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

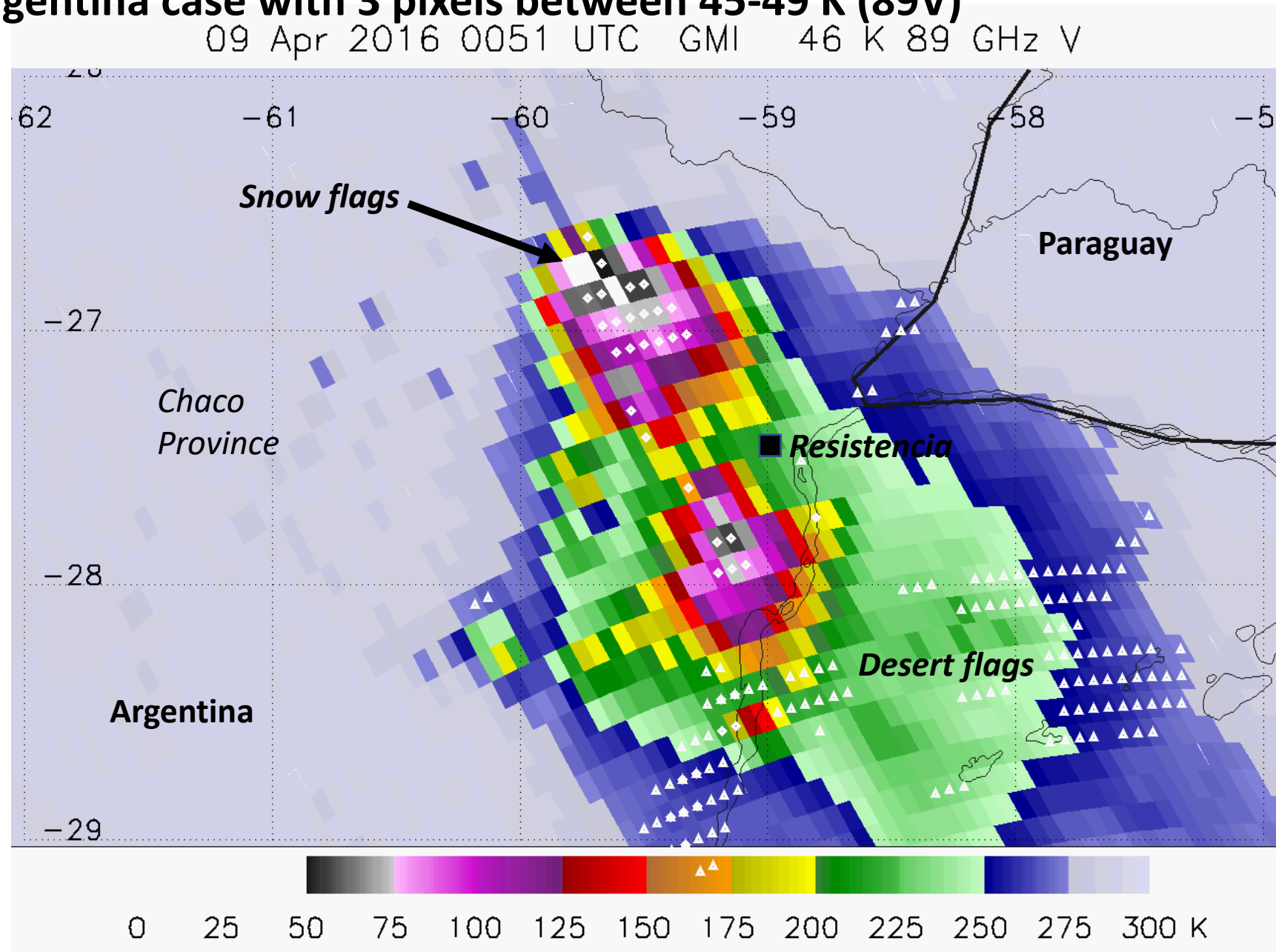
- Example GMI case from N. Argentina shows how Precip Feature would be treated by Constellation PF algorithm.

- 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

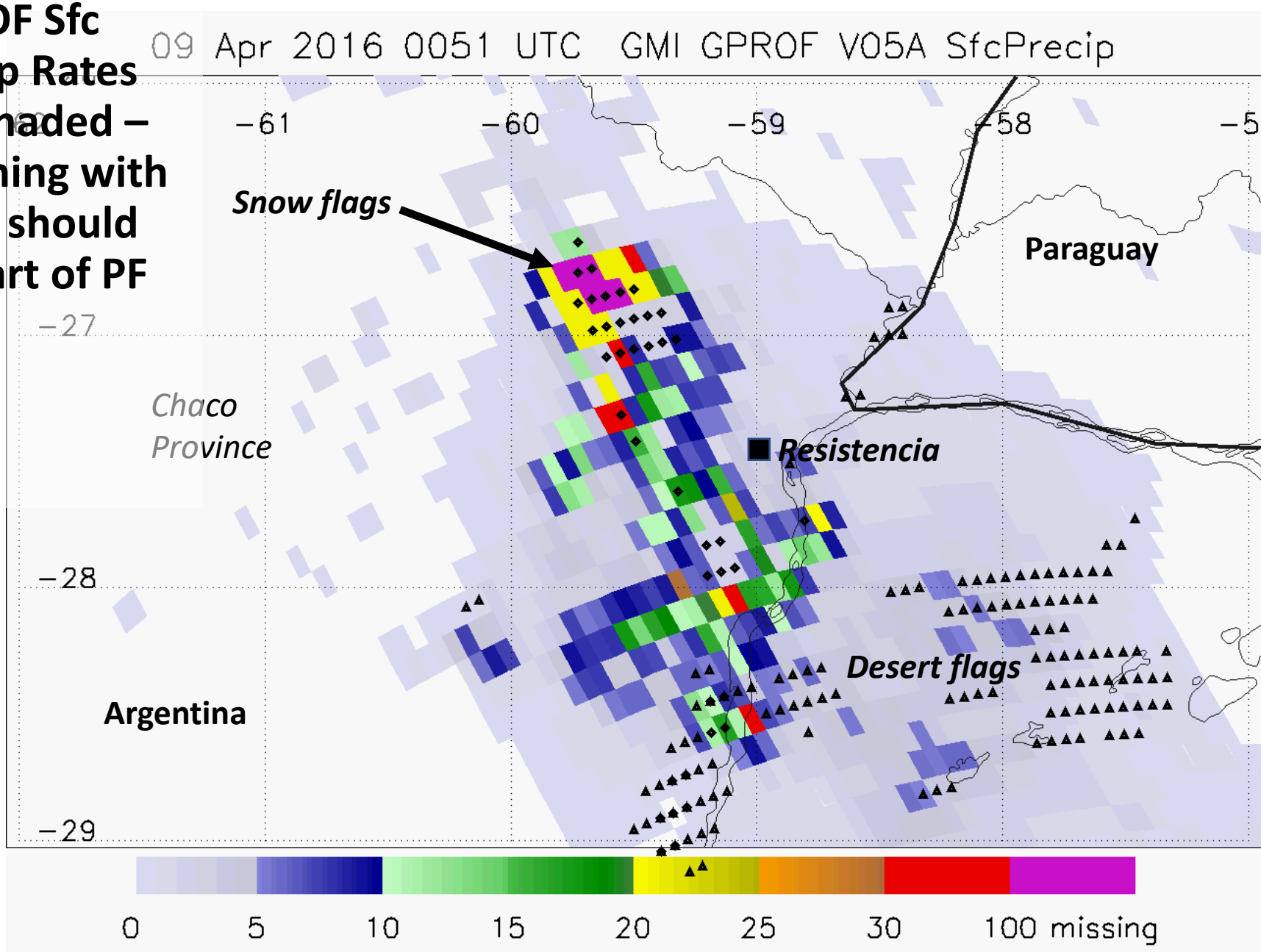
Intense convection erroneously flagged as snow

