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VERTICAL FLUXES OF CARBON DIOXIDE IN PEATLAND ECOSYSTEMS IN THE AUTUMN

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SUMMARY

The paper presents results of carbon dioxide fluxes investigations made by eddy covariance method in the ecosystem of meso-oligotrophic peatland of European North-East of Russia during autumn. The impact of soil surface temperature and solar radiation on the rate of uptake and emission of CO_2 is shown. The complete cessation of carbon dioxide uptake/emission in the system “phytocenosis – atmosphere” after the stable snow cover formation have not been identified.

KEY WORDS: meso-oligotrophic peatland, carbon dioxide, eddy covariance.

INTRODUCTION

There is an important role of peatland ecosystems in the regulation of carbon dioxide content in atmosphere. Carbon balance of a peatland depends on climatic conditions. The object of this paper is to evaluate carbon dioxide uptake and emission from the surface of meso-oligotrophic peatland of middle taiga in autumn period.

STUDY SITE AND METHODS

The object of investigations is Medla-Pev-Nur (Ust-Pojeg) peatland, situated in 40 km from Syktyvkar city, Republic of Komi, Russian Federation. The area of the peatland is 2790 hectares; average thickness of a peat is 1.4 m (Peat resources…, 2000).

The peatland includes different plant communities. There are meso-eutrophic grass-mosses flooded swamps and oligotrophic pine-shrub-grass-mosses communities, oligotrophic and mesotrophic sites (Fig. 1). Dominant species in vegetative cover of the peatland are shrubs (*Andromeda polifolia* L., *Chamaedaphne calyculata* L., *Ledum palustre* L., *Oxycoccus microcarpus* Turcz. ex Rupr., *Oxycoccus palustris* Pers., *Rubus chamaemorus* L.), grasses (*Equisetum fluviatile* L., *Pedicularis palustris* L., *Utricularia intermedia* Hayne, *Eriophorum vaginatum* L., *Eriophorum gracile* W.D.J. Koch, *Menyanthes trifoliata* L., *Scheuchzeria palustris* L. sedges g. *Carex*,) and mosses (*Polytrichum strictum* Brid., *Warnstorfia exannulata* (Schimp.), g. *Sphagnum* and g. *Calliergon*).

Investigations were carried from September 30th to November 23rd 2010. Closed type eddy covariance measuring system was situated on the high of 4.23 m from the peatland surface (without snow cover) and included sonic anemometer (Solent R3, Gill Instruments Ltd., GB) and infrared gas-analyzer (Li-7000, Li-Cor Inc., USA). Microclimate parameters were recorded by an automatic meteorological station (Campbell Scientific, USA).

Mean values of *NEE* were calculated from 30-minutes intervals using EdiRe software (Robert Clement, University of Edinburgh, GB). After the data processing errors of measured *NEE* values were identified (Foken and Wichura, 1996), and not correspondent to check parameters values of CO_2 fluxes were removed from the data set. Appeared gaps (12% of data) were then filled using on-line gap-filling tool (http://www.bgc-jena.mpg.de/~MDIwork/eddyproc/). Using the same tool we separate *NEE* into ecosystem respiration (R_{eco}) and gross-photosynthesis (P_{gross}).

