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SCREEN CAPTURE WELCOME

ACTRiS CCRES

Microwave radiometer data quality monitoring and retrieval development framework for network operation

Tobias Marke[1], Bernhard Pospichal[1], Tobias Böck[1], Pauline Martinet[2], and Ulrich Löhnert[1]

[1]University of Cologne, Institute for Geophysics and Meteorology, Cologne, Germany
[2]Centre National de Recherches Météorologiques, Météo-France, Toulouse, France

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Content

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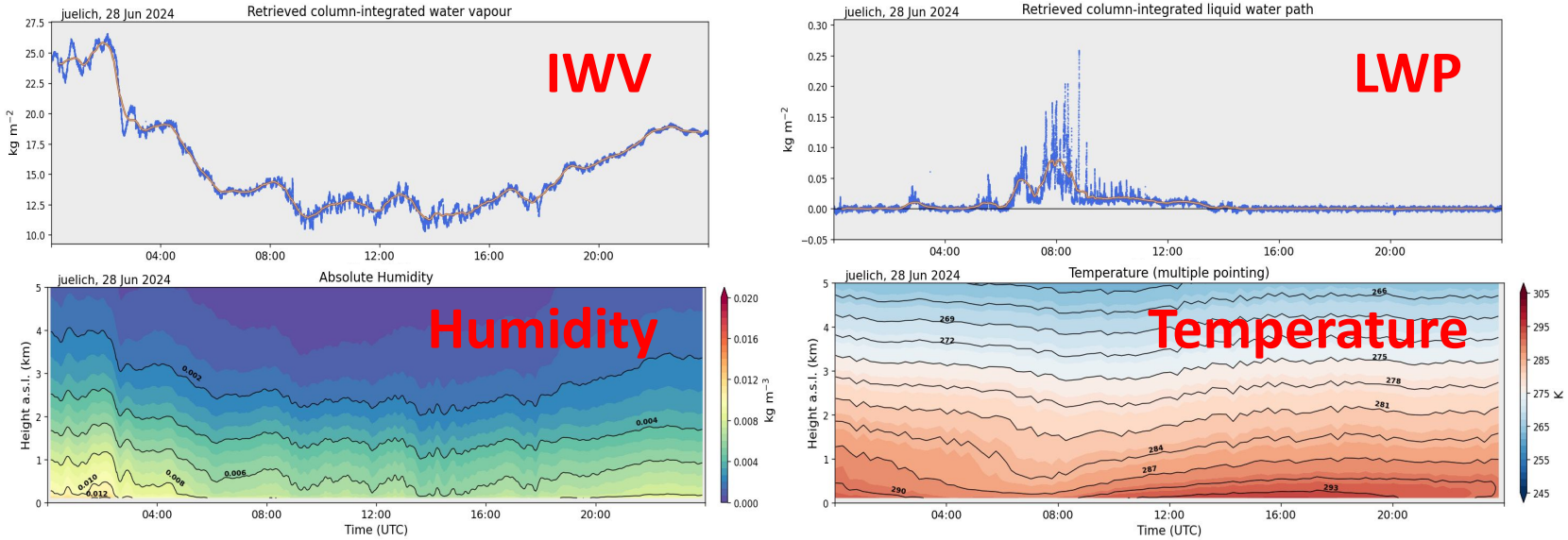
1.1

Microwave Radiometer (MWR) Observations

- **Passive MWRs:** measure radiances, expressed as brightness temperatures (**TB**), in two frequency ranges (absorption of water vapor and oxygen), as well as in window regions for liquid water clouds

- **Retrieved products:**
  - Cloud liquid water path (LWP)
  - Integrated water vapor (IWV)
  - Profiles of atmospheric humidity and temperature

} high temporal, but coarse vertical resolution



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1.2 ACTRIS – Aerosol Cloud and Trace Gases Research Infrastructure

- 6 main components (in-situ / remote sensing of Aerosol, Clouds and Trace Gases) aiming to provide **long-term harmonized** data streams

- MWRs are part of the Center for Cloud Remote Sensing (**CCRES**):
  - Offers standard operating procedures (**SOPs**) and regular workshops
  - Newly developed **processing code**[1] is implemented in central data architecture

