Lessons on calibration and radar sensitivity from CloudSat

Mark T. Richardson[1,*], Matthew D. Lebsock[1], Mark Smalley[1], Hanii Takahashi[1], Roger Marchand[2]

*markr@jpl.nasa.gov

[1]Jet Propulsion Laboratory, California Institute of Technology

[2]University of Washington

DISCLAIMER: During the preparation of this work the author(s) used Google Gemini in order to generate cartoons. After using this tool/service, the author(s) reviewed and edited the content as needed and take(s) full responsibility for the content of the publication.

- Launched in 2006
- W-Band cloud radar
- Launch sensitivity better than -31 dBZ
- Battery anomaly in 2011 forced switch to Daytime Only Operations (DO-Op)
- Sadly didn’t make it to EarthCARE launch

Image: Wikimedia Commons

How do we know what the sensitivity is?

- External calibration… Pick a target

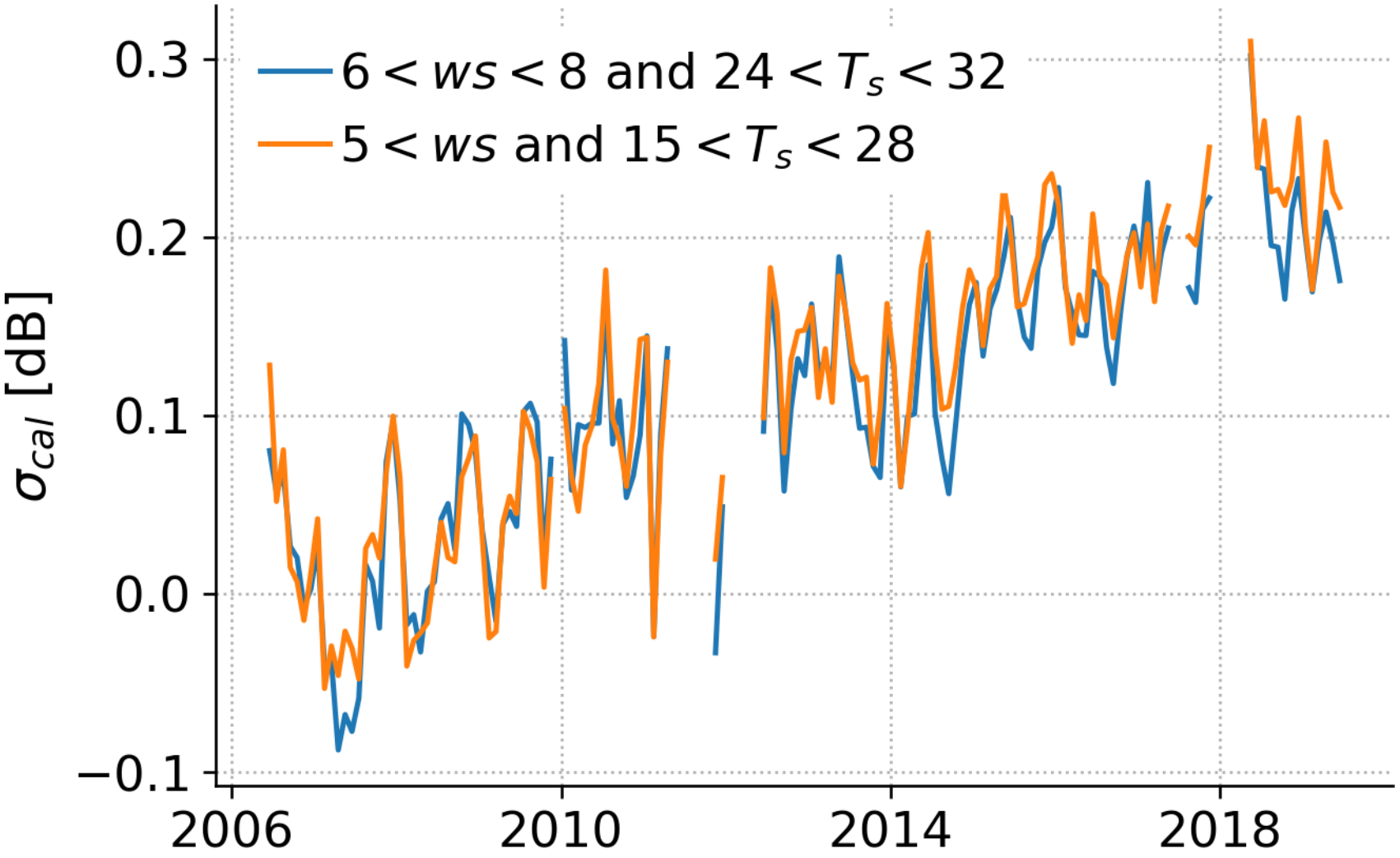
- Very common in other instruments, e.g. for radiometric instruments: deep space, the Moon, “stable” targets like Railroad Valley, Nevada:

Image: Wikimedia Commons

We look at the ocean radar cross section (RCS) aka σ_0

- **clear sky**
- correct for **atmospheric gaseous attenuation**
- Account for **surface conditions** (wind, SST…)

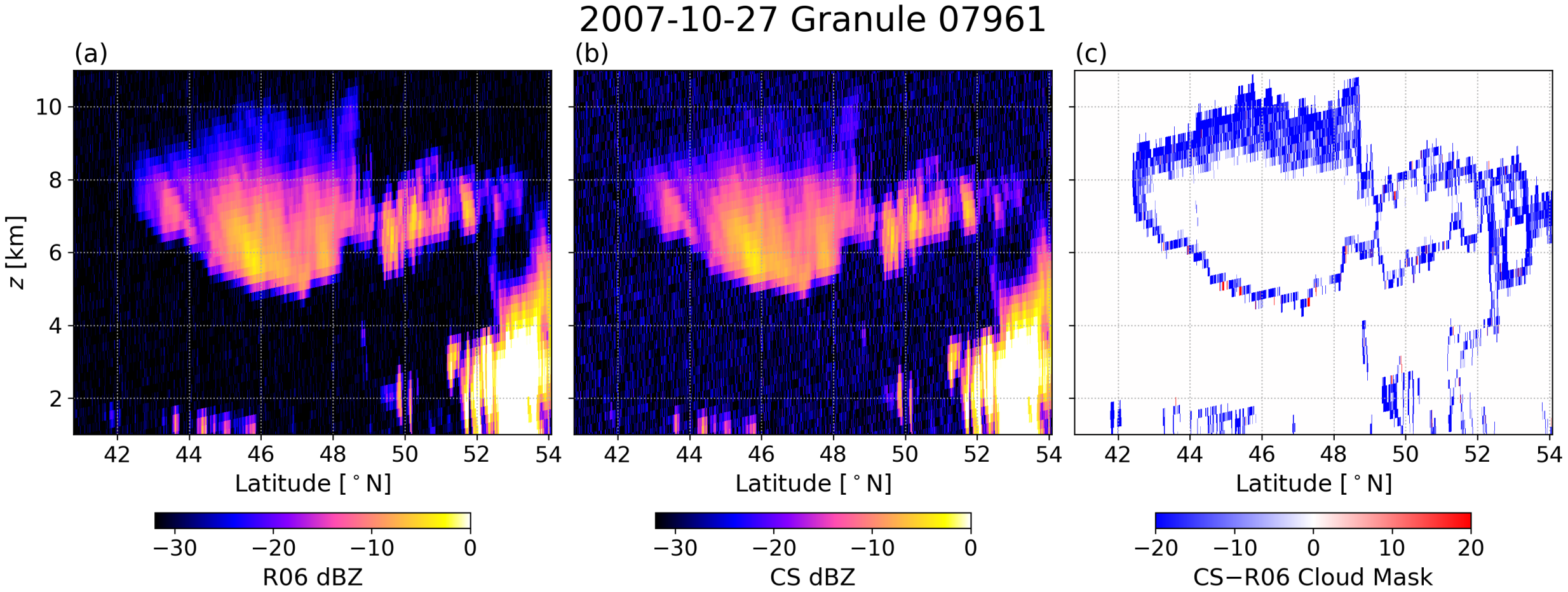
Using different clouds and surface properties = 0.2 dB through the mission



