RS41 GRUAN Data Product Version 1 (RS41-GDP.1)

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14th GRUAN Implementation and Coordination Meeting (ICM-14)

La Réunion, Session 2, 28 November 2022

Outline

- Long journey
- Characterisation
- Data processing & GDP
- Documentation
- Invitation

Long journey to final GDP

- 2014-07 → first calibration check of RS41 in lab (SHC)
- 2014-12 → first launches with RS41 at Lindenberg
- 2015-03 → first time-lag experiments in climate chamber
- 2016-03 → start of development of radiation wind tunnel (SISTER)
- 2016-06 → start restructuring of GDPS and optimising of modules
- 2017-07 → first radiation experiments inside SISTER
- 2019-02 → first official alpha version of GDP (ALPHA.1)
- 2020-03 → start writing technical document (TD)
- 2020-05 → start writing radiation paper
- 2020-06 → first official beta version of GDP (BETA.1)
- 2021-06 → last beta version of GDP (BETA.3) as RC
- 2021-06 → radiation paper submitted (amt-2021-187)
- 2021-11 → final version 1 of GDP (provisional certification)

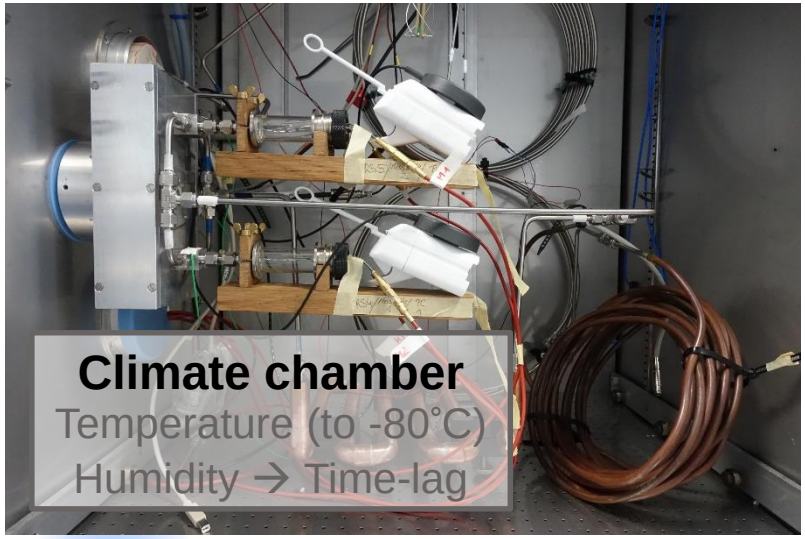
ICM-13

- 2021-12 → start writing comparison paper (RS92 vs. RS41)
- 2022-01 → radiation paper published (amt-15-383-2022)
- 2022-04 → technical document (TD) submitted to review
- 2022-11 → user guide published as technical note (TN)

