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GLOBAL CLIMATE OBSERVING
SYSTEM (GCOS)

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Session 5

GRUAN Site Report for Boulder

(Submitted by Elizabeth Asher)

Summary and Purpose of this Document

Report from the GRUAN site Boulder for the period January 2022 to December 2023.

Overview

RS41, Intermet radiosonde, ozonesonde and NOAA Global Monitoring Laboratory (GML) frost point hygrometer data are submitted on a monthly basis to the GRUAN LC via RSLaunchClient. Our group does weekly ECC ozonesonde launches (both an Intermet radiosonde, and a RS41 radiosonde are regularly part of these payloads), and launches approximately every three weeks with a NOAA GML frost point hygrometer, an ECC ozonesonde, a Portable Optical Particle Spectrometer (POPS) and a RS41. POPS data is collected but is currently not submitted to the GRUAN LC.

Change and change management

No change in GRUAN related operation procedures has occurred. We continue to launch NOAA GML frost point hygrometers and RS41 radiosondes. As the iMet-1 radiosonde is no longer available for purchase, we have begun using iMet-4 radiosondes on ozonesonde launches and iMet-54 radiosondes on our launches with the NOAA GML frost point hygrometer. We will update RSLaunchClient as soon as possible.

Resourcing

Our site is not facing any resourcing challenges.

Operations

Our site is not facing any operational challenges. We currently launch both R23 and Dry Ice and Alcohol NOAA GML frost point hygrometers.

Covid-19

We faced some limitations in the availability of staff due to Covid-19.

Site assessment and certification

Our site is certified.

GRUAN-related research

Our group has been involved in a number of GRUAN-related research projects and publications, primarily studying stratospheric water vapor and aerosol. Related publications are listed below.

Peer-reviewed publications:

- Tinney, E.N., C.R. Homeyer, L. Elizalde, D.F. Hurst, A.M. Thompson, R.M. Stauffer, H. Vömel, and H.B. Selkirk, A modern approach to a stability-based definition of the tropopause, *Mon. Wea. Rev.*, 150, 3151-3174, doi:10.1175/MWR-D-22-0174.1, 2022.
- Kiefer, M., D.F. Hurst, G.P. Stiller, S. Lossow, H. Vömel, J. Anderson, F. Azam, J.-L. Bertaux, L. Blanot, K. Bramstedt, J.P. Burrows, R. Damadeo, B.M. Dinelli, P. Eriksson, M. Garca-Comas, J.C. Gille, M. Hervig, Y. Kasai, F. Khosrawi, D. Murtagh, G.E. Nedoluha, S. Nol, P. Raspollini, W.G. Read, K.H. Rosenlof, A. Rozanov, C.E. Sioris, T. Sugita, T. von Clarmann, K.A. Walker, and K. Weigel, The SPARC water vapour assessment II: Biases and drifts of water vapour satellite data records with respect to frost point hygrometer records, *Atmos. Meas. Tech.*, 16, 4589-4642, doi:10.5194/amt-16-4589-2023, 2023.
- Davis, S.M., K.H. Rosenlof, D.F. Hurst, H. Voemel, and R. Stauffer, Stratospheric Water Vapor [in "State of the Climate in 2021"], *Bull. Amer. Meteor. Soc.*, 103 (8), S93-S96, doi:10.1175/BAMS-D-22-0092.1, 2022.
- Davis, S.M., K.H. Rosenlof, D.F. Hurst, H. Voemel, and R. Stauffer, Stratospheric Water Vapor [in "State of the Climate in 2022"], *Bull. Amer. Meteor. Soc.*, 104 (9), S96-S98, doi:10.1175/BAMS-D-23-0090.1, 2023.
- Asher, E., Todt, M., Rosenlof, K., Thornberry, T., Gao, R., Taha, G., Walter, P., Alvarez, S., Flynn, J., Davis, S.M., Evan, S., Brioude, J., Metzger, J., Hurst, D.F., Hall, E., and Xiong, K., Unexpedtedly rapid aerosol formation in the Hunga Tonga plume, *PNAS*, 120 (46), doi: 10.1073/pnas.2219547120, 2023.
- Todt, M., Asher., E., Hall, E., Cullis, P., Jordan, A., Xiong, K., Hurst, D.F., and Thornberry, T., Baseline Balloon Stratospheric Aerosol Profiles (B2SAP) Systematic Measurements of Aeroosol Number Density and Size, *JRG Atmos.*, 128 (12), doi: 10.1029/2022JD038041, 2023.

Book Chapter:

- Hurst, D.F., M. Fujiwara, and S.J. Oltmans, Frost point hygrometers, In: *Field Measurements for Environmental Remote Sensing: Instrumentation, Intensive Campaigns, and Satellite Applications*, 37-55, Ed. N.R. Nalli, Elsevier, Amsterdam, 458 pp, doi:10.1016/B978-0-12-823953-7.00015-02022, 2022.

WG-GRUAN interface

At this time, our site does not require any assistance or support from the GRUAN working group.

Other archiving centers

NDACC, NOAA GML

Participation in campaigns

Our group was involved in the following field campaigns, of relevance to GRUAN:

- Dynamics and Chemistry of the Summer Stratosphere (DCOTTS) campaign (part two of a two year NASA field campaign) to study convective impacts on the summer stratosphere, focusing largely on water vapor enhancements related to convection across North America.
- Aire-Sur-L'adour (ASA) 2022 balloon-borne intercomparison campaign: This instrument intercomparison campaign involved the NOAA GML frost point hygrometer, the Pico-Light H_2O, the micro hygrometer (in an early phase of development) and the M20 and iMet-4 radiosondes.
- Stratospheric Aerosol processes, Budget and Radiative Effects (SABRE) campaign in 2023: Balloon-borne NOAA GML frost point hygrometer measurements and ozonesonde measurements as well as Portable Optical Particle Spectrometer (POPS) measurements were made in support of a NASA WB-57 the high-altitude aircraft campaign in the Artic.

