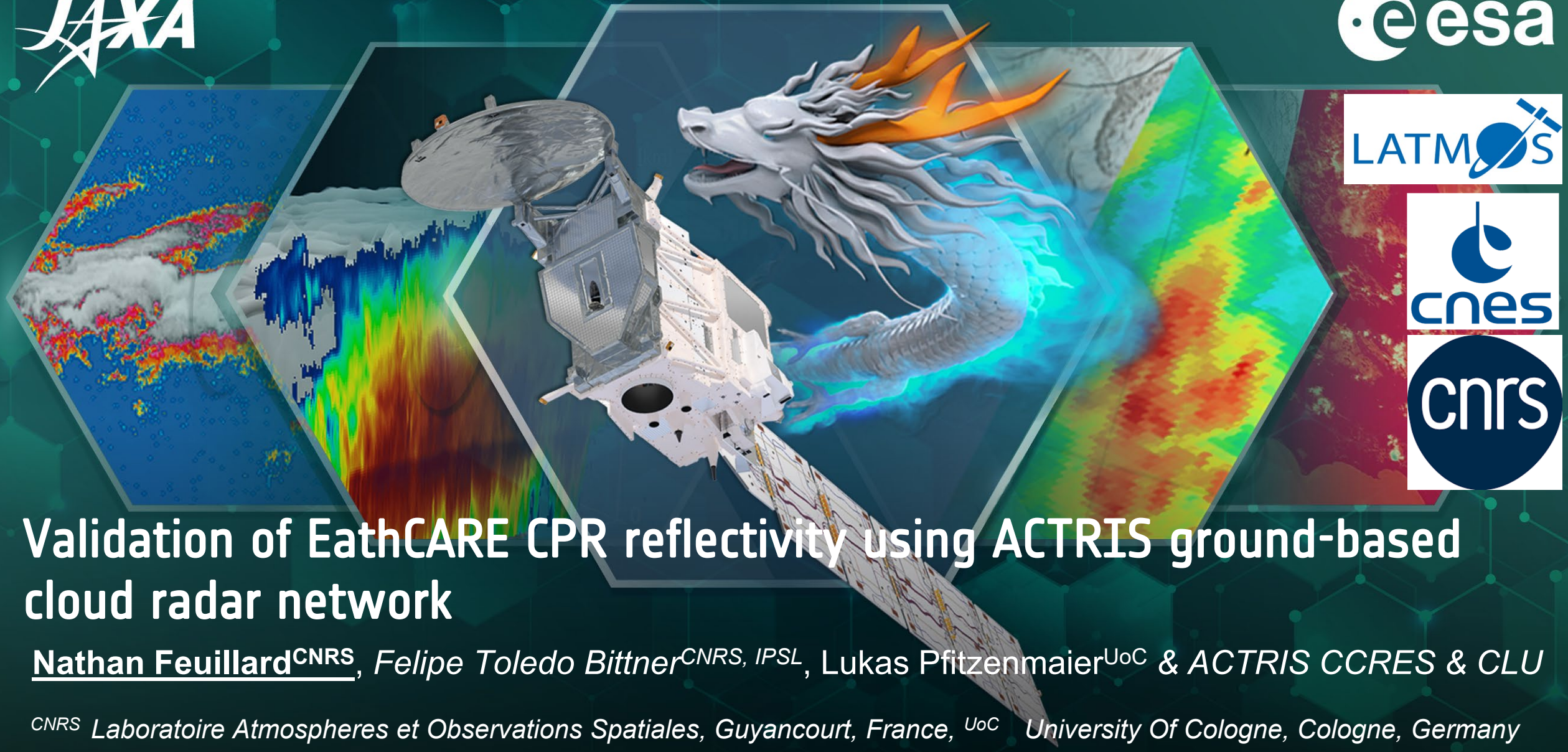

Validation of EathCARE CPR reflectivity using ACTRIS ground-based cloud radar network