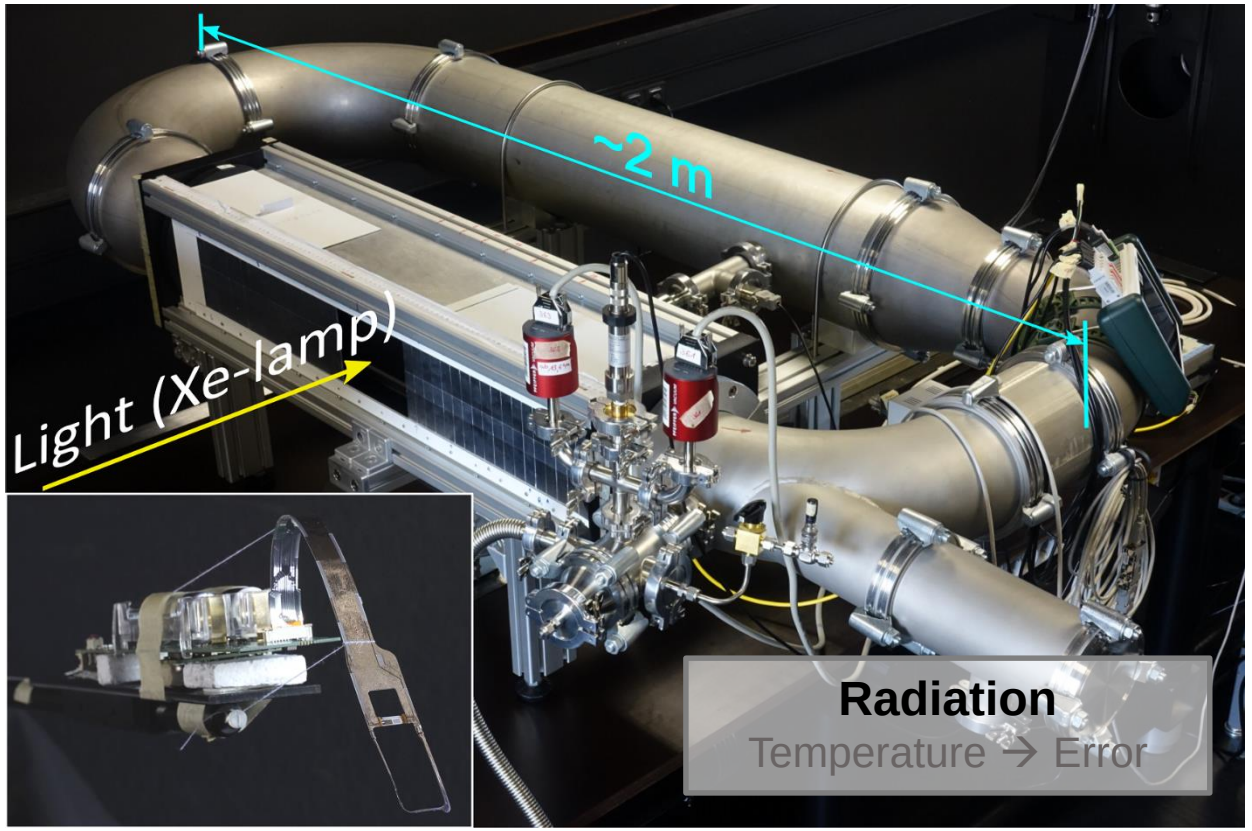
Characterisation of RS41

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

Standard Humidity Chamber
Humidity → Calibration



Climate chamber
Temperature (to -80°C)
Humidity → Time-lag



Radiation
Temperature → Error

Development of and experiments with new radiation wind tunnel

Simulator for Investigation of Solar Temperature Error of Radiosondes (SISTER)

Radiation temperature error

Atmos. Meas. Tech., 15, 383–405, 2022
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Laboratory characterisation of the radiation temperature error of radiosondes and its application to the GRUAN data processing for the Vaisala RS41

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Received: 25 June 2021 – Discussion started: 20 July 2021
Revised: 13 December 2021 – Accepted: 20 December 2021 – Published: 27 January 2022

Abstract. The paper presents the Simulator for Investigation of Solar Temperature Error of Radiosondes (SISTER), a setup that was developed to quantify the solar heating of the temperature sensor of radiosondes under laboratory conditions by recreating as closely as possible the atmospheric and illumination conditions that are encountered during a daytime radiosounding ascent. SISTER controls the pressure (T… tion with model calculations of the actual radiation field during the sounding to estimate the correction profile. In the second part of this paper it is described how this procedure was applied in the development of the GRUAN data product for the Vaisala RS41 radiosonde (version 1, RS41-GDP.1). The magnitude of the averaged correction profile increases gradually from 0.1 K at the surface to approximately 0.8 K at 35 km

GDPS – Processing of RS41-GDP.1

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

General & ground check	Pressure & altitude	Wind & ventilation	Temperature	Humidity
Make time axis steady	Calculate position (XYZ → LLA)	Pendulum analyse	Position of sun	Time-lag correction
Combine & grid data sources	Pressure calibration	Calculate ventilation	Estimate radiation (RTM simulations)	Smoothing (time-lag related)
Quality control of all input vars.	Recalculate alt. MSL, GPH	Calculate wind speed & direction	Radiation correction	Recalculation (internal T to air T)
Detect launch points	Calculate pressure using alt. (GNSS)	Smoothing (pendulum effects)	Smoothing (pendulum effects)	Estimate uncertainties
Detect ascent/descent SP/C / shell	Estimate uncertainties	Estimate uncertainties	Estimate uncertainties	Calculate further humidity variables
	Quality control of pressure & alt.	Quality control of wind	Quality control of temperature	Quality control of humidity

