Abstract Submitted
for the DFD20 Meeting of
The American Physical Society

A relaxation wall model for large eddy simulations of turbulent flows[1] MITCHELL FOWLER, TAMER ZAKI, CHARLES MENEVEAU, Johns Hopkins University — The equilibrium wall model (EQWM) is the simplest and most widely adopted wall model in large eddy simulations (LES). The standard EQWM utilizes a known velocity profile, observed in a statistically stationary configuration, to relate the wall stress to the LES velocity. Even in non-equilibrium conditions the EQWM performs remarkably well since LES includes non-equilibrium effects outside the wall model layer. However, in rapidly changing conditions, near-wall changes are not captured by EQWM-LES. In this scenario, it appears conceptually important to be able to separate equilibrium and non-equilibrium effects to model each separately. We posit that the wall stress determined by the assumed velocity profile in EQWM can only respond within a relaxation timescale to changes in the LES velocity. From the integrated boundary layer equations, we derive an evolution equation for the wall stress which relaxes to the equilibrium value at the derived timescale. This "relaxation wall model (ReWM) accounts for the effectively time-filtered response of the wall stress due to the viscous layer between the LES velocity and the wall. The model thus enables us to properly separate the quasi-equilibrium response captured by EQWM and the non-equilibrium parts requiring more advanced modeling.

[1]Research supported by the Office of Naval Research (grant N00014-17-1-2937)

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Date submitted: 30 Jul 2020 Electronic form version 1.4