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OFFICE OF SCIENCE AND TECHNOLOGY POLICY
WASHINGTON, D.C. 20502

September 25, 2009

MEMORANDUM FOR THE HEADS OF EXECUTIVE DEPARTMENTS AND AGENCIES

FROM: John Holdren
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SUBJECT: Interagency Ocean Science and Technology Priorities for FY 2011

Introduction

This memorandum describes the Fiscal Year (FY) 2011 interagency ocean science and technology priorities as called for in the January 2007 *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 National Science and Technology Council's 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 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. Rather, these priorities have been identified as the most important areas for FY 2011 in which the federal agencies should work cooperatively. The focus of this memorandum is on the JSOST's interagency ocean science and technology near-term priorities: a) Forecasting the Response of Coastal Ecosystems to Persistent Forcing and Extreme Events, b) Comparative Analysis of Marine Ecosystem Organization, c) Sensors for Marine Ecosystems, and d) Assessing Meridional Overturning Circulation Variability. These are described in detail below and we anticipate that these will enhance the overall effectiveness of each of the 25 participating agencies as they execute their individual 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* influenced the President's budget request to Congress for FY 2008 and FY 2009, the FY 2010 budget cycle was the first to begin since the release of *Charting the Course for Ocean Science*. 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 the FY 2011 budget process.

This memorandum summarizes the priorities for FY2011, developed by the JSOST, including near-term priorities and infrastructure priorities. These are designed to advance work in support of the six societal themes of *Charting the Course for Ocean Science*:

- Stewardship of Natural and Cultural Ocean Resources,
- Increasing Resilience to Natural Hazards,
- Enabling Marine Operations,
- The Ocean's Role in Climate,
- Improving Ecosystem Health, and
- Enhancing Human Health.

Appendix A describes these six societal themes and accounts for changes within them since *Charting the Course for Ocean Science* was published in January 2007. It is the intent of the JSOST to regularly revisit the priorities and update them as necessary as measured against metrics for success and completion.

Priority Areas

The six societal themes mentioned above framed the development of 20 research priorities highlighted in *Charting the Course for Ocean Science*. This memorandum provides a strategy for moving forward on these research priorities 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. 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 years), and partnerships (i.e., the effort will maximize collaborations among agencies and external partnerships thereby reducing redundancies and ensuring comprehensive results). The Near-term Priorities identified in *Charting the Course for Ocean Science* are multi-year efforts that will require sustained funding if substantial progress is to be made on them. We are now in the third year of focus on the four Near-term Priorities, and much remains to be done.

For FY 2011, 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 2011, based on, and working toward, the overarching focus of each Near-term Priority.

Near-Term Priorities	Key Emphases for FY 2011
"Forecasting the Response of Coastal Ecosystems to Persistent Forcing and Extreme Events"	• Develop and implement strategies to assess risk and vulnerability to coastal hazards for coastal communities, ecosystems, and public health and safety, integrating across time-scales from extreme storms through sea-level rise to provide tools for management decision-making that address catastrophic and long-term coastal change. • Support community engagement to define needs for information and decision-support tools and to prioritize, plan, and implement observational and research efforts with federal and non-federal partners and stakeholders, including state partners, regional alliances, and interagency working groups and advisory committees,. • Provide tools to enhance and integrate regional observing elements, facilitating community model development and application and transferring research results to management applications at regional and national scales.
"Comparative Analysis of Marine Ecosystem Organization (CAMEO)"	• Build on conceptual and model results from FY09 and FY10 projects that may focus on ecosystem structure, productivity, behavior, resilience, and population connectivity, as well as effects of climate variability and anthropogenic pressures on living marine resources and critical habitats. • Conduct a community workshop that will facilitate discussions of academic and federal scientists with living marine resource managers to assess and review how CAMEO research findings can be used in the development of decision support tools. • Finalize a science plan (research approaches, gap analysis and community needs, implementation) based on the input of a scientific steering committee.

Near-Term Priorities	Key Emphases for FY 2011
"Sensors for Marine Ecosystems"	• Sensors to support validation of ocean satellite and in-water observation systems • Sensors with biogeochemical capabilities [e.g., nutrients and trace elements) • Uncertainty assessment of new sensors in development and mature sensors ready for commercial transition
"Assessing Meridional Overturning Circulation Variability: Implications for Rapid Climate Change (AMOC)"	• The design and implementation of an AMOC observing system that will complement existing space-based and grounded sensors. • An assessment of AMOC's impact on regional and global climate, sea level rise, ocean heat and carbon uptake, marine ecosystems and cryospheric changes. • An assessment of our ability to reconstruct and model past AMOC changes and to predict future changes.

Selection of Future Interagency Ocean Science and Technology Priorities

The annual Interagency Ocean Science and Technology Priorities Memo, of which this is the second, 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 articulated 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 and assessments, 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 2011, the JSOST is not specifically identifying new infrastructure priorities; however the committee does recognize the importance of ongoing activities.

Following up on the Oceanographic Fleet Status Report the JSOST Interagency Working Group on Facilities (IWG-F) continues to assess and coordinate among the JSOST agencies how major investments in specific infrastructure components, such as ships, satellites and unmanned systems, should be balanced across a broader spectrum of infrastructure needs.

