

# Progress to a RS41 GRUAN data product



--- Part 1 ---

## Data processor & ALPHA.2

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Singapore

Session 4, 21 May 2019

- Data processor
  - Possibilities and general structure
- Current version (RS41-GDP-ALPHA.2)
  - Examples for different modules
  - Status of development
- Schedule and conclusion

## ➤ GRUAN data processor

- Alias name of → GRUAN Data Processing System (GDPS) for Radiosonding
- General modular processing system for radiosonde data
- Open system which could be adapted for any radiosonde types/models
- Output files will be created as NetCDF
- Creation of any number of analysis plots

## ➤ Current adaption tests

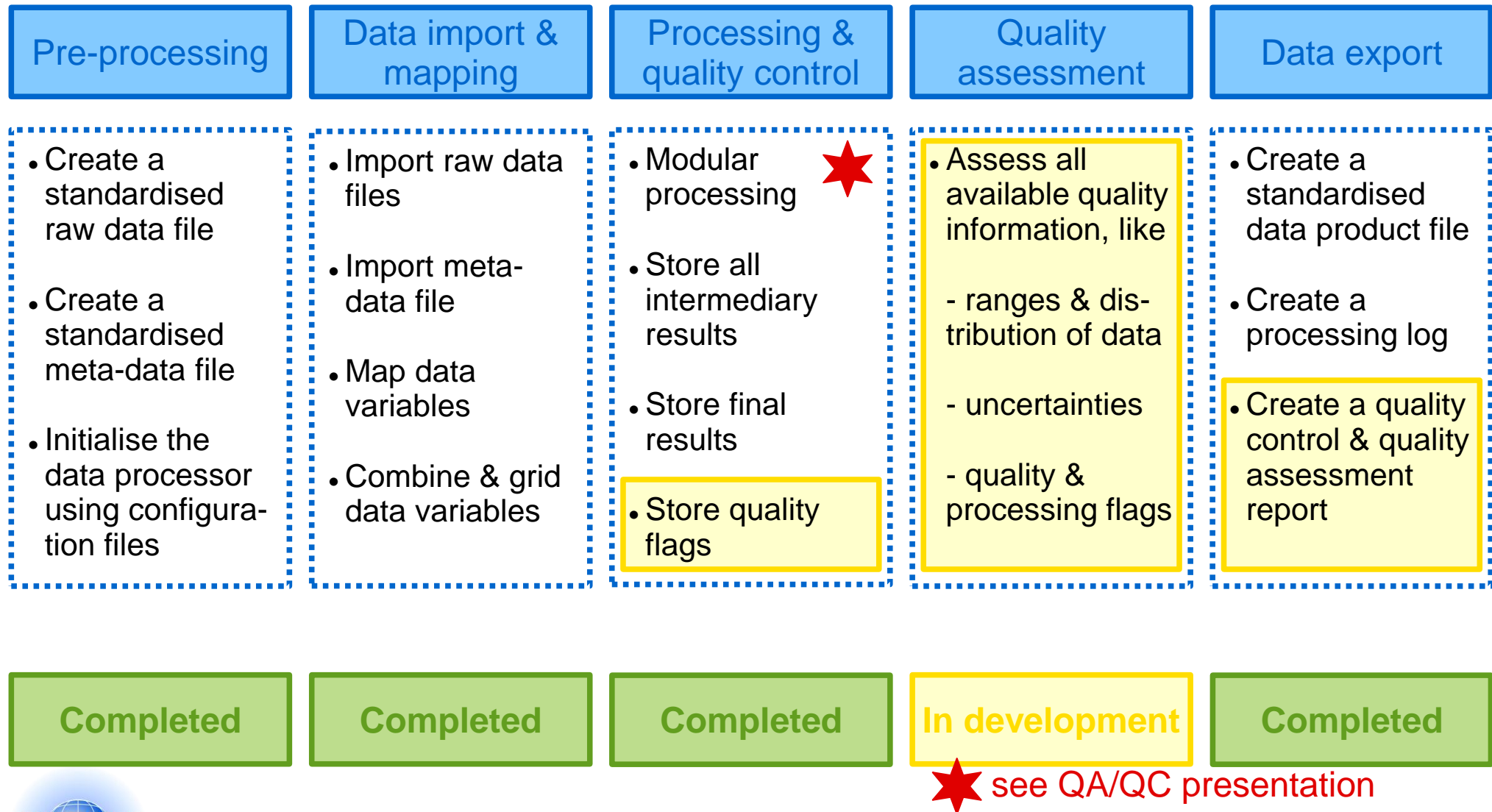
- Ground check analysis only (GCA) → RS92-GCA.1, RS41-GCA.1
- (Extract/convert) Manufacturer Data Products (EDT) → RS92-EDT.1, RS92-EDT.1
- GRUAN Data Products (GDP) → RS41-GDP.1, RS92-GDP.3, DFM-09-GDP.1

## ➤ Possible future adaptations

- ECC ozone, CFH, ...

# Scheme of GRUAN data processor

Deutscher Wetterdienst  
Wetter und Klima aus einer Hand

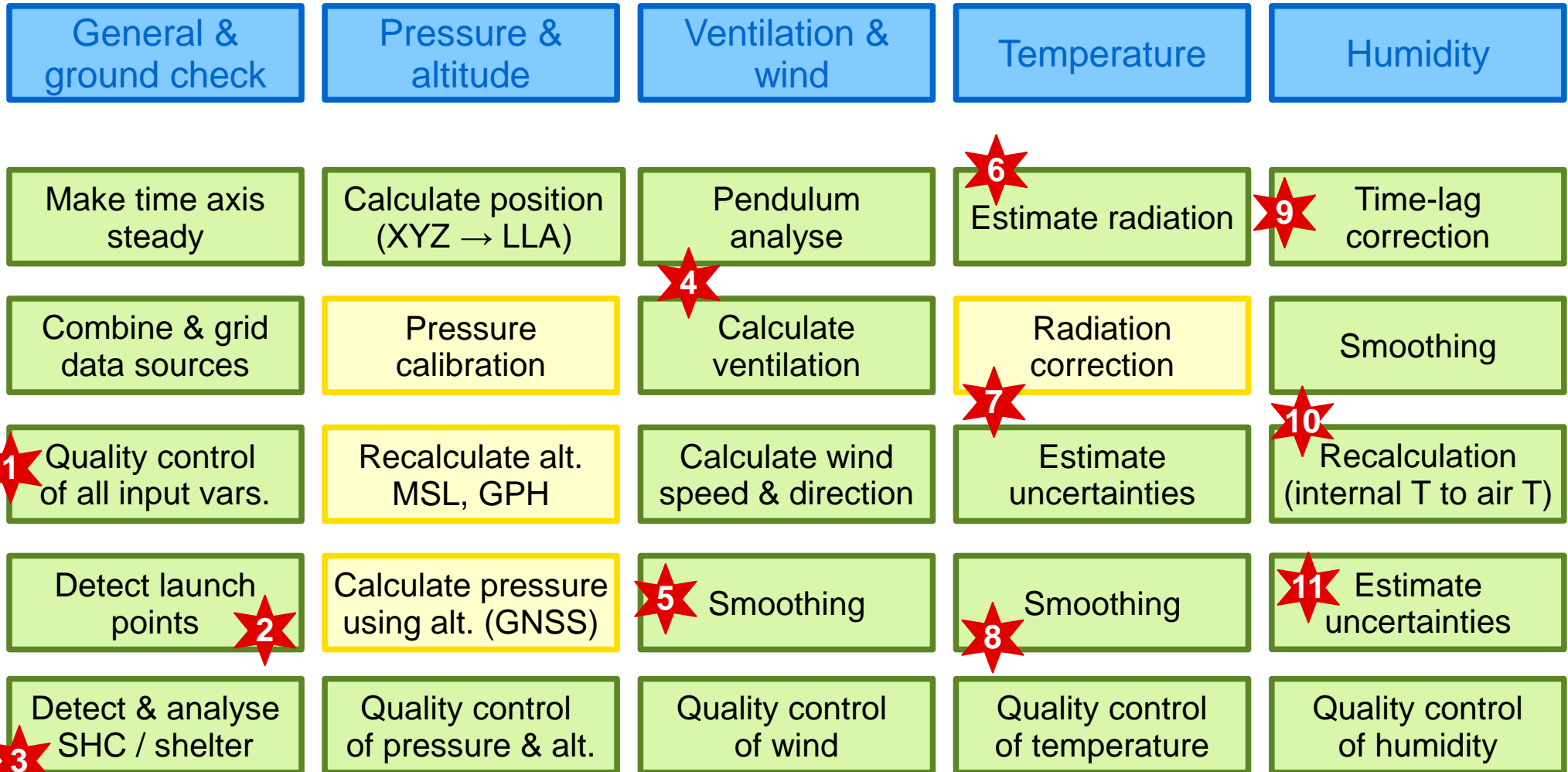


see QA/QC presentation



# ALPHA.2 – Processing scheme

Deutscher Wetterdienst  
Wetter und Klima aus einer Hand

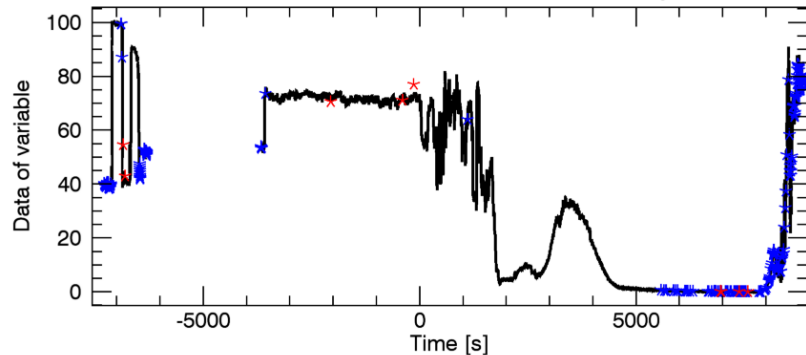


# 1: Quality control of input variables

Deutscher Wetterdienst  
Wetter und Klima aus einer Hand



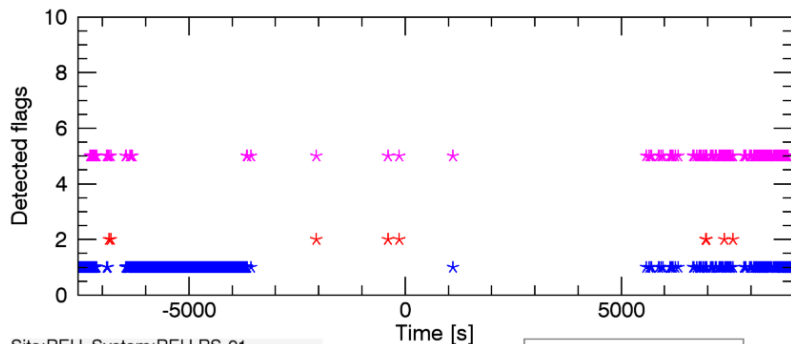
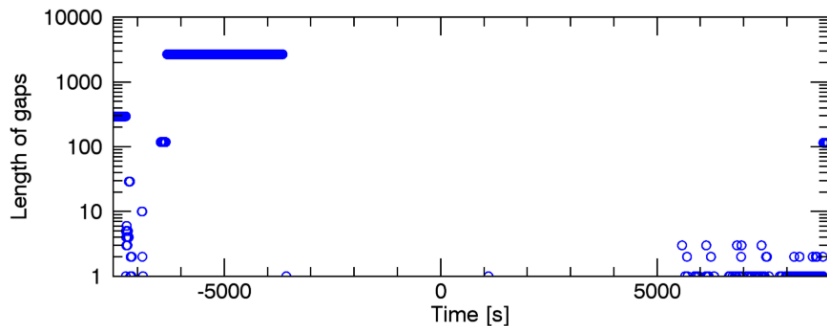
Check Outliers & NaN of RelativeHumidity



