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Reproducing scalar mixing of turbulent jets in a 3D periodic box

K. JEFF RAH, GUILLAUME BLANQUART, Caltech — A triply periodic DNS is a convenient framework to analyze the turbulent mixing process, since it can produce statistically stationary turbulence. In addition, the periodic boundary condition makes it easy to compute the spatial spectra of scalars. However, it is difficult to create a realistic turbulent flow with such a geometry. In this current investigation, we aim to develop a method to simulate a realistic turbulent mixing process inside a 3D periodic box. The target real flow is an axisymmetric jet with passive scalars on its centerline. The velocity and scalar information of turbulent jets on the centerline is applied to the momentum equation and scalar transport equation in physical space. The result is the combination of a mean gradient term and a linear forcing term in the scalar equation. These new forcing terms are derived to replicate the scalar mixing properties of jets in a triply periodic DNS. The present analysis differs from other forcing schemes for their derivation process did not involve any use of the velocity or scalar information of a real turbulent flow. A set of DNS has been performed with the new forcing term, and various turbulent parameters and spectral relations are compared against experiments.

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