How the GCOS Reference Upper Air Network (GRUAN) contributes to the future of upper air monitoring

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Working Group Atmospheric Reference Observations

GRUAN Task Teams

Water vapor trends in the troposphere?

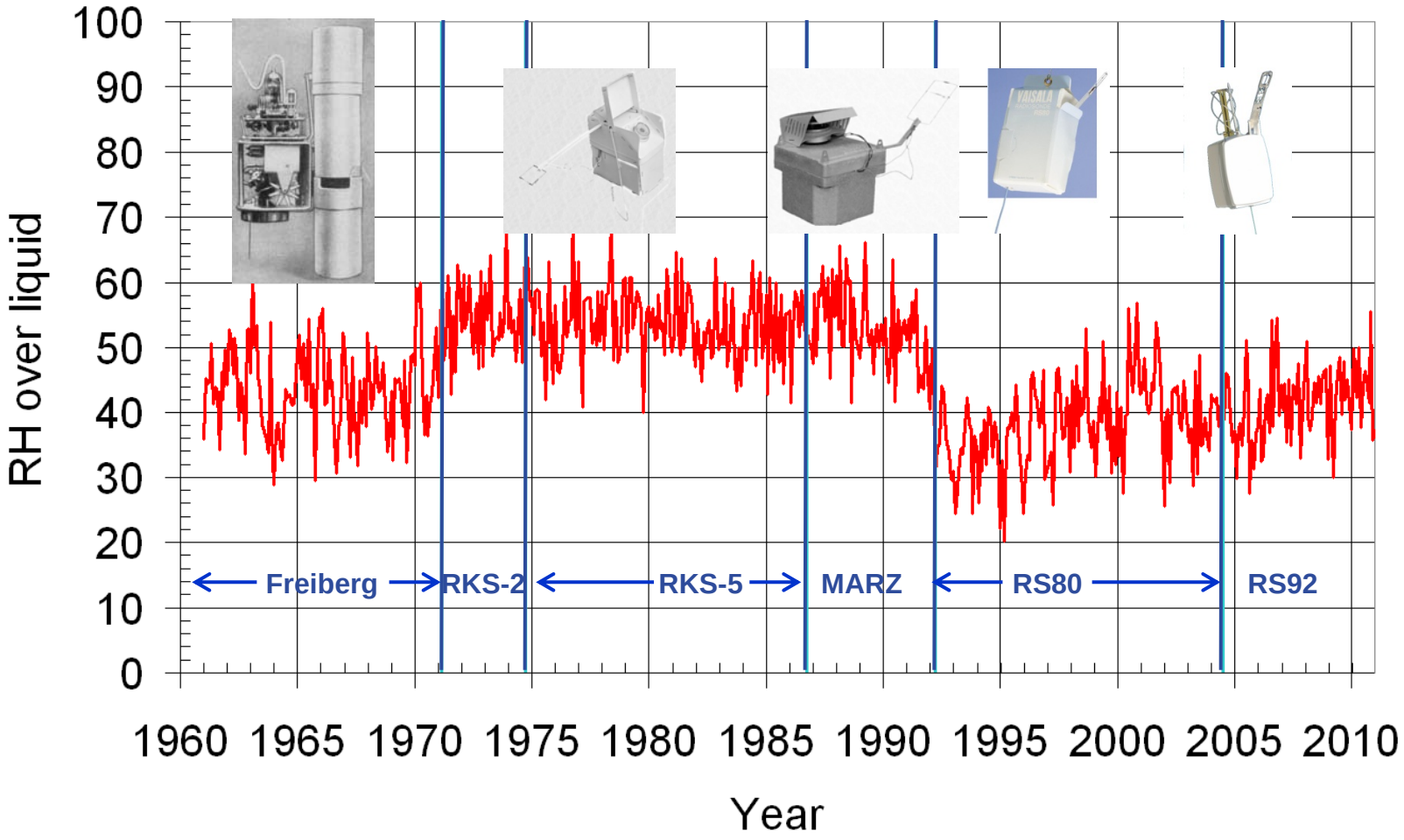
Deutscher Wetterdienst
Wetter und Klima aus einer Hand

Example “long term trend”: humidity

Water vapor trends in the upper troposphere?