Completely new developed

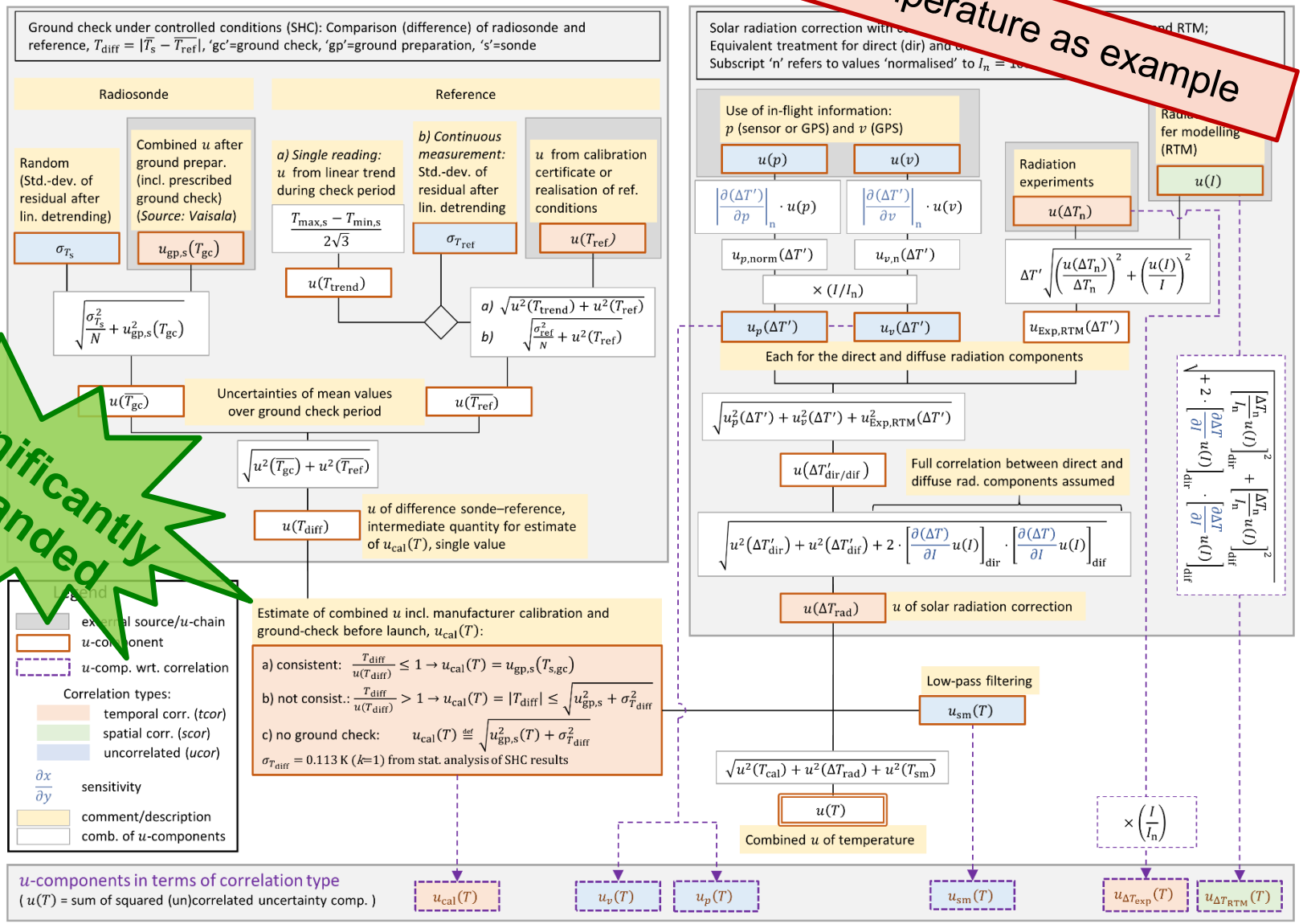
Estimation of uncertainty

Temperature
Relative humidity
Pressure (sensor)
Pressure (gnss)
Altitude (gph)
Altitude (amsl)
Altitude (wgs84)
Latitude
Longitude
Wind direction
Wind speed
Zonal wind comp.
Meridional wind c.
Dew point temp.
WVMR (mass)
WVMR (vol)
WV partial press.
WV sat. press.
Ventilation
Ascent speed

Temperature as example

Significantly expanded

Combination of uncertainty components for temperature in GDP for Vaisala RS41 radi



