAN, WYOMING TERRITORY—Continued.

SHERMAN, JUNE 21, 1872.

Hour.	Barometer at 32° Fahrenheit.	Dry bulb.	Wet bulb.	Relative humidity.	WIND.		LOWER CLOUDS.		UPPER CLOUDS.			Amount of rain and melted snow.	Aneroid barometer.	Remarks.
					Direction.	Velocity per hour.	Kind.	Amount.	Kind.	Amount.	Moving from			
1 a. m.	22.499	43.0	40.2	.789	N. E.	3.7	St.	8					22.372	Lightning seen in N. E
2 a. m.	.486	41.9	39.3	.799	N. E.	6.4	St.	8					.373	at 1 a. m.
3 a. m.	.496	41.0	38.9	.833	N. E.	7.1	Cu. St.	8					.374	Mist, 2.30 p. m., moving
4 a. m	.490	42.2	41.9	.976	N. E.	11.6	Fog.	9					.384	N. E. to S. W.
5 a. m.	.538	41.2	40.5	.943	N. E.	11.1	Fog.	9					.392	Heavy falling fog.
6 a. m.	.490	41.7	41.2	.959	N. E.	9.4	Fog.	9					.399	Heavy falling fog.
7 a. m.	.440	46.8	45.1	.873	N.	1.8	Fog.	9					.398	Heavy falling fog.
8 a. m.	.495	54.1	47.1	.596	N.	3.4	Cu. St.	1					.395	Mist cleared off at 7.30
9 a. m.	.488	58.9	44.8	.366	W.	6.3	Cu. St.	1	Cu. St.	1			.388	a. m.
10 a. m.	.500	60.6	43.8	.306	N.	2.6	Cu. St.	1	Cu. St.	1	N. by W.		.385	
11 a. m.	.496	63.8	45.5	.285	N. by W.	8.9	Cu. St.	1	Cu. St.	3	S. by W.		.370	
12 m.	.495	62.4	44.0	.277	W.	1.2	Cu. St.	3	Cu. St.	8	W. S. W.		.365	
1 p. m.	.487	60.4	42.9	.289	W.	13.0	Cir.	2	Nim.	8	N. W.		.360	
2 p. m.	.479	62.4	44.9	.297	N.	13.2	Cir. St. & Cu. St.	4					.358	At 12.22 p. m. commenced to sprinkle
3 p. m.	.456	64.5	44.5	.253	N. W.	10.6	Cir. St.	5	Cu. St.	6	N. W.		.352	rain, and sprinkled
4 p. m.	.467	64.9	44.4	.245	N. W.	12.7	Cu. & Cu. St.	6					.325	until 12.46 p. m.
5 p. m.	.469	64.5	44.2	.247	N. N. W.	13.9	Cir. Cu. & Cu. St.	6					.330	
6 p. m.	.473	63.0	42.7	.241	N. W.	21.3	Cu. St.	4					.340	
7 p. m.	.478	58.7	40.6	.265	N. W.	20.2	Cu.	1					.359	
8 p. m.	.487	52.5	41.1	.416	E.	12.6	St.	1					.375	
9 p. m.	.506	51.0	42.9	.528	E.	11.4	St.	1					.382	
10 p. m.	.506	48.8	42.7	.616	S. E. by S.	7.6	St.	1					.380	
11 p. m.	.499	47.6	42.7	.674	S. E. by S.	11.8	St.	1					.398	Lightning in S. E. at
12 p. m.	.494	45.5	42.1	.757	S. E. by S.	14.5							.390	11.20 p. m.
	22.488	53.4	42.8	.534		236.3							22.373	Still lightning S. E.

METEOROLOGICAL JOURNAL.—SHERMAN, WYOMING TERRITORY—Continued.

SHERMAN, JUNE 22, 1872.

Hour.	Barometer at 32° Fahrenheit.	Dry bulb.	Wet bulb.	Relative humidity.	Wind. Direction.	Wind. Velocity per hour.	Lower clouds. Kind.	Lower clouds. Amount.	Upper clouds. Kind.	Upper clouds. Amount.	Upper clouds. Moving from—	Amount of rain and melted snow.	Aneroid barometer.	Remarks.
1 a. m.	22.499	45.5	42.3	.770	S. E.	13.9	....	....	Clear.	0	....	......	22.376	
2 a. m.	.454	45.3	42.3	.782	S. E. by S.	13.3	....	....	Clear.	0	....	......	.372	
3 a. m.	.431	45.0	39.6	.638	S. E. by S.	5.4	....	....	Clear.	0	....	......	.357	
4 a. m.	.439	45.3	37.6	.522	S. E. by S.	7.2	....	....	St.	3	....	......	.370	
5 a. m.	.444	48.8	38.8	.444	S. E. by S.	17.7	....	....	St.	3	....	......	.372	Light mist seen at 5 a. m.; disappeared at 5.50 a. m.
6 a. m.	.446	54.8	41.8	.377	S. E. by S.	9.2	....	....	Cir.	2	....	......	.373	
7 a. m.	.460	58.0	41.8	.307	W.	15.0	....	....	St.	1	0	......	.349	
8 a. m.	.454	61.7	43.5	.278	W.	9.7	....	....	Cir. St.	1	0	......	.339	
9 a. m.	.445	63.2	42.8	.240	W.	24.0	....	....	Cu. St.	1	N. W.	......	.325	
10 a. m.	.437	65.2	43.7	.228	W.	7.3	....	....	Cu. St.	2	N. by W.	......	.299	
11 a. m.	.436	67.2	44.8	.220	N. W.	20.7	....	....	Cu. St.	8	N. by E.	......	.287	
12 m.	.415	69.7	45.3	.198	W.	18.3	....	....	Cu. St.	6	W. by N.	......	.270	
1 p. m.	.400	72.0	48.5	.221	S. W.	18.0	....	....	Cu. St.	8	W.	......	.245	
2 p. m.	.363	71.3	45.9	.190	N. W.	17.6	Cir.	1	Cu. St.	1	N. W.	......	.230	
3 p. m.	.369	71.5	45.5	.182	N. W.	21.4	Cir. & Cir. St.	4	....	....	....	......	.237	
4 p. m.	.355	70.8	48.7	.240	N. W. & W.	19.9	Cir. & Cir. St.	4	....	....	....	......	.220	
5 p. m.	.349	70.0	45.5	.197	N. W.	19.5	Cir. & Cir. St.	4	....	....	....	......	.190	
6 p. m.	.350	69.5	46.5	.219	N. W.	21.7	Cir. & Cir. St.	4	....	....	....	......	.196	
7 p. m.	.349	67.0	46.8	.259	N. W.	14.4	Cir. & Cir. St.	5	....	....	....	......	.200	
8 p. m.	.344	59.5	44.1	.335	S. W. by W.	6.2	Cir. St.	3	....	....	....	......	.215	
9 p. m.	.337	57.1	43.5	.373	S. W.	3.2	Cu. St.	1	....	....	....	......	.218	
10 p. m.	.321	55.7	42.6	.380	S.	8.1	Cu. St.	1	....	....	....	......	.180	
11 p. m.	.308	55.2	43.9	.435	S.	2.0	Cir. Cu.	4	....	....	....	......	.192	
12 p. m.	.285	54.9	41.4	.362	S. W.	12.7	Cir. St.	4	....	....	....	......	.184	
	22.395	60.2	43.6	.349	....	326.4	....	....	....	....	....	......	22.275	

METEOROLOGICAL JOURNAL.—SHERMAN, WYOMING TERRITORY—Continued.

SHERMAN, JUNE 23, 1872.

Hour.	Barometer at 32° Fahrenheit.	Dry bulb.	Wet bulb.	Relative humidity.	Wind. Direction.	Wind. Velocity per hour.	Lower clouds. Kind.	Lower clouds. Amount.	Upper clouds. Kind.	Upper clouds. Amount.	Upper clouds. Moving from—	Amount of rain and melted snow.	Aneroid barometer.	Remarks.
1 a. m.	22.300	52.7	40.3	.383	S. W.	8.2	St.	1	...	...	...	...	22.173	
2 a. m.	.298	51.7	39.5	.383	S. W.	7.7	Very cl'dy	...	...	...	...	...	.164	
3 a. m.	.293	49.8	38.5	.402	S. W.	7.2	St.	3	...	...	...	...	.163	
4 a. m.	.305	48.9	37.6	.395	S. W.	6.1	Cir. St.	3	...	...	...	...	.172	
5 a. m.	.311	51.8	39.5	.380	S. W.	11.2	St.	2	...	...	...	...	.173	
6 a. m.	.311	55.8	41.9	.355	S. W.	7.1	St.	2	...	...	...	...	.180	
7 a. m.	.293	61.3	44.2	.301	N. W.	9.6	St.	1	...	...	...	...	.172	
8 a. m.	.297	65.3	46.2	.274	W. by N.	12.0	...	...	Cir. St.	1	...	...	.170	
9 a. m.	.295	69.5	47.9	.244	N. W.	39.3	...	...	Cir. St.	1	N. W.	...	.163	
10 a. m.	.287	71.1	47.9	.223	W.	13.9	...	...	Cir. St.	2	N.W. by W.	...	.145	
11 a. m.	.280	73.5	49.0	.211	W.	36.2	Cir.	5	Cir. St.	9	N. W.	...	.132	Wind blowing in squalls.
12 m.	.267	73.2	48.9	.214	N. W.	18.3	Nim.	4	Cir.	9	W. by N.	...	.119	
1 p. m.	.250	72.4	48.4	.215	W.	30.8	Cir. Cu.	7	...	...	...	...	.109	
2 p. m.	.244	74.3	49.1	.204	W.	24.0	Cir. St., Cir. Cu.	9	...	...	...	...	.090	
3 p. m.	.231	74.5	49.1	.202	N. N. W.	21.9	Cir. St., Cir. Cu.	9	...	...	...	...	.075	
4 p. m.	.234	73.4	49.7	.224	N. N. W.	23.8	Cir. St., Cir. Cu.	9	...	...	...	...	.070	
5 p. m.	.227	71.1	49.5	.250	N. N. W.	20.8	Nim., Cir., Cu. St.	8	...	...	...	...	.070	
6 p. m.	.225	69.2	50.2	.292	N. N. W.	6.6	Cir. Cu.	7	...	...	...	...	.075	
7 p. m.	.230	65.6	53.3	.445	N. W.	7.0	Cir. St.	8	...	...	...	...	.080	
8 p. m.	.236	64.5	52.0	.435	N. W.	25.0	Cu. St.	8	...	...	...	...	.083	
9 p. m.	.232	63.6	50.8	.421	N. W.	7.6	Cu. St.	6	...	...	...	...	.090	
10 p. m.	.237	68.8	47.5	.246	W.	9.1	Cu. St.	4	...	...	...	...	.098	
11 p. m.	.237	59.5	47.4	.428	W.	4.6	Cir. St.	4	...	...	...	...	.100	
12 p. m.	.237	56.7	46.0	.462	N. W.	6.1	Cir. Cu.	4	...	...	...	...	.100	
	22.265	64.1	46.4	.316	...	364.1	...	...	...	...	...	...	22.124	

METEOROLOGICAL JOURNAL.—SHERMAN, WYOMING TERRITORY—Continued.

SHERMAN, JUNE 24, 1872.

Hour.	Barometer at 32° Fahrenheit.	Dry bulb.	Wet bulb.	Relative humidity.	WIND.		LOWER CLOUDS.		UPPER CLOUDS.			Amount of rain and melted snow.	Aneroid barometer.	Remarks.
					Direction.	Velocity per hour.	Kind.	Amount.	Kind.	Amount.	Moving from—			
1 a. m.	22. 220	55. 8	42. 5	.374	S. W.	8. 6	St.	2	....	...	....	......	22. 102	
2 a. m.	.207	54. 7	41. 3	.364	S.W.	8. 5	St.	2	....	...	....	......	.102	
3 a. m.	.206	54. 6	40. 9	.354	S. W. by S.	11. 1	St.	2	....	...	....	......	.103	
4 a. m.	.214	51. 5	39. 5	.388	S. W.	12. 8	St.	3	....	...	....	......	.104	
5 a. m.	.225	52. 8	40. 3	.380	S. W.	8. 8	St.	4	....	...	....	......	.114	
6 a. m.	.230	57. 3	43. 2	.359	S. W. by S.	8. 0	St.	4	....	...	....	......	.114	
7 a. m.	.252	61. 4	46. 1	.344	W. by S.	17. 6	Cir. St.	1	....	...	....	......	.125	
8 a. m.	.270	61. 0	48. 9	.434	W. by S.	5. 9	St.	1	Cir.	1	S. W.	......	.132	
9 a. m.	.275	68. 4	49. 8	.297	W.	4. 3	....	...	Cir. St.	8	N. W.	......	.130	
10 a. m.	.272	71. 2	51. 2	.279	W.	2. 7	Cir.	1	Cir. St.	7	W. by S.	......	.125	
11 a. m.	.267	72. 4	51. 5	.266	S. W.	2. 1	Cir.	1	Cu., Cir. St.	8	W.	......	.119	At 11 a. m. to the east, the clouds are cirro-stratus; at 12 m., to the west, the clouds are cumulus.
12 m...	.253	75. 0	52. 8	.252	N. W.	6. 4	Cu., Cir. Cu.	3	Cir. St., Cu. St.	10	W. by N.	......	.097	
1 p. m.	.246	77. 2	54. 9	.258	S. W.	6. 3	Cu. St.	10	....	...	....	......	.079	
2 p. m.	.242	78. 1	55. 1	.249	S.	9. 7	Cu. St.	9	....	...	....	......	.069	
3 p. m.	.221	75. 3	54. 0	.270	S.	17. 5	Cu. St.	10	....	...	....	......	.050	Wind blowing in squalls.
4 p. m.	.207	71. 5	52. 6	.302	S.	21. 6	Nim.	10	....	...	....	......	.050	
5 p. m.	.214	68. 5	51. 5	.331	S. W. by S.	16. 3	Nim.	10	....	...	....	......	.060	Wind blowing in squalls.
6 p. m.	.222	64. 1	49. 3	.368	S. W.	13. 6	Nim.	10	....	...	....	......	.070	
7 p. m.	.217	62. 5	48. 6	.385	N. W.	15. 8	Nim.	10	....	...	....	......	.070	Wind blowing in squalls.
8 p. m.	.221	61. 5	48. 0	.393	N.W. by W.	11. 8	Nim.	10	....	...	....	......	.080	
9 p. m.	.231	60. 5	48. 5	.435	N. W.	14. 2	Nim.	10	....	...	....	......	.110	At 9 p. m., begins to rain; lasts 15 minutes; at 10 p. m., very dark.
10 p. m.	.227	59. 5	48. 1	.450	W.	11. 5	Nim.	10	....	...	....	......	.090	
11 p. m.	.225	59. 2	48. 3	.466	S. W.	2. 4	Nim.	10	....	...	....	......	.094	
12 p. m.	.188	59. 9	47. 5	.420	S.	14. 4	Nim.	10	....	...	....	......	.090	Wind blowing in squalls.
	22. 232	63. 9	48. 1	.351	....	251. 9	....	...	....	...	....	......	22. 095	

METEOROLOGICAL JOURNAL.—SHERMAN, WYOMING TERRITORY—Continued.

SHERMAN, JUNE 25, 1872.

Hour.	Barometer at 32° Fahrenheit.	Dry bulb.	Wet bulb.	Relative humidity.	Wind. Direction.	Wind. Velocity per hour.	Lower clouds. Kind.	Lower clouds. Amount.	Upper clouds. Kind.	Upper clouds. Amount.	Upper clouds. Moving from—	Amount of rain and melted snow.	Aneroid barometer.	Remarks.
1 a. m.	22.197	58.9	47.5	.448	S. W.	5.1	Cu. St.	8					22.084	
2 a. m.	.192	56.3	46.5	.493	S. W.	15.6	Cu. St.	4	Cir. Cu.	3	S. W.		.073	
3 a. m.	.188	54.7	45.5	.507	S. W.	6.4	Cu. St.	4	Cir. Cu.	3	S. W.		.072	
4 a. m.	.195	51.4	44.7	.599	S. W.	18.0	Cu. St.	3	St.	6	S. E.		.074	
5 a. m.	.196	51.9	45.2	.601	S. W.	21.5	Cu. St.	7					.082	
6 a. m.	.197	54.9	46.9	.557	S. W.	21.7	Cu. St.	8					.084	
7 a. m.	.221	55.4	47.9	.581	W. N. W.	42.0	Cu. St.	7	Cir. St.	10	W. by S.		.099	
8 a. m.	.224	56.1	48.4	.576	N. W.	29.1	Nim.	5	Cir. St.	10	S. W.		.105	8.15 a. m., raining and slight shower; ceased at 8.30; 9 a. m., wind blowing in gusts; 9.35 a. m., light sprinkling of rain; continuous moderate rain.
9 a. m.	.225	59.1	48.9	.491	W. by N.	31.8	Nim.	8	Cir. St.	10	W.		.103	
10 a. m.	.238	61.5	51.2	.496	W. by N.	41.8	Cu. St.	5	Cir. St.	9	W. by S.		.112	
11 a. m.	.231	61.4	51.2	.499	N. W.	31.5	Nim., Cir. St.	3					.102	
12 m.	.235	58.2	48.9	.520	N. N. W.	22.7	Cu. St., Nim.	9					.102	
1 p. m.	.264	54.0	48.9	.688	W. by S.	22.7	Nim.	10					.139	Continued rain; wind moderate and squally.
2 p. m.	.263	52.9	48.7	.733	W.	18.9	Nim.	10					.159	
3 p. m.	.263	51.5	48.7	.809	S. W.	20.2	Nim.	10					.150	Ceased raining.
4 p. m.	.252	55.1	48.5	.620	S. W.	18.7	Cir. & Cir. St.	8					.150	Wind blowing in gusts.
5 p. m.	.244	56.4	47.7	.536	W.	24.5	Cir. & Cir. St.	9					.130	Wind blowing in gusts.
6 p. m.	.248	57.8	48.5	.518	W.	20.1	Cir. St.	4					.130	
7 p. m.	.260	55.0	47.5	.579	W.	14.7	Cu. St. & Cir. St.	5					.148	Began to rain, with storm of wind, at 8 o'clock.
8 p. m.	.290	49.5	46.2	.774	N. W.	24.1	Nim.	9					.170	
9 p. m.	.281	47.0	44.5	.818	N.	25.3	Nim.	6					.175	9 p. m., rain ceased; wind moderate; lightning N.; 10 p. m., lightning S. S. E.; 11 p. m., lightning S. S. E.; dark.
10 p. m.	.303	45.5	43.5	.850	W. N. W.	11.2	Cu. St.	4					.200	
11 p. m.	.292	44.5	43.5	.921	S. W.	11.5	Cu. St.	3					.193	
12 p. m.	.313	45.5	43.5	.850	S. W.	10.1	Cu. St.	4					.193	
	22.242	53.9	47.2	.628		500.2							22.126	

METEOROLOGICAL JOURNAL.—SHERMAN, WYOMING TERRITORY—Continued.

SHERMAN, JUNE 26, 1872.

Hour.	Barometer at 32° Fahrenheit.	Dry bulb.	Wet bulb.	Relative humidity.	Wind.		Lower clouds.		Upper clouds.			Amount of rain and melted snow.	Aneroid barometer.	Remarks.
					Direction.	Velocity per hour.	Kind.	Amount.	Kind.	Amount.	Moving from—			
1 a. m.	22. 308	42. 5	41. 9	. 951	S. W.	23. 0	St.	3					22. 193	Light falling fog.
2 a. m.	. 316	42. 2	41. 5	. 943	S. W.	4. 1	St.	2					. 194	Light falling fog.
3 a. m.	. 312	43. 6	41. 5	. 839	S. W.	21. 8	St.	2					. 202	Light falling fog.
4 a. m.	. 307	43. 7	41. 5	. 833	S. W.	14. 3	St.	2					. 210	Light falling fog.
5 a. m.	. 312	43. 8	41. 2	. 805	S. W.	17. 0	St.	3					. 214	Light falling fog.
6 a. m.	. 321	45. 8	41. 7	. 715	S. W.	14. 0	St.	2					. 224	
7 a. m.	. 332	50. 1	44. 3	. 637	W. by N.	13. 5	St.	1					. 240	
8 a. m.	. 341	54. 0	46. 3	. 565	W.	21. 4	Cu. St.	1					. 242	
9 a. m.	. 340	57. 7	46. 9	. 464	N. W.	8. 7	Cu.	1					. 240	
10 a. m.	. 338	60. 9	47. 9	. 406	W. N. W.	23. 1	Cir. Cu.	1					. 250	
11 a. m.	. 330	61. 7	47. 7	. 380	W. N. W.	22. 5	Cir. Cu.	3					. 206	
12 m.	. 330	68. 9	46. 1	. 220	N. W.	21. 7	Cir. Cu.	4					. 199	
1 p. m.	. 311	65. 7	47. 8	. 301	W.	29. 9	Cir. Cu.	8					. 179	
2 p. m.	. 311	67. 1	48. 9	. 301	W. by N.	6. 2	Cir. Cu.	9					. 167	
3 p. m.	. 305	66. 6	49. 2	. 316	N. W.	12. 6	Cir. Cu.	8					. 150	
4 p. m.	. 290	67. 0	48. 7	. 298	N. W.	11. 9	Cir. Cu.	6					. 150	
5 p. m.	. 283	67. 0	49. 5	. 315	N.	8. 9	Cir. Cu.	7					. 140	
6 p. m.	. 280	66. 2	48. 0	. 297	N. W.	11. 3	Cir. Cu. & Cir. St.	6					. 130	
7 p. m.	. 281	60. 6	46. 7	. 378	N. W. by N.	7. 3	Cir. St.	7					. 140	
8 p. m.	. 278	59. 5	48. 7	. 471	S. E.	6. 2	Cir. St.	8					. 140	
9 p. m.	. 277	57. 0	47. 5	. 507	S. E.	11. 7	Cir. St.	6					. 150	
10 p. m.	. 272	54. 5	46. 5	. 555	S. E.	8. 6	Cir. St.	5					. 150	
11 p. m.	. 277	53. 2	45. 5	. 562	S. E.	10. 8	Cu. St.	4					. 134	
12 p. m.	. 246	50. 9	44. 8	. 626	S. E.	9. 0	Cu. St.	4					. 132	
	22. 304	56. 3	45. 8	. 528		339. 5							22. 182	

METEOROLOGICAL JOURNAL.—SHERMAN, WYOMING TERRITORY—Continued.

SHERMAN, JUNE 27, 1872.

Hour.	Barometer at 32° Fahrenheit.	Dry bulb.	Wet bulb.	Relative humidity.	Wind.		Lower clouds.		Upper clouds.			Amount of rain and melted snow.	Aneroid barometer.	Remarks.
					Direction.	Velocity per hour.	Kind.	Amount.	Kind.	Amount.	Moving from—			
1 a. m	22.231	49.9	44.5	.657	S. E.	10.8	Cu. St.	3					22.123	
2 a. m	.232	49.5	43.8	.639	S. W.	6.0	Cu. St.	2					.132	
3 a. m	.224	48.0	40.8	.560	S. W.	8.8	Cir.	7					.130	
4 a. m	.234	48.9	40.9	.528	S. W.	5.7	Cir. St.	5					.123	
5 a. m	.230	48.3	40.5	.533	S. W.	10.4	Cir. St.	5					.132	
6 a. m	.230	49.9	41.8	.527	S. W.	9.3	Cir. Cu.	8					.124	
7 a. m	.246	54.9	44.9	.478	W.	8.9	Cir. St. & Cu. St.	9					.130	
8 a. m	.250	58.9	46.9	.429	S. W.	6.1	Cir. St. & Cu. St.	9					.133	
9 a. m	.250	62.2	46.9	.348	W.	21.2	Nim. & Cir. St.	9					.127	Nimbus-cloud to westward.
10 a. m.	.239	66.1	49.5	.332	W. by N.	19.6	Cir. St. & Nim.	7					.118	Nimbus-cloud to westward and northwest.
11 a. m.	.230	66.2	48.2	.301	S. W.	17.1	Cu., Cir. St., & Cu. St.	4					.092	
12 m...	.207	71.0	51.0	.278	W. by S.	13.2	Cu. St., Cir.	3					.059	
1 p. m	.194	63.8	47.3	.324	W. N. W.	22.0	Nim, Cu. St.	10					.055	
2 p. m	.205	62.7	47.6	.333	N. W.	20.7	Nim., Cu. St.	10					.070	
3 p. m	.207	63.8	50.3	.402	S. E.	8.1	Nim., Cu. St.	10					.070	
4 p. m	.210	59.0	46.6	.416	N. W.	19.2	Nim.,	10					.075	
5 p. m	.230	53.5	45.8	.563	W.	24.4	Nim.,	10					.107	
6 p. m	.210	56.4	45.2	.443	W. by N.	18.3	Cir. St.	9					.090	
7 p. m	.201	54.2	45.6	.528	S.	1.5	Cir. St. & Cu. St.	9					.090	
8 p. m	.228	52.7	44.1	.520	N. W.	9.0	Cir. St.	9					.100	Lightning seen S. E.
9 p. m	.202	51.6	44.5	.581	S. W.	7.1	Cir. St.	9					.090	Lightning seen S. E.
10 p. m	.195	49.6	43.5	.619	S. W.	8.8	Cir. St.	8					.080	Lightning seen S. E.
11 p. m	.181	49.8	42.5	.563	S. W.	9.8	Cir. St.	8					.070	
12 p. m	.175	48.8	42.2	.592	W.	7.1	Cir. St.	8					.070	
	22.218	55.8	45.2	.479	....	293.1							22.099	

METEOROLOGICAL JOURNAL.—SHERMAN, WYOMING TERRITORY—Continued.

SHERMAN, JUNE 28, 1872.

Hour.	Barometer at 32° Fahrenheit.	Dry bulb.	Wet bulb.	Relative humidity.	Wind.		Lower clouds.		Upper clouds.			Amount of rain and melted snow.	Aneroid barometer.	Remarks.
					Direction.	Velocity per hour.	Kind.	Amount.	Kind.	Amount.	Moving from—			
1 a. m.	22.178	47.5	41.2	.601	W.	2.9	Cu. St.	7	....	...	....	......	22.070	
2 a. m	.153	49.5	41.8	.543	W.	4.9	Cu. St.	5	....	...	....	......	.064	
3 a. m.	.154	49.4	41.5	.534	S. W.	4.3	Cu. St.	8	....	...	....	......	.057	
4 a. m.	.164	46.5	39.7	.573	S. W.	9.6	Cu. St.	5	....	...	....	......	.057	
5 a. m.	.166	45.5	39.3	.598	S. W.	5.4	Cu. St.	5	....	...	....	......	.057	
6 a. m.	.165	50.7	42.5	.528	S. W.	9.3	Cir.	4	....	...	....	......	.077	
7 a. m.	.195	55.3	44.3	.445	W. by N.	11.1	Cir. St.	9	....	...	....	......	.081	
8 a. m.	.213	58.2	46.0	.420	W.	16.8	Cir. St.	8	....	...	....	......	.084	
9 a. m.	.221	61.2	47.7	.392	W.	12.6	Cir. St. & Cu.	7	....	...	....	......	.087	
10 a. m.	.211	64.7	47.9	.322	S. W.	10.4	Cir. St. & Cu. St.	5	....	...	....	......	.081	
11 a. m.	.205	67.2	48.7	.294	S. W.	6.8	Cir. & Cu. St.	7	....	...	....	......	.062	
12 m ...	.200	66.1	48.9	.318	E.	8.5	Nim. & Cu. St.	9	....	...	....	......	.049	
1 p. m	.199	61.7	47.3	.369	S. W.	15.5	Nim.	10	....	...	....	......	.055	
2 p. m.	.193	56.5	46.2	.475	S. E.	22.1	Nim.	10	....	...	....	......	.058	Slight sprinkle of rain
3 p. m.	.210	60.4	48.5	.438	S. E.	21.4	Nim.	10	....	...	....	......	.085	at 1.30 p. m.
4 p. m.	.191	57.4	47.4	.490	W. N. W.	5.6	Nim.	9	....	...	....	......	.070	
5 p. m	.177	58.3	47.3	.459	W.	9.6	Nim.	10	....	...	....	......	.050	
6 p. m.	.186	57.3	46.0	.445	W.	2.8	Cir. St.	10	....	...	....	......	.050	
7 p. m.	.183	55.5	46.6	.523	S. W.	4.1	Cir., Cir. St.	9	....	...	....	......	.060	
8 p. m	.176	51.5	43.6	.544	N. W.	3.8	Cir. St.	8	....	...	....	......	.060	
9 p. m.	.184	50.5	44.0	.604	E.	5.3	Cir. St.	6	....	...	....	......	.070	Lightning east.
10 p. m.	.182	50.7	44.0	.595	S. E.	1.0	Cir. St.	5	....	...	....	......	.070	Lightning southeast.
11 p. m	.175	50.5	43.5	.580	S. W.	4.5	Cir. St.	4	....	...	....	......	.067	Lightning east.
12 p. m.	.166	47.5	41.5	.616	S. E.	5.7	Cir. St.	3	....	...	....	......	.060	
	22.185	54.9	44.8	.488	....	204.0	....	...	....	...	....	......	22.066	

METEOROLOGICAL JOURNAL.—SHERMAN, WYOMING TERRITORY—Continued.

SHERMAN, JUNE 29, 1872.

Hour.	Barometer at 32° Fahrenheit.	Dry bulb.	Wet bulb.	Relative humidity.	WIND. Direction.	WIND. Velocity per hour.	LOWER CLOUDS. Kind.	LOWER CLOUDS. Amount.	UPPER CLOUDS. Kind.	UPPER CLOUDS. Amount.	UPPER CLOUDS. Moving from—	Amount of rain and melted snow.	Aneroid barometer.	Remarks.
1 a. m	22. 177	48. 2	42. 5	.635	S. E.	7. 9	Cu. St.	3	....	...	....	.....	22. 047	
2 a. m	.127	46. 2	41. 9	.705	S. E. by S.	8. 9	Cu. St.	2	....	...	....	.....	.040	
3 a. m	.129	46. 5	41. 7	.677	S. E. by S.	8. 7	Cu. St.	5	....	...	....	.....	.042	
4 a. m	.128	45. 5	40. 8	.678	S. E. by S.	6. 9	Cu. St.	4	....	...	....	.....	.034	
5 a. m	.161	47. 5	44. 5	.787	S. E. by S.	9. 4	Cu. St.	4	....	...	....	.....	.034	
6 a. m	.113	54. 7	45. 7	.515	S. E. by S.	4. 0	St.	3	....	...	....	.....	.031	
7 a. m	.119	58. 3	45. 4	.399	W. by N.	2. 9	St.	1	....	...	....	.....	.018	
8 a. m	.110	61. 2	46. 4	.357	W.	19. 3	St.	1	....	...	....	.....	.000	
9 a. m	.110	64. 5	47. 9	.326	W.	6. 9	Cir. St.	1	....	...	....	.....	21. 992	
10 a. m	.107	66. 8	48. 3	.292	W.	17. 5	Cir. St.	1	....	...	....	.....	.982	
11 a. m	.102	70. 3	49. 5	.261	W.	15. 3	Cir. Cu. & Cir. St.	5	....	...	....	.....	.970	
12 m	.094	72. 1	51. 1	.263	W. by S.	30. 1	Cir. St., Cu. St.	7	....	...	....	.....	.959	
1 p. m	.076	74. 4	51. 9	.246	S. W.	3. 9	Nim., Cu. St.	7	....	...	....	.....	.925	A squall accompanied by a little rain passed over at 3.45 p. m. Lightning seen S. E. 8.30 p. m.; lightning seen E. 9 p. m.; lightning seen S. E. at 10 p.m.; a squall, accompanied by rain, at 10 p. m., ceased at 10.40 p. m.; lightning seen E. 11 p. m.; lightning seen E., squall and rain, 12 p. m.
2 p. m	.079	71. 0	50. 0	.260	W. N. W.	16. 4	Nim., Cu. St.	7	....	...	....	.....	.925	
3 p. m	.068	72. 2	49. 8	.240	W. N. W.	8. 5	Nim., Cu. St.	8	....	...	....	.....	.910	
4 p. m	.071	65. 2	51. 5	.402	N. W.	16. 5	Nim.	9	....	...	....	.....	.918	
5 p. m	.059	64. 8	50. 5	.384	S. E.	8. 6	Cu. St.	7	....	...	....	.....	.915	
6 p. m	.065	63. 7	50. 8	.419	S. S. E.	6. 9	Cu. St.	8	....	...	....	.....	.917	
7 p. m	.064	58. 5	48. 4	.492	S. E.	10. 7	Cir. St., Cu. St.	8	....	...	....	.....	.930	
8 p. m	.076	55. 4	46. 6	.526	E.	5. 7	Cir. St.	5	....	...	....	.....	.950	
9 p. m	.071	54. 5	46. 2	.542	S. E.	4. 9	Cir. St.	6	....	...	....	.....	.950	
10 p. m	.075	54. 3	45. 1	.505	S.	9. 6	Nim., Cu. St.	8	....	...	....	.....	.950	
11 p. m	.057	55. 2	45. 0	.472	S. E.	13. 0	Nim., Cu. St.	9	....	...	....	.....	.940	
12 p. m	.059	56. 8	44. 7	.416	S. W.	25. 8	Nim.	9	....	...	....	.....	.940	
	22. 096	59. 5	46. 9	.449	....	268. 3	....	...	....	...	....	.....	21. 972	

METEOROLOGICAL JOURNAL.—*SHERMAN, WYOMING TERRITORY*—*Continued.*

SHERMAN, JUNE 30, 1872.

Hour.	Barometer at 32° Fahrenheit.	Dry bulb.	Wet bulb.	Relative humidity.	Wind. Direction.	Wind. Velocity per hour.	Lower clouds. Kind.	Lower clouds. Amount.	Upper clouds. Kind.	Upper clouds. Amount.	Upper clouds. Moving from—	Amount of rain and melted snow.	Aneroid barometer.	Remarks.
1 a. m.	22 016	55.2	44.5	.455	S. W.	5.8	Nim.	6	...	...	...	...	21.914	
2 a. m.	.026	53.5	44.2	.497	S. E.	1.6	Nim.	8	...	...	...	...	.914	
3 a. m.	.010	52.5	43.9	.520	S. E.	9.9	Nim.	8	...	...	...	...	.910	
4 a. m.	.001	52.3	43.7	.519	S. E.	0.5	Nim.	7	...	...	...	...	.900	
5 a. m.	.006	50.2	43.5	.592	S. E.	8.5	Nim.	5	...	...	...	...	.897	
6 a. m	.011	57.5	42.3	.330	S. E.	9.3	Cir.	4	...	...	...	...	.895	
7 a. m	.009	63.4	48.9	.373	S. W.	12.5	St.	1	...	...	...	...	.891	
8 a. m	.005	67.1	49.0	.302	W. by S.	19.8	Cir. St.	7	...	...	...	...	.875	
9 a. m.	21.995	68.9	49.9	.291	S. W.	15.7	Cir. St.	6	...	...	...	...	.850	
10 a. m	.990	71.9	51.0	.264	S.	12.5	Cir. St.	8	...	...	...	...	.839	
11 a. m	.971	72.8	51.9	.268	S. E.	16.6	Cir. St., Cir. Cu.	6	...	...	...	...	.805	
12 m ...	.948	72.4	51.2	.261	E. S. E.	27.6	Cir., Cu.St.	6	...	...	...	...	.782	A strong wind blowing
1 p. m	.932	73.7	51.5	.248	E. S. E	27.7	Cu., Cu.St.	4	...	...	...	...	.763	in squalls at 12 m. and 1 p. m.
2 p. m.	.915	67.9	49.0	.289	S.	31.5	Nim.	9	...	...	...	...	.752	A strong wind blowing.
3 p. m.	.872	66.1	49.1	.322	S. E. by S	26.5	Cir.St., Nim.	9	...	...	...	...	.730	A strong wind blowing.
4 p. m	.920	63.8	48.5	.356	S.	31.2	Nim., Cu. St.	9	...	...	...	...	.780	Blowing a storm, and sprinkling rain.
5 p. m.	.943	52.8	45.5	.578	W.	25.3	Nim., Cu. St.,	10	...	...	...	...	.810	Blowing a storm and raining.
6 p. m	.989	48.3	43.2	.666	W.	28.7	Cu.St., Nim.	10	...	...	...	...	.870	Continued rain; wind blowing in squalls.
7 p. m.	.971	49.2	42.6	.593	W.	25.9	Cu.St., Nim.	9	...	...	...	...	.850	Wind blowing in squalls.
8 p. m.	.977	49.4	39.0	.432	N.W. by W.	31.8	Cu.St., Nim.	8	...	...	...	...	.868	At 8 p. m., blowing a
9 p. m	.969	47.0	37.4	.448	N.W. by W.	43.7	Cu.St., Nim.	8	...	...	...	...	.870	storm-wind; light-
10 p. m	.981	42.7	35.1	.512	N.W. by W.	39.1	Cir. St., Cu. St.	5	...	...	...	...	.839	ning seen east to 8.30; at 9 and 10 p. m., blow-
11 p. m	.995	38.9	33.5	.604	S.W. by W.	40.3	Cu. St.	4	...	...	...	...	.882	ing a storm; wind.
12 p. m	22.008	35.8	31.5	.642	S.W. by W.	41.7	Cu. St.	4	...	...	...	...	.914	
	21.977	57.2	44.6	.432	...	533.7	...	...	...	...	...	...	21.852	

METEOROLOGICAL JOURNAL.—SHERMAN, WYOMING TERRITORY—Continued.

SHERMAN, JULY 1, 1872.

Hour.	Barometer at 32° Fahrenheit.	Dry bulb.	Wet bulb.	Relative humidity.	WIND.		LOWER CLOUDS.		UPPER CLOUDS.			Amount of rain and melted snow.	Aneroid barometer.	Remarks.
					Direction.	Velocity per hour.	Kind.	Amount.	Kind.	Amount.	Moving from—			
1 a. m	22.009	33.9	30.2	.650	S. W. by W.	30.1	Clear.	....					21.924	
2 a. m	.017	33.5	29.5	.613	S. W. by W.	26.3	St.	2					.934	
3 a. m	.027	32.2	29.3	.668	S. W. by W.	26.4	St.	3					.944	
4 a. m	.033	30.5	28.3	.703	S. W.	5.5	Cu. St.	4					.953	
5 a. m	.041	33.7	29.9	.636	S. W. by W.	24.6	Cu.	4					.957	
6 a. m	.054	38.2	32.2	.560	S.	26.0	Cu.	3					.964	
7 a. m	.051	42.6	33.4	.437	S. W.	47.6	Cir. Cu.	1					.965	
8 a. m	.066	45.7	36.0	.436	S. W.	31.6	Cir.	1					.970	
9 a. m	.067	48.4	36.4	.367	S. W.	41.1	Cu.	3					.975	
10 a. m	.066	49.7	36.7	.343	S. W.	38.0	Cu.	4					.960	
11 a. m	.067	53.5	39.9	.350	S. W.	49.9	Cu.	5					.958	
12 m...	.078	55.7	41.2	.338	S. S. W.	40.1	Cu.	3					.957	
1 p. m	.074	56.9	41.1	.311	S. W.	37.8	Cu.	5					.950	
2 p. m	.067	57.3	40.4	.285	S. W.	29.7	Cu.	5					.940	
3 p. m	.072	58.0	40.8	.282	S. W.	33.0	Cu. & Cir. St.	5					.940	
4 p. m	.078	55.9	39.8	.297	S. W.	31.3	Cir. St.	5					.937	
5 p. m	.082	55.3	39.5	.301	S. W.	32.2	Cir. St.	3					.950	
6 p. m	.096	52.3	37.5	.308	W. S. W.	28.6	Cir. St.	3					.970	
7 p. m	.067	46.4	34.6	.362	W. N. W.	36.4	Cir. St.	6					.950	Blowing a storm-wind.
8 p. m	.081	42.5	32.4	.398	W. N. W.	32.4	Cir. St., Cu. St.	6					.970	Blowing a storm.
9 p. m	.105	41.4	32.7	.449	W.	30.9	Cir. St., Cu. St.	6					.990	At 9, 10, 11, 12 p. m., lightning seen E. and
10 p. m	.102	39.5	32.7	.528	W. N. W.	28.4	Cu. St.	6					.990	S. E.; blowing.
11 p. m	.094	37.1	31.7	.585	W. N. W.	31.4	Cu. St.	6					.997	
12 p. m	.093	35.6	30.5	.583	W.	20.4	Cir. St.	4					.997	
	22.066	44.8	34.8	.449	....	759.7							21.960	

METEOROLOGICAL JOURNAL.—SHERMAN, WYOMING TERRITORY—Continued.

SHERMAN, JULY 2, 1872.

Hour.	Barometer at 32° Fahrenheit.	Dry bulb.	Wet bulb.	Relative humidity.	WIND.		LOWER CLOUDS.		UPPER CLOUDS.			Amount of rain and melted snow.	Aneroid barometer.	Remarks.
					Direction.	Velocity per hour.	Kind.	Amount.	Kind.	Amount.	Moving from—			
1 a. m.	22.069	35.7	30.6	.584	W.	25.4	Cu. St.	4					21.994	
2 a. m.	.072	34.5	30.4	.632	W.	16.4	Cu. St.	4					.994	Lightning east.
3 a. m.	.087	33.9	29.4	.528	W.	37.0	Cu. St.	3					.994	
4 a. m.	.092	35.3	30.4	.593	W. N. W.	25.0	Cu. St.	3					22.015	
5 a. m.	.110	35.5	30.6	.597	W. N. W.	24.6	Cu. St.	4					.027	
6 a. m.	.107	38.4	33.6	.636	W.	14.6	Cu. St.	2					.027	
7 a. m.	.124	42.3	34.8	.513	W.	47.3	Cu. St.	4					.024	
8 a. m.	.134	43.7	35.7	.498	W.	38.9	Cu. St.	4					.030	
9 a. m.	.144	47.7	38.3	.461	W.	33.8	Cir. Cu. & Cir. St.	6					.040	
10 a. m.	.168	48.5	38.5	.442	W.	26.7	Cu. St.	8					.050	
11 a. m.	.174	50.4	38.7	.391	W.	27.5	Cu.	9					.054	
12 m ...	.204	52.0	40.0	.391	W.	30.7	Cu. St.	8					.054	
1 p. m.	.194	51.4	39.6	.395	W. N. W.	38.6	Cu. St.	8					.073	
2 p. m.	.200	52.4	39.8	.374	W.	29.3	Cu. St.	7					.077	
3 p. m.	.202	53.0	40.6	.385	W.	19.2	Cir. & Cu. St.	5					.076	
4 p. m.	.203	54.7	41.7	.376	W.	29.4	Cir. St.	3					.076	
5 p. m.	.210	55.3	41.6	.359	W. N. W.	28.5	Cir. St.	2					.076	
6 p. m	.223	53.8	41.3	.387	W. N. W.	24.5	Cir. St.	2					.085	
7 p. m.	.233	50.0	39.5	.432	W. N. W.	14.2	Cir. St.	2					.095	
8 p. m	.234	47.2	37.7	.453	W. N. W.	28.6	St.	1					.108	
9 p. m	.249	44.4	36.7	.517	N. N. W.	20.0	St.	1					.130	
10 p. m	.258	40.0	35.7	.679	N.	16.8	Clr.						.140	
11 p. m	.262	38.3	34.6	.709	N.	13.7	Clr.						.150	
12 p. m	.262	37.1	34.3	.765	W. N. W.	10.5	Clr.						.177	
	22.176	44.8	36.4	.507		621.2							22.065	

METEOROLOGICAL JOURNAL.—SHERMAN, WYOMING TERRITORY—Continued.

SHERMAN, JULY 3, 1872.

Hour.	Barometer at 32° Fahrenheit.	Dry bulb.	Wet bulb.	Relative humidity.	WIND.		LOWER CLOUDS.		UPPER CLOUDS.			Amount of rain and melted snow.	Aneroid barometer.	Remarks.
					Direction.	Velocity per hour.	Kind.	Amount.	Kind.	Amount.	Moving from—			
1 a. m.	22.296	35.7	33.4	.794	N. W.	4.6	St.	2	....	....	....	....	22.187	
2 a. m.	.295	36.2	33.5	.767	N. W.	4.1	Cu. St.	3	....	....	....	....	.187	Lightning at south.
3 a. m.	.301	35.7	33.8	.826	S. E.	3.8	Cu. St.	5	....	....	....	....	.193	
4 a. m	.282	34.7	33.9	.917	S. S. E.	4.4	Cu. St.	5	....	....	....	....	.184	Fog formed at 4.20 a. m.
5 a. m	.283	34.4	33.8	.938	S. S. E.	3.2	....	....	....	....	....	....	.183	Falling fog.
6 a. m.	.284	36.2	35.9	.972	S. S. E.	11.2	....	....	....	....	....	....	.182	Falling fog.
7 a. m	.290	40.4	38.4	.838	S.	17.2	Cir. Cu.	6	....	....	....	....	.184	Cumulus-stratus moving from south.
8 a. m	.287	45.8	41.5	.704	S.	13.1	Cir. Cu.	6	....	....	....	....	.187	
9 a. m.	.303	51.8	44.6	.577	S.	13.6	Cir. St.	4	....	....	....	....	.177	Cirro-cumulus, 3.
10 a. m	.271	57.8	47.5	.482	S. S. E.	11.6	Cir. St.	8	....	....	....	....	.174	
11 a. m	.282	57.5	45.7	.430	S. S. W.	8.8	Cir. St.	8	....	....	....	....	.165	Rain commenced at 11.30 a. m.
12 m...	.277	59.5	48.3	.457	S.	9.8	Cu. St.	5	....	....	....	....	.137	
1 p. m	.280	59.0	47.2	.436	S. S. W.	13.8	Cu. St.	9	....	....	....	....	.140	Thunder, accompanied by a fall of hail, at 1.15 p. m.; hailing ceased at 1.30 p. m.; commenced to rain; 2.30 p. m. ceased. Sprinkling at 4 p. m.
2 p. m	.296	51.4	43.4	.539	N. N. W.	10.8	Cu. St.	9	....	....	....	....	.150	
3 p. m	.304	53.8	45.7	.447	N. E.	11.3	Cu. Nim. Cu. St.	8	....	....	....	....	.170	
4 p. m	.316	49.9	46.1	.745	N. E.	12.3	Nim. Cu. St.	9	....	....	....	....	.185	
5 p. m.	.316	47.1	44.5	.812	N. E.	17.8	Cir. St.	8	....	....	....	....	.190	
6 p. m.	.325	46.6	43.6	.785	N. E.	13.4	Cir. St. Cu. St.	7	....	....	....	....	.200	
7 p. m	.319	46.6	43.5	.779	N. E.	12.1	St.	3	....	....	....	....	.203	
8 p. m	.324	42.6	41.0	.874	E. N. E.	7.8	St.	2	....	....	....	....	.215	Lightning S. E. to S.
9 p. m	.356	41.7	40.3	.887	S.	6.5	St.	1	....	....	....	....	.240	Lightning S. E.
10 p. m	.364	40.8	39.2	.870	....	....	St.	1	....	....	....	....	.250	Lightning S. E. to S. from 8 to 12 p. m. No lantern to read anemometer at 10, 11, and 12 p. m.
11 p. m	.350	41.0	40.7	.975	....	....	St.	1	....	....	....	....	.240	
12 p. m.	.340	41.2	40.0	.902	....	....	St.	2	....	....	....	....	.237	
	22.306	45.3	41.0	.748	....	211.2	....	....	....	....	....	....	22.190	

METEOROLOGICAL JOURNAL.—SHERMAN, WYOMING TERRITORY—Continued.

SHERMAN, JULY 4, 1872.

Hour.	Barometer at 32° Fahrenheit.	Dry bulb.	Wet bulb.	Relative humidity.	WIND.		LOWER CLOUDS.		UPPER CLOUDS.			Amount of rain and melted snow.	Aneroid barometer.	Remarks.
					Direction.	Velocity per hour.	Kind.	Amount.	Kind.	Amount.	Moving from—			
1 a. m.	22.325	39.6	37.9	.859	S.	*33.0	St.	2					22.225	The anemometer was not read for the four preceding hours for want of a lantern. Heavy dew at 3 a. m.
2 a. m.	.318	39.4	37.7	.858	S.	3.3	St.	2					.207	
3 a. m.	.310	39.1	37.4	.858	S.	2.6	St.	1					.200	
4 a. m.	.308	39.3	37.7	.860	S.	3.6	St.	1					.195	
5 a. m.	.317	40.6	38.8	.853	S.	0.5	Cir. St.	1					.203	
6 a. m.	.317	44.2	42.6	.877	S.	6.6			Cir. Cu.	3	N. W.		.203	
7 a. m.	.312	47.3	44.9	.826	S.	8.4	Cir. St.	3					.205	
8 a. m.	.311	50.0	46.3	.752	S.	11.6	Cu.	3					.204	
9 a. m.	.308	54.1	47.7	.625	S. S. E.	10.5	Cu.	3					.194	
10 a. m.	.308	56.4	48.8	.581	S.	10.1	Cu.	4					.182	
11 a. m.	.295	60.8	50.3	.486	S.	14.1	Cu. St.	6					.164	
12 m.	.293	55.0	48.1	.605	S. S. E.	17.3	Nim.	7					.157	Thunder; thunder accompanied by rain commenced at 11.50 a. m.
1 p. m.	.293	56.5	48.3	.556	S.	16.3	Cu.St., Nim.	9					.155	
2 p. m.	.286	57.5	47.5	.491	S.	17.9	Cu.St., Nim.	10					.150	
3 p. m.	.273	50.6	46.0	.703	S. S. W.	21.2	Cu.St., Nim.	10					.148	Continued thunder and rain at 3, 4, and 5, p. m.
4 p. m.	.272	53.2	45.0	.540	S. S. E.	12.9	Cu.St., Nim.	9					.148	
5 p. m.	.262	52.3	46.0	.622	S. S. E.	12.6	Cu.St., Nim.	9					.138	
6 p. m.	.287	52.4	44.5	.549	S.	9.9	Cu.St., Nim.	9					.160	
7 p. m.	.287	53.6	46.1	.572	N. N. E.	6.0	Cir. St., Cu. St.	8					.160	Lightning seen east at 8 and 9 p. m.
8 p. m.	.304	51.2	45.5	.647	N. N. E.	0.2	Cir. St., Cu. St.	8					.178	Lightning accompanied by rain at 10 p. m.; frequent lightning, fine rain, at 11 p. m.; lightning southeast at 12 p. m.
9 p. m.	.311	48.9	44.1	.685	S.	1.1	Cu. St.	8					.192	
10 p. m.	.312	45.4	43.2	.836	S.	9.8	Cu. St.	9					.194	
11 p. m.	.324	45.3	42.6	.802	S.	7.3	Cu. St.	8					.195	
12 p. m.	.324	43.4	41.6	.861	S.	5.5	Cu. St.	3					.175	
	22.302	49.0	44.1	.705		242.3							22.180	

* Velocity for four hours, 33.0.

METEOROLOGICAL JOURNAL.—SHERMAN, WYOMING TERRITORY—Continued.

SHERMAN, JULY 5, 1872.

Hour.	Barometer at 32° Fahrenheit.	Dry bulb.	Wet bulb.	Relative humidity.	WIND.		LOWER CLOUDS.		UPPER CLOUDS.			Amount of rain and melted snow.	Aneroid barometer.	Remarks.
					Direction.	Velocity per hour.	Kind.	Amount.	Kind.	Amount.	Moving from—			
1 a. m.	22.290	42.4	40.7	.866	S. W.	7.7	St.	1	......	...	......	......	22.165	Lightning S. E.
2 a. m.	.275	42.9	40.9	.845	S. W.	2.7	St.	1	......	...	......	......	.165	Thunder and lightning
3 a. m.	.277	41.3	40.2	.910	W. S. W.	3.7	Cir. St.	1	......	...	......	......	.160	S. E.
4 a. m.	.277	43.5	38.6	.659	W. N. W.	4.1	Cir. St.	2	......	...	......	......	.170	
5 a. m.	.289	42.5	38.7	.722	W. N. W.	3.5	Cir. St.	2	......	...	......	......	.175	
6 a. m.	.287	44.8	40.7	.711	N. W.	5.6	Cir. & Cu.	1	......	...	......	......	.180	
7 a. m.	.293	50.7	44.4	.615	N. N. E.	7.2	Cu.	3	......	...	......	......	.180	
8 a. m.	.294	53.6	44.5	.506	N. W.	8.3	Cu.	3	......	...	......	......	.175	
9 a. m.	.284	56.8	45.8	.452	W.	8.5	Cu.	3	......	...	......	......	.167	
10 a. m.	.283	58.6	46.4	.422	W. N. W.	11.3	Cu.	3	......	...	......	......	.163	
11 a. m.	.287	61.2	46.8	.367	N. W.	12.1	Cu.	4	......	...	......	......	.174	
12 m...	.281	62.5	47.5	.356	N. W.	15.1	Cu.	5	......	...	......	......	.137	Wind blowing in
1 p. m.	.275	62.7	47.5	.352	N. W.	17.6	Cu.	6	......	...	......	......	.137	squalls, accompanied
2 p. m.	.271	63.3	47.4	.337	N. W.	18.8	Cu.	6	......	...	......	......	.130	by rain, at 1 p. m.; rain
3 p. m.	.267	66.7	46.8	.264	N. N. W.	23.2	Cu.	6	......	...	......	......	.122	ceased at 1.25 p. m.
4 p. m.	.283	65.6	46.5	.275	N. N. W.	29.1	Cir. St. & Cu.	5	......	...	......	......	.122	Wind blowing in squalls.
5 p. m.	.275	65.7	46.2	.268	N. N. W.	33.3	Cir. St. & Cu.	4	......	...	......	......	.122	Wind blowing in squalls.
6 p. m.	.278	64.6	46.3	.288	N.	11.1	Cir. St. & St.	4	......	...	......	......	.124	
7 p. m.	.280	62.2	46.0	.325	N. N. E.	16.6	Cir. St. & St.	3	......	...	......	......	.130	
8 p. m.	.300	55.5	45.7	.489	E.	10.1	Cir. St.	3	......	...	......	......	.150	
9 p. m.	.316	54.5	46.7	.563	S. E.	6.0	Cir. St.	2	......	...	......	......	.170	
10 p. m.	.309	50.7	46.5	.726	S.	11.3	St.	1	......	...	......	......	.180	
11 p. m.	.313	47.5	45.0	.820	S.	14.3	St.	1	......	...	......	......	.178	
12 p. m.	.306	46.6	44.6	.852	S.	13.5	St.	1	......	...	......	......	.178	
	22.288	54.4	44.6	.541	......	295.7	......	...	......	...	......	......	22.156	

METEOROLOGICAL JOURNAL.—SHERMAN, WYOMING TERRITORY—Continued.

SHERMAN, JULY 6, 1872.

Hour.	Barometer at 32° Fahrenheit.	Dry bulb.	Wet bulb.	Relative humidity.	WIND. Direction.	WIND. Velocity per hour.	LOWER CLOUDS. Kind.	LOWER CLOUDS. Amount.	UPPER CLOUDS. Kind.	UPPER CLOUDS. Amount.	UPPER CLOUDS. Moving from—	Amount of rain and melted snow.	Aneroid barometer.	Remarks.
1 a. m.	22.298	46.5	43.6	.791	S.	10.00	Cir.	0	....	...	....	......	22.165	
2 a. m.	.286	46.3	43.6	.804	S.	12.5	Cir.	1	....	...	....	......	.163	
3 a. m.	.282	46.3	42.9	.760	S.	10.0	Cir.	1	....	...	....	......	.160	
4 a. m.	.287	46.7	43.0	.742	S.	10.5	Cir.	1	....	...	....	......	.160	
5 a. m.	.289	48.2	47.3	.932	S.	11.0	Cir.	1	....	...	....	......	.165	
6 a. m.	.284	54.6	53.7	.937	S.	11.3	Cir.	1	....	...	....	......	.167	
7 a. m.	.282	57.7	50.2	.590	S.	14.0	Cir.	2	....	...	....	......	.164	
8 a. m	.293	61.9	50.7	.466	S. S. W.	9.1	Cir. Cu.	7	....	...	....	......	.164	
9 a. m.	.294	64.9	49.2	.348	W. S. W.	7.2	Cu. St.	5	....	...	....	......	.157	
10 a. m.	.292	67.8	47.9	.269	S. W.	12.4	Cu. St.	6	....	...	....	......	.148	
11 a. m.	.287	69.5	48.5	.254	N. W.	16.9	Cu. St.	8	....	...	....	......	.132	
12 m ...	.313	71.9	49.8	.244	W.	19.7	Cu. St.	6	....	...	....	......	.123	
1 p. m.	.297	66.5	48.5	.302	W.	13.8	Cu. St.	9	....	...	....	......	.123	
2 p. m.	.287	70.3	49.3	.257	N. W.	40.7	Cu. St.	8	....	...	....	......	.118	
3 p. m.	.288	69.1	48.3	.256	W. S. W.	36.0	Cu. St.	7	....	...	....	......	.117	
4 p. m.	.263	70.5	50.8	.282	S. W.	3.1	Nim. Cu. St.	8	....	...	....	......	.097	
5 p. m.	.268	67.8	50.5	.323	S. S. E.	10.6	Nim. Cu. St.	9	....	...	....	......	.101	
6 p. m.	.275	65.4	48.7	.327	W. S. W.	11.3	Nim. Cu. St.	9	....	...	....	......	.110	
7 p. m.	.278	64.4	48.4	.339	W. N. W.	13.5	Cu. St.	9	....	...	....	......	.120	
8 p. m	.283	60.3	47.7	.416	S.	2.2	Cu. St.	9	....	...	....	......	.130	Lightning seen from N. N. E. to S. S. E. at 8, 9, 10, 11, and 12 p. m.
9 p. m.	.295	58.5	46.5	.427	S.	6.2	Cu. St.	9	....	...	....	......	.143	
10 p. m.	.291	59.5	46.0	.385	S. S. E.	7.1	Cu. St.	8	....	...	....	......	.140	
11 p. m.	.286	54.5	45.4	.510	S.	13.0	Cu. St.	4	....	...	....	......	.138	
12 p. m.	.287	52.3	44.4	.548	S.	10.6	Cu. St.	3	....	...	....	......	.138	
	22.287	60.0	47.7	.484	....	312.8	....	...	....	...	....	......	22.139	

METEOROLOGICAL JOURNAL.—SHERMAN, WYOMING TERRITORY—Continued.

SHERMAN, JULY 7, 1872.

Hour.	Barometer at 32° Fahrenheit.	Dry bulb.	Wet bulb.	Relative humidity.	WIND. Direction.	WIND. Velocity per hour.	LOWER CLOUDS. Kind.	LOWER CLOUDS. Amount.	UPPER CLOUDS. Kind.	UPPER CLOUDS. Amount.	UPPER CLOUDS. Moving from-	Amount of rain and melted snow.	Aneroid barometer.	Remarks.
1 a. m	22.288	52.4	43.4	.503	S.	11.8	Cir. & St.	1					22.145	
2 a. m	.285	53.3	43.3	.470	S. S. W.	8.0	Cir. & St.	1					.145	
3 a. m	.285	53.0	42.3	.443	N. N. W.	15.0	Cir. & St.	1					.145	
4 a. m.	.290	52.0	41.4	.440	N W.	5.0	Cir. & St.	1					.145	
5 a. m.	.293	53.4	42.2	.427	W. N. W.	4.3	Cir. & St.	1					.155	
6 a. m	.298	57.2	45.5	.431	N. W.	7.5	Cir. & Cu.	1					.160	
7 a. m	.301	62.7	47.5	.352	W. N. W.	10.4	Cir.	2					.160	
8 a. m	.300	66.1	48.7	.314	W. N. W.	13.6	Cir.	3					.154	
9 a. m	.309	69.6	50.3	.287	W. N. W.	13.7	Cir.	4					.154	
10 a. m	.306	71.7	49.8	.246	W.	19.4	Cir.	2	Cu.	3	W. to E.		.137	
11 a. m.	.299	49.5	49.9	.213	W. N. W.	20.9	Cir.	2	Cu.	5	W. to E.		.132	
12 m...	.301	76.3	51.9	.222	N. W.	17.9	Cir.	2	Cu.	6			.114	
1 p. m.	.285	76.7	51.5	.212	N. W.	15.5	Cu. St.	8					.107	
2 p. m	.290	72.4	49.5	.232	N. W.	17.2	Cu. St.	7					.117	1.30 p. m., fresh gale from N. E.
3 p. m.	.294	72.3	50.5	.251	N. W.	5.3	Cu. St.	8					.115	
4 p. m.	.293	65.4	48.3	.317	W. S. W.	24.0	Nim. & Cu. St.	9					.118	Wind blowing in squalls.
5 p. m.	.312	61.8	47.7	.378	W. S. W.	36.4	Nim. & Cu. St.	9					.150	Wind blowing in squalls.
6 p. m	.291	68.0	50.0	.308	W.	12.9	Nim. & Cu. St.	9					.130	
7 p. m.	.281	64.9	50.3	.376	S. W.	3.0	Cir. & Cir. St.	7					.125	
8 p. m	.280	59.2	46.7	.414	S. S. W.	6.9	Cir. St.	7					.123	
9 p. m.	.291	58.1	46.6	.442	S. W.	11.5	Cir. St.	5					.140	
10 p. m	.291	57.3	46.3	.455	S. W.	9.2	Cir. St.	5					.142	Lightning seen from S. E. to S. W. from 7.30 to 10 p. m.
11 p. m.	.291	56.7	45.0	.428	N. N. W.	12.2	Cir. St.	4					.145	
12 p. m.	.285	55.5	44.4	.442	W.	16.1	Cir. St.	3					.140	
	22.293	62.9	47.2	.358		317.7							22.137	

METEOROLOGICAL JOURNAL.—SHERMAN, WYOMING TERRITORY—Continued.

SHERMAN, JULY 8, 1872.

Hour.	Barometer at 32° Fahrenheit.	Dry bulb.	Wet bulb.	Relative humidity.	WIND. Direction.	WIND. Velocity per hour.	LOWER CLOUDS. Kind.	LOWER CLOUDS. Amount.	UPPER CLOUDS. Kind.	UPPER CLOUDS. Amount.	UPPER CLOUDS. Moving from—	Amount of rain and melted snow.	Aneroid barometer.	Remarks.
1 a. m.	22.285	54.5	53.3	.917	W. N. W.	14.6	Cir. St.	2	....	...	....	......	22.140	
2 a. m.	.283	55.0	53.6	.906	W. N. W.	13.3	Cir. St.	2	....	...	....	......	.140	
3 a. m	.282	55.7	53.9	.881	W. N. W.	9.7	Cir. St.	3	....	...	....	......	.145	
4 a. m.	.295	56.7	55.0	.889	W. N. W.	14.8	Cir. Cu.	4	....	...	....	......	.145	
5 a. m.	.295	55.0	53.0	.867	W. N. W.	13.2	Cir. Cu.	3	....	...	....	......	.145	
6 a. m	.295	58.5	56.3	.861	W. N. W.	16.5	Cir. & St.	2	....	...	....	......	.145	
7 a. m	.297	61.4	48.3	.404	W. N. W.	18.2	Cir. & St.	2	....	...	....	......	.155	
8 a. m	.310	64.3	49.4	.366	W. N. W.	19.3	Cir. St.	1	....	...	....	......	.157	
9 a. m.	.305	67.1	50.5	.336	W.	24.5	Cir.	1	....	...	....	......	.147	
10 a. m	.309	69.4	50.7	.298	W.	23.3	Cir. & Cir. St.	5	....	...	....	......	.1[illegible]	
11 a. m.	.308	72.0	51.6	.274	W. N. W.	18.6	Cir. & Cir. Cu.	5	....	...	....	......	.145	
12 m..	.306	72.6	51.5	.264	W. N. W.	16.2	Cu. & Cu. St.	7	....	...	....	......	.130	
1 p. m	.303	72.3	52.2	.281	S. W.	13.8	Cu. St.	9	....	...	....	......	.130	
2 p. m.	.293	73.2	52.7	.276	S. W.	9.2	Cu. & Cu. St.	8	....	...	....	......	.110	
3 p. m	.298	69.2	52.6	.343	N. N. W.	14.4	Cir. & Cu. St.	9	....	...	....	......	.110	
4 p. m	.296	73.0	52.6	.278	N. N. W.	17.0	Nim. & Cu. St.	9	....	...	....	......	.100	
5 p. m	.284	63.5	49.3	.381	N. W.	13.7	Nim. & Cu. St.	9	....	...	....	......	.115	
6 p. m.	.292	66.3	50.4	.349	N. N. W.	16.3	Cu. St.	8	....	...	....	......	.132	
7 p. m.	.303	66.0	50.9	.368	W. N. W.	7.0	Cu. St.	5	Cir.	3	S. to N.	......	.132	
8 p. m	.307	60.9	50.1	.476	E. N. E.	4.8	Cu. St.	6	....	...	....	......	.145	Lightning in S. E.
9 p. m	.322	59.7	49.3	.486	S. E.	0.6	Cu. St.	5	....	...	....	......	.157	Lightning in S. E.
10 p. m	.311	58.7	49.3	.518	W. N. W.	0.4	St.	4	....	...	....	......	.155	
11 p. m.	.307	57.3	46.7	.469	W. S. W.	2.2	Cir. St.	3	....	...	....	......	.157	
12 p. m	.310	55.9	47.6	.549	W.	3.8	Cir. St.	3	....	...	....	......	.158	
	22.299	63.3	51.3	.502	....	305.4	....	...	....	...	....	......	22.141	

METEOROLOGICAL JOURNAL.—SHERMAN, WYOMING TERRITORY—Continued.

SHERMAN, JULY 9, 1872.

Hour.	Barometer at 32° Fahrenheit.	Dry bulb.	Wet bulb.	Relative humidity.	WIND. Direction.	WIND. Velocity per hour.	LOWER CLOUDS. Kind.	LOWER CLOUDS. Amount.	UPPER CLOUDS. Kind.	UPPER CLOUDS. Amount.	UPPER CLOUDS. Moving from—	Amount of rain and melted snow.	Aneroid barometer.	Remarks.
1 a. m.	22.305	55.5	45.1	.467	N. W.	2.2	Cir. St.	1					22.152	
2 a. m.	.299	53.3	44.1	.500	N. W.	6.0	Cir. St.	1					.152	
3 a. m.	.303	52.8	45.0	.555	N. W.	7.0	Cir. St.	1					.157	Lightning S. E.
4 a. m.	.314	50.9	43.1	.546	N. W.	6.5	Cir. & Cir. St.	2					.160	
5 a. m.	.321	51.6	43.7	.545	N. W.	8.0	Cir. & Cir. St.	3					.176	
6 a. m.	.322	55.3	45.5	.488	N. W.	8.2	Cir. St.	6					.182	
7 a. m.	.331	58.7	47.2	.444	W. N. W.	11.0	Cir. St.	4					.200	
8 a. m.	.335	62.4	48.9	.397	W. N. W.	12.1	Cir. St.	3					.208	
9 a. m.	.341	66.5	50.6	.349	W. N. W.	8.1	Cir. & Cir. St.	7					.197	
10 a. m.	.347	69.5	50.6	.295	N. N. W.	10.4	Cir. & Cir. St.	8					.193	
11 a. m.	.351	68.5	50.5	.310	N. N. W.	12.9	Cir. & Cir. St.	8					.190	
12 m.	.345	75.1	54.3	.278	N. N. W.	7.4	Cir. & Cu.	7					.170	
1 p. m.	.336	76.6	54.6	.261	N. W.	6.4	Cir. & Cu.	6					.155	
2 p. m.	.334	72.5	55.3	.343	N. E.	8.0	Cu. & Cu. St.	9					.157	
3 p. m.	.336	71.2	55.0	.361	E. S. E.	18.2	Cir. St. & Nim.	5	Cir. & Cu.	3	W.		.163	
4 p. m.	.329	73.2	57.2	.374	S. E.	15.8	Cu. & Cu. St.	5	Cir. & Cu.	2	N. W.		.150	
5 p. m.	.329	69.3	54.8	.396	S. E.	13.9	Cu. St.	4	Cir. St.	3	W.		.162	
6 p. m.	.335	68.5	54.6	.409	S. E.	14.6	Cu. & Cu. St.	4	Cir.	3	N. W.		.160	
7 p. m.	.341	65.3	53.9	.471	S. E.	10.3	Cu. St.	4	Cir. St.	3	S. E.		.175	
8 p. m.	.353	61.2	51.3	.508	E. S. E.	6.3	Cu. St.	5	Cir. St.	2	W.		.176	Lightning seen at E. S. E. 8 p. m.; at E. S. E & W. 9 p. m.; at E. S. E. 10 p. m.
9 p. m.	.363	60.1	50.8	.526	E. N. E.	6.4	Cu. St.	7					.178	
10 p. m.	.361	59.9	50.5	.523	E. N. E.	4.6	Cu. St.	9					.202	
11 p. m.	.369	59.5	50.8	.547	E.	6.7	Nim.	10					.210	
12 p. m.	.370	57.2	51.5	.671	N.	5.7	Nim.	8					.212	Lightning and rain 11 p. m.; lightning in the E. and S. E., accompanied by rain, at 12 p. m.
	22.336	63.1	50.4	.440	....	216.7	....		....		....	......	22.177	

METEOROLOGICAL JOURNAL.—SHERMAN, WYOMING TERRITORY—Continued.

SHERMAN, JULY 10, 1872.

Hour.	Barometer at 32° Fahrenheit.	Dry bulb.	Wet bulb.	Relative humidity.	WIND. Direction.	WIND. Velocity per hour.	LOWER CLOUDS. Kind.	LOWER CLOUDS. Amount.	UPPER CLOUDS. Kind.	UPPER CLOUDS. Amount.	UPPER CLOUDS. Moving from—	Amount of rain and melted snow.	Aneroid barometer.	Remarks.
1 a. m.	22.375	54.5	49.9	.716	N.	10.5	Cu. St.	8	....	....	....	....	22.220	Lightning in E. from 1 to 3 a. m.; at 3 a. m. rain began to fall and fell lightly for 15 minutes.
2 a. m.	.370	56.4	48.3	.559	N. W.	20.5	Cu. St.	7	....	....	....	....	.220	
3 a. m.	.356	56.2	48.1	.558	N.	9.5	Cu. St.	7	....	....	....	....	.212	
4 a. m.	.372	55.4	49.4	.649	S.	5.8	Cu. St.	8	....	....	....	....	.220	
5 a. m.	.373	55.3	50.9	.730	S.	5.6	Cir. Cu. & Cu. St.	7	....	....	....	....	.240	
6 a. m.	.378	58.3	53.4	.713	S.	0.4	Cir.&Cir.St.	5	....	....	....	....	.242	
7 a. m.	.384	64.4	54.4	.515	N. E.	2.2	Cir.& Cu.St.	4	....	....	....	....	.247	
8 a. m.	.392	66.9	55.2	.468	N. E.	9.0	Cu.	5	....	....	....	....	.240	
9 a. m.	.392	65.6	53.3	.445	E.	10.6	Cu.& Cu.St., Nim.	8	Cir.	1	N. W.	....	.247	Thunder accompanied by rain at 9.40 a. m.; lightning at 10.15 a. m.; contin'd thunder, lightning and rain, 11 a. m.
10 a. m.	.406	58.2	51.7	.636	N. N. E.	8.5	Cu. St., Nim.	9	....	....	....	....	.235	
11 a	.423	54.6	49.9	.711	S.	12.0	Nim.	10	....	....	....	....	.267	
12 m...	.423	52.6	49.4	.789	S. S. E.	9.1	Nim.	10	....	....	....	....	.277	Continued thunder and rain.
1 p. m.	.424	52.6	49.0	.766	S. E.	5.2	Nim.	10	....	....	....	....	.284	Continued rain.
2 p. m.	.399	57.4	53.5	.762	S. W.	5.3	Cu. St., Nim.	10	....	....	....	....	.267	Raining moderately.
3 p. m.	.392	61.3	53.7	.598	S. W.	9.8	Cu. St., Nim.	7	Cu.	2	N. E.	....	.250	Rain ceased.
4 p. m.	.395	59.2	52.5	.631	S. S. W.	10.6	Cu. St., Nim.	7	Cu. St.	2	N. E.	....	.250	
5 p. m.	.404	58.5	51.6	.619	S. E.	2.4	Nim.	7	Cu. St.	2	N. E.	....	.257	
6 p. m.	.409	56.4	51.2	.693	S.	8.0	Cir.	3	Cu. St.	5	N. E.	....	.257	
7 p. m.	.401	55.6	51.4	.741	S.	10.3	Cir.	7	Cu. St.	3	N. E.	....	.257	
8 p. m.	.421	52.5	49.9	.825	S.	0.9	Cir. Nim.	5	Cu. St.	3	N. E.	....	.268	
9 p. m.	.424	51.7	49.4	.843	S.	10.7	Nim.	5	Cu. St.	3	N. E.	....	.277	Lightning seen at N.
10 p. m.	.422	51.2	48.4	.809	S. S. E.	8.7	Nim.	6	Cu. St.	3	N. E.	....	.279	Lightning seen at N. E.
11 p. m.	.406	51.2	48.0	.785	S.	17.0	Cir. Nim.	5	Cir. & Cu. St.	3	N. E.	....	.277	Lightning seen at N. E.
12 p. m.	.398	51.5	48.4	.791	S. S. W.	5.4	Cu. St., Nim.	7	....	....	....	....	.270	
	22.397	56.6	50.9	.681	....	197.5	....	....	....	....	....	....	22.252	

METEOROLOGICAL JOURNAL.—SHERMAN, WYOMING TERRITORY—Continued.

SHERMAN, JULY 11, 1872.

