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Characterization of airflow turbulent zones across a foredune and beach surface under offshore winds: implications for aeolian sediment transport

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The existence of onshore sediment transport under offshore winds has been identified as a primary mechanism for post-storm dune recovery and maintenance. However, airflow separation, lee-side eddies and secondary flows may play an essential role on the evolution of sand dunes in coastal areas where the dominant wind direction is *offshore* (lee side coasts). However, neither the numerical characterisation of turbulent zones at the lee side of coastal dunes nor the extent to which secondary airflow patterns are important for foredune sediment budgets have been clearly established.

This study examines the extent and temporal evolution of turbulent zones and their implications for beach-dune interaction at Magilligan, Northern Ireland. Field measurements of wind parameters were collected over a grid covering 65 m cross-shore by 90 m long-shore. Twenty four ultrasonic anemometers (UAs) were deployed in April-May 2010, as part of a larger experiment to capture airflow information under a range of incident wind velocities and offshore directions. UAs were located at 5 m intervals along a central profile over the beach, which allowed detailed examination of the RZ with empirical data, and at 10 m along three more profiles, which allowed observations of spatial patterns. Field results were compared with numerical modelling results from Computational Fluid Dynamics (CFD) software, running over a surface mesh generated from LiDAR and DGPS surveys.

Field data reveals that turbulent structures visible from 1-min averages are significantly constant over time, and are generated at wind velocities as low as 3 m s^{-1}. At this time scale, there appears to be no relation between significant changes in wind direction ($\approx 0\pm25^{\circ}$) and wind velocity (3 to 16 m s^{-1}) along the central profile. However, complex spatial patterns are evident along profiles containing the tallest dune crests when there are changes in wind direction. These complexities are likely related with undulations in the dune crest, variable roughness, and the possible existence of helical corkscrewing. In general terms, the magnitude of the maximum extent of the RZ is consistent with previous studies conducted in desert dunes and wind tunnel simulations for offshore winds blowing over tall and sharp-crested dunes.