NOAA Technical Report NOS CS 43

NOAA'S SOUTHEAST COASTAL OPERATIONAL FORECAST SYSTEM (SECOFS): MODEL DEVELOPMENT AND HINDCAST SKILL ASSESSMENT

Silver Spring, Maryland

October 2026



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U.S. DEPARTMENT OF COMMERCE
National Ocean Service
Coast Survey Development Laboratory

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NOAA'S SOUTHEAST COASTAL OPERATIONAL FORECAST SYSTEM (SECOFS): MODEL DEVELOPMENT AND HINDCAST SKILL ASSESSMENT

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EXECUTIVE SUMMARY

This report describes the model development and hindcast skill assessment for the Southeast Coastal Operational Forecast System (SECOFS). SECOFS was developed by Virginia Institute of Marine Science (VIMS) for NOAA's National Ocean Service (NOS) to provide high-resolution nowcast and forecast guidance of water levels, three-dimensional (3D) currents, water temperature, and salinity for the southeastern U.S. coastal region, including the Southeast Atlantic coast, Florida Shelf, Puerto Rico, and the U.S. Virgin Islands, to support safe marine navigation, coastal resilience planning, and emergency management decision-making. It uses the Semi-implicit Cross-scale Hydroscience Integrated System Model (SCHISM) as its core hydrodynamic model, with an unstructured mesh consisting of approximately 1.7 million nodes and 3.3 million triangular and quadrangular elements. The SECOFS mesh consists of two disjoint domains: the U.S. Southeast Coast domain, with 1,475,939 nodes, and the Puerto Rico and U.S. Virgin Islands domain, with 210,726 nodes. The spatial resolution ranges from less than 1 m in selected rivers and coastal features to approximately 3 km near the open-ocean boundary. SCHISM's flexible LSC2 vertical grid, with the number of vertical layers varying from 62 in the deep ocean to one in shallow waters and averaging 5.5 layers across the model domain, maximizes computational efficiency.

A one-year, 3D hindcast simulation was initialized on December 1, 2017, with the first month used as model spin-up. Tidal elevations and velocities at the open-ocean boundary for eight major constituents (M_2, N_2, K_2, S_2, K_1, O_1, P_1, and Q_1) were derived from TPXOv9, while non-tidal boundary velocities were obtained from HYCOM. Initial and non-tidal boundary elevations were based on AVISO absolute dynamic topography (ADT), with a −30 cm adjustment applied to account for the datum difference between ADT and xGEOID20b, the vertical datum used by SECOFS. Atmospheric forcing was provided by HRRR for the U.S. East Coast and GFS for Puerto Rico and the U.S. Virgin Islands, while hydrologic forcing was incorporated through one-way coupling with the National Water Model (NWM) v3.0.

The Coast Survey Development Laboratory (CSDL) at the Office of Coast Survey in NOS conducted the tidal and hindcast skill assessments using the 2018 simulation produced by VIMS. Tidal skill was evaluated at 316 NOAA CO-OPS stations using harmonic constants derived from the 2018 3D hindcast. For one-year predicted tides, the mean root mean square error (RMSE) was 0.065 m and the mean central frequency (CF) was 91%, with better performance at stations having more than one year of observations. The one-year hindcast assessment evaluated water levels, surface temperature, salinity, and currents using standard NOS skill assessment procedures. The model achieved an average water-level RMSE of 0.126 m, surface-temperature RMSEs of approximately 0.7–2.2°C, and current-speed RMSEs generally ranging from 0.10 to 0.27 m/s, while salinity showed strong performance, particularly in open-water environments. In addition, CSDL developed the vertical datum conversion file for operational use, which provides

transformations between tidal and orthometric datums. Simulations of Hurricanes Florence and Michael by VIMS further demonstrated SECOFS's capability to reproduce the timing and magnitude of peak storm surges under compound flooding conditions. Overall, the assessments demonstrate that SECOFS provides robust and computationally efficient forecast guidance for water levels, temperature, salinity, currents, and storm surge.

Key Words: SECOFS, model development, 3D hindcast, skill assessment, OFS, SCHISM, vertical datums, tidal harmonic analysis, water level, surface current, temperature, salinity, and storm surge

1. INTRODUCTION

NOAA's National Ocean Service (NOS), in collaboration with other NOAA offices, federal partners, academic and research institutions, and the coastal modeling community, has developed and implemented 3D hydrodynamic model-based Operational Forecast Systems (OFS), with safe and efficient marine navigation as the primary mission. These systems provide nowcast and forecast guidance for water levels, currents, salinity and temperature in U.S. ports, harbors, estuaries, coastal waters, and the Great Lakes. In addition to marine navigation, OFS forecast guidance has been used to support many other coastal applications, including oil spill response, harmful algal bloom (HAB) forecasting, search and rescue, emergency response, commercial and recreational fisheries, deep-sea mineral exploration and mining operations, water quality applications, and coastal resource management**.**

Early OFS model developments were primarily carried out by the Coast Survey Development Laboratory (CSDL) within the Office of Coast Survey (OCS) in NOS (Kelly et al., 2001; Gross, 2002; Wei and Chen, 2002; Hess et al., 2003; Zhang et al., 2006; Wei and Zhang, 2011; Wei et al., 2014, 2015; Lanerolle et al., 2011; Schmalz, 2011, 2014; Yang et al., 2019, 2022; Shi et al., 2020). To ensure that these models have been developed and implemented in a scientifically sound and operationally robust way, Hess et al. (2003) established the standards, procedures and skill assessment statistics for the evaluation of nowcast/forecast models. Since the primary user group is the navigational community, and their major concerns are under-keel clearance and maneuvering in port areas, the primary variables to be evaluated are water levels, currents, and salinity and temperature (e.g., water density). In addition to its coastal OFS development efforts, OCS also conducted hindcast skill assessments and disseminated navigation products for Great Lakes OFSs developed by NOAA's Great Lakes Environmental Research Laboratory and its partners (Kelly et al., 2007a, 2007b, 2008, 2010, 2018, 2020, 2022, 2023, 2024).

The early development of OFS was limited by the computational capabilities and operational requirements of the time. Because surface currents are essential for safe marine navigation, OFS requires three-dimensional (3D) hydrodynamic modeling to accurately represent the vertical structure of currents. However, the high computational cost of 3D modeling limited the spatial extent of each system. As a result, early OFSs were developed on a port-by-port basis, with each model covering only a single major port, estuary, or nearby coastal waters. This approach ultimately resulted in a collection of many independent, small OFSs, each with its own model grid, configuration (including specific boundary condition treatment), and operational maintenance requirements. The Office of Coast Survey's Navigation Services Division has emphasized a growing need from the navigation community for seamless forecast guidance across broader coastal regions to support vessels transiting multiple ports and waterways and for effective route planning. As advances in computational resources and numerical modeling made larger-scale simulations feasible, OCS/CSDL initiated parallel consolidation efforts across all three of its

modeling systems: 2D operational storm-surge models, 3D OFSs, and 2D VDatum tide models, transitioning from multiple regional or local models toward larger, more integrated modeling systems. For 2D storm surge modeling, three regional operational storm-surge models were consolidated into a single global system in 2020 (Funakoshi et al., 2025). For 3D OFS, Yang et al. (2022) described the first implementation of the consolidation strategy, integrating three OFSs into a single OFS for the northern Gulf of America. This consolidation improved operational efficiency while expanding spatial coverage.

The Southeast Coastal Operational Forecast System (SECOFS) described in this report is being developed by the Virginia Institute of Marine Science (VIMS) to provide high-resolution, 3D forecast guidance for the entire southeastern U.S. coastal region. SECOFS will also consolidate three small coastal OFSs for Chesapeake Bay (CBOFS), Tampa Bay (TBOFS), and St. John's River (SJROFS) into one system (Zhang et al., 2006; Lanerolle et al., 2011; Wei and Zhang, 2011).

Following the successful implementation of STOFS-3D-Atlantic in 2023 (Cui et al., 2024), SECOFS became the first OFS to adopt the Semi-implicit Cross-scale Hydroscience Integrated System Model (SCHISM) as its core hydrodynamic model (Zhang et al., 2016). In addition, it is the largest coastal OFS developed to date. It not only provides substantially broader spatial coverage than earlier OFSs but also employs an unstructured grid with approximately 1.7 million nodes. This is more than five times the size of other OFSs based on the Finite Volume Community Ocean Model (FVCOM) in operation**,** which typically contain 200k–300k nodes. This unprecedented increase in grid size, made possible by SCHISM, enables seamless forecasting over a large regional domain with the high spatial resolution required for safe and efficient navigation.

This technical report documents the SECOFS model development by the Virginia Institute of Marine Science (VIMS) and presents the results of the tidal and one-year hindcast skill assessments performed jointly by the Coast Survey Development Laboratory and VIMS. Evaluation of the semi-operational nowcast and forecast guidance running on NOAA's Weather and Climate Operational Supercomputing System 2 (WCOSS2) will be conducted by the Center for Operational Oceanographic Products and Services (CO-OPS), and the results will be published in a separate technical report.

2. SYSTEM DEVELOPMENT

2.1 DEM Preparation and Mesh Generation

SCHISM's philosophy in mesh generation and model configuration is explained in Zhang et al. (2024). Most importantly, SCHISM setup seeks to faithfully represent the underlying bathytopo as prescribed by DEMs, without any artificial smoothing or manipulation. As demonstrated by Zhang et al. (2024), this is a first-order problem for coastal modeling, as bathymetry is a major driver in all physical processes of interest. The same principle is applied throughout the entire workflow, from pre- to post-processing; an important implication is that the locations of observation stations need to be very accurate to take full advantage of SCHISM's capability. Zhang et al. (2024) illustrated a rigorous validation process by resolving the details of bathymetry around stations without the need to relocate them to avoid the drying issue. However, as described in Section 4, uncertainties at some CO-OPS stations do exist.

SECOFS mesh development started with a careful compilation of the best available DEMs along the southeast coast. Not surprisingly, no single DEM was found to be best for such a large area and a combination of sources, with prioritization in overlapping areas, was used in the end. For example, Figure 1 illustrates some issues found with BlueTopo in Charleston Harbor. The highest priority was given to the latest BlueTopo, followed by CUDEM, CRM and GEBCO. Since DEM information is highly questionable in some stretches of upstream rivers, we had to supplement the standard DEMs with NOAA navigation charts in some areas, including the upstream Wando River (Figure 1a), upstream Cooper River, upstream Savannah River, and the eastern shore of Virginia near Wachapreague.

Inspired by SCHISM's robustness (to skew elements) and efficiency, multiple semi- or fully automatic mesh generators have been implemented in the past few years (Ye et al., 2023; Cassalho et al., 2026a). These tools are entirely DEM-driven and are able to very faithfully capture key features, such as narrow rivers and coastal defense (e.g., levees and jetties), using locally very high resolution (Figure 2). For SECOFS mesh development, we used RiverMapper to automatically generate polygons and arcs for watershed rivers, which are then combined with other polygons and arcs manually made for other regions (coastal ocean and major estuaries) (Figure 2). The delineation of watershed rivers by RiverMapper using DEMs and NHDplus also provided a major advantage in that the same thalweg information can be conveniently used in coupling with NWM: the intersections between SCHISM's land boundary and NWM hydrofabric were computed using the thalweg information. The fine resolution of rivers enabled by RiverMapper ensured freshwater delivery from upstream to downstream regardless of how narrow the river stretches are (Figure 3).

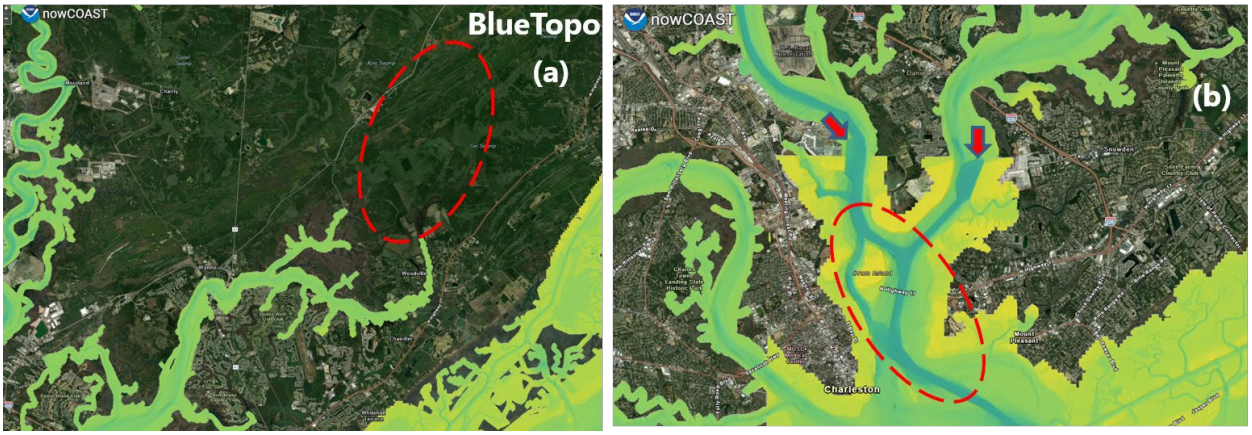


Figure 1. (a) Missing upstream Wando River in BlueTopo (dashed circle). (b) Some abrupt changes in channel bathymetry (indicated by arrows) in BlueTopo near Charleston Harbor.

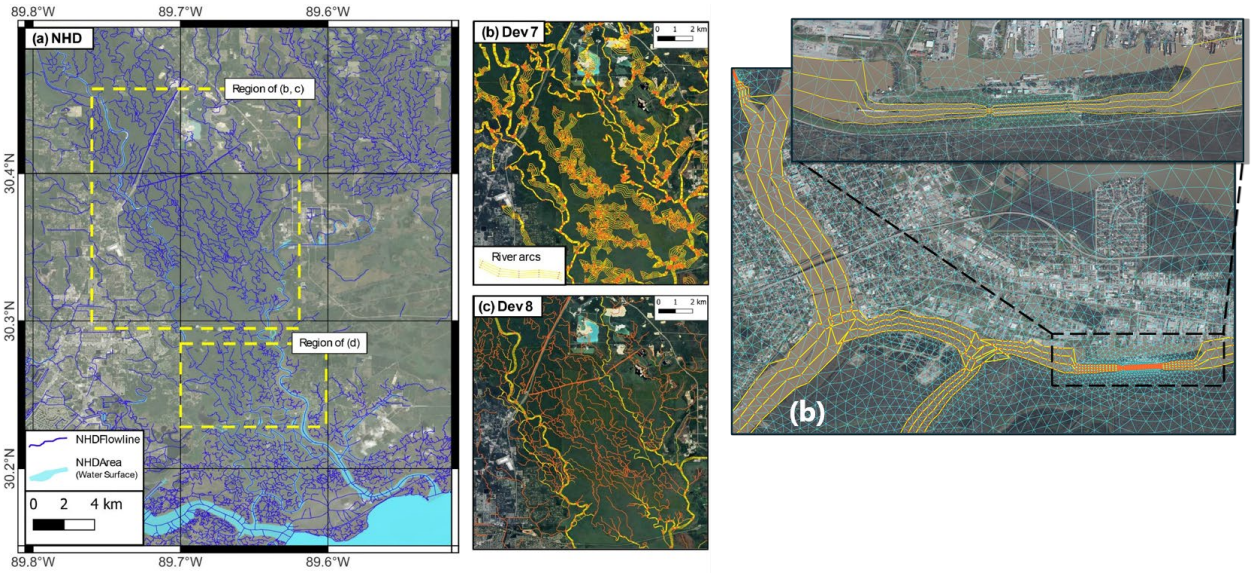


Figure 2. Automatic mesh generation in watershed rivers with RiverMapper. (a) Thalwegs extracted from NHDplus and from DEMs; (b) Polygons and arcs (orange lines) created by RiverMapper for watershed rivers and the resultant mesh.

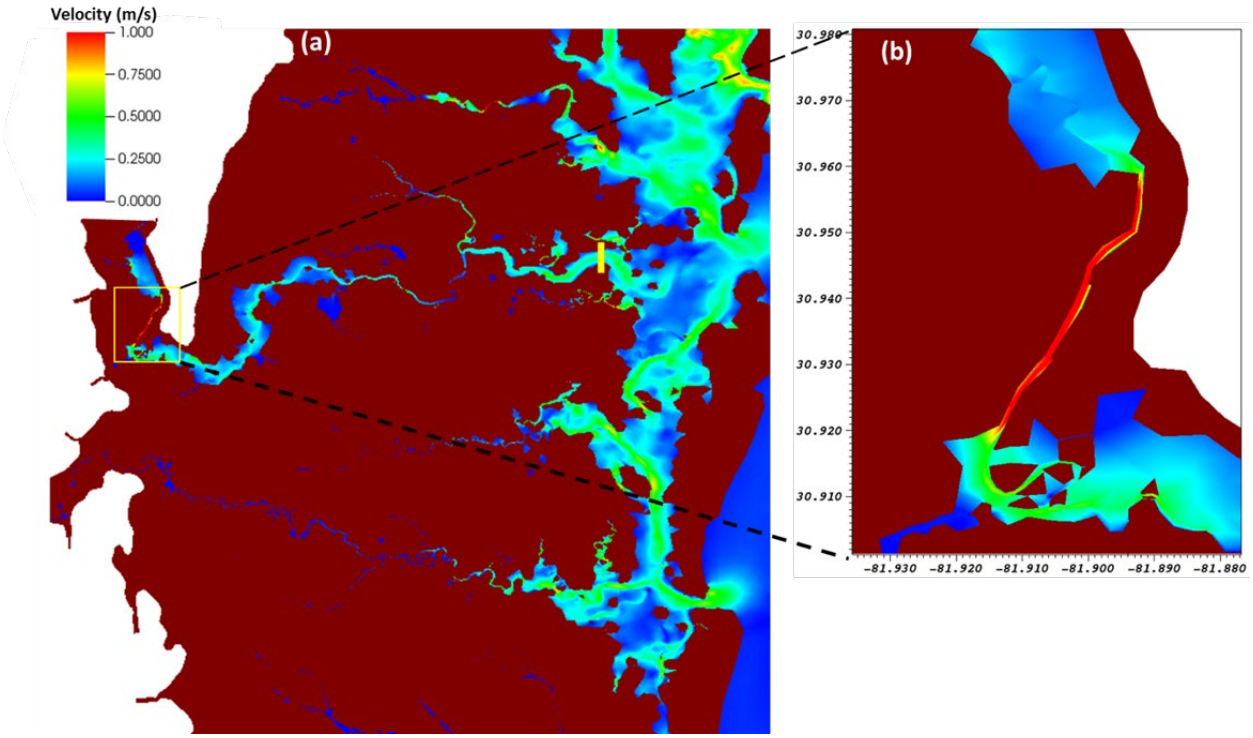


Figure 3. River routing in watershed enabled by the mesh (burgundy areas are dry).

The mesh generation process is so flexible that we were able to easily accommodate user feedback. We worked very closely with OCS navigation managers (N. Alvarado et al., personal communication, 2024) as well CariCOOS users (c/o SECOORA) throughout the process. Figure 4 illustrates how we directly incorporated navigation manager's shapefiles and requested resolution in the Caribbean Sea into the mesh generator to produce a mesh that satisfied the requests.

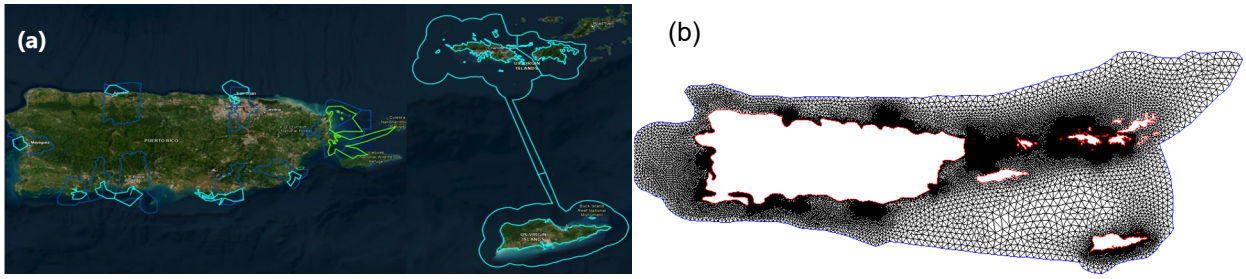
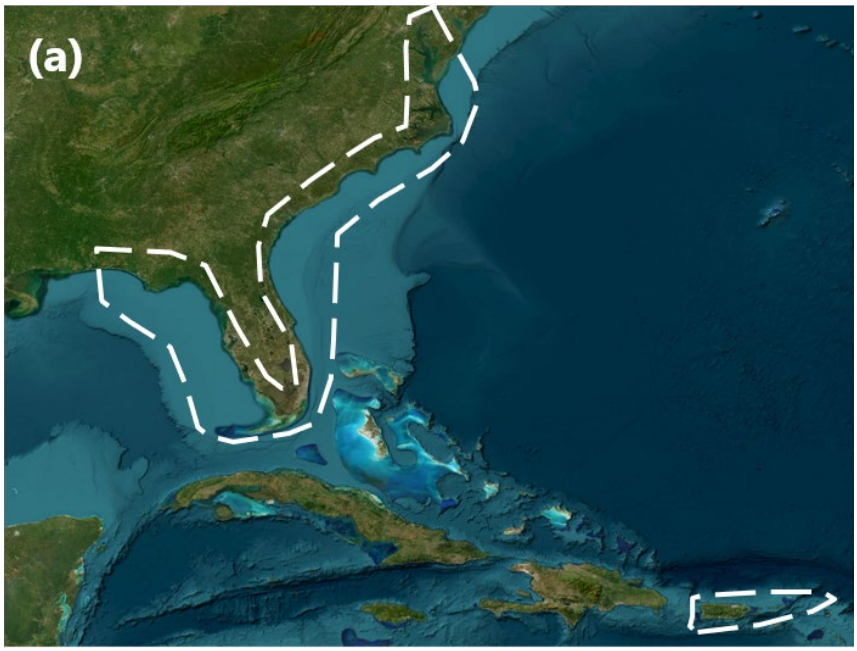
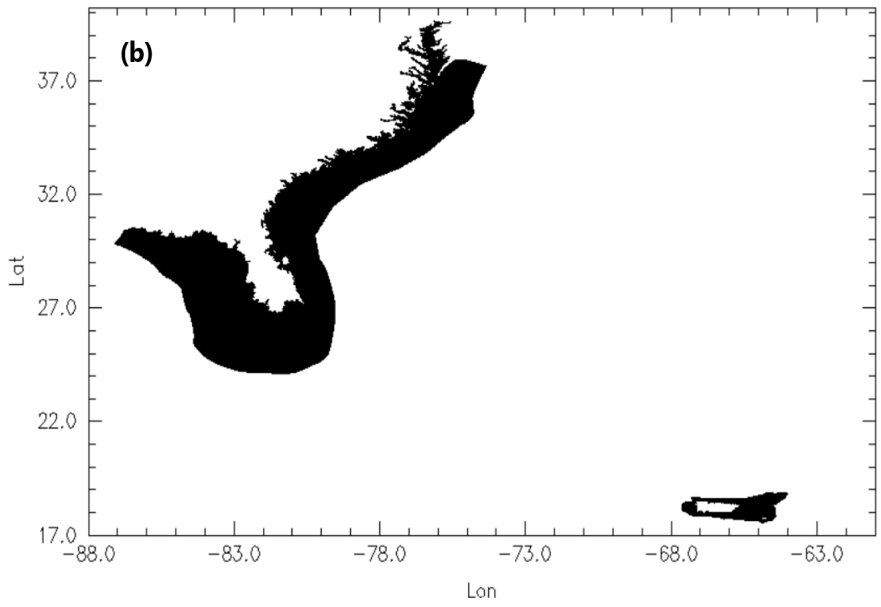
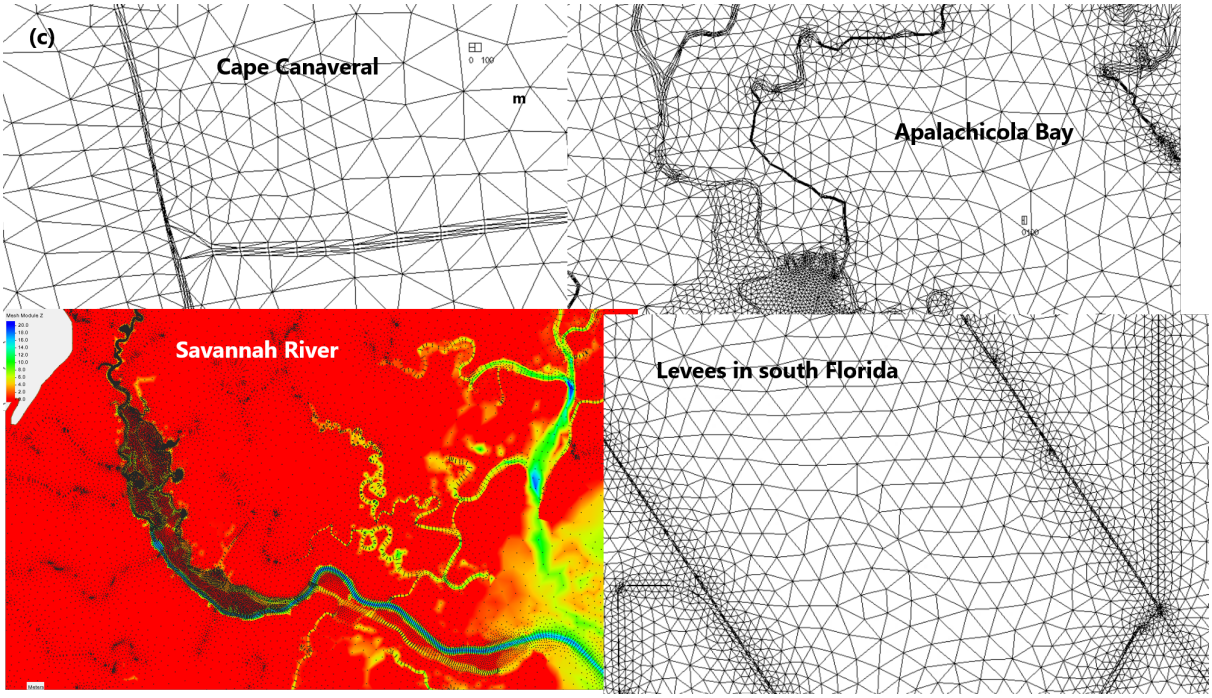


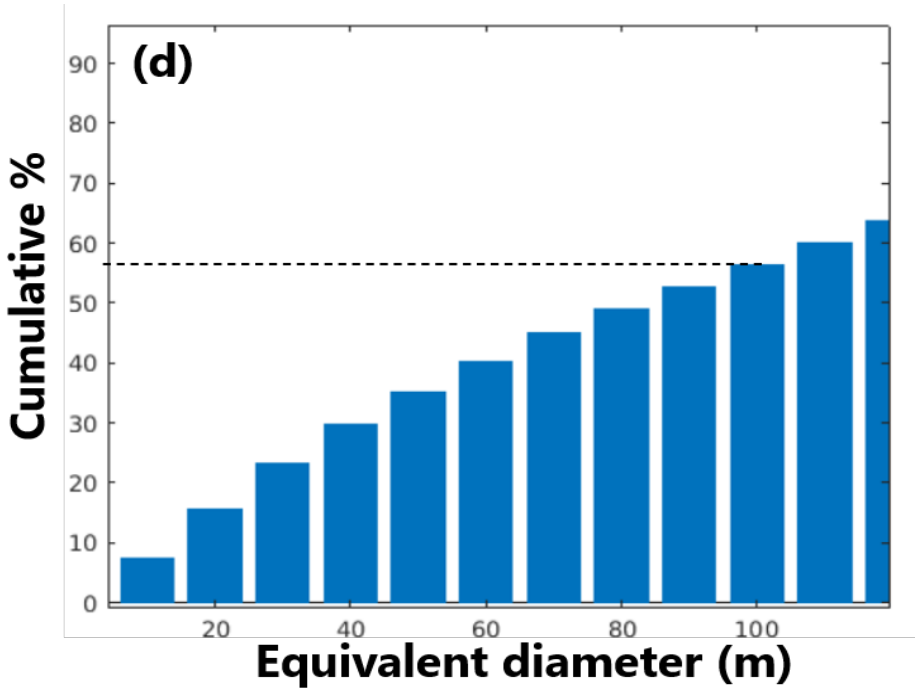
Figure 4. (a) Shapefiles from OCS navigation manager (N. Alvarado); (b) resultant mesh that incorporates the shapefiles and requested resolution literally.

The SECOFS mesh generated is shown in Figure 5 and consists of two disjoint parts: one for the southeast coast and the other for Puerto Rico and Virgin Islands. SCHISM is able to handle this type of disjoint meshes. Altogether, the mesh has 1,686,665 nodes, 3,313,754 triangular and 11,301 quadrangular elements. Resolution in sample regions is shown in Figure 5c, including some highly resolved rivers and levees. Using equivalent diameter (of the circle that has the same area as the original element) as a measure for resolution, about 57% of the elements have resolution finer than 100 m (Figure 5d). The coarsest resolution of 3 km is found near the ocean boundary, and the finest element has a resolution slightly below 1 m. After the mesh is generated, the DEMs are linearly interpolated onto the mesh without any further manipulation.






(c)
Cape Canaveral
m
Apalachicola Bay
Savannah River
Levees in south Florida


(d)
Cumulative %
0
10
20
30
40
50
60
70
80
90
20
40
60
80
100
Equivalent diameter (m)

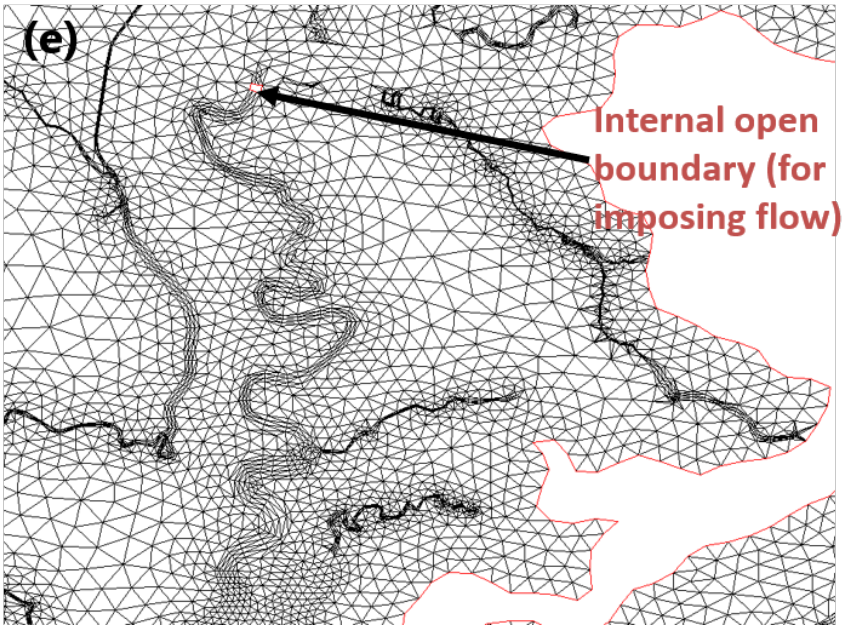


Figure 5. SECOFS (a) domain extent and (b) mesh; (c) zoom-ins of the mesh in different regions, showing ultra-fine resolution (down to ~1m) in watershed and narrow rivers. Cross-channel resolution in major rivers (e.g., Savannah River) is ensured using at least 4 quadrangular cells across the channels. (d) Cumulative histogram of mesh resolution expressed as equivalent diameter of each cell. (e) Internal open boundary used to impose observed flow at a USGS gauge.

2.2 Model Setup

After the horizontal mesh is generated, SCHISM's flexible LSC2 vertical grid is created to maximize efficiency (Figure 6). The number of layers varies from 62 in the deep ocean to 1 in the shallow waters (Figure 6) and the average is only 5.5 layers, resulting in greater efficiency.

Hindcast simulation was conducted for 2018, starting from Dec 1, 2017, with the 1st month used as the spin-up and excluded in analysis. Tidal elevation and velocity at the ocean boundary for 8 major constituents (M_2, N_2, K_2, S_2, K_1, O_1, P_1, and Q_1) were derived from TPXOv9, and the non-tidal velocity boundary condition is from HYCOM. The initial and non-tidal elevation boundary conditions were based on AVISO ADT observation, adjusted by -30 cm to account for the datum difference between ADT and xGEOID20b, which was the vertical datum used in SECOFS (Cui et al., 2023). Atmospheric forcing was provided by HRRR for the U.S. East Coast (https://rapidrefresh.noaa.gov/hrrr/) and by GFS for PR/USVI, where HRRR is not available (https://www.emc.ncep.noaa.gov/emc/pages/numerical_forecast_systems/gfs.php).

The model uses a non-split time step of 120 sec, achieving speeds ~120 times faster than real time on 2,800 cores of NOAA RDHPC (Hercules). The bottom roughness is mostly based on calibration, assuming a piecewise-linear variation as a function of depth: 1 mm at 15 m depth to

1cm at -3 m; in addition, specific adjustments in some estuaries (e.g., Chesapeake Bay) were made in the calibration process (Figure 7). A combination of bi-harmonic and Smagorinsky horizontal viscosity is used to stabilize the momentum equation. A 3rd-order WENO transport solver (Ye et al., 2019) is used for tracer transport but transitions to upwind in shallow waters (<6m depth) in order to take care of the small numerical dispersion in WENO. In the watershed where strong wetting and drying occur frequently and the mesh resolution is fine, even the (explicit) upwind becomes inefficient; therefore we use the unconditionally stable Eulerian-Lagrangian transport when the transport time step becomes smaller than 8 seconds.

Coupling with hydrology is done using NWM v3.0. We use a simple one-way forcing approach here; because SECOFS land boundary is located at 10m above MSL, the backwater effect is expected to be minimal (Ye et al., 2021). The use of RiverMapper in mesh generation greatly facilitates the coupling procedure, in that the thalweg information can be effectively used to find the intersections between NWM's hydrofabric and SECOFS land boundary (Figure 8). NWM flows at the intersections are then used to inject the inflow via SCHISM's source/sink approach. Direct precipitation onto our mesh is accounted for using SCHISM as a rainfall runoff router.

To maximize model skill for hindcast simulations, we replaced NWM predicted flow with observed flow at a few USGS gauges in St. Johns River, Savannah River, and Charleston Harbor. To more precisely impose inflow at the gauges, we employed an 'internal open boundary' approach: small 'islands' were created near the gauges with in/outflow imposed at two opposing faces (Figure 5e). This approach was found necessary for the salt intrusion study. For forecast simulations, either persisted USGS observations or NWM predictions can be used at those open boundaries.

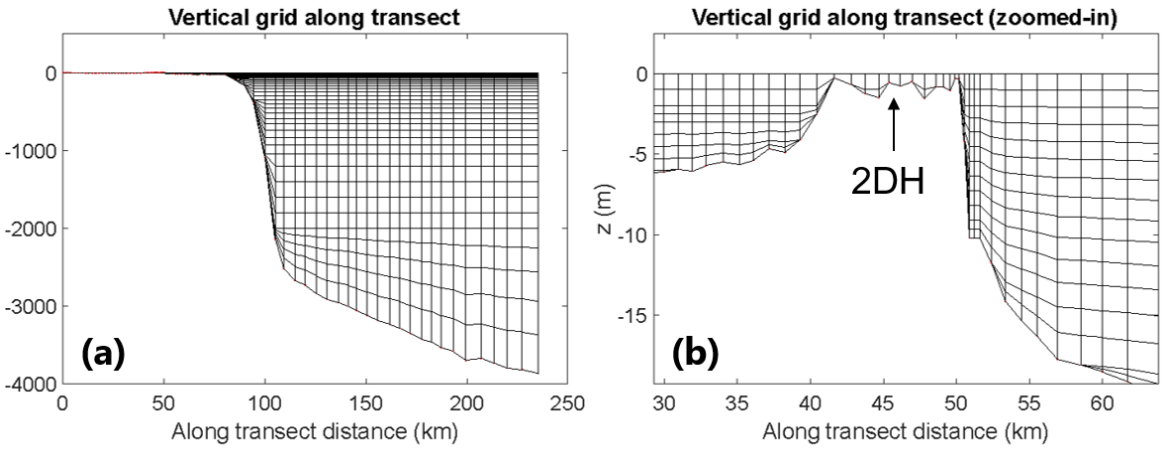


Figure 6. Vertical grid along two transects illustrating SCHISM's flexible LSC^2 configuration: (a) from deep ocean into flood plain; (b) across barrier island in North Carolina, including locally depth-averaged mode (2DH).

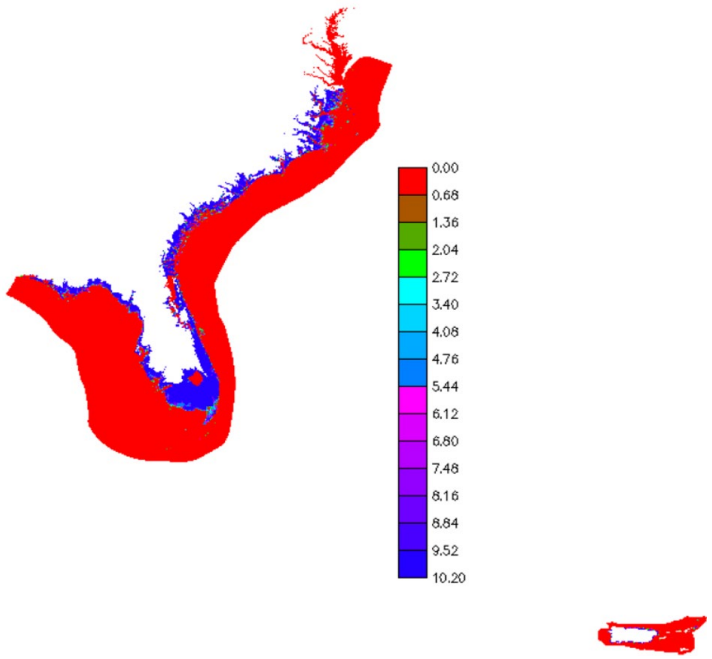


Figure 7. Bottom roughness in millimeters.

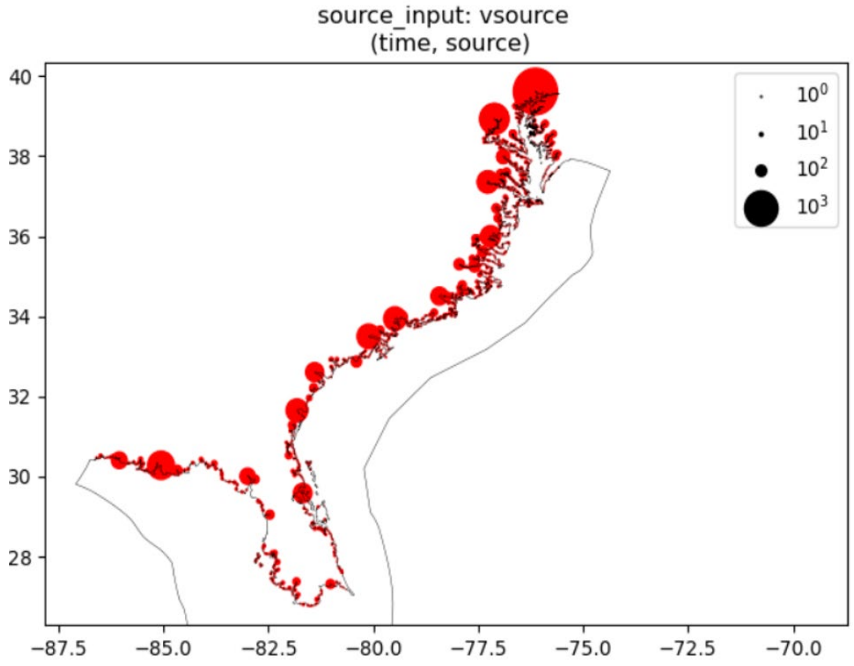


Figure 8. NWM injection locations, where the NWM flow is injected into SECOFS mesh. The circle sizes indicate mean flow (in 2018) along the east coast. For this version of SECOFS, we have not included PRVI rivers as the latter were not available a few years ago. We will add those missing rivers in the next upgrade.

3. VDATUM DEVELOPMENT

This section describes the process used to prepare the VDatum conversion file for SECOFS real-time operation. The conversion file provides vertical transformations in two main categories: tidal datums and orthometric datums. These two datum categories are linked through Local Mean Sea Level (LMSL); therefore, the following eight datum transformations in the file are all referenced to LMSL:

Tidal datums: Mean Higher High Water (MHHW), Mean High Water (MHW), Mean Low Water (MLW), and Mean Lower Low Water (MLLW).

Orthometric datums: xGEOID20b, North American Vertical Datum of 1988 (NAVD 88), Puerto Rico Vertical Datum of 2002 (PRVD02), and Virgin Islands Vertical Datum of 2009 (VIVD09). As discussed in Section 3.2, in areas where issues were identified in xGEOID20b, GEOID2022 was substituted to improve the accuracy of the topography of sea surface (TSS).

3.1 Introduction

Model-produced water level forecast guidance must be transformed from the model reference datum to the appropriate application-specific tidal datums to meet end-user requirements. This transformation enables users to correctly reference elevations on land and depths in water for coastal decision making. Different applications require different vertical datums. The following sections describe the datums included in the VDatum conversion file and their applications.

3.1.1 Marine Navigation Needs

NOAA serves as the nation's primary provider of the foundational data and services that enable vessels, particularly large commercial ships, to navigate safely and efficiently through U.S. ports and waterways. The Precision Marine Navigation Program of NOAA's National Ocean Service, Office of Coast Survey, integrates high-resolution, real-time forecast data into next-generation navigational systems (https://marinenavigation.noaa.gov/). The goal is to make these resources easily accessible and interoperable through internationally recognized navigation standards, such as the International Hydrographic Organization (IHO) S-100 framework, to ensure that navigation products are complementary and work together.

The United States is one of the most active members of the International Hydrographic Organization (IHO), driving modernization and capacity building. OCS provides the primary technical leadership behind the development and implementation of the S-100 framework as the new digital standard for marine navigation. The Precision Marine Navigation program is the practical U.S. implementation of these international standards. Note that navigation software cannot directly use raw model output because the output does not conform to S-100 navigation

standards. OCS has been instrumental in finalizing operational editions of the following navigational products, ensuring these layers can work together in navigational systems:

- S-101 NOAA's Electronic Navigational Charts (ENCs)
- S-102 High-Resolution Bathymetry Data
- S-104 Water Level Forecast Guidance
- S-111 Surface Currents Forecast Guidance

Mean Lower Low Water (MLLW) is the standard datum used for three navigational products in tidally dominated regions of the U.S.: S-101 ENCs, S-102 Bathymetry Data, and S-104 Water Level Forecast Guidance. MLLW is defined as the average of the lower of the two (or one) daily low waters over a 19-year National Tidal Datum Epoch. Referencing water level forecast guidance to MLLW provides mariners with water levels relative to the charted depths, to estimate of under-keel clearance and support safe navigation.

It is important to note that water level forecast guidance provides only partial information for under-keel clearance assessments. Accurate, up-to-date, high-resolution bathymetric data are also needed to compute the total available water depth. Similarly, forecast guidance for surface water currents alone is insufficient for voyage and route planning; accurate bathymetric information and other environmental data are also required to optimize navigational efficiency and ensure maritime safety.

User feedback has consistently highlighted the need for integrated, all-in-one dissemination platforms that provide seamless and easy access to forecast guidance, environmental information, and marine safety products. For example, displaying surface current nowcasts and forecasts on top of the high-resolution bathymetry, enables mariners to make more informed operational decisions, improving both navigational safety and efficiency.

In addition, NOAA's Air Gap system (which measures bridge clearance) typically references the MHW (or MHHW) tidal datum. This provides mariners with the minimum vertical clearance available during high tides, ensuring vessels can pass safely even when the water is at its highest. Since Air Gap sensors measure the space between the water and the lowest steel of a bridge, referencing MHW ensures a safe "worst-case scenario" measurement during normal daily tides.

3.1.2 Coastal Resilience Needs

Mean Higher High Water (MHHW) is a widely used reference tidal datum for coastal flooding and inundation applications. MHHW is defined as the average of the higher of the two daily high waters over the 19-year National Tidal Datum Epoch. Referencing water level forecasts to MHHW enables users to assess the likelihood and severity of coastal flooding by comparing forecast water levels with established flood thresholds and local topography. This information supports flood

forecasting, emergency management, infrastructure planning, and coastal resilience by providing a consistent vertical reference for evaluating inundation risk.

3.1.3 Hydrodynamic Modeling Needs

In 3D hydrodynamic modeling, all model inputs and outputs must be consistently referenced to appropriate vertical datums:

Input: Subtidal water levels input at the open boundary, bathymetry, and topography must all be referenced to a common vertical geopotential datum to ensure consistency.

Output: Modeled water level output subsequently needs to transform to application-specific tidal datums. This conversion involves a two-step process. First, the model output is transformed from the model's reference geopotential datum to Local Mean Sea Level (LMSL). Second, the LMSL-referenced water levels are converted to the desired tidal datum (e.g., MLLW or MHHW).

For hydrodynamic modeling, Model Zero (MZ) is the zero elevation of the model's vertical (z) coordinate under static water conditions. It is a model defined equipotential surface that represents the undisturbed ocean surface. The geoid is an equipotential surface of the Earth's gravity field that best fits global mean sea level in a least squares sense. When the water depth is referenced to a geoid model, we align the model zero to a geopotential datum. That is to say, modeled water surface elevation references this geopotential datum. All of the bathymetry, topography, boundary subtidal elevation input to the model should also be referenced to this common datum.

Local Mean Sea Level (LMSL) represents the long-term average water surface under dynamic ocean conditions. Note that LMSL is distinct from both the model zero (MZ) and the geoid because it includes the effects of tides, currents, winds, river inflows, and other oceanographic processes. VDatum defines the difference between the two, the height of the NGS' geoid model relative to Local Mean Sea Level (LMSL) as the Topography of Sea Surface (TSS). This orthometric datum serves as the bridge between the input geoid reference and the output tidal datums.

3.1.4 VDatum Software

The VDatum (Vertical Datum Transformation) software tools (available https://vdatum.noaa.gov/) are developed by NOAA's National Ocean Service (NOS) through the collaborative efforts of its tri-office team, consisting of the National Geodetic Survey (NGS), the Office of Coast Survey (OCS), and the Center for Operational Oceanographic Products and Services (CO-OPS).

VDatum software enables the transformation among tidal, orthometric, and ellipsoidal datums, allowing elevation data from different sources to be referenced within a common vertical framework. By providing consistent vertical referencing, VDatum facilitates the integration of bathymetric, topographic, hydrographic, and coastal datasets that would otherwise be difficult to

combine because they are referenced to different vertical datums. This capability supports a wide range of NOAA mission and coastal applications, including nautical charting, hydrographic surveying, coastal inundation and storm surge modeling, sea level rise assessments, shoreline mapping, habitat management, and coastal resilience planning.

In coastal regions, VDatum uses hydrodynamic tidal models developed by the Coast Survey Development Laboratory (CSDL) in the Office of Coast Survey to compute tidal datums. The modeled tidal datums are subsequently assimilated with observations using variational data assimilation (Shi and Myers, 2016; Tang et al., 2018). This approach ensures consistency with CO-OPS' published tidal datums while providing accurate vertical transformations throughout U.S. coastal waters. The target accuracy is less than 1 cm error at each station and the target spatially varying uncertainty is less than 10 cm. The Topography of the Sea Surface (TSS), defined as the elevation of the geoid relative to Local Mean Sea Level (LMSL), was computed by interpolating data from CO-OPS tide gauges and satellite altimetry. The final TSS field was generated on the VDatum structured marine grids by NGS using a minimum-curvature interpolation algorithm.

One challenge is that U.S. East Coast, Gulf of America, Caribbeans are currently covered by 9 small coastal VDatum models developed over near 20 years (Spargo et al., 2008; Yang et al., 2012; Hess et al., 2013, 2016; White et al., 2016; Tang et al., 2018; Tolkova et al., 2023; Tang et al., 2026). The topography of sea surface used different GEOID models available at the time of development. This complicates datum transformations across boundaries of different VDatum tide models. It is important to understand that the transformation roadmap differs between the old and recent updated VDatum models in order to use VDatum software (https://vdatum.noaa.gov/docs/userguide.html).

Several VDatum coastal models, including those for the Chesapeake/Delaware Bay and Puerto Rico/U.S. Virgin Islands, have been updated in recent years (Tolkova et al., 2023; Tang et al., 2026). Within these updated regions, when transforming to or from Local Mean Sea Level (LMSL) or tidal datums, VDatum software automatically changes the horizontal reference frame to International GNSS Service 2014 (IGS14). This occurs because the VDatum transformation roadmap traverses through the IGS14 reference frame, applies the xGEOID20b geoid model (Wang et al., 2022), transforms to LMSL with the Topography of the Sea Surface (TSS), and then to the desired tidal datum. The use of xGEOID models was intended to facilitate the future transition to the modernized National Spatial Reference System (NSRS).

