

# GRUAN basics for new GRUAN ICM participants

Ruud Dirksen

GRUAN Lead Centre

DWD Meteorological Observatory  
Lindenberg

ICM-7  
23 February 2015



# 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 ....“

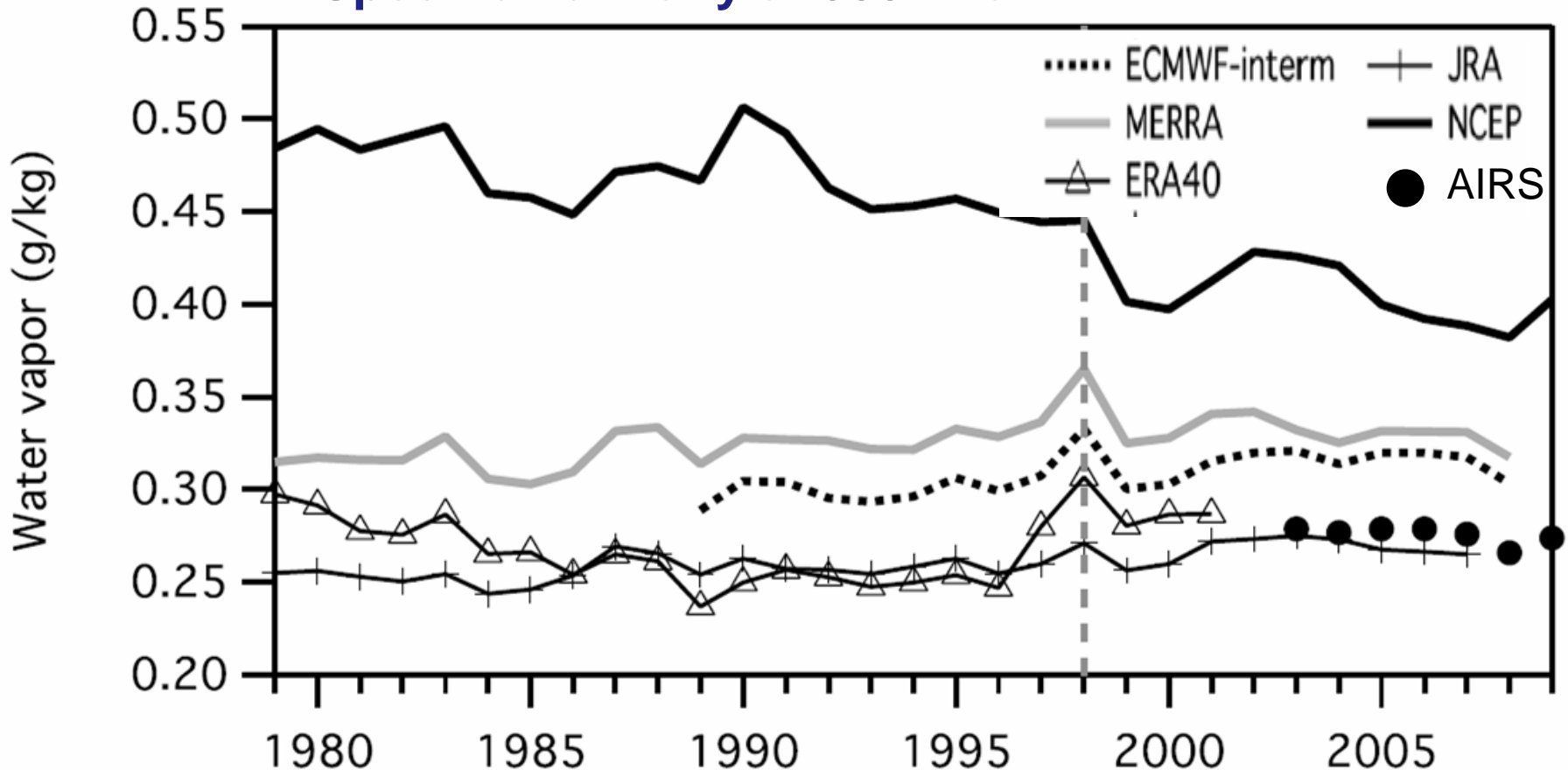
Upper troposphere:

“... the absence of a homogenized data set across multiple satellite platforms presents some difficulty in documenting coherent trends from these records (of upper tropospheric humidity).”

Stratosphere:

“Because of the large variability and relatively short time series, confidence in long-term stratospheric H<sub>2</sub>O trends is low.”

