CoSSIR

(Compact Scanning Submillimeter-wave Imaging Radiometer) Measurements of Ice Clouds and Water Vapor During TC^4

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Objectives and Instrument Characteristics

- Objectives:

- To measure ice cloud properties (ice water path and particle size)

- To measure water vapor profiles in clear sky and cirrus

- CoSSIR Characteristics:

- A total power radiometer with 11 channels from 183 to 874 GHz

- Range of scanning geometries with view angles from nadir to 53^{o}

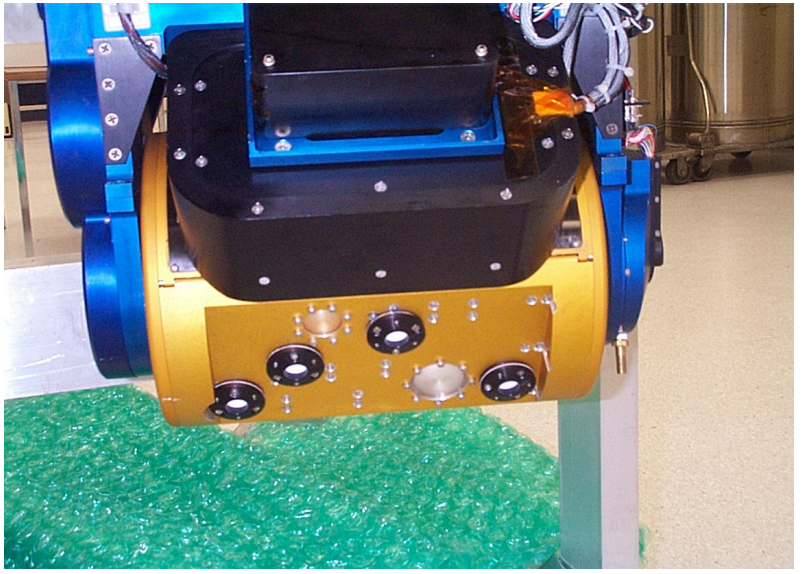
CoSSIR Specifications

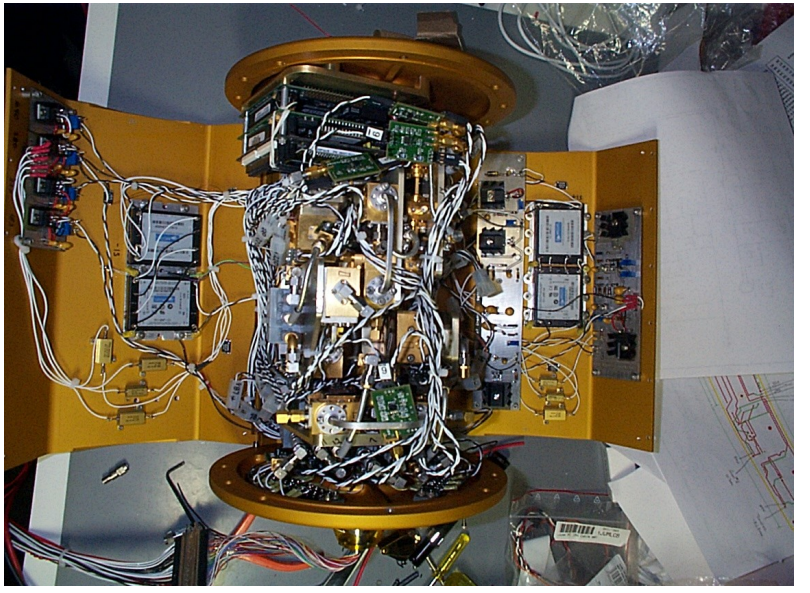
Center Frequency (GHz)	Bandwidth (MHz)	Tsys (K)	NEΔT for τ =100 ms @ 200K (K)	Beamwidth (degrees)	Polarization
183.31 ± 1	500	1341	0.22	4	H
183.31 ± 3	1000	1341	0.15	4	H
183.31 ± 6.6	1500	1341	0.13	4	H
220	3000	1418	0.09	4	H
380±0.8	700	3361	0.43	4	H
380±1.8	1000	2964	0.32	4	H
380±3.3	1700	2964	0.24	4	H
380±6.2	3600	2964	0.17	4	H
640	4000	4306	0.71	4	H and V
874	5000	<5000*	0.84	4	V

