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Interannual variation of methane emissions in a boreal peatland – cross-evaluation of chamber measurements (7 years) and model results (LPJ-WHyMe)

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Boreal peatlands are a major natural source of methane (CH_4). Due to a lack of longterm measurements, the interannual variability of CH_4 emission is still uncertain. To fill this gap, a combination of measurements and models is necessary. Here, we present chamber measurements of 7 years from a boreal mire in Finland and compare them with the output of a methane model that is integrated into a dynamic global vegetation model (LPJ-WHyMe: Wania et al. 2010). The mire is characterized by three microsite types which vary in vegetation cover and hydrology (hummocks, lawns, flarks). Chamber measurements have been conducted on all three microsite types in 1993 (Saarnio et al. 1997) and 2005-2007 (Becker et al. 2008, Schäfer 2007, Forbrich et al., in prep.), while in 1996-1998 they have been conducted exclusively on lawns (Saarnio et al. 2000). When all microsite types were measured, we upscale these measurements using classified high-aerial photographs (Becker et al. 2008). Additionally, we analyze the time series of measurements on lawns, which represent the most dominant CH_4 source in the peatland (contributing on average 80% to the ecosystem flux: Forbrich et al., in prep.). LPJ-WHyMe has been applied for the grid cell containing the peatland for the years 1988-2008 using the settings of Wania et al. (2010).

The upscaled chamber measurements (ecosystem flux estimate) for 1993 and 2005-2007 are generally lower than the model estimates (7-52%). Reasons for the mismatch can be both caused by the measurements and the model: Chamber measurements do miss ebullition fluxes (contributing 68.2% to the modelled annual emission: Wania et al. 2010) and/or the linear flux calculation underestimates the actual flux (Forbrich et al. 2010) while LPJ-WHyMe tends to overestimate the available carbon pool (Wania et al. 2009). Absolute values of observations of lawns in 1993 are well matched by model results (Wania et al. 2010). However, for the other years the model output is substantially larger than the measured fluxes (54-89%). This mismatch is decreasing when ebullition fluxes are neglected. To analyze this mismatch we will conduct an uncertainty analysis of the upscaling procedure of measurements and test different parameter settings.

The interannual variability of measured CH_4 fluxes can best be explained by the varying hydrology (Schäfer 2007): When the water table is low during the growing season, the measured fluxes decrease while they follow a seasonal curve when the water table is relatively stable over time. This is not exactly matched by LPJ-WHyMe, although generally the modelled mean water table matches very well the measured mean water table of lawns. Only the modelled diffusion fluxes seem to be affected by the water table position, while modelled emissions due to plant-mediated transport stay relatively stable for the investigated years. Modelled ebullition fluxes show a high variability: The amount of days when ebullition fluxes are modelled to take place range from 89 (2006) to 141 (2005 and 2007).

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