Ground-Based Observations of Clouds in the Arctic -- Implications for CloudSAT-related studies

Gijs de Boer (1)

Edwin W. Eloranta (1), Gregory J. Tripoli (1), Jennifer Kay (2), Matthew D. Shupe (3)

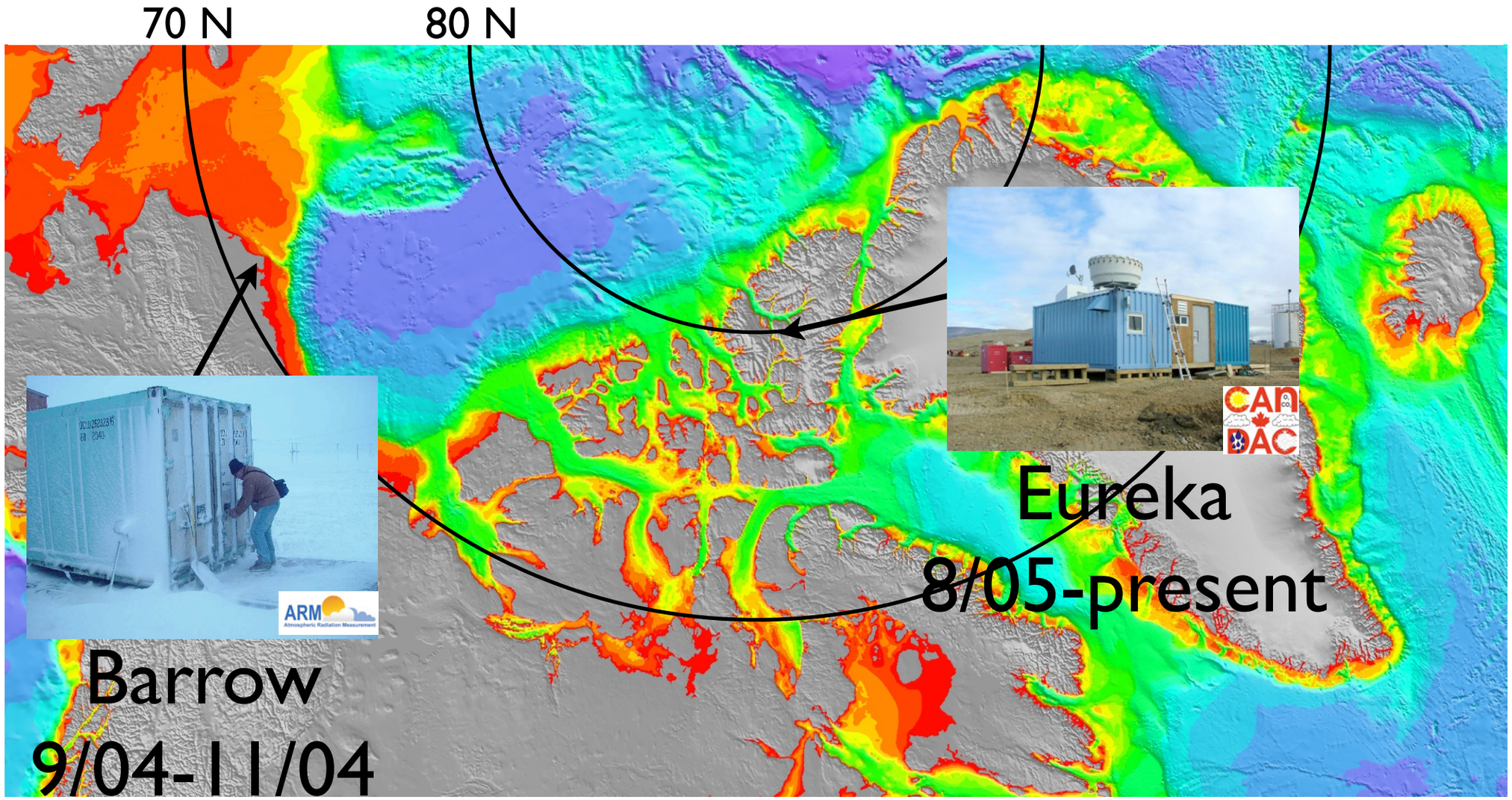
(1) THE UNIVERSITY of WISCONSIN MADISON

(2) NCAR

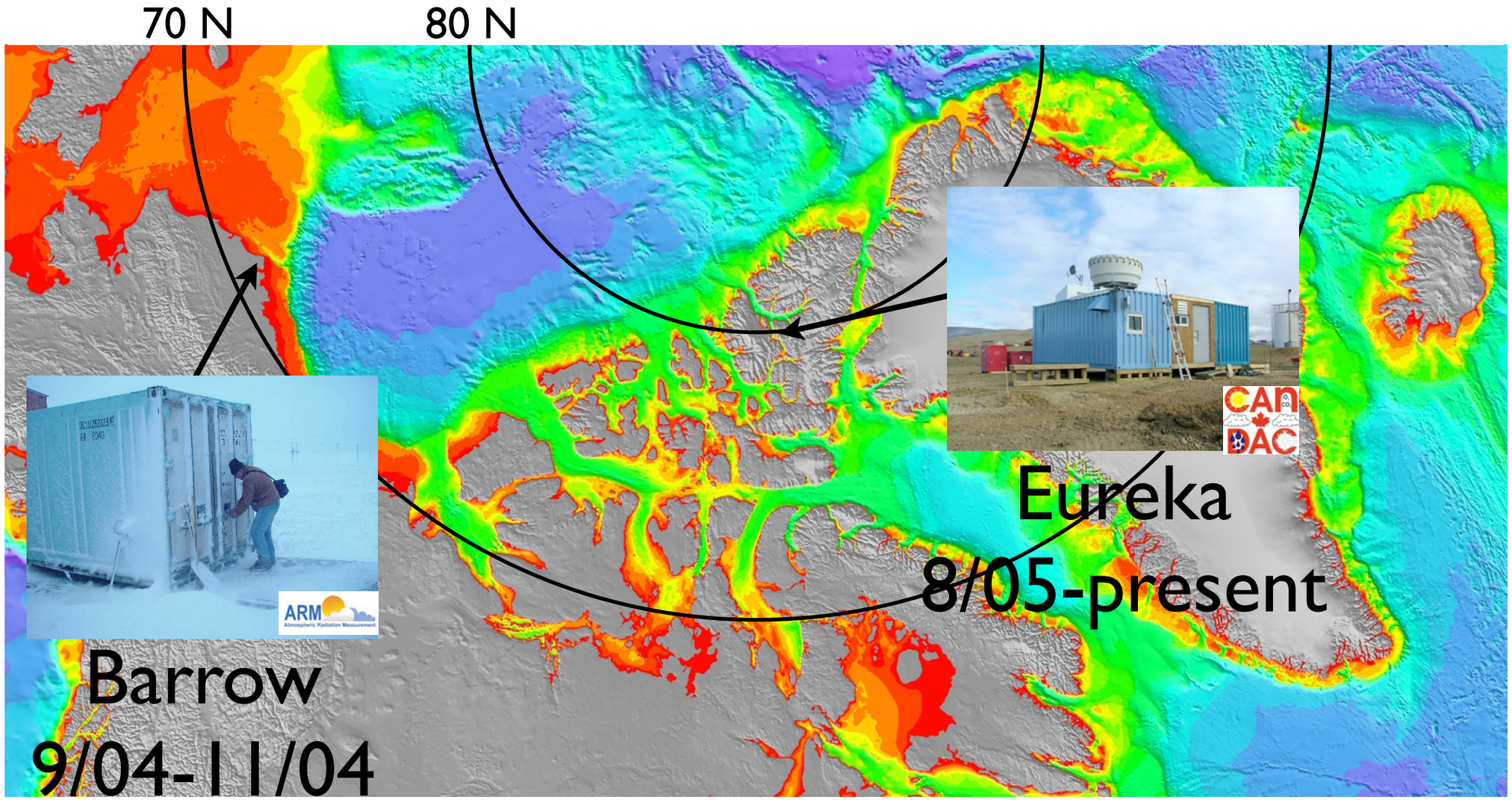
(3) CIRES NOAA

CloudSAT Science Team Meeting, Seattle, WA 19-21 August, 2008

Introduction

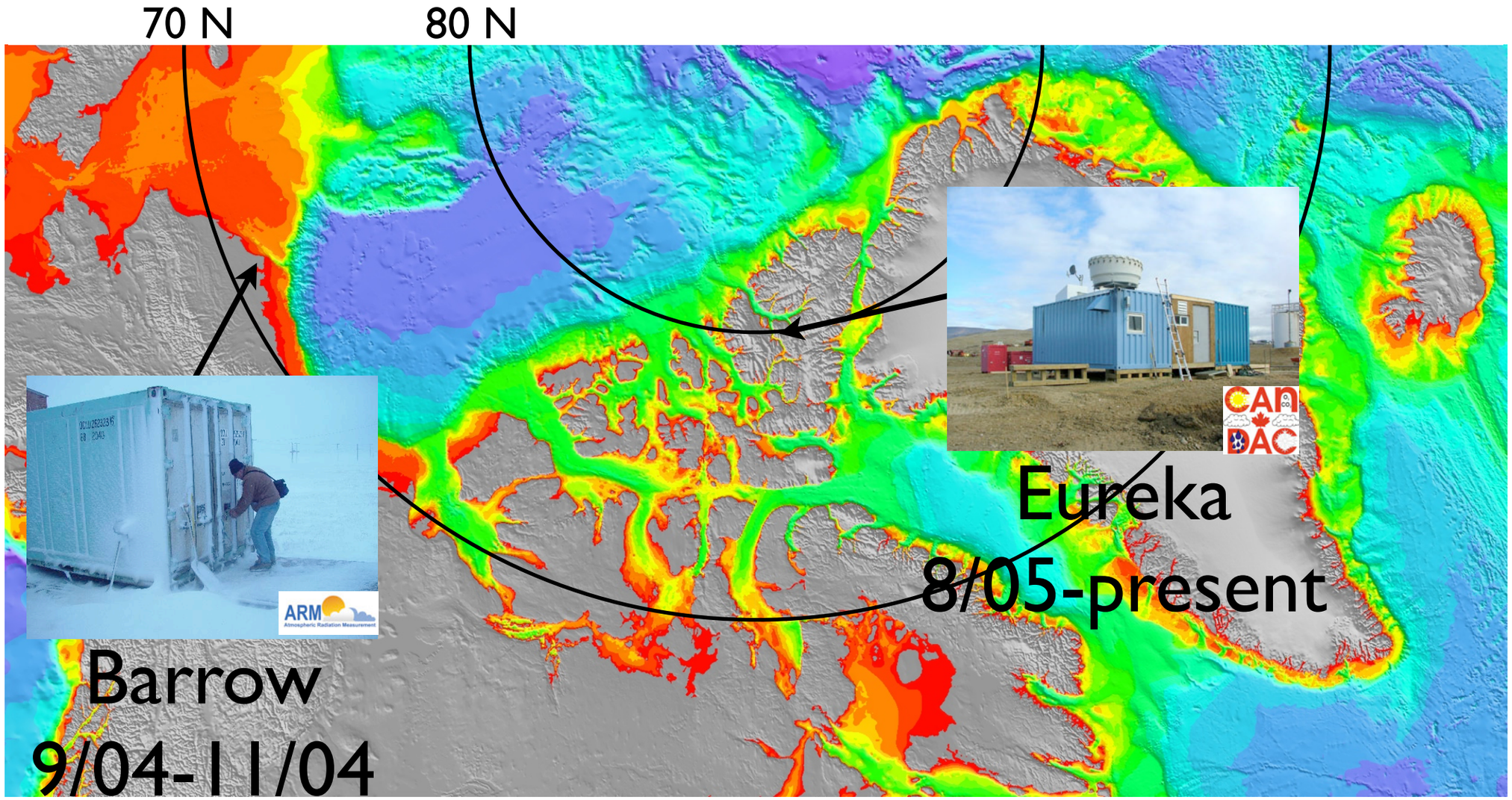


Introduction



1) Observation of Mixed-Phase Stratus clouds

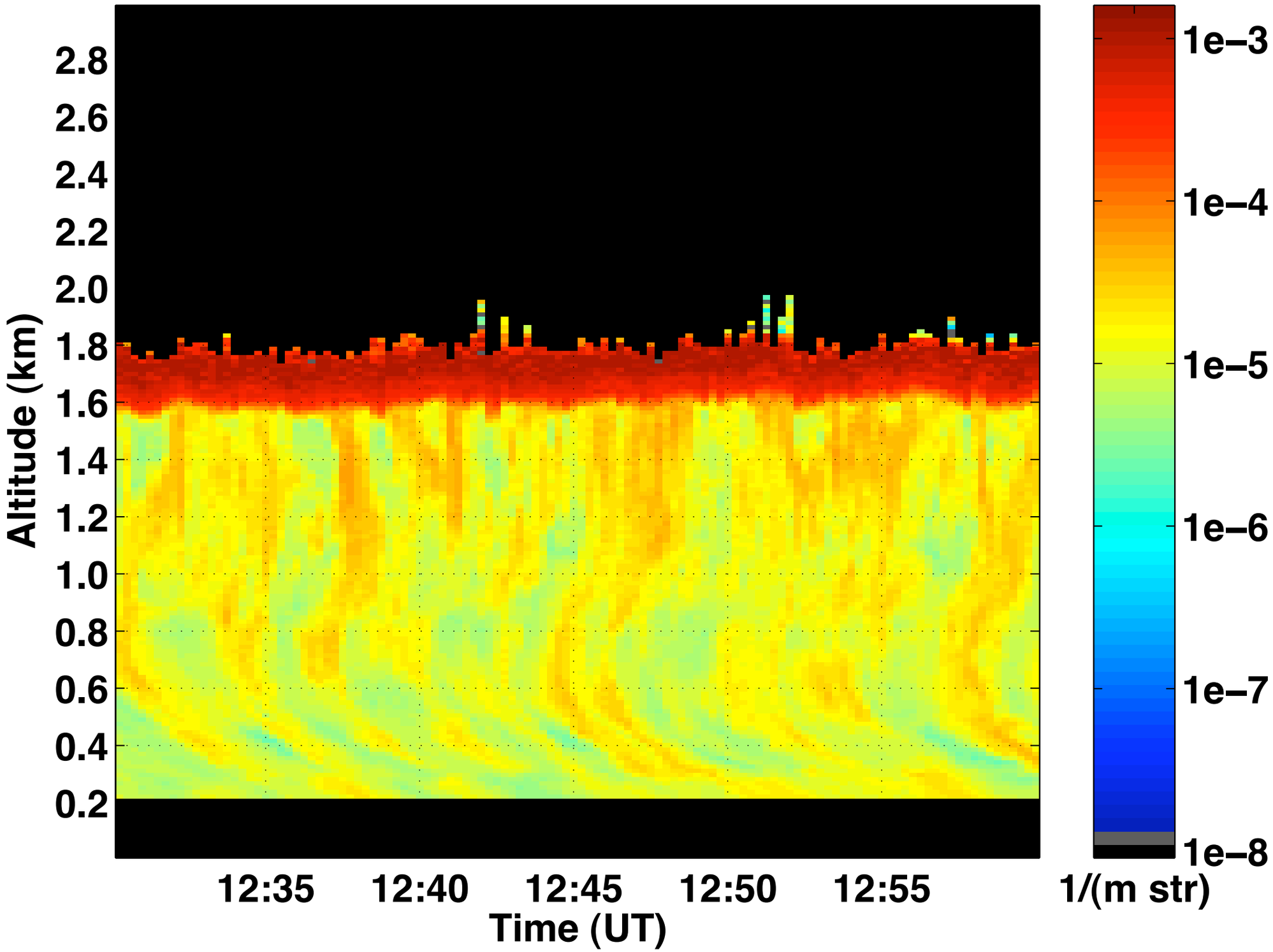
Introduction



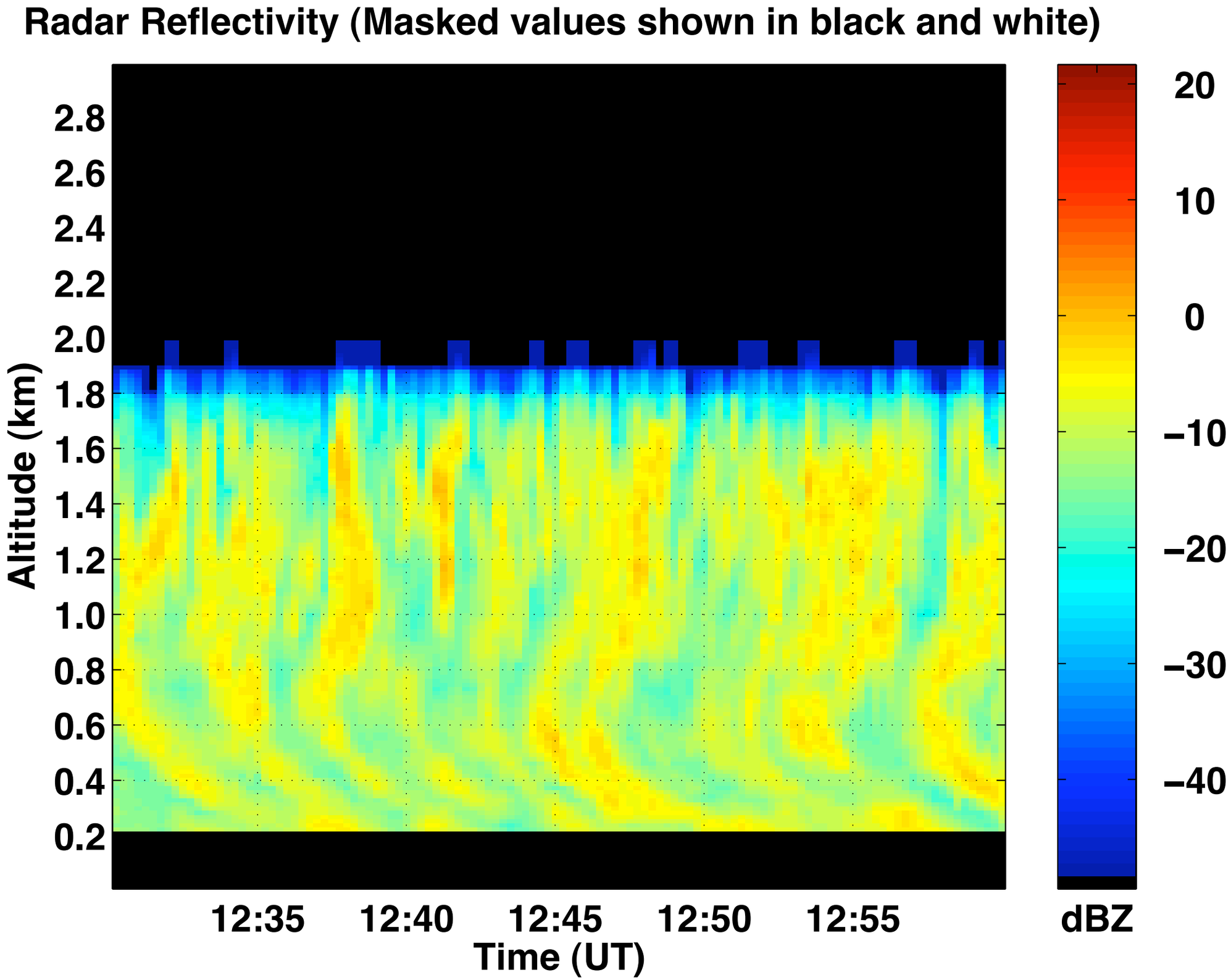
1) Observation of Mixed-Phase Stratus clouds
2) Representativeness of "point" comparisons

