NOS MODELING STRATEGY 2023-2028

NOS MODELING VISION: Individuals and communities nationwide understand and use reliable, accurate, and accessible predictions of coastal conditions

INTRODUCTION

Coastal communities need answers to critical questions about future water levels, flooding, and water quality on a moment-by-moment to a multi-decadal basis and at every increment in between. Mounting threats and costs from extreme events and cascading hazards endanger the 42% of the U.S. population that calls coastal areas home as well as the 48%of the Nation's Gross Domestic Product (GDP)[1] that is produced there.

Moreover, aging and deteriorating coastal and inland infrastructure cannot accommodate the increasingly frequent and intense floods caused by sea-level rise, subsidence, and high-tide flooding. Any failures of these systems threaten fresh water supplies, transportation and energy systems, agricultural outputs, and other types of infrastructure that are not meant to be inundated, especially with salt water.

Preparing for, and becoming resilient to, these threats require predictive capabilities to provide useful information across spatial and temporal scales—from the nearshore coastal waters to the global oceans and from days to decades. An effective coastal, ocean, and Great Lakes prediction capability will provide forecasts, hindcasts, projections, and reanalysis across these spatial and time scales to meet the current and emerging needs of decision makers at all levels while stoking collaboration across the scientific community.

CASCADING HAZARDS EXAMPLE

Marine heatwaves can cause harmful algal blooms that contaminate crabs with levels of domoic acid that is unsafe for human consumption, delays West coast crab fishing activity from winter into spring, disrupts historically offset seasonal patterns of fishing and whale migration, and potentially leads to greater incidents of humpback whale entanglements in fishing gear.[2]

A COMPREHENSIVE COASTAL, OCEAN, AND GREAT LAKES FORECASTING SYSTEM is required to answer key questions, such as: Where is the water? How much water is there? Is it safe to go to the beach? Is it safe to drink the water? Will the roads be flooded?

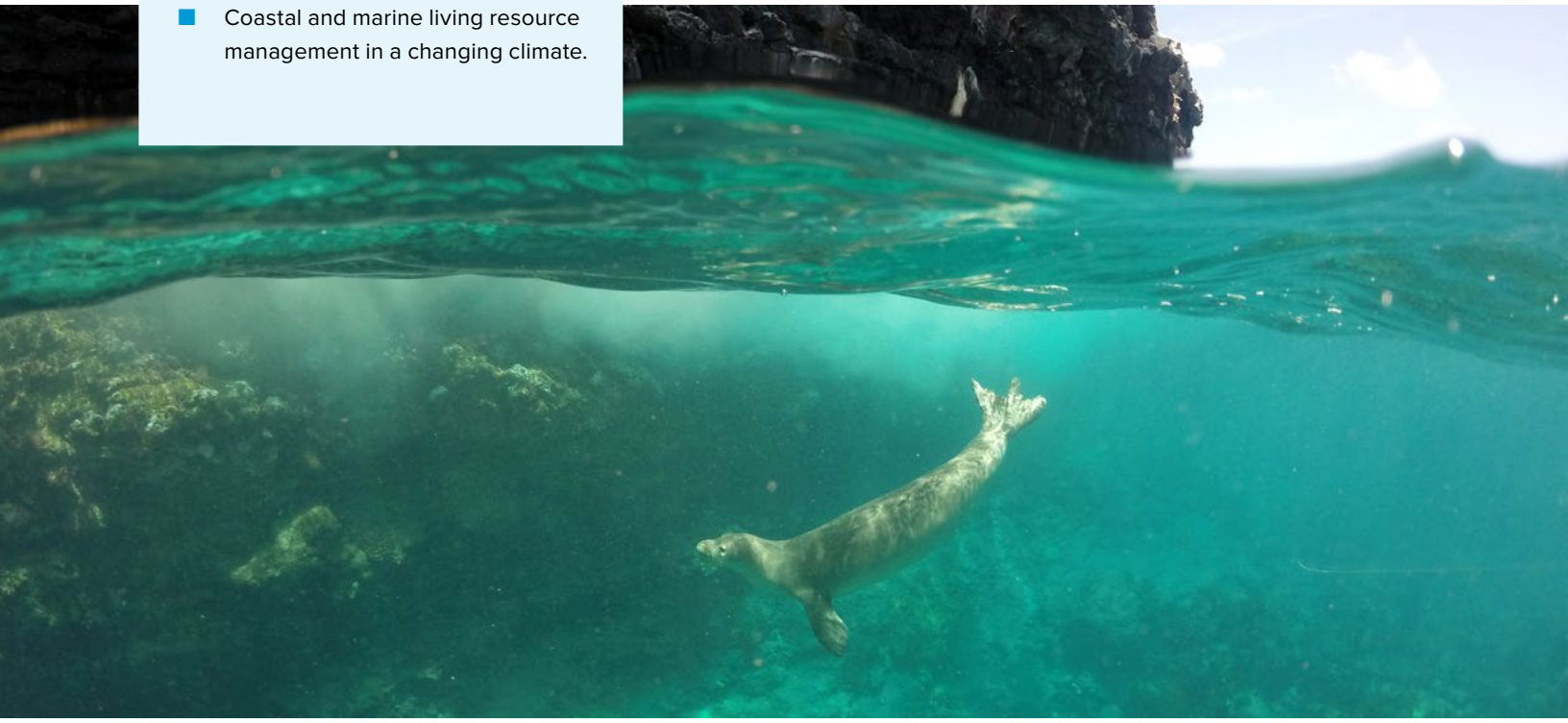
NOS'S MODELING EFFORTS WILL ADVANCE ITS PRIORITIES of coastal resilience, conservation, and equity, and improved data access to enhance the scope and scale of the blue economy. These efforts will provide better models for:

