Performance Assessment of the Jason-3 Advanced Microwave Radiometer

Shannon Brown and Tanvir Islam
Jet Propulsion Laboratory, California Institute of Technology

November 1, 2016

JA2 and JA3 AMRs

- Jason-3 AMR is nearly identical to Jason-2 AMR
  - Minor modifications were made to the receiver design to simplify testing and manufacturing
- First time two identical radiometer systems have flown in tandem in space
  - Possible to characterize differences down to theoretical noise floor of each system

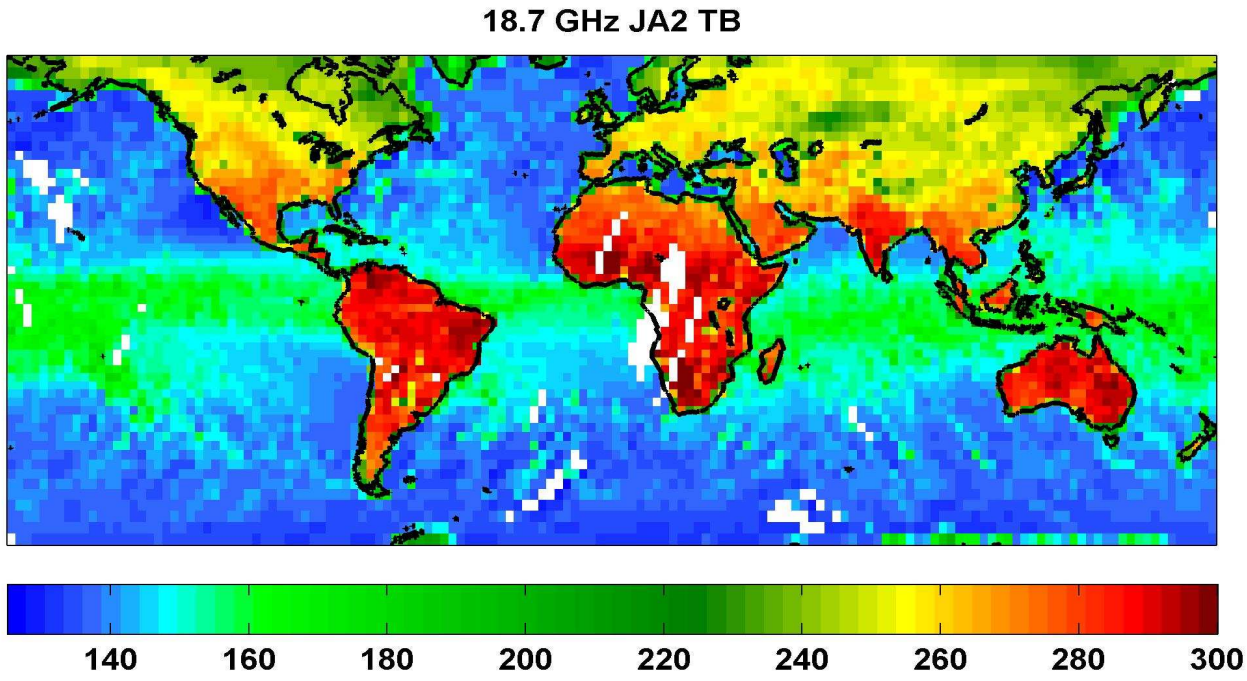
Jason-2 AMR

Jason-3 AMR

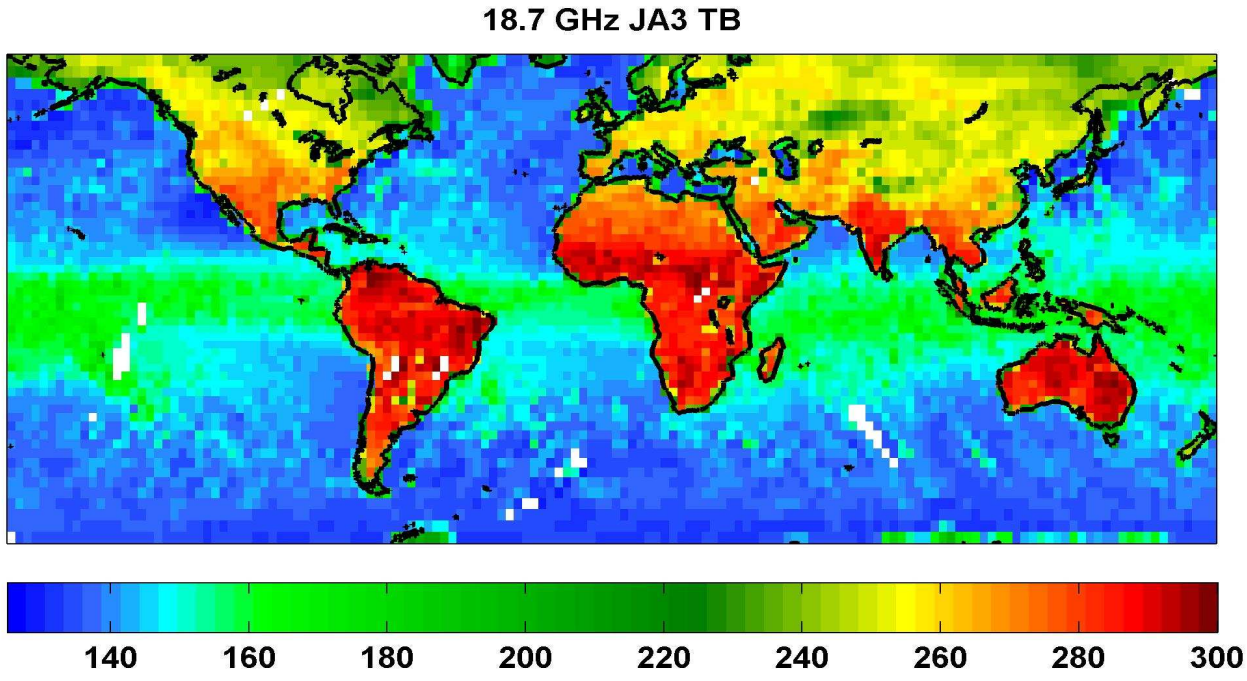
Overall AMR Assessment

- Calibration updated after 1st day on-orbit to make coarse adjustment to absolute calibration (~1% level adjustment)
- Overall, good agreement with Jason-2 at the 1Hz level, nearly equivalent performance
- J3 AMR exhibited drift since launch
  - Under investigation, but preliminary analysis suggests out-gassing as cause
  - Drift will continue to be monitored and removed prior to GDR processing
- Routine calibration coefficient delivery corrects drift in GDR product
- Four cold sky maneuvers have been completed to date, aiding in drift calibration

