Actual SAB Response.

NOAA Response to NOAA Science Advisory Board NCEP Ocean Modeling Review Panel

The July 30, 2004 report of the National Oceanic and Atmospheric Administration Science Advisory Board evaluation of Ocean Modeling at the National Centers for Environmental Prediction contains three major recommendations. **The overarching recommendation points to a central role for NCEP in the ongoing effort by NOAA to advance ocean observations and their use in more sophisticated data assimilation and related numerical prediction models.** This response is intended to lay out the general new and coordinated thrust that cuts across all of NOAA and reaches out to growing and diverse groups of users. Although some overarching principles are addressed herein and details are provided, where appropriate, the complete action list will be developed through NOAA's Environmental Modeling Program Plan. This plan will be updated every year and provided to the SAB for review and comment.

NOAA/NCEP is developing plans and taking a central role to develop a national backbone capability for ocean and coastal ocean and Great Lakes modeling as part of an integrated operational Earth System Model supporting the Nation's weather, climate, hydrological, ocean and ecological forecasting needs. The national backbone will consist of generalized global and regional environmental models. It will integrate appropriate existing and planned land, atmosphere, ocean and cryospheric data assimilation and prediction models into the NCEP operational environment and, by making output readily available to all users, serve as the foundation for operational environmental prediction for a diverse array of customers and partners. The goal is to leverage NCEP-produced generalized environmental predictions to drive or link to specialized models and applications to meet specific local or agency requirements. This will allow customers and partners to develop complementary models to meet specialized local, regional and mission needs. This strategy will require initiatives in each of the three areas noted in the summary recommendations of the Ocean Modeling Review Panel. Specifically, **NOAA will:**

- **Migrate all appropriate NOAA ocean, coastal ocean and Great Lakes models into the NCEP operational environment**
- **Develop external partnerships with appropriate federal, regional, academic and private sector modeling organizations**
- **Develop required business strategies and policies**

The specific response to each of the three summary SAB recommendations follows:

Major Recommendation #1: Integrate Ocean Modeling – Ocean, coastal ocean and Great Lakes modeling must be fully integrated into operational weather, climate, hydrologic and earth system forecasts.

Response #1: NOAA is developing the internal NOAA partnerships to fully integrate appropriate operational ocean, coastal ocean and Great Lakes modeling capabilities into an operational Earth System Modeling System to provide the foundation for climate,

weather, hydrologic and ecological forecasts. NCEP will provide a comprehensive operational national backbone ocean and coastal ocean modeling capability across time-scales of a few hours to a year or more.

NOAA will integrate appropriate ocean, coastal ocean, estuarine and Great Lakes models, including NOS Regional operational models, into NCEP's operational modeling system. This integration will include existing and planned models. The driving principle will be to create an Earth System suite of models linked and coupled in a geophysically correct and consistent way to provide the most accurate simulations and forecasts for all appropriate physical processes affecting the production of NOAA's required environmental information. Modeling will be accomplished in an Earth System Modeling Framework, which standardizes computing architectures, formats and standards to minimize sustainment and tech infusion costs over the life cycle of the operational models. The modeling architecture will consist of models run centrally and regionally/locally, as mission needs and business efficiencies dictate. The envisioned modeling suite will include:

- **Data assimilation** schemes, which exploit National Water Level Observational Network (NWLON), NDBC buoys, C-MAN stations and other appropriate ocean, coastal and estuarine observations.
- Fully **coupled components** of atmosphere, ocean, coastal and land elements.
- Models of **coastal watersheds** (from heads of rivers to coastal zone) appropriately coupled to atmospheric models.
- **Hydrological models** coupled to atmosphere and land models.
- **Mesoscale-admitting resolution** models.
- Appropriately **nested, regional coupled ocean-atmosphere forecast models**, including coastal ocean, estuary and Great Lakes models, storm surge, tides and wave models, and appropriate ocean hazards trajectory models.
- Models run in **deterministic and probabilistic** (ensemble) mode

Major Recommendation #2: Partnerships – Develop internal and external partners committed towards implementing two-way, interactively coupled ocean-coastal-atmosphere models for operational forecasting.

