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FINNISH METEOROLOGICAL INSTITUTE

Observations at Sodankylä

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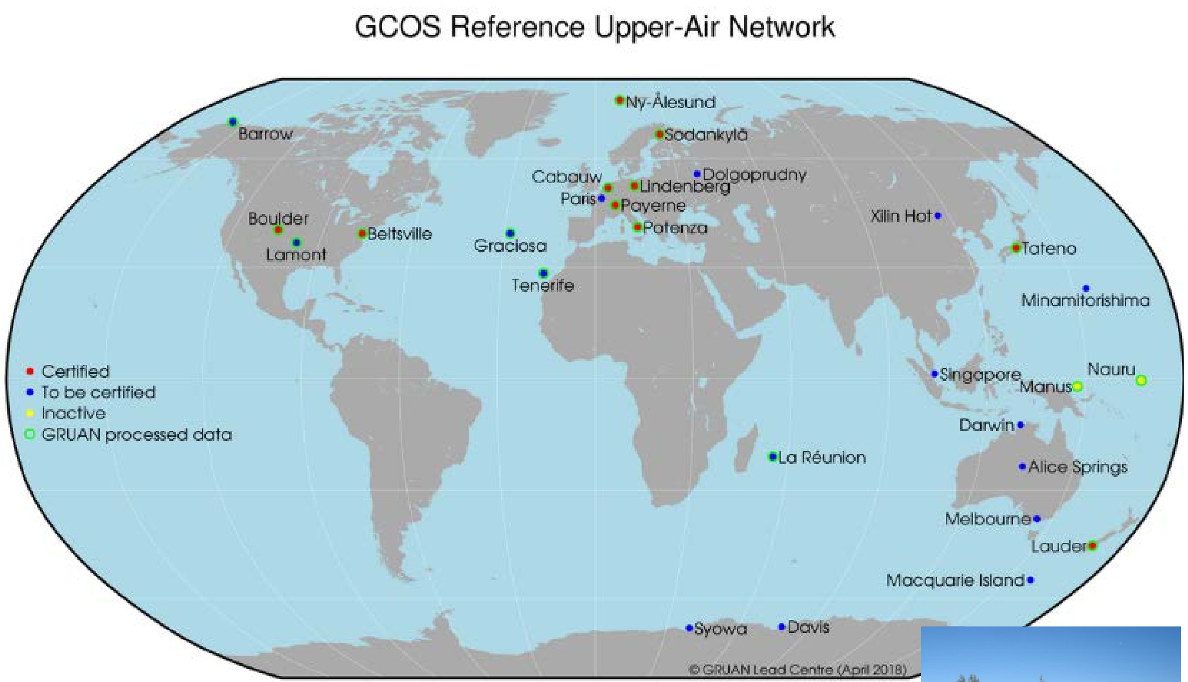
Outline

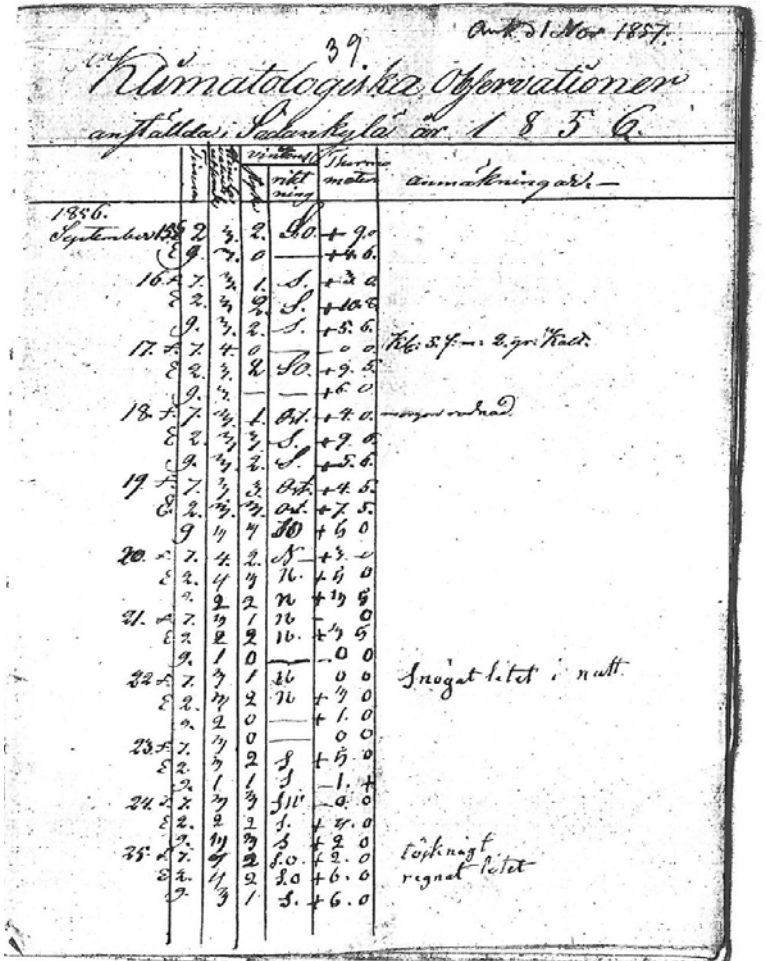
- Overview of the observations
- CFH, RS41, RS92 flights
- AirCore flights to measure profiles of CH_4, CO_2, other gases
- Campaigns/experiments: JOSIE, Match, YOPP, FRM4GHG, RINGO, CoMet