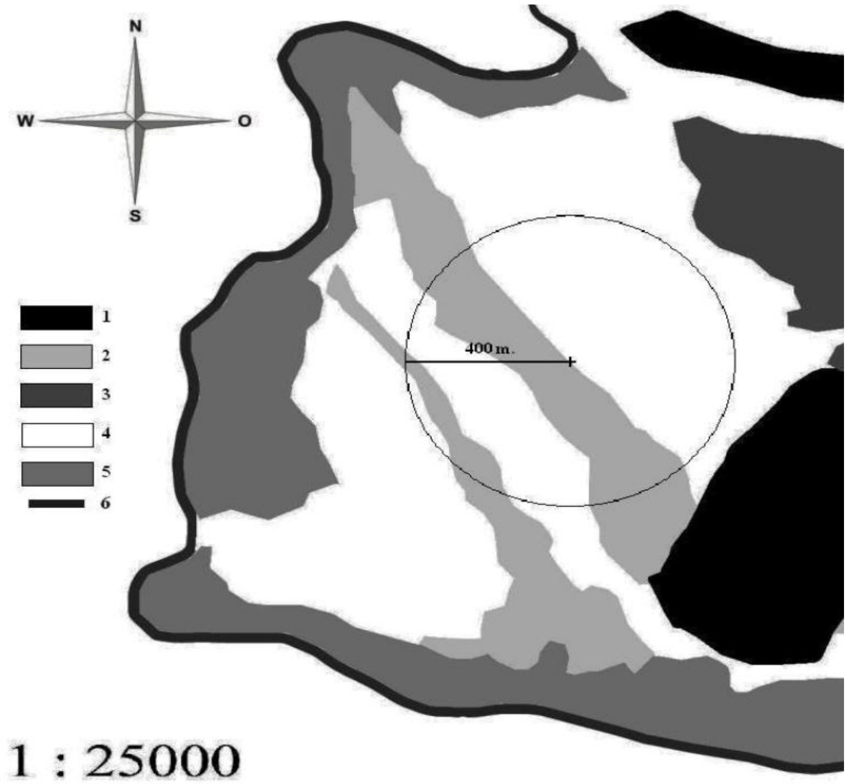

Fig. 1. Arrangement scheme of the measuring system at the site of the peatland
1 – forest; 2 – meso-eutrophic grass-mosses flooded swamp; 3 – oligotrophic pine-shrub-grass-mosses communities; 4 – meso-eutrophic shrub-grass-sphagnum communities; 5 – edge swamp; 6 – border of the peatland

RESULTS AND DISCUSSION

There was an unstable temperature conditions during investigation period, when negative mean diurnal temperature of soil surface (up to -5 °C) often changed by rapid warming up to +10 °C. First snow was mentioned in the middle of October. Stable snow cover began to form in the first decade of November, but until the end of November its depth does not exceed 3-5 cm.

The maximum intensity of PAR in the first half of October reached 730 μmol $m^{-2}s^{-1}$, and then gradually decreased, and in late October did not exceed 300 μmol $m^{-2}s^{-1}$. During this period was dominated by south-west and south-east winds, so on the basis of measuring system location (Fig. 1), 80% of the flux data was registered from the communities of meso-eutrophic grass-mosses flooded swamp.

In the end of September the maximum values of *NEE* in the system "peatland – atmosphere" were -107 – -109 μg $m^{-2}s^{-1}$ (Fig. 2). During the first decade of October mean diurnal air temperature was positive (+2 – +4 °C), but CO_2 emission have already exceeded its uptake. The change of carbon dioxide flux direction in the ecosystem of peatland could be related to the end of the growing season. In the middle taiga of European North-East of Russia the end of vascular plant vegetation begins in the II – III decades of September (Forests…, 1999). In Canada, the excess emission uptake in peatland ecosystem identified to be in the middle of August, in 15-20 days after first signs of wilting of vascular plants have been appeared (Lafleur et al., 1997), and in tundra ecosystem of Russian Far East this switch was registered in the end of August – first part of September (Zamolodchikov et al., 2005)

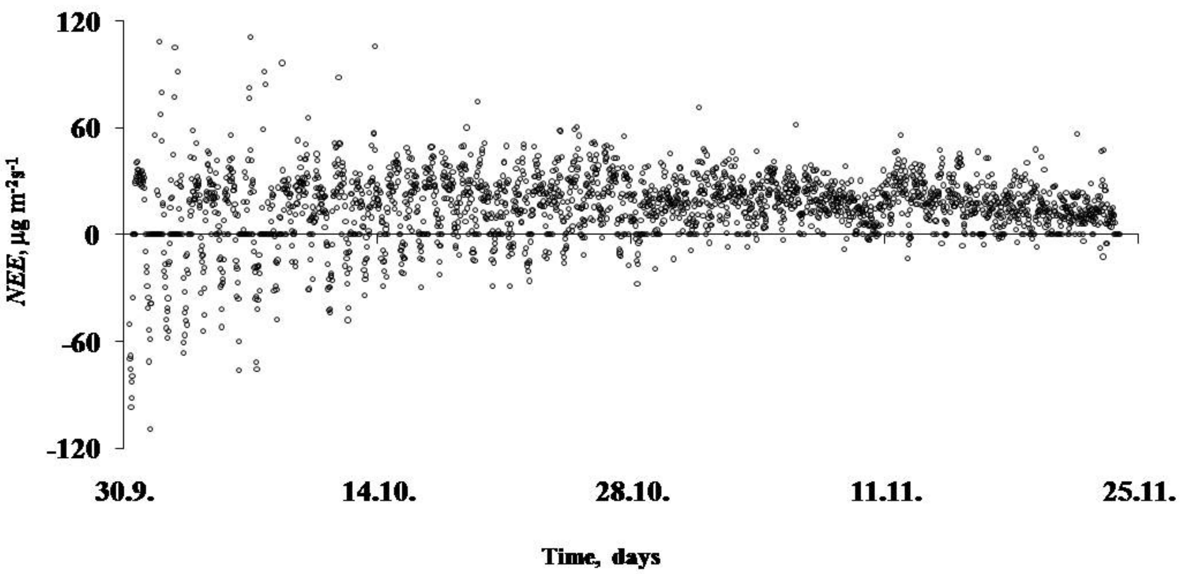

Fig. 2. *NEE* dynamics in the ecosystem of meso-oligotrophic peatland from September 30th to November 23rd 2010