- CCRES also operates Doppler Cloud Radars (e.g. Ka, W-band), Ceilometer, and Doppler lidars for wind profiling:
  - Allows deriving instrument **synergy** products like the cloud classification algorithm **Cloudnet**

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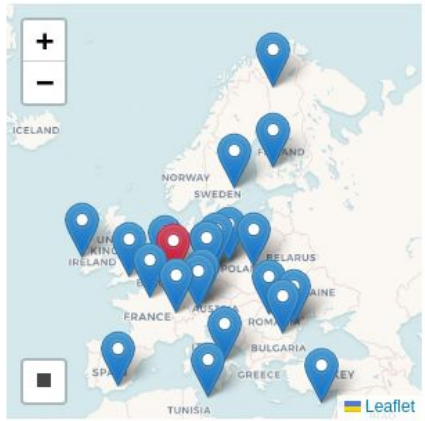
[1] Marke et al., (2024). MWRpy: A Python package for processing microwave radiometer data. Journal of Open Source Software, 9(98), 6733, https://doi.org/10.21105/joss.06733



Location

Jülich ×

Show all sites

Date

2024-06-13

Product

MWR single pointing ×

Classification ×

Show experimental products

Variable

Target classification ×

Liquid water path ×

Integrated water vapour ×

Air temperature ×

Absolute humidity ×

Instrument model

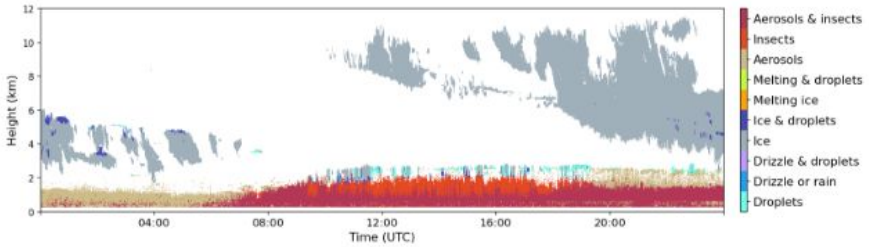
Select

