Monitoring EarthCARE CPR Data Quality and Calibration Using the ECMWF Operational Forecast System

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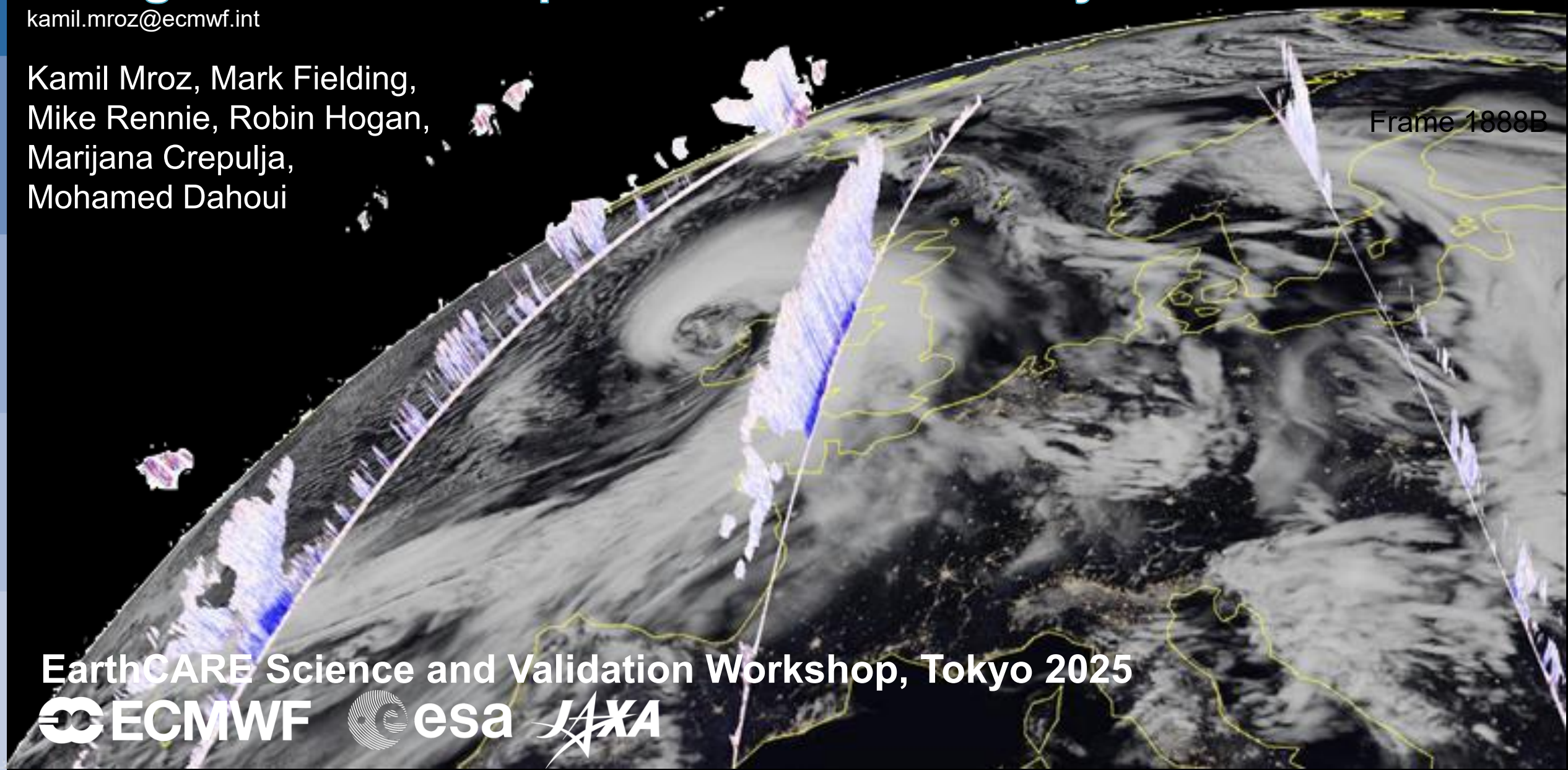
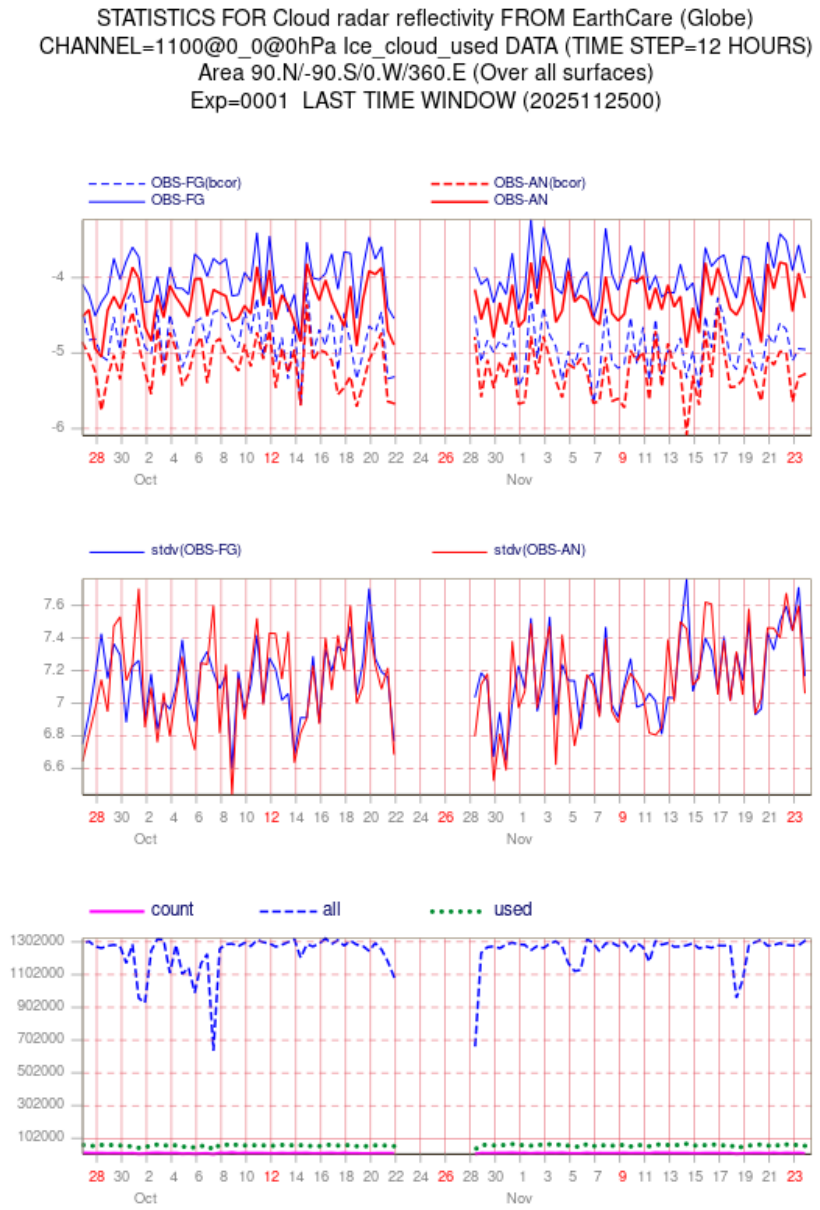


EarthCARE Science and Validation Workshop, Tokyo 2025

ECMWF esa JAXA

What are the benefits of validating CPR against NWP?

