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Probabilistic Forecasts of 1-15-day 500 hPa Geopotential Height over Northern Hemisphere based on Bayesian Model Averaging

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Three single-model ensemble prediction systems (EPSs) and their multimodel ensemble system were used to carry out the Bayesian Model Averaging (BMA) probabilistic forecasts of geopotential heights at 500 hPa over Northern Hemisphere with lead times of 1-15 days. The three single-model EPS datasets were obtained from the European Centre for Medium-Range Weather Forecasts (ECMWF), the National Centers for Environment Prediction (NCEP) and United Kingdom Meteorological Office (UKMO), respectively, contained in The Observing System Research and Predictability Experiment (THORPEX) Interactive Grand Global Ensemble (TIGGE). The used common period was 2011-2013. The BMA probabilistic forecasts of 500 hPa geopotential height were conducted in a recursive mode by using a sliding training period. BMA gave a full probability distribution function (PDF), which depicted the quantitative uncertainty of the forecasts, instead of predicting the probability of exceeding a threshold like other several methods. With the increasing latitude and lead time, the forecast uncertainty became more significant. The original ensemble forecasts had negative deviations, while the BMA prediction PDF was much better calibrated. According to the calculations of three metrics, i.e. mean absolute error, continuous ranked probability score and average width of the 90% prediction intervals from the BMA prediction PDF, the optimal length of the sliding training period for the BMA experiments was determined as 45 days. Comparisons between the original ensemble forecasts and BMA predicted results suggested that the BMA forecasts performed better than the original ones for all lead times in terms of not only deterministic but also probabilistic forecasts. Furthermore, the forecast skill varied as season changed, especially for the extended-range (10-15 days) period. Similar to the original ensemble forecasts, the BMA prediction was most skillful in summer but not efficient enough in winter. However, the calculated skill score indicated that the forecast improvement promoted by the BMA method in winter was much larger than those in other seasons. That is, BMA can ameliorate the worse raw ensemble to a larger extent. Besides, the brier skill score showed that the BMA probabilistic forecasts were superior to the climatology ones, especially in middle and high latitudes. The BMA predictions based on multimodel ensemble system also outperformed those of single-model EPSs for all lead times. Generally, the BMA method significantly improved the probabilistic forecasts of 500 hPa geopotential height over Northern Hemisphere from short-to-medium-range to extended-range.