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GLOBAL CLIMATE OBSERVING
SYSTEM (GCOS)

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**15th GRUAN Implementation-
Coordination Meeting (ICM-15)**

Session 5

Bern

11 March - 15 March 2024

GRUAN Site Report for Lindenberg

(Submitted by Ruud Dirksen)

Summary and Purpose of this Document

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

Overview

Lindenberg contributes to GRUAN with the following operational data streams: RS41 radiosonde (4 times per day) and GNSS-IPW. In addition, regular comparisons with other GDP radiosondes (RS92 & iMS-100) are performed. Other data streams, which are not official GRUAN products yet, include: Ozone, CFH, COBALD, Graw, Skydew, DFM-09 and DFM-17. In March 2017, RS41 replaced RS92 as operational radiosonde. In the beginning of 2023 the CFH measurement program was put on hold awaiting an alternative to the R23 cryogen. The site contributed to the development and testing of a liquid nitrogen container for CFH in search for an alternative cooling method.

All measurements are performed in accordance with GRUAN operational procedures, which in case of the radiosondes means the application of a manufacturer-independent ground check in an SHC at 100 %RH prior to launch. Data are submitted to the Lead Centre using the RsLaunchClient, generally directly after the sounding has been completed. For extended payloads (research soundings) there may be 1-2 days delay in data submission.

Change and change management

The procedures for the operational RS41 and GNSS data streams have not been altered. In March 2017 the RS92 has been replaced by the RS41 as operational radiosonde. In order to manage this change regular RS92-RS41 twin soundings were performed from 2015 until 2018 as part of the GRUAN-wide effort in the management of the RS92-RS41 transition. From 2023 onwards, soundings with RS92 are performed on a regular basis as part of a large research payload. For research instruments such as CFH, Skydew, COBALD and Ozone sonde, the RS41 is employed as carrier sonde.

Resourcing

The resourcing situation at Lindenberg generally speaking is good: we have stable (financial + personnel) resources to perform 4 radiosoundings per day, as well as ozone and research soundings (CFH, Skydew, COBALD, etc) on a regular basis. However for 2024 budget cuts are foreseen due to a sudden tightening of the German government's budget.

Operations

The impending ban on R23 cryogen for CFH still is a major concern.

Covid-19

Covid-19 led to the postponement of the WMO radiosonde intercomparison campaign (UAI) to 2022, and was a concern in the first half of 2022, but it did not affect the radiosounding operations at Lindenberg.

Site assessment and certification

The Lindenberg site was GRUAN-certified (for the RS92 measurement program) in 2014, and recertified in May 2018.

GRUAN-related research

- DFM-17–RS41–RS92-iMS-100-M10 intercomparison.
- Regular soundings with research instruments such as CFH, Skydew, Ozone, COBALD.
- Support for the development of a liquid nitrogen container for CFH. Testing of Skydew and LN₂-CFH.
- Characterization of radiosonde errors and uncertainties under laboratory conditions.
- Characterization of the radiation error of the temperature sensor of RS41, M10 and Graw radiosondes, in support of data product development.
- Development of the GRUAN data product for the RS41 (completed).

Publications:

- Ingleby, B., Motl, M., Marlton, G., Edwards, D., Sommer, M., von Rohden, C., Vmel, H., and Jauhainen, H.: On the quality of RS41 radiosonde descent data, *Atmos. Meas. Tech.*, 15, 165183, <https://doi.org/10.5194/amt-15-165-2022>, 2022.
- von Rohden, C., M. Sommer, T. Naebert, V. Motuz, and R. Dirksen, Laboratory characterisation of the radiation temperature error of radiosondes and its application to the GRUAN

data processing for the Vaisala RS41, Atmospheric Measurement Techniques, 15(2), 383405, <https://doi.org/10.5194/amt-15-383-2022>, 2022.

- Sommer, M., et al., GRUAN characterisation and data processing of the Vaisala RS41 radiosonde, GRUAN Technical Document 8 (GRUAN-TD-8), GRUAN Lead Centre, 2023, <https://www.gruan.org/documentation/gruan/td/gruan-td-8,v1.0> (2023-06-28).

WG-GRUAN interface

- GRUAN Lead Centre resides at Lindenberg observatory.
- Christoph von Rohden is member of task team radiosondes.
- Tzvetan Simeonov leads the Quality Task Force (QTF).

Other archiving centers

GUAN, NDACC, WOUDC, BSRN.

Participation in campaigns

The WMO Radiosonde intercomparison campaign (UAI2022) was hosted in Lindenberg. The laboratory campaign ran from February 2022 - January 2023 and the field campaign took place August - mid September 2022.

Future plans

- Continue GDP intercomparisons.
- Continue investigation/testing of R23-free stratospheric hygrometers (Skydew, N2-CFH).
- Continue measurements with new set-up to assess solar radiation error of radiosondes temperature sensor and use these results in the GRUAN dataproducts for RS92, Modem-M10, Graw.
- Collaborative development of GRUAN data product for Graw radiosondes.



GRUAN Site Report for Lindenberg (LIN), 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	Lindenberg
Unique GRUAN ID	LIN
Geographical position	52.2100 °N, 14.1200 °E, 98.0 m
Operated by	MOL Meteorologisches Observatorium Lindenberg, part of: DWD Deutscher Wetterdienst
Main contact	Dirksen, Ruud
WMO no./name	10393 LINDENBERG
Operators	currently 23, changes +6 / -0
Sounding Site	1
GNSS	2

1.1 General information about GRUAN measurement systems

System	Name	Type	Setups	Measurements
LIN-GN-02	GNSS Site LDB2	GNSS	0	not operational
LIN-GN-03	GNSS Site LIN0	GNSS	1	operational
LIN-RS-01	Lindenberg Radiosonde Launch Site	Sounding Site	8	1578

1.2 General comments from Lead Centre

1.2.1 General

The field campaign of WMO Upper-Air Instrument Intercomparison Campaign (UAI2022) was successfully executed between 8 August and 13 September.

2 System: GNSS Site LDB2 (LIN-GN-02)

Object	Value
System name	GNSS Site LDB2
Unique GRUAN ID	LIN-GN-02
System type	GNSS (GN - GNSS)
Geographical position	52.2091 °N, 14.1209 °E, 159.5 m
Operated by	-
Instrument contact	Dirksen, Ruud
Started at	-
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 LIN0 (LIN-GN-03)

Object	Value
System name	GNSS Site LIN0
Unique GRUAN ID	LIN-GN-03
System type	GNSS (GN - GNSS)
Geographical position	52.2093 °N, 14.1217 °E, 165.0 m
Operated by	GFZ Deutsches GeoForschungsZentrum GFZ, part of: HELMHOLTZ Helmholtz-Gemeinschaft
Instrument contact	Dirksen, Ruud
Started at	2020-10-01
Defined setups	1 (HOURLY)
Possible streams	-

3.1 Lead Centre comments

3.1.1 Dataflow

Dataflow of GNSS data to GRUAN LC and to the GRUAN GNSS processing centre at GFZ has started in October 2020. The current dataflow includes manufacturer raw data, converted raw data (RINEX), instrument logs, and processed data.

Meteorological data is available since January 2021, therefore the operational processing as GNSS-PW-GDP is also possible since then.

3.1.2 General

This GNSS system is performing measurements since October 2020.

4 System: Lindenberg Radiosonde Launch Site (LIN-RS-01)

Object	Value
System name	Lindenberg Radiosonde Launch Site
Unique GRUAN ID	LIN-RS-01
System type	Sounding Site (RS - Radiosonde)
Geographical position	52.2100 °N, 14.1200 °E, 112.0 m
Operated by	MOL Meteorologisches Observatorium Lindenberg, part of: DWD Deutscher Wetterdienst
Instrument contact	Dirksen, Ruud
Started at	-
Defined setups	8 (ROUTINE, RESEARCH, OZONE, DUAL1, ROUTINE2, OZONE2, DUAL2, UAI2022)
Possible streams	CFH, COBALD, DFM-09, DFM-17, ECC, FLASH, FPH, IMET-54, M10, PCFH, RS41, RS80, RS92, SKYDEW

4.1 Lead Centre comments

4.1.1 Dataflow

Routine soundings with Vaisala RS41 are performed 4 times per day. Ozone soundings are performed once per week. Research soundings including CFH, ECC and RS41 are performed once per month. Various sonde combinations have been flown throughout the reporting period.

The dataflow includes streams of the Vaisala RS41-SGP, Graw DFM-17, Meisei iMS-100, ECC Ozone sonde, CFH and some other radiosondes. All launches are promptly recorded using the RsLaunchClient. The site is used as test bed for the RsLaunchClient.

4.1.2 General

Good performance of stratospheric water vapor measurement programm (CFH) and ECC ozone soundings can be confirmed.

There is very good performance in terms of burst altitude which is regularly 10 hPa to 5 hPa and higher.

The field campaign of WMO UAI2022 was successfully executed between 8 August and 13 September.

4.2 GRUAN data products

Product	Version	Soundings received	Available at LC	Distributed by NCEI
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4.2.1 Stream: CFH

CFH		14	14	
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4.2.2 Stream: COBALD

COBALD		9	9	
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4.2.3 Stream: DFM-17

DFM-17		96	96	
DFM-17-RAW	001		45	

4.2.4 Stream: ECC

ECC		65	65	
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4.2.5 Stream: FLASH

FLASH		2	2	
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4.2.6 Stream: IMET-54

IMET-54		50	50	
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4.2.7 Stream: IMS-100

IMS-100		151	151	
IMS-100-GDP	002		81	

4.2.8 Stream: ISOLDE

ISOLDE		6	6	
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4.2.9 Stream: M10

M10		12	12	
M10-RAW	001		12	

4.2.10 Stream: RS41

RS41		1638	1638	
RS41-RAW	001		1586	
RS41-EDT	001		1560	
RS41-GDP	001		1568	

4.2.11 Stream: RS92

RS92		12	12	
RS92-RAW	002		12	
RS92-EDT	001		11	
RS92-GDP	002		12	

4.2.12 Stream: SRS-C34

SRS-C34		1	1	
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4.2.13 Stream: SRS-C50

SRS-C50		5	5	
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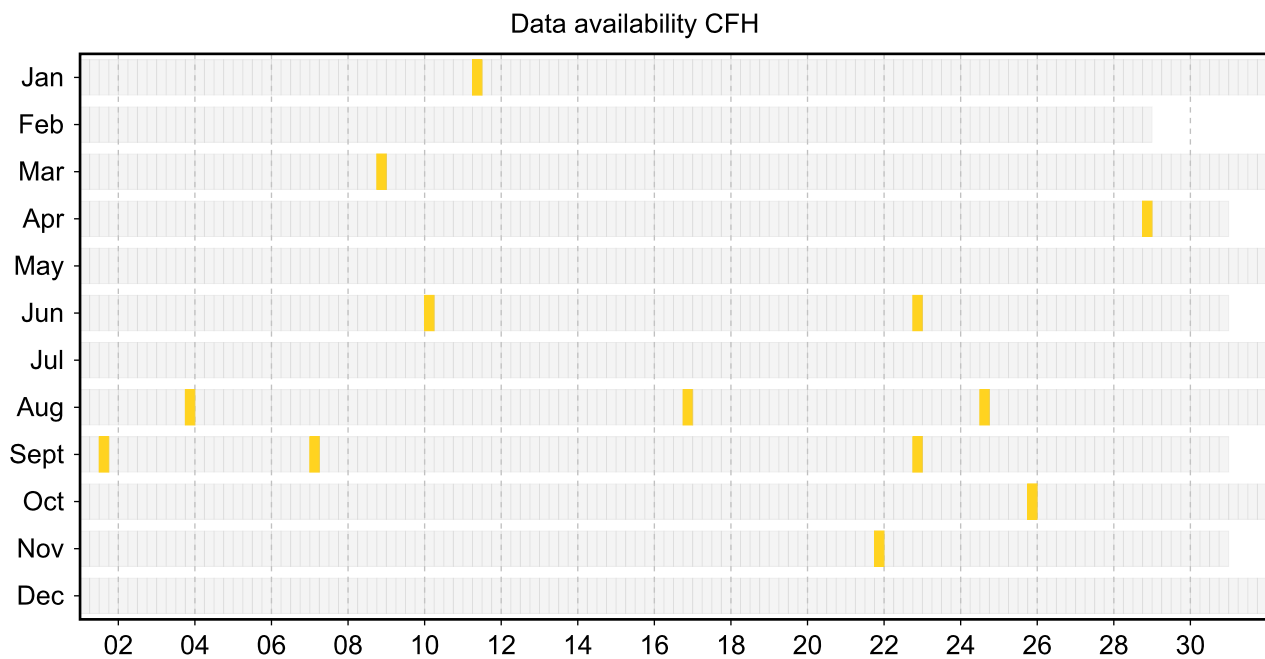
4.3 Availability of data products

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).

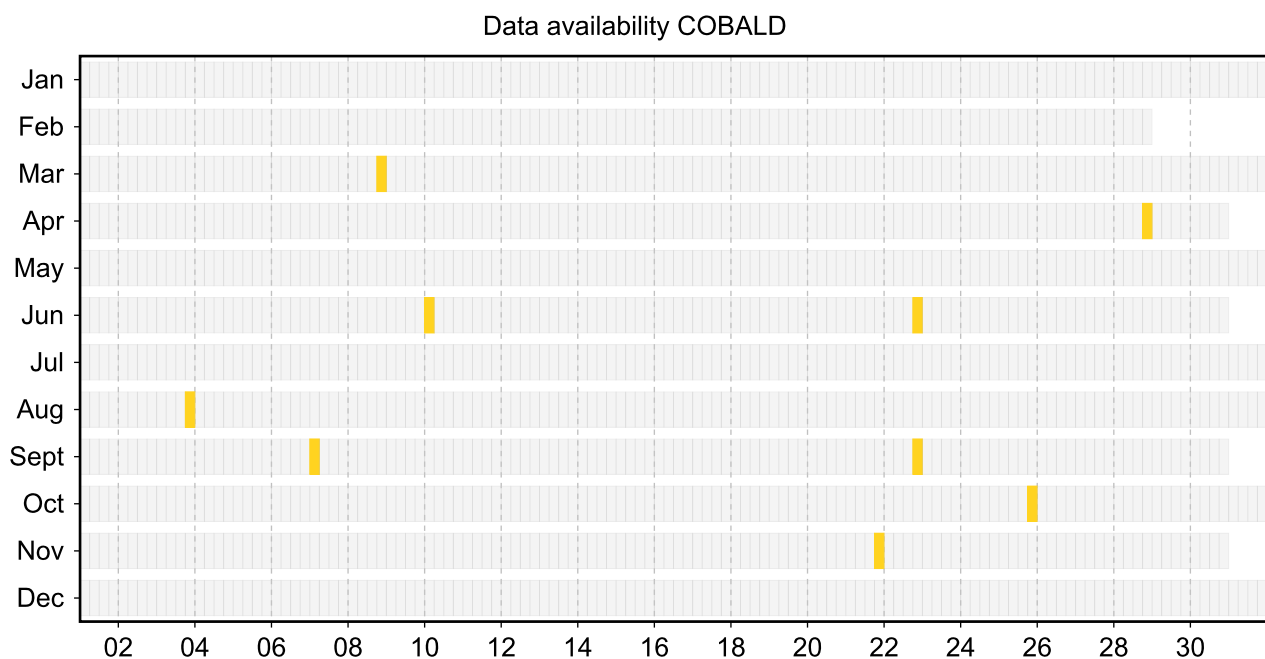
Unprocessed (yellow): The manufacturer-produced file with raw measurement data has been successfully converted into a GRUAN-standardized raw data format (NetCDF). The GRUAN data processing has not been performed or was aborted. Reasons for this may be a still missing GRUAN data processor or a processing-software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