- Safe, efficient marine navigation;
- Human health protection;
- Coastal resilience and risk reduction;
- Improved maps and coastal management;
- Hazardous spill response and search and rescue; and
- Coastal and marine living resource management in a changing climate.

NOAA's National Ocean Service (NOS) is uniquely positioned to lead the development of such a coastal and ocean prediction capability for the Nation and to effectively deliver the range of applications and services needed to meet the threats facing impacted coastal communities along the U.S. coasts and the Great Lakes. With roots that go back to 1807, NOS is dedicated to providing science-based solutions through collaborative partnerships to address evolving economic, environmental, and social pressures on our ocean and coasts.[3]

However, NOS cannot do this alone; a collective effort is required inside and outside of the agency. Together, technical experts from across the federal agencies and academia and users from across sectors and coastal regions, will help NOS to provide answers to people in need at the moment they need them and in a format they can use.

The plan that follows provides a strategic approach to improving NOS' ability to simulate and predict coastal and ocean phenomena together with community partners across NOAA, the federal government, academia, and the private sector to build and advance models to issue reliable ocean predictions and address the needs of the public.



NOAA engagement. Image Credit: NOAA.

GOAL #1:

Address User Needs through Sustained Community Engagement and Partnerships

Citizens, private enterprises, coastal communities, and other stakeholders require predictive information about our ocean and coasts to prepare for and respond to extreme events, plan infrastructure projects that ensure coastal resiliency, forecast for food production, and mitigate billion-dollar disasters. Consistent with NOAA's Service Delivery Framework, this predictive information must be useful, usable, and used. NOS recognizes that the broader community—which includes every individual and organization from every sector, state, and nation—is needed both to provide input to NOS on their current and emerging needs and to co-produce with NOS the tools and services that will meet those needs.

NOS' partners have critical capacity and capabilities for delivering predictive information about the nation's coasts, oceans, and Great Lakes, which can be more fully addressed when we work together. To do this, NOS commits to sustaining predictable, coordinated, and transparent engagement and partnerships across the community including NOAA Line Offices, other federal agencies, state, local, and tribal governments, non-profits, academia, and private industry.

Specifically, NOS will sponsor community modeling workshops and seminars, share model development and implementation plans, and grow a Community of Practice focused on fostering partnerships amongst the coastal modeling community, ensuring NOS' operational modeling code and predictive information are accessible via shared cyberinfrastructure, and collaborating on projects that advance the mission needs of NOS and its community of partners.

