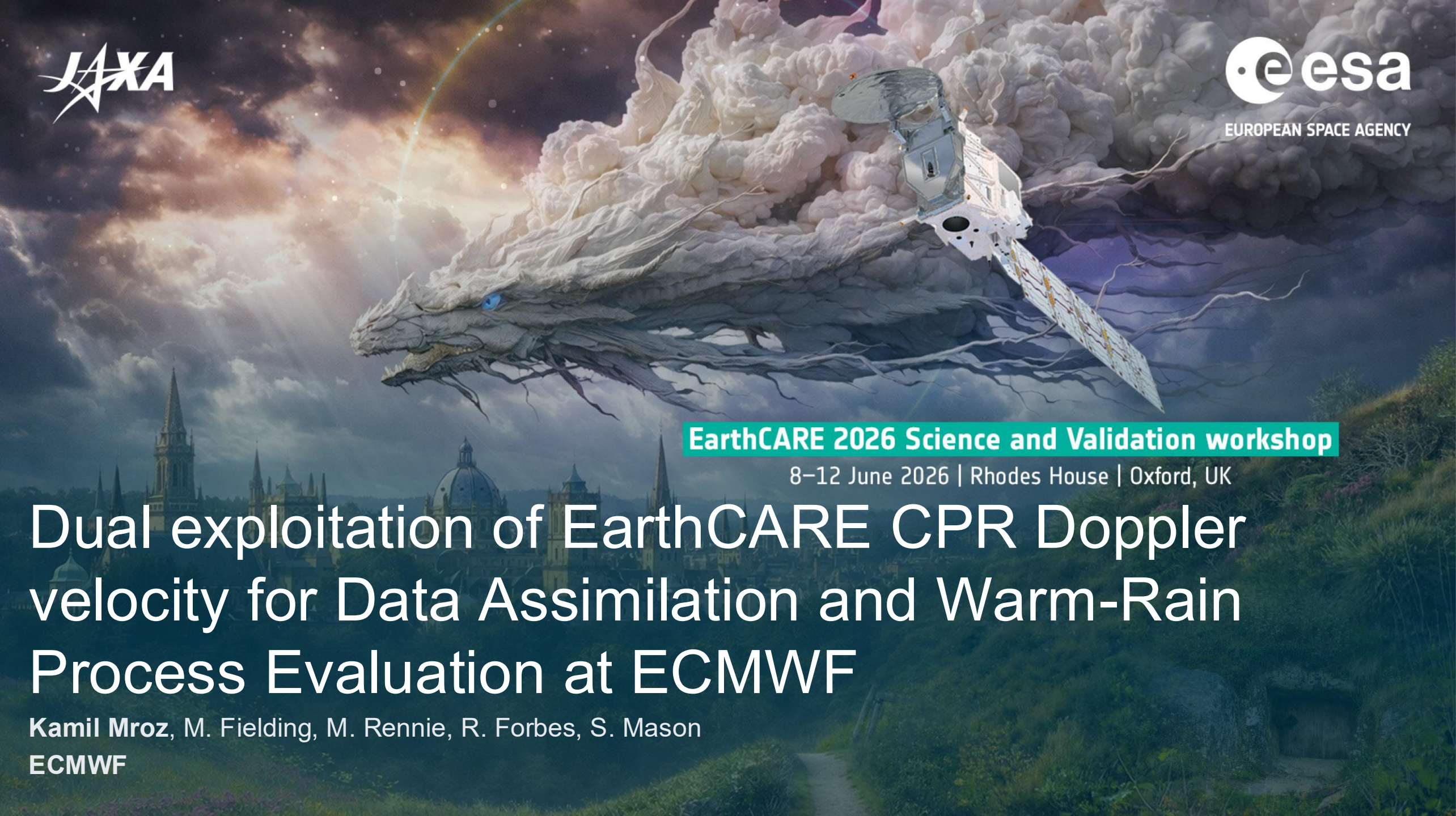


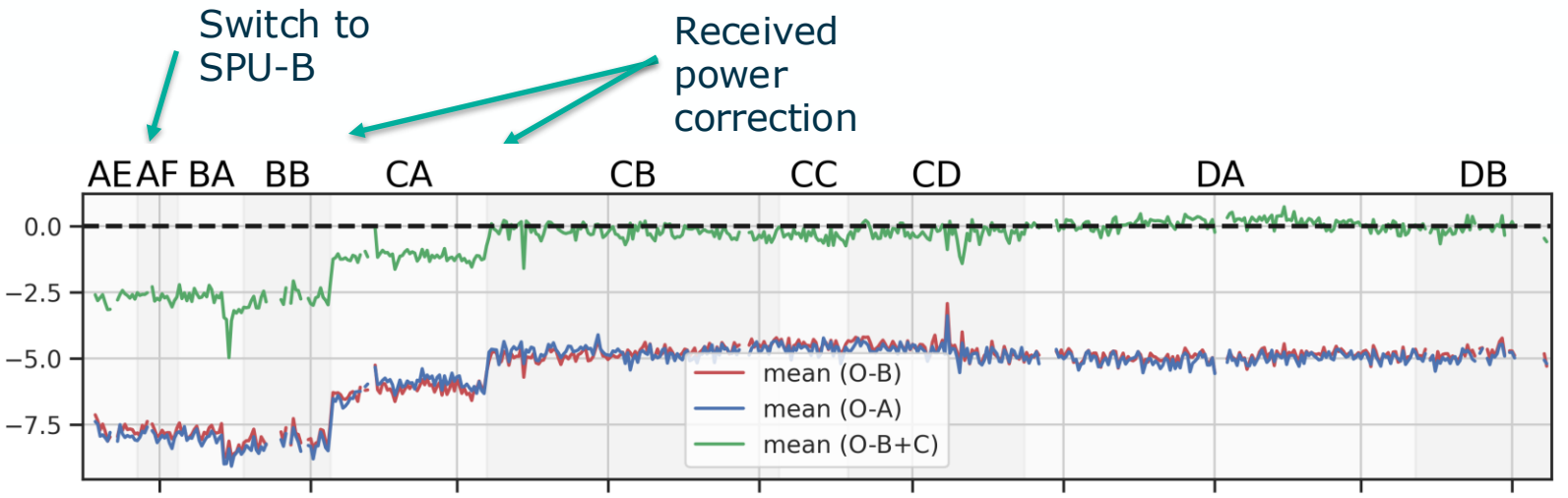
Dual exploitation of EarthCARE CPR Doppler velocity for Data Assimilation and Warm-Rain Process Evaluation at ECMWF

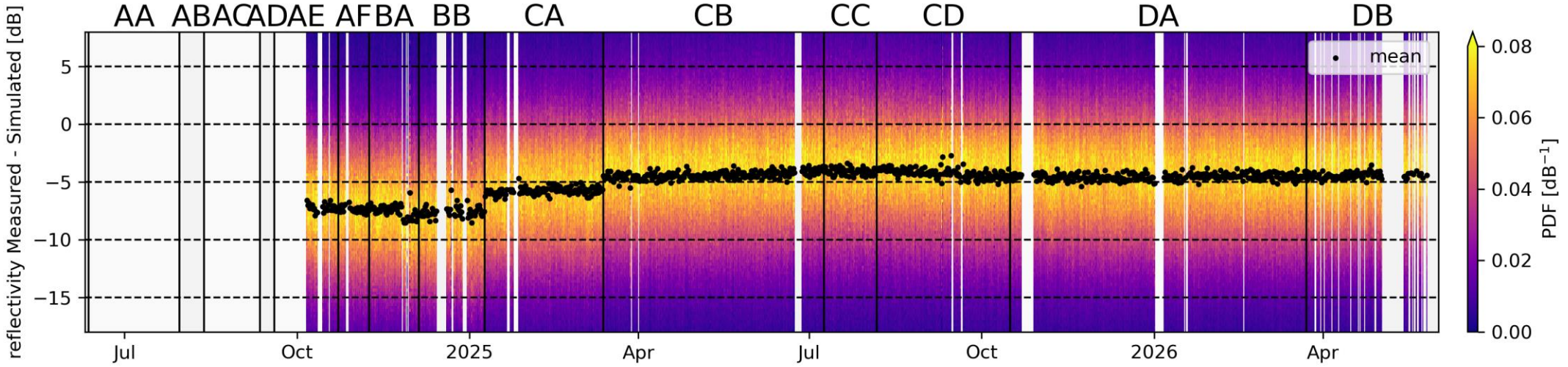
Kamil Mroz, M. Fielding, M. Rennie, R. Forbes, S. Mason

