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A phenomenological model for the roughness function in turbulent boundary layers with macro-scale roughness elements.[1] JASIM SADIQUE, XIANG YANG, CHARLES MENEVEAU, RAJAT MITTAL, The Johns Hopkins University — There has been extensive work done in the past to predict the roughness function associated with rough wall boundary layers and to connect it to the roughness topology. Correlations have been obtained from experiments for a variety of cases and attempts have also been made to use physics based models to obtain the roughness function. In this talk we present a way to derive an explicit formula that connects the rough wall boundary layer parameters to the roughness geometry and arrangement. We assume a two-layer model for the velocity: a log-law in the outer layer and an exponential profile in the canopy layer, and make use of the concept of 'mutual sheltering'. The analysis focuses mainly on rectangular prism shaped roughness elements with different arrangements such as aligned, staggered, rotated, and inclined to the flow, and also with a distribution of heights. It is found that the derived formula, which is simple to apply, matches the results from a variety of large-eddy simulations and experiments. It is also shown that the disparate cases collapse onto a single curve using a parameter depending only on the geometry. This formula gives a quick and accurate way to predict the roughness function from the surface geometry, and can also be extended to other types of surfaces.

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