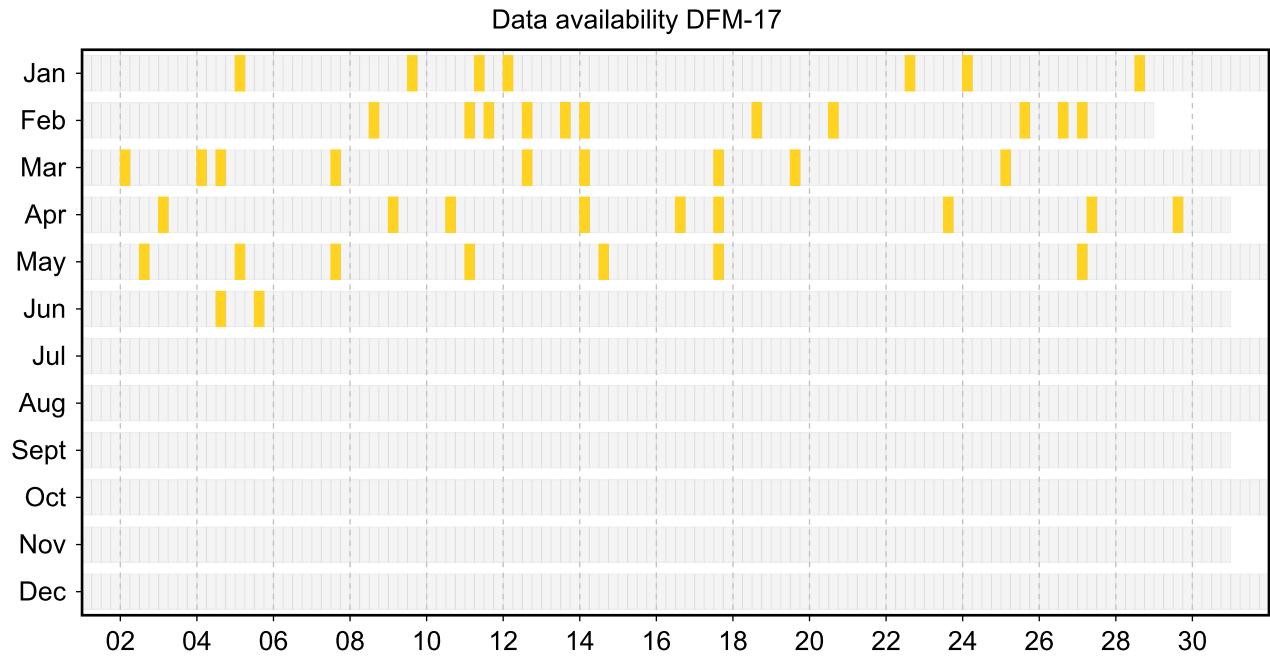
4.3.1 Stream: CFH



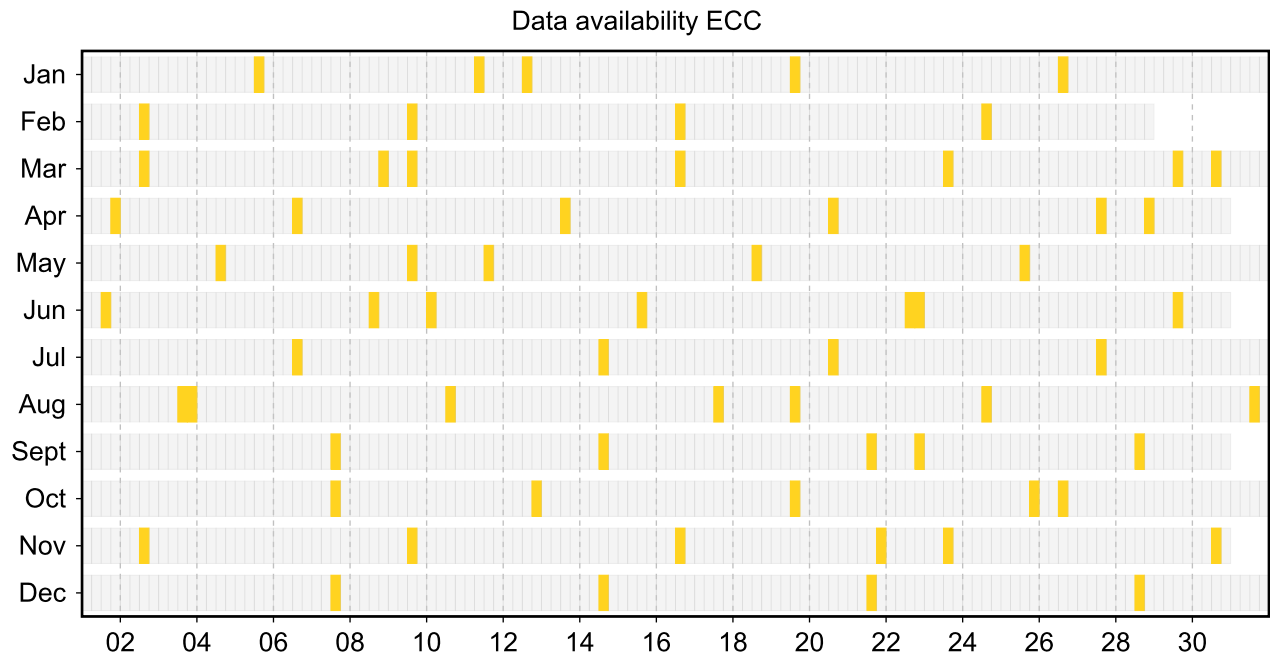
4.3.2 Stream: COBALD



4.3.3 Stream: DFM-17

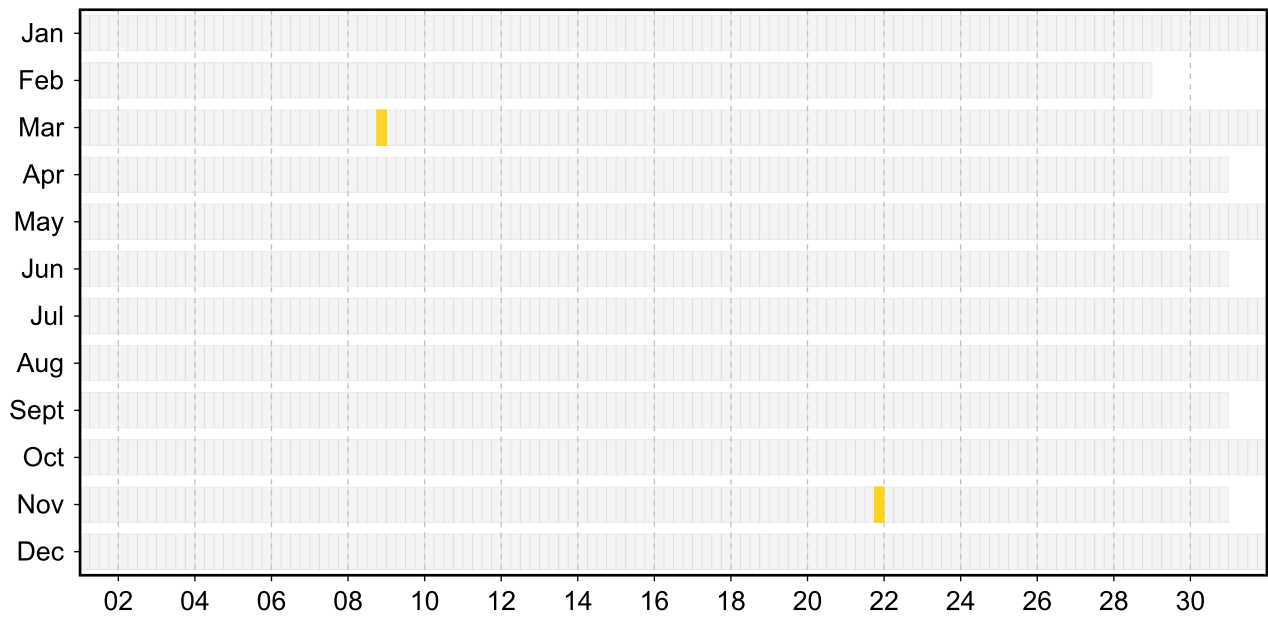


4.3.4 Stream: ECC



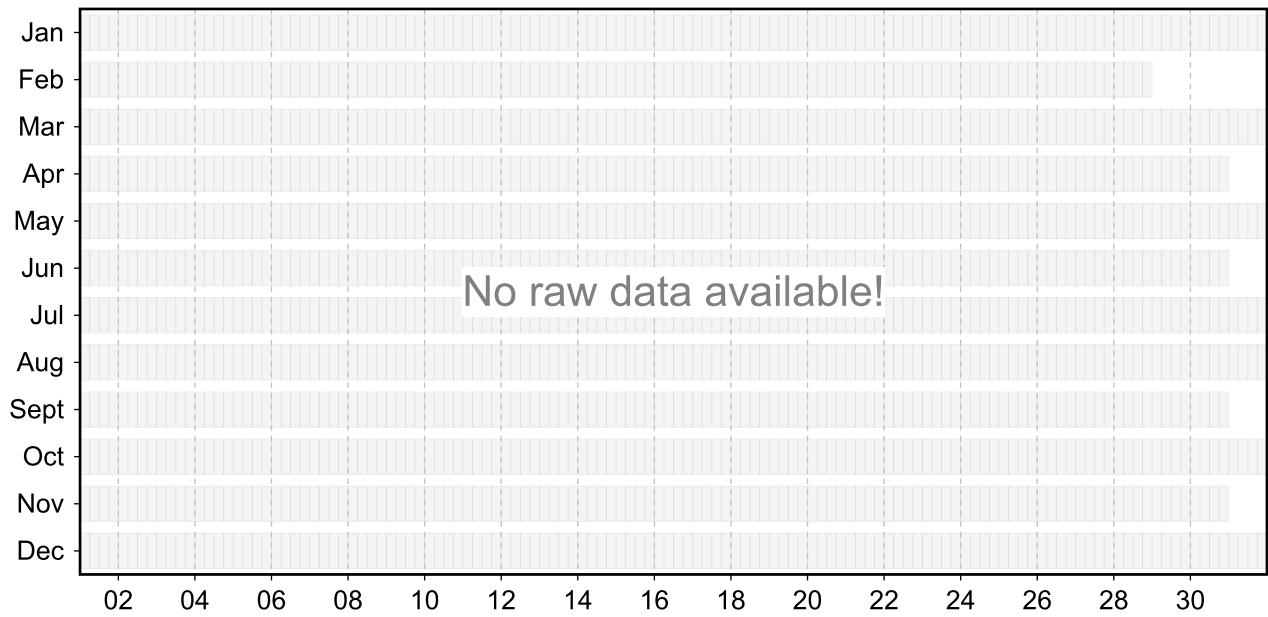
4.3.5 Stream: FLASH

Data availability FLASH

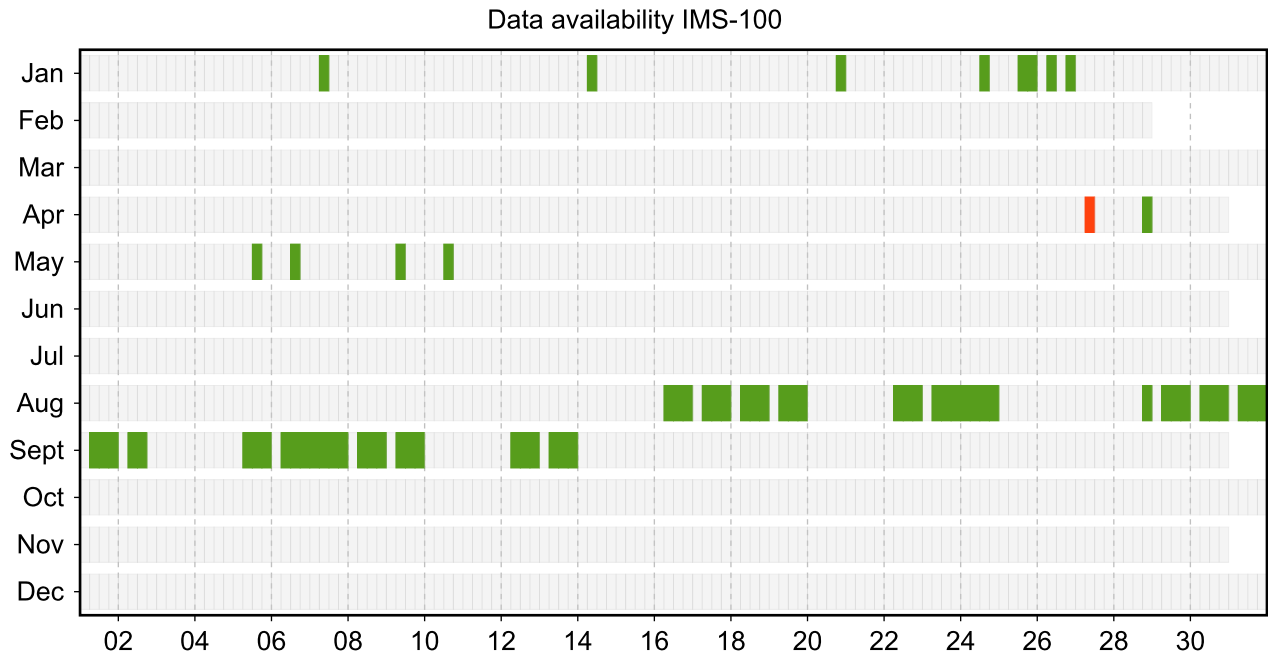


4.3.6 Stream: IMET-54

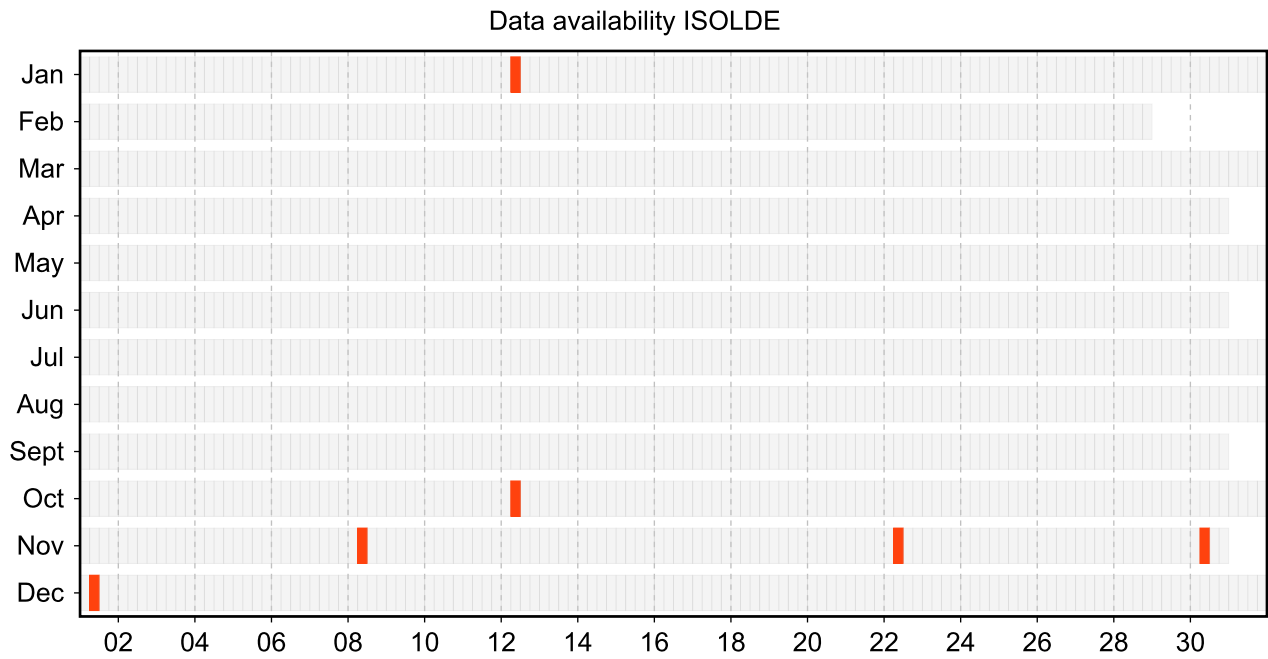
Data availability IMET-54



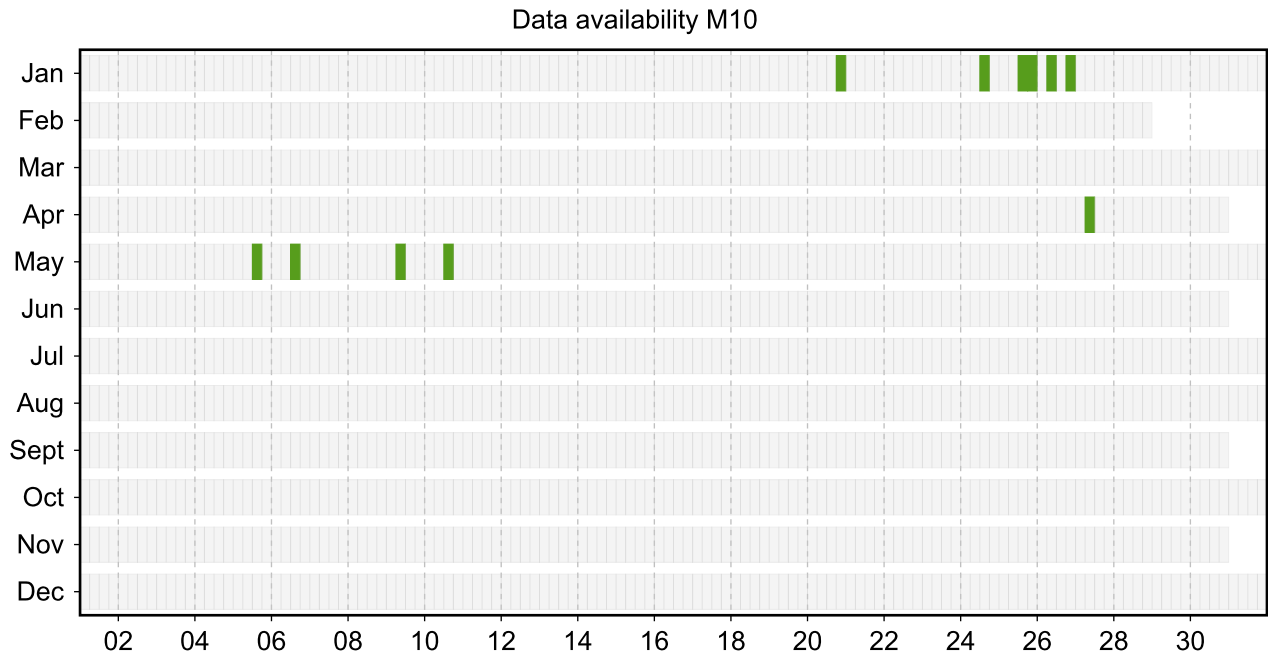
4.3.7 Stream: IMS-100



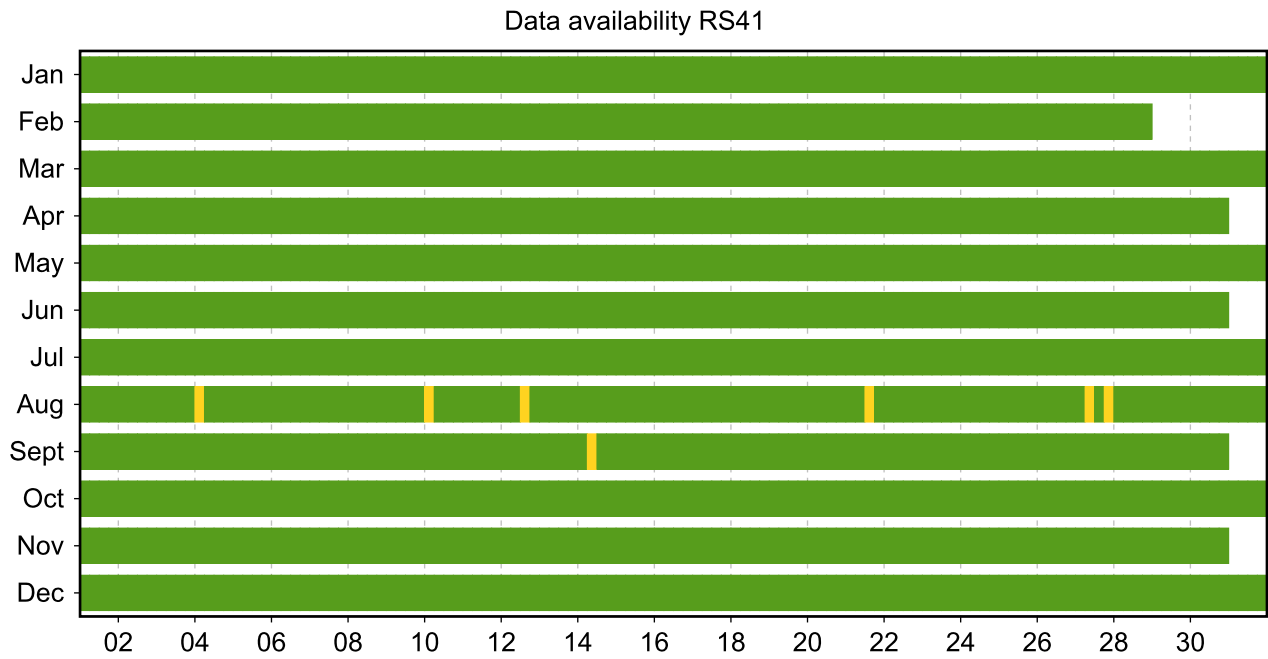
4.3.8 Stream: ISOLDE



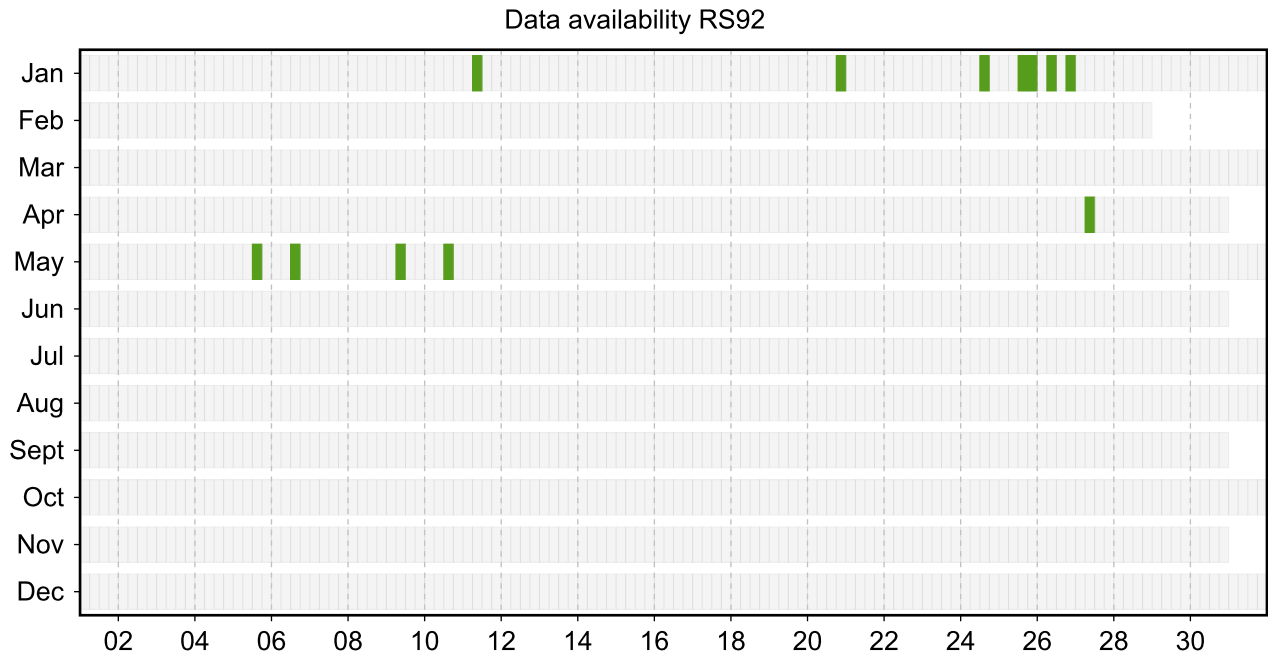
4.3.9 Stream: M10



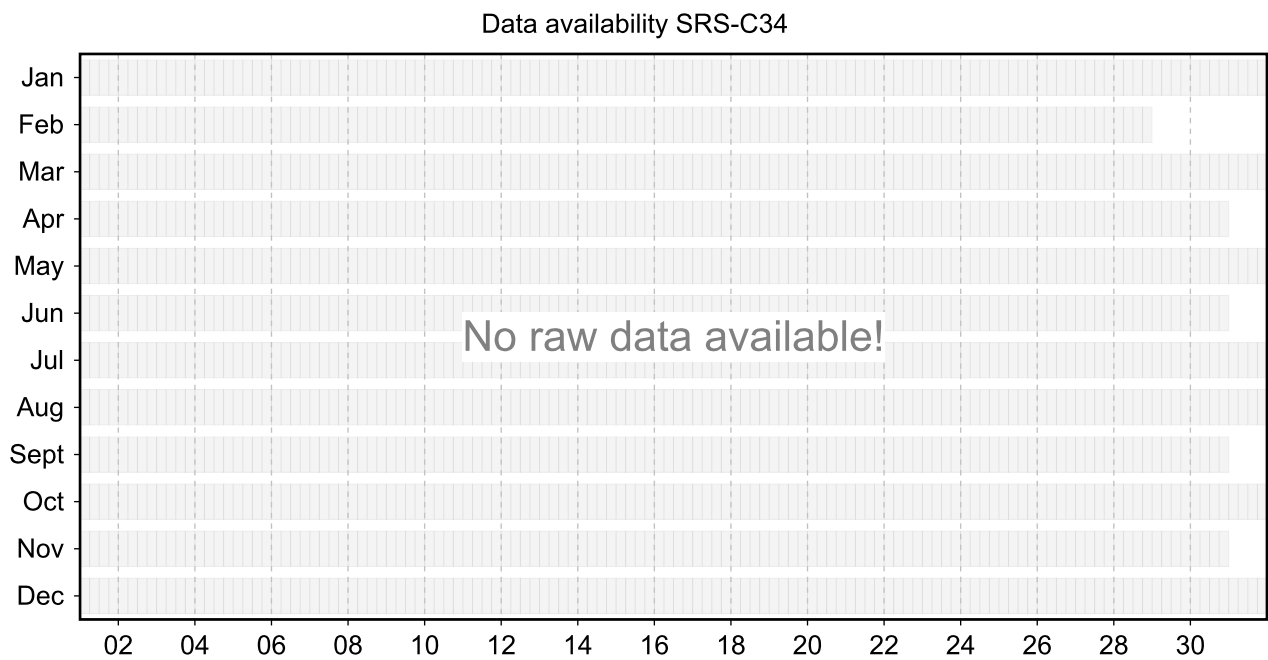
4.3.10 Stream: RS41



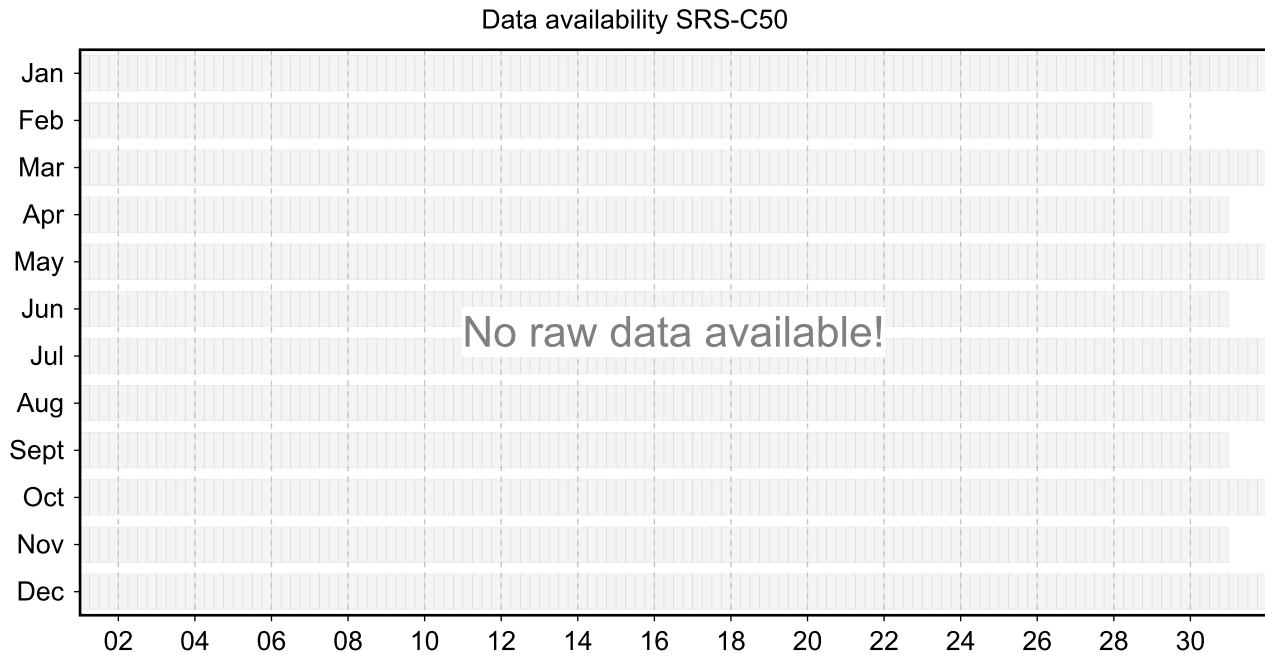
4.3.11 Stream: RS92



4.3.12 Stream: SRS-C34



4.3.13 Stream: SRS-C50



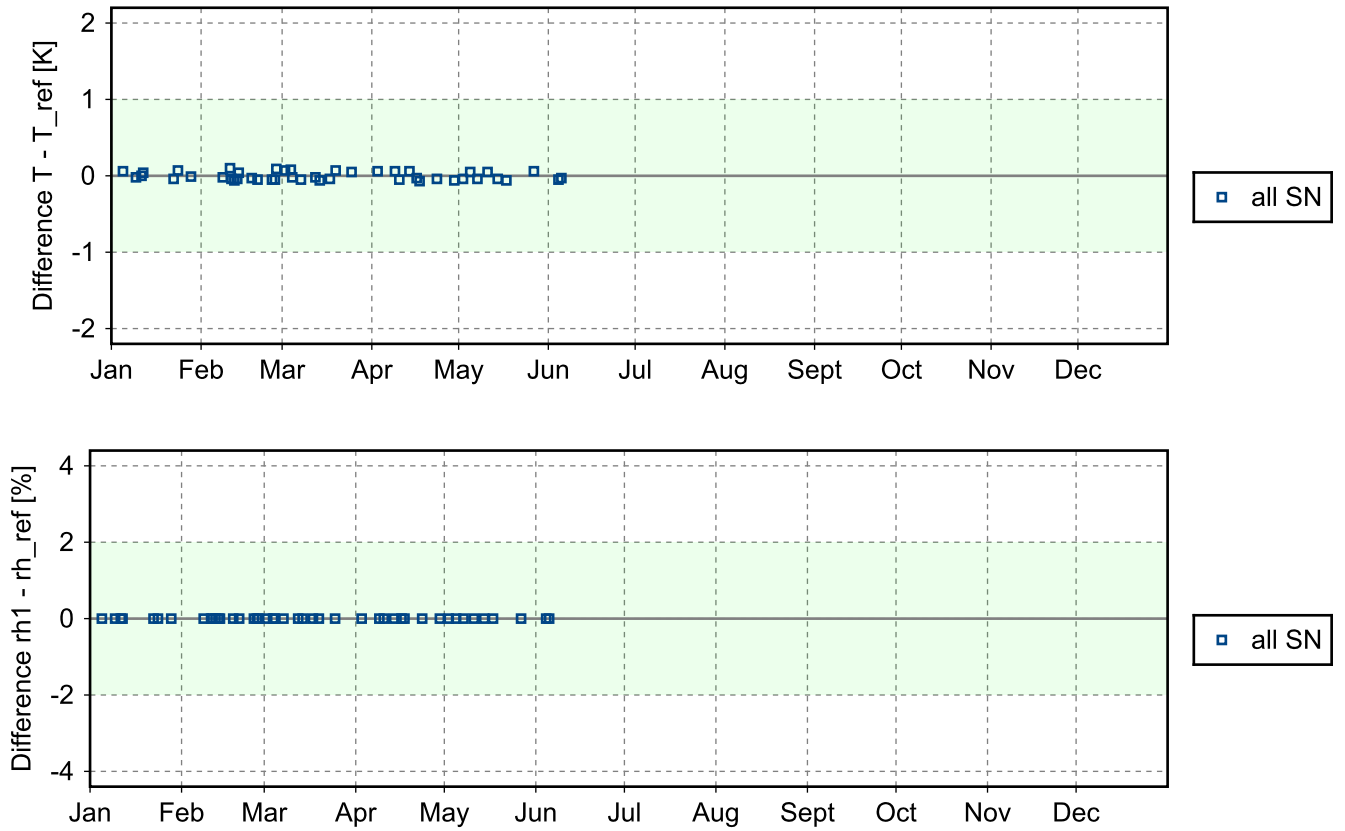
4.4 Instrument combinations of LIN-RS-01