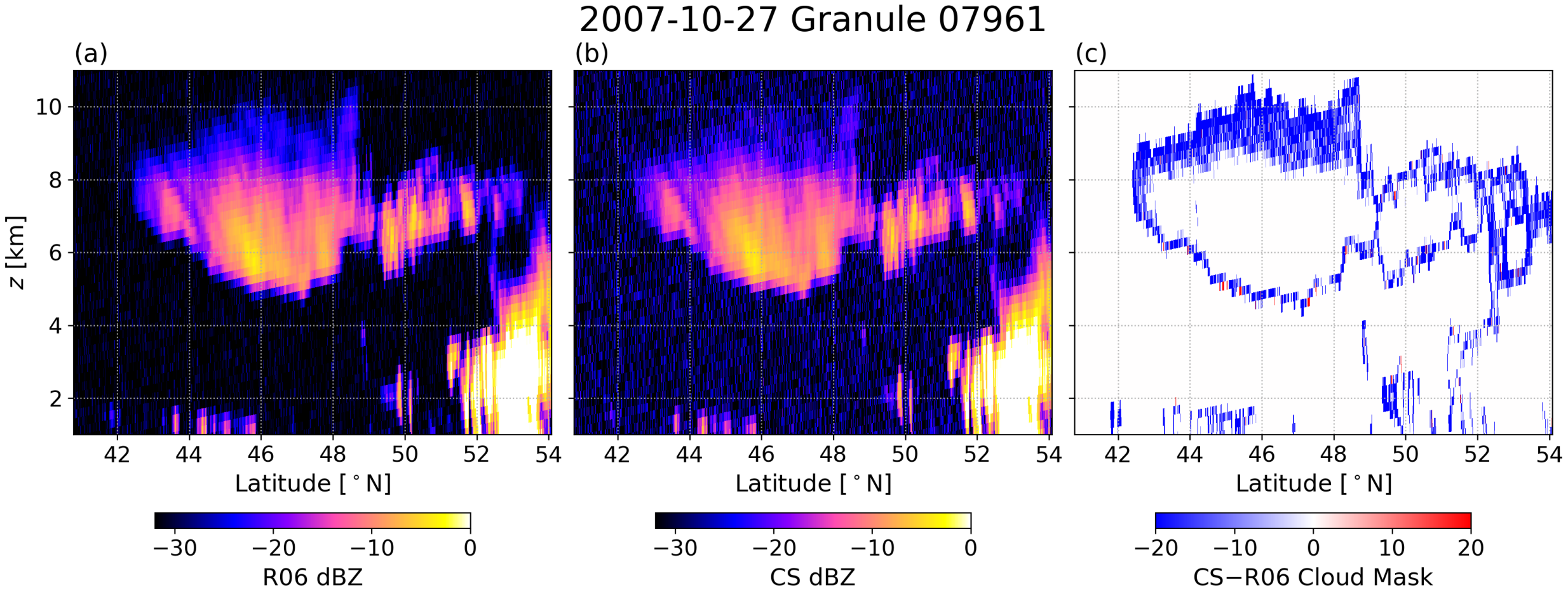
We are working on more consistent calibration, with aims for stability in **cloud detection**, **gaseous attenuation** and **surface modelling**

I wanna look at cloud science, why do I care about this specific nerd stuff?

