Methodology for an Improved Federal-Regional Modeling Strategy for U.S IOOS

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Purpose

The purpose of this initiative is to develop a strategy to link local, regional, national, and global modeling efforts associated with the U.S. Integrated Ocean Observing System (IOOS), to advance IOOS initiatives, and to meet an FY14 National Ocean Policy Implementation Plan milestone. The milestone is to "Develop a national modeling strategy that uses the various ocean models (ocean circulation, waves, atmospheric, biological, ecosystem, etc.) to determine how regional scale models supported by IOOS regions can be integrated into Federal efforts, and describes how they can be developed in a nested fashion to support local, regional, national, and global needs." In this document, we suggest a set of initial steps to incorporate regional and federal involvement in the development of the strategy as well as some broad candidate issues for the strategy.

Background

Modeling, and the products and applications derived from model results, are critical to the ongoing mission of IOOS to protect lives and livelihoods. IOOS has made substantial progress in regional, coastal, and ocean modeling over the last decade through the growth of non-federal models and products serving regional stakeholder needs and through the development of a U.S. IOOS Coastal and Ocean Modeling Testbed (COMT) endorsed by federal agencies. However, this strategy is an opportunity to advance the modeling subsystem beyond the COMT. The development of this strategy is to satisfy a 2014 National Ocean Policy (NOP) milestone and is not connected explicitly with the COMT FFO.

The IOOS Modeling and Analysis Workshop Report[1] in 2008 provided nine recommendations for IOOS modeling in the physical, biogeochemical, and ecological ocean sciences (reproduced in Appendix A, below), and many of the recommendations are still applicable today with minor adjustments to today's constraints. Presentations and discussions at the 2012 IOOS Summit highlighted the need for better integration between federal, state, regional, local, academic, and industry modeling efforts and integrated observational and modeling analysis subsystems which better meet informational requirements by national and regional stakeholders. Additionally, several white papers were submitted to the Summit proceedings to advance IOOS modeling, including two by Mooers[2] and Leuttich *et al.*[3] addressing the COMT, one by Blumberg *et al.*[4]

[1] The Integrated Ocean Observing System (IOOS) Modeling and Analysis Workshop Report, 2008: Ocean.US Publication No. 18, Arlington, VA, July 22-24.
[2] Mooers, C. N. K., Large Regional Testbeds: Bridging the "Valley of Death", White paper submitted to the 2012 IOOS Summit, 5 pp, http://www.iooc.us/summit/white-paper-guidelines/community-white-paper-submissions/
[3] Leuttich, R., R. Signell, D. Wright, G. Crane, and L. Smith, A US IOOS Coast and Ocean Modeling Testbed to Improve Prediction of Coastal and Estuarine Systems, White paper submitted to the 2012 IOOS Summit, 4 pp, http://www.iooc.us/summit/white-paper-guidelines/community-white-paper-submissions/

discussing future multi-model multi-disciplinary prediction systems, and one by Rosenfeld *et al.*[5] presenting a vision and implementation strategy for the IOOS modeling subsystem.

Furthermore, IOOS Regional Associations (RAs) recently completed 10-year build out plans, which included visions for estuarine, coastal, and ocean modeling in each of the regions over the next decade[6]. These plans propose that models for waves, ocean circulation, weather, inundation, ecosystems, and water quality are a core requirement that should be available in all 11 RAs ten years from now[6]. At the federal level, the NOAA National Ocean Service released a Technical Memorandum on Establishing National Ocean Service Priorities for Estuarine, Coastal, and Ocean Modeling in 2007, which describes approaches to modeling within NOS and with internal and external partners and brings NOS modeling priorities in line with user communities[7]. Other federal modeling initiatives, such as the Earth System Modeling Framework (ESMF), the National Unified Operational Prediction Capability (NUOPC) within the Earth System Prediction Capability (ESPC), the NOAA Storm Surge Roadmap, and the NOAA Ecological Forecasting Roadmap, will also contribute valuable information to an updated IOOS modeling strategy. At the international level, engagement with the GODAE Coastal Ocean and Shelf Seas Task Team (COSS-TT) may also be beneficial.