Hour.	Barometer at 32° Fahrenheit.	Dry bulb.	Wet bulb.	Relative humidity.	WIND.		LOWER CLOUDS.		UPPER CLOUDS.			Amount of rain and melted snow.	Aneroid barometer.	Remarks.
					Direction.	Velocity per hour.	Kind.	Amount.	Kind.	Amount.	Moving from—			
1 a. m	22.391	52.6	48.3	.726	S. S. W.	1.5	Cu. St.	7					22.255	
2 a. m.	.384	52.6	47.4	.678	S.	0.0	Nim., Cu. St.	7					.245	
3 a. m.	.378	52.7	47.6	.683	S.	1.5	Nim., Cu. St.	5					.242	
4 a. m.	.373	52.4	47.1	.672	N. E.	2.2			Cir. & Nim.	7	S.		.239	
5 a. m.	.381	53.0	47.6	.669	S. E.	5.1	Nim.	8					.246	
6 a. m.	.390	53.7	48.5	.682	S. E.	5.0	Nim.	9					.258	Slight rain commenced
7 a. m.	.406	53.4	49.6	.757	S. E.	9.9	Nim.	9					.275	at 6.30 a. m.
8 a. m.	.416	51.8	49.5	.843	S. E.	10.0	Nim.	9					.282	Raining.
9 a. m.	.417	51.4	49.7	.878	S.	10.2	Nim.	10					.287	General rain.
10 a. m.	.420	51.0	49.7	.908	S.	9.9	Nim.	10					.288	General rain.
11 a. m.	.424	51.7	49.7	.861	S.	13.5	Nim.	10					.290	General rain.
12 m...	.427	52.6	49.8	.813	S. S. E.	11.5	Nim.	10					.291	General rain.
1 p. m.	.410	52.5	48.6	.748	E.	10.5	Nim.	10					.280	General rain.
2 p. m.	.403	52.5	48.5	.742	E. N. E.	10.5	Nim.	10					.273	General rain.
3 p. m.	.391	54.2	48.7	.669	E. N. E.	11.6	Cu. & Nim.	9					.267	Rain ceased.
4 p. m.	.393	54.6	49.4	.686	E. N. E.	13.4	Cu. St. & Nim.	10					.266	Raining.
5 p. m.	.393	54.8	49.5	.681	N. E.	10.1	Cu. St. & Nim.	10					.258	
6 p. m.	.389	52.7	50.8	.870	S. E.	12.6	Cu. St. & Nim.	9	Cir.	3	S. E.		.258	Raining.
7 p. m.	.402	50.4	48.3	.853	S. E.	14.5	Cu. St. & Nim.	9					.269	
8 p. m.	.397	50.0	48.1	.865	S. S. E.	7.0	Cu. St. & Nim.	9					.267	Continued raining.
9 p. m.	.400	50.5	48.3	.847	S. S. E.	5.0	Cu. St. & Nim.	9					.272	Lightning seen at E. S. E.
10 p. m.	.390	50.5	48.5	.859	S. S. E.	7.4	Cu. St. & Nim.	9					.270	Raining fine rain.
11 p. m.	.387	50.5	48.6	.866	S. S. E.	6.0	Cu. St. & Nim.	9					.267	Raining fine rain.
12 p. m.	.378	50.5	48.2	.839	S. E.	6.7	Cu. St. & Nim.	9					.250	
	22.397	52.2	48.7	.779		195.6							22.266	

METEOROLOGICAL RECORD.—SHERMAN, WYOMING TERRITORY—Continued.

SHERMAN, JULY 12, 1872.

Hour.	Barometer at 32° Fahrenheit.	Dry bulb.	Wet bulb.	Relative humidity.	WIND.		LOWER CLOUDS.		UPPER CLOUDS.			Amount of rain and melted snow.	Aneroid barometer.	Remarks.
					Direction.	Velocity per hour.	Kind.	Amount.	Kind.	Amount.	Moving from—			
1 a. m.	22.359	50.2	48.6	.886	S. S. E.	9.6	Nim.	10					22.238	1 a. m., fine rain.
2 a. m.	.349	50.5	49.2	.907	S. S. E.	11.0	Nim.	10					.228	Fine rain at 2.20 a. m. Slight fog falling 4 a. m.
3 a. m.	.346	50.9	49.4	.893	S. S. E.	10.5	Nim.	8					.226	Fine rain falling from 4.05 to 4.35 a. m.;
4 a. m.	.344	50.5	49.2	.907	S. S. E.	12.0	Nim.	9					.222	5 a. m., raining, fog
5 a. m.	.351	49.9	49.0	.934	S.	11.5	Nim. and Cu. St.	9					.222	denser; clouds moving from S. W. at 5.30
6 a. m.	.355	50.3	49.9	.971	S. E.	10.5							.224	a. m.; heavy fog shuts out clouds at 6,
7 a. m.	.367	51.1	50.6	.964	S. E.	16.0							.240	7, and 8 a. m.; raining commenced at 7.40,
8 a. m.	.382	52.3	51.5	.943	S. S. E.	15.0							.246	ended 8.15 a. m.
9 a. m.	.370	53.5	52.5	.930	S. S. E.	19.9	Nim.	10					.245	Fog cleared off; rain'g.
10 a. m.	.367	55.5	53.5	.868	S. S. E.	18.5	Nim.	10					.247	Raining.
11 a. m.	.364	57.6	54.7	.818	S. S. E.	19.8	Nim.	10					.237	Raining.
12 m...	.346	59.5	55.5	.763	S. S. E.	22.2	Cu. St., Nim.	9					.223	Wind blowing in gusts.
1 p. m.	.348	57.8	54.6	.801	S. S. E.	22.0	Cu. St., Nim.	9	Cir.	1	S. W.		.218	Raining.
2 p. m.	.341	56.2	54.2	.869	S. S. E.	18.4	Cu. St., Nim.	9					.210	Raining; thunder at 1.20 p. m.
3 p. m.	.327	57.6	55.7	.877	S. S. E.	19.2	Cu. St., Nim.	9					.192	Raining.
4 p. m.	.323	59.5	56.4	.811	S.	20.9	Cir. & Cu. & Cu. St.	7	Cir.	1	W.		.187	Thunder at 5.25 p. m.; windblow'g in squalls;
5 p. m.	.312	59.5	56.3	.806	S. S. E.	16.6	Cir. & Cu. & Cu. St.	8					.179	fog formed at 6.15 p. m., falling and rising
6 p. m.	.317	56.2	54.5	.889	S. E.	26.7	Cu. St. & Nim.	9					.185	rapidly at 6.30 p. m.; thunder and lightning
7 p. m.	.318	54.5	53.7	.944	S. S. E.	18.0	Cu. St. & Nim.	9					.178	at 8.30 p. m., accompanied by rain at 9 p.
8 p. m.	.313	53.5	52.7	.944	S. S. E.	21.2	Cu. St. & Nim.	9					.180	m.; heavy rain at 9.25 p. m., ended at 9.45 p.
9 p. m.	.338	54.5	54.2	.979	S.	22.5	Nim.	9					.202	m.; thunder and light-
10 p. m.	.328	54.5	52.5	.867	S. S. W.	7.4	Cu. St. & Nim.	9					.190	ning in E.; 10 p. m., thunder and lightning
11 p. m.	.313	54.0	52.4	.892	S.	8.0	Cu. St. & Nim.	9					.179	S. E.; 10.15 p. m., fine rain, thunder, and
12 p. m.	.294	52.8	51.5	.910	S.	12.8	Cu. St. & Nim.	10					.170	lightning; 11.10 p. m., rain ceased.
	22.340	54.3	52.7	.891		390.02							22.212	

METEOROLOGICAL RECORD.—SHERMAN, WYOMING TERRITORY—Continued.

SHERMAN, JULY 13, 1872.

Hour.	Barometer at 32° Fahrenheit.	Dry bulb.	Wet bulb.	Relative humidity.	Wind.		Lower clouds.		Upper clouds.			Amount of rain and melted snow.	Aneroid barometer.	Remarks.
					Direction.	Velocity per hour.	Kind.	Amount.	Kind.	Amount.	Moving from—			
1 a. m.	22.279	52.9	49.9	.802	S.	15.4	Nim.	7					22.150	Rain.
2 a. m.	.278	53.3	49.7	.768	W.	4.0	Nim.	9					.147	Rainy; lightning N. W.
3 a. m.	.269	53.9	50.1	.758	E.	4.0			Nim. & Cu. St.	6	W.		.142	Lightning N. W.
4 a. m.	.268	53.7	48.6	.686	W.	4.0	Nim. & Cu. St.	7					.138	Lightning E.
5 a. m.	.264	52.3	47.5	.698	W.	5.5	Cu. & Cu. St.	5					.140	
6 a. m.	.258	56.3	50.2	.648	W.	18.5	Cir. & Cu.	4					.138	
7 a. m.	.262	59.3	51.9	.600	W.	4.0	Cir. & Cu.	3					.138	
8 a. m	.264	60.8	52.2	.556	W. N. W.	14.0	Cir. & Cu.	4					.135	
9 a. m	.265	63.3	53.4	.514	W. N. W.	16.6	Cir. & Cu. & Cir. St.	5					.125	
10 a. m	.254	65.3	55.5	.526	W. S. W.	18.0	Cu. & Cu. St.	7					.113	Thunder at 9.45 a. m.
11 a. m	.248	66.0	53.7	.445	W.	21.2	Cu. & Cu. St.	7					.102	Lightning seen E.
12 m ...	.230	67.2	53.5	.410	W. N. W.	19.5	Cir. & Cu. St. & Nim.	8					.078	Thunder at 12.30; lightning at 12.45.
1 p. m.	.233	64.6	54.5	.512	W. S. W.	20.0	Cu. St. & Nim.	9					.075	Raining.
2 p. m.	.221	67.5	55.4	.458	S. W.	9.4	Cu. St. & Nim.	8					.064	Thunder; raining.
3 p. m.	.213	67.5	53.6	.405	W.	20.5	Cu. St. & Nim.	9					.050	Thunder; raining.
4 p. m.	.191	70.6	52.6	.317	N. W.	15.6	Cu. & Cir. St. & Nim.	6					.032	
5 p. m.	.187	67.5	57.5	.527	S. S. W.	13.9	Cu. & Cir. St. & Nim.	7					.022	
6 p. m.	.179	67.3	55.0	.451	W. S. W.	19.2	Cu. & Cir. St. & Nim.	5					.019	
7 p. m.	.175	64.0	51.7	.439	W.	21.0	Cir. & Cu. Nim.	5					.010	
8 p. m.	.169	58.6	49.5	.529	W. N. W.	9.6	Cu. & Nim.	4					.010	Lightning seen at S. E.
9 p. m.	.181	57.2	47.5	.501	N. W.	15.0	Cu. & Nim.	4					.034	at 8 and 9 p. m.; at S.
10 p. m	.192	57.5	48.0	.509	W. N. W.	21.4	Cu.	3					.047	E. and S. W. at 10 p.
11 p. m.	.192	55.7	48.1	.578	W. N. W.	18.6	Cu.	2					.049	m; at E. and S. S. E.
12 p. m	.191	54.5	47.3	.590	W. N. W.	14.4	Cir. St.	4					.045	at 11 and 12 p. m.
	22.228	60.7	51.5	.551		342.8							22.083	

METEOROLOGICAL JOURNAL.—SHERMAN, WYOMING TERRITORY—Continued.

SHERMAN, JULY 14, 1872.

Hour.	Barometer at 32° Fahrenheit.	Dry bulb.	Wet bulb.	Relative humidity.	Wind. Direction.	Wind. Velocity per hour.	Lower clouds. Kind.	Lower clouds. Amount.	Upper clouds. Kind.	Upper clouds. Amount.	Upper clouds. Moving from—	Amount of rain and melted snow.	Aneroid barometer.	Remarks.
1 a. m.	22. 190	54. 1	46. 9	. 588	W. N. W.	15. 1	St.	1	....	...	....	......	22. 040	
2 a. m.	. 182	54. 9	47. 3	. 575	W. N. W.	14. 0	St.	1	....	...	....	......	. 043	
3 a. m.	. 185	53. 1	46. 9	. 630	N. W.	14. 0	St.	1	....	...	....	......	. 045	Lightning E.
4 a. m.	. 188	53. 3	46. 8	. 616	W. N. W.	15. 5	Cu. St. & St.	1	....	...	....	......	. 049	Lightning E.
5 a. m.	. 191	53. 3	47. 0	. 626	W. N. W.	14. 5	Cu. St.	2	....	...	....	......	. 050	
6 a. m.	. 194	56. 5	49. 1	. 589	W. N. W.	13. 5	Cir. St.	1	....	...	....	......	. 057	
7 a. m.	. 185	58. 4	51. 1	. 691	W. N. W.	15. 5	Cir. St.	1	....	...	....	......	. 046	
8 a. m.	. 187	62. 3	52. 6	. 519	W. N. W.	18. 5	Cir. St.	1	....	...	....	......	. 042	
9 a. m.	. 191	64. 6	52. 7	. 453	W. N. W.	22. 0	Cir. St.	3	....	...	....	......	. 042	
10 a. m.	. 188	66. 6	54. 6	. 457	N. W.	14. 9	Cu. & Cir. St.	3	....	...	....	......	. 038	
11 a. m.	. 188	68. 0	54. 5	. 419	N. W.	14. 3	Cir. & Cu. & Cu. St.	6	....	...	....	......	. 032	Thunder, 11.15; shower of rain, 11.40.
12 m.	. 184	63. 9	53. 5	. 500	N. W.	13. 6	Cu. & Cu. St. & Nim.	8	....	...	....	......	. 020	
1 p. m.	. 162	67. 7	53. 4	. 395	N. W.	8. 0	Cu. St. & Nim.	9	....	...	....	......	. 005	Thunder; raining.
2 p. m.	. 152	62. 5	55. 3	. 618	S. S. W.	13. 8	Cu. St. & Nim.	9	....	...	....	......	21. 992	Thunder; lightning E.; continued rain.
3 p. m.	. 148	65. 7	56. 7	. 557	E. S. E.	3. 1	Cu. St. & Nim.	9	....	...	....	......	. 990	Thunder; raining.
4 p. m.	. 153	61. 7	54. 7	. 624	N. E.	9. 6	Cu. St. & Nim.	9	....	...	....	......	. 992	Thunder; lightning N. N. E.; rainy.
5 p. m.	. 154	60. 0	53. 5	. 642	E. N. E.	9. 1	Nim.	5	Cu. St.	7	W. S. W.	......	. 997	Rain, thunder, and lightning W. N. W. at 5 and 6 p. m.
6 p. m.	. 164	58. 8	52. 3	. 638	E.	5. 4	Nim.	5	Cu. St.	5	W. S. W.	......	22. 019	
7 p. m.	. 198	50. 6	48. 8	. 873	N. N. W.	12. 6	Cu. St. & Nim.	9	....	...	....	......	. 052	
8 p. m.	. 177	51. 3	47. 9	. 774	N.	15. 0	Cu. St. & Nim.	8	....	...	....	......	. 043	Moderate rain commenced at 6.20; end 7.15 p. m.
9 p. m.	. 180	52. 5	47. 5	. 688	N. N. E.	7. 5	Cu. St. & Nim.	7	....	...	....	......	. 040	Light seen to N. N. E.
10 p. m.	. 149	51. 2	47. 4	. 749	N. W.	6. 3	Cir. & Cu. St. & Nim.	6	....	...	....	......	. 023	Light seen to S. E.
11 p. m.	. 142	51. 8	48. 4	. 775	W. N. W.	6. 7	Cir. & Cu. St. & Nim.	6	....	...	....	......	. 014	
12 p. m.	. 133	52. 4	47. 8	. 708	W. N. W.	11. 5	Cir. & Cu. & Nim.	6	....	...	....	......	. 010	
	22. 174	58. 1	50. 7	. 609	....	294. 0	....	...	....	...	....	......	22. 028	

METEOROLOGICAL JOURNAL.—SHERMAN, WYOMING TERRITORY—Continued.

SHERMAN, JULY 15, 1872.

Hour.	Barometer at 32° Fahrenheit.	Dry bulb.	Wet bulb.	Relative humidity.	WIND.		LOWER CLOUDS.		UPPER CLOUDS.			Amount of rain and melted snow.	Aneroid barometer.	Remarks.
					Direction.	Velocity per hour.	Kind.	Amount.	Kind.	Amount.	Moving from—			
1 a. m.	22.136	51.3	46.9	.716	W. N. W.	29.0	Cir. St.	1	....	....	....	......	22.013	Lightning.
2 a. m.	.141	51.0	46.4	.704	W. N. W.	19.6	Cir. St.	1	....	....	....	......	.020	Lightning E.
3 a. m.	.164	47.4	46.5	.931	N.	17.5	Cu. St.	3	....	....	....	......	.040	Falling fog.
4 a. m	.186	45.0	44.7	.977	N. N. E.	29.0	....	....	....	....	....	......	.063	Dense falling fog.
5 a. m	.190	44.0	43.7	.976	N.	23.0	....	....	....	....	....	......	.077	Dense falling fog.
6 a. m.	.216	42.6	42.3	.976	N. N. E.	21.5	....	....	....	....	....	......	.083	Rising fog.
7 a. m.	.230	45.4	42.9	.816	N. N. E.	32.5	....	....	Cu.St., Nim.	9	W. N. W.	......	.110	
8 a. m.	.236	48.8	45.8	.790	N. N. E.	2.5	....	....	Cu. St.	7	W.	......	.113	
9 a. m.	.218	52.2	47.7	.713	N. N. E.	8.5	Cir., Cu. St.	6	Cir.	3	S. W.	......	.095	
10 a. m.	.220	57.1	51.5	.675	N. E.	6.9	Cu. St.	8	Cir., Cu. St.	3	S. W.	......	.088	
11 a. m.	.214	57.6	51.7	.662	S. E.	12.5	Cu. St.	8	Cir.	3	W. N. W.	......	.078	
12 m...	.206	59.4	52.5	.622	S. S. E.	17.2	Cir. & Cu.	6	Cir.	1	W. S. W.	......	.055	
1 p. m.	.190	60.2	53.3	.624	S. S. E.	18.4	Cir. & Cu.	5	Cir. & Cu.	4	W. N. W.	......	.040	
2 p. m.	.176	61.5	54.3	.615	S. S. E.	21.6	Cir. & Cu.	6	Cir. & Cu.	3	W. N. W.	......	.020	
3 p. m.	.166	62.5	54.6	.589	S. S. E.	19.6	Cir. & Cu.	6	Cir.	1	W. N. W.	......	.004	
4 p. m.	.158	58.6	52.7	.665	S. S. E.	20.9	Cir. & Cu.	6	Cir. & Cu.	4	W. N. W.	......	.000	
5 p. m.	.137	57.8	51.9	.663	S. S. E.	22.8	Cir. & Cu.	7	....	....	....	......	21.993	
6 p. m.	.141	53.5	49.8	.762	S. S. E.	26.0	Cu. & Nim.	7	Cu. St.	3	N. W.	......	.993	Light seen in S. and N.E.
7 p. m.	.155	52.7	49.6	.795	S.	35.4	Cu. & Nim.	6	Cu. St.	3	W. S. W.	......	.995	8 p. m.; in the S. and
8 p. m.	.131	51.4	48.9	.829	S. S. E.	10.2	Cu. & Nim.	8	....	....	....	......	.993	S. S. E. 9 p. m.
9 p. m.	.127	51.3	48.5	.809	S. E.	18.1	Cir., Cu. St.	7	....	....	....	......	.995	Clearing off at 10.20; fog
10 p. m.	.132	49.9	48.7	.913	S.	3.0	Nim.	10	....	....	....	......	22.009	rising at 11.35; en-
11 p. m.	.130	48.7	47.2	.890	S. S. E.	17.3	Cu. St.	4	....	....	....	......	.005	tirely overcast with
12 p. m.	.126	47.9	47.1	.939	S. W.	15.6	....	....	....	....	....	......	21.998	falling fog at 1
	22.172	52.4	48.7	.777	....	448.6	....	....	....	....	....	......	22.037	

METEOROLOGICAL JOURNAL.—SHERMAN, WYOMING TERRITORY—Continued.

SHERMAN, JULY 16, 1872.

Hour.	Barometer at 32° Fahrenheit.	Dry bulb.	Wet bulb.	Relative humidity.	Wind.		Lower clouds.		Upper clouds.			Amount of rain and melted snow.	Aneroid barometer.	Remarks.
					Direction.	Velocity per hour.	Kind.	Amount.	Kind.	Amount.	Moving from—			
1 a. m.	22.113	47.4	44.6	.800	W.	4.5	Cir. & Cu. St.	1					21.985	Lightning S. E.
2 a. m.	.106	47.0	42.4	.690	W.	4.0	Cir. St.	1					.989	Lightning N. and N. E.
3 a. m.	.101	47.8	42.0	.628	W.	14.0	Cu. St. & Cir.	2					.980	Lightning N. E.
4 a. m.	.103	46.4	41.2	.655	W.	19.0	St.	1					.982	
5 a. m.	.112	47.0	38.8	.510	W.	19.0	Cir. St.	1					.985	
6 a. m.	.126	50.4	41.0	.477	W. N. W.	21.8	St.	1					22.000	
7 a. m.	.144	52.4	41.5	.432	N. W.	13.2	St. & Cu.	1					.020	
8 a. m.	.148	55.0	42.6	.398	N. N. W.	14.3	Cu. St.	1					.020	
9 a. m.	.150	58.1	44.0	.363	W.	11.3	Cir. & Cu.	2					.010	
10 a. m.	.151	61.0	45.5	.337	W. N. W.	12.5	Cu. St. & Nim.	7					.002	
11 a. m.	.167	55.4	45.0	.466	N. W.	24.9	Cu. St. & Nim.	9					.015	Commenced to rain 11.10 a. m., wind blowing in squalls; rain ceased 12.15 p. m.; wind blowing in squalls.
12 m	.210	48.5	44.4	.723	W.	34.4	Cu. St. & Nim.	10					.056	
1 p. m.	.152	56.2	50.6	.671	S. S. W.	7.7	Cir. & Cir. St.	4					.012	
2 p. m.	.138	60.6	52.1	.559	S. S. E.	10.5			Cir. & Cu.	5	W.		21.994	
3 p. m.	.133	58.0	51.1	.617	S.	13.8			Cu. St. & Nim.	9	W.		.965	Thunder, lightning, and rain at 3.10.
4 p. m.	.148	50.0	46.6	.769	S.	15.8			Cu. & Cu. St. & Nim.	9	W.		.986	Thunder; rainy.
5 p. m.	.119	54.5	50.6	.753	S.	12.7	Cu.	4	Cir. & Cu. St.	6	W. N. W.		.985	
6 p. m.	.128	57.5	50.2	.598	W. S. W.	13.6	Nim.	4	Cir. & Cu. St.	6	S. E.		.998	Few drops of rain at 6.06 p. m.
7 p. m.	.174	53.5	49.3	.735	N. E.	11.0	Nim. & Cu.	4	Cir. & Cu. St.	5	W. N. W.		22.030	Rain commenced at 7.30 p. m.; ended 7.50.
8 p. m.	.192	48.4	47.3	.917	N. E.	15.0	Nim.	7	Cu. St.	4	N. W.		.059	Falling fog commenced at 8.25 p. m.; falling fog at 10 and 11 p. m.
9 p. m.	.229	45.4	45.3	.992	N. E.	22.2							.097	
10 p. m.	.249	40.3	39.7	.949	N. N. E.	25.8							1.25	
11 p. m.	.256	39.4	39.2	.983	N. N. E.	18.7							.142	
12 p. m.	.267	38.3	37.9	.965	N. N. E.	19.9							.155	White frost at 11.15 p. m.
	22.159	50.7	44.7	.666		379.6							22.025	

METEOROLOGICAL JOURNAL.—SHERMAN, WYOMING TERRITORY—Continued.

SHERMAN, JULY 17, 1872.

Hour.	Barometer at 32° Fahrenheit.	Dry bulb.	Wet bulb.	Relative humidity.	Wind.		Lower clouds.		Upper clouds.			Amount of rain and melted snow.	Aneroid barometer.	Remarks.
					Direction.	Velocity per hour.	Kind.	Amount.	Kind.	Amount.	Moving from—			
1 a. m.	22.261	38.6	38.1	.957	N. N. E.	19.8							22.140	Rising fog.
2 a. m.	.257	38.5	37.9	.947	N. N. E.	8.9	Nim.	10					.140	Rain.
3 a. m.	.268	38.4	37.7	.938	N. N. E.	8.2							.155	Fog.
4 a. m.	.272	38.1	37.3	.930	N. N. E.	9.7							.150	Fog.
5 a. m.	.275	37.5	37.0	.956	N. N. E.	10.3							.145	Fog.
6 a. m.	.278	37.3	36.8	.954	N. E.	7.2							.163	Fog.
7 a. m.	.280	39.1	38.4	.940	E.	4.4							.165	Fog.
8 a. m.	.274	41.8	41.3	.959	S. E.	6.9							.160	Fog.
9 a. m.	.273	42.9	42.4	.960	S. S. E.	12.0							.150	Fog and rain.
10 a. m.	.274	44.4	43.2	.907	S. E.	14.9							.154	Fog and rain.
11 a. m.	.274	46.2	44.1	.844	S. S. E.	14.1							.154	Fog clearing off : rain.
12 m.	.267	50.6	46.6	.736	S. E.	15.6							.145	
1 p. m.	.268	50.6	46.7	.741	S. S. E.	14.6							.135	
2 p. m.	.262	46.6	44.7	.858	S. S. E.	19.7							.130	Fog falling.
3 p. m.	.268	45.3	43.6	.872	S. S. E.	18.1							.140	Fog falling and rain.
4 p. m.	.275	44.0	43.2	.937	S. S. E.	20.7							.141	Fog falling and rain.
5 p. m.	.266	44.5	43.5	.922	S. S. E.	20.3							.149	Fog falling.
6 p. m.	.268	43.5	42.5	.921	S. S. E.	17.4							.153	Fog falling.
7 p. m.	.275	42.7	42.8		S. S. E.	16.2							.157	Fog falling.
8 p. m.	.294	42.6	41.8	.934	S. S. E.	16.0							.172	Fog falling.
9 p. m.	.307	42.6	42.3	.976	S. S. E.	14.2							.182	Fog falling.
10 p. m.	.306	42.6	42.3	.976	S. S. E.	27.4							.190	Fog falling.
11 p. m.	.317	43.1	42.6	.960	S. S. E.	9.0							.193	Fog falling.
12 p. m.	.315	43.3	42.6	.944	S. S. E.	9.2							.190	Fog falling.
	22.278	42.7	41.6	.879		334.8							22.156	

METEOROLOGICAL JOURNAL.—SHERMAN, WYOMING TERRITORY—Continued.

SHERMAN, JULY 18, 1872.

Hour.	Barometer at 32° Fahrenheit.	Dry bulb.	Wet bulb.	Relative humidity.	Wind. Direction.	Wind. Velocity per hour.	Lower clouds. Kind.	Lower clouds. Amount.	Upper clouds. Kind.	Upper clouds. Amount.	Upper clouds. Moving from—	Amount of rain and melted snow.	Aneroid barometer.	Remarks.
1 a. m.	22. 303	43. 2	42. 5	.944	S.	23. 1							22. 190	Fog with fine rain.
2 a. m.	.306	43. 2	42. 5	.944	S.	15. 0							.185	Falling fog.
3 a. m.	.302	42. 8	42. 3	.960	S.	9. 0							.185	Falling fog.
4 a. m.	.305	40. 6	40. 0	.950	E.	0. 7							.180	Fog clearing off.
5 a. m.	.316	41. 9	41. 1	.934	S. W.	0. 0							.190	Fog formed a snowy
6 a. m.	.312	44. 9	42. 7	.835	N. W.	0. 8	St.	1					.190	landscape east at 5
7 a. m.	.316	48. 7	44. 4	.712	N. W.	0. 0	St.	1					.196	and 6 a. m.
8 a. m.	.326	51. 8	49. 2	.823	W.	5. 5	Cu. St.	1					.200	Clouds all in the east.
9 a. m.	.330	55. 4	42. 8	.393	W. N. W.	13. 0	Cu.	1					.207	
10 a. m.	.338	58. 3	44. 7	.379	W. N. W.	13. 7	Cu.	1					.197	
11 a. m.	.333	61. 0	45. 7	.343	W. N. W.	12. 3	Cu.	2					.188	
12 m...	.327	64. 2	47. 4	.320	S. W.	10. 3	Cu.	3					.167	
1 p. m.	.324	67. 0	48. 7	.298	N. W.	9. 1	Cu. & St.	7					.143	
2 p. m.	.312	62. 8	55. 4	.612	S. S. E.	9. 8	Nim.	2	Cu. St. & Nim.	9	W.		.140	
3 p. m	.309	61. 6	55. 4	.661	S.	17. 9			Cu. St. & Nim.	9	W.		.140	
4 p. m.	.312	60. 6	52. 7	.583	S.	10. 7			Cu. St. & Nim.	9	W.		.137	Commenced to rain.
5 p. m.	.334	55. 5	48. 2	.590	N. N. E.	5. 4	Nim.	4	Cu. St. & Cir.	5	W. S. W.		.179	Continued raining; ended 5.30 p. m.
6 p. m	.314	57. 3	49. 9	.593	S. S. E.	7. 3	Cu.	4	Cu. St.	6	W.		.157	
7 p. m.	.334	55. 5	46. 1	.504	W. S. W.	7. 0	Cu.	3	Cu. St.	6	N. W.		.183	A shower of rain.
8 p. m.	.334	53. 5	47. 4	.637	W.	9. 4	Cu., & Cu. St.	7					.190	Light at S.
9 p. m.	.329	52. 8	47. 8	.688	S.	7. 8	Cu.	3					.187	
10 p. m.	.327	51. 7	47. 1	.706	E. S. E.	1. 7	St.	2					.185	
11 p. m.	.323	50. 2	45. 7	.707	S. S. E.	7. 9	St.	2					.180	
12 p. m	.304	49. 3	46. 0	.774	S.	9. 2	St.	2					.178	Light seen at S. S. E.
	22. 319	53. 1	46. 5	.662		206. 6							22. 178	

METEOROLOGICAL JOURNAL.—SHERMAN, WYOMING TERRITORY—Continued.

SHERMAN, JULY 19, 1872.

Hour.	Barometer at 32° Fahrenheit.	Dry bulb.	Wet bulb.	Relative humidity.	WIND.		LOWER CLOUDS.		UPPER CLOUDS.			Amount of rain and melted snow.	Aneroid barometer.	Remarks.
					Direction.	Velocity per hour.	Kind.	Amount	Kind.	Amount.	Moving from—			
1 a. m.	22.301	48.3	45.4	.794	S.	8.0	Cu. St.	1	....	...	....	......	22.165	Lightning S. E.
2 a. m.	.294	48.2	45.5	.808	S.	12.5	Cir.	1	....	...	....	......	.160	Lightning E.
3 a. m.	.289	49.4	46.9	.825	S.	6.0	St.	1	....	...	....	......	.157	Lightning E.
4 a. m.	.290	52.1	45.3	.597	N. W.	2.0	Cir. Cu. & St.	1	....	...	....	......	.146	
5 a. m.	.293	52.8	44.4	.530	N. W.	7.5	Cir. St.	2	....	...	....	......	.161	
6 a. m.	.290	55.0	47.0	.557	N. W.	8.5	Cir. St.	2	....	...	....	......	.155	
7 a. m.	.288	59.7	48.5	.458	N. W.	8.0	Cir. St.	3	....	...	....	......	.151	
8 a. m.	.290	62.3	49.7	.424	W. N. W.	11.8	Cu. St. & Cir. St.	3	....	...	....	......	.152	
9 a. m.	.286	64.6	50.7	.394	W.	11.5	Cir. St. & Cu. St.	5	....	...	....	......	.132	
10 a. m.	.291	60.6	50.7	.506	N. N. W.	20.3	Cu. St. & Nim.	8	....	...	....	......	.132	Thunder; wind blowing in squalls.
11 a. m.	.320	53.7	48.2	.667	N. N. W.	40.8	Cir. & Cu. St. & Nim.	9	Cir.	2	S. E.	......	.167	Thunder; wind blowing in squalls; raining.
12 m.	.308	58.6	50.3	.560	N. W.	24.0	Cir. & Cu. St. & Nim.	8	....	...	....	......	.153	Thunder; wind blowing; raining.
1 p. m.	.287	60.4	51.3	.535	W.	19.0	Cu. St. & Nim.	9	....	...	....	......	.133	Shower of rain at 1.20 p. m.
2 p. m.	.265	64.3	53.7	.493	S. S. W.	17.3	Cu. & Cu. St. & Nim.	7	....	...	....	......	.107	
3 p. m.	.243	65.6	51.4	.390	W. S. W.	13.0	Cu. & Cu. St. & Nim.	7	....	...	....	......	.082	
4 p. m.	.220	66.3	53.4	.429	W. S. W.	18.1	Cir. St., Cu. St., & Nim.	7	....	...	....	......	.053	
5 p. m.	.215	64.2	51.5	.428	W. S. W.	28.8	Cir. St., Cu. St.	7	....	...	....	......	.054	
6 p. m.	.234	57.7	49.1	.544	N.	17.8	Cu., Nim.	4	Cu. St.	4	S. W.	......	.060	
7 p. m.	.245	53.5	47.2	.627	N. N. E.	26.7	Cu., Nim.	5	Cu. St.	4	S. S. W.	......	.090	Light in the W. S. W.
8 p. m.	.254	49.1	45.7	.767	N.	28.4	Cu., Nim.	9	....	...	....	......	.113	Light in the S. W.
9 p. m.	.220	48.9	46.5	.830	S. W.	30.8	Cu. St. & Nim.	8	....	...	....	......	.080	Commenced raining at 8 p. m.; ended at 8.50 p. m.
10 p. m.	.241	49.7	46.2	.762	N. N. E.	7.5	Cu., Cu. St.	7	....	...	....	......	.105	A shower of rain at 10.25 p. m.
11 p. m.	.250	48.4	45.6	.802	N.	11.7	Cu.	4	....	...	....	......	.105	
12 p. m.	.230	48.7	44.7	.729	N.	12.8	Cu.	3	....	...	....	......	.100	
	22.268	55.9	48.3	.602	....	392.8	....	...	....	...	....	......	22.121	

METEOROLOGICAL JOURNAL.—SHERMAN, WYOMING TERRITORY—Continued.

SHERMAN, JULY 20, 1872.

Hour.	Barometer at 32° Fahrenheit.	Dry bulb.	Wet bulb.	Relative humidity.	Wind. Direction.	Wind. Velocity per hour.	Lower clouds. Kind.	Lower clouds. Amount.	Upper clouds. Kind.	Upper clouds. Amount.	Upper clouds. Moving from—	Amount of rain and melted snow.	Aneroid barometer.	Remarks.
1 a. m.	22.225	49.0	44.6	.708	N. W.	1.8	Cir. St. & Cu.	1	......	...	......	......	22.104	
2 a. m.	.212	45.3	45.8	......	N.	1.3	Cir. St.	2	......	...	......	......	.083	
3 a. m.	.210	49.7	45.2	.705	S.	0.0	......	...	St.	1	N. W.	......	.079	
4 a. m.	.200	48.3	44.1	.716	S. S. E.	5.8	......	...	Cir. St.	1	N. W.	......	.073	
5 a. m.	.205	49.2	44.8	.708	S. S. E.	10.0	......	...	Cir. St.	1	N. W.	......	.075	
6 a. m.	.200	53.1	48.2	.695	S.	9.5	......	...	Cir. St.	1	W. N. W.	......	.067	
7 a. m.	.206	57.6	51.4	.648	S.	12.5	......	...	Cir. St.	1	N. W.	......	.070	
8 a. m.	.210	61.5	53.5	.582	S. S. W.	8.2	......	...	Cir.	1	N. W.	......	.070	
9 a. m.	.215	65.4	54.3	.481	W. S. W.	6.3	Cir. St.	1	......	...	......	......	.060	
10 a. m.	.213	67.3	53.2	.400	W. N. W.	13.7	Cir. St.	2	......	...	......	......	.053	
11 a. m.	.215	70.1	52.9	.333	W.	19.2	Cir. & Cu.	5	......	...	......	......	.045	
12 m...	.224	69.3	53.3	.358	N. N. W.	29.6	Cir. & Cu. & Cu. St.	7	......	...	......	......	.042	Windblowinginsqualls
1 p. m.	.227	69.6	53.6	.358	W. N. W.	18.5	Cir. & Cu. & Cu. St.	7	......	...	......	......	.050	
2 p. m.	.225	71.8	89.7	......	W. N. W.	33.6	Cu.	4	......	...	......	......	.042	Wind blowing in squalls at 2, 3, and 4 p. m.
3 p. m.	.222	73.0	49.7	.228	W. N. W.	33.9	Cu.	4	......	...	......	......	.040	
4 p. m.	.223	71.7	49.2	.236	N. W.	31.5	Cir. & Cu.	4	......	...	......	......	.033	
5 p. m.	.217	71.9	50.1	.249	N. W.	28.2	Cir. & Cu.	3	......	...	......	......	.004	
6 p. m.	.224	71.9	50.1	.249	N. W.	20.0	Cir. & Cu.	4	......	...	......	......	.035	
7 p. m.	.231	66.5	50.5	.347	N.	11.8	Cir. & Cu.	5	......	...	......	......	.053	
8 p. m.	.242	61.3	50.1	.464	S.	5.6	Cu.	3	Cu. St.	5	W. N. W.	......	.065	
9 p. m.	.262	58.7	52.5	.652	S.	10.2	Cu. & Cir. St.	5	......	...	......	......	.080	
10 p. m.	.275	56.1	51.5	.723	E. N. E.	11.3	Cu.	3	......	...	......	......	.102	Passing fog at 10.35; cleared off at 10.50 p. m.; falling fog at 11.15 p. m.
11 p. m.	.275	50.7	49.1	.887	N. E.	12.5	Cu.	3	Cir.	3	S. E.	......	.112	
12 p. m.	.268	49.7	48.8	.932	E. N. E.	6.6	......	...	Cu. St.	4	N. W.	......	.112	
	22.226	60.8	51.5	.486	......	341.6	......	...	......	...	......	......	22.065	

METEOROLOGICAL JOURNAL.—SHERMAN, WYOMING TERRITORY—Continued.

SHERMAN, JULY 21, 1872.

Hour.	Barometer at 32° Fahrenheit.	Dry bulb.	Wet bulb.	Relative humidity.	WIND. Direction.	WIND. Velocity per hour.	LOWER CLOUDS. Kind.	LOWER CLOUDS. Amount.	UPPER CLOUDS. Kind.	UPPER CLOUDS. Amount.	UPPER CLOUDS. Moving from—	Amount of rain and melted snow.	Aneroid barometer.	Remarks.
1 a. m.	22. 268	50. 4	49. 8	.956	E.	8. 3	....	...	....	...	....	......	22. 117	Slight fog.
2 a. m.	.265	52. 2	50. 8	.903	S. E.	5. 0	....	...	....	...	....	......	.120	Dense fog.
3 a. m.	.266	53. 2	51. 9	.910	S. S. E.	12. 7	....	...	....	...	....	......	.117	Dense fog.
4 a. m.	.255	51. 5	50. 5	.929	S.	13. 3	....	...	....	...	....	......	.110	Dense fog.
5 a. m.	.251	51. 5	50. 4	.921	S.	15. 5	....	...	....	...	....	......	.105	Dense fog.
6 a. m.	.249	51. 2	50. 1	.921	S.	10. 5	....	...	....	...	....	......	.102	Dense fog.
7 a. m.	.249	59. 4	54. 6	.717	S. W.	1. 7	Cir. St. & Cu.	1	....	...	....	......	.102	Fog off.
8 a. m.	.255	65. 3	57. 7	.611	S. W.	3. 5	Cir. & Cu.	5	....	...	....	......	.105	
9 a. m.	.252	63. 6	57. 4	.666	S. S. W.	6. 5	....	....	Cir. & Cir. Cu.	7	W.	......	.093	
10 a. m.	.246	72. 5	54. 3	.320	S. S. W.	9. 0	....	....	Cir. & Cir. St.	7	W.	......	.074	
11 a. m.	.236	73. 7	52. 7	.270	W.	25. 0	Cir. St.	9	....	...	....	......	.055	
12 m.	.228	72. 3	56. 6	.378	S.	18. 8	....	....	Cir.St.,Cu. St., & Nim.	9	W.	......	.033	
1 p. m.	.230	66. 7	55. 2	.474	S.	14. 5	....	....	Cu. St., Nim.	9	W.	......	.040	Raining at 1 p. m.; a shower of rain at 1.25 p. m.: wind blowing in squalls.
2 p. m.	.245	64. 2	51. 3	.422	S.	34. 7	....	....	Cu. St., Nim.	10	W.	......	.063	
3 p. m.	.274	58. 1	51. 3	.622	W.	20. 3	Cu. St. & Nim.	9	....	...	....	......	.095	Continued rain.
4 p. m.	.235	57. 7	51. 5	.649	W.	20. 3	Cir.St.,Cu. St., & Nim.	8	....	...	....	......	.065	Rain ceased at 3.35 p. m
5 p. m.	.206	61. 5	53. 1	.566	W. S. W.	20. 8	Cir.St.,Cu. St., & Nim.	8	....	...	....	......	.040	
6 p. m.	.200	62. 1	51. 9	.501	W. S. W.	33. 0	Cir. Cu. & Cu. St.	7	....	...	....	......	.040	
7 p. m.	.179	61. 9	51. 9	.507	W. S. W.	28. 0	Cir. Cu. & Cu. St.	6	....	...	....	......	.020	
8 p. m.	.179	58. 7	51. 8	.619	W. S. W.	28. 0	Cir. Cu. & Cu. St.	6	....	...	....	......	.017	Light seen in the S. E.
9 p. m.	.194	57. 1	50. 3	.618	W. S. W.	24. 0	Cu., Cu.St.	6	....	...	....	......	.042	
10 p. m.	.184	57. 5	50. 6	.615	W. S. W.	24. 0	Cu., Cu.St.	7	....	...	....	......	.023	
11 p. m.	.191	57. 5	50. 6	.615	W. S. W.	33. 4	Cu., Cu.St.	8	....	...	....	......	.037	
12 p. m.	.197	57. 0	49. 3	.579	W. S. W.	30. 8	Cir. Cu. & Cu. St.	8	....	...	....	......	.043	
	22. 231	59. 8	52. 3	.637	....	441. 6	....	...	....	...	....	......	22. 069	

METEOROLOGICAL JOURNAL.—SHERMAN, WYOMING TERRITORY—Continued.

SHERMAN, JULY 22, 1872.

Hour.	Barometer at 32° Fahrenheit.	Dry bulb.	Wet bulb.	Relative humidity.	WIND. Direction.	WIND. Velocity per hour.	LOWER CLOUDS. Kind.	LOWER CLOUDS. Amount.	UPPER CLOUDS. Kind.	UPPER CLOUDS. Amount.	UPPER CLOUDS. Moving from—	Amount of rain and melted snow.	Aneroid barometer.	Remarks.
1 a. m.	22. 203	56. 9	49. 0	. 570	W.	27. 7	Cir. St. & Cu. St.	8	....	...	....	......	22. 045	
2 a. m	. 189	55. 6	48. 3	. 590	W. N. W.	20. 0	Cir. & Cu.	6	....	...	....	......	. 040	
3 a. m.	. 210	55. 1	48. 0	. 597	N. W.	18. 0	Cir. & Cu.	5	....	...	....	......	. 058	
4 a. m.	. 214	55. 4	48. 2	. 594	W.	6. 0	Cir. & Cu. St.	5	....	...	....	......	. 062	
5 a. m.	. 221	55. 6	48. 2	. 586	W.	18. 0	Cir. & Cu.	6	....	...	....	......	. 075	
6 a. m.	. 245	55. 5	49. 2	. 635	W.	21. 0	Cir. St. & Cu.	8	....	...	....	......	. 097	
7 a. m.	. 243	56. 0	49. 8	. 642	W.	16. 0	Cir. St. & Cu.	8	....	...	....	......	. 090	
8 a. m.	. 255	60. 4	51. 7	. 551	W.	19. 8	Cir., Cir. St., Cu. St., & Cu.	6	....	...	....	......	. 100	
9 a. m.	. 261	61. 3	51. 6	. 516	W.	23. 7	Cir. & Cir. St.	6	....	...	....	......	. 097	
10 a. m.	. 259	64. 6	52. 6	. 450	W.	25. 9	Cir. & Cir. St.	5	....	...	....	......	. 090	
11 a. m.	. 257	67. 6	53. 4	. 397	W. N. W.	27. 0	Cu., Cir. St.	7	....	...	....	......	. 084	
12 m...	. 263	67. 4	54. 3	. 428	W. N. W.	21. 6	Cir. St. & Cu., Nim.	8	....	...	....	......	. 082	Commenced to rain at 11.40; thunder at 12.5.
1 p. m.	. 257	68. 1	56. 7	. 483	S. S. W.	9. 7	Cu. St., Nim	9	....	...	....	......	. 062	
2 p. m.	. 267	66. 3	54. 7	. 469	S. W.	13. 2	Cu. St., Nim	9	....	...	....	......	. 082	Commenced to rain at 1.30 p. m.; raining at intervals at 2 and 3 p. m.
3 p. m.	. 259	67. 7	53. 6	. 401	W. S. W.	20. 5	Cu. St., Nim	9	....	...	....	......	. 082	
4 p. m.	. 253	66. 3	52. 7	. 409	W. S. W.	19. 6	Cu. St., Nim	9	....	...	....	......	. 073	
5 p. m.	. 275	61. 3	50. 7	. 484	N. W.	25. 1	Cu. St., Nim	9	....	...	....	......	. 099	
6 p. m.	. 285	57. 2	49. 4	. 564	N. W.	27. 3	Cu. St., Nim	9	....	...	....	......	. 120	
7 p. m.	. 286	57. 9	48. 8	. 526	W. N. W.	15. 8	Cu. St., Nim	9	....	...	....	......	. 121	
8 p. m.	. 287	56. 2	47. 6	. 538	W.	12. 3	Cu. St., Nim	9	....	...	....	......	. 127	Light seen at E. S. E. at 8 p. m.; at S. S. E. and N. N. E. at 9 p. m.; and at S. S. E. at 10 p. m.
9 p. m.	. 290	54. 7	47. 2	. 577	N. W.	9. 4	Cu. St., Nim	9	....	...	....	......	. 123	
10 p. m.	. 290	54. 7	47. 5	. 591	N. W.	4. 2	Cu. St., Nim	7	....	...	....	......	. 125	
11 p. m.	. 283	55. 5	48. 2	. 590	N. W.	7. 4	Cu. & Cu. St.	7	....	...	....	......	. 122	
12 p. m.	. 293	51. 6	49. 5	. 855	E. S. E.	5. 4	Cu. & Cu. St.	7	....	...	....	......	. 123	
	22. 256	59. 5	50. 4	. 543	....	414. 6	....	...	....	...	....	......	22. 092	

METEOROLOGICAL JOURNAL.—SHERMAN, WYOMING TERRITORY—Continued.

SHERMAN, JULY 23, 1872.

Hour.	Barometer at 32° Fahrenheit.	Dry bulb.	Wet bulb.	Relative humidity.	WIND. Direction.	WIND. Velocity per hour.	LOWER CLOUDS. Kind.	LOWER CLOUDS. Amount.	UPPER CLOUDS. Kind.	UPPER CLOUDS. Amount.	UPPER CLOUDS. Moving from—	Amount of rain and melted snow.	Aneroid barometer.	Remarks.
1 a. m.	22. 292	50. 1	48. 4	. 879	N. E.	5. 5	....	0	Cir.	5	W. S. W.	......	22. 135	
2 a. m.	. 297	50. 0	48. 0	. 858	S. W.	....	Cir.	4	....	....	....	......	. 140	
3 a. m.	. 293	50. 3	47. 8	. 826	S. W.	....	Cir.	3	....	....	....	......	. 140	
4 a. m.	. 298	50. 2	47. 3	. 800	W.	0. 2	Cir. & St.	2	....	....	....	......	. 143	
5 a. m.	. 299	49. 3	46. 7	. 818	N. W.	5. 0	Cir. St. & Cu.	3	....	....	....	......	. 153	
6 a. m.	. 302	52. 1	47. 2	. 692	N. W.	4. 0	Cir.	6	....	....	....	......	. 158	
7 a. m.	. 311	55. 2	48. 6	. 620	N. W.	5. 7	Cir. St.	7	....	....	....	......	. 165	
8 a. m.	. 321	60. 7	51. 1	. 517	W.	4. 7	Cir. St. & Cu.	5	....	....	....	......	. 170	
9 a. m.	. 319	66. 0	53. 7	. 445	S. S. W.	4. 6	Cu. & Cir. St.	6	....	....	....	......	. 160	
10 a. m.	. 334	68. 6	54. 6	. 406	S. S. W.	8. 3	Cir. & Cir. St.	7	....	....	....	......	. 150	
11 a. m.	. 315	70. 1	54. 5	. 371	S.	8. 0	....	....	Cir. & Cu. St.	7	W.	......	. 130	
12 m.	. 308	70. 5	56. 3	. 410	S.	14. 1	....	....	Cu. & Cir. St. & Cu. St.	7	W.	......	. 110	
1 p. m.	. 299	72. 7	56. 7	. 372	S.	17. 0	....	....	Cir. & Cir. St., Nim.	6	W.	......	. 100	
2 p. m.	. 286	73. 2	58. 4	. 404	S. S. E.	18. 5	....	....	Cir. & Cir. St., Nim.	6	W.	......	. 087	Thunder N. E. at 1.25.
3 p. m.	. 281	72. 3	56. 8	. 382	S. S. E.	19. 8	....	....	Cir. & Cir. St., Nim.	5	W.	......	. 075	
4 p. m.	. 269	71. 3	55. 5	. 372	S. S. E.	19. 4	....	....	Cir. & Cir. St., Nim.	4	W.	......	. 070	
5 p. m.	. 255	69. 6	56. 3	. 431	S. S. E.	18. 8	....	....	Cir. & Cir. St., Nim.	5	W.	......	. 062	
6 p. m.	. 258	65. 0	54. 9	. 514	S. S. E.	16. 3	....	....	Cir. & Cir. St., Nim.	6	W.	......	. 075	Thunder at 6 p. m.
7 p. m.	. 284	52. 7	48. 3	. 721	N. N. W.	20. 3	Cu. & Nim.	5	Cir. & Cu. St.	5	S. S. W.	......	. 095	Thunder and lightning N.E., S.E., and N.N.W
8 p. m.	. 252	51. 3	47. 4	. 744	N. W.	20. 7	Cu. St., Nim	6	....	....	....	......	. 099	Raining at 8 p. m.; lightning seen from N. N. E. to S. E. at 8 and 9 p. m.; sky entirely overcast with fog at 10 p. m.; cleared off at 10.20 p. m.
9 p. m.	. 261	50. 9	47. 3	. 760	S. W.	6. 3	Cu. & Cu. St.	5	....	....	....	......	. 113	
10 p. m.	. 263	49. 5	47. 7	. 871	S. E.	6. 2	....	0	....	....	....	......	. 120	
11 p. m.	. 285	53. 7	52. 1	. 892	S. S. E.	16. 2	Cu. St. & Nim.	7	....	....	....	......	. 132	
12 p. m.	. 280	53. 1	51. 9	. 917	S.	16. 5	Cu. St. & Nim.	9	....	....	....	......	. 123	
	22. 290	59. 5	51. 6	. 626	....	256. 1	....	....	....	....	....	......	22. 121	

METEOROLOGICAL JOURNAL.—SHERMAN, WYOMING TERRITORY—Continued.

SHERMAN, JULY 24, 1872.

Hour.	Barometer at 32° Fahrenheit.	Dry bulb.	Wet bulb.	Relative humidity.	Wind.		Lower clouds.		Upper clouds.			Amount of rain and melted snow.	Aneroid barometer.	Remarks.
					Direction.	Velocity per hour.	Kind.	Amount.	Kind.	Amount.	Moving from—			
1 a. m.	22.263	52.7	52.7	......	S.	15.0	....	....	....	....	....	......	22.117	Overhanging fog.
2 a. m.	.262	50.8	50.8	......	W. S. W.	8.8	St.	1	....	....	....	......	.120	
3 a. m.	.259	51.4	47.9	.768	N. W.	1.5	Cir. St.	1	....	....	....	......	.116	
4 a. m.	.252	51.9	45.3	.606	W. N. W.	11.7	Cir.	7	....	....	....	......	.102	
5 a. m.	.247	53.9	46.2	.565	N. W.	9.0	Cir. St. & Cu.	8	....	....	....	......	.111	
6 a. m.	.262	55.8	46.6	.512	W. N. W.	11.0	Cu. St.	9	....	....	....	......	.118	
7 a. m.	.266	60.6	50.3	.493	W. N. W.	16.6	Cir. & Cu.	7	....	....	....	......	.115	
8 a. m.	.272	63.1	51.2	.448	W. N. W.	19.4	Cir. & Cir. St.	5	....	....	....	......	.117	
9 a. m.	.265	66.5	53.6	.429	W.	17.6	Cir. & Cu. St.	7	....	....	....	......	.102	
10 a. m.	.270	68.7	53.5	.376	W.	21.0	Cu. & Cu. St.	6	....	....	....	......	.100	
11 a. m.	.263	70.6	54.2	.354	W. N. W.	19.4	Cir., Cir. St., & Cu. St.	6	....	....	....	......	.090	
12 m ...	.249	74.5	55.8	.318	S. W.	17.0	Cu., Cu. St., Nim.	7	....	....	....	......	.067	Thunder.
1 p. m.	.241	72.8	58.3	.409	S. S. E.	12.6	....	....	Cu. St., Nim.	8	S. W.	......	.047	Thunder.
2 p. m.	.259	60.7	52.3	.564	N. N. W.	15.4	....	....	Cu. St., Nim.	9	S. W.	......	.063	Thunder; commenced rain at 1.15; ceased at 2.15 p. m.
3 p. m.	.237	68.1	56.2	.467	S. S. E.	3.0	....	....	Cu. St., Nim.	6	S. W.	......	.060	
4 p. m.	.244	66.4	56.7	.534	S. S. E.	10.1	....	....	Cu. St., Nim.	9	S. W.	......	.062	Thunder and rain at intervals.
5 p. m.	.272	59.9	51.5	.561	N.	15.4	Cu. St.	5	Nim.	6	S. W.	......	.099	Fine rain ended at 5.20 p. m.
6 p. m.	.248	66.8	55.7	.487	S E.	5.4	....	....	Cu. St., Nim.	7	W S. W.	......	.078	
7 p. m.	.256	61.4	53.9	.602	S. E.	3.2	Cu. St., Cu., & Nim.	7	....	....	....	......	.078	
8 p. m.	.264	59.5	52.3	.609	S. W.	7.1	Cu. St., Nim.	8	....	....	....	......	.097	Lightning in E. S. E.; commenced at 7 p. m.
9 p. m.	.264	56.9	49.3	.583	W. S. W.	13.3	Cu. St., Nim.	6	....	....	....	......	.092	Lightning in E. S. E.
10 p. m.	.268	54.9	47.8	.596	W. N. W.	11.5	Cu. St., Nim.	5	....	....	....	......	.100	Lightning in E. S. E.
11 p. m.	.270	55.9	47.3	.537	W. N. W.	9.2	Cu. St.	5	....	....	....	......	.102	
12 p. m.	.276	53.7	46.1	.568	N. N. W.	12.9	St.	3	....	....	....	......	.102	
	22.259	60.7	51.5	.474	....	287.1	....	....	....	....	....	......	22.094	

METEOROLOGICAL JOURNAL.—SHERMAN, WYOMING TERRITORY—Continued.

SHERMAN, JULY 25, 1872.

Hour.	Barometer at 32° Fahrenheit.	Dry bulb.	Wet bulb.	Relative humidity.	WIND.		LOWER CLOUDS.		UPPER CLOUDS.			Amount of rain and melted snow.	Aneroid barometer.	Remarks.
					Direction.	Velocity per hour.	Kind.	Amount.	Kind.	Amount.	Moving from—			
1 a. m.	22.267	55.3	46.4	.522	N. W.	12.7	Cir. St.	2	....	...	....	......	22.110	
2 a. m.	.282	53.9	46.0	.556	N. W.	11.2	Cir. St.	1	....	...	....	......	.115	
3 a. m.	.287	52.2	45.2	.588	N. W.	18.0	Cir. St.	1	....	...	....	......	.123	
4 a. m.	.297	50.2	44.6	.647	N. N. W.	14.3	Cir. St.	1	....	...	....	......	.137	
5 a. m.	.307	51.2	45.8	.662	N.	11.7	Cir. St.	1	....	...	....	......	.157	
6 a. m.	.324	53.9	47.7	.633	N. N. W.	11.4	Cir. St.	1	....	...	....	......	.170	
7 a. m.	.333	57.9	48.7	.522	N. N. W.	8.6	Cir. St.	1	....	...	....	......	.178	
8 a. m.	.341	61.8	50.2	.454	W. N. W.	8.2	Cir.	1	....	...	....	......	.180	
9 a. m.	.341	63.8	51.3	.432	W.	7.8	Cu.	1	....	...	....	......	.170	
10 a. m	.345	67.6	54.0	.414	S. S. W.	19.7	Cir. & Cu.	2	....	...	....	......	.167	
11 a. m.	.341	71.5	57.7	.424	S. S. E.	10.2	....	...	Cu. & Cu. St.	5	W.	......	.143	
12 m ...	.317	70.3	57.3	.442	S. S. E.	19.1	Cir.	1	Cu. St., Nim.	7	W.	......	.127	Sprinkling rain, thunder, at 12 m.; raining,
1 p. m.	.334	67.7	56.5	.487	S.	17.7	....	...	Cu. St., Nim.	9	W.	......	.140	thunder, at 1 p. m.;
2 p. m.	.325	69.0	55.4	.420	S.	10.7	....	...	Cu. St., Nim.	6	W.	......	.135	raining at 2 p. m.
3 p. m.	.330	70.6	57.5	.440	S.	14.0	....	...	Cu. St., Nim.	6	W.	......	.132	
4 p. m.	.322	69.2	57.3	.471	S. E.	13.5	....	...	Cu. St., Nim.	5	W.	......	.120	
5 p. m.	.338	58.5	53.5	.708	S. E.	17.9	Cu.	2	Cu. St., Nim.	6	N. W.	......	.152	Rain, accompanied by thunder and lightning,
6 p. m.	.325	59.9	53.8	.659	S. S. E.	12.3	Cu.	4	Cu. St.	3	N. W.	......	.152	commenced at 4.50 and
7 p. m.	.324	57.9	53.1	.717	S. S. E.	14.7	Cu.	4	Cir. & Cu. St.	4	S. W.	......	.152	ended at 5.45 p. m.
8 p. m.	.327	54.9	52.1	.819	S.	8.1	Cu. & Cir. St.	3	Nim.	3	E. S. E.	......	.149	Light seen at 7 p. m.
9 p. m.	.334	52.1	50.5	.889	S.	23.8	Cu. St. & Nim.	5	....	...	....	......	.172	S. S. E.; at 9 p. m. S. E.
10 p. m.	.332	51.5	49.6	.868	S.	18.8	Cu. St. & Nim.	3	....	...	....	......	.170	and E. S. E.; at 10 p. m.; and at 11 p. m.
11 p. m.	.341	50.2	48.7	.892	S.	23.0	Cu. St. & Nim.	3	....	...	....	......	.197	
12 p. m.	.343	49.5	47.7	.871	S.	23.6	Cu. St.	3	....	...	....	......	.199	
	22.323	59.2	51.3	.606	....	351.0	....	...	....	...	....	......	22.152	

METEOROLOGICAL JOURNAL.—SHERMAN, WYOMING TERRITORY—Continued.

SHERMAN, JULY 26, 1872.

Hour.	Barometer at 32° Fahrenheit.	Dry bulb.	Wet bulb.	Relative humidity.	Wind. Direction.	Wind. Velocity per hour.	Lower clouds. Kind.	Lower clouds. Amount.	Upper clouds. Kind.	Upper clouds. Amount	Upper clouds. Moving from—	Amount of rain and melted snow.	Ameroid barometer.	Remarks.
1 a. m.	22.342	49.2	47.6	.884	S.	18.9	Cir.	1					22.199	
2 a. m.	.340	49.0	47.3	.876	S.	17.4	Cir. St.	1					.200	
3 a. m.	.345	48.6	47.0	.883	S.	16.0	Cir. St.	3					.205	
4 a. m.	.349	48.4	46.4	.854	S. W.	15.5	Cir. St.	4					.209	
5 a. m.	.350	49.8	47.3	.825	W. S. W.	12.2	Cir. St.	7					.213	Shower of rain.
6 a. m.	.348	53.1	50.0	.796	N. W.	9.9	Cir. St.	6					.215	
7 a. m.	.356	60.9	51.3	.518	N. W.	6.0	Cir. St.	7					.216	
8 a. m.	.363	62.4	51.0	.461	N. W.	6.0	Cir. St.	7					.222	
9 a. m.	.366	65.5	50.6	.370	W. N. W.	9.9	Cir. & Cir. St.	7					.213	
10 a. m.	.369	67.4	50.7	.335	W. N. W.	7.6	Cir. & Cir. St.	4					.203	
11 a. m.	.359	74.0	55.6	.322	S.	6.0			Cu., Cir. & Cir. St.	5	W. N. W.		.175	
12 m.	.352	75.4	55.8	.302	S.	7.8			Cu., Cir. St., Cu. St.	7	W. N. W.		.150	
1 p. m.	.337	77.1	56.3	.284	S. S. E.	6.4	Cir. St., Nim	3	Cu. & Cu. St.	4	W. N. W.		.130	Thunder.
2 p. m.	.347	74.6	58.4	.373	S. S. E.	17.3			Cu. St., Nim.	6	W. N. W.		.112	
3 p. m.	.329	70.7	55.5	.385	S.	20.0			Cu. St., Nim.	8	W. N. W.		.120	Thunder, a shower of rain, gale of wind, at 2.15 p. m.; thunder, at 4 p. m.
4 p. m.	.329	70.4	55.5	.391	W.	14.7	Cir. St., Cu. St., Nim.	4					.140	
5 p. m.	.311	71.5	56.3	.388	S. E.	5.2	Cir. St., Cu. St.	4					.120	
6 p. m.	.312	66.4	54.3	.453	E.	8.2	Cu. & Cu. St.	4					.120	
7 p. m.	.321	59.5	51.2	.563	S. E.	5.7	Cu.	3	Cu. St.	4	N. W.		.137	
8 p. m.	.324	59.5	51.1	.559	N.	8.2	Cu., Cu. St.	5					.140	
9 p. m.	.348	56.5	50.5	.653	S.	3.8	Cu. St.	3					.152	Light in E.
10 p. m.	.318	55.1	49.8	.682	S.	6.0	Cu. St.	4					.150	Light in E.
11 p. m.	.309	56.0	50.0	.651	S.	7.8	Cu. St.	3					.142	Light in E.
12 p. m.	.302	55.5	49.5	.649	N. W.	4.2	Cu. St.	2					.142	
	22.339	61.5	51.6	.561		240.7							22.168	

METEOROLOGICAL JOURNAL.– SHERMAN, WYOMING TERRITORY—Continued.

SHERMAN, JULY 27, 1872.

Hour.	Barometer at 32° Fahrenheit.	Dry bulb.	Wet bulb.	Relative humidity.	WIND. Direction.	WIND. Velocity per hour.	LOWER CLOUDS. Kind.	LOWER CLOUDS. Amount.	UPPER CLOUDS. Kind.	UPPER CLOUDS. Amount.	UPPER CLOUDS. Moving from—	Amount of rain and melted snow.	Aneroid barometer.	Remarks.
1 a. m	22.305	56.3	49.3	.606	W. N. W.	1.0	Cir.	1	....	...	....	......	22.142	
2 a. m.	.295	56.2	47.5	.535	N. W.	3.6	Cir.	1	....	...	....	......	.137	
3 a. m.	.291	54.9	46.2	.528	N. W.	5.6	Cir.	4	....	...	....	......	.133	
4 a. m.	.288	55.5	46.3	.511	N. W.	7.2	Cir. St.	6	....	...	....	......	.130	
5 a. m.	.294	54.3	46.1	.546	N. W.	8.1	Cir. St.	7	....	...	....	......	.140	
6 a. m.	.301	57.4	47.6	.498	N. N. W.	11.0	....	....	Cir. & Cir. St.	6	W.	......	.142	
7 a. m.	.302	61.8	49.5	.431	N. W.	12.5	....	....	Cir. St.	3	W.	......	.162	
8 a. m.	.306	64.8	50.5	.384	W. N. W.	14.5	....	....	Cir. St.	2	W.	......	.159	
9 a. m.	.303	67.6	51.7	.354	W.	14.0	Cir. Cu.	1	....	...	....	......	.130	
10 a. m.	.307	71.5	53.4	.318	W.	7.0	Cu. & Cir. St.	2	....	...	....	......	.125	
11 a. m.	.301	76.0	57.7	.331	S. S. E.	6.7	....	....	Cu. & Cu. St.	5	W.	......	.105	
12 m ...	.298	70.6	54.5	.361	N. E.	8.0	....	....	Cu. & Cu. St., Nim.	7	W.	......	.095	Sprinkle of rain at 12.30.
1 p. m.	.291	66.5	52.7	.404	N. N. E.	8.8	....	....	Cu. St., Nim.	8	W.	......	.090	Thunder.
2 p. m.	.284	64.0	51.0	.418	N. N. E.	14.0	....	....	Cu. St., Nim.	8	W.	......	.095	Thunder, hail, and rain.
3 p. m.	.283	56.3	50.3	.652	S. E.	13.4	....	....	Cu. St., Nim.	7	W.	......	.105	Continued thunder, hail, and rain.
4 p. m.	.257	66.3	56.3	.522	S. E.	14.5	....	....	Cu. St., Nim.	6	W.	......	.093	Thunder; rain.
5 p. m.	.261	67.7	55.4	.453	E. S. E.	17.0	Cu.	3	Cir. & Cu. St., Nim.	4	W.	......	.092	
6 p. m.	.256	65.5	54.9	.498	E. S. E.	10.7	Cu.	3	Cir., Cu. St.	4	S. W.	......	.079	
7 p. m.	.260	60.3	52.5	.587	S. S. E.	6.7	Cu.	4	Cir., Cu. St.	3	S. W.	......	.091	
8 p. m.	.268	57.3	50.1	.601	S.	11.6	Cu. & Cu. St.	7	....	...	....	......	.098	Light seen S. E., E. N. E., and N. W.
9 p. m.	.270	57.0	49.9	.605	S.	12.7	Nim. & Cu. St.	7	....	...	....	......	.100	Light seen S. E. and E. N. E.
10 p. m.	.269	57.1	50.4	.624	S.	12.1	Nim. & Cu. St.	7	....	...	....	......	.102	Light seen E. N. E.
11 p. m.	.251	56.5	48.9	.582	S.	8.3	Cu. St.	3	....	...	....	......	.100	Light seen E. N. E.
12 p. m.	.247	55.3	48.9	.630	S. W.	11.1	Cu. St.	3	....	...	....	......	.090	
	22.283	61.5	50.9	.499	....	241.1	....	....	....	...	....	......	22.114	

METEOROLOGICAL JOURNAL.—SHERMAN, WYOMING TERRITORY—Continued.

SHERMAN, JULY 28, 1872.

Hour.	Barometer at 32° Fahrenheit.	Dry bulb.	Wet bulb.	Relative humidity.	Wind.		Lower clouds.		Upper clouds.			Amount of rain and melted snow.	Aneroid barometer.	Remarks.
					Direction.	Velocity per hour.	Kind.	Amount.	Kind.	Amount.	Moving from—			
1 a. m.	22.237	57.1	48.3	.534	W. N. W.	4.4	....	....	St.	1	W. S. W.	......	22.080	
2 a. m.	.233	54.3	45.6	.525	N. W.	7.0	....	....	St.	1	W. S. W.	......	.080	
3 a. m.	.226	55.0	46.1	.521	N. W.	10.0	....	....	Cir. St.	2	W. S. W.	......	.077	
4 a. m.	.229	54.6	46.0	.530	N. N. W.	11.0	....	....	Cir. St.	1	W. S. W.	......	.080	
5 a. m.	.223	53.9	45.5	.536	N. N. W.	14.0	....	....	Cir. St.	2	W. S. W.	......	.080	
6 a. m.	.242	57.9	48.2	.504	W. N. W.	9.0	....	....	Cir. & Cir. St.	2	W. S. W.	......	.084	
7 a. m.	.248	63.0	50.6	.432	N. W.	9.0	Cir. St.	2	....	....	....	......	.092	
8 a. m.	.263	67.0	55.1	.462	N. W.	8.8	Cir. St.	2	....	....	....	......	.100	
9 a. m.	.263	69.7	56.2	.426	S. E.	6.3	....	....	Cu., Cir. St.	2	W.	......	.087	
10 a. m.	.273	69.6	54.0	.369	E. N. E.	5.9	....	....	Cir. & Cir. St.	2	W.	......	.085	
11 a. m.	.266	71.3	54.0	.335	E. N. E.	9.2	....	....	Cir. St., Cu. St.	4	W.	......	.080	
12 m	.263	71.7	54.5	.339	N. E.	9.8	....	....	Cir. & Cu. St., Nim.	6	W.	......	.073	Thunder.
1 p. m.	.259	70.5	54.3	.358	E.	8.2	....	....	Cu. St., Nim.	8	W.	......	.065	Thunder.
2 p. m.	.274	66.2	53.0	.420	S.	8.8	....	....	Cu. St., Nim.	7	W.	......	.075	Thunder; raining.
3 p. m.	.253	63.5	52.5	.478	E.	26.6	....	....	Cir. & Cu. St., Nim.	7	W.	......	.070	Thunder, blowing a gale, and raining at 2.40 p. m.
4 p. m.	.239	69.4	53.6	.363	E.	18.1	....	....	Cir. St., Cu. St., Nim.	6	W.	......	.060	Ceased raining at 3.05 p. m.
5 p. m.	.239	68.7	55.4	.427	E. S. E.	10.8	....	....	Cir., Nim., Cu. St.	6	W.	......	.060	
6 p. m.	.235	67.5	54.3	.425	S. S. E.	7.0	Cu.	2	Cu. St., Nim.	4	S. W.	......	.050	
7 p. m.	.243	63.7	53.0	.488	S. S. E.	6.7	Cu.	2	Cu. St., Nim.	5	S. W.	......	.062	
8 p. m.	.246	60.5	51.5	.539	N. E.	4.3	Cu.	2	Nim., Cu. St.	5	S. W.	......	.071	
9 p. m.	.252	59.5	54.3	.701	S. S. E.	7.7	Cu. St.	3	....	....	....	......	.075	
10 p. m.	.245	57.5	53.8	.774	S. E.	15.1	Cu. St.	3	....	....	....	......	.075	Lightning seen N. N. E.
11 p. m.	.242	56.7	52.8	.760	S. S. E.	13.2	Cu. St.	3	....	....	....	......	.077	Lightning seen N. N. E.
12 p. m.	.230	56.2	52.3	.759	S. S. E.	10.3	Cu. St.	2	....	....	....	......	.077	
	22.247	62.7	51.9	.500	....	241.2	....	....	....	....	....	......	22.076	

METEOROLOGICAL JOURNAL.—SHERMAN, WYOMING TERRITORY—Continued.

SHERMAN, JULY 29, 1872.

Hour.	Barometer at 32° Fahrenheit.	Dry bulb.	Wet bulb.	Relative humidity.	WIND.		LOWER CLOUDS.		UPPER CLOUDS.			Amount of rain and melted snow.	Aneroid barometer.	Remarks.
					Direction.	Velocity per hour.	Kind.	Amount.	Kind.	Amount.	Moving from—			
1 a. m.	22.225	55.7	52.0	.769	S.	7.2	Cir. St.	1	....	...	....	......	22.065	Lightning N. E. and W.
2 a. m.	.219	56.2	51.9	.738	S. W.	5.5	St.	1	....	...	....	......	.065	
3 a. m.	.216	57.0	57.0	......	S. W.	4.5	St.	1	....	...	....	......	.060	
4 a. m.	.220	56.8	51.0	.664	N. W.	4.0	Cu. St.	1	....	...	....	......	.065	
5 a. m.	.224	52.5	46.0	.613	N. W.	11.0	Cu. St.	1	....	...	....	......	.072	
6 a. m.	.230	56.5	48.4	.560	N. W.	12.0	Cir. Cu.	1	....	...	....	......	.073	
7 a. m.	.233	60.5	49.8	.478	W. N. W.	12.0	Cu.	1	....	...	....	......	.080	
8 a. m.	.242	64.2	51.4	.425	W. N. W.	17.0	Cir. St.	1	....	...	....	......	.083	
9 a. m.	.256	66.7	51.3	.363	W.	20.5	Cir. St.	1	....	...	....	......	.085	
10 a. m.	.260	68.8	51.8	.332	W.	23.6	Cu.	1	....	...	....	......	.082	
11 a. m.	.267	71.5	52.6	.302	W.	22.6	Cir. & Cu.	2	....	...	....	......	.083	
12 m.	.266	73.2	51.4	.254	W.	20.1	Cu. & Cu. St.	4	....	...	....	......	.077	
1 p. m.	.275	73.0	51.3	.254	W.	19.6	Cir. & Cu. St.	5	....	...	....	......	.080	
2 p. m.	.276	74.4	51.5	.239	W.	24.6	Cu. & Cu. St.	5	....	...	....	......	.080	
3 p. m.	.285	71.7	49.7	.245	W.	24.8	Cu. & Cu. St.	4	....	...	....	......	.080	
4 p. m.	.293	72.5	49.5	.231	W.	21.8	Cir. & Cu. & Cu. St.	4	....	...	....	......	.090	
5 p. m.	.285	72.7	50.7	.248	S. W.	21.2	Cu. & Cu. St.	4	....	...	....	......	.087	
6 p. m.	.307	68.3	47.9	.261	N. W.	16.7	Cir. & Cu. St.	3	....	...	....	......	.112	
7 p. m.	.314	67.3	46.8	.254	W. N. W.	17.3	Cir.	3	....	...	....	......	.120	
8 p. m.	.326	62.3	44.3	.285	N. W.	12.7	Cu., Cu. St.	4	....	...	....	......	.135	
9 p. m.	.356	59.2	43.4	.323	W. N. W.	11.0	Cir. St.	2	....	...	....	......	.173	Lightning E. and S. E.
10 p. m.	.358	58.9	41.5	.283	N. W.	15.5	Cir. St.	3	....	...	....	......	.180	Lightning S. E.
11 p. m.	.376	54.2	39.3	.317	N. W.	19.0	Cir. St.	2	....	...	....	......	.200	Lightning E. S. E.
12 p. m.	.372	54.1	38.4	.295	N. W.	15.0	Cir. St.	1	....	...	....	......	.200	Lightning S. E.
	22.278	63.7	48.7	.364	....	379.2	....	...	....	...	....	......	22.101	

METEOROLOGICAL JOURNAL.—SHERMAN, WYOMING TERRITORY—Continued.

SHERMAN, JULY 30, 1872.

