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Quantifying the uncertainty of spatial precipitation analyses with observation ensembles

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It has become popular to call for precipitation analyses at higher and higher spatial resolution. Finer grid spacing may satisfy these requests from a purely technical viewpoint, but the scales effectively resolved in such “high-resolution” analyses are constrained by the resolution and accuracy of the underlying observations. As a result, there are large uncertainties, which may be relevant for the outcome of an application. However, there is little quantitative information about these uncertainties. We propose to frame knowledge about spatial precipitation distributions by ensembles of fields, randomly generated, but conditioned on measurements. They shall quantify uncertainties due to limited observation density. In this study, we develop an ensemble approach for a radar rain-gauge combination over Switzerland and present results of km-scale, daily precipitation ensembles for several cases.

The ensemble simulation is based on the stochastic concept of random Gaussian fields with a spatially varying mean and a second order stationary covariance. The concept is identical to that for kriging rain-gauge observations using radar as external drift. Our implementation involves a case dependent data transformation to better comply with the Gauss model and the stationarity assumption. Uncertainty estimates obtained with this stochastic concept turned out to be reasonably reliable (in a statistical sense) as was verified by cross-validation. Our applications suggest that there can be considerable residual uncertainty in km-scale precipitation patterns, even when radar information is included. The degree of uncertainty, however, varies considerably from case to case with typically larger ensemble spread for convective cases. The ensembles bare plausible dependencies upon aggregation scale (mean over catchments of different size) and network density. Observation ensembles may be a promising alternative to “best estimate” grid datasets, especially when uncertainties are large and when it is desirable to propagate them into application models.