Geophysical Research Abstracts
Vol. 20, EGU2018-1427, 2018
EGU General Assembly 2018

Wave-tide interaction and future coastal hazards

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The interaction of physical processes can increase coastal flood hazard. The combination of the storm tide and wave effects can conspire to greatly increase an extreme water-levels at the coast, whilst wave-induced erosion and damage also combine to greatly increase the flood risk. Tidal dynamics are also known to influence wave generation and propagation; therefore, wave-tide interaction could play an important role in coastal flood risk. Furthermore, as projected mean sea-level rise induced changes to tidal dynamics may also influence wave-tide interaction effects and sediment transport pathways, future changes to wave-tide interaction processes need to be understood. The COAWST model, which dynamically couples the 3D hydrodynamics (ROMS) and wave (SWAN) model, is applied to the Irish Sea (UK) for a two month period (January-February 2014). The importance of wave-tide interaction upon coastal flood risk, including potential effect of wave-tide interaction changes due to mean sea-level rise and model sensitivity to spatial resolution, was investigated. The difference between the coupled and uncoupled simulated wave climate was calculated, and modulation of wave height at the frequency of tidal currents (6.21hrs) and elevation (12.42hrs) found. A 20% increase in significant wave height was simulated for some regions of the Welsh coastline due to wave propagation effects, which could have a significant influence on flood risk predictions (i.e. increased wave run up and wave over-topping). Simulated wave refection around large-scale features (e.g. headlands) was found to be affected by the strong associated tidal currents altering apparent wave period, and thus wave refraction. Therefore, wave-tide interaction was simulated to increase in the future because mean sea-level rise induced changes to tidal dynamics altered simulated wave-tide interaction patterns. Finally, the sensitivity of model spatial resolution was tested with three Irish Sea grids: 1/60° (∼1.1km), 1/120° (∼550m), and 1/240° (∼280m). All models validated to a similar level of accuracy, but simulated wave-tide interaction effects were found to differ in the high tidal current regions where bathymetric constrictions (e.g. headlands) accelerated the flow (with the coarser model resulted in lower tidal currents and wave-tide interaction effects). We therefore find wave-tide interaction is an important combined hazard process, and necessary to resolve in coastal flood risk assessment of some regions.