Hour.	Barometer at 32° Fahrenheit.	Dry bulb.	Wet bulb.	Relative humidity.	WIND.		LOWER CLOUDS.		UPPER CLOUDS.			Amount of rain and melted snow.	Aneroid barometer.	Remarks.
					Direction.	Velocity per hour.	Kind.	Amount.	Kind.	Amount.	Moving from—			
1 a. m.	22.365	52.1	37.2	.303	N. W.	24.0	Cir. St.	1					22.200	Lightning S. E.
2 a. m.	.382	49.5	36.2	.333	W. N. W.	13.0	Cir. St.	1					.250	
3 a. m.	.389	48.2	35.2	.333	W. N. W.	14.0							.222	
4 a. m.	.401	46.5	34.7	.362	W.	13.0	Cir. & St.	1					.240	
5 a. m.	.406	45.6	33.9	.360	W.	10.0	St.	1					.245	
6 a. m.	.412	48.5	35.7	.342	W.	13.0							.250	
7 a. m.	.425	52.5	37.6	.306	W. N. W.	17.0							.266	
8 a. m.	.435	55.2	39.2	.294	W.	20.8							.267	
9 a. m.	.439	58.6	41.3	.284	W.	14.8							.260	
10 a. m.	.431	61.4	42.5	.263	W.	15.4	Cu.	1					.250	
11 a. m.	.423	64.6	44.5	.251	W.	20.1	Cu.	1					.237	
12 m...	.416	67.2	45.3	.228	W.	24.9	Cu.	1					.225	
1 p. m.	.411	68.5	46.0	.223	W.	21.2	Cu.	1					.215	
2 p. m.	.410	69.8	46.5	.215	W.	22.8	Cu.	1					.210	
3 p. m.	.403	70.7	46.5	.205	W.	23.5	Cu.	1					.200	
4 p. m.	.400	70.5	46.4	.206	W.	20.2	Cu.	1					.193	
5 p. m.	.390	70.2	46.5	.211	W.	20.2	Cu.	1					.190	
6 p. m.	.399	68.3	45.8	.222	W.	19.7	Cu.	1					.195	
7 p. m.	.391	64.8	44.9	.257	W.	13.1	Cu.	1					.202	
8 p. m.	.406	58.5	41.5	.290	W.	12.1	Cu.	1					.220	
9 p. m.	.412	57.5	40.7	.289	W. N. W.	10.0							.241	
10 p. m.	.423	55.0	39.9	.317	N. W.	5.5							.252	
11 p. m.	.429	53.8	39.3	.326	N. W.	4.2							.255	
12 p. m.	.422	53.1	38.8	.327	N. W.	1.9							.252	
	22.409	58.8	41.1	.281		374.4							22.231	

METEOROLOGICAL JOURNAL.—SHERMAN, WYOMING TERRITORY—Continued.

SHERMAN, JULY 31, 1872.

Hour.	Barometer at 32° Fahrenheit.	Dry bulb.	Wet bulb.	Relative humidity.	WIND.		LOWER CLOUDS.		UPPER CLOUDS.			Amount of rain and melted snow.	Aneroid barometer.	Remarks.
					Direction.	Velocity per hour.	Kind.	Amount.	Kind.	Amount.	Moving from—			
1 a. m.	22. 420	52. 0	39. 7	. 381	S. W.	......	......	......	......	......	......	......	22. 255	
2 a. m.	. 422	50. 3	37. 8	. 364	N. W.	4. 0	......	......	......	......	......	......	. 255	
3 a. m.	. 421	47. 5	37. 6	. 439	N. N. W.	3. 2	......	......	......	......	......	......	. 260	
4 a. m.	. 420	47. 0	36. 2	. 401	N. W.	8. 1	Cu.	1	......	......	......	......	. 257	
5 a. m.	. 431	45. 0	34. 6	. 404	N. W.	9. 7	Cu.	1	......	......	......	......	. 272	
6 a. m.	. 444	47. 6	38. 0	. 452	N. N. E.	8. 8	......	......	Cu.	1	N. W.	......	. 280	At 6, 7, and 8 a. m. observations, the wet-bulb thermometer was dry.
7 a. m.	. 446	52. 5	52. 5	......	N. N. E.	11. 0	......	......	Cu.	1	N. W.	......	. 280	
8 a. m.	. 447	56. 2	56. 5	......	N. N. E.	8. 5	......	......	Cu.	1	W.	......	. 282	
9 a. m.	. 449	57. 6	43. 7	. 366	N. N. E.	9. 3	......	......	Cu. St.	1	W.	......	. 275	
10 a. m.	. 447	60. 2	45. 3	. 349	N. N. E.	10. 0	......	......	Cu. St.	1	W.	......	. 275	
11 a. m.	. 451	65. 5	48. 3	. 315	E.	10. 2	......	......	Cu.	1	W.	......	. 270	
12 m...	. 449	62. 6	46. 6	. 331	E.	11. 5	......	......	Cu.	2	W.	......	. 260	
1 p. m	. 441	62. 4	46. 7	. 338	N. E.	11. 3	......	......	Cu. St., Cu.	2	W.	......	. 250	
2 p. m.	. 432	63. 6	47. 7	. 338	N. E.	11. 0	......	......	Cu. St., Cu.	2	W.	......	. 240	
3 p. m.	. 428	66. 2	49. 5	. 330	E.	9. 7	......	......	Cir. St., Cu. St.	3	W.	......	. 240	
4 p. m.	. 420	65. 6	48. 6	. 320	E.	6. 5	......	......	Cir. St., Cu. St.	3	W.	......	. 230	
5 p. m.	. 430	65. 5	49. 1	. 333	S. E.	9. 3	......	......	Cu., Cu. St.	3	W.	......	. 232	
6 p. m	. 432	64. 5	48. 7	. 344	E. S. E.	12. 5	......	......	Cu., Cu. St.	4	W.	......	. 237	
7 p. m.	. 435	57. 5	45. 7	. 430	E. S. E.	12. 4	Cu. St., Cir.	4	......	......	......	......	. 253	
8 p. m.	. 442	52. 7	43. 1	. 482	E. S. E.	6. 9	Cu. St.	4	......	......	......	......	. 270	
9 p. m.	. 459	51. 3	42. 3	. 497	E.	7. 5	Cu. St., Cir. St.	4	......	......	......	......	. 295	Light seen in the S.
10 p. m.	. 469	49. 0	40. 5	. 507	E. S. E.	6. 8	Cu. St.	3	......	......	......	......	. 299	Light seen in the S.
11 p. m	. 463	49. 4	42. 5	. 579	S. E.	9. 0	......	......	......	......	......	......	. 259	
12 p. m.	. 454	49. 6	45. 2	. 710	S. S. E.	12. 5	Cu. St.	4	......	......	......	......	. 297	
	22. 439	55. 9	44. 4	. 375	......	209. 7	......	......	......	......	......	......	22. 265	

METEOROLOGICAL JOURNAL.—SHERMAN, WYOMING TERRITORY—Continued.

SHERMAN, AUGUST 1, 1872.

Hour.	Barometer at 32° Fahrenheit.	Dry bulb.	Wet bulb.	Relative humidity.	Wind. Direction.	Wind. Velocity per hour.	Lower clouds. Kind.	Lower clouds. Amount.	Upper clouds. Kind.	Upper clouds. Amount.	Upper clouds. Moving from—	Amount of rain and melted snow.	Aneroid barometer.	Remarks.
1 a. m	22.457	50.4	47.9	.826	S. E.	16.1	......	......	......	......	......	......	22.300	Slight falling fog.
2 a. m.	.449	50.3	48.0	.839	S. S. E.	10.0	Cir. St.	7	......	......	......	......	.296	
3 a. m.	.435	48.5	46.8	.875	S.	10.0	Cir. St.	1	......	......	......	......	.282	
4 a. m.	.426	48.1	47.0	.917	S.	10.0	......	......	......	......	......	......	.280	Slight fog.
5 a. m.	.428	48.4	47.5	.932	S.	17.0	......	......	......	......	......	......	283	Dense fog.
6 a. m.	.441	51.2	50.0	.915	S.	15.0	......	......	......	......	......	......	,295	Slight fog; clearing off.
7 a. m	.446	54.0	51.5	.835	S.	11.0	Cir. & Cu. St.	1	......	......	......	......	.299	
8 a. m.	.447	58.5	52.6	.665	S. S. E.	14.5	......	......	......	......	......	......	.300	
9 a. m.	.452	61.8	52.6	.536	S.	13.2	......	......	Cu.	1	W.	......	.290	
10 a. m.	.453	65.5	53.7	.459	S.	11.2	......	......	Cu. & Cu. St.	3	N. W.	......	.260	
11 a. m	.441	69.3	55.3	.410	S. S. E.	12.3	......	......	Cir., Cu. St., Nim.	6	N. W.	......	.250	Thunder; sprinkling rain.
12 m..	.425	66.8	53.4	.416	S.	18.1	......	......	Cu., Cu. St., Nim.	7	N. W.	......	.235	Thunder; sprinkling rain.
1 p. m.	.429	57.7	48.5	.521	S. E.	20.8	......	......	Cu., Cu. St., Nim.	8	N. W.	......	.247	Thunder; raining.
2 p. m	.435	60.6	50.8	.510	S.	16.4	......	......	Cu., Cu. St., Nim.	7	N. W.	......	.253	Thunder.
3 p. m	.423	68.7	52.7	.356	S. E.	16.0	......	......	Cu., Cu. St., Nim.	6	N. W.	......	.237	
4 p. m	.417	68.6	52.7	.358	S.	8.7	......	......	Cu., Cu. St., Nim.	4	N. W.	......	.223	
5 p. m	.409	68.1	51.9	.349	S. E.	5.4	......	......	Cu., Cu. St.	4	N. W.	......	.222	
6 p. m	.411	65.5	49.9	.353	E. S. E.	8.5	......	......	Cu., Cu. St.	4	N. W.	......	.224	
7 p. m	.415	60.7	49.4	.459	N. E.	7.1	Cu., Cu. St.	4	......	......	......	......	.230	
8 p. m.	.436	55.5	46.7	.527	E.	1 1	Cu., Cu. St.	4	......	......	......	......	.258	Light seen E. S. E. and S. S. E. at 8, 9, and 10 p. m.
9 p. m.	.462	52.5	44.9	.563	S. E.	5.6	Cu. St.	4	......	......	......	......	.295	
10 p. m.	.469	50.6	44.5	.625	S. E.	6.2	Cu. St.	3	......	......	......	......	.300	
11 p. m.	.466	49.7	44.5	.666	S.	6.3	Cu. St.	3	......	......	......	......	.305	Light seen S. S. E. at 11 and 12 p. m.
12 p. m.	.462	48.7	44.5	.718	S.	8.5	Cu. St.	3	......	......	......	......	.310	
	22.439	57.5	49.5	.609	......	272.0	......	......	......	......	......	......	22.271	

METEOROLOGICAL JOURNAL.—SHERMAN, WYOMING TERRITORY—Continued.

SHERMAN, AUGUST 2, 1872.

Hour.	Barometer at 32° Fahrenheit.	Dry bulb.	Wet bulb.	Relative humidity.	WIND. Direction.	WIND. Velocity per hour.	LOWER CLOUDS. Kind.	LOWER CLOUDS. Amount.	UPPER CLOUDS. Kind.	UPPER CLOUDS. Amount.	UPPER CLOUDS. Moving from—	Amount of rain and melted snow.	Aneroid barometer.	Remarks.
1 a. m.	22.458	49.2	44.0	.664	S.	13.5	St.	1	......	...	......	......	22.310	Lightning S. E.
2 a. m.	.454	48.7	43.9	.684	S.	10.0	Cir. St.	1	......	...	......	......	.299	Lightning S. E.
3 a. m.	.452	48.7	43.8	.677	S.	9.0	Cir. St.	1	......	...	......	......	.298	Lightning S.
4 a. m	.451	49.1	43.8	.659	S. W.	5.0	Cir. St.	2	......	...	......	......	.298	
5 a. m	.455	50.3	44.0	.613	W.	2.0	Cir. St.	4	......	...	......	......	.300	
6 a. m	.462	55.5	46.2	.507	N. W.	0.0	Cir. St.	4	......	...	......	......	.304	
7 a. m	.466	60.3	47.2	.400	N. W.	0.7	Cir. Cu., Cir. St.	2	......	...	......	......	.311	
8 a. m.	.471	64.5	49.9	.375	W.	2.1	Cu.	1	......	...	......	......	.303	
9 a. m.	.470	67.6	50.5	.326	S. E.	2.2	......	...	Cu. & Cu. St.	2	W.	......	.290	
10 a. m.	.471	68.2	50.3	.311	E.	4.2	......	...	Cir. St. & Cu. St	3	W.	......	.280	
11 a. m.	.470	70.0	51.4	.303	W.	5.8	Cir. & Cu. St.	5	......	...	......	......	.267	
12 m ...	.467	66.5	49.5	.324	E.	6.7	......	...	Cu. St., Nim.	7	W.	......	.260	
1 p. m.	.459	67.8	50.7	.326	E.	9.3	......	...	Cu. St., Nim.	8	W.	......	.254	Thunder.
2 p. m.	.449	72.5	52.7	.307	E. S. E.	6.7	Cu. St.	1	Cu. St., Nim.	7	N. W.	......	.245	Thunder; a shower of rain at 1.40 p. m.
3 p. m.	.441	71.6	52.7	.303	E. S. E.	9.9	......	...	Cu. & Cu. St., Nim.	5	N. W.	......	.230	
4 p. m.	.435	70.5	52.7	.322	S. E.	9.4	......	...	Cu. & Cu. St., Nim.	7	N. W.	......	.222	
5 p. m.	.425	67.1	50.1	.326	E.	7.8	......	...	Cir., Cu. St., Cu.	6	W. N. W.	......	.223	
6 p. m.	.417	67.4	50.9	.339	E. N. E.	10.5	Cu.	3	Cir., Cu. St.	4	W. N. W.	......	.223	
7 p. m.	.420	61.2	49.5	.448	E. N. E.	10.6	Cu., Cu. St.	5	......	...	......	......	.237	
8 p. m	.431	57.0	47.3	.500	E. S. E.	6.3	Cu., Cu. St.	4	......	...	......	......	.255	Light seen E. S. E.
9 p. m	.438	56.2	46.7	.503	S. S. E.	5.7	Cu. St.	4	......	...	......	......	.277	Light seen E. S. E.
10 p. m.	.437	54.3	45.6	.525	S. S. E.	10.4	Cu. St.	3	......	...	......	......	.278	
11 p. m	.440	53.4	45.2	.541	S.	10.8	Cu. St.	2	......	...	......	......	.279	
12 p. m	.425	51.9	44.8	.582	S.	9.3	......	...	......	...	......	......	.260	
	22.448	60.4	48.1	.453	......	167.9	......	...	......	...	......	......	22.271	

METEOROLOGICAL JOURNAL.—SHERMAN, WYOMING TERRITORY—Continued.

SHERMAN, AUGUST 3, 1872.

Hour.	Barometer at 32° Fahrenheit.	Dry bulb.	Wet bulb.	Relative humidity.	WIND.		LOWER CLOUDS.		UPPER CLOUDS.			Amount of rain and melted snow.	Aneroid barometer.	Remarks.
					Direction.	Velocity per hour.	Kind.	Amount.	Kind.	Amount.	Moving from—			
1 a. m.	22.421	52.2	45.0	.579	S.	10.6	St.	2					22.260	Lightning S. E.
2 a. m.	.412	52.1	45.2	.592	S.	8.5	Cir. St.	1					.260	
3 a. m.	.417	52.2	45.3	.592	S.	8.5	Cir. St.	1					.265	
4 a. m.	.417	51.1	44.2	.587	S. W.	7.0	Cir. St.	1					.260	
5 a. m.	.417	52.8	43.8	.505	N. W.	6.0	Cir. St.	1					.260	
6 a. m.	.418	54.1	43.6	.456	N. N. W.	0.0	Cir. St.	1					.262	
7 a. m.	.424	60.0	47.0	.402	N. W.	3.0	Cir. St.	1					.265	
8 a. m.	.427	63.6	47.2	.326	W.	5.0	Cir. St.	1					.265	
9 a. m.	.424	65.5	47.3	.294	W.	10.7	Cu.	1					.245	
10 a. m.	.417	68.7	47.6	.249	W.	7.5	Cu.	1					.233	
11 a. m.	.411	70.8	47.7	.223	W.	7.3	Cir. Cu.	2					.210	
12 m.	.402	71.3	42.2	.143	N. W.	11.6	Cu.	3					.200	
1 p. m.	.393	73.5	48.7	.207	N. W.	11.4	Cu., Cu. St.	5					.180	
2 p. m.	.379	72.2	48.8	.223	N. W.	10.0	Cu. & Cu. St., Nim.	7					.170	
3 p. m.	.368	73.7	49.4	.216	N. W.	12.2	Cu. & Cu. St., Nim.	8					.160	Shower of rain at 3.15 p. m.
4 p. m.	.358	72.7	50.6	.247	N. W.	10.3	Cu. & Cu. St., Nim.	8					.150	
5 p. m.	.358	71.0	47.6	.218	N. N. W.	14.7	Cu. & Cu. St., Nim.	8					.160	
6 p. m.	.355	69.5	47.6	.237	N. W.	11.8	Cu. & Cu. St., Nim.	8					.159	
7 p. m.	.357	67.2	46.9	.258	N. E.	12.0	Cu., Cu. St.	7					.163	
8 p. m.	.366	63.4	45.5	.292	N. E.	8.4	Nim., Cu. & Cu. St.	7					.177	
9 p. m.	.373	60.7	44.5	.320	N. E.	8.4	Nim., Cu. & Cu. St.	7					.193	
10 p. m.	.377	59.0	43.4	.327	N. E.	10.0	Nim., Cu. & Cu. St.	5					.200	
11 p. m.	.382	58.9	43.4	.329	N. E.	11.2	Nim., Cu. & Cu. St.	6					.202	
12 p. m.	.377	58.7	43.4	.334	N. E.	9.1	Nim., Cu. & Cu. St.	6					.200	
	22.394	63.1	46.1	.339		215.2							22.212	

METEOROLOGICAL JOURNAL.—SHERMAN, WYOMING TERRITORY—Continued.

SHERMAN, AUGUST 4, 1872.

Hour.	Barometer at 32° Fahrenheit.	Dry bulb.	Wet bulb.	Relative humidity.	Wind.		Lower clouds.		Upper clouds.			Amount of rain and melted snow.	Aneroid barometer.	Remarks.
					Direction.	Velocity per hour.	Kind.	Amount.	Kind.	Amount.	Moving from—			
1 a. m.	22.365	57.2	43.2	.361	N. N. E.	9.9	....	...	Cu. St., Nim.	7	W.	......	22.197	
2 a. m.	.388	56.3	43.2	.383	N. N. E.	6.5	....	...	Cu. St., Nim.	9	W.	......	.210	
3 a. m.	.390	55.1	42.8	.401	N. N. E.	18.0	....	...	Cu. St.	4	W.	......	.217	
4 a. m.	.390	51.3	41.5	.467	N. E.	13.5	....	...	Cu. St.	3	N. W.	......	.219	
5 a. m.	.400	50.8	41.8	.494	N. E.	12.0	....	...	Cu. St. & Cir.	4	N. W.	......	.235	
6 a. m.	.411	54.6	44.1	.459	N. E.	10.0	....	...	Cu. St. & Cir.	3	N. W.	......	.244	
7 a. m.	.432	58.5	46.7	.435	E. N. E.	10.0	....	...	Cu. St. & Cir.	4	N. W.	......	.258	
8 a. m.	.429	60.2	46.9	.394	E. N. E.	11.5	....	...	Cir. St. & Cu. St.	3	N. W.	......	.260	
9 a. m.	.428	64.5	49.0	.351	E.	9.7	....	...	Cir. St.	2	N. W.	......	.245	
10 a. m.	.421	67.7	50.8	.331	S. E.	12.9	....	...	Cu., Cir. St.	2	N. W.	......	.233	
11 a. m.	.419	70.6	51.7	.299	S. E.	18.1	....	...	Cu. St.	2	N. W.	......	.220	
12 m ...	.413	72.5	52.6	.286	S. E.	15.0	....	...	Cu. St.	3	N. W.	......	.207	
1 p. m.	.399	74.6	53.6	.273	S. E.	16.6	....	...	Cu. St., Nim.	4	N. W.	......	.187	
2 p. m.	.389	70.6	52.5	.315	S. S. E.	19.3	....	...	Cu. St., Nim.	8	N. W.	......	.173	Shower of rain.
3 p. m.	.380	69.5	51.2	.307	S. S. W.	18.4	....	...	Cu. St., Nim.	8	N. W.	......	.163	Raining; thunder.
4 p. m.	.375	69.5	51.6	.315	S.	7.2	....	...	Cu., Cu. St., Nim.	7	N. W.	......	.162	Thunder.
5 p. m.	.361	71.7	51.9	.285	S. E.	8.7	....	...	Cir., Cu. & Cu. St.	6	N. W.	......	.163	
6 p. m.	.361	67.5	51.5	.351	S. E.	23.2	Cir., Cu. St.	5	....	...	....	......	.162	
7 p. m.	.372	61.1	49.9	.464	S. E.	22.8	Cir., Cu. St.	5	....	...	....	......	.181	
8 p. m.	.394	56.3	47.8	.543	S. E.	14.8	Cir., Cu. St.	3	....	...	....	......	.217	
9 p. m.	.405	55.4	47.6	.568	S.	13.6	Cu. St.	2	....	...	....	......	.237	
10 p. m.	.402	54.4	47.3	.594	S. S. E.	17.8	Cu. St.	2	....	...	....	......	.238	
11 p. m.	.397	53.1	46.8	.625	S.	18.4	Cu. St.	2	....	...	....	......	.233	
12 p. m.	.395	51.4	46.0	.663	S.	19.7	Cu. St.	3	....	...	....	......	.230	
	22.396	61.4	48.0	.415	....	347.6	....	...	....	...	....	......	22.212	

METEOROLOGICAL JOURNAL.—SHERMAN, WYOMING TERRITORY—Continued.

SHERMAN, AUGUST 5, 1872.

Hour.	Barometer at 32° Fahrenheit.	Dry bulb.	Wet bulb.	Relative humidity.	WIND.		LOWER CLOUDS.		UPPER CLOUDS.			Amount of rain and melted snow.	Aneroid barometer.	Remarks.
					Direction.	Velocity per hour.	Kind.	Amount.	Kind.	Amount.	Moving from—			
1 a. m.	22.384	51.1	46.2	.688	S.	5.8	St.	1					22.220	
2 a. m.	.382	51.0	46.0	.682	S.	12.5	St.	2					.222	
3 a. m.	.379	52.0	45.0	.587	S.	11.5	St.	1					.220	
4 a. m.	.376	53.1	44.3	.515	S.	9.0	St.	1					.222	
5 a. m.	.388	53.9	41.7	.397	N. W.	4.5							.224	
6 a. m.	.393	56.1	42.0	.352	W. N. W.	19.5							.230	
7 a. m.	.399	60.2	43.6	.309	W. N. W.	14.7							.235	
8 a. m.	.414	63.2	45.4	.294	W. N. W.	18.3							.235	
9 a. m.	.418	67.4	46.7	.251	W. N. W.	15.8							.227	
10 a. m.	.419	71.0	47.6	.218	W. N. W.	14.8	Cu.	1					.222	
11 a. m.	.423	72.6	47.8	.203	W. N. W.	17.4	Cu.	1					.222	
12 m.	.412	74.4	49.6	.210	W. N. W.	10.4	Cu.	2					.200	
1 p. m.	.403	76.7	51.6	.213	W. N. W.	11.0	Cu.	3					.182	
2 p. m.	.393	77.2	50.0	.186	W. N. W.	13.6	Cu.	4					.173	
3 p. m.	.388	77.8	51.6	.201	W.	13.0	Cu.	4					.160	
4 p. m.	.377	79.5	50.3	.168	W.	9.7	Cu., Cu. St.	4					.150	
5 p. m.	.375	77.5	49.1	.171	N. W.	10.0	Cu., Cu. St.	4					.155	
6 p. m.	.375	76.7	47.9	.165	N. W.	12.2	Cu., Cu. St.	4					.155	
7 p. m.	.375	71.7	47.6	.210	N. W.	10.0	Cu., Cu. St.	4					.160	
8 p. m.	.386	65.7	46.3	.270	S. E.	4.0	Cir. St., Cu. St.	4					.180	
9 p. m.	.390	64.0	43.9	.249	S. E.	2.4	Cu. St.	2					.168	
10 p. m.	.376	62.4	47.5	.358	S.	2.2	Cu. St.	2					.161	
11 p. m.	.375	62.3	43.8	.274	W.	2.9	Cu. St.	2					.160	
12 p. m.	.364	61.3	41.5	.242	N. W.	2.8	Cu. St.	2					.152	
	22.390	65.8	46.5	.309		248.0							22.193	

METEOROLOGICAL JOURNAL.—SHERMAN, WYOMING TERRITORY—Continued.

SHERMAN, AUGUST 6, 1872.

Hour.	Barometer at 32° Fahrenheit.	Dry bulb.	Wet bulb.	Relative humidity.	WIND.		LOWER CLOUDS.		UPPER CLOUDS.			Amount of rain and melted snow.	Aneroid barometer.	Remarks.
					Direction.	Velocity per hour.	Kind.	Amount.	Kind.	Amount.	Moving from—			
1 a. m.	22.355	59.7	40.9	.254	N. W.	8.8	Cir. St.	1					22.165	
2 a. m.	.351	59.5	40.5	.249	N. W.	9.0	Cir. St.	1					.160	
3 a. m.	.355	56.4	39.4	.277	N. W.	10.0	Cir. St.	1					.165	
4 a. m.	.351	56.7	46.2	.469	N. W.	10.0	Cir. St.	1					.169	Observation of wet bulb
5 a. m.	.356	56.0	55.6	.973	N. W.	4.0	Cir. St.	1					.175	rejected at 4 a. m.;
6 a. m.	.357	59.0	41.0	.269	N. W.	10.0	Cir. St.	1					.179	wet bulb dry at 5 a. m.
7 a. m.	.358	63.5	43.2	.243	N. W.	15.0	Cir. St.	1					.170	
8 a. m.	.364	66.4	45.3	.240	W. N. W.	14.5	Cir. & Cir. St.	2					.175	
9 a. m.	.364	71.5	48.6	.228	W.	13.0	Cir. St.	1					.153	
10 a. m.	.361	74.0	49.0	.206	W.	13.6	Cir. St.	2					.142	
11 a. m.	.352	75.6	49.0	.189	W.	18.9	Cu. & Cir. St.	2					.130	
12 m.	.339	77.5	49.6	.178	W.	13.1	Cu. & Cu. St.	5					.107	
1 p. m.	.321	79.5	52.8	.198	W.	10.4	Cu. & Cu. St.	6					.083	
2 p. m.	.300	80.5	49.6	.152	W.	12.0	Cir., Cu. St., Nim.	6					.062	
3 p. m.	.287	81.6	53.4	.185	W.	13.6	Cu., Cu. St., Nim.	8					.045	
4 p. m.	.289	77.7	52.6	.216	W.	14.4	Cu. St., Nim.	8					.042	
5 p. m.	.274	77.4	51.4	.202	N. W.	6.6	Cu. St. & Nim.	7					.042	
6 p. m.	.274	80.4	54.8	.216	S. W.	5.8	Cu. St. & Nim.	6					.033	
7 p. m.	.267	71.3	49.7	.251	S. E.	4.5			Cu. St., Nim.	5	W. N. W.		.033	
8 p. m.	.262	68.9	49.6	.284	E. S. E.	1.9	Cu. St. & Nim.	5					.041	
9 p. m.	.269	66.3	45.4	.243	N. W.	3.6	Cu. St. & Nim.	5					.062	
10 p. m.	.264	62.3	44.7	.294	N.	11.5	Cu. St.	4					.063	
11 p. m.	.271	59.3	42.8	.306	N. W.	8.0	Cu. St.	2					.070	
12 p. m.	.271	57.0	42.1	.335	N. W.	12.1	Cu. St.	2					.068	
	22.317	68.2	47.4	.277		246.3							22.106	

METEOROLOGICAL JOURNAL.—SHERMAN, WYOMING TERRITORY—Continued.

SHERMAN, AUGUST 7, 1872.

Hour.	Barometer at 32° Fahrenheit.	Dry bulb.	Wet bulb.	Relative humidity.	Wind. Direction.	Wind. Velocity per hour.	Lower clouds. Kind.	Lower clouds. Amount.	Upper clouds. Kind.	Upper clouds. Amount.	Upper clouds. Moving from—	Amount of rain and melted snow.	Aneroid barometer.	Remarks.
1 a. m	22.263	57.6	42.0	.320	N. W.	9.5	Cir. St.	3	....	...	....	......	22.070	
2 a. m.	.259	56.5	42.0	.343	N. W.	11.0	Cir. St.	2	....	...	....	......	.065	
3 a. m.	.258	56.4	41.5	.331	N. W.	10.0	Cir. St.	3	....	...	....	......	.070	
4 a. m.	.251	56.0	41.5	.340	N. W.	12.0	Cir. St.	4	....	...	....	......	.070	
5 a. m.	.257	56.0	41.5	.340	N. W.	9.0	Cir. St.	3	....	...	....	......	.070	
6 a. m.	.258	60.3	44.4	.325	N. W.	11.5	Cir. St.	3	....	...	....	......	.075	
7 a. m.	.255	65.5	47.4	.296	N. W.	9.5	Cir. & Cir. St.	7	....	...	....	......	.067	
8 a. m.	.266	67.3	48.0	.278	W.	7.2	Cir. & Cir. St.	8	....	...	....	......	.070	
9 a. m.	.262	71.0	49.4	.250	W. N. W.	8.4	Cir. & Cir. St.	8	....	...	....	......	.060	
10 a. m.	.258	74.6	50.6	.223	W. N. W.	7.0	Cir. & Cir. St.	8	....	...	....	......	.045	
11 a. m.	.254	72.2	49.0	.227	W.	10.1	Cir. St., Cu. St., Nim.	9	....	...	....	......	.030	Shower of rain, accompanied by thunder, 11.20; continued thunder, 12 m.
12 m.	.232	75.6	52.5	.241	S. E.	6.7	....	...	Cu.St., Nim.	9	S. W.	......	.010	
1 p. m.	.230	68.4	53.6	.385	S. E.	18.8	....	...	Cu.St., Nim.	9	S. W.	......	.008	Thunder and rain at intervals during hour.
2 p. m.	.227	68.6	49.8	.293	S.	19.3	....	...	Nim.	10	S. W.	......	.013	Thunder and rain at intervals during hour.
3 p. m.	.209	69.3	50.5	.296	S.	20.8	....	...	Nim.	10	S. W.	......	.000	Thunder and rain.
4 p. m.	.214	68.4	48.4	.269	S. W.	17.6	Nim.	10	....	...	....	......	.014	Raining.
5 p. m.	.236	60.2	48.5	.444	N. W.	31.0	Cu. St.	3	Cu.St., Nim.	9	S. W.	......	.042	
6 p. m.	.239	63.3	51.0	.436	S. W.	8.6	Nim., Cu. St.	8	Cu. St.	4	N. W.	......	.044	
7 p. m.	.220	58.6	47.6	.460	N. W.	12.4	....	...	Nim., Cu. St.	8	S. W.	......	.021	
8 p. m.	.220	58.8	47.4	.448	N. W.	12.5	Nim.	6	Cu. St.	5	S. W.	......	.032	Rain commenced at 8.30 p. m., fine.
9 p. m.	.235	58.1	50.1	.570	S. W.	15.5	Cu.St., Nim.	6	....	...	....	......	.060	
10 p. m.	.222	54.3	48.3	.644	N. W.	10.2	Cu.St., Nim.	7	....	...	....	......	.040	
11 p. m.	.216	51.5	47.5	.688	N. W.	17.4	Cu.St., Nim.	6	....	...	....	......	.037	Rained at intervals until 11.45 p. m.
12 p. m.	.204	50.5	46.7	.746	W. N. W.		Cu.St., Nim.	5	....	...	....	......	.034	
	22.239	62.4	46.7	.746	....	312.6	....	...	....	...	....	......	22.044	

METEOROLOGICAL JOURNAL.—SHERMAN, WYOMING TERRITORY—Continued.

SHERMAN, AUGUST 8, 1872.

Hour.	Barometer at 32° Fahrenheit.	Dry bulb.	Wet bulb.	Relative humidity.	WIND.		LOWER CLOUDS.		UPPER CLOUDS.			Amount of rain and melted snow.	Aneroid barometer.	Remarks.
					Direction.	Velocity per hour.	Kind.	Amount.	Kind.	Amount.	Moving from—			
1 a. m.	22.189	51.3	46.7	.705	W.	21.1	Cu. St.	8	......	...	......	......	22.022	
2 a. m.	.178	51.6	46.4	.675	W.	19.2	Cu. St. & Nim.	9	......	...	......	......	.018	
3 a. m.	.170	52.2	46.3	.641	W.	9.1	Cu. St. & Nim.	7	......	...	......	......	.005	Commenced to rain and thunder at 12.35; ceased raining at 1.20 p. m.
4 a. m.	.176	51.0	45.2	.641	W.	13.1	Cu. St. & Nim.	8	......	...	......	......	.008	
5 a. m.	.182	52.7	45.0	.559	W.	14.1	Cu. St. & Nim.	9	......	...	......	......	.015	Shower of rain at 2.45 p. m.
6 a. m.	.178	53.4	45.0	.533	W. N. W.	10.3	Cu. St. & Nim.	9	......	...	......	......	.015	Thunder and rain-storm-wind, at 3.30 p. m., and continued during hour.
7 a. m.	.175	56.1	46.0	.480	W.	12.0	Cu. St. & Nim.	9	......	...	......	......	.005	
8 a. m.	.176	57.3	46.7	.469	W.	18.3	Cir. St. & Cu. St.	8	......	...	......	......	.002	Fine rain commenced at 5.45 p. m.; lasted 25 minutes.
9 a. m.	.183	59.8	47.8	.432	W. N. W.	14.3	Cir. St. & Cu. St.	8	......	...	......	......	.003	
10 a. m.	.188	60.8	48.3	.420	W. N. W.	19.6	Cir. St. & Cu. St.	8	......	...	......	......	.003	At 8.45 p.m., a fine auroral display was observed, which ended at 9 p. m. When first seen, it was circular and about in the zenith, from which it fell like a curtain to the northern horizon, along which it extended from N. N. W. to N. N. E., and, at 9 p. m., began to shoot out long projections, one, the brightest and longest, along the Milky Way, and extending itself a little past the zenith.
11 a. m.	.191	63.5	49.1	.376	W. N. W.	20.5	Cir. St. & Cu. St.	7	......	...	......	......	.003	
12 m.	.190	65.8	49.4	.335	W. N. W.	14.3	Cir. St. & Cu. St.	8	......	...	......	......	.000	
1 p. m.	.193	65.5	51.6	.397	W.	10.2	Cu. St., Nim.	9	......	...	......	......	21.996	
2 p. m.	.165	69.3	53.5	.363	S.	5.1	......	...	Cir. St., Cu. St., Nim.	7	W.	......	.970	
3 p. m.	.179	64.8	48.8	.340	N.	10.7	......	...	Cu. St., Nim.	9	W.	......	.980	
4 p. m.	.208	50.6	46.2	.714	N. N. W.	48.9	Nim.	10	......	...	......	......	22.020	
5 p. m.	.216	51.5	47.5	.739	N. N. W.	25.7	Nim.	6	Cu. St.	5	S. S. W.	......	.055	
6 p. m.	.216	49.3	46.3	.792	N. W.	22.3	Cu. St., Nim.	9	......	...	......	......	.057	
7 p. m.	.217	49.0	46.4	.817	W.	13.0	Nim., Cu. St.	6	......	...	......	......	.057	
8 p. m.	.217	48.6	45.7	.795	W.	4.0	Nim., Cu. St.	9	......	...	......	......	.060	
9 p. m.	.251	46.9	45.7	.909	N. E.	9.9	Nim., Cu. St.	7	......	...	......	......	.092	
10 p. m.	.255	46.5	45.5	.923	N. E.	14.7	......	...	......	...	......	......	.097	
11 p. m.	.262	44.8	44.9	......	N. E.	10.6	......	...	......	...	......	......	.102	
12 p. m.	.269	42.5	42.5	......	N. E.	20.5	......	...	......	...	......	......	.113	
	22.201	54.4	46.9	.544	......	381.5	......	...	......	...	......	......	22.029	

METEOROLOGICAL JOURNAL.—SHERMAN, WYOMING TERRITORY—Continued.

SHERMAN, AUGUST 9, 1872.

Hour.	Barometer at 32° Fahrenheit.	Dry bulb.	Wet bulb.	Relative humidity.	Wind. Direction	Wind. Velocity per hour.	Lower clouds. Kind.	Lower clouds. Amount.	Upper clouds. Kind.	Upper clouds. Amount.	Upper clouds. Moving from—	Amount of rain and melted snow.	Aneroid barometer.	Remarks.
1 a. m.	22.281	41.9	41.5	.967	N. E.	13.9							22.125	Dense fog, with fine rain
2 a. m.	.281	40.3	40.7		N. E.	15.5							.135	Dense fog.
3 a. m.	.294	40.3	39.6	.940	N. E.	15.0							.142	Dense fog.
4 a. m.	.296	39.5	39.4	.991	N. E.	22.0							.147	Dense fog.
5 a. m.	.305	39.2	39.0	.983	N. E.	15.0							.160	Dense fog
6 a. m.	.319	39.0	38.6	.966	N. E.	12.0							.170	Dense fog.
7 a. m.	.325	39.3	39.0	.974	N. E.	10.0							.180	Dense fog.
8 a. m.	.337	39.3	38.7	.948	N. E.	6.5							.190	Dense fog.
9 a. m.	.337	43.2	41.5	.868	N. E.	4.8							.190	Fog clearing off.
10 a. m.	.344	44.8	42.5	.828	E.	6.2	Nim.	10					.190	
11 a. m.	.339	44.3	41.3	.780	E.	9.3	Nim.	10					.187	
12 m	.335	45.4	42.0	.757	E. S. E.	12.6	Nim.	10					.180	
1 p. m.	.325	45.7	42.3	.758	S. E.	16.0	Nim.	10					.172	
2 p. m.	.318	45.5	42.0	.751	S. E.	16.5	Nim.	10					.167	
3 p. m.	.303	45.7	42.4	.764	S. E.	16.4	Nim.	10					.147	
4 p. m.	.304	44.5	42.2	.827	S. E.	19.7	Nim.	10					.150	
5 p. m.	.291	44.3	42.2	.840	S. E.	16.4	Cu.St.,Nim.	10					.140	
6 p. m.	.272	43.0	41.9	.913	S. E.	17.4							.135	Dense fog.
7 p. m.	.271	42.6	41.7	.926	S. S. E.	18.1							.137	Falling fog.
8 p. m.	.263	42.5	41.7	.934	S.	22.0							.121	Falling fog.
9 p. m.	.285	42.7	42.2	.960	S.	20.0							.142	Falling fog.
10 p. m.	.268	43.2	42.6	.952	S. S. E.	16.8							.122	Falling fog.
11 p. m.	.261	43.3	42.3	.920	S. E.	16.2							.105	Falling fog.
12 p. m.	.247	42.7	42.1	.952	S. E.	13.8							.102	Falling fog.
	22.300	42.6	41.2	.854		353.1							22.151	

METEOROLOGICAL JOURNAL.—SHERMAN, WYOMING TERRITORY—Continued.

SHERMAN, AUGUST 10, 1872.

Hour.	Barometer at 32° Fahrenheit.	Dry bulb.	Wet bulb.	Relative humidity.	Wind. Direction.	Wind. Velocity per hour.	Lower clouds. Kind.	Lower clouds. Amount.	Upper clouds. Kind.	Upper clouds. Amount.	Upper clouds. Moving from—	Amount of rain and melted snow.	Aneroid barometer.	Remarks.
1 a. m.	22. 246	42. 6	42. 2	. 968	S. S. E.	16. 2	....	...	....	...	....	......	22. 010	Falling fog.
2 a. m.	. 233	42. 5	42. 9	......	S. E.	14. 0	....	...	....	...	....	......	. 095	Falling fog.
3 a. m	. 236	43. 0	42. 2	. 936	S. E.	11. 6	....	...	....	...	....	......	. 097	Falling fog.
4 a. m.	. 234	42. 9	42. 2	. 944	S.	12. 5	....	...	....	...	....	......	. 095	Falling fog.
5 a. m.	. 236	42. 9	42. 2	. 944	S.	14. 0	....	...	....	...	....	......	. 095	Dense fog.
6 a. m.	. 239	43. 4	42. 9	. 960	S.	13. 5	....	...	....	...	....	......	. 100	Dense fog.
7 a. m.	. 244	44. 0	43. 6	. 968	S.	16. 5	....	...	....	...	....	......	. 100	Fog.
8 a. m.	. 259	47. 2	46. 5	. 946	S. S. W.	9. 5	....	...	....	...	....	......	. 100	Sun peeping through fog.
9 a. m.	. 247	50. 2	48. 4	. 872	S. S. W.	7. 0	Cir., Cu. St.	6	....	...	....	......	. 093	Fog cleared off.
10 a. m.	. 240	56. 6	50. 7	. 659	S. S. W.	5. 2	Cu., Cir. St.	4	....	...	....	......	. 082	
11 a. m.	. 232	59. 6	48. 2	. 451	W.	5. 9	Cu., Cir. St.	5	....	...	....	......	. 063	
12 m...	. 225	61. 0	47. 4	. 389	W.	9. 9	Cu., Cir. St.	7	....	...	....	......	. 053	
1 p. m.	. 220	62. 5	52. 7	. 516	S.	7. 5	....	...	Cu. St., Nim.	7	W.	......	. 040	
2 p. m.	. 215	61. 3	52. 6	. 554	S.	16. 2	....	...	Cu. St., Nim.	7	W. N. W.	......	. 023	Shower of rain at 1.30
3 p. m.	. 207	59. 7	51. 6	. 571	S. S. E.	16. 6	....	...	Cu. St., Nim.	7	W.	......	. 015	p. m.
4 p. m	. 203	59. 6	51. 3	. 563	S. S. E.	20. 2	....	...	Cu., Cu. St.	6	W.	......	. 015	Shower of rain at 2.10
5 p. m.	. 192	56. 5	49. 5	. 607	S. S. E.	30. 5	Nim., Cu. St.	5	....	...	....	......	. 017	p. m.
6 p. m.	. 187	54. 2	49. 5	. 710	S. S. E.	25. 4	Nim., Cu. St.	6	....	...	....	......	. 030	
7 p. m.	. 203	51. 2	48. 3	. 803	S.	13. 9	Nim., Cu. St.	5	....	...	....	......	. 040	
8 p. m	. 213	50. 7	48. 7	. 859	S.	22. 7	Nim., Cu. St.	8	....	...	....	......	. 055	
9 p. m.	. 221	50. 4	48. 3	. 853	S.	25. 0	Nim., Cu. St.	9	....	...	....	......	. 062	
10 p. m.	. 226	49. 7	48. 1	. 885	S.	21. 0	Nim., Cu. St.	6	....	...	....	......	. 070	
11 p. m	. 232	48. 5	47. 2	. 904	S.	17. 0	....	...	....	...	....	......	. 075	Dense fog.
12 p. m.	. 230	48. 0	47. 0	. 924	S. S. W.	8. 0	....	...	....	...	....	......	. 073	Dense fog.
	22. 226	51. 2	47. 3	. 741	....	360. 8	....	...	....	...	....	......	22. 062	

METEOROLOGICAL JOURNAL.—SHERMAN, WYOMING TERRITORY—Continued.

SHERMAN, AUGUST 11, 1872.

Hour.	Barometer at 32° Fahrenheit.	Dry bulb.	Wet bulb.	Relative humidity.	Wind. Direction.	Wind. Velocity per hour.	Lower clouds. Kind.	Lower clouds. Amount.	Upper clouds. Kind.	Upper clouds. Amount.	Upper clouds. Moving from—	Amount of rain and melted snow.	Aneroid barometer.	Remarks.
1 a. m.	22.234	46.2	44.8	.894	W.	2.5	...	...	...	...	...	...	22.075	Slight fog at 1 a. m.; lightning, N. W., at 4 a. m.; thunder at 11 a. m. and 12 m.
2 a. m.	.230	48.6	43.0	.641	S. W.	5.0	...	...	...	...	...	...	.070	
3 a. m.	.235	48.2	42.6	.640	S. W.	2.0	Cir. St.	2	...	...	...	...	.070	
4 a. m.	.233	49.0	41.7	.560	W.	3.0	Cir. & Cir. St.	3	...	...	...	...	.075	
5 a. m.	.259	50.2	41.2	.491	N. W.	4.0	Cu. St. & Cir.	1	...	...	...	...	.080	
6 a. m.	.258	51.1	42.9	.530	N. W.	9.0	Cu. St. & Cir. St.	2	...	...	...	...	.090	Commenced to rain and thunder at 12.15 p.m.; thunder, continued to rain, at 2 p. m.; at 3 p. m., raining at intervals during the hour; ceased raining at 4 p. m.; light seen at 5.30 p. m., accompanied by thunder, in the N. and N. E.; at 5.25 p. m., heavy gale from S. W., accompanied by thunder and lightning; at 5.30 p. m., heavy shower of hail; at 5.35 p. m., shower of hail; rain during the time to 5.55 p. m.; wind changed from S.W. to E. N. E. at 6 p. m.; continued thunder and lightning, accompanied by fine rain.
7 a. m.	.262	54.7	44.8	.480	W. N. W.	9.0	Cu. & Cu. St.	5	...	...	...	...	.100	
8 a. m.	.265	56.9	44.8	.416	W.	19.0	Cir. & Cir. Cu., Cir. St., Cu.	6	...	...	...	...	.097	
9 a. m.	.263	60.7	46.7	.376	W.	18.7	Cir., Cir. St	4	...	...	...	...	.090	
10 a. m.	.260	63.7	47.8	.338	W.	21.0	Cir. St., Cu. St.	7	...	...	...	...	.080	
11 a. m.	.250	66.5	48.6	.304	W.	17.1	Cir. St., Cu. St., & Nim.	7	...	...	...	...	.060	
12 m.	.243	65.5	47.6	.300	W.	17.5	Cu., Cu. St., Nim.	8	...	...	...	...	.045	
1 p. m.	.241	60.5	51.7	.547	E.	13.7	...	...	Cu. St., Nim	9	S. W.	...	.047	
2 p. m.	.264	56.3	49.5	.615	S. S. E.	21.8	...	...	Cu. St., Nim	9	S. W.	...	.070	
3 p. m.	.230	62.3	51.4	.477	S. E.	18.9	...	...	Cu. St., Nim	7	S. W.	...	.042	
4 p. m.	.221	62.0	49.7	.432	S. E.	14.8	...	...	Cu. St. Nim	7	S. W.	...	.033	
5 p. m.	.210	58.2	49.0	.523	E. S. E.	20.1	...	...	Cu. St., Nim	7	S. W.	...	.032	
6 p. m.	.218	55.9	47.2	.533	E. N. E.	14.2	...	...	Cu. St., Nim	8	S. W.	...	.042	
7 p. m.	.257	45.2	42.6	.808	N. E.	30.7	...	...	Cu. St., Nim	9	S. W.	...	.097	
8 p. m.	.261	48.2	43.8	.704	W.	3.4	Cu. St., Nim	9	...	...	...	...	.100	
9 p. m.	.267	45.6	42.7	.789	W.	10.9	Cu. St., Nim	7	...	...	...	...	.109	
10 p. m.	.278	45.6	43.5	.843	W.	11.7	Cu. St., Nim	6	...	...	...	...	.118	
11 p. m.	.281	46.1	44.1	.851	W.	15.0	Cu. St., Nim	6	...	...	...	...	.123	
12 p. m.	.279	45.9	44.1	.865	W.	15.4	Cu. St., Nim	9	...	...	...	...	.123	
	22.249	53.9	45.7	.582	...	310.4	...	...	...	...	...	...	22.078	

METEOROLOGICAL JOURNAL.—SHERMAN, WYOMING TERRITORY—Continued.

SHERMAN, AUGUST 12, 1872.

Hour.	Barometer at 32° Fahrenheit.	Dry bulb.	Wet bulb.	Relative humidity.	WIND.		LOWER CLOUDS.		UPPER CLOUDS.			Amount of rain and melted snow.	Aneroid barometer.	Remarks.
					Direction.	Velocity per hour.	Kind.	Amount.	Kind.	Amount.	Moving from—			
1 a. m.	22.266	46.6	43.6	.785	W. N. W.	7.6	Nim.	10					22.115	Lightning E.
2 a. m.	.272	46.3	43.2	.778	N. W.	10.0	Nim. & Cu. St.	9					.120	Shower of rain at 1.05
3 a. m.	.270	46.2	43.7	.817	N. E.	5.5			Cu. St. & Nim.	10			.120	Shower of rain at 1.25
4 a. m.	.266	46.2	47.6	......	W.	5.0	Cu. St.	6					.115	
5 a. m.	.277	45.0	42.0	.781	W. N. W.	8.0	Cu. St.	7					.120	
6 a. m.	.288	46.6	43.4	.773	N. W.	5.5	Cu. St., Cir.	5	Cir.	1	S.		.130	
7 a. m.	.295	46.6	44.2	.825	N.	13.5	Cir.	1	Cu. St.	3	W.		.140	
8 a. m.	.280	50.6	45.7	.686	W. S. W.	11.0	Cu. St. & Cu.	3					.128	
9 a. m.	.290	53.7	45.5	.543	W.	15.5	Cir. & Cir. St.	3					.125	
10 a. m.	.296	57.4	47.5	.494	W.	14.8	Cir. & Cir. St.	4					.125	Commenced to rain and thunder at 11.35 and
11 a. m.	.279	62.5	49.6	.415	W. S. W.	14.4	Cu. St., Nim.	6					.110	continued during the
12 m.	.292	55.5	45.4	.477	N. W.	17.8			Cu. St., Nim.	10	S. W.		.105	hour.
1 p. m.	.299	51.2	44.9	.618	W.	25.0	Cu. St., Nim.	9					.127	Thunder ceased at 1 p. m.
2 p. m.	.300	50.4	43.5	.565	N. W.	31.0	Cir., Cu. St., Nim.	7					.125	A storm-wind with rain at 1.30; wind during
3 p. m.	.272	58.2	44.5	.375	W. N. W.	25.0	Cir., Cu. St., Nim.	7					.093	hour.
4 p. m.	.288	58.0	46.4	.438	W. N. W.	21.0	Cir. St., Cu. St., Nim.	8					.105	
5 p. m.	.302	54.4	46.1	.542	W. N. W.	20.0	Cu. St., Nim.	8					.127	
6 p. m.	.333	45.6	43.4	.837	W. N. W.	28.9	Cu. St., Nim.	9					.162	Rain commenced at
7 p. m.	.306	46.3	43.0	.766	S. W.	13.4	Cu. St., Nim.	5					.140	5.05, ended at 6.15.
8 p. m.	.340	45.4	43.3	.843	N. W.	6.0	Cu. St., Nim.	5					.181	
9 p. m.	.365	43.9	43.0	.929	N. W.	21.4							.213	Dense fog clearing off
10 p. m.	.360	43.4	42.5	.928	N. W.	6.5	Cir. St., Cu. St.	4					.207	at 9.45 p. m.
11 p. m.	.369	41.5	40.6	.925	N. W.	11.7							.220	Dense fog.
12 p. m.	.347	42.4	40.4	.844	S. W.	13.0							.197	Falling fog.
	22.303	49.3	44.3	.666		351.5							22.139	

METEOROLOGICAL JOURNAL.—SHERMAN, WYOMING TERRITORY—Continued.

SHERMAN, AUGUST 13, 1872.

Hour.	Barometer at 32° Fahrenheit.	Dry bulb.	Wet bulb.	Relative humidity.	Wind.		Lower clouds.		Upper clouds.			Amount of rain and melted snow.	Aneroid barometer.	Remarks.
					Direction.	Velocity per hour.	Kind.	Amount.	Kind.	Amount.	Moving from—			
1 a. m.	22.325	39.2	38.4	.963	W.	6.5	Cir. St.	3					22.175	Lightning S. E.
2 a. m.	.326	41.2	39.1	.833	N. W.	2.5	Cir. St.	2					.175	Lightning S. E.
3 a. m.	.317	42.0	38.8	.759	N. W.	6.0	Cir. St.	1					.165	
4 a. m.	.315	42.0	38.8	.759	N. W.	9.5	Cir. St.	1					.165	
5 a. m.	.330	41.0	38.2	.783	N. W.	10.0	Cir. St. & Cu. St.	2					.180	
6 a. m.	.353	43.0	39.9	.770	N. N. E.	10.0			N. N. W.	3			.200	
7 a. m.	.367	46.1	42.5	.747	N.	8.0			W.	4			.220	
8 a. m.	.365	48.1	43.6	.699	W.	11.5	Cir. Cu. & Cu. St.	7					.210	
9 a. m.	.359	50.7	48.8	.867	W. N. W.	13.1	Cir. St.	2					.203	
10 a. m.	.368	53.1	52.5	.958	W. N. W.	17.9	Cu. & Cir. St.	2					.205	Wet bulb dried up at 10.
11 a. m.	.378	56.6	46.2	.472	W.	13.1	Cu. & Cu. St.	3					.205	
12 m ...	.373	59.5	47.3	.425	W. N. W.	15.8	Cu. & Cu. St.	3					.195	
1 p. m.	.368	59.4	46.1	.390	W. N. W.	16.0	Cu. St. & Nim.	6					.187	Thunder; shower of rain at 1.25 p. m.
2 p. m.	.375	56.5	43.5	.387	W. N. W.	16.8	Cu. St. & Nim.	9					.182	Thunder and showers of rain.
3 p. m.	.369	57.5	46.5	.456	N. W.	16.2	Cu., Cu. St., & Nim.	7					.182	Rain and thunder during the hour.
4 p. m.	.366	58.6	45.7	.401	N. W.	19.6	Cu., Cu. St., & Nim.	5					.173	Thunder.
5 p. m.	.364	59.8	46.2	.384	N.	19.5	Cir. & Nim.	4	Cu. St.	2	W. S. W.		.180	
6 p. m.	.385	53.3	47.1	.630	N. E.	17.0			Cu. St. & Nim.	5	W. S. W.		.197	
7 p. m.	.390	49.3	45.6	.749	N. E.	14.2			Cu. St. & Nim.	5	S. W.		.220	
8 p. m.	.406	47.0	44.8	.839	S. E.	6.8	Nim. & Cu. St.	4					.242	Light seen at S. S. E.
9 p. m.	.424	46.4	43.2	.772	N. N. E.	5.4	Cu. St.	3					.258	Light seen at S. S. E.
10 p. m.	.427	45.7	42.5	.771	N. E.	5.0	Cir. St.	2					.260	Light seen at S. S. E.
11 p. m.	.423	46.4	42.1	.705	N. E.	3.2	Cu. St.	2					.260	Light seen at S. S. E.
12 p. m.	.422	46.1	42.1	.721	S. E.	3.8	Cu. St.	3					.263	Light seen at S. S. E.
	22.371	49.5	43.7	.677		267.4							22.204	

METEOROLOGICAL JOURNAL.—SHERMAN, WYOMING TERRITORY—Continued.

SHERMAN, AUGUST 14, 1872.

Hour.	Barometer at 32° Fahrenheit.	Dry bulb.	Wet bulb.	Relative humidity.	Wind. Direction.	Wind. Velocity per hour.	Lower clouds. Kind.	Lower clouds. Amount.	Upper clouds. Kind.	Upper clouds. Amount.	Upper clouds. Moving from—	Amount of rain and melted snow.	Aneroid barometer.	Remarks.
1 a. m	22.412	45.2	42.0	.769	S.	7.6	Cu. St.	1	....	...	....	......	22.255	Lightning S.
2 a. m	.413	44.9	41.9	.781	S.	7.5	Cu. St.	2	....	...	....	......	.255	Lightning S.
3 a. m	.413	44.8	41.7	.774	S.	8.0	Cu. St.	1	....	...	....	......	.250	
4 a. m	.410	44.0	41.0	.779	S. S. E.	9.0	Cu. St.	1	....	...	....	......	.250	
5 a. m	.406	43.0	40.3	.797	S.	16.0	Cir. St.	1	....	...	....	......	.245	
6 a. m	.411	45.3	42.3	.782	S.	12.5	Cir. St.	1	....	...	....	......	.255	
7 a. m	.405	49.2	45.3	.737	S.	16.0	....	...	....	...	....	......	.250	
8 a. m	.403	52.3	47.3	.687	S.	14.5	....	...	....	...	....	......	.245	
9 a. m	.401	56.6	49.6	.607	S.	13.6	Cu.	1	....	...	....	......	.240	
10 a. m	.402	61.5	49.5	.439	S.	10.1	Cu.	1	....	...	....	......	.222	
11 a. m	.395	62.6	47.6	.356	S.	4.8	Cu.	2	....	...	....	......	.202	
12 m ...	.382	68.5	52.5	.355	W. S. W.	7.0	Cu. & Cu. St.	4	....	...	....	......	.175	
1 p. m	.368	70.6	54.7	.366	S. W.	9.5	Cu. & Cu. St.	5	....	...	....	......	.150	
2 p. m	.352	69.0	53.3	.364	S. S. E.	14.1	....	....	Cu. St. & Nim.	7	S. W.	......	.127	
3 p. m	.348	69.3	53.5	.363	S. S. E.	22.4	....	....	Cu. St. & Nim.	7	W.	......	.120	Thunder.
4 p. m	.344	68.3	53.4	.381	S. S. E.	16.9	....	....	Cir., Cu. St., Nim.	5	W.	......	.120	
5 p. m	.331	66.8	52.7	.398	S. S. E.	11.8	....	....	Cir. & Cu. St.	5	W.	......	.118	
6 p. m	.320	62.5	49.8	.421	S. S. E.	22.3	....	....	Cir. & Cu. St. & Nim.	5	W.	......	.120	
7 p. m	.327	56.3	48.5	.572	S. S. E.	12.9	....	....	Cu. St. & Nim.	5	W.	......	.133	Light seen in S. E. and N. E. 8 and 9 p. m.
8 p. m	.332	53.7	48.5	.682	S. S. E.	11.1	Cu. St.	3	....	...	....	......	.150	Display of north'n lights
9 p. m	.336	51.7	47.9	.751	S. S. E.	16.8	Cu. St.	2	....	...	....	......	.167	seen at 9.35 p. m., ex-
10 p. m	.328	49.8	47.4	.832	S. S. E.	15.2	Cu. St.	2	....	...	....	......	.160	tending from N. W. to
11 p. m	.322	49.2	46.7	.824	S. S. E.	12.0	Cu. St.	3	....	...	....	......	.148	N. E.; disappeared at
12 p. m	.310	48.8	46.6	.843	S. S. E.	11.3	Cu. St.	3	....	...	....	......	.140	10.10 p. m.
	22.369	55.6	47.7	.611	....	302.9	....	...	....	...	....	......	22.187	

METEOROLOGICAL JOURNAL.—SHERMAN, WYOMING TERRITORY—Continued.

SHERMAN, AUGUST 15, 1872.

Hour.	Barometer at 32° Fahrenheit.	Dry bulb.	Wet bulb.	Relative humidity.	Wind. Direction.	Wind. Velocity per hour.	Lower clouds. Kind.	Lower clouds. Amount.	Upper clouds. Kind.	Upper clouds. Amount.	Upper clouds. Moving from—	Amount of rain and melted snow.	Aneroid barometer.	Remarks.
1 a. m.	22.294	48.3	46.2	.848	S.	10.7	Cu. St.	2	...	...	...	...	22.130	
2 a. m	.286	48.7	44.5	.718	S.	11.5	Cu. St.	1	...	...	...	...	.125	Lightning S. E.
3 a. m.	.276	50.1	43.0	.573	S. W.	10.5	Cu. St.	2	...	...	...	...	.120	
4 a. m.	.257	51.1	39.8	.411	W.	2.5	Cu. St.	3	...	...	...	...	.120	
5 a. m.	.284	49.8	41.7	.527	N. W.	6.5	Cu. St.	4	...	...	...	...	.120	
6 a. m	.287	52.2	43.2	.502	N. W.	7.5	Cu. St.	4	...	...	...	...	.125	
7 a. m	.293	54.0	43.2	.445	W. N. W.	9.0	Cu.	3	...	...	...	...	.125	
8 a. m.	.291	63.1	46.2	.313	W.	12.0	Cu.	3	...	...	...	...	.120	
9 a. m	.288	66.4	46.7	.267	W.	18.2	Cu.	1	...	...	...	...	.100	
10 a. m	.292	68.6	46.4	.229	W.	22.8	Cu.	1	...	...	...	...	.100	
11 a. m	.288	70.4	47.3	.221	W.	21.5	Cu.	2	...	...	...	...	.090	
12 m ...	.279	71.5	48.3	.224	W.	17.7	Cu. & Cu. St.	5	...	...	...	...	.073	
1 p. m.	.268	71.6	48.6	.227	W.	14.5	Cu. & Cu. St.	6	...	...	...	...	.060	
2 p. m.	.259	73.8	49.3	.212	W.	21.8	Cu. & Cu. St.	4	...	...	...	...	.046	
3 p. m.	.245	75.2	50.7	.217	W.	20.5	Cu. & Cu. St.	4	...	...	...	...	.027	
4 p. m.	.242	74.7	49.3	.203	W.	24.2	Cir. & Cu.	3	...	...	...	...	.017	
5 p. m.	.238	74.1	49.4	.211	S. W.	22.5	Cir. & Cu. St.	3	...	...	...	...	.015	
6 p. m.	.236	71.4	47.0	.205	W. S. W.	25.0	Cir. & Cu. St.	3	...	...	...	...	.015	
7 p. m.	.246	64.9	45.1	.258	W.	14.8	Cu. St.	4	...	...	...	...	.020	
8 p. m.	.242	61.7	44.5	.300	W. S. W.	10.7	Cu. St.	3	...	...	...	...	.038	
9 p. m.	.236	59.1	43.2	.329	S. W.	12.3	Cu. St.	3	...	...	...	...	.040	
10 p. m.	.240	57.7	42.7	.336	S. W.	13.9	Cu. St.	2	...	...	...	...	.040	
11 p. m.	.225	56.8	42.3	.345	W.	9.0	Cu. St.	2	...	...	...	...	.038	
12 p. m.	.213	56.9	43.2	.368	S. W.	8.1	Cu. St.	4	...	...	...	...	.023	
	22.262	62.2	45.5	.353	...	347.7	...	...	...	...	...	...	22.072	

SHERMAN, AUGUST 16, 1872.

Hour.	Barometer at 32° Fahrenheit.	Dry bulb.	Wet bulb.	Relative humidity.	Wind. Direction.	Wind. Velocity per hour.	Lower clouds. Kind.	Lower clouds. Amount.	Upper clouds. Kind.	Upper clouds. Amount.	Upper clouds. Moving from—	Amount of rain and melted snow.	Aneroid barometer.	Remarks.
1 a. m.	22.204	55.8	43.2	.395	W.	9.0	Cu.	2	...	...	...	...	22.020	
2 a. m	.193	57.3	43.5	.368	W. S. W.	11.5	Cu. St.	2	...	...	...	...	.005	
3 a. m.	.180	57.3	43.3	.362	S. W.	20.0	St.	1	...	...	...	...	.000	
4 a. m.	.182	57.4	42.9	.348	W. S. W.	17.0	Cu. St.	1	...	...	...	...	21.998	
5 a. m	.178	56.1	42.2	.358	W. S. W.	15.5	Cu. St.	2	...	...	...	...	.995	
6 a. m	.172	57.8	43.2	.348	W. S. W.	21.0	Cu. St. & Cu.	2	...	...	...	...	.993	
	22.185	56.9	43.0	.363	...	94.0	...	...	...	...	...	...	22.002	

PART II.—ASTRONOMICAL OBSERVATIONS AT SHERMAN, WYOMING TERRITORY, BY PROF. C. A. YOUNG.

DARTMOUTH COLLEGE, *October* 21, 1872.

SIR: I have the honor to present the following report of my observations in connection with the Coast Survey party which was stationed at Sherman, Wyoming Territory, during the months of June, July, and August, 1872.

Leaving my home at Hanover, N. H., on the 28th of June, I stopped three days in New York for the purpose of consulting with certain of the scientific gentlemen who reside there and in the vicinity as to the observations most important under the circumstances. To President Morton, of the Stevens Institute of Technology, I am under special obligations for the loan of a radiation-thermometer and a pyrheliometer.

I arrived in Sherman upon the 6th of July, in company with my colleague, Prof. C. F. Emerson, who had kindly consented to act as my assistant during the expedition. Mr. C. K. Wead was also with us, a young gentleman much interested in scientific matters, who remained at Sherman a few weeks on his way to California, and aided us in various observations with great zeal and intelligence

We found the party under the charge of General R. D. Cutts, United States Coast Survey, already established and vigorously at work, having arrived upon the ground nearly a month before. Our instruments, which had been sent on by express, had preceded us by a few days, and the observatory was nearly ready for their occupancy.

As the report of General Cutts will probably contain all the necessary data regarding the topographical position of the observatory, I need only say that it was situated about 100 yards south of the railroad, and some 40 feet above its level, upon the summit of a small hill. (Approximately latitude, 41° 07′; longitude, 1^h $55^m.3$ west of Washington; elevation, 8,300 feet above sea-level.)

The observatory consisted of a single room of rough boards, about 16 feet square and 9 feet high, with a sliding roof, removable in three sections. The telescope when in use was, so to speak, completely out of doors, and it was very soon found that some further protection was needed from the violent winds. Accordingly, a high fence was erected upon the north side of the roof, while upon the east and west masts were placed upon which tent-flies could be drawn up like sails when occasion demanded. The range of vision was thus considerably reduced, being limited on the north to a distance of about 20° from the zenith; but it became possible to observe the sun, whenever the wind was not too strong, nearly as satisfactorily as in a revolving dome.

The interior of the observatory was painted a dead black; the extent to which this facilitates the observation of the fainter portions of the spectrum is really surprising.

By the liberality of the trustees of Dartmouth College, I was permitted to take with me the fine equatorial belonging to that institution. This instrument, one of the latest and most perfect productions of Alvan Clark & Sons, has a telescope of 9.4 inches aperture, and 12 feet focal length. The mounting is in the main the same which carried the old 6-inch Munich telescope, which it replaces; but the clock-work is new and excellent.

This mounting, though entirely satisfactory under a dome, is hardly heavy and firm enough for so large a telescope in the open air; and a breeze of any considerable strength, notwithstanding the protecting tent-flies I have mentioned, used to make the telescope vibrate sufficiently to interfere seriously with the observation.

The instrument is provided with a full battery of eye-pieces, ranging in power from 50 to 1,500, with ring and filar micrometers, and with a very perfect spectroscope; the same described in the Journal of the Franklin Institute for November, 1870, but with certain improvements there indicated, by which it is rendered automatic.

The collimator and view-telescope have each an aperture of seven-eighths of an inch, and a focal length of 10 inches. The full prism-train is equivalent to 12 prisms of flint glass, but can easily be reduced to any extent desired. The whole dispersive power was always used, however, and I should have been very glad to double it if possible.

I also brought a quantity of polarizing apparatus for the purpose of examining the sky-polarization, and a pyrheliometer and radiation-thermometer, already mentioned as loaned by the Stevens Institute of Technology.

The pyrheliometer, however, proved to be unmanageable on account of a trick it had of detaching a greater or less portion of its mercury-column whenever it was inverted into the position for observation—the vacuum above the mercury being too perfect; sometimes, instead of detaching a portion of the column, it would fill the whole tube with mercury, having a vacuum-bubble in the bulb.

It is not necessary to say much about the weather, as inspection of the meteorological report will at once show the state of things. For a week and more after our arrival, it was exceedingly discouraging; and, during our whole stay, only about one day in three turned out good enough for observation; and the proportion of good nights was considerably smaller. The contrast between the climates of Sherman and Salt Lake City was very striking. It is, however, only just to add that all the citizens of Sherman concur in representing the summer as a very unusual one in respect to its cloudiness; and this is quite probable, since the amount of snow which fell the preceding winter was entirely unprecedented, and at the end of July it was still lying to a depth of 8 feet on the plateau from which rises the Medicine Bow Mountain, about fifty miles west of our station. This was the report of Mr. Gardner, the topographer of King's geological expedition, who twice visited us. It is easy to see that the moisture from such a body of melting snow, carried by the prevailing westerly winds, could hardly fail to affect the clearness of our sky.

But when the sky was clear, it was beautifully so. At night, hundreds of small stars, which I never saw at home, came out distinctly. Thus, within the "Bowl of the Dipper"—the quadrilateral marked by α, β, γ, and δ Ursæ Majoris—I have been accustomed, under favorable circumstances, to count three stars with glimpses of a fourth; at Sherman, I could see eight; and Professor Emerson, whose eyes seem to be superior to mine, could see ten, and sometimes eleven. Indeed, I think a majority of the stars rated in the British Association Catalogue of the seventh magnitude were fairly within reach of the naked eye. The Milky-Way especially was magnificently brilliant near the southern horizon as well as in the zenith. α Lyræ was several times observed with the naked eye from 10 to 15 minutes before sunset.

As observations of the sun required about as many hours of work each day as my eyes would bear, I did less at night with the telescope than I otherwise should; spending on seven different nights perhaps three or four hours each. On two of these nights, the seeing was exquisitely perfect; on two others, very fine; and on the other three, it ranged from fair to poor, *i. e.*, there was more or less quivering and twitching of the images.

As tests of definition, I tried δ Cygni, ζ Herculis, δ Equulei, μ^2 Herculis, and γ^2 Andromedæ. All of these were readily seen, of course, and very beautifully so on the best nights; the background being far more dark, and the images cleaner and sharper than I had ever seen them. γ Coronæ was tried, but I could only suspect that the image was a little wedge-shaped. ι Bootis seemed to me perfectly round, with a power of 1,200, and the air almost perfectly steady.

Having with me only Struve's "*Mensuræ Micrometricæ*," Smyth's Celestial Cycle, and Webb's little book, I was not prepared for any very serious work. I picked up two or three double stars, not in either of their catalogues, (one of them, B. A. C. 6468, rather delicate at Hanover, was conspicuous here,) but I find them all in other lists. My observations involved no measurements, but for the most part only the examination of objects with which I was previously more or less familiar; and I have no hesitation in affirming that I never was able to see them at Hanover with anything like the perfection attainable here.

I was able to examine the moon only once, (July 13,) and then under unfavorable circumstances, as it was very windy. Linné was observed; no crater was visible; only a small white spot. In the case of Hyginus, with a power of 550, no wall could be made out around the crater; and if there is any at all, it must be very low.

Saturn was examined repeatedly, and on two occasions the views were exquisitely beautiful—July 26 and August 1. Notwithstanding the low altitude of the planet, the definition was almost absolutely perfect, excepting a slight coloration of all horizontal lines due to the atmospheric dispersion, and all the details came out in the most delightful manner with powers ranging from 400 to 1,200; a power of about 600, on the whole, did best.

Bond's dusky ring was clearly seen, and also, on both occasions, a dark streak on the outer ring about one-third of the way from the outer edge; this streak was hardly black enough, however, to indicate a complete division of the ring.

On both these evenings, and also on others, when the air was as clear though not so steady, Mimas and Enceladus were both easily seen at distances from the ring ranging between 5″ and 25″.

At the suggestion of Mr. Alvan Clark, I carefully examined *α* Ophiuchi for small stars near it, and easily saw the four very faint ones, in the same field, one south preceding, and the other three nearly in line following, and a little north. Of this, Mr. Clark writes, in reply to a letter of mine with diagram, "I have examined *α* Ophiuchi with the 26-inch, now building for Government, but made no drawing. I think you have all that we can see. The little preceding star is the faintest, and is the one I supposed you might possibly reach, though, if you did, it would indicate a great advantage in position."

The minute companion of α^2 Capricorni was well seen double, (pos. 245°, dist. 1″.7, both estimated.) The companion of *γ* Aquilæ, which I see with difficulty at Hanover, was conspicuous.

γ Lyræ was examined for the minute companion discovered by Alvan G. Clark in 1868 with the 12-inch glass still in his possession. I knew nothing as to its distance and position, and accordingly, when I found a minute star about 40″ s. p., I supposed I had it, especially as there are two other stars, nearly as faint, barely visible at Hanover with my instrument, under favorable circumstances. Mr. Clark calls the new companion "about the faintest thing that any one could possibly see with 12-inch aperture," and I was accordingly very greatly pleased at having seen it as I supposed. I was equally chagrined on receiving, a day or two before we left, a letter informing me I was mistaken, and had missed it.

I did not have another clear night or I should have tried again, and I believe with success, though that, of course, is only matter of opinion, based on the behavior of other tests.

With reference to this companion, Mr. Clark writes, "It precedes, though I am now unable to say in which quadrant, but your distance shows that you have not got it. Alvan was astonished that the Newhall telescope made so bold a thing of it, but since seeing it through ours he finds he did not see it at all, but only the star you allude to. It is very faint. Even with 26 inches, no one but a fierce star-gazer would be struck with it at once." Later, he informs me that it almost exactly precedes the larger star at a distance of about 10″.

I regret very much that I could not have devoted more of my time and attention to determining the precise range of the power of my telescope, so as to furnish a more reliable estimate of the gain incident to our elevation; still, putting everything together, it is my deliberate opinion that at Sherman my 9.4 object-glass was just about equal to a 12-inch glass at the sea-level.

Spectroscopic observations of the sun, however, occupied me almost entirely. These were made upon twenty-two different days, between July 13 and August 12, mostly between the hours of 6 a. m. and noon. On three occasions only, observations were possible in the afternoon. In the ordinary course of things, during the best summer-weather, clouds would begin to form between 10 and 11 a. m., and soon after noon there would be a thunder-storm, actual or threatened, which would clear away before sunset, leaving the night cloudless for observation. In many cases, however, the storm did not burst till late in the afternoon, and the clearing-up was postponed till after midnight.

On eleven days of the twenty-two, the observations were confined within an hour or two by unfavorable weather; on the other eleven, the whole forenoon, or at least four or five hours of it, was available.

My spectroscopic work naturally separates itself into three portions:

1. Observations on the spectrum of the chromosphere.
2. Observations on the spectra of the spots.
3. Observations of solar storms and eruptions.

SPECTRUM OF THE CHROMOSPHERE.

