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Estimating and correcting global weather model error

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Numerical weather forecast errors are generated by model deficiencies and by errors in the initial conditions which interact and grow nonlinearly. With recent progress in data assimilation, the accuracy in the initial conditions has been substantially improved so that accounting for systematic errors associated with model deficiencies has become even more important to ensemble prediction and data assimilation applications. Leith (1978) proposed a statistical method to account for model bias and systematic errors linearly dependent on the flow anomalies. DelSole and Hou (1999) showed this method to be successful when applied to a very low order quasi-geostrophic model simulation with artificial "model errors." However, Leith's method is computationally prohibitive for high-resolution operational models.

In this talk we will describe a new method of state-dependent error correction which uses SVD to identify coupled signals between model state anomalies and 6-hour forecast error anomalies. The method was applied to the SPEEDY primitive equations global model; the annual and diurnal model bias was estimated from the 6-hour errors (relative to the NCEP reanalysis). Correcting the model bias during the integration yielded better forecasts than statistical corrections performed a posteriori. The dominant error and state anomaly patterns (identified by SVD) were used to make state-dependent corrections and further improved forecasts of data independent from the training period. The method requires only a time series of analysis and analysis increments to estimate the cross covariance of the anomalous model errors and corresponding states. The additional computations needed for forecast corrections during the numerical integration are negligible. As a result, the method should be suitable for operational use at very low computational cost.