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Sensitivity of mid-latitude temperature to albedo parameterization in the regional climate model COSMO-CLM linked to extreme land use changes

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In the framework of CORDEX FPS LUCAS multi-model studies are uncertain about the biophysical impact of afforestation in the northern hemisphere mid-latitude summers, and show either a cooling or warming. The magnitude and direction is still uncertain with implications to the surface energy balance and temperature response. In this study, the effect of three different albedo parameterizations in the regional climate model COSMO-CLM (v5.09) is examined performing de-/afforestation experiments at 0.44° horizontal resolution across the EURO-CORDEX domain during 1986-2015. Idealized de- and af-forestation simulations are compared to a simulation with no land cover change. Emphasis is put on the impact of changes in radiation and turbulent fluxes. A clear latitudinal pattern is found, which results partly due to the strong land cover conversion from forest- to grassland in the high latitudes and open land to forest conversion in mid-latitudes. Afforestation warms the climate in winter, and strongest in mid-latitudes. Results are indifferent in summer owing to opposing albedo and evapotranspiration effects of comparable size but different sign. Thus, the net effect is small for summer. Depending on the albedo parameterization in the model, the temperature effect can turn from cooling to warming in mid-latitude summers. The summer warming due to deforestation to grassland is up to 3 °C higher than due to afforestation. The cooling by grass or warming by forest is in magnitude comparable and small in winter. The magnitude of individual biophysical changes together with the specific climate conditions result in the described near-surface temperature changes. Considering albedos of different vegetation types is more important than soil moisture dependent albedos only. This is important information for model development.