Concurrent CO_2 and COS fluxes across major biomes in Europe

Felix M. Spielmann 1), Florian Kitz1), Albin Hammerle1), Katharina Gerdel1), Andreas Ibrom2), Olaf Kolle3), Mirco Migliavacca3), Gerardo Moreno4), Steffen M. Noe5), Georg Wohlfahrt1)

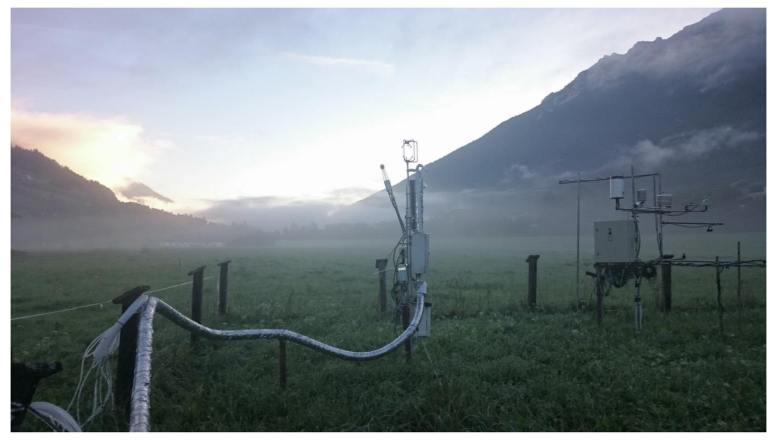
1) University of Innsbruck, Institute of Ecology, Innsbruck, Austria | 2) Technical University of Denmark, Dep. of Environmental Engineering, Kongens Lyngby, Denmark | 3) Max Planck Institute of Biochemistry, Jena, Germany | 4) Universidad de Extremadura, Forest Research, Placencia, Spain | 5) Estonia University of Life Sciences, Institute of Agricultural and Environmental Sciences, Tartu, Estonia

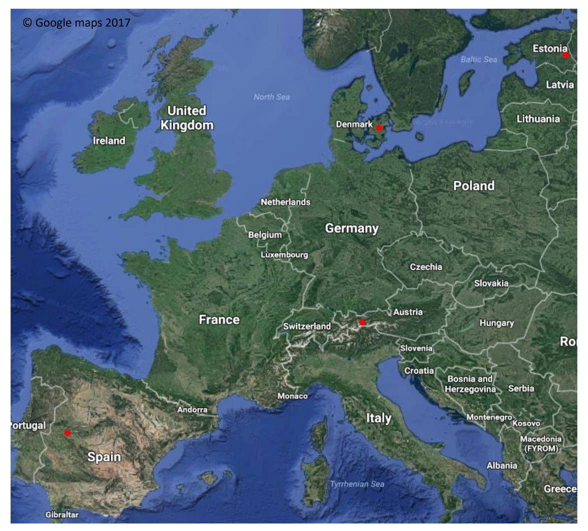
Introduction: The trace gas carbonyl sulfide (COS) has been proposed as a tracer for canopy gross primary production (GPP). COS enters the plant leaf through the stomata and diffuses through the intercellular space, the cell wall, the plasma membrane and the cytosol like carbon dioxide (CO_2). It is 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 (Leaf relative uptake), which must be determined in field experiments covering a wide variety of ecosystems.

In our study we conducted eddy covariance and soil chamber measurements using a Quantum cascade laser (QCL) (Aerodyne-Research Inc).

At different field sites across Europe:

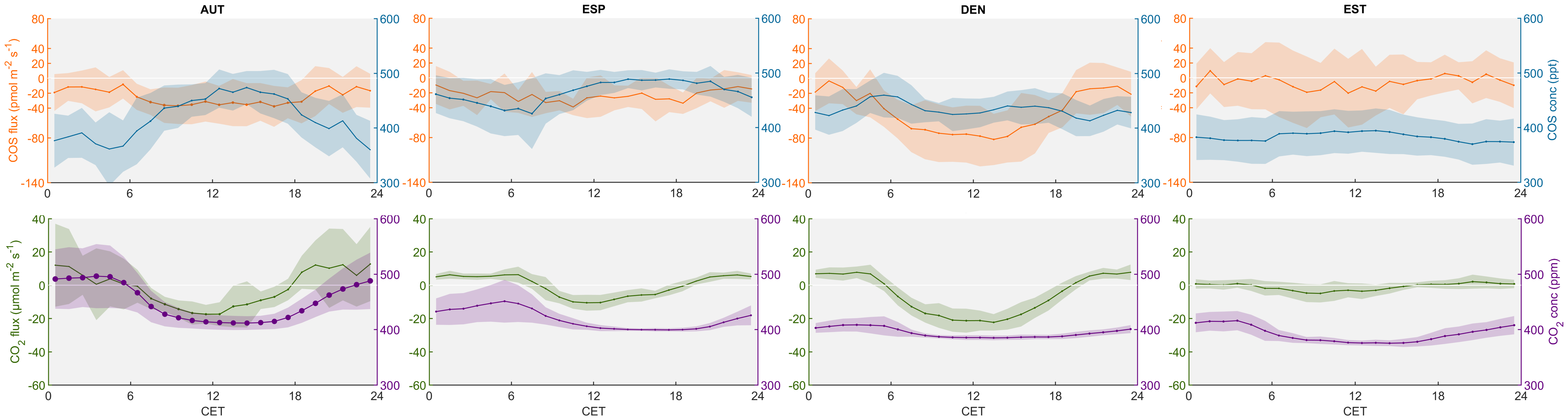
- Neustift (Austria) – managed temperate grassland 07-09/15
- Sorø (Denmark) – temperate beech forest 06/16
- Las Majadas (Spain) – mediterranean savanna ecosystem 05/16
- Järvselja (Estonia) – hemiboreal coniferous forest 08/16 **[once-over]**



