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Aeolian source-controlled dynamics in a cellular automaton model

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Aeolian dunes form complex landscape patterns that are strongly influenced by magnitude and variation in sediment supply, sediment availability and transport capacity. A second generation cellular automaton (CA) model with added capabilities simulates dune field development through self-organization and allows us to investigate the influence of fluctuating conditions on dune dynamics. The two-dimensional morphology of a bare sand system is governed by three simple, physically-based rules: probabilities of erosion and deposition control sediment transport, a shadow zone prevents transport in the lee of a dune, and the angle of repose is enforced through avalanching. The algorithm has been modified from the Werner model to allow source-to-sink sediment transport, resulting in more realistic simulations of complex and diverse dune fields. The ability to model open sediment systems, with both barchan dunes and transverse ridges, allows exploration of source-controlled dynamics as a function of landscape evolution and pattern development. Temporal variations in sediment flux result in more abundant and varied dune-dune interactions. A continuum of landscape states has been simulated: 1) sediment-starved systems; 2) stable dune configurations in dynamic equilibrium; 3) superimposed bedforms, two scales of bedforms with a velocity differential; and 4) accumulating systems. This simple model illustrates the strength of CA models to address fundamental questions of differing aeolian landscape evolution.