ECMWF

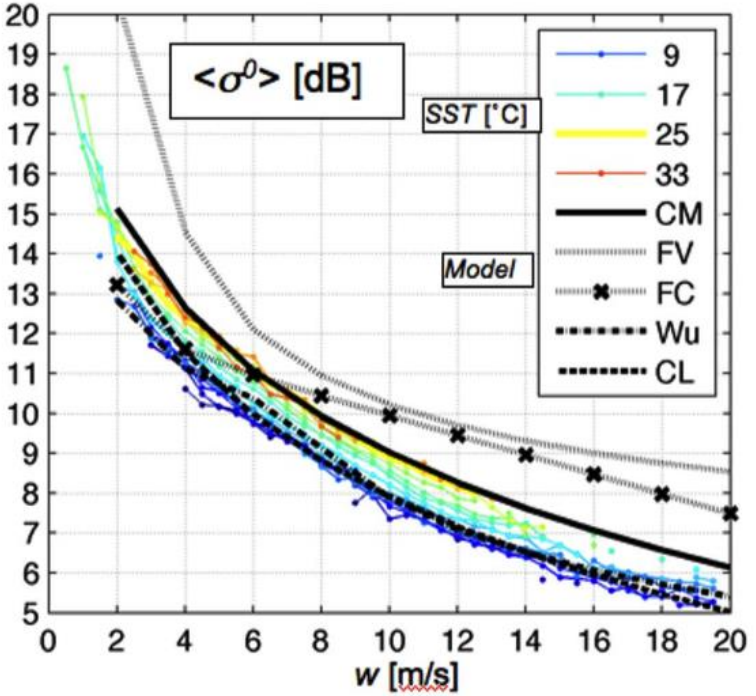
CPR NRT quality monitoring

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

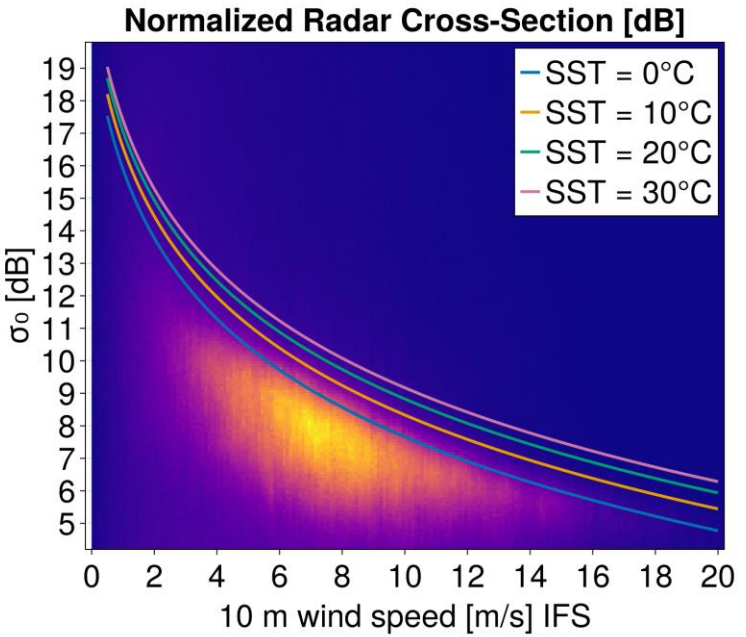




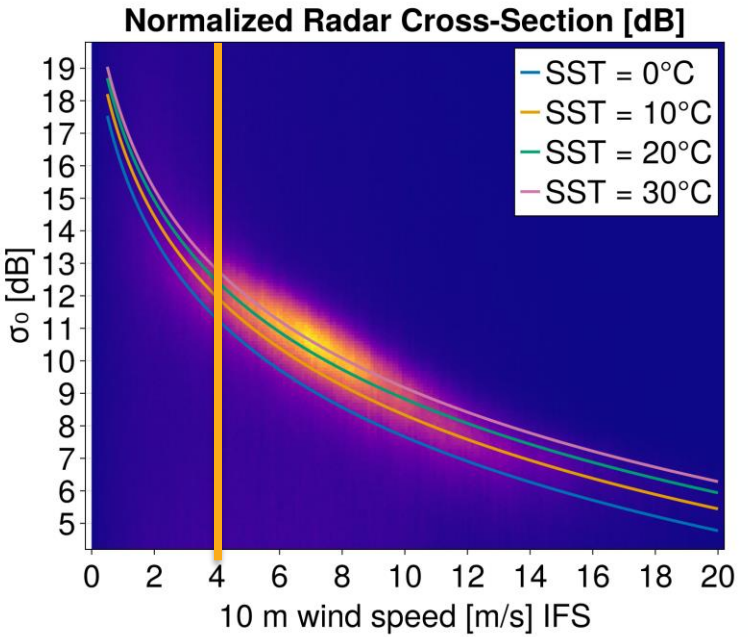
CPR offline monitoring: sea surface return in clear sky



Tanelli et al. (2008)
wind and SST based on AMSR-E obs.

