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Impact of surface waves on the atmosphere in a coupled wave-atmosphere regional climate model

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When modelling the atmosphere 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 since 70 % of the global surface is covered with water. The turbulence in the atmosphere as well as the surface fluxes is different over the ocean since the roughness of the surface (the waves) changes as a response to the atmospheric forcing; altered surface roughness also changes the heat fluxes. 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 has in several experimental investigations been shown to give significantly lower friction at the surface as well as altered wind profiles and atmospheric turbulence (Rutgersson et al, 2001; Högström et al., 2009; Smedman et al., 2009). The lower friction at the surface can be expressed by a reduced drag coefficient (Carlsson et al., 2009). This is potentially of great climatological importance since the world's oceans are dominated by swell conditions (Semedo et al., 2011). We have developed a coupled wave-atmosphere regional climate model (RCA-WAM) using the WAM wave model and the RCA regional climate model (Rutgersson et al., 2010). The coupling is done using different methods and this has some impact on the response of the atmosphere. The resolution of the coupled model is important, with larger feedback effects of the waves on the atmosphere for higher resolution. In general are the higher wind speeds slightly reduced when the feed-back of the growing waves are included. When including also the reduction of roughness due to swell waves, the momentum transport is significantly reduced, this includes reduced turbulence in the atmosphere and has a significant impact on heat fluxes as well as other secondary parameters including precipitation pattern and cloudiness.

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