Future plans

We plan to take part in the ATMOSFER campaign in Kiruna, Sweden this June. Specifically, our group will be participating in a free-flying balloon intercomparison, launching the NOAA GML frost

point hygrometer. Other instruments that will be involved in this intercomparison are the Pico-Light H_2O, and the LN_2 CFH.

GRUAN Site Report for Boulder (BOU), 2022

Reported time range is Jan 2022 to Dec 2022
Created by the Lead Centre
Version from 2024-03-01

1 General GRUAN site information

Object	Value
Station name	Boulder
Unique GRUAN ID	BOU
Geographical position	39.9500 °N, -105.2000 °W, 1743.0 m
Operated by	GMD | Global Monitoring Division, part of: ESRL | Earth System Research Laboratory, part of: NOAA | National Oceanic and Atmospheric Administration
Main contact	Asher, Elizabeth
WMO no./name	-
Operators	currently 6, changes +1 / -0
Sounding Site	1
GNSS	2

1.1 General information about GRUAN measurement systems

System	Name	Type	Setups	Measurements
BOU-GN-01	GNSS Site P041	GNSS	0	not operational
BOU-GN-02	GNSS site TMS3	GNSS	1	operational
BOU-RS-01	Radiosonde Launch Site (Marshall)	Sounding Site	4	47

1.2 General comments from Lead Centre

1.2.1 Request

The site is kindly requested to adapt the documentation of the upcomming radiosoundings to reality (create and use new RsLaunchClient templates).

2 System: GNSS Site P041 (BOU-GN-01)

Object	Value
System name	GNSS Site P041
Unique GRUAN ID	BOU-GN-01
System type	GNSS (GN - GNSS)
Geographical position	39.5658 °N, -105.1139 °W, 1728.8 m
Operated by	GMD | Global Monitoring Division, part of: ESRL | Earth System Research Laboratory, part of: NOAA | National Oceanic and Atmospheric Administration
Instrument contact	Asher, Elizabeth
Started at	2004-02-13
Defined setups	-
Possible streams	-

2.1 Lead Centre comments

2.1.1 Dataflow

No GNSS dataflow to LC has been established yet.

3 System: GNSS site TMS3 (BOU-GN-02)

Object	Value
System name	GNSS site TMS3
Unique GRUAN ID	BOU-GN-02
System type	GNSS (GN - GNSS)
Geographical position	40.0748 °N, -105.1358 °W, 1668.7 m
Operated by	GFZ | Deutsches GeoForschungsZentrum GFZ, part of: HELMHOLTZ | Helmholtz-Gemeinschaft
Instrument contact	Bradke, Markus
Started at	2014-06-20
Defined setups	1 (HOURLY)
Possible streams	-

3.1 Lead Centre comments

3.1.1 Dataflow

No GNSS dataflow to LC has been established yet.

4 System: Radiosonde Launch Site (Marshall) (BOU-RS-01)

Object	Value
System name	Radiosonde Launch Site (Marshall)
Unique GRUAN ID	BOU-RS-01
System type	Sounding Site (RS - Radiosonde)
Geographical position	39.9500 °N, -105.2000 °W, 1743.0 m
Operated by	GMD | Global Monitoring Division, part of: ESRL | Earth System Research Laboratory, part of: NOAA | National Oceanic and Atmospheric Administration
Instrument contact	Asher, Elizabeth
Started at	-
Defined setups	4 (RESEARCH, OZONE, FPH-OZONE, FPH)
Possible streams	FPH, IMET-1, IMET-4, IMET-54, POPS, RS41, RS80, RS92

4.1 Lead Centre comments

4.1.1 Dataflow

Operational dataflow of radiosonde measurement data to the GRUAN LC since August 2014.

Currently, the dataflow includes radiosoundings with Vaisala RS41-SG, Intermet iMET-1, ECC Ozone and FPH. All data are transmitted using the RsLaunchClient within one month after the sounding.

A regular and intensive measurement program for the observation of stratospheric water vapor was performed using FPH.

Radiosonde soundings are incorrectly described: iMet-1 is documented as telemetry sonde of ECC and FPH, but often iMet-4 or iMet-54 are used. Additional sensor POPS is used, but also not documented.

4.1.2 Data quality

Ground check (SHC) temperature differences are very large and noisy at -3 to -7 K. There appears to be a fundamental flaw in the reference temperature measurement.

