Geophysical Research Abstracts
Vol. 15, EGU2013-10433, 2013
EGU General Assembly 2013

How scaling fluctuation analyses can transform our view of the climate

Shaun Lovejoy (1) and Daniel Schertzer ()

(1) McGill University, Department of Physics, Montreal, Canada (lovejoy@physics.mcgill.ca, +1-(0)514-3988434), (2) 2CEREVE Université Paris Est, 6-8, avenue Blaise Pascal Cité Descartes 77455 MARNE-LA-VALLEE Cedex, France

There exist a bewildering diversity of proxy climate data including tree rings, ice cores, lake varves, boreholes, ice cores, pollen, foraminifera, corals and speleothems. Their quantitative use raises numerous questions of interpretation and calibration. Even in classical cases – such as the isotope signal in ice cores – the usual assumption of linear dependence on ambient temperature is only a first approximation. In other cases – such as speleothems – the isotope signals arise from multiple causes (which are not always understood) and this hinders their widespread use.

We argue that traditional interpretations and calibrations – based on essentially deterministic comparisons between instrumental data, model outputs and proxies (albeit with the help of uncertainty analyses) - have been both overly ambitious while simultaneously underexploiting the data. The former since comparisons typically involve series at different temporal resolutions and from different geographical locations – one does not expect agreement in a deterministic sense, while with respect to climate models, one only expects statistical correspondences. The proxies are underexploited since comparisons are done at unique temporal and / or spatial resolutions whereas the fluctuations they describe provide information over wide ranges of scale.

A convenient method of overcoming these difficulties is the use of fluctuation analysis systematically applied over the full range of available scales to determine the scaling proeprties. The new transformative element presented here, is to define fluctuations ΔT in a series T(t) at scale Δt not by differences ($\Delta T(\Delta t) = T(t+\Delta t) - T(t)$) but rather by the difference in the means over the first and second halves of the lag Δt . This seemingly minor change – technically from "poor man's" to "Haar" wavelets – turns out to make a huge difference since for example, it is adequate for analysing temperatures from seconds to hundreds of millions of years yet remaining simple to interpret [Lovejoy and Schertzer, 2012]. It has lead for example to the discovery of the new "macroweather" regime between weather ($\Delta t <\approx$ 10days) and climate ($\Delta t \approx> 30$ yrs) in which fluctuations decrease rather than increase with scale [Lovejoy, 2013].

We illustrate the transformative power of combining such fluctuation analysis with scaling by giving numerous examples from instrumental data, multiproxies, ice core proxies, corals, speleothems and GCM outputs [Lovejoy and Schertzer, 2013].

References:

Lovejoy, S. (2013), What is climate?, EOS, 94, (1), 1 January, p1-2.

Lovejoy, S., and D. Schertzer (2012), Haar wavelets, fluctuations and structure functions: convenient choices for geophysics, Nonlinear Proc. Geophys. , 19, 1-14 doi: 10.5194/npg-19-1-2012.

Lovejoy, S., and D. Schertzer (2013), The Weather and Climate: Emergent Laws and Multifractal Cascades, 480 pp., Cambridge University Press, Cambridge.