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Research Activities at Sodankylä

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GRUAN ICM-9, 12-16 June 2017, Helsinki

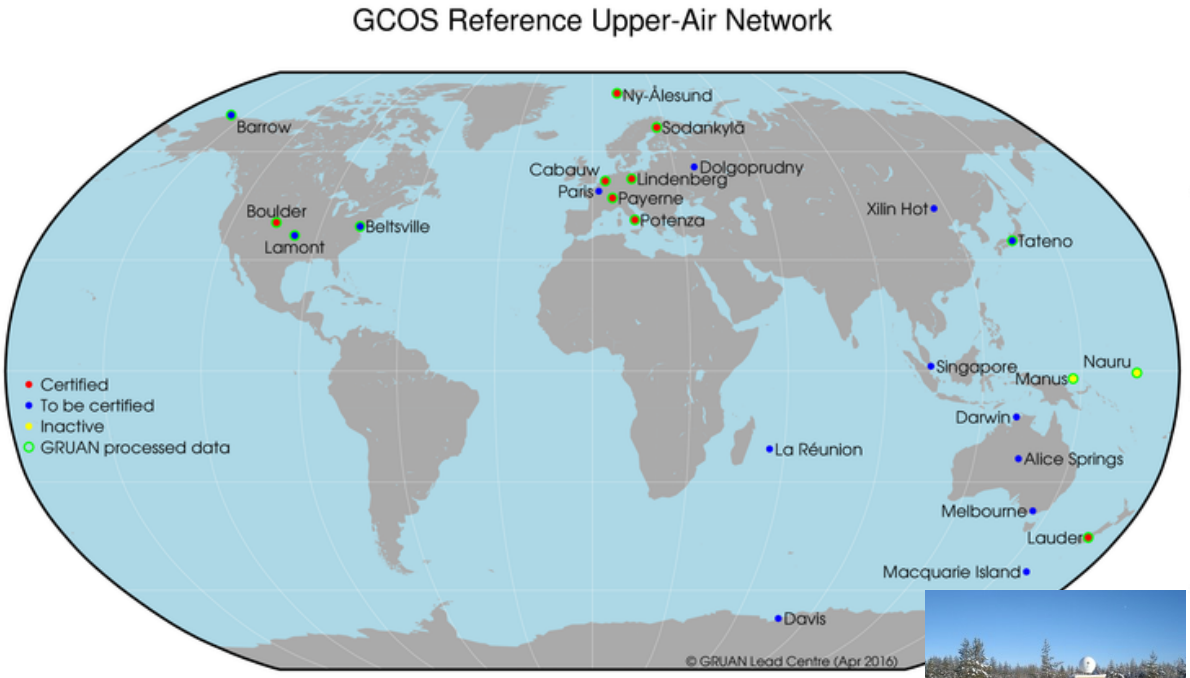
GRUAN

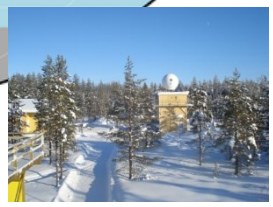
Outline

- Overview of the observations
- CFH, RS41, RS92 flights
- AirCore flights to measure profiles of CH_4, CO_2, other gases
- GAIA-CLIM, FRM4GHG
- YOPP

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.





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
- First Lidar campaign in 1991/1992
- Stratospheric Aerosol sondes since 1994
- Frost Point Hygrometers since 1996
- RS92 since 2004, RS41 since April 2017
- Automated sonde launches since 2005, parallel manual launches
- TCCON FTS started in 2009
- AirCore since 2013
- FRM4GHG campaign 2017-2018
- CoMet campaign April-June 2018

Press releases

12.6.2017 8:00

Upper air measurements are receiving increasing attention among the climate scientists

http://en.ilmatieteenlaitos.fi/press-release/371789216

Sonde observations at Sodankylä: 1

- Twice daily 00/12 UT: RS92 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 38 manual RS92 soundings and 776 autosonde launcher 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.
- Flights of RS41 versus CFH and RS92 continued in 2016-2017.
- Started regular RS41 flights on March 30, 2017.
- 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. WMO O3 sonde-DQA is an ongoing activity.

