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Methane fluxes in relation with redox potential of soil on temperate mire in NE Poland (dry conditions case study)

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Wetlands occupy a special place in the mosaic of landscapes around the globe, which, as a moist areas covered with vegetation, intensively release methane. Long-term research on vertical methane exchange between wetlands and the atmosphere has shown that the intensity of this process is a function of the climatic conditions at the observation site and the physico-chemical properties of the soil, such as moisture, temperature, pH and oxidation-reduction potential (redox) which reflects the ability of the soil to develop oxidizing or reducing conditions and thus indicates whether soil conditions are currently aerobic or anaerobic, necessary for the development of methanogenesis. Wetlands with a permanently high level of soil moisture content, located in mid-latitudes, are characterized by a clear annual variation in the vertical flux of methane to the atmosphere with clear relation to soil temperature. In recent years, permanently lowered or strongly fluctuating groundwater levels lead to continuous or episodic drying of the soil, which causes a continuous or temporary reduction in the intensity of methanogenesis. Thus, in dry years, the variability of methane fluxes is disturbed and the annual methane emissions is several times lower than in wet years.

In the years 2013-2018, continuous measurements of methane flux (FCH_4) were carried out in the marshes of the Biebrza National Park (NE Poland). The results, similar to those from other stations in middle latitudes, showed a clear annual variability of FCH_4 in wet years (2013 and 2014) with minimum values in winter and intense methane release to the atmosphere from April to September (up to +0.35 $gCH4 \cdot m^{-2} \cdot day^{-1}$). In dry years (2017 and 2018) in turn, the annual variability was clearly disturbed due to lower groundwater levels.

The aim of the study is to perform a comparative analysis of the variability of FCH_4 under typical and reduced soil moisture conditions, as well as an analysis of the temporal variability of the redox potential measured at five depths as a parameter supporting the analysis of the variability of methane fluxes in dry years. The variability of FCH_4, disturbed in comparison to the wet years, was analyzed based on the variability of the redox potential in the soil, with particular emphasis on the relationship between the intensity of methanogenesis and the depth at which favorable conditions for methanogenesis appear. In such years, only the occurrence of intense but short-term methanogenesis was observed in April-May (up to + 0.1 $gCH4 \cdot m^{-2} \cdot day^{-1}$), then a rapid decrease in the FCH_4 value with the groundwater level falling to values close to those of winter and an

irregular appearance of elevated FCH_4 values in the period from June to November.

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