Jason-2 18.7 GHz TB Jan-Mar 2016

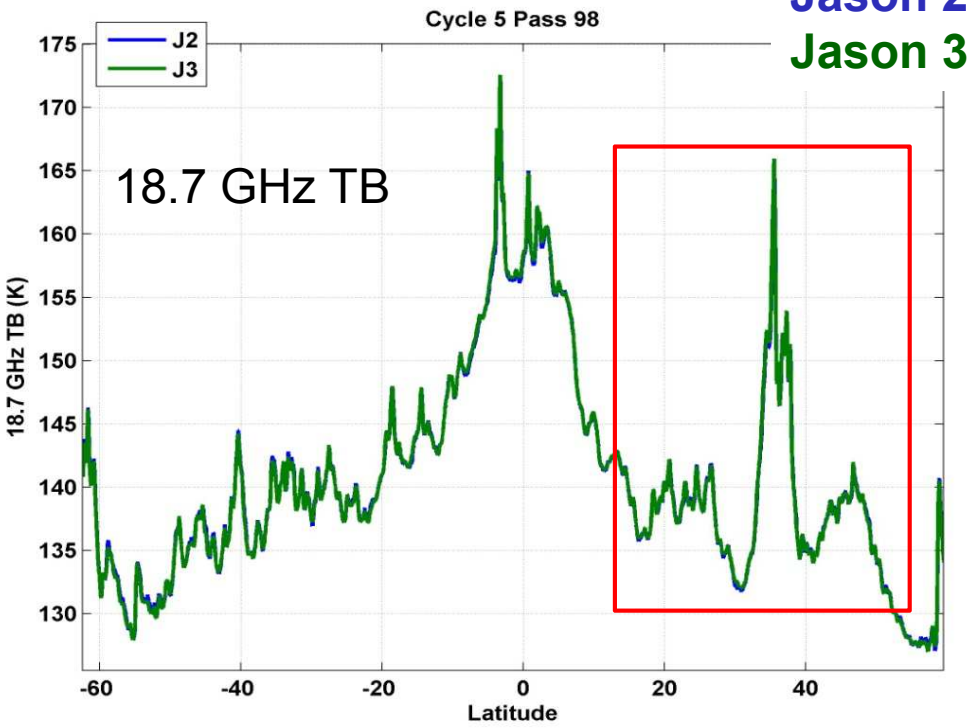


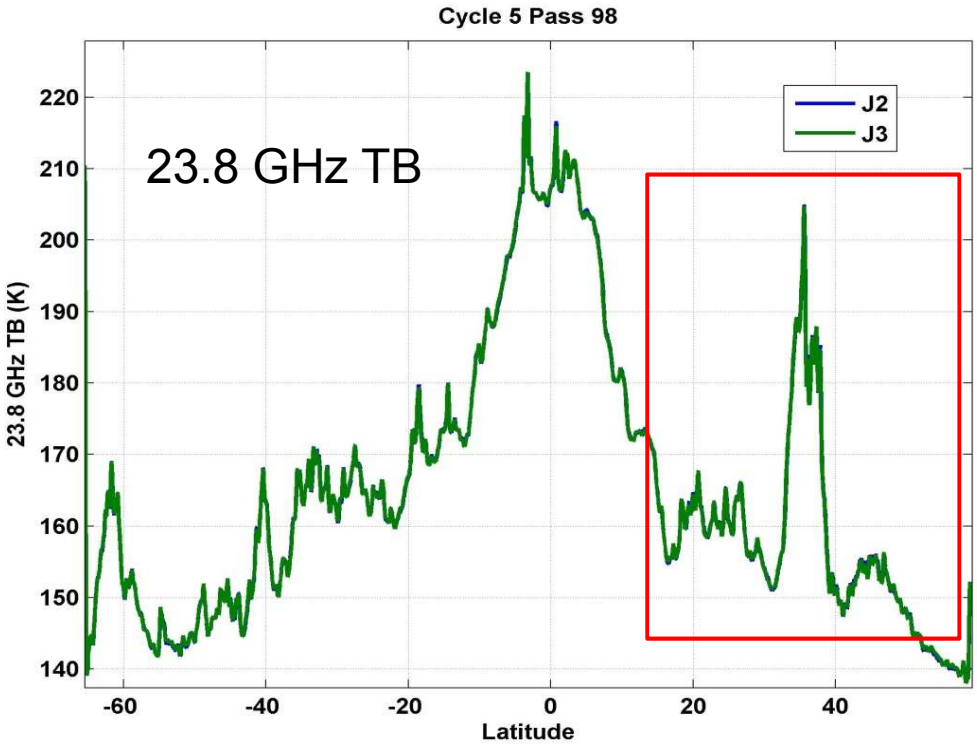
Jason-3 18.7 GHz TB Jan-Mar 2016



JA2 and JA3 1Hz TB Comparison

Jason 2
Jason 3

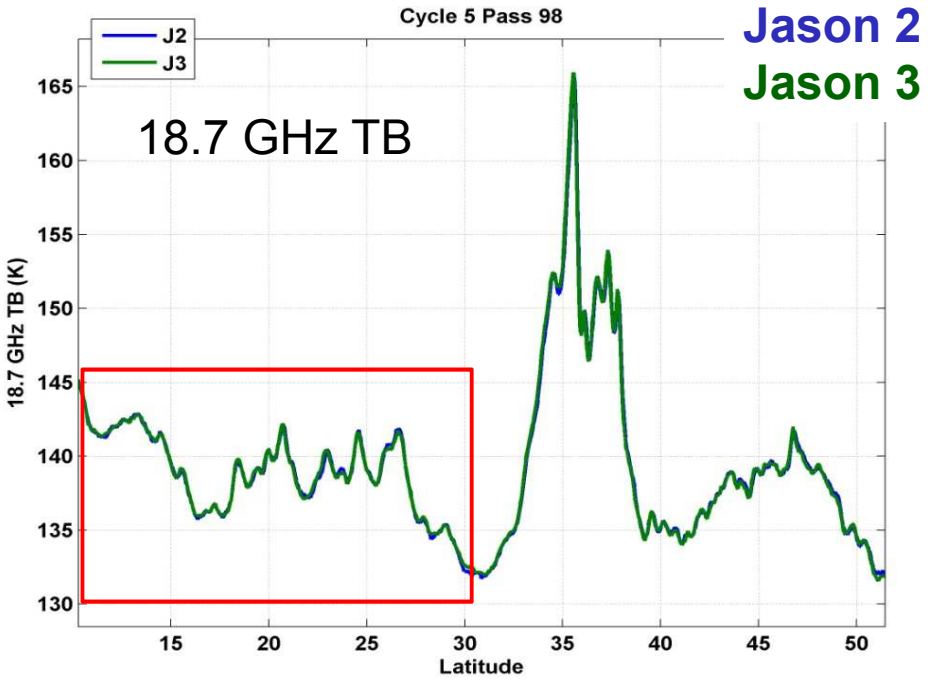


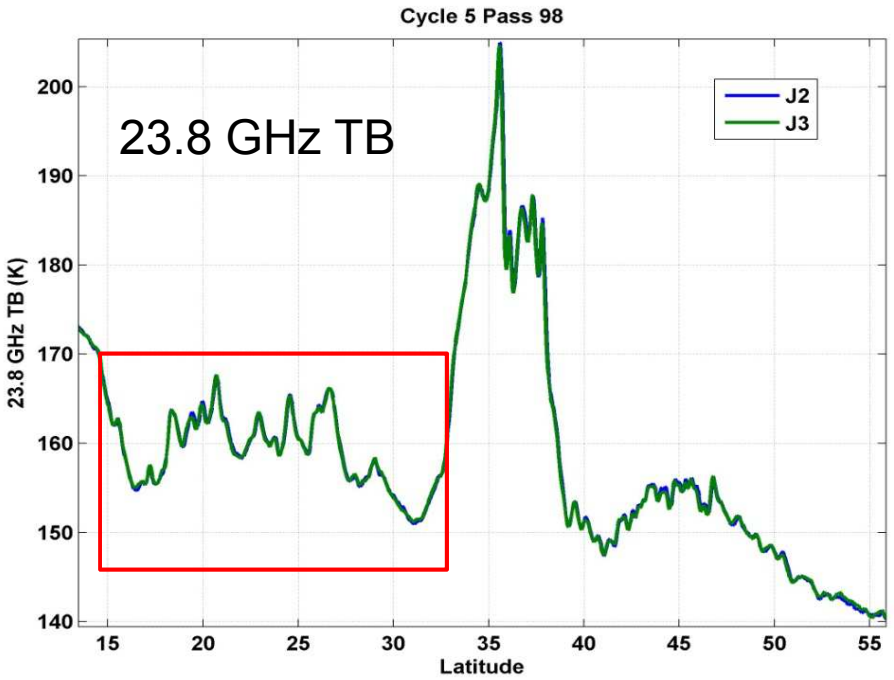


Cycle 5, pass 98

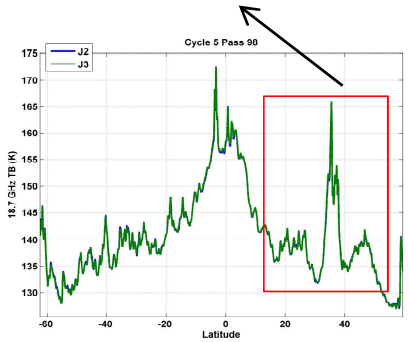
JA2 and JA3 1Hz TB Comparison

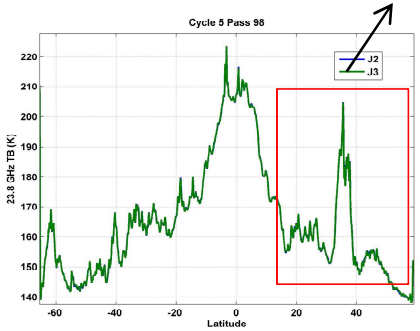
Jason 2
Jason 3





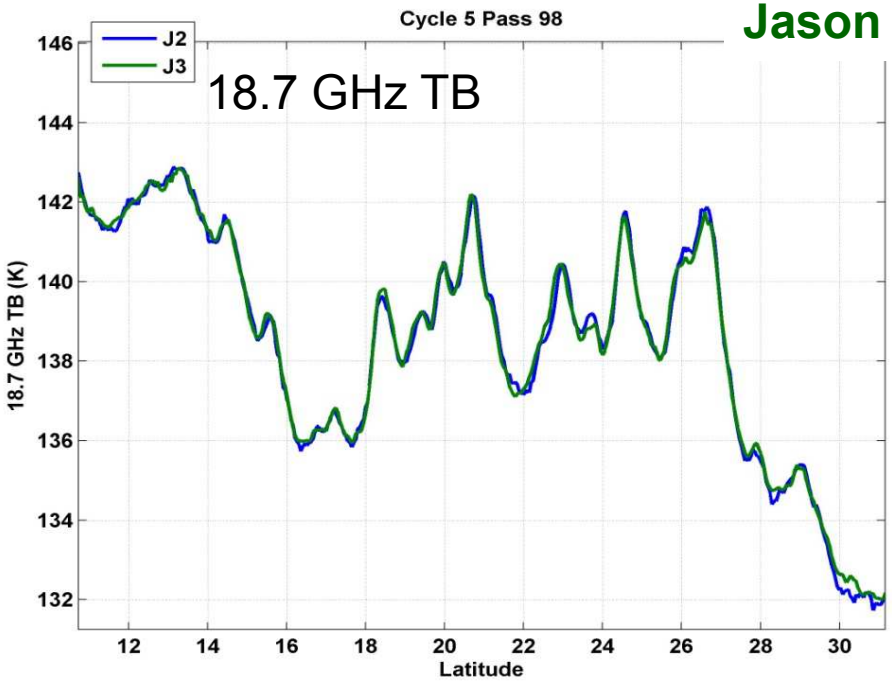
Cycle 5, pass 98

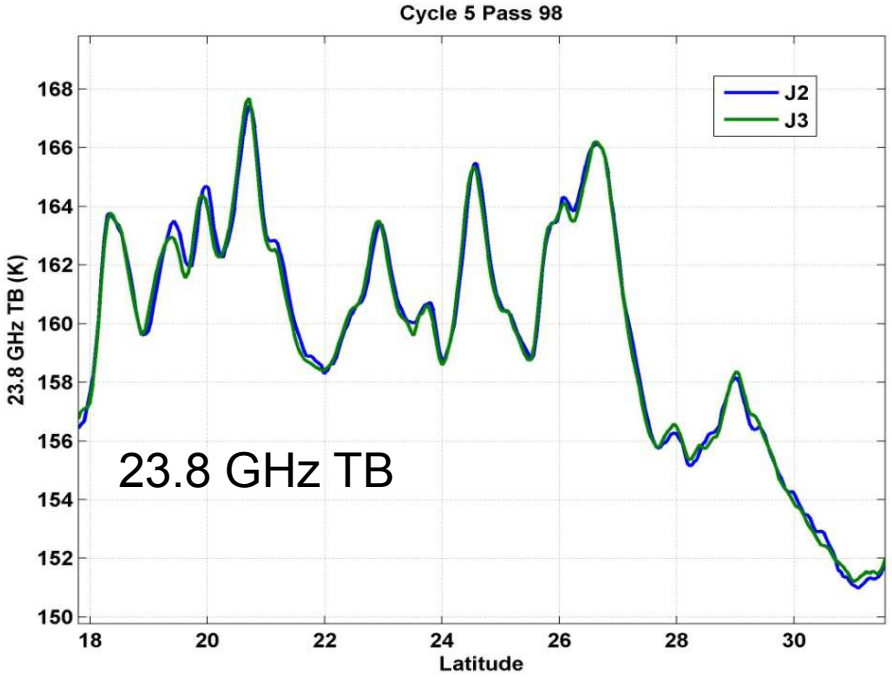




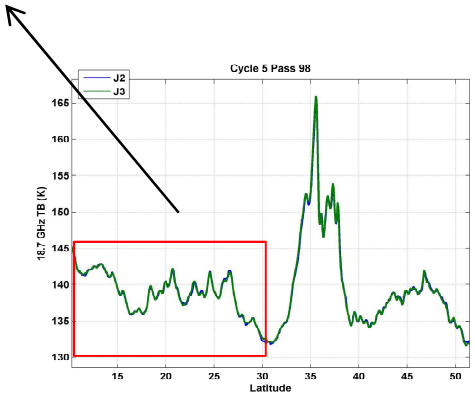
JA2 and JA3 1Hz TB Comparison

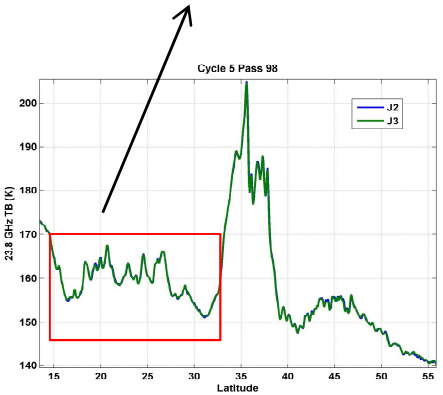
Jason 2
Jason 3



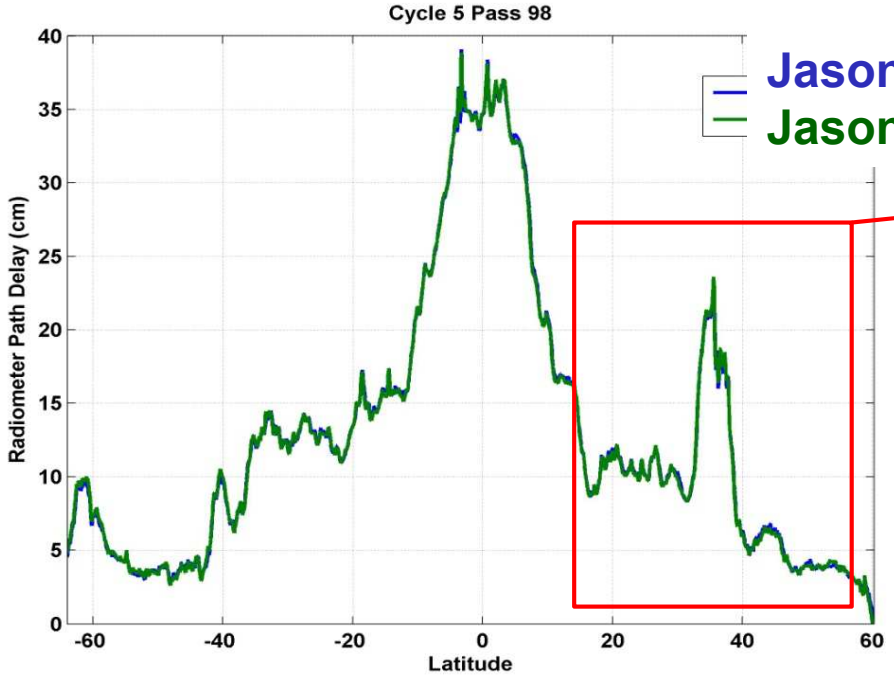


