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Integrating field measurements of carbonyl sulfide, chlorophyll fluorescence and biosphere modelling to constrain photosynthesis.

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The dominant sink of carbonyl sulfide (COS) by vegetation makes COS relevant for studies on the biosphere-atmosphere exchange. Recent efforts to measure all components of COS exchange over a boreal forest ecosystem in Hyytiälä, Finland, have shown that COS uptake is strongly dependent on stomatal conductance. Modelling approaches could benefit from this strong stomatal control and use COS to improve estimates of Gross Primary Productivity (GPP). For the application of COS as GPP tracer, we need a proper characterisation of all sources and sinks of COS. The soil exchange of COS, for example, is typically smaller than the vegetative sink, but needs to be considered when we want to constrain the global COS budget. We are currently implementing the soil exchange of COS in the Simple Biosphere Model (SiB4) and are validating the simulated soil and leaf exchange of COS with the measurements made in Hyytiälä on leaf, soil, and ecosystem fluxes of COS. The COS soil flux implementation in SiB4 will later be used to run SiB4 globally, coupled to the atmospheric chemistry transport model TM5-4DVar. This work is part of a bigger project that aims to integrate measurements of COS mole fractions and isotopologues into an inverse modelling framework to better constrain the COS budgets and global distributions of COS in the troposphere and stratosphere.

Besides the validation of the model, we use leaf measurements of COS and CO_2 fluxes and chlorophyll fluorescence in boreal Scots Pine to provide better constraints on photosynthesis. The results strengthen previous findings that in contrast to COS, CO_2 uptake is primarily limited by light. Instead, COS uptake is more strongly limited by stomatal conductance than CO_2 uptake is, which needs to be considered when COS flux measurements are used to interpret changes in photosynthesis.