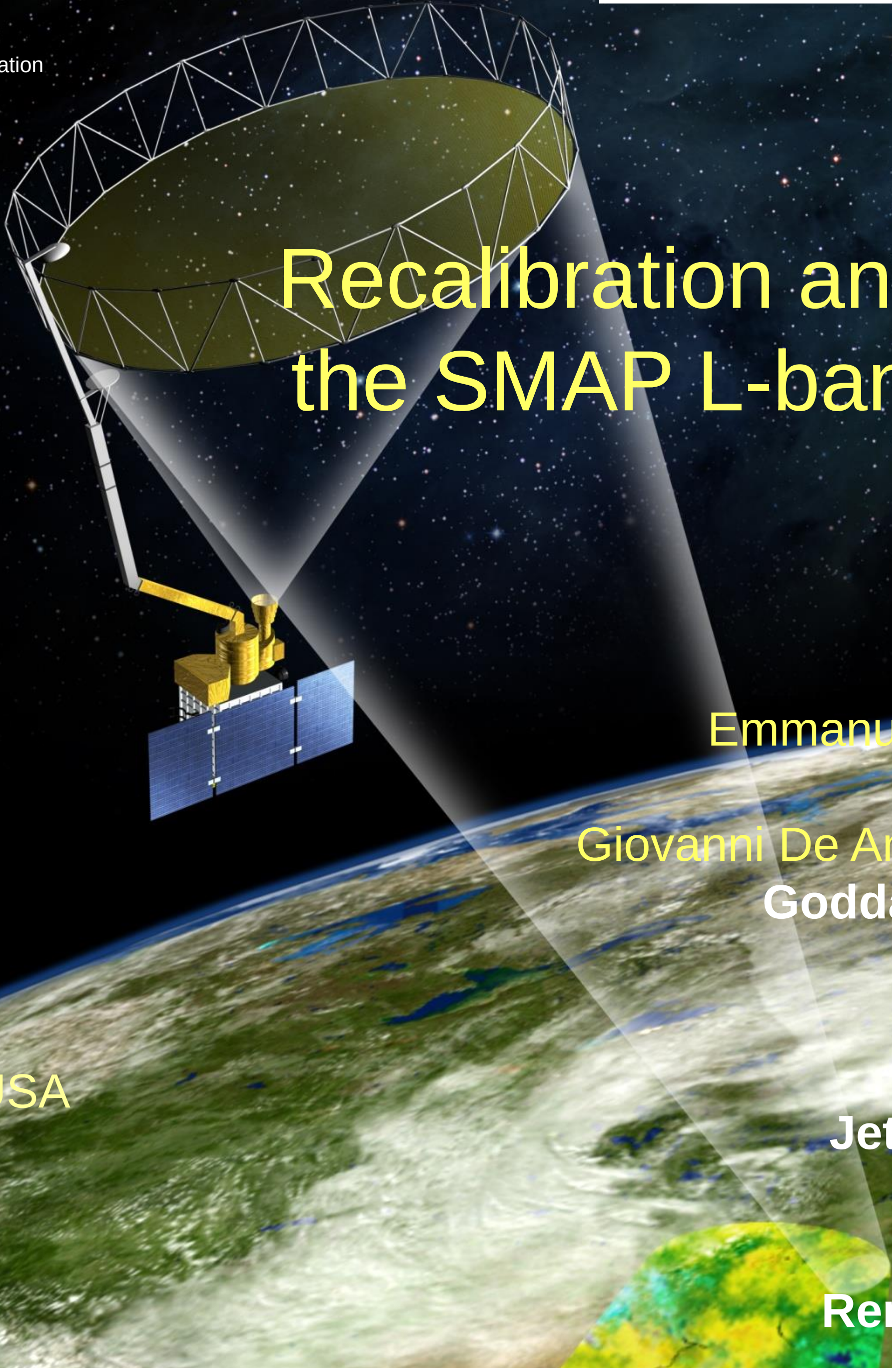
National Aeronautics and Space Administration