Sonde observations at Sodankylä: 2

UTLS water vapor :

- Cryogenic Frostpoint Hygrometer, CFH (6-12 /year)
- Fluorescent Advanced Stratospheric Hygrometer FLASH, including experimental versions of the instrument
- Flights of the Vaisala climate research sonde RR01

Aerosol backscatter:

- Cloud and aerosol detection by COBALD sondes. CFH/COBALD flights have been performed.

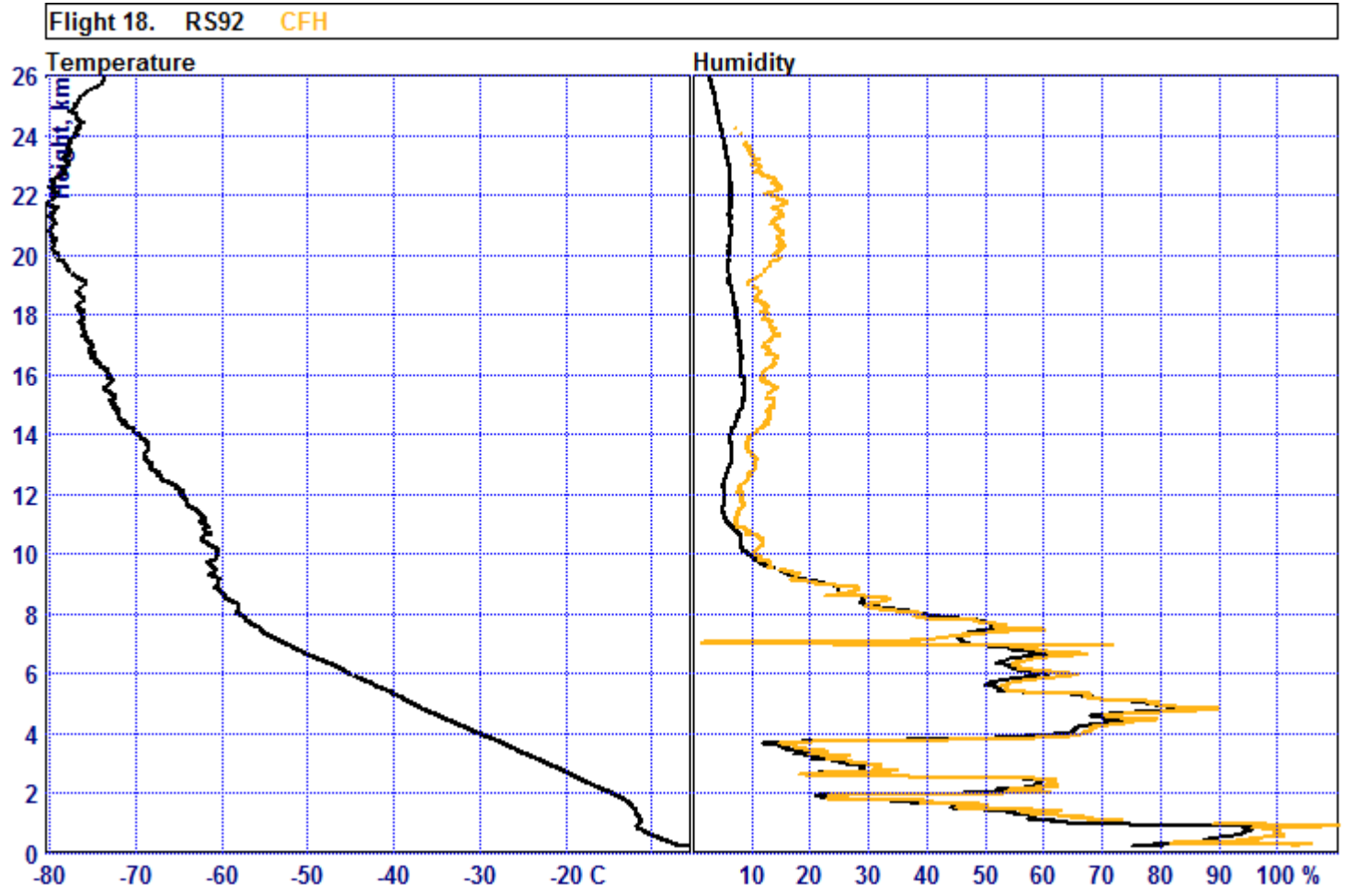
CO_2, CH_4 profiles:

- AirCore Flights

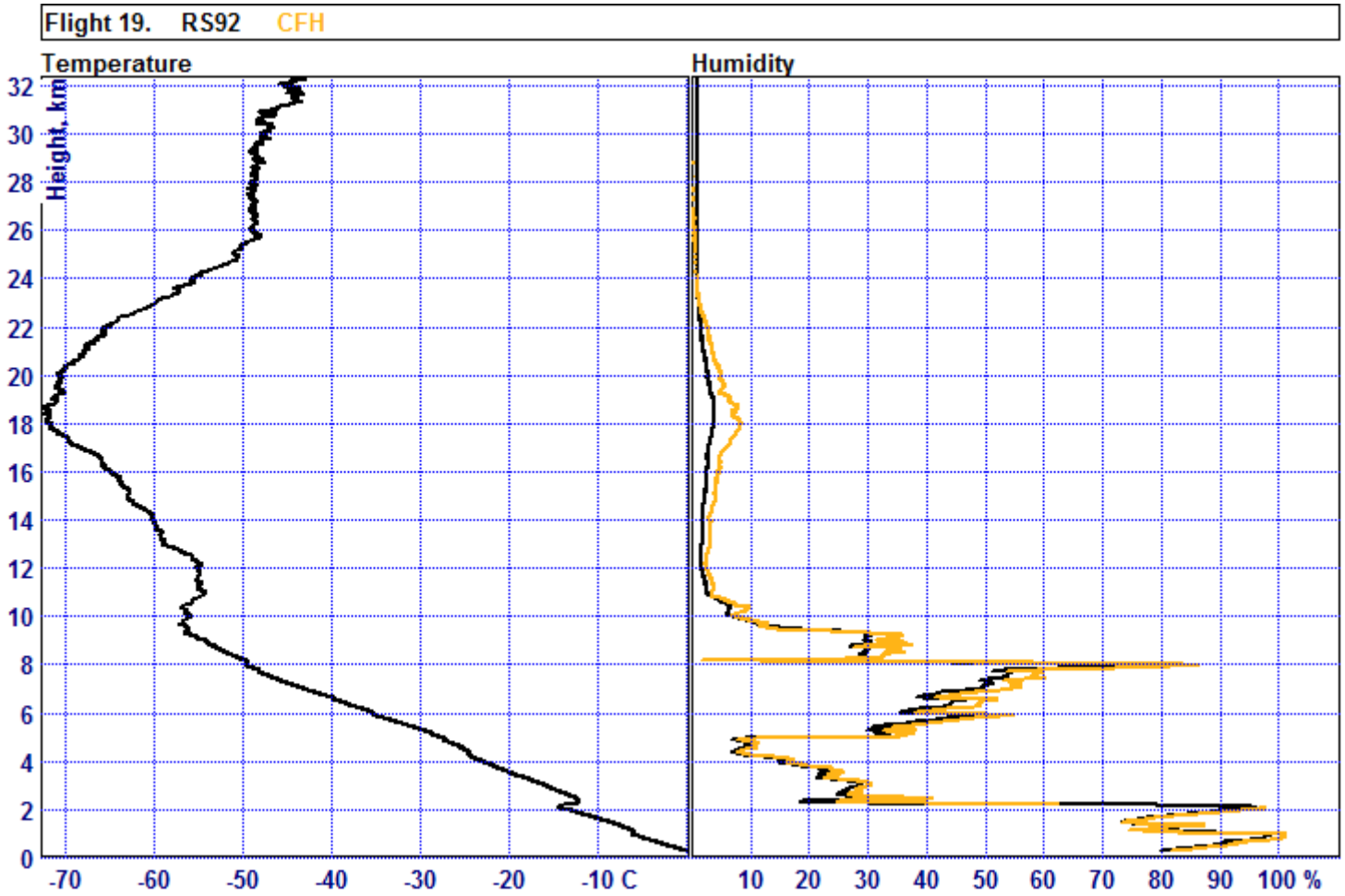
RS41/RS92 observations

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

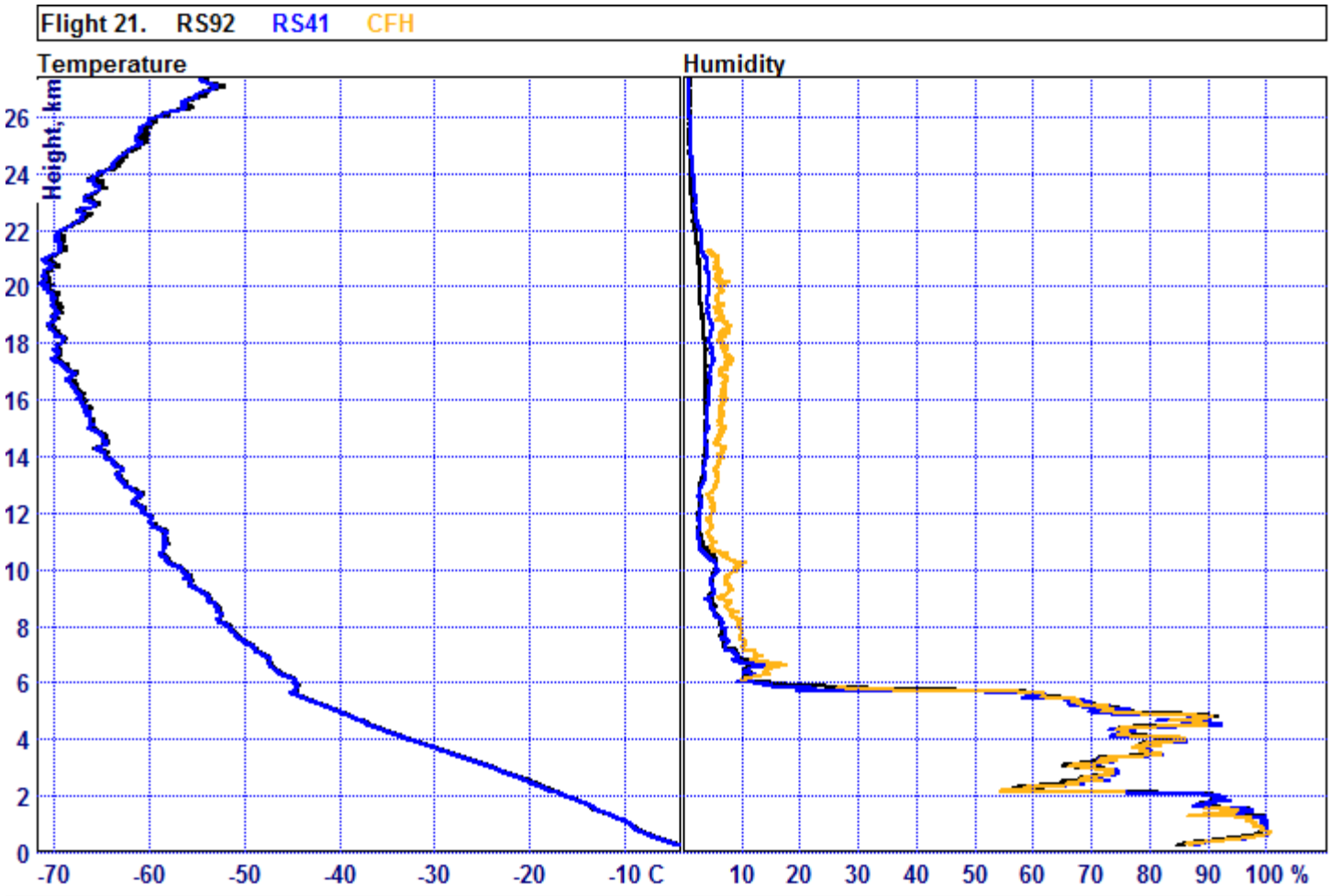
2016-02-26


Flight 18. RS92 CFH
Temperature
Humidity
Height, km
26
24
22
20
18
16
14
12
10
8
6
4
2
0
-80 -70 -60 -50 -40 -30 -20 C
10 20 30 40 50 60 70 80 90 100 %

