

# Status update on RS41 GRUAN Data Product (RS41-GDP.1)



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**Tzvetan Simeonov, Ruud Dirksen**

*GRUAN Lead Centre, DWD*

13<sup>th</sup> GRUAN Implementation and Coordination Meeting (ICM-13)

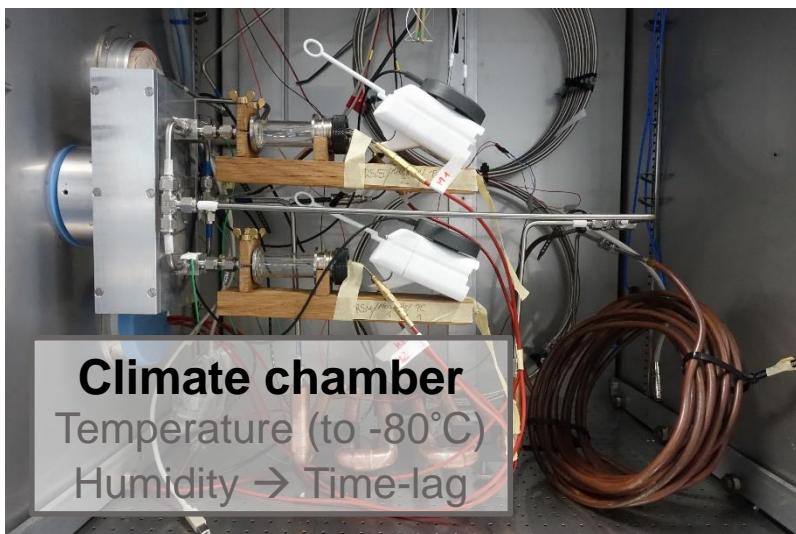
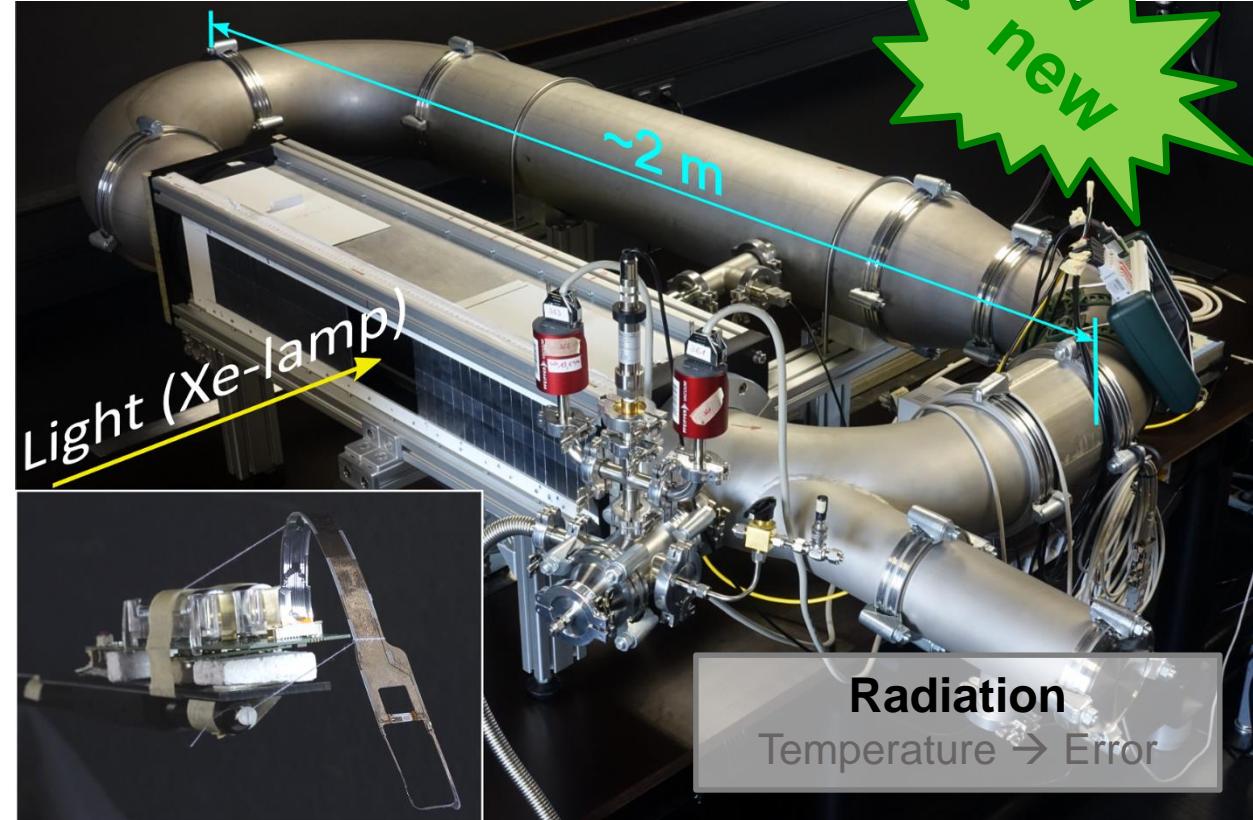
Virtual, Session 1, 15 November 2021

