New Dimension of NCEP Short-Range Ensemble Forecasting (SREF) System: Inclusion of WRF Members

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1 Introduction

A 10-member Short-Range Ensemble Forecasting (SREF) system was operationally implemented and used at NCEP in May 2001 (Du and Tracton, 2001), which was the first real-time, operational regional ensemble prediction system in the world. From the very beginning of its development stage, NCEP SREF system has been emphasizing on **both** initial condition (IC) and model physics uncertainties at the same time by using multi-analysis (edas and gdas), multi-LBCs (using NCEP global ensemble members), multi-model (Eta and RSM) and perturbing ICs (breeding method) mixed approaches (Tracton et. al. 1998). In September 2003, another set of 5 Eta members but with a different version of convective scheme (Kain-Fritch) was added (make a total of 15 members) to further address physics uncertainty (Du et. al. 2003). The date of August 17, 2004 marks a new level of addressing physics diversity by implementing a total of 6 various convective schemes to the syetem besides perturbing ICs in 12 out of its 15 members (Du et. al. 2004; McQueen et. al. 2005).

This paper describes another important milestone which was achieved recently at NCEP. Six Weather-Research-Forecast (WRF) model based members were operationally implemented as part of the NCEP SREF system on December 6, 2005. Three members use NCEP NMM core, while other 3 members use NCAR EM core (Table 1). Now, there are a total of 21 members in NCEP SREF system in each cycle (two cycles per day to 87 hours, holizontal resolution varies among members from 32 to 45 km). This implementation marks the transition of NCEP SREF into WRF era. For the NCEP SREF products, please go to http://wwwt.emc.ncep.noaa.gov/mmb/SREF/SREF.html.

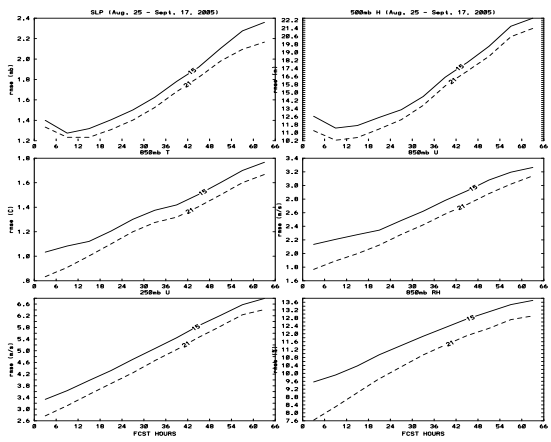

Figure 1: RMSE of the 21-member based ensemble mean forecast is largely reduced over that of the 15-member based for six selected fields: SLP, 500mb H, 850mb T, 850mb U, 250mb U and 850mb RH.

2 Results

Reader is referred to the captions of Figures 1-6 for the description of results. All results are evaluated against the NCEP global analysis (GDAS) and averaged over the 212 AWIPS grid domain (40km CONUS) and the period of Aug. 25 to Sept. 17, 2005.

3 Looking Forward

Bias correction is an immediate need for this 21-member system to be more robust (Fig. 6). It's also desired to investigate if WRF-member only SREF system will have similar quality comparing to the current multi-model based system, i.e. comparable accuracy in both ensemble mean and probabilistic forecasts and similarly large and good spread. For references, please see the NCEP SREF web.

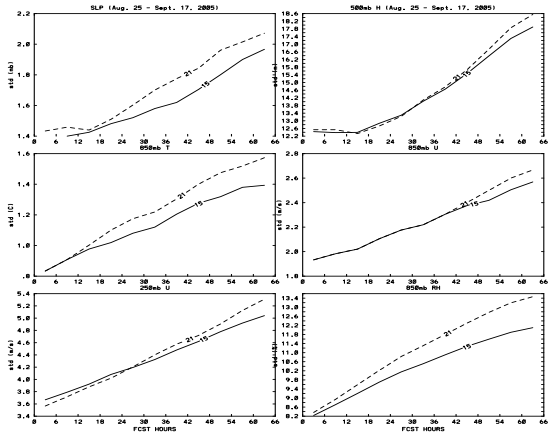

Figure 2: The ensemble spread is increased from the 15-member based to the 21-member based SREF system with a larger growth rate too!

