Intense Convection That is Problematic for GPROF, XCAL, and Precipitation Features

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Background

• Intense convection has very low brightness temperatures in many GMI channels, with a wide variety of TB combinations

• Specific multi-channel combinations of TB can be rarely encountered, so GPROF may have trouble recognizing them as intense convection with heavy rain

• XCAL and GPROF screen out TB below 50 K, but legitimate values in the 40’s (K) have been encountered from GMI, TMI, and AMSR 85 & 89 GHz
Background

• Precipitation Features that are compiled across a passive microwave imager swath may require GPROF rain rate > 0. Some versions require PCT89 < 250 K instead.

• In GPM Constellation Precip Features (i.e., applied to AMSR, SSMI, etc.), a snow flag and a desert flag are used, to remove signatures that are related to the surface instead of precip. These are not applied to GMI or TMI.

• All of these can remove intense convective pixels from the Precipitation Features.
89 GHz TB < 50 K Removed by XCAL

- If Level 1B has TB < 50 K, Level 1C (XCAL) sets it to -9999.9
  - Threshold to be lowered to 40 K for GMI, AMSR-2
- This may be a pet peeve of mine, but I’ll admit it rarely happens with legitimate low TB values (i.e., with other channels and other nearby pixels having very low TB, adding credibility to the low values in level 1B).
  - ~20 pixels from 13 orbits in 4 years of GPM (1 Apr 2014–31 Mar 2018)
  - Even SSMI (coarse resolution) has had cases very near 50 K, although I have not seen cases < 50 K from SSMI
- 85 or 89 GHz does go below 50 K in Level 1B data from:
  - TMI, GMI, and AMSR
  - Possibly SSMI, but footprint size may be too large for that
- When it does happen, those are potentially cases of high interest (likely with hazardous weather)
89 GHz TB < 50 K Removed by XCAL

- This is happening in places where you would expect very deep, intense convection
Precip Features missing strongest pixels

- Example GMI case from N. Argentina shows how Precip Feature would be treated by Constellation PF algorithm.

- In this example, around 25 pixels with 89 GHz < 100 K are removed because they are flagged as snow, and a few more are removed with 89 GHz between 100-200 K.

- Dozens of other pixels removed by desert flag, but those are likely light precip
Intense convection erroneously flagged as snow

- N. Argentina case with 3 pixels between 45-49 K (89V)
Intense convection erroneously flagged as snow

- GPROF Sfc Precip Rates are shaded – anything with color should be part of PF
GPROF putting light rain where TBs are very low

• In that N. Argentina example, 14 of the pixels with $89V < 100 \text{ K}$ have retrieved rain rates between 1 - 3 mm/h (mostly near 2.5 mm/h).

• 6 other pixels have missing retrievals
  • 4 of those due to TB < 50 K
  • Even the missing precip rates are listed as 36% probability of precip. Otherwise, most pixels with low TB are listed as 100% probability of precip.
GPROF Probability of Precip

- looks reasonable, other than pixels < 50 K

09 Apr 2016 0051 UTC  GMI GPROF VO5A ProbPrecip
89 GHz H

- N. Argentina case with 4 pixels between 44-48 K (89H)

09 Apr 2016 0051 UTC  GMI  45 K 89 GHz H

Chaco Province
Argentina

Resistencia

Paraguay
GPROF Precip rates unrealistically low (or missing) in many places
DPR Ku Max Precip In Column

- Radar gives sanity check
- GPROF rain rates clearly too low in some places
- But should also resist temptation to paint all the low-TB pixels as extreme rain
DPR Ku Near Surface Precip

- Ku Near Sfc Precip

09 Apr 2016 0051 UTC  GMI  223 mm/h  Ku V05A NearSfcPrecip

Chaco Province

Argentina

Paraguay

Argentia

Resistencia

0 5 10 15 20 25 30 300 missing
DPR Ku Near Surface Precip

- Extended color scale to show higher rain rates

09 Apr 2016 0051 UTC  GMI  223 mm/h Ku V05A NearSfcPrecip
DPR Ku Max Precip In Column

- Extended color scale to show higher rain rates

09 Apr 2016 0051 UTC  GMI Ku V05A Max Precip

Chaco Province

Argentina

Paraguay

Resistencia

Extended color scale to show higher rain rates
183 +/- 7 GHz

09 Apr 2016 0051 UTC GMI 60 K 183+/-7 GHz V

Chaco Province

Argentina

Paraguay

Resistencia
183 +/- 3 GHz

09 Apr 2016 0051 UTC  GMI  60 K 183+-/3 GHz V

Paraguay
Argentina
Chaco Province
Resistencia
Summary

• 50-K threshold in XCAL and GPROF removes some of the strongest convection from GMI, TMI, and AMSR.
  • Admittedly, this happens rarely.
  • To be changed to 40-K for GMI and AMSR

• Snow flags in Constellation Precip Features inadvertently remove many of the coldest pixels
  • Can revise those flags in next version. Might not fully solve problem, but greatly mitigate it.

• GPROF precip rates often much too low for the lowest-TB pixels.
  • Assigning all the low-TB pixels an extreme rain rate would be over-reaction, based on comparison to radar
  • Quantitative impacts under investigation using large sample