

Fiducial Reference Measurements for Ground-Based IR Greenhouse Gas Observation (FRM4GHG)

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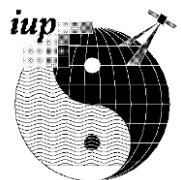
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Current situation and requirements

- Satellite trace gas observations require validation
- Validation requires instruments sampling the atmosphere in a comparable way



Optimum validation for NADIR satellite observations of GHGs is provided by ground-based solar absorption spectrometry

- Similar path through atmosphere (nadir versus slant path)
- For CO₂ and CH₄ same spectral region

Bruker IFS 125 HR is considered the best instrument for the validation. Global observations are organised within TCCON (sometimes same instruments as used in NDACC, but not the same operational procedures)

- Complete TCCON observation system (container, Bruker 125 HR, solar tracker) is expensive 400-500 k€
- Requires high maintenance and operations costs
- Difficult to transport, limits possibility for campaigns
- Limits the extension of the network



Development of cheaper and easier deployable systems for remote sensing GHG observations, mainly driven by scientific research institutions

Aim of FRM4GHG

Perform an intercomparison of measured total column concentrations of a few GHG (CO_2 , CH_4 , CO) using several different infrared spectrometric instruments at a TCCON site.

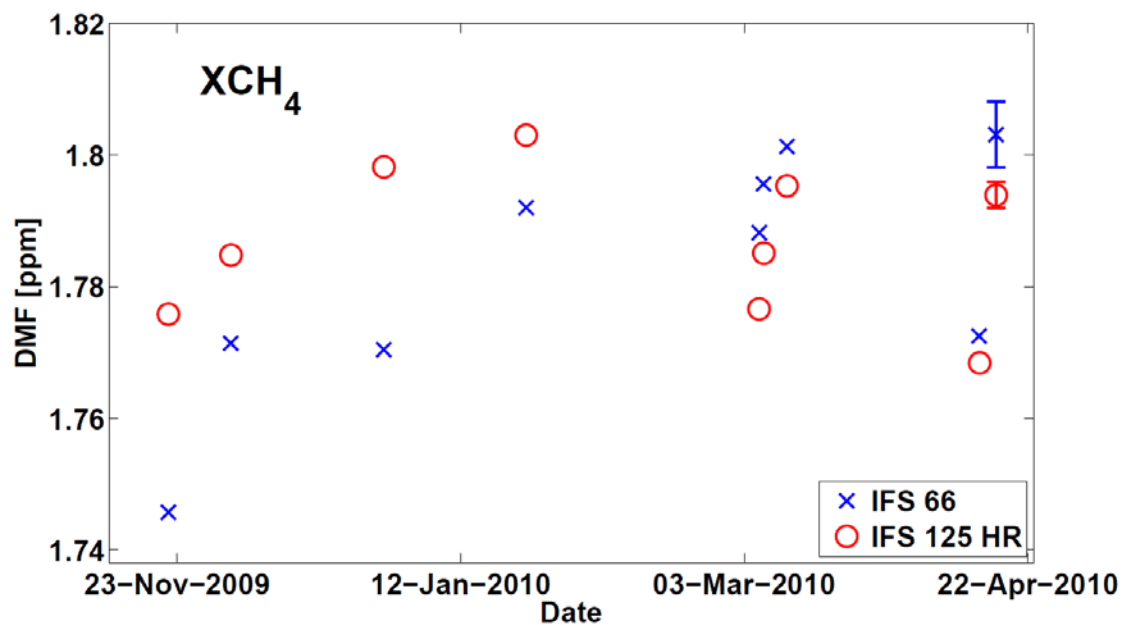
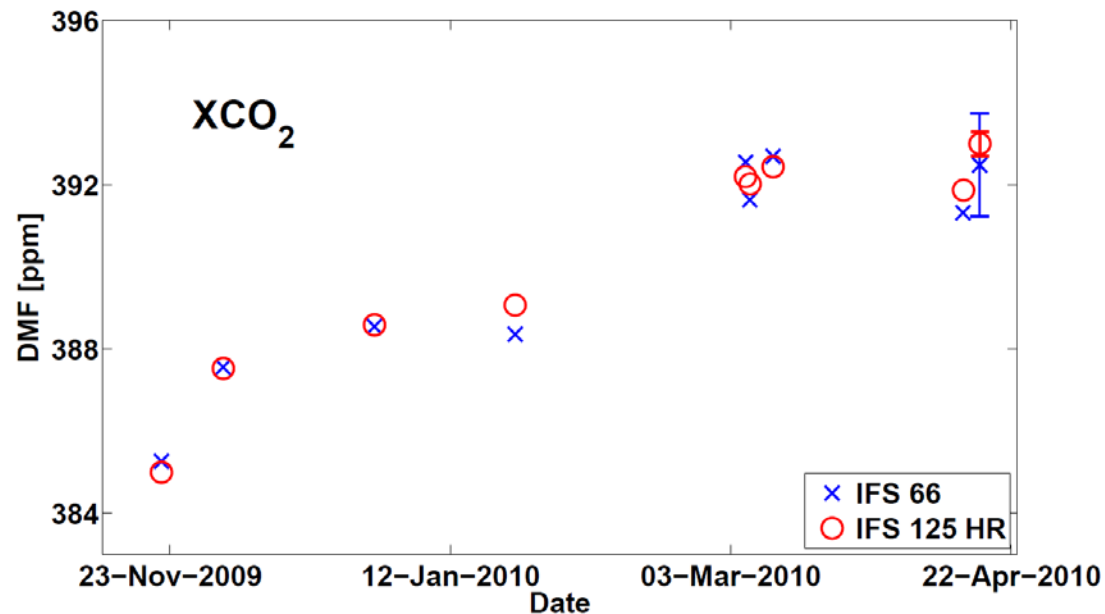
We plan to measure with five different spectrometers plus the in-situ Aircore balloon system measuring the vertical concentration profile of the trace gases, and which can be calibrated relative to the WMO standards.

