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Integral Radar Volume Descriptors for Quantitative Areal Precipitation

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Hydrology is in dire need of improved Quantitative areal Precipitation Estimates (QPE). Water management needs high quality QPE for optimally running sewage plants, sewerage systems, and retention basins especially in case of extreme precipitation. Areal QPE is further needed for the detection and forecast of flooding events. Nevertheless, the quality of the results is still unsufficient for the most urgent needs.

An improved Quantitative area Precipitation Estimation (QPE) with ground based radar will be achieved by exploiting the spatial and temporal variability of the radar signal. Therefore tracking of radar-detected precipitation-centroids is performed and rain events are investigated using Integral Radar Volume Descriptors (IRVD).

Our analyses start with the simplified method (Doneaud et al., 1981) for estimating convective rainfall by considering only the horizontal extent of the storms within a threshold radar reflectivity isopleth and the duration of the precipitation. Atlas et al. (1990) found that the method is based upon the existence of a well-behaved probability density function (PDF) of a single storm during its life. In other words, we assume that the distribution of individual rain rate values is very similar from one convective situation to the other. The relation S between the total volume rainfall and the area time integral is then entirely determined by the climatological PDF of the regime in question.

Even though former publications describe the scatter from one storm to another as remarkably small, the updraft strength, the moisture content of the atmosphere and a variety of other factors influence the rain rate in a storm cell in addition. An appropriate set of descriptors will be derived on the basis of spatial and temporal structures in 4-dimensional radar measurements to minimize the remaining unexplained variance and significantly improve the estimation of precipitation in comparison to currently used local Z-R-relations.

The analyses shown are based on pseudo-radar data derived from a meso-scale weather prediction model (Lokal-Modell of the German Weather Service) on one hand and archived C-Band radar data and simultaneous surface observations of rain intensity on the other hand. As an example, enclosed reflectivities of tracked storm cells are interpreted as a realization of a Weibull distributed random variable. The relation S between the total volume rainfall and the area time integral increases quadratically with the estimated standard deviation of the Weibull distributed reflectivities.