GRUAN basics for new GRUAN ICM participants

Ruud Dirksen

GRUAN Lead Centre

DWD Meteorological Observatory Lindenberg

ICM-8 Boulder
25 April 2016

Motivation for GRUAN

(GCOS Reference Upper Air Network)

IPCC AR5 long term trends

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 abse
platforms pr om
these recor

Stratospher

"Because of
confidence in long term stratospheric H_2O trends is low."

Alain Ratier (Dir. Eumetsat):

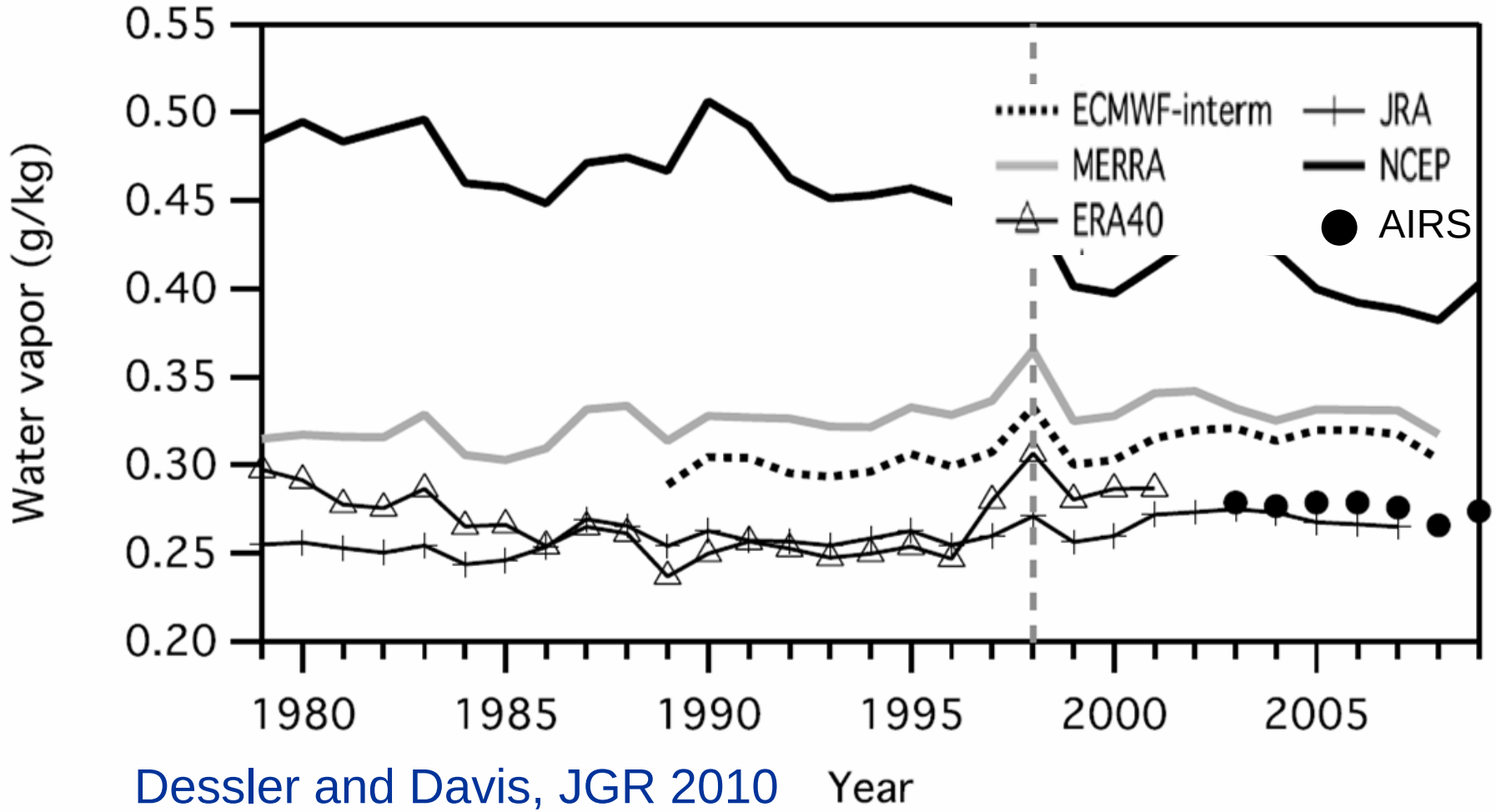
"[the satellite community] needs calibrated reference data."

