**Introduction**

At NASA Kennedy Space Center (KSC), Cape Canaveral, Florida, two persistent surfzone sand bars occur in a region that also includes Cape-associated dunes and multiple shore-parallel ridges at depths below the fair-weather wave base of sediment transport. These features transform intermittent deep-water waves, redistributing the spatial pattern of wave energy alongshore and cross-shore. To observe beach and sandbar response in this complex environment, we have collected and georectified hourly beach images at KSC since April 2010. A double-bar system, with ~25-50 m spacing between crests, has persisted over the last 2 years. Welding of the inner and outer bars occurs intermittently. The preferred welding location coincides with a dune overwash area that has been an erosion hotspot (EHS) over the last decade. Strong nor’westerly activity in November 2011 activated wave breaking across a range (~10 km long, ~500 m wide, ~5 m tall) shore-parallel subaqueous ridge that intersects the nearshore system at the EHS. Our observations allow for testing of hypotheses that the ridge controls nearshore morphodynamics through two mechanisms: 1) by providing a sediment source to the nearshore system and 2) by disrupting, dissipating, and shoaling wave energy, especially during storm events.

**Study Site**

KSC is located just north of Cape Canaveral on the Atlantic coast of Florida (inset, left). A series of surfzone sand bars occur in an area that also includes shore-parallel storm ridges as well as cape-associated shoals (below). These features transform the deep-water swell, redistributing the spatial pattern of wave energy delivery alongshore. The resulting longshore-sediment transport gradients cause emergent highspitts to emerge under specific offshore wave condition. A major emergent highspit over the last decade is highlighted on the base map at left.

**Deep-Water Wave Climate**

The deep-water wave climate varies in magnitude between typical winter (mean Hs = ~2 m) and summer (mean Hs ~1 m) conditions as well as individual storm events (mean Hs up to 10 m) lasting days or hours. Typical winter conditions occur from September through April, whereas summer is between May and August. hurricane events can punctuate the summer and early winter months (e.g., Hurricanes Dennis and Floyd, left). Most of the winter season is characterized by frequent nor’easter activity.

**Methodology**

An autonomous camera has been collecting hourly beach images at KSC since April 2010 from the Eagle 4 security tower (at the left edge, shown on base map, left panel). The camera system produces hourly outputs: 1) a snapshot image, 2) a time-lapse image, and 3) a variance image. An example of each output is shown below. The system has been operating continuously since its deployment and has produced a total of 12,000+ georectified images (right).

**Shore-Oblique Storm Ridge**

In November 2011, an energetic nor’easter provided an elongated high-wave window (2-4 m hourly Hs for approximately one week). Camera output delineated a shore-oblique storm ridge (S-OSR) interacting with the nearshore double-bar system just north of the emergent highspit (left). The ridge provides sediment and a buffer to the shoreparallel nearshore system by absorbing wave energy, decreasing the divergence of drift (dQ/dt). Downshore of the interaction, the nearshore system has no buffer and is subject to higher wave energy and, thus, higher dQ/dt. This sudden increase stresses the nearshore of sediment — yielding a landward migration of the shoreline and susceptibility to dune overwash during high wave events (right).

**Mechanism #1: Sediment source**

Two ADCPs were deployed at KSC between February 15, 2012 and July 12, 2012 (~5 m depth, map left). One of the instruments, a Natl. Acquapod, failed. The remaining Aquadopp, was found nearly buried, implying significant local sediment transport. Current profiles, compared to the thresholds for mobilization from Miller et al. (1977), were insufficient to mobilize fine sand over more than a few meters of the continental shelf during the record period. This result implies that the sediment likely originated from wave breaking over the adjacent S-OSR, perhaps during Tropical Storm Debby (June 23-27, 2012).

**Mechanism #2: Wave energy transmission**

The nearshore wave field was also recorded during the 2012 ADCP deployment (A, B, and C). The observation period is a relatively calm nor’easter season and the transition into quiescent summer conditions. Two tropical cyclones - Tropical Storm Beryl (May 26-30) and Tropical Storm Debby (June 25-30) — punctuated the latter record.

The average energy transmission between deep-water (NZBC 41009) and nearshore (Aquadopp) was ~0.5 (D). An analysis of the amplified waves (E and F) — those with a transmission 1.0 — show that most of these waves were small (<1.5 m), moderate period (5 < T < 15 s), and arriving in a narrow window from the northnor’westerly. This window matches with the orientation of the main S-OSR and other smaller offshore features, suggesting the ridge focuses energy from the NNE towards the EHS.

**Resulting Bar Morphodynamics**

An algorithm used with similar systems was used to derive the inner and outer bar locations from the georectified images. A histogram of their locations at specified alongshore locations with 0.5 km spacing is shown at right. The first bar is an emergent one (~15,000 km from the nearest EHS). The second bar is more stationary, as implied by its higher variance. Other bars, such as a low-order ridge, are visible in some images. In general, bar spacing is greater and less variance in the shadowed region. Frequent temporary welding of the inner and outer bar occurs where the S-OSR intersects the nearshore, producing greater variability in bar position.

**References**


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