Changing sensitivity of the radar → loss of detection of the highest cloud volumes



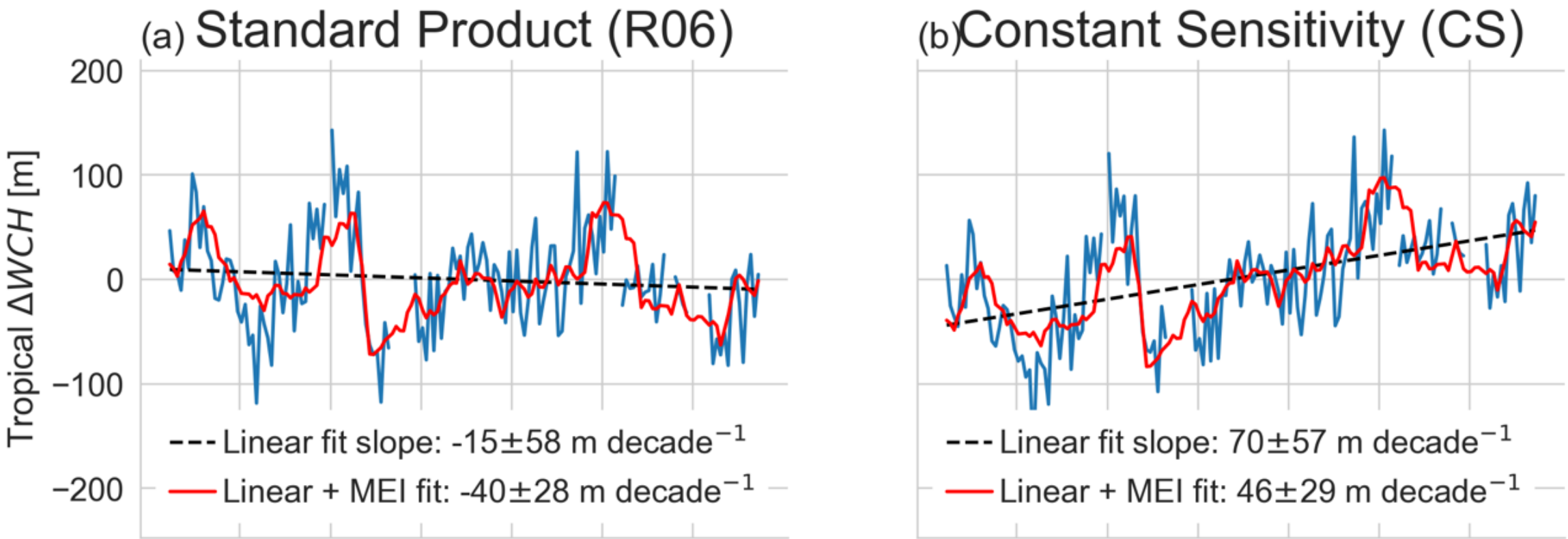
We add time-varying noise to get consistent - 25 dBZ sensitivity