GCOS science conference, Amsterdam, 02.03.2016

- Lack of good reference measurements for climate observations

Tropospheric water vapor trends

Specific humidity at 300 hPa

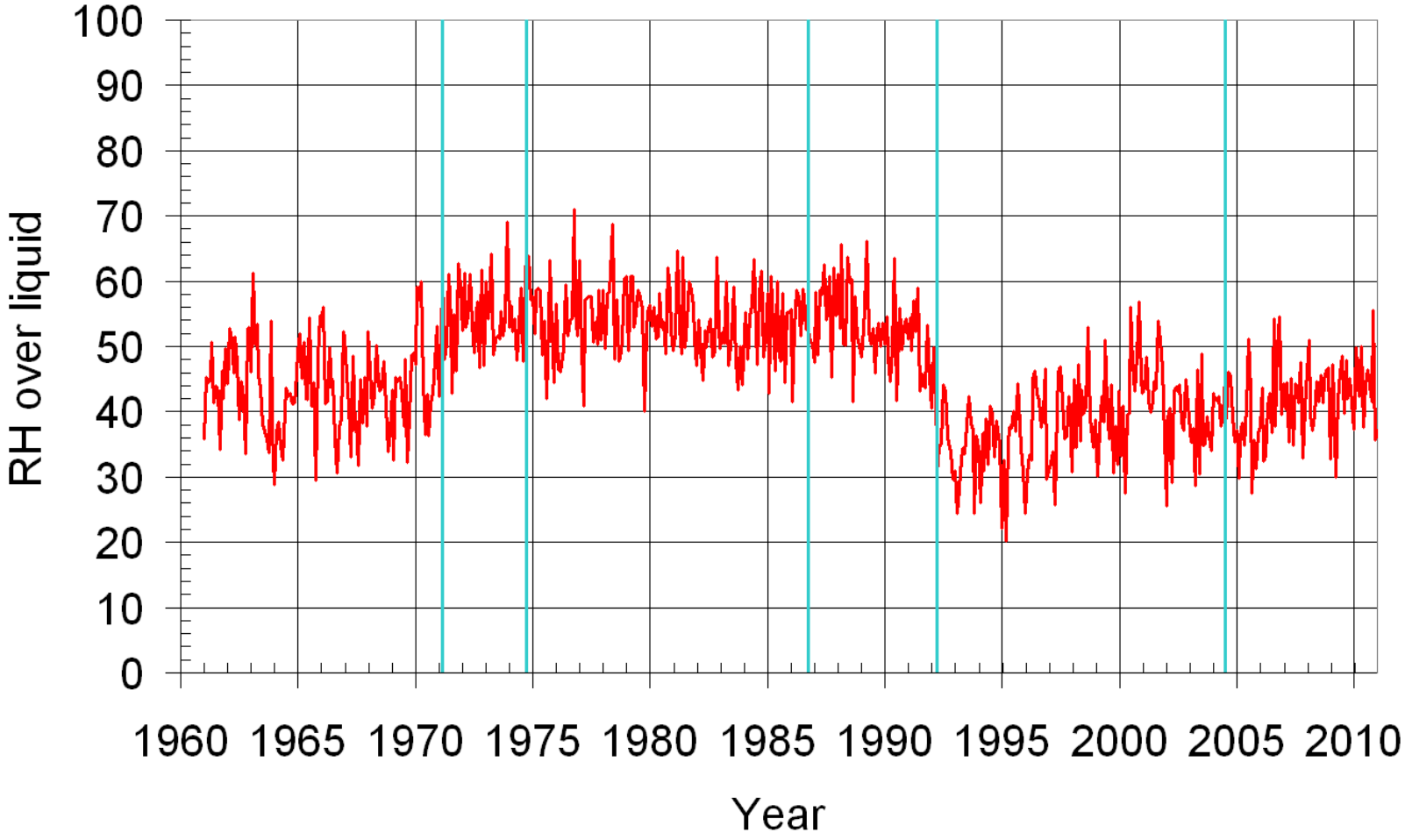


Dessler and Davis, JGR 2010

Water vapor trends in the troposphere?