Soil Moisture Active Passive Mission

SMAP

Recalibration and Validation of the SMAP L-band Radiometer



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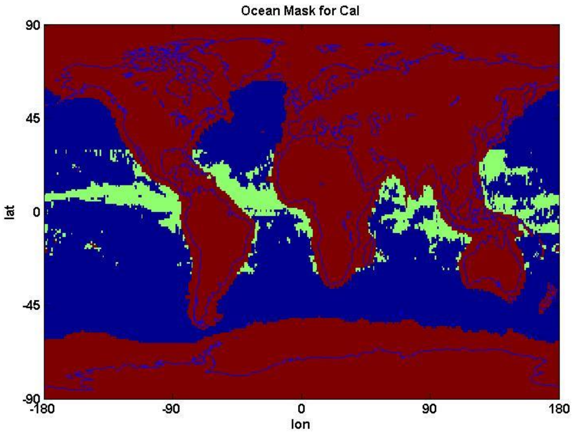
IGARSS 2017
July 23-28, 2017
Fort Worth, Texas, USA

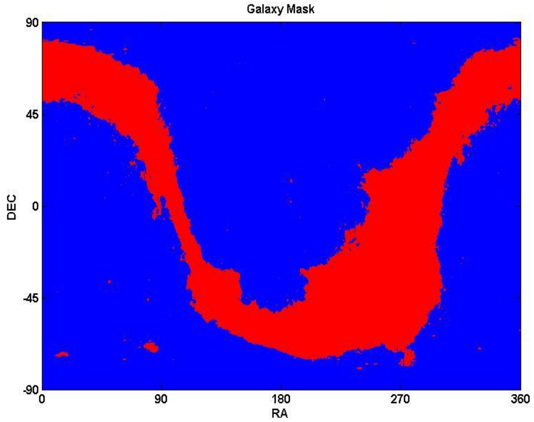
Outline

- Current Performance of Release v3
  - Calibration bias/drift over global ocean and cold sky
- ReCalibration Algorithm and Performance for next release
  - Algorithm
  - TA validation
  - TB validation
- Conclusion

