# ACTRiS

## Cloud Remote Sensing in support of EarthCARE cal/Val

This project receives funding from the European Union's Horizon 2020 research and innovation programme under grant agreements No 871115

# Cloud remote sensing in ACTRIS

## CCRES Centralised QA/QC

- Develop & define operation & calibration procedure
- Verify implementation
- Monitor measurement quality

## ACTRIS Site PI

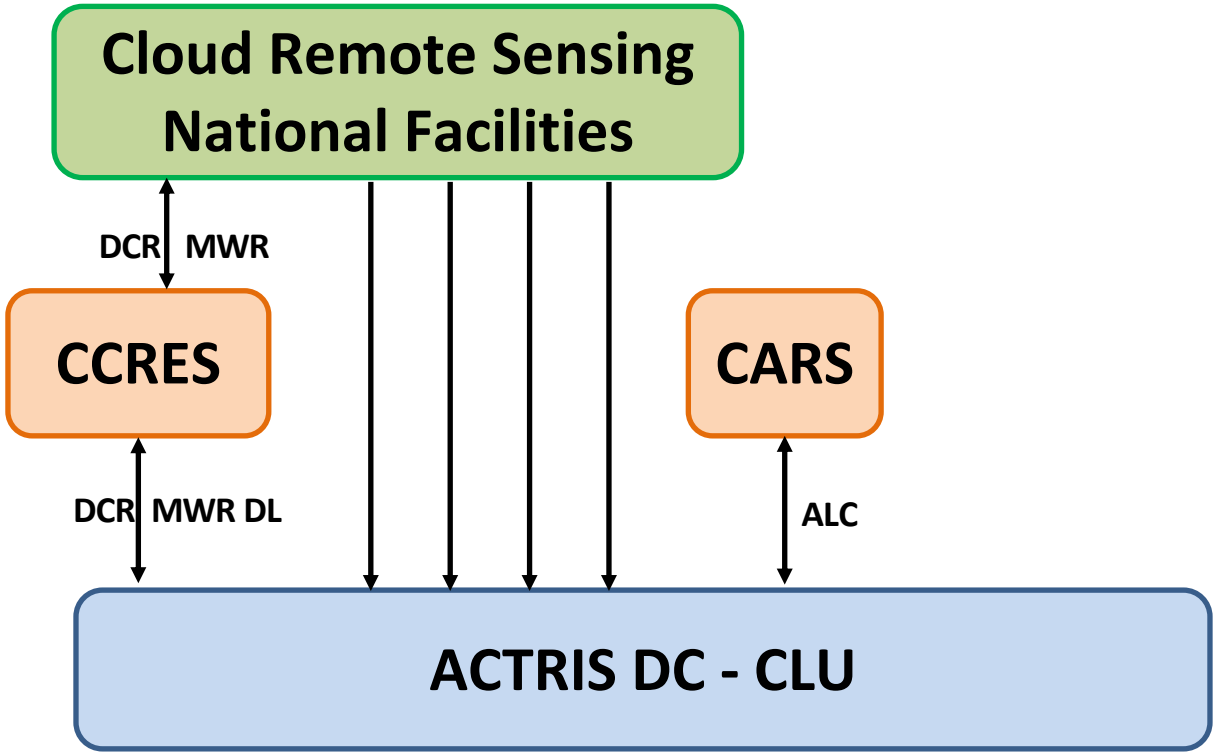
- Operate cloud radar, microwave radiometer, ceilometer, disdrometer (Doppler lidar) ...
- Monitor instrument status
- Submit data

## CLU Data Centre

- Operate centralised Cloudnet processing
- Calculate and propagate all measurement uncertainties
- QC of data products




# Cloud remote sensing in ACTRIS



# Common practices applied to QC and calibration

- CCRES provides:
  - Guidelines for instrument design and setup
  - Standard Operation Procedures
  - Standard Quality Assurance tests
  - Software tools for instrument housekeeping data monitoring

- CCRES organises:
  - Regular meetings with other networks to ensure consistency in instrument measurement, quality, formats, procedures: FRM4RADAR, E-PROFILE, …
  - Training for ACTRIS site personnel about calibration and QA
  - Annual expert analysis of the QA/QC tests
    - Characterise individual instrument performance
  - Calibration and intercomparison exercises at CCRES facilities or ACTRIS sites (funding required!)

