



# LISA: a lightweight stratospheric air sampler

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# Contents

- Motivation
- Design
- Accuracy
- Flight results & Comparison with AirCore
- Potential for Isotope measurements
- Conclusions and outlook

# Why a new sampler?

## Existing methods

- High-altitude aircraft
  - ER-2 and Geophysica
  - 22 km
- Balloon measurements
  - Cryogenic sampler (100-250 kg payload)



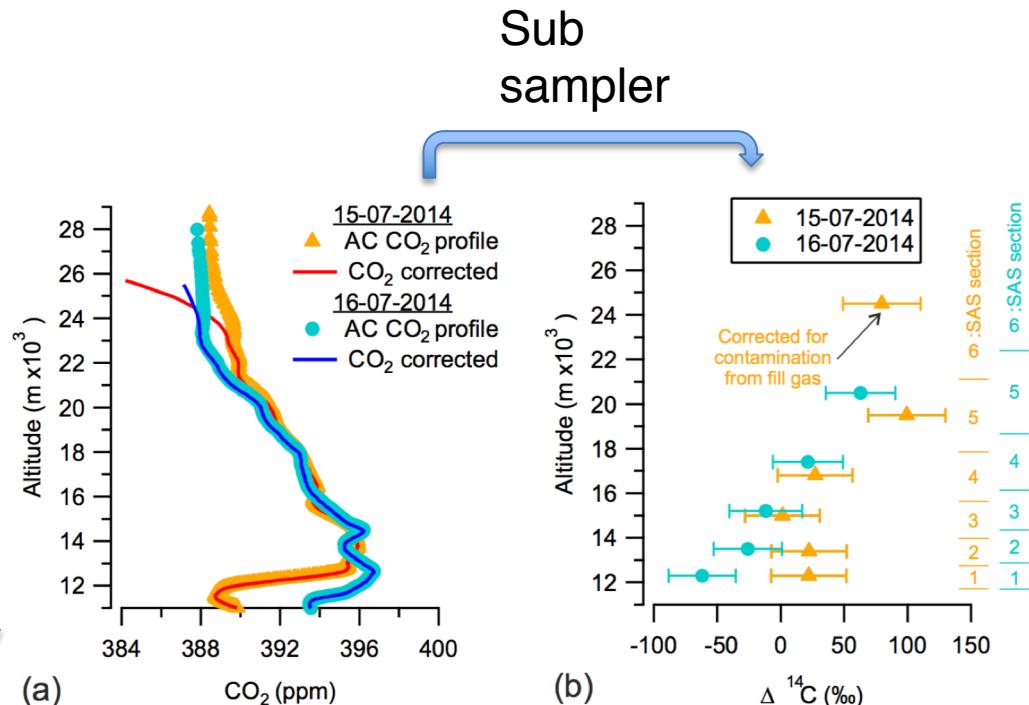
# Stratospheric sampling using AirCore



AirCore, Karion et al.  
2010



Profile



Stable isotope analysis, Mrozek et al. 2016  
Radiocarbon analysis, Paul et al. 2016

