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Sensitivities and uncertainties in the simulation of Arctic sea ice with a coupled regional atmosphere-ocean-ice model

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A series of sensitivity experiments has been performed with the coupled regional atmosphere-ocean-ice model HIRHAM-NAOSIM in order to assess the importance of uncertainties in the physical process descriptions for the simulation of Arctic sea ice with a fully coupled model. The significance of the following physical parameterizations has been addressed: snow and ice albedo, snow cover, cloud cover, ocean heat transfer, lateral freezing of sea ice as well as the heat flux treatment in the ice growth scheme at large. It has been found that the simulation of Arctic summer sea ice responds very sensitively to the parameterization of snow and ice albedo but also to the treatment of ice growth. Large sensitivities also arise with respect to the parameterizations of cloud cover, snow cover, and ocean heat transfer, but the response is not as strong as compared to the albedo and ice growth schemes. Arctic winter sea ice is only little affected by all these parameterizations, but the parameterization of lateral freezing controls the rate of increase in ice thickness, which significantly influences summer sea ice conditions in multi-year simulations. Uncertainties in the simulation of the atmospheric heat fluxes and the atmospheric circulation hamper the accurate simulation of Arctic sea ice and may decrease the overall model performance due to feedback effects.