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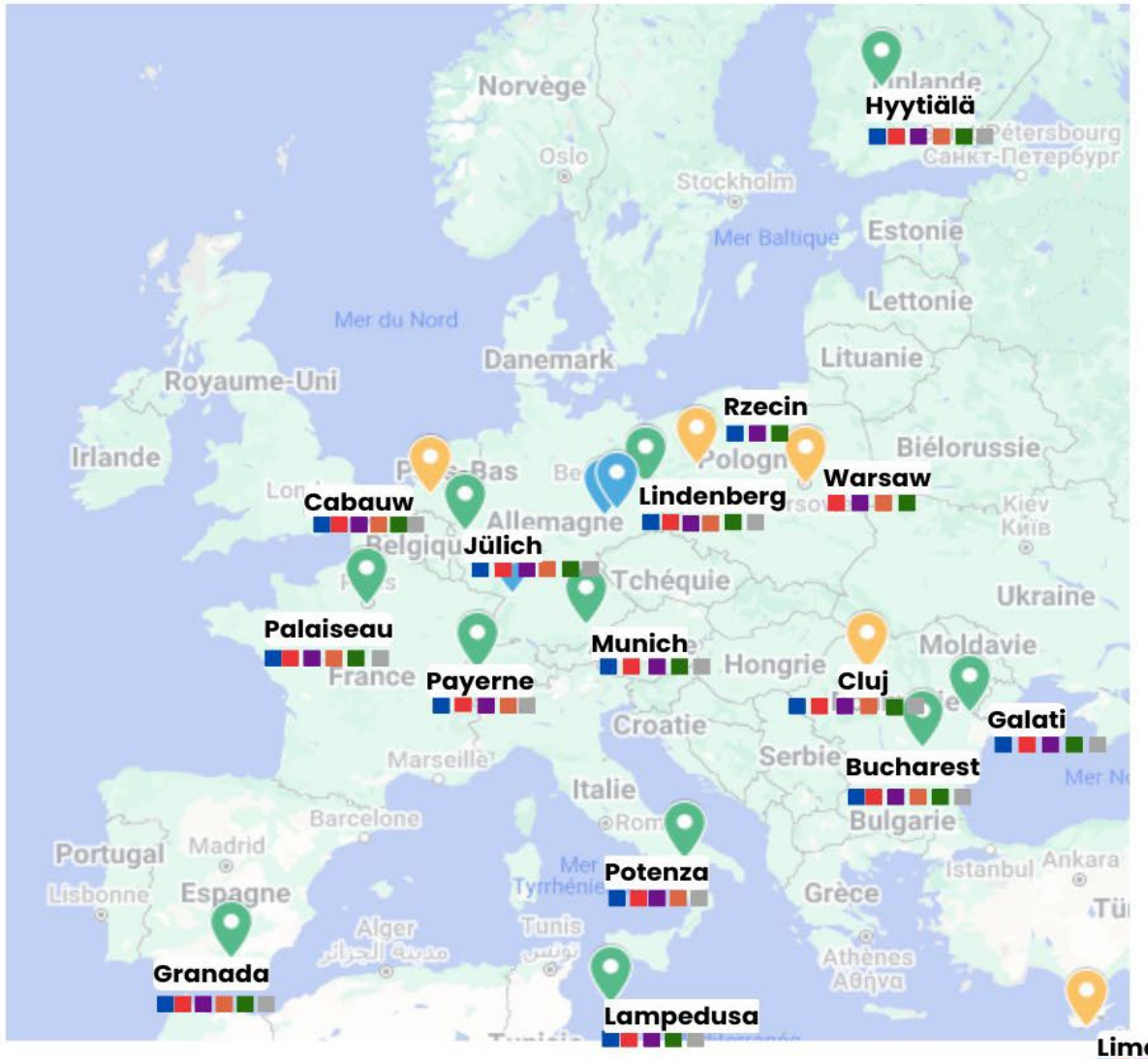
2nd ESA-JAXA EarthCARE In-Orbit Validation Workshop

17 – 20 March 2025 | ESA-ESRIN | Frascati (Rome), Italy

ACTRIS network of cloud remote sensing sites

- DCR
- MWR
- ALC
- DL
- Disdrometer
- Weather station

- ACTRIS CRS Labelling in progress
- ACTRIS CRS Labelling initiated
- ACTRIS CRS candidate



Finland

Cape Verde

La Réunion

ACTRIS data quality control and products

ACTRIS cloud remote sensing network

- 25 fixed sites + mobile station => good geographical coverage
- CLU (CloudNet) data centre: automated data quality controlled and centrally processed
- CCRES expert centre: ongoing cloud radar calibration using reference radar & stability monitoring using disdrometer
- cloud radar + microwave radiometer + backscatter lidar

➔ cloud target classification

Data are available at: cloudnet.fmi.fi

Cape Verde

Finland

La Réunion

Data and method used

Data used:

➢ CPR: L2a, AB baseline data. Period: 12/2024 - 02/2025 ~ 2.5 months.