* Estimated

CoSSIR Hardware

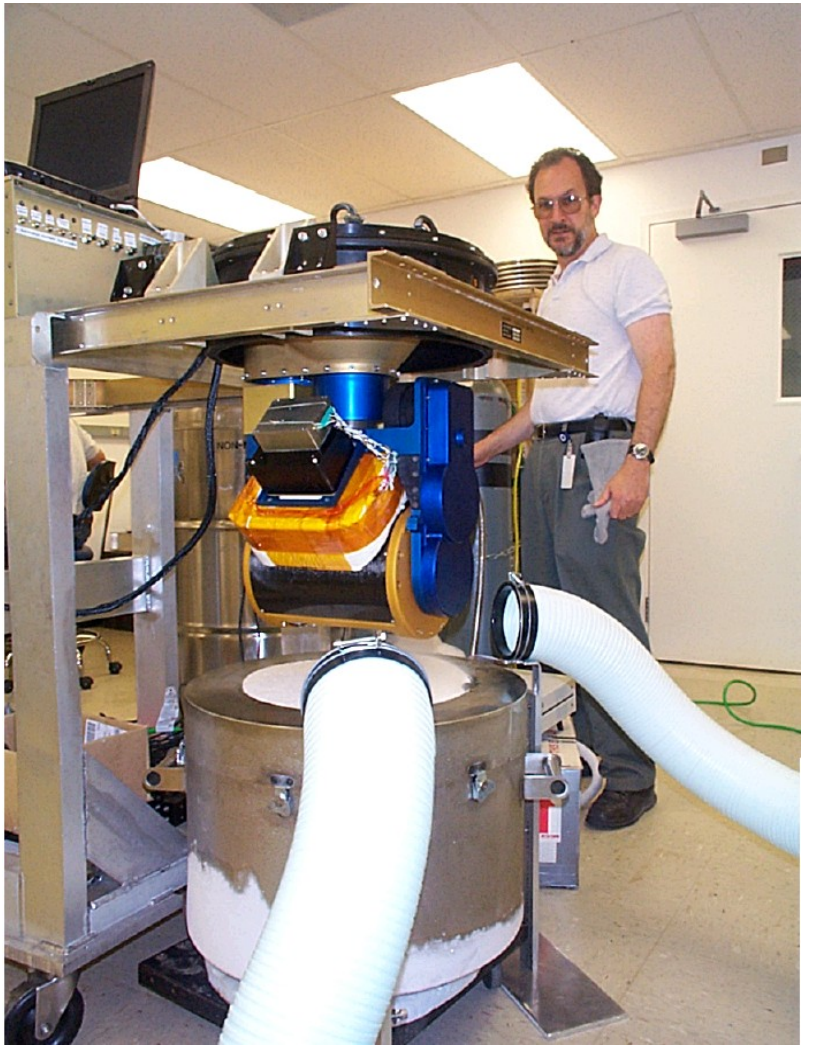
- The top picture on the right shows the CoSSIR scan head (gold color) and one of its two (hot and cold) calibration targets (black color, another one is on the back).
- The scan head is about 8 inches in diameter and 11 inches in length.
- The scan head and calibration targets rotate together freely in 360 degrees in both azimuth and elevation.
- The temperatures of the hot and cold calibration targets during flights are about 250 and 330 K and are measured to within 0.1 K.
- The bottom picture on the right shows the top view of the CoSSIR scan head when opened.
- The scan head contains all 6 receivers and the front end electronics, power supplies, heaters, and the scan head computer.





