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GLOBAL CLIMATE OBSERVING  
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**9th GRUAN Implementation-  
Coordination Meeting (ICM-9)**

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Session 7

Helsinki, Finland

12 - 16 June 2017

## GRUAN Site Report for Boulder

*(Submitted by Dale Hurst)*

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### **Summary and Purpose of this Document**

Report from the GRUAN site Boulder for the period March 2016 to April 2017.

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## Overview

The Boulder GRUAN site continues to perform balloon soundings with weekly launches of a Vaisala radiosonde, an InterMet radiosonde and an EnSci ECC ozonesonde. Once per month a NOAA Frost Point Hygrometer (FPH) is added to the payload. Prior to the update of our Vaisala receiving system software from MW31 to MW41 in early September 2016, 69% of our weekly RS92 soundings passed GRUAN quality control (version 2). During September-November 2016 all MWX files (both RS92 and RS41) were problematic because of entry errors in the launch pressure (see below), so they were not submitted. All unsubmitted RS92/RS41 MWX files with incorrect launch pressure values will be submitted once it is possible to correct the launch pressures in the MWX files. Since late February 2017 the MW41 system has experienced intermittent problems that have prevented some RS41 launches (see below).

ECC and FPH data files were submitted to GRUAN for the same flights as the submitted RS92/RS41 files. ECC and FPH data files for problematic RS92/RS41 flights (as described above) will be submitted when the problematic MWX files are corrected or fixed. Other data streams available from the Boulder site include GNSS-IPW (at Marshall Field Site and the NCAR Foothills Lab in Boulder), Dobson and FTIR measurements of column ozone, and FTIR measurements of column water vapor, CO<sub>2</sub> and methane.

## Change and change management

As described above, our Vaisala receiving system software was upgraded from MW31 to MW41 in early September 2016. For the first 3 months using the MW41, the surface pressure at the launch site was erroneously entered into the software instead of the pressure at the location of the ground check unit (RI41) at the time of launch. According to Michael Sommer, these files cannot be corrected at the present time, but will be correctable in the future, hence they have not yet been submitted to the GRUAN database. The last RS92 flight at Boulder was December 27, 2016; In 2017 solely RS41 radiosondes have been launched. According to Michael Sommer, some of the submitted MWX files from December 2016 have synchronization problems and cannot be fixed at the present time. Files submitted in January 2017 apparently did not have these problems. In February 2017 our Vaisala receiving system started experiencing intermittent software terminations, with the screen displaying a very informative message that the sounding program has quit. Approximately 50% of the RS41 soundings attempted during March-May 2017 have resulted in the MW41 software shutting down before sonde launch, with subsequent difficulties in re-booting the system. During this time we have continually sought advice from the Vaisala help desk regarding this problem, but to date no solution has been found.

In reviewing the Boulder site description on the GRUAN web page, the following updates and

corrections are needed:

In August 2016 the Boulder GRUAN sites balloon launching location at Marshall Field Site was given a WMO station identifier of 72471.

GPS column water vapor measurements are made at Marshall Field Site as well as in Boulder, 10 km NW of Marshall Field Site.

The Boulder GRUAN site has no microwave radiometer.

A presentation about activities at Sterling, VA (Fitzgibbons and Brewer) is erroneously posted under Relevant Documents for the Boulder site.

## **Resourcing**

It is anticipated that budget cuts to NOAA by the current administration may significantly impact GRUAN operations at the Boulder site. Stay tuned.

## **Operations**

Balloon soundings with Frost Point Hygrometers are intentionally prevented from bursting so that controlled descent is achieved for contamination-free water vapor measurements. This means that soundings with FPHs consistently do not reach 10 hPa, but those without FPHs do.

## **Site assessment and certification**

The Boulder site is already certified.

## **GRUAN-related research**

The Boulder GRUAN site manager (Dale Hurst, NOAA) serves on the Working Group of GRUAN and is a co-chair of the task team of site representatives.

John Braun (NCAR) continues to serve as a member of the task team of GNSS-IPW measurements.

James Hannigan (NCAR) is a member of the task team of ancillary measurements for his expertise in solar FTIR measurements of water vapor and trace gases.

### **GRUAN-related papers published in 2016:**

- Hurst, D.F., W.G. Read, H. Vömel, H.B. Selkirk, K.H. Rosenlof, S.M. Davis, E.G. Hall, A.F. Jordan, and S.J. Oltmans, Recent divergences in stratospheric water vapor measurements by

frost point hygrometers and the Aura Microwave Limb Sounder, *Atmos. Meas. Tech.*, 9, 44474457, doi:10.5194/amt-9-4447-2016, 2016.

