Radar-based characterization of heavy precipitation in the eastern Mediterranean and its representation in a convection-permitting model

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Heavy precipitation events (HPEs) can lead to natural hazards (floods, debris flows) and contribute to water resources. Spatiotemporal rainfall patterns govern the hydrological, geomorphological and societal effects of HPEs. Thus, a correct characterization and prediction of rainfall patterns is crucial for coping with these events. However, information from rain gauges suitable for these goals is generally limited due to the sparseness of the networks, especially in the presence of sharp climatic gradients and small precipitating systems. Forecasting HPEs depends on the ability of weather models to generate credible rainfall patterns. In this study we characterize rainfall patterns during HPEs based on high-resolution weather radar data and evaluate the performance of a high-resolution (1 km²), convection-permitting Weather Research and Forecasting (WRF) model in simulating these patterns. We identified 41 HPEs in the eastern Mediterranean from a 24-year long radar record using local thresholds based on quantiles for different durations, classified these events into two synoptic systems, and ran model simulations for them. For most durations, HPEs near the coastline were characterized by the highest rain intensities; however, for short storm durations, the highest rain intensities were characterized for the inland desert. During the rainy season, center of mass of the rain field progresses from the sea inland. Rainfall during HPEs is highly localized in both space (<10 km decorrelation distance) and time (<5 min). WRF model simulations accurately generate the structure and location of the rain fields in 39 out of 41 HPEs. However, they showed a positive bias relative to the radar estimates and exhibited errors in the spatial location of the heaviest precipitation. Our results indicate that convection-permitting model outputs can provide reliable climatological analyses of heavy precipitation patterns; conversely, flood forecasting requires the use of ensemble simulations to overcome the spatial location errors.
