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Spatial models for climate extremes. Application to extreme snow depth in the Swiss Alps.

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In recent years, there has been a growing interest in spatial extremes within the climate community. For many practical applications, an important issue is to model extreme events anywhere in space, and not only at some specific locations. A naive way of doing this is to estimate the distribution of extremes (the so-called *Generalized Extreme Value* -GEV- distribution) at individual locations and to make prediction where data are not available in a second step (using kriging for example). Such a method should nevertheless be avoided and may lead to unrealistic results. A better approach is to model directly the GEV distribution as a smooth function in space. With the help of good covariates, this simple method allows to build realistic return level maps of extremes events without requiring *a posteriori* interpolation. It nevertheless relies on the assumption that extremes at different places are uncorrelated which is obviously wrong for climate extremes. The theory of max-stable processes provides the most natural way for the specification of spatially-dependent extremes. Max-stable processes can be seen as an extreme value analogy of Gaussian processes. But they have rarely been applied to real climate problems and may be too simplistic models to describe the complexity of climate extremes in reality. We therefore propose a modified max-stable characterization of extremes designed explicitly for climate data. It can in particular account for the presence of climate regions and directional weather movement effects. Performance and comparison of the different approaches discussed above are illustrated by analysing annual maximum snow depth distributions in Switzerland. The new method shows a higher performance and is able to provide more information than the other methods.