Large deviation theory applied to climate physics, a new frontier of statistical physics

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Abstract

We propose to review some of the recent developments in the theoretical aspects of the non-equilibrium statistical mechanics of climate dynamics. At the intersection between statistical mechanics, turbulence, and geophysical fluid dynamics, this field is a wonderful new playground for theoretical physics involving tools from statistical physics: large deviation theory, path integrals, and diffusion Monte-Carlo algorithms. We will discuss two classes of applications. First extreme heat waves as an example of a rare events with huge impacts. Second rare trajectories that suddenly drive the complex turbulent dynamical system from one attractor to a completely different one, related to abrupt climate changes. Relation with instanton theory and effective models of first order transitions and their transition rates will be emphasized.

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