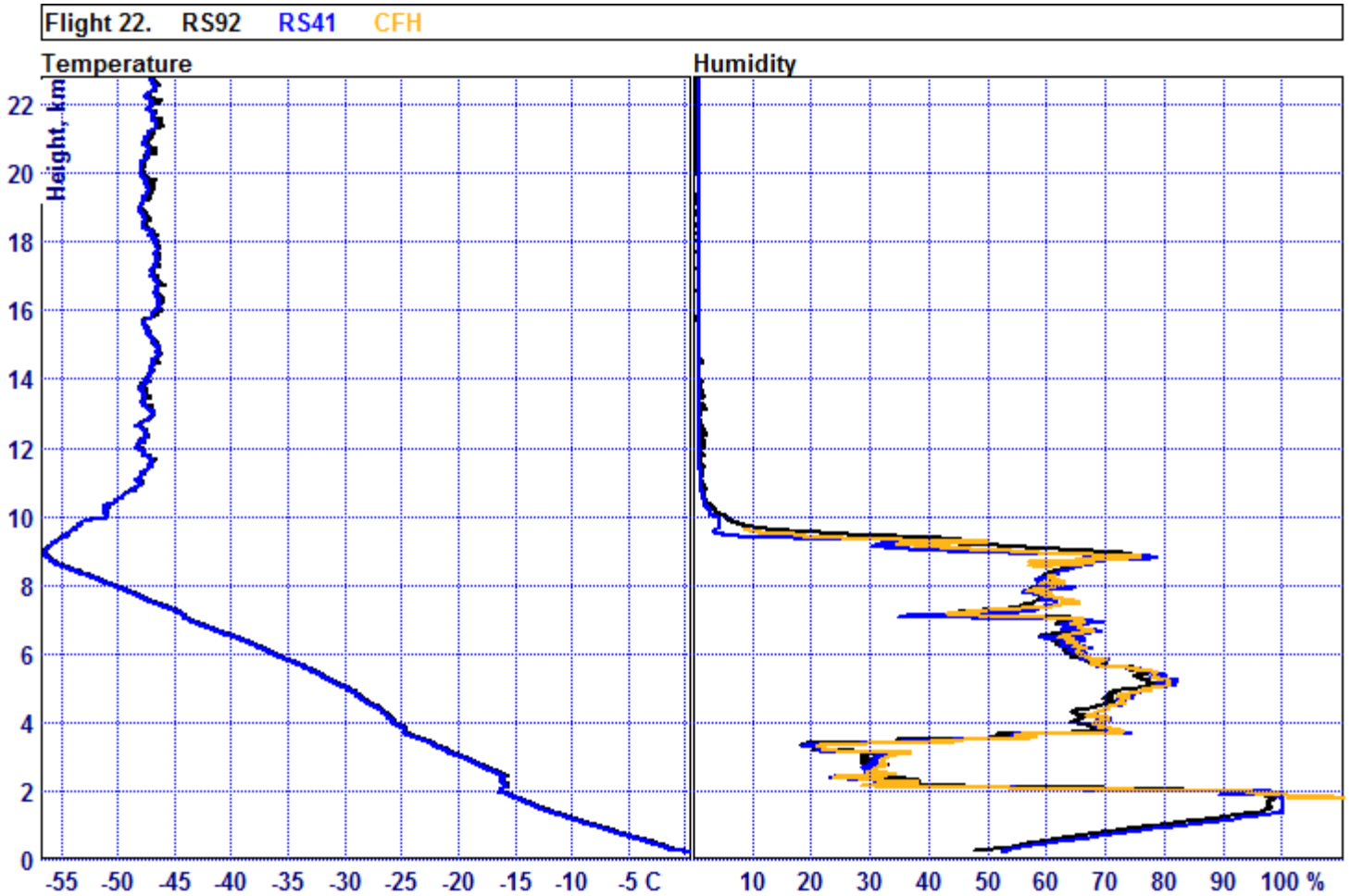
2016-03-10


Flight 19. RS92 CFH
Temperature
Humidity
Height, km
32
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
-70 -60 -50 -40 -30 -20 -10 C
10 20 30 40 50 60 70 80 90 100 %

2017-03-03


Flight 21. RS92 RS41 CFH
Temperature
Humidity
Height, km
26
24
22
20
18
16
14
12
10
8
6
4
2
0
-70 -60 -50 -40 -30 -20 -10 C
