Different peatland types cover a significant area in the Northern hemisphere. The anaerobic, under-the-water-table (WT), part of peatland is a major source of powerful greenhouse gas CH$_4$. Due to higher evaporation, climate change scenarios have predicted a lowering of WT in peatlands. To study this possible phenomena and its effect on greenhouse gas dynamics we took advantage of a WT drawdown gradient near a groundwater extraction plant. Methane & CO$_2$ fluxes and CH$_4$ production and oxidation potentials were studied simultaneously with microbial communities accounted for these activities in four locations (wet, semiwet, semidry, and dry) within Suonukkasuo, a minerotrophic fen. A clear separation of four locations in the gradient was detected according to principal component analyses on the vegetation, pH, CH$_4$, and WT.

Long-term lowering of WT was connected with decreased coverage of Sphagnum and aerenchymatic plants, decreased CH$_4$ field emissions & CH$_4$ production potential and increased CO$_2$ field emission. The methanogen community structure, based on methyl coenzyme M reductase A (mcrA) terminal restriction fragment length polymorphism, correlated best with the methane production and coverage of aerenchymatic plants along the gradient. At the pristine i.e. wet end of the gradient Methanosarcinaceae and Methanocellales were also found whereas the Fen cluster almost solely dominated the dry end. The methanoxidizing bacterial community consisted solely of Methylocystis bacteria and five different alleles (T, S, R, M, and O) of the particulate methane monooxygenase marker gene (pmoA) were detected in DGGE analysis. The M allele dominated the wet locations, and the occurrence of alleles O, S, and T increased with lowering WT. The R allele characterized the upper peat layer of the wet end where Sphagnum occurred and correlated with CH$_4$ oxidation potential. These results improve our understanding of mire gas dynamics after long-term WT drawdown and of the microbiological bases of methane emissions from mires.

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