

CoSMIR Data from MC3E and GCPEX

Gail Skofronick Jackson, NASA Goddard Space Flight Center,
Greenbelt MD Gail.S.Jackson@nasa.gov

James R. Wang, SSAI, Lanham, MD, James.R.Wang@nasa.gov



Presentation Outline

Conically Scanning Millimeter Wave Radiometer (CoSMIR)

- * CoSMIR
 - * Heritage and channel set
 - * Scanning mode: Hybrid cross-track and conical
 - * Use for algorithm development and validation
- * CoSMIR in Field Campaigns
 - * Midlatitude Continental Convective Clouds Experiment (MC3E)
 - * Stratiform rain (Polarization signatures)
 - * Convective rain
 - * GPM Cold season Precipitation Experiment (GCPEX)
 - * Snow cases
- * Summary & References



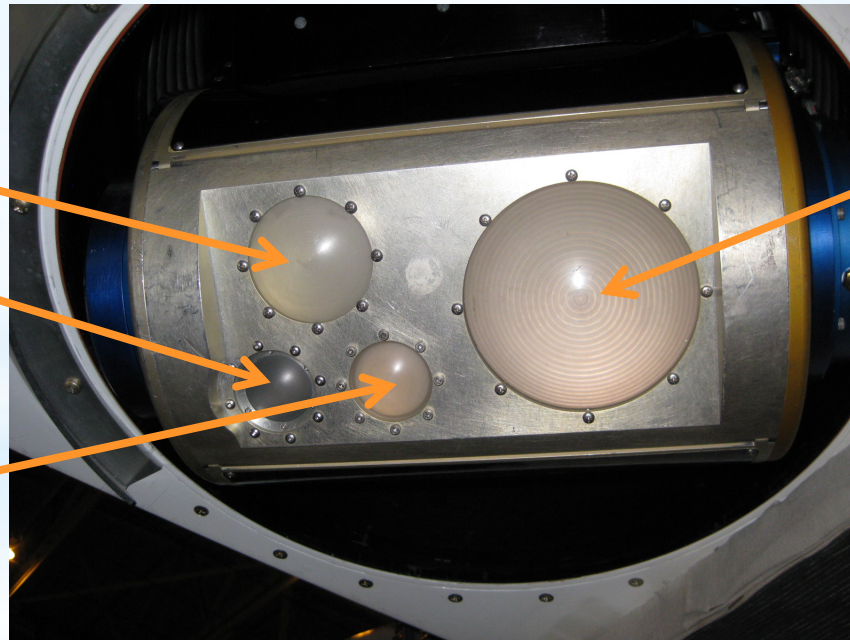
Conical Scanning Millimeter-wave Imaging Radiometer (CoSMIR)

- * Heritage: Originally developed for SSMIS Cal/Val in the early 2000's with "SSMIS" channels
- * Modified channel set for use as a high frequency GPM/GMI airborne simulator for GPM pre-launch algorithm development

GMI High Freq Chan
89 V&H GHz

165.5 V&H GHz

183.3±1, ±3, ±7 H-pol



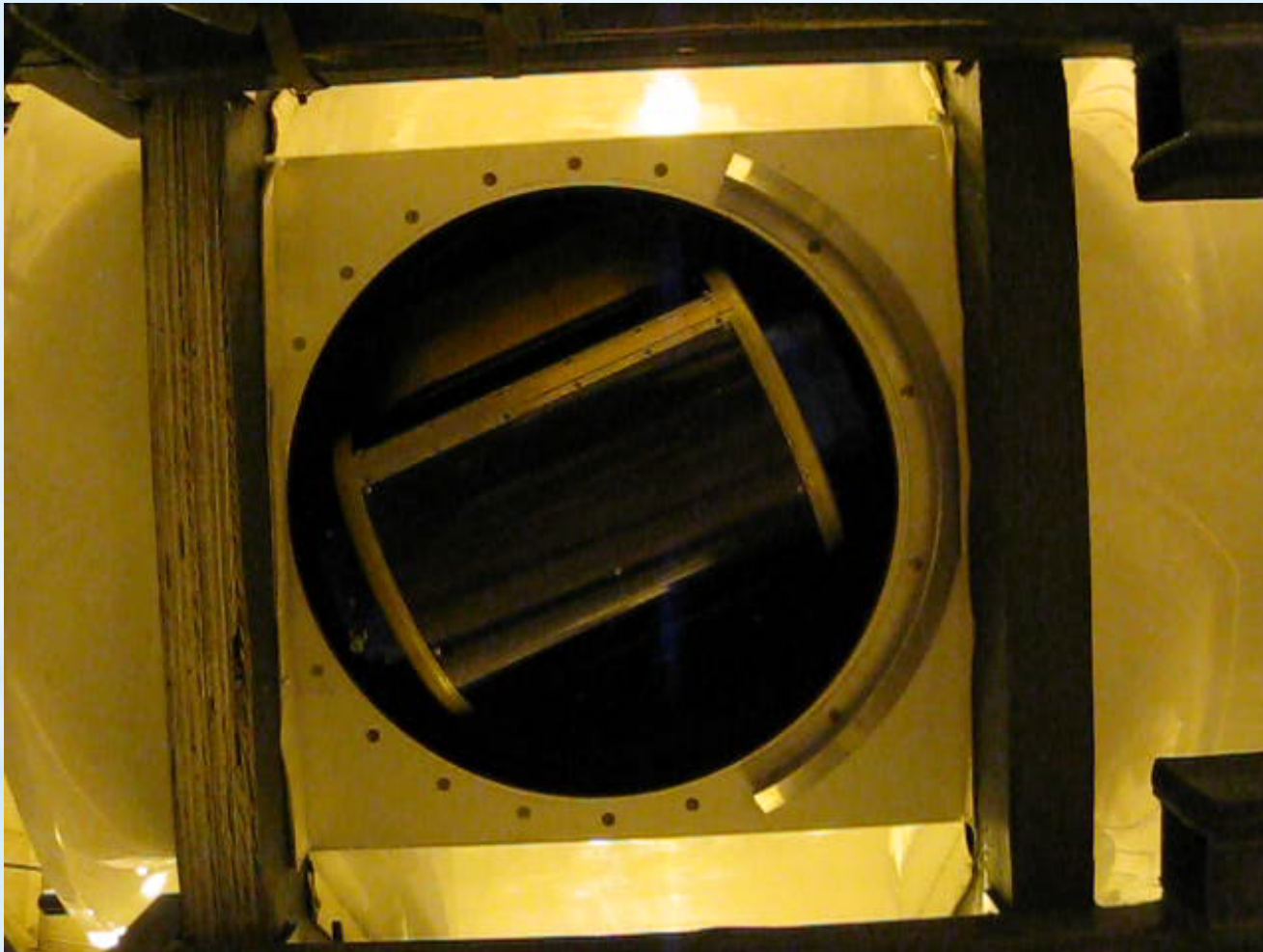
50.3 H-pol and
52.8 H-pol GHz
(not on GMI)