- Long journey
- Characterisation
- Data processing & GDP
- Documentation
- Summary & outlook

# 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)

# Characterisation of RS41



**Development of and experiments with new radiation wind tunnel**

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

<https://doi.org/10.5194/amt-2021-187>  
Preprint. Discussion started: 20 July 2021  
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in review

Atmospheric  
Measurement  
Techniques  
Discussions  
Open Access



<https://doi.org/10.5194/amt-2021-187>

## 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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### 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.

- 5 SISTER controls the pressure (3 hPa to 1020 hPa) and ventilation speed of the air inside the windtunnel-like setup to simulate the conditions between the surface and 35 km altitude, to determine the dependence of the radiation temperature error on the irradiance and the convective cooling. The radiosonde is mounted inside a quartz tube, while the complete sensor boom is illuminated by an external light source to include the conductive heat transfer between sensor and boom. A special feature of SISTER is that the radiosonde is rotated around its axis to imitate the spinning of the radiosonde in flight. The characterisation

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

Detects analysis  
SMC / shelter

Estimate  
uncertainties

Estimate  
uncertainties

Estimate  
uncertainties

Calculate further  
humidity variables

Quality control  
of pressure & alt.

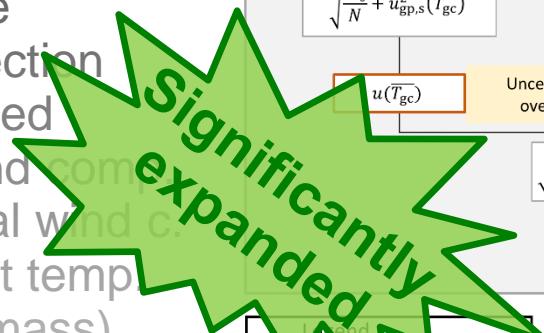
Quality control  
of wind

Quality control  
of temperature

Quality control  
of humidity

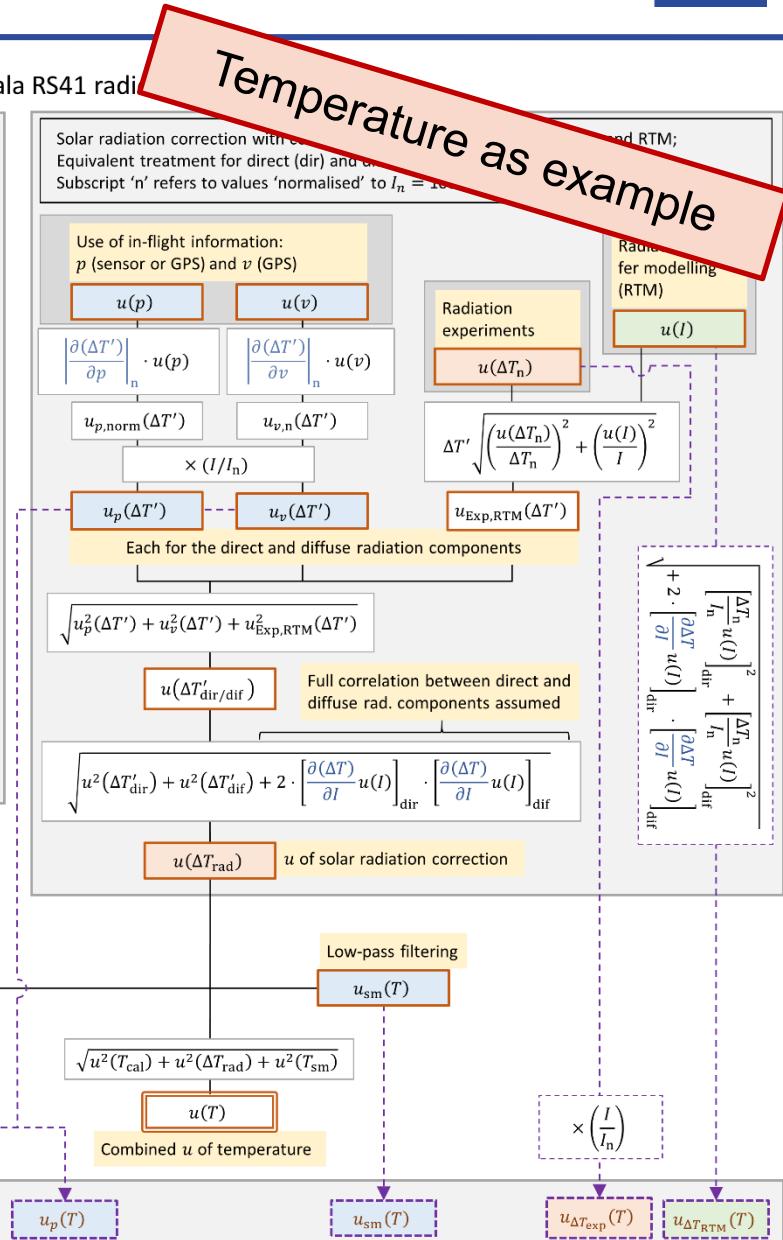
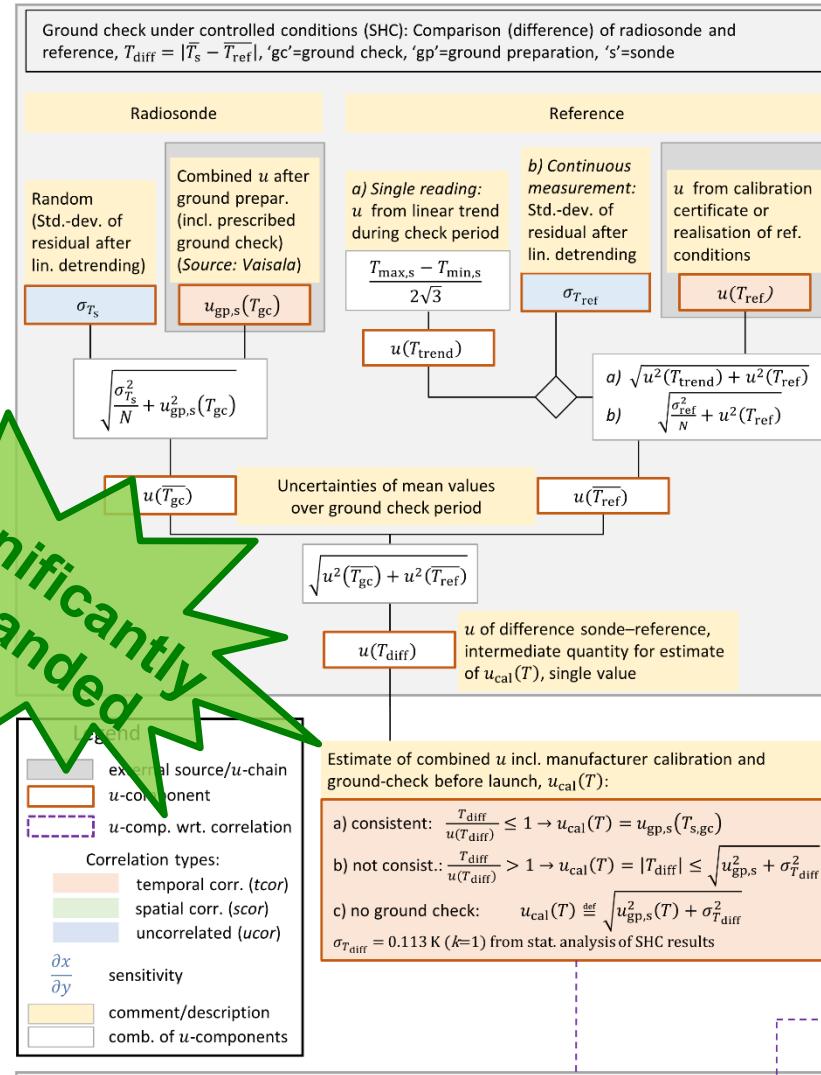
# Estimation of uncertainty

