Progress in Retrieval of Light Rainfall and Falling Snow Rates from GPM Core Satellite's GMI and DPR Sensors

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GPM Instrument Capabilities

DPR – Active Sensor

Increased sensitivity for light rain and snow detection

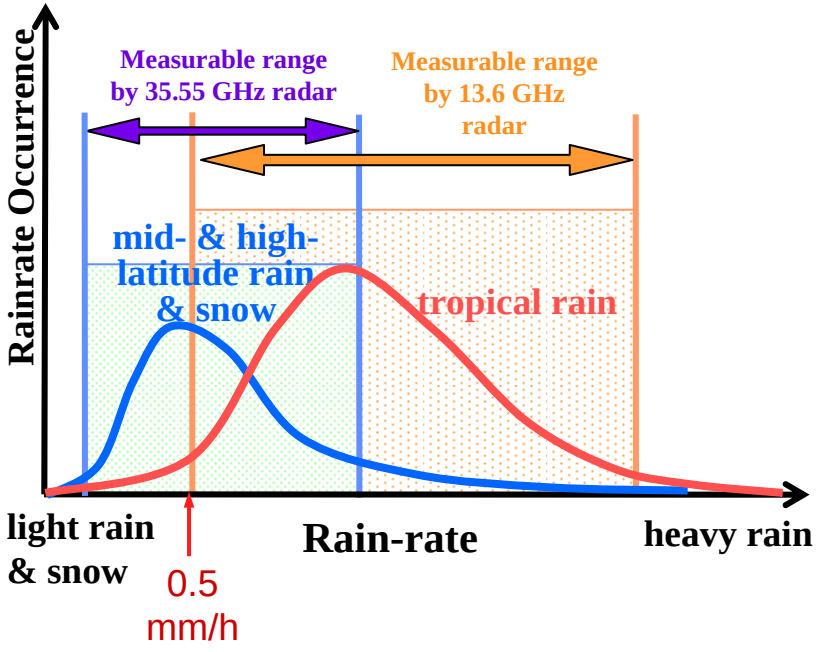
- Ka+Ku improves the detection threshold from 0.5 to 0.17 mm/h

Better overall measurement accuracy

- New PIA methods with 2 channels

More microphysical information

- PSDs and identification of liquid, frozen, and mixed phase precipitation



GMI – Passive Sensor

Increased sensitivity for snow and light rain

- New channels at 166, 183±3, and 183±8 GHz are important for scattering signals

Includes TMI channel set

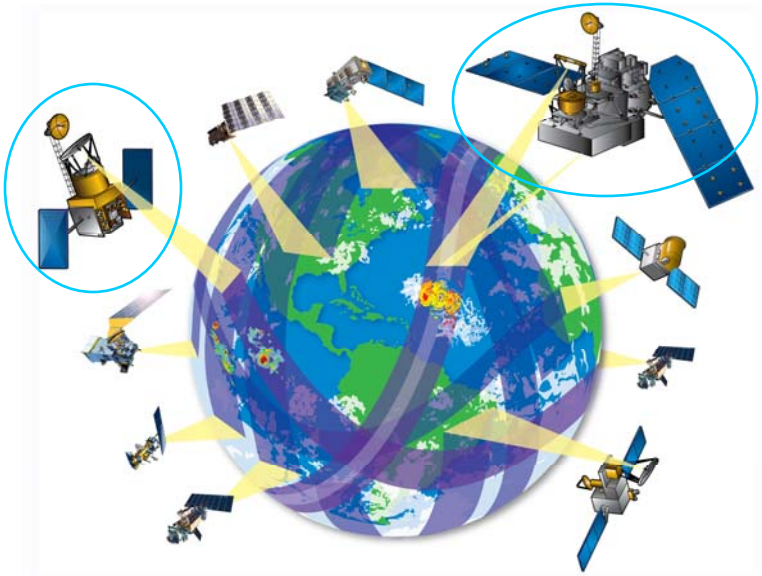
- 10 to 89 GHz for continuity with TRMM data set and constellation members

