Probabilistic Convection and Lightning Forecasts: A Multi-Model 'Consensus' MOS Approach

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For many years the National Weather Service's Meteorological Development Laboratory (MDL) has been producing Model Output Statistics (MOS) forecasts for various weather elements based on a single model, e.g., the National Centers for Environmental Prediction (NCEP) Global Forecast System (GFS) or the North American Mesoscale Prediction System (NAM). In recent years, a push toward "consensus forecasting" has led to increased use of ensembles in order to better quantify forecast uncertainty. Of particular importance to aviation safety is the availability of reliable probabilistic guidance for convection and cloud-to-ground (CTG) lightning. This paper describes the development of experimental 2-h probabilistic MOS guidance for convection and lightning used as input to the Localized Aviation MOS Program (LAMP), with a focus on demonstrating the potential benefits of combining multi-model information into a "consensus" MOS system.

For this development, the MOS convection and thunderstorm predictands are defined the same as for LAMP; that is, "convection" is defined as the occurrence of either ≥ 40 dBZ radar reflectivity or one or more CTG lightning strikes within a 20-km grid box over a 2-h period, while a "lightning" event is defined only by the occurrence of one or more CTG strikes without regard to reflectivity. Separate MOS convection and lightning probabilitiy equations were developed based on the GFS alone and the NAM alone, with roughly 9 years of developmental data available for the GFS and 5 years available for the NAM. Important predictors in these equations include convective precipitation amount, an interactive term involving the K-index multiplied by the climatological relative frequency, and other model forecast variables. In addition to the GFS and NAM systems, a "consensus" MOS system was developed which contained only three predictors: the GFS MOS probability, the NAM MOS probability, and the product of these two probabilities. The consensus regression equations were developed using the 5 year sample of data common to both the GFS-based and NAM-based equation developments.

Comparative verification of the three sets of convection and lightning probability equations was performed using one spring, one summer, and one cool season of independent data for the 00Z model cycle. For all seasons and forecast projections, Brier Skill Scores (BSS) for the consensus MOS probabilities were significantly better than those for both the GFS MOS and NAM MOS systems alone, with the amount of improvement greater during the cool season and less during the spring and summer seasons. Also, consensus MOS probabilities generally showed better sharpness and reliability than the single model probabilities. This verification clearly demonstrates the potential significant benefits of combining forecast information from multiple models into a "consensus" MOS system, not only for convection and lightning but potentially for other MOS elements as well.

The experimental 2-h GFS MOS and NAM MOS convection and lightning guidance is currently used as predictor input for producing corresponding LAMP convection and upgraded lightning probabilities, and has resulted in sharper and more skillful LAMP forecasts. Given the success of this multi-model "consensus" MOS application, future plans include developing MOS convection and lightning guidance from the NCEP Short-Range Ensemble Forecast System (SREF). Further details about the development and verification of the MOS convection and lightning products will be presented at the conference.