THE MODEM SONDE DATA PRODUCT

PROGRESS AND PLANS

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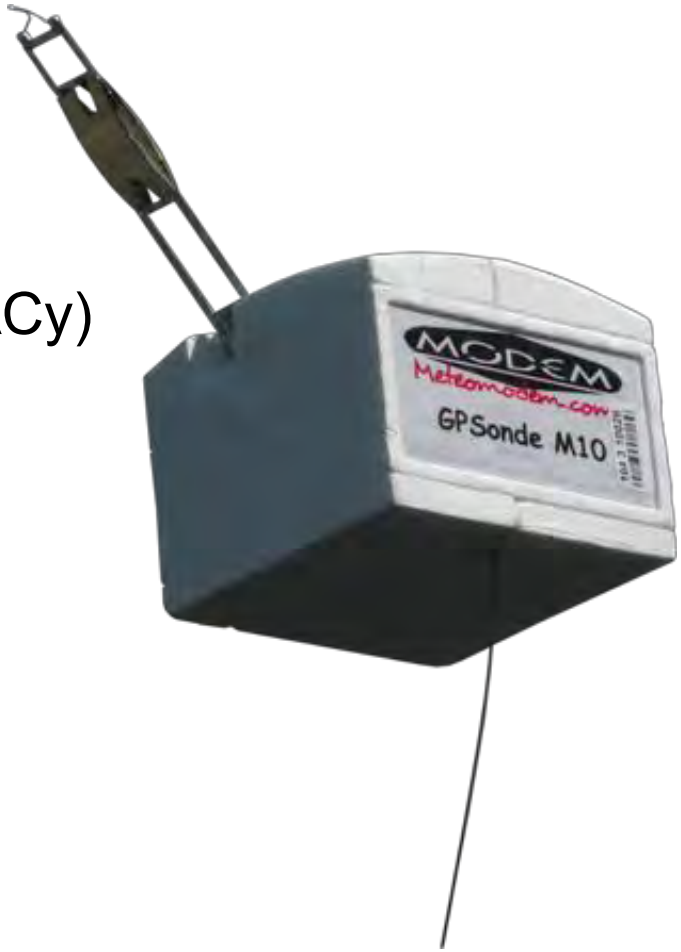


GRUAN Helsinski – June 2017

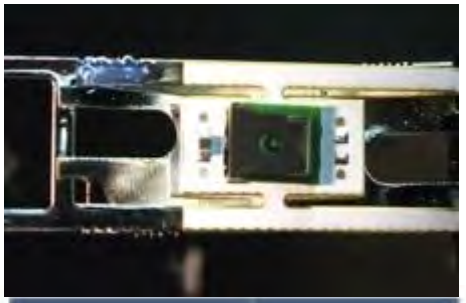
Outline

1. Measurement compensations and uncertainties
   - RH sensor temperature bias at high altitude
   - Robotsonde effect at low altitude
   - Comparisons with RS92
2. GRUAN M10 ground-check procedure
3. GRUAN M10 Robotsonde operations
4. GRUAN M10 data processing and Documentation
5. Future activities 2017-2018

Relative Humidity compensations and uncertainties

Principle:

- Capacitive sensor
- Oscillation frequency of the sensor is measured by a microcontroller
- Capacitor frequency varies with temperature



Calibration:

- Oscillation frequency at 55% RH

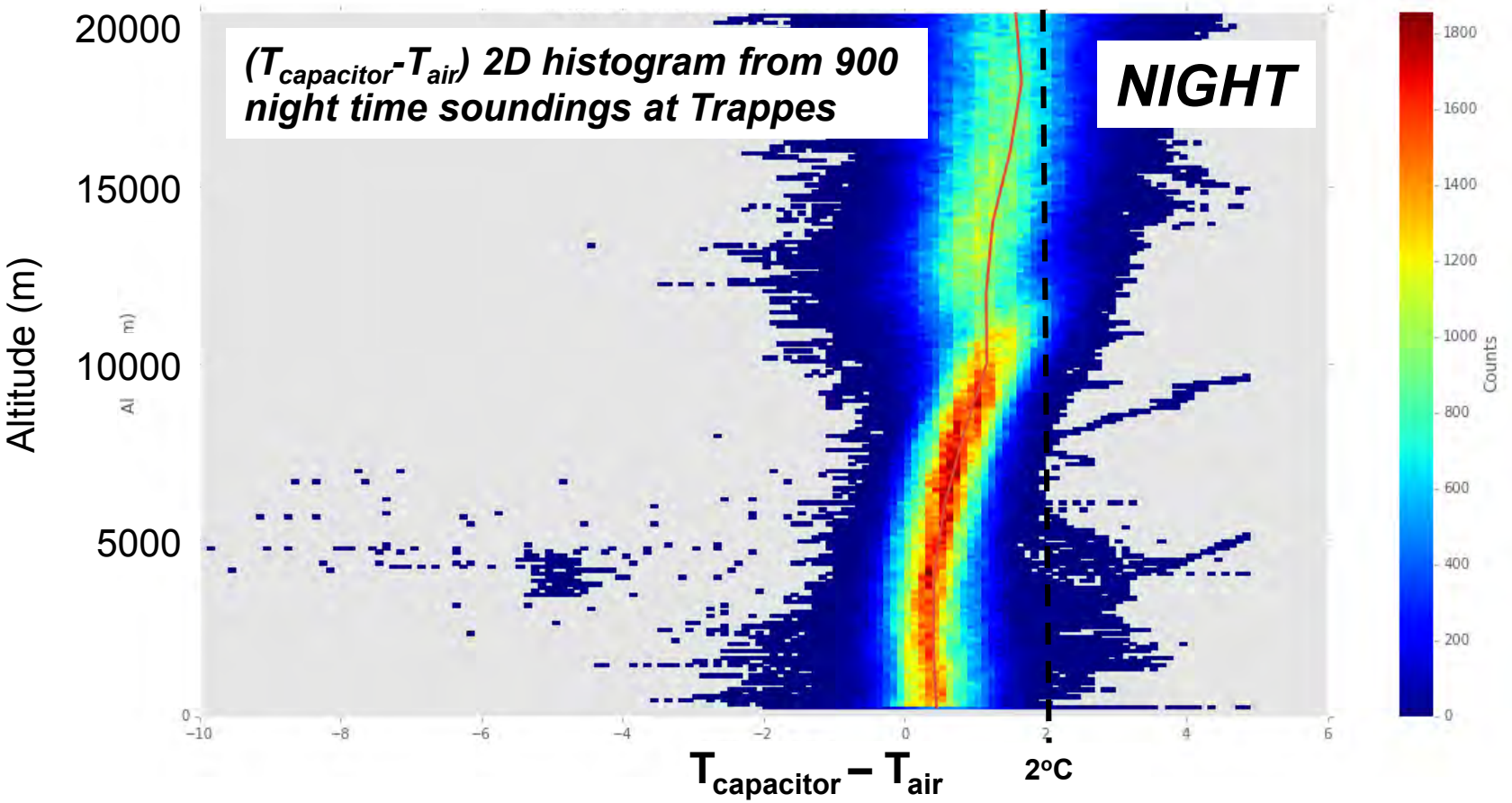
New corrections: accounting for temperature differences between Air and RH capacitive sensor