The older VDatum coastal models on the East Coast traverse through the North American Datum of 1983 (NAD 83) and then to NAVD88 utilizing a NGS Hybrid GEOID. Note Southeast Alaska uses IGS08 and then utilizes xGEOID17b.

The current VDatum software requires users to partition input points into separate regions before processing when different regions are either associated with different VDatum tidal models or

different GEOID models. This preprocessing step is cumbersome and reduces efficiency, particularly for large model grids on the U.S. East Coast like SECOFS. The VDatum modeling team is fully aware of this limitation and is currently developing a unified East Coast VDatum model that will consolidate the existing nine small coast models into a single model. Once implemented, this unified model will eliminate the need for regional partitioning and significantly streamline the VDatum processing. A similar consolidation was completed for the West Coast in 2021, when several coastal models were merged into a single unified West Coast VDatum model (Tang et al., 2025).

3.2 Workflow for Preparation of the VDatum Conversion File

A workflow was developed to generate the VDatum conversion file for SECOFS. The procedure is listed in Table 1. The SECOFS model domain spans several VDatum models developed over approximately 15 years. Because these VDatum models were created at different times, their Topography of Sea Surface (TSS) products are referenced to different NGS geoid models available at the time of development. Specifically, the Chesapeake/Delaware Bays and Puerto Rico/U.S. Virgin Islands VDatum models use xGEOID20b, whereas the remaining use NAVD88-based transformations derived from earlier geoid models.

To accommodate these differences, the SECOFS mesh nodes were partitioned by VDatum model regions prior to processing, as the VDatum software cannot perform transformations across multiple geoid models in a single run. Nodes located outside the VDatum coverage also need to be separated and processed in the later extrapolation step, because, under certain circumstances, they may cause the software to stop working.

Each group of nodes was processed independently through VDatum to generate the following vertical datum transformations one by one:

- Two orthometric datums: NAVD88-to-LMSL and xGEOID20b-to-LMSL,
- Four tidal datums: MHHW-to-LMSL, MHW-to-LMSL, MLW-to-LMSL and MLLW-to-LMSL.
- Two local orthometric datums for the Puerto Rico and U.S. Virgin Islands region: PRVD2002-to-LMSL and VIVD2009-to-LMSL

Note that for the Puerto Rico/U.S. Virgin Islands region, NAVD88 is not defined. The local orthometric datums, PRVD2002 and VIVD2009, were used instead.

Next, we use the transformation between NAVD88 and xGEOID20b over the entire SECOFS grid to compute the value for nodes not available from VDatum software directly.

- For nodes in the Chesapeake/Delaware Bay, we compute NAVD88-to-LMSL as

NAVD88-to-LMSL = NAVD88-to-xGEOID20b + xGEOID20b-to-LMSL

- For nodes in other VDatum models, we compute xGEOID20b-to-LMSL as:
  xGEOID20b-to-LMSL = NAVD88-to-LMSL - NAVD88-to-xGEOID20b

The two datasets, obtained from above computation and from the VDatum software respectively, were merged for each datum. An offset of approximately 10 cm was observed along the boundary between the two datasets in both the xGEOID20b-to-LMSL and NAVD88-to-LMSL transformations. To minimize boundary discontinuities, nodes within the transition zone were then not used as the input, to create a buffer zone between the two datasets.

For the tidal datum transformations, results from the ongoing Atlantic VDatum model were available for the northern half of the domain, from Maine to Chesapeake Bay (E. Tolkova, personal communication, 2026). These updated tidal transformations were used to replace the corresponding four tidal datum fields (MHHW, MHW, MLW, and MLLW) where available. In addition, the existing VDatum regional models (FL_SAB_01, NEGOM, and PRVI) were incorporated to provide coverage for the remaining portions of the SECOFS domain wherever applicable.

The next step is to use the Shallow Water Equations (SWE) interpolation in Shi et al. (2013) to extend the vertical datums to mesh nodes without assigned values. New, additional tide station data has become available since the original VDatum models were developed. These new observations were incorporated into the interpolation. A buffer zone around each observation was created as necessary. Thus, the input to SWE includes both the transformed nodes and observations. Table 2 shows the number of stations with observations for use in the SWE interpolation. A total of 8 SWE interpolations were performed for the 8 datums respectively.

Finally, quality assurance was performed for each vertical datum transformation by comparing the computed values with the complete set of NOAA CO-OPS tide station observations, ensuring consistency and accuracy.

Figure 9 shows the datum variables included in the VDatum file for SECOFS. Black indicates that the datum is unavailable and a non-value of -99999.9 is assigned. A zero value for the tidal datums indicates that the node is located within a non-tidal polygon. The non-tidal polygons were estimated by CO-OPS where periodic tidal signals are present and consistent but the mean tidal range (defined as MHW- MLW) is less than 0.09 m and negligible. VDatum software sets tidal datums in the non-tidal polygons as 0. The TSS on the SECOFS offshore boundary increases from near zero in the south to about 0.5 m offshore Chesapeake Bay to the north (Figure 9, panel 1)

During the SECOFS hindcast water level skill assessment, vertical datum offset issues were identified with the TSS derived using xGEOID20b in the U.S. Virgin Islands. We have checked with the latest gravimetric geoid model GEOID2022. GEOID2022 serves as the zero surface for

orthometric heights in the North American-Pacific Geopotential Datum of 2022 (NAPGD2022), the National Geodetic Survey's (NGS) next-generation geopotential reference system. GEOID2022 was developed using terrestrial gravity data, GRAV-D airborne gravity, the latest satellite gravity model, and satellite altimetry data. It has an estimated accuracy of 1-2 cm in flat areas and 2-3 cm in mountains (https://geodesy.noaa.gov/web/science_edu/webinar_series/progress-of-geoid-2022.shtml). The GEOID2022-based TSS products are currently under development first for the Alaska VDatum model and are not yet available in the VDatum software. However, CO-OPS has computed GEOID2022-based TSS at all tide stations, providing the basis for evaluation (N. Murry, personal communication, 2026).

Further investigation revealed that there are 10–15 cm differences between xGEOID20b and GEOID2022 derived TSS. Figure 10a displays the difference in TSS (dTSS) computed by these two geoid models at 467 tide stations:

$$dTSS = TSS_{GEOID2022} - TSS_{xGEOID20b}$$

Figure 10b shows the distribution of station counts by dTSS. 302 of the stations have less than 2 cm difference. There are 39 stations with |dTSS| > 5cm which are plotted as circles in Figure 10a. The 10 stations with |dTSS| > 10cm are plotted as larger circles in Figure 10a. To address the issues, the TSS for the Puerto Rico/U.S. Virgin Islands region was recomputed using GEOID2022.

We noted that there are two stations with |dTSS|> 10 cm and five with |dTSS|> 5cm in Chesapeake Bay. Because there is sufficient observational coverage within the bay, the TSS for Chesapeake Bay was also recomputed using GEOID2022. The Shallow Water Equations (SWE) interpolation was then rerun to regenerate the TSS field and produce the revised VDatum conversion file. Figure 9 reflects the revised VDatum conversion file for SECOFS.

Table 1. Vertical Datum transformation processing flow for SECOFS.

<table>
<tr><th>Steps</th><th colspan="3">Procedure</th></tr>
<tr><td>Grid segmentation</td><td colspan="3">Separate SECOFS nodes into four VDatum model groups using bounding polygons from VDatum software directories</td></tr>
<tr><td rowspan="4">VDatum software conversions</td><td colspan="3">Process group by group through corresponding VDatum regions to obtain available datum transformations</td></tr>
<tr><td colspan="2">Orthometric datums</td><td>Tidal datums</td></tr>
<tr><td>Ches-Del ,PRVI regions</td><td>Other regions</td><td rowspan="3">MHHW-to-LMSL
MHW-to-LMSL
MLW-to-LMSL
MLLW-to-LMSL</td></tr>
<tr><td>xGEOID20b-to-LMSL
PRVD2002-to-LMSL
VIVD2009-to-LMSL</td><td>NAVD88-to-LMSL</td></tr>
<tr><td colspan="2">NAVD88-to-xGEOID20b over the entire domain</td></tr>
<tr><td>Datums computation or updates (tidal)</td><td>NAVD88-to-LMSL</td><td>xGEOID20b-to-LMSL</td><td>Update from recent VDatum models if applicable</td></tr>
<tr><td>Merging nodes</td><td colspan="2">xGEOID20b _LMSL, NAVD88_LMSL</td><td></td></tr>
<tr><td>Observations</td><td colspan="3">Preprocess observations at tide stations for SWE interpolation; replace xGEOID20b TSS with GEOID2022 for tide stations in Ches-Del Bays, PRVI regions.</td></tr>
<tr><td>Shallow Water Equations Interpolation</td><td colspan="3">Extrapolate over the whole SECOFS domain for each of the 8 datums.</td></tr>
<tr><td>Output</td><td colspan="3">Write 9 variables to netCDF file; re-compute NAVD88-to-xGEOID20b</td></tr>
<tr><td>Quality check</td><td colspan="3">Compare the results with observations at tide stations</td></tr>
</table>

Table 2. Number of tide stations with observed datums (referenced to LMSL).

Datums	xGEOID20b	NAVD88	PRVD2002	VIVD2009	4 Tidal Datums	**All**	GEOID2022
Counts	502	376	19	17	939	953	512

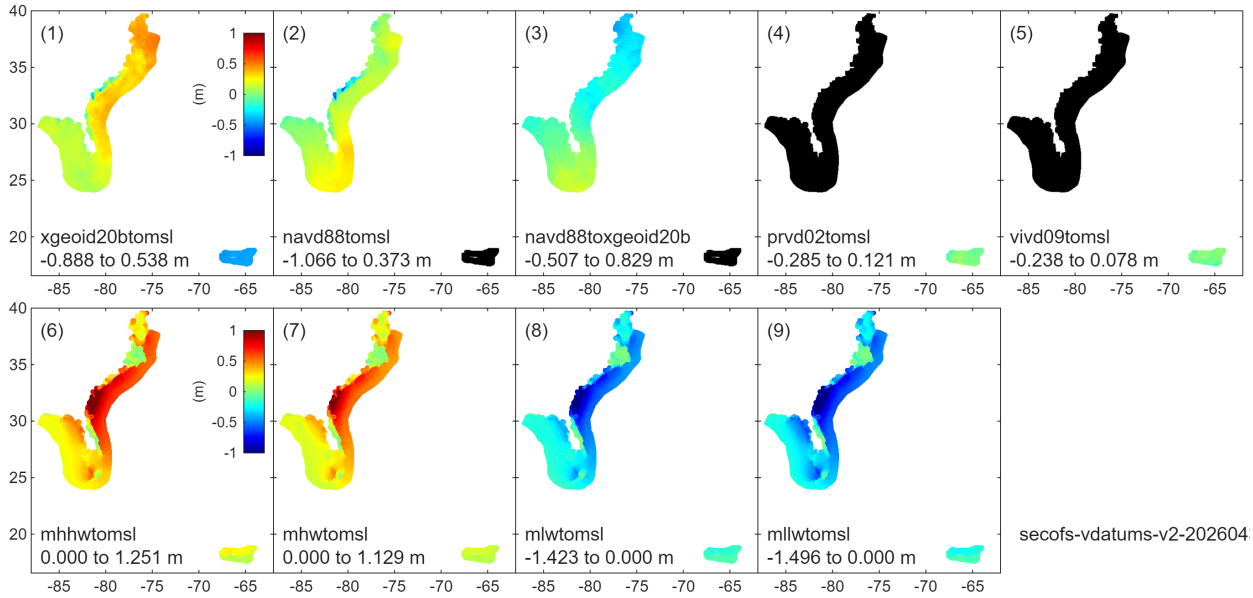


Figure 9. Transformations in the VDatum conversion file for SECOFS. Top row, orthometric datums; bottom row, tidal datums.

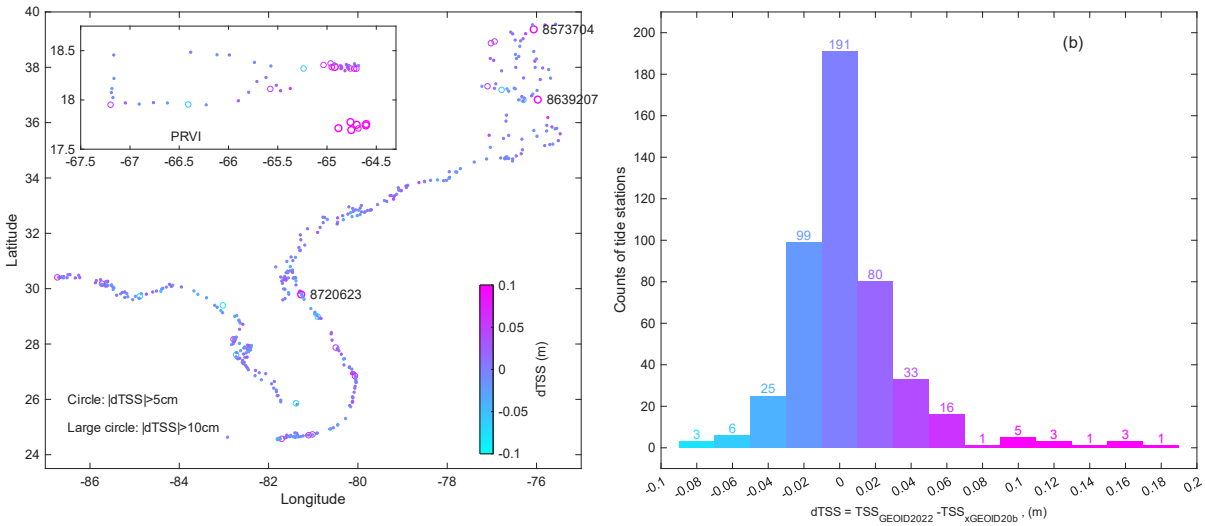


Figure 10. (a) Difference in TSS (dTSS = $TSS_{GEOID2022}$ − $TSS_{xGEOID20b}$) at 467 tide stations. Dots, |dTSS| < 0.05m; circles, |dTSS|> 0.05m; large circles, |dTSS| > 0.1m. (b) Histogram showing the distribution of station counts by dTSS.

4. TIDAL SKILL ASSESSMENT

In this section, we conduct tidal skill assessment for SECOFS using the hourly water level output from the 1-year hindcast simulation.

4.1 Introduction

Tidal skill assessment complements hindcast skill assessment in the development of NOS Operational Forecast Systems (OFS). While hindcast skill assessment evaluates the model's overall performance under realistic environmental forcing, data availability is often limited to the hindcast simulation year. Tidal harmonic data are available at many more CO-OPS tide stations, with broader spatial coverage. Therefore, this enables a more comprehensive assessment of tidal performance over the model domain.

Tidal skill assessment was traditionally performed using a 2D astronomical tide-only, 6-month simulation (Hess et al., 2003). The model was forced solely by tidal boundary conditions while excluding atmospheric forcing, river discharge, density-driven circulation, and other non-tidal processes. The tidal simulation served as the initial step in model calibration and validation before conducting a more challenging 3D, 1-year hindcast simulation (Yang et al., 2022).

Recent advances in 3D hydrodynamic modeling and increased computational capability have made it practical to conduct tidal skill assessments directly from the 1-year, 3D hindcast simulation. This adapted approach offers several advantages. First, SCHISM employs different bottom-friction formulations in its 2D and 3D configurations (Huang et al., 2022). Using the 3D hindcast for tidal calibration ensures consistency with the operational model configuration. Second, it eliminates the tide-only simulation and reduces the overall effort to maintain two different modeling scenarios. Finally, the 1-year hindcast simulation provides not only a longer time series, but also more realistic environmental conditions, including atmospheric forcing, river discharge, temperature, salinity, and density-driven circulation. Note that the observations used for validation reflect these same real-world conditions. Therefore, evaluating tidal skill based on the hindcast simulation can enable a more accurate assessment of model performance.

Traditionally, tidal harmonic constants were computed using the least-squares harmonic analysis codes described by Zervas (1999) and Hess (2003). The programs fit the prescribed tidal constituent frequencies to the modeled water-level time series and estimate the amplitude and phase of each constituent through a least-squares solution. These legacy FORTRAN codes have not been actively maintained and have not been updated for more than 20 years. To ensure consistency with the harmonic constant data currently produced by CO-OPS, we consulted with the CO-OPS data processing team (L. Abrams and N. Murry, email communications, 2025)**.** They noted that CO-OPS now routinely uses community-supported harmonic analysis packages,

primarily T_Tide (Pawlowicz et al., 2002) and UTide (or variations thereof), for processing observational data. These packages implement the same least-squares harmonic analysis methodology originally developed by Foreman in the 1970s and are available in both MATLAB and Python. They have provided results that are consistent with the historical CO-OPS approach while benefiting from modern software support. Therefore, we used T_Tide to derive the modeled tidal harmonic constants.

4.2 Comparison of Tidal Harmonic Constants

Tidal harmonic constants from 316 tide stations within the SECOFS domain were used for comparison (Figure 11). Among these, data at 148 stations are based on more than one year of observations, while 168 stations have less than 1 year (very often 1–3 months) of measurements. One issue encountered during the validation process was that many station locations, defined by their NAD83 coordinates, fell on land. The CO-OPS datum team helped to manually check some stations against Google Earth images and adjusted coordinates based on ITRF2020 accordingly (N. Murry, personal communication, 2025).

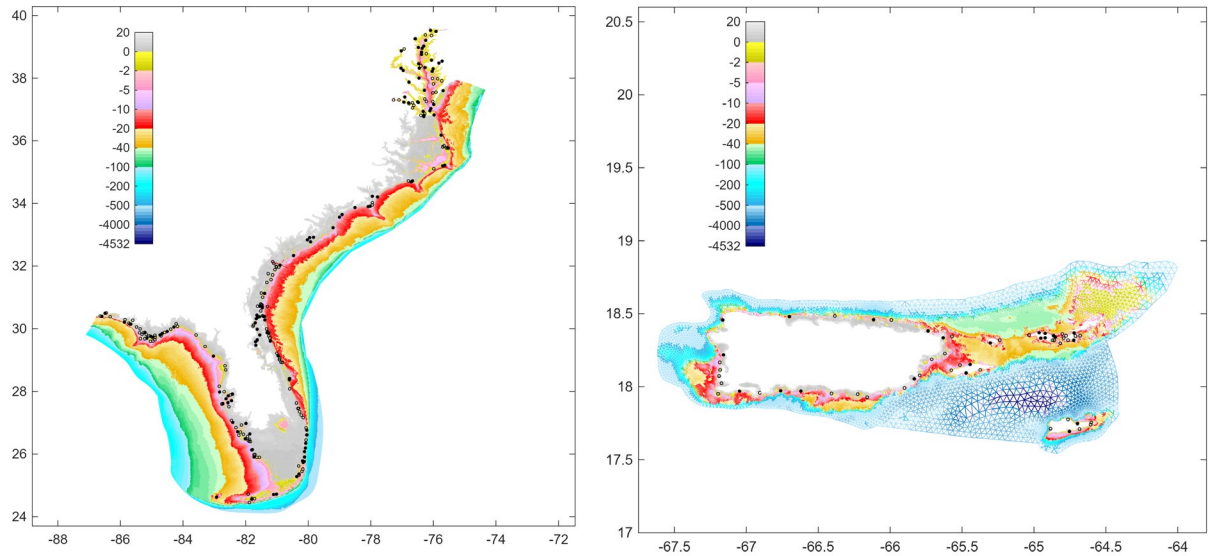


Figure 11. Locations of 316 tide stations used for SECOFS tidal skill assessment. Solid black circles: 148 stations with more than 1 year of measurements; open black circles: 168 short-term stations. Color represents water depth in meters.

Modeled hourly water level was extracted at the nearest wet node to each station location. The first month of the simulation was discarded as model spin-up. Harmonic analysis was performed on the remaining 12 months of the model water level time series, from January 1 to December 31, 2018.

Figure 12 and Figure 13 show the model-data comparisons of harmonic amplitudes and phases for eight major tidal constituents: M_2, N_2, K_2, S_2, K_1, O_1, P_1, and Q_1. Red dots indicate long-term stations, whereas blue dots indicate short-term stations. Table 3 and Table 4 summarize the model errors at 316 stations. Overall, the model reproduces the tidal constants with good accuracy. For all stations, the average absolute error (AAE) in amplitude ranges from 0.004 to 0.045 m, with the largest error occurring for the dominant M_2 amplitude (0.045 m). The corresponding root mean square error (RMSE) ranges from 0.006 to 0.076 m. Phase errors are also generally small, with AAEs ranging from 9° to 20° and RMSEs from 15° to 33°**.** Again, the largest errors are associated with the semidiurnal tides. Long-term stations consistently exhibit lower amplitude and phase errors than short-term stations, reflecting the greater reliability of harmonic constants derived from longer time series.

The largest difference in M_2 amplitude occurred at three river stations in Georgia: −0.39, −0.35, and −0.34 m at stations 8672875, 8677406, and 8674975, respectively, where the observed M2 amplitudes are 1.07, 1.04, and 1.04 m. These stations also exhibit large M_2 phase differences of 28°, 35°, and 43°, respectively. They are located upstream in the Sunbury Channel, Brunswick River, and Mud River. Note that the harmonic constants at these stations were all derived from only three months of observations during 2/1/2012 to 4/30/2012 (Table A.1). We have discussed the reliability of these short-term records with the CO-OPS Data Processing Team (Todd Ehret, email communication, 2025). Tidal harmonics derived from short-term observations are susceptible to temporary environmental conditions and may therefore be biased. Ideally, observations should span at least one year, and preferably three to five years, to minimize the influence of transient environmental variability and produce more representative harmonic constants. In addition, these short-term, 3-month, tide stations are typically deployed during periods of low river discharge, when tidal propagation is strongest and tidal amplitudes tend to be larger. Consequently, the observed M_2 amplitudes at short-term river stations are likely biased high. Given the uncertainty associated with the short observational records, these river stations were retained in the analysis but were not considered for model calibration. As will be discussed in section 4.3, the prediction tides from these three stations show the lowest central frequency and largest RMSE.

During the initial tidal skill assessment, we found that the model underestimated the M_2 amplitude by more than 50% at one long-term station 8573927, located in the Back Creek at Chesapeake City, Maryland. The observed M_2 amplitude is 0.41 m, whereas the model shows only 0.17 m. This discrepancy was further discussed by the VDatum modeling team. Station 8573927 is located in a narrow channel connecting the Chesapeake Bay and Delaware Bay. It exhibits a complex tidal regime influenced by tidal propagation from both ends of the channel. The eastern entrance

receives tides from Delaware Bay, which has a substantially larger tidal range. Because the model domain does not include Delaware Bay, it cannot fully reproduce the tidal dynamics at this location. The VDatum modeling team recommends excluding it from the tidal skill assessment as an outlier, as its observed tidal characteristics cannot be adequately represented by the current model boundary. In addition, since this station is already covered by both the STOFS-3D-Atlantic and NECOFS models, performing additional calibration/justification specifically for this location is not considered an efficient use of effort for SECOFS.

Table 3. Summary of model errors in the tidal harmonic amplitudes.

Error	Station Type	Station Number	M_2 (m)	S_2 (m)	N_2 (m)	K_2 (m)	K_1 (m)	O_1 (m)	P_1 (m)	Q_1 (m)
AAE	>1 year	148	0.039	0.009	0.009	0.003	0.010	0.008	0.004	0.002
	Short-term	168	0.05	0.012	0.013	0.006	0.012	0.009	0.005	0.003
	All	316	0.045	0.011	0.011	0.005	0.011	0.008	0.004	0.002
RMSE	>1 year	148	0.063	0.014	0.015	0.005	0.014	0.011	0.005	0.003
	Short-term	168	0.086	0.021	0.024	0.009	0.018	0.013	0.007	0.004
	All	316	0.076	0.018	0.020	0.007	0.016	0.012	0.006	0.003

Table 4. Summary of model errors in the tidal harmonic phases.

Error	Station Type	Station number	M_2 (deg)	S_2 (deg)	N_2 (deg)	K_2 (deg)	K_1 (deg)	O_1 (deg)	P_1 (deg)	Q_1 (deg)
AAE	>1 year	148	13	14	15	17	9	8	9	14
	Short-term	168	19	21	23	23	12	10	14	18
	All	316	16	18	19	20	10	9	12	16
RMSE	>1 year	148	21	21	25	27	13	11	14	20
	Short-term	168	30	33	39	35	20	18	25	28
	All	316	26	28	33	31	17	15	21	24

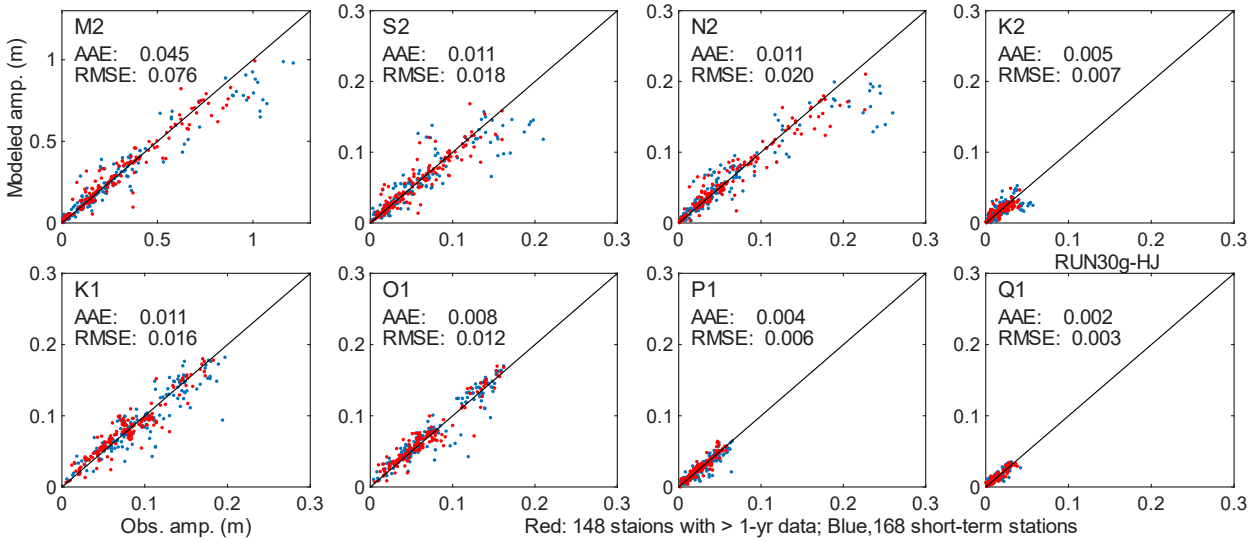


Figure 12. Comparison of observed and modeled amplitudes for eight major tidal constituents. Long-term and short-term stations are shown as red and blue dots, respectively.

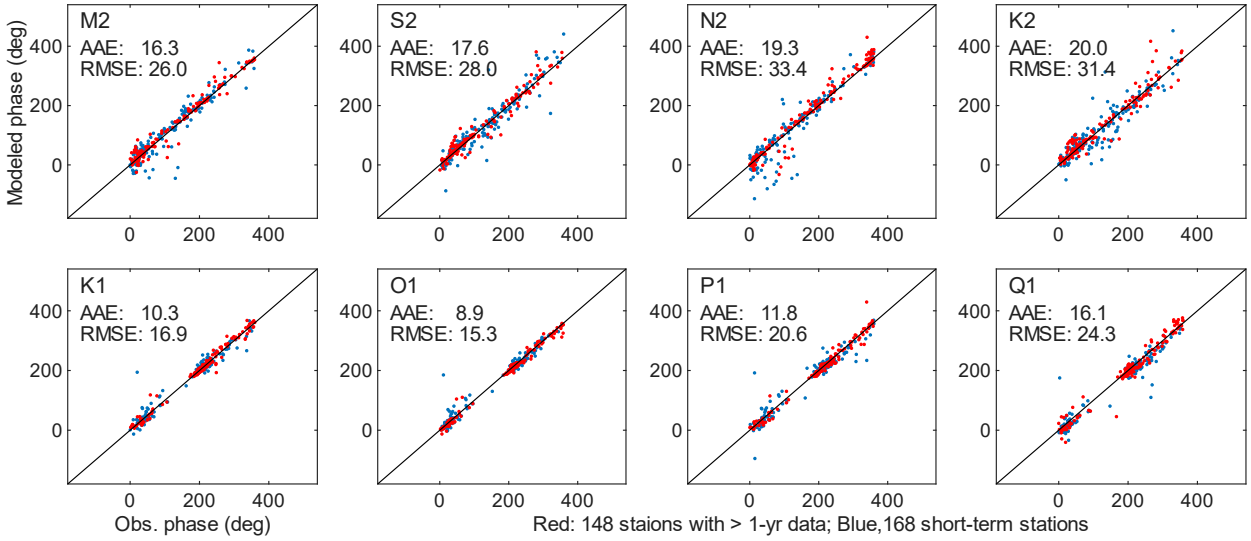


Figure 13. Comparison of observed and modeled phases for eight major tidal constituents. Long-term (>1 year) and short-term stations are shown as red and blue dots, respectively.

4.3 Comparison of Predicted Tides

In this section, we compare tidal water level predicted by using modeled and observed tidal harmonic constants at the 316 stations.

The harmonic constants for the eight major tidal constituents were input to T_Tide to predict a one-year tidal water level time series for 2018. The same procedure was applied to both observed and modeled harmonic constants to generate the corresponding tidal predictions. Figure 14 compares the observations and SECOFS predicted tidal water levels for the first month of 2018 at 316 stations. Statistical metrics, including the root mean square error (RMSE) and central frequency (CF), were computed from the full one-year tidal prediction. Please see Section 5 for the definition of the statistical metrics. We can see dynamic ranges of tidal amplitudes throughout the SECOFS domain, ranging from several cms to about 2 m.

Figure 15 panels (a) and (b) display the color-coded RMSE and CF maps, respectively. Table A.1 lists the values at each of the 316 stations. Table 5 summarizes the skill assessment statistics. For all 316 stations, the root mean square error (RMSE) ranges from 0.008 to 0.554 m, with a mean of 0.065 m and a standard deviation of 0.074 m. Long-term stations (>1 year of observations) exhibit better agreement than short-term stations, with a lower mean RMSE (0.054 m versus 0.075 m) and smaller standard deviations. The central frequency (CF) ranges from 13**%** to 100**%**, with a mean of 91**%** for all stations. The mean CF is 93**%** at long-term stations and 89**%** at short-term stations. The results indicate that tidal predictions based on the modeled harmonic constants agree closely with those derived from the observed harmonic constants at most locations. The largest RMSE (0.55 m) with the lowest CF of 13% occurred at station 8672875 (Figure 14 No. 180). This is the one of the three, 3-month short-term river stations with the largest errors in the M_2 amplitude. Figure 14 panels No. 177, 180 and 182 show the comparison of the predicted tides for the three stations. Figure 15 panels (c) and (d) present enlarged views of the Georgia stations, highlighting several upstream river stations with the poorest tidal prediction performance. Meanwhile, the consistently lower RMSE and higher CF at long-term stations further demonstrate the improved reliability of validation using harmonic constants derived from longer time series. For example, at the long-term, open coast station 8670870 Fort Pulaski, regardless of its large tidal range, the RMSE is only 3 cm and the central frequency is 100% (Figure 15 panels c and d). RMSE and CF for the rest of coastal stations can be found in panels (e) to (v).


Predicted tide (m)
Days since 2018 1 1; Black: tide station prediction; Red: SECOFS predicted tide

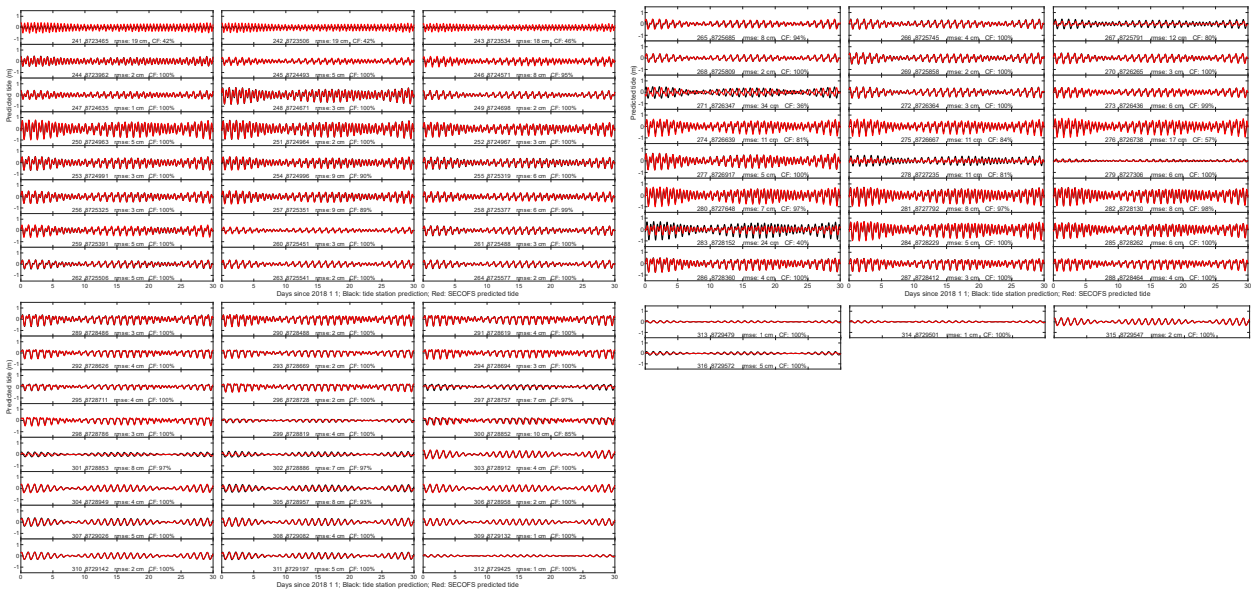
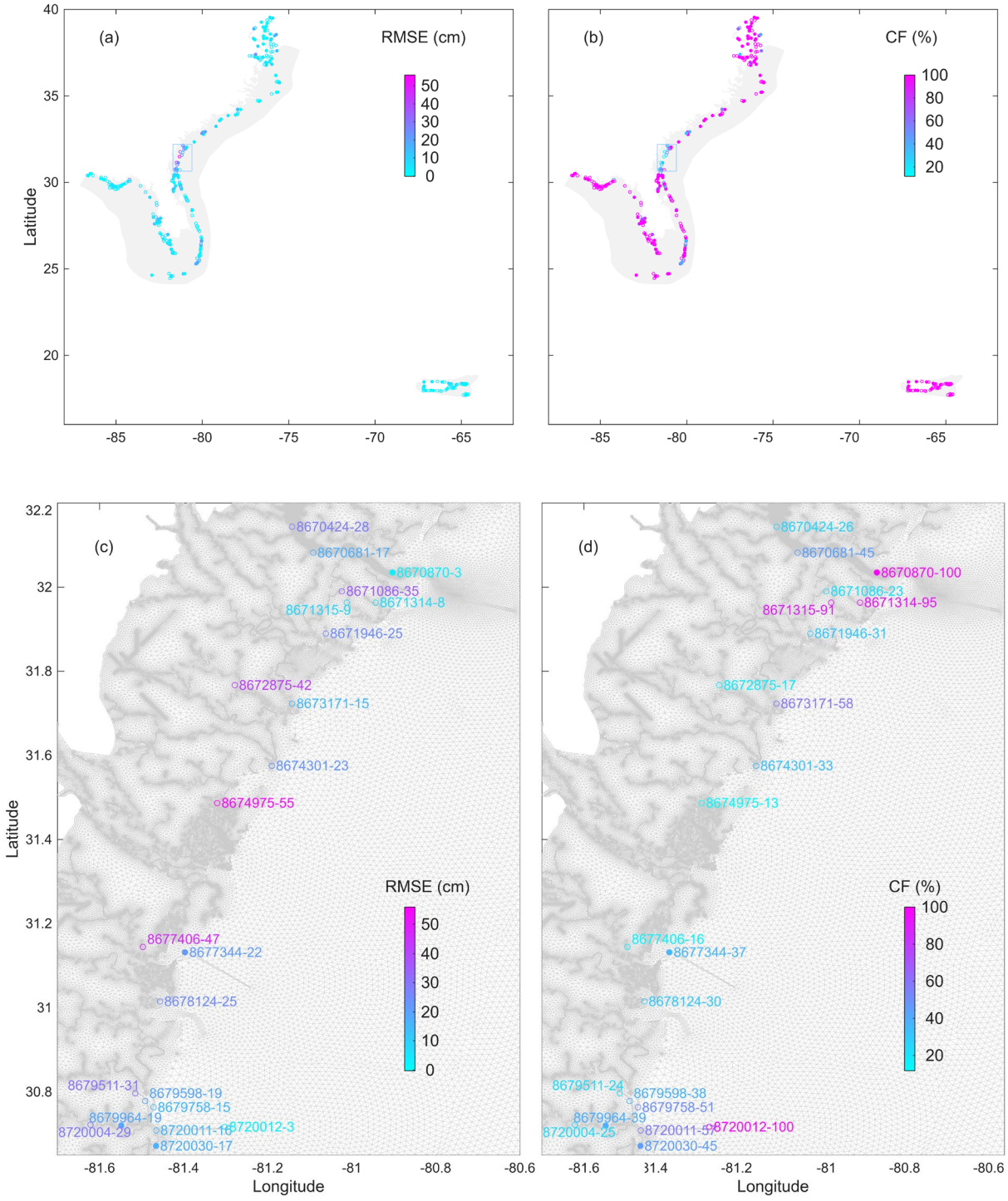
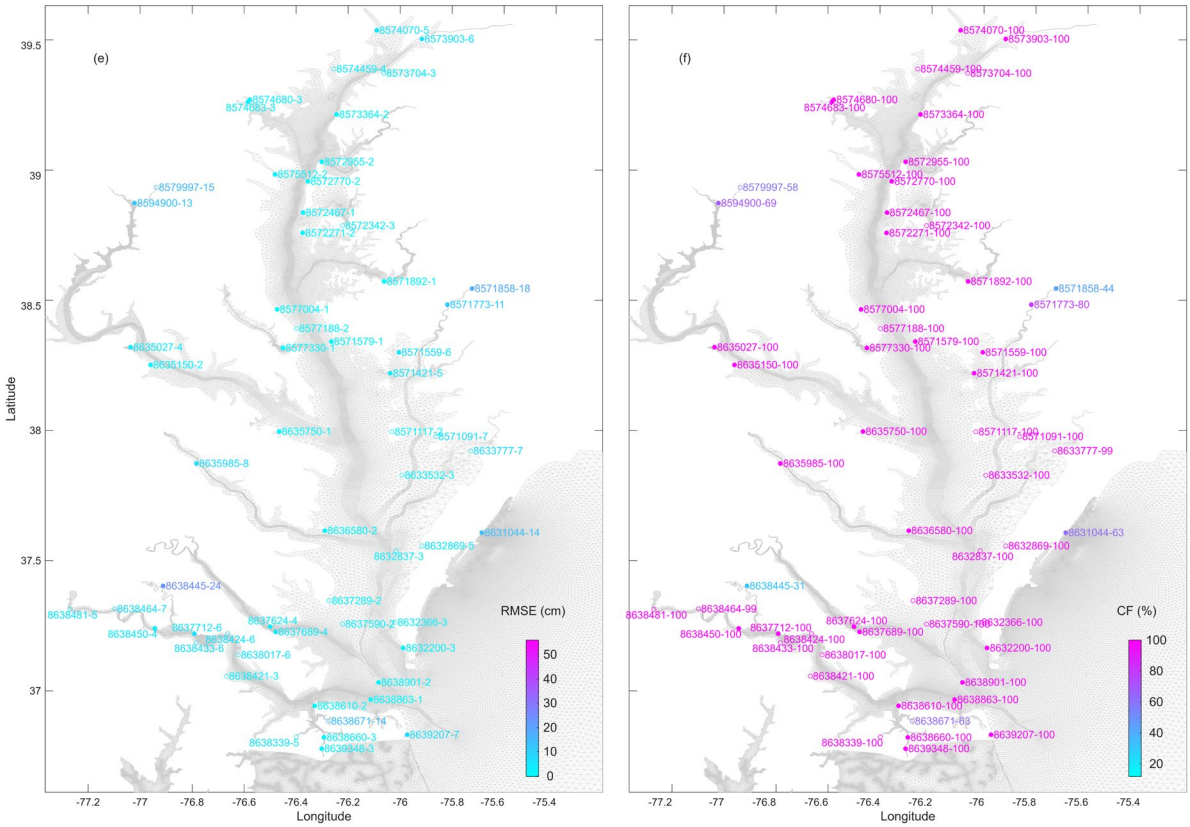


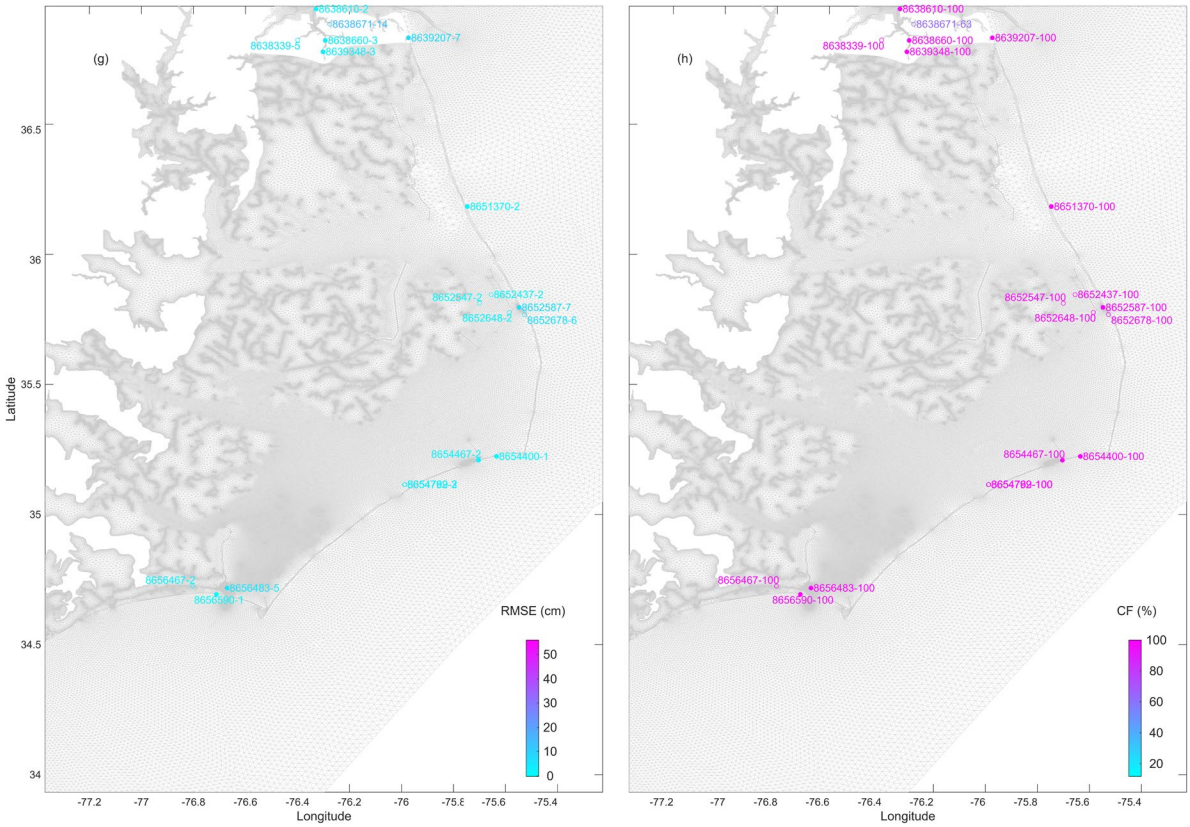
Figure 14. Comparison of predicted tidal water levels for the first month of 2018 at 316 tide stations. Black, station prediction; red, SECOFS prediction.

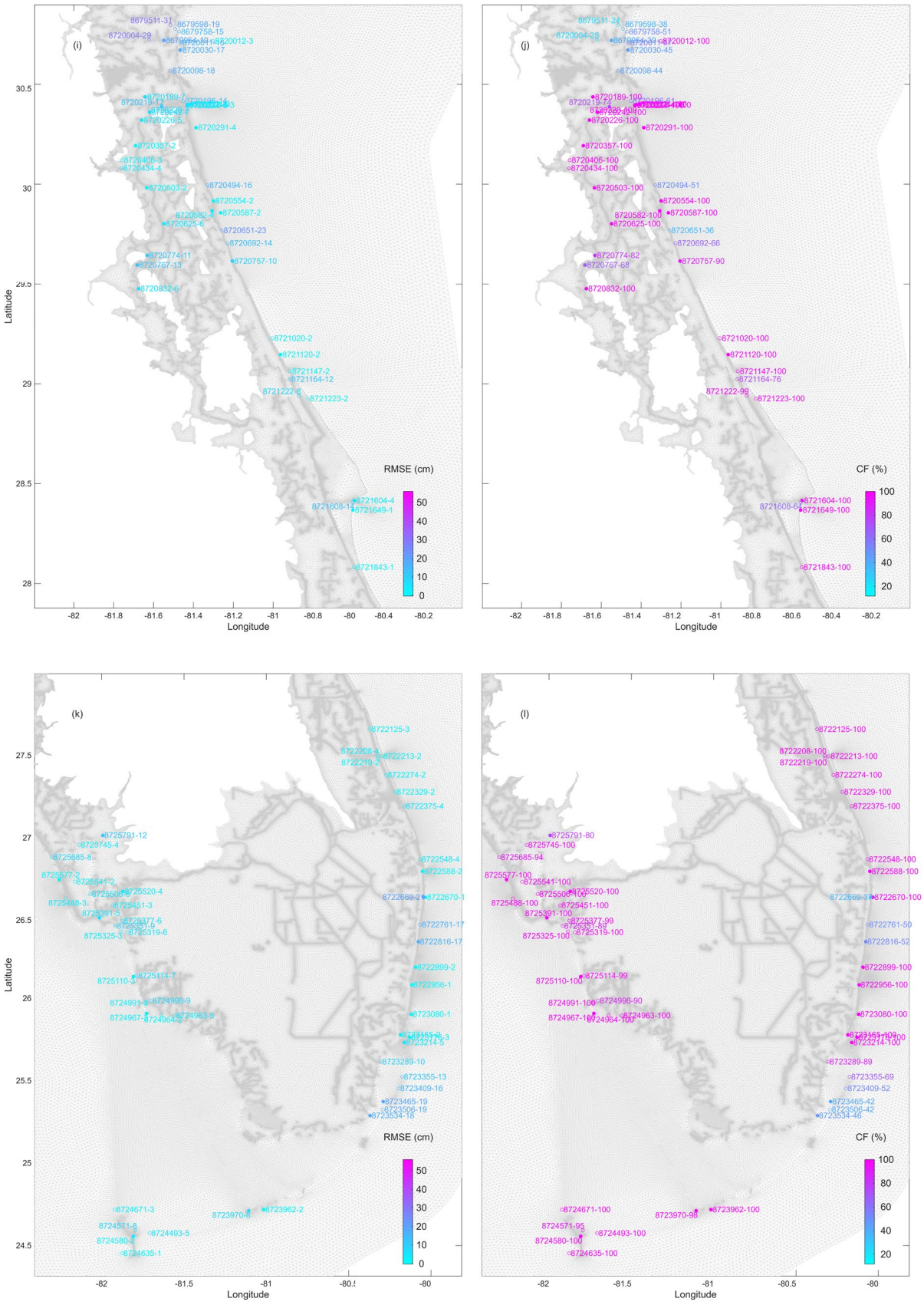
Table 5. Summary of skill assessment statistics for the predicted tides.