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

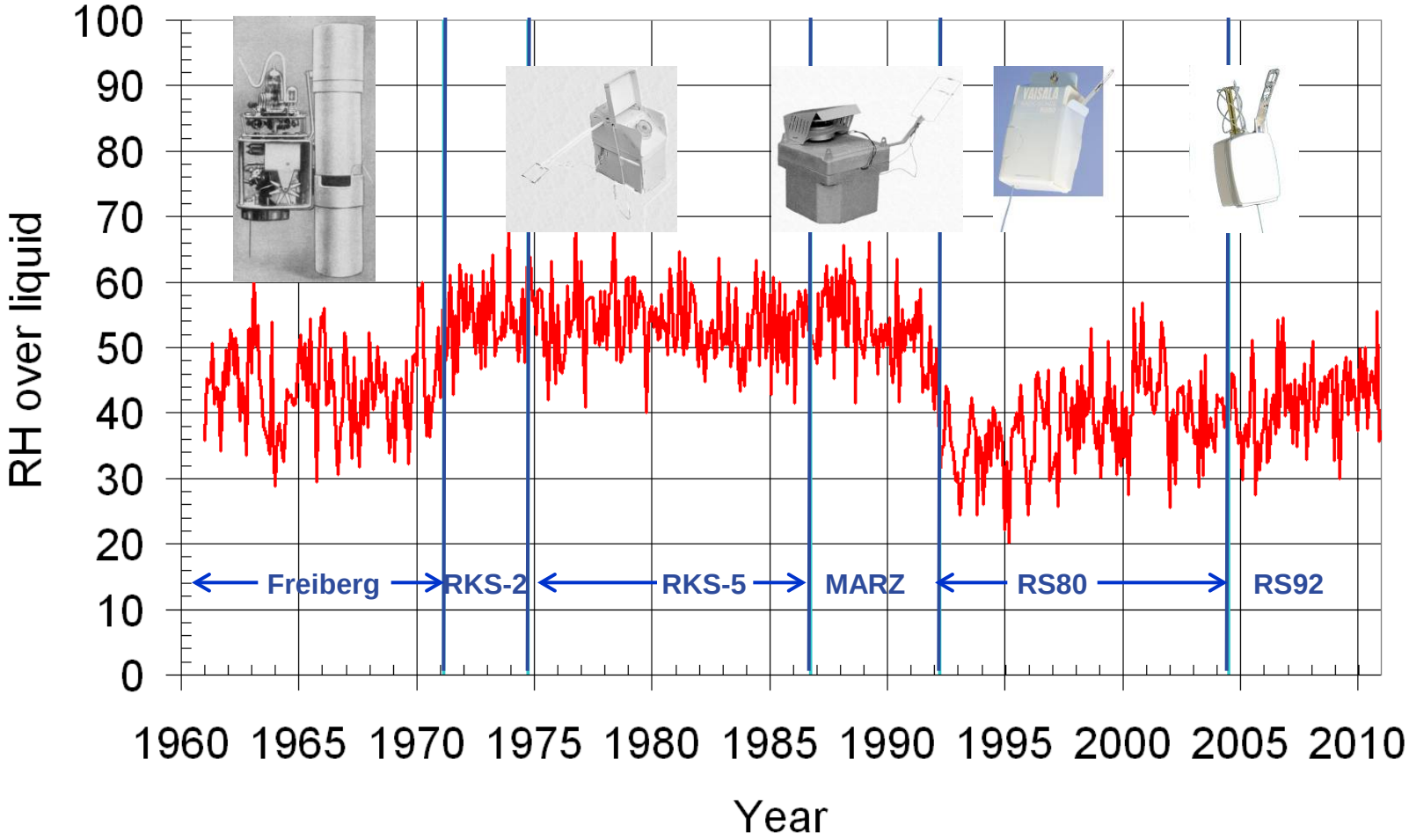
e.g.: Lindenberg 8km (0:00 UT)



