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Assessing the added value of using a Wave Boundary Layer Model in a coupled wave-atmosphere model system

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The energy input from the wind to the waves determines the growth of waves due to wind. In wave models, this is parameterised by a wind input source function. The third generation ocean wave model WAM currently parameterises the wind input according to Janssen (1991). However, this approach has some drawbacks. For instance, it overestimates the wave drag at high wind speeds, it assumes the existence of a logarithmic wind profile, which is only approximately correct within the wave boundary layer and it neither conserves momentum nor kinetic energy. To address these issues, the Wave Boundary Layer Model (WBLM, Du et al. (2017, 2019)) is implemented in WAM. The WBLM improves the wind input source function by accounting for those conversations and calculating the wind profile within the wave boundary layer, thereby linking the atmospheric and wave modelling. This accordingly improves the estimation of the friction velocity and therefore also the wave induced stress and the roughness length, which are key parameters in the calculation of the growth rate of the wind input source function. To match the input source function, the dissipation source term is re-calibrated following Du et al. (2019). The aim of this study is to assess the added value of using such a WBLM in WAM both in stand-alone model simulations of the wave model and in coupled simulations with the atmospheric model COSMO-CLM (CCLM). To do so, the output of a stand-alone simulation of the WAM model with the new input source function and dissipation term is compared against the simulation results of the original source input and dissipation terms of Janssen (1991). For the validation, in-situ measurements from the Global Telecommunication System (GTS) and remote sensing measurements from Sentinel-3A are used. In a second step, the WBLM is then used in two-way coupled simulations within WAM-CCLM. Based on the simulation results it will be concluded what the added value of the WBLM is and during which situations the use of the WBLM might be most important.

References:

Du, J., Bolaños, R., & Larsén, X. G. (2017): The use of a wave boundary layer model in SWAN. Journal of Geophysical Research: Oceans, 122(1), 42-62.

Du, J., Bolaños, R., Larsén, X. G., and Kelly, M. (2019): Wave boundary layer model in SWAN revisited, Ocean Sci. Discuss., https://doi.org/10.5194/os-15-361-2019.

Janssen, P. A. E. M. (1991): Quasi-linear theory of wind-wave generation applied to wave forecasting, J. Phys. Oceanogr., 21(11), 1631–1642, doi:10.1175/1520-0485(1991)