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H_2O and CO_2 exchange between a sphagnum mire ecosystem and the atmosphere

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The modern climatic conditions are strongly influenced by both internal variability of climatic system, and various external natural and anthropogenic factors (IPCC 2007). Significant increase of concentration of greenhouse gases in the atmosphere and especially the growth of atmospheric CO_2 due to human activity are considered as the main factors that are responsible for modern global warming and climate changes. A significant part of anthropogenic CO_2 is absorbed from the atmosphere by land biota and especially by vegetation cover. However, it is still not completely clear what is the role of different land ecosystems and especially forests and mires in global cycles of H_2O and CO_2 and what is a sensitivity of these ecosystems to climate changes.

Within the framework of this study the spatial and temporal variability of H_2O and CO_2 fluxes between a mire ecosystem and the atmosphere was described using results of the field measurements and modeling approach. For the study a mire ecosystem located in Tula region in European part of Russia was selected. The selected mire has karst origin, depth of peat float is 2.5-3.0 m (depth of depression is more than 10 meter), area is about 1 ha. The mire vegetation is characterized by sedge and sphagnum mosses cover. The mire is surrounded by broad-leaved forest of about 20 meter high.

To describe the temporal and spatial patterns of H_2O and CO_2 fluxes within selected mire the chamber method was applied. The measurement were carried out along transect from mire edge to center from June to September of 2012. For measurements the transparent ventilated chambers combined with portable infrared CO_2/H_2O analyzer LI-840 (Li-Cor, USA) was used. To estimate the gross primary production and respiration of different type of vegetation within the mire the measurements were conducted both under actual light conditions and artificial shading.

Results of the experimental studies showed that the maximal CO_2 fluxes was observed in central part of the mire in June and reached 6.8+-4.2 mkmol m-2 s-1. In July the net CO_2 flux is lower and doesn't not exceed -4.2 +- 2.8 mkmol m-2 s-1. Maximal values of H_2O flux (0.23 +- 0.10 mm hour-1) was observed in August in central part of the mire.

Do describe the spatial pattern of the H_2O and CO_2 exchange within the mire ecosystem a three dimensional model 3D Forbog-3D was applied. The model operates with the horizontal grid resolution - 2 m x 2 m, vertical resolution - 1 m, and primary time step - 1 hour. Forbog-3D uses data about position of each individual tree around the mire, mean height, crown and stem diameters of the trees to simulate patterns of plant and leaf area densities of a forest stand. The model algorithm describing solar radiation transfer through a forest canopy considers direct and diffuse radiation penetrating through gaps in the canopy, transmitted by leaves and reflected from leaves, bark and soil surface. It uses information about the 3D structure of each tree species in the forest stand, and about the optical properties of their leaves and bark. It takes into account clumping and gapping of foliage, spatial variations in leaf orientation angles and site topography.

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