An Impact Study of the GPS Radio Occultation Data on the Simulation of a Heavy Rainfall Event along the West Coast of India Using WRF 3DVAR

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Abstract

The west coast of the Indian peninsula receives very heavy rainfall during the summer Monsoon (June–September) season. The average rainfall over some parts exceeding 250 cm. Heavy rainfall events with the precipitation rate more than 15 cm per day along the west coast of India occur frequently and cause considerable damage. A special observational programme, Arabian Sea Monsoon Experiment (ARMEX), was carried out during the monsoon season of 2002 to study these events. There were several Intensive Observation Periods in ARMEX experiment. One of the heavy rainfall events, 26-28 June 2002 was selected from IOP periods for this case study. In this study, a high-resolution mesoscale model WRF2.1.2 (Weather Research and Forecasting) with three-dimensional variational data assimilation (3DVAR) was utilized for 96-hour forecast. Cloud microphysics scheme of Lin et al. and surface physics (thermal diffusion) in all the domains, cumulus parameterization of Kain-Fritsch scheme in the two outer domains were used in the simulations with the first guess from the NCEP AVN global model analysis. There were two experiments, one was control run (without data assimilation) and the other was the assimilation run with Global Positioning System (CHAMP and SAC-C) radio occultation (RO) refractivity data, to investigate predictability of heavy rainfall occurrence over the Indian peninsula. Each run consists of three nested domains at resolution of 90 km, 30 km and 10 km, respectively. There were twenty two GPS RO points (ten from CHAMP and twelve from SAC-C) found in the outer most domain as shown in Fig. 1. The moisture increments were analyzed at the initial and forecast times to assess the impact of GPS RO data assimilation. We compared the results at 24 and 48 hours for the control run and the assimilation run. The daily rainfall observations show major over the northwest coast as seen in Fig. 2, with some precipitation extending inland. In the second day, a daily rainfall amount over 60 cm right over the middle coast. The control run exhibits prediction of more overall spread rainfall which is also over-

produced as compared to the assimilation run. The inland precipitation is more reasonably captured by the assimilation run. Assimilation of these GPS refractivity soundings thus gives a positive impact on rainfall prediction over the west coast of India.

