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Cross-shore variability of mean wind velocities and turbulent kinetic energy across a bar-beach-dune morphology

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Coastal foredunes recover after storms by aeolian sediment transport from the (intertidal) beach. However, models capable of predicting this recovery are still in their infancy because of, among a number of other aspects, the potentially strong spatial variability in wind characteristics on the beach. Mean wind characteristics are likely to vary due to the presence of an intertidal bar-trough system and the often steep foredune front. Additionally, the strong intermittent character in aeolian transport points to the need for understanding wind turbulence to improve sediment transport rate predictions. Here, we examine mean wind velocity and turbulence characteristics across a bar-beach-foredune morphology at Egmond Beach in The Netherlands. Three-dimensional wind velocities were measured at a height of 0.90 m and a frequency of 10 Hz in a cross-shore array using 4 to 6 ultrasonic anemometers between the waterline and the dune foot, depending on the beach width. During a 6-week field campaign in autumn 2015, measurements were performed nearly every day during daytime. This resulted in an extensive dataset with mean wind speeds over the full range of no wind up to 10 m/s. The velocity data were processed into a 5-minute mean turbulent kinetic energy (TKE) and velocity ($\overline{u}$). Preliminary analysis shows a positive dependence of the TKE on $\overline{u}$ during onshore winds, indicating an increasing gustiness (up to 1.5 m^2/s^2) with increasing mean wind velocity. In contrast, during offshore winds the TKE-values reach up to 4 m^2/s^2 during mean wind speeds smaller than 6 m/s that are unrelated to $\overline{u}$. During onshore winds the relation of TKE to $\overline{u}$ is spatially varying: at distances of about 50 m seaward from the dune foot, mean wind velocities can be 1.5 times higher than at the dune foot with identical TKE values. Future work will focus on the influence of beach width (tide), wind direction and bar-trough morphology on the relation between turbulence and mean wind velocity across the beach.