A key consideration in *Charting the Course for Ocean Science* is the availability of the infrastructure required to implement the near-term priorities and the broader research themes. As such, the IWG-F is developing an inventory of facilities and infrastructure for each of the Near-Term Priority categories, and specific to only the needs of those four specific projects. This inventory will highlight the existing trends, capacity, and budgeted future assets across multiple agencies. The inventory will yield a "Facilities and Infrastructure Implementation Strategy" that will be reviewed by the Ocean Research and Resources Advisory Panel, and could serve as a basis for a broader facilities and inventory study. The IWG-F will also be the focal point in working with the National Research Council's Ocean Studies Board on the project entitled "An Ocean Infrastructure Strategy for U.S. Ocean Research in 2030," sponsored by JSOST member agencies. This project will provide advice and a perspective from the worldwide ocean community on the types of U.S. ocean infrastructure that will facilitate research in 2030, including advice as to what criteria may be most appropriate for setting priorities.

In addition, the IWG-F will expand its traditional role of coordinating ships and related facilities to include coordination of unmanned operations such as gliders, unmanned air systems, and autonomous underwater vehicles. Under the JSOST interagency structure, incorporation of unmanned operations into the discussion of traditional infrastructure and facilities will minimize duplication among agencies and facilitate coordination of newer technologies that are increasing in use.

Appendix A.

Theme 1: Stewardship of Natural and Cultural Ocean Resources

Central to effective stewardship of natural and cultural ocean resources is the ability to accurately assess their current condition. Such knowledge provides the foundation to understand the complex relationships between living and non-living resources, to address the cumulative impacts of human activities, and to help determine the likely impacts of various management alternatives. Research into issues of resource development, use, and extraction will be important to society. This research will include, for example, the effects of exploration for mineral resources on pelagic and benthic communities, and its regional variability. This research will help society prevent major deleterious impacts to ecosystems, promote sound development and use of resources, preserve cultural sites, and support management efforts to restore depleted populations to healthy and sustainable levels.

A key component of the Administration's vision for energy independence is a comprehensive approach to the management of offshore energy resources, one based on sound information taking into account the full spectrum of other natural and cultural resources. Such a comprehensive approach is dependent upon the continued compilation of existing information, acquiring new information, and the continued integration of monitoring activities, both biological and physicochemical. Ecosystem-based and adaptive approaches to both relevant scientific research and resource management will be key in considering the range of decisions to be made over broad geographic areas. These approaches must also factor in the cumulative effects of climate change in terms of long-term ecosystem changes (and effects on species and habitats), changes in renewable energy resources (e.g. wind and wave frequency, persistence, etc.), and changes in environmental conditions and impacts to energy infrastructure (storms, sea level, wave heights, etc.). Important decisions in terms of coastal and ocean resources management will continue to motivate state-of-the-art experimental research, observations, and modeling.

Theme 2: Increasing Resilience to Natural Hazards

Diverse coastal hazards, occurring across a range of spatial and temporal scales, threaten ecosystem and economic productivity, as well as public health and safety. Of increasing concern to coastal managers is the modification of coastal community vulnerability in response to long-term climate change, including sea-level rise. Vulnerable coastal environments, particularly around major population and transportation centers, are the focus for continued and increased development. This development includes infrastructure for alternative energy generation and transmission (wind, tidal, current), nuclear power generation, and liquid natural gas transport, storage, and energy generation – critical components of national energy and climate policy. Safe and sustainable development and the safety of coastal communities requires science-based tools to ensure that decision-making anticipates and reflects risk, and enhances resilience in response to natural hazards and human and natural change.

Research efforts are required to develop consistent methodologies and tools to provide regional-scale integrated assessments that effectively translate scientific understanding, including uncertainty, to management decision making. This will help ensure that risk and vulnerability assessments reflect current conditions and anticipate the impacts of climate change and development decisions. Efforts are also needed to make site-specific assessments of risk and vulnerability to critical infrastructure and adjacent communities and natural resources. This will advance an integrated multi-hazard perspective including both global and local processes spanning extreme (storms, earthquakes, tsunami, slope failures) and persistent (erosion, sea-level rise) hazards acting on the sea-bed, shoreline, and coast.

Theme 3: Enabling Marine Operations

Marine operations are essential components of a prosperous global economy, national security, and homeland defense. Understanding and predicting the effects of climate change on maritime operations has become a high-priority item for the United States. The potential effects are wide ranging and include the necessary changes to ports, harbors, and coastal platforms as sea levels rise and coastal storms increase in frequency and intensity. Increased understanding of the potential changes in shipping routes and traffic especially due to increased Arctic sea-ice melt is needed to identify new patterns and assess impacts on the evolving natural environment. A second consequence of the Arctic change is the potential need for a greater national security presence. Research is needed to improve forecasts providing atmospheric and ocean conditions such as sea-height, wind, ice conditions, and severe storm forecasts necessary to enable safe marine operations. This will require more refined climate monitoring and data collection.

