

Climate Working Group Report
In support of the NOAA Science Advisory Board

Review of the Coastal Inundation at Climate
Timescales White Paper

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Review of the “Coastal Inundation at Climate Timescales White Paper”

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Introduction

We want to congratulate the authors for their well-crafted Coastal Inundation at Climate Timescales White Paper. With rising temperatures and sea level rise, coastal communities continue to become increasingly vulnerable to coastal inundation and need tools and services to guide them when making decisions for their community in the future. Additionally, critical infrastructure and facilities, such as nuclear power plants, port facilities, bridges, and wastewater treatment plants are facing escalating risks due to increases in extreme, acute events and long-term changes caused by climate change, effectively threatening the Nation’s economy, national security, and public health. Managers and decision-makers currently lack the tools and information (e.g. infrastructure and community vulnerability maps, coastal erosion predictions, coastal inundation scenarios, scale-appropriate projections, etc.) necessary to effectively plan, prepare, respond, and adapt for the coastal inundation challenges they are facing at local, regional, and national spatial scales. Given the plethora of NOAA’s mandates for the Nation’s coasts (Figure 1; see Appendix B of the Coastal Inundation at Climate Timescales White Paper for all coastal mandates), it is critical that they work to fill these gaps.

The Coastal Inundation at Climate Timescales White Paper does a fantastic job of describing the vision for NOAA’s capability to produce and provide authoritative data, products, and services that quantify and communicate the risk of coastal flooding and inundation for the U.S. and its territories at subseasonal-to-centennial timescales. It proposes a framework that emphasizes continuous engagement; this will allow the data,

information, and applications to be tailored to the users' decision-making processes and capabilities.

