

The Belgian Institute for Space Aeronomy and ICOS

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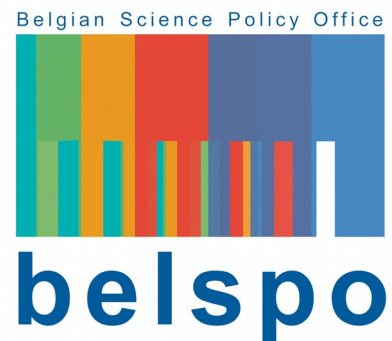
Belgian Institute for Space Aeronomy (BIRA-IASB)

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University of La Réunion



ICOS Belgium Study Day, Antwerp, 2015-04-22



- >> BIRA-IASB is a federal research institute
- >> Located in Ukkel, in the South of Brussels, on a Campus with RMI and ROB
- >> Studies the physics and chemistry of the atmosphere

Using

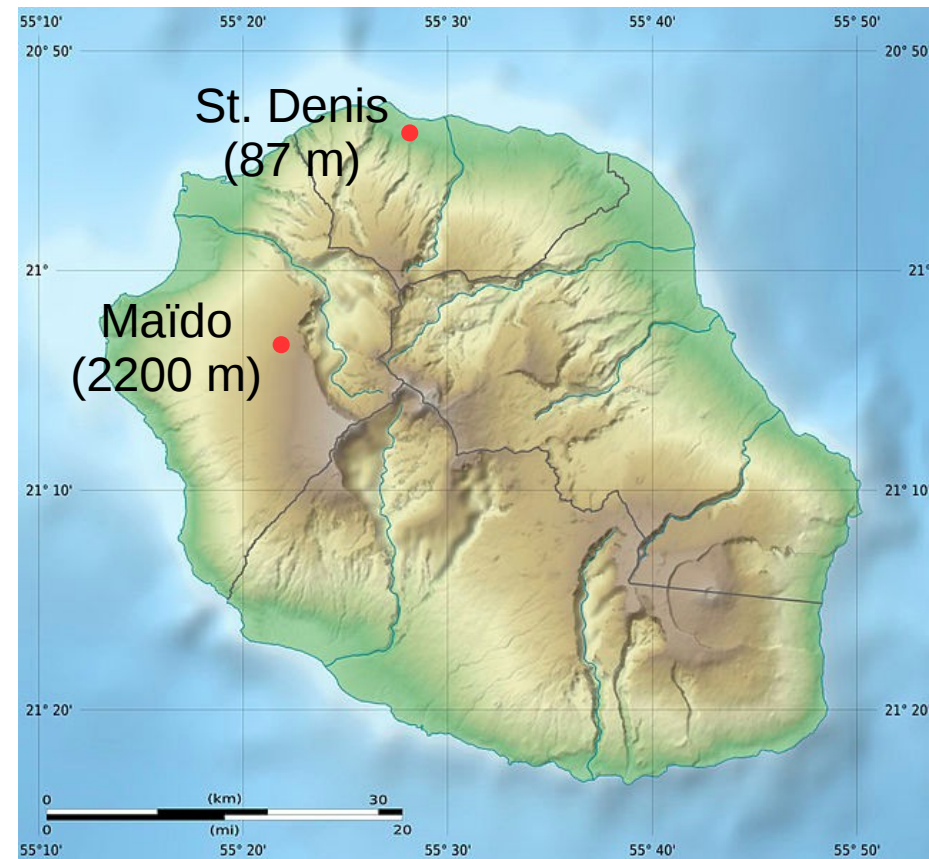
- Ground based measurements
- Air-borne observations
- Satellite observations
- Models

- >> Designs and builds instruments for satellites to study atmospheres of other planets
- >> Studies space-physics
- >> Operates Belgian experiments on board the ISS



