ACTRIS
CCRES

Microwave Radiometer operational services

Updates on MWR retrieval development

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CCRES MWR Network – Current Status & Updates

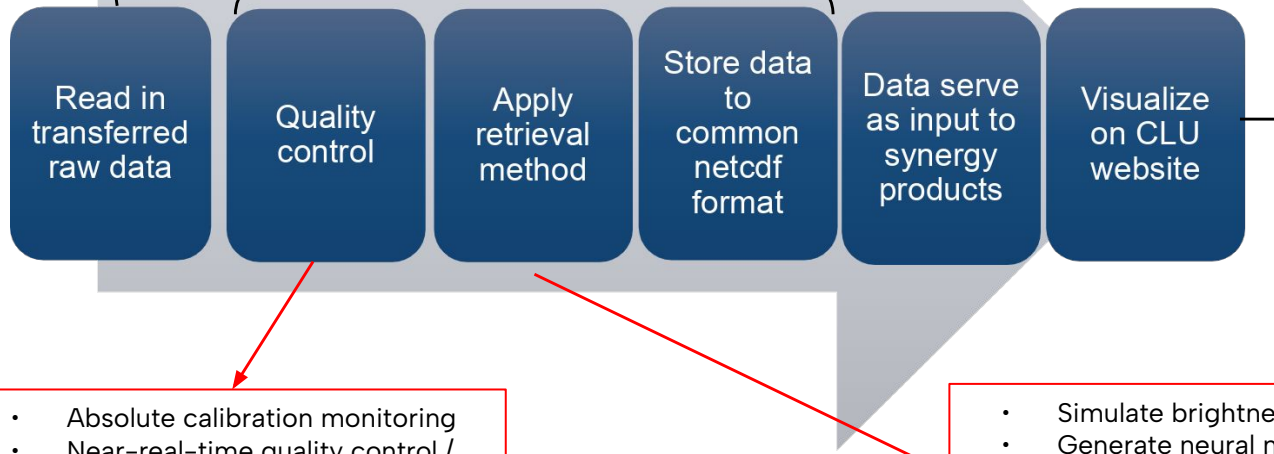
- Around 20 RPG HATPRO systems currently **upload raw data** (binary files) to CLU
- Processing is performed by the Python based package MWRpy
- Recent and pending **software updates** include:
  - Implementation of unified library for thermodynamic calculations (atmoslib)
  - Stand-alone usage without config files and data format choice (Cloudnet vs E-Profile)
  - Read in and display absolute calibration .LOG file data

Microwave radiometer processing in ACTRIS

Station operators transfer **raw data** to CCRES data center unit (CLU)

Python package **MWRpy** implemented in Cloudnet:

github.com/actris-cloudnet/mwrpy



cloudnet.fmi.fi

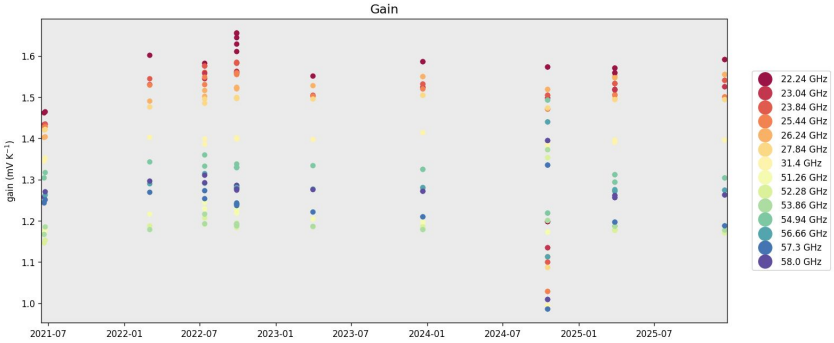
- Absolute calibration monitoring
- Near-real-time quality control / data flagginng
- Long-term stability analysis