1. Induce a dry bias at high altitude
2. Induce a dry bias at very low altitude (robotsonde)

High-altitude heating effect (dry bias)

Compensation at NIGHT : statistical approach

- New compensation based on mean ($T_{capacitor} - T_{air}$) model as a function of height and Air temperature at NIGHT
- At NIGHT : T_{air}: 0 to -80°C; ΔT: 1-2°C → RH x 1.05 – 1.5

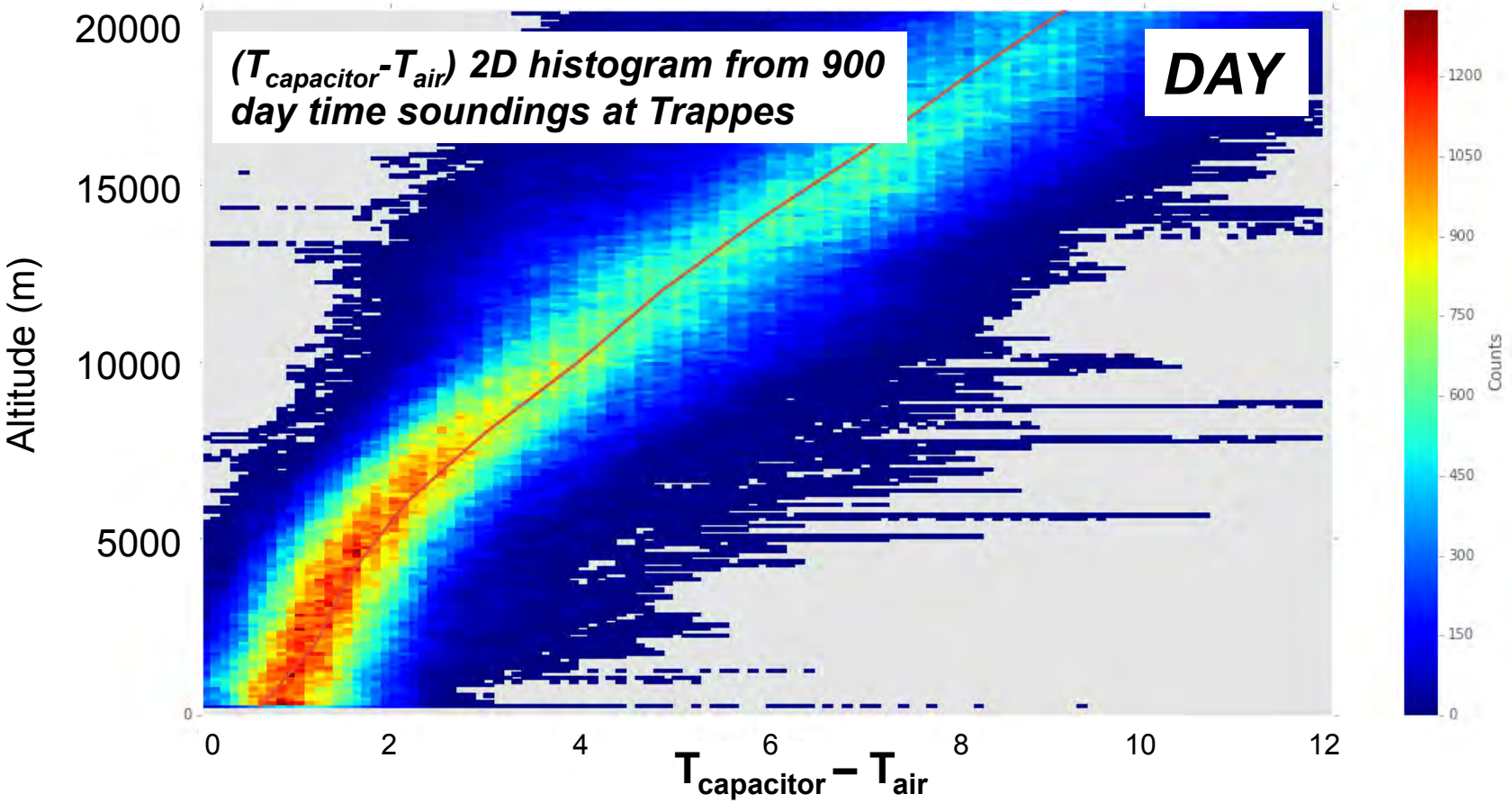


Heating effect of capacity sensor well quantified
Compensation law developed to correct dry bias

High-altitude heating effect (dry bias)

Compensation during DAY: statistical approach

- New compensation based on mean ($T_{capacitor} - T_{air}$) model as a function of height and Air temperature during DAY
- During DAY : T_{air}: 0 to -80°C; ΔT: 1-10°C → RH x 1.05 – 2.0



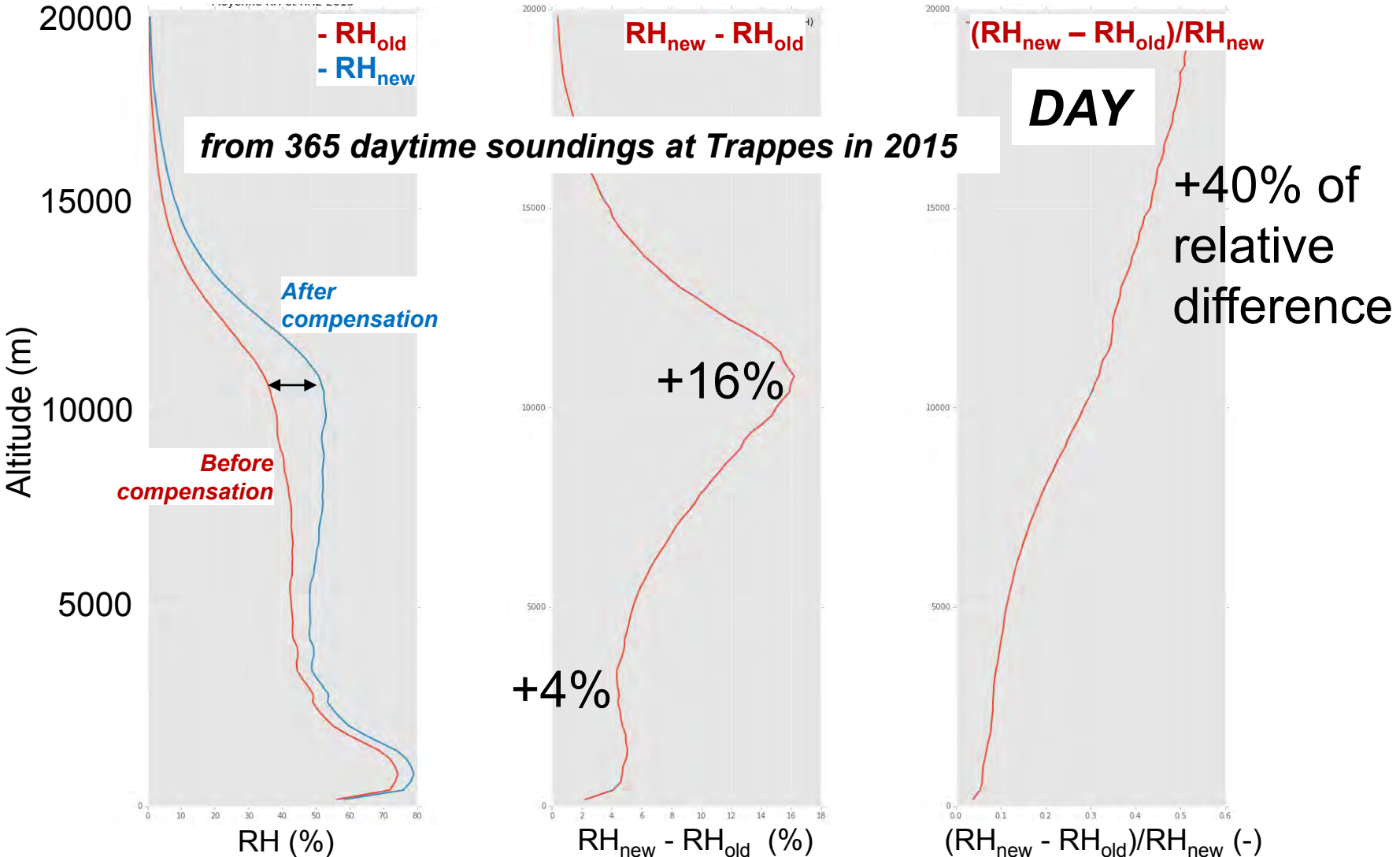
Heating effect of capacity sensor well quantified

