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Ensemble initialization procedures in the GME-EFS

JD Keller (1), A Rhodin (2), and L Kornblueh (3)

(1) Universität Bonn, Meteorologisches Institut, Bonn, Germany (jkeller@uni-bonn.de), (2) Deutscher Wetterdienst, Offenbach, Germany, (3) Max-Planck-Institut für Meteorologie, Hamburg, Germany

In the new ensemble forecasting system GME-EFS (KELLER ET AL., 2008; 2010) based on the German Meteorological Service's global weather forecasting model, two different methods for the generation of analysis perturbations have been used: the *breeding of growing modes* (BV) technique (TOTH AND KALNAY, 1993; 1997) and a localized Ensemble Transform Kalman Filter (LETKF). For the former, an Ensemble Transform (ET) approach similar to that described by WEI ET AL. (2008) was implemented for the BV procedure. However, our approach differs from that of WEI ET AL. in the choice of the metric used to calculate the basis for the orthogonal ET:

$$\mathbf{Z}^T\mathbf{M}\mathbf{Z}\widetilde{\mathbf{E}} = \widetilde{\mathbf{E}}\Lambda \tag{1}$$

where $\mathbf{Z}$ is the set of original BVs and $\mathbf{M}$ the matrix of coefficients to convert the BVs to the corresponding energy contributions to the BV perturbations. Hence $\mathbf{Z}^T\mathbf{M}\mathbf{Z}$ is the energy covariance matrix of the BVs. The transformed othogonal perturbations can then be retrieved as

$$\mathbf{Z}_\perp = \mathbf{Z}\widetilde{\mathbf{E}}\Lambda^{-1}\mathbf{I}_k. \tag{2}$$

Results of a long-term GME-EFS forecast experiment (three months) show significant enhancements for the ensemble forecasts based on the ETBVs described above over the original set of BVs. The gain in ensemble forecast quality can not only be seen in an enhanced ensemble reliability (ensemble spread) but also in a higher forecast quality regarding the ensemble resolution (performance over climatological forecast).