Réunion Island

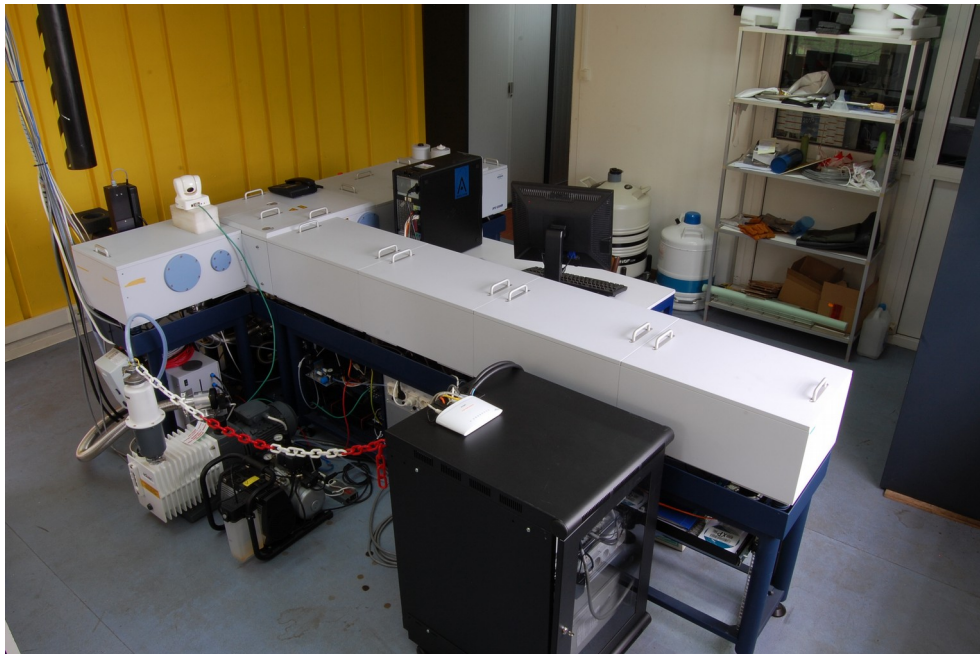
- >> Situated in the Indian Ocean, 800 km to the East of Madagascar
- >> One of very few observation sites in Africa
- >> Influence of biomass burning in Madagascar, South Africa, South America
- >> BIRA-IASB has been performing measurements at Réunion for more than 10 years, First on a campaign basis, continuously since 2009

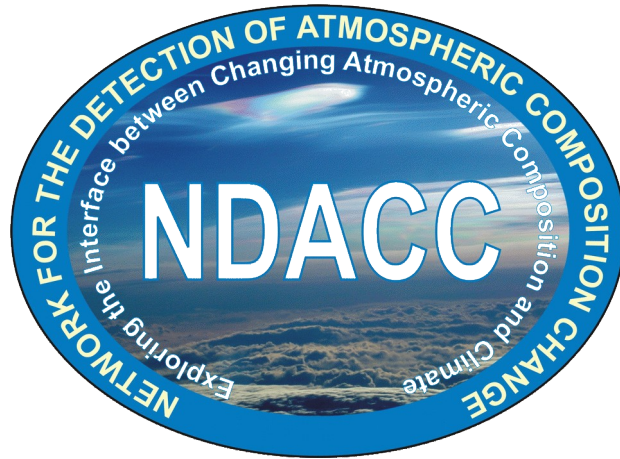


Atmospheric Measurements at Réunion

Ground-based remote sensing of the composition of the atmosphere using light in the infrared spectral region.

- >> Solar tracker captures sunlight and guides it into the spectrometer
- >> Infrared spectrometer records absorption spectra of atmospheric gases
- >> Inversion using non-linear least-squares fitting of spectra
- >> Retrieves total columns (molecules / m²) of target gases
Vertical profile information for some gases

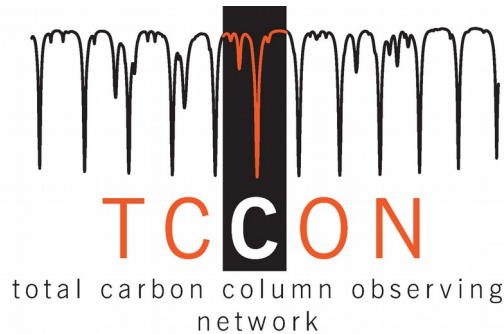




NDACC infrared working group

- >> Main focus: Measurements in the Mid-IR region: more than 20 species
- >> Long-term measurements, some site's data go back more than 20 years
- >> Via the EU FP7 project NORS: efforts for harmonization and rapid delivery of data, for validation purposes (see <http://nors.aeronomie.be>)

