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Carbonyl Sulfide (OCS) in the stratosphere

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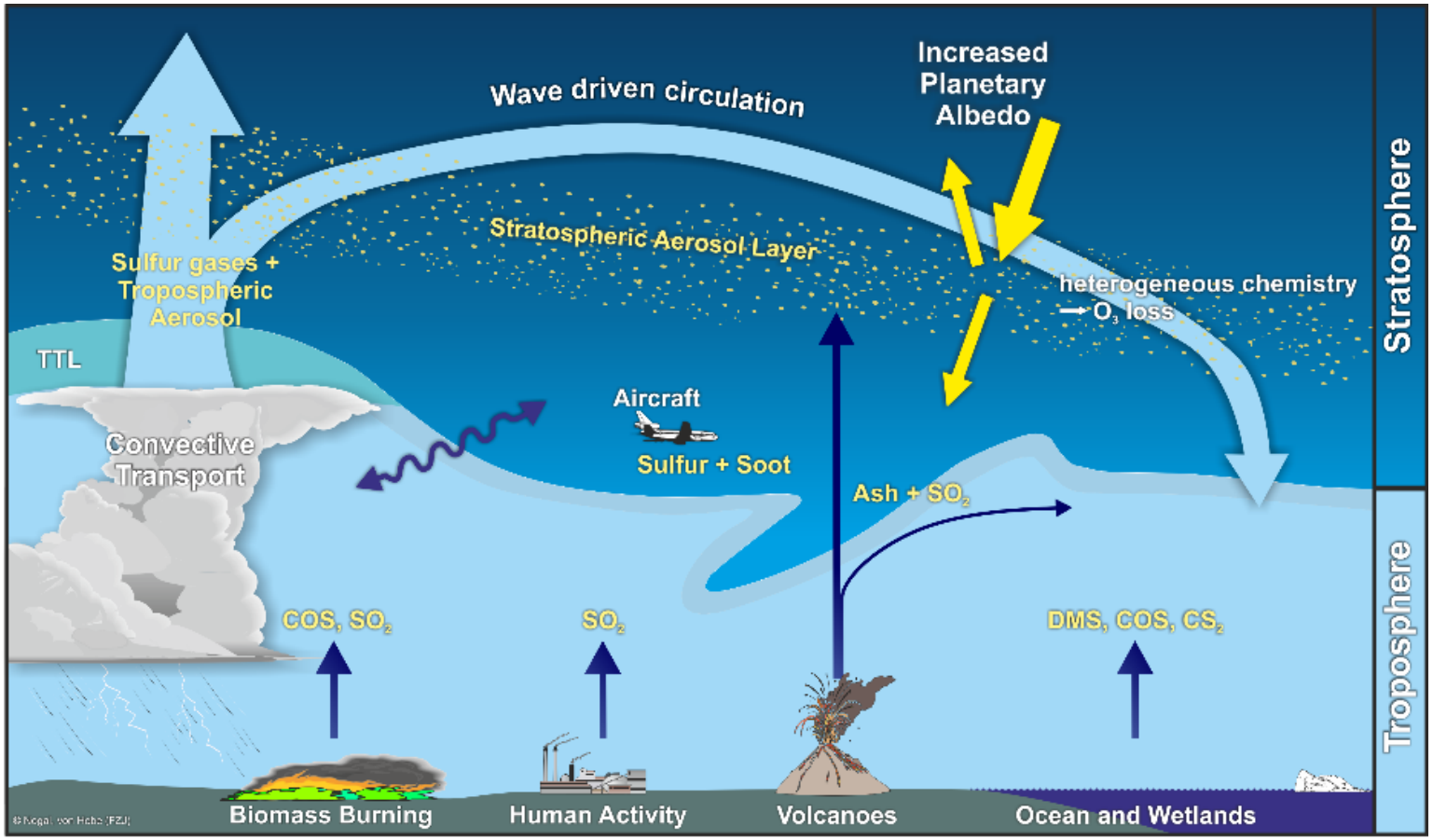
Introduction: Carbonyl sulfide (OCS)

⟶ Carbonyl sulfide: O=C=S, Sources and Sinks

- Most abundant sulfur containing gas in the atmosphere in the absence of volcanic eruptions
- Long tropospheric lifetime of 2-6 years
- OCS is photolyzed and the sulfur oxidized and condensed to aerosols, contributing to the stratospheric aerosol layer



Broad Overview of the project

→ ACE-FTS and AMICA

ACE-FTS

- Satellite based solar occultation spectrometer
- Vertical resolution: 3km
- Profiles of over 30 chemical species

AMICA

- Airborne in-situ absorption spectrometer
- Time resolution: 1Hz
- Measured species: OCS, CO_2, CO, H_2O (HCN, C_2H_2)

Global and in-situ high resolution measurements of carbonyl sulfide (OCS)