Introduction: Mixed-Phase Stratus

Lidar backscatter cross section (Masked values shown in black and white)



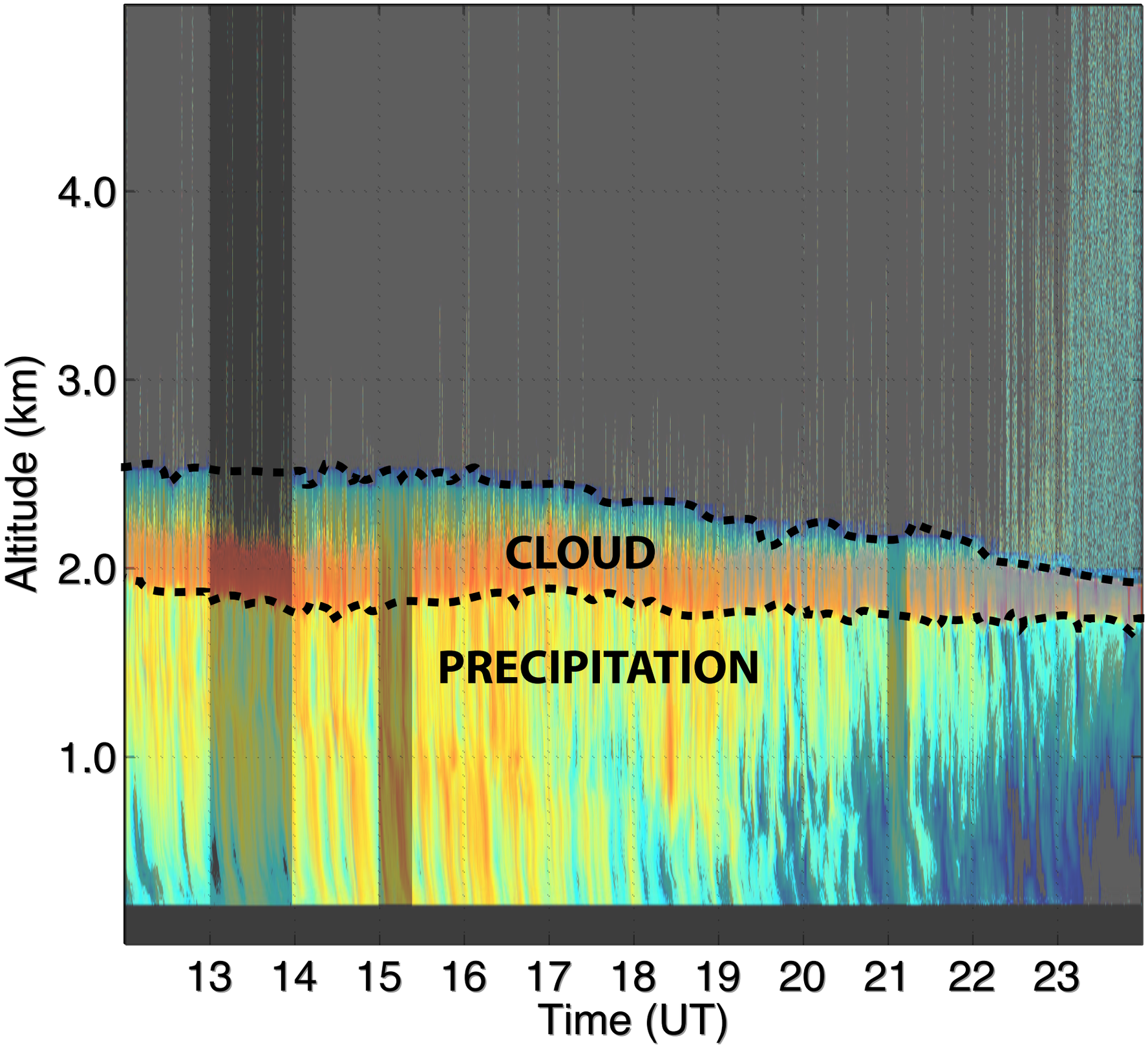
Introduction: Mixed-Phase Stratus



Introduction: Mixed-Phase Stratus

- Low altitude stratus frequency of up to 70% during transition seasons (Herman and Goody, 1976; Curry et al., 1996)
- Reduces wintertime net surface cooling by 40-50 W/m^2 (Curry et al., 1996)
- Commonly observed during several recent Arctic experiments (SHEBA, MPACE, SEARCH, ISDAC)
- Often long-lived, surviving up to several days at a time (de Boer et al., 2008)
- Difficult to simulate because of unstable state (Klein et al., 2008)

Property Statistics

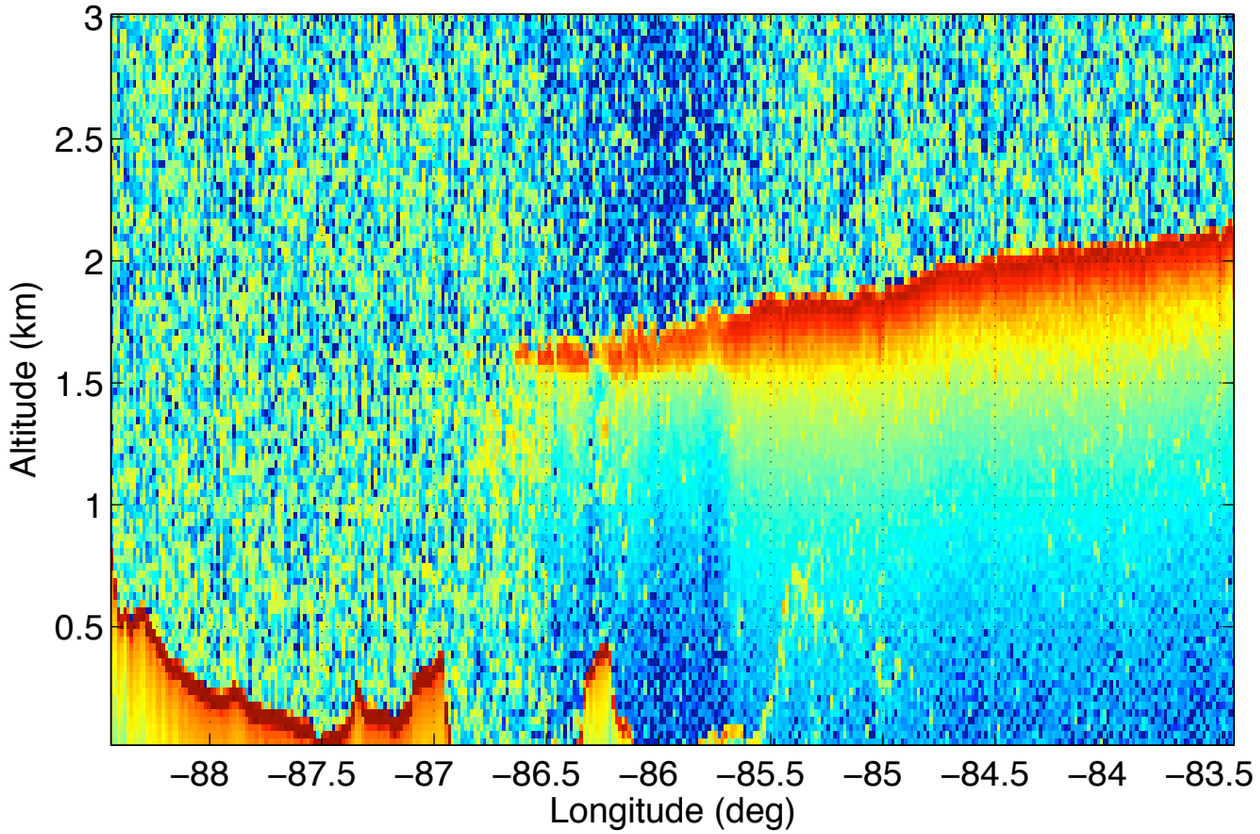


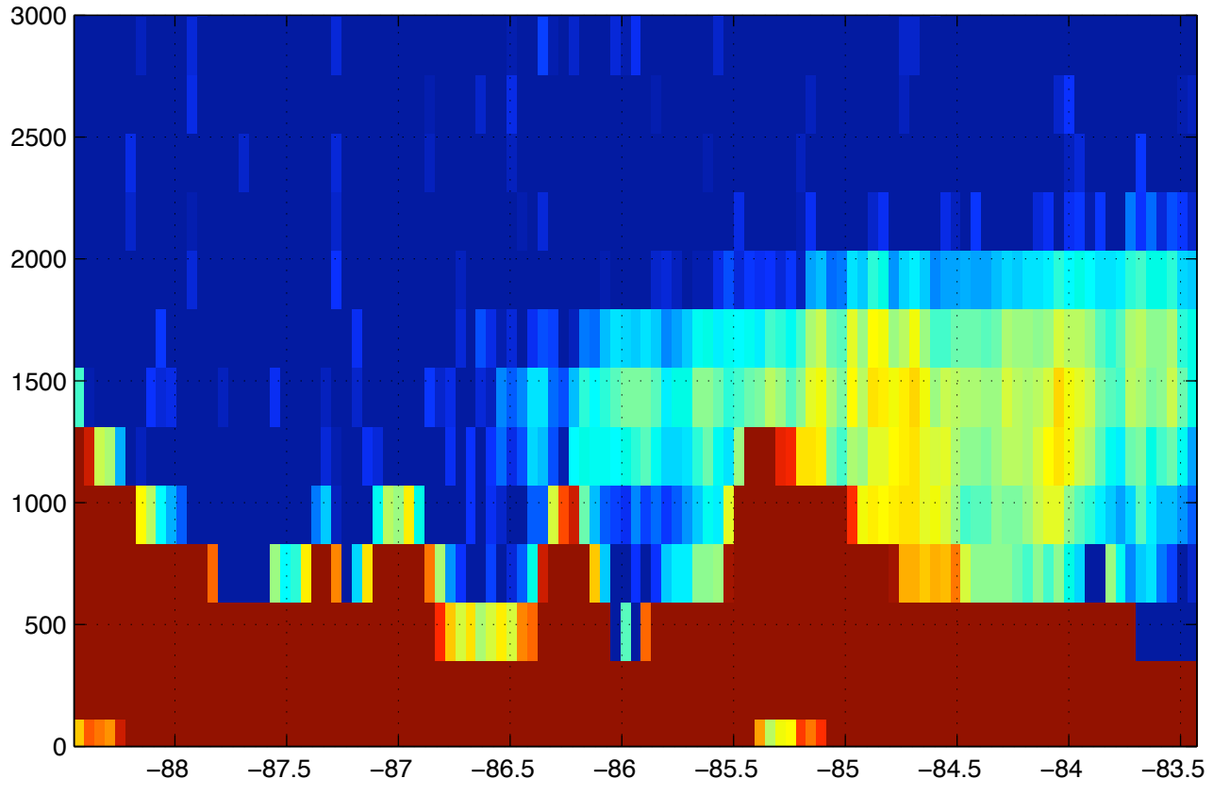
Single-layer mixed phase stratus observations