Count	Instrument combination
2	CFH, COBALD, ECC, FLASH, 2x RS41
6	CFH, COBALD, ECC, RS41
1	CFH, COBALD, IMS-100, 2x RS41
1	CFH, DFM-17, ECC, RS41, RS92
4	CFH, IMS-100, 2x RS41
1	DFM-17, 2x IMS-100, 2x M10, 2x RS41, RS92
11	DFM-17, IMS-100, 3x RS41
10	2x DFM-17, IMS-100, 2x RS41
20	DFM-17, IMS-100, 2x RS41
43	DFM-17, RS41
56	ECC, RS41
18	IMET-54, 2x IMS-100, RS41
10	2x IMET-54, 2x IMS-100, RS41
10	IMET-54, 3x IMS-100, RS41
1	2x IMET-54, 3x IMS-100, RS41
10	IMS-100, M10, RS41, RS92
1	2x IMS-100, RS41
2	IMS-100, RS41
1	ISOLDE, RS41, SRS-C34
5	ISOLDE, RS41, SRS-C50
1365	RS41

4.5 Instrument ground check

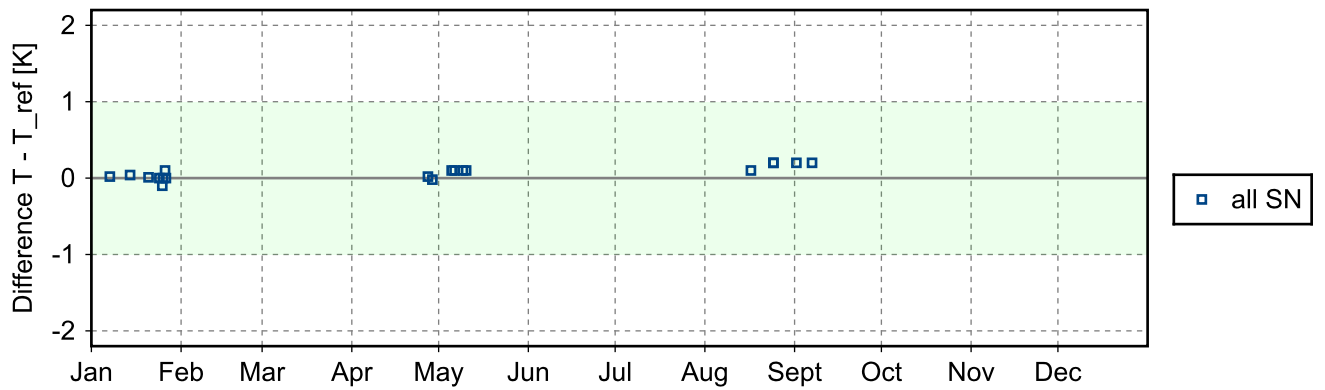
4.5.1 Stream: DFM-17

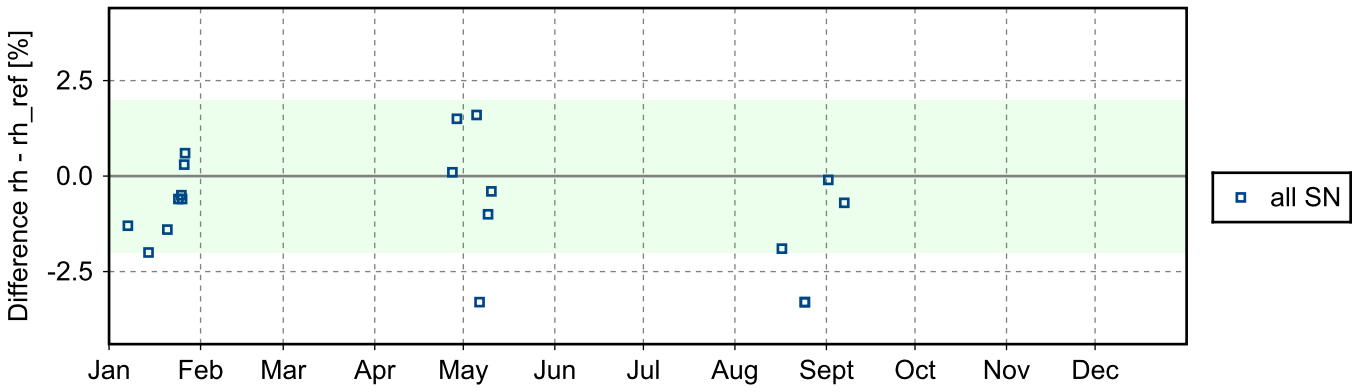
(1) GroundCheck: GC-SHC



4.5.2 Stream: IMS-100

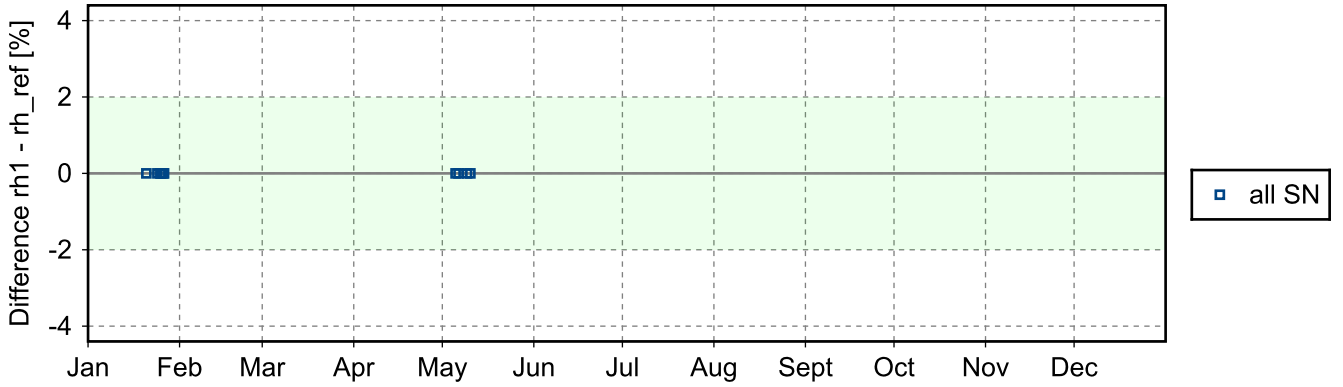
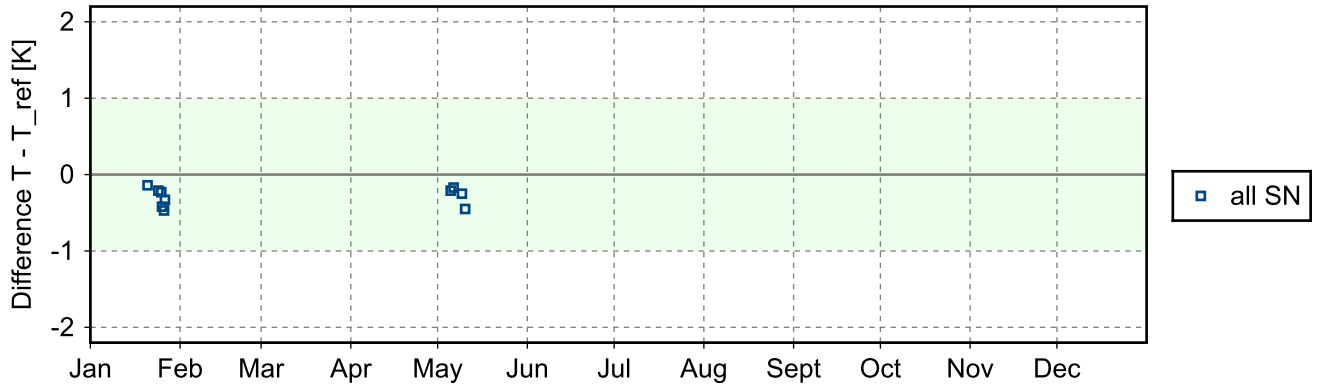
(1) GroundCheck: GC-TU(room)



