



Findings on Level 1 product from ESA Level 2A algorithm verification

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McGill University*

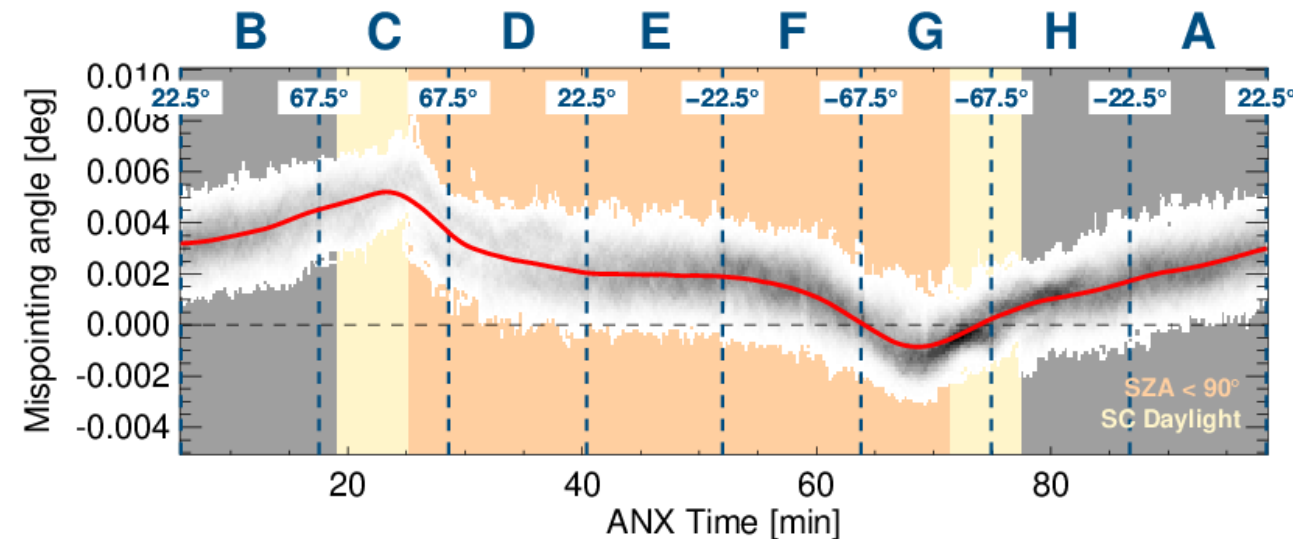
1st ESA-JAXA EarthCARE In-Orbit Validation Workshop
14 – 17 January 2025 | VIRTUAL EVENT



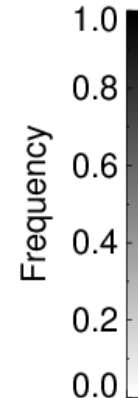
EarthCARE CPR antenna mispointing

Derived from clear-sky surface Doppler measurements over the sea surface (free of ice) and snow-covered land

Mispointing trends influenced by solar illumination cycles and thermoelastic distortions on the antenna



Satellite line-of-sight velocity contamination
 $0.01^\circ (7.6\text{km/s}) \rightarrow 1.32\text{m/s}$

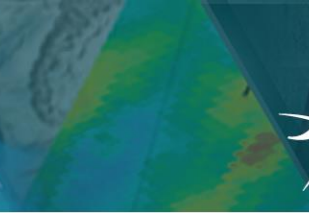
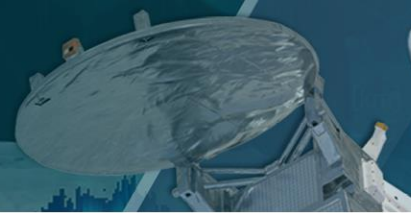


