

Exploring the Need for Reliable Decadal Prediction

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Building an Interannual to Decadal Prediction and Projection Capability for Decision Support

What: While no federal agency has a mandate for climate prediction beyond 2 years, this workshop, attended by 70 participants representing 10 federal and state agencies, the Federal Office of Management and Budget, the Office of Science and Technology Policy, federal laboratories, private industry, and universities, explored the need, the scientific and technological capability, and the coordination required to deliver a reliable suite of products on decadal time scales.

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Where: College Park, Maryland

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Changes in climate, demography, technology, and subsequent environmental, economic, and geopolitical responses are driving efforts to modernize long-term planning strategies. Moving forward, extended-range Earth system predictions/projections will be incorporated into strategic decisions over the 2–30-yr time range in order to mitigate cost and vulnerability of national security, economic vitality, infrastructure, and natural resources.

Limited resources do not permit any individual federal agency to address these issues comprehensively, nor do all the decisions fall within any one agency's individual mission. However, the commonality of the physical problem creates an opportunity to pursue a coordinated capability across agencies for a more unified response for decadal prediction decision support, rather than ad hoc reactions representing short-term, potentially divergent, resource-expensive solutions.

This workshop explored the need for coordinated updating of physical Earth system predictions to support a wide range of long-term decisions drawing on multi-agency expertise and existing or emerging capabilities. The workshop focused on the challenges of providing and maintaining an updating, but non-operational, capability including the potential dual use of ongoing research efforts supporting coordinated capability/knowledge improvement as well as informing decision support. Discussions emphasized collaborative efforts to create a path forward and facilitate interagency efficiency.

The workshop served as a foundation for continuing information exchange leading to a unified, reliable, and actionable prediction capability, and built on the prior work of agencies involved in the U.S. Global Change Research Program (USGCRP) and the U.S. Climate Variability and Predictability program (USCLIVAR). Attendance consisted of representatives from all federal agencies participating in the Federal Committee for Meteorological Services and Supporting Research (FCMSSR), most involved in the USGCRP, providing long-range predictions/projections, and using or potentially using long-range predictions/projections of the Earth system in their decision support, including several commercial sector and nongovernmental organization representatives.

The workshop was organized to inform participants of identified user needs, provide overviews of present capability and research efforts, fully understand the complexities and challenges surrounding decadal prediction, understand the range of emerging capabilities and research efforts, and begin to develop an initial unified U.S. strategy for fulfilling user needs. In each of these main categories of information, presenters outlined the scope of their work, and responded to questions from the participants.

The discussions identified key challenges and a plan of action toward cross-agency coordination for interannual to decadal prediction (2–30 years). Discussions identified the following primary challenges and categories of need, and suggested avenues, mechanisms, or best approaches to achieving a framework for a unified decadal prediction capability going forward.

Challenges in Building an Interannual to Decadal Capability for Decision Support

A primary challenge to building an interannual to decadal capability for decision support is the lack of mission and mandate for operational (or experimental) predictions or projections on this time scale. There is no mandate in the United States to provide for this kind of “climate service.” While there are existing efforts focused on subseasonal-to-seasonal (S2S) and multiyear projection, these efforts generally have mandated operational capabilities and experimental frameworks which the interannual to decadal time scale does not have. This gap emphasizes the need for improved and sustained coordination among agencies.

Currently, there is diversity in the configurations of operational systems for long-range forecasting across different centers. Advancing operational infrastructure may include design configuration factors of operational prediction systems, development of products and

communication of probabilistic outlooks, and variation of forecasts based on sample sizes and skills variation.

Delivery of a useful, regularly updated, reliable decadal product with contributions from both the research and operational communities will require redefining the concept of “operational.” The National Earth System Prediction Capability (National ESPC) has been encouraging the community to move toward more integration between the research community and the operational community, with measurable progress over the past few years. Decadal prediction not only requires significantly more integration between these communities, but the workshop clearly demonstrated that it also requires inclusion of the private sector and, in particular, sustained input of user communities to be successful.

In addition to this primary challenge of the lack of mission or mandate for predictions or projections on this time scale, the interannual to decadal (I2D) time scale lies in a transition zone between S2S prediction and climate assessments. There are open questions concerning the predictability of important variables such as precipitation, sea surface temperature, and land temperatures, and understanding of the physical processes that control or impact these variables (e.g., sunspots, volcanic eruptions) and their interactions with the global climate system. These interactions must be ultimately included in global climate models. This modeling and research challenge necessitates advances in high-performance computing (HPC) resources. We also need to assess and improve key observational datasets to address these research and development questions. Potential future observations needed or to be assessed for improving decadal prediction include sea ice thickness, permafrost, soil moisture, methane, and deep ocean observations.

This capability can only be successful with agency and organizational partnerships, and effective methodologies on how to encourage and nurture them. These partnerships are critical to understanding and meeting the needs of users. Finally, communications challenges exist with users and with climate data and decision-makers. Determining how feasibility and user needs discussions should occur between researchers, developers, and end-users is needed, focusing on *what is predictable*.

Key Needs for Developing an Updating System

Key needs identified include effective coordination of such an expansive national cross-agency effort for decadal prediction, assessment of capabilities, and coordination with the international community; mechanisms for sustained user engagement and input into climate community development of decadal prediction; and identification of key initial steps to build and sustain the effort.