➢ *Scientific analysis of the OCS data set*

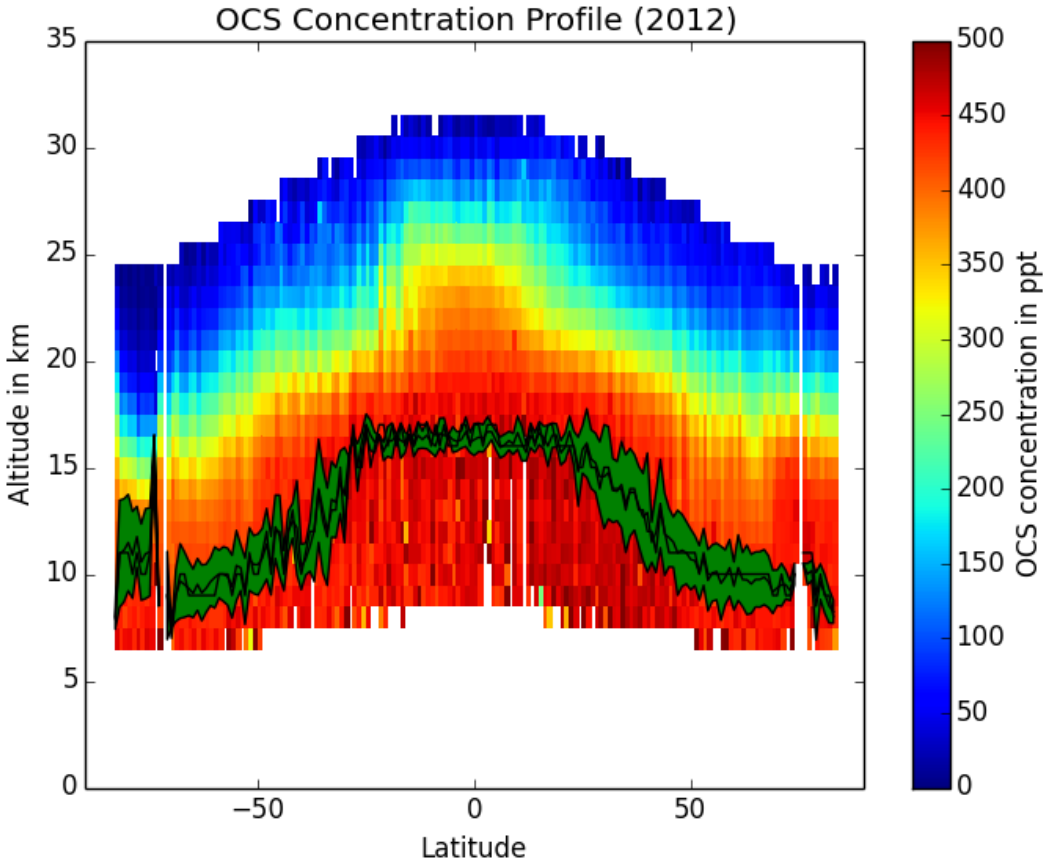
➢ *Development of the instrument*
➢ *Operation at campaigns*
➢ *Scientific analysis*

OCS with ACE-FTS

→ Stratospheric OCS Burden

- The mean of all profiles along all latitudes, during the year 2012 is taken
- The ECMWF thermal tropopause is used here: indicated in green
- Stratospheric OCS burden 2012:
  ~ 515 Gg
  ≙ 275 Gg S

→ Excellent agreement with Sheng et al. 2015 (283.1 Gg S)



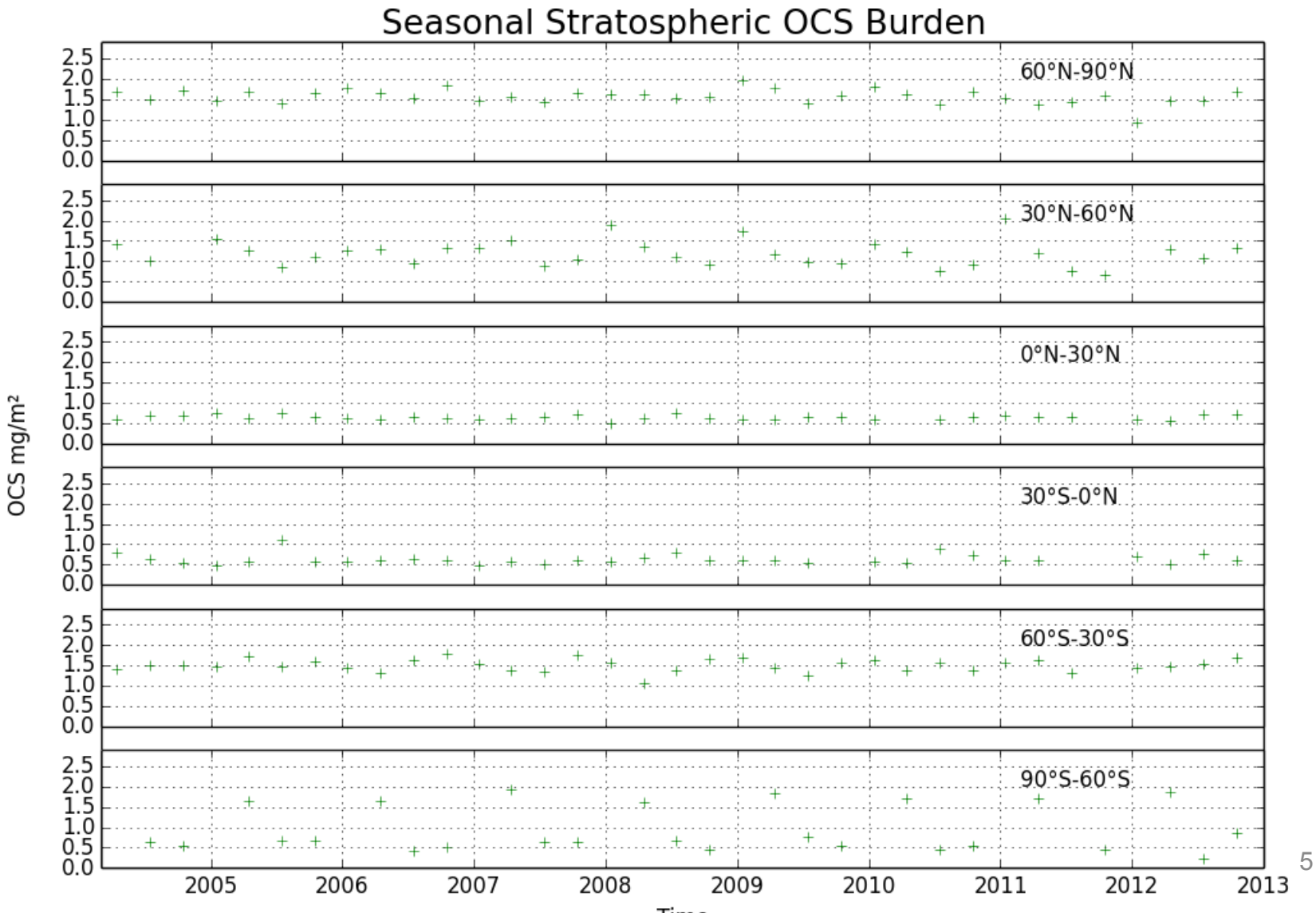
→ Decreasing OCS mixing ratios with stratospheric age