Data selection inspired from Protat et al (2009).

- ➢ CPR: sample overpass in 200 km range from sites.
- ➢ Ground: zenith observations in ±1h around overpass time.

→

Filter liquid clouds: take account of differences in attenuation.

- ➢ CPR: L2a target classification.
- ➢ Ground: CloudNet classification

→

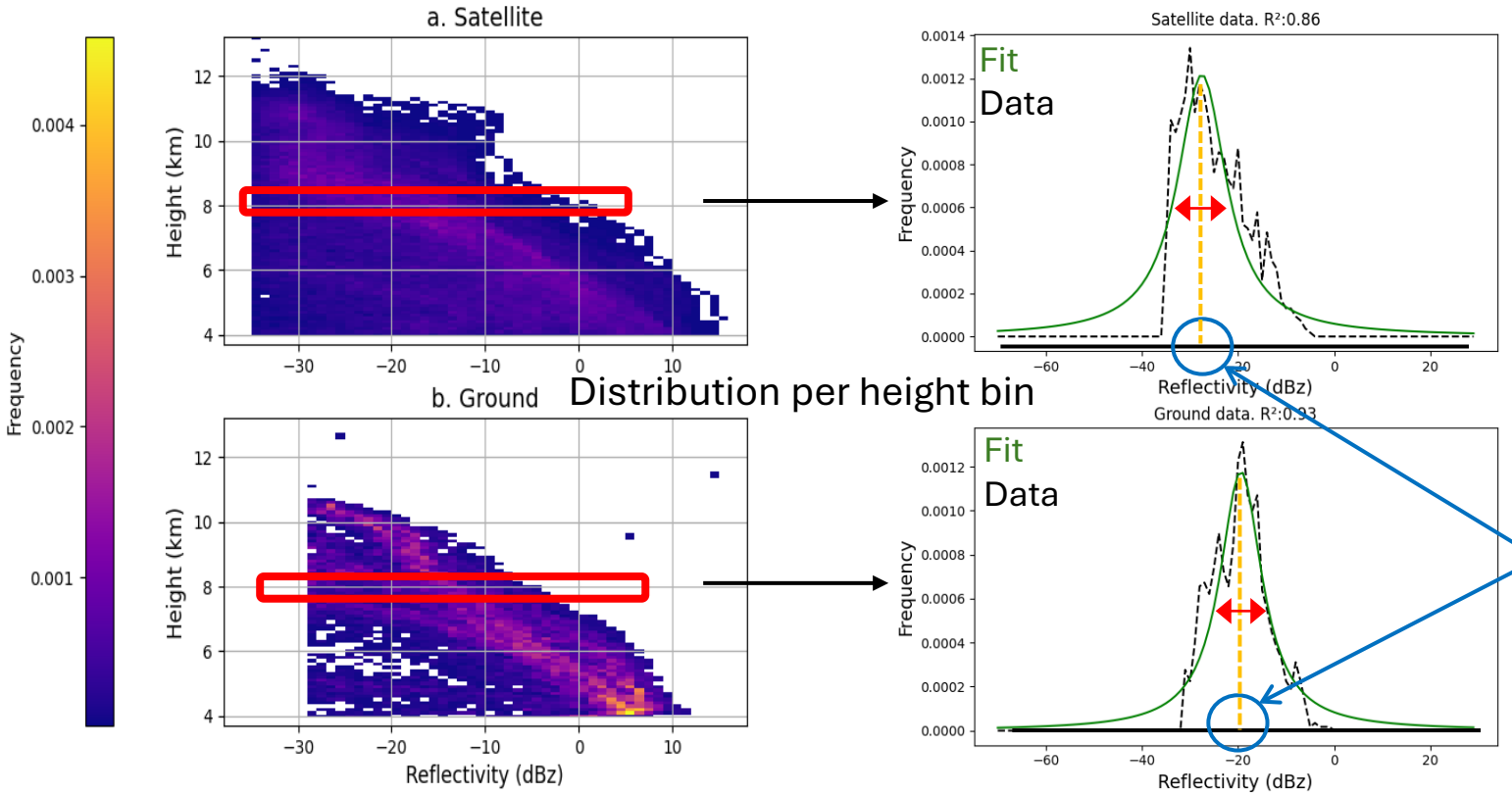
- Ground data resampling to match satellite range.
- Sensitivity matching.