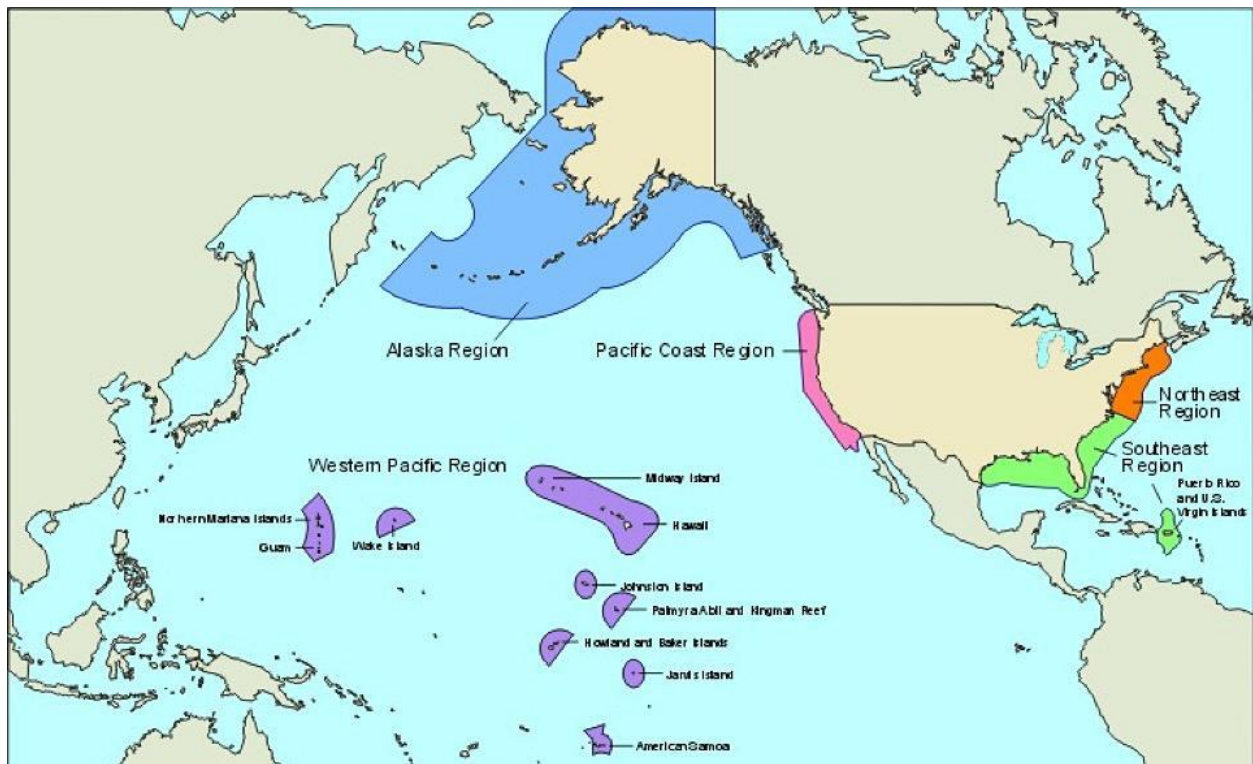


Figure 1: The Exclusive Economic Zone (EEZ) of the United States and affiliated islands which border the U.S. and U.S. Territorial coasts for which NOAA is responsible¹.

NOAA suggests that to meet current needs will require them to enhance data collection and model prediction systems and develop capability to characterize uncertainty in predictions at all timescales. Additionally, NOAA outlined the following steps to accomplish this vision:

- Establish a Program Management Structure
- Pursue a Partnership Approach
- Develop Implementation Plans
- Inform Federal Policymakers
- Inform the Federal Budget Process
- Inform Federal Policies

The coastal inundation program proposed in the white paper is very ambitious and timely given the urgent need established by disaster events along the east, gulf, and west coasts of the Nation and globally, threatening public safety and critical infrastructure. Together with increased awareness of a changing coastal environment,

¹ The National Oceanic and Atmospheric Administration, <https://oceanservice.noaa.gov/facts/eez.html>

an integrated plan on how to marshal all the capabilities from human capital to sensors to high performance computing is needed to guide NOAA in contributing to a national need.

The Climate Working Group, of the NOAA Science Advisory Board, was asked by NOAA to review this white paper to provide guidance on improving the approach prior to the agency's next step to develop the Implementation Plan. The Climate Working Group established a small team of experts to consider this document. The team provides the following recommendations.

Recommendations

1.0 - NOAA's aspirational vision

Recommendation: Clearly state the aspirational vision at the beginning of the document. This statement should include the need, the type of tools to be developed, NOAA's capacity, and how the initiative fits with the focus of several other federal agencies in planning for a more dynamic coast.

Need: NOAA has a critical role in developing transformational products to enable vulnerable communities to actively address improved flood prediction, protection, and response. Providing service tools that can simulate consequence models showing how flood risk will impact people, industry, and infrastructure must use a systems design that can address the very different requirements. One model will not provide services to all (e.g. small islands in the U.S. Territories will likely require different services than those used by the continental U.S.); one type of service may require several different models. This information can be used to enhance pre- and post-disaster planning efforts.

The report is an excellent inventory of the various capacities that exist within NOAA that could contribute to an elevated effort and enhanced impact in coastal inundation forecasting. The image on page 3 develops the framework to describe these tools in three categories, and page 4 has a list of 12 development requirements for the tools. This is followed by a section on 'what is needed' that includes program organization and implementation. The glue for these sections could be an acknowledgement that an approach focused on 'collaborative design' is needed to link the tools with the purpose and programmatic needs (Figure 2).