The measurement campaign is planned to take place in **Sodankyla/Finland** in **2017**. Project starts in Aug. 2016.

FMI runs there a TCCON instrument and has experience with AirCore launches since September 2013.

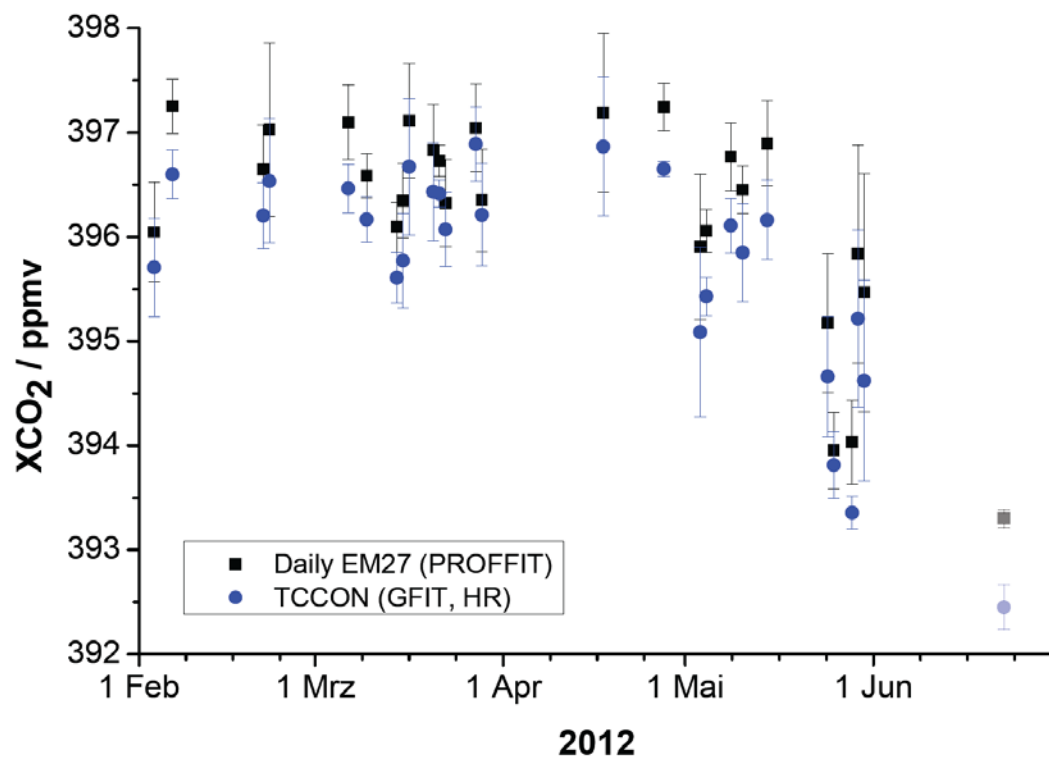
Bruker, IFS 66
Resolution: 0.11 cm^{-1}

CO_2 and CH_4





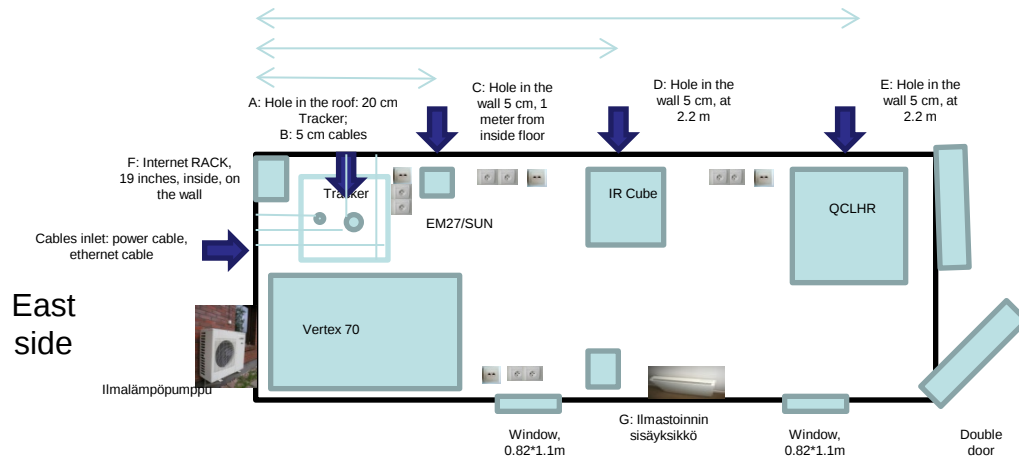
Bruker EM27 with solar tracker attached
Resolution: 0.5 cm^{-1}
 CO_2 and CH_4



More recent results: see F. Hase's talk

FRM4GHG campaign set-up

South side



North side

Container dimensions 9 m long, 3.25 m wide, 2.6 m high

Solar Tracker cover box: 1.10*1.15 m;
 Vertex 70: 1.5*2.5; 150 kg
 IR Cube: 1.0*1.0, 50 kg
 EM27/SUN: 0.35*0.4; 30 kg
 QCLHR: 1.5*1.5, 150 kg

- A: Hole in the roof, $\varnothing$ 20 cm, etäisyys eteläseinästä 82.5 cm, itäseinästä 115 cm.