NOS is dedicated to advancing equity as an integrated part of developing these models. To that end, NOS will work to identify and address the unique needs of historically underserved and underrepresented communities. Additionally, NOS will ensure that it engages with businesses and other organizations to facilitate the use of its models in third party products and services that generate economic value for the blue economy and address societal challenges.

Within hours of Sandy's departure, NOAA deployed research vessel Bay Hydro II to survey ship channels in the Hampton Roads area of Virginia, speeding the resumption of shipping and naval operations. Image Credit: NOAA.

To facilitate collaboration, NOS will be transparent by publicly communicating our intentions, capabilities, and gaps via an annual guidance memorandum and will encourage other federal modeling entities to do the same. As a result, partners will be able to plan for transitions, follow-on ideas, and innovations, and develop alternatives when needed. Additionally, NOS will advise and/or participate in scientific and engineering challenges that are designed to catalyze innovation for ocean and coastal user needs.

GOAL #1 OBJECTIVES:

1.1 Adopt the NOAA Service Delivery Framework and Implementation Approach.

1.2 Foster and productively participate in a robust community dedicated to meeting the needs of predictive information for our ocean and coasts.

1.3 Address the unique needs of underserved and vulnerable communities.

1.4 Highlight opportunities for the private and academic sectors by issuing an annual guidance memorandum of what NOS is and is not doing around coastal, ocean, and Great Lakes modeling.

NOS will be successfully addressing user needs through sustained community engagement and partnerships when:

- User needs are incorporated in NOS modeling plans in an ongoing and iterative process;
- The community knows about NOS' plans and is empowered to act in support of them;
- NOS has annually published a list of partners and their accountabilities;
- Qualitative and quantitative measures for enduring and reliable partner relationships are adopted and employed;
- Points of contact from NOS Program Offices are identified for modeling, communication, and collaboration;
- NOS Model Advisory Board is expanded to include more NOS office representatives; and
- NOS develops scientifically and technically diverse working groups.

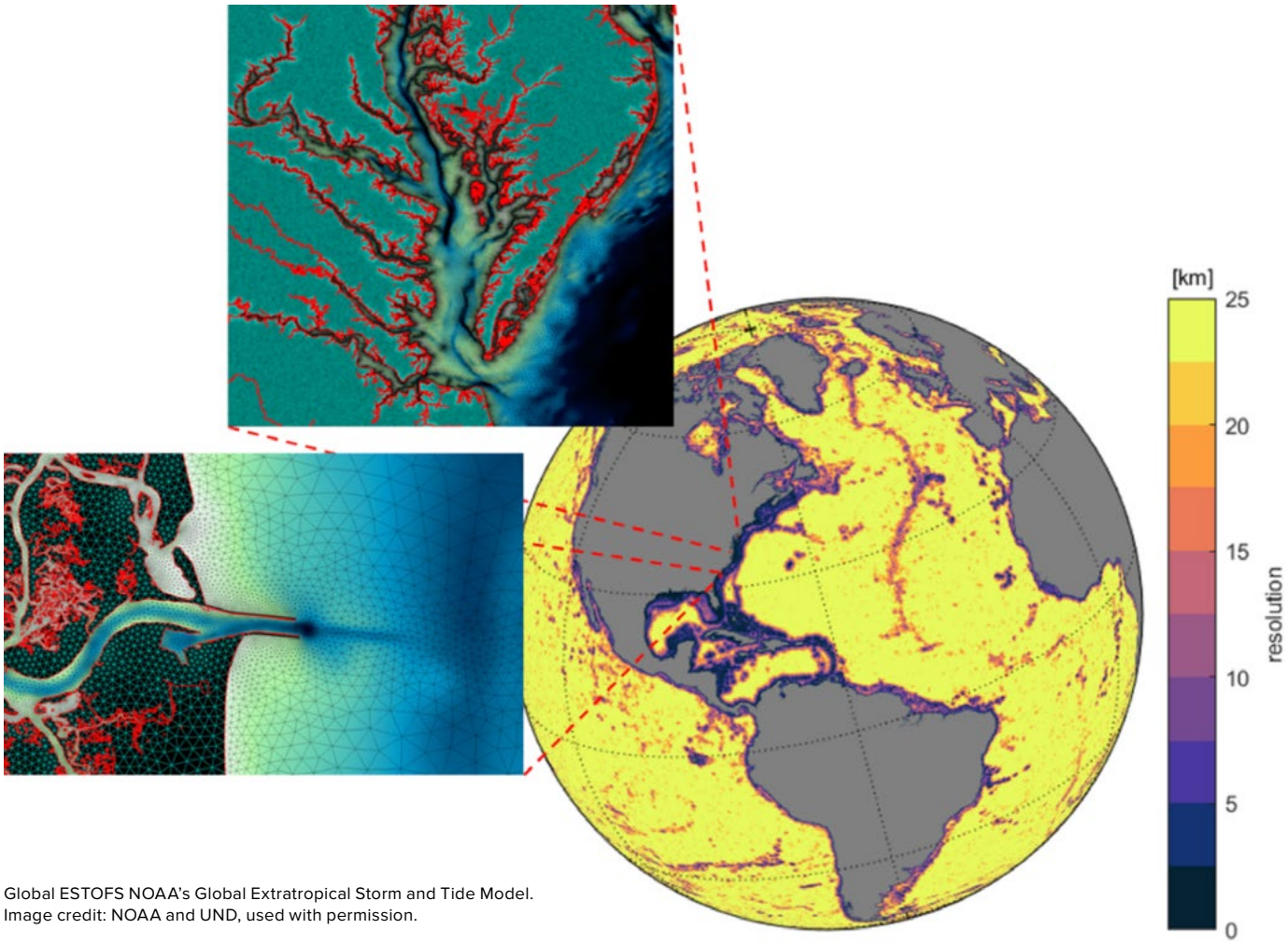
GOAL #2:

Develop Ocean and Coastal Models through Community Modeling

Users of NOS' coastal, ocean, and Great Lakes models and information have a wide variety of needs for predictive information about our oceans and coasts. Meeting these needs demands a collection of models that are flexible, multipurpose, and tailorable to specific geographic or temporal scales. Flexible, multipurpose models also enable a transition from information provided on a temporary basis (e.g., research) to information provided on a consistent, predictable cadence basis (e.g., operational or application).

By incorporating circulation information and land and water reference systems into models, NOS will provide usable, useful, and accessible information related to sea level rise, water quantity, and water quality. The model outputs will better inform decisions around public health, climate adaptation and resilience, and ecological management.

Like other software, models are developed in a collaborative and iterative manner. They require performance evaluations and feedback to improve from one version to the next. This means that the entire community must have a shared understanding of the model as well as its purpose and likely life cycle, including anticipated transitions (e.g., via quarterly updates to the NOS modeling website).



Global ESTOFS NOAA's Global Extratropical Storm and Tide Model.
Image credit: NOAA and UND, used with permission.

Muskegon Buoy Deployment, July 2020. Taken during the deployment of M20, a NOAA GLERL Real-time Coastal Observation Network (ReCON) buoy, off the coast of Muskegon, MI. NOAA GLERL's ReCON buoys continuously collect meteorological data and provide sub-surface measurements of chemical, biological, and physical parameters. Credit: NOAA GLERL, 7/30/20

GOAL #2 OBJECTIVES:

2.1 Clarify which models are needed for what purposes, and how they will be developed and operated by NOS, including any anticipated transitions.

2.2 Detail which models NOS will not develop or operate.

2.3 Participate actively as a community member by presenting the community with opportunities to provide feedback on NOS models, and offering feedback on models not developed by NOS.

2.4 Support and conform to the Unified Forecast System (UFS) Strategic Plan, Earth Prediction Innovation Center (EPIC) Strategic Plan,Department of Commerce (DOC) Geospatial Strategy, NOAA Environmental Data Management Framework, and community model development.

2.5 Adhere to modern software management principles (e.g.,maintain a code repository that has the latest version, clean, well-organized, dynamic documentation, feature development branches, and active and well-defined code management rules, standards, and practices).

2.6 Ensure that the products and data derived from NOS modeling systems are openly available and consistent with F.A.I.R. principles.

