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Using cellular automaton model simulations and pattern analysis to investigate the role of boundary conditions in dune-field pattern development

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Boundary conditions are fundamental to dune-field pattern evolution and include the location and distribution of the sand source, antecedent dune topography and spatial restrictions in the along-crest and down-wind length scales. The influence these conditions impose on pattern development and ordering is investigated through empirical measurements of dune-field pattern parameters and sensitivity testing using cellular automaton simulations. Spacing, crest length, defect density and crest orientation are measured from dune fields dominantly affected by one of each of these boundary conditions. Measurements are plotted against distance in the migration direction and each other to elicit pattern trends. Boundary conditions are incorporated into the two-dimensional bare-sand model to replicate the natural dune fields and investigate how each boundary condition impacts the pattern dynamics through time. Observations of defect dynamics and spacing and crest length evolution are made during model runs. Measurements are made from model outputs and compared to natural dune fields to test the accuracy of the simulated landscape and make predictions of the constructional age of each natural dune field. Using models in conjunction with empirical studies of dune fields significantly improves our ability to interpret modern dune-field patterns.