

NATIONAL UNIFIED OPERATIONAL PREDICTION CAPABILITY: PROGRESS AND NATIONAL RESEARCH INITIATIVES

Fred Toepfer *
NOAA/NWS, Silver Spring, MD
David McCarren
Navy, Silver Spring, MD
Scott Sandgathe
Applied Physics Laboratory University of Washington, Seattle, WA

1. INTRODUCTION

The National Unified Operational Prediction Capability (NUOPC) is an Air Force, Navy, and NOAA strategic partnership to improve the Nation's environmental prediction capability. The end result is a managed National multi-model ensemble prediction system which:

- Incorporates state of the art science
- Increases performance over individual models
- Provides a measure of uncertainty
- Meets the operational needs of all Agencies

NUOPC also incorporates a modeling framework exploited by operations and research to promote:

- Scientific innovation
- State of the art research
- Rapid, efficient research to operations
- Timely, effective operational exploitation of development efforts

2. VISION

As presented at last year's AMS meeting, the NUOPC vision seeks to accelerate the transition of research into operations through collaboration. Specifically, it is:

- A National System with a Tri-Agency commitment to address common requirements.

- Multi-component system with interoperable components built upon common standards and a framework such as the ESMF.
- Managed ensemble diversity.
 - Significantly improve forecast accuracy.
 - Quantify, bound, and reduce forecast uncertainty
- Joint ensemble.
 - Produce most probable forecast, e.g. high impact weather.
 - Provide mission specific ensemble products.
 - Drive high-resolution regional and local predictions.
 - Drive other downstream models.
- Establish a national global NWP research agenda to accelerate development and transition.

3. APPROACH

The Air Force, Navy, and NOAA are partnering to address common operational global numerical weather prediction needs and requirements. The approach is to develop and implement a managed, multi-model ensemble system and to accelerate the transition of new technology to operations. Better use of existing science will be applied to obtain a step change in capability. Common model architecture will be adopted to facilitate interoperability of associated models. A community modeling approach is being taken with a philosophy of "develop once, use in many applications." Additionally, a National Research and Development (R&D) agenda is being pursued to guide the activities of the broader R&D community in support of this strategic initiative.

4. CHALLENGES

Close cooperation between individual Agencies on a unified task such as NUOPC is always challenging, particularly when funding is limited

* *Corresponding author address:* Fred Toepfer, NOAA/NWS, Silver Spring, MD 20910; e-mail: Frederick.toepfer@noaa.gov

and must be applied to a Tri-Agency solution. Diverse organizational cultures, unique Agency needs, and differing expectations between operational and research communities can be challenges. An additional challenge for NUOPC will be to foster a collaborative research environment where non-operational Agencies will recognize the benefits of participation. Resources will also pose a challenge. Expanded operational and R&D computing capabilities as well as communications resources will be critical to the success of NUOPC.

5. BENEFITS

Anticipated benefits of NUOPC would be improved capabilities to support Agency missions as measured by:

- Effective disaster prediction, preparation, response and mitigation
- More effective global military operations
- Less weather delay and disruption for air transportation
- Energy saved
- Improved efficiencies throughout the Nation's economy
- National response to changing climate
- Lives saved
- Dollars saved

6. STATUS

NUOPC is currently a well-established Tri-Agency partnership. Initial Operational Capability (IOC) of the National Unified Ensemble is planned for January 2011. The NUOPC program is implementing software architecture standards to provide integration framework for future prediction systems. NUOPC standards are being incorporated into the Earth System Modeling Framework (ESMF) Version 5.1. This includes a compliance checker and meta data standards. Additionally, agreement has been achieved on the use of common verification metrics for NUOPC implementation.

7. R&D NEEDS

The purpose of this talk is to focus on the research and development needs identified at a NUOPC workshop held in August 2010 and to encourage the participation by the broader R&D community. That workshop included both operational and development participants from the three agencies as well as university and laboratory

scientists and program managers representing the funding agencies.

The top three R&D needs of NUOPC as identified at that workshop and endorsed by the three Agency principals are:

1. Research to support decision making including:

- Use of ensemble/probabilistic forecast information
- Communicating forecast certainty/uncertainty
- Propagating quantitative certainty/uncertainty into downstream applications
- Developing decision support tools

2. Marketing infrastructure and associated research to:

- Assess user needs
- Quantify value
- Present and improve products

3. Calibrating ensemble output for complex applications:

- Techniques for high dimensional problems (e.g., aircraft and ship routing)
- Calibrating derived variables
- Calibration of multiple parameters while maintaining dynamic relationships

Decision making in this context can be interpreted as "wholesale users", i.e., those individuals and organizations that take primary products from the three production centers and use them to provide a value-added product to an end user. These could be agency forecasters, commercial weather prediction activities such as media, agricultural, or energy forecasting concerns or sophisticated end users such as airlines and large utilities.

Marketing infrastructure refers to infrastructure to routinely survey and assess benefit to wholesale users primarily, but also to end users. An example might be an automated survey routinely sent to users or even an automated tally of number of "hits" a particular product received.

The third priority, calibration for complex applications refers to multi-parameter applications where either dynamic consistency between parameters is required (CAPE, icing, electromagnetic propagation, etc.) or where an application depends on thresholds in several parameters (e.g. aircraft routing: icing, head winds, severe turbulence or ship routing: severe winds, high seas, swell direction).

The workshop participants singled out these three areas as critical for increased or new emphasis but also felt the science goals established in the THORPEX Science Plan (http://www.ucar.edu/na-thorpex/documents/thorpex_nov82004.pdf) were still applicable.

Workshop presentations are available at: <http://www.dtcenter.org/events/workshops10/nuopc/index.php>

8. PARTICIPATION IN NUOPC R&D

The NUOPC R&D agenda has been provided to U.S. research funding agencies. Specifically, program managers at NSF, ONR, and OAR have been briefed on NUOPC priorities and encouraged to support proposals addressing high priority NUOPC requirements.

Various community outreach activities are planned for NUOPC in the coming year. A user workshop is planned for exploration of expanded applications of ensemble modeling products. This workshop is currently planned to be held in the Seattle area in April. Further information will be available on the NUOPC website (<http://www.weather.gov/nuopc/>) and everyone is encouraged to contact us if they are interested in participating or if they have comments.

A 2nd Annual NUOPC R&D Workshop is also planned for Summer 2011. We are hoping to expand participation in this workshop and would be interested in nominations for attendees. Additional information will be posted on the NUOPC website when available.

9. PLANS FOR 2011

NUOPC plans for 2011 include the continued implementation of the National Unified Ensemble System. Management of the ensemble will be established and development of a Post-Processing Toolkit will begin. Additionally, an

IOC-2 post-processing framework will be resolved. In 2011, incorporation of NUOPC standards in ESMF will continue and development of a Single Column Model for further model interoperability will begin.