



**GLOBAL CLIMATE
OBSERVING SYSTEM**



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**GCOS STEERING COMMITTEE
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Report from GCOS Networks: GRUAN

The following report is based on the draft report of the most recent GRUAN Implementation Coordination Meeting (ICM-15, Bern, Switzerland 11th – 15th March, 2024). It is the summary of the updates from the GRUAN Lead Centre, the Working-Group co-chairs and the GRUAN site reports.

The full report of the GRUAN ICM-15 will be published as a GCOS publication and will be available on the WMO e-library.

1.1 GRUAN – Introduction (Ruud Dirksen, Head of GRUAN Lead Centre)

GRUAN is a ground-based network for upper air observations that was established in response to the need identified by WMO and GCOS for highest-accuracy data possible. GRUAN's goals include long-term consistent data records for the; validation of satellite systems, process studies and Numerical Weather Prediction (NWP). The requirements for a GRUAN data product are traceability, uncertainty analysis, inclusion of raw data and meta data, proper documentation and validation. At the moment, priority variables are temperature, water vapour and pressure, with the development of data products for other variables, such as ozone, following in a second phase. GRUAN comprises of 33 sites, with the aim to expand to 30-40 sites worldwide, at locations representative for various climate zones.

Important aspects of GRUAN include change management, certified measurement programs and dedicated data processing that corrects for all known biases and measurement errors. These factors ensure that GRUAN provides reference-quality data that is free of instrument-related artifacts and inhomogeneities.

1.2 GRUAN - Update since ICM-14 and GDP Status (Fabio Madonna GRUAN WG co-chair)

Fabio Madonna provided an overview of the progress made in the implementation of GRUAN since ICM-14. Enhanced management has been achieved through regular meetings with co-chairs and the Lead Centre (LC), including the mid-term meeting in Lindenberg, and regular Task Teams meetings attended by co-chairs and the GCOS secretariat. The network currently comprises 33 sites, with 23 actively streaming data and 14 certified. Site recertification has been conducted regularly.

Regarding network expansion and consolidation, one site in Helwan, Egypt, has applied for certification, and there are potential new sites at Dome-C, Antarctica; Punta Arenas, Chile; and San Juan, Puerto Rico. Additionally, a policy for silent sites has been approved by the Working Group (WG) and implemented at the start of 2024. This policy is aimed at maintaining the current network configuration while ensuring that it's real observing capabilities and data availability are properly advertised to the users.

No new GRUAN Data Products (GDPs) have been delivered since ICM-14, but progress has been made with radiosonde types and lidar, with the GNSS GDP nearing final publication. Further discussions on the performance of instruments for R23 replacement took place during ICM-15.

Regarding the dissemination of GRUAN data to the user community, options for relevant data hubs are being investigated, including PANGEA, NOAA NCEI, Copernicus C3S, and the GRUAN website itself. The evolving network shape necessitates an update of the GRUAN guide and manual, which will be completed in the next 18 months to reshape the requirements for the stations.

Joint scientific publications and webinars, the latter supported by Copernicus, have been conducted, with the community collaborating on providing observations for satellite validation, funded by EUMETSAT, and submitting joint competitive proposals for funding.

1.3 Lead Centre and Site Reports: summary and key threads (Ruud Dirksen, Head of GRUAN Lead Centre)

Ruud Dirksen presented updates from the Lead Centre since ICM-14 (Nov 2022). The network currently consists of 33 sites, 14 of which have been certified. Helwan (Egypt) and Fa'aa (Tahiti) accepted the invitation to become candidate sites. The certification of Tenerife is pending, certification packages were sent to various sites (La Reunion, Neumayer, Hongkong), awaiting submission of the application. Several sites were re certified (Boulder, Lauder, Ny Alesund, Payerne, Potenza, Sodankyla), whereas the recertification of Cabauw is under review.

The flow of data to the Lead Centre is steady, although consistently lacking for several sites. The GRUAN archive contains more than 160k radiosoundings, with operational data streams for RS41-GDP.1, RS92-GDP.2, RS-11G-GDP.1 iMS-100-GDP.2. There is no data stream for Australian site, due to strict IT-security at BoM. A solution has been developed and will be implemented. The sites Dakar and Dolgoprudny are not responsive and provide no data. A data stream is not established yet for Xilinhot, but progress was made during the meeting.

Since ICM-14 several GRUAN documents have been published (TD-8, TNs 12, 13, 14) as well as 15 papers on GRUAN-related research. Following the publication of TD-8, the GRUAN data processing for the RS41 is now fully certified (RS41-GDP.1).

Instrument-research activities included test flights with Meisei Skydew and N2-CFH in search for alternatives to R23 for stratospheric water vapor observations, the investigation of the reproducibility of the M10 (laboratory & soundings), and an intercomparison program for various radiosondes (GDP & non-GDP) RS41, RS92, iMS-100, M10, DFM-17.

A research contract to investigate the added value of GRUAN data processing was awarded and was completed.

The report of the WMO radiosonde intercomparison campaign (UAI2022), a joint DWD-MeteoSwiss effort by Lindenberg/LC and Payerne, was written, reviewed and completed in 2023. The publication of the report by WMO was announced during the ICM-15 site visit in Payerne.

The work plan for the coming months covers a wide range of tasks including:

- Support development of GRUAN data product for Modem M10 & Graw DFM-09, DFM-17 radiosondes -Start development of GRUAN data product for RS92 (RS92-GDP.3).
- Continue testing and assessment of non-R23 frostpoint hygrometers.
- Assist certification of sites.
- Initiate missing datastreams for silent sites.
- Publish result of GRUAN-wide RS92-RS41 comparison.
- Further develop operational processing of cryogenic frostpoint hygrometer (CFH) data.

In addition, Ruud presented the main points from the site reports:

- Covid-19 fortunately ceased to be an issue after 1st half of 2022. Tropical sites are struggling with premature balloon bursts.
- Many sites face impeding budget cuts, and are concerned about rising costs of Helium. One site (BEL) switched to H2.
- The CFH measurement program has been halted at various sites due to R23 restrictions (EU + Japan).

- Several sites have questions about the consequences on data quality by the use of environmentally friendly materials such as Biotwine, or the new RS41 SGE radiosonde.
- ROS and BoM-sites use small balloons, causing too low burst altitudes.
- Budget restrictions prevent Bureau of Meteorology (BoM) sites from launching CFHs.
- The introduction of an autolaucher at TAT lead to a decrease of burst altitude.
- POT schedules radiosonde launches to coincide with satellite overpasses (using GRUAN overpass predictor service)
- The GRUAN Lead Center data reports helped NYA to identify a 0.5K jump in the temperature measurements in the ground check shelter.
- The ARM sites prolong the Rival program (RS92-RS41 intercomparison coincident with satellite overpasses); Standard Humidity Chambers (SHC) will be purchased for all ARM sites
- No upload of CFH/FPH data by REU.
- ROS suffered a damaged SHC. SHC checks are only performed for 00Z soundings.