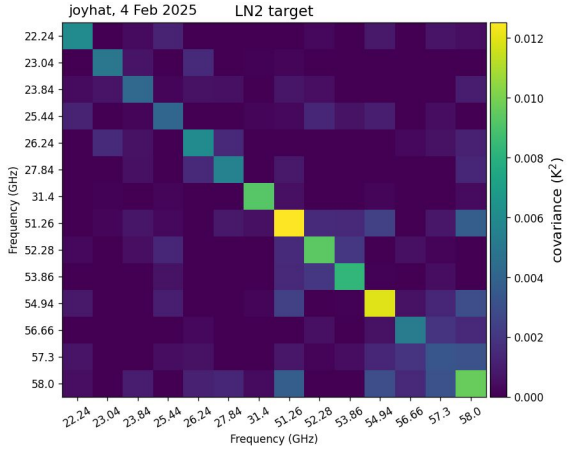
- Simulate brightness temperatures
- Generate neural network retrievals
- Testbed for retrieval evaluation using radiosondes

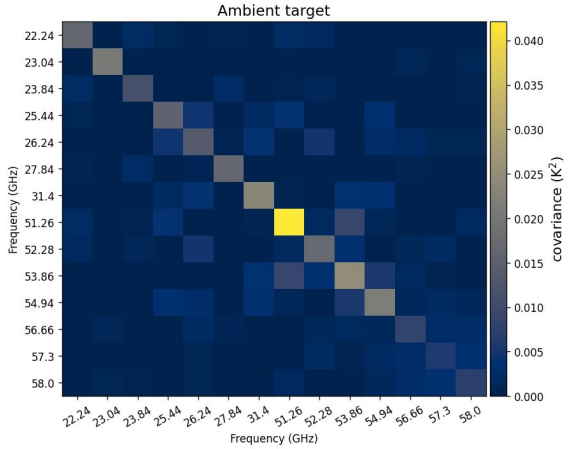
Calibration monitoring / Absolute calibration

- RPG files created during absolute calibrations **(CovMatrix*.LOG, ABSCAL*.HIS/LOG)** are collected from all stations

- Covariance matrix together with the **calibration history** can be analyzed and visualized in MWRpy to:
  - monitor long-term **stability** of calibration parameters
  - characterize measurement **uncertainties**