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

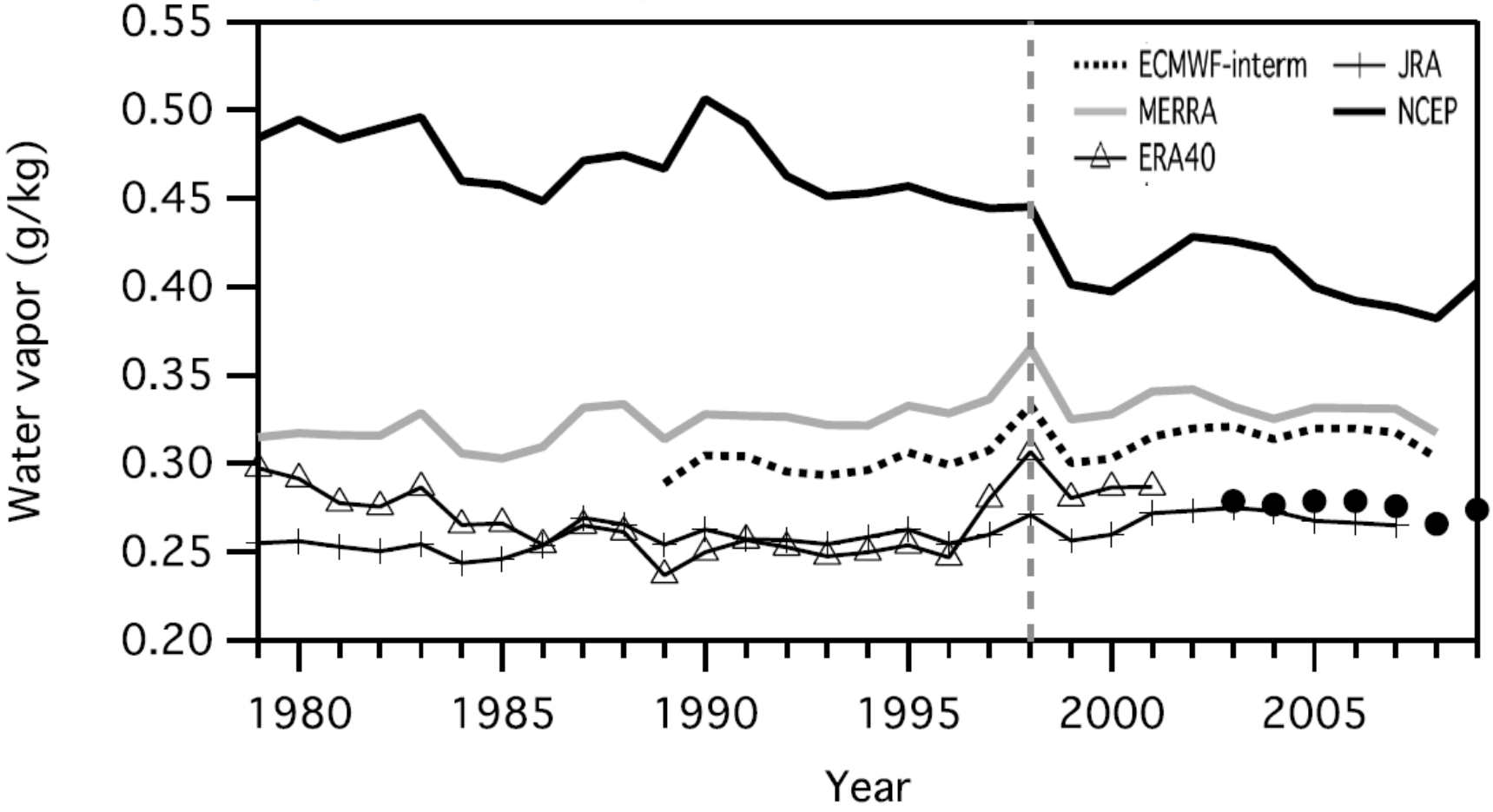
e.g.: Lindenberg 8km (0:00 UT)



Water vapor trends in the troposphere?

