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Interpolating Non-Parametric Distributions of Hourly Rainfall Intensities Using Random Mixing

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The correct spatial interpolation of hourly rainfall intensity distributions is of great importance for stochastical rainfall models. Poorly interpolated distributions may lead to over- or underestimation of rainfall and consequently to wrong estimates of following applications, like hydrological or hydraulic models.

By analyzing the spatial relation of empirical rainfall distribution functions, a persistent order of the quantile values over a wide range of non-exceedance probabilities is observed. As the order remains similar, the interpolation weights of quantile values for one certain non-exceedance probability can be applied to the other probabilities. This assumption enables the use of kernel smoothed distribution functions for interpolation purposes.

Comparing the order of hourly quantile values over different gauges with the order of their daily quantile values for equal probabilities, results in high correlations. The hourly quantile values also show high correlations with elevation. The incorporation of these two covariates into the interpolation is therefore tested.

As only positive interpolation weights for the quantile values assure a monotonically increasing distribution function, the use of geostatistical methods like kriging is problematic. Employing kriging with external drift to incorporate secondary information is not applicable. Nonetheless, it would be fruitful to make use of covariates. To overcome this shortcoming, a new random mixing approach of spatial random fields is applied. Within the mixing process hourly quantile values are considered as equality constraints and correlations with elevation values are included as relationship constraints. To profit from the dependence of daily quantile values, distribution functions of daily gauges are used to set up lower equal and greater equal constraints at their locations. In this way the denser daily gauge network can be included in the interpolation of the hourly distribution functions.

The applicability of this new interpolation procedure will be shown for around 250 hourly rainfall gauges in the German federal state of Baden-Württemberg. The performance of the random mixing technique within the interpolation is compared to applicable kriging methods. Additionally, the interpolation of kernel smoothed distribution functions is compared with the interpolation of fitted parametric distributions.