Estimation and Correction of GFS Systematic Errors Using Analysis Increments

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Systematic forecast errors form a significant portion of the total forecast error in weather prediction models like the Global Forecast System (GFS). They result from the model bias and the impact of observation biases in the model initial conditions that then grow nonlinearly as the model is integrated in time, until the errors saturate. Our goal is to estimate and explore the initial model biases, time -mean and periodic, as a first step towards correcting them within the model as in Danforth, Kalnay and Miyoshi 2007 (DKM07). We estimate the model biases from the time average of the 6-hr analysis increments (AIs), which are the corrections that the observations make on the 6-hr forecasts.The 6-hr forecast is short enough that the systematic errors grow approximately linearly.

The seasonal mean AIs for 2012-2016 indicate that our estimate of the model bias is generally robust despite increases in model resolution and advances in data assimilation. These errors have broad continental scales, and hence independent of changes in model resolution. Thus, the seasonal mean bias can be corrected online using an approach similar to that proposed by DKM07, except the correction may contain observational bias. The periodic component of model bias dominated by errors in diurnal and semidiurnal cycle, completely described by four leading EOFs, can be corrected by the low dimensional approach of DKM07. Our examination of the model biases in 2015 and 2016 shows a significant reduction relative to those from 2012-2014, which we attribute to the improvement in the specification of the SST boundary conditions.

We plan to test the impact of correcting the model online using these estimations of model bias , and verify whether the encouraging reduction of systematic and random errors obtained by DKM07 are still present in a much more realistic NWP system.