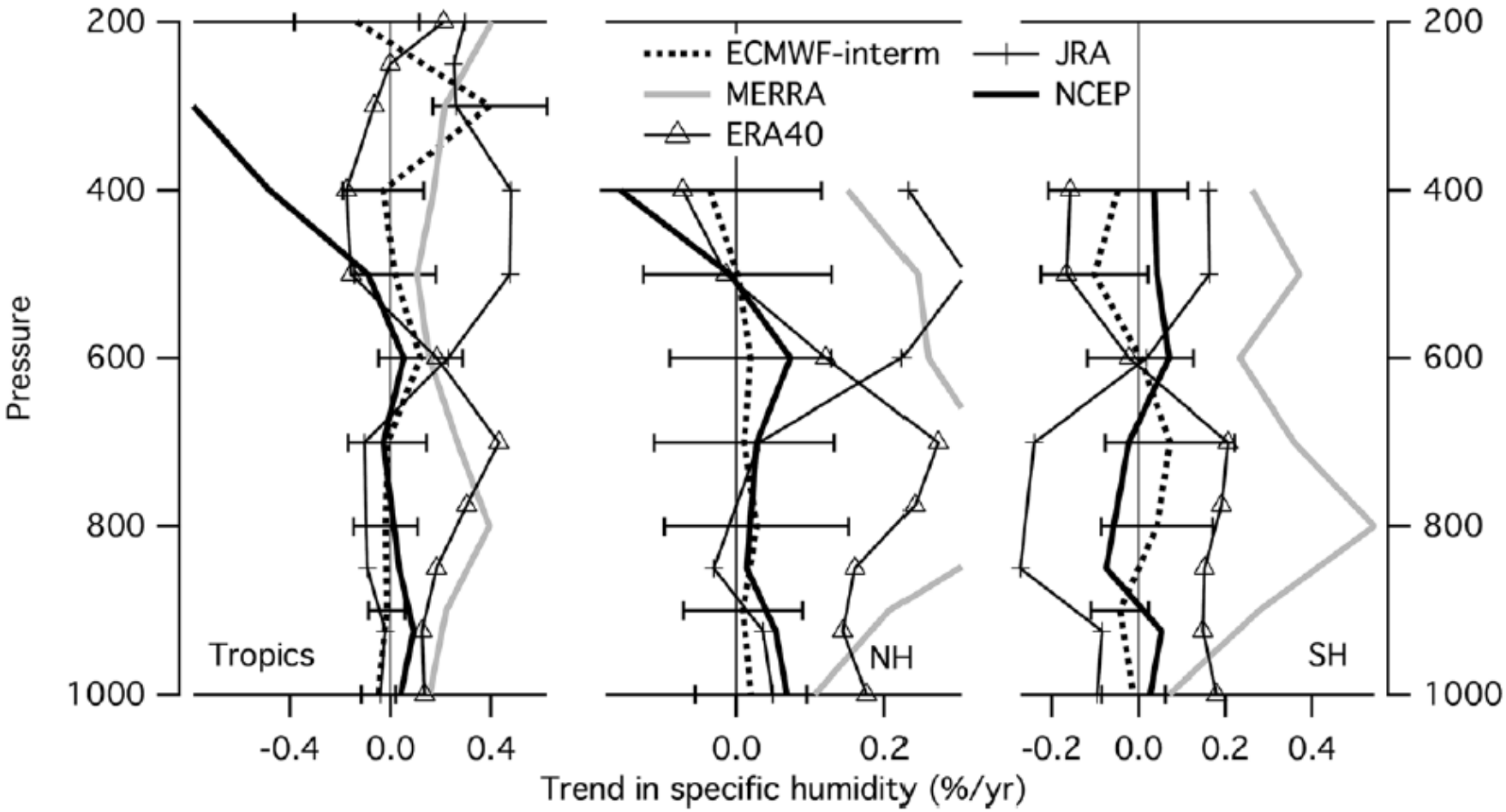
Deutscher Wetterdienst
Wetter und Klima aus einer Hand

Specific humidity at 300 hPa



Dessler and Davis, JGR 2010

Water vapor trends in the troposphere?



Dessler and Davis, JGR 2010

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

- No trend estimate possible: Trend signals dominated by instrumental change
- Observations have been done for numerical weather prediction, not for long term climate
- Instrumental change spontaneous not been managed
- Instrumental uncertainties and biases have not been (well) characterized or documented
- Meta data are incomplete
- Note: Even the Vaisala RS92 data record is inconsistent