If, as is generally admitted, the solar photosphere consists of a layer of luminous cloud, having a physical constitution essentially like that of terrestrial water-clouds, it would seem to be almost a necessary consequence that those portions of the solar atmosphere in which these photospheric clouds float must consist not only of permanent gases, but must be fully saturated with the vapors whose condensation furnishes the cloud-droplets. Nor would it seem at all likely that these vapors disappear from the solar atmosphere just at the upper level of the clouds—in our own atmosphere, certainly aqueous vapor is not absent in the clear air above the aqueous clouds—but it is far more probable that these vapors extend far beyond the cloud-level, though, of course, rapidly diminishing in density, temperature, and luminosity. Undoubtedly, also, their percentage in the solar atmosphere falls off rapidly, so that, while in the photospheric region they may form a large proportion of the whole, the permanent gases will vastly preponderate in the upper portions of the chromosphere and in the coronal atmosphere. Different vapors, too, would "thin out," as Mr. Lockyer expresses it, and lose their luminosity at very different rates.

As a consequence of this view, that portion of the solar atmosphere just above the photosphere must contain, in the gaseous form, all the substances existing in the photosphere itself; and the absorption of such a region accounts for the Fraunhofer lines as seen. Further, whenever the direct light of the sun is excluded, as in a total eclipse, we ought to get, for the spectrum of this layer next the photosphere, a positive or bright-lined spectrum complete, with all the Fraunhofer lines reversed; as the elevation increases, we should find certain of the lines becoming fainter, and then vanishing, at a height depending very much, in most instances, upon the perfection of the spectroscope employed and the sensitiveness of the observer's eye. It might, however, very possibly happen that the lines of some substances would disappear suddenly at some particular elevation, where the temperature falls to a certain critical point, or some associated chemical element ceases to react. The apparently definite upper limit of the chromosphere may perhaps be explained in this way. The hydrogen-spectrum here undergoes a sudden and sharp degradation of brilliance, although, as we now know, this gas extends high into the coronal regions. The "D_3-stuff," however, whatever that may be, ceases entirely at the boundary of the chromosphere, so that, as Proctor suggests, it looks very much as if the brightness of the hydrogen in the chromosphere were mainly due to its association with this other mysterious substance. Unusual disturbances of the solar surface would, of course, carry vapors (and often, perhaps, masses of solid or liquid matter) far above their ordinary habitat.

These views, I think, are fully confirmed by all the observations thus far made. The existence of a thin layer at the base of the chromosphere, whose spectrum reverses all the Fraunhofer lines, a fact which has been rather persistently doubted in some quarters, would seem to be satisfactorily established by the observations of the late total eclipse in India, and the still later observations of Mr. Pogson on the annular eclipse of last June.

Of course, the reflective power of our own atmosphere is the only cause which prevents our seeing this reversal at any time.

The spectrum of the illuminated air near the sun's place is simply a complete solar spectrum of considerable brilliance with all its dark lines. When now this is superposed upon another spectrum containing the same lines bright, then, according to the relative intensity of the spectra, the result may be, either a solar spectrum with its dark lines weakened; a bright-line spectrum with the bright lines rendered faint by the brilliance of the continuous spectrum which is made to form its background; or, finally, if there is an approximate compensation, a continuous spectrum with all lines sensibly obliterated; and it may happen, also, if the bright lines in the one spectrum do not correspond in intensity to the dark lines of the other, (which is actually the case,) that while some lines are simply obliterated, others will be distinctly bright, and others yet strongly dark.

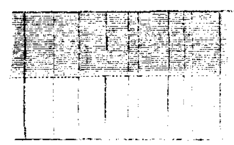
In New England, the first is the actual result: at the very edge of the sun the dark lines are somewhat weakened, but, generally speaking, there is no reversal.

In Italy, Father Secchi long ago reported that a thin layer close to the limb gives a sensibly continuous spectrum.

I had hopes that at Sherman the atmospheric illumination would be sufficiently reduced to realize the second case, and permit me again to see a reversed solar spectrum, as in the eclipse of 1870. In this, however, I was disappointed; I did not find *all* the lines reversed, or even most of them, unless momentarily and doubtfully on certain occasions when there was evidently some unusual disturbance in progress. But, whenever the air was perfectly steady, allowing me to magnify the image of the sun to a diameter of about four inches, then, on placing the slit of the spectroscope perpendicular to the sun's limb, I obtained the appearance which I have tried to represent in the figure. Running through the spectrum along the line which divided the spectrum of the sun from that of the region outside, there was a narrow streak, in which many of the lines turned bright, most of them sensibly vanished, while some persisted, though generally much weakened.

This effect was still better seen on placing the slit at an angle of not more than 8° to 10° with the limb. When it was made tangential, then, just as the image of the sun's limb touched the slit, the dark lines, for the most part, either turned bright, or more or less completely disappeared.

FIG. 1.



The thickness of the layer producing this effect could not have been more than 2″, and I think was inside of 1″; that is to say, it was only within five hundred or one thousand miles from the surface of the photosphere that the vapors to which are due most of the dark lines exist in sufficient quantity and suitable condition to manifest their presence, subject to the atmospheric and instrumental limitations under which I observed. The constitution of the chromosphere being such as I have indicated, the observation of the bright lines in its spectrum becomes perhaps of less interest than if only a few were to be discovered in it. Still, this kind of work is not without value, since the lines most easily seen are naturally those which are really most conspicuous in the spectrum of the chromosphere, and this conspicuousness stands in important, but by no means obvious, or even entirely simple, relations to the intensity of the corresponding dark lines, when such exist; that is to say, the lines which are conspicuous as dark lines in the solar spectrum are not at all certain to be equally conspicuous as bright lines in the chromosphere-spectrum, so that the latter spectrum still remains a separate and important subject of investigation. It cannot be doubted that a careful study of these bright lines, and their behavior, will bring out many significant facts as to the constitution and habitudes of the solar atmosphere.

I accordingly took great pains to determine as accurately as possible the position of every line I was able to perceive reversed. At Dartmouth College, I had succeeded in making out a list of 103. I do not know of anything which brings out the atmospheric advantages of Sherman more clearly than the fact that here, in the course of six weeks, I observed not only all those previously seen, but 170 new ones in addition. I give herewith a catalogue of all the lines observed. It seems to me very singular that no new bright lines should have been found below C. It was not for want of careful search.

The only ones among the new lines of any especial importance are the H's. These seem to be always reversed in the spectrum of the chromosphere; at least, after their first discovery, I never had any difficulty in perceiving their reversal when the seeing was good; or, rather, I was always able to do it, for the observation was never a really easy one, but required the use of every precaution in the way of excluding extraneous light, careful adjustment of the slit in the focus of the telescope for the particular rays, &c.

As will be seen a little further on, the same lines are also reversed in the *spot-spectrum.*

I am persuaded that there are many more of these chromospheric bright lines in the ultra-violet portion of the spectrum, which could probably be found by means of photography. The telescope used for the purpose of searching for them ought to be corrected for photography, (unless a reflector is employed,) and the clock-work would need to run very perfectly.

In the catalogue, the first column contains simply a reference-number; a ‡ refers to a note at the end of the catalogue.

The numbers in the second column refer to my "Preliminary Catalogue," containing 103 lines, which was published a year ago in the "American Journal of Science." In this column, a † indicates that some other observer has anticipated me in the determination and publication of the line. As I have depended for my information almost solely upon the Comptes Rendus and the Proceedings of the Royal Society, (which give the observations of Lockyer, Janssen, Rayet, and Secchi,) it is quite possible that some other lines ought to be marked in the same manner.

The third column, headed K, gives the position of the lines on Kirchoff's scale; the numbers above G being derived from Thalen's continuation of Kirchoff's maps. In this column, an asterisk (*) denotes that the map shows no corresponding dark line; a ? that the exact position, not the existence, of the line, is for some reason slightly uncertain.

The fourth column, headed A, gives the wave-length of the line in ten-millionths of a millimeter, according to Angström's atlas.

The numbers in this and the preceding column were taken, not from the maps themselves, which present slight inaccuracies on account of the shrinking and swelling of the paper during the operation of printing, but from the numerical catalogues of Kirchoff and Angström, which accompany their respective atlases. In the preliminary catalogue, the numbers were derived from the maps; hence, some slight discrepancies in the tenths of division.

The fifth column, marked F, contains a rough estimate of the percentage of frequency with which the lines were seen during the six weeks of observation; and the sixth column, B, a similar estimate of their maximum brightness compared with that of the hydrogen-line, C.

The variations of brilliance, however, when the chromosphere was much disturbed, were so considerable and so sudden that no very great weight can be assigned to the numbers given; nor is it to be inferred that lines which have in the table the same index of brightness were always equally bright. On certain occasions, one set of lines would be particularly conspicuous; on others, another.

With two or three exceptions, indicated in the notes, no lines have been catalogued which were not seen on at least two different days. In the few cases where lines observed only on one occasion have been admitted to the list, the observations were at the time carefully verified by my assistant, Professor Emerson, so as to place their correctness beyond a doubt. Many other lines were "glimpsed" at one time and another, but not seen steadily enough or long enough to admit of satisfactory determination. The last column of the catalogue contains the symbols of the chemical elements corresponding to the respective lines. The materials at my disposal are the maps of Kirchoff and Angström, Thalen's map of the portion of the solar spectrum above G, and "Watts" Index of Spectra."

Since the positions of the lines in the latter work are given only to the nearest unit of "Angström's scale," I have marked the coincidence indicated by it with a (w), considering them less certain than those shown by the maps.

In addition to the elements before demonstrated to exist in the chromosphere, the following seem to be pretty positively indicated: sulphur, cerium, and strontium; and the following with a somewhat less degree of probability: zinc, erbium and yttrium, lanthanum and didymium. There are some coincidences also with the spectra of oxygen, nitrogen, and bromine, but not enough, considering the total number of lines in the spectra of these elements, or of a character to warrant any conclusion. One points to the presence of iridium or ruthenium, and there are only three lines known in the whole spectrum of these metals.

No one, of course, can fail to be struck with the number of cases in which lines have associated with them the symbols of two or more elements. The coincidences are too many and too close to be all the result of accident, as, for instance, in the case of iron and calcium, or iron and titanium.

Two explanations suggest themselves. The first, which seems the most probable, is that the metals operated upon by the observer who mapped their spectra were not absolutely pure; either the iron contained traces of calcium and titanium, or *vice versa*. If this supposition is excluded, then we seem to be driven to the conclusion that there is some such similarity between the molecules of the different metals as renders them susceptible of certain synchronous periods of vibrations—a resemblance, as regards the manner in which the molecules are built up out of the constituent atoms, sufficient to establish between them an important physical (and probably chemical) cousinship, so to speak. I have annexed to the catalogue a table, showing the number of lines of each substance, or combination of substances, observed in the chromosphere-spectrum, omitting, however, oxygen, nitrogen, and bromine, since, with one exception, (line 230,) neither of them ever stands alone, or accounts for any lines not otherwise explained.

Catalogue of bright lines in the spectrum of the chromosphere, 1872.

No.	P. C.	K.	A.	F.	B.	E.	No.	P. C.	K.	A.	F.	B.	E.
‡1	†1	*534. 0	7055. ?	100	12		65	....	1324. 8	5475. 9	1	1	Ni.
2	†2	654. 3	6676. 9	25	50	Fe, Ba (w).	66	....	1328. 7	5472. 3	3	1	
3	†3	C 694. 1	6561. 8	100	100	H.	67	....	1337. 0	5462. 3	1	1	Fe, N (w).
4	....	711. 4	6515. 5	15	4		68	16	1343. 5	5454. 7	10	4	Fe.
5	4	718. 7	6496. 0	18	5	Ba.	69	17	1351. 1	5445. 9	10	4	Fe, Ti, Br (w).
6	....	731. 7	6461. 7	5	2	Ca.	70	....	1360. 9	5435. 4	5	2	Zn, Br (w).
7	5	734. 6	6453. 8	10	6		71	....	1362. 9	5433. 0	2	2	Fe.
8	....	740. 9	6438. 1	5	2	Ca, Cd.	‡72	18	1364. 3	5431. 8	8	5	
‡9	6	744. 3	6429. 9	20	4		73	19	1367. 0	5428. 8	8	3	Fe, Ti.
10	....	750. 1	6415. 6	5	2		74	20	1372. 1	5424. 5	25	6	Ba, Ti, S (w).
11	....	756. 9	6399. 0	5	2	Fe.	75	21	1377. 4	5417. 9	5	2	Ti, Mn.
12	....	759. 3	6392. 6	5	1	Fe.	76	....	1380. 5	5414. 5	2	2	Fe.
13	....	*767. ?	6373. ?	5	2		77	22	1382. 5	5412. 4	4	2	Mn (w).
14	7	*768. ?	6371. ?	5	3		78	....	1384. 7	5410. 0	2	1	Fe, Ni.
15	....	778. 3	6346. 1	10	4	Ruth, Ir.	79	....	1385. 7	5409. 0	2	2	Cr.
‡16	8	823. 5	6245. 4	8	5	Fe.	80	....	1389. 4	5404. 8	2	1	Fe.
‡17	9	827. 6	6237. 3	8	2		81	23	1390. 9	5403. 1	5	3	Fe, Ti.
18	....	830. 2	6231. 5	5	1	Fe.	82	....	1394. 2	5399. 6	2	1	Mn.
19	....	836. 5	6218. 3	3	1	Ti.	83	24	1397. 5	5396. 1	4	2	Fe, Ti.
20	....	839. 2	6214. 1	3	1	Ti.	84	....	1401. 6	5392. 2	2	1	Fe, Ce.
21	....	845. 7	6199. 6	2	2	Fe.	85	....	1412. 5	5380. 2	3	2	Ti.
22	....	849. 7	6190. 5	10	2	Fe.	86	†25	1421. 5	5370. 5	10	3	Fe.
23	....	859. 7	6168. 3	3	1	Ca.	87	....	1423. 0	5369. 0	1	1	Fe.
24	....	863. 9	6161. 2	8	3	Ca.	88	....	1425. 4	5366. 5	1	1	Fe.
25	....	{ 870. 9	6148. 1	3	2	Fe, E (w).	89	....	1428. 2	5364. 0	1	1	Fe.
26	....	} 871. 4	6146. 8	3	2		90	†26	1430. 1	5361. 9	20	10	Fe.
27	10	874. 3	6140. 6	25	10	Ba.	91	....	1438. 9	5352. 4	4	2	Fe, Co, Ce.
28	....	{ 876. 5	6136. 1	2	1		92	....	1446. 7	5345. 0	1	1	
29	....	} 877. 0	6135. 6	2	1	Fe.	93	....	1450. 8	5340. 2	1	2	Fe, Mn, O (w).
30	....	884. 9	6121. 2	5	3	Ca, Co.	94	27	1454. 7	5335. 9	5	2	Ti, Zn (w).
31	....	890. 2	6109. 9	2	1	Ba.	95	....	1461. 5	5329. 1	6	4	
32	....	894. 9	6101. 7	3	2	Ca, Li, Zn (w).	96	28	{ 1462. 8	5327. 1	5	2	Fe.
33	....	903. 1	6083. 1	3	2	Ti.	97	29	} 1463. 3	5327. 6	5	2	Fe.
34	....	912. 1	6064. 5	5	2	Fe, Ti.	98	....	1464. 8	5325. 1	6	2	
35	....	933. 8	6018. 0	2	1	Ba.	99	....	*1471. 9	5318. 0	1	1	
36	....	949. 4	5990. 0	10	4		‡100	†31	1473. 9	5315. 9	90	50	Fe ?, O (w) ?.
37	....	992. 0	5913. 2	2	1	Fe.	101	....	1476. 8	5313. 1	3	1	
38	†11	D_1 1002. 8	5895. 0	50	30	Na.	102	....	1497. 3	5292. 0	1	1	Cu, Br (w).
39	†12	D_2 1006. 8	5889. 0	50	30	Na.	103	32	1505. 3	5283. 4	20	10	Ti (w).
‡40	†	1011. 2	5883. 0	2	1	Fe.	104	†33	1515. 5	5275. 0	30	15	
‡41	†13	*D_3 1016. 5	5874. 9	100	90		105	34	E_1 1522. 7	5269. 5	15	4	Fe, Ca.
42	....	1031. 8	5852. 7	8	2	Ba.	106	35	E_2 1523. 7	5268. 5	12	3	Fe.
43	....	1135. 1	5708. 3	1	1	Fe.	107	†36	1527. 7	5265. 8	10	4	Fe, Co.
44	....	1151. 1	5687. 2	2	1	Na.	108	....	1530. 2	5263. 3	1	1	Ca, Br (w).
45	....	1154. 2	5683. 5	5	3		109	....	*1538. 5	5256. 2	2	1	Sr.
46	....	1155. 8	5681. 4	2	1	Na, Fe, N (w).	110	....	1541. 9	5254. 1	1	2	Fe, Mn.
47	....	1165. 7	5667. 8	2	2	S (w).	111	....	1547. 7	5249. 7	3	1	Fe, Zn (w), Br (w).
48	....	1167. 0	5666. 0	1	1		112	....	1551. 6	5246. 3	3	1	Fe.
49	....	1170. 6	5661. 5	15	2	Fe, Ti, E (w).	113	37	1561. 0	5239. 0	4	2	Fe.
50	....	1175. 0	5656. 7	8	3	S (w), N (w).	114	38	1564. 2	5236. 3	4	2	
51	....	1176. 6	5654. 4	2	1	Fe.	115	†39	1567. 5	5233. 6	10	8	Mn, Zn (w).
52	....	1187. 1	5640. 2	1	1	S (w).	116	40	1569. 6	5232. 1	1	3	Fe.
53	....	1189. 3	5637. 3	1	1		117	....	1575. 4	5227. 5	1	1	Sr ?.
54	....	1200. 6	5623. 2	2	1	Fe.	118	41	{ 1577. 4	5226. 2	10	3	Fe.
55	....	1207. 3	5614. 5	2	1	Fe.	119	....	} 1578. 1	5225. 5	2	3	Sr, Br (w).
56	....	1229. 6	5587. 6	2	2	Ca.	120	42	1580. 1	5224. 3	2	2	Ti.
57	....	1231. 3	5585. 5	2	1	Fe.	121	....	1589. 1	5216. 5	2	1	Fe.
58	†14	1274. 2	5534. 1	50	12	Ba, Fe, Sr.	122	....	1590. 7	5215. 5	3	2	Fe.
59	15	1281. 3	5525. 9	40	5	Fe.	123	....	1592. 3	5214. 4	2	1	Fe.
60	....	1287. 5	5518. 7	15	2	Ba.	124	....	*1597. 9	5210. 5	1	1	
61	....	1298. 9	5505. 8	2	1	Fe.	125	....	1598. 9	5209. 5	1	2	Ti.
62	....	1303. 5	5500. 5	2	1	Fe, La.	126	43	1601. 5	5207. 6	10	6	Fe, Cr.
63	....	1306. 7	5496. 6	2	1	Fe, E (w).	127	44	1604. 4	5205. 2	10	6	Cr, E (w).
64	....	1320. 6	5480. 2	2	1	Ti, Sr.	128	45	1606. 4	5203. 7	01	6	Cr, Fe.

Catalogue of bright lines in the spectrum of the chromosphere, 1872—Continued.

No.	P. C.	K.	A.	F.	B.	E.	No.	P. C.	K.	A.	F.	B.	E.
129	46	1609.2	5201.5	5	3	Fe.	193	65	2358.4	4629.0	15	8	Ti, N (w).
130	47	1611.3	5199.7	4	2	S (w), E (w).	194	....	*2359.5	4628.2	2	1	Ce.
131	....	1613.9	5197.9	1	1	Fe.	195	....	2369.7	4620.3	1	1	
132	†48	1615.6	5197.0	15	10		196	....	2410.2	4589.4	1	1	
133	....	1617.4	5195.0	1	1	Mn.	197	....	2412.8	4587.5	2	2	
134	....	1618.6	5194.1	2	2	Fe.	198	66	2419.3	4583.2	15	6	
135	....	1627.2	5188.2	10	5	Fe, Ca.	199	....	2429.5	4576.0	4	2	
136	....	1628.2	5187.3	1	1	Ti.	200	67	2435.5	4571.4	10	4	Ti.
137	....	1631.5	5185.1	5	2	Fe, Ti.	201	68	2443.9	4564.8	10	3	
138	†49	b_1 1634.1	5183.0	50	30	Mg.	202	69	2446.6	4563.2	10	5	Ti.
139	†50	b_2 1648.8	5172.0	50	35	Mg.	203	....	2452.1	4559.5	8	2	
140	†51	b_3 1653.7	5168.3	40	30	Fe, Ni, Br (w).	204	....	2454.1	4558.1	8	1	
141	†52	b_4 1655.6	5166.7	30	20	Fe, Mg.	205	70	2457.9	4555.3	10	5	Fe, Ti.
142	....	1666.?	5160.?	1	1		206	71	2461.2	4553.4′	10	5	Ba.
143	....	1671.5	5154.8	3	1	Na.	207	....	2463.4	4551.8	1	1	Ti, S (w).
144	53	1673.7	5152.5	3	1	Na, Cu ?.	208	72	2467.6	4548.9	10	8	Ti.
145	54	1677.9	5150.1	2	2	Fe, Br (w).	209	....	2480.8	4539.2	2	1	Ce.
146	....	1689.5	5142.2	1	2	S (w).	210	73	2486.6	4535.5	2	2	Ti, Ca.
147	....	1701.8	5133.0	1	1	Fe.	211	74	2489.4	4533.2	5	5	Fe.
148	....	1704.7	5130.8	1	1	Fe.	212	....	2490.5	4532.1	3	2	Ti, Ca.
149	....	1707.9	5128.6	1	1	Ti.	213	76	2502.2	4524.4	3	2	Ba, Fe.
150	....	1710.7	5126.7	1	1	Fe, Ti.	214	77	2505.6	4522.0	3	3	Ti, S (w).
151	....	1712.2	5125.5	1	2		215	....	2517.0	4514.0	2	1	
‡152	....	1713.4	5124.4	1	1	Fe.	216	....	2518.4	4513.0	1	1	
153	....	1715.2	5123.2	1	1	Fe.	217	....	2527.0	4506.0	2	1	
154	....	1717.9	5121.0	1	1	Fe.	218	78	2537.1	4500.3	15	6	Ti.
155	....	1719.4	5119.9	1	1	Ti.	219	79	2552.4	4490.9	20	8	Mn.
‡156	....	1727.3	5114.9	1	1	Ni.	220	80	2555.0	4489.4	15	3	Fe, Mn.
157	....	1734.6	5108.8	2	2	Ti (w).	221	81	2566.3	4480.9	5	2	Mg.
158	....	1737.7	5107.0	1	1	Fe.	‡222	†82	*f. 2581.2?	4471.2	100	25	Ce.
159	....	1750.4	5098.1	1	1	Fe.	223	83	2585.4	4468.5	20	5	Ti, O (w).
160	....	1752.8	5096.5	1	1	Fe, S (w).	224	....	2620.8	4446.3	1	1	Ti.
161	....	*1765.0	5087.0	2	1	E (w).	225	84	2625.2	4443.0	10	2	Ti.
162	....	1771.5	5083.5	1	1	Zn (w).	226	....	2633.0	4436.7	1	1	Mn ?.
163	55	1778.5	5077.9	1	2	Fe.	227	....	2639.6	4433.5	1	1	
164	....	1823.6	5047.8	2	2	Fe ?, Zn (w).	228	....	*2651.5	4426.0	2	3	
165	....	1833.4	5041.2	2	2	Fe, Ca.	229	....	2653.2	4425.0	2	2	Ca.
166	....	1834.3	5040.1	2	2	Fe.	230	....	2664.9	4418.0	2	1	O (w).
167	....	1848.9	5030.1	4	3	S (w).	231	....	2665.9	4417.5	3	1	Ti.
168	....	1856.9	5023.5	3	1	S (w).	232	85	2670.0	4414.7	1	1	Fe, Mn, O (w).
169	†56	1867.1	5017.6	30	15	Fe, Ni.	233	....	2680.0	4407.7	1	1	Fe, Ca.
170	†57	1870.6	5015.0	30	10	Ti (w).	234	....	2686.8	4404.2	1	1	Fe.
171	....	1905.1	4993.3	2	1	Fe, N (w).	235	....	2696.0	4398.5	1	1	Ti, Ce, O (w).
‡172	....	*c* 1961.0	4956.7	1	2	Fe.	236	....	2698.2	4396.5	1	2	
173	†58	1989.5	4933.4	30	8	Ba.	237	87	2702.5	4394.6	15	3	
174	†59	2001.6	4923.1	40	12	Fe, S (w), Zn (w).	238	....	2715.2	4388.5	1	1	Fe ?.
175	†60	2003.2	4921.3	30	8	S (w).	239	88	2718.5	4384.7	8	2	Ca, Ce.
176	61	2007.2	4918.2	20	3	Fe.	240	....	2720.2	4383.5	1	1	
177	....	2016.0	4911.2	3	2	Zn (w).	241	89	2721.6	4382.8	1	1	Fe, Cr.
178	†62	2031.1	4899.3	30	6	Ba, La, E (w).	242	....	2725.8	4380.4	1	1	
179	†63	*2052.5?	4882.9	10	4	Ce.	243	....	2728.0	4379.1	1	1	Ca.
180	....	2067.8	4869.4	5	1		244	90	2733.7	4375.5	5	3	Fe.
181	†64	F_1 2080.0	4860.6	100	80	H.	245	91	2736.9	4374.2	8	3	E (w).
182	....	2087.6	4854.7	5	2	Fe, Ni, E (w).	246	....	2762.0	4359.1	1	1	Cr.
183	....	2094.0	4848.1	3	2	Ca, O (w).	247	92	2775.7	4351.8	3	1	Cr.
184	....	*2116.?	4826.5	1	1		248	†93	2795.7	4340.1	100	65	H.
185	....	2121.2	4822.8	10	2	Mn.	249	....	2798.0	4338.2	10	2	Cr.
186	....	2142.4	4804.4	3	1	Ti, S (w), O (w).	250	....	2805.4	4335.1	2	1	La.
187	....	2171.5	4778.7	3	2	Co, N (w).	251	....	2823.4	4324.0	1	2	
188	....	2229.1	4730.8	1	1	Fe.	252	....	2830.7	4320.1	1	1	Ti, O (w).
‡189	....	*2251.3	4712.5	2	2	Ce, O (w).	253	....	2843.0	4313.5	1	1	Ti.
190	....	2309.5	4666.3	3	1	Fe, Ti.	254	94	G 2854.2	4307.2	3	2	Ca, Fe.
191	....	2314.3	4663.3	2	1		255	95	2867.7	4302.1	3	2	Ca, Fe.
192	....	2323.0	4656.0	2	1	Ti.	256	96	2874.2	4298.0	1	1	Ca, Fe.

Catalogue of bright lines in the spectrum of the chromosphere, 1872—Continued.

No.	P. C.	K.	A.	F.	B.	E.	No.	P. C.	K.	A.	F.	B.	E.
257	97	2894. 5	4289. 4	1	1	Cr, Ca, Ce (w).	266	....	3187. 0	4166. 7	1	1	Ca.
258	98	2928. 5	4274. 6	2	1	Cr, Ca.	267	†103	h 3363. 5	4101. 2	100	50	H.
259	99	2961. 2	4260. 0	2	1	Fe.	268	....	3431. 0	4077. 0	25	2	Ca.
260	100	2996. 2	4245. 2	30	3	Fe.	269	....	3526. 0	4045. 0	3	2	Fe.
261	....	3018. 0	4235. 5	30	5	Fe.	270	....	3703. 3	3990. ?	2	1	
262	....	3022. 8	4233. 0	5	5	Fe, Ca.	271	....	3769. 5	3970. ?	2	1	Fe.
263	101	3040. 0	4226. 3	3	3	Ca, Sr.	‡272	....	H_1 3778. 5	3967. 9	75	3	Fe, Ca.
264	102	3061. 8	4215. 3	40	7	Ca, Sr.	‡273	....	H_2 3882. 5	3932. 8	50	1	Fe, Ca.
265	....	3155. 5	4178. 8	1	1								

NOTES.

1. The position assigned to this line, first observed by Respighi, (a fact of which I was ignorant when the Preliminary Catalogue was published,) rests upon two series of micrometric measurements, referring it to four neighboring dark lines; the probable error is about one-twentieth of a division of Kirchoff's scale.

9. No. 6 in P. C. Position there given, 743 ?.

16 and 17. Nos. 8 and 9 of P. C. Position given as 816.8 and 827.6 by a mistake in identifying lines upon the map.

40. I have never myself seen this line reversed. Professor Emerson, however, saw it several times. It was first reported by Rev. S. J. Perry, in Nature, vol. III, p. 67.

41. The position of this line has been independently determined by three series of micrometric comparisons with neighboring lines. My result agrees exactly with that of Huggins.

72. Erroneously given in P. C. as 1363.1, which line does not reverse, or, at least, was never seen reversed at Sherman.

100. The principal line in the spectrum of the corona. The corresponding line in the spectrum of iron is feeble; and on several occasions when the neighboring lines of iron (1463, &c.) have been greatly disturbed, this has wholly failed to sympathize; hence I have marked the Fe with a ?. Watts indicates a strong line of oxygen at 5315 A.

152 and 156. Observed only on one day, but verified by Professor Emerson.

172. Called little C by Mr. Stoney.

179. Given by Lockyer as K 2054. Its position is a little uncertain; it seems to coincide with neither of the dark lines at 2051 and 2054, but lies between them, a little nearer to 2051.

189. Rather a band than a line.

222. The position of this line, which, however, like 189, is rather a band, was determined by two series of careful micrometrical measurements. It was first discovered by Rayet, January, 1869. It was named *f* by Lorenzoni, who, ignorant of the previous work of other observers, claimed it as a discovery of his own.

272 and 273. These lines were both reversed (by a narrow bright stripe running down the center of the broad hazy band) as constantly, whenever the seeing was good, as *h* or C itself. The observation was difficult, however, and required the most scrupulous exclusion of foreign light, and a careful adjustment of the slit in the plane of the solar image formed by these particular rays. They were also found to be regularly reversed upon the body of the sun itself, in the *penumbra and immediate neighborhood of every important spot.*

Table showing the number of coincidences between the bright lines observed in the spectrum of the chromosphere and those of the spectra of the chemical elements.

Fe, Ti, E (w).	1	Ti, S (w).	3	*Unknown.*	52	*Total.*
Fe, Ba, Sr.	1	Ti, Ca.	2	Fe.	64	110
Fe, S (w). Zn (w)	1	Ti, Mn.	1	Ti.	23	43
Fe, Co, Ce.	1	Ti, Ce.	1	Ca.	10	29
Fe, Ni, E (w).	1					
Ca, Cr, Ce.	1	Ti, Sr.	1	Ba.	8	13
Ca, Li, Zn.	1	Ti, Zn.	1	S (w).	7	14
Ti, Ba, S (w).	1			Mn.	6	12
Ba, La, E (w).	1	Ca, Cd.	1	Ce.	5	11
		Ca, Ce.	1	H.	4	4
Fe, Ca.	10	Ca, Co.	1	Na.	4	6
Fe, Ti.	9	Ca, Cr.	1	Cr.	4	10
Fe, Mn.	4	Ca, Sr.	1	Mg.	3	4
Fe, Cr.	3			Sr.	3	6
Fe, Ni.	3	S (w). E (w).	1	Zn.	3	9
Fe, Ba.	2			[E (w).	2	9
Fe, Zn.	2	Mn, Zn.	1	Ni.	2	6
Fe, E (w).	2			Co.	1	5
		Cr, E (w).	1	Cu.	1	2
Fe, Ce.	1			La.	1	3
Fe, Co.	1	Ce, Co.	1	Ru, Ir.	1	1
Fe, Mg.	1			Cd.	......	1
Fe, Na.	1	Na, Cu.	1	Li.	.....	1
Fe, S (w).	1					
Fe, La.	1	Lines marked with an *.	14			

The numbers in the last column denote the whole number of times that the symbol of each element appears in the catalogue, either singly or combined with others.

SPECTRA OF SUN-SPOTS.

These were observed on several occasions very carefully, but not so frequently as would have been the case if the time at my disposal had been greater. I felt that, as the observations on the chromosphere were especially favored by the atmospheric conditions, they should have the precedence, and I accordingly paid particular attention to the spots only at times, when there appeared to be nothing peculiar going on at the sun's limb, a state of things which occurred but seldom.

I annex a catalogue of the lines between B and b, which were found to be especially affected; above b it was found difficult to observe the lines separately. Between the limits mentioned, the spectrum of the nucleus appeared simply as a dark band running lengthwise through the field, and crossed by the same dark lines as the spectrum of the surrounding photosphere. Most of these dark lines were entirely unaffected. Many, however, were more or less widened and deepened, while a few were *thinned* and rendered less conspicuous, and a very few were sometimes reversed. This was frequently noticed as to the hydrogen-lines, and very rarely as to the following: 654 K, D_1, D_2, D_3, 1474 K, b_1, b_2, b_3, b_4, and 2002 K.

Most of the lines in reversing become simply thinner and fainter and then finally bright. But the sodium and magnesium lines behave quite differently; they become wider and blacker, and finally, so to speak, split open down the middle, showing a bright streak in the center of the shade.

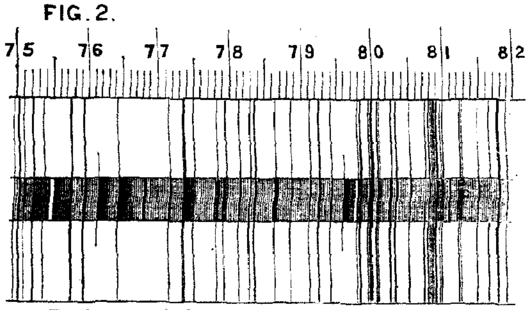
In this way the two H's were always seen reversed, (by a bright stripe down the center of the broad hazy shade,) not only in the nucleus and penumbra of the spot itself, but over a large area surrounding it. On widening the slit, the whole region could in some cases be seen through H to be covered with cloud-forms much like masses of heaped-up cumulus.

The definition, however, was never good like that of the prominences seen through the C-line and open slit, the reason, of course, being simply that the *bright* H is not like C, a sharp line in the spectrum, but a band hazy at the edges, and of considerable width, perhaps one-sixth the width of the dark shade.

This reversal of the H's over a spot was usually brighter and more easily seen than their reversal in the chromosphere, though, of course, by no means visible without careful adjustments and the use of all precautions as to extraneous light. There can be no doubt of the fact, however, as it was seen by me in nearly twenty different spots, and verified by Professor Emerson in many of them—in all that he had the opportunity to examine.

I have said that many of the dark lines were much widened; but those most affected in this way were not generally among the more prominent ones of the ordinary spectrum. In many cases, strong dark lines showed themselves which had no corresponding line at all in the photosphere-spectrum. Occasional bright lines (or, at least, *interruptions* in the dark-nucleus spectrum) were also found; also in one or two places such a peculiarity as I have attempted to exhibit in the annexed figure, at 761 and 764. (The scale is Kirchoff's, and bright lines are shown at 755 and 797.)

FIG. 2.



It is possible that these peculiar shadings, so closely resembling some of the appearances in one of Plucker's first-order spectra, may be the Persiennes, on which at one time so much stress was laid as indicating the presence of the vapor of water. The figure also shows very well the appearance of the lines which are widened and strengthened in the spot-spectrum.

The observation of the spot-spectrum was rendered difficult by the almost total absence at Sherman of the air-lines which usually abound between C and D; their disappearance made this portion of the spectrum almost unrecognizable.

The fact is easily accounted for by the dryness of the air, which, in fine weather, was extreme. On the 18th of July, while observing, I several times obtained slight sparks on touching the metal of the instrument; blankets of a dark color had been laid upon the floor to diminish the reflected glare of the sunlight, and the motion of my boots upon them generated the electricity which produced the spark. Such phenomena are common enough in our steam and furnace heated houses in the winter, but I do not remember ever to have heard of a similar occurrence under natural conditions.

In the catalogue, the first column, headed K, gives the position of the line according to Kirchoff's scale. A *c* denotes that the same line occurs in the chromosphere-spectrum; a * that there is no corresponding dark line in the ordinary solar spectrum. The second column, headed A, gives the position of the line on Angström's scale. The third column, headed E, gives the symbol of the corresponding chemical element when known. The last column indicates the amount of widening or re-enforcement of the line according to an arbitrary scale from 1 to 10. These numbers, however, are not greatly to be relied on. The same line appears quite differently in different spots, or even in the same spot at different times, and the numbers given are only the mean of three or four observations, as a general rule.

In the list, iron is represented by 52 lines; calcium, by 19, including the H's; titanium, by 15; sodium and manganese, by 6 each; magnesium, by 4; and chromium, barium, and nickel, by 3 each; lithium and strontium, 2 each; while hydrogen, cobalt, ruthenium, and cadmium each present but a single representative within the limits of the catalogue. The number of stars (*) is 26. In this estimate, a line which is marked with the symbol of more than one element is credited to each.

Catalogue of lines affected in the spot-spectrum between B and b.

K.	A.	E.	Widening.	K.	A.	E.	Widening.
582.5	6894.8	....	1	*870.	6149.?	....	4
585.0	6888.0	....	1	c871.4	6146.8	....	*Vanishes* in spot-spectrum.
641.0	6716.4	Ca.	1	**c877.0**	6135.6	Fe.	3
*644.0	6702.3	Li ?.	2	*883.	6124.?	....	2
c654.3	6676.9	Fe ?.	1, but sometimes reversed.	c884.9	6121.2	Ca, Co.	4
*678.0	6615.?	....	2	887.7	6115.3	Ni.	3
681.4	6597.1	....	3	c894.9	6101.7	Ca, Ci.	4
690.9	6571.1	....	4	901.4	6086.5	....	4
C c694.0	6561.8	H.	Often reversed.	c903.1	6083.1	Ti.	3
*697.0	6554.?	....	4	904.6	6080.0	....	4
698.1	6549.8	....	4	912.5	6064.5	Fe, Ti.	3
720.1	6492.1	Ba, Ca.	3, (? 718.7.)	*913.0	6062.3 ?	Ba ?.	2
736.9	6449.0	Ca.	2	*915.5	6057.3 ?	....	2
740.9	6438.1	Ca, Cd.	3	*924.0	6039.5 ?	Pb ?.	2
*755.0	6404.?	....	Bright streak faint. See figure.	940.2	6007.5	Fe ?.	Double; nearly invisible in
*761.5	6387.?	....	2 } Shading toward blue. See				in spot-spectrum.
764.2	6379.7	....	2 { figure.	958.0	5977.1	Ti.	4
773.4	6357.7	Fe.	4, shaded slightly.	963.7	5965.3	Ti.	2
c778.3	6346.1	Ru, Qr.	2	cD_1	5895.0	Na.	6, but sometimes reversed.
779.5	6343.1	....	3	cD_2	5889.0	Na.	6, but sometimes reversed.
786.8	6338.0	....	4	$*cD_3$	5874.9	....	1, but sometimes reversed.
*796.5	6305.0	....	5	1022.5	5866.3	....	2
*797.1	6303.0	....	Bright; brightness, 2.	1023.0	5865.3	Ti.	2
802.7	6291.5	....	3	1029.3	5856.5	Ca, Ni.	2
809.9	6276.9	....	3	1114.4	5740.9	....	2
813.1	6269.1	....	4	*1116.	5735.0	....	2
818.0	6260.2	Ti.	3, double.	*1119.5	5729.5	....	3
*821.5	6249.5	....	3	*1122.	5727.0	....	3
826.4	6240.3	....	5	1137.8	5705.1	Fe.	4
832.5	6225.4	....	2	1143.6	5697.2	....	4
835.0	6220.9	....	*Bright;* brightness, 2.	c1151.1	5687.2	Na.	3
841.	6209.3	....	4	c1156.8	5681.5	Na.	3
·846.5	6197.0	....	4	*1162.5	5672.3	....	3
c849.7	6190.5	Fe.	2	*1163.5	5671.5	....	3
c860.7	6168.3	Ca.	4, double.	c1170.6	5661.5	Fe, Ti.	4
c863.9	6161.2	Ca.	4	*1197.5	5627.0	....	5
864.4	6160.0	Na.	4	c1200.6	5623.2	Fe.	2
867.6	6154.2	Na.	4	c1207.3	5614.5	Fe.	3

Catalogue of lines affected in the spot-spectrum between B *and* b—Continued.

K.	A.	E.	Widening.
1217.8	5601.7	Ca, Fe.	2
1221.6	5597.2	Ca, Fe.	2
1224.7	5593.4	Ca, Fe.	2
1226.2	5591.2	Fe.	2
c1231.3	5585.5	Fe.	3
1232.8	5583.7	Fe.	4
1242.6	5571.7	Fe.	2
1264.4	5546.3	....	6
1272.4	5536.3	....	3
c1274.2	5534.1	Ba, Fe, Sr.	2
1276.5	5531.6	Fe.	2
1280.0	5527.4	Mg.	2
1289.7	5515.6	....	2
1291.9	5513.4	Ti.	3
c1298.9	5505.8	Fe.	2
1299.7	5505.1	....	3
*1301.5	5503.8	....	2
1303.5	5500.5	Fe.	2
1306.7	5496.6	Fe.	2
1312. to 1313.5	5490.	....	3, a wide dark shade.
1315.0	5486.8	Fe.	3
c1320.6	5480.2	Ti, Sr.	2
*1339.	5460.	....	4
c1343.5	5454.7	Fe.	3
1351.1	5445.9	Fe, Ti.	4
*1358. to 1359.5	5438.	....	3, a wide dark shade.
c1362.9	5433.0	Fe.	4
1364.8	5431.8	....	Blackened, not widened.
c1367.0	5428.8	Fe, Ti.	3
*1371.0	5425.	....	4
1372.6	5423.6	Fe.	3
c1377.4	5417.9	Mn, Ti.	2
c1380.5	5414.5	Fe.	3
1387.4	5406.5	....	4
c1389.4	5404.8	Fe.	4
1390.9	5403.1	Fe, Ti.	4
c1397.5	5396.1	Fe, Ti.	7
c1421.5	5370.5	Fe.	4
c1423.0	5369.0	Fe.	4
1439.9	5352.4	Co.	2
1443.5	5348.6	Ca.	3
1444.4	5347.4	....	3
c1446.7	5345.0	....	6

K.	A.	E.	Widening.
c1450.8	5340.2	Fe, Mn.	2
1451.8	5339.2	Fe.	2
c1463.0	5327.3	Fe.	2
c1473.9	5315.9	....	Distinctly weakened and sometimes reversed.
1491.6	5297.5	....	2
c1515.5	5275.0	....	2
1516.5	5274.3	....	2
cE_1	5269.5	Fe, Ca.	3
cE_2	5268.5	Fe.	3
c1527.7	5265.8	....	2
1528.7	5264.5	Ca.	2
*1536.5	5257.5	....	2
1544.4	5254.2	Mn.	2
*1563.	5237.5	....	3, close double.
c1569.6	5232.1	Fe.	2
1573.5	5229.0	Fe.	2
c1577.4	5226.2	Fe.	2
1580.	5224.3	Fe.	3
1582.	5222.5	....	3
c1598.9	5209.5	Ti.	4
c1601.5	5207.6	Cr, Fe.	4
c1604.4	5205.2	Cr.	4
c1606.4	5203.7	Cr, Fe.	4
c1609.2	5201.5	Fe.	2
c1613.9	5197.9	Fe.	3
1622.3	5191.7	Fe.	2
1623.4	5190.5	Fe.	2
1627.2	5183.2	Ca.	3
1628.2	5187.4	Ti.	3
cb_1	5183.0	Mg.	3, but sometimes thinned and even reversed.
cb_2	5172.0	Mg.	3, but sometimes thinned and even reversed.
cb_3	5168.3	Fe, Ni.	4, but sometimes thinned and even reversed.
cb_4	5166.7	Mg, Fe.	2, but sometimes thinned and even reversed.
1662. to 1663.	5162.	....	3, shading.
1676.5	5151.3	Fe.	2
*1688.0	5143.5	....	Bright; brightness, 2.
*1699. ‡	‡5135.	....	Three bright lines, very close; brightness, 3.

Above here to K 1830, the spectrum of the nucleus is made up of dark transverse shadings, almost continuous, but interrupted by bright streaks too numerous to count.

Above 1830, the spot-spectrum was not observed systematically, except to note the reversal of the two H's.

SOLAR ERUPTIONS AND OTHER DISTURBANCES.

Although I was not fortunate enough during our stay in Sherman to observe any eruptions equal to some which had previously fallen under my notice, at least as regards the velocity of the ejected matter and the elevation attained by it, yet, on several occasions, phenomena of a very interesting and instructive character were witnessed, many of them in connection with a large spot, which, during its previous revolution, had been the source of disturbances described by Secchi in the Comptes Rendus for August 5.

On July 16, I note that for a few minutes, about $9^h\ 30^m$ a. m., (Sherman time,) a little spike of the chromosphere on the western limb, besides showing a great number of bright lines between *b* and F, showed also a continuous spectrum, which was very bright for a few minutes.

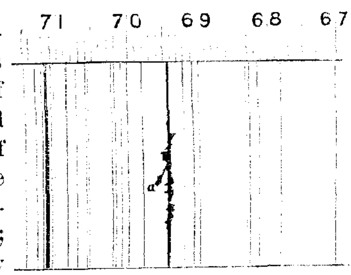
July 19.—A prominence situated on the sun's limb south 8° east, about 4″ high and 3′ long, was very brilliant, and reversed the sodium and magnesium lines to a height of about 20″; 1474 was reversed only to a height of 3″ or 4″.

July 25.—Considerable eruptive energy was manifested in a series of small but very active prominences, situated about 5° south of the west point. At 6 a. m., only three or four small flames were visible, about 25″ high, and very bright.

At $8^h\ 12^m$, happening to turn back from the portion of the spectrum I was examining to the C-line, I found it greatly broken up, as in the figure annexed, (Fig. 3.)

The point marked *a* was displaced 17½ divisions of the micrometer-scale, nearly 7 divisions of Angström's scale, or 2.44 of Kirchoff's. Calculating the velocity which would produce such a displacement,* we find it one hundred and ninety-five miles per second toward us. The change of refrangibility was so great and so different, at even closely contiguous points, that when I opened the slit to obtain a view of the form of the prominence, definition was found to be almost destroyed, and the intensely brilliant point which corresponded to the point *a* of the figure appeared to be wholly detached from the rest of the prominence, and thrown quite out of the slit upon the bright portion of the spectrum. The appearance lasted about four minutes; before I could get fairly adjusted upon the F-line, it had nearly vanished.

FIG. 3



(It should be noticed that, in fact, the C-line was *bright*, and the point "*a*" *very* bright, though in the figure represented by dark lines and points.)

In the afternoon, returning to observation after the sky had cleared up from the almost regular midday storm, my attention was again called to the same prominence by the brilliance of the spikes of which it was composed. At $2^h\ 20^m$, these were about 40″ high. At $2^h\ 30^m$, a jet was formed of vertical filaments, which at—

$2^h\ 31^m$ measured 1′ 25″ = 37,250 miles.
Velocity, + 80.2 miles per second.
2 37 2 28 66,600
+ 30.4

---

* The formula for calculating the velocity producing a given displacement of a line in the spectrum is simply—

$$V = L\left(\frac{\lambda - \lambda'}{\lambda'}\right)$$

in which—

L is the velocity of light;

λ is the wave-length of the ray under normal circumstances, (*i. e.*, coming from a luminous point at rest to a prism, also at rest;) and

λ' is the apparent wave-length of the ray when displaced by a motion which causes the prism and source of light to approach each other;

V is the velocity of this approach.

Assuming the velocity of light to be 185,500 miles, we find the annexed table, in which the first column contains the designation of certain lines in the spectrum; the second, headed A, contains the velocity (in miles per second) which would produce in the corresponding line a displacement of one division of Angström's scale; and the third, the velocity which would displace the line one of Kirchoff's divisions. The irregularity of the numbers in this last column is due simply to the irregularity of Kirchoff's scale.

Line.	A.	K.
C	28.27	79.90
D_3	31.57	46.04
E	35.21	28.19
F	38.16	28.34
H γ (near G)	42.75	24.02
H	46.75	15.87

2^h 41^m measured	2′ 42″ =	73,900 miles.	
			Velocity, + 29.5 miles per second.
2 44	2 56	79,200	
			+ 55.5
2 47	3 18	89,100	
			− 37.5
2 51	2 58	80,100	
			− 57.5
2 54	2 35	69,750	
			− 35.0
2 55.5	2 28	66,600	
			− 52.5
2 56.5	2 21·	63,450	
			− 41.0
3 04	1 40	45,000	
			− 26.4
3 10	1 18	35,500	
			− 21.7
3 20	50	22,500	

The altitudes were measured by observing the time required by the prominence to pass across the slit when the clock-work of the equatorial was stopped; corrections being applied, of course, for the sun's declination, and the inclination of the prominence to the parallel of declination passing through its base. The observation was rather difficult, owing to a breeze that often jarred the instrument, and the times at which the measurements were made were only recorded to the nearest half-minute; so that the results as to the altitude of the prominence at different times, and still more the numbers representing the velocity with which the summit rose and fell, can be considered only as approximate. But the irregularity noticeable in the column of velocities corresponds to a fact of which I feel certain, that the eruption was paroxysmal, and the rate at which the summit moved was neither uniform nor uniformly varied.

At 3^h 30^m, the eruption was renewed on a smaller scale, and, at 3^h 45^m, had attained an elevation of 2′ 15″, *i. e.*, sixty-one thousand miles.

During the first eruption, the stem of the prominence indicated, by the displacement of the C-line, motion *toward* us with a velocity of about one hundred and fifteen miles per second.

FIG. 4. 2 h 45 M.

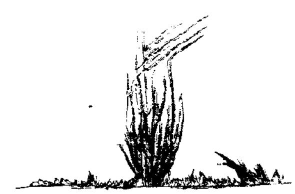


FIG. 5 3 h. 45.M.

The top of the prominence was carried violently toward the south, (from the equator,) as shown in Figure 4, which represents its appearance at 2^h 45^m.

On the renewal of the eruption at 3^h 45^m, the prominence assumed a brush-shaped form, which is rather unusual, and the upper current seemed to be nearly as strong in the opposite direction, (see Figure 5.)

July 29.—Considerable disturbance was manifested at the base of a pair of prominences, whose position-angle was 10° south of east; altitude, ninety thousand miles. At 10^h 45^m, the C-line showed displacement toward us, amounting to 18 micrometer-divisions, and indicating a velocity of about one hundred and ninety-eight miles. At 10^h 58^m, as seen through the F-line, the northern edge of the brighter prominence *a*, in Figure 6, had a motion toward us of about one hundred and twenty-seven miles per second; while the southern edge, *b*, in the same figure, was moving from us with a velocity of about eighty-seven miles. At 11^h 10^m, the velocity of the southern edge had considerably increased, while that of the northern had fallen off nearly one-half.

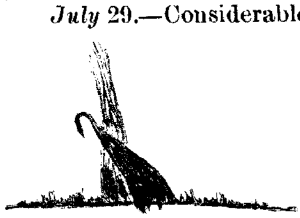


FIG. 6 b a

The prominence was clearly a tremendous cyclone, and its spirality was shown in the distribution of its filaments, as represented in the figure.

On examining the principal bright lines which appeared in the spectrum of this prominence, I found that some of them exhibited no displacement at all, while others showed the disturbance nearly as well as the hydrogen-lines. I regard the observation as important in enabling us to discriminate between the gases ejected from the sun and those which form the comparatively quiet atmosphere into which the ejected matter is thrown; the spectral lines of the atmospheric matter would be, of course, slightly, but only slightly, disturbed by the rush of the foreign current through it.

The disturbed lines, besides the hydrogen, were those of sodium, magnesium, and barium, D_3, the E's, and many other of the iron-lines. Those which, though very bright and easily seen, were apparently undistorted, were 2581, 1474, and 534, (but, on August 3, this last line participated in a disturbance.)

With reference to the H-lines, I could not make out to which category they belong, as the seeing was not very fine.

These phenomena occurred on the edge of the group of small spots, which were just coming into view around the edge of the sun.

July 31.—An immense plume shaped prominence, about 2′ high, (55,000 miles,) with accompanying filaments running toward it from a distance of nearly 3′ on each side, made its appearance at a point whose position-angle was nearly south 85° east. For several days it maintained roughly the same place and general aspect, and was found to be the precursor of the re-appearance of the great spot, which, having disappeared on July 21, again came into view on the 4th of August.

In this plume, the sodium and magnesium lines were reversed entirely to the summit. The same was true of the line 2581 K, (Lorenzoni's *f*,) and also of 1870, although this, in the chromosphere, is far less brilliant than some of its neighbors. The line 654 K also at times showed itself at a great altitude.

At $9^h\ 05^m$, the displacement of F was to 2086.5 K, indicating a velocity of about 190 miles, which a minute later had increased to 218. At $9^h\ 07^m$, I turned to the C-line and found a displacement of 2.6 divisions of Kirchoff, corresponding to a velocity of 208 miles, a very satisfactory accordance.* At $9^h\ 13^m$, the displacement of F was to 2087, corresponding to 204 miles. At $9^h\ 15^m$, a small displacement in the opposite direction showed itself, but came to nothing; and, by $9^h\ 20^m$, everything was quiet.

After the eruption, the seeing was very poor for a while, and I took up work on the spectrum of a spot. Returning to the chromosphere about $11^h\ 30^m$, I found things again in motion.

The line 654 K was reversed finely to the very top of the plume. Considerable velocity was indicated, and it was especially noted that the line 1870 K was distinctly, and even largely affected, while 1867, though much brighter, was not. No disturbance was manifest in 534 K, in 1474, in *f*, (2581.2,) or in either of the H's, though *h* showed it well. At this time, the reversal of the sodium-lines at the summit of the prominence was distinctly more brilliant than at the base, and the same was true of the magnesium-lines. It is a circumstance which is not often met with.

August 3.—As the spot approached nearer to the limb, the surrounding prominences were, of course, better seen, and on this day the disturbance was incessant, and sometimes very violent.

At $11^h\ 35^m$, I find in my notes that F exhibited displacement upward as far as 2086, (175 miles per second,) that in K 2003 the disturbance extends quite as far; so also in 1870; 1867 seems to be somewhat affected; 2001.5, and the barium-lines 1989 and 2031 show nothing. The magnesium-lines are distorted; 1474, 1505, and 1515 are not; E slightly; the sodium-lines very much dis-

*Perhaps this is the proper place to recant an opinion expressed in 1870, that the displacements and disturbances of spectral lines might be due to causes other than the motions of the luminous matter. The opinion was based upon a failure to detect in the spectrum of a prominence where the F-line was greatly disturbed, even "shattered to pieces," any corresponding effect upon the C-line. I did not then comprehend the rapidity with which these phenomena alter, and presume the explanation of the observation was simply that the disturbance had come to an end while I was changing the adjustment of my instrument from F to C; a process which, with the instrument I then used, would take two or three minutes. In order, however, to test the matter more carefully, I have devised, and hope some day to execute, an arrangement of two spectroscopes by which the disturbances of two lines may be simultaneously observed and directly compared in the spectrum of any point on the sun's limb.

turbed, and D_3 of course. C is very much broken up and very brilliant; and both 654 K and 534 K are distinctly affected.

At $11^h\ 40^m$, the upward displacement had ceased, and was replaced, at a point very near, by a downward displacement, which brought a portion of the F-line down to K 2077.5, (96 miles per second.) This ceased at $11^h\ 48^m$. At $11^h\ 51^m$, a new and even more violent disturbance began. This time two points, about 2′ apart, were simultaneously affected, and the ejected gas at both points was under so great a pressure or at so high a temperature as to give a continuous spectrum; *i. e.*, the spectrum was marked by two bright streaks running the whole length of the field, and where these streaks crossed certain of the Fraunhofer lines they were turned bright and distorted, while others were not in the least affected. The displacement at the northern point indicated a velocity of 230 miles per second, the matter receding from us, while at the southern of the two points the motion was toward us with even a slightly greater swiftness. By $12^h\ 0^m$, noon, it was all over. The afternoon was cloudy.

August 5.—By this time, the spot had come around the limb of the sun, and was distinctly advanced upon the disk. Between $6^h\ 30^m$ and $7^h\ 20^m$ a. m. of this day, there was a very unusual amount of disturbance in and around the spot, exceeding anything of the sort I ever before witnessed. I find the following notes:

"$6^h\ 30^m$ a. m., C is plainly reversed in spectrum of nucleus, but much more brightly in certain points about $1\frac{1}{2}$′ south of it; also in one point about 1′ north.

"At these points, (undoubtedly the orifices through which prominence-matter was ejecting,) 654 K is also distinctly reversed upon the body of the sun; 534 K is not.

"The sodium-lines reverse faintly in points, but generally are only much thickened. D_3 reverses distinctly but faintly, and, where not reversed, is visible as a dark shade rather than as a fine black line.

"b_1 and b_2 are plainly reversed and somewhat distorted; b_4 is reversed, but more faintly; but b_3—and this is very singular—is more brightly reversed than either of the others, and more distorted. The points which reverse these lines give also a bright continuous spectrum, and the 1474-line is faintly reversed when crossed by the bright streaks. The line 2001.6 is reversed in the penumbra, not in the nucleus, faintly, but unmistakably; its neighbors are not. $6^h\ 50^m$ a. m., F is magnificently reversed and shattered; portions are displaced to 2088.3, and, on the other side, to 2071.5, indicating velocities of nearly 240 miles per second in both directions. By opening the slit of the spectroscope slightly, a prominence can be traced on the sun's surface from its origin on the southern margin of the penumbra to the limb; there it projects from the chromosphere. *f* (2581.2) shows no effect at all; 2796 (H γ) is affected like F, but less brilliantly; *h* was like 2796, but still fainter."

H_1 was distinctly reversed across the whole width of the spectrum 6′. In the penumbra, it was also much distorted; the effect being certainly more marked than in *h*. H_2 also sympathized, but was difficult of observation.

On turning back to C at this time, I found its reversal far more brilliant than I have ever seen on any other occasion. For a length of nearly 2′, it was turned into a bright and jagged streak of light, and from one side (the more refrangible) projected a flame, in form closely resembling a candle urged by a blow-pipe, but so bright that even on the scarlet background of the spectrum it blazed like a calcium-light; the line 654 K, plainly in sight in the same field, faintly imitated the C-line, showing corresponding irregularities of form and thickness, and especially the flame.

By $7^h\ 40^m$, the disturbance was entirely over, nor did I see any repetition of it that day, although I continued observing till noon.

On August 3, the photographer of the party had been occupied during the morning with magnetic observations, under the direction of Assistant Mosman. About 11 o'clock, he began observing deflections for the purpose of determining the horizontal intensity. From the first, he found his observations unusually discordant. From $11^h\ 30^m$ to $11^h\ 45^m$, the results were very bad; and, at $11^h\ 54^m$, he was forced to give up work, the magnet swinging entirely beyond the range of the scale, in such a direction as to indicate a diminution of the earth's magnetic power.

On the 5th, the magnetic work did not begin until after 8 o'clock, and, when it did, nothing unusual was noticed.

The coincidence on the 3d seemed to me sufficiently striking to deserve investigation; and I accordingly wrote to Greenwich and to Stonyhurst College (England) for copies of their automatic-magnetic records during the time in question. From Greenwich I have received nothing as yet; but Rev. S. J. Perry, of Stonyhurst, has most kindly sent me the annexed copies of his own magnetic curves, with tracings of those obtained at Kew during the same period, accompanied by the following interesting letter, (see sketch No. —:)

"STONYHURST COLLEGE,
"*Blackburn, September* 15, 1872.

"DEAR SIR: I am forwarding to-day by book-post the magnetic records which you require, and also two remarkable curves traced by the vertical-force magnet during the past month.

"As I supposed you would prefer photographic copies to tracings by hand, I have sent photograms of the three curves for August 3, 4, and 5; but, though the originals are quite distinct, the tint of the curves is not deep enough to give a very satisfactory copy.

"Unfortunately, the apparatus for cutting off the light of the H. F. and V. F. magnets was out of order for an hour or two on the 3d; I have therefore sent you a copy of the corresponding Kew curves, for which I am indebted to the kindness of the director of the Kew Observatory, S. Jeffery, esq.

"I am sending two copies of the declination-curve, and also a tracing of the same. Of course, the photograms are the most satisfactory for exact measurements.

"You will notice at once the disturbance that corresponds with your observation of the 3d; but I think this is not so satisfactory as might at first appear, on account of the day being one of great magnetic perturbation.

"The agreement on the 5th appears to me to be much more striking, both on account of the quiet character of the curve through the day, and from the peculiar nature of the movement.

* * * * * * *

"Yours, sincerely,

"S. J. PERRY.

"Prof. YOUNG."

I entirely agree with him that the coincidence on the 3d is not of very great weight in itself on account of the remarkable magnetic disturbance running through the whole day; and yet it is by no means to be forgotten that the whole day, so far at least as my observations go, was also a day of unusual solar activity.

But the coincidence on the 5th seems to me of very great force; this peculiar shiver of the needle, on a day otherwise magnetically quiet, simultaneous with an intense solar paroxysm, which was probably the only one of much violence within twelve hours.

Considering the number of coincidences of this sort already noted, it becomes highly probable that among the causes which produce magnetic perturbations on the earth, we must include such solar disturbances as those I have described. What may be the relative importance of this direct solar action as compared with other forces which co-operate in producing the magnetic storms, it is too early yet to estimate.

I feel that in bringing this report to its close, I should be guilty of a great injustice if I omitted to acknowledge how much I owe to the patient and intelligent skill with which Professor Emerson assisted me. My obligations to him are very great.

Respectfully submitted:

C. A. YOUNG.

Prof. BENJAMIN PEIRCE, LL. D., &c., &c.,
Superintendent of the United States Coast Survey.

ADDENDUM.

Within a very few days after writing the above, a most courteous reply was received from Sir G. B. Airy, containing the desired information, as follows:

"ROYAL OBSERVATORY, GREENWICH,
"*London, S. E., October* 9, 1872.

"DEAR SIR: I have much pleasure in sending you traces of our photographic magnetic records for 1872, August 3 and August 5. I should be glad to learn that they reached you safely. And I am glad to send them for the following reason: On August 3, there was a jump, which corresponds well with the solar burst that you observed, allowing an interval of some three hours and a half. Now, in a letter to *Nature* some weeks ago, (I forget the precise number, but the date of my communication is 1872, August 14,) I sent a comparison of an outburst observed by Secchi on July 7 from $2^h\ 40^m$ to $6^h\ 0^m$ Greenwich time, (apparently Secchi did not see the beginning,) with a magnetic jump on our sheets, forming the sudden and strong beginning of a magnetic storm. If it be true that we have thus got an interval of a few hours for transmission of magnetic influence *a great point is gained.* * * * * * *

"I am, dear sir, yours, very truly,

"G. B. AIRY."

I annex the tracings of the curves of vertical force and declination; and, for the purpose of comparison, I have drawn in upon the latter the declination-curve from the Stonyhurst sheet, reduced to the same scale. It will be seen that at both places there are considerable jumps not found at the other, arising, of course, from local causes. I have marked some of the most important of them with a letter *l*, to call attention to them.

I am unable to agree with Professor Airy in the idea that several hours are occupied in transmitting magnetic disturbance from the sun, on account of the indications of the curves for August 5, when the only disturbance appears to be strictly simultaneous with the outburst noted on the sun.

So, also, on the 3d, all the curves show at $11^h\ 50^m$ (Sherman time) a sudden movement, (clearest upon the vertical-force curve.) My conviction is strengthened by finding, in my note-book, the following remarks: $8^h\ 45^m$ a. m: "All the lines in this part of the spectrum reversed at moments," showing that at that time, and for a few minutes, there was great activity at the base of the prominence I was then examining, which was the same in which the $11^h\ 50^m$ disturbance was afterward noted. Again, at $10^h\ 30^m$, "A little bunch gives a continuous spectrum much of the time," and these are the only records of extraordinary activity during the whole morning. Now, on looking at the vertical-force curve, we find precisely at those moments, and at no other time during the morning, sudden and violent disturbances. The same are recognizable on the declination-curves, though less conspicuous. I am therefore disposed to conclude that *every violent eruptive disturbance on the surface of the sun propagates a magnetic disturbance to the earth with a velocity sensibly the same as that of light*, or, at least, with a velocity of the same *order* as that of light; for our time-observations are not sufficiently precise to enable us to measure the rates of the velocities with any accuracy. We can only assert that no sensible difference in the time of propagation is evident.

It seems also clear that even a violent disturbance on the sun produces *directly* only a comparatively small effect on the earth's magnetic elements; and it is very doubtful, therefore, whether intense magnetic storms can be ascribed to *direct* solar influence. On the other hand, it is not at all unlikely that even a small magnetic impulse, acting simultaneously and alike over the whole surface of the earth, may so disturb an unstable magnetic equilibrium as to give rise to convective actions, and thus, in the course of a few hours, *indirectly* produce a magnetic storm of an intensity only remotely proportional to its exciting cause. The subject, however, evidently needs further and careful investigation.

APPENDIX No. 9.

ASTRONOMICAL OBSERVATIONS ON THE SIERRA NEVADA, BY GEORGE DAVIDSON, ESQ., ASSISTANT IN THE UNITED STATES COAST SURVEY.

SAN FRANCISCO, CAL., *October* 7, 1872.

DEAR SIR: In accordance with the plan I submitted to you on the 16th of February, I occupied a station on the line of the Central Pacific Railroad at Summit, in the pass of the Sierra Nevada, at an elevation of 7,200 feet above the sea, and in latitude 39° 20′, longitude 120° 20′, both approximate, to determine whether great elevations were better than small ones for astronomical observations. The plan contemplated the using of instruments which I had used for years on the Pacific coast, and observing upon objects with which I was familiar in the regular operations of the Coast Survey. My experience had extended through elevations from high-water mark to 3,471 feet above the sea.

DESCRIPTION OF THE COUNTRY ADJACENT TO SUMMIT.

Preceding the occupation of Summit, I had for a month been making transit, azimuth, and latitude observations at Verdi, in connection with the determination of the one hundred and twentieth meridian. Verdi is about twenty-five miles east of the Summit, at an elevation of 4,870 feet above the sea. It is on the right bank of the Truckee River, in a contracted basin-shaped widening of the Truckee Cañon, and surrounded by mountains about 2,000 feet above the river. There the weather was extremely dry and hot, reaching 127° Fahrenheit during part of the time in which I measured the base for the triangulation; the nights were generally cool.

Summit, at the head of Donner Lake, is in a gap of the Sierra Nevada, and about 2,000 feet below the general elevation of the chain northward and southward. The summer-winds draw through it from the westward sometimes very strongly. A few days before I occupied the station, the smoke from the great forest-fires of Oregon, Washington, and British Columbia had drawn down the great valley of the Sacramento, filled it nearly to the tops of the mountains, and completely obscured the Coast Range of Mountains that are visible during the greater part of the year. At this time of the year, I labored under that disadvantage, and this other, that the heated air of the valley was partially drawn through Summit Pass. I could have occupied an elevation of about 9,000 feet within three miles of the station and avoided these difficulties, but at more expenditure of time than could then be given.

The Sierra Nevada in this region is a narrow backbone or ridge, rising at least 3,000 feet within twenty or twenty-five miles on each side; it is mostly grass-covered, and, in many places, has pine-forests along its flanks, and close under the crest. I examined the ridges for several miles to the north and south of Summit, and was well satisfied that localities of 9,000 feet elevation were available to railroad and telegraphic communication; but the question of the best location on the Sierra Nevada can be readily settled by examination of the prominent mountains farther north and south, within reasonable reach of communication. Peaks of 10,000 feet and over lie just south and west of Lake Tahoe, near the Placerville road; and of 9,000 feet and over to the northward of Summit Pass.

THE CLIMATE AND THE OPPORTUNITIES FOR OBSERVING.

My own experience is limited to the month of July and part of August, 1872. At Verdi, in July, there were about six nights cloudy; and the same proportion held good for the Summit. And, while I was at the Summit, every night was clear.

In January, February, March, 1859, I was stationed on Table Mountain, north of San Francisco, and could see the Sierra Nevada, one hundred and fifty miles distant, as clear, sharp, and steady as objects seen ordinarily fifty miles distant. I then observed upon some of the peaks for direction and elevation.

But I have examined the meteorological records kept at Summit from December 7, 1866, to the end of November, 1867, and find the following results:

Months.	Clear days and nights.	Cloudy days and nights.	Remarks.
December, 1866	6	19	Stormy.
January, 1867	19	12	"Fine weather;" stormy.
February, 1867	13	15	One storm lasted 13 days; snow 10 feet.
March, 1867	21	10	
April, 1867	23	7	And on the 14th the journal says, "Fine weather for next three months, except May 24th and 25th."
May, 1867	29	2	
June, 1867	30	0	
July, 1867	31	0	
August, 1867	30	1	
September, 1867	26	4	
October, 1867	27	4	
November, 1867	15	15	
358 days	270	88	

The total snow-fall was about 45 feet, and, dur ing February, March, and April, the average depth was about 13 feet. Hills were free from snow about May 1, but 10 feet of snow lay in some valleys. Weather frosty early in May; flowers in bloom June 4.

The winds are mostly east and west, the latter very largely prevailing, and, when strong, with bad weather, the barometer falling with westerly and rising with easterly or light westerly winds. Greatest range of the barometer during the year, one inch.

The weather during the summer is very pleasant, and the nights cool; the clear, cool nights of winter are reported as marvelously clear.

As the mountain-flanks are covered with verdure, there is freedom from great clouds of dust that prevail in strong winds eastward of the Sierra, where the rain-fall as far as Ogden does not average more than one-fourth of that on the Sierra. This rain-fall is during the winter only, with an occasional cloud-burst on the eastern slope of the Sierra in summer.

THE OBSERVATIONS.

At Verdi, unfavorably situated for steadiness of atmosphere, and 4,870 feet above the sea, I was using for azimuth a telescope of 2.0 inches aperture, 25 inches focal length, and magnifying-power of about 35 or 40.

I made a regular series of azimuth-observations upon B. A. C. 4165, sixth magnitude, (Argelander,) upon two nights, using good illumination and diagonal cross-threads. I also used α Ursæ Minoris at the other elongation, and was astonished to see the companion. I was making no search for it and had no catalogue to refer to, but noted its position, &c. It was so distinct that I think I could have made, with difficulty however, measures of precision upon it.

With the zenith-telescope No. 1, I observed stars for latitude, and could make good observations upon stars of the eighth magnitude. At ordinarily low stations of 200 to 500 feet elevation, the same telescope is good for stars of the sixth-and-a-half magnitude.

At Summit station, my observations were made for one week in the open air, with a telescope of three (3.0) inches aperture, 45½ inches focal length; direct eye-piece, with magnifying-power of about 60 or 65; an inverting eye-piece, not a good one, and power of about 250. The telescope was poorly mounted upon a tripod-stand.

My principal observations were made upon the companion of Polaris, the moon, Saturn, some double stars, and the sun, and full field-notes were roughly entered at the time. The examinations were always completed before ten o'clock at night.

Polaris.—Every night the companion was distinctly visible with the direct eye-piece, not only to myself but to my aids, who have had very little experience, and even to the employé of the party. It was so distinct at times that there would have been no difficulty whatever in making observations of precision upon it. Upon two or three nights I found it as soon after sunset as I could find Polaris; the twilight being quite bright.

I noticed no jumping of the pole-star whatever, as is generally the case at low elevations.

Saturn.—The rings of Saturn were well divided at the extremities of the apparent ellipse with the direct eye-piece, and the form of the shadow of the planet on the ring plainly defined. With the inverting eye-piece, the division of the rings was carried completely around the ellipse, and the brighter appearance of the inner ring, as shown with the direct eye-piece, more plainly apparent. The markings across the body of the planet were visible, but not well marked or defined.

Upon the last two evenings, I moved the telescope until the planet was just outside the field of view, and I could detect one of the satellites.

The body of the planet and the rings were sharply defined and very steady; no jumping or irregular motion or blurring, so that I could very readily have made good observations of precision upon them.

The division of the rings was traced by my aids and employé, and by strangers who came to look on.

The moon was more familiar than the other objects, for I had made a continuous series of four or five years' observations upon it for longitude, by transits and occultations, from beach stations up to 3471 feet elevation. My present observations upon it revealed a distinctness, sharpness, and steadiness for which I was wholly unprepared. When there was the slightest unsteadiness in the early evening, the impression upon my mind was that a very thin tremulous medium was between the moon and the observer, and not as if a dense medium was immediately enveloping the moon, which is the impression conveyed at moderate elevations. When the moon was young (less than three days old) and very low, I traced the cusps to extreme fine lines of light with a wonderful distinctness; and followed the ash-gray limb very sharply all around; using direct eye-piece and power of 60. This sharpness of the cusps was marked on subsequent evenings even before dark, and the points of the cusps traced to finer lines than the finest spider-threads in our instruments. They were traced even 3 and 5 degrees farther than what I could ordinarily expect to see. The mountains were very sharply defined, and the outstanding bright points on the dark limb minute, sharp, and very steady. There was not the least haziness or unsteadiness to the fine lines of the cusps, and no blurring whatever with a power of 250. The outline of the bright limb was so sharp and clear and steady that every night I noted the irregularities throughout its border, and, with proper means and more time, could have made measures and drawings of them all. I had never seen them before. In one place, I noted a large elevation projecting so far beyond the general curve of the limb that it would have occasioned an error of one or one and a half seconds in the time of emersion of a star at that place. And all around the limb were irregularities from the general outline that would very sensibly affect the time of emersion of a star.

On the dark limb of the moon, I was able to trace the lights and shadows with great distinctness; minute points of light and shadow were visible. I traced the outline of the dark limb when the moon was nine or ten days old.

On the 9th of August, I observed the occultation of a star of the eighth-and-a-half or ninth magnitude behind the dark limb, keeping the bright part of the limb out of the field of view, and was certain of noting the time of its disappearance to the tenth of a second.

From my previous experience in observing transits of the moon, occultations, and eclipses, I have no hesitation in saying that direct measures upon the moon for diameter, &c., made under similar circumstances to the above, would, in one or two nights, be of greater value than the results of six months' observations at small elevations. For occultations, the observations would have special value, as the topographical character of the moon's limb at the points of immersion and emersion would be known; for observing transits of the moon's bright limb by using the double transit-threads, the sharpness and steadiness of the limb would give results fully equal to star-transits; and I am not sure but that the transit of the ash-gray limb could be observed under favorable circumstances in the long nights of winter. The phenomenon of a star's appearing upon the body of the bright limb before disappearing in an immersion (as I have twice observed in the case of α Scorpii) could be well studied, probably for both limbs, and also at emersion.