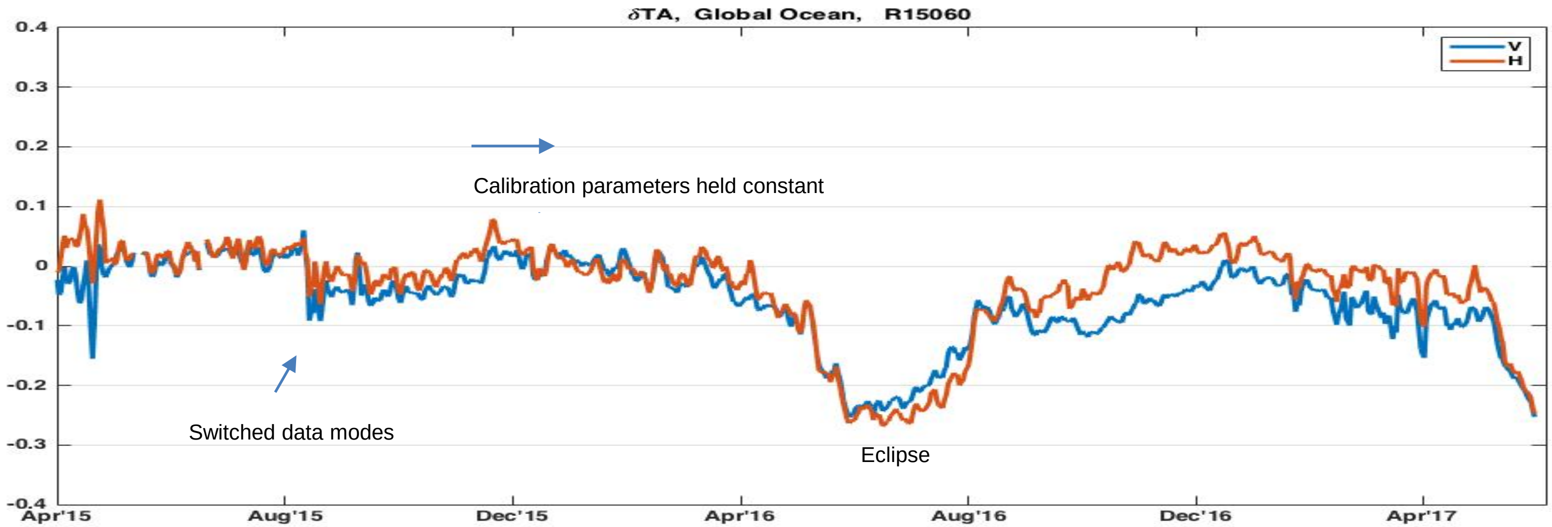
Bias/Drift Monitor Approach

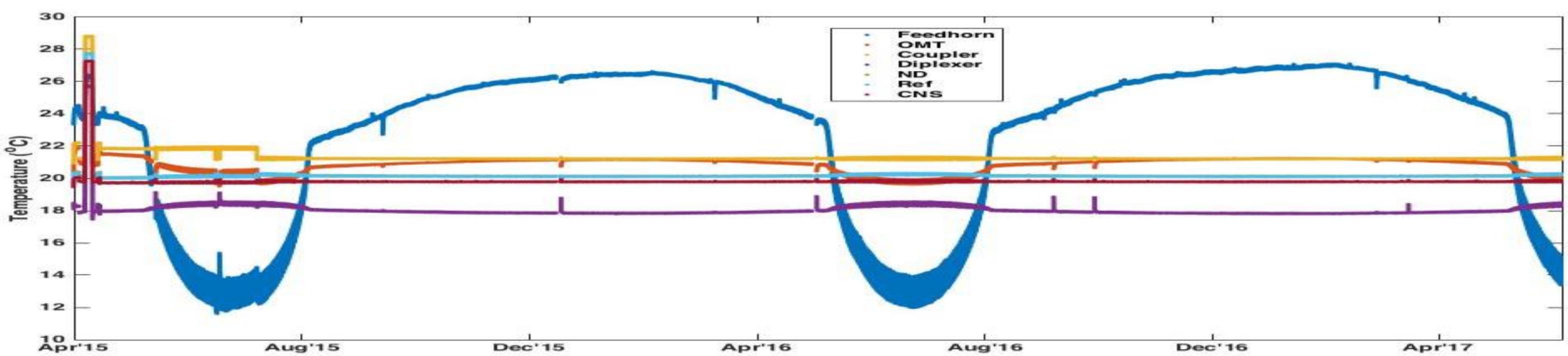
- Compare calibrated antenna temperature to modeled antenna temperature over desired calibration targets
- Data selection criteria
  - Good data quality and antenna direct/reflect boresight away from the Sun/galaxy plane
- Selected Calibration Targets
  - 1) Global ocean exclude heavy rain zone and 200 km away from land
    - Daily averaged TA difference monitor the calibration bias/drift
  - 2) Cold Sky
    - Monitor bias/drift monthly





Current Calibration Performance
(Global Ocean)