Detect outlier & missing values

Analyse gaps

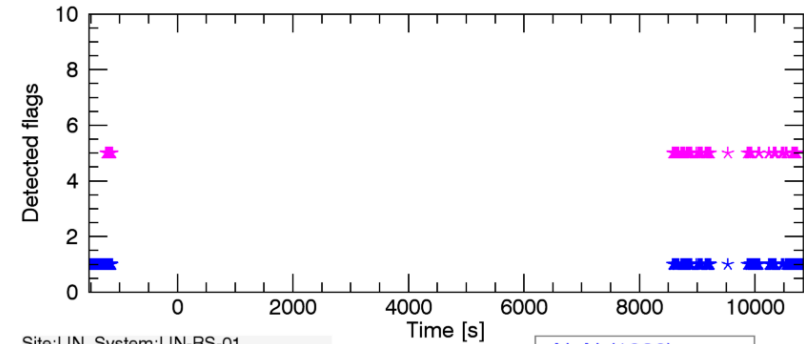
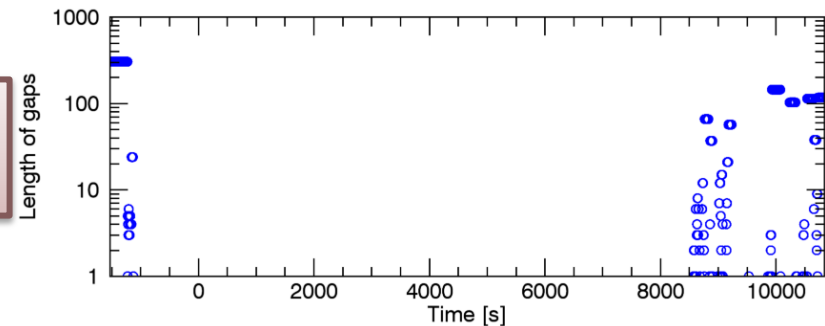
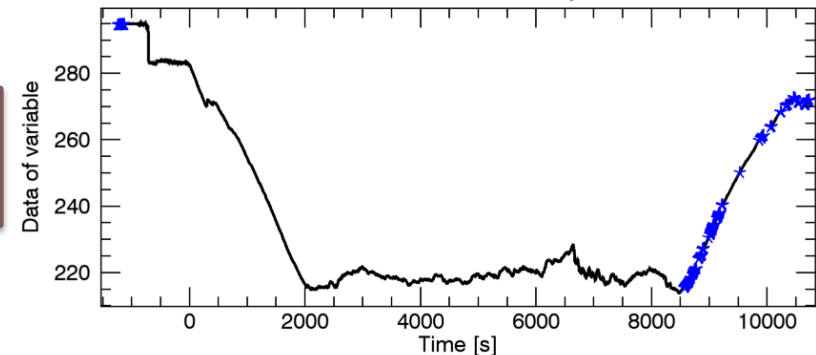
Interpolate gaps & store flags



Site:REU, System:REU-RS-01  
Date:2019-01-11T17:56:00  
B-No:2, DPS-No:0  
Sonde:RS41-SGP-REV1, SN:N4120581  
Step:15 (PreCheckRelativeHumidity)

\*NaN (3461)  
\*Outlier (9)  
\*Interpolated (364)

Check Outliers & NaN of Temperature

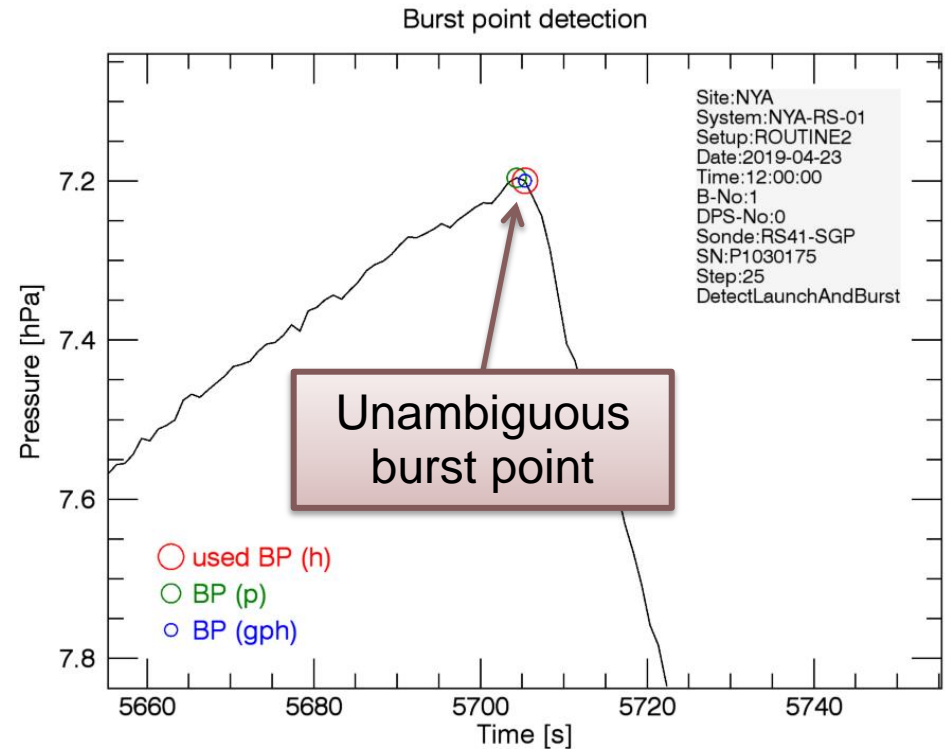
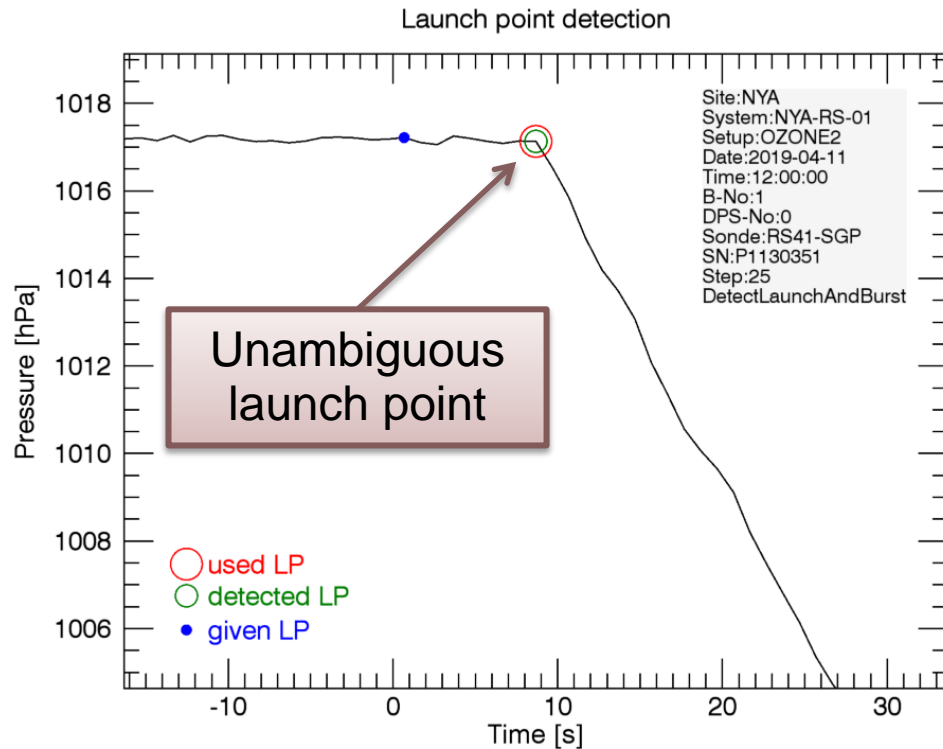


Site:LIN, System:LIN-RS-01  
Date:2019-04-01T18:00:00  
B-No:1, DPS-No:0  
Sonde:RS41-SGP-REV2, SN:P3410084  
Step:16 (PreCheckTemperature)

\*NaN (1280)  
\*Interpolated (538)



## 2: Detect launch and burst point – using pressure sensor

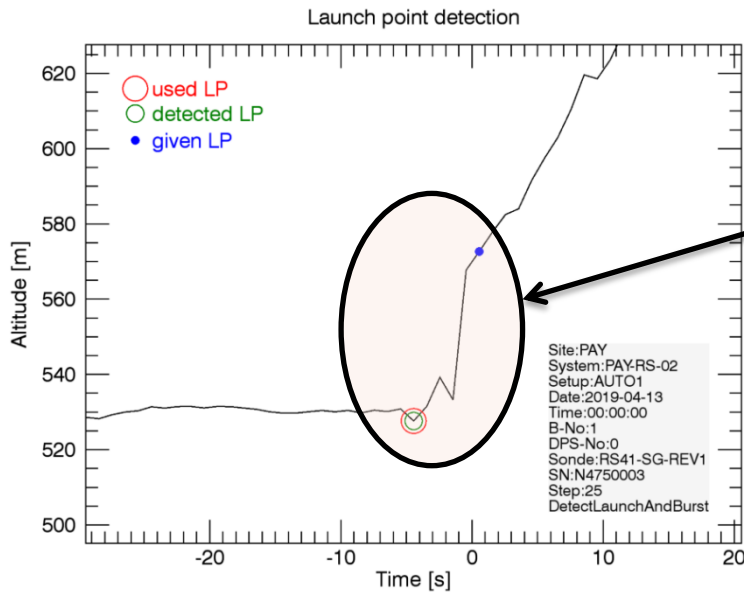


If a pressure sensor can be used:

