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Changes in regional boreal climate due to historic and future structural vegetation changes and variations in soil moisture memory

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Amplified warming at high latitudes over the past decades already has led to, and will continue to lead to, changes in the boreal and arctic part of the climate system. Climate change induced alterations include structural shifts in high latitude ecosystems such as boreal forest expansion towards higher latitudes and altitudes, and shrub-ecosystems replacing tundra in large areas of the arctic. These shifts affect surface physical qualities such as albedo, roughness length, and soil properties. Shifts in vegetation species may also lead to alterations in soil- and boundary layer moisture. Resultant changes in land surface properties and processes provide important feedbacks to regional climate by changes in radiation, and water and energy fluxes. Structural vegetation changes that appear on local scale may through these feedback mechanisms also propagate to affect large scale climatic features. In this study, the Weather Research and Forecasting model (WRF) with the Noah Land surface model is used in a series of experiments in order to investigate the influence of observed and anticipated structural changes in the boreal ecosystem on changes in the land–atmosphere feedbacks. MODIS land surface data are used together with observational data and dynamical vegetation model output from the CMIP5 database, to simulate the influence of historical and future structural vegetation changes over the Northern European Boreal domain. In a series of three experiments the MODIS dataset is manually altered in order to reflect observed and anticipated changes in Boreal forest geography on summer water and energy fluxes at the surface, including Bowen ratio changes. As results are highly sensitive to soil moisture variations, experiments are conducted under wet and dry soil moisture regimes, to take into account uncertainties in future soil state projections and to estimate sensitivity to soil moisture memory in surface flux estimates.