Precipitation forecast using a multi model superensemble and understanding its diurnal variability

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Modelling the diurnal change of precipitation is a challenging scientific problem because the phase of the diurnal change varies quite a lot over the globe. This paper explores satellite data sets and the predicted precipitation from a suite of global coupled atmosphere ocean models to validate the phase and amplitude of the diurnal mode. The models are based on several versions of the FSU coupled global models that utilize different radiative transfer and cloud radiation schemes. These models differ in their prescription of cloud specifications. With these models we carry out a large sample of five-day forecasts. This study utilizes 3 hourly TRMM and model based data sets between 40°S and 40°N and highlights the advantage of constructing a superensemble for the forecasts of diurnal change since it reduces the large phase and amplitude errors of the member models.

The overall picture of afternoon rain over land areas and early morning rain over the ocean area are only partially true. Strong exception to this rule exists over many land and oceanic areas. Over the eastern Tibetan Plateau, during the northern summer season, afternoon showers are prevalent, however if we proceed 300 km to the southeast over the eastern foothills of the Himalayas the rainfall maximum occurs in the early morning hours. The aforementioned asymmetries within land or within ocean domain of the tropics suggests the possible complexity involved in the modelling of these features.

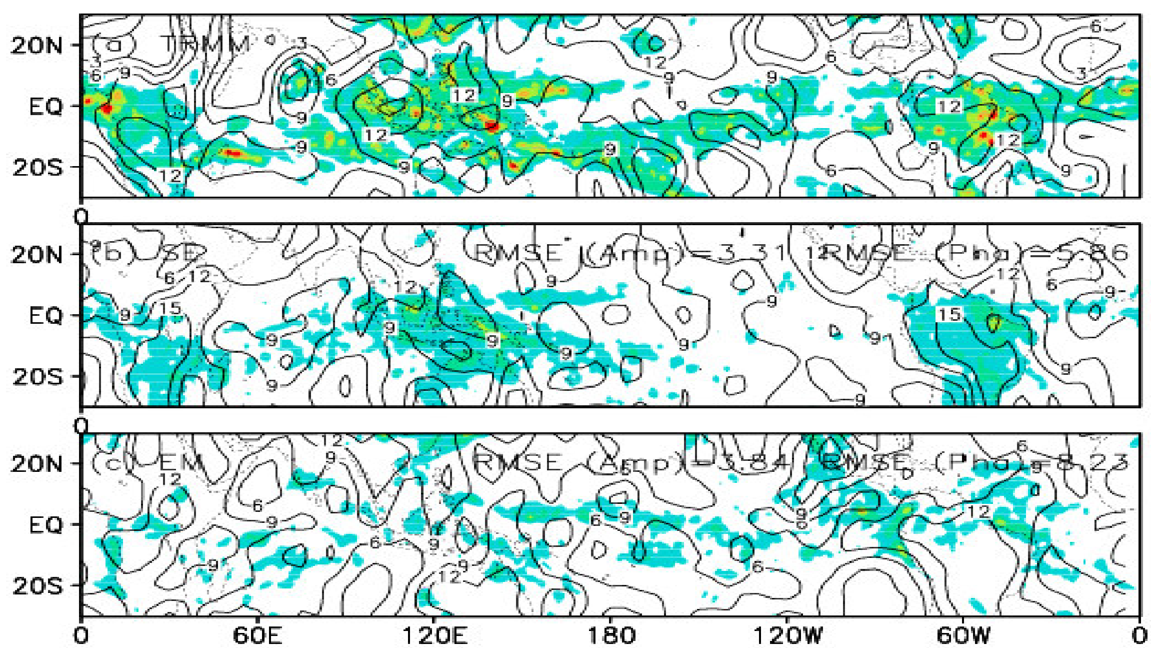

Fig. 1: Amplitude and phase (diurnal cycle) during 31 Mar–4 Apr 2000(Day 5 forecast)

Figure 1 describes the amplitudes and phases of the diurnal cycle of the observed, superensemble and ensemble mean of the member models. The rms errors of the amplitude and phase of the diurnal modes predicted for day 1 of forecasts show that the phase of the superensemble is considerably better than those of other forecasts. The oceans generally carry a phase angle 06 and 09 hours local time (early morning). The land areas of South America and Africa carry a phase angle of around 15 to 18 hours (late afternoon). These features are best captured by the superensemble.