- B: Hole in the roof $\varnothing$ 5 cm, etäisyys eteläseinästä 80 cm, itäseinästä 80 cm.
- C: Hole in the wall $\varnothing$ 5 cm, etäisyys itäseinästä 240 cm, korkeus lattiasta 100 cm.
- D: Hole in the wall $\varnothing$ 5 cm, etäisyys itäseinästä 480 cm, korkeus lattiasta 200-220 cm.
- E: Hole in the wall $\varnothing$ 5 cm, etäisyys itäseinästä 800 cm, korkeus lattiasta 200-220 cm.
- F: ATK teline seinälle, 19 tuumainen RJ45-paneeli jonne tulee liittimet
- G: Ilmastoinnin sisäyksikkö, noin 300 cm itäseinästä



Instruments for FRM4GHG

TCCON Bruker 125HR (FMI) → XCH₄, XCO, XCO₂; resol. 0.02 cm⁻¹

Bruker EM27/SUN (KIT) → XCH₄, XCO₂; resol. 0.5 cm⁻¹
+ dual channel version ? (KIT) → + CO

Bruker Vertex 70 (BIRA & IUP) → XCH₄, XCO, XCO₂; resol. 0.16 cm⁻¹

IR cube (UoW) → XCH₄, XCO, XCO₂; very low resol.

