



GRUAN fundamentals

(GRUAN basics for new ICM participants)

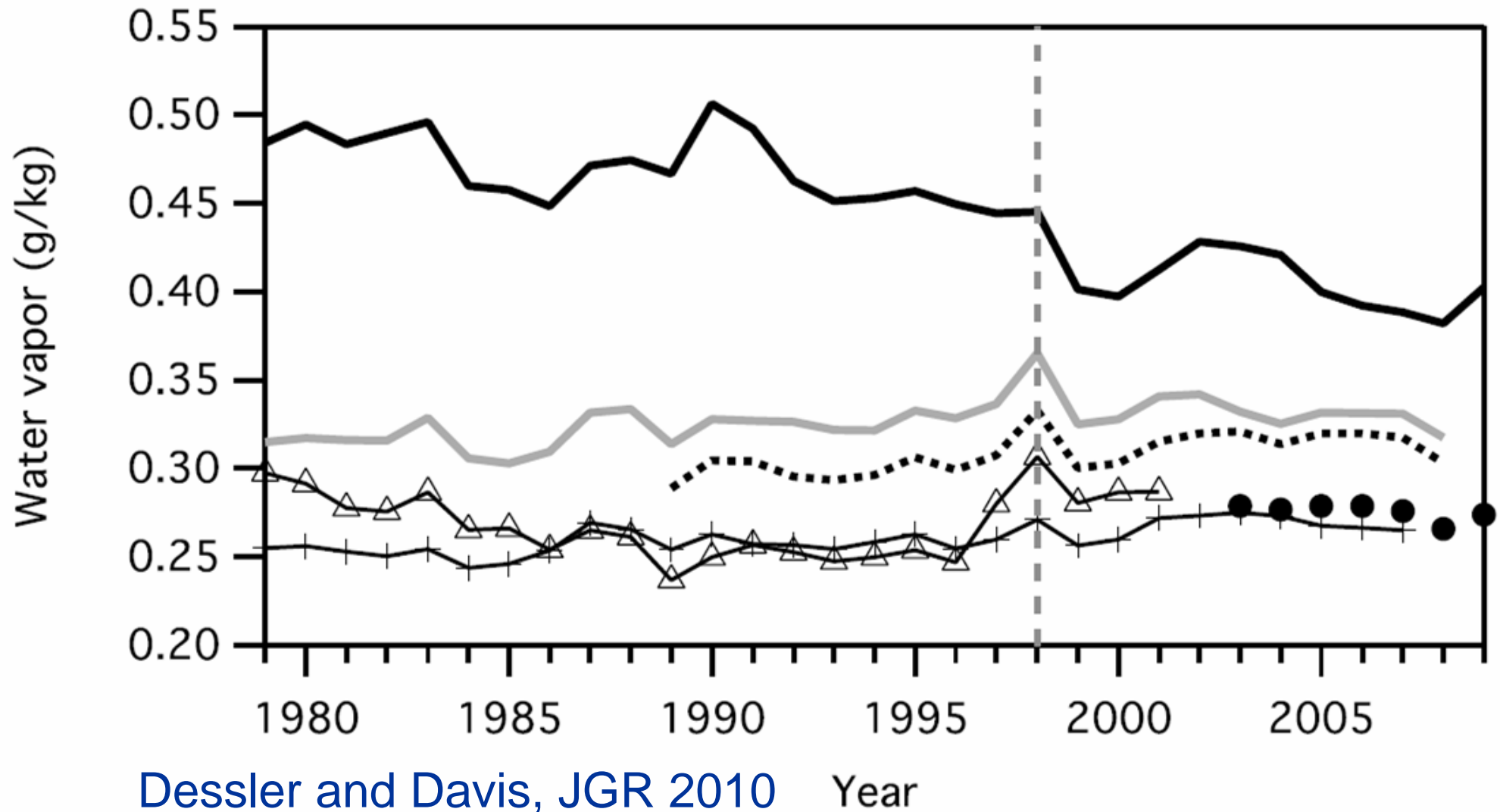
Ruud Dirksen
GRUAN Lead Centre, DWD

14th GRUAN Implementation and Coordination Meeting (ICM-14)
Saint Denis, La Reunion
28 Nov- 2 Dec 2022

Motivation for GRUAN (GCOS Reference Upper Air Network)