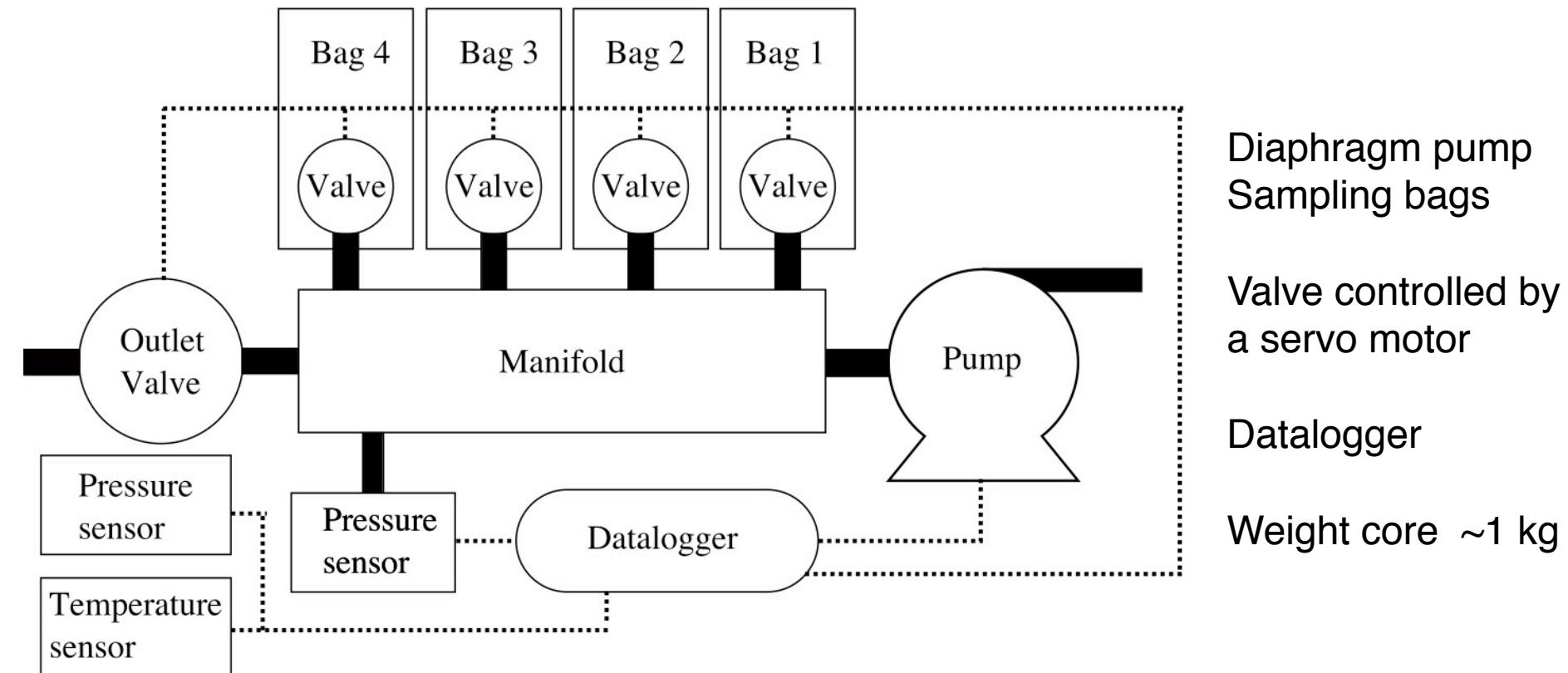
Limited by:

- Vertical resolution
- Sample size

# A new stratospheric sampler

- Lightweight (easy operation and low cost)
- Larger amount of air per sample
- Higher vertical resolution per sample
- Reasonable accuracy for GHG measurements
- Applications:
  - Validation of AirCore vertical altitude
  - Analysis of isotopic compositions
  - ....

# System design



# Accuracy (Storage tests)

- Accuracy:
    - Analyzer (Calibrated)
    - Contamination (exposure to lines and pump diaphragm) <-Small
    - Drift due to diffusion
  - Storage test of sampling bags
    - Drift = [4 hours] - [Initial measurement]

