# *SIRTA and REUNION Observatories*

# *Feasibility study to become GRUAN candidates*

SIRTA
www.sirta.fr

**Institut Pierre-Simon Laplace**
**Atmospheric Research Observatory**

**National Experimental Facility**

OPAR
OSU-RÉUNION
LACy
LATMOS
http://opar.univ-reunion.fr

**Observatoire de Physique de l'Atmosphère de la Réunion**

**Contributions to French GRUAN discussion group**

- **CNRS/INSU/IPSL:** M. Haeffelin, P. Keckhut, JC. Dupont
- **CNRS/U. Réunion:** J-L. Baray, F. Posny, J. Leclair-de-bellevue
- **Météo-France:** F. Besson, J. Parent-du-chatelet, M-G. Renaudin
- **MODEM:** P. Charpentier, R. Pépin, C. Craux

# *Outlook*

- Summary of March 2012 - February 2013 activities
  - Establishing national framework for GRUAN activities
  - Radiosonde activities
  - H20 Lidar activities
  - GPS activities
  - Inter-comparisons
- Proposed activities 2013-2015

# *March 2012 - February 2013 Activities*

**FRAMEWORK** ***March 2012 - Feb 2013 Activities***

*Establishing a national framework for GRUAN activities:*

- ROSEA: Network of Observatories for Surveillance of Atmospheric Water - Climate Applications (project validated in May 2012)
  - Radiosonde, Lidar, GPS
  - Includes GRUAN activities in France
  - SIRTA and Réunion Observatories part of ROSEA
  - Contributions from CNRS, U. Réunion, Météo-France, IGN
- IPSL & M-F convention with GRUAN objectives
  - Engaging in a feasibility study
  - Cooperation agreement (Sept 2012)
- IPSL & MODEM
  - Engaging in measurement uncertainty evaluation
  - Sharing of data and algorithms

RS

# *Towards qualification of MODEM M10 sondes*

M10


MODEM

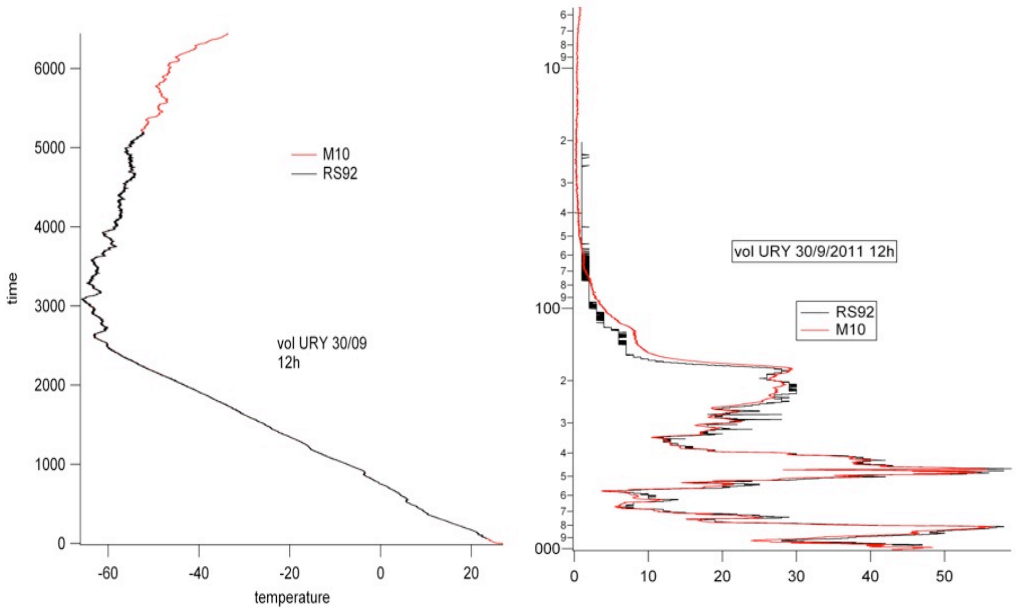
- Enthusiastic about uncertainty evaluation of the M10 in GRUAN framework
- Discussion of M10 processing algorithm with IPSL
- Committed to provide raw data
- Committed to provide support with measurements and tests

