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Machine-learning quasilinear Gaussian moment closures for uncertainty quantification of turbulent fluid flows[1] ALEXIS-TZIANNI CHARALAMPOPOULOS, THEMISTOKLIS SAPSIS, Massachusetts Institute of Technology MIT — We present a novel nonlocal closure scheme for turbulent systems that utilizes deep recurrent neural networks. The dynamical equations of the turbulent systems of interest consist of a linear part, external forcing (potentially stochastic) and a quadratic and energy preserving term. We develop a closure scheme for the mean field of interest as well as the covariance of its perturbations. Our neural network architecture takes into account the energy-preserving properties of the nonlinear terms allowing for numerical stability during coarse-scale simulations, a feature lost when this constraints are not imposed. Spatial convolutions and time-delays are included in the deep learning network to incorporate nonlocal spatio-temporal information that enhances the accuracy of our predictions. For numerical results we focus on two different systems. A turbulent multiphase current where bubbles that act as passive tracers are being transported by an incompressible fluid, and high latitude turbulent quasi-geostrophic flows excited be surface wind forcing.

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