Response #2: NOAA will develop and rely on internal and external partnerships committed to making the United States the world leader in operational ocean, coastal ocean, and estuarine modeling. Given the growing spectrum and scientific complexity of: ocean, coastal ocean and estuarine models, their coupling with atmospheric components, and the nesting necessary to achieve fine resolutions where needed to meet mission requirements, we believe no one agency or organization, including NOAA, has the resources to accomplish such a challenging task on its own. NCEP will reach out across NOAA, the Federal Government, Academia, and Non-governmental Organizations, including the Private Sector, to entrain the necessary scientific and

technical expertise to develop and sustain world-class operational ocean, coastal ocean and estuarine models.

Internal partnerships will span all NOAA line offices and include expertise in observations, data assimilation, dynamical and statistical prediction, and specialized applications. External partnerships will include federal, academic, NGOs and private sectors, and will span research, development and operational communities. Specifically, NOAA will establish partnerships with the United States Navy, the National Science Foundation, NASA, US Environmental Protection Agency, and the broader academic community, and will leverage the growing Integrated Ocean Observing System (IOOS) partnership programs, as appropriate. These partnerships will span research and development and transition to operations, as well as the operational component. Envisioned partners will include:

- **Internal NOAA Line Offices:** to improve Ocean prediction links to:
  - NOAA research (PMEL, AOML, GLERL, GFDL);
  - NOS model development activities (NCCOS, CSDL, CO-OPS, CSC) focused on ports and other fine-scale coastal mission requirements;
  - Coastal modeling applications (e.g., storm surge) in MDL, FSL, and other NOAA labs;
  - HL hydrological modeling for coastal watersheds;
  - Joint OAR, NOS and NMFS developmental activities laying the foundation for ecological forecasting for oceans, coastal oceans and estuaries.
- **US Navy and NASA**: a joint ocean and coastal management and communications program to generate information products relevant to national, regional, state and local needs. The goal is to expeditiously develop necessary operational global ocean and coastal ocean modeling capability.
- **IOOS partners, including Ocean.US and Regional Associations**: a distributed modeling arrangement is envisioned in which NOAA provides backbone operational models and information which are integrated into regional concepts of operation to meet local needs outside NOAA's mission.
- **Oceanographic research and academic communities**: to assist in the development of operational ocean, coastal ocean, and estuarine data assimilation and forecasting models.
- **Non-Governmental Organizations, including the Private Sector**: to assist in the development of operational ocean, coastal ocean, and estuarine data assimilation and forecasting models, as appropriate, and to facilitate links to users of ocean services and products.

Major Recommendation #3: Strategy – Lead the development of a comprehensive strategy with the ocean community.

Response #3: NOAA will develop a comprehensive National strategy for operational ocean, coastal ocean and estuarine modeling through the internal and external partnerships developed in response to recommendation 2. The Nation needs a comprehensive National ocean modeling strategy to organize and synchronize a diverse array of modeling activities to ensure the United States is the world leader in ocean, coastal ocean, and estuarine modeling. The impact of the environment in these regions on public safety and health, National security, and the US economy is well documented. Unnecessary duplication and competition between various sectors is hindering rapid advancement of science to create great benefit for society. Through NCEP, NOAA is well positioned to organize a National strategy to synchronize and align developmental and operational activities of NOAA and partners to meet critical national needs for improved ocean, coastal ocean and estuarine models.

The envisioned strategy is intended to be a National ocean model strategy and to address roles and responsibilities, research through operational implementation, as well as the supporting infrastructure. A national steering committee will be required to provide the necessary scientific and technical direction. The strategy's foundation will be based on NOAA's existing operational backbone capability, which ingests, processes, and predicts atmospheric and ocean elements. This operational backbone should be used by regional entities, such as IOOS Regional Associations, to provide complementary information to meet local needs (beyond the scope of NOAA's mission) in a collaborative centralized-distributed operational framework. As part of the national strategy, NCEP will explore a collaborative centralized-distributed operational partnership with appropriate regional entities.

A partnership strategy is also envisioned for all phases of a model's development life cycle – from research to operations. A developmental partnership similar to that in place for the Weather Research and Forecast (WRF) Model, in which DoD, FAA, NSF, and NOAA are collaborating to develop the next-generation operational fine-scale weather forecast model, will be attempted. It is envisioned that such an arrangement would allow NCEP to outsource most, if not all, of the developmental responsibility for ocean, coastal ocean and estuarine models, and to focus its internal efforts on transitioning new models and science and their sustainment in its operational environment. It should be noted that such a strategy would still require improved ocean modeling expertise at NCEP. NCEP will organize a crosscutting team focused on strengthening the links to research advances in ocean science to ensure consistency and coordination across the wide spectrum of operational models, to accelerate the transition of new science into these models and to lay the foundation for extending existing operational models into ecological forecasting. NOAA will recruit a nationally known scientist to lead this team and to advise key leaders on appropriate ocean modeling needs and strategies.