EarthCARE after entering daylight



EarthCARE a few moments before exiting daylight

Puigdomènech et al., 2025

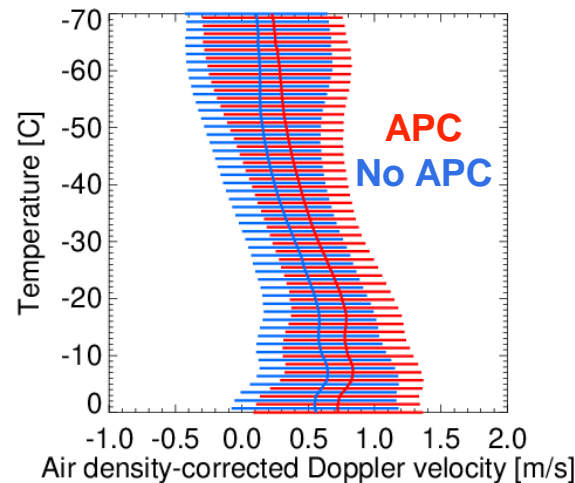


EarthCARE CPR antenna mispointing

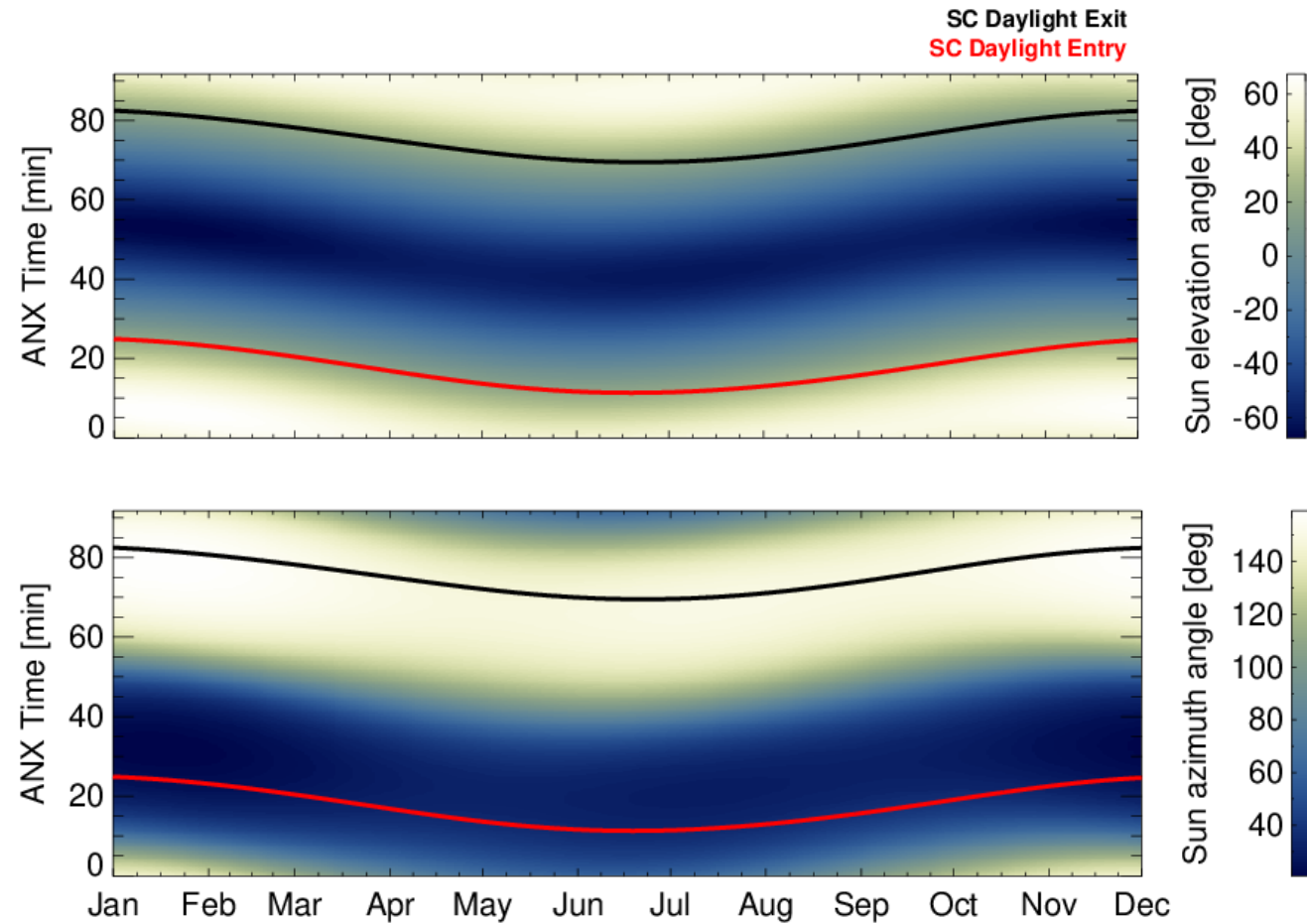
The antenna mispointing pattern is affected by solar activity and seasonal affects (daylight entry and exit times changing as a function of the day of the year) is being continuously monitored

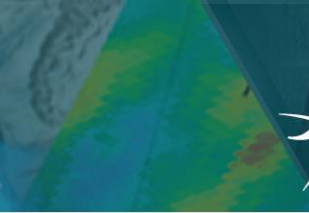
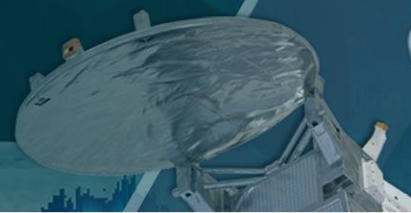
The pointing correct Doppler velocities will be available in the L2 products and possibly in the L1b as well

