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A top-down approach of potentially complicating factors for using carbonyl sulfide (COS) to assess regional-scale GPP in western France

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Tracking atmospheric carbonyl sulfide (COS) could help better assessing how much carbon dioxide land ecosystems take up for photosynthesis (Campbell et al., 2017; doi:10.1029/2017EO075313). Recent discoveries have introduced new complications in COS budgets which could decrease the promise of COS as a tracer of gross primary productivity (e.g. soil uptake, dark uptake by plants, ecosystem and anthropogenic sources). We investigated on an hourly basis the diurnal and seasonal variations of atmospheric surface concentrations from August 2014 to July 2017 at Gif-sur-Yvette, a suburban atmospheric measurement site in France. Vertical profiles were also measured with an infra-red spectrometer at a high tower located about 80 km away from GIF (TRN ICOS station). Both surveys generally showed nighttime net uptake of COS. COS fluxes and deposition velocities were calculated for nocturnal situations of low boundary layer height using the Radon-Tracer Method. Nighttime COS uptake rates (Fcos) ranged from -1.5 to -32.8 pmol.m-2.s-1 and were, on average, equal to -7.3 $\pm$ 4.5 pmol.m-2.s-1 (n= 198). We found that dark uptake by plants does not dominate nighttime COS fluxes. Moreover, strong similarities between COS and molecular hydrogen (H2) dry deposition velocities (v) were found in terms of annual mean and ranges of variation, and data showed linear correlation between the two (vCOS/vH2= 1.4, n= 97). This study provides strong evidence of the loss of COS near the ground via non-photosynthetic processes but this is not that much a complicating factor because of the absence of seasonality in Fcos and vCOS. Conversely, an ecosystem source of COS was detected each year in June-July. From the surveys carried out during major pollution events over the Parisian area it can be concluded that the region is free of anthropogenic sources of COS. Sporadic pollution events generally coinciding with air masses transported from Germany and Central Europe occur in winter, the origin of which was tentatively attributed to coal power plant exhausts.