Effort towards combining passive sub-mm microwave (Arctic Weather Satellite) and IR for cloud ice mass

Utilization of L2 synergy product ACM-CAP

Forward Model

Radiative Transfer

Particle Size Distribution (ACM-CAP profiles)

Particle Habits (Yang, ARTS scattering DB)

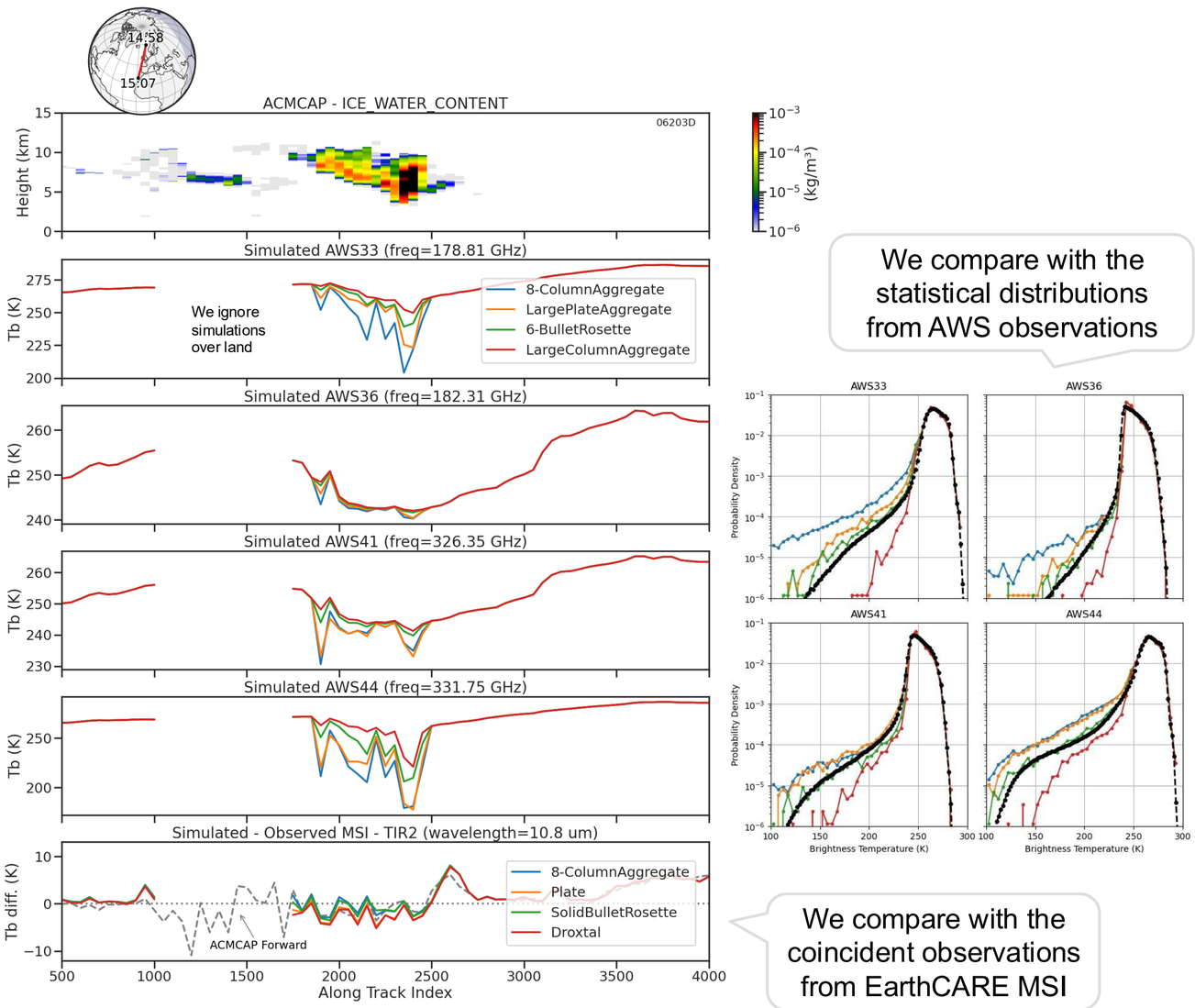
ARTS

T_b @ 183 GHz

T_b @ 325 GHz

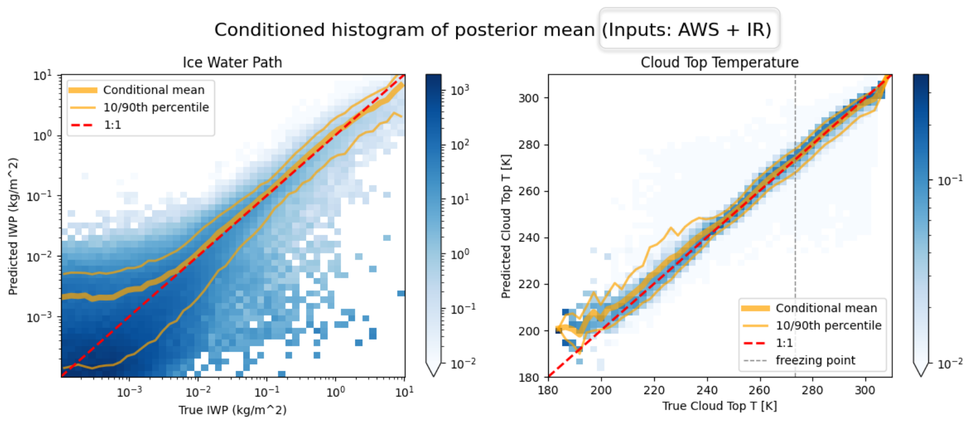
T_b @ 10.8 μm

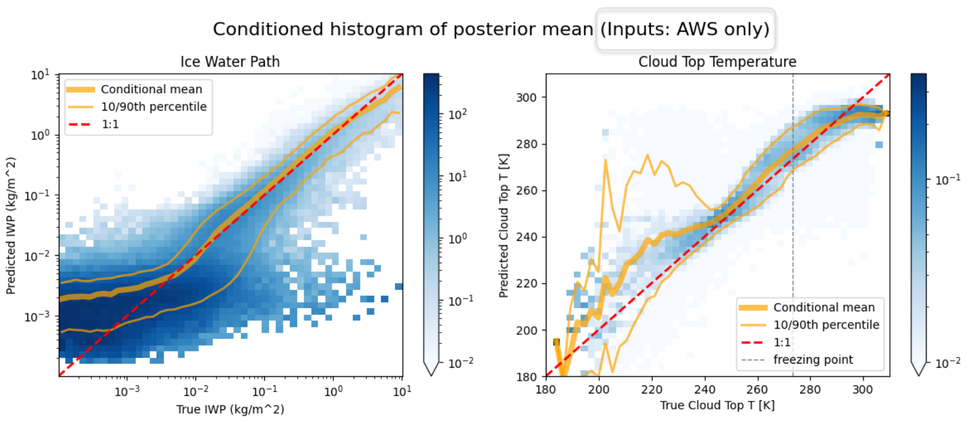
Arctic Weather Satellite (AWS) carries a passive sub-millimeter instrument that aims to measure ice mass. Among its 19 channels, 6 are located around 183 GHz and 4 around 325 GHz (new!!), which are sensitive to scattering processes caused by cloud ice.

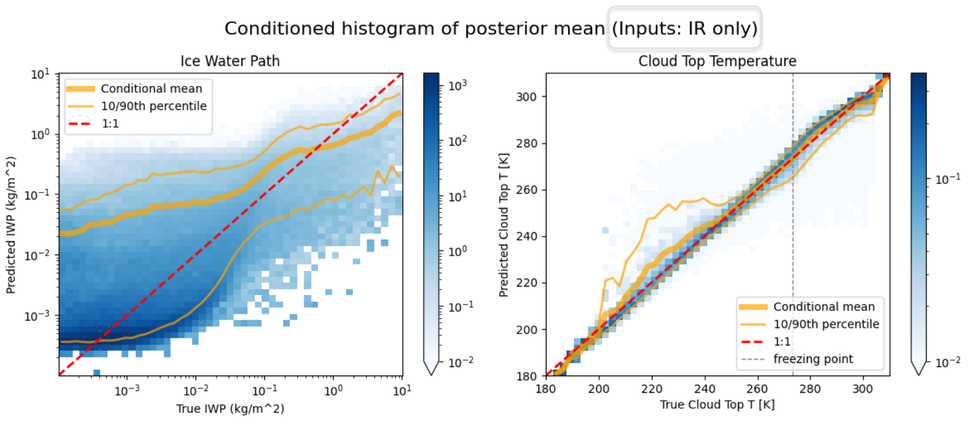


We compare with the statistical distributions from AWS observations

We compare with the coincident observations from EarthCARE MSI







Inverse Model

Quantile Regression Neural Network

T_b @ 183 GHz

T_b @ 325 GHz

T_b @ 10.8 μm

QRNN

Ice Water Path

Cloud Top Temperature

A large number of simulated cases (N = 1.2 million) is used to build a retrieval database. The ice water path is taken from the ACM-CAP retrieval using its ice particle model, while the cloud top is defined as the highest altitude at which the integrated liquid and ice water content above equals 35 g m⁻². Three QRNN models are evaluated: (1) sub-mm only, (2) IR only, and (3) IR + sub-mm. The results highlight the benefit of combining IR and sub-mm measurements, which provide complementary information.

Key Points

- The EarthCARE synergy product ACM-CAP provides particle size distribution (PSD) profiles which are retrieved from IR, radar, and lidar measurements. Radiative transfer simulations are performed based on these profiles.
- For a given PSD assumption, particle habits greatly influence the simulated brightness temperature at sub-mm; less at IR.
- Combining IR and sub-mm measurements improves the joint retrieval of ice water path and cloud top temperature.

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