



## Two modes of orientation for longitudinal dune deserts

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The shape of dunes depends mainly on wind regimes (alternate magnitude and direction of winds) and the availability of sand. In deserts where winds blow successively in two different directions, dunes are found to be long linear ridges. These linear dunes are the most common dunes on Earth. Indeed, the conditions to their formation are often met because of the succession between summer and winter winds in equatorial deserts, or between day and night winds in coastal deserts. The trend of linear dunes depends on the winds transport capacity and the angle between the two wind directions. When both winds have comparable magnitude and period, dunes are either perpendicular (transverse dunes) or parallel (longitudinal dunes) to the average sand transport direction, respectively for angles between winds smaller or bigger than  $90^\circ$ . When both winds have different magnitude and/or period, dunes orientation is found oblique to the average sand transport direction. Following the pioneering work of Rubin and Hunter, it is widely accepted that linear dune orientation maximizes the orthogonality between the structure and sand fluxes. However, we show in underwater experiments that oblique longitudinal dunes may have two different orientations, depending on the way they grow. These results suggest that in deserts subject to bimodal (and multimodal) wind regimes dune trends depend on initial and limit conditions. Finally, we show that the multiple dune orientations observed within a same field and sometimes on the same structure may not rely on a change of wind regime but can be explained by a unique wind regime.