- 216 hours from Barrow

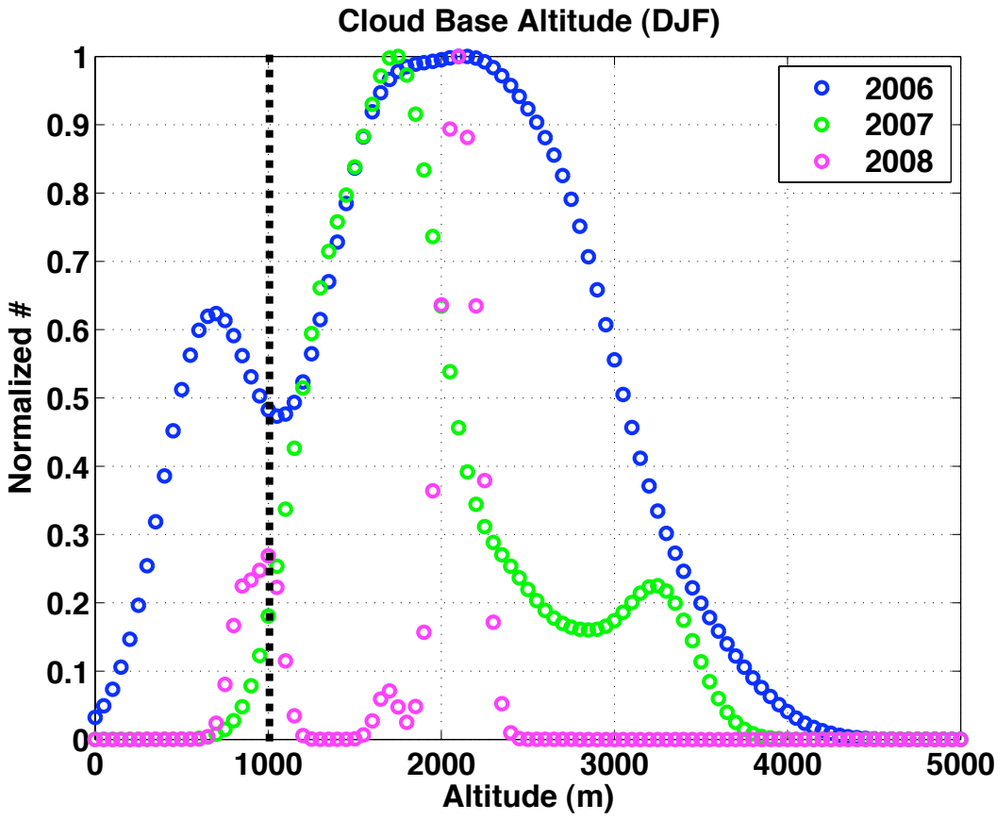
- 1143 hours from Eureka

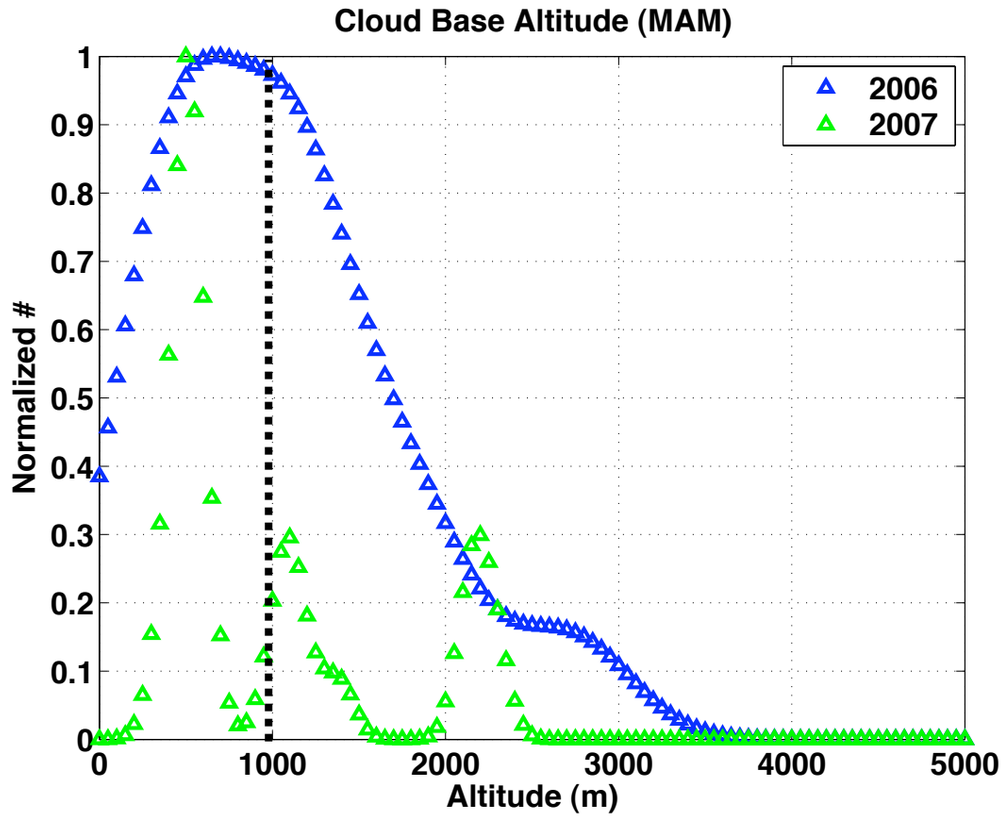
Cloud Height

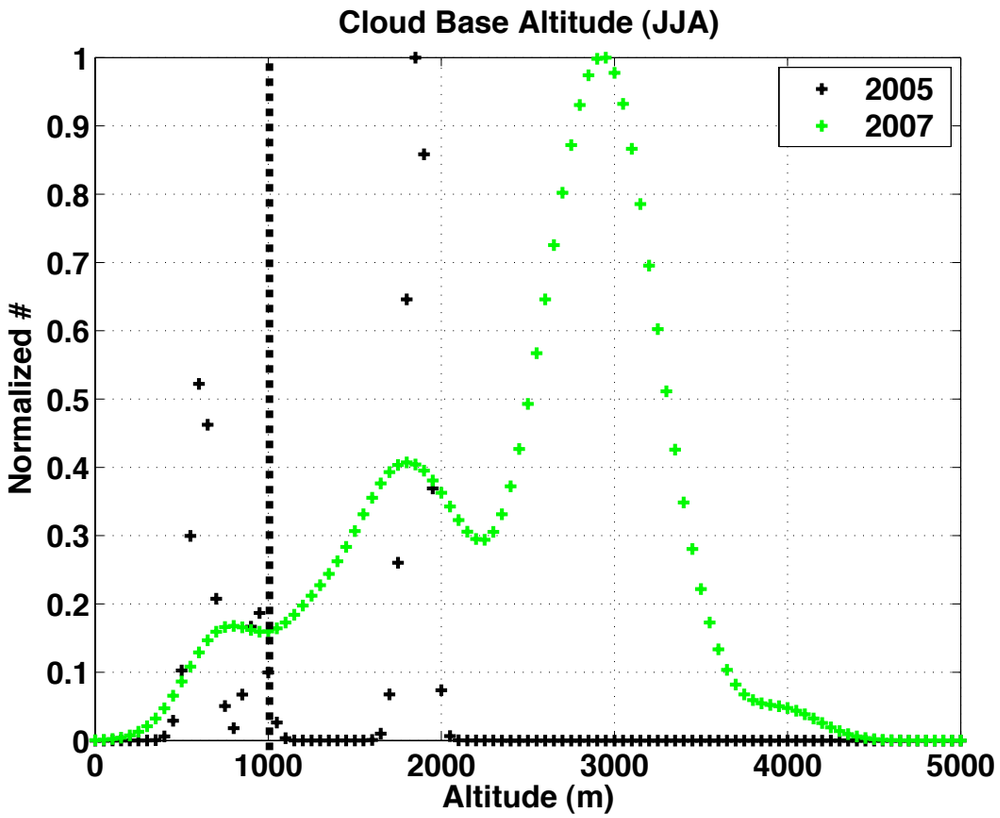


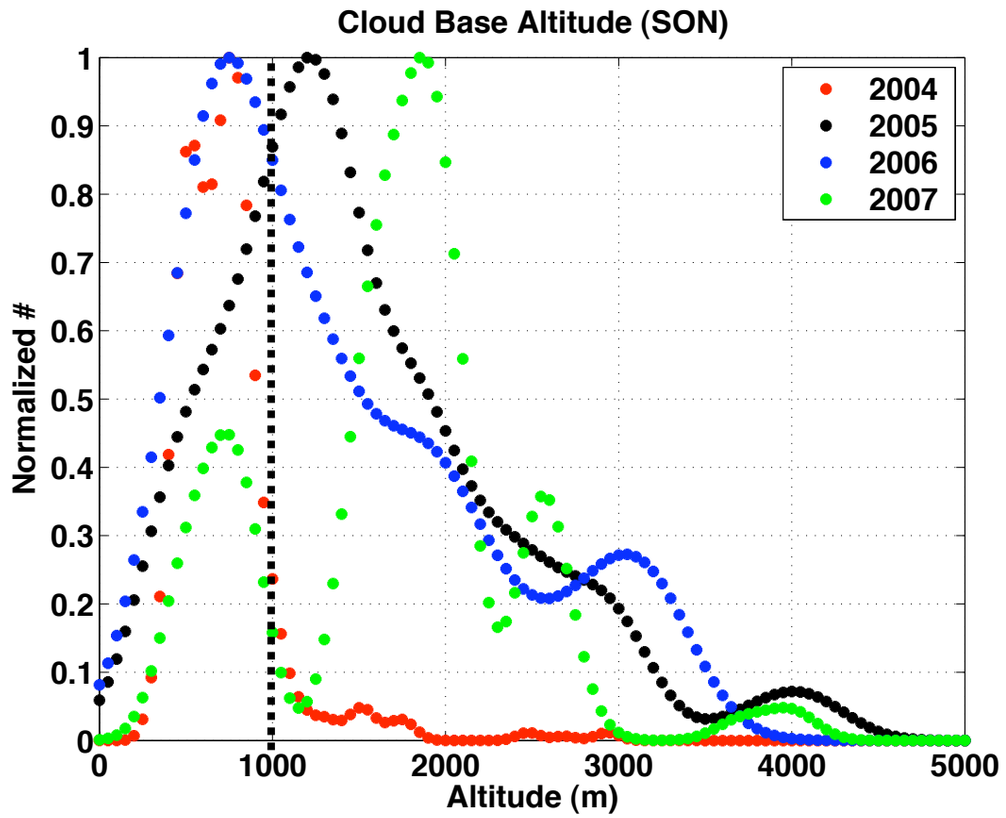


Cloud Height





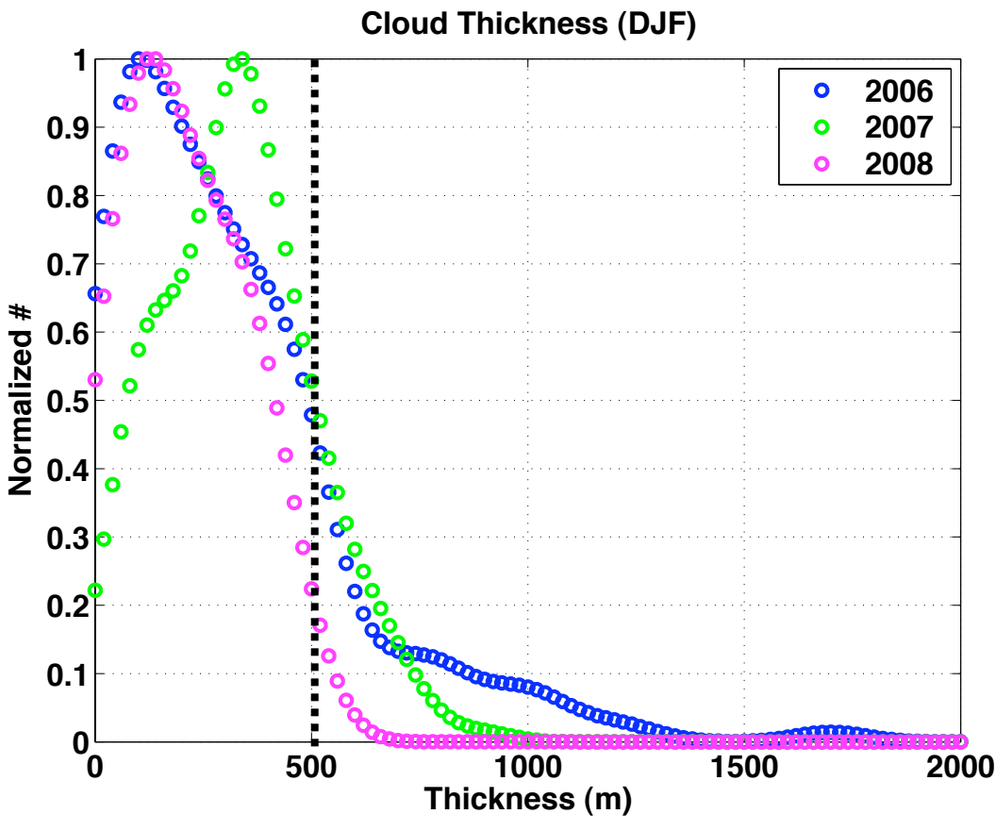


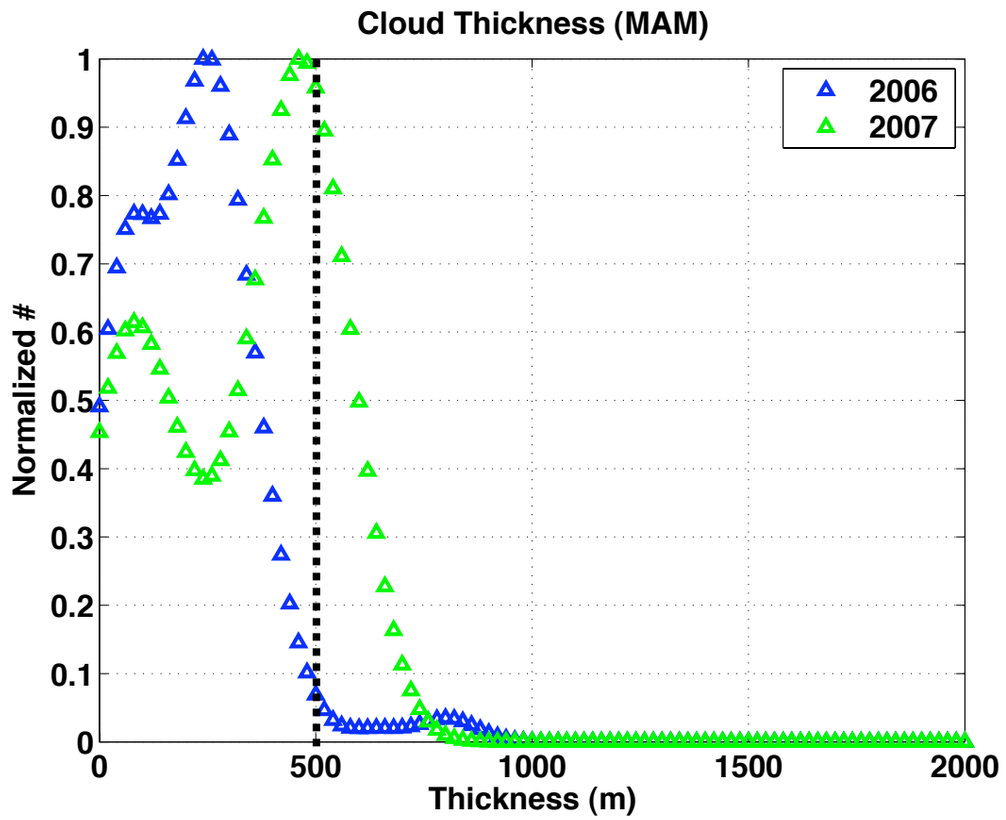


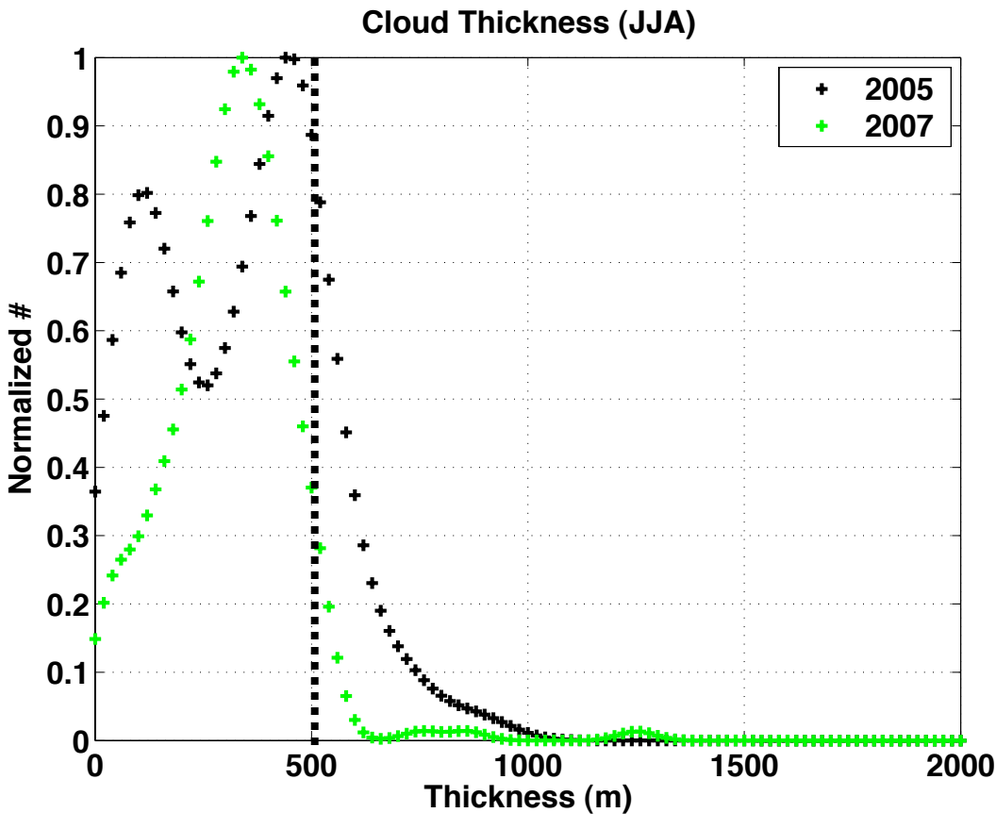
Cloud Thickness

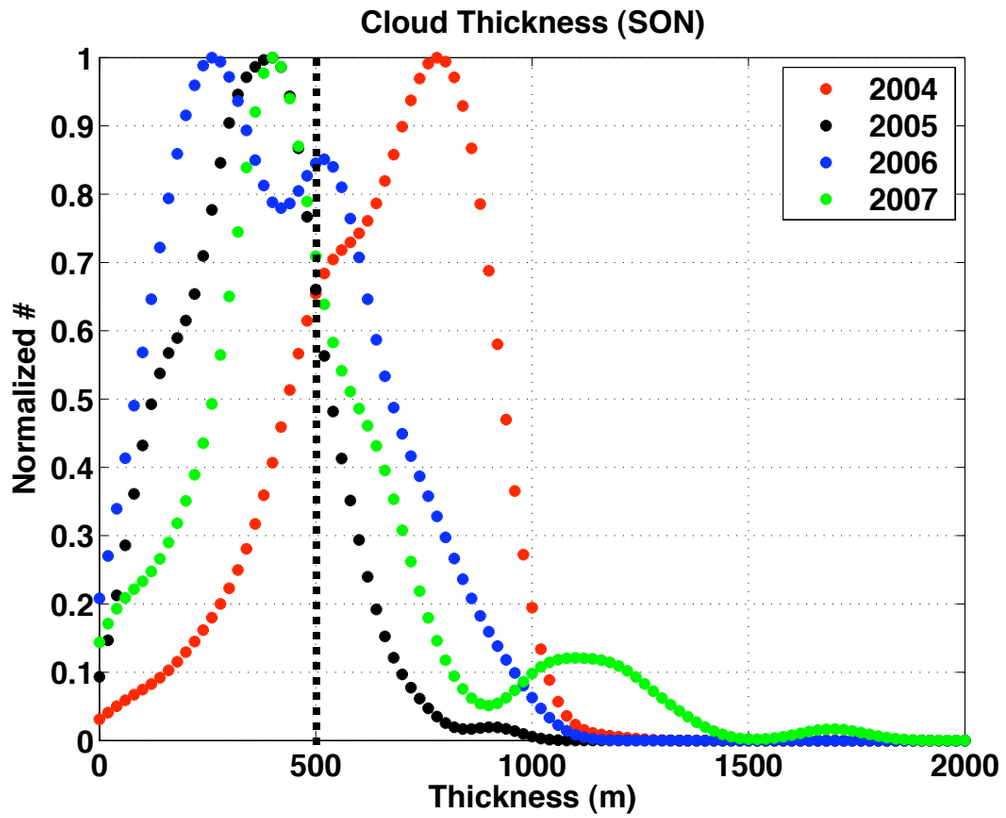
CloudSAT Vertical Resolution: ~500 m

Cloud Thickness





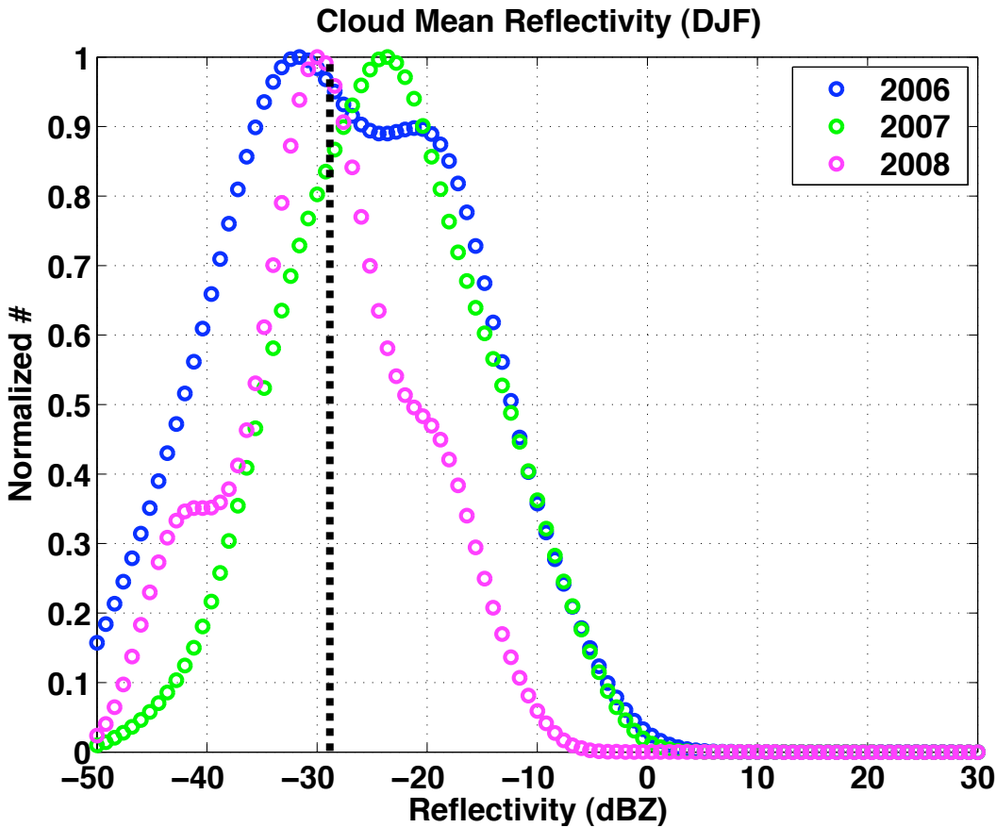


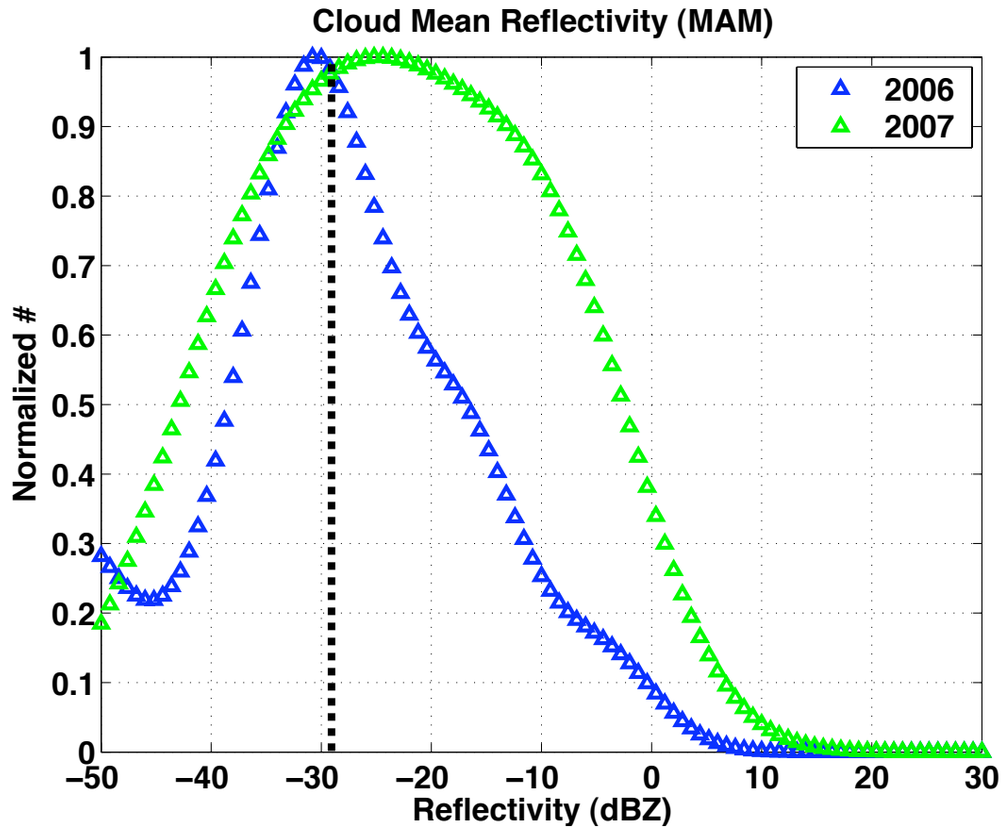


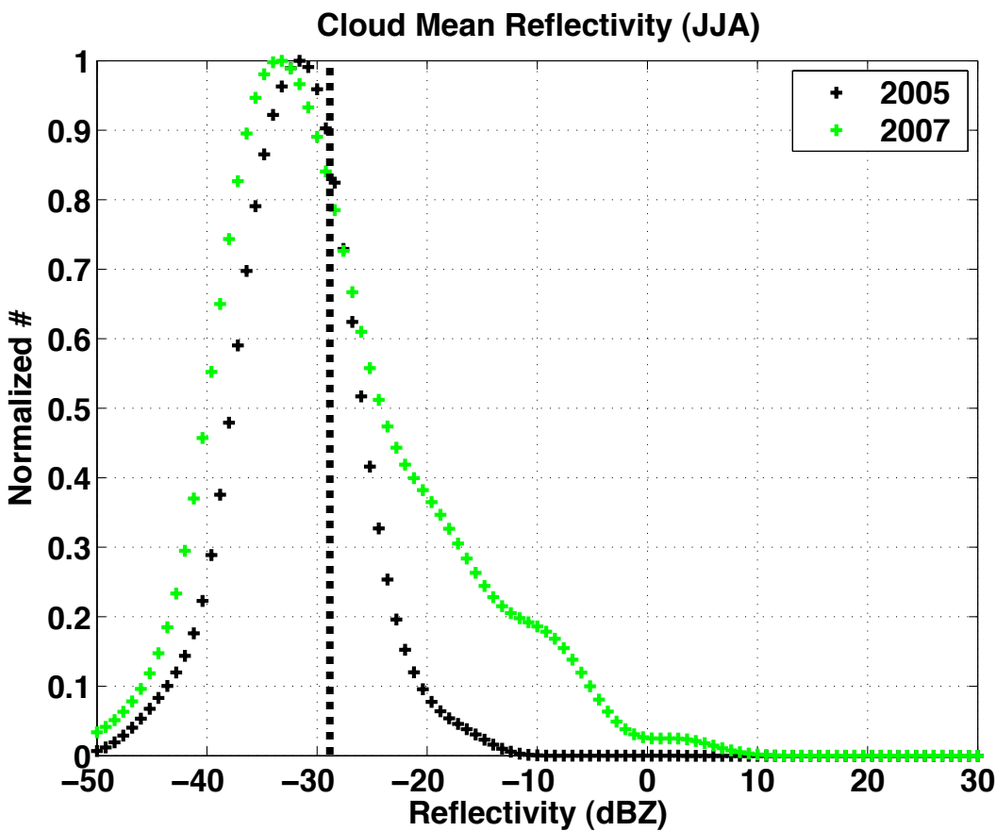
