NOAA THORPEX: UNDERSTANDING AND IMPROVING THE ENSEMBLE TRANSFORMA KALMAN FILTER TARGETING STRATEGY

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The primary goal of this project is to evaluate and further develop the Ensemble Transform Kalman Filter (ETKF) adaptive observing strategy, which is presently in use in operational NWS Winter Storm Reconnaissance (WSR) programs. The main focus is to assess the ability of the ETKF to perform out to 3-7 days, by understanding how forecast error variance is reduced in different flow regimes.

Summary of work to date

In order to assess the performance of the ETKF, the actual influence of observations on numerical forecasts first needs to be studied. Much of the first year has been spent learning the "Global Parallel" software at EMC and running it using the T126 L28 GFS for denial of rawinsonde or dropwindsonde data from: (i) east Asia, (ii) north America, and (iii) WSR flights. Some bugs in the software have been found and are presently being corrected by EMC personnel. When available, the software will be re-run for a 3-month period during winter 2004/5, to compute "signals" produced by the different observation sets (i.e. differences between operational and data denial runs). The quantitative improvement of these observations on 3-7 day forecasts will be evaluated.

A parallel study with Dr Daniel Hodyss of RSMAS/U.Miami is being conducted to understand the fundamentals of signal growth and propagation, building on the work of Szunyogh et al. (2000, 2002). Preliminary results from a small sample indicate that

(i) Signals in mid-latitudes are affected considerably by propagation of tropical signals caused by tiny initial perturbations.

(ii) The evolution of signals from targeted data (e.g. WSR dropwindsondes) is generally more coherent than signals from non-targeted data (routine rawinsondes).

(iii) Downstream effects are important, although it is unclear whether the rapid amplification of a signal downstream is associated with downstream baroclinic development or rapid local growth of a small perturbation (e.g. due to convection).

(iv) Tracking 'forecast improvement' may be much clearer than tracking signals.

Hovmoller diagrams and vertical cross-sections of signals are being analyzed to assess the structure and time evolution of signals and forecast improvement.

After the NCEP parallel runs have been re-computed, the ability of the ETKF to predict signal variance of 3-6 day forecasts will be evaluated. The accompanying Powerpoint file shows the predicted ETKF signal variance (using a 20-member NCEP GFS ensemble initialized at 2005011900) and a preliminary NCEP signal for a WSR flight over the northeast Pacific Ocean on 2005012000. Some similarities and differences exist between the two plots. Early results indicate that the ETKF shows promise in predicting signal variance out to 3-7 days provided that observations are selected in locations of high ensemble variance. In locations of low ensemble variance, the ETKF often produces spurious initial long-distance correlations between errors in the observation area and errors in regions of high variance downstream. Results will be updated on the following website throughout the project: http://orca.rsmas.miami.edu/~majumdar/thorpex/

Tasks for Year 2:

Re-compute T126 L28 NCEP GFS "signals" (Summer 05)

Quantify the influence of rawinsondes and dropwindsondes on 3-7 day forecasts (Fall 05)

Identify flow regimes during the winter period (Fall 05 – Spring 06)

Quantify the ability of the ETKF to predict forecast error variance (Fall 05 – Spring 06)

New analysis error covariance matrices based on the routine observational network and large ensembles (1000 T62 GFS) will be tested in the ETKF (Fall 05 – Summer 06)

A paper with Dr Yucheng Song on the 2003 Atlantic THORPEX Observing Systems Test and the 2004 and 2005 WSR Programs will be submitted (Fall 05-Summer 06).