Scan Modes: Conical & Cross-Track



Platform: ER-2 Aircraft for MC3E and DC-8 Aircraft for GCPEX



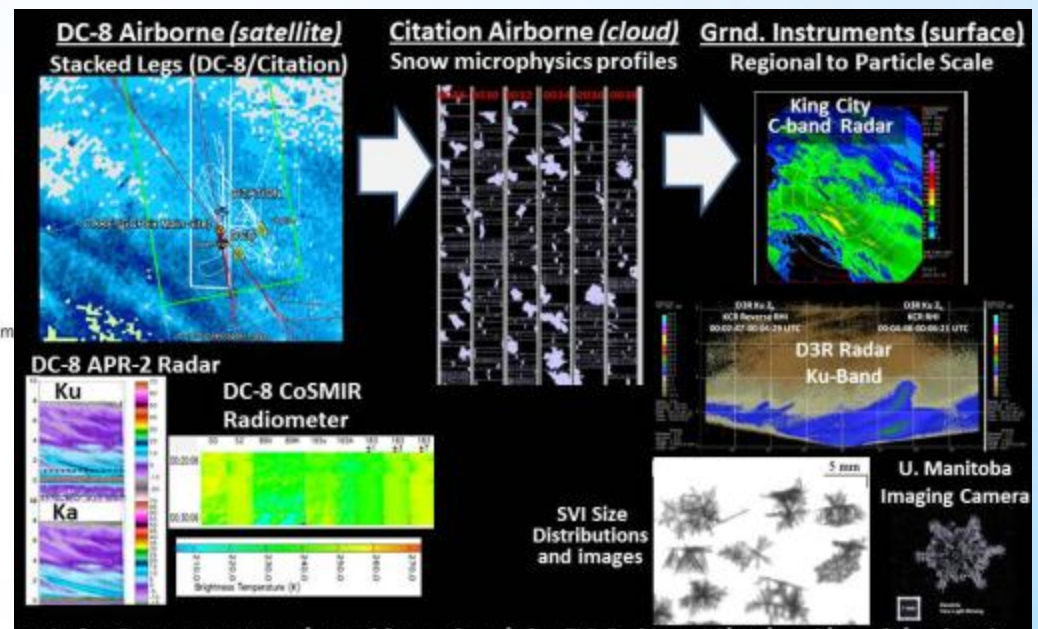
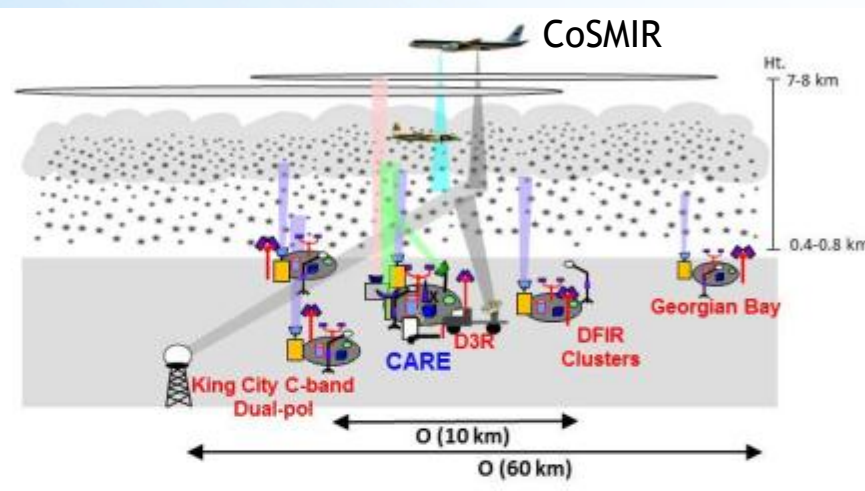
Flight
Direction
→



Algorithm Development & Validation



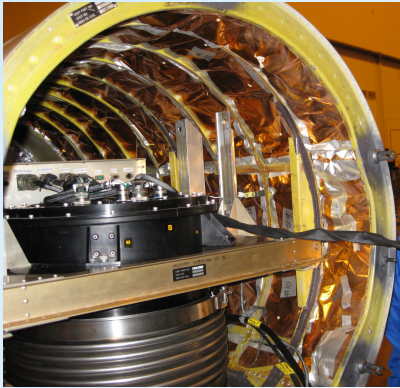
- * GPM GMI added 165 and 183 GHz channels (to TRMM channels) for the measurement of *light rain* and *falling snow*
- * Pre-launch CoSMIR TBs are correlated to supporting field campaign ground data to help reduce assumptions in satellite retrieval algorithms (GMI and constellation sensors)
- * Post-launch archived field campaign data will be used as a validating data set