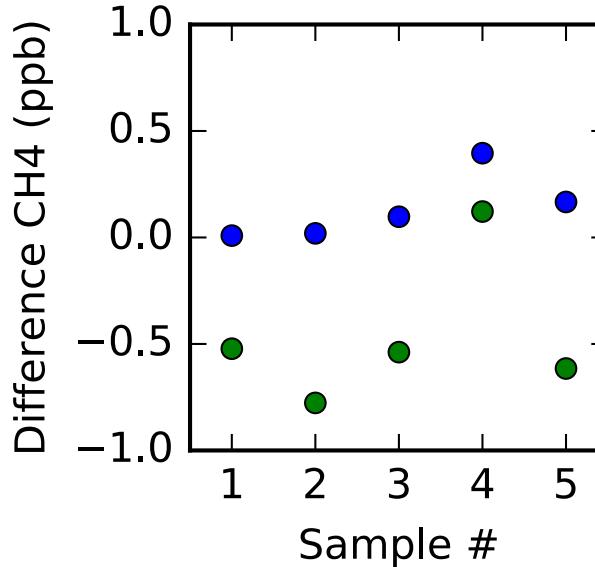
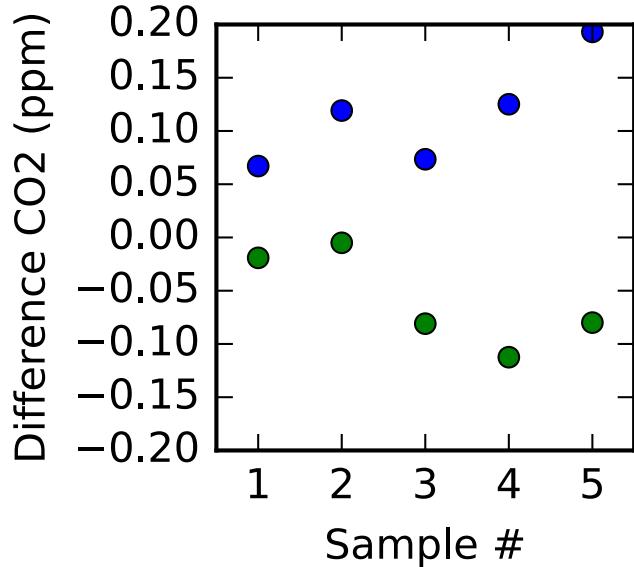


# Tedlar

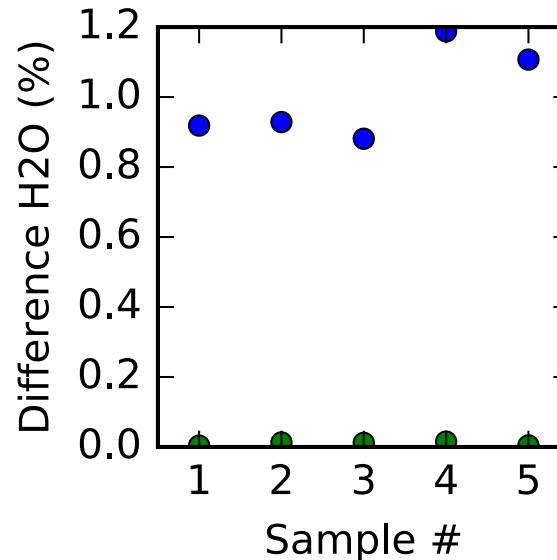
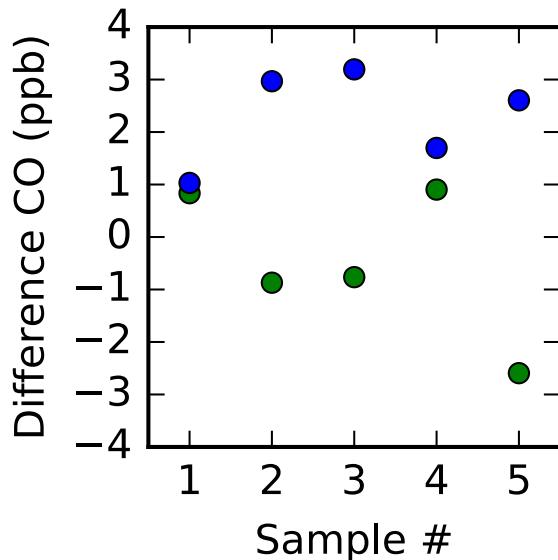