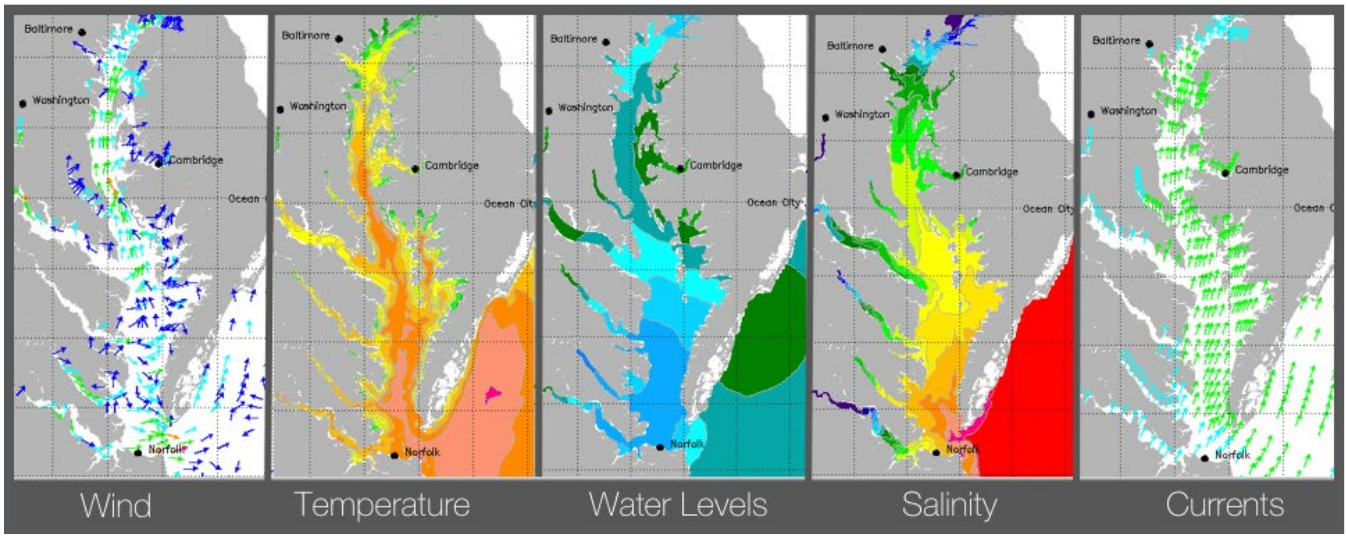
2.7 Develop modeling products and services consistent with the National Spatial Reference System (NSRS) for which NOS has a primary national responsibility.

2.8 Confer with experts from other parts of NOS, NOAA, and other government agencies to inform the modeling approach and develop value-added products.

2.9 Identify and address the unique needs of underserved communities.

NOS will be successfully developing coastal, ocean, and Great Lakes models through community modeling when NOS has:

- Reduced the time required to develop, test, and deploy operational model based products;
- Expanded the vibrant, open source model development community;
- Implemented open governance structure and strategic goals for community modeling systems;
- Hosted annual opportunities for community exchange of advances in coastal and ocean modeling;
- Facilitated modelers across NOS, academia, and industry as they worked collaboratively to develop applications and models for operational use through iterative development and improvements throughout a model's life cycle;
- Elicited and incorporated community feedback to improve applications and models for operational use;
- Developed and maintained multipurpose coastal, ocean, and Great Lakes component modeling systems; and
- Ensured that modeling conforms to DOC/NOAA guidance and is compliant with the UFS.



Typical hourly forecasts of different oceanographic conditions for Chesapeake Bay. Image credit: NOAA

GOAL #3:

Issue National Ocean Service Forecasts through Accurate and Reliable Operational Models

NOS' collection of coastal, ocean, and Great Lakes models will be designed to provide nowcasts, forecasts, hindcasts, reanalysis, and seasonal/climate-scale projections that—much like a set of building-block toys, can be combined in numerous ways to produce a variety of results. This coherent, national framework of models — also known as an operational forecast system — will be able to scale consistently from the macro- to the micro-levels. NOS will determine the geographic and temporal scales for the operational forecast system based on user needs and NOS' mission, mandates, priorities, and other factors.

