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Do convection-permitting models improve the representation of the impact of LUC?

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In this study we assess the added value of convection permitting scale (CPS) simulations in studies using regional climate models to quantify the bio-geophysical climate impact of land-use change (LUC). To accomplish this, a comprehensive model evaluation methodology is applied to both non-CPS and CPS simulations. The main characteristics of the evaluation methodology are (1) the use of paired eddy-covariance site observations (forest versus open land) and (2) a simultaneous evaluation of all surface energy budget components. Results show that although generally satisfactory, non-CPS simulations fall short of completely reproducing the observed LUC signal because of three key biases. CPS scale simulations succeed at significantly reducing two of these biases, namely, those in daytime shortwave radiation and daytime sensible heat flux. Also, CPS slightly reduces a third bias in nighttime incoming longwave radiation. The daytime improvements can be attributed partially to the switch from parameterized to explicit convection, the associated improvement in the simulation of afternoon convective clouds, and resulting surface energy budget and atmospheric feedbacks. Also responsible for the improvements during daytime is a better representation of surface heterogeneity and thus, surface roughness. Meanwhile, the modest nighttime longwave improvement can be attributed to increased vertical atmospheric resolution. However, the model still fails at reproducing the magnitude of the observed nighttime longwave difference. One possible explanation for this persistent bias is the nighttime radiative effect of biogenic volatile organic compound emissions over the forest site. A correlation between estimated emission rates and the observed nighttime longwave difference, as well as the persistence of the longwave bias provide support for this hypothesis. However, more research is needed to conclusively determine if the effect indeed exists.