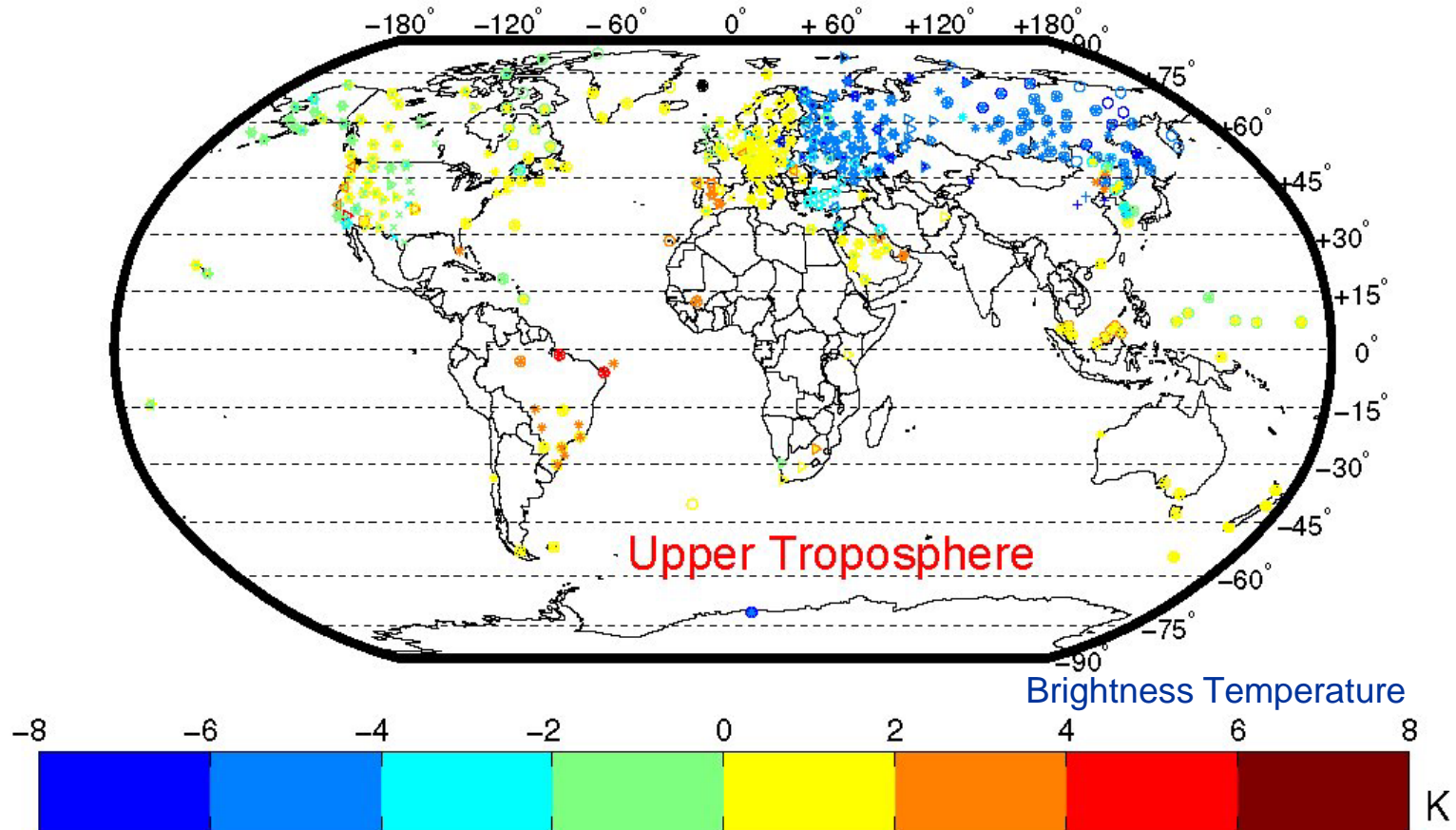
## Specific humidity at 300 hPa



Dessler and Davis, JGR 2010 Year

# Upper Tropospheric Humidity: Difference Radiosonde – Satellite (2013)

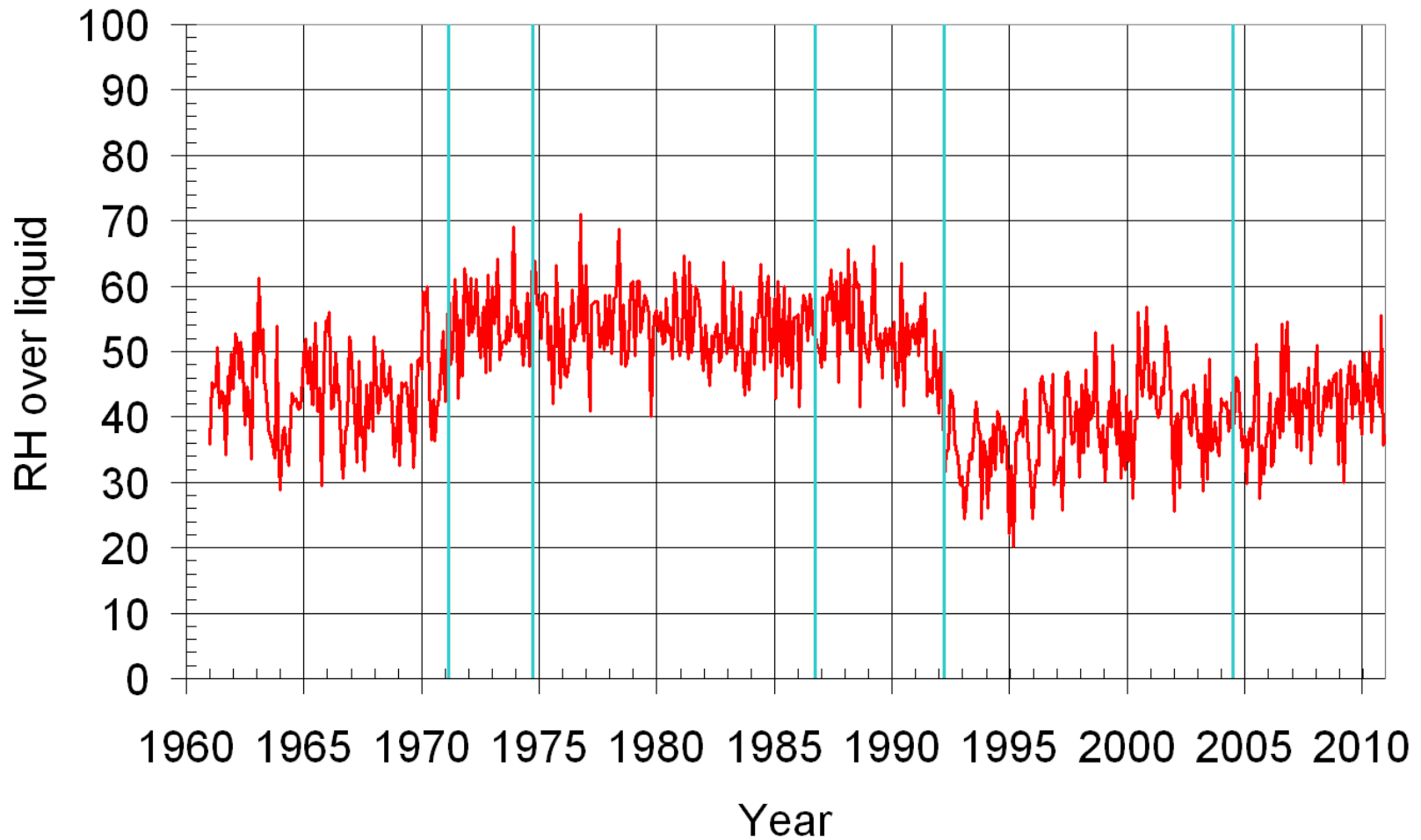
Deutscher Wetterdienst  
Wetter und Klima aus einer Hand



