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Object-based diagnostic verification of precipitation forecasts

B. Brown (1), C. Davis(1), and R. Bullock (1)
(1) National Center for Atmospheric Research (bgb@ucar.edu; FAX: +1 303-497-8401)

To better diagnose spatial characteristics of model capabilities, an object-based verification approach is applied to precipitation and convective forecasts from the Weather Research and Forecast (WRF) model. The object-based approach allows identification and comparison of meaningful precipitation (or convective) objects in the forecast and observed fields. Basic attributes of the objects (e.g., size, shape, location, intensity) are measured and compared to either discern climatological errors in object attributes or to evaluate errors in the forecasts of matched objects. The types of errors that are measured allow diagnosis of fundamental characteristics of model performance to the extent that the object attributes are related to physical or dynamical processes.

The object-based approach is applied to WRF precipitation forecasts on both a 22-km and 4-km grid. On the former, convection is parameterized, but it is explicit on the latter. Results of the comparisons provide much greater insight into characteristics of the model performance than could be attained through more traditional verification approaches. For example, the analyses indicate that the model produced too many large areas of precipitation and too few small areas; and that extreme precipitation intensities are under-predicted on the coarser grid, whereas moderate intensities are predicted too frequently. Application to fine-scale (4-km) WRF forecasts from the BAMEX project indicates, among numerous other results, that the model produced too many rain areas and that rain systems generally started late and lasted too long. Errors in placement, size and intensity of objects were also shown to vary diurnally. Forecasts with the cumulus parameterization produced areas that were too large and with precipitation too light mainly in the afternoon. Explicit (4 km) forecasts produced areas that were too large late at night, typically during the dissipation stage of organized convection.

Results of these studies indicate some of the benefits of the object-based verification approach for evaluation of model forecasts. Many different types of diagnostic information can be obtained through this approach. The object-based approach is currently being extended to explicit forecasts of convection and is being enhanced toward evaluation of three-dimensional objects (where the third dimension is time).