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Assessment of snow cover and surface albedo in the ECHAM5 general circulation model

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Land surface albedo, snow cover fraction (SCF) and snow depth (SD) from two versions of the ECHAM climate model are compared to available ground-based and remote-sensed climatologies.

ECHAM5 accurately reproduces the annual cycle of SD and correctly captures the timing of the snow melt. ECHAM4, in contrast, simulates an excessive Eurasian snow mass in spring due to a delayed snow melt. Annual cycles of continental snow cover area (SCA) are captured fairly well in both ECHAM4 and ECHAM5. The negative SCA trend observed during the last two decades of the 20th century is evident also in the ECHAM5 simulation but less pronounced. ECHAM5 captures the interannual variability of SCA reasonably well, which is in contrast with results that were reported earlier for AMIP-2 models. An error analysis revealed that, for studies on SCA, it is essential to test the data records for their homogeneity and trends.

The second part of the paper compares simulated surface albedos with remote-sensed climatologies derived from PINKER and MODIS. ECHAM5 is in better agreement with observations in the Himalayan/Tibetan area than ECHAM4. In contrast, the positive surface albedo bias over boreal forests under snow conditions in ECHAM4 is even more pronounced in ECHAM5. This deficiency is mainly due to the neglect of the snow masking effect of stems and branches after trees have lost their foliage.

The analysis demonstrates that positive biases in the SCA are not necessarily related to positive albedo biases since the reflectivity of snow-covered regions in ECHAM5 is greatly influenced by the forest fraction and the foliage density. Furthermore, an overestimation of the area-averaged SD need not necessarily be related to positive SCF anomalies as the relationship between SD and SCF is highly nonlinear.