Geophysical Research Abstracts
Vol. 21, EGU2019-468, 2019
EGU General Assembly 2019

A new approach in characterizing heavy precipitation in the eastern Mediterranean: Combining radar data and a high-resolution weather model

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Heavy precipitation events (HPE) are a significant hydrometeorological phenomenon in the highly variable climate of the eastern Mediterranean (EM). They can cause flash-floods, and are closely-related to water availability. The formation of a HPE requires specific atmospheric conditions that result in relatively high precipitation efficiency, and causes distinct spatiotemporal rainfall patterns. Analyses of rainfall patterns during HPEs traditionally utilize atmospheric or hydrological indices, Intensity-Duration-Frequency curves based on rain gauges, high-resolution meteorological simulation of case studies, or coarser resolution climatological simulations. However, these are insufficient to characterize the spatiotemporal rainfall patterns in HPEs, and high resolution simulation of large number of HPEs are scarce. To characterize the rainfall patterns in HPEs in the EM, and to evaluate the ability to simulate them using a weather model we (a) identified HPEs in the EM using a uniquely long calibrated weather radar data, consisting of 24 years, (b) simulated the same HPEs using a convection-permitting, high-resolution numerical weather research and forecasting model (WRF). Then we analyzed jointly the rainfall patterns derived both from the radar record and the WRF, and evaluated the model's ability to simulate the observed patterns through fractional skill scores, structure-amplitude-location analysis, temporal and spatial autocorrelation of rain-cells, among other techniques.

Pixel-based (1X1 km^2) identification of HPEs from the radar record yielded 41 events that were later simulated by the WRF. Model simulated rainfall patterns are in good agreement with the radar data, except for two highly-localized, short duration HPEs. EM rainfall in HPEs, derived both from the radar and the model, consists of small ($\sim$10 km decorrelation distance) and intense rain-cells, oriented WSW-ENE, covering a small portion of the region at each stage of the event (the median fraction of the area covered by at least 50 mm for 30 min is less than 5%). However, given enough time, frequent arrival of rain-cells accounts for the accumulation of high rainfall depths over increasingly wider area ($>$80% of the area is covered by $>$150 mm for 24 h).

The methodology and analyses presented above, of high-resolution, event-based simulations, is highly valuable in representing the specifics of rainfall patterns during HPEs and allow the investigation of causative meteorological ingredients for HPEs. Thus, it will be further used in our future research to study and simulate rainfall patterns under a changing climate.