- Hall, E.G., A.F. Jordan, D.F. Hurst, S.J. Oltmans, H. Vömel, B. Kühnreich, and V. Ebert: Advancements, measurement uncertainties and recent comparisons of the NOAA frost point hygrometer, *Atmos. Meas. Tech.*, 9, 42954310, doi:10.5194/amt-9-4295-2016, 2016.
- Kräuchi, A., R. Philipona, G. Romanens, D.F. Hurst, E.G. Hall, and A.F. Jordan, Controlled weather balloon ascents and descents for atmospheric research and climate monitoring, *Atmos. Meas. Tech.*, 9, 929938, doi:10.5194/amt-9-929-2016, 12559-12588, 2016.
- Bodeker, G., S. Bojinski, D. Cimini, R. Dirksen, M. Haeffelin, J. Hannigan, D. Hurst, T. Leblanc, F. Madonna, M. Maturilli, A. Mikalsen, R. Philipona, T. Reale, D. Seidel, D. Tan, P. Thorne, H. Vömel, and J. Wang, Reference upper-air observations for climate: From concept to reality, *Bull. Amer. Meteor. Soc.*, 97, 123-135, doi:10.1175/BAMS-D-14-00072.1, 2016.
- Müller, R., A. Kunz, D.F. Hurst, C. Rolf, M. Krmer, and M. Riese, The need for accurate long-term measurements of water vapor in the upper troposphere and lower stratosphere with global coverage. *Earth's Future*, 4, doi:10.1002/2015EF000321, 2016.

## **WG-GRUAN interface**

We appreciate the continued support of the Boulder GRUAN site through presentations and papers that include data from Boulder, especially those in easy view of ESRL management and NOAA administrators.

## **Items for ICM-9 plenary discussions**

It would be timely and informative for the Lead Center to present an update on the processing and quality control of MWX files from the RS41, including proposed data file formats and release dates.

## **Future plans**

In mid-2017 the Boulder GRUAN site will begin monthly balloon launches coordinated with overpasses of the Stratospheric Aerosol and Gas Experiment (SAGE III) aboard the International Space Station to validate its vertical profile measurements of ozone, water vapor and aerosols.



# GRUAN Station Report for Boulder (BOU), 2016/17

Reported time range is Mar 2016 to Apr 2017

Created by the Lead Centre

Version from 2017-06-06

## 1 General GRUAN station information

Info	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	current 5, change +0 / -0
Sounding Site	1
GNSS	1

### 1.1 General information about GRUAN measurement systems

System	Type	Setups	Measurements	As scheduled
BOU-GN-01	GNSS	0	not operational	not scheduled
BOU-RS-01	Sounding Site	4	37	not scheduled

### 1.2 General comments from Lead Centre

#### 1.2.1 General

The site is requested to establish a GRUAN data product for the frostpoint hygrometer.

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

<b>Info</b>	<b>Value</b>
System name	GNSS Site P041
Unique GRUAN ID	BOU-GN-01
System type	GNSS (GN - GNSS)
Geographical position	39.9495 °N, -105.1943 °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	-
Defined setups	-
Possible streams	-

### 2.1 Lead Centre comments

#### 2.1.1 Dataflow

No GNSS dataflow to GRUAN LC as yet.

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

<b>Info</b>	<b>Value</b>
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

#### 3.1 Lead Centre comments

##### 3.1.1 Dataflow

A GRUAN data product for the frostpoint hygrometer is not yet available.

This dataflow includes data from the Vaisala RS41-SGP, RS92-SGP, ECC ozone sonde, FPH water vapour and Internet IMET-1. All soundings are submitted using the RsLaunchClient within a month after the launch.

The possibility to launch Vaisala RS41-SGP was added 2016.

## 3.2 GRUAN data products

Product	Version	Soundings received	Available at LC	Distributed by NCDC
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### 3.2.1 Stream: ECC

ECC		37	37	
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### 3.2.2 Stream: FPH

FPH		6	6	
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### 3.2.3 Stream: IMET-1

IMET-1		37	37	
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### 3.2.4 Stream: RS41