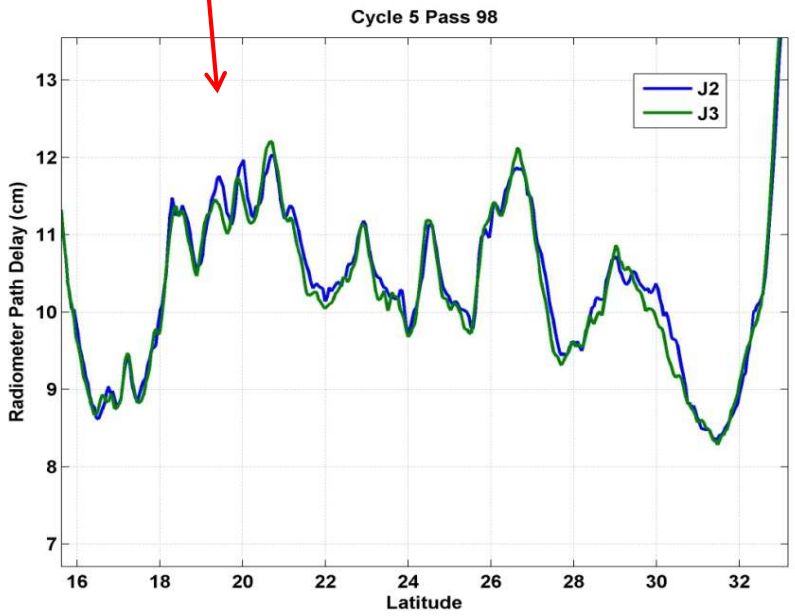
Cycle 5, pass 98





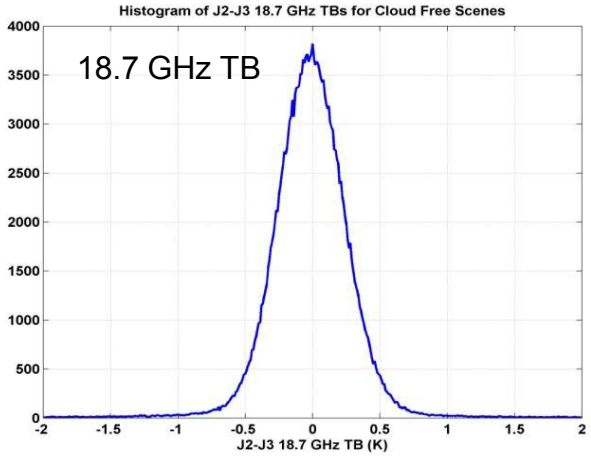
JA2 and JA3 1Hz PD Comparison

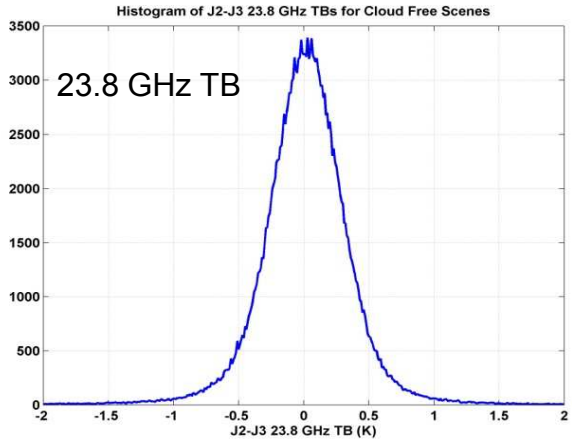


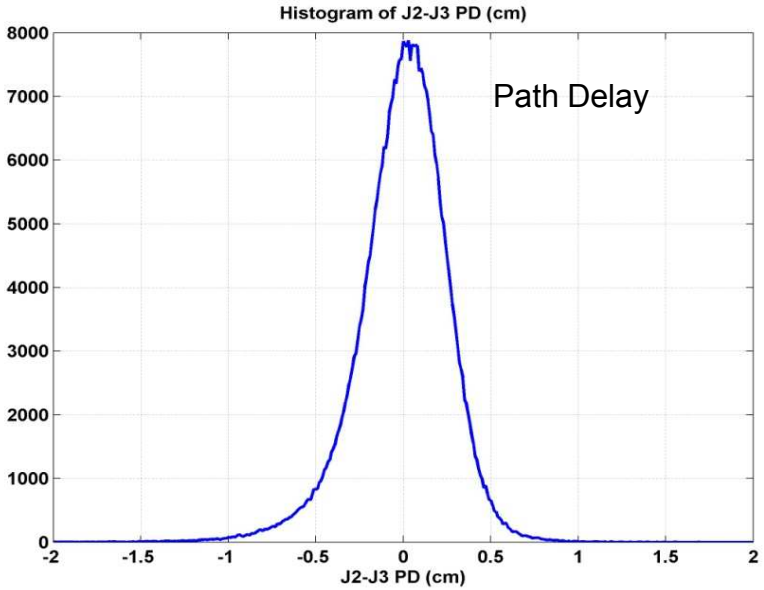


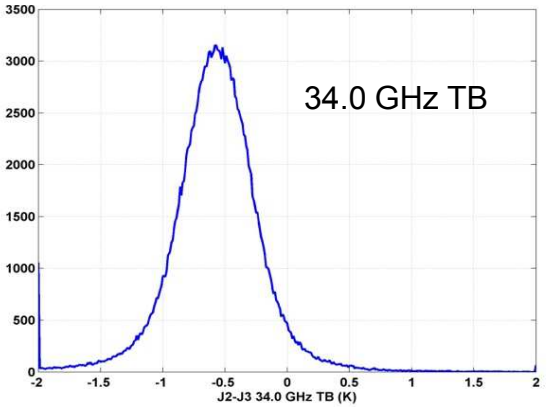
JA2-JA3 1Hz Standard Deviation

	JA2-JA3	Theoretical Minimum
18.7 GHz TB	0.25 K	0.21 K
23.8 GHz TB	0.30 K	0.16 K
34.0 GHz TB	0.31 K	0.13 K
Path Delay	0.25 cm	0.14 cm



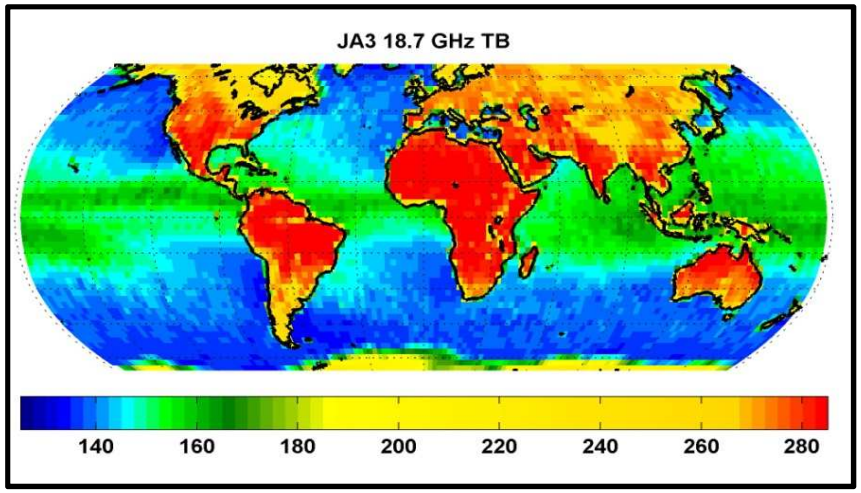




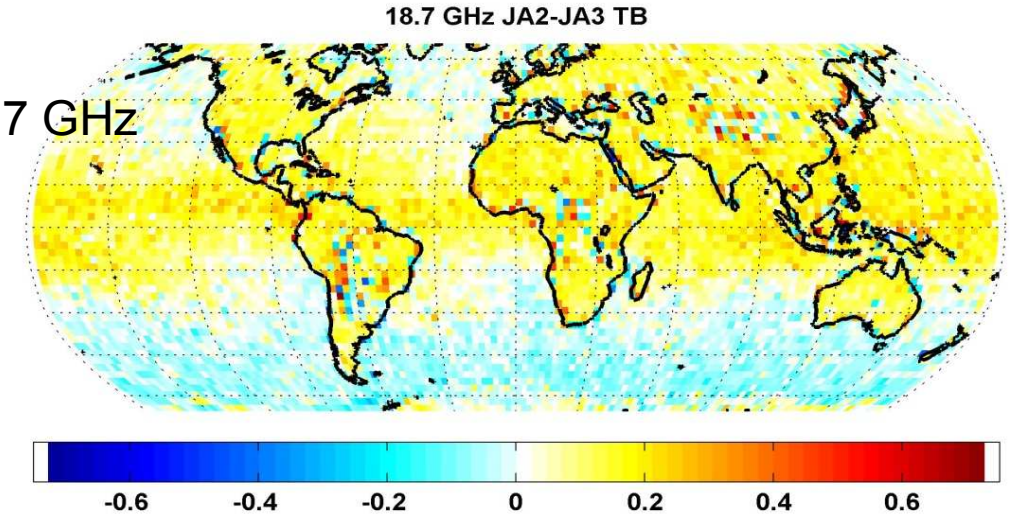


- JA2-JA3 TB differences < 0.2 over full dynamic range
- JA3 absolute calibration used cold sky calibration data points, resulting in small differences relative to JA2
- JA2 calibration will be updated in a future reprocessing