4.2 GRUAN data products

Product	Version	Soundings received	Available at LC	Distributed by NCEI

4.2.1 Stream: ECC

ECC		47	47	

4.2.2 Stream: FPH

FPH		14	14	

4.2.3 Stream: IMET-1

IMET-1		47	47	
IMET-1-RAW	001		47	

4.2.4 Stream: RS41

RS41		47	47	
RS41-RAW	001		47	
RS41-EDT	001		46	
RS41-GDP	001		46	

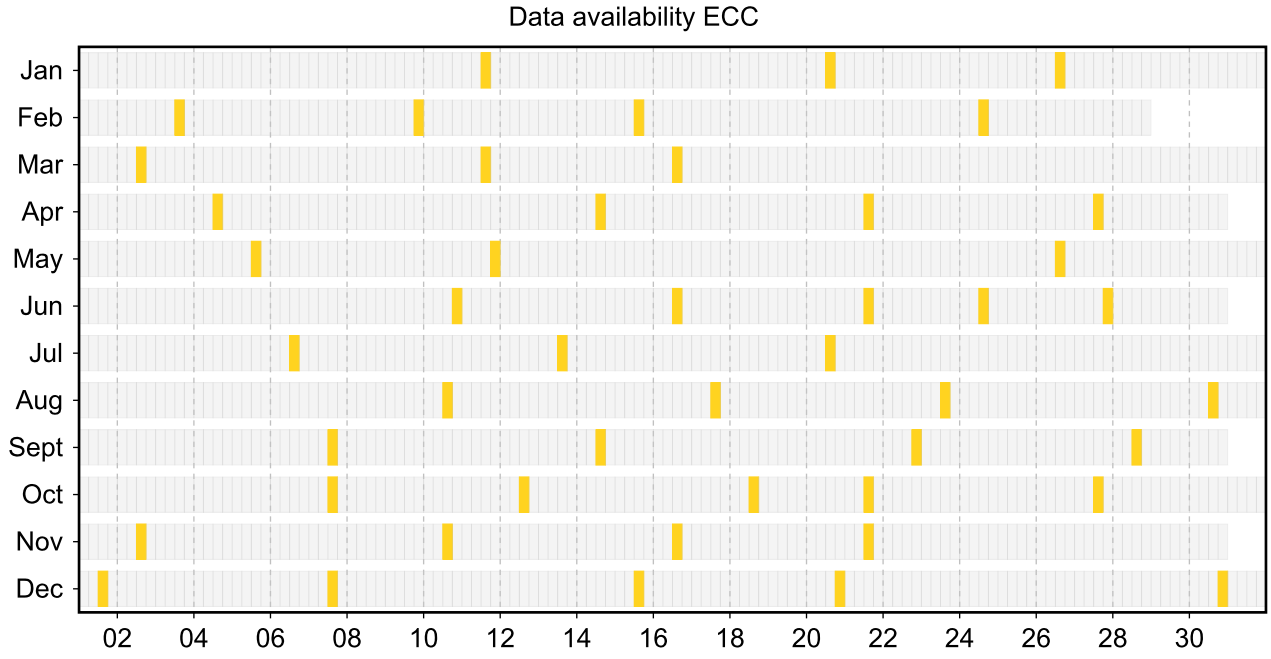
4.3 Availability of data products

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).

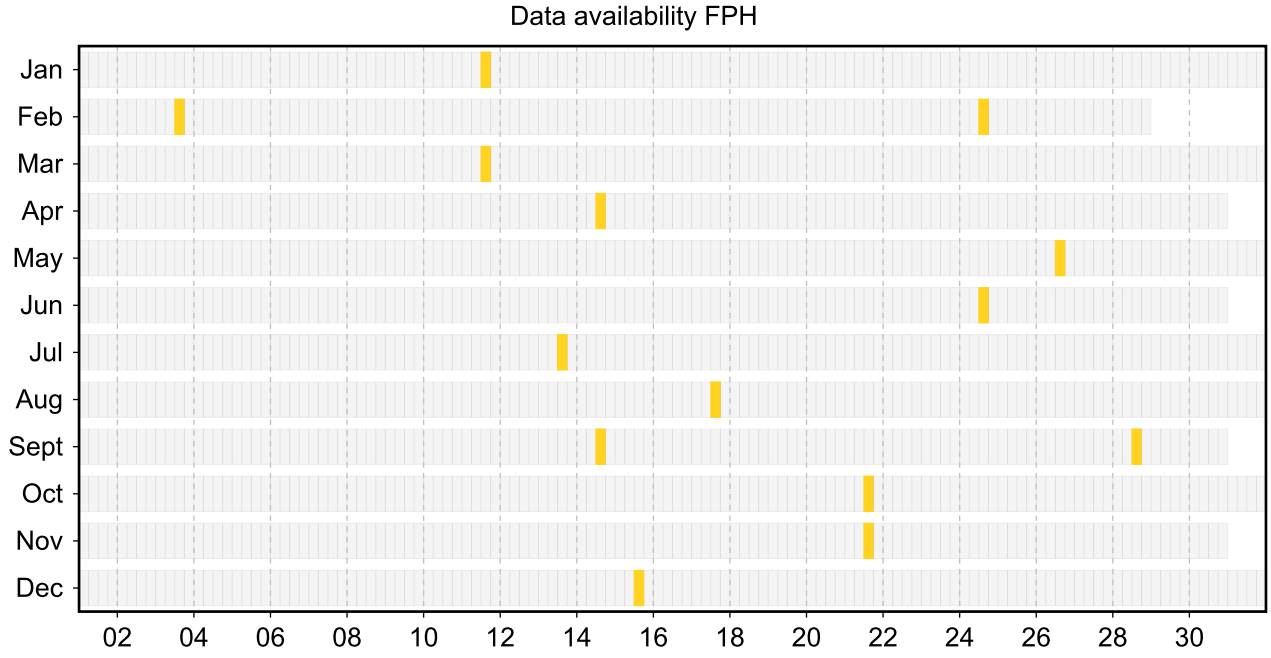
Unprocessed (yellow): The manufacturer-produced file with raw measurement data has been successfully converted into a GRUAN-standardized raw data format (NetCDF). The GRUAN data processing has not been performed or was aborted. Reasons for this may be a still missing GRUAN data processor or a processing-software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