GRUAN

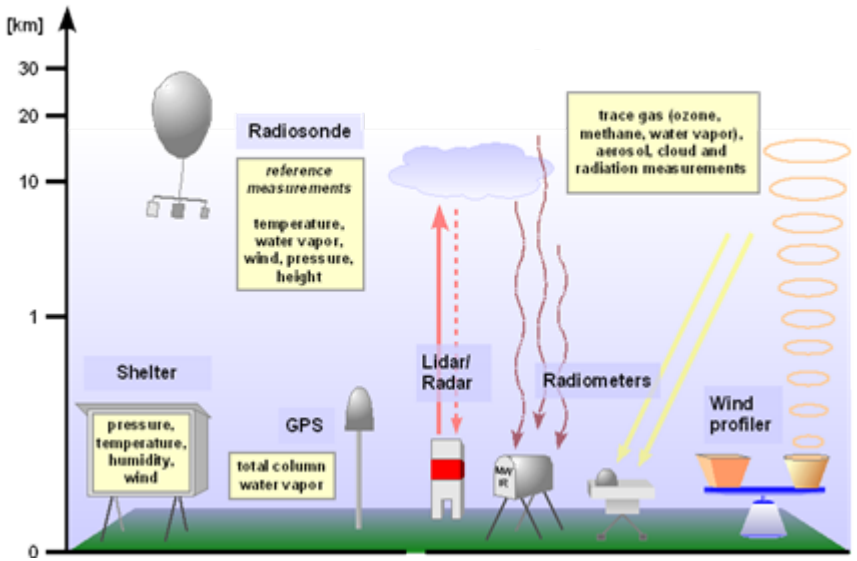
What is GRUAN?

- GCOS Reference Upper Air Network
- Ground based network for reference observations for climate within GCOS, with current focus on water vapor and temperature (troposphere and stratosphere)
- Currently 15 initial sites, with aim to expand to 30 to 40 sites worldwide

Check out **www.gruan.org**

GRUAN goals

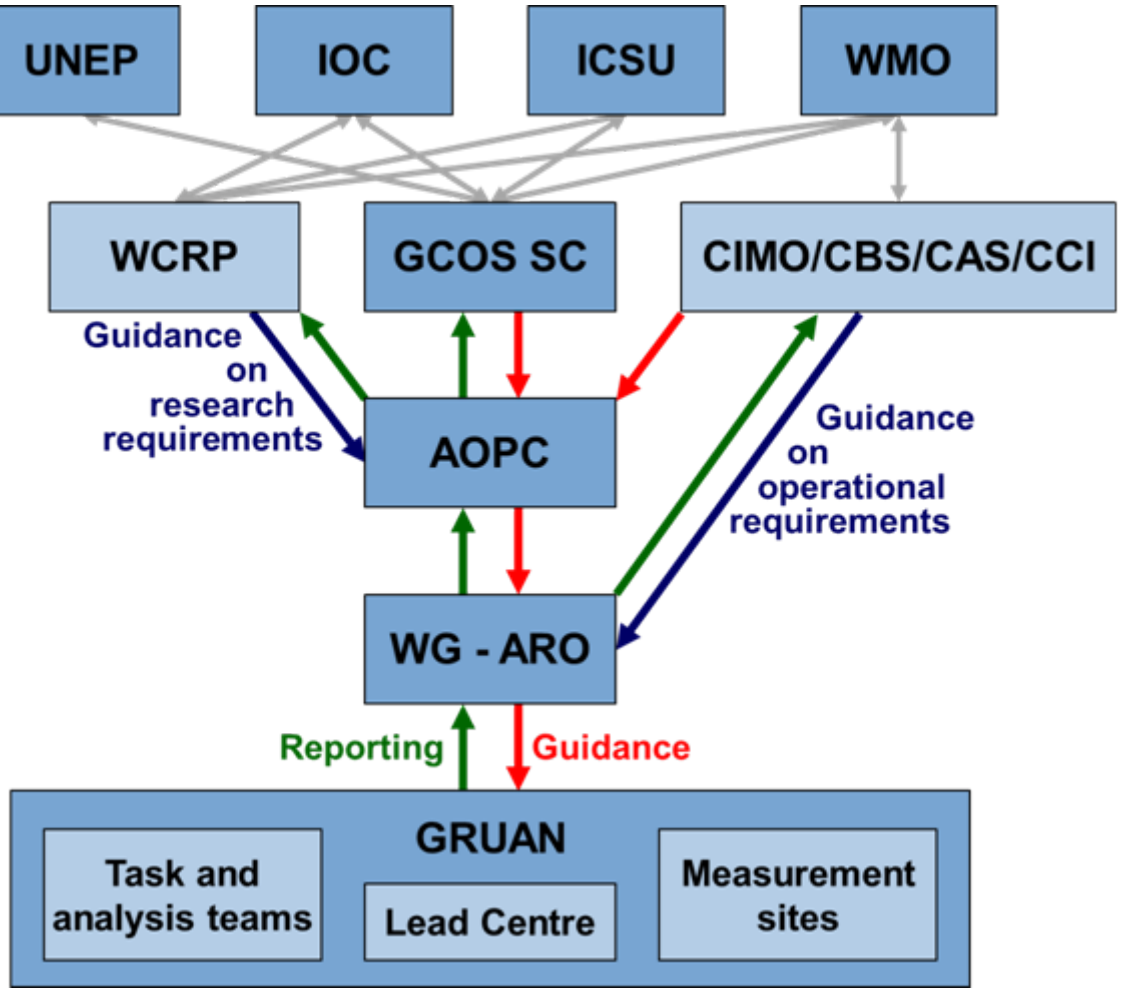
- Maintain observations over decades
- Validation of satellite systems
- Characterize observational uncertainties
- Traceability to SI units or accepted standards
- Comprehensive metadata collection and documentation
- Long-term stability through managed change
- Validate observations through deliberate measurement redundancy