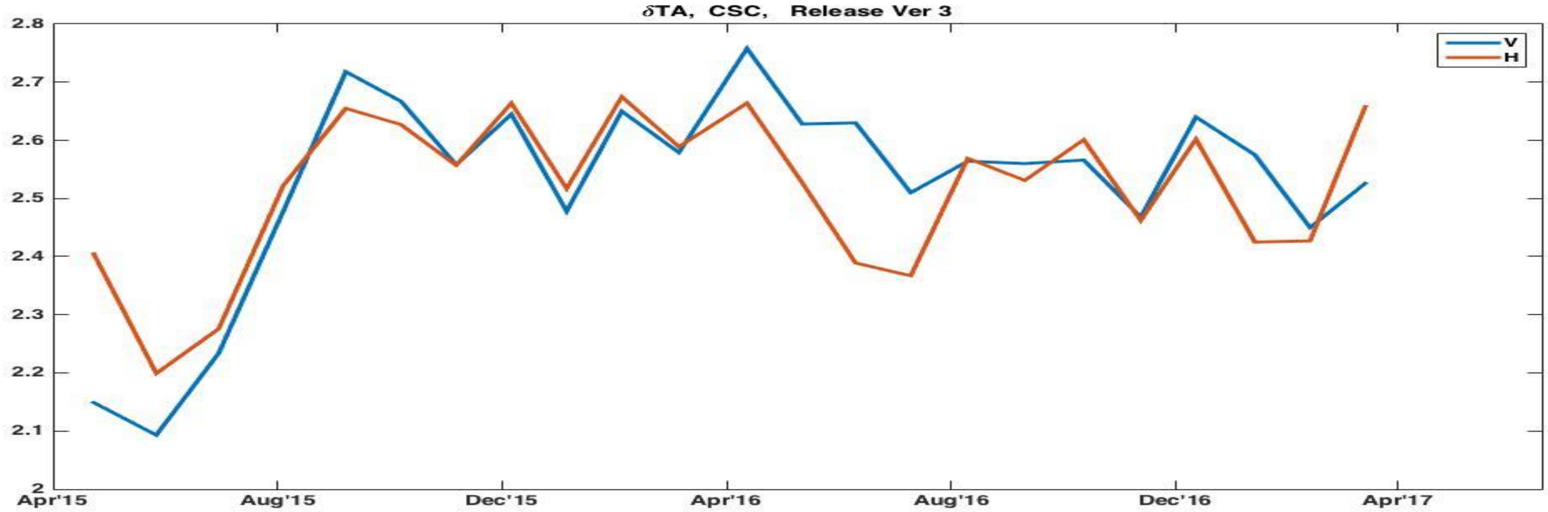


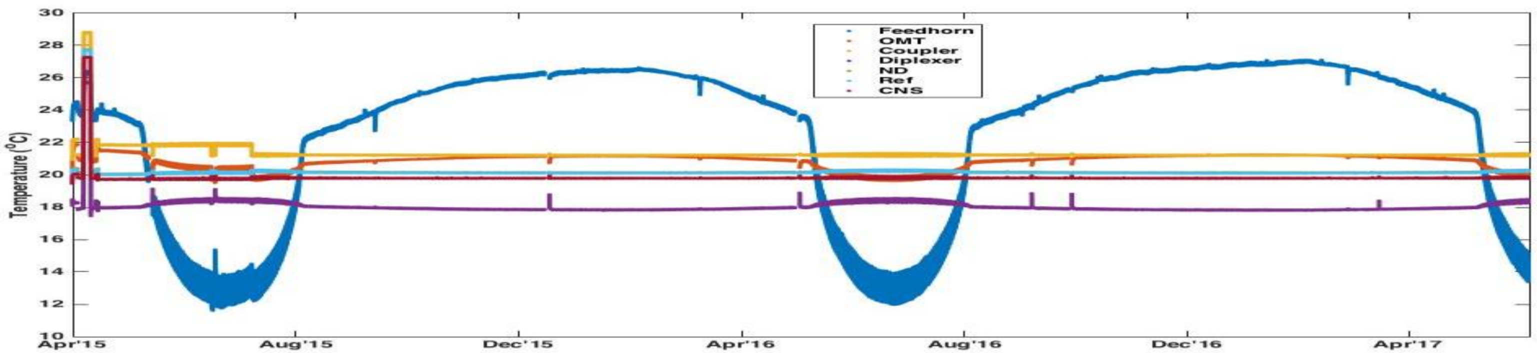


Current Calibration Performance

(Cold Sky)

