

Minutes of the session on Earth Prediction Innovation Center (Sec. 102*) Session

Bill Lapenta, Director, National Centers for Environmental Prediction, presented an overview and some details of the Earth Prediction Innovation Center (EPIC), the establishment of which grew out of public law PL 115-25, also known as Weather Research and Forecasting Improvement Act of 2017, with its funding explicitly written into the 2017 NIDIS reauthorization bill. Bill Lapenta was joined by DaNa Carlis, OWAQ Program Manager for NGGPS/EPIC at NOAA's Office of Oceanic and Atmospheric Research. Lapenta began the presentation with a review of NOAA's strategic vision to simplify NOAA's modeling suite by starting from the quilt of models and products created by NOAA to moving to a product-based system that covers all presents of the production suite in a more systematic and efficient way. The aim is to engage and interact with all of the stakeholders in academia, private sector, and other organizations outside the National Weather Service. The recommendation to simplify the modeling suite was made by the external committee that had reviewed the National Centers.

The goal of EPIC is "to advance numerical guidance skill, reclaim and maintain international leadership in NWP, and improve the research to operations transition process." In order to achieve that goal, NOAA will: a) leverage the weather enterprise; b) enable scientists and engineers to effectively collaborate; c) strengthen NOAA's ability to undertake research projects; d) leverage existing resources in NOAA; and e) create a community global weather research modeling system that is accessible by the public, computationally flexible, and utilizes cost-effective, innovative strategies and methods that include cloud-based computing capabilities as well as solutions for hosting and management of part or all of the system.

Lapenta noted that the landscape for operational NWP has changed in the last 5 years due to technological developments, organizational changes, and shift in cultural attitudes. He then gave an overview of the Next Generational Global Prediction System (NGGPS). The NGGPS will:

- Identify and adopt an advanced non-hydrostatic dynamic core and evolve it to meet operational needs for the foreseeable future
- Apply evidence based decision making process to ensure scientific integrity and excellence
- Benefit from enhanced O2R2O process and a unified and efficient infrastructure for community engagement and rapid transition of advanced research into operations
- Result in seamless solutions for tropical weather and climate in a unified global-to-local-scale modeling framework

Lapenta also presented the following details and expectations of the Unified Forecast System (UFS).

Purpose: The Unified Forecast System (UFS) is a comprehensive, community-developed Earth modeling system, designed as both a research tool and as the basis for NOAA's operational forecasts.

Scope: UFS is configurable into multiple applications that span local to global domains and predictive time scales from less than an hour to more than a year.

Design: UFS is a unified system because the applications within it share science components and software infrastructure

Impact: UFS is a paradigm shift that will enable NOAA to simplify the NCEP Production Suite, to accelerate use of leading research, and to produce more accurate forecasts for the U.S. and its partners.

Governance: Planning and evidence-based decision-making support improving research and operations transitions and community engagement.

Lapenta recounted the decision by NOAA two years ago to move to Finite Volume 3 (FV3), which is the foundation for the UFS. The UFS is envisioned to be a comprehensive community-developed Earth modeling system, designed as both a research tool and as the basis for NOAA's operational forecasts. NOAA is presently developing a governance structure for the UFS and the EPIC community modeling effort, and it is expected to leverage the existing Steering Committee for the UFS, along with 12 working groups.

The reasons why EPIC will deliver more innovative operational outcomes was also resented. Those reasons include the identification of scientific priorities, test plans, metrics for validation and verification, all jointly by NOAA and the community. That will enable co-development of the UFS by research and operational scientists, allowing partner agencies to common components. In addition, EPIC will facilitate exploration of cloud-based High Performance Computing solutions in alignment with NOAA's Cloud Vision, build up agile development capacity and mitigate problematic access to NOAA HPC assets. Lapenta was careful to reiterate that NOAA will still require "Big iron" infrastructure for operations and Research and Development. An OAR-NWS scientist exchange program is also in the plans, per the recommendation of the Weather Act. Collectively, these activities are expected to spur innovation and rapid prototyping capability. It is expected that EPIC will be a virtual center, building on and leveraging the existing Memorandum of Agreement (MOA) between NOAA and UCAR/NCAR in several areas. The NOAA-NCAR MOA covers several areas including:

- Leveraging and enabling interagency co-development
- Building the community modeling tool set
- Serving the scientific community and operations

Lapenta then presented the results of the EPIC Alignment Workshop that was held in March 6-7, 2019 in Boulder, CO. Twenty federal agency employees with vast experience in numerical weather prediction participated in the workshop. In addition to developing a vision document for EPIC, the workshop identified the following core investment areas:

- Software engineering
- Software infrastructure
- User support services
- Cloud high performance computing
- Scientific innovation
- Management and planning
- External engagement and community

The presentation ended with the discussion of the initial EPIC program implementation and Fiscal Year 2019 tasks. The EISWG was informed that the OAR Office of Weather and Air Quality (OWAQ) is responsible for executing the EPIC program. The OWAQ Director will have ultimate oversight of the program. EPIC activities will be managed by the current OAR Program Manager for NGGPS, DaNa Carlis. Funding for FY19 activities are being supported from several sources including FY18 Disaster Relief Supplemental funding, the Joint Technology Transfer Initiative, the USWRP, and other base resources within OAR and NWS. Collectively, it is estimated that approximately \$5M will be spent in FY19 to accomplish EPIC-related activities. The FY20 President's budget includes \$15M for EPIC.

