Abstract Submitted
for the DFD20 Meeting of
The American Physical Society

Machine Learning Statistical Lagrangian Geometry of Turbulence

CRISTON HYETT, MICHAEL CHERTKOV, Program in Applied Mathematics, University of Arizona, Tucson, AZ 85721, YIFENG TIAN, DANIEL LIVESCU, Computer, Computational and Statistical Sciences Division, Los Alamos National Laboratory, Los Alamos, NM 87544 — Recently, there has been great success machine learning the Lagrangian dynamics of fluid particles in turbulent flows. We extend this work in search of Lagrangian dynamics of coarse-grained fluid volume/geometry and velocity gradient. Our work builds on the machine learning of Lagrangian dynamics, as well as the development of phenomenological reduced order models by approximating the closure of a physics-based model using neural networks to create a parameterized stochastic differential equation; coupling the evolution of the geometry to the evolution of the coarse-grained dynamical quantities; including deterministic and stochastic dynamics. Further, because the stochastic terms are themselves parameterized, we are able to target higher-order moments of dynamical quantities of interest. We train and evaluate the parameterized SDE against filtered Lagrangian DNS data to obtain a data-driven closure to the hypothesized model. We then evaluate the trained model to recover the learned insights to the phenomenological model.

Criston Hyett
Program in Applied Mathematics, University of Arizona, Tucson, AZ 85721

Date submitted: 10 Aug 2020 Electronic form version 1.4