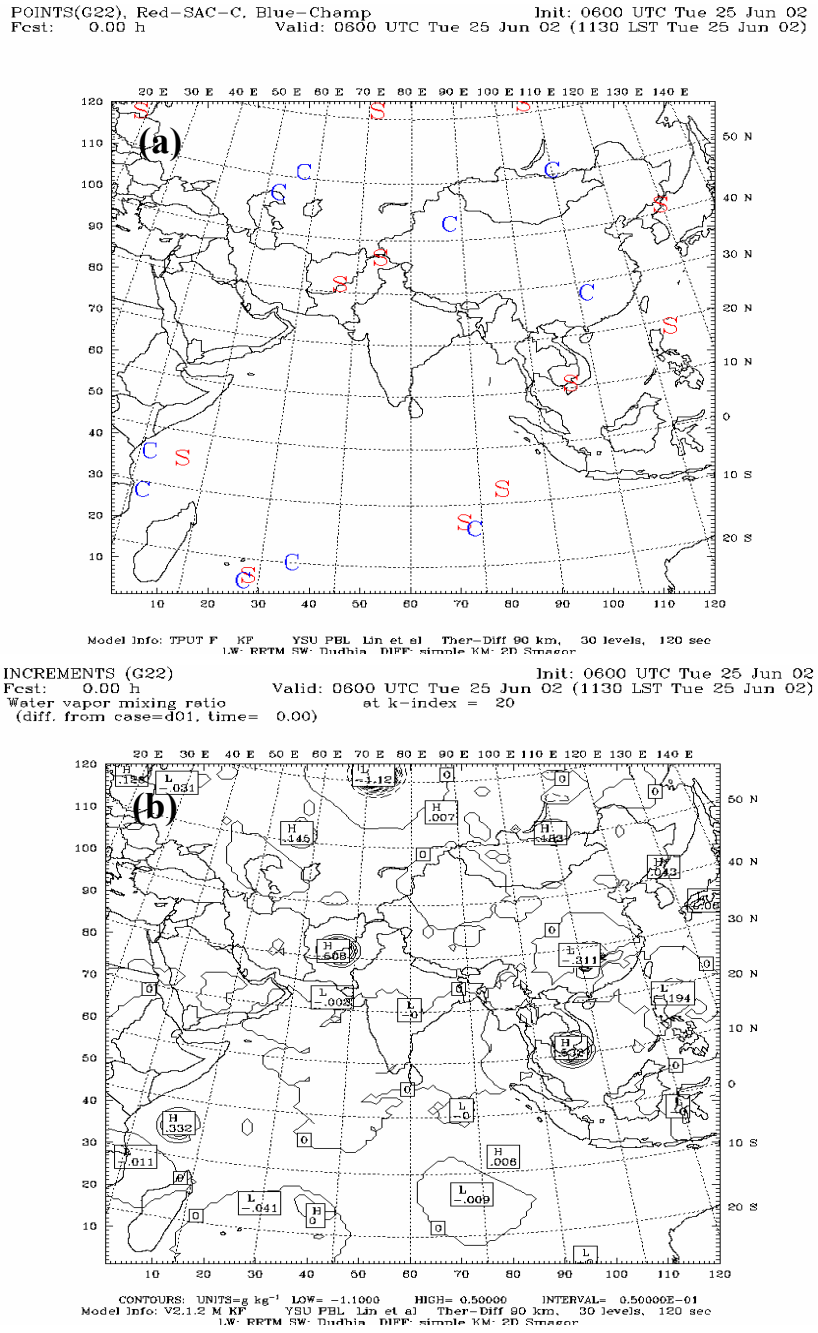

Fig.1. (a) Distribution of GPS (CHAMP + SAC-C) observation points in the outermost domain where 'C' denotes CHAMP and 'S' denotes SAC-C. (b) Moisture difference (g/kg) at the initial time between the assimilation run and the control run.

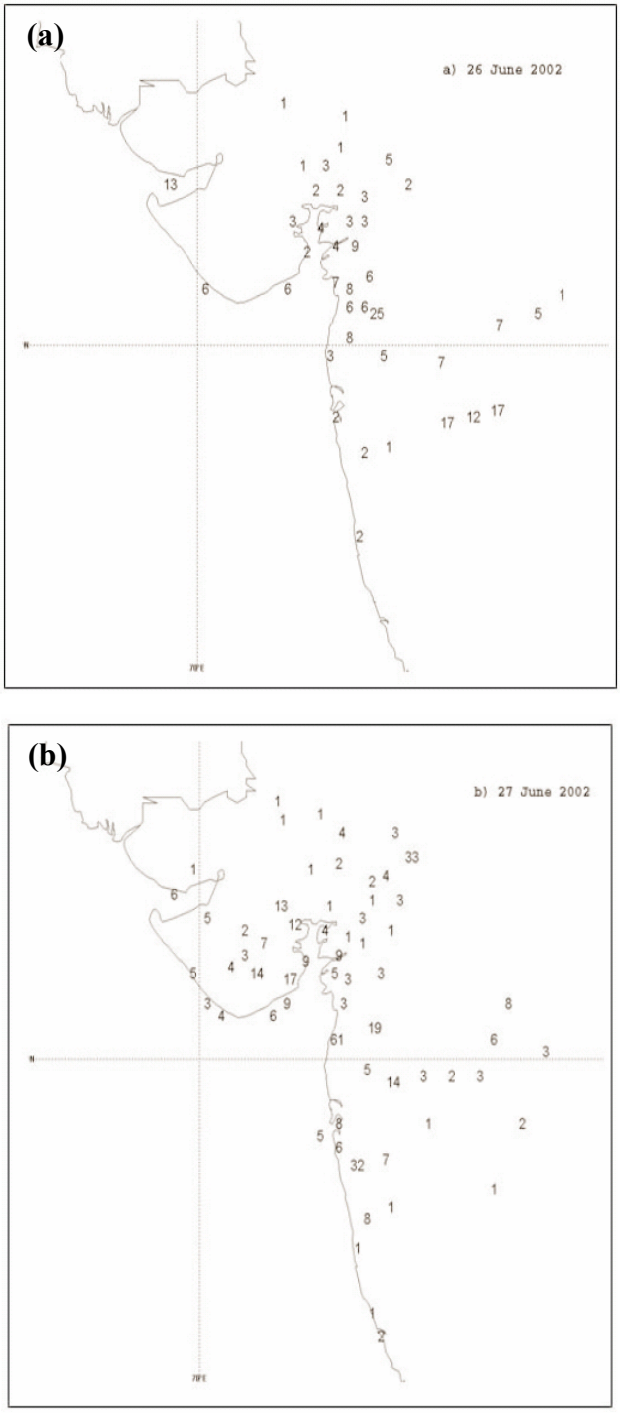

Fig. 2. The daily observed accumulated rainfalls over the west coast of India from (a) 03UTC 26 and (b) 03UTC 27 of June 2002.