Total Carbon Column Observing Network



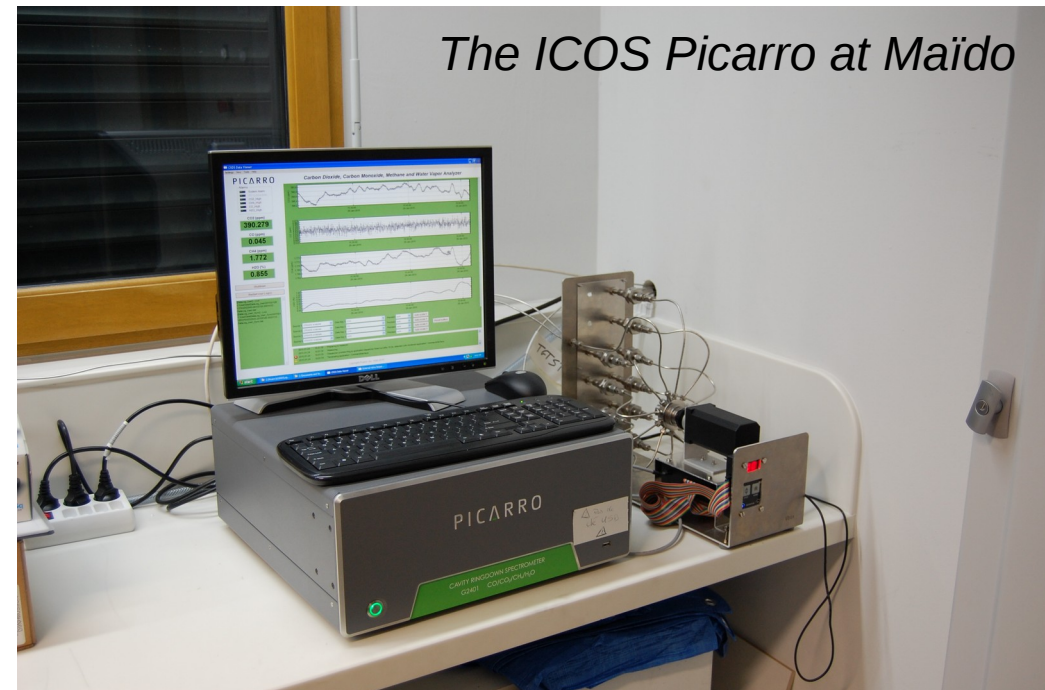
- >> Main focus: Greenhouse gases: CO_2 , CH_4 , N_2O
- >> Official data hosted at CDIAC (<http://tccon.ornl.gov/>)
- >> Highly harmonized network: same instruments, software, procedures
- >> Primary validation source for GOSAT, OCO-2, SCIAMACHY, Carbonsat
- >> High accuracy (1- σ): XCO_2 : 0.1% XCH_4 : 0.1 % XN_2O : 0.5% XCO : 2%
- >> Calibration to WMO standards are required to guarantee the accuracy

Both sites at Reunion island have a co-located in-situ trace gas analyzer.

- >> Maïdo (RUN) Picarro G2401: CO₂, CH₄, H₂O, CO Owner: BIRA-IASB
- >> St. Denis (STD) Picarro G2301: CO₂, CH₄, H₂O Owner: LSCE
Horiba: CO

Interest for remote sensing:

- >> Combined data product (FTIR and in-situ) for satellite validation
- >> Additional information for the inversion of the FTIR spectra (ground value)
- >> Station at 87 m and 2200 m: profile information



