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Investigating radar subpixel-scale rainfall variability and uncertainty from observations of a super dense rain-gauge network

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Runoff and flash flood generation are very sensitive to rainfall's spatial and temporal variability. The increasing use of radar and satellite data in hydrological applications, due to the sparse distribution of rain gauges over most catchments worldwide, requires furthering our knowledge of the uncertainties of these data. In 2011, a new super-dense network of rain gauges, containing 27 gauges covering an area of about 4 km2, was installed in northern Israel, representing Mediterranean climate regime. This network was established for a detailed exploration of the uncertainties associated with radar and satellite rainfall resulting from rainfall variability at the subpixel-scale. The gauge–rainfall spatial correlation and uncertainty were examined along with the estimated radar error. The zero-distance correlation between rain gauges was high (0.92 on the 1-min scale) and increased as the time scale increased. A difference was detected in the spatial correlations of the convective and nonconvective rainfall, as the convective rainfall correlation decreases much faster than the nonconvective one. The variance of the differences between radar pixel rainfall and averaged point rainfall (the variance reduction factor) was 1.6% for the 1-min scale. It was also found that at least four uniformly distributed rain stations are needed to adequately represent the rainfall on the radar pixel scale. The radar–rain gauge rainfall difference was mainly contributed by radar estimation errors while the gauge sampling error contributed no more than 22% to the total error. The radar rainfall estimations improved with increasing time scale and the radar-to-true rainfall ratio decreased with increasing time scale. The analysis of the radar errors and uncertainties suggest that a temporal scale of at least 10 min should be used for hydrological applications of the radar data.