Visualisations for 13 June 2024

comparison view

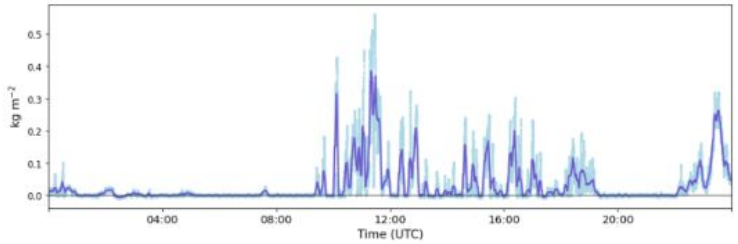
Jülich Classification Volatile

Target classification

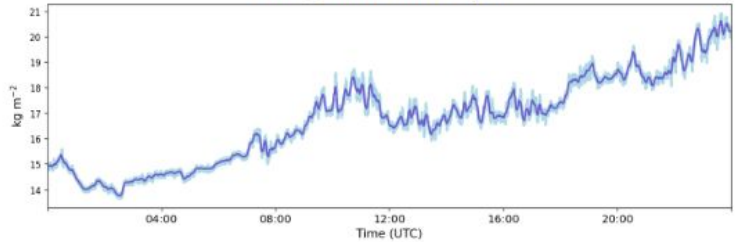


Jülich HATPRO microwave radiometer Volatile

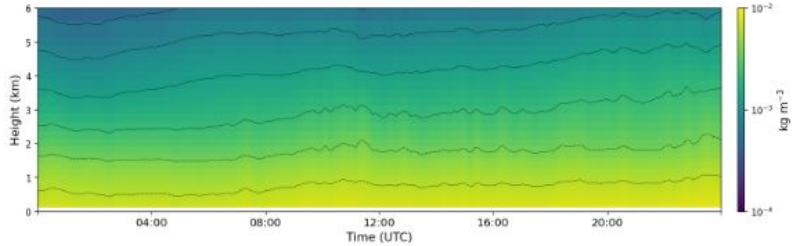
Liquid water path



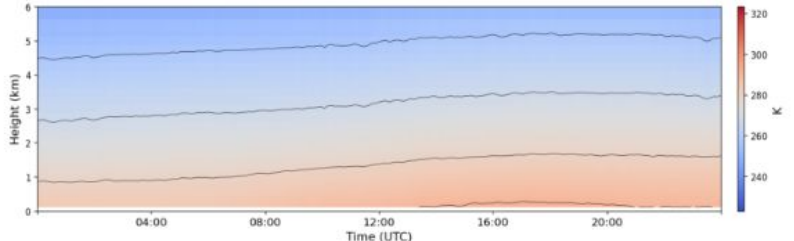
Integrated water vapour



Absolute humidity



Air temperature



cloudnet.fmi.fi

1.2

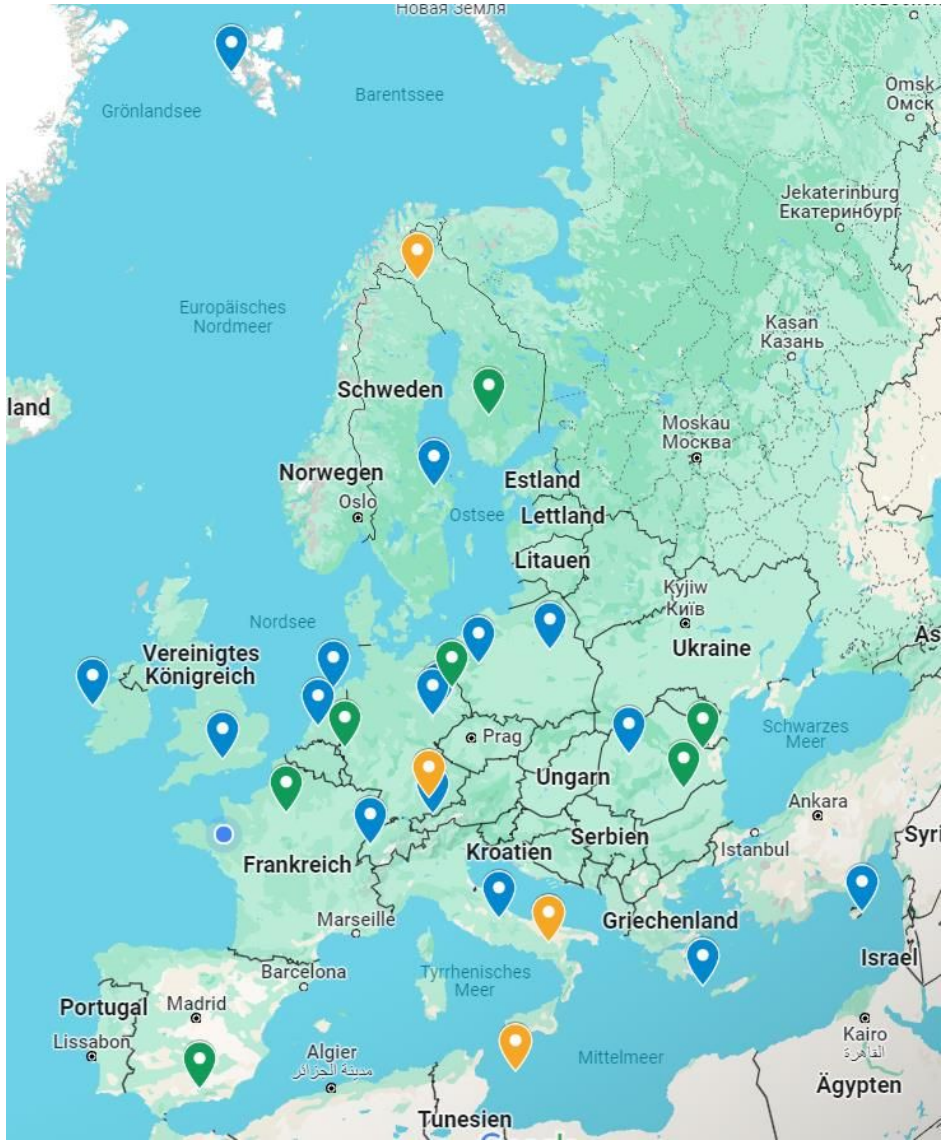
Ground-based MWR Networks in Europe

- More and more stations equipped with a MWR are running continuously throughout Europe

- Two initiatives are establishing coordinated networks:
  - ACTRIS-CCRES
  - EUMETNET / **E-Profile** (meteorological services)

EUMETNET

- Challenges for network operation (calibration, data processing, **quality control, retrievals,** etc.)