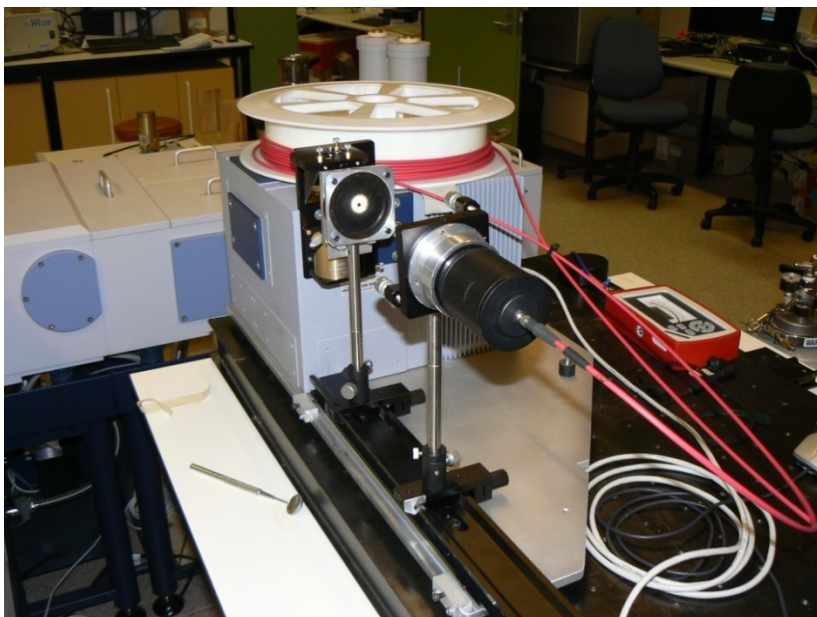
Quantum cascade laser heterodyne radiometer (RAL)
→ CH₄, CO, CO₂; resol. 0.005 cm⁻¹

In-situ Aircore system (RUG) → CH₄, CO, CO₂ vertical profiles
Calibrated to WMO standards

Bruker Vertex 70



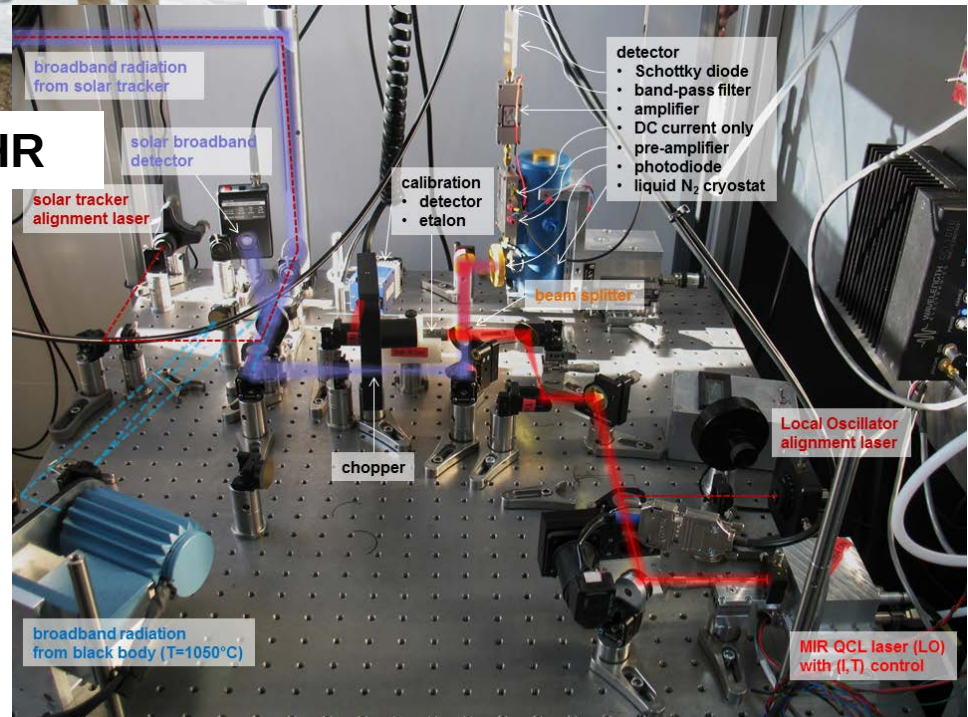
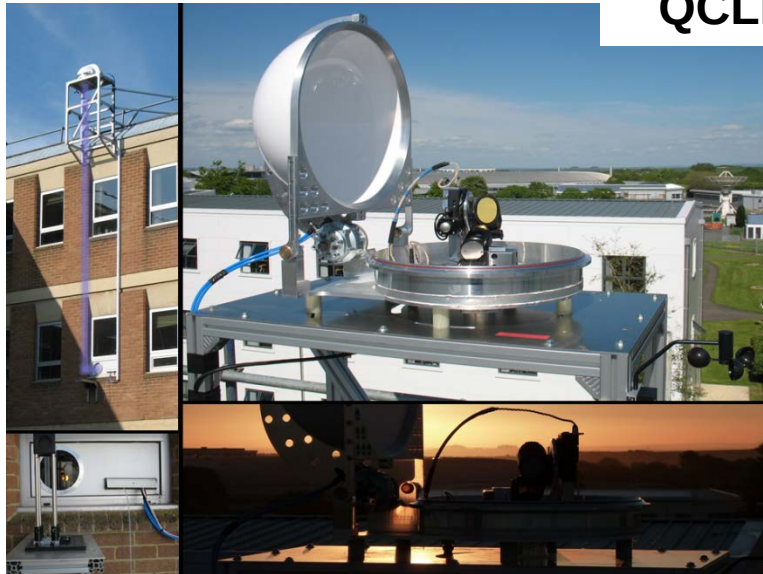
IR cube