Photographic pictures of the moon could be taken with remarkable effects.

The sun.—Upon three days, when not on reconnaissance-duty, I observed upon the body of the sun, commencing as late as 10¼ a. m., and using direct eye-piece, power 60, sunshade (not good) showing sun pearl-color. Telescope in the open air; weather, smoky. The limb of the sun was as sharply defined and as steady as that of the moon at night; any slight unsteadiness occasionally experienced gave the impression of a very thin medium moving between the observer and the sun; or that the telescope was very gently vibrated by a light wind.

There was no confused border to the sun as if a boiling material enveloped it. The lines of the faculæ were distinctly visible on the body of the sun, and several peculiar patches noted particularly in order to trace changes in their position, shape, or brightness. Some of the lines were very fine, interlaced, and stretching from spots near the border to the border with such distinctness that it seemed as if I ought to see them projected beyond it. With a larger telescope and higher power, I have no doubt these lines could be seen changing; in one and a half hours I noted changes in a group of bright spots and lines favorably disposed and of different degrees of brightness, for satisfactory observation. Around all the spots near the sun's border I noted these faculæ; around the great spot existing August 9, well toward the middle of the sun, I saw indistinct lines and masses of faculæ, and over the body of the sun could detect a mottled appearance, the more especially when I intentionally jarred the telescope slightly.

On the second day I noted changes in the great central spot; distinctly saw the striations over the penumbra toward the central black spot, and the inflowing of the white stream across the penumbra and black spot; also saw the white stream stretching into the spot near the lower border of the sun. Around the penumbra of the great spot there was a mottled appearance that seemed as if an intermediate penumbra existed between the penumbra proper and the brighter body of the sun beyond. This secondary penumbra (?) embraced all the small and scattered spots in the vicinity of the great spot. The spots, penumbra, striations in the penumbra, and the faculæ are so marked that all might possibly be exhibited in a photograph.

On the last morning of my observations there was a heavy dew, and at 5^h 20^m a. m. I found the atmosphere too unsteady for good observations; but, at 9^h a. m. the seeing was as good as on previous days, and I verified all my previous observations.

Upon each day I was impressed with the remarkable sharpness of outline and steadiness of border of the sun, and what a capital object it was for measures of precision. The spots, penumbra, striations through penumbra, inflowing white streams, faculæ near border, were remarkably well defined and good objects for study and observation; but the secondary penumbra (?) and the mottled appearance over the middle part of the sun's body were not well made out.

From my examinations I am satisfied that one or two days' observations for the diameter of the sun, made under similar circumstances, would be better than six months' results at low altitudes. With our instruments, I felt convinced that I could observe with the same precision upon the sun as upon the moon, both for diameter and for right ascension and declination; and that the observations would have a value equal to our best observations upon stars for latitude.

The spots and penumbra appeared to me much clearer, better defined, and in greater detail than when I saw one or two spots through the 6-inch (?) equatorial, with spectroscope attached at Cambridge on the 28th of March.

Yours, very respectfully,

GEORGE DAVIDSON,
Assistant in the United States Coast Survey.

Prof. BENJAMIN PEIRCE,
Superintendent of the United States Coast Survey, Cambridge, Mass.

APPENDIX No. 10.

HARBORS OF ALASKA AND THE TIDES AND CURRENTS IN THEIR VICINITY, BY W. H. DALL, ACTING ASSISTANT IN THE UNITED STATES COAST SURVEY. (SKETCH No. 18.)

SAN FRANCISCO, CAL., *October* 22, 1872.

SIR: I have the honor to report that, in pursuance of your instructions of May 25, 1871, I sailed from San Francisco for Unalashka on the 28th of August, 1871, arriving at our destination on the 23d of September.

Continuous current-observations were kept up during the voyage, comprising in all 264 observations for temperature, 36 for longitude, and 18 for latitude.

Continuous meteorological observations have been kept up during the year, including temperatures of the sea at the surface and at the depth of five fathoms.

We lay in the harbor of Unalashka from the 23d of September, 1871, until the 23d of March, 1872, and subsequently from the 23d of April, 1872, until the 15th of June. During this period, the following observations were made:

Observations of ⊙'s altitude for time	308
Observations of ⊙'s altitude for azimuth	48
Observations of Polaris for magnetic declination	25
Observations for tidal currents in and out of harbor	336
Observations of horizontal angles from 19 stations	274
Individual observations of angles	2,272
Observations for magnetic dip, 10 sets	120
Observations for magnetic dip, Lloyd's method, 5 sets	60
Observations telemetric observations bearings and angles while running shore lines	2,470
Total distance run, (meters)	214,755.18
Number of soundings on 93 ranges	2,198
Miles of soundings	23.7

Saxton's self-registering tide-gauge No. 14 was kept running (with but one break of any consequence) from October 13, 1871, to February 14, 1872.

On the 23d of March, 1872, we sailed for Coal Harbor, Unga Island, arriving there March 30, and remaining until April 18. During this and the return voyage to Unalashka, current-observations were kept up continuously while the weather permitted, making in all about 144 observations for temperature and 20 observations for position.

At Coal Harbor the following observations were taken:

Observations for latitude	12
Observations for longitude	41
Observations for dip, ordinary, 6 sets	72
Observations for dip, Lloyd's method, 7 sets	84
Telemetric observations, bearings, &c., for shore-lines	289
Shore-lines run, (meters)	19,597.2
Soundings (second visit) on 33 ranges	1,438
Miles of soundings	13.63

On the 14th of June we sailed again from Unalashka for the Shumagins, arriving at Popoff Strait on the 16th, continuing our current-observations by the way. We remained in Popoff Strait and the immediate vicinity until July 23, 1872. Here we accomplished the following work:

Telemetric observations, bearings, &c., on shore-lines	893
Shore-lines run, (meters)	66,271.2
Horizontal angles from 12 stations	26

Number of observations	468
Soundings of 45 ranges	2,636
Miles of soundings	35.0

On the 23d of July, we sailed for Sanborn Harbor, Nagai, reaching our destination on the 24th and remaining until the 26th of August, accomplishing the following work:

Observations for latitude	32
Observations for longitude	86
Horizontal angles from 17 stations	45
Observations for angles	762
Telemetric observations, bearings, &c., shore-lines	865
Lines measured, (meters)	50,485.4
Observations of interinsular angles and bearings, at 5 stations	155
Sketches of adjacent harbors	2
Soundings on 108 ranges	962
Miles of soundings	14.35

On the 26th of August, we sailed for Little Koniushi Island, arriving at Northeast Harbor the same day. Here we took—

Observations for latitude	40
Observations for longitude	90
Horizontal angles from 4 stations	8
Observations for angles	48
Observations for vertical angles	26
Observations of interinsular angles, at 1 station	31
Sketch of harbor	1
Telemetric observations, bearings, &c	142
Lines run, (meters)	2,062.1

On the afternoon of the 28th of August, we left Northeast Harbor, and entered a new harbor on Simeonoff Island, where we obtained—

Observations for longitude	18
Soundings	23
Sketch of harbor	1
Interinsular angles and bearings, at 2 stations	132

During these short voyages between the islands, a large number of miscellaneous notes in relation to tides and currents, bearings, &c., were obtained, and also fifteen views of prominent headlands, entrances to harbors, &c. Fourteen new harbors or anchorages and ten islands or rocks were noted (and more or less definitely placed) which are not to be found on the charts.

On the 2d day of September, 1872, we left Simeonoff Island for St. Paul, Kadiak, where we arrived on the 7th. On the way, current-observations were continuously taken; and, on the 5th, we sounded on an unknown bank (in latitude 56° 13′ and longitude 153° 39′ west) in 22½ fathoms, and found cod and halibut in great abundance.

At Kadiak, we obtained sixty observations of ⊙'s equal altitudes for time, and proceeded to sea, bound for San Francisco, on the 9th of September. Current-observations were continued as usual until our arrival in San Francisco, on the 20th of September, 1872. Here, on the 16th of October, the dip was determined by the ordinary (6 sets, 72 observations) and Lloyd's methods for comparison with our northern observations. On the 18th of October, the eccentricity of our compass-needles was determined by comparison with a determined azimuth. The vessel has been placed in charge of a ship-keeper, and the party employed in office-work since our arrival.

Three rolls of tidal registers, one package each of duplicate dip-observations and abstracts of angles, and fifteen volumes of duplicate copies of observations and notes, have been forwarded to the office; also our accounts to the 30th of September, 1872.

In compliance with your instructions, I append to this report a summary of such hydrographic and other observations as require presentation in a connected form, together with synoptical tables of the observations on meteorology and currents, a diagram illustrating our observations on the latter, and on the tides of Iliuliuk, Unalashka, together with the views of headlands and sketches of harbors made during the voyage. The plotting of charts, for which the materials were obtained during the season, will require considerable time; and it is, of course, impracticable to forward them with the present report. If desired, I am prepared to draw up sailing-directions to accompany them when they are completed.

I remain, very respectfully,

W. H. DALL,
Acting Assistant in the United States Coast Survey.

Prof. BENJAMIN PEIRCE,
Superintendent of the United States Coast Survey, Washington, D. C.

NOTES ON THE NORTH PACIFIC CURRENTS, MADE ON THE VOYAGE FROM SAN FRANCISCO TO UNALASHKA, SEPTEMBER, 1871.

On leaving the California coast, in latitude 38° 50′, and longitude 125° 38′, on the 1st of September, 1871, our records show light southerly and easterly currents of a third of a knot an hour, with a temperature of 60° and 61°. At 4^h, nautical time, September 3, the temperature, which had fallen to 58°, abruptly rose to 62°, and the observations showed a change toward the west in the direction of the current. The temperature increased to 63°, at 20^h, on the 3d, and continued so for about twenty-four hours, when it fell to 62° again, and the observations indicated a slight northerly and westerly drift. On the 4th, at 24^h, the temperature rose again, reaching 65°, and averaging 63°.5 for the next twenty-four hours, with a slight drift to the south and west of about 0.2 of a knot an hour. The temperature culminated on the 6th, at 8^h, in 67°, after which it fell rapidly to 64°, which continued for the remainder of the day; the observations showing a strong northerly and westerly current, about forty-five or fifty miles broad, running at the rate of a knot and an eighth an hour.

Another sudden rise of temperature took place between 0^h and 4^h, on the 7th, reaching 69°, and averaging 68°, with a slight fall of 1° at night, the water being warmer than the air. This change was coincident with a current diametrically opposed to the previous one, running to the south and east at the rate of more than half a knot an hour. This gradually diminished in velocity, though the average temperature of 67°.5 was maintained for nearly forty-eight hours longer.

On the 9th, the temperature fell simultaneously with a succession of southeast gales, which obliged us to lay to for two days, and prevented astronomical observations from being made. On the 13th, the temperature had fallen to 52°, which was steadily maintained until 0^h of the 14th. Here, in latitude 48° 40′ and longitude 152° 35′, approximate, a sudden and very remarkable change of temperature was experienced, being an abrupt rise from 52° to 65°. The temperature of the air, though lower than that of the water, changed in a similar manner. We sailed over this hot stream for twelve hours, when the temperature fell, as abruptly as it had risen, to 51°. The width of the stream was about forty miles in an east and west direction. The impossibility of getting any astronomical observations unfortunately prevented the determination of its rate and direction.

From this time until the 18th, the temperature maintained an average of 49°.5. A current running from half a knot to a knot an hour was perceptible, which proved to run, on the 15th, in a southwesterly direction; on the 16th, nearly to the east; and on the 17th, to the south and east. On the 18th, we could obtain no observations. On the 19th, we struck the south arm of the Alaska stream, with a temperature of 49°, and a northerly and westerly velocity of nearly a knot an hour. On the 20th, we passed through an eddy, which will be hereafter referred to, having a southeasterly direction, and about half the velocity of the last mentioned.

On the 21st, we entered the north arm of the Alaska current, about latitude 53°; the temperature rose to 50°, which was maintained while we were in the body of the stream. The rate (with strong adverse wind and the vessel making a great deal of leeway) was over a third of a knot an hour at first, gradually increasing to a knot and a third on the 22d. The temperature fell two degrees (48°) as we neared the shores, and two more (46°) when the mouth of the Akutan Pass was reached, where the cold water of Bering Sea was following the falling tide into the Pacific. The following morning, however, when we were laying becalmed within the Pass, the warm Pacific water rising with the tide drove all before it, and the temperature rose accordingly.

About noon of the same day, we reached Captain's Bay, and completed the voyage.

HYDROGRAPHIC NOTES ON CAPTAIN'S BAY AND VICINITY.

The peculiar pinnacle off Cape Kalekhta, which marks the entrance into Captain's Bay, is locally known as the Priest Rock, while the inner pinnacle at the south head of Letum, or Summer Bay, is sometimes called the Second Priest.

The entire eastern shore of the bay, from Cape Kalekhta nearly to Iliuliuk Village, is more or less studded with sunken rocks, and vessels should give it a fair berth.

The first bay south of Cape Kalekhta, on the east shore of the Eastern Road, is known as Constantine Bay. A vessel called the Constantine, belonging to the Russian-American Company, attempted to enter it and was wrecked.

A reef extends clear across the entrance, and the whole bay is shoal and full of rocks. Just off the entrance we obtained 27 fathoms, smooth, rocky bottom.

The next bay to the south, on the same shore, is known as Letum, or Summer Bay. The village situated upon it is known as Imagnée. This bay may be entered until the vessel is in line with the North Head and the Second Priest pinnacle. Beyond that line, the bay is full of rocks, which do not break except in heavy weather. Near the lake, at the south end of this bay, are hot springs.

The southern end of the Eastern Road has improperly been marked on the Coast Survey chart as Iliuliuk Harbor. That name applies only to the land-locked harbor northwest of the village, formed by Amaknak Island.

Ulakhta Harbor is known to the Russians as Dutch Bay, a Dutch vessel, it is said, having been the first to enter it. The holding-ground in the middle of this harbor is good, being soft, black mud and shell, in 14 to 16 fathoms. Close to the end of the spit 22 fathoms may be had with shingly bottom. To the east of the spit, rocky shoals, covered with kelp, extend some distance into the Eastern Road. A good rule for navigators in this region is to "keep out of the kelp." There is no kelp without rocks, (though there may be plenty of water,) and there are few rocks in less than 8 fathoms which are not marked by kelp.

The shore between the entrance of this harbor and the village is very rocky, and should be avoided.

The small island in Iliuliuk Harbor is named Expedition Island. Sarycheff moored his exploring-vessel behind it during one winter.

The land to the west and southwest of this harbor, on Amaknak, is rocky and mountainous, not low and marshy, as represented on the charts.

The southern entrance to Iliuliuk Harbor has a very narrow and tortuous channel, and may be considered unfit for navigation.

The bay to the south of the south end of Amaknak is the harbor properly known as Captain's Harbor, or Port Levasheff. It is not used by vessels at present. A rock off Obernoi Point exists, which is not down on the later charts. Its position was rediscovered and fixed by our party; though we afterward found it laid down on Sarycheff's chart of 1792.

The passage between Hog Island and Amaknak is full of reefs, though a channel probably exists. It should be avoided by vessels until more is known.

Extensive shoals extend off the south end and the southwest shores of Hog Island. The bay south-southwest of Hog Island is known as Nateekin Bay. The shores are entirely broad sand-beaches, and a low valley extends several miles south from them, watered by two streams of considerable size. The Coast Survey chart erroneously represents the shores as rocky and precipitous. A good boat-harbor exists on the extreme western side; but the bay affords no protection for vessels.

The bay south of Igognak Point is known as Broad Bay. Behind the reef of Igognak, a safe anchorage exists. There is no village now existing on this point, nor is there one on Kalekhta Bay. A small village is situated on Hog Island, near its southern end.

A bank, noted for its cod, is situated two miles west of Igognak Point. It has 50 fathoms water on it, with gravelly bottom. From this bank to Ulakhta Head, the water deepens to 72 fathoms. We were able to find no depth over 72 fathoms anywhere in the bay, and outside of Captain's Bay it rapidly shoals to 68, 60, and 50 fathoms sandy mud.

The portage between Constantine and Kalekhta Bays is very incorrectly represented on the charts. It is entirely low, and the lakes extend from beach to beach. With regard to the approaches to Unalashka, it may be noted that the tide-rips (which occur at half-tide) are not dangerous to vessels except in severe storms. They are in general to be met with at the northern entrance of the Unalga and Akutan Passes, and are especially violent off the northwest point of Akutan Island.

The Unalga Pass is preferable for steamers and small vessels. The depth of water is about 60 fathoms, with a rocky bottom, and the tide-rips are less severe than in the Akutan Pass. For large vessels, the latter affords more room, and they are in less danger of being drifted ashore by the tidal currents. It is a noteworthy fact that there is never any wind over the tide-rips, however fresh it may be blowing before they are reached and after they are passed. I can offer no explanation of this well-attested fact, which I have myself observed on several occasions.

NOTES ON THE METEOROLOGY OF UNALASHKA.

The table herewith forwarded contains the means and extremes of our meteorological observations. The prevalent winds in winter are southeast, and bring rain and fog. Northeast winds bring clear weather, and north and northwest, snow. The heaviest gales are said to come from the southwest; the worst we experienced were from the southeast. The winds generally change from east to south and west, with the sun, when they change, a fact corroborated by the testimony of the inhabitants, and by Veniaminoff in his work on Unalashka. The high mountains and deep valleys, acting as funnels, change the course of the wind about the island before it reaches the bay, and greatly increase its force. It is rarely possible to judge correctly of the direction or force of the wind outside, when in the bay, and *vice versa*.

From similar causes, we have been unable to connect the changes of the barometer with those of the winds in such a manner as to afford any guide for navigators. Westerly winds usually bring high barometers, and southeasterly winds the reverse; but exceptions are very common. Indeed, during one of the fiercest gales we encountered during the year, at Coal Harbor, the barometer stood at 30.420, while a few days before, with a strong northeaster blowing, it stood at 28.634. No ice obstructs the outer road of Captain's Bay in winter as a rule. Once, after two weeks of northers, floating ice from the north did enter the bay, and remained for some time; but this is the only case on record.

Skim-ice, very destructive to boats, will form during every calm winter-night, but it never attains any thickness unless by the freezing of wet snow which may fall upon it. In any case, it will be broken up by the first strong breeze.

The force of the winds, even in the land-locked harbor of Iliuliuk, must be felt to be appreciated. It surpasses everything I have ever experienced elsewhere. The squalls are especially violent in Ulakhta Harbor and in Iliuliuk Harbor, with westerly or southeasterly winds.

Shocks of earthquake and other volcanic phenomena are of almost daily occurrence, though none of great severity happened during our visit. In 1866, however, half the village was shaken down, and a portion of the spit on which it is situated was rendered uninhabitable by the sinking of the surface nearly to a level with that of the sea.

As a rule, the winter-nights are clear, and astronomical observations could, except for the wind, be very frequently obtained. In summer, however, the reverse is the case, and hardly a clear night or day will be met with from May to August.

The aurora borealis, very faint, was once or twice observed as a white glow on the northern sky. It is said to be very rare here.

It may be mentioned here, for want of a more appropriate place, that in August we observed lightning in the Shumagins during a northeaster, the first reported as observed in this region. Also after shortly leaving Kadiak, in September, 1872, as a squall was passing to leeward of the vessel, two miles distant, a lunar rainbow, forming a complete arch, and faintly exhibiting the colors of the spectrum, was observed. Parhelia and paraselenæ are of rather common occurrence in these regions, and usually precede a storm.

TIDES OF ILIULIUK.

The tides of the Aleutian region have long been considered as likely to afford a key to many problems connected with the general subject, and hence any contribution to a knowledge of them cannot fail to be of interest. The only observations on these tides which have yet been made, so far as I am able to discover, are those of the United States Coast Survey. A tidal observer was engaged by Assistant George Davidson during his visit to this region in 1867, and prosecuted his labors for some time with a simple box-gauge and staff. These observations closed with the dissolution of the Russian-American Company, and the removal of the observer to Unga Island from Unalashka. His records were taken charge of by Capt. Charles Bryant, special agent of the United States Treasury, and by him forwarded to the Coast Survey Office at Washington; but I have not had access to them, and the following remarks are solely the result of our own observations. The latter were taken with Saxton's self-registering gauge, (No. 14,) carefully regulated by chronometers to mean local time, and extend, with but one break of any consequence, over the time from October 13, 1871, to February 14, 1872.

These tides belong to the "mixed type" emphatically, and at least a year's observations would be necessary to unravel the tangled skein and afford materials for a prediction-table. They agree, in most particulars, with the tides which prevail over the entire northwest coast of America, though a thorough comparison would probably expose some individual peculiarities.

Something may be gained from our present fund of observations, and so far as they supply the materials, tables (herewith forwarded) have been prepared according to the method recommended by Assistant Henry Mitchell in his "Tides and Tidal Phenomena." The result of scattered observations among the islands to the eastward of Unalashka shows that they are of the same type, though the range or volume of the tide increases as we go eastward, being nearly twice as great in the Shumagins as it is in Iliuliuk.

The method suggested by Mitchell, as will presently be shown, appears to need some modifications, at least in theory, before it can fairly be applied to the peculiar tides of this region. This report will be confined, as far as possible, to a statement of their observed characteristics, leaving the reference to their proper causes, of the various effects exhibited, to those who have greater facilities for research, and more experience in the treatment of tidal phenomena. During two-thirds, or thereabouts, of each lunar month at Iliuliuk, two high and two low waters per day may be observed. For the remainder of that period, one high and one low water occur daily. The latter are here designated as compound tides, being evidently the result of the merging in one diurnal tide of the previous semidiurnal tides. The different kinds will be considered separately. As a whole, these tides attain their maximum range about the time of the moon's maximum declination, north or south, and their minimum range about zero declination; but the highest water occurs about the time of the moon's quartering, apparently without much reference to the declination. The bench-mark to which these observations refer (a line cut into a perpendicular rock near the gauge) was 13 feet above the zero of a graduated staff outside the crib. The plane of reference, being the mean of all the low waters observed at that station, was 4 feet on the staff, or 9 feet below the level of the bench-mark.

The following general observations may be mentioned:

	Ft. In.
Plane of reference (as above) = mean of *low* low waters	0 00
Mean of *high* high waters, *i. e.*, those rising more than 4 feet 4 inches above the plane of reference	4 10½ +
Mean of *all* high waters	3 09.7
Mean of *all* low waters	1 02.7
Mean level of water	2 06.2
Mean of tides which fell below the plane of reference	—0 06.7
Highest water observed	+6 00
Lowest water observed	−1 05.5
Mean rise and fall	+2 07

In platting the profile which accompanies this report, the observations of the high waters, and their succeeding low waters, were referred, respectively, to the upper and lower transits immediately preceding. The order thus established has been carried through the entire profile, and the tides colored accordingly; that due to lower transits being blue, and that due to upper transits carmine, forming, where they overlap, a purple, of which a slightly lighter shade has been used to define more clearly the compound form of the tide. The high and low water assigned to each transit have been used as abscissæ on the ordinate reserved for the transit. In most respects, the figure explains itself, (Sketch No. 18.)

We may now proceed to examine the different components of the tide separately.

COMPOUND TIDES.

These tides invariably occurred during the moon's north declination, and at no other time. Their greatest height was usually reached about one lunar day after the moon's maximum north declination. Their greatest range was at the time of maximum north declination.

The other tides united to form the compound tide from one to three lunar days before the north maximum, and it ended by their separation from three to six and a half lunar days after the maximum; their duration varying (relatively with the interval between the maximum north declination and the time of full moon) from five to eight lunar days. The shorter the interval referred to, the greater the duration of the compound tide, and *vice versa*, without reference to the priority of either the phase or the declination.

A greater portion of the increase in duration of any epoch of this tide appears in that portion of the epoch which follows the maximum declination, rather than in that which precedes it. The last-mentioned portion, as well as the range, appears larger when the phase precedes the declination than when the declination precedes the phase.

The increase in height of this tide toward the time of maximum declination, as well as a smaller increase apparently due to the phase, does not increase the range in like proportion, as the line of low waters bears to the plane of reference a relation very similar to that sustained by the line of high waters, both rising and falling together, in a general way.

	Ft. In.
Highest observed compound tide	+5 03.0
Lowest observed compound tide	−0 08.0
Greatest observed range in one day	4 04.0
Smallest observed range in one day	3 00.5
Average diurnal range	3 11.0

SEMI-DIURNAL TIDES.

The period which elapses between the end of one epoch of compound tides and the beginning of another averages twenty lunar days, being longest when its full moon approximates most nearly to a zero declination, and *vice versa*. During the time covered by our observations, the duration of this period varied from nineteen to twenty-one lunar days. While it lasts, two tides occur daily, due to a combination of forces, which the material in hand is insufficient to exhibit fully.

Mitchell, in his paper already referred to, states that, in mixed tides, similar elements follow upper transits in north declination and lower in south declination, and upper transits in south and lower in north declination. (*Loc. cit.*, *p.* 17.)

This generalization will not always apply to the tides of this region, (assuming the semi-diurnal waves of the same day to be of equal age,) as the change in the nature of the tidal elements of one of the waves, at least, does not invariably occur until a greater or lesser period has elapsed after the moon's change in declination. This period varies from two to ten lunar days; the north declination of the moon actually lasting longer than the south declination, and also exerting an influence upon the tide for a longer time after she has passed south of the equator than is the case under the opposite circumstances.

Therefore, it has seemed preferable, in this preliminary work, (hereafter to be revised by abler and more experienced hands,) to plat the tides as they actually occurred, rather than to attempt to shape the observations to fit a hypothesis seemingly at variance with the facts.

Treated in this way, these tides resolve themselves naturally into two series, apparently corresponding in nature, though not in duration, to those referred to by Mitchell. They finally unite, as previously mentioned, to form a diurnal compound tide.

The time occupied in passing from the middle of one compound series, through the various changes, to the middle of the next compound series, is about a month. The duration of the semi-diurnal tides is somewhat more than two-thirds of this time. The two are theoretically referred to the two orders of transits, upper in north and lower in south declination, and *vice versa*. The north declination, more enduring and potential, exercises a greater amount of attraction, and is thus apparently enabled to overcome the various opposing forces, and combine both waves in one compound tide. In this, nevertheless, the various elements can be more or less distinctly traced, though not sufficiently pronounced to form a true tide. During the epoch of south declination, the attraction of the moon, even at its maximum, is insufficient to combine the two waves.

It will be sufficient for present purposes to describe their respective characteristics.

TIDE REFERRED TO LOWER TRANSITS.

This tide, colored blue in the profile, preserves in its total range a greater elevation above the plane of reference than the other, though its range averages much less than that of the other. The highest waters appertain to this group.

This tide reaches its maximum in height about the time of the moon's first quarter, that maximum being greatest when the moon's zero declination most nearly corresponds with that phase; or, in other words, when the moon exercises the least attractive influence. The maximum height is smallest when the quadrature approximates most nearly to the maximum of declination, north or south.

In these respects, and in some others, it is the opposite of the other semi-diurnal wave. The latter seems to be governed by the declination to a preponderating extent, while upon this the phase seems to exert a more exclusive influence.

As the phase gained upon the declination about four lunar days a month, (that is, the interval between new moon and the preceding zero declination increased at that rate,) during the period covered by our observations; so the body of this tide seemed to gain on the body of the other in time. The irregularities of the periods of phase and declination, however, prevent the gain of the tide from being exactly proportioned to the gain of the phase.

From October 13, 1871, to February 14, 1872, they were respectively as follows:

	Start in October.	November.	December.	January.	February.
Interval between new moon and zero declination.	1 transit.	5 transits.	9 transits.	13 transits.	18 transits.
Interval between zero declination and time of preponderance of blue tide.	8 transits.	10 transits.	15 transits.	18 transits.	20 transits.
Gains of ●	....	4 transits.	8 transits.	12 transits.	17 transits.
Gains of tide	....	2 transits.	7 transits.	10 transits.	12 transits.

This tide, being referable to the lower transits, should, according to the theory, have preponderated over the other in height immediately after the moon's southing, but this did not actually take place until some days (four to ten) after; a fact not easy to explain, even if, taking the heights as an index to the age of the tide, (as maintained by Airy,) we consider this tidal wave as being from four to ten days old. In that case, we should have to admit the possibility of a difference in age between the semi-diurnal waves of one day at one locality—and not only a difference, but a variable difference—for the other wave appears to agree very constantly and promptly with the declination in its changes in height and range.

The "blue" tide emerges from the compound tide about the time of the south moon's least influence; *i. e.*, about her third quarter. The shorter the interval of time between this phase and the zero declination, the earlier the tide appears. It is inconsiderable when compared with the "red" tide, both in height and range, increasing slightly in the latter about the time of zero declination, and then diminishing, reaching sit minimum range about the time of new moon. The height and range then gradually increase, and, at the varying period previously mentioned, it leaves its subordinate position behind and below the "red" tide, and apparently passes the latter, taking the lead in height and rapidly increasing in range, the last being greatest at zero declination. If the body of the "red" wave retained the same position with regard to that of the "blue" one, the former would resume its superiority about full moon. As before stated, however, the "blue" tide gains with the gain of the interval between the phase and zero declination, and, therefore, it happens that, with the approximation of the full moon to maximum north declination, the "blue" tide has gained so much in the race that both are engulfed in the compound tide before the "red" one can attain its original position in advance. A full year's observations are required before the details of the varying and persistent conflict can be enumerated. It is probable, however, that at some time during the tidal year, the "blue" tide emerges from the compound tide, above and before the other, though only a hint of this is to be found in our observations.

TIDE REFERRED TO UPPER TRANSITS.

It now remains to describe the peculiarities of the "red" tide.

It is naturally referable to the upper transits, but appears to be mainly governed by the changes in the moon's declination.

When the compound wave separates into its dual elements, (always in north declination,) as far as our observations go, the "red" tide at once takes the lead, rapidly increasing its range and (in general) its height. It reaches its maximum range within half a lunar day of the moon's maximum south declination. It attains its maximum height sometimes before, sometimes after that time, varying with the relative interval between the time of new moon and that of her maximum south declination, but varying so irregularly as to render any generalization on the matter impracticable without more material in the shape of observations.

At the variable period referred to in the account of the "blue" wave, this tide falls behind the latter in height. It continues in this subordinate position until (when the full moon is sufficiently distant from maximum north declination) about the time of full moon, or a period varying with the advance of the phase upon the zero declination, but always some days after the latter.

It then resumes the place in advance and the superiority in height which it had lost. At the same time, it diminishes very rapidly in range until it is merged with the "blue" in one compound tide.

As before mentioned, however, as the time of full moon and maximum north declination approximate, (through the gain of the phase on the declination,) this tide becomes unable to regain its superiority, before it is merged in the compound tide, in what would otherwise be the moment of victory.

MEMORANDA IN REGARD TO THE SEMI-DIURNAL TIDES.

	Ft. In.
Highest upper transit (red) tide, high water	+5 07.0
Smallest upper transit (red) tide, high water	+1 08.0
Lowest low water transit (red) tide	—1 05.5
Greatest diurnal range of "red" tides	+6 04.0
Smallest diurnal range of "red" tides	+0 01.0
Average diurnal range of "red" tides	+3 01.0
Highest lower transit (blue) tide, high water	+6 00.0
Smallest lower transit (blue) tide, high water	+1 09.5
Lowest low water	—0 11.5
Greatest diurnal range of "blue" tide	+4 03.5
Smallest diurnal range of "blue" tide	+0 00.5
Average diurnal range of "blue" tide	+1 08.5

ON THE TIDAL CURRENTS OF UNALASHKA.

The old residents of Unalashka believe the tide to come from the eastward through Akutan Pass, and this belief is fully corroborated by our observations.

A series of observations for determining the relation between the oceanic tide and the tide as it appears at Iliuliuk was decided upon in June, 1872. The circumstances which led me to undertake the observations in the Pass unassisted were detailed in my report of progress.

The station selected was a small islet in the middle of the Akutan Pass, one of a group known as the Gull Rocks. No other position near Unalashka was at once so accessible and less subject to the action of disturbing influences on the tide.

A sunken buoy, with float attached, and a surface buoy were used in determining the currents. The simultaneous observations of the height of the water were read on a graduated staff, and the temperature of the water was determined with a Casella thermometer. The weather was eminently favorable for observation, being calm, and without any ground-swell; the sky was overcast. The observations in the pass comprised readings every ten minutes for twenty-four consecutive hours. Those at Unalashka began before and lasted longer than those taken in the Pass, but were otherwise simultaneous. The results may be regarded as approximating to general accuracy, and are briefly as follows:

I. The tide attains its maximum and minimum in the Pass about two hours before these points are reached at Iliuliuk.

II. The difference between the Iliuliuk tides and the Pass tides, in range or volume, is about eight inches. Using the corresponding lowest waters as a plane of reference, the Iliuliuk tide is the higher.

III. The tide in reaching Iliuliuk, through the various passage-ways about to be described, is shorn of some of its irregularities in form; and the distinctness of the two elementary waves of which it is compounded is to a great extent lost. A reference to the accompanying profile will exhibit these propositions more clearly. With regard to the current caused by the action of the tidal wave, it appears:

IV. The rising tide is stronger than the falling tide.

V. The rising tide advances on the surface a little before the water at a depth of 6 fathoms, and begins to move northward. It also creeps along the shores slightly before it becomes noticeable in mid-channel.

VI. The temperature of the water which comes in with the tide is a degree higher than the Bering Sea water which it drives before it. In this case, the temperatures were respectively 45° and 44°.

In regard to proposition I, it may be remarked that the two hours which elapse before the tide reaches its full height at Iliuliuk, after having done so in the pass, cannot be considered as entirely taken up with the regular march of the tide. Much of this time is lost in forcing a passage-way into Bering Sea, during which process tide-rips are formed. These rips normally are just beyond the northern entrance of the Pass, and only occur within the Pass when, to the barrier of Bering Sea water, is added the additional force of a northerly wind.

In proportion to the strength of the latter, the rips will approximate more nearly to the middle of the Pass, and will be more violent. They are never known to occur to the south of the middle or smallest diameter of the Pass, and with southerly winds are comparatively insignificant or even wanting. These facts indicate that the bulk of the tidal flow is from the south, northerly and westerly in the direction of the axis of the Pass, and afterward with the trend of the islands.

Observations taken off the heads of Captain's Bay, April 22, showed a surprising difference between the surface-temperature of Bering Sea and the deep water; the former being 39°, and the latter, even with the correction applied, falling below the freezing-point. It appears that the stratum of warmer water (which is clearly due to the influx through the passes of warm water from the northern edge of the Alaska current) was extremely thin, less than 28 fathoms, and probably not much over 15 fathoms. The distribution of life also corroborates this evidence; the animals living on the bottom of Bering Sea being all arctic forms, while many of those of the shores and shallow water are of warm temperate types. Among the former may be named *Astarte, Car-*

dita borealis, *Peronæa*, &c., and, among the latter, *Nacella*, *Scaphella*, and *Cancellaria*. After clearing the Pass, the tidal current curves to the west and south, striking full on the west shore of Captain's Bay, and is reflected to the southeast. But a small part of it passes to the eastward of Amaknak Island; the majority finds its way through the strait between South Amaknak and the west side of the bay, one branch being deflected to the northeast by Obernoi Point and entering Iliuliuk Harbor. The accompanying sketch shows the general course of the flood-tide in the southern and eastern part of Captain's Bay and its appertaining harbors in calm weather.

The ebb takes a nearly reverse direction, except that a large portion of the water accumulated in the bight forming the east entrance passes out through Iliuliuk Harbor, south, and then northwest through the heads of Captain's Harbor.

Thus, in calm weather, with an ebb-tide, there is usually a strong current into Iliuliuk Harbor, though, with a rising tide, but little runs out in a reverse direction. All this, however, may be altered by the wind prevailing. If it be north or northwest, (tide rising,) a larger part of the current may be deflected to the east of Amaknak, and we shall have a current into instead of out of Iliuliuk Harbor. A northeast or southeast wind has a contrary effect. With ebb-tide and a southerly wind, a strong current may run out of the northeast entrance of Iliuliuk Harbor, the egress of the water by its usual channel being impeded; and these conditions may be indefinitely varied. Taken as a whole, however, in Iliuliuk Harbor, the tide rises and falls principally through the southern entrance. Although it is frequently stated that the height of the tide here is much affected by the wind, yet no important difference attributable to this cause presented itself during our observations.

It is stated that the Bering Sea tides increase in volume to the eastward, reaching their maximum (16 to 22 feet) in the narrow estuaries of the Kuskoquim and Bristol Bay, and diminishing to the northward and westward.

THE ALASKA CURRENT.

I use the above appellation to designate, in this report, a current which bathes a greater portion of the coast-line of this territory than any other one oceanic stream; and to which, in great part, is due the peculiar climate of most of the Alaska coast south of Bristol Bay. Certain peculiarities in the distribution of animal and vegetable life may also be reasonably referred to its influence. The existence of such a current as a whole, was, to the best of my knowledge, first contended for by Assistant George Davidson, United States Coast Survey, in an able argument, (Coast Survey Report for 1867, p. 205,) in which the high isothermal line of the shores of the Gulf of Alaska, the isolated but rather numerous observations of the older navigators, the Russians and others, and the notes of the Coast Survey geographical reconnaissance of Alaska in 1867, were all brough to bear upon the subject. During the last fourteen months, I have collected a number of addi, tional notes upon those portions which we did not visit ourselves, the testimony being all one way; and, indeed, there is hardly any room for a doubt upon the subject. The existence of a continuous current, trending with the shores of the Gulf of Alaska, the peninsula of Aliaska, and at least the eastern portion of the Aleutian Islands, will be assumed here. Its origin by a deflection of a portion of the great North Pacific stream in longitude 148° west has been treated of in the report of Assistant Davidson already alluded to. As a contribution to the knowledge of the subject, I have to offer a summary of observations taken under my direction by our party on that portion of this stream situated beween longitude 150° and 167° west, and extending south of the coast from two to six degrees in latitude; also some notes obtained from others in relation to those portions of the current lying to the eastward.

Our observations were taken during three voyages between Unalashka and the Shumagins, respectively in March, April, and June, 1872, on the latter part of our voyage from San Francisco to Unalashka in September, 1871; during our stay among the Shumagins from June to September, 1872; and on our voyage thence to San Francisco via Kadiak. A synopsis of the observations is given herewith, comprising not only the notes on currents and temperatures, but also the direction of the winds at the time of observation. The thick and foggy weather and frequent severe storms which prevail through a great part of the season have somewhat interrupted the continuity of our record. The great amount of leeway made by the Humboldt under all circumstances, has, in most cases, tended to diminish the apparent rate of the current; and it was impossible to obtain observations as frequently as could be desired, from the prevalence of fog and clouds. Bearings on the land were also unavailable for the most part, as the coast-lines on the only charts in existence are laid down very inaccurately. Nevertheless, the material collected is less meager and more interesting than might have been expected, and a greater knowledge of the tides of this region will probably reconcile many discrepancies in the observations of the older voyagers. It must constantly be kept in mind that, like all currents which hug the coast, especially if the latter be irregular or studded with islands, this current is more or less affected at every part of its course by the irregularities of the shore and depth of water, and the never-ceasing action of the winds and tides. It is not surprising that its true course should often be masked or temporarily diverted by these agencies. An officer of the revenue marine on duty on this coast has even reported that, in his opinion, "the currents along this part of the coast are controlled entirely by the winds."*

It has, however, been proved by our observations that, in the body of the current off shore, a southerly and westerly drift of at least a knot and two-thirds an hour may be maintained directly in the teeth of a strong adverse wind. I will leave the discussion of these modifying agencies for the present, and give, in as compact a form as possible, the general characteristics of the current within the region over which our observations extended. The general course of the current is about west-southwest, varying from this to the north and south according to the locality and the modifying agencies, which increase in power as we approach the coast. In general, it trends with the trend of the land. At some indeterminate point, the current deflected from the great North Pacific stream divides into two branches, one of which passes between Kadiak and the mainland, hugging the coast, and finally striking off to the southward in the vicinity of the Shumagins. The other has a more evenly western course, and its extreme southern limit is yet undefined, but may probably be found between latitude 51° and 52° north. Between these two arms, a counter current or eddy exists, running in an easterly direction.

September 19, 1871, and March 26, 1872, we found a northwest by north current of nearly a knot an hour in latitude 52° and longitude 163° west, approximate; but about sixty miles to the north of this, on the 20th of September, we came upon the eddy above mentioned, having a velocity of two-thirds of a knot an hour, with a temperature of 49°; and again on the 27th of March, 1872, we reached its upper or northern edge when lying to, and found a velocity, against a strong adverse wind, of a quarter of a knot an hour, with a temperature of 40°. Between longitude 157° and 163° west, this eddy appears to be very narrow, probably not exceeding twenty miles in width, and has a temperature about the same as the north edge of the south arm of the Alaska current. Later in the season, we encountered it (or a similar one) again, and found it striking to the southward, where, pressed by the northern arm of the Alaska current before reaching the shelter of Kadiak, and then continuing in an easterly direction south of that island close to its shores; its rate averaging a little less than a knot an hour, and its temperature about 52°, nearly the same as that of the south arm of the Alaska current, which we entered a few days subsequently. The counter current mentioned by Lisiansky, and encountered by Assistant Davidson in 1867 when searching for the Pamplona Rocks, is very probably the same. The southern edge of the south arm would appear from our observations on the voyage from Kadiak to San Francisco to be met with in about latitude 50° 30′ north; but very many more observations must be made before we can arrive at a correct understanding of these details. There can be no doubt that we struck the great North Pacific easterly stream, with a temperature of about 60°, on the 14th of September, in about latitude 48° 37′, approximate.

Our observations of September, 1871, give a temperature at the surface of 49° for the north arm near its southern edge, 50° for the middle of the stream, gradually decreasing to 48° on the edge, which impinges on the islands. At the same time, the temperature of the Bering Sea water was 46°; and, the tide turning to rise while we were in the Akutan Pass, the influx of Pacific water was marked by a rise of one degree in temperature of the surface. A similar rise of temperature was observed while making tidal observations in the Pass in June, 1872. In March and April, the north edge averaged 37° and 37°.5, the center of the current 40°, and the southern edge 38°. At no time was it practicable to obtain trustworthy temperatures of the water of this current at any depth below the surface. In September, 1872, we were able to obtain observations at 25 fathoms below the sur-

* Report on a cruise in Alaska, Capt. J. W. White, Senate Ex. Doc. No. 8, January, 1869.

face of the counter current or eddy before described, and found the temperature, when the correction for the thermometer was applied, to be the same as at the surface.

In June, 1872, the temperature of the north edge of the north arm had risen to 43°, farther south 44°, though we did not reach the center of it, which was not improbably a degree higher. The temperature of the south arm in September, 1872, ranged from 49° to 52°.

With regard to velocity, that of the north arm may be safely set down as at least a knot and a quarter an hour in those parts most free from the action of external agencies. It is much greater in many places where the actions of the tide and wind combine to accelerate it, and correspondingly less when they combine to retard it.

The rate of the south arm appears to be about a knot an hour, though our opportunities for observing it were so few that this must be regarded as merely approximate. On the first occasion in September, 1871, it was 0.92 knots per hour; on the 26th of March, 1872, 1.63 knots; and farther east, in September, 1872, we determined it to be slightly over a knot an hour. In regard to the width, the north arm may safely be assumed to average about a hundred miles. That of the south arm is probably twice as great, but further observations are necessary to determine this accurately. Captain Archimandritoff, late of the Russian-American company, informs me that that portion of the north arm which passes north of Kadiak (sending a branch into Cook's Inlet) through Shelikoff Strait, has a velocity of five or six knots an hour with the tide favoring. M. Aphonse Pinart, a gentlemen who has lately explored this region in the interests of philology, gave me a graphic account of his passage across the Shelikoff Strait. According to his statement, the current is very strong; the passage in skin-canoes, from the peninsula to the island, is commenced from a point on the former twenty miles to the eastward of the point on Kadiak, which it is proposed to reach; the current, even at slack water and in calm weather, (when alone it is practicable to cross,) carrying the canoes over that distance to the south and west. I take it to be this portion of the stream which, crossed by the barrier of the Shumagins, pours through it principally by two channels; the main one being the deep gap between Nagai and the islands to the westward of it, and the other the strait between the north end of Unga and the peninsula. The former strikes full on the south end of Unga Island, near Delaroff Harbor, and is slightly deflected to the southward. It may be mentioned here that the current in these straits of Nagai is very strong. The tide has no perceptible effect in retarding it. Vessels at anchor there always tail to the southwest, and with a southwest or west wind an extremely bad sea is produced. The south end of Unga is, however, the gainer. This locality becomes green weeks before the surrounding country, and vegetables grow more rapidly and mature earlier than elsewhere, on account of the balmy air and higher temperature brought by the current.

The branch which passes to the north of Unga is less powerful, but by no means insignificant, also deflected to the southward by the islands and shoals off the coast of Aliaska, it joins with the Nagai branch, and both dash upon the rocks and reefs of Sannakh with all their velocity. The current at this point attains, under favorable circumstances, a far greater rapidity than came under our notice elsewhere, and may reach three or four knots an hour at times when wind, tide, and current are passing in one direction. The deflection caused by the Sannakh reefs turns this portion of the current to the south of southwest for a time, but it soon regains its normal course, trending with the islands and having its center of velocity from thirty to forty miles south of them, when in the vicinity of Unalashka.

It is an established fact that the tides of this region rise toward the west, and fall toward the east, approximately; this is universally known among the natives and residents of the region, and is confirmed by my observations in the Akutan Pass. This course being coincident with (and perhaps caused by) the general trend of the coast and direction of the currents, it naturally follows that the rate of the latter inshore is accelerated with the rise, and, to some extent, retarded by the fall of the tides, particularly in passages and straits, and their vicinity. The fall, being opposed to the direction of the current, is always less powerful than the rise. This is especially noticeable in the vicinity of the passes, where the outward current is so effectually checked by the coast-current that but a very small proportion of the Bering Sea water enters the Pacific, while a correspondingly large proportion of Pacific water pours into Bering Sea with every flood-tide. How far this may hold good to the westward of Unalashka I cannot say; but it is eminently true throughout the region we have visited. So, too, in those passes which have a more nearly north and south axis, like Unimak and False Pass, we find fewer tide-rips and fierce bores, such as prevail in Akutan and Unalga Passes, where the axis inviting the influx of the current is nearly east and west.

The force of the wind in affecting the direction of the current, except in narrow passages and in shoal water, has, I think, been much overrated. In shoal water, like the eastern half of Bering Sea, the wind is all-powerful, and drives the water irresistibly before it. But in deep water, such as the offshore portions of the Gulf of Alaska and the northern border of the North Pacific, I am inclined to believe that the principal result of a strong wind opposed to the current is the creation of a very bad sea. Small and narrow bodies of water, like the deflected strip of current at Sannakh, may be diverted from their usual course, and in narrow passages the power of the wind in retarding the opposed current cannot be questioned, but our observations lead me to think that elsewhere its effects are comparatively insignificant, or, at all events, less obvious. A long and careful series of observations would be needed to decide the question, which presents the greater difficulties from the fact that the agencies to be investigated in their very nature present almost insurmountable obstacles to observation.

EFFECT OF THE ALASKA CURRENT ON THE CLIMATE OF THE ALEUTIAN DISTRICT.

The temperatures of the sea-water at the surface and at a depth of five fathoms were observed, during the entire year, as continuously as circumstances would permit. The means and extremes for each month and quarter and for the year are appended in the meteorological abstract herewith forwarded. It will be seen on comparison that the temperature of the Bering Sea water below the surface averages about 3° lower than the temperatures taken south of the islands during the same months, and this appears to hold good throughout the year. This would give a yearly average temperature for the Alaska current of about 45°, which cannot be far from the truth. It is a significant fact that the mean annual temperature of Unalashka is within a degree of the mean temperature of the deep-sea water for the same period. The latter averages a little higher and the surface-water a little lower than the mean temperature of the air. All three do not vary among themselves more than a degree and a half. The air, however, reaches its maximum in August, while the sea-water is warmest in September.

THE CIRCULAR CURRENT OF BERING SEA.

I make use of this term to designate a current supposed by Assistant Davidson to result from the impinging of the Bering Sea branch of the Kuro-Siwo on the island of Saint Lawrence, and which is described by him as sweeping around that sea, in a subcircular manner, from west to east, south, and finally west again, north of the Aleutian Islands. We have not visited the western portion of Bering Sea, and can therefore supply no information in regard to the existence of such a current there; but I have collected a number of notes from others, and made some observations on the eastern portion of the sea. A more or less intermittent current does appear to exist around the eastern and southeastern shores of Bering Sea, but it may be accounted for by the following causes: The large rivers of that coast all *débouche* toward the south and west. The tides rise toward the north and fall toward the south and west with great force in the numerous shallow estuaries east of Unimak Pass; while the westerly drift north of the islands, as far as Unalashka, has been shown to result in great part from the influx of Pacific water with the tide. The whole of that portion of Bering Sea is exceedingly shallow, averaging less than thirty fathoms; and it may reasonably be supposed that this body of water, with the great river-currents, the tides, and the tidal currents through the passes, all pushing on its circumference in one direction, would receive a motion in that direction varying in velocity with the variations in the above-mentioned factors. The following notes have a bearing on this subject:

In July, 1870, Bernard Bendel, esq., in the schooner Lizzie Sha, started for Unalashka from the mouth of the Kuskoquim. The first land sighted was the point north of Destruction Volcano, in longitude 164° 45′ west, approximate. A strong westerly wind and clear weather prevailing, they beat all day off this point without being able to make any westing. The night was foggy, and they continued to beat against the same wind until 9 a. m. the next day, when the fog lifted, and they found themselves, to their great astonishment, off Akhun Bay, in longitude 165° 45′. The wind then hauled a little to the northward, so that they could barely run to westward; and toward night, the fog rising, they proposed to run into Akhun Bay, as they supposed, but, on examination, the land proved to be that of Unalashka, near Cape Kalekhta. A dead calm prevented their working into Kalekhta Bay, and during the night they were carried by the ebb-tide to the eastward as far as the longitude of Unalga. The first stretch was made in twenty-four hours.

On a voyage toward the Kuskoquim in the same season, when off Cape Newenham, it shut in calm and foggy. In the morning, the fog lifted, and they were off Hagemeister Island, having drifted the whole of that distance in twelve hours.

When on the Frances L. Steele, in 1868, bound from Amak Island toward Unimak Pass, we were unable for several hours to make headway against an easterly current, although the wind favored. With the turn of the tide, however, though the wind meanwhile had shifted to an unfavorable quarter, the vessel was able to make a fair course toward her destination.

Capt. E. Hennig, of the Alaska Commercial Company, who has spent several years in this region and made many voyages between Unalashka and the Kuskoquim and Nushergak Rivers, informs me that the currents in this part of Bering Sea are very variable, and, in his opinion, depend in great part on the tides.

The above notes, taken together with the low temperature of the water below the surface, and its slight depth, seem to imply that no regular oceanic current exists on the extreme eastern border of Bering Sea, even if the small depth of water would admit of it.

It is a well-known fact that the ice-line in winter describes a curve from the Siberian coasts in latitude 62° to 64° north, inclosing the Saint Matthew group of islands, reaching south nearly to the island of Saint Paul, of the Pribiloff group, and thence extending eastward into the head of Bristol Bay. This ice first gives way to the westward, along the Siberian coast, and the whalers press in on this line every spring, following the open water until they reach the Arctic. To the east of Saint Matthew, the ice endures much longer, and a passage into Norton Sound can frequently be made by going to the westward of Saint Lawrence, while the ice to the northeast of Saint Matthew, between Saint Lawrence and the mainland, still presents an impenetrable barrier. This would hardly be the case were any large portion of the warm current deflected to the eastward by impinging on Saint Lawrence Island.

According to information furnished by Captain Chapman, of the Hannah B. Bourne, who has wintered in Plover Bay and at Unalashka, on one occasion a whaler, stove in the ice off Cape Saint Thaddeus, drifted into Seniavine Strait shortly after the ice passed out of the latter place.

Also, in the spring of 1871, the ice between Plover Bay and Saint Lawrence Island gave way late in May, and, in the middle of June, a vessel might have been navigated there safely if she could have forced her way through the floating ice to the southward. The ice on the west of Saint Lawrence Island, according to Captain Chapman, is always open before that to the east and southeast of it. In 1869, Capt. E. Hennig, in the schooner Hutchinson, bound for Saint Michael's, Norton Sound, encountered floating field-ice in the month of June. This was in the latitude of Cape Romanzoff, about half-way between Saint Matthew, Saint Lawrence, and the mainland. At the same time, Capt. E. E. Smith, in another vessel, went to the westward of these islands, and found all clear of ice. Captain Hennig, after working through one hundred miles of this ice, found all clear to the north of it. It appeared to extend from the islands to the main.

In the spring of 1872, Captain Archimandritoff, in the schooner John Bright, on an exploring expedition, fitted out by the Alaska Commercial Company, visited the Pribiloff Islands in the early part of June. He sailed north from them, and found the ice south of Saint Matthew, in latitude 58° 30′. He sounded a good deal about the island of Saint Paul, finding 70 fathoms eighty miles southwest of it, and a few miles farther, on the same line, 120 fathoms without bottom. He found a cold current running fifteen miles a day in a due south direction north of Saint Paul, and stated that the currents in that vicinity vary with the winds, &c., but that season are generally southwesterly. Judging by what we know of the topography of Bering Sea bottom, and by the memoranda above recorded, it would seem more probable that the deflection of any portion of the northerly warm stream in Bering Sea to the eastward and southward would be more likely to occur at the edges of the shallow plateau to the south and west of St. Lawrence, St. Matthew, and St. Paul Islands than upon it nearer their shores. If this were the case, the southern deflection would strike the Aleutians to the westward of Unalashka, and thus would be explained the absence of any trace of its existence in the evidence I have been able to accumulate.

That some deflection of a portion of the northerly warm stream does occur, or, at least, that a part of it is lost or remains quiescent in the main basin of Bering Sea, is very probable. In evidence of it may be mentioned the fact that cocoa-nuts (and perhaps other tropical productions) are frequently cast on the northern shores of the Aleutians. In the winter of 1871–'72, I picked up on the west shore of Amaknak Island nearly the whole of a cocoa-nut shell, with the husk attached, and I was informed by the residents that they are not unfrequently found there. Among the miscellaneous drift-stuff which accumulates in those bays which open to the northward are found in particularly large quantities the peculiar spruce (*Abies alba*) of the Yukon and Kuskoquim, and that (*A. Sitkensis*) of Kadiak and Sitka; also, the Sitka cedar, (*C. Nutkatensis*,) the poplar or cottonwood, birch, and alder. The cedar is frequently called "camphor-wood," from its odor, and erroneously supposed to be of Asiatic origin. The three first mentioned are particularly abundant in those bays opening to the northeast, and compose nearly all of the drift-wood found on the islands. We found one tree of the Sitka spruce, with green leaves still attached to it, and one specimen of wild ginseng, (*P. horridum*,) which is more or less peculiar to the Sitka district. A more thorough examination of the drift-wood deposits would doubtless reveal many interesting facts. Among other matters thrown up on the beach of Captain's Bay by the winter-storms of 1871–'72 was a piece of the schooner Idaho, wrecked the previous year on the south coast of Unimak.

NOTES ON THE SHUMAGIN ISLANDS.

The following hydrographic and other memoranda were collected during our visits to the Shumagins. This group is very incorrectly laid down on all existing charts, and we made great exertions to obtain as many intersections as possible from known points on the other islands. In this way, we shall be able, when our work is platted, to define the area within which a majority of the islands are situated, and also to correct the shore-lines to some extent wherever they came under our immediate observations. We shall also be able to define much more nearly than has yet been done the actual position of the more prominent points by these intersections.

The geological features of the group, which are very simple, (as partly shown in the annexed diagram,) have considerable bearing on their hydrographic characteristics. Two axes of elevation are especially noticeable; the main one being at right angles to the great volcanic axis of the peninsula of Aliaska, and the other parallel with it, and, of course, at right angles with the former. The axis of every harbor, ridge, or strait among these islands lies in one or the other of these two axes. The rocks all dip at various angles to the westward, (magnetic,) and preserve the following order.

To the east the islands are composed of massive granite, not bedded, and intruding in the form of dikes and veins into the metamorphic slates and sandstones, which surmount it in the middle islands.

The metamorphic rocks in their turn, as we reach the western Shumagins, are surmounted by Tertiary strata, of which the upper beds contain fossiliferous layers of Miocene age, the lower ones containing remains of warm temperate vegetation, and the uppermost the remains of marine animals, mollusks, and cetacea. The Tertiary and granite rocks, opposite extremes, decompose into sand, forming good beaches, while the recent lavas (which interrupt the continuity of the succession of the other rocks, especially about Popoff Strait) and the metamorphic slates are of such a flinty hardness that the beaches and shores of the islands composed of them are rocky and irregular, so that it is exceedingly difficult to make one's way along the beaches or to find a boat-landing even in the harbors.

The bottom of the straits and passages about these islands partakes of the irregularities which characterize the islands themselves, in which, however, there is a certain uniformity. Thus, all the islands being composed of uplifted waves of strata having their axis trending in a north and south direction, so, in a general way, the submarine elevations are parallel with them. This is especially marked in the strait which separates Nagai from the islands to the westward. At the mouth of the large bay, without a name, which heads to the eastward in Sanborn Harbor, Nagai, we obtain 60 fathoms, gradually deepening to 100 and 120 fathoms; two miles off shore is a long submarine elevation known to the fishermen as the "Ridge," where 45 and 50 fathoms may be obtained. Beyond this, again, is a deep depression, where over 200 fathoms are reported, (and through which one branch of the north arm of the Alaska current pours,) which separates Nagai and the islands east of it into a different hydrographic group from those to the westward. Each of these groups is composed of islands separated from each other by comparatively shallow water.

In these notes, I shall consider these groups separately. To save repetition, those islands, harbors, &c., which are not to be found on the charts, will be marked with an asterisk, and those which are without names by a dagger.

In all cases, I have adopted the names used on the first published charts, as far as they have come under my observation, and any other names of subsequent date are inclosed in brackets.

WESTERN SHUMAGINS.

This group consists of Unga Island, Popoff Island, Korovin, Bouldyr, and Andronica Islands, the Haystacks, Seal Rocks, and five or six smaller islands.

Unga.—This island contains two good harbors and one anchorage. In connection with Popoff Island in the strait another good harbor is formed.

Delaroff Harbor, so called, is the best known, but is merely a safe anchorage in northerly and westerly winds. The holding-ground is poor and rocky; several reefs in ill-determined positions exist off the entrance; and the inner anchorage affords only a fathom and a half at low water, rocky bottom, with room for only one of the smallest class of vessels, and open to southeast winds, which are the most prevalent and powerful in the stormy season.

New harbor. * †—A new harbor exists on the east side of Unga in the deep bay north of Delaroff Harbor. It is formed by a sand-spit, behind which, in a southeaster, Captain Morse, of the schooner J. D. Sanborn, in 1869, found 9 fathoms water, good holding-ground, and protection from all winds. We did not enter it.

Two small islands † exist in the middle of the wide strait between Popoff and Unga Islands. There is plenty of water on either side of them, and no hidden dangers known.

Zachary Bay, (Coal Harbor, North Harbor of Unga, &c.)—This bay is open to all northerly winds, the holding-ground is bad, and the shoals extend half a mile from shore on the west side, while on the east side, within the same limits, are numerous reefs and shoals, some of which are hidden. A very long and dangerous reef extends two miles from the West Head, north by compass, toward Gull Island, a small rounded rock, 20 feet high, which lies off the mouth of the bay. That portion of this bay lying to the southwest of Round Island is shoal, but a navigable passage exists on each side of Round Island into a *new harbor.* † This harbor was first entered by the boats of the Western Union Telegraph expedition in 1865, and very roughly sketched by their parties. It is one of the best harbors in the Shumagins. The holding-ground is the best in 9 fathoms water, muddy bottom, with plenty of room; water, wood, (alders,) and fine sand all conveniently situated.

A small islet (called in our notes Range Island) lies between Round Island and the point to the south of it; it is about 15 feet above high-water mark in height. A long and narrow shoal extends in a southeast direction from the spit on Round Island for half a mile. Vessels beating in by the northeast entrance should keep open the eastern end of Range Island and the western end of the point south of it, thus avoiding this shoal. The astronomical position of Round Island was obtained by us, the shore-line run with the telemeter, and the harbor sounded, but we had not the time to devote to triangulation. A view of the northern entrance to this harbor is herewith forwarded. Observations for magnetic dip were also obtained here, and the height of Round Island determined to be 427 feet.

The western shore of Zachary Bay is rapidly wearing away under the heavy swell caused by northeast storms in winter. At least 200 feet have been washed away since my visit in 1865, and the water along the shore has become much more shoal. The maximum range of the spring-tides here was observed to be 12 feet; the ordinary tides average from 3 to 6 feet.

The bottom of the *Strait* † north of Unga Island is very irregular and rocky. Just east of Gull Island good fishing is reported, on a bank of small extent, with 40 fathoms water.

Popoff Strait.—This strait, varying from half a mile to two miles wide, separates Popoff from Unga Island. It is of considerable importance; as, besides containing a good harbor, it forms the easiest and shortest passage from Unga to Belkoffsky settlement, and from the fishing-grounds about Korovin it is the nearest and most accessible shelter in storms. It is obstructed by two reefs, which may, however, with the information gathered by us, be easily avoided.

One reef† on the west shore makes out from the first rocky point on that side after passing the sand-spit from the south. It was known to the Russians, and is well marked by kelp and partly bare at low water. The other*† is abreast the first point on the east side after passing the sand-spit. It is never bare, has but little kelp on it, and may have 9 feet of water on it in extreme low tides. It was not known to the Russians. In June, 1867, the brig Olga and the J. D. Sanborn got on this reef, while the schooner F. L. Steele passed safely inside of it. In 1869, the schooner J. H. Roscoe and another vessel touched on it. Vessels may keep in the channel and avoid both reefs by the following rule: After passing the sand-spit from the south or Range Island from the north, keep in line with the west ends of the spit and island, which will clear all obstructions. The least water on this line is 5½ fathoms at lowest water.

North of the two reefs, a rocky patch, with a good deal of kelp on it, lies in mid-channel; but it has not less than 4 fathoms at any tide, and may be passed over safely.

Range Island is in the northern entrance to the strait at its narrowest point. There is no passage to the east of it, and vessels should give the shore north of it a fair berth on either side as it makes off shoal and rocky for a quarter of a mile.

We obtained a reconnaissance triangulation, soundings, sketches of the topography, and ran the shore-line of this strait from the northern entrance to the sand-spit.

*The harbor**† is formed by the sand-spit and the shores of Popoff Island. A vessel may anchor almost anywhere north of the spit, getting the best protection close into the Popoff shore, in 9 fathoms hard sand. Excellent water, easily accessible, and plenty of driftwood, may be obtained here. If it seemed advisable, I would suggest that the name of the Humboldt might not improperly be associated with this harbor, which, through her indirect agency, has now been made known for the first time.

Popoff Island, (Popoffsky of the Russians.)—This island, besides the harbor above mentioned, partly formed by its shores in the strait, contains another anchorage, said to be good, though small. The southeast end of the island is known as Popoff Head. It is a high, rounded promontory, rising some 500 feet above the water. Off this point, good fishing is reported in 45 fathoms. On the southwestern shore of the island is an open cove, marked by a bluff of reddish sandstone, and known as Red Cove. A stream noted as a salmon-run comes in here, and there is a small settlement at its mouth, where fresh fish, eggs, &c., may usually be obtained. On this shore the water is bold and the beaches rocky, but there are no outlying reefs.

There are several indentations on the eastern shore, the most northern of which contains the *anchorage**† before mentioned. It has been entered by several fishermen, who report fair holding-ground and protection in most winds, with 7 fathoms water. Just north of this harbor is a small, round island, 100 feet in height, called by the Russians *Vesoki*, or High Island. Off this island good fishing is reported, but the bottom is rocky and irregular, varying from 45 to 90 fathoms within a cable's length. *The Strait*† between Popoff and Korovin Islands affords no anchorage, the water being deep and the bottom as above described. We found a very strong current setting through it to the westward.

Korovin Island, (Korovinsky of the Russians; name derived from Korovin, one of the early explorers.)—This island is very high, and divided by a broad isthmus or low valley into two portions. It is extended much too far to the eastward on the charts. A small settlement exists on the south shore, in the valley above mentioned. Eggs, potatoes, and fresh salmon can usually be obtained.

This, with those previously mentioned, comprises all the native settlements on the Shumagins, though there are several localities on Unga, where the Delaroff Harbor natives go for salmon in summer.

A reef*† extends half a mile off shore from the southeast end of Korovin. Off the southwest end of this island is a small, low island,† separated by a narrow channel with 4 fathoms water. Here good fishing is reported, and good holding-ground in 25 fathoms, gravelly bottom.

*An anchorage**† exists on the north side of Korovin, which affords good protection from all winds, except northers and northeasters; in 7 fathoms, sandy mud. It has been entered by a number of the fishermen. In the *strait*† between Korovin and Bouldyr, good fishing was reported in 1872.

A rock*† exists on the line between the northeast end of Korovin and the southern end of Bouldyr, one-third of the way from the latter to the former. It has 8 feet of water on it, and is marked by a patch of kelp. It was touched with an 8-foot oar by the fishermen of the schooner Scotland in 1871, and seen in 1872 by Captain Henderson, of the Wild Gazelle.

Bouldyr is a rocky and very high island, without any indentations or even a landing-place. The water around it is said to be deep and bold.

The straits between Korovin and Andronica Islands are known to the fishermen as *Gorman's Straits.* They are a favorable fishing-ground, though the bottom is reported to be rocky and irregular.

Andronica Island, (Yasni, or Foggy Island.)—This island is very incorrectly represented on the charts. It is moderately high, and its shores are fringed with reefs, especially on the southern and eastern sides.

The Haystacks.—These are a group of five large and a number of small rocks, which trend to the southeast from Andronica, and extend about two miles off shore. They present from the south a pretty evenly-rounded appearance, from which their name is derived. The largest one is perforated by an arch, it is from 60 to 75 feet in height. They are covered with sea-bird's eggs in the season, and the water about them is said to be bold.

EASTERN SHUMAGINS.

Nagai.—This is the largest island of the group, and remarkably irregular in its form and topography. It is really composed of six islands, united by low isthmuses. The western side is indented by five deep bays, all of them without names, three of which terminate in harbors. The shores are bold, and, in most cases, precipitous, rising, toward the middle of the island, about 1,500 feet. The few reefs which may be found off the headlands are close inshore, and have deep water close to them. The north end of the island is a rocky bluff, separated by an isthmus, hardly higher than the beach, from the middle portion of the island, which is very mountainous. The extreme northern end rises to the height of about 300 feet. A single rock lies off of it to the northward. It is about 40 feet high, and half a mile offshore. A reef lies off the northern head of the bay next southwest, distant about half a mile southwest from the point. The southern arm of this bay† is long, but the shores are precipitous, and it affords no anchorage. Passing to the southwest, the last of three successive points is marked by a pinnacle, 50 feet in height, and is known as *Pinnacle Point.* This marks the north headland of a *deep bay*,† six miles long, which terminates in two harbors. This bay has 40 to 60 fathoms water, and no hidden dangers. At its eastern end, it suddenly contracts to a narrow passage, three-quarters of a mile in width. The southern head of this passage is called *Granite Point*, and is composed of a mountain, 1,500 feet in height, with a serrated crest, and precipitous sides to the south. A bight exists just southwest of it, which should be avoided by vessels, as it is extremely shoal. Everywhere else, in beating in, a vessel may go close inshore. The north head of the entrance above mentioned is a low point, off which is a small rounded *island*,* known as *Mack's Head.* Within the entrance, the bay suddenly expands in a northeast and southwest direction, forming *Sanborn Harbor.**

On the north side of the bay are several shallow indentations and one deep one, marked by a peculiar conical mountain about 1,500 feet high and a peculiar cup-like arrangement of the ridge below it, and also by a low rounded knob-like point on the eastern side; this is *Porpoise Harbor.**

Both sides of the bay are high, and in entering this and all similar localities in the Shumagins navigators should be on their guard against sudden squalls from the mountains, locally known as "woolleys." These are more than sufficiently strong enough to throw down a vessel if care be not exercised. The schooner Vivid was thrown down in this manner during the summer of 1872, at the entrance of Falmouth Harbor, Nagai.

*Porpoise Harbor.**—This is a small and well-protected harbor for small vessels, but the entrance is not over 100 yards wide, and at lowest water has but 9 feet of water off the end of the sand-spit which forms the harbor. It derives its name from the small schooner Porpoise, which wintered there during one season; a fishing-station having been established there. We obtained a reconnaissance-chart of this harbor, with a few soundings.

*Sanborn Harbor.**—This harbor derived its name from the schooner J. D. Sanborn, commanded by Capt. Wm. Morse, who, driven by a storm, sought shelter in the outer bay, and discovered this fine harbor in May, 1866. There are no hidden dangers in this harbor, unless we except a rocky patch, dry at lowest water, a cable's length from the shore directly opposite the entrance. The anchorage is in the northern arm of the harbor, in 12 to 14 fathoms shelly mud. Shoaler water may be obtained by going farther in, but the holding-ground is not so good. The stream at the south end of the habor contains multitudes of salmon and trout. Two low portages, one rendered still more narrow by a large lake, indicate that at no distant period the waters of this harbor may have communicated with the sea on the east side of Nagai. As it is, the island is nearly cut in two, or rather in three, at these points. A complete reconnaissance-chart and observations for geographical position were obtained by us. This harbor is constantly in use as a port of refuge by the fishermen.

The next indentation of the coast of Nagai to the southwest is a large *bay*† about five miles in length and two in width. It is surrounded by mountains, but its shores are less precipitous than those of the bay last mentioned. Two-thirds of the way toward its eastern termination are two remarkable spit-formations, one on each shore, and opposite one another. They are both very narrow and hardly raised above the surface of the water. That on the southern shore incloses a sheet of water a mile and a half long and half a mile wide, without a navigable outlet. The other stops short at its eastern extremity, forming a secure anchorage known as *Eagle Harbor.** Between these two spits at the most contracted point, the water shoals to 4 fathoms. On either side of this bar, there is abundance of water. At the head of the bay is a peculiar conical mountain about 1,500 feet in height and called *Eagle Mountain.*

*Eagle Harbor.**—This is formed by the spit before mentioned and forms a perfectly-protected anchorage with from 7 to 10 fathoms muddy and stony bottom. It is frequently used as a harbor of refuge by the fishermen, who first entered it. A sketch of this harbor, taken from a bird's-eye view, assisted by bearings, accompanies this report.

Between the southern headland of this bay and the northern head of the next, the western shore of Nagai reaches its most western longitude and greatest altitude. This high precipitous bluff reaches about 2,000 feet above the water, and, from the frequent severe squalls which come down from it, has received the name of "*Woolly Head*" from the fishermen.

Several isolated *rocks**† lie off this head about a quarter of a mile from shore, with deep water close to them, and elevated about 10 or 12 feet above the tide. South of Woolly Head about two miles, lies the north headland of another *bay*† without a name. A few rocks lie off this headland close inshore, rising 10 to 20 feet above the water. Half a cable's length outside of them is another rock awash, marked by kelp and a breaker. This is about a quarter of a mile from shore. Southwest by west from the southern head of the bay, a reef extends a quarter of a mile with a single rock three-quarters of a mile from shore in the same direction. This *rock**† is awash, bare at low water, marked by kelp and a breaker.

The northern headland rises some 500 feet in a perpendicular cliff. The southern one rises much more gradually, and is low, at the water's edge reaching 25 feet or more.

The north shore of the bay is rocky and bold. A single *rock*,*† 5 feet above the water, stands about a quarter of a mile from shore a mile and a quarter west of the north headland. South (true) from this rock, on the southern shore, is a low point, with a rock close to it known as *Cape Horn** among the fishermen. East of this, the bay widens a little and ends with a triangular spit, rounded at its southern end, and composed of coarse shingle and rounded boulders. A large amount of drift-wood lies here.

*Falmouth Harbor.**—Behind this spit lies Falmouth Harbor, so named from a vessel driven by a gale into the bay, which first entered it. The entrance is not over 300 yards wide, and contains no hidden dangers. It carries 6 fathoms in, behind the spit expanding into a sheet of water about half a mile across. Here 7 and 8 fathoms sandy bottom may be obtained. The northern shores are broad, sand flats, which drop suddenly to 4 fathoms. The harbor is perfectly protected from all winds, but there is room only for one vessel, and she must have a fair wind, to enter and go out. At the head of the harbor is a stream, coming from a good-sized lake, full of salmon and trout. Good water may be obtained here. A fishing-station was established here in 1872. The land surrounding the bay and harbor is high and broken, some of the hills reaching 1,500 feet. The entire bay is about five miles long. There are no hidden dangers known. A sketch of this bay and harbor, from a bird's-eye view, aided by bearings, accompanies this report.

To the south of the south headland of this bay, the shore of this island trends to the southeast some seven miles, to a low point without a name. Off this point lies a small rounded rocky *island*† rising to the height of 300 or 400 feet. This portion of the coast has never been carefully examined, as far as I am aware. I observed from off shore that that portion of the island of Nagai to the southward of this small island is composed of two clusters of rocky hills perhaps 1,000 feet in height, united to each other and to the main body of the island by low flat isthmuses, evidently remains of raised beaches like those on the northern portion of the island. A view of the southwestern shore of Nagai accompanies this report.

Off the south cape, which is 500 or 600 feet high, a reef marked by a breaker extends southward for three-quarters of a mile.