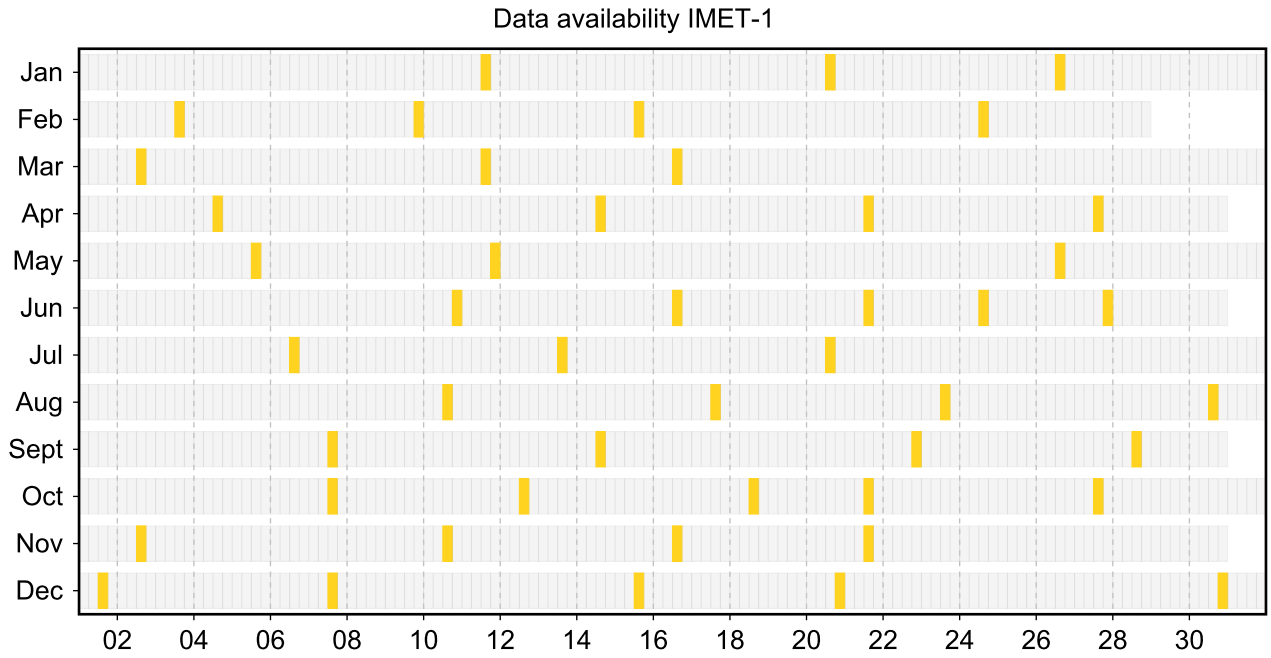
4.3.1 Stream: ECC



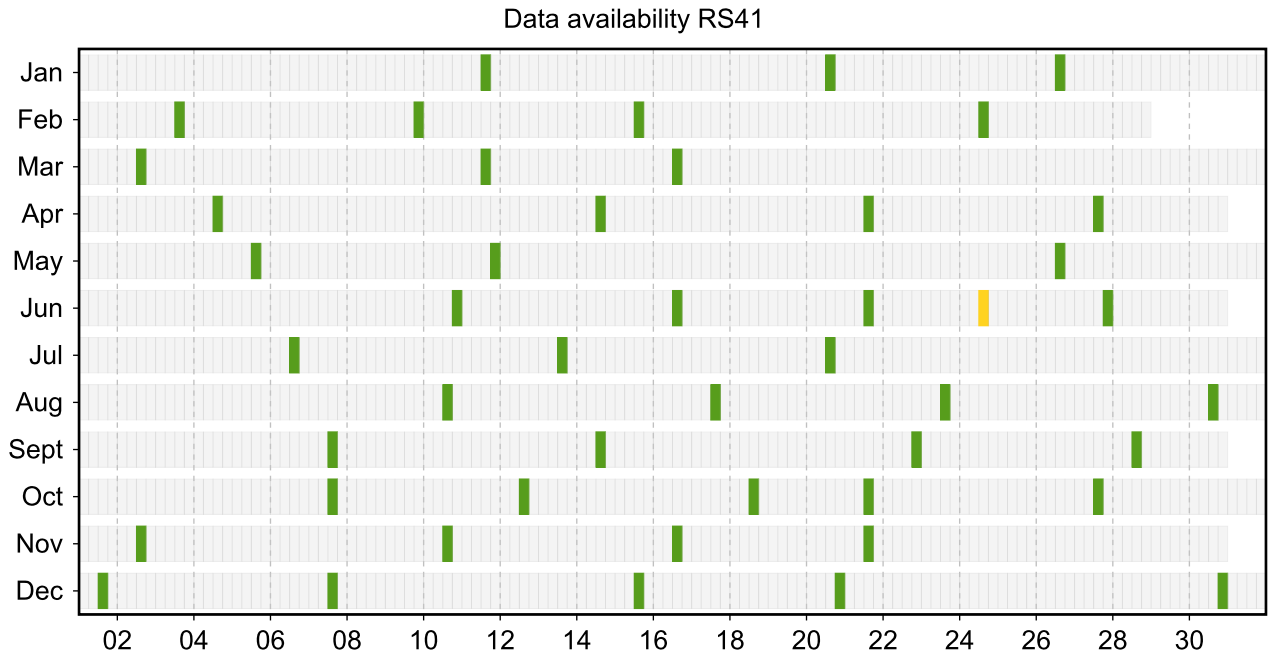
4.3.2 Stream: FPH



4.3.3 Stream: IMET-1



4.3.4 Stream: RS41



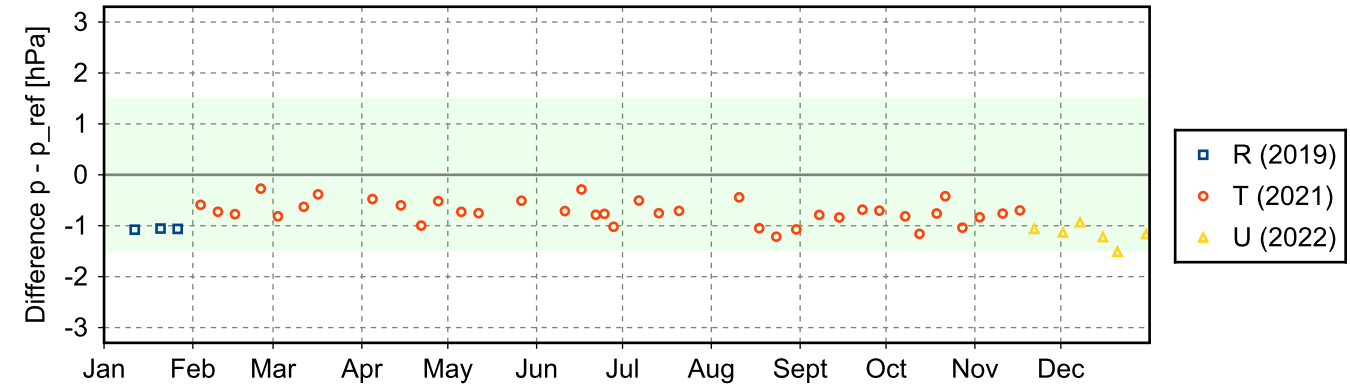
4.4 Instrument combinations of BOU-RS-01