MC3E - Flights on ER-2 Aircraft

Spring 2011 ARM site Oklahoma



Jim Wang and Bryan Monosmith

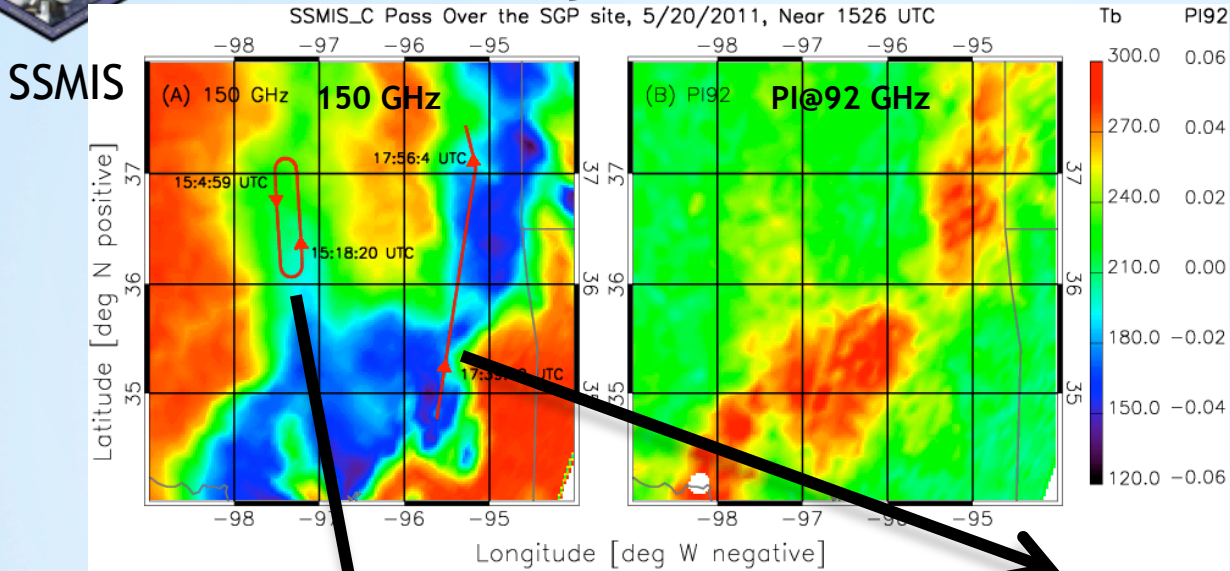


May 20, 23, 24 are dates of interest

Date	Scene	Comments
4/22	Ferry and convective storm	All channels functioned well
4/25	Convective storm	All channels functioned well
4/27	Convective storm	CoSMIR operational error
5/07	Calibration over Gulf of Mexico	RFI in conical scan at 183.3±7 GHz
5/08	Surface properties at SGP	RFI in conical scan at 183.3±7 GHz
5/11	Stratiform/weak convective storm	RFI in conical scan at 183.3±7 GHz
5/18	Convective storm	CoSMIR slip ring failure
5/20	Stratiform rain	RFI in conical scan at 183.3±7 GHz
5/23	Convective storm	RFI in conical scan at 183.3±7 GHz
5/24	Convective storm	RFI in conical scan at 183.3±7 GHz
5/29	5/07 & 5/08 combined	RFI in conical scan at 183.3±7 GHz
6/01	Convective storm	Lost 165 GHz (H) channel

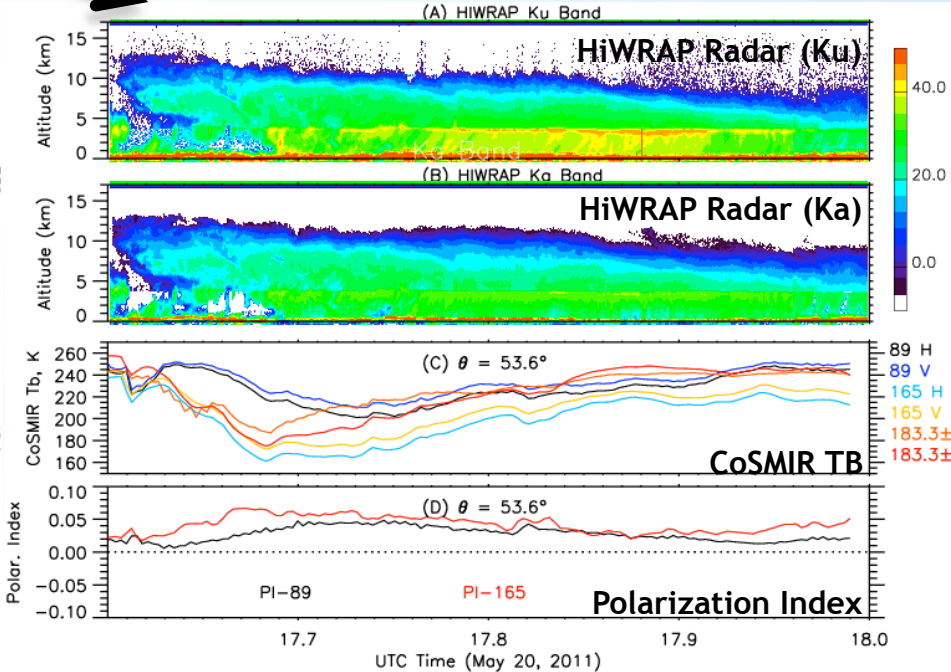
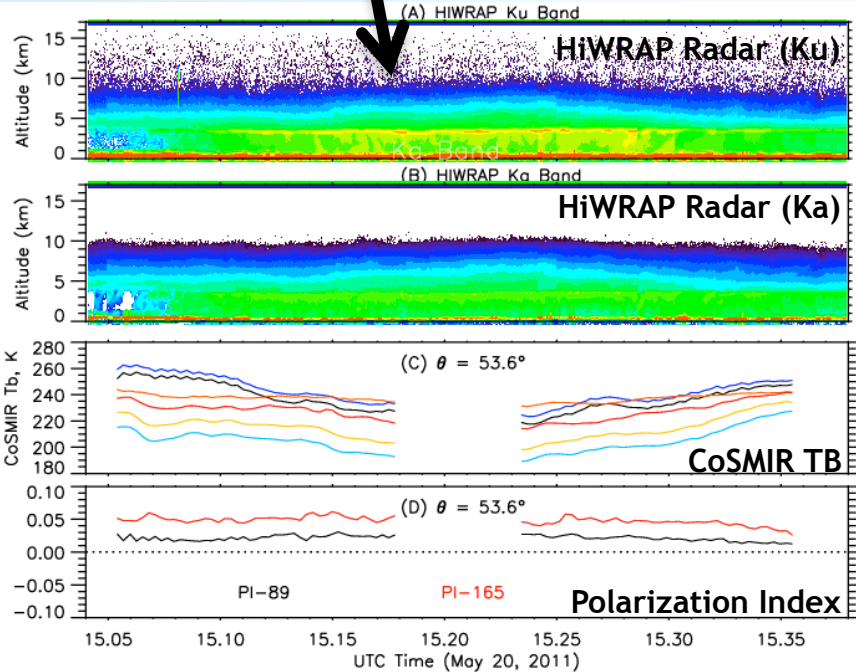


MC3E - May 20, 2011 - Statiform Rain



$$PI(\nu) = \frac{2 \cdot (T_{bv}(\nu) - T_{bh}(\nu))}{(T_{bv}(\nu) + T_{bh}(\nu))}$$

J. R. Wang, G. Skofronick-Jackson, M. Schwaller, C. Johnson, B. Monosmith, and Z. Zhang, "Observations of Storm Signatures by the Recently Modified Conical Scanning Millimeter-wave Imaging Radiometer," IEEE Trans. Geosci. Remote Sens, Jan 2013.