Cloud Mean Reflectivity

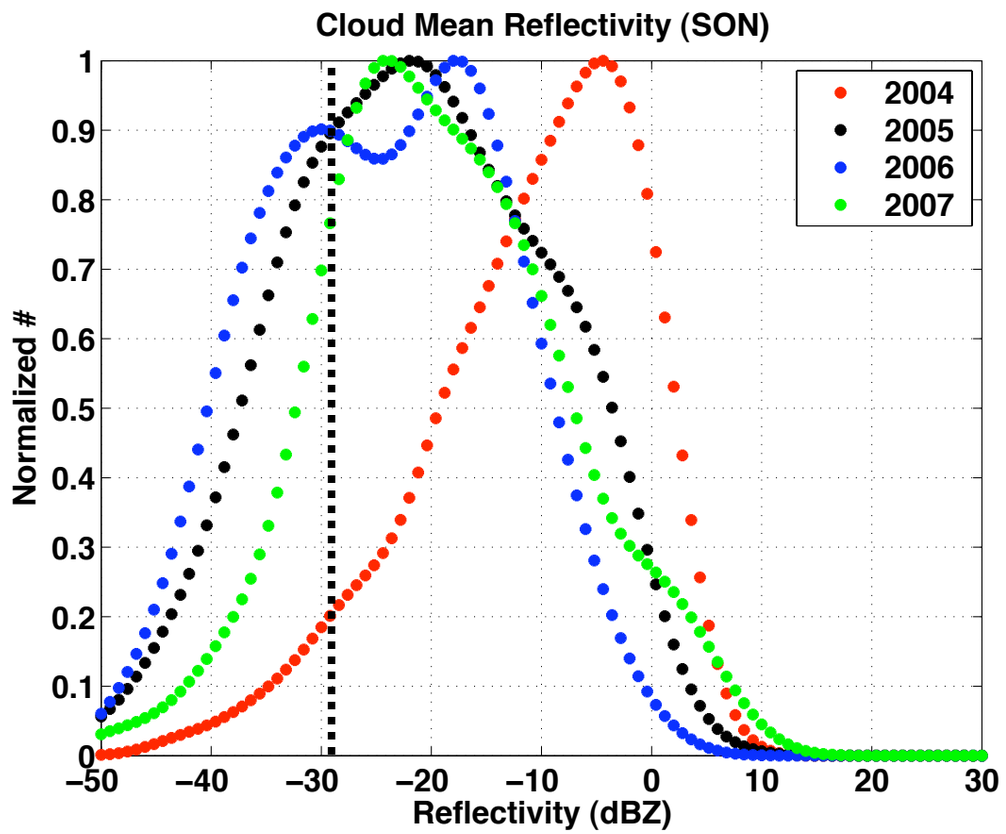
CloudSAT sensitivity: ~-29 dBZ

Cloud Mean Reflectivity

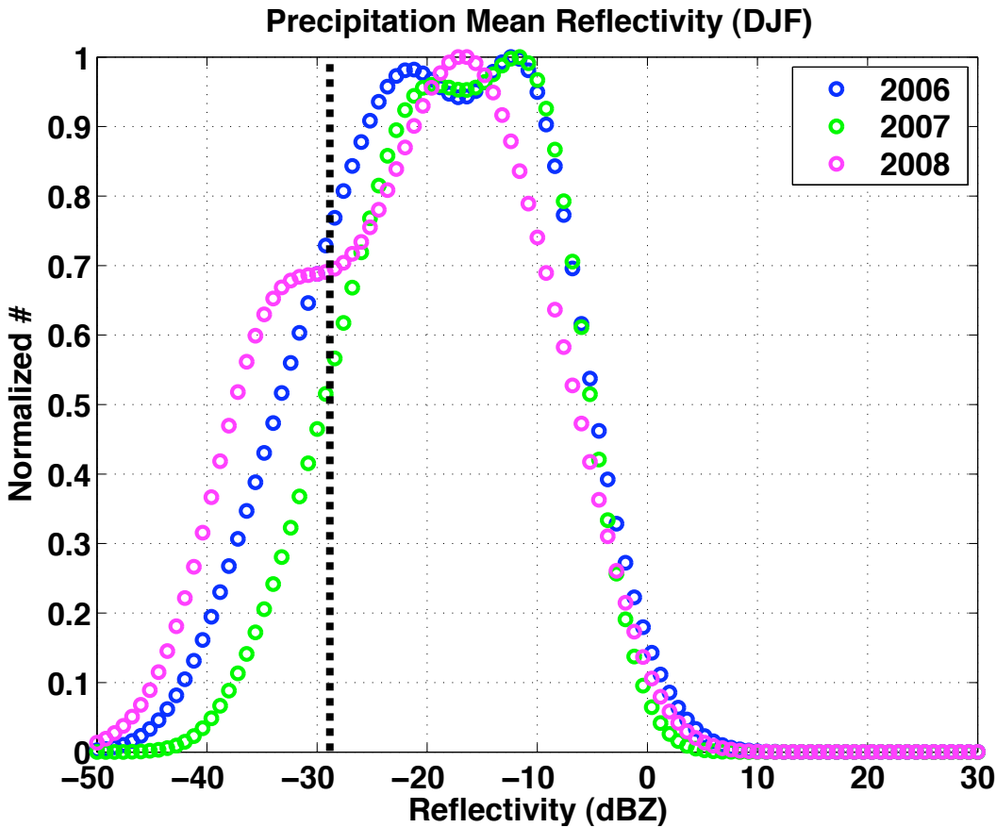


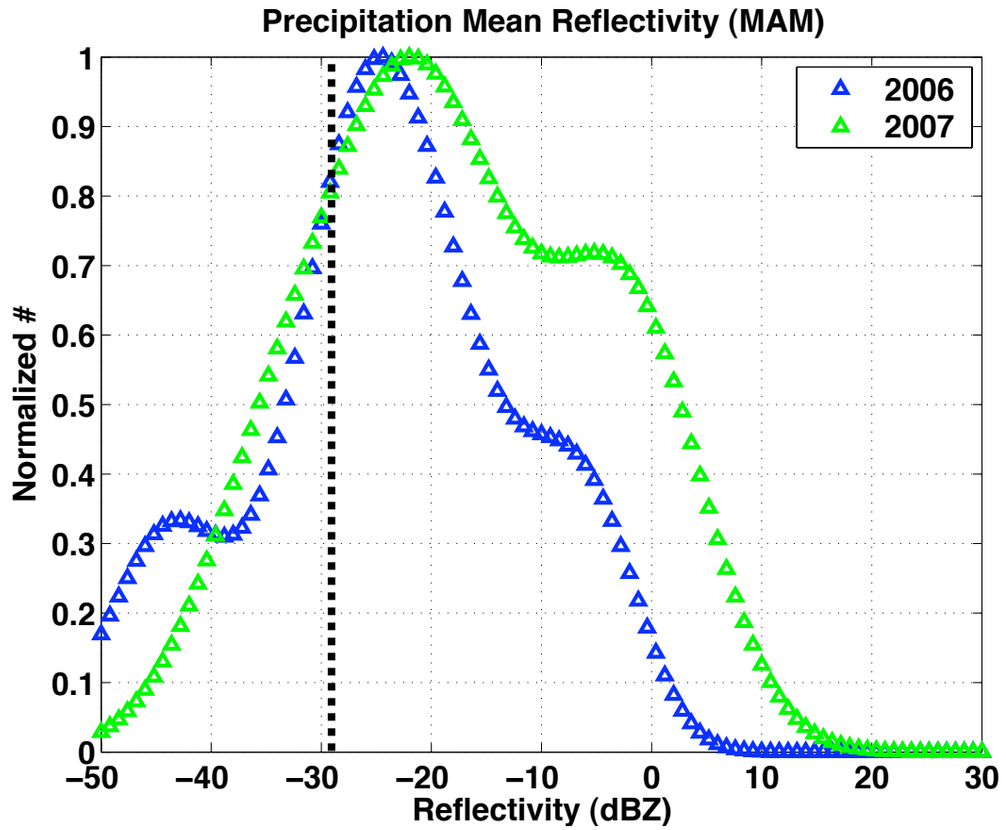


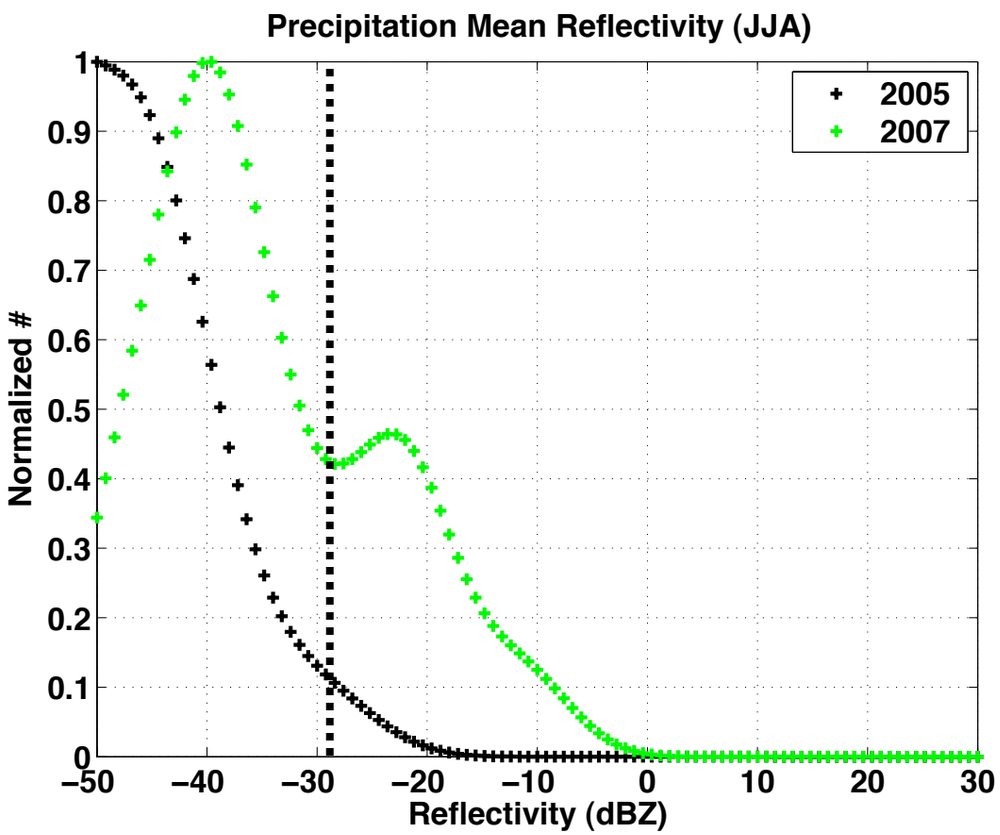


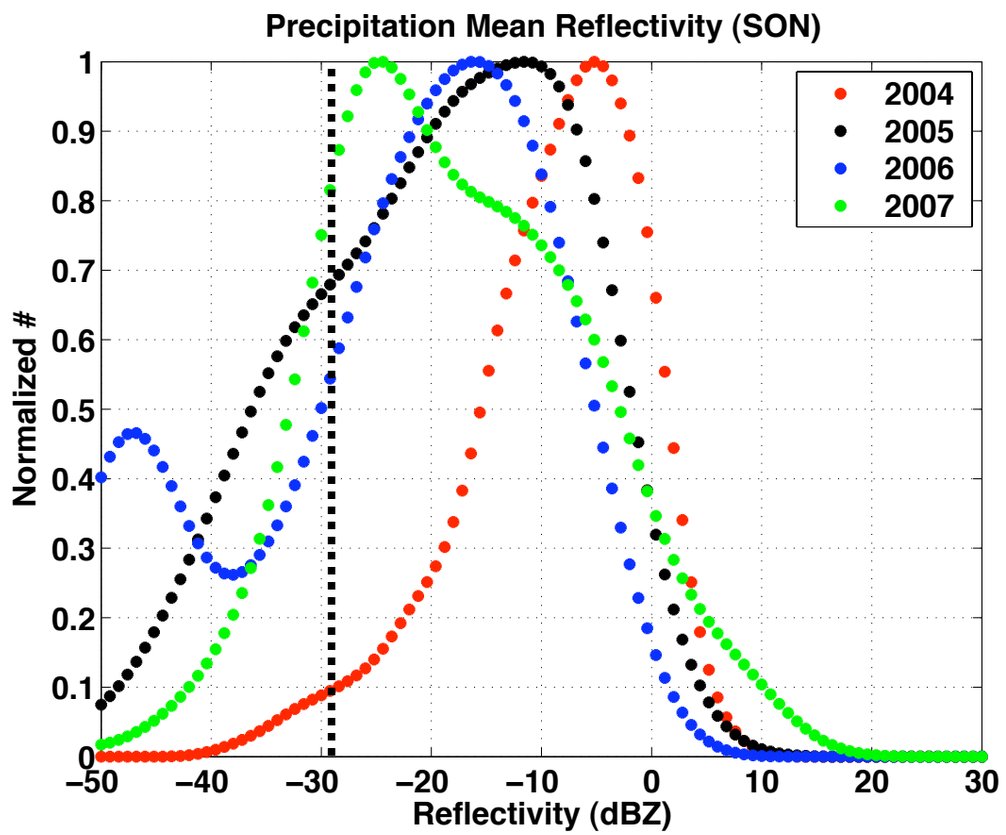


Precipitation Mean Reflectivity





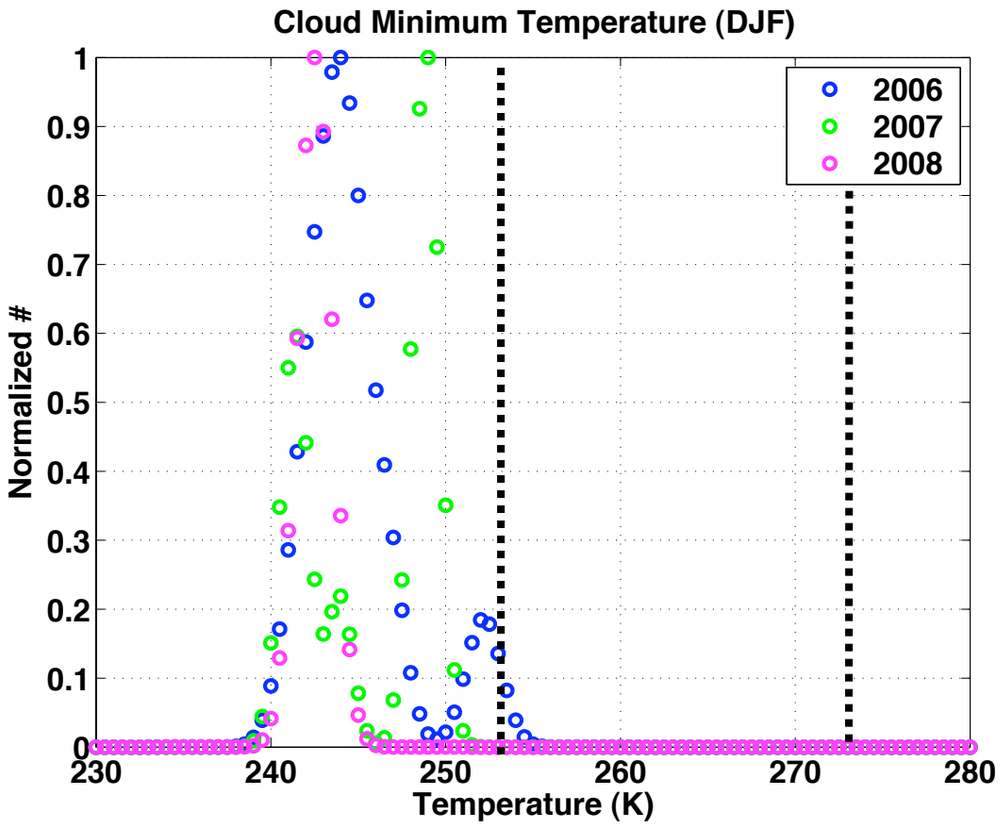


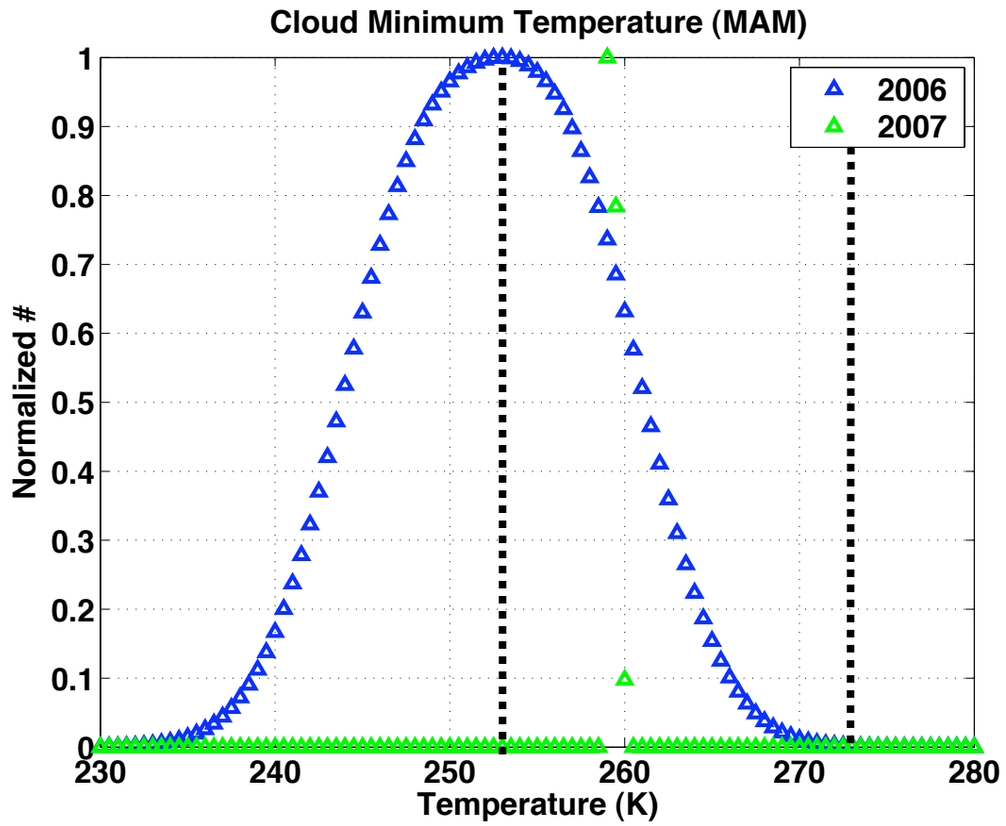


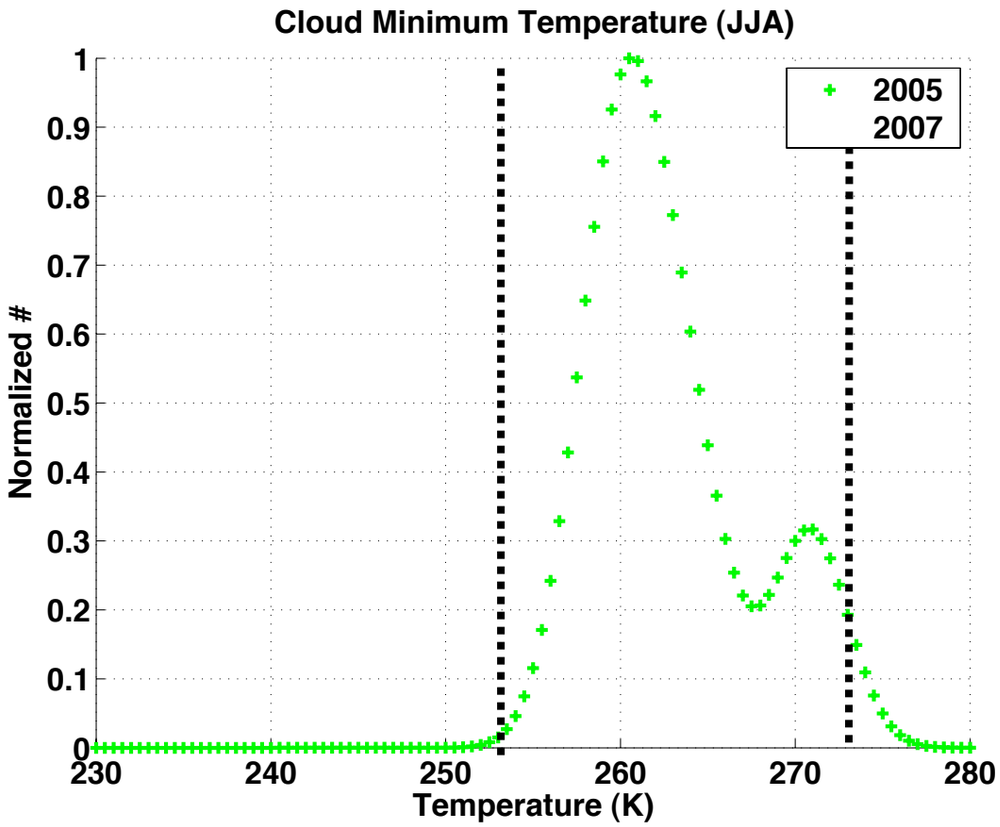
Cloud Temperature

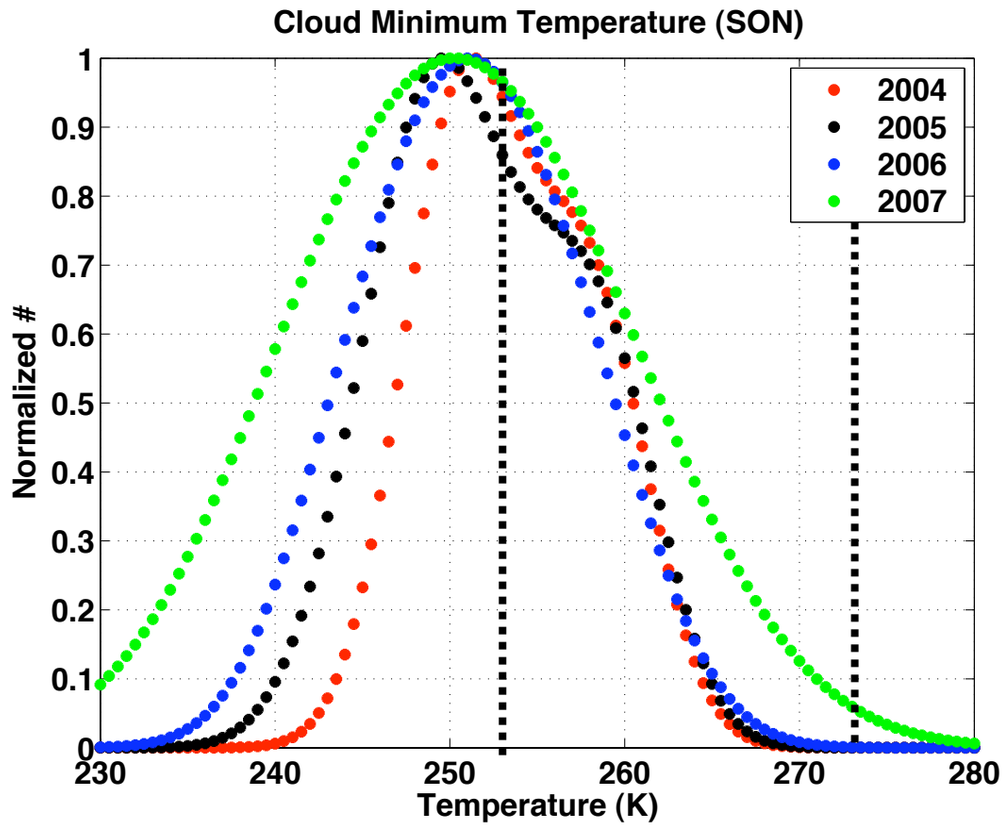
Temperature range for mixed-phase clouds used in CloudSAT Radar-Only Microphysical Retrievals: -20-0 C