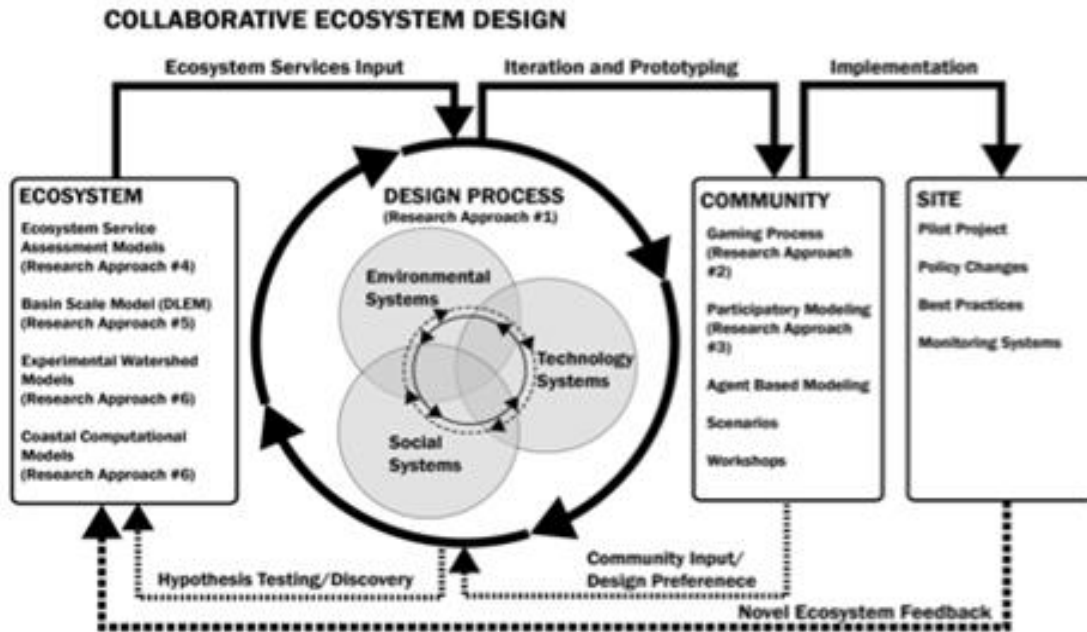


Figure 2: The linkages show that model designs with feedback from users can improve products that benefit society by integrating social-environmental-technology systems (SETS). The iteration and prototyping are critical parts to building collaborative design models to forecast coastal inundation².

Collaborative design in coastal system dynamics combines coastal hydrodynamics, climate change, ecological impacts and social well-being. The design of modeling tools, data processing, and discovery are focused on prototyping designs that are relevant to the problem and social needs. The report has a wealth of information on the pieces and needs but would benefit from a clear statement in this section on how they will be put together to meet diverse needs (and the timescales of those needs).

Actions:

Review and revise the opening statement of the document to clearly state the aspirational vision as it engages NOAA’s commitment to protect life and property and NOAA’s unique mandate to provide forecast information. This statement should address the timeframe and extent of the need, the type of tools to be developed, and NOAA’s current capacity and additional needs. It should also address how the information to be provided by the initiative supports the efforts of other federal agencies in building the capacity of all communities to adapt to an increasingly dynamic coast.

The research plan should consider the Emergency Management Cycle (Figure 3) as an appropriate way to frame the need of NOAA’s coastal inundation tools in homeland

² Personal communications, R. Twilley.

security sectors. This would also link the well-developed framework on how tools address different timelines in capabilities with the need by users from just before and after a flooding event to long-term mitigation. Forecasting exposure and consequences at immediate and climate timescales is critical to addressing the disaster cycle, and this may provide users with tools that address real problems by following the collaborative design process, which like co-production engages decision makers in the design (Figure 3).



Figure 3: The emergency management cycle includes the four phases of emergency management: preparedness, response, recovery, and mitigation. This is an ongoing process that includes planning for and reducing the impact of disasters, reacting during and immediately following a disaster, and taking steps to recover after a disaster has occurred³.

2.0 - Scale-appropriate decision-making information

Recommendation: Include a research plan on developing multi-scale inundation products or user-accessible downscaling tools for translating proposed coastal inundation forecasts into scale-appropriate decision-making information.

