Developing Collaborative Solutions for Continental-Scale Integrated Water Prediction

COASTAL COUPLING COMMUNITY OF PRACTICE

Developing Collaborative Solutions for Continental - Scale
Integrated Water Prediction:
Coastal Coupling Community of Practice

Meeting Report
Met May 7-9, 2019
Published June 13, 2019

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Meeting Goal

The goal of the Coastal Coupling Community of Practice Meeting, held May 7-9, 2019, was to create a sustainable framework for engagement between Federal agencies and model developers that supports collaborative solutions for continental-scale integrated water prediction. To identify the priorities for engagement, participants discussed technical requirements and transition approaches (Day 1). To create the engagement approach, participants engaged in facilitated discussions informed by experience and research-guided best practices (Day 2).

Meeting Objectives

1. Discuss national-scale coupling—freshwater to coastal forcing—enhancements and issues related to operational forecasting.
2. Develop a structure and strategy for information exchange through a Coastal Coupling Community of Practice (CCCoP).
3. Provide updates on case studies from current coastal coupling efforts.
4. Consider operational transition approaches to increase transparency with external audiences.
5. Identify future engagement opportunities and the timeline for sustained engagement.

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Outcomes and What's Next?

1.0 Introduction

Approximately 100 million people who live in coastal areas do not have access to accurate water forecasts because current models cannot skillfully and appropriately represent complex riverine, estuarine, and coastal hydraulic processes. In the coastal zones, where rivers widen and flow into estuaries, current modeling techniques do not appropriately capture the complexity of combined freshwater, estuarine, and coastal processes. Water levels near river mouths and estuaries vary depending on tides, winds, storm surge, freshwater inflows, and atmospheric pressure. Without freshwater input, these coastal models often lack critical river input, which may result in inaccurate forecasts. In addition, some of these models do not have the capability to simulate wetting and drying during flooding and, therefore, are not able to produce flood forecasts and visualizations.

In order to address this challenge, scientists and modelers from the federal government and academia met at the National Water Center in Tuscaloosa, Alabama on May 7-9, 2019. While the immediate goal of the meeting was to create a sustainable framework for engagement between Federal agencies and model developers that supports collaborative solutions for continental-scale integrated water prediction, the long-term goal for this community is to develop products and services that meet the needs of water resources managers, water suppliers, planners, and decision-makers that help to protect the lives and property of those 100 million people in the coastal zone.

2.0 Vision

The vision of the Coastal Coupling Community of Practice (CCCoP) is to build and sustain communication pathways and relationships to facilitate collaborative development of continental-scale solutions to integrated water simulations and analysis in the coastal zone.

3.0 Mission

The mission of the CCCoP is to enable:

- Coupling of models across the coastal zone, starting with hydrologic and hydrodynamic models, to better simulate and analyze earth system processes and provide physical parameters such as: water levels, flows, water quality, sediment, geomorphic changes, etc.
- Actionable information on these parameters (water levels, flows, water quality, sediment, geomorphic changes, etc.) provided to stakeholders in accessible and user-friendly formats.
- Accelerated national coverage of integrated water prediction capabilities through the adoption of community research and models that acknowledge stakeholder-driven requirements.

4.0 Pillars

The Challenge: Coastal coupling of models through collaborative community engagement for integrated coastal solutions employing research, model development and application, data provision, observations, analysis, and service delivery.

The Community: Identify the groups/people that are coming together to discuss and address the common challenge (i.e., federal, state, local and Indian tribal governments, academia, industry, and other stakeholders).

The Practice: Develop the framework to exchange information, share perspectives, and better align members' goals, and move our collective work in the same direction, including:

- Identifying community members based on current needs and understanding the members' strengths, priorities, and resources;
- Identifying knowledge gaps;
- Identifying the available models and understanding their strengths and weaknesses;
- Determining the best strategies for coastal coupling that are responsive to stakeholder requirements and that consider business models that include a balance between focus and diversity (i.e., consider business models that focus on the issue at hand while utilizing a diversity of options for solving it).
- Determining the best strategies for coastal coupling, including science and operational requirements for implementation of the coupled models; and
- Establishing an active, functioning, and sustainable community that continues to interact, develop, compare, and apply coastal solutions.

The Principles:

- Communicate;
- Define the successful outcomes early and often;
- Involve end users throughout, and learn continuously about requirements. In particular:
    - Connect Research and Development and Operations to define needs and expectations;
    - Connect funders (e.g., government) and researchers (e.g., academia) to identify issues and arrive at solutions;
- Define common terms and maintain a common vocabulary;
- Provide data access and a common operating platform; and
- Develop common code management and documentation.

5.0 Considering the Questions

Participants addressed a series of questions before and during the meeting. Based on the agreements in the meeting, synthesized answers follow.

5.1 Question #1. What does coastal coupling mean? What if coastal coupling refers to fully dynamically coupled systems with a two-way exchange of information, especially with the National Water Model (NWM)?

Coastal coupling means the passing of water between coastal and hydrologic models to predict all phases in the water cycle. The first step is to get hydrologic predictions flowing into a coastal model, but two-way coupling would enable water to flow upstream from the coast during high water conditions. It is part of the concept of a unified forecasting system wherein contributions of weather and precipitation, runoff, channel flow, coastal circulation, and wind waves all interact.

Two-way coupling would communicate ocean information on sea level at a high frequency back to the NWM, which would be configured to use dynamic sea level in moderating groundwater discharge rate, and modified dynamic head in the outflow from coastal cells in the NWM. Coastal and lake circulation models would simulate inundation (wetting/drying) with river source points that adaptively move across the flooded terrain in accordance with a dynamic land/sea boundary. In short, the coastal model would provide solutions for tide effects and storm-surge inundation that affect the water levels in the rivers. NWM should receive these enhanced water level predictions (at certain riverine locations) and the water content in inundated areas (crucial in the cycle evaporation - precipitation) to re-evaluate flow rate and surface runoff predictions that will be passed back to the coastal model. Also consider biogeochemical export from watersheds to the coastal ocean as these are vital to water quality, health, and ecosystem services.

Consider coupling under a variety of scenarios: In one scenario, a natural river system is connected with a larger open body of water such as a lake or the open coast. A second scenario involves the river transitioning into a delta or bayou that goes into a wetland/marsh that merges into the larger body of water. A third scenario switches to an urbanized environment, wherein drainage networks route water to rivers that are managed (channelized, hardened banks, levees, floodwalls, gates) with well-defined boundaries and those rivers then connect in with larger bodies of water (lakes, estuaries, etc.), perhaps with a wetland area in between. Coastal coupling is the interplay of all these relevant systems.

Consider coupling under a variety of limitations: For water, one-way coupling is likely the function of a limitation of hydrology models. Predominant formulation based on the kinematic wave approximation precludes abilities to handle the backwater profile from the storm surge propagating up in the upper reaches of the riverine areas. Additionally, the run time for both the hydrodynamic and hydrologic model vary greatly and it might be that these models would have to be under the same modeling framework to accurately pass information to one another at the correct times.

Consider coupling lessons learned in other areas: Full two-way coupling is already implemented between the atmosphere, the land surface, and the hydrology overland flow/river routing through an Office of Naval Research – National Oceanographic Partnership Program project that coupled the Naval Research Laboratory COAMPS [Coupled Ocean Atmosphere Mesoscale Prediction System] to WRF-Hydro (with the NOAH-MP land surface model).

Table 1. Highlights from Question #1: What does coastal coupling mean?

Question #1 Areas	Question #1 Answers

For water	Integrated water solution for saltwater, river flow, and local precipitation
For domains	Watershed, estuary, coastal ocean
For processes	Hydrodynamic, suspended sediment, various water quality and ecological processes, etc. are coupled with feedback. For example, both heat and water (and other constituents) come off the land and may be involved in driving part of the atmospheric dynamic
For products and guidance	Level and inundation, as well as guidance for water quality/hazardous algal blooms, beach erosion/dune over topping, etc.

