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GRUAN Site Report for Boulder

(Submitted by Dale Hurst)

Summary and Purpose of this Document

Report from the GRUAN site Boulder for the period January to December 2020.

Overview

The Boulder GRUAN site, managed by NOAAs Global Monitoring Laboratory, continued to launch Vaisala RS41 radiosondes on the same balloons as our weekly ozone soundings (EnSci ECC model 2Z ozonesonde and InterMet model iMet-1/iMet-4 or RS-54 radiosonde). Starting in June 2020, the frequency of water vapor (NOAA FPH) and ozone soundings was doubled to twice monthly and the payload was enhanced with a Portable Optical Particle Spectrometer (POPS) that measures aerosol number and size distribution. These changes were driven by a research opportunity within NOAAs new Earths Radiation Budget (ERB) program. Data from all these sondes (except the RS-54 and POPS) were submitted to GRUAN for processing, quality control and archival. The RS-54 soundings are still experimental in nature, and the POPS sounding data is the property of NOAAs Chemical Sciences Laboratory.

The GFZ-Potsdam-owned GNSS receiving system (TMS3) located at the NOAA Table Mountain facility near Boulder is now providing data to GRUAN. We continue to await approval from the manager of the Marshall Field Site (property of NCAR) to move TMS3 from Table Mountain to the balloon-launching site at Marshall, as they are still concerned about who will care for and maintain TMS3 because it belongs to GFZ-Potsdam.

Change and change management

There were several changes to the Boulder GRUAN balloon launches during 2020, but none directly affected the RS41 soundings. As mentioned above, in late 2020 we started intermittently launching InterMet iMet-4 radiosondes instead of the iMet-1 radiosondes that had been routinely used since 2013. Similarities between the data output of the iMet-1 and iMet-4 enabled the continued submission of data from ECC and FPH soundings using RsLaunchClient. In November 2020, we began testing the InterMet RS-54 radiosonde on some of our ECC flights. The data output from the RS-54 is very different from the iMet-1 and iMet-4, hence only RS41 data were submitted for these soundings. We are working towards submitting all the data from ECC and FPH soundings using iMet-1 and iMet-4 that will be necessary for GRUAN to process the ozone and water vapor profile data in the future. Our ability to submit ECC and FPH data from soundings using the RS-54 radiosonde is also a work in progress.

There are no changes required for the description of the Boulder site on the GRUAN web page.

Resourcing

For the first time in the last decade the Boulder GRUAN site is well funded thanks to NOAAs new Earths Radiation Budget program. Given the long-term nature of the science being pursued by the

ERB program, we believe ample financial support will be available for at least several years.

Operations

Unlike for our ozone soundings, where balloons are allowed to ascend until they burst, the flight train for our FPH soundings continues to include a valve inserted into the balloon neck that opens to release helium from the balloon at about 16 hPa, preventing burst and allowing controlled descent of the balloon. This enables contamination-free stratospheric water vapor measurements by the FPH during controlled descent. Hence, by design, about 50% of our soundings will not quite reach 10 hPa. We do not have a reliable temperature sensor within the SHC and this is the first time we have been asked to report the SHC temperature while the RS41 is being checked for RH=100%. Also, we have never checked the InterMet radiosondes in the SHC, as they provide only non-critical measurements of RH. However, the iMet measurements of T and P are critical for the processing of ECC and FPH profile data.

Covid-19

FPH soundings were suspended from 13 March 2020 to 02 June 2020 due to the constraints on laboratory and balloon launching personnel imposed by COVID-19. Once a safe collaborative procedure for building, testing and launching the FPH was developed and approved, the soundings resumed.

Site assessment and certification

The Boulder GRUAN site has already been certified and recertified.

GRUAN-related research

I contribute to GRUAN by serving as a co-chair of the Task Team of Site Representatives, a member of the Working Group GRUAN, and the Boulder site representative.

The Boulder site continues to test the use of a dry ice + ethanol cold bath as the coolant for the NOAA Frost Point Hygrometer thanks to a CIRES innovative research grant awarded in late 2019. This research was mostly suspended in 2020 due to COVID-19 constraints placed on balloon launching personnel, and there is nothing new to report here.