- 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**



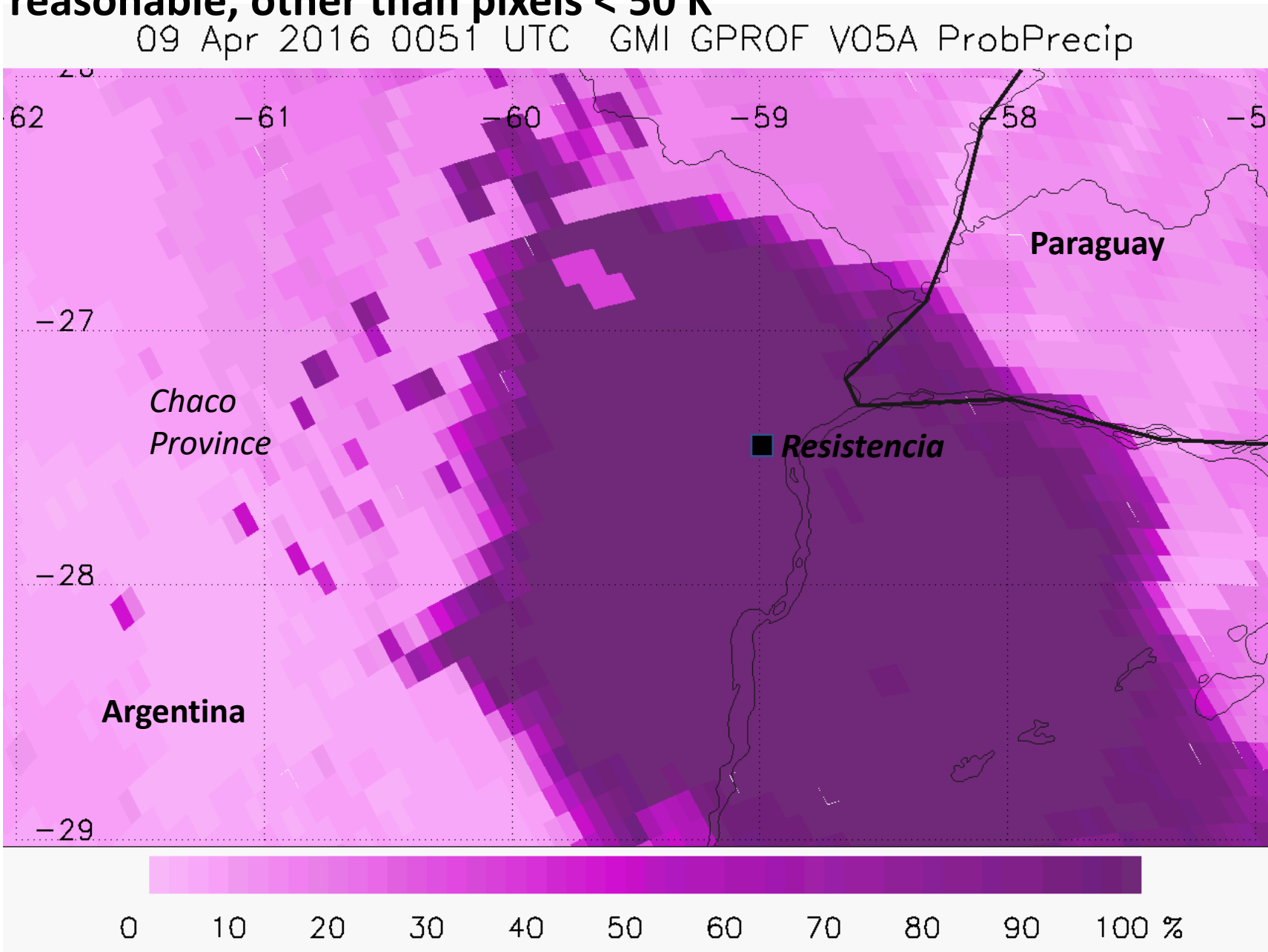
GPROF putting light rain where TBs are very low

- In that N. Argentina example, 14 of the pixels with 89V < 100 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.