- Lower troposphere (PW):
- “Radiosonde, GPS and satellite observations of tropospheric water vapor indicate very likely increases at near global scales since the 1970s”
- Upper troposphere: **Alain Ratier (Dir. Eumetsat):**
“[the satellite community] needs calibrated reference data.”
GCOS science conference, Amsterdam, 02.03.2016
- “... the satellite platform from these records (of upper tropospheric humidity).”
- Stratosphere:
 - “Because of the large variability and relatively short time series, confidence in long-term stratospheric H₂O trends is low.”
- Lack of good reference measurements for climate observations

Specific humidity at 300 hPa



Dessler and Davis, JGR 2010

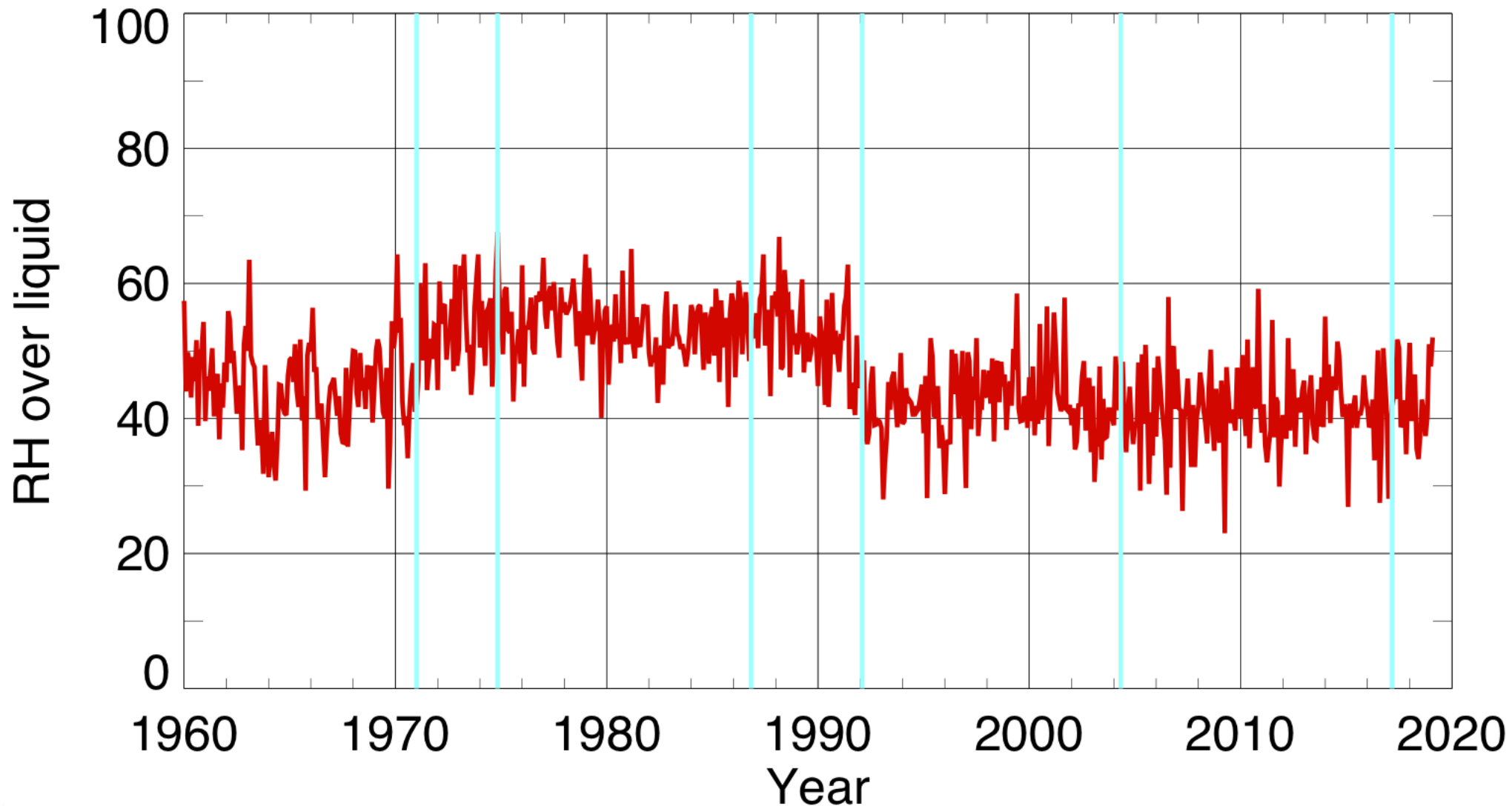
Year

Water vapor trends in the troposphere?

