Abstract Submitted
for the DFD20 Meeting of
The American Physical Society

Influence of Reynolds Number and Flow Configuration on Turbulence Model Form Errors KERRY S. KLEMMER, MICHAEL E. MUELLER, Princeton University — Model form error arises from physical assumptions made in constructing models either to reduce the physical complexity or to model physical processes that are not well understood. In turbulence modeling, specifically Reynolds stress modeling, model form errors result from the Boussinesq hypothesis and other modeling choices, such as the specific form of the eddy viscosity. In this work, an "implied models" approach is used to better understand how the sources and dynamics of turbulence model form errors for the Reynolds stresses vary with Reynolds number and flow configuration. In the "implied models" approach, a transport equation for the Reynolds stress model error is derived by taking the difference between the exact Reynolds stress transport equation and the transport equation implied by the Boussinesq hypothesis. Budgets of the model error transport equation are analyzed to determine how well the Boussinesq hypothesis captures the underlying physics and the contribution of error cancellation that may benefit a model's apparent predictiveness even if fundamentally physically inaccurate. Both turbulent channel flows (at various friction Reynolds numbers) and turbulent free-shear flows are considered.

Kerry S. Klemmer
Princeton University

Date submitted: 03 Aug 2020 Electronic form version 1.4