- **Rapid detection** of instrument issues (removes most of day-to-day variability)
- **Continuous evaluation** in space and time
- Platform for **comparison with other instruments**, including historical missions
- Precursor for **data assimilation**



https://charts.ecmwf.int/catalogue/packages/obstat/products/hist_ECare_CRREF_v3

EarthCARE monitoring cycle using global NWP

L1B radarReflectivityFactor

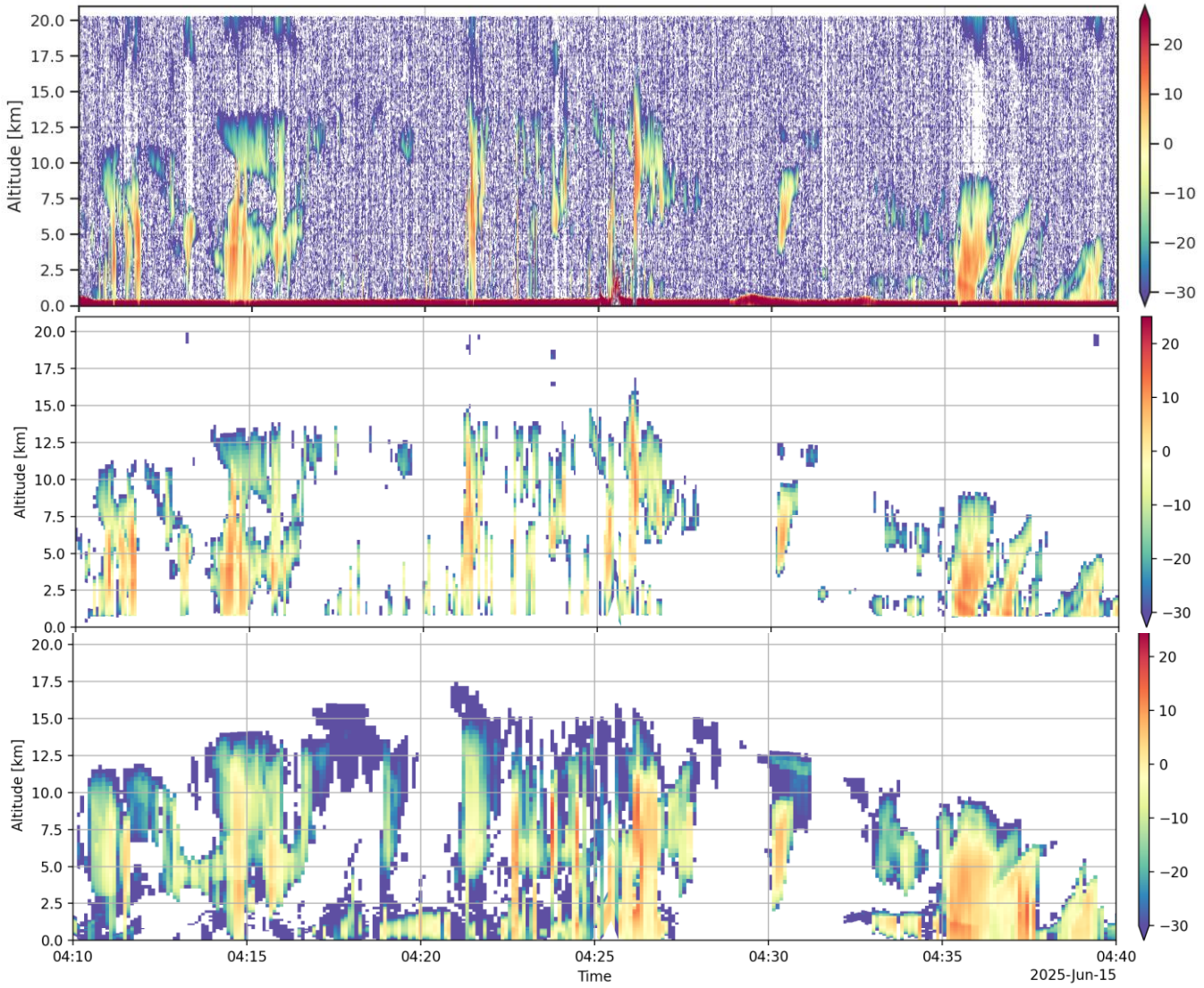
Data Screening

re-gridded ‘superob’

