NOAA's National Ocean Service:
Recent Advances & Future Directions

CIROH Developers Conference

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Agenda

- NOAA's National Ocean Service
- Recent Advances
- Future Directions
- NOS & CIROH
- NOS' Communities of Practice
- Questions?

NOAA's National Ocean Service

- Office of Marine & Aviation Operations & NOAA Corps
- National Marine Fisheries Service
- Oceanic & Atmospheric Research
- **National Ocean Service**
- National Weather Service
- National Environmental Satellite, Data & Information Service

NOS Mission

Provide science-based solutions

through collaborative partnerships

to address evolving economic,

environmental, & social pressures

on our Great Lakes, ocean, and coasts.

NOS Priorities

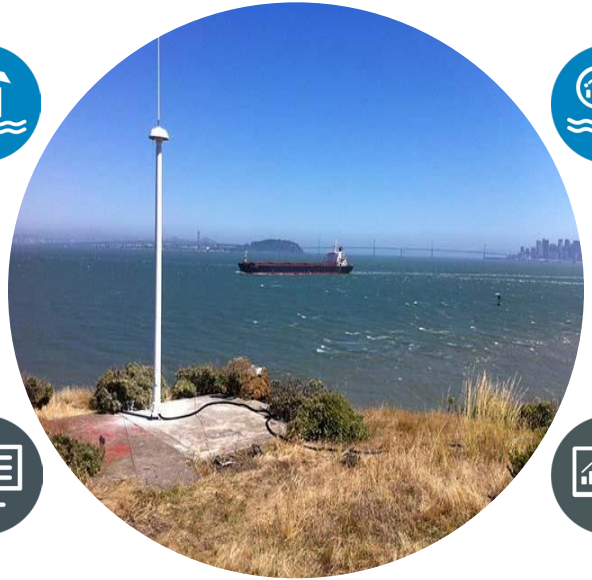
- **Navigation, Observations & Positioning**
  - Hydrography, shoreline mapping, and nautical cartography
  - Water levels, tides, and currents
  - Geodesy, reference frames, and geoid modeling
  - Integration of cross-sector ocean observations and data to produce coastal models, forecasts, and prediction services
- **Coastal Science & Assessment**
  - Ecological forecasting and long-term monitoring
  - Risk analyses for marine toxins and threats, such as harmful algal blooms and hypoxia
  - Ecological, economic, and social science information to promote ecological resilience
- **Ocean & Coastal Management & Services**
  - Work in partnership with local governments, states, non-profit organizations, and other partners to advance coastal management, research, education, and engagement

NOS Program Offices

Center for Operational Oceanographic Products & Services (CO-OPS)

U.S. Integrated Ocean Observing System (IOOS)

National Centers for Coastal Ocean Science (NCCOS)



Office of Response and Restoration (OR&R)

National Geodetic Survey (NGS)

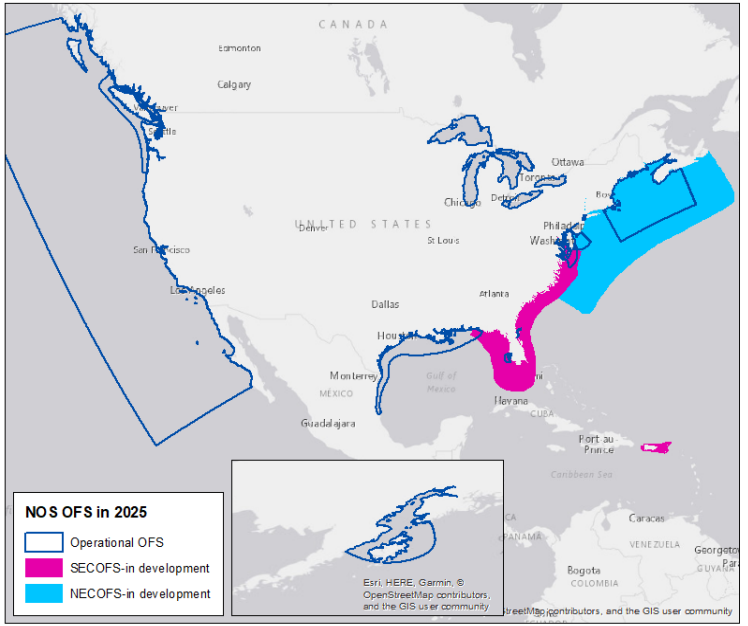
Office of National Marine Sanctuaries (ONMS)

Office for Coastal Management (OCM)