5.2 Question #2. What techniques and technologies should be used to allow for development in the future? What are the drawbacks of the current techniques and technologies and how can we improve what we are doing?

The key is to work consistently within the standard infrastructure (outlined in the NOAA-NCAR Memorandum of Understanding, January 2019). Modeling frameworks like the NOAA Environmental Modeling System ensure that models can "talk" to each other and that datasets can be shared.

Although hydraulic and hydrodynamic models may both provide valid predictions in streams and rivers, connecting them is challenging because they are based upon different assumptions around the underlying model equations and different model configurations. Providing accurate boundary conditions at the model interfaces is critical to modeling accuracy.

Currently, the modeling communities speak different languages and do not serve respective data sets in formats that are readily usable for experimentation. For example, it is not a standard output product from the NWM to report streamflow (m3/s) as a set of longitude and latitude points that define the edge of the land (i.e., an output that would readily be adopted by a coastal ocean modeler as a line source of discharge). Similarly, groundwater discharge at the NWM coast is not a product. Many coastal modelers do not pay close attention to referencing their sea level to a recognized geodetic datum that would aid use in conjunction with surface water models to define ocean-driven inundation. These quantities must be defined unambiguously through the adoption of a controlled dictionary of data variables and standards in order to facilitate sensible model connections through some dynamic coupler or coupling toolkit.

Experimentation would be facilitated by establishing some common sandboxes in which non-experts can easily run a pre-configured model without the need to duplicate all the codes and data sets. This may require establishing instances of NOAA models outside of NOAA firewalls, perhaps by adopting some cloud-computing environments for the community to use. This would also assist inter-comparison of results. At the same time, the community needs to (1) agree upon metrics for model skill that will allow coupled experiments to demonstrate meaningful progress; and (2) establish the data sets to inform those skill metrics.

The major water modeling systems have specialized functionality and underlying assumptions that allow them to model successfully the well-delineated flow regimes: routing models to rivers, riverine flow models, overland flow models, open water models to include lakes, estuaries, oceans. These models operate on different spatial and temporal scales; use different numerical discretization techniques to represent the systems; are written in different computer languages; function in specialized computing platforms; and require different kinds of data to parameterize their input. The zone where coastal coupling becomes important is where most of these model's assumptions fail or their computational efficiencies fall way off. Models and source functions will need to be defined so that the models can be functionally called/controlled by other programs and the source functions are written in a unified file format that has a well-documented API. Proprietary codes are going to be a drawback in many cases, particularly for a CCCoP comprised of such a wide array of necessary disciplines and institutions.

Consider using the full dynamic wave equations within the hydrology model in order to allow it to capture the backwater profiles produced by the storm surge propagating back upstream into the upland riverine areas. The downside to changing to the dynamic wave equation is the run times associated with the hydrology model would increase significantly due to increase in physics included in the model. Additionally, current hydrology models run with grids that have spatial scales on the order of 1 km over the CONUS; however, most run at much finer resolution at a regional scale. On the other hand, hydrodynamic models often run at scales of 10 to 50 m over the inland areas of their grids, which makes some of the riverine areas more refined in these models versus those in the hydrology model.

Thus, hydrology and hydrodynamic models may not line up together when trying to pass information to one another (i.e., the connection points given to the hydrology model from the hydrodynamic model may not coincide with the river environment in the hydrology model). An issue for the hydrodynamic models is the availability of riverine shorelines and accurate depths in the riverine environments in the upper reaches of these coastal zones. This information is used to help define some of the hydrodynamic gridding in the riverine environment. This information can be obtained in some U.S. coastal areas due to extensive floodplain mapping programs or from hydraulic models that have already been developed in portions of these riverine areas. However, these are not always available in all coastal rivers in every U.S. state.

Table 2. Highlights from Question #2: What techniques and technologies should be used to allow for development in the future?

Question #2 Areas	Question #2 Answers
For sampling	Ensure that there are adequate observation networks in the coastal areas for validation/assimilation
For models	• Build from the standard infrastructure (outlined in the NOAA-NCAR Memorandum of Understanding, January 2019) • Define a set of acceptable community (component) models to work with and focus on these, consistent with the vision of Unified Modeling • Identify consistent protocols on maintaining models and model libraries • Develop visualization approaches that aid the development process (especially when multiple models are involved)

	• Automate basic modeling tasks • Develop and establish a standard set of tools as community resources for processing input and output files for the National Water Model. The lack of such tools has been a burden for the uninitiated user
For data	Develop a consistent approach to receiving and analyzing data to create model inputs (development of background programs and scripts should follow advances in technology - for example use evolving python scripting and libraries)
For connectivity	• Provide accurate boundary conditions at the model interfaces for modeling accuracy • Use person-power to build the linkage pathways and processes between models
For code	Use Apache Subversion to ensure proper code management techniques and to ensure that it remains open to the community for development and use
For computing	Use cloud computing to reduce limitations on high-performance access
For tradeoffs	Balance between resolution and efficiency of model runs: Sacrifice finer resolution to some degree in order for the model to run in a timely manner

5.3 Question #3. How might we decide the location to exchange boundary conditions? What happens if we choose not to decide?

Consider a heuristic in which we think first of the service requirements. Then, given those service requirements:

1. What kind of products are needed for serving these requirements (resolution, forecast range, cadence, accuracy)?
2. How does this fit with the "other" products (e.g., water versus weather, etc.)?

If the answers to #1 are similar, go to a single, fully-coupled model. If the answers to #1 are different, then here will be models with boundary exchange "offline," and you can ask another set of questions.

Because the "optimal" exchange is going to be difficult to define and is probably situation-dependent, develop a boundary that can either dynamically adapt to current conditions or overlaps far enough inland and into the coastal waters that the boundary location itself is not important. If dynamically adapting, then define it as the physics changes. Define the limit using non-dimensional parameters or consider minimum runoff, minimum velocities, water depth, or dependency on tides.

The decision on the location to exchange boundary conditions depends largely on the physics available in the different models. Many hydrologic models use the kinematic wave equation in their solution scheme, which allows for quick solution; however, this equation does not capture the backwater effects that can happen in the upper reaches of some of the riverine areas due to storm surge from hurricanes propagating up the riverine areas. For coupling to kinematic wave-based models, the coupling location must be located above the area of backwater effects. In some locations and for certain storm characteristics, this can exceed the location where the tidal influences are no longer seen in the hydrographs. Thus, to determine the boundary condition exchange location you need to not only analyze the gauging station information in the riverine areas but also examine these gauging stations for influences of storm surge during previous historical storms. In some instances, a full dynamic hydraulic model has been placed "in-between" the hydrologic and hydrodynamic models (so-called middleware) in order to capture the fluid dynamics in the "backwater" region due to the storm surge propagating into the upper reaches of the riverine areas.

However, as described in the previous section, some of the difficulties with coupling these models in a real-time framework is the exchange of boundary information from the hydrology and hydrodynamic models; also, the downstream hydrodynamic model requires boundary information from the hydraulic model. Thus, to accurately compute the water levels, one approach would be to run the hydrodynamic twice or place the hydraulic model into the estuarine areas in order to eliminate the overlapping areas where the riverine flows influence the hydrodynamic models. However, because not all hydraulic models employ the full Navier-Stokes equations that are necessary for capturing the dynamics in estuarine areas, the developer/user has to choose a model that is properly equipped to capture the dynamic in these areas.

