GCOS Reference Upper-Air Network

GRUAN Technical Note 1

Establishing Data Products For New Radiosondes in GRUAN

HOLGER VÖMEL, MICHAEL SOMMER AND RUUD DIRKSEN

Publisher

GRUAN Lead Centre

Number & Version

GRUAN-TN-1
Rev. 1.0 (2013-07-08)

Document Info

Title:	*Establishing Data Products For New Radiosondes in GRUAN*
Topic:	Observation
Authors:	Holger Vömel, Michael Sommer and Ruud Dirksen
Publisher:	GRUAN Lead Centre, DWD
Document type:	Technical note
Document number:	GRUAN-TN-1
Page count:	9
Revision / date:	1.0.3 / 2013-07-08 12:06:33

Abstract

GRUAN sets high standards on all instrumentation used within GRUAN to measure essential climate variables. A central requirement is quantifying the measurement uncertainty and documenting the procedures to arrive at the final data product.

This document describes the information needed to generate a GRUAN data product using radiosondes and the studies and tests that may be needed to generate this information.

Revision History

Version	Author / Editor	Description
2013-05-16	M. Sommer	First document
2013-05-26	H. Vömel	Re-structured document
Draft 0.2 (2013-05-28)	M. Sommer	Reformatted as GRUAN Technical Document; First draft version
Rev. 1.0 (2013-07-08)	M. Sommer	Renamed as GRUAN Technical Note 1 (GRUAN-TN-1); Including comments from a first review of TT Radiosonde

Table of Contents

1 Introduction

GRUAN sets high standards on all instrumentation used within the network to measure essential climate variables. A central requirement is quantifying the measurement uncertainty and documenting the procedures to arrive at the final data product.

This document describes the information needed to generate a GRUAN data product for radiosondes and the studies and tests that may be needed to supply this information. A final GRUAN product shall satisfy the following criteria:

- It shall not be based on black-box software and undocumented software;
- it shall include data versioning;
- it shall contain a full data description;
- it shall be based on complete raw data and meta-data and shall allow reprocessing;
- and most important of all, processed data shall be provided with vertically resolved measurement uncertainties.

The goal of this document is to provide guidelines for establishing an GRUAN data product that satisfies above-mentioned criteria.

We acknowledge that the level of understanding of the measurement system in question may be incomplete. This may not necessarily be a deficiency of the documentation which hampers establishing a GRUAN data product, as long as the missing knowledge is clearly documented and steps are identified to fill this gap.

The source of the information can be:

- the manufacturer,
- the result of acceptance test by the institution using the radiosonde,
- the result of dedicated instrument studies.

2 Documentation by manufacturer

The information requested here should be provided by the manufacturer and should include a detailed description of the radiosonde as well as the software used to analyse the data recorded by the radiosonde.

2.1 Radiosonde

General description:

- Size (dimensions), weight, frequency range of radio transmission
- Layout (picture, drawing, description), including pictures focusing on the sensors
- Possibility to connect external sensors such as ECC, CFH, FLASH, Cobald, etc.
    - If yes, which protocol?
    - If XData protocol please provide maximum data rate (number of bytes per second) that can be sent.

For each sensor (pressure, temperature, humidity, and GPS), if applicable:

- Measurement range
- Range for which the sensor was calibrated
- Calibration accuracy and its dependencies of the calibration range
- Time resolution of the data transmission, i.e. of the raw data and of the final processed data
- Accuracy, precision, repeatability, or uncertainty
  - Clarify which uncertainty description is provided by the manufacturer
- Time-lag constants and their dependences on temperature and other parameters
- Is a recalibration required as part of the launch preparation?
  - If so, describe.
- Expiration date of the sensor calibration, or specified drift in the calibration accuracy with time

Additional description for humidity sensor:

- Vapour pressure equation used in the calibration of RH (Following CIMO recommendations this should be either Hyland and Wexler (1983), Wexler (1976), or Sonntag (1994))
- Is there a temperature dependence in the calibration of RH? If so, what is it?

Deficiencies in documentation of manufacturer identified by institution:

- What is missing or insufficient?
- Are further actions planned to improve this situation?

2.2 Software

Which data are being sent to the ground station: engineering units (e.g. currents, voltages, resistances, frequencies), or calibrated sensor data?

