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Measuring isotopologues of carbonyl sulfide

COS modelling meeting, Rotterdam,
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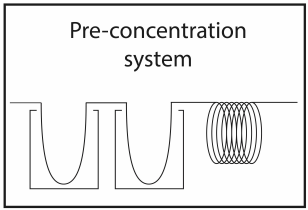
COS isotopologues

- Can help understand the budget by:
  - Characterizing sources
  - Understanding processes
- S isotopes from COS

^{32}S	^{33}S	^{34}S	^{36}S
95.02%	0.75%	4.21%	0.02%

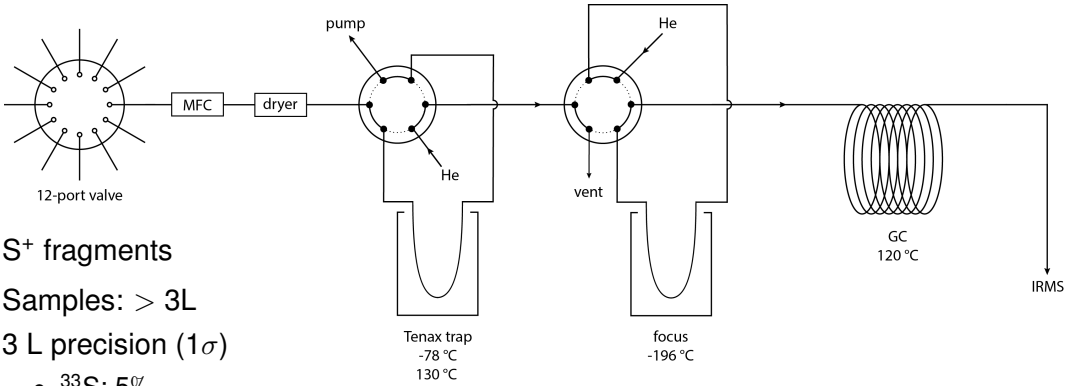
$$CO^{32}S + h\nu \xrightarrow{\text{faster}} CO + S$$
$$CO^{34}S + h\nu \xrightarrow{\text{slower}} CO + S$$

Measuring COS isotopes



Raw data → Data correction → Isotope ratios

Pre-concentration system

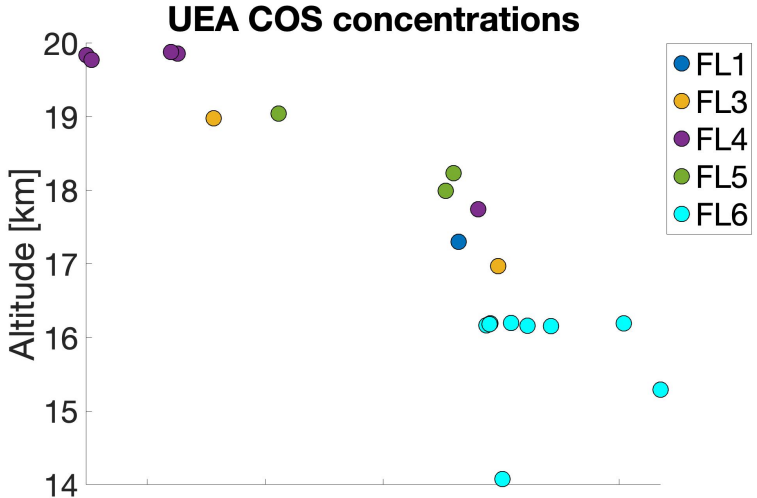


- S^+ fragments
- Samples: $>$ 3L
- 3 L precision (1σ)
  - ^{33}S: 5‰
  - ^{34}S: 2‰

System status

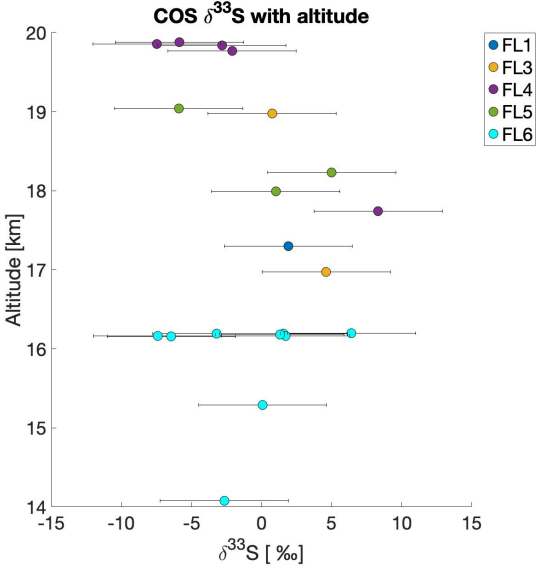
- COS trapping efficiency: 100%
- Tested influence of materials, dryer and pump
- Trying to increase signal $\rightarrow$ increase precision
- Set up system for measuring from outside the building
- Calibration to international standard still needed