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



Significantly expanded

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



➤ 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

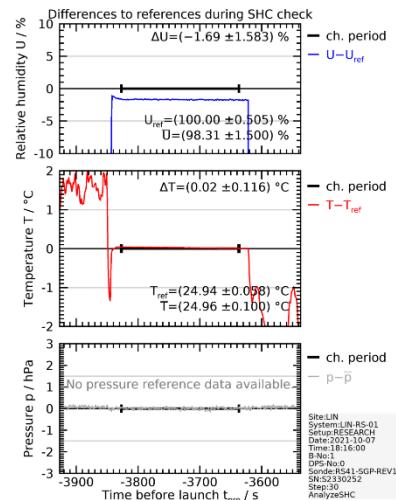
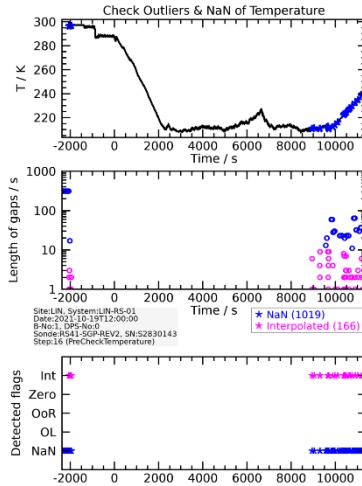
significantly expanded

- Combined, correlation parts, source components

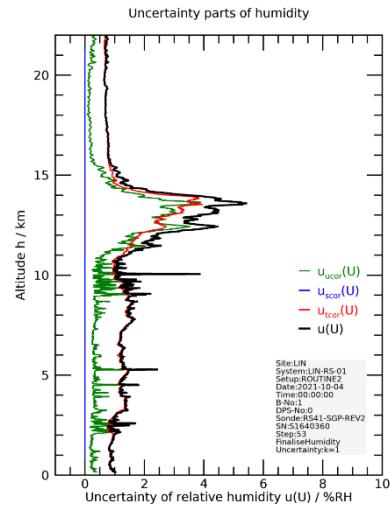
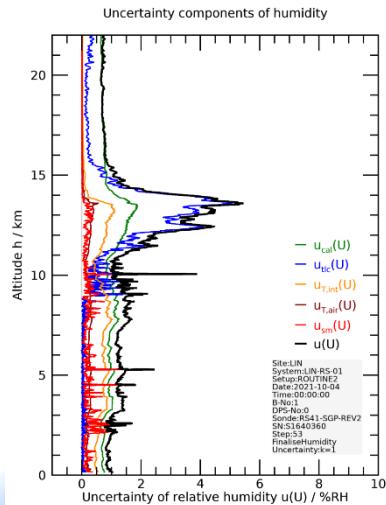
Compared to RS92-GDP.2

