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Dynamics of Aeolian Sand Streamers and Airflow Turbulence over a Beach Surface

Andreas Baas
King's College London, UK (andreas.baas@kcl.ac.uk)

Sand transport by wind over granular beds displays dynamic structure and organisation in the form of streamers (aka 'sand snakes') that appear, meander and intertwine, and then dissipate as they are advected downwind. These patterns of saltating grain populations are thought to be initiated and controlled by coherent flow structures in the turbulent boundary layer wind that scrape over the bed surface raking up sand into entrainment. Streamer behaviour is thus fundamental to understanding sand transport dynamics, in particular its strong spatio-temporal variability, and is equally relevant to granular transport in other geophysical flows (fluvial, submarine).

This paper presents findings on streamer dynamics and associated wind turbulence observed in a field experiment on a beach, with measurements from 30Hz video-imagery using Large-Scale Particle Image Velocimetry (LS-PIV), combined with 50Hz wind measurements from 3D sonic anemometry and co-located sand transport rate monitoring using an array of laser particle counters ('Wenglors'), all taking place over an area of ~10 m^2 and over periods of several minutes. The video imagery was used to identify when and where streamers advected past the sonic anemometer and laser sensors so that relationships could be detected between the passage of turbulence structures in the airflow and the length- and time-scales, propagation speeds, and sand transport intensities of associated streamers. The findings form the basis for a phenomenological model of streamer dynamics under turbulent boundary layer flows that predicts the impact of spatio-temporal variability on local measurement of sand transport.