SAND TRANSPORT BY NONLINEAR WAVES

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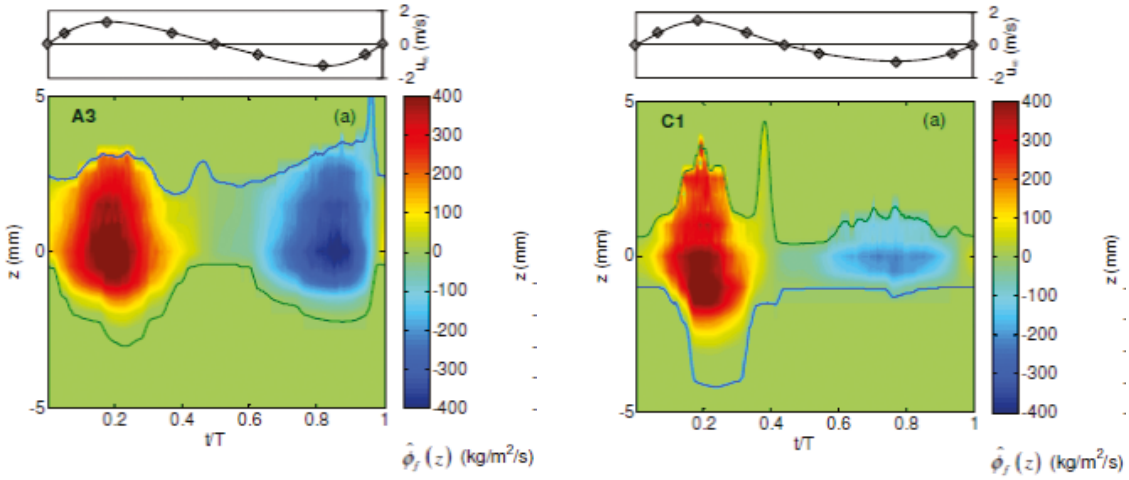

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The evolution of an offshore sandbar depends, amongst other processes, on the ability to accurately describe the near-shore wave field and the corresponding sediment transport. When surface gravity waves propagate from deep water onto beaches, their sinusoidal appearance transforms to shorter and higher crests and longer and shallower troughs in the shoaling zone towards a sawtooth-shaped profile in the inner surf and swash zone. Both these nonlinear features induce near-bed horizontal oscillatory flow asymmetries that drive sediment transport, but the details of the leading processes remain unclear.

The experimental project TRANSKEW, carried out in the Large Oscillating Water Tunnel at Deltares, The Netherlands, was designed to unravel the influence of near-bed oscillatory flow nonlinearities on sediment transport. The test cases were selected to simulate the near-bed cross-shore sediment motion representative of the upper shoreface, mimicking the degree of velocity and acceleration skewness found before and after wave breaking, including the associated mean flow (due to undertow). Both net sediment transport rates and detailed time-dependent sediment concentrations and flow velocities were measured with state-of-the-art equipment, which allow estimation of the erosion depth and the sediment fluxes in the lower layer near the sand bed.

The results show that acceleration/velocity skewed oscillatory flows produce a net sand transport in the direction of the largest acceleration/velocity, i.e., in onshore direction, opposite the offshore-directed sediment flux observed under near-sinusoidal waves and a mean undertow. Two mechanisms were found to play a key role in the sediment transport: the skewed bed shear stress and unsteady phase lag effects between the sediment concentration and flow velocity observed at flow reversal. The results achieved contribute to a better knowledge of sediment dynamics and to the development of more accurate predictive sediment transport models in the coastal zone.

FIGURE 1
Large Oscillating Water Tunnel (LOWT) at Deltares, the Netherlands.

FIGURE 2
Free-stream velocity (upper panel) and time-space diagram of instantaneous flux ϕ (lower panel) for the experimental conditions A3 and C1.