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.

- 5.5 mm/hr (Melted)

**Physically-Based**

*Retrieved (@1.5 km)*

- Radar (1/14/01)

- 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
Ocean/lakes have same $T_B$ as snow cloud.

Surface obscured, sees only snow cloud.

Cold, cloud top.
<table>
<thead>
<tr>
<th>GHz</th>
<th>Clear Air</th>
<th>Rain</th>
<th>Anvil</th>
<th>Light Snow</th>
<th>Moderate Snow</th>
<th>Heavy Snow</th>
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</thead>
<tbody>
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<td>10</td>
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<td>49,21,2</td>
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<td>17,31,8</td>
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<tr>
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<td>183±1</td>
<td>0,0,99</td>
<td>0,63,36</td>
<td>0,18,82</td>
<td>0,2,98</td>
<td>0,5,94</td>
<td>0,21,79</td>
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<tr>
<td>183±3</td>
<td>0,0,99</td>
<td>0,67,31</td>
<td>0,26,73</td>
<td>0,5,94</td>
<td>0,15,85</td>
<td>0,45,55</td>
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<tr>
<td>183±7</td>
<td>5,0,94</td>
<td>0,66,27</td>
<td>0,17,82</td>
<td>4,14,81</td>
<td>2,35,62</td>
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<tr>
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<tr>
<td>448±1.5</td>
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<tr>
<td>448±7.2</td>
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<td>0,67,30</td>
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<tr>
<td>642</td>
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<td>874 GHz</td>
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<td>0,41,52</td>
<td>0,75,19</td>
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</table>
Retrieval Challenges: Particle Models

- 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