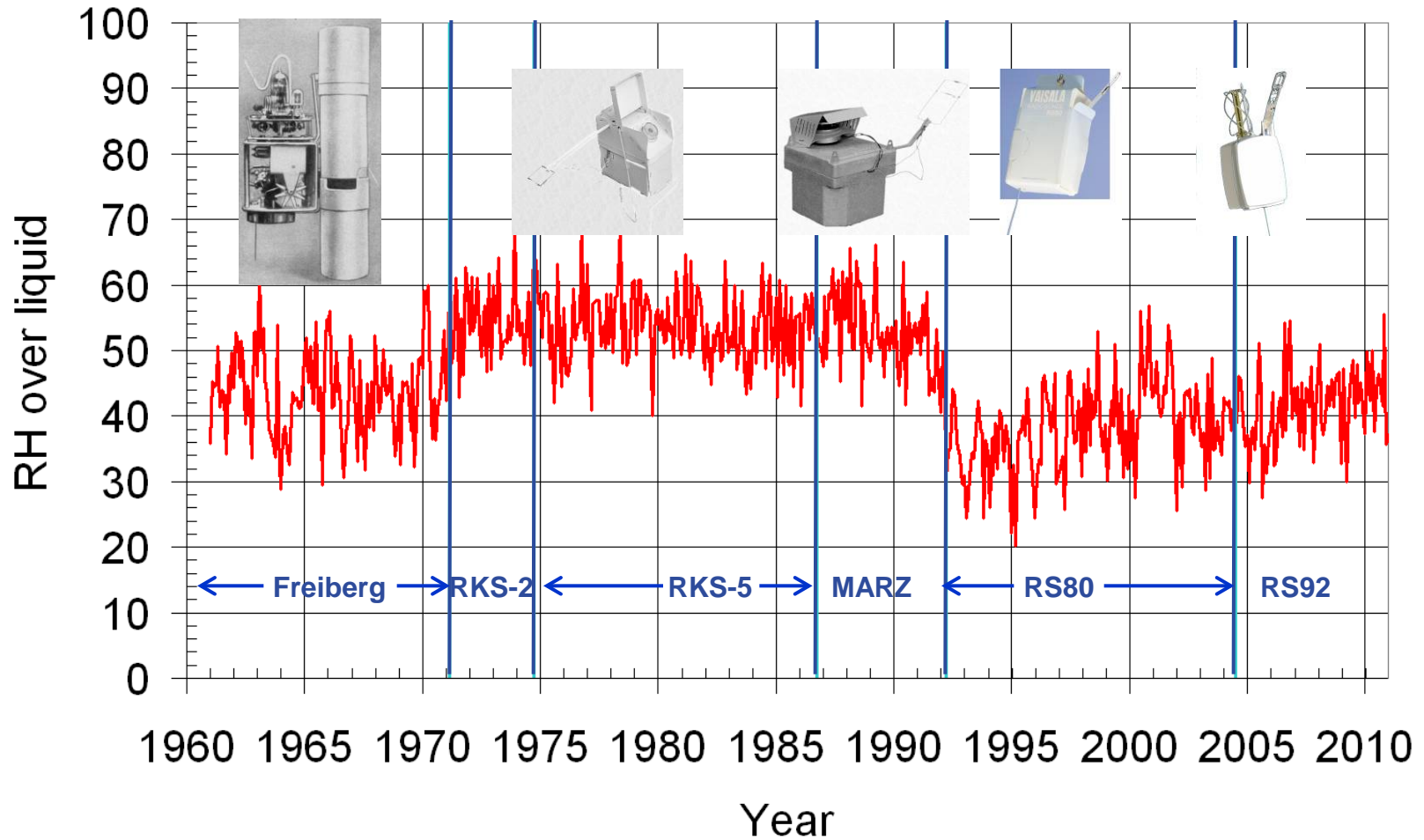
Moradi et al.: Assessing the quality of humidity measurements from global operational radiosonde sensors, J. Geophys. Res. 118, 8040–8053, 2013.



