Geophysical Research Abstracts
Vol. 14, EGU2012-13322, 2012
EGU General Assembly 2012

Multifractal Geophysical Extremes: Nonstationarity and Long Range Correlations

I. Tchiguirinskaia (1), D. Schertzer (1), and S. Lovejoy (2)

(1) Univ. Paris-Est, Ecole des Ponts ParisTech, Marne-la-Vallee, France (ioulia@cereve.enpc.fr, +33-(0)1-64153764), (2) McGill U., Montreal, Canada

Throughout the world, extremes in environmental sciences are of prime importance. They are key variables not only for risk assessments and engineering designs (e.g. of dams and bridges), but also for resource management (e.g. water and energy) and for land use. A better understanding of them is more and more indispensable in settling the debate on their possible climatological evolution. Whereas it took decades before a uniform technique for estimating flow frequencies within a stationary framework, it is often claimed that « stationarity is dead ! ». The fact that geophysical and environmental fields are variable over a wider range of scales than previously thought require to go beyond the limits of the (classical) Extreme Value Theory (EVT). Indeed, long-range correlations are beyond the scope of the classical EVT theory.

We show that multifractal concepts and techniques are particularly appealing because they can effectively deal with a cascade of interactions concentrating for instance energy, liquid water, etc. into smaller and smaller space-time domains. Furthermore, a general outcome of these cascade processes -which surprisingly was realized only rather recently- is that rather independently of their details they yield probability distributions with power-law fall-offs, often called (asymptotic) Pareto or Zipf laws. We discuss the corresponding probability distributions of their maxima and its relationship with the Frechet law.

We use these multifractal techniques to investigate the possibility of using very short or incomplete data records for reliable statistical predictions of the extremes. In particular we assess the multifractal parameter uncertainty with the help of long synthetic multifractal series and their sub-samples, in particular to obtain an approximation of confidence intervals that would be particularly important for the predictions of multifractal extremes.

We finally illustrate the efficiency of this approach with its application to large databases, ranging from hydro-meteorological fields to internet traffic flows. In particular, we show how the statistical analysis of rather moderate fluctuations, which are present on almost samples, can used to estimate reliable return periods of the extremes.