Deutscher Wetterdienst
Wetter und Klima aus einer Hand



Lindenberg 8km (0:00 UT)

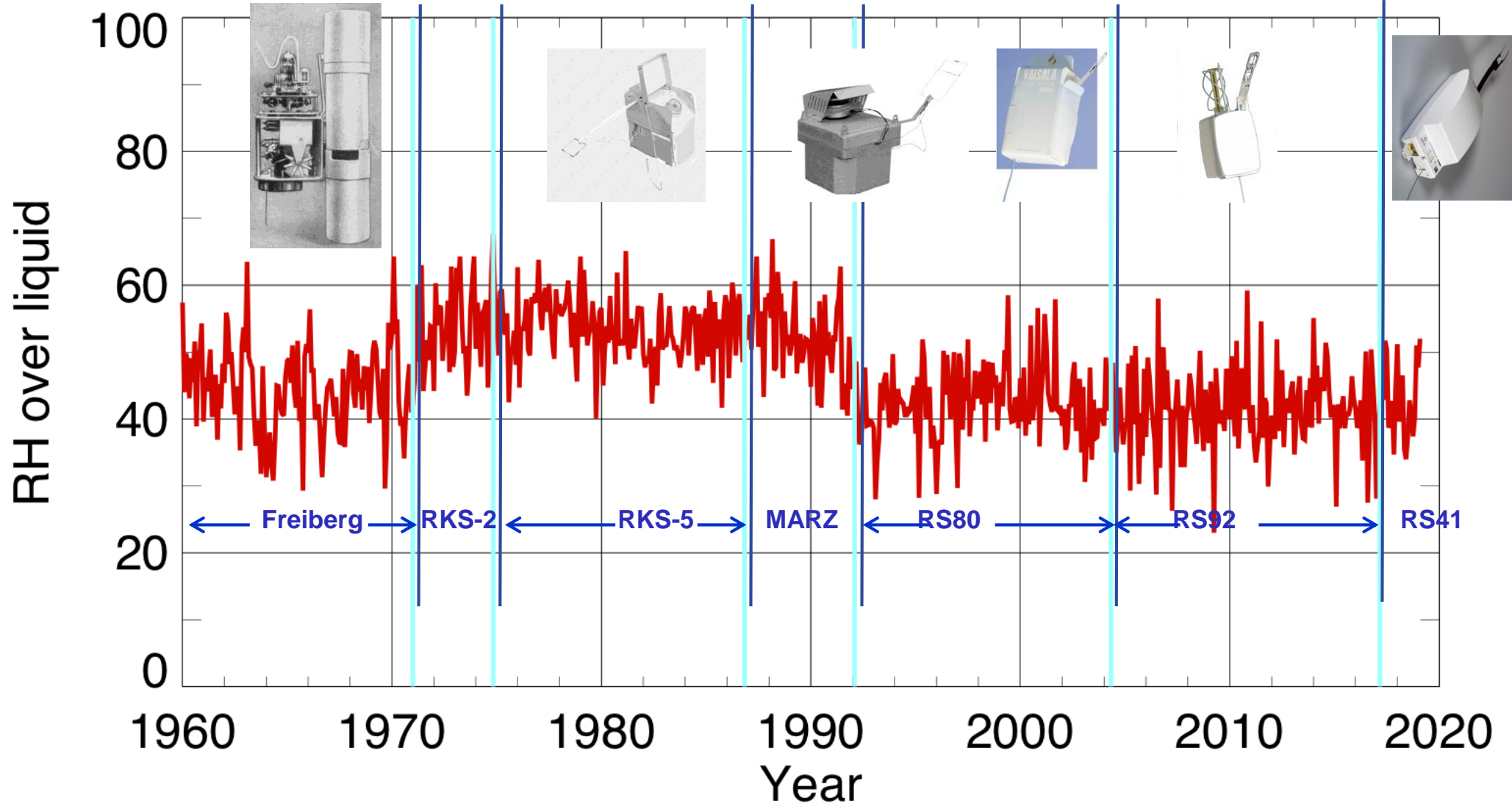


Water vapor trends in the troposphere?