Effects on Ice Clouds



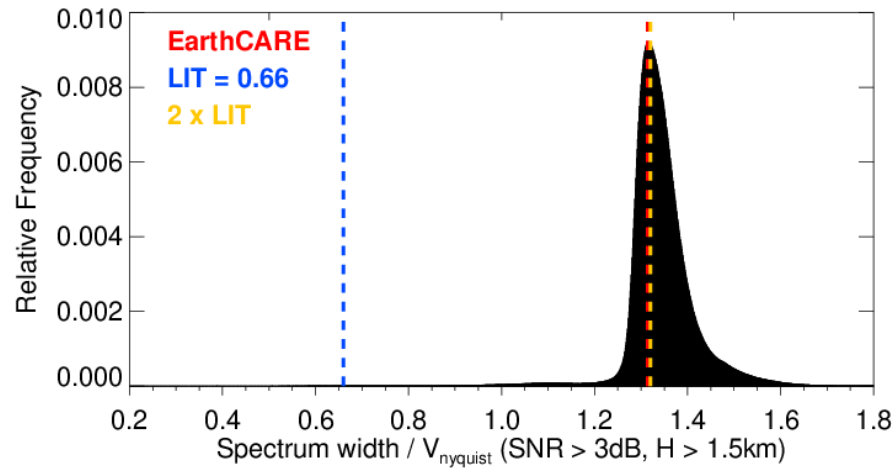
Puigdomènech et al., 2025



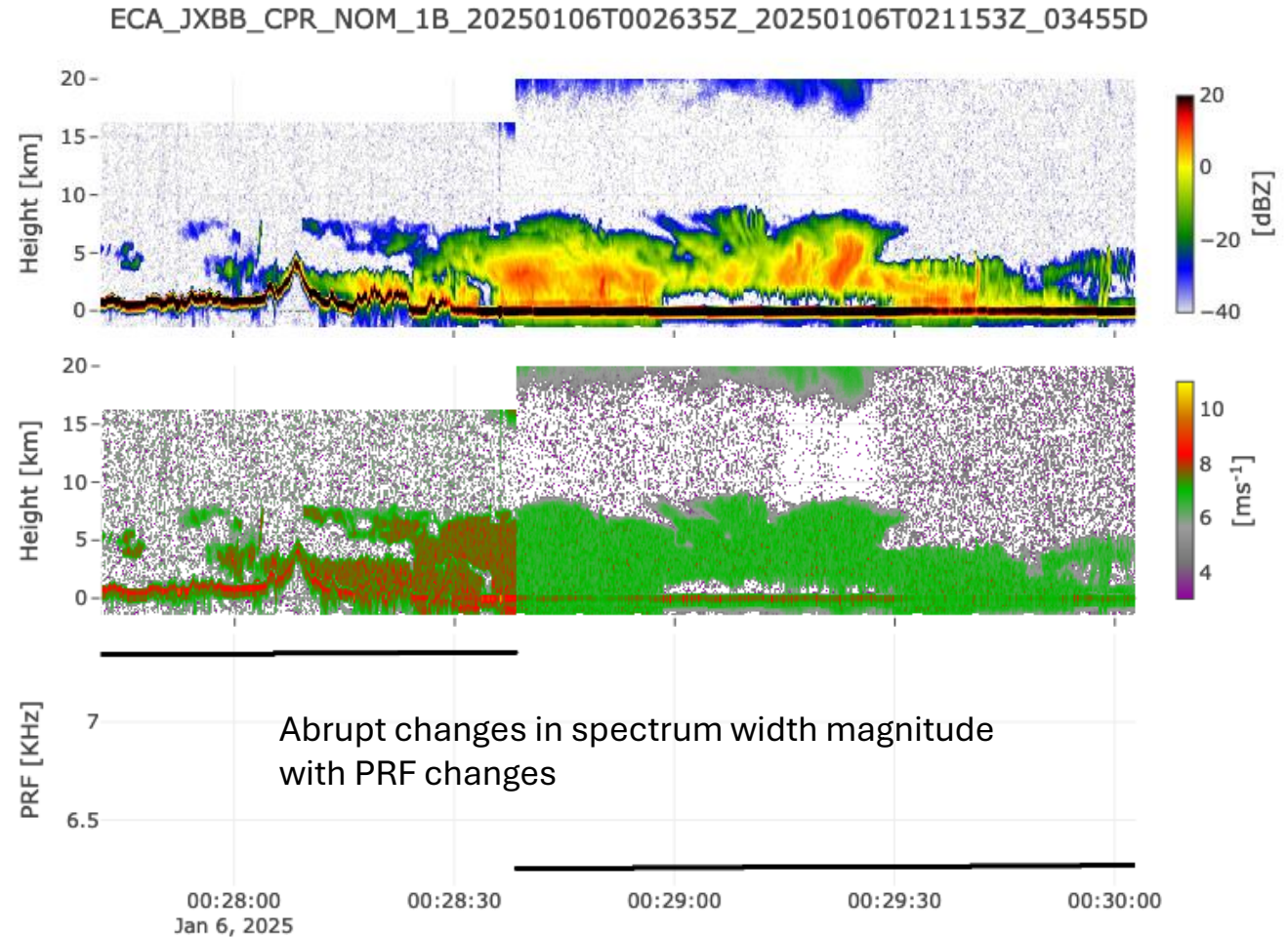


Spectrum Width

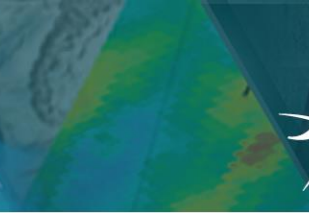
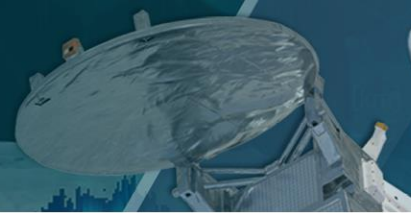
In the L1b files the spectrum width magnitudes look significantly overestimated and they change as a function of the CPR Pulse Repetition Frequency (PRF)