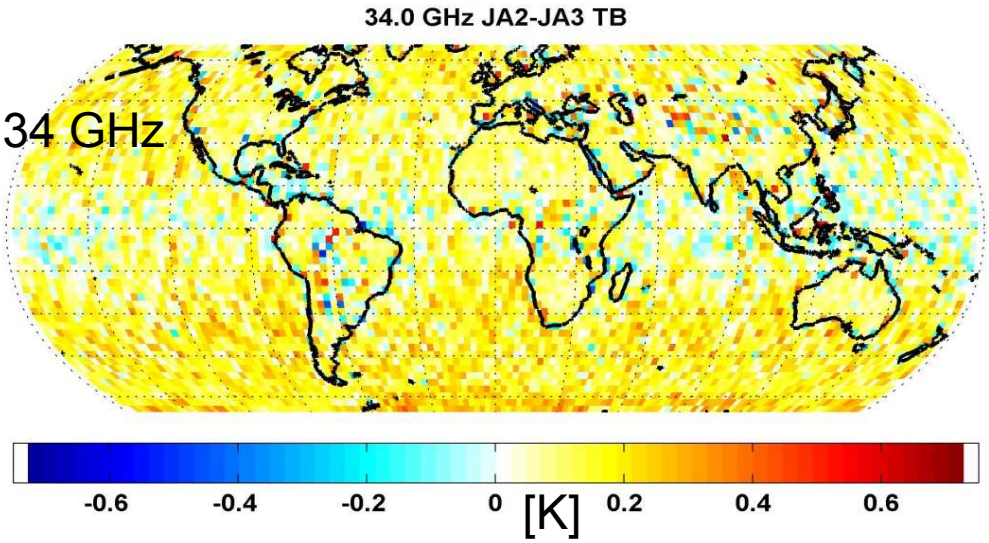
JA2-JA3 TB Global Maps Cycles 1-21



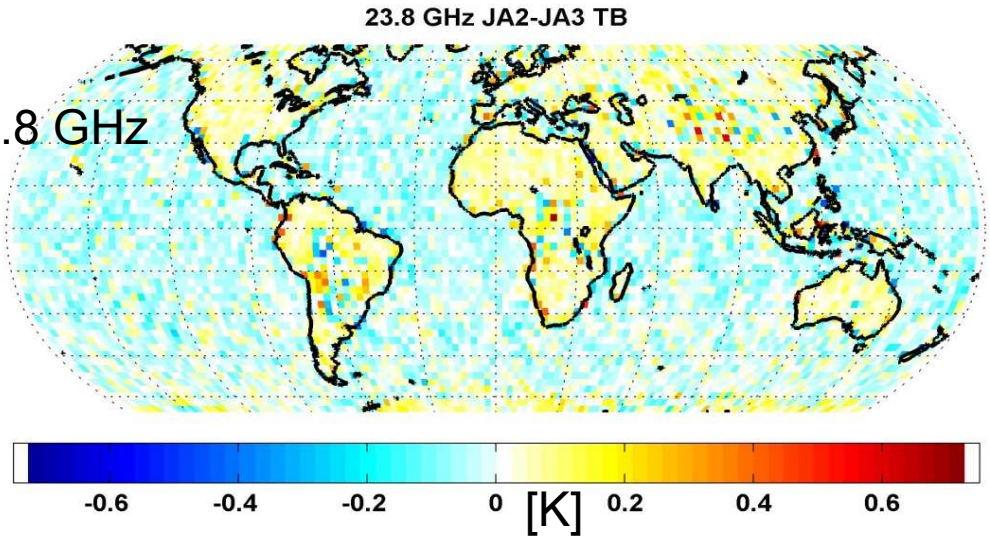
18.7 GHz



34 GHz

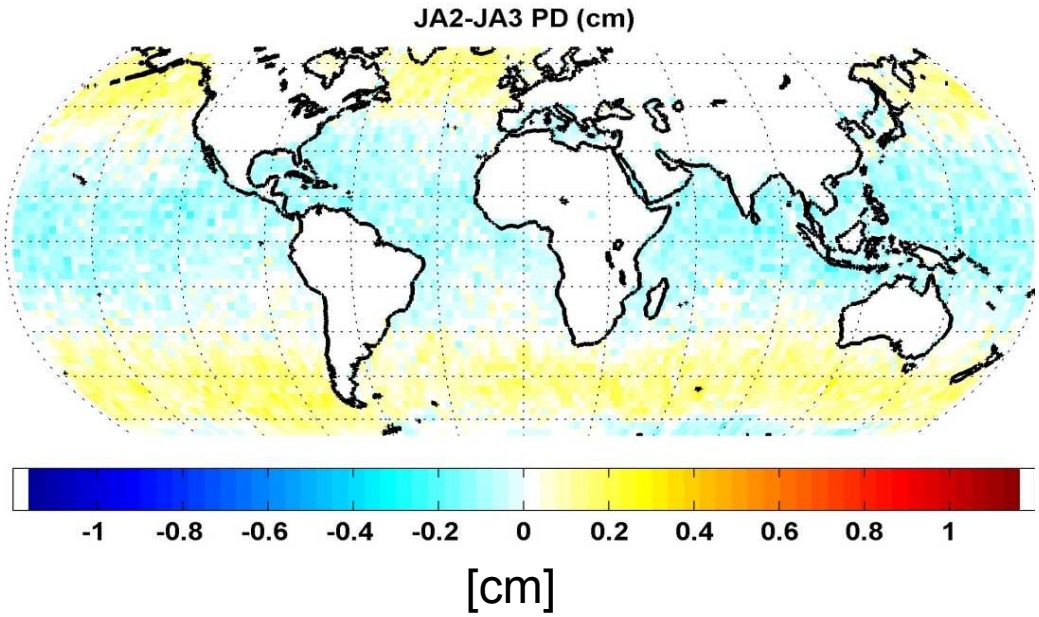


23.8 GHz

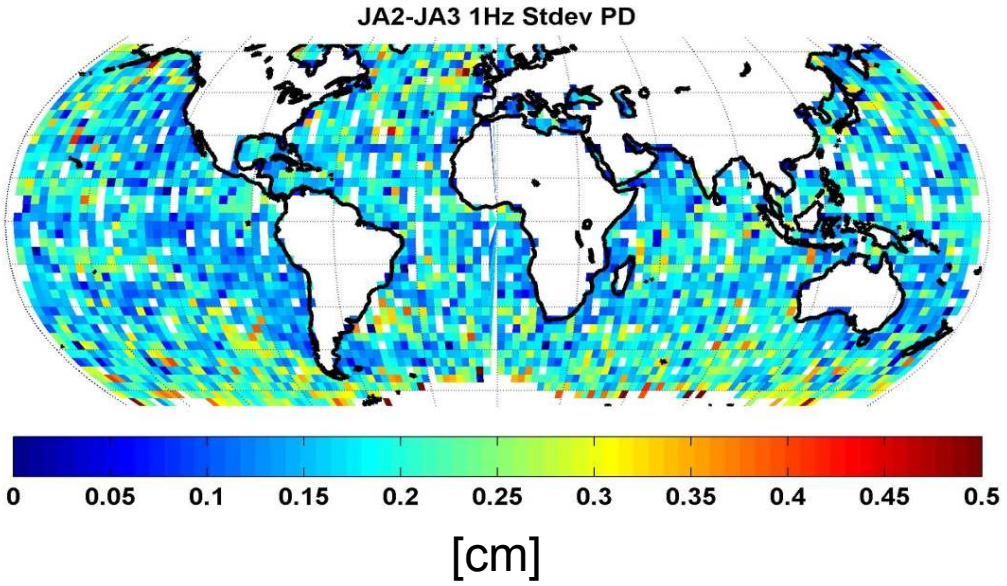


JA2-JA3 PD Difference Map

Cycle 1-21 Mean Bias



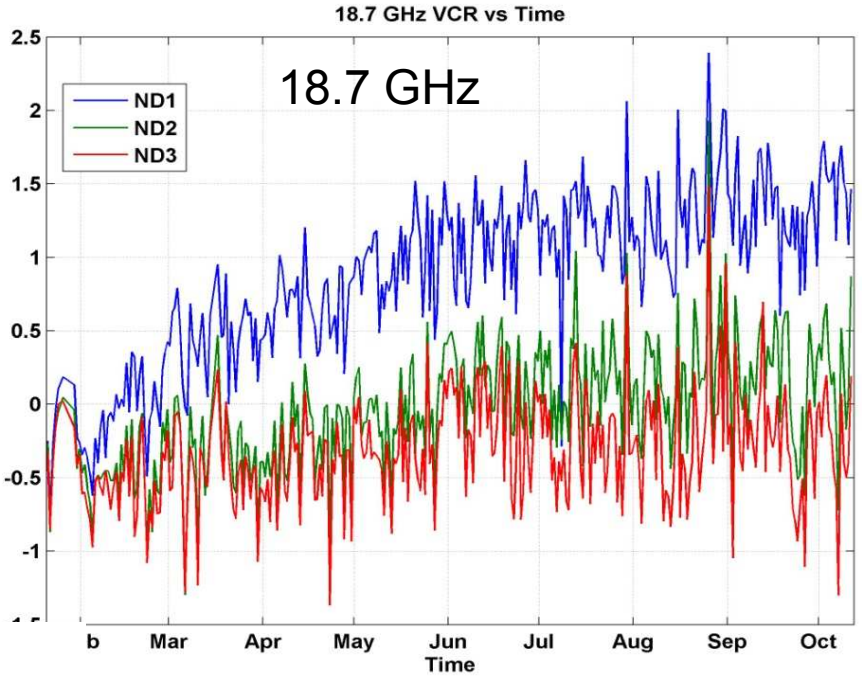
Cycle 20 1Hz Standard Deviation



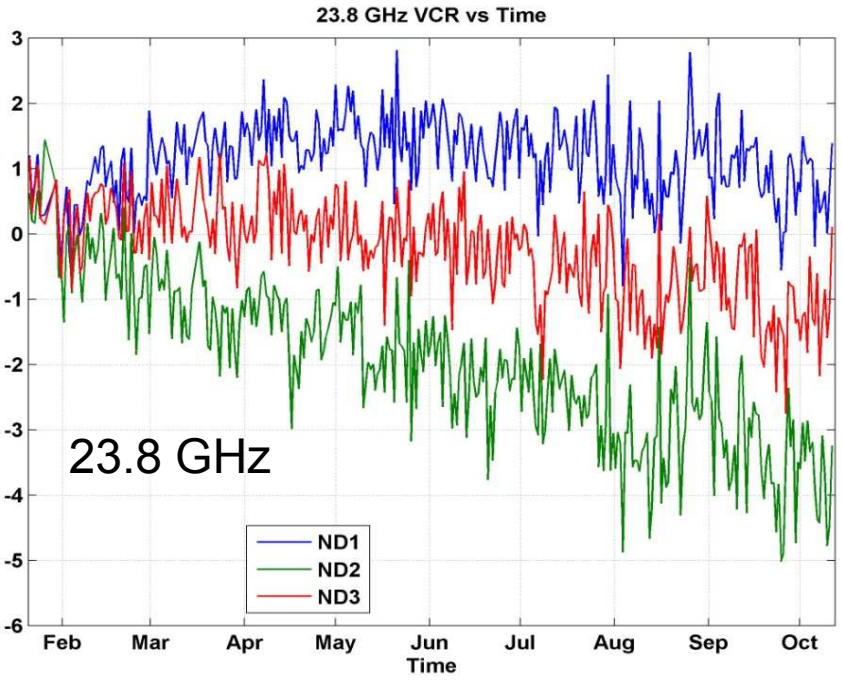
- Mean PD Biases at the mm-level
- Latitudinal structure due to small absolute calibration differences - JA2 calibration to be updated from cold sky data
- 1Hz PD standard deviation between JA2 and JA3 < 3mm globally