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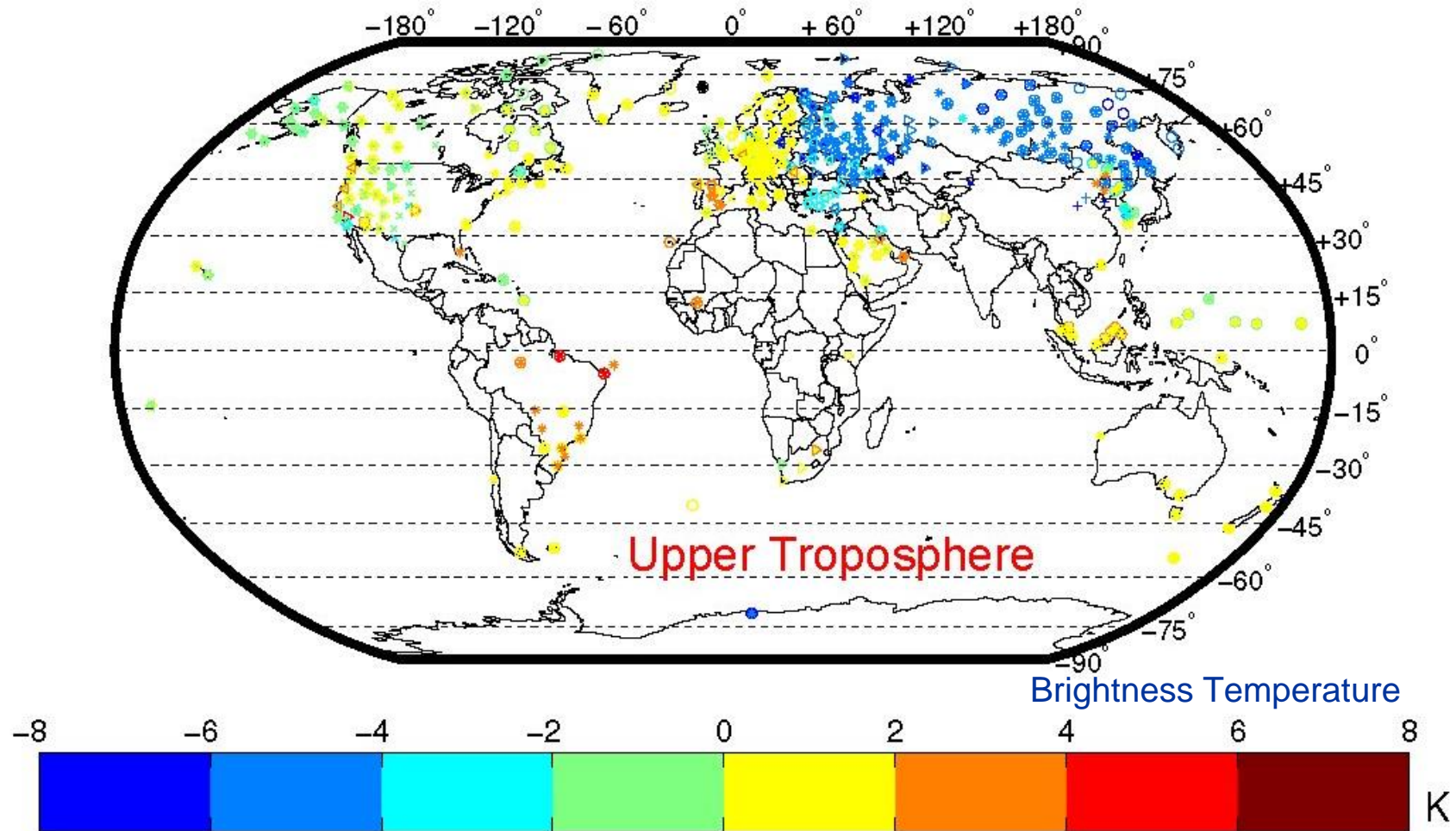


Lindenberg 8km (0:00 UT)



Upper Tropospheric Humidity: Difference Radiosonde – Satellite (2013)

