The impact of assimilating MeghaTropiques SAPHIR radiances in the simulation of tropical cyclones over the Bay of Bengal using the WRF model

M. Dhanya, Deepak Gopalakrishnan, A. Chandrasekar, and Sanjeev Kumar Singh and V. S.Prasad
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Abstract: The present study aims to investigate the impact of assimilating SAPHIR (Sounder for Probing Vertical Profiles of Humidity) radiances in the simulation of tropical cyclones over the Indian region by the Weather Research and Forecasting (WRF) model. Three tropical cyclones which formed over the Bay of Bengal are chosen as the case studies. Since SAPHIR is a humidity microwave sensor, it is interesting to assess the impact of these observations in simulating cyclones which depend significantly on moist-convective processes. The study makes use of the three-dimensional variational (3DVar) assimilation technique of the WRF variational assimilation system. The results of the study indicate that the assimilation of SAPHIR radiances do have a positive impact on the simulation of tropical cyclones considered here. Two model simulations are performed – a control run (Ctrl) with only conventional and satellite wind observations assimilated, and a SAPH run (SAPH) where SAPHIR radiances are also assimilated in addition to conventional and satellite wind observations. Both these simulations are compared to each other and to observations from the India Meteorological Department (IMD), Joint Typhoon Warning Centre (JTWC), and Tropical Rainfall Measurement Mission (TRMM), as well as analysis fields from Global Forecast System (GFS) from the National Centres for Environmental Prediction (NCEP). Comparison of minimum sea level pressure and maximum wind speed simulated by the model with the IMD and JTWC observations shows that the SAPHIR assimilation has a moderate impact on the simulation of these features by the model. Track prediction of the model is also improved at initial forecast times, as evidenced by the reduced track errors in the model run with SAPHIR radiances assimilated. The warm core structure, as well as the relative vorticity structure of the cyclones, are also impacted in a moderate manner by the assimilation of SAPHIR radiances. The assimilation also positively impacted the rainfall simulation of the model. This is seen from the higher equitable threat score, lower false alarm ratio, and higher probability of detection estimated with respect to TRMM observations, in the SAPH run as compared to the Ctrl run.