RECAPITALIZING THE NATION'S WEATHER AND OCEAN PREDICTION CAPABILITY

The National Earth System Prediction Capability and the NUOPC Ensemble

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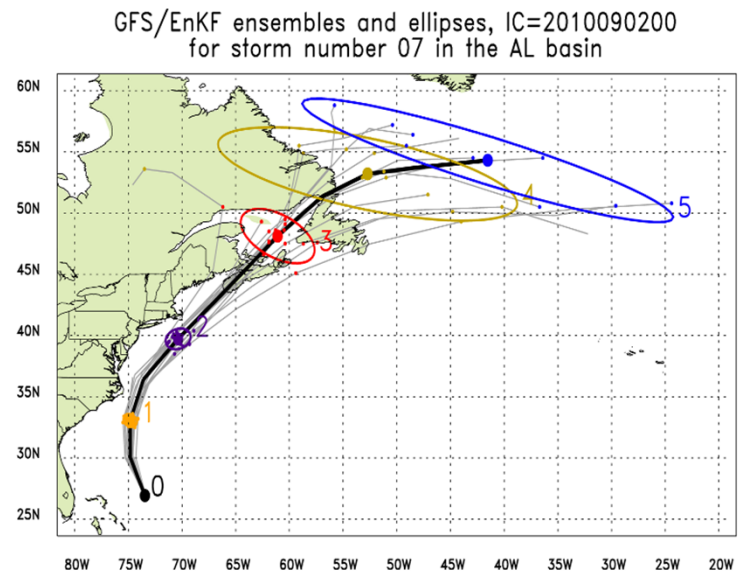
6th NCEP/NWS Ensemble Users Workshop

Vision

- Air Force, Navy, NOAA partnership for Operations and a six-agency supporting research effort
- A managed National multi-model ensemble prediction system.
- A common modeling framework linking operations and research.
- Draws on individual partner analysis, modeling and prediction strengths.



Benefits

Improved capabilities to support agency missions measured by:

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

Where We Are

- Well Established Tri-Agency Partnership for Operations
- Initial Operational Capability of National Unified Ensemble in January 2011
- Implementing software architecture standards to provide integration framework for future prediction systems
- Well Established Research Partnership for R2O

- Town Hall presented to American Meteorological Society Meeting – January 2014

Future

Next Generation Prediction Capability

- New modeling techniques to improve predictive skill
- Exploit interoperability architecture for a fully coupled system: land, ocean, ice, wave, atmosphere, space, ecosystem
- Exploit emerging computing capabilities
- Improved inter-annual to decadal predictions

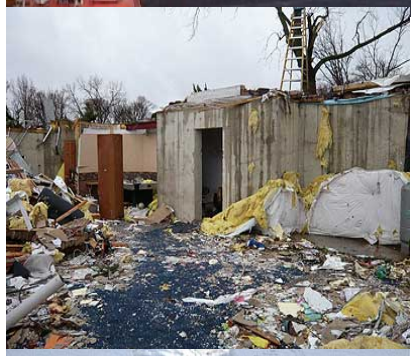
The National Earth System Prediction Capability (ESPC)

ESPC Overview

An interagency collaboration, initiated in 2010 between DoD (Navy, Air Force) and NOAA, and expanded to DoE, NASA, and NSF in 2012 for coordination of research to operations of a National earth system analysis and prediction capability.

Seeks to improve communication and synergy, for global prediction of weather, ocean, and sea ice conditions at weather to short-term climate variability timescales.

- Common prediction requirements and forecast model standards that enable agencies to improve leverage and collaboration.
- A national research agenda that will improve prediction across scales from days to decades.
- Cooperative demonstration projects to assess predictability of global scale high impact environmental conditions to inform S&T, R&D, and transition to operations.
- Towards an multi-model ensemble based air-sea-land coupled global prediction capability



ESPC Goals

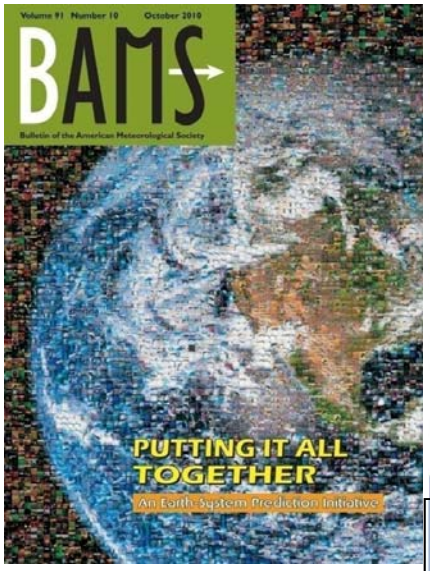
Build the next generation operational seamless national environmental prediction system across time scales:

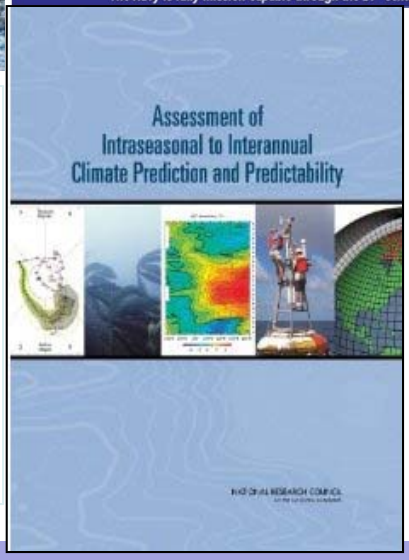
- Advance computational and environmental numerical prediction science and technology through coupled model development
- Enhance our understanding of the complex interactions of the earth environmental system through process studies
- Identify and quantify uncertainty and risk though probabilistic prediction
- Improve operational predictive capability with better skill scores and longer lead times through technology transition
- Provide insight and guidance for informed decisions in an increasingly complex and changing global human enterprise

