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Extreme dry spells: Problem of rounding and Bayesian solution

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Two theoretically justified models of extremes are applied to dry spell (DS) series: The generalized Pareto distribution is applied to peak-over-threshold data (POT-GP), and the Generalized Extreme Value distribution is applied to the annual maxima (AM-GEV). DS data are categorized according to three precipitation-per-day thresholds (1, 5 and 10 mm). The well-known classical methods for parameter estimation (L-moments and Maximum Likelihood) are applied both to measured and to simulated DS time series. When applied within the GEV model, both methods yield very similar results. Somewhat surprisingly, in the case of the GP model, these methods lead to substantially different estimates of parameters, as well as return values. This is found to be a consequence of the fact that DS values are recorded discretely as a whole number of days, whereas the classical extreme value distributions are intended for continuous data. The inference is further evaluated within the Bayesian paradigm, where the process of rounding can be incorporated in a straightforward manner. The study confirmed precautionary estimations when applying the AM-GEV model in comparison with the simpler AM-Gumbel model. Regarding POT-GP modelling, the Bayesian approach reveals a high uncertainty that can occur in parameter estimations when very high thresholds are considered. It is found that there are no clear criteria in the assessment of some optimal threshold, nor is there a necessity for its detection. Instead, Bayesian inference provides a reasonable overall picture of the range of thresholds compatible with the GP-model. Furthermore, it is concluded that when using rounded data, all three GP parameters should be assessed. The location estimates should be compatible with the theoretical value of 0.5. Although the present study is performed mainly on the DS series from two stations in Croatia spanning the period of 1961-2010, the authors believe that the methodology developed here is applicable to other regions.