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Session 3

GRUAN Site Report for Sodankylä

(Submitted by Rigel Kivi)

Summary and Purpose of this Document

Report from the GRUAN site Sodankylä for the period January 2024 to December 2024.

Overview

Sodankylä GRUAN site performs both research soundings and automatic radiosonde launches. Data from the sounding systems have been submitted to the GRUAN archive. The manual sounding data-flow includes Vaisala RS41, Vaisala RS92-SGP, ECC ozonesonde, CFH water vapor soundings and Intermet iMet-1 data. The data have been uploaded using the RsLaunch Client software. The RsLaunch Client software is provided by the GRUAN Lead Centre. In addition to the balloon borne measurements, the GNSS dataflow at SODF is operational. Recent research activities include ozonesonde and radiosonde test flights with MW41 and MW51 systems. We have also flown a new version of the CFH sonde using liquid nitrogen. The Sodankylä GRUAN site is certified.

Change and change management

No major radiosonde changes have taken place during the reporting period. The site has upgraded the Vaisala sounding system software to the most recent versions available. The site has several radiosonde receiving units, therefore it is possible to perform dual and multiple soundings. We performed dual ozonesonde flights using Vaisala MW41 and MW51 systems.

Resourcing

Research soundings are often funded by external projects, for example regarding the CFH soundings. The site has performed project-based AirCore launches since early September 2013. We have also built a novel flask sampler to study water vapor isotopologues.

Operations

Recommended burst altitude of 10 hPa was often not reached in wintertime, regarding the operational radiosoundings. The reason for this anomaly is currently under investigation. Summertime soundings reached typically 10 hPa or higher altitudes.

Site assessment and certification

Sodankylä site has been recertified in December 2023.

GRUAN-related research

GRUAN-related research includes participating in the Radiosonde task team activities, CFH and ozonesonde related studies, research activities involving balloon borne AirCore and FTS instrument to measure methane and other greenhouse gases.

FMI Sodankylä site is leading an international research project focusing on accurate measurements of water vapor isotopologues. Within the WIFVOS project a novel balloon borne instrument has been developed to measure water vapor isotopologues in the free troposphere. The balloon borne observations are used to improve remote sensing retrievals by ground based and space borne instruments.

Researchers at the site have contributed to GRUAN-related publications:

- Nilsen, K., Kivi, R., Laine, M. et al. Time-varying trends from Arctic ozonesonde time series in the years 1994 2022. Sci Rep 14, 27683 (2024). https://doi.org/10.1038/s41598-024-75364-7
- Fujiwara, M., et al., Justification for high-ascent attainment for balloon radiosonde soundings at GRUAN and other sites, Atmos. Meas. Tech., 18, 29192955, https://doi.org/10.5194/amt-18-2919-2025, 2025.
- Laughner, J. L., et al., Total Carbon Column Observing Network's GGG2020 data version, Earth Syst. Sci. Data, 16, 21972260, https://doi.org/10.5194/essd-16-2197-2024, 2024.
- Denton, M., et al., Experiments at the edge of space: balloon flights to the stratosphere, Phys. Educ. 59 025024 DOI 10.1088/1361-6552/ad1f5e, 2024.
- Sha, M. K., et al. (2024). Fiducial Reference Measurement for Greenhouse Gases (FRM4GHG). Remote Sensing, 16(18), 3525. https://doi.org/10.3390/rs16183525.
- Hooghiem, J.J.D., Gromov, S., Kivi, R. et al. Isotopic source signatures of stratospheric CO inferred from in situ vertical profiles. npj Clim Atmos Sci 8, 110 (2025). https://doi.org/10.1038/s41612-025-00986-1.
- Tsuruta, A., et al., Global CH4 fluxes derived from JAXA/GOSAT lower-tropospheric partial column data and the CarbonTracker Europe-CH4 atmospheric inverse model, Atmos. Chem. Phys., 25, 78297862, https://doi.org/10.5194/acp-25-7829-2025, 2025.

