NOS MODELING IMPLEMENTATION PLAN

AUGUST 2024

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Executive Summary

The National Ocean Service (NOS) Modeling Implementation Plan serves as a roadmap to meet the NOS 2023-2028 Modeling Strategy. Together with community partners — including federal, state, and local agencies; academia; non-profit organizations; tribal and Indigenous communities; and the private sector — NOS will advance modeling systems to ensure the equitable delivery of accurate and reliable predictions for the ocean, coasts, and Great Lakes, enabling informed decision-making processes surrounding environmental risks. These combined efforts will advance NOS priorities to 1) increase U.S. coastal resilience; 2) make equity central to our mission; 3) accelerate growth of the ocean enterprise and the Blue Economy; and 4) conserve, restore, and connect healthy coastal and marine ecosystems. This publicly available implementation plan is written for and by NOS modeling teams; it supports the NOS Modeling Strategy; and it focuses upon three primary goals, with commitments to support successful execution and detailed supporting actions.

NOS Modeling Strategy Goals

GOAL 1: Address user needs through sustained community engagement and partnerships • User needs will be incorporated into NOS modeling plans using an ongoing and iterative process, thereby sustaining predictable, coordinated, and transparent engagement and partnerships across the community.

GOAL 2: Develop ocean and coastal models and products through community modeling • NOS will provide usable, useful, and accessible information to inform decisions around public health, climate adaptation and resilience, and ecological management. NOS will reduce the time required to develop, test, and deploy new or upgraded operational forecast modeling systems and associated products by implementing an overarching governance structure, expanding the open-source modeling development community, and aligning to NOAA guidance compliant with the Unified Forecast System.

GOAL 3: Issue NOS forecasts through accurate and reliable operational models • NOS will have a national coastal, ocean, and Great Lakes modeling system that supports decision-making at the appropriate geographic and temporal scales using tools readily available to the community and the public. NOS model products and services will be informed by combinable and scalable nowcasts, forecasts, hindcasts, reanalysis, and seasonal/climate-scale projections.

1.0 Introduction

The National Ocean Service (NOS) provides stakeholders products and services derived from direct or remote observations and dynamical or statistical predictions of our oceans and coasts[1]. Recently, NOS published the NOS Modeling Strategy 2023-2028 to expand and improve the scope and quality of the modeling elements of our public products and services[2]. This Modeling Implementation Plan (MIP) builds upon that strategy and outlines the implementation steps to be carried out to achieve NOS Modeling Strategic Goals.

For this implementation plan, we consider the diverse portfolio of NOS modeling efforts, including ocean, lake, and coastal circulation models; ecosystem models, including biogeochemical processes or species dynamics; and models supporting the NOS vertical and horizontal georeferencing mission. This document refers to these as “ocean and coastal models” or just “models.”

The NOS MIP guides the evolution of the modeling portfolio to meet the three goals outlined in 2023-2028 NOS Modeling Strategy for addressing user needs through sustained stakeholder engagement, embracing community modeling, and producing accurate and reliable forecasts. This will be done in close collaboration with the industry and university partners to fulfill the vision that individuals and communities nationwide understand and use reliable, accurate, and accessible predictions of coastal conditions. The NOS MIP includes a proposed governance structure that emphasizes unification and innovation through a prioritization process to optimize efficiencies by consolidating systems based on stakeholder feedback and objective verification.

The plan includes processes for documenting and clarifying which models are needed for what purposes, and how NOS will develop and operate them — including any anticipated transitions to new systems and sunsetting of old ones. These processes will align with the NOAA Modeling Strategy, the Unified Forecast System (UFS) Strategic Implementation Plan, the Earth Prediction Innovation Center (EPIC), Department of Commerce (DOC) Geospatial Strategy, and the NOAA Environmental Data Management Framework. General guidelines and best practices for code management are also provided. The data and derived products from NOS modeling systems will be openly available and consistent with CARE and FAIR principles, as recommended in the NOAA Science Advisory Board Report on Open Data/Open Science for scientific data management and stewardship.

To reduce the time required to develop, test, and deploy operational forecast modeling systems and associated products, interactions between NOS program offices, NOAA line offices, and community modeling partners who are involved in all steps, will be optimized. Consistent with the updated NOS modeling governance structure, NOS will rely on decision-makers at each level of working group (WG), the NOS Modeling and Prediction Team (MPT), and the NOS Executive Leadership Team (ELT) to prioritize cross-program office coordination throughout the research to operations (R2O) process and ensure support. Adherence to NOAA guidance to ensure alignment with UFS will be managed via coordination with the MPT, ELT, and the NMT.

[1] National Ocean Service. 2023. Strategic Plan Fiscal Year 2024-2028
[2] National Ocean Service. 2023. NOS Modeling Strategy

Cross-program office coordination and consistent processes are critical to ensure the efficient expenditure and prioritization of resources (both human and computational resources), which will improve the efficiency and effectiveness of the NOS modeling program. Key elements of the implementation plan include:

- Defining requirements, goals, responsibilities, timelines, and milestones
- Determining and sustaining resources *(budget, personnel, and IT infrastructure*)
- Defining criteria for quantifying the level of success
- Developing an iterative process to improve coordination, strengthen engagement, and accelerate innovation

This plan will be considered successful when ocean and coastal modeling needs are developed in partnership with the community, met and sustained in a unified system by NOS, and useful, usable, and reliable products are available to stakeholders to inform decision-making. This plan will be reviewed annually and updated to reflect necessary adjustments and to adapt to advances in Earth System Science, software engineering and computational science. Success of this implementation plan will be enabled by increased coordination and greater transparency across NOS program offices, reduced duplication across the modeling portfolio, adoption of uniform modeling standards across all program offices, and dissemination service for accessing and distributing forecast system predictions and derived products.

