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Physics-informed Spatio-temporal Deep Learning Models KARTHIK KASHINATH, ADRIAN ALBERT, RUI WANG, MUSTAFA MUSTAFA, Lawrence Berkeley Lab, ROSE YU, Northeastern University — Simulating the spatio-temporal evolution of a complex system over a realistic domain is extremely compute-intensive with current PDE-solvers. Deep learning (DL) shows great promise for augmenting or replacing compute-intensive parts of computational physics models. However, it remains a grand challenge to incorporate physical principles in a systematic manner to the design, training and inference of such models. Physics informed DL aims to infuse principles governing the dynamics of physical systems into DL models, but existing studies are either limited to linear dynamics or purely spatial constraints of physical systems.We study spatiotemporal modeling of velocity fields for a highly nonlinear turbulent flow using various state-of-the-art physics informed DL methods. We benchmark these methods on the task of forecasting velocity fields at different future time horizons, given historic data of different lengths. We find that incorporating prior physics knowledge can not only speed up the training process but improve model performance. Our results show that the Spatiotemporal Generative Networks with an autoregressive U-net as the generator performs the best for varying forecasting horizons.

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