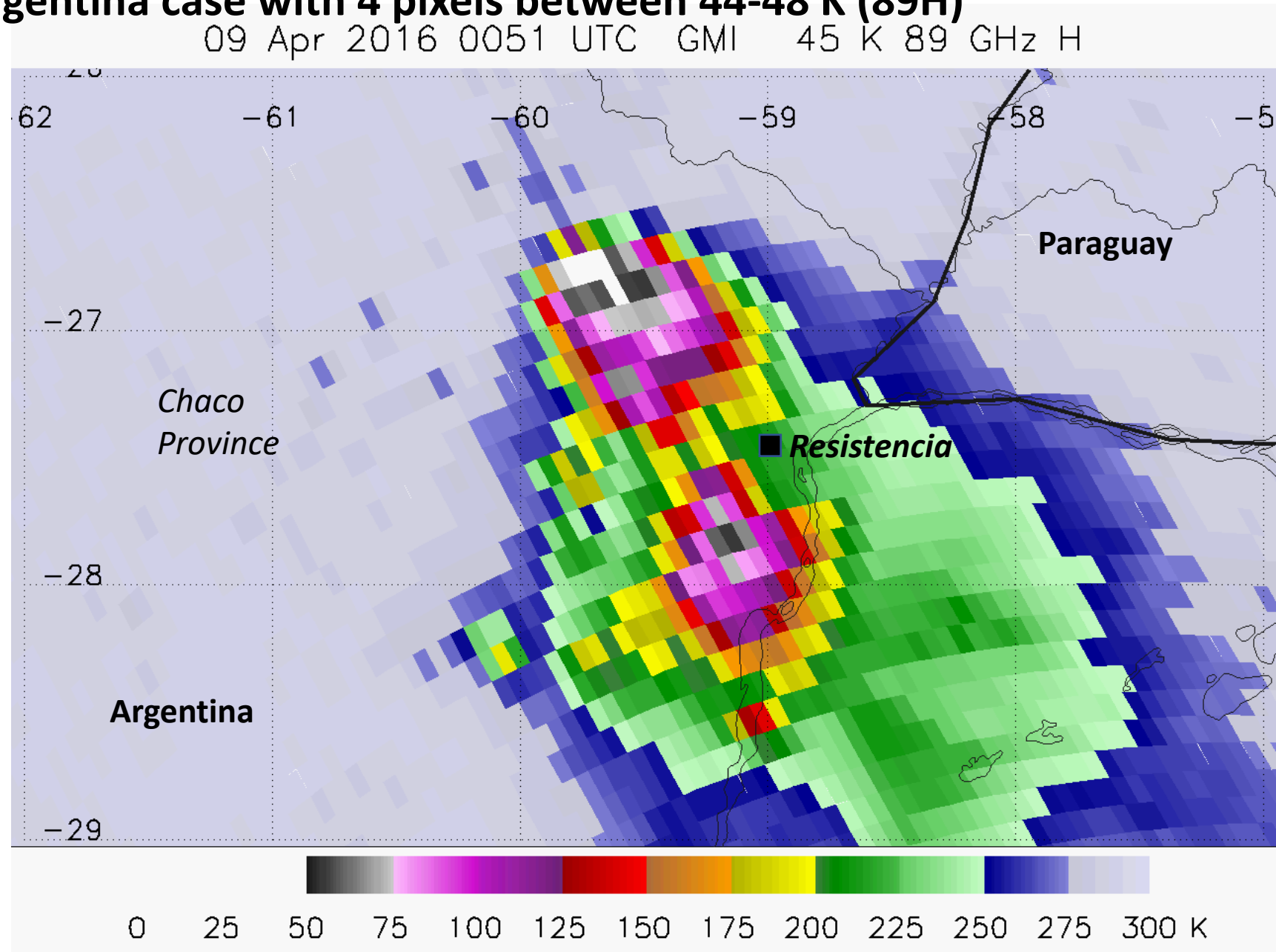
GPROF Probability of Precip

- **looks reasonable, other than pixels < 50 K**



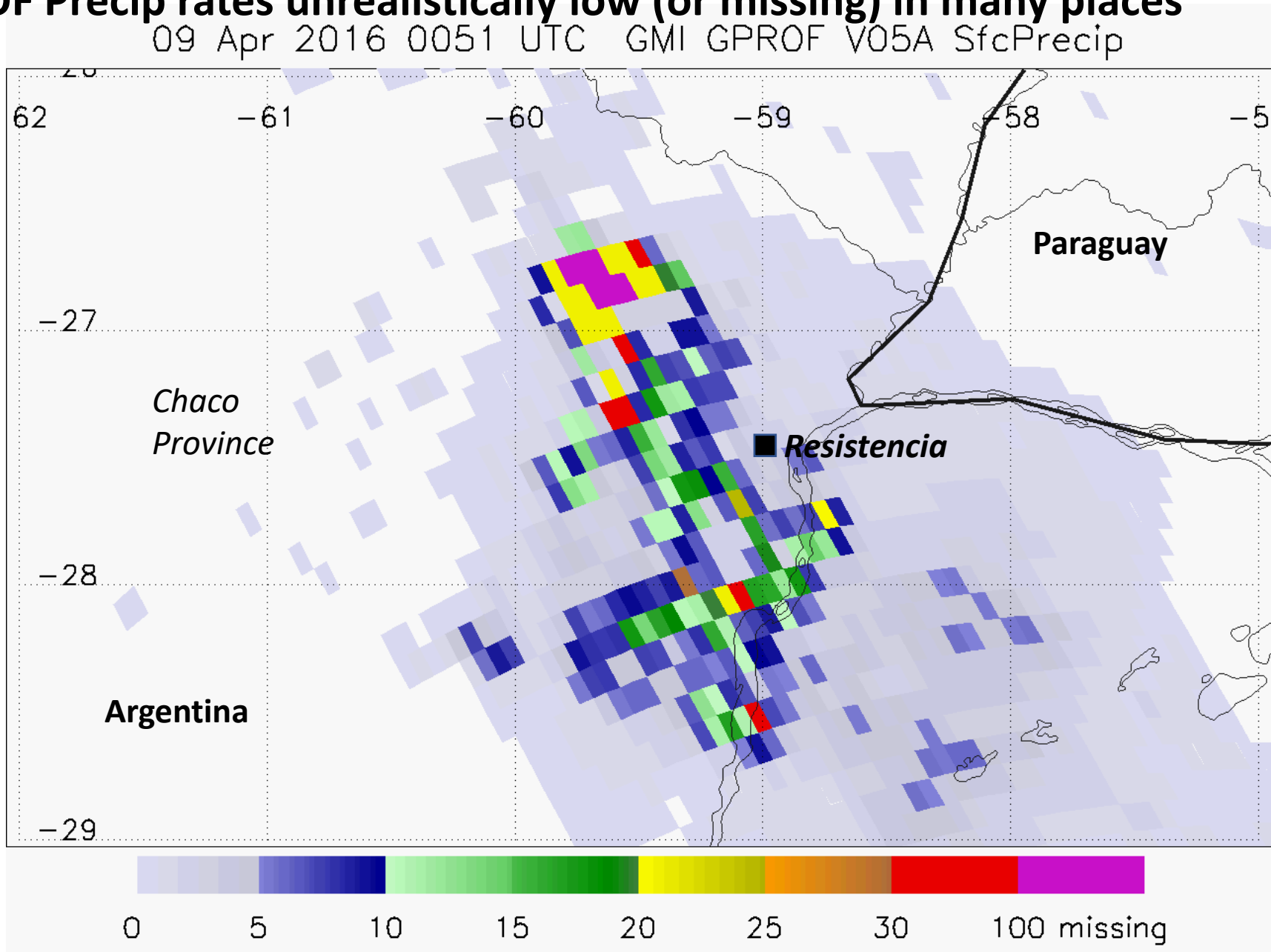
89 GHz H

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



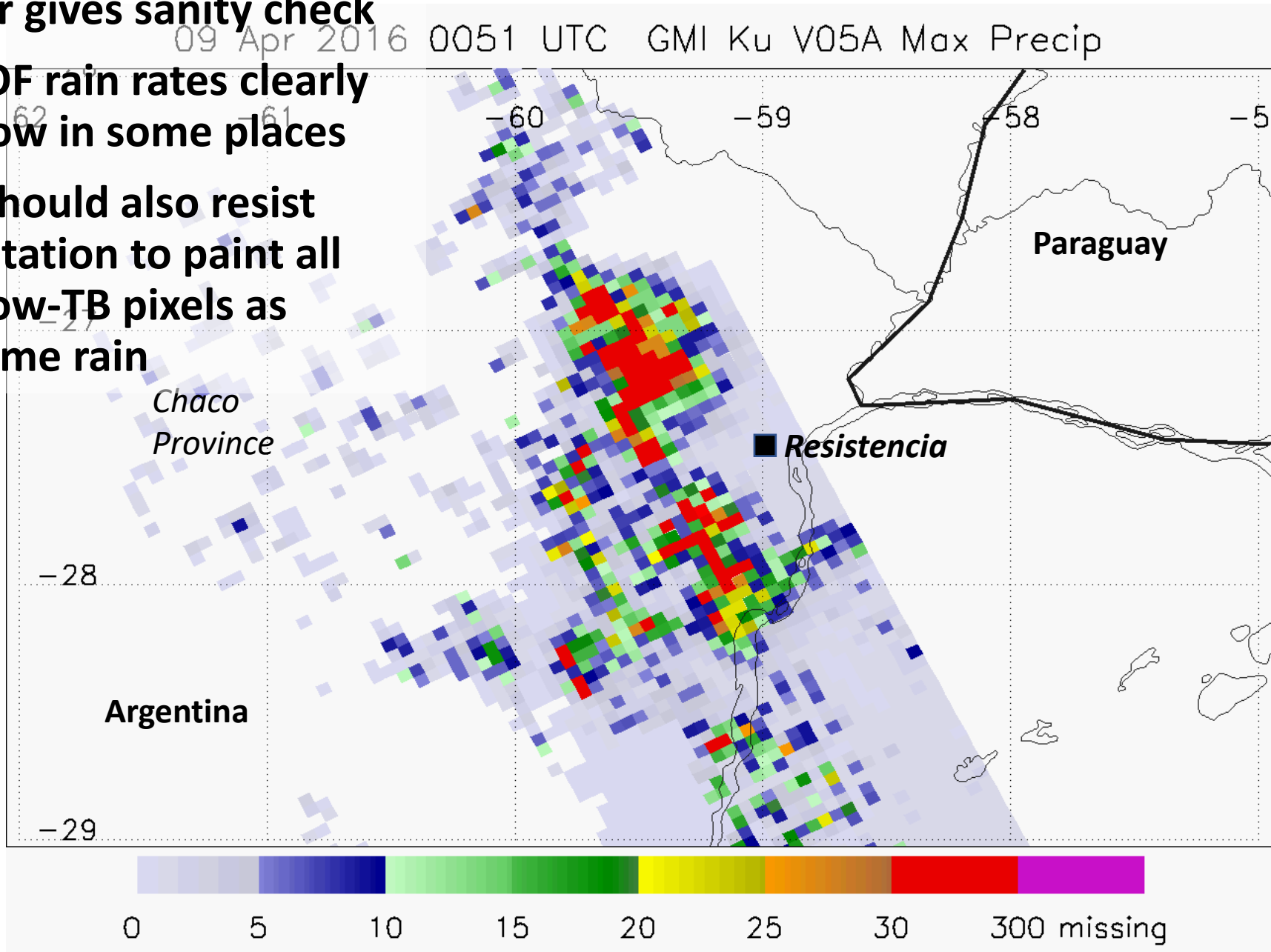
GPROF Surface Precipitation

- **GPROF Precip rates unrealistically low (or missing) in many places**



