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Watch the tail! A story on extreme hourly precipitation

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The problem of tail identification and estimation in hydro-meteorological variables is in principle difficult due to limited empirical extreme observations, while it becomes even more challenging under the assumption of non-stationary conditions arising from climatic and/or anthropogenic factors. In this study a rigorous analysis of 7,000 stations of hourly precipitation over the United States is performed in order to: (a) identify which major type of tail, i.e. power-type or stretched exponential, describes better extreme hourly precipitation, (b) quantify the tail shape parameter and examine how results are affected by the quantile used to define the tail, and (c) investigate the spatial variation of the tails of hourly precipitation over the U.S. and its relation to Köppen–Geiger climate classification. The findings suggest that stretched exponential tails are more consistent with observations, while the estimated mean shape parameter value equals to 0.55, a value indicating that hourly precipitation extremes are more frequent and larger in magnitude than what popular and commonly used models suggest, e.g., the Gamma distribution. Also, the analysis shows that the power-type shape parameter is affected by the empirical definition of the tail. Finally, it is interestingly to observe that the spatial variation of the shape parameter matches in general the spatial pattern of the Köppen–Geiger climate classification, suggesting that extreme hourly precipitation is strongly related on specific climatic types.