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Design and experiment of a 3D model bias damping scheme in GRAPES Ensemble forecast System

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In general, an ensemble prediction system (EPS) deals only with random error but not systematic error. If an EPS has systematic error, ensemble quality will be affected. Model bias can be decomposed into linear and nonlinear parts by using linear regression. The linear part of model bias at a grid is defined the calculation of slope by linear regression and represented the systematic error. A 3D model bias damping scheme based on linear bias of equlivalent potential temperature for a 15-member regional EPS (GRAPES-EPS) is designed and tested over a period over China.The linear bias of equlivalent potential temperature are deducted from its tendency after every integral step. The variables of upper air and surface (geopotential height, temperature, wind on pressure level and 2-m temperatures, 10-m wind speed and precipitation) are verified. RMS of ensemble mean, spread, outlier and probabilistic forecasts are assessed and compared before and after a 3D model bias damping. The results show that not only the RMS of ensemble mean of temperature, but also the RMS of ensemble mean of geopotential height and wind are obvious improved after a 3D model bias damping, For example, the GRAPES-EPS is severely large RMS for temperature before the bias damping but becomes calibrated afterwards. Although the improvement in spread is much less, the spread-skill relation is also improved. The probabilistic forecasts become much sharper after the bias damping. Therefore, it is valuable to remove forecast biases if model suffer the systematic bias. An implication of this study is that EPS developers should not only be expected to introduce methods to handle random error but also to introduce methods to handle systematic bias through prediction system developments.
Key words: linear part of model bias experiment, a 3D model bias damping scheme, GRAPES-EPS, experiment.