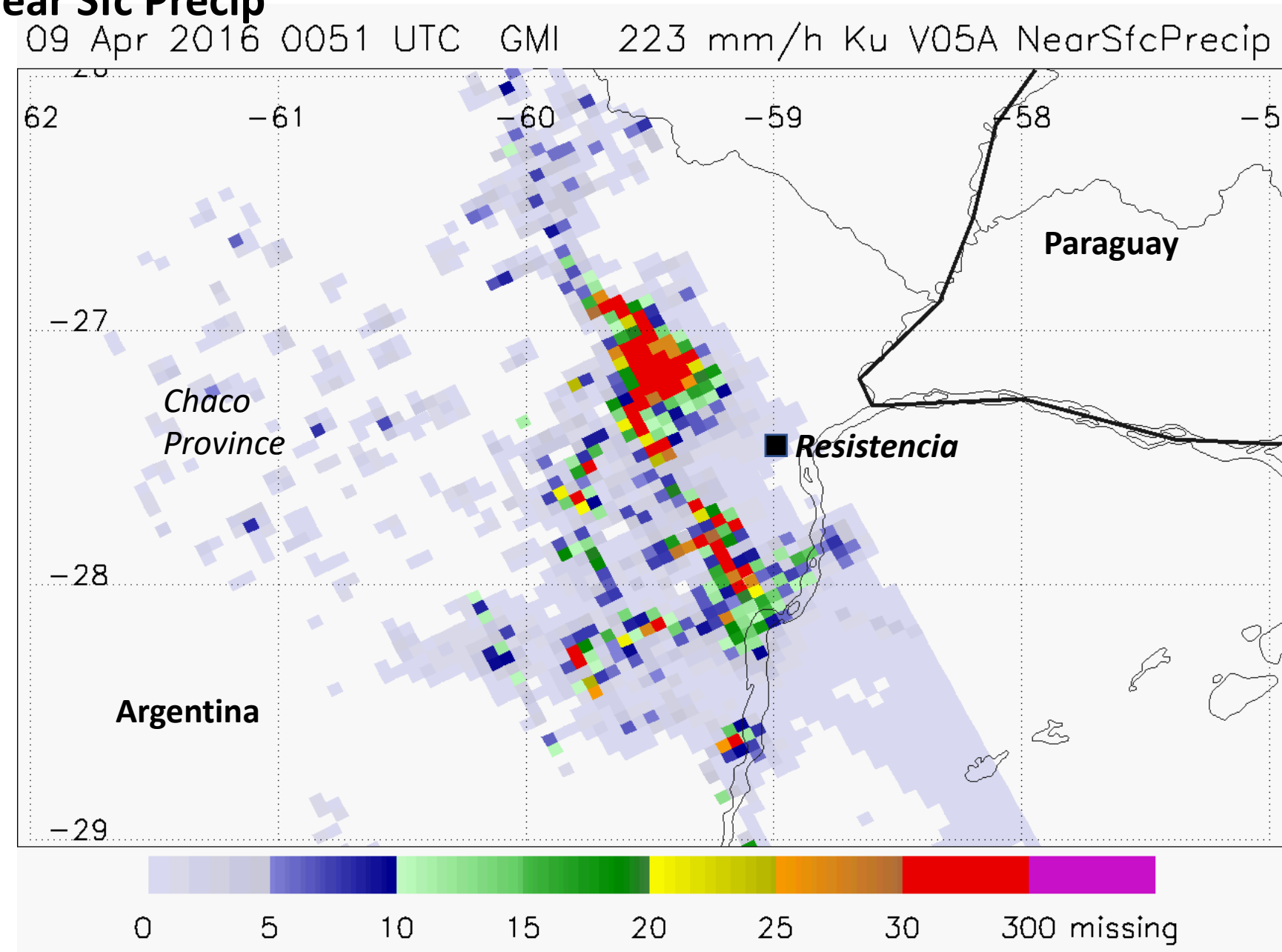
DPR Ku Max Precip In Column

- 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



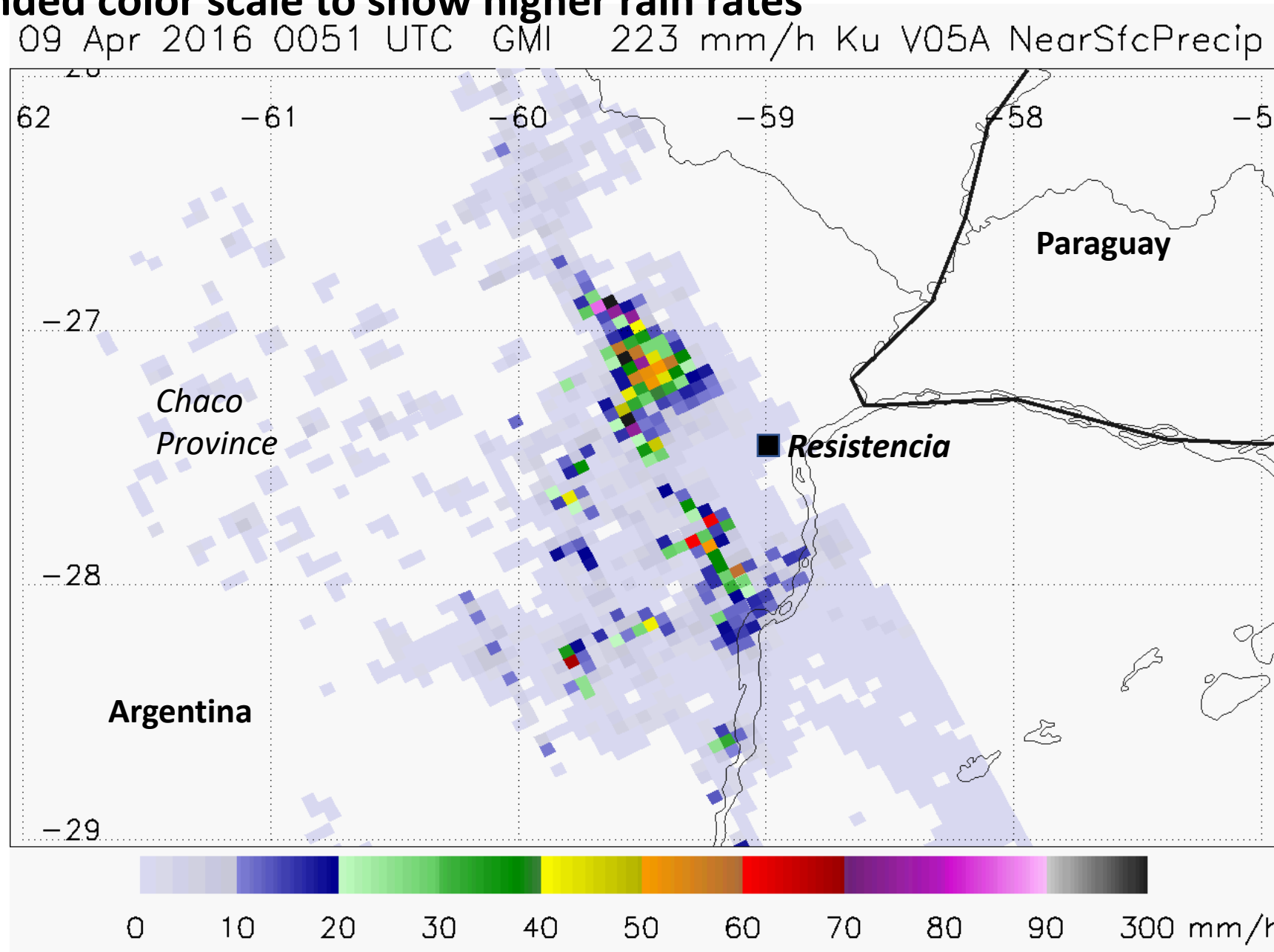
DPR Ku Near Surface Precip

- **Ku Near Sfc Precip**



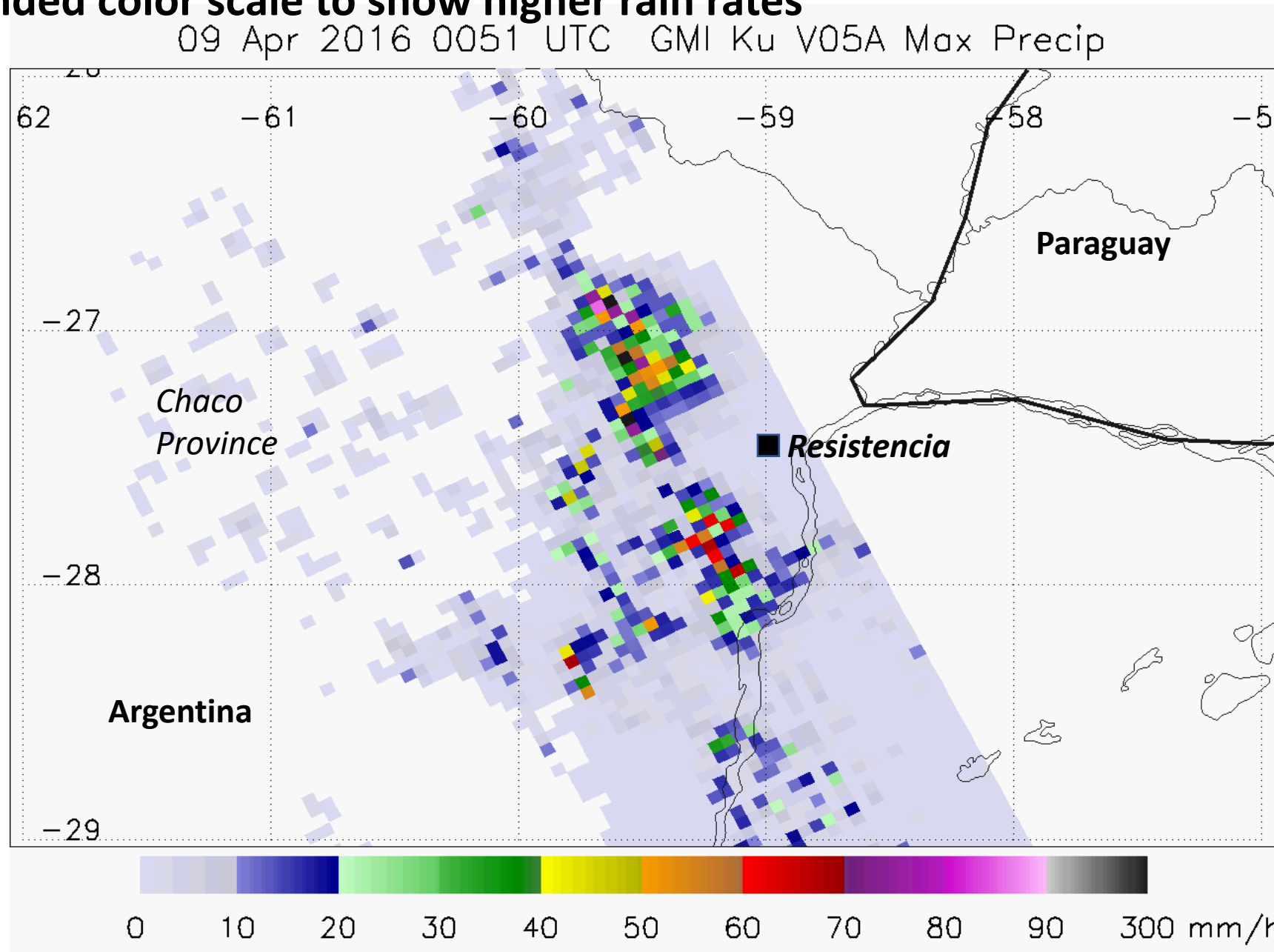
DPR Ku Near Surface Precip

- **Extended color scale to show higher rain rates**

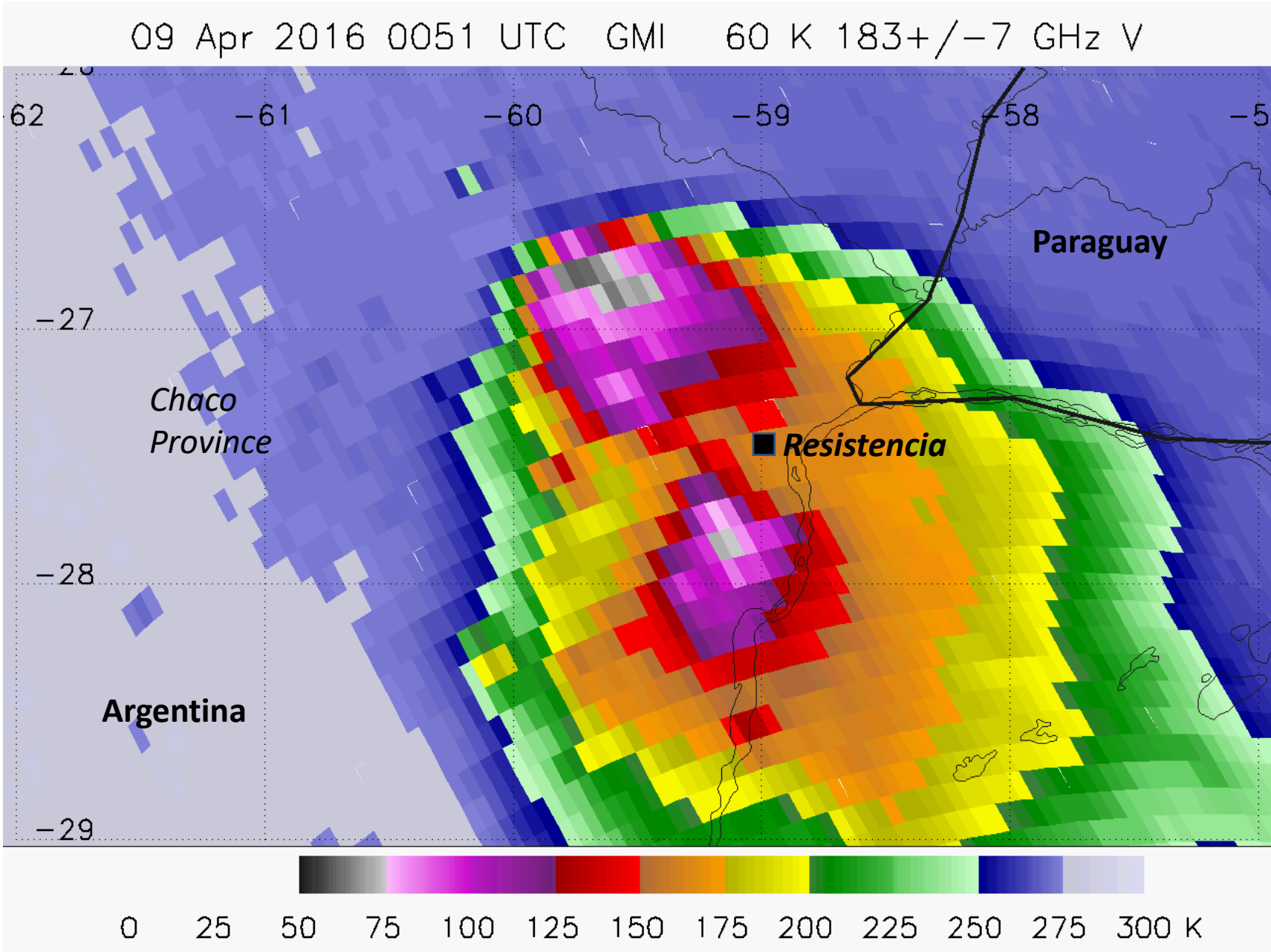


DPR Ku Max Precip In Column