Timeline and First Steps:

Initially, an IOOS modeling steering group will be assembled that will be charged with developing the strategy. It is envisioned that a mix of technical and programmatic backgrounds should be represented in this steering group. The IOOS Association will select members from the regions to represent the RAs and this group will work with the IOOS Program Office to identify additional members from either the federal or regional level to enable thorough engagement. The specific method to select the steering group will be discussed at the IOOS RA Program Meeting in March. Some suggestions include a representative from each RA, super-regional representation (e.g. all west coast RAs select one representative), or an elected process through the IOOS Association.

The steering group would perhaps create a Plan of Actions and Milestones (POAM), to document and analyze input from federal and regional modelers associated with IOOS, which would be used to develop an inclusive IOOS modeling strategy.

Activities in the POAM could include:

1. Describing the high-level landscape of estuarine, coastal, and ocean modeling within IOOS,

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[4] Blumberg, A. F., J. Wilkin, and A. Gangopadhyay, Multi-scale, multi-model, Data-Based Prediction Systems Supporting Navigation and Maritime Safety, White paper submitted to the 2012 IOOS Summit, 4 pp. http://www.iooc.us/summit/white-paper-guidelines/community-white-paper-submissions/

[5] Rosenfeld, L., Y. Chao, and R. Signell, 2012: IOOS Modeling Subsystem: Vision and Implementation Strategy, White paper submitted to the 2012 IOOS Summit, 5 pp, http://www.iooc.us/summit/white-paper-guidelines/community-white-paper-submissions/

[6] IOOS Regional Build Out Plans, 2012: http://www.usnfra.org/buildout.html

[7] Cloyd, E.T., A.P. Leonardi, D.L. Scheurer, and E.J. Turner, 2007: Establishing National Ocean Service Priorities for Estuarine, Coastal, and Ocean Modeling: Capabilities, Gaps, and Preliminary Prioritization Factors, NOAA Technical Memorandum NOS NCCOS 57. 56 pp.

2. Engaging the modeling community to address capabilities, gaps, requirements, goals, etc.
3. Documenting the important modeling-related issues facing each RA. These issues could be event-based (e.g. hypoxia, storm surge) or technical (e.g. data assimilation, assistance with employing community models),
4. Investigating the potential for regional modeling efforts to contribute to strategic goals at the federal level (e.g. NOAA Ecological Forecasting Roadmap, NOAA Storm Surge Roadmap, etc.) and for federal modeling efforts to contribute to regional requirements and goals,
5. Comparing inputs with RA build-out plans,
6. Identifying current funding and project future funding of the IOOS modeling subsystem.

Execution of the POAM will result in critical information needed to develop an informed modeling strategy that enhances the effectiveness of IOOS modeling efforts. We believe the development of a community-based strategy could accomplish for the modeling subsystem what it accomplished for the IOOS data management and communications (DMAC) subsystem, a strategy that promotes collaboration, standards, and best practices between federal and regional entities.

Since our success will depend on the IOOS modeling community's active engagement and input, we encourage IOOS RAs to identify key modelers in their regions, alert them to this initiative, and encourage participation in the process. A draft timeline associated with the strategy development is below:

Activity	**Timeline**
Discuss modeling white paper at IOOS RA Program Meeting	Month 1
Select IOOS Modeling Steering Team	Month 1
Discuss goals of steering team, Develop POAM	Month 2-4
Receive feedback on the POAM and revise	Month 5
Execute the POAM	Month 6-7
Online or in person workshop (resource dependent)	Month 7
Document findings and share with IOOS Modeling Steering Team/RAs	Month 8-9
Develop a draft modeling strategy	Month 10-12
Disseminate draft modeling strategy with RAs and other federal and regional partners for review and comment	Month 13
Receive feedback and revise the strategy	Month 14
Finalize strategy and begin execution	Month 15

Candidate Issues for the Strategy

Below, we discuss some candidate elements of the strategy:

1. **Understanding Local, Regional, and National Modeling Capabilities to Improve Integration between Modeling Communities:** An up-to-date understanding of the current landscape of estuarine, coastal, and ocean modeling from the federal to the local level may be an important first step to an improved IOOS modeling strategy. This does not equate to an inventory of models, but instead to a better understanding of the efforts of and relationships between operational modelers at the federal level (e.g. NAVO, NWS, NOS,