In October and November with increasing thickness of snow cover the absolute values of *NEE* gradually decreased and in the end of November amounted to an average of 17.56 μg $m^{-2}s^{-1}$. The maximum value of P_{gross} in September was -146.19 μg $m^{-2}s^{-1}$, and snowfall in early November decreased it up to -30 μg $m^{-2}s^{-1}$. The maximum value of R_{eco} during this period also decreased about four times (Fig. 3). Short-time decreasing of photosynthesis and respiration in the ecosystem of peatland was pointed in some days of October before the continuous snow cover formed when mean diurnal air temperature was negative. We have not registered the complete cessation of CO_2 vertical fluxes with the increasing of thickness of snow cover. Perhaps in this period the main function of photosynthetic assimilation on the ecosystem level do *Sphagnum* mosses, as they have more wide limits of temperature and light optimum (Lafleur et al., 2001; Popov et al., 2006).

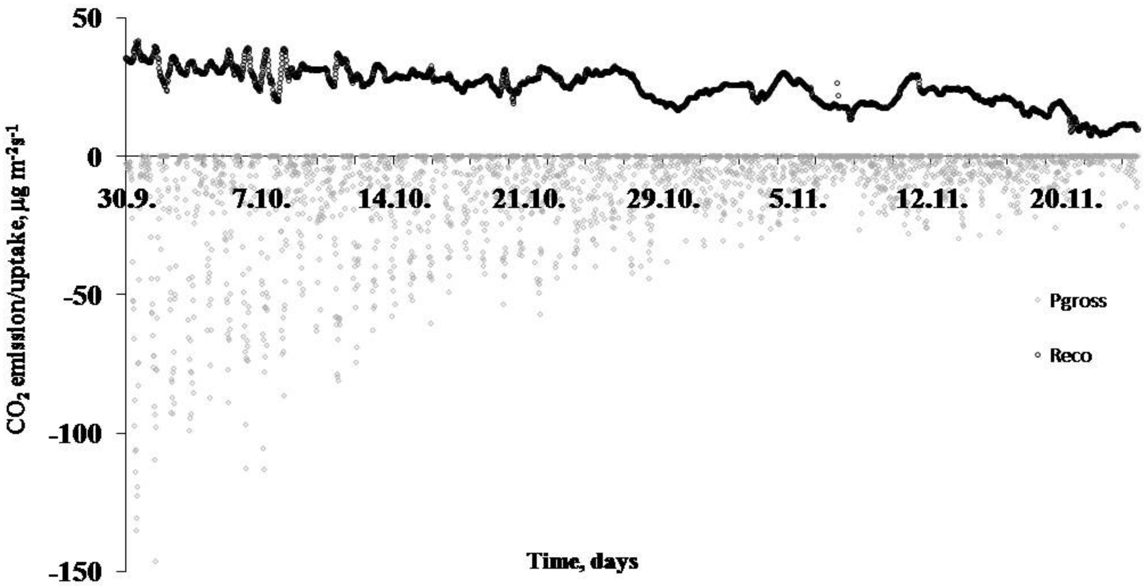

Fig. 3. P_{gross} and R_{eco} dynamics in the ecosystem of meso-oligotrophic peatland from September 30th to November 23rd 2010

In general, mean value of *NEE* we found in the end of November (17.56 μg $m^{-2}s^{-1}$) is close to results of the other investigations made in Finland (Aurela et al., 1998) and in Canada (Lafleur et al., 2001) in autumn.

The statistical analyze of data set showed negative correlate dependence of *NEE* on the PAR. In late September – early October while photosynthetic functions of some vascular plants in the peatland were remained, the correlation coefficient was higher than in October – November (Fig. 4, 5).