WG-GRUAN interface

A letter of support to the FMI Administration from the Working Group on GRUAN would be useful.

Other archiving centers

Data are submitted to NDACC, WOUDC, TCCON, COCCON, NILU and to project databases.

Participation in campaigns

FMI has performed soundings with CFH, RS41, RS92, iMet, ozonesondes. We have also participated in Match ozonesonde campaign. FMI hosted WIFVOS campaign to measure water vapor isotopologues and an EU funded ATMO-ACCESS campaign in July-August 2024, with a focus on balloon borne stratospheric measurements, including AirCore observations. FMI hosted an NSF-funded campaign in June 2024 to perform stratospheric soundings of ozone and particles. Campaign news have been posted for example at the FMI Space and Earth Observation Centre web page.

Future plans

Continuation of GRUAN research activities is expected. FMI is able to host research campaigns at the FMI Sodankylä site. Dedicated balloon launches at Sodankylä are possible, for example Vaisala RS41 sondes, CFH sondes, ECC ozonesondes, coordinated with satellite overpass times.

GRUAN Site Report for Sodankyla (SOD), 2024

Reported time range is Jan 2024 to Dec 2024
Created by the Lead Centre
Version from 2025-11-07

1 General GRUAN site information

Object	Value
Station name	Sodankyla
Unique GRUAN ID	SOD
Geographical position	67.3700 °N, 26.6300 °E, 179.0 m
Operated by	FMI | Ilmatieteen laitos
Main contact	Kivi, Rigel
WMO no./name	02836 SODANKYLÄ
Operators	currently 8, changes +0 / -0
Sounding Site	2
GNSS	1

1.1 General information about GRUAN measurement systems

System	Name	Type	Setups	Measurements
SOD-GN-01	GNSS Site SODF	GNSS	1	operational
SOD-RS-01	Sodankylä Radiosonde Launch Site	Sounding Site	4	30
SOD-RS-02	Automatic Sodankylä Launch System (AUTOSONDE)	Sounding Site	2	737

1.2 General comments from Lead Centre

No comments from Lead Centre.

2 System: GNSS Site SODF (SOD-GN-01)

Object	Value
System name	GNSS Site SODF
Unique GRUAN ID	SOD-GN-01
System type	GNSS (GN - GNSS)
Geographical position	67.4209 °N, 26.3890 °E, 299.7 m
Operated by	FMI | Ilmatieteen laitos
Instrument contact	Kivi, Rigel
Started at	-
Defined setups	1 (HOURLY)
Possible streams	-

2.1 Lead Centre comments

2.1.1 Dataflow

Dataflow of GNSS data to GRUAN LC and the GRUAN GNSS processing centre at GFZ has started in February 2015. The current dataflow includes manufacturer raw data, converted raw data (RINEX) and instrument logs, containing all equipment changes.

There is no operational processing of GNSS-PW-GDP due to lack of meteorological data.

3 System: Sodankylä Radiosonde Launch Site (SOD-RS-01)

Object	Value
System name	Sodankylä Radiosonde Launch Site
Unique GRUAN ID	SOD-RS-01
System type	Sounding Site (RS - Radiosonde)
Geographical position	67.3700 °N, 26.6300 °E, 179.0 m
Operated by	FMI | Ilmatieteen laitos
Instrument contact	Kivi, Rigel
Started at	-
Defined setups	4 (OZONE, RESEARCH, ROUTINE2, OZONE2)
Possible streams	CFH, COBALD, FLASH, RS41, RS80, RS92

3.1 Lead Centre comments

3.1.1 Dataflow

Sonde dataflow to the GRUAN LC is operational since October 2010.

Weekly soundings of ECC Ozone sonde and sporadic soundings of CFH are part of the dataflow. All soundings are submitted using RsLaunchClient.

