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Dune morphologies in a lattice gas cellular automaton model for sediment transport

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We use a $3D$ cellular automaton model for bedform dynamics in which all physical processes such as erosion, deposition and transport are implemented at the elementary scale by nearest neighbour interactions and a time-dependent stochastic process. Simultaneously, a lattice gas cellular automaton model is used to compute the flow and quantify the wind shear stress on the evolving topography. Local erosion rates are proportional to the shear stress in such a way that there is a complete feedback mechanism between flow and bedform dynamics. We show how this particular model differs from previous discrete methods that have been proposed for aeolian sand dunes. In particular, we pay attention to the evolution of dune shapes according to variations in flow intensity. For barchan dunes, we analyze conditions for wave propagation on the windward face. For transverse dunes, we analyze shear stress maxima with respect to the topography and the ratio between flow depth and dune height. These analyses are used to reproduce different morphologies of star dunes with respect to rotating wind conditions.