The location for boundary exchange depends on modeling objectives: Are you interested in representing the dynamics or small-scale geometry of the river channels? Are you using river channels as a means to propagate surge and tides inland for flooding? Does the ocean model include inundation and recession over topography, or are you just interested in getting freshwater to the coastal ocean? The modeling objectives will dictate the best location for the coupling interface so the protocols for the exchange boundary location should be adopted for various types of applications.

Specialized models already have exchange boundaries that are often far enough away from the "main area of interest" that the imperfect forcing interactions occurring at those boundaries are damped out. However, for the coastal coupling paradigm, this will not be the case. The boundaries between models are likely to be overlapping and not at a delineated location as is the case in standalone models. Figuring out the respective domains of influence for each model under varying flow regimes is going to be a central research theme for the CCCoP. In some cases, a simple hand-off of information can take place from one model to the next, allowing for both one-way and two-way data exchanges. Another approach would be to derive from the governing equations of the two models a new boundary condition type that would allow one model's domain to actually shrink, but still "feel" the effects as if the domain was still present and now being represented by the other model. These overlapping areas might be treated in a more probabilistic approach to "merging" the two models results in that area or even data assimilation techniques being applied in that area. Finally, the different models could actually be reformulated and solved (partially solved) as a combined system of equations.

This deserves to be a subject of experimentation and will likely be handled differently by different ocean models depending on how they themselves define the coast. Intermediate models may be required (e.g., specialized models of flow through salt marshes/wetlands; addressing the role of subaquatic vegetation and the inundation of terrestrial vegetation). And, as all of these ideas are tested, consider sensitivity studies to learn more about the effects of the boundary condition choice.

Table 2. Highlights from Question #3: How might we decide the location to exchange boundary conditions?

Question #3 Areas	Question #3 Answers
Think ahead	• Consider the service requirements first • Reduce the number of software packages to focus on work • Give up pet projects that lead to too many models • Balance between finding a location that provides the best data while accounting for what we have the capacity to handle/process at the needed speeds
Consider	• Easy to over-constrain these models by attempting to provide both water levels and flows at model boundaries. It can be difficult to define ideal locations for boundary conditions where information is well known due to observations • In coastal rivers, flow conditions can be defined by either upstream or downstream flows, depending on current conditions. This requires models to pass information back and forth each way
Choose between and among	• By geography • By dynamic environment • Beyond the point at which the major governing process (e.g., tides) becomes insignificant or zero

5.4 Question #4. What are the hurdles around conducting collaborative coupling work?

The respective modeling communities are highly siloed: Topic specialists generally have little exposure to other modeling communities and these communities do not routinely speak of the same quantities in the same units with common definitions, conventions, or metadata. The systems of coordinates also are different (e.g., total water depth for river and depth and water elevation).

At the scales necessary for realistic coupling, these models are large and expensive to run. To a novice, they are complex to experiment with at the sophisticated level at which coupling occurs. This hampers experimentation. This hurdle could be lowered by promoting the adoption of coupling interfaces (e.g., NUOPC) wherein the topic experts develop the output interface for the quantities that the other modelers need, and these needs are clearly articulated. There will not be a single set of variables to exchange, there will be some redundancies, but a modest subset of model state variables should be within reach to define.

Today the hydrological and coastal modeling communities are totally disconnected. Some of the vocabulary and the system of coordinates (total water depth for river, and depth+water elevation) used are just the first example of these two worlds.

Collaborating coupling work assumes that data are shared and scientific issues are discussed. Data sharing can be a time-consuming task that might need to involve additional resources other than just the requester and the sharer of data. Hurdles include: 1) time constraints - request need to be submitted in advance to allow for timely deliverance, 2) usage of data should be clearly defined (eliminates a lot of issues political, inter-agency, etc.), 3) many times credit is not attributed at all to the people that share/create the data.

An operating platform that would allow the different community members access for development needs to be created.

- Where would this be hosted and what are the computing resources needed?
- How the model results will be evaluated during the development will also need to be considered. Will the end users be provided with products to evaluate? If so, how will they be disseminated?
- Will the coupling work start with a smaller test area, or will there be a push to try for larger coastal reaches? What are the data networks available for validation and assimilation?
- What are the end goals? Beyond water level and inundation, will there be a way to provide modeling results for the water quality, beach erosion/dune over topping?
- Will this be handled consistently with the National Hurricane Center during tropical events? Will there be an ensemble run using P-Surge guidance? There has to be consistency with other NWS products, especially during the high impact events.

Some of the hurdles around conducting collaborative coupling work might be as follows:

- Must have a team that agrees on the objective and approach and models to be coupled (or multi-model).
- Need to include end-users/stakeholders in the decision-making process.
- Coordination, especially across institutions, can be challenging at times, given busy schedules, so project delays are more frequent than single investigator projects.
- Common access to similar computing resources.

Establishing community test cases for various types of coupling could be quite instructive and helpful. A method should be established for software exchange and version management for contributed software and developments. Such a repository should be open to the community with documentation a required component.

The biggest hurdle will be the researchers being able to dedicate sufficient time/resources to the work in balance with their own funding and research directives. The second problem will be researchers wanting to keep their own models (codes) for use and not being willing to use other models. Another problem will be on select groups concentrating too much on a particular aspect of the coupling problem or a particular application of the coupled models.

NOAA needs to open up, period. If it claims to only support a few models, how can we collaborate? In many cases, we have not been part of the discussion until late, and sometimes never. Ultimately, NOAA managers need to make informed decisions based on nothing but solid science.

Improve representation and consistency of the data for rivers farther upstream from the shoreline, which will help with coupling them to the regional ocean models. A unified plan to develop, test, and transition this capability to operations should be developed where all can collaborate and contribute according to the primary function they fulfill (research, development, transition, operations).

Table 4. Highlights from Question #4: What are the hurdles around conducting collaborative coupling work?

Question #4 Area	Question #4 Answer
Funding	• Make the value case and secure more money • Ensure that development decisions take into account mission requirements
Models	• Stop playing favorites with models • Be clear about each model's limitations
Communication	• Ensure consistent communication
Structure	• Coupling the different codes in a consistent way is probably the biggest hurdle • Ownership, territoriality, and lack of open communication
Beware	• Egos • Computing architecture and infrastructure • Funding • Busyness • Invested/attached to particular models

6.0 Establishing Ongoing Engagement

6.1 In-person Engagement Opportunities

Small groups worked together to identify engagement opportunities and processes. In the first report-out, the CCCoP agreed on the following overarching points and potential opportunities for in-person meetings:

- The CCCoP should meet annually.
- Other gatherings (e.g., AGU Fall Meeting Town Hall) will most likely not include the entire CCCoP membership. However, efforts should be made to specify how these meetings will support the CCCoP and should include a mechanism for reporting back to the whole on the discussion.
- Due to funding constraints, and where possible, meetings should have an option for remote participation.

Table 5: In-person CCCoP meeting opportunities

Date	Event	Location	Proposed Frequency
May 7-8, 2019	CCCoP Kick-off Meeting	NWC Tuscaloosa, AL	Annually
May 9, 2019	Technical Modeling Session	NWC Tuscaloosa, AL	As needed
July 26, 2019	Summer Institute Capstone Meeting *The 2019 Summer Institute includes a focus on coupled inland-coastal hydraulics*	NWC Tuscaloosa, AL	Annually
October 22-24, 2019	Coastal and Modeling Testbed (COMT) Annual Meeting	Silver Spring, MD	Annually
October 22-25, 2019	American Shore and Beach Preservation Society National Conference *2019 Theme: Where Coasts and Rivers Meet*	Myrtle Beach, SC	Annually
November 10-15, 2019	International Workshop on Waves, Storm Surges and Coastal Hazards	Melbourne, Australia	As needed
November 18-20, 2019	National Centers for Environmental Prediction (NCEP) Production Suite Review	College Park, MD	Annually
December 9-13, 2019	AGU Fall Meeting Town Hall	San Francisco, CA	Annually
January 12-16, 2020	AMS Annual Meeting *The 18th Symposium on the Coastal Environment call for papers includes a focus on Coupled Forecasting of Extreme Weather and Coastal Flood Events*	Boston, MA	Annually
February 16-21, 2020	Ocean Sciences Meeting Scientific Session	San Diego, CA	Biennially
TBD, 2020	2020 ADCIRC Users Group Meeting		Annually

6.2 Virtual Engagement Opportunities

The CCCoP agreed on the following overarching points and potential opportunities for online meetings:

- Webinars and working groups meetings should move forward. However, a monthly cadence for technical calls could be too much; rather they should meet when appropriate and when there is something to discuss that would further the goals of the CCCoP.
- Webinars are an inexpensive method for information exchange and can provide a platform for 1) updates from the participants; and 2) a deep dive on a specific topic.
- Working groups should only be created if something similar does not already exist and if a champion for it can be identified.

