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Spatial distribution of precipitation extremes in Norway

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Estimates of extreme precipitation, in terms of return levels, are crucial in planning and design of important infrastructure. Through two separate studies, we have examined the levels and spatial distribution of daily extreme precipitation over catchments in Norway, and hourly extreme precipitation in a point. The analyses were carried out through the development of two new methods for estimating extreme precipitation in Norway.

For daily precipitation we fit the Generalized Extreme Value (GEV) distribution to areal time series from a gridded dataset, consisting of daily precipitation during the period 1957-today with a resolution of 1x1 km^2. This grid-based method is more objective and less manual and time-consuming compared to the existing method at MET Norway. In addition, estimates in ungauged catchments are easier to obtain, and the GEV approach includes a measure of uncertainty, which is a requirement in climate studies today. Further, we go into depth on the debated GEV shape parameter, which plays an important role for longer return periods. We show that it varies according to dominating precipitation types, having positive values in the southeast and negative values in the southwest. We also find indications that the degree of orographic enhancement might affect the shape parameter.

For hourly precipitation, we estimate return levels on a 1x1 km^2 grid, by linking GEV distributions with latent Gaussian fields in a Bayesian hierarchical model (BHM). Generalized linear models on the GEV parameters, estimated from observations, are able to incorporate location-specific geographic and meteorological information and thereby accommodate these effects on extreme precipitation. Gaussian fields capture additional unexplained spatial heterogeneity and overcome the sparse grid on which observations are collected, while a Bayesian model averaging component directly assesses model uncertainty. We find that mean summer precipitation, mean summer temperature, latitude, longitude, mean annual precipitation and elevation are good covariate candidates for hourly precipitation in our model. Summer indices succeed because hourly precipitation extremes often occur during the convective season.

The spatial distribution of hourly and daily precipitation differs in Norway. Daily precipitation extremes are larger along the southwestern coast, where large-scale frontal systems dominate during fall season and the mountain ridge generates strong orographic enhancement. The largest hourly precipitation extremes are mostly produced by intense convective showers during summer, and are thus found along the entire southern coast, including the Oslo-region.