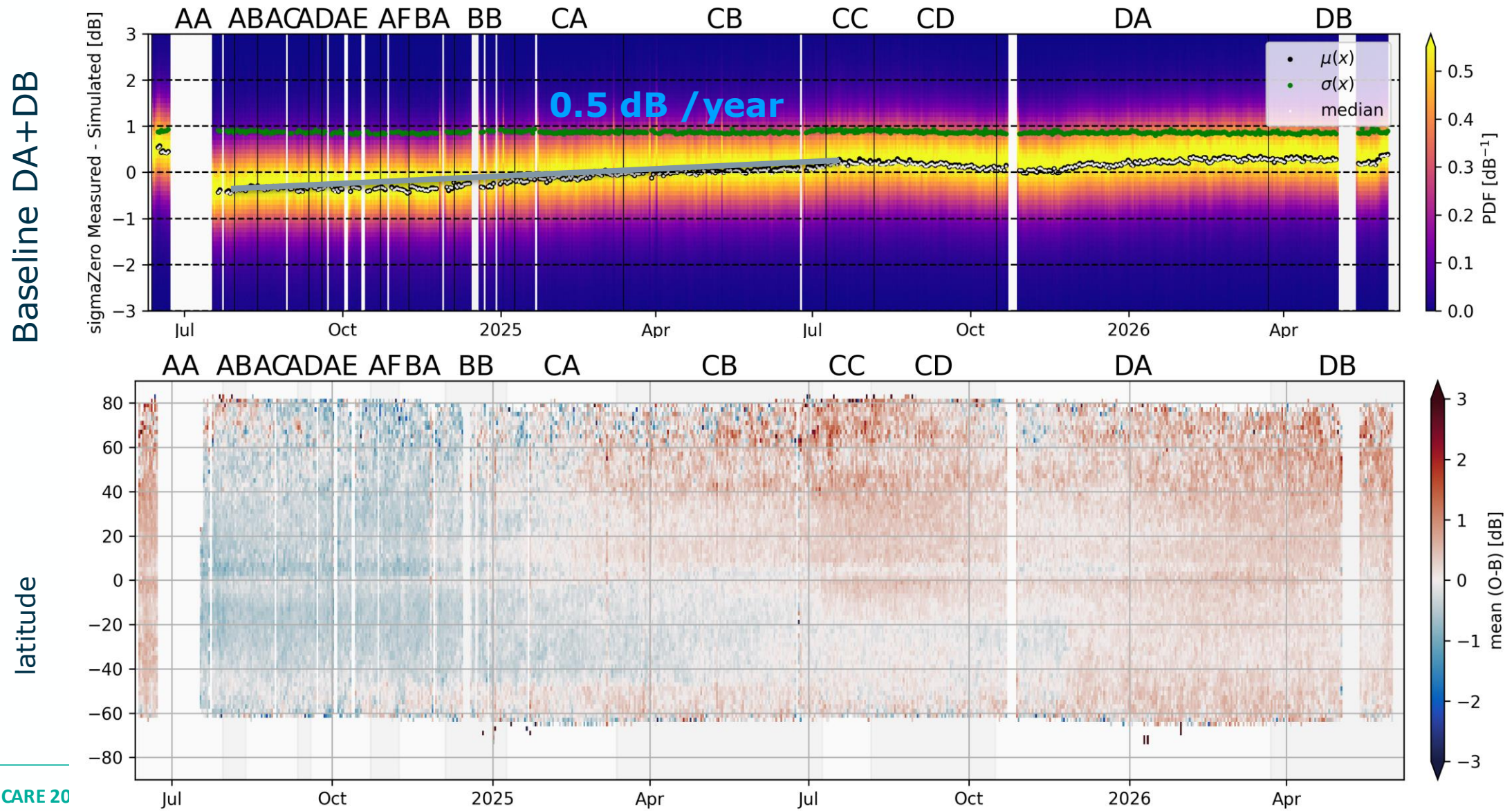


Modeled σ_0
ECMWF forecast
SST > 5°C

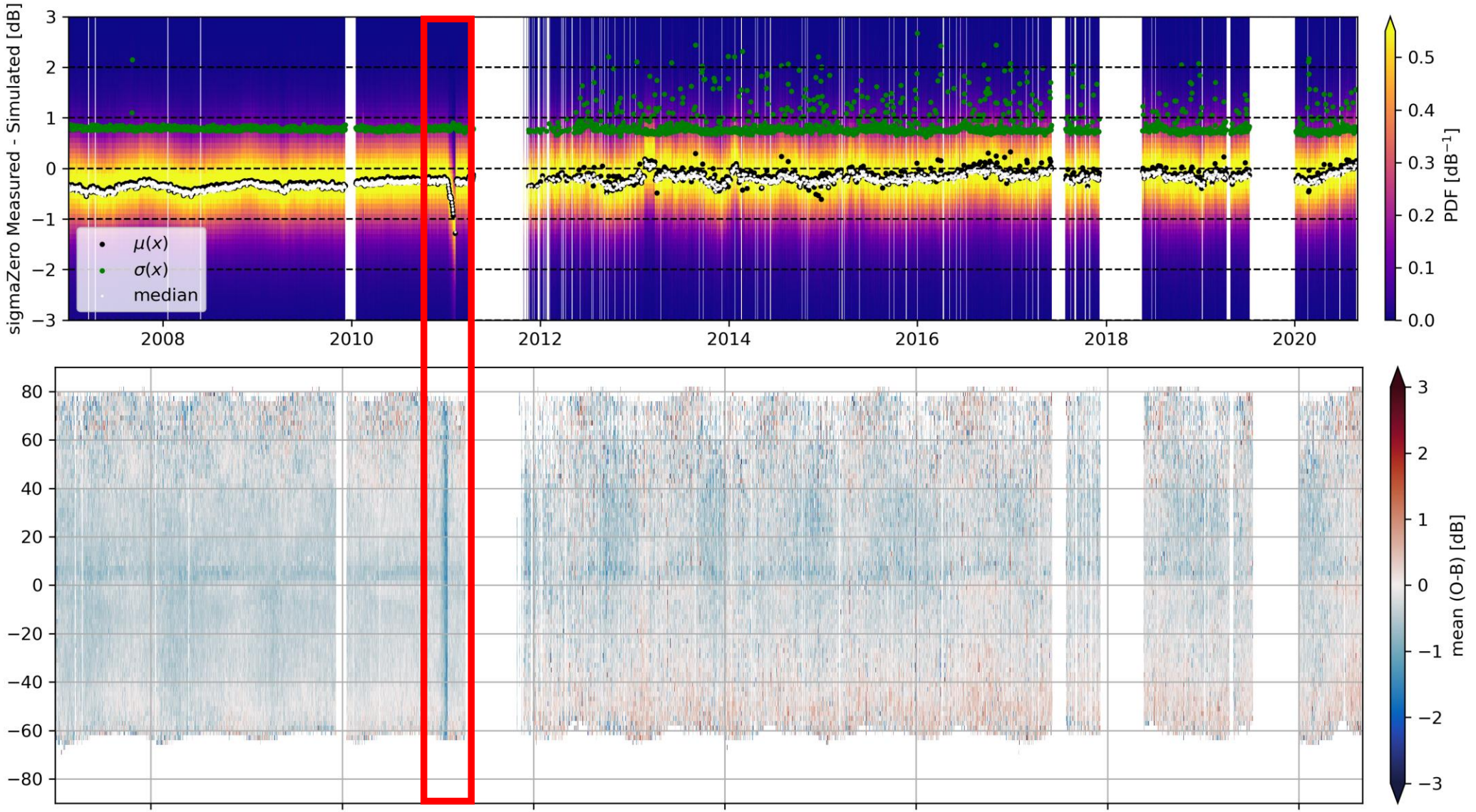


The attenuation of gases accounted for

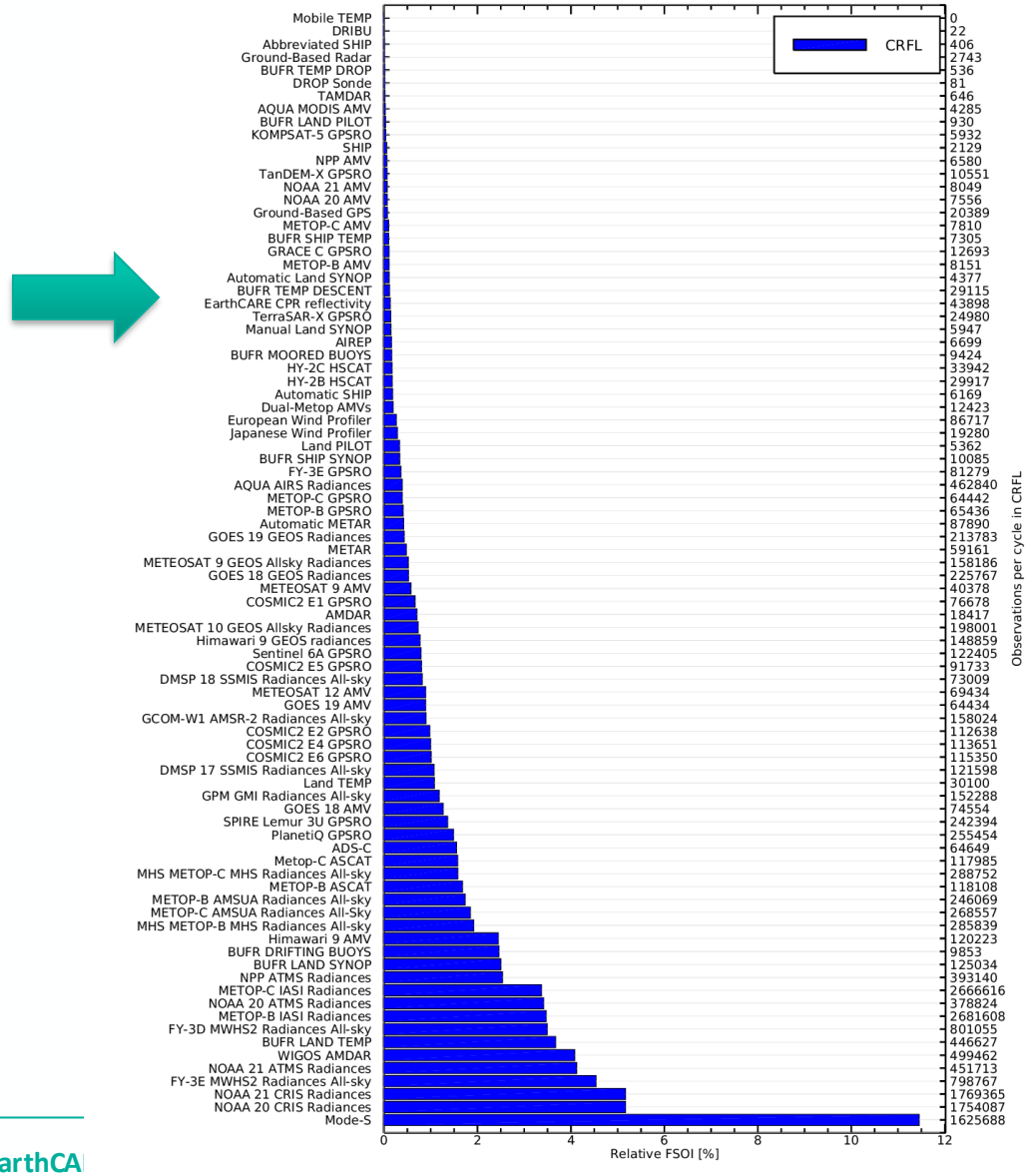
CPR offline monitoring: sea surface return



