Executive Office of the President
Office of Science and Technology Policy

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Council on Environmental Quality

MEMORANDUM FOR JOHN H. MARBURGER, III, DIRECTOR,
OFFICE OF SCIENCE AND TECHNOLOGY POLICY (OSTP)

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INTERAGENCY COMMITTEE ON OCEAN SCIENCE AND RESOURCE MANAGEMENT INTEGRATION (ICOSRMI)

SUBJECT: FY 2010 Interagency Ocean Science and Technology Priorities

This memorandum describes the Fiscal Year (FY) 2010 interagency ocean science and technology priorities as called for in *Charting the Course for Ocean Science in the United States for the Next Decade: An Ocean Research Priorities Plan and Implementation Strategy.*

The interagency ocean research priorities described in this document build upon the work of the Joint Subcommittee on Ocean Science and Technology (JSOST) and the ocean science community in the production of *Charting the Course for Ocean Science*, and take advantage of new interdisciplinary research approaches, sophisticated research and computational tools, and the availability of shared assets such as personnel and research platforms. An appropriately balanced science and technology portfolio will provide insight into ocean processes that will enable better and timelier policy and resource-management decisions. This approach will require careful coordination among local, tribal, state, regional, and federal government agencies as well as academic, private sector, and nongovernmental entities.

The ocean science and technology priorities herein are federal and multi-agency in scope. However, the federal agencies are not the only entities conducting research in these areas; partnerships are critical to ocean research. These priorities have been identified as the most important areas for FY 2010 in which the federal agencies should work cooperatively. It should also be noted that each of the 25 participating agencies also has its own priorities based on agency missions and mandates that contribute to furthering ocean research.

While the findings and recommendations of *Charting the Course for Ocean Science* guided the President's budget request to Congress for FY 2008 and FY 2009, agency planning efforts for the FY2010 budget are the first to begin since the release of *Charting the Course for Ocean Science*. Thus, the various Federal agencies with ocean science and technology development responsibilities are expected to carefully consider the implications of *Charting the Course for Ocean Science* during preparation for future FY 2010 budget development by the next Administration.

Prioity Areas

There are 20 priorities listed across six societal themes in *Charting the Course for Ocean Science*. This memorandum provides emphasis to those priorities and a strategy for moving forward by addressing three areas: near-term priorities, with timelines of two to five years; selection of future priorities, looking beyond the five year horizon; and selection of infrastructure priorities.

Near-Term Priorities

Charting the Course for Ocean Science highlights four near-term priorities developed to initiate rapid progress toward the 20 longer-term ocean research priorities. They are not a direct subset of the 20 broader research priorities, but they incorporate issues highlighted in many of them. These near-term priorities were selected from a larger suite of efforts using the criteria outlined in *Charting the Course for Ocean Science*, with an added focus on impact i.e., the value of the work, urgency i.e., the need for a concentrated effort over the next two to five year, and partnerships (i.e., the effort will maximize collaborations among agencies and external partnerships). The near-term priorities identified in *Charting the Course for Ocean Science* and noted below as the FY 2010 Near-Term Interagency Ocean Research Priorities are multi-year efforts that will require sustained funding if substantial progress is to be made on them.

Selection of Future Interagency Ocean Science and Technology Priorities

The annual Interagency Ocean Science and Technology Priorities Memo, of which this is the first, will not likely change substantially from year to year; however, as time goes by, there will need to be an evolution of the near-term priorities as efforts are completed and new issues move to the forefront. The four near-term priorities identified in *Charting the Course for Ocean Science* apply the three central elements of ocean science and technology highlighted in that document: (1) capability to forecast key ocean-influenced processes and phenomena; (2) scientific support for ecosystem-based management; and (3) deployment of an ocean observing system. Consistent with these elements, the federal agencies, working with the broader ocean science and policy community, may identify new near-term priorities as progress on the four current near-term priorities is made. Three criteria have been suggested to assure that new near-term priorities take into account ongoing developments in science and technology, and the user communities, in future years:

- External influences e.g., new scientific discoveries, new capabilities;
- Natural events e.g., the 2004 tsunami, recognition of the implications of ocean acidification; and
- Changes in ocean-related policies.

Infrastructure Priorities

For FY 2010, the JSOST is not specifically identifying new infrastructure priorities however the committee does recognize the importance of ongoing activities.

The JSOST Interagency Working Group on Facilities (IWG-F) recently completed an Oceanographic Fleet Status Report, which focuses on the federal research fleet. This effort pointed out the need to understand how major investments in specific infrastructure components, such as the research fleet, satellites, or in situ observing networks, must be balanced across the broader spectrum of infrastructure needs.