Deutscher Wetterdienst
Wetter und Klima aus einer Hand



Moradi et al. JGR 2013

- G
- O
- G
- C
- In
- S



2018

ents

GCOS Reference Upper Air Network

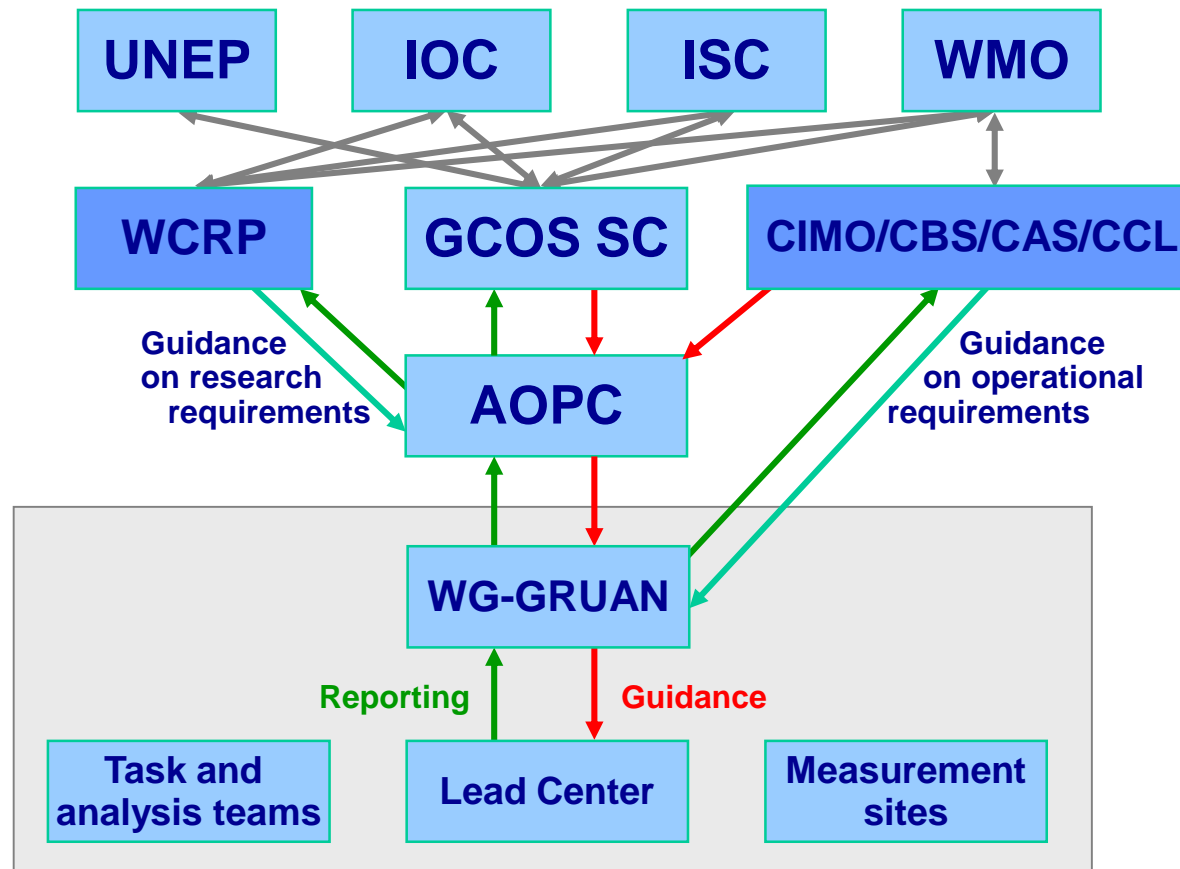
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GCOS Reference Upper-Air Network