Count	Instrument combination
14	ECC, FPH, IMET-1, RS41
33	ECC, IMET-1, RS41

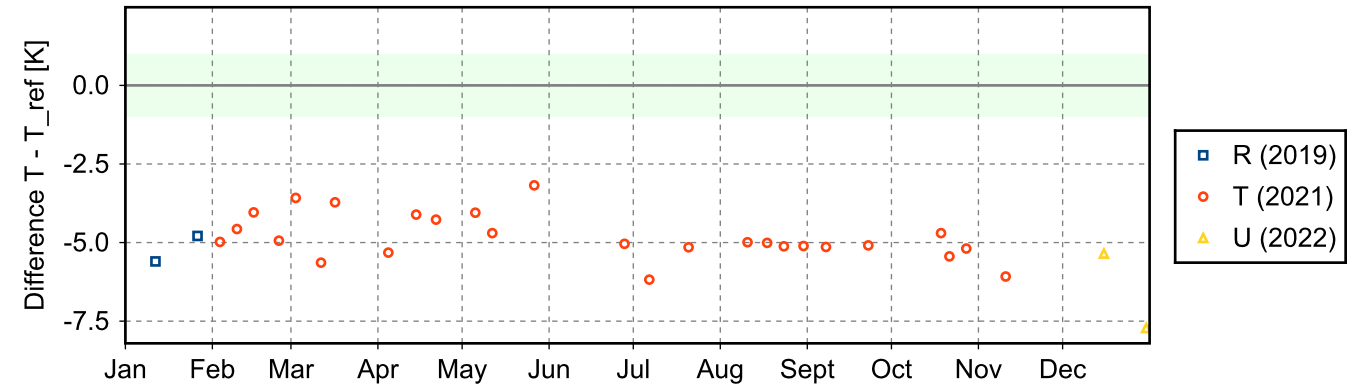
4.5 Instrument ground check

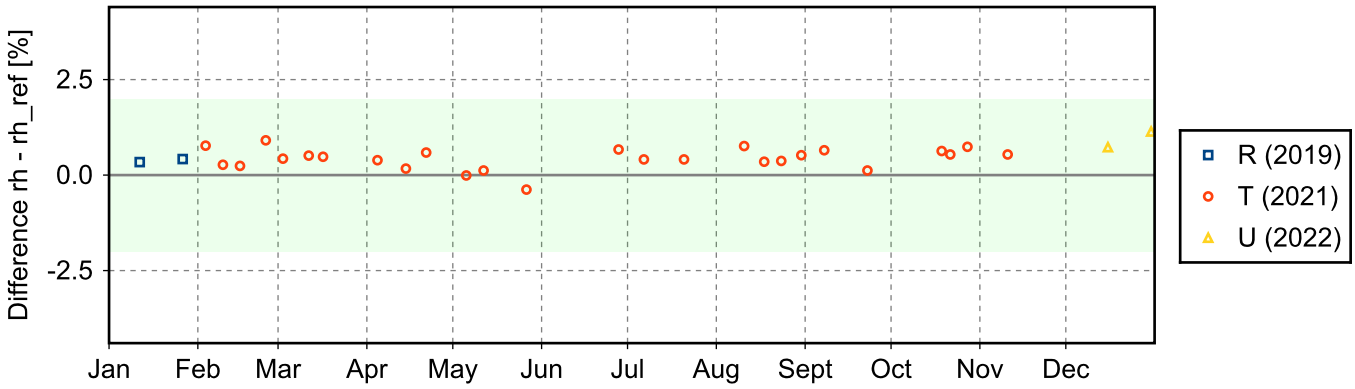
4.5.1 Stream: RS41

(1) GroundCheck: GC-RI41

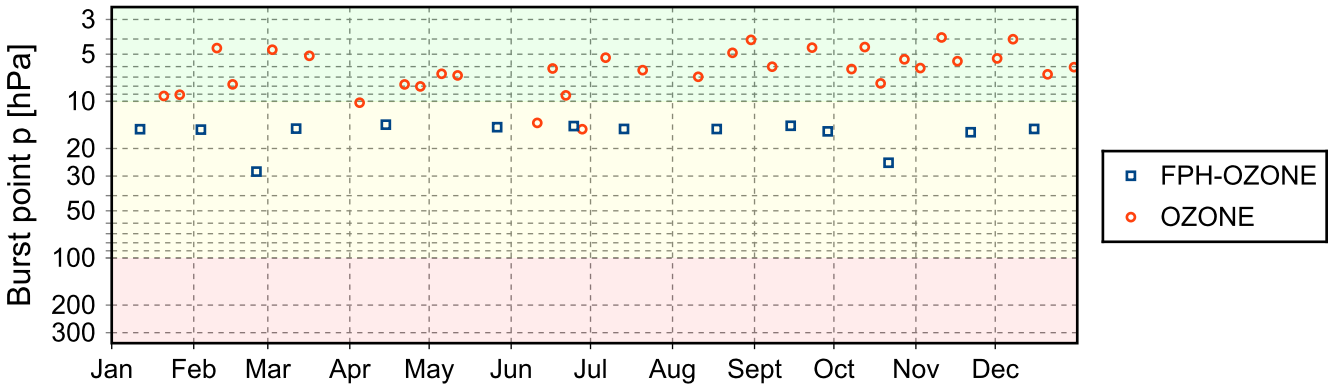


(2) GroundCheck: GC-SHC





4.6 Measurement events



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Instrument contact	Asher, Elizabeth
Started at	2004-02-13
Defined setups	-
Possible streams	-

