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Ecological analysis of a boreal peatland CO2 flux based on eddy covariance data set from Ust Pojeg, Russia.

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Boreal peatlands are an important reservoir of carbon as they store one third of the terrestrial soil organic carbon (C) pool. In the last decades, more and more continuous measurements using eddy covariance technique were conducted in arctic and subarctic regions and these non-intrusive continuous measurements of C fluxes from boreal peatlands proved to be a valuable tool in peatland ecology studies. Results from such non-intrusive experiments were used to address possible changes in peatland functioning. Eddy covariance datasets typically suffer from gaps introduced during technical problems, or when the environmental conditions are not fulfilling the basic theory of eddy covariance. However, enough data points are usually left, to successfully model the missing values. Empirical models, using various environmental variables related to the measured fluxes are a common method.
The carbon dioxide (CO2) flux, consistent with the term net ecosystem exchange (NEE), is composed of two reciprocal processes: C assimilation by photosynthesis and ecosystem respiration, consisting of plant and soil respiration. Generally, C accumulation is related to photosynthetically active radiation (PAR) through green leaf area and temperature. Plant respiration is related to temperature changes, and soil respiration additionally to carbon substrate concentrations in the soil solution. With such assumptions, the empirical models are created. However, these models are simple approximations of the world in which the conditions are not stable, but changing over shorter periods, and don't necessarily describe real changes in the environmental controls. Thus, important ecological processes might be "buried" in models integrating over long time periods.
Year round measurements of CO2 fluxes from a Russian boreal peatland are presented here, and we test an alternative approach to understand the underlying ecological controls within the annual signal. Moving window regression analysis was used to better identify the responsible controlling parameters, especially those changing over short time periods throughout the year. The analysis shows interesting results. While, the annual trend explained by an empirical model does not contradict general assumptions on CO2 cycling in the peatlands, mostly controlled by the temperature and available PAR, The moving window regression analysis brings interesting insight into partitioning of various CO2 flux components throughout the year. In the early spring, the processes contributing to NEE of the peatland ecosystem are influenced by temperature. With increasing temperatures, vascular plants start to develop and night part of the CO2 flux seems not to follow the relationship with soil temperature. Thus, with the development of the vascular plants, the partitioning of NEE components might be solely driven by plant activity, through nutrient competition with soil biota. According to our findings, this period might be decisive for partitioning of night time CO2 flux between soil and plant respiration, and can affect the processes later in the growing season. Our analysis shows, that a complex view on peatland ecology is needed, to prevent misunderstanding of ecological processes going on in the different parts of the year. The results of our analysis presented here for discussion are promising, and moving window regression might be an effective tool, able to systematically explain changing environmental controls on CO2 flux throughout the year.