Resolution

- Footprints smaller than TRMM TMI

Independent Calibration Checks

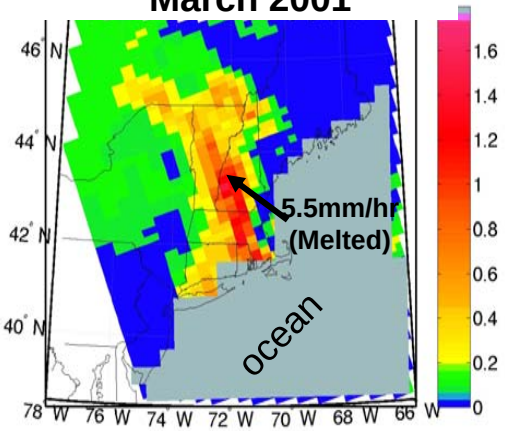
- ensures high quality observations



US Falling Snow Retrieval Algorithm Methodologies

Physically-Based

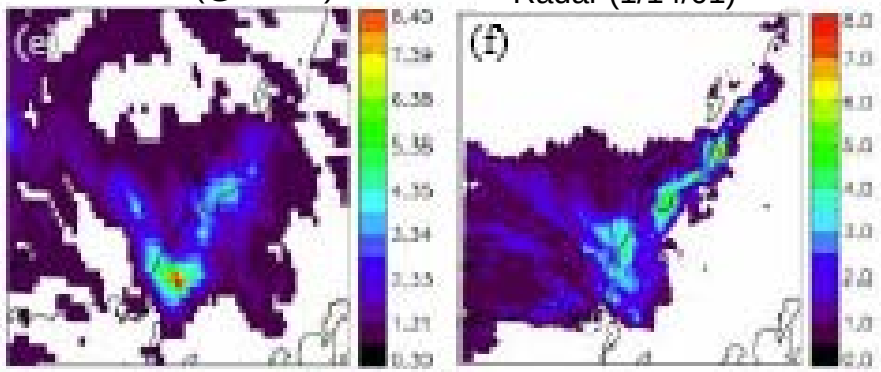
March 2001



NASA Goddard/U. Wash.
Kim, Skofronick-Jackson, 2004, 2007

Physically-Based

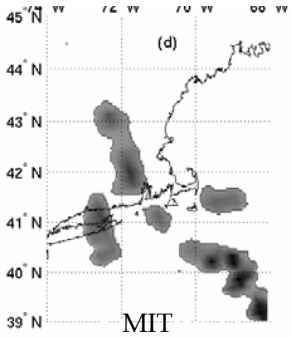
Retrieved (@1.5km) Radar (1/14/01)



FSU, Liu & Noh, 2004, 2005
Wakasa Bay, Japan data

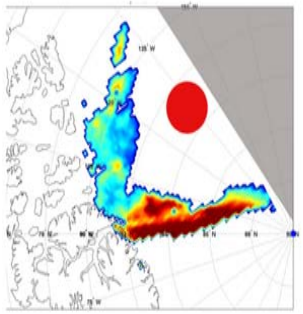
Neural Networks

March 2001



MIT
Chen and Staelin
Trans Geosci Remote Sens 2003

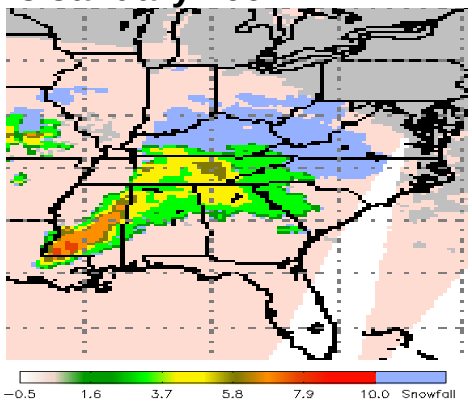
Polar Retrievals



MIT, Staelin

Empirical Approach

25 January 2004



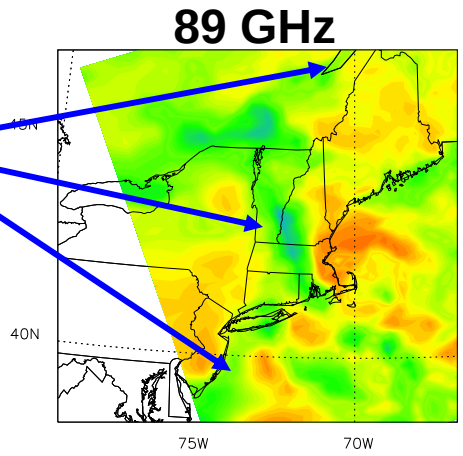
NOAA, Kongoli, et al
Geophys Res. Letters 2003
& Ferraro et al TGARS 2005