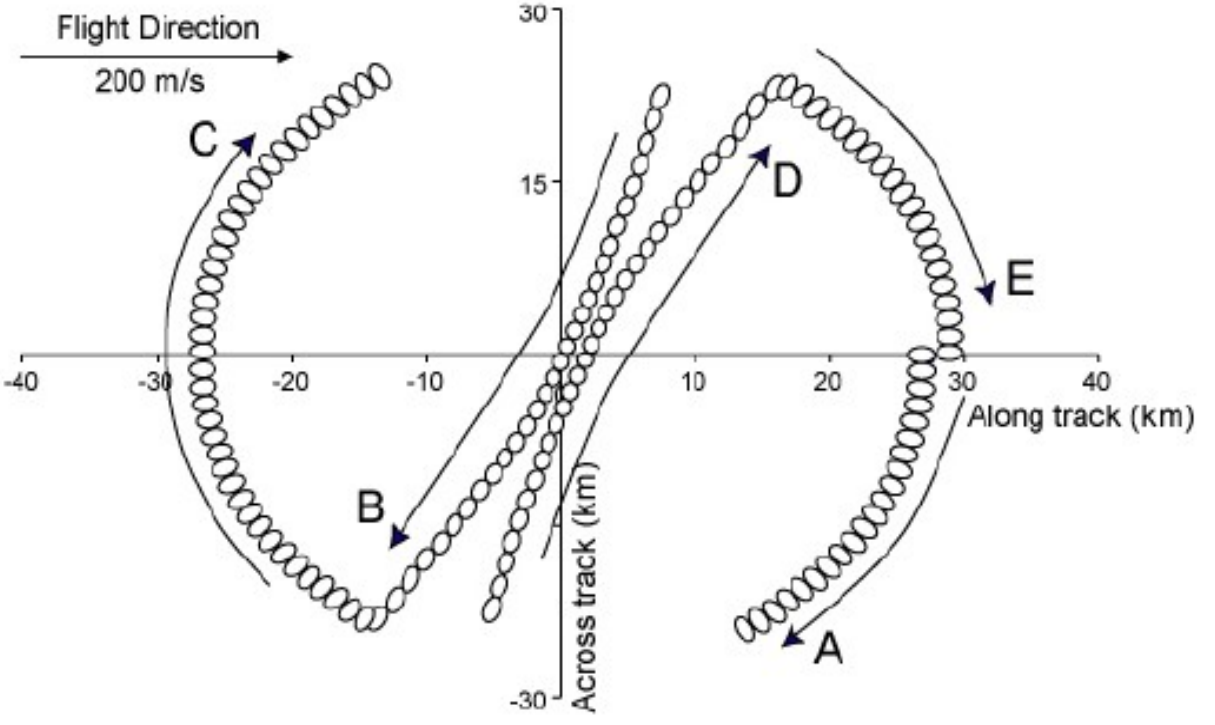
CoSSIR Laboratory Calibration with Liquid Nitrogen Target

- The picture on the right gives a full view of CoSSIR, when it was undergoing a laboratory calibration with liquid nitrogen target (the cylinder directly below the scan head.
- Three computers are employed to operate the instrument; the first one is the main archival computer, which is inside the external electronics box (sitting on top of the rack at the extremely left of the picture), the second one is the scan head computer, and the third one is the calibration target computer.
- It is necessary to continually blowing cold air to the scan head (via two white trunks in the picture) to keep it from overheating.
- The calibration accuracy of CoSSIR was found to be be on the order of ±1 K prior to deployment for CR-AVE in 2006.



CoSSIR Data Acquisition During TC4

- CoSSIR scan geometry is software programmable.
- The sketch on the right shows the scan pattern (for one cycle of 10 s) that will be employed during TC4. Data from both conical scans (forward and aft, segments A, C, and E) and across-track scans (segments B and D) will be acquired.
- Between A and B segments, and between C and D segments, the instrument acquires data from the hot and cold calibration targets.