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2.1

Quality Control

Quality flags (per channel) derived for Level 1 data (also provided in product files)

- Contains checks of TB values, system parameters, and spectral consistency

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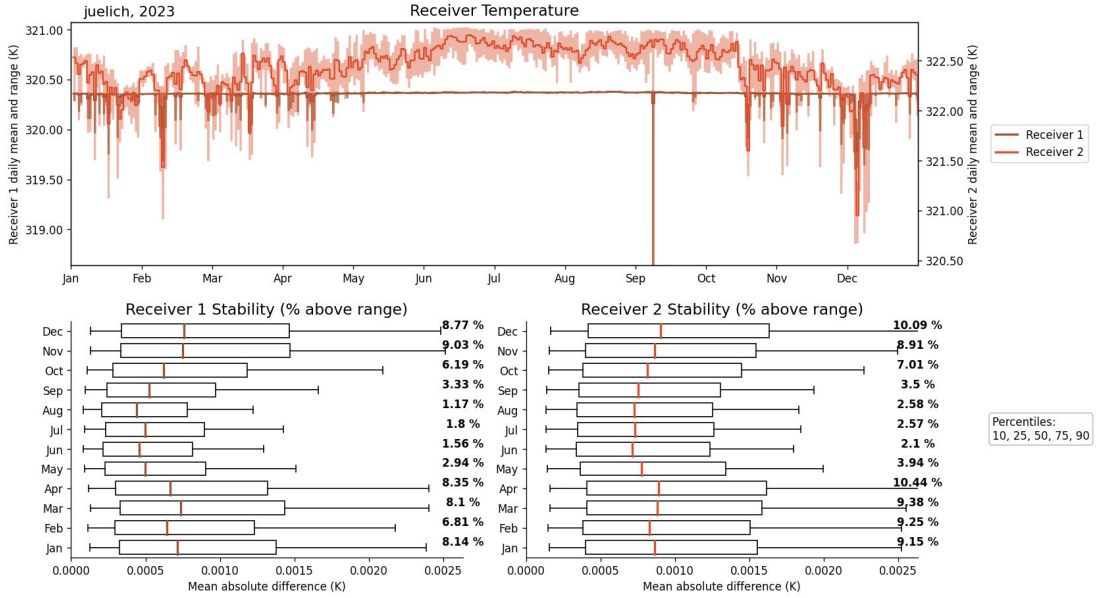
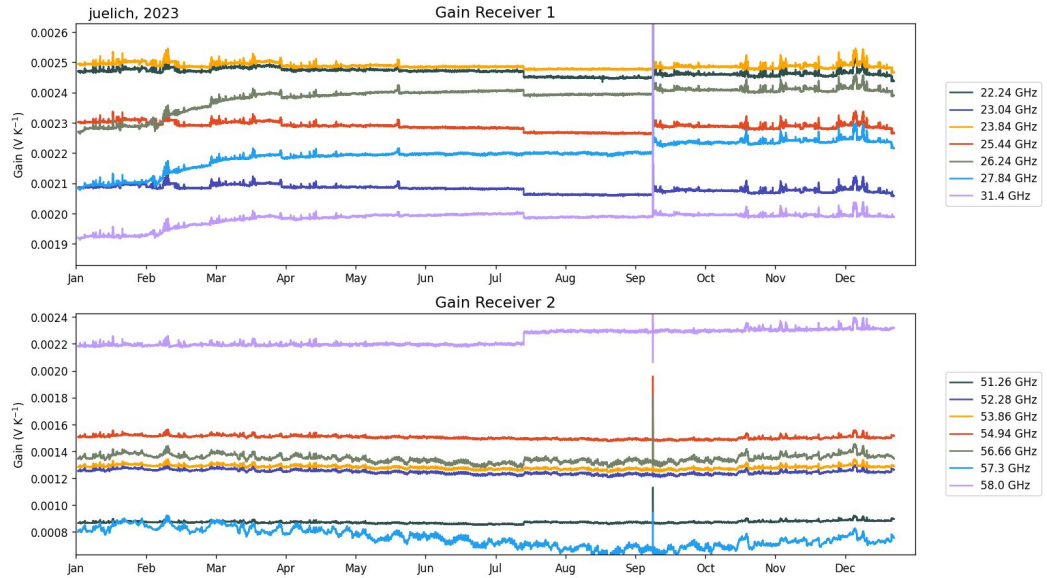
Long term quality assessment