Key elements of the Administration's vision for enabling marine operations include enhancing monitoring and data collection to characterize and assess the evolving climate with specific impact on marine operations; developing marine observational technology capable of operating in Arctic and subarctic areas; surveying priority ports across the country to improve navigational safety; documenting evolving patterns of shipping and assessing any impacts on the environment; improving weather and ocean forecasting to assure safe marine operations, to improve search and rescue and to enable improved oil spill prevention and recovery; utilizing unmanned vehicles to provide volumetric and bottom sampling data for various industries; and robustly fusing environmental observing and prediction systems with multi-use marine operations prediction and simulation systems to promote economically efficient, environmentally sound and successful operations across the broad spectrum of the marine operations. In the Arctic regions emphasis must be given to documenting marine uses by indigenous Arctic natives, supporting continued development of a comprehensive Arctic marine traffic system, developing circumpolar environmental response capacity, improving hydrographic, meteorological, and oceanographic data in area subject to extreme climate changes, and facilitating national security operations on land and at sea.

Theme 4: The Ocean's Role in Climate

The ocean plays a central role in Earth's climate, serving for instance as its major heat reservoir and absorbing carbon dioxide. Understanding the interplay between the ocean, and the atmosphere and terrestrial components of the climate system is essential to more realistically predicting future behavior of the climate system. Although important insights continue to be achieved in ocean physics, chemistry and biology, these advances have highlighted areas requiring additional work in the near-term to better inform upcoming national and international assessments and climate decisions. These include processes occurring at the boundaries between polar ice sheets and the oceans; the effects of ocean acidification and increases in ocean temperature on ocean biology and chemistry; the causes and impacts of hypoxia in coastal regions; the dynamical properties of the Atlantic meridional overturning circulation and its dependence on future climate; and the quantitative analysis of sea level rise using observed changes in ice mass, ocean temperatures, and coastal geodesy.

Enhanced research and the utilization of new tools and capabilities will be key to developing the greater insight required to provide better predictions of climate and so inform national policy development, and, ultimately, climate services. New and developing bio-optical, chemical, physical, and biological sensors can be deployed on in-situ observing systems and various types of autonomous underwater vehicles, and new satellite capabilities (e.g. sea-surface salinity) are being deployed. Such capability is central to improving constraints on fluxes of greenhouse gases, the sequestration potential of biological systems, and the exchange of carbon between land and atmosphere, and the ocean margins, surface and deep regions. Unexpected or previously unobserved behavior of the oceans, such as the significant decrease in the annual minimum of Arctic sea ice in 2007 and 2008, will require continued innovation and deployment of new capabilities on a global basis to fully understand the drivers and impacts of these changes. Anticipated changes in ocean temperature and chemistry will have profound impact on marine ecosystems, but we lack operational commitment to observe global oceanic biology (productivity, phytoplankton types, and physiology) with sufficient accuracy and stability to quantitatively address its long-term evolution and relationship to observed climate changes.

Theme 5: Improving Ecosystem Health

Protecting and restoring marine ecosystems requires an understanding of the complex interactions within these systems, including effects of human activities. Research into how these ecosystems operate will involve studies of natural and perturbed systems at scales ranging from local to regional to international. These studies extend from the influence of land-based activities on coastal environments and protected species to the ability of large protected areas to provide refugia for maintenance and restoration of biological diversity.

Our understanding will be greatly enhanced by the continued development of international capabilities for ocean observation. Such capabilities will provide data for improving our knowledge of the interactions of physical, chemical and biological ocean properties as well as the foundation for ecosystem models that can guide management decisions leading to sustainable use for future generations. Among the ocean observing capabilities showing greatest promise for biological data collection are improved animal tagging and telemetry, passive acoustic monitoring of soniferous mammals and fishes, use of unmanned aircraft and underwater vehicles and genomics.

Theme 6: Enhancing Human Health

To describe how interactions with oceans protect or endanger human health, we must assess current health, societal, and economic risks and benefits with the aim of providing a foundation from which to predict future changes.

Issues of particular concern include microbial contamination of recreational waters, chemical and microbial contamination of seafood, changes in seafood quality associated with stock depletion and alternative fisheries, how direct health risks to marine animals translate to possible health risks for people, the impacts of harmful algal blooms (HABs), and the impacts of severe weather and changes in climate on coastal communities.

Key strategies to assess risks and benefits include basic and applied research to understand the effects of HAB toxins and how their outbreaks occur; impacts of chemical and microbial contaminants; ocean observing systems, monitoring, and sensors for chemical, biological, and physical assessment; interpretation and data packaging to support societal risk identification and decision-making. Improvements in *in situ* ocean sensing and data management capabilities are essential for better understanding of natural oceanic processes and the impacts of human activities and climate change on oceans and human health Increased participation by coastal managers, public health practitioners, and stakeholders in optimizing observing-system capabilities will create opportunities to improve human health. Development and incorporation of sensors for pathogens, indicator microorganisms, harmful algae, toxins, other contaminants, and water quality into observing systems at local to regional scales will allow acquisition of essential data to support public health applications and decision making.