3.1.2 General

This is the manual launch site, used for ECC ozone sondes, CFH sondes and other manually released research sondes.

3.2 GRUAN data products

Product	Version	Soundings received	Available at LC	Distributed by NCEI

3.2.1 Stream: ECC

ECC		30	30	

3.2.2 Stream: RS41

RS41		30	30	
RS41-RAW	001		30	
RS41-EDT	001		30	
RS41-GDP	001		30	

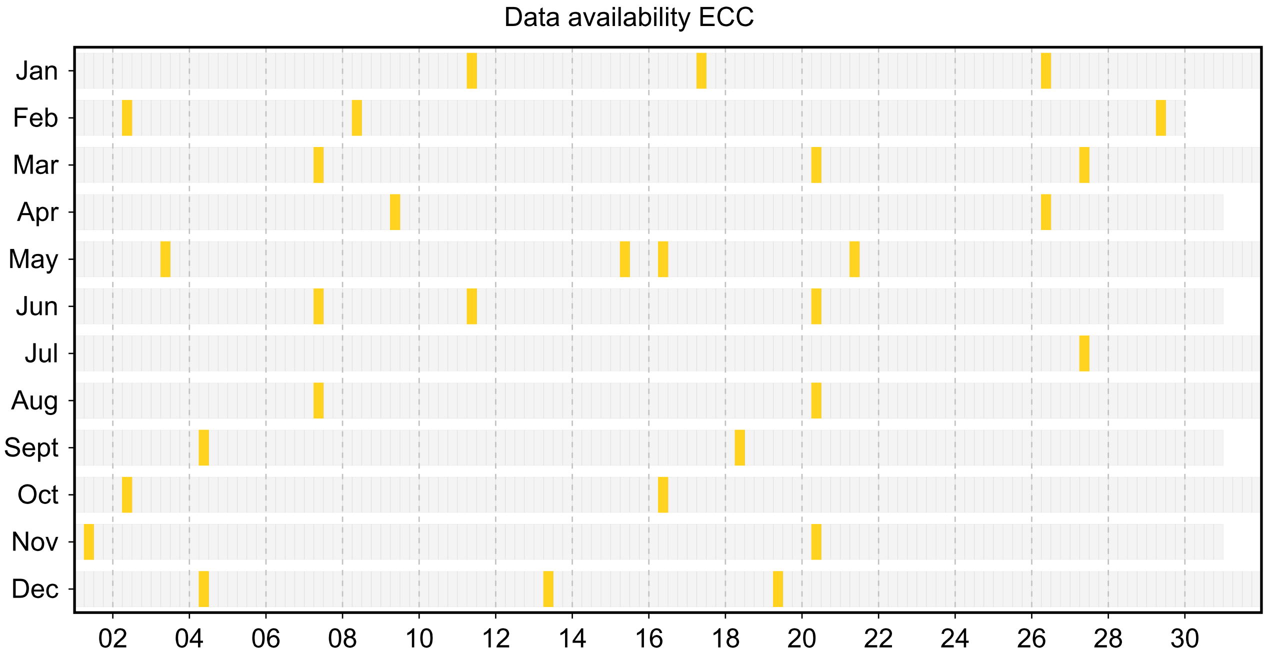
3.3 Availability of data products

Available (green): All steps of data processing have been successfully completed. The data product file is available at LC (e.g. files that didn't pass QA/QC or uncertified GRUAN data products) and/or at NCEI (a certified GRUAN data product file that did pass QA/QC).

