

Dune morphology changed by multiple flow conditions using a numerical simulation

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Sand dunes are found in many places such as deserts, the sea bottom and the surface of Mars. They are formed through interplay between sand and air flow or water flow. When a strong flow blows, sand grains are dislodged from the sand surface. The entrained sand grains collide with the ground and are sometimes deposited. This process takes place repeatedly, resulting in the formation of a dune. The profile of the wind flow is modified by dune topography. We reproduced some dune morphology in numerical simulations and investigate the dynamics, changing the environmental condition such as the direction of winds..

The motion of sand grains is realized by two processes: saltation and avalanche. Saltation is the transportation process of sand grains by flow. The saltation length and saltation mass are denoted L and q , respectively. Saltation occurs only for cells on the upwind face of dunes. The saltation length L and the amount of transported sand q are modeled by the following rules, $L = a + bh(x,y,t) - ch^2(x,y,t)$, where $a=1.0$, $b=1.0$, and $c=0.01$ are phenomenological parameters. The last term is introduced for L not to become too large. Note that L is used only in the range where L increases as a function of $h(x,y,t)$. The saltation mass is fixed at 0.1 for simplicity. In the avalanche process the sand grains slide down along the locally steepest slope until the slope relaxes to be (or be lower than) the angle of repose which is set to be 34 degrees.

The dune pattern is classified by the amount of initial sand and directions of flow. For simulating multidirectional flow, wind direction is changed in a certain period Pch from one direction to the other. When the wind is unidirectional and the sand bed is thin barchans appear. When the wind is unidirectional and the sand bed is deeper, transverse dunes appear. As the amount of sand mass increases, the transverse dunes become wider. Linear dunes appear when the wind direction is two and sand bed is thick. As the amount of sand mass decrease, the linear dunes become drop dunes. When the number of wind direction is four $Pch=100$, star dunes appear. Also we reproduced network dune and make a catalog of them. We discussed about the formation processes of network dune.

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