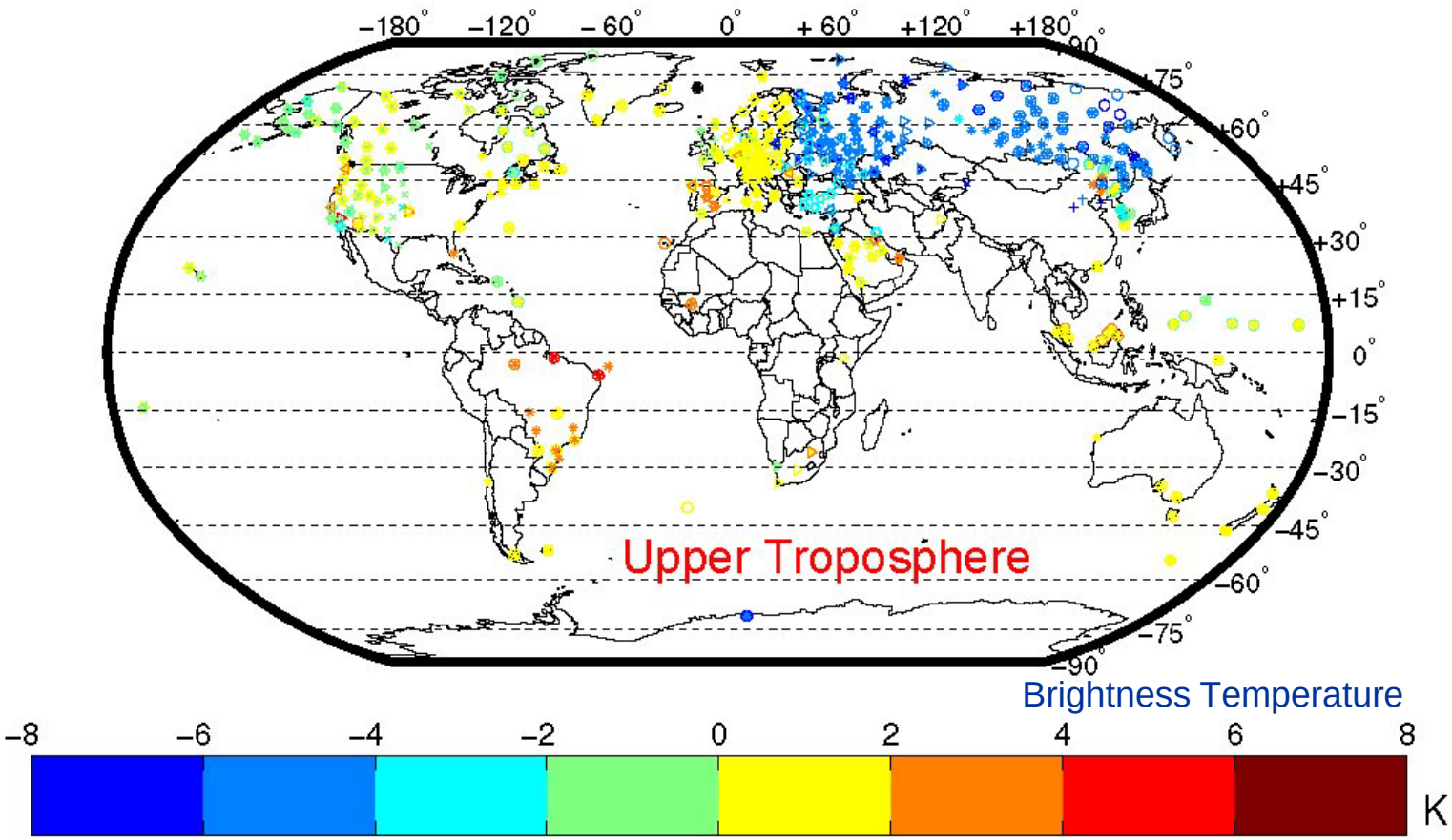
Water vapor trends in the troposphere?

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

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



Upper Tropospheric Humidity: Difference Radiosonde – Satellite (2013)