Compensation law developed to correct dry bias

High-altitude heating effect (dry bias)

Compensation during DAY: statistical approach

- Compensation law applied to correct dry bias
- Dry bias is around 16% at 10km

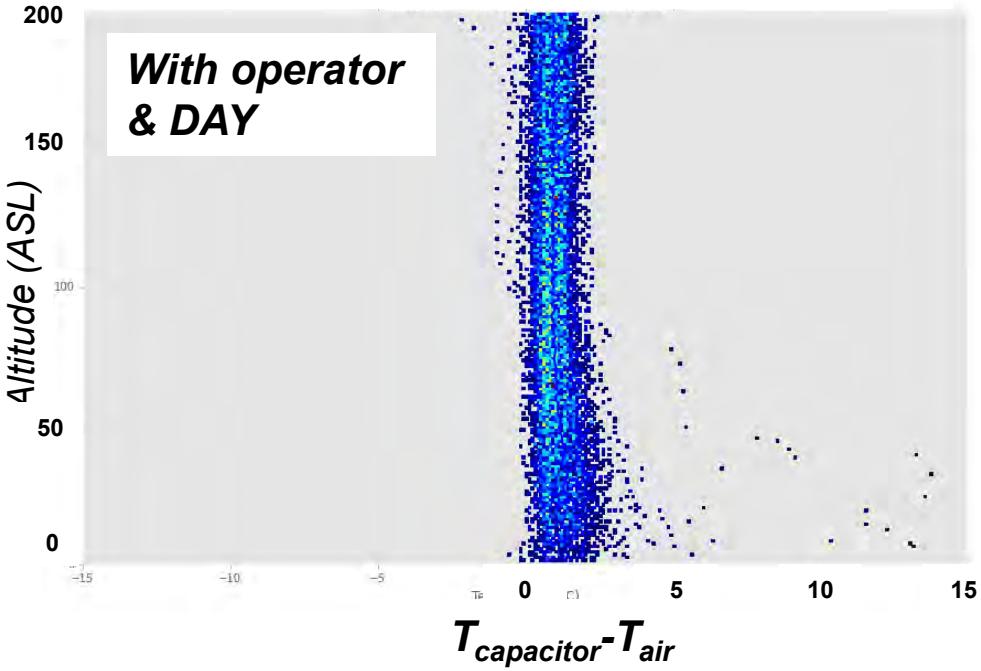


Very-low-altitude effect (dry/moist bias)

Impact of robotsonde launch on very low altitude RH:

- Météo-France uses Robotsonde since April 2015;
- Temperature controller inside shelter induces $T_{capacitor}$ difference with outside Air temperature during ~150m meters.
- Compensation law applied to correct low-altitude humidity bias

($T_{capacitor}$-T_{air}) for 365 day time soundings at Trappes (Jan. – Dec. 2014)



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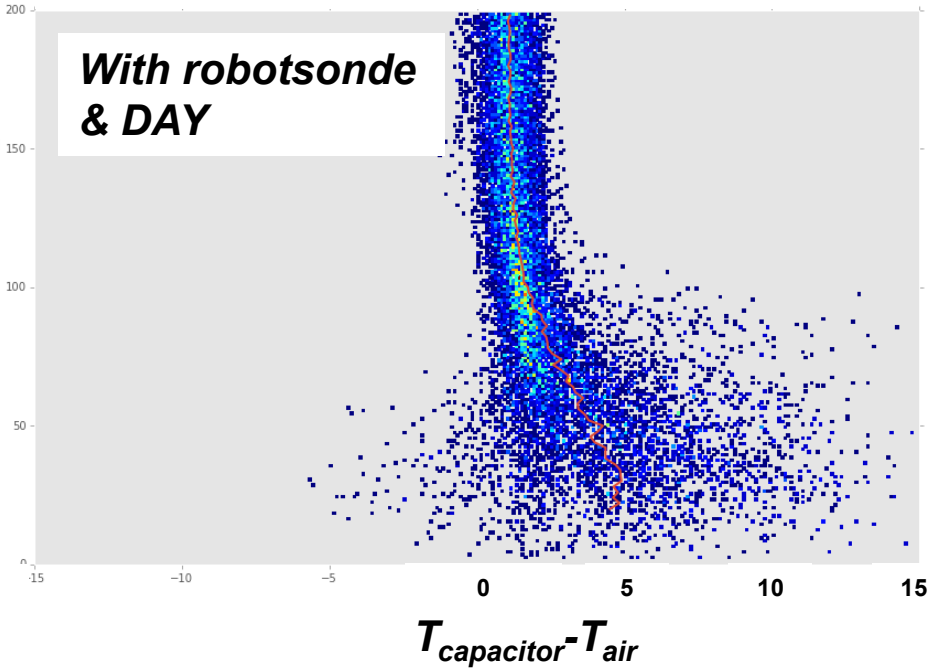


