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The impact of afforestation on the diurnal cycles of temperature and turbulent heat fluxes

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The biophysical characteristics of the land surface, such as surface albedo, leaf area index or surface roughness, are inseparably linked to the form of land use. Thus, land use changes (LUCs) can considerably influence the regional climate conditions, since they modify the surface radiation budget and the turbulent heat exchange between the surface and the atmosphere. But the actual impact of LUCs on the regional climate conditions is very difficult to quantify and is therefore controversially discussed within the scientific community. In order to improve the understanding of the LUC contribution to regional climate change, with the Land Use and Climate Across Scales (LUCAS) initiative, a coordinated regional climate model comparison was designed.
In the first phase of LUCAS, the impact of extreme LUCs on the regional climate in Europe is investigated, by simulating idealized LUC experiments with an ensemble of nine different Regional Climate Models. In the first experiment, Europe is completely covered with forest (FOREST), in the second experiment with grassland (GRASS).
The focus of the presented study is on the impact of these extreme LUCs on the diurnal cycles of temperature and turbulent heat fluxes. For this, the results of the LUCAS ensemble were analyzed with respect to land surface characteristics affecting the turbulent heat exchange (e.g. surface roughness and albedo). Analysis revealed that an afforestation in the FOREST experiment leads to a reduced diurnal temperature cycle at the surface and an increased diurnal temperature cycle in the lower atmosphere compared to the GRASS experiment. The contrary effects of afforestation on the temperatures at the surface and in the lower atmosphere are mainly caused by the higher surface roughness of forest compared to grassland. In consequence, the sensible heat exchange between the surface and the atmosphere is increased over forest, leading to a warmer atmosphere during the day and a colder atmosphere during the night.