Gauge-radar adjustment by using multivariate kernel regression and spatiotemporal Kriging

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Identification of different factors contributing to gauge-radar discrepancy is essential in quantitative precipitation estimation (QPE). We use a statistical model that describes the gauge-radar discrepancy F=10*log(G/R) over different accumulation periods. The model consists of a systematic long-term bias component and a normally distributed stochastic component representing local and short-term deviations. In principle the model can be used for the adjustment of uncorrected radar measurements. We apply physically based corrections (e.g. attenuation, effects due to VPR) and use the statistical approach for adjusting the residual gauge-radar discrepancy after each physical correction.

In practice, systematic bias, and variance of the stochastic component depend on several factors such as the measured accumulation, altitude of the radar bin, attenuation along the radar beam and terrain blockage. Thus, we use multivariate Gaussian kernel regression to account for such factors, resulting to better separation of systematic and random errors. After correcting the systematic bias, the remaining residual originates from uncorrected or unknown sources and from incompleteness of the physical corrections. We model the stochastic component of the gauge-radar discrepancy as a time-dependent random process and investigate its correlation structure. Using a four-dimensional spatiotemporal covariance model, we apply Kriging to produce gridded ground-level estimates of the stochastic component and its uncertainty.

Based on the statistical model, we perform gauge-based adjustment of the physically corrected radar rainfall estimates. Being able to identify multiple factors affecting the gauge-radar discrepancy, the model can also be used as a tool for validation of radar-based rainfall estimates under different circumstances and corrections. We cross-validate the model and effectiveness of the physical corrections on independent rain gauges by using the Finnish gauge and radar networks.