

# Measuring isotopes of carbonyl sulfide

BBOS 2019

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Sophie Baartman<sup>1</sup>, Elena Popa<sup>1</sup>, Maarten Krol<sup>1,2</sup>, Thomas Röckmann<sup>1</sup>

<sup>1</sup>Utrecht University, <sup>2</sup>Wageningen University and Research



# Climate change

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- Limit and mitigate climate change → model predictions
- Uncertainties in climate modelling
  - Carbon sink biosphere and soil
  - Stratospheric chemistry → aerosol formation
- How to best quantify photosynthesis?
- What is the main source of stratospheric sulfur aerosols (SSA)?

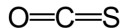




# Climate change

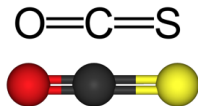
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**We can use carbonyl sulfide!**

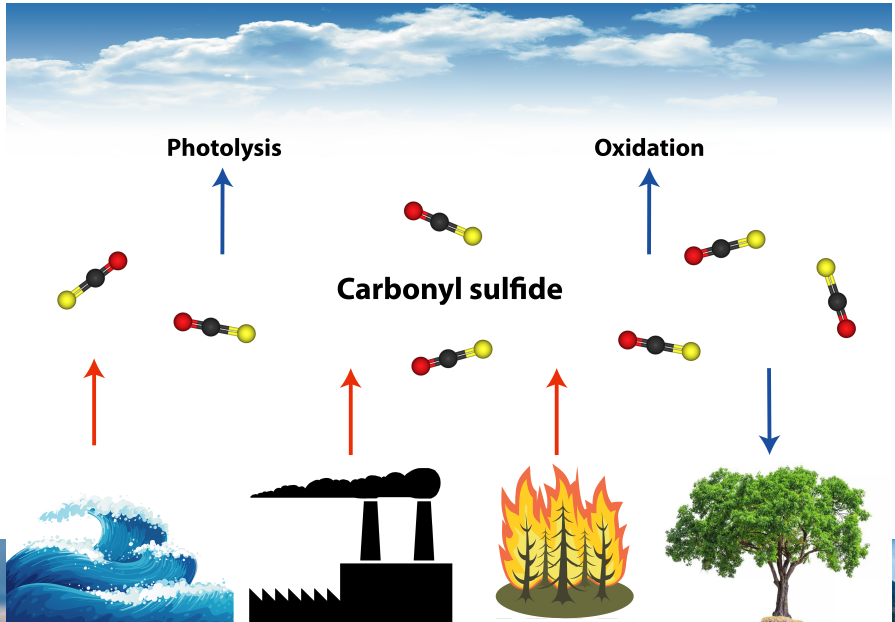


## Carbonyl sulfide (COS or OCS)

- Most abundant sulfur containing trace gas
- 500 parts per trillion (ppt)
- Lifetime of about 2 years
- Travels into the stratosphere

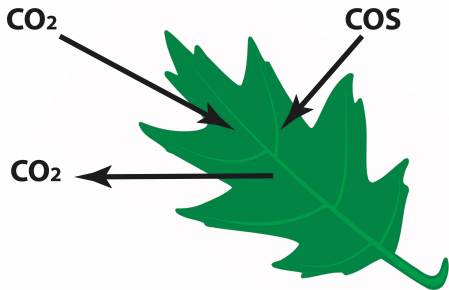


# Carbonyl sulfide cycle



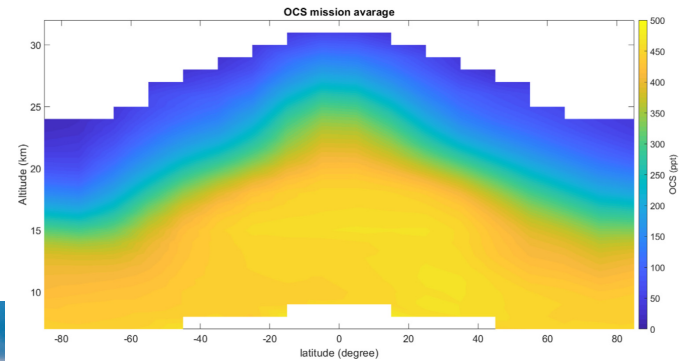
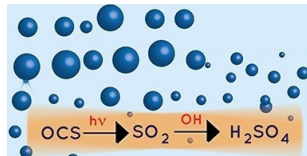
# COS in the biosphere

- Biosphere  $\text{CO}_2$  exchange: uptake and respiration
- COS uptake: one-way reaction
- COS uptake related to  $\text{CO}_2$  uptake
- Use COS as a tracer for photosynthesis