RS41		11	11	
RS41-RAW	001		11	
RS41-EDT	001		11	11

### 3.2.5 Stream: RS92

RS92		26	26	
RS92-RAW	001		23	
RS92-RAW	002		26	
RS92-EDT	001		24	24
RS92-GDP	002		18	14

### 3.3 Data availability of data products

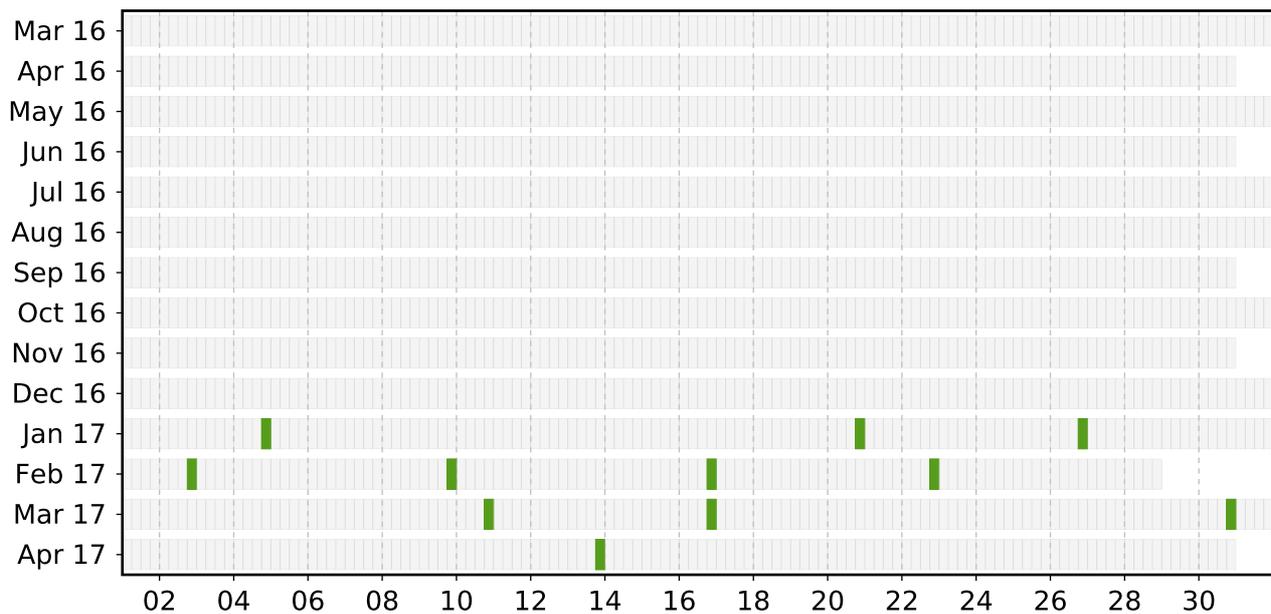
Available (green): All steps of processing have been successfully completed. The data file is available at NCEI (NCDC).

Unprocessed (yellow): The raw data file has been successfully converted to a GRUAN standardized raw data file format (NetCDF). The processing itself (e.g. extracting manufacturer data product or GRUAN data processing) is not done yet, or could not be completed. Reason may be missing raw data, or software bugs.

Failed (red): Raw data file could not be converted to a GRUAN standardized raw data file format (NetCDF). Reason may be a corrupt original raw data file, or software bugs.

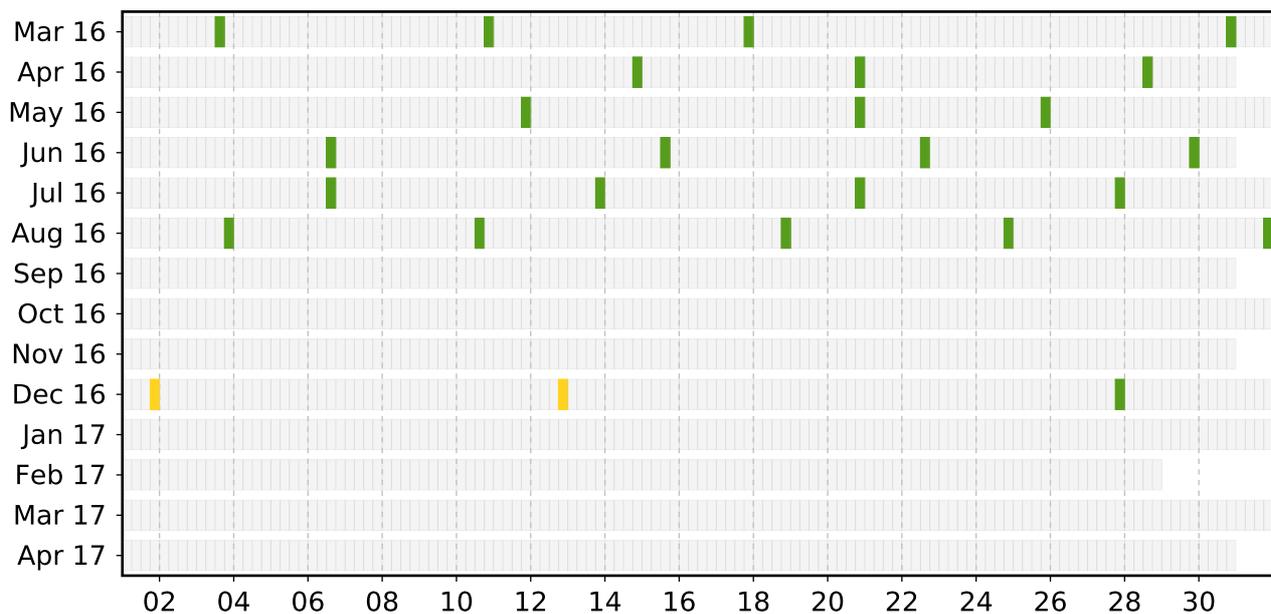
#### 3.3.1 Stream: RS41 (Product: RS41-EDT-001)

