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Simulation of longwave enhancement beneath coniferous forests

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CMIP5 models have been shown to underestimate both trend and variability in northern hemisphere spring snow cover extent, a substantial fraction of which is covered by boreal forests. Forest coverage shades the ground and enhances longwave radiation thereby impacting the radiation budget of the ground which is dominating the snow energy balance in forests. Longwave enhancement is a potential mechanism that contributes to uncertainty in snowmelt modelling. Here we use radiation measurements from an alpine forest to assess the simulation of sub-canopy longwave radiation by CLM4.5, the land component of the NCAR Community Earth System Model.

CLM4.5 overestimates the diurnal cycle of sub-canopy longwave radiation and consequently longwave enhancement. Overestimation results from clear sky conditions, due to high absorption of shortwave radiation during daytime and radiative cooling during nighttime. Using recent improvements to the canopy parameterisations of SNOWPACK as a guideline, CLM4.5 simulations of sub-canopy longwave radiation improve through the implementation of a heat mass parameterisation, i.e. including the thermal inertia effect due to biomass. However, this improvement does not substantially reduce the amplitude of the diurnal cycle, a result also found during the development of SNOWPACK.