Office of Coast Survey (OCS)

NOS Modeling

- **NOS Modeling Summit:** to make recommendations on the NOS organizational structure to best support NOS Modeling needs
- **Core Model Evaluation:**
  - Working with external modeling community to conduct formal evaluation based on agreed upon criteria
  - **Goal:** determine optimal set of core model codes that can meet NOS' modeling and statutory requirements (i.e. its mission) while positioning the program to incorporate advances in computing infrastructure, data integration, and non-physics-based prediction methodologies over the coming decade.
- **Consolidating the NOS Operational Models** to optimize resources and computing resources

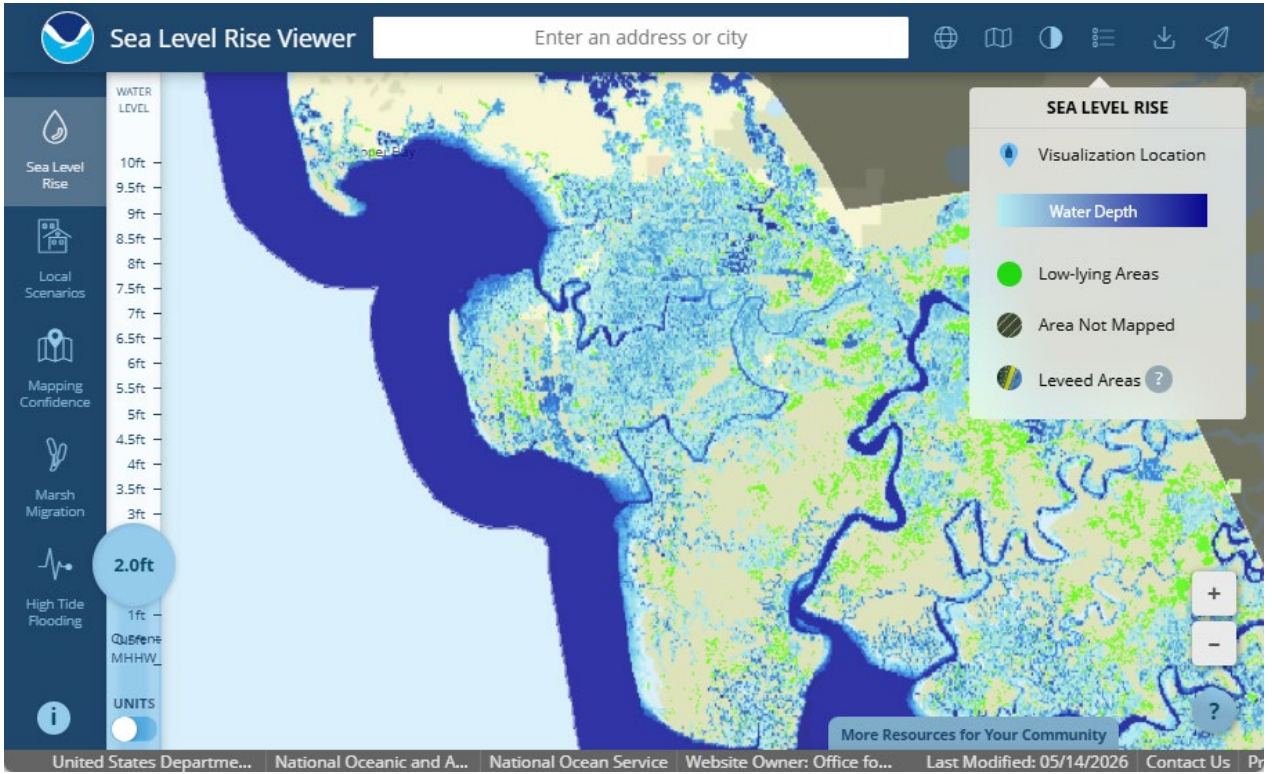


Recent Advances

Recent Advances

Expanding Sea Level Rise Viewer & Sea Level Calculator in AK (OCM)

- Visualize community-level impacts from coastal flooding or sea level rise
- Photo simulations of how future flooding might impact local landmarks



