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Particle dynamics of a cartoon dune

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(Submitted on 4 Nov 2009)

The spatio-temporal evolution of a downsized model for a desert dune is observed experimentally in a narrow water flow channel. A particle tracking method reveals that the migration speed of the model dune is one order of magnitude smaller than that of individual grains. In particular, the erosion rate consists of comparable contributions from creeping (low energy) and saltating (high energy) particles. The saltation flow rate is slightly larger, whereas the number of saltating particles is one order of magnitude lower than that of the creeping ones. The velocity field of the saltating particles is comparable to the velocity field of the driving fluid. It can be observed that the spatial profile of the shear stress reaches its maximum value upstream of the crest, while its minimum lies at the downstream foot of the dune. The particle tracking method reveals that the deposition of entrained particles occurs primarily in the region between these two extrema of the shear stress. Moreover, it is demonstrated that the initial triangular heap evolves to a steady state with constant mass, shape, velocity, and packing fraction after one turnover time has elapsed. Within that time the mean distance between particles initially in contact reaches a value of approximately one quarter of the dune basis length.

Subjects: **Pattern Formation and Solitons (nlin.PS)**; Soft Condensed Matter (cond-mat.soft); Adaptation and Self-Organizing Systems (nlin.AO); Fluid Dynamics (physics.flu-dyn)

Cite as: **arXiv:0911.0757v1 [nlin.PS]**

Submission history

From: Christopher Groh [view email]

[v1] Wed, 4 Nov 2009 09:36:49 GMT (479kb)

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