- CLU ensures:
  - Centralised processing (Cloudnet)
  - Data traceability (provenance)
    - PIDs for individual files
    - DOIs for data collections
  - Centralised automated QC
  - Standard Quality Assurance tests
  - Standardisation of advanced products across diverse sensor networks
  - Calibration monitoring and implement instrument specific corrections

- CLU evaluates:
  - clouds in NWP and climate models
    - routine metrics
      - Climatologies
      - Mean profiles, distributions
    - Evaluate NWP forecast skill
      - Forecast the correct cloud at the right time
    - Evaluate different model versions
      - More sophisticated schemes
    - Location or regime specific aspects

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# Instruments

Cloud radars: Metek (35GHz), RPG (35, 94 GHz), Meteomodem (94GHz)

Microwave radiometers: HATPRO (RPG), Radiometrics

Disdrometers: Parsivel, Thies

Ceilometers: CS135, CL31, CL51, CL61D, CHM15k, CHM15x

Doppler lidar: Halo Photonics (Streamline, XR, Pro), Leosphere (100S, 200S, 400S)


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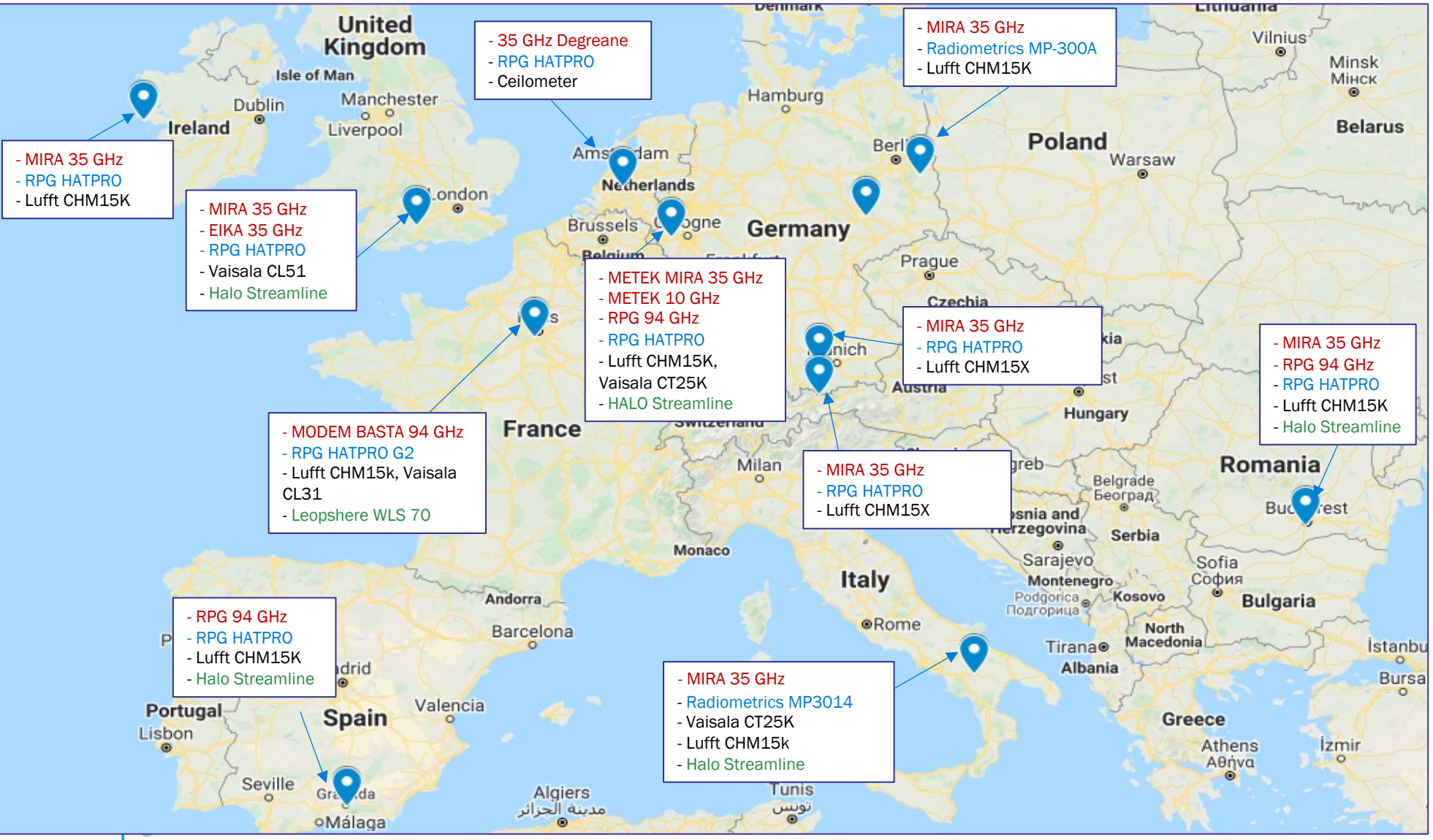
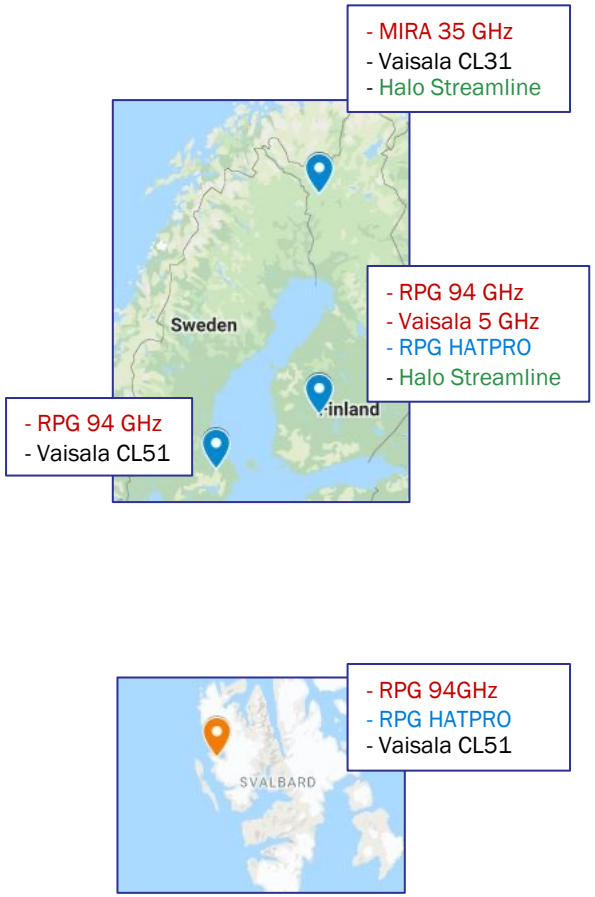
# ACTRIS Cloud Remote Sensing Facilities