IFS forecast

ZmVar forward model

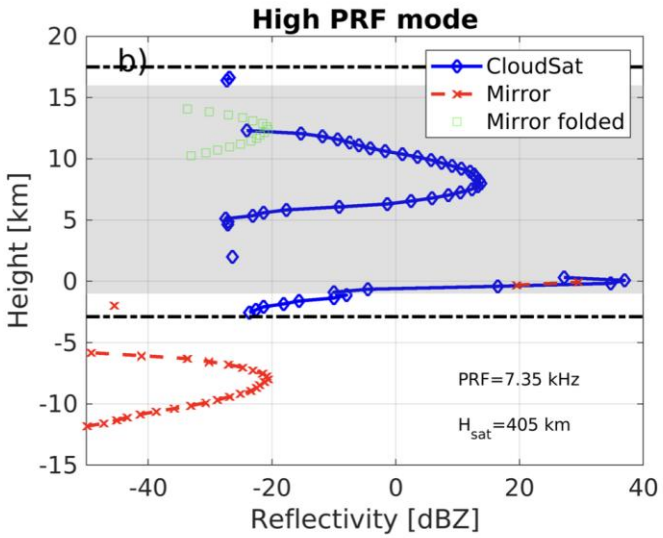
4D-Var data assimilation

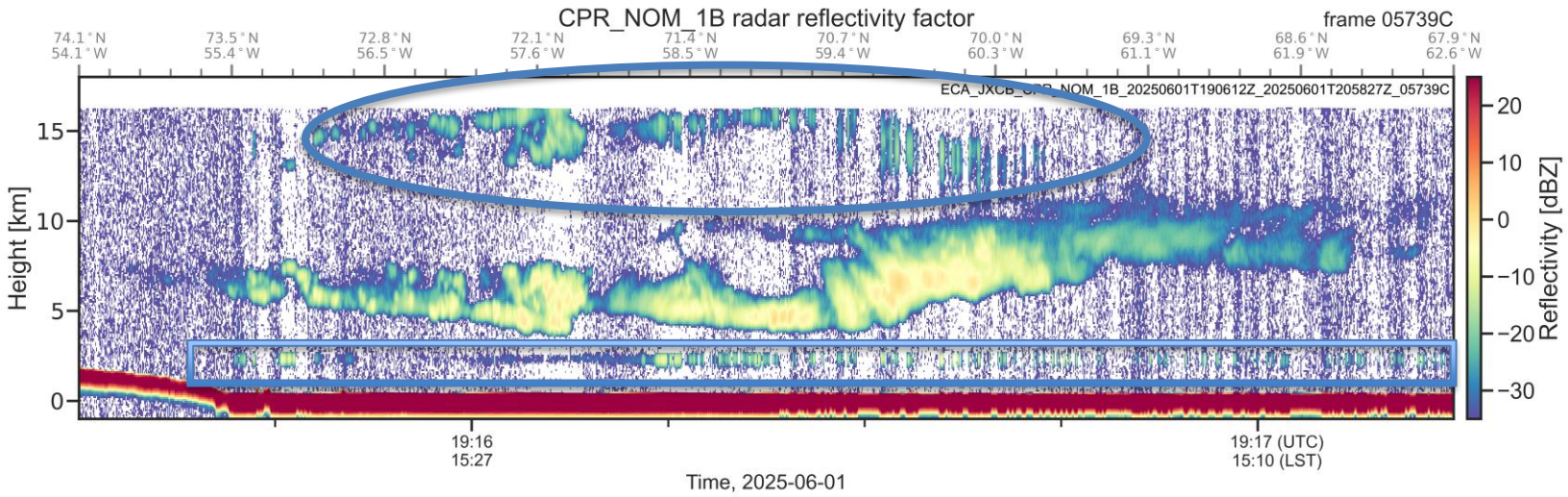


Second trip echo removal

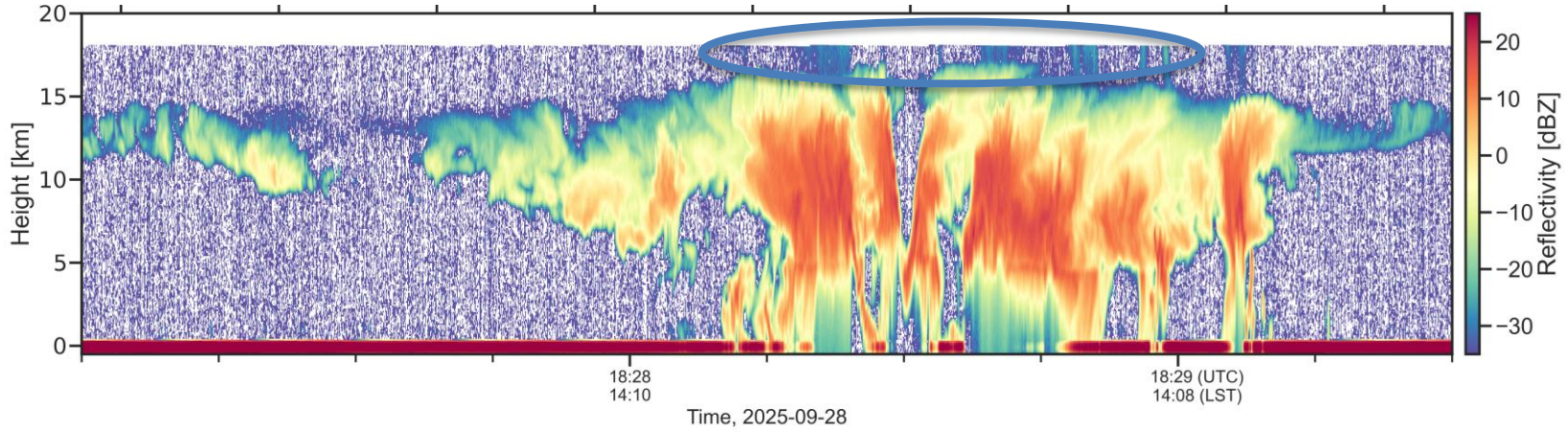
1) Mirror images of clouds

As predicted by Battaglia 2021





3) Mirror image of the satellite



