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Field observations of short wave transport efficiency across the surf zone during wind and swell wave conditions

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Measurements of orbital velocity, mean flows, turbulence and suspended sediment concentration were obtained in the surf zone on the beaches at Durras, NSW, Australia and Vejers, Denmark. At Durras, the wave fields were dominated by swell waves, while at Vejers, wind waves dominated. In addition, the mean grain size at Durras beach (360 μm) was coarser than at Vejers beach (188 μm). Swell-dominated medium/coarse grained beaches typically exhibit intermediate-state morphologies and recover more rapidly after storm events compared to fine-grained beaches exposed to wind waves that are typically more dissipative. We hypothesize that long-period swell waves and coarser grain size promote onshore sediment transport and hence beach recovery as sand mobilized on the wave crest-phase is likely to settle before the wave trough-phase. Moreover, swell conditions often result in plunging breakers which generate high levels of turbulent kinetic energy early under the crest-phase of the wave. This could imply larger differences in the sediment load under the crest- and trough-phases compared to spilling breakers and surf bores, and hence larger onshore-directed short wave sediment fluxes (qw). In order to compare the short wave sediment transport efficiency (qw/C, where C is the mean sediment concentration) for different wave types, waves were classified based on their individual relative wave height (Hz/h). Based on a visual classification of the waves in a subset of the data, it was found that waves with Hz/h < 0.3 were primarily of the non-breaking type, while waves with Hz/h = 0.3-0.5 were either spilling breakers or surf bores. For Hz/h > 0.5 plunging breakers dominated. By applying a wave-by-wave analysis where the individual waves of the time series were grouped according to Hz/h (using a bin width of 0.1), a mixture of different wave types within a relative wave height bin was prevented. The results showed that, for the same relative wave height, short wave transport efficiency was comparable in magnitude at Durras beach and Vejers beach. This contradicts our hypothesis that wave period and grain size affect the short wave transport efficiency. However, the results also showed that short wave transport efficiency is indeed related to wave type since wave type scales with Hz/h. Non-breaking waves resulted in small and offshore-directed short wave transport efficiencies, while spilling breakers/surf bores and plunging breakers resulted in onshore-directed transport efficiencies. However, plunging breakers were up to four times more effective in transporting sediment onshore compared to spilling breakers and surf bores.