Table 6: Virtual meeting opportunities

Event	Purpose	Proposed Frequency

Webinars	Provide briefings on CCCoP ongoing efforts and new initiatives	Quarterly
Working Group Monthly Meetings	Forum for the working groups once they are established around specific topics, including: ● Regional issues ● Model evaluation ● End-user requirements ● Data management ● Shared resources ● Topical (e.g., water quality, ecological, etc.)	Monthly
Coast Survey Development Lab (CSDL) Monthly Technical Calls	Discuss ongoing NOS 2D and 3D modeling details	Monthly
USACE Coastal Working Group	Presentations focusing on the CCCoP	Monthly
Model Evaluation Group		Weekly
Wave Watch	Community Models	Monthly
Ice Modeling		Monthly

6.3 Outreach

The CCCoP agreed that developing a digital newsletter, a library of best practices/lessons learned/recent publications, and a website for the CCCoP would be useful; a Slack channel was viewed as less useful due to the size of the group.

6.4 Additional Community Activities

Additional activities for the CCCoP include:

- Training each other about how research levels (RLs) are decided upon and the decision tree that is used for moving from one research level to another.
- Exploring with NOAA the research-to-operations (R2O) process to learn more.
- Determining best practices on how to run a model (e.g., timing of updates, running the code, workflow, failures documented, proper code management, etc.).
- Consulting with end users throughout the process – in the beginning to ensure that the product that is being designed meets their requirements and then throughout to make sure that those requirements have not changed.

6.5 Industry Activities

The participants agreed that industry's role in this effort is to create value-added products from the government's data and information for decision making in sectors (e.g., insurance, navigation, energy development, etc.) and/or regions. The CCCoP could host an "Industry Day" in order for industry to:

- Provide the CCCoP with their requirements (data resolution, frequency, quality).
- Provide feedback to the CCCoP whether their current tools/services are useful and accessible.

- Hear from the CCCoP about the tools/services under development, which would allow industry to begin thinking about the market-driven products they can develop based on those tools/services.
- Provide the CCCoP with the market case for developing certain tools and services.
- Discuss sharing their observational data with the CCCoP.
- Discuss opportunities for contributing to community modeling.

7.0 What's Next?

Given the work before and during the meeting, the following timeline and priorities emerged.

Image: Upcoming Milestones

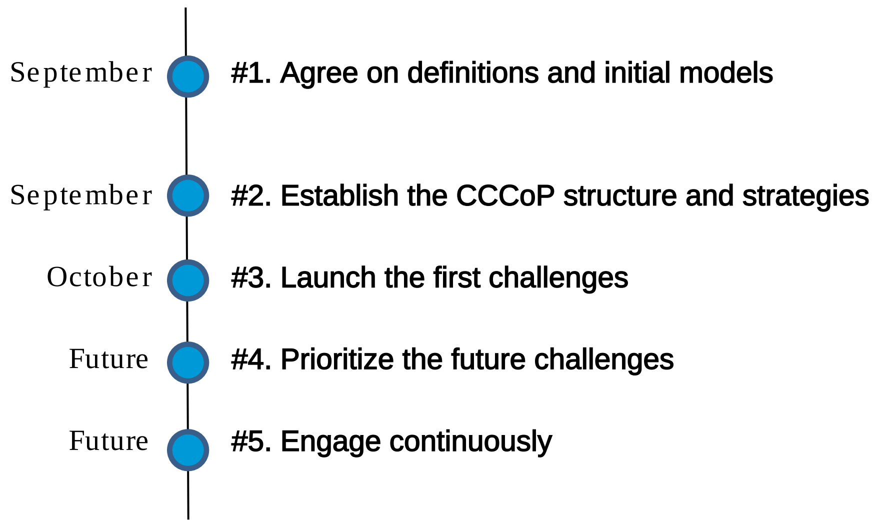

Table 7: Upcoming Projects (sorted by milestone)

Milestone	Lead: Organizers or Community?	Projects
1	Community	Agree on definitions for commonly used terms that may have different meanings for different segments of the Community of Practice (e.g., coastal zone, stakeholder, operational, etc.)
1	Community	Define an initial set of acceptable community (component) models to work with, and focus on these
2	Organizers	Establish a CCCoP Steering Committee to define the process for gathering, understanding, and prioritizing stakeholder requirements as well as the method for communicating completed work
2	Organizers	Develop a strategy for in-person CCCoP meetings
2	Organizers	Develop a strategy for CCCoP working groups
2	Organizers	Develop a strategy for CCCoP webinars
2	Organizers	Develop a strategy for the CCCoP's online existence, including a website, a library of best practices/lessons learned/recent publications, and digital newsletters
2	Organizers	Develop a strategy for the CCCoP to engage with industry/end-users
3	Community	Launch the first challenges (e.g., coordinate to develop techniques that reduce the computational time of simulations)
4	Organizers and Community	Choose the future challenges on which everyone will focus
5	Organizers and Community	Engage continuously

Appendix A: Read-aheads and Agenda

Read-aheads and Meeting Materials

1. National Coastal Coupling White Paper
2. NAO Policy on Research and Development Transitions

Agenda

Tuesday, May 7th

12:30 ALL | Registration

1:00 ED CLARK | Welcome

The Challenge: Approximately 100 million people who live in coastal areas do not have useable flood forecasts because current models cannot skillfully and appropriately represent complex riverine, estuarine, and coastal hydraulic processes.

1:20 FACILITATED | Coastal Coupling Activities and Opportunities [Part 1 of 2]

Following lightning talks about coastal coupling activities and case studies [50 minutes], participants will reference the presented material and the pre-work to discuss:

- What does coastal coupling mean? What if coastal coupling refers to fully dynamically coupled systems with a two-way exchange of information, especially with the National Water Model (NWM). The current approach is mostly a one-way coupling in which the hydrodynamic model gets freshwater/discharge inputs from the NWM and there is no feedback to the NWM, atmospheric models, or ocean models.
- What techniques and technologies should be used to allow for development in the future? What are the drawbacks of the current techniques and technologies and how can we improve what we are doing?
- How might we decide the location to exchange boundary conditions? What happens if we choose not to decide?
- What are the hurdles around conducting collaborative coupling work?

2:45 ALL | Break

3:15 FACILITATED | Operational Transition Approaches

Based on the case study/lessons learned provided by Chris Massey (USACE) and Brian Blanton (RENCI), discuss current and preferred transition approaches, particularly:

- How might we improve early linkages between research and the likely operational end-user(s)? What's working now? What might we improve?
- How might we improve the balance between research agendas and changing operational requirements, especially for the research content and timelines?
- Given the necessity of producing transition plans and specifying Readiness Levels, what might we leverage in those processes?