Aircore



QCLHR



AirCore measurements

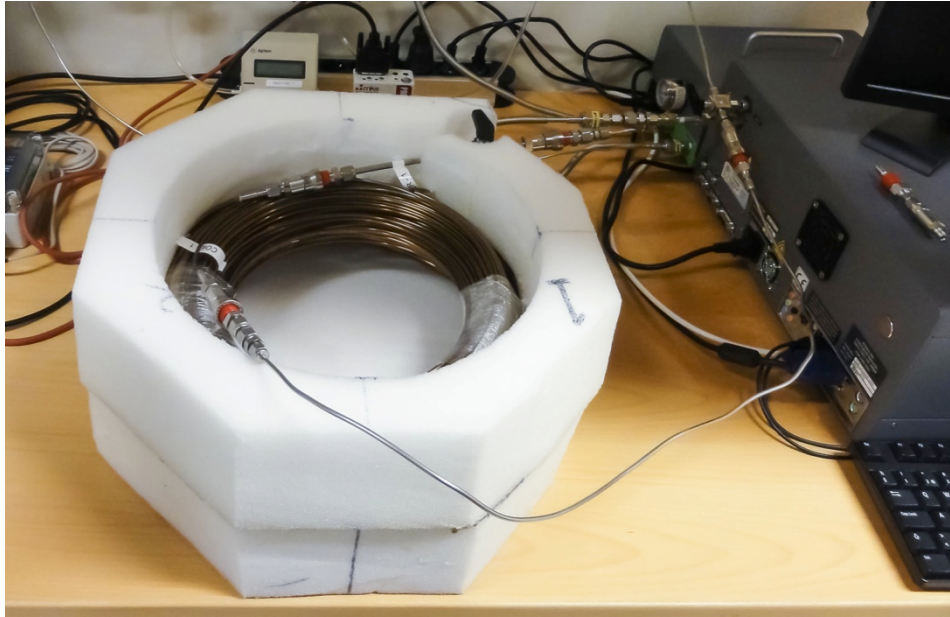


The AirCore with magnesium perchlorate driers and shut-off valves attached on each end, 152 m long, 7 kg

Air samples passively collected during descent



AirCore measurements over Sodankylä



TCCON station



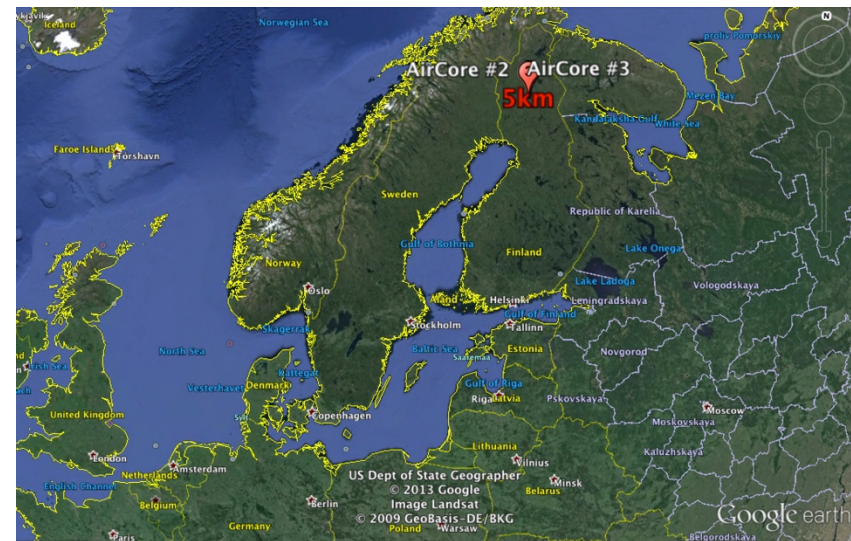
Location 67° North

AirCore: 40 m 1/4" + 60 m 1/8"