Schedule data availability of stream RS41



#### 3.3.2 Stream: RS92 (Product: RS92-EDT-001)

Schedule data availability of stream RS92



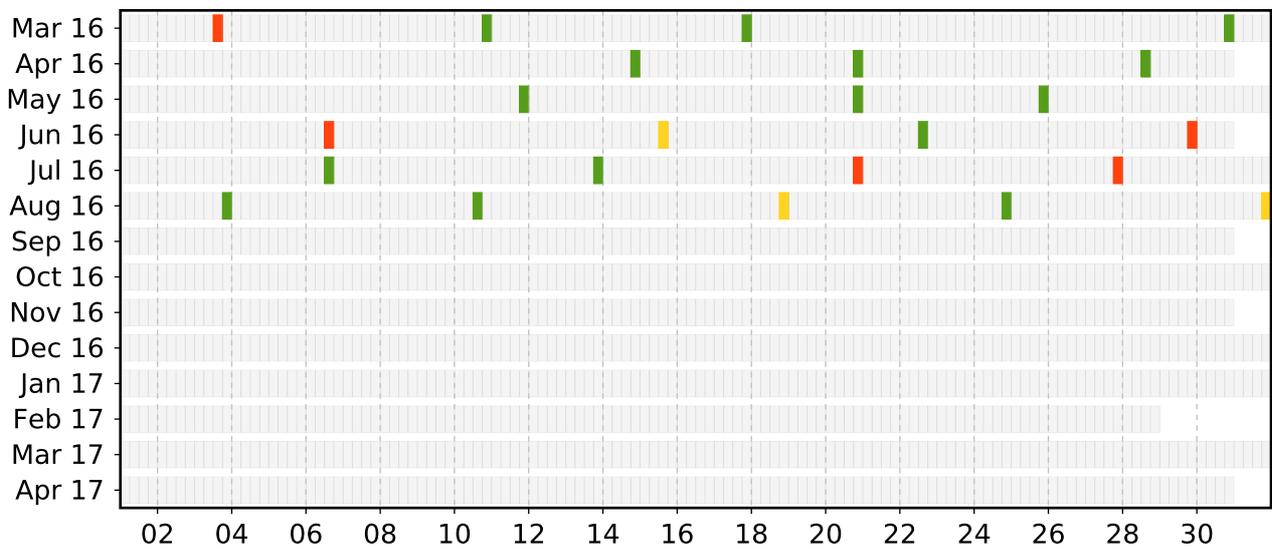
### 3.4 Data quality of current GRUAN data products

Month	Count	GRUAN Data Quality			Issues				
		Approved	Checked	Rejected	Meta-data	Process.	Press	Temp	RH

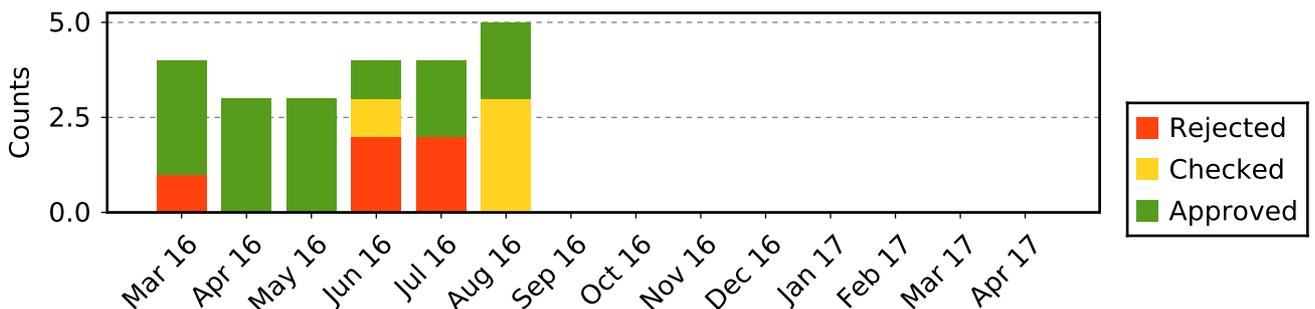
#### 3.4.1 Stream: RS92 (Product: RS92-GDP-002)

