Geophysical Research Abstracts
Vol. 19, EGU2017-8985, 2017
EGU General Assembly 2017

A numerical 4D Collision Risk Model

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With the growing number of marine renewable energy (MRE) devices being installed across the world, some concern has been raised about the possibility of harming mobile, marine fauna by collision. Although physical contact between a MRE device and an organism has not been reported to date, these novel sub-sea structures pose a challenge for accurately estimating collision risks as part of environmental impact assessments. Even if the animal motion is simplified to linear translation, ignoring likely evasive behaviour, the mathematical problem of establishing an impact probability is not trivial. We present a numerical algorithm to obtain such probability distributions using transient, four-dimensional simulations of a novel marine renewable device concept, Deep Green, Minesto's power plant and hereafter referred to as the 'kite' that flies in a figure-of-eight configuration. Simulations were carried out altering several configurations including kite depth, kite speed and kite trajectory while keeping the speed of the moving object constant. Since the kite assembly is defined as two parts in the model, a tether (attached to the seabed) and the kite, collision risk of each part is reported independently. By comparing the number of collisions with the number of collision-free simulations, a probability of impact for each simulated position in the cross- section of the area is considered. Results suggest that close to the bottom, where the tether amplitude is small, the path is always blocked and the impact probability is 100% as expected. However, higher up in the water column, the collision probability is twice as high in the mid line, where the tether passes twice per period than at the extremes of its trajectory. The collision probability distribution is much more complex in the upper end of the water column, where the kite and tether can simultaneously collide with the object. Results demonstrate the viability of such models, which can also incorporate empirical field data for assessing the probability of collision risk of animals with an MRE device under varying operating conditions.