Key to the success of these strategies will be agreement on:

- Governance, including a National oversight board, and agreed upon centers of expertise
- Research requirements and priorities
- Research to Operations processes and strategies
- Operational collaboration strategies
- Data management and communications to ensure interoperability
- Supporting IT architecture and standards, to include a standardized Earth System Modeling Framework, and developmental and operational testbeds
- Sufficient computing and IT resources

The initial roadmap for meeting the commitments summarized in the above responses is at Appendix A. It lists goals, tasks and associated dates for Integration of Ocean models, and development of partnerships and strategy.

Appendix A

Integrate ocean, coastal ocean and Great Lakes modeling must be fully integrated into operational weather, climate, hydrologic and earth system forecasts				
Tasks	**Completion Date (Quarter/Year)**	**Months after start**	**Specific steps and responsible office**	**Responsible Party**
Testing and planned implementation of the HYCOM-based Real-Time Ocean Forecast System RTOFS.	Q1 FY06	6	Implement HYCOM-based RTOFS for the North Atlantic Basin, including the Gulf of Mexico.	NWS/NCEP
Ongoing operational use of the Wave Watch III model.	Ongoing	N/A	Implement NOAA WaveWatch-3 into operational production producing a full line of wave forecast products for global, regional and hurricane applications.	NWS/NCEP
Migration of the NOS and transition to operations of OAR coastal, estuarine, and Great Lakes hydrodynamic models to the NCEP operational environment and coupling with NCEP's ocean and regional atmospheric models.	Q4 FY07	10	Migrate an NOS operational coastal model to NCEP.	NOS/CO-OPS/NCEP
		11	Validate data access and demonstrate product delivery.	NOS/CO--OPS/NCEP
		12	Operational transfer evaluation complete.	NOS/COOPS /NCEP
		15	Operational Agreement.	NOS/NWS
		18	Establish NOS operational infrastructure at NCEP.	NOS/NCEP
		24	Migrate other appropriate operational NOS models to NCEP.	NOS/NCEP
		24	Transition to operations appropriate OAR models	NCEP/OAR
Operational implementation of the GFDL Modular Ocean Model Version 3 as part of the recently implemented NCEP Climate Forecast Systemand develop MOM-4.	Q2 FY07	Complete	Implement Climate Forecast System including Global Forecast System coupled to Modular Ocean Model-3 and Global Ocean Data Assimilation System.	NWS/NCEP
		24	Develop use of Modular Ocean Model-4 in the GODAS and to include polar latitudes and a Sea Ice Model.	NCEP/EMC with GFDL

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Integrate ocean, coastal ocean and Great Lakes modeling must be fully integrated into operational weather, climate, hydrologic and earth system forecasts				
Tasks	**Date (Quarter/Year)**	**Months after start**	**Specific steps and responsible office**	**Responsible Party**
Continue support for research into improving data assimilation and the utility of ocean observations for assimilation	Q4 FY09	36	Put out an RFP through the NOPP process asking for proposals evaluating the effectiveness of currently available data availability and data assimilation at improving the accuracy of coastal ocean models.	NOS
Continue investment in SLOSH modeling and storm surge forecast production	Q4 FY07	3-6	In the short-term (FY06), NOAA will increase its investment in SLOSH modeling to meet NOAA mission requirements.	NWS/NCEP
		12-24	Increase the basin update rate from once every 12 years to once every 6 years in order to improve current storm surge forecasting.	NCEP & CSC & EMP/CEO
		12-24	Evaluate ways to extend forecast lead time, including probabilistic forecasts.	NWS/NCEP
Develop a community-modeling approach to the next generation of storm surge modeling and forecasting	Q4 FY08	12	Develop a simple standard set of tools (e.g., data ingestion, data sets, and output formats) to evaluate models. Criteria for evaluation should have modeling community agreement.	CEO/EMP
		24	Begin a community-wide modeling approach that includes as part of this approach, SLOSH being made available to the broad modeling community to allow modelers to offer improvements. Improve probabilistic forecasts, including wave effects, increasing horizontal and vertical resolution and accuracy, incorporating tides and freshwater effects.	EMP
		24-36	Establish a test-bed program to work with the modeling community on the evaluation of models.	EMP/CEO/IOOS