2.1 Lead Centre comments

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Possible streams	-

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4.2.1 Stream: ECC

ECC		42	42	

4.2.2 Stream: FPH

FPH		17	17	

4.2.3 Stream: IMET-1

IMET-1		42	42	
IMET-1-RAW	001		32	

4.2.4 Stream: RS41

RS41		42	42	
RS41-RAW	001		42	
RS41-EDT	001		42	
RS41-GDP	001		41	

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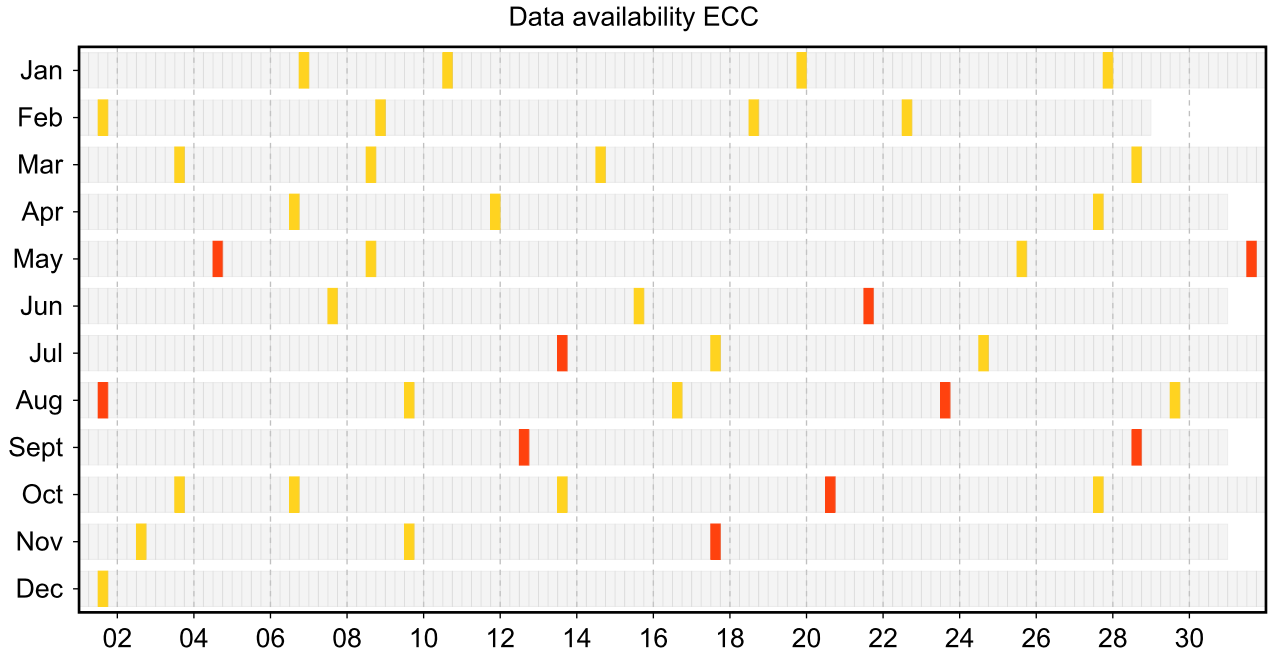
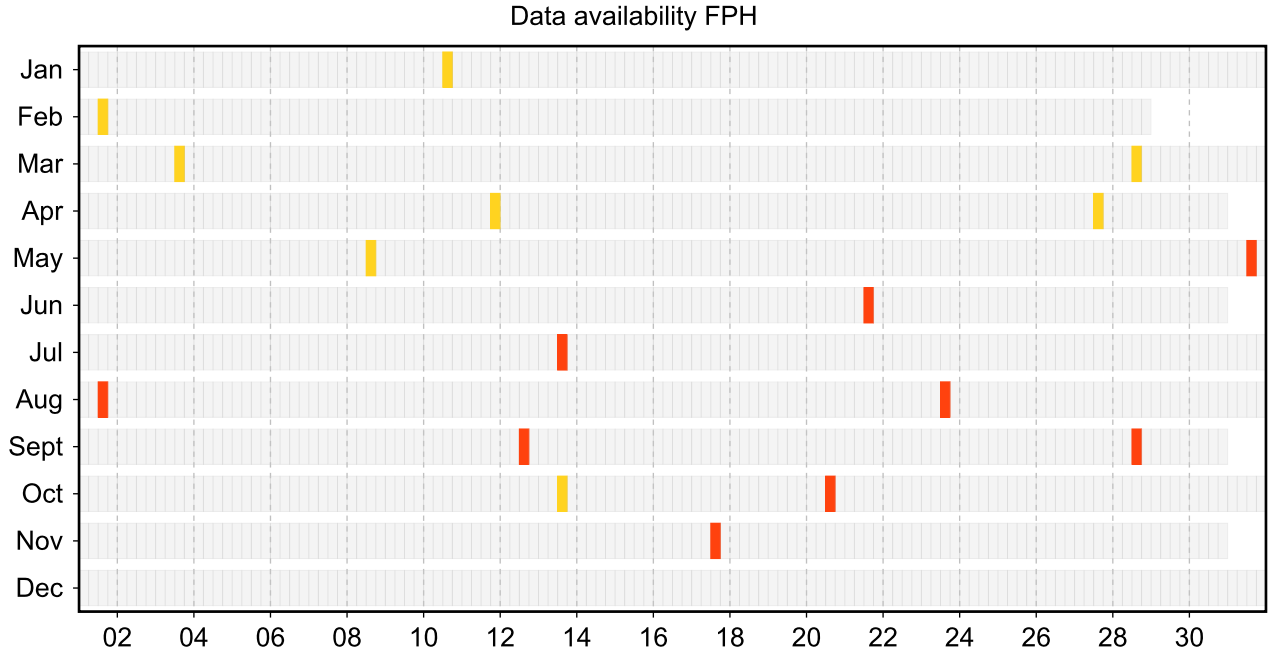
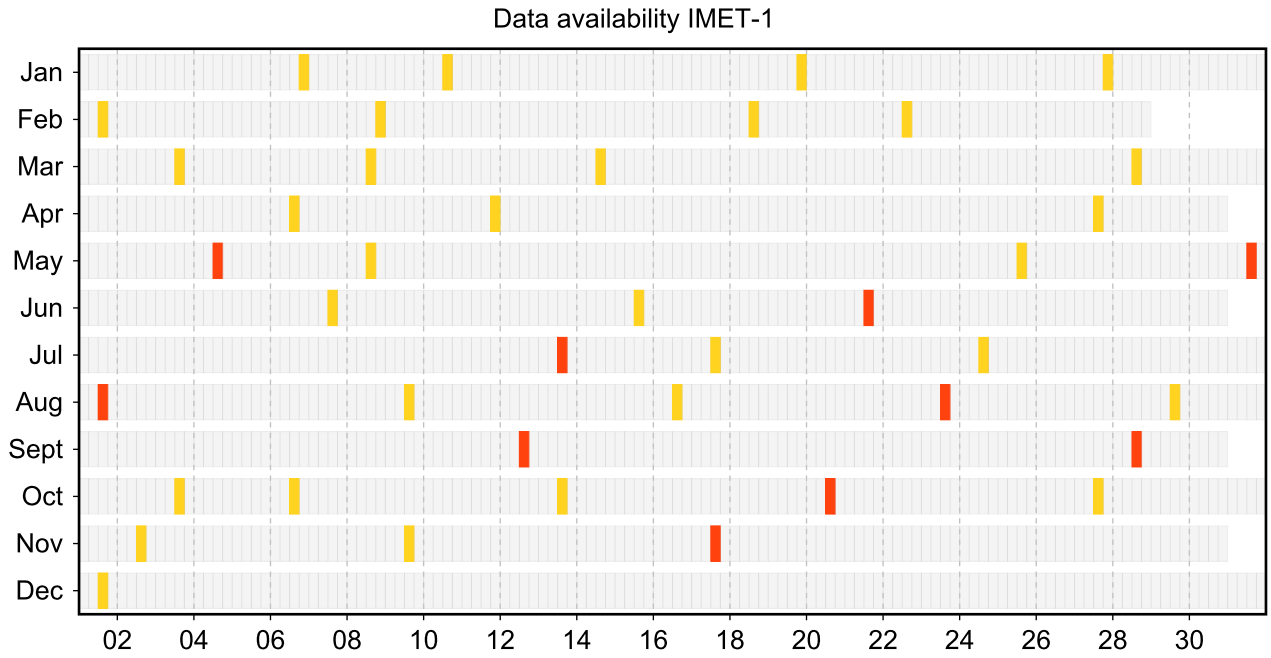
4.3.1 Stream: ECC