→ OCS concentration distribution as expected (Barkley et al. 2008)

→ ~10% of atmospheric OCS is situated in the stratosphere
(Estimate of total atmospheric OCS burden by Barkley et al., 2008: 5.34 Tg)

OCS with ACE-FTS

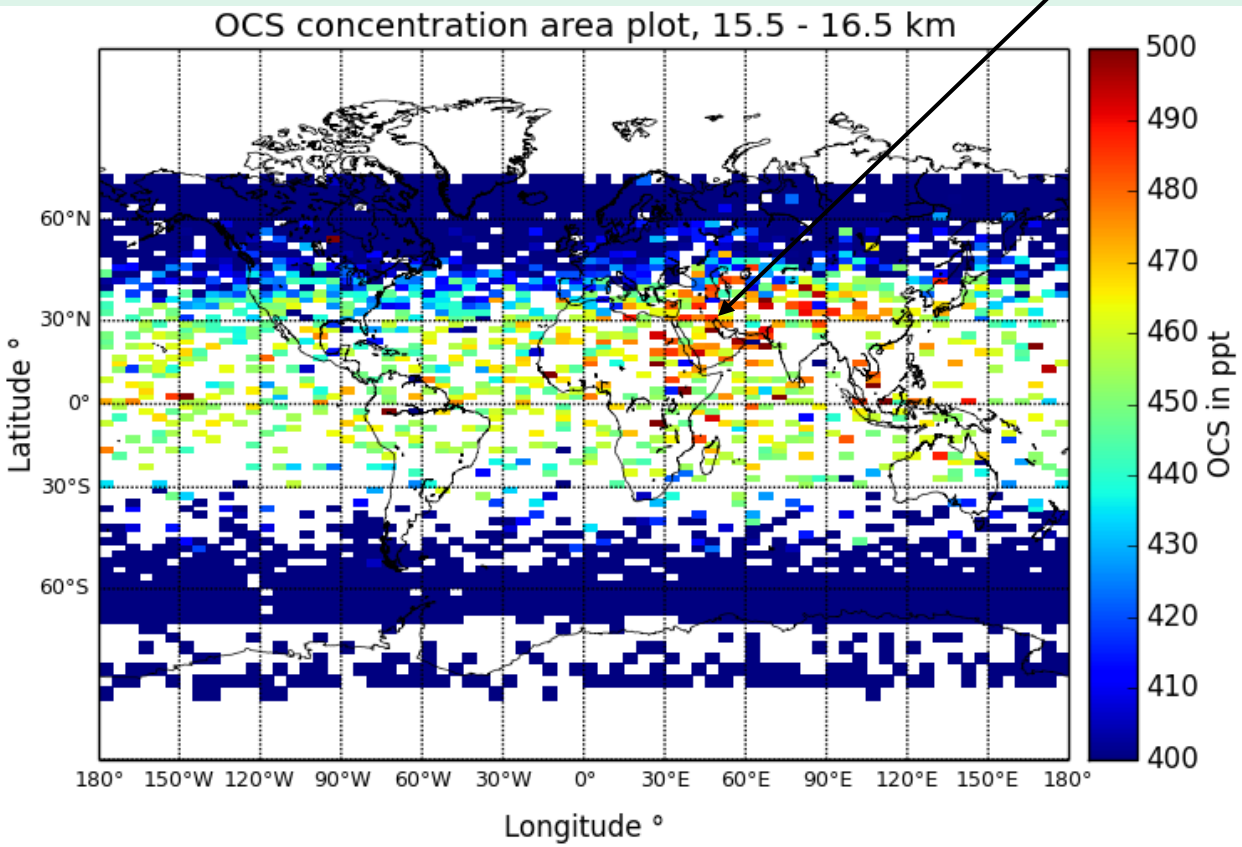
→ Stratospheric OCS Burden time line



OCS with ACE-FTS

⟶ Global OCS distribution during the Asian Monsoon

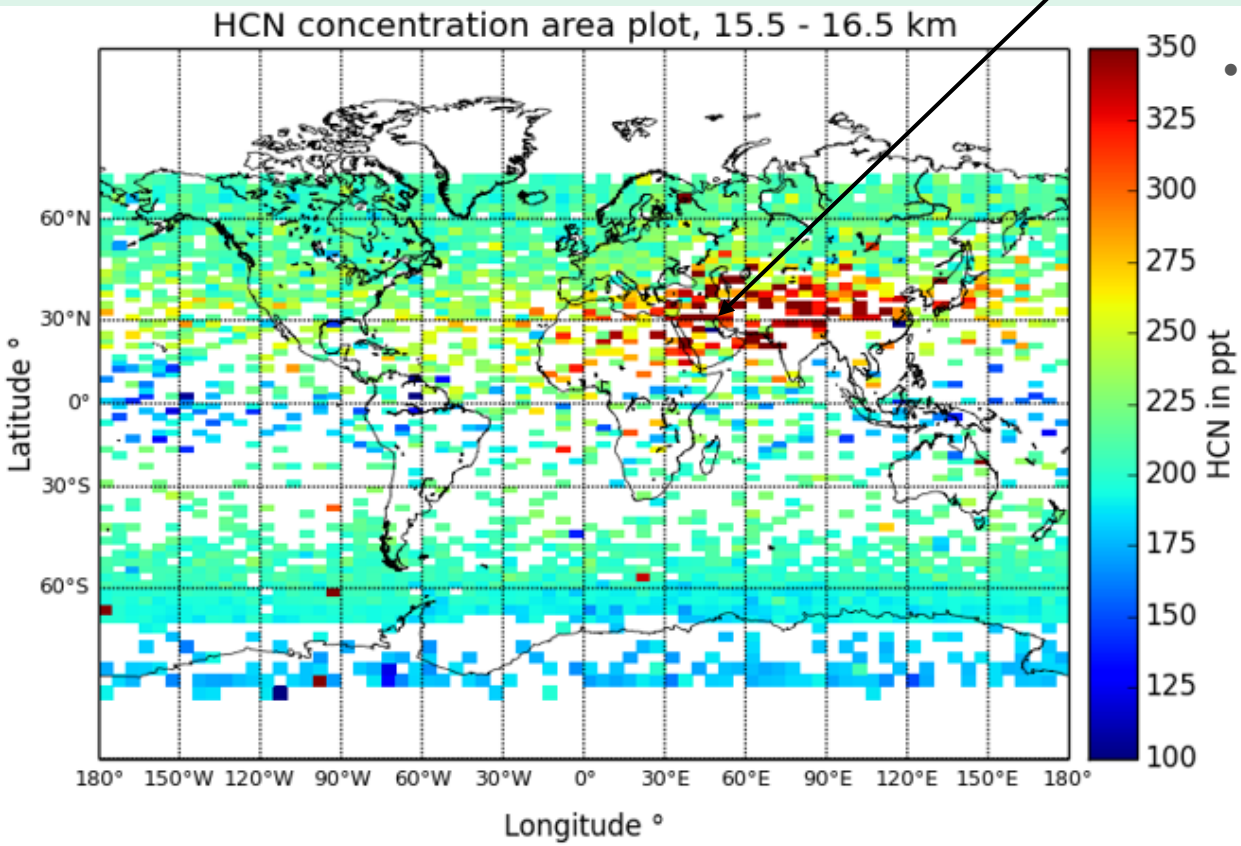
- Averaged OCS mixing ratios during the Asian Monsoon season (June-August) at 15.5 -16.5 km altitude
- A significant increase of OCS mixing ratios in the Asian Monsoon Anticyclone



OCS with ACE-FTS

→ Global OCS distribution during the Asian Monsoon

- Averaged HCN mixing ratios during the Asian Monsoon season (June-August) at 15.5 -16.5 km altitude
- A significant increase of HCN mixing ratios in the Asian Monsoon Anticyclone



- HCN signature, extended from Park et al. (2008)

