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Pattern formation in granular binary mixtures under shear flow

Xin Gao, Clement Narteau, and Olivier Rozier

Geological Fluid Dynamics Laboratory, Institut de Physique du Globe de Paris, Sorbonne Paris Cité, Univ. Paris Diderot, UMR 7154 CNRS, 1 rue Jussieu, 75238 Paris, Cedex 05, France.

We study numerically the formation and evolution of bed forms using a binary granular mixture. The two types of particles may have different dynamic properties and angle of repose. We associate these changes to two different grain sizes, the so-called coarse and thin particles. Our computation are based on a real-space cellular automaton that combines a model of sediment transport with a lattice-gas cellular automaton. Thus, we implement the permanent feedbacks between fluid flow and topography. Keeping constant the strength of the flow, we explore a parameter-space by varying the size of the coarse particles and their proportion within the bed. As a result of avalanches and sediment transport, we systematically find regions of segregation and stratification. In a vast majority of cases, we also observe the formation of an armoring layer mainly composed of coarse particles. Its depth is mainly controlled by the proportion of coarse grains and not by the size of these larger particles. When there is a larger proportion of thin particles, transverse dunes develop on the top of the armoring layer. As this proportion decreases, we may observe barchans or even no clear bed forms. We conclude that the main control parameter for dune pattern formation is the thin sediment availability. Finally, we discuss the processes responsible for the formation of the armoring layer and show how it controls the overall sediment transport.