Geophysical Research Abstracts
Vol. 15, EGU2013-8449, 2013
EGU General Assembly 2013
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Does climate have heavy tails?

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When we speak about a distribution with heavy tails, we are referring to the probability of the existence of extreme values will be relatively large. Several heavy-tail models are constructed from Poisson processes, which are the most tractable models. Among such processes, one of the most important are the Lévy processes, which are those process with independent, stationary increments and stochastic continuity. If the random component of a climate process that generates the data exhibits a heavy-tail distribution, and if that fact is ignored by assuming a finite-variance distribution, then there would be serious consequences (in the form, e.g., of bias) for the analysis of extreme values. Yet, it appears that it is an open question to what extent and degree climate data exhibit heavy-tail phenomena.

We present a study about the statistical inference in the presence of heavy-tail distribution. In particular, we explore (1) the estimation of tail index of the marginal distribution using several estimation techniques (e.g., Hill estimator, Pickands estimator) and (2) the power of hypothesis tests. The performance of the different methods are compared using artificial time-series by means of Monte Carlo experiments.

We systematically apply the heavy tail inference to observed climate data, in particular we focus on time series data. We study several proxy and directly observed climate variables from the instrumental period, the Holocene and the Pleistocene.

This work receives financial support from the European Commission (Marie Curie Initial Training Network LINC, No. 289447, within the 7th Framework Programme).