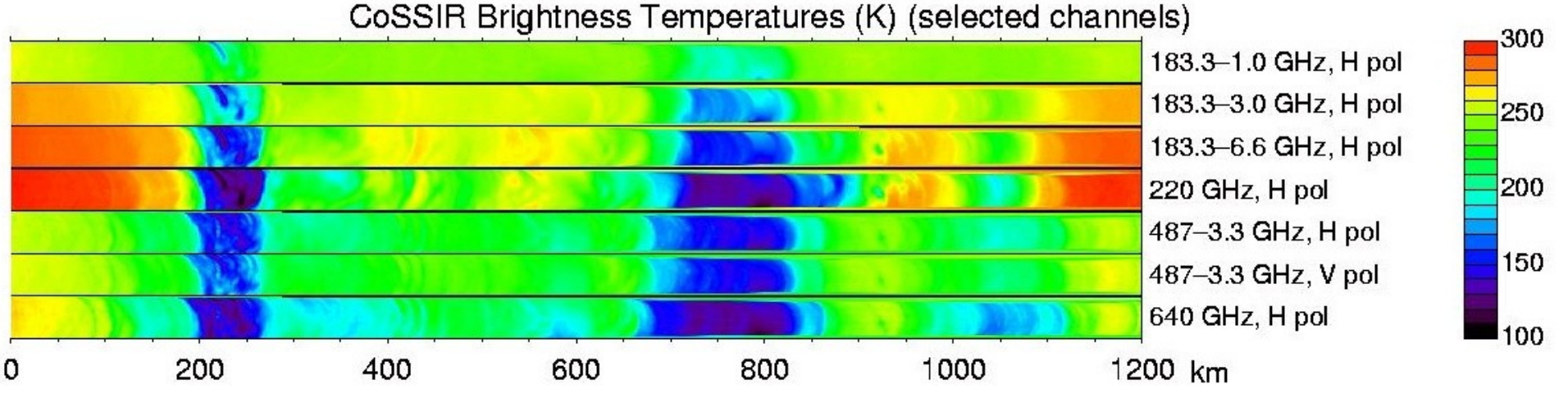
- The observational angle during conical scans is fixed at 53.4 degrees.
- For an ER-2 aircraft cruising altitude of ~ 20 km, the CoSSIR ground footprint is about 1.4 km at nadir, and about 2.3x3.9 km at 53.4 degree angle.
- At ~ 20 km altitude, the ground swath of CoSSIR is about 46 km for both across-track and conical scans.

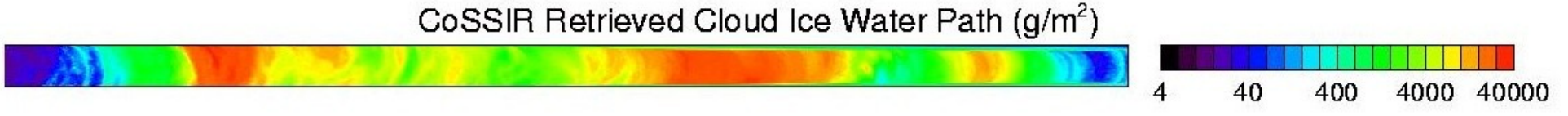
Derived Products from the CoSSIR Team

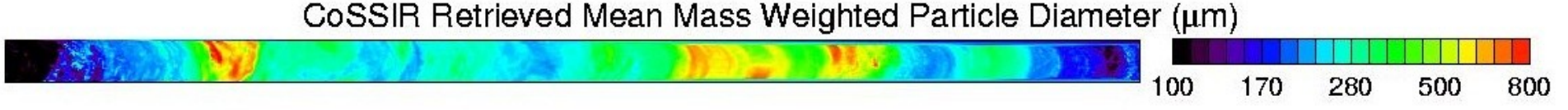
- Retrievals from CoSSIR and selected MAS mid-IR channels:
  1. Ice water path (IWP) (5 to 10,000 g/m^2)
  2. Mean mass-weighted equivalent sphere ice particle diameter (D_{me}) (40 to 800 μm)
  3. 640 GHz Polarization Index $(T_V-T_H)/(T_{clear}-T_H)$ and eventually particle aspect ratio/orientation
  4. Relative humidity profiles (0 to 15 km) in clear sky and ice clouds
- Retrievals are swath-wide.
- All products have error bars from Bayesian retrieval algorithm.