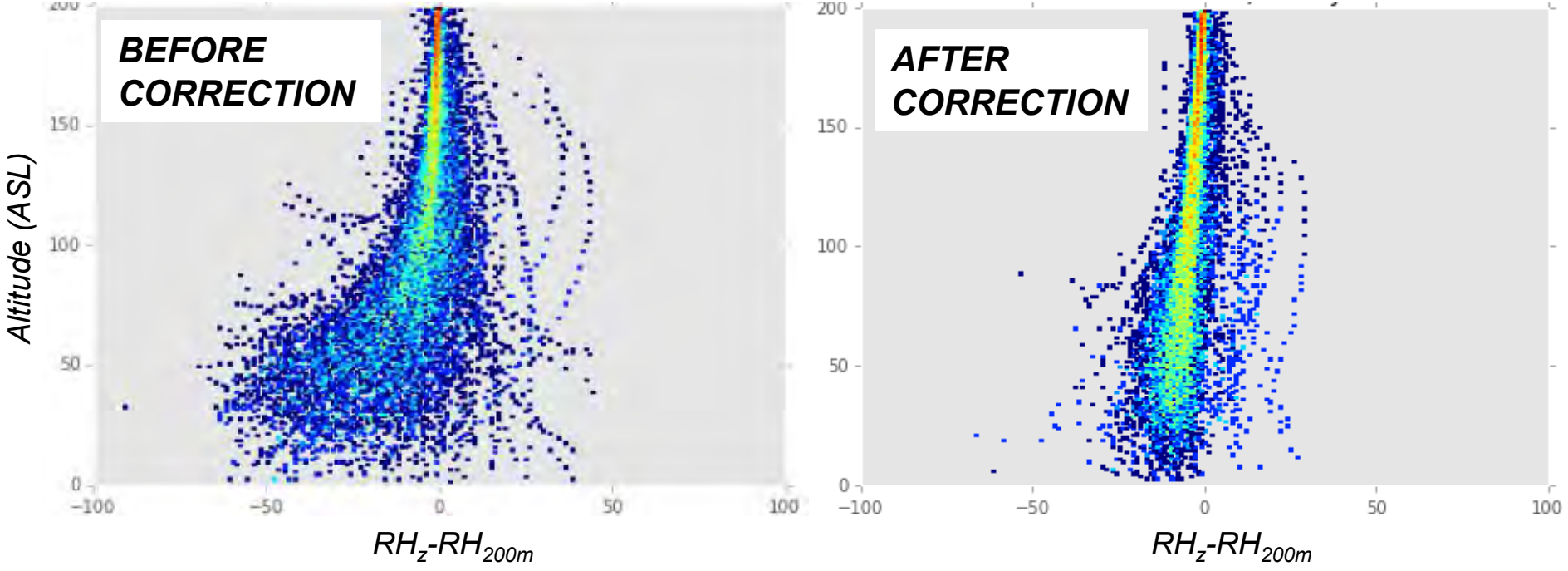
A compensation law must be applied at very low altitude

Very-low-altitude effect (dry/moist bias)

Impact of robotsonde launch on Relative Humidity.

- Observed (mostly) dry bias due to $T_{capacitor}$ higher than T_{air}
- Correction of dry bias will be implemented in GRUAN code

(RH_z-RH_{200m}) versus T_{air} for 365 night time soundings at Trappes (Jan. – Dec. 2016)



MODEM compensation law corrects the very low altitude bias

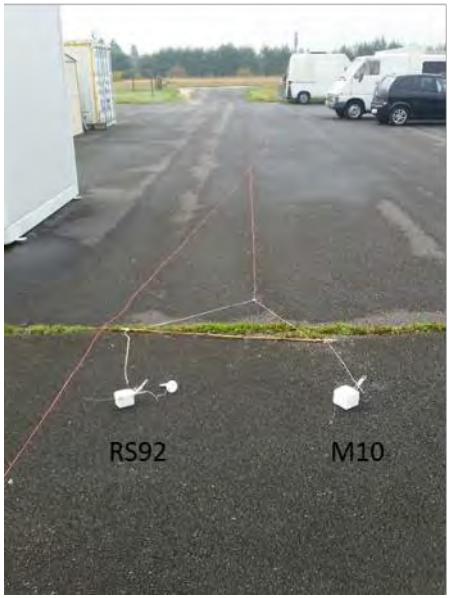
Comparison with RS92 radiosondes

Analysis of M10+RS92 simultaneous RS

- 7 M10+RS92 launches done at SIRTA

- RH compensations have been tested to better understand and document the current corrections for GRUAN procedures.
- Complete methodology for GRUAN procedures has been tested (raw M10 data + metadata, GRUAN algorithm, level 1 GRUAN products)

11/10/2016



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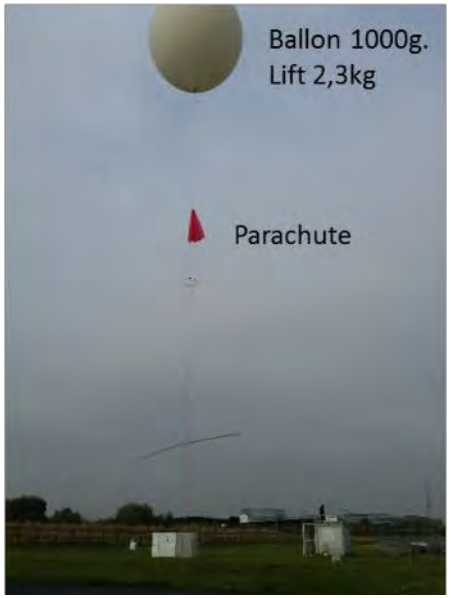
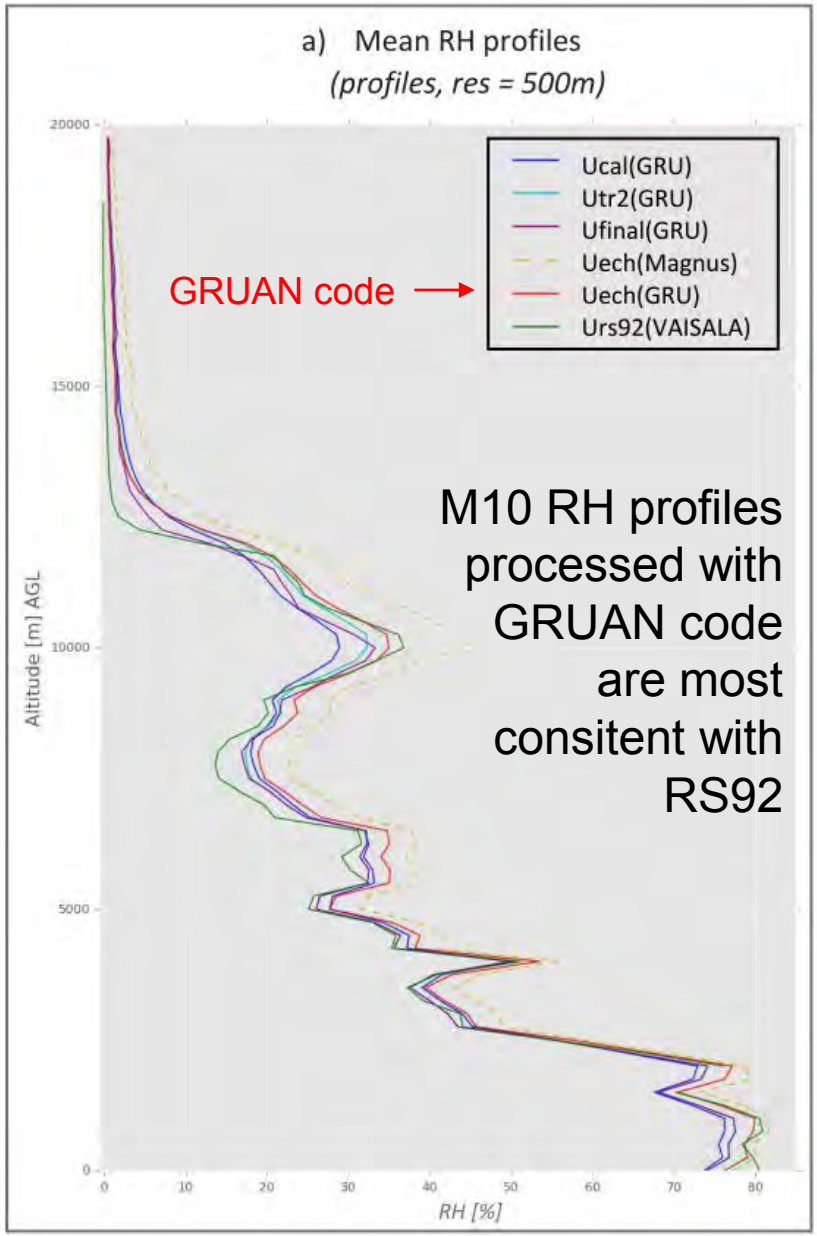




