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Nonstationary frequency analysis of hydrological extremes

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Although the impact of climate change on hydrological extremes is still an area of active research, the stationarity assumption used in standard frequency analysis methods is questionable. This communication therefore aims to present statistical models for describing hydrological extremes in a nonstationary context. These models are based on extreme value theory and refer to both at-site and regional scales. In a first step, at-site models are derived by modeling trends on the parameters of the distribution used to describe data. Inference is performed in a Bayesian context, which allows accounting for the uncertainty related to the existence of a trend through the Bayesian Model Averaging method. In a second step, this approach is generalized at the regional scale, by means of regional models. Such models assume that some parameters are equal for all sites within a homogeneous hydro-climatic region. Assuming independence between at-site data, which is an assumption made in most regional frequency analysis methods, we derive the posterior distribution of parameters of the regional model and perform the inference using Markov Chain Monte Carlo (MCMC) methods. A case study using six hydrometric stations illustrates the benefit of regional frequency analysis, which leads to a strong reduction of uncertainties compared with at-site frequency analysis. In a third step, the impact of spatial dependence between sites is studied. To this aim, spatial dependence is explicitly taken into account by means of a Gaussian copula. The results demonstrate its significant impact on parameter estimates: ignoring intersite dependence leads to biased parameters with underestimated variance. As a consequence, the significance of a trend can be strongly overestimated. Lastly, we will discuss further methodological developments that should improve the

description of the spatial and temporal variability of hydrological extremes.