T: Thermistor

U: Capacity sensor

Precision GPS

Regularly perform dual sonde flights for inter-comparisons

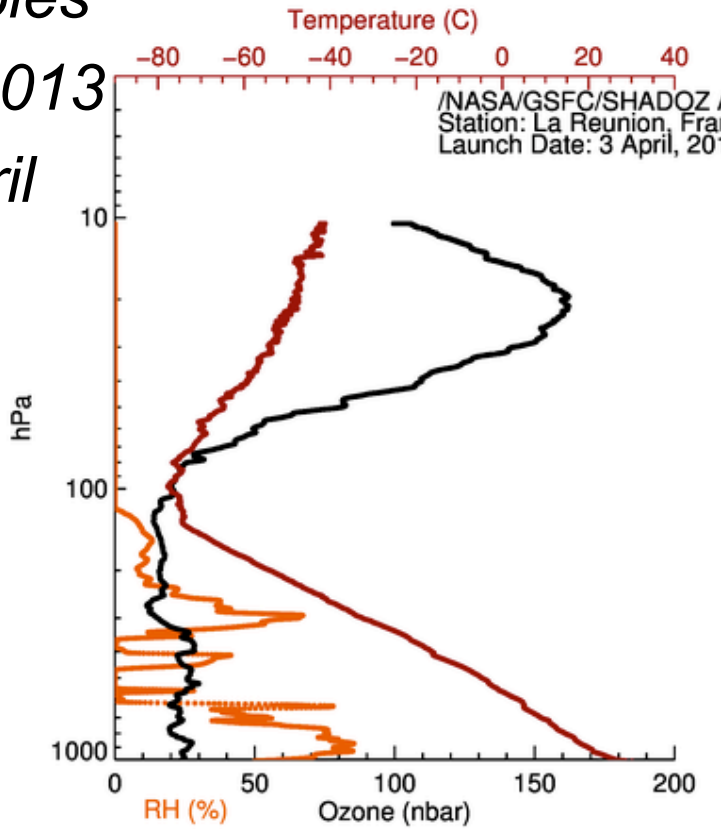


RS

# *RS measurements at La Réunion (21°S)*

- *Weekly by U. Réunion: 35-40 (PTU + O3) profiles submitted to SHADOZ network yearly*
- *PI: F. Posny (U. Réunion)*
- *SHADOZ and NDACC since 1998*
- *Motivated to implement GRUAN protocoles*
- *Transition from MODEM M2 to M10 in 2013*
- *ROSEA + NDACC field campaign in April 2013:*
  - *Lidar calibration (w. GPS + RS)*
  - *M2, M10, RS92 intercomparisons*