GRUAN M10 ground-check

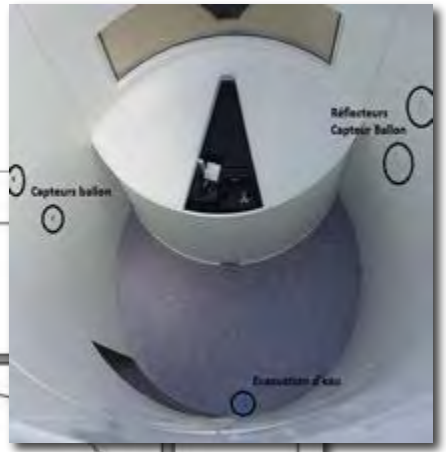
2-step ground-check (about 10 min per sonde for data acquisition):

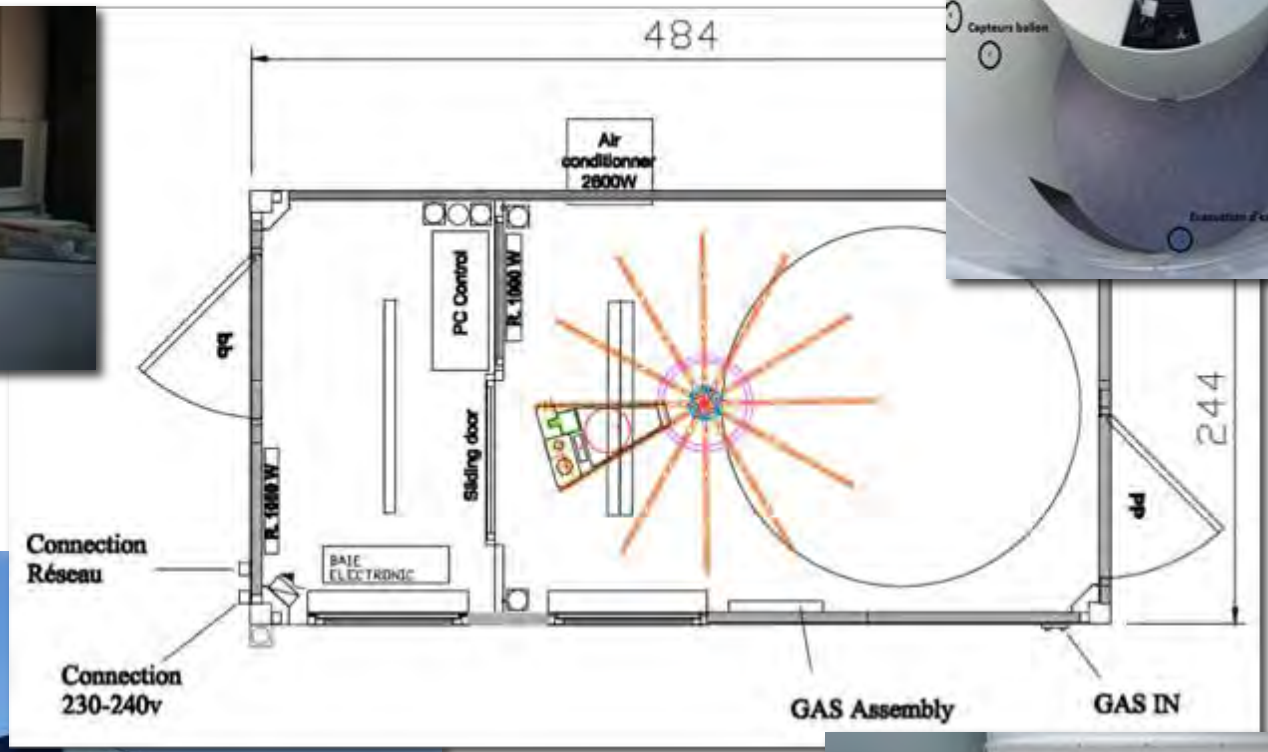
Comparison with calibrated temperature and RH sensors in ventilated hut – ambient conditions

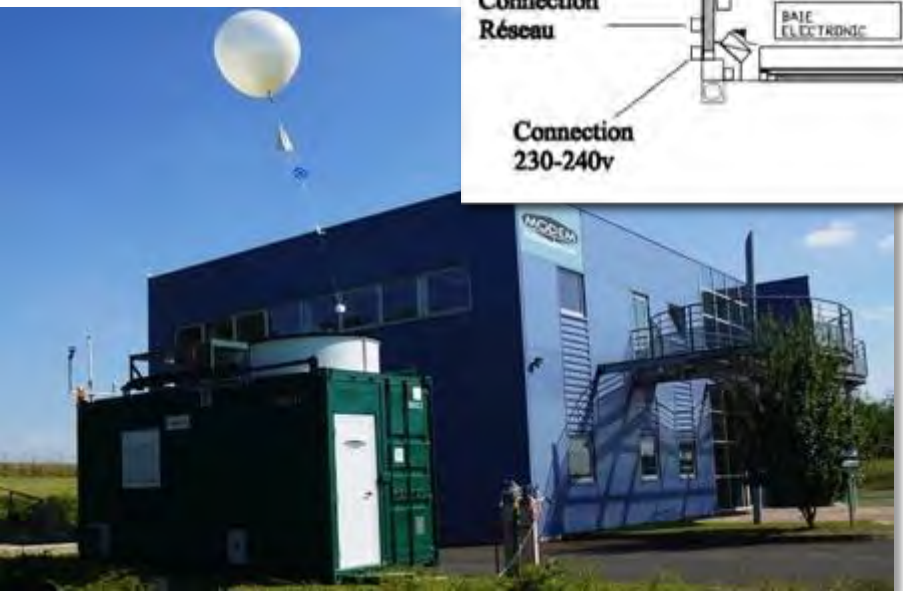
RH measurement in saturated environment using SHC1