OCS with ACE-FTS

⟶ Global OCS distribution during the Asian Monsoon

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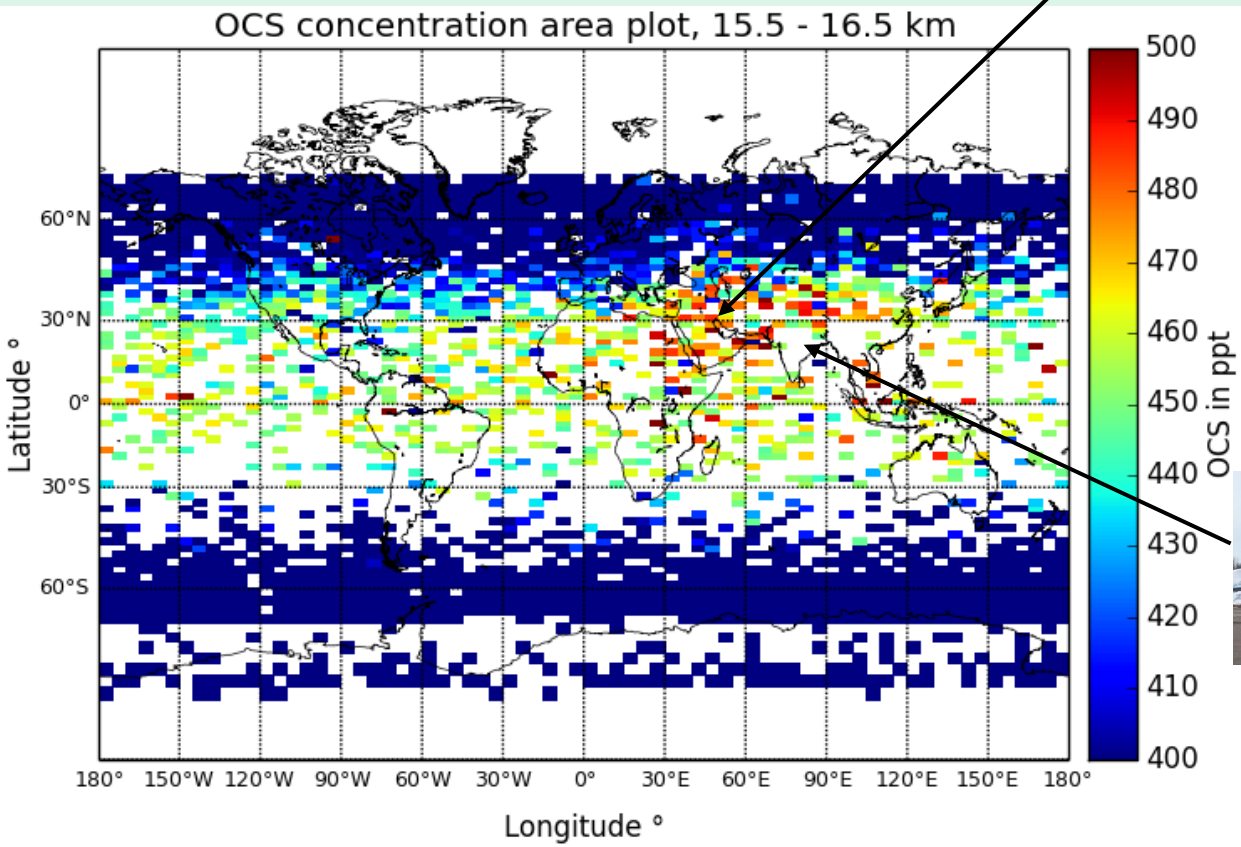