Looking ahead, a key consideration in implementing *Charting the Course for Ocean Science* is what physical infrastructure is required. The JSOST is working both internally and with the ocean community on this issue. It has tasked the IWG-F with developing an inventory of current and planned federal facility retirements/closures/gaps and incoming federal infrastructure available to accomplish goals of *Charting the Course for Ocean Science*. The JSOST is also working with the National Research Council on a study of ocean infrastructure. As the federal ocean agencies work with the community to set priorities for ocean infrastructure, input is needed on infrastructure issues, including criteria most appropriate for prioritization. These efforts may lead to a prioritized list of infrastructure investments sometime in FY 2010. Agencies are encouraged to participate in this process and prepare to implement these findings when they are available.

Fiscal Year 2010 Near-Term Interagency Ocean Research Priorities

For FY 2010, the Near-term Interagency Ocean Research Priorities are the same as the near-term priorities listed in *Charting the Course for Ocean Science.* The table below notes specific activities of emphasis for implementing these near-term priorities in FY 2010, based on and working toward, the overarching focus of each near-term priority as described in Attachment A.

Near-Term Priorities	**Key Emphases for FY 2010**
"Forecasting the Response of Coastal Ecosystems to Persistent Forcing and Extreme Events"	• Continue development of mechanisms to ensure prioritization, planning and implementation are coordinated with and advance other ORPP priorities, related administration priorities, and priorities established through state and regional efforts. • Enhance observational systems and develop tools for integration of regional observing elements to support model development and application. • Support community development of assessment and forecast tools at regional scales and engage user-community in product definition to ensure that decision-support tools effectively transfer research results to management application.

Near-Term Priorities	Key Emphases for FY 2010
"Comparative Analysis of Marine Ecosystem Organization (CAMEO)"	• Support a broad-based steering group that will develop the scope and oversee the planning and execution of the CAMEO program • Develop new models and approaches that will allow systematic comparison of marine and coastal ecosystems to human activities and environmental variability • Undertake comparative studies of the ecological, social, and economic effects of the establishment of representative marine protected areas
"Sensors for Marine Ecosystems"	• Select geographic validation sites and studies for genomic, biological, chemical, and bio-optical sensor development • Begin development of new sensors to allow multi-scale observations of new aquatic ecological properties • Initiate studies to measure and/or improve quantification of previously unresolved or existing observations of aquatic ecosystem properties and the response to environmental forcings
"Assessing Meridional Overturning Circulation Variability: Implications for Rapid Climate Change"	• Fundamental research on the AMOC structure and variability • Ocean re-analyses leading to present and past estimates of the AMOC • Design and initial implementation of an observing and monitoring system for the AMOC

Attachment A - Narrative Description of the JSOST FY 2010 Near-term Interagency Ocean Priorities Based on *Charting the Course for Ocean Science*

1. Forecasting the Response of Coastal Ecosystems to Persistent Forcing and Extreme Events

Coastal ecosystems are subject to a variety of forcings, ranging from extreme events (*Charting the Course for Ocean Science* Societal Theme 2 - Increasing Resilience to Natural Hazards), to human activities (Societal Theme 5 - Improving Ecosystem Health), to changing ocean conditions (Societal Theme 4 - The Ocean's Role in Climate). Understanding the response of natural and constructed landscapes and ecosystems, (e.g., algal blooms, hypoxia, coral-reef bleaching, decline in sea ice), to these forcings; forecasting the frequency, intensity, and impact of these forcings; and providing tools to develop policy and management responses are integral to constructing more resilient structures and communities, and protecting the natural environment. Research and observations will focus on establishing the basis for both short-term forecasts and long-term, probabilistic assessments of coastal vulnerability to extreme events, persistent natural processes, and human influences across the coastal zone. This effort will enhance regional observing systems and models, integrate substantial existing observations, and incorporate new observations to address critical regional data gaps. Data and information products will be made widely available to diverse end users through a national ocean-observing capability. Results from this effort will inform hazard mitigation and response plans, provide forecasting data to support navigation safety, and assist regional resource managers and public health officials in sustaining ecosystem and public health, and promoting hazard resilience.

Observations of physical characteristics and processes, including material inputs from adjacent watersheds and contributing airsheds, ocean influences on hurricane intensification, and characterization of submerged and coastal landscapes, will be integrated to support data-assimilative modeling of, for example, water quality, nutrient, sediment, and contaminant transport; waves and water levels; and the coastal response to hurricane processes.

