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Carbonyl sulfide (OCS) as a proxy for GPP: Complications derived from studies on the impact of CO_2, soil humidity and sterilization on the OCS exchange between soils and atmosphere

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Carbonyl sulfide is discussed to be used as a proxy for gross primary productivity (GPP) of forest ecosystems. However, soils may interfere. Soils play an important role in budgeting global and local carbonyl sulfide (OCS) fluxes, yet the available data on the uptake and emission behavior of soils in conjunction with environmental factors is limited. The work of many authors has shown that the OCS exchange of soils depends on various factors, such as soil type, atmospheric OCS concentrations, temperature or soil water content (Kesselmeier et al., J. Geophys. Res., 104, No. D9, 11577-11584, 1999; Van Diest & Kesselmeier, Biogeosciences, 5, 475-483, 2008; Masyek et al., PNAS, 111, No 25, 9064–9069, doi: 10.1073/pnas.1319132111, 2014; Whelan and Rhew, J. Geophys. Res. Biogeosciences., 120, 54-62, doi: 10.1002/2014JG002661, 2015) and the light dependent and obviously abiotic OCS production as reported by Whelan and Rhew (2015).

To get a better constraint on the impact of some environmental factors on the OCS exchange of soils we used a new laser based integrated cavity output spectroscopy instrument (LGR COS/CO Analyzer Model 907-0028, Los Gatos, Mountain View, California, USA) in conjunction with an automated soil chamber system (as described in Behrendt et al, Biogeosciences, 11, 5463-5492, doi: 10.5194/bg-11-5463-2014, 2014). The OCS exchange of various soils under the full range of possible soil humidity and various CO_2 mixing ratios was examined. Additionally OCS exchange of chloroform sterilized subsamples was compared to their live counterparts to illuminate the influence of microorganisms.

Results were quite heterogeneous between different soils. With few exceptions, all examined soils show dependence between OCS exchange and soil humidity, usually with strongest uptake at a certain humidity range and less uptake or even emission at higher and lower humidity. Differences in CO_2 mixing ratio also clearly impacts on OCS exchange, but trends for different soils vary strongly. One arable soil from organic farming even showed a trend directly opposed to the other arable soils examined.

We interpret the heterogeneity in reaction of soils to different soil humidity and CO_2 mixing ratios as related to activity of different microbiological communities within the soils. Preliminary experiments with sterilization agents that preferably act again bacteria (streptomycin) or fungi (nystatin) indicate that fungi might have played the dominant biotic role in the soils examined.

These complex interactions will affect the exchange of OCS between forest ecosystems and the atmosphere and may hinder the use of this compound to catch GPP in a more CO_2 independent way.