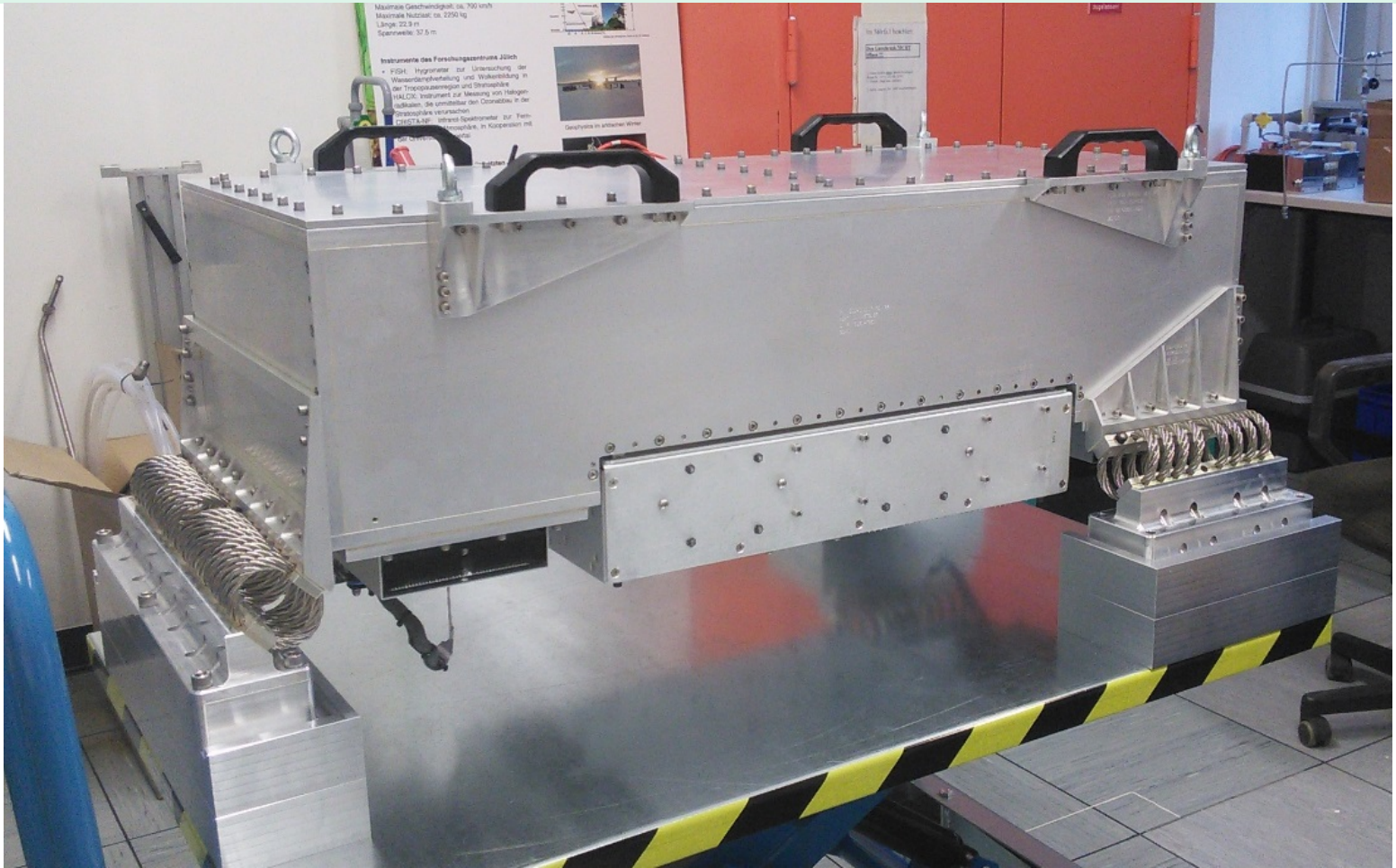


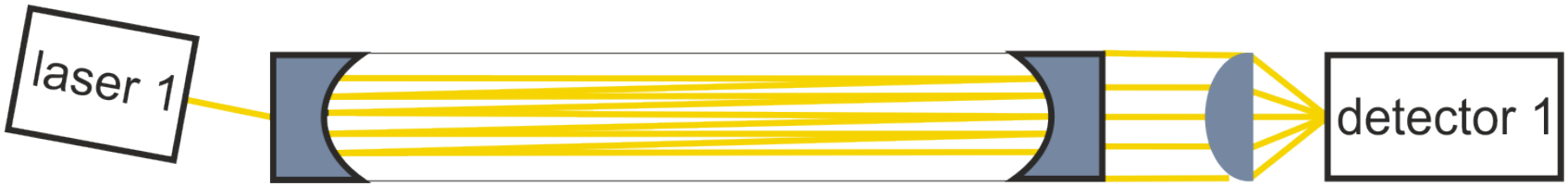
AMICA (Airborne Mid-Infrared Cavity enhanced Absorption Spectrometer)