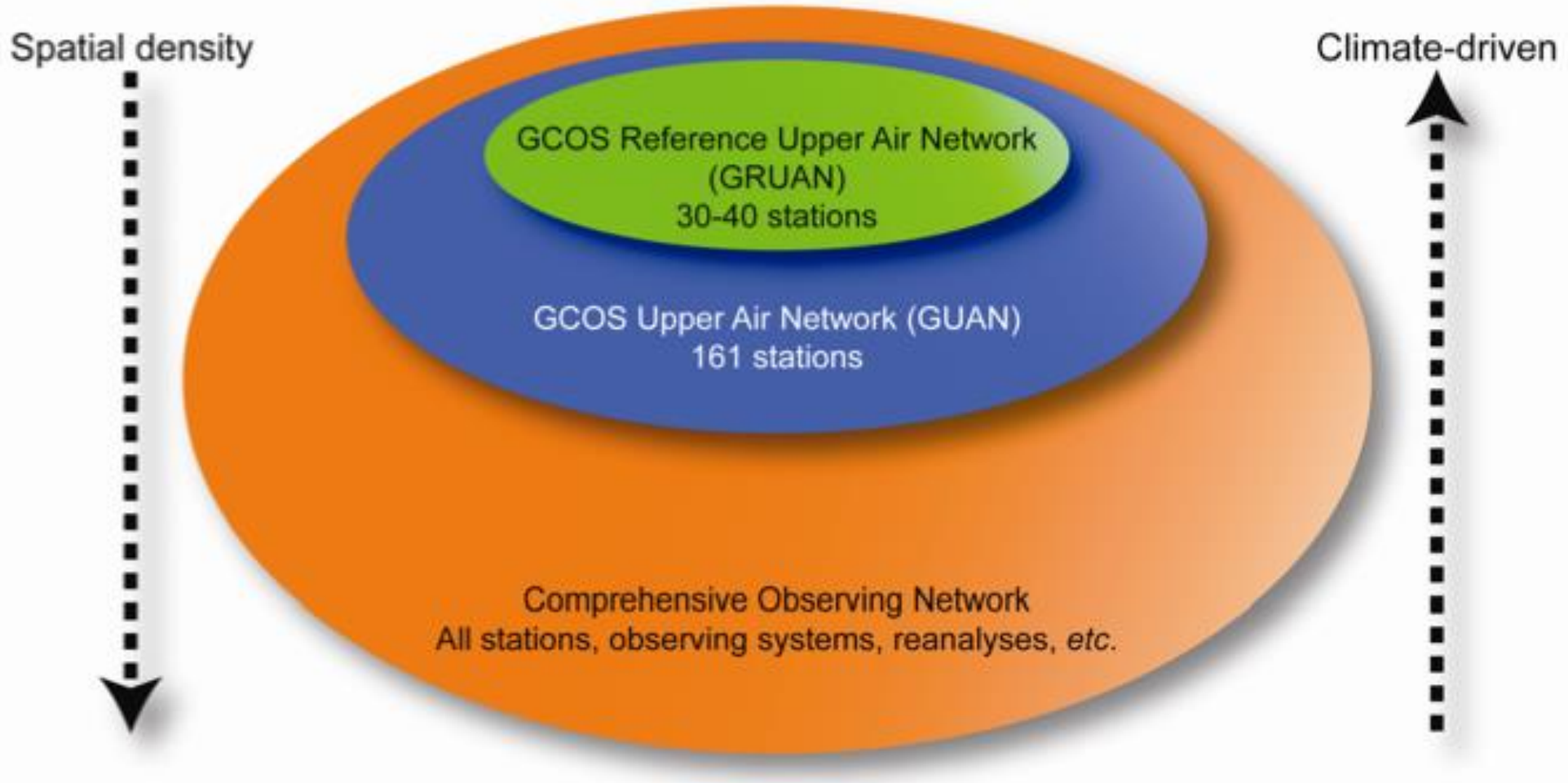


AOPC:
Atmospheric
Observation
panel for
Climate

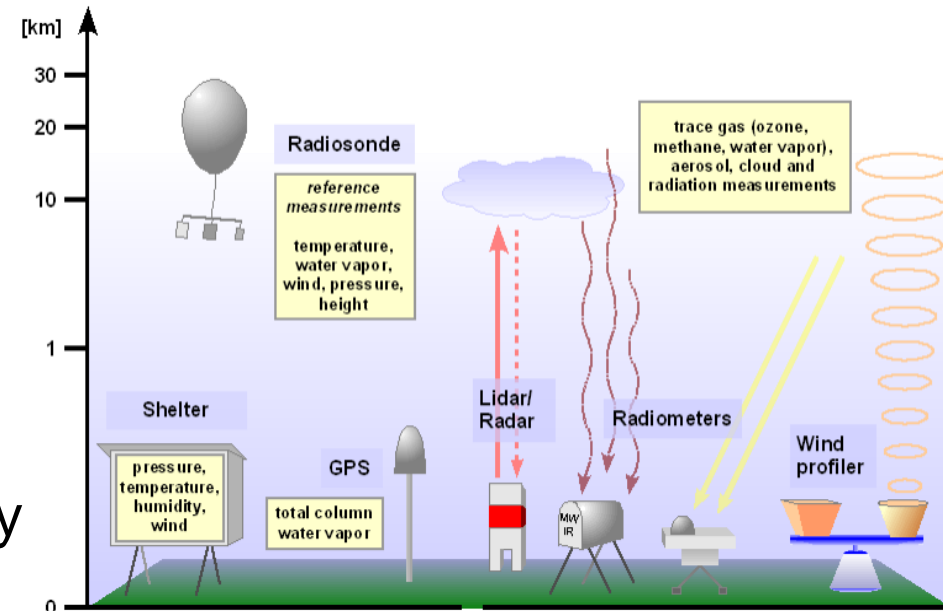
- Lead Centre: day-to-day management of the network
 - Coordination among stations
 - Archival and dissemination of GRUAN data

GRUAN's relationship to existing observational networks

Deutscher Wetterdienst
Wetter und Klima aus einer Hand



- Maintain consistent observations over decades
- Validation of satellite systems
- Understanding of atmospheric processes
- Deliberate measurement redundancy
- Standardization and traceability
- Quality management and managed change

