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A comparative assessment of statistical methods for extreme value analysis

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Robust estimates of frequency and quantity of extreme events are needed for a range of hydro-meteorological variables as a basis for natural hazard and water resources management. We compare different extreme value statistics approaches and fitting methods with respect to their value for assessing hydro-meteorological extremes. Based on a diverse Austrian records data set, we assess the added value of partial duration series over the standardly used annual maxima series in order to give recommendations for performing extreme value statistics. Results show the merits of the robust L-moment estimation, which yield better results than maximum likelihood estimation. At the same time, results question the general assumption of the threshold excess approach (employing partial duration series, PDS) being superior to the block maxima approach (employing annual maxima series, AMS) due to information gain. For low return periods (non-extreme events) the PDS approach tends to overestimate return levels as compared to the AMS approach, whereas an opposite behaviour was found for high return levels (extreme events). In extreme cases, an inappropriate threshold was shown to lead to considerable biases that may outperform the possible gain of information from including additional extreme events by far. This effect was neither visible from standardly used graphical diagnosis (mean residual life plot), but from a direct comparison of AMS and PDS in synoptic quantile plots. We therefore recommend performing AMS and PDS approaches simultaneously in order to select the best suited approach. This will make the analyses more robust, in cases where threshold selection and dependency introduces biases to the PDS approach, but also in cases where the AMS contains non-extreme events that may introduce similar biases. For assessing the performance of extreme events we recommend using conditional performance measures that are more sensitive on rare events only in addition to standardly used unconditional performance measures. The findings of this study are of relevance for a broad range of environmental variables, including meteorological and hydrological quantities.