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EarthCARE
Cloud Profiling Radar Validation
using ACTRIS ground-based Cloud Radar Network

Why ACTRIS is a perfect for CPR validation?

The ACTRIS ground-based Cloud Remote Sensing Network has the potential to serve as a validation centre (Europe and campaigns) for EarthCARE CPR measurements and EarthCARE cloud products.

- 25 fixed sites + mobile facilities → good geographical coverage
- Automated data quality control and central data processing
- ACTRIS Centre for Cloud Remote Sensing → monitoring of data quality
  - Cloud radar calibration using a reference radar (Jorquera, 2023)
  - Reflectivity monitoring using disdrometers
- Instrumental Synergy: radar + microwave radiometer + backscatter lidar
  ➢ cloud target classification → EarthCARE L2 cloud product validation

→The ACTRIS cloud radar network meets all validation needs for EarthCARE CPR L1 reflectivity (Ze) and Doppler velocity (Vm) measurements. Additionally, all necessary tools for validating EarthCARE L2 Doppler velocity and cloud products are given

→ Preliminary work at 11 sites

Cloudnet data server

ACTRIS CCRES webpage

EarthCARE Cloud Profiling Radar (CPR):

- Operating frequency 94 GHz
- CPR blind zone ~ 0.6 km
- First Doppler cloud radar in space → Nyquist Velocity ± 5.8 m s^{-1}
- Retrieval of in-cloud motion and cloud and precipitation microphysics

ACTRIS Cloud Remote Sensing network:

- Cloud radars operate at 35 GHz and/or 94 GHz
- All radars have Doppler capabilities
- Radars point zenith ± 1.5 h around an EarthCARE overpass
- ACTRIS data center runs a CPR forward simulation tool from Pfitzenmaier et al., 2025, for all sites

→ Improves the comparison of ground-based radar data to EarthCARE CPR

CPR reflectivity validation:

Data used for the statistical comparison (Protat, 2010 & 2011):

- Ground: zenith pointing ± 1 h around the overpass
- CPR: all overpasses within a 200 km around the site
- Use ice clouds only (limit attenuation effect)
  - filtering: ACTRIS cloud target classification and EarthCARE L2 CTC product