## e.g.: Lindenberg 8km (0:00 UT)



## e.g.: Lindenberg 8km (0:00 UT)



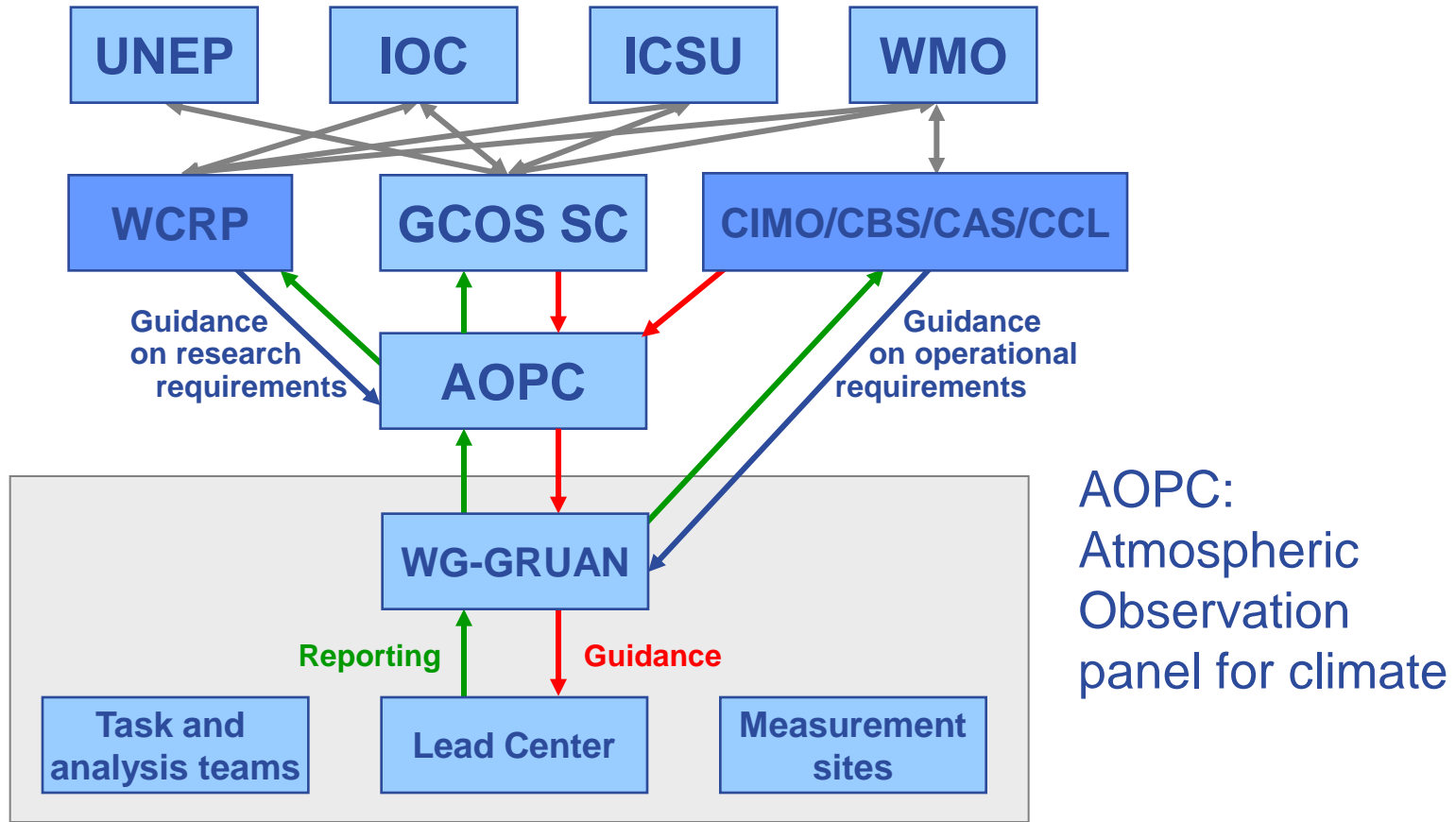
## What is GRUAN?



- GRUAN is response to the need of WMO and the Global Climate Observing System for highest accuracy data possible
- Ground based network for reference upper air observations for climate under GCOS and integrated into WIGOS
- Currently 16 sites, with aim to expand to 30 to 40 sites worldwide
- Started in 2008