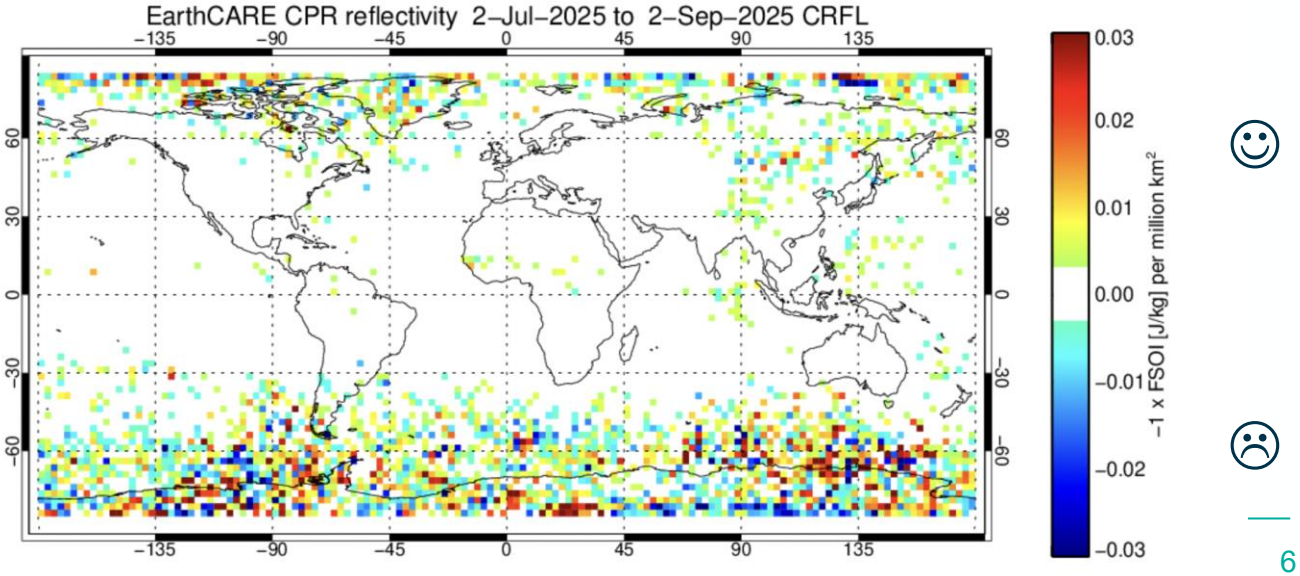
CPR offline monitoring: sea surface return CloudSat



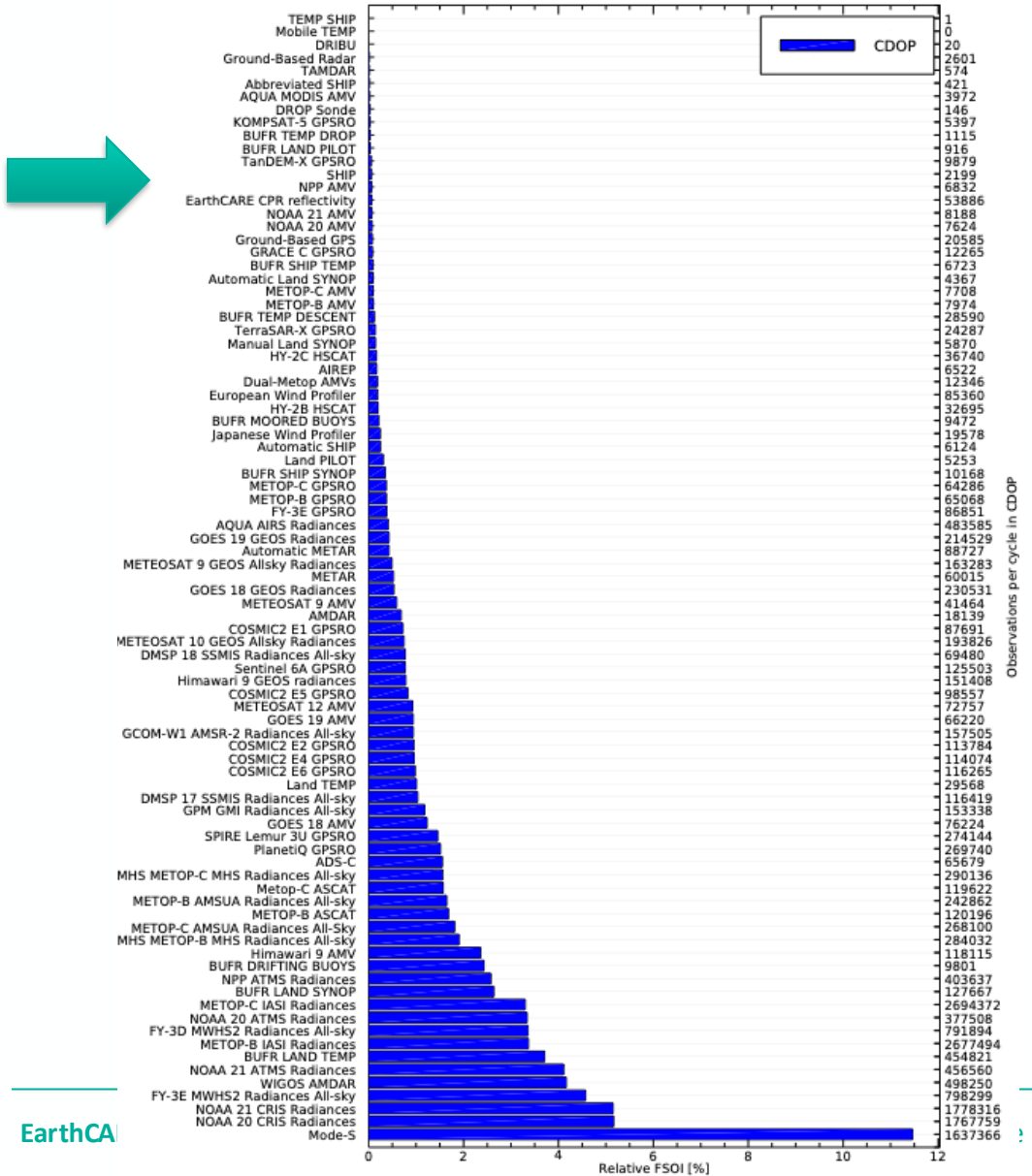
EarthCARE CPR assimilation: impact relative to other observations - Reflectivity



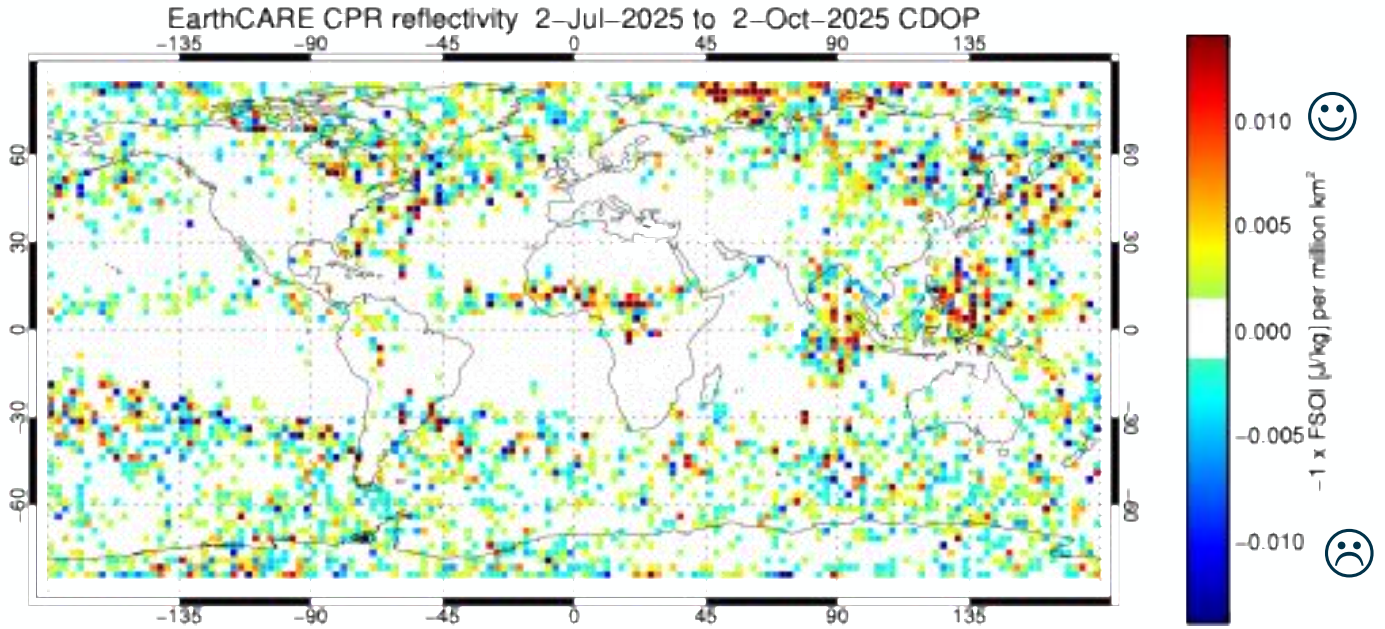
- Forecast sensitivity to observations impact (FSOI) scores use an adjoint technique to assess the impact of different observation types on forecast error.
- Analysis increments from **EarthCARE CPR observations contribute 0.15 %** to the total reduction in 24 hour forecast error for each 4D-Var cycle.
- FSOI scores can be misleading due to correlations between observation types, non-linearities and neglected humidity information (when using dry energy norm).



