French GRUAN sites using M10 and M20 radiosondes

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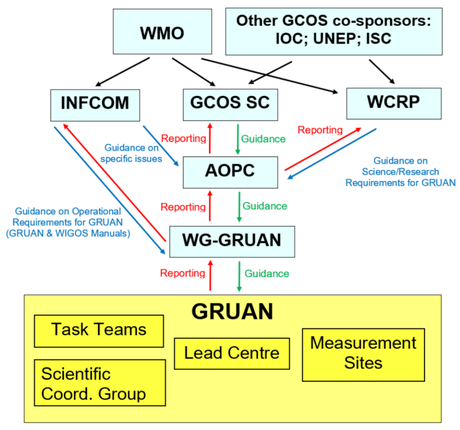
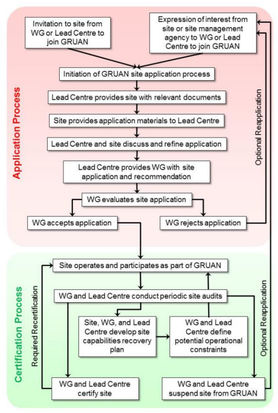
OBJECTIVES – CHALLENGES

GRUAN (GCOS Reference Upper-Air Network) is the scientific community's response to the urgent need for reference measurements in the context of climate change (GCOS-112, GCOS-171). Its objective is to establish a network of around 40 reference sites worldwide, providing long-term monitoring of Essential Climate Variables (ECVs) as defined by the WMO (GCOS-138).



Schematic outline of the structure of GRUAN



Schematic representation of the site assessment and certification process.

The Trappes radiosonde station (48.77°N; 2.01°E), operated by Meteo-France with Meteomodem technology, was the first site in France to adopt operational procedures and prepare a certification file. Since 2018, a second station at Le Chaudron (20.89°S; 55.59°E) has also been in operation.

French sites with Reference GRUAN Radiosounding

3 French Sites are considered as reference GRUAN stations: **Trappes and Chaudron (M10), Faa'a (M20)**

Meteomodem Robotsonde for TRP Site (TRappes & Palaiseau)

Meteomodem Robotsonde for REU Site (Chaudron & Maïdo)

Meteomodem Robotsonde for Faa'a Site (French Polynesia)

Six criteria must be validated to be qualified as a GRUAN reference radiosounding site (GRUAN-TN-4)**:**

1) Provide a complete description of the measurement site, including the instrument (its measurement principle and uncertainties for each geophysical parameter), the operational methods, associated metadata, data collection procedures, and how data are routed to the GRUAN central server.
2) Publish a peer-reviewed article describing the certified data product from the site.
3) Operate a site implementing the documented instruments and methods.
4) Ensure a data center receives the raw data and processes it using the described corrections and algorithms.
5) Maintain a sufficiently long dataset to evaluate the stability of the methods and their potential as a reference.
6) Submit the site document for review by the GRUAN working group.

Organization, Results and progress details

The French GRUAN radiosounde site requires the coordination of 3 partners: Météo-France, IPSL and Meteomodem. Each partner has specific responsabilities: Météo-France handles the operational implementation of GRUAN flights, IPSL manages scientific relations, prepares the certification documents and oversees the implementation of data streams , and Meteomodem is reponsible for establishing measurement uncertainties.

OPERATIONALITY: Météo-France

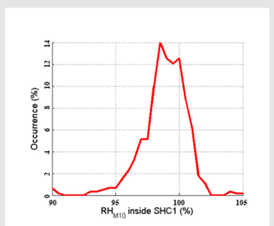
The three French GRUAN radiosonde sites conduct two flights per day (00TU et 12TU) using Meteomodem M10 sondes (at Trappes and La Réunion) and M20 sondes (at Faa'a)

These flights are carried out using a Robotsonde developed by Meteomodem.