D. Hurst was a co-author on 6 peer-reviewed journal papers published in 2020 that have scientific connections to GRUAN:

- Philipona, R., A. Kräuchi, R. Kivi, T. Peter, M. Wild, R. Dirksen, M. Fujiwara, M. Sekiguchi, D.F. Hurst, and R. Becker, Balloon-borne radiation measurements demonstrate radiative forcing by water vapor and clouds, *Meteorologische Zeitschrift*, 29 (6), 501-509, doi:10.1127/metz/2020/1044, 2020.
- Davis, S.M., R. Damadeo, D. Flittner, K.H. Rosenlof, M. Park, W.J. Randel, E.G. Hall, D. Huber, D.F. Hurst, A.F. Jordan, S. Kizer, L.F. Millan, H. Selkirk, G. Taha, K.A. Walker and H. Vömel, Validation of SAGE III/ISS solar water vapor data with correlative satellite and balloon-borne measurements, *J. Geophys. Res. Atmos.*, 125, doi:10.1029/2020JD033803, 2020.
- Jensen, E.J., L.L. Pan, S. Honomichl, G.S. Diskin, M. Krämer, N. Spelten, G. Günther, D.F. Hurst, M. Fujiwara, H. Vömel, H.B. Selkirk, J. Suzuki, M.J. Schwartz and J.B. Smith, Assessment of observational evidence for direct convective hydration of the lower stratosphere, *J. Geophys. Res. Atmos.*, 125, doi:10.1029/2020JD032793, 2020.
- Davis, S.M., K.H. Rosenlof, D.F. Hurst, H.B. Selkirk, and H. Voemel, Stratospheric Water Vapor [in “State of the Climate in 2019”], *Bull. Amer. Meteor. Soc.*, 101 (8), S81-S83, doi:10.1175/2020BAMSStateoftheClimate.1, 2020.
- Dirksen, R.J., G.E. Bodeker, P.W. Thorne, A. Merlone, T. Reale, J. Wang, D.F. Hurst, B.B. Demoz, T.D. Gardiner, B. Ingleby, M. Sommer, C. von Rohden, and T. Leblanc, Managing the transition from Vaisala RS92 to RS41 radiosondes within the Global Climate Observing System Reference Upper-Air Network (GRUAN): a progress report, *Geosci. Instrum. Method. Data Syst.*, 9, 337-355, doi:10.5194/gi-9-337-2020, 2020
- Wang, H.J.R., R. Damadeo, D. Flittner, N. Kramarova, G. Taha, S. Davis, A.M. Thomposon, S. Strahan, Y. Wang, L. Froidevaux, D. Degensein, A. Bourassa, W. Steinbrecht, K.A. Walker, R. Querel, T. Leblanc, S. Godin-Beekmann, D. Hurst and E. Hall, Validation of SAGE III/ISS Solar Ozone Data with Correlative Satellite and Ground-Based Measurements, *J. Geophys. Res. Atmos.*, 125, doi:10.1029/2020JD032430, 2020.

WG-GRUAN interface

The Boulder GRUAN site requires no special assistance or support by the WG at this time.

Other archiving centers

Ozone and water vapor sounding data from Boulder are archived on the NOAA/GML anonymous FTP server (<ftp://aftp.cmdl.noaa.gov/data/ozwv/>), the NDACC public data ftp server (<ftp://ftp.ndacc.org/>)

//ftp.cpc.ncep.noaa.gov/ndacc/station/boulder/ames/) and at NOAAs National Centers for Environmental Information (NCEI) in Asheville, North Carolina.

Participation in campaigns

There were no campaigns conducted at the Boulder GRUAN site during 2020. We continued to perform ozone and water vapor soundings in coordination with overpasses of Boulder by the Stratospheric Aerosols and Gas Experiment III instrument aboard the International Space Station (SAGE III/ISS). The ECC and FPH (and now POPS) profiles are being used to validate the SAGE III/ISS measurements of ozone, water vapor and aerosol extinction. Data from these soundings have been submitted to GRUAN if a RS41 was included in the payload.

Future plans

Our plan for 2021 is to stay the course and hope that the COVID-19 vaccines will eventually return things back to “normal”. We are grateful that the new administration in the USA is handling both the coronavirus and climate change in a serious manner that involves science.



GRUAN Site Report for Boulder (BOU), 2020

Reported time range is Jan 2020 to Dec 2020

Created by the Lead Centre

Version from 2021-04-27

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	Hurst, Dale F.
WMO no./name	-
Operators	currently 5, changes +0 / -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	48

1.2 General comments from Lead Centre

No comments from Lead Centre.

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	Hurst, Dale F.
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

No comments from Lead Centre.