PDF of Spectrum Width normalized by Nyquist velocity
EarthCARE mean value
LIT = value in literature (UBF, 7kHz)
2 x LIT



Abrupt changes in spectrum width magnitude with PRF changes

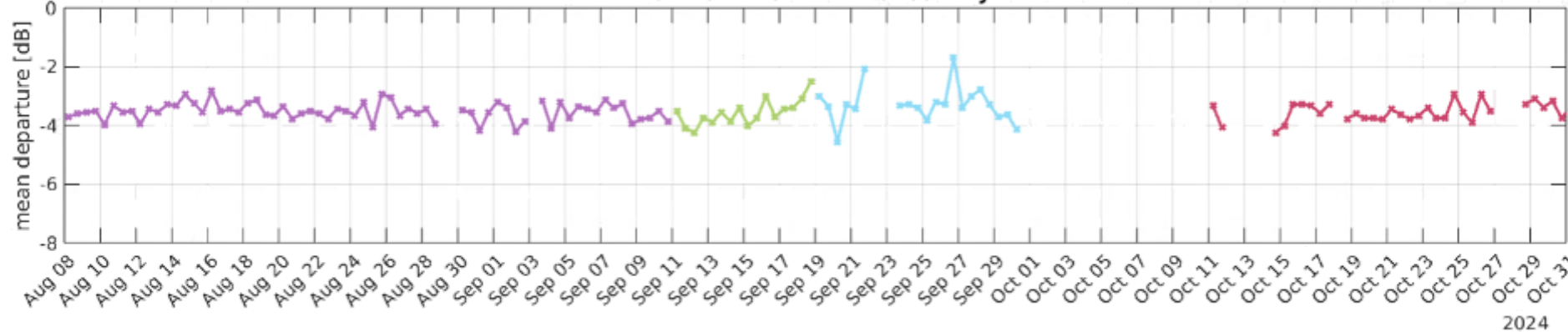


Power calibration

ECMWF analysis - relative calibration with CloudSat

Conditional on:

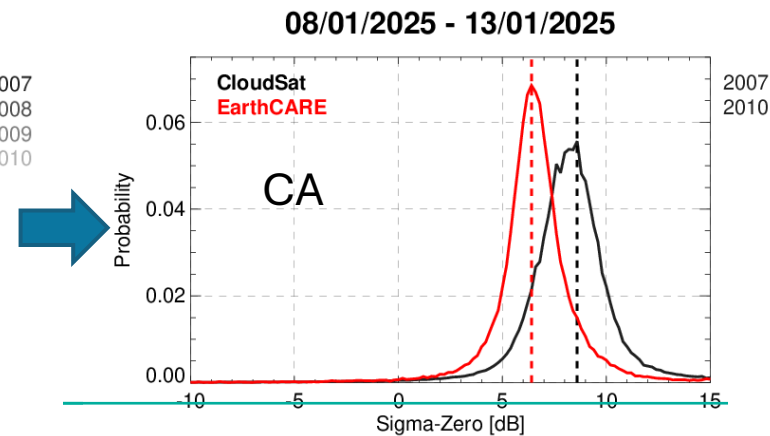
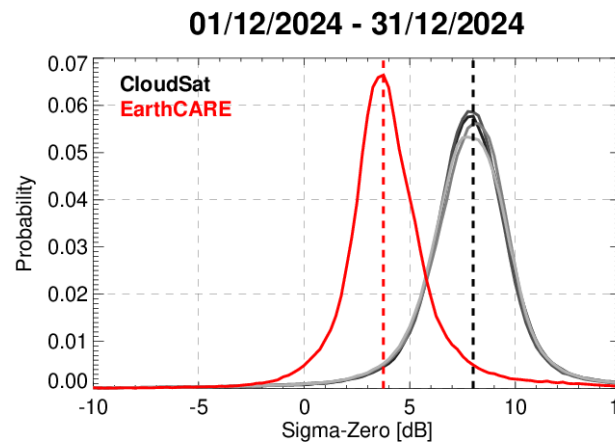
model radar reflectivity > -30 dBZ; Obs radar reflectivity > -30 dBZ; model temperature < 260 K; altitude > 3km; Max(Z) < 0 dBZ

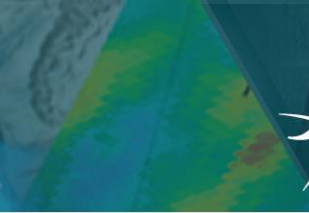
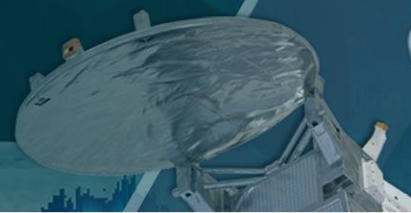