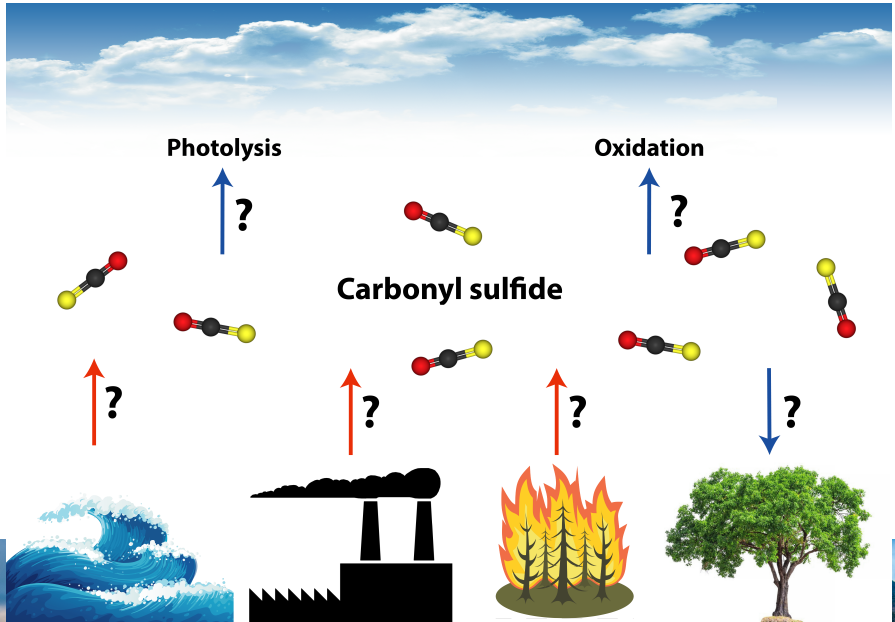


# COS in the stratosphere

- COS broken down by oxidation and photolysis
- Largest contributor to stratospheric sulfur aerosols

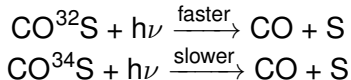


# Carbonyl sulfide cycle



# COS isotopes

- **Isotopes:** "atoms that have the same number of protons and electrons but different number of neutrons and therefore have different physical properties"
- Sulfur: mass 32, 33, 34 and 36
- Can help close the budget by:
  - Characterizing sources
  - Understanding chemical processes



## $\delta$ notation

$$^{34}R = \frac{^{34}S}{^{32}S} \quad (1)$$

$$\delta = \frac{R_{\text{sample}} - R_{\text{standard}}}{R_{\text{standard}}} * 1000\text{‰} \quad (2)$$

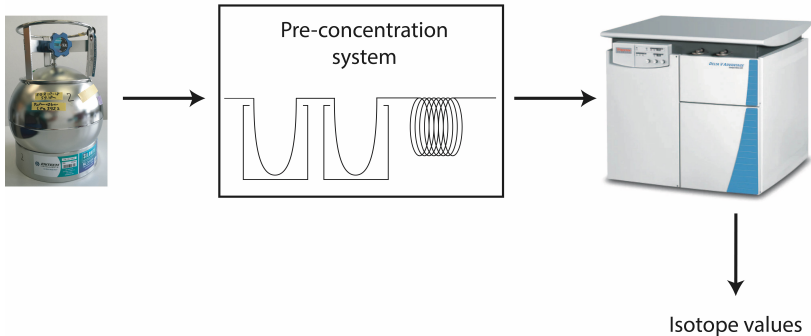
Positive  $\delta \rightarrow$  enriched in heavy isotope

Negative  $\delta \rightarrow$  depleted in heavy isotope



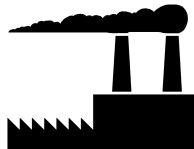
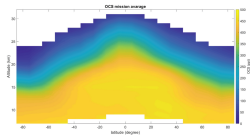


# Measuring COS isotopes



Low concentration → Very challenging!!