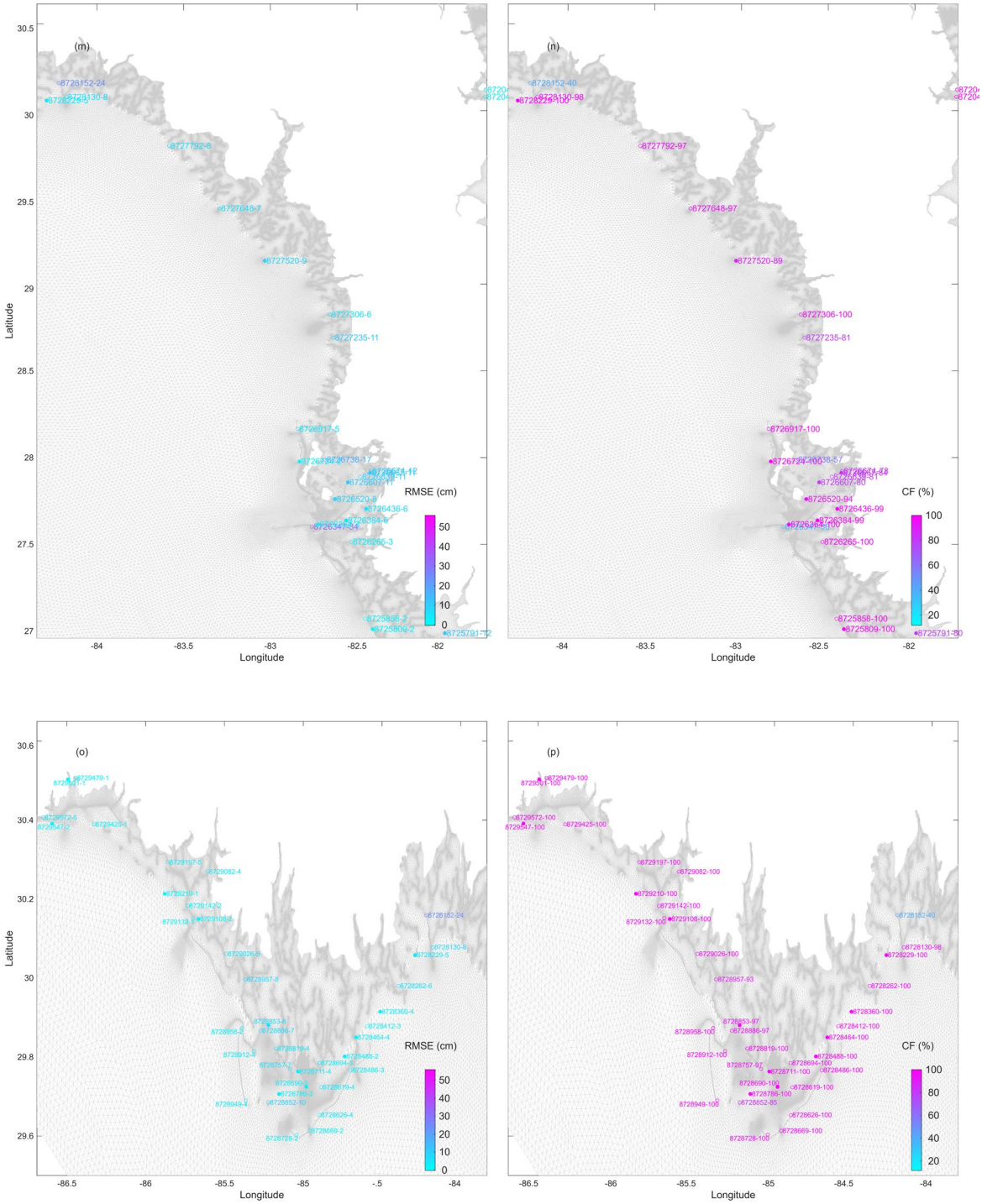
Statistics	Station Type	Number of stations	Min	Max	Mean	Standard Deviation
RMSE (m)	>1 year	148	0.008	0.242	0.054	0.052
	Short-term	168	0.009	0.554	0.075	0.088
	All	316	0.008	0.554	0.065	0.074
CF (%)	>1 year	148	31	100	93	17
	Short-term	168	13	100	89	23
	All	316	13	100	91	20


(a)
RMSE (cm)
50
40
30
20
10
0
Latitude
(b)
CF (%)
100
80
60
40
20
(c)
8670424-28
8670681-17
8670870-3
8671086-35
8671314-8
8671315-9
8671946-25
8672875-42
8673171-15
8674301-23
8674975-55
8677406-47
8677344-22
8678124-25
8679511-31
8679598-19
8679758-15
8679964-19
8720004-29
8720011-16
8720012-3
8720030-17
RMSE (cm)
Latitude
Longitude
(d)
8670424-26
8670681-45
8670870-100
8671086-23
8671314-95
8671315-91
8671946-31
8672875-17
8673171-58
8674301-33
8674975-13
8677406-16
8677344-37
8678124-30
8679511-24
8679598-38
8679758-51
8679964-39
8720004-25
8720011-57
8720012-100
8720030-45
CF (%)
Longitude


(e)
(f)
RMSE (cm)
CF (%)
Latitude
Longitude


(g)
(h)
RMSE (cm)
CF (%)
Latitude
Longitude


(i)
(j)
(k)
(l)
RMSE (cm)
CF (%)
Latitude
Longitude


(m)
(n)
(o)
(p)
Latitude
Longitude
RMSE (cm)
CF (%)

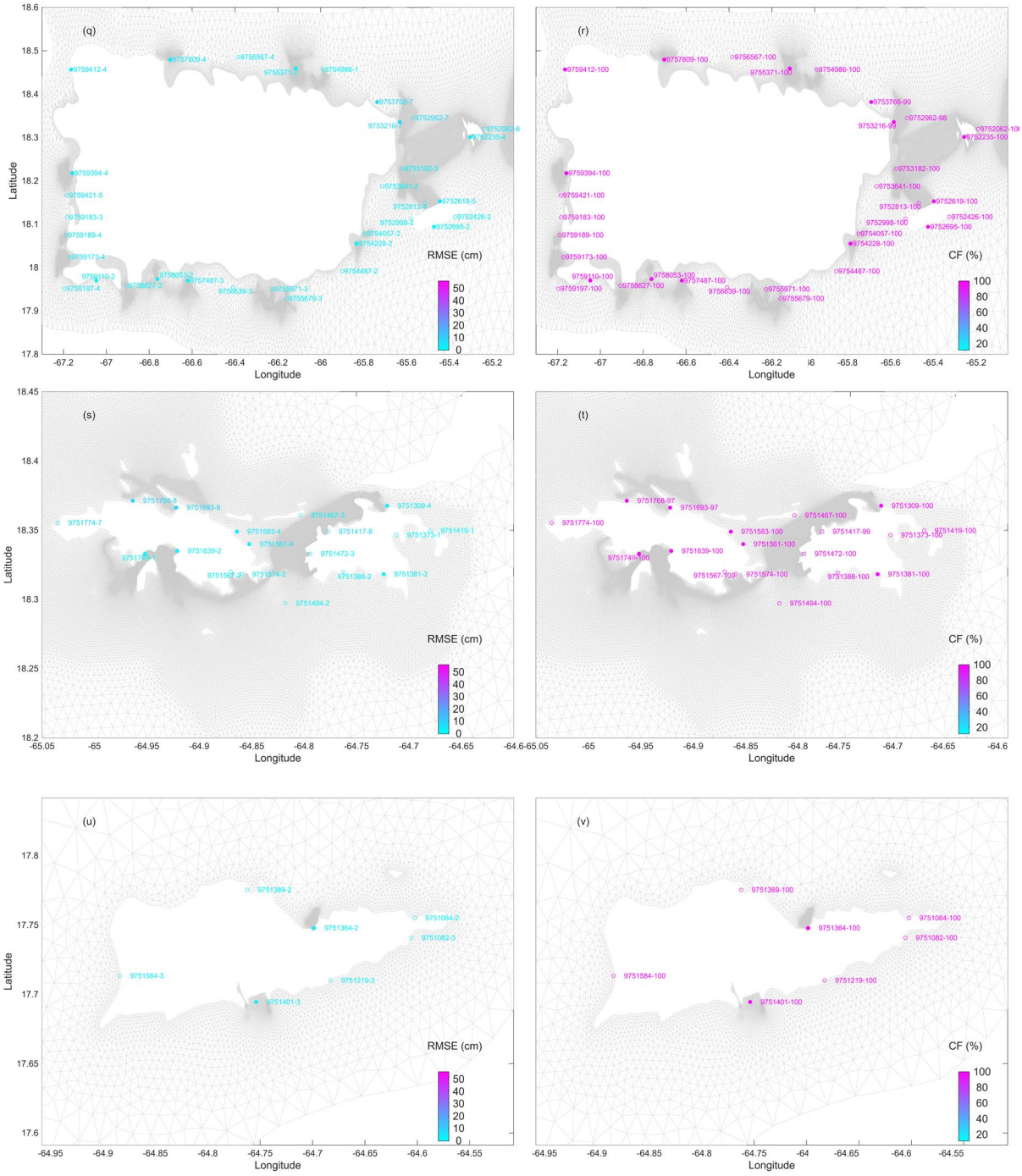


Figure 15. (a) RMSE and (b) CF of predicted tides at 316 CO-OPS stations listed in Table A.1. Panels (c) and (d) are enlarged views of the boxed area in (a) and (b), respectively, with corresponding values shown after each station ID. Panels (e) to (v) Southeast and PRVI tide stations. Solid circles, stations with >1-year data; open circles, short-term stations.

5. HINDCAST MODEL SKILLS

5.1 Hindcast Periods

The one year hindcast model simulation using the SCHISM-based SECOFS was conducted by VIMS on the Hercules, operated by Mississippi State University (MSU), Starkville, MS. The hindcast verification period for water levels, water temperatures, water salinity, and water currents covered from Jan. 1 to Dec. 31, 2018. The ramp up period, December 2017, is not used for model evaluation. The model evaluation was completed on the Stampede3 system at the Texas Advanced Computing Center (TACC) of University of Texas at Austin, funded by the National Science Foundation.

5.2 Method of Evaluation

The model skill evaluation was conducted using the 1st version (FORTRAN-based) and 2nd version (Python-based, the Next Gen NOS Ocean Forecast Model Skill Assessment and Processing Software) of NOS standard skill assessment software (Zhang et al., 2006, 2010, https://github.com/NOAA-CO-OPS/dev-Next-Gen-NOS-OFS-Skill-Assessment). The second version is structured as a modern Python package following best practices, making it suitable for both command-line usage and programmatic integration into other projects. Both versions used the standard NOS suite of skill assessment statistics. These statistics included Error, or more commonly referred to as Mean Algebraic Error (MAE) or bias, Root Mean Squared Error (RMSE), Central Frequency (CF), Positive Outlier Frequency (POF), Negative Outlier Frequency (NOF), Maximum Duration of Positive Outliers (MDPO), and Maximum Duration of Negative Outliers (MDNO). These statistics are described briefly in Table 6, while more detailed descriptions can be found in Hess et al. (2003). The comparisons were done using the NOS standard skill assessment software (Zhang et al., 2010, 2013).

Table 6. Description of NOS skill assessment statistics (Modified from Hess et al., 2003) along with NOS Acceptance Criteria (targets).

Statistic	Units	Description	NOS Acceptance Criterion
Mean Algebraic Error (MAE) or Bias	Meters or Hours	The error is defined as the predicted value, p, minus the reference (observed value)	NA
SD	Meters or Hours	Standard Deviation	NA
RMSE	Meters or Hours	Root Mean Square Error	NA
SM	Meters or Hours	Series Mean. The mean value of a series y	NA
CF(X)	%	Central Frequency. Fraction (percentage) of errors that lie within the limits $\pm$X.	$\geq$ 90%
POF(X)	%	Positive Outlier Frequency. Fraction (percentage) of errors that are greater than X.	POF(2X) $\leq$ 1%
NOF(X)	%	Negative Outlier Frequency. Fraction (percentage) of errors that are less than -X.	NOF(2X) $\leq$ 1%
MDPO(X)	Hours	Maximum Duration of Positive Outliers. A positive outlier event is two or more consecutive occurrences of an error greater than +2X. MDPO is the length of time in hours (based on the number of consecutive occurrences) of the longest positive outlier event.	MDPO(2X) $\leq$ L
MDNO(X)	Hours	Maximum Duration of Negative Outliers. A negative outlier event is two or more consecutive occurrences of an error less than -2X. MDNO is the length of time in hours (based on the number of consecutive occurrences) of the negative outlier longest event.	MDNO(2X) $\leq$ L
NOS Standard Acceptance Criteria		where X = acceptable error magnitude (cm or minutes) X = $\pm$ 15 cm for water level amplitude errors X = $\pm$ 1.5 hours (90 minutes) for water level timing errors X = $\pm$ 3.0 °C for water temperature amplitude errors	Where L=time limit or max. allowable duration L= 24 hours

5.3 Observational Data

The observational data used to verify the model results include time series of water level, currents, and water temperature and salinity. The water level data were collected at the National Ocean Service (NOS) CO-OPS as well as USGS water level stations (Section 5.3.1). The current data were collected from the CO-OPS current stations (https://tidesandcurrents.noaa.gov/cdata/StationList?type=Current+Data&filter=historic) (Section 5.3.2). The water temperature (T) data were from either the CO-OPS meteorological observation stations or the National Data Buoy Center (NDBC) buoys or the USGS water data stations (Section 5.3.3). The salinity (S) data were also from either the CO-OPS meteorological observation stations or the National Data Buoy Center (NDBC) buoys or the USGS water data stations (Section 5.3.4).

Since SCHISM naturally incorporates wetting and drying of tidal flats, and the model outputs keep dry values raw; however, the current skill assessment package does not evaluate inundation. Therefore, only the stations that were considered as totally wet (no dry node or element from both model output and observations) for the entire hindcast period were included in the evaluations. Stations with poor or uncertain data quality were also excluded in the skill assessments.

5.3.1 Water Level

Observational water level data from fifty NOS CO-OPS stations with 6-minute interval were used for the WL skill assessments for the hindcast period of 2018 (Table 7 and Figure 16)

Table 7. Station metadata of water level observations.

#	ID	Station Name	State	Longitude (°E)	Latitude (°N)
1	8724580	Key West	FL	-81.808334	24.555000
2	8723970	Vaca Key, Florida Bay	FL	-81.106667	24.711666
3	8723214	Virginia Key	FL	-80.161667	25.731667
4	8722956	South Port Everglades	FL	-80.115906	26.078787
5	8725110	Naples	FL	-81.808334	26.131666
6	8722670	Lake Worth Pier, Atlantic Ocean	FL	-80.033333	26.613333
7	8725520	Fort Myers	FL	-81.871666	26.648333
8	8726384	Port Manatee	FL	-82.561668	27.638332
9	8726520	St. Petersburg	FL	-82.626663	27.760000
10	8726607	Old Port Tampa	FL	-82.553329	27.858334
11	8726667	Mckay Bay Entrance	FL	-82.425003	27.913334
12	8726724	Clearwater Beach	FL	-82.831665	27.978333
13	8721604	Trident Pier, Port Canaveral	FL	-80.593330	28.415001
14	8727520	Cedar Key	FL	-83.030884	29.133858

#	ID	Station Name	State	Longitude (°E)	Latitude (°N)
15	8728690	Apalachicola	FL	-84.980003	29.725000
16	8729108	Panama City	FL	-85.665001	30.150000
17	8729210	Panama City Beach	FL	-85.878334	30.213333
18	8720226	Southbank Riverwalk, St Johns River	FL	-81.658333	30.320000
19	8720219	Dames Point	FL	-81.558334	30.386667
20	8720218	Mayport (Bar Pilots Dock)	FL	-81.428329	30.398333
21	8720030	Fernandina Beach	FL	-81.466667	30.671667
22	8670870	Fort Pulaski	GA	-80.903336	32.035000
23	8665530	Charleston	SC	-79.923332	32.781666
24	8661070	Springmaid Pier	SC	-78.918335	33.654999
25	8658163	Wrightsville Beach	NC	-77.786667	34.213333
26	8658120	Wilmington	NC	-77.953331	34.226665
27	8656483	Beaufort, Duke Marine Lab	NC	-76.669998	34.716667
28	8654467	USCG Station Hatteras	NC	-75.704750	35.209225
29	8652587	Oregon Inlet Marina	NC	-75.548332	35.794998
30	8651370	Duck	NC	-75.746666	36.183334
31	8639348	Money Point	VA	-76.303116	36.776962
32	8638610	Sewells Point	VA	-76.331856	36.943024
33	8638901	CBBT, Chesapeake Channel	VA	-76.083336	37.033333
34	8632200	Kiptopeke	VA	-75.988335	37.165001
35	8637689	Yorktown USCG Training Center	VA	-76.478333	37.226665
36	8636580	Windmill Point	VA	-76.290001	37.615002
37	8631044	Wachapreague	VA	-75.686279	37.607483
38	8635750	Lewisetta	VA	-76.464996	37.996666
39	8635027	Dahlgren	VA	-77.036514	38.319118
40	8571421	Bishops Head	MD	-76.038330	38.220001
41	8577330	Solomons Island	MD	-76.451668	38.316666
42	8571892	Cambridge	MD	-76.061668	38.571667
43	8573364	Tolchester Beach	MD	-76.247383	39.215385
44	8574680	Baltimore	MD	-76.578331	39.266666
45	8594900	Washington	DC	-77.021667	38.873333
46	9751401	Lime Tree Bay	VI	-64.753334	17.695000
47	9751364	Christiansted_Harbor St Croix	VI	-64.698334	17.748333
48	9751639	Charlotte Amalie	VI	-64.925003	18.333332
49	9759394	Mayaguez	PR	-67.162476	18.218863
50	9755371	San Juan La Puntilla San Juan Bay	PR	-66.116669	18.458332

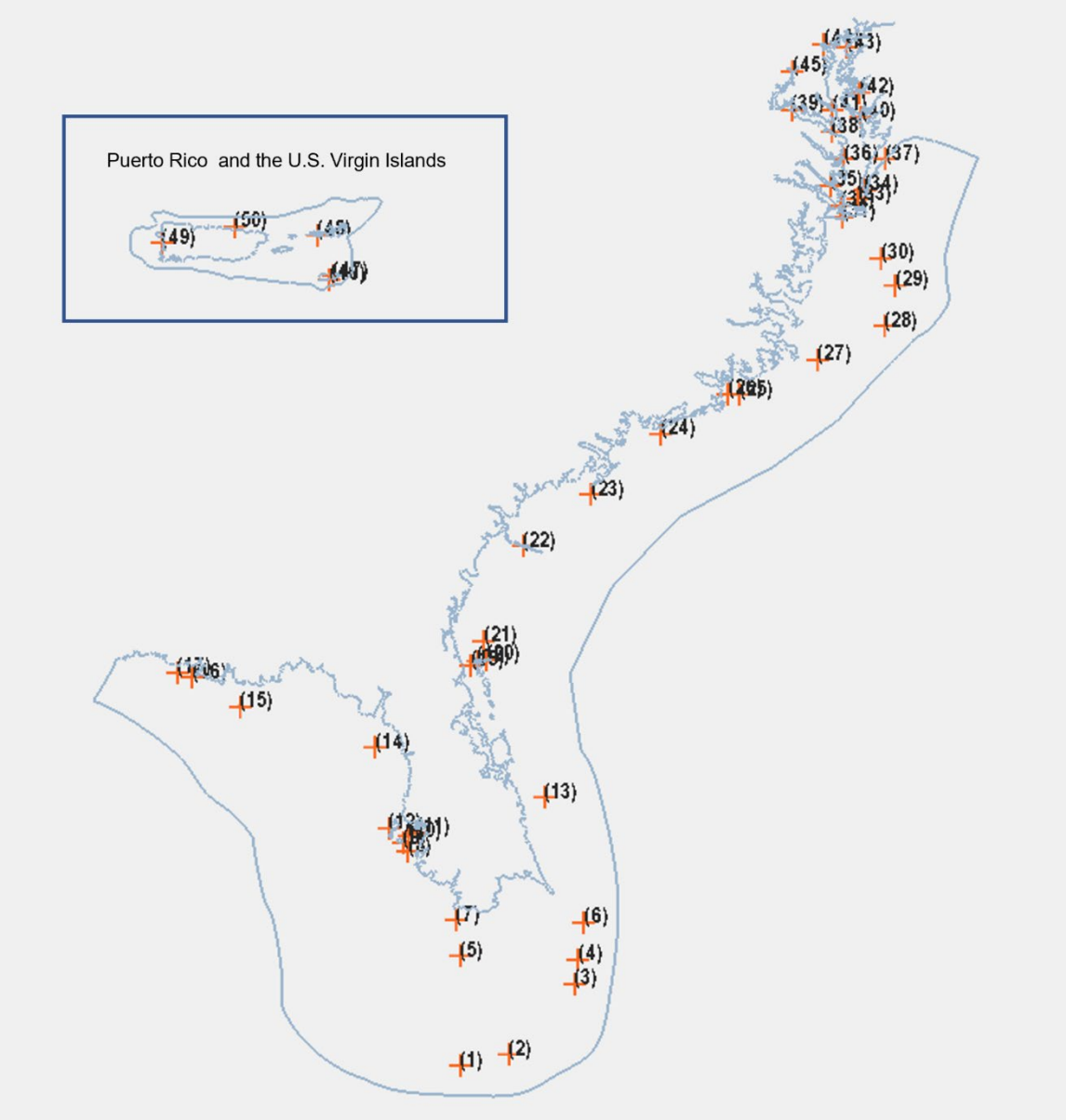


Figure 16. Map of water level stations (Table 7).

5.3.2 Current

The water current data are Acoustic Doppler Current Profiler (ADCP) measurements from CO-OPS CMIST buoys (Pruessner et al., 2007) and from the buoys of NOAA's Chesapeake Bay Interpretive Buoy System (CBIBS) system. Data from the CBIBS were downloaded from the NDBC, and all historical data has gone through NDBC's post-processing analysis. Tables 8 - 10 show the station IDs, names, geographical information, and sensor (or measurement) depths for the buoy stations. Observational currents data at specific bin-levels or bin-locations from both vertical- and side-looking CO-OPS CMIST buoys were downloaded for model evaluations. The selection of bins was matching with the currents data demonstrations at CO-COPS website (https://tidesandcurrents.noaa.gov/cdata/StationList?type=Current+Data&filter=active). The vertical-looking sensor orientations are either "Down" (buoy-mounted) or "Up" (bottom-mounted). The estimated longitudes and latitudes of the selected bins for side-looking buoys (Table 10) were used for extracting the model station output. Note that CBIBS owns and maintains all buoys in Table 9, however the station IDs were assigned by NDBC.

Table 8. Station metadata of water current observations from CO-OPS CMIST's vertical-looking ADCP buoys.

#	ID	Station Name	Sensor Lon (°E)	Sensor Lat (°N)	Sensor Orientation	Ver. bin #	Est. Depth (m)
1	jx0401	Fulton Cutoff LB 34	-81.496780	30.390970	Down	4	6.4
2	jx0601	Trout River Cut LB 64	-81.625940	30.391030	Down	4	6.7
3	t01010	Sunshine Skyway Bridge ADCP	-82.653995	27.621286	Up	9	4.9
4	t02010	Old Port Tampa	-82.55373	27.86287	Up	7	4.8
5	t03010	Port Manatee	-82.59877	27.66395	Up	10	2.1
6	cb0102	Cape Henry LB 2CH	-76.012800	36.959400	Down	4	6.5
7	cb0201	York Spit LB 22	-76.143500	37.139833	Down	7	9.4
8	cb0801	Rappahannock Shoal Channel LB 60	-76.154617	37.674417	Down	4	6.7
9	cb1101	Chesapeake Channel LBB 92	-76.384667	38.982150	Down	4	6.8
10	cb0301	Thimble Shoal LB 18	-76.249033	37.011083	Down	2	4.6
11	cb0402	Naval Station Norfolk LB 7	-76.333883	36.962950	Down	4	6.3
12	cb0601	Newport News Channel LB 14	-76.423120	36.957093	Down	4	6.5

Table 9. Station metadata of water current observations from CBIBS' depth-rated buoys.

#	ID	Station Name	State	Sensor Lon (°E)	Sensor Lat (°N)	Sensor Depth (from sea surface, m)
1	44064	First Landing	VA	-76.08722	36.99806	3
2	44072	York Spit	VA	-76.26611	37.20056	3
3	44058	Stingray Point	VA	-76.2575	37.56722	3
4	44042	Potomac	MD	-76.33556	38.03306	3
5	44062	Gooses Reef	MD	-76.41472	38.55639	3
6	44063	Annapolis	MD	-76.4475	38.96306	3

Table 10. Station metadata of water current observations from CO-OPS CMIST's side-looking ADCP buoys.

#	ID	Station Name	Sensor Lon (°E)	Sensor Lat (°N)	Horiz. Bin #	Distance from sensor (m)	Lon at Bin (°E, Est.)	Lat at Bin (°N, Est.)
1	jx0501	Dames Point Bridge	-81.55706	30.38599	13	53.0	-81.5570	30.3855
2	jx0701	Acosta Bridge	-81.66462	30.32266	20	81.5	-81.6641	30.3221
3	cb1001	Cove Point LNG Pier (SL-ADP)	-76.38417	38.40283	20	81.0	-76.3834	38.4030
4	cb1301	Chesapeake City	-75.82762	39.53053	20	82.0	-75.8276	39.5313

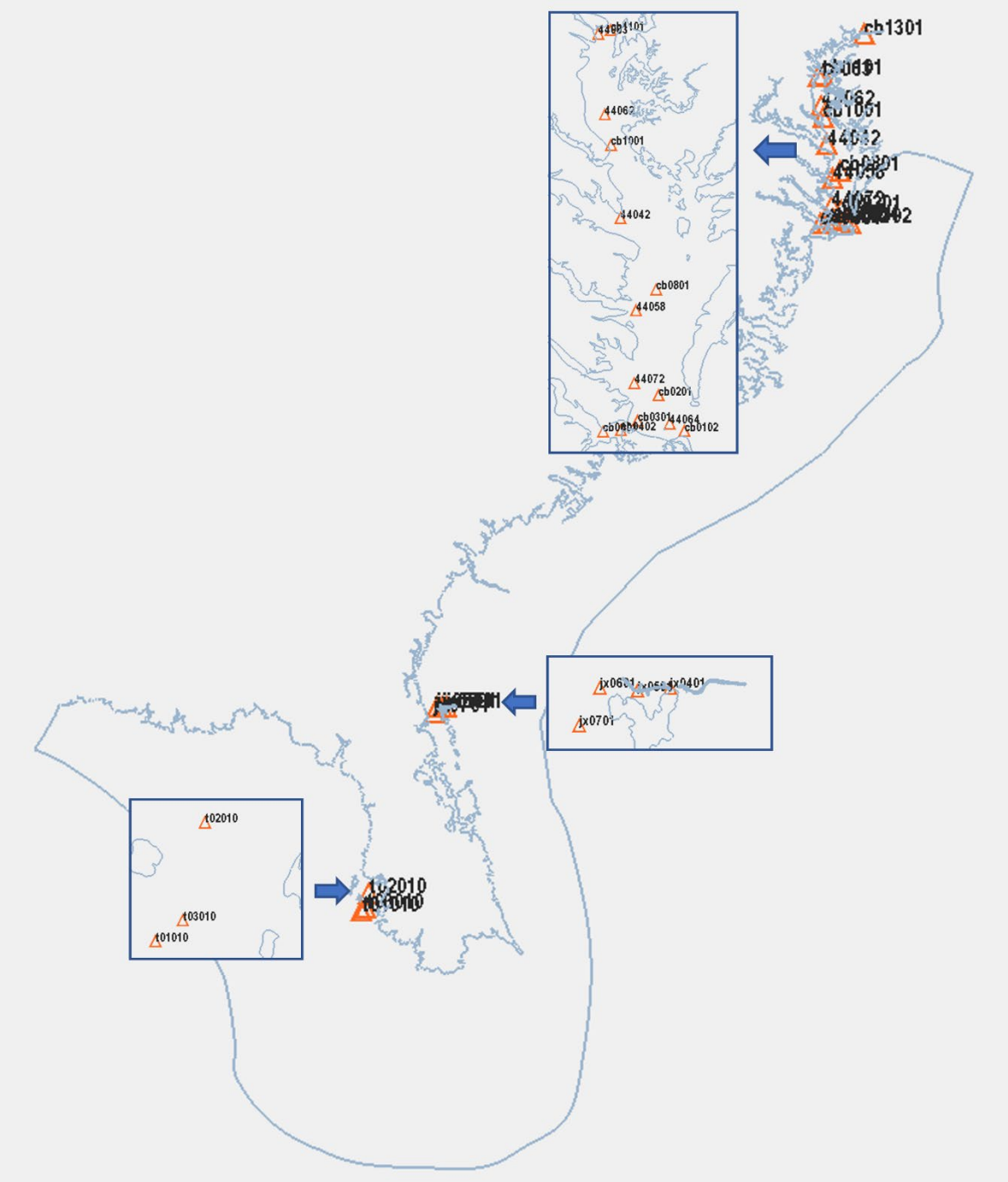


Figure 17. Map of water current stations.

5.3.3 Temperature

The temperature (SST) observation data came from three resources: the CO-OPS stations, the CBIBS buoys, and the USGS gauges. Again, the data from the CBIBS were downloaded from the National Data Buoy Center (NDBC), and all historical data has gone through NDBC's post-processing analysis. Tables 11 - 13 show the station IDs, names, the geographical and the sensor depth information for SST from three resources, respectively.

Note that all buoys in Table 12 are owned and maintained by the CBIBS, however the station IDs were assigned by NDBC. Also, the sensor depth units shown in the tables are different. Figure 18 and Figure 19 display the station maps for NOAA and USGS stations respectively.

Table 11. Station metadata of water temperature observations from CO-OPS gauges.

#	ID	Station Name	State	Longitude (°E)	Latitude (°N)	Sensor Depth (ft)
1	8726607	Old Port Tampa	FL	-82.552803	27.857800	-1.4
2	8726667	Mckay Bay Entrance	FL	-82.425003	27.913300	-1.6
3	8726724	Clearwater Beach	FL	-82.838203	27.982700	-6.4
4	8720219	Dames Point	FL	-81.558701	30.386000	-3.4
5	8720218	Mayport (Bar Pilots Dock)	FL	-81.428802	30.399599	-7.2
6	8670870	Fort Pulaski	GA	-80.901703	32.036701	-8.8
7	8665530	Charleston	SC	-79.921097	32.780499	-6.3
8	8638610	Sewells Point	VA	-76.335403	36.943199	-3.9
9	8637689	Yorktown USCG Training Center	VA	-76.478302	37.226700	-10.1
10	8631044	Wachapreague	VA	-75.686302	37.607498	-3.3
11	8635750	Lewisetta	VA	-76.415398	38.021099	-4.1
12	8571421	Bishops Head	MD	-76.045700	38.212399	-2.5
13	8577330	Solomons Island	MD	-76.449997	38.316700	-2.3
14	8573364	Tolchester Beach	MD	-76.245003	39.213299	-1.9
15	8573927	Chesapeake City	MD	-75.939400	39.487598	-5.5
16	8594900	Washington DC	DC	-77.021698	38.873299	-9
17	9751364	Christiansted_Harbor St Croix	VI	-64.698334	17.748333	-3.1
18	9752695	Esperanza Vieques Island	PR	-65.471664	18.093332	-7.6
19	9759394	Mayaguez	PR	-67.162476	18.218863	-1.8
20	9755371	San Juan La Puntilla San Juan Bay	PR	-66.116669	18.458332	-4.6

Table 12. Station metadata of water temperature observations from CBIBS' depth-rated buoys.

#	ID	Station Name	State	Longitude (°E)	Latitude (°N)	Sensor Depth (below water line, m)
1	44063	Annapolis	MD	-76.4475	38.96306	-0.5
2	44062	Gooses Reef	MD	-76.41472	38.55639	-0.5
3	44042	Potomac	MD	-76.33556	38.03306	-0.5
4	44058	Stingray Point	VA	-76.2575	37.56722	-0.5
5	44072	York Spit	VA	-76.26611	37.20056	-0.5
6	44064	First Landing	VA	-76.08722	36.99806	-0.5

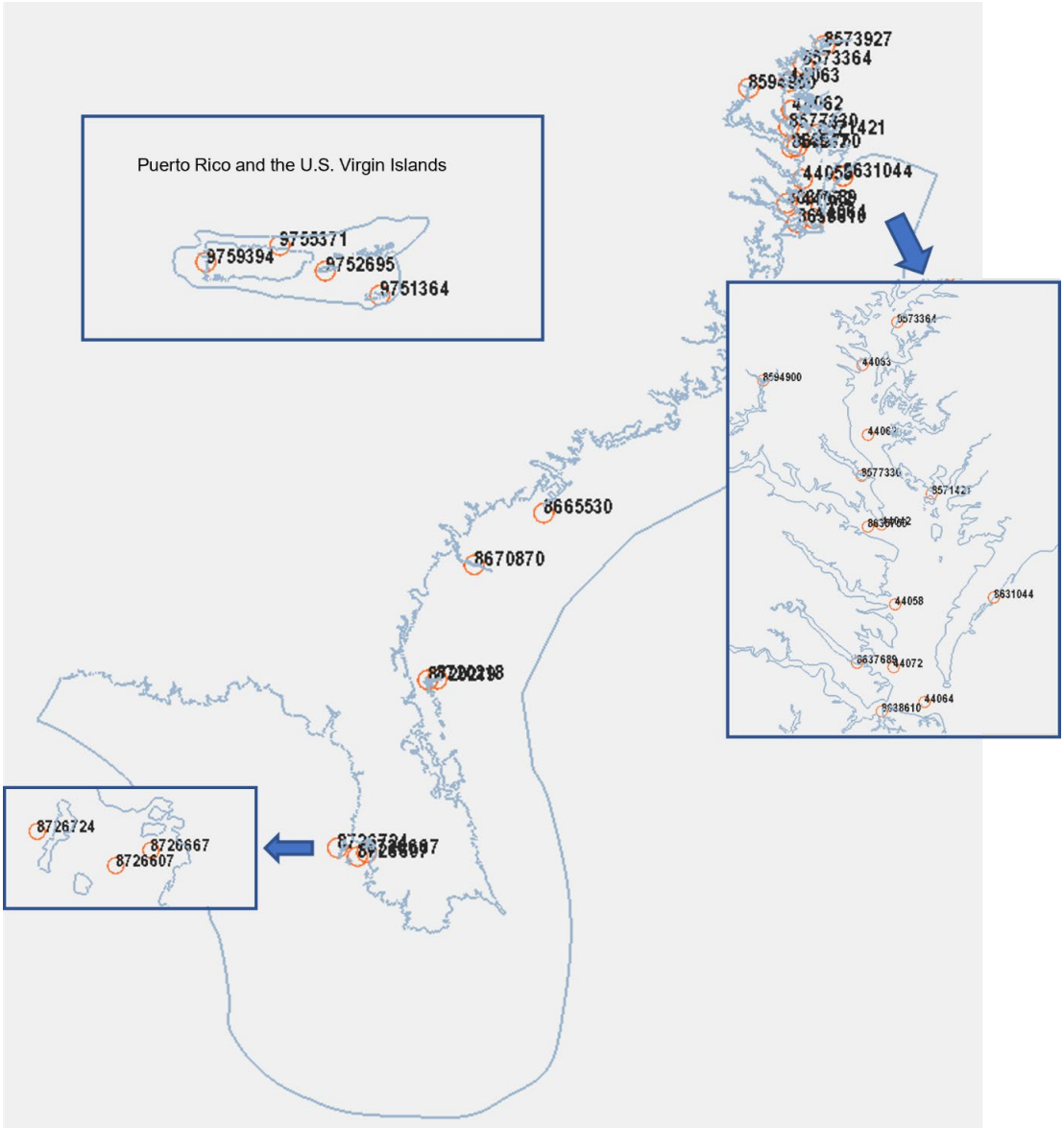


Figure 18. Map of all NOAA water temperature stations (Table 11 and Table 12).

Table 13. Station metadata of water temperature observations from USGS gauges.

#	ID	Station Name	State	Longitude (°E)	Latitude (°N)	Sensor Depth (ft)
1	294213081345300	St. Johns River at Dancy Point Near Spuds	FL	-81.581200	29.703899	-11.5
2	301124081395901	St. Johns River Buckman Bridge at Jacksonville	FL	-81.666199	30.190201	-8
3	301510081383500	St. Johns Rvr at Christopher PT Nr Jacksonville	FL	-81.648903	30.249500	-4
4	301817081393600	St. Johns River BL Marco LK at Jacksonville	FL	-81.665001	30.308399	-4
5	02246500	St. Johns River at Jacksonville	FL	-81.665398	30.322500	-17
6	302309081333001	St. Johns R Dames Point Bridge at Jacksonville	FL	-81.558197	30.386101	-15
7	02198980	Savannah River at Fort Pulaski	GA	-80.906097	32.035801	-13.2
8	021989773	Savannah River at Usace Dock, at Savannah	GA	-81.081398	32.080399	-7.4
9	0219897945	Back River 0.4 MI Downstream US17, NR Savannah	GA	-81.082802	32.097801	-3.3
10	0219897993	Savannah River at Elba Island, Near Savannah	GA	-81.006897	32.103100	-12
11	021989715	Savannah River at Garden City	GA	-81.128304	32.116100	-13.3
12	021989793	Little Back River at Hog Island, Near Savannah	GA	-81.121902	32.136700	-3.3
13	02198955	Middle River at Fish Hole at Port Wentworth	GA	-81.135300	32.142799	-13
14	02198920	Savannah River at GA 25, at Port Wentworth	GA	-81.154900	32.165298	-8.1
15	02198950	Middle River at GA 25 at Port Wentworth	GA	-81.138000	32.165699	-12
16	021989792	Little Back River at GA 25 at Port Wentworth	GA	-81.129997	32.165798	-12.4
17	02198820	Abercorn Creek at Mouth Near Savannah	GA	-81.153603	32.249199	-7
18	02198810	Abercorn Creek Near Savannah	GA	-81.178001	32.256001	-7.6
19	021989791	Little Back River at FW Dock, Near Limehouse	SC	-81.117599	32.171001	-7.7
20	021989784	Little Back River Above Lucknow Canal, Near Limehouse	SC	-81.117897	32.185799	-3.9
21	021720710	Cooper River at Customs House Aux at Charleston	SC	-79.921097	32.780499	-5.3
22	021720709	Cooper River at Us Hwy 17 at Charleston	SC	-79.910103	32.802399	N/A
23	021720869	Ashley River Near North Charleston	SC	-80.023697	32.834599	N/A
24	0217206935	Cooper River at Ports Authority Pier K Charleston	SC	-79.952698	32.855701	-13.33
25	021720698	Wando River Above MT Pleasant	SC	-79.896202	32.859100	-22.1
26	021720677	Cooper River at Filbin Creek at North Charleston	SC	-79.962898	32.890499	-8.5
27	0217206962	Wando River at Cainhoy Below Wando	SC	-79.824402	32.921299	N/A
28	02172053	Cooper River at Mobay Near N Charleston	SC	-79.922401	32.984100	-6.9
29	021720508	Cooper River Above Goose Creek	SC	-79.906799	33.015800	-7.8
30	02172020	W Branch Cooper River at Pimlico Near Moncks Corner	SC	-79.944702	33.096500	-8.9

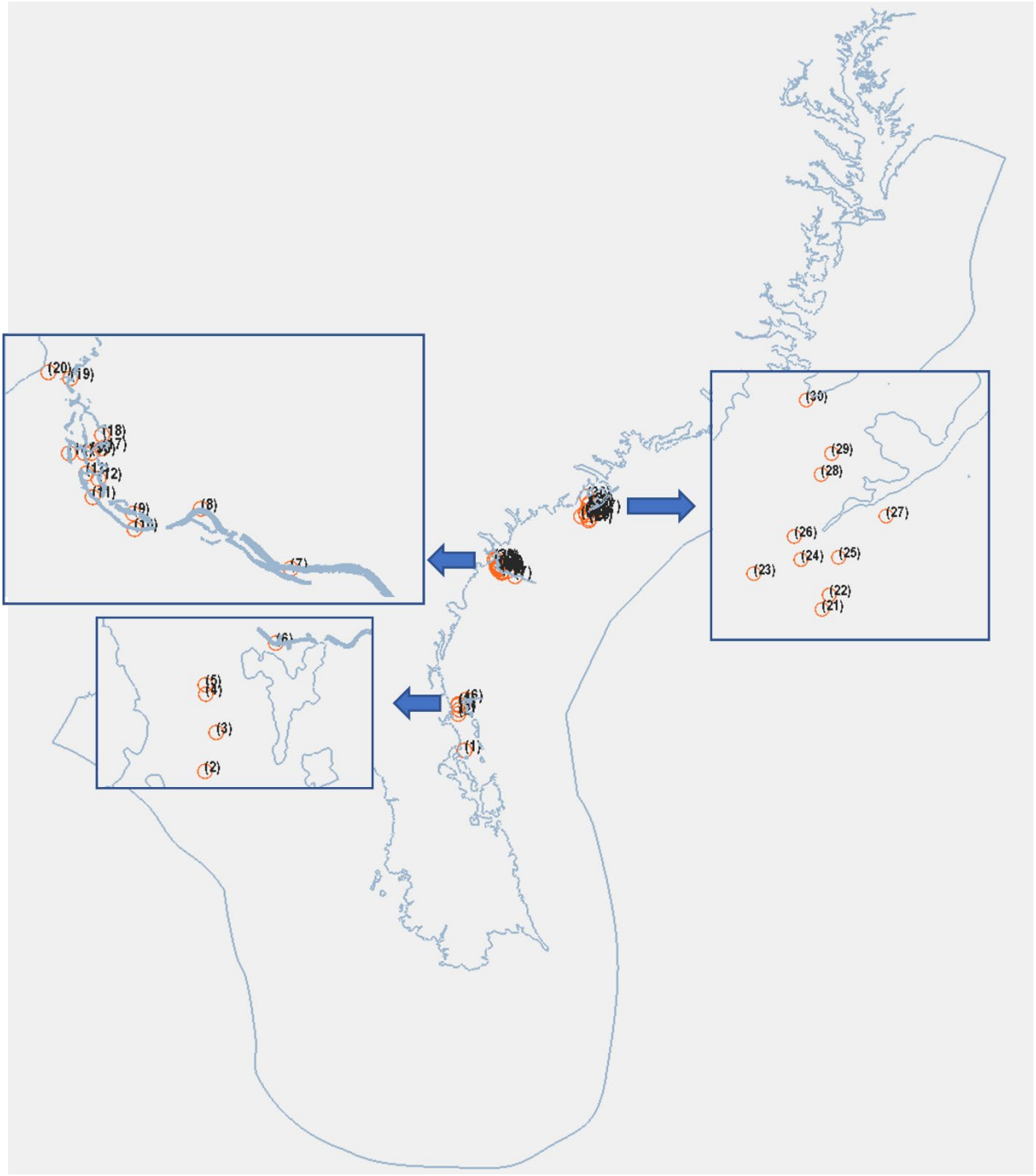


Figure 19. Map of USGS water temperature stations (Table 13).

5.3.4 Salinity

The salinity (SSS) data was collected from three resources too: the CO-OPS, the NDBC (buoys are owned and maintained by CBIBS), and the USGS. NDBC assigned IDs to the CBIBS buoys, and the data has gone through NDBC's post-processing analysis. Tables 14 - 16

show the station IDs, names, geographical and sensor depths information for salinity from three resources, respectively. Note that the sensor depth units shown in the tables are different. Figure 20 and Figure 21 display the station maps for NOAA and USGS stations respectively.

Table 14. Station metadata of salinity observations from CO-OPS gauges.

#	ID	Station Name	State	Longitude (°E)	Latitude (°N)	Sensor Depth (ft)
1	8720219	Dames Point	FL	-81.558701	30.386000	-3.4
2	8638610	Sewells Point	VA	-76.335403	36.943199	-3.9
3	8637689	Yorktown USCG Training Center	VA	-76.478302	37.226700	-10.1
4	8635750	Lewisetta	VA	-76.415398	38.021099	-4.1
5	8573927	Chesapeake City	MD	-75.939400	39.487598	-5.5

Table 15. Station metadata of salinity observations from CBIBS' depth-rated buoys.

#	ID	Station Name	State	Longitude (°E)	Latitude (°N)	Sensor Depth (below water line, m)
1	44063	Annapolis	MD	-76.4475	38.96306	-0.5
2	44062	Gooses Reef	MD	-76.41472	38.55639	-0.5
3	44042	Potomac	MD	-76.33556	38.03306	-0.5
4	44058	Stingray Point	VA	-76.2575	37.56722	-0.5
5	44072	York Spit	VA	-76.26611	37.20056	-0.5
6	44064	First Landing	VA	-76.08722	36.99806	-0.5

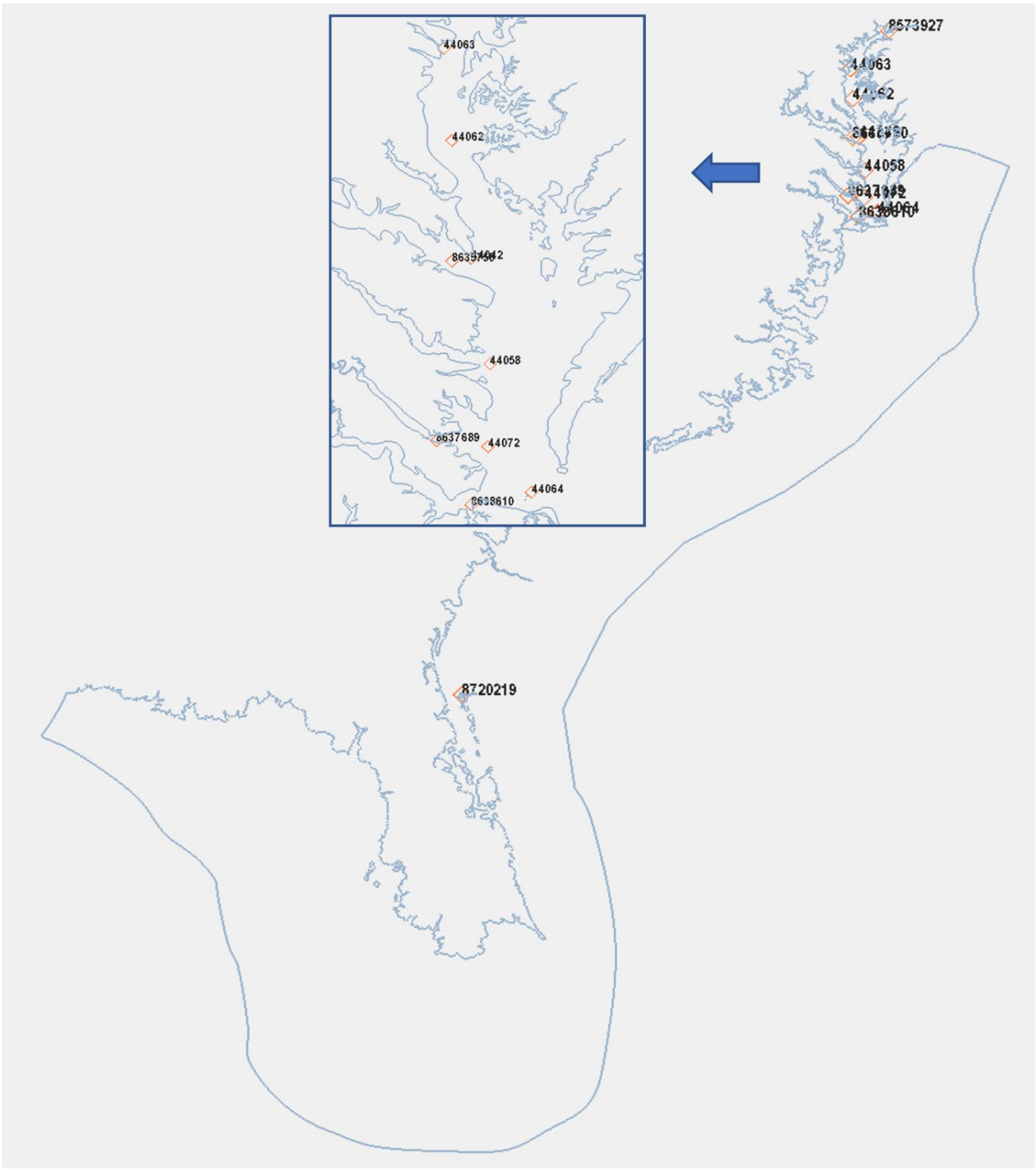


Figure 20. Map of all NOAA water salinity stations (Table 14 and Table 15).

Table 16. Station metadata of water salinity observations from USGS gauges.