Location

Sodankylä site is operated by the Finnish Meteorological Institute Arctic Research Centre (FMI-ARC). Location of the site is 67.4 °N, 26.6 °E, 179 m above mean sea level; station's WMO number is 02836. Participates in GRUAN, ICOS, GAW, NDACC, TCCON, AERONET, EUBREWNET, etc.



Weather observations first time1856



Radiosondes start in 1949. 27.2.1949. Lapin Kansa

Sodankylän Tähtelään ilmatieteellinen observatorio

Yläilmoja tutkitaan radioluotaimien avulla.

Saatuamme tietää Ilmatieteellisen keskuslaitoksen ryhtyvän keväällä rakennuspuuhiin Sodankylässä, tiedustelimme asiasta prof. J. Keräseltä, joka kertoi seuraavaa:

– Tänä keväänä ilmatieteellinen keskuslaitos ryhtyy rakennuttamaan Sodankylään Tähtelän alueelle ilmatieteellistä observatoriota, johon tulee, paitsi täydellisiä ilmatieteellisiä havaintokoneita, yläilmojen tutkimus radioluotaimen avulla. Päivittäin lähetetään korkeuksiin vetykaasulla täytetty kuminen ilmapallo mukanaan radioluotain, jossa erikoisrakenteiset kojeet pallon lennon ajan mittaavat ilman lämpötilan, paineen ja kosteuden. Nämä tiedot kojeen pieni radiolähetin ilmoittaa maassa olevaan vastaanottimeen. Pallo voi nousta aina 25 km:n korkeuteen kunnes se halkeaa ja sen kulkua seurataan maasta käsin erikoisrakenteisella kaukoputkella, jolloin saadaan mitatuksi tuulen suunta ja nopeus eri ilmakerroksista. Kaikki nämä tiedot ylemmistä ilmakerroksista ovat tarpeellisia nykyaikaiselle sääennustukselle.

– Keskuslaitos palkkaa henkilökunnan tätä työtä varten ja on julistanut aseman luotausteknikon ja pallomestarin toimen haettaviksi. Henkilökunnan koulutus tapahtuu Ilmalan observatoriossa Helsingissä, mutta laitos toivoo saavansa Lapin läänin asukkaita työhönsä täällä pohjoisessa.

Observations at the meteorological observatory

- **First thermo-/barometer based records in 1856**
- **Met station during the 1st IGY 1882/83**
- **Continuous weather records since 1908**
- **Radiosondes since 1949**
- **Solar radiation observations since 1957/58 (1st IPY)**
- **Radioactivity monitoring since 1963**
- **Air quality observations since 1970s**
- **Ozone sondes and Brewer 1988**
- **SAOZ since 1990**
- **MW ozone since early 1990s**
- **First Lidar campaign in 1991/1992**
- **Stratospheric Aerosol sondes since 1994**
- **Frost Point Hygrometers since 1996**
- **RS92 since 2004, RS41 will start in April 2017**
- **Automated sonde launches since 2005, parallel manual launches**
- **TCCON FTS started in 2009**
- **MOSAIC MW since 2012**
- **GNSS SODF, SODA**
- **AirCore since 2013**
- **ESA FRM4GHG campaign March-October 2018**
- **CoMet aircraft campaign May-June 2018**
- **EU RINGO measurements in June 2018**