The east coast of Nagai is exceedingly irregular, and the greater part of it has never been correctly determined. Just south of the elevated northern end of the island before mentioned, a bight makes in toward the low isthmus before described. In this bight is a very small, low, rocky *islet.**† To the south of this bight is a deep, pointed *bay*,*† extending to the westward and southward, which has never been entered. The land around it is high and broken. South of the south headland the land trends in a nearly south direction until we arrive at a deep bay having two arms, which we have called in our notes the East Bight of Nagai.* The north arm is open to the eastward, has high, rocky shores, and occasional high, steep, shingle-beaches, and terminates to the westward at a long beach of boulders and shingle, behind which is a large lake, the opposite shore of which is separated by a very low portage from Sanborn Harbor. To the northwest of this lake is a high, conical mountain, over 2,000 feet in altitude, forming the end of a long ridge, and called in our notes *Mount Peirce.* South of the lake, the promontory dividing the bay into two arms, is a rounded mountain, 1,500 feet in height, called by us *Mount Hilgard.* A high ridge, terminating in a precipitous cliff of 1,000 or 1,200 feet, which forms the southern headland of the height, we named *Mount Davidson.* The south arm of the bight ends to the westward in a narrow-pointed inlet, nearly reaching the middle of Sanborn Harbor, from which it is divided by a low portage, half a mile wide, but really diminished to about half that width by a shallow lagoon making in from Sanborn Harbor. On the south shore of the south arm is a *new harbor.**† This appears to be a discovery of our own, as I could find no one who had heard of it before. It is formed by the usual shingle-spit, which incloses it on the east and north. It appears to have an abundance of water, though we had no means of sounding, as we did not take the vessel in there, but ran the shore-lines by crossing the portages from Sanborn Harbor. The shores are gravelly. From the north side of the spit, shoals, marked by kelp, extend northward about a quarter of a mile, and a narrower shoal fringes the southeast foot of Mount Hilgard on the opposite side of the entrance. This harbor has perfect protection from all winds, room enough for three or four vessels, and can be entered or left with any wind. It is also the only harbor on the east side of the island.

South of Mount Davidson, a broad granite promontory, with a valley in the middle, extends for a mile or two, and is succeeded by a shallow *bay*,*† with a broad sand-beach, having a lagoon behind it, and a portage (over a low ridge to the south end of Sanborn Harbor) about two miles wide. There is a small peninsula on the south side of this bay, composed of a rocky islet united by a low sand-beach to Nagai, which might afford shelter for boats; but the bay is very shoal and has several rocks above water in the middle of it, on which we observed sea-otters. The bottom is sandy, and the depth of water less than a fathom at low tide.

South of the *cape*† forming the south headland of this bay is the low isthmus before referred to, which connects the main body of the island with a cluster of broken hills, which is succeeded by another isthmus connecting the latter with the elevated southern end of the island.

The *strait*† between Big Koniushi Island and Nagai is deep, with an irregular, rocky bottom. It is crammed with islands, none of which are on the charts, and between which plenty of water seems to exist. After leaving the northern isthmus of Nagai, we have on the east side of the strait a *new island*.*† It reaches 800 feet in height, two miles in length, and a mile and a half in width. From its southeastern end a spit, succeeded by a long shoal trends toward the nearest cape of Big Koniushi. There appeared to be a clear passage between the end of this shoal and Koniushi of a mile in width.

On the west side of the strait, a little to the southward, is another *new island*.*† It is of oblong form, in a north and south direction, and divided by two transverse depressions into three elevated portions. Length about a mile and a half, height about 500 feet. Off its southwestern end, and apparently connected with it by a shoal, is a small, rounded islet, an eighth of a mile long, and very low.

Immediately to the south of the last mentioned is another *new island**† of about the same size, but more irregular in shape and not quite so high. A series of reefs extends from the south and southwest edges of this island, apparently about a quarter of a mile from the shore. This lies directly opposite the east bight of Nagai, three or four miles from the south headland of the latter. A view of it, taken from Mount Hilgard, accompanies this report.

Spectacle Island.*—Directly in mid-channel, between Nagai at Mount Davidson and the southern end of Big Koniushi, lies a large island not on any chart, and known by the foregoing name among the fishermen, as its northern and southern portions are connected by a comparatively low ridge. The length of this island is about five miles, and it may be two miles wide in some places. The highest peak may reach the height of 1,000 feet or less. Close in to the southern end lie a few rocks. On the southwest side there appears to be a cove where boats might find shelter. The shores are bold and the beaches narrow. We saw no signs of any outlying dangers.

Twin Rocks.*—To the south and west of the last named, bearing south 37° east about 6 miles from Mount Hilgard station, lie two rocky islets not on the charts, and known by the above name. No reefs or breakers being visible about them in heavy weather, it is presumed that there are no outlying dangers. They appear to be from 60 to 100 feet in height, and an eighth of a mile long in their greatest diameter. The southwestern rock is much narrower than the other, and they appear to be separated only by a narrow chasm. Their sides are precipitous and apparently devoid of vegetation. A view of them as seen from Mount Hilgard is herewith forwarded.

Near Island, (Blizhni Island of the Russians.)—This island lies about two miles east of the northern of the two isthmuses on the southern end of Nagai. It is about two miles long and about the same in width, appearing about 600 feet high. The sides are precipitous and rocky. The island is easily recognized by a very regular serration, which cuts its crest into five little peaks.

Castle Rock.*—A large rocky island lying off the north end of Big Koniushi, about five miles, is so denominated by the fishermen. It is of rounded shape, high and broken, with precipitous sides. The northern and highest peak may reach an altitude of 1,200 feet. It is about a mile and a half in diameter, and no outlying dangers are reported. It is so prominent that it is a matter of surprise that it has not found its way on to the charts.

Big Koniushi Island.—This island bears no resemblance to that which represents it on the charts. Its northern end is pointed and comparatively low. Its western shore is very irregular, and its most salient feature is a peninsula which is high and rounded, projecting between two bays and connected with the main body of the island by a high but narrow isthmus. South of this peninsula, a safe *anchorage**† is reported by the fishermen in 8 fathoms sandy bottom. It is more or less open, however, to southwest winds. The whole of this side of the island is rocky, precipitous, and broken, and of the most desolate character, being absolutely destitute of any vegetation except lichens. At the southern end is a long and narrow point connected with the island by a very high and narrow ridge. From some points of view it resembles an island, and has been laid down as one by Tebenkoff. The native name is Kungagingan. Behind this point to the eastward is a deep *bay*,*† but the water is reported to be so bold as to afford no anchorage. East of this bay is another,*† larger and wider, in which vessels have anchored in 16 fathoms hard bottom, with protection from northerly and westerly winds. The holding-ground is poor. To the east of this the island, always high and rocky, trends to the northeast until it forms a headland, which is the east head of Koniushi Strait. A small rocky *islet*.*† lies close to this shore, half-way from the bay just mentioned to the strait.

North of this strait is a shallow *bay* *†, the mouth of which is reported to be nearly closed by *two small islands* *† forming a secure *anchorage* * in westerly weather. To the northward the island trends to the northwest, forming a *cape*,*† between which and the northern end of the island is another *bay*,*† in which the fishing-vessels are said to anchor in southerly gales, finding good protection in 7 to 10 fathoms water. The soundings to the northeast of this part of the island, and southeast of Castle Rock, are reported to be very even, averaging 28 fathoms, and afford good fishing. The island of Big Koniushi is one of the most rugged of the group, and the average height of the peaks may be 1,500 to 2,000 feet.

Koniushi Strait.—This strait is much narrower than represented on the charts. It will exceed a mile and a half in width, and the soundings reported are 16, 20, and 28 fathoms.

Little Koniushi Island.—This island also differs entirely in outline from anything on the charts. It is really composed of three islands united by raised sand-beaches, intersected by lagoons. The shape is very irregular. The western coast trends somewhat to the west of north. The southern end terminates in a high rocky, pointed *cape*,*† with a reef, marked by a breaker, extending about a quarter of a mile southwest from it. The eastern coast is indented by two bays,† of which the northern one is much the widest and deepest. Off the northeast cape of Little Koniushi, and connected with it by a shoal half a mile long, is *Atkins Island*,* so named after the schooner Minnie G. Atkins, whose commander first discovered the fishing-grounds about it. This is an oval and rather high island, about two miles and a half long, and reaching an altitude of about 800 feet, but with a comparatively even surface and slope from the central crest. The northern coast of Little Koniushi extends in a nearly due east direction from Atkins Island to Koniushi Strait, indented midway by a *bay*,*† off which lies a triangular island.*† Behind this island is situated the so-called *Northwest Harbor* * of the fishermen. This may be entered from either end, and affords good holding-ground and ample protection from all except northeast winds. At one time a fishing-station was established here. We did not visit this locality. On the west side of Little Koniushi is an opening two miles wide into a large bay which divides into two arms, and is known as *Northeast Harbor*.* The northern arm of this bay is somewhat open to westerly winds, and the holding-ground is said to be rocky and poor. The extreme southern end of the eastern arm is more protected, and for some reason is a favorite refuge for the fishermen, though the bottom, being alternate patches of rock and sand, does not afford a good hold for the anchors. There is a small and well-protected boat-harbor here, where a fishing-station was formerly established. Astronomical observations were obtained here, and a series of angles, bearings, and other observations sufficient to make up a tolerably accurate sketch of the harbor, herewith forwarded. The mountains on this island reach a height of 1,000 to 1,500 feet. They are of solid granite, and the whole aspect of the island is barren and desolate.

Twelve-Fathom Straits.—The straits separating Little Koniushi and Simeònoff Islands are known by the above name among the fishermen. The depth averages from 12 to 16 fathoms. With the exception of a few patches of kelp near Simeònoff Island we saw no signs of any dangers.

Simeònoff Island, (Simeonòffsky of the Russians; Tiakinak of Tebenkoff.)—This is the most eastern of the group and a very peculiar island. It is composed of two clusters of hills, surrounded and connected by a low, nearly level, plateau, composed of decomposed granite and sand. This plateau is nearly cut in two by a very irregularly-shaped harbor.*† A glance at the accompanying sketch of this island will convey a better idea of its peculiarities than a detailed description.

About five-eighths of a mile from shore is a kelp-patch off the northern point of the island, which probably marks a submerged cluster of rocks. A reef extends half a mile in a westerly direction from the north point of the entrance of the harbor.

Off the south point is a low, flat, rocky *island*,*† fringed with reefs. The whole coast of Simeònoff is bristling with reefs and shoals. Those from the south end of the island are variously reported to extend from three to seven miles off shore. Three miles off shore to the east of the island, a series of reefs parallel to the latter are reported with a clear passage between the island and the reefs. The *harbor* *† is perfectly protected from all winds, but the shores are rocky and the water very shoal. The inner anchorage is in 2½ fathoms, not exceeding 2, at lowest water, with a smooth gravelly bottom. This harbor is a favorite hunting-ground for sea-otters. There is plenty of drift-wood on the eastern shore, but the water is poor. The hills on the northern end may be 800 feet high, those to the south perhaps 1,000 feet.

Bird Island, (Petitski of the Russians.)—This is situated nearly south of Big Koniushi. Its shores are bold; there are no bays or harbors upon it. The island is comparatively low, though its surface is broken. None of the hills much exceed 600 feet in height. No outlying dangers are reported. A rock above water lies off the southern end a short distance.

Chernobour Island, (Niuniak of Tebenkoff.)—This in most respects resembles the last, but is narrower and longer. It lies to the southward and eastward of Bird Island, and is the most southern island of the group. A rocky islet apparently connected by a bar with the main island lies off its northern end. On the east coast are three small bays, the middle one of which is reported to afford an anchorage in westerly winds. As we saw this island and the last only from a distance, I can give but few details in regard to them.

With regard to the meteorological features of these islands, it may be remarked that the winter is rather colder than at Unalashka, owing to the winds which blow directly from the ice-covered mountains of the peninsula. From May to the middle of August, cloudy, overcast weather may be expected, with some rain, but little fog, and not much wind. After that time there is more clear weather, but attended with strong gales from the north and east. In winter, the succession of gales is hardly interrupted by an occasional pleasant day. We obtained the first flowers of the season in the early part of April, and the spring as a rule is early, and the growth of vegetation on the Western Shumagins is rapid and luxuriant.

NOTE ON A BANK NOT LAID DOWN ON THE CHARTS.

On our passage from Simeònoff Island to Kadiak, Thursday, September 5, 1872, the weather being clear and calm, we sounded at noon, the water being discolored, and, much to our surprise, found but 22½ fathoms, gravelly bottom. We immediately put over some lines and obtained a number of fine cod, and some halibut weighing over 100 pounds. The approximate position of this bank is latitude 56° 13′ north, longitude 153° 39′ west. The soundings continued without material change all the afternoon, the course being northeast by compass. At 6 p. m. we got 38 fathoms, and at 8.30 the next morning we obtained 60 fathoms. We had run by Massey's log during that time about thirty miles. The wind shortly afterward rising, we obtained no further soundings, but the water resumed its normal hue.

I may also note that at 8 a. m. this morning, (September 6,) we were able to see distinctly the Semidi Islands, Ugamok, and Cape Granville on Kadiak. If the reported island of Saint Stephen had also existed, we could hardly have failed to see it. By our observations, the latitude of the island of Ugamok is more correctly given on the Russian Admiralty Charts of 1847 than in the later maps. The longitude of the latter, however, seems the most correct, though the topography of the old map is far the best.

The Semidi Islands agreed in their bearings with the latitude given on the charts, but their extreme visibility would seem to indicate a more eastern longitude.

We saw no breakers on the Vasilieff (William's) or Kadiak reefs at Saint Paul, though there was a heavy sea on when we entered and at the time of our departure.

MISCELLANEOUS HYDROGRAPHIC NOTES.

The following notes have been collected during the voyage and are here appended. Even if they possess no other value, they will serve to call attention to existing doubts on the points in question.

I. Archimandritoff calls attention to some rocks which he states exist abreast of the Gull Rocks (Chika ostrova) in the Akutan Pass. We saw and heard nothing further in regard to any such rocks, though they probably exist.

II. He also notes the reef off Cape Kalekhta, which he says extends half a mile off shore. We saw this reef breaking on one occasion, but had no opportunity of fixing its position.

III. He also reports that the island of Tanaga, or the one next west of it, is erroneously located on Tebenkoff's chart, as the bearings there given do not connect.

IV. Also that Amukhta Pass, which is mapped by Tebenkoff as thirty-six miles wide, is really forty-six miles wide, but cannot state where the error lies. Also that Buldyr is ten miles south of Tebenkoff's position for it.

V. He also states, from information derived from the natives, that there is a good harbor on Semisopochnoi (Seven Volcano) Island; but E. Hennig states that it is a very poor harbor, and that the passage leading to it is rocky, with dangerous tide-rips.

VI. Capt. E. Hennig states (in regard to the reef commonly reported to extend from the north-east end of Umnak to Bogosloff Island) that while there is a short reef extending from Umnak, a quarter of a mile or so, the supposed continuous reef does not exist, as he has passed close to both islands in good weather, and could find no bottom with two cod-lines, (58 fathoms.)

VII. Captain May, of the bark Cyane, having reported some unknown rocks near the Shumagins, I made the following copy of his log:

"Ship Cæsarewitch, June 25, 1869. Point of departure, Chernobour Island, bore northwest by north, by compass, (noon,) about 25 miles. Latitude, by observation, 54° 22′ north; longitude, 159° 21′ west. Course, northeast."

June 26, 1869, (begins at noon of 25th.) "Began fresh breeze from southwest. Later, (6 p.m.,) wind moderate, hazy." (No estimate of distance run is given in the log.) "8.30 p.m. Made two rocks above water, bearing northwest by compass, distance about eight miles. Changed course to southeast. Estimated position, latitude, 55° 15′ north; longitude, 158° 50′."

Captain May reports that the rocks were 30 feet high, and that he saw breakers before he changed the course.

This latitude is evidently a clerical error, as it was impossible for the vessel to have been in latitude 55° 15′ under the circumstances. Archimandritoff, from information received from Captain May directly after the occurrence, estimated the position at latitude, 54° 49′; and longitude, 157° 38′. I cannot explain the discrepancies, but Archimandritoff's position would seem the most probable from the courses and probable distance run. In this case, it would bring these rocks on or near the outer fishing-ground, where it is in the highest degree improbable that such rocks could exist and not have been seen by fishermen. I am of the opinion that Captain May saw two fishing-vessels at anchor on the outer ground, though he is quite positive that they were rocks.

VIII. We visited Delaroff Harbor in boats on the 4th of July, 1872, and found that the greatest depth of water in the inner anchorage is 9 feet at low water, with room only for one vessel of the smallest class. This place is full of rocks and shoals, and the Russian chart is extremely inaccurate. Whether the shoal water (now existing where the chart gives more) is due to the action of an earthquake or not, I am unable to state; it was so reported to me by Capt. Charles Riedell, in 1868.

IX. Captain Giles, of the sloop Jabez Howes, who had wintered at Isanotsky, or False Pass, gave me the following notes in regard to that locality.

The southern entrance of this pass though narrow is extremely deep, no bottom having been reached at 50 fathoms. There are a few rocks close in to the East Head. The tides run very swiftly in this passage. The flood tide (from the south) is much more powerful than the ebb. The tides resemble those of Unalashka, but the flood does not meet with sufficient resistance from the north to create tide-rips. The northern entrance is very shoal. The channel is close to the Unimak shore, and is often changed and (when heavy northers occur) even silted up by the shifting sand which forms the bottom. There is about one fathom water in it. The Jabez Howes, drawing 4 feet 2 inches, and the Lizzie Sha, drawing 3 feet 6 inches, had gone through, but he did not think the Humboldt, drawing 8 feet, could get through even at high water. This explains the inability of Captain Smith to find even a boat-channel through, in 1868, as reported to me.

X. A bay without a name is laid down on Tebenkoff's chart, on the northeast end of Akhun Island, facing Unimak Pass. Approximate latitude 54° 17′ north and longitude 165° 33′ west.

The entrance is represented by Tebenkoff as shoal or closed by a barrier of sand. Capt. E. E. Smith, an old whaler, of the schooner Eustace, reported to me that he anchored near the mouth of this bay in June, 1872, and saw over a sand-spit finback-whales spouting and playing in great numbers. Now, this species of whale does not go into very shallow water, and I am of the opinion (and several whalers whom I have consulted agree with me) that there must be a comparatively deep channel by which these whales entered; and that being the case, a good harbor would exist here. If so, it would be of great importance to traders and whalers bound out of Bering Sea, as they are frequently delayed several days (as I have been) at the mouth of the Unimak Pass, awaiting an opportunity of getting through. I endeavored to reach this locality in June, 1872, but was prevented by bad weather.

XI. The narrow pass between Akhun and Akutan is represented as full of rocks and unnavigable by Tebenkoff. It is in no case to be attempted, as the tides rush through with great fury; but in the fall of 1871, the natives reported that a large whale-ship was driven by storms into Akhun Bay and passed through this opening in safety to the Pacific, greatly to their surprise, as every one expected to see her dashed to pieces on the rocky shores.

Meteorological abstract from September, 1871, to October, 1872, of observations taken on board the United States Coast-Survey schooner Humboldt, lying previous to June, 1872, in Iliuliuk Harbor, Unalashka and after that date among the Shumagins, Aleutian district, Alaska Territory.

	Sept.*	Oct.	Nov.	Dec.	Quarter.	Jan.	Feb.	March.	Quarter.
Barometer:									
Mean of 9 a. m. observations	....	29. 433	29. 913	29. 640	29. 662	29. 382	29. 465	29. 304	29. 383
Maximum	....	30. 058	30. 698	30. 386	30. 698	30. 100	30. 060	29. 940	30. 100
Minimum	....	28. 630	28. 658	28. 494	28. 494	28. 730	28. 900	28. 600	28. 600
Total range	....	1. 428	2. 040	1. 892	2. 204	1. 370	1. 160	1. 340	1. 500
Thermometer:									
Mean of 9 a. m. observations	47.	42. 5	37. 95	33. 5	37. 985	29. 00	29. 25	37. 75	32. 00
Maximum	50. ?	65. 0	54. 00	44. 0	65. 000	45. 00	48. 00	59. 00	59. 00
Minimum	40. ?	30. 0	22. 00	19. 0	19. 000	13. 00	13. 50	20. 00	13. 00
Total range	10. ?	35. 0	32. 00	25. 0	46. 000	32. 00	34. 50	39. 00	46. 00
Temperature of surface-water:									
Mean of 6 a. m observations	47. 7	43. 0	34. 3	34. 0	37. 1	35. 4	35. 3	34. 6	35. 1
Maximum	49. 0	48. 0	39. 0	38. 0	48. 0	37. 0	39. 0	37. 0	39. 0
Minimum	46. 0	40. 0	32. 0	31. 0	31. 0	32. 0	32. 0	32. 0	32. 0
Range	3. 0	8. 0	7. 0	7. 0	17. 0	5. 0	7. 0	5. 0	‡7. 0
Temperature at 5 fathoms: §									
Mean	....	....	....	40. 4	....	39. 8	36. 85	37. 3	37. 99
Maximum	....	....	....	41. 0	....	41. 0	39. 00	38. 0	41. 00
Minimum	....	....	....	39. 0	....	37. 0	33. 00	37. 0	33. 0
Range	....	....	....	2. 0	....	4. 0	6. 00	1. 0	8. 00
Perfectly clear days	2. 0	3. 5	5. 0	4. 0	12. 5	1. 00	2. 00	5. 00	8. 00
Cloudy days	3. 5	5. 5	11. 0	5. 0	21. 5	6. 00	4. 50	4. 50	15. 00
Rainy, snowy, and stormy days	2. 5	22. 0	14. 0	22. 0	58. 0	24. 00	22. 50	12. 50	59. 00
Days at sea	22. 0	0. 0	0. 0	0. 0	0. 0	0. 00	0. 00	9. 00	9. 00
Sundays	1. 0	5. 0	4. 0	5. 0	14. 0	4. 00	4. 00	5. 00	13. 00
Days work accomplished ‖	5. 25	9. 0	12. 0	6. 5	27. 5	2. 75	3. 00	7, 25	13. 00

	April.	May.	June.	Quarter.	July.	August.	Sept. †	Quarter.	Year.
Barometer:									
Mean of 9 a. m. observations	29. 631	29. 637	29. 932	29. 733	29. 904	29. 976	29. 701	29. 860	29. 6595
Maximum	30. 420	30. 060	30. 420	30. 420	30. 220	30. 230	29. 910	30. 230	30. 698
Minimum	28. 450	28. 950	29. 460	28. 450	29. 470	29. 460	29. 340	29. 340	28. 450
Total range	1. 970	1. 110	0. 960	1. 970	0. 750	0. 770	0. 570	0. 890	2. 248
Thermometer:									
Mean of 9 a. m. observations	37. 6	40. 6	46. 5	41. 6	51. 1	54. 6	50. 0	51. 5	40. 77
Maximum	49. 0	60. 0	62. 0	62. 0	72. 0	82. 0	60. 0	82. 0	82. 0
Minimum	30. 0	32. 0	38. 0	30. 0	42. 0	48. 0	43. 0	42. 0	13. 0
Range	19. 0	28. 0	24. 0	32. 0	30. 0	34. 0	17. 0	40. 0	69. 0
Temperature of surface-water:									
Mean of 6 a. m. observations	37. 6	40. 8	44. 0	40. 8	46. 0	50. 5	50. 1	48. 86	40. 46
Maximum	38. 0	44. 0	44. 0	44. 0	49. 0	54. 0	54. 0	54. 00	54. 00
Minimum	37. 0	39. 0	44. 0	37. 0	44. 0	49. 0	48. 0	44. 00	31. 00
Range	1. 0	5. 0	0. 0	7. 0	5. 0	5. 0	6. 0	10. 00	23. 00
Temperature at 5 fathoms: §									
Mean	38. 5	40. 6	43. 5	40. 96	46. 9	49. 9	....	....	‡41. 94
Maximum	40. 0	41. 0	45. 0	45. 0	48. 0	54. 0	....	....	54. 00
Minimum	37. 0	40. 0	41. 0	37. 0	45. 0	48. 0	....	....	33. 00
Range	3. 0	1. 0	4. 0	8. 0	3. 0	6. 0	....	....	21. 00
Perfectly clear days	2.	1.	0.	3.	2. 00	4. 00	1. 0	7. 00	32. 50
Cloudy days	9.	11.	17.	37.	11. 50	10. 75	6. 0	28. 25	105. 25
Rainy, snowy, and stormy days	19.	19.	13.	51.	17. 50	16. 25	5. 0	38. 75	209. 25
Days at sea	5.	0.	2. 5	7. 5	2. 50	1. 25	9. 0	12. 75	39. 25
Sundays	4.	4.	4.	12.	4. 00	4. 00	2. 0	10. 00	52. 00
Days work accomplished ‖	4.	12.	12. 5	28. 5	14. 00	13. 00	1. 0	28. 00	102. 25

* 23d to 30th, inclusive, in port.

† 1st to 12th, inclusive.

‡ Temperature of soil at 2½ feet below the surface, for quarter, 33°.

§ Observations often interrupted by ice in winter and in summer when at sea. 1° is added to these observations here in order to bring them up to standard thermometer.

‖ Fractions of days are here added together; the number of days on which some work was done was much larger. The number of working-days is less than the number of clear and cloudy days, as some Sundays and days at sea must be deducted.

Current-observations made on board the United States Coast-Survey schooner Humboldt during her voyage from San Francisco, Cal., to Iliuliuk, Unalashka, in September, 1871; taken mainly from the log-book.

Date.	Latitude.		Longitude.		Current.			Winds.
Nautical time.	D. R.	Observations.	D. R.	Observations.	Miles a day.	Knots an hour.	Direction to—	Direction from—
	° ′	° ′	° ′	° ′				
September 1, 1871	Pt. of dep.	38 50	Pt. of dep.	125 38	7.1	0.30	S. 82° E.	
September 2, 1871	39 19	39 11	128 46	128 40	9.2	0.35	S. 29°.5 E.	N. W., moderate.
September 3, 1871	39 59	39 53	131 38	131 45	8.1	0.325	S. 42° W.	N., strong.
September 4, 1871	40 35	40 38	134 47	134 52	4.8	0.20	N. 51° W.	N., strong.
September 5, 1871	41 29	41 28	138 15	138 22	5.2	0.20	S. 79°.5 W.	N., moderate.
September 6, 1871	40 50	41 13	140 02	140 20	26.7	1.125	N. 39° W.	N. W., light.
September 7, 1871	41 18	41 06	141 23	141 15	13.4	0.56	S. 26° W.	N. W., very light.
September 8, 1871	42 27	42 31	143 28	143 25	4.5	0.16	N. 29½° E.	S. W., moderate.
September 9, 1871	43 52	No obs.	145 33	No obs.	(?)	(?)	(?)	S. and S. E., gale.
September 10, 1871	*45 23	45 30	*147 09	147 08	7.0	0.35	N. 6°.5 E.	W. N. W., strong.
September 11, 1871	46 06	No obs.	147 38	No obs.	(?)	(?)	(?)	S. W., gale.
September 12, 1871	†47 14	No obs.	†149 12	No obs.	(?)	(?)	(?)	S., moderate.
September 13, 1871	†48 37	48 27	†150 23	No obs.	(?)	(?)	(?)	S. W., moderate.
September 14, 1871	48 40	No obs.	†152 31	No obs.	(?)	(?)	S. ?	S. W., light.
September 15, 1871	†49 12	48 54	†154 06	154 28	22.7	0.95	S. 38° W.	N. W., fresh.
September 16, 1871	50 31	50 34	155 44	155 11	21.2	0.88	N. 82° E.	W. S. W., moderate.
September 17, 1871	50 45	50 41	156 28	156 19	6.9	0.35	S. 54° E.	N. W., fresh.
September 18, 1871	‡51 11	51 10	‡157 34	No obs.	(?)	(?)	(?)	N. W., fresh.
September 19, 1871	‡52 05	52 18	‡159 18	159 47	22.1	0.92	N. 36° W.	S. W. and W., moderate.
September 20, 1871	53 22	53 14	161 11	160 51	14.4	0.60	S. 56°.5 E.	N. W. and W., moderate.
September 21, 1871	52 21	53 12	162 52	162 55	9.2	0.38	S. 11° W.	N. and W., light.
September 22, 1871	53 37	53 20	165 24	166 10	32.2	1.30	S. 58° W.	N. W., fresh.
September 23, 1871	Port						Variable	S. W., fresh.

Date.	Temperature of air and surface-water, distance, and time of observation for each day.																		Total distance.
	4 hours.			8 hours.			12 hours.			16 hours.			20 hours.			24 hours.			D. R.
Nautical time.	A.	W.	D.	A.	W.	D.	A.	W.	D.	A.	W.	D.	A.	W.	D.	A.	W.	D.	Nautical miles.
	°	°	k.	°	°	k.	°	°	k.	°	°	k.	°	°	k.	°	°	k.	
September 1, 1871																			
September 2, 1871	59	58	24	58	60	51	60	61	78	60	61	100	60	61	128	60	58	160	160
September 3, 1871	61	62	8	61	62	30	61	62	62	61	62	93	61	62	117	62	63	148	148
September 4, 1871	62	63	23	62	63	52	62	63	75	61	62	97	62	62	120	63	65	146	146
September 5, 1871	62	64	30	63	64	58	62	63	86	63	63	114	63	64	140	63	64	161	161
September 6, 1871	63	65	16	64	67	32	64	65	47	64	64	59	64	64	75	64	64	91	91
September 7, 1871	66	67	15	66	67	25	65	67	27	65	66	30	65	67	31	67	69	49	49
September 8, 1871	70	69	16	66	67	29	66	67	44	66	67	68	68	66	96	68	67	128	128
September 9, 1871	67	66	34	67	67	66	66	67	98	68	67	110	64	67	118	64	65	130	130
September 10, 1871	65	64	10	60	62	24	59	61	39	59	61	57	58	61	84	55	61	112	112
September 11, 1871	56	61	8	58	60	14	57	58	21	57	59	27	56	57	34	57	58	42	42
September 12, 1871	57	58	5	58	57	16	58	57	31	58	57	51	58	56	75	58	56	104	104
September 13, 1871	56	56	24	56	55	39	54	52	48	54	52	56	54	52	68	54	52	88	88
September 14, 1871	64	65	12	62	62	30	50	51	48	49	51	63	49	51	79	51	51	93	93
September 15, 1871	51	51	14	50	51	31	51	49	45	48	48	59	50	49	72	52	50	92	92
September 16, 1871	51	49	19	50	49	50	50	49	54	59	48	70	50	49	86	52	49	100	100
September 17, 1871	49	52	16	50	49	31	50	50	44	49	50	58	50	50	72	52	49	86	86
September 18, 1871	51	49	16	49	49	32	48	49	48	49	48	62	50	49	82	52	49	102	102
September 19, 1871	52	49	19	52	49	37	51	49	51	52	49	64	51	49	76	54	49	92	92
September 20, 1871	53	49	13	51	49	31	50	49	47	51	49	66	51	49	82	53	49	102	102
September 21, 1871	51	50	20	50	50	40	50	49	55	49	50	76	50	50	91	49	50	107	107
September 22, 1871	49	50	20	48	49	33	46	48	36	46	48	74	46	48	92	50	48	106	106
September 23, 1871	48	46	18	46	46	29	46	46	44	46	46	46	47	46	50				†55

* Computed from the observations of the 8th.
† Computed from the observations of the 10th.
‡ Computed from the observations of the 17th.

The temperatures of air and water were taken at the same time and with the same instrument. The day begins with noon and ends with the next noon, as in nautical time. The dead reckoning has not been taken directly from the log-book, where it runs on uncorrected for the whole voyage, but has been recomputed each day, from the last preceding position, by observation; in most cases that of the previous noon. The distance is by dead reckoning, and shows the distance of each point of temperature-observation from the starting-point of the day. The rate and direction of the currents are really only approximate, and represent the mean rate and direction of all the currents passed through during the day or since the last observatien.

Current-observations made on board the United States Coast-Survey schooner Humboldt during the voyage from Iliuliuk, Unalashka, to Unga Island, in March, 1872.

Date.	Latitude.		Longitude.		Current.			Winds.
Nautical time.	D. R.	Observations.	D. R.	Observations.	Miles a day.	Knots an hour.	Direction to—	Direction from—
	° ′ ″	° ′ ″	° ′	° ′				
March 23, 1872	Pt. of dep.	53 34 20	Pt. of dep.	165 57	....	....		
March 24, 1872	53 54 00	53 30 00	162 07	162 43	28.6	1.20	S. 33° W.	S. W. and W., fresh.
March 25, 1872	52 49 42	No obs.	161 54	No obs.	(?)	(?)	(?)	N. E., gale.
March 26, 1872	*52 24 36	52 34 00	*160 34	161 02	†19.6	1.63	N. 61° W.	N. E., light, and calm.
March 27, 1872	53 04 48	53 01 00	160 46	160 37	6.7	0.23	S. 53°.5 E.	N. E., light, then gale.
March 28, 1872	53 26 42	No obs.	160 03	No obs.	(?)	(?)	(?)	N. E. and S. E., gale.
March 29, 1872	‡53 47 48	54 25 00	‡159 40	161 08	§63.6	1.325	N. 54°.5 W.	S. E., fresh.
March 30, 1872	....	Coal Harbor.	....	Coal Harbor.	....	....	In shore, variable.	S., strong.

Date.	Temperature of air and surface-water, distance, and time of observation for each day.																		Total distance.
	4 hours.			8 hours.			12 hours.			16 hours.			20 hours.			24 hours.			D. R.
Nautical time.	A.	W.	D.	A.	W.	D.	A.	W.	D.	A.	W.	D.	A.	W.	D.	A.	W.	D.	Nautical miles.
	°	°	k.	°	°	k.	°	°	k.	°	°	k.	°	°	k.	°	°	k.	
March 23, 1872	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	....
March 24, 1872	39	37	3	40	37	15	38	37	28	34	38	58	39	38	88	42	39	100	100
March 25, 1872	41	40	12	37	40	27	33	40	35	34	38	43	34	39	51	36	40	59	59
March 26, 1872	36	40	11	34	40	23	34	40	35	35	40	46	38	39	51	44	39	62	62
March 27, 1872	44	40	2	40	40	2	40	39	3	40	39	11	38	38	21	44	40	33	33
March 28, 1872	40	40	14	40	40	33	39	40	53	39	40	61	38	40	69	40	39	77	77
March 29, 1872	40	39	8	40	39	16	38	39	26	39	39	38	40	39	55	36	39	70	70
March 30, 1872	40	40	12	38	40	26	40	38	41	40	37	47	...	...	...	...	...	...	....

* Computed from observations of 24th. † For twelve hours only. ‡ Computed from observations of 27th. § For two days.

Current-observations made on the Humboldt during the return voyage to Unalashka, in April, 1872.

Date.	Latitude.		Longitude.		Current.			Winds.
Nautical time.	D. R.	Observations.	D. R.	Observations.	Miles a day.	Knots an hour.	Direction to—	Direction from—
	° ′	° ′	° ′	° ′				
April 17, 1872	Pt. of dep.	55 10	Pt. of dep.	160 35	....	....		
April 18, 1872	54 13	No obs.	161 05	No obs.	(?)	(?)	S. and W.	N. W., gale.
April 19, 1872	53 27	53 08	162 08	162 28	22.5	0.93	S. 32° W.	Westerly, light.
April 20, 1872	53 27	No obs.	162 26	No obs.	(?)	(?)	S. and W.	Westerly, light.
April 21, 1872	53 17	52 51	163 48	No obs.	(?)	(?)	S. and W.	Westerly, light.
April 22, 1872	54 10	No obs.	165 30	No obs.	(?)	(?)	S. and W.	S. W., light.

Date.	Temperature of air and surface-water, distance, and time of observation for each day.																		Total distance.
Nautical time.	4 hours.			8 hours.			12 hours.			16 hours.			20 hours.			24 hours.			D. R.
	A.	W.	D.	A.	W.	D.	A.	W.	D.	A.	W.	D.	A.	W.	D.	A.	W.	D.	Nautical miles.
	°	°	k.	°	°	k.	°	°	k.	°	°	k.	°	°	k.	°	°	k.	
April 17, 1872	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
April 18, 1872	33	36	16	32	36	28	33	37	32	31	37	39	34	37	50	36	37	64	64
April 19, 1872	37	38	15	34	38	27	33	37	37	31	37	49	34	38	61	35	38	71	71
April 20, 1872	38	37	12	35	38	22	34	38	24	33	38	29	34	38	32	35	38	38	38
April 21, 1872	38	39	9	36	38	18	35	38	26	36	38	39	37	38	52	41	37	67	67
April 22, 1872	42	40	12	39	40	30	38	39	45	37	39	59	39	38	74	....	....	84	84

Current-observations made on board the Humboldt during the second voyage from Unalashka to Unga, in June, 1872.

Date.	Latitude.		Longitude.		Current.			Winds.
Nautical time.	D. R.	Observations.	D. R.	Observations.	Miles a day.	Knots an hour.	Direction to—	Direction from—
	° ′	° ′	° ′	° ′				
June 17, 1872	54 06	54 02	161 51	162 25	20.5	1.17	S. 78° W.	W. S. W., fresh.
June 18, 1872	55 02	55 05	159 58	160 22	14.?	(?)	N. 77°.5 W.	W. S. W., strong.

Date.	Temperature of air and surface-water, distance, and time of observation for each day.																		Total distance.
Nautical time.	4 hours.			8 hours.			12 hours.			16 hours.			20 hours.			24 hours.			D. R.
	A.	W.	D.	A.	W.	D.	A.	W.	D.	A.	W.	D.	A.	W.	D.	A.	W.	D.	Nautical miles.
	°	°	k.	°	°	k.	°	°	k.	°	°	k.	°	°	k.	°	°	k.	
June 17, 1872	...	...	...	43	44	12	43	43	76	41	43	76	43	44	108	47	44	149	169
June 18, 1872	50	44	30	44	44	61	40	44	83	43	44	83	43	44	103	48	44	121	121

Current-observations made on board the United State Coast-Survey schooner Humboldt during her voyage from Simeönoff Island, Shumagins, to Saint Paul, Kadiak, September, 1872.

Date.	Latitude.		Longitude.		Current.			Winds.
Nautical time.	D. R.	Observations.	D. R.	Observations.	Miles a day.	Knots an hour.	Direction to—	Direction from—
	° ′ ″	° ′	° ′	° ′				
September –, 1872	Pt. of dep.	54 58	Pt. of dep.	159 09				
September 3, 1872	55 33 00	55 20	156 40	156 19	17.6	0.83	S. 42½ E.	S. E., light.
September 4, 1872	55 48 30	55 35	155 27	155 04	18.7	0.89	S. 44 E.	Easterly, light.
September 5, 1872	56 12 00	56 13	154 04	153 39	13.9	0.59	N. 86 E.	S. by E., light.
September 6, 1872	56 30 12	56 27	153 05	153 02	3.6	0.15	S. 27½ E.	S. E. and S. W., light.
September 7, 1872	57 44 00	57 47	152 00	151 17	23.1	0.96	N. 82½ E.	S. E. and S. W., fresh.

Date.	Temperature of air and surface-water, distance, and time of observation for each day.																		Total distance.
Nautical time.	4 hours.			8 hours.			12 hours.			16 hours.			20 hours.			24 hours.			D. R.
	A.	W.	D.	A.	W.	D.	A.	W.	D.	A.	W.	D.	A.	W.	D.	A.	W.	D.	Nautical miles.
	°	°	k.	°	°	k.	°	°	k.	°	°	k.	°	°	k.	°	°	k.	
September –, 1872																			
September 3, 1872	56	52	18	57	52	17	52	50	19	54	50	18	51	51	10	54	52	11	93
September 4, 1872	54	52	12	52	50	11	54	52	10	54	54	15	54	54	12	54	53	18	78
September 5, 1872	54	52	8	55	53	8	55	51	9	52	52	9	55	52	9	58	53	7	50
September 6, 1872	54	50	4	54	51	0	54	52	9	54	52	8	54	52	1	56	52	4	26
September 7, 1872	55	52	4	54	52	4	53	52	19	52	51	23	53	50	20	54	51	20	88

The distance in this case is computed by the dead reckoning between the several points where temperature-observations were taken, instead of between the latter and the starting-point of the day.

Current-observations made on board the United States Coast-Survey schooner Humboldt during her voyage from Saint Paul, Kadiak, to San Francisco, Cal., in September, 1872.

Date.	Latitude.		Longitude.		Current.			Winds.
Nautical time.	D. R.	Observations.	D. R.	Observations.	Miles a day.	Knots an hour.	Direction to—	Direction from—
	° ′ ″	° ′	° ′	° ′				
September —, 1872	Pt. of dep.	57 47	Pt. of dep.	152 09				
September 10, 1872	56 45 00	No obs.	150 15	150 08	(?)	(?)	Easterly.	N. by E., fresh.
September 11, 1872	54 26 00	54 25	146 12	146 54	24.5	1.0+	S. 87½ W.	N. E. to W., fresh.
September 12, 1872	52 15 36	52 20	143 24	143 16	6.6	0.25	N. 48 E.	West, fresh.
September 13, 1872	50 23 54	50 29	139 36	139 43	6.8	0.25	N. 41 W.	S. and S. W., fresh.
September 14, 1872	48 34 24	48 37	136 52	136 45	5.3	0.24	N. 60½ E.	S. and S. W., moderate.
September 15, 1872	48 03 12	47 55	135 32	134 53	27.4	1.14	S. 72½ E.	S. W. to S. E., light.
September 16, 1872	46 53 00	46 55	133 27	133 51	16.9	0.70	N. 83 W.	Westerly, light.
September 17, 1872	44 25 00	44 27	130 35	130 51	10.5	0.43	N. 80 W.	N. W., fresh.

Date.	Temperature of air and surface-water, distance, and time of observation for each day.																		Total distance.
	4 hours.			8 hours.			12 hours.			16 hours.			20 hours.			24 hours.			D. R.
Nautical time.	A.	W.	D.	A.	W.	D.	A.	W.	D.	A.	W.	D.	A.	W.	D.	A.	W.	D.	Nautical miles.
	°	°	k.	°	°	k.	°	°	k.	°	°	k.	°	°	k.	°	°	k.	
September —, 1872																			
September 10, 1872				50	48	13	51	49	27	51	48	15	51	46	18	52	46	16	89
September 11, 1872	47	50	32	46	50	27	46	51	31	44	51	33	47	50	35	49	52	38	196
September 12, 1872	50	51	27	48	52	31	49	52	34	48	52	36	49	52.5	31	54	52	36	195
September 13, 1872	53	52	27	53	52	28	48	52	32	46	52	32	47	52	32	59	57	32	183
September 14, 1872	62	56	35	58	56	28	60	57	30	60	57	24	60	59	21	62	59	18	156
September 15, 1872	63	60	12	60	60	8	61	60	7	60	60	8	62	60	10	65	60	16	61
September 16, 1872	69	61	15	62	60	11	60	61	10	60	61	12	62	61	20	62	61	24	92
September 17, 1872	64	62	24	63	62	30	62	62	36	62	62	38	63	62	38	63	62	37	203

The distance in this case is computed by the dead reckoning between the several points where temperature-observations were taken, instead of between the latter and the starting-point of the day.

Tides of Iliuliuk, Captain's Bay, Unalashka.

I.—UPPER TRANSIT IN NORTH DECLINATION AND LOWER TRANSIT IN SOUTH DECLINATION.—B.—LOW WATER.

Hour of transit.	Days before the moon's maximum declination.														Day of moon's maximum declination.	
	7th day.		6th day.		5th day.		4th day.		3d day.		2d day.		1st day.		0 day.	
	Int.	Ht.	Int.	Ht.	Int.	Ht.	Int.	Ht.	Int.	Ht.	Int.	Ht.	Int.	Ht.	Int.	Ht.
	h. m.	*ft. in.*	*h. m.*	*ft. in.*	*h. m.*	*ft. in.*	*h. m.*	*ft. in.*	*h. m.*	*ft. in.*	*h. m.*	*ft. in.*	*h. m.*	*ft. in.*	*h. m.*	*ft. in.*
1									11 01½	7 00½					8 40	7 03
2											9 15	6 07	9 41	7 06½		
3															9 25	7 03
4													10 22	7 09¼		
5																
6																
7																
8																
9																
10																
11																
12																
13																
14																
15			9 25	5 04½												
16			8 45	5 03½	9 35	6 02										
17	9 10	6 01¼	9 25	6 03½	8 53	5 07	9 19	6 01								
18			8 24	5 10	9 47	6 09½			8 20	6 01½						
19	9 12	4 10	9 19	5 00	8 10	6 06½	8 43	6 09½			8 31	6 08				
20					8 33	6 10			9 00	5 11					8 22	7 01½
21	9 32	5 00	9 07	5 02			8 30½	7 03			8 04	7 06	7 43	7 07		
22					7 56	5 09			8 41	7 05					6 11	7 02½
23	9 40	6 04	10 40	6 07½			9 54	6 08			7 10	7 07	6 34	7 09		
24							10 09	6 11½			8 30	7 01½	7 02	8 07		

Hour of transit.	Days after the moon's maximum declination.													
	1st day.		2d day.		3d day.		4th day.		5th day.		6th day.		7th day.	
	Int.	Ht.	Int.	Ht.	Int.	Ht.	Int.	Ht.	Int.	Ht.	Int.	Ht.	Int.	Ht.
	h. m.	*ft. in.*	*h. m.*	*ft. in.*	*h. m.*	*ft. in.*	*h. m.*	*ft. in.*	*h. m.*	*ft. in.*	*h. m.*	*ft. in.*	*h. m.*	*ft. in.*
1			8 44	8 03					9 25	6 07				
2	9 02	8 01	9 02	8 01	8 49	7 10¼					9 40	6 04		
3	10 03	7 06½			10 15	8 06¼	9 47	7 06½	10 15	7 00			11 12	5 10¼
4			10 02	7 00½			10 14	7 03½			10 38	6 10½		
5	9 39	7 05½			10 25	7 00			11 36½	6 02	10 47	5 11	11 36	6 07¼
6			10 12	6 07	12 09	6 02	10 03	6 10¼						
7					9 57	6 00	10 26	6 02½	10 28½	6 02				
9							10 10	5 09			10 29½	5 00		
10									9 57	5 02				
11											9 29	5 03		
12														
13														
14														
15														
16														
17														
18														
19														
20														
21														
22														
23														
24														

Tides of Iliuliuk, Captain's Bay, Unalashka—Continued.

I.—UPPER TRANSIT IN NORTH DECLINATION AND LOWER TRANSIT IN SOUTH DECLINATION.—A.—HIGH WATER.

Hour of transit.	Days before the moon's maximum declination.														Day of moon's maximum declination.	
	7th day.		6th day.		5th day.		4th day.		3d day.		2d day.		1st day.		0 day.	
	Int.	Ht.	Int.	Ht.	Int.	Ht.	Int.	Ht.	Int.	Ht.	Int.	Ht.	Int.	Ht.	Int.	Ht.
	h. m.	*ft. in.*	*h. m.*	*ft. in.*	*h. m.*	*ft. in.*	*h. m.*	*ft. in.*	*h. m.*	*ft. in.*	*h. m.*	*ft. in.*	*h. m.*	*ft. in.*	*h. m.*	*ft. in.*
1									6 01½	7 08			6 51	7 07	5 05	7 08
2											5 05	7 04½	5 16	8 01½		
3													5 51	8 11	6 00½	8 01½
4													5 04	9 02		
5																
6																
7																
8																
9																
10																
11																
12																
13																
14																
15			3 25	7 05½												
16			3 00	6 04	4 45	7 08										
17	3 30	8 03	3 55	7 06	4 07	6 04	4 36½	6 11								
18			3 05	6 09	5 22	7 08½			5 30	6 06						
19	4 12	6 01½	4 34	6 03½	4 10	6 11½	5 13	7 01½			5 45	6 10				
20					5 05	7 01			5 27½	7 02½					5 57	7 04
21	4 27	6 00	4 32	5 09			5 43	7 06			5 49	7 07	5 03	7 10		
22					5 06	6 03			6 38½	7 06		7 08			5 35	7 03
23	4 05	7 03	5 35	7 02			6 29½	7 00			5 30	7 08	5 27	7 07½	8 16	7 07½
24							5 26½	7 05½			6 20½	7 06½	5 03	7 10	7 10	7 08

Hour of transit.	Days after the moon's maximum declination.													
	1st day.		2d day.		3d day.		4th day.		5th day.		6th day.		7th day.	
	Int.	Ht.	Int.	Ht.	Int.	Ht.	Int.	Ht.	Int.	Ht.	Int.	Ht.	Int.	Ht.
	h. m.	*ft. in.*	*h. m.*	*ft. in.*	*h. m.*	*ft. in.*	*h. m.*	*ft. in.*	*h. m.*	*ft. in.*	*h. m.*	*ft. in.*	*h. m.*	*ft. in.*
1			4 44	8 06					4 02	8 10				
2	6 07	8 01	5 17	8 07½	4 52	8 00½	6 12	7 11			3 58	8 02		
3	5 03	8 06	6 37	7 05	4 55?	9 06	4 32	8 11	4 34½	8 07			4 27	7 04½
4	6 11	9 03	4 42	8 05	6 04	7 05½	4 58	8 05			4 57	9 01¼		
5	4 35	9 02	5 37	8 06	4 35	8 11			4 26	8 02	4 12	9 08¼	4 35	8 03
6			4 12	8 06	4 54	7 07	4 23	9 01			4 36?	8 06?		
7					4 12	5 00	4 36	7 04¼	4 08½	8 05				
8								7 11			3 49½	7 08½		
9									4 30	7 09				
10											3 36	7 07		
11														
12														
13														
14														
15														
16														
17														
18														
19														
20														
21														
22														
23														
24	8 06	7 09½												

Tides of Iliuliuk, Captain's Bay, Unalashka—Continued.

II.—UPPER TRANSIT IN SOUTH DECLINATION AND LOWER TRANSIT IN NORTH DECLINATION.—A.—HIGH WATER.

Hour of transit.	Days before the moon's maximum declination.														Day of moon's maximum declination.	
	7th day.		6th day.		5th day.		4th day.		3d day.		2d day.		1st day.		0 day.	
	Int.	Ht.	Int.	Ht.	Int.	Ht.	Int.	Ht.	Int.	Ht.	Int.	Ht.	Int.	Ht.	Int.	Ht.
	h. m.	*ft. in.*	*h. m.*	*ft. in.*	*h. m.*	*ft. in.*	*h. m.*	*ft. in.*	*h. m.*	*ft. in.*	*h. m.*	*ft. in.*	*h. m.*	*ft. in.*	*h. m.*	*ft. in.*
1																
2																
3	3 53	8 06														
4			3 55½	8 02½	4 03	8 09										
5			3 22	9 02½	3 14	7 08										
6	4 04	7 10			3 18½	8 08	2 59	8 03½								
7			5 10?	7 01			2 16	8 07	2 53½	8 01						
8	3 34	7 05			3 31	8 02	2 54½	8 04	3 14	8 00½	2 31½	8 00				
9			3 07½	6 06					2 41½	8 05	1 41	8 08	1 35	8 10½		
10			2 52	7 07	2 26	6 05½	2 42	6 01½			1 31	8 11½	1 16	8 10		
11					3 02	7 05	2 05	7 01	1 05	6 11			1 09	8 11	1 06	8 07
12							2 22	7 03½	1 30	7 09	1 31	7 09			0 55	9 04½
13									2 19½	7 07	2 47	7 04				
14											1 54	7 07	1 23	7 09		
15													1 39	7 04	1 24	8 00
16															1 58	8 03
17																
18																
19																
20																
21																
22																
23																
24																

Hour of transit.	Days after the moon's maximum declination.													
	1st day.		2d day.		3d day.		4th day.		5th day.		6th day.		7th day.	
	Int.	Ht.	Int.	Ht.	Int.	Ht.	Int.	Ht.	Int.	Ht.	Int.	Ht.	Int.	Ht.
	h. m.	*ft. in.*	*h. m.*	*ft. in.*	*h. m.*	*ft. in.*	*h. m.*	*ft. in.*	*h. m.*	*ft. in.*	*h. m.*	*ft. in.*	*h. m.*	*ft. in.*
1														
2														
3														
4														
5														
6														
7														
8														
9														
10														
11														
12	0 56	9 01	1 30	8 11										
13	0 59	9 00½	1 16	9 03½	1 33	8 10½								
14			1 05	9 00	1 13	8 10½			2 12	7 08½				
15					1 01	9 02	1 35	8 04						
16	1 22	8 01					1 47	8 01	2 31	8 00				
17	2 00	8 09½	1 52	7 10					2 22	6 09½			2 53	6 10½
18			1 51	8 04½	2 28	8 00½	2 16	7 05	2 12	6 06½	3 41?	6 02		
19					1 41	7 07			2 38½	7 03½				
20							2 24	7 09	2 48	7 03	3 00	6 07		
21											3 06	7 00	2 48	5 09½
22													3 34	7 02
23														
24														

Tides of Iliuliuk, Captain's Bay, Unalashka—Continued.

II.—UPPER TRANSIT IN SOUTH DECLINATION AND LOWER TRANSIT IN NORTH DECLINATION.—B.—LOW WATER.

Hour of transit.	Days before the moon's maximum declination.														Day of moon's maximum declination.	
	7th day.		6th day.		5th day.		4th day.		3d day.		2d day.		1st day.		0 day.	
	Int.	Ht.	Int.	Ht.	Int.	Ht.	Int.	Ht.	Int.	Ht.	Int.	Ht.	Int.	Ht.	Int.	Ht.
	h. m.	*ft. in.*	*h. m.*	*ft. in.*	*h. m.*	*ft. in.*	*h. m.*	*ft. in.*	*h. m.*	*ft. in.*	*h. m.*	*ft. in.*	*h. m.*	*ft. in.*	*h. m.*	*ft. in.*
1																
2																
3	10 22	5 10														
4			10 41½	5 06	10 47	5 01										
5			11 07	6 00	10 37	4 07½										
6	10 54	4 05			10 48½	5 04	10 48½	4 03								
7			10 35	4 00½			10 26	4 07	10 44½	3 11						
8	10 24	3 10½			10 36	4 08	10 24½	4 03½	10 44	4 02	10 19	3 07½				
9			10 10	3 07					10 21½	4 02½	9 56	3 07	9 41	3 04½		
10			9 44	4 11½	9 36	3 05½	10 47	3 05			10 07	3 07	9 34	2 11		
11					10 04½	4 11½	9 25	3 06½	10 16	3 09½			9 58	3 04½	9 23	2 06½
12							9 47	4 06½	9 35	3 02	9 54	3 03¼			9 40¼	3 04
13									10 04½	3 10	10 17	5 00½	10 04	3 06		
14											9 46	3 05	10 03½	3 08	9 58	3 05
15													9 44	2 10	9 45	3 07
16															9 45	4 00½
17																
18																
19																
20																
21																
22																
23																
24																

Hour of transit.	Days after the moon's maximum declination.													
	1st day.		2d day.		3d day.		4th day.		5th day.		6th day.		7th day.	
	Int.	Ht.	Int.	Ht.	Int.	Ht.	Int.	Ht.	Int.	Ht.	Int.	Ht.	Int.	Ht.
	h. m.	*ft. in.*	*h. m.*	*ft. in.*	*h. m.*	*ft. in.*	*h. m.*	*ft. in.*	*h. m.*	*ft. in.*	*h. m.*	*ft. in.*	*h. m.*	*ft. in.*
1														
2														
3														
4														
5														
6														
7														
8														
9														
10														
11														
12	9 38½	3 04½	9 05	3 04										
13	9 19	2 11½	9 27	3 08	9 18	3 04								
14	10 06	3 04	9 15	3 06	9 12	3 09	9 05	3 10½	9 21	4 09				
15			9 47	3 07½	9 26	3 09¼	9 28	4 00					9 14	4 07½
16	9 29	4 00			9 20	3 09	9 22	3 09½	9 22¼	5 01	9 24	5 01¼		
17	9 46	4 02	9 24	4 03	9 39	4 05	9 18	4 03	9 27	3 09			9 06	5 03
18			9 23	3 09	9 08	4 02½	9 11	4 09½	9 02	5 01	9 16	4 01½		
19					9 25	3 06			9 13¼	5 01				
20								3 10½	9 32	4 06	9 15	4 10½		
21											9 25	4 11	8 48	4 05½
22													9 19	5 09
23														
24														

APPENDIX No. 11.

VOYAGE OF THE STEAMER HASSLER FROM BOSTON TO SAN FRANCISCO, BY L. F. POURTALES, ESQ., ASSISTANT IN THE UNITED STATES COAST SURVEY.

On the afternoon of the 4th of December, the Hassler left the Charlestown navy-yard, and steamed down the harbor. After passing Boston light, the weather compelled her to return, and anchor for a few hours in Nantasket Roads, but the next day she ran around Cape Cod and anchored in Vineyard Haven in company with a large fleet of weather-bound coasters. Here she was compelled to remain until the 7th, the weather being stormy and very cold. The delay gave a good opportunity to improve the storage of the numerous boxes of apparatus, &c., put on board at the last moment. A final start was made in the afternoon, the pilot discharged at Tarpaulin Cove, and a course taken for Saint Thomas. After leaving Vineyard Sound, a series of hourly observations of surface-temperature and density of the water was instituted, and kept up by Messrs. Pourtales, Steindachner, White, and Blake, each taking a watch. The course lying almost at right angles to the Gulf Stream, the observations gave its northern edge with considerable accuracy, but at a distance of nearly forty miles farther south than the Coast Survey chart indicates. This being only the edge of the superficial warm stratum overflowing the cold water of the so-called polar stream, it is not surprising that its position may vary considerably with the seasons and the prevailing winds. The main body of the stream still extending to considerable depth in this latitude, there is no probability of its being affected by these influences; but we have no observations yet on the subject.

On the 10th, the cold weather had been definitely left behind; and, on the following days, the sea was remarkably calm, and the weather very pleasant. The opportunity was improved by Professor Agassiz for collecting Gulf weed and studying its inhabitants, and by Lieutenant Kennedy and Mr. Pourtales in measuring and marking deep-sea lines, mounting dredges, &c. It is a subject of regret that the instructions contemplated no deep-sea researches prior to reaching Saint Thomas, as this locality would have presented a very favorable ground; the weather being all that could be wished, and the ocean being supposed to be of very considerable depth in this region. The missing of this opportunity was felt the more afterward, when the chances for this kind of researches grew less and less during the progress of the voyage.

On the 14th, the high mountains of Porto Rico hove in sight; and, on the 15th, the ship anchored in Saint Thomas, having first been threatened with quarantine on account of exaggerated reports of small-pox in the United States. It was, however, remitted by Governor Bille on the representation of Professor Agassiz. The ship remained in Saint Thomas until the 22d; some repairs having been found necessary. During that time considerable collections of natural history were made by Professor Agassiz and Dr. Steindachner, and various points of interest visited on the island. During the stay of the Hassler in the harbor, courtesies were extended to the officers and the scientific party by Governor Bille, formerly Danish minister in Washington.

On the 22d, the ship left Saint Thomas. In accordance with the instructions of the Superintendent, it had been intended to test all the deep-sea apparatus between Saint Thomas and Santa Cruz, where the depth is known to be more than 2,000 fathoms. Very interesting results were anticipated, besides the useful practice to be acquired by the officers and men in the use of the instruments. Unfortunately, after leaving the harbor, the trade-wind was found to blow with great violence, raising quite a rough sea, so that operations had to be deferred until evening, when under the lee of the island of Santa Cruz. It was too late to do more than run out a little more than a thousand fathoms of line to stretch it, and, night coming on, the anchor was cast off the town of Frederickstadt. The next morning a few casts of the lead were taken, to test the indicators; but, although the sea was comparatively smooth, the wind blew so fresh that the ship drifted away from the lead too rapidly for good work, and particularly for determining instrumental corrections. No attempt was made to dredge for the same reason. Experiments were made by Lieutenant Day, at the same time as the soundings, with Mr. Morse's apparatus for sounding without line. This consists in a tin cylinder with pointed ends, containing hollow glass balls as floats, tested to resist a great pressure. The whole is carried down by a weight, which detaches on touching the bottom, allowing the cylinder to rise to the surface again. The depth is recorded by a peculiar arrangement, registering the pressure. In this case, (and in every subsequent experiment,) the weight was detached at only a short distance below the surface, from some cause not easily explained, when, of course, the float immediately rose to the surface again. The Hassler continued on her way against a heavy head sea, passing in sight, and between the islands, of Montserrat and Guadaloupe. On the 26th, the air-vessel of the donkey-pump burst; and, as it could not be repaired on board, it was deemed prudent to bear up for Barbadoes, when anchor was cast the same evening in the harbor of Bridgetown. The governor, Mr. Rawson W. Rawson, showed much interest in the Hassler's researches in natural history, being himself a distinguished conchologist, and possessing a valuable collection of West India shells and corals. The repairs being finished, the afternoon of the 29th and the greater part of the 30th were employed in dredging off the coast a few miles north of the harbor; Governor Rawson being a guest on board during that time. The harvest was the richest obtained in dredging during the voyage, as well in quantity as in the great variety of the objects brought to light. Many forms heretofore unknown were obtained, and, what is perhaps of equal or greater interest, several animals found in the deep-sea researches of previous years, in the waters of Florida, of the British isles, and even of Norway, but in those localities generally in much greater depths. The *Asthenosoma*, a soft-shelled sea-urchin, and the *Rhizocrinus* may be mentioned as striking examples; more will probably be found when the collection is critically examined. A great rarity was a fine, living specimen of *Pleurotomaria*, of which only one other is known to exist in collections.

On the evening of the 30th, after landing the governor, and Dr. Martin, who, from increasing trouble in his eyes, was reluctantly compelled to give up the voyage and return home, the voyage was resumed. The course was almost directly against the trade-winds, which, raising a very disagreeable sea, and accompanied by occasional rain-squalls, rendered this part of the voyage exceedingly disagreeable. The motion of the ship was so considerable (the pendulum recording sometimes as high as 42° for the rolling) that sea-sickness, or, at least, great discomfort, was very prevalent, and anything like study or research out of the question. This lasted more or less until the 15th of January, when, the coals running rather short, it was deemed prudent to touch at Pernambuco for a small supply. The United States steamer Ticonderoga was anchored in the roadstead. The Hassler went inside of the remarkable reef forming the natural breakwater of the harbor, but, on account of the prevalence of the yellow fever among the shipping, very little communication was had with the shore. The ship was visited by the United States consul and his family and a few other persons.

On the 16th, having finished coaling and watering, the Hassler sailed for Rio Janeiro.

On the 17th, in latitude 9° 45′ south, a few casts of the lead were taken to obtain the corrections of the indicators. The temperatures obtained at the same time were 80°.5 at the surface, 67° at 100 fathoms, 44°.5 at 485 fathoms, and 42°.5 at 556 fathoms.

On the 18th, in latitude 11° 49′ south, soundings were taken at different distances from shore. In 613 fathoms, the temperature was found to be 39°; surface, 80°.3; in 12 fathoms, nearer shore, 80°. Several casts of the dredge were taken in depths varying from 12 to 200 fathoms, with moderate success.

On the 20th, off the Abrothos, the most extensive coral reefs on the coast of South America, several casts of the dredge were taken in 20 to 44 fathoms, (temperature at 30 fathoms, 72°.) The harvest was not very rich, though interesting.

On the 22d, in the neighborhood of Cape Frio, in 35 to 45 fathoms, a quantity of concretions formed by *Bryozoa*, about the size and shape of potatoes, were obtained by the dredge; also a few corals and shells.

Early on the morning of the 23d, the Hassler entered the magnificent bay of Rio Janeiro, favored by a clear atmosphere, through which the Sugar Loaf, the Corcovado, and the Tijuca shone in their full splendor in the morning sun, with the city stretching along the water at their foot, while in the distance the picturesque Organ Mountains receded in the hazy distance.

The stay in Rio was prolonged to the 15th of February, on account of necessary repairs and alterations, the most important of which were the removal of a fender running around the hull, under which numerous leaks allowed the water to penetrate in heavy weather, and the calking of the deck. A very unfortunate incident was the flooding of the hold from a water-cock being left open by neglect or mischief in the fire-room. There is no doubt that the stock of dredging-line stowed below was damaged by it, and caused the failure of the subsequent attempts at dredging in great depths.

Excursions were made by members of the scientific corps and such of the officers as could be spared from their duties to Tijuca, Petropolis, and other places of interest. By invitation of Mr. Ellison, superintendent of the Don Pedro II Railroad, an excursion was made across the mountains to the end of the railroad, and from there, by the kindness of Mr. Morrett, superintendent of the turnpike and stage company *Union y Industria*, to Juiz de Fora, and back through Petropolis. The two gentlemen mentioned accompanied the party throughout the trip, and, by their thorough knowledge of the country, rendered it as instructive as it was pleasant. The season being midsummer in the southern hemisphere, the heat was generally excessive during the day, tempered on board ship by the sea-breeze, which could not be felt in the streets of the city.

Leaving on the 15th, the plan was to run a line of soundings and dredgings off the coast. But it was found to be blowing too fresh for the purpose, and the wind during the day increased to a heavy gale, which compelled Captain Johnson to lie to the greater part of the next twenty-four hours.

The ship behaved well under the circumstances, though the motion was rather too lively for comfort. On the 20th, the sea was calm enough to allow of a cast of the dredge, in latitude 32° south, in 70 fathoms, and bottom of soft mud. The results were not of particular interest. Another heavy gale was encountered on the 21st. On the 22d, several casts of the dredge were taken in 19 fathoms, near the entrance of the Rio de la Plata, with good results.

On the 23d, in the morning, the Hassler anchored in Montevideo, and was immediately put in quarantine, although having a clean bill of health from Rio Janeiro. The efforts of Admiral Lanman, United States Navy, commanding the South Atlantic squadron, and of the United States consul, proved unavailing to have *pratique* extended; the fearful ravages of the yellow fever at Buenos Ayres a year or two before having rendered the authorities timorous and overcautious. Having misunderstood the terms of a relaxation of the rules allowing a landing to be made in a sparsely-inhabited neighborhood for scientific purposes, Professor Agassiz, accompanied by Mr. Pourtales and Lieutenant Kennedy, visited the Cerro, the only hill interrupting the monotony of the surrounding plains, situated on the north side of the harbor. Here plain, though not abundant, proofs of glacial action were discovered in the shape of small granite and quartzite bowlders, lying over the slate composing the hill. The object of the excursion was fully accomplished, when the whole party was arrested by the police for breach of quarantine, and marched to the guard-house. The matter having been explained to the commissary by Lieutenant Kennedy, they were immediately released, on condition of sinning no more. At the expiration of the quarantine, which was aggravated by disagreeable weather, the ship went into the inner harbor for a few hours to take in a further supply of coal, and sailed on the 28th. Several casts of the dredge were made on the following days with interesting results, all inside of 50 fathoms. On the 4th of March, the ship entered San Matias Bay, on the coast of Patagonia, passing close along the remarkable bluffs of horizontally-stratified clays and sandstones, and anchored at night off Cliff End. The next morning, an exploring party went ashore: some were employed in hauling the seine, obtaining by its means a large collection of fishes; while others ascended the bluffs, collecting fossils in their strata. The most remarkable were an oyster of monstrous dimensions, found in great abundance, and a flat sea-urchin, (*Monophora.*) The bluffs formed the border of extensive rolling plains, very arid, with a scanty vegetation of scrubby and thorny bushes. After a few hours' delay at this place, the anchorage being rather exposed, the anchor was weighed, and better shelter obtained at the head of the bay, in the well-protected harbor of San Antonio. Here the bluffs had disappeared, the land being but moderately elevated, and intersected by numerous creeks. The following morning, parties scattered in different directions to collect specimens of natural history. A party crossed to the western shore of the harbor, where a large creek opened into it, and followed its shores for a considerable distance in a vain attempt to reach the hills beyond. The country was found to be entirely without fresh water; no traces of even the passage of human beings or domestic animals were found; and the usual animals of Patagonia, the guanaco, the cavia, and the ostrich, were far from abundant. On the shores, however, wading-birds were found in great numbers—a tide of nearly thirty feet offering them a vast extent of feeding-ground at low water. In the evening, the ship stood out of the bay, and experienced during the night a severe hail-storm.

During the following days, some interesting casts of the dredge were obtained, always in very moderate depths, when the rather variable weather permitted. During a heavy squall on March 7, the engine was damaged by the breaking of the governor-valve, but was repaired by the engineers, the steamer being hove to on the next day for the purpose. On the 9th, occasional patches or rafts of floating kelp were passed. On the morning of the 13th, Cape Virgin, at the entrance to the Strait of Magellan, was sighted, forming a headland of bluffs, apparently similar to those visited in San Matias Bay. They rose to a considerable height at Cape Possession, which was passed shortly afterward. At night, the anchor was cast off Tandy Point, in Possession Bay. The singular appearance of the mountains known as Mount Aymon and the Asses' Ears, distant about eight miles from the shore and breaking the uniformity of the Patagonian plains, formed an inducement for an effort to visit them, particularly as they would be more likely to afford an opportunity for the observation of ancient glacial phenomena. So, while Professor Agassiz reserved for personal examination the more accessible parts of the neighborhood, a party, consisting of Messrs. Kennedy, Pourtales, Mansfield, White, and Dee, with two sailors, started at daybreak for the interior. The path led over the usual Patagonian desert, here almost entirely destitute of bushes; the country having been apparently swept by fire at frequent intervals. The surface was undulating, varied by hills and valleys of moderate elevation or depth, seldom abrupt; the valleys presenting the usual appearances of having been excavated by running water, such being a regular incline toward the sea, affluents, &c., but nowhere could any trace be seen of *recent* effects of waters; there were no gullies, no fresh sand-bars; on the contrary, the sward, scanty to be sure, but certainly ancient, covered hill and dale with perfect uniformity. In a few depressions, shallow ponds or puddles were seen. One of them, near the sea, but elevated at least 100 feet above it, was found by Professor Agassiz to be salt, and contained living sea-mollusks, a proof of the elevation of the land at no very remote date. Another more elevated puddle was found by one of the party to be fresh, but so shallow and so trampled by animals that he could not procure any water for drinking. The whole surface of the country was found to be covered with glacial drift; bowlders three or four feet in diameter were not rare. Guanacoes were seen in abundance; also a few ostriches. The mountains were reached after a fatiguing walk, and found to be volcanic cones, of no great age, with well-formed craters, elevated some two to three hundred feet above the surrounding plain. They had evidently pierced through the drift, and covered it with their streams of lava. From the summit of Mount Aymon, which appears to be the easternmost of the chain, a large number of similar volcanoes were seen, extending in an irregular chain to the westward. No sign of the place having been visited before could be found. A record was left in a bottle on the summit, covered by a cairn of blocks of lava. The same chain has been observed farther west by Commander Musters, Royal Navy, during his extended trip through Patagonia. The party reached the shore after sunset, almost exhausted for want of water, a want felt particularly severe on account of the dryness of the atmosphere. Professor Agassiz had been quite successful in his explorations, having found abundant traces of glacial action. Valuable additions were made to the collections at this place; among them a fine guanaco killed by Mr. Kennedy.

On the 15th, favored by very fine weather, the passage of the First and Second Narrows was made, taking advantage of the powerful tidal current sweeping through them. In the afternoon, the Hassler anchored in Royal Roads between Elizabeth Island and Peckett's Harbor. The island was visited, and found to consist entirely of drift, forming high cliffs all around. It is, in the proper season, a great breeding-place of swans and geese, but was nearly abandoned at this time, and only inhabited by small flocks of the latter. The remains of a former settlement of the natives were visited, and some interesting relics obtained. The site of every hut was marked by an excavation about a foot deep and several feet in diameter, in front of which, toward the water, is a large heap of shells and bones, the former chiefly *Mytilus*, the latter of seal, birds, and fishes, mingled with great quantities of chips of slate, perhaps used to open the shell-fish. No tree or bush grows on the island. From this point we began to see some of the high mountain-ranges in the west, covered with snow and ice. The next morning a few hours were spent in visiting Magdalena Island, only a couple of miles distant from Elizabeth Island. It is of the same character, but the cliffs are rather higher and steeper; in some places, the drift is stratified in a very irregular manner, the strata being very much contorted and interrupted, as if the deposit had been made under the influence of a powerful current. This island has been chosen as a breeding-place by the penguins and cormorants; the grassy parts being everywhere undermined by the burrows of the former, while the latter build their nests on the ledges of the cliffs, and also on some particular level spots, where the nests are almost in contact with each other. A large number were killed for specimens. The same afternoon the anchor was cast at Sandy Point, (Punta Arenas,) a Chilian convict-settlement, the only spot inhabited by civilized men in the straits. Considerable collections of fishes were made here. The coal-mine opened within a few years was visited by Professor Agassiz, and fossils from the surrounding rocks obtained.

Some of the coal was used on board the Hassler, but was found of rather inferior quality, making a great deal of smoke, and burning too rapidly. The vicinity of Sandy Point forms a transition between the arid plains of Eastern Patagonia and the glacier-region of the western channels. It can boast of a very luxuriant, though not varied, forest-vegetation; the antarctic beech, growing here to a very large size, and being the chief constituent of the forest.

On the 19th, the voyage was resumed. The morning being very clear, a glorious view of the snow-clad peaks of Sarmiento, Buckland, and Darwin was obtained. In the afternoon we stopped for the night at Port Famine, and visited the remains of the ill-fated settlement of the Spaniards, whose sad end is commemorated in the name.

The next morning, in passing by the mouth of San Gabriel Channel, a fine view was obtained of the enormous glaciers overhanging its shores. Mount Sarmiento, from which they descend, was unfortunately obscured by clouds. On this day, the southernmost point of the voyage was reached at Cape Froward, and henceward the expedition could consider itself homeward bound. Port Gallant, the anchoring-place for the night, was reached early enough during the afternoon to allow of excursions on the shore in various directions. The bareness of the hills, and their very characteristic glaciation as seen from a distance, seemed to promise a good field for observing the direction of the glacial scratches; but a closer examination showed that the original surface of the rock, a kind of slate with quartz veins, had weathered off to a depth of nearly half an inch, as shown by the relief of the harder veins. On one of the latter, some distinct scratches were recognized by Mr. Pourtales, bearing west-northwest and east-southeast.

On the 21st, a violent northwest gale rendered the progress so slow that, after passing Cape Quod, the ship making scarcely any headway, it was deemed advisable to run back and seek shelter in Port Borja, a very snug little harbor surrounded by high mountains. The gale continued the next day, accompanied by squalls of rain and snow. Messrs. Kennedy and Pourtales ascended one of the mountain-spurs overhanging the harbor to a height of about five hundred feet, and noticed that the valley which they overlooked from the height formed two wide basins, elevated above each other, and each occupied by a small lake, the discharge of which fell as a cascade from one to the other. This feature of the valleys, being as it were dammed up at various levels and retaining the water in the form of lakes, was found afterward to be almost universal. The barrier is formed by the rock *in situ*, and only in a very few cases by moraines.

While in this port, signals were exchanged with an English steamer passing outside, bound east.