- **Extended color scale to show higher rain rates**



183 +/- 7 GHz


09 Apr 2016 0051 UTC GMI 60 K 183+/−7 GHz V
62
−61
−60
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−58
−27
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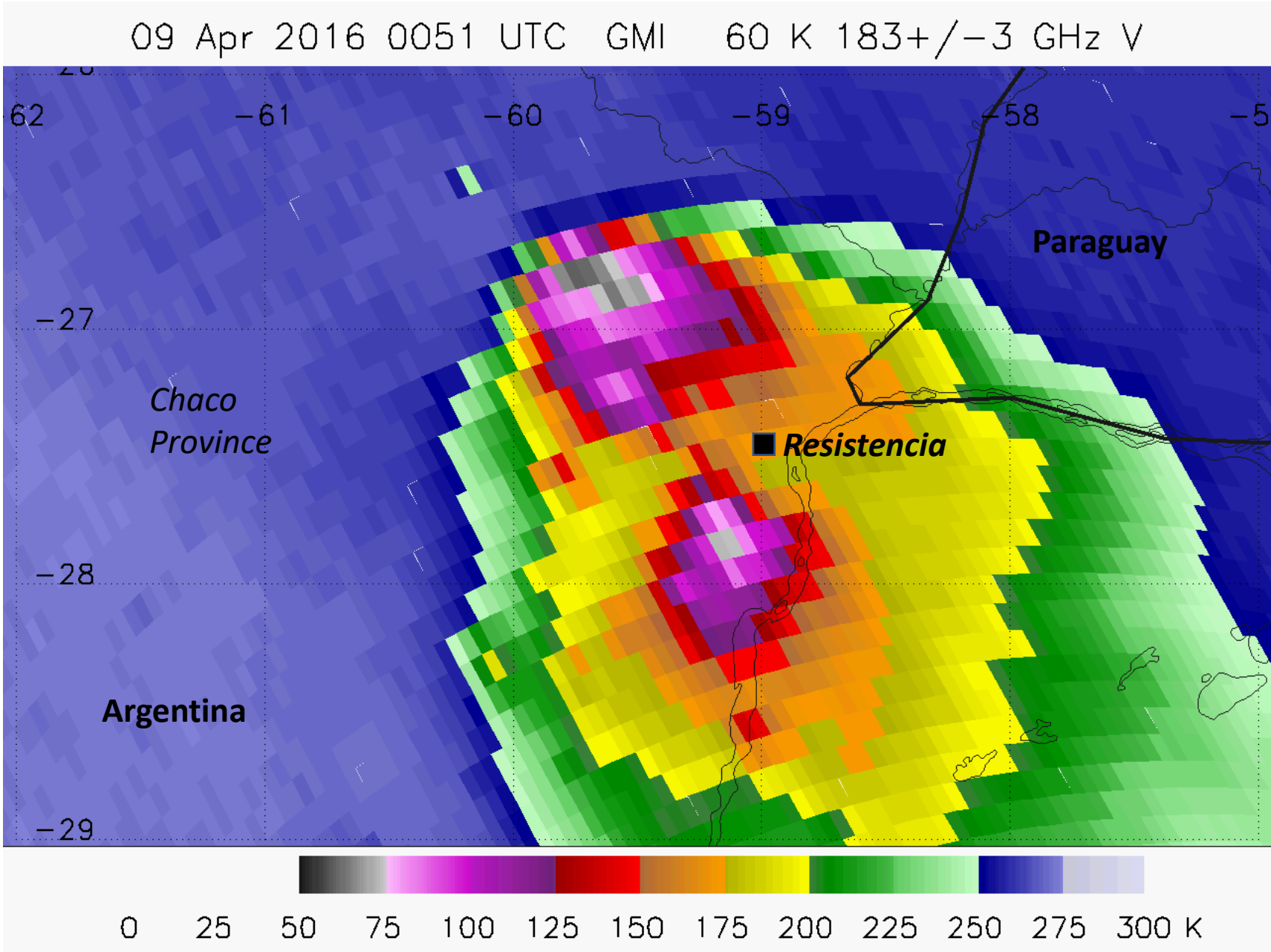
−29
Paraguay
Chaco
Province
Resistencia
Argentina
0 25 50 75 100 125 150 175 200 225 250 275 300 K

