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Upscaling of Mixing Processes using a Spatial Markov Model[1]
DIOGO BOLSTER, University of Notre Dame, NICOLE SUND, Dessert Research Institute, GIOVANNI PORTA, Politecnico de Milano — The Spatial Markov model is a model that has been used to successfully upscale transport behavior across a broad range of spatially heterogeneous flows, with most examples to date coming from applications relating to porous media. In its most common current forms the model predicts spatially averaged concentrations. However, many processes, including for example chemical reactions, require an adequate understanding of mixing below the averaging scale, which means that knowledge of subscale fluctuations, or closures that adequately describe them, are needed. Here we present a framework, consistent with the Spatial Markov modeling framework, that enables us to do this. We apply and present it as applied to a simple example, a spatially periodic flow at low Reynolds number. We demonstrate that our upscaled model can successfully predict mixing by comparing results from direct numerical simulations to predictions with our upscaled model. To this end we focus on predicting two common metrics of mixing: the dilution index and the scalar dissipation. For both metrics our upscaled predictions very closely match observed values from the DNS.

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