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Identification and quantification of sources and sinks of carbonyl sulfide

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Carbonyl sulfide (COS) is used as a tracer for gross primary production (GPP) of terrestrial ecosystems and stomatal conductance of leaves. At present, sources and sinks of COS have not been fully assessed, as proven by the poor agreement between the modelled global budget and the most recent measurements. This uncertainty limits both the existing and potential future applications of COS. To understand sources and sinks of COS, the atmospheric station in Lutjewad (53°24'N, 6°21'E, 1m a.s.l.) performs continuous in situ mole fraction profile measurements. Nighttime COS fluxes of -3.0 ± 2.6 pmol m^{-2} s^{-1} were determined using the radon-tracer correlation approach. In three occasions between 2014 and 2018, COS enhancements ranging between 100 and 1000 ppt were measured in Lutjewad at 7, 40 and 60 meters above ground level. To identify the sources of these enhancements, both discrete and in situ samples were collected in the province of Groningen to be analysed with a quantum cascade laser spectrometer (QCLS). Several COS sources were identified, such as biodigesters, sugar production facilities and silicon carbide production facilities. These sources were added to the available databases, at a 0.1°x0.1° resolution. To simulate the initial dispersion, they were assumed to spread latitudinally and longitudinally over grids of 0.5°x0.5° width, as bidimensional Gaussian distributions. The updated databases were then combined with a Stochastic Time-Inverted Lagrangian Transport (STILT) model to check the influence of these sources on the Lutjewad measurements. Current results suggest a strong influence on the mole fraction of COS related to air parcels transported from known industrial sources, in particular from the Antwerp (51.2° N, 4.4° E) and Rotterdam (51.9° N, 4.5° E) regions. However, a mismatch still persists and preliminary results suggest that a local influence could explain the gap between modelled and measured COS concentrations. Possibly, COS emissions from these sources fluctuate according to different factors, such as the production rate of a specific facility or particular events. On the other hand, it is also possible that the enhancements in Lutjewad could be explained by scaling up the results to regional, national or international levels, adding similar facilities to the current databases. Nonetheless, these results could provide a useful insight about new sources of COS that could contribute to a more precise

assessment of the global budget of this gas species.