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Backscattering and stability of data-driven subgrid-scale parameterization for 2D turbulence YIFEI GUAN, ASHESH CHATTOPADHYAY, ADAM SUBEL, PEDRAM HASSANZADEH, Rice University, THE ENVIRONMENTAL FLUID DYNAMICS GROUP TEAM — To alleviate the stringent requirement of DNS, large eddy simulation (LES) is one of the favorite alternatives of atmospheric scientists and fluid mechanics engineers. This study investigates data-driven models for parameterization of the subgrid-scale interactions for 2D turbulence. The data-driven models are based on the framework of random forest, fully connected neural network, or convolutional neural network. The models provide a functional joining the resolved flow field in terms of vorticity and stream function to the SGS momentum flux, which acts as a closure of the system. The SGS momentum flux can be obtained from filtered DNS data and used as the target for the training process. The models accurately predict the SGS momentum flux in a priori analysis. However, when coupled back to the LES, the data-driven models may lead to instabilities. The instabilities can be attributed to the backscattering effect, which is a physical process transferring energy from SGS terms to the large scale (grid resolved) terms. Data-driven models can be stabilized by canceling the backscattering effect at post-processing. However, the backscattering cancellation leads to an inaccurate prediction of the SGS term and, eventually, an over-diffusive system. We proposed regularization methods to alleviate the backscatter cancellation while maintaining the stability of the data-driven models.

Yifei Guan
Rice University

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