10 20 30 40 50 60 70 80 90 100 %

2017-05-11

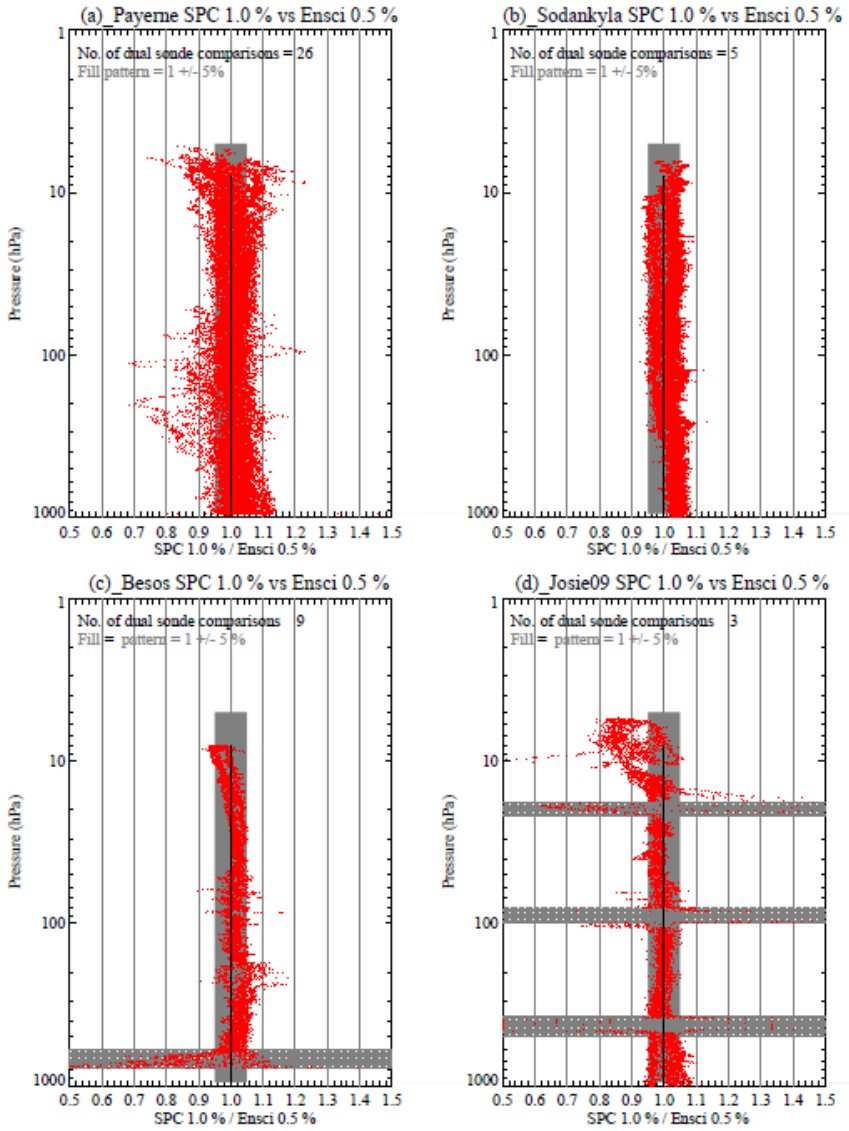

Flight 22. RS92 RS41 CFH
Temperature
Humidity
Height, km
22
20
18
16
14
12
10
8
6
4
2
0
-55 -50 -45 -40 -35 -30 -25 -20 -15 -10 -5 C
10 20 30 40 50 60 70 80 90 100 %

CFH flights summary

- RH differences ((RS92 or RS41) -CFH) smaller than 1.5 % RH.
- Temperature differences (RS92-RS41) smaller than 0.13 K.

