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Investigation of global atmospheric carbonyl sulphide between 2004 and 2018: an observational and modelling study

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The challenge in quantifying the sources and sinks of atmospheric carbon dioxide (CO_2) is that the CO_2 taken up by plants during photosynthesis cannot be distinguished from the CO_2 released by plants and micro-organisms during respiration. It has been shown that carbonyl sulfide (OCS), the sulphur-containing analogue of CO_2, can be used as a proxy for photosynthesis. The relationship between the vegetative flux of OCS and CO_2 has been quantified for various species of plants and ecosystems, the results of which have been used in observing the relationship on a continental scale. The aim of this project is to both quantify the location and magnitude of the sources and sinks of atmospheric OCS, and to use these data to infer photosynthetic uptake of CO_2 by vegetation on a global scale.

A tracer version of the 3-dimensional chemical transport model TOMCAT has been adapted to include eleven different sources and sinks of OCS, including direct and indirect oceanic emissions, vegetative uptake and stratospheric photolysis. The modelled OCS (TOMCAT-OCS) distribution between 2004 and 2018 has been co-located spatially and temporally to OCS profiles measured by the Atmospheric Chemistry Experiment (ACE-FTS) over the 5 – 30 km altitude, showing generally good agreement. Furthermore, surface TOMCAT-OCS has been compared to OCS measurements made at twelve NOAA-ESRL sites, across both hemispheres, showing that the model captures the seasonal cycle at the surface.

There have been several calls in recent years for a new satellite product of atmospheric OCS, which this project aims to satisfy. Work is ongoing to retrieve OCS total columns from measurements taken by the Infrared Atmospheric Sounding Interferometer (IASI) instruments on-board the MetOp satellites. The University of Leicester IASI Retrieval Scheme (ULIRS) has been adapted to retrieve OCS columns globally. Various case studies for different geographic regions and time periods will be presented and compared to other satellite observations.