#	ID	Station Name	State	Longitude (°E)	Latitude (°N)	Sensor Depth (ft)
1	294213081345300	St. Johns River at Dancy Point Near Spuds	FL	-81.581200	29.703899	-11.5
2	301124081395901	St. Johns River Buckman Bridge at Jacksonville	FL	-81.666199	30.190201	-8
3	301510081383500	St. Johns Rvr at Christopher PT Nr Jacksonville	FL	-81.648903	30.249500	-4
4	301817081393600	St. Johns River BL Marco LK at Jacksonville	FL	-81.665001	30.308399	-4
5	02246500	St. Johns River at Jacksonville	FL	-81.665398	30.322500	-17
6	302309081333001	St. Johns R Dames Point Bridge at Jacksonville	FL	-81.558197	30.386101	-15
7	02198980	Savannah River at Fort Pulaski	GA	-80.906097	32.035801	-13.2
8	021989773	Savannah River at Usace Dock, at Savannah	GA	-81.081398	32.080399	-7.4
9	0219897945	Back River 0.4 MI Downstream US17, NR Savannah	GA	-81.082802	32.097801	-3.3
10	0219897993	Savannah River at Elba Island, Near Savannah	GA	-81.006897	32.103100	-12
11	021989715	Savannah River at Garden City	GA	-81.128304	32.116100	-13.3
12	021989793	Little Back River at Hog Island, Near Savannah	GA	-81.121902	32.136700	-3.3
13	02198955	Middle River at Fish Hole at Port Wentworth	GA	-81.135300	32.142799	-13
14	02198920	Savannah River at GA 25, at Port Wentworth	GA	-81.154900	32.165298	-8.1
15	02198950	Middle River at GA 25 at Port Wentworth	GA	-81.138000	32.165699	-12
16	021989792	Little Back River at GA 25 at Port Wentworth	GA	-81.129997	32.165798	-12.4
17	021989791	Little Back River at FW Dock, Near Limehouse	SC	-81.117599	32.171001	-7.7
18	021989784	Little Back River Above Lucknow Canal, Near Limehouse	SC	-81.117897	32.185799	-3.9
19	02172053	Cooper River at Mobay Near N Charleston	SC	-79.922401	32.984100	-6.9

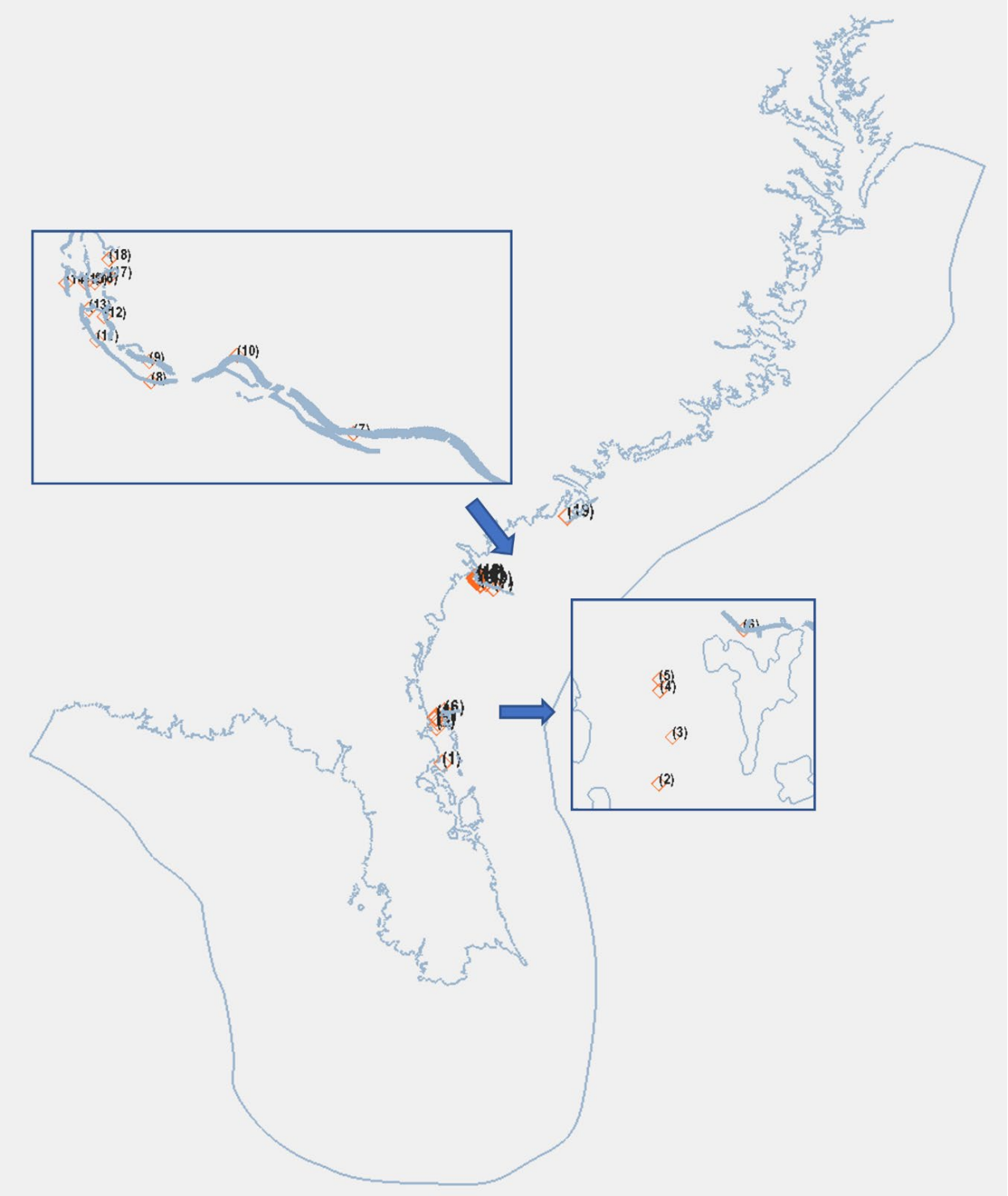


Figure 21. Map of USGS water salinity stations (Table 16).

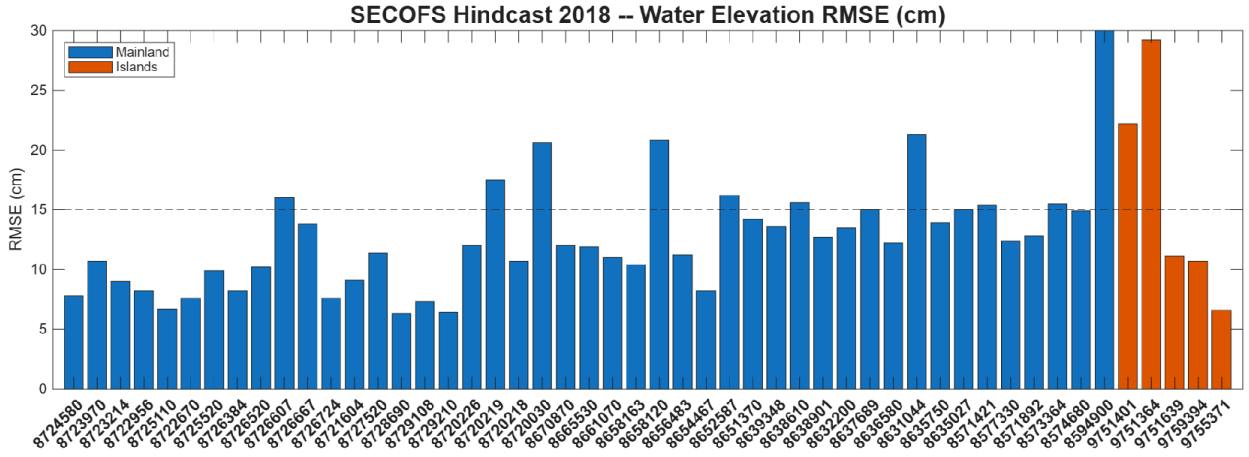
5.4 Hindcast Skill Assessment Results

SECOFS model output from January 1, 2018 to December 31, 2018 were organized into time series for analysis using the skill assessment software. The Fortran based 1st version skill assessment package was used to evaluate water level, water temperature and salinity. The Python based next-generation skill assessment package was used to handle water current skill assessments. For water level and current skill assessments, 6-minute interval model outputs were compared with 6-minute observation data. For water temperature and salinity, skill assessments were conducted using both hourly and 6-minute interval model outputs, and the results are invariably consistent.

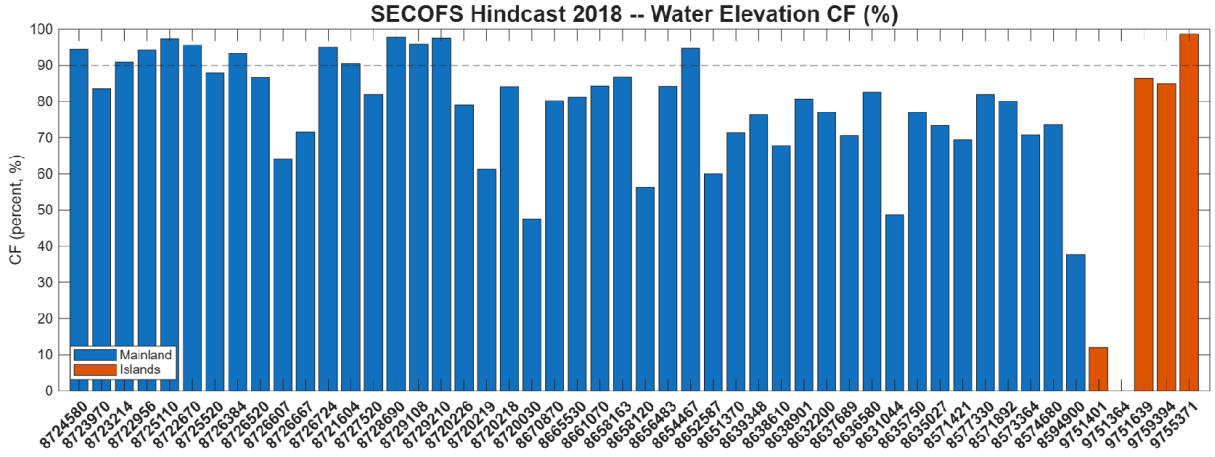
5.4.1. Water Level

A vertical datum conversion was made from the model's geoid-based vertical datum to the LMSL to match the observation data datum for all SECOFS station WL outputs. A Python package, "coastalmodeling-vdatum" (Cassalho et al., 2026b, https://github.com/oceanmodeling/coastalmodeling-vdatum), was used for the WL data datum conversion from xGEOID20b to LMSL.

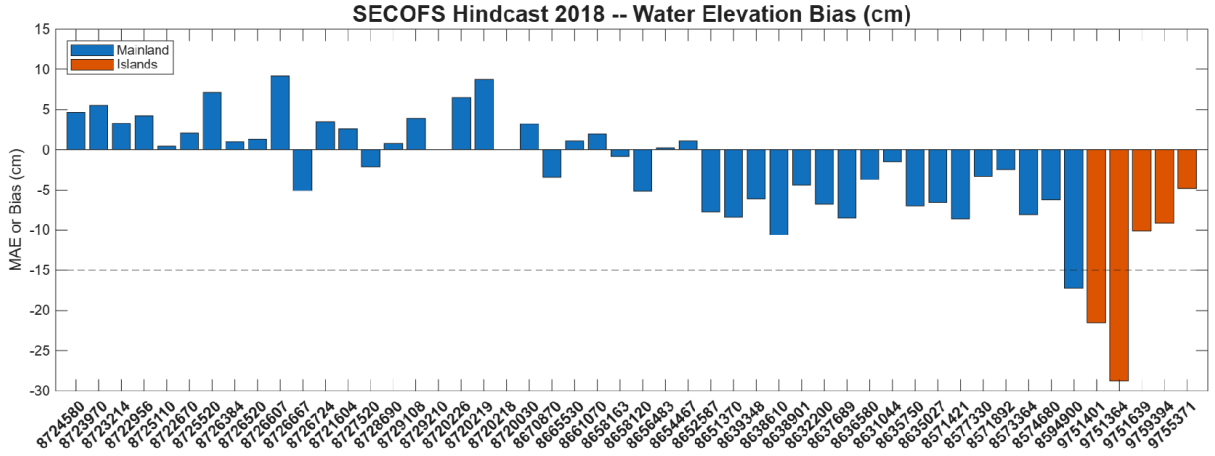
The bar graphs of Figures 22(a), 22(b), and 22(c) exhibit the RMSE, CF, and Bias for all 50 WL stations (datum converted from xGEOID20b to LMSL), respectively. The RMSE from all U.S. southeast coast stations ranges from 6.3 cm at west Florida to 30 cm at station 8594900 Washington DC. The CF ranges from 40% to 98%. The average RMSE and CF are equal to about 12.6 cm and 80%, respectively. Figure 23 showed the RMSEs and CFs at 50 stations (Table 7) on a map. In general, the water level prediction at the bay areas performed well, yet at some stations are challenging. The simulations at the open ocean demonstrated a high standard of work.



(a)



(b)



(c)

Figure 22. Skill assessment results, (a) RMSE, (b) CF, and (c) Bias, of the total water level at 50 stations (Table 7, blue: southeast coast of US mainland, and orange: Puerto Rico and US Virgin Islands).

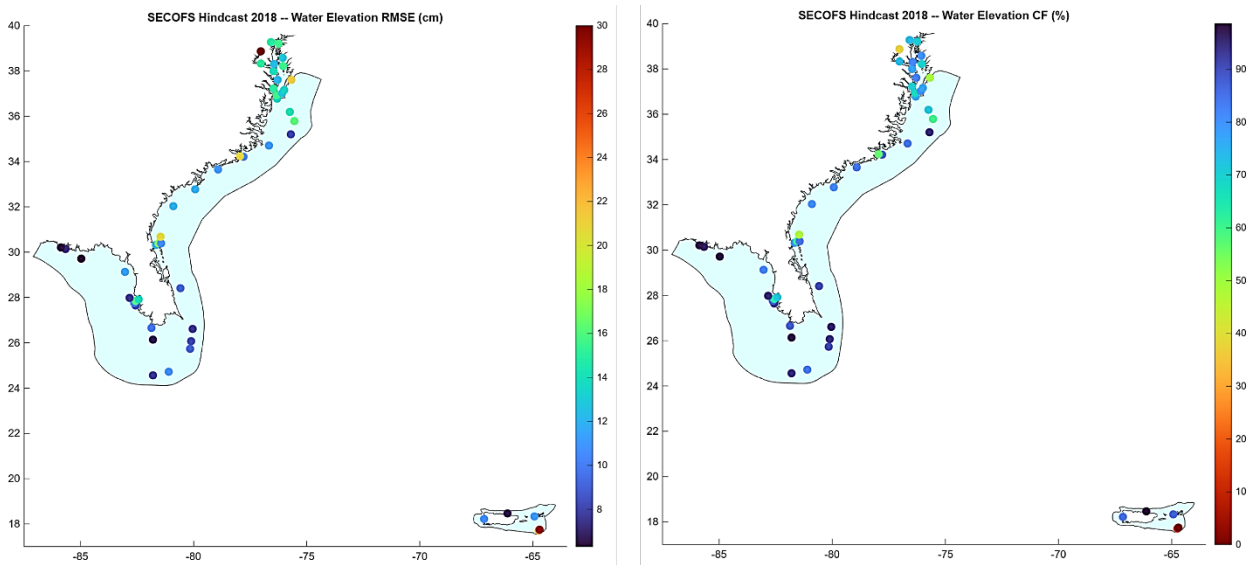
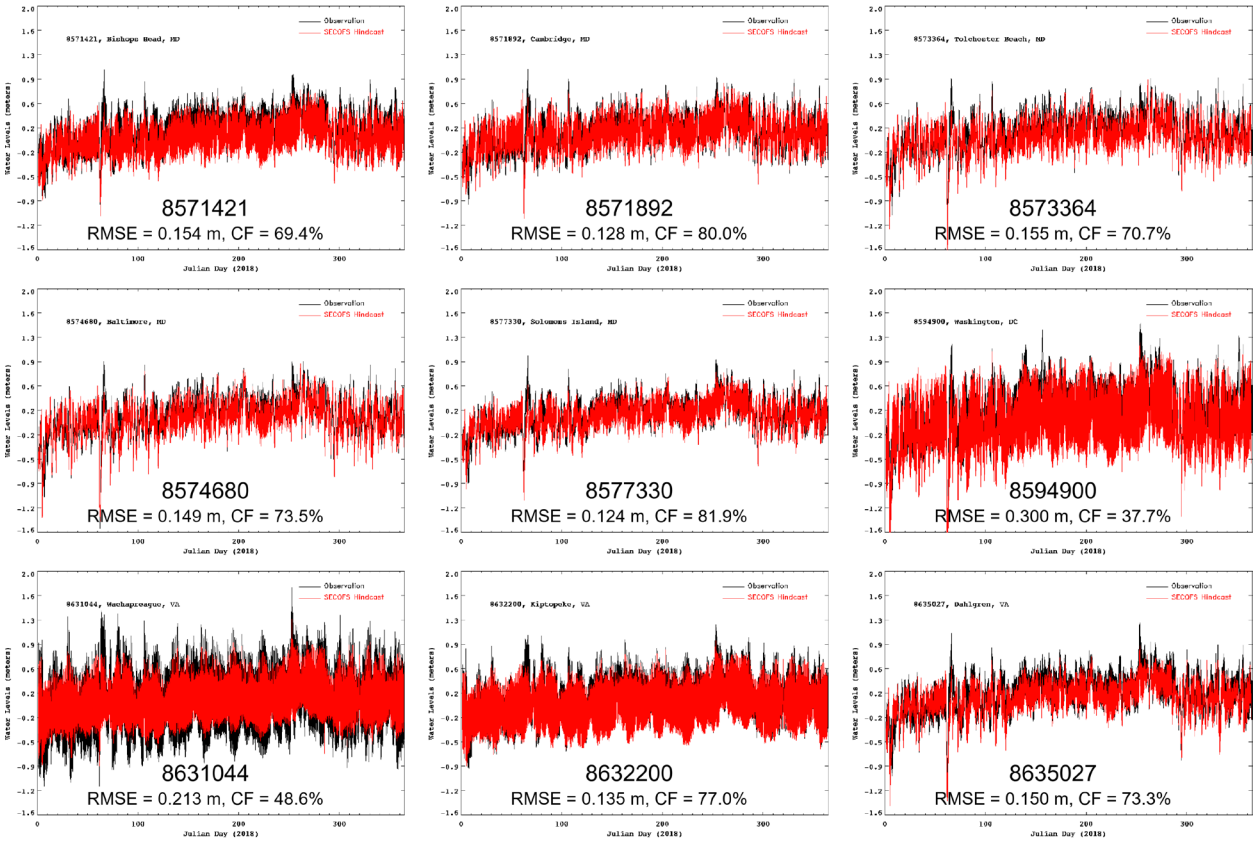
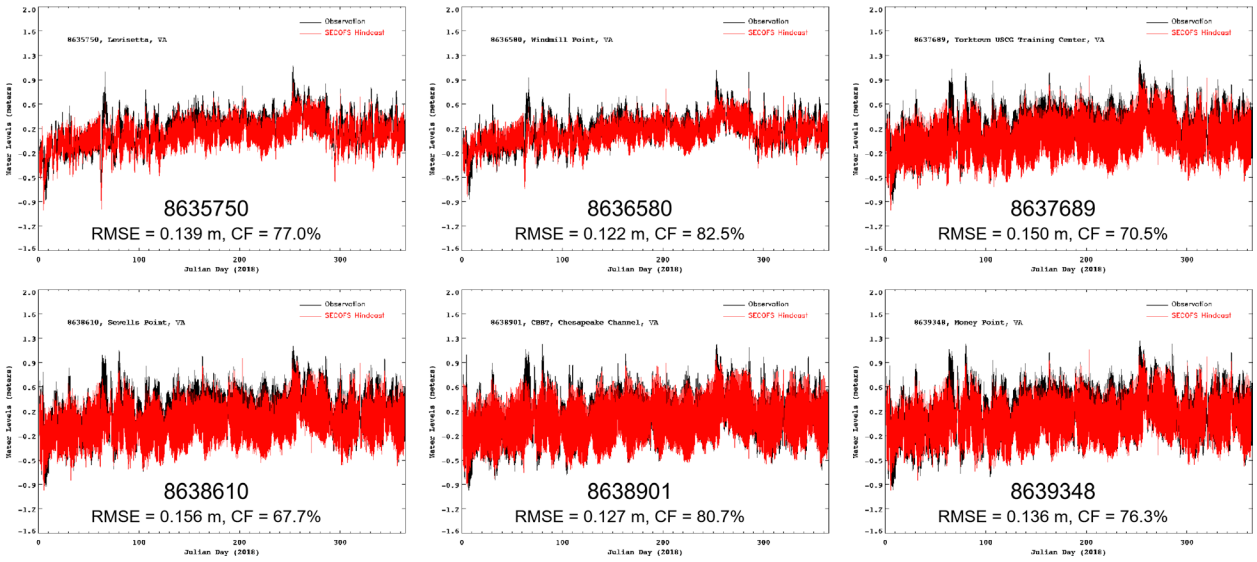
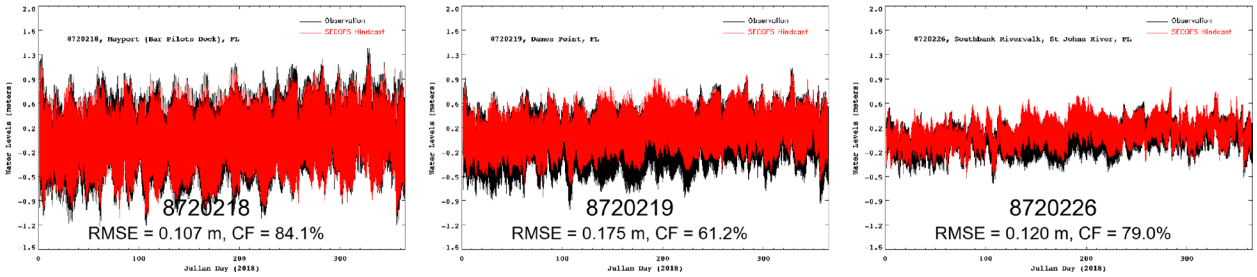


Figure 23. The RMSE (a) and CF (b) map of the hindcast total water levels at 50 CO-OPS stations (Table 7).

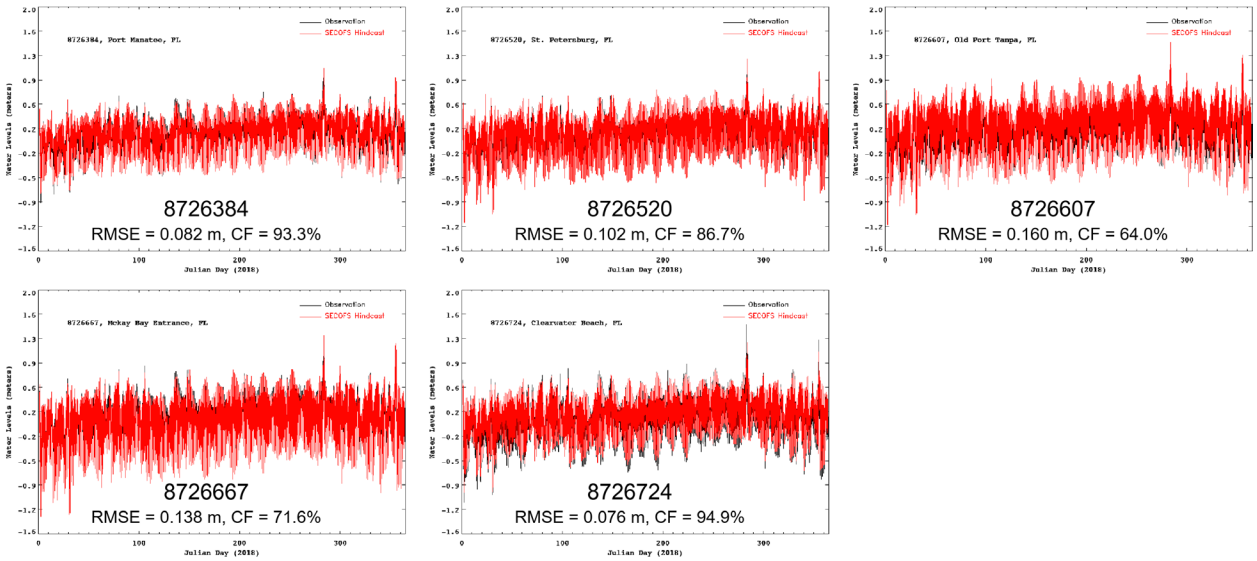




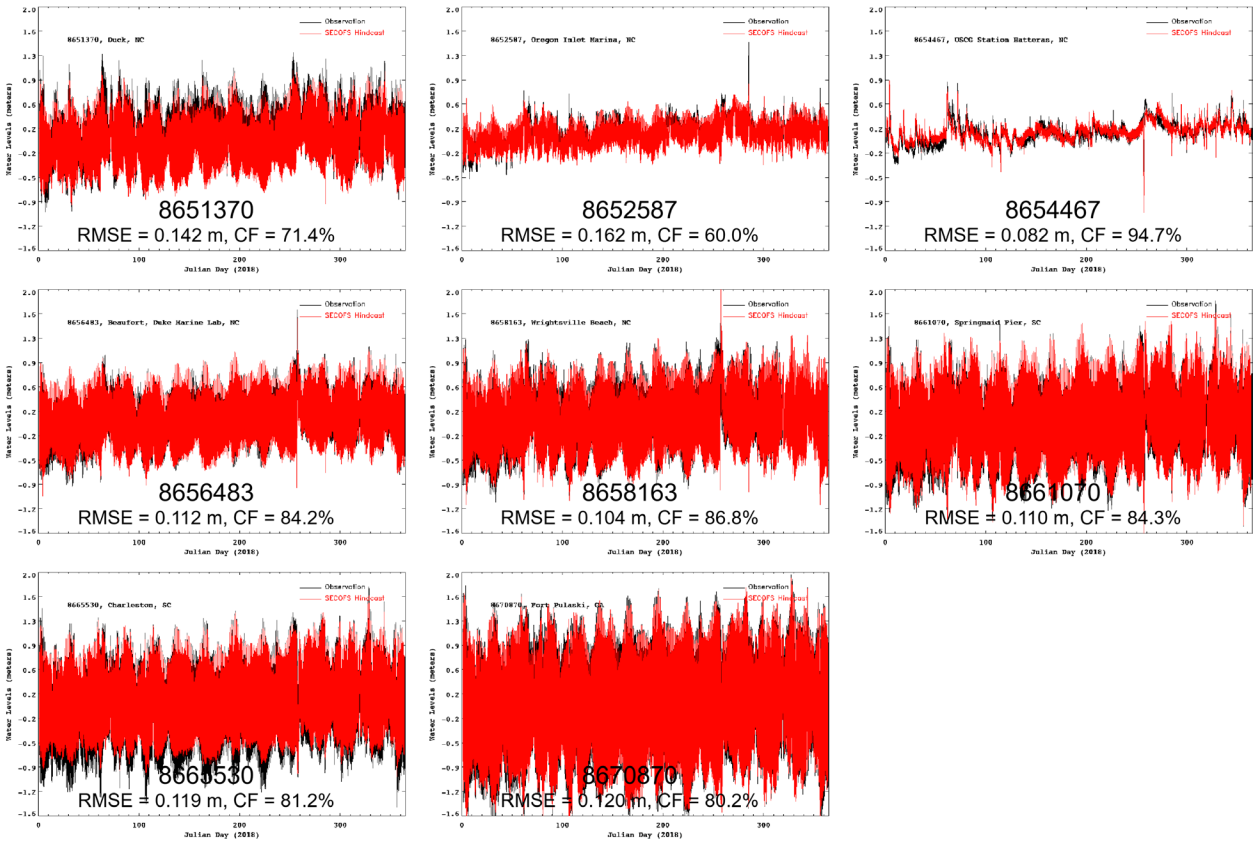
(a) Chesapeake Bay



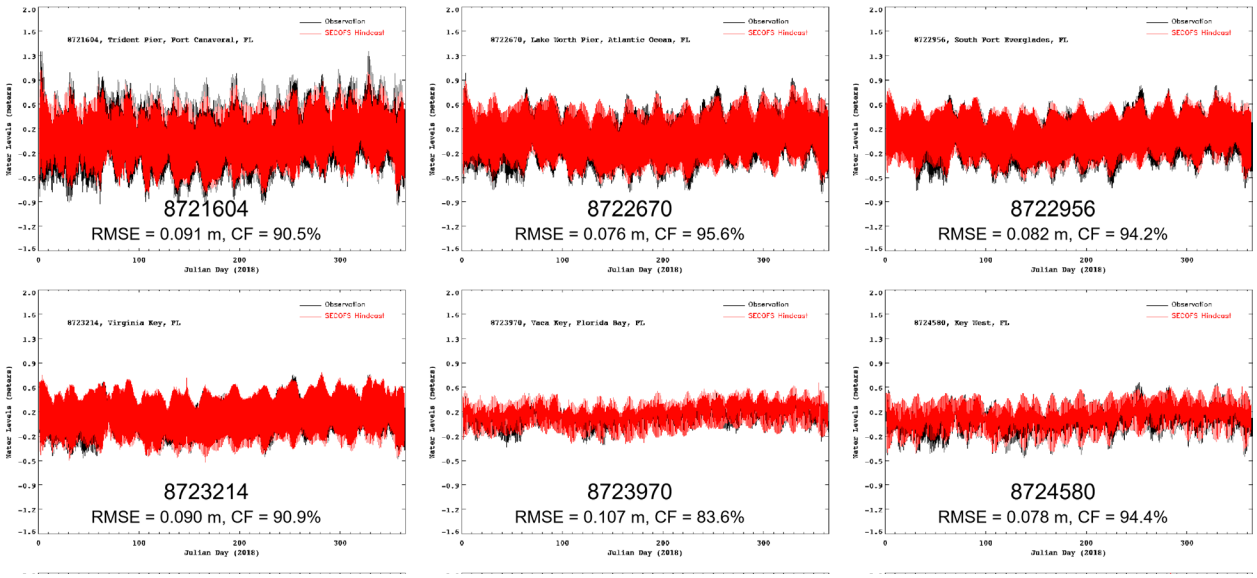
(b) St. John's River

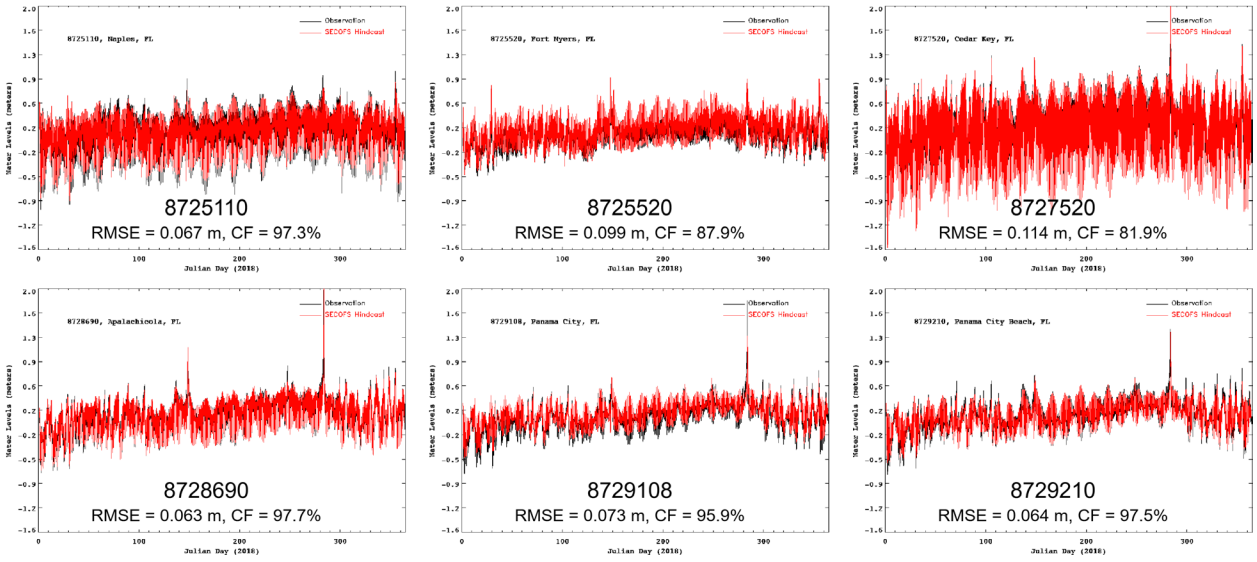


(c) Tampa Bay

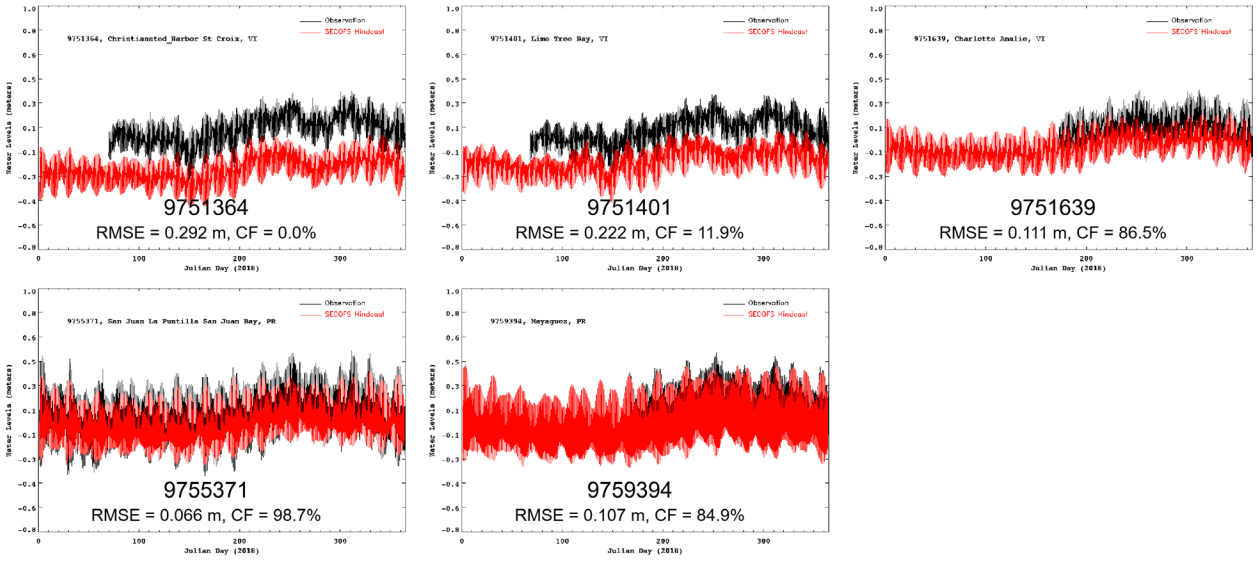


(d) NC, SC, and GA coastal





(e) Other stations in FL



(f) PR and VI

Figure 24. Comparison of hindcast (red) vs. observed (black) water level time series, RMSE, and CF at: (a) Chesapeake Bay, (b) St. John's River, (c) Tampa Bay, (d) NC, SC, and GA coastal, (e) Other stations at FL, and (f) PR and VI.

The averaged RMSE and CF at CBOFS region are 15.6 cm and 71% respectively. These values at the SJROFS and the TBOFS regions are 13.4cm and 74.8%, and 11.1 cm and 82.1%. The water

level simulation at all FL stations match best to the observations. Correspondingly, the averaged CF is 92.3% and the averaged RMSE is 8.4 cm.

The vertical datum conversion accounts for the dramatic RMSE and CF variations at three VI stations. Table 17 shows the improvements of CFs after using the newer geopotential datum GEOID2022. Further experiments might be conducted to examine the influence brought by the datum accuracy at different locations.

Table 17. CF comparisons at five PR and VI stations using different datum conversion values.

ID	Lon	Lat	xGEOID20b	GEOID2022
			CF (%)	CF (%)
9751401	-64.753334	17.695000	11.9	93.6
9751364	-64.698334	17.748333	0	53.0
9751639	-64.925003	18.333332	86.5	99.9
9759394	-67.162476	18.218863	84.9	88.8
9755371	-66.116669	18.458332	98.7	97.7

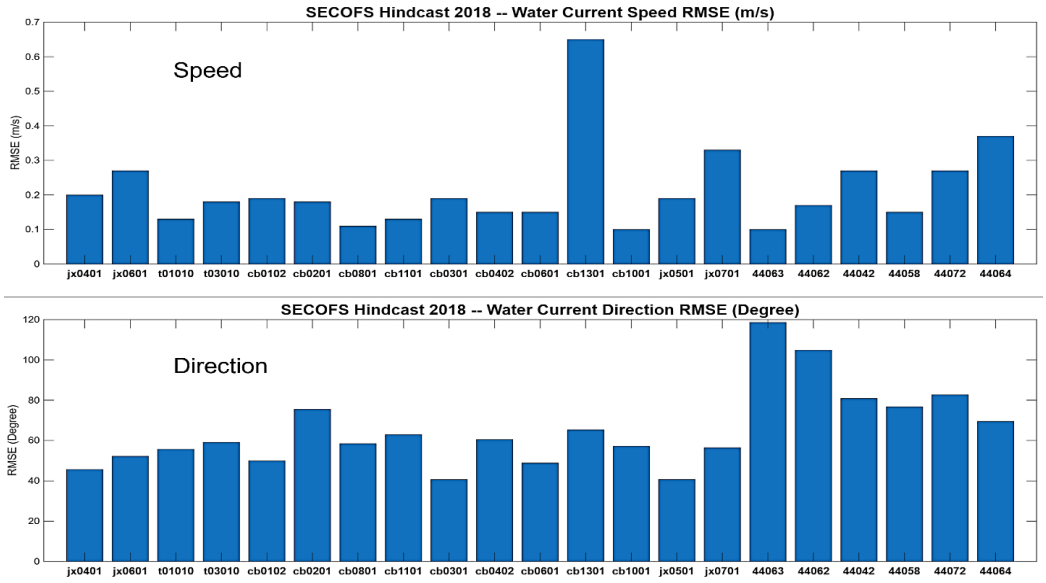
5.4.2. Current

The model current time series and the observed current time series, at 16 CO-OPS CMIST buoys and 6 CBIBS buoys (Section 5.3.2), were compared. There are multiple vertical or horizontal bins at each CMIST observation buoy location; however, only one depth data was selected at each station for carrying out current skill assessment. The selection is generally close to the 4.5 m below the water surface which is the current navigation depth.

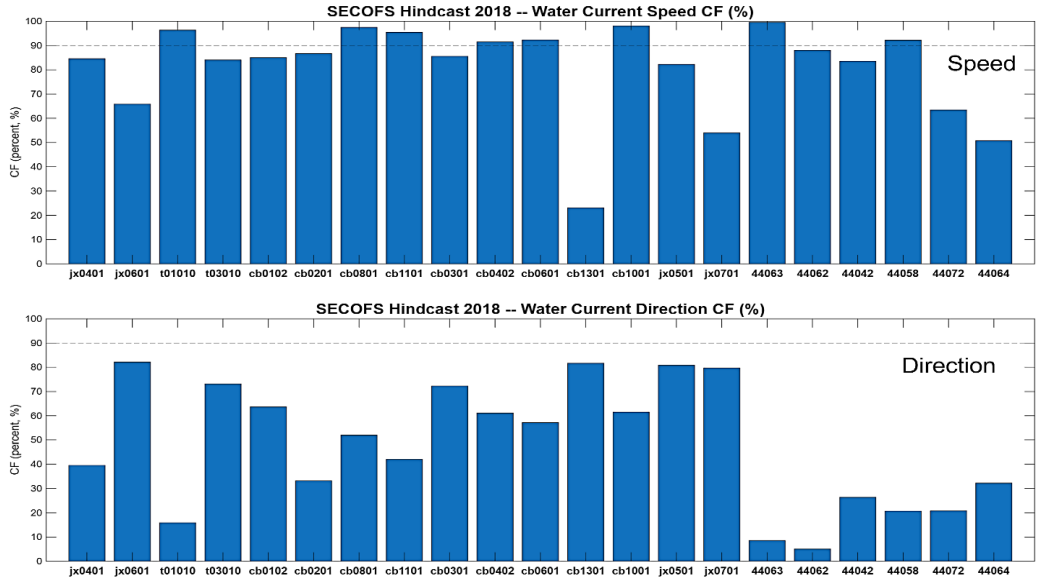
The bar graphs of Figures 25(a) and (b) show the RMSE and CF of both current speed and current direction for buoy stations, respectively. The current speed SA results at all locations are comparable with each other except at cb1301, Chesapeake City. Note that, the Chesapeake City is located at the Back Creek where the SEOCFS mesh ends a few miles away, and there is no outlet to the Delaware River. Therefore, the current data at this location should not be evaluated. The current direction comparisons at all CBIBS (NDBC) buoys are generally poor than the CMIST buoys. Since all CBIBS buoys are depth-rated buoys, the current direction accuracy depends heavily on surface wave action, compass calibration, and buoy motion compensations etc., and therefore the data quality is unknown.

Figure 26 demonstrated comparisons between the model current time series (red) and the observed current time series (black) at all stations across the SECOFS domain. The model results display generally favorable agreement with observations in both magnitude and direction. This favorable

agreement can be seen from all CMIST buoys except the amplitude at the Chesapeake City (explained above). The current speed at all CBIBS stations also exhibit well agreement.

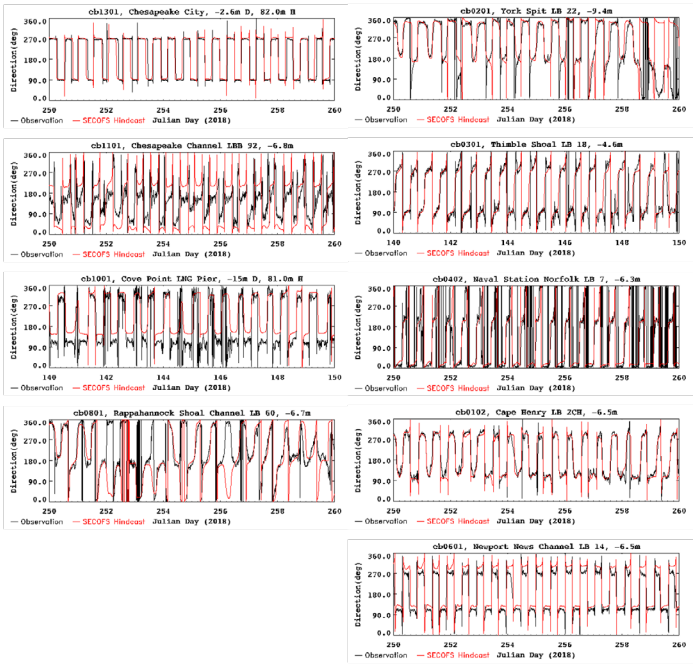


(a)

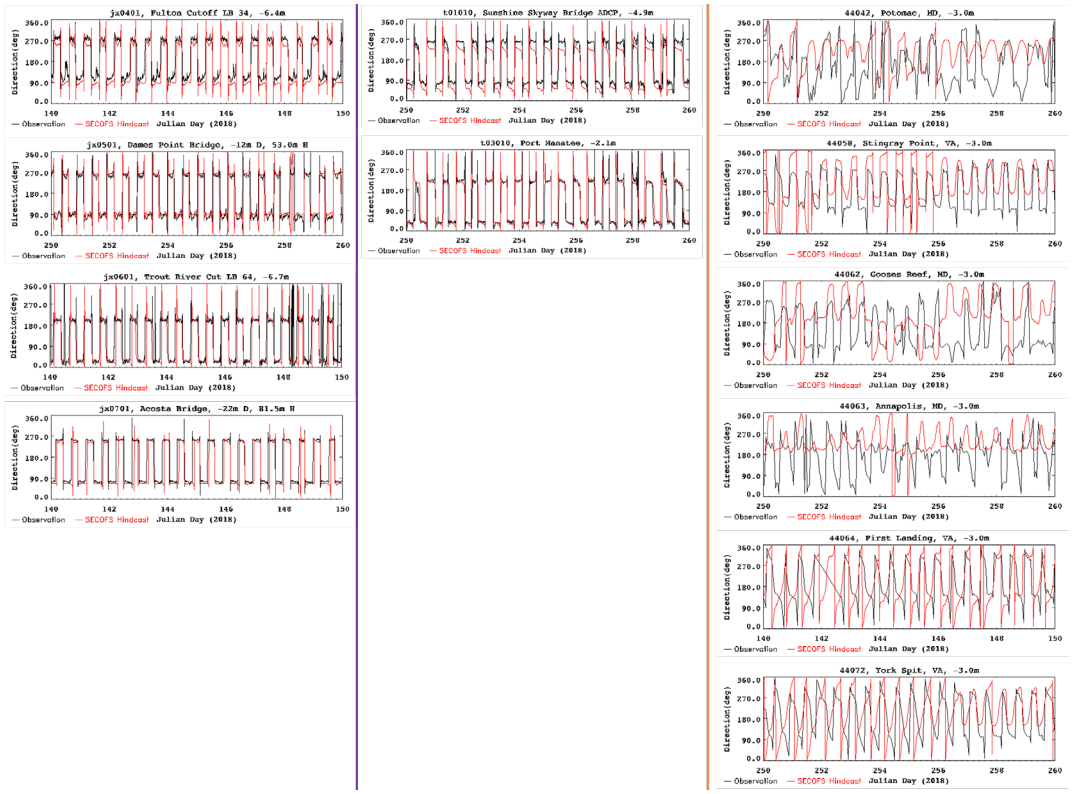


(b)

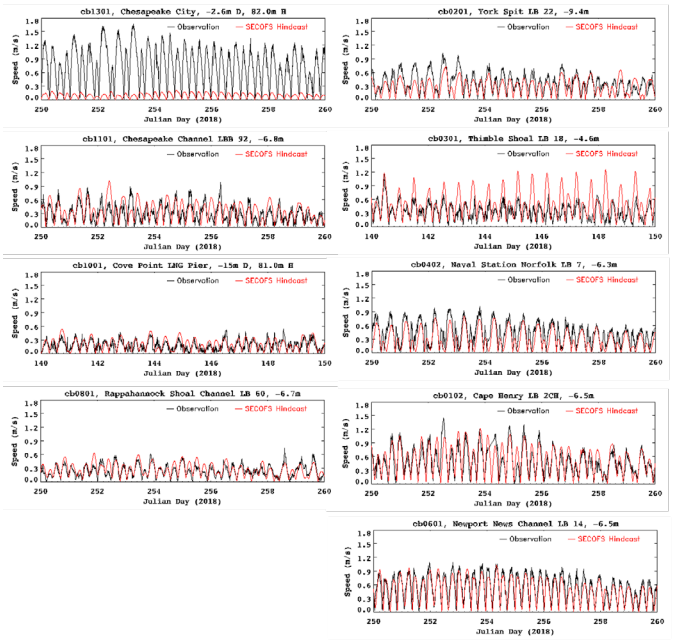
Figure 25. Skill assessment results, (a) RMSE and (b) CF, of the water current at different buoy stations.



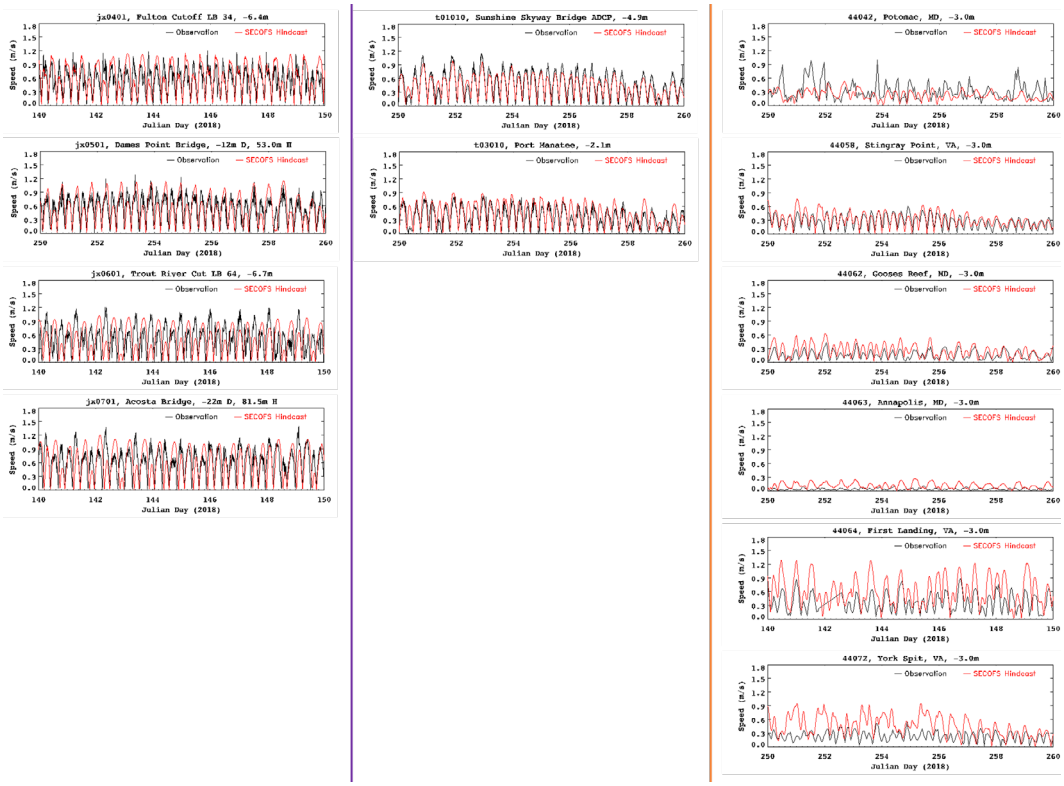
(a.1) Direction in the northern (first column) and southern (second column) Chesapeake Bay.



(a.2) Direction in Jacksonville, Tampa Bay, and at CBIBS buoys, from left to right columns.



