Extremely Low Brightness Temperatures with Deep Convection - Discriminating Signal From Noise

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TRMM case with lowest 37 GHz; northern Argentina

Cross section on next slide

Lowest 37 GHz I have seen in 16 years

Soil moisture shows up in 10 GHz, 19
Radar Reflectivity Cross Section – 30 Dec 1997

Without corroborating radar data, such low TBs would seem suspicious.

50 dBZ @ ~12 km
45 dBZ @ ~18 km

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37 GHz PCT
69 K

NW
SE

NW–SE Reflectivity Cross Section

0 dBZ
15 dBZ
20 dBZ
25 dBZ
30 dBZ
35 dBZ
40 dBZ
45 dBZ
50 dBZ

0 50 100 200 300 400
Distance along section (km)

0 5 10 15 20 km

0 225 250 275 300
Altitude [m]

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40 dBZ
50 dBZ
Objectives

1) document the lower limits on brightness temperatures from previously observed storms
   ➢ From TMI, SSMI, AMSR-E; to be extended to GMI
      
      *Spoiler Alert*: ~40 K @ 85 GHz, ~70 K @ 37 GHz

2) describe objective methods for identifying valid measurements of extreme storms and separating out the measurements likely compromised by noise

3) map the locations where the “strongest of the strong” storms do occur.

   *Spoiler Alert*: mostly northern Argentina
## Sensors Used

SSMI data from CSU; AMSR-E from NSIDC; TMI from TISDIS/PPS

<table>
<thead>
<tr>
<th>Sensor / Platform</th>
<th>Period of record</th>
<th>37 GHz footprint</th>
<th>85 GHz footprint</th>
<th>mode time of day</th>
</tr>
</thead>
<tbody>
<tr>
<td>SSMI / F08</td>
<td>Jul 1987 – Dec 1988</td>
<td>37 x 29 km</td>
<td>15 x 13 km</td>
<td>5-7 am; 5-7 pm</td>
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<td>37 GHz footprint</td>
<td>85 GHz footprint</td>
<td>5 am NH; 5 pm SH</td>
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<td>SSMI / F10</td>
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<td>37 x 29 km</td>
<td>15 x 13 km</td>
<td>8-11 am; 8-11 pm</td>
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<td>37 GHz footprint</td>
<td>85 GHz footprint</td>
<td>10 am NH; 10 pm</td>
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<td>Dec 1991; Mar 2000</td>
<td>37 x 29 km</td>
<td>15 x 13 km</td>
<td>5-8 am; 5-8 pm</td>
</tr>
<tr>
<td></td>
<td></td>
<td>37 GHz footprint</td>
<td>85 GHz footprint</td>
<td>7 am NH; 7 pm</td>
</tr>
<tr>
<td>SSMI / F13</td>
<td>May 1995; Nov 2009</td>
<td>37 x 29 km</td>
<td>15 x 13 km</td>
<td>5-7 am; 5-7 pm</td>
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<td></td>
<td>37 GHz footprint</td>
<td>85 GHz footprint</td>
<td>5 pm NH; 5 am</td>
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<tr>
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<td>37 x 29 km</td>
<td>15 x 13 km</td>
<td>7-10 am; 7-10 pm</td>
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<td></td>
<td></td>
<td>37 GHz footprint</td>
<td>85 GHz footprint</td>
<td>8 pm NH; 8 am</td>
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<tr>
<td>TMI / TRMM</td>
<td>Dec 1997 Feb 2014</td>
<td>16 x 9 km</td>
<td>7 x 5 km</td>
<td>any</td>
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<tr>
<td>AMSR-E / Aqua</td>
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<td>14 x 8 km</td>
<td>6 x 4 km</td>
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<td>Date</td>
<td>Time UTC</td>
<td>Time LST</td>
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<tr>
<td>SSMI / F14</td>
<td>May 1997 Aug 2008</td>
<td>04 Jul 1999</td>
<td>1507</td>
<td>9 am</td>
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<tr>
<td>TMI / TRMM</td>
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<td>30 Dec 1997</td>
<td>0127</td>
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<td>AMSR-E / Aqua</td>
<td>Jul 2002 Dec 2010</td>
<td>05 Jan 2010</td>
<td>1824</td>
<td>2 pm</td>
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</table>
SSMI – Sorting Signal from Noise

Faulty 85 GHz

Faulty 37 GHz

Real storms, mostly in May-Aug

Snow / ice, mostly in Oct-Apr

N. America cases, color-coded by month

Strongest storms can be hard to distinguish from instrument noise, w/o extra info. QC checks can assume a lower limit on “real” TB.
Using a Snow Screen

Using a basic snow screen applied to individual pixels should eliminate much of the noise.

In practice, it splits up many features by removing some pixels and leaving others. So instead of having a few ridiculously large features due to snow (blue in the plot), the screen leaves many small features (red in the plot).

The ridiculously large features are easier to filter out statistically, so in some ways we are better off not screening the individual pixels before filtering the precipitation features.
Statistical filters for Precip Features

Precipitation features with intense convection tend to have recognizable statistical properties:
• They are clusters of several adjacent pixels with low brightness temperatures.
• Their total size is larger than the area of intense convection itself.
• The 85 GHz PCT is substantially lower than the 37 GHz PCT.

These criteria are used for the current filtering, applied to SSM/I data:

\( \text{n} \text{pixels } \gt 3 \): Removes isolated bad pixels (pixel size \( \sim 200 \text{ km}^2 \))
\( \text{n} \text{pixels } \lt 5000 \): Removes enormous snowpacks
\( \text{min} \text{37pct } \gt \text{min} \text{85pct} \): Removes problematic channel combinations
\( \text{nlt150 } \gt 2 \): From experience, intense storms are large enough for multiple pixels
\( \text{n} \text{pixels } \text{gt nlt150} \): If all the pixels have low TB, something is probably wrong.
\( \text{min} \text{85pct } \lt 130 \) and \( \text{min} \text{37pct } \lt 200 \): Helps to remove snowpack
\( \text{min} \text{85pct } \gt 40 \) and \( \text{min} \text{37pct } \gt 80 \): From examination of cases satisfying the above criteria—anything that looks like a real storm has values well above these
SSMI 85 GHz PCT ≤ 65 K

- 48 cases from F10, F11, F13, F14, F15
- Disproportionate number (27) from F13
SSMI 37 GHz PCT ≤ 150K

53 cases from F08, F10, F11, F13, F14, F15

Disproportionate number (21) from F15