Sensitivity of cumulus parameterisation schemes on simulation of tropical cyclone Fani: an evaluation with ground-based radar products

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The present study investigates the sensitivity of the tropical cyclone simulations to parameterised deep convection with a special focus on the Advanced Indian Mesosphere–Stratosphere–Troposphere (MST) Radar (AIR) observations collected during the passage of Fani. Five simulations are conducted using the weather research and forecasting (WRF) model by varying cumulus parametrisation (CP) schemes, which clearly suggest that the simulated cyclone behaviour is highly sensitive to the choice of selected CP schemes. Among the CP schemes, the Kain-Fritsch, followed by the Grell-Freitas ensemble, simulates the precise estimates of track and intensity and captures the time-height pattern of vertical winds as seen by the AIR, while the Betts-Miller-Janjic and modified Tidke schemes exhibit a poor performance in simulating tropical cyclone parameters and fail to reproduce the observed features of vertical velocities.

Keywords: Cumulus parametrisation, MST radar, secondary circulation, tropical cyclone, vertical winds

and better representation of physical processes. Recent studies have shown that the Weather Research and Forecasting (WRF) model has better fidelity in simulating the track and intensity of TCs up to four days over the Bay of Bengal, as it is equipped with the advanced dynamics and physics parameterisation schemes[3–6]. Though there has been considerable progress in the prediction of TCs over the BoB, some limitations still exist, e.g., inadequate simulation of moist convection and boundary layer processes[7,8]. The majority of these studies pointed out that the cumulus parameterisation (CP) scheme, which deals with the feedback process of deep convective clouds on the large-scale atmospheric flow, plays a critical role in determining the skill of numerical models[7] especially for track predictions. The CP, or cumulus physics in numerical models, resolves the subgrid-scale variation of moist convection and precipitation processes, and it influences the simulated storm environment through the feedback to grid-scale variables such as temperature and moisture. Inaccurate representation of these sub-grid scale convection processes and their feedback to grid-scale variables are major constraints in the accurate prediction of the track and intensity of the TCs.

Several CP schemes are proposed [illegible]