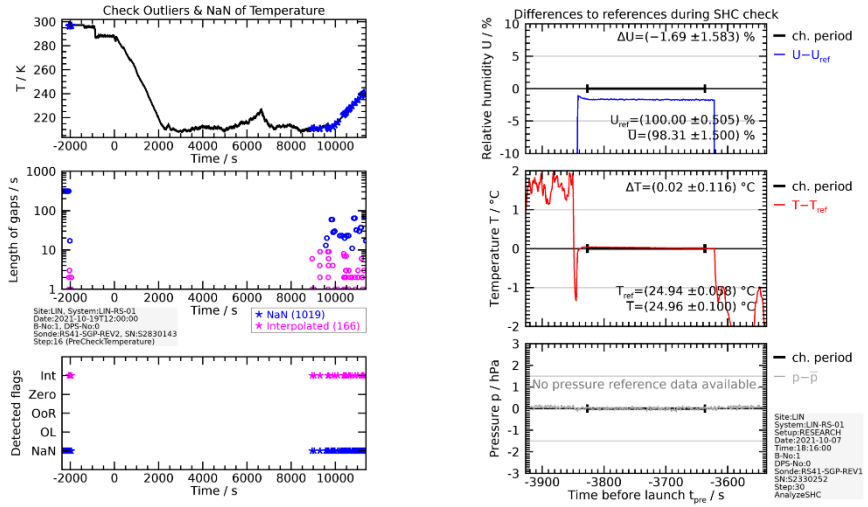
Content of RS41-GDP.1 files

- Meta-data — significantly expanded
  - Product, file, site, measurement system, measurement setup, surface obs., measurement (times, equipment, day/night, position, pwc, tropopause, burst point), main/telemetry sonde, ground system, ground checks (ri41, shc, shelter), …
- Variables — significantly expanded
  - Position (lat, lon), altitude (gph, wgs84, amsl), pressure (sensor, gnss), temperature, humidity (rh, dp, mr, …), wind variables (wdir, speed, wzon, wmeri), supplementary variables (sun angles, radiation, ventilation, pendulum, …)
- Corrections — significantly expanded
  - Final data, total correction, correction components, raw data (+ flags)
- Uncertainties — significantly expanded
  - Combined, correlation parts, source components

