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Data-Driven Augmentations of Second Moment Closures for Turbulent Flow Prediction WALTER CROSBY, ANAND PRATAP SINGH, KARTHIK DURAISAMY, University of Michigan — Second moment closures of turbulence - while having the potential to faithfully represent key turbulence processes - have not yet proven to offer significantly improved accuracy compared to linear eddy viscosity closures in practical problems. While meticulous theories are used to define models for pressure strain and near-wall dissipation anisotropy, the net imbalance in errors in the structural form of the modeled terms has traditionally limited the accuracy of these models. In this work, we address these model-form uncertainties using a framework based on inverse modeling and machine learning. We embed discrepancy functions within the governing equations of the simulation model. In contrast to parametric models, we seek the functional form of the model discrepancy. Once the spatio-temporal forms of the discrepancy function is inferred, machine learning is used to reconstruct the discrepancy functions in terms of local, Galilean invariant variables. The final step is to embed the learned discrepancy terms into the model equations. When uncertainties in the data and the inversion step are propagated to the embedded discrepancy term, bounds can be obtained in the predictive results by sampling the discrepancy terms. Results are demonstrated on wall-bounded turbulent flows.

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