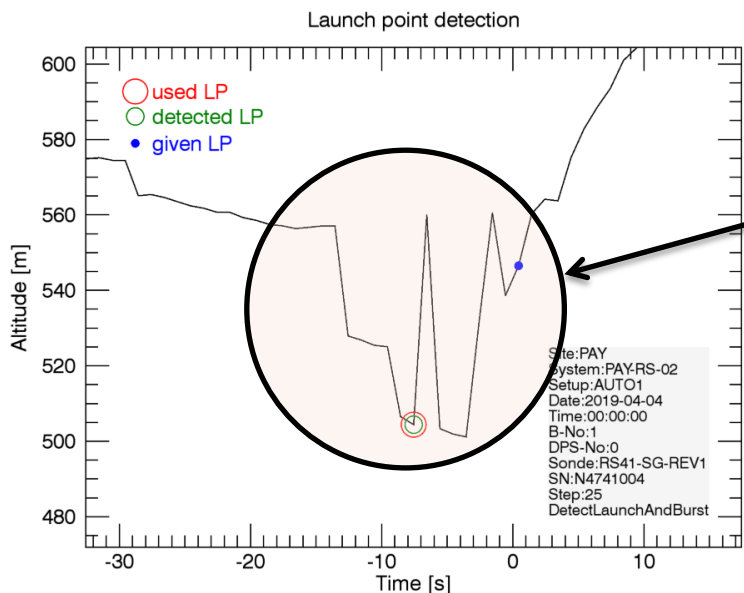
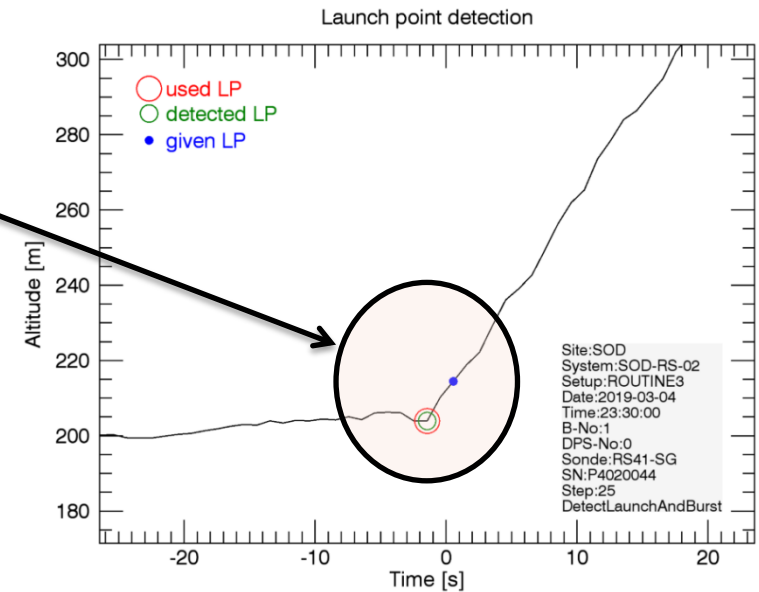
- most cases → unambiguous detection possible
- often → equal detection results of manufacturer and GRUAN



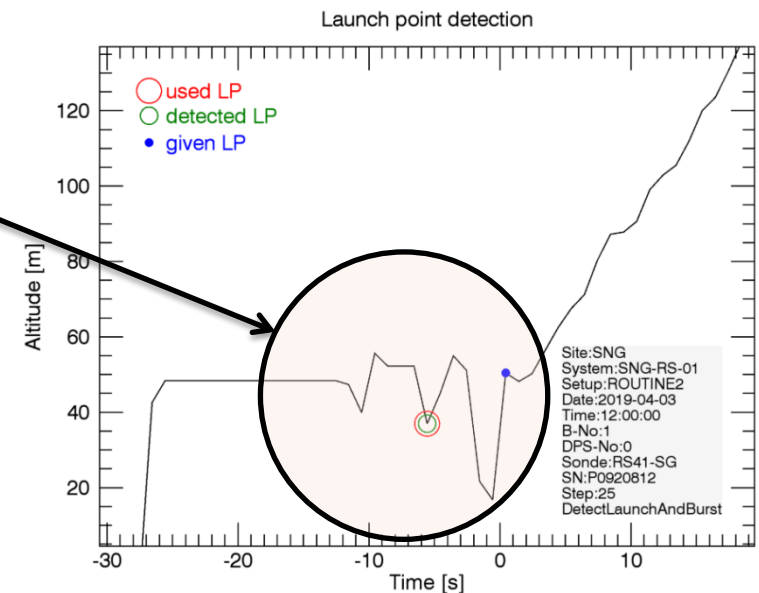
## 2: Detect launch point – using GNSS altitude



Often different  
detection between  
manufacturer and  
GRUAN (<10 sec)

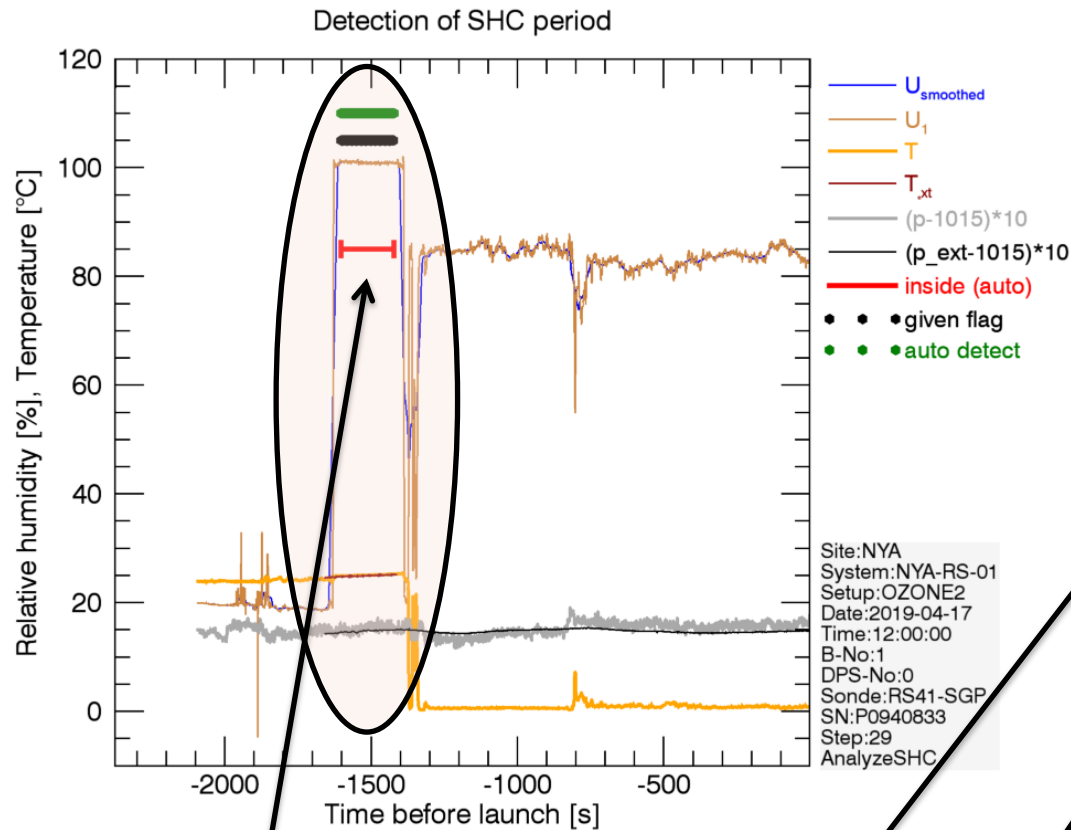


Sometimes GNSS  
issues at ground  
with auto-launcher  
& indoors



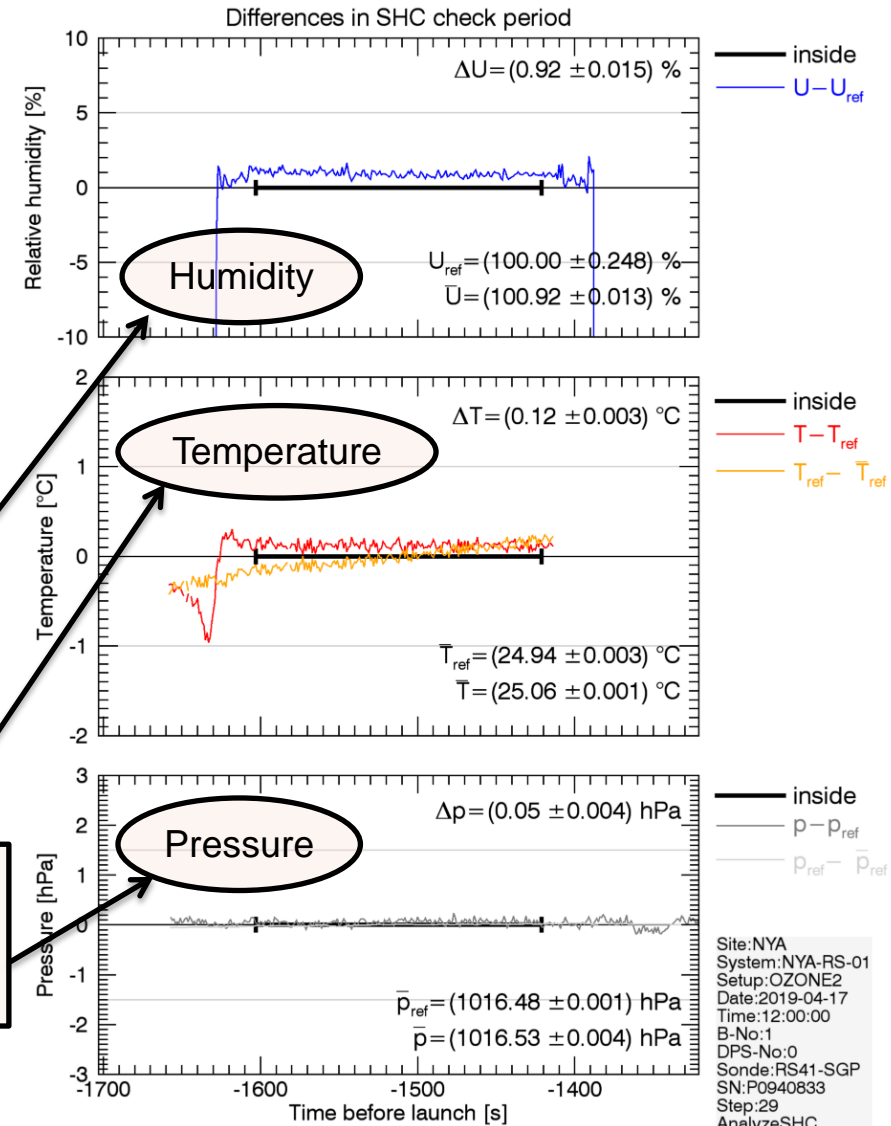


# 3: Detect and analyse SHC check

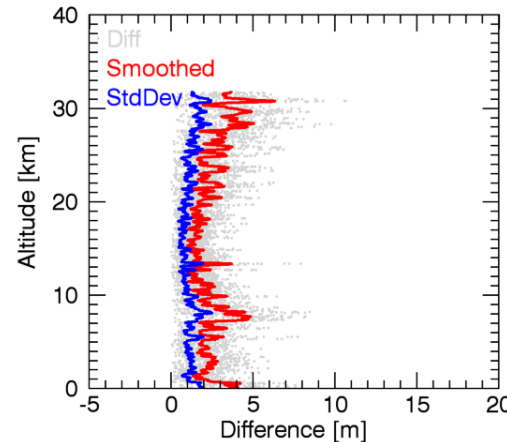
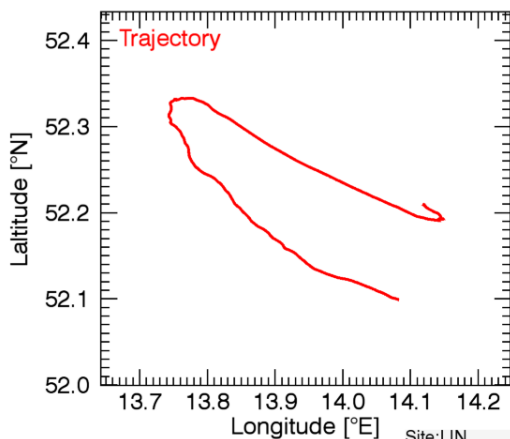


