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# Morphodynamics of superimposed bedforms in a cellular automaton dune model

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In a lattice gas cellular automaton designed to study sediment transport, we analyze the morphodynamics of bedforms produced under unidirectional flow conditions. In this model, the same instability is responsible for the formation of dunes on flat sand beds and the initiation of superimposed bedforms on dune slopes. In transverse dune-fields, secondary bedforms increase crestline sinuosity and number of defects (end of crestlines). On the other hand, avalanches and lateral grain motions tend to eliminate these defects to produce more regular crestlines. Lateral fluxes of sediment are also essential for stabilizing the shape of isolated barchan dunes. We measure the propagation speed of superimposed bedforms on steady-state barchan dunes, and show how they contribute to the formation and detachment of smaller barchans along horns. The model predicts that barchan dunes are not scale invariant and that their shape varies with respect to the strength of the flow. In addition, we show that the increase in bed shear stress between the ground and the crest is proportional to the dune aspect ratio. Finally, we present a general methodology for estimating the sediment flux over the brink from dune aspect ratio and flow velocity. Using these fluxes, we rescale the propagation speed of different generations of bedforms to verify that dunes and secondary bedforms are dynamically identical. Despite more fluctuations than in the case of isolated barchan dunes, all these geometric and dynamical relationships hold for a population of dunes with complex dune-dune interactions.