How Do TROPICS Frequencies Respond to Large Hail?

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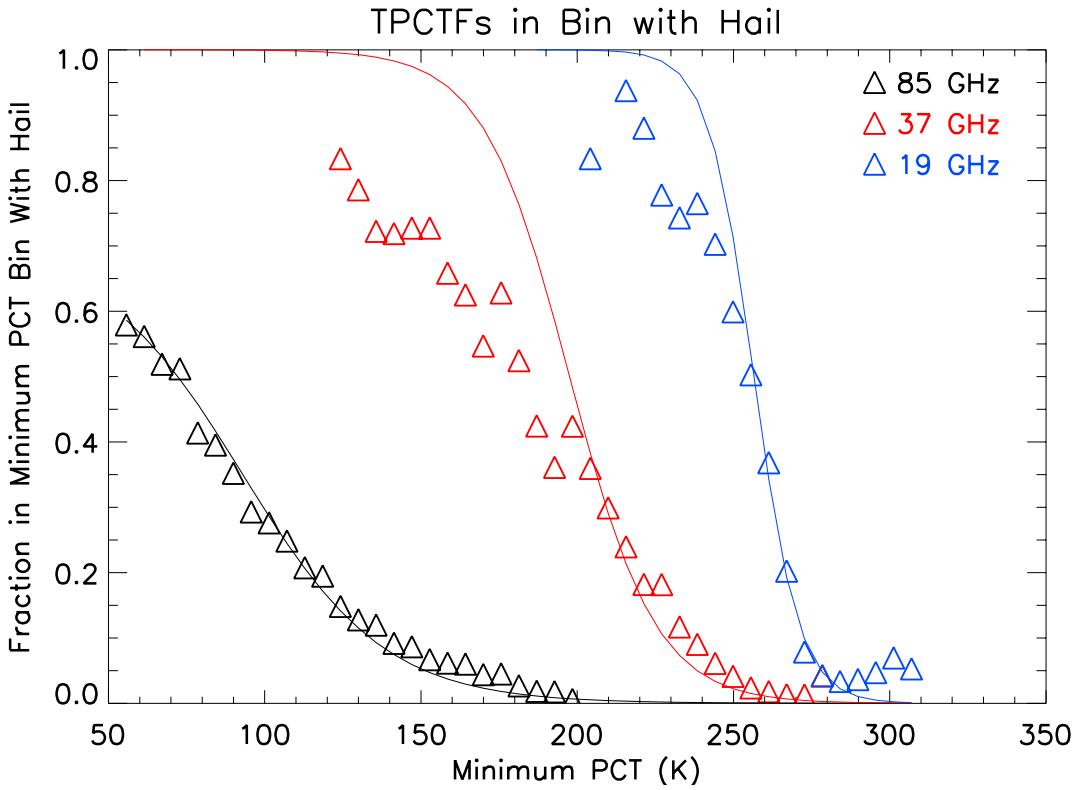
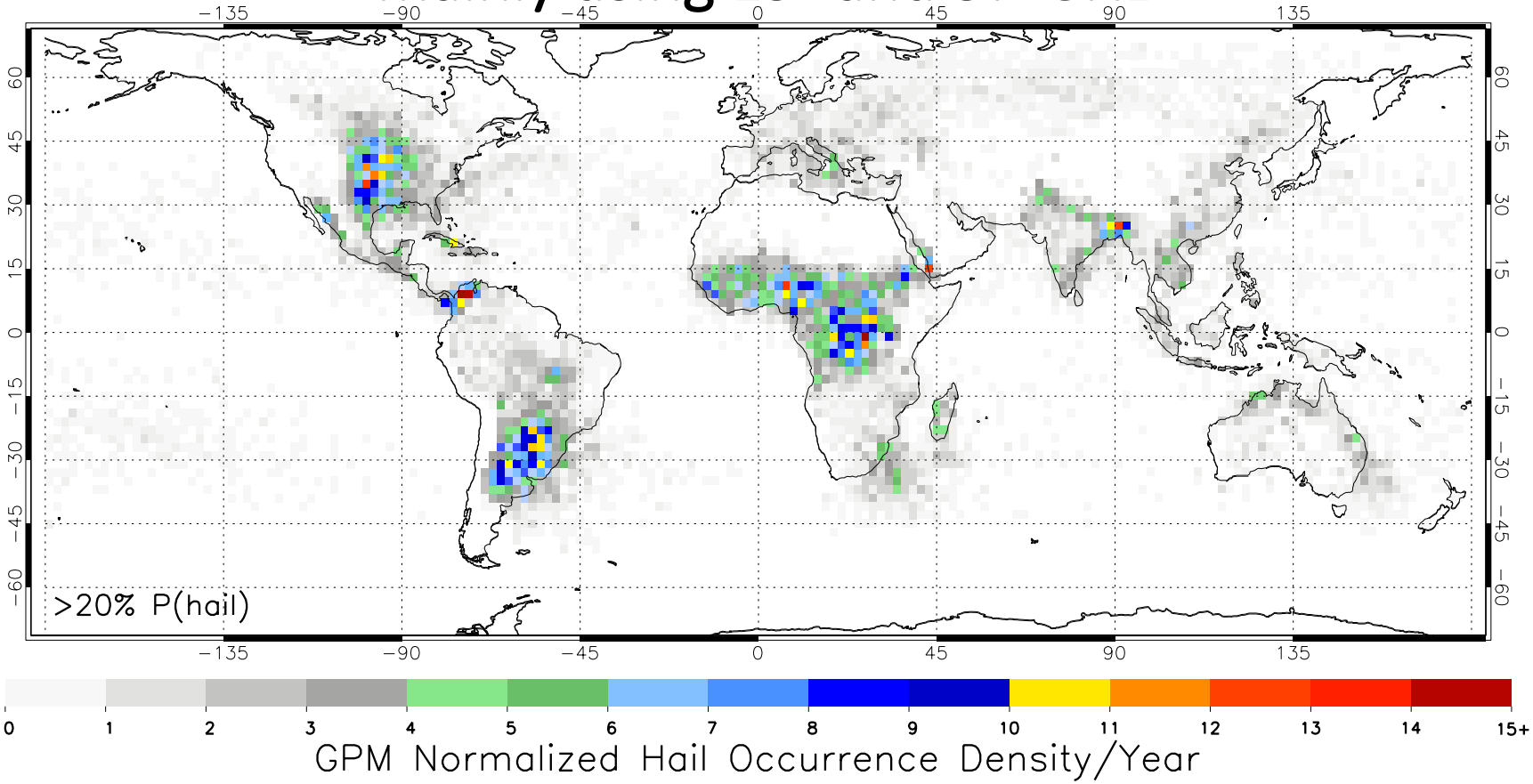
Hail vs Brightness Temperature

