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A new lightweight stratospheric air sampler

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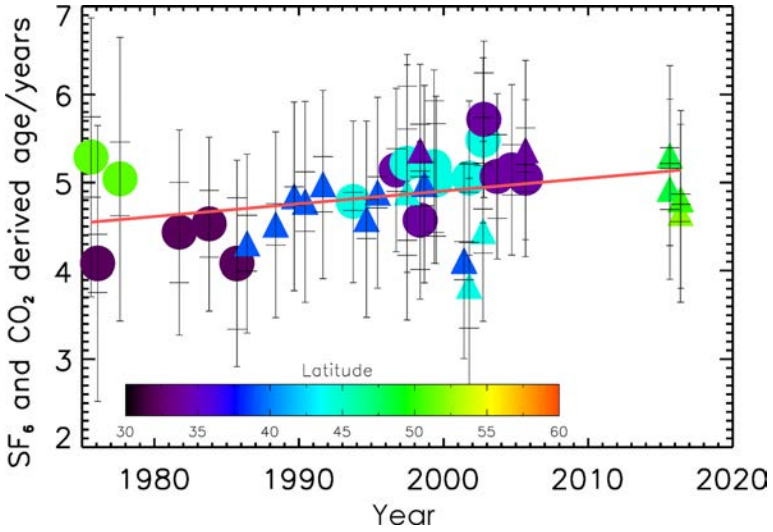
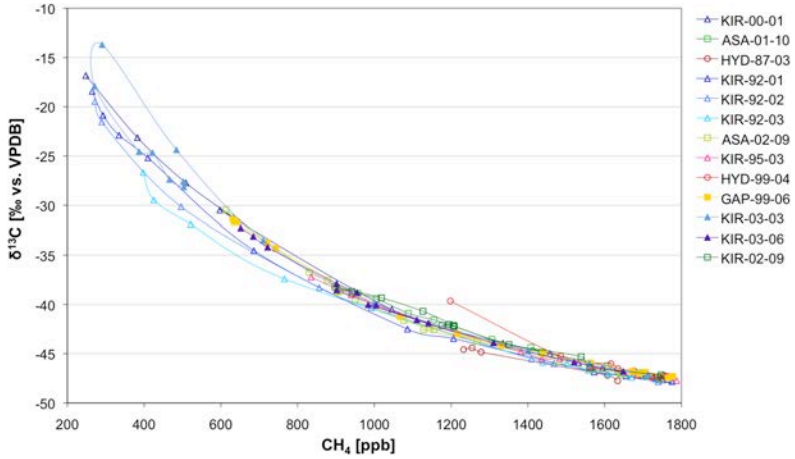
Contents

- Motivation
- Design
- Characterization
  - Storage effects
  - Vertical resolution
- Test flight & Comparison with AirCore
- Conclusions and outlook

Stratospheric sampling, why?





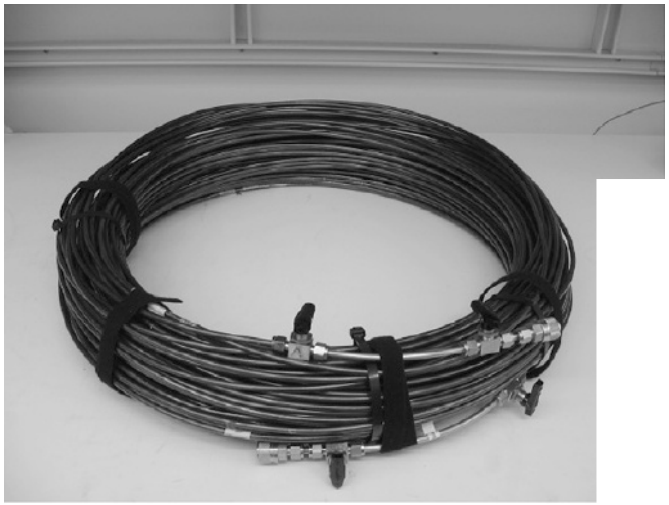
- Understand the impact of climate change on stratospheric transport - Engel (2009, 2017)
- Constrain the stratospheric sink of CH4 using isotope measurements
  - Röckmann (2011)

Existing stratospheric measurements

- High-altitude aircraft
  - ER-2 and Geophysica
  - 22 km

- Balloon measurements
  - Cryogenic sampler (250 kg payload)

