A Coupled Atmospheric and Wave Modeling System for Storm Simulations

This study aims at improving the simulation of wind and waves during storms in connection with wind turbine design and operations in coastal areas. For this particular purpose, we investigated the Coupled-Ocean-Atmosphere-Wave-Sediment Transport (COAWST) Modeling System which couples the Weather Research and Forecasting (WRF) Model with the third-generation ocean wave model SWAN. This study investigates mainly two issues: spatial resolution and the wind-wave interface parameter roughness length ($z_0$). To study the impact of resolution, the nesting function for both WRF and SWAN is used, with spatial resolution ranging from 25km to 2km. Meanwhile, the atmospheric forcing data of different spatial resolution, with one about 100km (FNL) and the other about 38km (CFSR) are both used. In addition, bathymetry data of different resolutions (1arc-minute and 30arc-seconds) are used. We used three approaches to parametrize $z_0$. The results are validated through QuikScat data and point measurements from an open ocean site Ekosk and a coastal, relatively shallow water site Horns Rev. It is found that the modeling system captures in general better strong wind and strong wave characteristics for open ocean condition than for the coastal condition. With the current model setup, using high spatial resolution gives better results for strong winds both for the open ocean and coastal sites. The significant wave height ($H_{m0}$) is very sensitive to the model resolution and bathymetry data for the coastal zone. In addition, using Janssen (1991) $z_0$ expression gives better results of the significant wave height under high sea state conditions.

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