« xxx »: Doppler Cloud Radar
« xxx »: Microwave radiometer
« xxx »: Ceilometer
« xxx »: Doppler lidar

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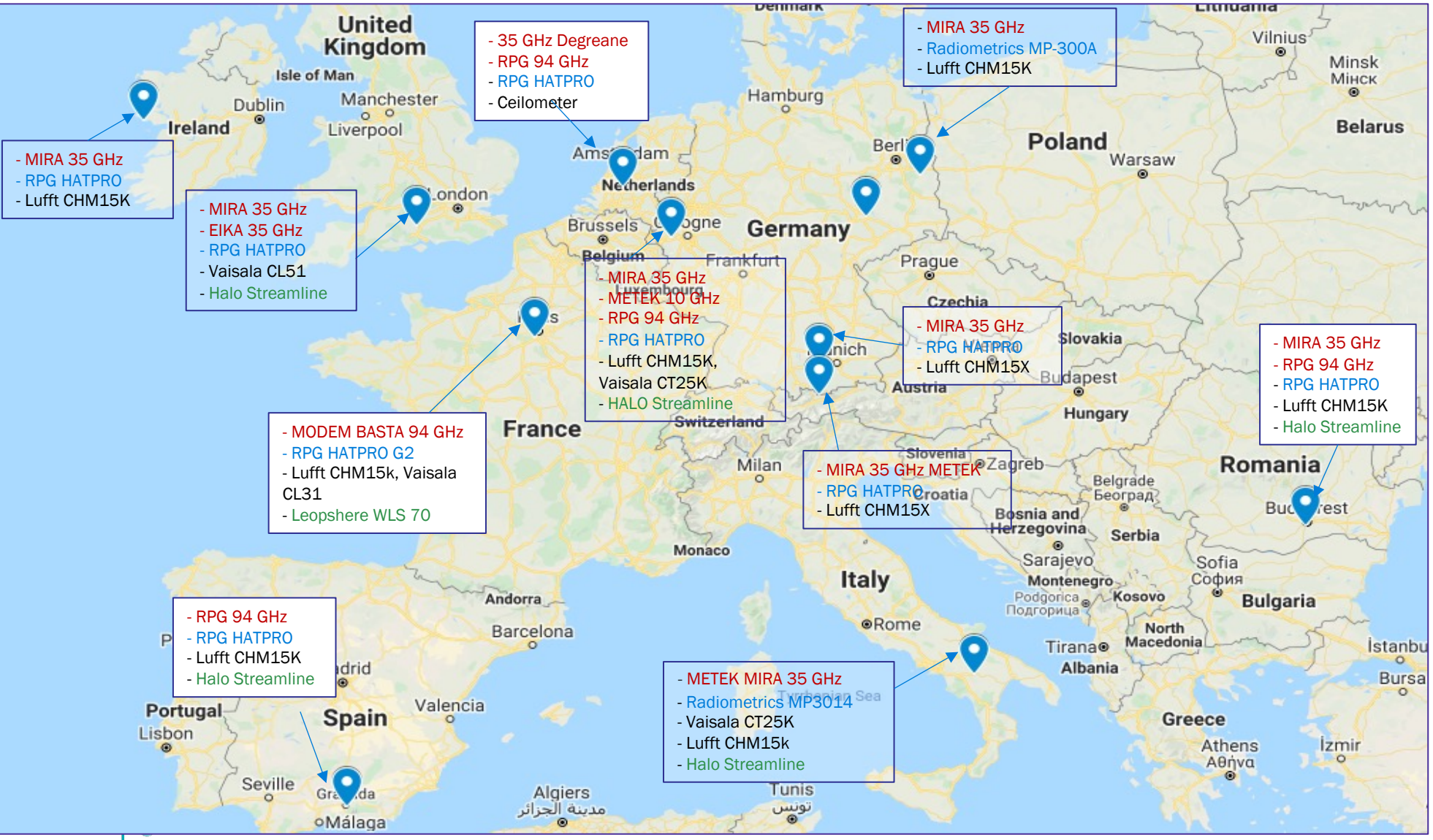
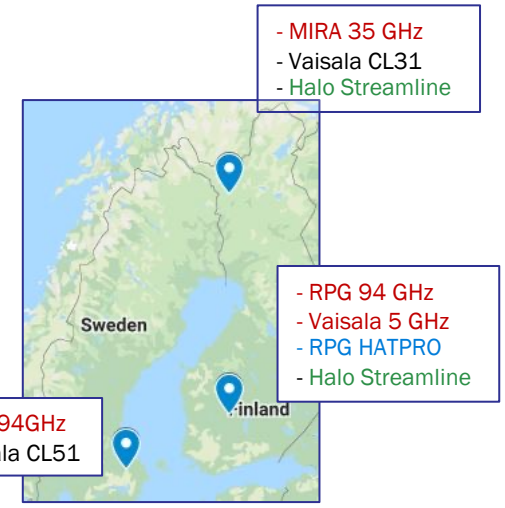
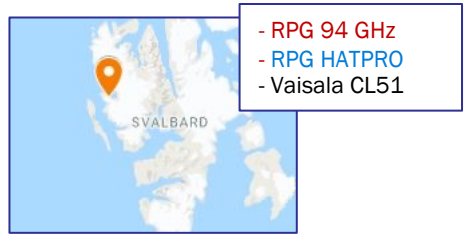
## Instrument diversity with centralized QA/QC and data processing