Moradi et al. JGR 2013

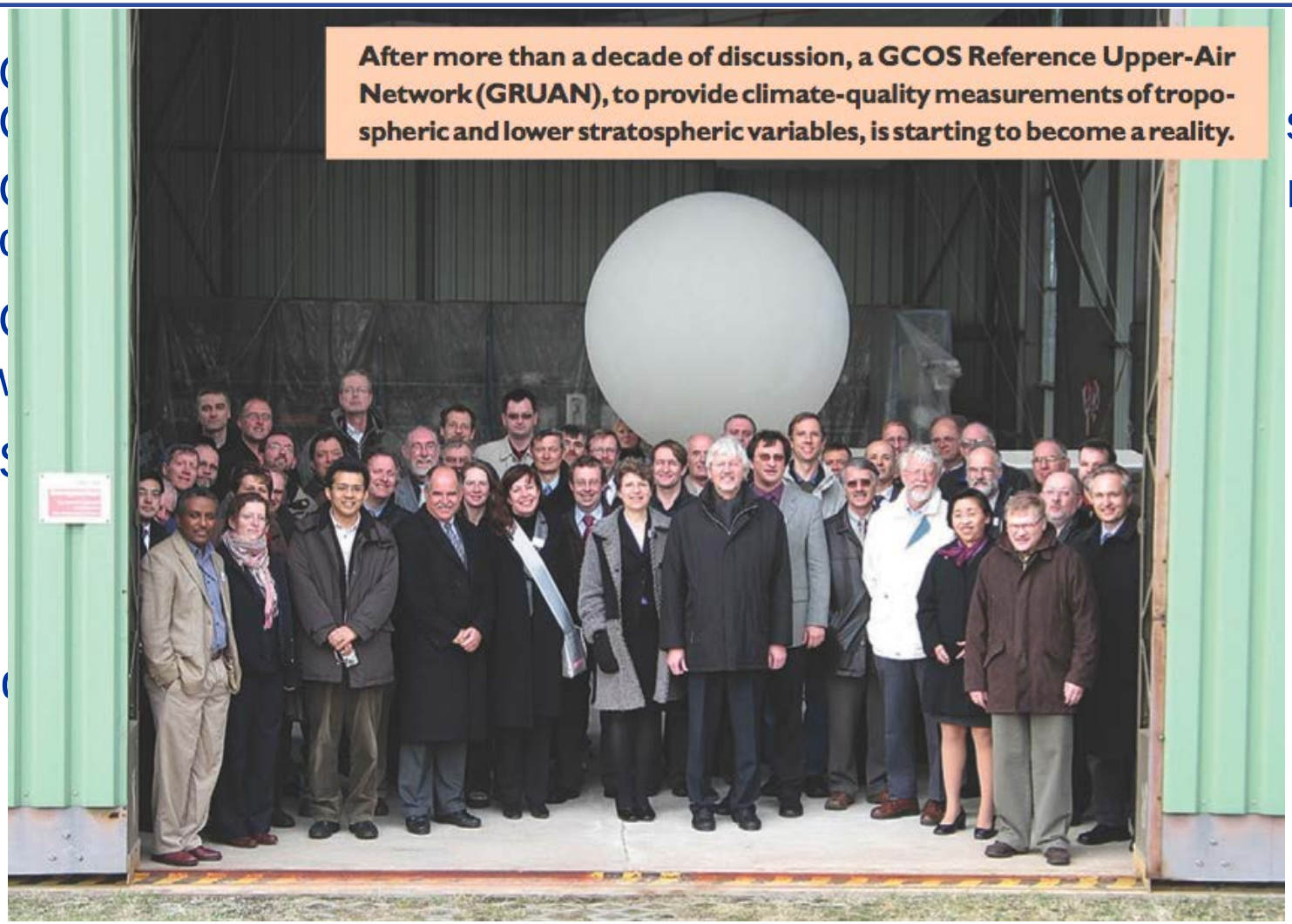
What is GRUAN?