- Checks availability / quality of data and whether SOPs are being followed
- Detection of malfunction possible in operational use
- Statistical analysis and reports are planned





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Centralized housekeeping data (HKD) monitoring

- Synchronizes HKD data with CCRES data center
- Includes instrument type specific thresholds and alert settings
- Helps operator to take action and increase uptime of instruments

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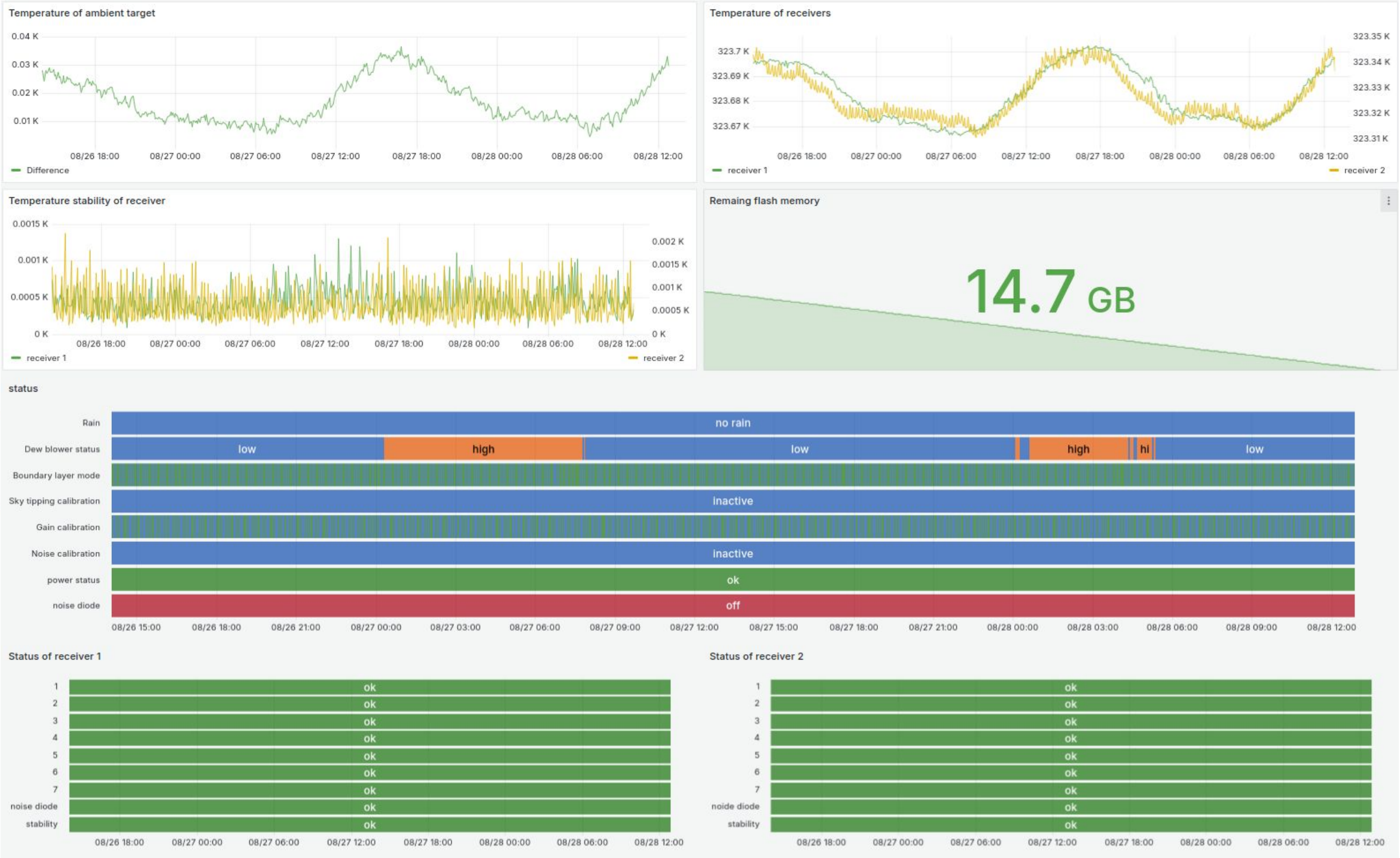
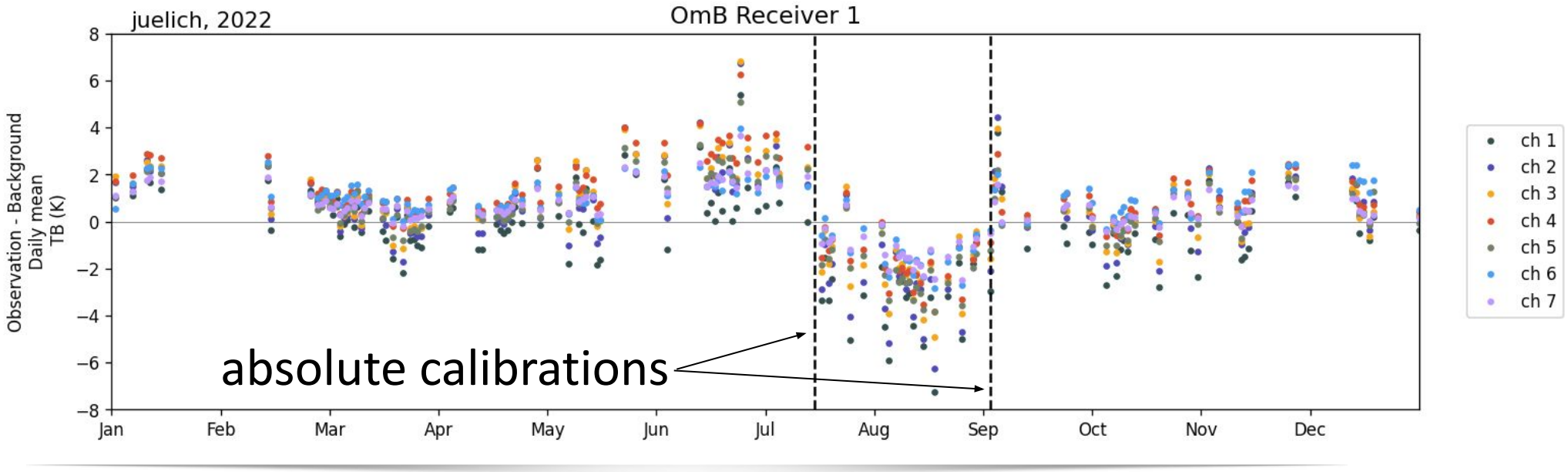

