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Autoencoded Reservoir Computing for the Spatio-Temporal Prediction of a Turbulent Flow[1] NGUYEN ANH KHOA DOAN, WOLFGANG POLIFKE, Technical University of Munich, LUCA MAGRI, University of Cambridge —
The spatio-temporal prediction of turbulence is challenging because of the sensitivity of the temporal evolution of the flow to perturbations, the nonlinear spatial interactions between turbulent structures of different scales, and the seemingly-random nature of sudden energy/dissipation bursts, which are extreme events. However, turbulence exhibits spatio-temporal correlations, such as the energy cascade, which can be inferred by a data-driven method. We develop an AutoEncoded Reservoir Computing (AE-RC) framework to predict the evolution of turbulent flows. The AE-RC consists of a Convolutional Autoencoder, which learns an efficient latent representation of the flow state, and a reservoir approach based on Echo State Networks, that learns the time evolution of the flow in the latent space. The AE-RC is applied to learn the dynamics of the 2D Kolmogorov flow in the quasi-periodic and turbulent regimes with/without extreme events. The AE-RC is able to predict adequately the short-term evolution of the Kolmogorov flow and the long-term statistics in all cases. This AE-RC approach demonstrates the potential of machine learning in the spatio-temporal prediction of turbulence.

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