USGS, USACE, NASA), non-federal modelers at regional and local levels (e.g. MARACOOS, PacIOOS), research modelers at the academic level (e.g. SURA, USF, Stevens Institute of Technology), and modelers in private industry with the goal of improving these relationships in the future. The goal is also to document requirements, gaps, objectives, and concerns in addition to current efforts and capabilities. To do this, it will be necessary to engage these somewhat disparate modeling sub-communities and while it is not possible to involve every modeler, we hope to engage a majority of the big players at each level and document the greater part of the modeling landscape. Engagement with the community developing open-source models, as well as the funders of these efforts, may also be valuable. We believe that better integration of academic, regional, and federal modeling efforts and initiatives will mutually benefit each of these modeling communities. There are opportunities to improve research model infrastructure for transition to federal agencies, and also to improve federal communication of needs to researchers.

2. **Connect the modeling subsystem to regional resource management issues:** Rather than beginning the strategy development process with gathering information about modeling efforts and gaps across the RAs, start with understanding the critical resource management issues that may be addressed with modeling in each RA. These issues may have ties to the federal modeling community and private industry, in addition to the regional modeling community. The proposed modeling steering team would not have to start from scratch; these issues have largely been identified in RA blueprints, progress reports, and build-out plans. After the primary issues are identified, modeling-related objectives and strategies which address issues that cross-cut multiple RAs could then be developed.

3. **Improve Coordination between the Observational, DMAC, and Modeling and Analysis Sub-Systems:** The IOOS Summit identified the need to better integrate the observational, DMAC, and modeling subsystems to generate an informational subsystem that could more effectively meet end-user requirements than each subsystem independently. As a result, this strategy may contain specific recommendations for RAs to improve coordination between these subsystems when delivering data or developing products for users.

Appendix A: Nine Findings and Recommendations from the 2008 Modeling and Analysis Workshop (MAST) Report

1. The IOOS Modeling and Analysis Steering Team (MAST) effort, having served to foster the emergent partnership of the National Backbone and RCOOS communities, has naturally evolved into an IOOS Ocean Prediction and Analysis (OPA) effort (this alternative terminology has the collateral benefit of being easier to explain to marine stakeholders and agency program managers) and should now be replaced with an OPA Joint Working Group (OPA-JWG)

2. The OPA Community needs a forum to maintain periodic group communications on a face-to-face basis for fostering research and operational partnerships; therefore, the OPA-JWG should be expected to sustain this activity.

3. Aggregate a set of standard attributes (e.g., space-time resolution, accuracy, forecast horizons, and timeliness) for operational ocean prediction core variables that can be traced back to user requirements;

4. Assemble a suite of model skill assessment metrics which form the basis for uncertainty estimates of predictions, tradeoff studies between alternative observing system networks, and validation studies;

5. Summarize attributes of standard observational data (e.g., variables, including topographic, hydrological, meteorological, ecological, etc. data; space-time resolution; and accuracy) needed for multi-disciplinary model forcing, verification, validation, and data assimilation;

6. Define needs and outline design and implementation plan for a distributed, "one-stop shopping" national data portal and archive system for ocean prediction input and output data;

7. Draft a CONOPS that delineates the respective roles and responsibilities of the National Backbone and RCOOSes, including joint activities; e.g., testbeds and ocean prediction experiments.

8. Submit simultaneous Inter-Agency Working Group on Ocean Observations (IWGOO) requests to the Oceanographer of the Navy (N84) and the Commander, Navy Meteorology and Oceanography Command (CNMOC), to provide the regional ocean prediction products with mesoscale variability produced by the Naval Oceanographic Office (NAVO) to NOAA for use by the National Weather Service/National Centers for Environmental Prediction (NWS/NCEP) and the National Ocean Service/Center for Operational Ocean Products and Services (NOS/CO-OPS) and NOS Coast Survey Development Laboratory (NOS/CSDL), and by the RCOOSes for open boundary conditions applied to higher resolution coastal ocean models, skill assessments, diagnostic studies, etc.

9. OPA activities are leading to infrastructure components (e.g., skill assessment metrics, testbeds [alias 'model evaluation environments' in NOS parlance], data assimilation schemes, and Observing System Experiments (OSEs)/Observing System Simulation Experiments (OSSEs)) that are essential to the overall system design and performance evaluation of IOOS in the logical context of systems engineering (SE), the pursuit of which is encouraged to provide a defensible, logical basis for the design and management of the long-term program.