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Thermal Coupling between Air and Ground Temperatures in the CMIP5 Historical and Future Simulations

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The decadal-scale thermal coupling between air and ground temperatures across North America is examined for 32 General Circulation Models (GCMs) from the fifth phase of the Coupled Model Intercomparison Project (CMIP5). For each simulation, we evaluate the relationship between air and ground temperatures. Our results show that the transport of energy across the air-ground interface differs from observations, and among GCMs depending on each model's land-surface component. While the decadal variability among GCMs can be explained by the physics and parameterizations of each land-surface model, the spatial variability of the air-ground coupling for the historical and future simulations is associated with model treatment of the soil thermal properties as well as with processes associated with snow and vegetation cover within GCMs. The difference between air and ground temperatures at high latitudes within the majority of the CMIP5 models is related to the insulating effect of snow cover. On the other hand, the difference between air and ground temperatures at low latitudes within some of the CMIP5 models is inversely proportional to the leaf area index, due to changes in latent and sensible heat fluxes. The large variability among GCMs and the marked dependency of the results on the choice of the land-surface model illustrates the need for improving the simulation of air-ground coupling in land-surface models towards a robust simulation of near-surface processes, such as permafrost and soil carbon stability within GCMs.