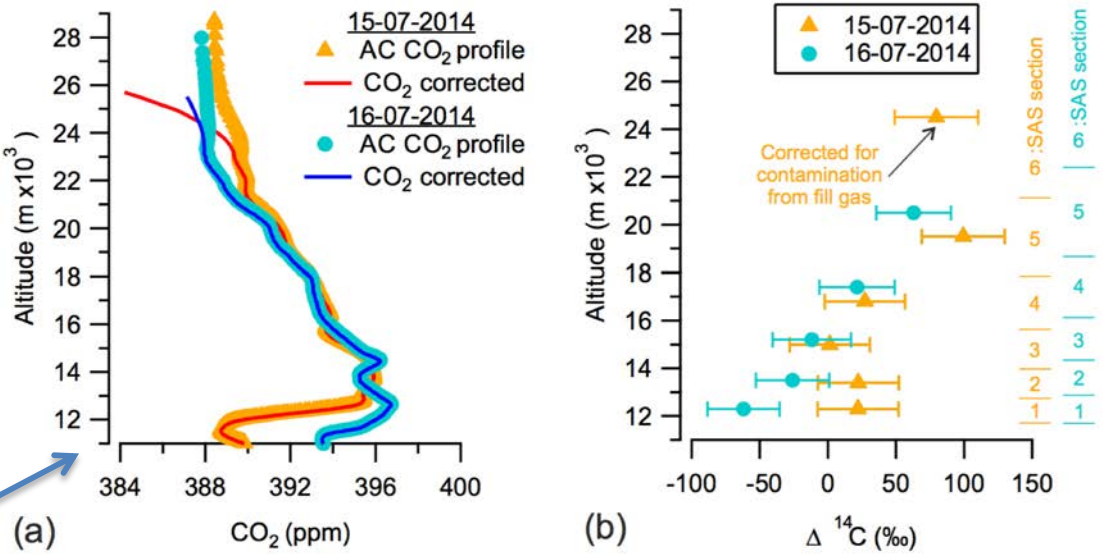
Stratospheric sampling using AirCore



AirCore, Karion et al. 2010

Profile

Sub sampler



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

Limited by:

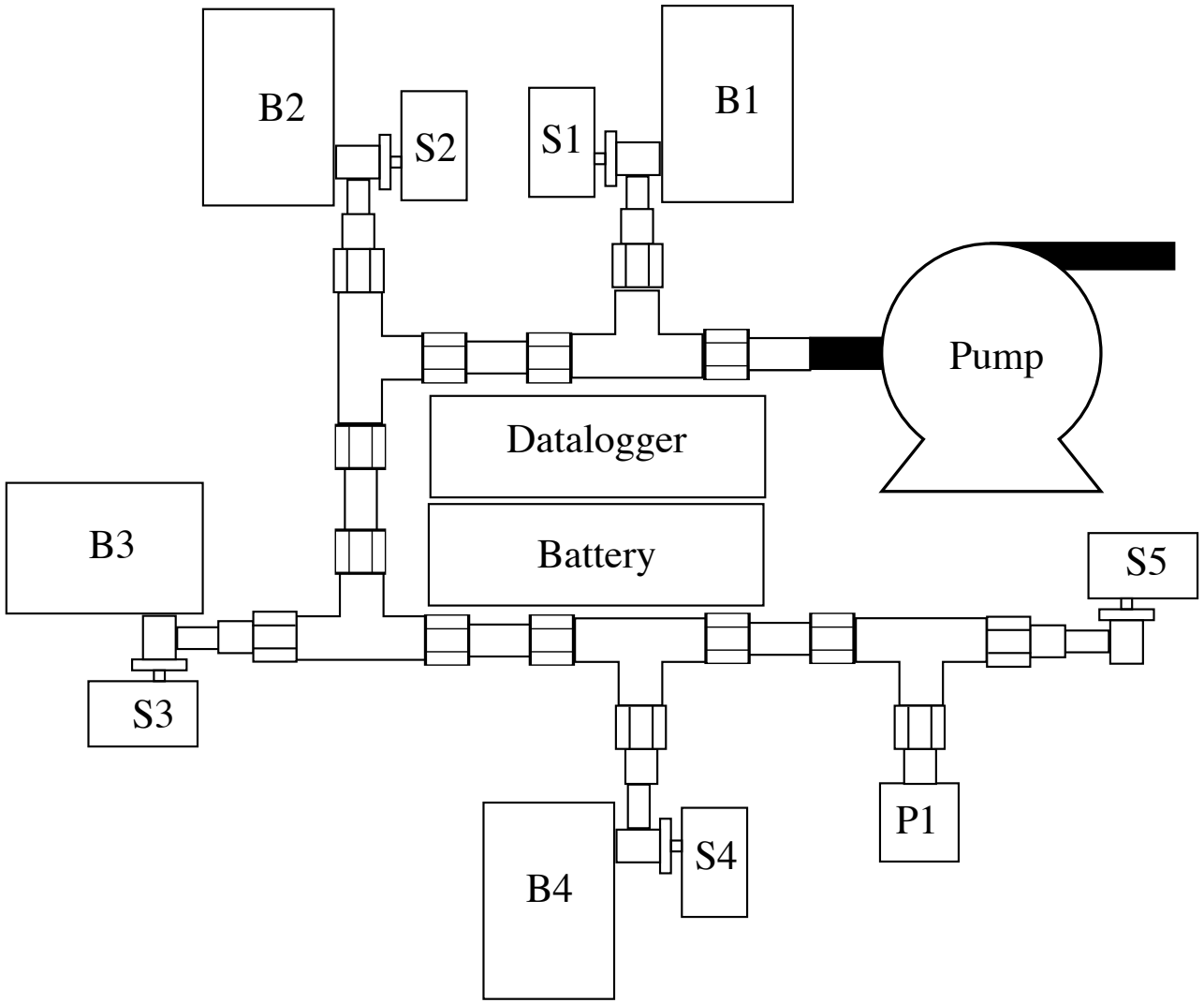
- Vertical resolution
- Sample size

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



Diaphragm pump (8 l/m)

