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High-resolution space-time characterization of convective rain cells: implications on spatial aggregation and temporal sampling operated by coarser resolution instruments

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Forecasting the occurrence of flash floods and debris flows is fundamental to save lives and protect infrastructures and properties. These natural hazards are generated by high-intensity convective storms, on space-time scales that cannot be properly monitored by conventional instrumentation. Consequently, a number of early-warning systems are nowadays based on remote sensing precipitation observations, e.g. from weather radars or satellites, that proved effective in a wide range of situations. However, the uncertainty affecting rainfall estimates represents an important issue undermining the operational use of early-warning systems. The uncertainty related to remote sensing estimates results from (a) an instrumental component, intrinsic of the measurement operation, and (b) a discretization component, caused by the discretization of the continuous rainfall process. Improved understanding on these sources of uncertainty will provide crucial information to modelers and decision makers. This study aims at advancing knowledge on the (b) discretization component. To do so, we take advantage of an extremely-high resolution X-Band weather radar (60 m, 1 min) recently installed in the Eastern Mediterranean. The instrument monitors a semiarid to arid transition area also covered by an accurate C-Band weather radar and by a relatively sparse rain gauge network ($\sim$1 gauge/ 450 km2). Radar quantitative precipitation estimation includes corrections reducing the errors due to ground echoes, orographic beam blockage and attenuation of the signal in heavy rain. Intense, convection-rich, flooding events recently occurred in the area serve as study cases. We (i) describe with very high detail the spatiotemporal characteristics of the convective cores, and (ii) quantify the uncertainty due to spatial aggregation (spatial discretization) and temporal sampling (temporal discretization) operated by coarser resolution remote sensing instruments. We show that instantaneous rain intensity decreases very steeply with the distance from the core of convection with intensity observed at 1 km (2 km) being 10-40% (1-20%) of the core value. The use of coarser temporal resolutions leads to gaps in the observed rainfall and even relatively high resolutions (5 min) can be affected by the problem. We conclude providing to the final user indications about the effects of the discretization component of estimation uncertainty and suggesting viable ways to decrease them.