Biological observations, including new DNA-based techniques, will enable development of coupled physical and biological models of ecosystem-level response to various stressors. Coupled research, observations, and model development focus on identification, quantification, and transport of pathogenic microbes and various species of harmful algae, and lead to robust, timely forecasts of human-health threats and natural-resource impacts. Additionally, linking environmental-quality data with public-health surveillance activities will support modeling and prediction of the geographic expansion of potential health risks from hurricanes and specific waterborne vectors, toxins, and pathogens.

This effort will build upon extensive existing data sets, surveillance, observational, and modeling capabilities; promote the transition of models from research tools to operational applications; and support the establishment and linkage of regional and national ocean and coastal water-quality data networks. Decision-support models will inform prevention strategies, rescue and recovery operations, spill tracking, safe maritime navigation, water-quality forecasting, and resource assessment and management, taking into account the vulnerability of ecosystems as well as their capacity for mitigating harmful impacts. Focus areas for implementation will be identified to build upon existing assets where integration and enhancement provide the greatest opportunity to impact public safety and public, economic, and environmental health.

Agency Activities:

- *United States Geological Survey*—Conduct hydrological and biological monitoring and regional geologic and environmental mapping and characterization. Perform research on coastal processes and response to persistent forcing and extreme events. Develop models to forecast hydrologic, landscape, and ecosystem response, and tools to provide assessments of coastal vulnerability and predict future ecosystem conditions.
- *NOAA*—Acquire and integrate (including standards development) monitoring and mapping data from existing and enhanced coastal observation platforms. Conduct assessments to identify region-specific coastal and marine research priorities. Develop community inundation and ecosystem models for assessing storm vulnerability, oil-spill movements, and ecological impacts. Develop a Web-based geospatial framework and digital-elevation models essential for decision-support tools, including socioeconomic and environmental indices.
- *United States Army Corps of Engineers*—Expand shallow-water coastal mapping and wave-observation programs. Develop community, high-resolution coastal models and testbeds to support next-generation models for all agencies, and transition models from research to operational use. Enhance coupling among ecosystem, coastal hydrodynamic, and watershed models to provide integrated management tools for planning, hazard identification, and response.
- *Environmental Protection Agency (EPA)*—Integrate and assimilate observations from coastal-condition surveys and observational platforms. Enhance coastal-condition surveys and assessments. Develop ecosystem models to forecast changes in ecosystem services. Develop models and decision-support tools, including socioeconomic measures of goods and services, to assess changes in ecosystem services resulting from regulatory programs, land-use planning, and natural events.
- *National Science Foundation (NSF)*—Generate real-time, reconfigurable, open-ocean observations that may be used to properly initialize forecast models through the OOI. Conduct research on physical, ecological, and social processes relevant to model development and basic understanding of ecosystem response.

2. *Comparative Analysis of Marine Ecosystem Organization (CAMEO)*

Forecasting marine ecosystem responses to management strategies requires an understanding of the complex dynamics that control and regulate ecosystem processes (*Charting the Course for Ocean Science* Societal Theme 5 Improving Ecosystem Health, and Societal Theme 1 Stewardship of Natural and Cultural Ocean Resources). Management of marine ecosystems can be improved by elucidating the underlying dynamics of these systems at a variety of scales. This effort will provide a greater basic understanding of ecosystem processes and practical tools for evaluating the effectiveness of local and regional adaptive ecosystem-based management efforts.

Ecosystem-based approaches emphasize interactions among components and the impacts that various human activities have on productivity and organization. Forecasting these impacts requires understanding complex dynamics controlling: (1) productivity of various trophic levels, (2) predator-prey interactions, (3) connectedness of sub-populations, (4) impacts of natural climate variation, and (5) anthropogenic pressures. Because classical controlled experimentation provides limited information on the complex dynamics of marine ecosystems, two types of analyses will be undertaken. The first approach will construct and apply various classes of energy-budget and dynamic models to managed marine ecosystems to enable greater understanding of the impacts of human activities by contrasting biomass changes according to trophic level. The second approach will compare systems where marine managed areas have been enacted to conserve species and ecosystems.

Such comparisons will include before and after area designation contrasts where sufficient data are available, and inside versus outside comparisons for established managed ecosystems. Mapping efforts will include ecosystem-scale characterization, design of interpretive products, and provision of tools to assimilate and disseminate geospatial information in support of research, observations, modeling, forecasting and management decision support.

