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Biogeosciences Discussions

Interactive comment on "Reviews and Syntheses: Carbonyl Sulfide as a Multi-scale Tracer for Carbon and Water Cycles" *by* Mary E. Whelan et al.

D. Baldocchi (Referee)

baldocchi@berkeley.edu

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Reviews and Syntheses: Carbonyl Sulfide as a Multi-scale Tracer for Carbon and Water Cycles

Given the growing activity in this field, it seems a good time to produce a review on COS (OCS) as a tracer for photosynthesis and the possible pros and cons of this method, what are the sinks or sources of soils, litter and water bodies and how to scale from leaves, ecosystems, biomes and oceans

I suspect this paper has been very well vetted internally because nearly every expert in the field is a co author. This is reflected by its excellent shape.

Overall, I find the scholarship very high and it is a useful summary of the key literature

on a variety of scales, processes and ecosystems. It talks about processes, sources and sinks in major pools and uncertainties of the budgets. Good summary tables are produced. And the authors take the opportunity to produce a bottom up budget on the basis of the literature they reviewed and the uncertainties attributed to these terms. Kudos.

I am sure this paper will be useful to the community and well cited in the future. Overall this is a first rate review paper and the team is to be commended.

I only have a few philosophical issues to raise with the accuracy and utility of COS measurements and interpretations.

The difficulty of implementing more measurements of COS fluxes involve the extremely expensive sensor, using a quantum cascade tunable diode laser spectrometer and the need to resolve precise detection of fluctuations of COS on a very small background concentration. And to date few year round measurements of OCS fluxes are available to compare with eddy covariance estimates of GPP from CO2; a point noted in the paper. So in some regards this may remain a boutique measurement available only to a few well funded teams and for used in seasonal or episodic comparison mode.

Some of the other advantages of using COS include inversion of global concentration fields to estimate global photosynthesis. Yet, I strongly feel these estimates remain very high and I wonder if we have improved our understanding of global photosynthesis. It was hard to track down a number of global GPP in the Campbell paper, but buried deep in the supplemental information are quotes of 175 PgC/y. This is much higher than the quoted range of 107 to 152 PgC/y. I would argue that global GPP of 175 PgC/y is not defensible; I tend to favor values in the 110 to 120 PgC/y range. To my understanding if this was true the biosphere would be taking up all the CO2 emitted; flux networks clearly show that ecosystem respiration is about 0.8 of annual GPP; this would leave a net sink of 35 PgC/y, far more than C lost by human activity, natural fires and land use change. So I do encourage this community to strongly rethink the errors

and biases associated with estimating global GPP with COS. I don't think things have improved, yet. But as a scientist I am open to multiple constraints of complex systems and welcome and value the use of COS to help constrain current estimates of global GPP based on models, remote sensing, SIF and upscaling of flux neworks. All are needed to work together to my mind. My other pet peeve with the COS community is their use of Equation 1; I have raised this point in many papers I have reviewed in the past and will do so again here.

FOCS = FCO2[OCS][CO2]-1 vOCS/CO2 (1)

This is wrong from first principles and may only be used on the basis of some assumptions, that the compensation points of OCS and CO2 are zero! From first principles we should use

Fcos/FCO2=(gCOS(COS(air)-COS(internal)))/(gCO2(CO2(air)-CO2(internal)))

We do know from physiology that CO2 experiences a compensation point, eg 40 to 50 ppm for C3 plants. This issue raised here may help explain some of the complication of interpreting data from mixed C3/C4 grasslands as noted in this review. I would contend that not accounting for compensation points accounts for the skewed distribution in Figure 3 of LRU!

And surprise, I see that the aquatic community does use a version of Ohm's law to compute fluxes in their environment, as noted in Eq 2. So there remains a major disconnect between theory and application of the water and leaf communities that need to be acknowledged in this paper and resolved for the future.

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