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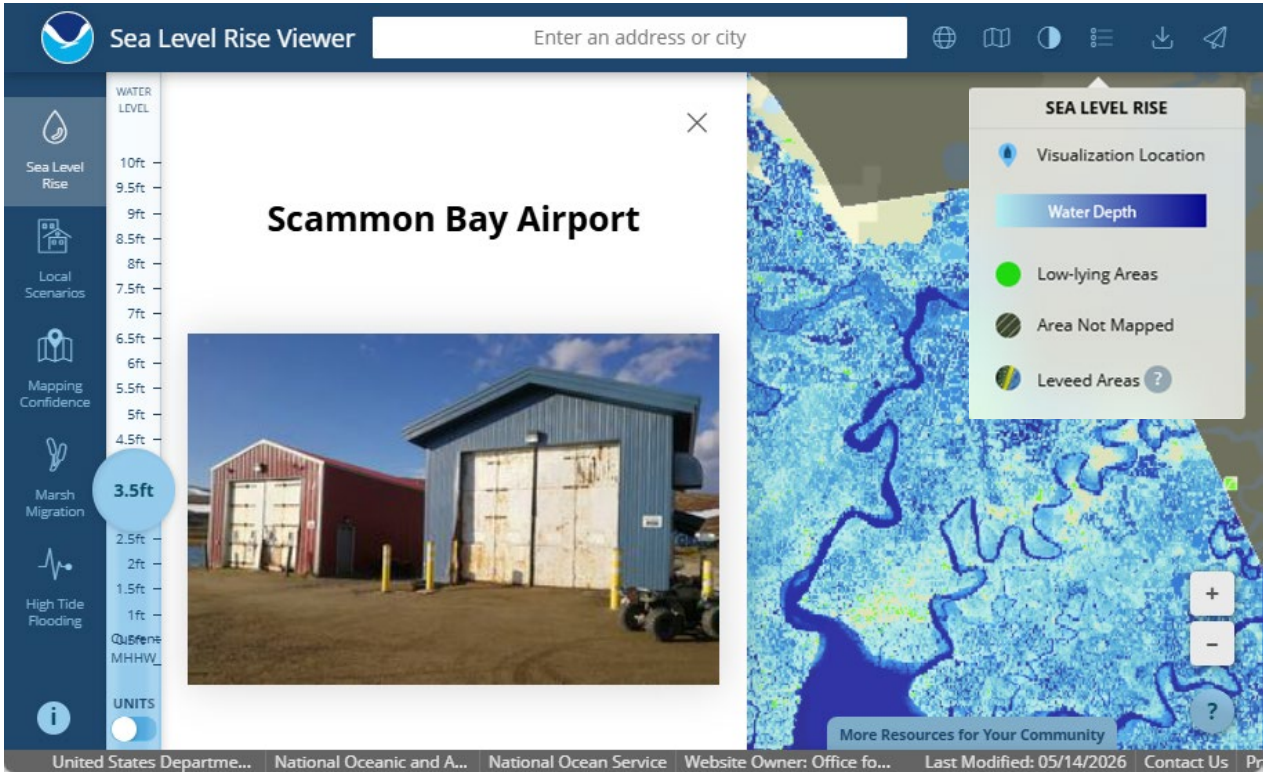