- Weight: 140 kg
- 104cm x 40cm x 30cm *(without feet)*

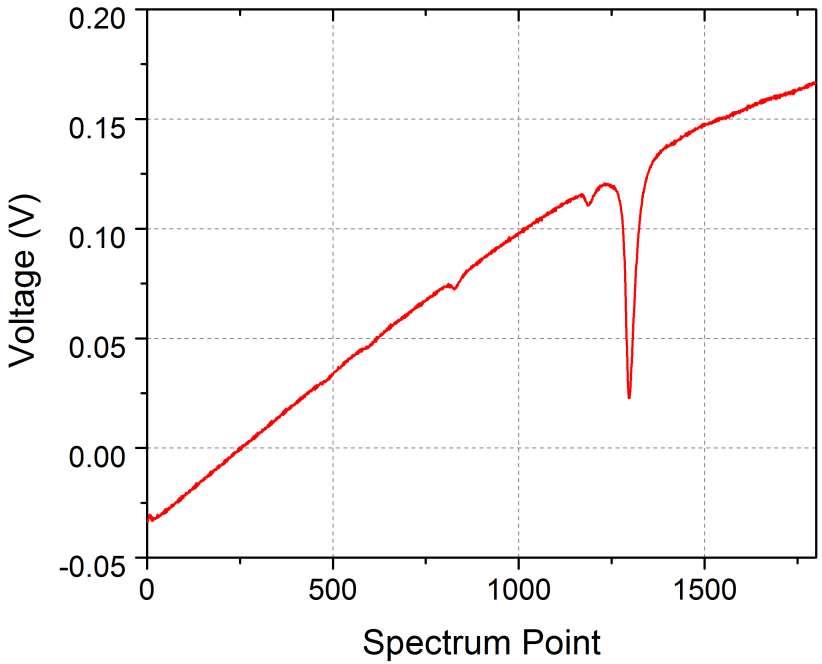


Measurement technique
→ ICOS

- **OA-ICOS: O**ff **A**xis-**I**ntegrated **C**avity **O**utput **S**pectroscopy
- 1st laser: 2050.3 – 2050.9 cm^{-1}, OCS, CO, H_2O, CO_2



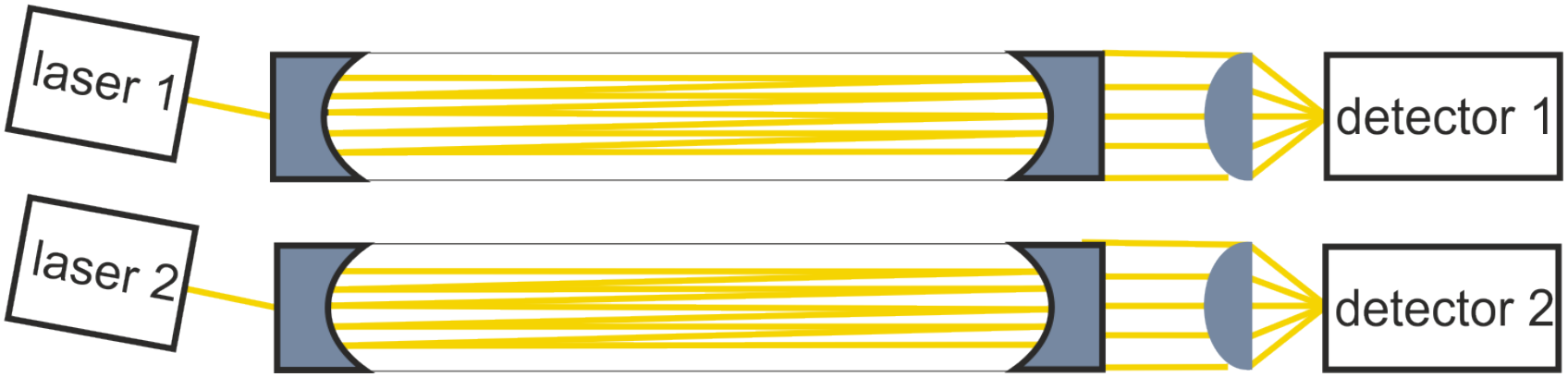
Example Spectrum, Kiruna lab:
- ~3000 ppm CO_2 !!



Measurement technique
→ ICOS

- **OA-ICOS: O**ff **A**xis-**I**ntegrated **C**avity **O**utput **S**pectroscopy

- 1st laser: 2050.3 – 2050.9 cm^{-1}, OCS, CO, H_2O, CO_2
- 2nd laser: ~3300 cm^{-1} , HCN, C_2H_2, N_2O



Status Quo
→ In Kiruna

- Integration onto Geophysica
- Testing and replacement of connectors
- We were ready for the *not existing* test flights

FZ-Jülich Blog about the StratoClim Campaigns

Key points

→ Calculations of ACE-FTS data show a stratospheric OCS burden (2012) of 275 Gg S, which is in good agreement with Sheng et al. 2015

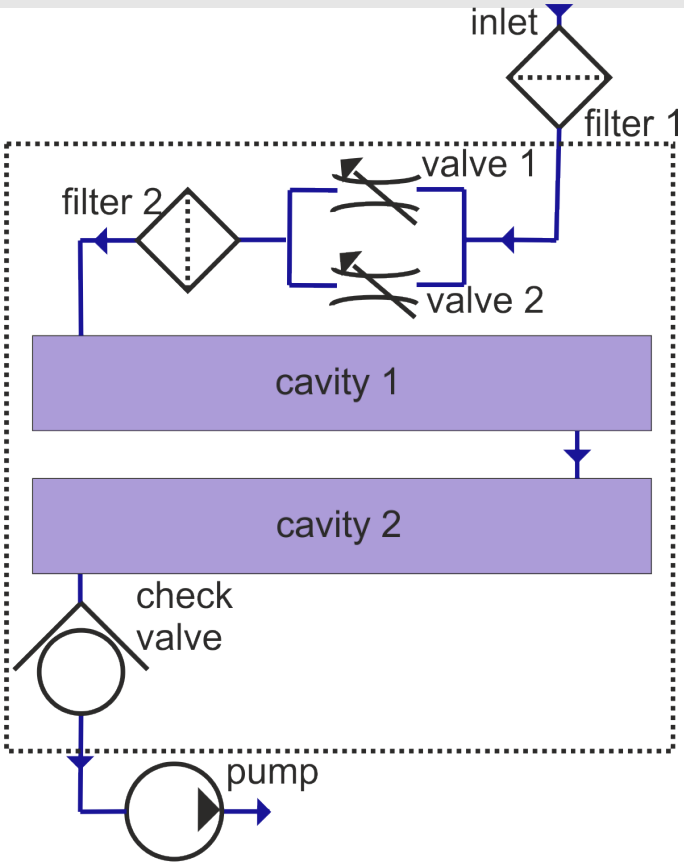
→ Decreasing OCS mixing ratio with increasing latitude, due to transport processes

