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

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Introduction: The modern climatic conditions is 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 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. The role of different land ecosystems and especially forests and mires in the global H_2O and CO_2 cycles as well a sensitivity of these ecosystems to climate changes is still not completely clear and need complex experimental and theoretical studies.

The main goal of the study is to quantify the temporal variability of net CO_2 exchange (NEE) and evapotranspiration (ET) of a sphagnum mire ecosystems in the northern part of the forest-steppe zone in European part of Russia using results of field measurements.

Study area. Tula region was selected as a key region for this experimental study (Fig. 1). It is unique area for such studies because almost all existed types of mire ecosystems of Northern Eurasia distinguished by a geomorphological position, water and mineral supply can be found in the area. As a target plot the karst-hole mire "Glavnoe" was selected (Fig. 2).

Methods. To describe the temporal and spatial patterns of NEE and ET fluxes within the selected sphagnum mire the chamber method was applied. The measurement were carried out along transect from the mire margin to center (Fig. 2) from June to September of 2012. For measurements the transparent ventilated chambers combined with portable infrared CO_2/H_2O analyzer LI-840A (Li-Cor, USA) was used. To estimate the gross primary production (GPP) and respiration (RE) of different types of vegetation within the mire the measurements were conducted both under actual light conditions and artificial shading. Simultaneously with measurements of NEE and ET at each measuring point along transect the measurements of incoming PAR (QS, Delta-T, USA), air and peat temperatures, and water level were provided. To quantify the flux partitioning among various plant groups and peat soil within each plant community of the mire several experiments including consecutive CO_2 and H_2O measurements before and after removal of separate plant groups in community were provided as well.

Fig. 3: Measurements of NEE of CO_2 and ET under actual light conditions and artificial shading.

Fig. 1: Geographical location of the study area.

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

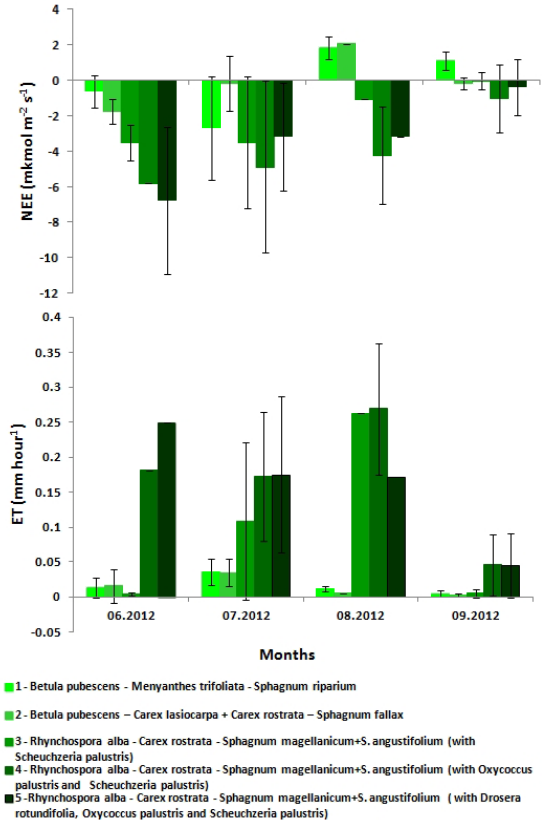

Fig. 4: Averaged seasonal variability of NEE and ET for various plant communities within the sphagnum mire.

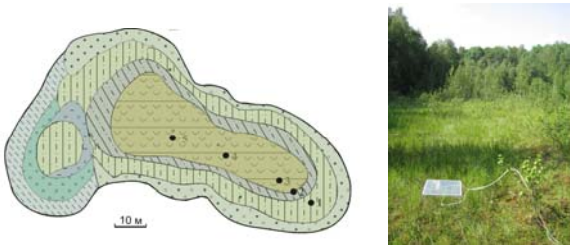

Fig. 2: Scheme of vegetation and photo of the sphagnum karst-hole mire "Glavnoe" (Tula region). Black cycles in the scheme indicates the points of transect where the measurements of NEE and ET were provided. Plant communities along transect are described in figure 4.

Results (continue). The provided experiment to determine the contribution of the various plant groups and peat soil within different plant communities of the mire into total NEE and ET fluxes showed that the herbs have maximum contribution to GPP in the central and margin parts of the mire. GPP of sphagnum layer is relatively small - 1.1 ± 1.1 mgC g^{-1} of dry weight per hour at the mire margin and 0.6 ± 0.2 mgC g^{-1} of dry weight per hour at the mire center. The contribution of various plant groups and peat to total ET in the central and margin parts of the mire is very non-uniform. In particular, whereas on the mire margin the dominating role in total ET belongs to herbs layer (Buck Bean), in the central part of the mire the maximal contribution to total ET belongs to the sphagnum layer and peat.

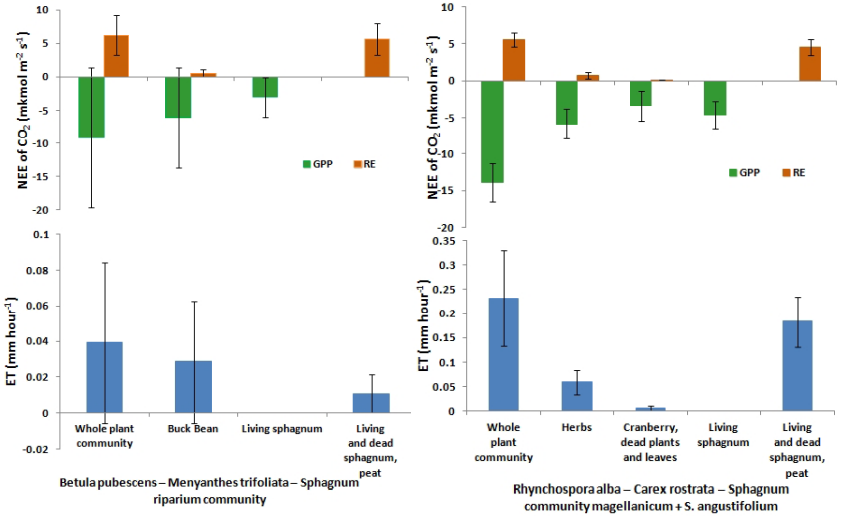

Fig. 5: Contribution of different plant groups and peat in GPP, RE and ET of two mire plant communities situated at the margin and center of the sphagnum karst-hole mire.

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More information can be found in https://sites.google.com/site/aoltchev/ and https://www.researchgate.net/profile/Alexander_Olchev/?ev=hdr_xprf