Dual ozone sondes

Ratios of SP-1.0% to EN-0.5% ozonesondes. The measurements are from (a) Payerne, (b) Sodankylä, (c) BESOS, and (d) JOSIE 2009. The filled regions represent 5% around 1.0. The hashed areas are to indicate regions of low ozone concentration during tests in JOSIE 2009 or difficulty with the data system in BESOS.



Deshler, T., Stübi, R., Schmidlin, F. J., Mercer, J. L., Smit, H. G. J., Johnson, B. J., Kivi, R., and Nardi, B.: Methods to homogenize electrochemical concentration cell (ECC) ozonesonde measurements across changes in sensing solution concentration or ozonesonde manufacturer, Atmos. Meas. Tech., 10, 2021-2043, https://doi.org/10.5194/amt-10-2021-2017, 2017.

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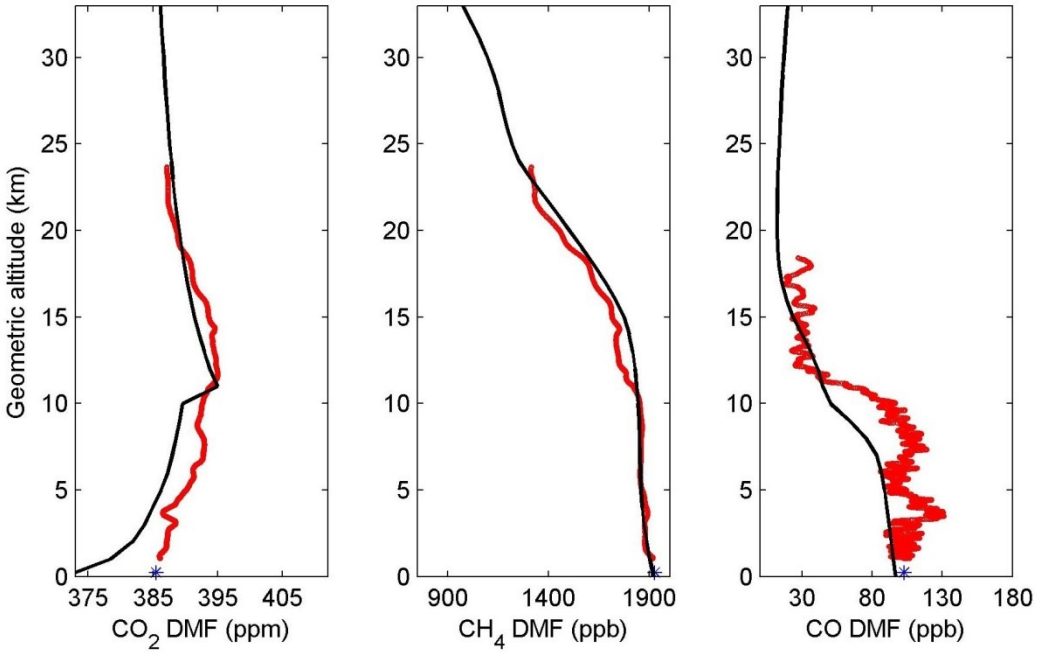
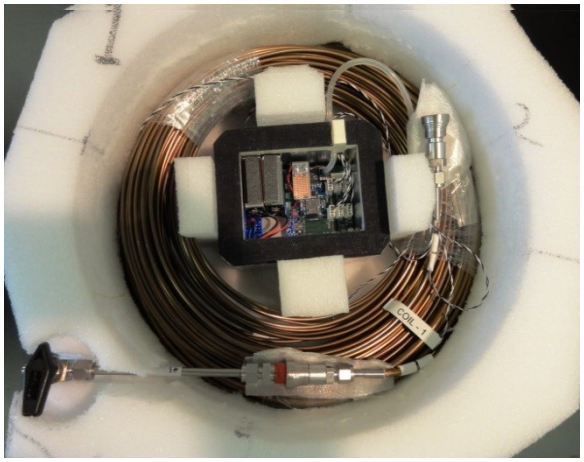
AirCore at Sodankylä



- 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. This work is related to the GAIA-CLIM WP2.



