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OUR MISSIONS

The mission of the Centre for Cloud Remote Sensing (CCRES) is to offer operational support to ACTRIS National Facilities operating Cloud remote sensing instrumentation. Additionally, the CCRES offers specialized services to ACTRIS users of various types: academia, business, industry and public services.

[ACCESS CCRES SERVICES](#)

OUR INSTRUMENTS

Click on the 5 CCRES instruments to know more about the methods and procedures available:



Doppler
Cloud Radar



Microwave
radiometer



Doppler
lidar



Low power
lidar and
ceilometer



Disdrometer



CCRES

Status and plans of MWR unit in ACTRIS CCRES

University of Cologne
& Research Centre Jülich, Germany

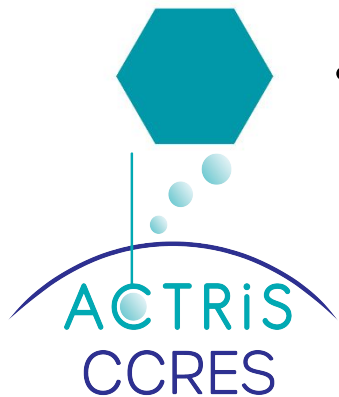
GRUAN ICM-15, Bern - Mar 11, 2024



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

Goals in ACTRIS CCRES

- Provide long-term **harmonized** observations of cloud properties through instrument **synergy** with cloud radars, lidars and passive microwave radiometers
- **Homogenized data streams from all sites, including common:**
 - data formats, file contents and metadata
 - quality control / flagging
 - retrieval development and application
 - data quicklooks of level1 and level2 products
- Continuous near real time processing and quality control of **raw data**
- Provide **standard operating procedures** (SOPs) within ACTRIS (and beyond) concerning measurement setup, calibration, maintenance, etc.
- Workshops and **hands-on training** for operators



NFs instrument diversity in 2023



Legend

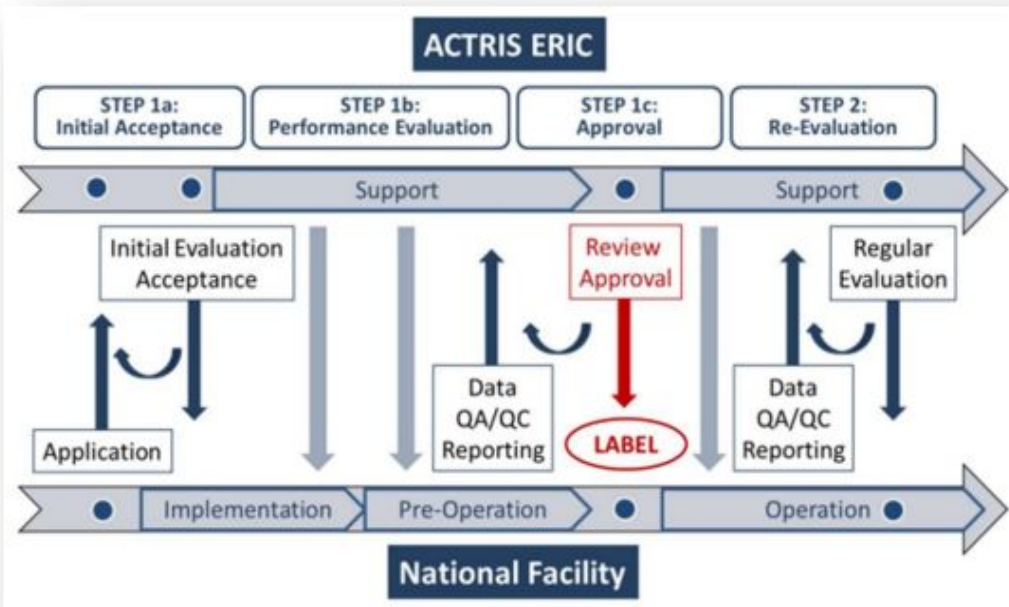
- Doppler Cloud Radar
- Micro wave radiometer
- Ceilometer
- Doppler lidar
- Disdrometers
- Weather stations

In Progress/Operational

- accepted for labelling step 1a
- in progress for labelling step 1a



CCRES labelling process in a nutshell



STEP 1 a: Initial acceptance

General feasibility check, collect of information on variables, instruments and personnel

→ [Compliance with CCRES requirements](#)



STEP 1 b: Performance evaluation

Data flow and operation support schedule created, Tracking of NF data (2 years), Upgrade of the facility (if necessary),

→ [Compliance with CCRES/CLU data requirements](#)



