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The Earth System Prediction Capability – A Multiagency Partnership to Advance US Environmental Prediction

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1. INTRODUCTION

The Earth System Prediction Capability (ESPC) arose from discussions between Department of Commerce and Department of Defense to design and build the next generation environmental analysis and prediction system to meet current and emerging requirements.

2. GOAL

We have embarked on a nationwide effort that we hope will pay huge future dividends. The path will not be easy and will require the coordinated effort of a significant majority of US environmental scientists and environmental agencies. The goal is to recapitalize our aging suite of global atmospheric models through advanced model physics and data assimilation, taking advantage of ongoing advances in computational capability, and couple advanced ocean, land, ice, and space models, to develop a comprehensive physical Earth system prediction capability.

3. WHY ESPC

The requirement is for a zero hours to three decades predictive capability – to meet hours to weeks operational weather needs, seasonal to annual planning, agricultural and energy needs, and decadal infrastructure development needs. In near term prediction, we recognize that we need to achieve very high cloud permitting or

cloud resolving resolutions in order to meet severe weather warning times, support the wind and solar energy industries and meet tactical operational needs for DOD. On decadal time scales, we need to accurately assess potential changes in regional and local climate to meet agricultural and infrastructure needs, such as mitigating sea level rise in major ports or raising levees. In the seasonal to annual time span, there is tremendous economic benefit to water and energy management and agricultural planning.

4. PARTNERS

We are pursuing this goal through a consortium of government agencies including DOC, DOD, DOE and NASA, and academic institutions. A key participant in this effort will be the Office of Science and Technology Policy's Committee on Environment, Natural Resources (CENR), established to promote coordination and collaboration between government departments and agencies. Activities who have indicated interest in participating are:

- NOAA Environmental Modeling Center, Earth Systems Research Laboratory and Geophysical Fluid Dynamics Laboratory
- Navy Research Laboratory Monterey, Stennis, and Washington, DC
- Sandia National Laboratories
- Los Alamos National Laboratories

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- Oakridge National Laboratories
- NASA Goddard Space Flight Center and Jet Propulsion Laboratory

5. COMPONENTS

ESPC will include:

- a national approach to deliver an advanced prediction system through data assimilation, forecast model physics, and coupled, diverse ensemble-based systems;
- a common set of agency requirements and standards while providing for agency specific mission capabilities;
- support for a national research agenda focused on improved forecast capabilities; and,
- cooperative development effort encompassing federal, private and academic expertise.

6. TECHNICAL CHALLENGES

The ESPC partnership will need to overcome significant technical and operational challenges in order to succeed. On the scientific and technical side, we will require advances in data assimilation, especially coupled data assimilation that takes into consideration the effect of one domain on another such as ocean, sea ice and waves on the atmosphere. We will require computer architectures and compilers to provide energy-efficient, multi-petaflop computational capability. We will need to reformulate earth system models that have been designed to operate in a single domain such as the atmosphere so that they operate effectively as part of a multi-domain system comprising the physical Earth from ocean to space. We will need to redesign and also expand the complexity of physical parameterizations to handle multi-time and – spatial scales in multi-domain systems. And, we will be challenged to effectively validate such an Earth system on decadal time scales.

There will be significant challenges as to how to effectively develop the new prediction system, produce and communicate new information, especially in a collaborative manner and they will require significant changes in infrastructure, especially computational resources.

7. PROGRESS

The sponsoring agencies held the first of a series of workshops in September, 2010 to develop a science, technical and management plan including a development roadmap. At that workshop, agency principals and operational customers discussed the requirements for an expanded earth system prediction capability and fully endorsed a national effort to meet those requirements. Participating scientists and laboratories also supported the need to press forward on a national level. Resource sponsors have initiated steps in the budget process to identify funds to pursue ESPC.

8. NEXT STEPS

The October issue of the Bulletin of the Atmospheric Sciences showcased several articles by an international group of scientists highlighting the need for a concerted international effort on an earth system prediction capability. In order to participate, the US will first need to establish a solid national program. A management workshop is in the planning stages for this winter. This workshop will establish a program management consortium to pursue a well defined ESPC effort. A science workshop is also in the planning stages for spring to identify participants and technical objectives and establish the initial development team.

9. SUMMARY

ESPC is a multi-agency effort underway to advance an Earth system prediction capability. It will provide a fully coupled operational earth prediction system extending from the sea floor to the stratosphere. In order to achieve this, it will be necessary to:

- Improve data assimilation
- Implement new dynamic core systems
- Improve physics
- Enhance community collaborations
- Build a software framework to enhance partners' progress
- Meet emerging user requirements for prediction of the environment

ESPC will be managed by a broad community development team and overseen by an agency principal Executive Oversight Board and an independent Science Panel.