2.0 Governance

2.1 Governance Structure, Roles, and Responsibility

As discussed above, the NOS Modeling Strategy envisions an expanded set of modeling capabilities while also introducing efficiencies in our overall system architecture, cross-office communications, and decision-making. Addressing these potentially competing goals simultaneously will require a governance structure empowered to prioritize objectives and communicate the impacts of this prioritization across the organization.

The Modeling Advisory Board was redesignated as the Modeling Prediction Team (MPT) to reflect a new NOS-wide governance model. The MPT Charter will ensure that modeling portfolio issues are shared broadly across the NOS modeling community. It further enables coordination across the NOAA modeling community. In this implementation plan, we provide more details on the work required by the new MPT and associated WGs. The NOS MPT governance structure will follow the principle of subsidiarity, where decisions are made at the organizational level closest to the impact(s) of the given decisions. Thus, the NOS MPT is informed by modeling groups on the forefront of modeling efforts and empowered to improve modeling capability based on continuous feedback from users, partners, and the NOS ELT.

The different NOS governing bodies and responsibilities for this structure are shown in Figure 1. The ELT will serve as the final approving authority for significant changes to the portfolio. The ELT ensures success metrics align with NOS priorities and fit within budget. The ELT will identify opportunities to leverage other line offices. The MPT will be chaired by the NOS deputy assistant administrator for navigation, observations, and positioning and is supported by the NOS modeling portfolio manager and representatives from each NOS program office as defined in the MPT Charter.

The MPT will be tasked to 1) coordinate environmental modeling and prediction research, development, operations, and applications; 2) provide strategic recommendations to the NOS ELT regarding modeling and high-performance computing (HPC) priorities and requirements; 3) serve as the NOS focal point for collaboration and coordination with the NOAA Modeling Team. The NOS MPT will establish standing WGs and provide focused goals with achievable timelines. Working groups will be updated as necessary in the MPT Charter. The notional descriptions and structure are listed below, as well as Figure 1.

- Consolidating and Cross-Cutting: (C3) Analyzes the current state and possibilities for system consolidation; this cross-cutting group will also produce a skill assessment of the current systems.

- Research and Development *(proposed)*: (R&D) Oversees and coordinates aspects of R&D for models and products based on the advancements in science and technology.

- Operations *(proposed)*: (Ops) Oversees and coordinates across NOS any aspect of operational implementation of the modeling systems on NOAA computational infrastructures.

- Dissemination and Support *(proposed)*: (D&S) Oversees and coordinates across NOS any aspect of dissemination of forecast products and services, and stakeholder support.

- Community Engagement *(proposed)*: (CE) Oversees and coordinates all the efforts across NOS involved with any aspect of community engagement.

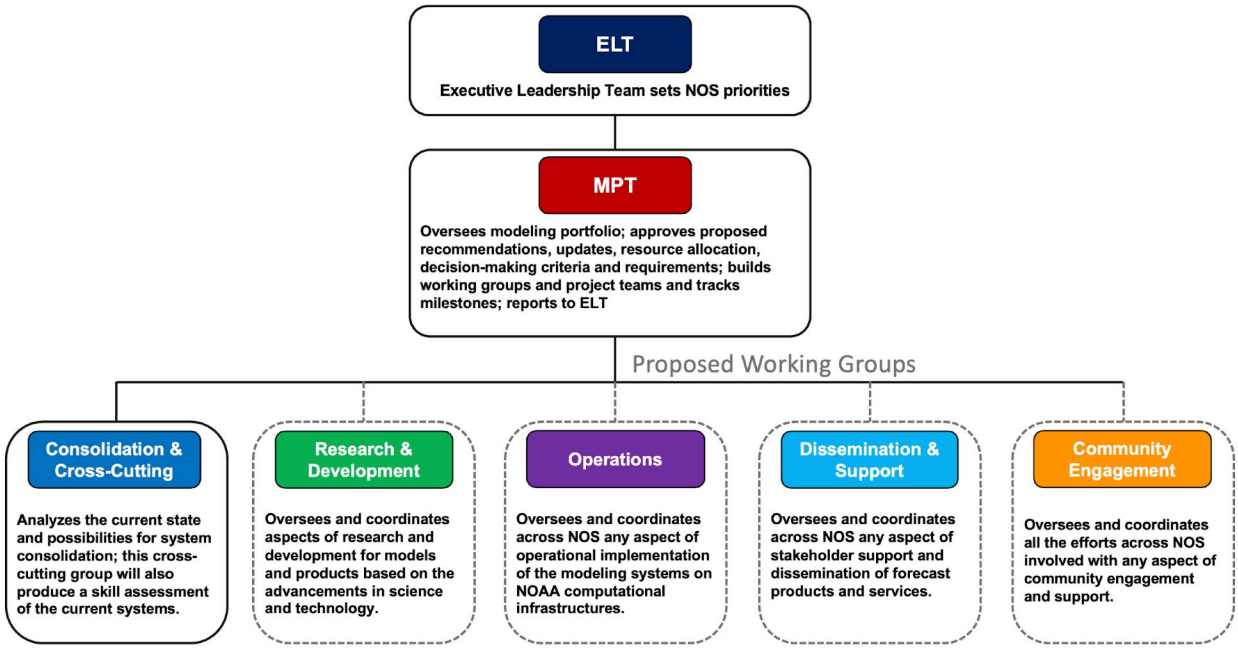

Figure 1. The new governance structure of the NOS modeling program. Dashed lines indicate tentative working groups that MPT will finalize and establish.

