Physical initialization for mesoscale weather prediction

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A method of physical initialization for large scale models was proposed by Krishnamurti et al (1991) and its impact on the weather prediction was well established. Based on this concept, a method of physical initialization for mesoscale models is proposed. The bases for this procedure is that the rainfall predicted through a cumulus parameterization scheme used in the model is sensitive to moist static stability and so the vertical humidity distribution and the initial humidity vertical profiles have uncertainty and could be calibrated to have a close match between the model rain and the observations. The rain rate initialization is implemented for a pre-forecast period of 24 hours. Satellite rainfall estimates are collected for this period and interpolated to each grid point of the model domain and for each time step of the model integration. The model vertical humidity profile at a grid point is perturbed with a factor, depending on a sloping angle, in the atmospheric layer from surface to about 500 hPa. The induced perturbations will be such that they are positive (negative) in the lower half and negative (positive) in the upper half. The model produces rain rates through the cumulus scheme corresponding to each of the perturbations profiles and a vertical humidity profile which matches best with the observations is taken to continue further with the model process. Implementation of this procedure at each time of the model integration for a period of 24 hours show marked improvement in the prediction up to 48 hours.

The results from a monsoon rainfall prediction experiment with the rain rate physical initialization procedure are presented here (Figures 1 and 2). The results show significant improvements during the period of physical initialization and forecast period up to 48 hours. The model rainfall at Day0 (i.e.) end of the 24 hour pre-forecast physical initialization period is compared with the model rainfall without physical initialization and the TRMM estimates. The results clearly illustrate a better estimate of the model rains through implementation of physical initialization with a tendency towards observations where as uninitialized experiment show large deficiencies with underestimation of rainfall over most of the region (Fig. 1a, b and c), as evident from the equitable threat scores (Fig.1d). A 2-day forecast is carried out with the model initial conditions derived from the physical initialization and another without any initialization in the observations. A comparison of the predicted rainfall after 48 hours (Figure 2), illustrate that the model rainfall prediction with physical initialization is far improved as evident from the rainfall distributions (Fig. 2b and c) and the equitable threat scores (Fig. 2d). However, it is also noted that the impact of the physical initialization is marked for rainfall rates below 7-8 mm/hr, which is due to the implementation of the procedure for the cumulus parameterization part alone and not for the explicit rain process. Further studies towards the inclusion of explicit processes and nudging of atmospheric variables are under progress.

References:

Krishnamurti, T.N., J. Xue, H.S. Bedi, K. Ingles and D. Oosterhof, 1991: Physical initialization for numerical weather prediction over the tropics. *Tellus*, **43**, 53-81.

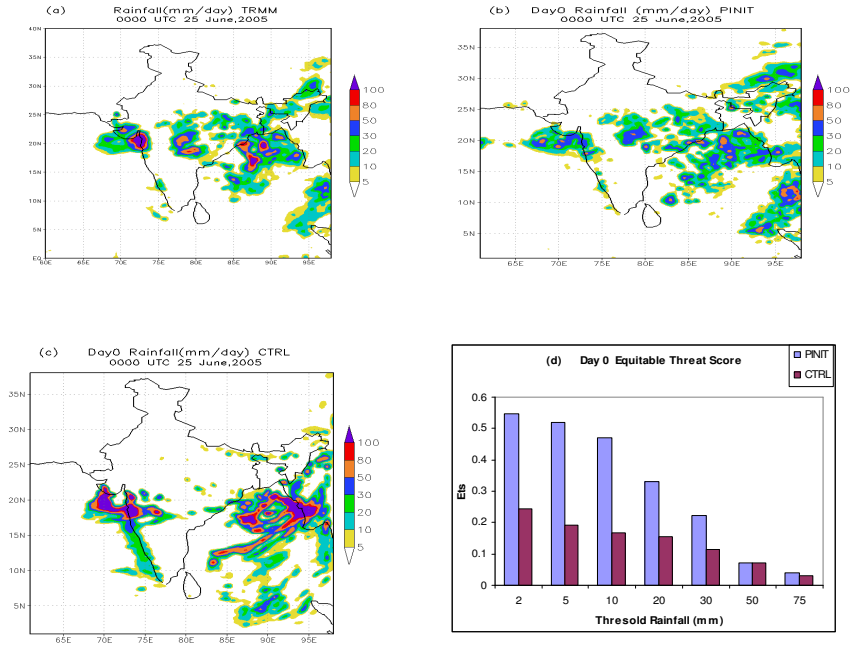

Figure 1 (a through d): Rainfall (mm/day) at Day0 (0000 UTC 25 June 2005) corresponding to (a)TRMM (b) Experiment with physical initialization (PINIT) (c) Control experiment without physical initialization (CTRL) and (d) Equitable threat scores for CTRL and PINIT experiments.

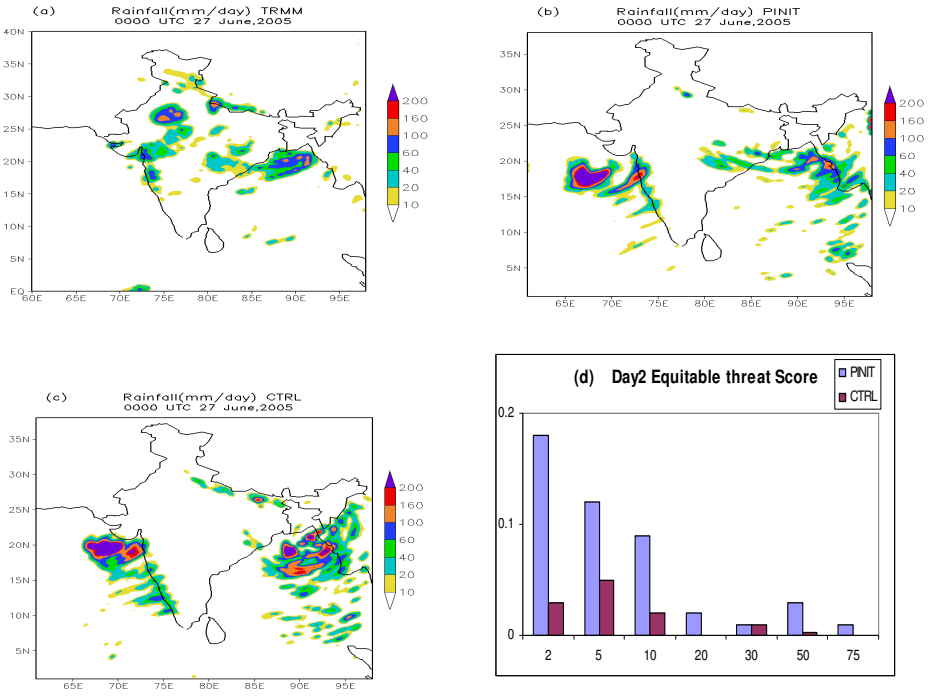

Figure 2 (a through d): Rainfall (mm/day) at Day2 (0000 UTC 27 June 2005) corresponding to (a) TRMM (b) Experiment with physical initialization (PINIT) (c) Control experiment without physical initialization (CTRL) and (d) Equitable threat scores for CTRL and PINIT experiments.