Sonde observations at Sodankylä: 1

- Twice daily 00/12 UT: RS41 radiosondes launched on regular basis, software v. 3.66 in operational and research soundings. Operational soundings are made using the Vaisala autosonde system. Near simultaneous manual and autosonde soundings have been performed. Soundings have been submitted to the GRUAN database. Altogether 32 manual RS92 soundings and 717 autosonde launcher RS41 soundings have been submitted using the GRUAN operating procedures. The manual sounding dataflow includes also the Intermet IMET-1 and Vaisala RS80. The data have been transmitted using the RsLaunchClient software. 4 times per day RS41 in February-March 2018.
- Flights of RS41 versus CFH and RS92 continued in 2017-2018.
- ECC ozonesondes were launched on regular basis once per week and additional ozonesondes have been included in other soundings, for example CFH soundings and ozone campaign soundings. Ozone soundings have been submitted to GRUAN database using the GRUAN RsLaunchClient software. Participation in JOSIE 2017 – SHADOZ campaign. Participation in Match Campaign in spring 2018 (ozone loss study).

Sonde observations at Sodankylä: 2

UTLS water vapor :

- Cryogenic Frostpoint Hygrometer, CFH (6-12 /year)
- Fluorescent Advanced Stratospheric Hygrometer FLASH,
- Aerosol backscatter:
- Cloud and aerosol detection by COBALD sondes. CFH/COBALD flights have been performed.

CO_2, CH_4 , CO profiles:

- AirCore Flights, comparisons with TCCON observations

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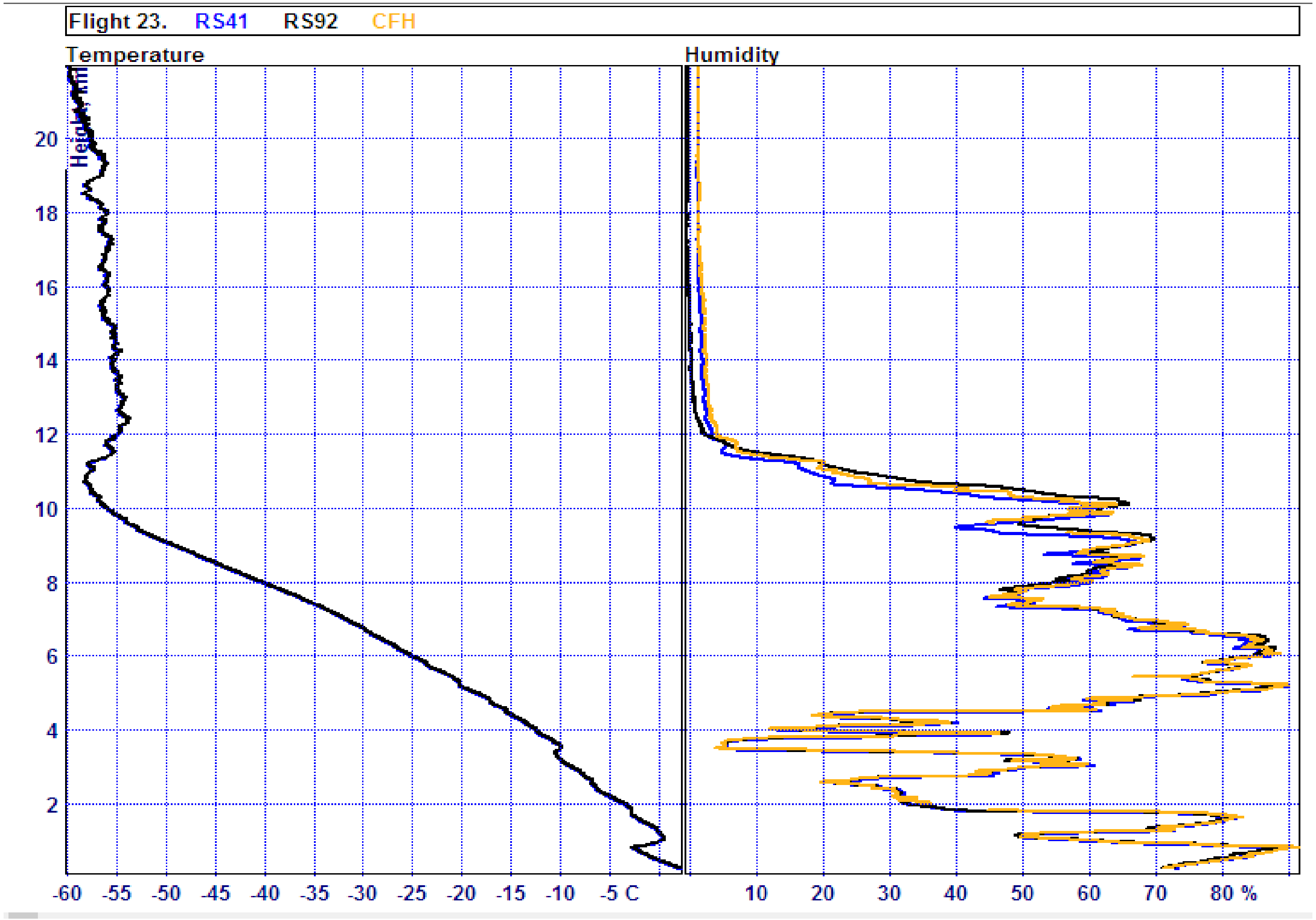
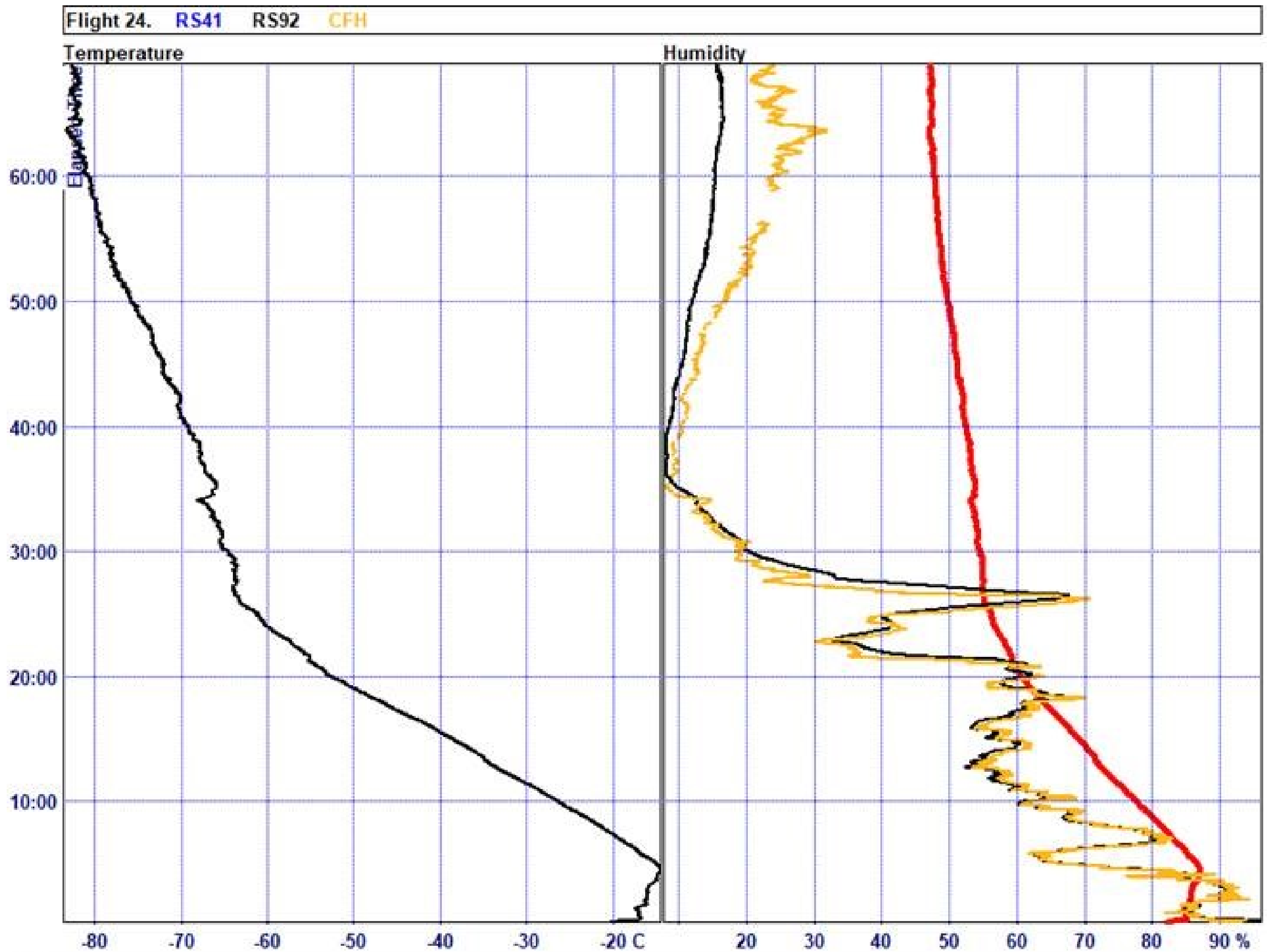
RS41/RS92 observations

