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Climate and weather across scales: singularities and stochastic Levy-Clifford algebra

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There have been several attempts to understand and simulate the fluctuations of weather and climate across scales. Beyond mono/uni-scaling approaches (e.g. using spectral analysis), this was done with the help of multifractal techniques that aim to track and simulate the scaling singularities of the underlying equations instead of relying on numerical, scale truncated simulations of these equations (Royer et al., 2008, Lovejoy and Schertzer, 2013).
However, these techniques were limited to deal with scalar fields, instead of dealing directly with a system of complex interactions and non trivial symmetries. The latter is unfortunately indispensable to answer to the challenging question of being able to assess the climatology of (exo-) planets based on first principles (Pierrehumbert, 2013) or to fully address the question of the relevance of quasi-geostrophic turbulence and to define an effective, fractal dimension of the atmospheric motions (Schertzer et al., 2012).
In this talk, we present a plausible candidate based on the combination of Lévy stable processes and Clifford algebra. Together they combine stochastic and structural properties that are strongly universal. They therefore define with the help of a few physically meaningful parameters a wide class of stochastic symmetries, as well as high dimensional vector- or manifold-valued fields respecting these symmetries (Schertzer and Tchiguirinskaia, 2015).

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