GRUAN M10 Robotsonde operations

- Each sonde goes through GRUAN ground-check and is then loaded in the carrousel
- Robotsonde records ground-check and metadata



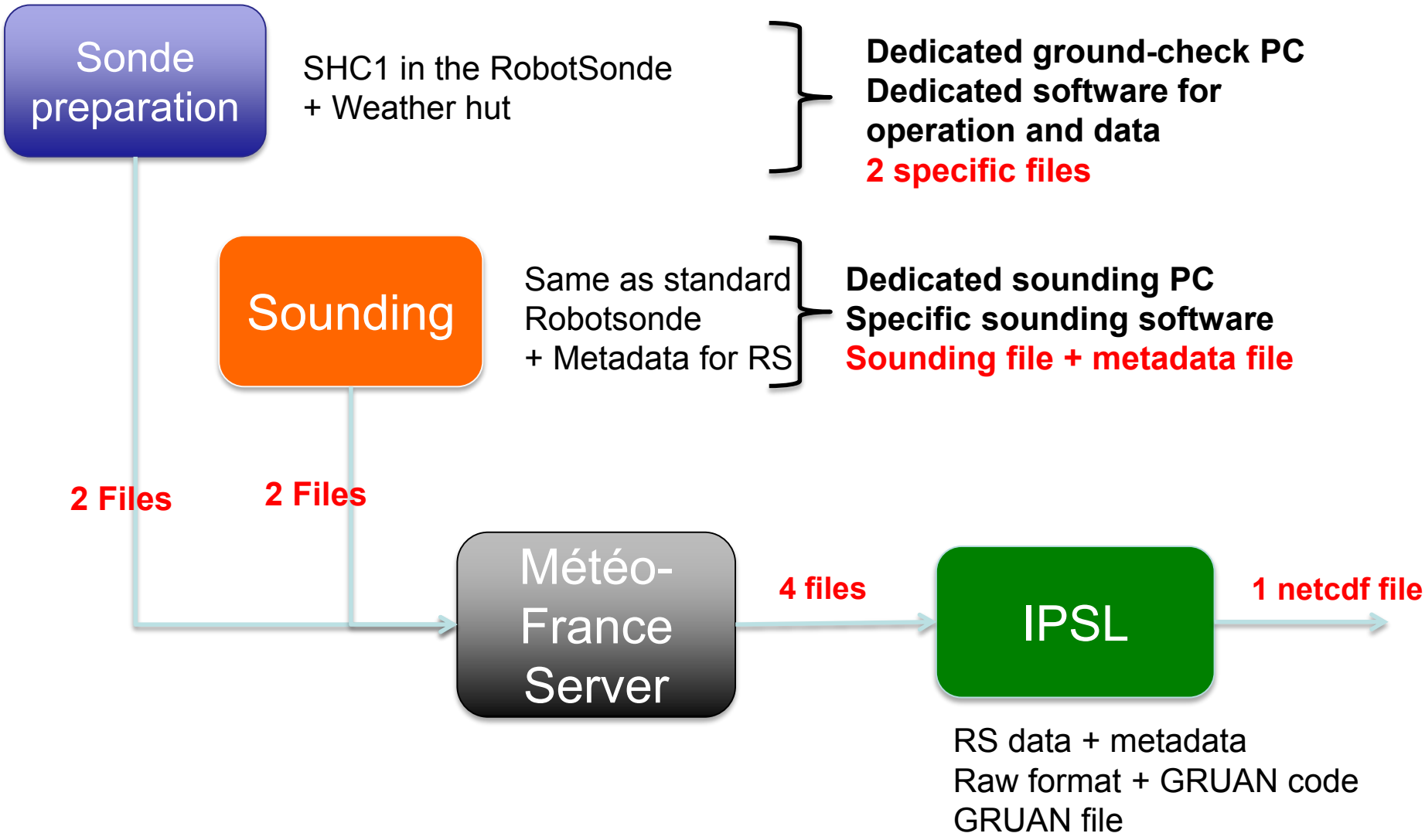




15 robotsondes in operation in the world

GRUAN – M10 RobotSonde Protocol

GRUAN M10 RobotSonde specifics:



M10/CFH sondes in La Réunion

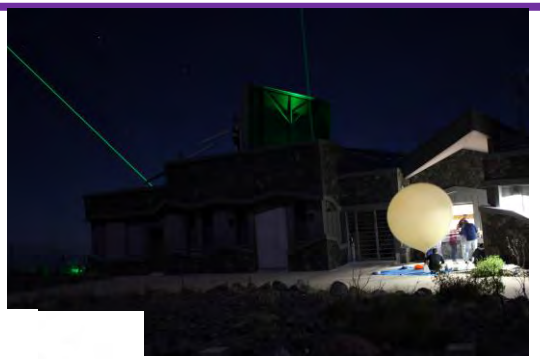
- Launches with CFH+M10 started in Nov 2014 at the Maïdo Observatory, since then 12 Launches with CFH+M10 (some of them include RS92)

Nov 2014
TNA-ACTRIS
1CFH+M10+RS92

May 2015
MORGANE campaign
4 CFH+M10+RS92

Jan/Mar 2016
HAIC campaign
+ TNA ACTRIS
2 CFH+M10

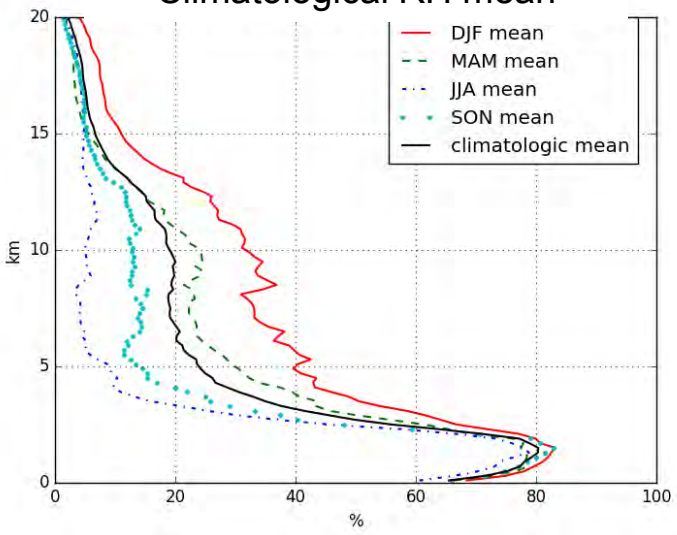
Mar/May 2017
TC Enawo
+ TNA ACTRIS
5 CFH+M10