* Mark Fielding (ECMWF)

CloudSat and EarthCARE CPR sigma-zero (σ_0) comparison over the Southern Atlantic

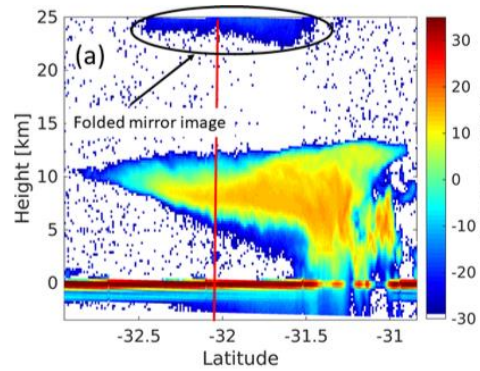
Ascending and descending, not filtered for surface winds, sea surface temperature or atmospheric loss



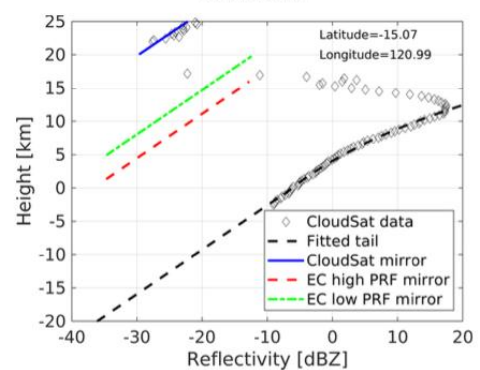
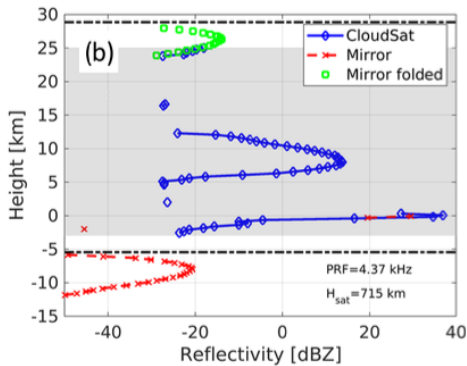
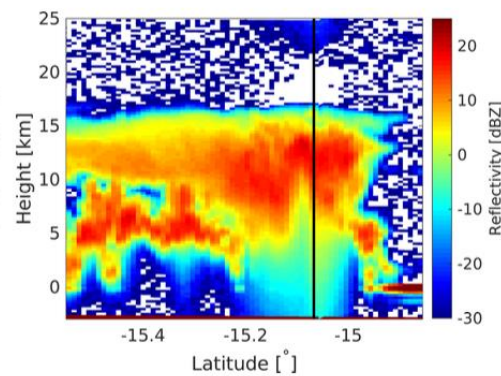