AirCore instrument with an open cover

Fiducial Reference Measurements for Greenhouse Gases (FRM4GHG), 2017-2018

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 2017-2018. FRM4GHG Project is led by the University Bremen and BIRA. Participants in FRM4GHG Project are FMI, University Bremen, BIRA, KIT, Uni Wollongong, RAL, Uni Groningen. Campaign web site http://frm4ghg.aeronomie.be/. AirCore measurements are also made within the FRM4GHG Project.

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

Enhanced observations

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

● An ongoing meteorological **UAV campaign** in the Fram Strait in May-June 2017, as a part of a R/V **Polarstern** expedition.

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

● Deployment of several **sea ice** mass balance buoys on Arctic sea ice, to provide real-time information on sea ice drift speed and direction, sea ice and snow thickness and temperature profile through ice and snow.

● Deployment of basic ice drifters in the Arctic Ocean as a part of the International Arctic Buoy Programme, to provide real-time information on atmospheric pressure and sea ice drift speed and direction.

Data analyses, model experiments, and product development

● Numerical weather prediction and sea ice modelling experiments for the Arctic and Antarctic to evaluate the model performance and the impact of data assimilation, particularly from the additional observations taken during YOPP, and to further improve the models. These activities belong to **nationally funded projects** “Antarctic Meteorology and Snow Research: from Process Understanding to Improved Predictions (ASPIRE)”, “Towards better tailored weather and marine forecasts in the Arctic to serve sustainable economic activities and infrastructure (TWASE)”, and FIN-YOPP, as well as the **H2020** project “Integrated Arctic Observation Systems” (**INTAROS**).

● Improvement of the usability of satellite remote sensing data for the needs of Arctic navigation, and improvement of satellite-based communication links in the Arctic to more efficiently transfer information on the actual and predicted weather and **ice conditions** to ships and other users (FIN-YOPP project).

● Inter-comparison of Polar ocean reanalyses as a part of the **COST** action ES-1402 “Evaluation of Ocean Syntheses“.

Data analyses, model experiments, and product development

- Coordination of the **COST** Action ES1404 “A European network for a harmonised monitoring of **snow** for the benefit of climate change scenarios, hydrology and numerical weather prediction.”

- Further development of methods to retrieve **snow and sea ice** parameters from satellites (several projects).

- Evaluation of socio-economic impacts of weather, marine, and climate services in the Arctic (TWASE project).

Summary and outlook

- CFH, RS41, RS92 comparisons were performed in year 2016-2017 during all seasons. 8 CFH flights in year 2016, so far 2 CFH flights in year 2017.
- RH differences ((RS92 or RS41) -CFH) smaller than 1.5 % RH.
- Temperature differences (RS92-RS41) smaller than 0.13 K.
- Ozone and water vapor measurements using CFH/ozone sondes
- Ozone dual sonde analysis
- AirCore measurements were continued in 2016-2017
- FRM4GHG campaign 2017-2018
- Participation in GAIA-CLIM, WP2, WP3
- FMI plans to contribute to YOPP

References:

Deshler, T., Stübi, R., Schmidlin, F. J., Mercer, J. L., Smit, H. G. J., Johnson, B. J., Kivi, R., and Nardi, B.: Methods to homogenize electrochemical concentration cell (ECC) ozonesonde measurements across changes in sensing solution concentration or ozonesonde manufacturer, Atmos. Meas. Tech., 10, 2021-2043, https://doi.org/10.5194/amt-10-2021-2017, 2017.

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