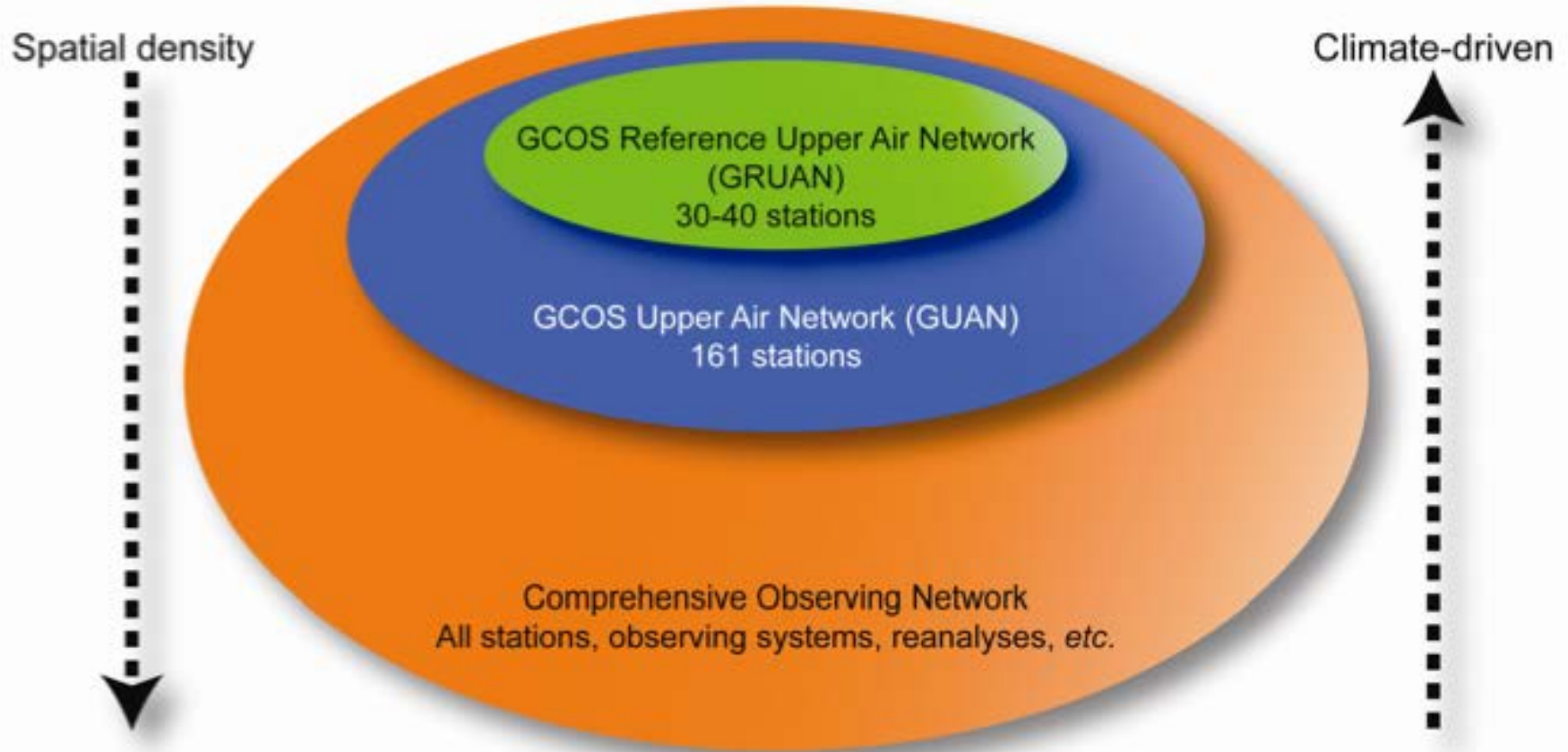
See [www.gruan.org](http://www.gruan.org)



- 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

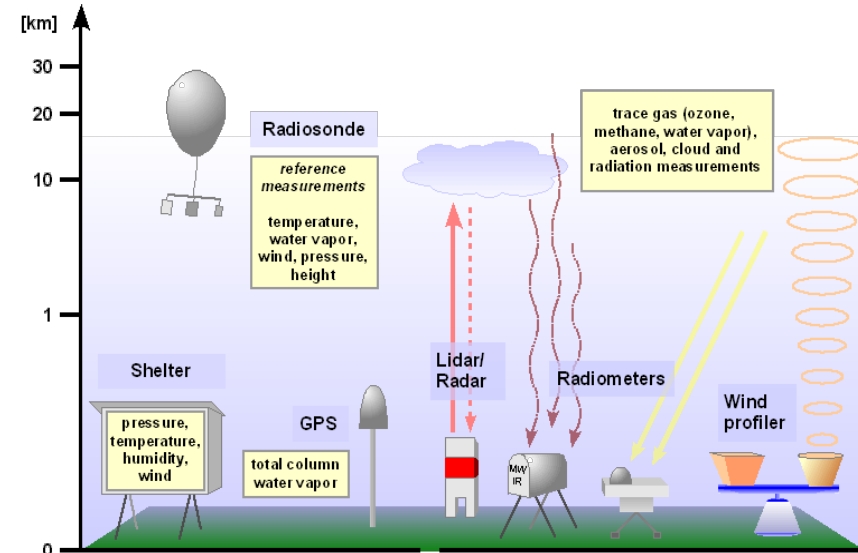


Seidel et al., 2009



What are GRUAN's goals?