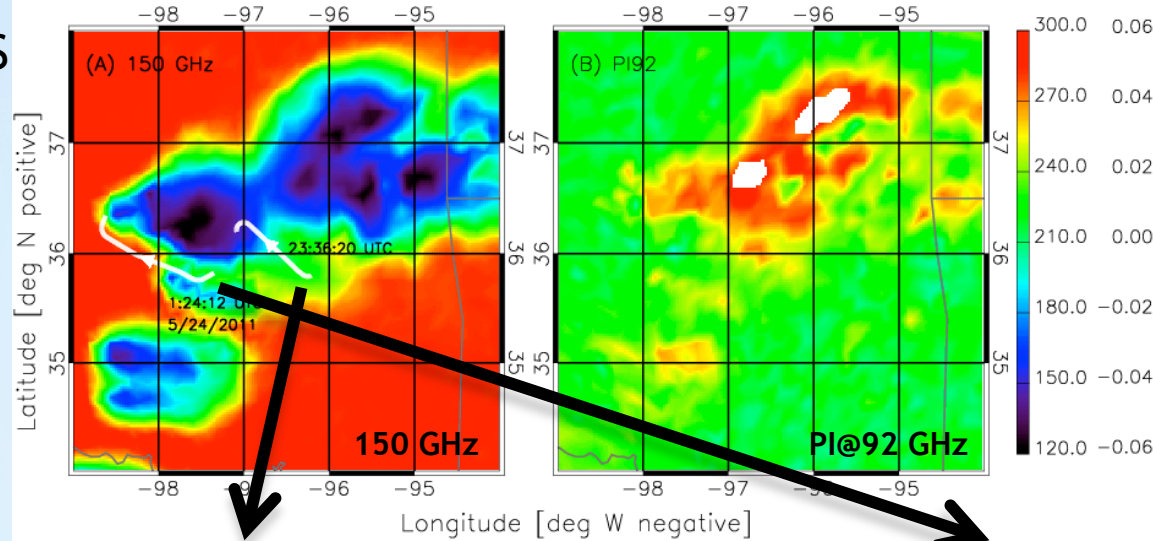


MC3E - May 23-24, 2011 - Convective

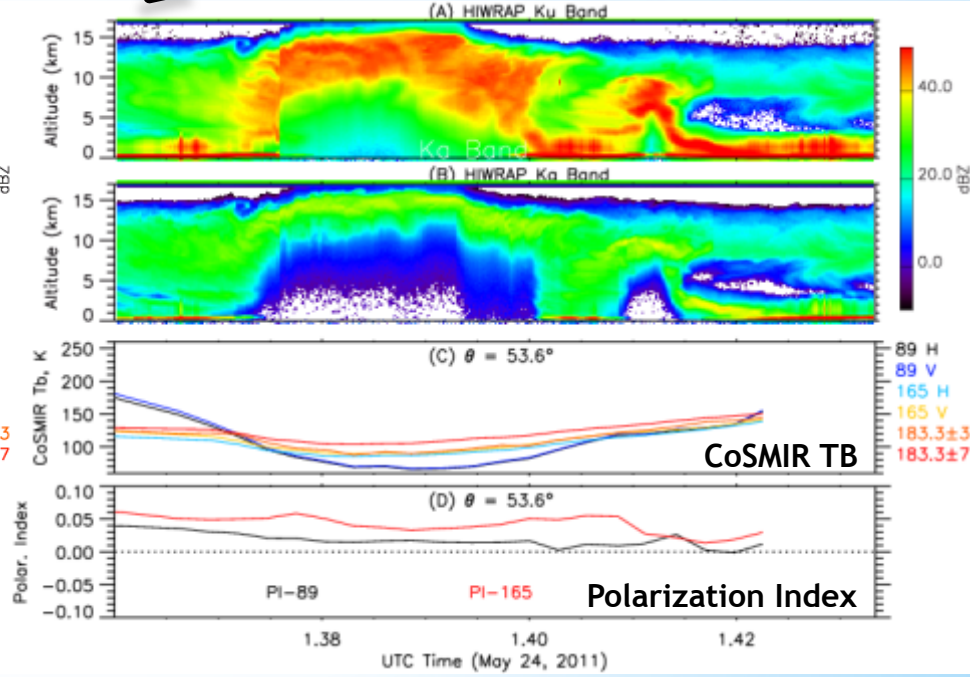
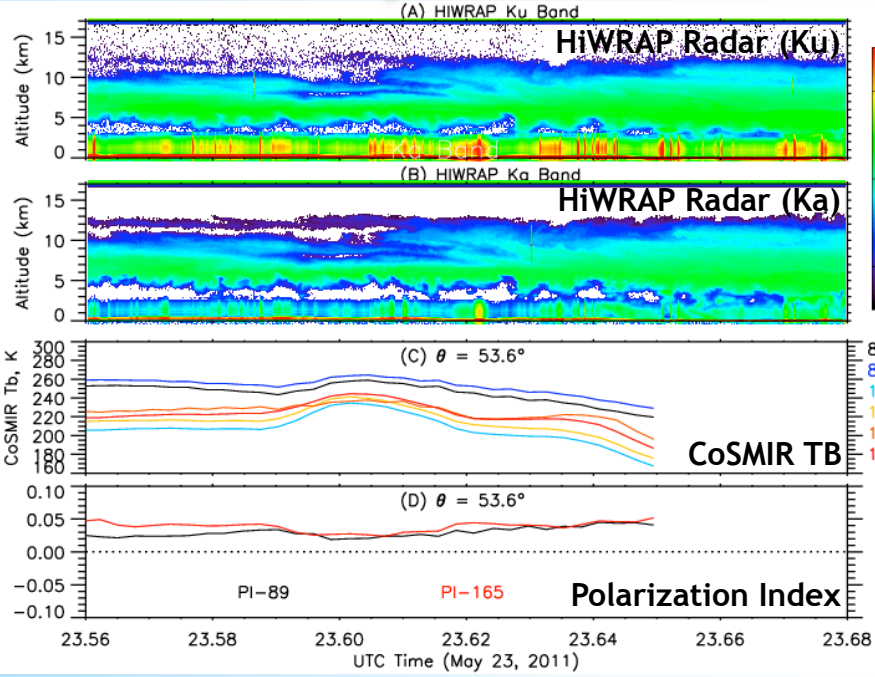