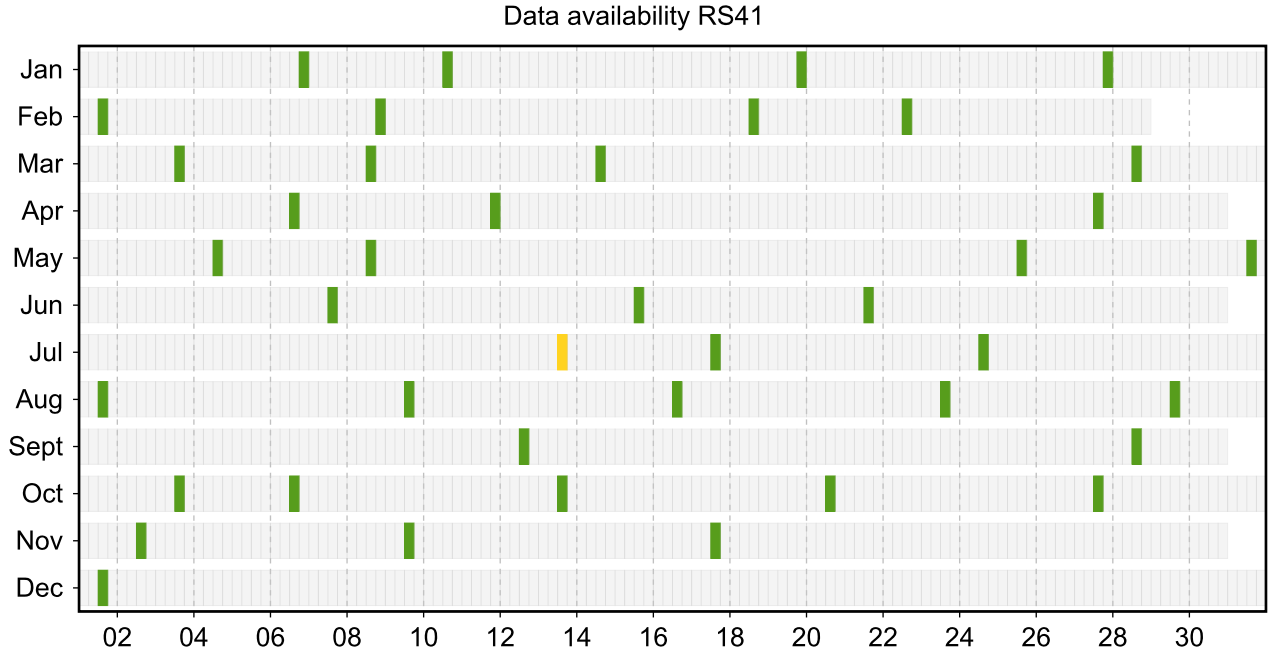
4.3.2 Stream: FPH



4.3.3 Stream: IMET-1



4.3.4 Stream: RS41



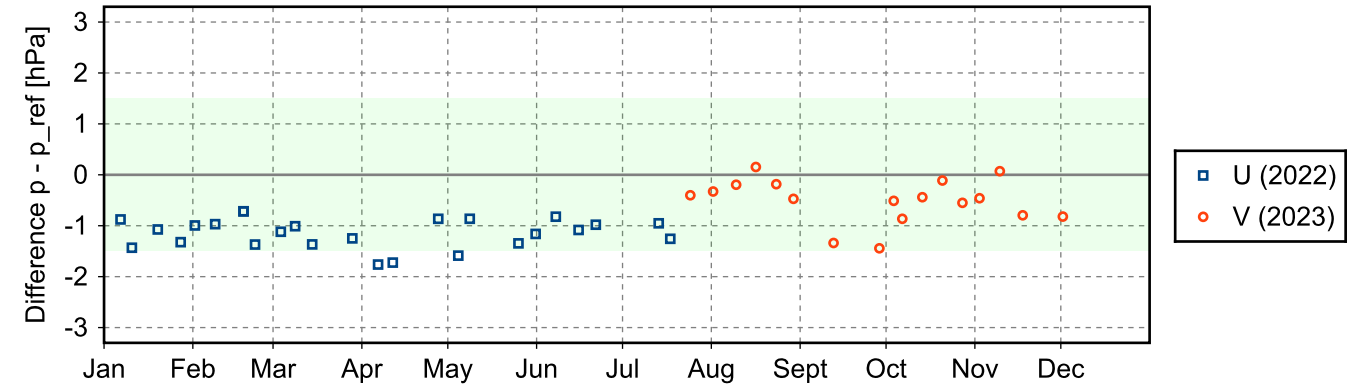
4.4 Instrument combinations of BOU-RS-01

Count	Instrument combination
17	ECC, FPH, IMET-1, RS41
25	ECC, IMET-1, RS41

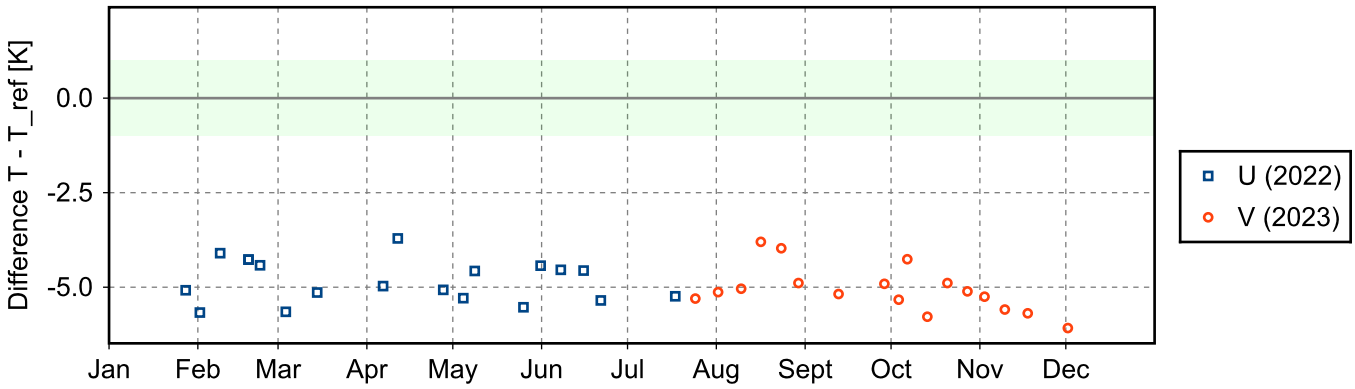
4.5 Instrument ground check

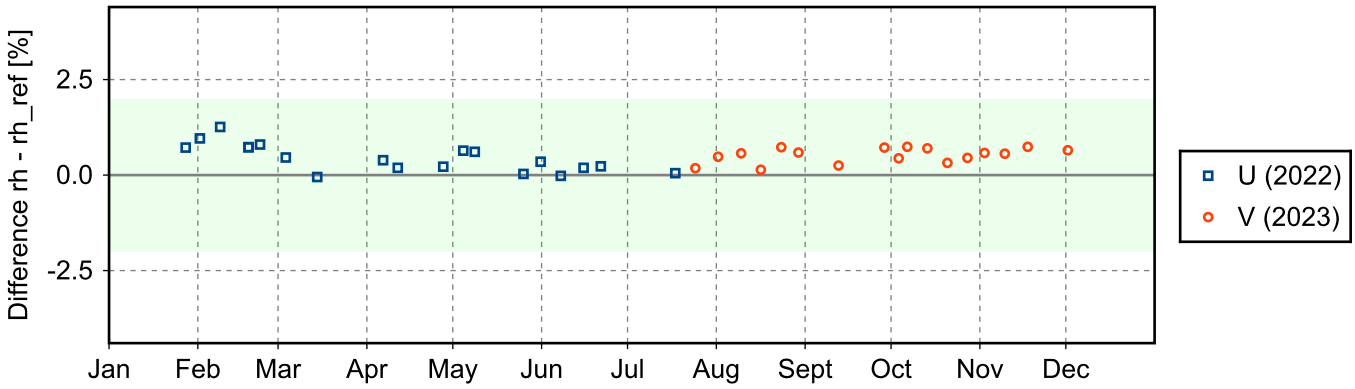
4.5.1 Stream: RS41

(1) GroundCheck: GC-RI41



(2) GroundCheck: GC-SHC





4.6 Measurement events