- What are the opportunities for, and importance of:
  - Leadership support?
  - Defining future states (at what time horizons)?
  - Monitoring operational requirements and metrics?
  - Determining staffing?
  - Leveraging relationships?
  - Codifying any or all of this in transition plans?
  - Establishing processes for documentation, dissemination, and evaluation?
  - Other roles?

5:00 AUDRA LUSCHER | Day 1 Highlights

5:15 ALL | Adjourn

6:00 OPTIONAL | No-host Dinner (R Davidson Chop House)

Wednesday, May 8th

8:30 ALL | Registration and Light Refreshments

9:00 TREY FLOWERS & AUDRA LUSCHER | Recap from Day 1

9:15 FACILITATED | Establishing a Coastal Coupling Community of Practice [Part 1 of 2]
In a mix of plenary and small-group sessions, participants will reference the preceding conversations and the pre-work to:

- Discuss the proposed vision and mission of the Coastal Coupling Community of Practice:
  - The **vision** of the Coastal Coupling Community of Practice (CCCoP) is to build communication pathways and relationships to facilitate collaborative development of continental-scale solutions to integrated water prediction in the coastal zone.
  - The **mission** of the CCCoP is to enable:
  - Accelerated national coverage of hydrodynamic models through the adoption of 3rd party research and models.
  - Coupling of hydrologic and oceanographic models across the coastal zone to better predict water inundation from both freshwater and saltwater and their compounding effects.
  - Integrated prediction of coastal total water level, flow timing and duration, currents, waves, ice, and water quality accounting for both in-channel and overland water surface elevations.
  - Actionable information on these parameters provided to stakeholders in user-friendly formats.

- Discuss the **main pillars** of the Coastal Coupling Community of Practice:
- **The domain:** Build relationships between the members that allow for open communication pathways that are needed to do the collaborative work of developing coastal coupling of models for integrated water prediction enabled by third party research and models.
- **The community:** Identify the groups/people that would be helpful to this discussion (e.g., NOAA, USACE, USGS, academia, industry, local, state, and Indian-tribal governments).
- **The practice:** Develop the framework to align members' goals and pull the work in the same direction, including:
  - Identifying community member strengths, priorities, and resources;
  - Identifying knowledge gaps;
  - Identifying the available models and understanding their strengths and weaknesses;
  - Determining the best strategies and requirements for coastal coupling including stakeholder needs; and
  - Determining the best strategies and requirements for coastal coupling including science and operational requirements for implementation of the coupled models.

10:45 ALL | Break

11:00 FACILITATED | Establishing a Coastal Coupling Community of Practice [Part 2 of 2]
[Continuation of the previous session, including report-outs]

12:00 ALL | Lunch

1:15 FACILITATED | Engagement [Breakout Sessions]
Small groups will work together to identify engagement opportunities and processes. In particular, they will consider the following questions:

- How might CCCoP continue to be active in the upcoming year? Options include:
  - In-person meetings (e.g., Summer Institute Capstone Meeting (Tuscaloosa, AL, July 26, 2019); 2019 AGU Fall Meeting (San Francisco, CA, December 9-13, 2019); 2020 Ocean Sciences Meeting (San Diego, CA, February 16-21, 2020)
  - In-person technical meetings
  - Newsletters
  - Webinars
  - Open source file archive
- Where else might the CCCoP put this into practice:
  - Funding opportunities, including research and reporting requirements
  - Transition documentation
  - Day-to-day best practices

- What is industry's role? What types of questions might we address with industry?
- When should the CCCoP start to bring end users (e.g., Jupiter, ESRI, First Street Foundation, etc.) into the conversation? What types of questions might we address with end users?

2:45 AUDRA LUSCHER | Consensus on Breakout Group Inputs
The goal of this session is to arrive at a consensus on the inputs from the 1) Establishing a Coastal Coupling Community of Practice; and 2) Establishing Ongoing Engagement for the Coastal Coupling Community of Practice breakout groups

3:15 ALL | Break

3:45 CELSO FERREIRA/TREY FLOWERS/EHAB MESELHE | With input from the participants, this panel will discuss the opportunities to connect the CCCoP with the Summer Institute, which this year is focused on the following themes:

- Coupled inland-coastal hydraulics;
- Scaling hydrologic and hydraulic models from small basins to regional watersheds;
- Utilizing hydroinformatics to address flood inundation; and
- Supporting remote sensing of water information through engagement with the computer science community.

4:30 AUDRA LUSCHER | Preview for Day 3

4:45 AUDRA LUSCHER | Meeting Highlights and Wrap-up
5:00 ALL | Adjourn

Thursday, May 9th (Optional)

8:30 ALL | Registration and Light Refreshments

9:00 ED MYERS/SAEED MOGHIMI | Welcome
The focus for this session is on some of the technical aspects of 2D and 3D model development.

9:30 ALL | Breakout Groups
Breakout groups will focus on 2D and 3D modeling, including addressing the questions raised at the end of the session on Day 2.

11:15 ALL | Review Breakout Group Reports
Reporters will provide the inputs from their groups, including future recommendations and strategy.

11:50 ED MYERS/SAEED MOGHIMI | Wrap-up Day 3

12:00 ALL | Adjourn

Appendix B: Invited Participants

Participant	Organization	Title	Email
Ali Abdolali	NOAA	Scientist, Coastal and Ocean Engineering	ali.abdolali@noaa.gov
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		Infrastructure and Interoperability (NESII)	
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*Denotes meeting attendee

Appendix C: National Coastal Coupling White Paper

INTRODUCTION - A Community of Practice (CoP) is defined as "a group of people who share a concern, a set of problems, or a passion about a topic, and who deepen their knowledge and expertise by interacting on an ongoing basis."[1] Three pillars central to fostering interaction within the CoP are:

- ***Domain*** - the specific area of focus; here, coastal coupling of models for integrated water prediction enabled by 3rd party research and models
- ***Community members*** - leadership team, core modeling scientist members, coastal practitioners, end users of model outputs, etc.
- ***Practice*** - sharing experiences, stories, techniques, methods, tools, and ways of addressing problems, enabling practitioners to focus on sharing knowledge and solving problems

A CoP is dynamic and organic by nature. The interests, goals, and members can evolve over time as the CoP develops and needs change. Typically, CoPs are long-term activities that require careful cultivation and last as long as there is interest or value in maintaining the group.

VISION AND PURPOSE- The vision of the Coastal Coupling Community of Practice (CCCoP) is to build communication pathways and relationships to facilitate collaborative development of continental-scale solutions to integrated water prediction in the coastal zone.
This CCCoP should enable

- Accelerated national coverage of hydrodynamic models through the adoption of 3rd party research and models.
- Coupling of hydrologic and oceanographic models across the coastal zone to better predict water inundation from both freshwater and saltwater and their compounding effects.
- Integrated prediction of coastal total water level, flow timing and duration, currents, waves, ice, and water quality accounting for both in-channel and overland water surface elevations.
- Actionable information on these parameters provided to stakeholders in user-friendly formats.

The CCCoP is envisioned to serve as a platform to foster greater dialogue on the challenges that will arise in coupling these models such as the location of boundary information handoff between models, differences in model mesh resolution, boundary condition and forcing requirements, and how to provide user-friendly model outputs to stakeholders.
The CCCoP will be designed as a tool for engagement and collaborative learning so that all members will interact, contribute and learn from one another's perspective, experience, and expertise on a routine basis. It will help the community learn from experts from different organizations including NOAA, USGS, USACE, academia, and the private sector with different viewpoints. By advancing coastal coupling efforts, the CCCoP is working toward the eventual

[1] (Wenger et al. 2002)

goal of developing the products and services that society needs to provide actionable water information at local, regional, and national scales. Ultimately, the CCCoP will allow water professionals to collaboratively work toward the shared objective of protecting communities, economies, and ecosystems from critical water challenges.