Candidate ecosystem types for inclusion in this study may include the sub-Arctic, continental shelves, coral reefs, and estuaries. Analyses of these ecosystems will focus on how feedbacks influence ecosystem productivity, biodiversity, and conservation of managed species through comparisons using consistent modeling frameworks. Evaluation of the effects of management efforts will involve assimilation and synthesis of existing biological information by trophic level, linkages to higher levels, and impacts on human-use patterns (e.g., displacement of human activities from marine protected areas and their socioeconomic effects). These efforts will help ensure that effective ecosystem-based management strategies are based on sound scientific understanding.

Studies of marine ecosystems have employed a diversity of models to help shape our ideas about population and community dynamics, trophic transfer of energy, individual foraging behaviors and habitat use, and the impact of human disturbance therein. CAMEO is interested in furthering models that can provide robust predictions on the impacts of physical, biological, and anthropogenic drivers on marine ecosystems. New ways of applying existing models may be found, and new classes of models may emerge. Moreover, modeling approaches will help identify which observational and experimental data are most critical to collect. CAMEO will ultimately rely on models to test the generality and operational use of concepts such as "resilience" or "regime shift."

Agency Activities:

- *NSF*—Improve ways of incorporating uncertainty in model-parameter estimates, the role of size and age structure in population demographics, and spatial dynamics. Facilitate application of quantitative frameworks to data sets to synthesize dynamics across ecosystems and conduct investigations with theory, design, observations, and experiments to interpret the ecosystem and socioeconomic impacts of MPAs.
- *NOAA*—Develop quantitative ecosystem models in partnership with academic and agency partners, apply appropriate data from multiple in-house monitoring databases, and interpret results. Analyze the MPA role in relation to conventional fisheries management tools, in addition to other ecosystem variables.
- *National Aeronautics and Space Administration (NASA)*—Expand existing biological and biogeochemical models to encompass the function of ecosystems under study, and facilitate incorporation of satellite ocean biological and biogeochemical data into models to improve spatial ecosystem-function analyses. Examine quantified variations in key ocean properties from satellite data that may influence the amount and composition of primary productivity in and around MPAs.
- *Department of Interior (DOI)*—Contribute quantitative approaches for species assessments and ecosystem evaluation, coral reef, deep benthic and wetland/estuarine ecosystem data for the models, and relevant seafloor mapping data and analyses,

especially where specific human activities that impact ecosystems are affected by the imposition of MPAs.

3. *Sensors for Marine Ecosystems*

Advances in ocean sciences have been made possible by technological innovation. The development of new sensor capabilities, integral to many of the research priorities, will help realize the full potential of *in situ* observing networks and satellite-based observations (Developing the Tools) and enhance understanding of marine ecosystems (Improving Ecosystem Health, Enhancing Human Health). Currently, significant limitations exist in observational capabilities and associated methodologies. Advancements in sensor capabilities can revolutionize understanding of the ocean environment by providing information at temporal and spatial scales not currently available.

Immediate improvements can be made to *in situ* instrumentation in eco-genomics, to interdisciplinary ocean observing, and to sensors in support of satellite-derived ocean color (used to estimate biological [phytoplankton] and biogeochemical [carbon] materials in surface waters) and new biological and biogeochemical observations. Creation of a common library of genetic "barcodes" is a critical step in the development of fast, economical genetic screening procedures to identify marine organisms. Such procedures will help reveal basic ocean processes controlling biodiversity and productivity, such as the distribution and abundance of harmful algae and pathogens. Advancing novel capabilities and moving high-impact/high-utility sensors from research to broad operational use will allow for physical sensors capable of providing a better understanding of ocean transport and fluid velocity, and chemical sensors that can reliably detect toxins and ecologically important nutrients. Enhancing in-water instrumentation used in ground-truth exercises will improve the quality and usefulness of ocean-color data provided by satellites, and will aid in the development of new space-based, ocean biological and biogeochemical measurements.

Improving ground-truth and *in situ* observations will significantly advance understanding of—and ability to model—ocean systems (ecology, biology, carbon) and their role in the Earth system, as well as the potential impact of human activities. Parallel advances in power-supply technologies and data transfer must also occur to ensure *in situ* sensor operation in a variety of environments and within a variety of networks. Advancing sensor capabilities will enable new, multi-scale observations that provide information needed to better define marine resource management options, help understand processes that influence ecosystem health, serve as the basis for forecasting ocean-related risks to human health and safety, and shed light on the impact of climate variability and change on the ocean, marine life, and humans. Expanding sensor capabilities will build on existing mechanisms of support (e.g., agency programmatic priorities) and coordination (e.g., public-private partnerships), and development efforts (e.g., laboratory-based prototypes, expanded capability of existing satellite sensors).