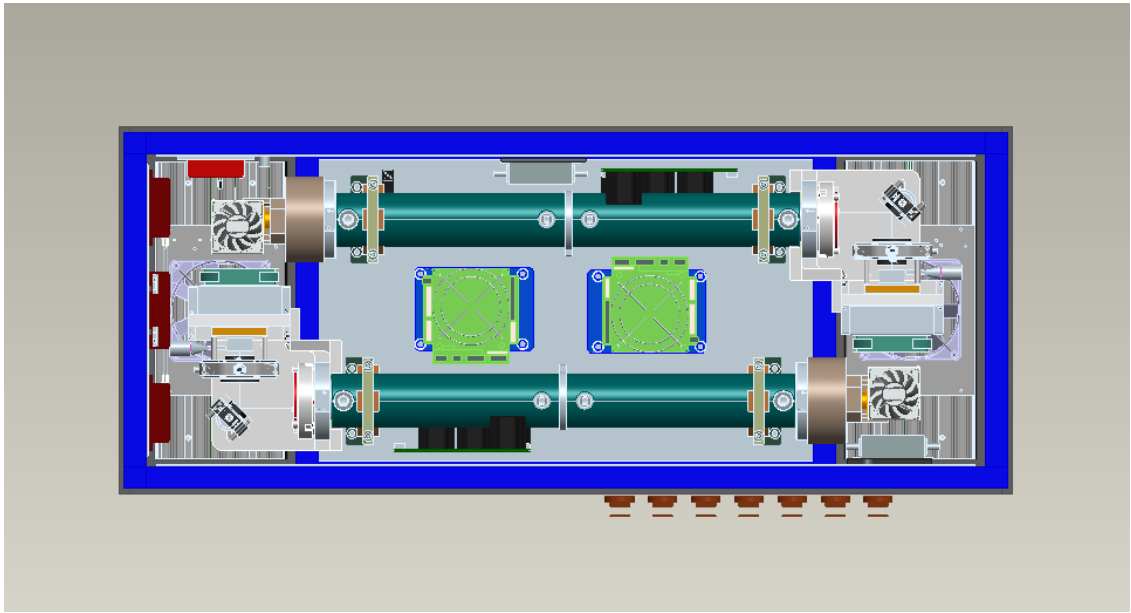
→ Elevated OCS concentrations in the Asian monsoon anticyclone was detected

AMICA will give high resolution, In-situ OCS measurements in the Asian monsoon region this year

Inside of AMICA

→ Flow system





Status Quo: Before Kiruna

- AMICA delivered to us in February
- Passed EMC and shaker test

Carbonyl sulfide (OCS) from ACE-FTS

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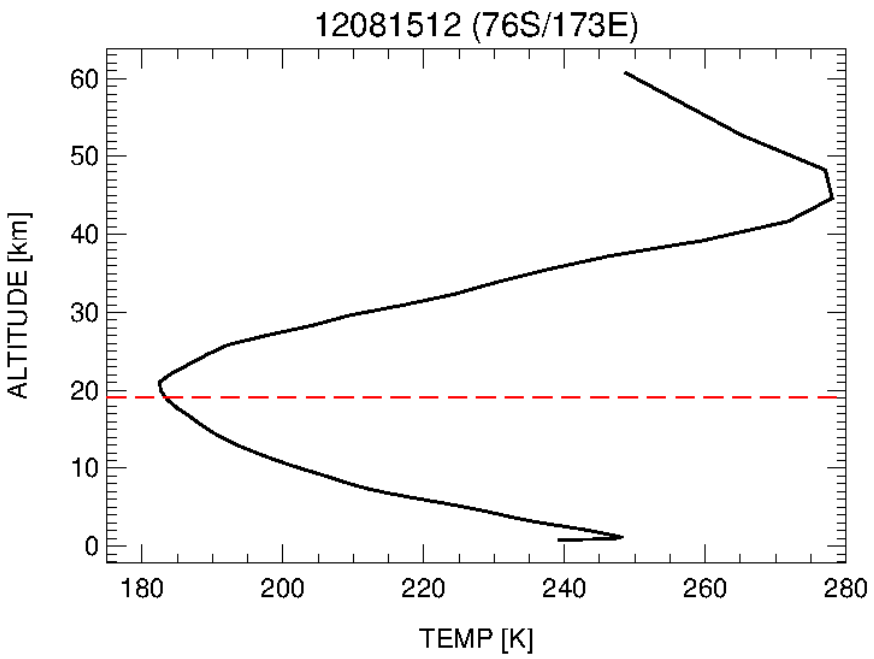
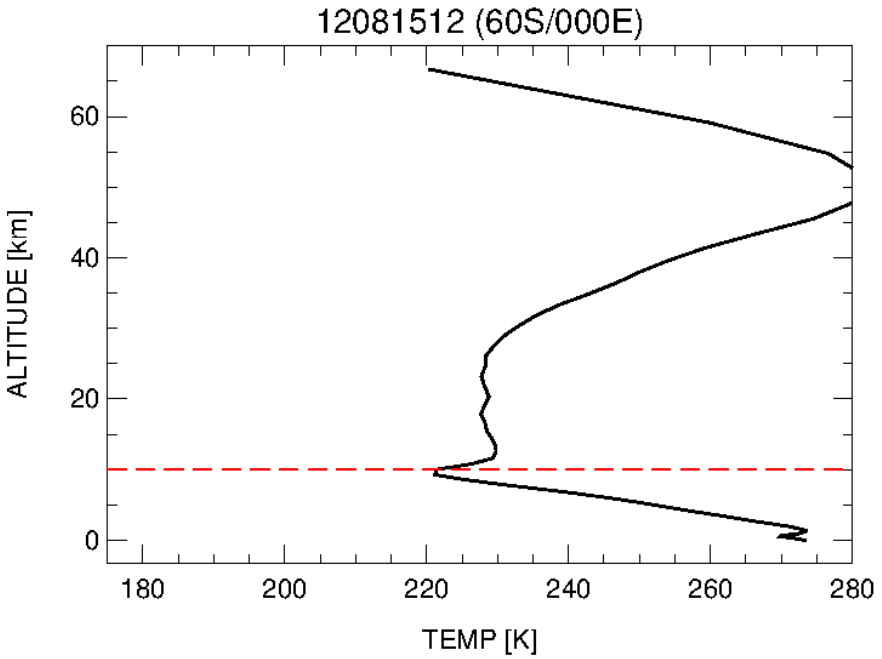
⟶ ECMWF Temperature profile in high latitudes in the Southern Hemisphere

