Regional Experimental Ensemble System (REES) Plans for 2012 and Beyond

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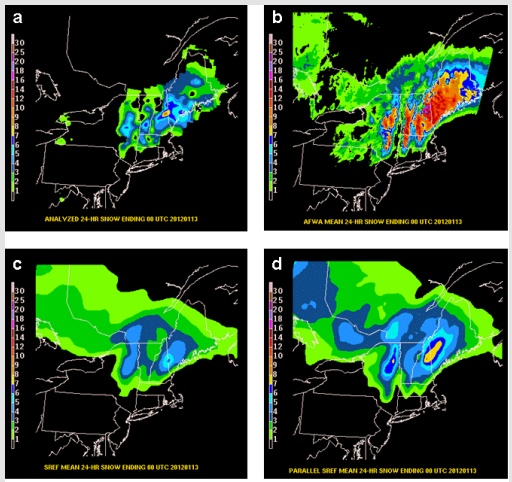
Research to Operations

MOTIVATION

In recent decades ensemble-based numerical weather prediction systems evolved rapidly, providing probabilistic weather forecasts as well as input in to decision support tools. Still, production of skillful probabilistic forecasts on the meso- and convective scales remains a major challenge, as noted in National Mesoscale Probabilistic Prediction: Status and the Way Forward (Eckel et. al 2010). We propose to help address this challenge by testing an experimental real-time ensemble prediction system over North America.

There are clear advantages of increased resolution. The figure below (from HPC, 2012) shows 24 hour snowfall forecasts. The present 32km SREF is in panel c, while panel d is the parallel 16 km SREF (panel b is the 4 km AFWA ensemble).



OBJECTIVES

- Bridge the gap between the current version of the operational NCEP SREF and future requirements of the NCEP SREF
- Allow testing of new methods for future NCEP SREF
- Allow near real-time feedback from forecasters and modelers, akin to the Storm Prediction Center (SPC), hazardous weather testbed (HWT), hydro-meteorological testbed (HMT), and aviation weather testbed (AWT)
- Allow testing of convection permitting ensembles embedded within for various applications (HWT, HMT, AWT, FireWx, and HFIP) and applications
- Demonstrate the value in very fine scale ensembles to justify and accelerate acquisition of the necessary high performance computing for operations

COLLABORATION

The development of this 9km experimental ensemble system will be collaborative.

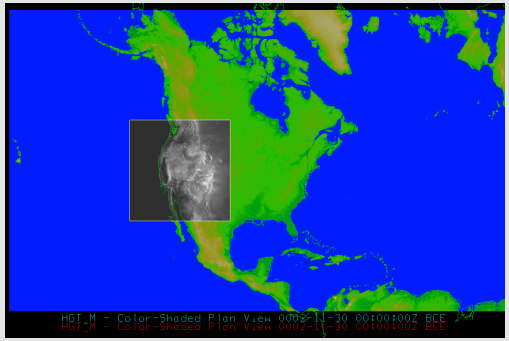
- DTC: develop scripts and workflow management software for execution of ensemble system on 'zeus' computing facility. Lead the effort in ongoing testing and evaluation, providing off-line parallel ensemble experiments and performing periodic evaluation of real-time ensemble performance.
- ESRL/GSD: develop initial configuration of the system, tapping into DTC scripts and workflow management. Responsible for maintaining the real-time execution of the system.
- NOAA/OST: provide input into the optimal design and testing and evaluation of the system, to ensure consistency with guidance in the NWS Science and Technology Roadmap and the specific goals outlined in Eckel et al. (2010).
- NOAA/EMC: provide guidance in building and testing the system for potential operational implementation.

Initial Configuration

CONFIGURATION

We envision an ensemble similar to that of the NCEP SREF to start.