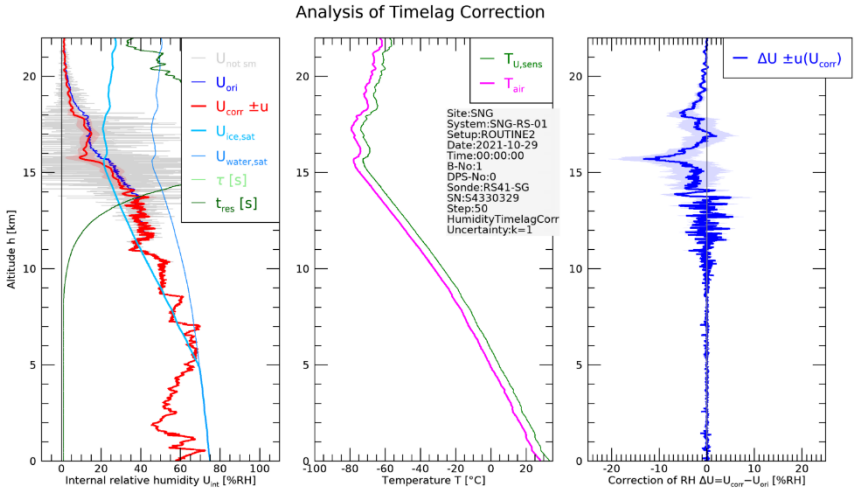
Compared to RS92-GDP.2

Analysis plots

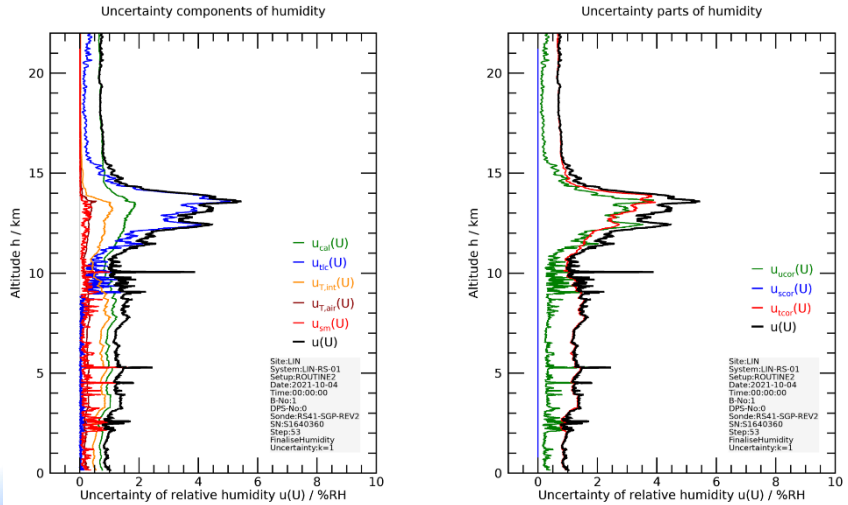
Raw data analysis & ground check plots



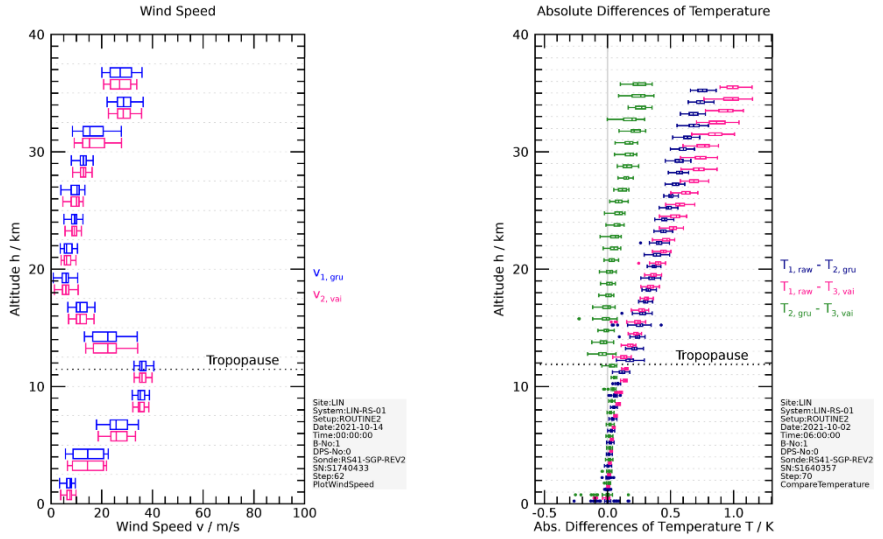
Internal analysis plots



Plots of uncertainty components & parts

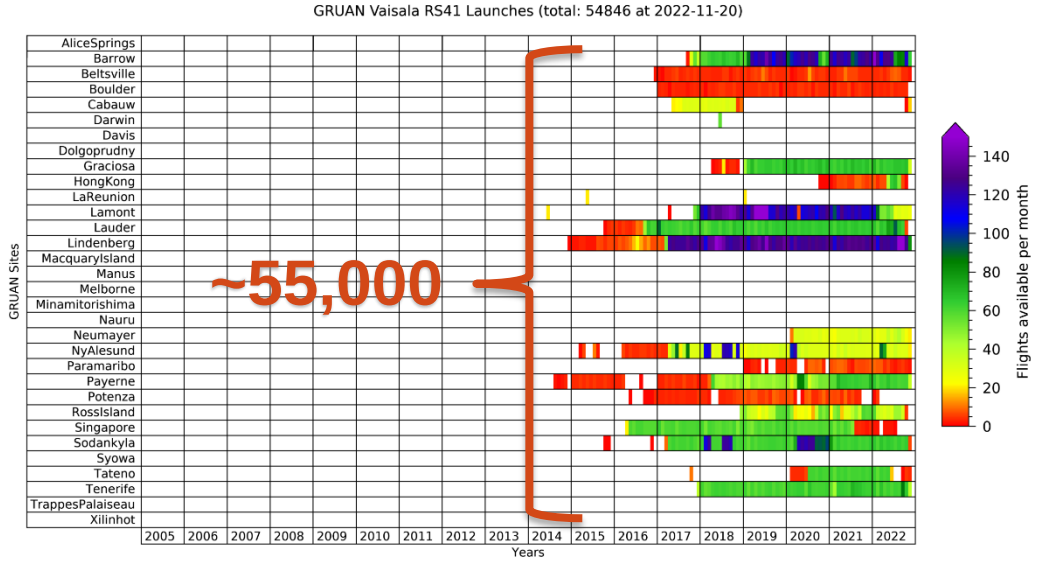


Comparison plots (GDP vs. Vaisala)