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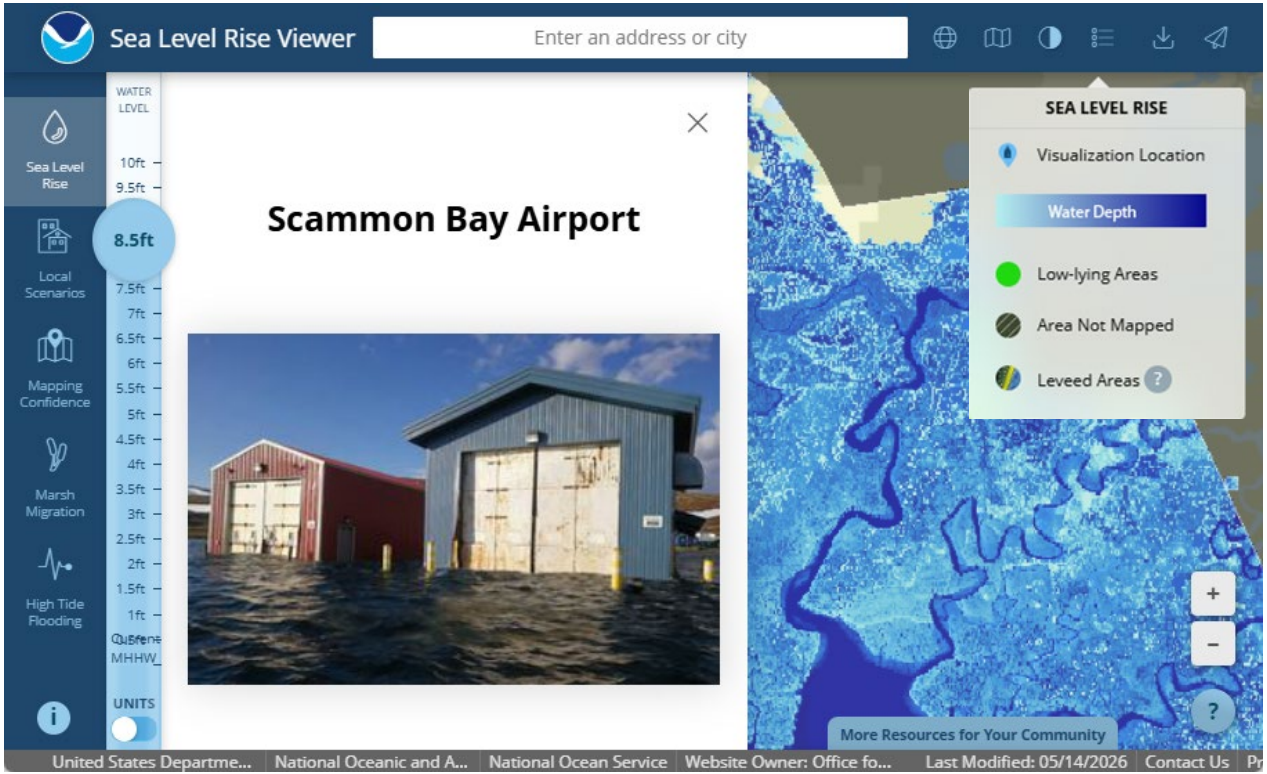

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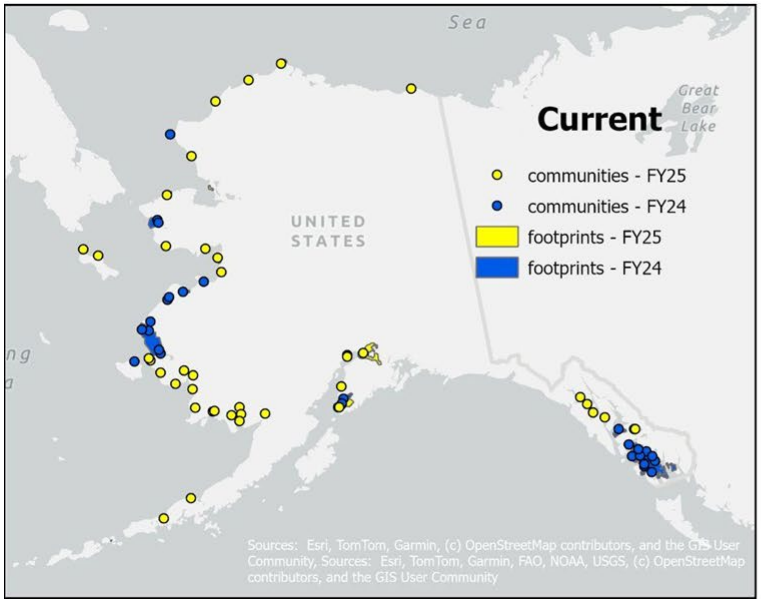
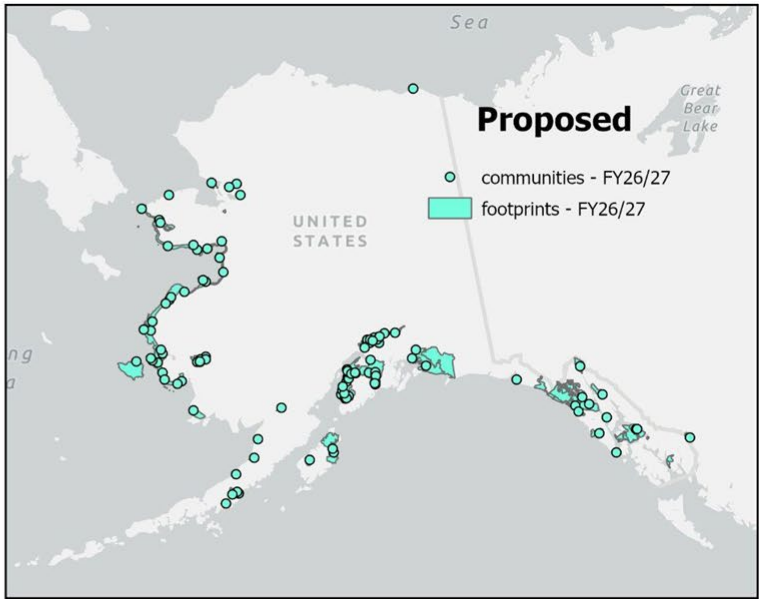
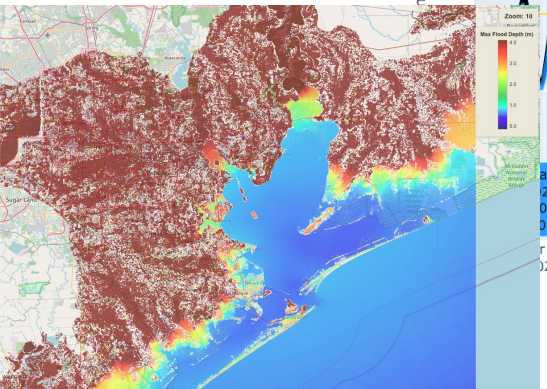