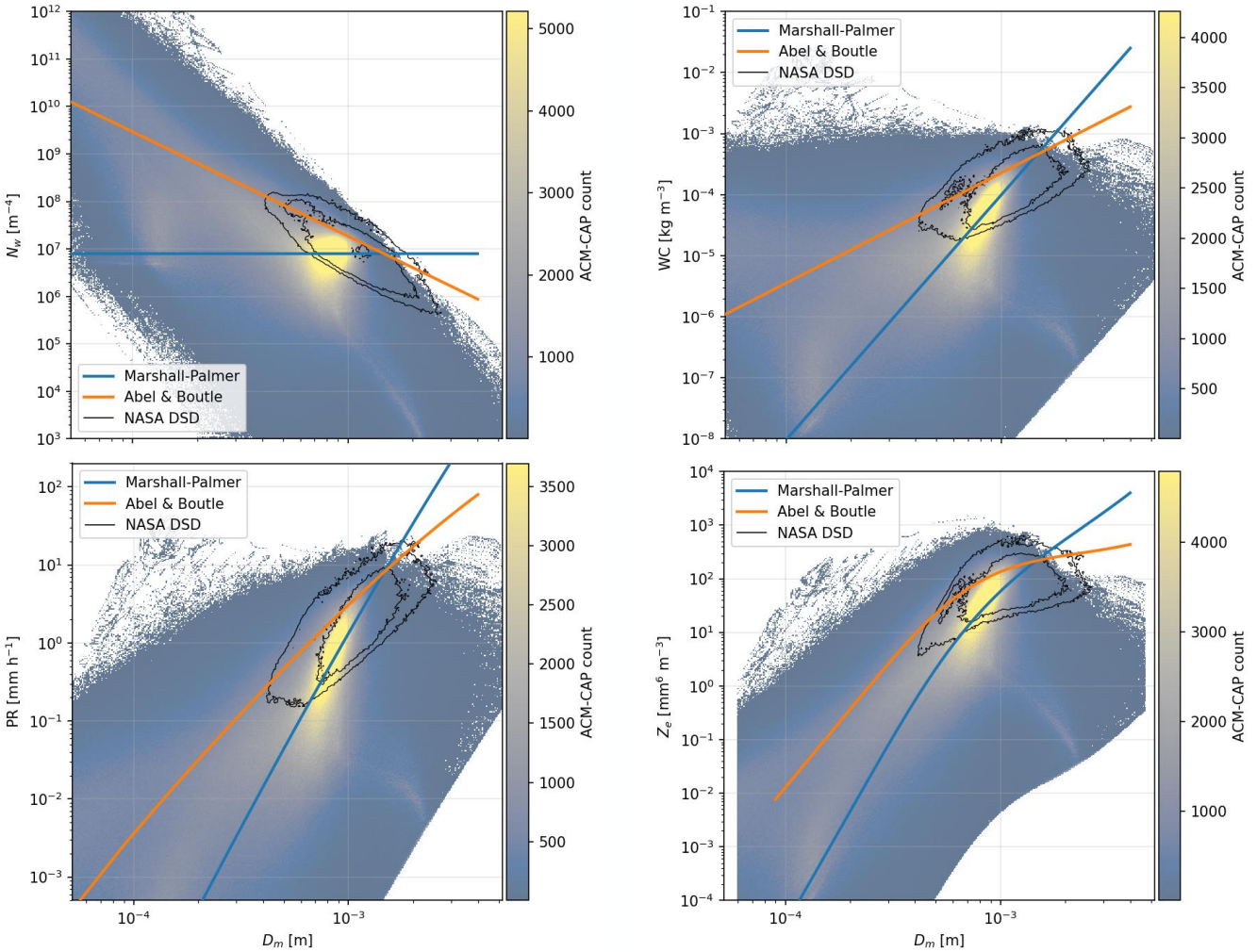
EarthCARE CPR assimilation: impact relative to other observations - Doppler



- Analysis increments from **EarthCARE CPR Doppler observations contribute 0.05 %** to the total reduction in 24 hour forecast error for each 4D-Var cycle.