STEP 1 c: Approval

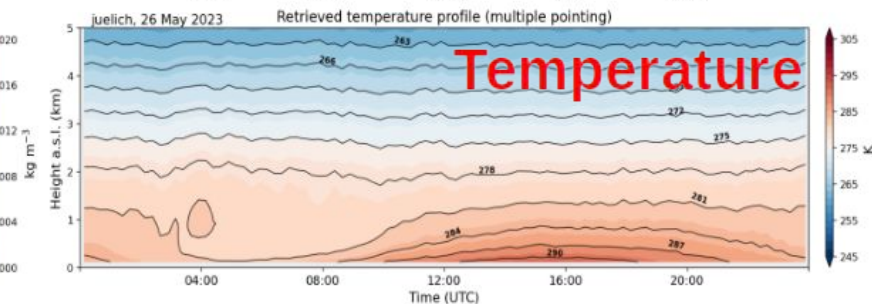
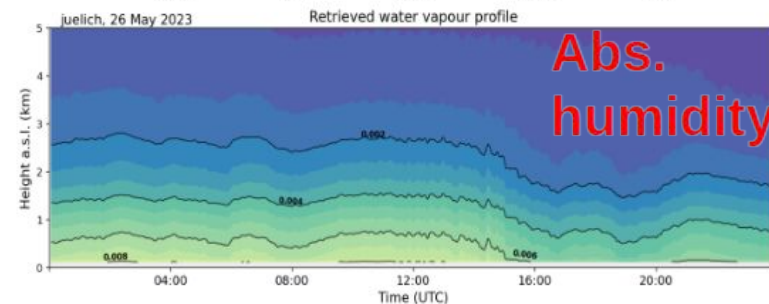
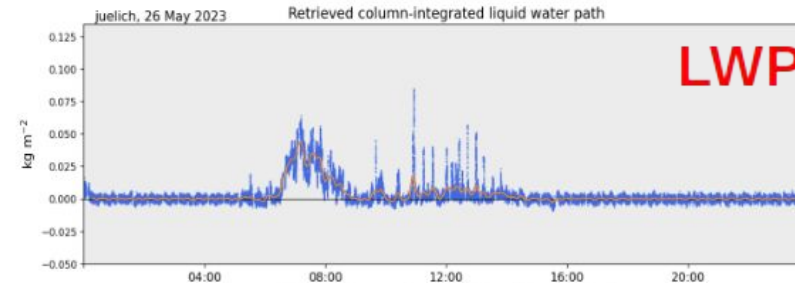
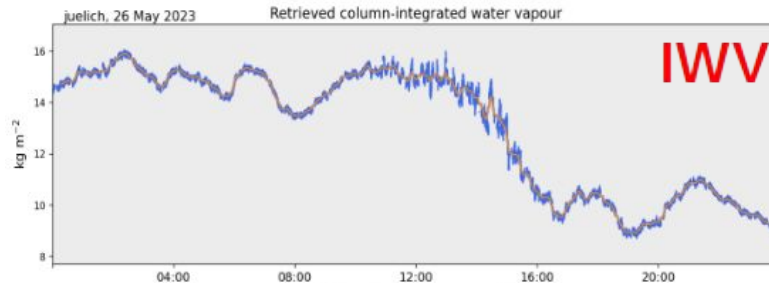
Full label is granted. Signature of ERIC and NF agreement.

Microwave Radiometer (MWR) Observations

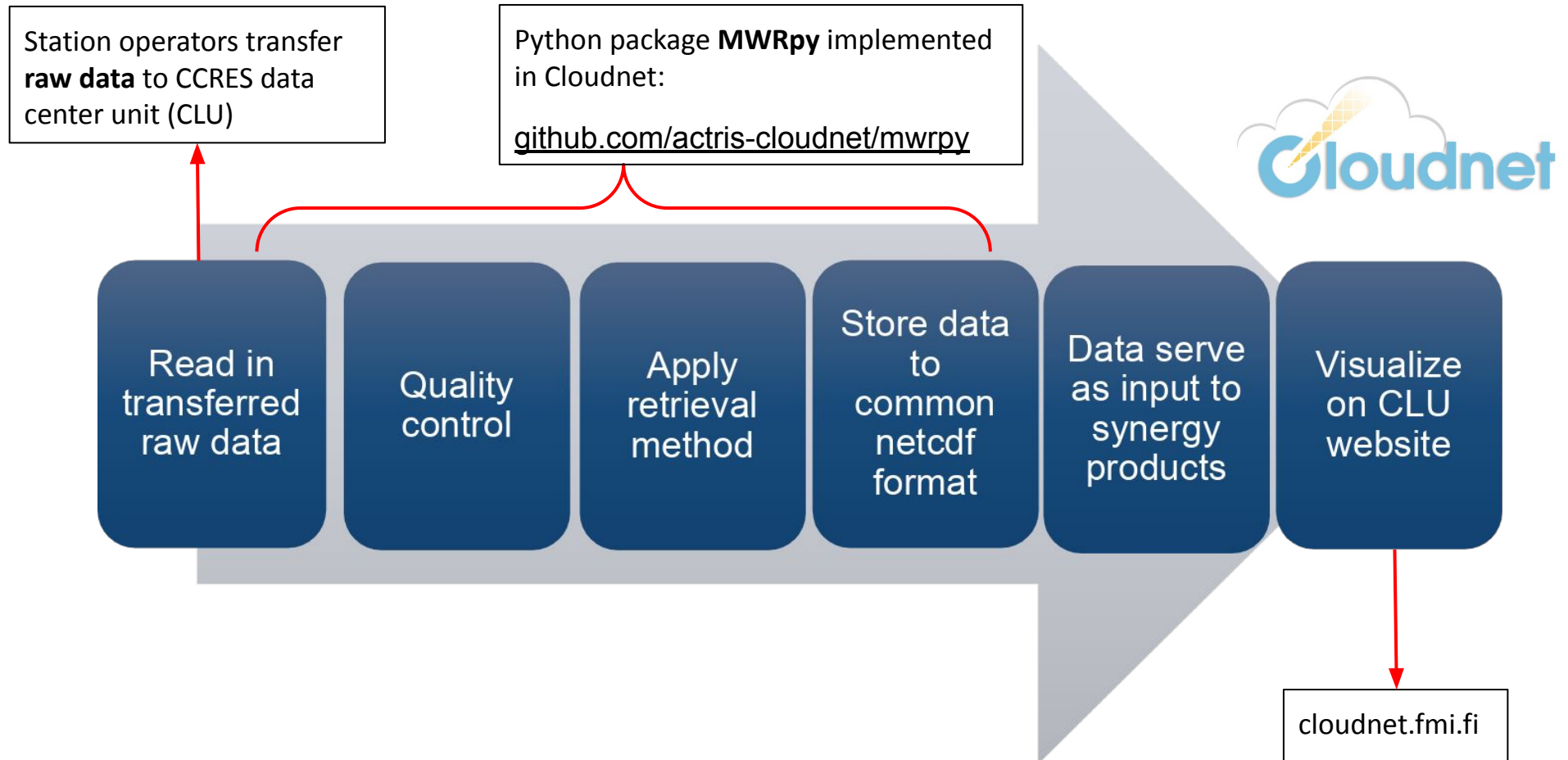
MWRs measure radiances in two frequency ranges along absorption lines of water vapor and oxygen, as well as in window regions for clouds.