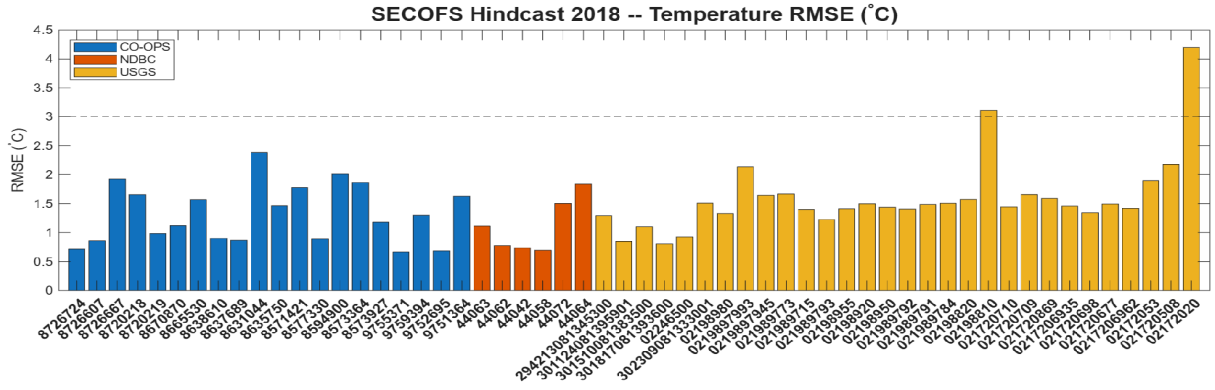
(b.1) Speed in the northern (first column) and southern (second column) Chesapeake Bay.



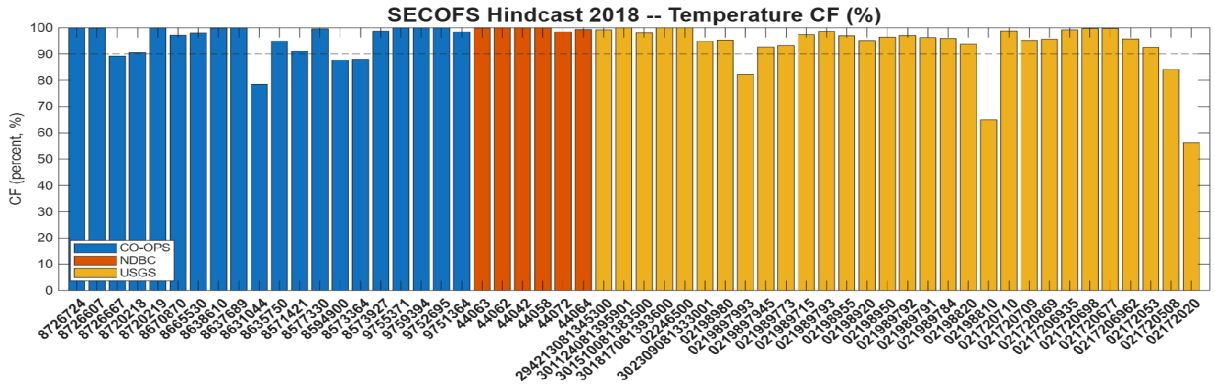
(b.2) Speed in Jacksonville, Tampa Bay, and at CBIBS buoys, from left to right columns.

Figure 26. Comparison of modeled (red) and observed (black) (a) current direction and (b) speed at all buoys.

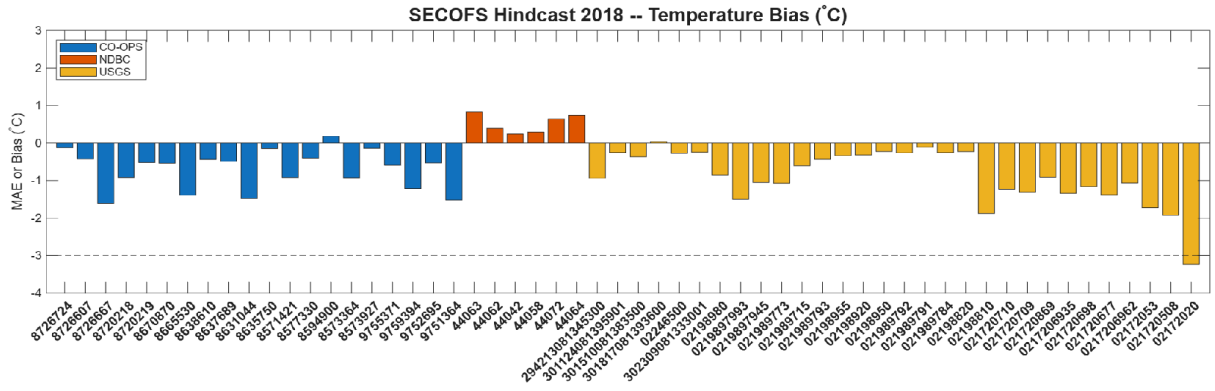
5.4.3. Temperature



(a)



(b)



(c)

Figure 27. Skill assessment results, (a) RMSE, (b) CF, and (c) Bias, of the water temperature at all stations (Tables 11-13, blue: CO-OPS, orange: CBIBS/NDBC, and yellow: USGS).

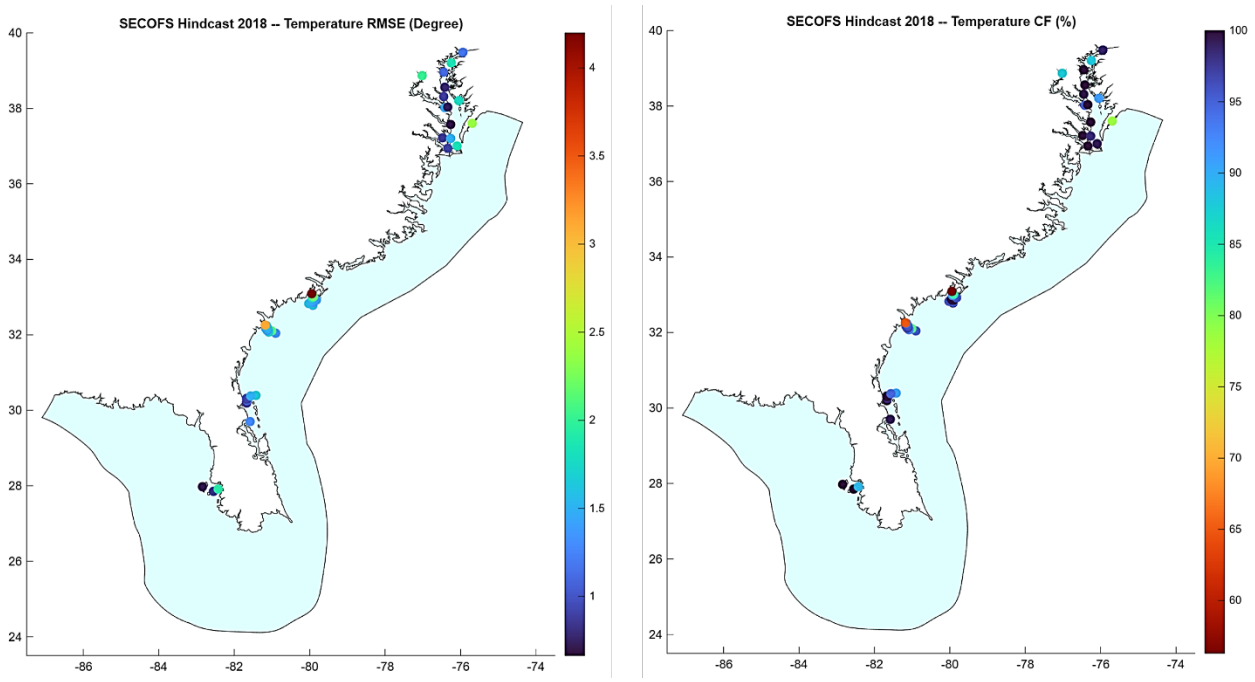
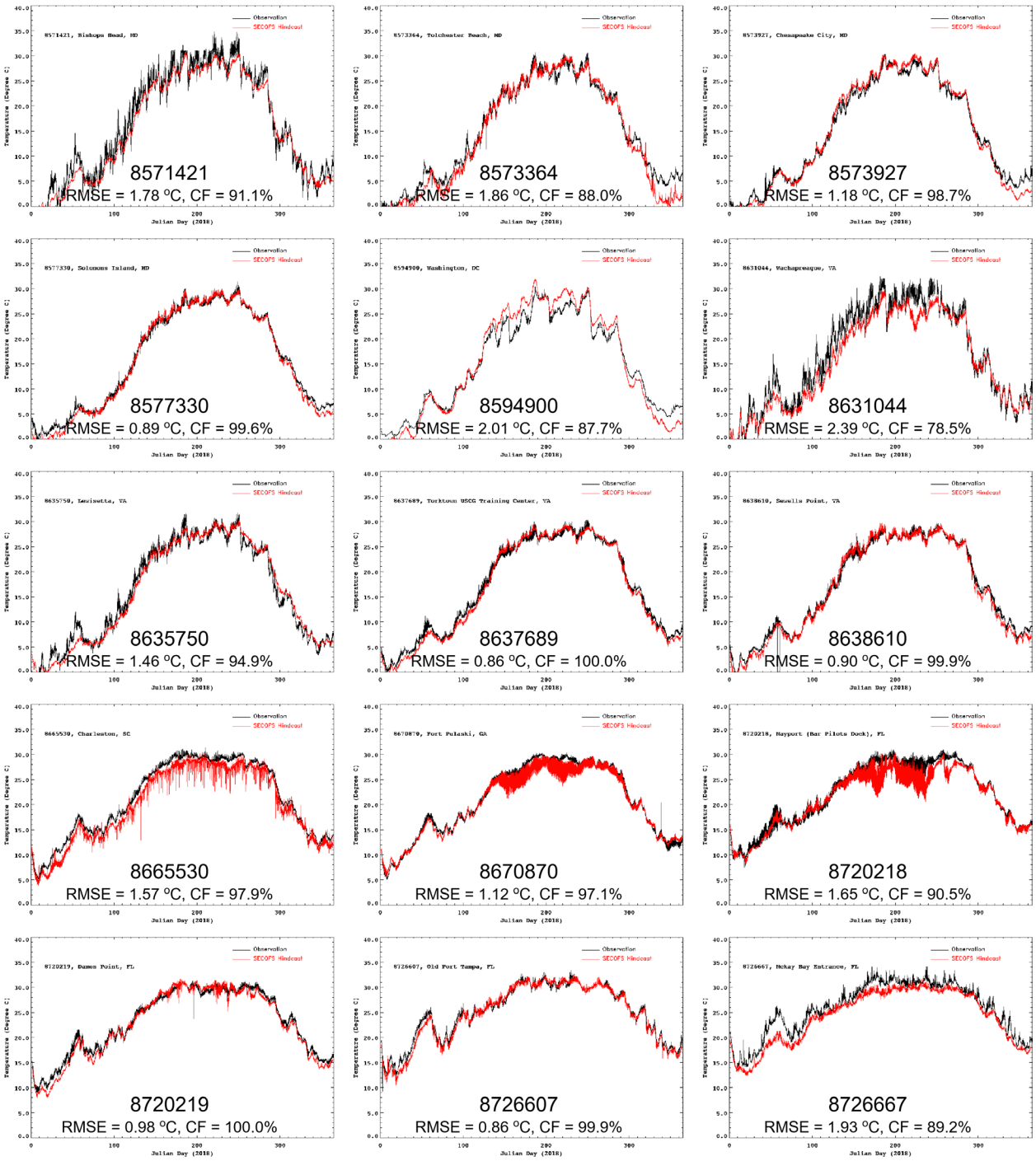
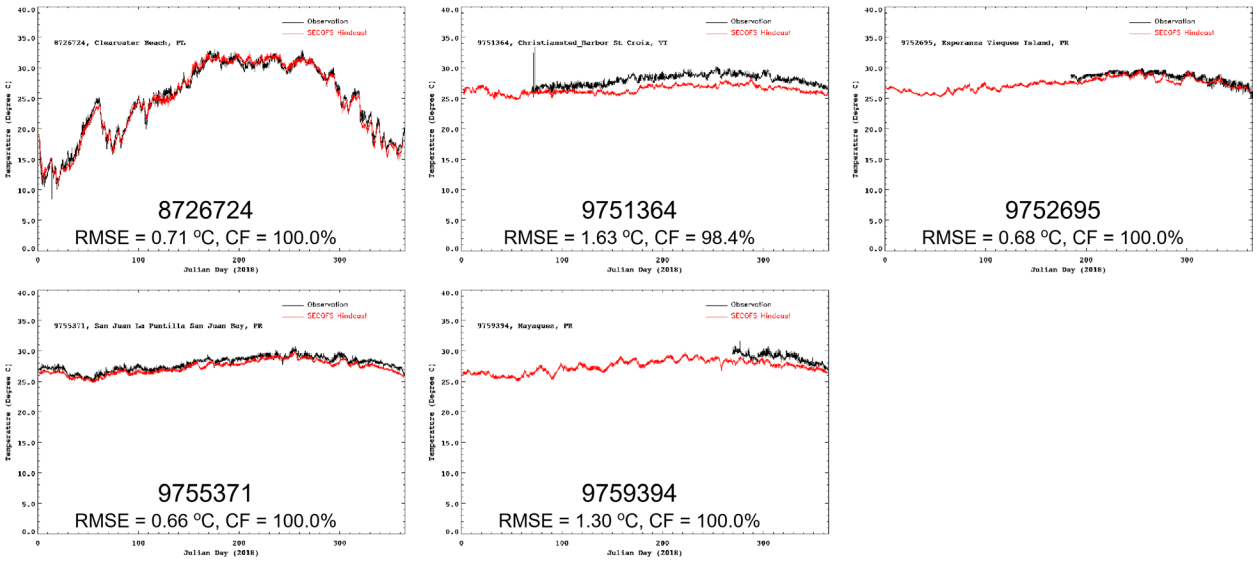


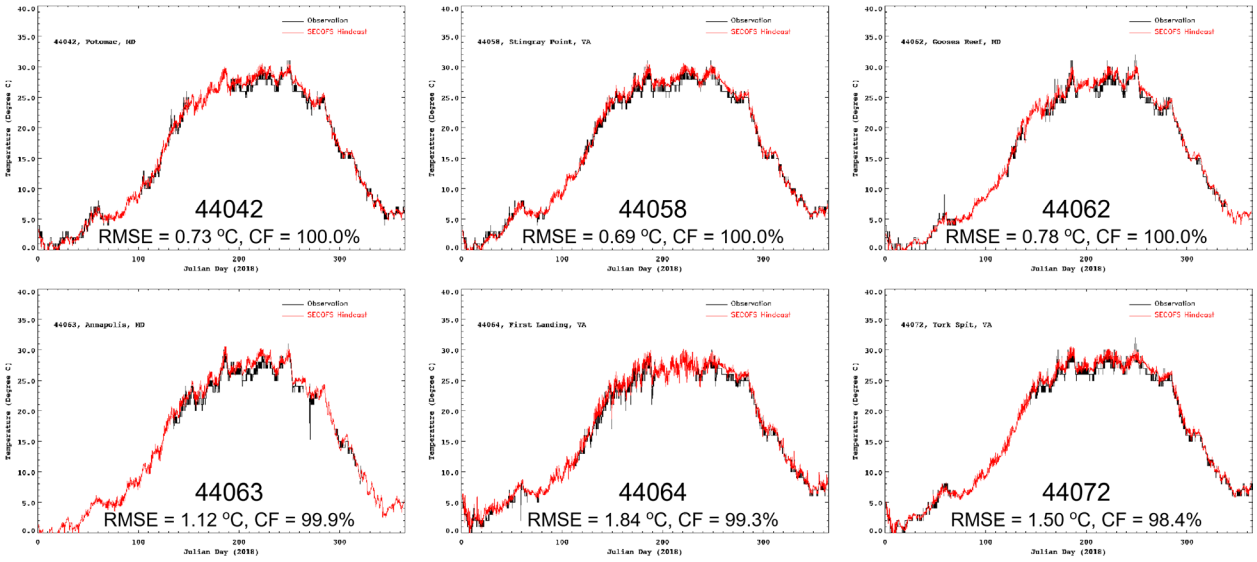
Figure 28. The RMSE (a) and CF (b) map of the hindcast water temperature at all NOAA and USGS stations (Tables 11-13).

The bar graphs of Figures 27 (a) - (c), and Figures 28 (a) and (b) illustrate the RMSE, CF, and the Bias levels and sketch the RMSE and CF distributions of water temperature for all buoy stations, respectively. Overall, the model and the observation data exhibit high agreement except at two USGS stations located at a station at the Cooper River (02172020) and a station at the Abercorn Creek (02198810) respectively. The model vs. observation time series comparison at these two stations clearly demonstrated the poor agreement over the entire hindcast year (Figure 29). The RMSE ranges from 0.7 ℃ to 2.2 ℃, and the CF ranges from 82.2% to 100% at the rest stations.

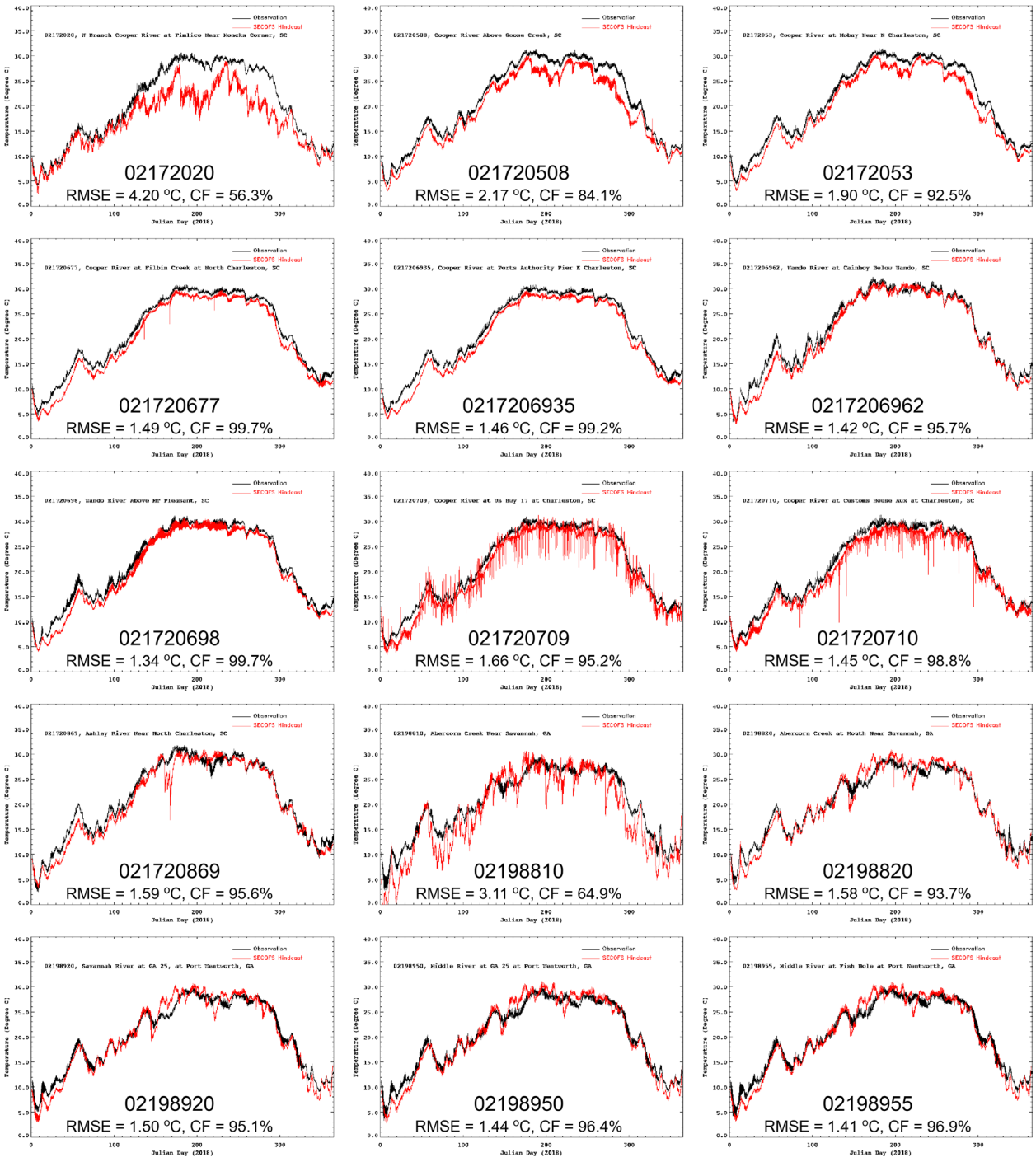

8571421, Bishops Head, MD
8571421
RMSE = 1.78 °C, CF = 91.1%
8573364, Tolchester Beach, MD
8573364
RMSE = 1.86 °C, CF = 88.0%
8573927, Chesapeake City, MD
8573927
RMSE = 1.18 °C, CF = 98.7%
8577330, Solomons Island, MD
8577330
RMSE = 0.89 °C, CF = 99.6%
8594900, Washington, DC
8594900
RMSE = 2.01 °C, CF = 87.7%
8631044, Wachapreague, VA
8631044
RMSE = 2.39 °C, CF = 78.5%
8635750, Lewisetta, VA
8635750
RMSE = 1.46 °C, CF = 94.9%
8637689, Yorktown USCG Training Center, VA
8637689
RMSE = 0.86 °C, CF = 100.0%
8638610, Sewells Point, VA
8638610
RMSE = 0.90 °C, CF = 99.9%
8665530, Charleston, SC
8665530
RMSE = 1.57 °C, CF = 97.9%
8670870, Fort Pulaski, GA
8670870
RMSE = 1.12 °C, CF = 97.1%
8720218, Mayport (Bar Pilots Dock), FL
8720218
RMSE = 1.65 °C, CF = 90.5%
8720219, Dames Point, FL
8720219
RMSE = 0.98 °C, CF = 100.0%
8726607, Old Port Tampa, FL
8726607
RMSE = 0.86 °C, CF = 99.9%
8726667, McKay Bay Entrance, FL
8726667
RMSE = 1.93 °C, CF = 89.2%
Observation
SECOFS Hindcast
Temperature (Degree C)
Julian Day (2018)

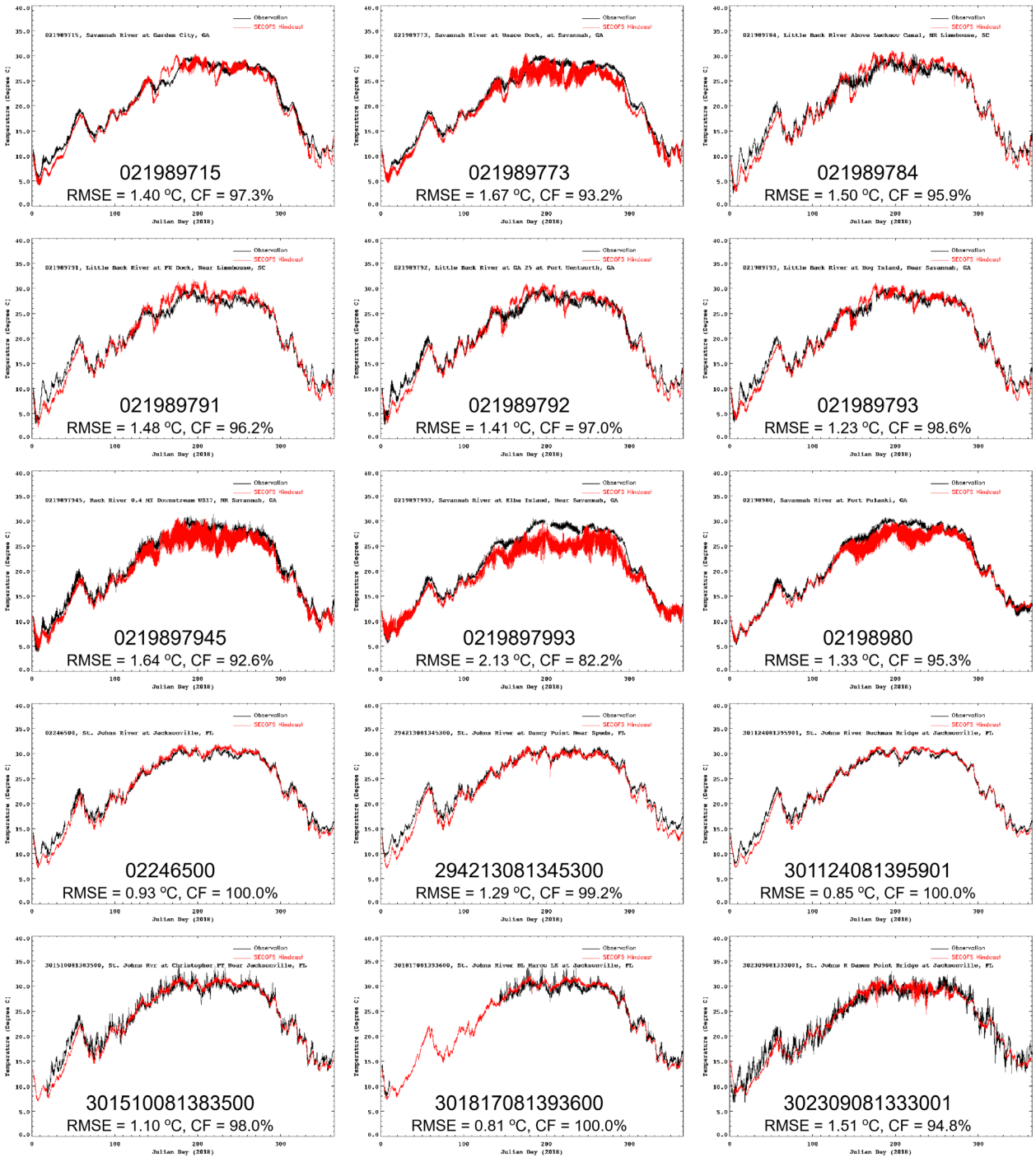


(a.1) Modeled (red) and observed (black) water temperatures at CO-OPS stations.



(a.2) Modeled (red) and observed (black) water temperatures at CBIBS/NDBC buoys.

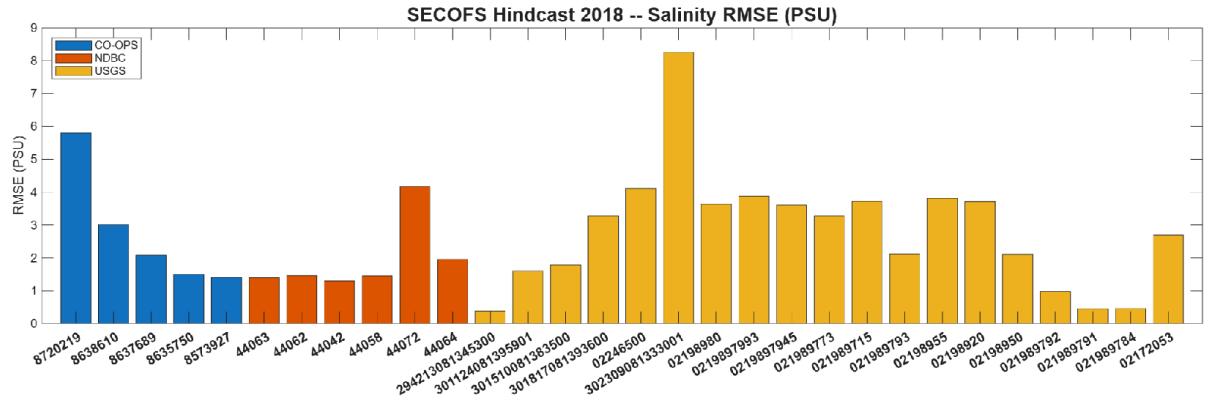

Observation
SECOFS Hindcast
02172020, N Branch Cooper River at Pimlico Near Monks Corner, SC
02172020
RMSE = 4.20 °C, CF = 56.3%
021720508, Cooper River Above Goose Creek, SC
021720508
RMSE = 2.17 °C, CF = 84.1%
02172053, Cooper River at Mobay Near N Charleston, SC
02172053
RMSE = 1.90 °C, CF = 92.5%
021720677, Cooper River at Filbin Creek at North Charleston, SC
021720677
RMSE = 1.49 °C, CF = 99.7%
0217206935, Cooper River at Ports Authority Pier K Charleston, SC
0217206935
RMSE = 1.46 °C, CF = 99.2%
0217206962, Wando River at Cainhoy Below Wando, SC
0217206962
RMSE = 1.42 °C, CF = 95.7%
021720698, Wando River Above MT Pleasant, SC
021720698
RMSE = 1.34 °C, CF = 99.7%
021720709, Cooper River at Us Hwy 17 at Charleston, SC
021720709
RMSE = 1.66 °C, CF = 95.2%
021720710, Cooper River at Customs House Aux at Charleston, SC
021720710
RMSE = 1.45 °C, CF = 98.8%
021720869, Ashley River Near North Charleston, SC
021720869
RMSE = 1.59 °C, CF = 95.6%
02198810, Abercorn Creek Near Savannah, GA
02198810
RMSE = 3.11 °C, CF = 64.9%
02198820, Abercorn Creek at Mouth Near Savannah, GA
02198820
RMSE = 1.58 °C, CF = 93.7%
02198920, Savannah River at GA 25, at Port Wentworth, GA
02198920
RMSE = 1.50 °C, CF = 95.1%
02198950, Middle River at GA 25 at Port Wentworth, GA
02198950
RMSE = 1.44 °C, CF = 96.4%
02198955, Middle River at Fish Hole at Port Wentworth, GA
02198955
RMSE = 1.41 °C, CF = 96.9%
Temperature (Degree C)
Julian Day (2018)



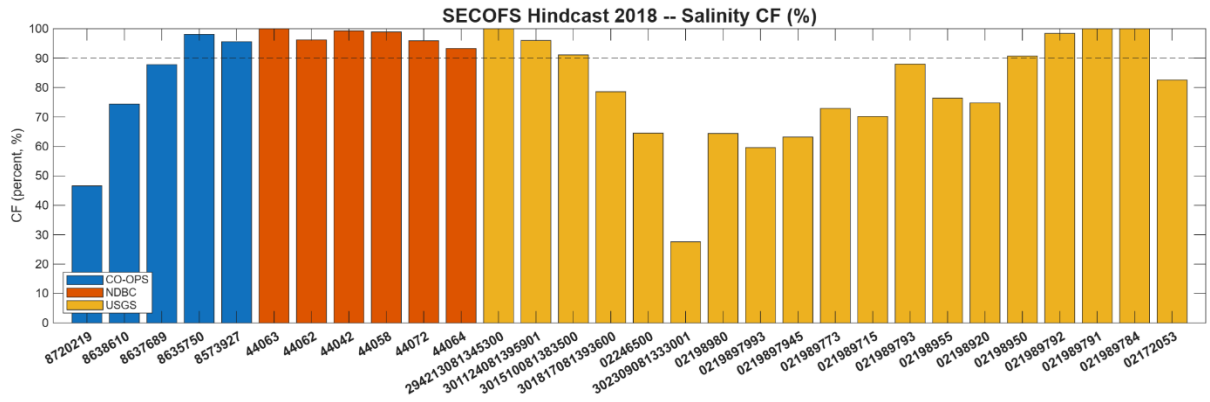
(b) USGS buoys

Figure 29. Comparison of modeled (red) and observed (black) water temperatures at (a) NOAA, and (b) USGS buoys.

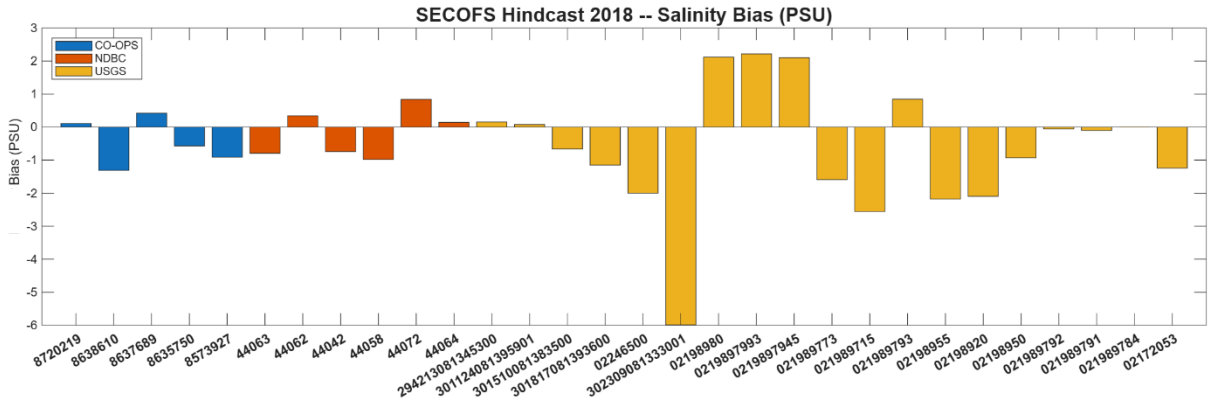
5.4.4 Salinity



(a)



(b)



(c)

Figure 30. Skill assessment results, (a) RMSE, (b) CF, and (c) Bias, of the water salinity at all stations (Tables 14-16, blue: CO-OPS, orange: CBIBS/NDBC, and yellow: USGS).

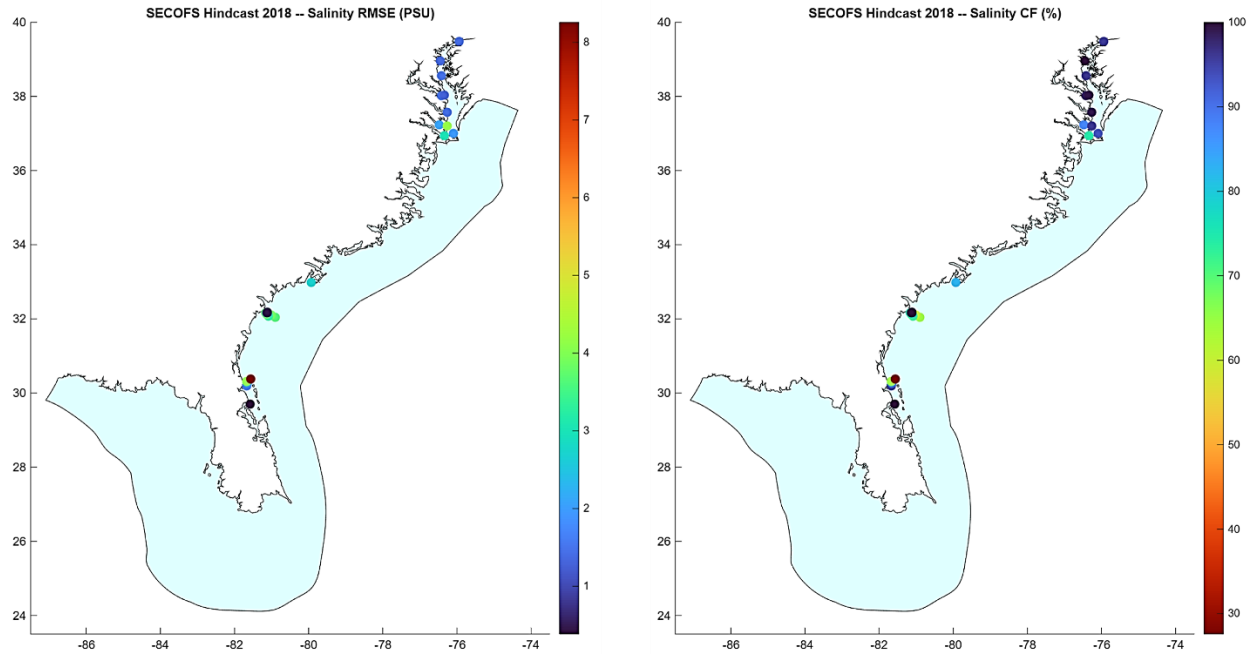
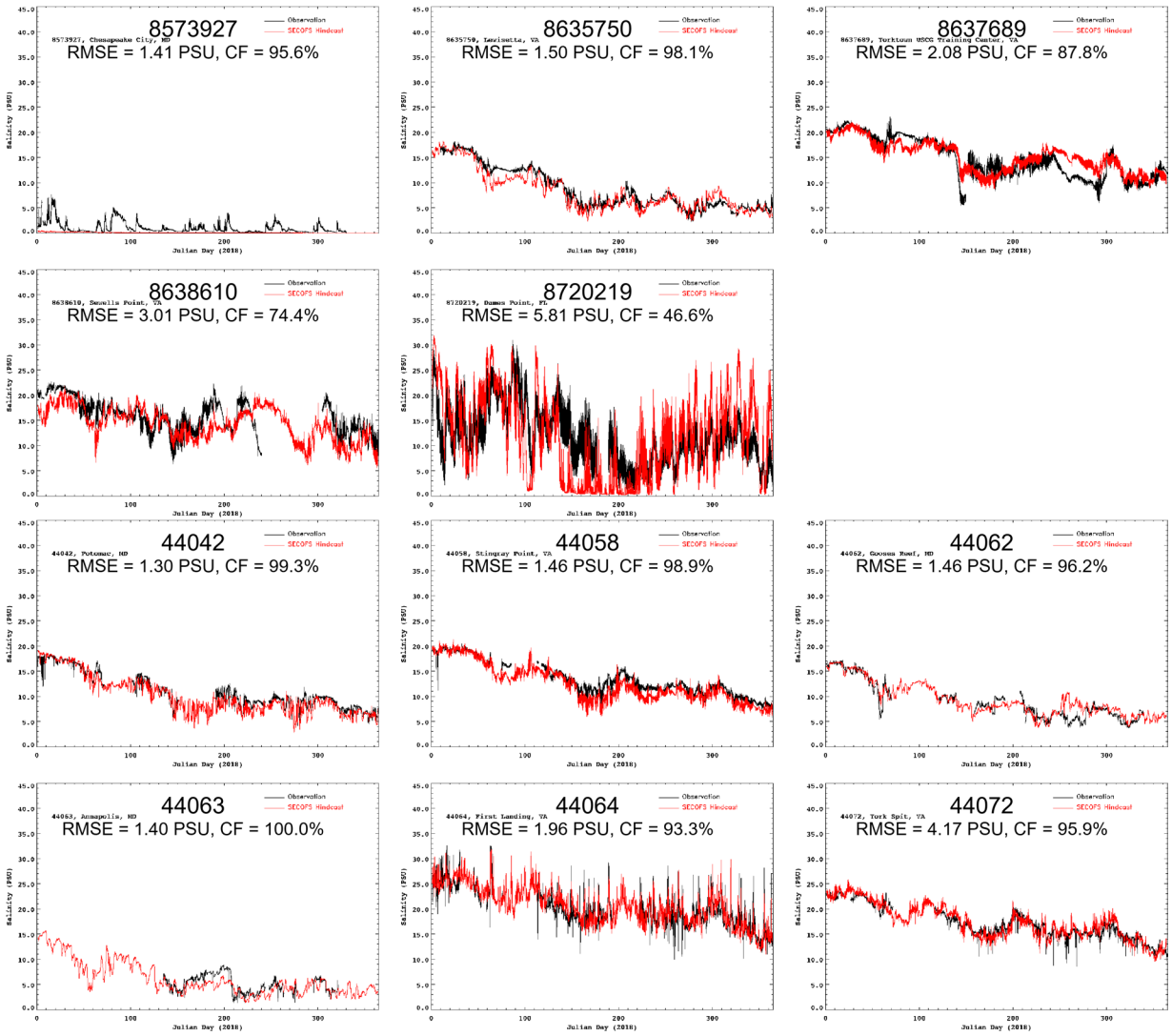
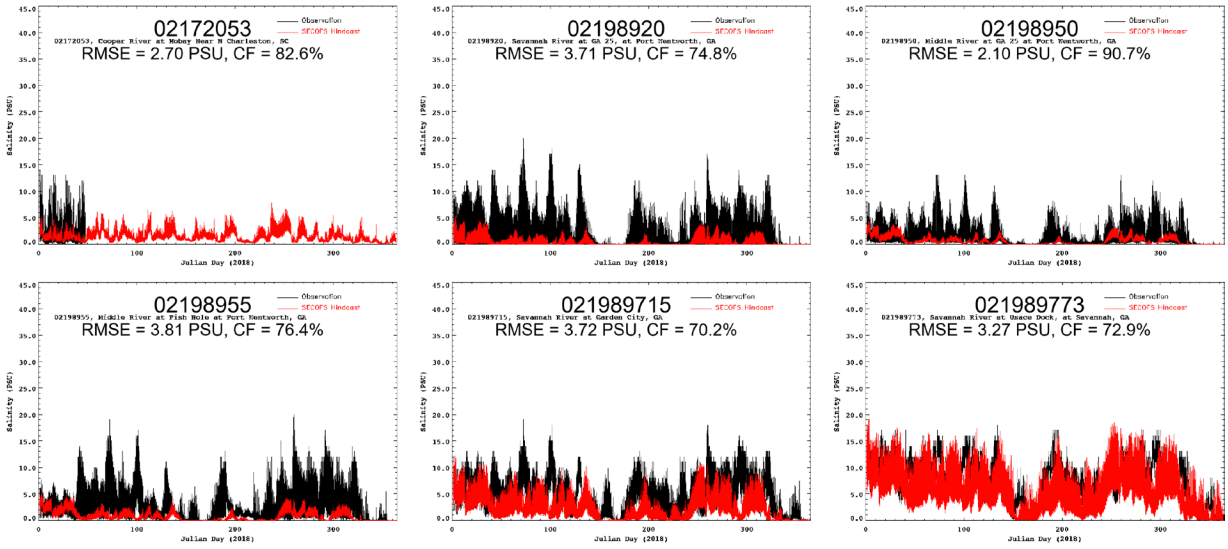


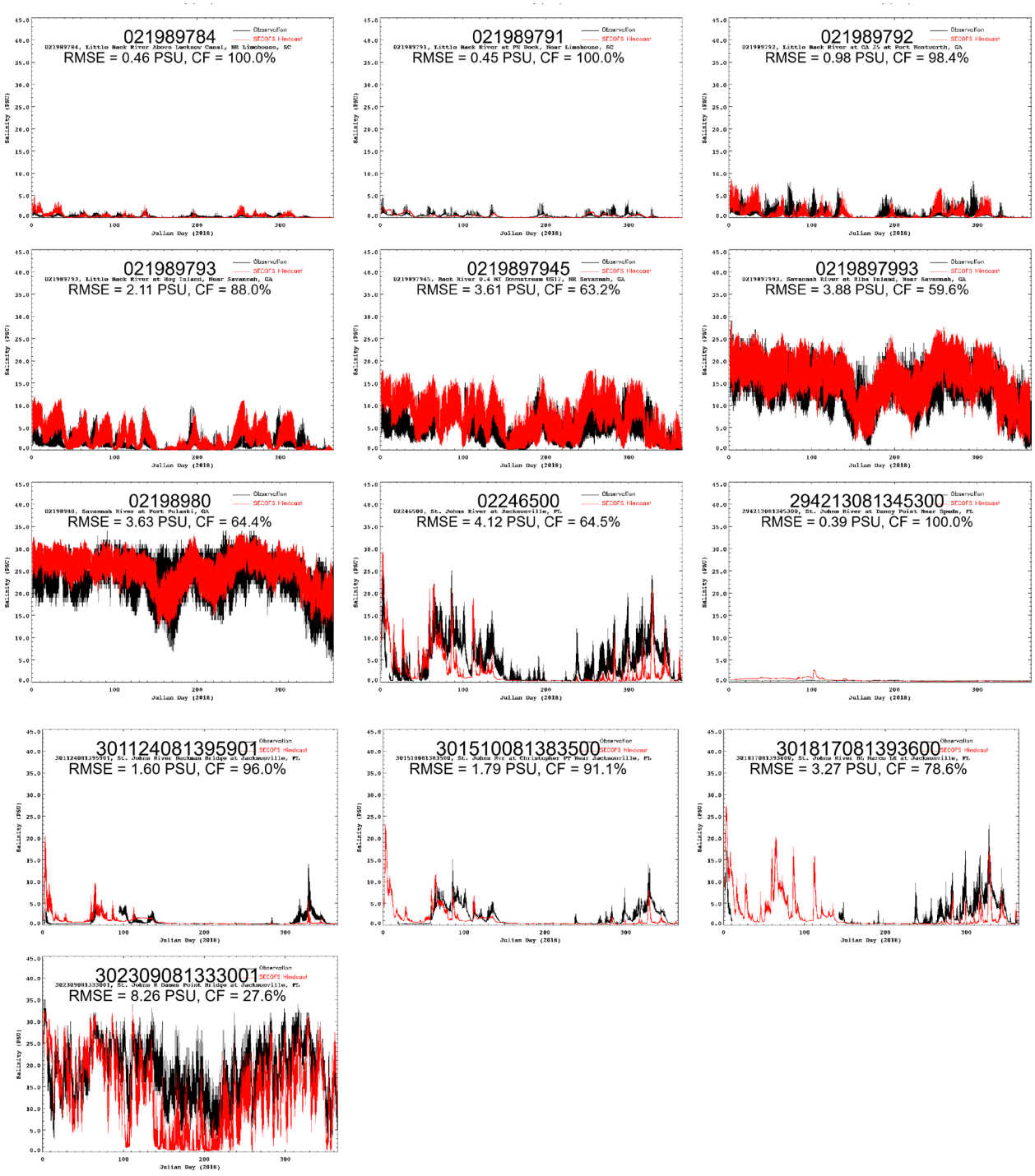
Figure 31. The RMSE (a) and CF (b) map of the hindcast water salinity at all NOAA and USGS stations (Tables 14-16).

Similar as the water temperate, the bar graphs of Figures 30 (a) - (c), and Figures 31 (a) and (b) demonstrate the RMSE, CF, and the Bias levels and sketch the distributions of RMSE and CF of water salinity for all buoy stations, respectively. There are much less salinity stations than the temperatures, and the data quality varies. Salinity simulation at the CO-OPS station 8720219 and the USGS station 302309081333001 showed the least agreement. Simultaneously, both stations are located at the Dames Point, St, John's River. Notably, the best fits happened at the CBIBS/NDBC buoy stations. The time series match each other and all CFs are over 93%. Since a few USGS stations are located too high upstream to have salinities, the comparisons at these stations are of lesser value.


8573927
RMSE = 1.41 PSU, CF = 95.6%
8635750
RMSE = 1.50 PSU, CF = 98.1%
8637689
RMSE = 2.08 PSU, CF = 87.8%
8638610
RMSE = 3.01 PSU, CF = 74.4%
8720219
RMSE = 5.81 PSU, CF = 46.6%
44042
RMSE = 1.30 PSU, CF = 99.3%
44058
RMSE = 1.46 PSU, CF = 98.9%
44062
RMSE = 1.46 PSU, CF = 96.2%
44063
RMSE = 1.40 PSU, CF = 100.0%
44064
RMSE = 1.96 PSU, CF = 93.3%
44072
RMSE = 4.17 PSU, CF = 95.9%
Observation
SECOFS Hindcast
Salinity (PSU)
Julian Day (2018)

(a) NOAA buoys


02172053
RMSE = 2.70 PSU, CF = 82.6%
02198920
RMSE = 3.71 PSU, CF = 74.8%
02198950
RMSE = 2.10 PSU, CF = 90.7%
02198955
RMSE = 3.81 PSU, CF = 76.4%
021989715
RMSE = 3.72 PSU, CF = 70.2%
021989773
RMSE = 3.27 PSU, CF = 72.9%
Observation
SECOFS Hindcast
Salinity (PSU)
Julian Day (2018)



(b) USGS buoys

Figure 32. Comparison of modeled (red) and observed (black) water salinities at (a) NOAA, and (b) USGS buoys.

6. SYSTEM PERFORMANCE DURING STORM SURGE EVENTS

Besides model errors, model performance during storm events is also dependent on the quality of forcing factors. In the case of compound flooding, the forcing factors include atmosphere, large-scale oceanic processes, 3D processes in estuaries, river discharges and sometimes precipitation (Ye et al., 2020).

Year 2018 is the 3rd year in a row that saw above-average hurricane activity. Here we present the model performance in two hurricanes: Florence (around the beginning of September 2018) and Michael (around the beginning of October 2018). The total water level (TWL) assessment from the combined forcing factors is shown in Figure 33 (for Florence) and Figure 34 (for Michael). The model generally did a good job in capturing the time and amplitude of the maximum surges; beside model errors, uncertainties in DEMs, river flow, atmospheric forcing, also impacted the model skill. For this limited domain simulation, because the open ocean boundary is located relatively close to the coastal region, the prescribed open ocean boundary conditions can have a significant influence on model results. In particular, HYCOM may not be able to capture the incoming velocity during the storm. Larger domain models like STOFS-3D, on the other hand, are less influenced by the boundary conditions. The river flow uncertainty from NWM can be clearly seen at the Wilmington gauge, where the model shows a substantial departure from the observations (Figure 33a).