Automatic detection of SHC period using stability of temperature and humidity level

Analyse in comparison with assumptions or references



# 4: Pendulum analysis & Calculate ventilation

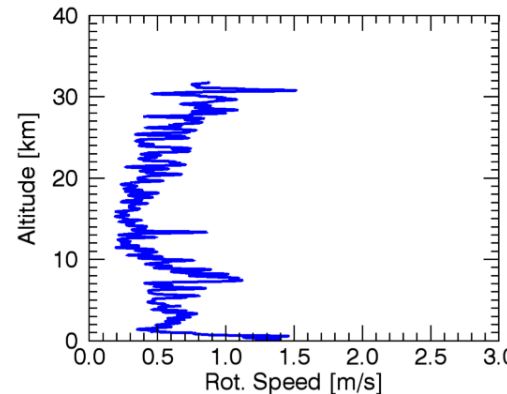
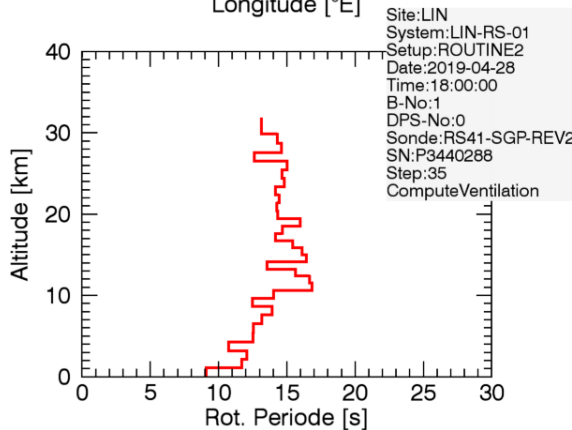


Analyse radiosonde trajectory to estimate pendulum:

- Rotation period
- Rotation speed

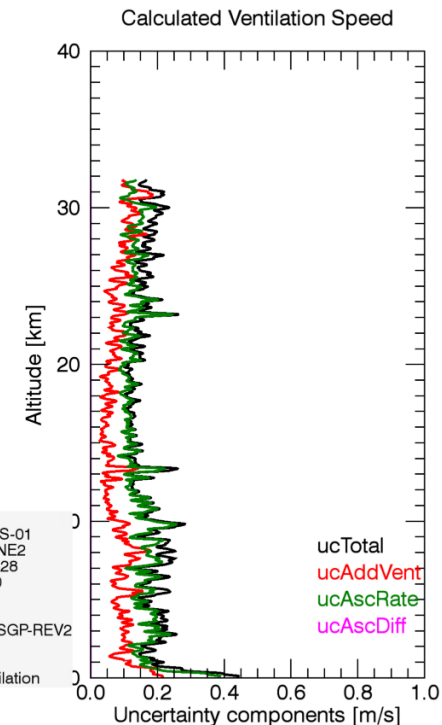
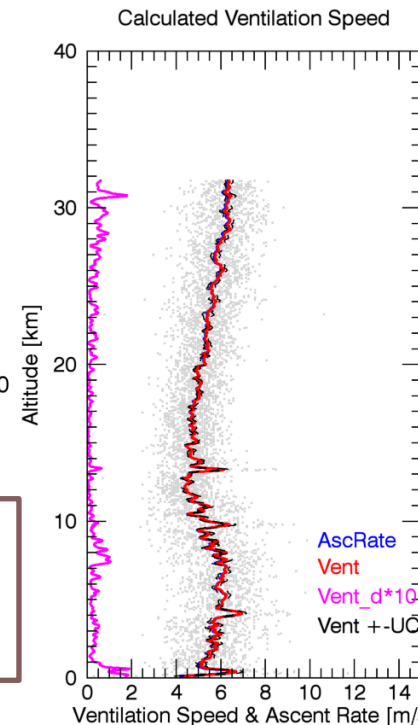
Calculate ventilation:

- ascent speed + rot. speed (vector)



Assumption is that:

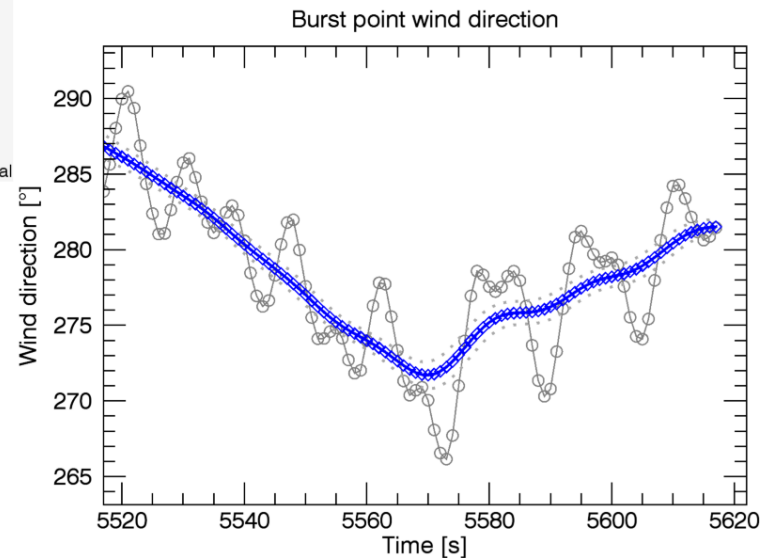
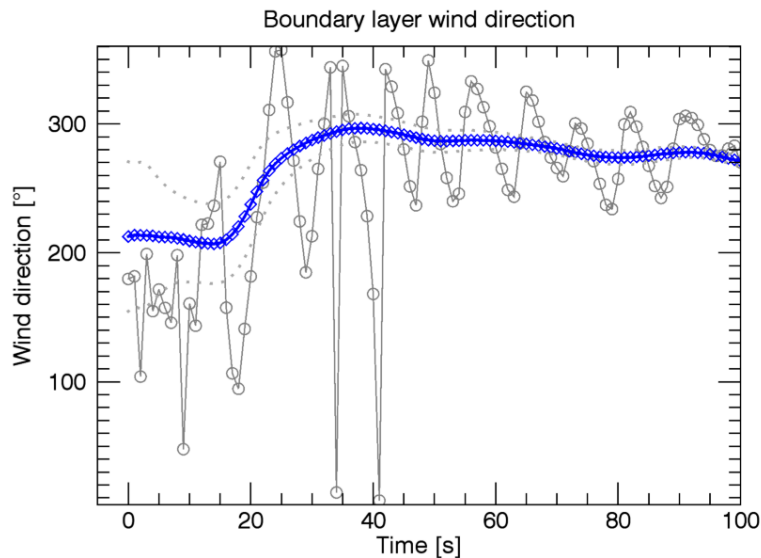
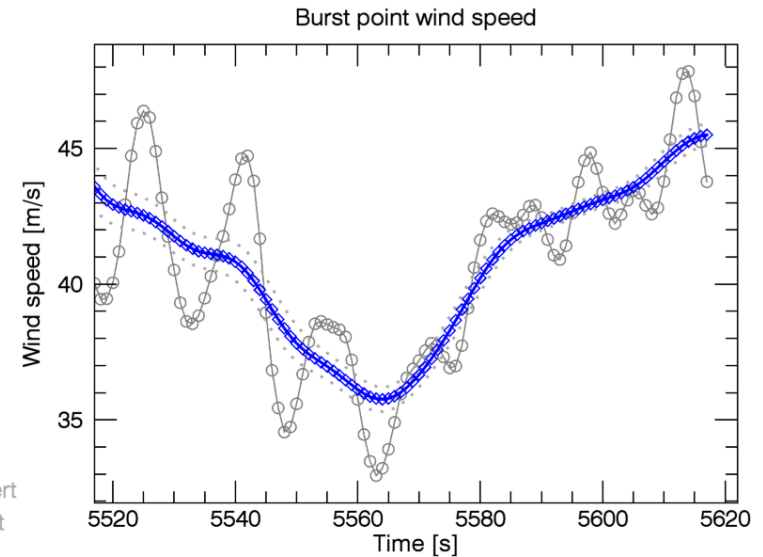
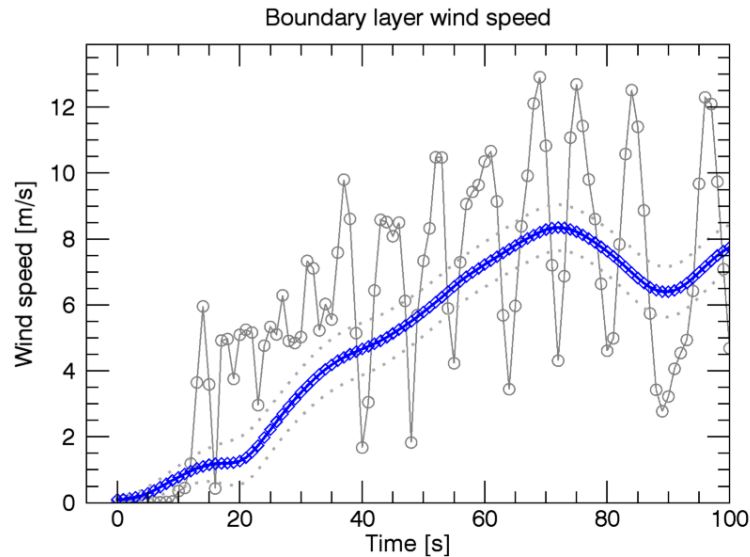
- ascent speed derived from GNSS is a real ventilation component



INFO: ascRate=5.43 m/s, vent=5.46 m/s (vent\_uc=0.17 m/s)

# 5: Smoothing wind vector – removing pendulum

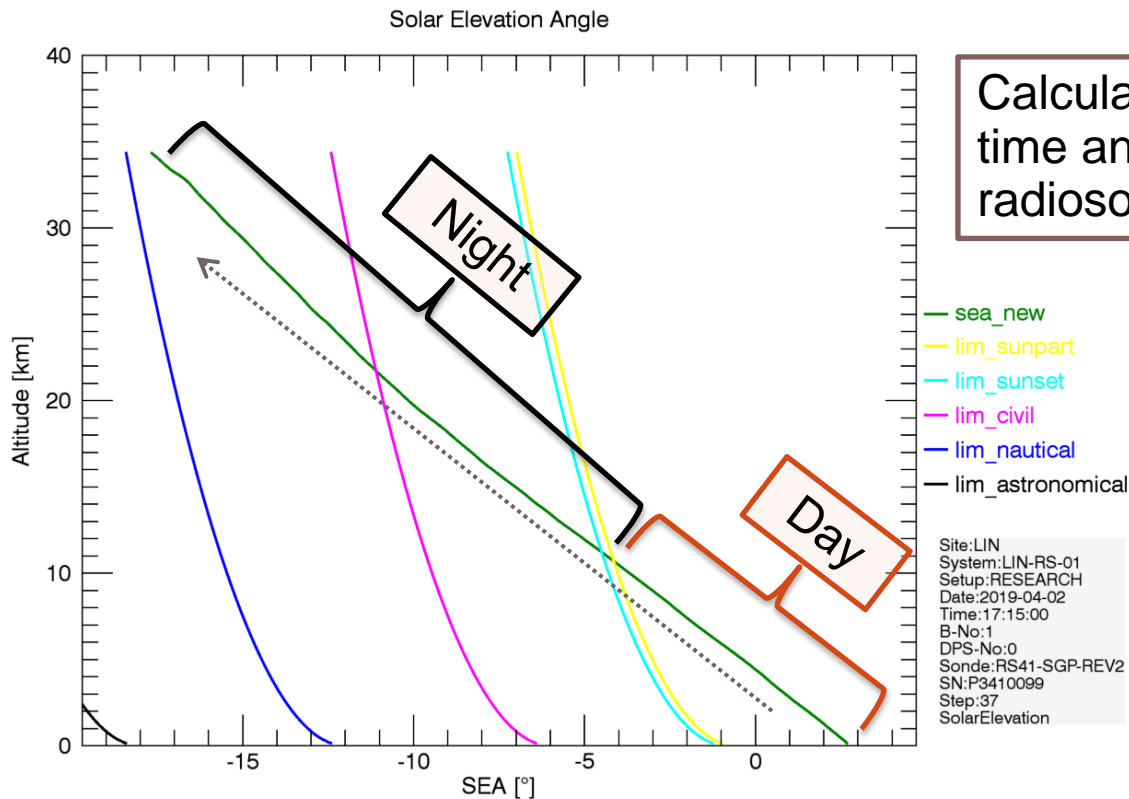
Deutscher Wetterdienst  
Wetter und Klima aus einer Hand