The following products are **retrieved**:

- **Integrated quantities**, like cloud liquid water path (LWP) and integrated water vapor (IWV) from vertical stare measurements with high-temporal resolution of 1s
- **Profiles** of atmospheric humidity and temperature



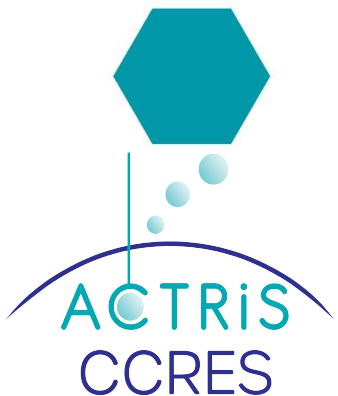
Microwave Radiometer Processing - Workflow



MWR Data Transfer

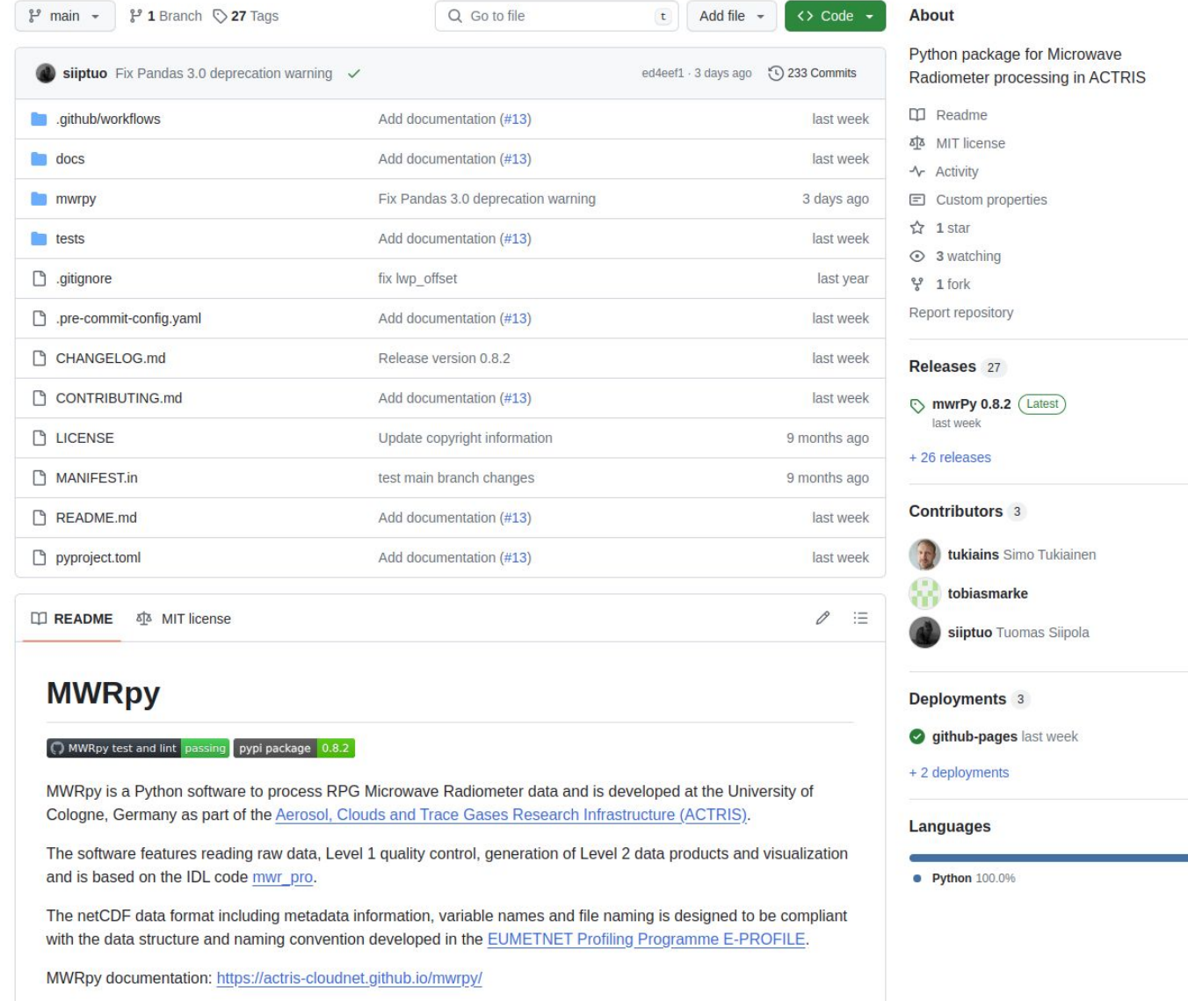
Data handling is performed by the Cloud remote sensing data centre unit (CLU):