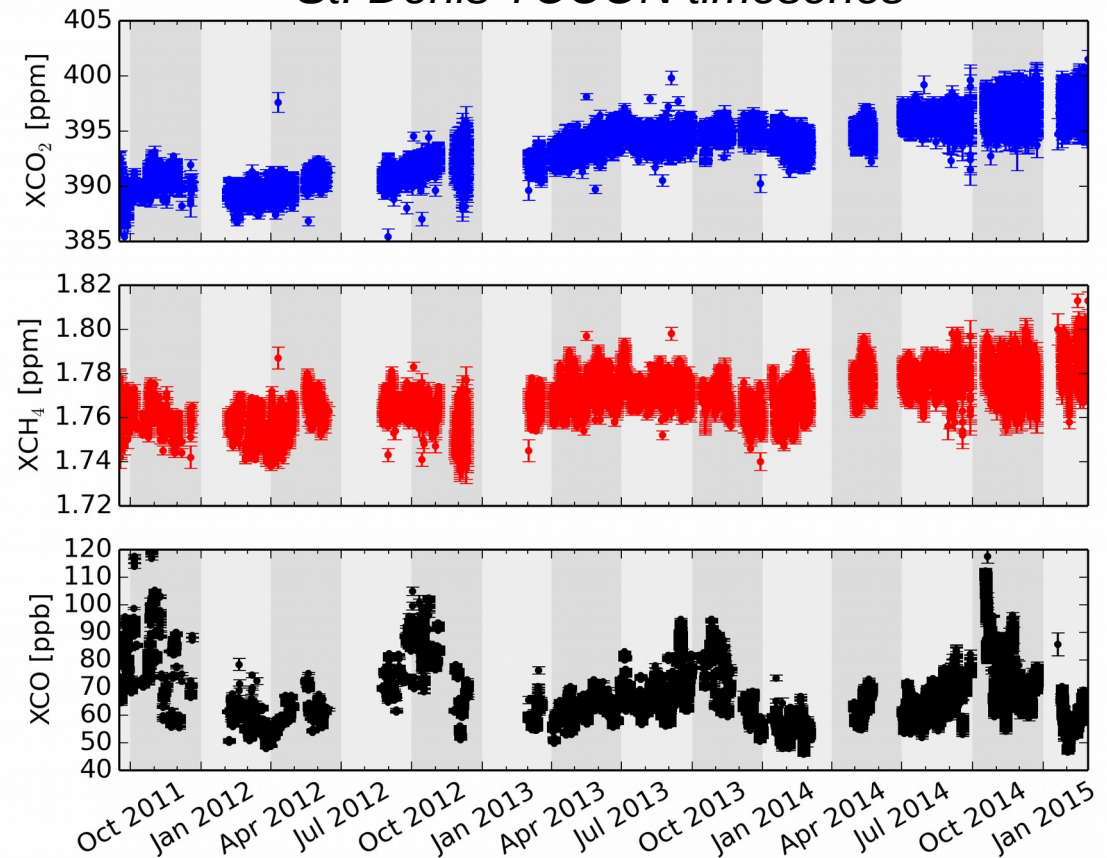


Towards integrated data-products combining in-situ and remote sensing measurements for the validation of satellite data.

Rapid delivery of TCCON data

Delivery TCCON-like data within 3 weeks after acquisition.

St. Denis TCCON timeseries



Analyze data collected during Week 1

Upload the analyzed data from Week 1 to server



Week 1
Acquisition of data

Week 2
Download Réunion data
Wait for NCEP data

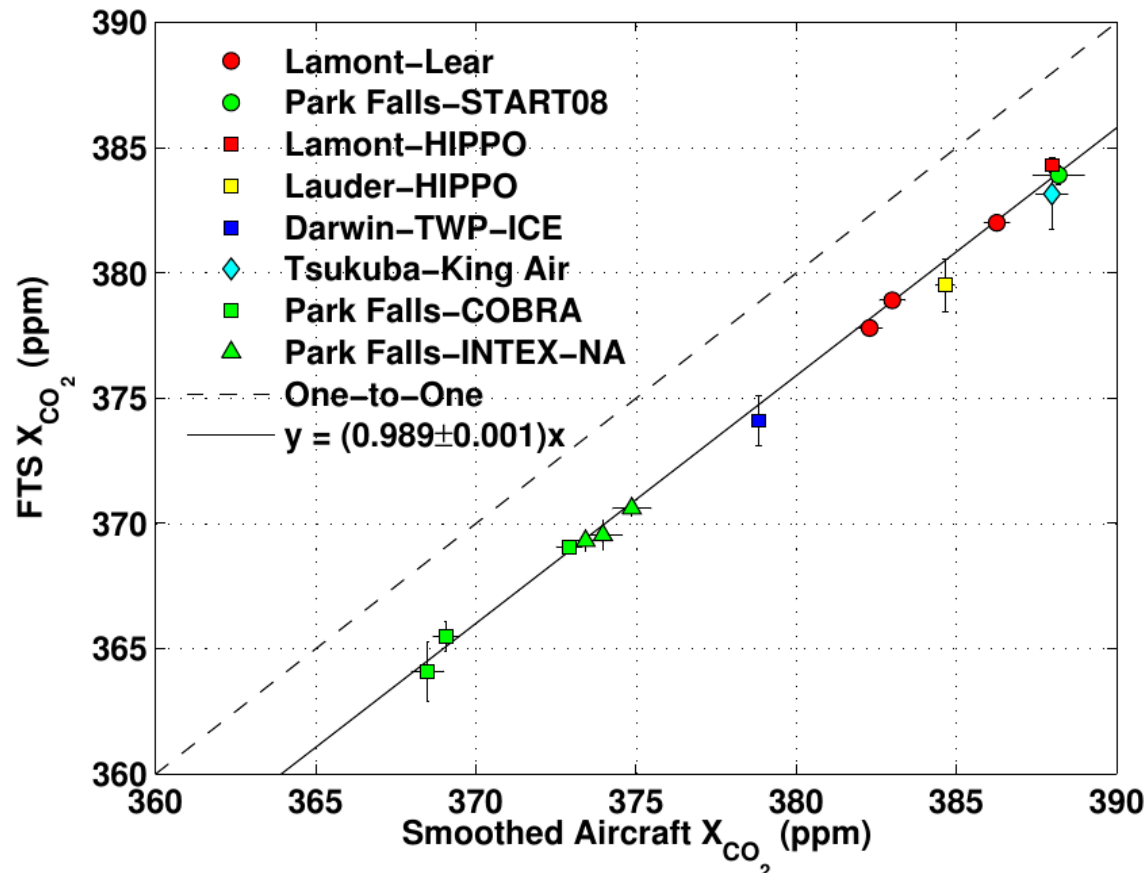
Week 3
Quality Assurance

TCCON Calibration to WMO Standards

Compare remote sensing IR data with in-situ vertical profile of the atmosphere obtained at the same time.