On the 25th, the weather having moderated, the ship proceeded to Glacier Bay, which was visited in boats, no good anchorage being known inside. A preliminary examination was made during the afternoon, and shelter taken for the night in Praya Parda Cove, a few miles farther north. The next day, early, a large party returned to Glacier Bay in the steam-launch, and spent the day in exploration. Professor Agassiz and Captain Johnson traced the former extension of the glacier to the mouth of the bay. Dr. Hill and Dr. White photographed the most interesting points. Mr. Pourtales, Dr. Steindachner, and Dr. Pitkin ascended the side of the glacier to about the lower limit of the permanent snow-line, found barometrically to be about fifteen hundred feet, but could find no point from which a general view of the upper part of the glacier could be obtained. At that height, the thickness of the ice, as seen in the exposed side of the glacier, was estimated at about seventy feet. In the middle of that thickness, angular bowlders of considerable size were seen imbedded in the ice, and added, when disengaged by melting, to the mass of the lateral moraine, composed here of very large blocks with slightly-rounded angles. Quite a number of lakes, of the character of those mentioned before, were seen during the excursions; one or two were retained by moraines.

The next day was very stormy, and the Hassler remained in its well-protected anchorage. On the 26th, the bay of Churuca, on the south side of the straits, was visited, in the hope of finding there a glacier discharging directly into the water; the one at Glacier Bay, named by Professor Agassiz the Hassler Glacier, having its terminus nearly half a mile from the water. No such a one was found; the bay, however, was one of the most beautiful visited, being surrounded by high mountains surmounted by glaciers, and deeply cut by lateral bays branching off in various directions. Without anchoring, therefore, we steamed out again, and, crossing the strait for the first time in sight of the Pacific Ocean beyond Cape Pillar, anchored for the night in Sholl Bay, at the mouth of Smyth's Channel.

On the 27th, Professor Agassiz went ashore with a party to fish and collect, while the Hassler steamed out into the middle of the strait to sound a dredge, between Sholl Bay and Cape Tamar. The greatest depth found was 135 fathoms. The surface-temperature was 49°; bottom, 47°.5. The water had a dark bottle-green color, and it may be remarked here that since leaving Montevideo the water had always presented this appearance, the ship being on soundings all the time. The dredge brought up mud and stones and a few shells and echinoderms. The collections made on shore were quite successful. The party on shore were visited by natives in an old ship's boat, who followed them to the steamer, begging for tobacco and biscuit. The same afternoon the steamer entered Smyth's Channel, and anchored for the night at Otter Islands. The next day we had at times magnificent views of the snowy peaks and glaciers of the Sarmiento Cordillera and of Mount Burney, its culminating point in this region. During the forenoon, the rod of the reversing quadrant of the engine broke, and occasioned a delay of about two hours. The anchorage for the night was at Mayne Harbor, where the next day was also spent while the engineers were making the necessary temporary repairs. An excursion on shore showed the usual granitic rocks, with greenstone veins passing into porphyry, and showing all the marks of glacier action. The next day's progress was as far as Porto Bueno, anchoring there early enough in the afternoon to permit of the usual collecting excursions. An early start was made on the 31st, with the hope of reaching an anchorage of Tom's Bay before night; the morning was clear, and afforded fine views of the snowy Cordillera and of Mount Stokes; but, unfortunately, in the afternoon the weather became very thick, so that the landmarks given in the sailing-directions could not be recognized. After trying several small bays, none of which agreed with the description or offered a convenient anchoring-ground, no choice remained but keeping in mid-channel for the night, with a boat-party keeping up a fire on the nearest island to enable us to retain our position. The 1st of April was a particularly fine day, enabling us to enjoy the fine scenery of this part of the strait. The mouth of Eyre Sound was passed, out of which numerous small icebergs were floating, detached from some large glaciers which discharge directly into the sea at the head of this sound, but were not in sight from the main channel. About noon the Narrows on the western side of Saumarez Island were passed, presenting on their sides remarkably fine glacial furrows, following the trend of the valley. Large glaciers in the higher parts of the mountains were frequently seen during the day. The night's anchorage was at Eden Harbor. In its neighborhood, fine terraces, near the mouth of some valleys, were observed from the ship, looking like artificial embankments. None had been noticed in the straits farther south. Fog prevented an early start the next morning, so that the day's journey extended only to Conner's Cove, passing on the way through the English Narrows.

On the 3d, the steamer left the straits, passing into the Gulf of Peñas. The chain of snowy mountains bounding the gulf on the east made a magnificent distant panorama at sunset. The passage from the Gulf of Peñas to the Gulf of Corcovado was rather disagreeable as far as the weather was concerned. The latter was reached on the 6th, and the steamer anchored in the afternoon in San Pedro Harbor, in the southeast part of the island of Chiloe. This port is uninhabited, thickly wooded to the water's edge, and, as previously observed by Darwin, the shores of Chiloe were found to exhibit distinct traces of glaciation and numerous erratic blocks, but no well-defined marks of the direction of the movement.

It had been intended to pass inside of Chiloe to San Carlos; but, after proceeding a short distance, the soundings were found so irregular, and the only chart on board so imperfect, that Captain Johnson preferred turning back and taking the outside passage. On the 8th, we anchored for a few hours in the harbor of San Carlos de Chiloe, or Ancud, for fresh provisions, of which there had been a great want on board lately. Pork and beans had been served at every meal for some time past, only varied occasionally by fish or muscles. In the neighborhood of the town, interesting observations were made by Professor Agassiz on the glacial drift superposed on lava-beds. On the mainland, the beautiful volcanic cone of Osorno, covered with its snowy mantle, presented an appearance not very unlike the well-known shape of Fusi-Yama, on Japanese landscapes. No trace of smoke could be seen on its summit, even with the glass; as is well known it was in violent eruption during Darwin's visit to this port. On the 10th went into the harbor of Lota, in the bay of Aranco, where considerable coal-mines are being worked. A supply was taken on board, and proved rather similar to the coal of Sandy Point. It is found in a Cretaceous formation, according to Professor Agassiz's observations.

The next day the Hassler anchored in Talcahuano Harbor, and remained there until the 25th, during which time a new reversing quadrant was cast in Concepcion. Professor Agassiz established his quarters ashore, and made, with the help of Dr. Steindachner and Mr. Blake, very extensive collections of natural history. In an excursion in the neighborhood, very well marked glacial scratches were discovered near San Vicente, by Mr. Pourtales, trending east and west nearly. Near Point Lobos, Mr. Pourtales and Dr. Steindachner observed strata of Cretaceous sandstones, containing Trigonias, several hundred feet in thickness, resting on nearly vertical strata of mica-slate.

At the junction of the two, an irregular stratum, several feet in thickness, of a kind of breccia, was observed, composed of fragments of the slate, imbedded in sandstone, and containing also small quartz-pebbles, and rounded bowlders of quartzite and granite, one or two feet in diameter, seeming to point to a drift-epoch previous to the deposit of the Cretaceous beds.

From Talcahuano, Professor and Mrs. Agassiz and Dr. Steindachner set out by land to Santiago. The Hassler left on April 25, to run a line of dredgings and soundings to Juan Fernandez, and thence to Valparaiso. The slope of the bottom was found very gradual to the hundred-fathom line, about thirty-five miles from the mouth of Concepcion Bay. At the distance of about fifty miles, a depth of 1,005 fathoms was reached. In latitude 35° 30′ south, longitude 75° 11′ west, about two-thirds of the way from Concepcion Bay to Juan Fernandez, 2,410 fathoms were found. The surface-temperature was 57°.5; at 117 fathoms, it was 51°; at the bottom, 35°. The bottom was soft mud, and fragments of silicious sponge were found adhering to the line. After the sounding, which took four hours and a quarter, the dredge was let down with about 3,800 fathoms of line. It was left on the bottom about an hour and a half, keeping it under proper motion by backing the steamer at intervals. It was then hauled up; but the tension was too strong for the line, which had evidently been damaged by dampness in the hold, and which, after having given endless trouble by stranding several times, finally parted. The dredge was lost, with 2,720 fathoms of line. The rest of the day and the next were spent in overhauling the line, and cutting out the doubtful or mildewed parts, the steamer keeping on her way under very slow speed. The weather during that time was not propitious for dredging.

On the 29th we arrived off Juan Fernandez early in the morning, and, the sea being calm, concluded to dredge off the island. About two miles off Cumberland Bay, sounded in 656 fathoms, surface-temperature 61°; at 377 fathoms, 41°.5; at bottom, 39°; took a cast of the dredge, which brought only a few small stones; then went about three miles off the northwest corner of the island, and sounded in 1,144 fathoms; bottom-temperature, 36°; specimen-cup full of fine gray sand and mud, with *Foraminifera*. A cast of the dredge brought up only a handful of fragments of clay, with one or two pebbles and parts of an *Isis*.

April 30, twenty-four miles north of the island, sounded in 2,214 fathoms; bottom-temperature, 36°; specimen-cup full of reddish mud. The dredge was then let down, but disappointment was again in store. After nearly three hours' labor in hauling it in with great precaution, the line parted and about 1,250 fathoms of it were lost.

During the dredging, Lieutenant Day made some more trials with the Morse sounding-apparatus, which were not more successful than those at Santa Cruz. Some defect in the balancing of the weight invariably caused its detachment after going down a very short distance. A cannon-ball, held by ice-tongs, found to be a sure mode of detaching in sounding, was substituted, but the float never re-appeared. Experiments on the penetration of light, devised by Dr. Hill, were made on board by himself, and from a boat by Lieutenant Day and Dr. White. In the evening, the steamer was headed for Cumberland Bay, island of Juan Fernandez, remained outside during the night, and anchored in the morning. May 1 was spent at the island, making collections on shore and in the bay, and visiting Alexander Selkirk's cave and lookout. The island is inhabited by a dozen Chilians only, who might, but do not, raise cattle and vegetables in sufficient quantities for providing passing ships.

May 2, started for Valparaiso, sounding and dredging; the depth was found to increase very rapidly from the shore. A sounding was taken near the position occupied on the afternoon of April 29, with 523 fathoms, and the dredge let down subsequently; but here again it parted in the attempt to haul it up, with a loss of 530 fathoms. The next day sounded in latitude 33° 33′ south, longitude 77° 2′ west; depth, 1,585 fathoms; bottom-temperature, 36°; bottom, fine, white foraminiferous mud. The line was in so bad a condition, and stranded so frequently, that it was only by the use of the greatest precautions that it could be recovered at all. The operation lasted from half past 6 in the morning to half past 2 in the afternoon. Under the circumstances, it was judged useless to attempt to dredge, and even to sound any more in deep water. The steamer, therefore, kept on her way to Valparaiso, where she arrived early on the morning of the 5th.

The Hassler remained at Valparaiso until the 13th; several of the party in the mean time visiting Santiago, where Professor Agassiz had arrived from Talcahuano. Much interesting information was obtained in Valparaiso about the Chonos Archipelago from the officers of the Chilian corvette Chacabuco, Captain Simpson, which had been employed in the survey of that little known region, and their charts were examined with great interest.

On the 15th, an attempt at sounding was made, but, the wind being too high, it was unsuccessful.

May 16, anchored during the day in the harbor of Caldera, where Professor Agassiz wished to make some collections and observations on the geology. It is the harbor for some mines situated in the interior, near Copiapo, with which it is connected by a railroad. But the country is a perfect desert, destitute of water; the inhabitants depending on a condensing-engine for their supply. Sailed again in the afternoon. The weather was not propitious for sounding or dredging on the following days.

May 21, anchored in Paraca Bay, near Pisco, and remained until the 23d, collecting. On the 24th, arrived at Callao. During the stay at this port, the party received many civilities from Mr. Henry Meiggs, the eminent contractor for the Peruvian railways. An excursion on the Oroya Railroad, intended to cross the Cordillera, was particularly interesting and instructive. On the 31st, the Hassler went to Ancon, a few miles northward, to take on board a large collection of skeletons and antiquities, exhumed from ancient Peruvian cemeteries in the neighborhood by Dr. Hutchinson, Her Britannic Majesty's consul at Callao, and intended for the Peabody Museum of American Antiquities in Cambridge.

June 1, left Callao, and arrived at Payta on the 4th, where the United States steamer Ossipee, Captain Miller, was met, ready to sail for home. Captain Miller kindly consented to take some of the collections for transmission. On the 6th, left for the Gallapagos, and arrived at Charles Island on the 10th, anchored in Post-Office Bay, and made considerable collections of natural history. The so-called governor or lessee from the government of Ecuador came down from the mountains, but could supply the ship with very little in the shape of fresh provisions: a severe drought had prevailed for several months, and more than one thousand two hundred head of cattle had perished for want of water. The Hassler was the first vessel calling at the island in the eight months the man had spent there. He was entirely out of many necessary supplies, such as flour, salt, &c.

On the 12th, went to Albemarle Island, intending at first to anchor in Iguana Cove on the south side, but this was found too much exposed, and the shore so steep as to prevent landing. We therefore kept on our way, passing along the west coast of the island, which presented a most interesting, though desolate, spectacle of volcanic action; enormous lava-streams had descended from the mountains into the sea, and the plain at the foot was studded with innumerable eruptive cones and chimneys. Keeping under slow speed all night, we rounded Narborough Island, one of the highest in the group, and probably one of the newest, the lava looking fresher and the vegetation more scanty than on any of the others. Entering into the passage between this and Albemarle Island, the Hassler anchored in Tagus Cove, a circular crater broken down toward the sea. Collections were made here, particularly of the large land-lizard, (*Amblyrynchus Demarli,*) which was found here in abundance. The marine species (*Amblyrynchus cristatus*) had been collected at Charles Island, but the land species does not occur there. The large terrestrial turtle, formerly so abundant on the islands, has become very rare; in consequence, the islands are now but rarely visited by the whalers, who used to take them in quantities for fresh provisions.

On the 15th, visited James Island; on the 16th, Jarvis Island; on the 17th, Indefatigable Island; and, on the 19th, sailed for Panama, where the anchor was cast on the 25th.

Here Assistant Pourtales concluded to leave for the United States by way of the Aspinwall and New York steamer, sailing on the 7th of July; the worthlessness of the remaining stock of deep-sea line rendering further attempts at deep-sea soundings and dredgings useless.

The Hassler remained at Panama until July 24, waiting orders from the Office. She was then engaged in searching for a reported shoal in the bay, and in the offing attempted a dredging in 500 fathoms, with indifferent success. From August 1 to 4, the vessel was employed in a survey of the Tartar Shoal, off Acapulco, and on the evening of the latter date went into port, and remained until the 7th, giving Professor Agassiz an opportunity to make extensive collections of natural history. At the last-mentioned date, the party sailed from Acapulco and arrived on the 13th in Magdalena Bay, Lower California. Starting again on the 14th, the vessel arrived in San Diego on the 18th. On the 23d, the steamer went out to search for a reported rock, leaving the scientific party ashore. The Hassler returned on the 26th, and on the 28th sailed for San Francisco, where she arrived safely on the 31st of August.

APPENDIX No. 12.

DETERMINATION OF WEIGHTS TO BE GIVEN TO OBSERVATIONS FOR DETERMINING TIME WITH PORTABLE TRANSIT-INSTRUMENTS, RECORDED BY THE CHRONOGRAPHIC METHOD.—REPORT TO THE ASSISTANT IN CHARGE OF THE COAST SURVEY OFFICE, BY CHARLES A. SCHOTT, ASSISTANT.

The introduction of the chronographic registration of transits of stars has considerably increased their precision, rendering it desirable to discuss the relative weights of the conditional equations resulting from the treatment by the method of least squares of observations made in that way.

The general form of the probable error of a transit-observation is the same for the chronographic as for the "eye and ear" method; which latter has been long since discussed by Bessel in the Berliner Jahrbuch for 1823, (see also Dr. Sawitsch's Practische Astronomie, vol. 1, pp. 128, 129, Hamburg, 1850.) In general, there is a constant value related to the personality of the observer, and a term variable with the star's declination, depending on the apparent motion of the star, and affected by the condition of the atmosphere and by the magnifying power of the telescope.

The close circumpolar stars still continue to be observed by the eye and ear method; use being made, however, of the click of the armature of the recording magnet. Some observers prefer two taps, corresponding to the apparent bisection of the star by the preceding and following edges of the threads.

The relative weights of incomplete transits are also slightly changed, since the determination of instrumental errors is but little improved, whereas the uncertainty in noting time on each thread has been considerably diminished by the chronographic method.

In Coast Survey practice, two classes of portable instruments are employed in the determination of longitudes by means of the telegraph: larger-sized transits of about 12 decimeters (nearly 47 inches) focal length, generally with reticules of twenty-five threads; and smaller-sized meridian-telescopes (transit and zenith telescope combined) of about 6.6 decimeters (nearly 26 inches) focal length, generally with glass diaphragms of fifteen lines. The latter instruments are used at stations of secondary importance.

RELATIVE WEIGHTS TO TRANSITS DEPENDING ON THE STAR'S DECLINATION.

The following tables of the probable error (ε) of an observation of a transit of a star over a *single* thread have been derived from a discussion of 1047 transits taken in February and March, 1869, at San Francisco, by Assistant G. Davidson, with the large transit C. S. No. 3, (aperture $2\frac{3}{4}$ inches, magnifying power 85;) and 875 transits taken about the same time at Cambridge by Assistant A. T. Mosman, including some observations by Sub-assistant F. Blake, with the large transit C. S. No. 5, (aperture $2\frac{3}{4}$ inches, magnifying power 100.) For the discussion of observations with a smaller instrument, 330 transits were used, taken in September, October, and November, 1871, at Cleveland, Ohio; and 585 transits, taken in December and January, 1871–'72, at Falmouth, Ky., by Assistant E. Goodfellow, with meridian-telescope C. S. No. 13, (aperture $1\frac{3}{4}$ inches, magnifying power about 70.)

Transit No. 3.		Transit No. 5.		Meridian-telescope No. 13.		Meridian-telescope No. 13.	
δ	ε	δ	ε	δ	ε	δ	ε
°	s.	°	s.	°	s.	°	s.
87.2	±0.74	86.9	±0.66	81.9	±0.62	76.3	±0.20
86.6	0.49	80.0	0.20	76.9	0.18	68.2	0.16
83.0	0.38	76.3	0.19	67.4	0.11	55.8	0.13
81.0	0.31	72.6	0.12	62.0	0.14	48.4	0.15
68.4	0.12	68.8	0.11	55.8	0.09	23.2	0.102
62.9	0.088	3.2	0.066	44.8	0.088	20.4	0.089
48.6	0.075	....	....	29.7	0.067	17.3	0.110
28.5	0.058	....	....	0.7	0.071	6.1	0.080
−7.8	0.060	....	....	....	....	....	....

These tabular values are fairly represented by the expressions—

Transit, No. 3, $\varepsilon = \sqrt{(0.060)^2 + (0.036)^2 \tan^2\delta}$

Transit, No. 5, $\varepsilon = \sqrt{(0.066)^2 + (0.036)^2 \tan^2\delta}$

Meridian-telescope, No. 13, $\varepsilon = \sqrt{(0.069)^2 + (0.078)^2 \tan^2\delta}$

Meridian-telescope, No. 13, $\varepsilon = \sqrt{(0.087)^2 + (0.055)^2 \tan^2\delta}$

Combining these expressions for the larger and smaller instruments we obtain—

$$\varepsilon = \sqrt{(0.063)^2 + (0.036)^2 \tan^2\delta} \text{ and } \varepsilon = \sqrt{(0.080)^2 + (0.063)^2 \tan^2\delta}$$

respectively,* from which the following tables of probable errors (ε) of relative weights (p), that of an equatorial star having the weight unity, and of the multipliers $\sqrt{p}$ for the conditional equations have been computed.

	δ		For large portable transits.			For small portable transits.		
			ε	p	$\sqrt{p}$	ε	p	$\sqrt{p}$
	°	′	s.			s.		
	0		±0.06	1	1	±0.08	1	1
	10		.06	1	1	.08	0.98	1
	20		.06	0.98	1	.08	.92	0.96
	30		.07	.91	0.95	.09	.83	.91
	40		.07	.82	.90	.10	.70	.83
	45		.07	.76	.87	.10	.62	.79
	50		.08	.69	.83	.11	.53	.73
	55		.08	.61	.78	.12	.44	.66
	60		.09	.51	.71	.14	.34	.59
	65		.10	.40	.63	.16	.26	.51
	70		.12	.29	.54	.19	.18	.42
	75		.15	.18	.43	.25	.10	.32
	80		.21	.09	.30	.37	.05	.22
	85		.42	.02	.15	.72	.01	.11
δ Ursæ Minoris..	86	36	0.61	0.011	0.103	1.1	0.006	0.075
51 Cephei.........	87	14	0.75	0.007	0.084	1.3	0.004	0.061
α Ursæ Minoris..	88	39	1.5	0.002	0.041	2.7	0.001	0.030
λ Ursæ Minoris..	88	56	1.9	0.001	0.033	3.4	0.001	0.024

In the application of the $\sqrt{p}$ it suffices to employ but one significant figure.

RELATIVE WEIGHTS TO INCOMPLETE TRANSIT-OBSERVATIONS.

Let ε = the probable error of a transit of an equatorial star over a *single* thread = ± 0s.063 and ± 0s.080 for our larger and smaller instruments, respectively; ε_1 = the probable culmination-error, referred to the equator, mainly due to atmospheric displacement, to outstanding instrumental errors, irregularities in clock-rate, and changes in the personal equation; n = number of threads observed, then—

$$r^2 = \varepsilon_1{}^2 + \frac{\varepsilon^2}{n}$$

will represent the square of the combined effect. To find r, individual determinations of right ascensions of stars, all referred to the same epoch, (mean place,) may be compared with their respective average values; thus, from 558 results of 36 stars observed at the United States Naval

* The following formula has been published by Dr. Albrecht on p. 7 of his Formeln und Hülfstafeln, &c., Leipzig, 1874, viz:

$$\varepsilon = \sqrt{(0.05)^2 + \left(\frac{3.18}{v}\right)^2 \sec^2\delta}$$

Putting v = 85 for the magnifying power, and changing sec into tan, this expression is equivalent to—

$$\varepsilon = \sqrt{(0.062)^2 + (0.037)^2 \tan^2\delta}$$

Observatory with the transit-circle (using a magnifying power of 186) in 1870 and 1871, I find $r = \pm 0^s.034$. To apply this value to our instruments, it must be somewhat increased, though not in proportion to the respective magnifying powers, since some of the errors involved approach the character of constants; multiplying it by 1.5 and 1.75, the equations—

$$(0.051)^2 = \varepsilon_1^2 + \frac{(0.063)^2}{25} \quad \text{and} \quad (0.060)^2 = \varepsilon_1^2 + \frac{(0.080)^2}{15}$$

give—

$$\varepsilon_1 = \pm 0^s.049 \text{ and } \varepsilon_1 = \pm 0^s.056$$

for the larger and smaller instruments respectively; and, consequently, the weights from—

$$p = \frac{\varepsilon_1^2 + \frac{\varepsilon^2}{N}}{\varepsilon_1^2 + \frac{\varepsilon^2}{n}}$$

for the larger instruments—

$$p = \frac{1 + \frac{1.6}{N}}{1 + \frac{1.6}{n}}$$

and for the smaller instruments—

$$p = \frac{1 + \frac{2.0}{N}}{1 + \frac{2.0}{n}}$$

very nearly. From these expressions, the relative weights have been computed for total number of threads N = 25 and 17 and N = 15 and 13.

Number of threads.	For large portable transits.				For small portable transits.			
	p	$\sqrt{p}$	p	$\sqrt{p}$	p	$\sqrt{p}$	p	$\sqrt{p}$
1	.41	.64	.42	.65	.38	.62	.38	.62
2	.59	.77	.61	.78	.56	.75	.58	.76
3	.69	.83	.71	.84	.68	.83	.69	.83
4	.76	.87	.78	.88	.75	.87	.77	.88
5	.81	.90	.83	.91	.81	.90	.82	.91
6	.84	.91	.86	.93	.85	.92	.87	.93
7	.87	.93	.89	.94	.88	.94	.90	.95
8	.89	.94	.91	.95	.91	.95	.92	.96
9	.90	.95	.93	.96	.92	.96	.94	.97
10	.92	.96	.94	.97	.94	.97	.96	.98
11	.93	.96	.95	.98	.96	.98	.98	.99
12	.94	.97	.96	.98	.97	.99	.99	1.0
13	.95	.97	.97	.99	.98	.99	1.0	1.0
14	.96	.97	.98	.99	.99	1.0		
15	.96	.98	.99	1.0	1.0	1.0		
16	.97	.98	1.0	1.0				
17	.97	.98	1.0	1.0				
18	.98	.99						
19	.98	.99						
20	.98	.99						
21	.99	.99						
22	.99	1.0						
23	.99	1.0						
24	1.0	1.0						
25	1.0	1.0						

For the larger instruments, the gain in accuracy between 17 and 25 threads is very trifling; and it is believed that the increased fatigue to the observer and consequent change in his personal equation will more than counterbalance it. Seventeen threads are recommended, which may conveniently be disposed in three tallies; the middle one (especially for the observations of close circumpolars) of 7 equidistant, and the two outer tallies of 5 equidistant threads, about 2^s apart. For the smaller instruments, 13 instead of 15 lines are recommended, with 7 lines in the middle and 3 lines each in the outer tallies. For occasional observations by the eye and ear, two outer single threads may be added, forming, with the central ones of the tallies, 5 equidistant threads, (about 12^s apart.) If the observer prefers, he may have close double lines, and tap the star when exactly between them.

Respecting the probable error of the tabular right ascensions of clock-stars, as given in the American Ephemeris, we may form some judgment from the table of corrections given in the Washington Observations for 1870 and 1871, (Table C, p. lxxxv.) Taking the square root of the average square of corrections to these 119 clock-stars, the mean correction, referred to the equator, becomes $\pm 0^s.041$.

The probable error of a tabular right ascension of a fundamental star may be estimated at not less than $\pm 0^s.03$, and comparatively greater for other stars. To give weights for relative uncertainty in the tabular right ascensions is generally impracticable; but we may obtain as consistent and accurate a set of results as the nature of the observations admits of by first using the conditional equations with equal weights *with respect to tabular places*, and deducing corrections to the assumed right ascensions for all stars not fundamental from the observations of the same star on different nights. A second formation of the numerical quantities of the conditional equations and solution of the normal equations will give the final results for instrumental deviations and for local time.

In this method, the apparent right ascensions of the stars are made to refer to the equinox belonging to the fundamental stars.

In the reduction of a set of transits by application of the method of least squares, (for which see Appendix No. 9, Coast Survey Report for 1866; also Appendix No. 10, Report for 1868,) it is recommended to introduce, in the conditional equations, two azimuthal deviations; one to apply to the state of the instrument before, the other after, reversal. It may also become desirable to introduce a correction to the assumed hourly rate of the clock, especially if the observations are greatly extended.

The following example, showing the arrangement of the reduction of transit-observations when weights are applied, is appended for the sake of completeness. The notation is the same as that used in Appendix No. 9, Coast Survey Report for 1866.

It will generally be found preferable, on account of the laborious process of forming and solving four normal equations, determining the collimation, two azimuthal deviations, and the clock-correction, to divide the labor into two sets of two normal equations, one for clamp east and the other for clamp west, provided an independent azimuth can be found for each. This treatment is due to Mr. James Main, astronomical computer in the Coast Survey. The field-computation, or a first rough reduction, will furnish an approximate value for the collimation, and of the hourly rate of the clock for which the observed times of the transits are corrected, leaving the azimuthal deviation and the clock-correction to be determined by two normal equations; for the second set, there result two similar normal equations, and the criterion for the correctness of the reduction will be the *equality of the clock-corrections*, which apply to the *epoch of the reversal of the instrument*. Should the two values for δT differ by a few hundredths of a second, the process is easily gone over, introducing an improved value of c. It will rarely be necessary to improve the correction for hourly rate; the latter being referred to the epoch of the reversal, the effect on δT becomes insignificant. It sometimes happens that the instrument is reversed twice in a night's work, in which case the reduction may be made as above, determining a third value for azimuthal deviation and demanding the identity of three values deduced for δT.

The example given below is drawn from the determination of the trans-atlantic longitude of 1872; being the observations at Paris, France, made August 16: instrument, C. S. transit No.

4; observer, F. Blake, jr.; latitude $=48° 50' 11''$; collimation $= -0^s.337$ for clamp west; epoch T_0 $=18^h 46^m$; hourly rate of chronometer insignificant; transits complete; weights, p, depending on δ, and taken from the table prepared for large transit-instruments. The last column, headed $p\Delta$, exhibits the differences, given by the individual stars on a uniform scale.

PARIS, AUGUST 16, 1872.

Reductions of observations for time.

Epoch, $18^h 46^m$.—Collimation $= -0^s.337$.—Clamp west.

Star.	Clamp.	Observed chronometer time—mean of threads.	Correction for rate.	Correction for inclination and pivot inequality.	Correction for collimation.	Correction for diurnal aberration.	Corrected t.	Adopted tabular right ascension, α.	$\alpha - t = \tau$
		h. m. s.	s.	s.	s.	s.	s.	h. m. s.	s.
ψ^1 Draconis	W.	17 44 17.22	0.00	+0.23	−1.10	−0.05	16.30	17 44 15.13	−1.17
η Serpentis	W.	18 14 45.07	0.00	+0.08	−0.34	−0.02	44.79	18 14 43.09	1.70
1 Aquilæ	W.	28 18.48	0.00	+0.08	−0.34	−0.02	18.20	28 16.49	1.71
α Lyræ	W.	32 39.86	0.00	+0.21	−0.43	−0.02	39.62	32 38.13	1.49
β Lyræ	W.	45 24.98	0.00	+0.17	−0.41	−0.02	24.72	45 23.11	1.61
50 Draconis	W.	50 34.50	0.00	+0.47	−1.33	−0.06	33.58	50 32.61	0.97
ζ Aquilæ	E.	59 34.77	0.00	+0.10	+0.34	−0.02	35.19	59 33.56	1.63
δ Draconis	E.	19 12 34.02	0.00	+0.29	+0.88	−0.04	35.15	19 12 33.86	1.29
τ Draconis	E.	18 03.10	0.00	+0.38	+1.15	−0.05	04.58	18 03.31	1.27
κ Aquilæ	E.	30 03.81	0.00	+0.07	+0.34	−0.02	04.20	30 02.51	1.69
γ Aquilæ	E.	40 13.73	0.00	+0.08	+0.34	−0.02	14.13	40 12.55	1.58
α Aquilæ	E.	44 35.55	0.00	+0.08	+0.34	−0.02	35.95	44 34.40	1.55
ϵ Draconis	E.	48 38.87	0.00	+0.26	+0.99	−0.05	40.07	48 38.79	1.28

Clamp west.—$\Delta T = -1^s.50$.

Star.	τ	d	A	p	p A	p A²	$p\,d$	p A d	a A	ΔT_0	Δ	$p\Delta$
	s.	s.					s.	s.	s.	s.	s.	s.
ψ^1 Draconis	−1.17	+0.33	−1.30	0.25	−0.32	0.42	+0.08	−0.11	+0.36	−1.53	+0.05	+0.01
η Serpentis	1.70	−0.20	+0.79	1.00	+0.79	0.62	−0.20	−0.16	−0.22	1.48	0.00	0.00
1 Aquilæ	1.71	−0.21	+0.85	1.00	+0.85	0.72	−0.21	−0.18	−0.24	1.47	−0.01	−0.01
α Lyræ	1.49	+0.01	+0.23	0.85	+0.20	0.05	+0.01	0.00	−0.06	1.43	−0.05	−0.04
β Lyræ	1.61	−0.11	+0.32	0.90	+0.29	0.09	−0.10	−0.03	−0.09	1.52	+0.04	+0.04
50 Draconis	0.97	+0.53	−1.75	0.20	−0.35	0.61	+0.11	−0.19	+0.49	1.46	−0.02	0.00
				4.20	+1.46	2.51	−0.31	−0.67	Check, Σ			0.00

$$\left.\begin{array}{l} 4.20\,\delta T + 1.46\,a = -0.31 \\ 1.46\,\delta T + 2.51\,a = -0.67 \end{array}\right\} \text{ hence } a = -0^s.280,\ \delta T = +0^s.02, \text{ and } \Delta T_0 = -1^s.48.$$

Clamp east.—$\Delta T = -1^s.50$.

Star.	τ	d	A	p	p A	p A²	$p\,d$	p A d	a A	ΔT_0	Δ	$p\Delta$
	s.	s.					s.	s.	s.	s.	s.	s.
ζ Aquilæ	−1.63	−0.13	+0.59	1.00	+0.59	0.35	−0.13	−0.08	−0.11	−1.52	+0.04	+0.04
δ Draconis	1.29	+0.21	−0.83	0.35	−0.29	0.24	+0.07	−0.06	+0.16	1.45	−0.03	−0.01
τ Draconis	1.27	+0.23	−1.42	0.25	−0.35	0.50	+0.06	−0.08	+0.27	1.54	+0.06	+0.01
κ Aquilæ	1.69	−0.19	+0.84	1.00	+0.84	0.71	−0.19	−0.16	−0.16	1.53	+0.05	+0.05
γ Aquilæ	1.58	−0.08	+0.63	1.00	+0.63	0.40	−0.08	−0.05	−0.12	1.46	−0.02	−0.02
α Aquilæ	1.55	−0.05	+0.65	1.00	+0.65	0.42	−0.05	−0.03	−0.12	1.43	−0.05	−0.05
ϵ Draconis	1.28	+0.22	−1.05	0.30	−0.32	0.33	+0.07	−0.07	+0.20	1.48	0.00	0.00
				4.90	+1.75	2.95	−0.25	−0.53				

$$\left.\begin{array}{l} 4.90\,\delta T + 1.75\,a = -0.25 \\ 1.75\,\delta T + 2.95\,a = -0.53 \end{array}\right\} \text{ hence } a = -0^s.190,\ \delta T = +0^s.02, \text{ and } \Delta T_0 = -1^s.48.$$

APPENDIX No. 13.

PRELIMINARY REPORT ON THE DETERMINATION OF TRANSATLANTIC LONGITUDES, BY J. E. HILGARD, ASSISTANT.

The exact determination of the longitude of some point in the triangulation of the Coast Survey from the principal observatories of Europe forms one of the most important problems of that work, and all the various means known to science have been successively brought to bear on its solution. The Coast Survey Reports from 1848 to 1866 show that the methods of moon-culminations, of chronometer-transportation, and of lunar occultations have each in turn received a large share of attention. The latter method has not yet yielded the full results that may be expected of it, in consequence of the infrequency with which corresponding observations are obtained in Europe and America, owing to the parallactic displacement of the moon. It cannot be doubted, however, that, with a suitably-organized system of observation, this method will, in time, give results of great exactness.

Upon the successful completion of the Atlantic telegraph from Ireland to Newfoundland, measures were at once taken to make use of that means for the determination of the longitude between the two continents. The results of these operations, conducted by Dr. B. A. Gould, have been given at length in the report for 1867. Although far more certain than the previous results, the value thus obtained still left a larger margin of doubt as to its precision than is desirable in so fundamental a determination. This uncertainty, which probably does not exceed one quarter-second of time, is owing in part to the fact that, though we can measure the total time of transmission of signals through the cable and back again, we are unable to separate the duration in opposite directions, and are obliged to assume it equal, an assumption which may not be exact within a sensible fraction of a second.

When the laying of the French cable, from Brest in France to Duxbury in Massachusetts, afforded an independent means of verifying the former result by observations under entirely different conditions, the opportunity was promptly seized, and the longitude between Brest and Duxbury determined by G. W. Dean, assistant in the Coast Survey, as set forth in the report for 1870.

At this time, no cable was yet in operation between Brest and England, so that Mr. Dean was unable to carry his determination direct to the observatory at Greenwich. Such a cable having since been laid, the wanting link in the chain of longitudes was supplied, during the past summer, by J. E. Hilgard, assistant in the Coast Survey, who temporarily gave up the charge of the Coast Survey Office in order to bring this much-desired operation to a satisfactory conclusion. While re-occupying Brest for that purpose, it appeared in every way desirable that the experiments through the French cable should be repeated; this time with an intermediate station at St. Pierre, where the long cable makes a landing. That part of the operations which connected St. Pierre with Cambridge was under the immediate direction of G. W. Dean.

The general plan of operations was to unite, at Brest, signals from St. Pierre, from Greenwich, and from Paris, sent nearly at the same time, and compared by means of the Brest chronograph; and to determine the personal equations of the several observers through one of them, who should observe successively with all the rest. This was done by Subassistant F. Blake, jr., who ably assisted Mr. Hilgard throughout the work. Through the kindness and assistance of Sir George B. Airy, the astronomer-royal of England, and of Mr. Delaunay, the distinguished director of the Paris observatory, whose lamented death occurred while the operations were in progress, and through the generous courtesy of the French Atlantic Telegraph Company and of the Submarine Telegraph Company, the work was brought to a successful conclusion in the month of September, 1872.

In the course of these operations, the longitude between Paris and Greenwich has been incidentally determined in two different ways: first, in July, via Brest; and afterward, in September, between Greenwich and Paris direct, through the "submarine" cable, via Calais. These two determinations are not entirely independent of each other, since the personal equation between Blake and the Paris observer enters into both; but the near satisfaction of the equation, (Brest—Paris+Paris—Greenwich+Greenwich—Brest=0,) or the closing of that longitude-triangle, must entitle the results obtained to great confidence.

We now proceed to give some account of the instruments and methods before reciting the principal results.

BREST—GREENWICH—PARIS.

The station at Brest was chosen on the *place d'armes* in front of the Transatlantic Telegraph Company's office, with which it was connected by wires. It was found to be $8''.46$ south and $0^s.44$ east of the tower of St. Louis Church, a point in the trigonometrical survey of France.

The instruments used were a transit-instrument by Simms, of 45 inches focal length, and 25 inches transit-axis, with a diaphragm of 15 lines; a circuit-breaking chronometer by Bond; and a Bond chronograph.

The plan adopted for determining the clock-corrections provides for observations in both right and left position of the transit-telescope; a set in each position comprising five time-stars, and two circumpolars, one above and one below the pole. By this system, it is practicable to deduce the azimuthal deviation of the instrument independently for either position, and even to arrive at a fair value of the collimation when observations have been obtained in but one position.

A careful determination of the inequality of pivots was made by a series of levelings; and the corrections found to be due were applied in the reduction of the observations.

The chronometer is fitted with a circuit-breaking attachment, by which the current is interrupted for an instant every two seconds, and likewise at the fifty-ninth second, to mark the minute. In order to avoid the inconvenience arising from the deflagration of contact-surfaces, by the spark developed at the break, a branch circuit, including a resistance-coil, was introduced according to the device of Mr. Hilgard, bridging the break, and permitting the ready passage of the secondary current, while the resistance is too great to affect sensibly the recording magnet.

It will be observed that the rate of this chronometer was not only determined by the observations made at Brest, but was also checked by daily comparisons with the clocks at Paris and Greenwich. Its performance was very satisfactory.

The observations of star-transits and the time-scale were recorded on the chronograph with the same pen, whereby any correction for relative position of the pens or styles is avoided, and the reading much facilitated.

At the Paris observatory, the general arrangements for the work were committed to Mr. Loewy, who lent a most cordial co-operation to our work. The chronographic method of recording time-observations, not then in ordinary use at the observatory, was adopted for the present occasion, and the assistant astronomer, Mr. L. F. Folain, who made all the corresponding observations, devoted a fortnight to preliminary practice with the new method, so as to obtain a settled habit of observing. The large transit-instrument (*lunette méridienne*) was employed for the work, which was prosecuted with the greatest assiduity. The instrument was reversed twice on each night, and two complete sets of observations were made, each comprising eight stars in each position of the instrument, besides circumpolars and micrometer-readings on the meridian-mark.

After completing the observations at Brest, Mr. Blake transported his instruments to Paris, and mounted his transit on a pier that had been provided for the purpose, a short distance to the south of the observatory-transit, very nearly in its meridian, in the garden. Each observer now determined the time with his own instruments and after his own method, and compared the time-keepers in the same way as had been done between Brest and Paris; the personal equation thus obtained including all peculiarities that may arise from instrumental causes.

At Greenwich, the regular routine of observing was followed, as described in the Greenwich Observations; the observers changing in a certain rotation; two observers generally determining the clock-corrections on each day, and their observations being referred to a common standard by the personal equations derived from the comparisons thus obtained.

When Mr. Blake, after completing the work at Paris, went to Greenwich for the purpose of comparing his personal equation with that of the Greenwich observers, his transit was mounted on a pier erected for the purpose by order of the astronomer-royal, and again observed in his accustomed way, comparing his time-keeper telegraphically with the Greenwich clock, and likewise with that at Paris, where Mr. Folain was still keeping up his corresponding observations. The Coast Survey party are specially indebted to Mr. William Ellis, who, under the direction of the astronomer-royal, aided them in every way in the prosecution of the work.

The place of the pier, which has since been marked by a slab of marble bearing the inscription "HILGARD," is $0^{s}.160$ west and $1''.74$ south of Greenwich transit-circle.

The method of exchanging signals was by means of arbitrary signals sent over the lines and recorded on the chronograph at each station. These signals were sent for five minutes at approximate intervals of five seconds, but the intervals were purposely varied so as to give different fractional readings. At 11 p. m., Greenwich began sending to Brest, then Brest sent to Greenwich, next Brest to Paris, and finally Paris to Brest. Between Greenwich and Brest but one series of signals was exchanged on each night, as the free use of the cable could not be granted for more than ten minutes. Between Brest and Paris, however, a wire was placed at the disposal of the party from 8 p. m., for the night, and, in general, two series of exchanges were obtained.

The observations of Mr. Blake have been reduced in the following manner. The chronograph-sheets having been independently read by two persons, and readings collated, each evening's work was reduced by Mr. Blake, on the plan of deriving the collimation and the azimuthal deviation of the instrument from all the observed stars by means of the usual normal equations, giving equal weight to all the stars; the clock-correction being finally determined from stars within 60° declination, omitting the circumpolars, by applying the instrumental corrections previously obtained. In a more elaborate second computation, made by R. Keith, each conditional equation was affected by a weight depending upon the star's declination according to a law derived from the observations themselves, and, moreover, separate values for the azimuthal deviation, before and after reversal, were deduced. The resulting clock-corrections, obtained by the two methods of reduction, show a very good agreement, the average difference being only $0^{s}.017$; the sum of the residuals for each star is less in the second than in the first in the ratio of twenty-six to thirty-one; but it should be observed that, in consequence of the introduction of four instead of three variables in the equation, the observations should be better represented in something near that ratio, and only a small improvement can be ascribed to the use of weights. This matter will be found more fully discussed in the Coast Survey Report for 1873, where the observations of the American parties will be given in full. Those made at Paris and Greenwich will be found in the regular publications of those observatories.

The right ascensions used in these reductions are a mean of those of the Washington Observatory from 1862 to 1867, and of the Harvard College Observatory from June to November, 1872. They do not agree precisely with either the Greenwich or the Paris right ascensions, but the differences are small. It would certainly have been desirable to use the same data in the reduction of the observations at all stations; but as Greenwich and Paris do not agree in their standard places, it was thought best to use the list adopted for the Coast Survey work and let the accidental variations be merged in the errors of observation, while any systematic difference in the places would form part of the personal equation. The longitudes cannot, in any sensible degree, be affected by the differences adverted to.

RESULTS OF OBSERVATIONS FOR PERSONAL EQUATION.

Paris.

		s.
Blake, west of Folain, August	16,	−0.135
	17,	+0.075
	18,	+0.193
	19,	+0.076
	20,	+0.054
Blake, west of Folain, mean,		+0.053±0.037

Greenwich.

Coast Survey station reduced to transit-circle.—Reduction, —0s.16.

Date.	Blake east of observer.	Reduction to standard observer.	Blake east of standard observer.
	s.	s.	s.
August 28	J. C. +0. 070	+0. 010	+0. 080
August 30	L. +0. 427	−0. 240	+0. 187
August 31	E. −0. 124	+0. 230	+0. 106
September 3	H. C. −0. 001	0. 000	−0. 001
September 4	L. +0. 365	−0. 240	+0. 125
September 5	J. −0. 025	+0. 060	+0. 035
September 6	J. C. −0. 050	+0. 010	−0. 040
September 7	Std. +0. 005	0. 000	+0. 005
September 9	E. −0. 117	+0. 230	+0. 113
Blake east of Greenwich standard observer, mean			+0. 068±0. 016

LONGITUDES.

Brest—Greenwich.

	m.	s.
July 1	17	57.149
3		57.124
4		57.120
5		57.068
11	17	57.026
Mean	17	57.097±0.015
Personal equation		+0.068±0.016
Difference of longitude	17	57.165±0.022

Brest—Paris.

	m.	s.
July 1	27	18.232
3		18.266
4		18.192
5		18.328
9		18.359
19		18.186
20		18.331
21		18.207
22	27	18.166
Mean	27	18.252±0.016
Personal equation		−0.053±0.037
Difference of longitude	27	18.109±0.039

Greenwich—Paris.

	m.	s.
August 28	9	21.020
31		21.009
Sept. 7		21.052
9		20.914
10		21.006
Mean	9	21.000±0.016
Personal equation		−0.053±0.037
Reduction to Greenwich transit		+0.160
Difference of longitude	9	21.107±0.039

The results of the first computation were as follows:

	m. s.
Brest—Greenwich	17 57.124
Brest—Paris	27 18.176
Greenwich—Paris	9 21.116

differing but very little from the preceding values.

The sum of the values Brest—Greenwich+Greenwich—Paris exceeds the direct determination Brest—Paris by $0^s.073$, which is within the limits of the assigned probable errors. If we now distribute this residual among the three values, without regard to weights, and omit the thousandths of seconds, we shall find as the resulting longitudes:

	m. s.
Brest—Greenwich	17 57.14
Greenwich—Paris	9 21.08
Brest—Paris	27 18.22

It appears that the uncertainty of any of the above values does not probably exceed $0^s.03$. If we compare them with other determinations heretofore made, we find that Brest—Paris was determined telegraphically in 1863, under the direction of Mr. Le Verrier, when the longitude of the "*tour de St. Louis*" from the "*méridienne de France*" (the center of the Paris observatory) was found to be $27^m\ 18^s.49$, (Annales de l'Observatoire de Paris, viii, 1866, p. 279.) In order to reduce our own result to the same point of reference, we must deduct $0^s.12$ at Paris and add $0^s.44$ at Brest, whence we obtain $27^m\ 18^s.54$, differing but $0^s.05$ from that found by the French operations, which were very elaborate, and are published in full; or if we compare with our direct determination, the difference is only $0^s.03$.

The longitude between the observatories of Greenwich and Paris was determined in 1854, at the instance of Mr. Le Verrier. The result then obtained, $9^m\ 20^s.63$, which is nearly half a second less than that resulting from our recent work, has ever since been accepted; but the Paris observations, upon which it depends, have never been published. Partly owing to this fact, and partly because in those operations the chronographic method was not used, the Central European Geodesic Association had, at its session at Vienna, in the autumn of 1871, expressed the wish that it should be redetermined. In pursuance of this expression, Mr. Delaunay had already entered into correspondence with Mr. Airy when the American party came into the field, and, desiring to refer their longitude to each observatory independently, obtained leave to determine the difference between the same as an incidental part of their operations. It is to be presumed that another determination will be made before long to verify this important datum.

Another combination of the results may be made in the following manner. Remarking that, on four occasions, observations were had at Greenwich, Brest, and Paris on the same evenings, we may deduce the longitude Greenwich—Paris directly, without using the observations at Brest, when we obtain:

	m. s.
Greenwich—Paris, July 1	9 21.083
" " " 2	.142
" " " 3	.072
" " " 4	.260
Mean	9 21.139
Personal equation	—.121
Longitude	9 21.018

The personal equation here applied is that between Folain and the Greenwich standard observer as derived through Blake, viz, .053+.068, as previously given in detail. Combining the result of these four nights with that of the five when Blake observed at Greenwich, viz, $9^m\ 21^s.107$ we get Greenwich—Paris $9^m\ 21^s.07$.

Combining further the two determinations Brest—Paris (1872) $27^m\ 18^s.20$, Brest—Paris (1863) $27^m\ 18^s.17$, and Brest—Greenwich (1872) $17^m\ 57^s.16$ with the foregoing, we shall obtain, as the most probable values that can be assigned:

	m. s.
Brest—Greenwich	17 57.14
Greenwich—Paris	9 21.06
Brest—Paris	27 18.20

BREST—ST. PIERRE—CAMBRIDGE.

It was intended that the observations at and exchanges of signals between the American stations should be as nearly simultaneous with those in Europe as the weather might allow, in order that the intermediate stations at Brest and St. Pierre should sensibly disappear from the determination of the longitude of Cambridge from Greenwich and Paris. Such simultaneous operations proved, however, to be impracticable, in consequence of the condition of the cables. The long cable between Brest and St. Pierre was working badly, and required to be repaired before it was fit for our use. When this was accomplished, it proved to have a better insulation than ever before, and transmitted the signals with great sharpness. Meantime, the cable between St. Pierre and Duxbury had been broken, and could not be repaired during the summer, in consequence of which our arrangements required to be changed. Mr. Dean, who had charge of the American part of the operations, at once proceeded to make arrangements for exchanging signals between St. Pierre and Cambridge, over the Nova Scotia and New Brunswick telegraph-lines, connected with St. Pierre by a short cable, and working with ordinary Morse registers, so that this part of the work offers no unusual features, the signals being registered automatically on the chronograph. The signals sent through the Brest–St. Pierre cable, on the contrary, were observed by means of the Thomson galvanometer, as heretofore described in the account of the 1867 longitude operations by Dr. Gould. The cable was working so well that no special battery or signal-arrangements were required; a single current at intervals of five seconds giving a very sharp movement of the index, which returned to its zero before the next signal was sent. The personal equation of each observer, in perceiving and recording these signals upon his chronograph by tapping a key, was frequently determined by means of a short circuit, and was found to be very constant for each observer as well as nearly equal for both. For Blake, at Brest, it was $0^s.24$; and, for Goodfellow, at St. Pierre, $0^s.23$.

The station at St. Pierre was in charge of Mr. Edward Goodfellow, assistant in the Coast Survey, who had taken part in the two previous determinations of transatlantic longitude by cable. All the observations were made by himself. The observer at Cambridge was Mr. Edwin Smith, of the Coast Survey. The instrument was mounted on a pier, one hundred and eight feet to the west of the observatory-dome, to which our longitudes are usually referred, requiring a reduction of $0^s.096$. Three piers were built in this temporary observatory, permitting the three transit-instruments used in the expedition to be mounted in the same meridian at one time. This was done after the return of the observers from Europe and St. Pierre, for the purpose of determining their personal equations and some instrumental constants. The instruments were alike in construction, having forty-five inches focal length, twenty-five inches transit-axis, mounted on a heavy cast-iron stand, and provided with a reversing-apparatus. They differed, however, in the arrangement of the diaphragm-lines; Mr. Goodfellow having preferred the usual spider-lines; Mr. Blake a system of double lines ruled on glass; and Mr. Smith single lines ruled on glass. The personal equations were compared by each observer determining the time with his own instrument in the customary manner, using the same stars, as well as by observing at the same instrument the transit of the same stars over alternate tallies of lines. The results by the two methods were found not to differ sensibly.

The personal equations found by the preliminary reductions are the following:

Blake places himself east of Smith	$0^s.07$
Blake places himself west of Goodfellow	$0^s.04$
Goodfellow places himself east of Smith	$0^s.11$

The first datum only enters into the longitude Cambridge—Brest, since Goodfellow occupied an intermediate position.

Advantage was taken of the opportunity of placing the three transit-instruments in the same meridian, for the purpose of testing them as to flexure of the transit-axis, by comparing in each the line of collimation as indicated by reversals, right and left, with that resulting from revolving it about the axis, using the two other instruments as collimators, each being in turn placed in the middle. The collimation resulting from the observation of circumpolar stars in the direct and reversed positions was likewise compared with that from reversal in the horizontal direction of the telescope, using the adjoining one as a mark. The results fully confirmed that there are no sensible inequalities of flexure in these instruments.

At the request of the Superintendent of the United States Naval Observatory in Washington, signals were also exchanged between St. Pierre and Washington during the progress of the work, and subsequently the several observers compared personal equations. Of this portion of the work, no results have yet been reported. The second and most elaborate computations of the longitudes St. Pierre—Brest and Cambridge—St. Pierre are also still in progress while this report is going to press, and the final results cannot therefore be given at this time. But they cannot differ materially from those of the preliminary computations given below, which were made by the observers in the field.

The difference in the time between Brest and St. Pierre, as derived from eastern and western signals, including the personal equations of the operators and the time of transmission forward and back through the cable, was, on the average, $1^s.19$, varying five-hundredths from the mean. Deducting from this the sum of the personal equations, $0^s.47$, we find, for twice the time of transmission through the cable, $0^s.72$, or $0^s.36$ for a distance of twenty-two hundred nautical miles. The signal-time between St. Pierre and Cambridge was $0^s.14$.

The following are the results for longitude:

	h.	m.	s. s.
St. Pierre—Brest, mean of seven nights	3	26	45.20 ± 0.05
Cambridge—Brest, mean of eight nights		59	48.78 ± 0.03
Correction for personal equation, St. Pierre—Brest			−0.07 ± 0.02
Reduction to Harvard Observatory dome			−0.09
Harvard—Brest	4	26	33.82 ± 0.06
Brest—Greenwich (as above)		17	57.14 ± 0.03
Harvard—Greenwich	4	44	30.96 ± 0.07

The term Harvard is here used to denote the center of the dome of the Harvard College Observatory at Cambridge, United States.

Comparing now this result with those formerly obtained, we have for the operations of 1870:

	h.	m.	s. s.
Cambridge transit—Duxbury	0	1	50.23 ± 0.02
Reduction of transit to dome			−0.04
Duxbury—Brest, station of 1870	4	24	42.87 ± 0.05
Reduction of station 1870 to 1872			+0.79
Brest, 1872—Greenwich	0	17	57.14 ± 0.03
Harvard—Greenwich	4	44	30.99 ± 0.06

The figures for Cambridge—Duxbury and Duxbury—Brest are taken from No. XVI, Memoirs of the American Academy, Cambridge, 1873, by Prof. J. Lovering, who had charge of the computations. By reference to that publication, it will seem that in those operations the ends of the two cables were joined at St. Pierre, by bringing their several condensers into contact, and in this way the signals were exchanged directly between Brest and Duxbury. The method of transmission was thus quite different in the two campaigns, and the close agreement of results can only be held as dissipating all doubt as to the sensible equality of the rate of transmission in opposite directions.

We will finally compare the preceding results with those obtained in 1866 through the Ireland-Newfoundland cables by the operations conducted by Dr. B. A. Gould, a full account of which is published in the Coast Survey Report for 1867, and also in vol. XVI of the Smithsonian Contributions. The results there given lack one link in order to be complete, that being the personal equation between Mosman, the observer at Foilhommerum, and the standard observer at Greenwich. This defect we have endeavored to supply, as far as is practicable after the lapse of some years, through the personal equations between Mosman, Blake, and the Greenwich observers in the following manner. The well-ascertained equation between Blake and Mosman is that Blake places himself $0^s.09$ to the west of Mosman. He is, moreover, $0^s.07$ to the east of the present Greenwich standard observer, (Criswick,) who again is $0^s.11$ to the east of the standard observer of 1867, (Dunkin.) Hence we deduce that Mosman placed himself $0^s.05$ more east than Dunkin, and the former difference of longitude between Greenwich and Foilhommerum must be increased by that amount.

The figures given in the publications above referred to require some other corrections in consequence of the personal equations having been applied with the wrong sign. We therefore recite the several links of the combination as follows:

	h.	m.	s.
1866. Greenwich to Foilhommerum	0	41	33.34
1866. Foilhommerum to Heart's Content	2	51	56.32
1866. Heart's Content to Calais	0	55	37.97
1857. Calais to Bangor	0	6	00.31
1851. Bangor to Harvard Observatory	0	9	23.06
Greenwich to Harvard Observatory	4	44	31.00

Considering the number of separate determinations entering into this result, we cannot well ascribe to it a probable error less than $\pm$ $0^s.10$, even when dismissing all further question of the inequality of transmission-time in opposite directions. The close agreement of the three independent determinations made in different years is therefore no less surprising than it is satisfactory. We have:

LONGITUDE OF HARVARD OBSERVATORY FROM GREENWICH.

	h.	m.	s.	s.
1866	4	44	31.00	±0.10
1870			30.99	±0.06
1872			30.96	±0.07
Mean	4	44	30.98	±0.05

To deduce finally the longitude of the dome of the United States Naval Observatory in Washington City, we add 23^m $41^s.11$, the value deduced from the elaborate determinations in 1867, published in the Coast Survey for 1870, (Appendix No. 13,) and find—

Washington—Greenwich .... 5^h 08^m $12^s.09 \pm 0^s.06$

and further, using the value Greenwich—Paris$=9^m$ $21^s.06$ above obtained, we have—

Washington—Paris .... 5^h 17^m $33^s.15 \pm 0^s.07$

APPENDIX No. 14.

TERRESTRIAL MAGNETISM.

NOTES ON MAGNETICAL OBSERVATIONS BY MEANS OF PORTABLE INSTRUMENTS, PREPARED FOR THE USE OF OBSERVERS BY C. A. SCHOTT, ASSISTANT IN THE UNITED STATES COAST SURVEY.

1.—DETERMINATION OF THE MAGNETIC DECLINATION.

The magnetic declination at any place, being the angle contained between the astronomical and magnetic meridians, requires for its measure two distinct operations, namely: The determination of the astronomical meridian, which is generally done by means of a theodolite; and the determination of the magnetic meridian (at a given epoch) by means of the declinometer, (or unifilar magnetometer.) The former of these planes is fixed, the latter variable, and the observations may have for their object the determination of the declination at various hours of the day, or its mean value for any one day, month, or year.

Respecting the determination of the astronomical meridian by means of observations of the azimuth of the sun or of a star, full information will be found in the paper on "The Determination of an Astronomical Azimuth," in the Coast Survey Report for 1866, Appendix No. 11, pp. 86–99; the example of observations and reduction given at the end of that paper is taken from a magnetic record. It may be stated that a determination of the meridian which is correct within 1′ fully suffices for magnetic work in general, since it is difficult to determine the magnetic meridian within the same limit, on account of its continued fluctuations. We shall suppose that the azimuth of some mark (any convenient distant object) is known, and that we have merely to find the magnetic azimuth of this mark in order to obtain the declination, which is generally distinguished by a + sign, if the magnetic meridian is west of the true north meridian, and by a — sign, if east of it.

Adjustment of the declinometer.—A station having been selected, apparently free from local attraction, the instrument is mounted, with the sides of the box containing the magnet directed nearly north and south, (magnetic,) which may be conveniently done by means of a pocket-compass; the instrument must be leveled and the theodolite or telescope adjusted.* In that form of construction of the instrument† which has the magnet-box mounted over the azimuth-circle, the observer may face either the north or south end of the magnet; but in the more complete form of the magnetometer, with attached theodolite, the observer would better face the north end of the magnet, in order to admit more readily of observing the sun for time and azimuth, (also for latitude.) The change, if desired, can be made by exchanging the lens and plane-glass of the collimator-magnet; but if the same magnet is also used for the intensity-determination, it must *not* be disturbed after the constants have once been determined.

The motion of the magnet is controlled by the observer by means of a small piece of magnetized steel, (a small screw-driver;) its magnetism (at its free end) being the same as that of the end of the magnet facing the observer, so as to repel it when brought near. It must neither be too strong, nor be brought too close to the magnet, otherwise the position of the magnetic axis might be disturbed. The suspension-tube should carry at its top a rack and pinion to admit of an easy vertical movement of the magnet. With a piece of cloth at the bottom of the box, the magnet can be let down, and come to rest by friction on the fibers of the cloth, and can then be raised and quickly steadied by the magnetized screw-driver, all without opening the box, which in windy weather must be avoided. The sides of the box, if of glass sliding in grooves, must have paste-board

* See appended paper on "The Adjustment of the Portable Alt-azimuth Instrument."

† Known as the theodolite-magnetometer.

covers to darken it, and the width of the slit facing the mirror must be specially regulated for the best definition of the scale; the shade placed over the object-end of the telescope should nearly touch the box, in order that all stray light may be excluded. The special adjustments to be made are the following:

Suspend the torsion-cylinder, which is of the same weight precisely as the magnet, and take out the twist of the suspension-fibers, of which there should not be more than are absolutely needed to support the weight without risk of breaking—say about 4 or 6 for the heavy magnets, and 1 or 2 for the light ones. With the aid of the rack-motion and the friction on the cloth, the whole turns of twist are readily taken out, and then the line of detorsion must be placed in the magnetic meridian, in which position the axis of the torsion-weight must be parallel with the side of the box.* In packing, the suspension should be kept free of twist, so that at any new station only the small changes in the twist need attention. The weight should be removed, the magnet suspended, and the telescope pointed nearly to the middle of its scale, or to the axis of the magnet. The axis of the collimator and the line of collimation of the telescope should then be, as nearly as possible, in the same straight line. To render the scale distinct, the telescope must be set to sidereal focus. The azimuth-circle is then read; the reading, when pointing to the mark,† having previously been recorded. The relative position of the theodolite and magnet is, of course, invariable, both being supported by the same stand.

The scale-reading of the magnetic axis of the collimator is determined by readings with scale erect and inverted, as shown in the following example:

Observations for axis of magnet A_1.

Magnet.	Scale-reading.		Mean.	Means of 1 and 3, 2 and 4, &c.	Axis.
	Left.	Right.			
E.	11.0	13.0	12.00		*d.*
I.	5.7	7.5	6.60	12.00	9.30
E.	10.9	13.1	12.00	6.55	9.28
I.	5.6	7.4	6.50	12.05	9.28
E.	11.5	12.7	12.10	6.50	9.30
I.	5.7	7.3	6.50	12.07	9.29
E.	11.3	12.8	12.05		
				Mean......	9.29

NOTE.—It is recommended to make these observations about the epoch of the day when the magnet is nearly stationary.

The angular value of a division of the scale is determined by successive pointings on the principal divisions, and noting the corresponding readings of the azimuth-circle, and repeating the operation in the reverse order. With that form of the instrument which has the box of the magnet connected with the azimuth-circle, the combination of the results will correct for change of declination during the measures, but a small correction for torsion may be needed; for the other form of construction the magnet may be fastened in its normal position during the scale-measures. The usual value of a scale-division is between 1′ and 3′, and tenths may be estimated. It is only for those instruments which give primarily the amount of deflection, in the intensity-measures, expressed in scale-divisions, that an accurate determination of the scale-value is needed.

* This process may require repetition until the observer is assured that there is no torsion when the collimator-magnet is suspended.

† The best position of the mark is near the horizon.

Determination of scale-value of magnet C_{16}.

Scale.	Theodolite-circle—mean of two readings.			Value of eighty divisions.		
d.	°	′	″	°	′	″
10	159	04	25			
20	158	36	30			
30	158	08	15			
40	157	40	35			
50	157	12	35			
60	156	44	30			
70	156	17	05			
80	155	49	00			
90	155	21	15	3	43	10
100	154	52	30		44	00
110	154	24	45		43	30
120	153	57	30		43	05
130	153	28	20		44	15
140	153	00	50		43	40
150	152	33	00		44	05
160	152	04	30		44	30
	Mean			3	43	47

Hence one division of scale$=2'.797$.

NOTE.—If the number of pointings is odd, instead of even, the mean reading corresponding to the *middle* division must be found and subtracted from each separate value. The differences so obtained must be added, and their sum, (irrespective of sign,) when divided by the corresponding number of scale-divisions, furnishes the desired value.

For an example of the amount of torsion, as measured from four twists of 90° each, see "Observations for Intensity-Oscillations."

It appears from observations of the daily fluctuation of the declination that the mean of the extreme easterly and westerly positions in any one day approaches nearly to the mean position of the day, as derived from hourly observations continued day and night. Since corrections to observed declinations to refer them to the mean of the day are generally very unsatisfactory, it is recommended to observe the declination for any one day at the epochs of the eastern magnetic elongation and of the western magnetic elongation, and take the mean position as representing the declination for that day. The epochs of extreme positions, as observed at Philadelphia and Washington, apply, with comparatively small changes, to nearly all places within the United States, and may be stated to be as follows: Referring to the north end of the magnet, the morning eastern elongation occurs, on the average, from April to September, inclusive, about 7½ a. m.; from October to March, inclusive, about 8¼ a. m.; earliest time in July and August, about 7 a. m.; latest in December or January, about 8½ a. m. These epochs, however, are subject to great fluctuations, and cannot be depended upon in any one case within one hour, and frequently they cannot be recognized at all, either on account of the small range of the daily fluctuation, (the amount of which in winter is but one-half, nearly, of the amount in summer,) which is easily disguised by small irregularities, or on account of disturbances, which reach their maxima in September and October, and generally are more predominant in winter than in summer. The afternoon western elongation occurs, on the average, a little before 1¼ p. m. from April to September, inclusive, and a little later than 1¼ p. m. from October to March, inclusive; also, earliest in August and September—some minutes before 1 p. m., and latest in March—about 1½ p. m. The afternoon epoch is subject to less fluctuation than the morning epoch.

The observations for declination, which consist in noting the scale-readings, must be made, say, every quarter of an hour from a sufficiently early time in the morning to make sure of preceding the eastern elongation; when this is fairly passed, and consequently the north end of the magnet has commenced its westerly motion, the observations may be discontinued, to be resumed again shortly after noon for the second epoch, as shown in the following example:

MAGNETIC DECLINATION.

Station, Washington, D. C.—Date, June 15, 1871.—Instrument, Declinometer No. 7.—Observer, C. A. S.—Mark reads, at 6^h 10^m, 242° 50′.5 and 62° 49′.5—Line of detorsion, 276°.—Magnet A suspended; scale erect.—Azimuth-circle set to 244° 25′.0 and 64° 24′.5.

Time.		Scale-readings. Left.	Scale-readings. Right.	Mean.	Remarks.
A. M.					
h.	*m.*	*d.*	*d.*	*d.*	
6	30	11.0	12.8	11.90	Removed torsion-weight at 6^h 15^m and suspended magnet.
	45	11.8	12.2	12.00	
7	00	12.0	12.3	12.15	
	15	12.2	12.5	12.35	
	30	12.4	12.5	12.45	Maximum.
	45	12.3	12.5	12.40	
8	00	12.1	12.3	12.20	Suspended torsion-weight after this observation.
P. M.					
h.	*m.*	*d.*	*d.*	*d.*	
0	15	5.9	6.9	6.40	Before commencing afternoon series, turned torsion-circle to 264°; azimuth-circle as before.
	30	6.0	6.6	6.30	
	45	6.2	6.5	6.35	
1	00	6.2	6.3	6.25	} Minimum.
	15	6.2	6.3	6.25	} Minimum.
	30	6.3	6.7	6.50	

Pointing on mark: 242° 50′.0 and 62° 49′.5.

Mean reading of east and west elongations.	*d.* 9.35, and difference of readings *d.* 6.20	
Axis of magnet reads	7.30	
Reduction to axis	+2.05=	5′.0
Azimuth-circle reads		244° 24′.8
Magnetic meridian reads		244° 29′.8
Mark reads		242° 49′.9
Mark west of north		4° 36′.1 ± 0′.1
Astronomical meridian reads		247° 26′.0
Magnetic declination		+2° 56′.2
Reduction to mean of day		+ 0′.2
Resulting magnetic declination, June 15, 1871		2° 56′.4 W.

We have, also, on this day, the daily range 15′.1, and the turning hours about 7^h 30^m a. m. and 1^h 05^m p. m.

The observer's attention should be specially directed to the frequent examination of the line of detorsion, since every change in the temperature or moisture of the air is apt to develop twist, which, if not removed, will injure the accuracy of the observations.

2.—ABSOLUTE AND RELATIVE MEASURES OF THE MAGNETIC FORCE.

It is usual, when accurate results are desired, to measure the horizontal component of the magnetic force by means of a portable magnetometer, and the dip by means of a dip-circle, and to derive the total force by combining these. In high magnetic latitudes, where the horizontal component is feeble in comparison with the vertical component, Lloyd's statical method is to be preferred. To measure the horizontal force, two distinct operations are required, known as "Observations of Deflections" and "Observations of Oscillations." Their combination will enable us to separate, in the observed force, that part which is due to the magnetism of the magnet from that which is due to the earth's magnetism. Either of these operations will determine relative horizontal intensity, and, when used in connection with a base-station where the magnetic force is known, absolute results will also be obtained. In this case, the observer should return to the base-station after the completion of his magnetic survey, and again measure the magnetism of his magnet, which, in the interval, must be carefully guarded against changes, and the results must be corrected, if necessary, for loss of magnetism.

The magnetometer, (see Sketch No. 20.)—There are two forms of unifilar magnetometers in use: hose with a complete astronomical theodolite, or alt-azimuth, mounted to the magnetic north or south of the box in which the collimator-magnet is suspended, and on the *same* stand with it; and those which have the box with suspended magnet mounted centrally over, and firmly connected with, an azimuth-circle, the reading-telescope being mounted eccentrically on supports. The first form (supposed to have been devised by Gauss) is the preferable one in field use; it admits of greater expedition, allows of greater ease in observing, and is almost indispensable when the astronomical meridian has to be determined. With the magnet to the south of the theodolite, it readily admits of observations of the sun, for the determination of time and azimuth (also of latitude, if required) without interfering with the magnetic work proper. Deflections are read off on the scale of the collimator-magnet, and must be converted into angular measures. The second form* (supposed to have been given by Dr. Lamont) is capable, perhaps, of greater accuracy, and is better suited for a fixed observatory, especially when declination disturbances also are to be observed, or at stations where there is a large daily range in the declination. The angles of deflection are at once read off. In order to observe the azimuth-mark, the magnet and box have temporarily to be removed, which is unnecessary in the first form of the instrument. When observing deflections, the bar, and consequently the deflecting magnet, remain fixed in the magnetic prime vertical, in the magnetometer, with attached theodolite; but, in the second form of the instrument, the deflecting and deflected magnets always remain at right angles to each other.† The operation for either construction of the instrument is essentially the same, and the simple modifications necessary in using one or the other form in observing and computing will be specially noted under the appropriate heads of the work. When observing for time and for duration of oscillations, a mean-time box-chronometer is most convenient for use; the observer will himself take up the beat (half-second) and estimate fractions of seconds. For a traveler, who dislikes to be much incumbered, a pocket-chronometer is much to be preferred, but the counting of the beats, generally five in two seconds, requires some previous practice. It is recommended to take up an even beat—say at 0, 10, 20, 30, &c., seconds—and count only the even beats, repeating the letters *a b c d* in the intervals; thus, 10 *a b c d*, 12 *a b c d*, 14 *a*, &c. The letters are afterward converted into their equivalents of time; thus, 14 *c* would be $15^s.2$.

Observations of deflections.—The instrument being adjusted as for observations of declination, attach the deflecting bar, suspend the shorter of the two magnets generally supplied for each

* See plate.

† In this case, the bar and box turning on the center of the azimuth-circle, a measurable amount of induced magnetism is developed in the deflector when inclined to the magnetic prime vertical.

instrument; the line of detorsion having been placed in the magnetic meridan, insert the copper damper, raise the suspended magnet to the horizontal level of the deflecting (or long) magnet, put the carrier at the proper distance on the bar, and, after placing the intensity (or long) magnet * centrally on it, commence making the observations as indicated in the following scheme:

HORIZONTAL INTENSITY. DEFLECTIONS.

FORM 1.

Magnetometer with attached theodolite.—Deflecting magnet in the magnetic prime vertical.

Station, Hampton.—Date, July 11, 1862.—Magnet C_{32} deflecting.—Magnet S_8 suspended.—Observer, N. N.

Magnet.	North end.	Time.	Temperature, t.	Scale-readings.	Alternate means.	Differences.	Distance.
		h. m.	°				
West.	W.	10 22	78.8	20.2			$r = 2$ feet; $\log r = 0.30103$.
	E.			133.5	20.30	113.20	
	W.	33	79.0	20.4	133.55	.15	
	E.			133.6			
		10 27.5	78.9			113.18	
East.	E.	10 26	79.0	133.0			
	W.			20.0	133.05	113.05	
	E.	10 29	79.0	133.1	19.95	.15	
	W.			19.9			
		10 27.5	79.0			113.10	
Means....		10 27.5	79.0		2u	113.14	

Torsion-circle.	Scale.	Differences.			Logarithms.
°					
83	76.5				
173	79.2	2.7	$u =$	$56^d.57$	1.75259
353	73.6	5.6	$1^d =$	$2'.843$	0.45378
83	76.5	2.9	$1 + \frac{h}{f}$		0.00064
Mean $= v = 2.80$			$u =$ $=$	$161'.07$ $2° 41'.07$	2.20701
				$\tan u$	8.67106
				r^3	0.90309
				$\frac{1}{2}$	9.69897
				$1 - \frac{P}{r^2}$	0.00040
				$\frac{m}{H}$	9.27352

	Logarithms.
$v = 7'.96$	
$5400' + v'$	3.73303
$5400'$ (ar. co.)	6.26761
$1 + \frac{h}{f}$	0.00064

NOTE.—The order of time indicated above is designed to correct for changes in declination during the observations of deflections.

*A vertical plane passing through its axis should also pass through the line of suspension of the shorter magnet.

FORM 2.

Theodolite-magnetometer.—Deflecting and deflected magnets at right angles to each other.

Station, Washington, D. C.—Date, May 16, 1867.—Magnet A deflecting.—Magnet B suspended.—Distance, $r = 1\frac{1}{6}$ feet. Log $r = 0.06695$. Observer, C. A. S.

Magnet.	North end.	No.	A	B	Mean.	No.	A	B	Mean.
			Circle-readings.				Circle-readings.		
			° ′	′	′		° ′	′	′
East.	E.	1	250 40.5	40.5	40.50				
	W.					2	237 29.5	29.0	29.25
	E.	3	40.5	40.0	40.25				
	W.					4	29.0	28.5	28.75
	E.	5	42.0	42.0	42.00				
	Mean				40.92				29.00
West.	W.					6	237 32.5	32.0	32.25
	E.	7	250 32.0	31.5	31.75				
	W.					8	32.5	32.5	32.50
	E.	9	31.0	31.0	31.00				
	W.					10	33.0	32.5	32.75
	Mean				31.37				32.50

		Logarithms.
Magnet E., $2u = 13°\ 11'.92$	$\frac{1}{2}$	9.69897
Magnet W., $2u = 12\ 58.87$	r^3	0.20085
Mean $= 13\ 05.40$	sin u	9.05684
$u = 6\ 32.70$	$1 - \frac{P}{r^2}$	0.00136
Beginning—time, 3h 29m Temp., 63°.5 Fah.	Induction	0.00009
Ending—time, 3 45 Temp., 65.8 Fah.		
64.65	$\frac{m}{H}$	8.95811

The preceding forms are arranged for determining the angle of deflection (u) by which the intensity-magnet, acting at a given distance, r, (expressed in feet,) deflects the suspended magnet from the magnetic meridian, and for determining the ratio of the magnetic force (m) of the deflecting magnet to that of the earth's horizontal component, (H.) For the case of the deflector remaining in the magnetic prime vertical, we have, with sufficient precision—

$$\frac{m}{H} = \frac{1}{2} r^3 \tan u \left(1 - \frac{P}{r^2} \quad . \quad . \quad . \quad . \right)$$

for the case of the magnets remaining at right angles—

$$\frac{m}{H} = \frac{1}{2} r^3 \sin u \left(1 - \frac{P}{r^2} \quad . \quad . \quad . \quad . \right)$$

The first form requires the torsion of the suspension to be measured and to be corrected for; in the second form, no twist is developed. The co-efficient P, depending upon the distribution of magnetism within the deflecting magnet, must be ascertained experimentally by means of deflections at two or three distances, and at least twenty-five independent measures should be made for its numerical value; it will generally be found to have a negative sign, provided the magnets have their proper proportions of length.