Radiosonde	RS92-SGPD	RS41-SG
Sensor type	Thin-film capacitor, heated twin sensor	Thin-film capacitor, integrated T sensor, heating functionality
Uncertainty in sounding	5 %RH	4 %RH
Response time (63 %)	< 20 s (T=-40 ºC)	< 10 s (T=-40 ºC)
Ground check	Corrected against 0%RH humidity generated by desiccants	Corrected with RS41 in-built Physical Zero Humidity Check

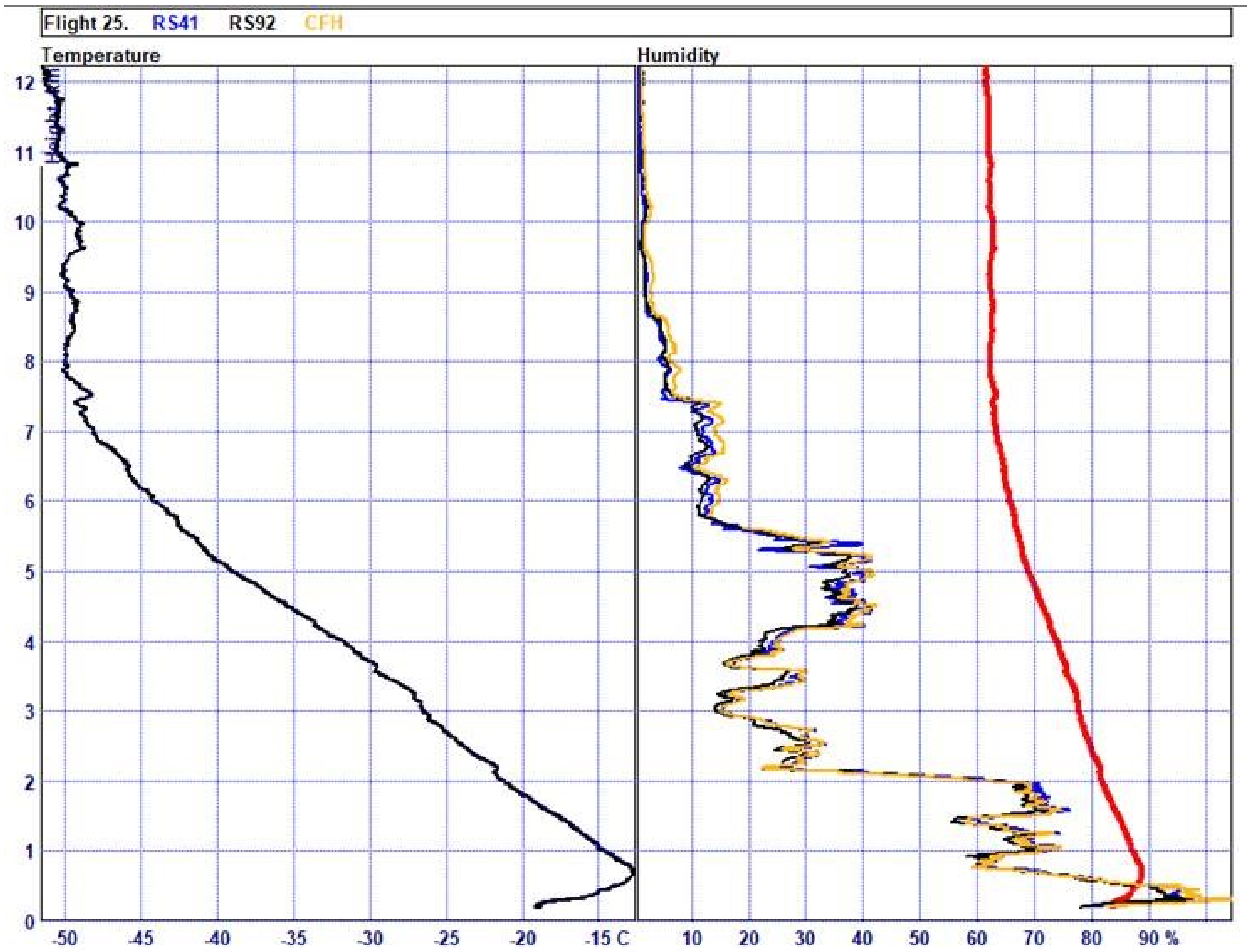
10-OCT-2017


Flight 23. RS41 RS92 CFH
Temperature
Humidity
Height, km
20
18
16
14
12
10
8
6
4
2
-60 -55 -50 -45 -40 -35 -30 -25 -20 -15 -10 -5 C
10 20 30 40 50 60 70 80 %

22-JAN-2018


Flight 24. RS41 RS92 CFH