The ability to implement the goals described in the NOS Modeling Strategy depends on a coherent, transparent, and collaborative governance structure that includes all NOS program offices. Table 1 shows the actions necessary to establish the suggested governance structure described herein. These first actions establish a construct to enable effective management of the NOS modeling portfolio in support of NOS strategic goals. The actions listed in Table 1 and Tables 3 through 5 align with the NOS Modeling Strategy goals and are the framework of the MIP. The tables identify the MPT actions, WGs responsible actions, associated NOS Modeling Strategy objectives, and the completion timeline. The MPT will lead oversight, implementation, assessment, and annual updates of the MIP.

2.1.1 Governance actions

Table 1. Actions to establish and implement governance.

ACTION ID	ACTION	LEAD	NOS MODELING STRATEGIC OBJECTIVE	TIMELINE FOR COMPLETION
A0.1	Establish the NOS MPT and Charter	NOS ELT	All	Q1 FY24
A0.2	Establish the C3 WG to support immediate MIP actions. Additional WGs will be established as determined necessary by MPT; define roles and responsibilities.	MPT	All	Q1 FY25
A0.3	Develop a NOS-wide inventory of current models, including skill assessment, development status, and cross-office dependencies.	MPT	1.1 Adopt the NOAA Service Delivery Framework and Implementation Approach.	Q1 FY24 and Updated Quarterly
A0.4	Develop a list of current products and services driven by those models.	MPT	1.1 Adopt the NOAA Service Delivery Framework and Implementation Approach.	Q1 FY25
A0.5	Develop a cross-program office project-tracking tool designed to increase accountabilities and promote transparency.	C3	1.1 Adopt the NOAA Service Delivery Framework and Implementation Approach.	Q2 FY25
A0.6	Conduct a routine assessment of implementation plan action progress using the Tracker template, and update accordingly	C3 with MPT	All	Q1 FY26 and annually

2.2 Service Delivery Framework

NOAA's Service Delivery Framework (SDF) provides a roadmap for successful public engagement. This framework includes components for addressing: 1) shared feedback received during engagements with forecast model end users; 2) identification and adjudication of stakeholder needs; 3) integration of those needs into the requirements cycle for NOS and product development partners; 4) delivery of use-inspired products; and 5) evaluation of current and planned modeling products. Together, these elements form a process that ensures the co-development of useful, usable, and used products and services in accordance with the NOS Modeling Strategy. The Community Engagement WG under the MPT will ensure that NOS modeling practices are consistent with the NOAA SDF. The elements of the SDF and NOS WG alignment are shown in Figure 2. Engaging users and partners by planning with them, rather than for them, presents the opportunity for a more effective, efficient, and reliable operational forecast suite through an agile approach to model development and implementation.

Figure 2. NOS modeling WGs to implement NOAA's SDF.[3]

[3] National Oceanic and Atmospheric Administration. 2022. A Model of Service Delivery for the NOAA Water Initiative.

3.0 Strategic Goals

3.1 Goal 1: Address User Needs Through Sustained Community Engagement and Partnerships

Coastal communities use predictive information describing the state of the ocean and coasts for decision-making in multiple scenarios, from assessing the safety of moving ships in and out of ports to determining the safety of opening a seafood fishery in the presence of Harmful Algal Blooms. However, turning raw data from models or observational platforms into actionable intelligence for decision-making requires input from across the value chain, as well as sustained and repeated engagement between professionals to understand each other's capabilities and needs.

3.1.1 Stakeholder engagement

The Modeling Vision and NOS Modeling Strategy highlight the importance of relationships with end users and partners[4] for providing input on current and emerging needs, and to co-produce the tools and services that will meet those needs. NOS will be successful at addressing user needs through sustained community engagement and partnerships when an iterative process is developed to incorporate needs into the plans for subsequent model implementations. This makes it essential that the community is involved in the ongoing evolution of the modeling strategy. Members of the NOS Modeling Team previously mapped the NOS SDF outlined in Table 2. The NOS SDF demonstrates a repeatable process to define the requirements for the NOS modeling portfolio and supports a regular outreach component.

Incorporating the NOS modeling portfolio into NOS's existing service delivery capabilities will require expanding partnerships across NOS program offices to develop a broad awareness of the features and capabilities of the coastal modeling portfolio. The Community Engagement WG will be tasked with managing customer engagement for the SDF. To implement this framework, NOS will leverage its outreach specialists (e.g., OCS navigation managers, CO-OPS Stakeholder Service Branch, and IOOS regional associations), as well as the outreach personnel in other parts of NOAA.

Table 2. Implementation of the SDF for NOS modeling mapped to Goal 1 actions.

STEP	NOS + END USERS	NOS + PARTNERS	WHAT TO DO NEXT
 **Continuous Engagement** **MPT**	Engage continuously to understand modeling needs and to ensure that the products being developed will meet those needs.	Engage continuously to understand emerging science and technology, changes in trends, and other expertise that will affect what's possible for addressing the challenges faced by both the end users and modeling communities.	Assign the development of protocols which implement the SDF throughout the R2O2X cycle, including protocols to close the feedback loop with users who provide input (Action A1.1).
 **Build** **Research & Development**	Organize and participate in end-user conferences and events to build trusted relationships with the end-user communities to understand their decisions and their support and information needs,	Build trusted relationships with the modeling community by sponsoring a workshop to understand who's doing what, how they are doing it, and with whom they are doing it.	1. Communicate requirements and NOS needs early in model development 2. Listen to community feedback and respond 3. Build true partnerships through co-development with external partner (Action A1.1)

[4]Per the NOAA Service Delivery Framework.

