Abstract Submitted
for the DFD13 Meeting of
The American Physical Society

Dynamic Immersed Boundary Method for Modeling of Turbulent Boundary Layers over Bio-Fouled Surfaces[1] XIANG YANG, JASIM SADIQUE, RAJAT MITTAL, CHARLES MENEVEAU, Johns Hopkins University — The growth of large organisms on ship surfaces, i.e. macrobiofouling, is a major contributor to drag, and consequently, fuel consumption. The problem of turbulence over biofouled surfaces may be reduced to that of a developing turbulent boundary layer over a surface with a wide range of roughness length scales. Due to the presence of these scales, direct numerical simulation (DNS) or even wall-resolved large-eddy-simulation (LES) is prohibitively expensive. We address this challenge by developing a dynamic immersed boundary method that does not require the flow field nor the roughness to be fully resolved. The effect of unresolved small eddies are included via an LES sub-grid model. The large-scale roughness elements are resolved by a sharp-interface immersed boundary method and the effect of small (unresolved) roughness elements is incorporated through the use of a wall model that assumes a log-law at the grid point closest to the wall. This computationally efficient method is validated against experiments of developing turbulent boundary layer with multiple-scale roughness elements. We present results from this study and provide a discussion of our findings.

[1]This work is funded by the Office of Naval Research (ONR) grant N00014-12-1-0582. Fruitful interactions with M. Schultz (USNA), B. Ganapathisubramani and M. Placidi (Southhampton) are also gratefully acknowledged.

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Date submitted: 02 Aug 2013 Electronic form version 1.4