# ACTRIS Cloud Remote Sensing Facilities




« xxx »: Doppler Cloud Radar
« xxx »: Microwave radiometer
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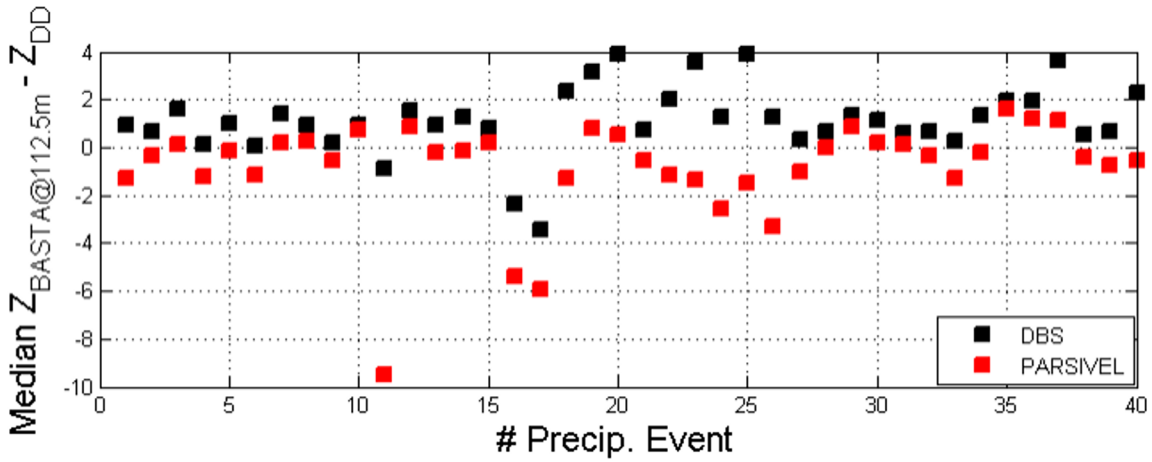
## Instrument diversity with centralized QA/QC and data processing

# Comprehensive instrument monitoring & calibration

**DCR monitoring using disdrometer**

- For selected precipitation events (0.2 < rainrates < 2 mm/hr)
- Monitor offset between DCR vs DSD Reflectivity
- Standard procedure under review

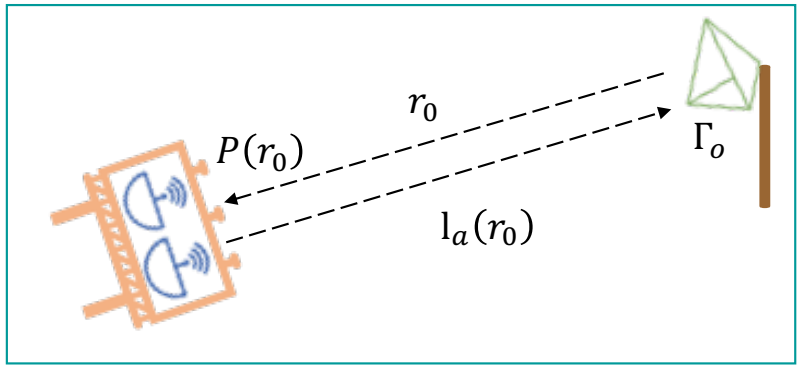


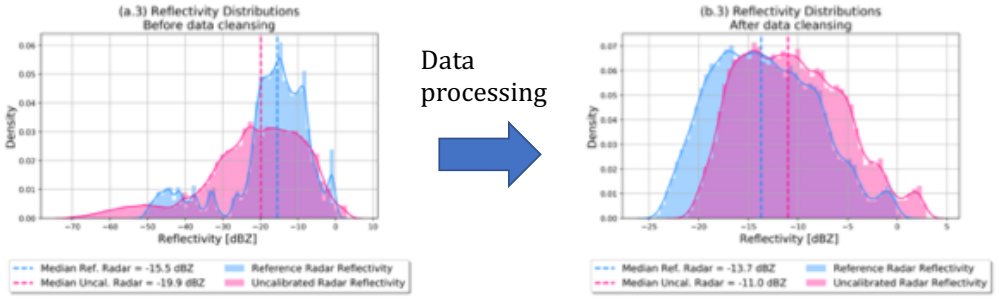
# Comprehensive instrument monitoring & calibration

**Absolute calibration of reference DCR**

- Using corner reflectors
- CCRES maintains 2 reference DCRs (Cabauw & Palaiseau)
- Calibration uncertainty: 0.5 dB

Calibration setup




**Regular calibration using calibration transfer**

- Co-located DCRs
- Requires sampling 5-10 non-precip cloud events
- Calibration transfer uncertainty: 1 dB

# Center for Cloud REmote Sensing (CCRES)
# Radar Calibration Experiment III
# March-April 2019, at SIRTA, Palaiseau

Parsivel and DBS disdrometers

SIRTA ACTRIS Cloud remote sensing station

RPG 95 GHz Radar from INOE

METEK 35 GHz Radar

LATMOS 95GHz Radar

Drop-Counting rain gauge, STFC-UK

UAV carrier for calibration target
Matrice 600 from TU Delft
Matrice 200 from Escadrone

