Simulation of a heavy rainfall event during southwest monsoon using high-resolution NCUM-modeling system

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Abstract: The study is undertaken to demonstrate and evaluate the skill of National Centre for Medium Range Weather and Forecasting (NCMRWF) Unified Model (NCUM) model with different horizontal resolutions in simulation of a heavy rainfall event (26ï 29 July 2015) occurred over Gujarat and Rajasthan region due to the presence of monsoon depression (MD). For this purpose, three numerical experiments are carried out such as NCUM12, NCUM4, and NCUM1.5 by configuring the NCUM model with different horizontal resolutions 12, 4 and 1.5 km, respectively. In all the experiments, the model is integrated for 72 h from 00 UTC of 26 July 2015. The model integration time step is considered for NCUM12 (300 s), NCUM4 (60 s), and NCUM1.5 (60 s). The overall results suggested that the high-resolution NCUM1.5 is reasonably well-simulated the position, northeastward movement as well as the pattern and intensity of rainfall associated with the MD as compared to the NCUM12 and NCUM4 simulations. The mean Direct Position Errors (DPEs) are reduced by 7 and 22% in the NCUM1.5 over NCUM4 and NCUM12 simulations. The intensity forecast based on 10 m maximum sustainable wind (MSW) is reasonably well-simulated in the NCUM1.5 as compared to other simulations. The mean percentage of error of MSW is about 39, 30, and 26% in the NCUM12, NCUM4, and NCUM1.5 simulations, respectively. It is showing that the intensity of the MD is realistically simulated in the high-resolution NCUM model. The CAPE value is improved by 47, 59, and 68%, in the NCUM12, NCUM4, and NCUM1.5, respectively. The skew-T plot suggested that the convection is more prominent in the NCUM1.5 simulation, which is reasonably well matched with the observation. The mean skill of HSS score from NCUM1.5 is improved by 67% (73%) and 40% (28%) with respect to the NCUM12 and NCUM4 simulations during day 1 (day 2), respectively. Further verification of this rainfall event is carried out based on the contiguous rain area (CRA) technique. The total mean square error (MSE) in day 1 is reduced by 35 and 16% in the NCUM1.5 simulation with respect to NCUM12 and NCUM4 for 5 cm threshold, respectively. Similarly, for 10 cm threshold, MSE in NCUM1.5 simulation is reduced by 16 and 14% with respect to NCUM12 and NCUM4 simulation, respectively. This verification technique also confirms that the better skill of NCUM1.5 over other simulations in terms of pattern, location, and volume errors of the rainfall with different thresholds.