GCOS Reference Upper Air Network

- G
  G
- G
  G
- G
  W
- S

→
Re

sible
ns for

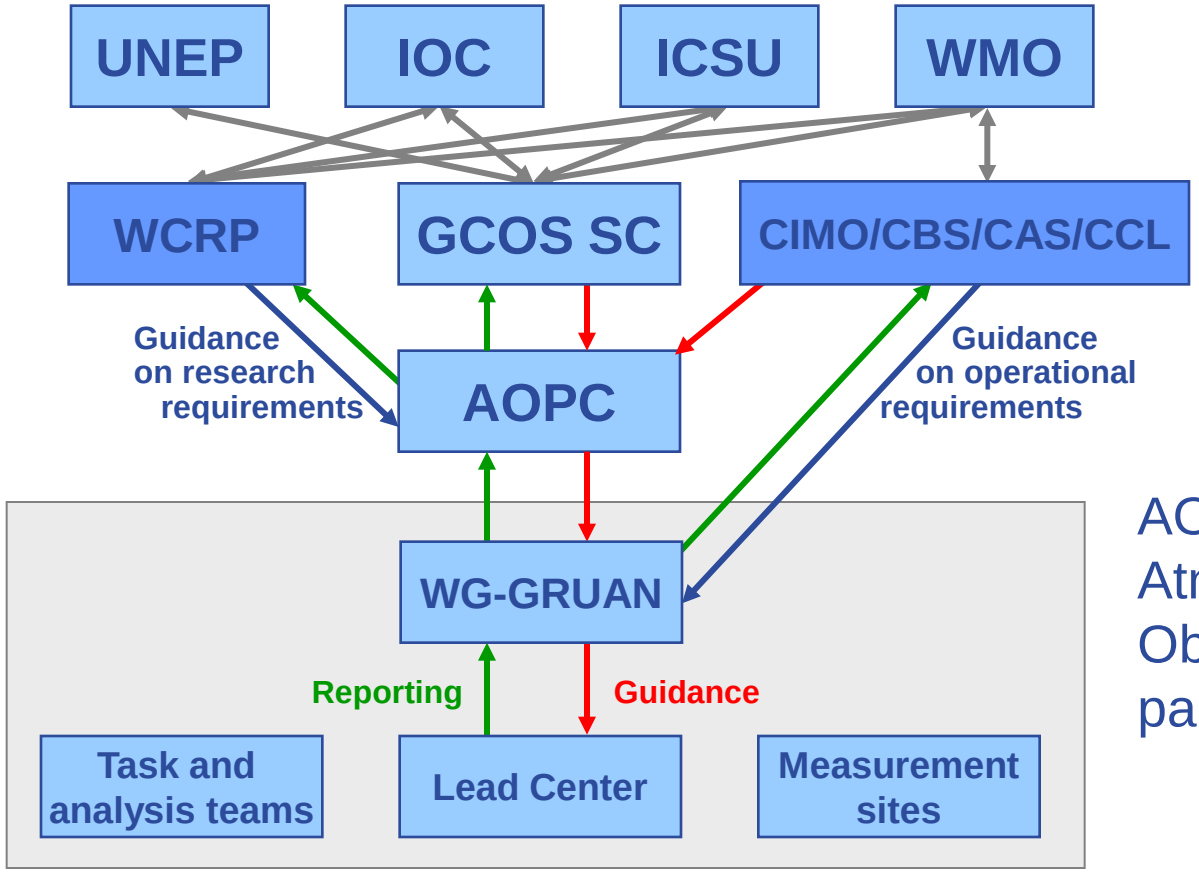


Seidel et al. 2009

GCOS Reference Upper Air Network

See **www.gruan.org**

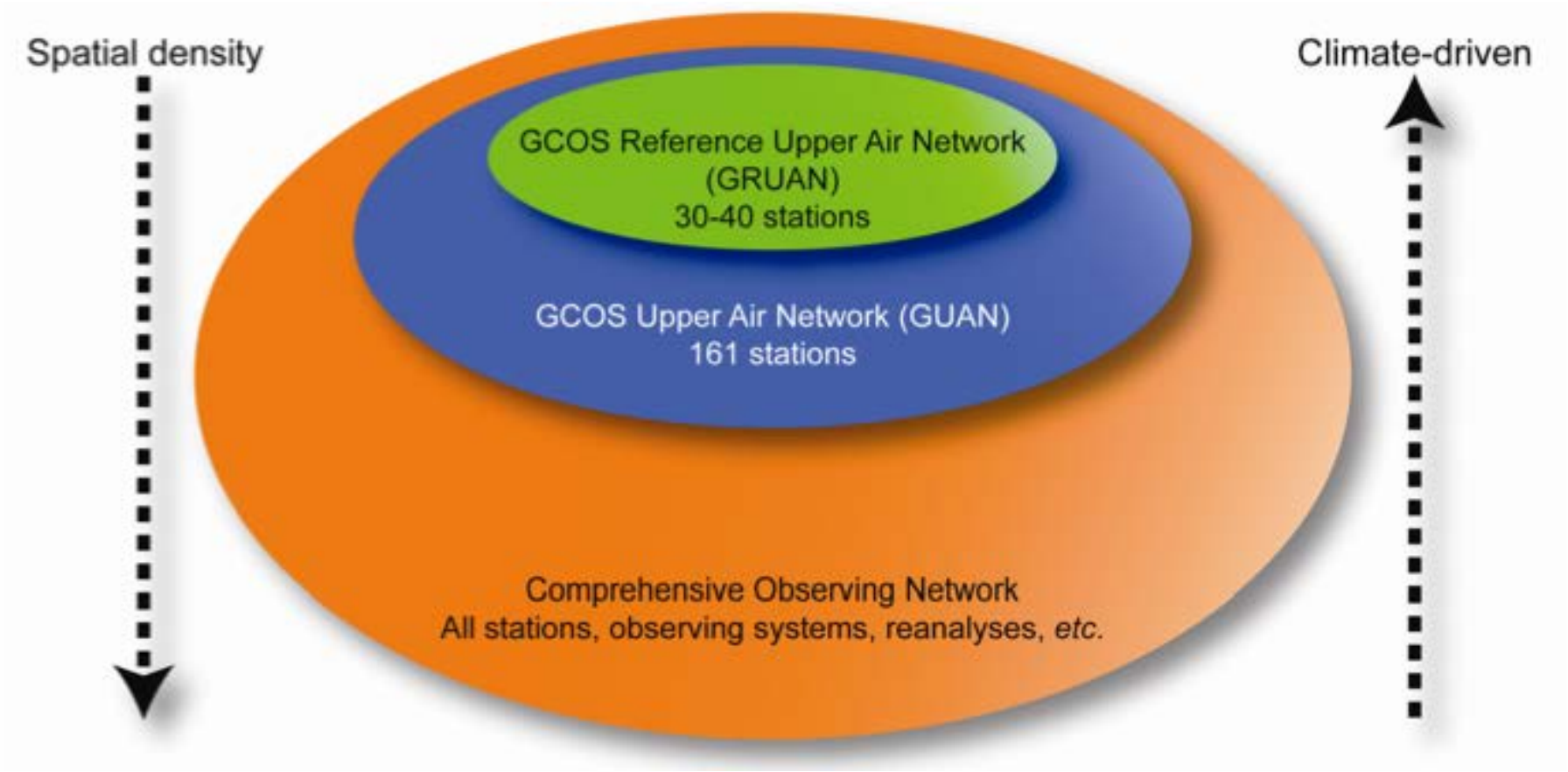