- CLU performs data versioning, data provision and archiving and also handles **Cloudnet**, incorporating MWR data in a synergistic cloud classification algorithm
- Operators are required to transfer **raw data** to CLU at least once per hour
- Calibration LOG files will be monitored and stored in CLU **calibration database**
- Application of **retrieval coefficients** from manufacturer until ACTRIS retrievals are developed (already stored in database)



Data Processing - MWRpy

- **MWRpy** is implemented in Cloudnet framework and maintained in Cloudnet's github repository
- Can be used as **stand-alone** software (with E-PROFILE data format)
- Harmonized Cloudnet output follows **ACTRIS vocabulary**
- First experimental products are derived operationally for 8 stations



main 1 Branch 27 Tags

Go to file Add file Code

siiptuo Fix Pandas 3.0 deprecation warning ✓ ed4eef1 · 3 days ago 233 Commits

File	Commit	Time
.github/workflows	Add documentation (#13)	last week
docs	Add documentation (#13)	last week
mwrpy	Fix Pandas 3.0 deprecation warning	3 days ago
tests	Add documentation (#13)	last week
.gitignore	fix lwp_offset	last year
.pre-commit-config.yaml	Add documentation (#13)	last week
CHANGELOG.md	Release version 0.8.2	last week
CONTRIBUTING.md	Add documentation (#13)	last week
LICENSE	Update copyright information	9 months ago
MANIFEST.in	test main branch changes	9 months ago
README.md	Add documentation (#13)	last week
pyproject.toml	Add documentation (#13)	last week

README MIT license

MWRpy

MWRpy test and lint: passing pypi package: 0.8.2

MWRpy is a Python software to process RPG Microwave Radiometer data and is developed at the University of Cologne, Germany as part of the [Aerosol, Clouds and Trace Gases Research Infrastructure \(ACTRIS\)](#).

The software features reading raw data, Level 1 quality control, generation of Level 2 data products and visualization and is based on the IDL code [mwr_pro](#).

The netCDF data format including metadata information, variable names and file naming is designed to be compliant with the data structure and naming convention developed in the [EUMETNET Profiling Programme E-PROFILE](#).

MWRpy documentation: <https://actris-cloudnet.github.io/mwrpy/>

About

Python package for Microwave Radiometer processing in ACTRIS

- Readme
- MIT license
- Activity
- Custom properties
- 1 star
- 3 watching
- 1 fork

