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A Gaussian random field approach 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, but available only at sparse and irregularly distributed locations, whereas remote measurements cover areas but suffer from spatially and temporally inhomogeneous systematic errors and non-linear relations between the measured value reflectivity and precipitation rate.

In our study we use precipitation rates from the composit of the two X-band radars in Bonn and Jülich in Germany. Our aim is to formulate a statistical model in space and time that aggregates and disaggregates precipitation rates from radar observations.We model a Gaussian random field as underlying process, where we face the task of dealing with a large non-Gaussian data set.

To start the analysis of the unadjusted radar rainfall rates, we follow the work of D. Allcroft and C. Glasbey (2003) and transform the data to a truncated Gaussian distribution.The advantage of the latent variable approach is that it takes account of the occurence of rainfall and the intensity using a single process. We proceed by estimating the empirical correlation as a function of lag distance in space from these transformed values with maximum likelihood methods.
Then we fit a parametric correlation function that yields a Gaussian random field.
Since the transformation gives censored values to dry locations, i.e. the locations below some threshold, we simulate values for this area that lie below the threshold and obtain a Gaussian field that covers the whole domain. We then use this field to aggregate and disaggregate the radar measurements to different scales and compare them to measurements from ground based instruments. Throughout our calculations we assume stationarity.