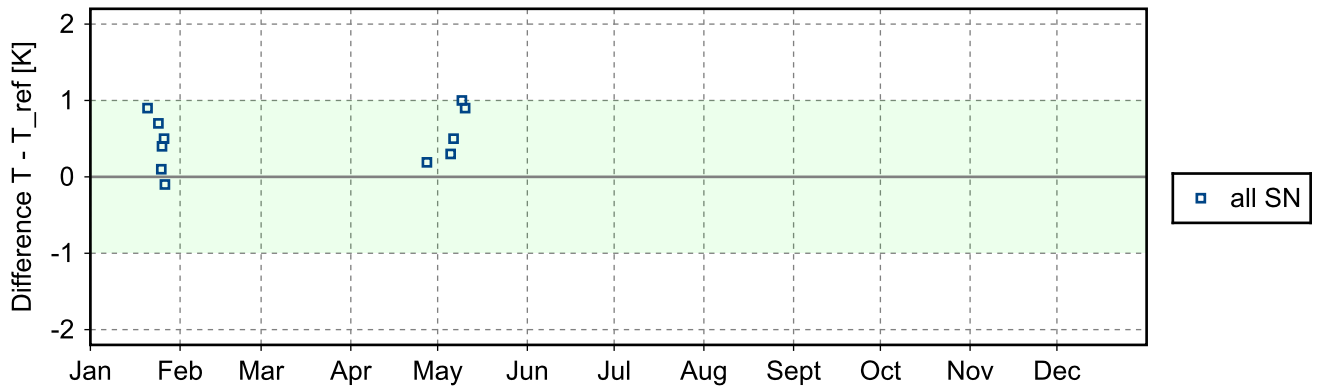


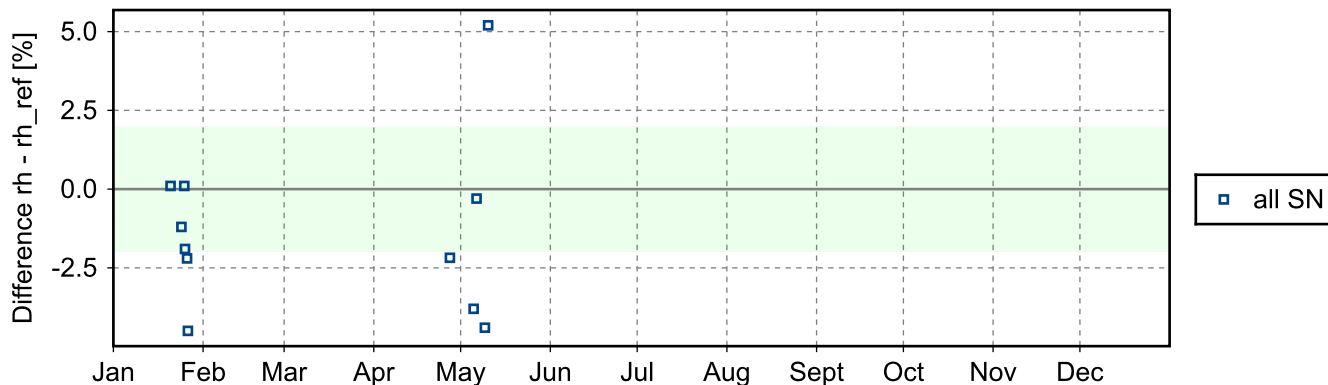
4.5.3 Stream: M10

(1) GroundCheck: GC-SHC



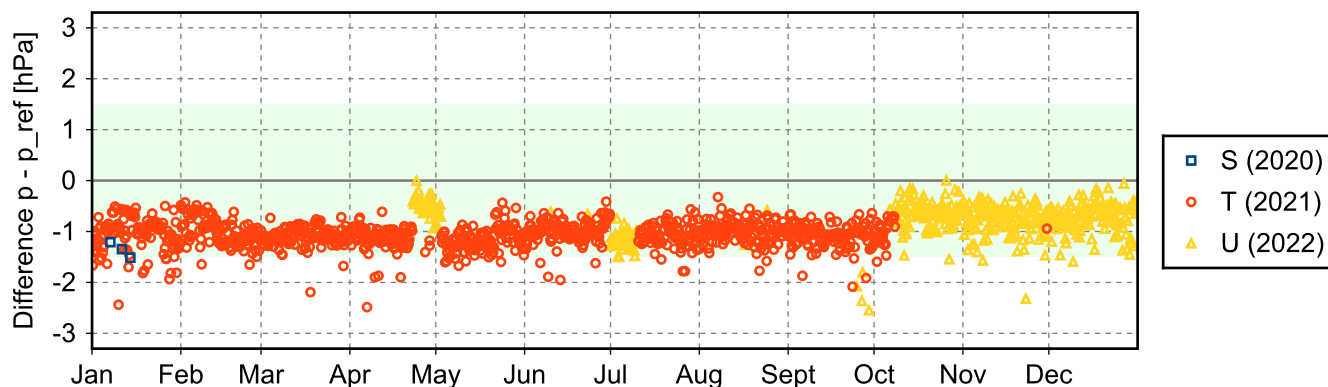
(2) GroundCheck: GC-TU(room)



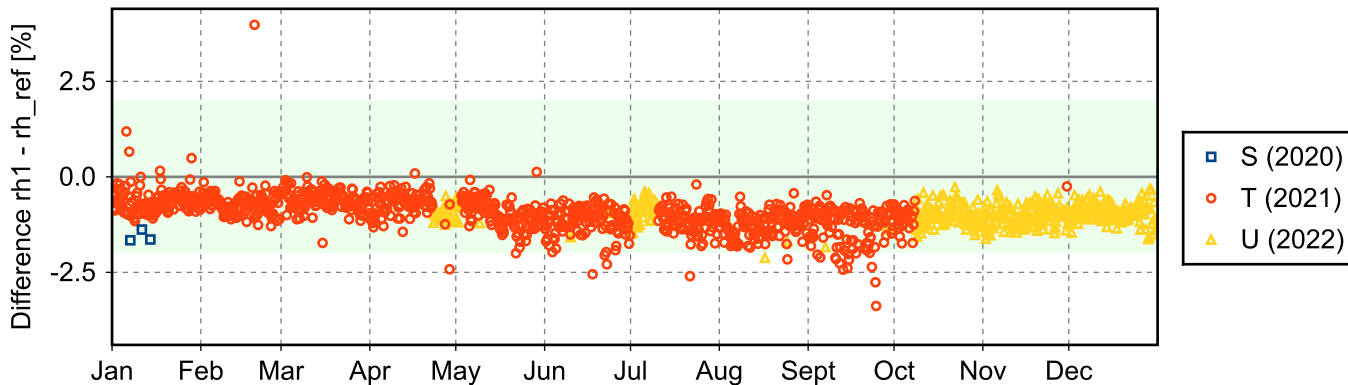
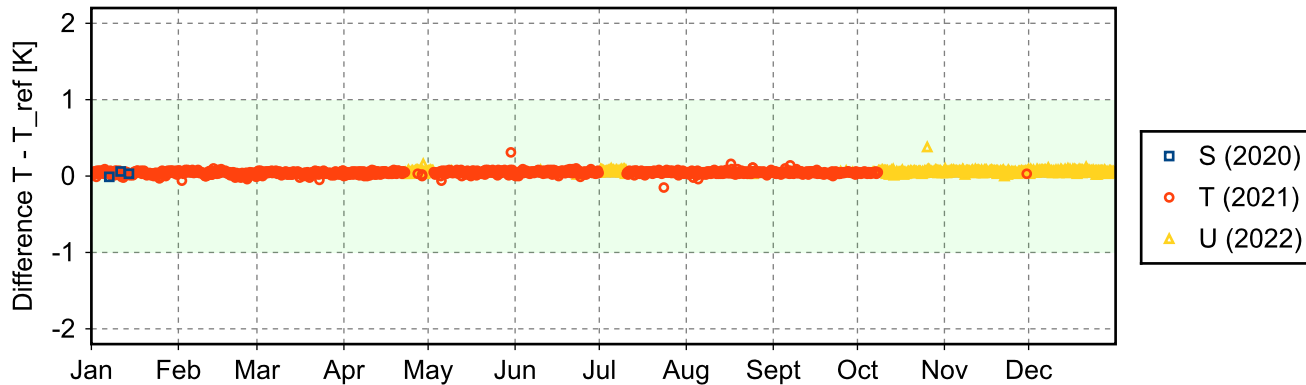


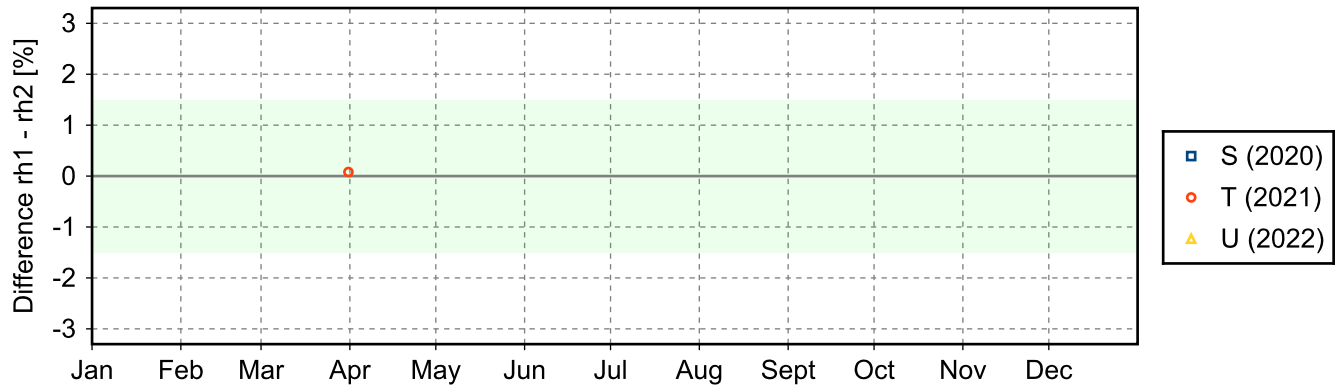
4.5.4 Stream: RS41

(1) GroundCheck: GC-RI41



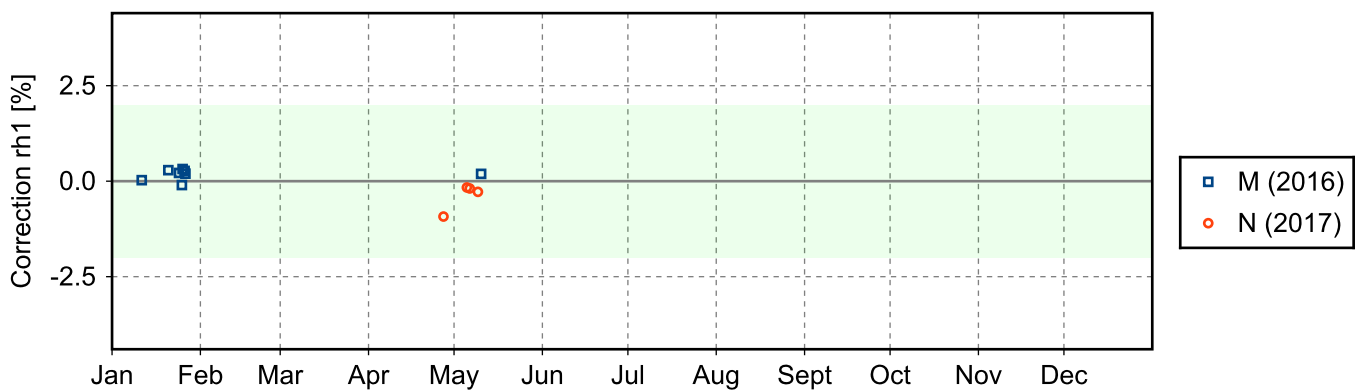
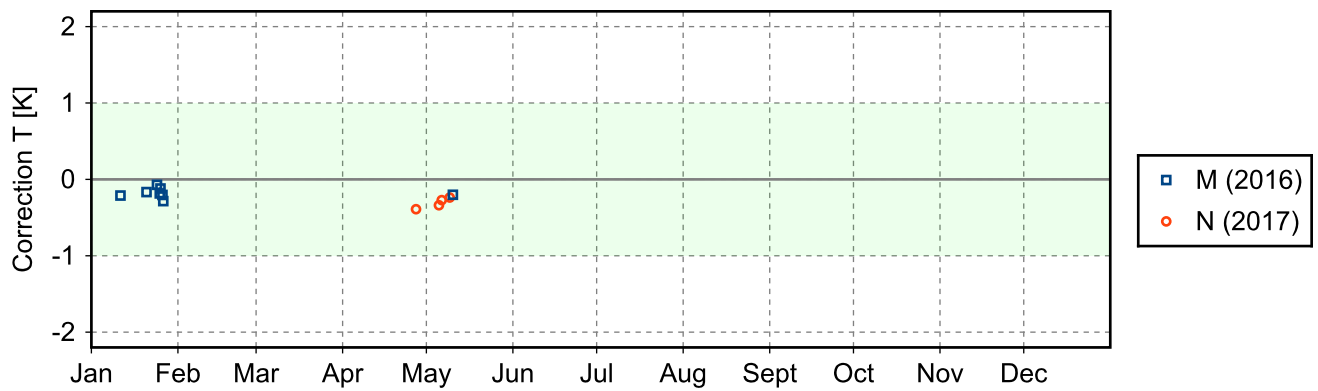
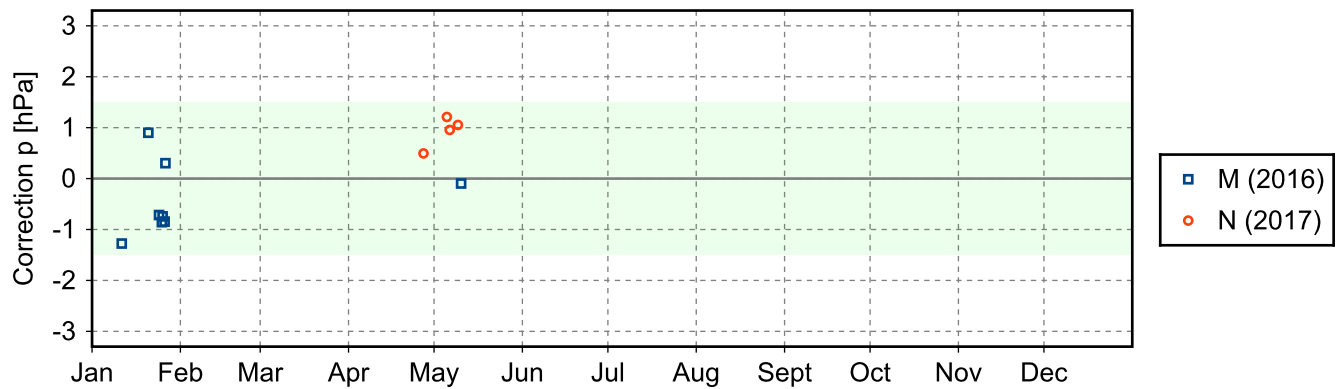
(2) GroundCheck: GC-SHC

