Abstract Submitted
for the DFD19 Meeting of
The American Physical Society

Extending the restricted nonlinear model to flow over rough surfaces with spanwise heterogeneities[1] XIAOWEI ZHU, BENJAMIN MINNICK, DENNICE GAYME[2], Johns Hopkins University — The restricted nonlinear (RNL) model has shown success in accurately predicting statistical features of smooth wall-turbulence. The RNL equations are obtained by decomposing the Navier-Stokes equations into a streamwise-averaged component and streamwise-varying perturbations, and then restricting the nonlinearity in the perturbations. The resulting dynamics are supported by a small number of streamwise varying modes (kx wave numbers) interacting with the streamwise constant mean flow. In this work, we extend the RNL modeling paradigm to rough walls by first determining the streamwise wave number support that correctly predicts the log-law behavior associated with rough wall flows. We demonstrate that the parametrization can be obtained analogously to the smooth-wall case, where it was shown that the particular streamwise varying modes required to correctly reproduce low-order statistics and spectra at low and moderate Reynolds numbers are associated with the outer-layer peak of the surrogate dissipation spectra. Comparisons of DNS and RNL simulations over riblets at various spanwise spacing using an immersed boundary method indicate that the properly parameterized rough-walled RNL model reproduces low-order statistics and spanwise energy spectra reminiscent of the DNS data.

[1]This work is supported by Office of Naval Research (N000141712649).
[2]Corresponding Author: dennice@jhu.edu

Xiaowei Zhu
Johns Hopkins University

Date submitted: 30 Jul 2019 Electronic form version 1.4