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

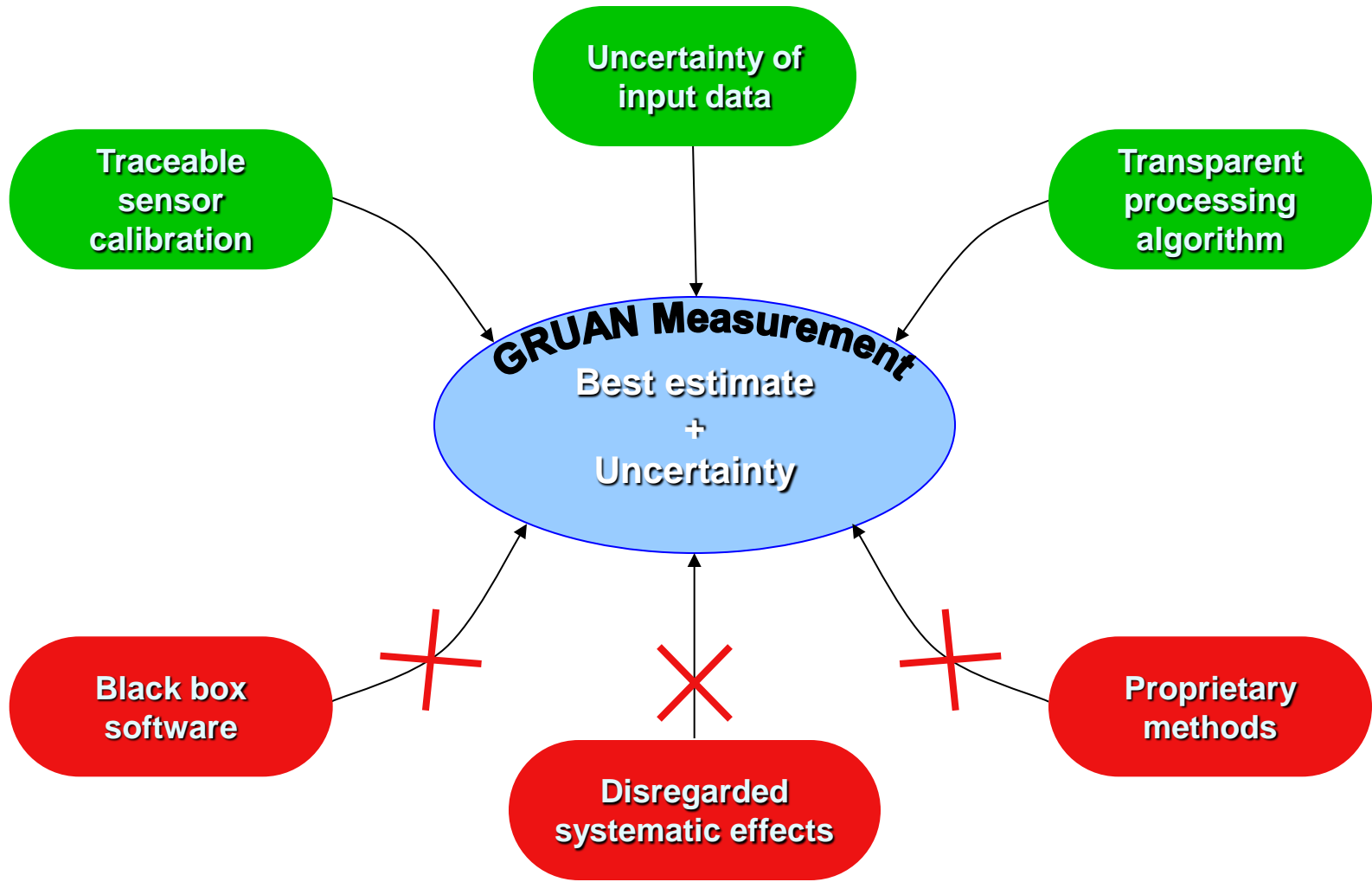


Priority 1: Water vapor, temperature, (pressure and wind)

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

- GRUAN has a long term view to observations of upper air essential climate variables
- Focus on priority 1 variables to start: Water vapor and temperature (starting to bring in other variables)
- *Reference* observation means:
  - ✓ quantified uncertainties
  - ✓ traceable
  - ✓ well documented
  - ✓ verify in redundant observations
- Management of change utilizes measurement uncertainty



