Isotopic Measurements: A New Tool for Studying Global Carbonyl Sulfide

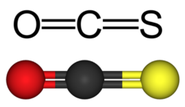
Sophie Baartman[1], Elena Popa[1], Thomas Röckmann[1], Maarten Krol[1,2]

[1]Institute for Marine and Atmospheric research Utrecht, Utrecht University, [2]Department of Meteorology and Air Quality, Wageningen University and Research Center

Introduction

Carbonyl Sulfide:

- Atmospheric concentration: 500 parts per trillion (ppt)
- Lifetime of about 2 years
- Sources: oceans, industry
- Sinks: terrestrial biosphere, photolysis in stratosphere

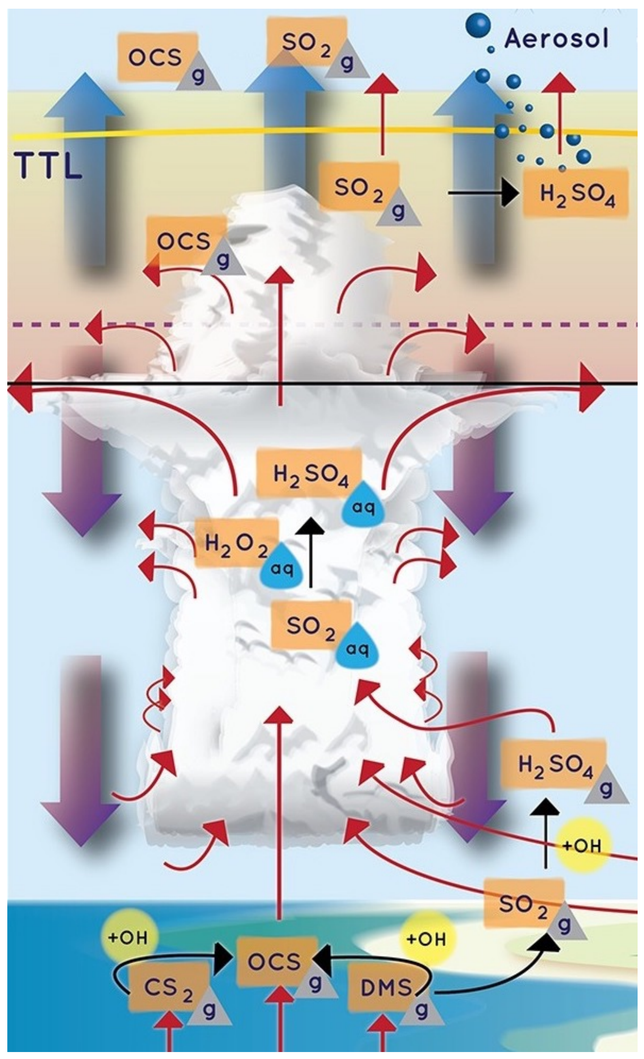


COS in the biosphere

There is much uncertainty about the sensitivity of Gross Primary Production (GPP) to climate change. GPP cannot be measured directly. COS follows essentially the same pathway during photosynthesis as CO_2, but in a one-way reaction → **use COS as a tracer for GPP**

Stratospheric Sulfur Aerosols

Because of its long lifetime, COS is transported into the stratosphere where it is converted into H_2SO_4 → aerosols. These aerosols reflect incoming solar radiation and thereby have a cooling effect on the climate



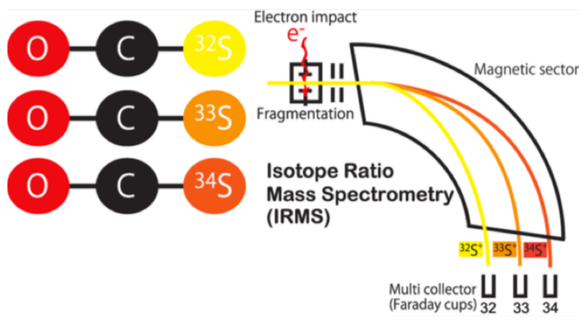
Formation of aerosols from COS and SO_2 (adapted from Kremser et al. [2016])

COS-OCS Project

- **Perform the first world-wide characterization of COS isotopologues**
- **Measure seasonal, latitudinal and altitudinal variations in troposphere and stratosphere**
- **Investigate COS fractionation effects**
- **Constrain the global budget of COS and CO_2**

This project: COS isotopologues

- Measure S^+ fragment ions from COS
- Gas Chromatograph-Isotope Ratio Mass Spectrometry (GC-IRMS)
- Samples: atmospheric measurement stations, North-South transect (cruise ship), stratospheric samples (aircraft and balloon samples)
- HEMERA 2020: stratospheric balloon sampling in Sweden



Measuring S^+ fragment ions from COS using GC-IRMS (adapted from Hattori et al. [2015])

Isotopic fractionation

Discrimination between isotopes by physical or chemical processes

COS photolysis example:

$$CO^{32}S + h\nu \xrightarrow{\text{faster}} CO + S$$

$$CO^{34}S + h\nu \xrightarrow{\text{slower}} CO + S$$

Remaining pool becomes enriched in heavy isotope

Each source has an isotopic signature → quantify sources and understand processes

References

Kremser, S. et al. (2016), Stratospheric aerosol—Observations, processes, and impact on climate, Reviews of Geophysics, 54(2), 278–335.

Hattori, S., A. et al. (2015), Determination of the Sulfur Isotope Ratio in Carbonyl Sulfide Using Gas Chromatography/Isotope Ratio Mass Spectrometry on Fragment Ions 32S +, 33S +, and 34S , Anal. Chem., 87(1), 477–484.

Contact: S.L.Baartman@uu.nl

COS-OCS website: `http://cos-ocs.eu/`

This project has received funding from the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation programme under grant agreement No 742798

Universiteit Utrecht

IMAU Institute for Marine and Atmospheric research Utrecht