Geophysical Research Abstracts
Vol. 19, EGU2017-12822, 2017
EGU General Assembly 2017

Morphodynamics of dome dunes under unimodal wind regimes

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Dome dunes are isolated sand piles with a rounded shape and no slip face. They are not only incipient or disappearing dunes, they can also reach a giant size and form dome-dune fields. Nevertheless, unlike other types of dunes, they have not been the subject of intense research, certainly because they result from complex multidirectional wind regimes. Here we analyze the morphodynamics of dome dunes under unimodal wind regimes. From numerical modeling using a normal distribution of sand flux orientation, we show that the transition from barchan to dome dunes occur when the standard deviation is larger than $40°$. As confirmed by sand flux roses of dome-dune fields in arid deserts on Earth, it corresponds to RDP/DP-value of 0.8 (RDP/DP is the ratio between the resultant drift potential and the drift potential). Both in the field and in the numerical model, the transition from barchan to dome-dunes can also be captured from the coefficient of variation of the planar dune shape. Not surprisingly, smaller dome dunes are faster than larger ones. However, the dependence of dune migration rate on the RDP-value changes according to the presence or absence of slip faces because of the speed-up effect. Transient finger dunes may develop in dome-dune fields, but they rapidly break-up into smaller bodies. This shows that, contrary to bidirectional wind regimes, a large dispersion of sand flux orientation is not efficient in building longitudinal dunes.