SSMIS

SSMIS_B Pass Over the SGP site, 5/23/2011, Near 2338 UTC



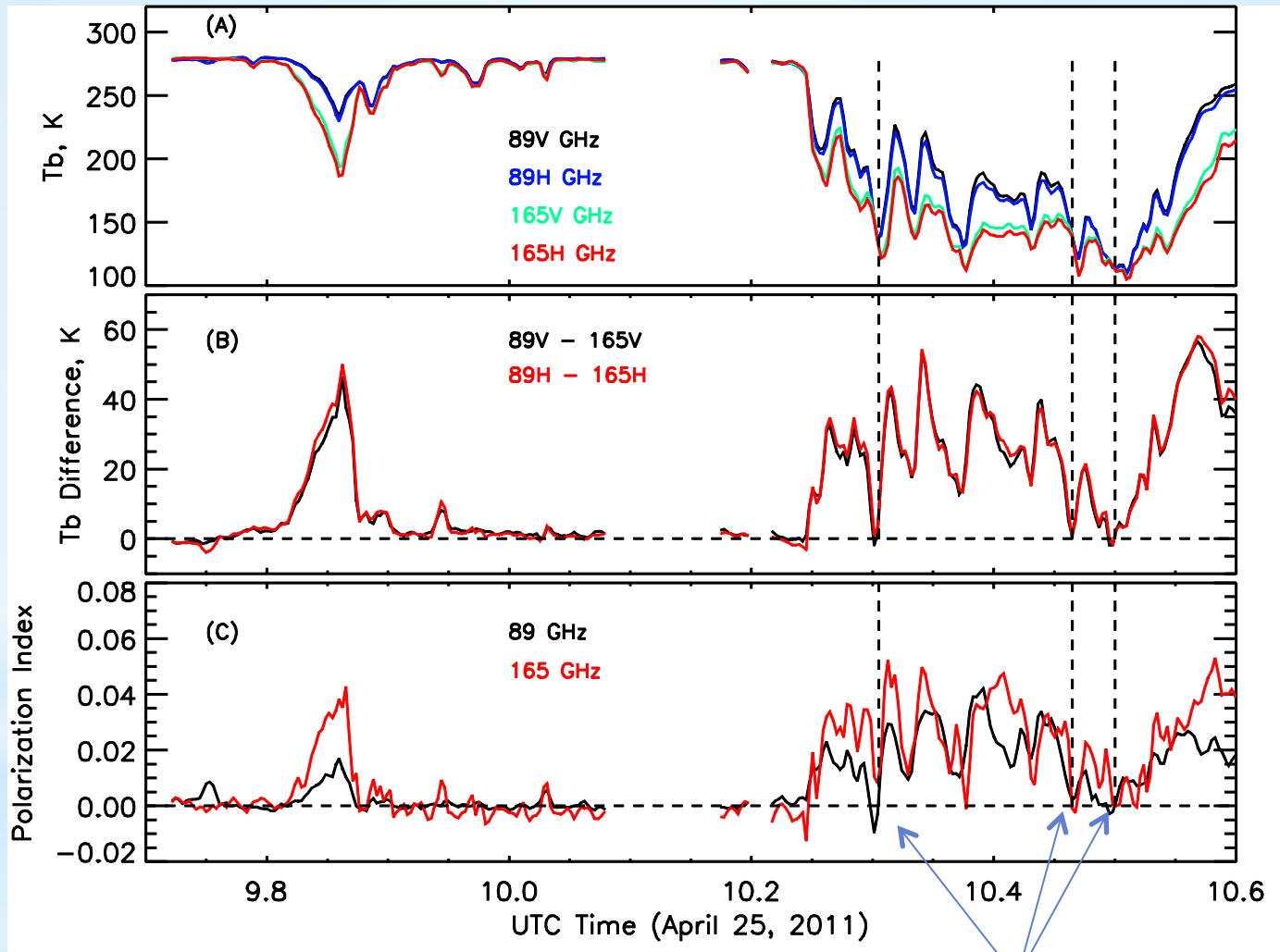
Modeling results (e.g., Xie & Miao, 2011) suggest the presence of mostly horizontally oriented non-spherical hydrometeors when $PI(v) > 0$.