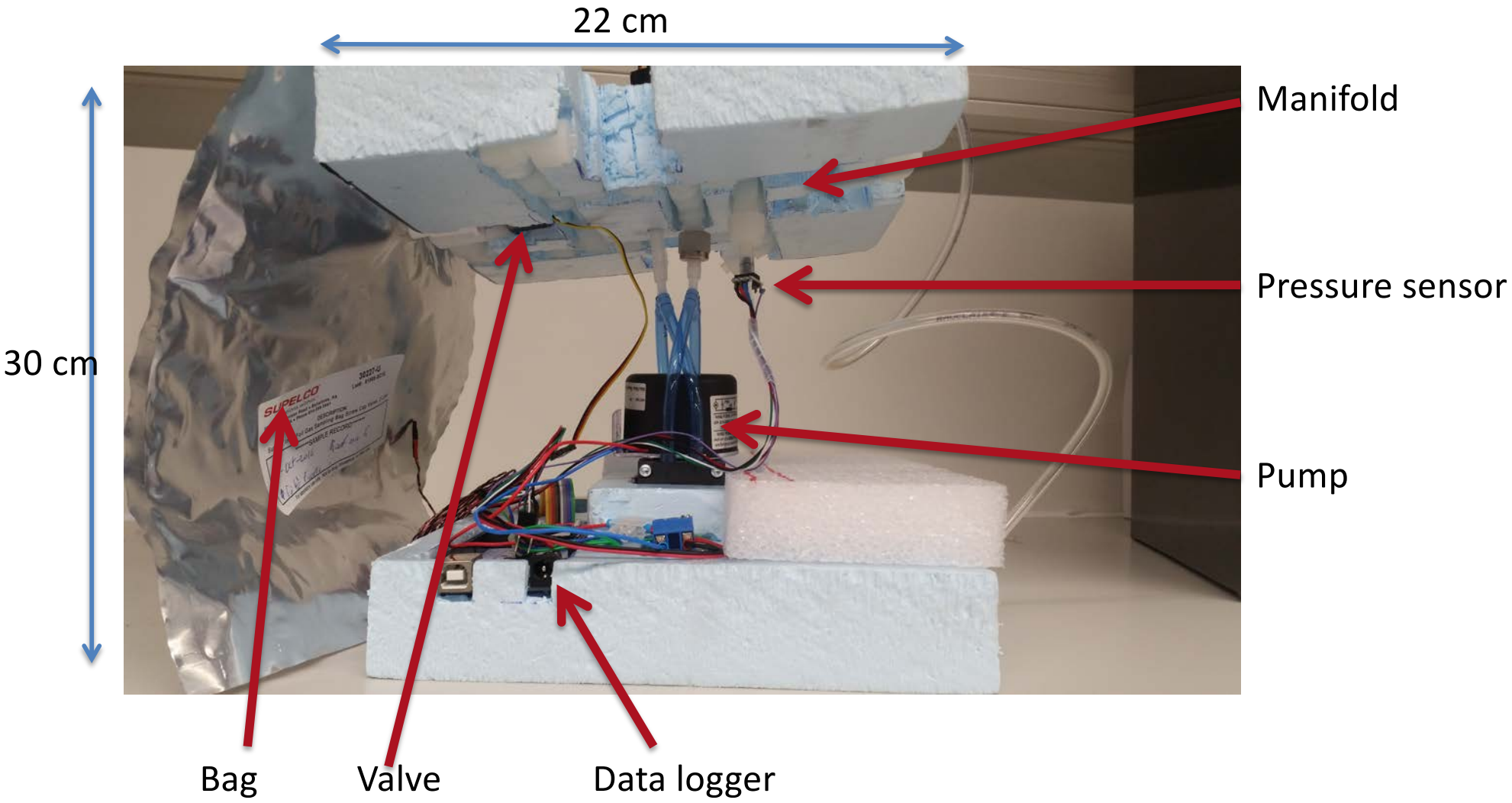
B1-B4: Sampling bags

S1-S5: Valve, controlled by a servo motor

Datalogger

Weight core ~1 kg

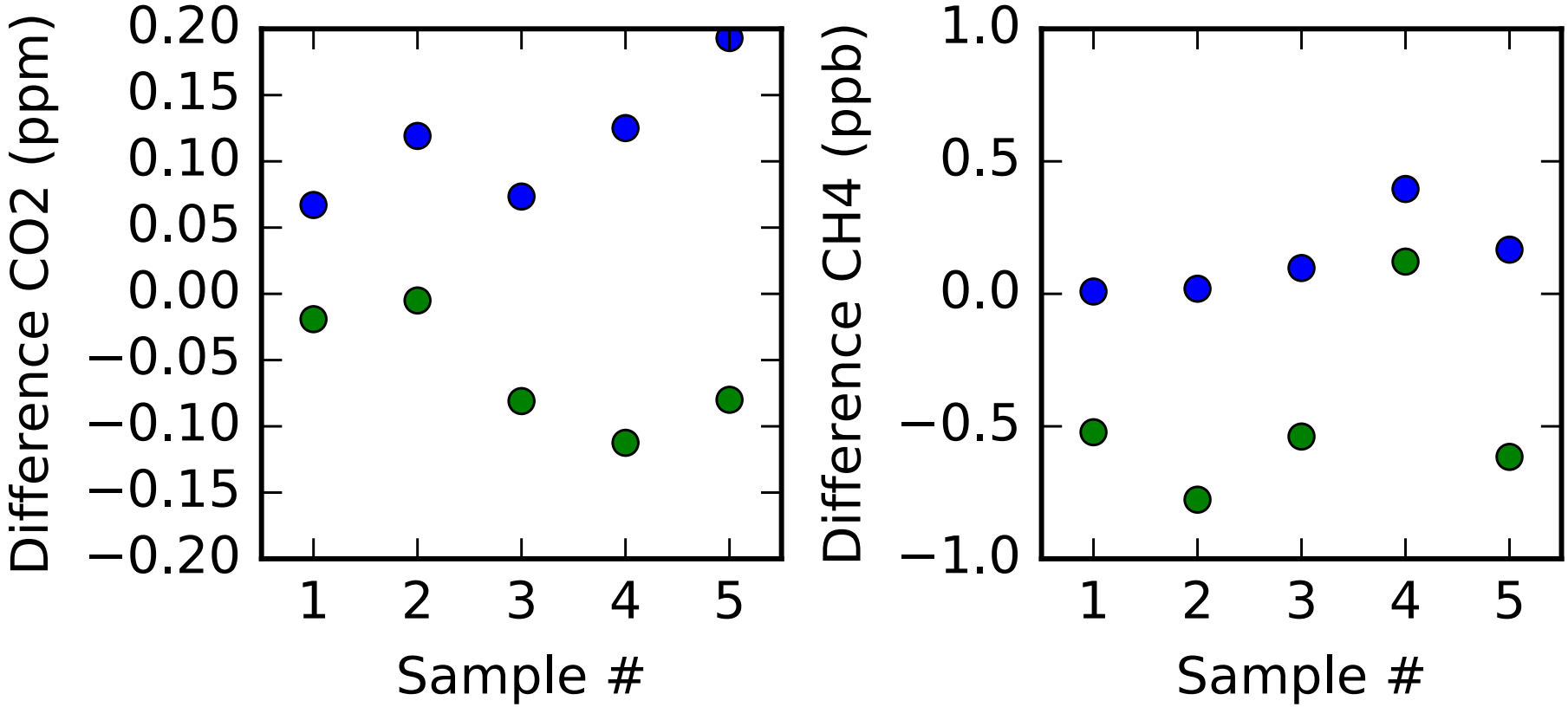
Design


22 cm
