A one-dimensional stochastic model of multi-scale dynamics in turbulent flows

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One computational strategy for capturing microscale processes not affordably resolved in multidimensional turbulence simulations is to represent these processes by a lower-dimensional formulation. An approach formulated in one spatial dimension, denoted One-Dimensional Turbulence (ODT), is outlined. ODT combines two 1D approaches that have individually proven successful: stochastic iterated maps and reduction of the governing equations using the boundary-layer approximation. Within ODT, subprocesses based on these two approaches are coupled so as to represent both turbulent cascade dynamics and microphysics at dissipative scales, with strong two-way interaction. Model performance in a geophysical context is illustrated by applications to building-block flows (Kelvin-Helmholtz instability, Rayleigh convection) and to geophysically relevant phenomena (e.g., multicomponent convection). Combustion applications and subgrid-scale implementation of ODT within multidimensional simulations are also discussed.

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