THIES disdrometer from RPG

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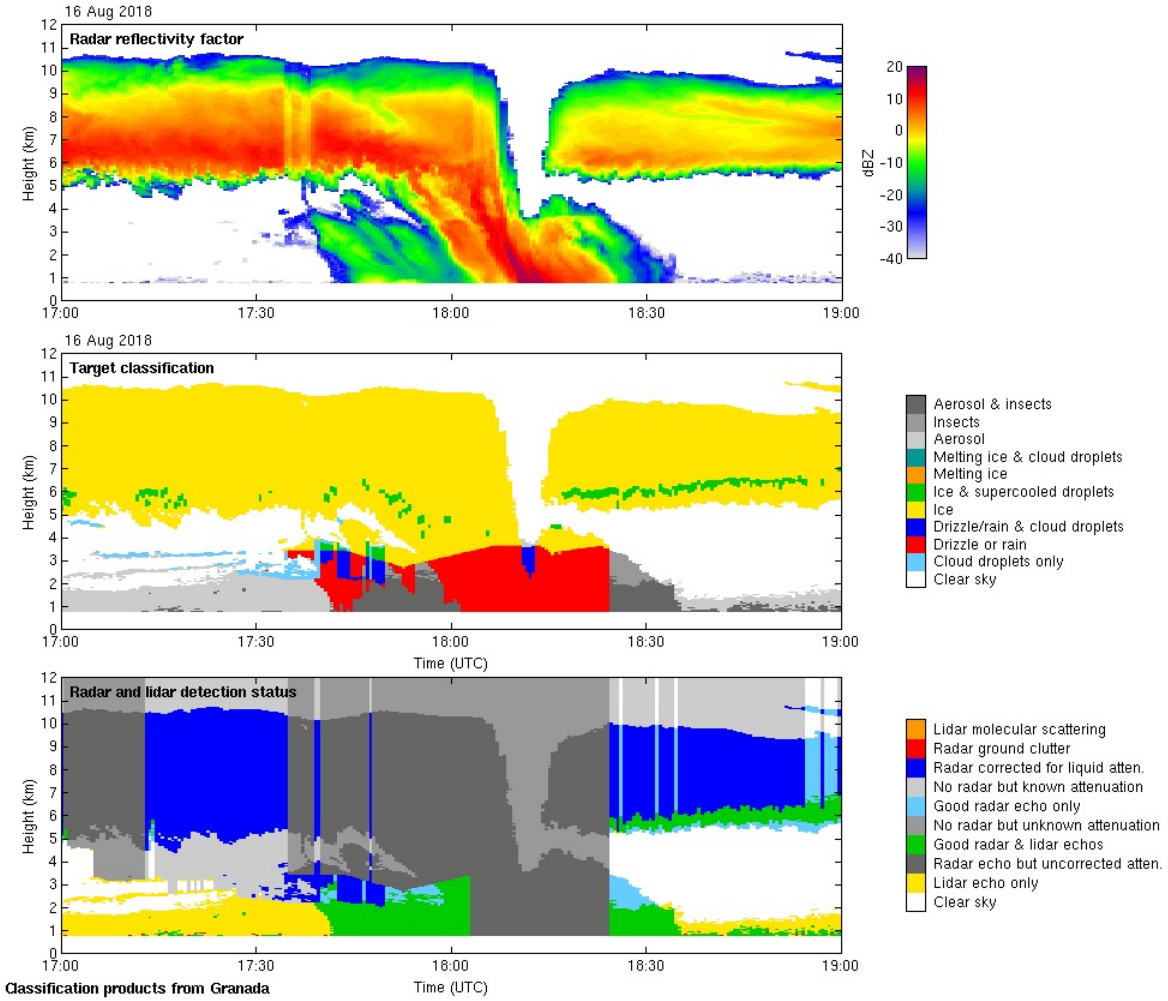
*Participants : IPSL, INOE, LATMOS, STFC, TU-D, U. Köln*
*Industry : Escadrone, Metek, Modem, RPG*

# Innovative tools to support measurement quality

**QA: measurement conditions**

- **Tool** for analyzing instrument technical data
- Data / metadata read **in near real time**;
- A**cceptable physical thresholds / variabilities** to detect correct operating interval;
- **Technical staff** automatically alerted ;
- Enables rapid intervention and problem solving ;
- Visualize in near real time if the **action has resolved the system fault** ;
- Provides metadata for QC