 **Gather** **Community Engagement**	Gather information on end users' emerging modeling needs at conferences and events.	Gather information via conferences, events, literature reviews, and foresight activities.	1. Track engagements in a shared document 2. Agree to a common set of questions to be asked, and capture the users, dates, questions and answers in the shared document 3. Carry out protocol to close the feedback loop with users who provide input (Action A1.2)
 **Translate** **Dissemination & Support**	Maintain ongoing conversations among NOS and end users as new requirements and capabilities emerge — and ensure they are emerging.	At external modeling events (e.g., the Coastal Coupling Community of Practice Annual Meeting) and internal NOAA and NOS meetings (e.g., MPT, ELT, NOS Water Team, NMT, Earth System Integration Board), share and translate user needs into technical aspects NOAA and partners could develop.	1. Agree to a common set of guidelines, principles, and criteria for prioritizing and articulating societal outcomes. 2. Track emerging requirements, capabilities, and criteria for prioritizing in a shared document and capture, at a minimum, which conversation, with whom, and when (Action A1.3)
 **Assess** **Consolidation & Cross-Cutting**	Assess and evaluate new requirements and capabilities based on the guidelines, principles, and criteria for prioritizing, and societal outcomes.	At external modeling events and internal NOAA and NOS meetings (e.g., MPT, ELT, NOS Water Team, NMT, Earth System Integration Board), assess and prioritize which technical aspects will be incorporated into the modeling and analysis tools that will respond to end-user needs.	1. Develop criteria for prioritization, emerging requirements, and capabilities in a shared document and capture, at a minimum, which conversation, with whom, and when (Action A1.2)
 **Address** **Community Engagement**	Transmittal of the annual guidance memorandum.	Transmittal of the annual guidance memorandum + grants offered + contracts completed	Principles, priorities, requirements, and capabilities are reflected in the annual guidance memo, annual budget process, and associated grants and contracts. (Actions A1.4 and A1.5)
 **Deliver** **Operations**	Continue to share information about new/refined products and services, whether provided by the public or private sectors.	Ensure equitable access to the new/refined product to the end users plus any others who could benefit from it.	Ensure there is a team responsible for users to (1) understand products; (2) know how they can be used to address their issues; and (3) apply the product to their decision-making needs. (Action A1.3)
 **Evaluate** **Dissemination & Support**	Conduct evaluations with the end users: (1) at the start of a project to understand their wants and needs; (2) throughout the project to understand their response to what is being developed; and (3) at the end of the project to understand how the new/refined product is meeting/not meeting their needs. This information feeds into the Translate step.	Conduct evaluations with partners on the development process and potential improvements.	1. Document and share feedback to the question "How is that working for you?" 2. Implement a five-star rating system for every product or service with a phone number and email address next to every rating opportunity. (Action A1.3)

3.1.2 Goal 1 actions

By adopting the SDF and adhering to the central principle of continuous engagement, the NOS modeling portfolio will evolve to better address customer needs. In pursuit of this goal, NOS will

initially pursue the actions in Table 3.

Table 3. Actions for Goal 1.

ACTION	ACTION	LEAD	NOS MODELING STRATEGIC OBJECTIVE	TIMELINE TO COMPLETION
A1.1	Develop and implement a plan for continuous engagement with the broader modeling community (by leveraging existing efforts) to promote open exchange of ideas, capabilities, and NOS requirements.	CE	1.1 Adopt the SDF. 1.2 Foster and productively participate in a robust community. 2.3 Community engagement 2.8 Confer with external SMEs.	Q3 FY25 and beyond
A1.2	Establish and perform a recurring (annually) stakeholder needs assessment through various means, platforms, and opportunities while considering how those needs might change in the future.	CE	1.1 Adopt the SDF. 1.2 Foster and productively participate in a robust community. 1.3 Address underserved and vulnerable communities.	Q3 FY25 and annually
A1.3	Publish an annual report that maps stakeholder needs to current and anticipated NOS products and services, including potential future domains such as ecological forecasting.	MPT/ CE	1.2 Foster and productively participate in a robust community. 1.4 Issue annual guidance memo.	Q3 FY25 and annually
A1.4	Develop and issue an annual guidance memorandum defining NOS priorities for the year based on input from key experts and stakeholders.	MPT	1.4 Issue annual guidance memo.	Q1 FY26 and annually
A1.5	Update the NOS modeling vision and strategy.	MPT	1.4 Highlight opportunities for the private and academic sectors. 1.2 Foster and productively participate in a robust community.	Q3 FY26 and Every 5 Years

3.2 Goal 2: Develop Ocean and Coastal Models Through Community Modeling

This second goal recognizes that addressing user needs "demands a collection of models that are flexible, multipurpose, and tailorable to specific geographic or temporal scales" (NOS 2023). Achieving this diverse collection of models requires a coordinated effort to develop partnerships across NOS, NOAA, academia, industry, and interagency and international bodies. Implementing this "community modeling" approach, which underpins the entire UFS, requires a commitment to transparency regarding our challenges, goals, and risk tolerance[5]. Successful community modeling requires a commitment to constant engagement, free flow of information, and adherence to code management best practices. While this will require dedicated resources, the payoff of a successful community modeling enterprise is an accelerated cycle of infusing innovations and scientific advances into NOS model-based products and services.