Second-trip echoes

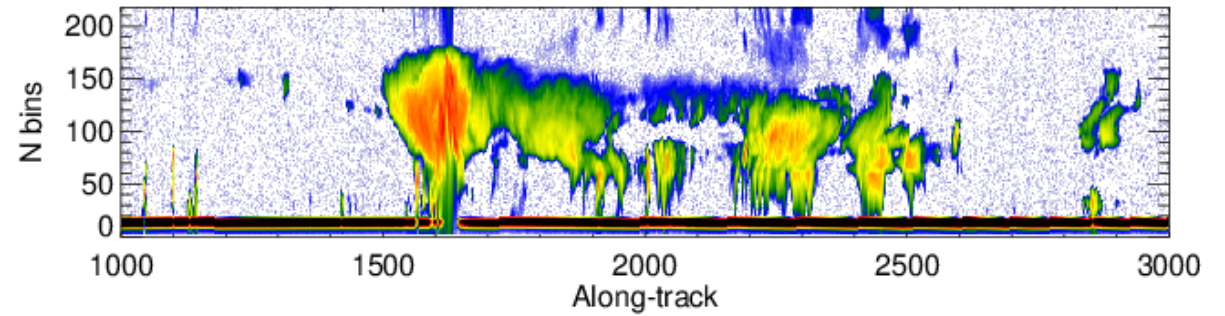
Mirror images



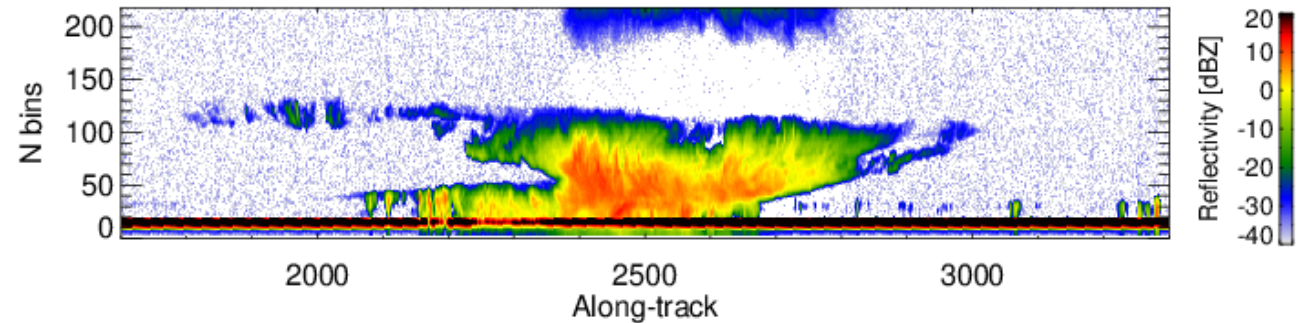
Multiple scattering tails



ECA_EXAA_CPR_FMR_2A_20240811T080501Z_20240812T005646Z_01157E

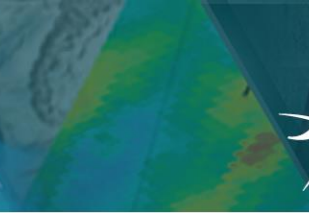
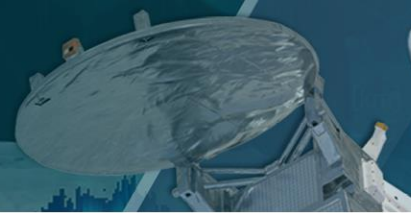


ECA_EXAA_CPR_FMR_2A_20240822T094026Z_20240822T105959Z_01329F



Impact of second-trip echoes for space-borne high-pulse-repetition-frequency nadir-looking W-band cloud radars

Alessandro Battaglia



Noise Floor

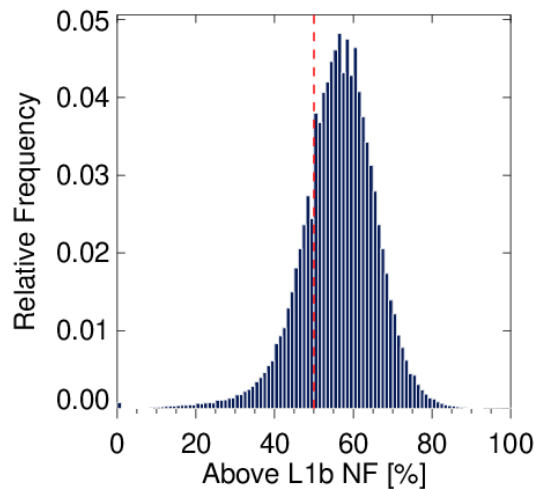
- Underestimated
- Affected by second-trip echoes
- Reported only every 14 profiles



