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Spatial properties of precipitation extremes

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Records of precipitation extremes are essential for hydrological design. Intensity duration frequency curves (IDFs) are typically used for urban hydrology. They are usually estimated from gauge observation records. These observations can be continuous in time but have no spatial extent. The areal component is then typically determined by the use of duration-dependent area reduction factors (ARFs). These however are based on speculations, as there are seldom any spatially continuous observations available.
In this contribution we investigate the problems: (i) to what extent are point observations representative for point extremes (as the real extremes are most likely to occur elsewhere than at the measurement points, (ii) how are the extremes occurring somewhere in a selected area related to extremes observed at a fixed location and (iii) what are the statistical properties of extreme areal precipitations occurring in subareas of a large domain?
The investigations are carried out using (i) a dense precipitation network in Germany, (ii) radar observations available for the same area and (iii) with simulated radar precipitation, based on 8 years of data from the Bethlehem radar station in South Africa, obtained using the String of Beads model.
Our investigations show that extremes measured at a single location may lead to considerable underestimation of the risks. Furthermore, an example using a non-Gaussian simulation shows that the structure of the spatial dependence of extreme events plays an essential role for determining space-time extremes.