Site:SOD  
System:SOD-RS-02  
Setup:ROUTINE3  
Date:2019-03-03  
Time:11:30:00  
B-No:1  
DPS-No:0  
Sonde:RS41-SG  
SN:P4020052  
Step:50  
WindparameterRetrieval

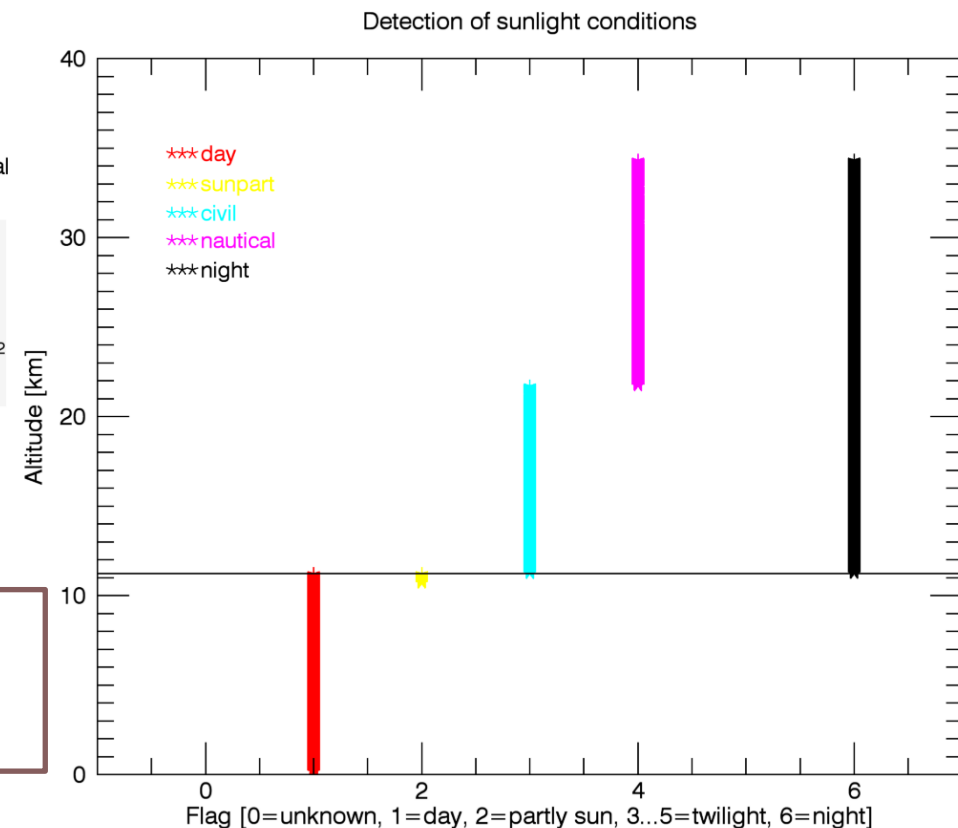


# 6: Detection of sunlight conditions (part to estimate radiation)

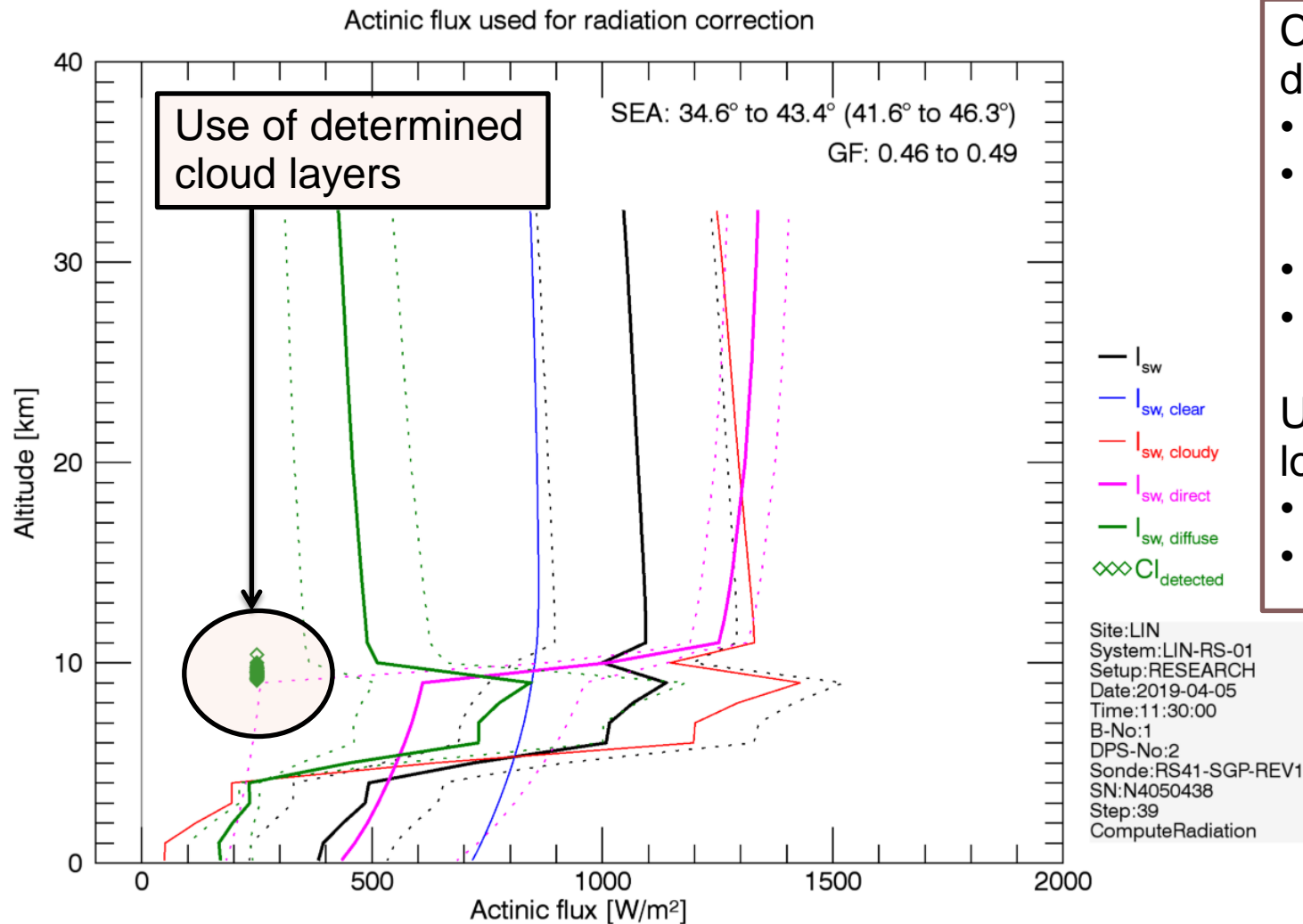


Calculation of all relevant angles, depending on time and individual position (lat, lon, alt) of radiosonde during flight

Detect relevant sunlight conditions using solar zenith angle and a horizon correction:  
e.g. day, twilight, night