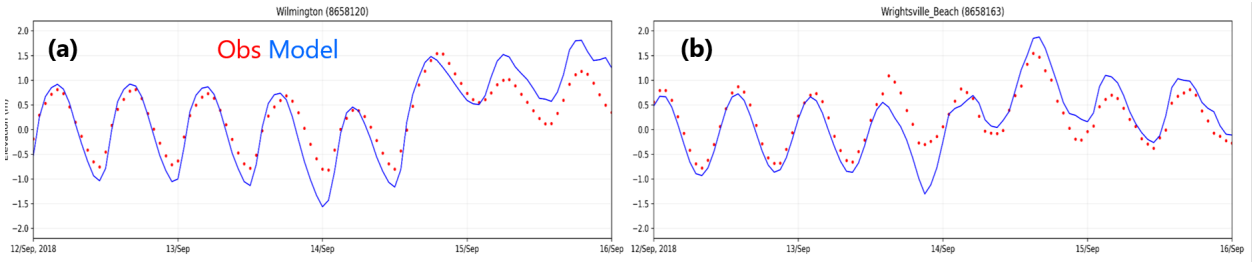


Figure 33. Total Water Level (TWL, m) comparison at some Wilmington and Wrightsville gauges during Hurricane Florence.

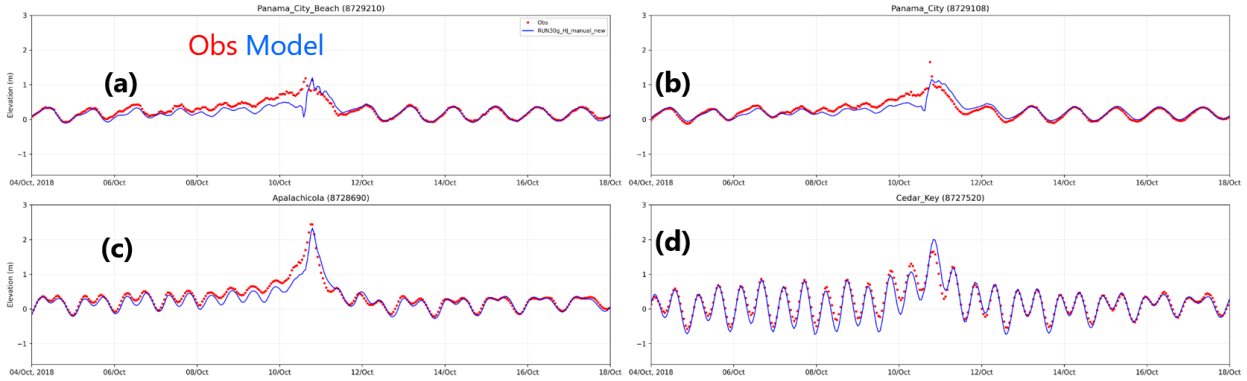


Figure 34. Total Water Level (TWL, m) comparison at 4 Florida gauges during Hurricane Michael.

7. CONCLUSIONS

This report details the development, vertical datum field construction, and performance evaluation of NOAA's Southeast Coastal Operational Forecast System (SECOFS). Spanning the U.S. Southeast Atlantic coast, Florida Shelf, Puerto Rico, and the U.S. Virgin Islands, SECOFS is a large-scale 3D hydrodynamic modeling framework built on the Semi-implicit Cross-scale Hydroscience Integrated System Model (SCHISM). It integrates combined forcing from atmospheric fields, ocean boundaries, 3D estuarine dynamics, river discharge, and direct precipitation. Using an ultra-high-resolution unstructured grid with approximately 1.7 million nodes and over 3.3 million elements, the system seamlessly couples open-ocean dynamics, complex estuarine systems, river networks and inland watersheds.

In a hindcast setup operating with a non-split computational time step of 120 seconds on 2,800 cores of NOAA's RDHPC Hercules supercomputer, SECOFS achieves an efficient execution speed roughly 120 times faster than real time. By thoroughly documenting the system's operational background, tidal skill, 3D hindcast performance, and extreme event guidance, this report provides end users with the confidence to apply SECOFS forecasts to real-world marine navigation, coastal resilience, and emergency management decisions.

Vertical Datum Fields This project developed a vertical datum (VDatum) conversion file for SECOFS to seamlessly bridge model outputs with critical applications in marine navigation, coastal resilience, and hydrodynamic modeling. Developed using grid partitioning across regional VDatum models, observational tide station data, Shallow Water Equations spatial interpolation, and updated geoid frameworks, the conversion file provides standardized transformations between model zero geopotential datums, Local Mean Sea Level, orthometric datums, and tidal datums. This framework fulfills user needs by enabling accurate under-keel clearance estimates for navigation, bridge clearance measurements, and coastal inundation risk assessments across the entire SECOFS domain.

Tidal Model Skill Direct evaluation of tidal performance from the 1-year 3D hindcast simulation demonstrated high accuracy across 316 CO-OPS stations, with a mean Root Mean Square Error (RMSE) of 0.065 m for predicted tides and a mean Central Frequency (CF) of 91%. Long-term stations (1 year of data) showed exceptionally high agreement (mean RMSE of 0.054 m, mean CF of 93%).

3D Hindcast Performance The 2018 1-year (Jan 1 – Dec 31, 2018) hindcast evaluation against standard NOS acceptance criteria verified that SECOFS provides robust nowcast/forecast guidance for water levels, currents, temperature, and salinity across diverse coastal environments.

Water level performance was evaluated across 50 water level stations. Across all coastal stations in the model domain, the system achieved an average RMSE of 12.6 cm and an average CF of

80%. Individual station RMSE values ranged from 6.3 cm to 30.0 cm, while station CFs ranged from 40% to 98%. Performance varied geographically, with open coastal stations generally demonstrating the strongest skill, achieving average RMSEs as low as 8.4 cm and average CFs reaching 92.3%. Mean RMSEs across different estuarine regions typically ranged between 11.1 cm and 15.6 cm, with corresponding mean CFs ranging from 71.0% to 82.1%.

Temperature was evaluated across 56 monitoring stations. Temperature RMSE ranged from 0.7°C to 2.2°C, and the CF ranged from 82.2% to 100%, with most stations achieving between 95% and 100% CF. The model exhibited a slight cold bias across estuarine and coastal stations, with MAE values ranging from -0.1°C to -1.8°C.

Salinity was evaluated across 30 monitoring stations. Across most estuarine and coastal locations, salinity Root Mean Square Error (RMSE) ranged from 1.3 PSU to 3.0 PSU. Central Frequency (CF) performance was exceptional at many open-water buoy locations, with all exceeding 93% and several achieving up to 100%. Along various river estuaries, salinity RMSE ranged from 0.38 PSU in freshwater stretches up to 4.1 PSU near dynamic salt-front transitions. The largest salinity discrepancy recorded an RMSE of 8.26 PSU and a CF of 27.6%, illustrating the numerical difficulty of modeling steep vertical and horizontal salinity gradients within narrow river channels; targeted calibration with accurate DEMs can be done in the future to address this issue.

Current data were extracted near a target depth of 4.5 meters below the surface across 22 observation stations to align with primary navigation depth requirements. Current speed RMSE across most stations ranged between 0.10 m/s and 0.27 m/s, and speed CF exceeded the 90% target at most open-water and channel locations, reaching up to 98.1%. A notable speed outlier exhibited an elevated RMSE of 0.65 m/s and a low CF of 23.1% largely because the model mesh terminates nearby in a narrow creek without an open outlet.

For current direction, vertical-looking stations yielded RMSE values generally between 40° and 65° with CFs ranging from 35% to 82%. Conversely, depth-rated buoy stations displayed higher direction RMSE values between 70° and 118° and lower CFs ranging from 5% to 32%, largely because surface-rated buoys are sensitive to wave action, compass tilt, and buoy motion compensation errors.

Extreme Event Guidance Simulations of two major 2018 extreme storm events—Hurricane Florence (early September) and Hurricane Michael (early October)—confirmed SECOFS's capability to accurately capture peak storm surge magnitudes and arrival timing across coastal and riverine stations under compound flooding conditions.

In summary, skill assessments across tidal water levels, the 2018 hindcast simulation, and extreme weather scenarios demonstrate the strong predictive capabilities of SECOFS for water levels, temperatures, salinities, currents, and storm surge under compound flooding conditions. The model achieved an average water level RMSE of 12.6 cm, temperature RMSEs between 0.7°C and 2.2°C,

and current speed RMSEs generally ranging from 0.10 to 0.27 m/s. Furthermore, salinity forecasts showed high accuracy in open-water environments, while storm surge simulations for Hurricanes Florence and Michael precisely captured peak magnitudes and arrival times. By consistently meeting standard NOS acceptance criteria and delivering robust performance during severe tropical cyclones, SECOFS provides reliable forecast guidance to support safe marine navigation, coastal resilience planning, and emergency management decision-making.

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APPENDIX A: TIDAL SKILL ASSESSMENT DATA SHEET

Table A.1 lists the results of tidal harmonic analysis and tidal prediction skill assessment for each of the 316 CO-OPS water level stations used in this study. It includes the station identification, geographic coordinates, location and observation period. For each station, the amplitudes and phases of the eight major tidal constituents (M_2, N_2, K_2, S_2, K_1, O_1, P_1, and Q_1) are presented in two rows: the first row lists the observations, and the second row is from SECOFS. Tidal prediction skill statistics are in column 20, with the first row reporting the RMSE (m) and the second row for the central frequency (CF, %). Large model departures from the observations are highlighted in red for long-term stations and blue for short-term stations.

Table A. 1 Observed and model-derived tidal harmonic constants and statistics for tidal predictions for the 316 CO-OPS water level stations.

No.	Longitude	M_2	S_2	N_2	K_2	K_1	O_1	P_1	Q_1		M_2	S_2	N_2	K_2	K_1	O_1	P_1	Q_1	Rmse (m)	Location	Obs Beg.
ID	Latitude	m	m	m	m	m	m	m	m		deg	deg	deg	deg	deg	deg	deg	deg	CF %		End time
1	-76.038333	0.26	0.04	0.06	0.01	0.04	0.03	0.01	0.01	obs	183	210	159	205	276	296	275	268	0.05	Bishops Head, MD	9/1/2005
8571421	38.220000	0.27	0.04	0.06	0.01	0.05	0.03	0.02	0.01	mod	197	225	175	217	287	289	273	296	100%		4/30/2019
2	-76.061667	0.23	0.03	0.05	0.01	0.05	0.04	0.02	0.01	obs	257	286	234	288	341	350	326	339	0.01	Cambridge, MD	1/1/1983
8571892	38.572500	0.24	0.04	0.05	0.01	0.05	0.04	0.02	0.01	mod	260	290	237	289	348	347	326	364	100%		12/31/2001
3	-76.244556	0.17	0.02	0.04	0.01	0.07	0.05	0.02	0.01	obs	347	11	322	10	5	13	352	357	0.02	Tolchester Beach, MD	9/1/1994
8573364	39.213444	0.18	0.03	0.04	0.01	0.08	0.06	0.02	0.01	mod	348	18	321	13	14	10	359	376	100%		9/30/2019
4	-76.578300	0.15	0.02	0.04	0.01	0.06	0.05	0.02	0.01	obs	336	8	313	9	7	14	2	358	0.03	Baltimore, MD	1/1/1983
8574680	39.270000	0.17	0.03	0.04	0.01	0.07	0.06	0.03	0.01	mod	347	18	322	20	19	13	10	367	100%		12/31/2001
5	-76.481600	0.14	0.02	0.03	0.01	0.06	0.05	0.02	0.01	obs	292	320	270	318	357	6	349	332	0.02	Annapolis, MD	1/1/1983
8575512	38.983280	0.12	0.02	0.03	0.01	0.06	0.05	0.02	0.01	mod	300	333	278	328	367	2	354	364	100%		12/31/2001
6	-76.450833	0.17	0.03	0.04	0.01	0.03	0.02	0.01	0.01	obs	199	226	172	224	316	332	319	307	0.01	Solomons Island, MD	1/1/1983
8577330	38.317222	0.18	0.03	0.04	0.01	0.03	0.03	0.01	0.00	mod	200	227	176	227	320	324	309	313	100%		12/31/2001
7	-77.021700	0.39	0.05	0.07	0.02	0.04	0.03	0.01	0.01	obs	21	64	358	58	356	20	11	9	0.13	Washington, DC	1/1/1983
8594900	38.873000	0.46	0.07	0.09	0.02	0.07	0.05	0.01	0.02	mod	0	34	336	29	346	-3	3	-29	69%		12/31/2001
8	-75.685833	0.54	0.10	0.12	0.03	0.08	0.08	0.03	0.02	obs	23	58	12	53	201	213	205	203	0.14	Wachapreague, VA	1/1/1983
8631044	37.607778	0.39	0.07	0.09	0.02	0.08	0.07	0.02	0.02	mod	36	67	19	65	209	216	208	213	63%		7/31/2018
9	-75.988444	0.39	0.07	0.09	0.02	0.06	0.05	0.02	0.01	obs	32	56	12	57	193	214	202	195	0.03	Kiptopeke, VA	1/1/1983
8632200	37.165190	0.39	0.07	0.09	0.02	0.07	0.05	0.02	0.01	mod	38	63	17	64	202	205	197	207	100%		12/31/2001
10	-77.036597	0.23	0.04	0.05	0.01	0.03	0.02	0.01	0.01	obs	222	259	202	253	299	324	308	309	0.04	Dahlgren, VA	3/1/2016
8635027	38.319753	0.19	0.03	0.04	0.01	0.04	0.03	0.01	0.01	mod	215	247	195	240	313	323	318	298	100%		2/28/2019
11	-76.465556	0.18	0.03	0.04	0.01	0.02	0.02	0.01	0.00	obs	176	200	152	201	276	299	293	287	0.01	Lewisetta, VA	1/1/1983
8635750	37.996389	0.20	0.03	0.04	0.01	0.03	0.02	0.01	0.00	mod	178	206	154	203	287	294	283	276	100%		12/31/2001
12	-76.289778	0.17	0.03	0.04	0.01	0.03	0.02	0.01	0.01	obs	103	126	82	126	226	247	233	233	0.02	Windmill Point, VA	6/1/2012
8636580	37.615500	0.18	0.03	0.04	0.01	0.04	0.03	0.01	0.01	mod	112	135	90	133	233	235	226	235	100%		5/31/2019
13	-76.478806	0.33	0.06	0.07	0.01	0.05	0.04	0.01	0.01	obs	53	78	34	74	197	222	194	200	0.04	Yorktown USCG Training Center, VA	11/1/2004
8637689	37.226500	0.36	0.06	0.08	0.02	0.06	0.04	0.01	0.01	mod	60	86	40	82	205	212	193	219	100%		10/31/2019
14	-76.328611	0.35	0.06	0.08	0.02	0.05	0.04	0.01	0.01	obs	47	76	28	72	200	224	198	210	0.02	Sewells Point, VA	1/1/1983
8638610	36.942778	0.36	0.07	0.09	0.02	0.06	0.04	0.02	0.01	mod	50	79	30	77	203	212	192	219	100%		12/31/2001
15	-76.083298	0.39	0.07	0.09	0.02	0.06	0.05	0.02	0.01	obs	22	47	4	48	187	211	187	195	0.02	CBBT Chesapeake Channel, VA	9/1/2017
8638901	37.032902	0.40	0.07	0.10	0.02	0.07	0.05	0.02	0.01	mod	26	52	6	51	193	200	187	203	100%		8/31/2019
16	-76.301861	0.41	0.07	0.09	0.02	0.05	0.04	0.01	0.01	obs	54	83	36	80	201	227	194	213	0.03	Money Point, VA	1/1/1998
8639348	36.778194	0.40	0.07	0.09	0.02	0.06	0.05	0.02	0.01	mod	58	88	39	86	207	215	197	222	100%		4/30/2019
17	-75.746696	0.47	0.09	0.12	0.02	0.09	0.06	0.03	0.01	obs	358	22	338	22	173	191	172	187	0.02	Duck, NC	1/1/1983
8651370	36.183300	0.48	0.09	0.11	0.02	0.08	0.06	0.02	0.01	mod	360	26	341	25	179	187	174	186	100%		12/31/2001

18	-75.548194	0.12	0.02	0.03	0.00	0.03	0.02	0.01	0.00	obs	17	32	359	23	191	194	219	220	0.07	Oregon Inlet Marina, NC	1/1/1995
8652587	35.795694	0.21	0.03	0.04	0.01	0.04	0.04	0.02	0.01	mod	15	38	358	42	188	188	199	178	100%		12/31/2011
19	-75.704194	0.04	0.01	0.01	0.00	0.01	0.01	0.01	0.00	obs	37	74	16	26	249	215	259	166	0.02	USCG Station Hatteras, NC	5/1/2010
8654467	35.208611	0.06	0.01	0.01	0.00	0.01	0.01	0.01	0.00	mod	11	25	-0	71	193	192	237	46	100%		8/31/2017
20	-76.671111	0.46	0.07	0.10	0.02	0.08	0.06	0.03	0.01	obs	6	30	349	27	198	205	199	200	0.05	Beaufort Duke Marine Lab, NC	1/1/1983
8656483	34.717500	0.50	0.08	0.12	0.02	0.08	0.07	0.03	0.01	mod	-0	24	342	20	192	196	194	182	100%		12/31/2001
21	-77.953611	0.62	0.08	0.13	0.02	0.08	0.06	0.03	0.01	obs	63	98	51	95	230	234	237	238	0.15	Wilmington, NC	1/1/1983
8658120	34.227500	0.82	0.12	0.16	0.03	0.09	0.08	0.03	0.02	mod	62	97	53	92	223	227	220	219	56%		12/31/2001
22	-77.786667	0.59	0.10	0.14	0.03	0.10	0.07	0.03	0.01	obs	353	14	334	13	186	193	188	186	0.01	Wrightsville Beach, NC	10/1/2004
8658163	34.213333	0.60	0.10	0.14	0.03	0.09	0.07	0.03	0.02	mod	352	17	334	18	186	192	185	177	100%		9/30/2018
23	-78.916389	0.74	0.13	0.18	0.03	0.10	0.07	0.03	0.02	obs	358	19	338	22	189	193	188	185	0.03	Springmaid Pier, SC	1/1/1983
8661070	33.655556	0.75	0.12	0.17	0.03	0.10	0.07	0.04	0.02	mod	355	17	337	24	186	189	181	180	100%		12/31/2001
24	-79.923889	0.77	0.12	0.17	0.03	0.10	0.08	0.03	0.02	obs	10	36	355	36	198	202	198	199	0.03	Charleston, SC	1/1/1983
8665530	32.775000	0.73	0.11	0.15	0.02	0.09	0.07	0.03	0.01	mod	9	32	352	38	195	198	194	191	100%		12/31/2001
25	-80.903028	1.01	0.16	0.23	0.04	0.11	0.08	0.04	0.02	obs	18	45	2	45	200	205	199	203	0.03	Fort Pulaski, GA	1/1/1983
8670870	32.034694	0.99	0.16	0.21	0.03	0.10	0.08	0.04	0.01	mod	16	39	-2	46	195	198	189	190	100%		12/31/2001
26	-81.491389	0.90	0.13	0.19	0.04	0.10	0.07	0.03	0.01	obs	40	69	34	72	223	210	222	203	0.19	Kings Bay MSF Pier, GA	10/1/2022
8679598	30.778056	0.78	0.12	0.16	0.02	0.10	0.08	0.03	0.02	mod	56	81	37	82	215	221	208	206	38%		10/31/2022
27	-81.465842	0.87	0.13	0.20	0.03	0.10	0.08	0.03	0.02	obs	34	62	18	62	209	214	208	210	0.17	Fernandina Beach, FL	1/1/1983
8720030	30.671356	0.76	0.12	0.17	0.02	0.10	0.08	0.03	0.02	mod	48	71	27	71	211	216	203	200	45%		12/31/2001
28	-81.427889	0.67	0.10	0.14	0.03	0.08	0.06	0.03	0.01	obs	26	50	8	48	204	211	201	208	0.05	Mayport (Bar Pilots Dock), FL	1/1/2001
8720218	30.398167	0.60	0.09	0.13	0.02	0.07	0.05	0.02	0.01	mod	28	52	8	44	198	204	191	193	100%		12/31/2018
29	-81.559166	0.53	0.07	0.11	0.02	0.06	0.04	0.02	0.01	obs	50	78	33	75	219	225	217	220	0.12	Dames Point, FL	1/1/2014
8720219	30.387222	0.40	0.05	0.08	0.01	0.04	0.03	0.01	0.01	mod	61	87	41	75	212	217	214	211	74%		12/31/2017
30	-81.659058	0.27	0.04	0.05	0.01	0.03	0.02	0.01	0.00	obs	74	105	56	99	247	256	242	245	0.05	Southbank Riverwalk St Johns River, FL	4/1/2002
8720226	30.320499	0.23	0.03	0.04	0.01	0.01	0.01	0.01	0.00	mod	87	118	67	110	246	266	242	245	100%		1/31/2017
31	-81.690000	0.13	0.02	0.02	0.01	0.02	0.02	0.01	0.00	obs	108	135	94	136	280	282	269	278	0.02	I-295 Buckman Bridge, FL	2/1/2004
8720357	30.192417	0.15	0.02	0.03	0.00	0.02	0.02	0.01	0.00	mod	118	148	97	147	280	289	267	255	100%		12/31/2016
32	-80.593056	0.50	0.08	0.12	0.02	0.10	0.07	0.03	0.02	obs	7	28	346	29	201	207	202	198	0.04	Trident Pier Port Canaveral, FL	1/1/1997
8721604	28.415833	0.47	0.07	0.11	0.02	0.08	0.06	0.03	0.01	mod	11	32	349	27	198	207	195	197	100%		1/31/2018
33	-80.034167	0.41	0.07	0.10	0.02	0.06	0.04	0.02	0.01	obs	14	35	354	35	219	236	220	233	0.01	Lake Worth Pier Atlantic Ocean, FL	7/1/2010
8722670	26.612778	0.40	0.06	0.09	0.02	0.06	0.05	0.02	0.01	mod	14	37	354	35	213	229	216	213	100%		12/31/2016
34	-80.115908	0.38	0.07	0.09	0.02	0.04	0.04	0.01	0.01	obs	20	46	0	47	231	256	235	256	0.01	South Port Everglades, FL	2/1/2018
8722956	26.078787	0.37	0.06	0.08	0.02	0.05	0.04	0.02	0.01	mod	21	45	1	42	241	258	239	240	100%		1/31/2019
35	-80.161667	0.30	0.05	0.07	0.01	0.03	0.03	0.01	0.01	obs	41	71	22	69	263	288	263	298	0.05	Virginia Key Biscayne Bay, FL	1/1/1994
8723214	25.731667	0.35	0.06	0.08	0.02	0.04	0.04	0.01	0.01	mod	35	64	17	55	279	298	267	281	100%		3/31/2019
36	-81.106500	0.06	0.01	0.01	0.01	0.07	0.07	0.02	0.02	obs	165	229	121	236	34	27	39	17	0.08	Vaca Key Florida Bay, FL	1/1/1983
8723970	24.711000	0.15	0.05	0.02	0.02	0.09	0.08	0.03	0.02	mod	162	199	153	197	17	13	18	2	98%		12/31/2001
37	-81.807899	0.18	0.05	0.04	0.01	0.09	0.09	0.03	0.02	obs	67	89	49	92	355	352	358	342	0.02	Key West, FL	1/1/1983
8724580	24.555700	0.19	0.05	0.03	0.02	0.10	0.09	0.03	0.02	mod	74	99	59	95	345	348	348	340	100%		12/31/2001
38	-81.807500	0.27	0.09	0.05	0.03	0.15	0.14	0.05	0.03	obs	145	157	130	150	9	3	7	353	0.03	Naples Gulf of Mexico, FL	1/1/1983
8725110	26.131667	0.24	0.08	0.05	0.02	0.15	0.14	0.05	0.03	mod	147	151	135	145	15	5	8	352	100%		12/31/2001
39	-81.788300	0.27	0.08	0.05	0.03	0.14	0.12	0.05	0.03	obs	164	180	152	166	19	14	26	7	0.07	NAPLES BAY NORTH, FL	8/1/1978
8725114	26.136700	0.23	0.07	0.05	0.03	0.15	0.13	0.05	0.03	mod	180	188	169	176	35	26	32	14	99%		8/31/1978
40	-81.871000	0.10	0.03	0.02	0.02	0.08	0.07	0.02	0.01	obs	255	272	244	269	93	86	106	87	0.04	Fort Myers, FL	1/1/1983
8725520	26.648000	0.14	0.04	0.03	0.02	0.11	0.10	0.04	0.02	mod	258	261	245	268	86	76	92	66	100%		12/31/2001
41	-82.562103	0.16	0.05	0.03	0.02	0.16	0.14	0.05	0.03	obs	175	188	168	191	40	27	46	19	0.06	Port Manatee, FL	12/1/1999
8726384	27.638700	0.21	0.08	0.05	0.02	0.16	0.15	0.06	0.03	mod	183	193	177	190	27	17	26	8	99%		12/31/2019
42	-82.626944	0.17	0.06	0.03	0.03	0.17	0.15	0.05	0.03	obs	197	212	191	215	50	38	58	26	0.08	St. Petersburg Tampa Bay, FL	1/1/1983
8726520	27.761111	0.26	0.09	0.05	0.03	0.17	0.16	0.06	0.03	mod	203	215	196	212	34	24	33	17	94%		12/31/2001
43	-82.552803	0.20	0.06	0.03	0.03	0.17	0.15	0.05	0.03	obs	216	234	210	230	57	44	67	37	0.11	Old Port Tampa, FL	1/1/1999
8726607	27.857800	0.32	0.11	0.06	0.04	0.18	0.17	0.06	0.03	mod	217	232	211	228	39	28	38	22	80%		12/31/2016
44	-82.421389	0.20	0.07	0.03	0.03	0.18	0.15	0.06	0.03	obs	202	212	190	231	53	38	57	37	0.12	East Bay, FL	10/1/2019
8726674	27.923056	**0.33**	0.12	0.07	0.04	0.18	0.16	0.06	0.03	mod	**210**	225	204	218	37	26	36	21	78%		12/31/2019
45	-82.831667	0.25	0.10	0.05	0.03	0.16	0.15	0.05	0.03	obs	123	141	120	135	12	4	12	348	0.02	Clearwater Beach, FL	1/1/1997
8726724	27.978333	0.25	0.10	0.05	0.03	0.14	0.14	0.05	0.03	mod	126	139	125	135	7	0	5	350	100%		4/30/2018
46	-83.030883	0.38	0.12	0.07	0.03	0.17	0.16	0.06	0.04	obs	189	226	182	224	35	27	27	12	0.09	Cedar Key, FL	1/1/1983
8727520	29.133858	0.46	0.17	0.09	0.05	0.17	0.16	0.06	0.03	mod	184	208	182	200	20	15	16	1	89%		12/31/2001
47	-84.980556	0.12	0.04	0.02	0.02	0.14	0.12	0.04	0.03	obs	257	285	245	258	53	46	56	31	0.03	Apalachicola, FL	1/1/1983
8728690	29.724444	0.14	0.04	0.03	0.02	0.14	0.13	0.04	0.02	mod	268	294	263	270	50	42	50	27	100%		12/31/2001
48	-85.664444	0.03	0.01	0.01	0.01	0.14	0.14	0.04	0.03	obs	136	150	156	119	35	26	38	12	0.02	Panama City, FL	1/1/1983
8729108	30.149722	0.03	0.01	0.01	0.01	0.13	0.13	0.04	0.03	mod	145	129	158	138	37	32	40	11	100%		12/31/2001

49	-85.878583	0.03	0.02	0.01	0.01	0.14	0.14	0.05	0.03	obs	91	93	104	78	17	9	17	354	0.01	Panama City Beach, FL	4/1/1992
8729210	30.213750	0.04	0.02	0.01	0.01	0.15	0.14	0.05	0.03	mod	107	92	117	78	14	10	14	350	100%		9/30/2019
50	-64.698487	0.03	0.01	0.00	0.00	0.08	0.06	0.03	0.01	obs	345	20	311	16	228	222	229	209	0.02	Christiansted Harbor St Croix, VI	11/1/2006
9751364	17.747781	0.05	0.01	0.01	0.00	0.08	0.06	0.02	0.01	mod	350	4	337	5	227	225	227	208	100%		3/31/2019
51	-64.724111	0.05	0.01	0.01	0.00	0.08	0.06	0.03	0.01	obs	24	23	11	17	229	222	231	210	0.02	Lameshur Bay St John, VI	9/1/2006
9751381	18.318186	0.05	0.01	0.01	0.00	0.08	0.06	0.02	0.01	mod	-2	3	-18	7	227	225	228	208	100%		2/28/2017
52	-64.753831	0.01	0.01	0.00	0.00	0.08	0.06	0.03	0.01	obs	329	12	232	355	237	229	236	211	0.03	Lime Tree Bay, VI	1/1/1984
9751401	17.694446	0.05	0.02	0.01	0.00	0.07	0.06	0.02	0.01	mod	325	-13	291	355	231	226	231	208	100%		12/31/2001
53	-64.921000	0.04	0.01	0.01	0.00	0.08	0.06	0.02	0.01	obs	23	10	14	5	230	222	231	209	0.02	Charlotte Amalie, VI	1/1/1983
9751639	18.335000	0.05	0.01	0.01	0.00	0.08	0.06	0.02	0.01	mod	3	9	-15	15	226	224	228	208	100%		12/31/2001
54	-65.302700	0.10	0.02	0.02	0.00	0.08	0.06	0.02	0.01	obs	13	32	347	30	224	223	225	209	0.04	Culebra, PR	6/1/2006
9752235	18.301000	0.09	0.01	0.02	0.00	0.09	0.07	0.03	0.01	mod	**44**	62	375	77	224	224	225	210	100%		3/31/2019
55	-65.471355	0.03	0.01	0.00	0.00	0.08	0.06	0.03	0.01	obs	343	9	308	6	233	226	233	212	0.02	Esperanza Vieques Island, PR	4/1/2007
9752695	18.093794	0.05	0.01	0.01	0.00	0.07	0.06	0.02	0.01	mod	345	-3	327	2	230	226	231	207	100%		2/28/2017
56	-66.116411	0.15	0.02	0.04	0.01	0.09	0.08	0.03	0.01	obs	20	49	358	50	228	226	229	211	0.02	San Juan La Puntilla San Juan Bay, PR	1/1/1983
9755371	18.458888	0.13	0.02	0.03	0.01	0.09	0.07	0.03	0.01	mod	22	51	356	54	221	220	223	208	100%		12/31/2001
57	-67.046667	0.01	0.01	0.00	0.00	0.08	0.05	0.02	0.01	obs	10	10	90	3	233	228	234	215	0.02	Magueyes Island, PR	1/1/1983
9759110	17.970000	0.03	0.01	0.00	0.00	0.07	0.05	0.02	0.01	mod	9	15	-7	23	229	225	230	210	100%		12/31/2001
58	-67.162477	0.14	0.02	0.04	0.01	0.06	0.05	0.02	0.01	obs	14	41	351	40	214	211	218	194	0.04	Mayaguez, PR	5/1/2015
9759394	18.218863	0.18	0.03	0.04	0.01	0.07	0.06	0.02	0.01	mod	25	62	360	54	208	205	209	190	100%		4/30/2017
59	-67.196690	0.01	0.02	0.01	0.00	0.07	0.05	0.02	0.01	obs	55	311	51	19	232	227	242	206	0.04	Bahia Salinas, PR	6/1/2011
9759197	17.951220	0.05	0.02	0.01	0.00	0.07	0.05	0.02	0.01	mod	**-44**	360	-80	11	231	224	230	205	100%		8/31/2011
60	-67.188780	0.06	0.00	0.01	0.01	0.06	0.05	0.02	0.01	obs	7	332	3	51	232	225	240	199	0.04	Puerto Real, PR	6/1/2011
9759189	18.074540	0.10	0.02	0.02	0.01	0.06	0.05	0.02	0.01	mod	-18	381	-50	21	225	217	226	198	100%		8/31/2011
61	-67.183194	0.08	0.02	0.02	0.01	0.06	0.05	0.02	0.01	obs	3	37	332	40	227	218	226	214	0.03	Joyuda, PR	1/1/2021
9759183	18.115806	0.12	0.02	0.03	0.01	0.06	0.05	0.02	0.01	mod	-2	34	329	33	220	213	221	195	100%		3/31/2021
62	-67.184438	0.11	0.02	0.02	0.01	0.06	0.05	0.02	0.01	obs	6	35	342	37	220	218	220	218	0.05	PUNTA GUANAJABO MAYAGUES, PR	4/1/2006
9759421	18.166258	0.16	0.03	0.03	0.01	0.07	0.06	0.02	0.01	mod	19	55	354	48	211	206	213	191	100%		5/31/2006
63	-67.173100	0.05	0.01	0.01	0.00	0.07	0.05	0.02	0.01	obs	9	28	336	30	226	220	226	218	0.04	Boqueron, PR	1/1/2021
9759173	18.024028	0.08	0.02	0.02	0.01	0.06	0.05	0.02	0.01	mod	**-21**	17	305	20	226	219	226	200	100%		3/31/2021
64	-67.164731	0.15	0.03	0.04	0.01	0.07	0.06	0.02	0.01	obs	1	30	340	26	208	205	211	193	0.04	Aguadilla Crashboat Beach, PR	9/1/2006
9759412	18.456647	0.13	0.02	0.03	0.01	0.08	0.06	0.02	0.01	mod	20	51	356	59	215	214	217	200	100%		8/31/2008
65	-66.906830	0.01	0.01	0.01	0.00	0.07	0.05	0.03	0.01	obs	342	13	128	12	232	225	232	221	0.02	Guanica, PR	1/1/2021
9758627	17.958028	0.02	0.01	0.00	0.00	0.07	0.05	0.02	0.01	mod	**387**	18	29	25	229	226	229	211	100%		3/31/2021
66	-66.761667	0.01	0.01	0.01	0.01	0.08	0.05	0.02	0.01	obs	39	7	103	40	234	233	240	224	0.02	Penuelas (Punta Guayanilla), PR	4/1/2001
9758053	17.973333	0.02	0.01	0.00	0.00	0.07	0.05	0.02	0.01	mod	26	21	24	24	229	226	229	209	100%		9/30/2004
67	-66.701600	0.17	0.03	0.04	0.01	0.10	0.08	0.03	0.01	obs	3	39	338	42	209	211	209	199	0.04	Arecibo, PR	5/1/2010
9757809	18.479700	0.14	0.02	0.03	0.01	0.09	0.07	0.03	0.01	mod	18	47	355	48	219	219	221	207	100%		4/30/2011
68	-66.619861	0.01	0.01	0.01	0.00	0.08	0.05	0.03	0.01	obs	107	354	113	355	239	228	238	223	0.03	Ponce, PR	12/1/2020
9757487	17.969583	0.03	0.01	0.00	0.00	0.07	0.06	0.02	0.01	mod	**25**	379	23	384	228	225	229	209	100%		2/28/2021
69	-66.408600	0.01	0.02	0.01	0.01	0.08	0.06	0.02	0.01	obs	11	280	83	124	238	231	250	217	0.03	Santa Isabel, PR	6/1/2011
9756639	17.954000	0.03	0.01	0.00	0.00	0.08	0.06	0.02	0.01	mod	10	370	4	17	229	226	229	209	100%		8/31/2011
70	-66.384000	0.17	0.02	0.05	0.01	0.10	0.08	0.03	0.01	obs	17	50	356	53	220	218	220	218	0.04	Boca del Cibuco, PR	1/1/2021
9756567	18.485170	0.13	0.02	0.03	0.01	0.08	0.07	0.03	0.01	mod	17	47	354	48	221	220	222	207	100%		3/31/2021
71	-66.226402	0.01	0.01	0.01	0.00	0.08	0.06	0.03	0.01	obs	138	14	78	4	230	230	230	230	0.03	Central Aguirre, PR	1/1/2021
9755971	17.950000	0.03	0.01	0.00	0.00	0.08	0.06	0.02	0.01	mod	**-9**	2	-24	6	229	225	229	208	100%		3/31/2021
72	-66.159818	0.01	0.01	0.01	0.00	0.08	0.06	0.03	0.01	obs	66	5	138	0	231	230	231	230	0.03	Las Mareas, PR	4/1/2001
9755679	17.928331	0.03	0.01	0.00	0.00	0.08	0.06	0.02	0.01	mod	**-16**	-2	-33	3	228	225	229	207	100%		5/31/2001
73	-65.991528	0.13	0.02	0.03	0.01	0.08	0.06	0.03	0.01	obs	26	58	7	61	229	233	229	235	0.01	BOCA DE CANGREJOS, PR	2/1/2021
9754986	18.456610	0.13	0.02	0.03	0.01	0.09	0.07	0.03	0.01	mod	27	55	1	59	221	221	222	208	100%		4/30/2021
74	-65.900000	0.02	0.01	0.01	0.00	0.08	0.06	0.03	0.01	obs	14	344	10	344	231	228	231	227	0.02	Puerto Maunabo, PR	1/1/2021
9754487	17.991417	0.04	0.01	0.00	0.00	0.07	0.06	0.02	0.01	mod	**-28**	347	-41	352	228	224	228	206	100%		3/31/2021
75	-65.833333	0.02	0.01	0.00	0.00	0.08	0.06	0.03	0.01	obs	18	0	85	337	232	228	231	212	0.02	Yabucoa Harbor, PR	8/1/2009
9754228	18.055000	0.04	0.01	0.01	0.00	0.07	0.06	0.02	0.01	mod	**-25**	-17	-32	350	228	225	228	206	100%		6/30/2010
76	-65.795583	0.02	0.00	0.01	0.00	0.08	0.06	0.03	0.01	obs	18	349	23	350	231	227	231	226	0.02	Palmas del Mar, PR	1/1/2021
9754057	18.078060	0.03	0.01	0.01	0.00	0.07	0.06	0.02	0.01	mod	**-21**	345	-28	350	229	225	229	206	100%		3/31/2021
77	-65.736500	0.16	0.03	0.04	0.01	0.07	0.06	0.02	0.01	obs	4	35	339	38	225	228	225	229	0.07	Luquillo PR, PR	12/1/2020
9753766	18.381700	0.14	0.02	0.03	0.01	0.09	0.07	0.03	0.01	mod	**41**	73	371	77	220	221	221	209	99%		2/28/2021
78	-65.711390	0.04	0.01	0.01	0.00	0.07	0.06	0.02	0.01	obs	30	307	16	94	230	230	229	205	0.02	Naguabo, PR	6/1/2011
9753641	18.187060	0.04	0.01	0.01	0.00	0.07	0.06	0.02	0.01	mod	**-1**	357	-14	4	228	225	228	205	100%		8/31/2011
79	-65.631200	0.16	0.02	0.04	0.01	0.07	0.06	0.02	0.01	obs	12	41	345	39	219	223	220	213	0.07	Fajardo, PR	8/1/2009
9753216	18.335500	0.13	0.02	0.03	0.01	0.10	0.07	0.03	0.01	mod	**50**	83	379	87	221	222	222	210	99%		7/31/2011

80	-65.619720	0.08	0.01	0.02	0.00	0.08	0.06	0.03	0.01	obs	23	41	5	42	223	224	223	224	0.03	Ceiba, PR	1/1/2021
9753182	18.228060	0.07	0.01	0.02	0.00	0.09	0.07	0.03	0.01	mod	47	55	19	69	227	226	227	210	100%		3/31/2021
81	-65.575900	0.03	0.01	0.01	0.00	0.08	0.06	0.03	0.01	obs	5	6	359	6	230	227	230	226	0.02	PUNTA ARENAS VIEQUES ISLAND, PR	1/1/2021
9752998	18.112400	0.06	0.01	0.01	0.00	0.07	0.05	0.02	0.01	mod	11	16	345	33	226	222	227	205	100%		3/31/2021
82	-65.569600	0.15	0.04	0.04	0.01	0.07	0.06	0.02	0.01	obs	15	359	350	156	221	224	223	206	0.07	Isla Palominos, PR	6/1/2011
9752962	18.344972	0.13	0.02	0.03	0.01	0.10	0.07	0.03	0.01	mod	**50**	441	379	86	222	223	223	210	98%		8/31/2011
83	-65.514861	0.10	0.02	0.03	0.00	0.08	0.06	0.03	0.01	obs	15	37	356	39	223	224	223	225	0.04	Mosquito Pier, PR	1/1/2021
9752813	18.148917	0.09	0.01	0.02	0.00	0.09	0.07	0.03	0.01	mod	**45**	65	377	74	224	224	225	210	100%		3/31/2021
84	-65.443816	0.11	0.02	0.03	0.01	0.08	0.06	0.02	0.01	obs	18	37	353	34	222	223	224	209	0.05	Isabel Segunda Vieques Island, PR	8/1/2009
9752619	18.152585	0.10	0.01	0.02	0.00	0.09	0.07	0.03	0.01	mod	**50**	72	381	81	224	224	225	211	100%		6/30/2010
85	-65.372900	0.02	0.01	0.00	0.00	0.08	0.06	0.03	0.01	obs	335	18	314	24	230	224	230	221	0.02	Playa la Plata, PR	1/1/2021
9752426	18.116600	0.05	0.01	0.01	0.00	0.07	0.06	0.02	0.01	mod	340	-3	321	2	231	228	232	208	100%		3/31/2021
86	-65.238000	0.11	0.02	0.03	0.01	0.07	0.06	0.03	0.01	obs	19	43	1	45	217	217	217	217	0.06	Culebrita, PR	1/1/2021
9752062	18.319400	0.11	0.02	0.02	0.01	0.09	0.07	0.03	0.01	mod	**57**	83	22	90	222	222	223	210	100%		3/31/2021
87	-65.035000	0.13	0.05	0.03	0.01	0.07	0.06	0.02	0.01	obs	16	73	360	330	216	216	220	198	0.07	Botany Bay St. Thomas, VI	5/1/2011
9751774	18.355300	0.12	0.02	0.03	0.01	0.09	0.07	0.03	0.01	mod	**56**	85	381	452	219	218	221	208	100%		7/31/2011
88	-64.963472	0.13	0.02	0.03	0.01	0.07	0.05	0.02	0.01	obs	16	44	354	47	210	213	210	215	0.08	Dorothea Bay Saint Thomas, VI	12/1/2010
9751768	18.371250	0.15	0.02	0.03	0.01	0.10	0.08	0.03	0.02	mod	**60**	94	388	100	219	220	220	209	97%		3/31/2011
89	-64.951694	0.04	0.01	0.01	0.00	0.08	0.06	0.03	0.01	obs	19	6	11	6	230	221	230	216	0.01	Crown Bay, VI	12/1/2020
9751749	18.332900	0.06	0.01	0.01	0.00	0.08	0.06	0.02	0.01	mod	12	16	-9	28	225	223	227	207	100%		2/28/2021
90	-64.922100	0.13	0.02	0.03	0.01	0.07	0.06	0.02	0.01	obs	16	45	360	48	216	214	216	212	0.08	Magens Bay, VI	12/1/2020
9751693	18.366300	0.15	0.02	0.03	0.01	0.10	0.08	0.03	0.02	mod	**61**	95	389	101	219	220	220	209	97%		2/28/2021
91	-64.884100	0.02	0.01	0.01	0.01	0.07	0.06	0.02	0.01	obs	44	52	44	326	237	229	248	208	0.03	Fredericksted St. Croix, VI	5/1/2011
9751584	17.713300	0.04	0.01	0.01	0.00	0.07	0.06	0.02	0.01	mod	**-21**	-3	-43	361	229	226	230	208	100%		8/31/2011
92	-64.870000	0.04	0.01	0.01	0.00	0.08	0.06	0.03	0.01	obs	28	19	6	18	228	223	228	220	0.02	BENNER BAY, VI	8/17/2021
9751567	18.320000	0.05	0.01	0.01	0.00	0.08	0.06	0.02	0.01	mod	0	6	-17	9	227	225	228	207	100%		8/17/2021
93	-64.864167	0.11	0.02	0.02	0.01	0.07	0.06	0.03	0.01	obs	13	38	352	40	218	217	218	216	0.04	Water Bay, VI	11/1/2010
9751583	18.348944	0.11	0.02	0.02	0.01	0.09	0.07	0.03	0.01	mod	43	65	372	73	220	220	222	207	100%		3/31/2011
94	-64.859500	0.04	0.01	0.01	0.00	0.08	0.06	0.03	0.01	obs	26	8	19	6	228	220	228	216	0.02	Jersey Bay, VI	1/1/2021
9751574	18.318139	0.05	0.01	0.01	0.00	0.08	0.06	0.02	0.01	mod	0	5	-17	9	227	225	228	208	100%		3/31/2021
95	-64.852361	0.10	0.02	0.02	0.01	0.07	0.06	0.02	0.01	obs	15	38	359	40	222	215	221	212	0.04	Pavillion Point, VI	12/1/2020
9751561	18.339917	0.10	0.02	0.02	0.00	0.09	0.07	0.03	0.01	mod	**45**	68	375	76	221	221	222	208	100%		3/31/2021
96	-64.817830	0.04	0.01	0.01	0.01	0.08	0.06	0.02	0.01	obs	24	136	23	26	231	222	234	197	0.02	Dog Island St. Thomas, VI	5/1/2011
9751494	18.297139	0.05	0.01	0.01	0.00	0.08	0.06	0.02	0.01	mod	11	15	-10	23	225	223	227	208	100%		7/31/2011
97	-64.803528	0.09	0.02	0.02	0.01	0.07	0.06	0.02	0.01	obs	11	70	355	21	224	216	232	192	0.03	Lovango Cay St. John, VI	5/1/2011
9751467	18.360666	0.10	0.02	0.02	0.01	0.08	0.06	0.03	0.01	mod	36	53	363	59	220	218	222	207	100%		7/31/2011
98	-64.794139	0.08	0.01	0.02	0.00	0.08	0.06	0.03	0.01	obs	10	29	352	30	222	215	221	212	0.03	Cruz Bay, VI	1/1/2021
9751472	18.332917	0.08	0.01	0.02	0.00	0.08	0.06	0.03	0.01	mod	34	47	364	59	221	219	223	207	100%		4/30/2021
99	-64.777000	0.12	0.02	0.03	0.01	0.08	0.06	0.03	0.01	obs	16	46	0	49	212	212	212	211	0.08	Hawksnest Beach, VI	1/1/2021
9751417	18.349000	0.12	0.02	0.03	0.01	0.10	0.07	0.03	0.02	mod	**63**	97	32	103	221	221	222	210	99%		3/31/2021
100	-64.762300	0.03	0.01	0.00	0.00	0.08	0.06	0.03	0.01	obs	352	18	350	21	228	221	227	217	0.02	Salt River Bay, VI	1/1/2021
9751389	17.775300	0.05	0.01	0.01	0.00	0.07	0.06	0.02	0.01	mod	347	3	335	5	228	225	228	208	100%		3/31/2021
101	-64.761830	0.04	0.01	0.01	0.00	0.08	0.06	0.03	0.01	obs	19	18	9	18	229	220	228	216	0.02	Fish Bay, VI	1/1/2021
9751388	18.319170	0.05	0.01	0.01	0.00	0.08	0.06	0.02	0.01	mod	-1	4	-18	9	227	225	228	208	100%		3/31/2021
102	-64.720722	0.10	0.02	0.02	0.01	0.08	0.06	0.03	0.01	obs	15	42	356	45	217	215	217	214	0.04	Leinster Point Leinster Bay St. John's, VI	12/1/2010
9751309	18.367611	0.08	0.01	0.02	0.00	0.09	0.07	0.03	0.01	mod	**49**	64	376	81	222	221	223	209	100%		3/31/2011
103	-64.711763	0.05	0.01	0.01	0.00	0.09	0.06	0.03	0.01	obs	16	26	2	27	226	223	226	221	0.01	ST JOHN'S ISLAND CORAL HARBOR, VI	3/1/1983
9751373	18.346491	0.05	0.01	0.01	0.00	0.08	0.06	0.02	0.01	mod	1	8	-14	-1	227	224	228	207	100%		5/31/1983
104	-64.682800	0.01	0.01	0.00	0.00	0.08	0.06	0.03	0.01	obs	357	15	70	16	235	227	234	223	0.03	Fareham Bay, VI	1/1/2021
9751219	17.710000	0.05	0.02	0.01	0.00	0.07	0.06	0.02	0.01	mod	**325**	-14	-66	-3	230	226	230	208	100%		3/31/2021
105	-64.679639	0.07	0.01	0.01	0.00	0.08	0.06	0.03	0.01	obs	15	35	351	37	223	220	223	218	0.01	HAULOVER BAY ST. JOHNS, VI	8/17/2021
9751419	18.349700	0.06	0.01	0.01	0.00	0.08	0.06	0.02	0.01	mod	12	17	353	26	226	224	227	208	100%		8/17/2021
106	-64.605800	0.01	0.01	0.00	0.00	0.08	0.06	0.03	0.01	obs	9	8	76	6	233	225	232	222	0.03	Grapetree Bay, VI	1/1/2021
9751082	17.740720	0.05	0.01	0.01	0.00	0.07	0.06	0.02	0.01	mod	**-29**	-11	-55	-3	229	225	229	208	100%		3/31/2021
107	-64.602390	0.03	0.01	0.00	0.00	0.08	0.06	0.03	0.01	obs	1	30	34	30	228	222	228	218	0.02	Teague Bay, VI	1/1/2021
9751084	17.754972	0.05	0.01	0.01	0.00	0.08	0.06	0.02	0.01	mod	-6	4	-18	6	227	224	227	207	100%		3/31/2021
108	-75.863300	0.28	0.05	0.05	0.01	0.05	0.05	0.02	0.01	obs	150	181	144	184	275	259	274	251	0.07	CRISFIELD, MD	5/1/1977
8571091	37.976700	0.27	0.05	0.06	0.01	0.05	0.04	0.02	0.01	mod	171	200	149	185	271	269	259	260	100%		11/30/1977
109	-76.031700	0.23	0.03	0.05	0.01	0.03	0.03	0.01	0.01	obs	162	192	141	194	280	293	281	300	0.02	Ewell Smith Island, MD	7/1/2010
8571117	37.995000	0.22	0.04	0.05	0.01	0.04	0.03	0.01	0.00	mod	158	184	135	181	272	273	261	272	100%		10/31/2010
110	-76.005000	0.31	0.05	0.07	0.01	0.04	0.03	0.01	0.01	obs	192	221	175	214	282	299	295	267	0.06	McCready's Creek, MD	2/1/2005
8571559	38.300000	0.29	0.04	0.06	0.02	0.05	0.03	0.02	0.01	mod	207	238	187	229	290	294	274	302	100%		12/31/2009