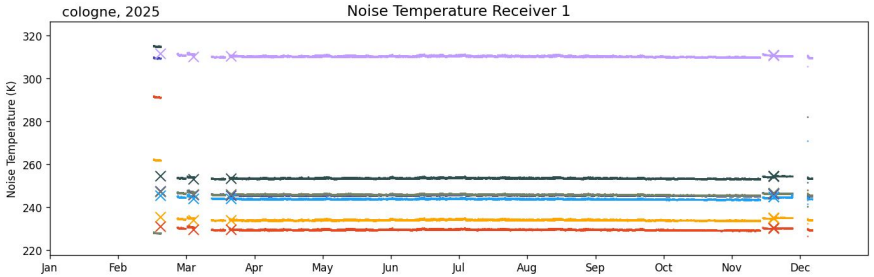


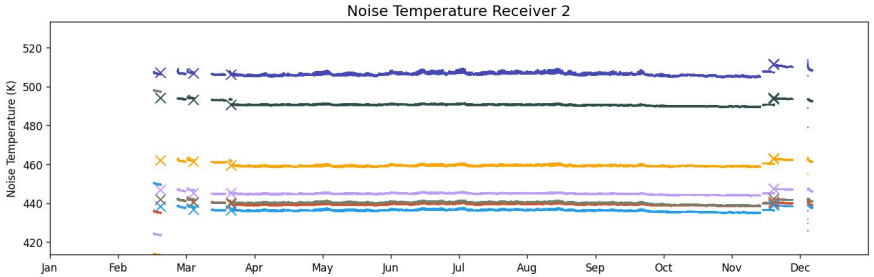


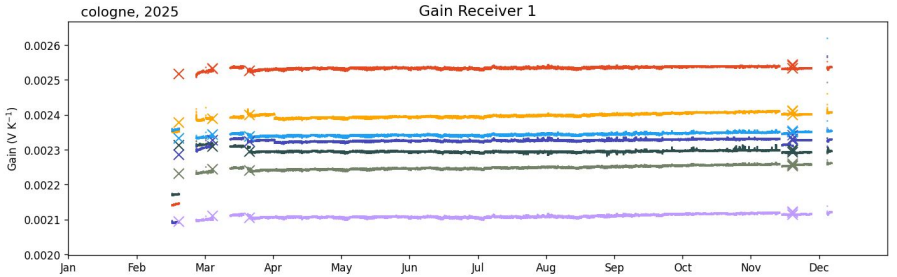


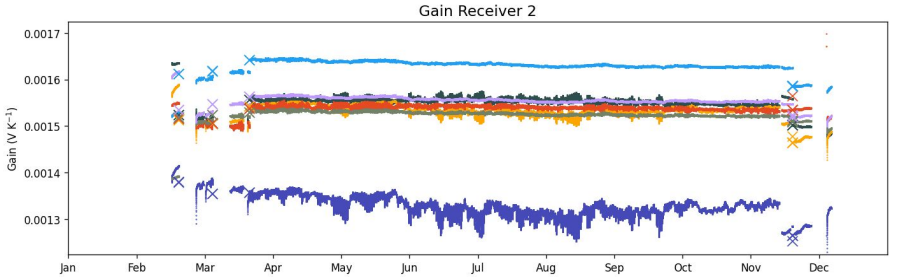
Calibration monitoring / Automatic calibration

- CAL.LOG files from **automatic calibrations** (every 5-10 minutes) contain the updated parameters gain and receiver noise temperature
- Interpretation still difficult and monitoring at CLU is currently not planned









Quality Control - Near-real-time

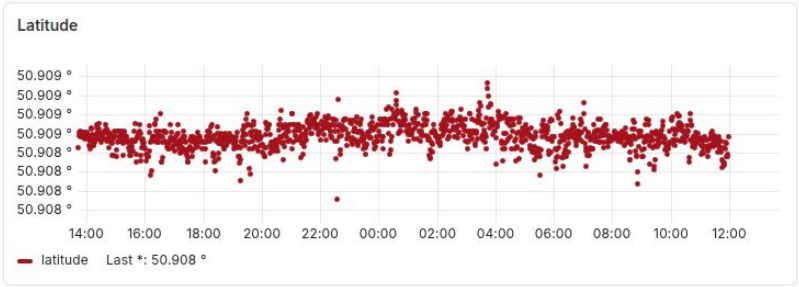
Spectral consistency check

- Part of **routine processing** (level 1) and one of the **quality flags** present in level 1&2 files
- Compares retrieved and observed spectrum
- Detection of rain, interferences, and faulty channels
- Planned: **statistical evaluation** of spectral consistency during non-rainy periods

Housekeeping monitoring in Grafana

- Allowing efficient **instrument failures** detection
- Help with instrument maintenance and ensure long-term high quality geophysical data
- **GPS coordinates** are now being monitored

