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Roadmap for Scaling and Multifractals in Geosciences: still a long way to go ?

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The interest in scale symmetries (scaling) in Geosciences has never lessened since the first pioneering EGS session on chaos and fractals 22 years ago. The corresponding NP activities have been steadily increasing, covering a wider and wider diversity of geophysical phenomena and range of space-time scales. Whereas interest was initially largely focused on atmospheric turbulence, rain and clouds at small scales, it has quickly broadened to much larger scales and to much wider scale ranges, to include ocean sciences, solid earth and space physics. Indeed, the scale problem being ubiquitous in Geosciences, it is indispensable to share the efforts and the resulting knowledge as much as possible. There have been numerous achievements which have followed from the exploration of larger and larger datasets with finer and finer resolutions, from both modelling and theoretical discussions, particularly on formalisms for intermittency, anisotropy and scale symmetry, multiple scaling (multifractals) vs. simple scaling,. We are now way beyond the early pioneering but tentative attempts using crude estimates of unique scaling exponents to bring some credence to the fact that scale symmetries are key to most nonlinear geoscience problems.

Nowadays, we need to better demonstrate that scaling brings effective solutions to geosciences and therefore to society. A large part of the answer corresponds to our capacity to create much more universal and flexible tools to multifractally analyse in straightforward and reliable manners complex and complicated systems such as the climate. Preliminary steps in this direction are already quite encouraging: they show that such approaches explain both the difficulty of classical techniques to find trends in climate scenarios (particularly for extremes) and resolve them with the help of scaling estimators. The question of the reliability and accuracy of these methods is not trivial.

After discussing these important, but rather short term issues, we will point out more general questions, which can be put together into the following provocative question: how to convert the classical time evolving deterministic PDE's into dynamical multifractal systems? We will argue that this corresponds to an already active field of research, which include: multifractals as generic solutions of nonlinear PDE (exact results for 1D Burgers equation and a few other caricatures of Navier-Stokes equations, prospects for 3D Burgers equations), cascade structures of numerical weather models, links between multifractal processes and random dynamical systems, and the challenging debate on the most relevant stochastic multifractal formalism, whereas there is already a rather general consent about the deterministic one.