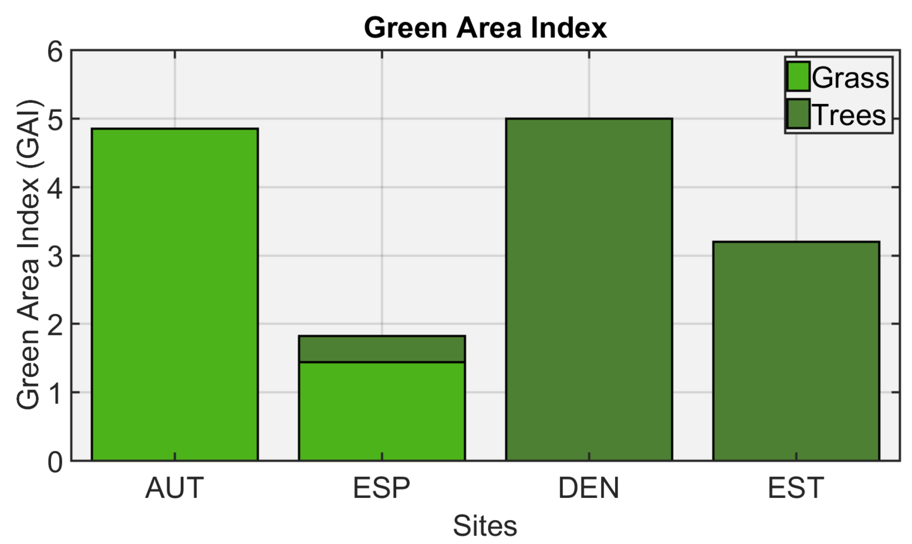


Relative uptake

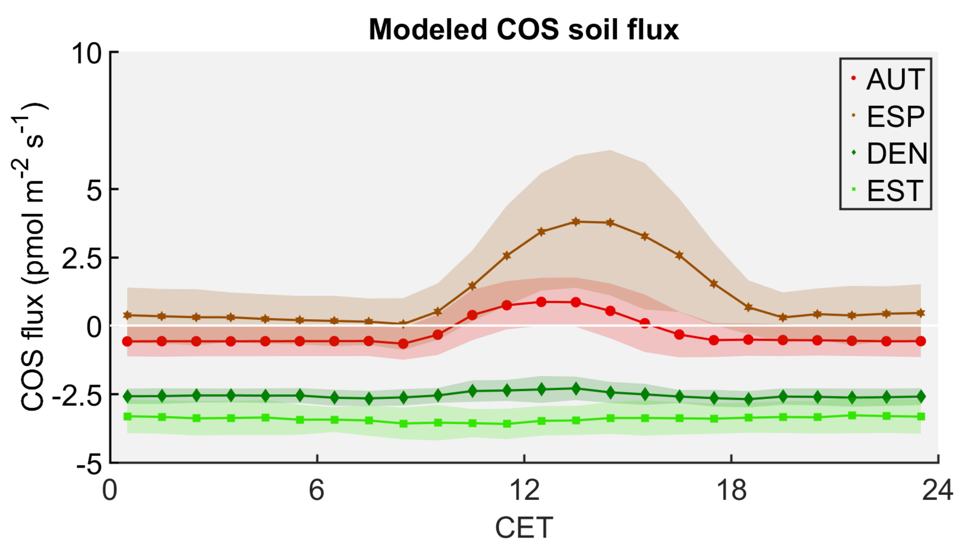
$$RU = \frac{\frac{Flux\ COS}{Concentration\ COS}}{\frac{Flux\ CO_2}{Concentration CO_2}}$$



(I) Mean daily variation of COS (orange/blue) & CO_2 (green, purple) ecosystem fluxes & ambient concentrations. The shaded area indicate the standard deviation.