# 6: Estimate radiation



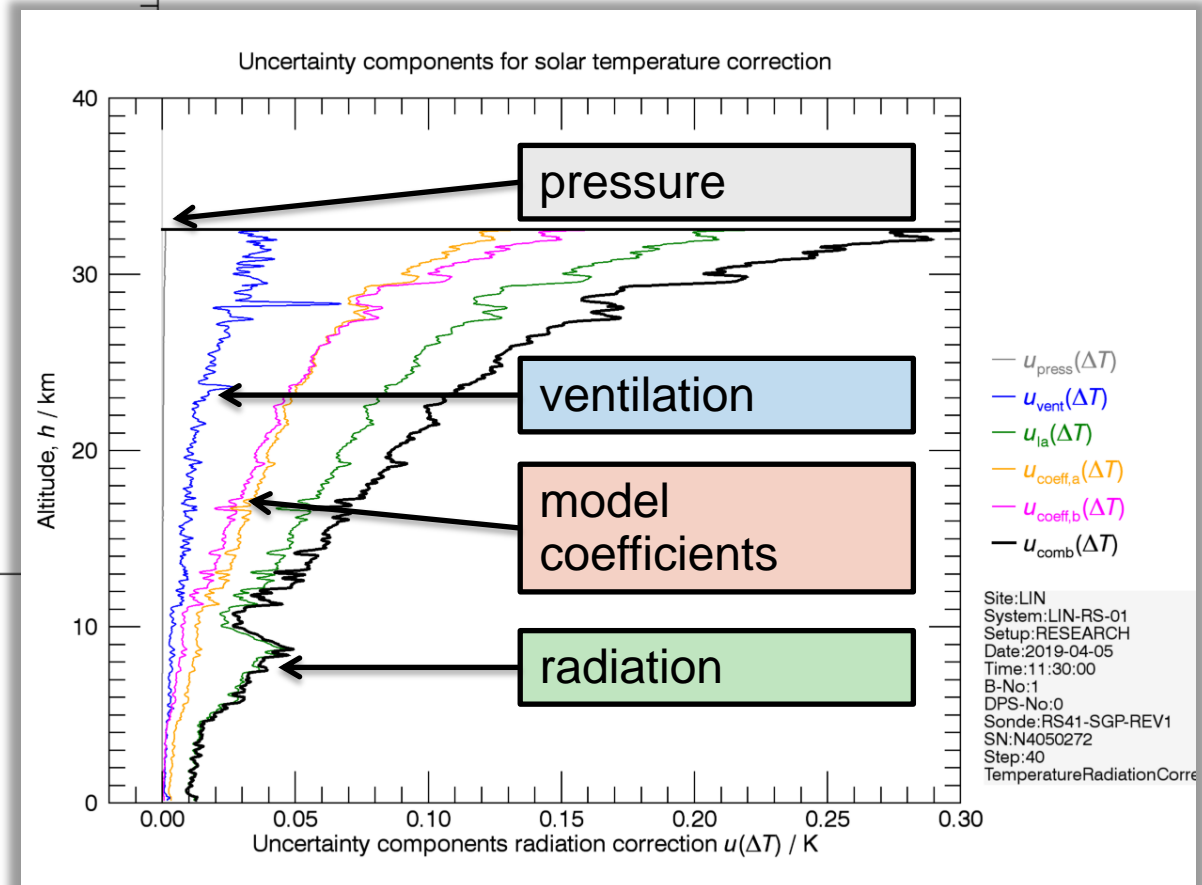
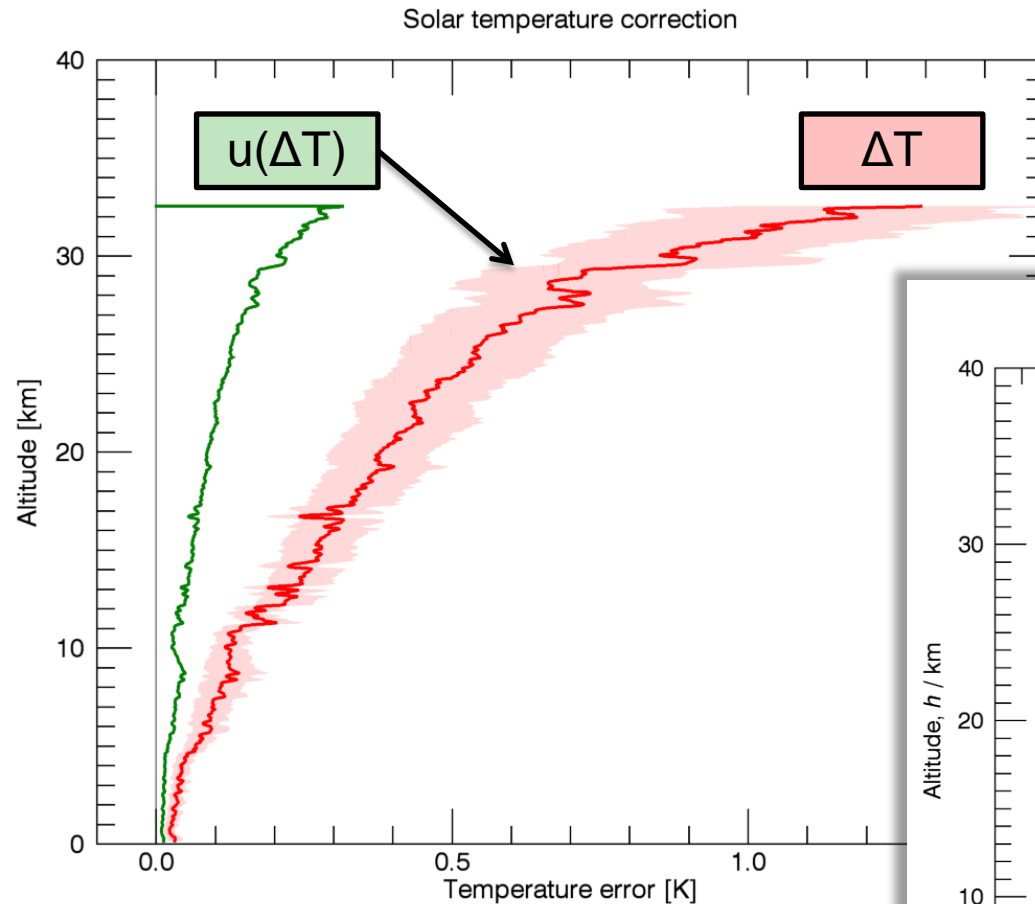
Calculation of actinic flux dependent on:

- solar zenith angle
- geometry factor (old approach)
- ventilation
- altitude/pressure

Usage of a pre-calculated look-up table:

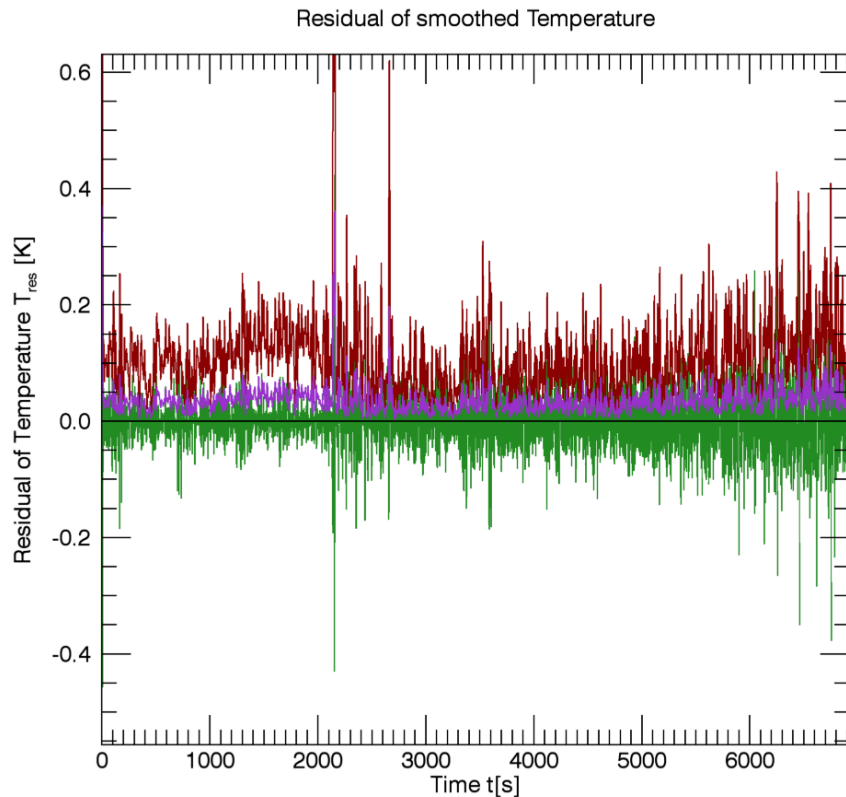
- clear sky / cloudy
- climate zone

# 7: Radiation correction of temperature sensor

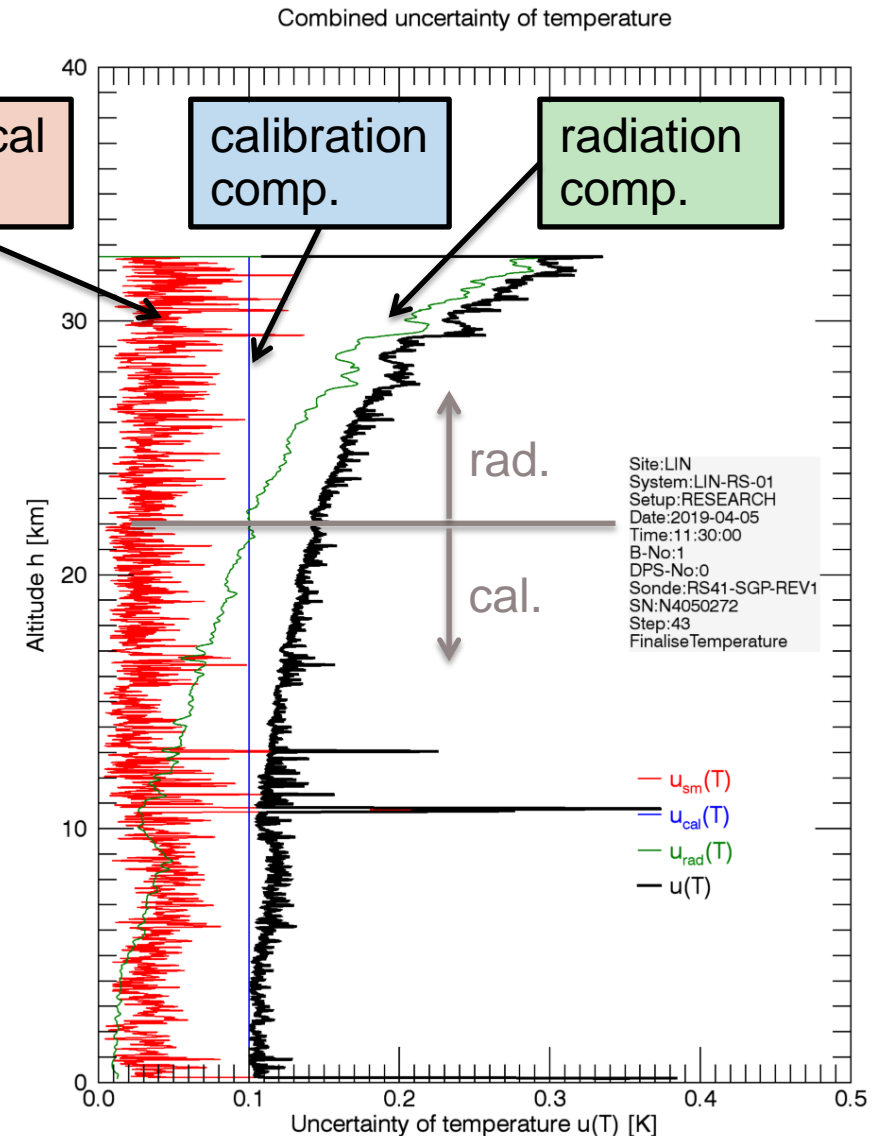




# 8: Smoothing temperature & combined uncertainty



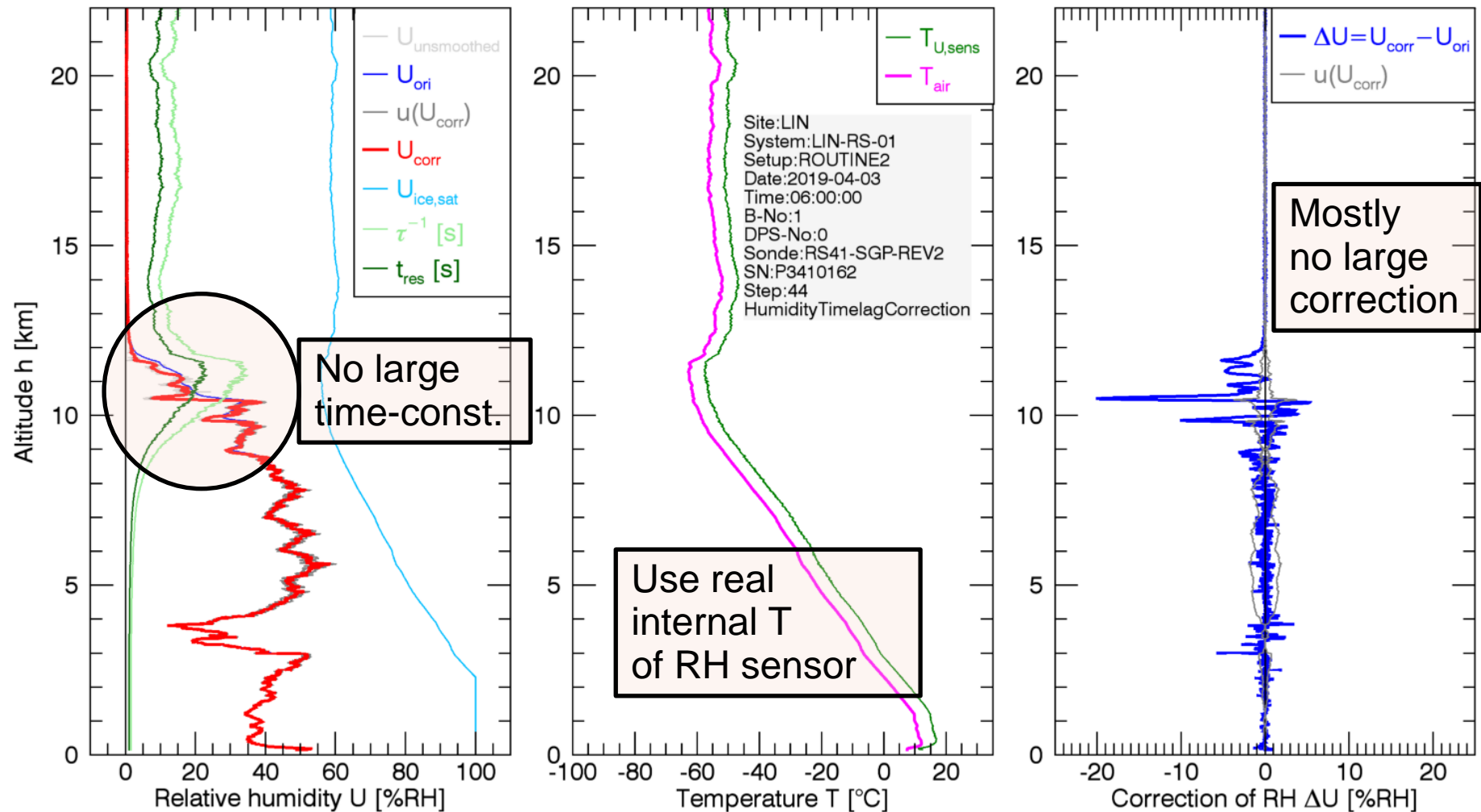
Smooth temperature (~10 s) and calculate the statistical part of uncertainty (<0.05 K)