Report repository

Releases 27

mwrPy 0.8.2 Latest
last week

+ 26 releases

Contributors 3

- tukiains Simo Tukiainen
- tobiasmarke
- siiptuo Tuomas Siipola

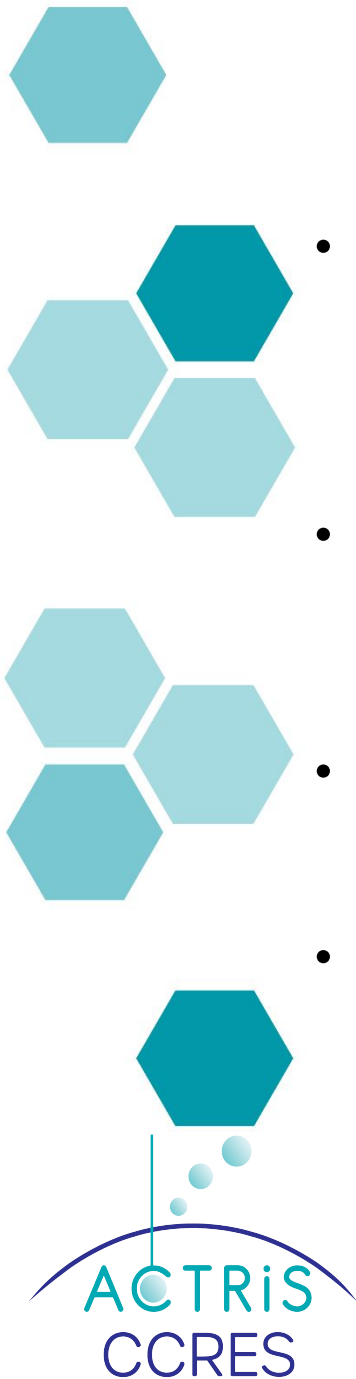
Deployments 3

github-pages last week

+ 2 deployments

Languages

- Python 100.0%





Visualisations for 28 February 2024

comparison view

Palaiseau MWR multiple pointing [↗](#) Volatile Experimental

Palaiseau MWR single pointing [↗](#) Volatile Experimental

Location

Palaiseau ×

Show all sites

Date

2024-02-28 📅 ← →

Product

MWR single pointing ×

MWR multiple pointing ×

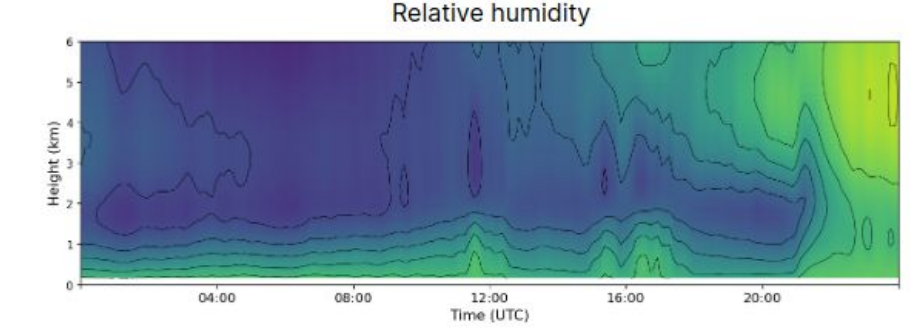
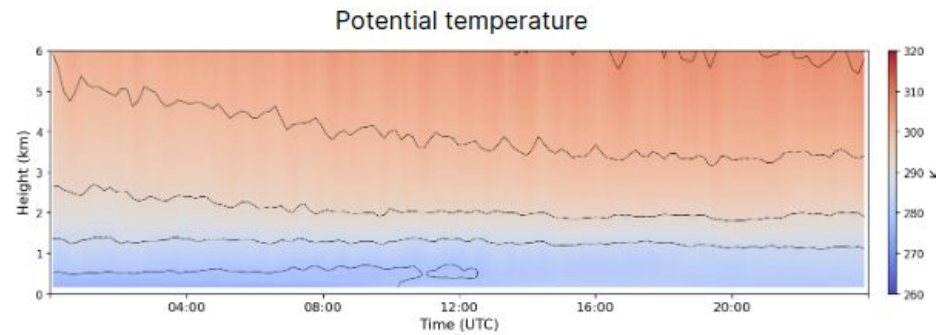
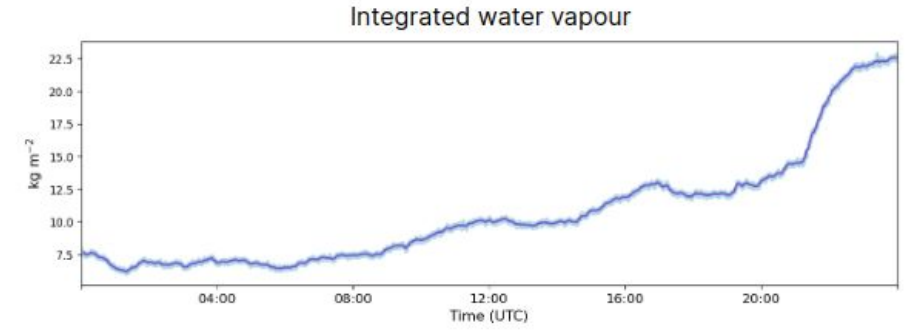
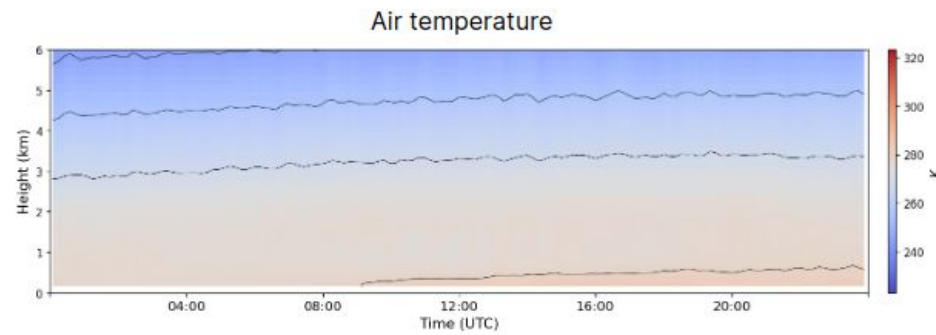
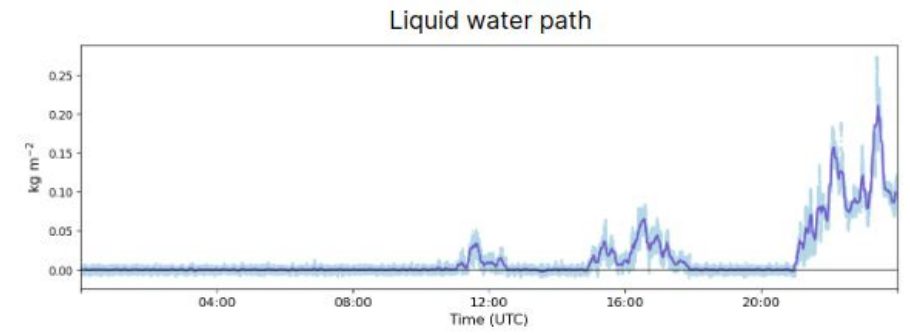
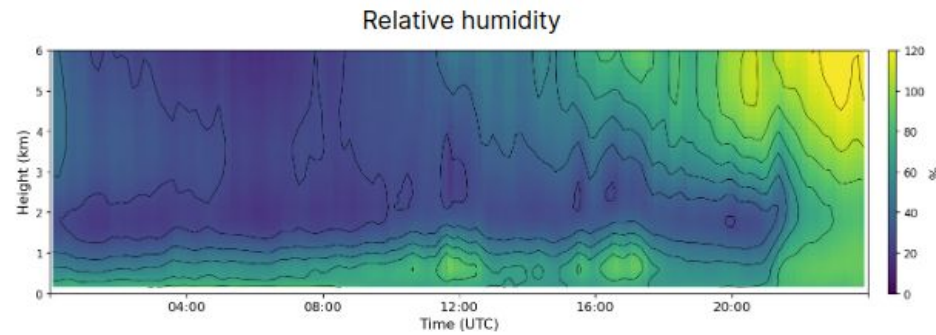
Show experimental products