30 cm
Manifold
Pressure sensor
Pump
Bag
Valve
Data logger

Storage tests

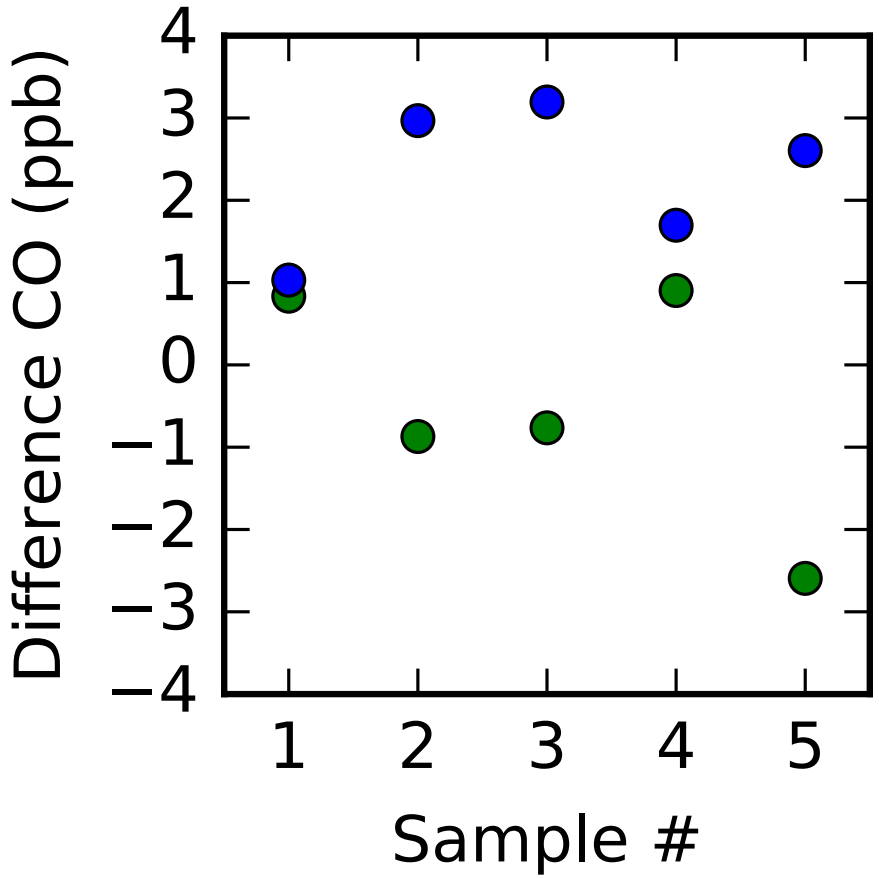
- Storage test of sampling bags
  - Drift=[4 hours]-[Initial measurement]