To find P, let A = value of $\frac{m}{H}$ for the shorter distance r, and A_1 = value of $\frac{m}{H}$ for the longer distance r_1; then—

$$P = \frac{A - A_1}{\frac{A}{r^2} - \frac{A_1}{r_1^2}}$$

If, for any two consecutive sets of observations, the temperature of the intensity-magnet is not the same, a correction for difference of temperature has first to be applied * to the observed angle of deflection. It may be done by means of the expression—

$$\sin u = \frac{\sin u_0}{1 - (t_0 - t)\,q}$$

where u_0 = observed angle of deflection of first set at temperature t_0;
u = corrected angle in order to refer it to the standard temperature t of the second set;
q = temperature co-efficient, to be determined from a series of observations of deflections, at a fixed distance, but at various temperatures.

The co-efficient Q, depending on the fourth power of r, may be neglected. The two distances r and r_1 (to be measured from the middle of the magnet) may be in the ratio of 1 to $\sqrt{3}$ nearly; or, for convenience, the second distance may be one-half greater than the first, but the shorter distance should not be less than about four times the length of the deflecting magnet. The correction for induction in Form 2 may be neglected in all cases where extreme accuracy is not required. In observing with the magnetometer and attached theodolite, we may save time by noting the two extreme scale-readings of an oscillation, instead of waiting for the magnet to come to rest; and, in Form 2, we can also reduce the time of observation by setting the azimuth-circle beforehand nearly to the reading corresponding to the particular position of the magnet, and afterward perfecting the pointing on the middle division by the azimuth-screw. The scale of the deflecting bar † should be examined for graduation and eccentricity errors, and corrected for them if necessary. When using a magnetometer with theodolite, the angular value of the scale of the deflected magnet must be ascertained with great precision, and, in general, special attention is to be paid to the temperature of the intensity-magnet, which must be the same, or be reduced to the same, temperature during the observations of deflections and oscillations. These two operations should, therefore, always immediately follow each other.

Observations of oscillations.—The instrument being adjusted, and the intensity (long) magnet ‡ suspended without twist, with scale horizontal, and the copper damper removed, the observer will arrange his scheme for observing the duration of a certain number of oscillations, from which the time of one oscillation is to be deduced. The bulb of the thermometer to indicate the temperature of the magnet is put inside the box. The mean-time chronometer,§ whose rate must be known, is placed at a safe distance below the telescope, allowing the observer to take up the time and to hear the beat without changing his place.

With the magnet at rest, the vertical thread of the telescope should point nearly to the reading on the scale of the magnetic axis, or to the center division. Care must be taken that the magnet have no up and down vibrations; a horizontal motion is then given to it by means of a small magnetized piece of steel, sufficient to make it vibrate for about twenty or twenty-five minutes before coming to rest. The oscillations are counted as follows: Suppose the center division of the scale to pass from apparent right to left, call its first transit over the line of collimation of the telescope 0, and note the time, (the minute having previously been noted, the second is added without taking

* For greater accuracy, the values of A and A_1 require also to be corrected for effect of induction in that form of instruments giving the *deflection-angle* directly.

† A wooden bar is preferable to one of brass, on account of its greater lightness and less variability in length with change of temperature.

‡ This magnet generally serves also for observations of declination.

§ If sidereal, we simply consider it as a mean-time chronometer with a large rate, and correct for it accordingly the eye from the telescope;) its next transit will be from left to right and is called 1, the next following one from right to left is called 2, and so on until the tenth transit is observed, when the time is again noted, for which purpose the beat of the chronometer has to be taken up in the usual manner. The duration of ten oscillations being thus approximately known, the intervals and whole number of oscillations to be observed can be properly arranged. With the light magnets now in use, two, and for those used in connection with three-inch Casella theodolites, even a single fiber suffices for the suspension. The best arrangement yet devised for ordinarily observing oscillations is the following: Begin with apparent motion of the magnet, say, from right to left, and note the times of, say, three transits; then take an equal number from left to right, to be followed, after an interval of a few minutes, (of rest to the observer,) in order to get the duration for, say, one hundred oscillations, by a similar set of transits from right to left; and conclude finally with an equal number of transits from left to right. It will be noticed that for even numbers of oscillations the apparent motion is from right to left, for odd numbers the reverse. We thus provide experimentally for any effect of a change in the declination during the observations, the final mean duration of one oscillation being unaffected by any such change. It is advisable not to extend the entire time consumed in a set of observations beyond a quarter of an hour, and to make the interval between any two consecutive observations (the magnet swinging in the same direction) between one-third and two-thirds of a minute. This gives ample time to take up the beat of the chronometer, which is done, say, ten seconds before the expected time of transit, and to await it deliberately. The arrangement, for a particular case, is shown in the form given below; here the three intervals (rough ones only) of 39^s, 43^s, and $3^m\ 12^s$ are known beforehand, and must be mentally added to the observed time in order to be prepared for the next following transits. With the time of a transit only roughly known, the observer will not be biased in his estimation of the observed fraction of a second. For each particular magnet, depending mainly on its magnetic force and mass, a special scheme must be devised, guided by the principles as explained above; but the same scheme may be adhered to for a number of stations, unless the survey extends over a space within the limits of which the earth's horizontal force has widely different values. Special attention is to be paid to the correct noting of the temperature, and the observations must be accompanied by measures of the torsion. The correction for induction may be omitted except when great accuracy is demanded; it arises from the fact of the magnet having greater force, by induction, when suspended in the magnetic meridian, than in the position at right angles to it, (as in deflections.)

HORIZONTAL INTENSITY. OSCILLATIONS.

Station, Washington, D. C.—Date, August 12, 1871.—Magnet A suspended.—Inertia-ring, No. —, (not used.)—Chronometer, Park. & Frod., 1216.—Daily rate, — 1s.75 on mean time.—Observer, C. A. S.

No. of oscillations.	Time.			Temperature. t'	Extreme scale-readings.		Time of 100 oscillations.	
	h.	m.	s.	°			m.	s.
0	11	28	24.0	79.0 Fah.	0.0	18.8		
10		29	03.0					
20			42.2					
31		30	25.1					
41		31	04.2					
51			43.2	79.5	1.8	16.8		
100		34	55.2				6	31.2
110		35	34.3					31.3
120		36	13.5					31.3
131			56.2					31.1
141		37	35.3					31.1
151		38	14.2	80.0	4.0	14.8		31.0
Means				79.5			6	31.17

Coefficient of torsion. Value of one scale-division = 2'.90.

Torsion-circle.	Scale.		Mean.	Differences.	$v = 2'.75$	Logarithms.
°						
300	8.8	11.2	10.0			
				1.0	$5400' + v'$	3.73261
30	7.5	10.5	9.0			
				1.9	5400 (ar. co.)	6.26761
210	9.8	12.0	10.9			
				0.9		
300	9.2	10.8	10.0			
Mean = v =				0.95	$1+\frac{h}{f}$	0.00022

Calculation.

$$T^2 = T'^2\left(1+\frac{h}{f}\right)\left(1-(t'-t)\,q\right)$$

			s.
Observed time of 100 oscillations	=		391.17
Time of one oscillation	=		3.9117
Correction for rate	=	−	0.0001
T'	=		3.9116

			Logarithms.
		T'	0.59235
q	0.00027		
$t'-t$	+0.33	T'^2	1.18470
$(t'-t)\,q$	0.00009	$1+\frac{h}{f}$	0.00022
$1-(t'-t)\,q$	0.99991	$1-(t'-t)\,q$	9.99996
		Induction	0.00079
		T^2	1.18567
	$m\,H = \frac{\pi^2 K}{T^2}$	$\pi^2 K$	1.40062
		$m\,H$	0.21495
		m	9.57516
		$4.3630 = H$	0.63979
		* $\frac{m}{H}$	8.93537
		$m\,H$	0.21495
		m^2	9.15032
		$0.3760 = m$	9.57516

* From observations of deflection: Date, August 12; $t = 79^\circ.17$ Fah.

Let H=the horizontal component of the earth's magnetic force; m=the magnetic moment of the intensity-magnet; K=its moment of inertia, (inclusive of stirrup and balancing-ring,** if any;) T=the time of one oscillation: then, from observations of oscillations, we have the expression for the product—

$$m\,H = \frac{\pi^2\,K}{T^2}$$

where $\pi = 3.14159$.

The observations of deflections give the ratio $\frac{m}{H}$, and the observations of oscillations the product m H; m and H can therefore be eliminated from the two equations, as shown in the preceding example.

To determine K, a truly-turned brass or bronze ring of known dimensions and weight (about equal to that of the magnet) is placed on the magnet. It is correctly centered by means of two centering-blocks, and when suspended must remain in a horizontal plane. The number of suspension-fibers must be doubled for the purpose. In this position, a set of oscillations is observed similar in arrangement to that already explained; and if T_1 be the time of one oscillation of the loaded magnet, and K_1 the moment of inertia of the ring, then—

$$K = K_1\left(\frac{T^2}{T_1^2 - T^2}\right)$$

** This small balancing-ring must remain in the same position as in the observations for intensity; but its use should be avoided, if at all possible.

A series of not less than twelve sets of observations of oscillations, with the magnet *alternately* unloaded and loaded, is to be made, each set duly corrected for torsion, rate of chronometer, and difference of temperature, from which the value of K is deduced. These results are to be combined with a view of eliminating the effect of changes in H during the observations; thus, the mean of sets 1 and 3 is used with set 2, the mean of 3 and 5 with 4, &c., the first and last sets being alike either with magnet unloaded or loaded. As the torsion changes with the weight, observations for torsion must also be made with the loaded magnet. To find K_1, let r and r_1 represent the inner and outer radii, expressed in decimals of a foot, and w the weight of the ring in grains; then—

$$K_1 = \tfrac{1}{2}\,(r^2 + r_1^2)\,w$$

The values of log π^2 K for different temperatures should be tabulated. It suffices to assume the ordinary co-efficient of expansion for brass, (0.000010.)

The reduction of the time of an oscillation to an infinitesimal arc is generally so small as not to affect the magnetic results. If a and a' express the initial and terminal semi-arcs of an oscillation, (in parts of the radius,) then the corrected value for T^2 will be—

$$\left(1 - \frac{a\,a'}{16}\right)^2 T^2$$

This correction can be avoided by swinging only through small arcs.

To reduce the measures of deflections and oscillations to the same temperature, let $t =$ the temperature of the magnet when deflecting; $t_1 =$its temperature when oscillating; $q =$ the change in magnetic moment of magnet for a change in temperature of 1° Fahrenheit, then the co-efficient to be applied to T^2 is equal to $1-(t'-t)\,q$, as shown in the example. The value of q is not constant, but, for a moderate range of temperature, may be taken as constant; it must be obtained experimentally, either from oscillations or from deflections, at various temperatures, but the magnet should not be subjected to a greater range of temperature than from about 32° to 100° Fahrenheit. These observations must be conducted by the alternate use of a jacket of ice and of hot water, or by the aid of extreme natural temperatures; ample time must, however, be given to the magnet to establish again an equilibrium it its magnetism; all *rapid* changes from cold to hot (or *vice versa*) will give decidedly erroneous values for q.

Supposing not less than three consecutive series of observations of deflections for finding a value of q, and the first and third series to be at nearly the same temperature, with their results combined to a mean, and the second or intermediate series at a greatly different temperature, then q may be found, with sufficient precision, by the expression—

$$q = \frac{a\,n \cot u}{t - t_0}$$

where $a =$ the arc value of one division of the scale of the suspended magnet in terms of the radius; $n =$ the difference of scale-readings corresponding to the difference of temperature $t - t_0$; and $u =$ angle of deflection at the lower temperature t_0. In every case, the arrangement must be such as to eliminate, as far as possible, any effects of changes in declination and intensity during the observations. If other instruments are available, it is best to correct the readings for changes in declination and intensity.

Example to observations of deflections for value of q *of magnet H.*

Washington, D. C.—Magnetic Observatory.—J. S. H., observer.—April 14, 1856.—Magnet C_{17} suspended.—Magnet H deflecting at a distance of 21 inches to the east of suspended magnet.—Mean declination-reading of the day, 62^d. 4.—One scale-division of C_{17} = 2'. 80.

Time.	No. of sets.	Declination-reading.*	Scale-reading of C_{17}, mean of five observations.	Mean minus observed declination.	Correction for change in declination.	Reading of C_{17} corrected.	Observed temperature, Fahrenheit.
h. m.		*d.*	*d.*	*d.*	*d*	*d.*	°
10 02 a. m.	1	59. 3	28. 82	+ 3. 1	− 1. 11	27. 71	44. 0
	2	59. 9	28. 84	2. 5	0. 89	27. 95	57. 3
	3	60. 5	29. 07	1. 9	0. 67	28. 40	73. 1
	4	60. 9	29. 15	1. 5	0. 54	28. 61	87. 9
	5	61. 3	28. 73	1. 1	0. 39	28. 34	74. 3
	6	61. 8	28. 21	0. 6	0. 22	27. 99	57. 3
	7	62. 2	27. 64	0. 2	0. 07	27. 57	42. 8
	etc.						

* Brooke's declinometer; 1 division of scale = 1'.

	d.
Reading of C_{17} before introducing H	149.4
Reading of C_{17} during deflection	28.0
Reading of C_{17} after removing H	149.3
Angle of deflection .... 5° 39'.6=	121.3

The above partial results, which form but a portion of the observations taken, may be arranged as follows:

Set, number—	Mean temperature.	Mean reading of C_{17}.	Differences in—	
			Temperature.	Scale-divisions.
	°	*d.*	°	*d*
1 and 7	43. 4	27. 64	22. 2	0. 51
2 and 6	57. 3	27. 97	8. 3	0. 18
3 and 5	73. 7	28. 37	8. 1	0. 22
4	87. 9	28. 61	22. 3	0. 46
Mean	65. 6	28. 15	Sum, 60.9	1. 37

Log a	0.447
Co. log rad. in minutes	6.464
Log n	0.137
Log cot u	1.004
Co. log $(t-t_0)$	8.215
Log q	6.267

q=0.000185

If it is desirable to check the preceding result, we can also find the value of q from three or more consecutive series of oscillations (always combined in accordance with the principle of eliminating changes in intensity) at different temperatures. Let T and T_0 be the observed times of one oscillation (corrected for rate of chronometer and effect of dilatation of magnet) at the temperatures t and t_0, then—

$$q = \frac{T^2 - T_0^2}{T_0^2 (t - t_0)}$$

If the magnetic moment m of the magnet has been determined at a number of stations, the different values may be reduced to a standard temperature. Let m_0=magnetic moment at the standard temperature t_0; m=the magnetic moment at any other temperature t, then—

$$m_0 = m[1 + (t - t_0)\, q]$$

If the values of m_0 are arranged according to time, the gradual loss of magnetism will become apparent in a few weeks, unless the magnet be an old one, when yearly determinations of m indicate but a slight loss. A new magnet is not well suited for intensity-determinations until after the lapse of a month or two.

If F=total magnetic force; H=its horizontal component; V=its vertical component; and θ=the angle of the dip, (reckoned from a horizontal line,) then—

$$F = H \sec \theta = V \operatorname{cosec} \theta$$

To convert measures of intensity expressed in English units into their equivalents expressed in the metric system, in which the millimeter=0.00328087 foot and the milligram=0.0154323 grain are adopted, we multiply by the factor 0.46108, (log factor 9.66378.) Its reciprocal is 2.1688, (log reciprocal factor 0.33622,) by which intensity-measures expressed in metric units are to be multiplied to give their equivalents according to the English weights and measures.

3.—DETERMINATION OF THE MAGNETIC INCLINATION.

The inclination, or dip, is measured in the vertical plane passing through the magnetic meridian of the place, and is the angle contained between a horizontal direction and the direction of a magnetic needle moving freely about a horizontal axis directed east and west magnetically. It is measured by means of a dip-circle, (see Sketch No. 21,) and is considered + when the north end of the needle dips below the horizon.

In a plainly-constructed circle, the graduation, which is directly read off at the ends of the needle, is generally not closer than quarter-degrees or ten minutes, and subdivisions are to be estimated. In the more elaborate instruments, the pointing at axial marks on the needle is done by the aid of two microscopes, with threads in the focus, and the circle is read off to the nearest minute or half-minute by means of two verniers. The latter construction is advantageous only with well-balanced needles, having as perfectly cylindrical axles as can be made.

To place the dip-circle in the plane of the magnetic meridian, we have two ways, either by the aid of an ordinary long compass-needle, which is supported between the agate plates, or by means of the dipping-needle, which will point vertically in the plane of the magnetic prime vertical. The former method is more expeditious; the latter can always be resorted to, and consists in four readings of the azimuth-circle of the instrument when placed successively in the positions: face of circle south, (magnetic,) with face of needle south and face of needle north; next, face of circle north, with face of needle north and face of needle south; the mean reading + 90° and − 90° will give the settings of the circle for the measure of the dip. A more precise value will be found if the process is repeated, with the polarity of the needle reversed.

In adjusting the dip-circle, preparatory to observing, the following conditions should be attended to, and the observations should be arranged so as to eliminate any small outstanding defects in the perfect condition of the instrument: the instrument must remain level when turned about a vertical axis; the agate or steel plates supporting the needle should have their upper surfaces level, should be of equal height, and a horizontal tangent-plane should pass below the center of graduation of the circle at a distance equal to the radius of the axle of the needle. The zero graduation of the circle should lie in a horizontal plane; also the plane of the suspended needle and that of the circle should be truly vertical; and, finally, the prolongation of the axle of the needle should pass through the center of graduation. For instruments provided with microscopes the following additional conditions should be satisfied: the microscopes must be focused and collimated; their threads should be 180° apart, and if produced should pass through the center of graduation.

The needles, before magnetization, should balance perfectly, and those intended for the relative measure of total intensity, according to Dr. Lloyd's method, should be guarded as much as possible against any change in their magnetism.

Reversal of poles of dipping-needles.—The needles which are exclusively used for the measure of the inclination should have their poles reversed at each place of observation, and the results with polarity north and polarity south must be combined to a mean value. If exceptionally the polarity should not have been reversed at a station, the difference in results between polarity north and south, as found at stations which have nearly the same dip, may be applied as a correction. To reverse the polarity we may proceed as follows: fasten the needle in the reversing-block, and, holding a bar-magnet in each hand, bring the *opposite* poles of the two bar-magnets close together at the middle of the needle so as to touch the same on either side of the axle; the needle is supposed to be on a level plane, and the bars are to be inclined outward about 45° to the horizon. They are then drawn slowly and steadily over the needle, carrying them *over* its ends, and, after lifting them some inches above the level of the needle, bring them back to the middle position, and move them again over the surface. This process may be gone through three times, when the upper face of the needle is turned down, in which position the magnetization is repeated as before. Care should be taken to have the motion exactly in the direction of the geometrical axis of the needle; the magnetizing-block usually has a ledge, along which the magnet can be drawn, closely touching it, which will insure a movement parallel to the axis of the magnetic needle. If its north end is to be changed to a south end, place the north (or marked) end over that end of the needle when magnetizing. The polarity as well as the face may be designated by means of the number or letter usually cut on the end of the needle. The reversing-bars should be carefully handled, and should not be allowed to touch each other except with opposite poles, and when placed in the box their ends of opposite polarity should be connected by a soft-iron armatures. If the reversal of the needle is to be repeated a short time after the operation, the method is only changed by using four instead of three passes over each face of the needle; if another reversal is needed shortly after, five passes would be required. This is done in order first to neutralize the existing magnetic polarity, and then to give it the opposite polarity desired; if, however, one or more days have elapsed between a reversal, enough of magnetism is lost to render any increased number of passes unnecessary. Their number depends primarily on the strength of the bars and the relative size of the bars and needles. Should the bars have too much intensity and the needles be long, an irregular distribution of magnetism might be produced. Should the bars be of unequal intensity, it is recommended to exchange them in the hands, after performing one-half of the operation of reversal, turning them at the same time end for end, and completing the operation in the new position. When not in use, and when observing for dip, the bar-magnets should not be kept nearer to the observer than about six meters; but when observing for declination, they should be kept at a greater distance.

The following example of a record of ordinary observations of the dip will sufficiently show the general arrangement. The readings in the second line are independent of those of the first, and between them the needle has always been lifted off its supports. If the position of the needle is recorded while slowly oscillating, it is customary to record the left and right extreme excursions, and, in order to correct for diminution of arc, the mean of the reading of the first extreme and of its next return to it should be taken before combining with the reading of the opposite extreme. In this case, the mean for the first extreme positions may be taken mentally, and the second extreme is recorded under it; then follow two more such readings after the needle has been lifted off and let down again on the agate supports.

It is recommended to observe the needle while slowly oscillating in preference to noting its position at rest, in which case the equilibrium may be influenced by a small irregularity in the axle at the point of contact, which would be passed over by an oscillating motion. Defects in the figure of the axle may also be recognized by irregularities in the motion of the needle.

The introduction of position-needles having a movable axle, which may be turned by means of a key to different positions with a view of eliminating small defects in the figure of the axle, has, so far, not proved as satisfactory as was anticipated, from the difficulty of perfectly figuring the axle and centering the movable arbor; if such needles are used, their polarity, after the first set of observations, must be reversed, and the observations be concluded before turning to a new position.

Magnetic dip.

Station, Washington, D. C.—Date, November 10, 1853.—Six-inch Barrow dip-circle No. 2.—Needle No. 1.—Observer, S. H.—Time commenced 10h 15m a. m.; concluded 10h 33m a. m.

POLARITY OF MARKED END NORTH.							
Circle east.				Circle west.			
Face east.		Face west.		Face east.		Face west.	
S.	N.	S.	N.	S.	N.	S.	N.
° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
71 24	71 08	71 08	71 31	71 08	70 50	70 56	70 42
26	03	08	31	00	58	54	42
71 25	71 05	71 08	71 31	71 04	70 54	70 55	70 42
71 15		71 19.5		70 59		70 48.5	
71 17.3				70 53.7			
71 05.5							
POLARITY OF MARKED END SOUTH.							
Circle west.				Circle east.			
Face west.		Face east.		Face west.		Face east.	
S.	N.	S.	N.	S.	N.	S.	N.
° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
71 12	71 17	71 05	71 05	71 41	71 30	71 43	71 18
11	17	04	04	45	25	44	20
71 11	71 77	71 05	71 04	71 43	71 27	71 43	71 19
71 14		71 04.5		71 35		71 31	
71 09.2				71 33.0			
71 21.1							
Resulting dip .... 71° 13′.3.							

Mean, circle E. and W., 71° 13′.3.

Mean, circle W. and E., 71° 13′.3.

NOTE.—Magnetic meridian obtained by horizontal needle.

Specimen of record for finding magnetic meridian.

	Azimuth-circle.
Circle south, needle south	99° 02′
Circle south, needle north	97° 58′
Circle north, needle south	278° 52′
Circle north, needle north	278° 28′
Setting: 8° 40′ and 188° 40′	98° 40′

It is desirable that in the various positions of the circle and needle the extreme readings should keep within a range of 1° or 2°; the closer the better the final result.

For the purpose of testing the regularity of the figure of the axle of the needle and the freedom of the metal of the circle from any magnetism, we may observe dips in various azimuths; if θ_a=observed dip in magnetic azimuth, a, then the true inclination is found by—

$$\tan\theta = \tan\theta_a \cos a$$

The values of a may be successively changed by intervals of about 10°.

We may also obtain the true inclination, without the knowledge of the magnetic meridian, by observing the dip in any two vertical planes at right angles to each other, and find the inclination by the formula—

$$\cot^2\theta = \cot^2\theta_{,} + \cot^2\theta_{,,}$$

But the best method would seem to be that of Mayer, (proposed in 1814,) which is peculiarly fitted for eliminating the effect of an irregularity in the figure of the pivots, since the di can be found on almost any part of the circumference of the axle. This method consists in loading the needle, (near its axis,) and thus changing its direction. The new position is conditioned by the equilibrium of the magnetic force and that of gravity. The tilt may amount to 90° or more; and should the needle be deflected in the adjacent quadrant, the algebraic sign of the observed dip changes, and must be attended to. For want of a better contrivance, a drop of sealing-wax may be applied to the side of the needle near its axle, and observations may be made with the needle variously deflected by changing its quantity, or by letting it act at a different leverage. The ordinary rules for observing dip are adhered to, but special care must be taken that the weight be not changed in position in the act of reversing the polarity. This method of reduction may also be followed if ordinary needles differ as much as 4° in any of their separate results, due to change of face or polarity.

Let $\theta_{,}$, $\theta_{,,}$, $\theta_{,,,}$, $\theta_{,,,,}$ be the observed dips, say, with face of needle E, face W, and after change of polarity, with face W and face E, respectively, and—

$$M = \cot\theta_{,} + \cot\theta_{,,} \qquad N = \cot\theta_{,,,} + \cot\theta_{,,,,}$$
$$m = \cot\theta_{,} - \cot\theta_{,,} \qquad n = \cot\theta_{,,,} - \cot\theta_{,,,,}$$

Then—

$$\cot\theta = \frac{M\,n + N\,m}{2\,(m+n)}$$

The record, as given in the following example to this method, shows that the dip was noted while the needle was oscillating, and that between the second and third horizontal lines the needle was lifted off the agates and let down again.

Magnetic dip.

Station, Washington, D. C.—Date, September 22, 1856.—Dip-circle Barrow No. 5.—Needle No. 2, loaded near axle.—Observer, C. A. S.—Time, commenced $11^h\ 30^m$; concluded $11^h\ 55^m$.

POLARITY OF MARKED END NORTH.							
Circle east.				Circle west.			
Face east.		Face west.		Face east.		Face west.	
S.	N.	S.	N.	S.	N.	S.	N.
° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
−34 50	−34 50	24 10	24 38	−35 30	−34 02	25 12	25 12
−35 25	−35 18	24 48	24 00	−34 10	−35 18	24 42	24 40
−34 45	−35 09	24 46	24 35	−33 59	−33 49	25 20	24 32
−35 38	−35 00	24 15	24 05	−35 38	−35 22	24 35	25 12
−35 09.5	−35 04.2	24 30.0	24 19.5	−34 49.2	−34 37.8	24 57.2	24 54.0
−35 06.9		24 24.7		−34 43.5		24 55.6	
−34 43.5		24 55.6					
$\theta_{,}$ = −34 55.2		$\theta_{,,}$ = 24 40.2					

POLARITY OF MARKED END SOUTH.							
Circle west.				Circle east.			
Face west.		Face east.		Face west.		Face east.	
S.	N.	S.	N.	S.	N.	S.	N.
° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
−41 00	−41 55	29 30	29 27	−42 14	−41 03	29 55	29 09
−42 10	−40 48	30 30	30 23	−41 02	−42 06	29 20	29 41
−42 10	−40 50	30 35	30 29	−42 09	−42 05	29 29	29 18
−41 00	−41 51	29 25	29 20	−41 10	−41 10	29 48	29 35
−41 35	−41 21	30 00	29 54.8	−41 38.8	−41 36.5	29 38.0	29 25.8
−41 28.0		29 57.4		−41 37.7		29 31.9	
−41 37.7		29 31.9					
$\theta_{,,,}$ = −41 32.8		$\theta_{,,,,}$ = 29 44.6					

Azimuth-circle.

Magnetic prime vertical.......... 69° 00′ by north polarity.
Magnetic prime vertical.......... 247° 50′ by south polarity.

Mean.......................... 68° 25′

Determined before needle was loaded.

Computation.

M - - - - - - - - - - - -	$= + 0.74476$
m - - - - - - - - - - - -	$= - 3.60956$
N - - - - - - - - - - - -	$= + 0.62167$
n - - - - - - - - - - - -	$= - 2.87855$
$\therefore \theta$ - - - - - - - - - - - -	$= +71^\circ\ 19'.1$

CONCLUDING REMARKS.—The degree of accuracy attainable in the magnetic measures can only be estimated, chiefly on account of the almost incessant changes in the action of terrestrial magnetism. With well-constructed instruments, such as have been supposed in this article, and with fair observations, the resulting declination for any one day may, in our magnetic latitudes, be affected with no greater probable uncertainty than about $\pm\ 3'$, and correspondingly less if the observations extend over more than one day. The dip may be affected with a probable uncertainty between $\pm\ 1'$ and $\pm\ 5'$, according to the perfection of the needles and the number of observations made; and the horizontal intensity, in general, may become known within about its $\frac{1}{400}$ part from any one day's observations. To find the effect on the total force, we have the relation—

$$d\,\mathrm{F} = d\,\mathrm{H} \sec \theta + \mathrm{F} \tan \theta\, d\, \theta.$$

APPENDIX.

MEMORANDUM ON THE ORDINARY ADJUSTMENTS OF THE THEODOLITE, OR PORTABLE ALT-AZIMUTH INSTRUMENT, FOR THE MEASUREMENT OF HORIZONTAL AND VERTICAL ANGLES.

The various operations for placing the parts of a theodolite in proper condition for observing, in order to eliminate, as far as possible, sources of error arising from instrumental defects, may be briefly stated as follows:

To adjust the levels.—After properly setting up the stand, clamping it, and mounting the instrument, adjust the most sensitive of the levels attached to it by bringing two of the foot-screws of the theodolite in line with the direction of the level, and, after leveling, turn the azimuth-circle 180°, correct any defect, one-half by means of the foot-screws, (always working them in opposite directions,) the other half by means of the adjusting-screws of the level; turn the circle back to first position and repeat the correction as before as often as may be necessary. If during this operation we turn the circle once or twice at right angles to the former position and make the bubble play in the middle by turning the third foot-screw of the theodolite, there may be no need of using the *graduation* to effect the adjustment of the level, the turning of 180° by estimation being sufficient to effect the purpose. If there is a second level attached to the circle at right angles to the former, it may be adjusted like the first, or, more expeditiously, by placing it in the same direction as the first, (when in adjustment,) and correcting any defect by its correcting-screw. Circular levels must be adjusted upon the same principles; they are, however, generally of inferior accuracy.

To place the axis of the azimuth-circle vertical.—By means of the adjusted level we place the vertical axis in position by leveling the instrument with the two foot-screws parallel with the direction of the level, and then turning the circle 90° and bringing the bubble again to the middle by turning the third foot-screw. The verticality of the axis is tested by the steadiness of the bubble in the middle of the tube when the instrument is slowly revolved in azimuth.

To adjust the threads of the telescope.—Place the threads in the focus of the eye-piece where their best definition is obtained, and test the position by pointing to a distant well-defined object to which the focus of the object-glass is adjusted for distinct vision; and if by moving the eye sidewise the object appears to move off the thread or pointing in the same direction as the eye, the diaphragm must be slightly pushed in, and pulled out, in the contrary case. If there are two threads intersecting in the middle of the field at right angles, the vertical thread may be set vertical by sighting a plumb-line suspended at a proper distance, or the vertical edge of a house may be used instead. The whole diaphragm (after loosening its four screws) is to be turned around the optical axis to effect the coincidence. The preceding adjustment must not be disturbed. The horizontal thread may also be tested by pointing to an object and then turning the azimuth-circle, previously set horizontal, when the object should remain bisected; it may also be effected by pointing on the sea-horizon.

To adjust the line of collimation of the telescope.—If the horizontal axis of the telescope admits of being reversed in its supports, a distant object is pointed to; and if, after reversal of the axis in its V's, the pointing remain perfect, the line of collimation is at right angles to the axis; if not, half of the difference is to be corrected by the azimuth-screw and half by the two adjusting-screws of the diaphragm, (its former adjustments remaining undisturbed.) If the axis does not admit of reversal in the V's, it must be reversed by reversal of the circle, using the graduation; and if the second reading, after reversal, should differ from it a little more or less than 180°, the difference must be corrected as before, and the process is to be repeated until the readings, direct and reversed, differ by 180° exactly. For greater accuracy, we may use a collimator instead of the distant object. In some instruments, the telescopes are mounted on one side instead of in the middle of the azimuth-circle; their collimation may be corrected by two distant marks separated exactly by twice the eccentricity of the axis of the telescope from the vertical axis of the theodolite. The process of adjustment is then the same as described, only changing the mark with a change of the telescope from one side to the other. For oblique intersections of the threads, the point of intersection must be brought into the optical axis of the telescope, the adjustment for collimation being the same as described. In this case, a collimator is used to advantage.

To place the horizontal axis of the telescope in position.—This axis must be at right angles to that of the azimuth-circle, and if in position or horizontal the line of collimation, when revolving the telescope, must pass through the zenith of the observer. It is effected by placing an adjusted level on the axis and correcting the whole error with the adjusting-screw of the pivot. If the level is fixed or uncorrected, it must be adjusted at the same time with the axis by leveling and then turning the azimuth-circle 180°, and correcting one half of the defect by the pivot-screw and the other half by the level-screw. This process also requires repetition for its perfection.

The instrument is now ready for the measurement of horizontal angles, either by "directions" or by "angles," with or without repetitions, according to the construction of the instrument or the requirements of the case. In either method, one half of the measures must of course be made with "circle direct," the other half with "circle reversed" by 180°, which process corrects the angles for any *remaining defect*, after adjustment, in the verticality of the axis, in the height of the V's, in the form of the pivots, and in the collimation. If the telescope is placed eccentrically, this reversal will at the same time refer the resulting measures to the axis of the circle, or, what should be the same, to the vertical of the station.

In repeating angles it suffices to record the readings of the circle at the commencement and at the end of the operation, the telescope being reversed after half the number of repetitions are secured. During the reversal of the telescope and the circles they remain firmly clamped until the new pointing is made. With non-repeaters, or when used as such, the records for telescope "D" and for telescope "R" are kept separate.

The eccentricity of a circle is corrected by taking the mean of the readings of two opposite verniers or microscopes, or the mean of the readings of any number of verniers or microscopes, provided they are so placed as to divide the whole circumference into equal parts.

To adjust the level required for vertical measures.—The measures of vertical angles depend, among other things, on the accuracy of the adjustment of the level. It is effected by leveling and reversing the azimuth-circle 180°, using one of the level-screws for correction, provided the former adjustment of the vertical axis has not been disturbed. This level may either be attached to the azimuth-circle or to the arms carrying the verniers or microscopes of the altitude-circle; in the former position, it is of course placed parallel to, or in the plane of, the altitude-circle.

The instrument is now in the proper condition for the measure of vertical angles. Generally, *double* zenith-distances are measured, by means of which the reading of the zenith (or nadir) point on the circle becomes known, and consequently also the reading of the horizon. If there is any index-error, it may either be corrected (most instruments admit of such a correction) or it may be allowed for as a constant when single altitudes are measured. This index-error is of no consequence if double zenith-distances are taken, (involving positions, circle right and circle left.)

Owing to the great diversity in the construction of theodolites, depending upon their particular use and the degree of perfection required of them, rules cannot be given to apply alike to all constructions; but the preceding notes will apply in all ordinary cases of the use of the portable instrument. To test the graduation, its eccentricity, systematic and irregular errors: to adjust the reading microscopes, (for run and focus;) to test the coincidence of the two horizontal axes, also of the two vertical axes in *repeating-instruments*; to examine the perpendicularity of the planes of the circles (graduation) to their respective axes; to measure the flexure of the telescope, and other circumstances, will require the attention of the observer when engaged in the more refined geodetic or astronomical use of the alt-azimuth.

The principle of repetition applies most advantageously when the optical power of the telescope exceeds relatively the accuracy of the graduation; in other words, when the pointing-error is less than the graduation-error. If the optical power is inferior, or not commensurate with the perfection of the graduation, we may still save time by using this method, the number of readings being less; or it may be utilized by giving *position* to the instrument, to spread the readings over the graduation. Although the principle of repetition is an elegant one, in practice it has been found to introduce a new source of error, namely, a constant error depending on the necessary imperfection of the clamping and general instability of the instrument. Unless the clamps are perfect, repeating will introduce a constant error, which cannot be eliminated from the result by the forward and backward movement of one circle upon the other, and the observer should carefully test whether or not his pointing will be preserved when repeatedly clamping and unclamping; this especially applies to the clamps upon which the movement of the inner circle depends, (for repeaters.) The clamps should never be at the circumference of the circle of graduation, but near the axis, unless for inferior instruments. Before observing its general stability, the clamping-apparatus should be examined as well as the proper amount of friction of the moving parts and the balancing of weights. Instruments with light spokes to their azimuth-circles, (though they may otherwise be high or thick enough,) and having a heavy superstructure, (vertical circle and counterpoise,) frequently show so much flexure or spring as to affect injuriously all horizontal measures, while solid and thin plates are not liable to this defect.

APPENDIX No. 15.

CORRESPONDENCE RELATIVE TO THE PRESERVATION OF NEW YORK HARBOR.

NEW YORK, *June* 20, 1872.

MY DEAR SIR: You will observe, from the tenor of the order issued by the Board of Commissioners of Pilots, that their action in declining for the present to approve of any proposed place for the deposit of dredged material within the limits of this harbor, was based upon a report from yourself detailing the results of a survey made under your order last season.

In behalf of the Department of Docks, I would inquire if the aforesaid report was designed to bear the wide interpretation reflected in the order from the honorable board above named, and, if not, whether you would be willing to designate localities where deposits might be made without detriment to navigation now and hereafter.

I would suggest that if no positive conclusion can be at once reached as to a proper site, those points which appear to you least objectionable might be stated, and made use of at once by way of experiment; the action of waves and currents being studied from day to day, until positive information is gained as to the disposition made by these natural agents of the material deposited. And I will further suggest that an officer of the Coast Survey, having the requisite experience and your confidence, may be selected to advise in the method of observing, and report upon the results from personal inspection as far as practicable; the expenses of the work being, of course, borne by this department.

If not conflicting with the regulations of the service, I shall be pleased if Prof. Henry Mitchell be assigned to this duty. His experience in observations of this nature will render his advice of great value to me.

Very respectfully, your obedient servant,

GEO. B. McCLELLAN,
Engineer-in-Chief.

Prof. BENJAMIN PEIRCE,
Superintendent of the United States Coast Survey.

NEW YORK, *March* 19, 1872.

GENTLEMEN: I regret to have to inform you that, after long deliberation, the pilot-commissioners feel it their duty to deny your application for permission further to deposit dredgings in the waters of the port. The result of the late survey (made at the request of this board by the officers of the United States Coast Survey with special reference to this subject) showing that shoals have been formed in the channel-ways by such deposits, admonishes the commissioners that a continuance of the practice will seriously damage the navigation, and enforces the conviction that they would but poorly perform their duty as guardians of the navigable waters of the harbor did they permit any further inroads of this nature. They must therefore adhere to their determination, already made public, to allow no deposits of any kind to be made in the waters of the port below Spuyten Duyvel Creek on the North River, or Throg's Neck on the East River, nor in the bay inside of Sandy Hook.

The law requires all dredgings to be placed above high-water mark, or inside of a bulkhead constructed to retain them for filling in.

Respectfully, by order of the board,

RUSSELL STURGIS, *President.*

DEPARTMENT OF DOCKS OF NEW YORK CITY.

JUNE 21, 1872.

DEAR SIR: The localities selected by Captain Patterson and myself to offer for your approval as trial-grounds for the deposit of dredged materials are as follows:

1st. Shore of Staten Island, within the 12-feet low-water curve, from one mile below Fort Tompkins to one mile above (northward of) the outer point of Great Kills.

This site is on the west side of the channel, lying between West Bank and Staten Island. In this channel the scour is northward, (as in False Hook channels generally;) but there would seem to be very little movement of current along shore. I think the material deposited would work shoreward under the action of waves.

2d. Owl's Head, opposite quarantine, between the parallel of quarantine and a point in Gowanus Bay, one mile northward. I know very little of this shore, and would recommend a little examination before making deposits, even for trial.

3d. East side of Lawrence Point, (below Hell Gate.) The deposits to be made on either side (eastward or westward) of Barrian's Island, within the 10-feet line at low water.

4th. Sites may be found near Sunken Meadow (below Hell Gate) and near south end of Riker's Island, but would require previous examination.

In recommending the above, we have considered only physical conditions, and know nothing of the interests of shore-proprietors. The site first named seemed to us the most unobjectionable.

Of course, we mention only those sites where inclosures would not seem to be necessary; there are several flat spots where complete reclamation would be harmless if bulkheads were constructed.

Very respectfully submitted.

H. MITCHELL, *Coast Survey.*

Prof. BENJAMIN PEIRCE,
Superintendent of the United States Coast Survey.

COAST SURVEY OFFICE, *June* 25, 1872.

MY DEAR SIR: My report upon the results of the coast survey in New York Harbor was a simple statement of the facts of observation, and I cannot be responsible for the inferences which other parties may have drawn from it, or their action in consequence of it. But I am glad at the prompt and decided action of the Board of Commissioners of Pilots for the preservation of the harbor, and it would be unbecoming in me to advise them to relax the stringency of their resolutions for any small or private enterprise.

The docks are, however, essential members of the harbor, and we must strive to relieve your department from the embarrassing position in which it is placed. It is to be regretted that any obstacle should have been put in the way of your depositing your material in the locality indicated in my report, and where it would have been of such public benefit. When I heard of the decision of the Commissioners of Pilots, I anticipated the difficulties of your position, and requested Professor Mitchell to make a preliminary examination, in order to "designate localities where deposits might be made without detriment to navigation," which is in exact accordance with your present request. I send you a copy of his report, which reached me at the same time with your letter. In all other respects I shall be happy to meet your wishes, and to assign Prof. Henry Mitchell to the duty proposed by you, for which I consider him to be eminently qualified.

I hope that the confidence which has already been manifested by the Board of Commissioners of Pilots in the Coast Survey will be extended so far that they will relax their resolution so as to permit the deposits of your dredgings to be made in the localities indicated, until there may be positive evidence that they are injurious and should be discontinued.

Very respectfully, your obedient servant,

BENJAMIN PEIRCE,
Superintendent of the United States Coast Survey.

Gen. GEORGE B. MCCLELLAN,
Engineer-in-Chief Department of Docks, New York City.

Resolution of the board of commissioners of pilots, passed in New York City July 3, 1872.

Resolved, That this board will not object to the deposit of dredged material by the department of docks within the 12-feet low-water curve, from one mile below Fort Tompkins to one mile northward of the outer point of Great Kills, on the west side of the channel between West Bank and Staten Island, being the place recommended by Professor Mitchell, and marked No. 1, in his communication to the Superintendent of the United States Coast Survey of June 21, 1872.

APPENDIX No. 16.

THE MIDDLE-GROUND SHOAL, NEW YORK HARBOR.

SIR: Gowanus Bay, as a feature in the physical geography of New York Harbor, owes its existence to causes which antedate, perhaps, all those in action at this day. It appears to be the submarine prolongation of a depression which may be followed back some distance into the uplands. It is, in fact, a little *fjord*, and, like all similar basins, it has been filling up with *débris* washed from the hills by the rains and brought in from the outside by waves and tidal currents, for, nobody knows, how many centuries. A glance at our earliest surveys shows that the more sheltered portions of this bay had been already converted into salt-marsh, and all of it had received enough deposit to conceal the original form of the bottom, and to replace all irregular features by a smooth covering of mud and sand.

This bay is naturally sheltered from the currents which flow in and out of the North and East Rivers, but not equally so as respects the ebb and flood. The ebb is turned off by Red Hook much more effectually than the flood is by Owl's Head, so that the latter sweeps farther into the bay than the former.

The consequence of this is, that a shoal appears extending southward from the vicinity of Red Hook, which occupies the neutral ground between the main channel, where the ebb prevails, and the Gowanus Bay Channel, where the flood has the stronger flow.

This shoal, which is known as the Middle Ground, belongs to a large class whose existence we have everywhere observed to be due to the variation in the paths of ebb and flood, to which we have referred; and this shoal is an appendage to Red Hook in precisely the same sense that the west bank is an appendage to the point of Staten Island, or as the False Hook is to Sandy Hook, or as the Middle Ground of Martha's Vineyard Sound is to West Chop. That our observations might show the conditions under which the shoal exists, we arranged our stations in pairs at the *upper*, *middle*, and *lower* parts of the Middle Ground, in each case placing one station inside and the other outside of the shoal, (see Sketch No. 22,) and made the observations simultaneously.

The three tables given below are compiled from the excellent observations of Mr. J. B. Weir and his associates, forming the party of the schooner Hassler. We have arranged all the velocities according to lunar hours, so that pairs of stations of different dates may be compared. I especially ask your attention to these tables, and the illustration of the first of them, which appears as Fig. 2 upon our sketch.

Let us begin with the upper pair of stations, a_1 and a_2. Each of them shows ebb and flood currents of very unequal velocities, but, in the pair, *relatively reversed—i. e.*, at the outside station—the ebb is the stronger, while at the inside station it is the flood that predominates.

If, for instance, you trace off one of the curves of Fig. 2, and apply it, reversed, to the other, you will be struck by the correspondence: you may almost replace the ebb of one of the stations by the flood of the other, and *vice versa.* The mean velocities of Table No. 1 stand, for the outside station, 0.86 ebb against 0.40 flood; and, for the inside station, 0.37 ebb against 0.74 flood. Could anything, dependent upon observations from the deck of a vessel, come out closer? The middle pair of stations, being farther apart, do not present so close an agreement by inversion: the outside station gives 0.86 ebb, against 0.48 flood; while the inside station gives 0.44 ebb, against 0.51 flood. The third pair gives velocities slightly favoring the ebb at both stations; this portion of the shoal, however, lies below the water-stratum observed upon. (We employed logs drawing about ten feet.)

Now, for all materials which are not suspended by the currents, like sand for instance, the currents observed during a half tidal day may be regarded as simultaneous forces, because a grain of sand during an entire ebb is not rolled so far as to fall among drifts that essentially differ from those which started it; therefore we should expect to find—and, as far as I know, *we invariably do find*—a shoal wherever the ebb and flood are equal and opposite forces.

As long ago as 1857 I showed that the shoals of New York Bar lay in districts where the resultants of the tidal currents composed for a tidal day from observations made every fifteen minutes were zero. The only difficulty I had in reducing the whole bar to a mere problem in mechanics lay in the fact that I had no means of measuring the forces of the waves, which at some exposed points played apparently a prominent part.

To return to our proper subject: between the stations of our "*upper*" and "*middle*" pairs, respectively, there must in each case be a point where the ebb and flood currents are exactly equal, *i. e.*, where there is no resultant force to carry away the material which is prone to roll along the bottom. The Middle Ground Shoal may be a deposit—it has that general appearance—but its existence would be quite as well accounted for by the current-observations given above, if we considered it the *remainder* of a wasted island.

The pier extended southward from Red Hook by the Erie Basin Company has not, that I can discover, disarranged the proper order of the currents; but I think any extension from this structure to the westward would bring about considerable changes, which, while they might not be generally injurious to the harbor, would change the accustomed paths of vessels seeking the docks, &c., of Gowanus.

Since, as we have said above, the Middle Ground is a dependence upon Red Hook, which creates the shelter under which it has formed or continued to exist, you should oppose, I think, any extension of this Hook, fearing that an increase of the shoal, and a consequent diminution in the width of the main channel, might be the result.

The survey of Gowanus Bay, which I transmit, was executed during the past season, principally at the expense of your board, by Mr. F. F. Nes and Mr. F. W. Dorr, assistants of the Coast Survey; the former having executed the hydrography, which was very much the more laborious part, and the latter the shore-lines. As both of these gentlemen are accomplished officers of the service, I feel a good deal of confidence in the chart they have made. I regret that I have no draughtsman to make a fair copy for your use.

Very respectfully, yours,

HENRY MITCHELL,
Chief of Physical Hydrography, United States Coast Survey.

Prof. BENJAMIN PEIRCE,
Superintendent of the United States Coast Survey.

Currents on either side of Middle Ground, middle pair of stations, occupied August 7, 1872.

b_1.				b_2.				Remarks.
Lunar hours.	Height of tide.	Current. Velocity.	Current. Azimuth.	Lunar hours.	Height of tide.	Current. Velocity.	Current. Azimuth.	
			°				°	
0......	3.31	1.31	25 E.	0......	3.31	0.57	23 E.	
	3.04	1.38	28		3.04	0.50	22	
I......	2.78	1.35	37	I....	2.78	0.45	25	
	2.63	1.22	35		2.63	0.40	25	
II......	2.68	1.03	38	II.....	2.68	0.29	24	
	3.02	0.16	34		3.02	0.08	350	
III.....	3.16	0.76	24	III ...	3.16	0.10	220 F.	
	3.74	0.55	17		3.74	0.35	229	Middle time of ebb of b_1 after ☽'s transit = 12*h*. 59*m*.
IV.....	4.37	0.22	28	IV....	4.37	0.55	225	
	5.01	0.06	54		5.01	0.59	215	Middle time of flood of b_1 after ☽'s transit = 7*h*. 28*m*.
V......	5.58	0.23	205 F.	V....	5.58	0.71	208	
	5.64	0.20	186		5.64	0.74	210	Middle time of ebb of b_2 after ☽'s transit = 11*h*. 45*m*.
VI.....	5.97	0.42	217	VI....	5.97	0.75	207	
	6.24	0.58	226		6.24	0.71	217	Middle time of flood of b_2 after ☽'s transit = 6*h*. 18*m*.
VII....	6.39	0.66	216	VII...	6.30	0.66	215	
	6.56	0.66	209		6.56	0.57	207	
VIII...	6.70	0.60	219	VIII..	6.70	0.45	209	
	6.60	0.47	219		6.60	0.30	197	
IX.....	6.36	0.18	241	IX....	6.36	0.07	155	
	5.95	0.16	12 E.		5.95	0.25	50 E.	
X......	5.45	0.50	31	X.....	5.45	0.60	22	
	4.79	0.74	31		4.79	0.74	24	
XI.....	4.17	0.97	25	XI....	4.17	0.73	23	
	3.65	1.18	32		3.65	0.64	24	
Mean velocity of flood = 0.44 nautical mile.				Mean velocity of flood = 0.50.				
Mean velocity of ebb = 0.82 nautical mile.				Mean velocity of ebb = 0.48.				

Currents on either side of Middle Ground, lower pair of stations, occupied August 12, 1872.

c_1.				c_2.				
Lunar hours.	Height of tide.	Current.		Lunar hours.	Height of tide.	Current.		Remarks.
		Velocity.	Azimuth.			Velocity.	Azimuth.	
			°				°	
0......	3.26	1.27	—— E.	0......	3.26	1.27	....	
	3.04	1.55	14		3.04	1.18	....	
I......	2.85	1.55	17	I......	2.85	1.11	23	
	2.80	1.55	21		2.80	1.09	37	
II......	2.85	1.53	23	II......	2.85	0.93	42	
	2.96	1.43	15		2.96	0.71	37	
III.....	3.30	1.08	21	III.....	3.30	0.40	37	
	3.75	0.75	29		3.75	0.00	—— F.	
IV.....	4.34	0.34	30	IV.....	4.34	0.67	172	Middle time of ebb of c_1 after ☽'s transit = 13*h*. 04*m*.
	4.94	0.05	76		4.94	1.01	201	
V......	5.52	0.14	—— F.	V....	5.52	1.06	204	Middle time of flood of c_1 after ☽'s transit = 7*h*. 40*m*.
	6.02	0.45	171		6.02	1.03	202	
VI.....	6.38	0.75	187	VI...	6.38	0.96	208	Middle time of ebb of c_2 after ☽'s transit = 11*h*. 47*m*.
	6.72	1.06	196		6.72	0.93	207	
VII....	6.98	1.32	186	VII...	6.98	0.91	204	Middle time of flood of c_2 after ☽'s transit = 6*h*. 10*m*.
	7.10	1.40	186		7.10	0.80	202	
VIII...	7.12	1.27	189	VIII..	7.12	0.60	197	
	7.00	0.96	188		7.00	0.40	189	
IX.....	6.65	0.55	176	IX...	6.65	0.17	187	
	6.29	0.26	148		6.29	0.18	50 E.	
X......	5.85	0.07	—— E.	X.....	5.85	0.61	29	
	5.34	0.35	33		5.34	0.92	28	
XI.....	4.79	0.88	28	XI....	4.79	1.32	....	
	4.35	1.06	20		4.35	1.30	....	
Mean velocity of flood = 0.81. Mean velocity of ebb = 0.96.				Mean velocity of flood = 0.78. Mean velocity of ebb = 0.85.				

Chief observer, Mr. J. B. Weir, United States Coast Survey, assisted by G. W. Blodgett and C. L. Howes.

Currents on either side of Middle Ground, upper pair of stations, occupied August 5, 1872.

a_1.				a_2.				Remarks.
Lunar hours.	Height of tide.	Current. Velocity.	Current. Azimuth.	Lunar hours.	Height of tide.	Current. Velocity.	Current. Azimuth.	
			°				°	
0......	3.47	1.14	355	0......	3.47	0.50	350	
	3.14	1.23	10		3.14	0.29	355	
I......	2.88	1.30	0	I......	2.88	0.24	351	
	2.63	1.38	8		2.63	0.40	338	
II......	2.57	1.18	0	II......	2.57	0.60	341	
	2.73	1.01	6		2.73	0.08	321	Middle time of ebb of a_1 after ☽'s transit = 13*h*. 18*m*.
III......	3.16	0.78	6	III......	3.16	0.17	181 F.	
	3.69	0.40	19		3.69	0.40	176	Middle time of flood of a_1 after ☽'s transit = 7*h*. 00*m*.
IV......	4.09	0.30	9	IV......	4.09	0.52	176	
	4.83	0.06	13		4.83	6.81	172	Middle time of ebb of a_2 after ☽'s transit = 12*h*. 14*m*.
V......	5.45	0.16	193 F.	V......	5.45	0.98	170	
	5.98	0.38	212		5.98	1.12	174	Middle time of flood of a_2 after ☽'s transit = 6*h*. 12*m*.
VI......	6.31	0.46	213	VI......	6.31	1.11	177	
	6.49	0.62	193		6.49	1.05	164	
VII......	6.63	0.65	201	VII......	6.63	0.92	171	
	6.70	0.56	203		6.70	0.79	173	
VIII......	6.69	0.42	202	VIII......	6.69	0.65	173	
	6.58	0.36	197		6.58	0.41	175	
IX......	6.37	0.30	171	IX......	6.37	0.13	173	
	6.00	0.06	142 E.		6.00	0.14	8	
X......	5.57	0.52	14	X......	5.57	0.38	13	
	5.02	0.75	10		5.02	0.61	356	
XI......	4.40	0.95	10	XI......	4.40	0.76	354	
	3.87	1.12	13		3.87	0.57	350	
Mean velocity of flood = 0.43.				Mean velocity of flood = 0.69.				
Mean velocity of ebb = 0.82.				Mean velocity of ebb = 0.41.				

Chief observer, Mr. J. B. Weir, United States Coast Survey, assisted by G. W. Blodgett and C. L. Howes, students of Massachusetts Institute of Technology.

APPENDIX No. 17.

REPORT ON SHORE-LINE CHANGES AT EDGARTOWN HARBOR, MASSACHUSETTS, BY H. L. WHITING, ESQ., ASSISTANT IN THE UNITED STATES COAST SURVEY.

BOSTON, MASS., *January*, 1872.

DEAR SIR: In compliance with your instructions of 18th of July last, I proceeded to Edgartown, Martha's Vineyard, to make a survey of the changes in the topography of the harbor for the purpose of comparing the results with those of my former surveys of this locality, and, in connection with the physical surveys of Professor Mitchell, to ascertain, if possible, the effect of these changes upon the harbor.

The comparison of the surveys just made with those of previous dates, 1846, 1854, 1855, and 1856, giving intervals of fifteen and twenty-five years, affords data for most interesting study, and gives an accurate exhibit of the action of waves and currents along this section of the coast.

In his former and late reports, Professor Mitchell has stated the peculiar physical relation of the tides of the Vineyard and Nantucket Sounds to those coming upon the south shores of the islands of Martha's Vineyard and Nantucket, and the circulation of currents through Edgartown Harbor, and the former opening in Cotamy Beach. I will not, therefore, discuss these subjects in my report, but merely give their effects as they appear.

At the time of my first survey in 1846, the opening through Cotamy Beach was at the eastern corner, so to speak, of the bay, but not beyond the southwestern point of Chappaquiddick Island; in fact, the inlet was formed by this point of Chappaquiddick and the east end of the beach, and was about 2,000 feet in width. Within the opening, however, were two small sand-islands, with channel-ways between and on either side of them. This condition of the inlet corresponded, in its general location and width, to that shown on the maps of Des Barres of 1776.

In 1856, I was ordered by Professor Bache to make a resurvey and examination of this same locality, in order to determine the position and dimensions of the new opening which was reported to have been made by a then recent storm.

By this survey I found great changes had taken place since 1846. The old inlet had worked about one mile to the eastward of its former site, and the point of the beach had lapped by the end of Chappaquiddick over half a mile. The shore of this island, along its southwestern face, had washed away to the extent of about 2,300 superficial feet. This action had changed the character and capacity of the inlet from a broad opening of 2,000 feet, directly opposite the waters of the bay, to a much narrower channel confined between the fast land of Chappaquiddick and the beach. This water-way between the ocean and the bay was about 3,000 feet in length and about 500 feet in width.

The new inlet had broken open about opposite the middle of the bay, and was, at the time of my survey, (1856,) about 1,400 feet in width; thus restoring the total inlet-capacity, so far as width was concerned, to nearly that of the old inlet of 1846.

Since 1856, we have had no determination of the beach until the surveys made last summer, when it was found to extend across the entire south front of the bay with no opening into the ocean. We have, however, quite reliable local information concerning the intermediate changes, from which we have obtained the following general facts.

Soon after the "West Opening," so called, of 1856 was formed, the "East Opening" closed, and the new west opening, following the law of motion which seems to govern all the inlets on the south side of the island, began its movement eastward, continued until it reached the site of the former inlet of Des Barres, and of the Coast Survey of 1846, passed on to the site of the inlet of 1856, and still continued working eastward, until the point of beach forming its outer chop reached a point in line with the general trend of the east shore of Chappaquiddick. Here the rapid tidal currents of Muskeget Channel checked its further progress. For a time the tidal currents into and out from

Cotamy Bay battled with the sea-dash upon the shore, the latter gradually gaining ground upon the current-power, crowding the beach farther and farther toward the mainland of Chappaquiddick, and narrowing the water-way between them, until, at the occurrence of a storm and tide, favoring the action, the most easterly portion of the beach was beaten in upon the island by the ocean-waves, and the inlet closed. This happened in 1869, since which time the beach has remained intact, and all the action and influence of a southern inlet connecting the waters of the ocean and the sound through the channels of Edgartown Harbor and Cotamy Bay has ceased.

There is the tradition of a continuous beach, and the closing of all inlets, as at present, in the early part of this century, and that people passed with teams from the main island to Chappaquiddick, but that the link was only temporary, a new opening breaking through the beach again in a few months after it was closed. With this exception, there is no record or tradition of the non-existence of an inlet through Cotamy Beach since this section of the coast has been known.

It is an interesting and important fact that we are able so accurately to determine the extent and nature of the changes which have occurred in this locality within the last twenty-five years, particularly in this beach, which is a type of many others along the sandy portions of our sea-coast, and presents much the same barrier against the encroachment of the sea, preventing the wasting action of storm-waves from extending into bays, lagoons, and ponds.

The length of Cotamy Beach from east to west is about three and a half miles, and its average width about 450 feet. As shown by my first and last surveys, this beach has been beaten bodily northward a distance about equal to its width. As this beach has re-formed its general natural slopes while changing its position, we find a present depth of about 8 feet below high water over the area occupied by the beach itself in 1846, and also a corresponding depth in the inside of the beach; so that in determining the amount of sands which have been moved we must take them from above the plane of about 6 feet below high water. The average height of the beach above high water is about 8 feet. This gives a gross amount of about 116,500,000 cubic feet. In other words, a bank, or mole of sand, 18,500 feet in length, 450 feet wide, and 14 feet high, containing 116,550,000 cubic feet, has been beaten in upon the bay and shore by the steadily encroaching action of the ocean-waves in a period of twenty-five years, a distance of 450 feet. This is not a case of any great convulsion, or powerful current-action. It is but a fair illustration of the gradual but increasing *waste* which is going on upon such shores.

The island of Martha's Vineyard was probably visited, and even settled upon, by the early colonists. How great must be the contrast of the present shores with those they then explored, when we consider that, according to the ratio of change, Cotamy Beach must then have been 4,500 feet to seaward of its present line!

In extending my survey westward from Cotamy, along the main shore of the island, I found the same encroachment of the ocean going on. Two ponds of some acres in extent, and having local names, were, at the time of my survey of 1846, about 450 feet back from the shore-line. These ponds are now entirely obliterated. The site of one is now occupied by the sand-hills of the beach, while a small tract of marshy ground marks the inner borders of the other. I found no important changes in the inner shores of Cotamy Bay, or at points not under the immediate influence of the ocean-forces.

With regard to the question of opening Cotamy Beach by artificial means, and thus restoring the former regimen of the bay and harbor, there seems but one answer to be given: it should be done at once.

The great value of Edgartown Harbor is for shelter, and the *only perfect shelter*, within reach of the crowd of vessels sometimes caught by bad weather in the dangerous approaches to Cape Cod. The importance cannot be questioned of an inlet or passageway from the harbor southward for the smaller pilot-boats, which in certain winds and storms can safely and quickly reach vessels needing a pilot off Muskeget Channel, *through a southern inlet*, when it would be *impossible* for them to round Cape Poge, or reach the ground of danger by any other route. The valuable fishing-interests of Edgartown and its vicinity, now seriously affected by the loss of this safe and direct pathway to the fishing-grounds, call for action and relief in the matter of this closed inlet.

The most favorable point at which to re-open Cotamy Beach seems to be at or near the west end or head of the bay.

The arguments in favor of this location are as follows:

1st. The greater length of time that the inlet will probably remain open, assuming that it will move from west to east as fast, and close as soon after reaching its eastern limit, as in former instances.

2d. The fact that this contracted section of the bay, by confining the tidal currents between the mainland of the island and the beach, as the currents flow to and from the actual inlet, favors the formation and maintenance of a channel through the shoal ground bordering the beach, into the deeper waters of the bay.

3d. Economy in cutting through the beach, as the cross-section at this point is about the minimum.

Although an opening through the beach sufficient to merely start the water, if made at the time predicted by Professor Mitchell, may, and probably will, create a natural inlet, for the physical demands required by tidal circulation through the harbor; still, the uncertainty of a single tide doing the required work, and the contingency of an intervening storm or ocean swell preventing the continued action of the succeeding tide, renders the scheme of depending upon the scouring-power of the tide alone, a questionable one, unless accompanied by a prepared pathway for it as far through the beach as practicable, and of such a width as shall at once secure, when opened, a stream of considerable volume.

Apart from the physical importance and effect of opening an inlet through the outer beach, there are difficulties of navigation, which such an inlet, only, would not relieve.

As seen on the map, or sketch, (No. 23,) which Professor Mitchell and myself jointly append to our reports, there is a range of shoal ground bordering the beach and extending from east to west along the entire south front of the bay. Professor Mitchell has stated in his report that this shoal ground has increased within the last fifteen years by the amount of about 1,000,000 cubic yards. This coincides with the popular opinion of the constant accumulation of material upon this ground, which is now so extensive and so shoal that it is difficult for the peculiar class of boats required for the outside fishing and pilotage to cross it; in fact, they cannot do so, except by one or two tortuous and imperfect channels.

If a channel-way through this shoal ground were made in connection with a new inlet through the beach, it would, of course, give great relief to the boating-interests, both for pilotage and fishing. Here, again, the western section of the bay, before alluded to, presents naturally favorable ground for such a channel, by improving what was probably once a natural channel leading to some former inlet.

The question of how much this pilotage and fishing-interest is worth, or what the value of the former may be to the general security of navigation, I will not presume to answer. It is not, however, an unreasonable supposition that within one year from opening an inlet and making such a channel-way a vessel in distress outside may be saved by a pilot reaching her through this channel, and that the value of the vessel and her cargo may be worth as much, or more, than the amount it will cost to make the channel-way. This is apart from the question of the saving or loss of life.

In connection with this view of the harbor-question, and in conclusion of the general subject, I have made some estimates concerning such a channel and inlet as I have named, which I submit for your consideration as suggestive items.

As a basis for the general dimensions and character of a channel and inlet as proposed, I have taken a width about equal to the narrowest section of the natural passage-way between the harbor and bay, which is about 300 feet. This is not wider than desirable for a beating-channel. The depth is regulated by the class of boats in general use, which require about four feet at mean low water.

As before stated, there are, in this part of the bay, the traces of a former channel through this shoal. By following the general course of this old channel, and removing such portions of the shoal as in places now block it up, a passage-way 300 feet wide and 4 feet deep may be obtained by the excavation of about 41,000 cubic yards of the material of the shoal.

A corresponding excavation through the beach, to the level of mean high water only, which is probably all that will be needed to insure a successful inlet, will require the removal of about 14,000 cubic yards of sand.

As the excavation through the beach will be dry digging in common sand, and the dredging through the shoal be in light sand and mud, I have assumed that the whole work will be below the average cost of ordinary dredging. Estimating it at 30 cents per cubic yard, it will cost $16,500. As it may be expensive to bring dredging-machines and other appliances to this rather remote locality, and to guard against contingencies which may interrupt the work, or embarrass its success, and thus cause increased expense, I would suggest as an estimate to cover and insure all the improvements that it may be desirable to make, in connection with the project under consideration, a sum not less than $20,000.

Upon the map before referred to, which accompanies Professor Mitchell's andmy report, I have shown the outlines of the beach and inlets as they have been determined by the several surveys which I have made. These surveys have all been based upon the original triangulation, and referred to the same base-lines, so that the changes shown are absolute. The last survey, although not involving much detail, required considerable time and labor in its execution. The very changes which it was its purpose to determine had caused the loss of all points and land-marks along the outer shore of the island, so that a new series of points, based upon the light-house and spires of Edgartown and the station on Sampson's Hill, had to be extended to the south shore of the island and to Chappaquiddick before the survey could be made.

I had but a small party-organization, and am indebted to Professor Mitchell and Mr. Marindin for many favors and much assistance in the execution of my field-work.

Very respectfully submitted.

HENRY L. WHITING.

Prof. BENJAMIN PEIRCE,
Superintendent of the United States Coast Survey.

APPENDIX No. 18.

IMPROVEMENT ON THE HIPP CHRONOGRAPH, BY WILLIAM EIMBECK.

SAN FRANCISCO, CAL., *October* 4, 1872.

DEAR SIR: I forward to you a letter and drawing of a device by Subassistant Eimbeck for regulating the speed of the Hipp chronograph.

The adjustment of Hipp is crude, very limited in range, uncertain, not adjustable with instrument in motion, and very annoying.

This improvement is ingenious, has a wide range, and admits of adjustment while the chronograph is in motion.

I suggest his description and drawing for an appendix to your report.

I hope to further improve the chronograph by placing springs in the wheel instead of the teeth upon which the governing spring strikes.

Yours, very respectfully,

GEORGE DAVIDSON,
Assistant in the United States Coast Survey.

Prof. BENJAMIN PEIRCE,
Superintendent of the United States Coast Survey.

SAN FRANCISCO, CAL., *September* 21, 1872.

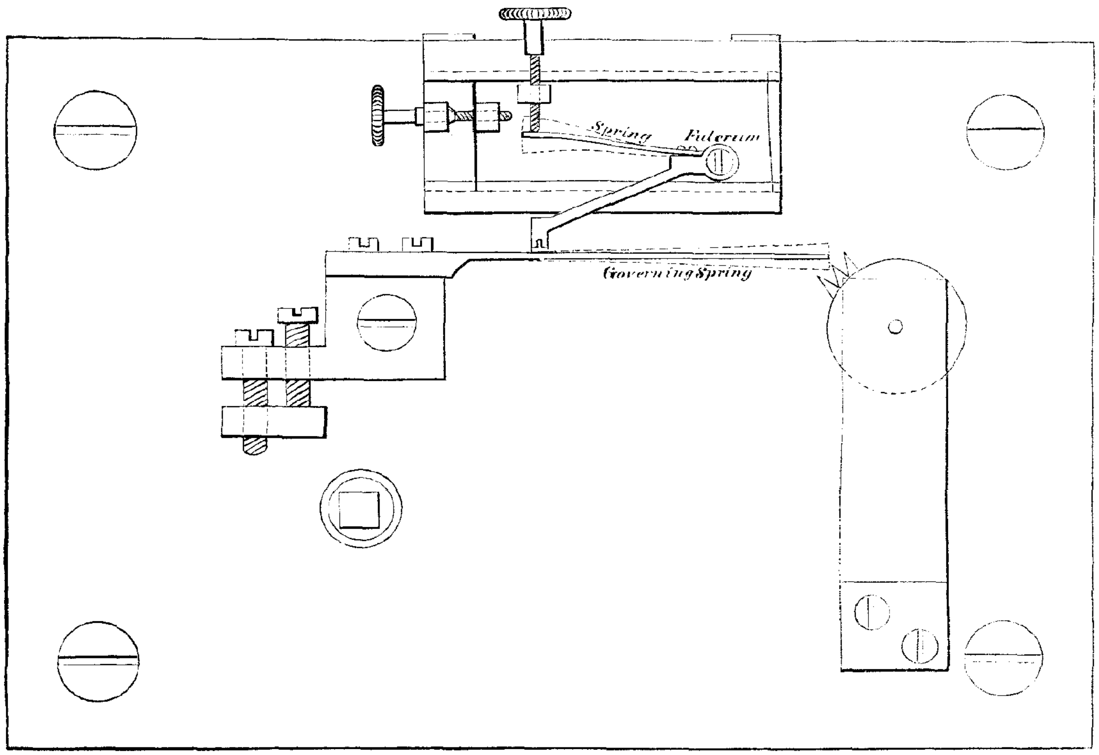
DEAR SIR: Upon experimenting with the Hipp chronograph at the observatory, station Washington Square, San Francisco, and finding that the adjustment for speed by the means provided was attended with much uncertainty, trouble, and sacrifice of time; and, that if upon repeated trials such an adjustment was finally attained, no reliance could be placed upon its constancy, it occurred to me that a better adjustment could be more readily effected if it were practicable to control the period (or number of vibrations per second) of the governing spring.

There are doubtless many contrivances for effecting this object; but of the two I had in mind, the one represented in the accompanying diagram has been thoroughly tried and tested, and seems to answer the intended purpose admirably.

The principle involved is a lengthening or shortening (within certain limits) of the governing spring. By reference to the diagram it will be seen that this shortening or lengthening is produced by pressing upon the governing spring at a point, to be determined experimentally, near its fixed end, causing a flexure or tension something greater than that produced by the vibrations. The pressure upon the governing spring is effected by pressing from one end of a bent lever, of which half is another spring, and the end of a fine screw, with milled head, presses upon the spring-end of this lever. The whole of this lever and appendages are upon a frame movable along the governing spring by another screw. That the period of vibration is thus rendered controllable and adjustable is in a marked degree audibly demonstrated by the varying pitch of the note of this spring ascending or falling as the pressure is increased or decreased.

By varying the position of the pressing point, the period of the governing spring is similarly effected, as by an increase or decrease of the pressure itself, and a desired adjustment may, therefore, thus be likewise effected. But upon trial it is soon found that for a certain amplitude of the governing spring there exists but one point or position at which the note of the spring is rendered clearest, and the gearing runs smoothly and with scarcely any noise.

With this device for adjustment of speed attached, the spring-regulator, as I have called it, may be said to be a very perfect one. Its action is prompt and reliable, and can be readily made without any interference with the motion of the chronograph-gearing. The very disagreeable and disturbing, humming noise produced by the working of the Hipp governor, which has frequently and justly been pointed out as an objection or disadvantage, is likewise greatly diminished, especially for the greater speed, (one and two revolutions of the cylinder per minute,) where the running becomes admirably smooth, and the note of the governing spring clear and audibly distinct.



The inclosed sample-sheets are in a measure illustrative of the speed-controlling power of the device.

No. 1 represents the speed at which the chronograph is usually run, or one revolution per minute.

No. 2 shows two different speeds, one and two revolutions per minute, passing from one into the other and from this again to the first. The pressure upon the governing spring requires increasing for a greater speed, and in this particular case two and one-quarter turns of the milled-head screw are sufficient to perfect the adjustment. The position of this screw once determined and known, any desired speed may be set for at once.

Sheet No. 3 is a double-speed sheet, or two revolutions of the cylinder per minute, used by Professor Davidson in receiving telegraphic signals in longitude-works. It will be observed that all the sheets are continuous, and that the various adjustments were made without the slightest interference with the running of the chronograph.

The slight periodic irregularities in the motion, indicated by the curvature of a line drawn through corresponding second-breaks of each minute, is doubtless due to defect in the wheel-work.

Indeed, the marked accordance existing between the time-length of each wave, as it were, and the time of revolution of the pulley to which the driving-weight is suspended, would seem to indicate that the source of this irregularity of motion lies in this pulley, and is probably due to eccentricity.

I have not had time to investigate this pulley.

The point of pressure upon the governing spring, when once adjusted, should remain perfectly constant. In the experiments so far made, this condition was not wholly fulfilled.

Respectfully submitted by your obedient servant,

WILLIAM EIMBECK,
Subassistant in the United States Coast Survey.

Prof. GEORGE DAVIDSON,
Assistant in the Coast Survey, in charge of Western Coast.

LIST OF SKETCHES.

PROGRESS SKETCHES.

ILLUSTRATIONS.

National Oceanic and Atmospheric Administration

Annual Report of the Superintendent of the Coast Survey

Please Note:

This project currently includes the imaging of the full text of each volume up to the "List of Sketches" (maps) at the end. Future online links, by the National Ocean Service, located on the Historical Map and Chart Project webpage (http://historicals.ncd.noaa.gov/historicals/histmap.asp) will includes these images.

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