# Analysis plots

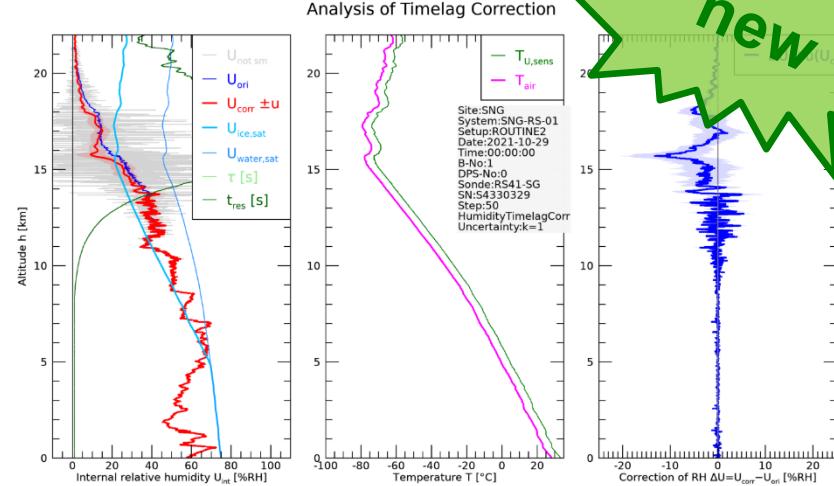
## Raw data analysis & ground check plots



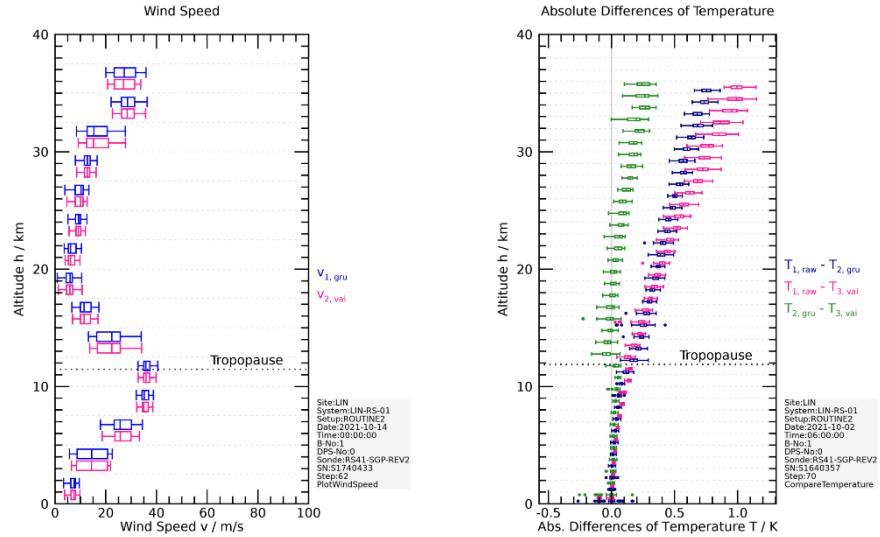
## Plots of uncertainty components & parts



## Internal analysis plots



## Comparison plots (GDP vs. Vaisala)



- 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?
- **Processing of RS41-GDP.1 started (2021-11-02)**