183 +/- 3 GHz


09 Apr 2016 0051 UTC GMI 60 K 183+/−3 GHz V
62
−61
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−27
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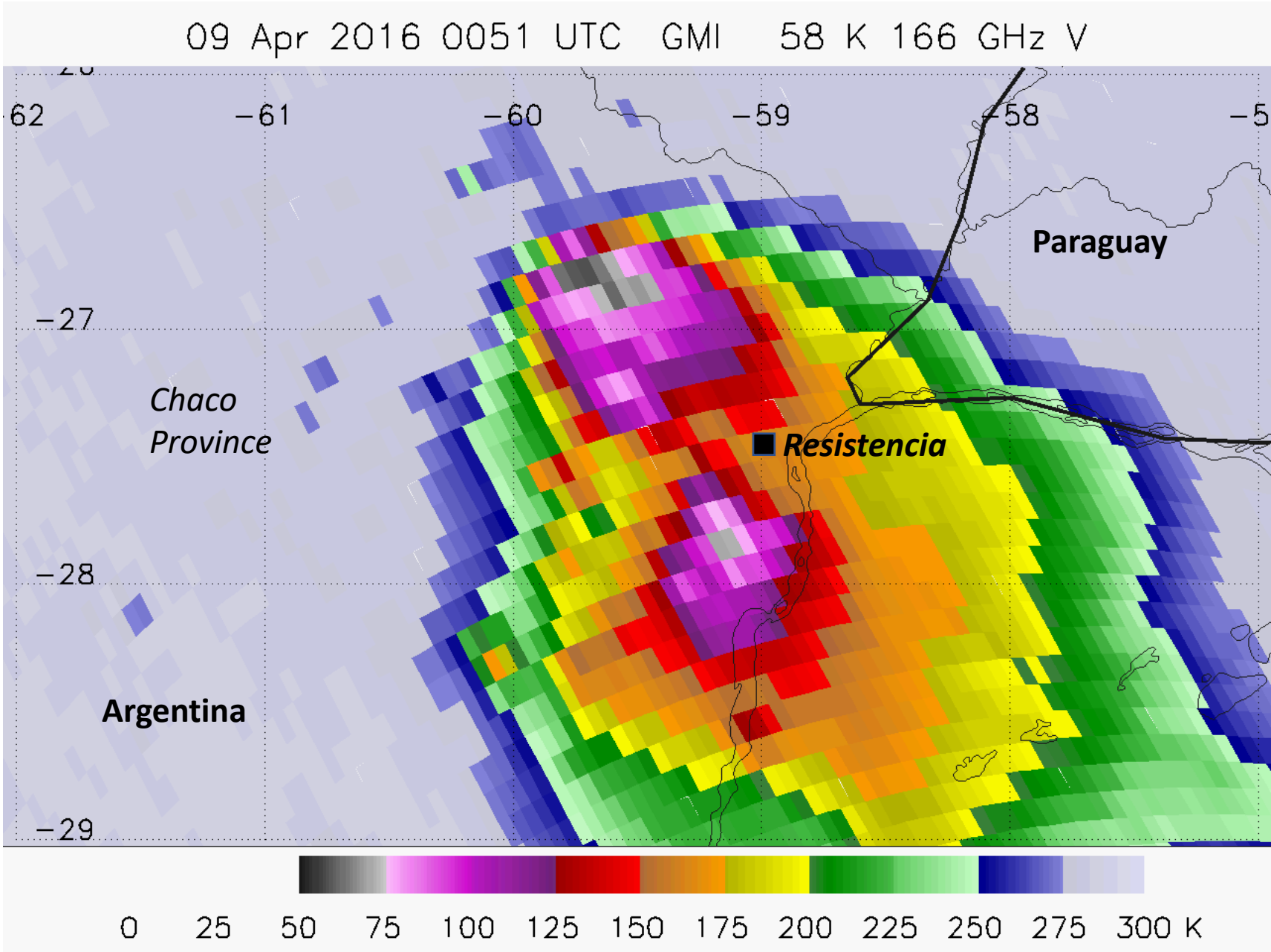
−29
Paraguay
Chaco
Province
Resistencia
Argentina
0 25 50 75 100 125 150 175 200 225 250 275 300 K

166 GHz V


09 Apr 2016 0051 UTC GMI 58 K 166 GHz V
62
−61
−60
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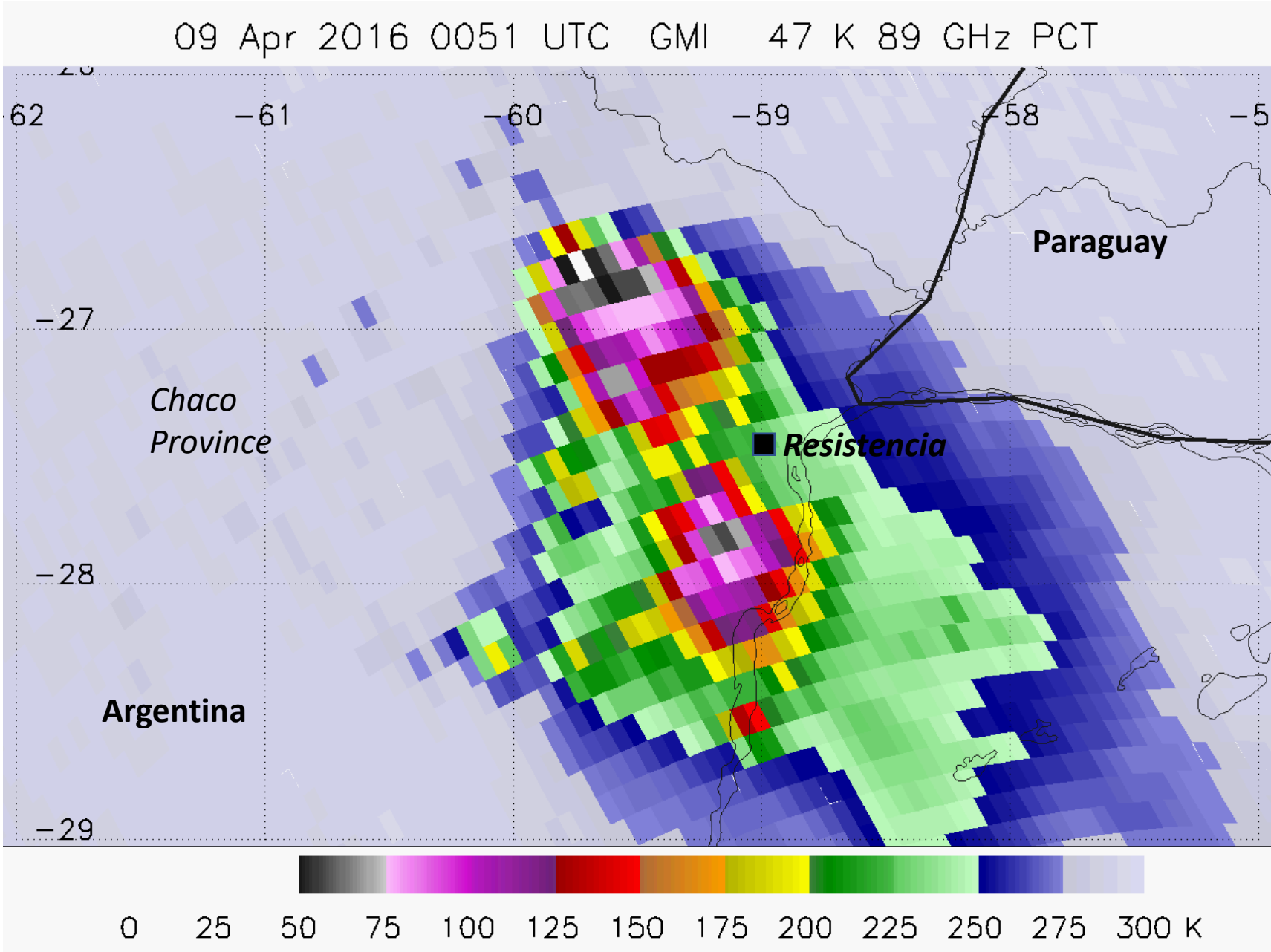
Paraguay
Chaco
Province
Resistencia
Argentina
0 25 50 75 100 125 150 175 200 225 250 275 300 K