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

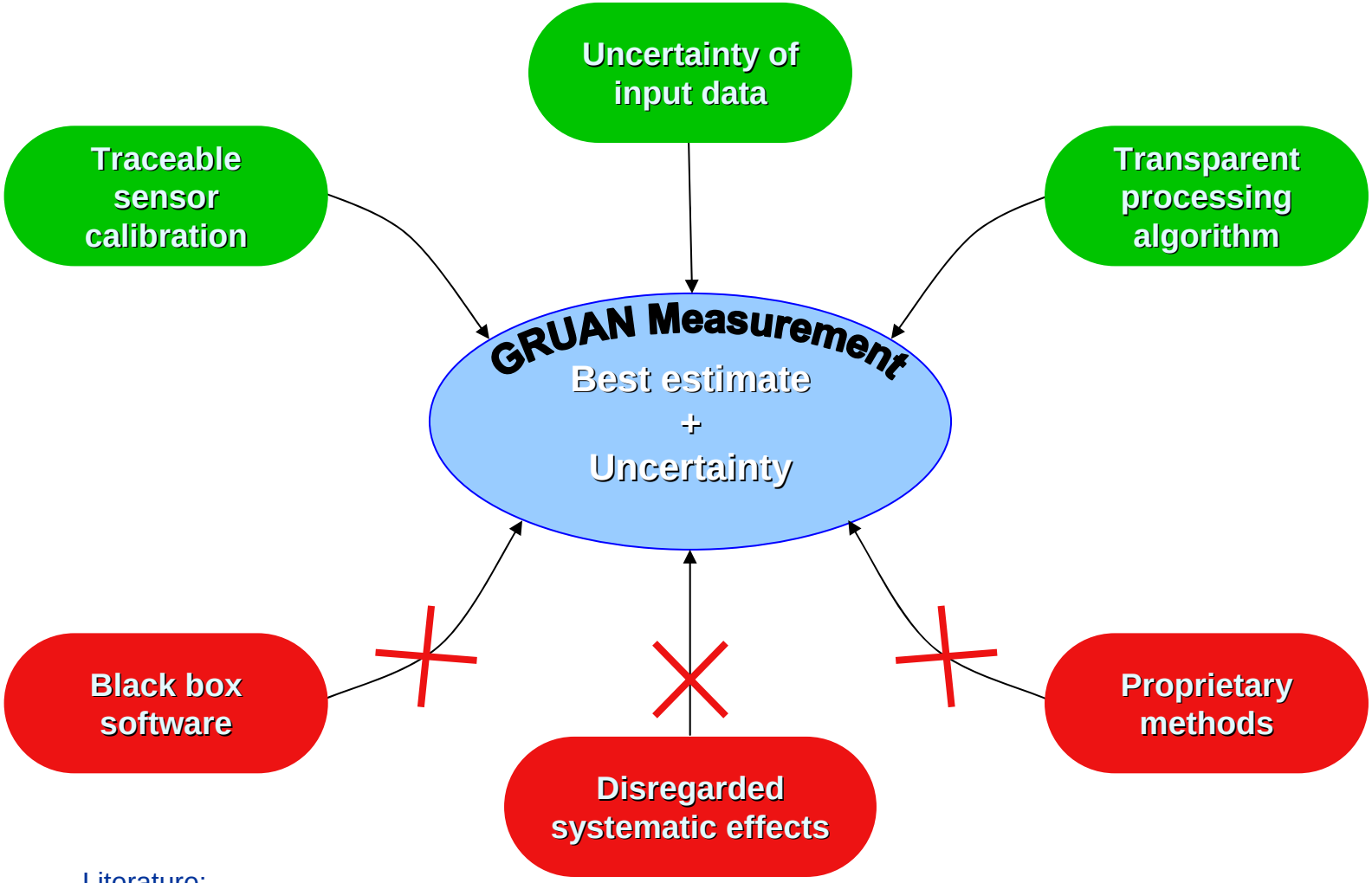
Priority 2: Ozone, clouds, …

GCOS Reference Upper Air Network



See **www.gruan.org** for further information

Establishing reference quality