Mar 16	4	3		1					
Apr 16	3	3							2
May 16	3	3							3
Jun 16	4	1	1	2				1	
Jul 16	4	2		2			1		
Aug 16	5	2	3				2	1	1
Sep 16									
Oct 16									
Nov 16									
Dec 16									
Jan 17									
Feb 17									
Mar 17									
Apr 17									
	<b>23</b>	<b>14</b>	<b>4</b>	<b>5</b>			<b>3</b>	<b>2</b>	<b>6</b>

Schedule data quality of stream RS92



Data quality statistic of stream RS92



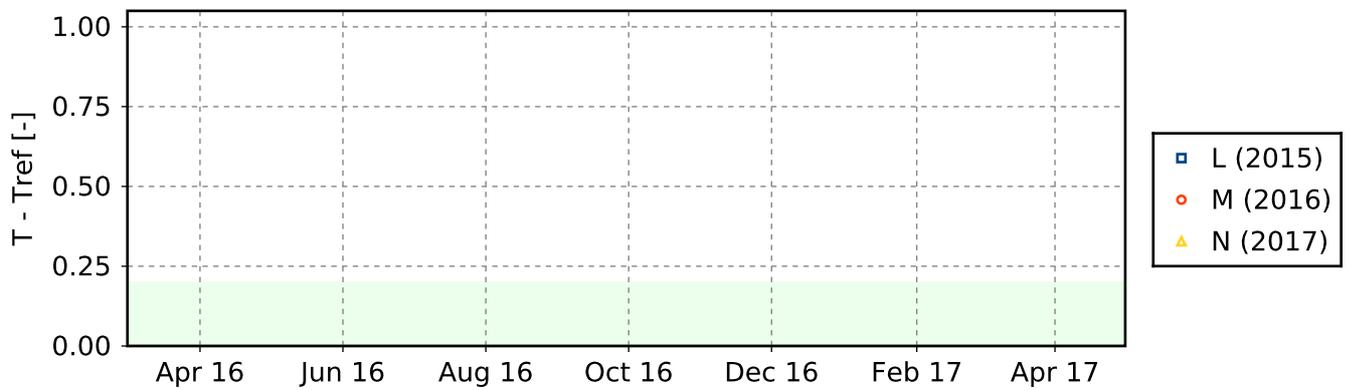
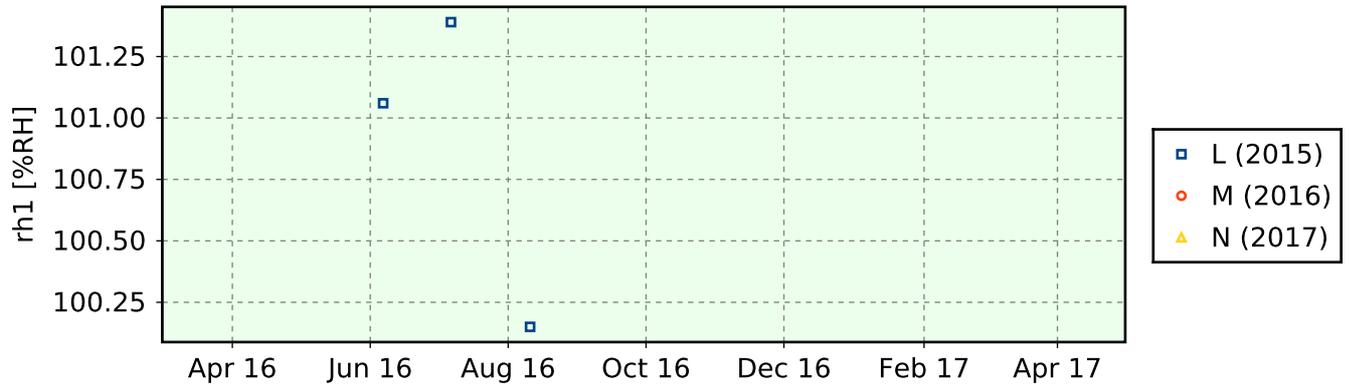
### 3.5 Instrument combinations of BOU-RS-01

<b>Count</b>	<b>Instrument combination</b>
2	ECC, FPH, IMET-1, RS41
4	ECC, FPH, IMET-1, RS92
9	ECC, IMET-1, RS41
22	ECC, IMET-1, RS92

