



WMO/IOC/UNEP/ICSU  
GLOBAL CLIMATE OBSERVING  
SYSTEM (GCOS)

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Doc. 7.08  
(22.IV.2016)

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**8th GRUAN Implementation-  
Coordination Meeting (ICM-8)**  
Boulder, USA  
25 April – 29 April 2016

Session 7

## GRUAN Station Report for La Reunion

*(Submitted by Stephanie Evan)*

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### **Summary and Purpose of Document**

Report from the GRUAN station La Reunion for the period February 2015 to February 2016.

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## GRUAN Station Report for La Réunion

Reporting for the period Feb 2015 to Feb 2016

Date: 22-04-2016

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### Overview

Reunion Island has three measurement sites: the Maïdo observatory on the western part of the island (2160 m ASL), Gillot Airport (northern part of the island, 10 m ASL) and the University of Reunion in Saint-Denis (northern part of the island, 80 m ASL). The Maïdo observatory opened in October 2012 and is managed by “Observatoire des Sciences de l’Univers de la Réunion” (OSU-R, head Jean-Pierre Cammas). Several PIs of instruments at the Maïdo Observatory work at the LACy (Laboratoire de l’Atmosphère et des Cyclones, head Pierre Tulet) laboratory. It is a joint institute of CNRS, Météo-France and the University of Reunion Island. LACy’s research involved many measurements from the Maïdo observatory.

The Maïdo facility is a multi-instrumented station and is part of the NDACC, AERONET, SHADOZ and ICOS global network. Reunion has not been certified as a GRUAN site yet but is collaborating with the GRUAN Lead Centre in Lindenberg since 2014. Several measurement programmes in Reunion may contribute to GRUAN data streams in the future, these are:

- Weekly SHADOZ ozone sondes (ECC ozone sonde + Modem M10 radiosonde, PI Françoise Posny, LACy) providing ozone profiles from the surface to mid stratosphere. The ozone sondes are launched from Gillot airport.
- CFH water vapor sondes (CFH sonde + Internet Imet-1-RSB radiosonde, PI Stephanie Evan, LACy) providing water vapor profiles from the surface to ~30 km. The CFH sondes are launched from the Maïdo Observatory on a campaign basis (with a minimum of 2 sondes per year since 2015).
- A Fourier Transform Infrared (FTIR, PI Martine De Mazière, BIRA-IASB) spectrometer providing partial column measurements of CH<sub>4</sub>, CO, NO<sub>2</sub>, O<sub>3</sub>, HCl, HF, HNO<sub>3</sub>, H<sub>2</sub>O. The FTIR is installed at the Maïdo observatory as part of a collaboration with the Belgian Institute for Space Aeronomy, BIRA-IASB. The FTIR is taking routine measurements since 2013 and is part of the NDACC network.
- A Raman H<sub>2</sub>O LIDAR system providing 4 to 6 water vapor profiles per month since April 2013 (PI Philippe Keckhut, LATMOS; Co-I Valentin Dufлот, LACy). LIDAR water vapor observations extending into the lower stratosphere were validated during the Maïdo Observatory Gas and Aerosol NDACC Experiment (MORGANE) intercomparison exercise in May 2015. The Raman H<sub>2</sub>O LIDAR is to be certified NDACC by 2018.
- The stratospheric ozone LIDAR (PI Thierry Portafaix, LACy), the tropospheric ozone LIDAR (PI Valentin Dufлот, LACy) and the Rayleigh temperature LIDAR (PI Alain Hauchecorne, LATMOS).
- A GNSS station (PI Jimmy Leclair de Bellevue) that provides routine measurements of integrated water vapor (IWV). The GNSS operates at the Maïdo observatory since 2013 and the IWV measurements are used for the nighttime Raman water vapor LIDAR system calibration.

### **Change and change management**

- The weekly NDACC/SHADOZ ozone sondes will benefit from the development on the M10 radiosondes (humidity correction, M10 New Design)
- In 2012 the LIDARs (stratospheric/tropospheric ozone, temperature and water vapor) were moved from the measurement site in Saint-Denis to the Maïdo Observatory.
- The Maïdo Observatory is part of the ACTRIS-ERI (Aerosols, Clouds, and Trace Gases Research Infrastructure, European Research Infrastructure) measurement network. ACTRIS-ERI is working towards global research infrastructures in environmental and earth sciences. As part of the ESFRI (European Strategy Forum for Research Infrastructure) roadmap, ACTRIS-ERI will support and develop a long term sustainable data centre that should play an important role as an intermediate between national/European observation networks and global networks such as NDACC or GRUAN.

### **Resourcing**

At the moment, the Reunion site is facing two main problems. The first concern is the possible retirement of Françoise Posny (PI of SHADOZ ozone sondes) by 2020. OSU-R and LACy are looking into hiring a researcher/engineer in the coming years to support GRUAN activities in Reunion Island. However the academic job market in France is quite difficult and very few positions open each year for the many french universities and research institutes. Another concern is the lack of fundings to support long-term monthly CFH measurements in Reunion. At the moment CFH measurements have been developed since 2014 with the support of the GRUAN Lead Centre, the French national "SOERE ROSEA" (Allenvi) network and OSU-R.