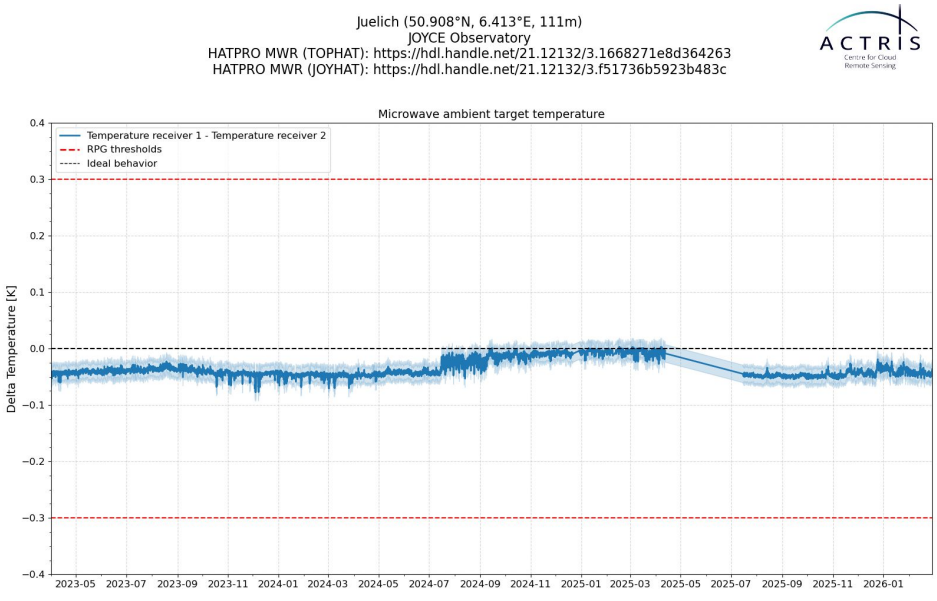
Alerting system will be set up

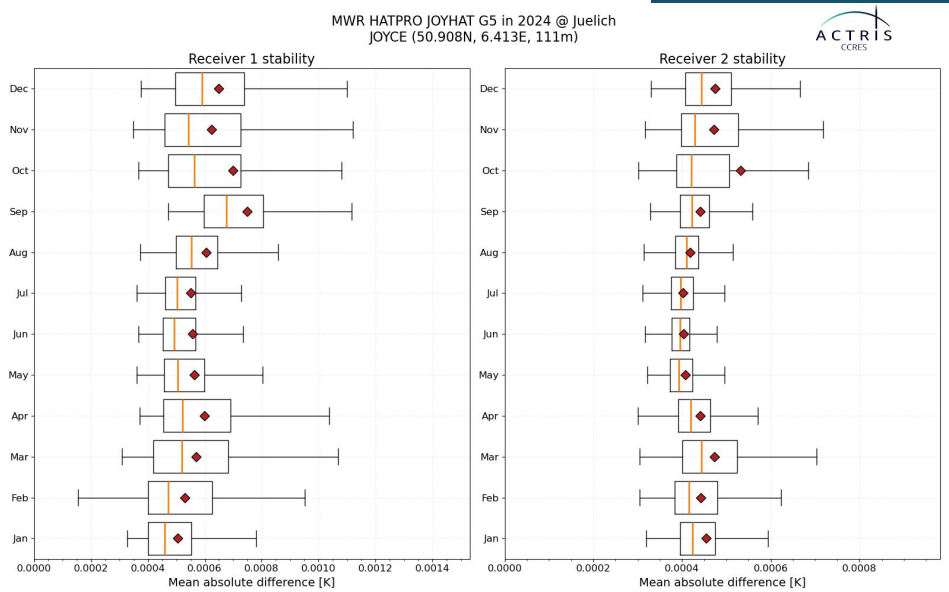


Quality Control - Long-term

Receiver and ambient target temperature stability as described in ReOBS ATBD (maintained by IPSL; https://ccres.aeris-data.fr/en/data-visualization-mwr/)

Also evaluated in **labelling step 1b**





MWR Retrieval Development

Goal: develop retrieval framework suited for ACTRIS, which includes:

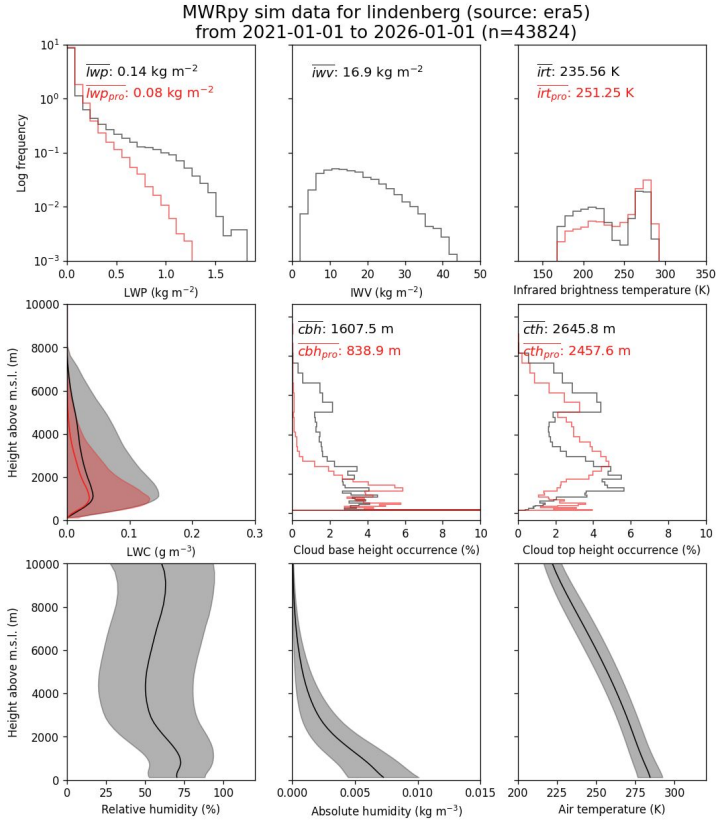
- **Harmonization** in terms of retrieval method, input data, etc.
- **Flexible** design to adapt to channel malfunction, viewing angle obstruction
- Providing sufficient **metadata** and traceability (together with CLU)
- Implementation into the ACTRIS-MWR processing chain (MWRpy)