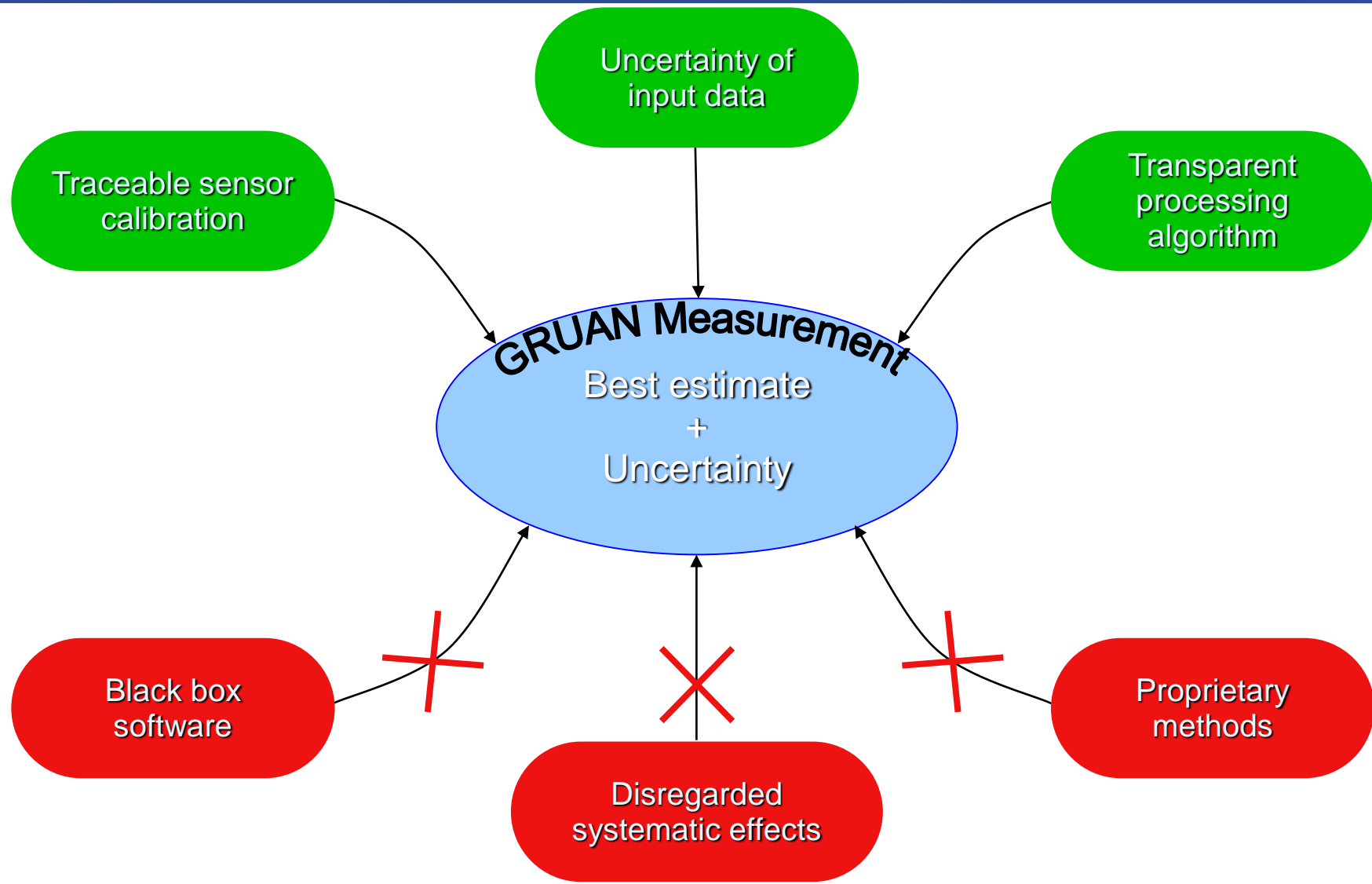


Priority 1: Water vapor, temperature, (pressure and wind)

Priority 2: Ozone, ...

