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Near surface airflow dynamics over a coastal dune blowout during oblique and onshore flow

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Dune blowouts are created by a number of factors such as wave erosion, climate change, water erosion, human activities and wind stress (Hesp, 2002). However their enlargement is driven primarily by aeolian transport where high velocity winds entrain and remove sediment from the deflation basin, deepening the landform whilst simultaneously steepening the erosional walls, resulting in avalanching and inducing their lateral growth (Carter et al, 1990). Where blowouts form in otherwise vegetated coastal dune systems, they greatly influence the stability of the system. Large scale deflation can result in a substantial increase in the landward mobility of dunes, which can result in burial of human infrastructure such as buildings and roads and dramatic changes to local ecosystems. Patterns of deflation in blowouts are poorly understood as near surface airflow in a blowout is complex. Previous research has shown that flow is topographically manipulated as it moves through the landform causing steering, reversal and jetting of the airflow (Hesp and Hyde, 1996; Hesp; Hansen et al 2009; Hugenholtz and Wolfe, 2009). However, empirical data from the field is limited due to inadequate deployment of sparse two dimensional anemometers arrays. Suitable numerical approaches to flow behaviour inside blowout features are also absent in the literature resulting in crude conceptual approaches to explain what is complex flow behaviour.

In this study two wind events at directions of 250° and 200° were recorded at 50Hz using 24 ultrasonic anemometers (3D Gill HS-50 model) placed at 1m above the surface in a north easterly orientated saucer blowout approximately 13 m deep, 60 m wide, and 100 m long from the throat to the depositional lobe. To obtain flow data unobtrusively over the entire blowout, flow simulations were also conducted, using the open source Computational Fluid Dynamics (CFD) modelling software, OpenFOAM. The two-equation airflow turbulence model, Renormalised Group (RNG) k-epilson, was calculated over a meshed surface of the blowout and the heterogeneous aerodynamic roughness of the vegetation at the site was taken into consideration by delineating areas of vegetation with a different roughness height from that of bare sand.

Preliminary results from anemometry measurements show that during both wind events flow reduced in velocity as it entered the blowout, oblique winds became steered along the axis of the blowout, before accelerating up the relatively steep erosional walls at the rear. The field data was also used to validate simulated flow from which a map of shear stress on the surface of the blowout was created. The Turbulent Kinetic Energy (TKE) and pressure on the surface of the blowout were calculated indicating that pressure and TKE were greatest on the blowout crest before the depositional lobe and least along the deflation basin.

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