Numerical study of open-channel flow involving deformable and fixed bed dunes

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Flows over sandy beds exhibit dune formation and strong fluid–sediment interaction. Understanding the spatial development of such flows is essential for predicting sediment transport and morphodynamics in fluvial environments. In this talk, we present a numerical study of open-channel flow in sand–water systems, involving both deformable and fixed beds, using a two-phase mixture-theoretic model. We consider cases at a bulk Reynolds number of 87,720 with a free-slip top boundary, while turbulence effects are taken into account via an eddy-viscosity model. For the case of deformable dunes, we employ the full two-phase model that incorporates non-linear granular rheology and a dynamic equation for the evolution of the granular volume fraction. Fixed beds are treated as a limiting case of this model by enforcing zero solid velocity while keeping the granular volume fraction constant in time. We discuss results for the velocity fields, shear stress distributions, vorticity and sediment mobilization. Further, we provide new insight into the effect of bed mobility in the flow structure in open-channel systems.

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