A comprehensive and reliable forecast system, must be:

- Easily inter-related to ensure scalability and consistency across the entire country from coast to coast and varying intervals of time;
- Comparable by applying a consistent framework for observations and providing sufficient metadata regarding the spatial orientation; and
- Aligned to international standards and consistent with tools and operational forecast system predictions from other countries.

GOAL #3 OBJECTIVES:

3.1 Adopt the framework defined by the UFS system architecture.
3.2 Ensure model output is widely available and compliant with pertinent international data standards.
3.3 Establish needed resources and personnel.
3.4 Identify and establish collaborations with other NOAA Line Offices.

NOS will be successfully issuing forecasts and warnings through accurate and reliable operational models when:

- A national coastal, ocean, and Great Lakes modeling system supports decision-making at the appropriate geographic and temporal scales is delivered;
- The standards for data conform with internationally accepted norms;
- The comparison of various operational forecast system model outputs can be easily accomplished using tools readily available to the community; and
- Community members, beyond the NOS modeling community, incorporate operational forecast system outputs into their decision making tools.

Biscayne Bay. Image Credit: NOAA.

THE WAY FORWARD

To realize the NOS Modeling Vision—where individuals and communities nationwide understand and use reliable, accurate, and accessible predictions of coastal conditions—the entire modeling community must combine their formidable skills and talents in a stable, predictable, and reliable way. Each NOS Program Office will help to establish a foundation by coordinating to problem-solve, testing ideas and providing feedback, and engaging with their partners and networks in service of this bigger goal.

Each NOS Program Office will provide:

1. Point(s) of contact to speak authoritatively on models, requirements, and user needs;
2. Coordination on modeling funding for public calls and budget initiatives;
3. Coordination on modeling implementations;
4. Communication of priorities and requirements;
5. Coordination of model system maintenance; and
6. Support of models that are consistent with UFS

The NOS Modeling Strategy will be successfully implemented when:

- User needs that are known and met;
- The external community knows NOS' plans and is empowered to act;
- The time required to develop, test, and deploy operational-model-based products is decreased; and
- National coastal, ocean, and Great Lakes modeling system that supports decision-making at the appropriate geographical and temporal scales.

APPENDIX A. References

1. https://aambpublicoceanservice.blob.core.windows.net/oceanserviceprod/facts/coastal-population-report.pdf.
2. NOAA Weather, Water, and Climate Strategy: FY23-27
3. NOS Mission Statement

APPENDIX B. Photo Credits

Front Cover and Page 9.
Biscayne Bay. Image Credit: NOAA.

Page 2.
A beautiful sunset shot in Schoodic, Maine. Image Credit: NOAA.

Page 2.
2017 Western Lake Erie harmful algal bloom. Image Credit: NOAA.

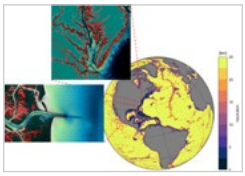
Page 2.
Road closed due to flooding. Image credit: NOAA

Page 3.
A beautiful coral reef. Image credit: NOAA

Page 3.
A magnificent photo of sea, swell, sky, a rock cliff, and a monk seal swimming over a coral reef bottom. Image credit: NOAA

Page 4.
NOAA engagement. Image Credit: NOAA.

Page 5.
Within hours of Sandy's departure, NOAA deployed research vessel Bay Hydro II to survey ship channels in the Hampton Roads area of Virginia, speeding the resumption of shipping and naval operations. Image Credit: NOAA.



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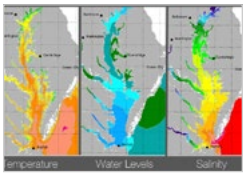
Global ESTOFS NOAA's Global Extratropical Storm and Tide Model. Image credit: NOAA and UND, used with permission.

Page 7.
Muskegon Buoy Deployment, July 2020. Credit: NOAA GLERL, 7/30/20



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Typical hourly forecasts of different oceanographic conditions for Chesapeake Bay. Image credit: NOAA