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Quantifying the importance of spatial sampling for short duration precipitation extremes

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Heavy downpours have a large impact on society, especially in urbanized areas and in fast responding hydrological catchments. The decisions of urban planners are generally based on return values of different relevant return periods, often with IDF-curves (Intensity-Duration-Frequency-curves), determined from gauge measurements. However, a gauge is merely sampling a point location in space at some given temporal frequency, while a convective storm has a strong spatial structure and short life time. A simplified view of a convective cell is that of a circular horizontal surface with the intensity increasing exponentially toward the center. Translating this cell over a gauge shows that it is very unlikely that the gauge is sampling from the highest core intensity of the cell. Further, it is also likely that the gauge is not sampling any part of the convective cell at all, so a network of gauges is necessary. However, given a typical size of a midlatitude convective shower of around 10 km^2, the gauge network needs to be very dense in order to sample the majority of the rain cells over the season, which is rarely the case in practice.

Here, we investigate the samples of extreme intensities for a given gauge network density by making use of high resolution (2x2 km^2; 15 min) radar measurements over Sweden. By treating one grid point as a pseudo-gauge, we can explore the measured intensity for a given recorded extreme event and compare it to surrounding recordings, as well as to explore the amount of "non-recorded" extreme events. From this analysis we obtain a statistical model to estimate the number of extreme rain showers from a sparse gauge network.