Geophysical Research Abstracts
Vol. 20, EGU2018-18405, 2018
EGU General Assembly 2018

Coupling of atmosphere and ocean through a dynamic wave interface

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The coupling of models is a commonly used approach when addressing the complex interactions between different components of earth system. In climate and forecasting research and activities, advanced models are needed and there is an urge towards the use of coupled modelling. This study presents the development of a new, high-resolution, coupled atmosphere, ocean and wave model system for the North Sea and the Baltic Sea, which is part of the Geestacht COAstal model SysTem GCOAST. We focus on the nonlinear feedback between strong tidal currents and wind-waves, which can no longer be ignored, in particular in the coastal zone where its role seems to be dominant. The proposed coupling parameterizations account for the feedback between of the upper ocean on the atmospheric circulation by accounting for the effects of sea surface temperature and the sea surface roughness. Several sensitivity experiments are performed to estimate the individual and collective effects of different coupling components. The performance of the coupled modelling system is illustrated for the cases of several extreme events. For example, the inclusion of wave coupling leads to decreases strong winds through wave dependent surface roughness or changes sea surface temperature, the mixing and ocean circulation; leading to better agreement with in-situ and satellite measurements. Comparisons with available atmospheric and oceanic observations showed that the use of the fully coupled system reduces the errors, especially under severe storm conditions. This justifies the further developments and implementation of the coupled model systems, (i.e. including the land, biogeochemical, fishery, etc. components) for both, operational and climate, research and development activities.