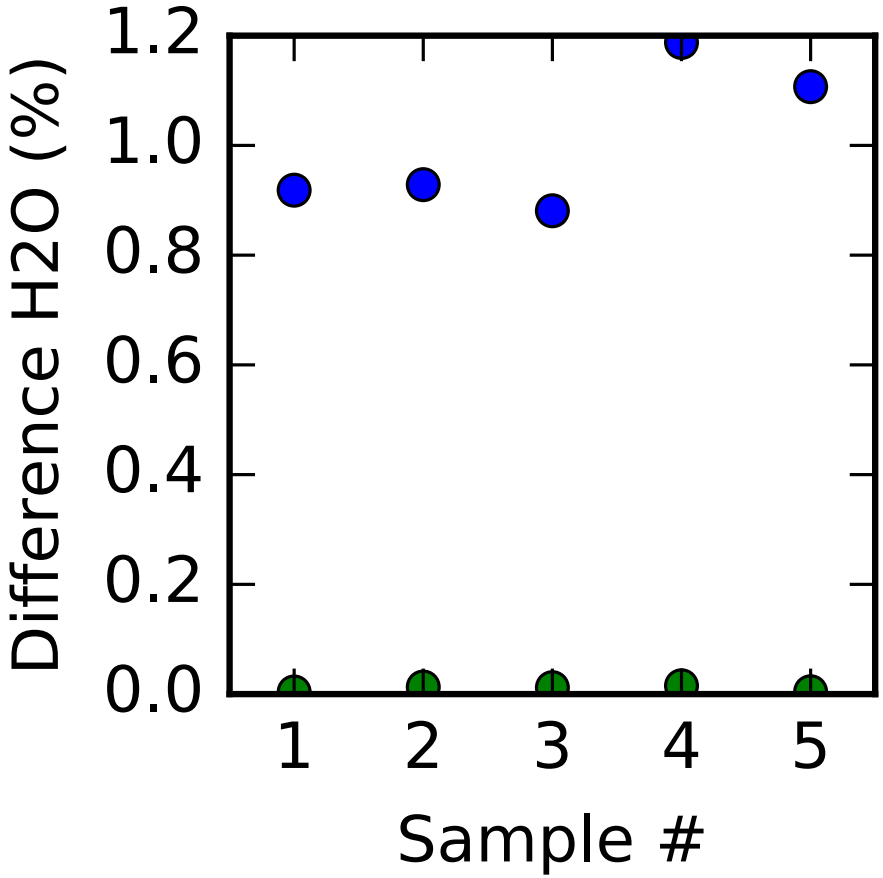
Storage test results



Tedlar **MLF**

Storage test results





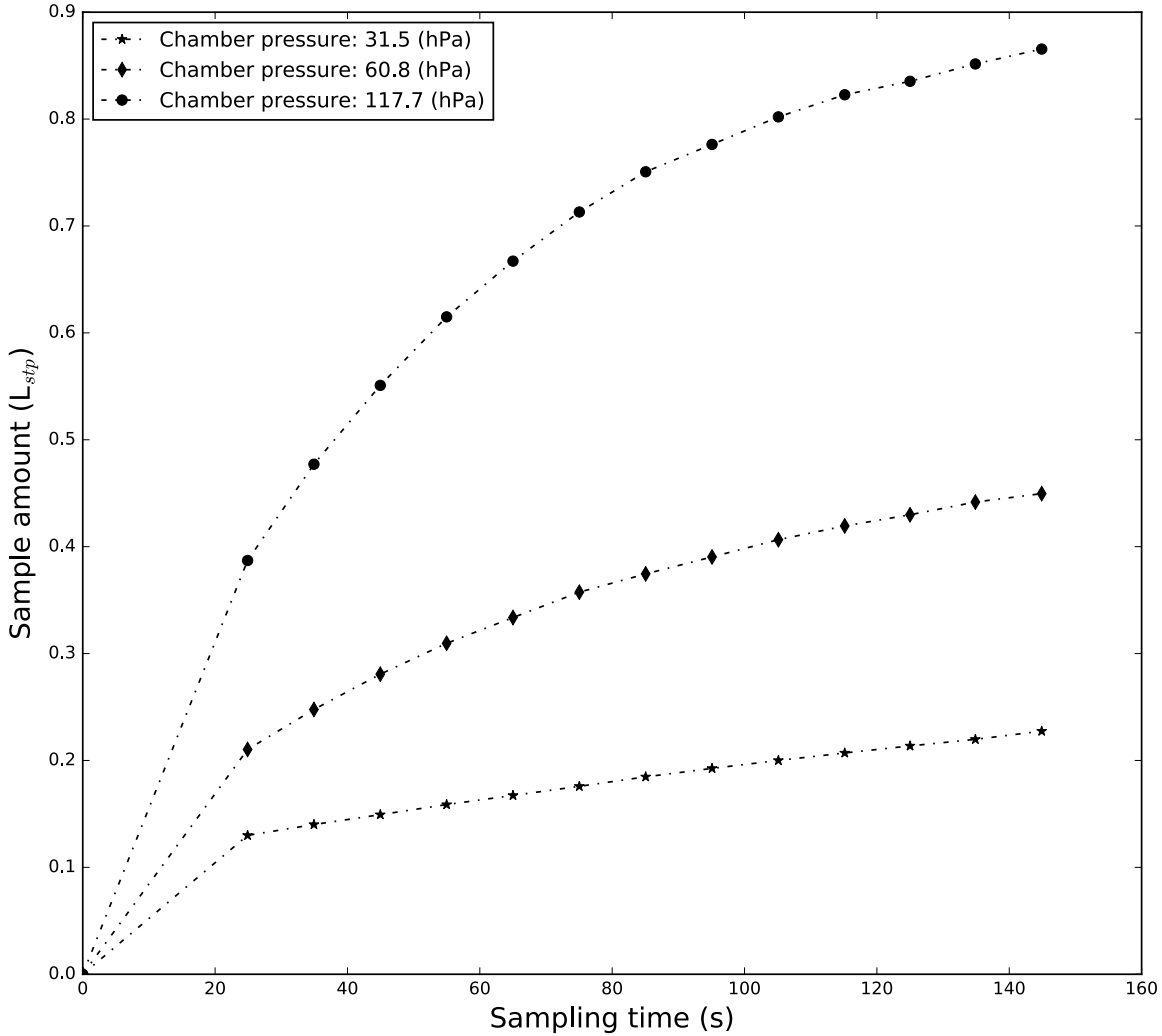
Tedlar **MLF**

Vertical resolution vs. Sample size

- Vertical resolution
  - Ascending speed (5 m/s)
  - Sampling time
- Sample size
  - Sampling time
  - Pumping capacity

