Superensemble Precipitation Forecasts using TRMM and DMSP Satellite Microwave Imager Products

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This study evaluates short- to medium-range quasi-operational ensemble rainfall forecasts over the global tropics through use of satellite measurements (e.g. TRMM and SSM/I), as a comprehensive extension of the previous multimodel/multianalysis superensemble (SE) studies of rainfall forecasts (Krishnamurti et al., 2001).

Three different precipitation ensemble configurations are first established from a great number of numerical experiments. These configurations are multianalysis (MA), multicumulus-scheme (MC), and multimodel (MM) configurations. A set of MA ensemble comes from the use of several different satellite-derived rain rates through the physical initialization procedure within the Florida State University Global Spectral Model (FSUGSM) system. Six different state-of-the art cumulus parameterization schemes are incorporated into the FSUGSM in order to introduce the MC ensemble configuration. The MM configuration is composed of an FSU control forecast and those provided by five operational numerical weather prediction centers.

The SE is a method of combining individual forecasts from a group of models to produce an optimal ensemble forecast. It differs from a regular ensemble (RE) mean forecast in that different models are weighed by sets of statistics obtained during a training period prior to the forecast mode. In addition to the original technique (SEO), a possible SE enhancement technique (regression dynamic linear model using the Kalman Filter algorithm (SEK), see West and Harrison, 1997) is then proposed and applied to the above three configurations of ensemble members as well as all of them together (i.e. ALL configuration).

Figures 1 and 2 display respectively 15-day averaged (August 1 to 15, 2000) RMSEs and spatial correlation coefficients of T126 precipitation forecasts for (a) MA, (b) MC, (c) MM, and (d) ALL ensemble configurations over the global tropics, 45^{o}S to 45^{o}N. The forecast skills of RE mean, SEO, individually bias-corrected ensemble (BCE), and SEK are compared with different bars. The training period includes the preceding 4 months (April 1 to July 31). It is clearly shown in the figures that the best precipitation forecasts are achieved by the SEK method for most of the configurations and forecast days. The skills of MM and ALL configurations are better than those of MA and MC.

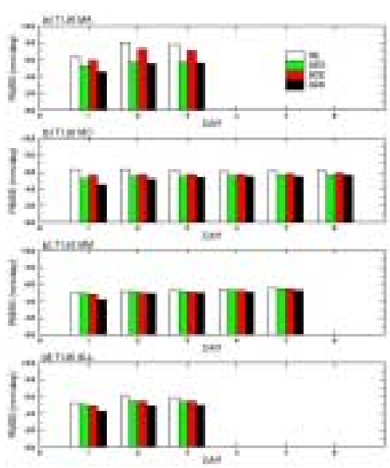

Fig. 1

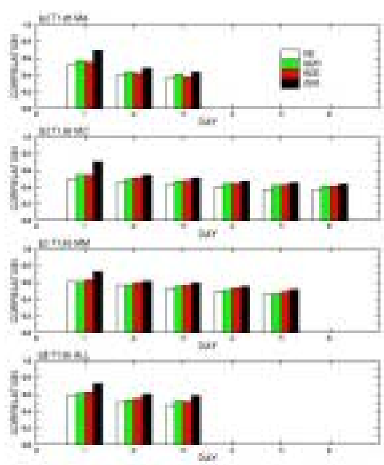

Fig. 2

Figures 3 and 4 show the equitable threat score (ETS) and the bias score (BS) (> 5 mm/d threshold) respectively inspected for 15-day mean precipitation forecasts for MA, MC, MM, and ALL ensemble configurations over the global tropics. The ETS diagram proves also that the SEK is the most effective technique for precipitation forecasts. Unlike that of RMSE or correlation coefficient, the score of SEO surpasses that of BCE in the ALL configuration. It implies that both SE approaches have their superiority to the simple bias correction forecast with improved ensemble members (such as, MM). Their superiority are much more evident in the BS diagram (Figure 4). While the scores of RE and BCE show unrealistically large rain extent, those of both SEO and SEK forecasts remain near the 1.0 line. As the forecast lead time increases, the SEK forecasts seem to be slightly under-forecasting of precipitation in the MA and MC configuration. On the other hand, slightly over-forecasting areas are maintained in MM and ALL configurations, but closest to the 1.0 line. Here, it is clear that compared to the SEO and SEK, the BCE can not efficiently remove the bias areas.

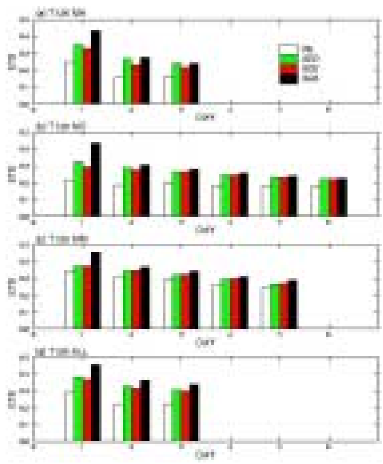

Fig.3

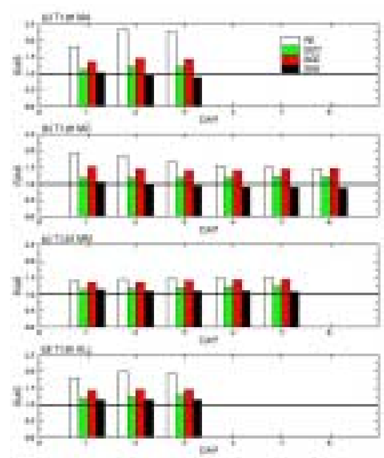

Fig.4

In summary, SE precipitation forecasts exhibit invariably superior forecast results to various conventional forecasts, such as individual model, RE mean, and BCE mean forecasts. A notably improved quantitative precipitation forecast is exhibited by the newly proposed SE technique (SEK). The success of the SE concept is owing to its selective nature in the construction of an optimal combination of available forecast products by eliminating spurious information contained in some models. In other words, the better the forecast performances are, the higher the weights, for each ensemble forecast at each grid point for each day of the forecast.

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