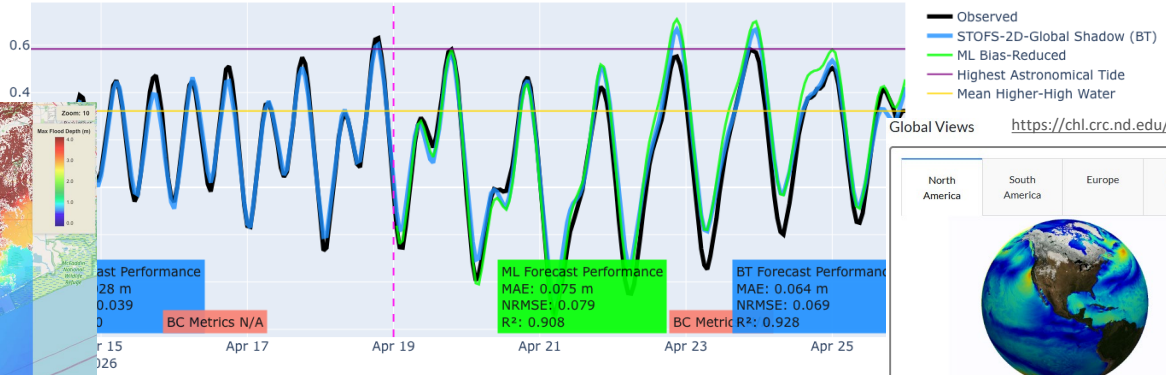


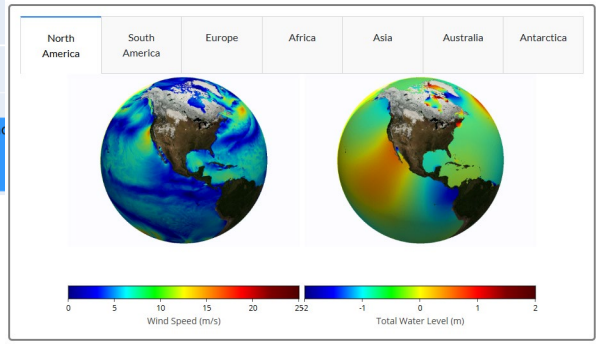
- FY24-delivered: 28 communities
- **FY25-delivered: 41 more communities ➔ 69 total**
- FY26 & FY27 proposed: 84 more (and 29 others updated) ➔ 153 total

Recent Advances
STOFS-2D+ Global (OCS)

- University of Notre Dame collaborating with the Office of Coast Survey (OCS)
- **Enhance STOFS-2D+ Global operational forecast model**
  - Incorporated the lunar and solar direct tidal forcing into the ADCIRC code
  - Incorporated/improved representation of: tsunamis, sea ice and surface waves
  - Extended grid further inland and aligned it with hydrologic basin