- Passive microwave imagers such as those in GPM constellation, TRMM, SSMI, can be good for identifying severe thunderstorms and developing maps of when/where they occur, how strong they are
- Decreasing Brightness Temperature → Increasing likelihood of large hail (≥1" diameter)
- TROPICS might not be well suited for that, because high-frequency channels can make it hard to distinguish between a deep layer of graupel and a smaller layer of hail. TROPICS has 91-205 GHz.



Fraction of storms with large hail, as a function of brightness temperature. Response is strongest for lowest frequencies.

GPM-based Hail Climatology mainly using 19- and 37-GHz



Map above is based on GPM. We are working on extending the same approach to TRMM, AMSR, and SSMI.

Project has partners in Re-Insurance Sector through NASA Applied Science / Disasters program.

What can TROPICS add on this topic?

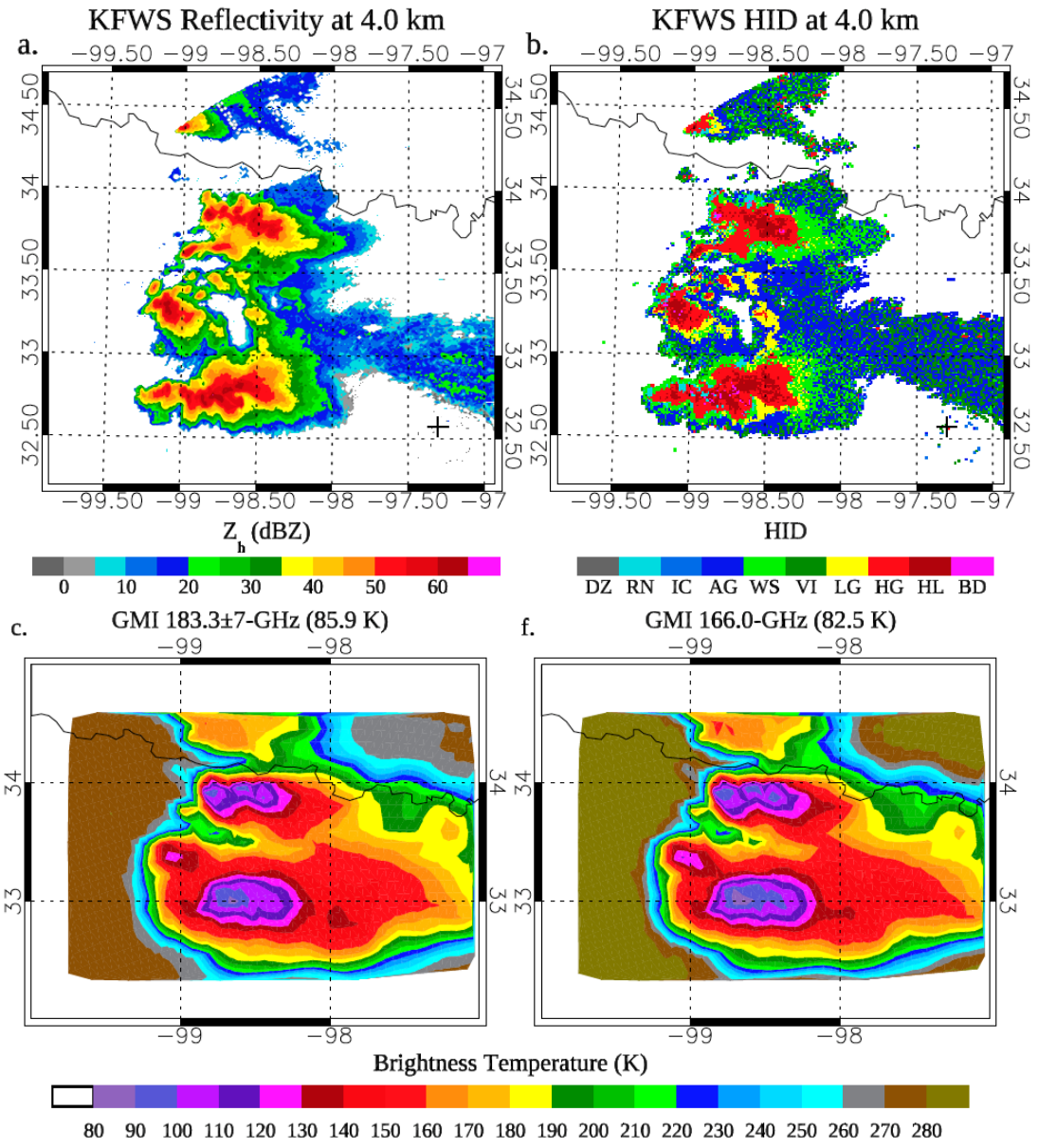
- More complete temporal sampling. Current constellation has many long gaps; many severe thunderstorms are entirely missed.
- TROPICS will see a greater number of storms, but with lower confidence in whether or not they are severe.
- With short intervals between TROPICS snapshots, assess whether a given storm is intensifying or weakening?
    - Pairing this with the GPM measurements, a temporal trend from TROPICS may be used for refining a GPM-based estimate of whether or not a storm is severe

Example case 26 May 2015 N. Texas hailstorm seen by GPM

Top: KFWS (Fort Worth) Radar Reflectivity and Hydrometeor Identification

Bottom: GPM GMI 183.3+/-7 GHz and 166 GHz brightness temperatures. Minimum brightness temperatures 86 K and 83 K, respectively.