↓

Reflectivity comparison between CPR and ground based radar.

Statistical fitted comparison method

Site: Jülich, 2.5 months



Distribution per height bin

Lorentzian model criteria:

R^2 of the fit

Width of the distribution

Amplitude of the distribution

Center of the distribution

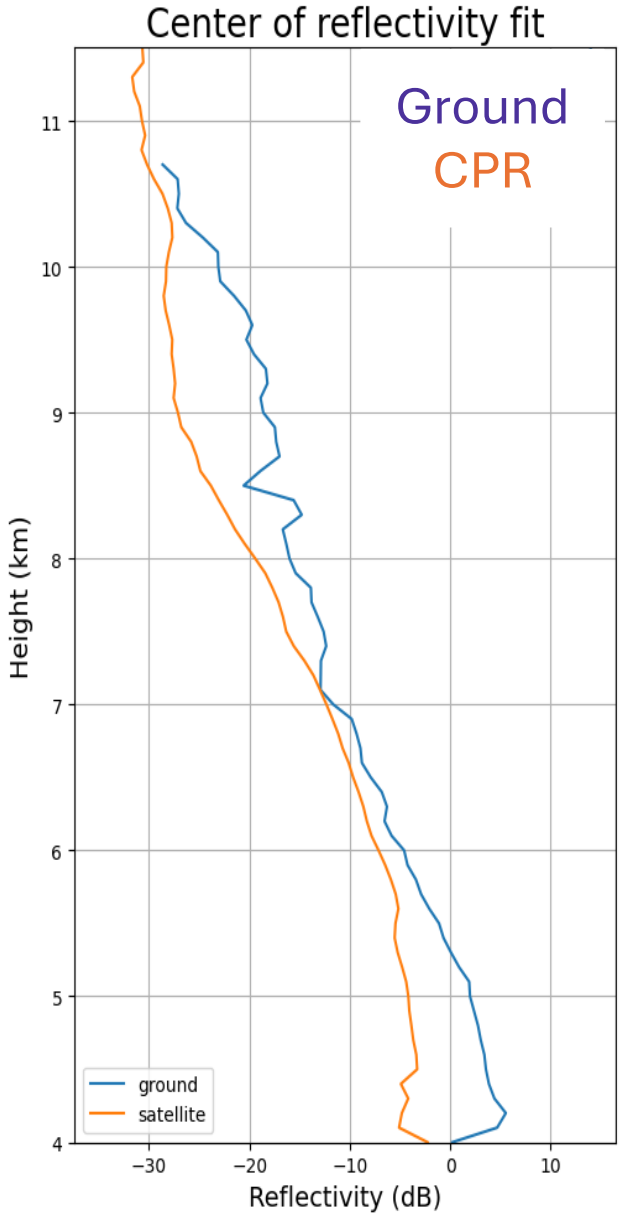
Fit with a Lorentzian model to sort data (threshold based):