3.2.1 UFS best practices

The UFS is an ambitious effort to redesign NOAA's approach to leveraging the external community to accelerate innovation in the Earth System modeling domain and to capitalize on that innovation to improve Earth System forecasting. The motivation for the UFS came from a series of external reviews of the NOAA Numerical Weather Prediction (NWP) enterprise, which provided recommendations for simplifying NCEP's production suite and leveraging external innovation more efficiently.

The primary characteristics of the UFS approach focus on software architecture and the best practices for managing code in a way that incentivizes community contributions. Implementation success relies on well-managed software and code to assure that researchers, developers, and operators are working from a common code base. Guidelines will be developed through the governance process and managed by the appropriate WG. In the process of streamlining the suite of NOS models, a transition towards a more agile approach for incremental development, deployment and testing will be employed. This will enable NOS to rapidly integrate innovative contributions from both NOS developers, as well as the broader research community.

3.2.2 Consolidating existing operational modeling systems

NOS must identify efficiencies across the modeling portfolio to optimize NOS program office budgets and to reduce internal competition for HPC resources, skilled coastal ocean modelers and software engineers. NOS will consider consolidation of existing hydrodynamic modeling systems where appropriate, validate interoperability, and determine the optimal operational modeling suite required by NOS applications, products, and services to meet core mission needs. When determining gaps in user needs, the suite of operational modeling products across NOS program offices and those models sustained by the academic community models will be considered. A notional timeline for updating and consolidating a subset of 25 OFS over a five-year period is shown in Figure 3. An analysis of the current navigational requirements for these systems and a comparison against the expanded requirements for multi-disciplinary issues is still required. A multi-mission modeling suite that leverages expertise from public, private, and academic communities will enable NOS to meet stakeholder needs more efficiently.

Models outside of OFS, such as ecologic models, may also be considered for consolidation, as appropriate. Advancements such as the UFS Coastal Application will provide the potential for upgrading the entire application suite more frequently, thereby infusing innovation into end-user products more efficiently.

[5] About the UFS https://ufs.epic.noaa.gov/about/

Region	25 Models	FY24	FY25	FY26	FY27	FY28	11 OFS
Atlantic	CBOFS			NECOFS			North East Atlantic Navigation, Coastal Resilience, Emergency Response and Public Health
Atlantic	DBOFS						
Atlantic	GoMOFS						
Atlantic	NYOFS						
Atlantic	SJROFS					SECOFS	Southeast and Eastern Gulf of Mexico Navigation, Coastal Resilience, Emergency Response and Public Health
Gulf of Mexico	TBOFS						
Gulf of Mexico	Gulf of Mexico Karenia brevis respriatory irritation forecast						
Gulf of Mexico	West Florida Red Tide intensification						
Gulf of Mexico	NGOFS2						Western Gulf of Mexico Navigation, Coastal Resilience, Emergency Response and Public Health
Atlantic and Gulf of Mexico	ECCOFS					STOFS-3D ATL or ECCOFS	Southeast and Gulf of Mexico Coastal Resilience, Ecosystem, and Public Health
Atlantic	STOFS-3D ATL						
Pacific	SFBOFS					CACOFS	California coast Navigtation, Coastal Resilience, Emergency Response, and Public Health
Pacific	CREOFS	SSCOFS					WA and OR coast Navigation, Coastal Resilience, Emergency Response and Public Health
Pacific	WCOFS					STOFS-3D Pac or WCOFS	Pacific coastal and Pacific islands Coastal Resilience, Ecosystem, and Public Health
Pacific	STOFS-3D-Pac						
Alaska	STOFS-3D-Alaska					Alaska OFS	Alaska Navigation, Coastal Resilience, Emergency Response, and Public Health
Alaska	CIOFS						
Great Lakes	LOOFS				Great Lakes OFS		Great Lakes Navigation, HABs, Hypoxia, Coastal Resilience, Ecosystem, Emergency Response and Public Health
Great Lakes	LSOFS						
Great Lakes	LEOFS						
Great Lakes	Lake Erie hypoxia forecast						
Great Lakes	Lake Erie cyanobaccteria						
Great Lakes	LMHOFS						
Global	GNOME						Spill and Hazard Response
Global	STOFS-2D-Global						Coastal Resilience

Figure 3. Notional Operational Forecast System Consolidation Plan example: an optimized approach will be applied to other NOS models as appropriate.

3.2.3 Model evaluation and selection criteria

The decision to sunset or consolidate modeling systems, as suggested in Figure 3, requires careful consideration of various factors, including forecast skill to software stability and computational performance. The NOS-led UFS Coastal Application Team has published performance metrics that will inform model evaluation and selection for applications focused on coastal inundation and marine navigation to supplement pre-existing evaluation criteria. Additional criteria for selection will be proposed by the WGs and approved via the governance presented in this plan. Strict adherence to NOS guidelines regarding code review, hierarchical testing, and documentation is essential to demonstrate alignment to the selection criteria and justify replacing or upgrading a model component or system.

Moving from the current process of siloed model development to an NOS-wide unified approach requires an inventory and evaluation of current modeling systems, which can be mapped to an assessment of current or anticipated stakeholder needs. This gap analysis can identify met and unmet mission and user requirements on both present systems and proposed future systems. The analysis can also enable the MPT to identify commonalities across all existing and proposed systems, which will inform the consolidation plan. The MPT will use the gap analysis to communicate recommendations to the NOS ELT for resource allocation. Each model will be evaluated based on a range of criteria put forth by the MPT, informed by stakeholder feedback, and subject to objective verification. When a forecast system or product does not continue to meet user requirements, as indicated by user feedback or metrics for usability, or when a better alternative becomes available, the system or product will be considered for sunsetting with advanced notice and communication to the user community.