Appendix A

Develop internal and external partners committed towards implementing two-way, interactively coupled ocean-coastal-atmosphere models				
Tasks	**Date (Quarter/Year)**	**Months to complete**	**Specific steps and responsible office**	**Responsible Party**
Relevant NOAA partners are working together toward the vision of an integrated suite of models providing product guidance and service to necessary programs	Q3 FY05	Complete	Vision, goal and objectives to achieve internal ocean, coastal ocean partnerships between NWS/EMC, NOS/CSDL, NOS/CO-OPS, OAR/GFDLEMP	EMP
		1	Roles and responsibilities agreed upon and documented in EMP charter.	EMP
	Q4 FY05	3	Establish ecosystem modeling coordination group to include EMP, Ecosystem Research Program, Ecosystem Observation Program, Hydrology and Mission Goal representatives to ensure coordination of programmatic activities	EMP
	Q1 FY06	6	Establish a technical coordination group among technical experts of affected programs to ensure design evolution will support ecosystem needs	EMP
Establish a national partnership with the US Navy for the development and joint evolution of a National Ocean Modeling Capability	Q4 FY06	1	Letter to Commander, NMOC, Stennis Space Center, MS requesting begin discussions.	NOS Technical Director
		3	Establish NOAA/Navy working group.	
		5	Agree to outline and scope of partnership.	
		7	Draft agreement between NOAA/Navy.	
		12	Agreement signed by appropriate parties.	

Appendix A

Establish a national partnership with the National Science Foundation, NASA, and US Environmental Protection Agency for the development and joint evolution of a National Coastal and Ocean Modeling Integrated Research Strategy	Q4 FY06	3	Letters to NSF, NASA, and EPA requesting begin discussions	OAR AA
		5	Establish NOAA/NSF/NASA/EPA working group	
		7	Agree to outline and scope of partnership	
		9	Draft agreement between NOAA/NSF/NASA/EPA	
		12	Agreement signed by appropriate parties	
Leverage existing external partnerships with various regional associations to expand the partnership to include modeling	Q3 FY07	24	Establish link to the NOAA representative on the US Ocean Action Plan.	N/A
Leverage existing external partnerships with various regional associations to expand the partnership to include modeling	Q3 FY07	Complete	Establish link to the NOAA representative on the US Ocean Action Plan.	N/A
		6	Establish IOOS Ocean Modeling Advisory Group	IOOS Manager with EMP
		12	Complete Integrated Ocean Observing System (IOOS) project plan to explicitly define role of modeling as an IOOS component.	IOOS Manager with EMP and CEO
		24	Through National Federation for Regional Associations, expand Regional Association Agreements to include explicit modeling partnership with NOAA.	CEO/EMP
Establish academic partnerships	Q2 FY07	9	Develop a series of regionally-based workshops to interact and collaborate with academic organizations and institutions.	NOS
		18	Establish a national forum to collaborate on outreach and education related to these efforts	NOS

Appendix A

Lead the development of a comprehensive strategy with the ocean community			
Tasks	**Date (Quarter/Year)**	**Specific steps and responsible office**	**Responsible Party**
Develop a continuing national forum on at least an every two year basis for the national community modeling strategy	Q1 FY06	Establish a steering committee to form the backbone for implementation of an annual or every other year conference on coastal and ocean modeling.	NOS/NWS co-leadership, SAB chair
	Q2 FY06	Complete inventory of the ocean observing and modeling capability, both existing and in development, from all sources including academia, private industry, all appropriate federal entities that can contribute to a community modeling approach.	NOS/NWS co-leadership
	Q3 FY06	Hold a national conference, to develop and document a comprehensive national strategy for the evolution of community-based ocean and coastal ocean modeling in the United States.	NOS/NWS co-leadership
	Q4 FY06	Hold a national workshop or series of regional meetings, in partnership with the NFRA and Sea Grant, to develop a process to create and promote the use of model derived nowcasts, forecasts, and other products.	NOS/NWS co-chairs
	Q4 FY06	Establish continuing process for coastal and ocean modeling forum.	CEO/EMP