Literature:

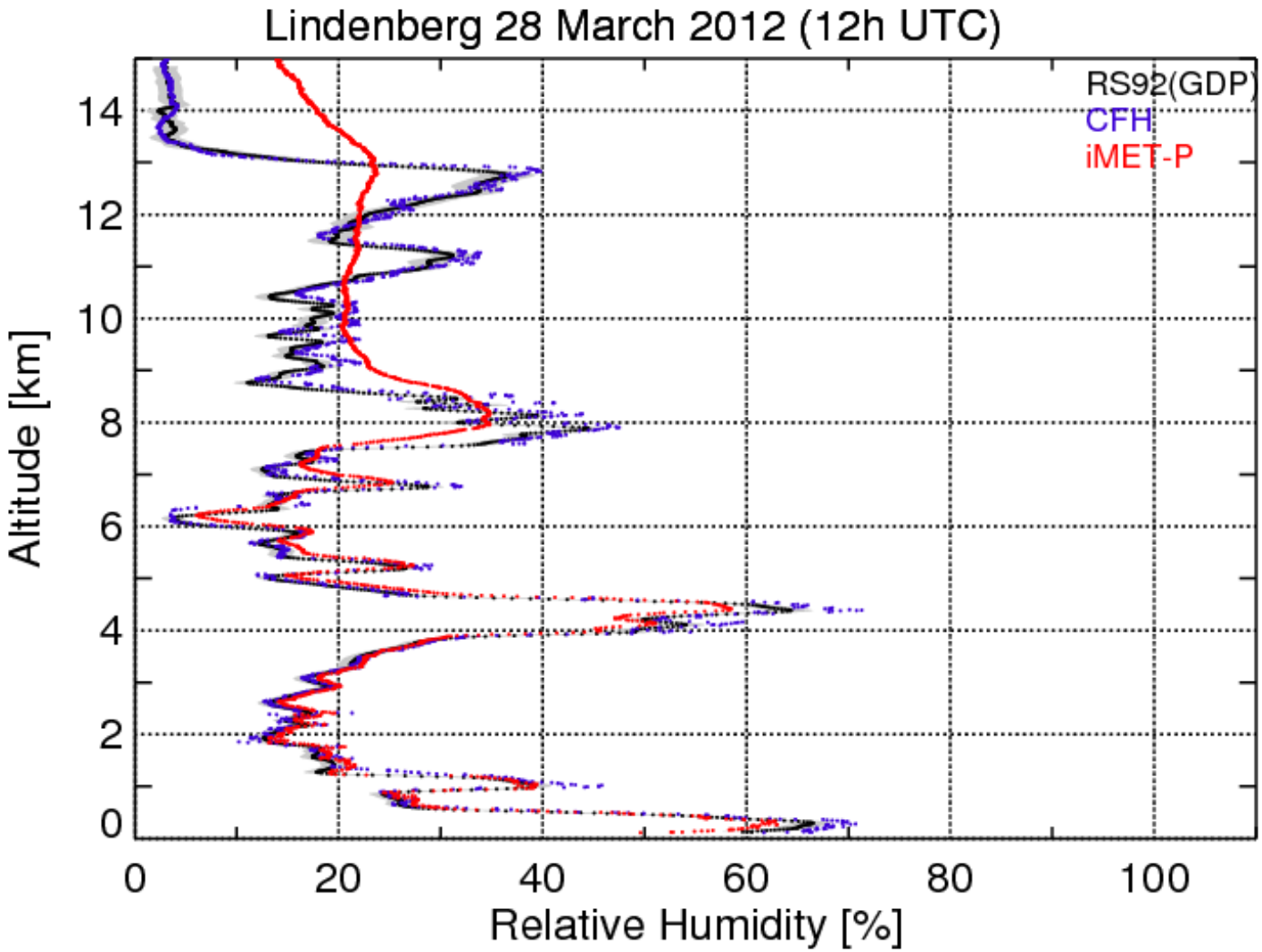
- Guide to the expression of uncertainty in measurement (GUM, 1980)
- Reference Quality Upper-Air Measurements: Guidance for developing GRUAN data products, Immler et al. (2010), Atmos. Meas. Techn.