A GRUAN reference observation:

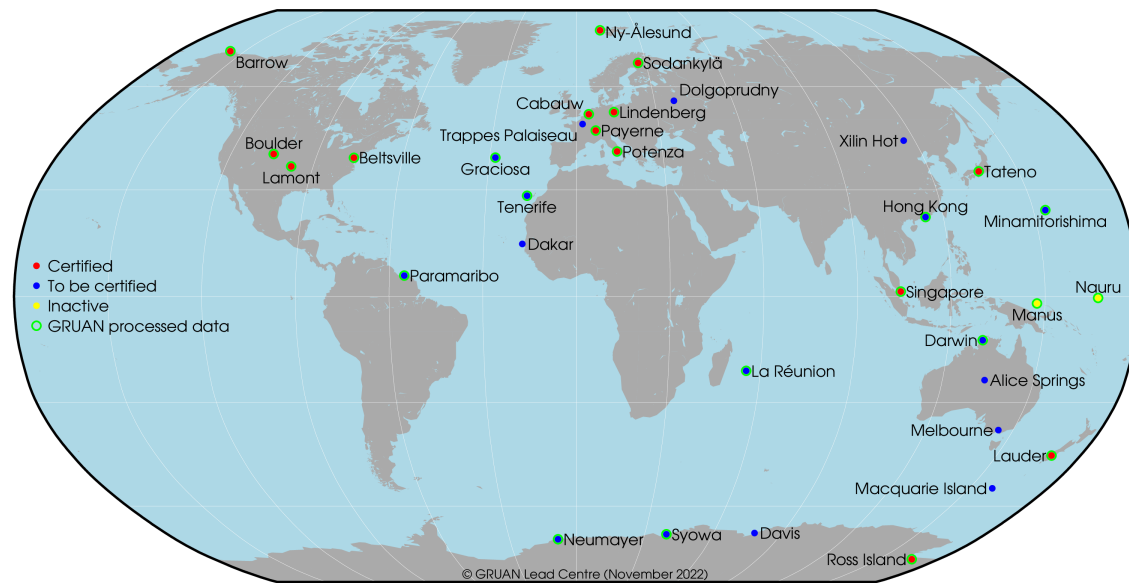
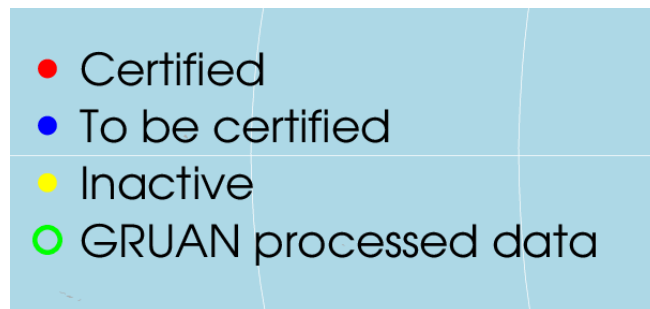
- ✓ Is traceable to an SI unit or an accepted standard
- ✓ Provides a comprehensive uncertainty analysis
- ✓ Maintains all raw data
- ✓ Includes complete meta data description
- ✓ Is documented in accessible literature
- ✓ Is validated (e.g. by intercomparison or redundant observations)



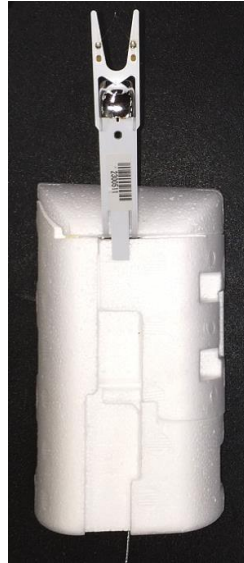
- Change management is mandatory
- A new system, software, or procedure must be evaluated prior to implementation
- Systematic and random errors must be quantified for the new system
- Redundant observations verify the new system (overlap)
- Use transfer functions on old data where required
- Example: RS92-RS41 transition

- Assessment of the site's measurement program
 - (e.g. continuity, operational procedures, change management)
- GRUAN-approved measurement quality

GCOS Reference Upper-Air Network



- GRUAN Dataproducts for Radiosondes:
 - Vaisala RS92, RS41, Meisei RS-11G, iMS-100
 - Modem M10, Graw DFM-9, DFM-17
- Other products & data:
 - GNSS-PW (total water vapor column)
 - Lidar (T, U)
 - Microwave-Radiometer (T, U)
- Archive of >100k Radiosonde-profiles
- > 100 GRUAN-related publications



ICM-1



Lindenberg Meteorological Observatory
Richard-Aßmann-Observatory



- Providing long-term reference observations of upper air essential climate variables
 - Quantified uncertainties
 - Well documented
 - Verify in redundant observations
 - Change management
 - Traceable

- Being a network
 - Gaining & sharing knowledge (task teams, lab-facilities)
 - Interaction with user community (ICM)