MLF

# Storage test results



Tedlar  
MLF



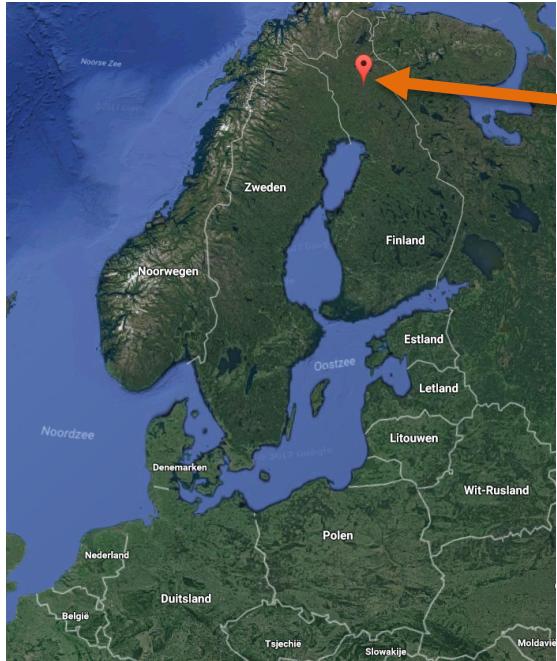
# Uncertainties

Uncertainty:

1. Measurement precision
2. Contamination (dead volume of 1.5 ml)
3. Drift due to diffusion

Species	Uncertainty
CO <sub>2</sub> (ppm)	0.14
CH <sub>4</sub> (ppb)	2.3
CO (ppb)	7.8

# Flights



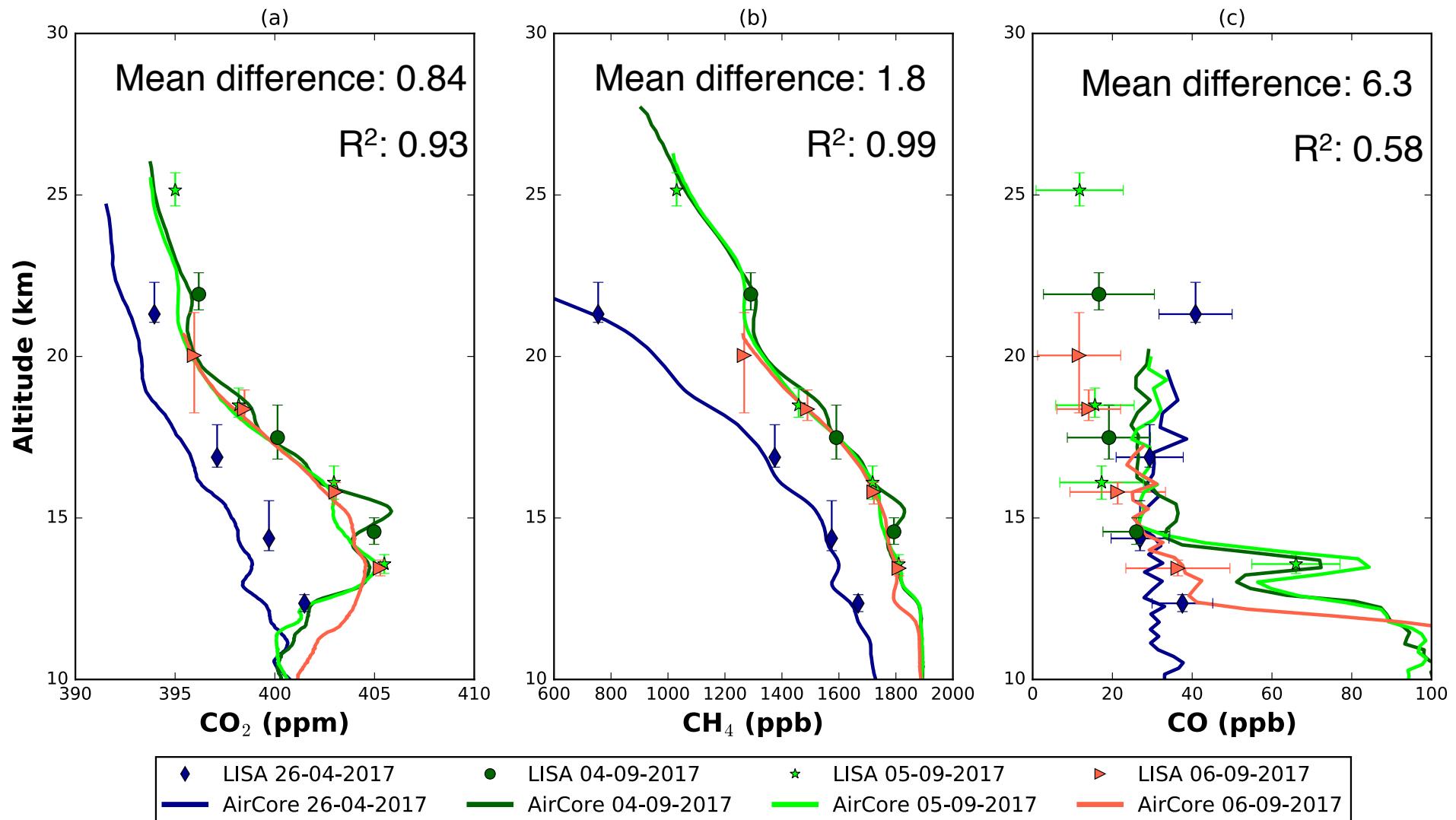
- Sodankylä (67.368N, 26.633E, 179 m.a.s.l )