Focus on *reference* observations

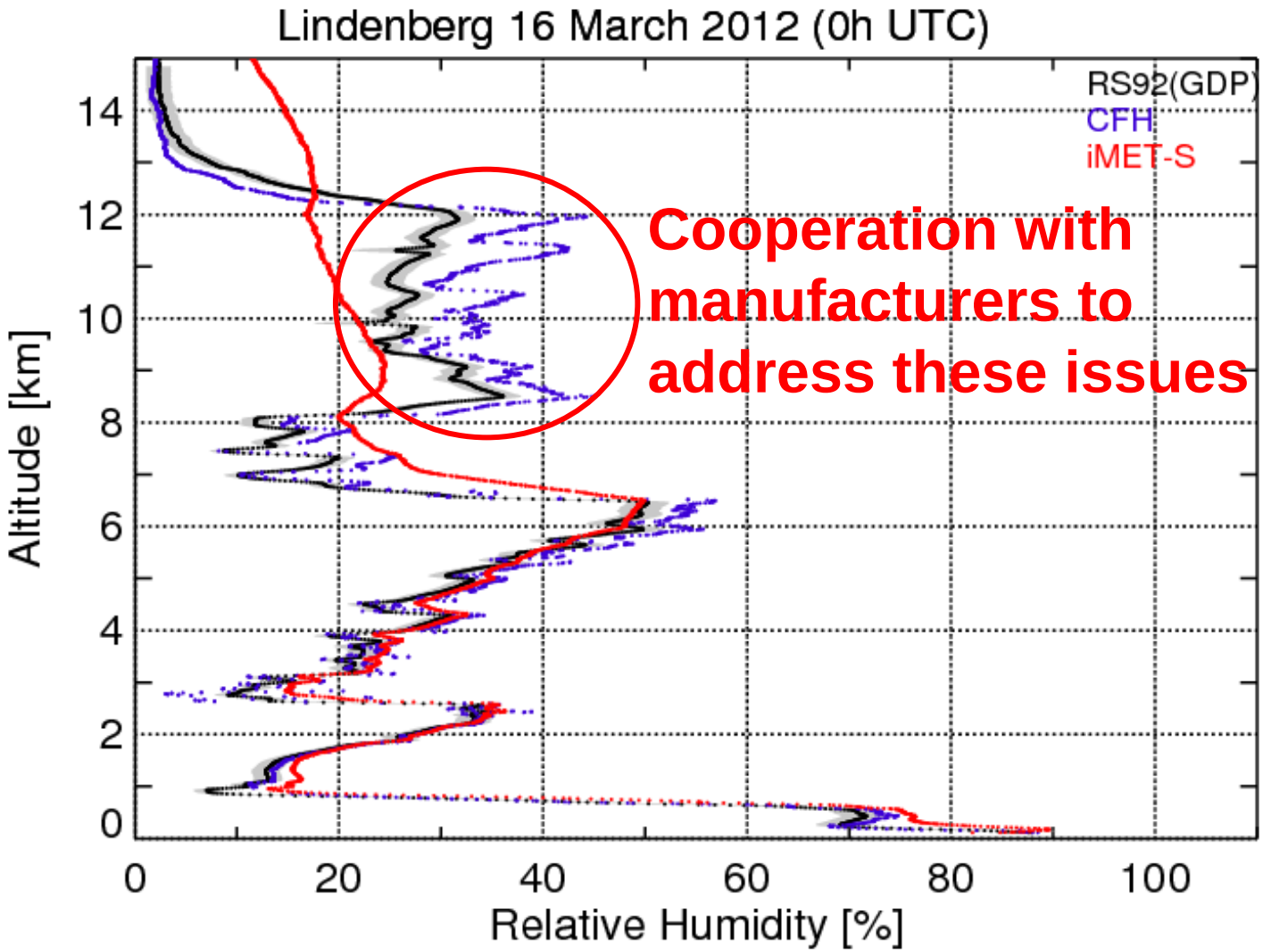
A GRUAN reference observation:

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

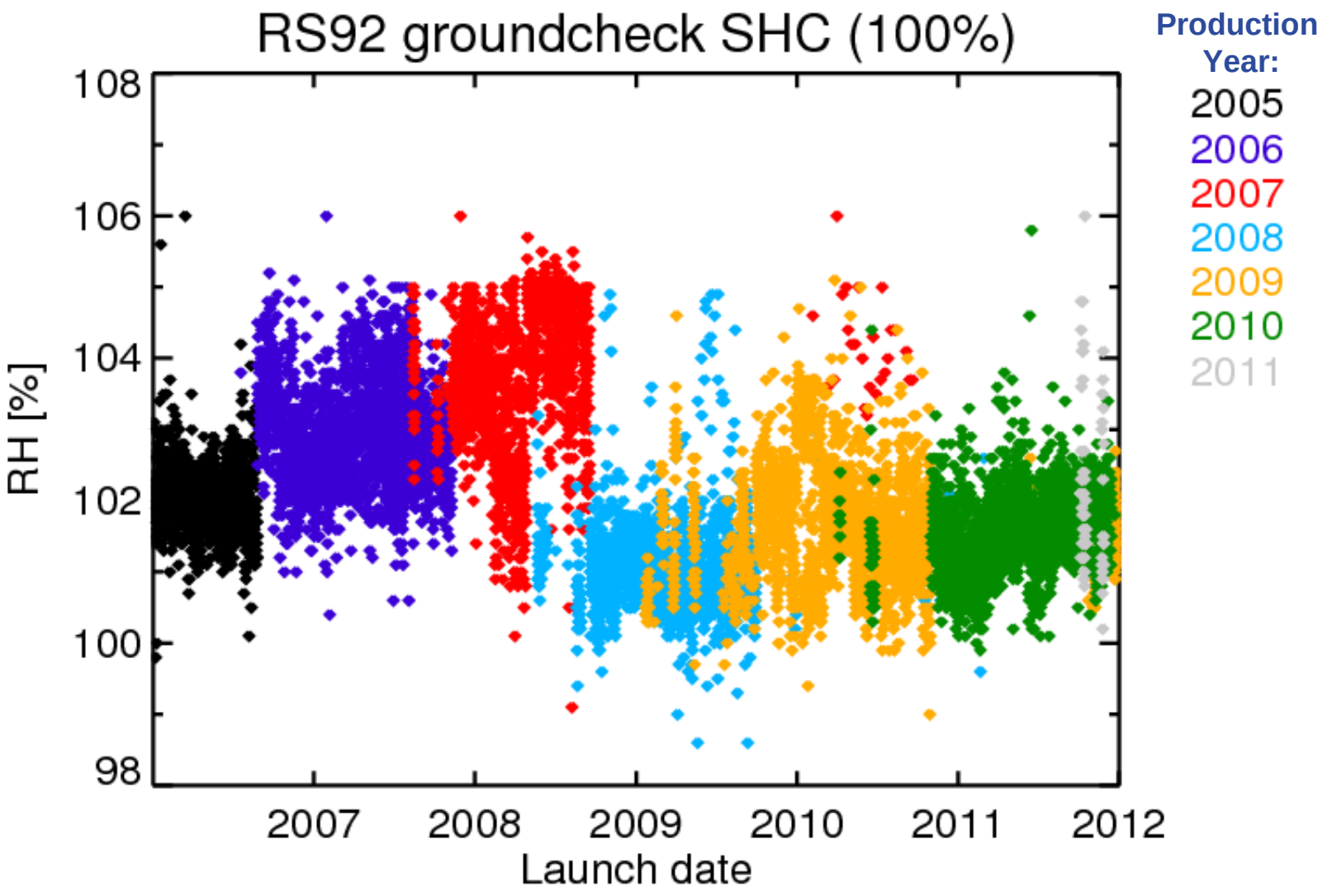
CFH uncertainty



CFH uncertainty



Additional Ground Checks



Summary

- GRUAN is a new approach to long term observations of upper air essential climate variables (Focus on priority 1 variables: Water vapor and temperature)
- Focus on *reference* observation:
  - ✓ quantified uncertainties
  - ✓ traceable
  - ✓ well documented
- Work with WMO and National Meteorological Services to improve operational procedures
- Work with manufacturer to make instruments more transparent to support change management