Fourth International Conference on Earth System Modelling
4ICESM-127, 2017

Assessing the viability of COS as a proxy for GPP in four major biomes across Europe

F. Kitz (1), F.M. Spielmann (1), A. Hammerle (1), K. Gerdel (1), A. Ibrom (2), O. Kolle (3), M. Migliavacca (3), G. Moreno (4), S.M. Noe (5), M. Gomez-Brandon (6), H. Insam (6), and G. Wohlfahrt (1)

(1) Institute of Ecology, University of Innsbruck, Innsbruck, Austria, (2) Department of Environmental Engineering, Technical University of Denmark, Kongens Lyngby, Denmark, (3) Max Planck Institute for Biogeochemistry, Jena, Germany, (4) Forest Research Group, Universidad de Extremadura, Plasencia, Spain, (5) Institute of Agricultural and Environmental Sciences, Estonian University of Life Sciences, Tartu, Estonia, (6) Institute of Microbiology, University of Innsbruck, Innsbruck, Austria

Flux partitioning, the quantification of photosynthesis and respiration, is a major uncertainty in modelling the carbon cycle and in times when robust models are needed to assess future global changes a persistent problem. A promising new approach is to derive gross primary production (GPP) from measurements of the carbonyl sulfide (COS) flux, the most abundant sulfur-containing trace gas in the atmosphere. This is possible because COS and CO_2 enter the leaf via a similar pathway, are processed by the same enzyme (carbonic anhydrase), but in contrast to CO_2, leaf COS exchange is unidirectional. Prerequisites for using COS as a proxy for photosynthesis is a robust estimation of all non-leaf sources and sinks in an ecosystem and a thorough understanding of the variability of the ecosystem relative uptake (ERU; the value linking CO_2 to COS uptake).

We conducted field campaigns in four major biomes – a managed temperate grassland (AUT), a savannah (ESP), a temperate beech forest (DEN) and a hemiboreal forest (EST) - across Europe. Ecosystem to atmosphere COS and CO_2 fluxes were measured using the eddy covariance technique, soil to atmosphere fluxes were measured using self-built fused silica soil chambers.

The grassland sites were characterized by highly positive soil COS fluxes during daytime and soil COS fluxes around zero during nighttime. In contrast, the soils at the forest sites (Denmark, Estonia), characterized by less radiation on the soil surface, acted as a sink for COS. To investigate the soil contribution further we took soil samples at the study sites and used them to measure COS fluxes under controlled conditions in the lab. Results from the temperate mountain grassland in Austria suggest high initial but rapidly decreasing COS emission from soil mixed with litter, but uptake by soil alone. Those lab measurements were followed up by genetical analyses to link the fluxes to the soil microbial communities present in the samples.

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 ERU of the different sites and tried to identify factors affecting its variability. After calculating the GPP using the COS approach we compared it to GPP values derived from conventional CO_2 flux partitioning techniques (e.g. nighttime respiration). We conclude by strengths and weaknesses of COS as a sensible constraint on GPP.