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Small-scale averaging coarse-grains passive scalar turbulence TOBIAS BÄTGE, MICHAEL WILCZEK, Max Planck Institute for Dynamics and Self-Organization — Capturing the multi-scale dynamics of turbulent mixing remains a theoretical and computational challenge. Therefore, many practical applications require a coarse-grained description, which treats the small scales effectively. Here, we address this challenge at the example of a stochastic, one-dimensional Kraichnan model for passive scalar mixing. We propose that effective large-scale equations can be obtained by ensemble-averaging over the small-scale velocity fluctuations. We show that this procedure leads to an effective diffusivity reminiscent of phenomenological eddy viscosity models. Additionally, we establish an exact filtering procedure that maps second-order statistics of the fully resolved passive scalar field to the one obtained by small-scale averaging. Combined with fully resolved simulations, we show that small-scale averaging also captures higher-order large-scale statistics of passive scalar fields.

Tobias Batge
Max Planck Institute for Dynamics and Self-Organization

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