111	-76.265000	0.18	0.03	0.04	0.01	0.03	0.02	0.01	0.01	obs	194	209	168	238	305	325	291	302	0.01	Barren Island, MD	1/1/2002
8571579	38.341700	0.19	0.03	0.04	0.01	0.04	0.03	0.01	0.00	mod	196	222	172	222	312	315	296	317	100%		3/31/2003
112	-75.818330	0.29	0.02	0.05	0.01	0.04	0.03	0.01	0.01	obs	258	284	243	287	332	330	332	329	0.11	Vienna, MD	9/1/2005
8571773	38.483330	0.37	0.05	0.07	0.02	0.05	0.03	0.02	0.01	mod	237	273	221	260	305	309	287	323	80%		8/31/2009
113	-75.723297	0.32	0.04	0.06	0.01	0.05	0.03	0.01	0.01	obs	280	322	264	324	332	354	323	337	0.18	SHARPSTOWN NANTICOKE	12/1/2017
8571858	38.545000	0.38	0.06	0.07	0.02	0.05	0.03	0.02	0.01	mod	**240**	275	224	262	307	312	288	326	44%	RIVER, MD	11/30/2020
114	-76.375000	0.16	0.02	0.03	0.01	0.05	0.04	0.02	0.01	obs	262	293	237	288	344	355	330	334	0.02	Poplar Island, MD	3/1/2007
8572271	38.758300	0.15	0.02	0.03	0.01	0.06	0.04	0.02	0.01	mod	268	301	246	293	355	351	340	351	100%		2/28/2010
115	-76.221700	0.21	0.03	0.04	0.01	0.07	0.04	0.02	0.01	obs	272	302	248	304	344	6	345	18	0.03	ST. MICHAELS MILES RIVER,	10/6/2023
8572342	38.786700	0.19	0.03	0.04	0.01	0.06	0.05	0.02	0.01	mod	279	313	254	251	366	1	343	40	100%	MD	10/6/2023
116	-76.373300	0.15	0.02	0.03	0.01	0.05	0.04	0.02	0.01	obs	268	297	246	292	346	358	334	340	0.01	Kent Point, MD	6/1/1996
8572467	38.836700	0.15	0.02	0.03	0.01	0.06	0.04	0.02	0.01	mod	273	304	251	296	356	353	340	356	100%		5/31/2000
117	-76.355000	0.14	0.02	0.03	0.01	0.06	0.05	0.02	0.00	obs	292	324	269	318	352	356	345	0	0.02	Matapeake, MD	1/1/1979
8572770	38.956700	0.14	0.02	0.03	0.01	0.07	0.05	0.02	0.01	mod	300	336	278	327	362	357	341	23	100%		12/31/1983
118	-76.301700	0.17	0.02	0.03	0.01	0.06	0.05	0.02	0.01	obs	323	355	298	354	2	11	347	332	0.02	Love Point Pier, MD	6/1/1996
8572955	39.031700	0.17	0.03	0.04	0.01	0.07	0.05	0.02	0.01	mod	328	359	304	353	10	5	355	370	100%		5/31/2000
119	-76.063300	0.22	0.03	0.04	0.01	0.08	0.05	0.02	0.01	obs	48	93	17	109	19	21	1	17	0.03	Betterton, MD	6/1/1999
8573704	39.371700	0.22	0.03	0.04	0.01	0.09	0.06	0.03	0.01	mod	41	72	14	67	35	29	19	38	100%		12/31/1999
120	-75.916700	0.30	0.04	0.06	0.01	0.06	0.05	0.02	0.01	obs	71	113	43	100	21	38	12	22	0.06	TOWN POINT WHARF, MD	1/1/1987
8573903	39.503300	0.25	0.03	0.05	0.01	0.09	0.07	0.03	0.01	mod	61	98	37	90	45	38	28	50	100%		12/31/1993
121	-76.090000	0.28	0.05	0.05	0.01	0.08	0.06	0.02	0.01	obs	72	113	44	108	28	32	20	8	0.05	Havre De Grace, MD	1/1/1979
8574070	39.536700	0.24	0.03	0.05	0.01	0.09	0.07	0.03	0.01	mod	62	95	37	93	46	38	31	45	100%		12/31/1991
122	-76.255000	0.18	0.02	0.04	0.01	0.11	0.04	0.04	0.01	obs	28	60	355	62	9	30	11	42	0.04	POND POINT (ABERDEEN	8/1/1995
8574459	39.388300	0.17	0.02	0.03	0.01	0.08	0.06	0.02	0.01	mod	32	62	367	66	35	29	23	30	100%	P.G.) BUSH RIVER, MD	8/31/1995
123	-76.585000	0.15	0.02	0.04	0.01	0.07	0.06	0.02	0.02	obs	336	8	315	354	7	16	0	345	0.03	Fort McHenry Marsh, MD	5/1/2004
8574683	39.261700	0.17	0.03	0.04	0.01	0.07	0.06	0.02	0.01	mod	346	17	321	378	19	12	9	370	100%		1/31/2005
124	-76.473300	0.14	0.02	0.03	0.01	0.03	0.03	0.01	0.01	obs	224	250	195	258	339	351	325	305	0.01	Long Beach, MD	11/1/1997
8577004	38.465000	0.15	0.02	0.03	0.01	0.04	0.03	0.01	0.00	mod	221	249	197	251	342	341	329	336	100%		4/30/2000
125	-76.398300	0.14	0.02	0.03	0.01	0.02	0.02	0.01	0.00	obs	208	231	177	233	351	339	350	333	0.02	COVE POINT, MD	11/1/1983
8577188	38.391700	0.15	0.02	0.03	0.01	0.03	0.03	0.01	0.00	mod	208	235	184	237	332	334	319	327	100%		11/30/1983
126	-76.938300	0.41	0.05	0.07	0.01	0.04	0.04	0.01	0.01	obs	31	82	10	86	10	22	11	28	0.15	BLADENSBURG ANACOSTIA	4/1/1996
8579997	38.933300	0.44	0.06	0.08	0.02	0.07	0.05	0.01	0.01	mod	5	35	-17	37	-13	-3	-1	-34	58%	RIVER, MD	7/31/1996
127	-76.020000	0.34	0.06	0.08	0.02	0.05	0.04	0.02	0.01	obs	44	70	24	72	198	217	200	226	0.03	CAPE CHARLES HBR (U.S. G.	10/6/2023
8632366	37.263300	0.34	0.06	0.08	0.02	0.06	0.04	0.02	0.01	mod	51	76	31	76	210	213	207	216	100%	WHARF), VA	10/6/2023
128	-76.015000	0.24	0.03	0.04	0.01	0.04	0.03	0.01	0.01	obs	87	113	67	115	222	248	224	262	0.03	Rappahannock Light, VA	6/1/2007
8632837	37.538333	0.24	0.04	0.05	0.01	0.05	0.04	0.02	0.01	mod	94	118	73	119	231	232	228	229	100%		9/30/2007
129	-75.916700	0.26	0.04	0.05	0.01	0.04	0.04	0.01	0.01	obs	95	130	68	133	235	249	236	256	0.05	GASKINS PT.	6/1/2007
8632869	37.556700	0.25	0.04	0.06	0.01	0.05	0.04	0.02	0.01	mod	109	134	89	135	240	237	240	232	100%	OCCOHANNOCK CREEK, VA	9/30/2007
130	-75.993300	0.23	0.03	0.05	0.01	0.04	0.03	0.01	0.01	obs	134	159	118	161	258	255	258	254	0.03	Tangier Island, VA	4/1/2005
8633532	37.828300	0.24	0.04	0.05	0.01	0.05	0.03	0.02	0.01	mod	142	169	121	166	256	254	248	252	100%		5/31/2005
131	-75.728300	0.33	0.07	0.07	0.02	0.05	0.04	0.01	0.01	obs	142	152	120	156	249	266	309	263	0.07	SAXIS STARLING CREEK, VA	8/1/1988
8633777	37.921700	0.32	0.05	0.07	0.01	0.05	0.04	0.02	0.01	mod	157	189	139	181	265	262	254	281	99%		11/30/1988
132	-76.960000	0.24	0.04	0.05	0.01	0.03	0.02	0.01	0.01	obs	215	249	193	246	294	322	302	300	0.02	Colonial Beach Potomac	1/1/1983
8635150	38.251700	0.22	0.04	0.05	0.01	0.04	0.03	0.01	0.01	mod	211	243	190	236	308	317	309	293	100%	River, VA	12/31/2001
133	-76.783300	0.26	0.04	0.05	0.01	0.04	0.02	0.01	0.01	obs	168	194	145	193	245	274	249	269	0.08	Wares Wharf, VA	5/1/2008
8635985	37.873300	0.27	0.04	0.06	0.01	0.04	0.03	0.01	0.01	mod	190	217	168	214	256	269	252	270	100%		4/30/2009
134	-76.273300	0.24	0.05	0.06	0.01	0.04	0.03	0.01	0.01	obs	48	73	29	70	197	219	198	218	0.02	NEW POINT, VA	10/6/2023
8637289	37.346700	0.25	0.05	0.06	0.01	0.05	0.03	0.01	0.01	mod	53	78	35	79	207	212	197	216	100%		10/6/2023
135	-76.221700	0.31	0.05	0.06	0.01	0.04	0.04	0.01	0.01	obs	41	68	20	71	191	224	193	240	0.02	NEW POINT COMFORT	10/6/2023
8637590	37.256700	0.31	0.06	0.07	0.02	0.05	0.04	0.02	0.01	mod	46	71	26	70	203	208	196	213	100%	SHOAL, VA	10/6/2023
136	-76.500000	0.36	0.06	0.08	0.02	0.05	0.04	0.01	0.01	obs	54	80	36	72	198	221	193	202	0.04	Gloucester Point, VA	1/1/1983
8637624	37.246700	0.38	0.06	0.08	0.02	0.06	0.04	0.01	0.01	mod	60	86	41	82	204	211	192	219	100%		12/31/2001
137	-76.791417	0.27	0.04	0.06	0.01	0.05	0.04	0.01	0.01	obs	130	160	114	158	252	273	244	250	0.06	Jamestown Wharf, VA	12/1/2018
8637712	37.220100	0.29	0.04	0.06	0.01	0.05	0.04	0.01	0.01	mod	145	177	126	169	261	269	241	284	100%		11/30/2019
138	-76.622750	0.32	0.05	0.07	0.01	0.06	0.04	0.02	0.01	obs	90	122	73	124	233	256	235	267	0.06	FORT EUSTIS (MARAD)	8/1/2010
8638017	37.138200	0.35	0.06	0.07	0.02	0.06	0.04	0.01	0.01	mod	102	132	85	129	234	241	214	257	100%	JAMES RIVER, VA	9/30/2010
139	-76.399100	0.40	0.07	0.09	0.02	0.05	0.04	0.01	0.01	obs	54	87	38	70	197	226	166	220	0.05	Western Branch, VA	4/1/2011
8638339	36.823200	0.37	0.06	0.08	0.02	0.06	0.05	0.01	0.01	mod	62	91	44	100	207	216	208	222	100%		9/30/2011
140	-76.668300	0.35	0.06	0.07	0.02	0.05	0.04	0.01	0.00	obs	84	113	62	102	222	243	213	203	0.03	BURWELL BAY JAMES	10/6/2023
8638421	37.056700	0.37	0.06	0.08	0.02	0.06	0.04	0.01	0.01	mod	90	120	71	117	225	234	209	248	100%	RIVER, VA	10/6/2023
141	-76.663300	0.33	0.06	0.07	0.02	0.06	0.04	0.02	0.01	obs	103	139	91	141	227	250	229	262	0.06	Kingsmill, VA	7/1/2003
8638424	37.220000	0.32	0.05	0.06	0.02	0.06	0.04	0.01	0.01	mod	116	146	97	141	244	251	220	267	100%		8/31/2003

142	-76.783300	0.29	0.05	0.06	0.01	0.06	0.04	0.02	0.01	obs	124	160	112	163	243	278	246	295	0.06	Scotland, VA	7/1/2003
8638433	37.185000	0.29	0.04	0.06	0.01	0.05	0.04	0.01	0.01	mod	141	171	122	164	259	267	239	280	100%		8/31/2003
143	-76.911700	0.37	0.06	0.07	0.02	0.06	0.04	0.01	0.01	obs	181	224	170	222	279	301	258	308	0.24	Lanexa Chickahominy	7/1/2008
8638445	37.403300	**0.10**	0.01	0.02	0.00	0.02	0.02	0.00	0.00	mod	**233**	262	215	275	315	323	287	331	31%	River, VA	6/30/2009
144	-76.943300	0.26	0.04	0.05	0.01	0.05	0.04	0.01	0.01	obs	156	187	136	183	265	288	252	285	0.04	Tettington James River, VA	8/1/2008
8638450	37.240000	0.28	0.04	0.05	0.01	0.05	0.04	0.01	0.01	mod	165	197	146	188	271	281	255	292	100%		7/31/2010
145	-77.098300	0.29	0.03	0.06	0.01	0.08	0.05	0.03	0.01	obs	202	230	182	232	288	297	288	302	0.07	Wilcox Wharf, VA	8/1/2010
8638464	37.315000	0.25	0.03	0.04	0.01	0.05	0.04	0.01	0.01	mod	218	253	199	247	297	308	284	317	99%		9/30/2010
146	-77.270000	0.35	0.04	0.06	0.01	0.06	0.05	0.01	0.01	obs	231	269	215	263	294	315	275	324	0.05	Hopewell, VA	2/1/2012
8638481	37.313300	0.28	0.04	0.05	0.01	0.05	0.04	0.01	0.01	mod	232	269	215	264	304	316	295	322	100%		4/30/2012
147	-76.293300	0.40	0.07	0.09	0.02	0.06	0.04	0.01	0.01	obs	52	82	38	79	201	222	193	202	0.03	PORTSMOUTH NORFOLK	1/1/1979
8638660	36.821700	0.39	0.07	0.09	0.02	0.06	0.05	0.02	0.01	mod	56	86	37	84	206	214	195	222	100%	NAVAL SHIPYARD, VA	12/31/1986
148	-76.275858	0.39	0.07	0.09	0.02	0.05	0.04	0.01	0.01	obs	52	79	36	84	194	228	188	224	0.14	Lafayette River, VA	3/1/2011
8638671	36.884200	0.31	0.05	0.07	0.02	0.06	0.05	0.01	0.01	mod	80	110	63	123	218	223	217	229	63%		9/30/2011
149	-76.113300	0.38	0.07	0.09	0.02	0.06	0.04	0.02	0.01	obs	21	46	1	46	185	209	188	191	0.01	Chesapeake Bay Bridge	1/1/1983
8638863	36.966700	0.38	0.07	0.09	0.02	0.06	0.05	0.02	0.01	mod	22	49	3	47	190	199	181	204	100%	Tunnel, VA	12/31/2001
150	-75.973300	0.48	0.09	0.11	0.02	0.07	0.06	0.03	0.01	obs	6	30	346	27	176	201	180	178	0.07	Rudee Inlet, VA	12/1/2005
8639207	36.831700	0.46	0.08	0.11	0.02	0.08	0.06	0.02	0.01	mod	16	44	359	50	187	193	183	196	100%		11/30/2007
151	-75.655000	0.04	0.01	0.01	0.00	0.01	0.01	0.00	0.00	obs	82	162	67	168	308	234	308	266	0.02	Oyster Creek, NC	6/1/2002
8652437	35.845000	0.05	0.01	0.01	0.00	0.01	0.01	0.01	0.00	mod	102	136	83	117	275	220	230	110	100%		9/30/2002
152	-75.700000	0.04	0.01	0.01	0.00	0.01	0.01	0.00	0.00	obs	81	159	66	164	336	239	339	269	0.02	Roanoke Marshes Light, NC	6/1/2002
8652547	35.811700	0.05	0.01	0.01	0.00	0.01	0.01	0.01	0.00	mod	87	121	67	112	266	216	234	152	100%		9/30/2002
153	-75.585000	0.09	0.01	0.02	0.00	0.01	0.02	0.00	0.00	obs	27	39	8	40	218	215	216	242	0.02	Old House Channel, NC	6/1/2002
8652648	35.776700	0.09	0.01	0.02	0.00	0.02	0.02	0.01	0.00	mod	45	58	24	93	203	196	224	177	100%		9/30/2002
154	-75.526700	0.32	0.06	0.07	0.02	0.07	0.04	0.03	0.01	obs	0	25	342	27	180	184	180	186	0.06	USCG LIFEBOAT STATION	5/1/1994
8652678	35.768300	0.40	0.07	0.10	0.02	0.07	0.05	0.02	0.01	mod	0	25	341	22	179	184	178	180	100%	OREGON INLET, NC	6/30/1994
155	-75.635000	0.45	0.08	0.11	0.02	0.09	0.07	0.03	0.01	obs	353	16	331	17	185	186	186	181	0.01	Cape Hatteras Fishing Pier,	1/1/1983
8654400	35.223300	0.45	0.08	0.11	0.02	0.09	0.07	0.03	0.01	mod	353	17	334	18	180	185	181	178	100%	NC	12/31/2001
156	-75.986900	0.11	0.02	0.02	0.01	0.02	0.02	0.01	0.00	obs	6	28	349	30	202	206	202	207	0.02	Ocracoke Pamlico Sound,	6/1/2022
8654769	35.115500	0.08	0.01	0.02	0.00	0.02	0.02	0.00	0.00	mod	8	33	351	55	196	205	222	177	100%	NC	9/30/2022
157	-75.988300	0.14	0.02	0.04	0.01	0.03	0.03	0.01	0.01	obs	6	35	348	37	192	199	192	202	0.03	OCRACOKE ISLAND, NC	3/7/1980
8654792	35.115000	0.10	0.02	0.02	0.01	0.02	0.02	0.00	0.00	mod	5	30	347	49	193	200	211	174	100%		4/23/1980
158	-76.803300	0.23	0.03	0.05	0.01	0.06	0.05	0.02	0.01	obs	53	68	37	69	230	231	230	231	0.02	Spooners Creek, NC	4/1/2012
8656467	34.725000	0.21	0.03	0.04	0.01	0.05	0.05	0.02	0.01	mod	54	79	35	70	238	241	240	226	100%		7/31/2012
159	-76.711700	0.55	0.10	0.13	0.02	0.09	0.07	0.03	0.01	obs	351	11	330	16	185	191	188	184	0.01	Atlantic Beach Triple S Pier,	6/1/1999
8656590	34.693300	0.55	0.09	0.13	0.02	0.09	0.07	0.03	0.01	mod	350	13	331	12	183	188	186	172	100%	NC	5/31/2000
160	-77.946700	0.58	0.08	0.13	0.02	0.10	0.06	0.03	0.01	obs	38	64	25	66	203	225	205	236	0.08	SUNNY POINT MOTSU	4/1/1976
8658579	34.023300	0.68	0.10	0.14	0.02	0.09	0.07	0.03	0.02	mod	38	67	24	63	210	214	209	205	99%	NORTH WHARF, NC	6/30/1976
161	-77.951700	0.57	0.09	0.13	0.02	0.10	0.06	0.03	0.01	obs	26	52	13	54	196	215	198	224	0.05	ZEKES ISLAND CAPE FEAR	4/1/1976
8658741	33.950000	0.64	0.09	0.13	0.02	0.09	0.07	0.03	0.02	mod	24	51	9	48	204	208	203	199	100%	RIVER, NC	6/30/1976
162	-78.018300	0.63	0.09	0.13	0.03	0.10	0.07	0.03	0.01	obs	9	32	348	34	196	200	196	202	0.03	Southport, NC	1/1/1978
8659084	33.915000	0.61	0.09	0.13	0.02	0.09	0.07	0.03	0.02	mod	11	35	354	36	198	202	197	193	100%		12/31/1987
163	-78.081700	0.69	0.12	0.16	0.03	0.10	0.07	0.04	0.02	obs	355	16	337	20	190	196	194	170	0.03	Oak Island Atlantic Ocean,	6/1/1996
8659182	33.901700	0.71	0.12	0.16	0.03	0.09	0.07	0.03	0.02	mod	352	14	334	20	185	189	182	178	100%	NC	5/31/1997
164	-78.506700	0.72	0.12	0.17	0.04	0.10	0.07	0.04	0.02	obs	356	13	339	6	189	196	188	181	0.04	Sunset Beach, NC	3/1/2005
8659897	33.865000	0.74	0.12	0.17	0.03	0.09	0.07	0.03	0.02	mod	352	14	334	21	186	189	180	181	100%		2/29/2008
165	-78.996700	0.73	0.12	0.17	0.03	0.11	0.07	0.04	0.01	obs	359	20	342	22	194	195	194	195	0.04	GARDEN CITY PIER	4/1/1975
8661437	33.575000	0.75	0.12	0.17	0.03	0.10	0.07	0.04	0.01	mod	355	17	337	25	186	189	181	180	100%	MURRELLS INLET, SC	3/31/1976
166	-79.203300	0.56	0.08	0.11	0.02	0.09	0.06	0.03	0.01	obs	25	51	7	47	208	213	208	212	0.09	WINYAH BAY SOUTH	1/1/1979
8662746	33.235000	0.52	0.08	0.11	0.02	0.08	0.06	0.03	0.01	mod	13	36	-4	43	200	203	198	197	97%	ISLAND PLANTATION, SC	12/31/1995
167	-79.830000	0.84	0.12	0.18	0.03	0.11	0.09	0.04	0.02	obs	28	67	20	51	214	217	206	200	0.21	Cainhoy Wando River, SC	5/1/1988
8664545	32.926700	0.70	0.09	0.14	0.02	0.09	0.07	0.03	0.01	mod	46	76	34	84	217	219	218	216	35%		4/30/1998
168	-79.951700	0.78	0.10	0.17	0.03	0.12	0.09	0.04	0.02	obs	25	54	10	57	206	213	206	217	0.13	Army Depot, SC	7/1/1987
8664662	32.910000	0.66	0.09	0.13	0.02	0.08	0.06	0.03	0.01	mod	34	60	18	66	211	214	209	210	68%		6/30/1989
169	-80.021700	0.82	0.13	0.18	0.02	0.11	0.09	0.04	0.01	obs	22	48	12	51	212	207	216	206	0.22	I-526 BRIDGE ASHLEY	11/1/1999
8665099	32.836700	0.62	0.09	0.12	0.02	0.09	0.07	0.03	0.01	mod	40	67	27	72	217	219	217	217	35%	RIVER, SC	4/30/2000
170	-80.465000	0.88	0.15	0.20	0.03	0.11	0.08	0.04	0.02	obs	10	33	356	37	199	202	202	194	0.05	Fripps Inlet, SC	3/1/2004
8668498	32.340000	0.83	0.13	0.17	0.02	0.10	0.08	0.04	0.02	mod	9	35	355	41	196	200	195	191	100%		2/28/2007
171	-81.141694	1.21	0.20	0.24	0.05	0.13	0.09	0.04	0.02	obs	35	70	28	73	205	218	206	225	0.28	Port Wentworth, GA	5/1/2002
8670424	32.143306	0.98	0.14	0.19	0.03	0.10	0.08	0.04	0.01	mod	51	78	36	84	217	220	212	216	26%		7/31/2002
172	-81.091700	1.16	0.17	0.23	0.04	0.12	0.08	0.04	0.02	obs	34	71	23	62	214	216	212	213	0.17	BULL STREET SAVANNAH	10/6/2023
8670681	32.081700	0.99	0.15	0.20	0.03	0.10	0.08	0.04	0.01	mod	43	69	27	76	211	214	207	210	45%	RIVER, GA	10/6/2023

173	-81.023300	1.05	0.21	0.26	0.06	0.11	0.08	0.04	0.01	obs	30	52	20	53	219	215	218	213	0.35	SKIDAWAY INSTITUTE	10/7/1994
8671086	31.990000	**0.75**	0.12	0.16	0.03	0.10	0.08	0.03	0.02	mod	**53**	81	38	89	225	229	218	221	23%	SKIDAWAY RIVER, GA	11/5/1994
174	-80.943300	0.96	0.19	0.23	0.05	0.10	0.07	0.03	0.01	obs	21	42	7	43	211	209	211	208	0.08	HALFMOON REEF	10/6/1994
8671314	31.963300	0.91	0.14	0.19	0.03	0.10	0.08	0.04	0.02	mod	24	48	7	54	201	205	197	194	95%	HALFMOON RIVER, GA	11/4/1994
175	-81.011700	1.00	0.20	0.24	0.05	0.10	0.07	0.03	0.01	obs	24	45	11	46	214	211	214	210	0.09	PRIEST LANDING	10/4/1994
8671315	31.963300	0.93	0.15	0.19	0.03	0.10	0.08	0.04	0.02	mod	27	53	11	59	204	208	198	200	91%	WILMINGTON RIVER, GA	11/2/1994
176	-81.061667	1.02	0.19	0.21	0.05	0.09	0.08	0.03	0.01	obs	20	49	7	51	203	210	203	214	0.25	Little Wassaw Island Green	1/1/2023
8671946	31.889722	0.86	0.13	0.17	0.02	0.10	0.08	0.04	0.01	mod	38	65	22	69	211	215	206	206	31%	Island Sound, GA	3/31/2023
177	-81.278300	1.04	0.15	0.24	0.04	0.11	0.08	0.04	0.02	obs	37	77	31	80	212	218	213	220	0.42	Sunbury Sunbury Channel,	2/1/2012
8672875	31.766700	**0.65**	0.10	0.13	0.02	0.09	0.08	0.03	0.02	mod	**65**	96	52	100	236	240	231	239	17%	GA	4/30/2012
178	-81.141700	1.01	0.16	0.24	0.04	0.11	0.08	0.04	0.01	obs	21	53	8	56	196	205	197	210	0.15	South Ossabaw Island Bear	2/19/2012
8673171	31.723028	0.88	0.14	0.18	0.03	0.10	0.08	0.04	0.01	mod	30	54	11	58	205	210	197	201	58%	River, GA	4/18/2012
179	-81.190000	1.00	0.15	0.23	0.04	0.11	0.07	0.04	0.01	obs	24	56	13	58	203	204	203	204	0.23	Daymark #135 South	3/1/2012
8674301	31.575000	0.80	0.12	0.16	0.02	0.10	0.08	0.03	0.01	mod	38	62	20	64	212	216	204	206	33%	Newport River, GA	4/30/2012
180	-81.320000	1.07	0.17	0.25	0.05	0.11	0.08	0.04	0.02	obs	31	68	23	70	207	211	207	213	0.55	Daymark #156 Head of	2/1/2012
8674975	31.486700	**0.73**	0.10	0.14	0.02	0.09	0.08	0.03	0.01	mod	**74**	103	60	104	230	232	224	226	13%	Mud River, GA	4/30/2012
181	-81.396700	0.98	0.16	0.23	0.04	0.11	0.08	0.04	0.02	obs	23	51	8	53	201	208	203	202	0.22	St.Simons Island, GA	11/1/1999
8677344	31.131700	0.77	0.12	0.16	0.02	0.10	0.08	0.03	0.01	mod	36	60	17	58	208	214	199	200	37%		10/31/2008
182	-81.496806	1.04	0.16	0.24	0.04	0.11	0.08	0.04	0.01	obs	32	67	22	70	204	212	205	216	0.47	Howe Street Pier	2/1/2012
8677406	31.144600	**0.68**	0.10	0.14	0.02	0.09	0.08	0.03	0.01	mod	**67**	94	51	91	226	231	217	219	16%	Brunswick, GA	4/30/2012
183	-81.455972	0.97	0.15	0.22	0.04	0.10	0.08	0.03	0.01	obs	28	59	15	61	199	209	200	213	0.25	Raccoon Key Spit, GA	2/1/2012
8678124	31.014806	**0.75**	0.11	0.16	0.02	0.09	0.08	0.03	0.01	mod	**45**	71	27	68	214	219	204	207	30%		4/30/2012
184	-81.515000	0.95	0.15	0.21	0.04	0.11	0.08	0.04	0.02	obs	36	68	20	66	210	218	207	217	0.31	KINGS BAY, GA	1/1/1990
8679511	30.796700	0.78	0.12	0.16	0.02	0.10	0.08	0.03	0.02	mod	61	87	42	88	219	224	210	210	24%		12/31/1990
185	-81.471700	0.91	0.14	0.19	0.04	0.10	0.08	0.03	0.01	obs	37	67	25	48	212	217	209	210	0.15	DUNGENESS SEACAMP	1/1/1979
8679758	30.763300	0.81	0.13	0.18	0.03	0.10	0.08	0.04	0.02	mod	49	73	29	74	212	217	203	203	51%	DOCK, GA	12/31/1979
186	-81.548300	0.86	0.13	0.17	0.04	0.10	0.08	0.04	0.02	obs	45	71	39	60	218	228	228	226	0.19	ST. MARYS ST. MARYS	7/1/1976
8679964	30.720000	0.72	0.11	0.15	0.02	0.10	0.08	0.03	0.02	mod	61	86	42	87	220	226	213	211	39%	RIVER, GA	6/30/1978
187	-81.621700	0.72	0.09	0.13	0.03	0.09	0.07	0.03	0.01	obs	60	98	58	101	222	248	224	261	0.29	CRANDALL ST. MARYS	2/1/1978
8720004	30.721700	0.59	0.08	0.12	0.02	0.09	0.08	0.03	0.01	mod	**93**	121	77	121	243	247	236	233	25%	RIVER, FL	5/31/1978
188	-81.465000	0.89	0.06	0.19	0.03	0.12	0.08	0.03	0.02	obs	27	57	10	146	201	216	186	215	0.16	CUT 1N FRONT RANGE ST	1/1/1998
8720011	30.708300	0.78	0.13	0.17	0.03	0.10	0.08	0.03	0.02	mod	38	60	17	61	205	211	196	196	57%	MARYS RIVER ENTR, FL	4/30/1998
189	-81.301700	0.86	0.14	0.19	0.03	0.10	0.08	0.04	0.02	obs	16	38	354	42	193	205	190	193	0.03	CUT 2N FRONT RANGE ST	10/6/2023
8720012	30.716700	0.89	0.15	0.20	0.03	0.10	0.08	0.04	0.02	mod	16	37	355	39	191	197	185	183	100%	MARYS RIVER ENTR, FL	10/6/2023
190	-81.515000	0.66	0.07	0.12	0.02	0.10	0.11	0.03	0.02	obs	52	87	40	89	231	229	231	228	0.18	NASSAUVILLE NASSAU	1/1/1978
8720098	30.568300	0.51	0.07	0.10	0.01	0.08	0.07	0.03	0.01	mod	70	97	53	89	230	233	225	220	44%	RIVER EAST, FL	12/31/1978
191	-81.641700	0.44	0.06	0.09	0.02	0.04	0.03	0.01	0.01	obs	68	101	56	103	247	244	247	242	0.07	CEDAR HEIGHTS, FL	10/1/1977
8720189	30.436700	0.37	0.05	0.07	0.01	0.04	0.03	0.01	0.01	mod	76	103	56	94	220	226	224	224	100%		1/31/1978
192	-81.453300	0.64	0.10	0.13	0.03	0.09	0.06	0.03	0.01	obs	46	76	36	78	228	221	228	217	0.14	SISTERS CREEK, FL	9/1/1977
8720196	30.416700	0.48	0.07	0.10	0.01	0.06	0.05	0.02	0.01	mod	57	82	38	71	213	217	211	206	61%		12/31/1977
193	-81.413300	0.70	0.11	0.16	0.03	0.09	0.06	0.03	0.01	obs	21	44	6	41	200	206	197	200	0.03	Mayport Naval Sta. St	11/1/2003
8720211	30.400000	0.67	0.11	0.15	0.02	0.08	0.06	0.03	0.01	mod	22	45	2	40	194	200	187	188	100%	Johns River, FL	10/31/2004
194	-81.395000	0.72	0.12	0.16	0.03	0.08	0.06	0.03	0.01	obs	20	44	358	41	192	206	198	196	0.03	Degaussing Structure, FL	5/1/1998
8720214	30.396700	0.75	0.12	0.17	0.03	0.09	0.07	0.03	0.01	mod	19	41	358	39	192	198	185	184	100%		10/31/1998
195	-81.431700	0.66	0.11	0.15	0.03	0.08	0.06	0.03	0.01	obs	28	52	10	50	204	212	196	201	0.07	Mayport (Ferry Depot), FL	1/1/1983
8720220	30.393300	0.58	0.09	0.13	0.02	0.07	0.05	0.02	0.01	mod	31	55	11	47	199	205	193	195	100%		11/30/2000
196	-81.431700	0.66	0.09	0.14	0.03	0.08	0.06	0.03	0.02	obs	28	50	9	38	205	213	191	201	0.06	MAYPORT ST JOHNS RIVER,	4/1/1997
8720224	30.395000	0.58	0.09	0.13	0.02	0.07	0.05	0.02	0.01	mod	31	54	10	46	199	205	193	195	100%	FL	2/28/1998
197	-81.620000	0.38	0.05	0.08	0.01	0.04	0.03	0.01	0.01	obs	64	95	50	97	230	240	228	231	0.07	Long Branch, FL	3/1/2002
8720242	30.360000	0.31	0.04	0.06	0.01	0.03	0.02	0.01	0.00	mod	75	102	55	92	224	231	228	224	100%		2/28/2003
198	-81.386700	0.76	0.12	0.18	0.03	0.11	0.08	0.04	0.01	obs	16	35	353	37	193	206	194	212	0.04	Jacksonville Beach, FL	5/1/1974
8720291	30.283300	0.79	0.13	0.18	0.03	0.10	0.08	0.03	0.02	mod	18	39	356	39	192	198	185	182	100%		4/30/1975
199	-81.758300	0.12	0.01	0.02	0.00	0.02	0.02	0.01	0.00	obs	130	169	122	172	286	295	286	303	0.03	DOCTORS LAKE PEORIA	6/1/1978
8720406	30.120000	0.14	0.02	0.03	0.00	0.02	0.02	0.01	0.00	mod	144	175	123	172	293	302	283	278	100%	POINT, FL	10/31/1978
200	-81.761700	0.14	0.02	0.03	0.00	0.02	0.02	0.01	0.00	obs	155	184	146	186	292	296	292	299	0.04	BLACK CREEK, FL	8/1/1978
8720434	30.080000	0.12	0.02	0.02	0.00	0.02	0.02	0.01	0.00	mod	178	207	156	196	304	311	297	292	100%		10/31/1978
201	-81.329444	0.63	0.07	0.13	0.02	0.10	0.08	0.03	0.01	obs	50	60	43	60	215	231	216	239	0.16	TOLOMATO RIVER ICWW,	6/1/2021
8720494	29.994722	0.43	0.06	0.09	0.01	0.09	0.08	0.03	0.01	mod	59	78	37	77	220	225	220	209	51%	FL	6/30/2021
202	-81.634170	0.12	0.01	0.02	0.00	0.02	0.02	0.01	0.00	obs	169	202	155	196	303	306	296	312	0.02	Red Bay Point St Johns	11/1/2003
8720503	29.981700	0.12	0.02	0.02	0.00	0.02	0.02	0.01	0.00	mod	181	206	159	194	304	308	296	296	100%	River, FL	4/30/2015
203	-81.300000	0.62	0.09	0.14	0.02	0.10	0.07	0.03	0.01	obs	28	51	13	50	206	212	201	209	0.02	Vilano Beach ICWW, FL	10/1/2003
8720554	29.916700	0.64	0.10	0.14	0.02	0.09	0.08	0.03	0.01	mod	28	50	7	49	199	206	194	191	100%		7/31/2004

204	-81.306700	0.62	0.10	0.14	0.02	0.10	0.07	0.03	0.01	obs	35	58	21	63	214	217	210	216	0.04	State Road 312 Matanzas River, FL	10/1/2003
8720582	29.866700	0.66	0.10	0.15	0.02	0.10	0.08	0.03	0.02	mod	35	60	17	60	203	209	198	196	100%		9/30/2004
205	-81.263300	0.68	0.11	0.16	0.03	0.10	0.07	0.04	0.01	obs	15	34	352	37	195	202	192	197	0.02	St. Augustine Beach, FL	6/1/1992
8720587	29.856700	0.70	0.11	0.16	0.03	0.10	0.08	0.03	0.01	mod	15	36	353	35	190	197	184	182	100%		5/31/2000
206	-81.548300	0.16	0.02	0.03	0.01	0.02	0.02	0.01	0.00	obs	208	244	188	234	316	320	306	332	0.06	Racy Point St Johns River, FL	5/1/2014
8720625	29.801700	0.16	0.02	0.03	0.00	0.03	0.02	0.01	0.00	mod	236	268	212	264	320	322	319	332	100%		3/31/2019
207	-81.258300	0.57	0.08	0.12	0.02	0.09	0.07	0.03	0.01	obs	55	88	44	87	225	228	222	222	0.23	Crescent Beach Matanzas River, FL	1/1/2004
8720651	29.768300	0.65	0.10	0.15	0.02	0.09	0.08	0.03	0.01	mod	28	52	9	52	198	204	194	190	36%		12/31/2004
208	-81.227860	0.51	0.08	0.12	0.02	0.09	0.06	0.03	0.01	obs	25	47	7	49	215	203	214	196	0.14	State Road A1A Bridge, FL	10/1/2003
8720692	29.704531	0.67	0.10	0.15	0.02	0.10	0.08	0.03	0.01	mod	18	40	-3	39	192	199	187	183	66%		10/31/2003
209	-81.205000	0.21	0.02	0.04	0.01	0.05	0.04	0.01	0.01	obs	104	140	101	132	264	266	258	260	0.10	Bings Landing Matanzas River, FL	10/1/2003
8720757	29.615000	0.28	0.04	0.05	0.01	0.07	0.07	0.02	0.01	mod	80	103	63	88	244	248	245	235	90%		9/30/2004
210	-81.681700	0.16	0.02	0.03	0.01	0.02	0.01	0.00	0.00	obs	243	284	227	270	334	340	356	358	0.13	Buffalo Bluff St Johns River, FL	10/1/2003
8720767	29.595000	0.21	0.03	0.04	0.01	0.02	0.02	0.00	0.00	mod	**297**	335	270	348	343	343	367	368	68%		9/30/2004
211	-81.631700	0.19	0.02	0.03	0.01	0.02	0.02	0.00	0.00	obs	227	266	214	258	325	331	344	343	0.11	Palatka St Johns River, FL	10/1/2003
8720774	29.643300	0.23	0.03	0.04	0.01	0.03	0.03	0.01	0.00	mod	**268**	304	243	311	330	331	345	361	82%		9/30/2004
212	-81.675000	0.06	0.01	0.01	0.00	0.01	0.01	0.00	0.00	obs	257	280	238	281	337	2	339	14	0.06	Welaka, FL	10/1/2003
8720832	29.476700	0.05	0.01	0.01	0.00	0.01	0.01	0.00	0.00	mod	**345**	381	324	385	368	4	429	43	100%		3/31/2004
213	-81.005000	0.59	0.11	0.15	0.02	0.10	0.08	0.03	0.01	obs	11	32	350	34	196	201	191	198	0.02	DAYTONA BEACH (OCEAN), FL	10/6/2023
8721020	29.228300	0.60	0.09	0.14	0.02	0.10	0.08	0.03	0.02	mod	13	34	352	30	190	198	187	183	100%		10/6/2023
214	-80.963300	0.57	0.09	0.13	0.02	0.10	0.07	0.03	0.01	obs	11	32	349	35	197	201	196	196	0.02	DAYTONA BEACH SHORES, FL	1/1/1978
8721120	29.146700	0.59	0.09	0.14	0.02	0.10	0.08	0.03	0.02	mod	12	33	351	29	190	198	186	184	100%		12/31/1983
215	-80.915000	0.44	0.07	0.10	0.02	0.08	0.06	0.03	0.01	obs	21	43	4	38	205	211	202	201	0.02	Ponce De Leon Inlet South, FL	4/1/2006
8721147	29.063000	0.46	0.07	0.10	0.02	0.08	0.07	0.03	0.01	mod	19	41	-1	32	198	206	196	193	100%		10/31/2006
216	-80.918300	0.36	0.04	0.08	0.01	0.07	0.05	0.02	0.01	obs	37	59	18	61	208	225	210	234	0.12	New Smyrna Beach, FL	4/1/1999
8721164	29.023300	0.22	0.03	0.05	0.01	0.06	0.05	0.02	0.01	mod	53	78	39	55	226	234	225	228	76%		6/30/1999
217	-80.870000	0.16	0.02	0.03	0.01	0.03	0.02	0.01	0.00	obs	67	94	57	96	224	232	225	236	0.08	PACKWOOD PLACE, FL	2/1/1979
8721222	28.940000	0.07	0.01	0.02	0.00	0.03	0.03	0.01	0.01	mod	**107**	122	83	78	254	259	261	234	99%		3/31/1979
218	-80.825000	0.06	0.01	0.01	0.00	0.01	0.01	0.01	0.00	obs	115	147	116	150	209	249	212	268	0.02	TURTLE MOUND, FL	3/1/1979
8721223	28.926700	0.05	0.01	0.02	0.00	0.02	0.02	0.01	0.01	mod	126	129	89	190	252	259	275	233	100%		3/31/1979
219	-80.601700	0.53	0.09	0.12	0.02	0.11	0.08	0.03	0.02	obs	6	27	348	25	201	204	209	199	0.14	CANAVERAL HARBOR ENTRANCE, FL	10/6/2023
8721608	28.408300	0.37	0.06	0.09	0.02	0.07	0.05	0.02	0.01	mod	17	38	355	34	205	216	202	206	64%		10/6/2023
220	-80.600000	0.50	0.08	0.12	0.02	0.10	0.07	0.04	0.02	obs	7	28	349	28	202	206	201	192	0.01	COCOA BEACH ATLANTIC OCEAN, FL	1/1/1995
8721649	28.368300	0.50	0.08	0.12	0.02	0.10	0.08	0.03	0.02	mod	8	29	347	24	195	203	192	193	100%		12/31/1996
221	-80.594722	0.02	0.00	0.01	0.00	0.01	0.00	0.00	0.00	obs	121	144	105	128	283	277	15	293	0.01	MELBOURNE CAUSEWAY, FL	10/6/2023
8721843	28.082222	0.03	0.01	0.01	0.00	0.01	0.01	0.00	0.00	mod	144	153	122	121	284	290	-95	264	100%		10/6/2023
222	-80.371700	0.10	0.01	0.02	0.00	0.02	0.02	0.01	0.00	obs	120	165	98	167	284	282	285	280	0.03	Vero Beach, FL	4/1/1999
8722125	27.631700	0.12	0.02	0.03	0.00	0.04	0.04	0.01	0.01	mod	123	145	102	114	274	277	276	269	100%		6/30/1999
223	-80.325000	0.22	0.03	0.05	0.01	0.05	0.04	0.02	0.01	obs	38	51	11	52	235	245	236	250	0.04	North Beach Causeway, FL	5/1/1999
8722208	27.471700	0.19	0.03	0.04	0.01	0.06	0.05	0.02	0.01	mod	46	68	26	63	235	243	238	234	100%		5/31/1999
224	-80.300000	0.30	0.05	0.07	0.01	0.06	0.05	0.02	0.01	obs	20	42	357	44	220	233	221	239	0.02	Binney Dock, FL	4/1/1999
8722213	27.468306	0.29	0.04	0.07	0.01	0.06	0.05	0.02	0.01	mod	24	46	363	38	223	236	220	224	100%		5/31/1999
225	-80.323300	0.21	0.03	0.05	0.01	0.05	0.04	0.02	0.01	obs	39	61	11	63	241	253	242	258	0.02	South Beach Causeway, FL	3/1/2000
8722219	27.456700	0.21	0.03	0.05	0.01	0.06	0.06	0.02	0.01	mod	41	63	21	60	231	239	233	230	100%		3/31/2000
226	-80.273300	0.19	0.02	0.04	0.01	0.05	0.04	0.01	0.01	obs	92	129	80	112	269	274	274	268	0.02	ANKONA INDIAN RIVER, FL	10/6/2023
8722274	27.355000	0.20	0.03	0.04	0.00	0.06	0.05	0.02	0.01	mod	88	106	67	84	253	258	256	244	100%		10/6/2023
227	-80.218300	0.19	0.02	0.04	0.01	0.05	0.04	0.01	0.01	obs	89	124	77	115	267	272	278	263	0.02	Jensen Beach Causeway Park, FL	10/6/2023
8722329	27.251700	0.20	0.03	0.04	0.01	0.05	0.05	0.02	0.01	mod	89	109	71	91	256	260	261	247	100%		10/6/2023
228	-80.163056	0.30	0.04	0.07	0.01	0.06	0.04	0.02	0.01	obs	23	42	5	45	230	241	228	230	0.04	SOUTH POINT ST LUCIE INLET, FL	10/6/2023
8722375	27.165278	0.35	0.05	0.08	0.01	0.07	0.06	0.02	0.01	mod	19	41	-1	39	215	227	216	215	100%		10/6/2023
229	-80.066700	0.38	0.06	0.09	0.01	0.06	0.05	0.02	0.01	obs	36	67	18	60	234	246	239	254	0.04	PGA Boulevard Bridge Palm Beach, FL	2/1/2010
8722548	26.843300	0.37	0.06	0.08	0.01	0.07	0.05	0.02	0.01	mod	28	53	10	48	219	233	222	220	100%		9/30/2010
230	-80.051700	0.40	0.07	0.10	0.02	0.06	0.05	0.02	0.01	obs	20	47	358	45	222	237	227	236	0.02	Port of West Palm Beach, FL	10/1/2008
8722588	26.770000	0.40	0.06	0.09	0.02	0.07	0.05	0.02	0.01	mod	18	41	358	39	213	227	216	214	100%		9/30/2010
231	-80.046700	0.37	0.06	0.07	0.02	0.06	0.04	0.02	0.01	obs	58	92	45	95	240	253	241	260	0.21	Lake Worth ICW, FL	10/1/2008
8722669	26.613300	**0.18**	0.03	0.04	0.01	0.04	0.04	0.01	0.01	mod	**103**	129	86	115	268	277	276	263	37%		9/30/2010
232	-80.065000	0.34	0.05	0.07	0.01	0.06	0.04	0.02	0.01	obs	77	122	62	126	268	277	268	281	0.17	SOUTH DELRAY BEACH, FL	4/1/1973
8722761	26.446700	0.29	0.04	0.06	0.01	0.05	0.04	0.02	0.01	mod	**36**	60	17	57	234	248	238	230	50%		4/30/1973
233	-80.076700	0.32	0.05	0.06	0.01	0.05	0.04	0.01	0.01	obs	52	88	38	80	248	264	250	262	0.17	BOCA RATON, FL	5/1/1970
8722816	26.343300	0.38	0.06	0.09	0.02	0.06	0.04	0.02	0.01	mod	**18**	42	-1	37	223	238	225	225	52%		4/30/1971
234	-80.093300	0.39	0.08	0.09	0.02	0.05	0.04	0.02	0.01	obs	16	37	352	42	220	251	243	247	0.02	LAUDERDALE-BY-THE-SEA, FL	2/1/1974
8722899	26.188300	0.38	0.06	0.09	0.02	0.05	0.04	0.02	0.01	mod	17	41	357	39	233	250	233	232	100%		1/31/1975