### 3.6 Instrument ground check

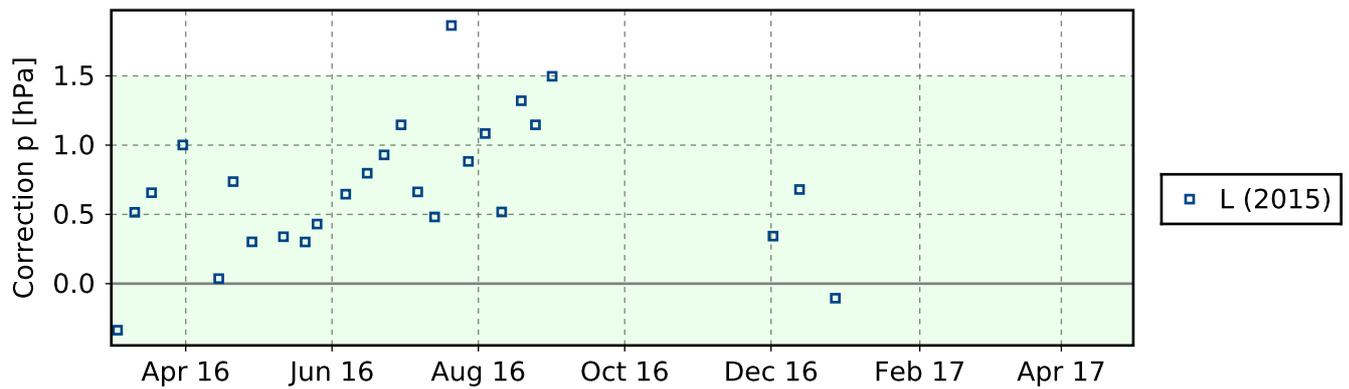
#### 3.6.1 Stream: RS41

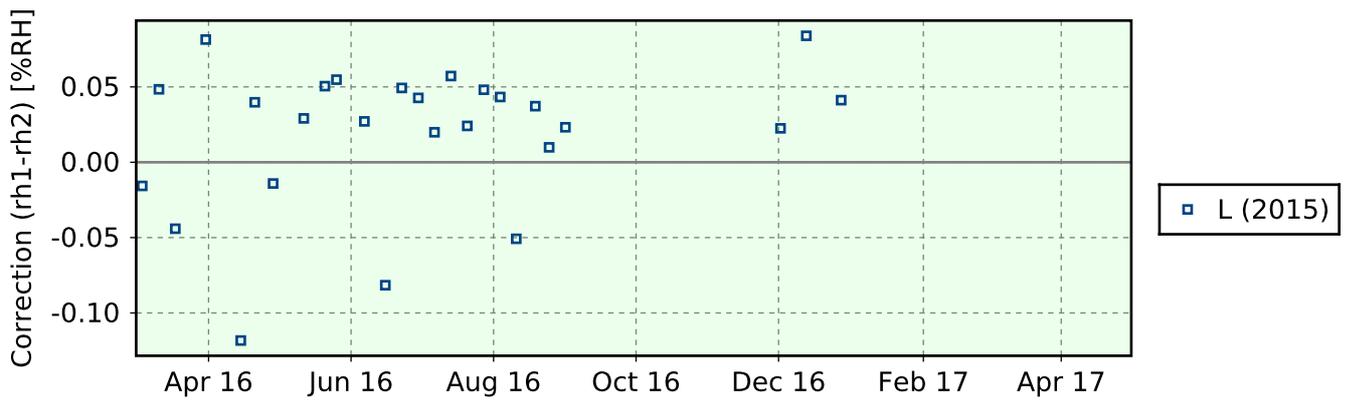
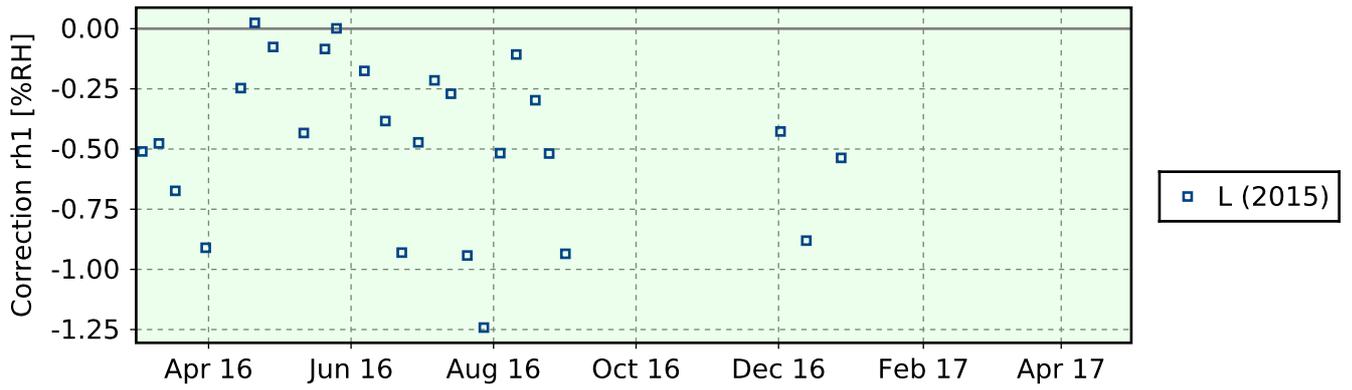
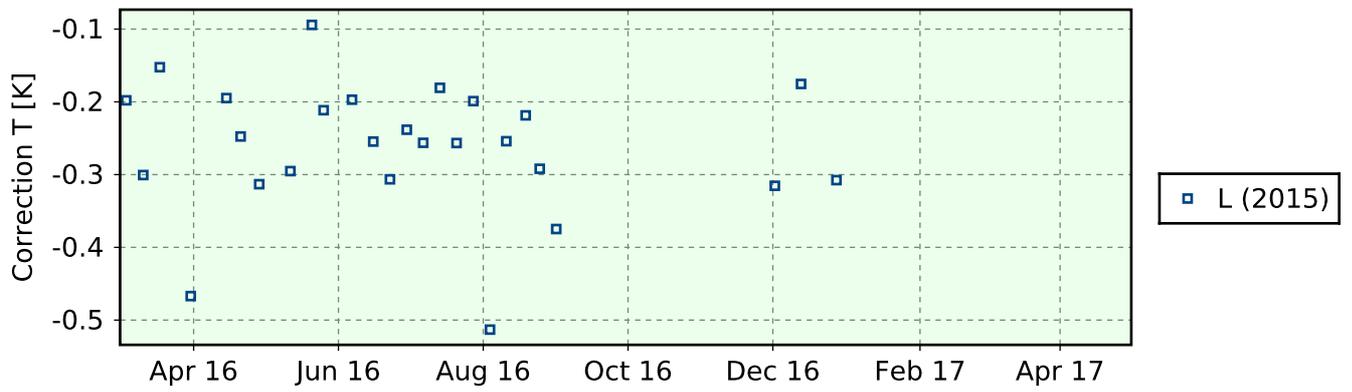
##### 3.6.1.1 GroundCheck: SHC



