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Sand sorting in aeolian ripples

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Due to size segregation (sorting) of sand the concentration of crude particles upon the bed surface is lower in the troughs between aeolian ripples than on their crests. Although it is known that ripples formed of homogeneous sand are flat and sand megaripples (or ridges) form only if sand is non-homogeneous, size sorting is usually ignored in existing mathematical models of wind ripples.

In this work we try to account for sand non-homogeneity and simulate the development of a typical size segregation pattern and formation of an armoring layer of crude particles on the ripple tops. The model is written for bi-disperse mixture of crude and fine particles. Both types participate in reptation but only fine particles saltate. The changes in bed surface composition are due to: (1) exchange between the sand bed and the sand transported by wind above and upon the bed surface: this process is affected by the sand bed profile and is influenced by shielding of fine particles by the crude ones; (2) bombardment by saltating particles: this makes the sand particles in the bed surface layer agitated; their mixing is described by diffusion with the diffusion coefficient proportional to intensity of impacts and decaying exponentially with the distance from the bed surface.

Numerical approximation of this model employs the predictor-corrector scheme for the equation of surface evolution and finite elements to solve the quasistationary equations for reptation of fine and crude particles (to accelerate computations the time-consuming integrals in these equations are linearized and presented as convolutions). By an appropriate change of variables, the diffusion equation is brought from an infinite domain with a moving boundary to a fixed bounded domain and solved by a pseudo-spectral method. The first simulation results are encouraging: the model is able to reproduce the realistic ripple shape and coarsening, the simulated segregation pattern is qualitatively correct.