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Assimilating Radar Observations to Study Heavy Rainfalls over the Arabian Red Sea Coast using the Weather Research and Forecasting (WRF) Model

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To simulate the heavy rainfall in December 2016 on the Saudi Arabia west coast we configured Weather Research and Forecasting (WRF) model using three nested domains with 9, 3 and 1 km grid spacing, respectively. The initial and boundary conditions were built using 12-km resolution ECMWF analysis data. We have performed 32 numerical experiments with different sets of boundary layer, surface processes, cloud microphysics, and convection parameterizations (the latter was only applied to the 9 and 3 km domains). The WRF model simulations were evaluated using ground-based weather station, radio-sound, radar reflectivity, and precipitation observations, as well as with MERRA-2 and ERA-Interim reanalysis to select the best physical settings.
To more accurately describe the development of the storm, we assimilated radar reflectivity and radial wind from the Jeddah Doppler weather radar, using Hybrid ETKF 3DVar assimilation scheme. We compared the model output with weather radar, NASA Tropical Rainfall Measurement Mission (TRMM) observations, and MERRA-2 reanalysis. The model captures the main convection patterns quite well indicating that radar data assimilation significantly improves simulations of the amount and localization of precipitation. These results indicate that radar data assimilation can potentially improve on the understanding of the physical mechanisms to the development of extreme precipitation in this complex region, which can improve forecast capabilities of these types of events in future.