Temperature of ambient target
0.04 K
0.03 K
0.02 K
0.01 K
08/26 18:00
08/27 00:00
08/27 06:00
08/27 12:00
08/27 18:00
08/28 00:00
08/28 06:00
08/28 12:00
Difference
Temperature of receivers
323.7 K
323.69 K
323.68 K
323.67 K
323.35 K
323.34 K
323.33 K
323.32 K
323.31 K
receiver 1
receiver 2
Temperature stability of receiver
0.0015 K
0.001 K
0.0005 K
0 K
0.002 K
0.0015 K
0.001 K
0.0005 K
0 K
Remaing flash memory
14.7 GB
status
Rain
Dew blower status
Boundary layer mode
Sky tipping calibration
Gain calibration
Noise calibration
power status
noise diode
no rain
low
high
low
high
hi
low
inactive
inactive
ok
off
08/26 15:00
08/26 18:00
08/26 21:00
08/27 00:00
08/27 03:00
08/27 06:00
08/27 09:00
08/27 12:00
08/27 15:00
08/27 18:00
08/27 21:00
08/28 00:00
08/28 03:00
08/28 06:00
08/28 09:00
08/28 12:00
Status of receiver 1
1
2
3
4
5
6
7
noise diode
stability
ok
Status of receiver 2
noide diode

2.2

Observation minus Background (O-B) Monitoring of TB

- **Idea**: Identify faulty calibrations or larger drifts/jumps in brightness temperatures
- **Method**: Simulate TB using radiative transfer with a “background” (radiosonde, model), during liquid water cloud free scenes, and compare to observations
- **Difficulties**: Attribution of differences due to uncertainties (model, radiative transfer, etc); small drifts are likely within expected O-B spread



