Geophysical Research Abstracts
Vol. 15, EGU2013-5400, 2013
EGU General Assembly 2013

Natural bog pine ecosystem in southern Germany is a steady and robust sink of CO_2 but a minor source of CH4

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Natural peatland ecosystems sequester carbon dioxide. They do this slowly but steadily, but also emit methane in small rates. Thus peatlands have both positive and negative greenhouse gas balance impacts on the climate system due to their influence on atmospheric CO_2 and CH4 concentration.

We present data of net ecosystem CO_2 exchange (NEE) of almost three years (July 2010 to March 2013) and of methane fluxes over a period of nine months (July 2012 to March 2013), measured by eddy covariance technique in the bog forest "Schechenfilz". The site (47°48' N; 11°19' E, 590 m a.s.l.) is an ICOS-ecosystems associate site, located in the pre-alpine region of southern Germany, where a natural Pinus mugo rotundata forest grows on an undisturbed, almost 6 m thick peat layer.

The slow growing bog pines and their low rates of carbon sequestration, in combination with high water table and thus low availability of oxygen, lead to low carbon dioxide fluxes. Photosynthesis as well as soil respiration are considerably attenuated compared to upland sites. Additionally, the high soil water content is damping the impact of dry and hot periods on CO_2 exchange. Thus the CO_2 balance is very robust to changing environmental parameters. While the CO_2 exchange is clearly related to soil temperature and photosynthetic active radiation, we have not yet identified a parameter that governs variations in methane exchange. Various environmental parameters appear to be related to methane emissions (including soil moisture, soil and air temperature and wind direction), but the scatter with respect to half hourly methane fluxes is too large to be useful for gap modeling. Analysis of daily averages reduces the scatter, but since methane exchange exhibits considerable daily variation, daily averages are not useful to fill data gaps of half hourly fluxes. In consequence, as the daily course is the summary result of all environmental parameters having influence on the methane exchange at the half-hour time scale of the measurements, the ensemble mean diurnal variation method over a suitable number of days is considered the most practical choice of gap filling method for methane fluxes at Schechenfilz site for estimating daily and annual sums.

Overall, the annual CO_2 uptake is estimated at a magnitude between -50 and -80 g C m-2 a-1, whereas the annual methane emissions are estimated to be about +6 g C m-2 a-1. Since N2O emissions can be neglected at natural peatland sites, the natural bog-pine ecosystem Schechenfilz is indicated to be a weak net sink of greenhouse gases in the past year, even if the higher global warming potential of methane is considered.