Can the conversion from engineering units to physical units (calibrated sensor data) be provided?

Calibrated sensor data are acceptable as raw data for GRUAN purposes as long as no corrections, smoothing or interpolations have been performed by the receiving software. Engineering units can be accepted as raw data if the algorithms converting engineering units into calibrated sensor output using the sensor calibration data are documented and available.

The data format of the raw data (containing all meta-data and all sensor data) shall be fully described.

3 Manufacturer independent sonde verification

The information requested here should be provided by the institution that implements the radiosonde. It is expected that the institution has already conducted acceptance tests, many of which cover the information needed here. Please provide the results of all tests available.

3.1 Environmental chamber

A limited number of sondes should be tested in an environmental chamber against reference

sensors.

Such tests allow checking of sensor calibration from manufacturer in the full measurement range. In addition, it is possible to analyse the time-lag of sensors, if the environment in the chamber can be changed very fast. Furthermore a combination of several environmental variables can be changed and therefore the sensor performance can be analysed under such conditions, e.g. a relative humidity measurement at very cold temperature.

Check following measurement ranges (if possible cover the multi-dimensional parameter space):

- Pressure – Check over full range, e.g. 1050 to 5 hPa
- Temperature – Check over full range, e.g. +40 to –100 °C
- Relative humidity – Provide the conditions over which the sensor was tested.

3.2 Relaxed conditions

Tests of a larger number of sondes at relaxed conditions (room temperature and pressure):

- Relative humidity – Room temperature check at 0 and/or 100 %RH (see chapter 6)
- Temperature – Room temperature check

3.3 Production variability

Test of the production variability:

- Between-batch variability – Tests at relaxed conditions with sondes from different production cycles.
- Within-batch variability – Tests at relaxed conditions with sondes from same production cycle.

3.4 Dual launches

Dual launches with a GRUAN accepted sonde (*Currently a GRUAN data product exists only for Vaisala RS92.*):

- Number of dual launches in specific conditions (e.g. daytime, seasons)
- Provide a report detailing the results. Ideally this report relates the information provided by the manufacturer and the laboratory tests done by the institution.
- Also provide the data files (and plots) so that details of the comparison can be studied.

4 Sensor uncertainties

The information requested here will form the basis of the GRUAN algorithms to quantify the vertically resolved measurement uncertainty. Address these points for each sensor. Please provide the source of information for each topic and describe the procedure in case of own experiments or analysis.

4.1 Calibration

- Calibration uncertainty (based on manufacturer information combined with acceptance test results)

4.2 Time-lag

- Provide time-lag parameters and their dependencies, e.g.
  - How does the time response of the humidity sensor vary with temperature?
  - How does the time response of the temperature sensor vary with pressure?
- Provide an uncertainty estimate for these parameters.

4.3 Radiation error

For temperature and humidity specify how the radiation correction was established and specify the correction model that is (or should) being used in the processing software.

The GRUAN processing currently uses a radiation error measured in dedicated experiments at the GRUAN Lead Centre as function of actinic flux, pressure, and ventilation. (*It is desired that the radiosonde is used in the same experimental setup.*) Provide the uncertainty of the correction parameters.

Is there a strong orientation dependence of the radiation error? If so, describe its impact on the uncertainty of the radiation correction.

4.4 Additional corrections

Are there additional corrections of sensor data or data processing operations not listed here? Describe which and include the uncertainty of the respective correction/operation.

5 Other sources of measurement error

The information requested here is meant for completeness of the documentation and should not necessarily enter the processing of data or establishing uncertainties.

- Describe the impact of sensor icing on temperature and humidity measurements in supercooled liquid water or ice-supersaturated conditions and how the system minimizes its impact.
- Are the sensors calibrated prior to the sonde assembly, or are the radiosonde sensors calibrated in the assembled sonde?
- Are there other sources of measurement error not discussed above (unwinder issues, system specific issues such as GPS availability, etc.)?

6 Pre-launch preparation

All GRUAN radiosondes should pass a manufacturer independent ground check of the temperature, humidity, and pressure (were applicable) sensors prior to launch. Describe which test can be implemented.

Currently GRUAN recommends a standard humidity chamber (SHC), which tests the temperature and humidity sensor at room temperature and high relative humidity (e.g. 100 %RH).