Similar frequency as TROPICS channels 9-11

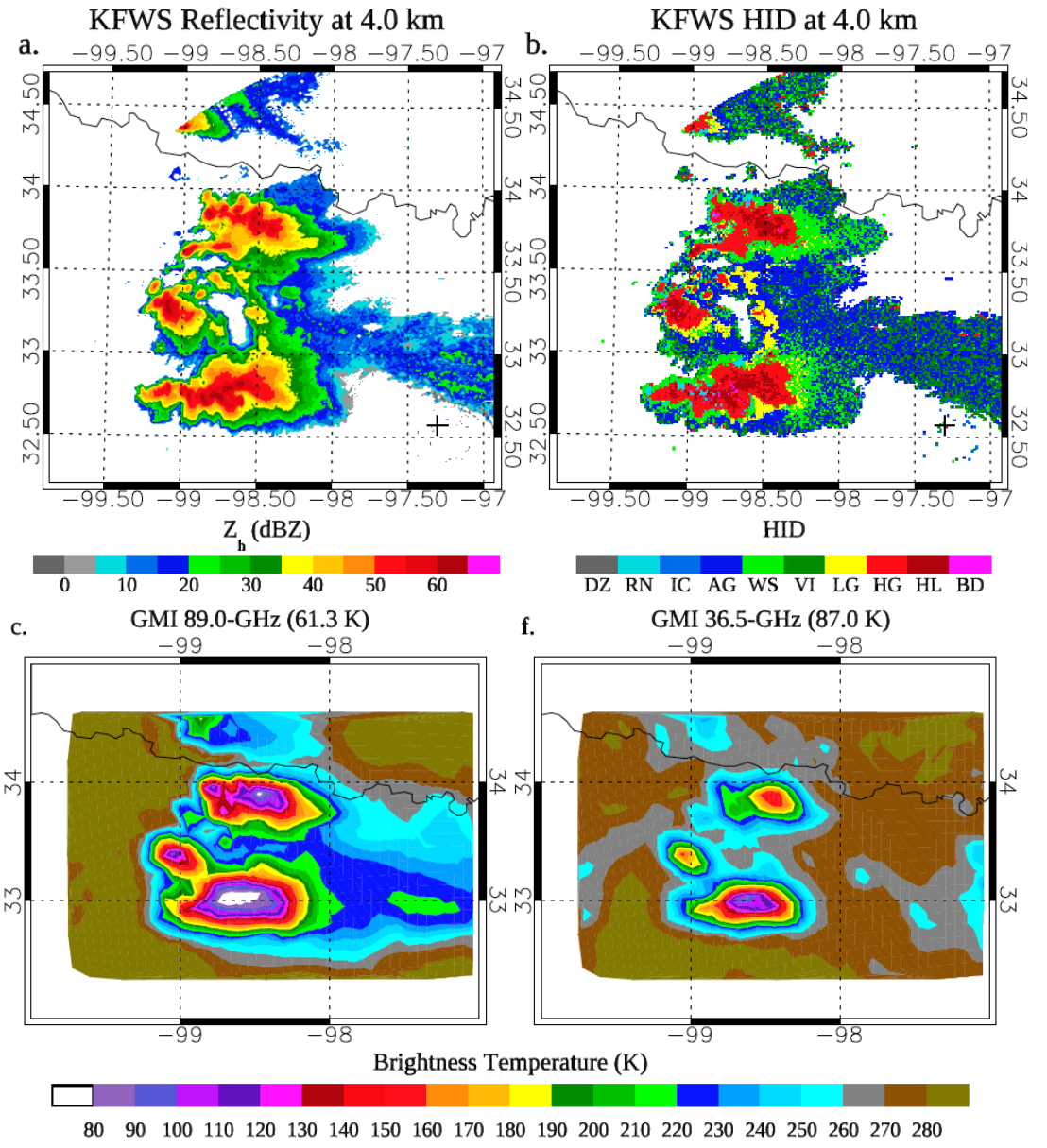


Example case 26 May 2015 N. Texas hailstorm seen by GPM

Top: KFWS (Fort Worth) Radar Reflectivity and Hydrometeor Identification

Bottom: GPM GMI 89.0 GHz and 36.5 GHz brightness temperatures. Minimum brightness temperatures 61 K and 87 K, respectively.