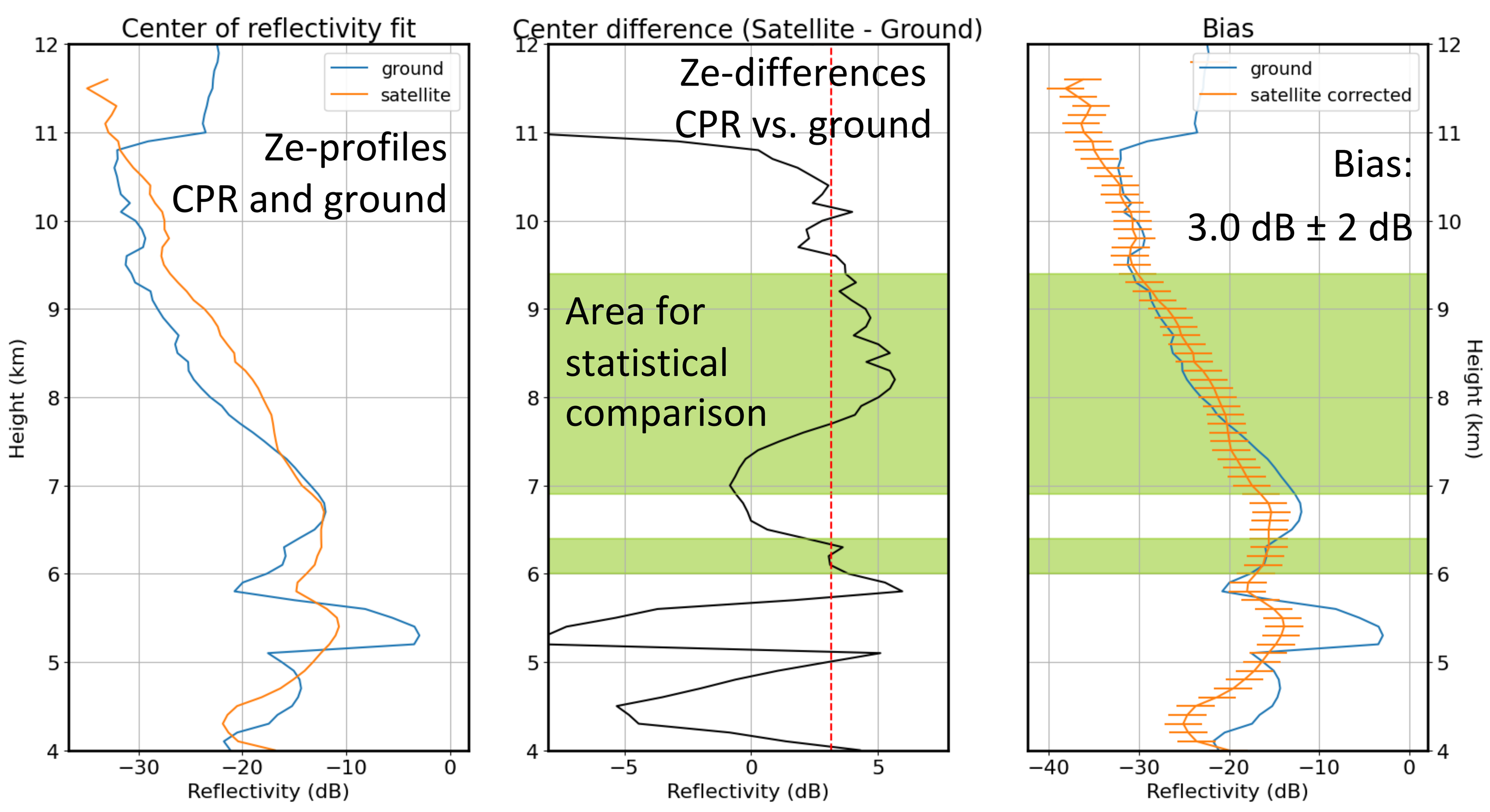
Methodology to evaluate the data before the comparison:

Check that the data are statistically comparable before validation

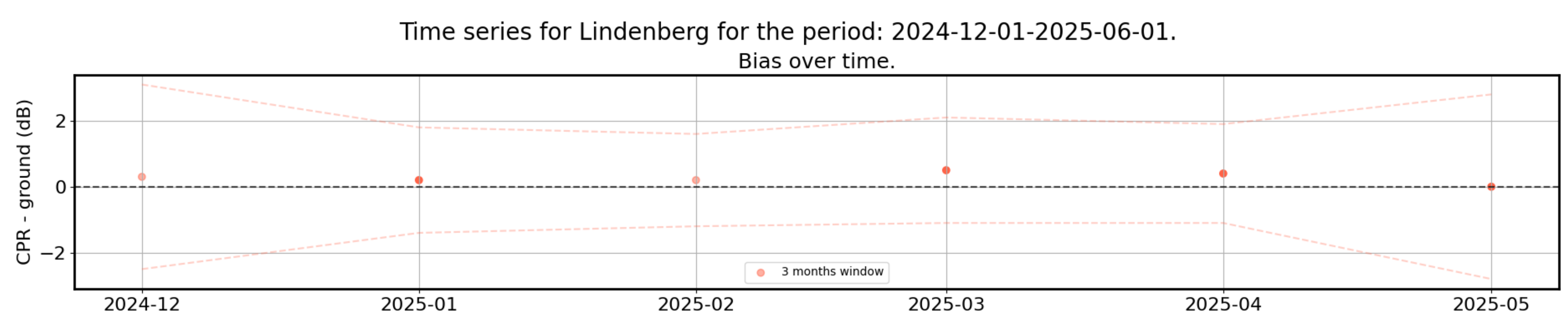
→ using a comparable method for all sites

