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Pairwise Spatial dependences of precipitation extremes over Belgium

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Classically, the statistical analysis of extreme events in climate studies has often be limited to the inference of the marginal distribution properties, assuming that the measurements are independent in time and space. Although temporal independence seems to be a reasonable assumption for some variables like annual precipitation maxima, it is much more difficult to argue that two nearby weather stations provide independent measurements.

Some techniques to evaluate spatial dependences amongst extremes have been proposed by the statistical community. For example, Coles (1991) studied such dependences by taking advantage of the concept of copula. More recently, Naveau et al. (2007) have put forward a new estimator to measure the pairwise dependence within a field of maxima. In addition to being closely related to the classical variogram used in geostatistics, this estimator called a $\lambda-$madogram has the advantage of taking into account the fact that the margins are unknown quantities in practice. These techniques have rarely been employed in climate studies.

In the present paper, they are applied and tested for two precipitation networks, the pluviographic and the climatological networks of the Royal Meteorological Institute of Belgium. Both methods show similar spatial dependences, but the second one provides smaller confidence intervals. The choice of the aggregation period has also been tested, from one hour to one day. For annual maxima of daily precipitation, a spatial dependence is found up to 200 km. For smaller aggregation periods, the pairwise dependence decreases, e.g. no dependence beyond a 50 km range for one hour. The origin and the implications of these results are discussed.