Need: The research plan aims to forecast coastal inundation extents at spatial scales that are much coarser than existing inundation products used for infrastructure planning and hazard mitigation. Finer scales are also needed to address the existential challenges from coastal inundation faced by small islands in the U. S. Territories. Processes for effectively downscaling coarse coastal inundation extents and water levels to actionable, finer resolution information such as water depths at specific structures, submerged or impassable roadways, risk of damage to infrastructure, or risk of life loss are not trivial and will require significant resources and expertise to implement. At coarse regional scales, near-shore waves and storm surge processes

³ Mergel I. 2014. Social Media Practices in Local Emergency Management: Results from Central New York. https://www.polver.uni-konstanz.de/typo3temp/secure_downloads/80540/0/0eb8a6c2d58221e14b26bf457fded0a08b9da522/SoTechEM_Executive_Report-mwedit111914.pdf

dominate inundation patterns. At local scales, land-surface dynamics such as freshwater discharge from rivers, shoreline erosion, and coastal wetlands influence the extent of inundation. Subgrid scale features, including linear infrastructure such as levees, roads, temporary barriers, tidal gates, and other hydraulic structures, also influence floodplain connectivity and inundation extents.

Actions: The research plan needs to develop scalable approaches for translating NOAA coastal inundation forecast products into usable, scale-appropriate information for decision makers and communities. These approaches could build on dynamic downscaling models such as those developed by the U.S. Geological Survey’s (USGS) Coastal Storm Modeling System (CoSMoS) program (Figure 4). Statistical downscaling approaches could also be used to downscale coarse inundation forecast products when informed by existing high resolution inundation products such as Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps or satellite-derived inundation extents for coastal areas.

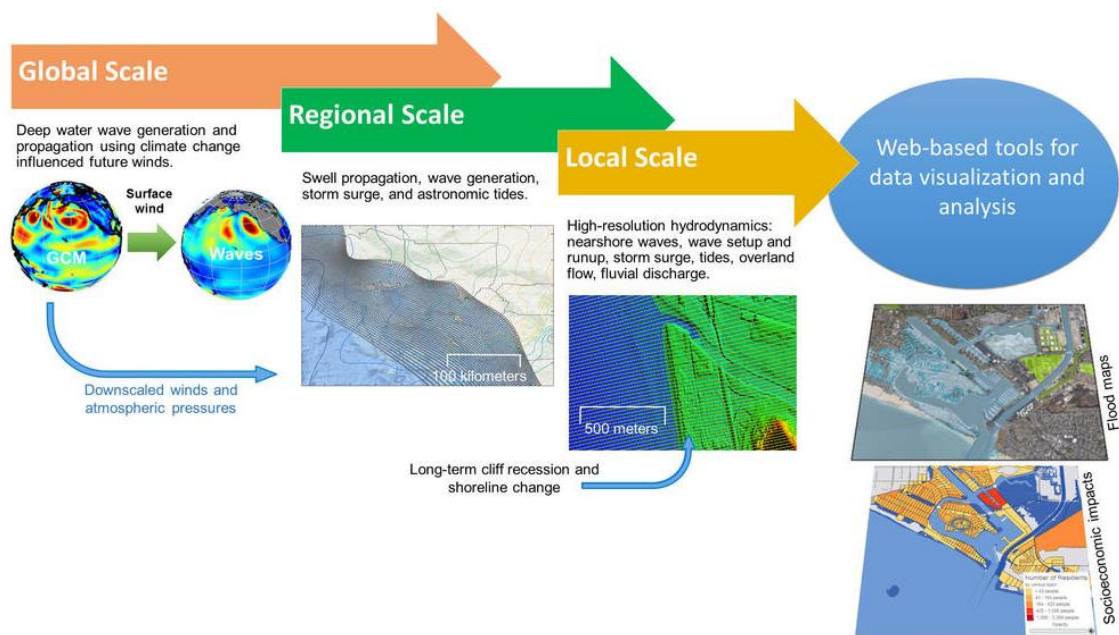


Figure 4: Illustration of key physical processes impacting coastal flooding at different spatial scales from the USGS Coastal Storm Modeling System⁴.

