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# Evaluation of surface albedo and snow cover in AR4 coupled climate models

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Surface albedo (ALB), snow cover fraction (SCF) and snow water equivalent (SWE) of state-of-the-art coupled climate models are compared and validated against ground-based and remote-sensed climatologies.

Most IPCC AR4 climate models predict excessive snow mass in spring and suffer from a delayed spring snow melt while the onset of the snow accumulation is generally well captured. This positive SWE bias is mainly caused by too heavy snowfall during the winter and spring season. Seasonal cycles of snow cover area (SCA) at continental scales are captured reasonably well by most participating models. Two models clearly overestimate SCA over both Eurasia and North America. Year-to-year variations are reasonably well captured over both Eurasia and North America in winter and spring. The most pronounced underestimation in the interannual SCA variability is generally simulated during snow melt. The pronounced negative SCA trend that has been observed from 1979-2000 is only partly reproduced in the AR4 model simulations. Furthermore, the computed trends show a large spread among the models. Results from time slice simulations with the ECHAM5 climate model suggest that accurate sea surface temperatures are vital for correctly predicting SCA trends. Simulated global mean annual surface albedos are slightly above the remote-sensed surface albedo estimates. The participating AR4 models generally reproduce the seasonal cycle of the surface albedo with sufficient accuracy while systematic albedo biases are predicted over both snow-free and snow-covered areas, with the latter being distinctly more pronounced. The study shows that the surface albedo over snow-covered forests is probably too high in various state-of-the-art global climate models. The analysis demonstrates that positive biases in SCA are not necessarily related to positive albedo biases. Furthermore, an overestimation of area-averaged SWEs is not necessarily related to positive

SCA anomalies since the relationship between SWE and SCF is highly nonlinear.