3.2.4 Goal 2 actions

Recognizing the value that a collaborative community will bring to ocean and coastal modeling, NOS will pursue the actions as outlined in Table 4.

Table 4. Actions for Goal 2.

ACTION	ACTION	LEAD	NOS MODELING STRATEGIC OBJECTIVE	TIMELINE TO COMPLETION
A2.1	Support cross-program office training and enrichment opportunities for software development and management techniques inline with NOAA-wide efforts.	MPT with R&D	2.4 Follow the UFS and EPIC framework. 2.5 Adhere to modern software management principles.	Q1 FY25 and beyond
A2.2	Perform a gap analysis between the stakeholder needs assessment findings (A1.2) and NOS modeling systems (operational and development), including downstream products and services.	MPT, with C3	2.1 Clarify which models are needed 2.2 Detail which models will not be needed	Q2 FY25
A2.3	Compile a prioritized list of proposed solutions to address any gaps in products and services based on A2.2.	MPT	2.1 Clarify which models are needed. 2.9 Identify and address the unique needs of underserved communities.	Q3 FY25
A2.4	From the gap analysis results, use the model inventory and match the fewest number of modeling systems required to drive all products and services by identifying commonalities	C3 with MPT	2.1 Clarify which models are needed. 2.2 Detail which models will not be needed. 2.6 Ensure that the products and data derived	Q4 FY25

	between software, architecture, and infrastructure; reconfiguring domains; eliminating redundancies; and consideration of models that are gaining support versus becoming obsolete.		from NOS modeling systems are openly available and consistent with F.A.I.R. principles.	
A2.5	Define evaluation criteria for model and system prioritization with community developer input.	C3 with CE	2.5 Adhere to modern software management principles. 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 NSRS developmental goals 2.8 Confer with external SMEs.	Q2 FY25
A2.6	Publish a model consolidation plan for implementing new systems and sunsetting redundant or obsolete systems, including the criteria used to make the decisions.	C3	2.1 Clarify which models are needed. 2.2 Detail which models will not be needed. 2.3 Community engagement	Q2 FY26
A2.7	Compile a list of HPC end users and storage resources needed to implement the consolidation plan.	Ops	2.5 Adhere to modern software management. 3.3 Establish necessary resources and personnel.	Q3 FY26
A2.8	Coordinate with EPIC and UFS to transition applications into operations.	Ops with R&D	2.4 Follow UFS and EPIC frameworks.	Q1 FY25 Quarterly

3.3 Goal 3: Issue NOS Forecasts Through Accurate and Reliable Operational Models

The focus of Goal 3 is to deliver accurate and reliable forecast products and services from NOS modeling systems, including nowcasts, forecasts, hindcasts, reanalyses, and climate-scale projections to better meet users' growing needs. This goal, which is detailed in the NOS Modeling Strategy, will require significant improvements to the current suite of modeling systems. It will also require additional coordination and regular review of the roles and responsibilities.

Improving stakeholder access to reliable and timely information will reduce risk to life and property, enhance the economy, and promote social well-being. Goal 3 is informed by stakeholder engagement and feedback (Goal 1) and driven by the optimized development cycle of ocean and coastal models (Goal 2).

3.3.1 Integrated approach to advance models, products, and services

NOS operational forecast models, and the products and services derived from them, must be developed under a NOS-wide integrated approach that coordinates efforts across shared requirements and common software. Historically, NOS offices have independently made decisions on model components, computer resources, data formats, dissemination methods, and data translation. NOS-wide coordination will limit redundancies, optimize efficiency, and streamline the architecture and infrastructure of the model portfolio. This approach will result in a more cost-effective use of HPC and commercial cloud resources, as well as reducing the workload on IT support staff.

3.3.2 Dissemination and visualization of NOS forecast guidance

NOS delivers forecasts and forecast guidance through external-facing dissemination and visualization platforms. Currently, NOS forecast guidance, applications, and visualization products are displayed across 12 different websites. NOS will consolidate these into a more user-friendly web-based access point guided by stakeholder feedback and enhanced cross-line office collaboration for shared NOAA missions. Forecast products and services must be fully validated and delivered on a predefined timeline or frequency and must have predetermined criteria or metrics for success. The SDF allows for the sustained delivery of both continuous/routine products, as well as seasonal, or event-based products to meet defined stakeholder needs. Model data distribution systems should be reviewed and assessed to ensure compliance with international data standards. NOS modeling products and services will be consistent with the National Spatial Reference System (NSRS).

3.3.3 Goal 3 actions

To issue NOS forecasts through accurate and reliable models, NOS will pursue the following actions in Table 5.

Table 5. Actions for Goal 3.