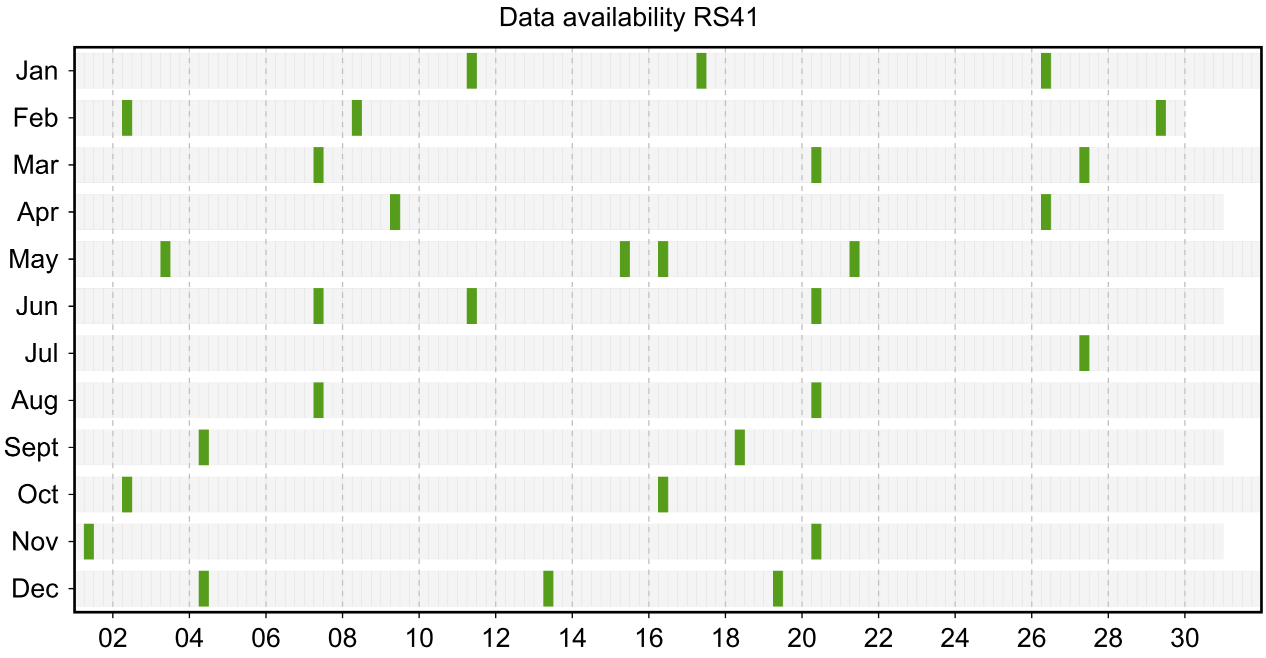
Unprocessed (yellow): The manufacturer-produced file with raw measurement data has been successfully converted into a GRUAN-standardized raw data format (NetCDF). The GRUAN data processing has not been performed or was aborted. Reasons for this may be a still missing GRUAN data processor or a processing-software error.

Original (red): The original, manufacturer-produced, raw data file is available (e.g. MWX data file) but was not converted into a GRUAN-standardized raw data format (NetCDF). Reasons for this may be missing data conversion software, a software error, or a corrupt data file.

3.3.1 Stream: ECC



3.3.2 Stream: RS41



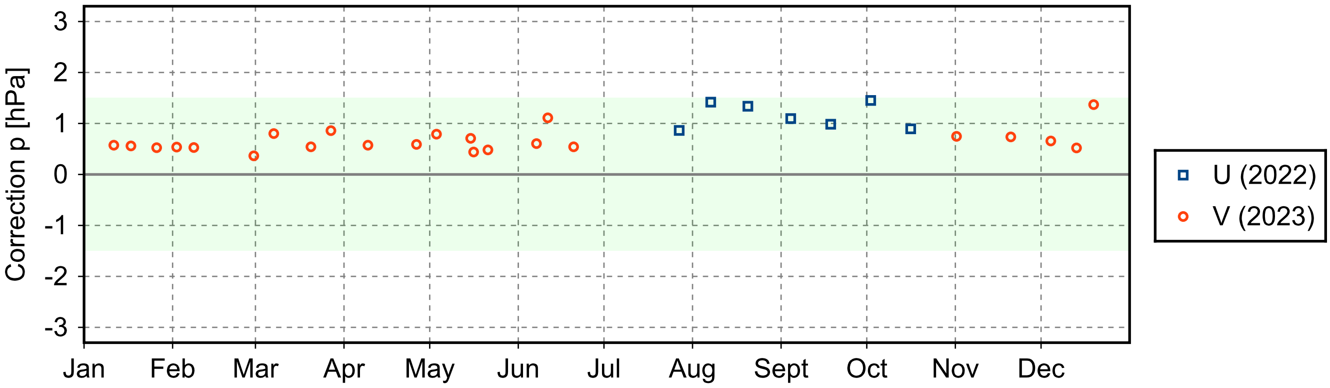
3.4 Instrument combinations of SOD-RS-01

