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Carbonyl sulfide (COS) as a tracer to constrain surface carbon fluxes

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The potential use of COS as tracer of CO_2 flux into leaves associated gross primary productivity (GPP), and separately from CO_2 flux associated with ecosystem respiration (Re), stimulate research on COS-CO_2 interactions during biosphere-atmosphere gas exchange. This is based on the observation that COS co-diffuse with CO_2 into vegetation, but without an emission outflux. Recent advances in laser spectroscopy and the availability of high precision field deployable quantum cascade laser systems resulted in accumulation of new results from laboratory-scale control experiments, field studies, atmospheric measurements and, in turn, large scale modeling. These studies demonstrate the potential in the COS application to carbon cycle research, but also highlight key uncertainties, such as associated with soil uptake of COS. Soil uptake is based on dissolution and hydrolysis in soil moisture, which can be enhanced by carbonic anhydrase (CA) that can exist in soil and litter and microorganisms. Our recent in-situ measurements over the diurnal cycle and across a range of ecosystems and tree species supported the idea of a robust COS to CO_2 uptake ratio of near 1.6, and indicated that soils act mostly as a relatively small COS sink, equivalent to 2-6% of canopy uptake during peak activity period. The results also indicated that small soil net COS emission can be observed under certain conditions. The importance of CA activities has been demonstrated in soils in CO_2 studies using stable isotopes (18O), and for COS in leaves using anti-sense lines, but quantifying its importance for soil COS uptake is still lacking. Measurements in canopy air showed that the daily co-variation between COS and CO_2 reflects the interplay among the effects of soil, leaf and atmospheric boundary layer dynamics. Further extending observations to background tropospheric measurements of the seasonal drawdown in CO_2 and in COS demonstrates that comparing the drawdowns of COS, CO_2 and its 13C, could provide additional constraints on the differential responses of photosynthesis and respiration, such as associated with C3 and C4 vegetation. Developing the use of COS as a powerful tracer of photosynthetic CO_2 fluxes at all scales can help improve prediction of future responses of the terrestrial biosphere to changing environmental conditions.

Key words
Carbonyl sulfide, COS, Carbonic anhydrase, CA, ecosystem respiration, GPP, Biosphere-atmosphere interactions, soil COS uptake.

References

Asaf D, Rotenberg E, Tatarinov T, Dicken U, Montzka SA & Yakir D (2013) Ecosystem photosynthesis inferred from carbonyl sulfide flux measurements. Nature GeoScience, 6, 186-190; DOI: 10.1038/NGEO1730

Berry J, Wolf A, Campbell E, Baker I, Blake N, Blake D, Denning AS, Kawa SR, Montzka SA, Seibt UY, Stimler K, Yakir D Zhu Z (2013) A coupled model of the global cycles of carbonyl sulfide and CO_2: A possible new window on the carbon cycle. J. Geophys. Res.: Biogeochem. 118, doi 10.1002/jgrg.20068, 2013

Stimler K, Berry JA, Montzka S, Yakir D (2011) Association between COS uptake and 18D during gas exchange in C3 and C4 leaves. Plant Physiol. Doi 10.1104/pp.111.176578