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Double-averaged velocity profiles over fixed dune shapes

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A b s t r a c t

Spatially averaged profiles of time averaged velocity, using integrals over thin horizontal slabs (Cartesian double average), are employed in characterizing the flow over fixed dune shapes. For comparison the spatial averaging method of Smith and McLean (1977) that averages along lines at constant distance from the local bed elevation is also investigated. The Cartesian double averaged profiles of the inverse of the velocity shear are nearly constant below the crest elevation, but increase rapidly above the crest level. This results in velocity profiles that increase linearly with distance from the bed below the crest. Above the crest it can be argued that the velocity increases logarithmically, but a power law profile can also be argued. Spatially averaged eddy viscosity profiles are calculated by multiplying the average Reynolds stress by the inverse shear. The resulting profile is more complex than the uniform flow counterpart.

Key words: boundary layers, double-average, dune, law of the wall, mixing, separation, spatial averaging, velocity profile.