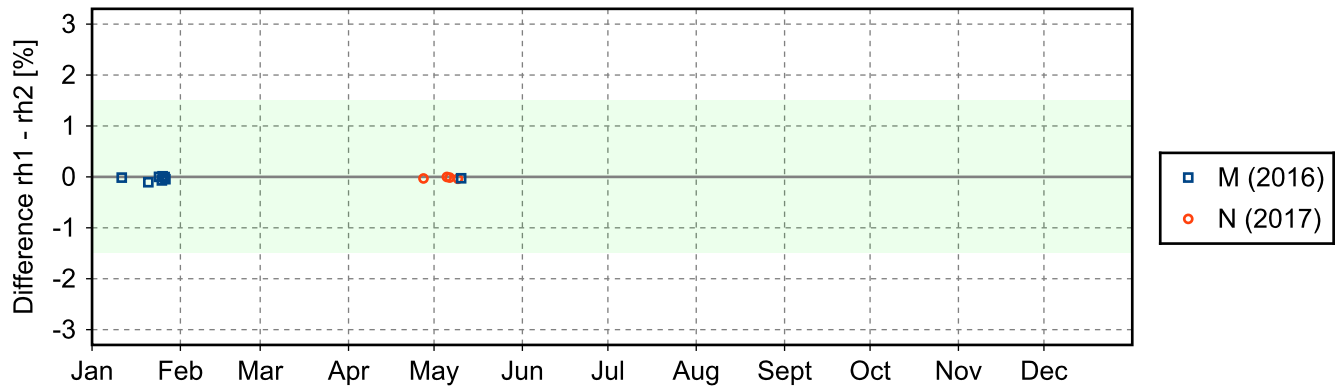
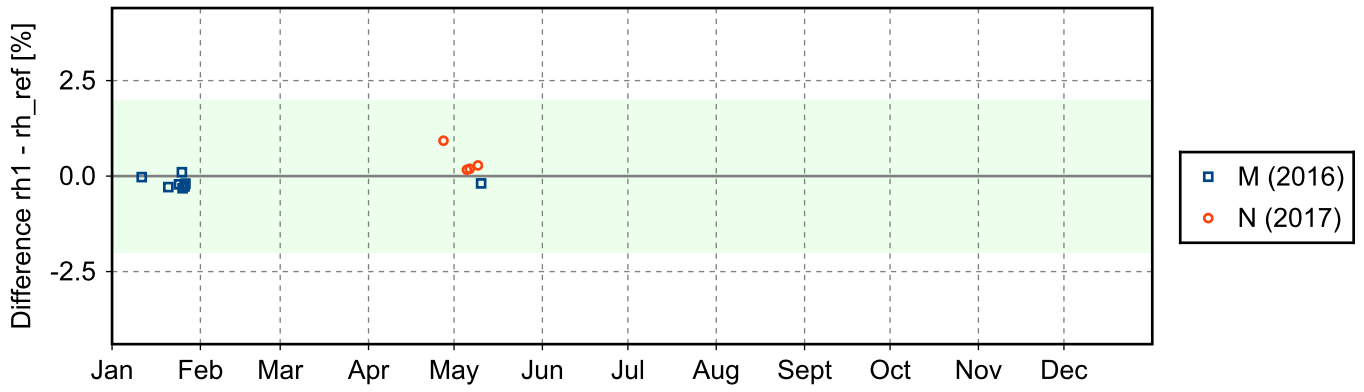




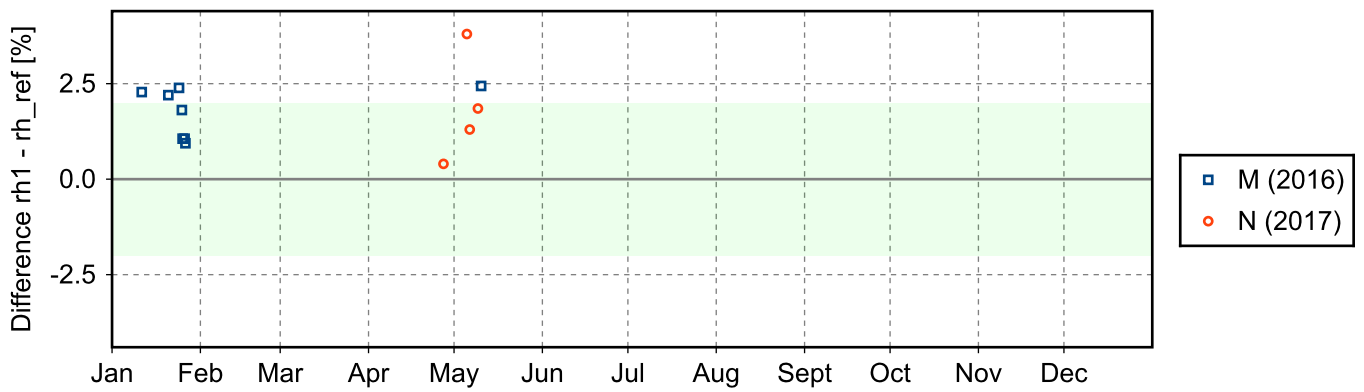
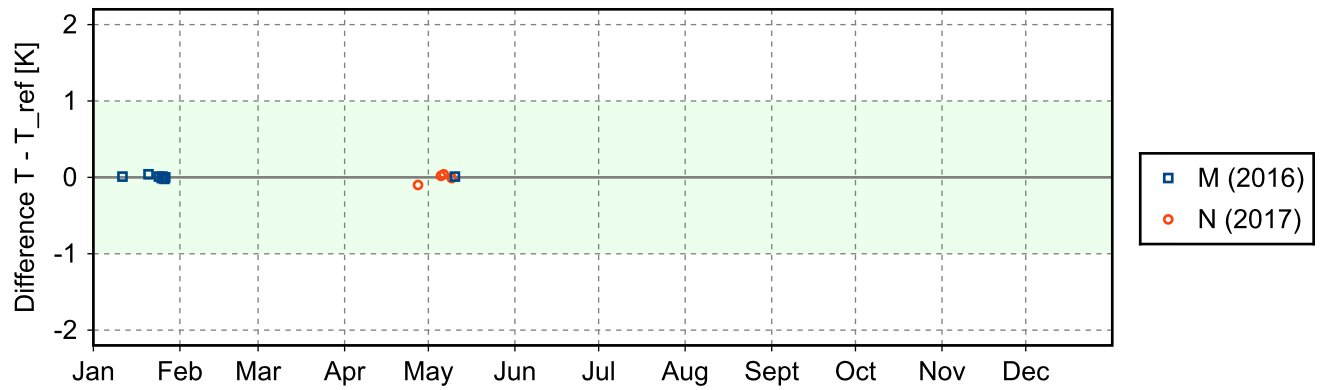
4.5.5 Stream: RS92

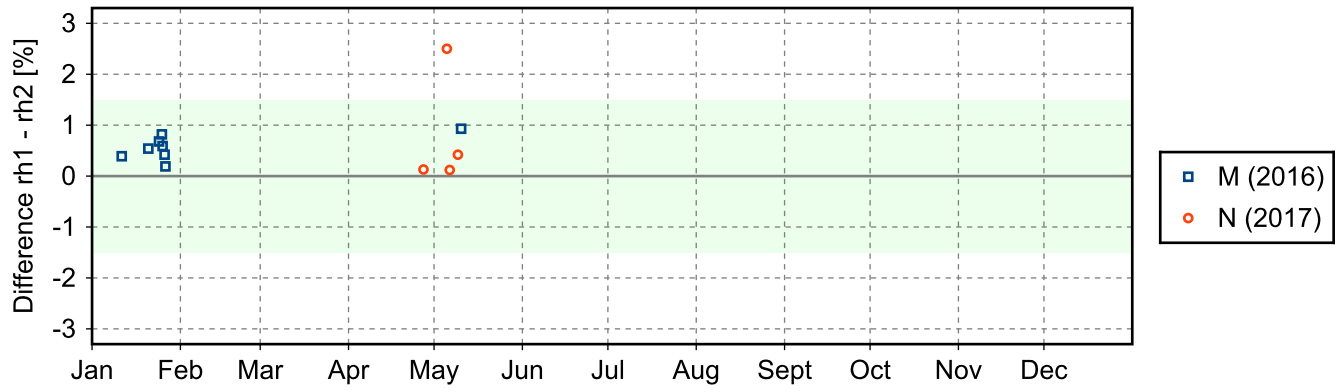
(1) GroundCheck: GC-GC25



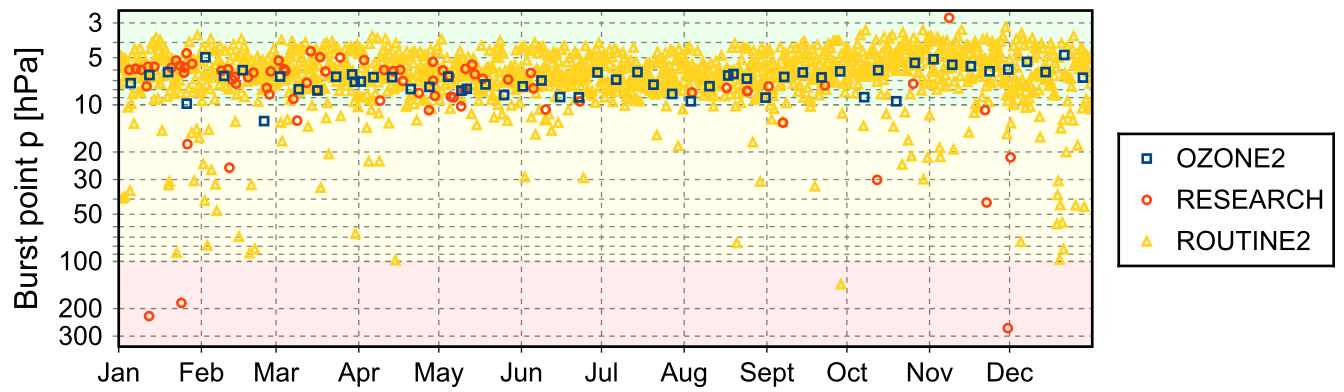


(2) GroundCheck: GC-SHC





4.6 Measurement events





GRUAN Site Report for Lindenberg (LIN), 2023

Reported time range is Jan 2023 to Dec 2023

Created by the Lead Centre

Version from 2024-03-01

1 General GRUAN site information

Object	Value
Station name	Lindenberg
Unique GRUAN ID	LIN
Geographical position	52.2100 °N, 14.1200 °E, 98.0 m
Operated by	MOL Meteorologisches Observatorium Lindenberg, part of: DWD Deutscher Wetterdienst
Main contact	Dirksen, Ruud
WMO no./name	10393 LINDENBERG
Operators	currently 23, changes +0 / -0
Sounding Site	1
GNSS	2

1.1 General information about GRUAN measurement systems

System	Name	Type	Setups	Measurements
LIN-GN-02	GNSS Site LDB2	GNSS	0	not operational
LIN-GN-03	GNSS Site LIN0	GNSS	1	operational
LIN-RS-01	Lindenberg Radiosonde Launch Site	Sounding Site	8	1513

1.2 General comments from Lead Centre

No comments from Lead Centre.

2 System: GNSS Site LDB2 (LIN-GN-02)

Object	Value
System name	GNSS Site LDB2
Unique GRUAN ID	LIN-GN-02
System type	GNSS (GN - GNSS)
Geographical position	52.2091 °N, 14.1209 °E, 159.5 m
Operated by	-
Instrument contact	Dirksen, Ruud
Started at	-
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 LIN0 (LIN-GN-03)

Object	Value
System name	GNSS Site LIN0
Unique GRUAN ID	LIN-GN-03
System type	GNSS (GN - GNSS)
Geographical position	52.2093 °N, 14.1217 °E, 165.0 m
Operated by	GFZ Deutsches GeoForschungsZentrum GFZ, part of: HELMHOLTZ Helmholtz-Gemeinschaft
Instrument contact	Dirksen, Ruud
Started at	2020-10-01
Defined setups	1 (HOURLY)
Possible streams	-

3.1 Lead Centre comments

3.1.1 Dataflow

Dataflow of GNSS data to GRUAN LC and to the GRUAN GNSS processing centre at GFZ has started in October 2020. The current dataflow includes manufacturer raw data, converted raw data (RINEX), instrument logs, and processed data.

Meteorological data is available since January 2021, therefore the operational processing as GNSS-PW-GDP is also possible since then.

3.1.2 General

This GNSS system is performing measurements since October 2020.

4 System: Lindenberg Radiosonde Launch Site (LIN-RS-01)

Object	Value
System name	Lindenberg Radiosonde Launch Site
Unique GRUAN ID	LIN-RS-01
System type	Sounding Site (RS - Radiosonde)
Geographical position	52.2100 °N, 14.1200 °E, 112.0 m
Operated by	MOL Meteorologisches Observatorium Lindenberg, part of: DWD Deutscher Wetterdienst
Instrument contact	Dirksen, Ruud
Started at	-
Defined setups	8 (ROUTINE, RESEARCH, OZONE, DUAL1, ROUTINE2, OZONE2, DUAL2, UAI12022)
Possible streams	CFH, COBALD, DFM-09, DFM-17, ECC, FLASH, FPH, IMET-54, M10, PCFH, RS41, RS80, RS92, SKYDEW

4.1 Lead Centre comments

4.1.1 Dataflow

Routine soundings with Vaisala RS41 are performed 4 times per day. Ozone soundings are performed once per week. Research soundings including SKYDEW, ECC and RS41 are performed once per month. Various sonde combinations have been flown throughout the reporting period.

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4.1.2 General

Good performance of stratospheric water vapor measurement programm (SKYDEW) and ECC ozone soundings can be confirmed.

There is very good performance in terms of burst altitude which is regularly 10 hPa to 5 hPa and higher.

4.2 GRUAN data products

Product	Version	Soundings received	Available at LC	Distributed by NCEI
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4.2.1 Stream: CFH

CFH		3	3	
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4.2.2 Stream: COBALD

COBALD		7	7	
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4.2.3 Stream: DFM-17

DFM-17		1	1	
DFM-17-RAW	001		1	

4.2.4 Stream: ECC

ECC		69	69	
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4.2.5 Stream: IMS-100

IMS-100		26	26	
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4.2.6 Stream: ISOLDE

ISOLDE		24	24	
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4.2.7 Stream: M10

M10		27	27	
M10-RAW	001		20	

4.2.8 Stream: RS41

RS41		1526	1526	
RS41-RAW	001		1526	
RS41-EDT	001		1525	
RS41-GDP	001		1524	

4.2.9 Stream: RS92

RS92		21	21	
RS92-RAW	002		20	
RS92-EDT	001		20	
RS92-GDP	002		19	

4.2.10 Stream: SKYDEW

SKYDEW		17	17	
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4.2.11 Stream: SRS-C50

SRS-C50		9	9	
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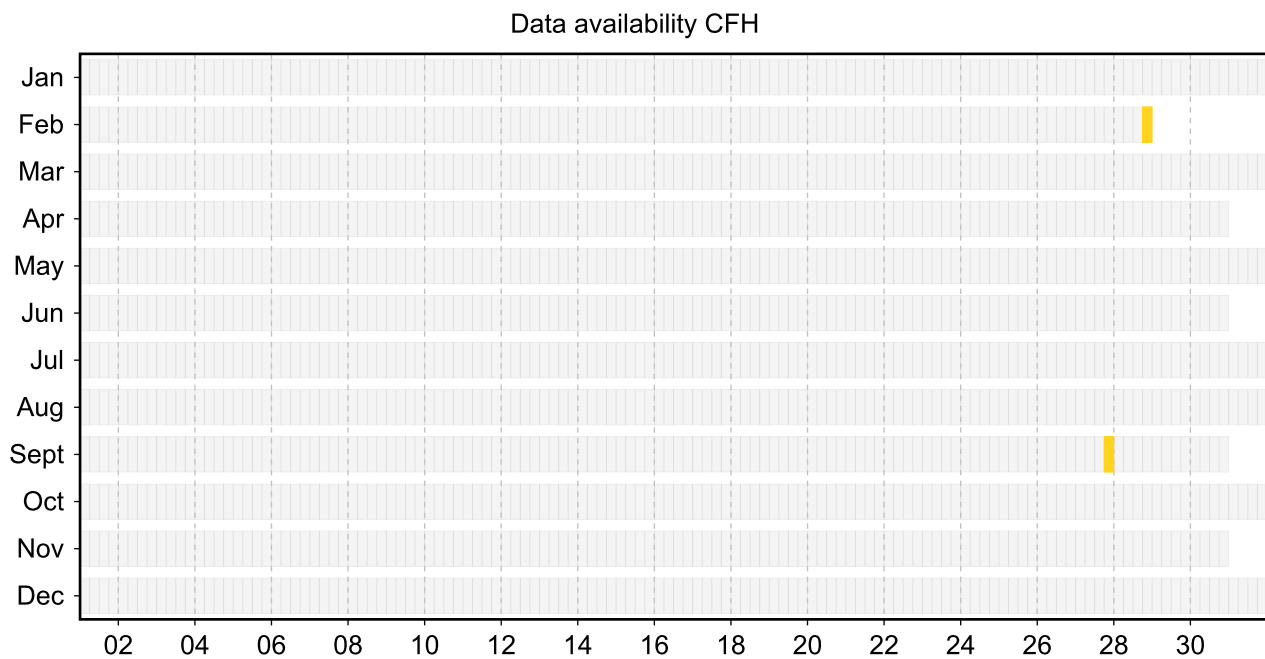
4.3 Availability of data products

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).