Final data product RS41-GDP.1

- Full characterisation → extensive & intensive experiments
- Comprehensive processing → correction & estimation of uncertainties
- GDP provided as very detailed NetCDF 4 files
- Analysis plots → Should they be available at website?
- Operational processing of RS41-GDP.1 (since 2021-11-09)



1 year operational processing

RS41 Technical Document

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

Title: "GRUAN characterisation and data processing of the Vaisala RS41 radiosonde"

Authors: Michael Sommer, Christoph von Rohden, Tzvetan Simeonov, Peter Oelsner, Tatjana Naebert, Hannu Jauhiainen, Petteri Survo, Ruud Dirksen

Aim: Full description of RS41 in GRUAN incl. instrumentation, measurement practice, characterisation, data processing, data flow

Status: on 2022-11-09, 198 pages, 100% complete → in review

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Submitted on 2022-04-12

RS41 User Guide

Title: "User Guide of the RS41 GRUAN Data Product Version 1 (RS41-GDP.1)"

Authors: Michael Sommer, Christoph von Rohden, Tzvetan Simeonov

Aim: Describe content of GDP files of RS41 and help users to handle these files correctly

Status: on 2022-11-21, 60 pages, 100% complete, GRUAN-TN-13

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Comparison paper (RS92 vs. RS41)

Title: "RS41/RS92 Radiosondes GRUAN Data Products comparison for more than 1000 flights: Characterization of radiosonde Temperature and Relative Humidity profiles"

Authors: Tzvetan Simeonov, Michael Sommer, Christoph von Rohden, Tatjana Naebert, Ruud Dirksen, Peter Oelsner

Aim: Compare GRUAN processing and data product (GDP) of both RS92 and RS41

Status: on 2022-11-21, 19 pages, active in progress

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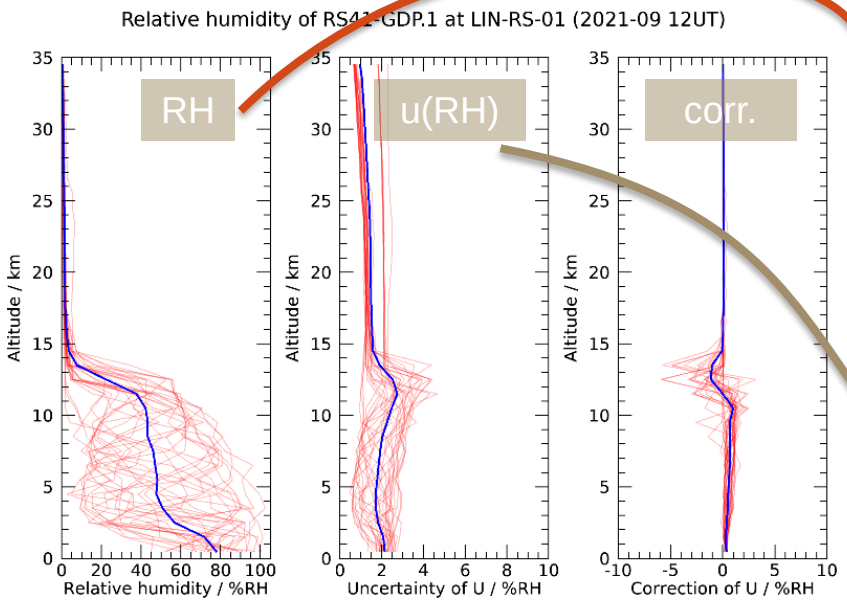
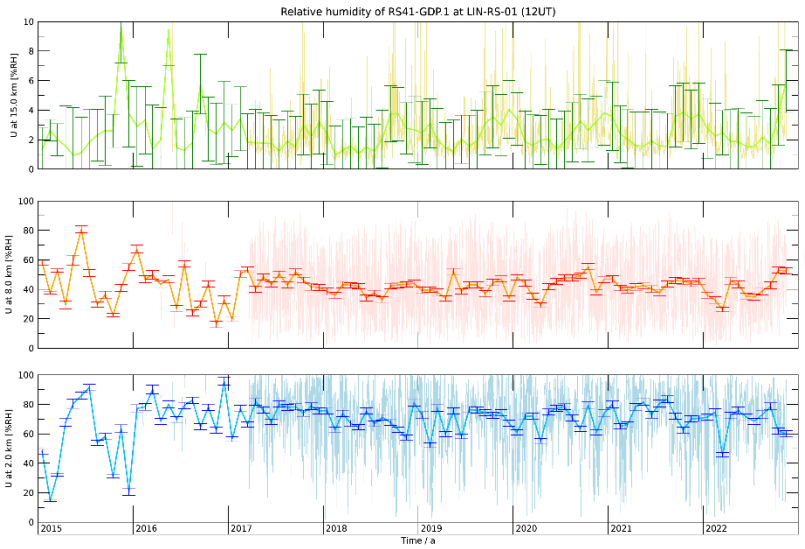
Invitation – please use the GDP, e.g. make long-term statistics ...

