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Direct simulation of momentum transport across sediment-water interfaces with various particle roughness GUANGCHEN SHEN, JUNLIN YUAN, MANTHA S. PHANIKUMAR, Michigan State University — Vertical transport processes across the sediment-water interface play a significant role in biogeochemical processes in aquatic ecosystems. Most natural sediment beds are characterized by random shape, orientation, and arrangement of sediment grains. However, detailed understanding of the effects of bed-roughness characteristics isolated from those of permeability and bed forms is limited. Here, we use direct numerical simulation of a turbulent open-channel flow with a friction Reynolds number of 395 over a grain-resolved sediment bed, with a permeability Reynolds number of 2.6, a particle size of 70 in wall units, and two different configurations for the arrangement of sediment grains in the uppermost-layer: regular and random. The random interface results in a higher friction, higher penetration depths, more isotropic Reynolds stresses, and a more heterogeneous local-permeability distribution with a higher mean. It also leads to larger-scale and more intense time-mean pressure variations, which augments the form-induced vertical velocity magnitudes across the interface. The results demonstrate the mechanisms underlying the link between the bed-roughness details and the mass and momentum transports across the interface.

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