# 9: Humidity time-lag correction – mid-latitude example: Lindenberg

Analysis of Timelag Correction

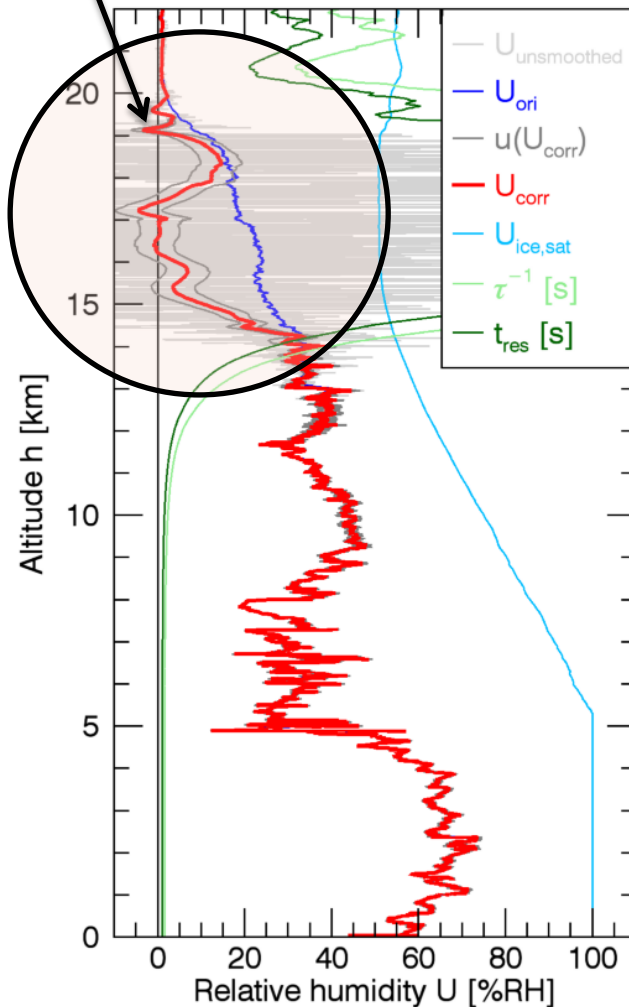


# 9: Humidity time-lag correction – tropical example: Singapore

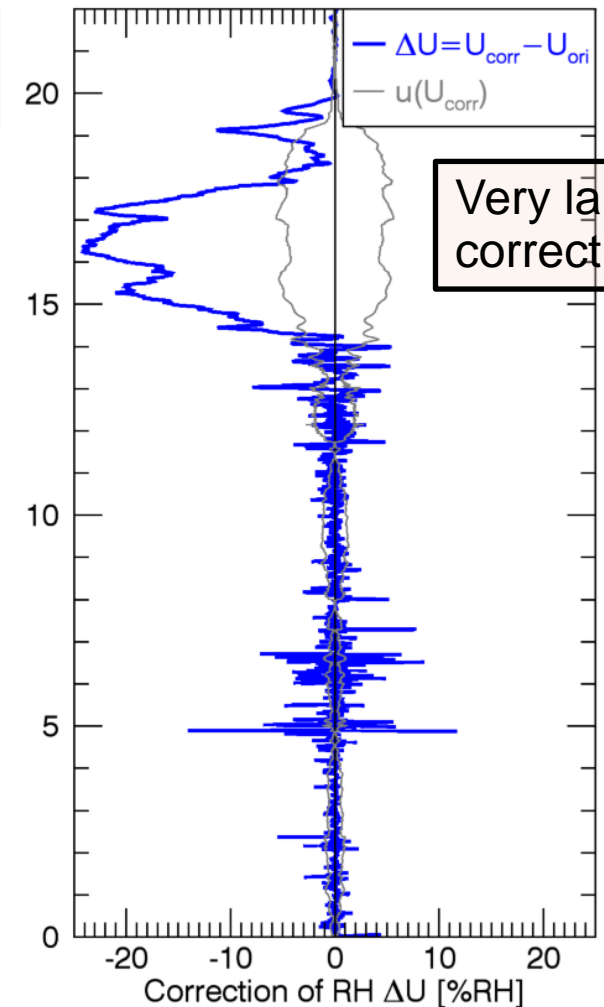
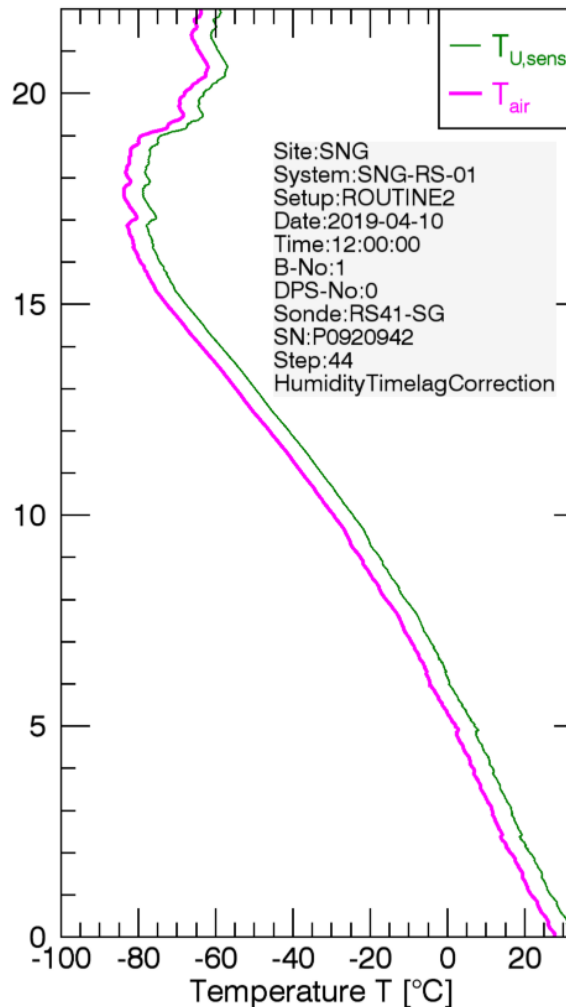
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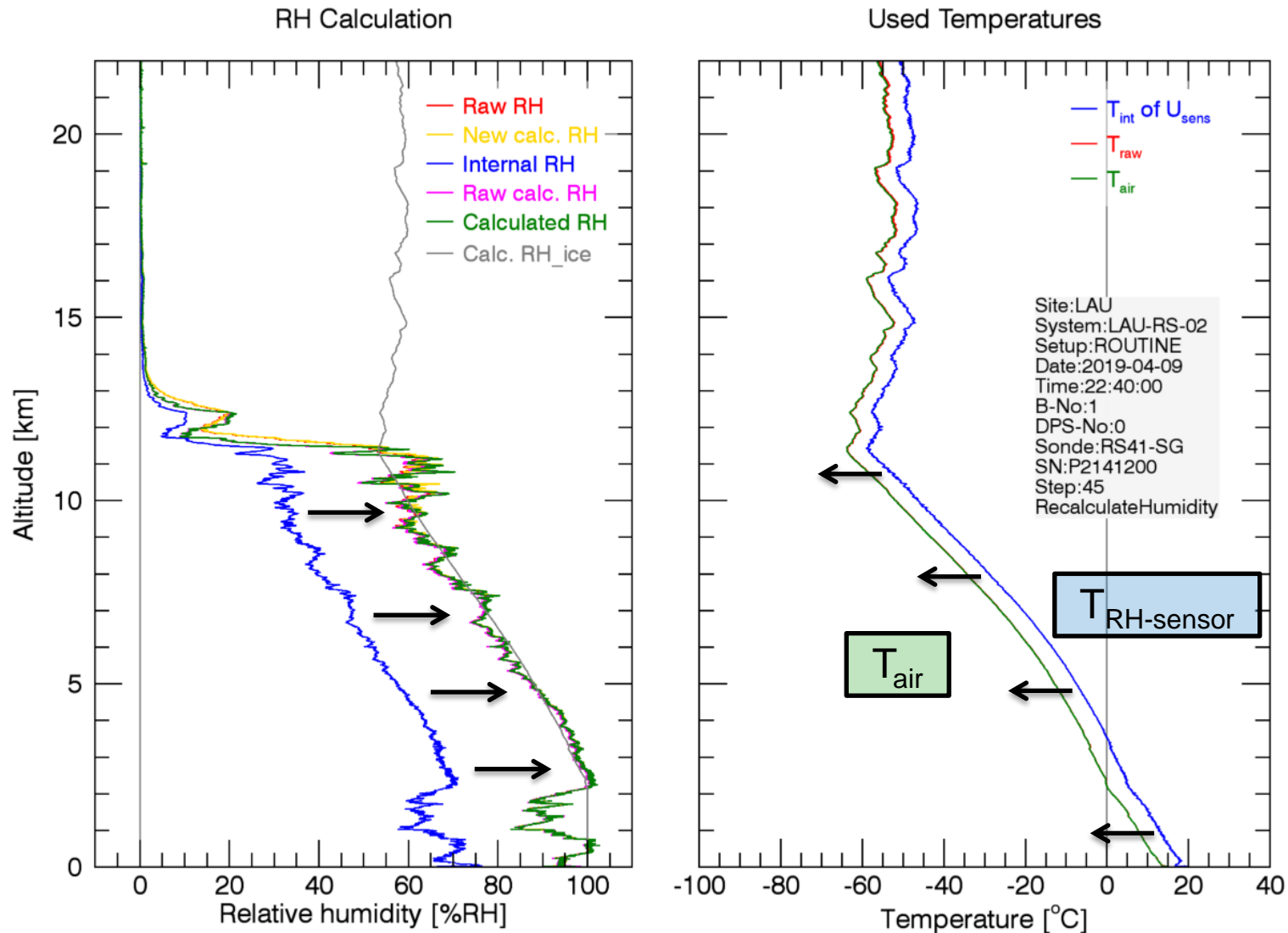
Over-correction



