



COS as a GPP proxy: Long-term ecosystem scale COS flux measurements over a boreal forest

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Carbonyl sulfide (COS) is the most abundant sulfur compound in the atmosphere, with global average tropospheric mixing ratio around 500 ppt. COS has been suggested to be a useful proxy for photosynthesis (described by gross primary production, GPP) as it shares the same pathway with carbon dioxide (CO₂) in the leaf stomata but, in contrast to CO₂, is not respired back to the atmosphere. Traditionally GPP is defined from ecosystem scale measurements of CO₂ flux taking into account respiration defined from the night-time CO₂ flux data. During recent years, ecosystem scale studies of COS have increased in number, yet only one multi-year study has been published over a temperate forest. In this study we measured COS and CO₂ exchange over a boreal forest in Finland using eddy covariance (EC) technique during years 2013–2017, complemented by two years of soil and branch chamber measurements. GPP is defined from both the traditional method and direct COS flux measurements, taking into account radiation dependency in leaf relative uptake (LRU) ratio, that defines the leaf-scale normalized ratio of COS to CO₂ assimilation rates. Flux measurements are examined together with different environmental factors – such as temperature, moisture and radiation – to find the most significant COS flux drivers and possible differences with the two GPP methods, as well as deficiencies in COS as a proxy for photosynthesis. To our knowledge, this is the first multi-year study on ecosystem scale COS exchange over a boreal forest, even though the boreal region covers 30 % of the Earth's total forest area.