ACTION ID	ACTION	LEAD	NOS MODELING STRATEGIC OBJECTIVE	TIME TO COMPLETION
A3.1	Develop a plan to consolidate web-based data access points for products and services and ensure cloud-based servers can handle peak loads.	D&S with C3, MPT	3.2 Ensure model output is widely available and compliant with international data standards. 2.5 Adhere to modern software management.	Q3 FY25
A3.2	Develop guidelines for visualizing and displaying model-derived products and services, including web	D&S	3.2 Ensure model output is widely available and compliant with international data standards. 2.6 Ensure products and	Q4 FY25

	optimization and file compression.		data are openly available and consistent with FAIR principles.	
A3.3	Coordinate with National Weather Service (NWS) on forecasts and develop a plan to leverage existing forecast infrastructure for dissemination of NOS products.	D&S	3.4 Identify and establish collaborations with other NOAA line offices. 2.6 Ensure products and data are openly available and consistent with FAIR principles.	Q4 FY26
A3.4	Develop and implement a data management plan for all output derived from NOS modeling systems in accordance with NOAA Administrative Order 201-118 on Software Governance and Public Release Policy.	D&S	3.2 Ensure model output is widely available and compliant with pertinent international data standards. 2.5 Adhere to modern software management. 2.7 NSRS developmental goals	Q4 FY25
A3.5	Develop a NOS forecast communication strategy to encourage website visits and growth in new users.	D&S, and CE with IMO	3.2 Ensure model output is widely available and compliant with pertinent international data standards. 2.3 Community engagement	Q3 FY25 and biannually (every two years)
A3.6	Compile and maintain a list of international data standards by which NOS project teams will abide.	R&D with D&S	3.2 Be compliant with International Data Standards.	Q3 FY25 and beyond

4.0 The Way Forward

The NOS MIP is the roadmap to implement the NOS Modeling Strategy. It employs the NOAA SDF to foster a robust modeling community by engaging in a mutually beneficial dialogue that addresses stakeholder needs, including those of underserved and vulnerable communities. The MIP outlines a governance and process that will inform decisions about which models are needed for what purposes, and how they will be developed and operated by NOS, including any anticipated transitions. As part of this plan, NOS commits to adhering to modern software management principles by adopting the best practices defined by the community UFS, and ensuring the model output, products, and services are widely available and aligned to international data standards. NOS will reduce the time required to develop, test, and deploy new or upgraded operational forecast systems and associated products by leveraging commercial cloud, optimizing HPC allocation, and growing the open-source model development community.

These combined efforts will advance priorities of coastal resilience, growth of the blue economy, and access to healthy coastal and marine ecosystems.

Given the preceding implementation approaches and principles, and consistent with the NOS Modeling Strategy (2023), the timeline to implementation is shown in Figure 5.

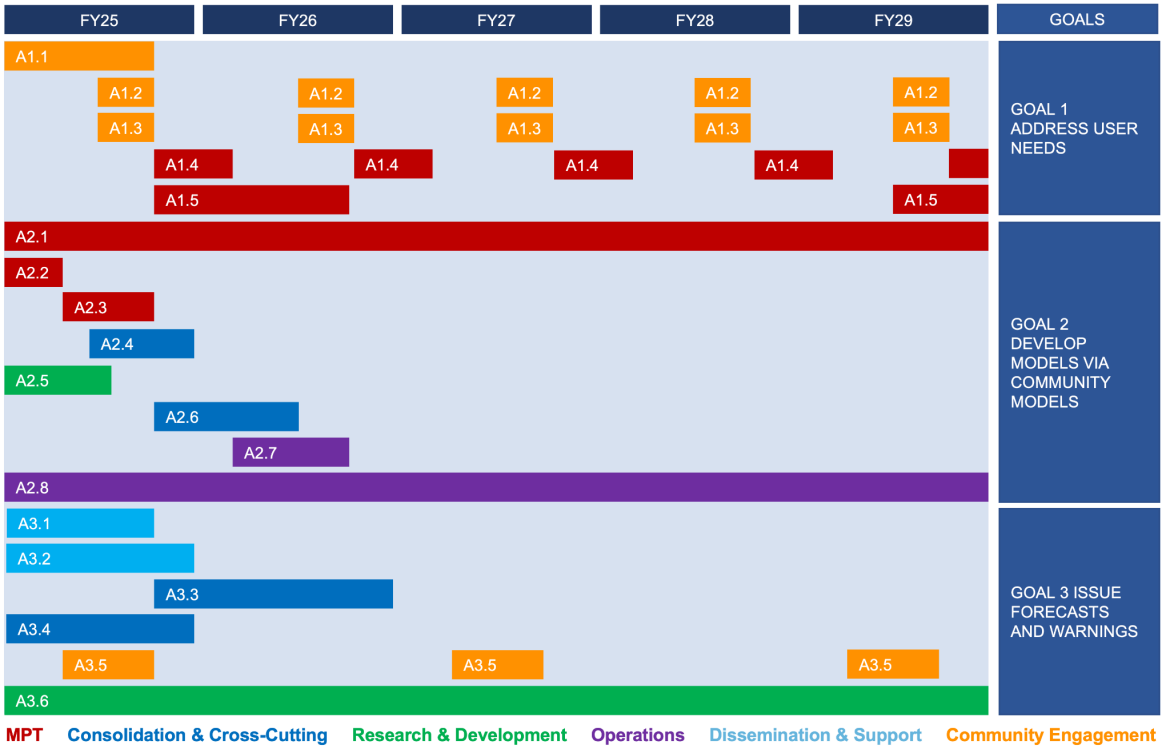

Figure 5. Timeline and implementation sequence for the NOS Modeling Strategy goals and objectives. Colors denote teams and (proposed) WGs.

Implementation process updates will be provided to the MPT Chair monthly and to the ELT quarterly. The process should be evaluated no less than annually.

The scientific and technological advancements, combined with the organizational efficiencies gained from an integrated approach described above, will produce forecast models, products, and services that are more reliable, accurate, and consistent to better serve NOS stakeholders and end-users.

