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Coexistence of bedforms: the star dune paradigm

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Star dunes are giant pyramidal dunes composed of interlaced arms with sinuous crests and slip faces oriented in various directions. The radial symmetry and the size of the pattern seem to illustrate a high degree of complexity between multidirectional wind regime and topography. However, compared to other dune types, little is known about the formation and the evolution of star-dunes, which are ubiquitous in major depositional centres of modern sand seas. Here, we report simulations in which the star dune morphology results only from a combination of longitudinal dunes produced by primary winds and their respective sand fluxes in crestal areas. Using 3D sedimentary structures produced by the model, we find that the both arm morphology and growth rate depend non-linearly on the frequency at which the wind changes direction and not only on the relative amount of time spent on individual direction. Then, radiating arms can detach to interact with other dunes in the neighbourhood. We infer that this is an important mass exchange mechanism in star-dune fields. Our results show that polymodal crest orientations may be stable bedform configurations, thus allowing to solve more efficiently the inverse problem consisting in reconstructing the climatic conditions from dune shape.