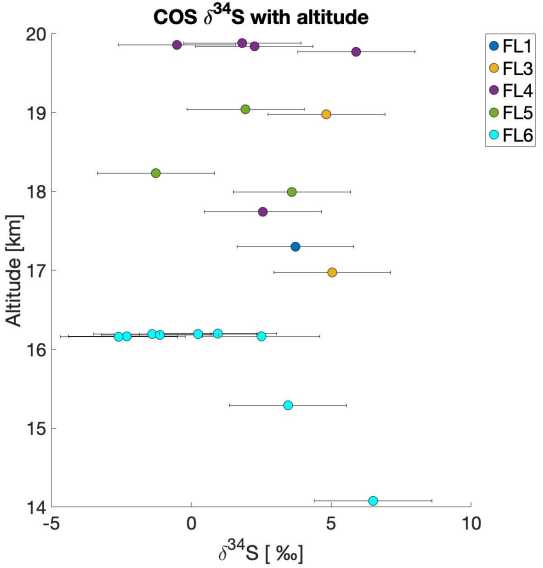
First results StratoClim



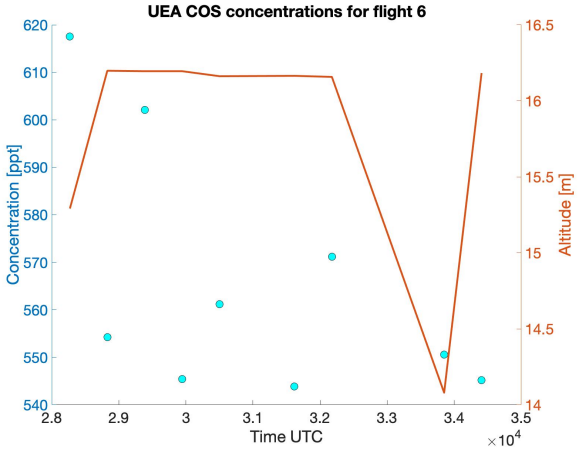
Adcock, K., Laube, J. (unpublished data)

First results StratoClim

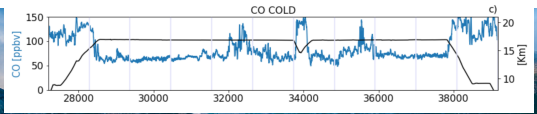




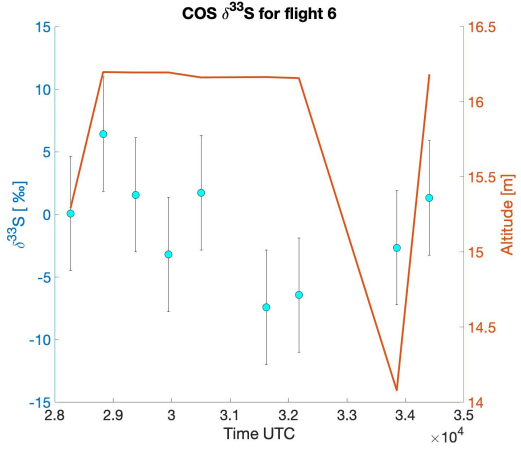
Flight 6 StratoClim

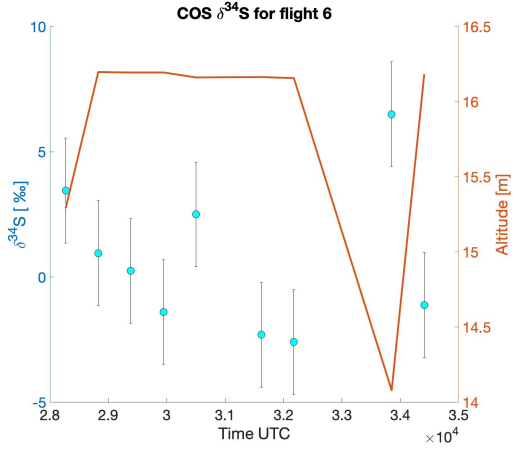


Bucci et al.(in review)



Flight 6 StratoClim





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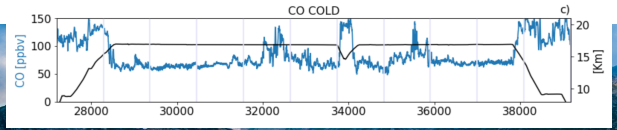


HEMERA 2020

- Balloon sampling in Kiruna, Sweden
- August or September 2020
- Sampling up to 35 km
- Strong signal expected

Future plans

- Increase precision
- Calibration
- Set up method for C and O isotopes from COS
- Measure samples
  - Stratosphere: StratoClim, NASA ATom, HEMERA
  - Diurnal and seasonal cycles: outside air from Utrecht (already in progress)

Summary

- Developed system for measuring S isotopes from COS
- Small sample measurements possible: from 3 L
- Can measure outside air continuously
- Increase in signal and precision needed