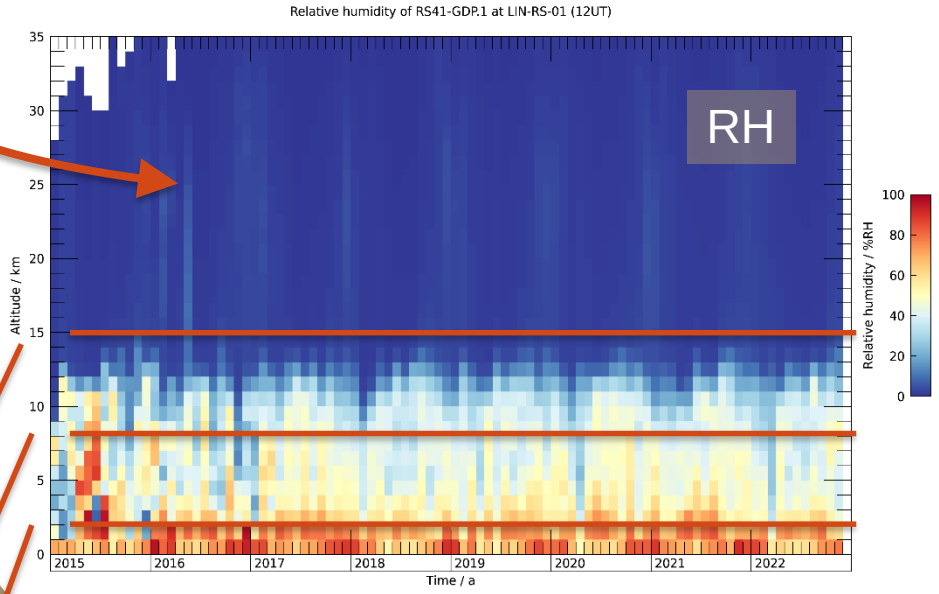
Deutscher Wetterdienst
Wetter und Klima aus einer Hand

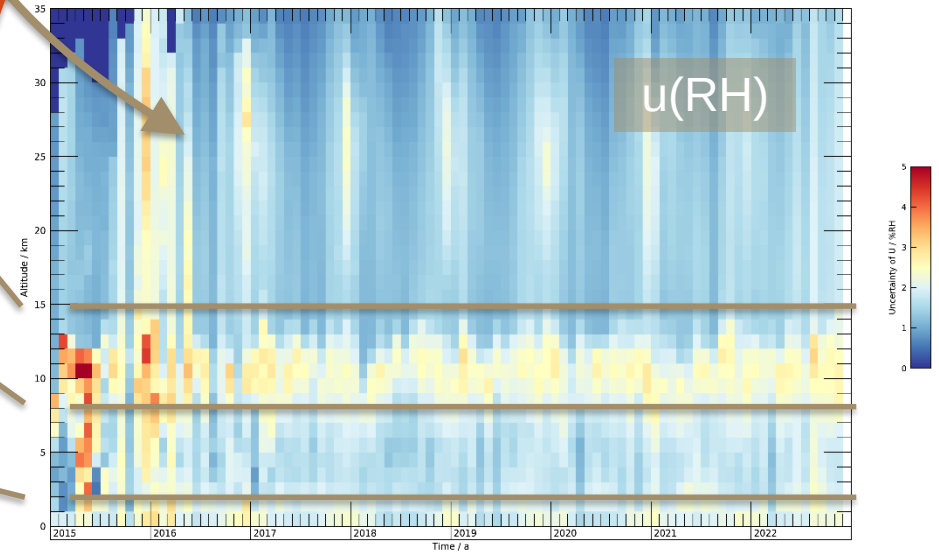
1km bins & monthly mean

Time series at alt. levs









Usage of GRUAN data products as working standard in WMO Upper-Air Instrument Intercomparison 2022 (UAII2022)

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