Instrument

Select

Variable

Select



Quality Control

Quality flags derived and applied for Level 1 data (also provided in product files)

Bit 1: **missing_tb**

Bit 2: **tb_below_threshold**

Bit 3: **tb_above_threshold**

} TB values are being checked

Bit 4: **spectral_consistency_above_threshold** ➡ Comparison: retrieved & observed TB

Bit 5: **receiver_sanity_failed** ➡ Receiver & ambient target stability + noise diode status

Bit 6: **rain_detected** ➡ Rain sensor

Bit 7: **sun_in_beam** ➡ Calculate sun position for site location (relevant for scans)

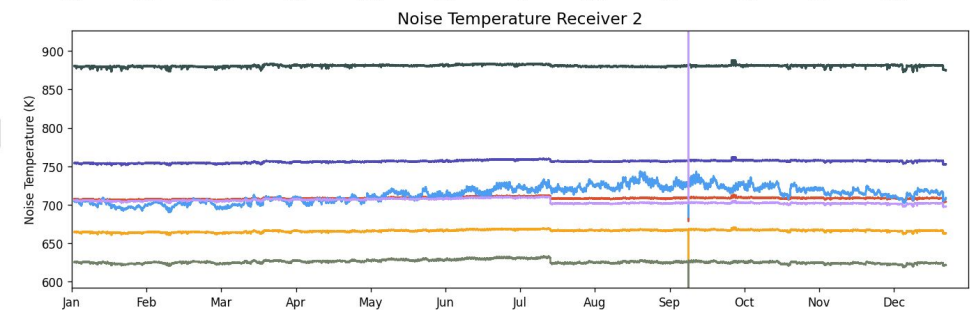
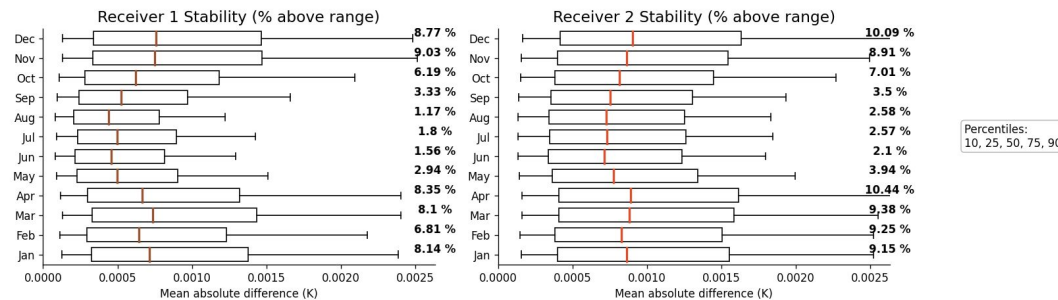
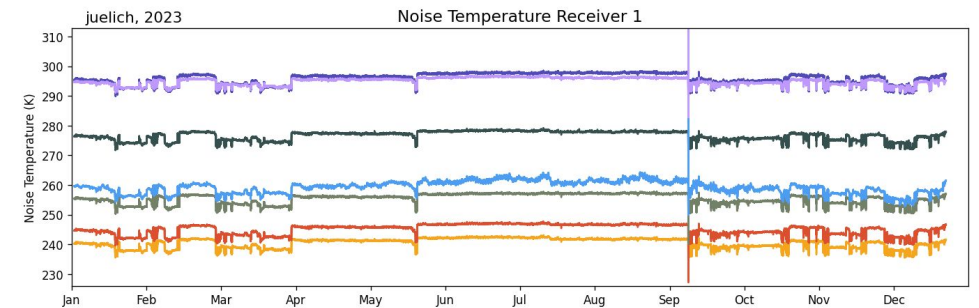
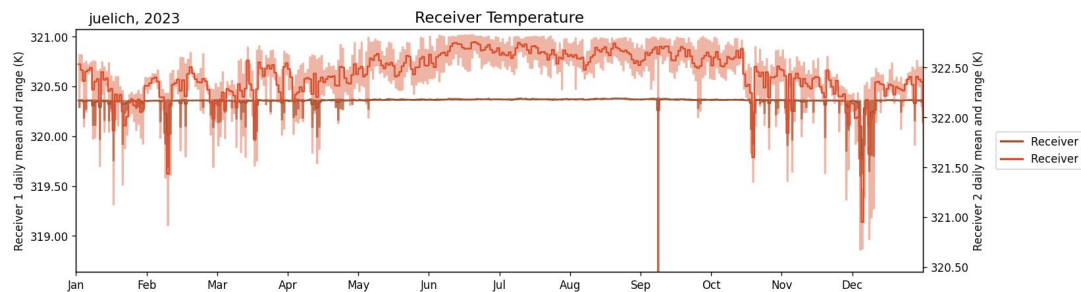
Bit 8: **tb_offset_above_threshold** ➡ Not implemented yet