During a discussion earlier in the EISWG agenda, Louis Uccellini, NWS Director, stated that having the operational code in the cloud that the research community can access and further enhance is a game changer. He added that there is a role for both the research as well as the operational community in unprecedented ways.

Questions, Comments and Discussions:

Porter asked: What does success for EPIC look like? What are short term wins? In 5-10 years?

Answer: a) the community uses and enhances the UFS; b) NOAA provides cloud-computing access outside the agency; c) In 5 years scientists are using the operational UFS and writing proposals to federal agencies and their work is getting into operations.

EPIC hopes to bring scientists together to work on grand challenge problems in data assimilation, ensemble prediction, etc.

It was re-emphasized that EPIC will not be bricks and mortar place.

When asked what people who are going to be executing EPIC's vision are saying, he admitted that people in general are skeptical and they want demonstration of success. That is why near term wins are critical.

Petty asked: Where will funds in the \$15M investment in FY20 go?

Response from Lapenta and DaNa Carlis: Investment in infrastructure components in partnership with NCAR, software engineers, code repositories, etc. Carlis added that his office is hiring eight software engineers and in partnership with NCAR.

Weller: Coupling of UFS/FV3 with ocean is important and it is possibly a grand challenge problem. Everything will need to be coupled with other systems.

Birk: Thinking about the infrastructure and engineering, have you set up a platform already?

Response from Tolman: The R2O requirements and steps are spelled out in the NOAA-NCAR MOA.

Snow: For EPIC to succeed, NOAA will need to partner with the university community. The CESM development is a good model to study in that regard.

Ramamurthy: The EPIC presentation didn't make any mention of Education and Training, and workshops.

Lapenta's reponse: Those are spelled out in the MOA and will be covered through the MOA-related activities.

Colman: What are the two or three near term wins, say in the 6-12 months?

Lapenta's response: Invest in early release of the UFS; Hold a UFS workshop and training session on the release that came out.

Hooke: Shouldn't we explore every aspect of environmental prediction? EPIC is just a tip of the iceberg.

Uccellini: We want to engage the universities, Universities follow the money. For the first time, NOAA is getting a critical mass of resources for EPIC. There is a cultural divide between Research and Operations. Other agencies (NSF?) have to change what they fund as well. In the U. K., University of Reading did all of the research on their operational models and U. K. funding agencies sponsored those projects.

Yuan: Universities follow money and scientists follow curiosity. Seems like a coordinated effort like the development of R, Python, etc. is needed. Also, there is no mention of data in the presentation. What about the human component?

Lapenta's response: It is an oversight in not emphasizing data. Data analytics is extremely important.

Xubin: Our goal is to overtake ECMWF, but they are also advancing at the same time. How will NOAA keep up with their innovation? We have to do something unique. There needs to be a Cooperative Institute for NWP, with partners selected NOAA operational people and in partnership with universities, private sector, among others.

Lapenta: Ongoing work in JCSDA includes the international community, including people in the UK Met Office.

Vieux: It will be important for EPIC to leverage what is in the private sector. E.g., code repositories in GitHub. It will also be important to invest in documentation of code.

Tolman's response: There will be dedicated code managers in EPIC.

Petty: What can EISWG do to help EPIC?

Lapenta: Support from EISWG would be valuable.

Uccellini: Now EISWG has a direct connection to the budget process. What EISWG writes and recommends rises through all the levels in the upper management. What has been budgeted is just the foundation. EISWG is in an important position to review and recommend future directions.

Petty: EPIC is still in an incipient phase, so we should not get too far ahead before the August workshop.

Birk: EISWG should put down specific tenets as ambassadors for EPIC

Uccellini: There is quite a bit of ongoing work in JCSDA. Coupling is important and so is data assimilation. There are a whole bunch of holes to fill; In a code audit, 85% of code in UFS came from outside.

Porter: There is a role for EISWG, including making recommendations and comments from us to support NOAA and EPIC. Trust needs to be built up (in reference to university partnerships?)

Hooke: Successful partnerships need common goals among partners, in addition to benefits accrued to all of the partners. Perhaps EPIC should connect to S2S as a guiding principle? Elevate those to the SAB, engaging them early in the process.

Uccellini: If you involve S2S, please keep in mind that there is already a Climate Testbed, led by Jim Kinter, George Mason University/COLA.