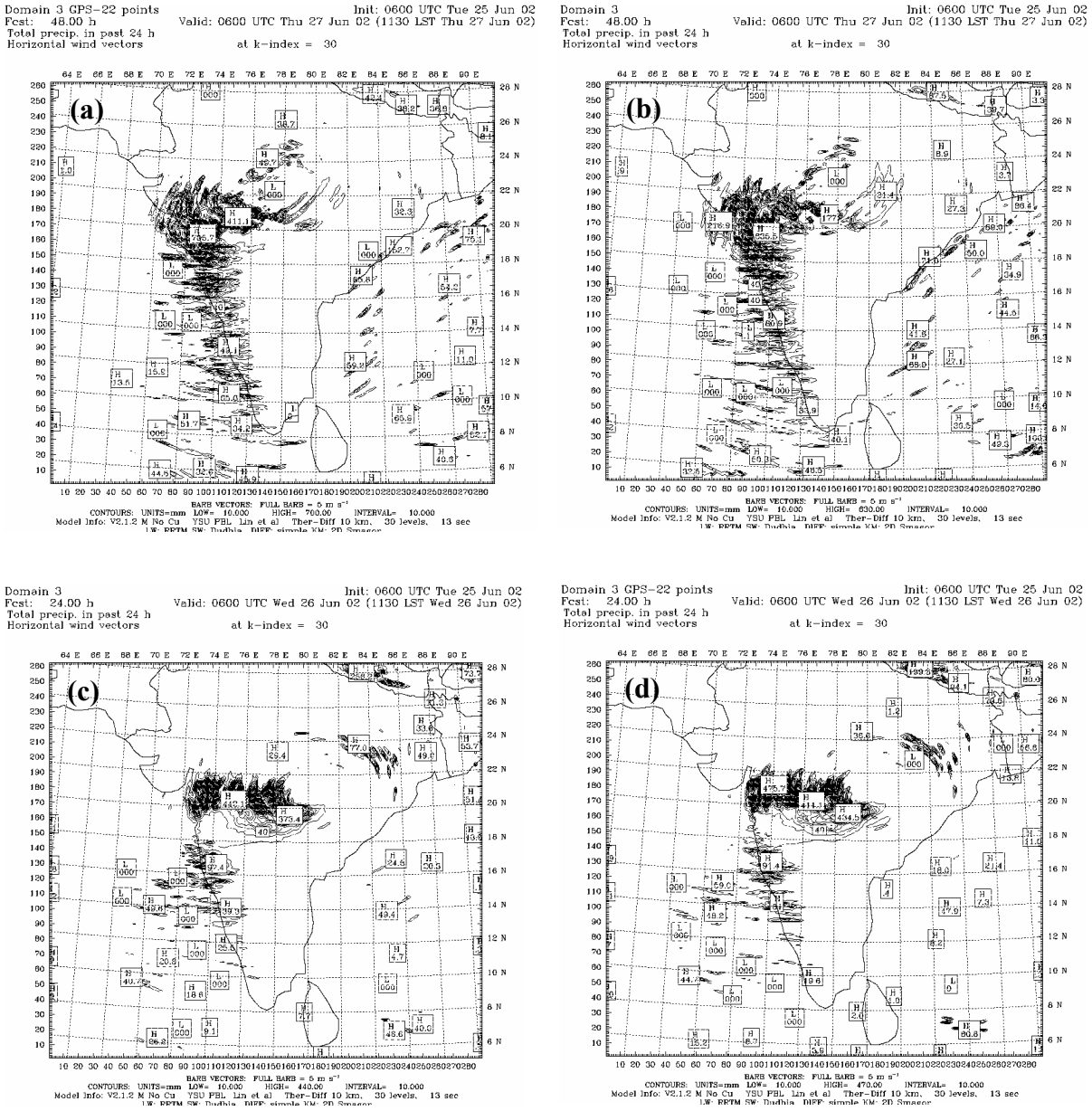

Fig. 3. The daily predicted accumulated rainfalls (mm) at Domain 3 for both runs. (a) 0-24 h and (b) 24-48 h for the control run, (c) 0-24 h and (d) 24-48 h for the assimilation run.