Temperature
Humidity
60:00
50:00
40:00
30:00
20:00
10:00
-80
-70
-60
-50
-40
-30
-20 C
20
30
40
50
60
70
80
90 %

23-FEB-2018


Flight 25. RS41 RS92 CFH
Temperature
Humidity
Height km
12
11
10
9
8
7
6
5
4
3
2
1
0
-50
-45
-40
-35
-30
-25
-20
-15 C
10
20
30
40
50
60
70
80
90 %

Summary of the comparison flights

- CFH flights versus RS41 and RS92
- Temperature differences (RS92-RS41) smaller than 0.12 K.
- RH differences ((RS92 or RS41) -CFH) smaller than 1.5 % RH.

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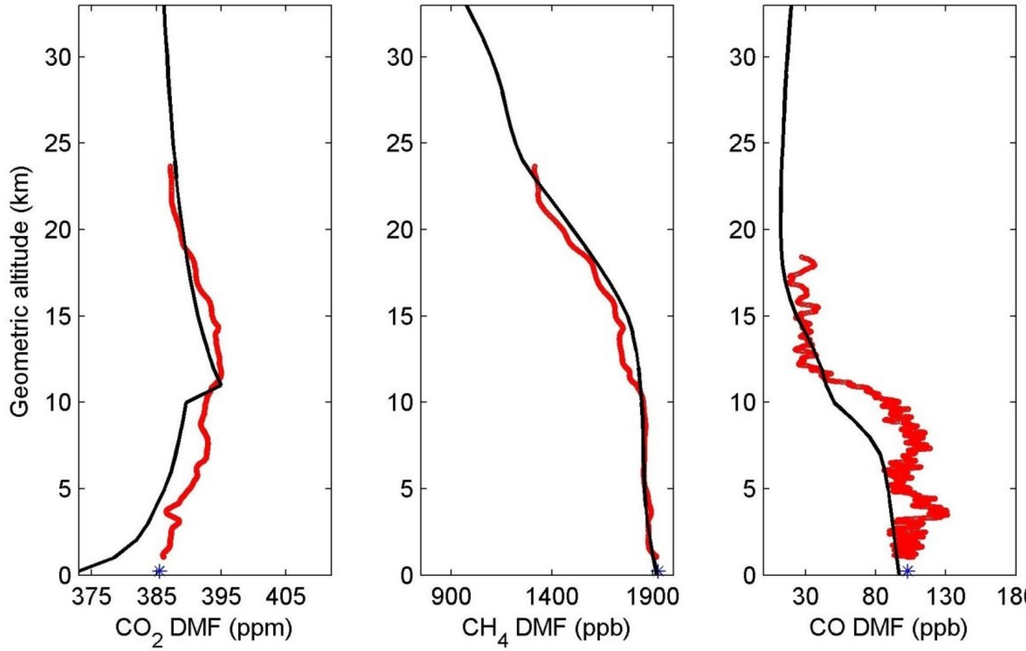
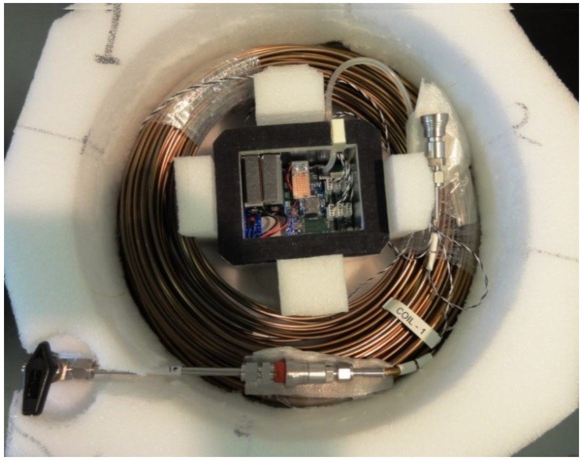
AirCore at Sodankylä