4 “Summer” profiles +

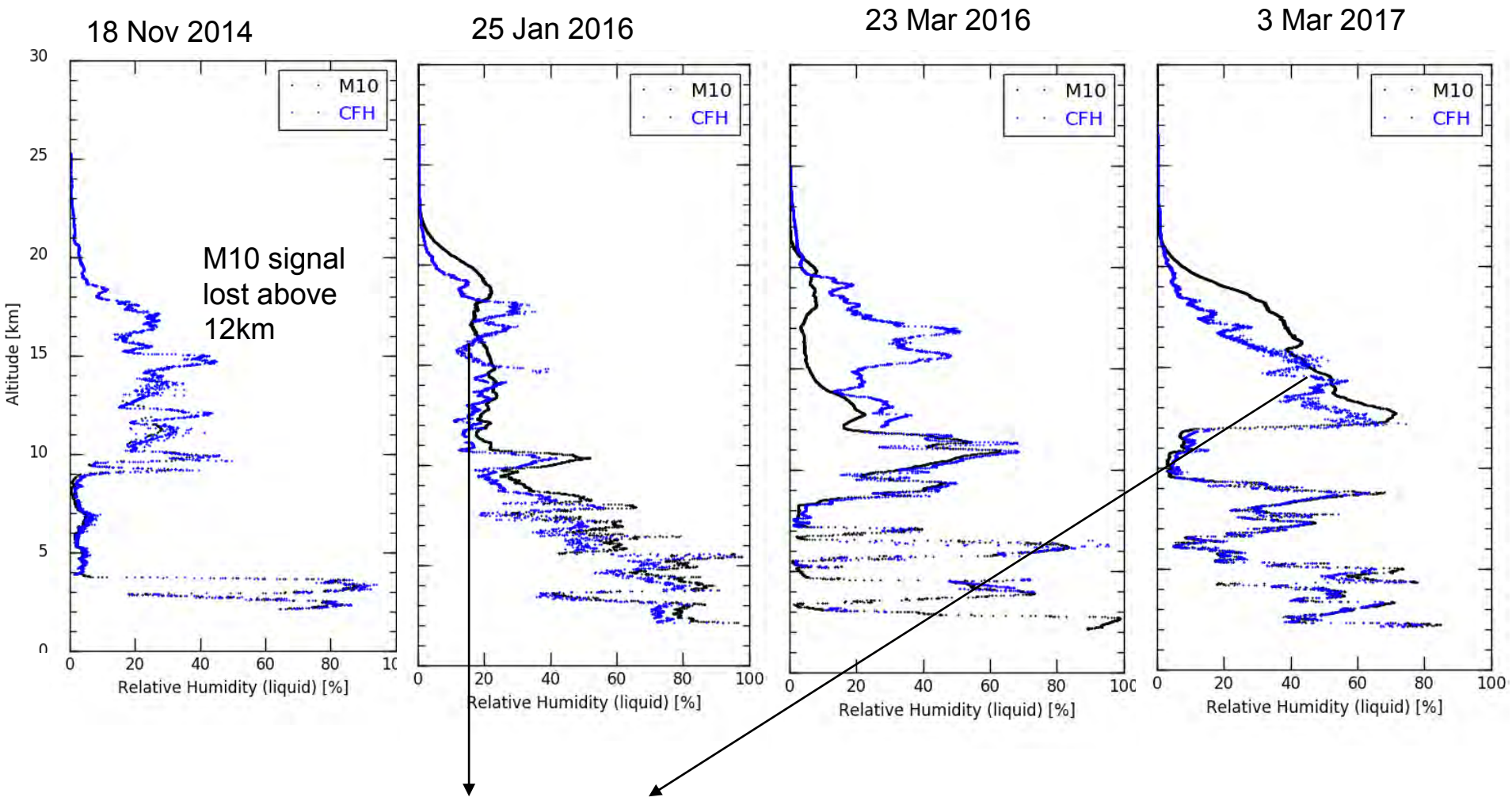
8 profiles for May conditions

Climatological RH mean



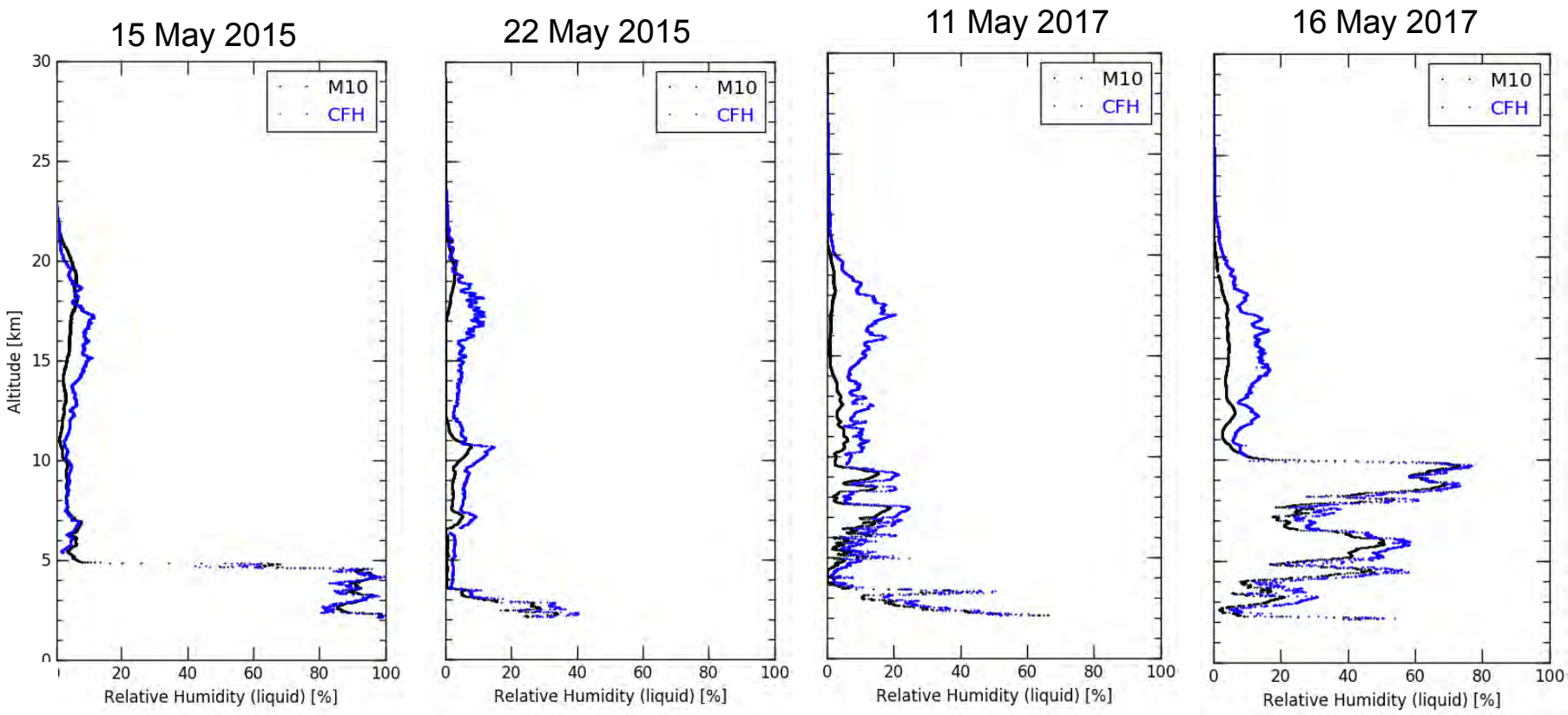
from Damien Héron

M10 comparisons with CFH: Summer conditions



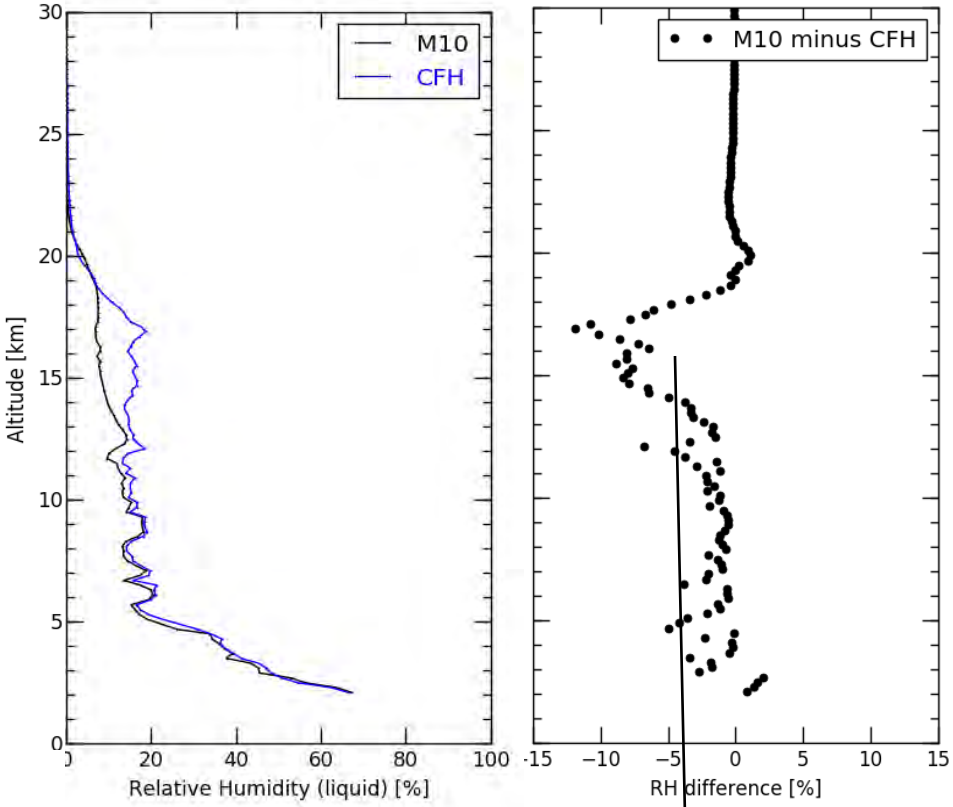
Convective outflows in the UT captured by M10 but smoother structures

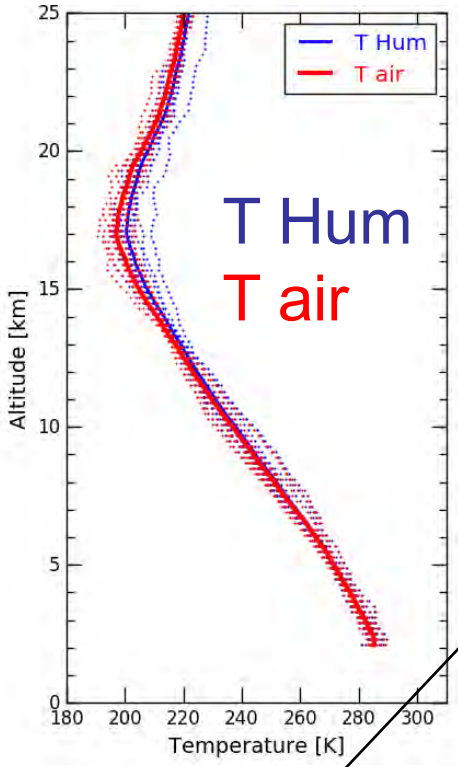
M10 comparisons with CFH: May conditions



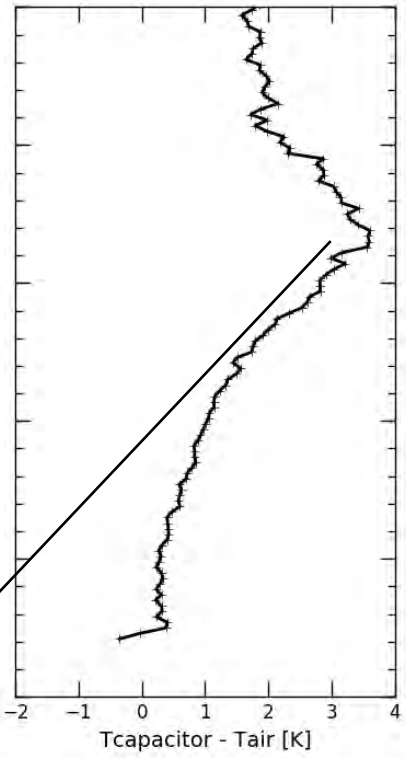
Dry bias above 10km observed for all May Profiles

M10 comparisons with CFH





T Hum
T air



T Hum -T air

Difference between capacitor temperature and air temperature explains the dry bias, should be reduced by applying GRUAN M10 corrections

GRUAN M10 data processing and documentation

- Ground check data and M10 metadata collected by Robotsonde → Metadata file
- RS profile data provided as “RAW M10” data file
- After the flight, Metadata + RAW datafiles sent by Météo-France to IPSL
- Specific GRUAN Python code converts RAW M10 data → GRUAN M10 data
- Metadata + GRUAN M10 data files → GRUAN data archive through RSLaunch client

Documentation

- Capacity sensor for RH measurements: description, corrections & uncertainties
- Thermistor for T measurements: detailed description, corrections & uncertainties
- Python code for M10 processing documentation
- *Badosa et al. M10 relative humidity measurements: description, corrections & uncertainties. Still in prep.*

Future activities 2017-2018

- Finalize procedures for M10 data processing and apply corrections for tropical conditions using La Réunion dataset of M10/CFH/RS92
- Implement GRUAN procedure at la Réunion for weekly NDACC/SHADOZ ozone sounding
- Meteo-France in La Réunion will start using the robotsonde in 2018.

- IOP at SIRTA site Sept. 2017 to compare RS92/RS41 and M10, and validate dry bias compensation law.
- Finalize data transfer with GRUAN algorithm until IPSL server
- Start weekly RS with GRUAN procedures at Trappes Meteo-France site using robotsonde.