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Carbonyl sulfide (COS) as a tracer for plant carbon and water cycling: how do recent models from COS science perform in a controlled ecosystem?

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A promising tracer for partitioning the global balance of CO_2 is carbonyl sulfide (COS or OCS), a trace gas with shared leaf-level mechanisms to CO_2 and H_2O. A number of studies have used COS to derive insights into photosynthesis and transpiration at ecosystem to global scales. Though it remains unclear whether COS reflects photosynthesis or stomatal conductance most strongly, as its leaf biochemical and physical processes are not perfectly analogous to CO_2 and H_2O. Recent work to characterize COS soil fluxes (e.g., microbial consumption[1] and coupled biological-abiotic emissions[2]) has advanced our ability to isolate leaf-level information from other ecosystem components. There is a need to evaluate the models that encapsulate our current understanding of leaf and soil COS fluxes and predictions of carbon and water cycling against independent constraints in tractable experimental systems.

Here, we describe a controlled and constrained experimental mesocosm in which fluxes of COS, CO_2, and H_2O were measured at ecosystem and soil scales and were compared to independent constraints on carbon and water cycling (i.e., CO_2 and H_2O isotopes), vegetation dynamics, and soil biological and abiotic properties. Our study system is the miniature replica (1 m^2) of the large Landscape Evolution Observatory (LEO) hillslopes (330 m^2) housed in the University of Arizona Biosphere 2 infrastructure and filled with 1-m deep basaltic soil from a bare soil state to a vegetated ecosystem. I will present the results of our aims to determine: 1) whether soil COS fluxes are significant and related to soil physical and microbial factors, including carbonic anhydrase gene diversity, 2) how plants and plant-microbe interactions influence COS fluxes, and 3) how well ecosystem-scale COS fluxes track photosynthesis and stomatal conductance.

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