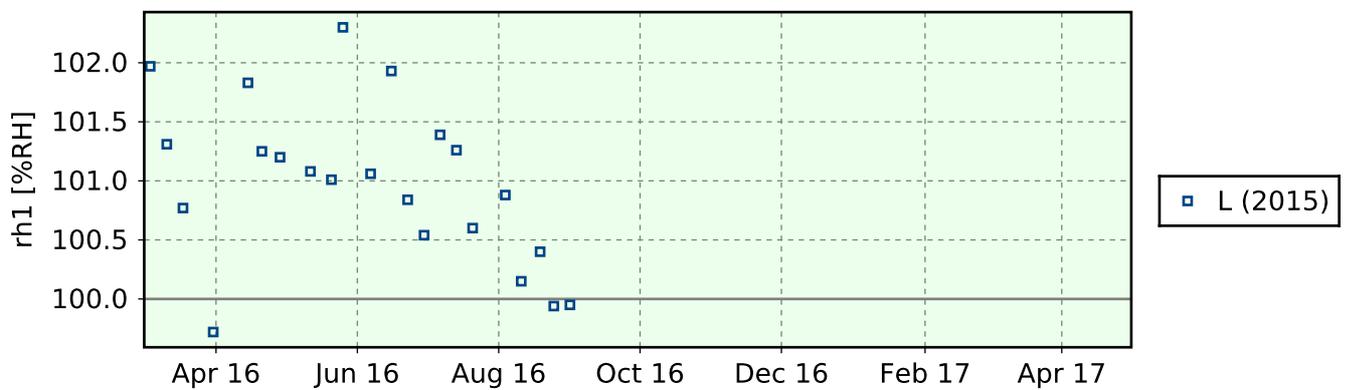
#### 3.6.1 Stream: RS92

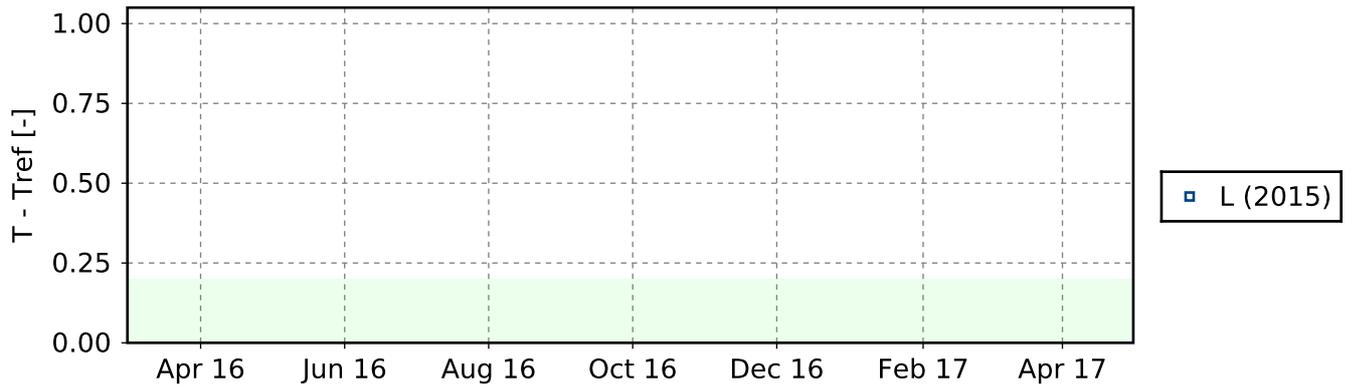
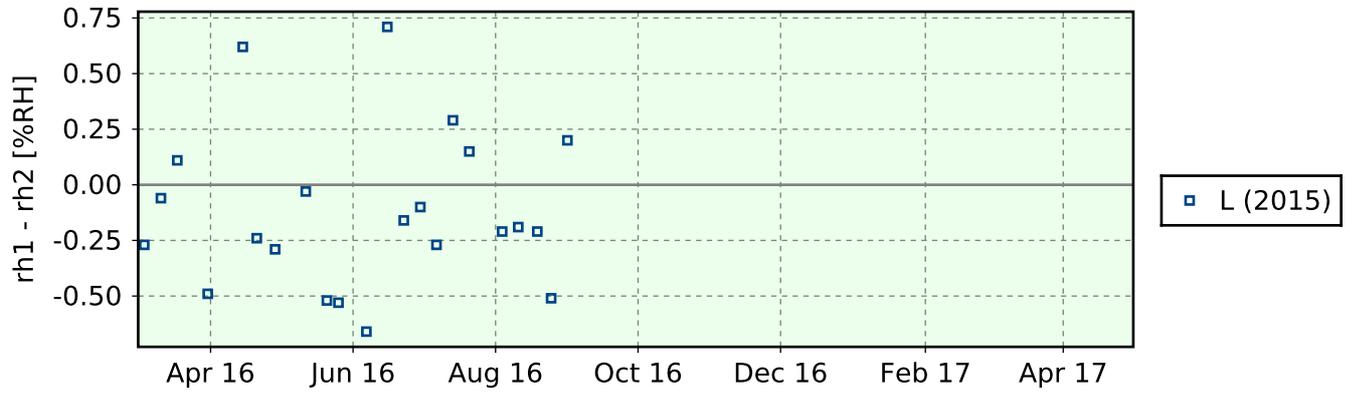