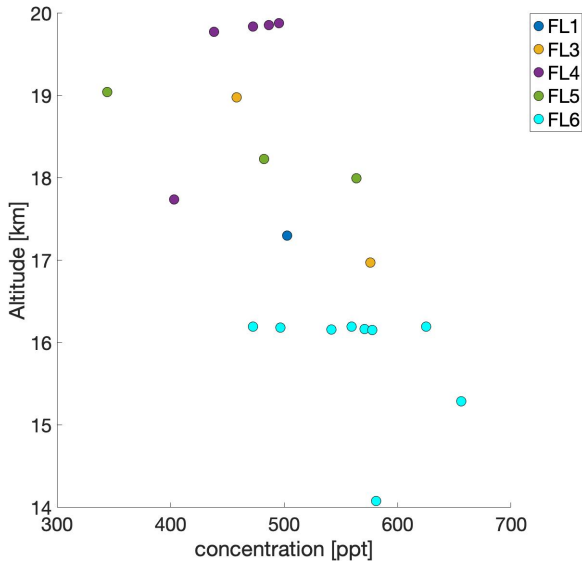




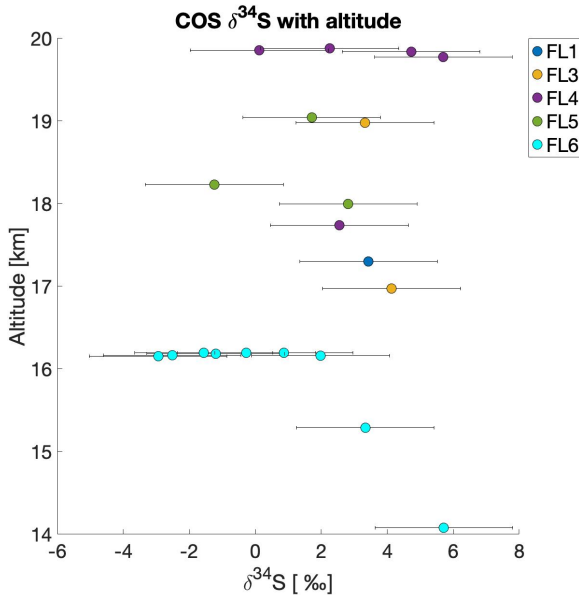
- Campaign with high altitude research aircraft
- Kathmandu
- Samples between 10 and 20 km
- COS isotopes in stratosphere never measured before



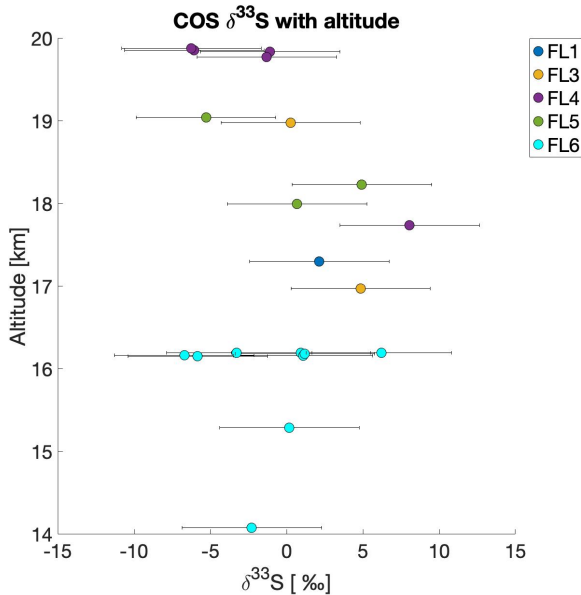
# First results StratoClim



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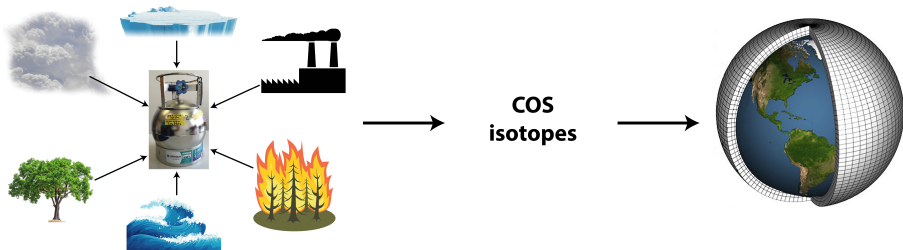


# More stratospheric samples

- HEMERA2020: balloon sampling in Sweden
- August or September 2020
- Up to 35 - 40 km!
- High latitude



# Combining the data



- COS-OCS project:

- Measurements
- Modelling
- Satellite observations

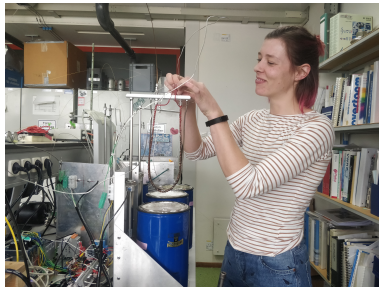


constrain COS and CO<sub>2</sub> budgets





## Questions?



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