- Monthly Cold Sky maneuver (110° pitch) to monitor drift

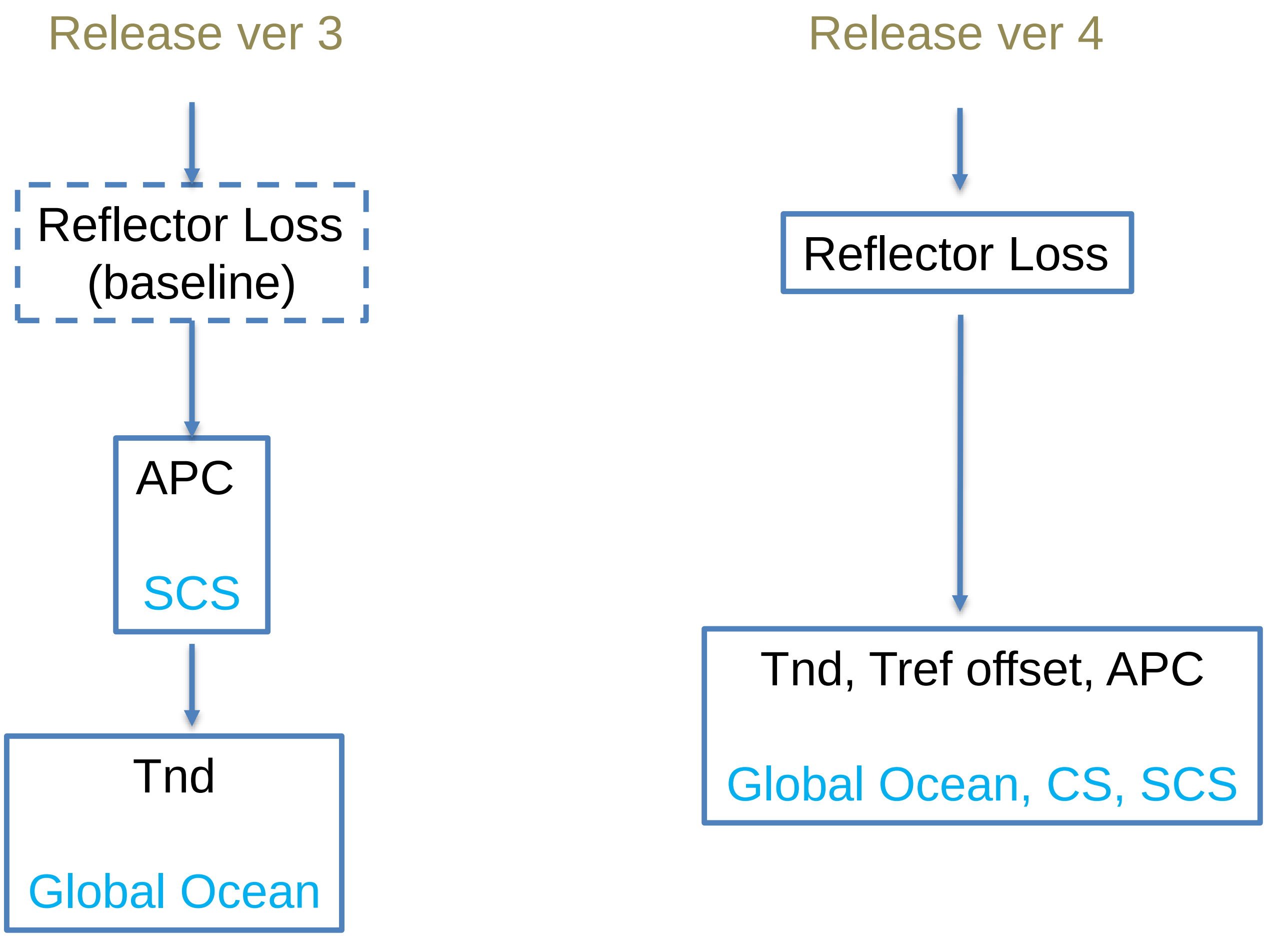




Existing Problems

- Bias/Drift in Version 3
  - Calibration drift satisfy requirement (<0.4 K/month)
  - Negative bias and drift over global ocean during 2^{nd} and 3^{rd} eclipse seasons
  - 2.6 K bias over CS for both V- and H-pol
- Intercomparison between SMAP v3 and SMOS v620 (Rajat Bindlish)
  - 2.6 K cooler than SMOS land TB
    - V & H-pols
- Uncertainty in the reflector/radome emissivity
  - Reflector temperature profile update before version 3 release
  - Baseline value of the reflector emissivity used in version 3