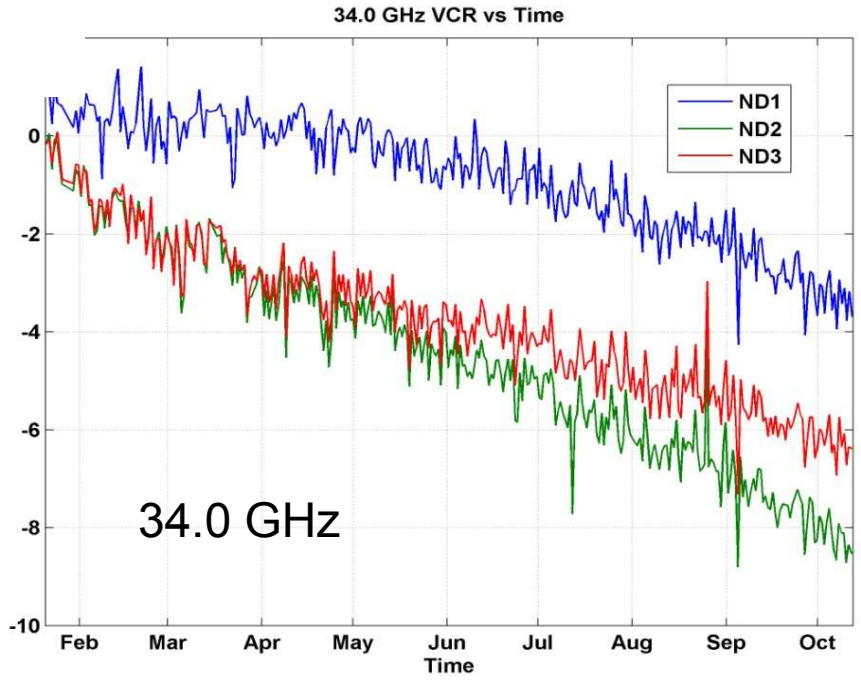
JA3 Drift – Cold Ocean Reference

- Data processed individually for each of 3 redundant calibration noise diodes
- Largest drift observed in 34 GHz channel, NDs 2 and 3
- Out-gassing is suspected cause, possibly exacerbated by extended storage time



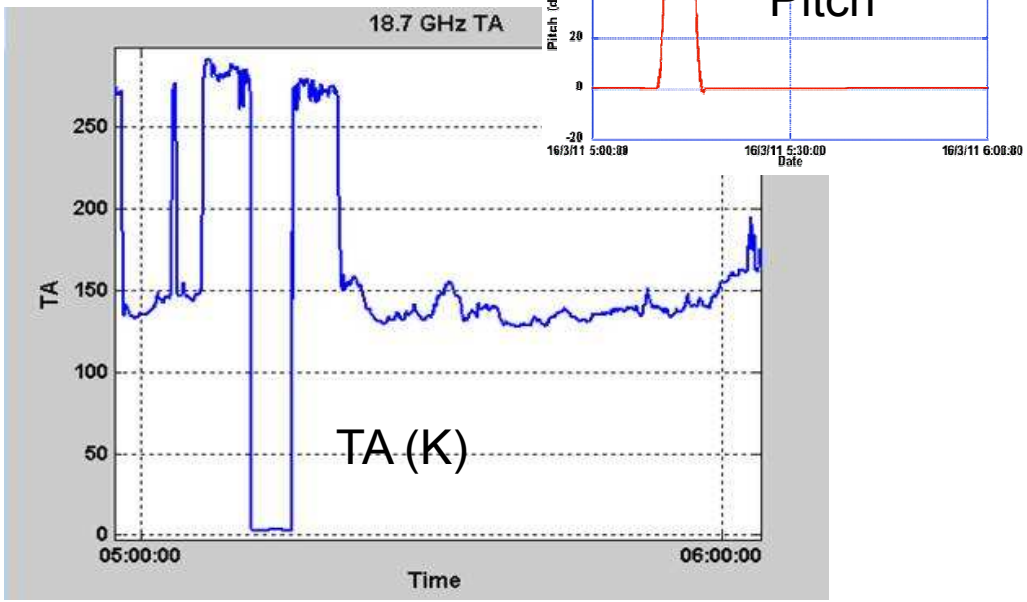
ND1
ND2
ND3

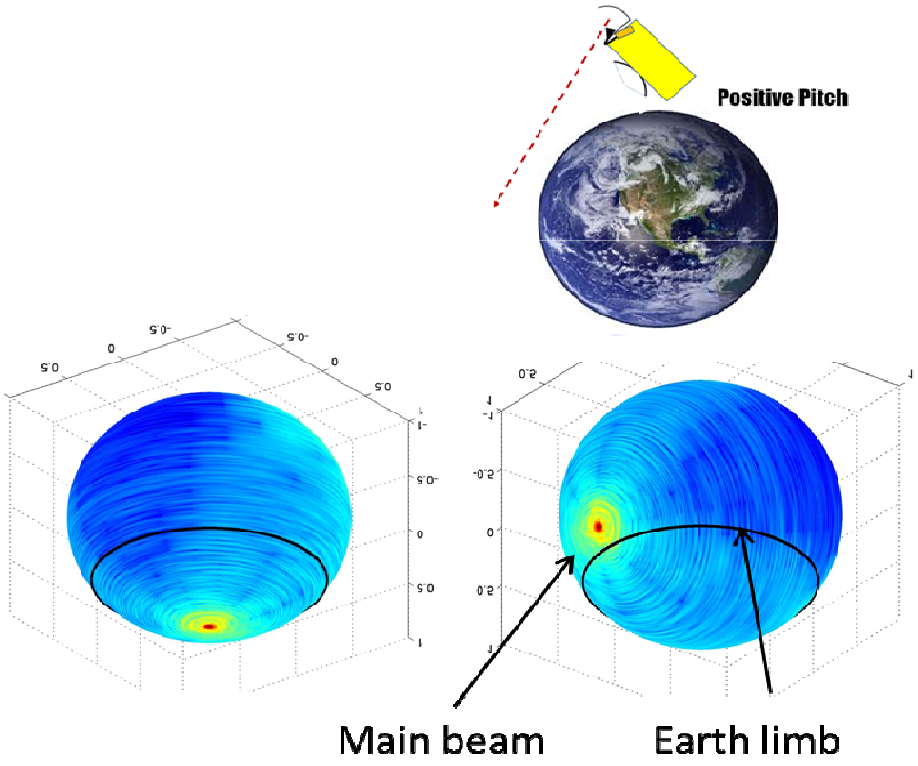




Cold Sky Maneuvers

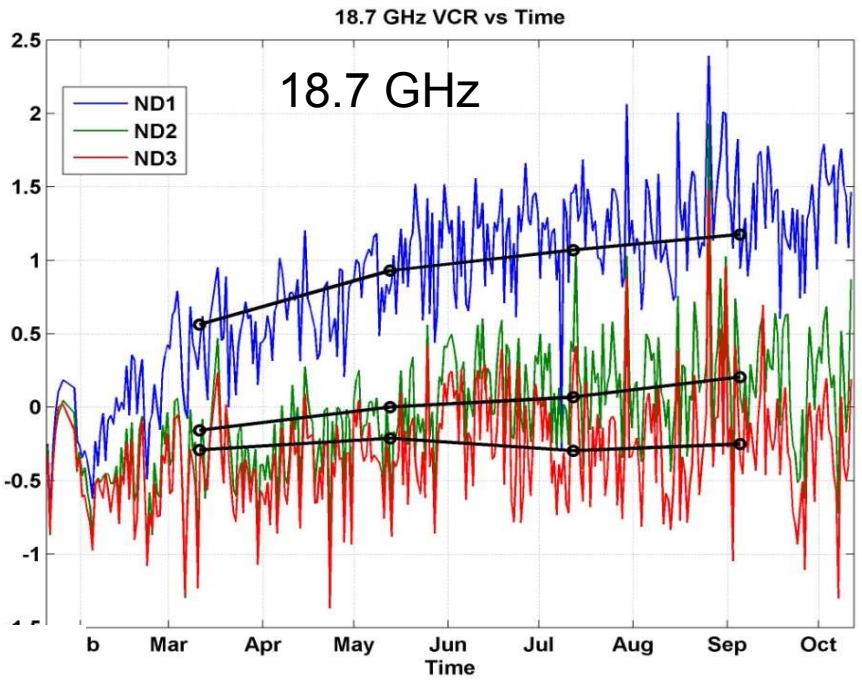
- Four cold sky calibration maneuvers have happened to date
  - S/C pitched to 80 degrees
  - Enables absolute gain calibration and precise noise diode inter-calibration on 2.7 sky background



