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Land cover change impacts on EURO-CORDEX climate by regional climate model (COSMO-CLM) simulations

Bo Huang (1), Xiangping Hu (1), Merja Tölle (2), and Francesco Cherubini (1)

(1) Industrial Ecology Programme, Department of Energy and Process Engineering, Norwegian University of Science and Technology (NTNU), Trondheim, Norway, (2) Department of Geography, Climatology, Climate Dynamics and Climate Change, Justus-Liebig University Giessen, Giessen, Germany

Paris Climate Agreements aim at stabilizing global mean temperature rise to 2 °C or less. The majority of the IPCC scenarios consistent with this 2 degree target envision large transformations in the land use sector. More evidence shows that land use/cover change (LUCC) likely impacts on local-to-regional climate. In this study, we quantify the local and regional climate response to extreme land use changes in EURO-CORDEX (European branch of the international Coordinated Regional climate Downscaling Experiment-CORDEX initiative) domain by regional climate model (COSMO-CLM v4.8) simulations. Five simulations have been created, i.e. control run and four idealized land use transitions across the entire EURO-CORDEX domain involving abrupt conversion of today forestland to bare land (BL) or herbaceous vegetation (HV), and conversion of today cropland to evergreen needle-leave forest (ENF) or deciduous broad-leave forest (DBF). We focus the analysis on the changes of temperature, precipitation, and frequency of temperature extremes at both the entire EURO-CORDEX domain (regional scale) and in the changed grids (local scale). On regional scale, we find an annual mean cooling of -0.06 $\pm$ 0.09 °C (mean $\pm$ standard deviation) for conversion to BL and -0.13 $\pm$ 0.08 °C to HV. Mean warming of 0.15 $\pm$ 0.09 °C and 0.13 $\pm$ 0.09 °C for conversion to ENF and DBF is found in the afforestation experiments. Deforestation causes a dry condition and afforestation leads to a wet climate, but there is a strong spatial variability of precipitation in the two group experiments. From south to north, deforestation impacts on mean temperature change from positive to negative at around 50° latitude, and causes the strongest cooling in spring (> 2 °C at high latitudes) but warming in summer (> 1 °C in some locations), when it increases the average number of hot days. Afforestation leads to a major warming in winter (0.69 $\pm$ 0.22 °C at a local scale), where it reduces the frequency of cold temperature extremes. Our findings strongly support that biophysical forcings from land use/cover determine local and regional climate. These findings can assist decision makers to design land management strategies in light of climate change mitigation and adaptation.