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Detecting a heavy precipitation signal over Central Europe

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Previous studies found that changes of extreme daily precipitation show on average a positive relationship with temperature close to Clausius-Clapeyron scaling with strong spatial variability. Due to the inherent scarcity of extreme events and high internal variability, a large amount of long station series is required, which makes it challenging to detect a signal at the regional to local scale. Research is often limited by data availability and thus mostly based on publically available pre-calculated extreme indices that do not allow to assess the dependence on event duration.

Here we use a new dense network of raw precipitation data series for Central Europe, extending over several countries including France, the Netherlands, Germany, Switzerland, and Austria, analysing intensity and frequency changes. Access to raw data allows to extract extreme precipitation indices for the yearly and seasonal maximum precipitation sum over a 1-, 3-, 5-, 7-, and 31-day period (i.e. Rx1day...) and the number of days per year exceeding the 95% and 99% precipitation quantiles of 1961-1990 (i.e. #R95p...) from series covering at least eighty years within the twentieth century. Based on this we assess the spatial and temporal patterns in heavy rainfall intensification over Europe and their dependence on event duration and season.

Non-parametric time series regression for the intensity and logistic regression for the frequency indices shows that a majority of series exhibit an increase since 1900, with a portion of significantly positive trends well exceeding those of resampled time series. This is also the case for almost all seasons and both winter and summer half years, as well as for almost all sub-regions, except for Austria having a wide range of stations showing negative trends. In space, trends show a clear spatial pattern across country borders. Non-stationary generalised extreme value distributions with temperature dependent location and scale parameters provide an estimate for the temperature dependency of yearly maximum precipitation and put the results in context of Clausius-Clapeyron scaling. Overall, we detect that the fraction of significantly positive trends is larger than expected by internal variability.