According to the GRUAN procedure, each sondes must be compared to a reference before launch. GRUAN France applies two steps:

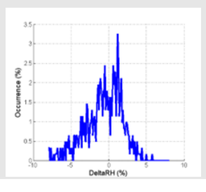
1 Saturated Environment Comparison at 100%RH

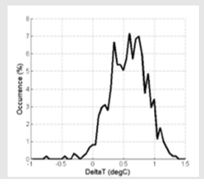
- Prepare SHC tank (20 min for 1st sonde, then 5 min)
- Place M20 sonde on adapter
- Measurement time: 5 min
- Results from ~1 year of data: M10 sondes show a slight dry bias (~1 %RH) with dispersion σ < 2 %RH



2 Ambient Environment Comparison

- Place sonde in outside shelter (near HMP110 [RH] & PT100 [T])
- Switch on shelter ventilation (once per session)
- Measurement time: 5 min
- Results from 1-year study:
  - RH≈ 0 ± 2 %RH (k=1)
  - T ≈ 0.5 ± 0.5 °C (k=1)

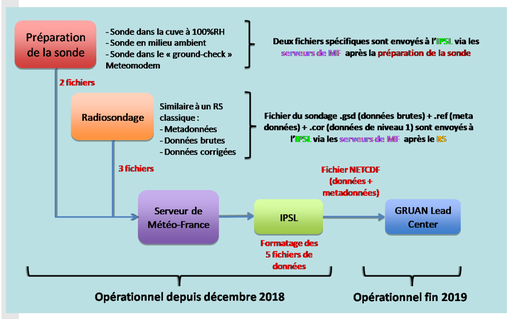




Data Organization and Flow: IPSL

For each GRUAN flight at Trappes, 5 files are produced and transferred to the GRUAN server:

- 2 preparation files:
  - Comparison in a humidity-saturated environment
  - Comparison under ambient outdoor conditions
- 3 radiosounding files:
  - Sonde metadata
  - Raw radiosounding data
  - Processed data (manufacturer's algorithm)



Schematic of the data flow from sonde preparation to the storage of data and metadata on the GRUAN server.

IPSL responsibilities:

- Development and maintenance of the data architecture
- Scientific relations with GRUAN
- Coordination of scientific valorization activities
- Drafting of the technical document required for certification
- Participation in GRUAN institutional discussions

Every year, the GRUAN community meets to exchange updates on site progress and related research.

GRUAN community at the ICM-14, La Réunion – Dec 2022

Instrumentation : Meteomodem

The Meteomodem M10 radiosonde measures :

- Relative humidity → capacitive sensor
- Air temperature → thermistor
- Altitude & wind speed → GPS

Each of these parameters is the subject of dedicated studies.

Parameter	Type of uncertainty	Methodology of determination
Relative Humidity	Calibration	Production analysis and/or comparative measurements during flight preparation
	Time-lag	1. Determination of time-lag 2. Estimation of time-lag uncertainty
	Slow regim	1. Determination of slow regim 2. Estimation of slow regim uncertainty
	Temperature bias	1. Based on uncertainty related to temperature determination 2. Laboratory experiments on temperature biais
Air Temperature	Calibration	Production analysis and/or comparative measurements during flight preparation
	Radiatif effect	1. Laboratory experiments to establish relationship between radiative flux and temperature response 2. Error related to correction
Geopotentiel height	Manufacturer's uncertainty	Value provided by the manufacturer
	Ground variability	Ground tests, with or without GPS simulator
	Transformation	Estimation of bias induced when converting geometric altitude to geopotential altitude
Zonal and méridional wind	Manufacturer's uncertainty	Value provided by the manufacturer
	Ground variability	Ground tests, with or without GPS simulator
	Smooth effect	Estimation of uncertainty due to smoothing (sonde swinging)

Références

- GCOS-112, GCOS Reference Upper-Air Network (GRUAN): Justification, requirements, siting and instrumentation options - April 2007: https://library.wmo.int/opac/doc_num.php?explnum_id=3821
- GCOS-171, The GCOS Reference Upper-Air Network (GRUAN) GUIDE. GCOS-171, Version 1.1.0.3, March 2013, WIGOS Technical Report No. 2013-03: http://library.wmo.int/pmb_ged/gcos_171.pdf
- GCOS-138, Implementation plan for the global observing system for climate In support of the UNFCCC (2010 update), August 2010, https://library.wmo.int/opac/doc_num.php?explnum_id=3851

Remerciements

Ce travail est possible grâce à l'engagement des partenaires Météo France, l'IPSL / CNRS et Meteomodem. Nous remercions également la communauté GRUAN et les infrastructures de recherche du DWD (Deutscher Wetterdienst) à Lindenberg.