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	Hurst, Dale F.
Started at	-
Defined setups	4 (RESEARCH, OZONE, FPH-OZONE, FPH)
Possible streams	FPH, IMET-1, 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 RS92-SGP, RS41-SG, Internet 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.

4.2 GRUAN data products

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

ECC		46	46	
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4.2.2 Stream: FPH

FPH		18	18	
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4.2.3 Stream: IMET-1

IMET-1		46	46	
IMET-1-RAW	001		46	

4.2.4 Stream: RS41

RS41		48	48	
RS41-GCA	001		48	
RS41-RAW	001		48	
RS41-EDT	001		46	
RS41-GDP-ALPHA	003		12	
RS41-GDP-ALPHA	004		9	
RS41-GDP-BETA	001		46	
RS41-GDP-BETA	002		45	

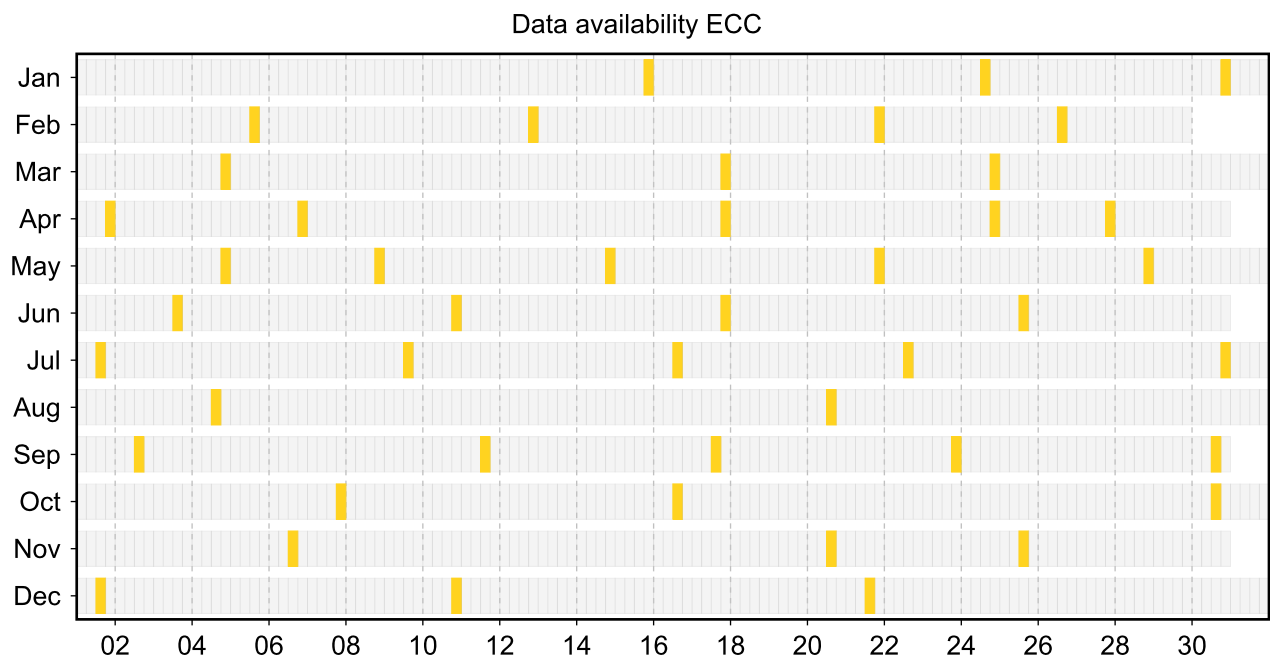
4.3 Availability of data products

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).