Framework consists of three Python based repositories:

- **MWRpy**: data processing and quality control (already implemented)
- **MWRpy_sim**: simulate brightness temperatures from atmospheric profiles
- **MWRpy_ret**: train retrievals based on a Neural Network approach

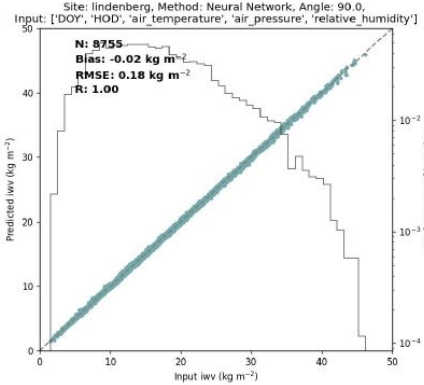
MWR Retrieval Development - MWRpy_sim

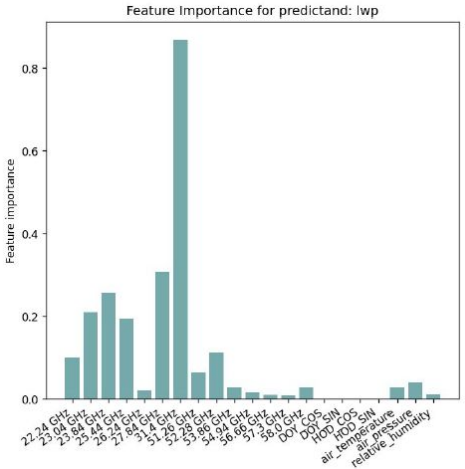
- Currently supported **input data**: ECMWF's IFS model, ERA5 reanalysis (both available at CLU), GRUAN radiosondes
- Profiles are extended with standard atmosphere and near surface heights get adjusted to the specified station altitude
- Absorption models are based on **Rosenkranz 2024**
- To simulate MWR brightness temperatures, torchMWRT is used:
  - Part of openMWR (developed at LMU)
  - Also includes forward calculation of the **infrared sensor** using libRadtran (solver: DISORT)

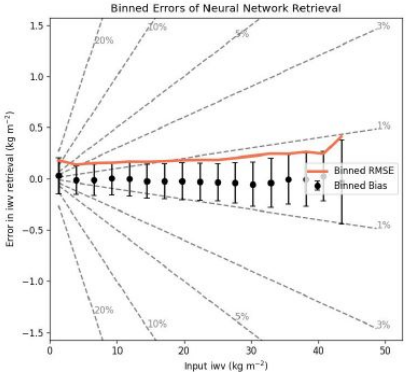


MWR Retrieval Development - MWRpy_ret

- Method: multi-layer densely-connected Neural Network
- Additional input (including noise): MET station data, day-of-year, hour-of-day
- Retrieval testing (based on splitted input data)
- Retrieval characteristics (e.g. DOF, feature importance)
- Output: netCDF files

