Geophysical Research Abstracts, Vol. 8, 04823, 2006
SRef-ID: 1607-7962/gra/EGU06-A-04823

Cellular Automaton Model for Simulation of Vegetated Dune Landscapes

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Vegetation plays an important role in landscapes that are shaped by aeolian sand transport, such as coastal dunes and semi-arid regions. We have a good knowledge of how and why different types of bare sand dunes and dune fields form (with no vegetation present), but our understanding of the effects of vegetation in the formation of coastal foredunes, parabolic dunes, blowouts, and nebkha's (shrub hummocks) is limited to descriptive observations and reasoning. This is especially true for vegetated dune fields on a landscape scale, and the effects of various plant species on the evolution and dynamics of such environments are not quantified. This contribution presents the basic framework of a cellular automaton simulation model based on the Werner model of moving around slabs of sand across a grid of cells that represents a landscape surface including varying amounts of vegetation in each cell. These movements are controlled by a set of simple rules that dictate interactions between the existing surface, the vegetation in each cell, and the propagation of the sand slabs. This model can simulate the evolution of aeolian landscapes through self-organisation into different types of dune fields without actually modelling the complex airflow dynamics and sand transport patterns. Preliminary results are compared with our current descriptive understanding of vegetated aeolian landscape development and some initial attractor states and trajectories are identified. The model is used to systematically investigate how and why various kinds of plant species and vegetation patterns influence the dynamics of dune development in aeolian environments.