Count	Instrument combination
30	ECC, RS41

3.5 Instrument ground check

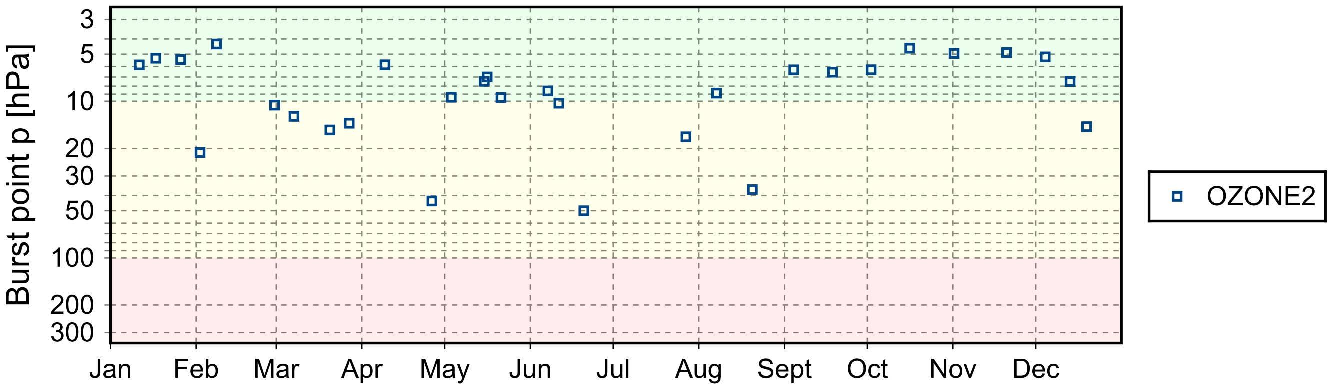
3.5.1 Stream: RS41

(1) GroundCheck: GC-RI41



(2) GroundCheck: GC-SHC

3.6 Measurement events



4 System: Automatic Sodankylä Launch System (AUTOSONDE) (SOD-RS-02)

Object	Value
System name	Automatic Sodankylä Launch System (AUTOSONDE)
Unique GRUAN ID	SOD-RS-02
System type	Sounding Site (RS - Radiosonde)
Geographical position	67.3663 °N, 26.6313 °E, 179.0 m
Operated by	FMI | Ilmatieteen laitos
Instrument contact	Kivi, Rigel
Started at	2008-01-01
Defined setups	2 (ROUTINE, ROUTINE3)
Possible streams	RS41, RS92

4.1 Lead Centre comments

4.1.1 Dataflow

Dataflow to GRUAN LC is operational since January 2011. The dataflow includes radiosoundings with Vaisala RS41-SG. All data are transmitted using the GRUAN tool gtRsl.

4.1.2 General

This is the autolauncher system.

Recommended burst altitude of 10 hPa is not reached in winter for the operational radiosoundings.