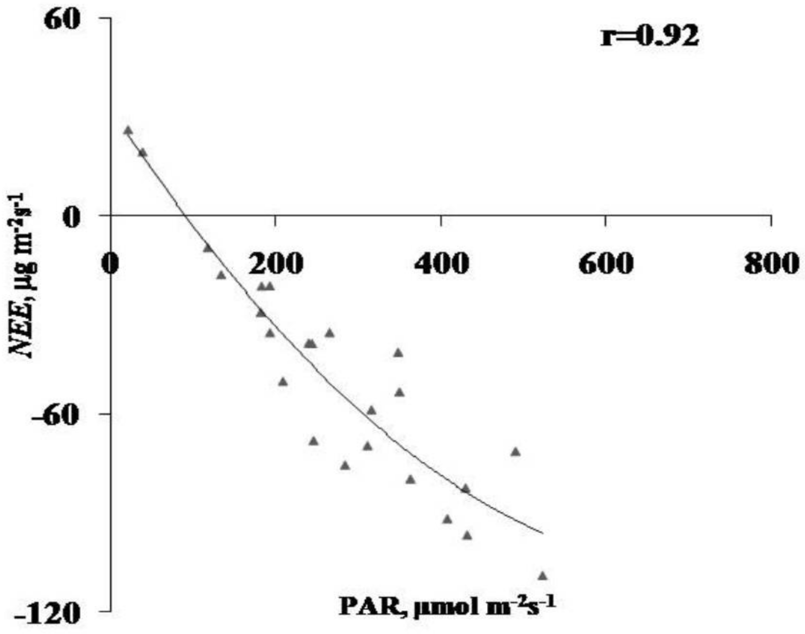

Fig. 4. The *NEE* dependence on PAR from September 30th to October 1st

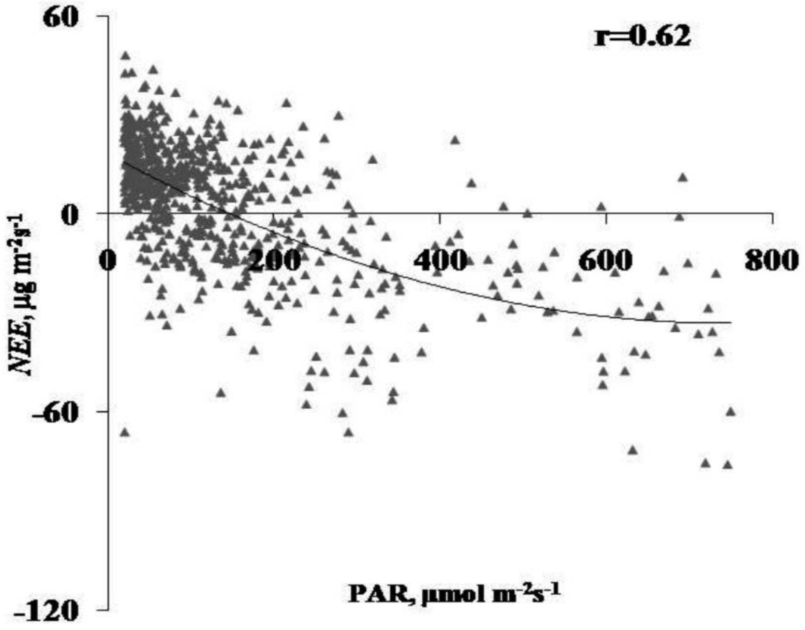

Fig. 5. The *NEE* dependence on PAR from October 2nd to November 23rd

During the same period the high correlate dependence of *NEE* on the soil surface temperature was found, but then this dependence disappeared with more frequent night frosts (Fig. 6,7).

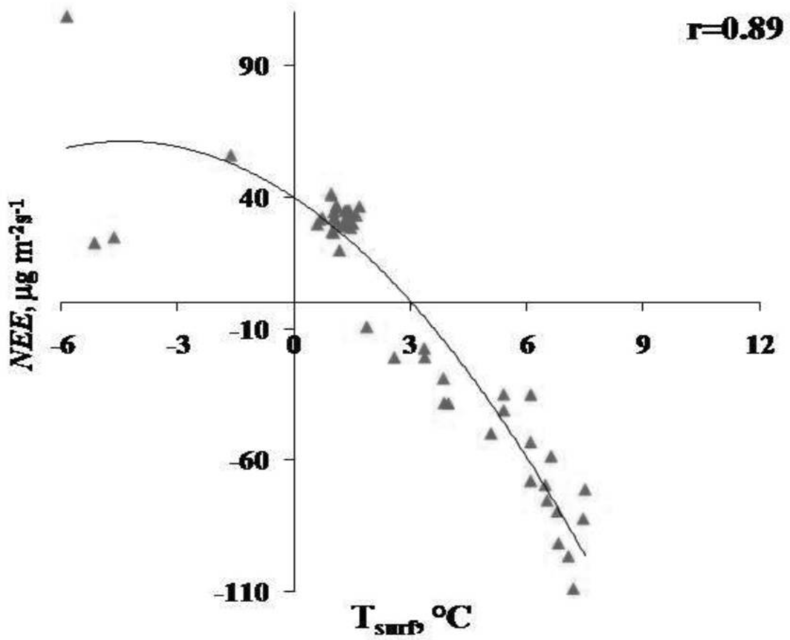

Fig. 6. The *NEE* dependence on soil surface temperature from September 30th to October 1st