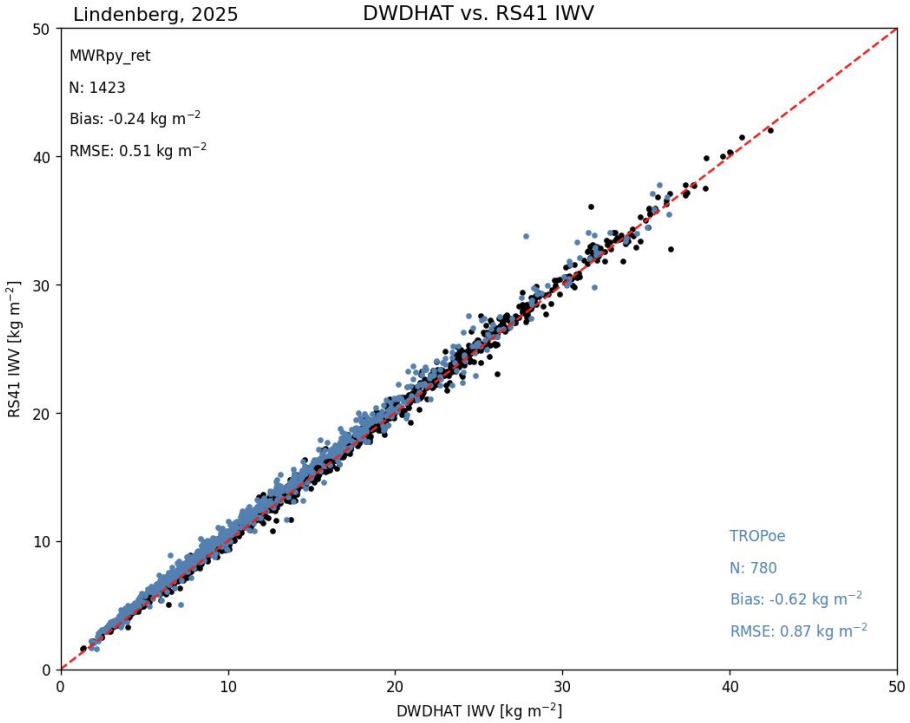






MWR Retrieval Development - Evaluation

- **Testbed** for evaluating retrievals using Lindenberg data for real network applications (e.g. faulty channels, higher noise)
- Frequent and quality controlled **radiosonde data** (GRUAN data products) available for evaluation
- Retrieval **training** based on 5 years of data
- **Comparison** with TROPoe (E-Profile), and new RPG retrieval during 2024 & 2025



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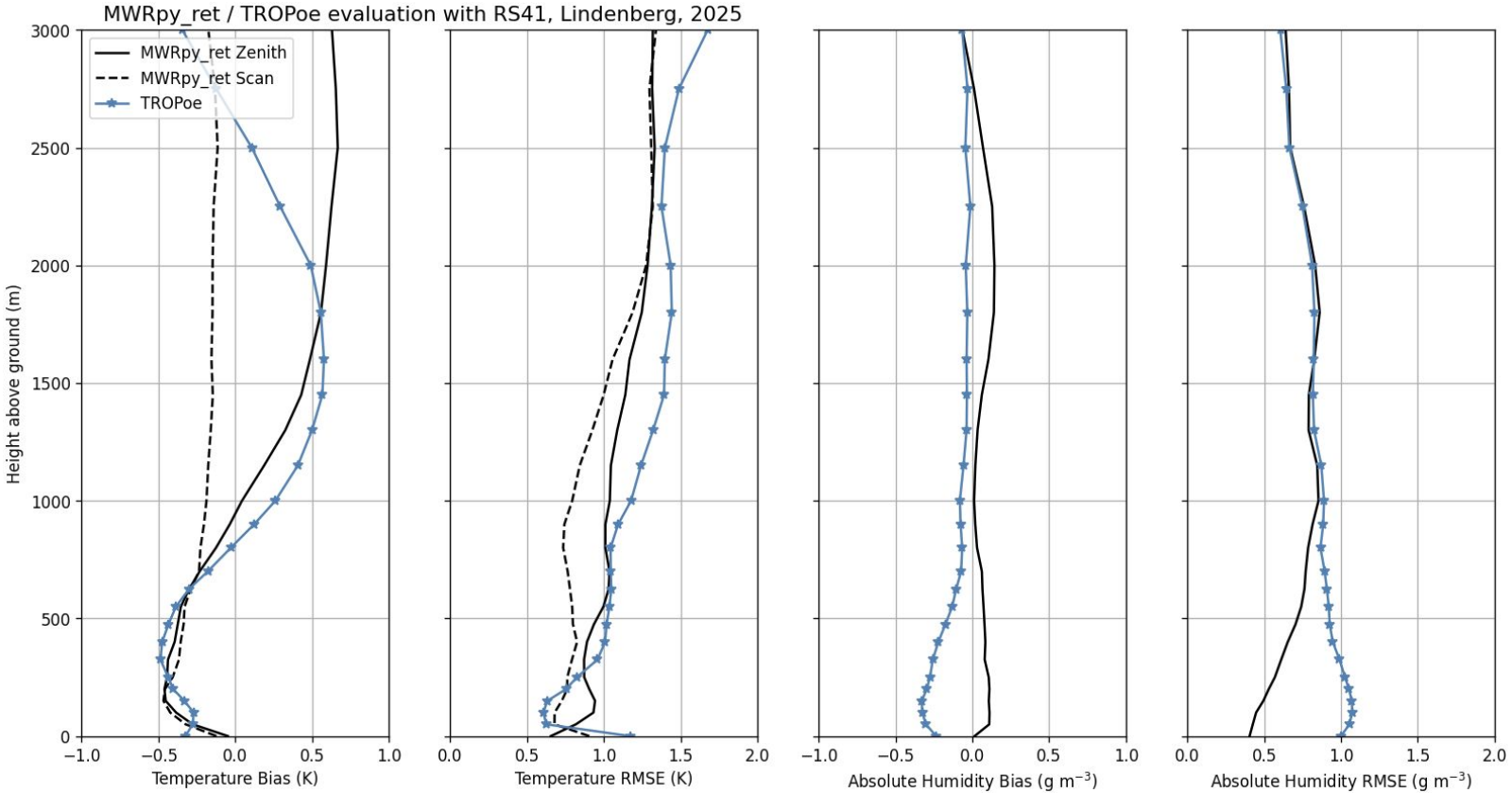


