Enterprise Effort to Advance the National Ensemble Prediction System

...a key initiative in the NWS Science and Technology Roadmap

- NOAA and NWS Strategic Plans
- Initiative Overview
- Current and Proposed EPS Plans
- Funding Priorities
- Governance Structure
Objective: Reduced loss of life, property, and disruption from high-impact events

An essential component of a weather-ready nation is integrated, impact-based forecasts and information so citizens, businesses, communities, governments, and first responders are prepared, ready to act, and able to recover. To be effective, the information must clearly communicate risk, impacts, and uncertainties, and be delivered through multiple channels. Increased and enhanced availability and use of weather-related information by citizens, businesses and government can reduce the impact of weather-related events on lives and livelihoods.

To achieve this objective, NOAA will maximize the use of weather-related information and decision support services to promote actions that minimize adverse impacts from environmental events. Key requirements include improving and expanding information services for hurricanes, severe weather, and fire weather; providing consistent, reliable, and accessible forecasts and warnings focused on specific impacts, risks, and confidence levels; and leveraging new technologies to ensure data is available, accessible, and timely. In collaboration with its partners, NOAA will provide direct, interpretive support to public sector officials and emergency responders, and expand environmental education and weather safety programs. This objective also requires: research and development to quantify forecast uncertainty and to understand the weather-climate linkage as well as human behavior and decision-making; sustained and improved observation networks; high resolution Earth system models; the development and implementation of a four-dimensional weather information database; and next-generation “warn on forecast” capabilities for convective weather.

Over the next five years, evidence of progress toward this objective will include:

• Fewer weather-related fatalities;
• Decreased economic loss from unnecessary evacuations and property damage; and
• Increased number of communities certified as TsunamiReady™ or StormReady®.
GOAL 1: IMPROVE WEATHER DECISION SERVICES FOR EVENTS THAT THREATEN SAFETY, HEALTH, THE ENVIRONMENT, ECONOMIC PRODUCTIVITY, OR HOMELAND SECURITY

Measures of Success
Improved community emergency preparedness leading to fewer fatalities from weather-related events; less economic losses from unnecessary evacuations and property damage

Strategy
*Forecast Uncertainty:* Develop and implement steps toward quantifying and communicating forecast uncertainty achieved through physical and social science research, ensemble model and forecast system improvements, and tools that assist users in applying forecast uncertainty in their decision making

S&T Roadmap

Need robust Ensemble Prediction System (EPS) to generate high-utility weather risk information and enable optimized decisions
By 2015, the US will implement a radically upgraded national capability for mesoscale probabilistic prediction to support current and future decision-making needs, helping return the US to a world-leadership role in numerical weather prediction.
Emphasis on EPS as a SYSTEM

Each component must be designed with consideration to its interaction with, and influence on, the other components

The system is only as good as its weakest piece
Current NCEP/EMC Ensemble Plans

- **GEFS** (Global Ensemble Forecast System)
  - **Now**: 21 Members, global, ET ICs, stochastic physics, T190 (~75 km grid), 384 h, 4 cycles/day
  - **2011**: T254 (~55 km grid)

- **SREF** (Short-Range Ensemble Forecast)
  - **Now**: 21 Members, N. America, Breeding & ET ICs, multi-model, 32-35 km, 87 h, 4/day
  - **2011**: 22 km grid, drop Eta & RSM, add NEMS-NMMB w/ stochastic parameterizations
  - **2013**: 12 km grid, ET ICs, 2 model (NEMS-NMMB and NEMS-ARW) w/ stochastic param.

- **NARRE** (North American Rapid-Refresh Ensemble, *focused on aviation forecast*)
  - **2014**: 6 Members, 3 km grids over CONUS and AK, 24 h, 24 cycles/day

- **HRRRE** (High-resolution Rapid-Refresh Ensemble, *focused on high-impact weather*)
  - **2014**: 6 Members, 1 km grid, small relocatable domain, 24 h, 24 cycles/day

*unfunded*
Proposed National EPS Target for 2015

- Robust EPS, yet practical for operations
  - Thoroughly sample analysis & model uncertainty with physically/dynamically-based algorithms
  - Postprocessing (calibration): increase raw ensemble’s skill & value by removing systematic error to ensure reliability, and by downscaling to improve resolution
  - Products / Decision Aids: support decision making for full spectrum of users’ needs & capabilities
- Resolution: **Regional**: Capture convective scale uncertainty
  **Global**: Capture mesoscale uncertainty and provide quality LBCs to regional ensemble

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<th>Model</th>
<th>Domain</th>
<th>Grid</th>
<th>Levels</th>
<th>Forecast Length (h)</th>
<th>Update Frequency (h)</th>
<th># of Members</th>
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- Compatible with NCEP operations
  - All development compliant with *National Environmental Modeling System* (NEMS)
  - Meet production requirements (i.e., on-time products cover spatial and temporal requirements)

Funding Priorities for National EPS

- High-Performance Computing – will need massive augmentation.
  - For Operations: consider changing acquisition process to make it more affordable?
  - For R&D: Acquire new HPC and/or fund use of existing HPC

- Possible R&D focus areas (*...to be vetted*):
  - **Optimal Ensemble Configuration** to meet NOAA customers’ need
    (Model resolution, # members, fcst length & update freq., domain(s), fcst timeliness, etc.)
  - **Simulation of Forecast Uncertainty**
    -- improved methods for initializing ensembles, e.g., multi-scale EnKF
    -- develop physically based methods for simulating model uncertainty, and compare to multi-model approaches
  - **Postprocessing (Calibration)**
    -- develop methods with consistency, e.g., precipitation type/temperature probabilities compatible
    -- need seamless (spatial and temporal) results for 4-D data cube; how to blend global, regional
    -- determine optimal application of reforecast datasets
    -- produce mesoscale reanalysis (also needed for verification)
  - **Application**
    -- design NWS CONOPS for a probabilistic forecast process
    -- develop user-specific decision support software to integrate probabilistic weather
    -- social sciences: understand % misinterpretation, impact of % on user trust, etc.
    -- perform business case studies
    -- build training and education materials
Probabilistic Prediction Advancement Committee (PPAC)
- Standing body in charge of R&D of Nation’s probabilistic forecast capability
- Members: NOAA, NCAR, DOD weather, academia, private sector, FAA
- Reports to NOAA Science Advisory Board

Proposed working groups to manage R&D activities and report to PPAC
- Ensemble Design -- # of members, resolution, methods to simulate uncertainty,...
- Postprocessing -- correction of systematic error, downscaling,...
- EPS Interface -- communication of uncertainty, education, verification of value,...
- Testing -- establish prototype EPS, standardize verification, judge EPS techniques,...
- Business Case -- prove EPS pays for itself many times over

work with DTC Ensemble Testbed (DET)
- Conduit for research to operations
- NEMS compliant
- Promote enterprise-wide collaboration
- Formalized testing and evaluation procedures
- Reduce overlap with other research activities

Open Questions:
- Relationship with NUOPC?
- Working groups’ design, job, make-up, etc.
- Team up with WRF Ensemble WG?
- R&D funding, and its distribution?