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Turbulent transport of a passive discharging fluid above sand ripples

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Highly permeable sandy sediments cover large regions of the global inner continental shelf areas [Hall 2002]. These sediments allow significant flow rates across the sediment water interface and therefore enable Submarine Groundwater Discharge (SGD) as well as a rapid pore water exchange [Burnett et al. 2003, Moore 2010, Taniguchi 2019]. In this flow, sediment-originated matter is transported to and mixed within the benthic boundary layer. Subsequently, transport and mixing within the lower water column are important factors influencing local concentrations of sediment-originated substances. Furthermore, sandy sediments tend to form ripple structures under oscillating flow conditions [Ayrton 1904]. Such structures massively affect the pore water exchange [Huettel et al. 1996, Precht et al. 2004, Santos et al. 2011] and the flow dynamics [e.g. Davies & Thorne 2008, Malarkey 2015] in the oscillating boundary layer. This study aims to understand the transport and mixing processes particularly depending on the wave-sea bed interactions. Therefore, wave tank experiments with multiple artificial and nature modelled rippled, permeable sea beds were conducted. A synchronous Particle Image Velocimetry (PIV) and Planar Laser induced Fluorescence (PLIF) measurement system was used to simultaneously obtain velocity and concentration fields evolving above the sea bed under oscillating flow conditions. Our previous measurements using the same measurement setup confirmed the results by [Huettel et al. 1996 and Precht et al. 2004] demonstrating that compared to flat sea beds sand ripples lead to enhanced pore water discharge and therefore to higher local concentration values within the boundary layer. We could also quantify, that on the other hand enhanced wave action leads to higher transport and mixing efficiency within the lower water column due to vortex generation and thus, lowers local concentration values within the near bottom boundary layer [Kandler et al. 2021]. The results of the present experiments investigating the influence of varying wave intensities, different ripple shapes and ripple asymmetry on turbulent flux w'c' and concentration profiles will be presented in the vPICO presentation.

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