Model microphysics evaluation

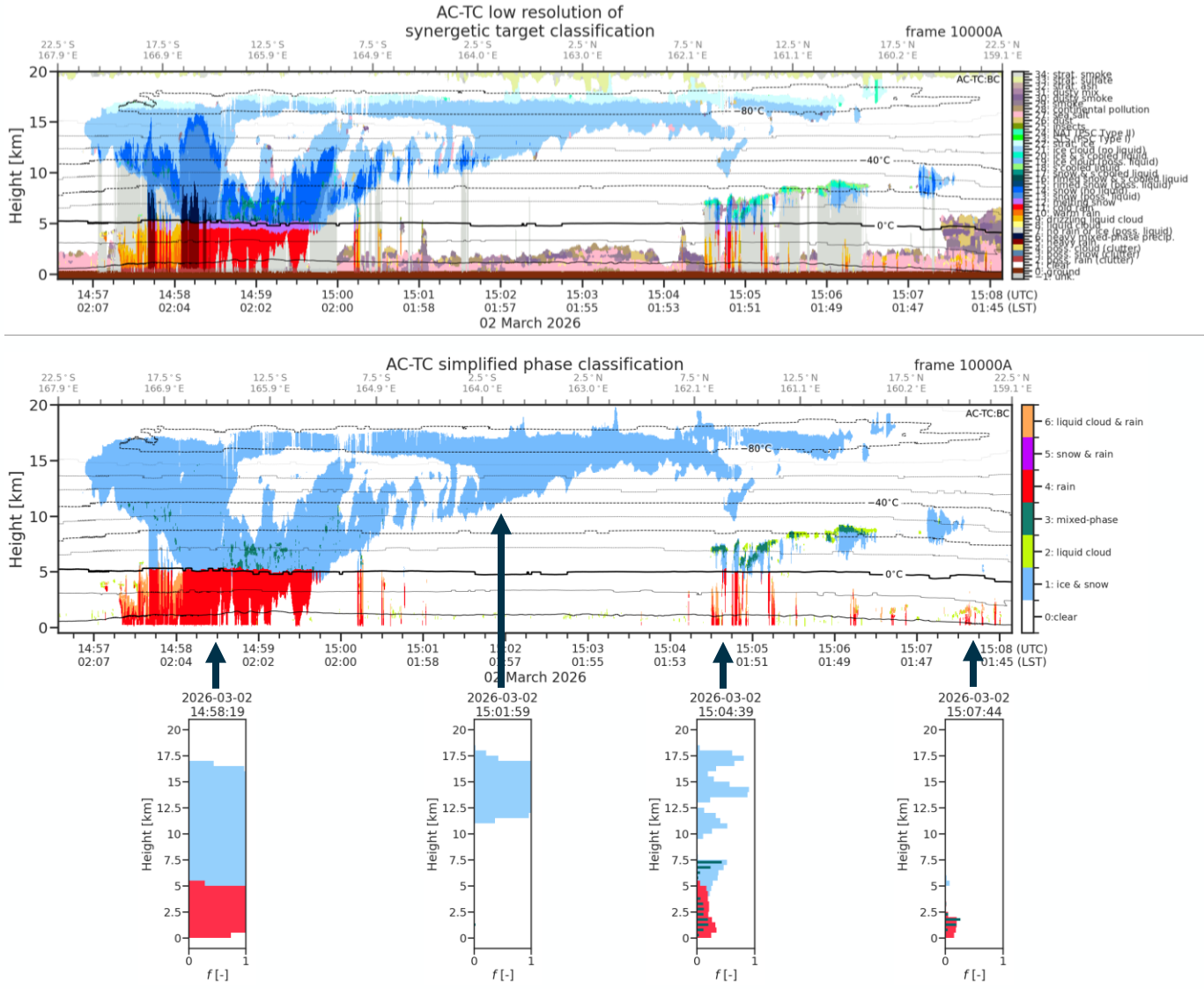


Mass weighted mean diameter

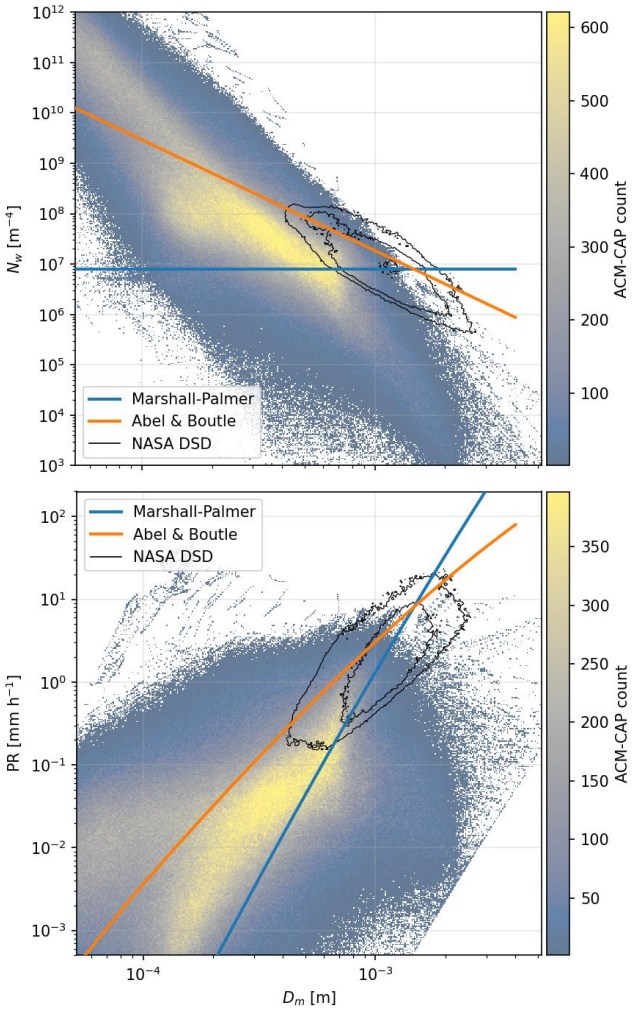
- 20 km along-track averaging was used
- Marshall-Palmer distribution captures bulk behaviour
- Abel & Boutle PSD parametrization capture better low precipitation rates (low D_m)
- A lot of uncertainty in the “drizzle” regime

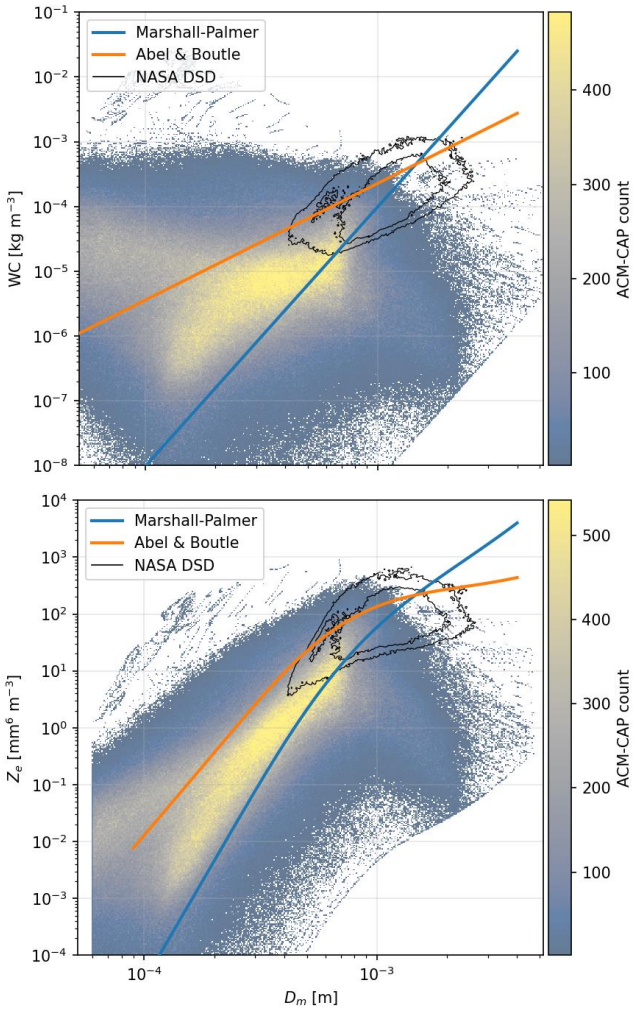
Macrophysical clustering (S. Mason)

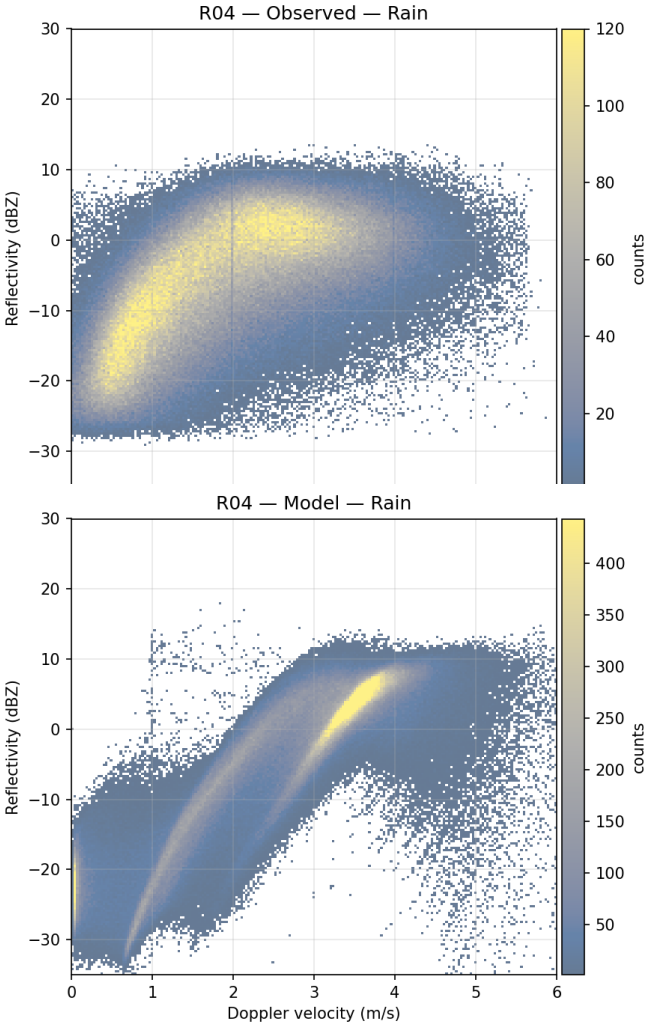
- Based on ATLID-CPR target classification (AC-TC) product
- Clustering over a simplified classification of cloud and precipitation fraction and thermodynamic phase: **ice & snow**, **rain**, **liquid**
- ~20km along-track chunks;
  500m vertical bins from 0—20 km
- K-means clustering on profiles of cloud/precipitation fraction:
  - Cluster centroids characterise recurring vertical structures
  - ***Need to select number of clusters—subjective***