In-situ data: generally obtained from an aircraft profile

Comparison with TCCON data yields a calibration factor for each target gas



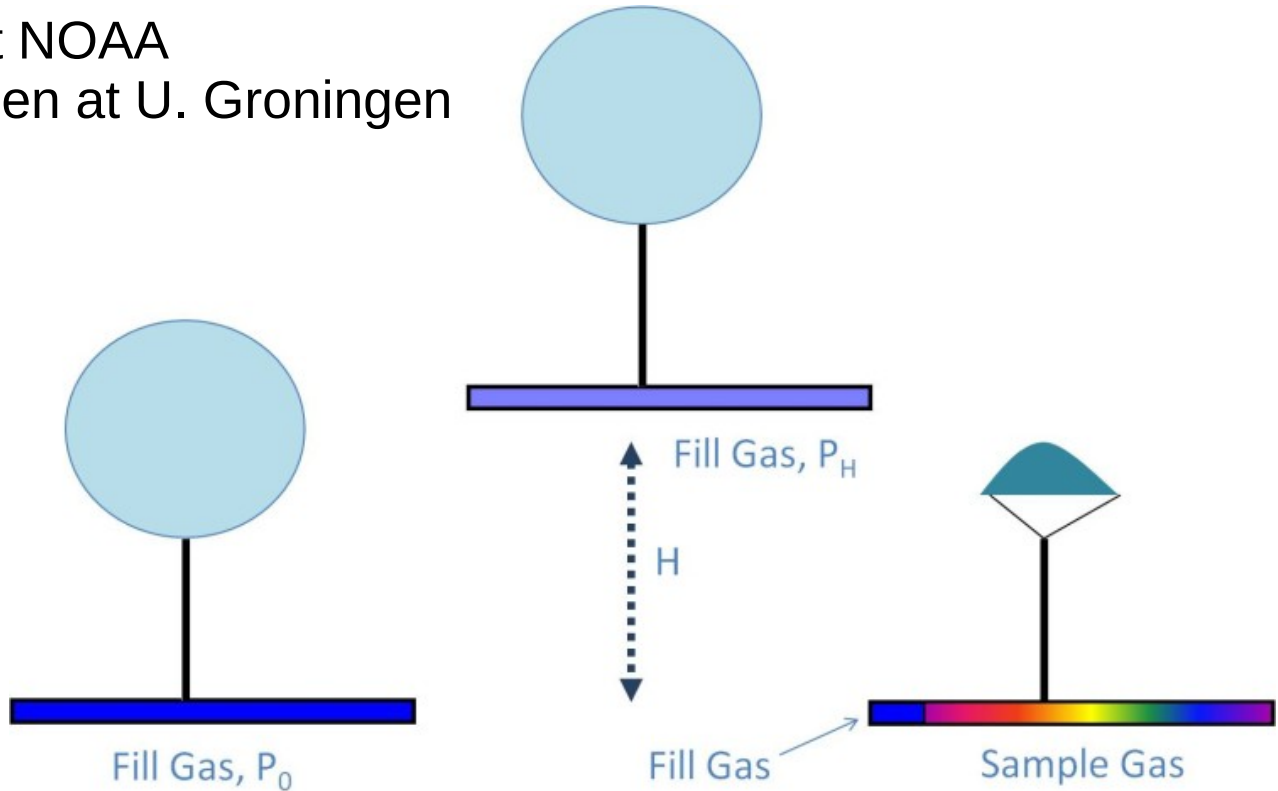
Problem at Réunion

Remote location

>> Costly and unpractical to be included in US, EU, Japan aircraft campaign.

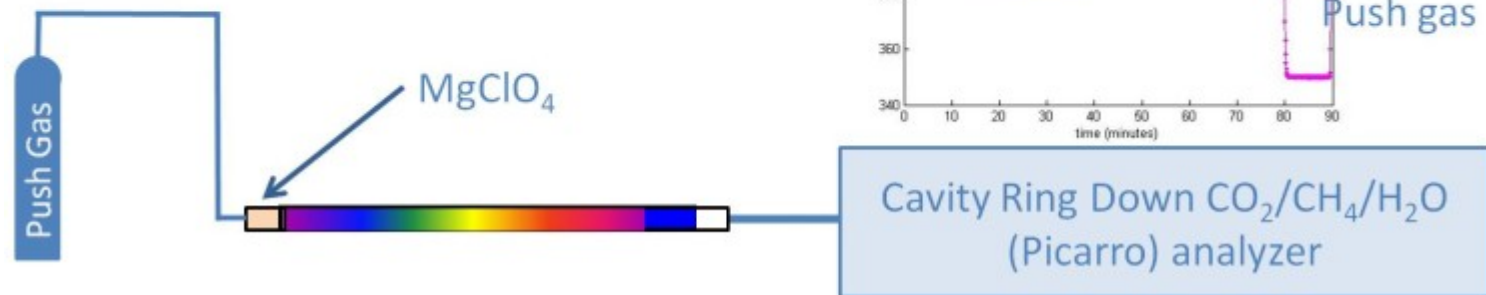
>> Small island (50 x 60 km²) with inaccessible interior