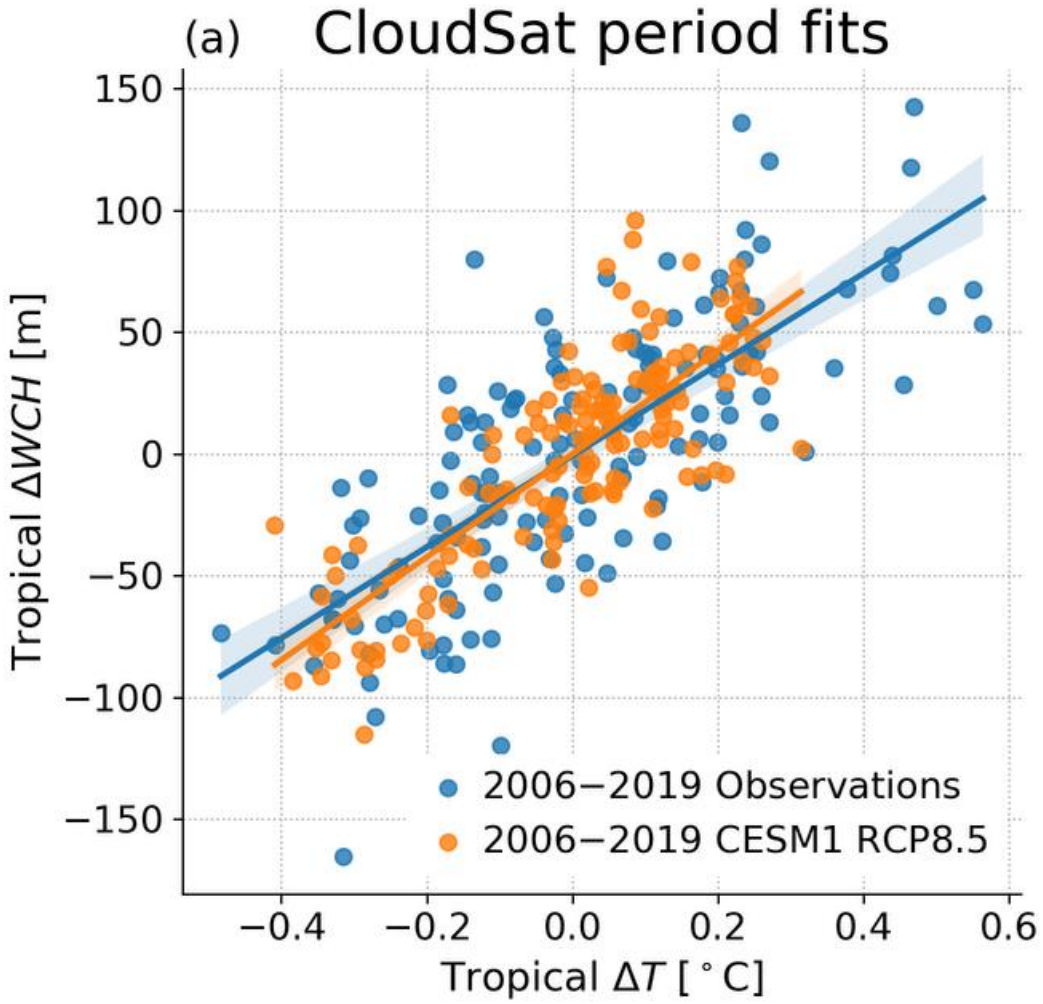
MEAN cloud height actually rose…

But the raw radar data show the opposite, because of the change in sensitivity.