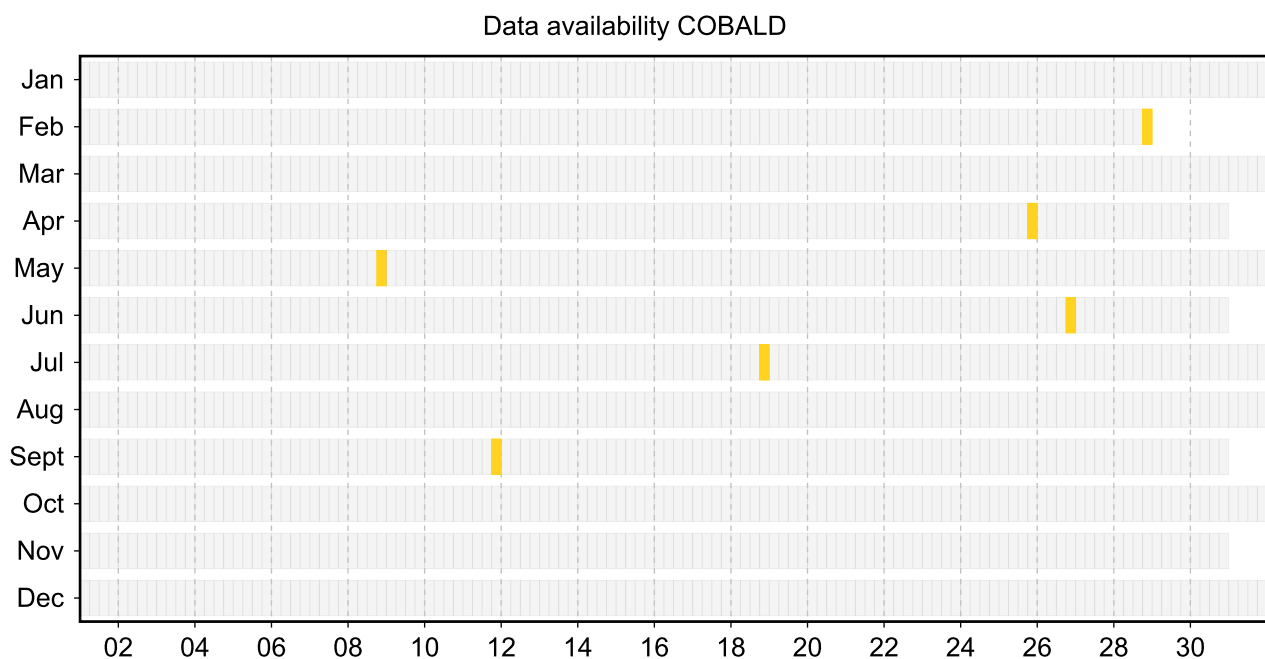
Unprocessed (yellow): The manufacturer-produced file with raw measurement data has been successfully converted into a GRUAN-standardized raw data format (NetCDF). The GRUAN data processing has not been performed or was aborted. Reasons for this may be a still missing GRUAN data processor or a processing-software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

