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Developing a swell-dependent surface roughness length for atmosphere-wave-ocean coupled models

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When modelling the atmosphere and the ocean it is of crucial importance to correctly describe the boundary conditions. The atmospheric-ocean boundary is an important source of turbulence and there is a significant exchange of momentum, heat and moisture. The marine atmospheric boundary layer (MABL) has a considerable impact on global climate atmospheric models as 70 % of the global surface is covered with water. For regional scale models with higher resolution correctly described coupling of spheres is of particular importance in coastal regions due to the greater variability of several parameters. Surface waves can be divided into growing sea (young sea) and decaying sea (swell) with very different impact on the atmosphere. The situation with decaying sea and low wave height has in several experimental investigations been shown to give significantly lower friction at the surface as well as altered wind profiles and atmospheric turbulence. New results using data taken outside Hawaii shows that for high swell waves, wind profiles and turbulence properties are altered similarly as for low swell waves, but the surface friction is significantly enhanced (Rutgersson et al, 2010; Högström et al., 2009; 2012; Smedman et al., 2009).

We use a three component regional climate modelling system to investigate the changed surface roughness description. The model covers northern Europe and model components include the atmosphere model RCA (Rossby Centre Climate model), WAM wave model and NEMO ocean model for the Baltic and North Seas. Presently the coupling is focused on introducing wave impact on the atmosphere. Sea surface roughness length is improved to take the variable swell properties into account. Roughness length is expressed in terms of the wave age and significant swell wave height. The impact of improved roughness length on surface fluxes and wind field is investigated as well as the impact on secondary parameters.

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