Quality Control

Quality flags derived and applied for Level 1 data (also provided in product files)

Long term quality assessment

- Checks quality of data and whether SOPs are being followed
- Detection of malfunction possible in operational use



Quality Control



Quality flags derived and applied for Level 1 data (also provided in product files)



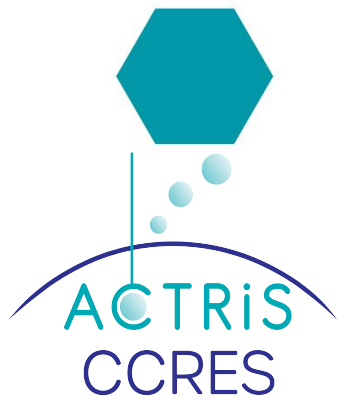
Long term quality assessment

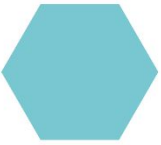
- Checks quality of data and whether SOPs are being followed
- Detection of malfunction possible in operational use



Centralized housekeeping data (HKD) monitoring in development

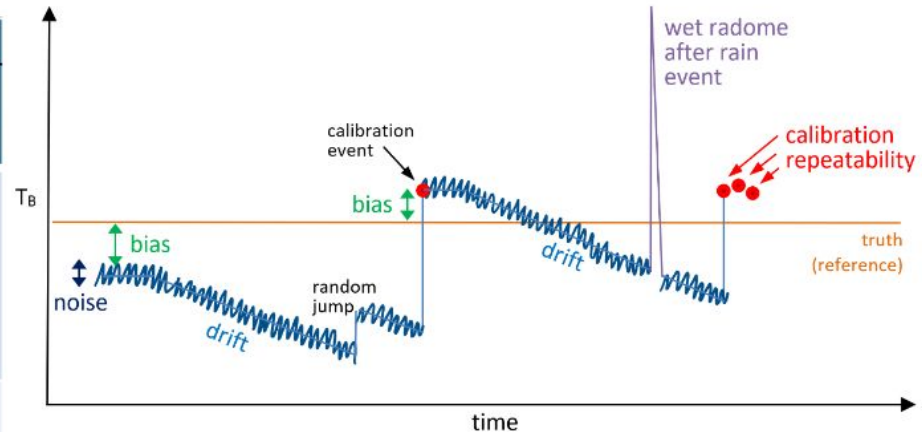
- Work is being done at IPSL together with data center CLU
- Synchronizes HKD data with CLU (of all CCRES instruments)
- Includes instrument type specific thresholds and alert settings





Uncertainty Assessment & Mitigation Strategy

Type of Error	Typical Error Values K-band	Typical Error Values V-band	Determined via	Can error be influenced by handling?	How to reduce Error?	Should be determined by the operator
Calibration Repeatability	≤ 0.12 K	≤ 0.16 K	Changes to zenith reference measurements after two immediate consecutive calibrations	yes	Quality of calibration	no
Noise Levels (3min cold load – 5 min hot load) (1s)	≤ 0.11 K – 0.19 K	≤ 0.11 K – 0.33 K	Standard deviation (from covariance matrix diagonal)	no	Not possible; instrument specific	yes
Drifts	usually ≤ 0.4 K	usually ≤ 0.8 K (up to 1.3 K)	Differences at cold load before and after a calibration	yes	Frequency of calibration	yes
Biases/Measurement differences	mostly ≤ 0.3 K (up to 0.48 K)	mostly ≤ 0.5 K (up to 1.15 K)	Zenith measurement differences between two MWRs	yes	Quality of calibration	no
Radome degradation	$\gg 0.5$ K??	$\gg 0.5$ K??	Observation minus SPC-retrieval in channel 10	yes	Frequency of exchange	yes