GCOS Reference Upper Air Network



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

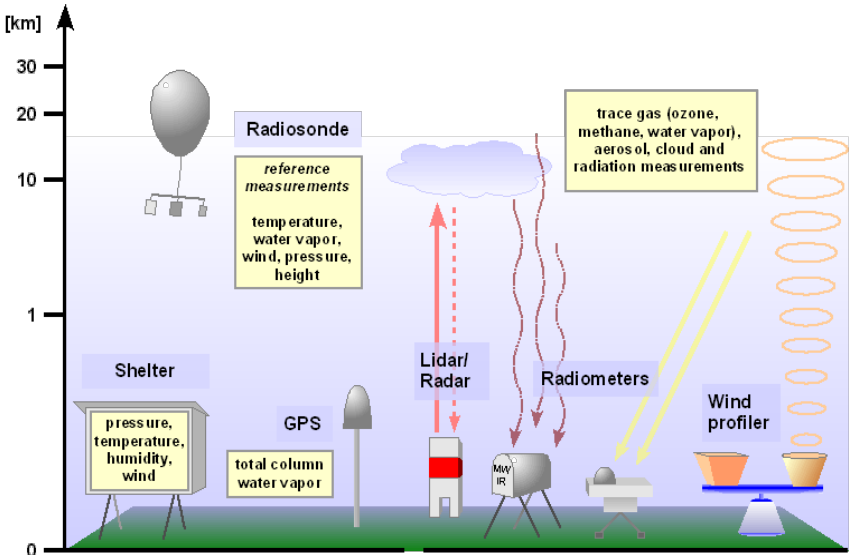


Seidel et al., 2009

What are GRUAN's goals?

GRUAN 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)