(II) Green Area Index for all field sites separated into grass- and tree-dominated



(III) Mean daily variation of modeled COS soil fluxes. The shaded area indicates the standard deviation.

Results:

During night time the soil acted as a small sink for COS at all field sites. The flux turned into emission on grass dominated ecosystems during daytime.

We observed COS uptake at ecosystem level at all sites during day and night. The COS fluxes showed a diurnal pattern with stronger COS uptake during midday at all sites.

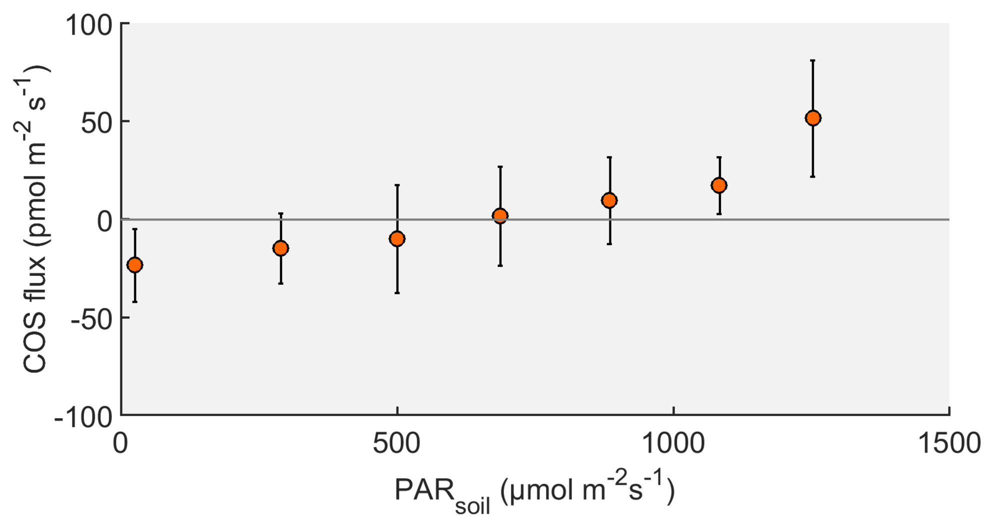
The ERU/ CRU rates were only stable during high light conditions and increased in low light reflecting increasing impairment of photosynthesis.

Conclusion:

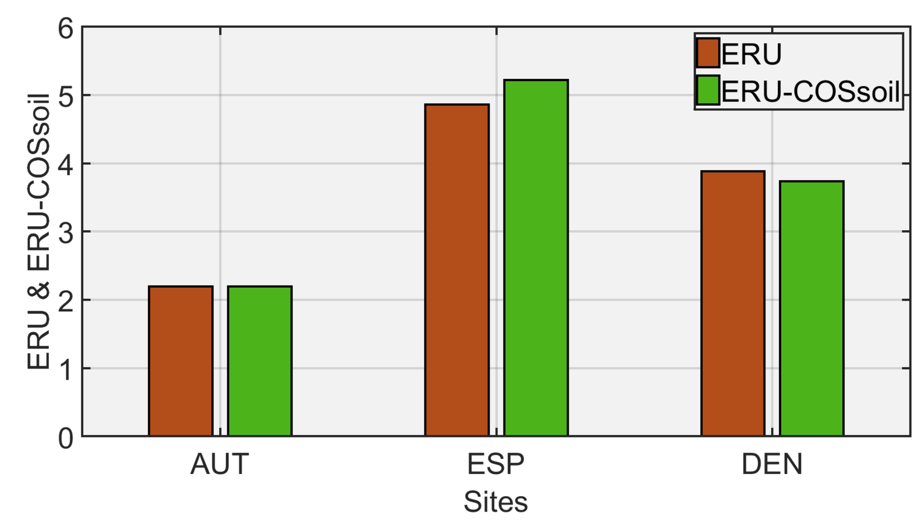
Soil fluxes were small compared to canopy fluxes, but can't be neglected at sites with sparse canopies, where more light was reaching the soil surface. To calculate the gross primary production at ecosystem level soil fluxes have to be accounted for.

Although the COS and CO_2 uptake follow the same pattern at ecosystem level during daytime, the relative uptake differed quite strong between the sites.

The use of COS to infer the GPP might not be as straight forward as previously suggested and more data from a larger variety of ecosystems/environmental conditions are needed.



(V) Ecosystem COS-flux plotted against the **P**hotosynthetic **A**ctive **R**adiation reaching the soil surface at the Austrian Field Site.



(IV) **E**cosystem **R**elative **U**ptake & COSsoil corrected **ERU** > 500 PAR

www.biomet.co.at | Contact: Felix.M.Spielmann@gmail.com