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3D airflow dynamics over transverse ridges Mpekweni, South Africa: implications for dune field migration behaviour

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Un-vegetated dune fields provide excellent opportunities to examine airflow dynamics over various types and scales of dune landforms. The three dimensional surface over which lower boundary layers travel, help adjust surface airflow and consequently the aeolian response of the dunes themselves. The use of computational fluid dynamic (CFD) modelling in recent studies now enables investigation of the 3D behaviour of airflow over complex terrain, providing new insights into heterogeneous surface flow and aeolian response of dune surfaces on a large (dunefield) scale.

Using a largely un-vegetated coastal dune field site at Mpekweni, Eastern Cape, South Africa, a detailed (0.1m gridded) terrestrial laser scanning survey was conducted to create a high resolution topographical surface. Using local wind flow measurements and local met station records as input, CFD modelling was performed for a number of scenarios involving variable direction and magnitude to examine surface flow patterns across multiple dune forms.

Near surface acceleration, expansion and separation of airflow inducing convergence and divergence (steering) of flow velocity streamlines are investigated. Flow acceleration over dune crests/brink lines is a key parameter in driving dune migration and slip face dynamics. Dune aspect ratio (height to length) is also important in determining the degree of crestal flow acceleration, with an increase in flow associated with increasing aspect ratios. Variations in dune height appear to be the most important parameter in driving general flow acceleration.

The results from the study provide new insights into dune migration behaviour at this site as well as surface flow behaviour across multiple dune configurations and length scales within un-vegetated dune fields.