- At Sodankylä we have performed AirCore observations since September 2013. The measurements cover all seasons. An example of AirCore profiles of CO_2, CH_4 and CO is shown above (from September 3, 2013). AirCore profiles are in red and the TCCON a priori profiles in black. Blue star corresponds to tower measurements at Sodankylä.
- The AirCore system at Sodankylä is built as a stainless steel tubing of about 100 m long, consisting of ~40 m of ¼” and ~60 m of 1/8” tube. This configuration makes it possible to measure profiles with vertical resolution of 5 mb in the stratosphere and 15 mb in the troposphere.
- The system also involves a data acquisition unit to store pressure and temperature during an AirCore flight, a RS92 radiosonde and a positioning device.
- AirCore is lifted to the stratosphere using a meteorological balloon. After the landing we have analysed the sample using the Picarro G2401 gas analyser.



AirCore instrument with an open cover

Fiducial Reference Measurements for Greenhouse Gases (FRM4GHG), 2017-2019

Instrument	Spectral range	Resolution	Main GHGs
Bruker 125HR	1800-15000	0.004 cm^{-1}	XCH4, XCO, XCO2
Bruker Vertex70	2500-15000	0.16 cm^{-1}	XCH4, XCO, XCO2
EM27/SUN	4000-9000	0.5 cm^{-1}	XCH4, XCO, XCO2
IR Cube	4500-15000	0.5 cm^{-1}	XCH4, XCO2
Heterodyne	950/1280	0.002 and 0.02 cm^{-1}	CH4, CO2
AirCore balloon		13.4 mbar (AmbP>232 mbar)- 3.9 mbar (AmbP<232 mbar)	CH4, CO, CO2 vertical profiles

Campaign in Sodankylä 2018-2019. Participants in FRM4GHG Project are FMI, University Bremen, BIRA, KIT, Uni Wollongong, RAL, Uni Groningen. AirCore measurements are also made within the FRM4GHG Project.

YOPP

FMI contribution to YOPP. YOPP - the Year of Polar Prediction. The YOPP core phase (mid-2017 to mid 2019)

Enhanced Radiosonde observations

● Participation in the Northern Hemisphere Special Observation Periods in **February– March 2018 and July– September 2018 via increased (4 times per day) radiosonde launches in Sodankylä.**

● If logistically possible, participation in the Southern Hemisphere Special Observation Period in November 2018 – February 2019 via **radiosonde** launches at the **Aboa** station in Dronning Maud Land, Antarctica for 1-2 months in December 2018 – January 2019.

Photo: Andreas Dörnbrack

Field Campaigns 2018:

YOPP radiosondes Feb-Mar, July-September

Match ozonesondes

FRM4GHG, incl. AirCore, S5P

CoMet in May-June

RINGO in June

BEXUS autumn

Drones

Summary and outlook

- CFH, RS41, RS92 comparisons continued in year 2017-2018.
- RH differences ((RS92 or RS41) -CFH) smaller than 1.5 % RH.
- Temperature differences (RS92-RS41) smaller than 0.12 K.
- Ozone and water vapor measurements using CFH/ozone sondes
- AirCore measurements were continued in 2017-2018
- FRM4GHG campaign 2017-2019
- FMI has contributed to YOPP, JOSIE, Match, FRM4GHG
- CoMet campaign in May-June 2018
- Upcoming RINGO campaign in June 2018
- Drone flights with AirCore and other systems

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