Similar frequency as TROPICS channel 1



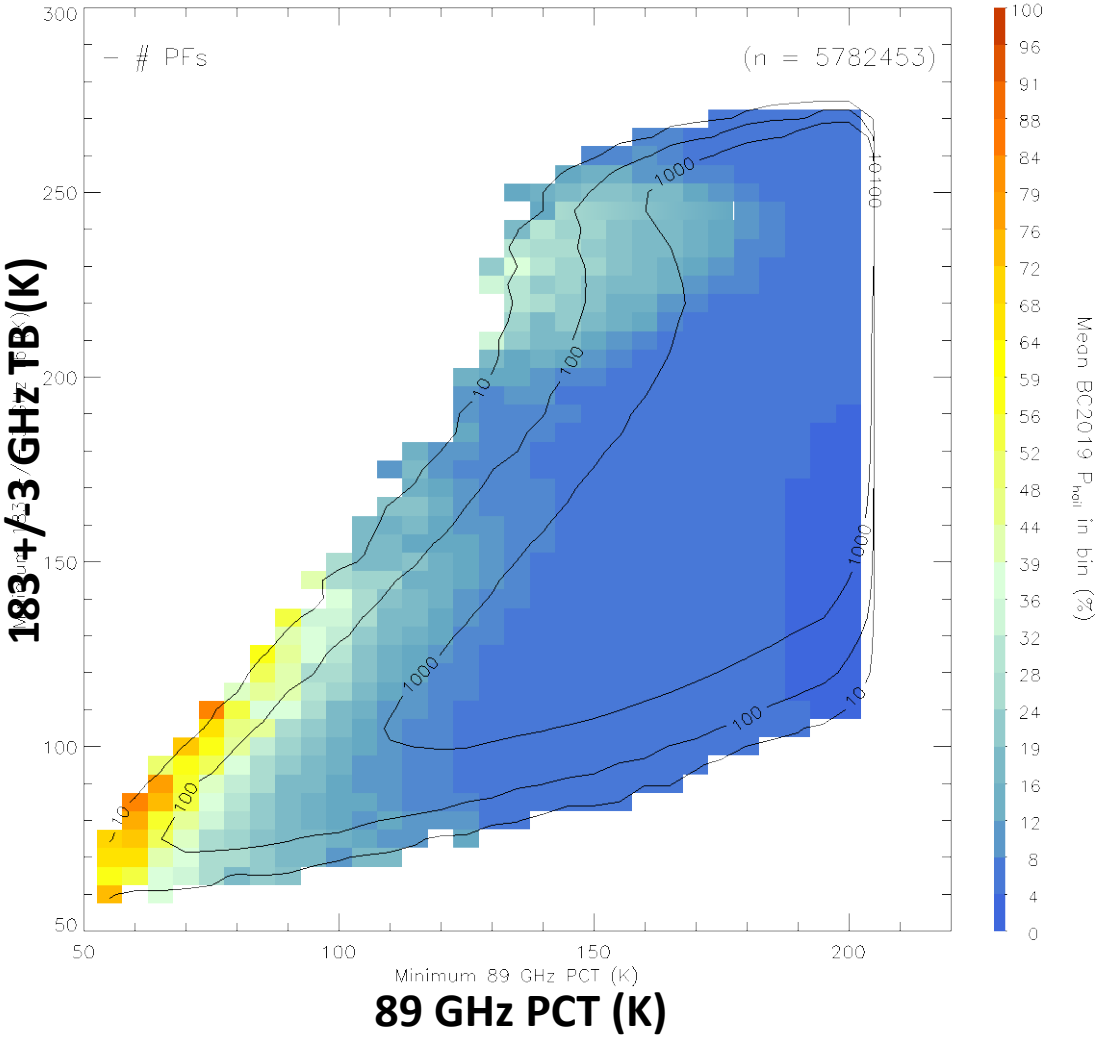
Probability of hail using channels similar to TROPICS

This is computed using results of our TRMM-GPM algorithm that uses 19 GHz and 37 GHz; (we did not train a new algorithm for 183 GHz using ground-truth hail reports)

Hail likelihood increases with decreasing 89 GHz.