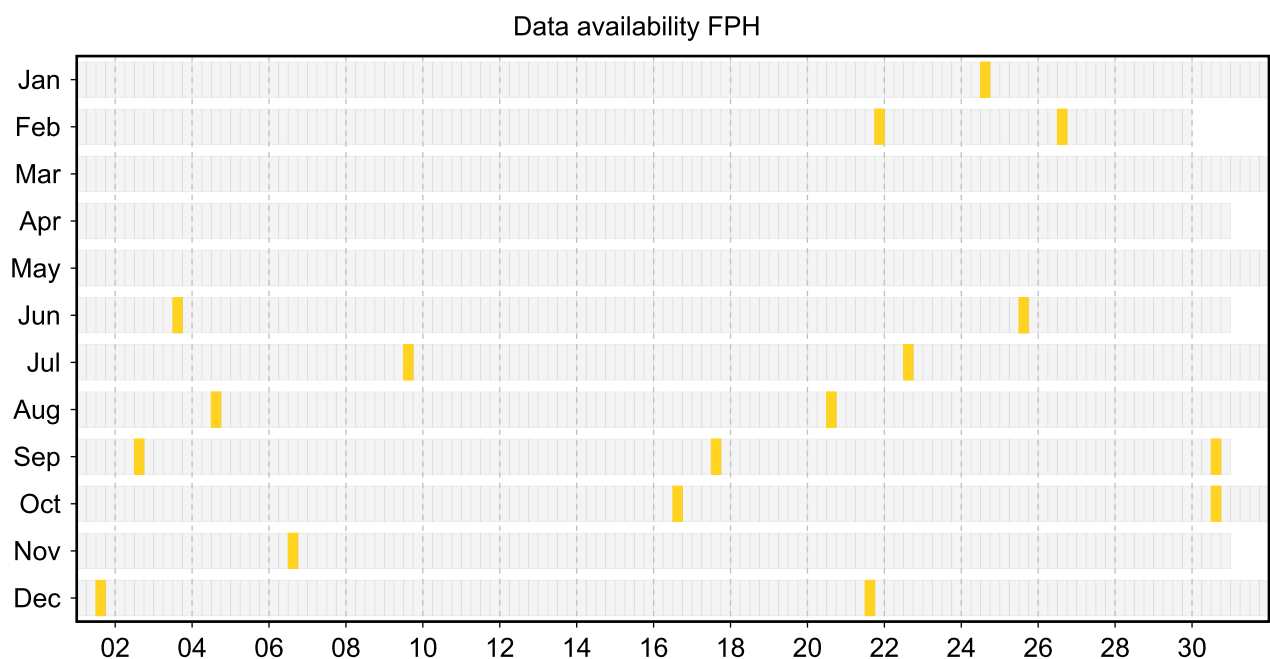
Unprocessed (yellow): The manufacturer-produced file with raw measurement data has been successfully converted into a GRUAN-standardized raw data format (NetCDF). The GRUAN data processing has not been performed or was aborted. Reasons for this may be a still missing GRUAN data processor or a processing-software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

