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REPEATABILITY OF MORPHOLOGICAL CHANGE ON A SANDY BEACH ACROSS MULTIPLE TIMESCALES

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INTRODUCTION

The swash zone is a highly dynamic region of the nearshore in terms of both hydro- and sediment dynamics. Previous work has demonstrated that the majority of swash events transport only small amounts of sediment and net beachface volume change over several hours tends to be small. However, a small number of individual swash events can deposit or remove hundreds of kilograms of sediment per metre width of beach. These events are typically associated with swash flows that involve one or more highly turbulent swash-swash interactions, causing enhanced suspension and transport of sediment (Blenkinsopp et al. 2011). The timing and location of these interactions is complex and small changes in either can lead to very different local flow conditions. The complexity of these flows make sediment transport prediction on a swash-by-swash basis very challenging, and raises the question whether deterministic physical and numerical modelling of swash sediment transport is warranted.

The medium-scale lab experiments of Baldock et al. (2017) demonstrated comparable final beach profiles after 50 hours of identical waves starting from different planar and convex initial profiles. In addition, at shorter timescales, Caceres et al. (2012) showed remarkable similarity in the sediment concentrations suspended by the same swash events within repeated wave groups.

METHODOLOGY

The 8-week DynaRev experiment was undertaken in the GWK Flume, Germany (Bayle et al., 2020). The primary experiment goal was to investigate the evolution of a sand beach in a rising sea for two cases: with (SB1) and without (DR1) a dynamic cobble berm revetment. In both cases the evolution of an initial 1:15 planar beach profile subjected to 20 hours of waves consisting of 10 repetitions of identical 2-hour timeseries (H_s = 0.8 m, T_p = 6 s) was measured. The surf and swash zone profile was captured at intervals between 20 minutes and 3 hrs using a mechanical profiler. Additionally, the swash morphology was measured at 25 Hz using LIDAR, which captured morphology change at swash-by-swash timescales.

RESULTS

Under near-identical forcing conditions, global morphology change was repeatable over timescales ranging from minutes to hours (Figure 1a,b). The profile evolution was nearly identical in both cases, with the main bar and berm growing at the same rate and at the same location (x_{bar} ≈ 225 m, x_{berm} ≈ 260 m). The RMS difference (RMSD) between two corresponding profiles did not exceed 0.047 m, and indeed most of the differences between the two sets of profiles was due to differences between the two initial profiles (RMSD = 0.036 m).

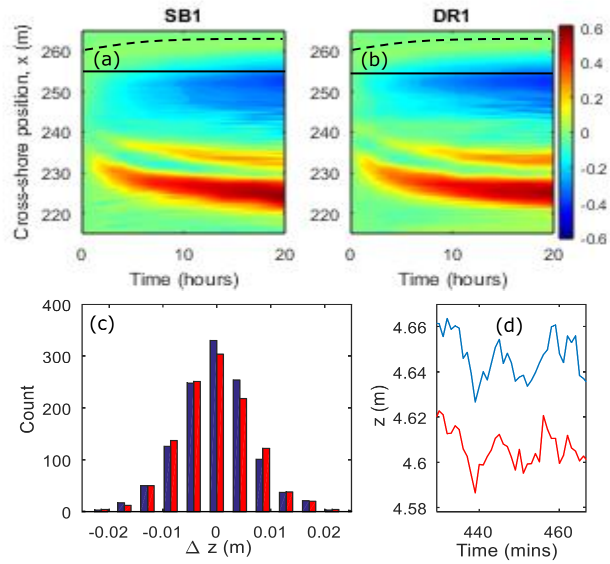

Figure 1 - Contour plots of bed elevation change as a function of time for (a) SB1 and (b) DR1 where dashed line marks the runup limit and the solid line indicates the SWL. (c) Histogram of minute-by-minute bed elevation changes at *x*=254 m for SB1 (blue) and DR1 (red). (d) 30 minute timeseries of bed elevation at *x* =254 m for SB1 (blue) and DR1 (red).

Local repeatability in swash zone bed evolution also occurred at shorter timescales. Histograms of the 1-minute bed elevation change in the swash zone (Figure 1c) are very similar and timeseries of the bed elevation (Figure 1d) show that the bed at a point on the beachface varies in a very similar manner at close to the individual wave timescale. The paper presentation will further explore the repeatability of morphological change in the swash zone at these different timescales and discuss the implications for future modelling.

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