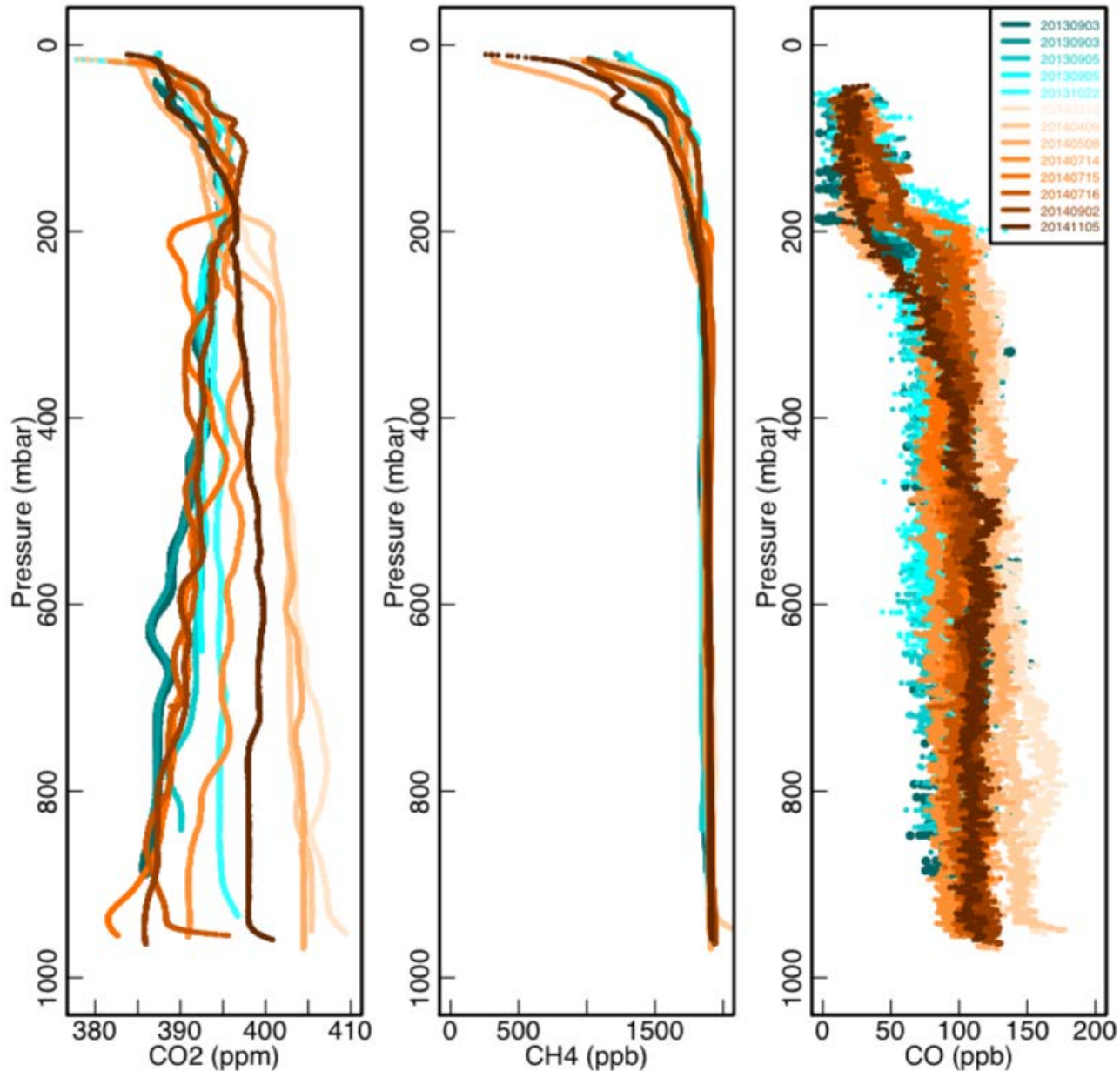
Coils: 2.8 kg

Total package: 3.6 kg

Analysis: Picarro CO₂/CH₄/CO



AirCore Sodankyla profiles (version 1.0)



Work packages within FRM4GHG

- WP0:** Preparation of container to host the spectrometers
(not financed by ESA)
- WP1:** Requirements Identification
- WP2:** Intercomparison Preparation (end of 2016)
- WP3:** Intercomparison Execution (2017)
 - semi-blind comparison
- WP4:** Data analysis and Corrective Measures
including aircore profiles as a priori
- WP5:** Project Outreach
 - conclusions
 - involvement of satellite groups, NDACC & TCCON
- WP6:** Development of an AirCore Gliding System
(optional, depending on funding)
- WP7:** Project management