Cloud Temperature







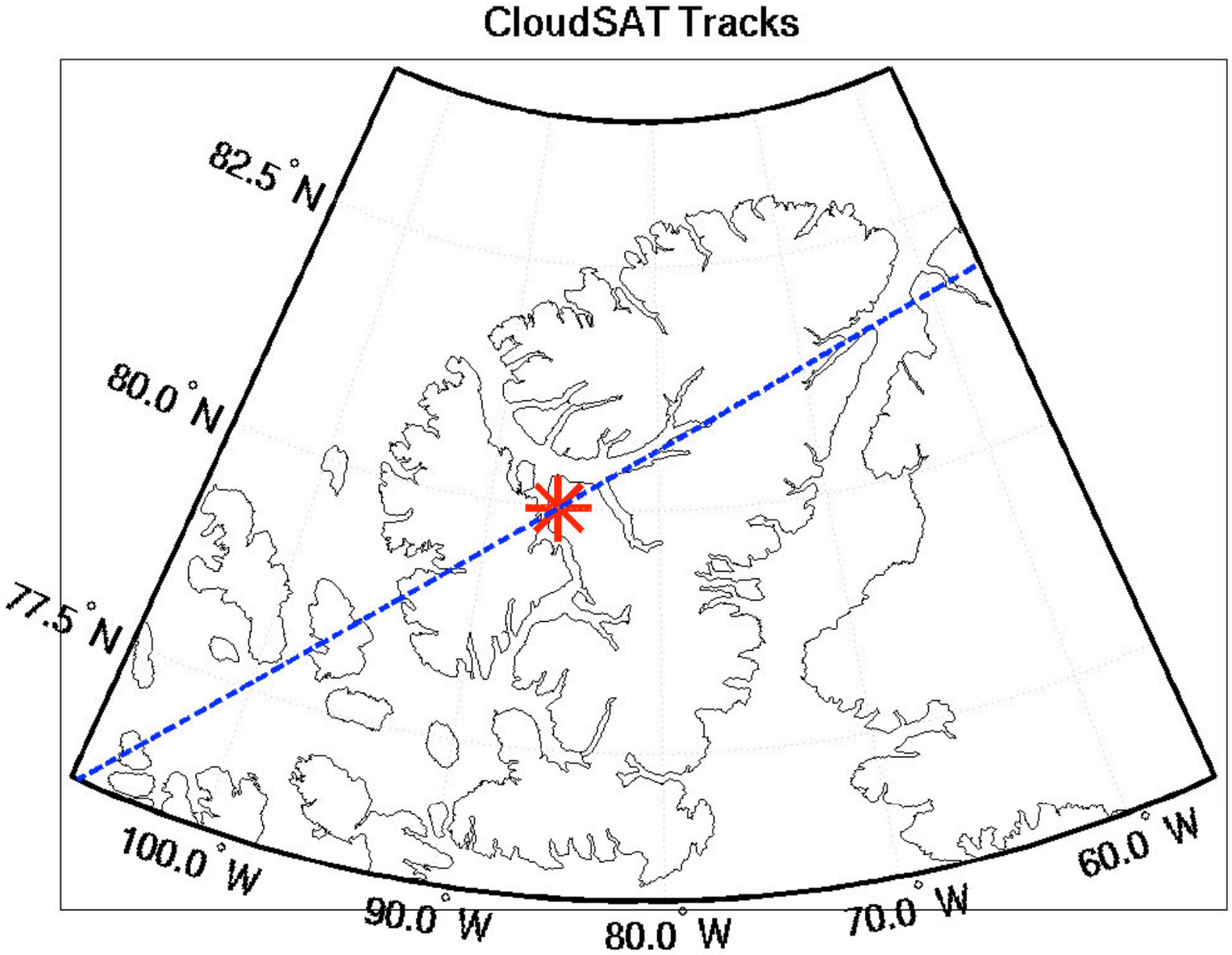


Summary #1

Single Layer Mixed-Phase Stratus

- Significant amounts have cloud bases <1000 m, particularly during transition seasons (MAM, SON)
- Low Reflectivities (<-30 dBZ) can often be found in the cloud layer, particularly during summer (JJA), when less ice is present
- Precipitation typically has reflectivities higher than -30 dBZ, but often falls within 1km of the surface
- Mixed-phase layer is often <500 m thick
- Cloud minimum temperatures range from 0 to -40 C, with a maximum of occurrence at around -20 C.