Hurricane Humberto

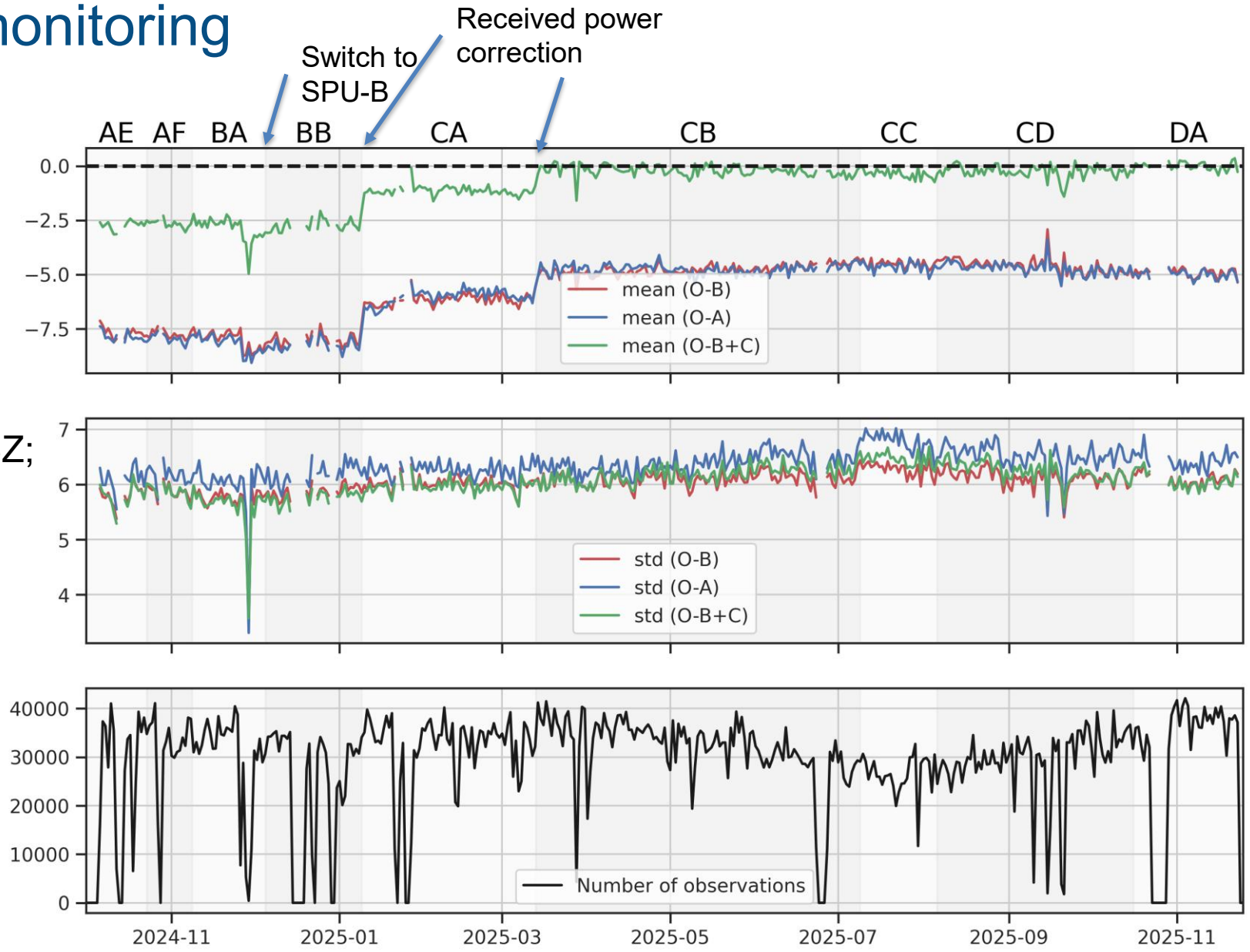
2) Multiple Scattering tails

CPR NRT quality monitoring

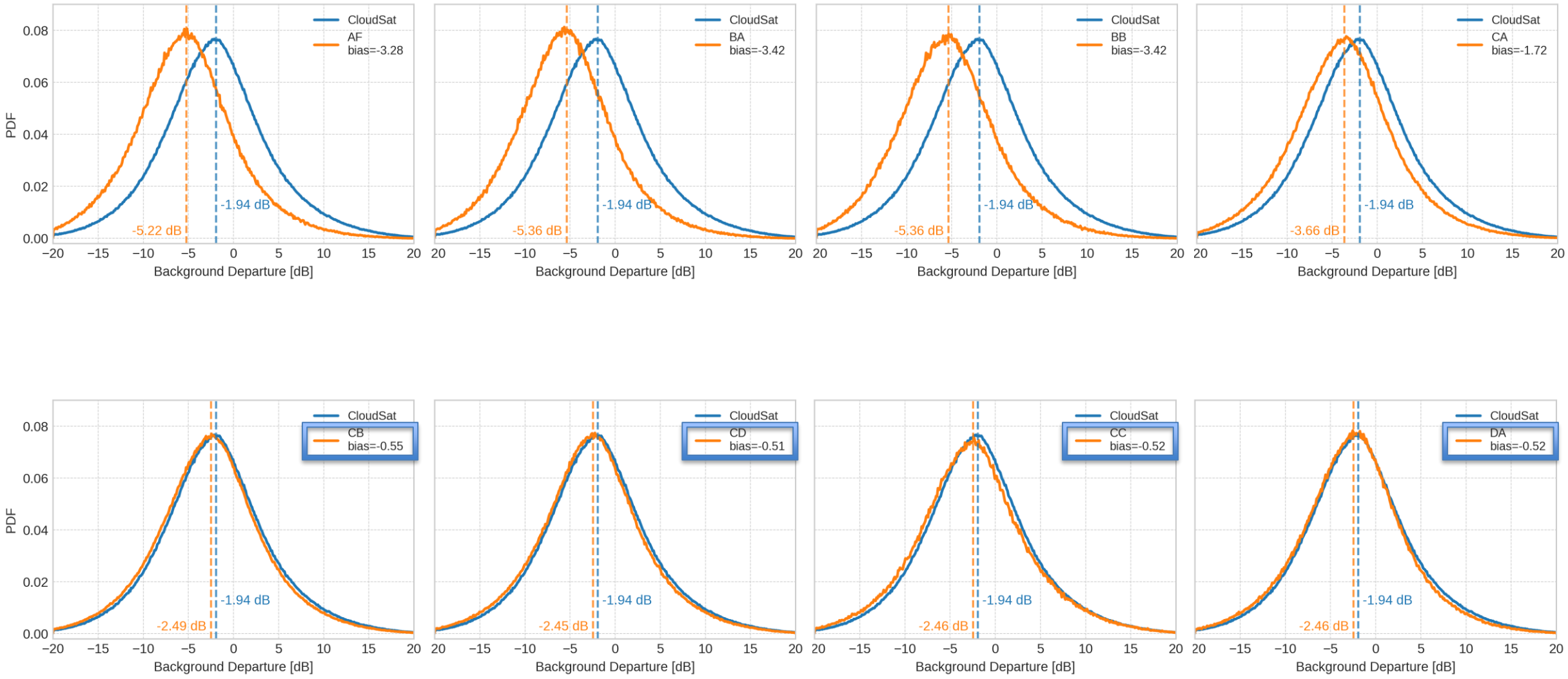
Global 12-hour mean FG dep [dB]

model radar reflectivity > -20 dBZ;
Obs radar reflectivity > -20 dBZ;
model temperature < 260 K;
altitude > 3km

