Abstract Submitted
for the DFD19 Meeting of
The American Physical Society

CFD-ready Turbulence Models from Gene Expression Programming: Unsteady Flows[1] CHITRARTH LAV, JIMMY PHILIP, RICHARD SANDBERG, University of Melbourne, TURBULENCE SIMULATION AND MODELLING GROUP TEAM — Prediction of flows exhibiting vortex shedding using URANS is still a challenge today. The existing turbulence closure in URANS, in addition to being a poor representation of the turbulence length scales also accounts for the deterministic shedding scales twice: through the closure and the scale resolution. We propose an alternative non-linear closure, which is built only for the stochastic scales, i.e., devoid of the shedding scales, allowing URANS to resolve the deterministic unsteadiness. The closure is obtained from a novel symbolic regression algorithm: Gene Expression Programming (GEP), which generates a tangible equation for the modelled anisotropy. Using a high-fidelity dataset as reference, the stochastic component of the anisotropy is extracted by triple decomposing the data, which is subsequently used by GEP to produce the new closure. Once obtained, the closure can be used in isolation within URANS as it doesnt rely on high-fidelity data anymore. The approach is demonstrated using a zero pressure gradient turbulent wake as the reference dataset. The obtained closure was tested on 6 unseen cases, including pressure gradients, and the model significantly outperforms the existing closure, while being 400 times cheaper than the high-fidelity simulation.

[1]This work was supported by resources provided by the Pawsey Supercomputing Centre with funding from the Australian Government and the Government of Western Australia.

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Date submitted: 30 Jul 2019 Electronic form version 1.4