Introduction: Representativeness



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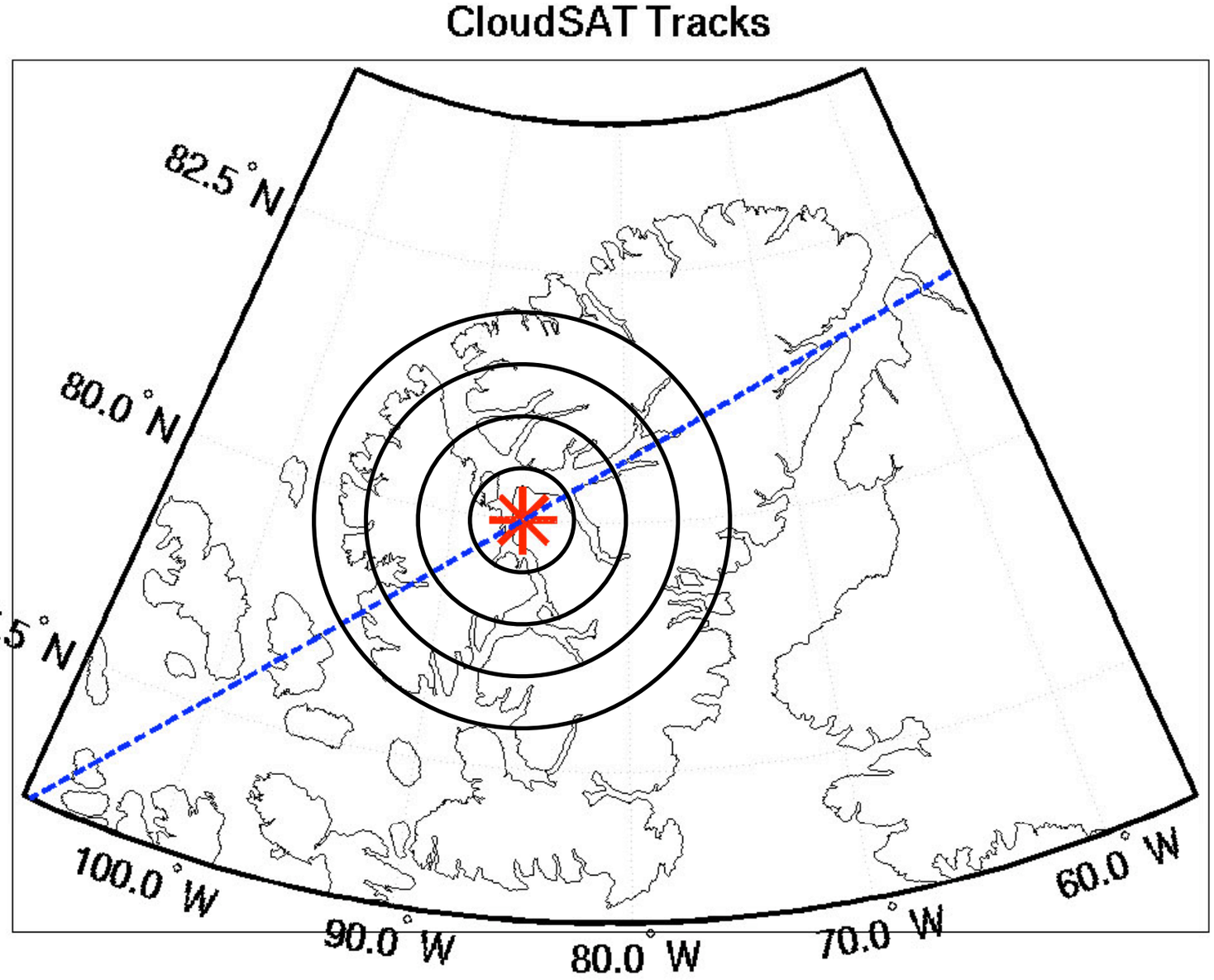
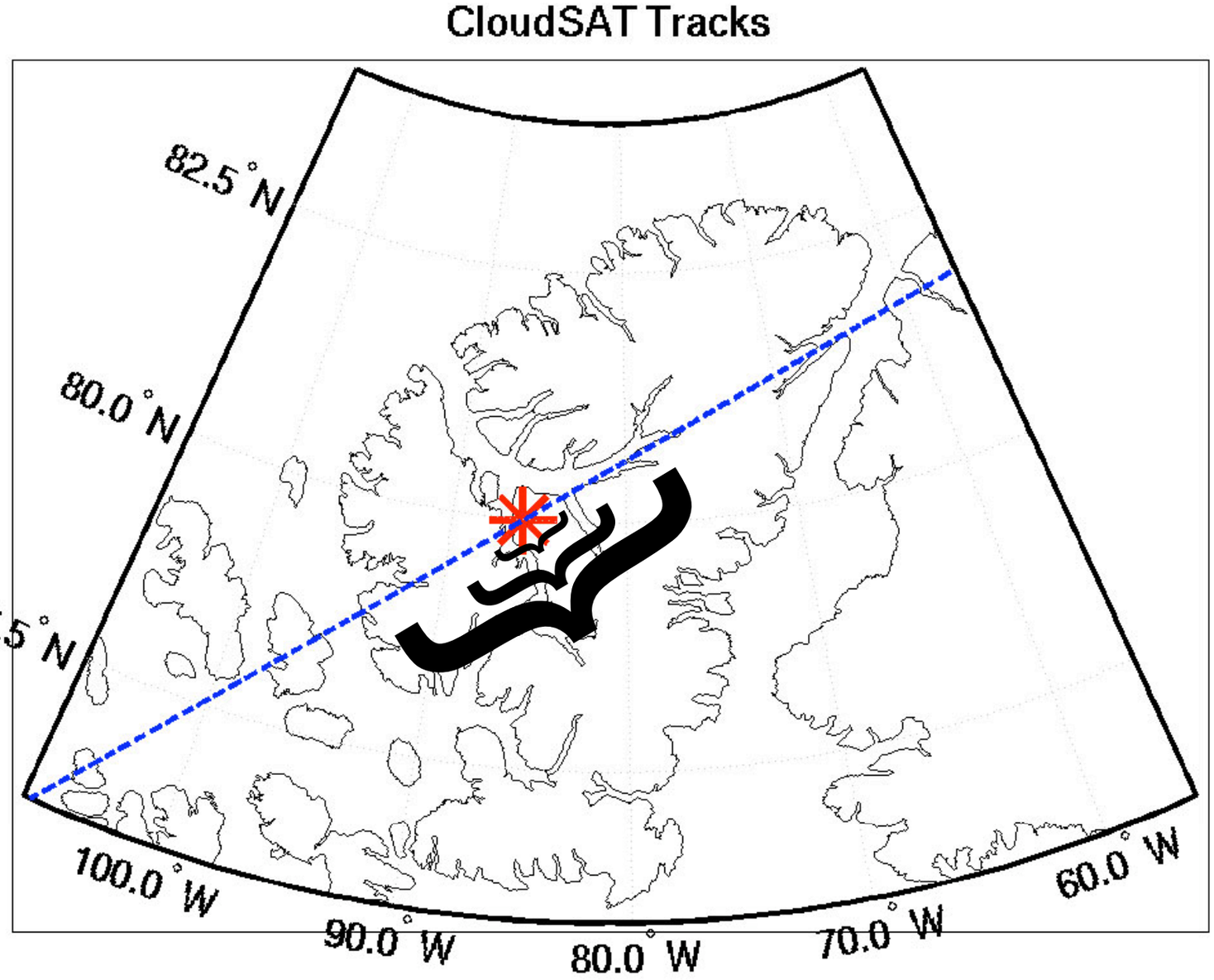


- Distance of overpass from ground site

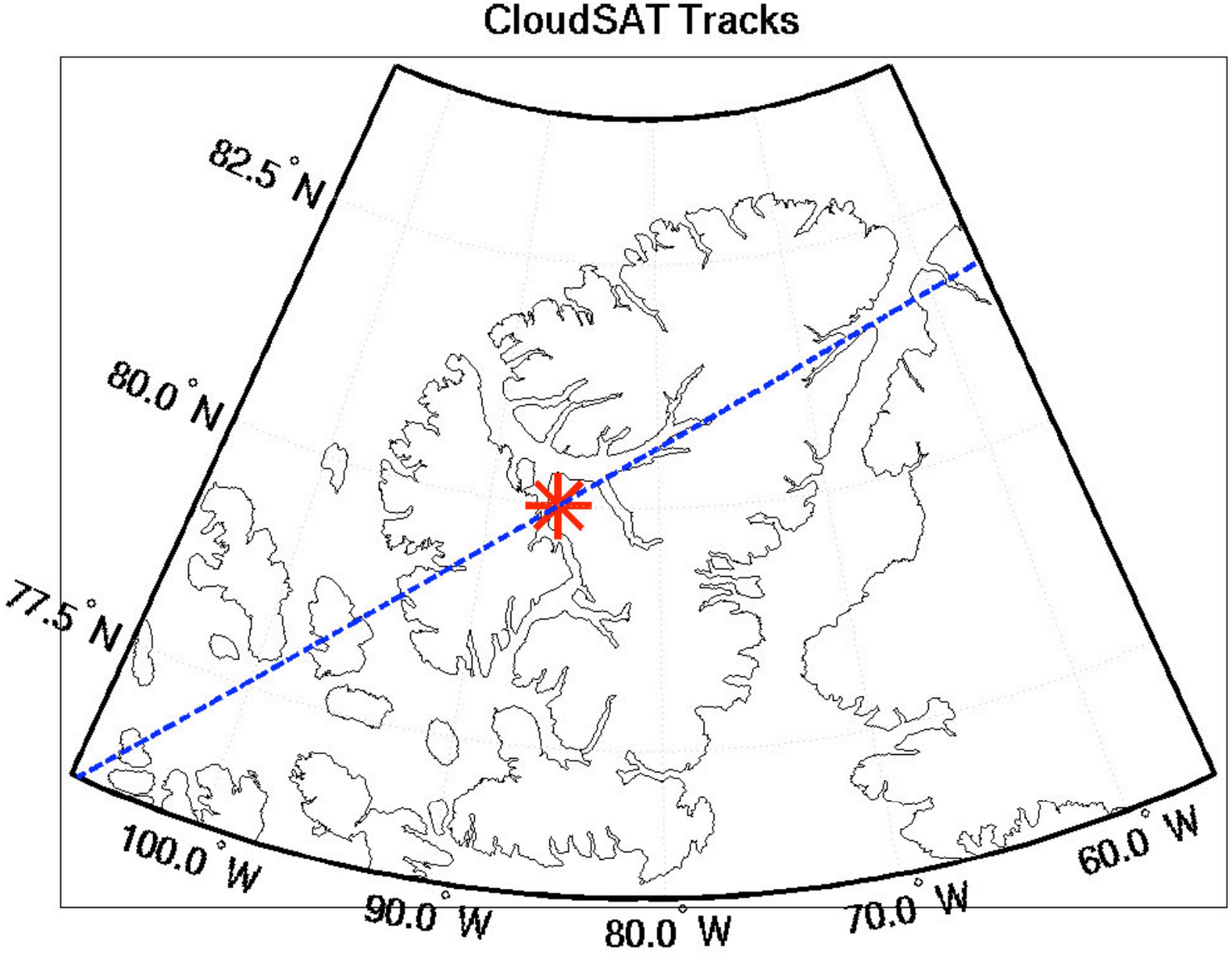
Introduction: Representativeness

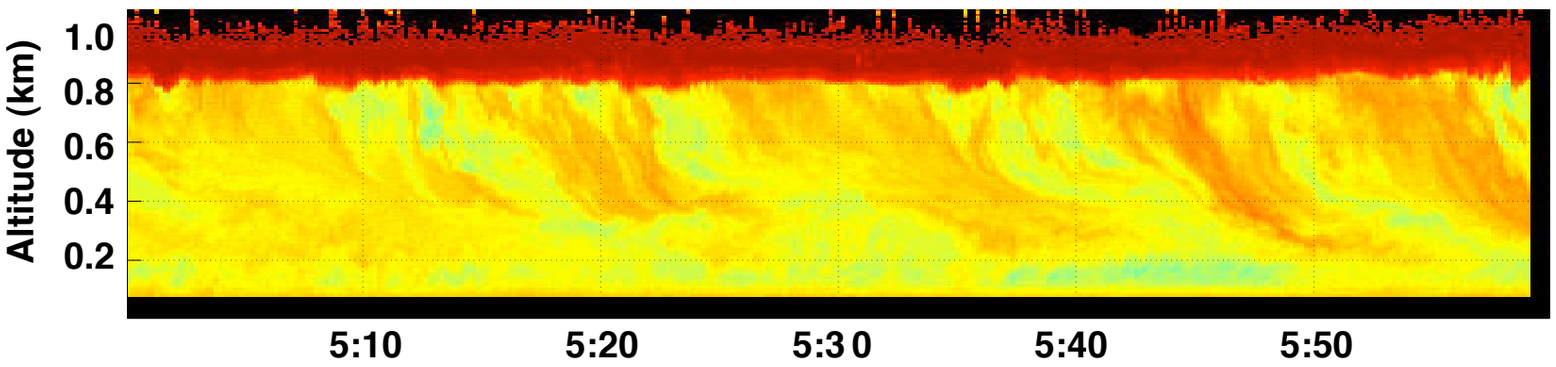


- Distance of overpass from ground site

- Along-track averaging window

Introduction: Representativeness



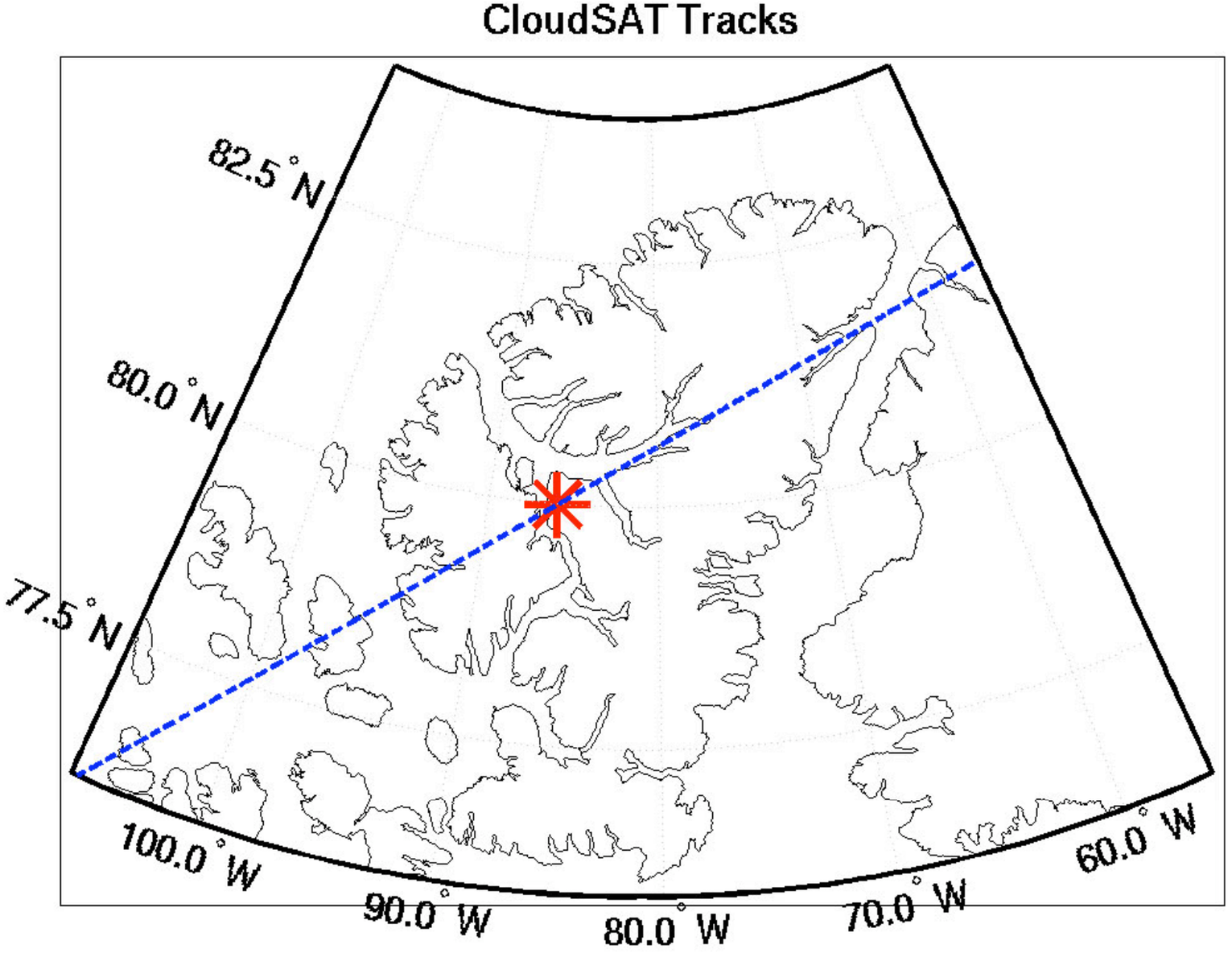


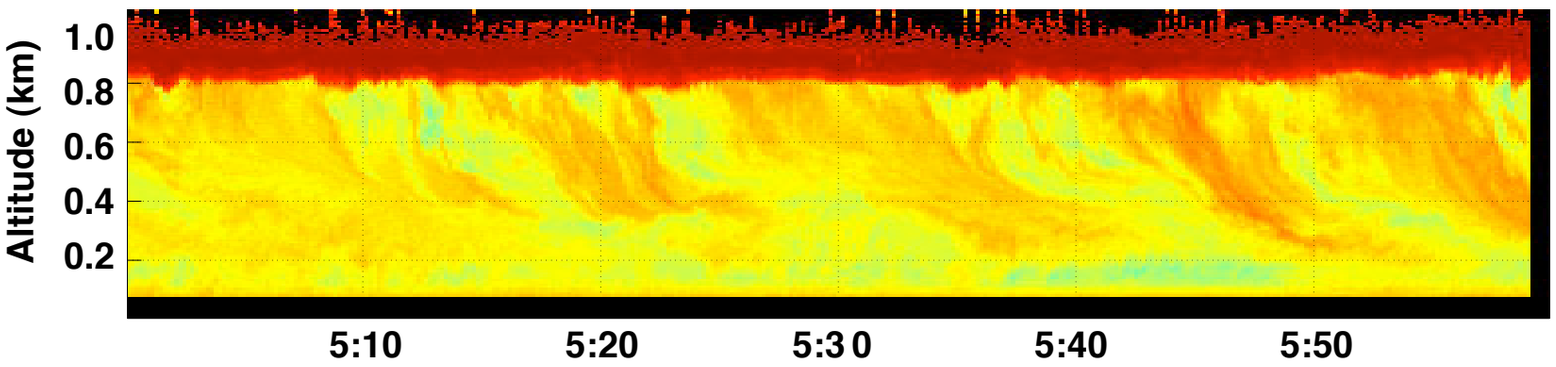
- Distance of overpass from ground site

- Along-track averaging window

- Ground-based averaging window

Introduction: Representativeness





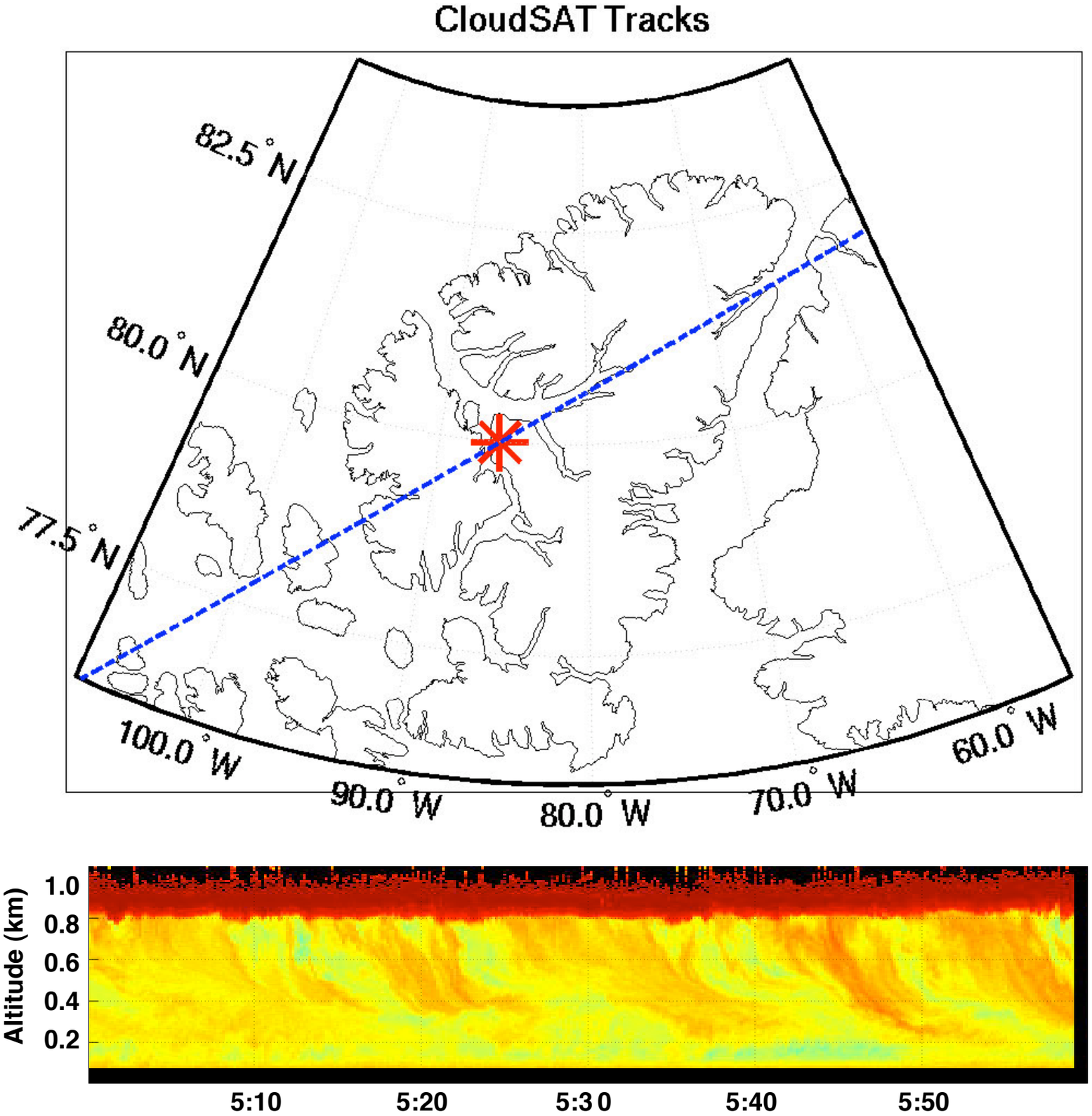
- Distance of overpass from ground site

- Along-track averaging window

- Ground-based averaging window

- Wind Direction, etc.