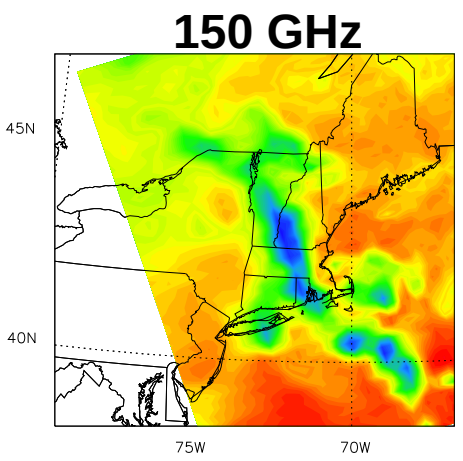
Snow Detection

AMSU-B Brightness Temperature Imagery

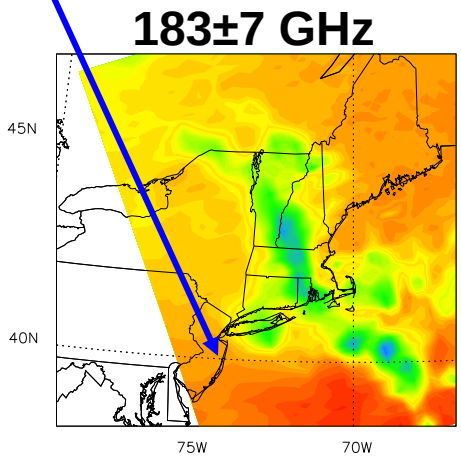
March 5-6, 2001 blizzard

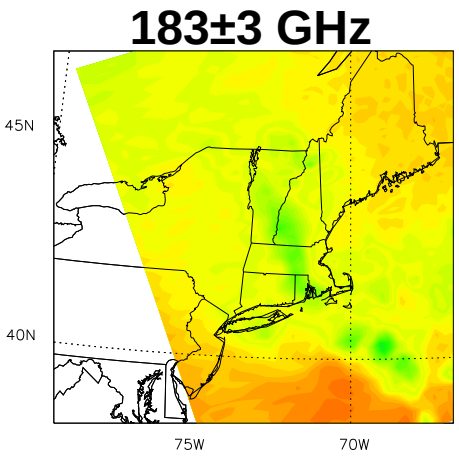
Ocean/lakes have same T_B as snow cloud.

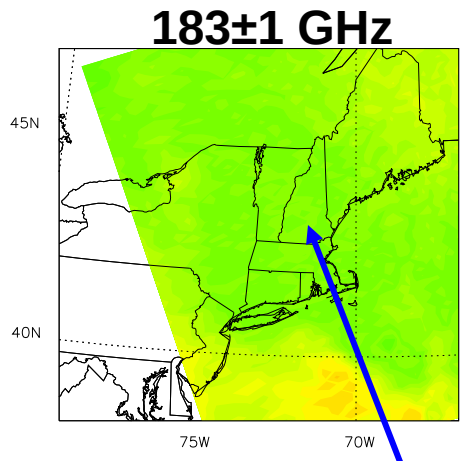


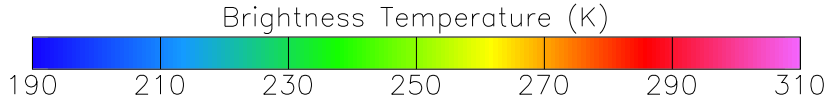


Surface obscured, sees only snow cloud





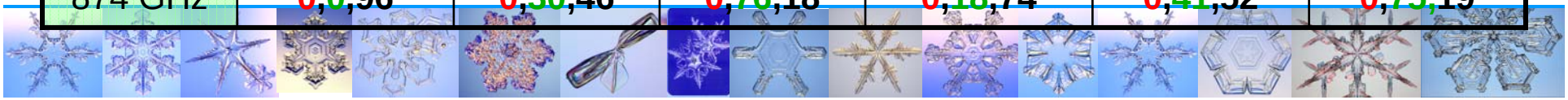




Cold, cloud top

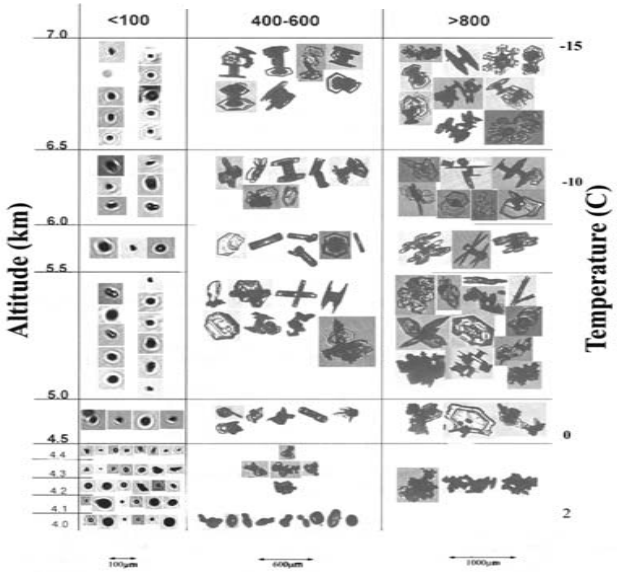
TB contributions (Surface, Snow, RH)