- *Daily by Météo-France using MODEM M10 since 2011*



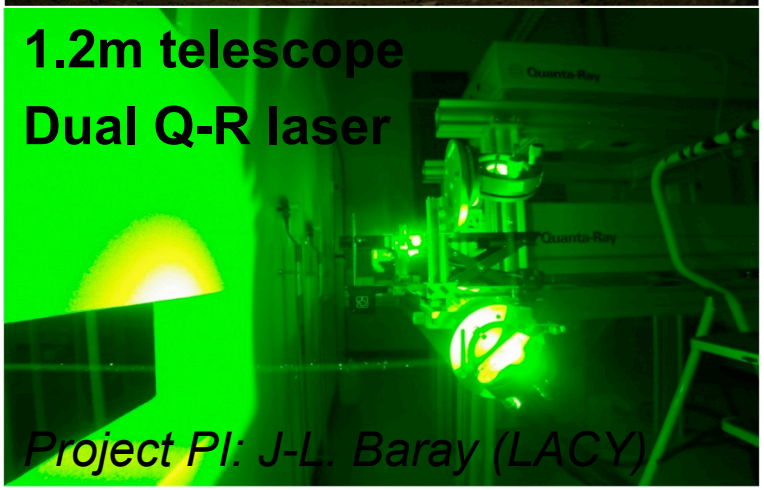

*PI: F. Posny (U. Réunion)*

**LIDAR**

# *H20 Lidar measurements at La Réunion (21°S)*

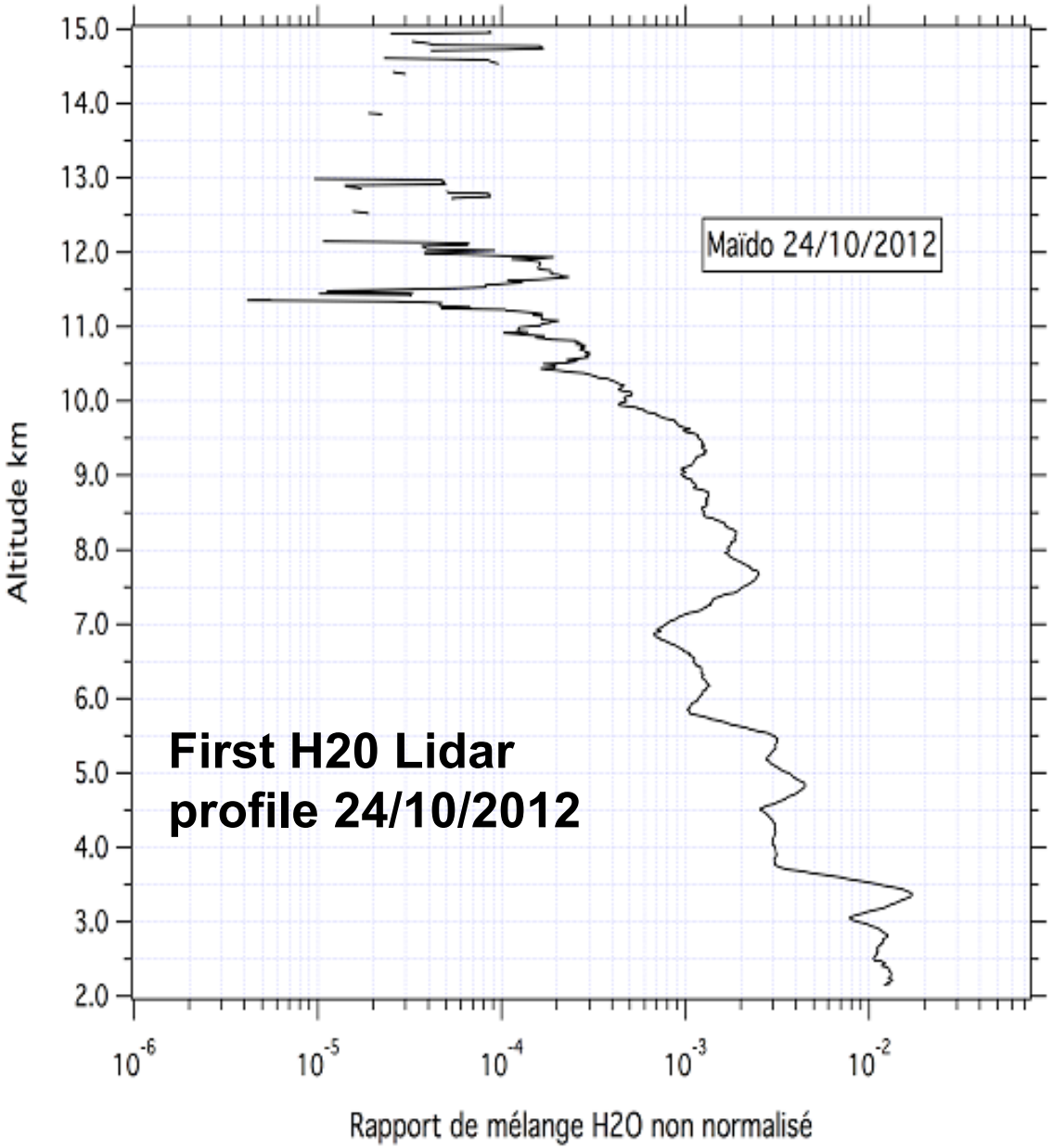
**Maïdo Observatory inaugurated in Oct 2012**

**New NDACC Lidar deployed**



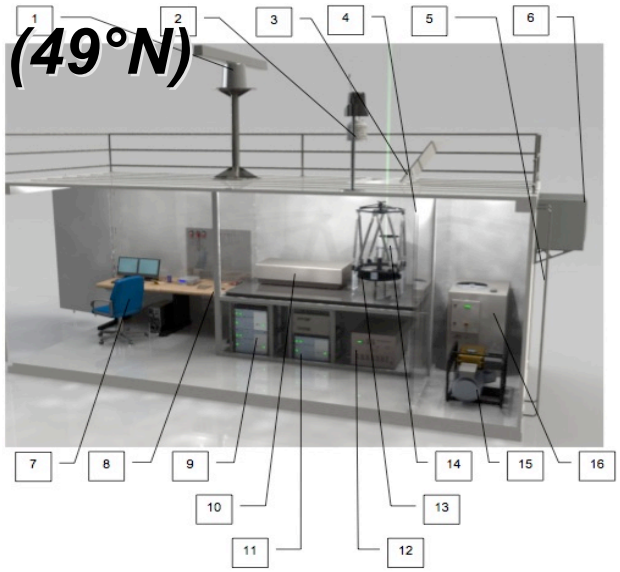
**1.2m telescope**
**Dual Q-R laser**

*Project PI: J-L. Baray (LACY)*



LIDAR

# *New Raman Lidar at SIRTA (49°N)*




1. Marine Radar
2. Weather Station
3. Hatch lid
4. Double wall glass
5. Ladder
6. Air condition unit
7. Office
8. Work bench
9. Transient recorders
10. Laser head
11. Other electronics
12. Laser Power supply
13. DK500 Telescope
14. DK 250 Telescope
15. Power Generator
16. Chiller