SCOPE- The CCCoP will develop a framework to align members goals and pull the work in the same direction. The scope of work for the CCCoP includes, but is not limited to, identifying groups that would be helpful to this discussion (e.g., NOAA, USACE, USGS, academia, industry, local, state, and tribal governments), identifying knowledge gaps, identifying the available models and understanding their strengths and weaknesses, determining the best strategies and requirements for coastal coupling including stakeholder needs, and science and operational requirements for implementation of the coupled models. As the CCCoP members and needs continue to evolve, the scope of the CCCoP may also evolve.

ROLES AND RESPONSIBILITIES Team - The CCCoP is based on an interagency framework, involving academia, industry, and end users. The CCCoP team will include leadership and practitioners.

- ***Leadership*** - needed to advance and sustain the CCCoP in the long term. The leadership team will consist of NOAA line office representatives in executive positions who will be responsible for developing a charter that outlines the mission, vision, scope, and priorities of the CCCoP. This team will also ensure that the CCCoP remains aligned with these priorities. Additionally, the leadership is responsible for allocating funding for support staff, travel, or other necessities.
- ***CoP Practitioners*** - an interdisciplinary team with members from various NOAA line offices and the external audience. These team members should consist of key thought leaders and subject matter experts of modeling and water information. These individuals will be responsible for developing a charter that outlines the mission, vision, scope, and objectives of the CCCoP.

Engagement methods - The CCCoP first meeting will be held at the National Water Center in Tuscaloosa, AL on May 7-8, 2019. This meeting will serve to establish communication pathways and develop the relationships needed to do collaborative work. Proposed ongoing engagement activities include:

- Annual in-person meetings, biweekly or monthly teleconferences to provide updates on progress and determine the best course of action moving forward.
- Communications externally through conference panels and Town Halls.
- Listserv emails providing updates on new tools, projects, etc., and a website or other forum to maintain open communication.
- Open dialogue amongst members to facilitate knowledge gathering on specific topics of interest.

Rules of interaction - Some rules of interaction must be established to facilitate a productive, innovative discussion to further the vision, purpose, and goals of the CCCoP. Some proposed rules are as follows:

- Members contribute to the community through their personal experiences and skills by sharing challenges, lessons learned, and successes in an organized fashion that contributes to the atmosphere of problem-solving.
- The topics, discussions, and work remain pertinent to the CCCoP scope.
- Members strive to create an environment of trust and respect by participating in insightful discussions of ideas and experiences and listen to each other with open and constructive minds.
- Members will not be afraid to respectfully challenge one another by asking questions but will refrain from personal attacks.

Appendix D: NAO 216-105B: Policy on Research and Development Transitions

Issued 10/17/2016; Effective 10/17/2016 Reviewed Last: 02/26/2019

NAO 216-105B: Policy on Research and Development Transitions PDF
Handbook_NAO216-105B_03-21-17

SECTION 1. PURPOSE AND SCOPE.

01 The National Oceanic and Atmospheric Administration (NOAA) is a science-based service agency. NOAA's ability to meet its mission through the delivery of continually improved products and services relies on the conversion of the best available research and development (R&D) endeavors into operation and application products, commercialization, and other uses. NOAA therefore requires an integrated transition enterprise linking research, development, demonstration, and deployment that is efficient and effective in identifying and using significant new R&D products to meet NOAA's mission needs.

02 This Order establishes the process for identifying, transitioning, and coordinating R&D output to operations, applications, commercialization, and other uses. This Order outlines the roles and responsibilities of various officials, including Line Office Transition Managers (LOTMs), associated with the transition of R&D. Additionally, this Order identifies those entities with the authority to implement this policy and those who are accountable for transitioning R&D.

03 This Order applies to all NOAA funded R&D activities, including those conducted by non-NOAA entities.

04 This Order defines the transition of R&D to any operation, application, commercialization, or other use, and includes products such as 24 hours/7days weather forecasts (typically referred to as research to operations), information products used in resource management (research to application), commercially-available sensors (research to commercialization), or government policies, regulations, synthesis of research, public education and outreach (research to other uses).

05 This Order does not replace any directive, policy, statute, or other guidance that applies to the prosecution of patents by NOAA or its employees for inventions made in the course of research, the licensing of government owned inventions in the custody of NOAA, or Cooperative Research and Development Agreements and Small Business Innovative Research awards. Such activities are addressed by NAO 201-103: Cooperative Research and Development and Invention Licensing Agreements Under the Federal Technology Transfer Act of 1986 (Public Law 99-502) and other applicable laws, regulations, and related policies. However, this NAO does apply to the identification of potential or realized uses of NOAA's R&D.

06 Transition projects for which funding or R&D originate outside of NOAA are included in this policy, at the discretion of the respective LOTM.

07 This Order recognizes that transitions can be either incremental improvements to existing products or applications, or entirely new products or applications.

SECTION 2. DEFINITIONS.

01 **Application:** The use of NOAA R&D output as a system, process, product, service, or tool. Applications in NOAA include information products, assessments, and tools used in decision-making and resource management.

02 **Commercialization:** The process of introducing a NOAA product or technology (e.g., invention) into the commercial market, including licensing.

03 **Construction Projects:** The development, construction, or installation of equipment/asset that is not real property; or the development or modification to software, which will be used internally. The project must equal $200,000 or more; the service life is estimated to be 2 years or more; the project will provide a long-term future economic benefit to the NOAA organization that maintains or obtains control; and it is not intended for sale.

04 **Demonstration:** Activities that are part of R&D and are intended to prove or to test whether a technology or method does, in fact, work as expected.

05 **Deployment:** The sustained operation, maintenance, and use of the product of R&D.

06 **Development:** The systematic work, drawing on knowledge gained from research and practical experience and producing additional knowledge, that is directed to producing new products or processes, or to improving existing products or processes (OECD, 2015).

07 **Line Office Transition Manager (LOTM):** An individual appointed by each Assistant Administrator (AA) and the Director of the Office of Marine and Aviation Operations (OMAO), who is responsible for managing the Line Office (LO) transition portfolio (collection of transition projects).

08 **NOAA Invention:** A new, useful process, machine, manufacture, or composition of matter, or any new and useful improvement to a process, machine, manufacture, or composition of matter, developed by NOAA.

09 **Operations:** Sustained, systematic, reliable, and robust mission activities with an institutional commitment to deliver specified products and services. Examples of operations in NOAA include weather and climate forecast models run on a routine basis to provide forecast guidance or seasonal outlooks, stock assessments conducted to determine changes in the abundance of

fishery stocks, and sustained observations for public services and for Earth-System research in the public interest (NSTC 2014).

10 **Proving Ground:** A framework for NOAA to conduct testing of advanced operations, services, and science and technology capabilities that address the needs of both internal and external users. Successful testing demonstrates readiness to implement into operations.

Capabilities to be tested in operational proving grounds have already passed developmental testing. Such capabilities include advanced observing systems, better use of data in forecasts, improved forecast model, and applications for improved services and information with demonstrated economic/public safety benefits.