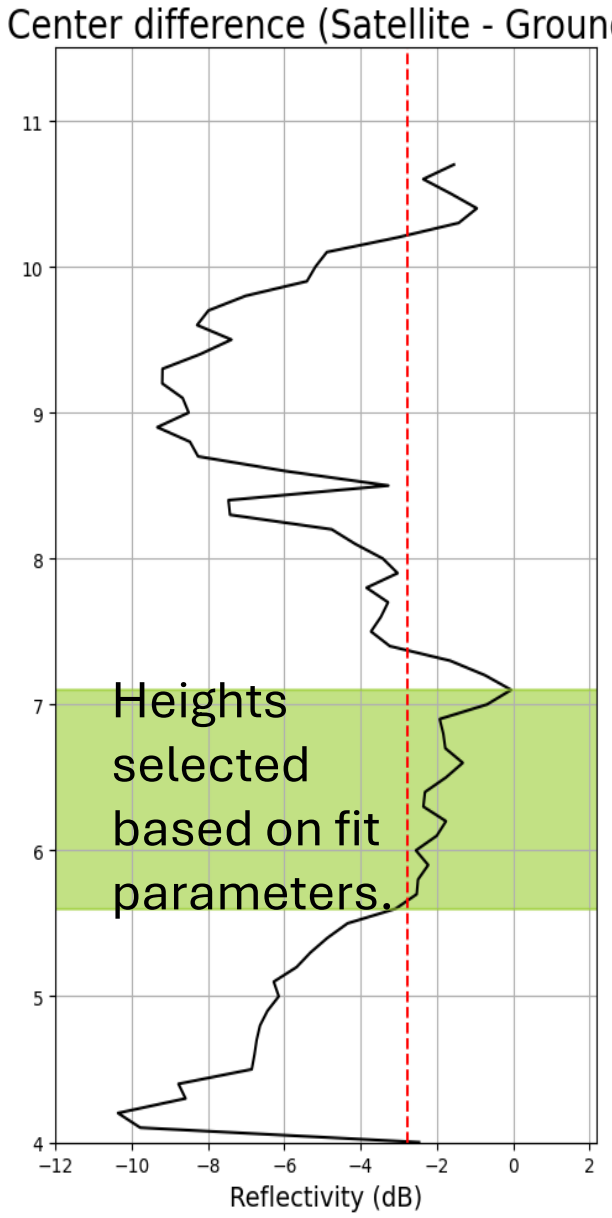
- If criteria fulfilled bin selected (width difference, center correlations, R^2).
- Otherwise bin filtered out.

The center of the fit is used as the estimator for the bias.

Statistical fitted comparison method

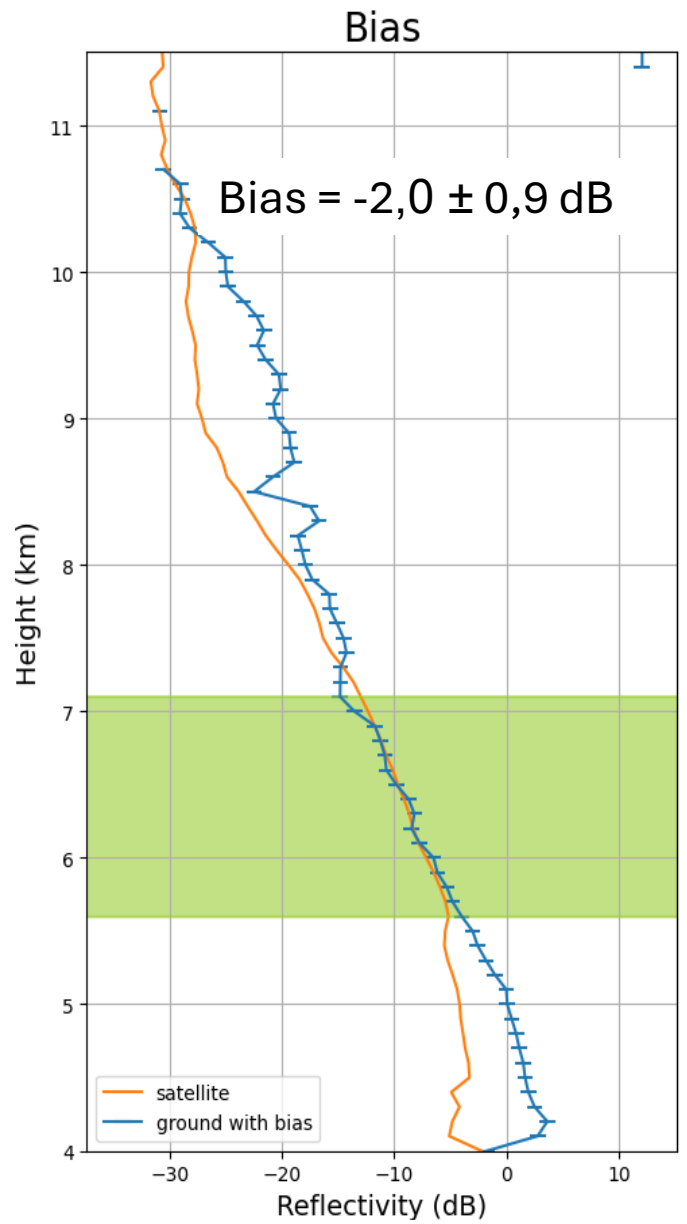
Site: Jülich, 2.5 months





Bias = mean(centers differences)

