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Flood hazard assessment: heavy tail behaviour of rainfall extremes across Germany

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Distributions are termed heavy-tailed, if extreme values are more likely than would be predicted by probability distributions that have exponential asymptotic behaviour. Heavy-tail behaviour often leads to surprise, because historical observations can be a poor guide for the future. Heavy-tail behaviour seems to be widespread for hydro-meteorological extremes, such as extreme rainfall and flood events. To date there have been only vague hints to explain under which conditions these extremes show heavy-tail behaviour. We use an observational data set consisting of 11 climate variables at more than 1000 stations across Germany. This homogenized, gap-free data set covers 110 years (1901-2010) at daily resolution. First we estimate the upper tail behaviour, including its uncertainty interval, of daily precipitation extremes for the study stations at annual scale (i.e. block maxima). Different tail indicators are tested, including e.g. the shape parameter of the Generalized Extreme Value distribution, the upper tail ratio and relative Mean Absolute Deviation (MAD). Second, we explore to which extent the tail behaviour can be explained by readily available geographical and climate factors. A large number of characteristics is derived, such as station elevation and hillslope aspect, mean annual precipitation, humidity, temperature and wind velocity. The link between the upper tail behaviour and these characteristics is investigated via data mining methods capable of detecting non-linear relationships in large data-sets. This exceptionally rich observational data set, in terms of number of stations, length of time series and number of explaining variables, allows insights into the upper tail behaviour, which is rarely possible given the typical observational data sets available.