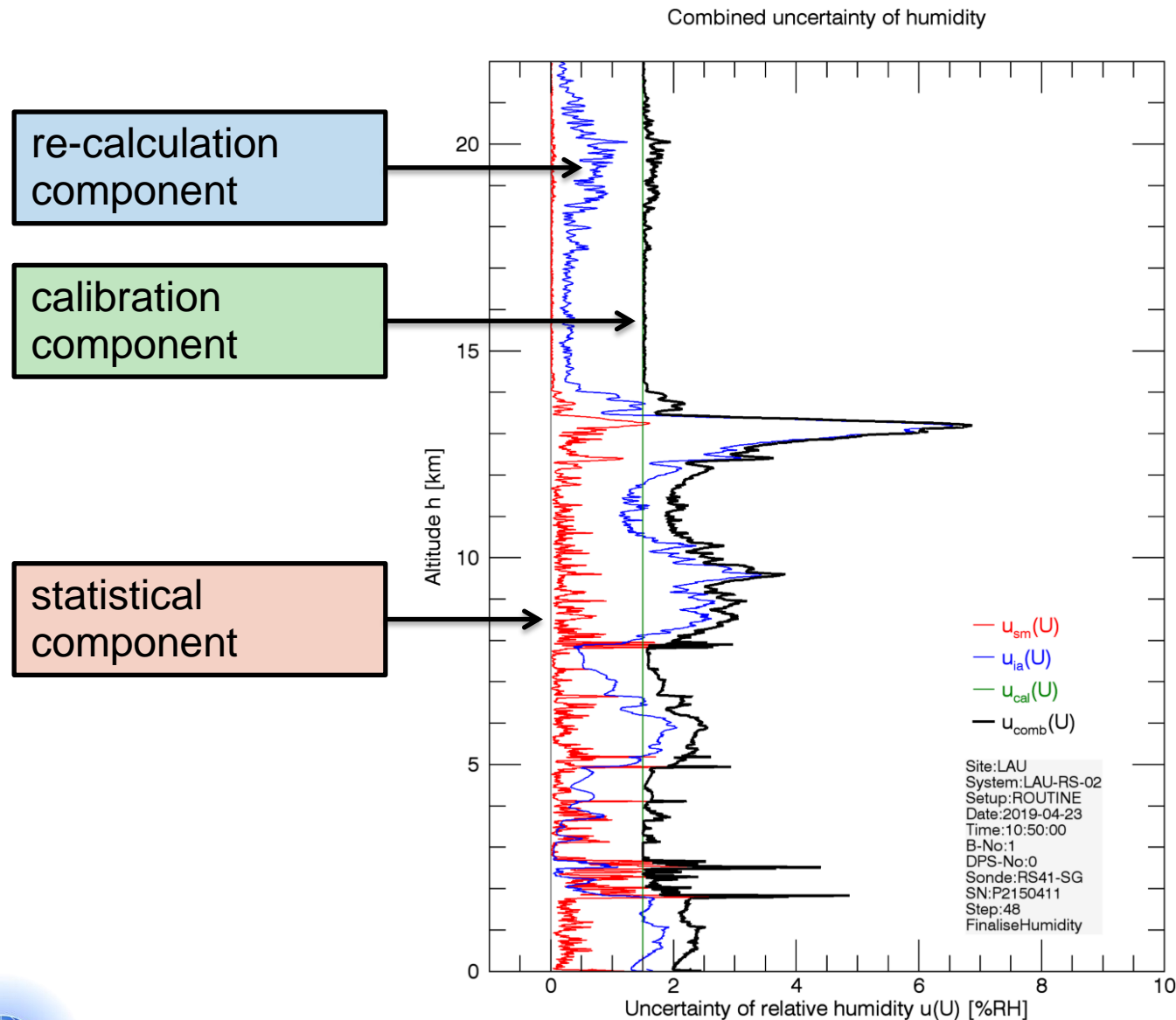
Analysis of Timelag Correction



# 10: Recalculation of RH – from $T_{\text{sensor}}$ to $T_{\text{air}}$



# 11: Estimate uncertainty of RH



- Time-lag correction of humidity → (**solved**) included in next version
  - Over-correction in case of very high and humid tropopauses, e.g. Singapore
- Altitude and pressure (GNSS, sensor) → (**open**)
  - linking of station pressure to launch altitude (if RS41 without pressure sensor)
  - drift of pressure sensor before launch (if RS41 with pressure sensor)
  - use correct altitudes of ground equipment (meta-data) at all GRUAN sites
- Launch detection (if RS41 without pressure sensor) → (**open**)
  - launch from inside an autolauncher or house
- Radiation correction → (**in progress**)
  - using of results from NEW radiation chamber (with sonde rotation)

- Main development phase since ICM-10 (2018-05 to 2019-01)
- Release of ALPHA.1 (2019-02-08) – LC intern only
- Release of ALPHA.2 (2019-03-04) – available to selected tester
- Release of ALPHA.3 (summer 2019) – all main issues solved (GOAL)
  - release more ALPHA versions if necessary (hopefully not)
- Release of BETA.1 (end of 2019) – RC1: data analysis
- Writing documentation (already started) and paper
- Certification and release of final **RS41-GDP.1**

ICM-10

ICM-11

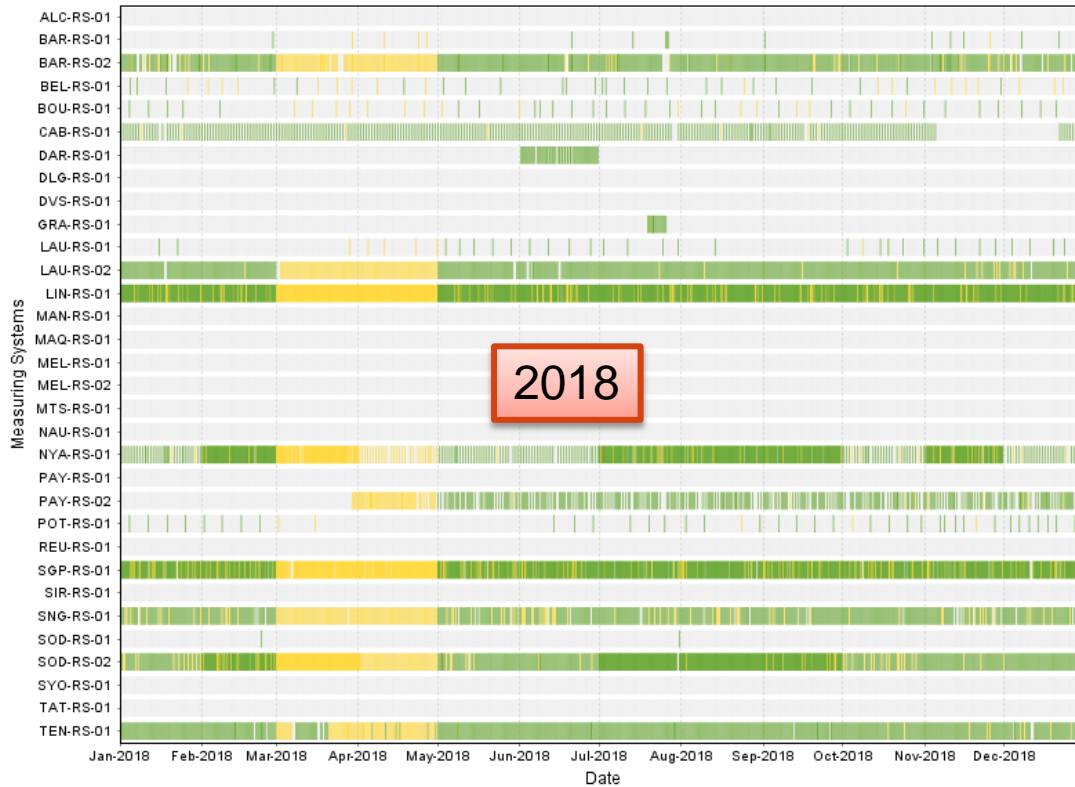
TD & article

# Processing status and many thanks

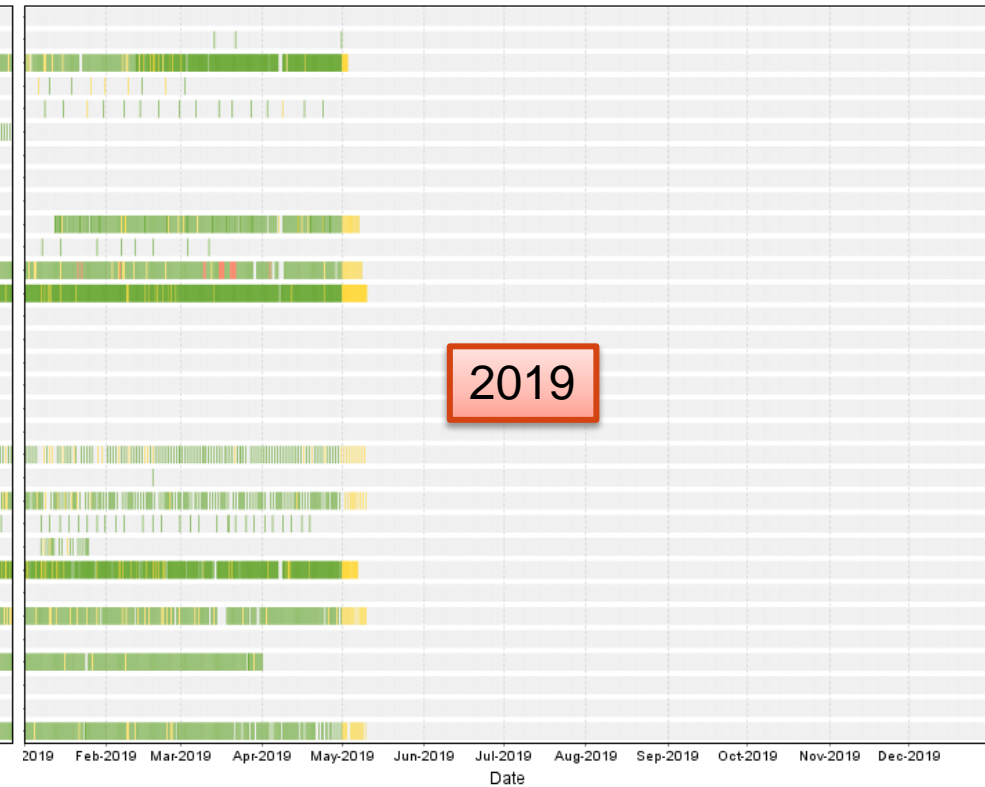
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Wetter und Klima aus einer Hand



Availability of GRUAN Data Product RS41-GDP-ALPHA.2



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Many thanks to all sites for RS41 measurements performed.