89 GHz PCT


09 Apr 2016 0051 UTC GMI 47 K 89 GHz PCT
62
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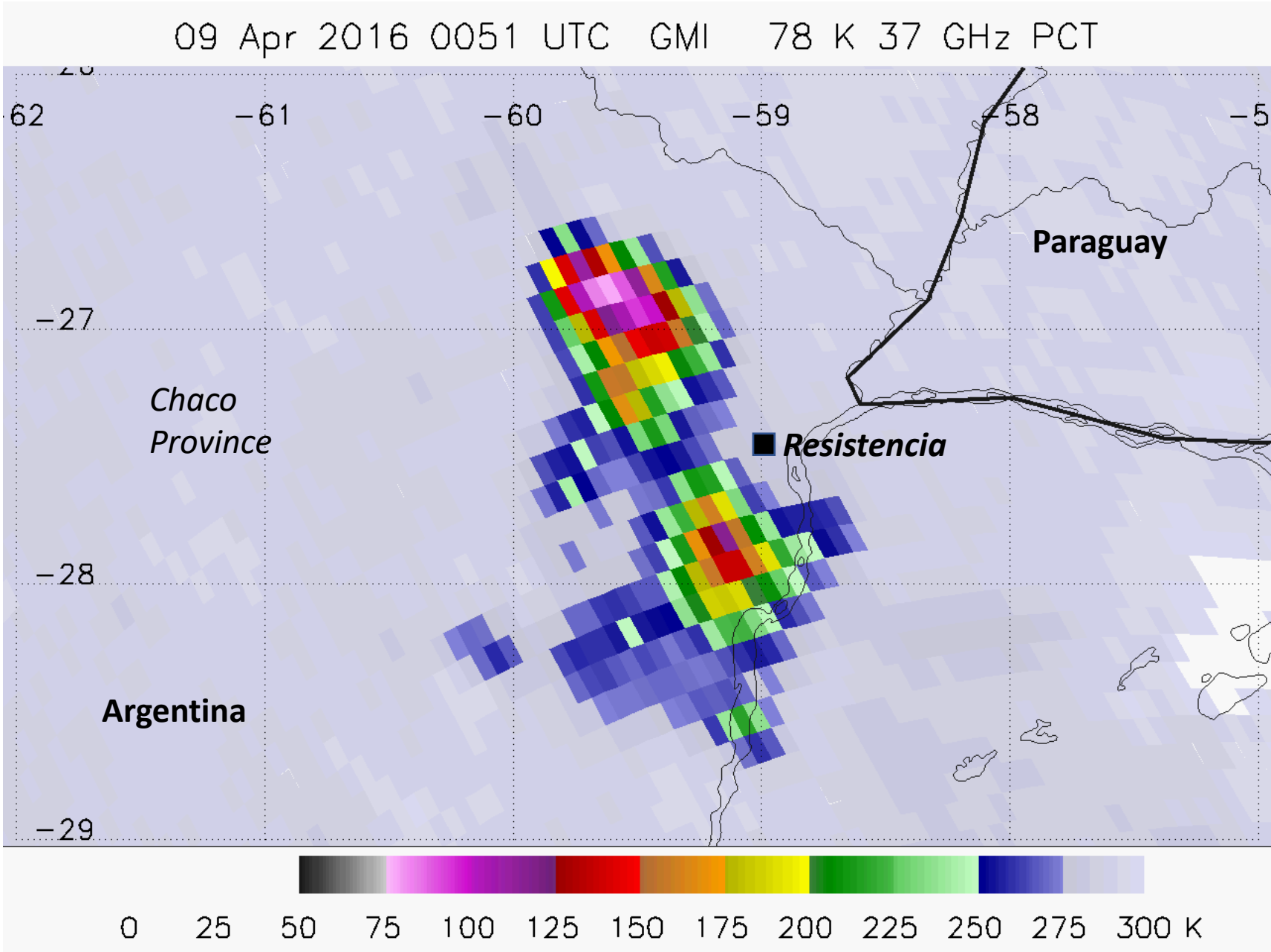
Paraguay
Chaco
Province
Resistencia
Argentina
0 25 50 75 100 125 150 175 200 225 250 275 300 K

37 GHz PCT


09 Apr 2016 0051 UTC GMI 78 K 37 GHz PCT
62
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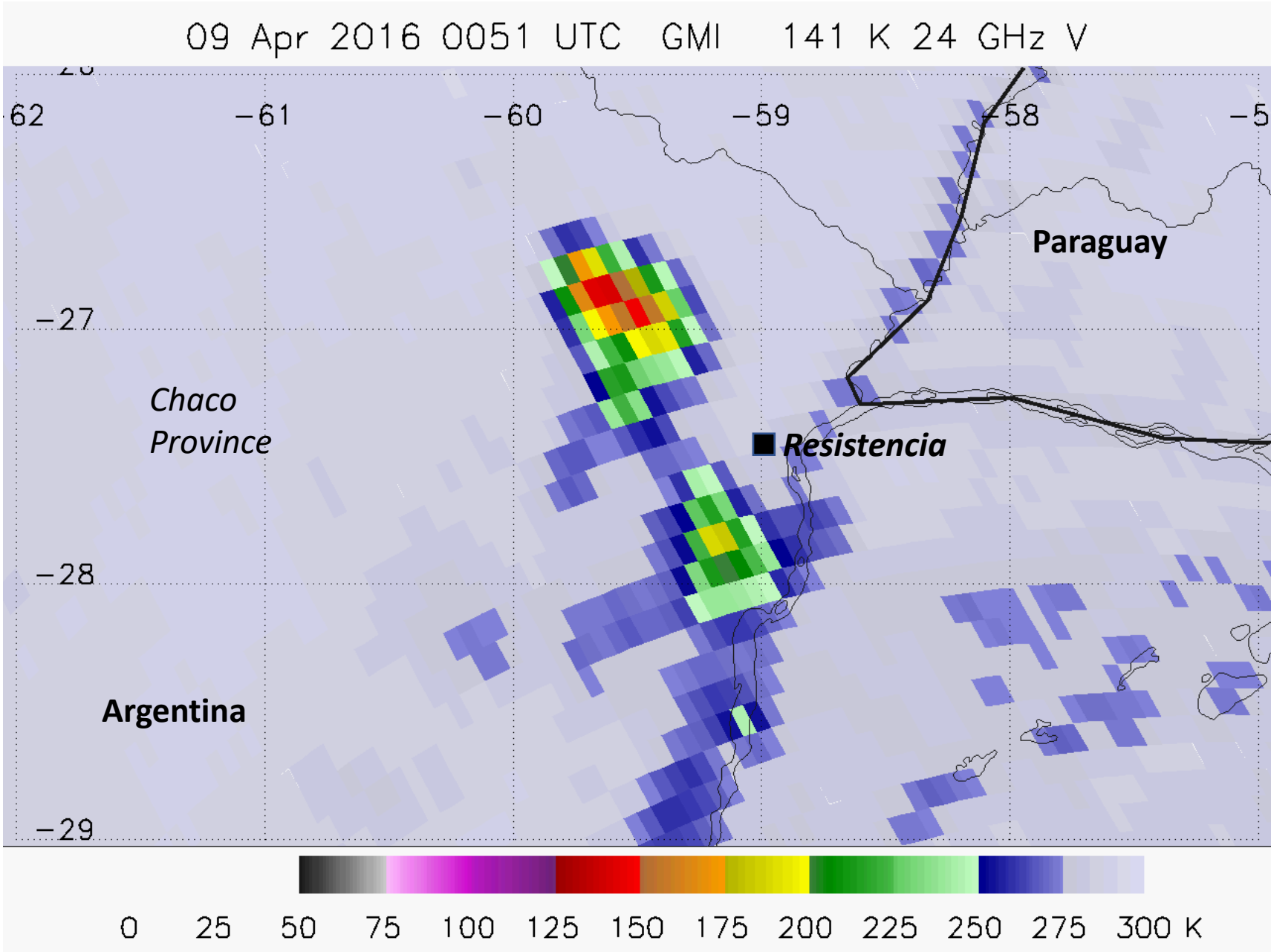
−29
Paraguay
Chaco
Province
Resistencia
Argentina
0 25 50 75 100 125 150 175 200 225 250 275 300 K

