Abstract Submitted
for the DFD19 Meeting of
The American Physical Society

Predicting the stochasticity: GAN-VAE based deep learning model for turbulence prediction CHANGLIN JIANG, AMIR BARATI FARIMANI, Carnegie Mellon University — Turbulence is a classical tempo-spatial system that has high non-linearity and prohibitively large degrees of freedom, which is basically considered impossible to solve analytically. Unlike Computational Fluid Dynamics (CFD) techniques which generally have considerable time and memory consumption, deep learning (DL) models could learn the hidden features automatically and hierarchically in multiple levels given massive dataset. Instead of solely learning to do turbulence parameterization, we seek to predict turbulence without any underlying physical rules. Our GAN-VAE based DL model could successfully simulate the ambiguous nature of turbulence by combining two distinct but complementary approaches: (a) a variational auto-encoder (VAE) which explicitly models stochasticity by latent layer sampling. (b) a generative adversarial network (GAN) that aims to produce realistic predictions. In the meantime, our model takes advantage of recent work in object detection and motion prediction, such as Convolutional Dynamic Neural Advection (CDNA) and convolutional LSTM. The model prediction is assessed with physics-based metrics like small scale statistics and flow morphology. Our results show promising capability of predicting turbulence that satisfies physical rules with high accuracy.

Changlin Jiang
Carnegie Mellon University

Date submitted: 26 Sep 2019 Electronic form version 1.4