Spatial and temporal development of the dune instability at White Sands Dune Field, New Mexico, USA

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In zones of loose sand, the emergence of sand dunes results from a linear instability of a flat sediment bed. This instability has largely been studied in spatially homogeneous conditions in experiments and numerical models, but rarely in-situ due to the time and length scales involved. In inhomogeneous conditions, such as the upwind edge of dune fields, the convective aspect of flat bed instability can express as migrating surface waves of spatially increasing amplitude. We present here the case of the upwind margin of White Sands Dune Field, and document the development of incipient dunes over 4 years using high-resolution lidar-derived topography data. In addition to the dune wavelength, growth rate and celerity, we also measure the characteristic length scale associated with the spatial growth of dunes. We show that all these quantities are consistent with those predicted by the linear stability analysis. The exponential growth of dunes in space and time may therefore provide useful constraints on wind regimes and sediment properties where direct measurements are not available.