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Effects of projected climatic changes on CO2 and H2O fluxes in pine forest ecosystems in Karelia, Russia

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Effects of possible climatic and vegetation changes on H2O and CO2 fluxes in pine forest ecosystems of Karelia in Russia were quantified using modeling and experimental data. To describe possible climate changes in the study area for the period up to 2100, the modeling results provided by the ECHAM5 global model (MPI Hamburg, Germany) were used (Roeckner et al. 2003). ECHAM5 reanalysis dataset (Roeckner 2004) was used to quantify present climate conditions. To generate the future meteorological conditions the moderate A1B emission scenario (IPCC 2007) was selected. In the first step, the possible century trends of the air temperature, air humidity, solar radiation, precipitation and wind speed for study area in Karelia were obtained as a difference between the predicted values for period 2080-2100 (Roeckner et al 2006) and the values taken for period 1980-2000 from reanalysis datasets (Roeckner 2004). The trends were calculated using average values from 3 model runs for four points located close to the area. In the second step, future annual pattern of meteorological conditions (with 1 hour time resolution) for the area was generated from the meteorological data set of 2000 (taken as reference) using obtained climatic trends.

The annual future pattern of CO2 and H2O fluxes of the forests were simulated using a process-based Mixfor-SVAT model (Olchev et al. 2002, 2008). The main concept used in the Mixfor-SVAT model is an aggregated description of the physical and biological processes in forest ecosystem on different spatial scales: individual leaf, individual tree and entire ecosystem. It allows describing both total ecosystem fluxes and flux partitioning among different tree species and canopy layers.

In modeling experiments it was considered several scenarios of vegetation changes assuming both keeping of modern vegetation properties and increasing canopy LAI, root biomass and N content in leaves.

Results of modeling experiments show that expected climatic and vegetation changes can have significant impact on evapotranspiration, transpiration, Net Ecosystem Exchange (NEE), Gross Primary Productivity (GPP) and Ecosystem Respiration (RE) of the pine forest ecosystems. These changes have a clear seasonal trend and they are very sensitive to LAI and N content changes in a plant canopy.

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