Test of a Weather-Adaptive dual-resolution Hybrid 3DEnVAR and WRF-DART Analysis and Forecast System for Severe Weather

Yunheng Wang[1,2], Jidong Gao[2], Patrick S. Skinner[1,2], Kent Knopfmeier[1,2], Thomas Jones[1,2], Pamela L. Heiselman[2], and Louis J. Wicker[2]

[1]Cooperative Institute for Mesoscale Meteorological Studies, University of Oklahoma [2]NOAA/National Severe Storm Laboratory

168

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Outlines

- Develop of a hybrid multi-scale data assimilation system.
- Test of the system with numerical predictions for convective-scale weather events.

Introduction

To support the Warn-on-Forecast (WoF) project operations, improvements to an original 3DVAR system was incorporated with balance constraints specifically for convective-scale variables and optimal incorporation of flow-dependent covariance from ensemble forecasts. The system is named the NSSL Ensemble Warning System – variational component (**NEWS-var**) and it cooperates (Fig. 1) together with the NSSL Experimental WoF System for ensembles (**NEWS-e**) to provide a hybrid approach for the convective-scale data assimilation schemes.

Dual resolution strategy is used with the convective scale low resolution (LR) ensemble analyses performed by NEWS-e at 3 km resolution and a deterministic high resolution (HR) analysis performed with NEWS-var at 1.5 km resolution. WRF-ARW forecasts are launched every half hour after 1-hour data assimilation cycles with 15-minute cycle intervals (Fig. 2).

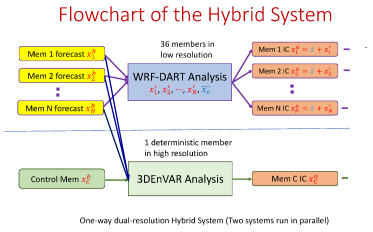

Fig 1. *Hybrid approach with NEWS-e and NEWS-var*

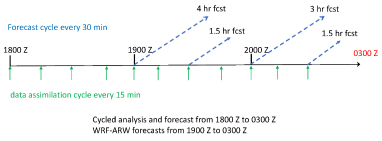

Fig 2. *Flow Chart of the HWT experiments in 2017*

Preliminary Results from HWT experiments

The NEWS-var system with dual-resolution capability is tested during the 5-week spring experiment period in 2017 (May 8 to June 9, 2017) for the NOAA Hazardous Weather Tested (HWT). There are three major severe weather outbreaks in the experiment period and the system performs reasonably well with most of the events with accurate forecasts in advance. We focus especially on May 16 case which produces a EF-2 tornado in Elk City Oklahoma.

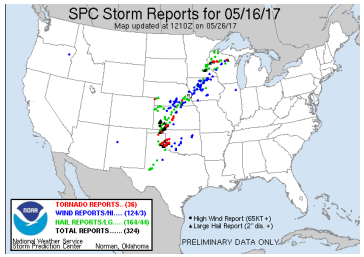

Fig 3. SPC *Storm reports on May 16, 2017.*

Fig 4. The *EF-2 tornado on May 16, 2017 and its damage in Elk City, Oklahoma*

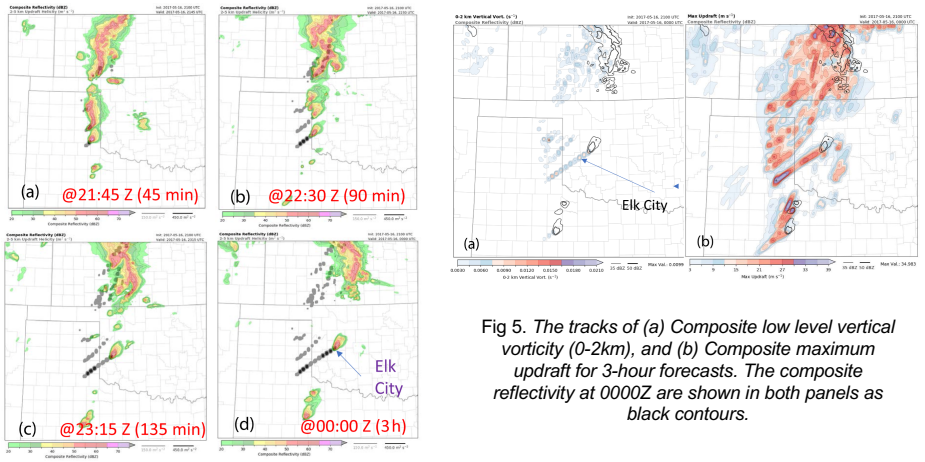

Fig 5. *The tracks of (a) Composite low level vertical vorticity (0-2km), and (b) Composite maximum updraft for 3-hour forecasts. The composite reflectivity at 0000Z are shown in both panels as black contours.*

Fig 6. *The track of updraft helicity between 2- 5 km above the ground (black contours) during the 3-hour forecast period starting from 2100 Z on 16 May 2017. The composite reflectivity (color shaded) are also shown at (a) 2145 Z, (b) 2230 Z, (c) 2315 Z, (d) 0000 Z.*

Sensitivity Study

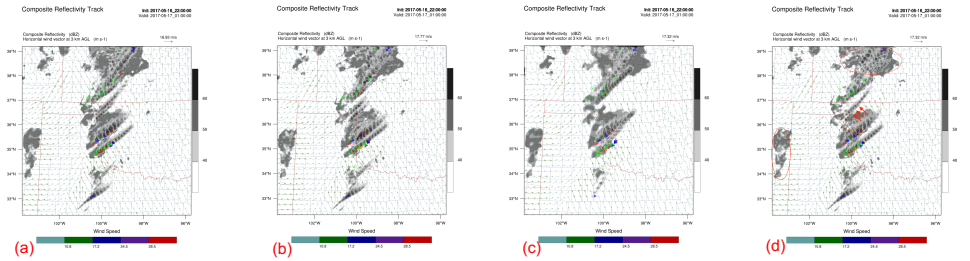

Fig 6. *3-hour forecasts of the composite reflectivity swath for May 16 2017 event starting from 2200Z. (a) Control experiment that radar reflectivity data is assimilated in the variational framework; (b) no flow-dependent covariance; (c) no dual-resolution; (d) addition with satellite cloud water path assimilation. Note that SPC storm reports are attached for visual verification and Elk City (denoted as a yellow star) has a tornado report at 00:35Z.*

Summary

The hybrid approach helps in phase error corrections (comparing *a* to *b*). High resolution analysis and forecast are important for both storm strength and position (comparing *a* to *c*). Satellite data assimilation has minor impacts but help to suppress development of some fake storms in the numerical prediction.

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