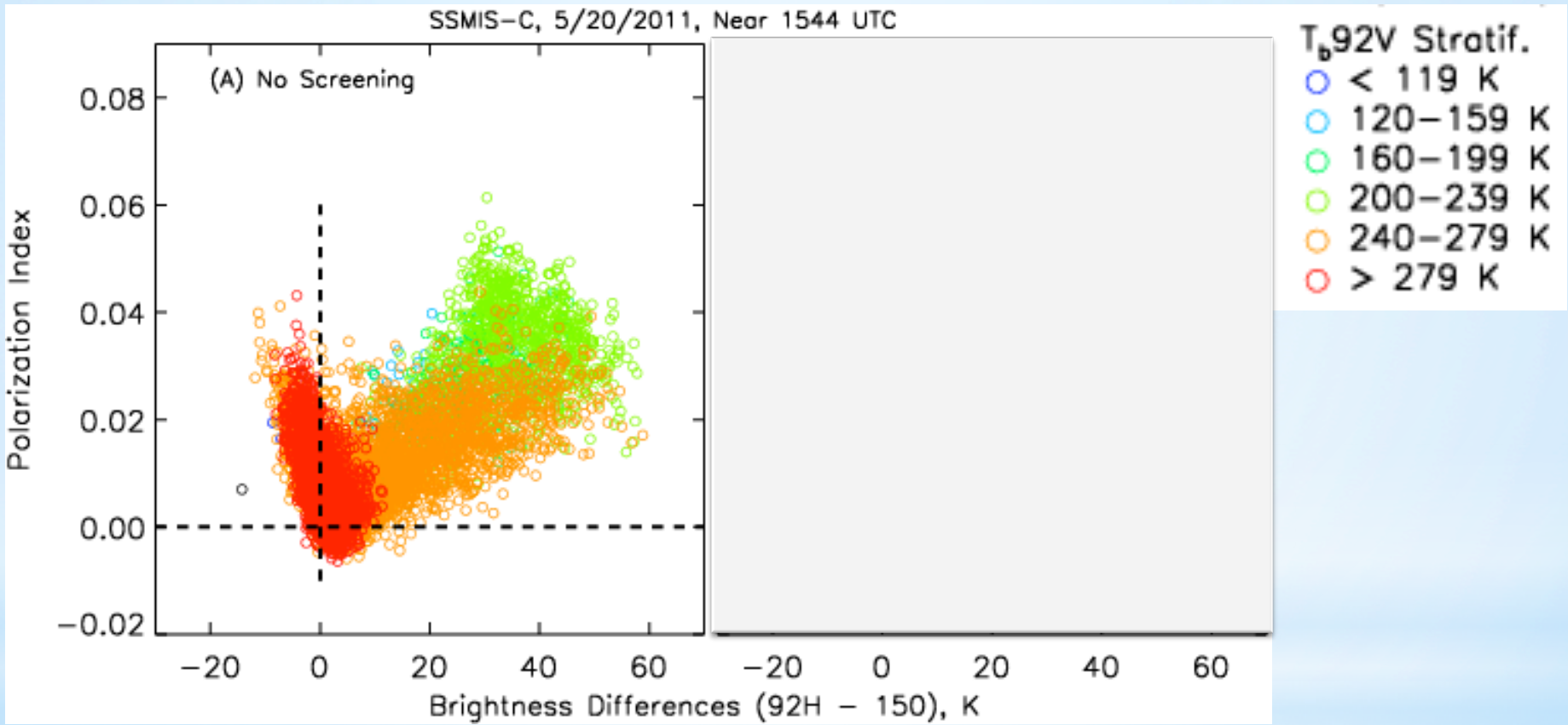
Polarization Index versus ΔT_B

April 25, 2011 data





Polarization Index in/out of Scattering Regions



The scatter plot of the 92 GHz polarization index and the brightness difference between 92H and 150 GHz (SSMIS_C, May 20, 2011): (A) without screening and (B) with screening to include pixels inside of the scattering region.

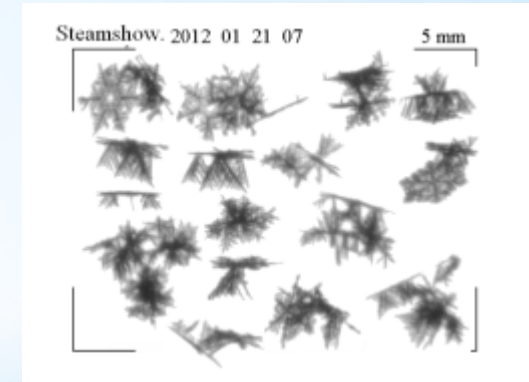


GCPEX - Flights on DC-8 Aircraft

Jan - Feb 2012 70 km north Toronto



Event	Start	End	SWE (mm)	Type	Context	Aircraft		
						DC-8	UND	Convair
1	17/1/2012/12 Z	18/1/2012/13 Z	11.1	R/S	F			
2	19/1/2012/15 Z	20/1/2012/04 Z	1.4	S	F	x	x	
3	21/1/2012/06 Z	21/1/2012/23 Z	0.7	S	L	x		
4	23/1/2012/07 Z	24/1/2012/00 Z	4	R	C			
5	24/1/2012/04 Z	25/1/2012/03 Z	0.7	S	C			
6	27/1/2012/01 Z	27/1/2012/20 Z	14.2	R/S	C	x	x	
7	28/1/2012/13 Z	29/1/2012/12 Z	1.9	S	U	x	x	
8	30/1/2012/20 Z	31/1/2012/04 Z	3.5	S	U	x	x	
9	1/2/2012/19 Z	2/2/2012/22 Z	0	None	U			x
10	4/2/2012/15 Z	4/2/2012/18 Z	0.1	None	R	x		
11	7/2/2012/02 Z	7/2/2012/12 Z	0.4	S	L	x		
12	10/2/2012/19 Z	11/2/2012/12 Z	3.2	S	F			x
13	11/2/2012/21 Z	12/2/2012/14 Z	1.8	S	L	x	x	
14	12/2/2012/16 Z	13/2/2012/02 Z	0.9	S	L	x	x	x
15	14/2/2012/08 Z	15/2/2012/14 Z	2.8	S	U		x	
16	16/2/2012/10 Z	16/2/2012/22 Z	1.3	R/S	F	x	x	x
17	18/2/2012/10 Z	18/2/2012/20 Z	13.9	S	C		x	
18	20/2/2012/15 Z	20/2/2012/17 Z	0	None	R	x		
19	21/2/2012/18 Z	22/2/2012/07 Z	0.3	S	U	x		x
20	24/2/2012/11 Z	25/2/2012/00 Z	8.4	S	C	x	x	x
21	25/2/2012/01 Z	25/2/2012/17 Z	12.1	S	L	x		
22	27/2/2012/20 Z	28/2/2012/10 Z	0.4	S	U			
23	29/2/2012/12 Z	1/3/2012/10 Z	12.7	S	C			
24	3/3/2012/01 Z	3/3/2012/10 Z	4.7	R	F			
25	4/3/2012/00 Z	4/3/2012/13 Z	1.5	S	F			



