CAPS STORM-SCALE ENSEMBLE FORECAST IN NOAA HAZARDOUS WEATHER TESTBED SPRING EXPERIMENTS

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1. OVERVIEW

A multi-year realtime storm-scale ensemble forecast (SSEF) effort has been conducted each spring since 2007 at the Center for Analysis and Prediction of Storms (CAPS) in the University of Oklahoma as part of the NOAA Hazardous Weather Testbed (HWT) Spring Experiment (Xue et al. 2009; Kong et al. 2011; Clark et al. 2011). Funded by the NOAA Collaborative Science, Technology, and Applied Research (CSTAR) program and in collaboration with the Storm Prediction Center (SPC) and the National Severe Storm Laboratory (NSSL), the CAPS SSEF is a multi-model multi-physics ensemble system, consisting of 10-50 members from four NWP model systems (WRF-ARW and NMM cores, ARPS, and COAMPS), covering the full continental United States at a 4-km convection-allowing horizontal grid spacing. CAPS SSEF members are configured with a combination of initial perturbations extracted from the coarser grid NCEP Short-Range Ensemble Forecast (SREF) ensemble members and various physics options in microphysics, PBL and land-surface model, and radiation. Radar data from over 140 WSR-88D Doppler weather radars, both radial wind and reflectivity, are analysed into the SSEF in realtime using the ARPS 3DVAR/Cloud Analysis system.

A wide range of ensemble products, some are experimental and evolving, are made available to HWT, including QPF and PQPF (both grid-wise and neighbourhood), and the probability matched ensemble mean QPF. Experimental products include the lightning threat factor and convection initiation (CI) parameters and their probabilities. Starting in 2012 spring, three different radiative transfer models are employed in the post-processing to produce in realtime the simulated synthetic GOES satellite radiance and brightness temperature products from the SSEF member forecasts.

2. CAPS SSEF SYSTEM

Prior to 2012, all SSEF forecasts are initiated at 0000 UTC, using NAM 12 km 00Z analyses as background and the initial condition perturbations for the ensemble members coming from the NCEP Short-Range Ensemble Forecast (SREF). Doppler radar radial wind and reflectivity data from over 140 available WSR-88D stations within the CONUS domain are assimilated through ARPS 3DVAR and Cloud Analysis package. Starting 2012 spring, a 12 UTC initiation sub-ensemble is also produced.

Daily 36 h forecasts are produced on the weekdays throughout the 5-week HWT Spring Experiment period from late April to early June. Special weekend runs are arranged if it is requested by HWT based on the severe weather outlook. All ensemble forecasts are performed remotely, utilizing the supercomputing resources located at the National Institute of Computational Sciences (NICS) in the University of Tennessee, the Pittsburg Supercomputing Center (PSC), as well as the Oklahoma Supercomputer Center for Research and Education (OSCER) at University of Oklahoma.

Table 1 outlines the CAPS SSEF system and its evolution history. Detail member configurations are described in Kong et al. (2007, 2008, 2009, 2010, 2011, 2012).

Table 1. CAPS SSEF system overview

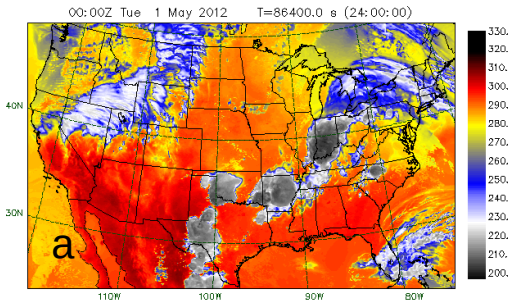
Year	2007	2008	2009	2010	2011	2012
Member #	10	10	20	26	51	28
Domain (grid spacing)	2/3 CONUS (4 km)	¾ CONUS (4 km)	¾ CONUS (4 km)	Full CONUS (4 km)	Full CONUS (4 km)	Full CONUS (4 km)
Forecast	33 h	30 h	30 h	30 h	36 h	36 h
NWP Model	WRF-ARW (v2.2)	WRF-ARW (v2.2)	ARW, NMM (v3.0.1.1) ARPS	ARW, NMM (v3.1.1) ARPS	ARW, NMM (v3.2.1) ARPS	ARW, NMM (v3.3.1) ARPS, COAMPS
Radar DA	No radar	Radial wind, reflectivity	Radial wind, reflectivity	Radial wind, reflectivity	Radial wind, reflectivity	Radial wind, reflectivity

New in 2012 season is the addition of a parallel set of 5-member ARW sub-ensemble that has all the same configuration as a counterpart sub-ensemble but with the newly available stochastic kinetic energy backscatter (SKEB) perturbation option coming with WRFV3.3 turned on. The primary goal of adding this sub-ensemble is to allow post-season evaluation of the impact of SKEB on storm-scale ensemble forecasting spread and skill that run at convection-permitting resolution.

3. ENSEMBLE PRODUCTS

CAPS SSEF ensemble forecast products are made available to the HWT Spring Experiment participants at HWT's daily weather briefing in SPC during the weekdays. In addition, CAPS also makes available a realtime forecast webpage showing the SSEF (**http://forecast.caps.ou.edu/**), with highlights to a demonstrative ensemble post-processed product page[1].

The product list includes ensemble maximum and mean, probability matching mean, ensemble exceedance probability, and neighborhood probability. Variables processed include forecast reflectivity, 1-, 3-, and 6-h accumulated precipitation, 2-m temperature and dew point, 10-m wind, 3-6 km updraft/downdraft velocities, updraft helicity, 0-1 km and 0-6 km wind share, vertically integrated grapeul/hail content, and some convective storm related indices (CAPE, CIN, LCL). Other variables diagnosed include Lightning Threat and CI probabilities, simulated GOES satellite IR brightness temperature product, and probabilities of several severe storm parameters such as the Significant Tornado Parameter (STP). Figure 1 shows example of simulated brightness temperature product.



[1] http://www.caps.ou.edu/~fkong/sub_atm/spring12.html

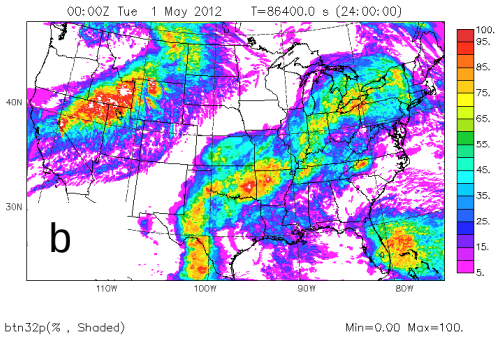


Figure 1. Simulated brightness temperature for the ARW_CN member (a), and the ensemble probabilities of BT below -32C (b) for the 24 h forecast time of April 30, 2012 case, valid at 0000 UTC April 25, 2012.

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