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Wind and sand transport over vegetated coastal foredunes

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Foredunes, shore-parallel dune ridges on the top of the backshore, are formed by aeolian sand deposition within vegetation. While foredune erosion during severe storm surges is reasonably well understood and can be predicted with fair accuracy, knowledge of the recovery of the foredune by aeolian sand transport from the beach is limited. The growth of foredunes from incipient or embryo dunes to established foredunes depends on the frequency and magnitude of sand transport, degree of vegetation cover, vegetation type and wave processes. Sand transport over the beach is influenced by various factors, such as beach geometry, angle and magnitude of the approaching wind, moisture content and critical fetch. Once transported sand reaches the foredune, vegetation modifies the wind field and its transport capacity, adding further uncertainty in spatio-temporal deposition patterns across the foredune. To address the knowledge gap on how a vegetated foredunes alters the wind field and wind driven sediment transport an intensive field campaign at Egmond aan Zee in October 2017 was carried out. The foredune at this site is about 20 m high has a steep foredune face (1:2.5) with its upper part densely vegetated by Ammophoila arenaria (marram grass). Measurements with high spatio-temporal resolution on wind velocities and directions (using sonic anemometers) and sand transport (using vertical arrays of sand traps) across the vegetated foredune together with a detailed vegetation characterization were conducted. Results indicate that wind acceleration across the foredune is governed by wind directions rather than incoming wind velocities. We measured maximum flow acceleration around cross-shore approaching wind directions of up to 300 percent between the foredune-foot and the foredune-top. In contrast, velocities decreased slightly between the foredune-foot and –top during alongshore wind. Measurements of sand transport across the foredune showed that turbulence (measured through turbulent kinetic energy, TKE) was a more important predictor for sand transport than absolute wind speed. The mass flux of sand transported across the foredune decreased rapidly from the foredune-foot to the foredune-top by up to 2 orders of magnitude. Further analysis will focus on linking the observed sand mass fluxes with foredune vegetation characteristics and sand deposition.