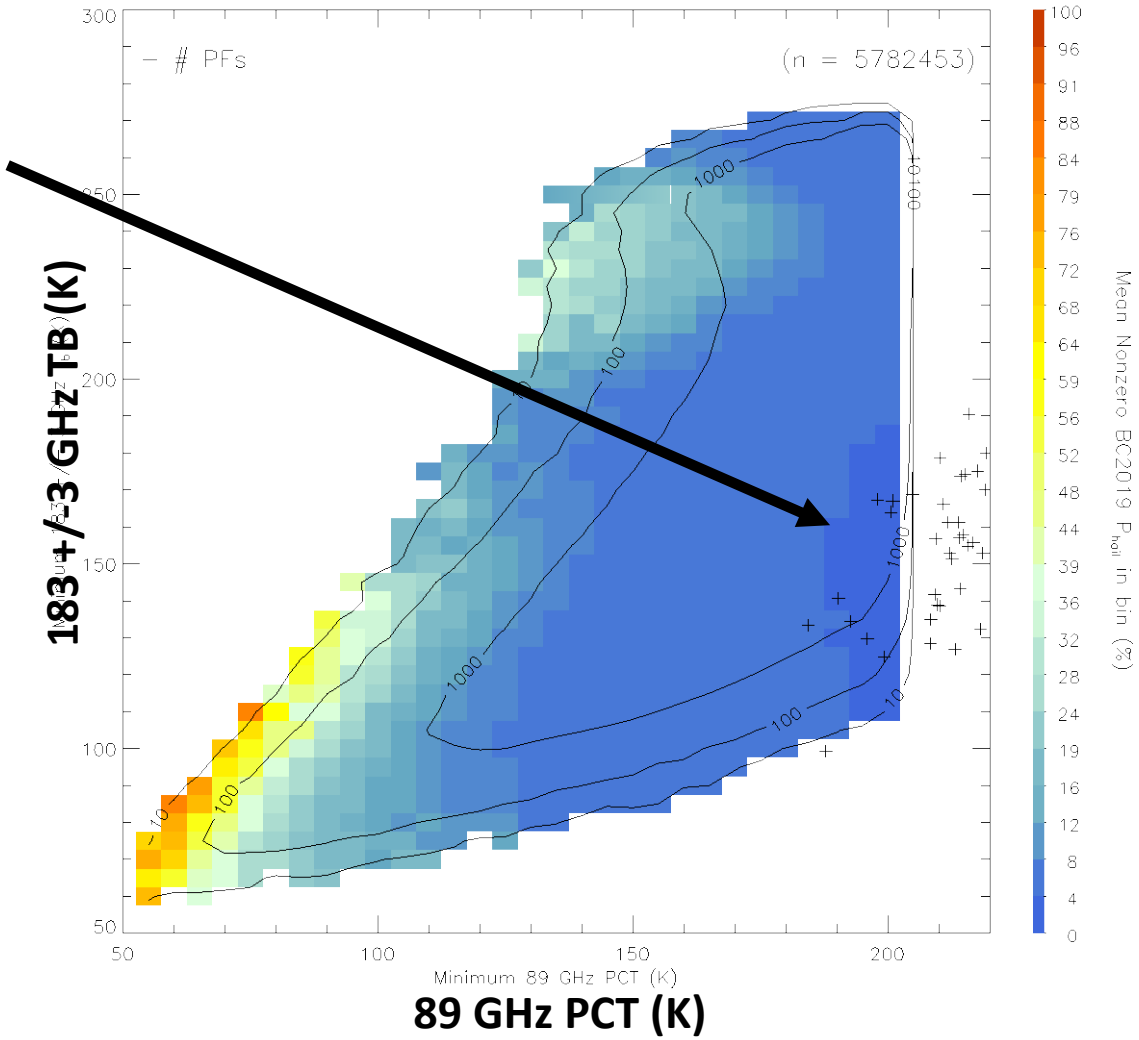
But for a given low 89 GHz value, having a high 183 GHz TB increases the hail likelihood.

Maybe having a lower 183 GHz TB suggests that the signal is coming from large concentrations of graupel, instead of larger hail.



Probability of hail using channels similar to TROPICS

TROPICS proxy data does not inhabit the relevant portion of the parameter-space for this topic



Data Needs

- Calibrated brightness temperature, 90 GHz channel as highest priority
- No data latency requirement for this research
  - Can envision applications in data sparse regions, with users wanting the data ASAP… Argentine Weather Service is a partner on our current Disasters project
- Can retrievals of temperature and moisture profiles be useful for assessing the inflow thermodynamics for these storms? Mesoscale regions where moisture pools, instability gets enhanced?