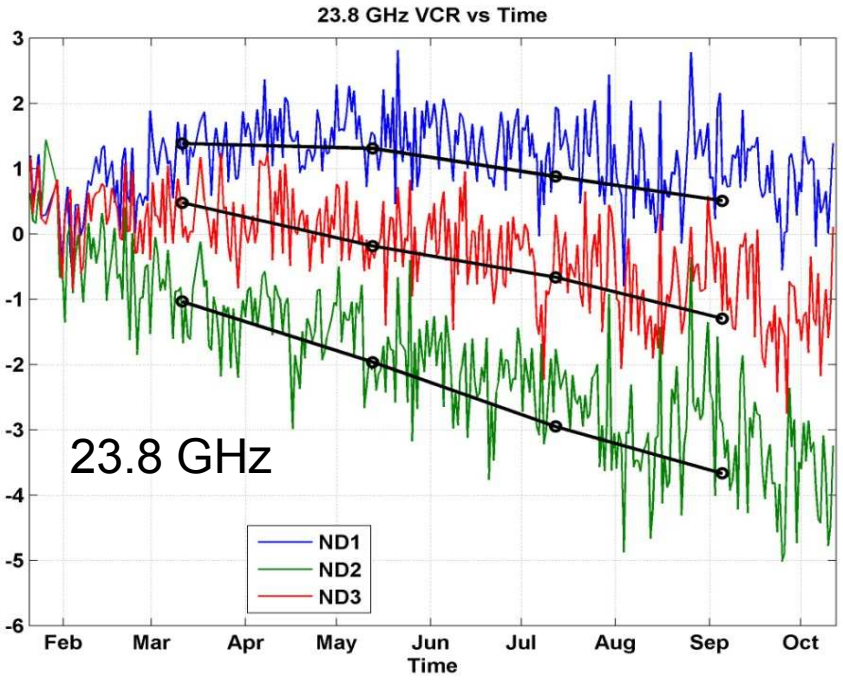


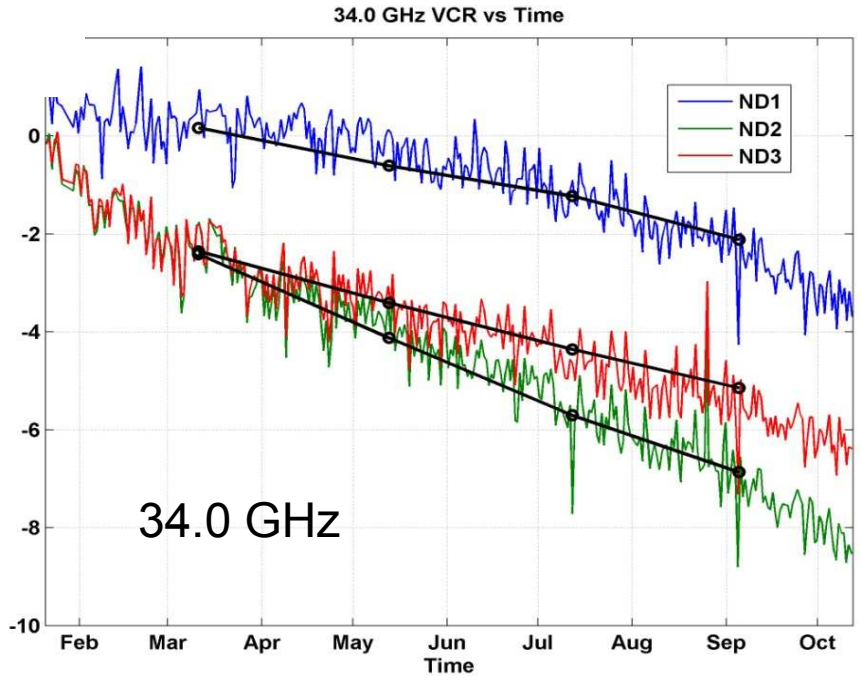
JA3 Drift – VCR and Cold Sky

- Percentage drift computed from cold measurements consistent with that computed over the ocean
- Suggests drift is isolated to noise diodes



ND1
ND2
ND3



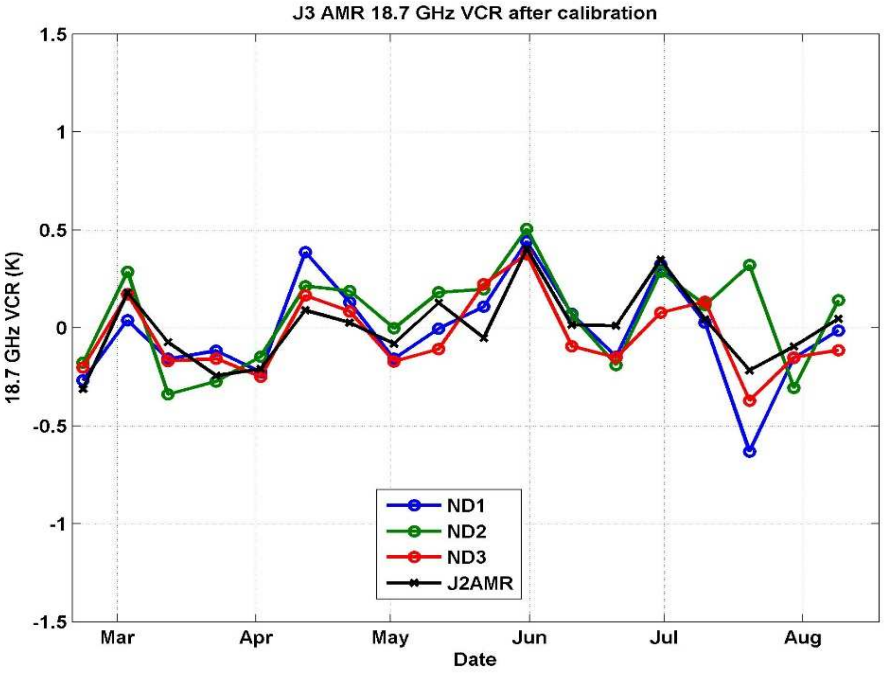


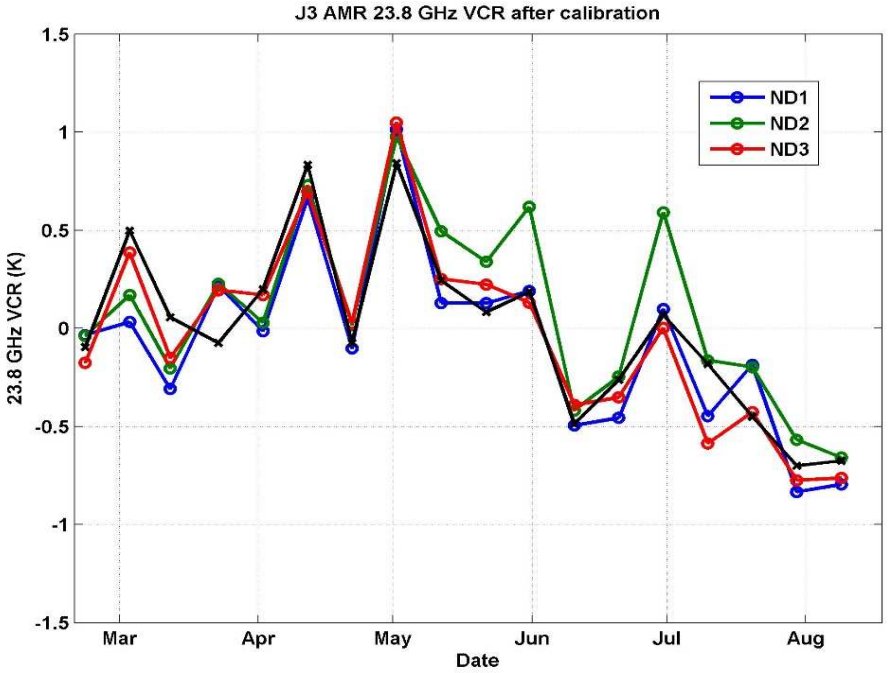
GDR Calibration Procedure

- Assumption that only NDs were changing with time, permits a single ended time dependent gain calibration
  - This was later verified by comparisons of TBs over land using the new calibration

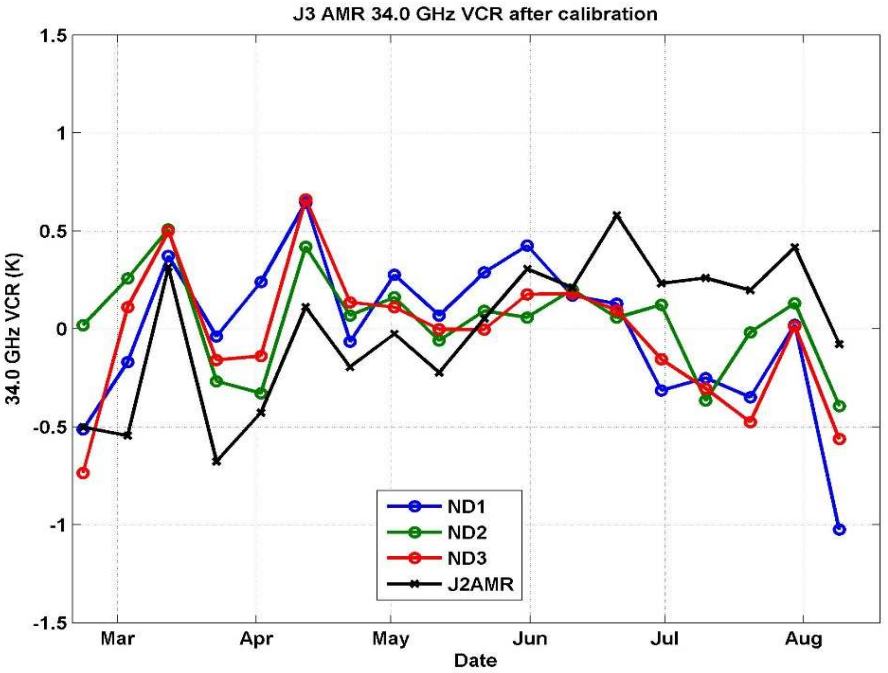
Procedure:

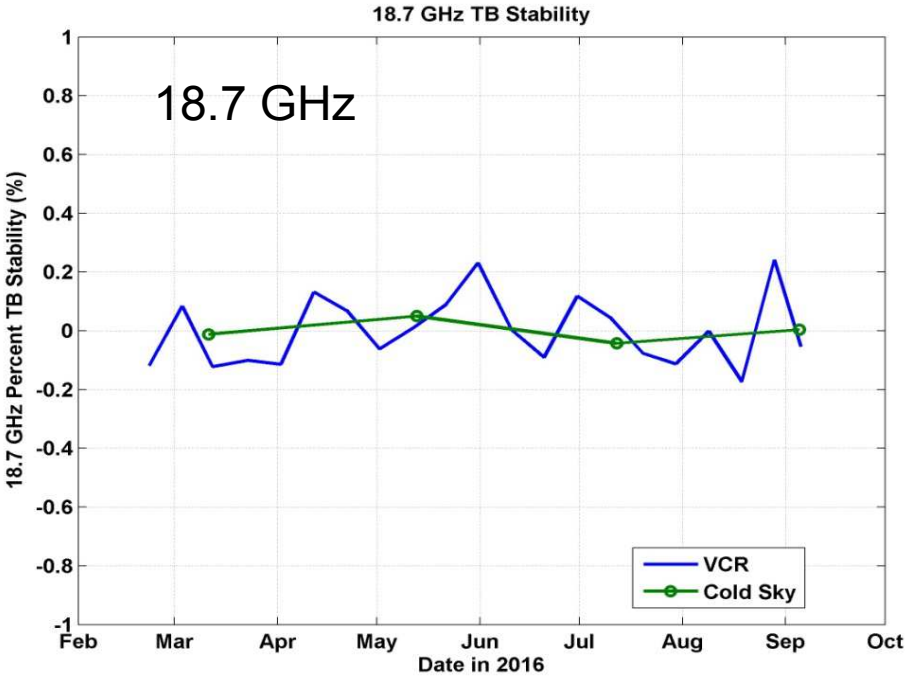
1. Jason-3 AMR noise diodes first calibrated using Jason-2 TBs as a reference on a cycle-by-cycle basis
2. Resulting ND time series were then de-trended using the 4-cold sky measurements spanning March-September
3. Ocean model was used as final validation of correction for each channel and noise diode
4. Finally, J3 AMR PDs compared to model as validation

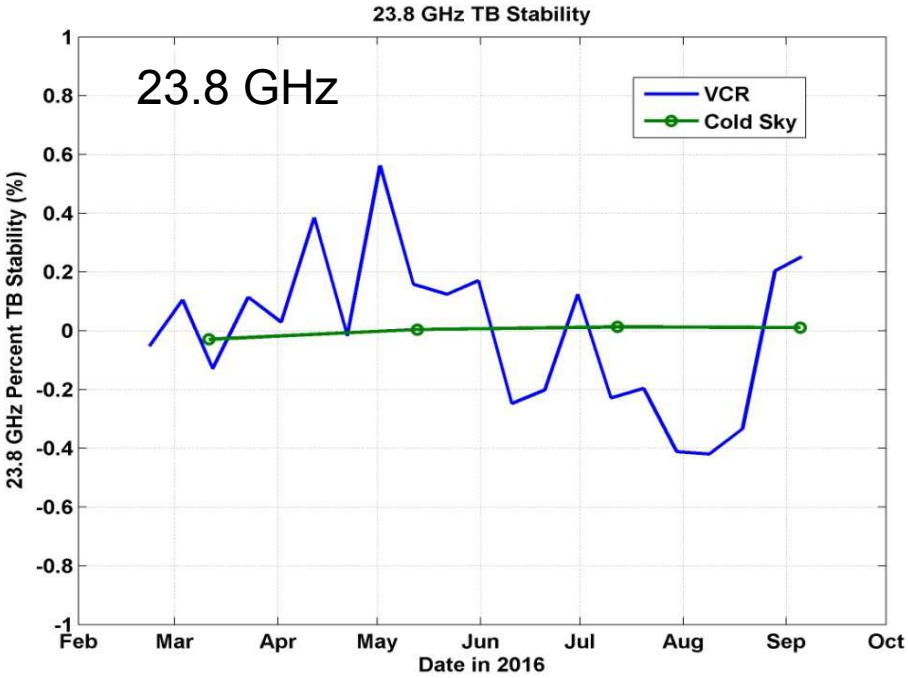




- After calibration, cycle-by-cycle variation of J3 AMR from ocean model within noise threshold for each channel and noise diode
- Jason-2 34 GHz channel shows small drift during cal/val period revealed from J3 cold sky calibration

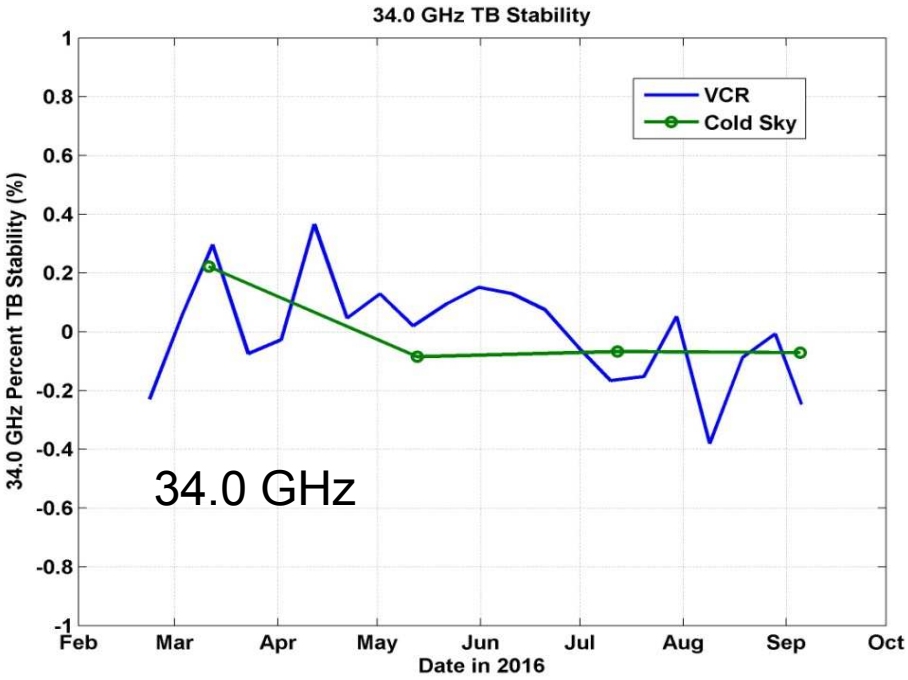






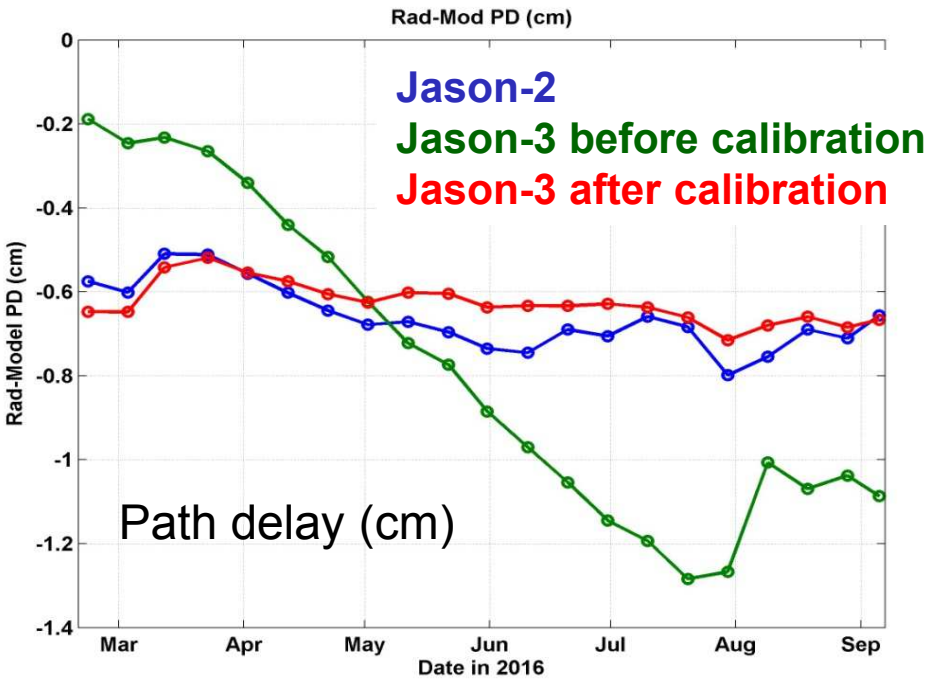
Vicarious Ocean Reference
Cold Sky

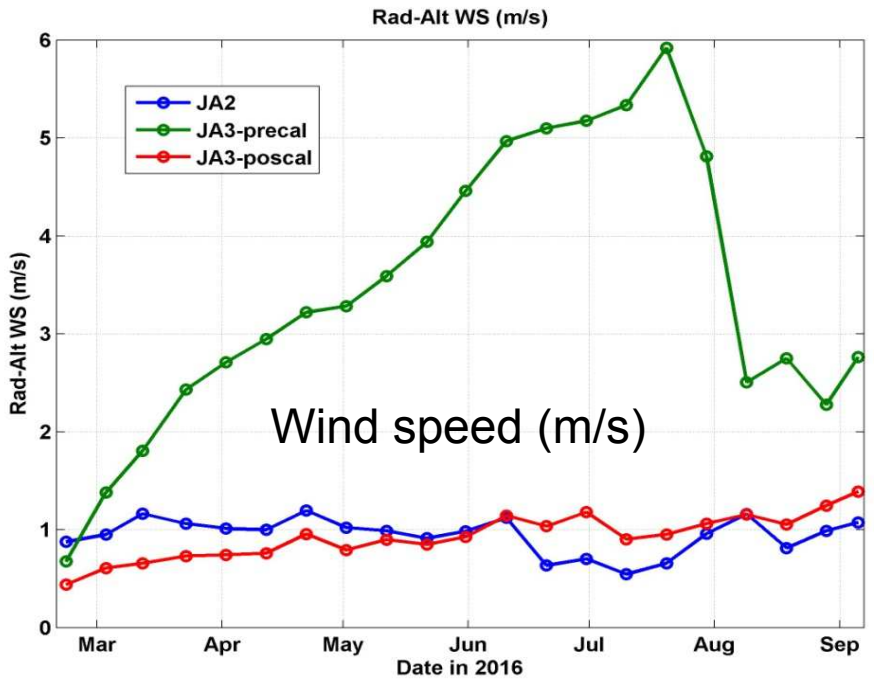
- After calibration, both cold sky measurements and vicarious cold reference stabilized



