Geophysical Research Abstracts
Vol. 21, EGU2019-5689, 2019
EGU General Assembly 2019

CFD modeling of ship wave induced sediment resuspension in the littoral zone, preliminaries

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The ever-increasing demand for fluvial navigation and the more and more efforts made for ecologically sustainable water usage (e.g. WFD of the EU) have highlighted potential conflicts of interest in fluvial management. Wave events generated by the movement of vessels in inland waterways reportedly have negative effects on the ecosystem of the littoral zone, where wave shoaling and breaking occurs. These effects are mostly related to the local the temporary alteration of the flow regime, especially in the near-bed region. As ship waves reach the shallower areas, the related hydrodynamic stresses affect the near-bed boundary layer more and more, bed shear stress increases gradually, leading to the resuspension of sediments. Though the field deployment of up-to-date turbidity sensors (ABS, OBS) are adequate for the characterization of suspended sediment concentrations in single points with high temporal resolution, the occurring complex morphodynamic features cannot be revealed.
The continuous increase of computational capacities entails rapid developments in computational fluid dynamics (CFD) as well, offering insights down to the finest scales. It has been presented that the accurate reproduction of ship induced wave events is feasible with such numerical methods, thus it may be expected that coupling a robust sediment transport model to such a hydrodynamic solver could reproduce, hence explain the nature of wave induced sediment resuspension in real life conditions.
In the present study, the open-source CFD tool, REEF3D is tested for the reproduction of wave induced sediment resuspension. The multi-phase numerical model uses the Level Set Method for capturing the free surface, and has been validated for a wide range of wave-related applications in the past. A thorough testing of the coupled (hydrodynamics and sediment transport) solver is tested, with special focus on the sensitivity analysis most relevant physical and numerical parameters. As a result, the capabilities and the limitations of the employed numerical model are revealed.