MWR Retrieval Development - Evaluation

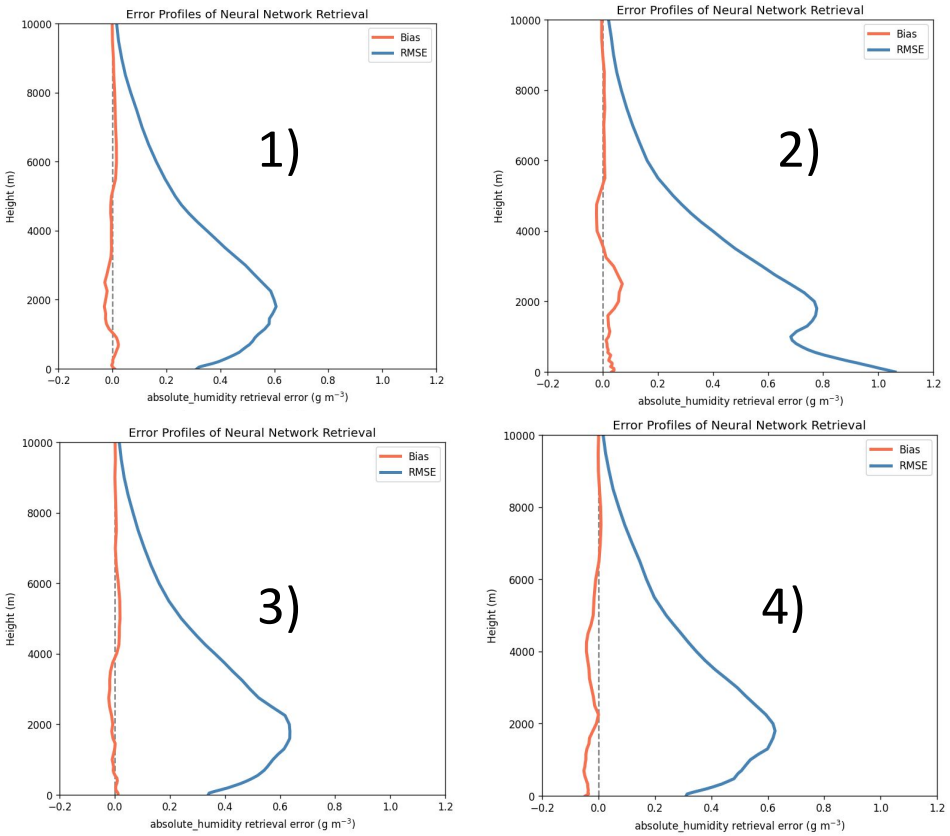
Humidity profile (zenith) retrieval from:

1) 7 channels K-Band, 7 channels V-Band, MET sensor data, day-of-year, hour-of-day

2) All except MET sensor data

3) All except 7 channels in V-Band

4) All except channel 1 (22.24 GHz)



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Thank you !