**IPRAL: IPSL Hi-Performance multi-wavelength Raman Lidar for Cloud Aerosol Water Vapor Research**

- **Contributions to GRUAN (H20), ACTRIS (Clouds, Aerosols), EarthCARE (Clouds, Aerosols)**
- **80% of funding obtained**
- **6-month pre-design study to match specifications and technical solutions (IPSL + Gordien Strato + Raymetrics)**
- **Manufacture fall 2013**
- **Measurements spring 2014**

| Specs | | |
|---|---|---|
| Telescope (near field) | 150 mm diameter | |
| Telescope (far field) | 500m diameter | |
| Laser Energy | 2000 m/pulse (375 mJ/pulse at 355 nm) | |
| Laser Repetition Rate | 30 Hz (10 Hz optional) | |
| Laser λ | 1064, 532, 355 nm | |
| Overlap[1] | 3500 m (far field telescope) 150 m (near field telescope) | |
| Depolarization | @ 355 and 532 nm | |
| Depol. Calibration | +/- 45 degree method | |
| Raman Nitrogen | Yes (607 and 387 nm) | |
| Raman Water Vapour | Optional | |
| Pre-trigger | Yes | |
| Optical Triggering | Optional | |
| Detection mode | Analog | Photon |
| Backscatter signal | Yes | Yes |
| Raman Signal | Yes (Nitrogen) | Yes |
| Upgradability[2] | Yes | |
| Deployment Type[3] | Vertical | |
| Eye-safe | No | |
| **Performance** | | |
| SNR[4] | | |
| Backscatter Signal | >100 @ 15 Km (Day, 10 min) | |
| Raman Signal Nitrogen | >3 @ 7-8 Km (Day, 15 min ) | |
| | >3 @ 10-12 Km (Night,15 min) | |
| Raman Signal Water Vapor | >3 @ 2-3 Km (Day, 20 min ) | |
| | >3 @ 10-12 Km (Night,20 min) | |
| **Power Consumption** | | |
| Voltage | 220 | |
| Power Consumption[5] | 5 KW | |
| **Dimensions (mm)** | | |
| ISOBOX | 6000 x 3000 x 2500 (mm, L X W X H) | |

*Project PI: M. Haeffelin (IPSL)*

GPS

# *GPS-IWV Retrieval Activities at SIRTA (49°N)*

- GPS solutions from analysis in PPP mode (Gipsy-Oasis II, 6.0.2) at ENSG / IGN
  - **PPP = Precise Point Positioning**
    → Precise absolute coordinates for a single receiver obtained without the need of a second receiver at a known location or a receiver network
    [Zumberge et al., 1997 JGR]
  - **Use of NASA / JPL products** for satellite orbits and clocks, ambiguity resolution, earth orientation parameters, etc.
  - Troposphere modeling :
    - Estimation of wet delay and horizontal gradients
    - VMF (derived from ECMWF 6h – analysis) for a priori and delay elevation dependency [Boehm et al., 2006 JGR]
    - Delay and gradients are modeled as stochastic parameters (random walk of 5 and 0.5 mm/sqrt(h) resp. – solution rate of 5 min)
  - **Operational processing at day + 2 (rapid solution) and day + 12 (final solution) (according to NASA / JPL products)**
  - Conversion ZWD to IWV using VMF mean temperature (derived from ECMWF 6h – analysis)
  - Advantages w.r.t relative strategy :
    - No processing induced correlations in troposphere estimates for the different stations
    - Processing time scales linearly with the number of stations
    - Each station is processed independently of the others
    - The consideration of a new station do not require the analysis of the whole network