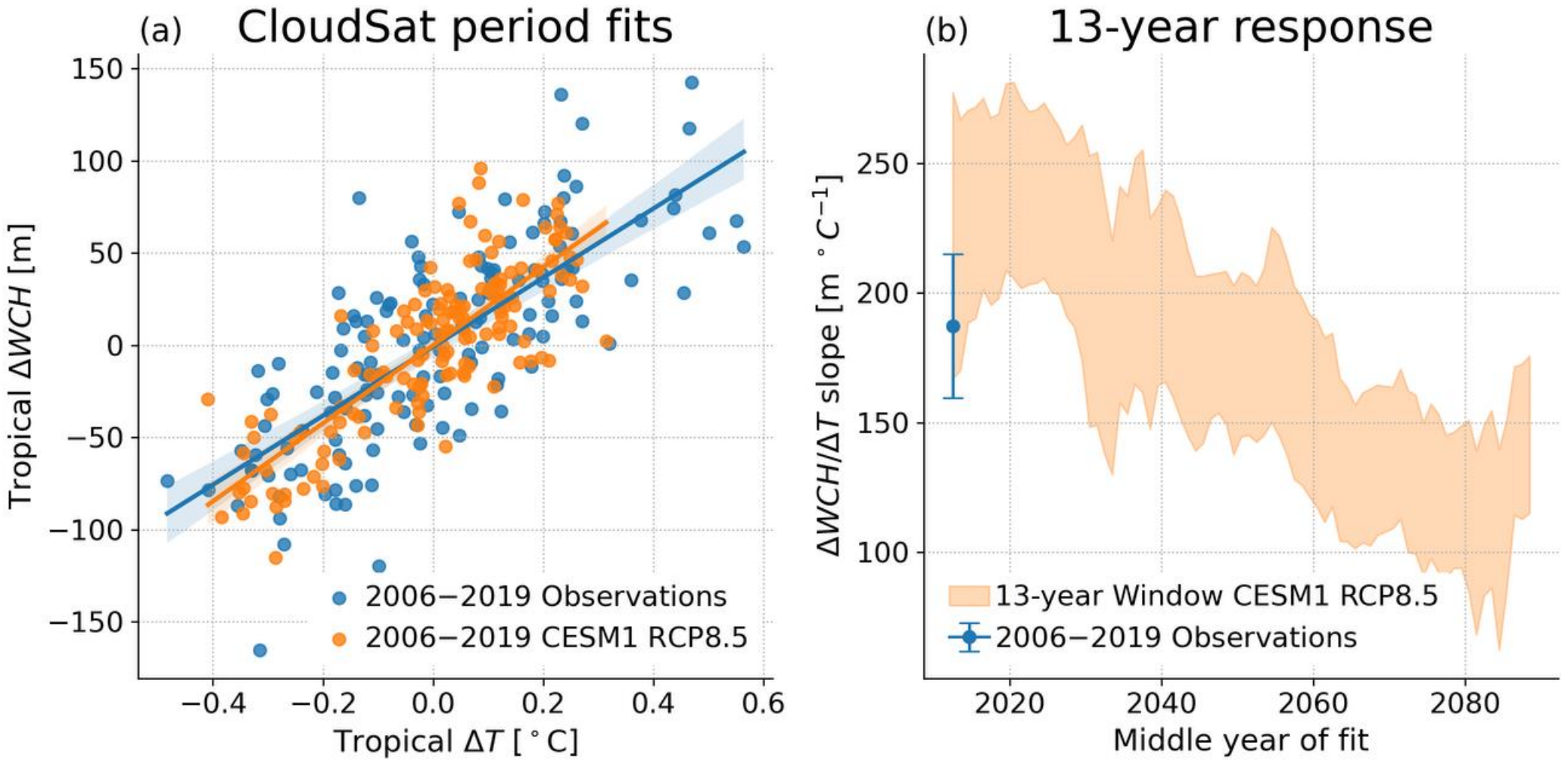
Need constant sensitivity to see the scientifically interesting changes



Tropical WCH-temperature response is similar to CESM1 simulation with W-Band simulator output



This model simulation suggests a decline in dWCH/dT**surface** response through the 21st century