→ Characterization of the pump

Characterization of the pump

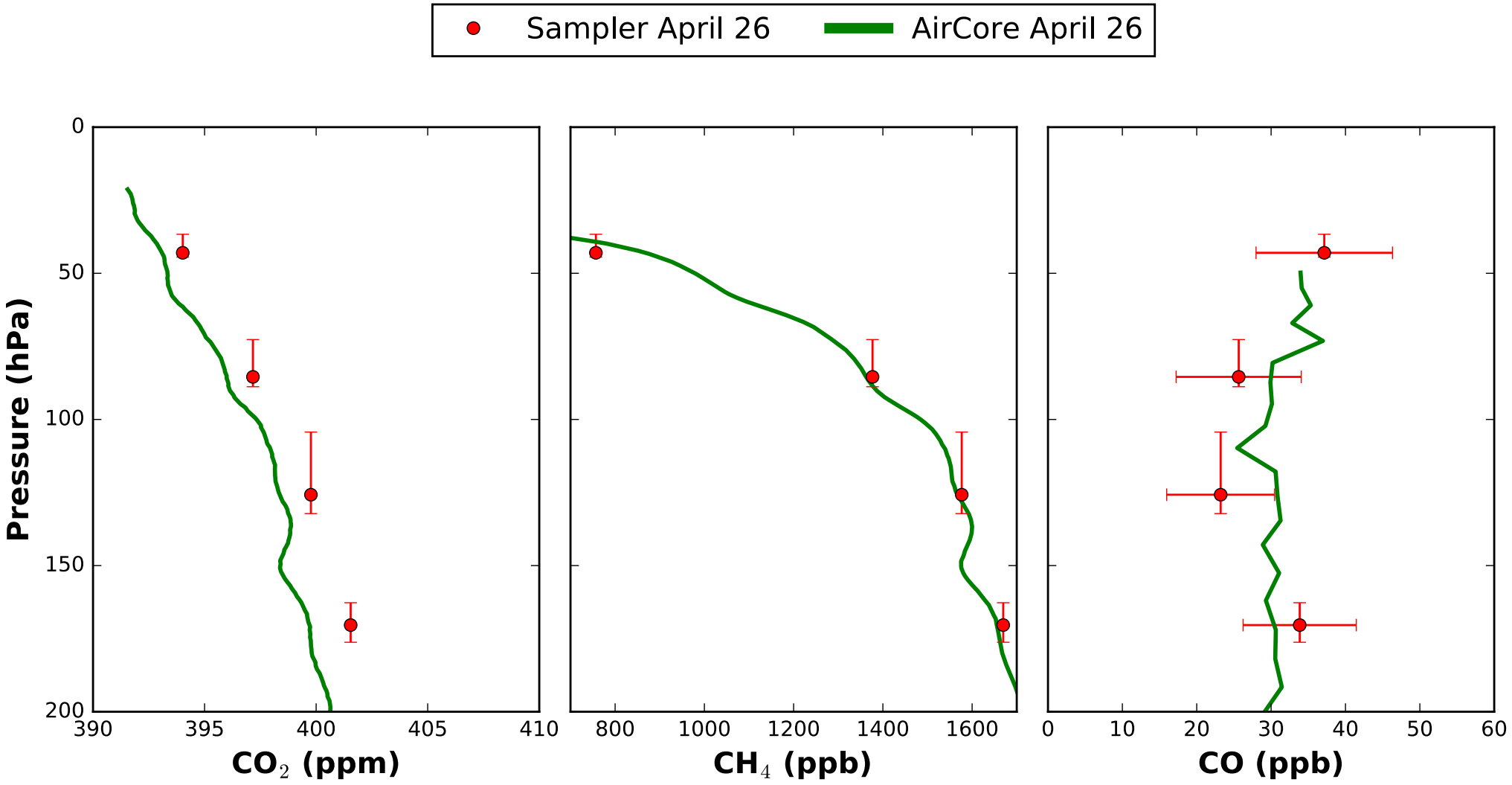


(/vertical resolution)

Test Flight

- Sodankylä (67.368N, 26.633E, 179 m.a.s.l)
- 26th of April 2017