Introduction: Representativeness



- Distance of overpass from ground site

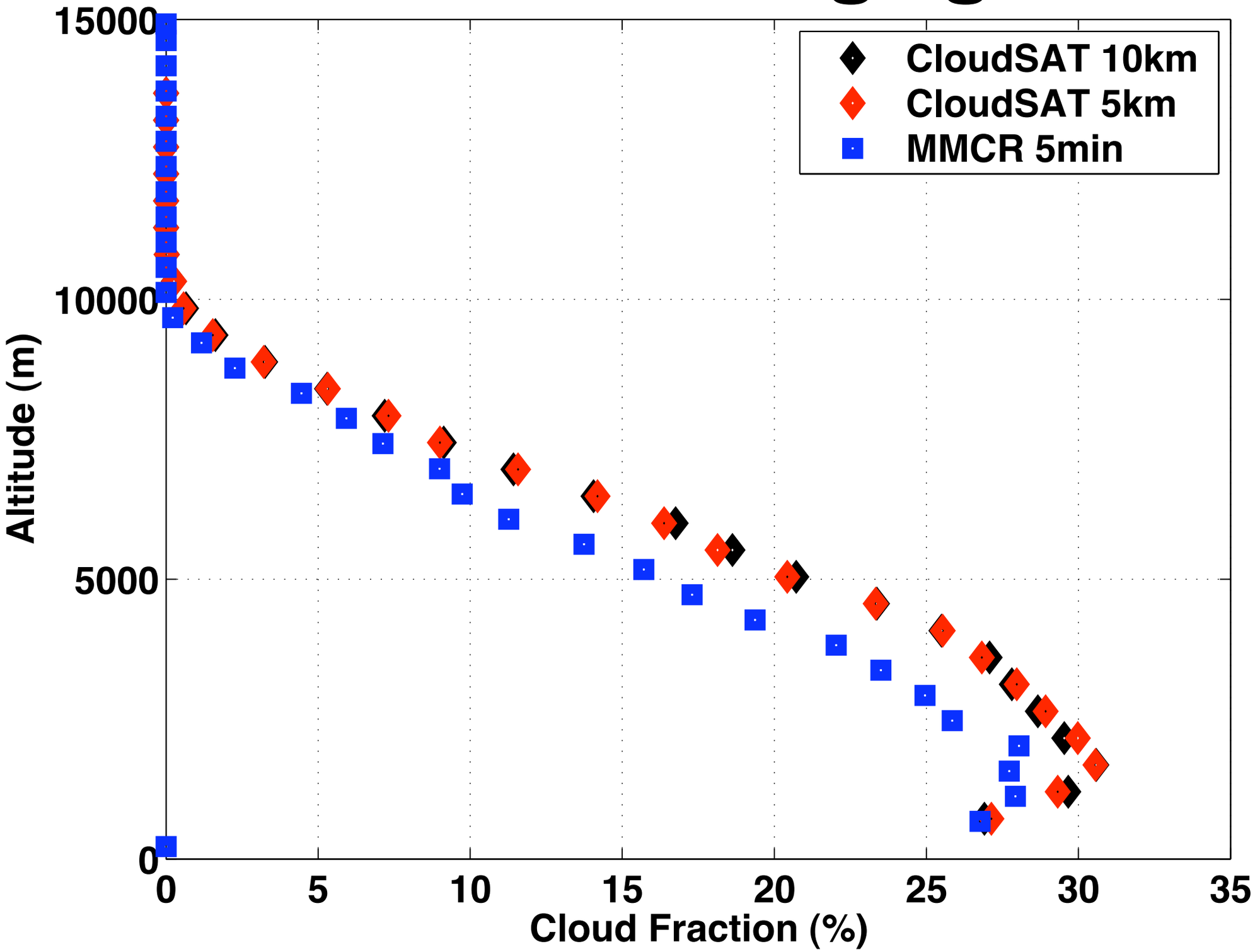
- Along-track averaging window

- Ground-based averaging window

- Wind Direction, etc.

- 437 cases @ <50km
- 181 cases @ <20km

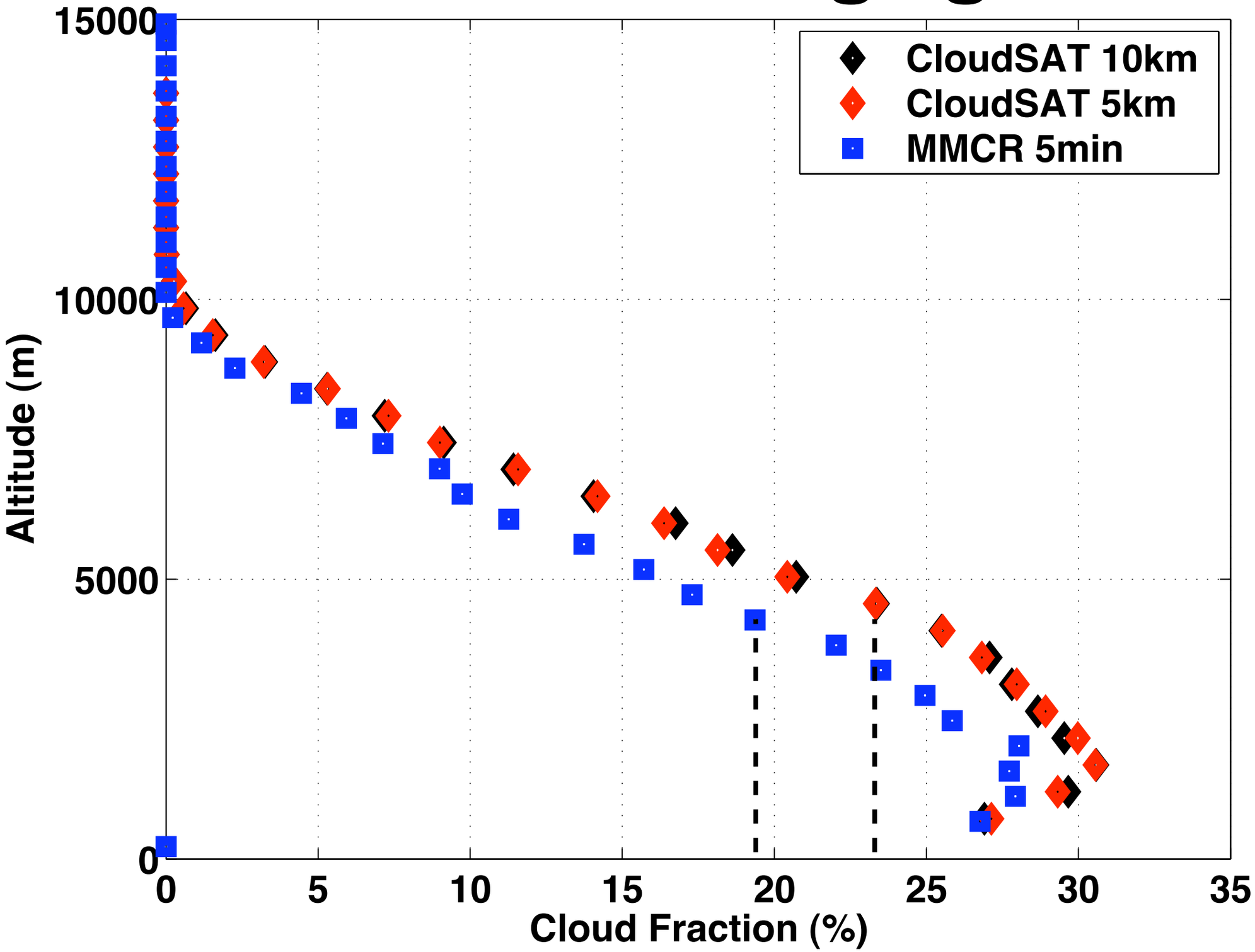
Ground Track Averaging Interval



Overpasses<50 km

(CloudSAT data from Jennifer Kay)

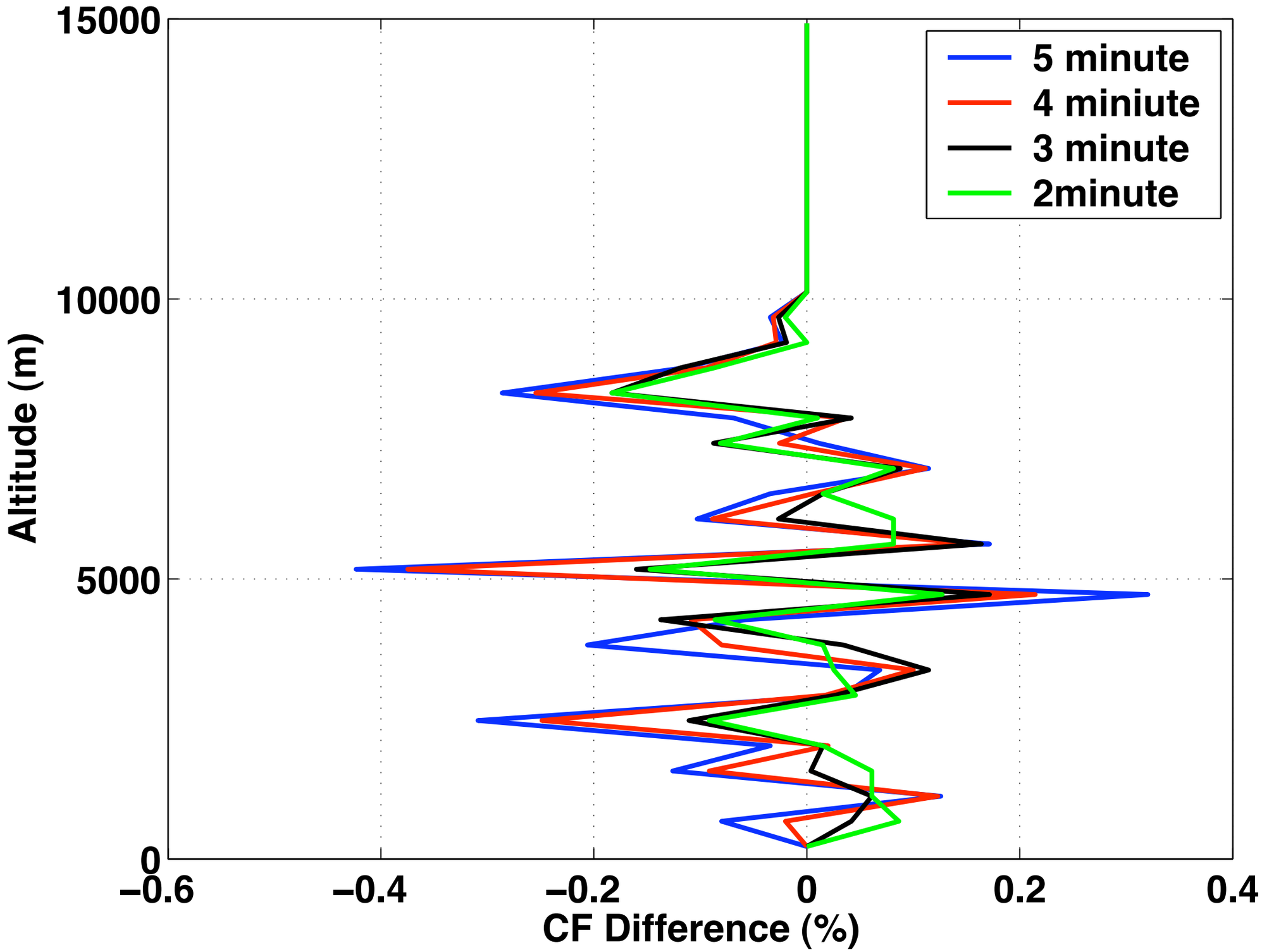
Ground Track Averaging Interval



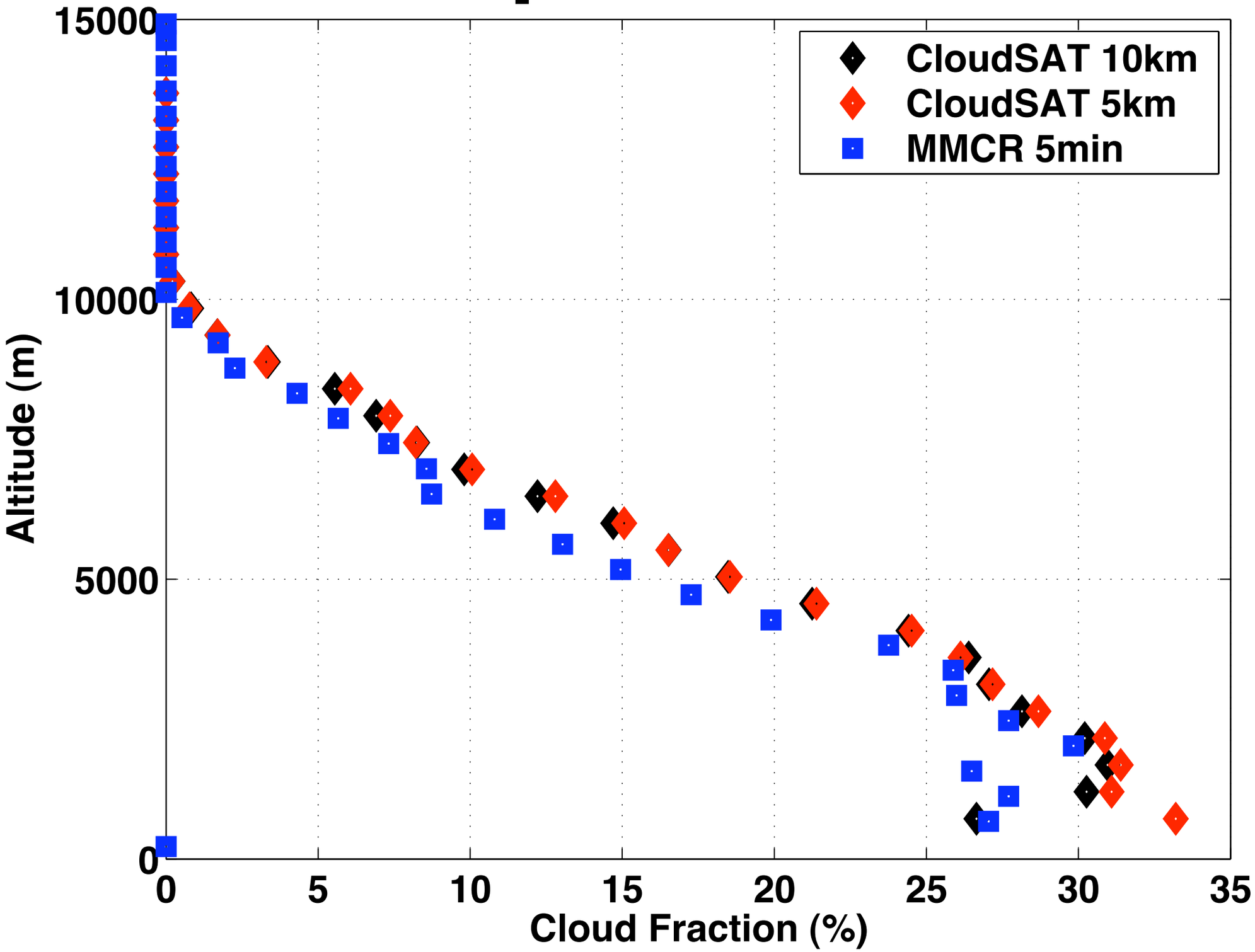
Overpasses<50 km

(CloudSAT data from Jennifer Kay)

Ground-Based Averaging Interval



Overpass Distance



Overpasses<20 km

(CloudSAT data from Jennifer Kay)

CloudSAT Science Team Meeting, Seattle, WA 19-21 August, 2008

Summary #2

Single Location Comparison

- Some significant differences (up to ~5%) exist between original CloudSAT and ground-based estimates.
- Ground-based and along track averaging intervals seem to have little effect on cloud-fraction calculation (within reason)
- Overpass distance considered has significant effect
- Future work will broaden this topic to come up with statistical analysis on how representative "point" comparisons are for different distances, averaging intervals, etc.

References

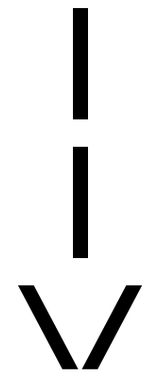
Curry, J.A., W.B. Rossow, D. Randall and J.L. Schramm (1996), Overview of Arctic Cloud and Radiation Characteristics. J. Climate, 9, 1731-1764.

de Boer, G., E.W. Eloranta and M.D. Shupe (2008), Arctic Mixed-Phase Stratus Properties from Multiple Years of Surface-Based Measurements at Two High-Latitude Locations. In Preparation.