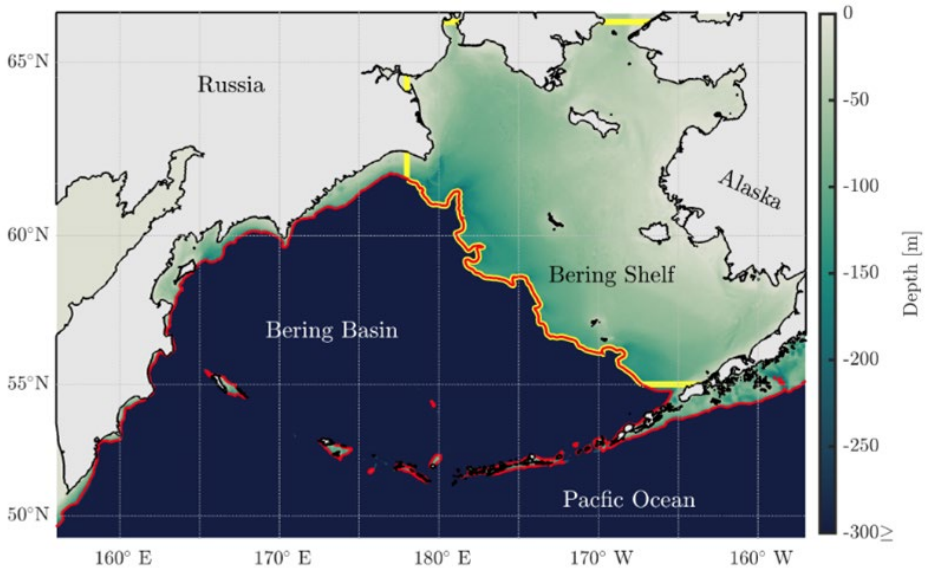




Recent Advances

Coupled Ice-Ocean Forecast Capabilities in STOFS-3D-Alaska (OCS)

- Oregon State University, the Virginia Institute for Marine Science, NCAR and OCS
- **Couple STOFS-3D-Alaska (SCHISM) and CICE** to provide **3- to 7-day forecasts of sea level, currents, salinity, temperature, waves, and ice concentration, thickness and motion** in support of disaster mitigation and safe navigation
- **Skill assess the forecasts** using in-situ observations (moored time series profiles and satellite observations)

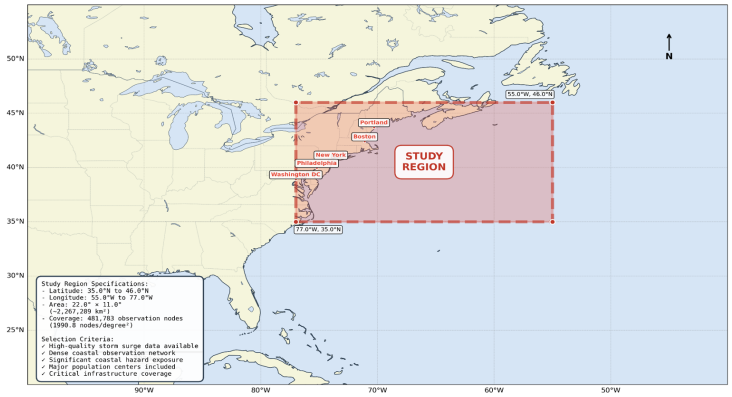


Recent Advances

Laying the Foundation for AI-powered Coastal Modeling (OCS & CO-OPS)

- Design **NOS operation model infrastructure** to support the development and operations of AI coastal models
  - Document operational requirements for running an experimental AI model
  - Define data and metadata needs, HPC needs for training and operations, requirements for UFS compliance
  - Implement the model prototype on HPC for near-real time testing and evaluation

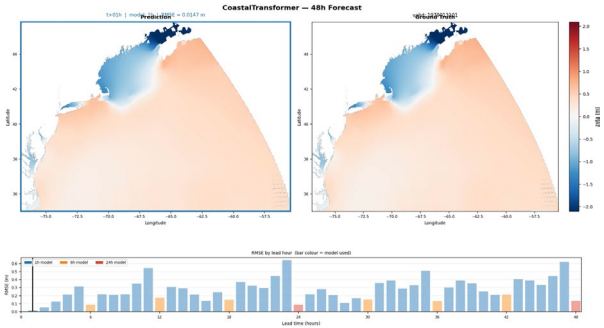
Figure 1: Study Region - Northern USA East Coast



Recent Advances

Laying the Foundation for AI-powered Coastal Modeling (OCS & CO-OPS)

- Develop a prototype based on **adaptive machine learning (ML)**
- Complete a **comprehensive variable analysis** that evaluates the influence of:
  - Coastal Ocean Reanalysis orcing data sources (ERA-5 atmospheric forcing, water levels)
  - reanalysis datasets (NOAA 44-year hourly reanalysis data)
  - observational data
  - bathymetry