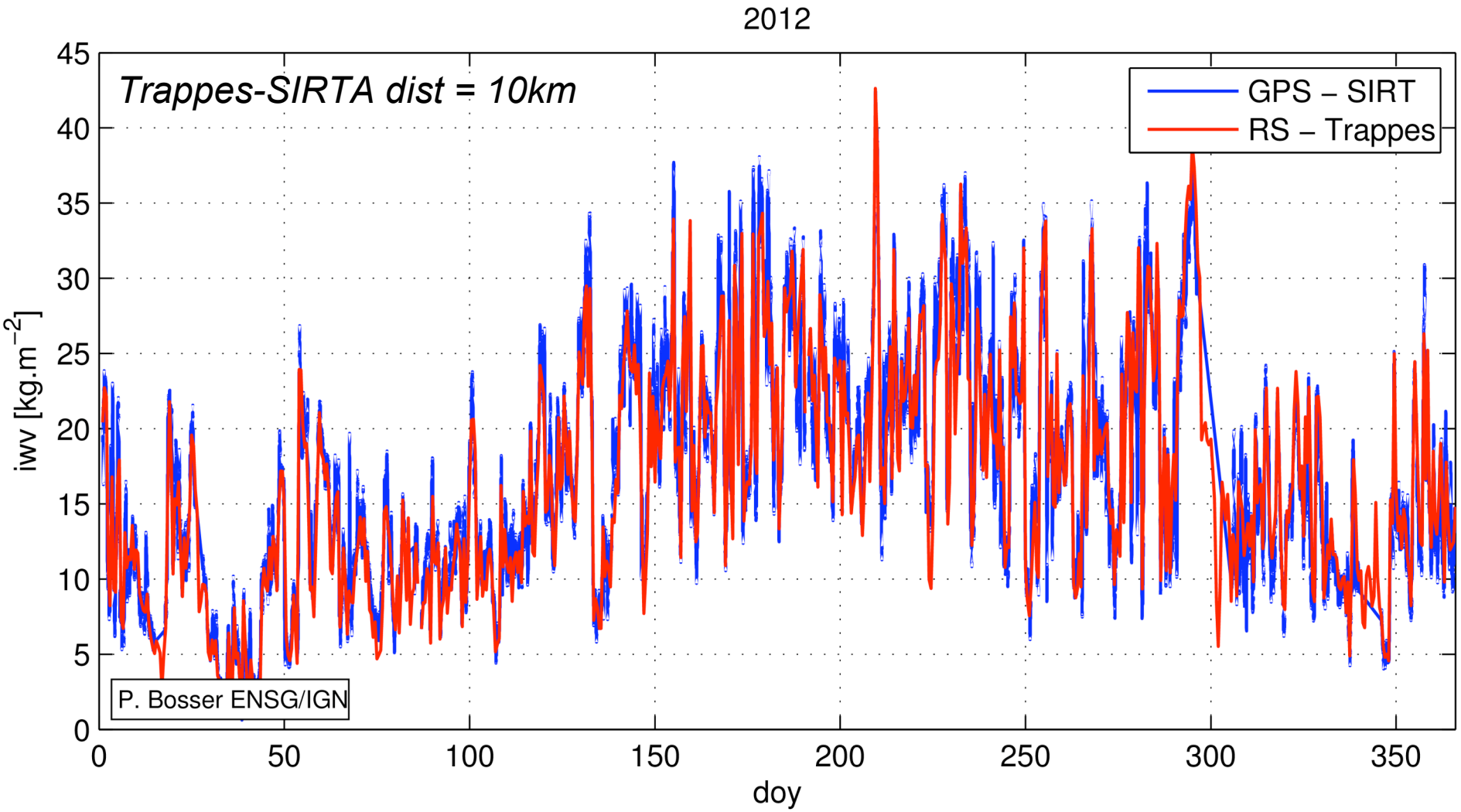
*GPS PI: P. Bosser (IGN)*

GPS

# *GPS-IWV Retrieval Activities at SIRTA (49°N)*

1 year inter-comparison between GPS-IWV and Radiosonde

**Bias = -0.34 kg.m$^{-2}$ / Std Dev = ± 1.71 kg.m$^{-2}$**




Radiosondes data from L. Oolman (U. Wyoming)

