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Arctic cloud cover bias in ECHAM6 and its sensitivity to cloud microphysics and surface fluxes

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Among the many different feedback mechanisms contributing to the Arctic Amplification, clouds play a very important role in the Arctic climate system through their cloud radiative effect. It is therefore important that climate models simulate basic cloud properties like cloud cover and cloud phase correctly. We compare results from the global atmospheric model ECHAM6 to observations from the CALIPSO satellite active lidar instrument using the COSP satellite simulator. Our results show that the model is able to reproduce the spatial distribution and cloud amount in the Arctic to some extent, but nevertheless, a positive bias in cloud fraction can be observed in high latitudes, which is related to an overestimation of low- and high-level clouds. We mainly focus on the bias in low-level clouds and show that this bias is connected to surfaces that are covered with snow or ice and is caused by an overestimation of liquid containing clouds. We explored the sensitivity of low-level cloud cover to the strength of surface heat fluxes, but only by increasing surface mixing the observed cloud cover bias cloud be reduced. As ECHAM6 already mixes too strongly in the Arctic, the cloud cover bias can mainly be attributed to cloud microphysical processes. Improvements in the phase partitioning of Arctic low-level clouds could be achieved by a more effective Wegener-Bergeron-Findeisen process but total cloud cover remained still overestimated. By allowing for a slight supersaturation with respect to ice within the cloud cover scheme, we were able to also reduce this positive cloud cover bias.