3.0 - Usability by underserved communities

Recommendation: Include a discussion of how the overall design of the suite of observations, models, tools, and products will provide off-the-shelf, public options that

⁴ Barnard P.L., Erikson, L.H., Foxgrover A.C. et al. 2019. Dynamic flood modeling essential to assess the coastal impacts of climate change. Sci Rep 9, 4309. <https://doi.org/10.1038/s41598-019-40742-z>

are sufficiently refined and tailored to be directly usable by under-resourced and underserved communities.

Need: The document lays out an ambitious vision for services to meet the needs of a growing group of decision makers through more boots on the ground, partnerships, networks, and connections with industry and NGOs. However, these resources intended to support the delivery of information are, themselves, unevenly distributed among sectors, places, and communities and may not assure equitable access. Table 2.2 lays out 7 sectors and 116 groups of decision makers, but there is no differentiation of decision makers among these, let alone within the Socially/Economically Underserved Communities. Meeting the local needs of underserved and under-resourced communities is a particular challenge that merits further consideration in this document.

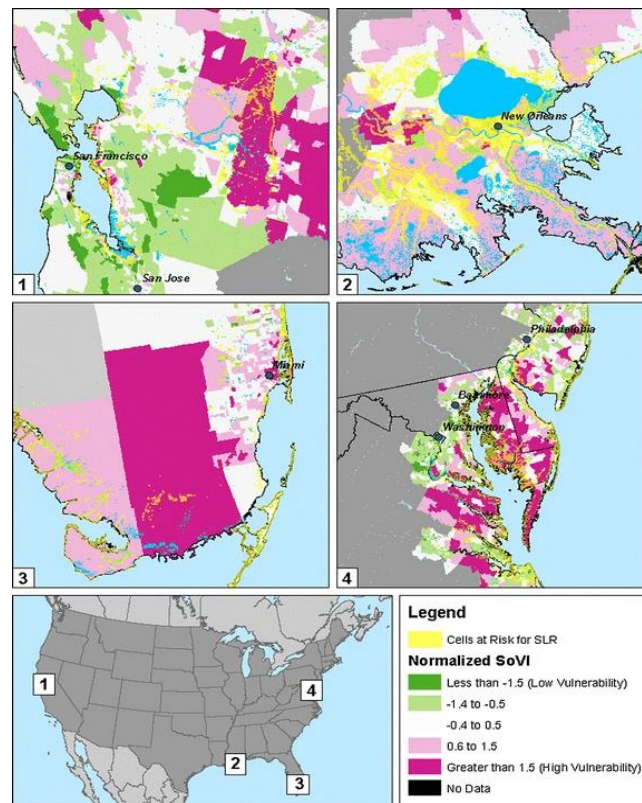


Figure 5: Four examples of sea level rise risk areas with high social vulnerability in the United States assuming no adaptation⁵. The areas at risk from a mid-sea level rise scenario (66.9 cm compared to 1990) are shown in yellow. The Social Vulnerability Index (SoVI) scores were calculated using 11 variables that have been found to contribute to social vulnerability (e.g. personal wealth, ethnicity, race, and infrastructure dependence among others)⁶.

⁵ Martinich J., Neumann J., Ludwig, L. et al. 2013. Risks of sea level rise to disadvantaged communities in the United States. *Mitig Adapt Strateg Glob Change* 18, 169–185. <https://doi.org/10.1007/s11027-011-9356-0>

⁶ Cutter S., Boruff B., Shirley W. 2003. Social vulnerability to environmental hazards. *Soc Sci Qrt* 84, 242–261.

As noted in Chapter 8 of the Fourth National Climate Assessment⁷, “climate change impacts along our coasts are exacerbating pre-existing social inequities, as communities face difficult questions about determining who will pay for current impacts and future adaptation and mitigation strategies and if, how, or when to relocate.”

