Abstract Submitted
for the DFD19 Meeting of
The American Physical Society

A data-driven approach to modeling turbulent decay at non-asymptotic Reynolds numbers MATEUS DIAS RIBEIRO, German Research Center for Artificial Intelligence (DFKI), GAVIN D PORTWOOD, Los Alamos National Laboratory, Los Alamos, PEETAK MITRA, University of Massachusetts, Amherst, TAN MIHN NYUGEN, NVIDIA Corporation, Santa Clara, BALASUBRAMANYA T NADIGA, MICHAEL CHERTKOV, Los Alamos National Laboratory, Los Alamos, ANIMA ANANDKUMAR, NVIDIA Corporation, Santa Clara, DAVID P SCHMIDT, University of Massachusetts, Amherst, NVIDIA TEAM, UMASS TEAM, LANL TEAM, DFKI TEAM — Dynamic modeling of turbulent processes away from asymptotic parameter limits is an active area of turbulence research. This study considers the transient modeling of the kinetic energy dissipation rate, an important component for turbulence closure models like $k - \epsilon$. While asymptotic analysis of the turbulent dissipation process effectively calibrates the model parameters at high and low Reynolds numbers, these calibrations are inaccurate at intermediate Reynolds with strong dependence on large-scale turbulence properties. In intermediate regimes, model tuning via data-driven regression has a leading-order effect on accuracy such that a purely data-driven approach is sensible. Here, we model the kinetic energy dissipation rate in decaying isotropic turbulence using a NeuralODE, a continuous-depth neural network which models continuous-time processes. After training a model using direct numerical simulations (DNSs) over a range of Reynolds numbers and large-scale turbulence initial conditions, we show that a purely data-driven approach to modeling turbulent dynamics via NeuralODEs provides an attractive solution to turbulence closure in non-idealized parameter regimes.

Mateus Dias Ribeiro
German Research Center for Artificial Intelligence (DFKI)

Date submitted: 31 Jul 2019 Electronic form version 1.4