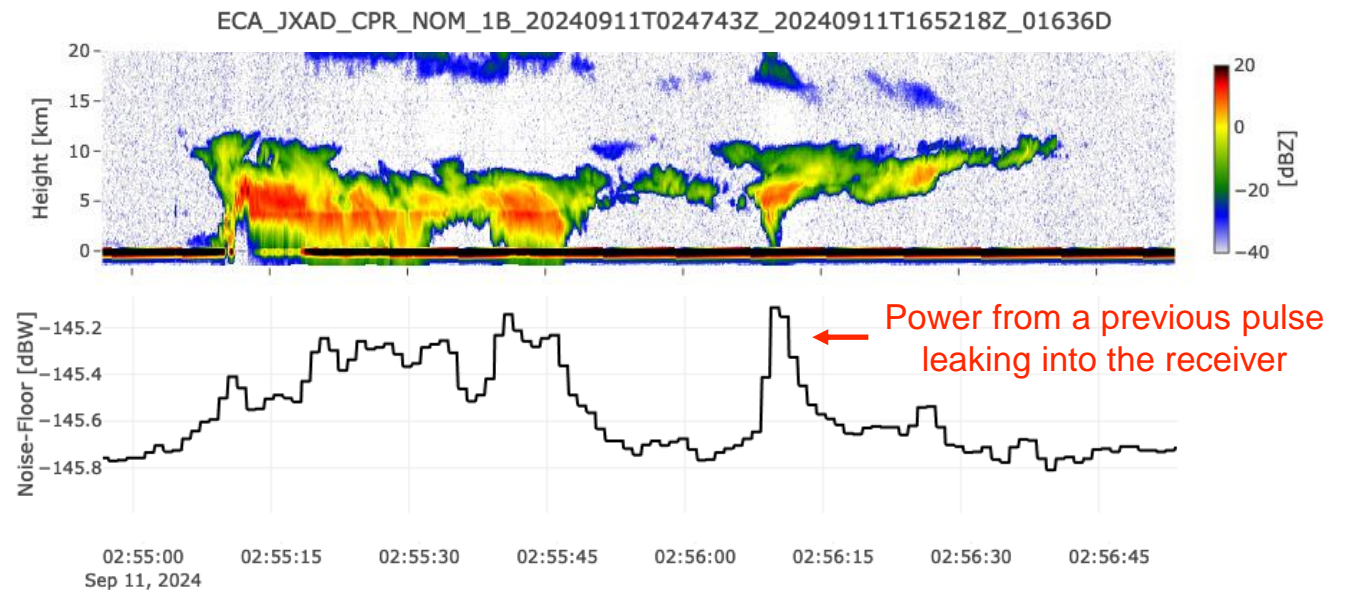
Impacts

L2a Cloud Mask

L2a Brightness temperatures



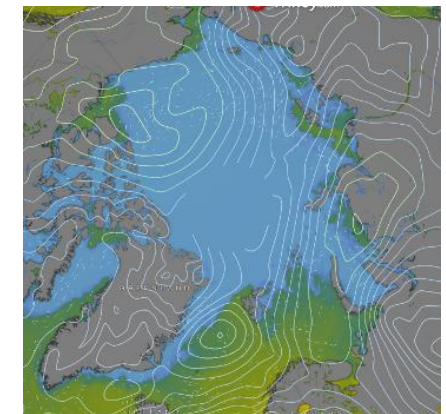
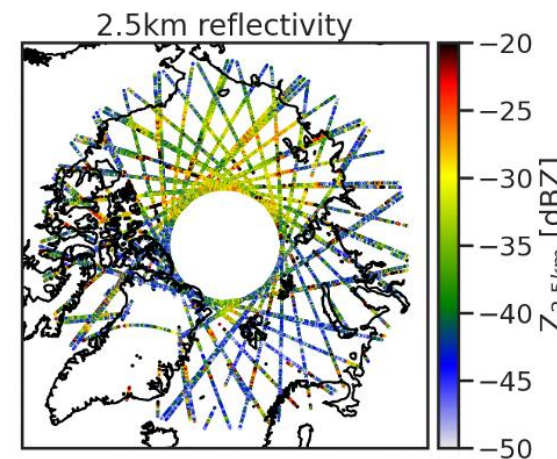
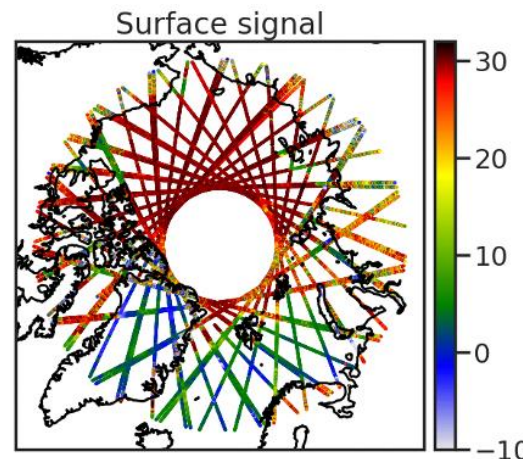
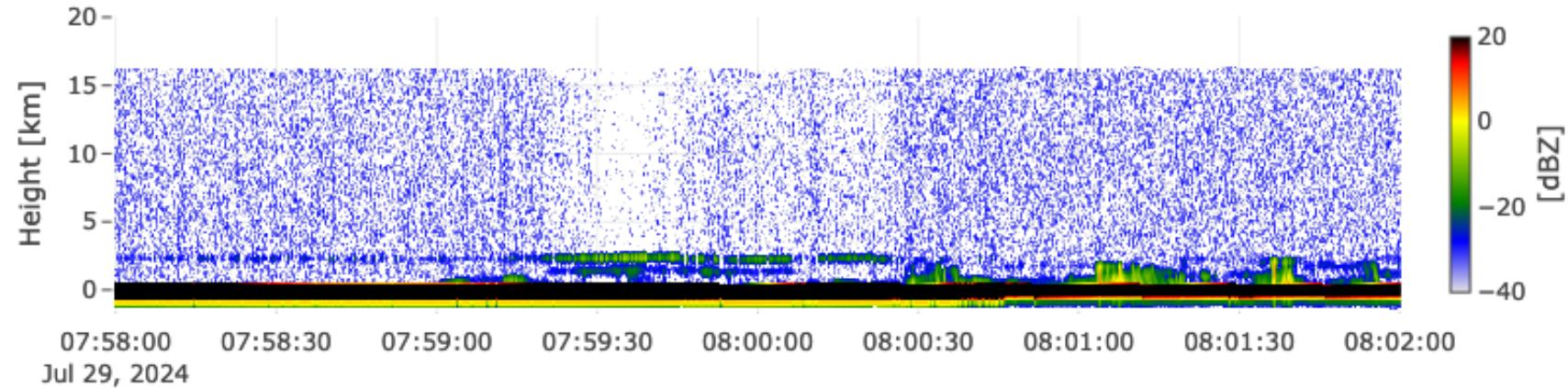
Percentage of values above the L1b NF in clear-sky conditions





Near-stationary 2.5km artifacts

The signal is strongly correlated with the presence of very high Earth's surface radar signal, normalized surface cross section ($\sigma_0 > \sim 23\text{dB}$) that saturate the CPR receiver. These artifacts are frequently observed at northern high latitudes above 70°