- Fitting a Lorentzian model to the data to test this hypothesis
- Filtering based on the width, amplitude and distribution mean

Ze-validation example: Lindenberg, Germany, Baseline CA,



Time dependencies of the Zm-offsets, Baseline CA &CB, L2 filtering



CPR Doppler velocity validation:

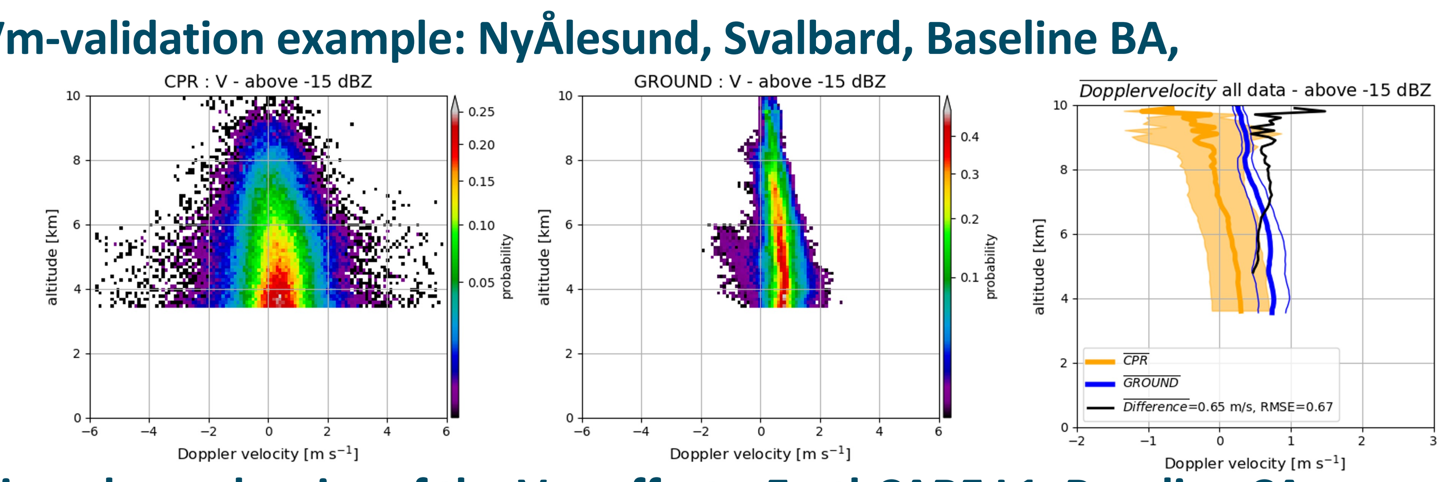
Data used for the statistical comparison (Protat, 2010 & 2011):

- Ground: zenith pointing ± 1 h around the overpass
- CPR: all overpasses within 100 km around the site → under investigation
- Filter EarthCARE L1 data: Vm only if Ze > -15 dBZ, site-specific high clipping to avoid influence of folding and orography.