Developed by Colm Sweeney at NOAA
We work together with Huilin Chen at U. Groningen



Post-flight analysis

Fill gas = push gas = 8000 ppb CO

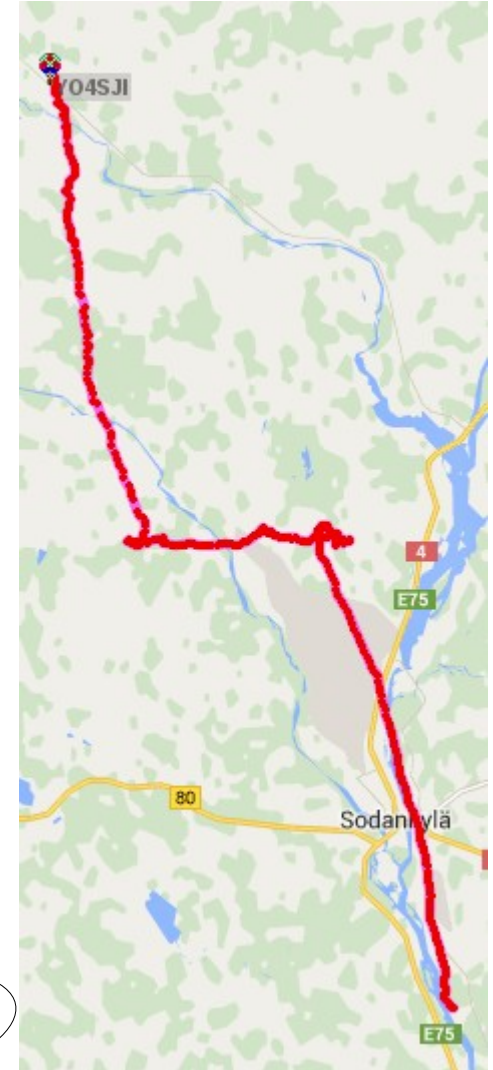


Benefits of AirCore

- >> Vertical profile up to 30 km (99% of the atmosphere) compared to 11 km for airplanes
- >> Low cost of the AirCore package (approx. 10 k€)
Radiosonde required for ambient p , T measurements
- >> Automatic valve makes recovery less urgent.
Landing on water is not a problem

Problems

- >> Air traffic regulations, and administration
Getting permission for flying in Europe is very difficult
Has presently only been flown in Finland
- >> Drifting of the balloon (long drive to recover payload)
- >> Recovery costs a lot of time and manpower



Use some kind of steerable UAV to bring the AirCore home

AirCore with Parafoil – Concept

The concept that we tested in Sodankylä, Finland in July 2014
Built and designed by Reev River Aerospace

