State Estimation with Huge Ensembles

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The primary focus for the first 6 months of funding has been to generate a huge ensemble using inexpensive methods. In the proposal three methods of generating the large ensemble were mentioned. Here is a quick report of progress so far on each of these methods.

1. Progress so far.

a. Space-time deformation ensemble

Code has been developed to shift 4-dimensional forecasts from global models smoothly in space and time (see Fig. 1 for an example). The first code to do this was based on the assumption that the correlation functions for shifts in space and time are separable into an horizontal, vertical and temporal. The first code obtained random shifts in the horizontal by performing a direct eigenvector decomposition of the horizontal correlation matrix implied by the prescribed horizontal covariance matrix. However, it was soon realized that this approach became extremely computationally expensive for the T250 – T500 resolution models currently used at operational centers. To overcome this problem, new code has been developed that is based on spherical harmonics. The resulting horizontal correlation model is now very similar to that used by NCEP's SSI scheme (Parish and Derber, 1992). This new scheme is orders of magnitude faster than the old scheme and will enable higher resolution experiments to be performed (Figure 1 is based on the old scheme).

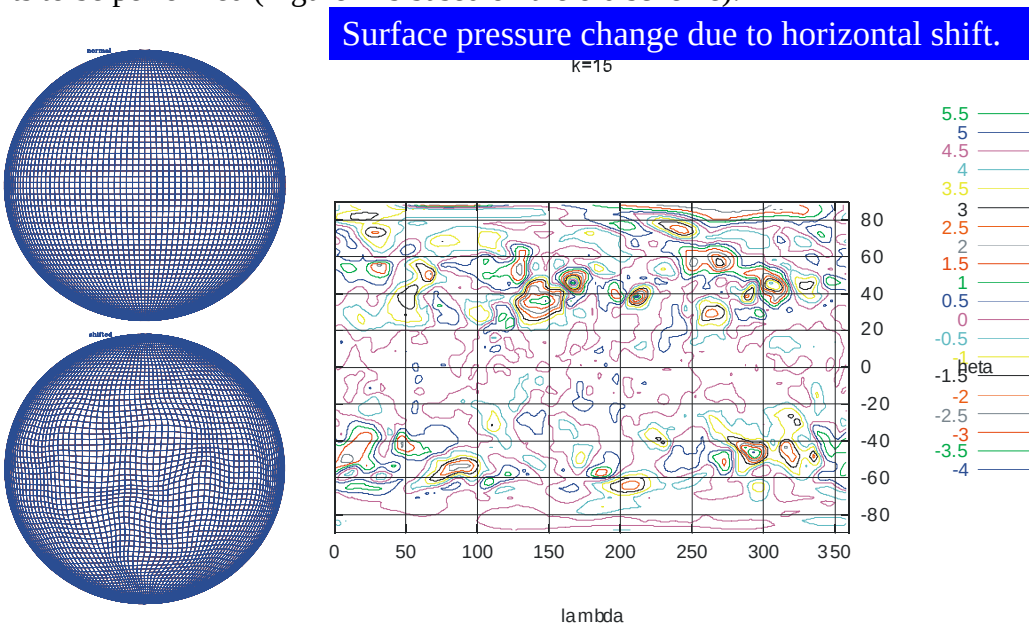

Fig. 1 The upper left panel gives the regular undeformed grid. The lower left panel gives the grid randomly but smoothly shifted on the sphere. The right panel gives the difference in surface pressures from the shifted and unshifted grids.

b. Isotropic error covariance ensemble.

After considerable effort and using the fact that the NAVDAS forecast error correlation functions are expressed in terms of a separable product of the horizontal coordinate, vertical coordinate and temporal coordinate, the means to randomly sample the NAVDAS forecast error covariance matrix was also obtained for coarse resolution grids. Again, it was found that the horizontal eigenvector decomposition was extremely costly. Our options now are either to just use the coarse resolution random perturbations currently available or, again, to build a new isotropic covariance model based on spherical harmonics. The spherical harmonic basis would enable us to use much higher resolution perturbations at a smaller computational expense.

c. Historical archive of perturbations.

Carolyn Reynolds has been archiving 20 member ensemble forecasts made every 12 hrs for the last 12 months. As such, we now have access to a very large historical set of ensemble perturbations.

d. Enlargement of dynamic ensemble with accurate error covariances.

Kevin Shanley (BSc) a Masters student at the University of Massachusetts at Boston has been employed under the Thorpex funding and has been working on the problem of maintaining accurate forecast error covariance estimates while enlarging ensemble size.

2. Plans for rest of year

Hopefully, a prototype huge ensemble filter will be tested later this year.