Appendix A: Project Tracker

An NOS-wide project tracker will be a management tool designed to ensure accountability for cross-NOS office efforts. This tool will provide a shared space for NOS efforts and enhance transparency. To track each project, a proposed project tracker template is shown below. It is critical that all projects follow a common syntax to keep the transition running efficiently. The MPT will work together to determine how NOS project management should be accomplished. For example, each tracker may show:

- Project overview (including owner, POC, and/or branch/division)
- Major risks and issues
- Major resource requirements
- Dependencies/linkages with other projects
- Dependencies/linkages with other models or products
- Core development partners and their roles
- Major milestones
- A QUAD chart, spreadsheet, or Gantt chart and associated dashboards

Project X.X: Name of project

Project overview: Summary of what the project is. Keep concise – half page.

Major Risks and Issues: Bullets listing potential risks, issues, gotchas, land mines, etc.

Major resources requirements: Bullets listing FTEs, in-kind, other people, HPC, cloud, storage, etc.

Dependencies/linkages with other projects: Bullets listing if/how this project is tied to some other project. Important for timeline if other projects will be impacted by a problem with this project.

Dependencies/linkages with other models or products: Bullets listing if/how this component, model, or product is tied to other upstream or downstream models or products.

Core development partners and their roles: Who are the POCs? People, labs, PIs, et

Appendix B: Models and Missions

Region	Operational Model	Model Operator	Safe, Efficient Marine Navigation	Protecting Public Health	Coastal Resilience and Risk Reduction	Improved Maps and Coastal Management	Hazardous Spill Response and Search and Rescue	Managing Coastal and Marine Living Resources
Atlantic	Aquaculture opportunity spatial model	**NCCOS**		**X**				**X**
Atlantic	CBOFS	**COOPS**	**X**	**X**			**X**	
Atlantic	DBOFS	**COOPS**	**X**					
Atlantic	GoMOFS	**COOPS**	**X**					
Atlantic	NYOFS	**COOPS**	**X**					
Atlantic	STOFS-3D-Atl	**OCS**	**X**		**X**		**X**	
Atlantic	SJROFS	**COOPS**	**X**				**X**	
Gulf of Mexico	TBOFS	**COOPS**						
Gulf of Mexico	NGOFS2	**COOPS**	**X**				**X**	
Gulf of Mexico	Karenia Brevis Forecast	**NCCOS**		**X**				
Gulf of Mexico	Aquaculture opportunity spatial model	**NCCOS**		**X**				**X**
Gulf of Mexico	Wind energy areas siting model for the Gulf of Mexico	**NCCOS**						**X**
Pacific	SFBOFS	**COOPS**	**X**				**X**	
Pacific	CIOFS	**COOPS**	**X**				**X**	
Pacific	WCOFS	**COOPS**		**X**	**X**			
Pacific	STOFS-3D-Pac	**OCS**	**X**		**X**		**X**	
Pacific	CREOFS	**COOPS**	**X**				**X**	
Pacific	Aquaculture opportunity	**NCCOS**		**X**				**X**

	spatial model							
Great Lakes	LOOFS	**COOPS**						
Great Lakes	LSOFS	**COOPS**						
Great Lakes	LEOFS	**COOPS**						
Great Lakes	LMHOFS	**COOPS**	**X**		**X**		**X**	
Great Lakes	Lake Erie Cyanobacteria	**NCCOS**		**X**				
Global	STOFS-2D	**OCS**	**X**		**X**			
US	GNOME	**ORR**		**X**			**X**	
US	ALOHA	**ORR**		**X**			**X**	
US	Cafe	**ORR**		**X**			**X**	
US	Geoid	**NGS**	**X**		**X**	**X**		
US	Deflection of the Vertical (DoV)	**NGS**	**X**		**X**	**X**		
US	HC/Lake water topography	**NGS**	**X**		**X**	**X**		**X**
US	EPP	**NGS**				**X**		
US	IFDM	**NGS**			**X**	**X**		
US	Coast and Shoreline Change Analysis Program	**NGS**	**X**		**X**	**X**		**X**
US	**Inundation Mapping Tidal Surface - Mean Higher High Water**	**OCM**			**X**	**X**		**X**

Appendix C: Measures, Metrics, and Impacts

For each goal in the NOS Modeling Strategy, there are measures of success. It is critical to have quantitative metrics to determine if an action or activity is complete. Initial metrics are provided below and will be reviewed annually by the MPT Chair. Defining quantitative metrics of success is critical in determining completion of an action or effort. While each model will have its own metrics for success, there are several measures and metrics that can be used to evaluate the success of the implementation plan. The NOS Modeling Strategy lists measures for success under each of the three goals. These should be refined with metrics and adjusted during annual or as needed review via the feedback loops above. Below are a summary of the NOS Strategy measures, along with potential metrics and impacts.

Measure	Metric	Impact
How current are modeling systems?	Number of model updates completed/ year	Enhanced model system performance, stability, and reliability
Improvement of staff capability	Number of staff that completed modeling or data management professional development	Enhanced ability to keep models current with most advanced science and disseminate and store data appropriately
Better coordination of NOS offices and model/data players	Amount of time it takes to release a model update	Improved model forecast and prediction outputs
Cross-program office coordination	Cross-office issues and conflicts resolved at the MPT WG level	Increased collaboration among NOS offices
Parallel/duplicate efforts	Number of parallel or duplicate projects reduced or resources better utilized	Better resource alignment, more efficiency
Community engagement	Number of engagement pathways/events and quantitative feedback solicited from the community	More effective communication, improved service delivery, stronger relationships

The Modeling Implementation Team may be reached at the following address with any questions: **nos.modeling-implementation@noaa.gov**.