235	-80.120000	0.37	0.07	0.08	0.02	0.04	0.03	0.01	0.01	obs	20	47	357	44	238	262	235	274	0.01	HAULOVER PIER N. MIAMI BEACH, FL	1/1/1982
8723080	25.903300	0.37	0.06	0.08	0.02	0.04	0.04	0.02	0.01	mod	20	45	360	41	253	271	247	254	100%		12/31/1991
236	-80.185000	0.32	0.06	0.07	0.02	0.03	0.03	0.01	0.01	obs	41	73	24	70	260	284	258	285	0.02	MIAMI BISCAYNE BAY, FL	1/1/1985
8723165	25.778300	0.35	0.06	0.08	0.02	0.04	0.03	0.01	0.01	mod	42	71	24	64	278	297	268	280	100%		12/31/1986
237	-80.130000	0.34	0.07	0.08	0.02	0.04	0.03	0.01	0.01	obs	26	53	7	54	250	278	248	276	0.03	MIAMI BEACH GOVERNMENT CUT, FL	2/1/1985
8723178	25.763300	0.37	0.06	0.08	0.02	0.04	0.04	0.01	0.01	mod	21	46	1	41	264	283	256	268	100%		1/31/1986
238	-80.305000	0.27	0.05	0.06	0.01	0.03	0.03	0.01	0.01	obs	64	100	44	89	282	302	265	298	0.10	CUTLER BISCAYNE BAY, FL	1/1/1971
8723289	25.615000	0.36	0.06	0.08	0.02	0.04	0.04	0.01	0.00	mod	46	79	29	63	290	306	282	282	89%		12/31/1971
239	-80.175000	0.22	0.04	0.04	0.01	0.03	0.02	0.01	0.01	obs	65	93	48	96	286	302	287	309	0.13	RAGGED KEY NO. 5 BISCAYNE BAY, FL	8/1/1987
8723355	25.523300	**0.33**	0.06	0.07	0.02	0.04	0.03	0.01	0.01	mod	**38**	65	19	58	286	304	277	293	69%		9/30/1987
240	-80.196700	0.20	0.03	0.04	0.01	0.02	0.02	0.01	0.00	obs	97	140	83	143	305	318	306	324	0.16	ELLIOTT KEY HARBOR ELLIOTT KEY, FL	7/1/1974
8723409	25.453300	**0.35**	0.06	0.07	0.02	0.04	0.03	0.01	0.01	mod	**62**	94	46	84	303	320	297	311	52%		7/31/1974
241	-80.290000	0.13	0.02	0.02	0.01	0.01	0.02	0.01	0.00	obs	110	148	85	151	313	358	316	20	0.19	EAST ARSENICKER CARD SOUND, FL	12/1/1971
8723465	25.373300	0.32	0.05	0.07	0.02	0.03	0.03	0.01	0.01	mod	**62**	93	46	81	310	325	303	-41	42%		2/29/1972
242	-80.293300	0.10	0.01	0.02	0.00	0.02	0.01	0.01	0.00	obs	120	150	101	152	336	344	336	348	0.19	PUMPKIN KEY CARD SOUND, FL	8/1/1987
8723506	25.325000	0.29	0.05	0.06	0.01	0.03	0.03	0.01	0.01	mod	**61**	91	44	80	314	330	306	325	42%		9/30/1987
243	-80.370000	0.08	0.01	0.01	0.00	0.01	0.01	0.00	0.00	obs	140	177	123	174	344	6	329	358	0.18	CARD SOUND BRIDGE, FL	5/1/1970
8723534	25.288300	0.25	0.04	0.05	0.01	0.03	0.03	0.01	0.01	mod	**71**	101	53	87	332	-13	321	337	46%		4/30/1971
244	-81.016700	0.24	0.06	0.05	0.02	0.07	0.07	0.02	0.02	obs	41	66	23	65	338	339	340	326	0.02	Key Colony Beach, FL	4/1/1977
8723962	24.718300	0.24	0.05	0.05	0.02	0.06	0.06	0.02	0.02	mod	43	68	25	62	323	332	329	328	100%		3/31/1995
245	-81.708300	0.10	0.03	0.02	0.01	0.08	0.07	0.03	0.01	obs	97	140	72	144	22	17	21	15	0.05	BOCA CHICA MARINA, FL	3/1/2000
8724493	24.575000	0.17	0.05	0.03	0.02	0.09	0.08	0.03	0.02	mod	108	137	98	131	5	7	9	-6	100%		5/31/2000
246	-81.795000	0.13	0.04	0.03	0.01	0.09	0.08	0.03	0.01	obs	126	156	112	158	28	23	28	20	0.08	Fleming Key, FL	4/1/2001
8724571	24.591700	0.21	0.07	0.04	0.02	0.11	0.10	0.04	0.02	mod	118	140	108	139	1	-0	3	-11	95%		5/31/2001
247	-81.878300	0.17	0.05	0.04	0.01	0.09	0.09	0.03	0.02	obs	49	69	27	71	348	349	348	350	0.01	SAND KEY LIGHTHOUSE, FL	3/1/2000
8724635	24.453300	0.18	0.04	0.03	0.01	0.09	0.09	0.03	0.02	mod	52	75	36	65	341	346	345	339	100%		4/30/2000
248	-81.921528	0.37	0.12	0.07	0.03	0.14	0.13	0.05	0.03	obs	132	146	120	147	0	354	360	352	0.03	Smith Shoal Light, FL	9/1/2011
8724671	24.718280	0.33	0.11	0.06	0.04	0.16	0.14	0.05	0.03	mod	129	143	121	139	1	355	357	341	100%		10/31/2011
249	-82.920000	0.14	0.05	0.03	0.01	0.11	0.11	0.03	0.03	obs	79	92	66	87	360	354	356	346	0.02	Loggerhead Key, FL	6/1/2000
8724698	24.631700	0.12	0.04	0.02	0.01	0.12	0.11	0.04	0.02	mod	85	95	76	88	361	358	357	344	100%		5/31/2001
250	-81.558300	0.41	0.13	0.07	0.04	0.18	0.14	0.06	0.03	obs	193	215	184	217	35	26	34	21	0.05	DISMAL KEY PUMPKIN BAY, FL	3/1/1978
8724963	25.895000	0.44	0.13	0.08	0.05	0.18	0.15	0.06	0.03	mod	186	209	180	194	28	19	26	9	100%		5/31/1978
251	-81.636700	0.41	0.13	0.07	0.04	0.17	0.15	0.06	0.03	obs	189	211	175	213	28	27	28	26	0.02	COON KEY PASS GULLIVAN BAY, FL	3/1/1978
8724964	25.896700	0.41	0.12	0.07	0.05	0.17	0.15	0.05	0.03	mod	189	211	182	197	30	21	28	11	100%		5/31/1978
252	-81.728300	0.28	0.10	0.06	0.03	0.15	0.12	0.05	0.02	obs	156	178	140	179	9	8	9	7	0.03	MARCO ISLAND CAXAMBAS PASS, FL	2/1/1976
8724967	25.908300	0.29	0.09	0.06	0.03	0.16	0.14	0.05	0.03	mod	153	161	140	155	14	5	8	-8	100%		1/31/1979
253	-81.728300	0.27	0.08	0.05	0.02	0.14	0.14	0.04	0.03	obs	170	184	152	185	25	14	24	8	0.03	MARCO BIG MARCO RIVER, FL	7/1/1989
8724991	25.971700	0.25	0.07	0.05	0.03	0.15	0.13	0.05	0.03	mod	174	183	162	174	29	20	25	7	100%		7/31/1989
254	-81.701700	0.26	0.08	0.04	0.02	0.11	0.12	0.04	0.02	obs	201	224	193	226	46	35	45	29	0.09	MCILVAINE BAY, FL	8/1/1978
8724996	25.985000	0.25	0.07	0.05	0.03	0.15	0.13	0.05	0.03	mod	178	189	167	179	32	22	28	11	90%		12/31/1978
255	-81.843300	0.23	0.06	0.04	0.02	0.13	0.12	0.04	0.02	obs	173	200	162	203	36	22	35	16	0.06	COCONUT POINT ESTERO BAY, FL	6/1/1973
8725319	26.400000	0.18	0.05	0.04	0.03	0.14	0.13	0.04	0.03	mod	185	187	174	190	43	32	39	20	100%		6/30/1973
256	-81.885000	0.23	0.07	0.04	0.03	0.14	0.12	0.05	0.03	obs	165	180	153	175	21	18	40	16	0.03	CARLOS POINT ESTERO BAY, FL	2/1/2020
8725325	26.405001	0.21	0.07	0.04	0.02	0.15	0.13	0.05	0.03	mod	159	161	147	160	25	15	18	2	100%		7/31/2020
257	-81.918300	0.24	0.06	0.04	0.02	0.13	0.12	0.04	0.02	obs	176	199	166	201	35	23	34	18	0.09	ESTERO ISLAND ESTERO BAY, FL	6/1/1973
8725351	26.438300	0.23	0.07	0.05	0.02	0.15	0.14	0.05	0.03	mod	151	154	139	149	18	8	11	-4	89%		6/30/1973
258	-81.876700	0.18	0.03	0.03	0.01	0.11	0.11	0.04	0.02	obs	207	252	197	256	64	54	63	49	0.06	HENDRY CREEK ESTERO BAY, FL	6/1/1973
8725377	26.470000	0.18	0.05	0.04	0.03	0.14	0.12	0.04	0.03	mod	191	195	182	198	47	37	45	26	99%		6/30/1973
259	-82.013333	0.20	0.05	0.04	0.03	0.11	0.12	0.03	0.03	obs	163	208	155	210	28	20	40	23	0.05	PUNTA RASSA SAN CARLOS BAY, FL	6/1/1977
8725391	26.488111	0.22	0.07	0.04	0.02	0.15	0.14	0.05	0.03	mod	164	166	152	173	24	13	18	2	100%		5/31/1978
260	-81.933296	0.09	0.02	0.01	0.01	0.08	0.07	0.02	0.01	obs	242	260	228	258	87	79	95	85	0.03	CAPE CORAL BR.CALOOSAHATCHEE R., FL	1/1/2020
8725451	26.563299	0.10	0.03	0.02	0.02	0.10	0.09	0.03	0.02	mod	246	248	233	256	83	72	88	62	100%		12/31/2020
261	-82.218300	0.15	0.05	0.04	0.01	0.13	0.13	0.04	0.03	obs	158	170	150	171	28	18	27	14	0.03	NORTH CAPTIVA ISLAND, FL	7/1/1989
8725488	26.605000	0.12	0.04	0.03	0.02	0.13	0.12	0.04	0.03	mod	169	162	159	172	35	23	31	12	100%		8/31/1989
262	-82.069170	0.15	0.04	0.03	0.02	0.12	0.12	0.05	0.02	obs	207	231	199	213	52	46	65	38	0.05	MATLACHA PASS (SWING BR.), FL	10/6/2023
8725506	26.632000	0.10	0.03	0.02	0.02	0.13	0.12	0.04	0.02	mod	227	226	217	231	71	57	72	53	100%		10/6/2023
263	-82.163300	0.11	0.03	0.02	0.01	0.12	0.12	0.04	0.02	obs	189	191	176	191	52	37	51	30	0.02	BOKEELIA CHARLOTTE HARBOR, FL	6/1/1989
8725541	26.706700	0.10	0.03	0.02	0.02	0.13	0.12	0.04	0.02	mod	184	178	175	187	47	34	45	26	100%		7/31/1989
264	-82.258300	0.11	0.04	0.02	0.01	0.12	0.12	0.04	0.02	obs	156	159	143	159	30	21	29	17	0.02	PORT BOCA GRANDE CHARLOTTE HBR., FL	10/1/1977
8725577	26.720000	0.09	0.03	0.02	0.01	0.12	0.11	0.04	0.02	mod	157	146	147	161	37	25	32	12	100%		5/31/1978

265	-82.303300	0.11	0.04	0.02	0.01	0.13	0.10	0.04	0.02	obs	165	170	156	171	41	32	40	28	0.08	CUTOFF SOUTH, FL	3/1/1978
8725685	26.855000	0.14	0.05	0.03	0.02	0.13	0.12	0.05	0.03	mod	**130**	127	123	127	18	8	14	-4	94%		5/31/1978
266	-82.136700	0.15	0.04	0.03	0.01	0.14	0.11	0.05	0.02	obs	230	231	215	231	69	63	69	60	0.04	LOCUST POINT HOG ISLAND, FL	4/1/1978
8725745	26.930000	0.13	0.04	0.03	0.02	0.14	0.12	0.04	0.03	mod	219	221	213	220	61	48	59	45	100%		5/31/1978
267	-81.993300	0.16	0.03	0.03	0.02	0.13	0.13	0.04	0.03	obs	246	262	239	282	77	65	106	70	0.12	HARBOUR HEIGHTS PEACE RIVER, FL	12/1/1977
8725791	26.988300	0.06	0.02	0.01	0.02	0.08	0.07	0.02	0.02	mod	**282**	280	269	303	115	110	130	112	80%		3/31/1978
268	-82.410000	0.11	0.04	0.02	0.01	0.12	0.11	0.04	0.02	obs	189	205	184	206	55	49	55	45	0.02	MANASOTA, FL	11/1/1977
8725809	27.011700	0.11	0.04	0.02	0.03	0.11	0.11	0.04	0.02	mod	183	179	179	194	53	43	59	32	100%		1/31/1978
269	-82.453300	0.17	0.06	0.04	0.02	0.15	0.14	0.04	0.03	obs	118	128	112	129	9	3	360	352	0.02	VENICE GULF OF MEXICO, FL	6/1/1990
8725858	27.071700	0.15	0.06	0.03	0.02	0.13	0.13	0.05	0.03	mod	120	119	115	115	13	3	369	352	100%		9/30/1990
270	-82.533798	0.15	0.05	0.03	0.02	0.15	0.13	0.04	0.03	obs	182	204	175	200	46	34	67	34	0.03	Ellenton Manatee River, FL	1/1/2020
8726265	27.514900	0.15	0.05	0.03	0.02	0.13	0.13	0.05	0.03	mod	187	194	183	187	40	30	43	20	100%		6/30/2020
271	-82.760000	0.17	0.07	0.04	0.02	0.14	0.14	0.05	0.03	obs	130	142	122	134	20	11	14	3	0.34	EGMONT KEY TAMPA BAY, FL	6/1/1990
8726347	27.601700	0.13	0.05	0.03	0.01	0.11	0.11	0.04	0.02	mod	**-45**	320	-45	313	194	185	192	175	36%		11/30/1990
272	-82.726700	0.15	0.06	0.03	0.02	0.15	0.14	0.04	0.03	obs	137	152	132	146	24	14	14	7	0.03	MULLET KEY TAMPA BAY, FL	6/1/1990
8726364	27.615000	0.13	0.05	0.03	0.01	0.14	0.14	0.05	0.03	mod	150	152	146	157	22	13	20	2	100%		5/31/1991
273	-82.448300	0.12	0.05	0.02	0.01	0.15	0.13	0.05	0.03	obs	226	261	224	264	63	62	63	61	0.06	LITTLE MANATEE RIVER, FL	12/1/1978
8726436	27.705000	0.19	0.06	0.04	0.03	0.12	0.11	0.04	0.02	mod	228	242	221	236	57	47	60	49	99%		3/31/1979
274	-82.480000	0.22	0.07	0.04	0.02	0.15	0.16	0.05	0.03	obs	201	221	192	222	56	42	55	35	0.11	TAMPA BALLAST POINT, FL	7/1/1996
8726639	27.890000	**0.33**	0.12	0.07	0.04	0.18	0.16	0.06	0.03	mod	**208**	222	202	216	36	25	35	20	81%		9/30/1996
275	-82.425003	0.22	0.07	0.04	0.03	0.17	0.15	0.05	0.03	obs	202	220	197	218	51	38	55	34	0.11	Mckay Bay Entrance, FL	1/1/1999
8726667	27.913300	**0.33**	0.12	0.07	0.04	0.18	0.16	0.06	0.03	mod	**210**	224	204	218	37	26	36	21	84%		12/31/2019
276	-82.685000	0.21	0.07	0.04	0.02	0.20	0.16	0.07	0.03	obs	242	262	238	264	69	58	68	53	0.17	SAFETY HARBOR OLD TAMPA BAY, FL	1/1/1991
8726738	27.988300	**0.39**	0.14	0.08	0.05	0.18	0.17	0.06	0.04	mod	**228**	243	223	236	45	35	45	29	57%		5/31/1991
277	-82.843300	0.28	0.12	0.05	0.03	0.19	0.14	0.06	0.03	obs	134	153	128	155	14	5	14	1	0.05	ANCLOTE LIGHTHOUSE ANCLOTE KEY, FL	3/1/1976
8726917	28.165000	0.31	0.12	0.06	0.03	0.15	0.14	0.05	0.03	mod	142	159	142	151	11	5	12	-4	100%		3/31/1976
278	-82.638300	0.21	0.07	0.03	0.04	0.11	0.12	0.04	0.02	obs	236	289	237	266	86	76	84	59	0.11	JOHNS ISLAND CHASSAHOWITZKA BAY, FL	7/1/1978
8727235	28.691700	0.14	0.05	0.02	0.02	0.04	0.04	0.02	0.01	mod	213	233	214	254	84	83	66	51	81%		11/30/1978
279	-82.658300	0.06	0.01	0.01	0.00	0.04	0.05	0.01	0.01	obs	335	18	14 - 114	21	162	152	161	148	0.06	OZELLO, FL	10/1/1978
8727306	28.825000	0.05	0.03	0.01	0.01	0.02	0.02	0.01	0.00	mod	**259**	-87		-50	149	130	108	81	100%		11/30/1978
280	-83.293300	0.36	0.14	0.05	0.04	0.15	0.15	0.05	0.03	obs	187	215	181	218	32	26	32	22	0.07	HORSESHOE POINT, FL	7/1/1978
8727648	29.436700	0.42	0.16	0.08	0.05	0.17	0.16	0.06	0.03	mod	183	205	179	196	18	13	14	-4	97%		12/31/1978
281	-83.583801	0.35	0.14	0.06	0.04	0.19	0.16	0.06	0.03	obs	198	217	202	219	40	27	38	20	0.08	Hagens Cove, FL	3/1/2022
8727792	29.797000	0.40	0.15	0.08	0.05	0.17	0.16	0.05	0.03	mod	191	214	187	205	20	15	19	-3	97%		5/31/2022
282	-84.178300	0.36	0.15	0.07	0.04	0.17	0.15	0.05	0.04	obs	198	225	194	212	31	28	34	12	0.08	ST. MARKS LHTSE. APALACHEE BAY, FL	1/1/1975
8728130	30.078300	0.40	0.15	0.08	0.05	0.17	0.16	0.05	0.03	mod	212	238	210	229	30	25	34	6	98%		12/31/1975
283	-84.218597	0.36	0.15	0.07	0.04	0.19	0.15	0.06	0.03	obs	227	250	240	252	49	37	48	32	0.24	St Marks Wakulla River, FL	3/1/2022
8728152	30.159000	**0.20**	0.07	0.03	0.03	0.09	0.10	0.02	0.01	mod	**277**	303	280	283	74	63	75	37	40%		5/31/2022
284	-84.290556	0.36	0.14	0.07	0.04	0.18	0.16	0.06	0.04	obs	208	234	204	229	36	30	40	16	0.05	SHELL POINT WALKER CREEK, FL	1/1/1974
8728229	30.058333	0.41	0.15	0.08	0.05	0.18	0.17	0.06	0.03	mod	210	234	207	227	28	22	27	3	100%		12/31/1986
285	-84.395897	0.29	0.12	0.05	0.03	0.15	0.15	0.05	0.03	obs	222	251	217	253	43	41	42	40	0.06	Ochlockonee Bay, FL	1/1/2023
8728262	29.980200	0.33	0.11	0.06	0.04	0.15	0.14	0.04	0.02	mod	235	262	234	251	46	39	47	20	100%		4/30/2023
286	-84.511700	0.26	0.10	0.05	0.03	0.17	0.16	0.05	0.04	obs	200	222	190	233	30	24	31	2	0.04	TURKEY POINT, FL	10/1/1989
8728360	29.915000	0.26	0.10	0.05	0.03	0.16	0.16	0.05	0.03	mod	210	233	205	222	27	21	26	3	100%		9/30/1995
287	-84.595000	0.22	0.09	0.04	0.02	0.18	0.15	0.06	0.03	obs	211	231	199	233	33	25	32	21	0.03	LANARK ST. GEORGES SOUND, FL	2/1/1977
8728412	29.878300	0.25	0.09	0.05	0.03	0.15	0.15	0.05	0.03	mod	211	233	206	226	28	22	28	3	100%		4/30/1977
288	-84.665000	0.19	0.07	0.03	0.02	0.15	0.13	0.05	0.03	obs	212	241	193	243	34	32	34	31	0.04	CARRABELLE RIVER ST. GEORGE SOUND, FL	11/1/1977
8728464	29.850000	0.22	0.08	0.04	0.03	0.15	0.15	0.05	0.03	mod	221	243	216	230	34	27	33	8	100%		2/28/1978
289	-84.700000	0.19	0.07	0.04	0.02	0.18	0.14	0.06	0.03	obs	234	257	215	259	43	37	42	33	0.03	NE END ST. GEORGE ISLAND, FL	9/1/1983
8728486	29.766700	0.19	0.06	0.04	0.02	0.15	0.15	0.05	0.03	mod	226	248	221	239	37	31	35	14	100%		9/30/1983
290	-84.736700	0.19	0.08	0.04	0.02	0.17	0.14	0.06	0.03	obs	220	249	206	252	34	32	34	31	0.02	SOUTH CARRABELLE BEACH, FL	12/1/1977
8728488	29.801700	0.21	0.07	0.04	0.02	0.16	0.15	0.05	0.03	mod	223	245	218	235	34	27	32	9	100%		5/31/1978
291	-84.887000	0.17	0.06	0.03	0.02	0.18	0.14	0.06	0.03	obs	241	254	237	255	35	38	35	39	0.04	CAT POINT APALACHICOLA BAY, FL	3/1/1984
8728619	29.723610	0.18	0.06	0.03	0.02	0.16	0.15	0.05	0.03	mod	249	273	244	259	44	37	43	21	100%		3/31/1984
292	-84.896700	0.12	0.04	0.03	0.01	0.15	0.13	0.05	0.03	obs	243	275	247	277	43	37	42	34	0.04	ST. GEORGE ISLAND BAYSIDE, FL	2/1/1973
8728626	29.653300	0.14	0.04	0.03	0.02	0.15	0.14	0.05	0.03	mod	263	291	257	268	48	42	49	26	100%		3/31/1973
293	-84.958300	0.10	0.03	0.01	0.01	0.14	0.13	0.04	0.02	obs	233	251	201	253	37	31	37	28	0.02	SIKES CUT ST. GEORGE ISLAND, FL	3/1/1984
8728669	29.613300	0.10	0.03	0.02	0.01	0.15	0.14	0.05	0.03	mod	235	255	224	249	33	27	29	8	100%		3/31/1984
294	-84.898300	0.13	0.04	0.02	0.01	0.15	0.13	0.05	0.03	obs	274	299	271	301	60	52	59	48	0.03	WHITE BEACH EAST BAY, FL	10/1/1978
8728694	29.785000	0.17	0.05	0.03	0.02	0.15	0.14	0.05	0.02	mod	271	298	268	266	54	46	58	30	100%		12/31/1978

295	-85.033300	0.09	0.03	0.01	0.01	0.11	0.10	0.04	0.02	obs	273	291	273	267	66	56	80	54	0.04	APALACHICOLA RIVER, FL	12/1/1981
8728711	29.763300	0.09	0.03	0.02	0.02	0.09	0.09	0.03	0.01	mod	295	319	289	288	71	63	70	45	100%		11/30/1982
296	-85.042800	0.12	0.03	0.02	0.01	0.14	0.12	0.05	0.02	obs	259	280	264	281	46	39	45	36	0.02	Little St George Island, FL	4/1/2022
8728728	29.603600	0.12	0.04	0.02	0.01	0.14	0.13	0.04	0.02	mod	271	302	265	272	46	39	45	24	100%		6/30/2022
297	-85.085000	0.07	0.02	0.01	0.01	0.11	0.10	0.04	0.02	obs	313	340	302	342	86	76	85	72	0.07	HUCKLEBERRY LANDING	6/1/1977
8728757	29.770000	0.04	0.01	0.01	0.01	0.06	0.06	0.01	0.01	mod	**344**	363	331	338	114	102	114	83	97%	JACKSON RIVER, FL	8/31/1977
298	-85.153300	0.10	0.03	0.02	0.01	0.13	0.13	0.04	0.03	obs	303	342	287	345	63	57	63	54	0.03	ELEVEN MILE ST. VINCENT	12/1/1977
8728786	29.706700	0.14	0.04	0.02	0.02	0.14	0.13	0.05	0.02	mod	298	330	299	285	63	54	63	41	100%	SOUND, FL	5/31/1978
299	-85.173342	0.03	0.01	0.01	0.00	0.07	0.07	0.02	0.01	obs	354	9	292	11	94	87	94	84	0.04	Lake Wimico, FL	1/1/2023
8728819	29.821425	0.03	0.01	0.01	0.01	0.06	0.06	0.01	0.01	mod	383	48	372	16	133	118	131	98	100%		4/30/2023
300	-85.221298	0.07	0.02	0.01	0.01	0.14	0.11	0.05	0.02	obs	274	287	273	288	36	28	35	24	0.10	Indian Pass, FL	4/1/2022
8728852	29.685100	0.11	0.03	0.02	0.02	0.12	0.12	0.04	0.02	mod	**322**	359	324	313	73	64	71	49	85%		5/31/2022
301	-85.221400	0.01	0.01	0.00	0.00	0.10	0.09	0.03	0.02	obs	22	60	340	265	58	49	58	40	0.08	White City ICWW, FL	1/1/2009
8728853	29.880694	0.01	0.01	0.00	0.00	0.05	0.06	0.02	0.01	mod	**84**	123	430	417	118	104	115	77	97%		12/31/2010
302	-85.270600	0.02	0.01	0.00	0.00	0.11	0.10	0.04	0.02	obs	98	101	98	102	34	24	34	18	0.07	White City Gulf County	2/1/2023
8728886	29.866792	0.02	0.01	0.00	0.00	0.06	0.06	0.02	0.01	mod	123	126	138	112	76	69	73	42	97%	Canal, FL	4/30/2023
303	-85.313300	0.04	0.02	0.01	0.01	0.15	0.14	0.05	0.03	obs	129	133	143	111	34	23	33	13	0.04	Port St. Joe, FL	1/1/1976
8728912	29.815000	0.05	0.02	0.01	0.01	0.16	0.15	0.05	0.03	mod	118	100	132	75	17	14	17	-7	100%		12/31/1976
304	-85.363300	0.04	0.02	0.01	0.01	0.15	0.14	0.05	0.03	obs	131	126	141	126	34	22	33	16	0.04	RICHARDSON HAMMOCK	10/6/2023
8728949	29.690000	0.05	0.02	0.01	0.01	0.16	0.15	0.05	0.03	mod	119	98	136	76	19	15	19	-5	100%	ST. JOSEPH BAY, FL	10/6/2023
305	-85.370000	0.03	0.01	0.00	0.00	0.15	0.14	0.05	0.03	obs	168	195	233	197	61	41	59	31	0.08	OVERSTREET, FL	5/1/1976
8728957	29.996700	0.02	0.01	0.01	0.01	0.11	0.11	0.04	0.02	mod	**232**	216	247	249	90	81	97	57	93%		5/31/1976
306	-85.390000	0.03	0.02	0.01	0.00	0.14	0.14	0.05	0.03	obs	96	98	102	98	18	7	17	1	0.02	ST. JOSEPH POINT ST.	7/1/1976
8728958	29.873300	0.05	0.02	0.01	0.00	0.15	0.15	0.05	0.03	mod	115	100	128	75	17	13	16	-8	100%	JOSEPH BAY, FL	7/31/1976
307	-85.488600	0.04	0.02	0.01	0.01	0.16	0.15	0.05	0.03	obs	155	158	182	158	46	33	45	26	0.05	East Bay Goose Point, FL	2/1/2022
8729026	30.061199	0.03	0.01	0.01	0.01	0.14	0.13	0.04	0.03	mod	**198**	179	212	201	61	54	65	31	100%		5/31/2022
308	-85.607903	0.04	0.02	0.01	0.01	0.17	0.15	0.06	0.03	obs	148	158	183	160	45	31	44	24	0.04	Deer Point Lake, FL	2/1/2022
8729082	30.269600	0.04	0.01	0.01	0.01	0.14	0.14	0.05	0.03	mod	**184**	176	201	175	53	47	60	22	100%		5/31/2022
309	-85.700000	0.03	0.01	0.00	0.00	0.14	0.13	0.04	0.03	obs	144	140	166	140	40	28	39	22	0.01	Courtney Point St Andrew	5/1/2021
8729132	30.151700	0.03	0.01	0.01	0.01	0.13	0.13	0.04	0.03	mod	144	129	158	145	38	33	41	12	100%	Bay, FL	7/31/2021
310	-85.732803	0.03	0.01	0.01	0.01	0.15	0.14	0.04	0.03	obs	143	152	158	123	39	29	49	12	0.02	Sulphur Point Port of	2/1/2022
8729142	30.183000	0.03	0.01	0.01	0.01	0.14	0.13	0.04	0.03	mod	155	141	170	162	42	36	45	15	100%	Panama City, FL	6/30/2022
311	-85.858299	0.04	0.01	0.01	0.00	0.15	0.14	0.05	0.03	obs	160	168	191	168	46	34	45	29	0.05	WEST BAY CREEK WEST	4/1/2021
8729197	30.293301	0.03	0.01	0.01	0.01	0.12	0.12	0.04	0.03	mod	189	172	210	197	63	56	68	33	100%	BAY, FL	7/31/2021
312	-86.328796	0.01	0.00	0.00	0.00	0.04	0.05	0.01	0.01	obs	158	102	147	98	108	94	107	87	0.01	Driftwood Point	4/1/2021
8729425	30.389400	0.01	0.00	0.00	0.00	0.04	0.04	0.01	0.01	mod	180	153	211	225	95	89	94	66	100%	Choctawhatcheee Bay, FL	7/31/2021
313	-86.446701	0.00	0.00	0.00	0.00	0.05	0.05	0.02	0.01	obs	159	143	98	141	107	96	106	91	0.01	ROCKY BAYOU, FL	5/1/2021
8729479	30.506701	0.00	0.00	0.00	0.00	0.04	0.04	0.01	0.01	mod	183	190	206	213	94	89	102	64	100%		7/31/2021
314	-86.493300	0.01	0.00	0.00	0.00	0.04	0.05	0.01	0.01	obs	170	157	176	223	106	96	112	91	0.01	Valparaiso, FL	11/1/2009
8729501	30.503300	0.00	0.00	0.00	0.00	0.04	0.04	0.01	0.01	mod	184	183	204	209	94	89	102	64	100%		10/31/2010
315	-86.593201	0.04	0.02	0.01	0.01	0.14	0.14	0.05	0.03	obs	91	97	93	98	19	11	18	7	0.02	Okaloosa Island, FL	12/1/2021
8729547	30.391399	0.04	0.02	0.01	0.01	0.15	0.15	0.05	0.03	mod	115	95	125	75	15	12	17	-8	100%		2/28/2022
316	-86.650497	0.01	0.00	0.00	0.00	0.08	0.08	0.03	0.01	obs	174	321	94	329	84	74	84	70	0.05	Mary Esther, FL	6/1/2021
8729572	30.406500	0.00	0.00	0.00	0.00	0.04	0.04	0.01	0.01	mod	**205**	174	221	308	111	107	119	85	100%		9/30/2021

APPENDIX B: HINDCAST SKILL ASSESSMENT RESULTS

Table B. 1 Results of water elevations skill assessment

Station ID	Longitude	Latitude	Station Name	MAE (m)	RMSE (m)	SD (m)	CF (%)
8724580	-81.808334	24.555000	Key West, FL	0.046	0.078	0.063	94.4
8723970	-81.106667	24.711666	Vaca Key, Florida Bay, FL	0.055	0.107	0.092	83.6
8723214	-80.161667	25.731667	Virginia Key, FL	0.033	0.09	0.083	90.9
8722956	-80.115906	26.078787	South Port Everglades, FL	0.042	0.082	0.07	94.2
8725110	-81.808334	26.131666	Naples, FL	0.004	0.067	0.066	97.3
8722670	-80.033333	26.613333	Lake Worth Pier, Atlantic Ocean, FL	0.021	0.076	0.073	95.6
8725520	-81.871666	26.648333	Fort Myers, FL	0.071	0.099	0.069	87.9
8726384	-82.561668	27.638332	Port Manatee, FL	0.01	0.082	0.082	93.3
8726520	-82.626663	27.760000	St. Petersburg, FL	0.013	0.102	0.101	86.7
8726607	-82.553329	27.858334	Old Port Tampa, FL	0.092	0.16	0.13	64
8726667	-82.425003	27.913334	Mckay Bay Entrance, FL	-0.051	0.138	0.128	71.6
8726724	-82.831665	27.978333	Clearwater Beach, FL	0.035	0.076	0.068	94.9
8721604	-80.593330	28.415001	Trident Pier, Port Canaveral, FL	0.026	0.091	0.087	90.5
8727520	-83.030884	29.133858	Cedar Key, FL	-0.021	0.114	0.112	81.9
8728690	-84.980003	29.725000	Apalachicola, FL	0.008	0.063	0.063	97.7
8729108	-85.665001	30.150000	Panama City, FL	0.039	0.073	0.062	95.9
8729210	-85.878334	30.213333	Panama City Beach, FL	0	0.064	0.064	97.5
8720226	-81.658333	30.320000	Southbank Riverwalk, St Johns River, FL	0.065	0.12	0.101	79
8720219	-81.558334	30.386667	Dames Point, FL	0.087	0.175	0.151	61.2
8720218	-81.428329	30.398333	Mayport (Bar Pilots Dock), FL	0	0.107	0.107	84.1
8720030	-81.466667	30.671667	Fernandina Beach, FL	0.032	0.206	0.203	47.5
8670870	-80.903336	32.035000	Fort Pulaski, GA	-0.034	0.12	0.115	80.2
8665530	-79.923332	32.781666	Charleston, SC	0.011	0.119	0.118	81.2
8661070	-78.918335	33.654999	Springmaid Pier, SC	0.02	0.11	0.108	84.3
8658163	-77.786667	34.213333	Wrightsville Beach, NC	-0.008	0.104	0.104	86.8
8658120	-77.953331	34.226665	Wilmington, NC	-0.052	0.208	0.201	56.3
8656483	-76.669998	34.716667	Beaufort, Duke Marine Lab, NC	0.002	0.112	0.112	84.2
8654467	-75.704750	35.209225	USCG Station Hatteras, NC	0.011	0.082	0.081	94.7
8652587	-75.548332	35.794998	Oregon Inlet Marina, NC	-0.077	0.162	0.142	60
8651370	-75.746666	36.183334	Duck, NC	-0.084	0.142	0.114	71.4
8639348	-76.303116	36.776962	Money Point, VA	-0.061	0.136	0.122	76.3
8638610	-76.331856	36.943024	Sewells Point, VA	-0.106	0.156	0.115	67.7
8638901	-76.083336	37.033333	CBBT, Chesapeake Channel, VA	-0.044	0.127	0.119	80.7
8632200	-75.988335	37.165001	Kiptopeke, VA	-0.068	0.135	0.117	77

Station ID	Longitude	Latitude	Station Name	MAE (m)	RMSE (m)	SD (m)	CF (%)
8637689	-76.478333	37.226665	Yorktown USCG Training Center, VA	-0.085	0.15	0.123	70.5
8636580	-76.290001	37.615002	Windmill Point, VA	-0.037	0.122	0.116	82.5
8631044	-75.686279	37.607483	Wachapreague, VA	-0.015	0.213	0.212	48.6
8635750	-76.464996	37.996666	Lewisetta, VA	-0.07	0.139	0.12	77
8571421	-76.038330	38.220001	Bishops Head, MD	-0.086	0.154	0.128	69.4
8577330	-76.451668	38.316666	Solomons Island, MD	-0.033	0.124	0.12	81.9
8635027	-77.036514	38.319118	Dahlgren, VA	-0.066	0.15	0.135	73.3
8571892	-76.061668	38.571667	Cambridge, MD	-0.025	0.128	0.125	80
8594900	-77.021667	38.873333	Washington, DC	-0.172	0.3	0.246	37.7
8573364	-76.247383	39.215385	Tolchester Beach, MD	-0.081	0.155	0.132	70.7
8574680	-76.578331	39.266666	Baltimore, MD	-0.062	0.149	0.135	73.5
9755371	-66.116669	18.458332	San Juan La Puntilla San Juan Bay, PR	-0.048	0.066	0.045	98.7
9759394	-67.162476	18.218863	Mayaguez, PR	-0.091	0.107	0.057	84.9
9751639	-64.925003	18.333332	Charlotte Amalie, VI	-0.101	0.111	0.046	86.5
9751364	-64.698334	17.748333	Christiansted_Harbor St Croix, VI	-0.288	0.292	0.047	0
9751401	-64.753334	17.695000	Lime Tree Bay, VI	-0.215	0.222	0.054	11.9

Table B. 2 Results of water current skill assessment

Station ID	Station Name	Speed RMSE (m/s)	Speed CF (%)	Direction RMSE (Degree)	Direction CF (%)
jx0401	Fulton Cutoff LB 34	0.2	84.57	45.61	39.57
jx0601	Trout River Cut LB 64	0.27	65.86	52.18	82.17
t01010	Sunshine Skyway Bridge	0.13	96.32	55.68	15.91
t03010	Port Manatee	0.18	84.05	59.08	73.16
cb0102	Cape Henry LB 2CH	0.19	85	49.92	63.7
cb0201	York Spit LB 22	0.18	86.68	75.47	33.18
cb0801	Rappahannock Shoal Channel LB 60	0.11	97.48	58.44	51.99
cb1101	Chesapeake Channel LBB 92	0.13	95.47	62.9	42.04
cb0301	Thimble Shoal LB	0.19	85.57	40.67	72.29
cb0402	Naval Station Norfolk LB 7	0.15	91.49	60.47	61.16
cb0601	Newport News Channel LB 14	0.15	92.3	48.83	57.2
cb1301	Chesapeake_City(Side)	0.65	23.13	65.29	81.68
cb1001	Cove_Point_LNG_Pier(Side)	0.1	98.1	57.17	61.56
jx0501	Dames_Point(Side)	0.19	82.23	40.7	80.84
jx0701	Acosta_Bridge(Side)	0.33	54.02	56.44	79.72
44063	Annapolis	0.1	99.55	118.55	8.54
44062	Gooses_Reef	0.17	88.01	104.82	5.04
44042	Potmac	0.27	83.54	80.85	26.38
44058	Stingray_Point	0.15	92.2	76.73	20.73
44072	York_Spit	0.27	63.47	82.71	20.83
44064	First_Landing	0.37	50.8	69.48	32.22

Table B. 3 Results of water temperature skill assessment

Station ID	Longitude	Latitude	Station Name	MAE (ºC)	RMSE (ºC)	SD (ºC)	CF (%)
8726724	-82.838203	27.982700	Clearwater Beach, FL	-0.127	0.713	0.702	100
8726607	-82.552803	27.857800	Old Port Tampa, FL	-0.427	0.856	0.742	99.9
8726667	-82.425003	27.913300	Mckay Bay Entrance, FL	-1.605	1.928	1.069	89.2
8720218	-81.428802	30.399599	Mayport (Bar Pilots Dock), FL	-0.918	1.654	1.376	90.5
8720219	-81.558701	30.386000	Dames Point, FL	-0.521	0.984	0.835	100
8670870	-80.901703	32.036701	Fort Pulaski, GA	-0.538	1.123	0.985	97.1
8665530	-79.921097	32.780499	Charleston, SC	-1.392	1.572	0.73	97.9
8638610	-76.335403	36.943199	Sewells Point, VA	-0.439	0.902	0.788	99.9
8637689	-76.478302	37.226700	Yorktown USCG Training Center, VA	-0.49	0.865	0.712	100
8631044	-75.686302	37.607498	Wachapreague, VA	-1.479	2.387	1.873	78.5
8635750	-76.415398	38.021099	Lewisetta, VA	-0.148	1.464	1.457	94.9
8571421	-76.045700	38.212399	Bishops Head, MD	-0.919	1.779	1.524	91.1
8577330	-76.449997	38.316700	Solomons Island, MD	-0.401	0.888	0.793	99.6
8594900	-77.021698	38.873299	Washington, DC	0.18	2.01	2.002	87.7
8573364	-76.245003	39.213299	Tolchester Beach, MD	-0.925	1.863	1.617	88
8573927	-75.939400	39.487598	Chesapeake City, MD	-0.142	1.179	1.17	98.7
9755371	-66.116669	18.458332	San Juan La Puntilla San Juan Bay, PR	-0.592	0.664	0.3	100
9759394	-67.162476	18.218863	Mayaguez, PR	-1.214	1.299	0.46	100
9752695	-65.471664	18.093332	Esperanza Vieques Island, PR	-0.53	0.683	0.431	100
9751364	-64.698334	17.748333	Christiansted_Harbor St Croix, VI	-1.518	1.628	0.586	98.4
44063	-76.447502	38.963100	Annapolis, MD	0.826	1.116	0.75	99.9
44062	-76.414703	38.556400	Gooses Reef, MD	0.387	0.777	0.673	100
44042	-76.335602	38.033100	Potomac, MD	0.237	0.735	0.696	100
44058	-76.257500	37.567200	Stingray Point, VA	0.29	0.693	0.629	100
44072	-76.266098	37.200600	York Spit, VA	0.642	1.501	1.357	98.4
44064	-76.087196	36.998100	First Landing, VA	0.739	1.837	1.682	99.3
294213081345300	-81.581200	29.703899	St. Johns River at Dancy Point Near Spud	-0.939	1.292	0.887	99.2
301124081395901	-81.666199	30.190201	St. Johns River Buckman Bridge at Jackso	-0.257	0.847	0.807	100
301510081383500	-81.648903	30.249500	St. Johns Rvr at Christopher PT Near Jac	-0.368	1.104	1.041	98
301817081393600	-81.665001	30.308399	St. Johns River BL Marco LK at Jacksonvi	0.038	0.805	0.804	100
02246500	-81.665398	30.322500	St. Johns River at Jacksonville, FL	-0.277	0.928	0.886	100
302309081333001	-81.558197	30.386101	St. Johns R Dames Point Bridge at Jackso	-0.246	1.506	1.485	94.8
02198980	-80.906097	32.035801	Savannah River at Fort Pulaski, GA	-0.849	1.327	1.02	95.3
0219897993	-81.006897	32.103100	Savannah River at Elba Island, Near Sava	-1.499	2.134	1.52	82.2

Station ID	Longitude	Latitude	Station Name	MAE (ºC)	RMSE (ºC)	SD (ºC)	CF (%)
0219897945	-81.082802	32.097801	Back River 0.4 MI Downstream US17, NR Sa	-1.05	1.643	1.265	92.6
021989773	-81.081398	32.080399	Savannah River at Usace Dock, at Savanna	-1.071	1.666	1.276	93.2
021989715	-81.128304	32.116100	Savannah River at Garden City, GA	-0.605	1.402	1.265	97.3
021989793	-81.121902	32.136700	Little Back River at Hog Island, Near Sa	-0.436	1.228	1.148	98.6
02198955	-81.135300	32.142799	Middle River at Fish Hole at Port Wentwo	-0.336	1.413	1.373	96.9
02198920	-81.154900	32.165298	Savannah River at GA 25, at Port Wentwor	-0.32	1.496	1.461	95.1
02198950	-81.138000	32.165699	Middle River at GA 25 at Port Wentworth,	-0.228	1.438	1.419	96.4
021989792	-81.129997	32.165798	Little Back River at GA 25 at Port Wentw	-0.263	1.408	1.384	97
021989791	-81.117599	32.171001	Little Back River at FW Dock, Near Limeh	-0.112	1.484	1.48	96.2
021989784	-81.117897	32.185799	Little Back River Above Lucknow Canal, N	-0.259	1.504	1.482	95.9
02198820	-81.153603	32.249199	Abercorn Creek at Mouth Near Savannah, G	-0.229	1.576	1.56	93.7
02198810	-81.178001	32.256001	Abercorn Creek Near Savannah, GA	-1.878	3.109	2.477	64.9
021720710	-79.921097	32.780499	Cooper River at Customs House Aux at Cha	-1.228	1.445	0.762	98.8
021720709	-79.910103	32.802399	Cooper River at Us Hwy 17 at Charleston,	-1.308	1.656	1.016	95.2
021720869	-80.023697	32.834599	Ashley River Near North Charleston, SC	-0.911	1.593	1.307	95.6
0217206935	-79.952698	32.855701	Cooper River at Ports Authority Pier K C	-1.343	1.458	0.568	99.2
021720698	-79.896202	32.859100	Wando River Above MT Pleasant, SC	-1.159	1.341	0.675	99.7
021720677	-79.962898	32.890499	Cooper River at Filbin Creek at North Ch	-1.382	1.492	0.562	99.7
0217206962	-79.824402	32.921299	Wando River at Cainhoy Below Wando, SC	-1.064	1.421	0.943	95.7
02172053	-79.922401	32.984100	Cooper River at Mobay Near N Charleston,	-1.725	1.9	0.797	92.5
021720508	-79.906799	33.015800	Cooper River Above Goose Creek, SC	-1.927	2.175	1.009	84.1
02172020	-79.944702	33.096500	W Branch Cooper River at Pimlico Near Mo	-3.232	4.199	2.681	56.3

Table B. 4 Results of water salinity skill assessment

Station ID	Longitude	Latitude	Station Name	MAE (PSU)	RMSE (PSU)	SD (PSU)	CF (%)
8720219	-81.558701	30.386	Dames Point, FL	0.108	5.807	5.806	46.6
8638610	-76.335403	36.943199	Sewells Point, VA	-1.31	3.011	2.711	74.4
8637689	-76.479797	37.231098	Yorktown USCG Training Center, VA	0.42	2.085	2.042	87.8
8635750	-76.415398	38.021099	Lewisetta, VA	-0.57	1.499	1.387	98.1
8573927	-75.9394	39.487598	Chesapeake City, MD	-0.91	1.407	1.074	95.6
44063	-76.447502	38.9631	Annapolis, MD	-0.793	1.397	1.15	100
44062	-76.414703	38.5564	Gooses Reef, MD	0.342	1.463	1.422	96.2
44042	-76.335602	38.0331	Potomac, MD	-0.74	1.298	1.066	99.3
44058	-76.2575	37.5672	Stingray Point, VA	-0.982	1.456	1.075	98.9
44072	-76.266098	37.2006	York Spit, VA	0.84	4.168	4.083	95.9
44064	-76.087196	36.9981	First Landing, VA	0.143	1.958	1.953	93.3
294213081345300	-81.5812	29.703899	St. Johns River at Dancy Point Near Spud	0.153	0.385	0.354	100
301124081395901	-81.666199	30.190201	St. Johns River Buckman Bridge at Jackso	0.079	1.604	1.603	96
301510081383500	-81.648903	30.2495	St. Johns Rvr at Christopher PT Near Jac	-0.664	1.793	1.666	91.1
301817081393600	-81.665001	30.308399	St. Johns River BL Marco LK at Jacksonvi	-1.151	3.273	3.064	78.6
02246500	-81.665398	30.3225	St. Johns River at Jacksonville, FL	-1.999	4.117	3.6	64.5
302309081333001	-81.558098	30.386101	St. Johns R Dames Point Bridge at Jackso	-5.986	8.257	5.687	27.6
02198980	-80.906097	32.035801	Savannah River at Fort Pulaski, GA	2.118	3.635	2.955	64.4
0219897993	-81.006897	32.1031	Savannah River at Elba Island, Near Sava	2.216	3.877	3.182	59.6
0219897945	-81.082802	32.097801	Back River 0.4 MI Downstream US17, NR Sa	2.103	3.606	2.93	63.2
021989773	-81.081398	32.080399	Savannah River at Usace Dock, at Savanna	-1.593	3.272	2.858	72.9
021989715	-81.128304	32.1161	Savannah River at Garden City, GA	-2.556	3.723	2.707	70.2
021989793	-81.121902	32.1367	Little Back River at Hog Island, Near Sa	0.846	2.113	1.936	88
02198955	-81.1353	32.142799	Middle River at Fish Hole at Port Wentwo	-2.179	3.813	3.129	76.4
02198920	-81.1549	32.165298	Savannah River at GA 25, at Port Wentwor	-2.097	3.71	3.061	74.8
02198950	-81.138	32.165699	Middle River at GA 25 at Port Wentworth,	-0.931	2.103	1.886	90.7
021989792	-81.129997	32.165798	Little Back River at GA 25 at Port Wentw	-0.059	0.985	0.984	98.4
021989791	-81.117599	32.171001	Little Back River at FW Dock, Near Limeh	-0.102	0.45	0.439	100
021989784	-81.117897	32.185799	Little Back River Above Lucknow Canal, N	0.016	0.459	0.459	100
02172053	-79.922401	32.9841	Cooper River at Mobay Near N Charleston,	-1.242	2.699	2.397	82.6