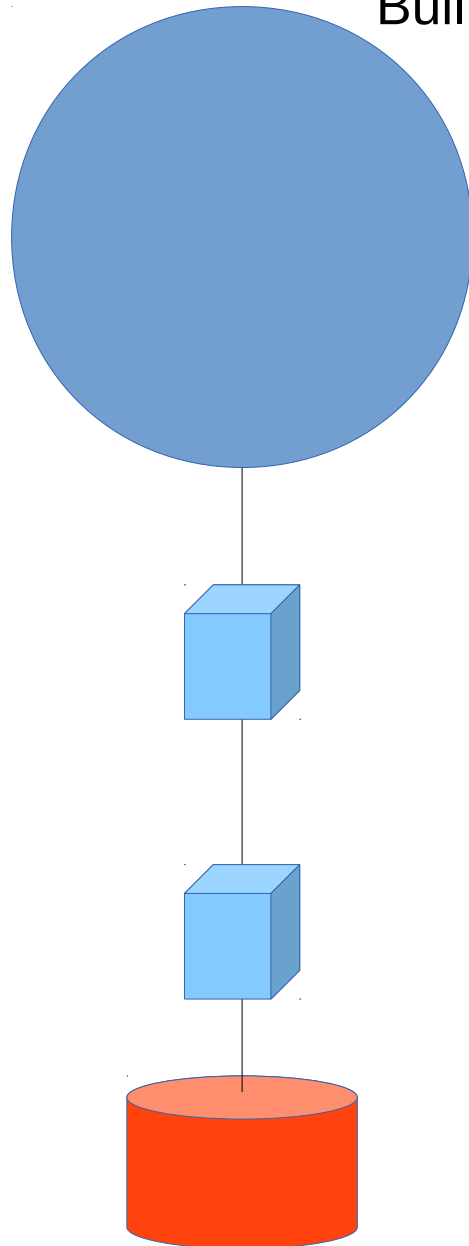
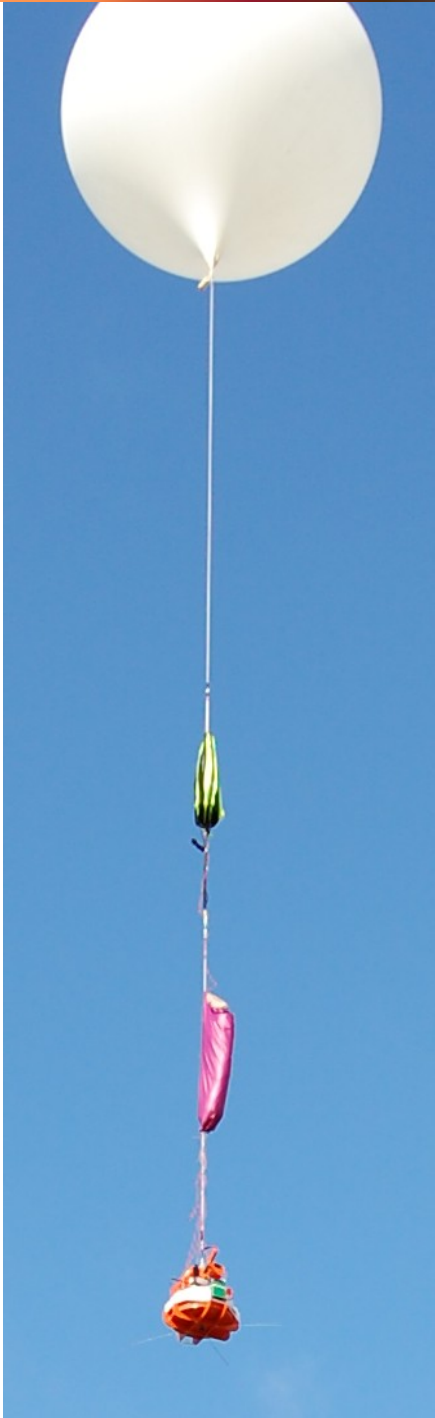
He or H₂ filled balloon (2 or 3 kg balloon)

