Geophysical Research Abstracts
Vol. 16, EGU2014-15598, 2014
EGU General Assembly 2014

A Gaussian field for aggregation and disaggregation of radar rainfall data

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The generation of reliable precipitation products that explicitly account for spatial and temporal structures of precipitation events is challenging, since it requires a combination of data with a variety of error structures and temporal resolutions. In-situ measurements are relatively accurate quantities, but available only at sparse and irregularly distributed locations. Remote measurements cover complete areas but suffer from spatially and temporally inhomogeneous systematic errors and non-linear relations between the measured value reflectivity and the precipitation rate.

Our aim is to provide a statistical model based on a latent Gaussian random field that suitably models radar precipitation rates and enables us to aggregate and disaggregate them in space and time.

We first transform radar rainfall rates such that they follow a truncated Gaussian distribution using a power transformation proposed by D. Allcroft and C. Glasbey (2003). The advantage of using a truncated Gaussian random field is that occurrence and intensity of rainfall are modeled using a single process. To parameterize the latent Gaussian random field we estimate the empirical correlation as function of lag distance in space using the maximum likelihood method and fit a parametric correlation function to the estimates. This yields a spatial Gaussian random field. The transformation only allocates censored values to dry locations, i.e. the locations below some threshold. In order to obtain a Gaussian random field that covers the whole domain, we need to simulate the unobserved values below the threshold conditional on the observed values. The parametrically defined Gaussian random field now allows us to aggregate and disaggregate the radar measurements to different scales and compare them to measurements from ground based instruments.