

UNITED STATES DEPARTMENT OF COMMERCE National Oceanic and Atmospheric Administration National Weather Service

Office of Science and Technology Integration 1325 East-West Highway, Silver Spring, MD 20910-3280, USA

A Strategic Vision for the US National Environmental Modeling

Enterprise

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Revision history			
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1 Purpose

The purpose of this document is to provide a high-level vision for the US National Environmental Modeling Enterprise, rooted in the Production Suite that is operated by National Centers for Environmental Prediction (NCEP) of the National Weather Service (NWS). The Production Suite consists of a large suite of environmental models, which are run on a strict schedule to support the mission of the NOAA. Whereas the focus of the Production Suite is on weather models and on the mission of the National Weather Service, there are contributions from and to other NOAA line offices, government agencies and academia.

The present Production Suite as well as the national approach to environmental modeling consists of a disparate set of solution (models) for ill-defined requirements. The goal of this strategic vision is to move to a unified and integrated modeling approach in the next 5 to 10 years. A unified and integrated Production Suite provides a better business model than the present "quilt" of solutions, both within the NWS, and in terms of leveraging the fast resources of the US government and academia.

Accompanying this vision document are a roadmap for this period, as well as a Strategic Implementation Plan focusing on starting the transitioning to the Strategic Vision in the next few years. This vision is fully aligned with, and draws on the recent NOAA whitepaper on Unified Modeling and the broader National Earth System Prediction Capability (National ESPC) effort.

2 The Big Picture

The key element of *unified environmental modeling approach* is the focus on *products* supporting mission *requirements*. To move to a product-oriented Production Suite and enterprise, several critical forecast ranges have been identified, as is illustrated in Figure 1. The "*Year* +" element identifies climate modeling beyond the one year range, outside the scope of the Production Suite, but the subject of at least six national climate modeling efforts. The "*Year*" element addresses seasonal forecasting, or climate in the definition of the NW. The "*Month*" element addresses the newly mandated services for week 3-4 predictions. The "*Week*" element addresses the rapid refresh short-range forecasts The hour element addresses envisioned Warn on Forecast approaches, with a forecast of only a few hours, produced several times per hour. Finally, the "*Now*" range covers traditional global analyses, as well as envisioned Rapidly Updating full-atmosphere analyses.



Figure 1: High-level design of a unified modeling system

All key elements of the unified approach are applications of a *unified modeling* and *unified data assimilation* system, with the understanding that unification should focus on the minimum number of models and data assimilation approaches that can serve a complete Production Suite or National Earth System Prediction Capability. Unitary modeling (only one model allowed) is *not the goal*, but, where possible, provides a solid *business model*.

Several additional considerations accompany the product-based high-level vision of the Unified Production Suite.

Whereas the initial description of the Production Suite focuses on weather elements, the Production Suite already includes land, aerosol, ocean wave, sea ice, ecological and space weather, products at many of the identified forecast ranges. A Unified Production Suite or National Earth System Prediction Capability has to be based on a *coupled* modeling approach, both in order to address the other non-weather elements in the production suite consistently, and because sustained improvement of all environmental modeling will require a holistic environmental approach.

Forecasting is moving from a deterministic "model of the day" approach, to a probabilistic *ensemble* approach, where the forecast and its uncertainty are addressed simultaneously. Ensembles are also a cornerstone of advanced data assimilation. All key elements of a unified approach should therefore be *ensemble* based, with all ensemble

members run at the core resolution of the product element (i.e., no higher resolution deterministic control run).

Particularly for longer forecast ranges, *reforecasts* and *reanalyses* provide improved forecast skills through calibration of raw model output, and in for Impact-driven Decision Support Services. When moving to full ensemble approaches for each element, traditional retrospective testing effectively attains the nature of a reforecast and reanalysis. Considering this, *reforecasts* and *reanalyses* will be considered as a core element of each implementation of an element of a Production Suite or National Earth System Prediction Capability.

Finally, *preprocessing* of observations, *postprocessing* of model output, including calibration, *verification* and *validation*, and presentation of products to the publics also need to be unified in the Production Suite or National Earth System Prediction Capability.

3 Basic Concepts

The previous sections describes a unified approach based on products and requirements, unified coupled ensemble modeling, data assimilation, pre- and postprocessing, reforecasts and reanalyses, validation and verification. Several other key concepts are essential for a Unified Productions Suite or National Earth System Prediction Capability.

3.1 Community modeling

The new Production Suite will use a *community modeling* approach that involves NOAA, other federal partners and the research and academic community at large. Only with appropriate contributions from the entire U.S. modeling community will we be able to build the best national modeling system in the world.

The *definition* of "community" is important, and not all community efforts are be identical. Prior community modeling efforts show both strengths and weaknesses of different approaches, and that one size does not fit all. The community approach will include training and support.

The community team has to include strong contribution of both *operations* and *research* groups, with different levels of partners. The unified modeling system will be built to support the needs of both *operations* and *research*, with a well-defined path for transitioning research to operations. Without that linkage, the incentives for the research community to participate will be sub-optimal.

The unified modeling system has to be a national system where all core partners have true *ownership*. As such, each core partner has to treat their role on the national team as a fundamental and enduring priority for their respective organization, supported where appropriate with internal core resources.

3.2 Evidence driven decisions

The environmental modeling community requires a rational, evidence-driven approach towards decision-making and modeling system development. Key decisions on architecture, scientific selection etc. will therefore be based on objective validation and verification, not assertion. This requires establishment of *requirements*, agreement on *validation metrics*, and a unified approach to computing such metrics.

3.3 Governance

With the community approach to modeling, all core partners will have a voice in making strategic decisions, not just the operational center(s). With the Production Suite being heavy on weather applications, its governance process is will have to be aligned with the formal National Weather Service governance process. This governance process identifies three key steps.

- 1. Establish *service requirements* and associated products, where the products define the core of the Unified Production Suite.
- 2. Determine scientific requirement and possible solutions.
- 3. Solutions for requirements are *prioritized* within the NWS by the Mission Delivery Council (MDC).

Partner input is essential in all steps.

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