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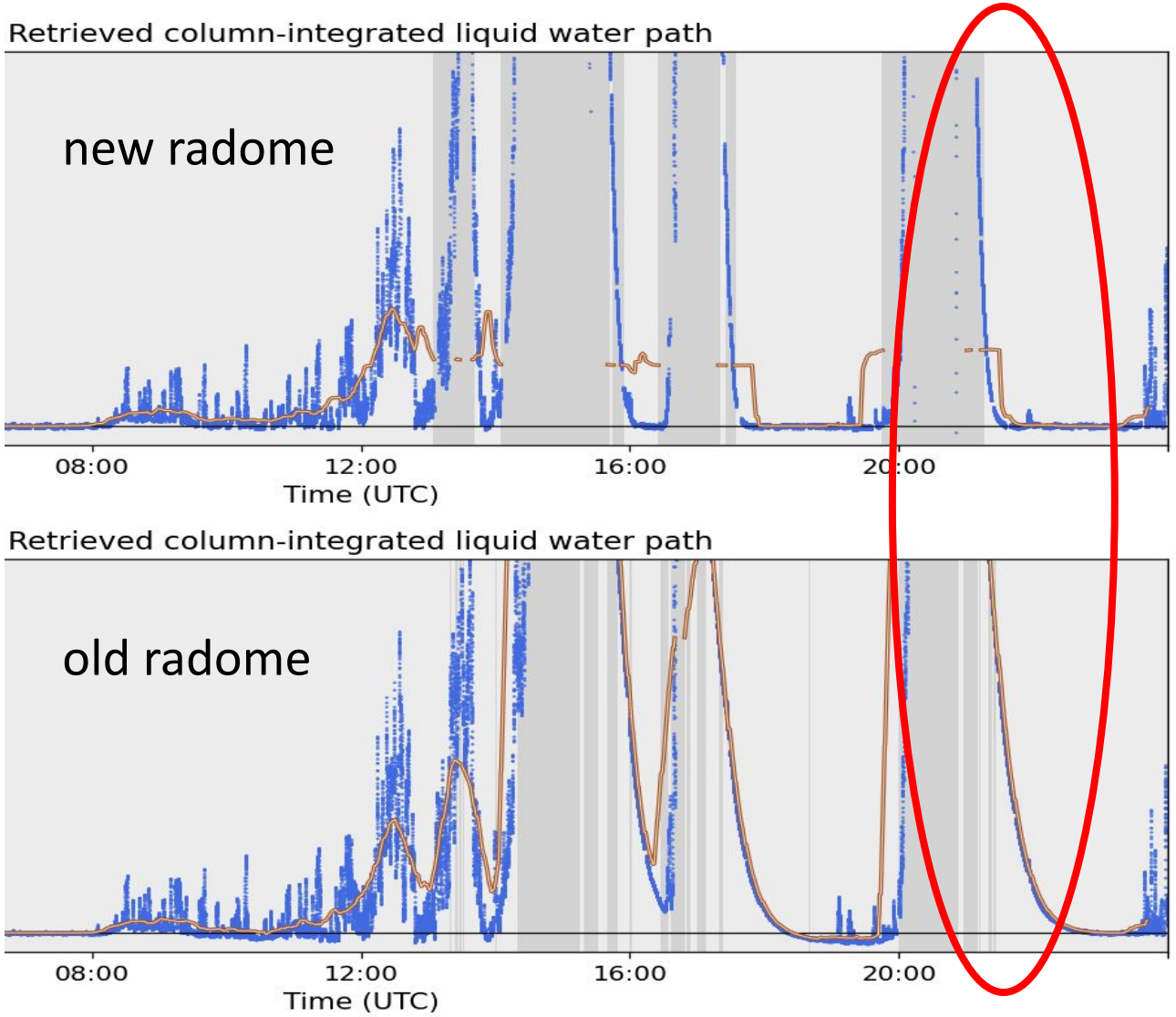
2.2

Radome Monitoring



- Work is done in collaboration with DWD
- **Idea**: evaluate “time-to-dry” of radome after rain events
- Uses spectral consistency retrieval (comparison of retrieved and observed TBs)
- Helps with instrument **maintenance** (radome change)