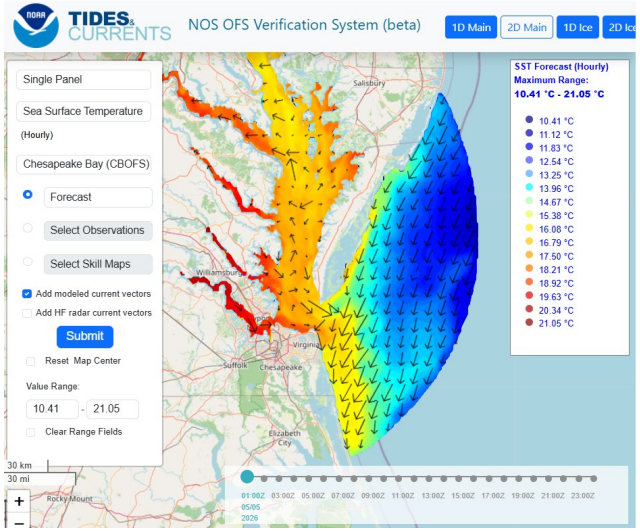
Preliminary results on total water level (Left: CORA data; Right: AI prediction)

Recent Advances

Next-generation Model Evaluation Tool (CO-OPS & OCS)

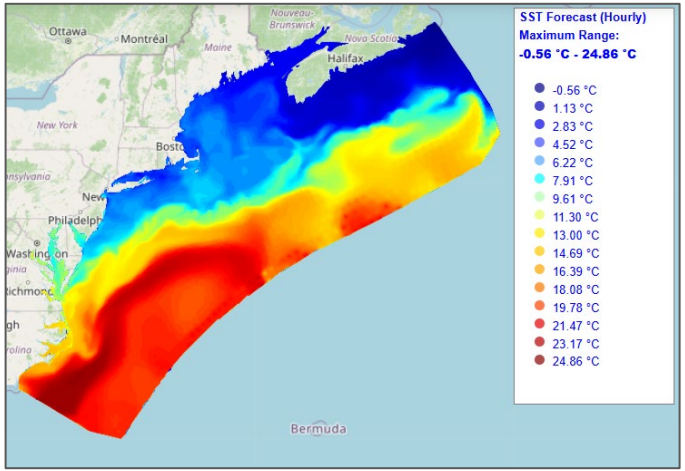
- **Publicly available python-based skill assessment package & GIS-based web application** for model evaluations and inter-comparisons (beta versions)
- **1D Skill Assessment** of water level, current velocity & direction, temperature, & salinity using real-time observations from: NOAA CO-OPS, NOAA NDBC stations, USGS and CHS
- **Validation of ice concentration & extent** using National Ice Center & Great Lakes Surface Environmental Analysis products
- **2D (sea surface) skill assessment** using remote sensing observations and products over entire OFS domain

GitHub Repo



Recent Advances

Next-generation Operational Forecast Systems



Northeast Coast Operational Forecast System

- A NOS BIL CIFIM-funded project in partnership with University of Massachusetts at Dartmouth and NERACOOS
- Expands OFS coverage along Northeast Coast from Chesapeake Bay to the Gulf of Maine

Southeast Coast Operational Forecast System

- Expands OF coverage along the Southeast Coast from Chesapeake Bay to Florida, and adds Puerto Rico and the U.S. Virgin Islands

Lake Ontario Operational Forecast System

- An OAR/GLERL, NWS/OWP & NOS BIL CIFIM-funded project
- Expanded domain includes the floodplain up to the 10m contour, higher resolution harbors & estuaries and the upper St Lawrence River

➔ **Legacy OFS in the regions will be retired following successful validation and implementation**

Future Directions

Future Directions

1. Prioritizing communities vulnerable to coastal hazards such as flooding, permafrost degradation, and erosion: Expanding the Sea Level Rise Viewer and Sea Level Calculator Alaska
2. Increasing the accuracy of 5-day total water level forecasts and the computational efficiency of the operational forecast model: Advancing STOFS 2D+ Global
3. Supporting disaster mitigation and safe navigation by providing 3-7 day forecasts of the sea level from:
    a. tides and storm surge
    b. ocean currents
    c. ice concentration, ice thickness, ice motion

    via a Coupled Ice-Ocean Forecast Capabilities
4. Continue designing an NOS operation model infrastructure to support the development and operations of AI coastal models or hybrid AI-numerical models

NOS & CIROH: FY25 NOS Priorities

1. **Social Science:** Compound flooding products and services
2. **Modeling:**
    a. Improve temperature and salinity performance in NOS coastal models
        i. to improve guidance and forecasting
        ii. to better support water quality modeling
    b. Extend the capabilities and domains of NOS operational models
3. **Geospatial Infrastructure:** Improve the digital elevation models along the floodplains to improve total water level forecasts