In figure 2 we show the equitable threat score for days 3 and 5 of forecasts. The results are similar for other days of forecasts. We include here the skills from the ensemble mean of the member models, those from a best model (that carries the lowest rms error for rainfall forecasts), those from a unified model (where a unified scheme for clouds is used) and those from the superensemble. The bar charts show the bias scores (close to 1.0 being a good score) along ordinate and the precipitation thresholds along the abscissa (i.e. Bias scores for rainfall totals greater than 2.5, 5, 10, 15, 20, 30, 40 and 50 mm/day). The right panels show the equitable threat score along ordinate plotted against the thresholds for rainfall totals. These illustrations show that the superensemble skills are the highest for all thresholds for precipitation forecasts for total rain up to 50 mm/day. The skill of the unified model, seen in the light of these probability skill measures, shows it to be superior to the best model for both the equitable threat score and the bias scores for most of the events. The best bias scores (closer to 1.0) are provided by the multi model superensemble.

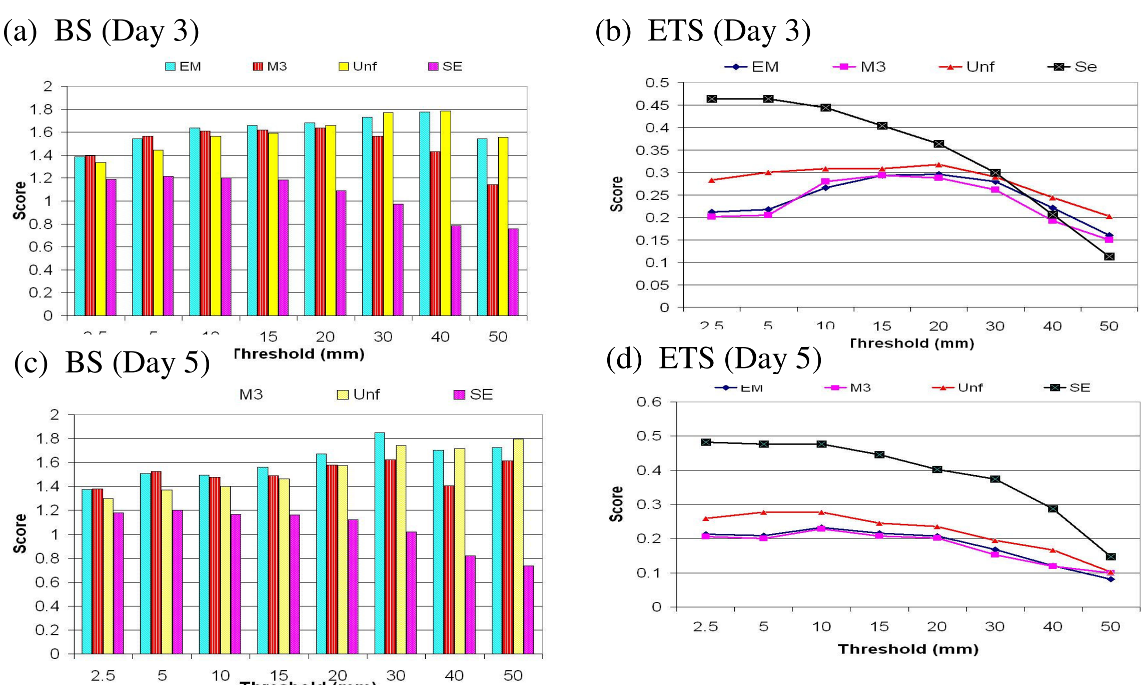

Fig. 2: The Bias Score (BS) [left panels] and Equitable Threat Score (ETS) [right panels] averaged over tropics, 0 to 360E, 30S to 30N during 29 Mar-02 Apr 2000 (Day 3 forecasts, top panels) and 31 Mar-04 Apr 2000 (Day 5 forecasts, bottom panels)