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Retrieval Development - ACTRIS

- Goal: derive homogeneous data streams focused on clouds/water cycle and retrieve quantities with a high temporal resolution (for atmospheric variability):

  - **Statistical retrieval** method (Neural Network including auxiliary information)
  - Retrieval training with **ERA5 climatology** (comparison with radiosondes)
  - MWR + IRT **synergy retrieval** for LWP
  - Include **89 GHz channel** of cloud radar / MWR for improvements in LWP retrieval

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Retrieval Development - E-Profile

Collaboration 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

Differences in generating products (retrieval method)

- Focus: nowcasting and data assimilation into weather forecast models
- Physical retrieval approach (optimal estimation)
- Lower temporal resolution

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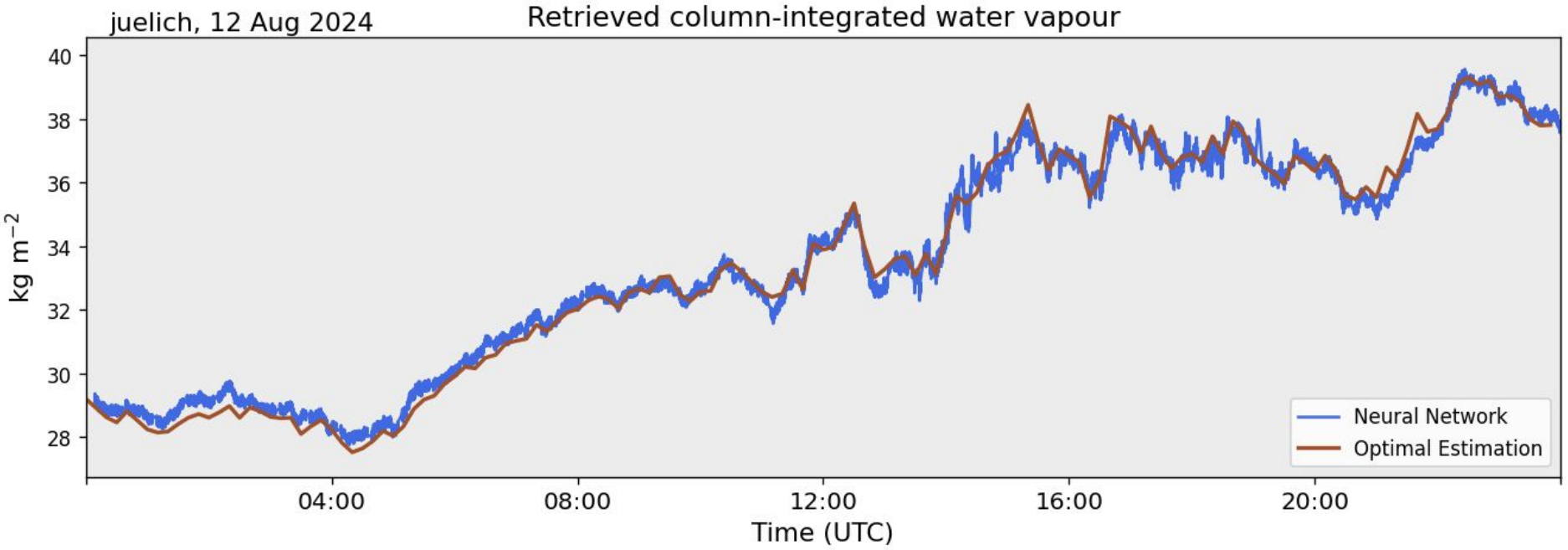
Retrieval Development - Comparison

- PANAME (PAris region urbaN Atmospheric observations and models for Multidisciplinary rEsearch) campaign is used as **testbed**

- Comparison of statistical and physical retrievals at different sites



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4

Summary & Conclusions

- ACTRIS-CCRES provides harmonized single instrument and synergistic data products for cloud remote sensing
- Emerging and coordinated ground-based MWR networks in Europe (ACTRIS / Cloudnet, E-Profile) with centralized data processing
- Comprehensive and long-term data assessment ensures high data quality, increase in uptime, and helps with instrument maintenance
- Intercomparison campaigns using different approaches will support current retrieval development

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