4 Balloon flights:  
26 April, 4-6 September (2017)

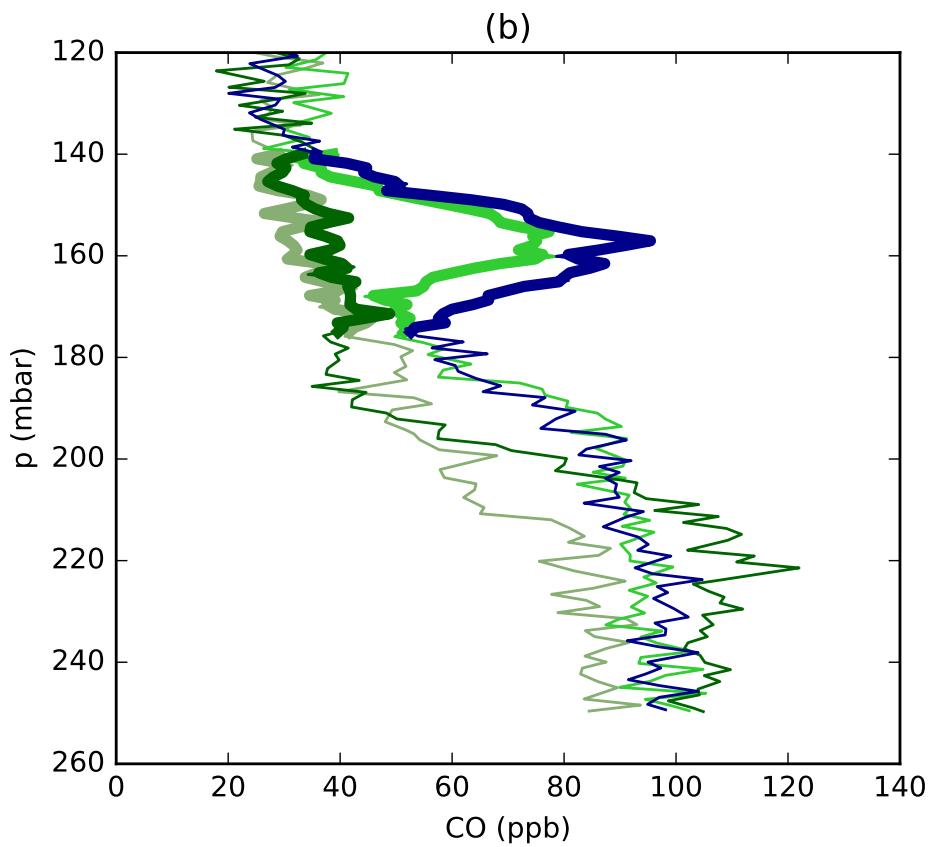
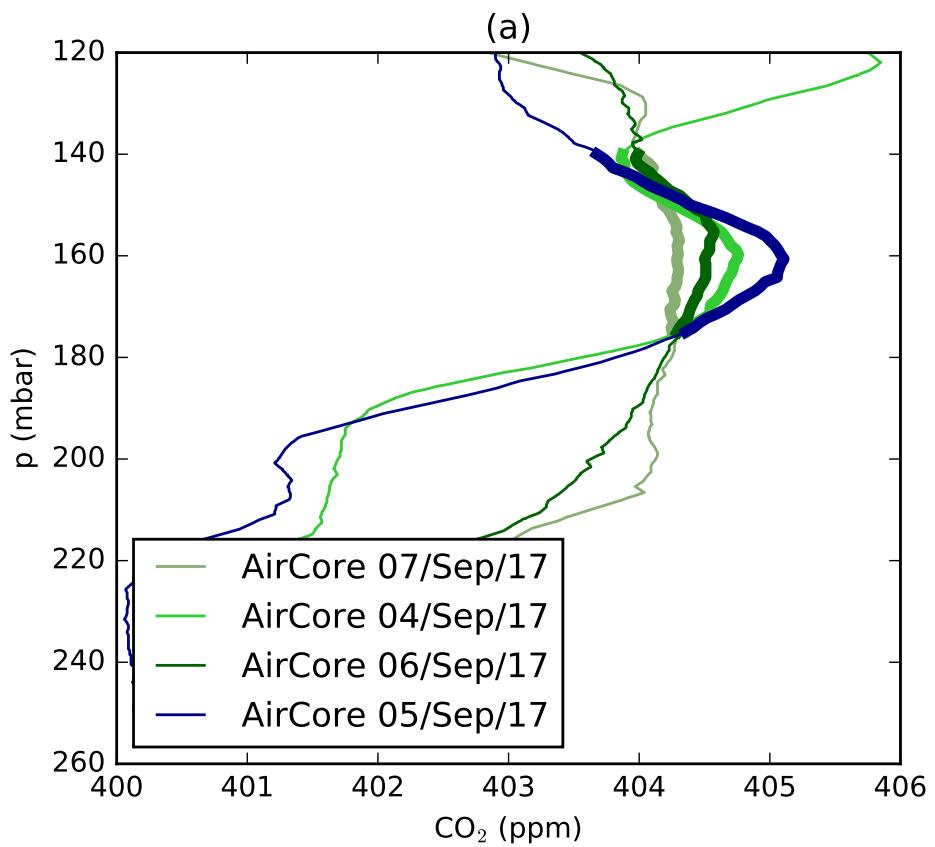
Payload: sampler (2.8 kg),  
AirCore, Radiosonde

# Flight & AirCore comparison



All AirCore flights supported by ESA.

# CO Plume (September 2017)



# Stable Isotope measurements

- Bias estimation:
  - Assuming CO<sub>2</sub> bias of 0.84 ppm, and CH<sub>4</sub> of 1.8 ppb

Species	Δδ  (‰)	Reproducibility (‰)
δ <sup>13</sup> C (CO <sub>2</sub> ) (VPDB)	0.002	0.02
δ <sup>18</sup> O (CO <sub>2</sub> ) (VPDB)	0.030	0.05
Δ <sup>17</sup> O (CO <sub>2</sub> ) (VSMOW)	0.015	0.2
δ <sup>13</sup> C (CH <sub>4</sub> ) (VPDB)	0.097	0.7
δ <sup>2</sup> H (CH <sub>4</sub> ) (VSMOW)	0.986	2.3

# Conclusions

A new lightweight stratospheric sampler:

- ① Uncertainty of 0.14 ( $\text{CO}_2$ ), 2.3 ( $\text{CH}_4$ ) and 7.8 (CO)
- ② Good vertical resolution and sample size
- ③ Validated against AirCore (15 samples)
- ④ Suitable for Isotope analysis of ( $\text{CO}_2$ ) and ( $\text{CH}_4$ )



# Questions?

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