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Temperature decomposition of paired site observations reveals new insights in climate models' capability to simulate the impact of LUC.

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The biogeophysical impact of land use change (LUC) has been shown to be a significant contributor to climate change. In this study, we present a new methodology for evaluating the impact of LUC in climate models. For this, we use observational data from paired eddy covariance flux towers, representing a LUC from forest to open land (deforestation). Two model simulations with a regional climate model (COSMO-CLM2) are performed which differ only in prescribed land use for site pair locations. The model is evaluated by comparing the observed and simulated difference in surface temperature (Ts) between open land and forests, an evaluation which is performed separately for summer/winter and daytime/ nighttime. Next, we identify the biogeophysical mechanisms responsible for Ts differences by applying a Ts decomposition method to both observations and model simulations, allowing us us to determine which LUC related biogeophysical mechanisms were well represented in COSMO-CLM2, and which were not. Results show that the model is able to simulate the increase in albedo and associated daytime surface cooling following deforestation reasonably well. Also well simulated is the overall decrease in sensible heat flux and associated daytime surface warming and nighttime surface cooling. However, it appears the model is missing one crucial impact of deforestation on the surface energy budget: a reduction in nighttime downwelling longwave radiation. As a result, the magnitude of nighttime cooling following deforestation is underestimated by 4 K. These new insights support a wider application of the methodology (to other climate models).