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Net ecosystem CO_2 exchange and evapotranspiration of a sphagnum mire: field measurements and model simulations

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The spatial and temporal variability of net ecosystem exchange of CO_2 (NEE) and evapotranspiration (ET) of a karst-hole sphagnum peat mire situated at the boundary between broad-leaved and forest-steppe zones in the central part of European Russia (54.06N, 37.59E, 260 m a.s.l.) was described using results of field measurements and simulations with Mixfor-3D model. The area of the mire is about 1.2 ha and it is surrounded by a broadleaved forest stand. It is a typical peat mire according to water and mineral supply as well as to vegetation composition. The vegetation of the peripheral parts of the mire is typical eutrophic whereas the vegetation in its central part is represented by meso-oligothrophic plant communities.

To describe the spatial variability of NEE and ET within the mire a portable measuring system consisting of a transparent ventilated chamber combined with an infrared CO_2 and H_2O analyzer LI-840A (Li-Cor, USA) was used. The measurements were provided along a transect from the southern peripheral part of the mire to its center under sunny clear-sky weather conditions in the period from May to September of 2012 and from May 2013 to October 2013. The chamber method was used for measurements of NEE and ET fluxes because of small size of the mire, a very uniform surrounding forest stand and the mosaic mire vegetation. All these factors promote very heterogeneous exchange conditions within the mire and make it difficult to apply, for example, an eddy covariance method that is widely used for flux measurements in the field.

The results of the field measurements showed a significant spatial and temporal variability of NEE and ET that was mainly influenced by incoming solar radiation, air temperature and ground water level. During the entire growing season the central part of the mire was a sink of CO_2 for the atmosphere (up to 6.8 ± 4.2 μmol m-2 s-1 in June) whereas its peripheral part, due to strong shading by the surrounding forest, was mainly a source of CO_2 for the atmosphere.

ET is reached maximal values in the central part of the mire (0.34 ± 0.20 mm hour-1 in May 2013) mainly due to high air and surface temperatures and the very wet upper peat horizon and sphagnum moss. ET the peripheral part of the mire was much smaller and usually didn't exceed 0.03 ± 0.02 mm hour-1.

To estimate the total mire NEE and ET taking into account spatial heterogeneity of solar radiation, thermal and soil moisture conditions within the mire the process-based Mixfor-3D model was applied. Parameters describing the photosynthesis, respiration and transpiration variability were derived from results of the field measurements.

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