
Sand transport under irregular waves

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Within morphodynamic models, wave-induced sand transport is generally predicted using transport formulas. These formulas, mainly based on experimental results obtained for regular waves / oscillatory flow, are then coupled to a regular wave representing the natural, irregular wave conditions, e.g. through the significant wave height and peak period. In this study, we investigate the differences between transport by regular and irregular waves and examine whether the aforementioned approach is appropriate.

We investigate this with a detailed process-based numerical model validated before for boundary layer velocities and transport of fine and medium sized sand under regular waves (Kranenburg, 2012, 2013). Firstly, we simulate a number of experiments on transport of fine and medium sand by irregular waves to check the model for this situation as well. Next, we run tests with representative regular waves, where the latter has similar energy, but also reflects the non-linear shapes of the irregular waves (i.e. comparable velocity skewness). To explain the differences, we study the sediment flux distribution over time and vertical, and determine the (1) individual wave, (2) wave group and (3) current related contributions to the total flux. We isolate the contributing processes by doing this both for realistic waves and for less complex oscillatory flows.

Our results reveal large differences in sand transport between irregular and representative regular conditions. For fine sand in oscillatory flow this even concerns a reverse in transport direction (figure 2: $d_{50} = 0.15\text{mm}$). In our talk/poster, we explain how this relates to differences in phase-lag behavior and discuss the implications hereof for the ‘representative wave approach’ in morphodynamic modeling.

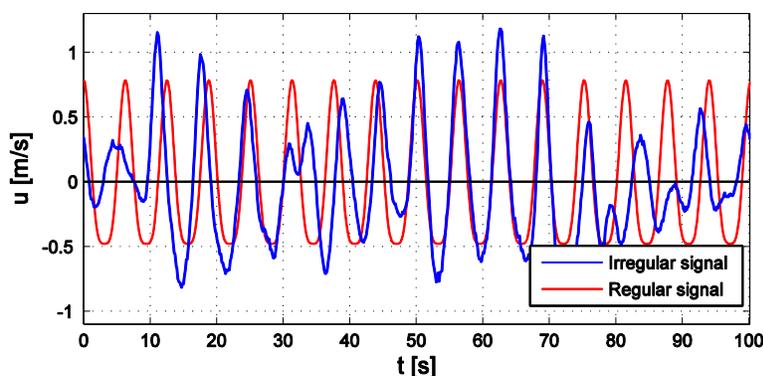


Figure 1. Irregular (blue) and representative regular velocity signal (identical peak period, u_{rms} and $\langle u(t)^3 \rangle$)

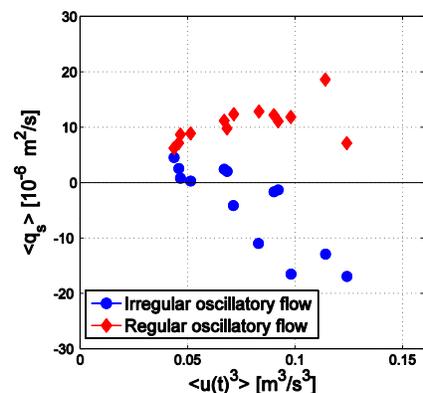


Figure 2. Transport rates for irregular (blue) and representative regular conditions