Agency Activities:

- *NSF*—Develop *in situ* ocean sensing systems, emphasizing chemical sensors for high-priority compounds such as nutrients, biological sensors for real-time ecosystem analysis, and physical sensors that enable better understanding of transport and fluid velocity. Develop associated technologies such as cyberinfrastructure tools (to link sensors in a broad network context) and advanced power-generation capabilities.

- *NASA*—Improve existing space-based, open-ocean, remote-sensing capabilities of biological and biogeochemical properties (and future satellite sensor capabilities in optically complex or coastal waters) by assessing accuracies in remote-sensing, optical, and bio-optical sensor calibration and validation data-collection activities. Develop next-generation optical and bio-optical field sensors and satellite data products that test new technological and methodological approaches.
- *NOAA*—Develop genomic libraries to advance understanding of ecosystem processes, as well as species abundance and distribution. Develop *in situ* sensors for rapid detection of pathogens, harmful algae, and toxins, and methods to integrate biosensor data with other ocean observations. Develop genomic and proteomic tools and supporting bioinformatics infrastructure to elucidate effects of multiple environmental stressors on marine organisms. Improve video plankton recorders for recruitment process studies.

4. *Assessing Meridional Overturning Circulation Variability: Implications for Rapid Climate Change*

The ocean plays a critical role in global climate. Incorporating ocean observations and understanding into an integrated Earth-system-analysis capability is needed to assess the current state of the coupled climate system and to provide a historical context for assessing changes in the ocean and the global climate system. Furthermore, models used to predict climate changes years to decades in the future are dependent on inclusion of deep ocean currents which are not currently well observed or modeled. Specifically, the Atlantic Ocean Meridional Overturning Circulation (MOC), an element of the global-scale ocean circulation responsible for long-term climate variations, has also been identified as one such ocean feature. Future changes if the Atlantic Ocean MOC may be predictable. Large changes in this feature are considered to be one possible mechanism leading to rapid or even abrupt climate change (i.e., changes over a few years to a few decades) (The Ocean's Role in Climate). Rapid changes the MOC could have a profound effect on temperature and precipitation patterns over the Atlantic and surrounding continents and ecosystems in the Atlantic Ocean.

Assessing the potential for future abrupt climate changes and developing the capability to predict their occurrence will require a national program that incorporates: (1) ocean observations, including *in situ* instruments (e.g., currents, temperature, carbon), satellites (e.g., sea surface height, surface vector winds), and ocean data computational and assimilation capabilities to provide routine, basin-scale analyses; (2) now-casting (an assessment of current conditions); (3) model development for decadal forecasting; (4) past climate change reconstructions; and (5) climate-impact assessments. Ongoing national and international observing efforts and process studies aimed at improving climate and ocean general circulation models provide the foundation upon which to expand the understanding, observation, and prediction of the MOC and its impacts. New research on the MOC will build on the legacy of seasonal-to-interannual climate prediction systems developed since the 1980s based on Pacific and Atlantic tropical ocean variability. Establishing the basis for a long-term monitoring system for the MOC over the next two to five years will provide the observational data needed to challenge and improve climate models, and to more accurately establish the true variability of the MOC and its effects.

Agency Activities:

- *NASA*—Use current and future ocean measurements from satellites to assess processes responsible for MOC variability and to improve ocean models through advanced ocean-state estimation. Refine ocean-state estimates spanning the past 50 years, incorporating all available *in situ* and remotely sensed observations. Use modeling studies to assess impacts of MOC changes on sea-level changes and high latitudes.
- *NOAA*—Conduct modeling experiments on the origins of MOC variability leading to improved understanding of the relative roles of wind and thermohaline forcing. Test models and theories against climate data sets and implement improved models for MOC-related studies.
- *NSF*—Conduct relevant ocean-process studies in the Atlantic and sub-Arctic Oceans to improve ocean-model parameterizations, and perform MOC analysis and modeling studies. Support historical MOC reconstructions and improved data assimilation systems; initiate modeling studies of the impacts of MOC changes on North Atlantic storminess, ecosystems, and ocean carbon uptake.
- *DOE* –Conduct Abrupt Climate Change Modeling Studies, focused on examining both attribution of recent past abrupt climate change, as well as potential future abrupt climate change based on climate change projections.