# Attenuation




Mitigate wet radome

- Blower
- Monitor power
- Disdrometer check

Mitigate rain

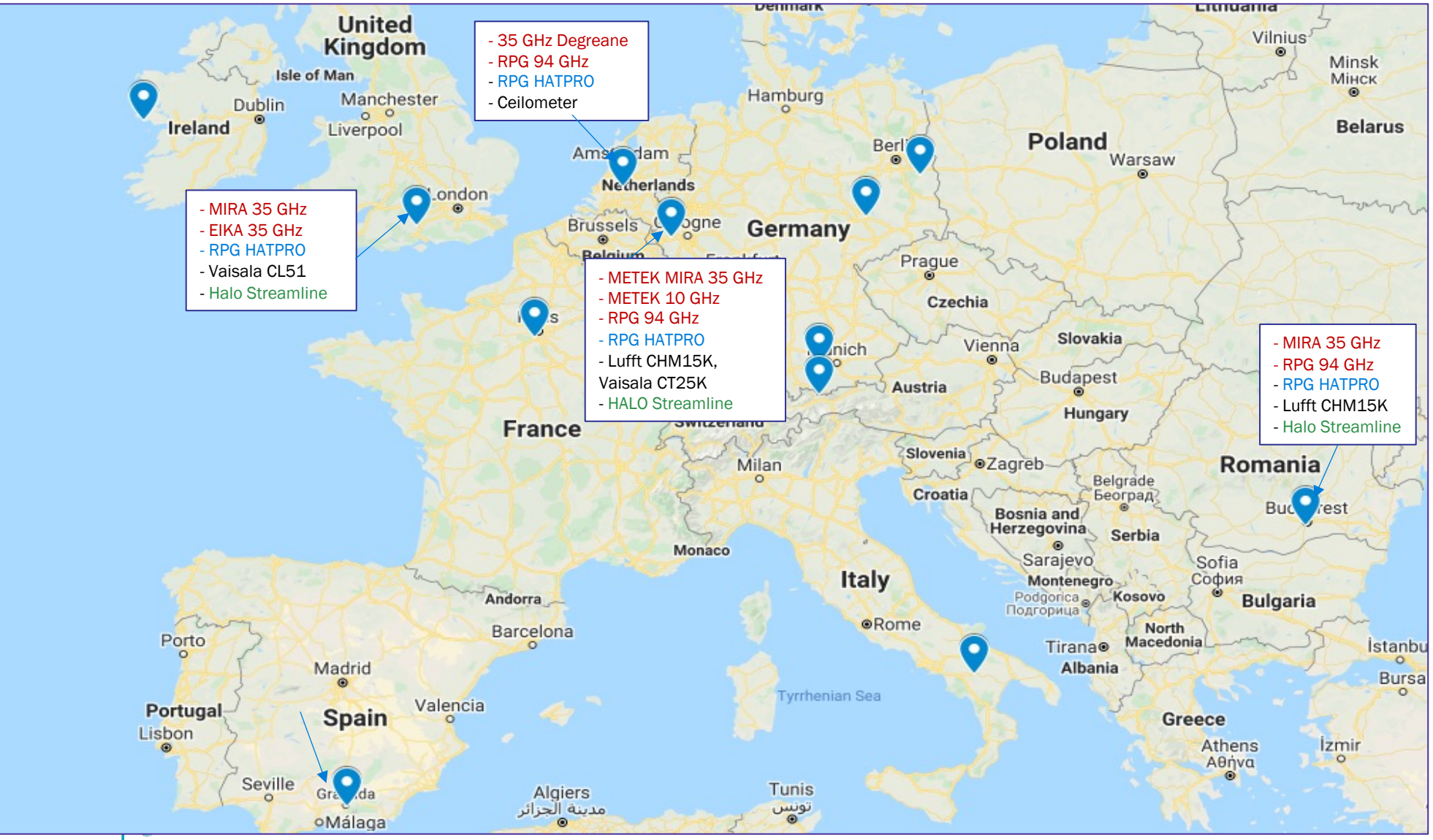
- Derive rain attenuation
  - Use disdrometer

Mitigate melting level

- Spectral approach
- Dual-λ approach


Li, H., & Moisseev, D. (2019). Melting layer attenuation at Ka- and W-bands as derived from multifrequency radar Doppler spectra observations. *Journal of Geophysical Research: Atmospheres*, 124, 9520– 9533. https://doi.org/10.1029/2019JD030316

# ACTRIS Cloud Remote Sensing Facilities – multi-λ radar



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# CLU timeline