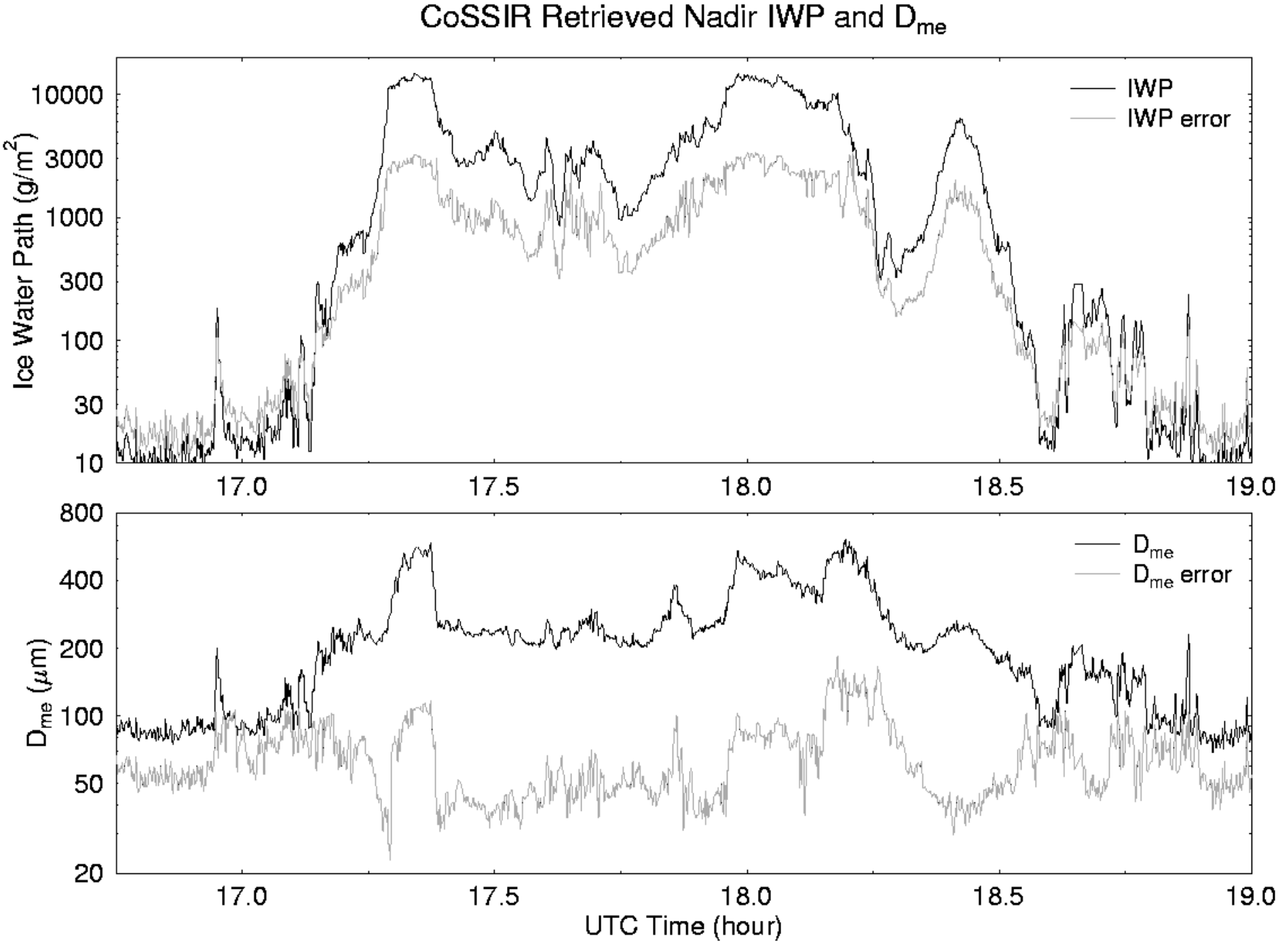
Compact Scanning Submillimeter-wave Imaging Radiometer

Results from CR-AVE (January 27, 2006)








CoSSIR Retrieved Nadir IWP and D_{me}
Ice Water Path (g/m^2)
10000
3000
1000
300
100
30
10
IWP
IWP error
17.0
17.5
18.0
18.5
19.0
D_{me} (μm)
800
400
200
100
50
20
D_{me}
D_{me} error
17.0
17.5
18.0
18.5
19.0
UTC Time (hour)

Satellite Validation Goals for CoSSIR

1. Provide ice cloud IWP and D_{me} and water vapor profiles to the satellite community.
2. Evaluate CloudSat ice water content retrieval algorithms with the CoSSIR IWP retrievals using the CRS to simulate the CloudSat radar.
3. Compare CoSSIR clear sky water vapor profiles with MLS products.

→ Underflights of CloudSat would be useful, but are not required.

Science Goals of CoSSIR Research

1. Further develop and *evaluate* the submillimeter ice cloud remote sensing technique, including developing a method to derive particle shape/orientation information from polarization.

2. Provide swath-wide ice cloud IWP and D_{me} and water vapor profiles to the TC^4 community.

3. Provide information on the ice water path accuracy of CloudSat retrievals for tropical convective clouds.

→ WB-57 and DC-8 underflights of ER-2 in geometrically thin, homogeneous cirrus anvils (for goal 1).