Geophysical Research Abstracts
Vol. 19, EGU2017-7685, 2017
EGU General Assembly 2017

Concurrent CO_2 and COS fluxes across major biomes in Europe

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The trace gas carbonyl sulfide (COS) has been proposed as a tracer for canopy gross primary production (GPP), canopy transpiration and stomatal conductance of plant canopies in the last few years. COS enters the plant leaf through the stomata and diffuses through the intercellular space, the cell wall, the plasma membrane and the cytosol like carbon dioxide (CO_2). It is then catalyzed by the enzyme carbonic anhydrase in a one-way reaction to hydrogen sulfide and CO_2. This one-way flux into the leaf makes COS a promising tracer for the GPP. However, this approach assumes that the ratio of the deposition velocities between COS and CO_2 is constant, which must be determined in field experiments covering a wide variety of ecosystems.
The overarching objective of this study was to quantify the relationship between the ecosystem-scale exchange of COS and CO_2 and thus, to test for the potential of COS to be used as a universal tracer for the plant canopy CO_2 exchange. Between spring 2015 and summer 2016 we set up our quantum cascade laser at different field sites across Europe. These sites included a managed temperate mountain grassland (AUT), a savanna (ESP), a temperate beech forest (DEN) and a hemiboreal forest (EST). On each of these sites, we conducted ecosystem scale eddy covariance and soil chamber measurements. Since the soil COS flux contribution, especially in grass dominated ecosystems, could not be neglected, we had to derive the actual canopy COS fluxes for all the measurement sites. Using these fluxes we compared the ecosystem relative uptake (ERU) of the sites and searched for factors affecting its variability. We then used the influential factors to scale the ERU to be comparable under different field sites and conditions. Furthermore we also calculated the GPP using conventional CO_2 flux partitioning and compared the results with the approach of using the leaf relative uptake.