GHz	Clear Air	Rain	Anvil	Light Snow	Moderate Snow	Heavy Snow
10	98,0,0.4	49,21,2	94,0,3	98,0,0.4	98,0,0.4	98,0.2,0.4
19	92,0,6	17,31,8	72,0.1,26	92,0,6	92,0,6	92,0.7,6
21	83,0,14	11,32,16	51,0.1,47	83,0.1,14	83,0.1,14	83,0.8,14
37	89,0,5	0.6,61,2	73,0.3,19	88,0.3,5	88,0.3,5	87,4,4
89	74,0,19	0,94,0.4	47,1,47	70,6,17	68,15,13	57,34,6
150	51,0,47	0,81,7	17,4,77	46,20,31	39,40,20	17,74,8
183±1	0,0,99	0,63,36	0,18,82	0,2,98	0,5,94	0,21,79
183±3	0,0,99	0,67,31	0,26,73	0,5,94	0,15,85	0,45,55
183±7	5,0,94	0,66,27	0,17,82	4,14,81	2,35,62	0.3,72,27
325	2,0,90	0,31,53	0,45,53	0.3,26,72	0.1,54,45	0,85,13
448±1.5	0,0,95	0,24,75	0,21,78	0,2,96	0,7,92	0,23,75
448±7.2	0,0,98	0,26,66	0,67,30	0,11,86	0,28,69	0,64,34
642	0,0,96	0,26,61	0,74,23	0,15,81	0,36,60	0,71,25
874 GHz	0,0,96	0,30,46	0,76,18	0,18,74	0,41,52	0,75,19



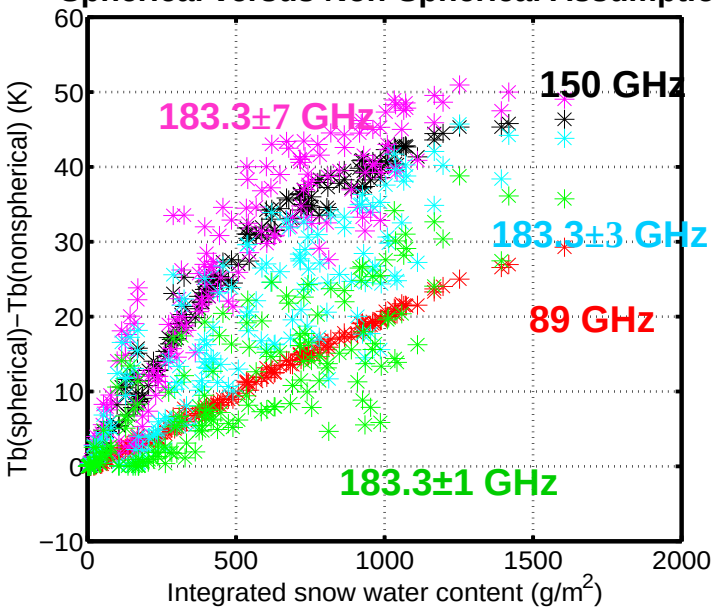
Retrieval Challenges: Particle Models

Complex Atmospheric Snow Particle Shapes



From A. Heymsfield et al. (2001)

Spherical versus Non-Spherical Assumptions



Courtesy of Min-Jeong Kim

- For simplicity, spheres and dielectric mixing theories have been used.
- Methodologies such as the Discrete Dipole Approximation (DDA) allow the computation of radiative properties for various idealized shapes of snow crystals.
- This is a major challenge for physically linking active and passive and we may need to concentrate on bulk radiative properties.
- **Must trust (or provide error models for) all assumptions**

GPM Era Falling Snow Algorithms

1. **Precipitating snow detection will be achievable**

   - Minimum detection threshold to be determined

2. **Precipitating snow rates are retrievable**

   - Accuracies to be determined with further analysis

3. **Ground validation systems *must* measure falling snow microphysics (PSD, shape, radiative properties) to reduce the number of assumptions in physically-based retrievals**

4. **Great opportunity exists for falling snow measurements using GPM's radar and radiometer, and then transferred to constellation satellites**