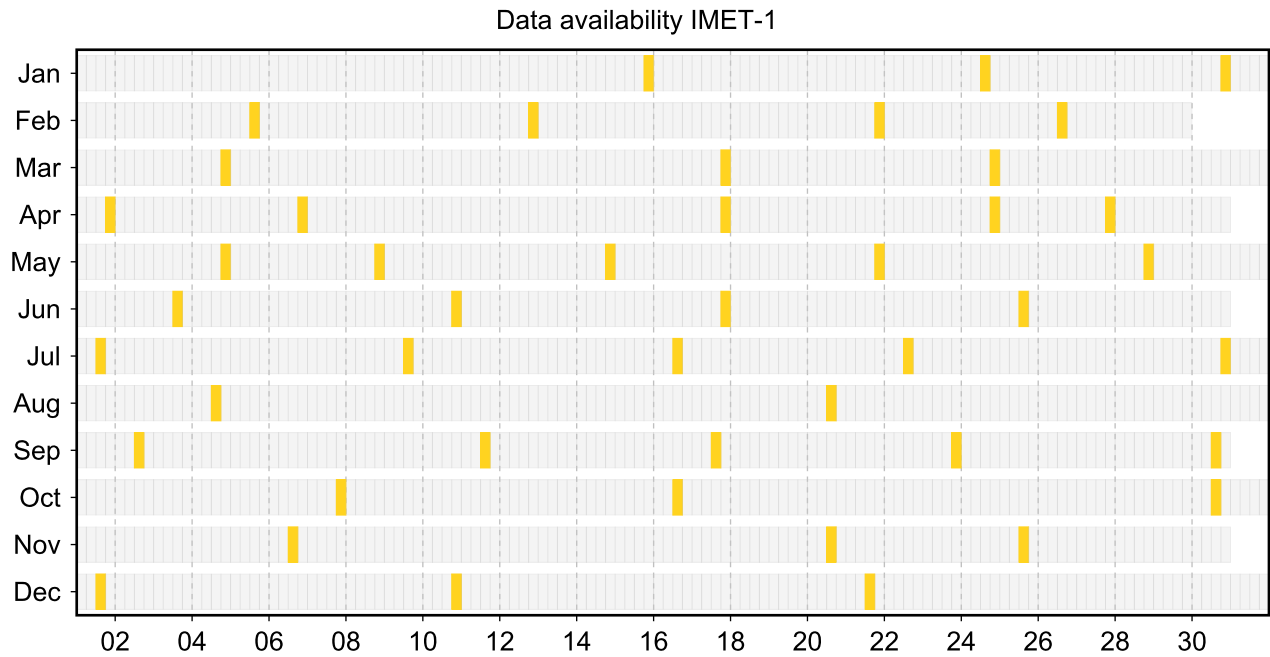
4.3.1 Stream: ECC



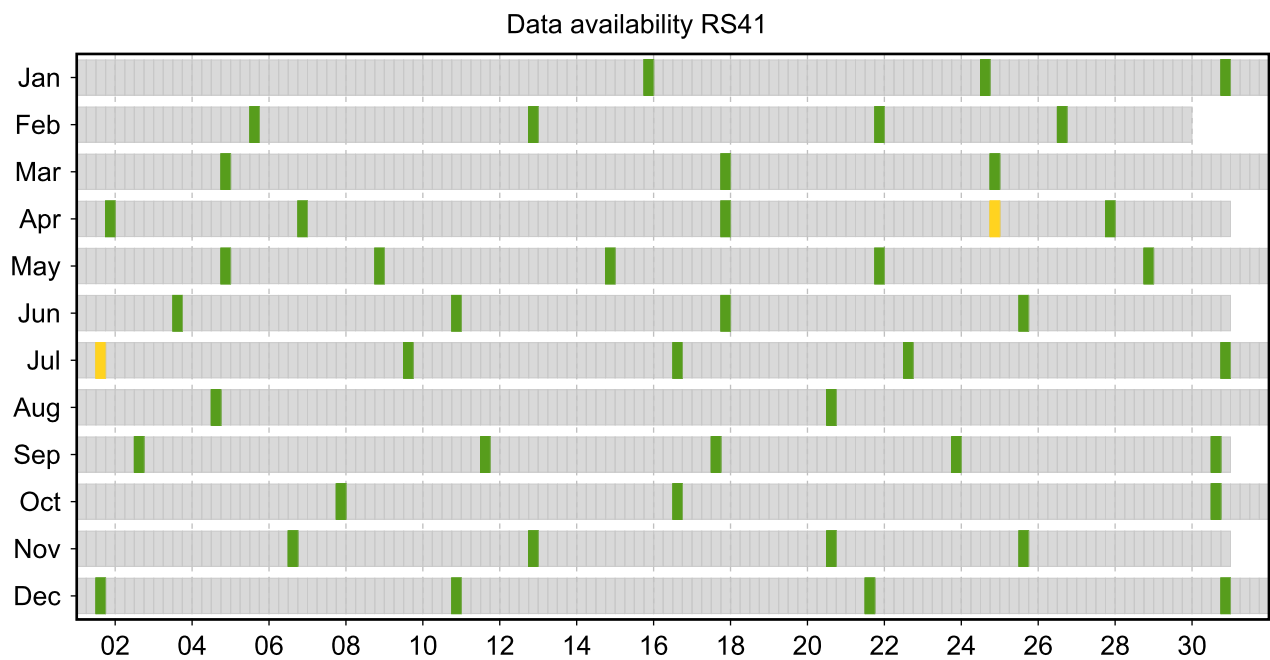
4.3.2 Stream: FPH



4.3.3 Stream: IMET-1



4.3.4 Stream: RS41



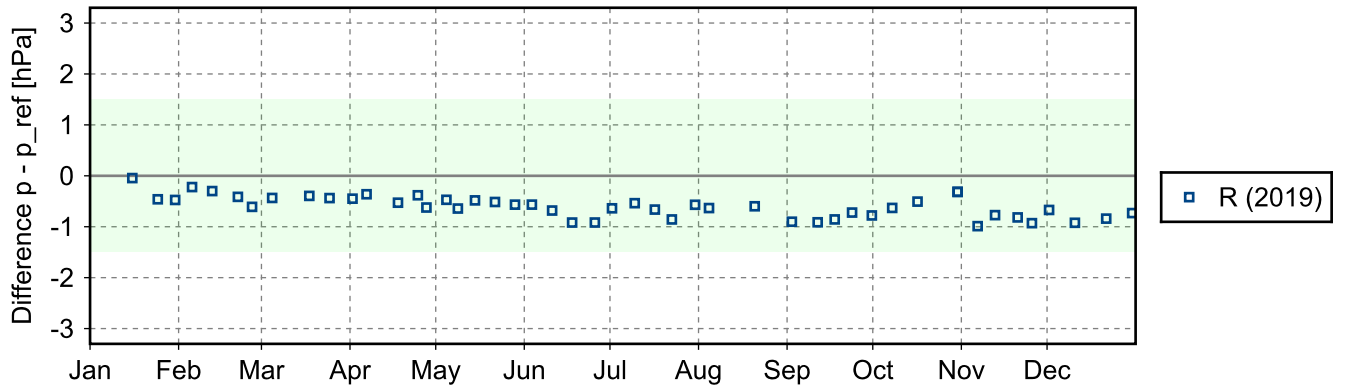
4.4 Instrument combinations of BOU-RS-01