24 GHz V


09 Apr 2016 0051 UTC GMI 141 K 24 GHz V
62
−61
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−58
−27
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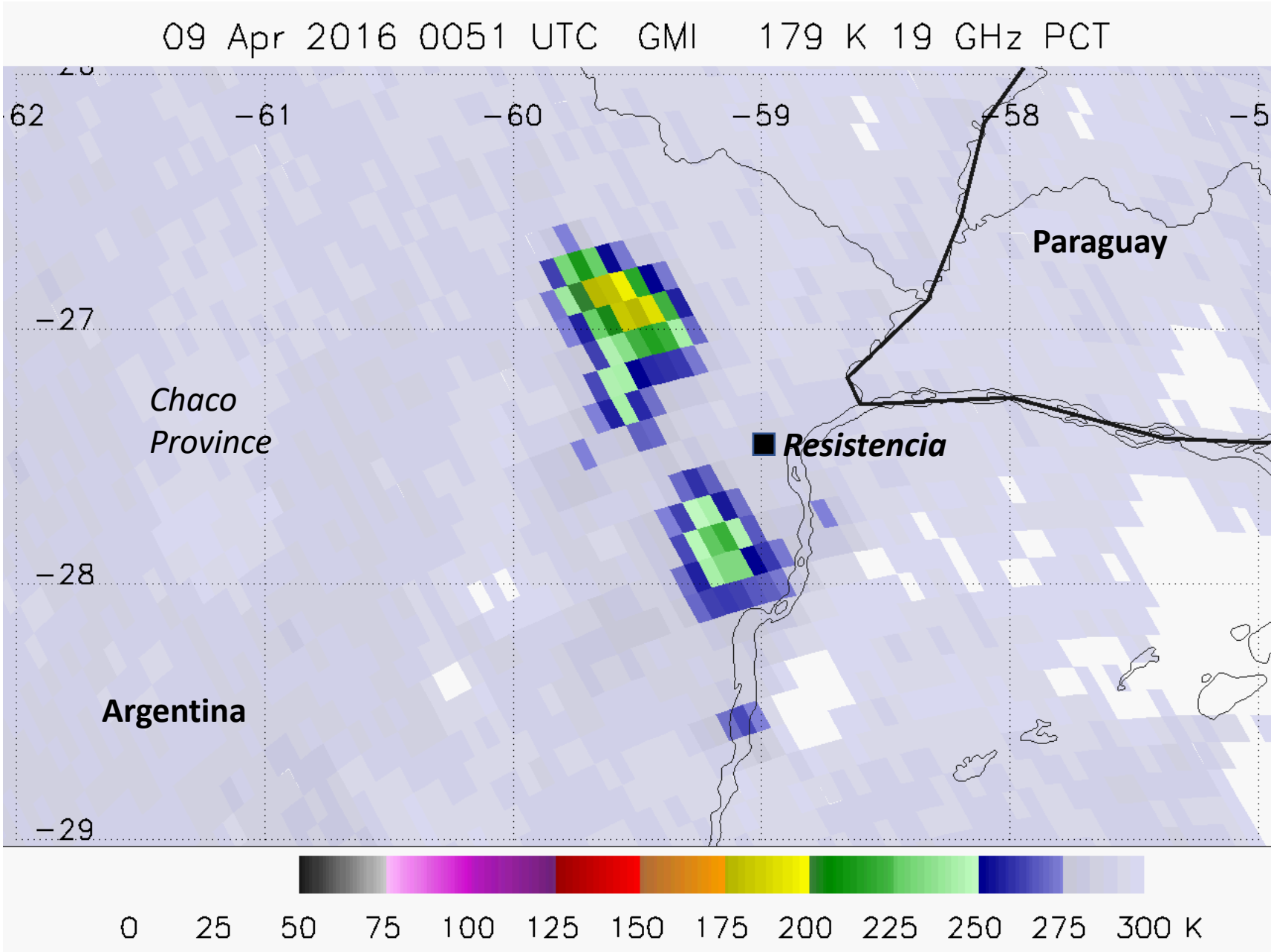
Paraguay
Chaco
Province
Resistencia
Argentina
0 25 50 75 100 125 150 175 200 225 250 275 300 K

19 GHz PCT


09 Apr 2016 0051 UTC GMI 179 K 19 GHz PCT
62
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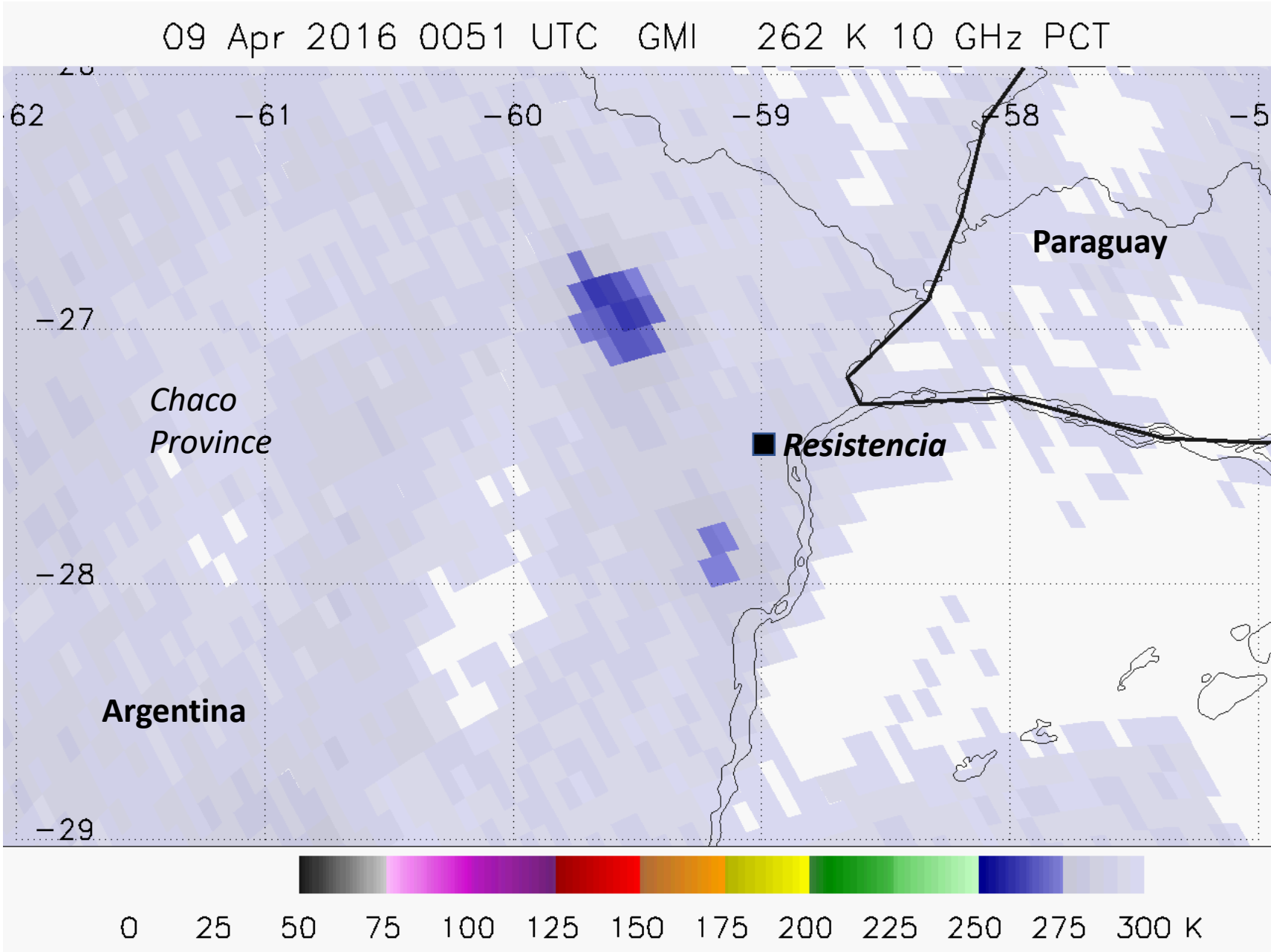
Paraguay
Chaco
Province
Resistencia
Argentina
0 25 50 75 100 125 150 175 200 225 250 275 300 K

10 GHz PCT


09 Apr 2016 0051 UTC GMI 262 K 10 GHz PCT
62
−61
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Paraguay
Chaco
Province
Resistencia
Argentina
0 25 50 75 100 125 150 175 200 225 250 275 300 K

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