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Mapping extreme precipitation return levels in Switzerland

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Information on the magnitude of rare heavy precipitation is an important basis for civil protection and the design of infrastructures. However, there is considerable uncertainty in the estimation of rare return levels, due to short measurement series and the extrapolation from measurement sites into space. In this study we develop a statistical model of the spatial dependence of precipitation extremes in Switzerland to (a) estimate return levels for un-instrumented locations, and (b) to reduce uncertainties by integrating data from a whole measurement network. The model combines the classical GEV distribution with a spatial dependence for the distribution parameters, involving several covariates as auxiliary information. Inference is made in the framework of Bayesian Hierarchical Modeling. The system is setup for one-day precipitation totals in summer over the territory of Switzerland using 350 stations with 50-year records. The model is evaluated against data from 75 independent test stations. Results show a plausible reproduction of the highly variable precipitation climate in the region, which is partly due to the successful assimilation of auxiliary information (covariates). Estimates with the spatial model have smaller uncertainty than estimates from at-site observations only. Even though a few of the observed extremes in the test dataset are considered very rare by the estimated distributions, it seems that the Bayesian predictive distributions are reasonably reliable. More reliable at least than results from Regional Frequency Analysis, a widely used procedure for mapping return levels today. The model used in this study has been explored previously in several other regions. Our application demonstrates its flexibility for dealing with a spatially highly variable climate in complex topography.