Geophysical Comparisons

- After stabilization using cold sky data, along with J2 and ocean model, independent comparison of geophysical retrievals validates independent TB calibration
- J3 stable to < 1mm relative to ECMWF during cal/val period





Summary

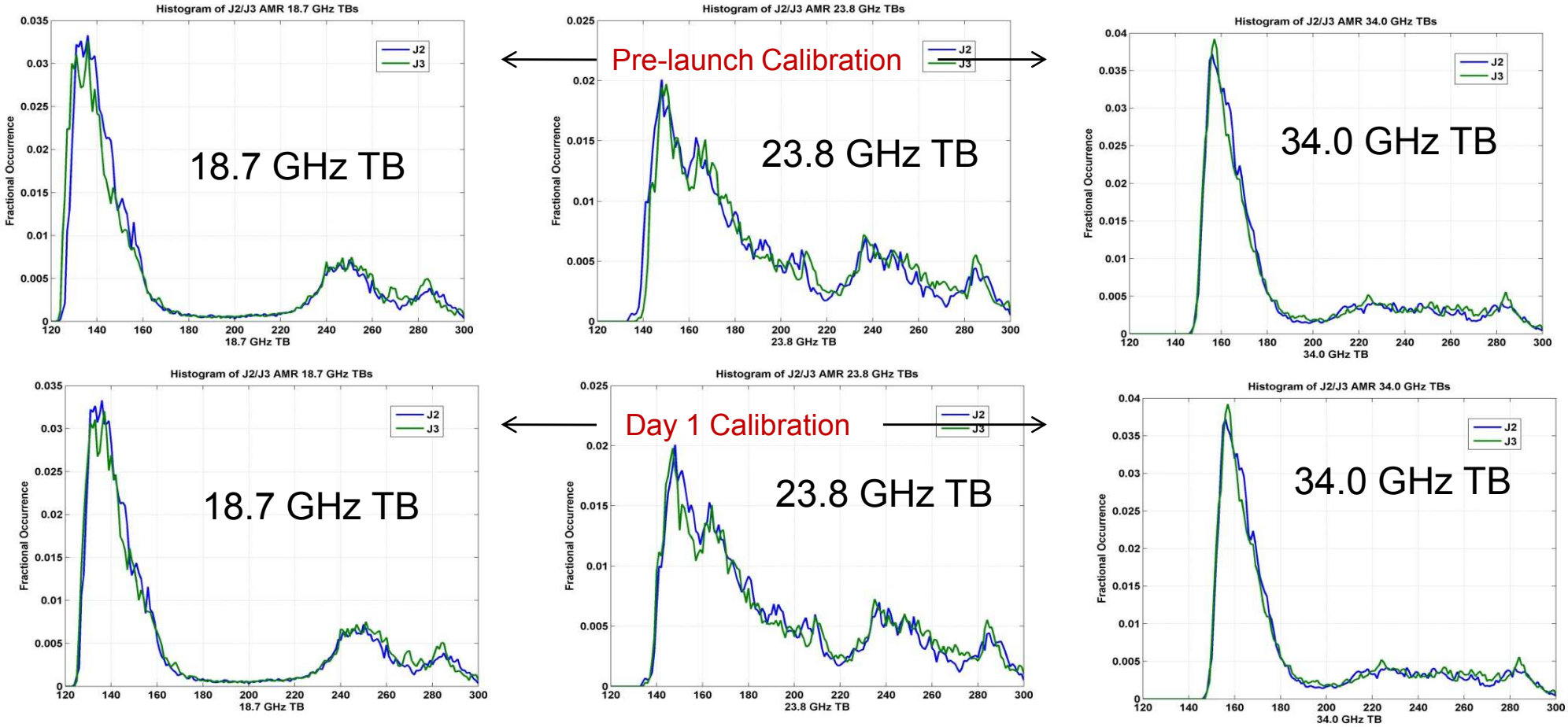
- Jason-3 AMR performing well
  - Jason-2 and Jason-3 producing identical PDs to within 3mm
- Jason-3 is experiencing a noise diode drift which is removed using the cold sky calibrations and the vicarious cold reference (ocean)
- Small mm-level differences between two sensors being studied
  - Goal is to understand JA2/JA3 differences to theoretical noise floor
- See poster by Tanvir Islam for more information

Backup

Pre-launch to Day 1 Calibration

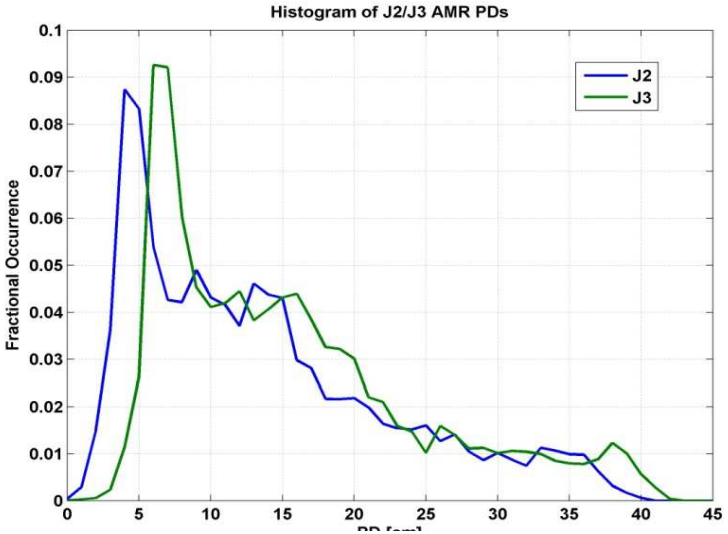
- Pre-launch calibration typically accurate to about 2-3% level
- Day 1 assessment indicated Jason-3 AMR calibration accurate to about the 1% level or better
- Small adjustments made on Day 1 to noise diode calibration values at 18 and 23 GHz

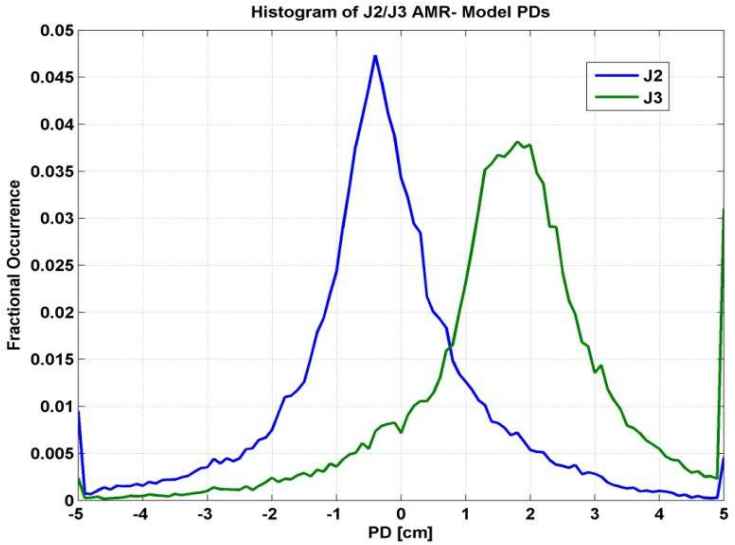
Histograms of Brightness Temperature



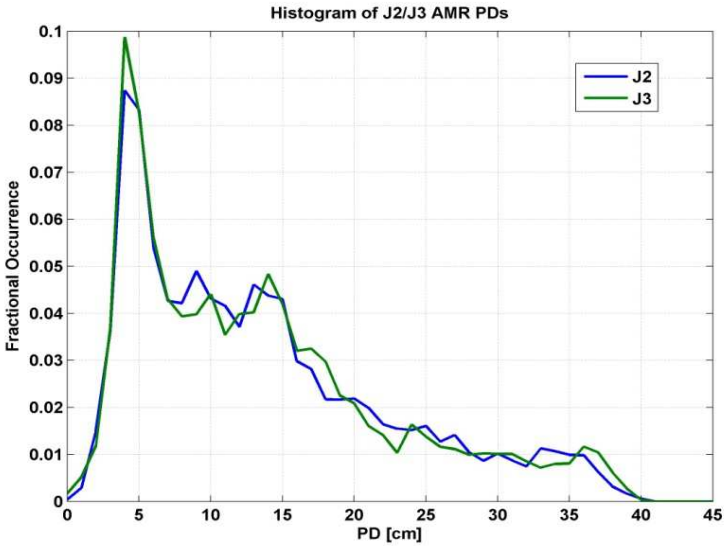
PD Comparison to Model

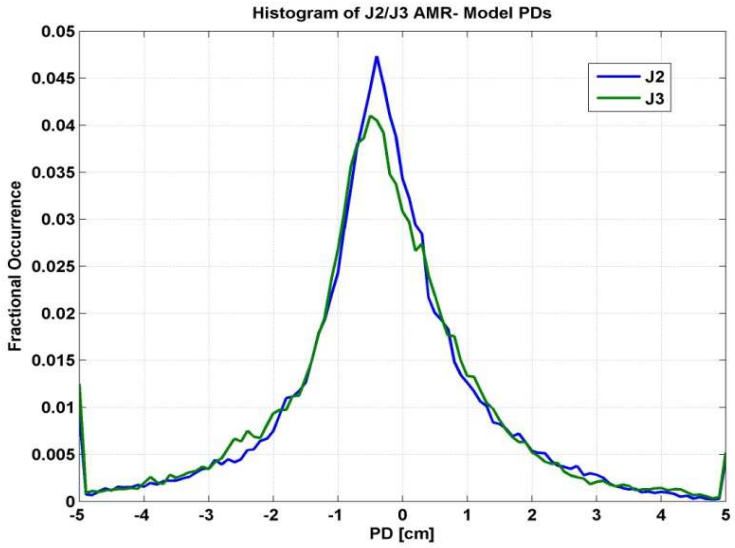
- PD comparison to the OGDR model value offers independent check on day 1 cal
- Agreement with J2 much better with the new calibration





Pre-launch calibration





"Day 1" calibration

JA2/JA3 Model Standard Deviation

- Mean standard deviation between model and measurement below 1cm
- Slightly higher for JA3
  - 0.25 cm excess error