OSU-R will cover the cost of one CFH per year starting in 2017 and the new french national "SOERE ATMO" network may contribute to the cost of a second CFH. Additional fundings will be required to cover the cost of more CFH launches.

### **Site assessment and certification**

The GRUAN ground-check procedure has been applied during the May 2015 MORGANE campaign at the Maïdo Observatory for the Vaisala sondes RS92/RS41 (use of the 100% relative humidity chamber). However, by MODEM's request, the GRUAN ground-check procedure was not applied to the M10 sondes. We will wait for final development of the M10 sonde before implementing the GRUAN ground-check procedure for the weekly SHADOZ measurements at Gillot Airport.

Jean-Pierre Cammas is also in contact with Martine de Mazière to integrate the FTIR of the Maïdo Observatory into the GRUAN network. OSU-R engineers are involved into the NDACC Lidar working group and as such will work in collaboration with Thierry Leblanc (GRUAN LIDAR working group) to establish a comparison between the GRUAN lidar algorithm and the one currently used for the Raman Lidar at the Maïdo Observatory. We would like to go through the GRUAN application process by the end of 2018.

### **GRUAN related research**

The measurements from the May 2015 MORGANE campaign are currently used in multiple studies that should lead to publications by the end of 2016.

### **WG-GRUAN interface**

The GRUAN working group may provide a letter of support for the use of the CHF<sub>3</sub> (Trifluoromethane, R23) gas used for the CFH measurements. Because of new European regulations, the use of R23 has become restricted. The European Council has called for a reduction of greenhouse gas emissions in the EU by 80-95 % by 2050. As R23 is a powerful greenhouse gas, its usage is now restricted. A certificate of usage is now required to buy R23. This certificate requires that the gas is used in closed systems only, with rigorous control mechanisms in place to detect and minimize leakage. This is not possible for the CFH instrument although small quantities of R23 are used (~350g) per launch.

We have contacted the VERITAS certification agency and according to them the use of R23 for scientific applications doesn't require the certificate of usage. We will try now to approach the French environment and energy management agency (ADEME) but will need the support from the GRUAN working group.

In addition, we are currently working with a private company in Reunion (AC-INNOV) to develop a fully automated UAV to recover balloon sonde instruments (see Future plans section). We will submit a proposal to the Regional Council of Reunion Island by the end of 2016 to support the cost of the UAV development and the first test flights (via the European Regional Development Fund, ERDF). A support letter from the GRUAN WG could help to obtain the ERDF fundings to develop a cost-effective method to develop in-situ UTLS measurements in the tropical Southern Hemisphere.

### **Items for ICM-6 plenary discussions**

Issue concerning the restricted usage of R23 gas in Europe (see above).

### **Future plans**

Several projects are underway in Réunion that could be of interest to GRUAN. These are:

- The CONCIERTO project (PI Stephanie Evan) has been submitted to the french national research agency (ANR) in April 2016. In this project, we propose to take balloon-borne vertical profile measurements of water vapor and aerosols in Reunion Island and apply an innovative modeling approach to understand how cirrus clouds and deep convection affect TTL humidity over the SH tropics. If funded the CONCIERTO project should cover the cost of ~15 CFH and COBALD instruments for 2 years (2017-2018)
- The development of a fully-automated UAV to recover balloon sonde instruments. Unfortunately we cannot control the balloon flight. The free fall and recovery of the valuable balloon payload is difficult, particularly in mountainous terrain (the topography of Reunion Island is quite craggy). In addition, most of the time the balloon payload is lost at sea and thus we cannot recover the instruments. Thus we need to buy instruments for each balloon launch. To reduce the cost of balloon measurements in the future, we are currently exploring an innovative project with AC-INNOV, a private UAV company in Reunion Island. They are currently performing test flights with a rhomboid-shaped UAV (1.5m wide) in Reunion Island to obtain DGAC certification for the commercialization of their UAVs. According to the head of AC-INNOV, it is technically feasible to adapt one of their rhomboid-shaped UAV as a flying wing with no engine, fully automated, to bring back the balloon payload even with the balloon reaches a top altitude at 35 km. The cost of a single UAV would be ~1000€ If such technical solution becomes available to the scientific community, it would help reduce the cost of balloon launch payload for accurate *in situ* water vapor and aerosol measurements in the horizon of 4 to 5 years. This should be of interest to the GRUAN community.
- The RenovRisk project that aims to develop an integrated approach to assess and manage hurricane risk for the southwestern Indian Ocean in a changing climate. As part of RenovRisk additional GNSS stations and radiosoundings will be deployed in the southwestern Indian Ocean to improve numerical weather prediction models. These data could be of interest to GRUAN.