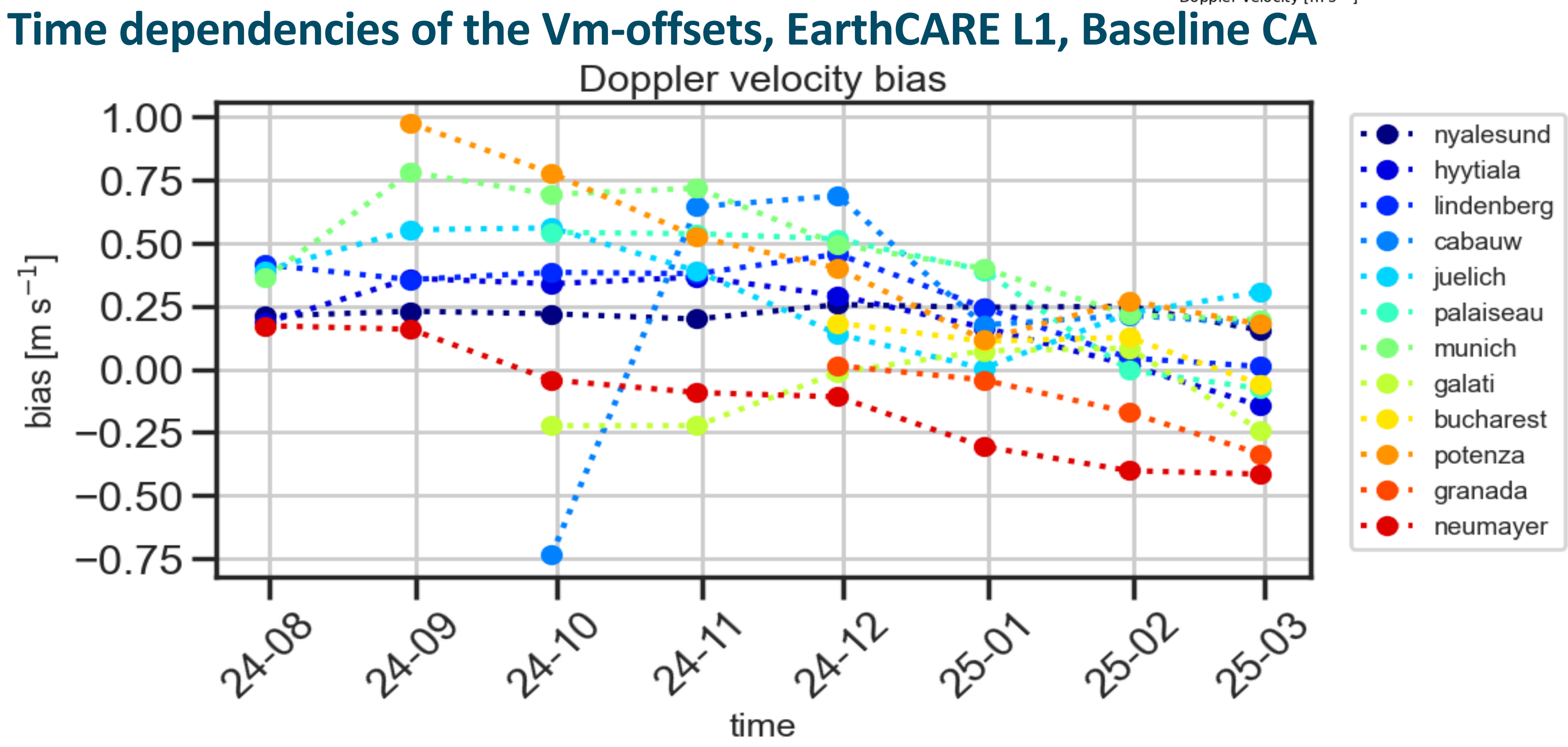
Methodology for calculating the mean offset of CPR and ground Vm-profiles

- Offset calculation based on the mean difference between the profiles yields robust results for several methods tested.

Vm-validation example: NyÅlesund, Svalbard, Baseline BA,



Time dependencies of the Vm-offsets, EarthCARE L1, Baseline CA



CPR antenna miss-pointing causes a Vm bias, which depends on the solar radiation hitting the antenna (Puigdomènech Treserras et al., 2025)

→ ACTRIS can validate pointing and its correction in EarthCARE L2 Doppler products over land.

Conclusion and Outlook Ze validation:

- Stable results over time using our method
- Make the Ze-validation operational at the ACTRIS data centre
- Publication of the Ze-validation method in preperation

Conclusion and Outlook Vm validation:

- Investigate the influence of the CPR sampling radius around the site
- Perform antenna miss-pointing validation
- Check antenna pointing of the ACTRIS radars → implement methodology

Literature:

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