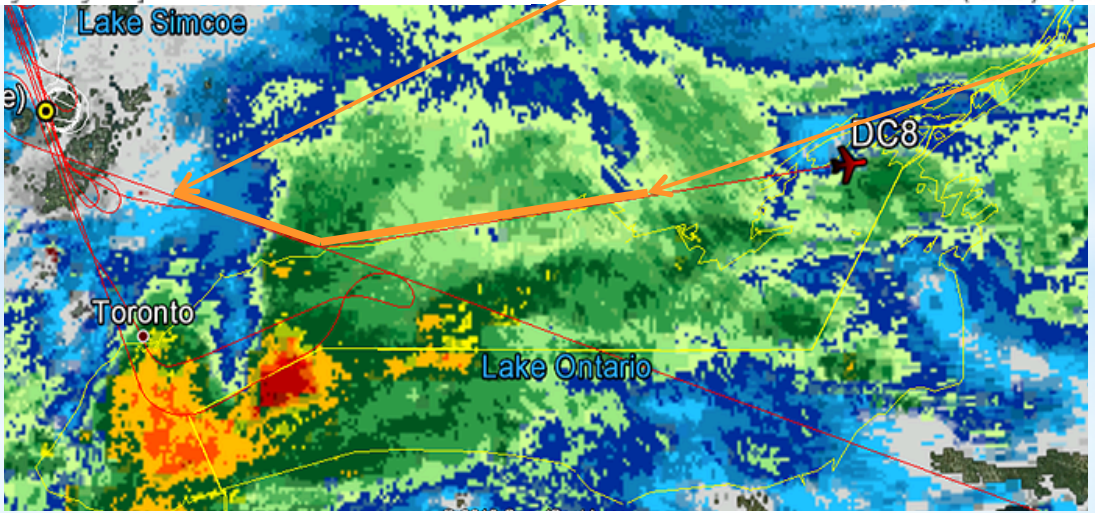
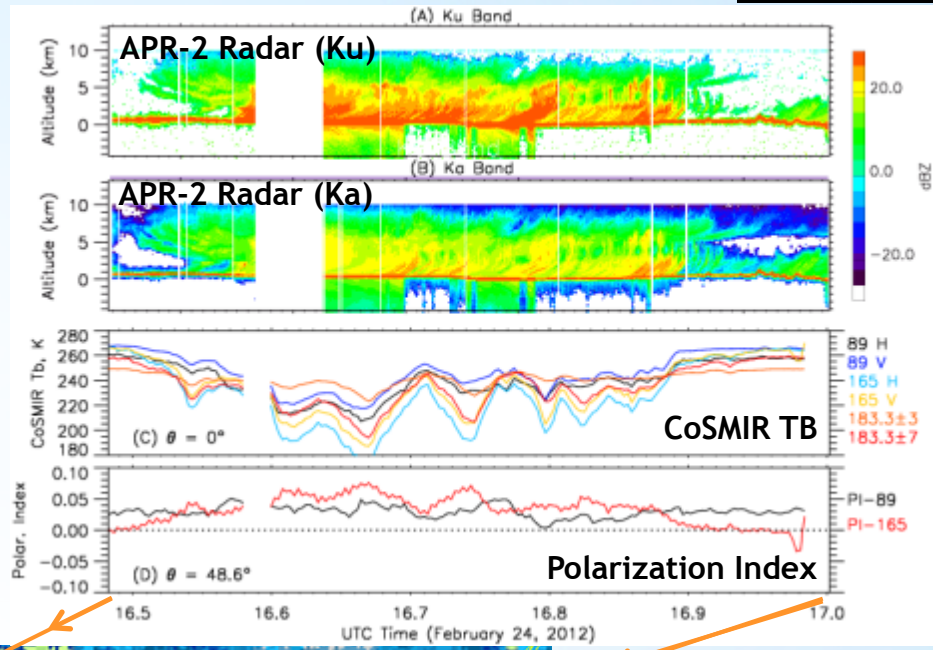
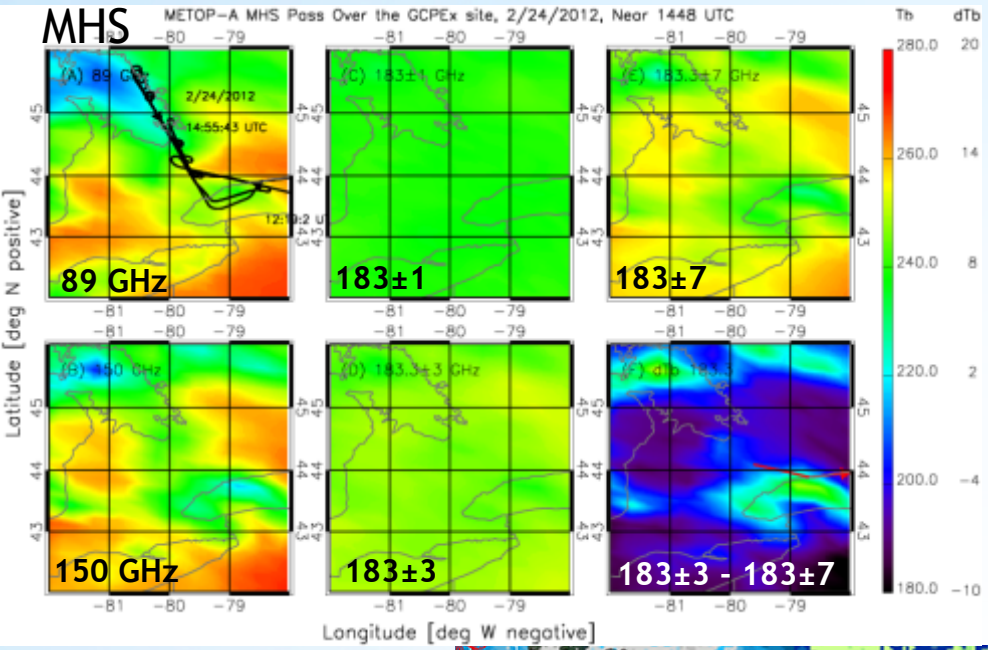
Feb 24, 2012 & Jan. 28, 2012
are dates of interest