NOS & CIROH: FY25 NOS Priorities & Funded Projects

1. **Social Science:** Compound flooding products and services
   - ➔ **Assess the Effectiveness of Communication of Total Water Level Visualizations and Conduct User Testing of Compound Flood Products (Kenney et al.)**
2. **Modeling:**
   a. Improve T&S in NOS models (to better support water quality modeling)
   - ➔ **A think tank envisioning CIROH's unique opportunities to advance water quality forecasting (Schroth et al.)**

   b. Extend the capabilities and domains of NOS operational models
   - ➔ **Enhancing Coupling and Forecasting with 3D Modeling of Coastal Transition Zone (Anderson et al.)**
   - ➔ **Assessing NOAA's Coastal Ocean Reanalysis' Skill for Short to Mid-range Tidal Flood Forecasting (Moftakhari et al.)**
3. **Geospatial Infrastructure:** Improve the digital elevation models along the floodplains to improve total water level forecasts

NOS & CIROH: FY26 NOS Priorities

1. **Social Science:** Compound Flooding Products and Services
2. **TWL/Inundation:**
    a. Assessing the NWM Coastal TWL Forecast Skill
    b. Evaluating the Impact of Updating the Hydro Fabric on NWM TWL Forecast Skill
    c. Advance the Coastal Ocean Reanalysis (CORA) to Version 2.0
    d. Validating Coastal Flooding Characteristics of CORA
    e. Assessing and Optimizing Dynamical Downscaling for Sub-seasonal to Annual Coastal Inundation Forecasting
3. **Water Quality/Model Coupling:**
    a. High-Resolution On-Demand 3D Modeling for Coastal Emergency Response
    b. Towards a Cook Inlet Ecosystem Forecast Supported by STOFS-3D-Alaska
    c. Improve Temperature and Salinity Performance in Coastal Ocean Models

NOS & CIROH: FY26 NOS Priorities & Funded Projects

1. **Social Science:** Compound Flooding Products and Services
   - ➔ **Project A**
   - ➔ **Project B**
2. **TWL/Inundation:**
   a. Validating Coastal Flooding Characteristics of CORA
   - ➔ **Project C**
3. **Water Quality/Model Coupling:**
   a. Towards a Cook Inlet Ecosystem Forecast Supported by STOFS-3D-Alaska

4. **FY25:** Improve the digital elevation models along the floodplains to improve total water level forecasts
   - ➔ **Project D**

NOS' Communities of Practice

IOOS Modeling Community of Practice

- The upcoming 2026 IOOS Modeling Workshop will kickstart the IOOS Modeling Community of Practice
- **Goals:**
  - to strengthen coordination across modeling efforts, align on operational coastal and ocean modeling priorities, and **emphasize a clear operational focus tied to NOS requirements**
  - knowledge exchange on innovations like AI/ML applications and collaboration to align resources
  - address gaps across federal, regional, academic, and industry partners

Coastal Coupling Community of Practice

Total Water Levels

Lead by:
Margaret Palmsten
Hassan Mashriqui

Bathymetric Data

Lead by:
Rick Luettich
David Welch

Ecosystems & Water Quality

Lead by:
Rebecca Atkins
Vacant

Communications, Education & Training

Lead by:
Hamed Moftakhari
Chris Massey

Coastal Coupling Community of Practice

- Advance science around modeling
- Coastal coupling modeling best practices
- Adoption of standards
- Look for collaboration points and align priorities
- Identify related projects
- Share work openly

Coastal Coupling Community of Practice

Working Group	Current work:	Meeting Roadmap Goals
Total Water Level	Peer-reviewed paper on the state of total water level modeling.	1. A manuscript, user cases, and catalog about the coupling between models
Bathymetric Data	A workflow for using HEC-RAS models to correct DEMs.	1. A complete set of bathymetric data 2. A community data portal for collecting, verifying, and validating bathymetry
Ecosystems and Water Quality	Documenting ecosystem and ecological modelers and forecasters' requirements.	1. A complete national data set of temperature and salinity in the transition zone 2. A manuscript, user cases, and catalog about the coupling between the ecosystem and water models
Communications, Education, and Training	Terminologies document.	1. A manuscript of definitions 2. A community platform for communication with links to education and training materials

Coastal Coupling Community of Practice

Join here!

Coastal.Coupling@noaa.gov

Thank you!

National Ocean Service