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Wave-atmospheric modelling, satellite and in-situ observations in the southern North Sea: the impact of two-way coupling on the lower atmosphere

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In this study, the effects of coupling of atmospheric and wind wave models on the lower atmosphere within the North Sea are studied. The two-way coupling of both models is enabled through an introduction of wave-induced drag in the atmospheric model (COSMO-CCLM) and updated wind in the wind wave model (WAM), which allows studying the non-linear feedback between the waves and the atmospheric models. This includes the effects on the exchange between the ocean and the atmosphere, as well as the effects within and above the boundary layer. As a result of the wave-induced drag many atmospheric parameters are directly or indirectly influenced by the sea state. The impact on the wind conditions at the surface is the most obvious effect of the wave-induced drag, however, the changes due to two-way coupling also spread into higher parts of the atmosphere. Other parameters like fluxes between the ocean and atmosphere as well as the temperature are influenced by the coupling within and above the boundary layer as well. The spatial distribution of the effects within the coupled area is analysed, where we identify locations where the effects of the coupling are the largest. Furthermore, the propagation of the changes due to the coupling within and also out of the coupled model area over the ocean and over different parts of Europe is assessed. Events with maximum impact of the two-way coupling on the atmosphere are identified. The coupled and uncoupled model data is compared to in-situ and remote sensing measurements in order to estimate the improvements due to the two-way coupling.