Coordination and Collaboration Resources

In discussions on how best to coordinate and collaborate in developing a decadal prediction endeavor, the following organizations were deemed primary resources to leverage as existing cross-agency organizations and initiatives:

- 1) The National ESPC¹ is a cross-agency collaboration across federally sponsored (NOAA; Department of Defense; NASA; DOE; NSF) environmental research and operational Earth system prediction communities and is a sponsor of this workshop for exploring issues related to decadal prediction.
- 2) The U.S. Global Change Research Program (USGCRP) offers both expertise and existing networks of communication and collaboration to utilize as the producer of the Fourth National Climate Assessment Report (2018).²
- 3) WMO progress in decadal prediction and products, including user interactions, can be leveraged. WMO programs might

¹ www.earthsystemprediction.gov/

² www.globalchange.gov/nca4

include the S2S Prediction Project; the Working Group on Subseasonal to Interdecadal Prediction (WGSIP); the Working Group on Coupled Modeling (WGCM); the WCRP CMIP; and the WMO Near-Term Climate Prediction (NTCP) project. Utilize WMO networks of communication and dissemination as options.

- 4) The Office of the Federal Coordinator for Meteorology (OFCM) and its Committee for Climate Services Coordination (CCSC) are responsible for continuing coordination of current climate-related services provided by federal agencies to national, regional, and local levels 2 weeks and beyond, and for identifying cross-cutting issues. OFCM's Inter-agency Weather Research Coordination Committee coordinates basic and applied U.S. research activities aimed at better fundamental understanding and improved prediction of high-impact weather with a potential for future socioeconomic and environmental benefits.
- 5) NOAA offices include the Climate Program Office (CPO), including the Regional Integrated Sciences and Assessments Program (RISA); the National Integrated Drought Information System (NIDIS); and the NOAA Climate Prediction Center (CPC).
- 6) The North American Multi-Model Ensemble (NMME)³ is a multimodel seasonal forecasting system of coupled models from North American modeling centers.⁴ This is a large network of climate science, prediction, and modeling expertise that may be utilized as an option for collaboration and dissemination of decadal prediction communications.
- 7) USDA Regional Climate Hubs focus on risk adaptation and mitigation; in addition to state climatology offices these entities can provide key input on user groups and needs.
- 8) Regional and state capabilities can increase both interest, participation, and advocacy while pursuing the national effort.

User Engagement in an Interannual to Decadal Capability

During the workshop it became clear that many in the research community (both federal and academic) had not necessarily met with various user communities and were not accustomed to each other's needs or concerns. This workshop, then, became an initial, noncomprehensive forum for those discussions and will require amplifying follow-up.

Discussions emphasized the need to involve users from the outset in coordinating a decadal prediction capability. Fully understanding the range and scope of user needs will be necessary to inform technical development and modeling capability, and is a paramount consideration. Involving social scientists would be beneficial to engage users. The private sector role should be defined in grooming answers for different user needs, and in providing input into climate community development of decadal prediction.

Specific recommendations included establishing mechanisms for sustained user engagement and feedback on decadal prediction and/or user needs; these recommendations follow:

- 1) An interannual to decadal case study or pilot program involving a key user group, such as agriculture, and determination of the needs of this sector, compared to 1–5-yr current capabilities, was proposed.
- 2) An ombudsman of climate data, or a skilled translator of climate data with the ability to explain climate prediction phenomena to varied audiences, as well as to the needs of researchers and agencies, was suggested as a key component.
- 3) USGCRP: Fourth National Climate Assessment (NCA4) Report.⁵ The NCA4, as well as NOAA's Climate.gov website, can serve as initial resources to recommend to users, whether organizational or individual.

³ www.ncdc.noaa.gov/data-access/model-data/model-datasets/north-american-multi-model-ensemble

⁴ Contributing centers are NOAA's National Centers for Environmental Prediction (NCEP), NOAA's Geophysical Fluid Dynamics Laboratory (GFDL), the National Center for Atmospheric Research (NCAR), NASA's Goddard Space Flight Center (GSFC), and Canada's Centre for Climate Modeling and Analysis (CCCma).

⁵ <https://nca2018.globalchange.gov/chapter/1/>

- 4) Town Hall sessions at the December 2019 American Geophysical Union (AGU) annual meeting and the January 2020 American Meteorological Society (AMS) annual meeting can inform and engage with various user communities.
- 5) National ESPC/USGCRP agency-to-user interactions can assist user engagement.

Plan of Coordinating Actions for Building an Interannual to Decadal Capability

The National ESPC is positioned to facilitate interagency efforts leading toward an interannual to decadal capability for decision support. By fostering collaborations and discussions with the organizations and entities discussed in this report, further engagement via additional workshops, and ongoing engagement with researchers, end users, and social science experts and communicators, a pathway can be laid out contributing to a unified decadal prediction capability for decision support. Coordination actions include meeting with OFCM and CCSC, engaging in discussions with USGCRP to leverage their experience in strategies utilized for the NCA4 report, convening future events to explore feasibility and user needs discussions, and to identify additional goals for decadal prediction. The meeting with OFCM should specifically discuss access and use of the CCSC database of existing cross-agency capabilities and services as a starting point for assessing current climate services capabilities and how they can meet the needs of users. Considering the potential for misinterpretation of decadal products, or misunderstanding of requirements which could lead to useless products, stakeholder engagement must be a critical component of any action plan. To this end, we suggest engaging USGCRP due to their expertise in user engagement mechanisms and agency networks that have “trickle-down power,” as well as cross-agency facilitation. Additionally, future workshops and other outreach methods must include identifying user data, product needs, and decision needs, and should act as forums to connect researchers, developers, and end-users. Other topics to continue exploring in a multi-agency format include

- 1) identifying current agency sources and decision-support capabilities;
- 2) determining/scoping gaps between current capabilities and needs; and
- 3) establishing recommendations for methods, frequency, reliability, and implementation of a decadal prediction capability.

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