Geophysical Research Abstracts
Vol. 21, EGU2019-14926, 2019
EGU General Assembly 2019

Simulating the waves on Huygens' moon Titan

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Titan presents us with the only example of sizable and stable bodies of liquid on the surface of a planet or moon outside of earth, and as such provides a unique object of study for exo-planet ocean studies.

Here, we examine the formation and propagation of wind-driven surface waves, revisiting this problem with a state of the art numerical model for the propagation of surface waves, and applying it to Titan surface seas. The model we use, SWAN, is extensively used in terrestrial ocean wave modelling. We developed an interface for this model for OMUSE, a python environment for multi-physics and multi-scale simulations, allowing its coupling to different atmosphere and general circulation models.

We describe the theory of wave formation and propagation under Titan conditions and our adaptations to the numerical model SWAN in order to model this and present the validation of the model. We derive minimum threshold wind speeds of 0.2-0.4 m/s (depending on viscosity), somewhat lower than previous estimates. We present results for calculations for the Kraken and Ligeia Mare basins deriving the local wave climate and littoral wave stresses, and we discuss these in relation to constraints from Cassini observations.