Uncertainty = std(centers differences)



Results overview

Site	Ze bias (dB) CPR-ground	ACTRIS calibration	Comments
Julich	**-2 ± 1**	Calibrated (Winter 2024)	Calibration 0.2dB Monitoring < 1 dB
Lindenberg	-1 ± 1	Calibration (spring 2025)	Calibration (soon) Monitoring < 1 dB
Cabauw	1 ± 1	Disdrometer monitoring	Monitoring in progress
Munich	1 ± 1	Disdrometer monitoring	Monitoring in progress
Granada	-1 ± 2	Disdrometer monitoring	Few heights selected
Lampedusa	1 ± 1	Disdrometer monitoring	Monitoring in progress
Ny-Alesund	-6 ± 1	Not monitored yet	Analysis of gnd-based radar in progress
Payerne	-6 ± 1	Not monitored yet	Analysis of gnd-based radar in progress

- Work in progress (2,5 months analyzed).
- Uncertainty might be underestimated. More time needed for better estimation (6-9 months of sampling).
- Great improvements compared to L1 data (Liquid water filtering, attenuation considerations).
- L2 - L1 difference: 1 ± 2 dB

Conclusion

- Developed an algorithm to estimate the difference between CPR and ACTRIS ground based radars reflectivity measurements.
  - The algorithm runs for the whole ACTRIS network (CloudNet database).

- Current estimated reflectivity difference: -2 ± 1 dB (CPR - ground based).
  - L2 products on a 2,5 months period.
  - Using the Julich site (calibrated with CCRES reference radar).

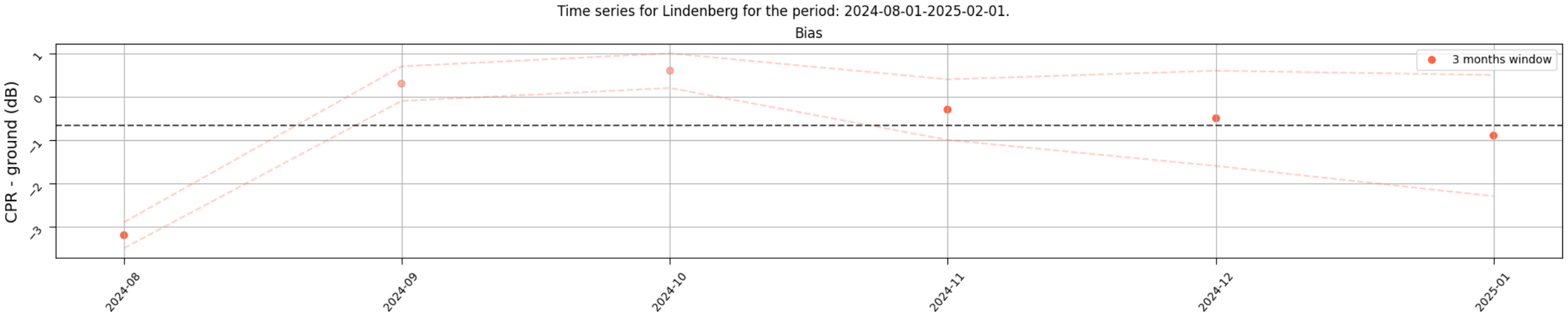
- L2 hydrometeor classification reduce the uncertainty on the liquid water filtering.

- Checked L2 - L1 difference with 8 ACTRIS radars as baseline and found:
  - L2 – L1 = 1 ± 2 dB

Perspectives

- Comparisons with more calibrated ACTRIS sites.
  - ➢ Three more sites undergoing calibration (spring 2025: Lindenberg, Rzecin, Leipzig).

- Implementation of time series to monitor calibration changes of CPR and the network.



- Implementation of Doppler velocity comparisons between EarthCARE and ACTRIS.