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

δ notation

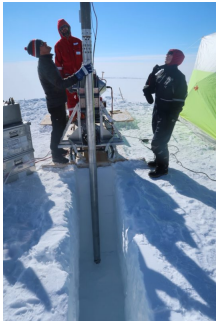
$$^{34}R = \frac{^{34}S}{^{32}S} \tag{1}$$

$$\delta = \frac{R_{sample} - R_{standard}}{R_{standard}} * 1000‰ \tag{2}$$

Positive $\delta \rightarrow$ enriched in heavy isotope

Negative $\delta \rightarrow$ depleted in heavy isotope

Results: EGRIP 2018 firn



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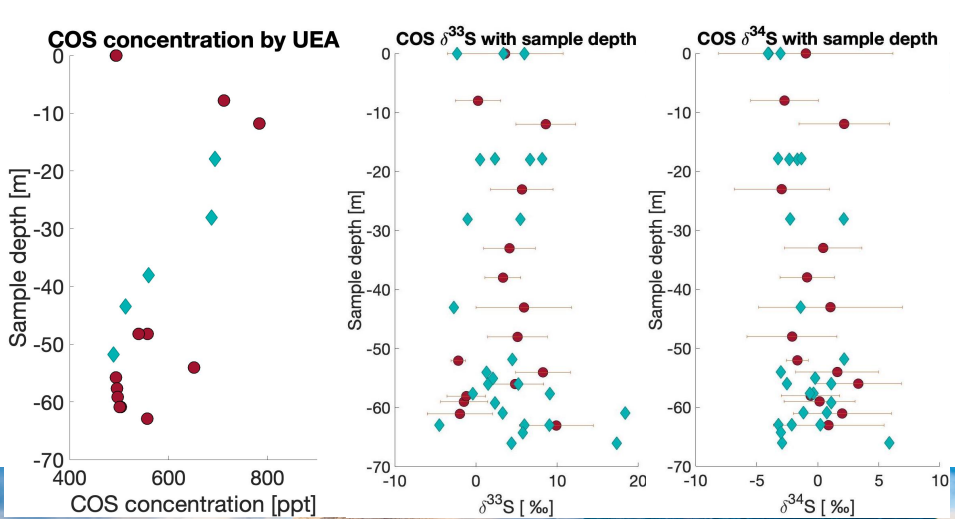
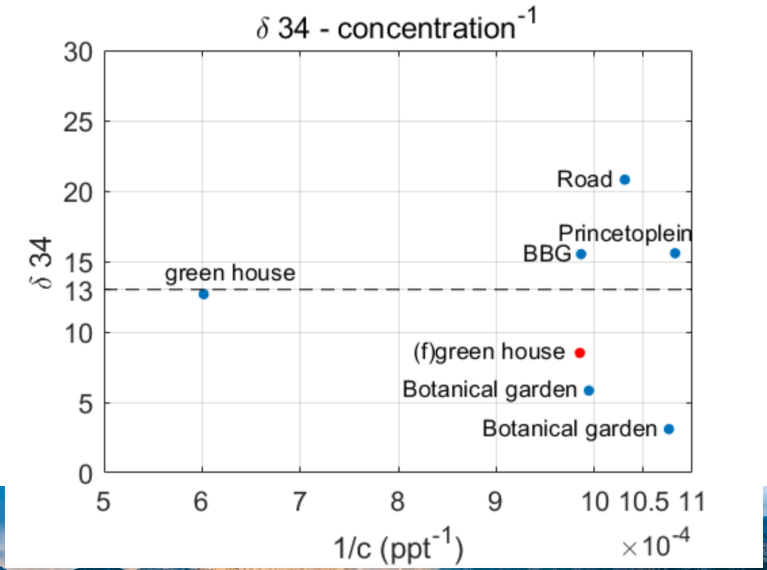
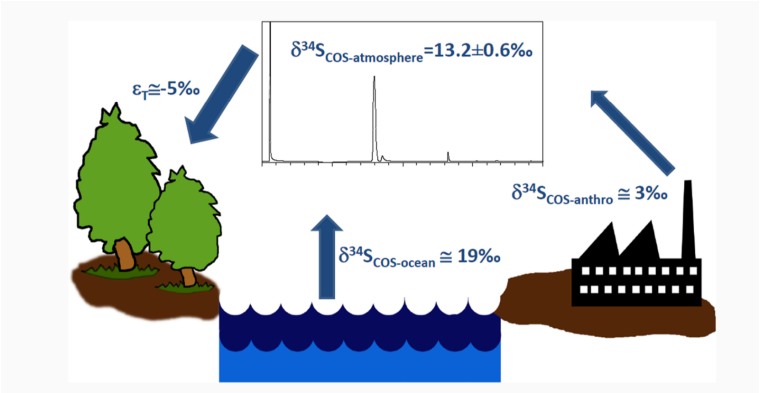


Student project results




$\delta^{34}S_{COS\text{-}atmosphere}$=13.2±0.6‰
ε_T≅-5‰
$\delta^{34}S_{COS\text{-}anthro}$ ≅ 3‰
$\delta^{34}S_{COS\text{-}ocean}$ ≅ 19‰