4.2 GRUAN data products

Product	Version	Soundings received	Available at LC	Distributed by NCEI

4.2.1 Stream: RS41

Product	Version	Soundings received	Available at LC	Distributed by NCEI
RS41		737	737	
RS41-RAW	001		732	
RS41-EDT	001		728	
RS41-GDP	001		726	

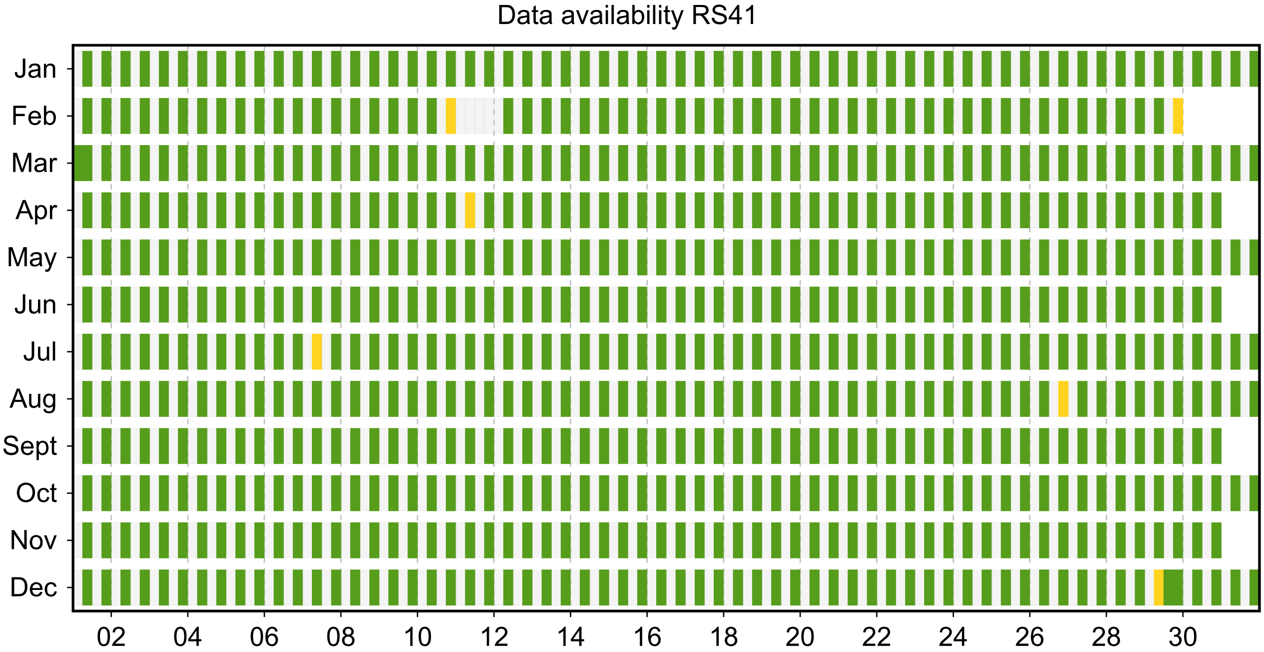
4.3 Availability of data products

Available (green): All steps of data processing have been successfully completed. The data product file is available at LC (e.g. files that didn't pass QA/QC or uncertified GRUAN data products) and/or at NCEI (a certified GRUAN data product file that did pass QA/QC).

Unprocessed (yellow): The manufacturer-produced file with raw measurement data has been successfully converted into a GRUAN-standardized raw data format (NetCDF). The GRUAN data processing has not been performed or was aborted. Reasons for this may be a still missing GRUAN data processor or a processing-software error.

Original (red): The original, manufacturer-produced, raw data file is available (e.g. MWX data file) but was not converted into a GRUAN-standardized raw data format (NetCDF). Reasons for this may be missing data conversion software, a software error, or a corrupt data file.

4.3.1 Stream: RS41



4.4 Instrument combinations of SOD-RS-02

Count	Instrument combination
737	RS41

4.6 Measurement events