These communities, e.g. historically marginalized, rural, and unincorporated areas, face many adaptation barriers including difficulty in accessing information and in affording resources necessary for additional processing of information needed to go from accessibility to usability in documenting threats to a community. Addressing these access and usability barriers is a crucial element in any overall effort to support these communities in obtaining necessary adaptation resources. Information on coastal inundation threats will be important to grant applications and other efforts to document need and obtain resources, such as those anticipated from the Biden Administration’s Justice40 Initiative directing 40 percent of his administration’s climate and clean energy investments to disadvantaged communities.

Citizen science holds the potential to bring to light the threats and challenges facing underserved communities. Table 4.1 identifies citizen science as a high level developmental requirement and suggests that the goal of citizen science is “to stay better connected and promote a more engaged public”. Beyond its potential for public engagement, there are significant opportunities for citizen science to make meaningful contributions to research and the understanding of communities, such as supporting a finer-grained observational network (e.g. the Community Collaborative Rain, Hail, and Snow (CoCoRaHS) network or the King Tides Project). Attention should be given to ensuring that citizen science programs are co-designed so that they are accessible to individuals in underserved communities.

Actions: The goals of citizen science need further consideration and elaboration in the main body of the document. There is no mention of citizen science outside of Table 4.1. Pages 15-16 of the document contain a discussion of decision makers which may be a place for expanded discussion of needs of underserved communities and strategies, including co-production of knowledge, to meet those needs.

More detail on strategies and goals in meeting these needs should also be reflected in detailed objectives presented in Appendix C. For example, the discussion of Integrated, Centralized, and Operational Infrastructure objectives (pg. 55) envisions a “one stop” web-based “shop” for coastal inundation as a 10-year goal. As currently described, the

⁷ U.S. Global Change Research Program. 2018. Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II. Reidmiller D.R., Avery C.W., Easterling D.R., Kunkel K.E., Lewis K.L.M., Maycock T.K., Stewart B.C. (eds.). 1515 pp. [doi: 10.7930/NCA4.2018](https://doi.org/10.7930/NCA4.2018)

shop is intended “to provide users and partners baseline data and decision-support information, thus enabling value-added information and services.” In this defining statement, it is important to address how NOAA will provide usable information, tools, and products for those unable to afford value-added services.

Current threats, losses, and needs are particularly acute in historically underserved communities and major federal initiatives to increase resilience (e.g., FEMA Building Resilient Infrastructure and Communities BRIC) are already underway. To better support the resilience of these historically underserved communities, NOAA should consider accelerating the 10-year timeframe suggested for “developing a coastal inundation partner engagement framework and capacity” (pg. 54).

Developing citizen science capacity, with recognition of the constraints on under-resourced communities should be integrated into detailed objectives in Appendix C, where it might be related to topics including monitoring, building understanding of local needs, and developing partnerships and trusted relationships.

4.0 - Coordination necessary for success

Recommendation: Consider including, and begin planning for, the extensive coordination that will be necessary for this effort to be a success. This will include both internal, cross-line office coordination and external, interagency coordination.

Need: The proposed effort contains content that crosses a number of NOAA line offices. It also intersects the activities of a number of other federal agencies. In order for the effort to be successful, consideration of the necessary internal and external coordination is needed that builds on the information presented. The coordination will facilitate engagement of the private sector, including consultants, and bring their capabilities to confronting the scale of the problem.

Actions: Include a section of the document with two sub-sections: (1) Internal NOAA cross-line office coordination and (2) External coordination across federal agencies. This section could describe the initial thoughts on the ‘who’ and ‘how’ to coordinate tool development, product development, and product delivery and outreach. NOAA has some fantastic resources that should be tapped for this effort; product delivery should meet the needs of fellow federal agencies that can facilitate the engagement with the communities of practice. This can be done in section 2 of the white paper and an augmented figure to figure 2.1 would be helpful. A concept is proposed below (Figure 6).