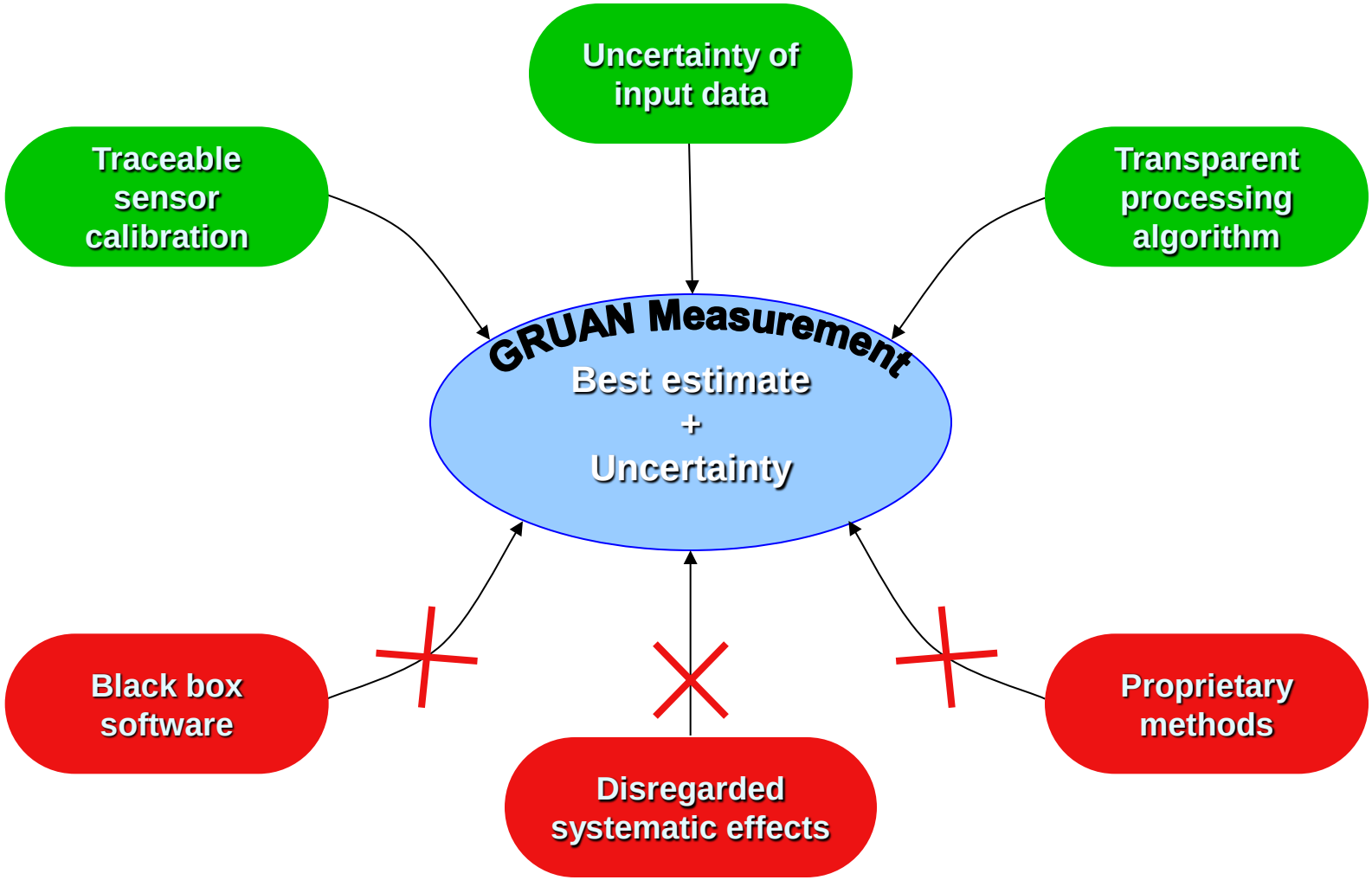
Priority 2: Ozone, …

Definition of “Reference Observation”

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)

Establishing reference quality



Management of Change

- 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

Summary

- 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

Assessment of measurement program

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

CAB
LIN
PAY
GRUAN
Certified Site
Sodankylä
Finland
Operated by FMI
The Certification is based on the GRUAN measurement RS92 GRUAN Data Product (RS92-GDP)
GRUAN Lead Centre
Lindenberg, Germany
GCOS
GLOBAL CLIMATE OBSERVING SYSTEM

GRUAN achievements

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

- GRUAN Dataproduct for Radiosondes: Vaisala RS92, Meteolabor SRS34, Meisei RS11-G
- Other radiosondes under development (Modem M10, Frostpoint-Hygrometer)
- Other products & data:
  - GNSS total water vapor column
  - Lidar (T, U)
  - Microwave-Radiometer (T, U)
- Archive of >30.000 Radiosonde-profiles
- > 20 GRUAN-related publications

GRUAN is about…

- 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 (annual meeting)

Questions

Uncertainty and raw data

- 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

GRUAN qualification of radiosondes

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