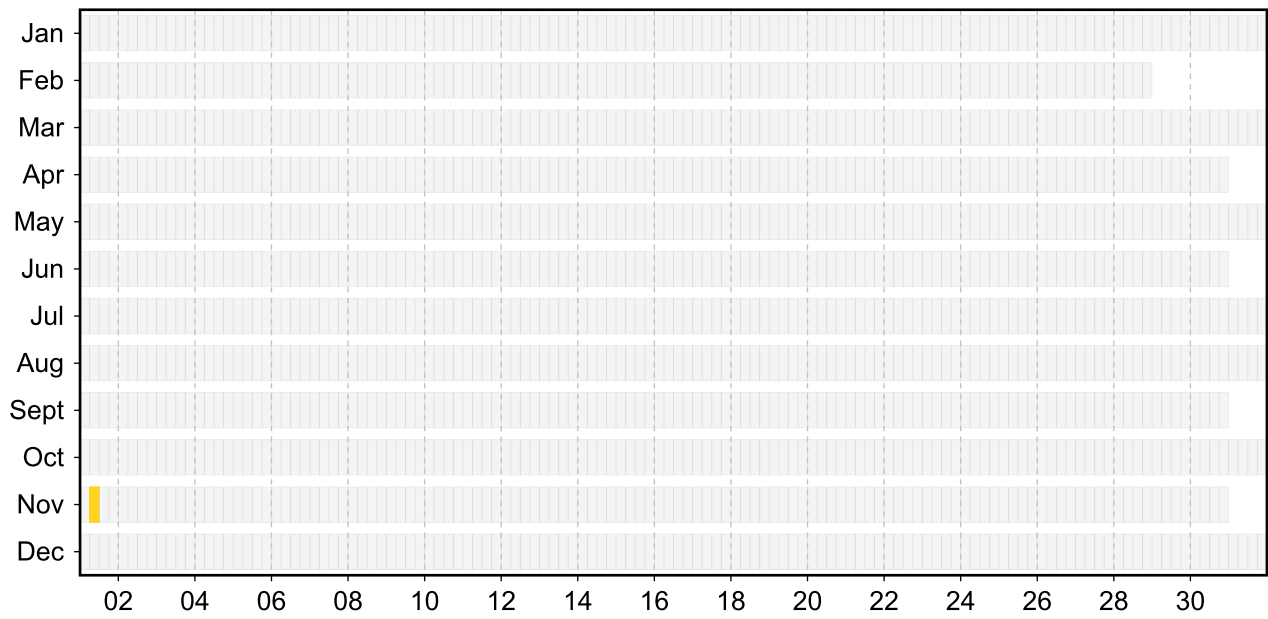


4.3.2 Stream: COBALD



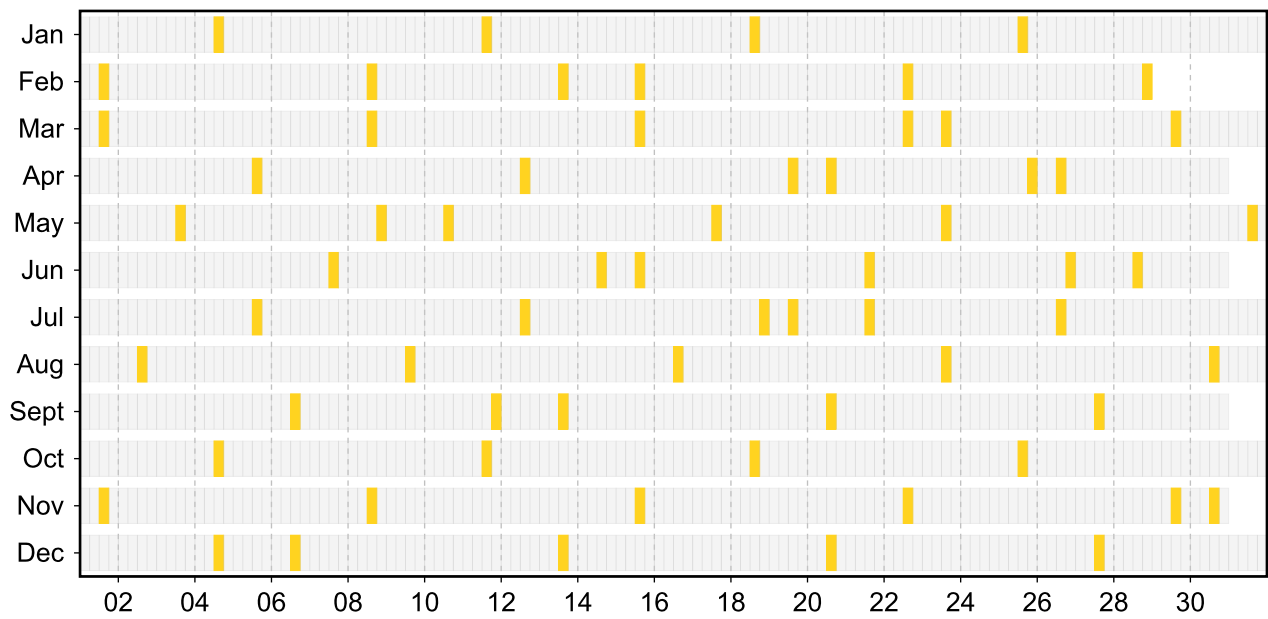
4.3.3 Stream: DFM-17

Data availability DFM-17



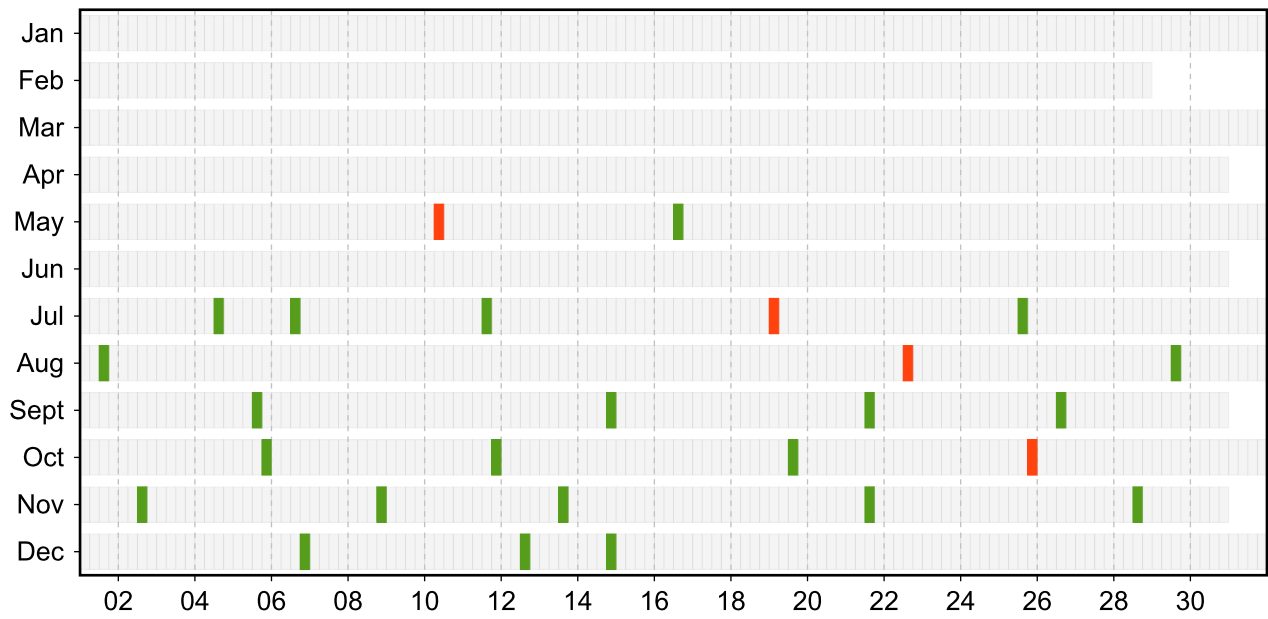
4.3.4 Stream: ECC

Data availability ECC



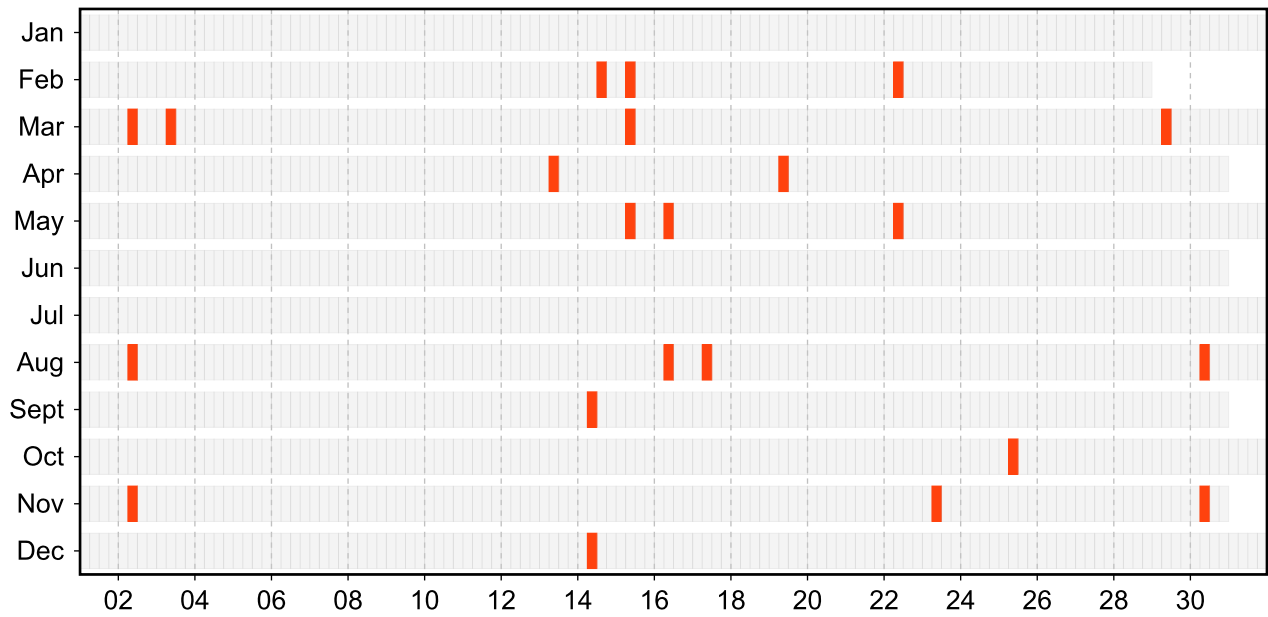
4.3.5 Stream: IMS-100

Data availability IMS-100



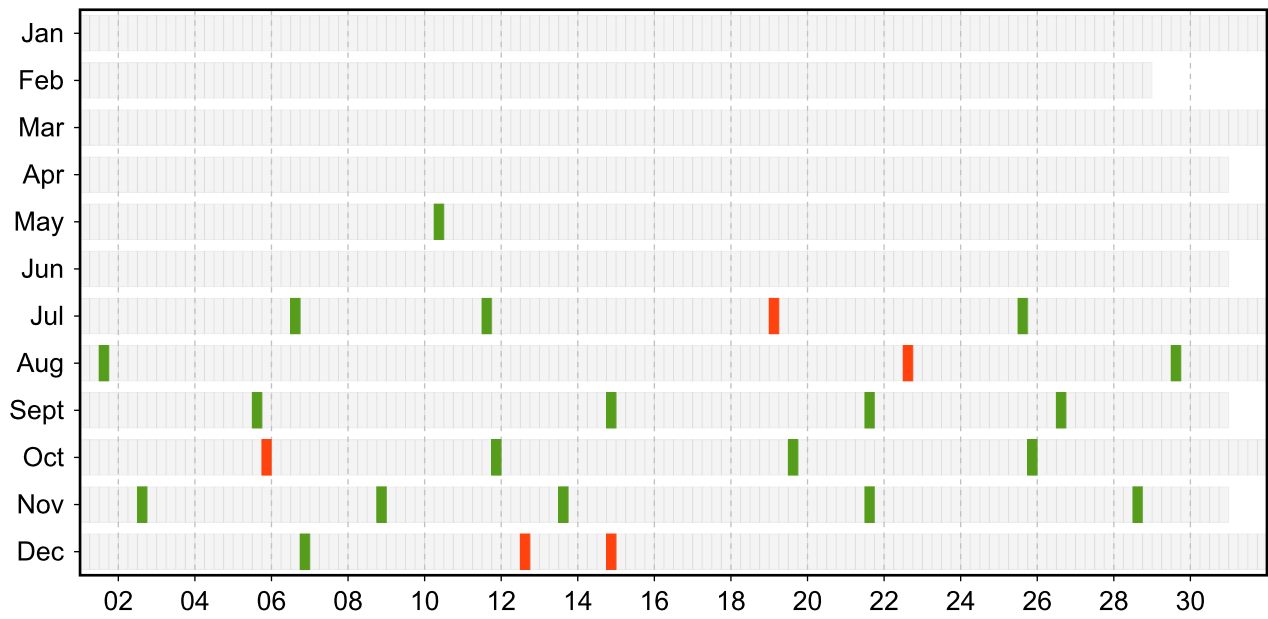
4.3.6 Stream: ISOLDE

Data availability ISOLDE



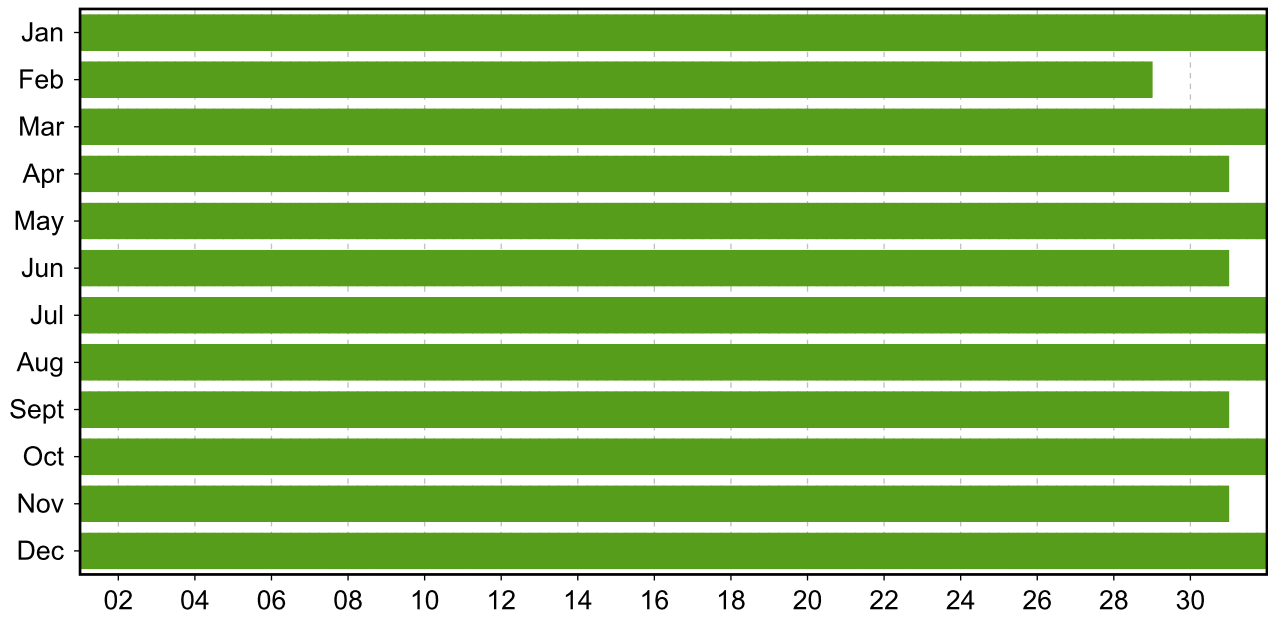
4.3.7 Stream: M10

Data availability M10



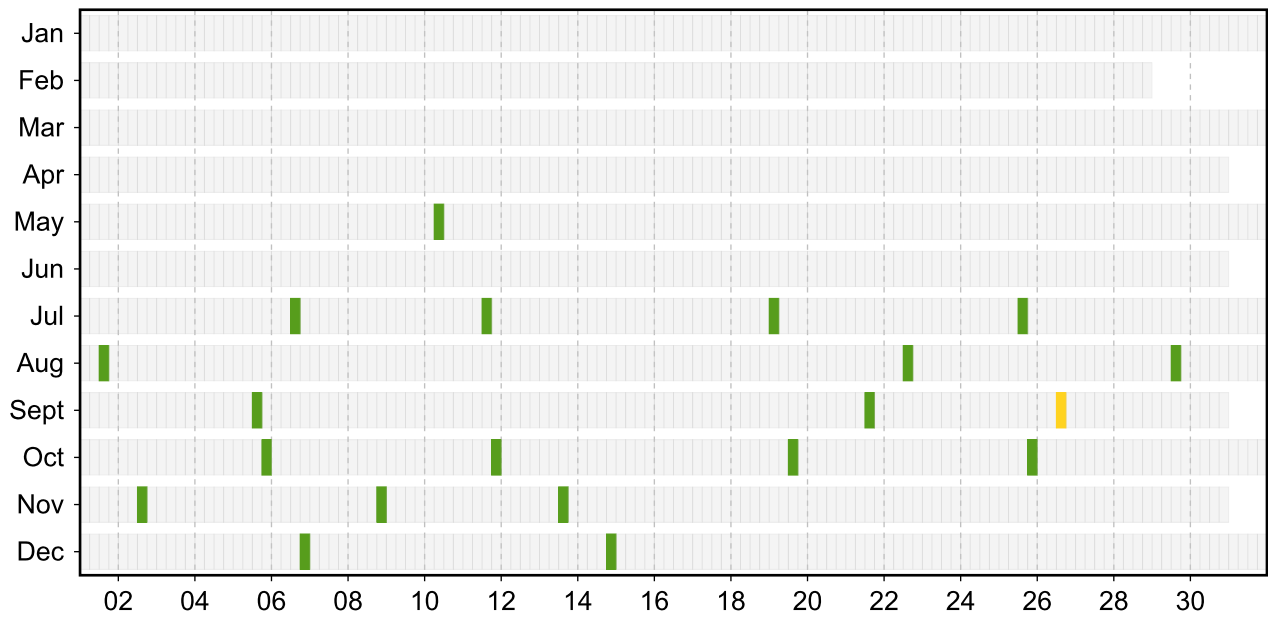
4.3.8 Stream: RS41

Data availability RS41



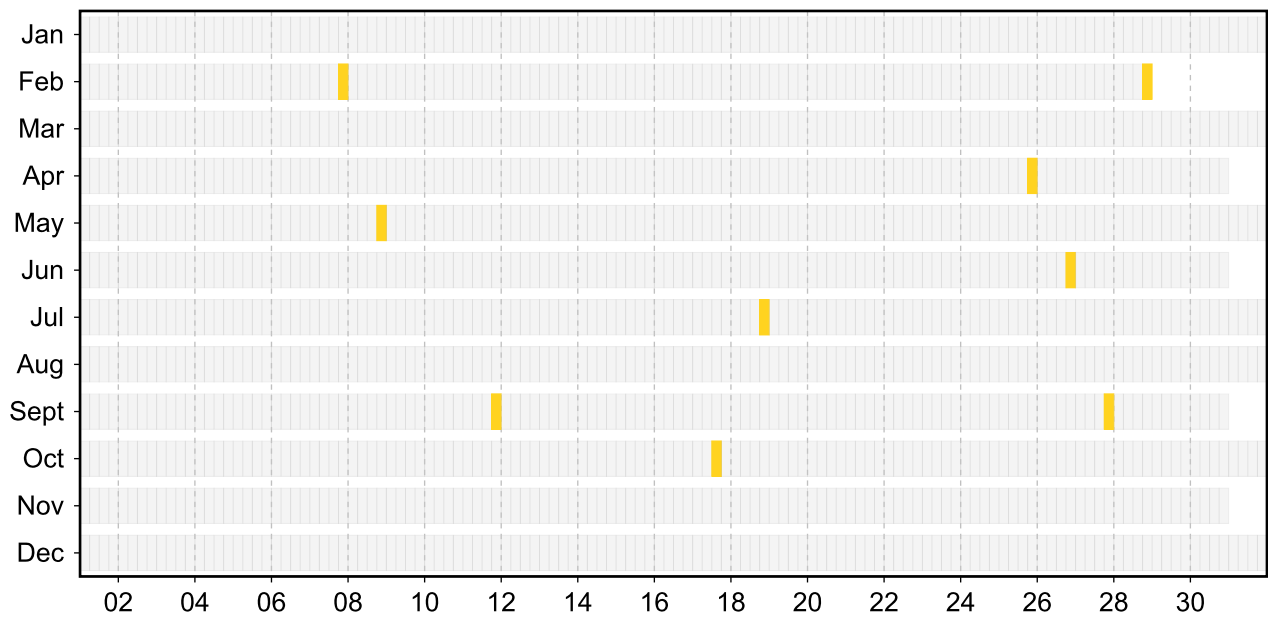
4.3.9 Stream: RS92

Data availability RS92

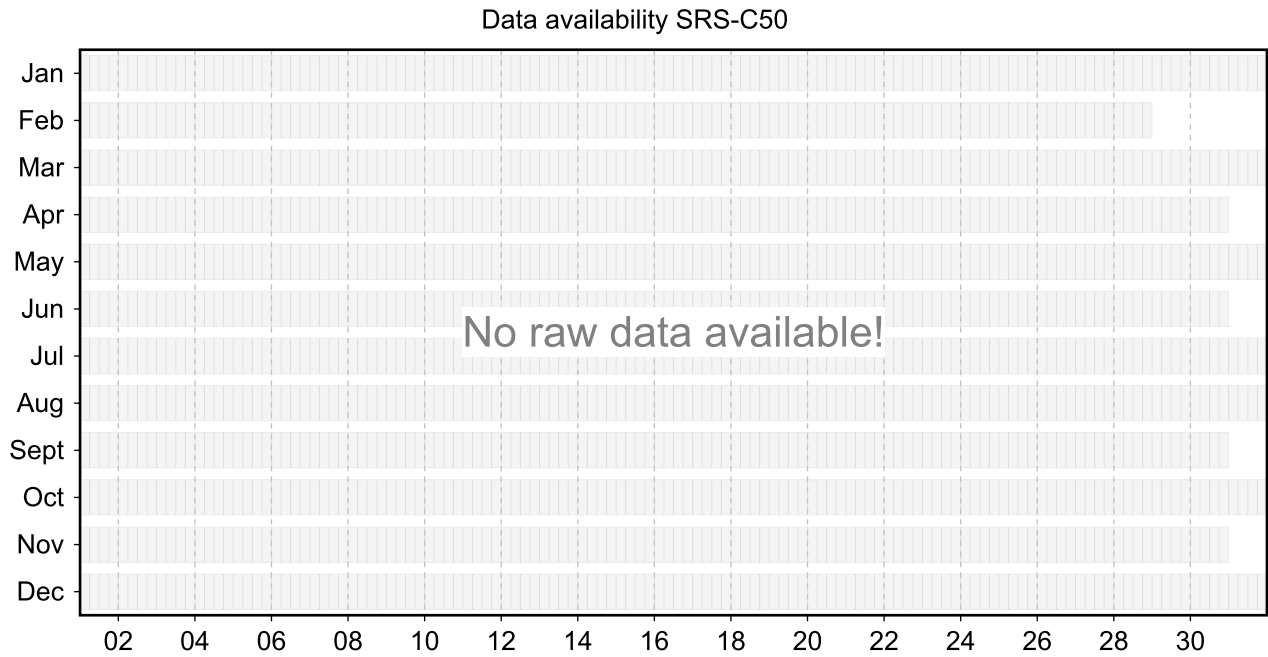


4.3.10 Stream: SKYDEW

Data availability SKYDEW



4.3.11 Stream: SRS-C50



4.4 Instrument combinations of LIN-RS-01

Count	Instrument combination
1	CFH, COBALD, RS41
1	2x CFH, 3x RS41, SKYDEW
6	COBALD, ECC, 2x RS41, 2x SKYDEW
1	DFM-17
2	3x ECC, 3x RS41
57	ECC, RS41
3	IMS-100, 2x M10, RS41
21	IMS-100, M10, RS41, RS92
2	IMS-100, RS41
15	ISOLDE, RS41
9	ISOLDE, RS41, SRS-C50
1393	RS41
2	2x RS41, 2x SKYDEW

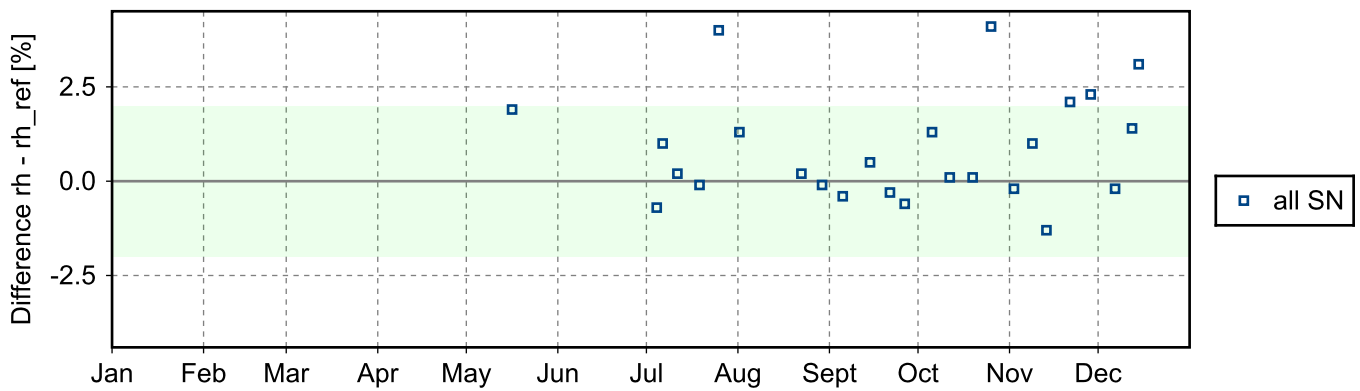
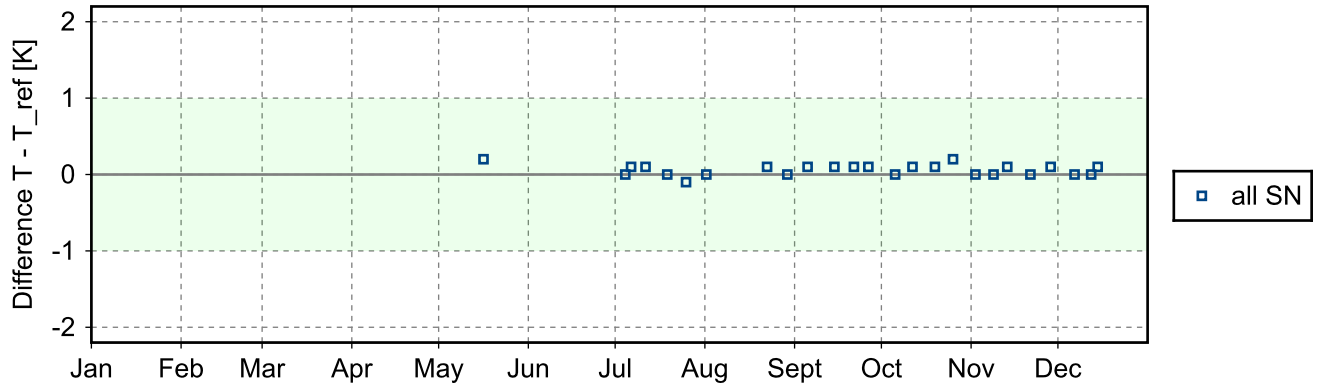
4.5 Instrument ground check

4.5.1 Stream: DFM-17

(1) GroundCheck: GC-SHC

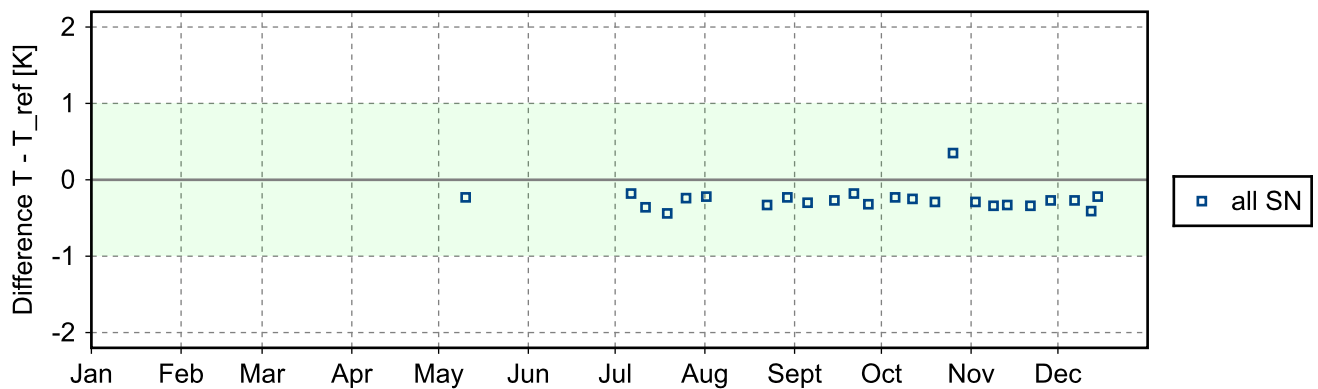
4.5.2 Stream: IMS-100

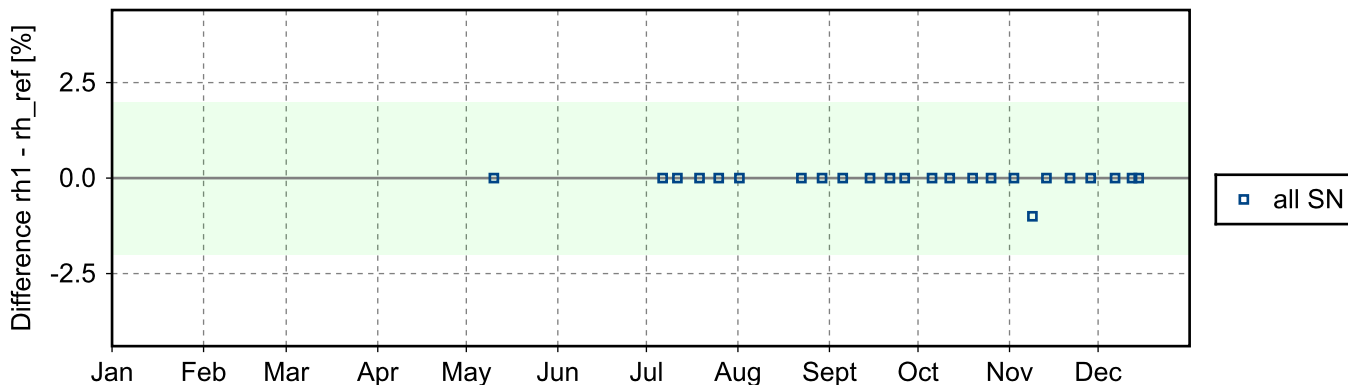
(1) GroundCheck: GC-TU(room)



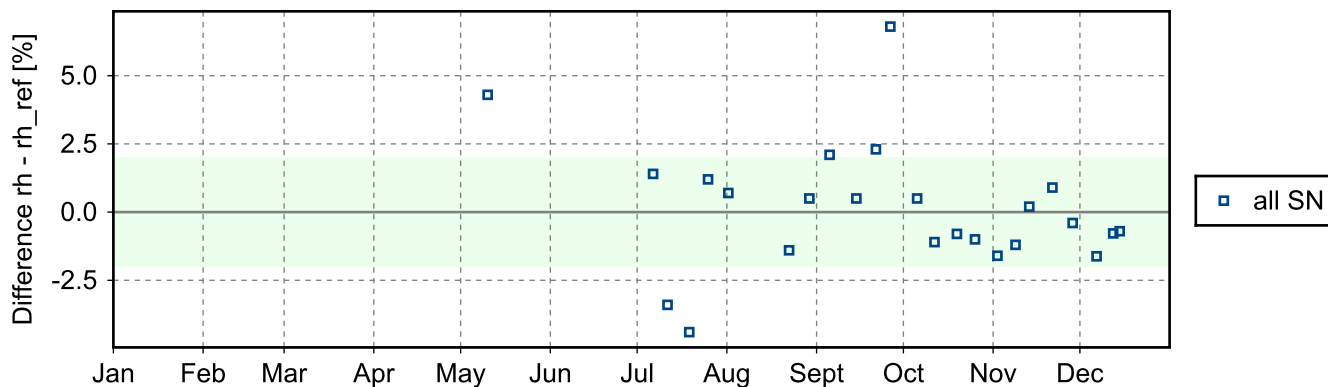
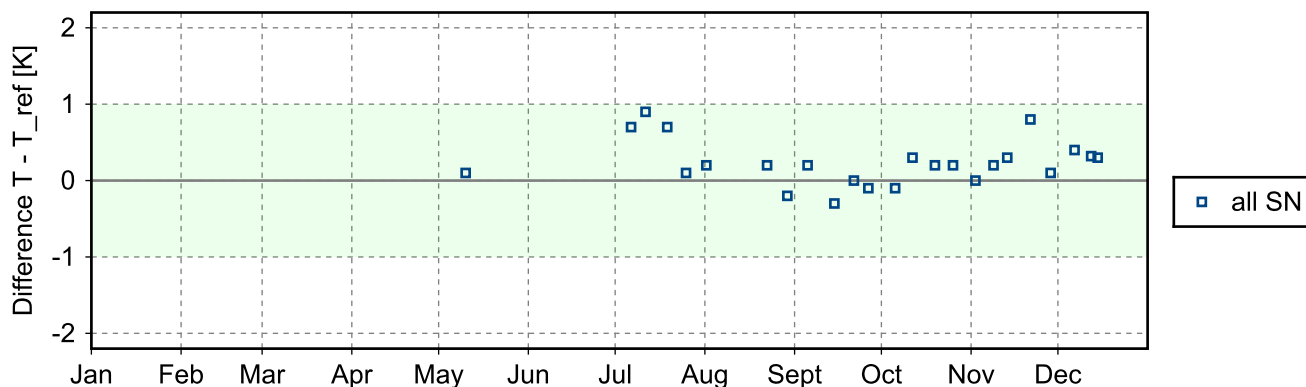
4.5.3 Stream: M10