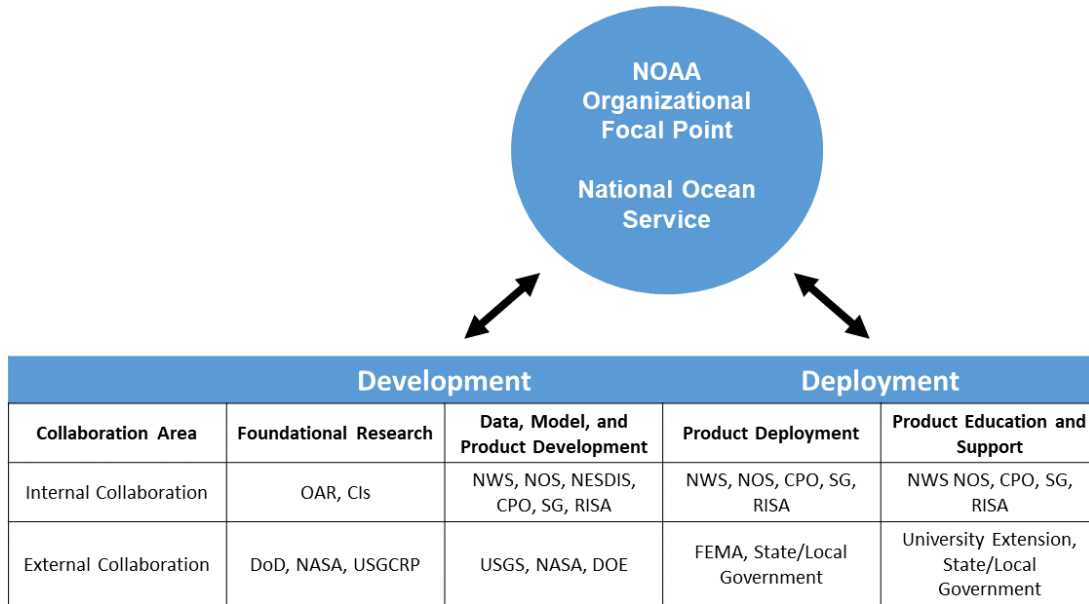


Figure 6: A suggested conceptual design of the internal and external collaboration needed for this effort to be successful. Collaboration areas include: 1) Foundational Research, 2) Data, Model, and Product Development, 3) Product Deployment, and 4) Product Education and Support. This figure assumes that the National Ocean Service would be the organizational focal point for NOAA as it undertakes this effort. Arrows indicate bi-directional content exchange between the National Ocean Service with internal and external collaborators during both development and deployment phases. See Appendix A for acronyms.

Conclusion:

With acknowledgements to NOAA, the Weather, Water, and Climate Board, the NOAA Climate Team, and each contributor to the White Paper, this document demonstrates that NOAA is preparing to make great strides towards a centralized, integrated, operational framework of information and services. This review was a collaborative effort to assist NOAA as it continues to move forward with this important issue. The Climate Working Group of NOAA’s Science Advisory Board is grateful for the review opportunity and look forward to engaging again.

Appendix A: Acronym Definitions

Definition for acronyms used in Figure 6, listed in alphabetical order.

Acronym	Definition
CPO	Climate Program Office
CI	Cooperative Institutes
DoD	Department of Defense
DOE	Department of Energy
FEMA	Federal Emergency Management Agency
NASA	National Aeronautics and Space Administration
NESDIS	National Environmental Satellite, Data, and Information Service
NOS	National Ocean Service
NWS	National Weather Service
OAR	Oceanic and Atmospheric Research
RISA	Regional Integrated Sciences and Assessments program
SG	National Sea Grant College Program
USGCRP	United States Global Change Research Program
USGS	United States Geological Survey