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Alongshore variability in nearshore-beach-dune interaction

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At straight, sandy coasts, wave- and wind-induced processes often lead to the development of an alongshore-variable morphology in the nearshore, beach and dune systems on spatial scales from tens of metres to a few kilometres. Although our understanding of this morphological patterning is quite mature for the different sub-systems, we are only starting to understand how these patterns affect each other across the entire nearshore-beach-dune system. The morphological patterns emerging in subtidal bars often exhibit landward-protruding shallower areas at regular intervals alongshore, known as horns. The alongshore depth variation in these so-called crescentic bars is thought to affect the morphodynamics of the more landward intertidal beach by acting as an alongshore-variable filter for the wave field, both during erosional storm events and the accretionary recovery periods in between storms. Recent studies have revealed that persistent (years – decades) foredune accretion and embryo dune development primarily border wider beach areas, especially along fetch-limited narrow (<200 m) beaches. In addition, embryo dunes along wider parts of the beach are less prone to erosion during 'moderate' storms. Although the alongshore variability thus clearly spans the entire nearshore-beach-dune system, this is not reflected in our current understanding of the underlying processes, especially those of beach-dune recovery.
In a 15-year data set of planview time-exposure images from Egmond aan Zee, The Netherlands, we observed that the horns of crescentic bars regularly separate from the bar and subsequently migrate onshore towards the beach as a spatially coherent structure, termed Shoreward Propagating Accretionary Waves, or SPAWs. We hypothesize that the onshore welding of these SPAWs results in alongshore variations in intertidal beach width that, in turn, provide alongshore variations in the magnitude of wind-induced transport and dune development. To test this hypothesis, we analysed a data set of Lidar measurements of the beach-dune area in addition to observations of embryo dune presence derived from the video images. The Lidar data set consists of frequent, 2 to 7 times a year since 2012, mobile Lidar measurements from a 4WD. Our observations show that SPAWs emerged at regular intervals of approximately 2 km alongshore. Furthermore, the positions of the horns from which they emerged remained rather consistent over a period of years, resulting in concentrated areas where SPAWs regularly welded to the beach. Surprisingly, the Lidar data show that in periods without significant erosion due to 'large' storm surges, dune development also varied alongshore with a spacing of approximately 2 km. This alongshore trend is especially apparent from erosion hotspots that appear south of locations where the SPAWs attach to the shore. This suggests that SPAWs play a significant role in the development of alongshore-variable dune morphology at our study site. At the conference, we will further explain the temporal and spatial variations involved in this morphological coupling across the entire nearshore-beach-dune system.