Cutting device
Parachute

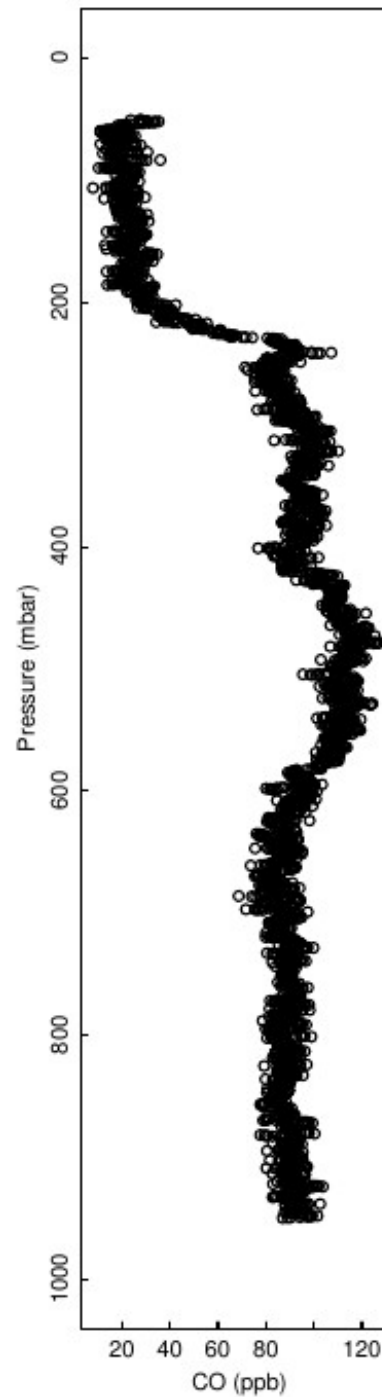
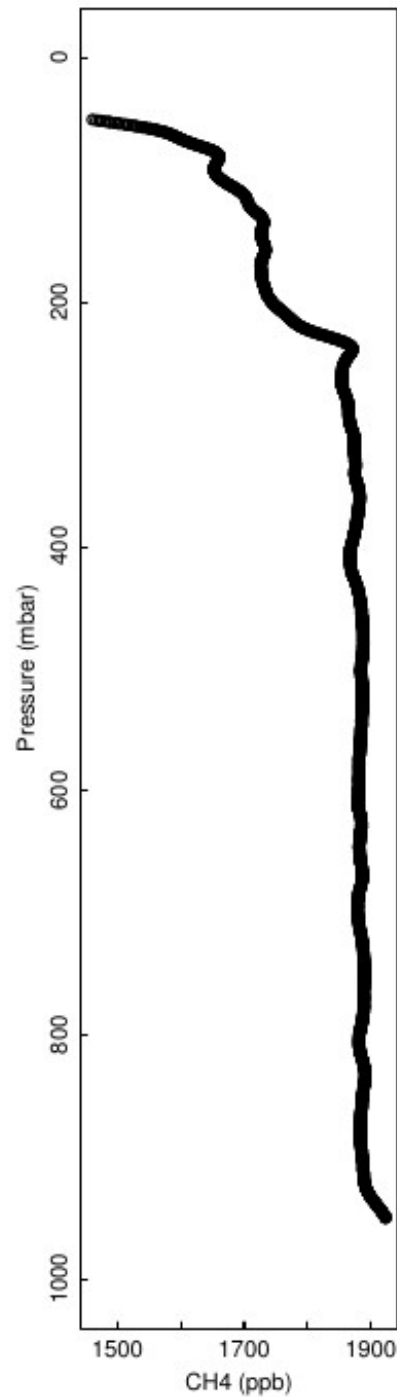
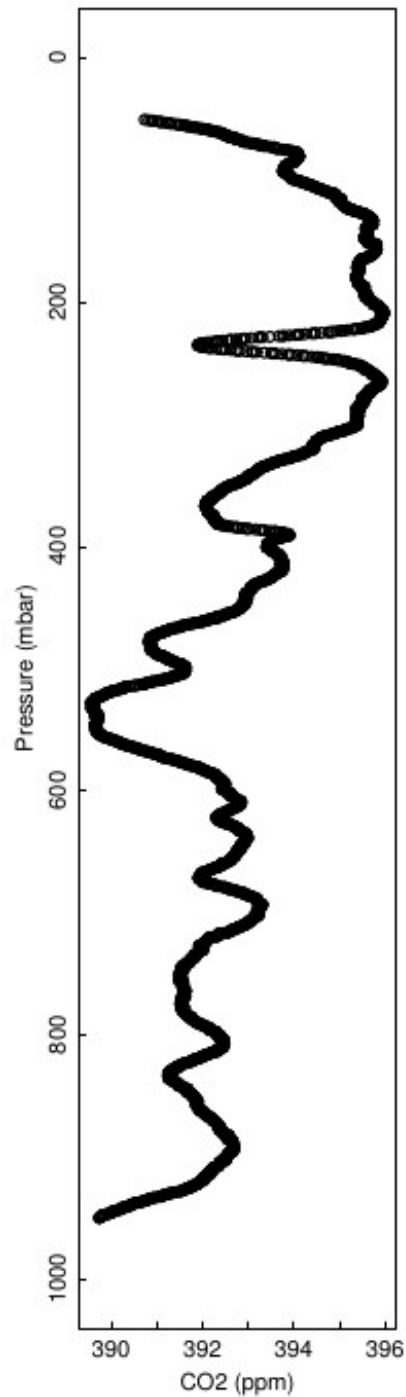
Cutting device
Folded parafoil

Steering device
Data loggers
Communication
AirCore tube

Total mass: 10 kg



Profiles (preliminary)



RUG AirCore #3

Length: 150m

Tropospheric part
95 m: diam. 4 mm

Stratospheric part
53 m: diam. 3.2 mm (1/8")

Weight: 2100 g

Preliminary data:

Profiles have not been corrected for non-equilibrium and thermal effects.

- >> **ICOS support** (BELSPO funding)
Operation and calibration of the St. Denis TCCON site
Monitor the Picarro and Horiba data
Satellite validation (Sentinel 5-Precursor, GOSAT, Sentinel 4 and 5)
- >> **ICOS-INWIRE** (FP7, subcontractor of UBremen)
Project ends December 2015
- >> **UAV_Reunion** (BRAIN-be pioneering)
New test flights planned in Sodankylä in June 2015
Mission at Reunion island: Sept. - Nov. 2015
Project ends March 2016
- >> Possible support for validation of the Copernicus
Atmospherical Monitoring Service via TCCON

ICOS

● ● ●
INTEGRATED
CARBON
OBSERVATION
SYSTEM