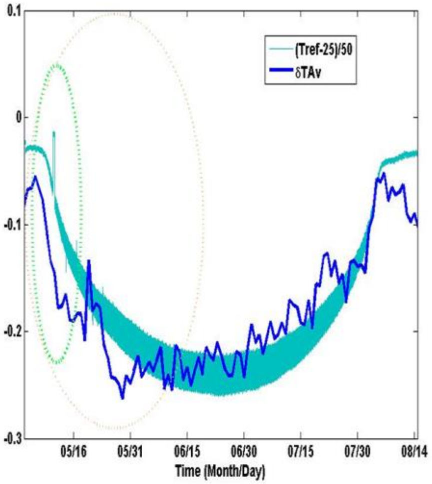
Flow of Calibration Approach

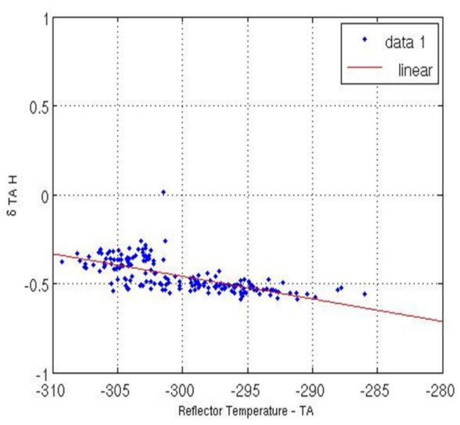


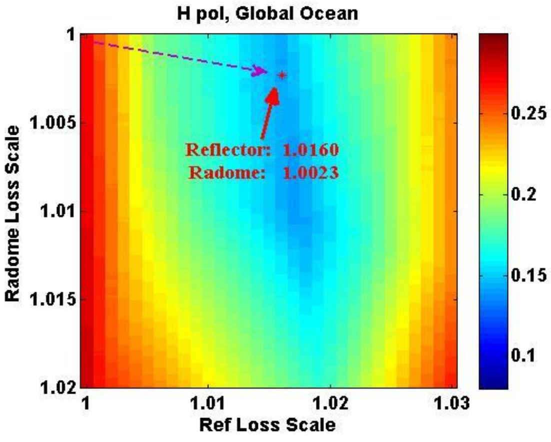
Reflector Calibration

- Excess loss for Reflector/Radome derived by 3 independent groups

	Pol	JPL	GSFC	RSS	Baseline
Reflector	H	1.014	1.016	1.01	1.0026
	V	1.012	1.012	1.01	1.0023
Radome	H	NA	1.0023	NA	1.0003
	V	NA	1.0017	NA	1.0003



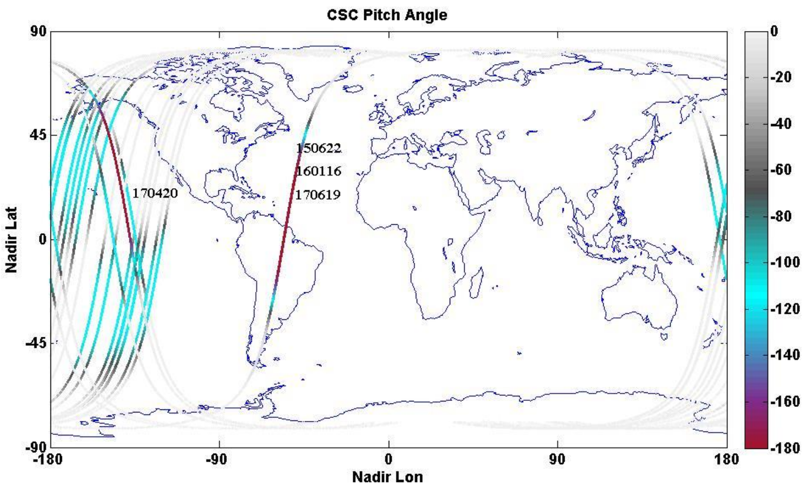


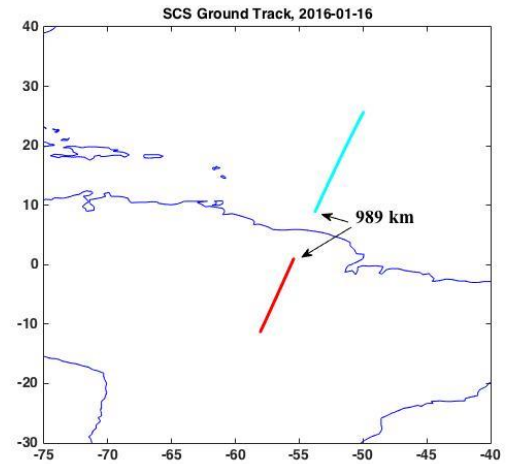


- A third method by RSS tried to reduce zonal signatures observed in δTA vs. time by adjusting the reflector value.

