Geophysical Research Abstracts
Vol. 20, EGU2018-8577-2, 2018
EGU General Assembly 2018

Sea hazards on offshore structures: waves, currents, tides and sea ice combined

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Offshore structures experience several kinds of sea hazards. Over most of the world ocean high waves or strong currents are the concern. In high latitudes sea ice poses an additional hazard. Loads on offshore structures from waves and current can be calculated using the well-known Morison equation. We have modified the equation to calculate the loads from sea ice, both static and dynamic. A global sea ice-ocean numerical model, combined with a waves-in-ice module, allows us to estimate loads on offshore structures from ocean waves, currents, tides and sea ice, both in ice-free and ice-covered conditions. Several types of structures can be considered. Here we consider monopoles for shallow areas and floating spar structures for deeper waters. Maps of ocean and sea ice loads for the whole Arctic and the North Sea area are created, as well as time series and associated statistics of expected loads for chosen locations or regions. This allows us to examine the relative importance of different hazards based on geographical location. For instance, waves are the main hazard in the North Sea area, except at the shelf slope, where the current is fast. In some coastal areas strong tidal currents are responsible for the largest loads on the structures and are the principal hazard. The approach developed here allows us to use ocean environmental information to predict the integrity of off-shore structures and help assessment of the potential risks for off-shore operations. For the study we acknowledge support from the NERC UK Innovation Grant no NE/N017099/1: 'Safer Operations at Sea - Supported by Operational Simulations (SOS-SOS)' and the EU FP7 Project 'Ships and waves reaching Polar Regions (SWARP), grant agreement 607476. We also acknowledge funding from the NERC Programme "The North Atlantic Climate System Integrated Study (ACSIS)" NE/N018044/1.