*GPS PI: P. Bosser (IGN)*

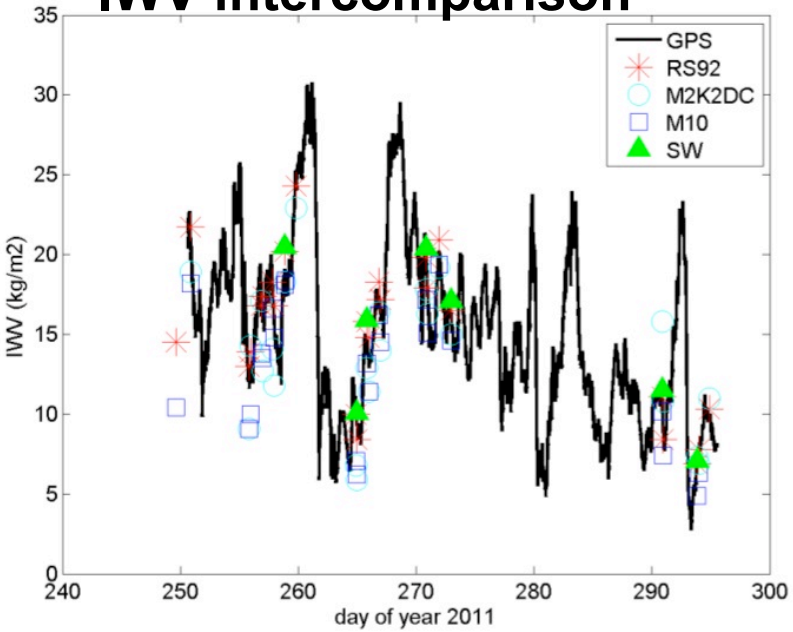
# Intercomparison

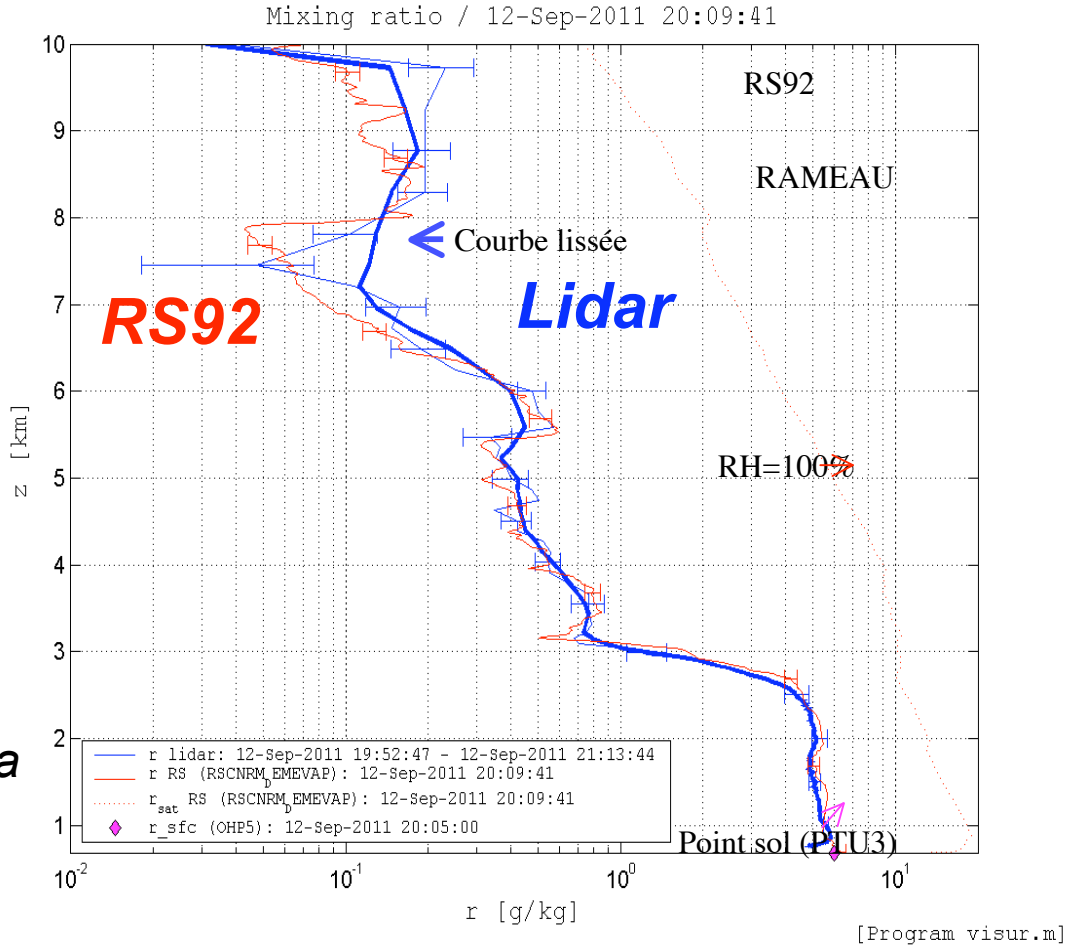
## *RS-GPS-LIDAR Campaign at OHP*

*To improve Lidar calibration using GPS for water vapor retrievals*

*To evaluate measurement uncertainties*

**IWV intercomparison**




*From Bock et al (2012) ISTP9, L'Aquila*

*26 nighttime flights: 79 sondes (RS92, M2K2, M10, SW)*

*RS-GPS biais = +1 to -1.5 kg/m2*

