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Multi-level stochastic refinement for turbulent time series and fields MICHAEL SINHUBER, Max Planck Institute for Dynamics and Self-Organization, Goettingen, JAN FRIEDRICH, ENS Lyon, RAINER GRAUER, Ruhr-Universitaet Bochum, GREGORY P. BEWLEY, Cornell University, MICHAEL WILCZEK, Max Planck Institute for Dynamics and Self-Organization, Goettingen — Many high-dimensional systems exhibit complex spatio-temporal dynamics. Typically, this complexity comes along with strong multi-scale correlations and scale-dependent deviations from Gaussianity, which requires multi-time-multi-point statistics for a full characterization. In many practical cases, obtaining sufficiently resolved data is prohibitively expensive or even impossible. While a statistical characterization of such systems is often sufficient, many applications where turbulence plays a key role require a complete spatio-temporal realization of the system. Examples range from modeling particle propagation in fusion plasmas to wind field modeling for wind energy applications. To address this challenge, we develop a stochastic refinement method that generates finely resolved data sets from readily available, coarsely sampled turbulence data as well as synthetic datasets within the scope of classical turbulence models. This is done by utilizing scale-Markovian properties of turbulence and scale-dependent three-point velocity statistics. We test our approach both for wind tunnel data from the VDTT at the Max-Planck-Institute for Dynamics and Self-Organization in Göttingen as well as for simulated turbulent fields based on classical turbulence models.

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