- Approximately 20 members
- WRF-ARW, WRF-NMM and NMMB dynamic cores
- Various physics options, as well as stochastic forcing techniques (e.g. SKEB).
- Executed twice per day in real-time.
- Outer domain, approximately 9km horizontal grid spacing, covers approximately the domain of the NCEP SREF, North America and adjacent waters, though our domain will extend further to the east to better cover tropical cyclones (see below).
- Inner domain, 3km horizontal grid spacing, will focus on high impact weather, with the possibilities being: the western US domain for HMT (winter), the central US domain for HWT (spring), the eastern US domain for AWT (summer), the southeast US domain for HMT and/or HFIP (later summer), and the western US domain for fire weather (autumn).
- Lateral Boundary Conditions will be obtained from the operational NCEP Global Ensemble Forecasting System (GEFS).
- The first approach to producing initial perturbations will be made using a 'cycling of regional perturbations' approach with those perturbations centered on best available analyses.



RESOURCES

The exact configuration will depend on available computational resources. To implement the 9 km ensemble system that was described require: on the order of 2500 compute cores (128 for each ensemble member) for a 2-3 hour reservation twice per day. Storage on the order of a terabyte for these runs, as well as more significant archive capacity on tape, is also needed. The new machine "zeus.rdc.noaa.gov", located in Fairmont, West Virginia will provide the resources for these runs.

PRELIMINARY RUN-TIME RESULTS

- *9km outer nest for 48 hours*

480 cores = 39min, 240 cores = 1hr 8 min, 120 cores = 2hr 10min

- *9km outer nest forecast for 72 hours, 3km inner nest forecast for 24 hours*

240 cores = 3hr 50min

TESTING

From this initial base configuration, parallel runs will be done for testing of various ideas. We will test:

- The use of the Ensemble Kalman Filter (EnKF) and other advanced techniques for generation of initial perturbations
- Different choices of center/control analyses.
- Physics perturbations within the ensemble (multi-scheme, single-scheme, etc.) will also be candidates for testing.

ACKNOWLEDGEMENTS

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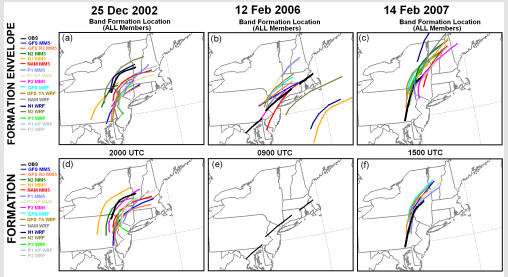
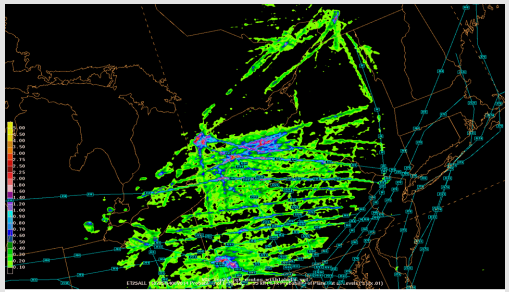
Applications

TESTBEDS

The utilization of this ensemble will be a multi agency effort. NOAA/HPC sees this ensemble as an important component in its HMT-HPC Winter Weather Experiment. HPC, HWT, HMT, AWT, and HFIP modeling participants are invited to use this ensemble for embedding their own convection permitting ensembles within, and those testbeds will offer valuable feedback on REES performance and reliability. Such feedback may be on raw ensemble output, but may also be for post-processed output and/or products created from that output. For example: a key aspect of ~9 km horizontal grid spacing ensembles is that they can provide uncertainty information for mesoscale features. The figure below (Figure 3 from Novak and Colle, 2012, below) shows how an ensemble can give snowband location information.



This ensemble system could be used in a manner similar to how AFWA's high-resolution ensemble was used during the 2011 AWT Summer Experiment. The ensemble provided probabilistic information of storm tops which was combined with historical aircraft position to create impact maps (below).



Impact Maps: Joint Probability of Echo Tops ≥ 25 KFT & Aircraft

In addition, this REES will allow for testing of the GSI-Hybrid data assimilation which is about to be implemented in GDAS. Ensemble sensitivity tools can also be built using the output of REES.

REFERENCES

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