***Next inter-comparison campaign: April 2013 in La Réunion***

***PI: P. Keckhut (IPSL)***

# *Proposed 2013 - 2015 Activities*

## *2013 - 2015 Activities*

2013-14

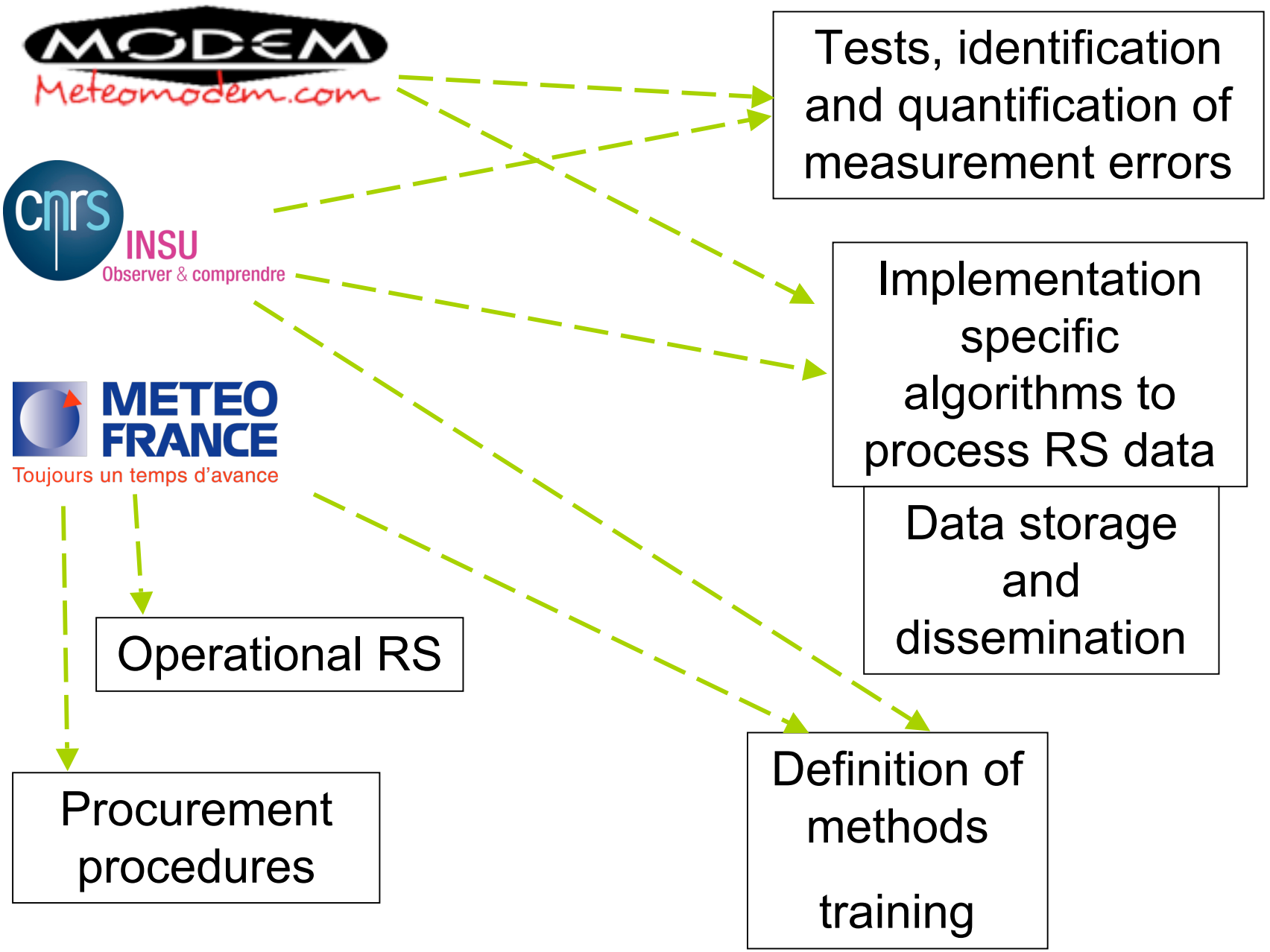
Necessary steps to validate French contribution

- MODEM M10 sonde uncertainty evaluations:
  - IPSL + MODEM + LC: develop test strategy
  - Perform tests and compute uncertainties
- GRUAN procedures in Météo-France
  - Evaluate impact of GRUAN procedures (finance, personnel): ground-check, meta-data collection, regular dual-sonde flights

2014-15

Further developments:

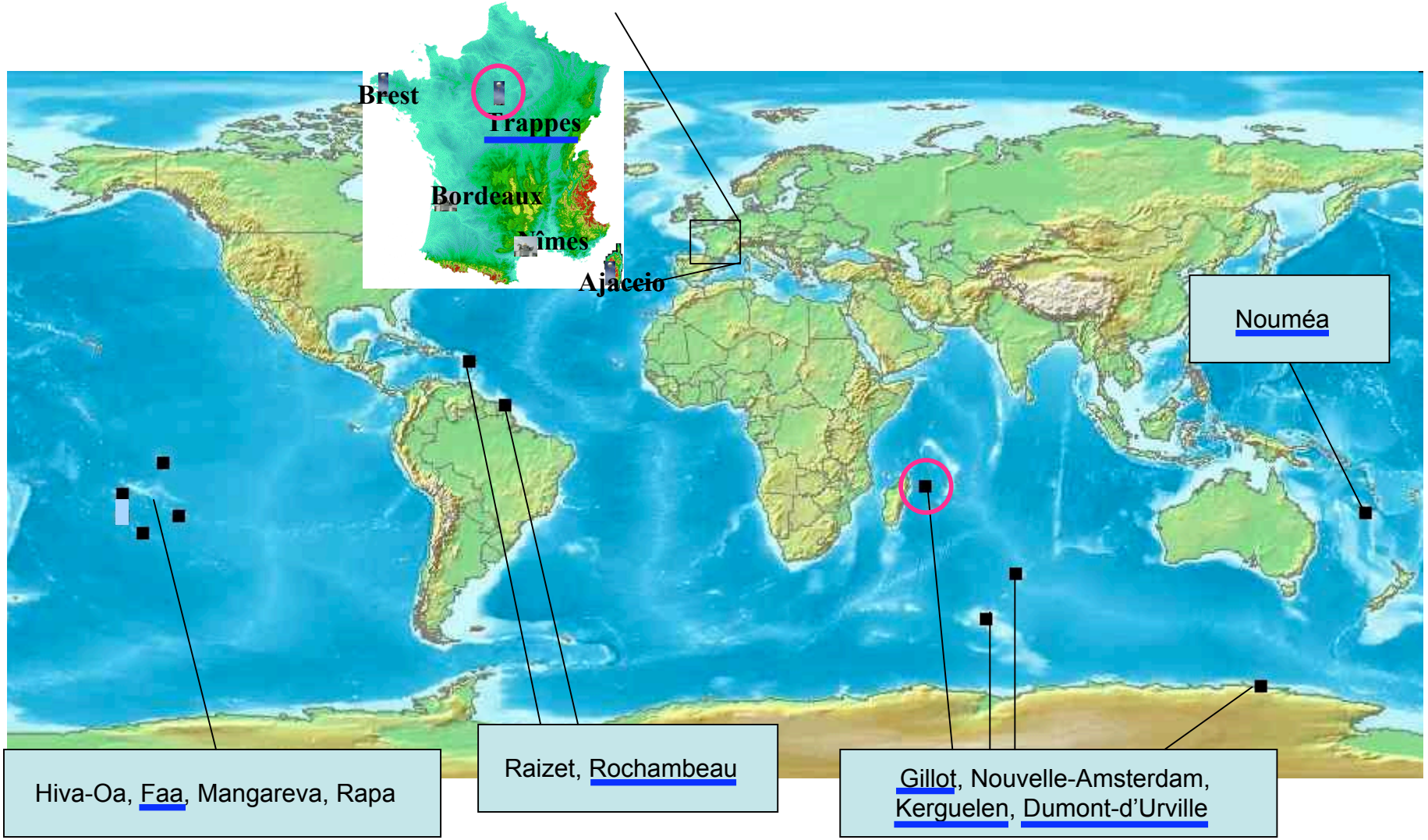
- Develop data processing software for M10 sonde
- Implement GRUAN procedures at SIRTA (M-F RS) & La Réunion (U. Réunion RS)
- Implement submission to LC
- Go through GRUAN certification
- Redundant measurement activities (sondes, H20 Lidar, GPS)


MODEM
Meteomodem.com
cnrs
INSU
Observer & comprendre
METEO FRANCE
Toujours un temps d'avance
Tests, identification and quantification of measurement errors
Implementation specific algorithms to process RS data
Data storage and dissemination
Operational RS
Procurement procedures
Definition of methods
training

# *Conclusions*

- Established a national framework for GRUAN activities
- Contributions from: IPSL, U. Réunion, Météo-France, MODEM, IGN
- GRUAN-type activities exist already at SIRTA and La Réunion
- 2013 = feasibility study
  - M10 sonde uncertainty evaluations
  - Validation by Météo-France of GRUAN procedures
- GRUAN certification towards 2014-2015

# *French Operational Radiosonde Network*




METEO FRANCE
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operates surface and upper air operational (24/7) networks including 15 radiosonde sites around the world (~24 sondes per day: > 8500 sondes/yr)