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Dyn Core	Physics	Hor-Res	Configuration	Membership	IC	LBC	LSM
NCEP NMM	Eta/BMJ-based	40km	N America/non-hydro	3 (1 ctl, 2 bred)	GDAS	MREF	NOAH
NCAR EM	MM5/KF-based	45km	N America/non-hydro	3 (1 ctl, 2 bred)	GDAS	MREF	NOAH

Table 1: Configuration of how 6 WRF members are setup.

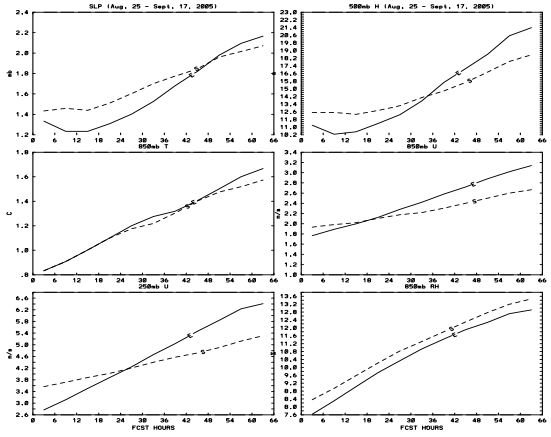

Figure 3: Due to the reduction of forecast error and the increase of ensemble spread, the spread-skill relationship is improved, i.e. the ensemble spread (lable "S") is now closer to the error of ensemble mean forecast (labled "E") for an originally underdispersive ensemble system.

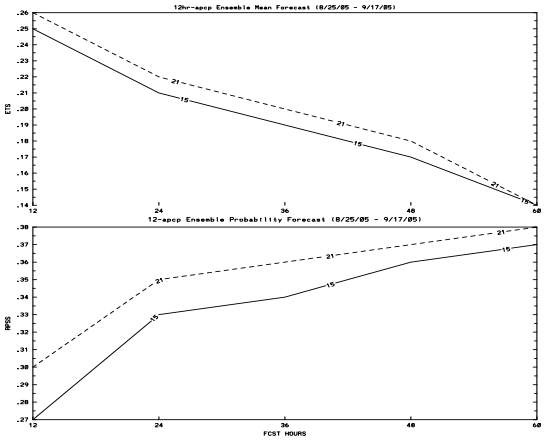

Figure 4: Similar improvements are also seen for ensemble mean precipitation forecasts in terms of Equitable Threat Score (upper panel) and for probabilistic precipitation forecasts measured by Ranked Probability Skill Score (here, the accuracy of 12km-NAM forecast is used as a reference in calculating the skill) (lower panel).

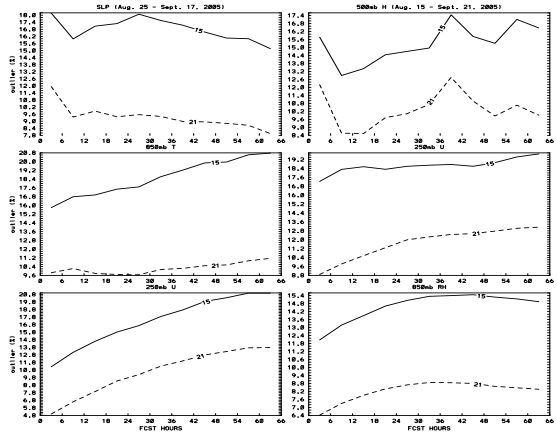

Figure 5: Outlier is decreased, i.e., the chance that truth to be left outside a forecast range predicted by the ensemble becomes much less after the 6 WRF members are added.

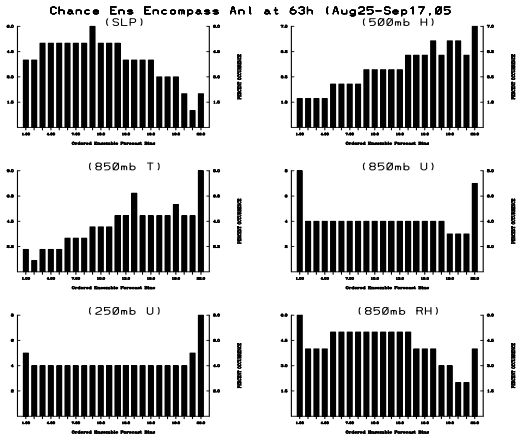

Figure 6: Talagrand Distribution or Rank Histogram shows that bias error is obviously possessed particularly for mass fields in the 21-member NCEP SREF system.