Geophysical Research Abstracts
Vol. 18, EGU2016-993-2, 2016
EGU General Assembly 2016


# Modelling the impact of soil Carbonic Anhydrase on the net ecosystem exchange of OCS at Harvard forest using the MuSICA model

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The exchange of $CO_2$ between the terrestrial biosphere and the atmosphere is driven by photosynthetic uptake and respiratory loss, two fluxes currently estimated with considerable uncertainty at large scales. Model predictions indicate that these biosphere fluxes will be modified in the future as $CO_2$ concentrations and temperatures increase; however, it still unclear to what extent.
To address this challenge there is a need for better constraints on land surface model parameterisations. Additional atmospheric tracers of large-scale $CO_2$ fluxes have been identified as potential candidates for this task. In particular carbonyl sulphide (OCS) has been proposed as a complementary tracer of gross photosynthesis over land, since OCS uptake by plants is dominated by carbonic anhydrase (CA) activity, an enzyme abundant in leaves that catalyses $CO_2$ hydration during photosynthesis. However, although the mass budget at the ecosystem is dominated by the flux of OCS into leaves, some OCS is also exchanged between the atmosphere and the soil and this component of the budget requires constraining.
In this study, we adapted the process-based isotope-enabled model MuSICA (Multi-layer Simulator of the Interactions between a vegetation Canopy and the Atmosphere) to include the transport, reaction, diffusion and production of OCS within a forested ecosystem. This model was combined with 3 years (2011-2013) of in situ measurements of OCS atmospheric concentration profiles and fluxes at the Harvard Forest (Massachussets, USA) to test hypotheses on the mechanisms responsible for CA-driven uptake by leaves and soils as well as possible OCS emissions during litter decomposition. Model simulations over the three years captured well the impact of diurnally and seasonally varying environmental conditions on the net ecosystem OCS flux. A sensitivity analysis on soil CA activity and soil OCS emission rates was also performed to quantify their impact on the vertical profiles of OCS inside the canopy and the net OCS exchange with the atmosphere.