11 **Readiness Levels (RLs):** A systematic project metric/measurement system that supports assessments of the maturity of R&D projects from research to operation, application, commercial product or service, or other use and allows the consistent comparison of maturity between different types of R&D projects. (Note: NOAA RL's are similar to Technology Readiness Levels developed by NASA (Mankins, 1995) and embody the same concept for quantifying the maturity of research). A project achieves a readiness level once it has accomplished all elements described within a readiness level. A program may include projects at different RLs depending on the goals of each project. Inventions may be generated at any RL. The nine readiness levels are as follows:

1. RL 1: Basic research, experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundations of phenomena and observable facts, without any particular application or use in view. Basic research can be oriented or directed towards some broad fields of general interest, with the explicit goal of a range of future applications (OECD, 2015).
2. RL 2: Applied research, original investigation undertaken in order to acquire new knowledge. It is, however, directed primarily towards a specific, practical aim or objective. Applied research is undertaken either to determine possible uses for the findings of basic research, or to determine new methods or ways of achieving specific and predetermined objectives (OECD, 2015).
3. RL 3: Proof-of-concept for system, process, product, service, or tool; this can be considered an early phase of experimental development; feasibility studies may be included.
4. RL 4: Successful evaluation of system, subsystem, process, product, service, or tool in a laboratory or other experimental environment; this can be considered an intermediate phase of development.
5. RL 5: Successful evaluation of system, subsystem process, product, service, or tool in relevant environment through testing and prototyping; this can be considered the final stage of development before demonstration begins.
6. RL 6: Demonstration of a prototype system, subsystem, process, product, service, or tool in relevant or test environment (potential demonstrated).

7. RL 7: Prototype system, process, product, service or tool demonstrated in an operational or other relevant environment (functionality demonstrated in near-real world environment; subsystem components fully integrated into system).
8. RL 8: Finalized system, process, product, service or tool tested, and shown to operate or function as expected within user's environment; user training and documentation completed; operator or user approval given.
9. RL 9: System, process, product, service or tool deployed and used routinely.

12 **Research:** Research can be classified as basic research or applied research.

1. Basic Research: Basic research is experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundations of phenomena and observable facts, without any particular application or use in view. Basic research can be oriented or directed towards some broad fields of general interest, with the explicit goal of a range of future applications (OECD, 2015).
2. Applied Research: Applied research is the original investigation undertaken in order to acquire new knowledge. It is, however, directed primarily towards a specific, practical aim or objective. Applied research is undertaken either to determine possible uses for the findings of basic research or to determine new methods or ways of achieving specific and predetermined objectives (OECD, 2015).

13 **Testbed:** A NOAA testbed is a working relationship for developmental testing in a quasi-operational framework among researchers and operational scientists/experts (such as measurement specialists, forecasters, IT specialists) including partners in academia, the private sector, and government agencies, aimed at solving operational problems or enhancing operations, in the context of user needs. A successful testbed involves physical assets as well as substantial commitments and partnerships.

14 **Transition:** The transfer of an R&D output to a capability ready for an operation, application, commercial product or service, or other use.

15 **Transition Plan:** A document that represents an agreement between clearly identified researchers and potential recipients, organizations, or other users of the product resulting from the transition of an R&D output.

16 **Transition Project:** A collective set of activities necessary to transfer R&D output to a capability ready for an operation, application, commercial product, or service, or other use (RL 9).

17 **Transition Project Lead(s):** Individual(s) responsible and accountable for ensuring that the transition project is planned, programmed, budgeted, and executed per the Transition Plan.

SECTION 3. POLICIES.

01 To meet mission needs, NOAA will optimize the timely and efficient use of R&D, including but not limited to that conducted by and funded by NOAA. To fulfill this goal, NOAA shall maintain:

1. A mission-oriented enterprise capable of quickly identifying and applying demonstrated R&D outputs to provide new and improved products, services, or more efficient operations while continuing to maintain reliable, cost-effective services for users;
2. An R&D enterprise that routinely provides proven R&D outputs to serve NOAA's mission while adapting its portfolio to address new research frontiers; and,
3. Project management, planning, and oversight processes that include routine identification of new opportunities/needs for research, development of Transition Plans, status reporting, and test and evaluation procedures.

02 Transition Plans are essential for describing and facilitating the transition of R&D to potential end use, and represent an agreement between researchers, operators and/or users that describes a feasible transition pathway and potential Concept of Operations (CONOPS).

03 Transition Plans should be developed as early as possible to reflect the relationship between R&D and NOAA's mission and the commitment by the entities involved to the potential transition of R&D.

04 Transition Plans are recommended for projects that seek to progress beyond RL 4.

05 The determination of whether a transition project shall have a written transition plan is at the discretion of the AA(s), or their designees, from the affected LO(s). In making this determination, factors that may be considered include but are not limited to the following:

1. The risks associated with, and the sensitivity of, the transition;
2. The organizations involved in the transition, and their history of implementing transition activities together;
3. The duration of the transition activities;
4. The cost of transition activities;
5. Potential societal impact; and
6. The complexity of the transition, including whether the project is novel or a routine update to existing operations or applications.

For transitions that involve multiple LOs, if any of the AAs or their designees determine that a written transition plan is justified then one shall be developed.

06 Transition Plans shall incorporate the following:

1. A description of the activities necessary to transfer an R&D output;
2. Clearly defined goals for the new/revised product or service, milestones, schedule, and transition success/acceptance criteria;
3. To the best estimate, the amount and source of funds needed to cover the costs associated with the transition, as well as the cost of future operations as necessary,

including relevant requirements for equipment, upgrades, staff training, and maintenance of redundant application capabilities during the transition period;

4. A clear designation of potential researcher(s), operational entity(ies) and/or end user(s), and a description of when they will engage and as often as necessary to ensure all parties are fully invested in the R&D transition process;
5. A mechanism for providing clear communication among all participants concerning the transition, including routine engagement of the management chain in the affected LO(s) and partner organizations; and
6. A mechanism for updating the plan as necessary to reflect changes in the plan warranted by results of the transition process or unforeseen events (e.g., updated budgets).

07 Transition Plans shall be approved by the AA(s), or their designees, from the affected LO(s).

08 Transition Planning integrated into Agency Planning: LOTMs shall strive to include transition projects within their portfolio as appropriate into NOAA planning documents, including NOAA strategic plans and LO Annual Operating Plans.

09 Transition Budgeting integrated into Agency Budgeting: LOTMs shall work towards ensuring that the resources needed to transition R&D outputs to sustainable applications, operations, construction projects, commercialization or other uses are appropriately addressed and included in the Line Office submissions in the appropriate NOAA budget processes.

10 Evaluation: All Transition Projects shall be reviewed on a periodic basis using the evaluation criteria identified in respective Transition Plans to ensure progress towards readiness levels, goals and milestones.

11 Reporting: LOTMs will work with Transition Project Leads to report on execution status of transition projects on a regular basis.

12 This Order follows the guidelines established in NOAA Administrative Order 216-115A, Research and Development in NOAA.

13 This Order supports the policies and procedures contained in the Paperwork Reduction Act, the Government Paperwork Elimination Act, the Federal Technology Transfer Act, the Bayh-Dole Act, Office of Management and Budget (OMB) Circular No. A-130, Management of Federal Information Resources, the NOAA Information Quality Guidelines, and other applicable relevant laws, regulations, and policies. These authoritative requirements apply government resources to activities in support of the agency's mission, outline procedures to ensure and maximize the quality, utility, and integrity of resultant information, and seek to maximize the benefits of resultant information and intellectual property to society.

14 NOAA shall be cognizant of and observe the valid rights of patent holders and owners of other intellectual property.

15 NOAA Invention Disclosure: Prior to any public disclosure (including but not limited to presentations at a public meeting, or publications on a public-facing webpage or in scientific literature), a NOAA invention shall be reported to the NOAA Technology Partnerships Office (TPO) for:

1. Rights determination;
2. Evaluation of patentability and commercial potential; and
3. Inclusion in the NOAA technology and innovation portfolio.

SECTION 4. GOVERNANCE & RESPONSIBILITIES.

01 The Under Secretary of Commerce for Oceans and Atmosphere (NOAA Administrator), the Deputy Under Secretary/Operations, and the NOAA Chief Scientist shall provide top management oversight for implementation of this policy, and the development and implementation of associated procedures.