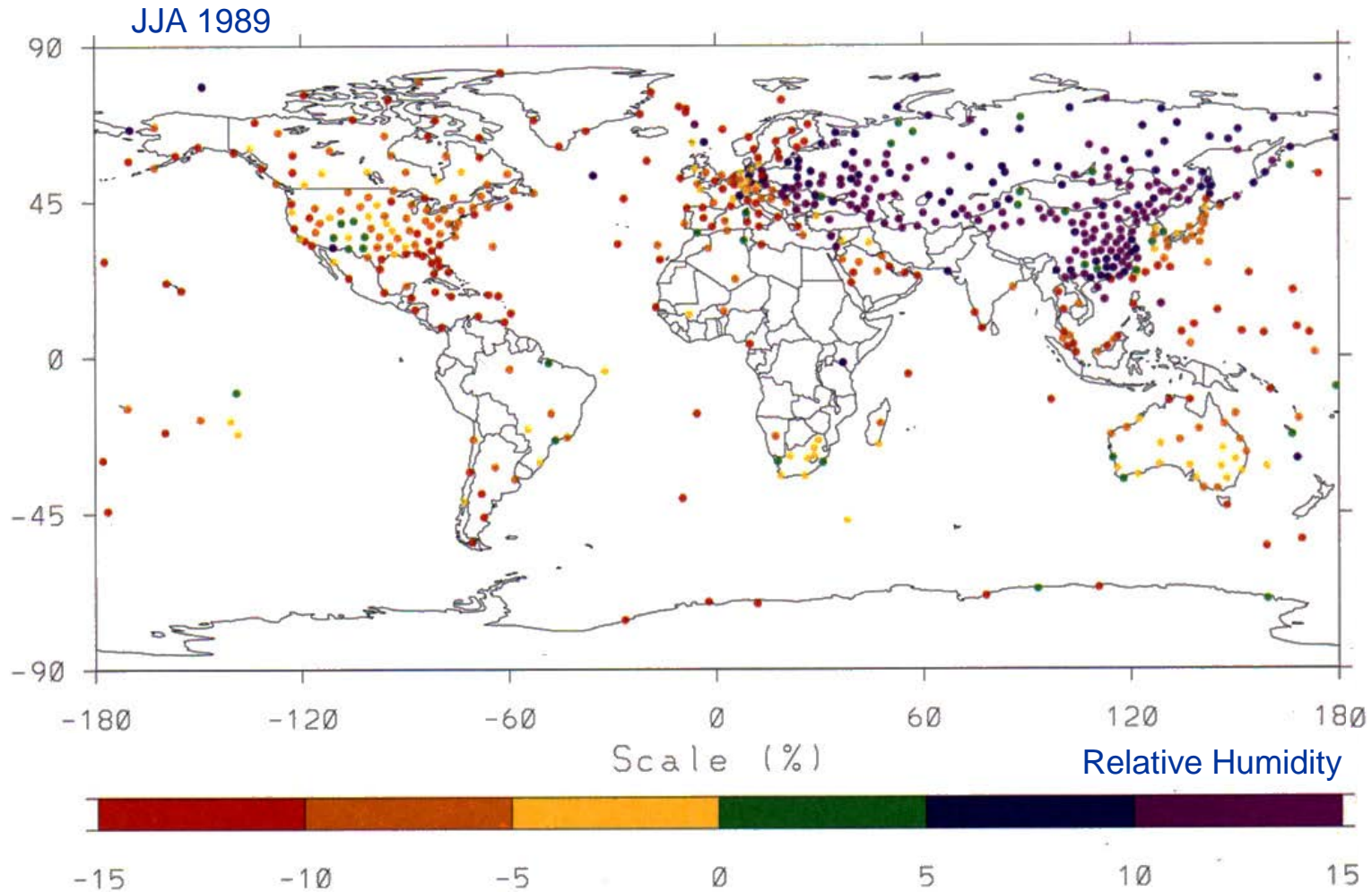
- Analyze sources of uncertainty:  
systematic: calibration, radiation errors, ...  
random: noise, production variability, ...  
Document this!
- Synthesize best uncertainty estimate:  
Uncertainties for every data point, i.e. vertically resolved
- Raw data:  
Store all raw and all meta data to allow future reprocessing

- Characterize errors/biases
- Properly documented correction algorithms (no proprietary corrections)
- Uncertainty estimates



# Upper Tropospheric Humidity: Difference Radiosonde – Satellite (1996)

Deutscher Wetterdienst  
Wetter und Klima aus einer Hand



B. Soden and J. Lanzante, An assessment of satellite and radiosonde climatologies of upper tropospheric water vapor, *J. Clim.*, 9, 1235–1250, 1996.