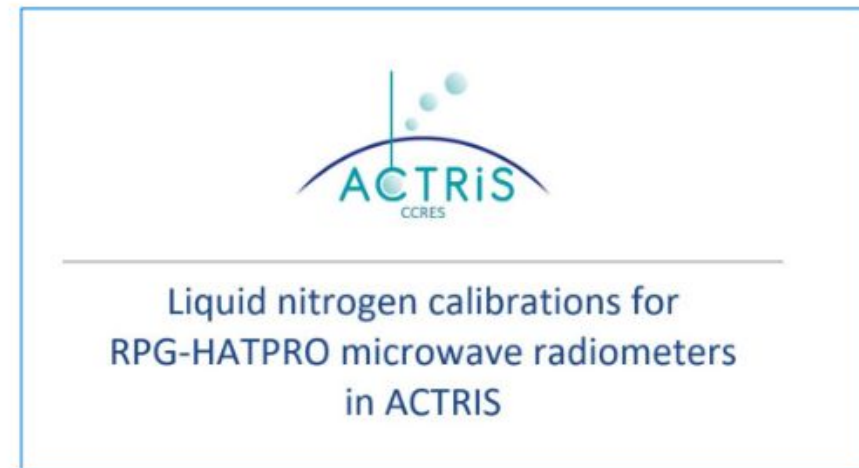
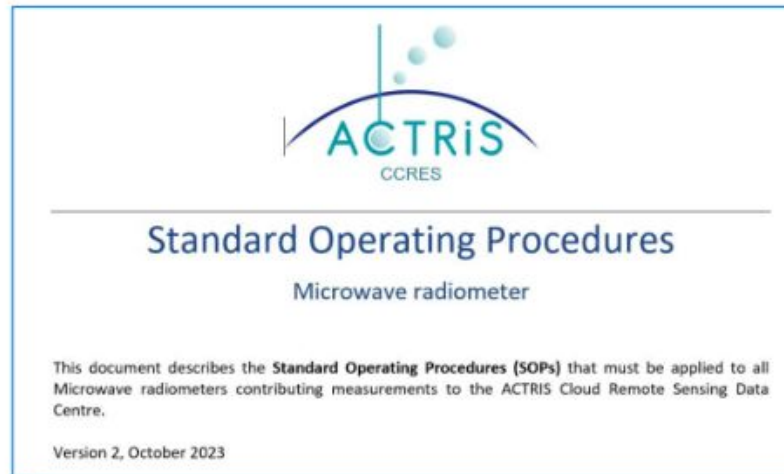
Böck et al. (2024), in preparation

- Develop standard procedure for error characterization
- Help operators determine uncertainties, perform system checks, and monitor stability to decide when and if an intervention is necessary
- Mitigation includes: frequent calibration, radome change



Microwave radiometer calibration and SOP

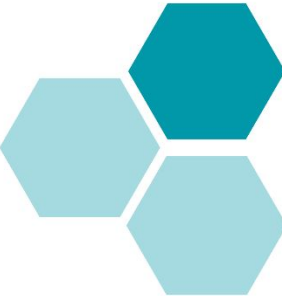
- New version of Standard operation procedures (SOP) for MWR (Microwave radiometer) in ACTRIS available
- Calibration guidelines for absolute (liquid nitrogen) calibrations for ACTRIS stations (necessary for labeling process)



Links with E-PROFILE



Common data format and standard operating procedure for a better cross network compatibility

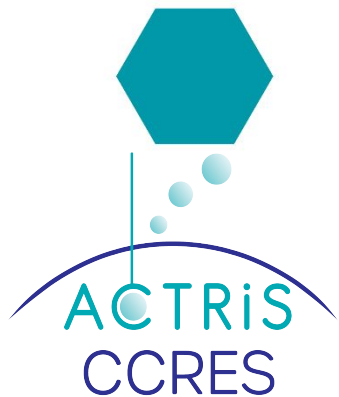
- 
- Enables stations to participate in both networks
 - Similar file types and data format (including metadata, quality flags)
 - Common SOP (with minimum requirements of both networks), including:
 - Calibration procedures and intervals
 - Scanning strategy (setup of observation mode and file transfer)



Differences in generation of Level 2 products (retrieval method)

Retrieval Development

- **Radiative transfer:** recent version of the Rosenkranz absorption code (2023) for oxygen, nitrogen, water vapor, and liquid water
- **Statistical retrieval** method (Neural Network including auxiliary information)
 - similar to RPG
 - comparison to E-PROFILE retrieval approach (TROPoe)
- Retrieval training with **ERA5 climatology** as input
 - allows homogeneous data streams
 - comparison with radiosondes (as input / product evaluation)
- MWR + IRT **synergy retrieval** for LWP



Retrieval Uncertainties

- **Vertical resolution:** profiles are rather “smooth” due to missing independent information (2-4 degrees of freedom for humidity profiles)
- **Elevation scans:** provide more information on boundary-layer temperature profile
- Typical retrieval **uncertainties:**
 - Temperature profiles: 1 K
 - LWP: 20 g/m² (critical for thin clouds)
 - IWV: 1 kg/m²