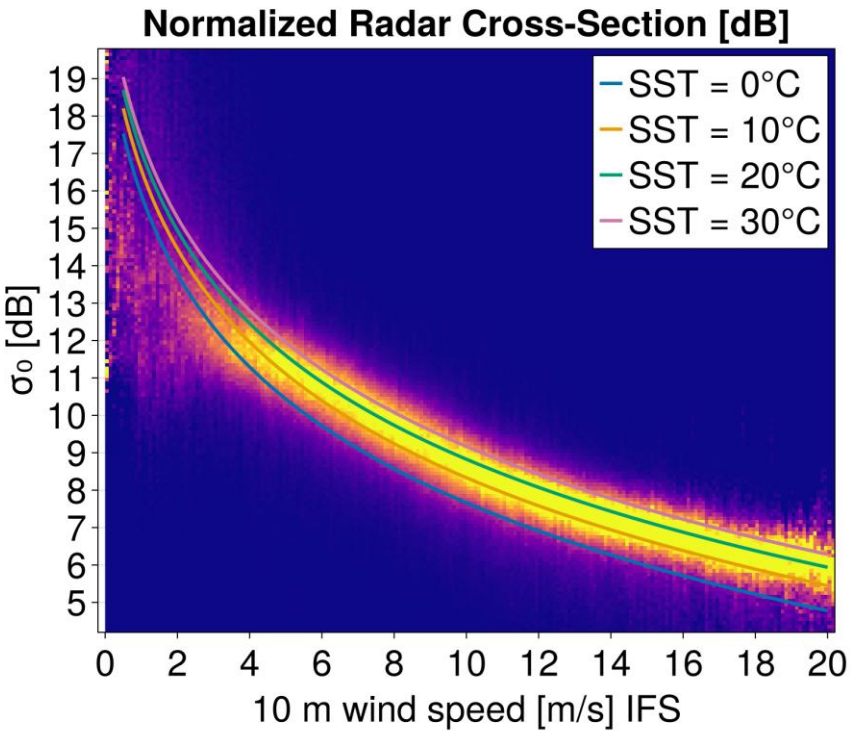
Number of obs. passing screening



CPR quantifying relative calibration with CloudSat



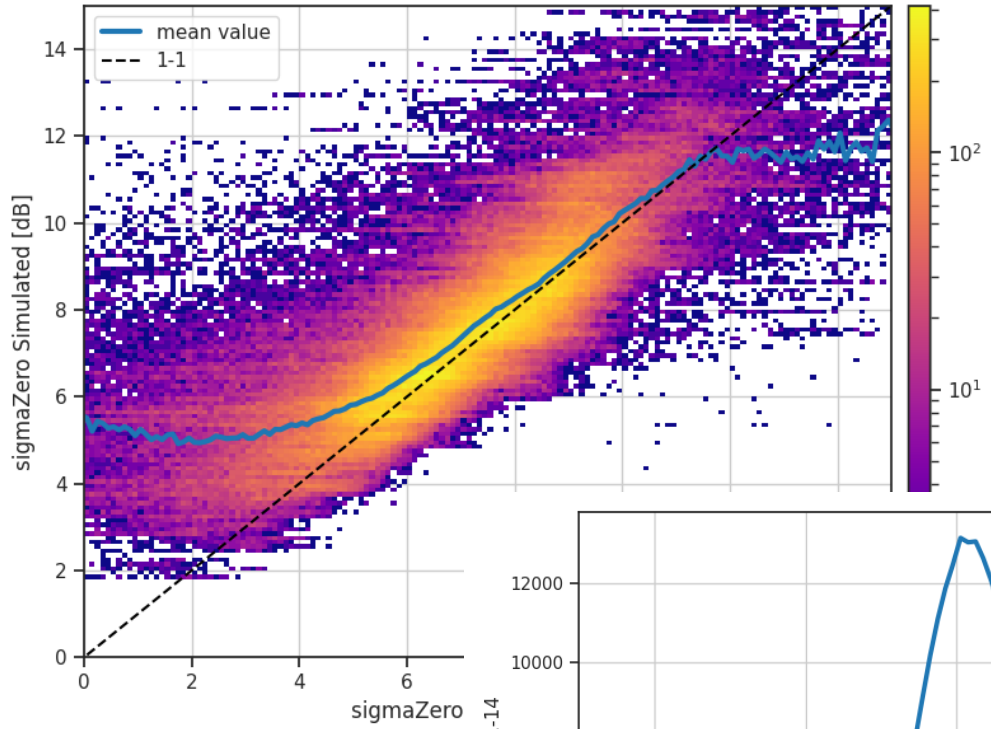
CPR NRT quality monitoring – surface return

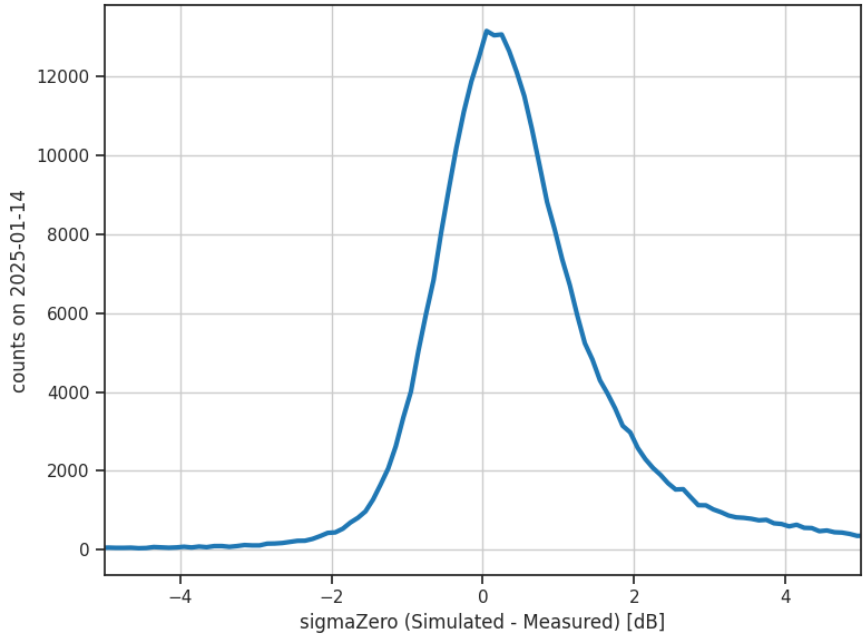


Model σ_0 tuned to ECMWF SST and wind forecast based on AMSR-E obs.

