An overview of the GCOS Reference Upper-Air Network (GRUAN)

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What is GRUAN?

The Global Climate Observing System (GCOS) Reference Upper Air Network (GRUAN) is an international reference observing network, designed to meet climate requirements and to fill a major void in the current global observing system. GRUAN is envisaged as a global network of 30-40 stations building, where possible, on existing observational networks and capabilities (Fig. 1).

Figure 1: Current sites in GRUAN

GRUAN's goals

- Maintain observations over several decades for accurately estimating climate trends
- Ensure long-term stability by managing instrumental changes
- Constrain and calibrate data from more spatially-comprehensive global observing systems (including satellites and current radiosonde networks)
- Characterize observational biases, including complete estimates of measurement uncertainty (e.g. by deliberate measurement redundancy)
- Ensure traceability of measurements by extended metadata collection and comprehensive documentation of observational methods
- Tie measurements to SI units or internationally accepted standards
- Ensure that potential gaps in satellite programmes do not invalidate the long-term climate record, thereby leading to improved satellite data products
- Further the understanding of climate variability and change

GRUAN's key user groups

I. The climate detection and attribution community
II. The satellite community
III. The atmospheric process studies community
IV. The numerical weather prediction (NWP) community

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)

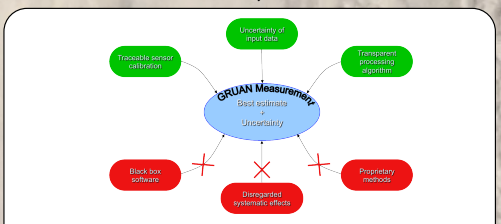

Figure 2: Essential (green) and forbidden (red) ingredients for a GRUAN reference measurement.

GRUAN RS92 radiosonde data product

Tailored GRUAN data processing has been developed to correct temperature, pressure, humidity, and wind profiles for all known systematic biases and to generate vertically resolved estimates of the measurement random uncertainties (Dirksen et al. 2014).

The dominant source of RS92 measurement errors is solar radiation, which causes temperature warm biases (partially compensated by ventilation) and humidity dry biases (Fig. 4).

Corrections for radiation-related biases, and their uncertainties, are based on the results of experiments made at the GRUAN Lead Centre.

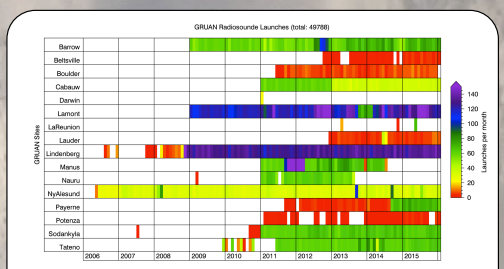

Figure 3: Availability of radiosonde raw data from across GRUAN as at January 2016.

Other GRUAN data products

- Additional radiosondes: Modem, Meteolabor, Meisei, Graw
- Water vapour profiles from high-resolution chilled-mirror frost point temperature measurements.
- Ground-based Global Navigation Satellite Systems (GNSS) total column water vapour.
- Lidar measurements of temperature, ozone and water vapour profiles
- Microwave radiometer (MWR) observations of temperature and water vapour profiles, total column water vapour and total cloud liquid water.
- Data products from FTS (Fourier Transform Spectroscopy) including water vapour, methane, carbon dioxide and ozone.

Availability of radiosonde data within GRUAN is shown in Fig. 3.

Getting involved in GRUAN

The primary point of contact is the Lead Centre through gruan.lc@gruan.org. Sites wishing to enter the network are encouraged to contact the Lead Centre. Scientists wishing to contribute to the network development and understanding can join one of several task teams or initiate a project under the science coordinators. Using GRUAN data benefits both GRUAN and your science. Please let us know if you undertake published work using the data and provide constructive feedback.

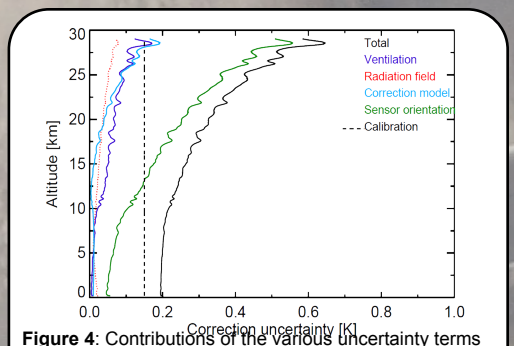

Figure 4: Contributions of the various uncertainty terms to the total uncertainty estimate of the GRUAN temperature correction for a selected sounding (Dirksen et al., 2014). The total uncertainty is the geometric sum of the squared individual uncertainties. The correction model is the estimated vertically resolved error on the temperature based on the estimated actinic flux, which is subtracted from the measurement temperature profile to produce the corrected ambient temperature.

References

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