Using Method for Object-Based Diagnostic Evaluation (MODE) to Analyze Systematic Biases in the Global Forecast System

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Errors in model forecasts are at times random and dependent on the state of the atmosphere. Other model errors demonstrate consistent biases requiring a model change to remove the bias. For example, the Global Forecast System (GFS) run by NOAA's Environmental Modeling Center (EMC) has gone through many scientific, infrastructure, resolution, and data assimilation upgrades since the 1980's. Each upgrade requires EMC personnel to evaluate how the changes in the model influenced the model's behavior and whether any systematic errors have been fixed or introduced.

One method used at EMC to identify biases in the GFS model is the Method for Object Based Diagnostic Evaluation (MODE), a part of the Model Evaluation Tools software package, developed by the National Center for Atmospheric Research and supported to the community by the Developmental Testbed Center. This object-based verification method was originally tested using accumulated precipitation amounts, but was also applied to jet streams and could be applied to many more forecast variables. The MODE tool computes aggregated statistics and scores based on the overall similarity between forecast and verification objects, including object pair attributes such as centroid distance, area ratio, angle differences in axis orientations, and intensities ratios. MODE avoids the well-known "double penalty" problem when even small spatial errors can result in the forecast being penalized twice, once for missing the observed precipitation and again for giving a false alarm. Systematic errors identified by MODE will be presented for older and current versions of the GFS and for other forecast systems.

During May-August 2016 GFS precipitation forecasts had a southern bias in late May and June, a northern bias in July, and an overall northern bias of 0.5-1 degree. It did well on light precipitation, but underestimated the heavier precipitation events and struggled with the axis of precipitation, especially in May.