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The Metastatistical Extreme Value Distribution

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The analysis and estimation of extreme event occurrences is a central problem in many fields of geoscience. Advances in our ability to understand and model extreme events have recently been limited, arguably in connection with the limitations set by asymptotic assumptions and Poisson approaches to derive the Generalized Extreme Value distribution within the traditional extreme value theory (EVT).

Here we introduce and illustrate the application of a Metastatistical Extreme Value Distribution (MEVD) which relaxes some of the limitations of the traditional EVT by recognizing that the extreme value distribution, i.e. the distribution of yearly maxima, emerges from the underlying distribution of “ordinary” events. In essence, the MEVD is derived from ensemble averaging over yearly distributions of annual maxima, thereby also accounting for the presence of interannual variabilities. We apply this general approach to the relevant case of daily rainfall, both from raingauge observations and from TRMM satellite estimates. We find that the MEV approach reduces the uncertainty in the estimation of high-quantile extremes by up to 50% with respect to the classical EVT. The improved predictive power of the MEV framework is connected with its recognizing that extremes emerge from repeated sampling of ordinary events, thereby being able to use all available observations. Finally, we illustrate the application of the MEVD to a variety of variables of geophysical interest.