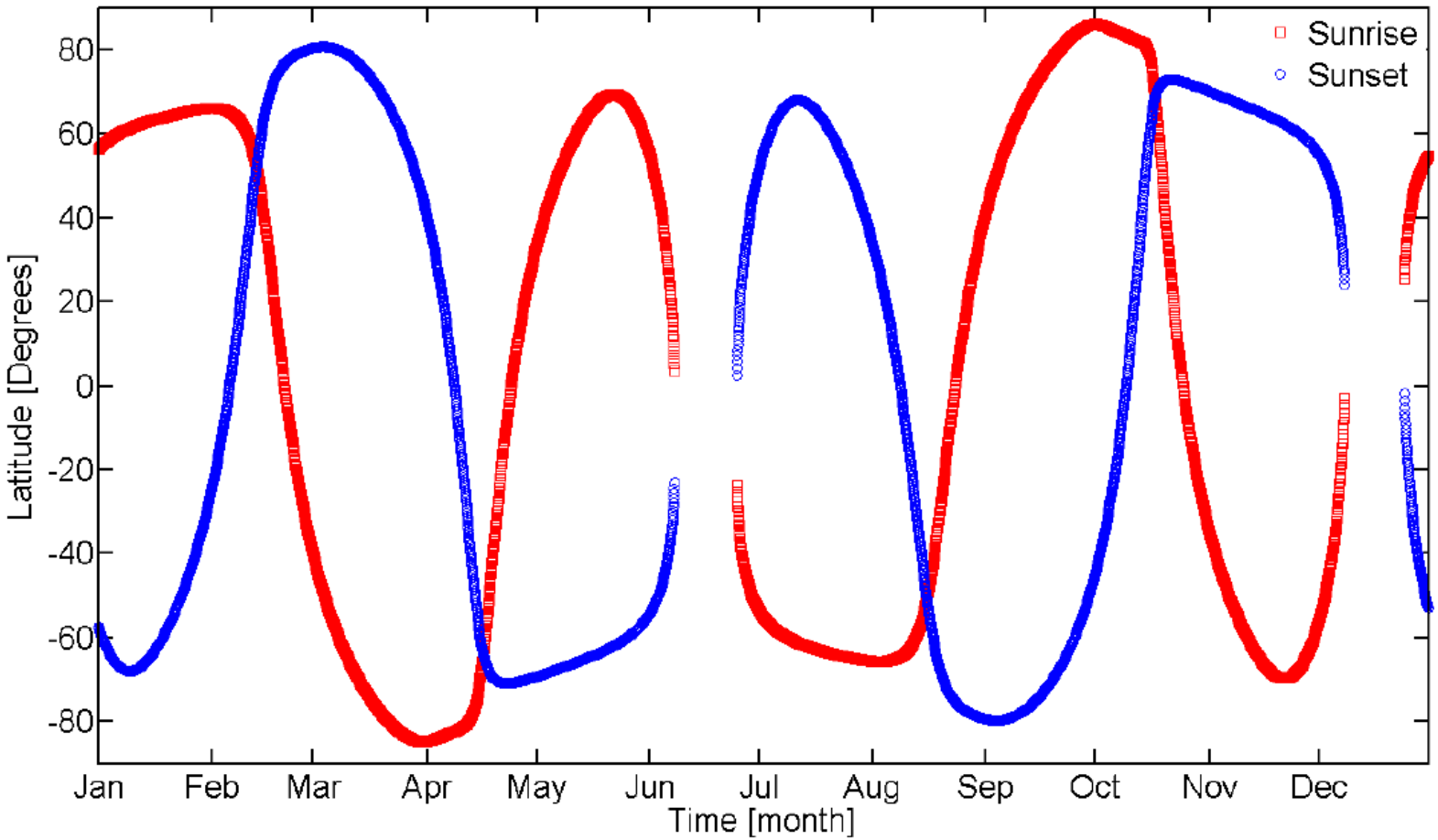
- Extracted tropopause altitude by ECMWF: Too high



- Extracted tropopause altitude by ECMWF: correct



ACE-FTS



Jones et al. (2012), *Atmos. Chem. Phys.*