- Article about the presented algorithm in preparation (Feuillard et al. in prep).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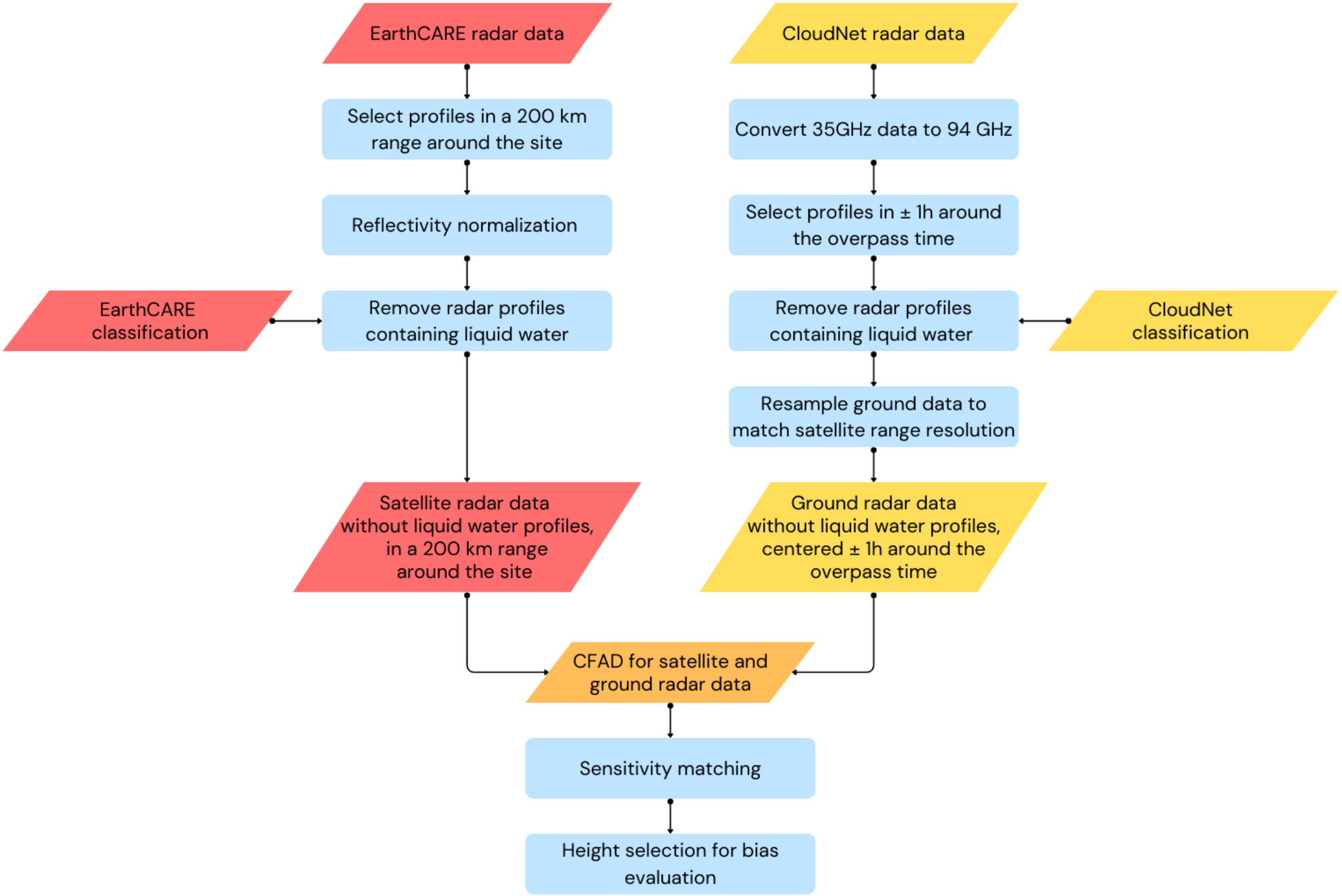
EarthCARE radar data
Select profiles in a 200 km range around the site
Reflectivity normalization
EarthCARE classification
Remove radar profiles containing liquid water
Satellite radar data without liquid water profiles, in a 200 km range around the site
CloudNet radar data
Convert 35GHz data to 94 GHz
Select profiles in ± 1h around the overpass time
Remove radar profiles containing liquid water
CloudNet classification
Resample ground data to match satellite range resolution
Ground radar data without liquid water profiles, centered ± 1h around the overpass time
CFAD for satellite and ground radar data
Sensitivity matching
Height selection for bias evaluation