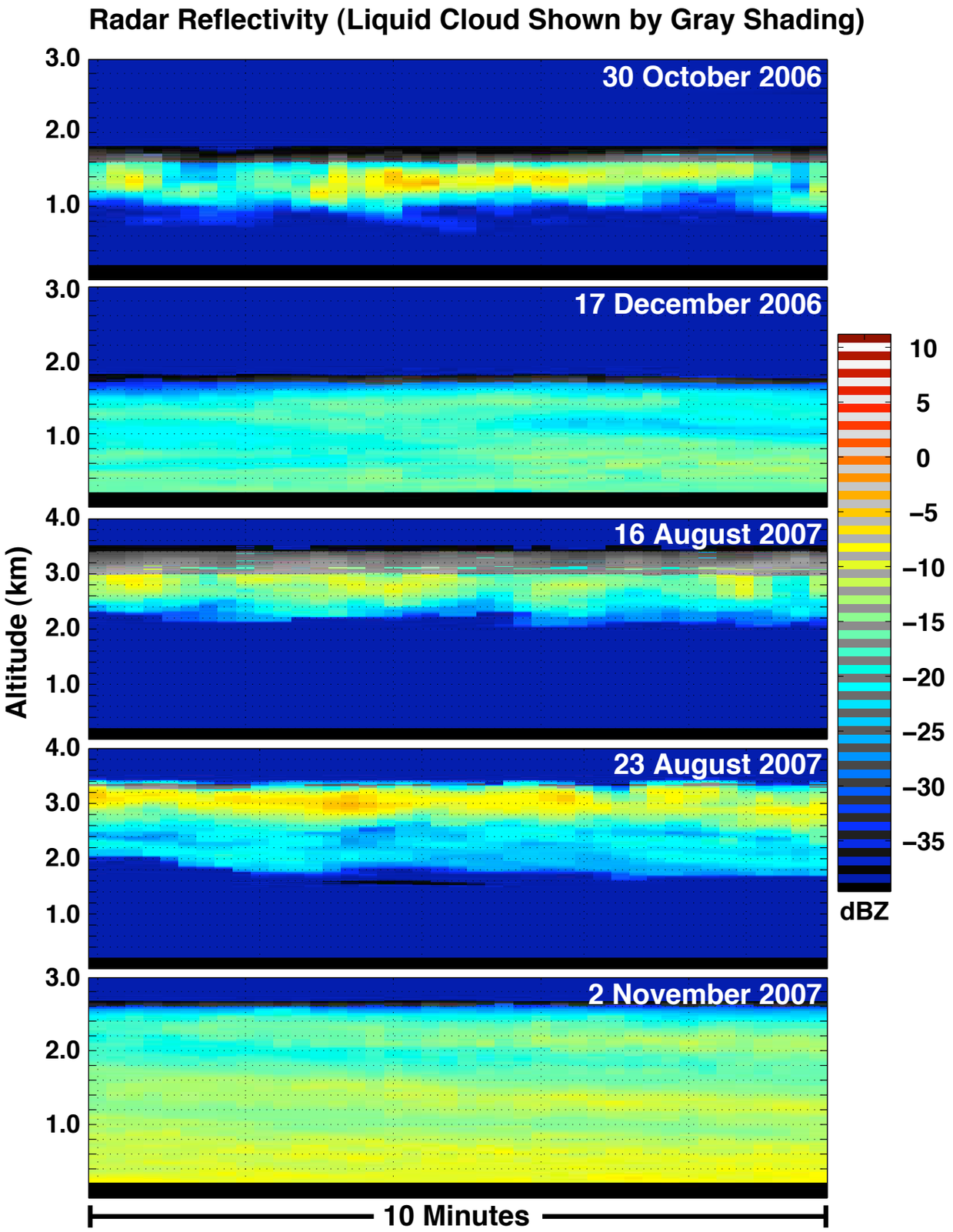
Herman, G., and R. Goody (1976), Formation and Persistence of Summertime Arctic Clouds. J. Atmos. Sci., 33, 1537-1553.

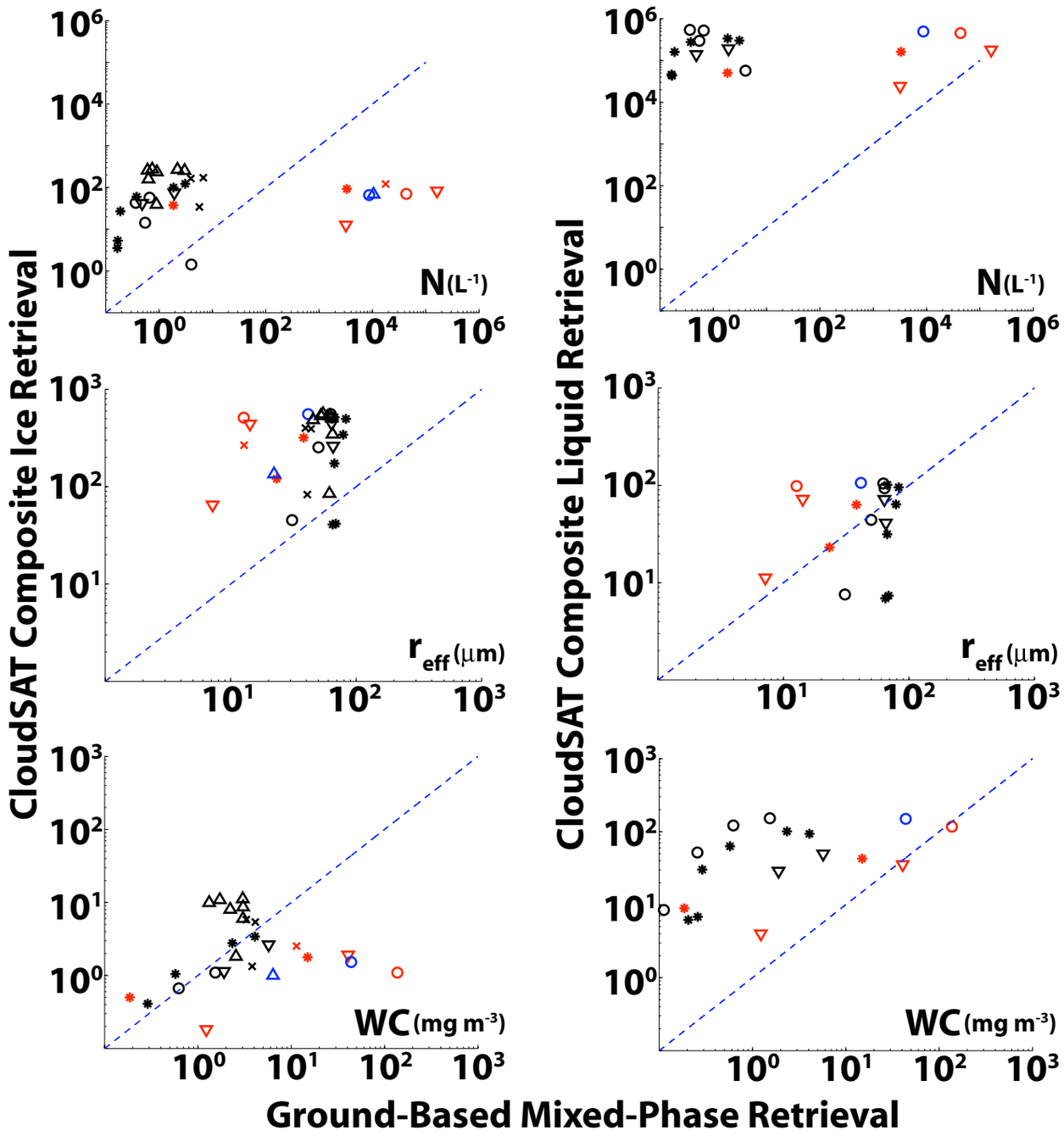
Klein, S.A., R. McCoy, H. Morrison, A. Ackerman, A. Avramov, G. de Boer, M. Chen, J. Cole, A.D. DelGenio, M. Falk, M. Foster, A. Fridlind, J.-C. Golaz, T. Hashino, J. Harrington, C. Hoose, M. Khairoutdinov, V. Larson, X. Liu, Y. Luo, G. McFarquhar, S. Menon, R. Neggers, S. Park, K. von Salzen, J.M. Schmidt, I. Sednev, B. Shipway, M. Shupe, D. Spangenberg, Y. Sud, D. Turner, D. Veron, G. Walker, Z. Wang, A. Wolf, S. Xie, K.-M. Xu, F. Yang, and G. Zhang (2008), Intercomparison of model simulations of mixed-phase clouds observed during the ARM Mixed-Phase Arctic Cloud Experiment. Part I: Single layer cloud. Submitted to the Quarterly Journal of the Royal Meteorological Society.

EXTRA SLIDES



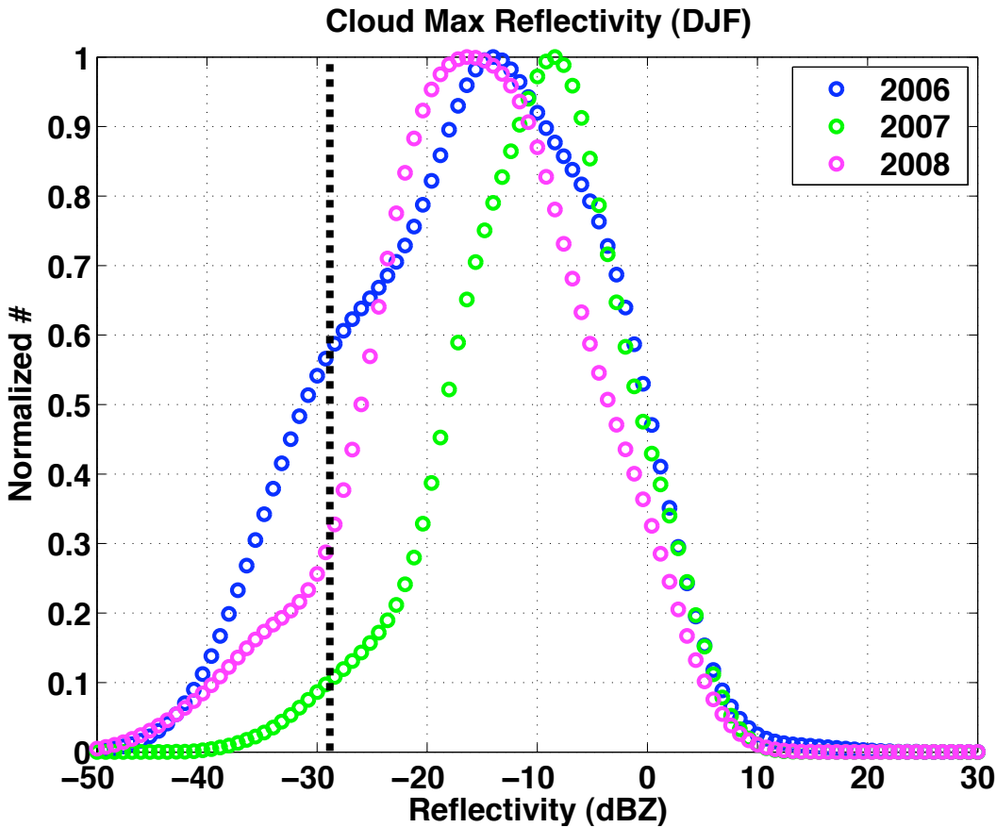
2B-RO Microphysical Retrievals

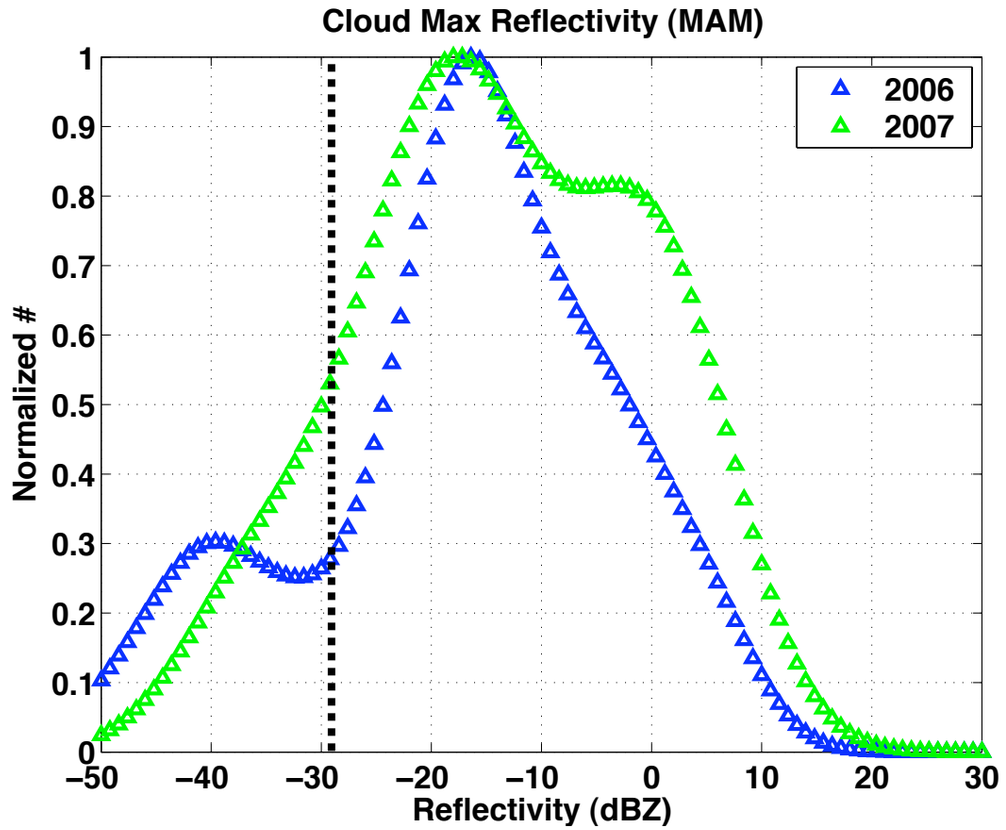


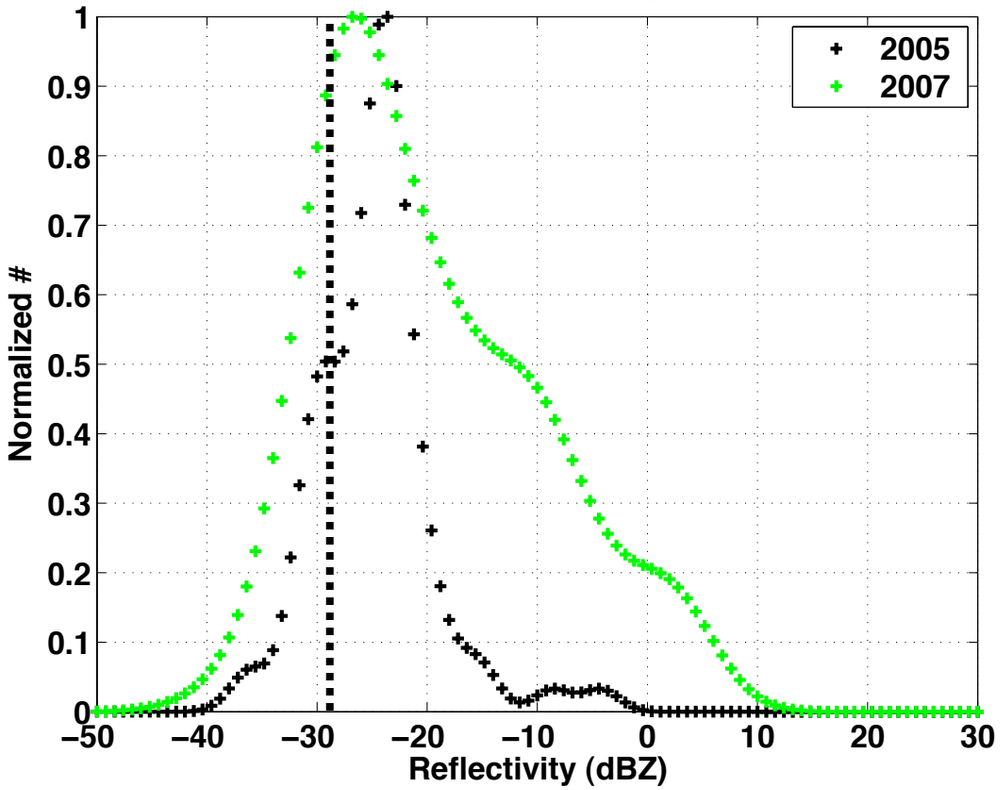


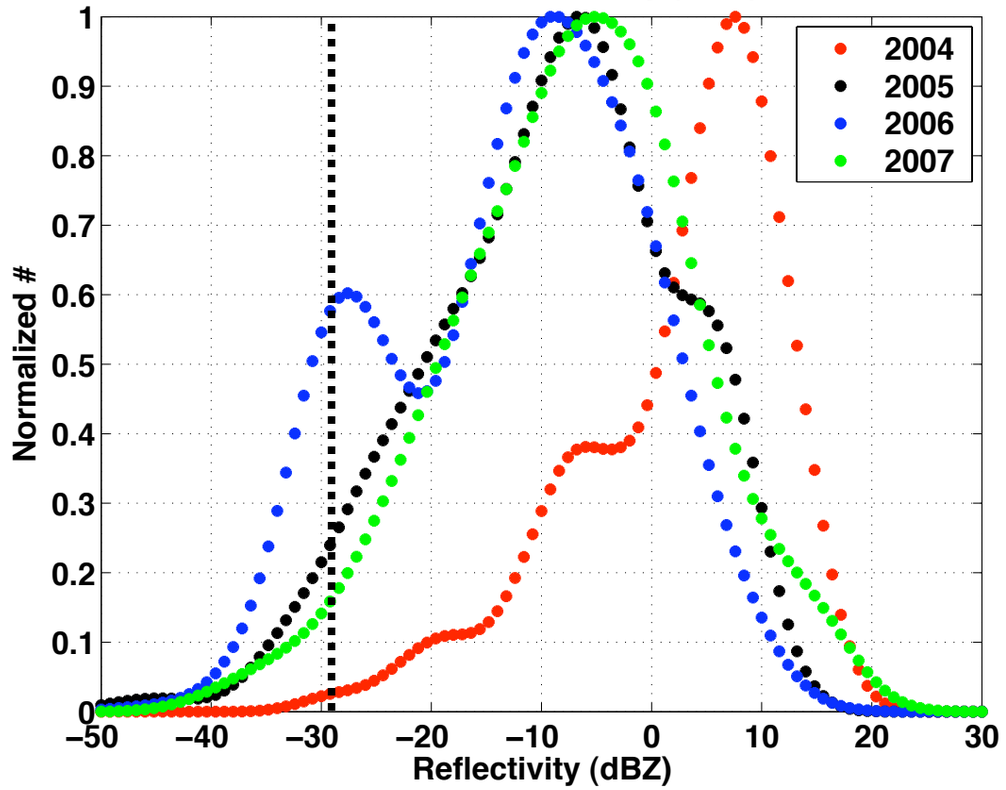
▽ Case 1 X Case 2 ○ Case 3 ✳ Case 4 △ Case 5

Cloud Maximum Reflectivity









Precipitation Maximum Reflectivity