##### 3.6.1.1 GroundCheck: GC25





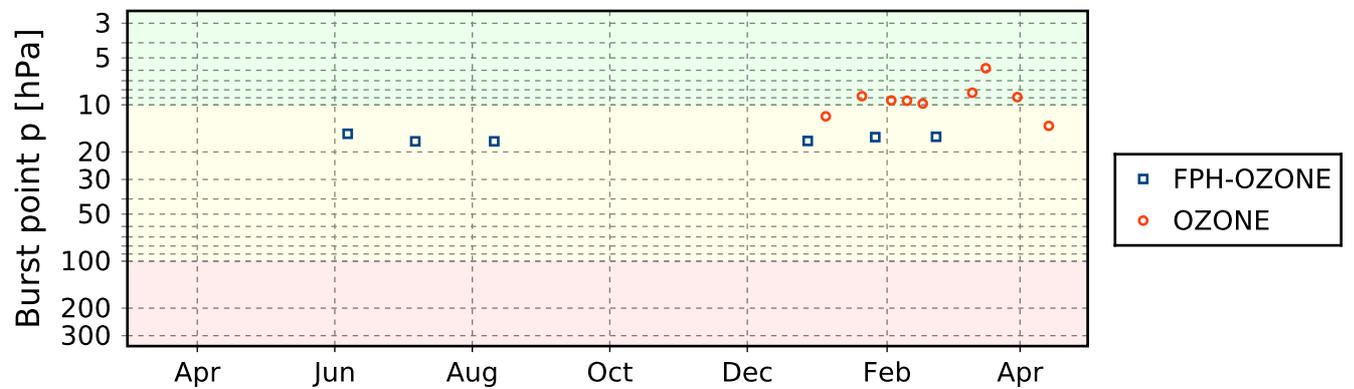
**3.6.1.2 GroundCheck: SHC**





### 3.7 Measurement events

#### 3.7.1 Stream: RS41



#### 3.7.1 Stream: RS92

