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Airflow dynamics and sediment transport through foredune blowouts

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Coastal dunes are effective natural buffers against climate change-induced sea-level rise and storminess. Coastlines characterised by the presence of blowouts at the beach-dune interface may be more susceptible to coastline retreat through the enhanced landward transport of beach and foredune sediment. Blowouts are highly effective transport pathways, but the dynamics of aeolian sediment transport governing their evolution are poorly understood. Their morphological form is indicative of aeolian transport, and the propensity of their topography to modify airflow sufficiently to support transport has been extensively researched. Although there is a growing number of studies detailing blowout sediment flux, those involving synchronous measurement of flow and sediment movement from the beach into the dune field are rare.

This study examined airflow and sediment transport dynamics at the beach-dune interface of a trough blowout at Sefton Dunes, northwest England. A dense array of 3D sonic anemometers were co-located with transport sensors and deployed during an oblique onshore wind event. Instantaneous flow and transport dynamics were measured on the back beach, the adjacent upwind foredune, and within the throat of the blowout. Strong alongshore deflected airflow across the upwind foredune led to high-intensity sediment transport into the blowout throat. Inside the blowout throat, airflow and transport displayed extremely high spatial and temporal variability across the relatively confined throat area. Airflow speeded up close to the upwind blowout wall but sped 'down' close to the exposed (downwind) blowout wall. Transport (expressed in counts min^{-1} and Activity Parameter) showed low correlations with a range of wind variables such as wind speeds and TKE. Transport intensity followed a general pattern opposite wind speeds, with lower transport intensities close to the upwind blowout wall and higher transport intensities close to the downwind blowout wall area. Multiple topographically-forced flow modifications were observed (particularly at the blowout throat), and relatively minor 10-20° directional shifts led to large

variations in flux intensity within the blowout. Results have provided detailed, high temporal, and spatial insights into how beach sediment is delivered to the blowout throat area and then driven landwards and reveals how foredune blowouts help facilitate beach sediment bypassing through foredunes, contributing to medium-scale coastal dune evolution behaviour.