Count	Instrument combination
18	ECC, FPH, IMET-1, RS41
28	ECC, IMET-1, RS41
2	RS41

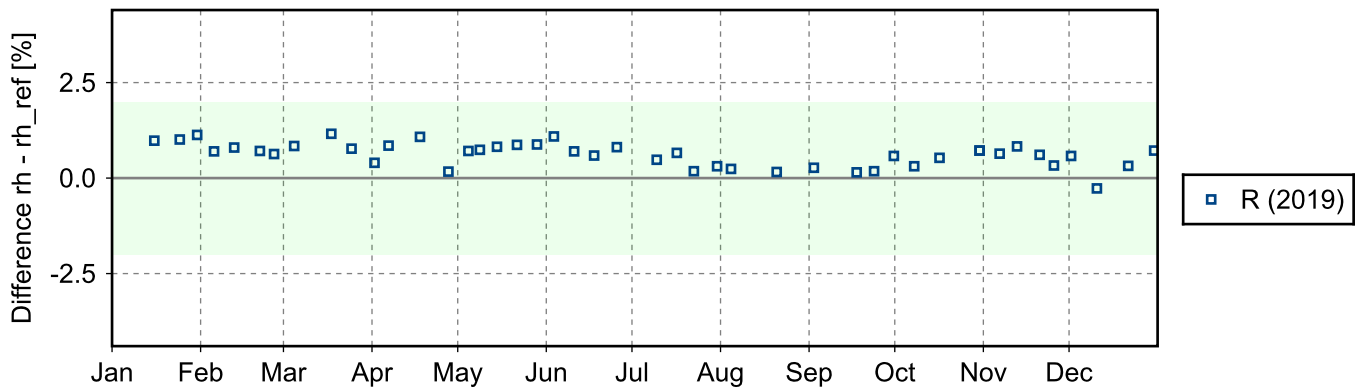
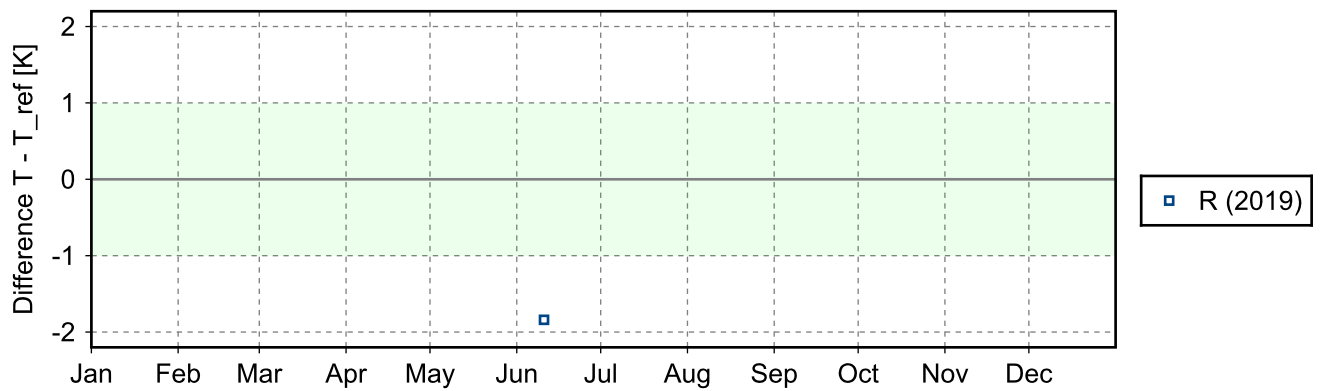
4.5 Instrument ground check

4.5.1 Stream: RS41

(1) GroundCheck: GC-RI41



(2) GroundCheck: GC-SHC



4.6 Measurement events