02 The AAs, the OMAO Director and appropriate NOAA Staff Offices (SOs) support the implementation of this policy through their roles in the NOAA Organizational Handbook.

03 LO AAs and the Director, OMAO are responsible for the following:

1. Promoting the goals and implementing the requirements of this policy;
2. Appointing LOTMs;
3. Determining, or delegating determination of, whether specific transition projects require written transition plans;
4. When appropriate, approving, or delegating approval of, Transition Plans;
5. Ensuring that Transition Teams are appropriately resourced to carry out their responsibilities;
6. Providing or delegating oversight for all transition projects in their LO;
7. Ensuring LO Transition Project reviews are conducted as appropriate; and
8. Reporting on the execution status of transition projects per instructions provided by the Deputy Under Secretary for Oceans and Atmosphere.

04 LOTMs include representatives of the LO AAs and the Director, OMAO. The LOTMs are responsible for the following:

1. Collectively monitoring the NOAA transition portfolio (collection of transition projects);
2. Incorporating applicable LO transition projects into NOAA's planning, budget, execution, and evaluation processes;
3. Tracking and providing timely reports to the NOAA Research Council on the status of the portfolio (collection of transition projects);
4. Ensuring the development of appropriate Transition Plans; and
5. Evaluating transition projects with respect to Transition Plans.

The collective LOTMs form a standing committee of the NOAA Research Council. As such, they are expected to report to the Council at least annually on the status of NOAA's transition activities and:

1. Inform the Council on issues of concern related to the transition of research; and
2. Respond to guidance and direction from the Council.

05 The TPO Director is responsible for:

1. Providing the LOTM committee with updates on TPO activities;
2. Maintaining a database of transitions occurring under TPO purview;
3. Informing the LOTMs of transition opportunities to NOAA application; and
4. Informing the LOTMs of potential intellectual property issues pertaining to specific technology projects.

06 Transition Project Leads are responsible for managing the transition projects and all associated activities. For transition projects that include construction projects (as defined in 2.03), Transition Project Leads are responsible for providing planning and budgeting documents to a designated Line Office Construction Work-In-Progress Project Manager, who will follow the process and procedures for constructed projects detailed in the NOAA CWIP Policy (http://www.corporateservic es.noaa.gov/finance/docs/CWIP/CWIPPolicy --May2016FINAL.pdf).

07 Transition Teams should include representatives from both the research output and operations or end-user communities. Transition Teams are responsible for the following:

1. Coordinating transition activities; and
2. Identifying, reporting, and responding to significant deviations in the execution of the Transition Plan.

08 The NOAA Research Council is responsible for the following:

1. Overseeing the LOTM committee;
2. Providing guidance and advice to the NOAA Chief Scientist as pertains to research transition policy, process and practice; and
3. Establishing or overseeing the establishment of policies and processes to foster effective transitions.

09 Other applicable Councils, such as the NOAA Observing Systems Council and the NOAA Ocean and Coastal Council, are responsible for participating in the NOAA's planning, budget, execution, and evaluation processes and providing comments regarding the identification and readiness of projects for transition and the relative priority of these projects.

SECTION 5. REFERENCES.

01 Working through the LOTM Committee, the Research Council will develop and disseminate written procedures, plans, and reports as necessary to implement this Order, including but not limited to:

1. Procedural Handbook covering, but not limited to, the following topics:
    1. Use and interpretation of readiness levels in NOAA; and
    2. Guidance for developing effective Transition Plans.

02 Existing documents referenced in this policy are as follows:

1. Mankins, John C. (6 April 1995). "Technology Readiness Levels: A White Paper" (PDF). NASA, Office of Space Access and Technology, Advanced Concepts Office. http://www.hq.nasa.gov/office/codeq/trl/trl.pdf
2. NSTC (2014). "National Plan for Civil Earth Observations", https://www.whitehouse.gov/site/default/file/microsites/ostp/NST/national_plan_for_civil_earth_observations_ - _july_2014.pdf
3. NOAA Invention Disclosure and Rights Questionnaire Instructions,
4. NOAA Invention Disclosure and Rights Questionnaire http://ocio.os.doc.gov/s/groups/public/@doc/@os/@ocio/@oitpp/documents/content/dev_01_002431.pdf

OECD (2015), Frascati Manual 2015: Guidelines for Collecting and Reporting Data on Research and Experimental Development, The Measurement of Scientific, Technological and Innovation Activities, OECD Publishing, Paris. DOI: http:/ldx.doi.org/10.1787/9789264239012 -en

SECTION 6. EFFECT ON OTHER ISSUANCES.

01 This Order supersedes NOAA Administrative Order (NAO) 216-105, Policy on Transition of Research to Application issued July 31, 2008.

02 The Under Secretary of Commerce for Oceans and Atmosphere signs because the matter has not been delegated.

An electronic copy of this Order will be posted on the NOAA Office of the Chief Administrative Officer website under the NOAA Administrative Issuances Section.
Signed,
Under Secretary of Commerce
for Oceans and Atmosphere
Office of Primary Interest:
Office of Oceanic & Atmospheric Research

Appendix E: Requirements Identified in the White Paper: A One -NOAA Approach to Integrated Water Prediction at the Coast (June 2018)

Integrated Coastal Water: Requirements

It is critical that NOAA's services meet the needs of water resources managers, water suppliers, planners, and decision-makers. This section is designed to provide detailed information on those user needs, including both a definition and attributes of each requirement plus NOAA's current capabilities.

Overarching Attributes/Functional Requirements for Integrated Coastal Water

- Provide understandable, accurate, timely, consistent, reliable, event-driven, high-impact, high-value, interoperable, authoritative, and seamless information.
- Communicate actionable information about integrated coastal water level, flow timing and duration, currents, waves (e.g., erosion, overtopping, etc.), ice, and water quality (e.g., dissolved oxygen and nutrient concentrations, HABs, salinity, temperature, etc.).
- Integrate with other geospatial information (e.g., infrastructure, economic, political).
- Provide stakeholder-informed information in formats for the users to derive value within their own systems (e.g., common geospatial formats and appropriate graphics) and to provide all formats of information for Decision Support Services (DSS) to users.
- Quantify uncertainty.
- Offer high operational availability.
- Provide an integrated modeling approach.
- Account for both in-channel and overland water surface elevations, including inundation (depth and extent of normally dry lands and surfaces).
- Available for both the 48 CONtiguous states of the US (CONUS) and Outside CONUS (OCONUS).

Key Attributes of User -Defined Needs

- For **routine high -value decision making** , stakeholders need integrated coastal water information at appropriate timescales that:
  - Delivers forecast updates by parameter (e.g., every six to 24 hours for long-range planning of water level and flow).
  - Delivers and disseminates products and services tailored to their decision environments.
  - Archives information routinely.
- For **high-impact events**, stakeholders need integrated coastal water information before, during, and after events that:
  - Delivers and disseminates information at appropriate time scales: at least 72-hour (sliding scale) lead time to initiate evacuations or mitigative actions; at least seven days of outlooks for advance planning; and hourly forecast updates for tactical decisions as an event unfolds.
  - Delivers and disseminates products and services tailored to impacts.
  - Documents impacts, resurveys, acquires stakeholder feedback, and archives information after an event.
- For core partners in the **Coastal Zone**, stakeholders require information that:
  - Provides consistently timely products with at least seven days of outlooks updated daily and 72 hours of lead time prior to the event with hourly updates provided for all NOAA areas of responsibility.

- Provides comprehensive total water level, flow, and quality products and data services for tropical, extratropical, and non-tropical events. Products and services are integrated with geospatial information that depict spatial impacts (inundation extent and flood depths) and temporal forecasts (water level vs. time) at affected areas that are made available to the core partner’s geoplatform.
- Provides accurate impacts down to the neighborhood scale with at least 72 hours of lead time.