Implement an ESPC Suite across partner Operational Prediction Centers

Community and Agency Calls to Action

- An Earth-System Prediction Initiative for the Twenty-First Century (Shapiro et al. 2010)
- Collaboration of the Weather and Climate Communities to Advance Subseasonal-to-Seasonal Prediction (Brunet et al. 2010)
- Assessment of Intraseasonal to Interannual Climate Prediction and Predictability (Weller, 2010)
- Arctic Security Considerations and the U.S. Navy's Roadmap for the Arctic (Titley and St. John, 2009)
- The Uncoordinated Giant: Why U.S. Weather Research and Prediction are not Achieving their Potential (Mass, 2006)





Why Coupled?

Short Range Prediction (Mesoscale)

- Tropical Cyclone intensity & track is dependent on ocean temperature and the depth of warm/cold water.
- Littoral/coastal prediction (Land-breeze/sea-breeze, sensor performance, abrupt wind/temperature changes at the north wall of the Gulf Stream, etc.)
- Sudden, gale force cold air surges (South China Sea, Ice shelf, etc.)

Medium Range Prediction (Synoptic)

- Tropical monsoon onset, breaks and intensity, active tropical convection periods (Madden Julian Oscillations (MJO) and other Intraseasonal Oscillations)
- Mid-latitude blocking patterns causing intense flooding and droughts
- Polar lows (resembling hurricanes), sudden stratospheric warming
- Ocean fronts and eddies and maritime weather

Long Range Prediction (Seasonal)

- Teleconnections or inter-global weather and climate links such as ENSO, Seasonal TC patterns, ocean SST patterns, climatology shifts & anomalies
- Arctic ice dynamics, droughts & floods, regional fires/smoke

What Do We Gain from Multi-Model Ensemble Prediction?

Practical approach to estimating and understanding forecast uncertainty due to initial conditions/observation errors, model formulation and numerical uncertainties

- Multiple instances of single models can reduce initial condition error
- Single model ensembles are often over-confident (low spread) and have persistent error modes and biases

- Multi-model ensembles reduce model and numerical errors
- Each center leverages distributed computing resources of a larger number of members
- Improves system flexibility across time scales by changing member mix

Result: a better prediction and understanding of uncertainty in prediction, and a natural focus for multi-institutional partnership

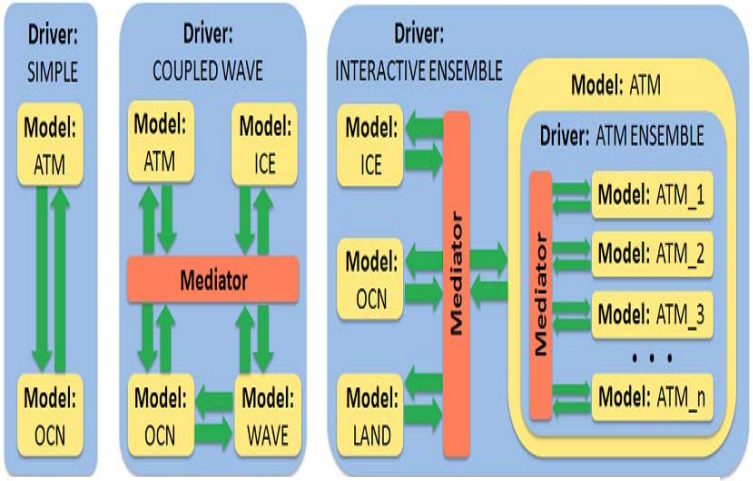
Earth System Prediction Suite (ESPS)
Common Model Architecture

ESPS is a collection of Earth system component models and interfaces that are interoperable, documented, and available for community use. ESPS is intended to

- formalize code preparation for cross-agency use
- simplify “toolkit” code selection for the broader research community
- focus on coupled modeling systems
- leverage legacy investments from NASA, NOAA, NSF, DOE, and Navy
- bridge climate (CESM) and weather (ESMF) scales through software convergence
- establish “plug-and-play” implementation via the NUOPC interoperability layer.

ESPS codes:

- are NUOPC-compliant
- include model documentation
- have clear terms of use
- include compliance checking and tests for correct operation across the development community.



http://www.earthsystemcog.org/

Deluca2013

Towards a National ESPC

Federal partnering to improve adoption of research breakthroughs from a wider community into operations.
HFIP, NUOPC, and NMME have shown great benefit to operational National forecast skill for short/medium/seasonal range weather; should be continued and expanded.

The goals of the ESPC Inter-Agency Project indicate that R2O should:

- Be extended to transition regional and global air-sea-wave-ice coupled models leveraging community models
- Improve adoption of ESMF standards through the ESPS initiative and CMA committee
- Extend/continue the multi-model ensemble approach at sub-seasonal and seasonal scales through an NMME follow-on for operationalizing this research.

A National ESPC will provide the next generation of operational Forecasts for 0-32 days and Seasonal Outlooks1-9 Months. A major challenge is still to address the sub-seasonal (weeks 2-12) where skill is lowest, and extend skill globally to Mid-Latitudes and Arctic.

Things to Consider

Questions?