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Non-local, frame-independent data-driven turbulence modeling by using deep neural networks MUHAMMAD IRFAN ZAFAR[1], Virginia Tech, JIEQUN HAN[2], Princeton University, HENG XIAO[3], Virginia Tech — Recent advances in machine learning techniques have enabled researchers to explore data-driven turbulence models as attractive alternatives to traditional algebraic or PDE-based models. However, current data-driven models are all based on local mapping and thus are only applicable to equilibrium turbulence (as with the eddy-viscosity model and algebraic stress models). In this work, we present a PDE-inspired deep neural network architecture based on non-local mapping, which will be used to discover a turbulent constitutive relation from data. Such a network-based representation retains the non-local transport physics embodied in the Reynolds stress transport equations but avoids explicit modeling of individual terms. Furthermore, the neural network is devised to be frame-independent, which is a basic requirement of all constitutive models. Simple illustrative examples are presented to demonstrate the merits of the proposed framework.

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