Model of Li et al. (2008)

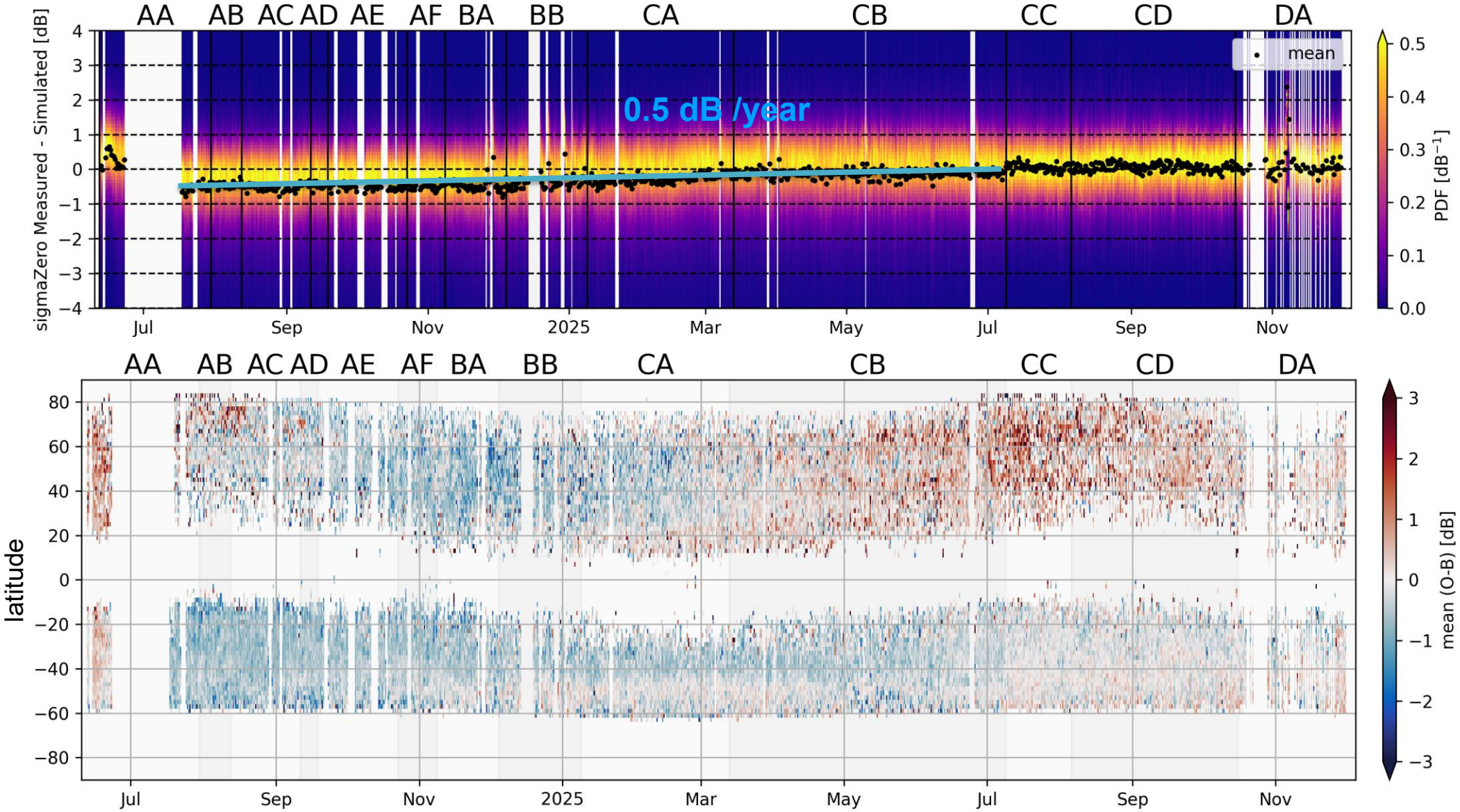
SST > 5°C
PIA < 2dB





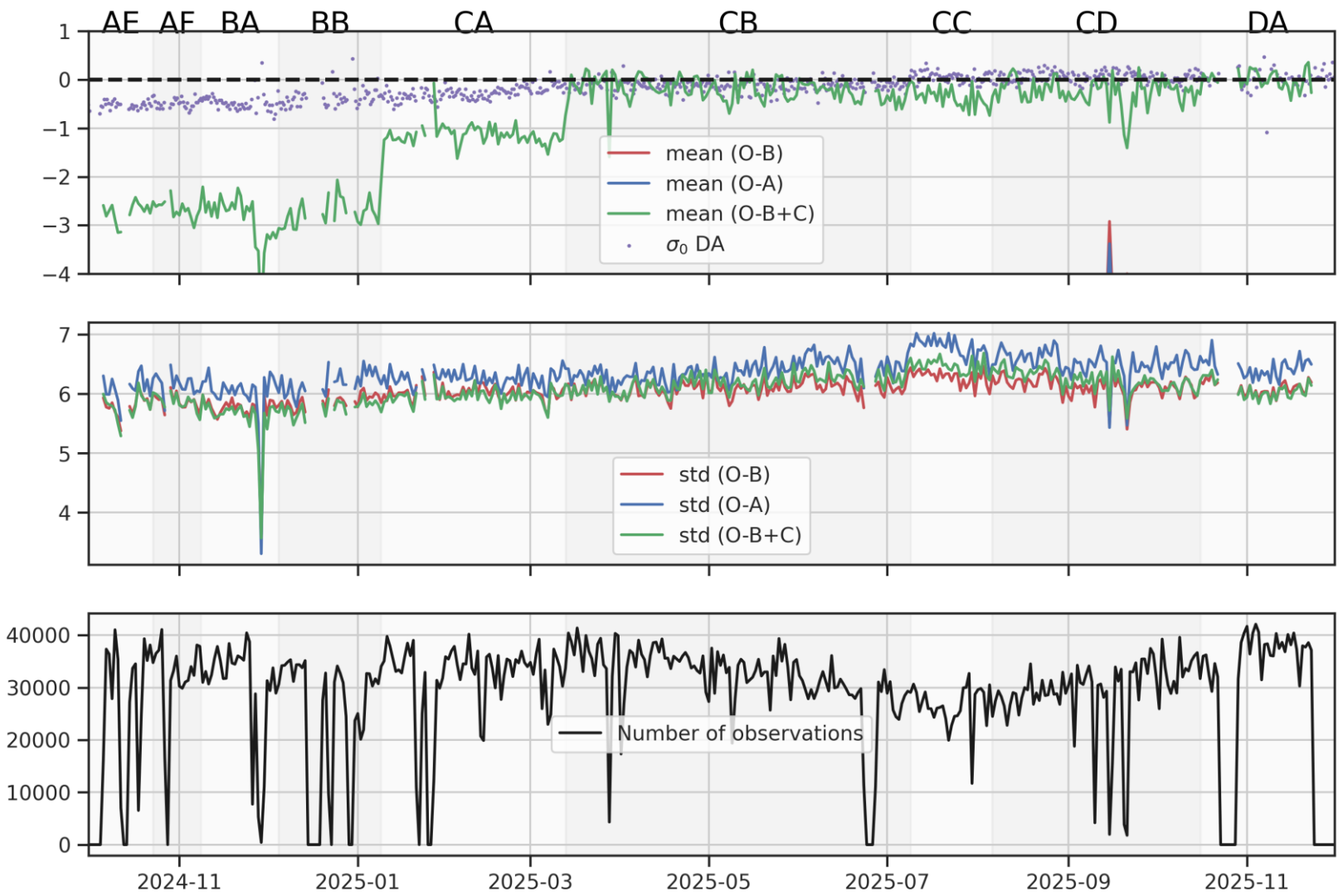
CPR NRT quality monitoring – surface return