(1) GroundCheck: GC-SHC



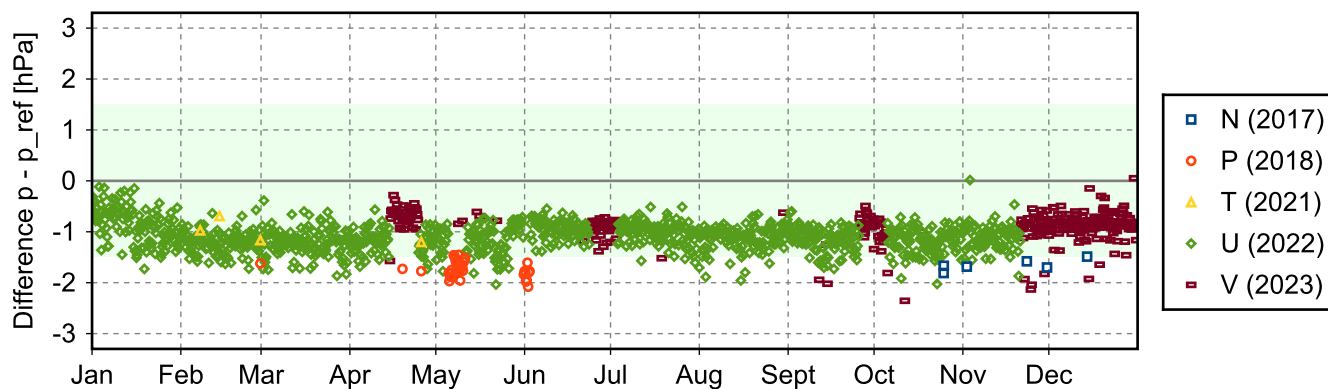


(2) GroundCheck: GC-TU(room)

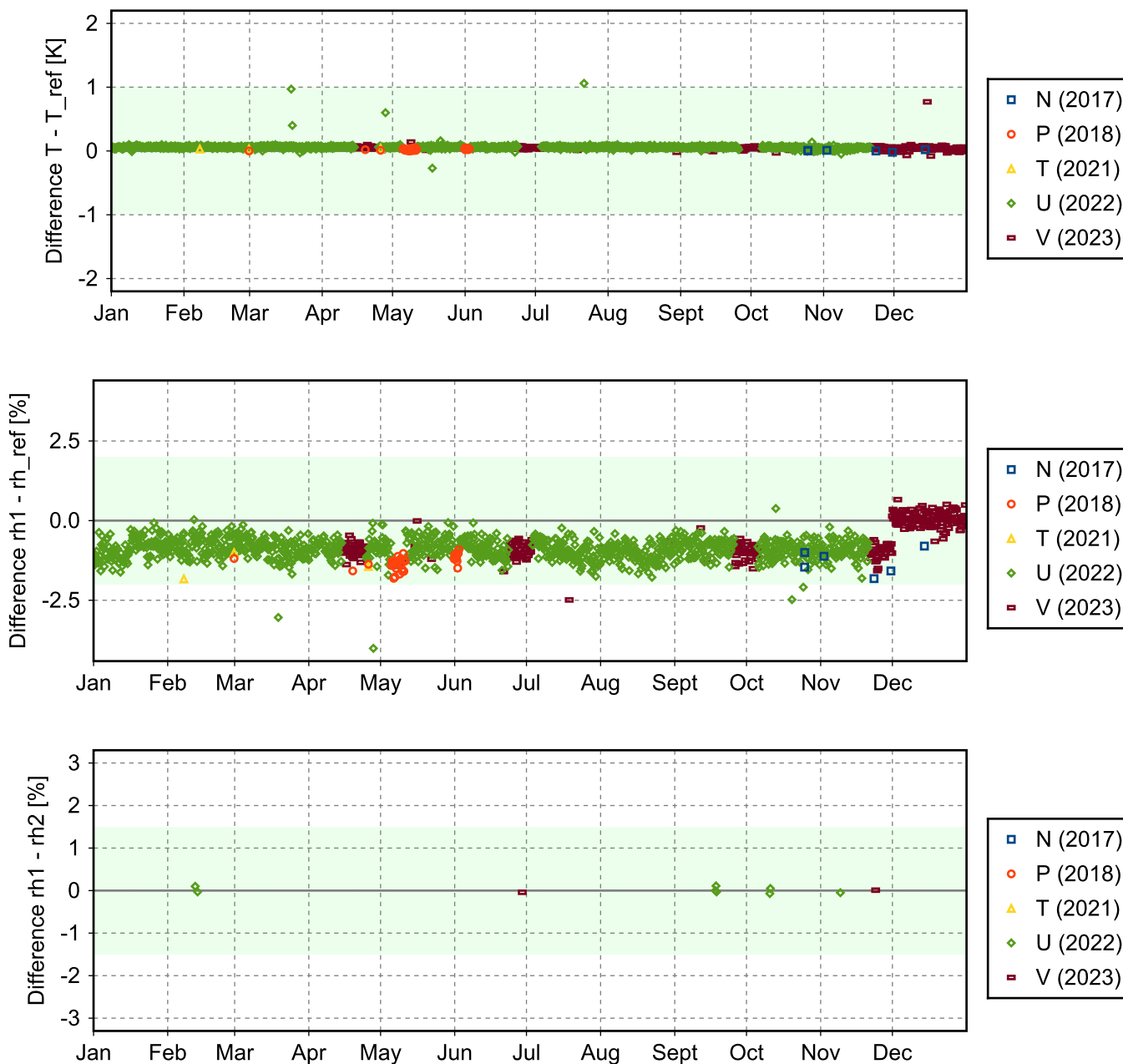


4.5.4 Stream: RS41

(1) GroundCheck: GC-RI41

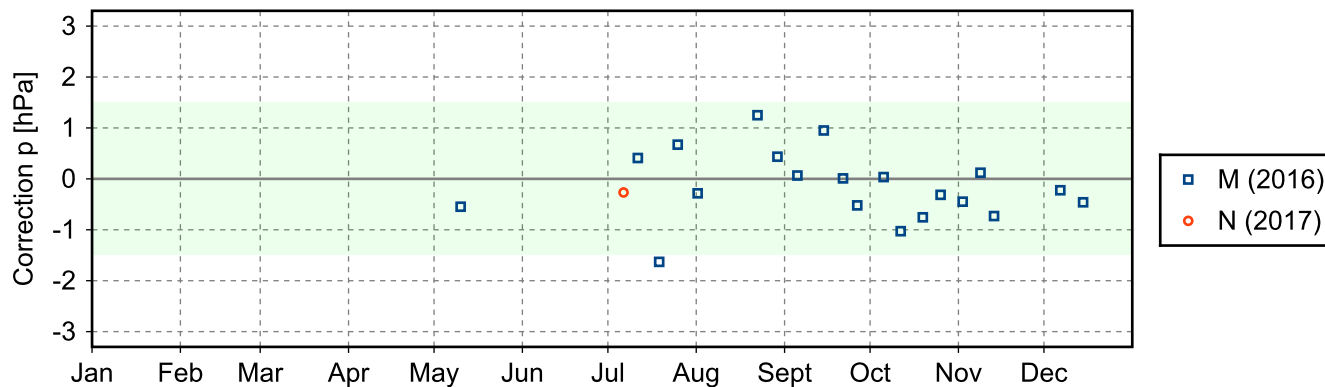


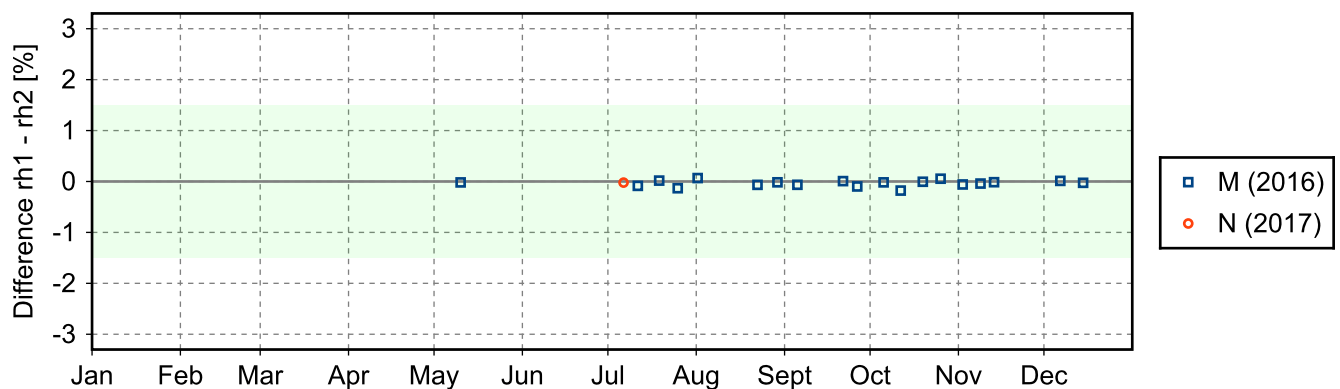
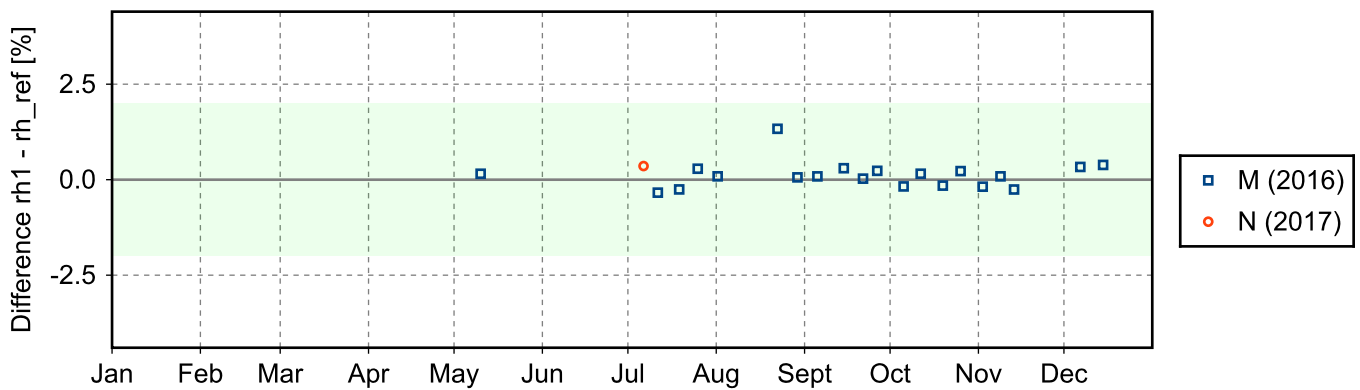
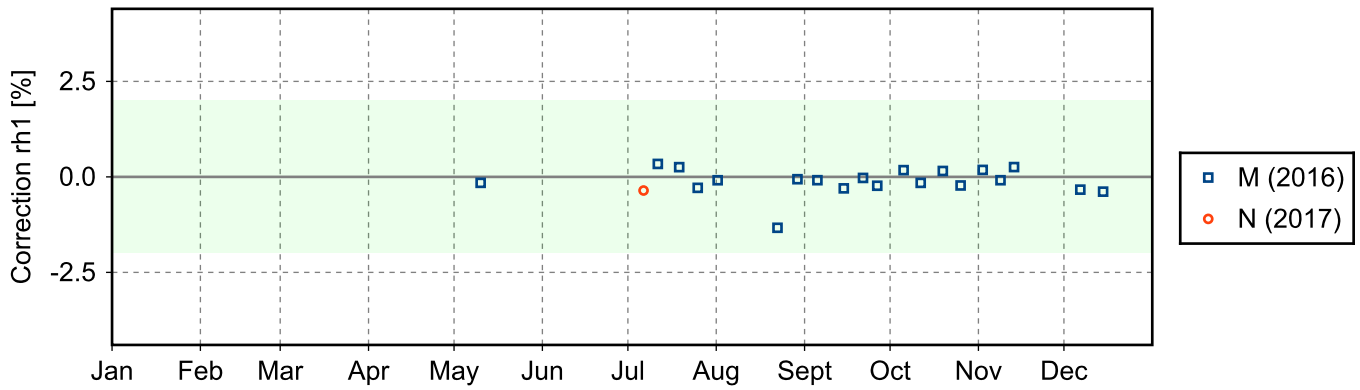
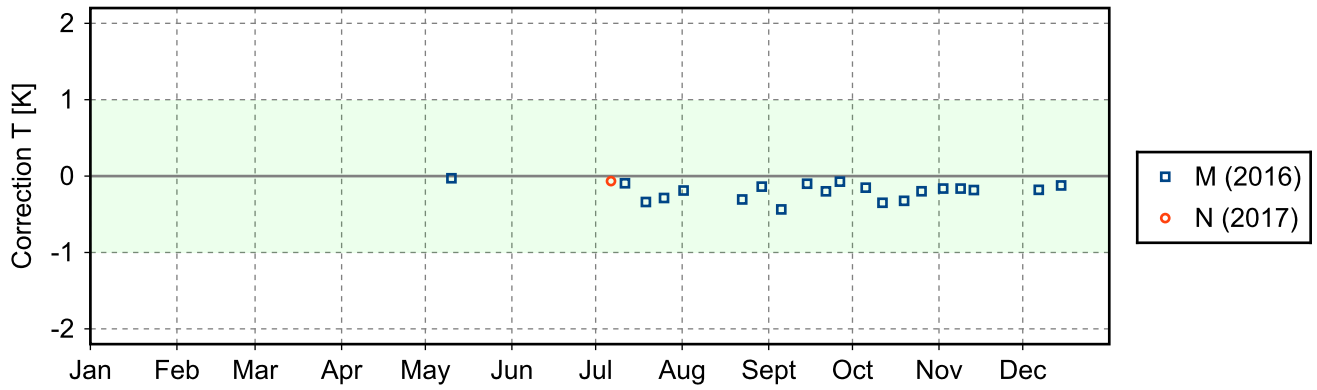
(2) GroundCheck: GC-SHC



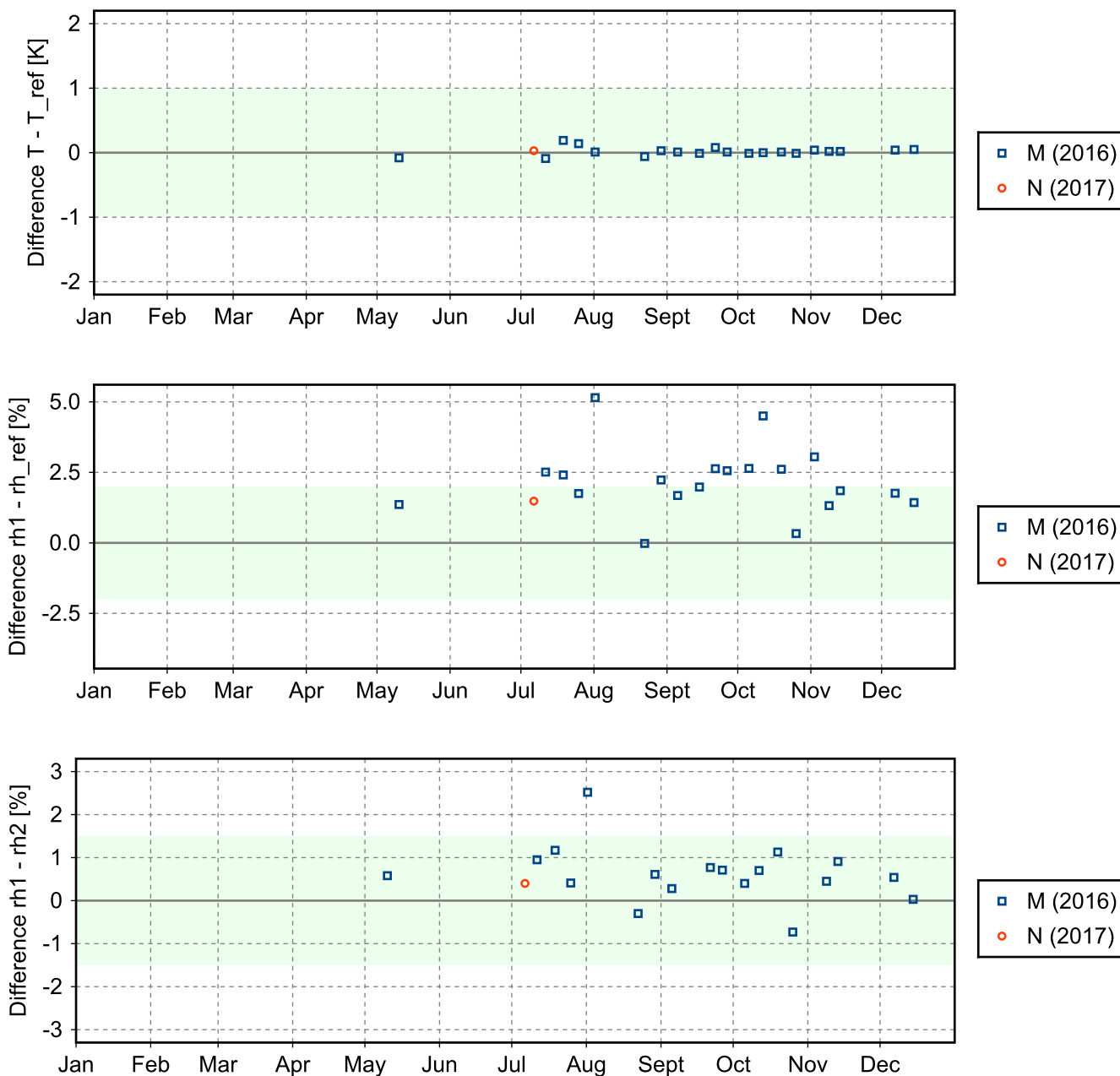
4.5.5 Stream: RS92

(1) GroundCheck: GC-GC25





(2) GroundCheck: GC-SHC



4.6 Measurement events