Conclusions

- We are developing more stable calibration for CloudSat

- Constant-sensitivity records reveal things about

Another interesting thing we can do with the radar…

- We can look at the changes or responses by reflectivity and height

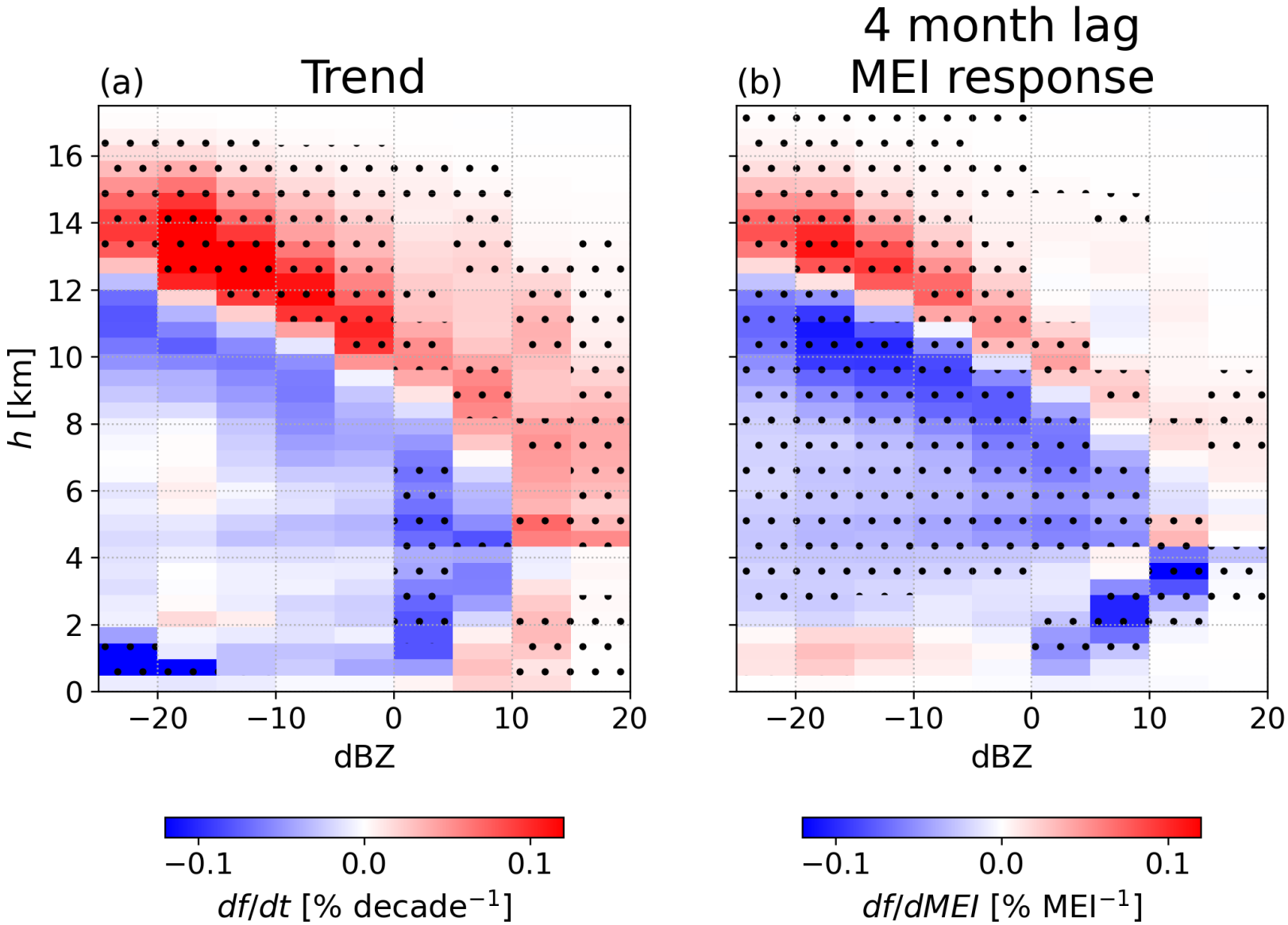
- Height is obvious, but think of x axis as going from smaller particles/sparse clouds on the left, to precipitation on the right

30°S–30°N cloud response

Trend seems to show a shift towards increased precipitation…

We are working to understand whether this is calibration related or ”real”.

It certainly looks different than the directly ENSO-driven part of the response.



Conclusions

- Appropriate, stable calibration and treatment for changing sensitivity is very important
- For a consistent W-Band radar record, we obviously must account for many things (time of observation, pulse shape, ….) but CALIBRATION is huge.
- We suggest using clear-sky oceans as a reference target, using the most consistent data possible (reanalysis) to account for wind/SST effects.
- Hopefully we can build a CloudSat-EarthCARE-FALCON record.