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Recent advances in developing COS as a tracer of Biosphere-atmosphere exchange of CO_2

D. Asaf, K. Stimler, and D. Yakir
Weizmann Institute of Science, Environmental Sciences and Energy Research, Israel (dan.yakir@weizmann.ac.il)

Potential use of COS as tracer of CO_2 flux into vegetation, based on its co-diffusion with CO_2 into leaves without outflux, stimulated research on COS-CO_2 interactions. Atmospheric measurements by NOAA in recent years, across a global latitudinal transect, indicated a ratio of the seasonal drawdowns in COS and CO_2 (normalized to their respective ambient concentrations) of about 6. We carried out leaf-scale gas exchange measurements of COS and CO_2 in 22 plant species of deciduous, evergreen trees, grasses, and shrubs, under a range of light intensities and ambient COS concentrations (using mid IR laser spectroscopy). A narrow range in the normalized ratio of the net uptake rates of COS and CO_2 (termed leaf relative uptake; LRU) was observed with a mean value of 1.61 ± 0.26. These results reflect the dominance of stomatal conductance over both COS and CO_2 uptake, imposing a relatively constant ratio between the two fluxes, except under low light conditions when CO_2, but not COS, metabolism is light limited. A relatively constant ratio under common ambient conditions will facilitate the application of COS as a tracer of gross photosynthesis from leaf to global scales. We also report first eddy flux measurements of COS/CO_2 at the ecosystem scales. Preliminarily results indicate a ratio of the COS flux, Fcos, to net ecosystem CO_2 exchange, NEE, of 3-5 (termed ecosystem relative uptake; ERU). Combining measurements of COS and CO_2 and the new information on their ratios at different scales should permit the direct estimation of gross CO_2 uptake, GPP, by land ecosystems according to: GPP=NEE*ERU/LRU. In addition, we show that COS effect on stomatal conductance may require a special attention. Increasing COS concentrations between 250 and 2800 pmol mol-1 (enveloping atmospheric levels) stimulate stomatal conductance. It seems likely that the stomata are responding to H2S produced in the leaves from COS.