- Payload: sampler (2.8 kg), AirCore, Radiosonde
- Other AirCore flights: 21st and 24th of April, 15th of May

Flight & AirCore comparison



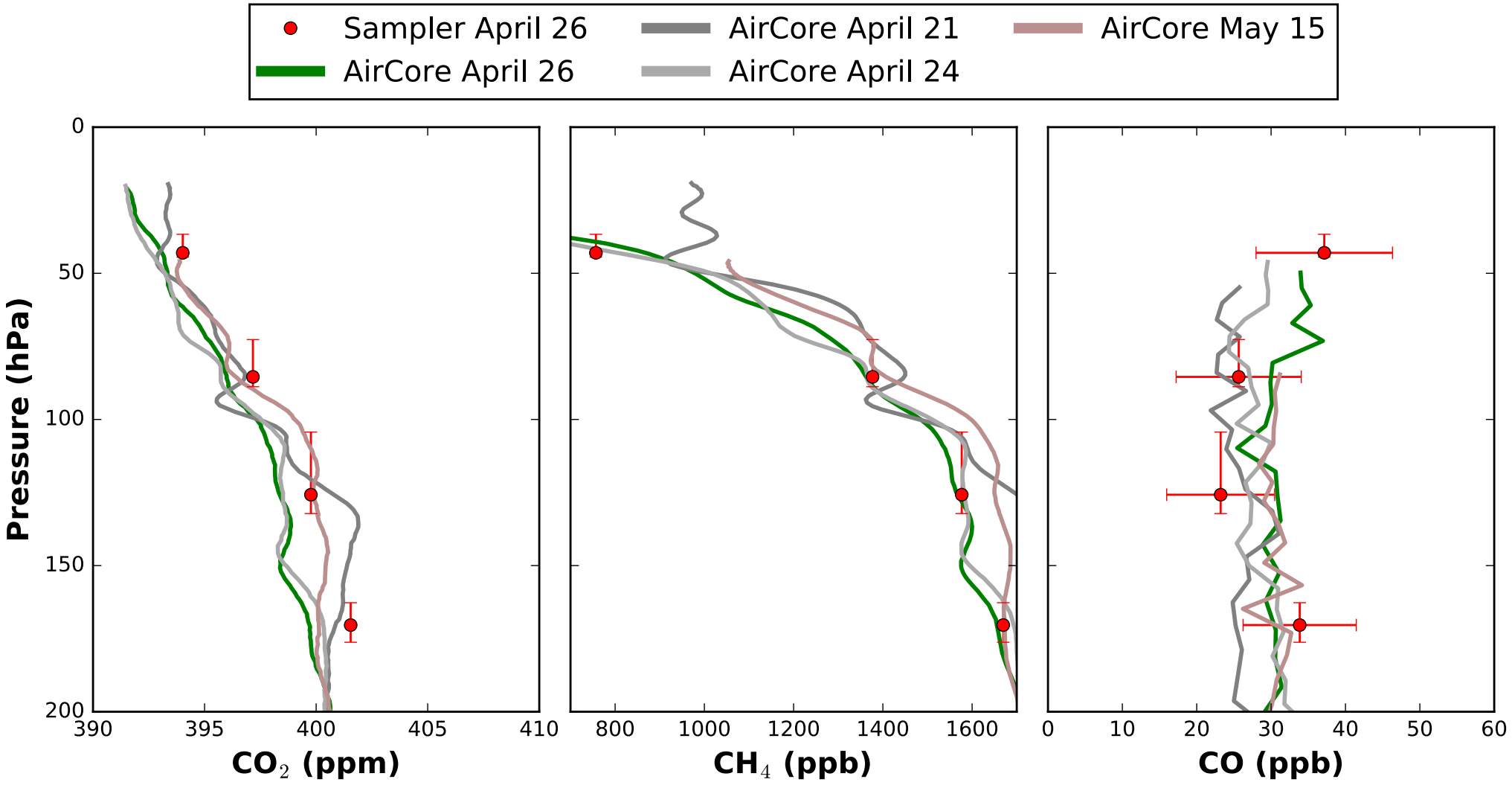
All AirCore flights supported by ESA.