Baseline DA



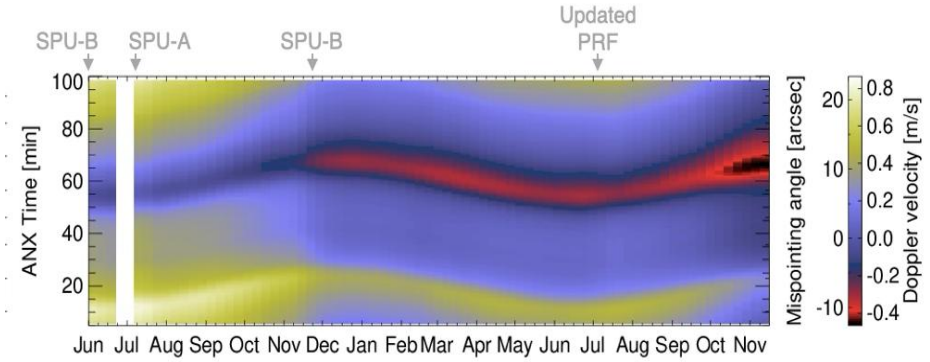
CPR NRT quality monitoring – surface return

Excellent agreement
between cloud- and surface-based calibration

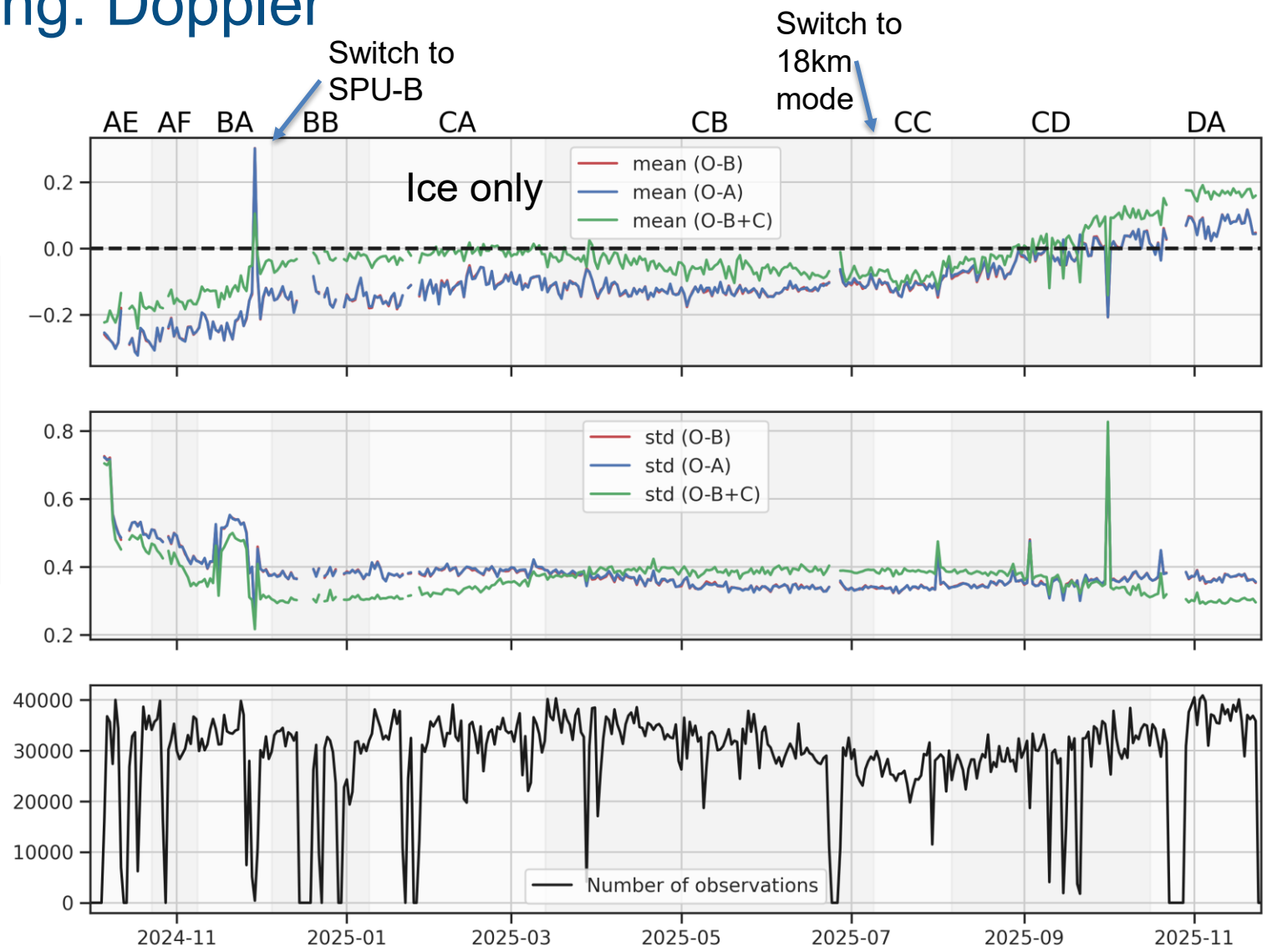


CPR NRT quality monitoring: Doppler

Thanks: Bernat



The CPR antenna mispointing trends suggest that all Doppler velocity measurements prior to December 2024 were influenced by an extra source of bias, affecting not only low echo-level values but also the entire range, including the surface return (which typically exceeds 30 dBZ)



