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Impact of the heatwave in 2003 on the summer CH4 and N2O budget of a spruce forest ecosystem: A four-year comparison

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Both CH4 and N2O reduction and oxidation are highly sensitive to variation in soil moisture. Significant changes of net CH4 and total N2O fluxes from soils can therefore be expected to accompany redistribution for precipitation in the course of climate change where more extreme events are predicted for the future. The extreme summer drought in 2003 offered the unique opportunity to study the impact of such events on the emission of greenhouse gases, such as methane or nitrous oxide, under field conditions. The main objective of the present study was to evaluate the impact of the summer drought in 2003 on the net methane and nitrous oxide budget of a spruce forest ecosystem (South-West Germany) with large variation in soil drainage. During the summers of 2000-2004 we measured net CH4 and N2O fluxes (bi)-weekly using the closed-chamber technique for six different soil types ranging from well-aerated Cambisols to poorly drained Gleysols and a wet Histosol.
With regard to CH4 the extreme summer draught (1) did not elevate net CH4-sink function of soils, but (2) highly reduced net CH4-source strength and (3) reversed the net CH4 source of the investigated catchment into a sink. In all four summers investigated, net ecosystem exchange of CH4 was found only in the hydromorphic soils but not in the dominant well-aerated soils. This highlighted the key role of hydromorphic soils for the investigated pedodiverse system. With regard to N2O the summer draught in 2003 significantly reduced N2O emissions at least for the Humic Gleysol and the Sapric Histosol and hence markedly reduced the net N2O source strength of the investigated ecosystem.