The deposition pattern of linear dunes using a cellular automaton (CA) model

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Although linear dunes are abundant on the Earth and found on other planets, like Mars and Titan, their internal structure remains not commonly recognized in the field. Here a CA model is employed to simulate the deposition pattern of elongating linear dunes under bidirectional wind regimes. Dunes initiate and evolve on a bare, non-erodible bed from a fixed source of sand. Sediment supply along the linear ridge is modelled with two types of boundary conditions: open boundaries for a zero supply, and periodical boundaries that compensate the outflux (Rozier, et al. 2019). With tracking the deposition time at the minimal scale, both the historical sedimentary structure and detailed deposition patterns within a cycle are investigated in respect to the wind duration ratio N.

As the dune reaches a steady-state, the overall architecture consists of a core permanently buried beneath an active layer mobilized by the wind oscillation. Within the core, the wind ratio N is reflected by the asymmetry of the strata dipping from the crest to both sides. Under open boundary conditions, the oldest sand within a cross section indicates that the elongation rate does not significantly vary with N at the early stage. The case is different under periodical boundaries. The track of oldest sand indicates that the increase of N causes earlier deposition to be preserved, whilst the instantaneous tip elongates approximately at the same rate. In all cases, there is a delay between the time when the dune tip extends to a section and when the first grain is preserved in it. The along-ridge sand supply under the periodical condition is considered as the driver. In addition to the historical dynamic recorded by the core, we also identify phases of deposition within one wind cycle. The phase is also determined by the wind ratio N on this small time scale.

Reference:

Rozier, O., Narteau, C., Gadal, C., Claudin, P. and Courrech du Pont, S., 2019. Elongation and stability of a linear dune. Geophysical Research Letters.