Data for Calibration

- Global ocean data of the day with CS (110° and 180° pitch)
- CS data (110° pitch)
- SCS data (180° pitch)
  - water fraction > 75% (over ocean) and < 25% (over Amazon)
- Date range: non-eclipse (09/07/2015 ~ 04/12/2016)
- Data quality
  - Antenna direct/reflected boresight away from the Sun/galaxy plane
  - RFI free





Calibration Coefficient

- Dataset with same & fixed cal coefficients
- Model

$$C_r \delta T_{ND} + \delta T_{ref} = \frac{1}{L_{RF}}(-\delta T_A + S\delta G)$$

where $C_r = \frac{C_{ant} - C_{ref}}{C_{nd}}$

L: loss of the SMAP RF front

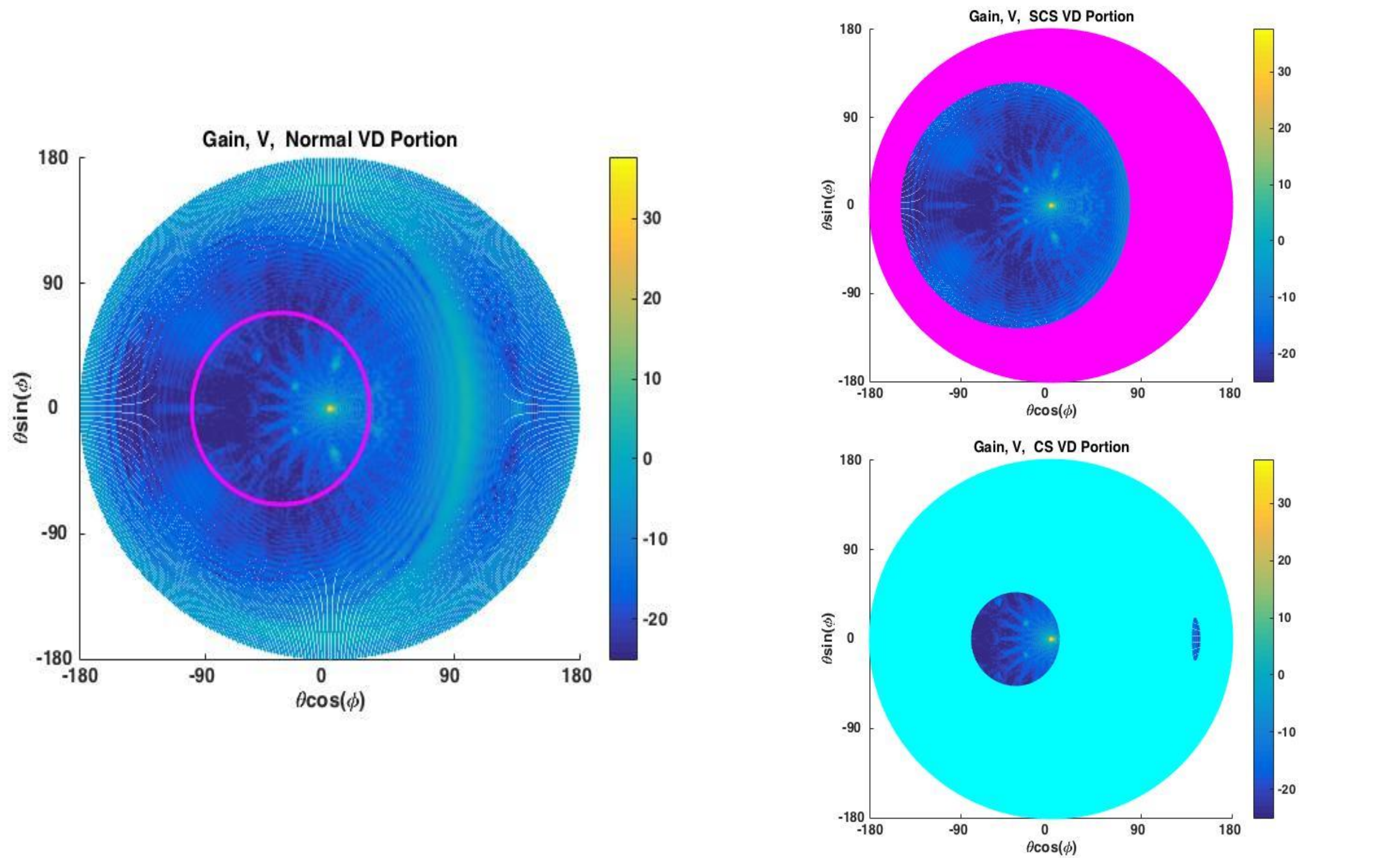
S: δT_A sensitivity to antenna gain variation