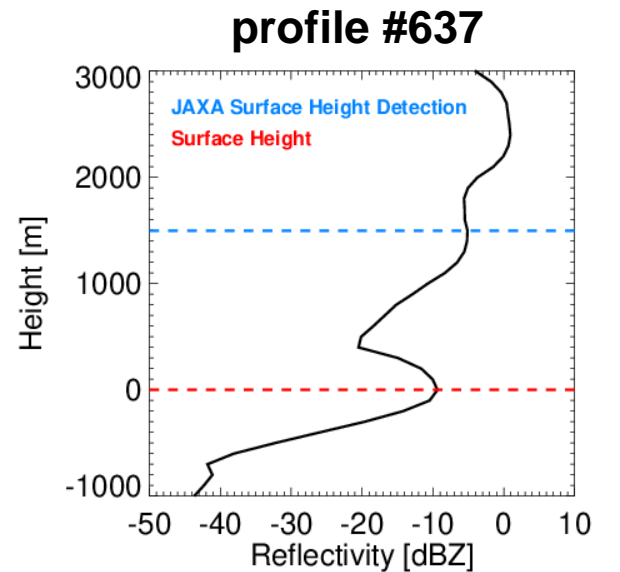
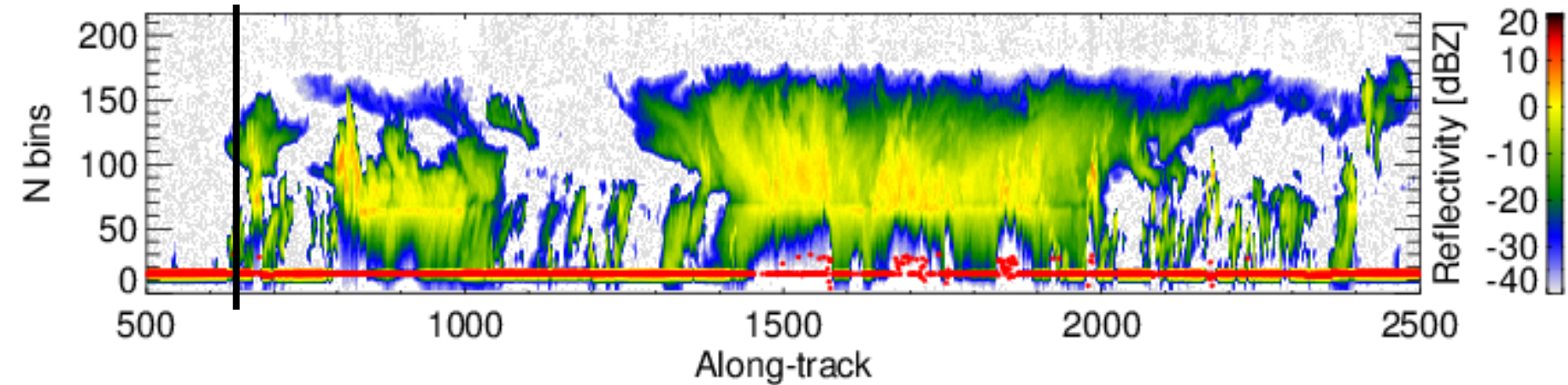
* Shannon Mason (ECMWF)



Surface Height Detection

The L1b surface height detection, defined by the C-NOM variable *surfaceBinNumber*, is sometimes incorrect in profiles with strong attenuation.

ECA_JXAD_CPR_NOM_1B_20240911T043201Z_20240911T165730Z_01637E



McGill EarthCARE Imagery Portal

<https://web.meteo.mcgill.ca/EarthCARE>

Earth Cloud Aerosol and Radiation Explorer (EarthCARE)

Home ATLID CPR About

Earth Cloud Aerosol and Radiation Explorer (EarthCARE)

Welcome to the EarthCARE Imagery Portal — your gateway to exploring and visualizing the latest data from the EarthCARE satellite, a joint mission by the European Space Agency (ESA) and the Japan Aerospace Exploration Agency (JAXA)

Resources

- ESA's EarthCARE Information and Media
- ESA's EarthCARE Research and Data Access
- JAXA's EarthCARE Special Site

Orbit Tracking

- TLE

Live Location

Imagery

- Atmospheric Lidar (ATLID)
 - ATLID Level 1b
 - ATLID Geolocation
- Cloud Profiling Radar (CPR)
 - CPR Level 1b
 - CPR Antenna Pointing Characterization
 - CPR Geolocation

The Mission

Equipped with four instruments, the Earth Cloud Aerosol and Radiation Explorer (EarthCARE) satellite mission has been designed to make a range of different measurements that together will shed new light on the role that clouds and aerosols play in regulating Earth's climate.

Earth Cloud Aerosol and Radiation Explorer (EarthCARE)

Home ATLID CPR About

CPR Level 1b

Date: 2025/01/09 N Orbits: 2 Size: Large 0350

Time: 09:55 09:56 09:57 09:58 09:59

ECA_JXCA_CPR_NOM_1B_20250109T094838Z_20250109T115531Z_035088

A web-based platform to explore and visualize EarthCARE data. It provides interactive access to near real-time data, making global measurements easily accessible to all