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Extreme value methods in dynamical systems of different complexity

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Extreme value theory provides a universal limit for the extremes of continuous independent and identically distributed random variables and has proven to be robust to generalisation to wider classes of random variables, including stationary processes, some nonstationary processes and even trajectories on deterministic chaotic systems. This universality, together with the fact that these methods require data from only one realization of the system, has been exploited in applications to study many series of climate data.

Fitting a probability distribution to the extreme events of a data series generated by a chaotic dynamical system gives us not only probabilistic predictions of the intensity and return time of the events themselves, but also geometrical information about the local structure of the attractor and the predictability and persistence of the extreme events.

However, these methods are sensitive to the mathematical properties of the dynamical system that generates the data, and are seldomly even mentioned when they are applied to real climate data. One further caveat of these methods is that they are hard to falsify, i.e. we cannot verify easily if an answer is wrong. For these reasons, we explore how these methods respond to different systems with different complexity and different mathematical properties, trying to understand which of the results on the literature could meaningful and which could be numerical artifacts.