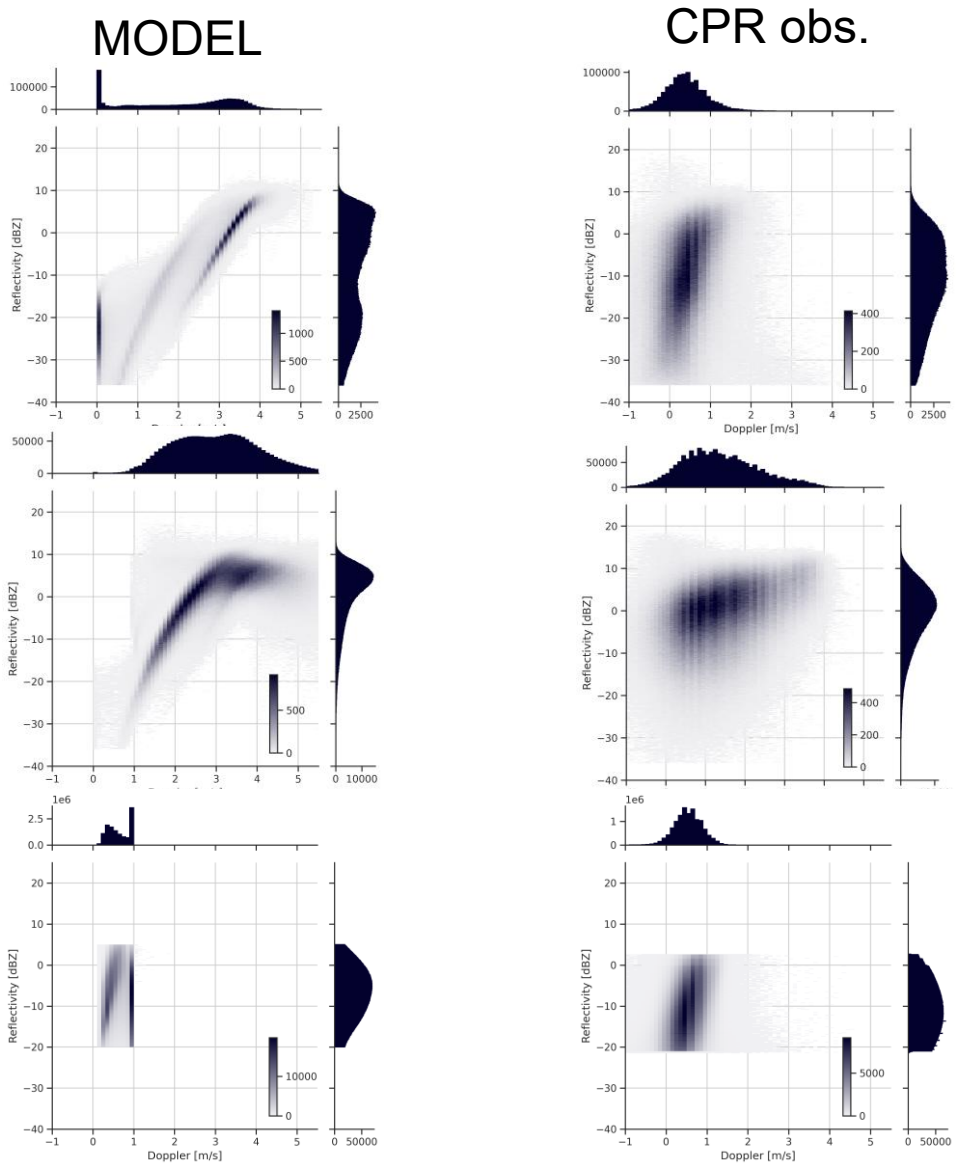
Key points

Using EarthCARE to improve the representation of microphysics in the IFS

- CPR L1B NRT quality monitoring is live:

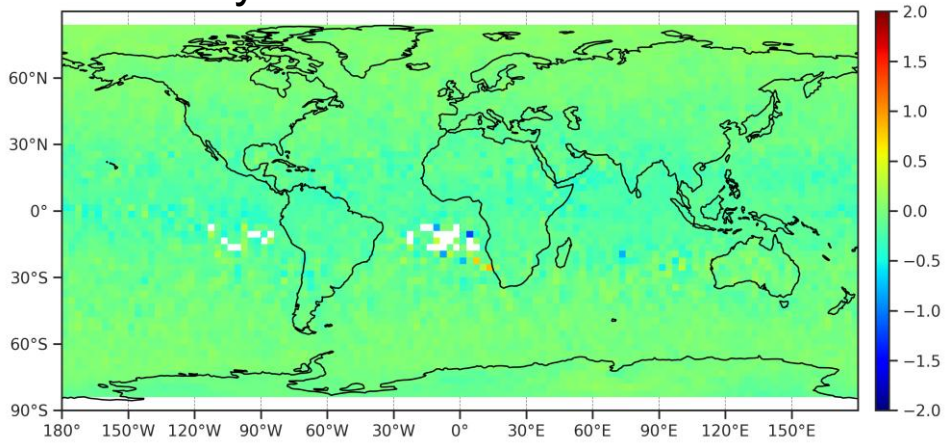
  https://charts.ecmwf.int/catalogue/packages/obstat/products/hist_ECare_CRREF_v3

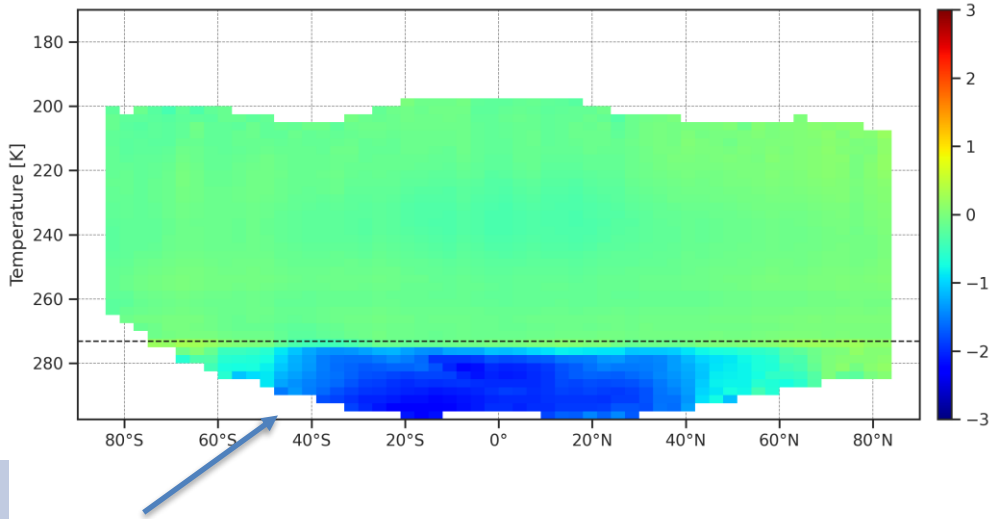
- Quality and stability of L1B CPR radar reflectivity observations are excellent when compared to ECMWF model.
- CPR radar reflectivity shows strong consistency with CloudSat - similar height and regional biases compared to model.
- Radar calibration contains offset compared to CloudSat. Strong agreement in AC-BB 4 dB correction required, 2 dB from CA, 0.5 dB from CB onwards
- Surface return can be use for more precise radar reflectivity monitoring
- Doppler velocity corrected for misspointing is in better agreement with modeled values than



CPR NRT quality monitoring: Doppler

Ice only





Warm rain bias