Warm rain: R04

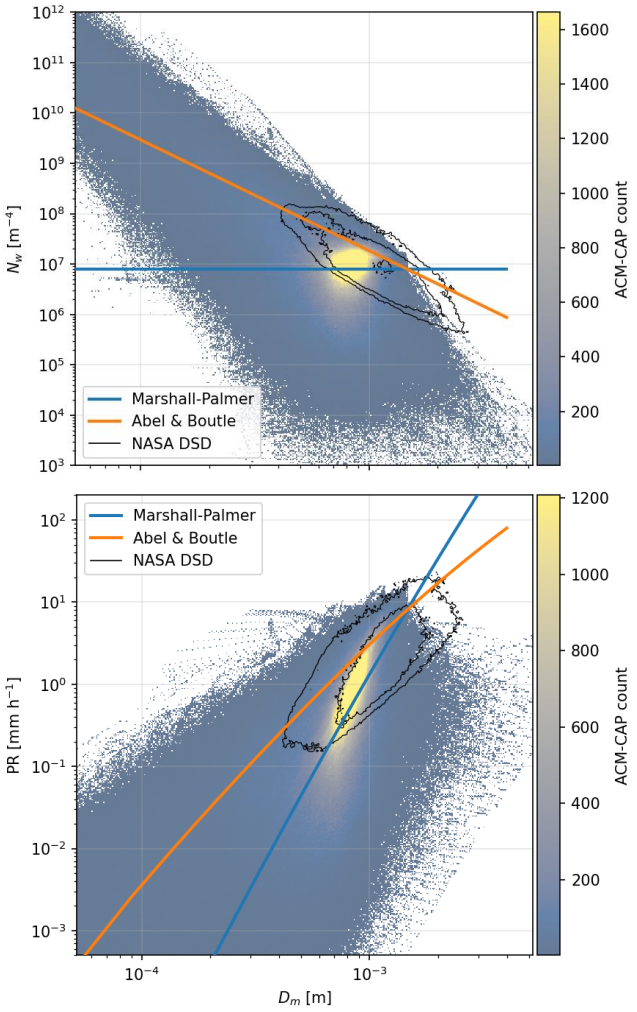


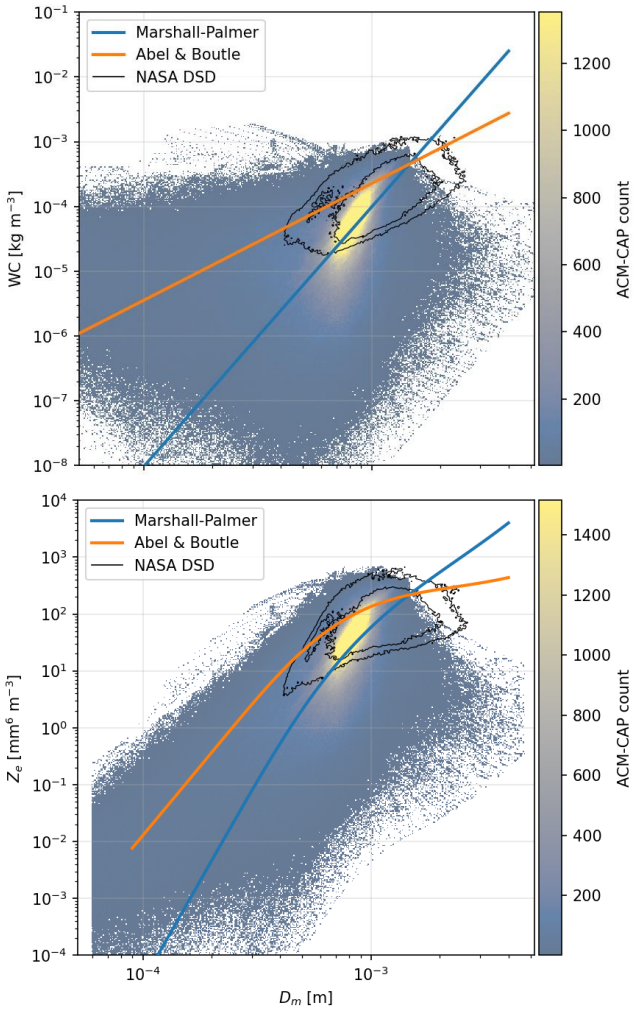


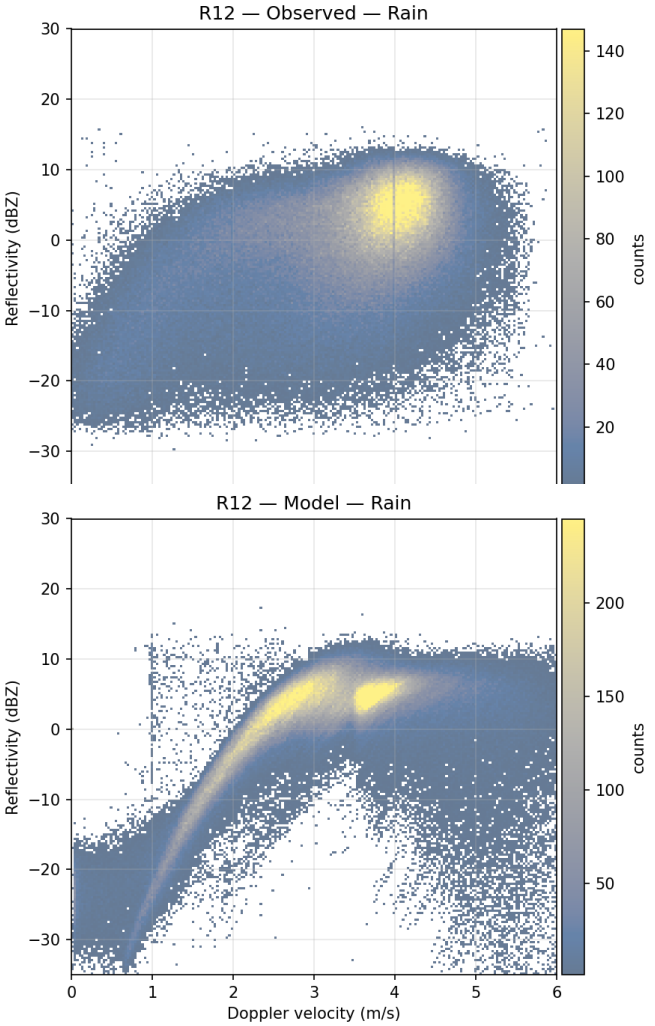


Mass weighted mean diameter

Cold rain: R12



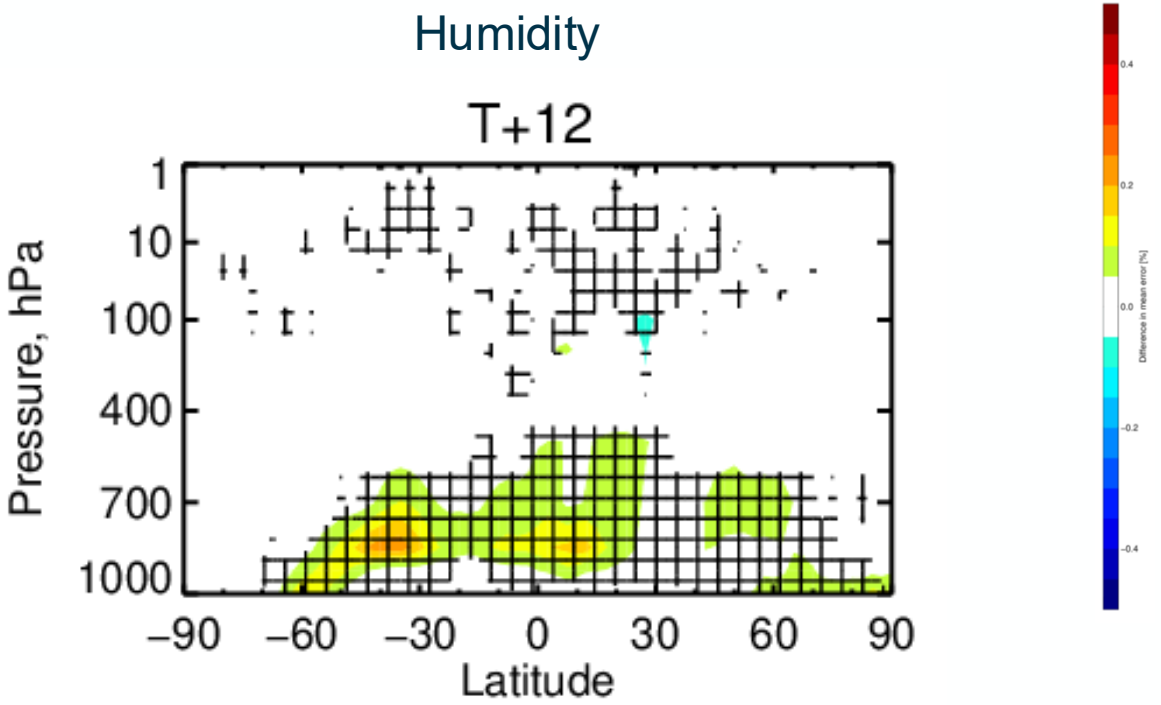




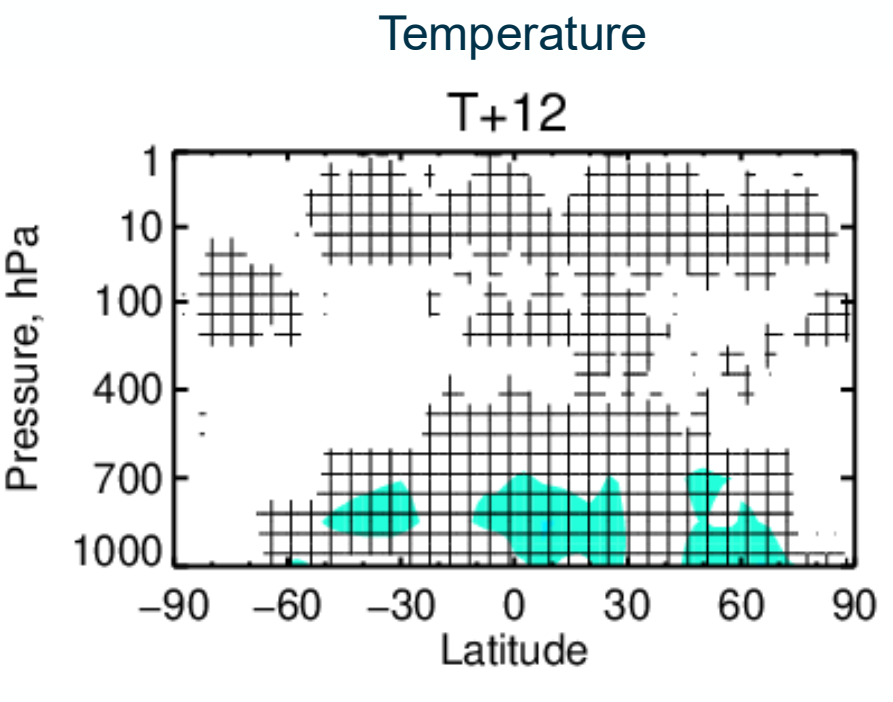
Mass weighted mean diameter

Model microphysics tests

Humidity



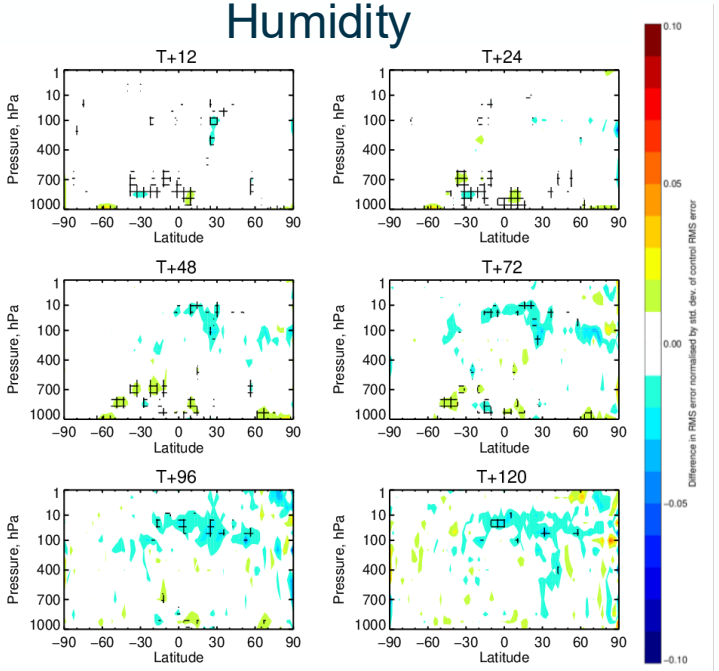
Temperature



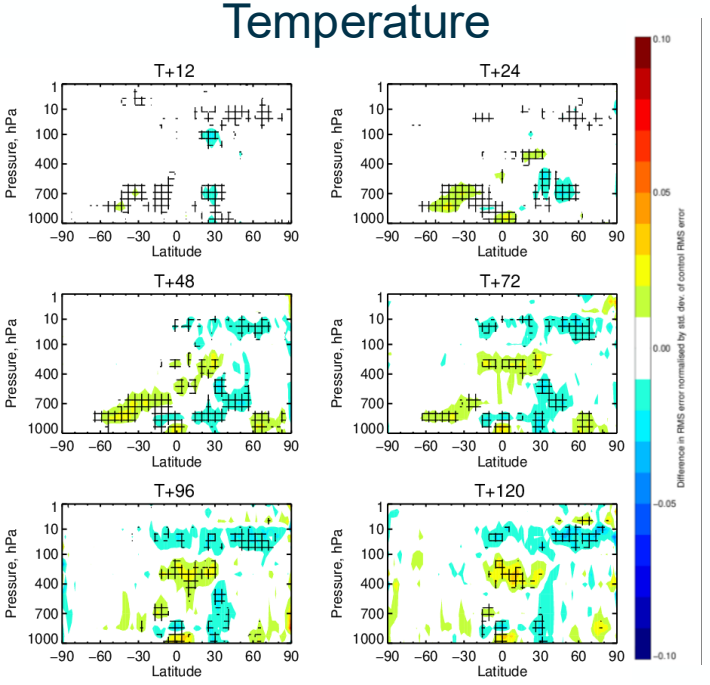
- Abel and Boutle (2012) DSD changed to Marshall-Palmer in cold rain.
- Humidity is increased (0.3% in 12 h).
- Temperature is reduced (0.1% in 12 h).

Model microphysics tests

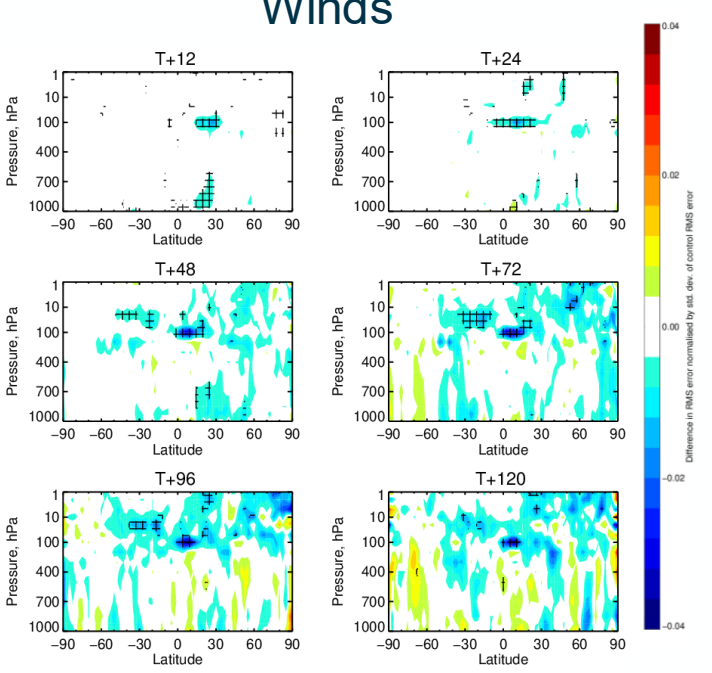
Humidity



Temperature



Winds



- Abel and Boutle (2012) DSD changed to Marshall-Palmer in cold rain.
- We see some improvements in the humidity fields, mainly in the lower stratosphere at day 2 forecast.
- Stronger improvements in the wind field forecast.

Summary

- EarthCARE data are monitored at ECMWF
- Reanalysis data can be used as a stepping stone between CloudSat and EarthCARE missions
- Assimilation in CY50 has been tested and is expected to be activated soon!
- EarthCARE data are used to evaluate model microphysics
- Ongoing testing of alternative PSD parametrizations
- Larger impact of the EarthCARE data expected once it's more in agreement with the observations