

HYDRODYNAMICS UNDER LARGE-SCALE REGULAR AND BICHROMATIC BREAKING WAVES

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MOTIVATION

Multiphase CFD models recently have proved promising in modelling cross-shore sediment transport and morphodynamics (Jacobsen et al 2014). However, modelling breaking wave turbulence remains a major challenge for these models, because it occurs at very different spatial and temporal length scales and involves the interaction between surface generated turbulence and turbulence generated in the bottom boundary layer. To an extent these challenges arise from a lack of appropriate experimental data, since most previous experimental studies involved breaking waves at small-scale, and have not permitted investigation of the turbulent boundary layer processes. Moreover, most existing studies have concentrated on regular waves, thereby excluding the flow and turbulence dynamics occurring at wave group time-scales under irregular waves within the surf zone. These limitations motivated a new experiment in the large-scale CIEM wave flume in Barcelona involving regular and irregular waves. The experiment was conducted in May-July 2017 within the HYDRALAB+ Transnational Access project HYBRID.

EXPERIMENTS

The bed consisted of a concrete barred profile generated in a previous experiment of van der A et al. (2017). For the present experiment a layer of gravel ($D_{50} = 9$ mm) was glued to the concrete surface to increase and homogenize the bed roughness. Two wave conditions were generated: a monochromatic case with $T = 6$ and $H = 0.55$ m and a bichromatic case with mean short-wave period $T_m = 4.2$ s, wave group period $T_{gr} = 31.5$ s, and maximum wave height $H_{max} = 0.60$ m. The instruments deployed from a mobile measurement frame included two acoustic velocity profilers (ADVP) for wave bottom boundary layer velocities, two Laser Doppler Anemometers (LDA), two acoustic Doppler velocimeters (ADV), and two electromagnetic flow meters (EMF) at elevations above the wave boundary layer. For each wave

condition, velocity profiles from the bed up to still water level were measured at 22 cross-shore locations across the shoaling to inner surf zone, typically with a vertical resolution of 1.5mm in the wave boundary layer and 10 cm at higher levels. Water surface elevations were measured across the entire flume using an array of pressure transducers, resistive and acoustic wave gauges.

RESULTS

Figure 1 shows a preliminary result of the time-averaged cross-shore velocity (undertow profiles) under the bichromatic wave condition. The high spatial coverage of measurements allows the cross-shore variation in undertow profiles to be examined in detail. Strongest velocities and the center of the undertow circulation occur above the breaker trough (around $x = 58$ m), the location where the largest waves in the group are breaking. Boundary layer measurements (not shown here) show distinct variations in boundary layer thickness and velocity skewness/ asymmetry behaviour, both temporarily (within the group) and spatially (across the bar). In the full-length paper, details on intra-wave(-group) velocity and turbulence distributions will be presented focussing in particular on the wave boundary layer dynamics across the profile, the effect of wave breaking generated turbulence on the near-bed flow, and the structure of the mean flow. Within the project the new dataset will be used to further develop multiphase CFD models for the breaking zone.

REFERENCES

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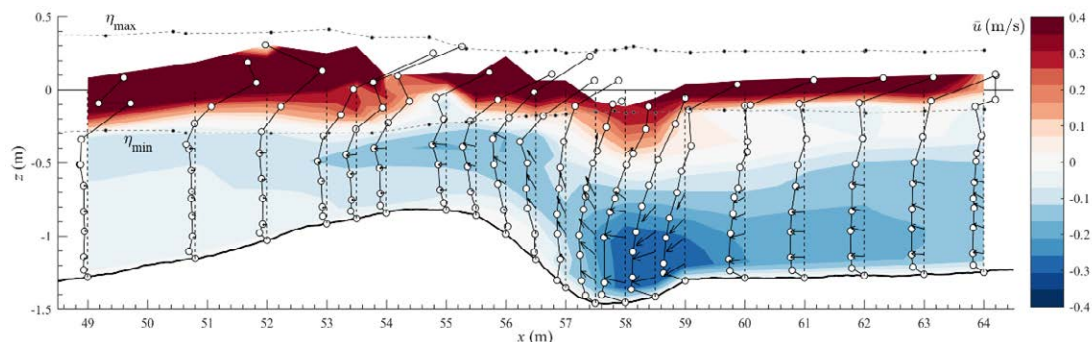


Figure 1 - Example time-averaged undertow profiles measured by ADV and EMF for the bichromatic wave condition.