Towards the CO_2 bias

1. Potential contamination of pump

2. Bag materials under very low temperature

Flight & AirCore comparison



All AirCore flights supported by ESA.

Conclusions

① A new lightweight stratospheric sampler was designed and tested in the laboratory
  - ① Drift due to storage was quantified to be less than 0.12 ppm CO2, 2 ppb CH4, 3 ppb CO
  - ② A relation between vertical resolution and sample amount was established for each pressure level

② The sampler successfully obtained 4 samples
  - ① First comparison with AirCore
  - ② Sample size: 290 to 890 mL
  - ③ Resolution .5 to 1.3 km

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Questions?

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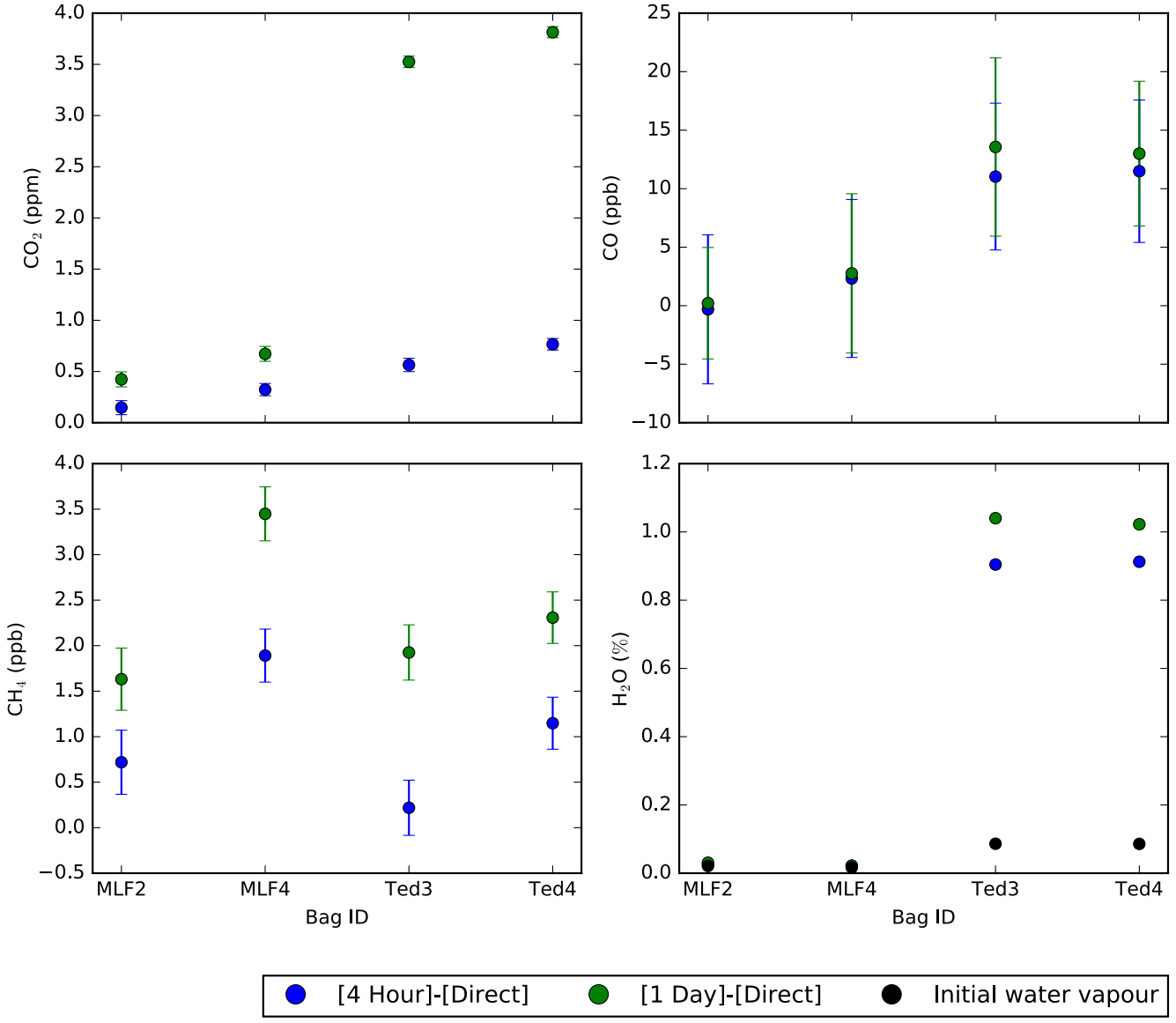
Storage test result (low mole fractions)



Flight samples

Pressure level (hPa)	Vertical Resolution (km)	Sample size (Lstp)
170.4	0.52	0.89
125.8	1.55	0.84
85.4	1.30	0.58
43.0	1.24	0.29