δG: antenna gain variation

- Antenna pattern will be modified corresponding δG

Antenna Pattern's Earth Visible Disk

- Portion of the antenna pattern intercepted by the Earth



Antenna Pattern Cal

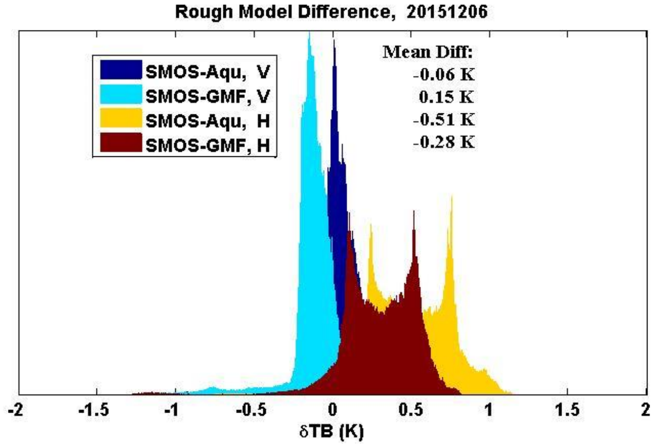
- Calibrate the front/back ratio of the antenna pattern
- For next release (version 4)
- Pre-Launch antenna pattern is used
  - Better performance than using the antenna pattern for release version 3
- The antenna mainbeam ($\theta \leq 3.75°$) is varied
  - Same as APC (4x4 matrix) in L1B
  - The backlobe (not intercepted by the Earth's surface in normal science mode) of the antenna pattern is changed in the opposite direction so that the whole antenna pattern is normalized.

Calibration Result and TA Validation

	δT_{ND}	δT_{ref}	δG
V-pol	-0.57	3.29	-0.23%
H-pol	-0.40	4.89	-0.51%

TB Verification

- L1B_TB generated by SDS using updated cal coefficients
- Compare to Version 3
  - Ocean TB diff: -0.08 K (V), 0.06 K (H)
  - Land TB increment (initial result): 2.90 K (V), 5.01 K (H)
- Bias might be added to H pol based on further TB validation
  - Radiometer nadir looking is planned
  - Ocean roughness model might introduce bias
    - Three ocean roughness models compared
      - GMF
      - Aquarius
      - 2-scale roughness model (earlier used by SMOS)



Conclusion

- Current radiometer calibration satisfy requirements
  - Drift and bias exist
- New calibration approach for next release can effectively reduce calibration bias drift removal over both global ocean and CS
  - TA validation
    - bias < 0.25 K (max) & drift < 0.1 K/month
  - TB validation (working)
    - Compared to SMAP L1B_TB version 3
    - Ocean TB increment: -0.08 K (V), 0.06 K (H)
    - Land TB increment: 2.90 K (V), 5.01 K (H)
- Further TB validation is planned
  - Radiometer nadir looking