GCPEX - Feb. 24, 2012 - Snow

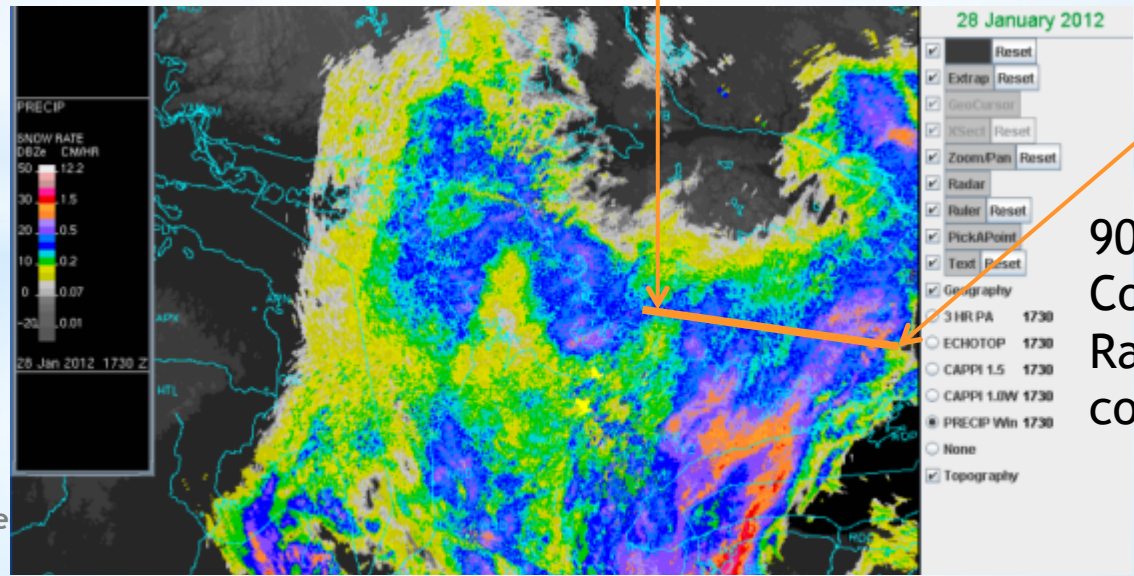
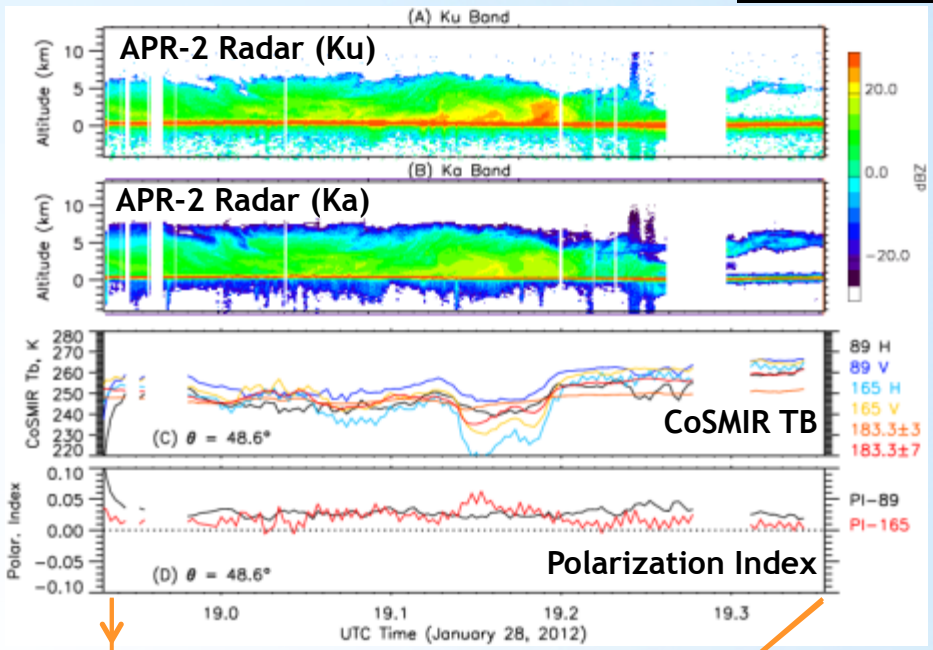
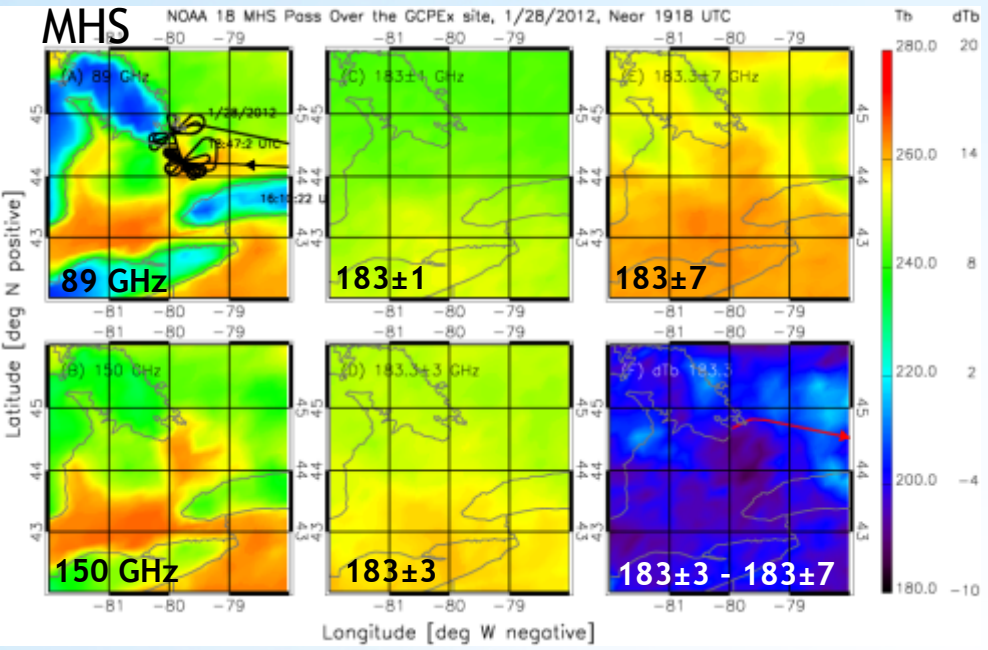
Heavy, Moderate, Light snow, Mixed phase





GCPEX - Jan. 28, 2012 - Snow

Synoptic snowfall event



90 min before
CoSMIR images;
Rapidly changing
conditions



Summary & References

- * CoSMIR data taken in the MC3E and GCPEX field campaigns provides evidence of polarization signatures due to oriented snow particles
- * Additional efforts are underway to model non-spherical oriented snow particles
- * Ongoing work is progressing for linking CoSMIR observations to the underlying precipitation processes for algorithm development activities
- * References
 - * J. R. Wang, G. Skofronick-Jackson, M. Schwaller, C. Johnson, B. Monosmith, and Z. Zhang, "Observations of Storm Signatures by the Recently Modified Conical Scanning Millimeter-wave Imaging Radiometer," IEEE Trans. Geosci. Remote Sens., Jan 2013.
 - * J. R. Wang, J. Zhan, and P. Racette, "Multiple Aircraft Microwave Observations of Storms Over the Western Pacific Ocean," Radio Science, 33(2), 351-368, 1998.
 - * J. R. Wang, G. Liu, J. D. Spinhirne, P. Racette, and W. Hart, "Measurements of cirrus clouds with airborne MIR, CLS, and MAS during FIRE III-ACE," J. Geophys. Res., 106(D4), 15,251-15,263, 2001.
 - * J. R. Wang, P. E. Racette, J. E. Piepmeier, B. Monosmith, and W. Manning, "Airborne CoSMIR Observations Between 50 and 183 GHz over Snow-Covered Sierra Mountains," IEEE Trans. Geosci. Remote Sens., 45(1), 55-61, 2007.
 - * J. R. Wang, P. E. Racette, and J. R. Piepmeier, "A comparison of Near Concurrent Measurements from the SSMIS and CoSMIR for some Selected Channels over the Frequency Range of 50-183 GHz," IEEE Trans. Geosci. Remote Sens., 46(4), 923-933, 2008.