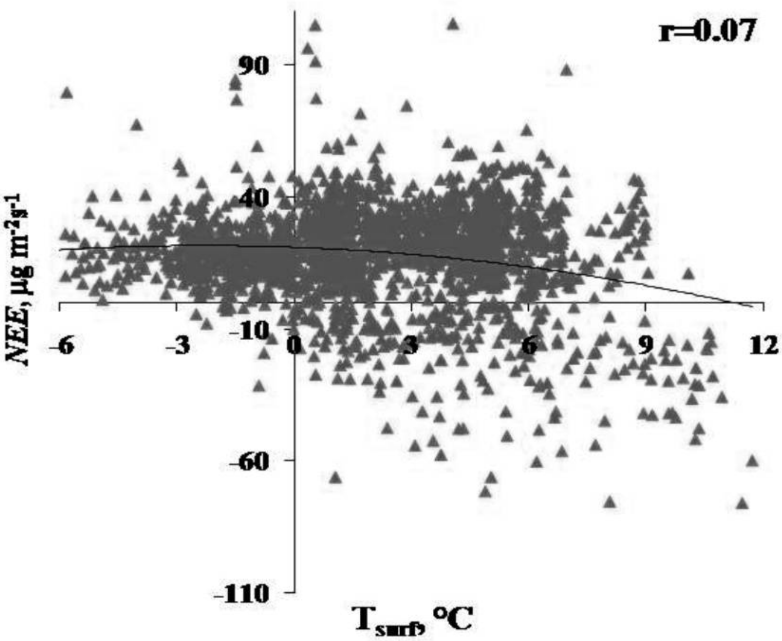

Fig. 7. The *NEE* dependence on soil surface temperature from October 2nd to November 23rd

CONCLUSION

As a result of carried out investigations we identified the vertical fluxes of carbon dioxide dynamics in the peatland in the autumn. It was found that the change in the direction of CO_2 flux from uptake to emission in the ecosystem of meso-oligotrophic peatland of middle taiga in European North-East of Russia take place in the first decade of October. This is 30-45 days later than it was shown for peatland ecosystem of Canada and Finland. In the beginning of autumn *NEE* depends on PAR and soil surface temperature, and with the formation of snow cover these dependences become weaker. Nevertheless the complete cessation of respiration and gross-photosynthesis with snowfall we have not observed. It may be the result of conservation of gas exchange in *Sphagnum* mosses.

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REFERENCES

Aurela, M., Tuovinen, J.-P. and Laurila, T. (1998) Carbon dioxide exchange in a subarctic peatland ecosystem in northern Europe measured by the eddy covariance technique. Journal of geophysical research 103, D10, 11289-11301.

Foken, Th., Wichura, B. (1996) Tools for quality assessment of surface-based flux measurements. Agricultural and forest meteorology 78, 83-105.

Kozubov, G.M. and Taskaev, A.I. (ed.) (1999) Forests of the Komi Republic. Moscow: Design. Information. Cartography, 332 pp.

Lafleur, P.M., McCaughey, J.H., Joiner, D.W., Bartlett, P.A. and Jelinski, D.E. (1997) Seasonal trends in energy, water, and carbon dioxide fluxes at a northern boreal wetland. Journal of geophysical research 102. D24, 29009 – 29020.

Lafleur, P.M., Roulet, N.T., Admiral, S.W. (2001) Annual cycle of CO_2 exchange at a bog peatland. Journal of geophysical research 106, D3, 3071-3081.

Peat recourses of Komi Republic (2000), Syktyvkar: Polygraph – service, 613 pp.

Popov, E.G., Talanov, A.V., Curets, V.K. (2006) Ecological and physiological characteristics of a number of autochthonous species of woody plants and mosses of Karelia. Proceedings of the Karelian Research Center RAS 10, 105-110.

Zamolodchikov D.G., Carelin D.V., Ivashchenko A.I., Lopes de Gerenu V.O. (2005) Micrometeorological assessment of biogenic fluxes of carbon dioxide in the typical tundra of Eastern Chukotka. Soil Science 7, 859-863.