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Bivariate spatial modeling of extreme snow load and snow depth in Austria

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While many long-term observations of daily snow depth exist in Austria, long-term measurements of snow water equivalent and snow load are very scarce. Spatial modeling of extreme snow loads would greatly benefit from long snow depth series. Therefore the question arises, how historical snow depths can be used to spatially model snow load extremes?

We use a newly developed semi-empirical snow model to derive historical snow loads and snow water equivalents from daily snow depth measurement series. Modeling extreme snow load on an arbitrary point in Austria can then be performed by fitting an appropriate max-stable process to the obtained long-term pseudo-observations of snow load and snow water equivalent. Assuming that extremes follow a GEV distribution, max-stable models are able to model the location and scale parameters very well. The shape parameter – determining the tail of the distribution – is however the most critical and the most difficult parameter to estimate.

To improve the accuracy of the shape parameter, the mean number of days between the occurrence dates of maximum snow depth and maximum snow water equivalent within a season is used as covariate for the shape parameter model. This joint property of snow depth and snow load extremes depends on the combination of altitude and the synoptic-climatic setting of a station location.

To further improve the spatial model, snow load extremes are modeled bivariately together with snow depth using a bivariate Extremal-t max-stable process. Preliminary results suggest an improvement in modeled margins compared to univariate max-stable processes, or a smooth modeling approach. In addition, modeling the joint distribution of extreme snow load and snow depth provides the possibility to derive snow load return levels conditioned on measured snow depths.