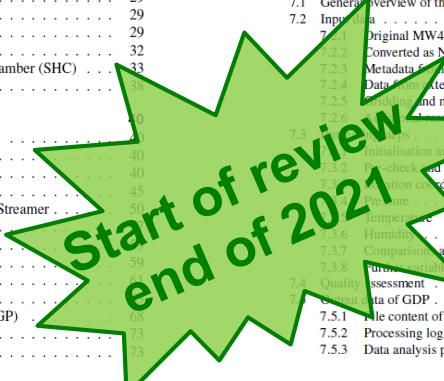


**Title:** “GRUAN characterisation and data processing of the Vaisala RS41 radiosonde”

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

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

**Status:** on 2021-11-02, 176 pages, ~95% complete

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<b>Title:</b>	“User Guide of the RS41 GRUAN Data Product Version 1 (RS41-GDP.1)”
<b>Authors:</b>	Michael Sommer, Christoph von Rohden, Tzvetan Simeonov, ...
<b>Aim:</b>	Describe content of GDP files of RS41 and help users to handle these files correctly
<b>Status:</b>	on 2021-11-01, 57 pages, ~90% complete



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# Comparison paper (RS92 vs. RS41)

Deutscher Wetterdienst  
Wetter und Klima aus einer Hand



<b>Title:</b>	"GRUAN RS41/RS92 data product comparison: Characterization of temperature and relative humidity profiles"
<b>Authors:</b>	Tzvetan Simeonov, Ruud Dirksen, Christoph von Rohden, Michael Sommer, ...
<b>Aim:</b>	Compare GRUAN processing and data product (GDP) of both RS92 and RS41
<b>Status:</b>	on 2021-11-12, data analysis ongoing

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### Abstract

### 1 Introduction

### 2 Description of RS41 GDP data handling and corrections

#### 2.1 Temperature

#### 2.2 Humidity

### 3 RS41 GDP data uncertainties

#### 3.1 Temperature

#### 3.2 Humidity

### 4 RS92/RS41 comparison

#### 4.1 Comparison methodology

#### 4.2 Temperature

#### 4.3 Humidity

### 5 Summary and conclusions

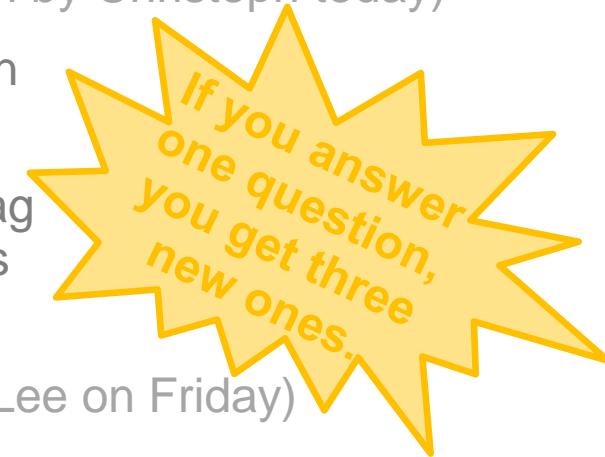


# Summary of current status

- **Radiation paper** in review process at AMT in review
- **RS41 technical document (TD)** in finalisation in finalisation
- **RS41-GDP user guide (TN)** in finalisation in finalisation
- **Comparison paper (RS92 vs. RS41)** in preparation in preparation
- **Provisional certification** go ahead
  - Final certification after publication of TD and comparison paper pending
- **Processing of RS41-GDP.1** started running



- Future research & improvements of data product **in next years**
  - Update on climate chamber setup to investigate time-lag of humidity sensor at cold temperatures (→ see presentation by Christoph today)
  - Investigate detected small systematic humidity differences in troposphere → RS41 vs. CFH / GNSS-PW
  - Development of an experimental setup to investigate time-lag of temperature sensor → main issue is time resolution of 1 s
  - Extension of temperature radiation correction to include the dependency to air temperature (→ see presentation by Lee on Friday)
  - ...
- In between → Use first version of RS41 GDP (RS41-GDP.1)



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



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