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Mean Excess Function as a method of identifying sub-exponential tails: Application to extreme daily rainfall

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Identifying precisely the distribution tail of a geophysical variable is tough, or, even impossible. First, the tail is the part of the distribution for which we have the less empirical information available; second, a universally accepted definition of tail does not and cannot exist; and third, a tail may change over time due to long-term changes. Unfortunately, the tail is the most important part of the distribution as it dictates the estimates of exceedance probabilities or return periods. Fortunately, based on their tail behavior, probability distributions can be generally categorized into two major families, i.e. sub-exponentials (heavy-tailed) and hyper-exponentials (light-tailed). This study aims to update the Mean Excess Function (MEF), providing a useful tool in order to asses which type of tail better describes empirical data. The MEF is based on the mean value of a variable over a threshold and results in a zero slope regression line when applied for the Exponential distribution. Here, we construct slope confidence intervals for the Exponential distribution as functions of sample size. The validation of the method using Monte Carlo techniques on four theoretical distributions covering major tail cases (Pareto type II, Log-normal, Weibull and Gamma) revealed that it performs well especially for large samples. Finally, the method is used to investigate the behavior of daily rainfall extremes; thousands of rainfall records were examined, from all over the world and with sample size over 100 years, revealing that heavy-tailed distributions can describe more accurately rainfall extremes.