

GSICS-MW Lunar Calibration Working Group

Progress Report

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Working Scope of the Group

- **Microwave lunar RTM model development**
 - ◆ Theoretical model development and inter comparison
 - ◆ RTM model validation with satellite observations
- **Lunar radiance measurements based on the satellite observations**
 - ◆ Lunar satellite observation calibration
 - ◆ Sensor related uncertainty in Lunar radiance measurements
- **Lunar observation applications**
 - ◆ Antenna beam pointing/Geolocation accuracy evaluation
 - ◆ Instrument long-term gain stability evaluation
 - ◆ Inter-satellite calibration

Achievements and Progress

Action Items	Person	Status	Comments
Create a sharing space in GitHub for code and document exchange	Niutao Liu	Done	Data and material shared in subgroup meeting has been uploaded to Github
Extract the influence of Sun-Moon distance on microwave TB from Metop-A MHS data.	Martin	Done	The data can be validated with the model.
Model the influence of Sun-Moon distance and remove this effect in the data.	Niutao Liu	Done	
Fitting the FWHM of AWS/EPS MWR with lunar intrusion	Tim	Done	
Detailed analysis of AWS with lunar intrusion observation.	Team efforts	In progress	
Develop an open source high- resolution community microwave lunar RTM for current and future microwave sounding instruments	Team efforts	In progress	

Highlights of the Research Work in Microwave Lunar Calibration Group

- Microwave Lunar RTM study
- Reference truth from the satellite observations
- Application of microwave lunar model in instrument calibration

Projects MW-Luna 1 and 2 Completed (Deutsche Forschungsgemeinschaft)

Research Question

Stability of MHS adequate for climate applications (0.04 K / decade)?

Method

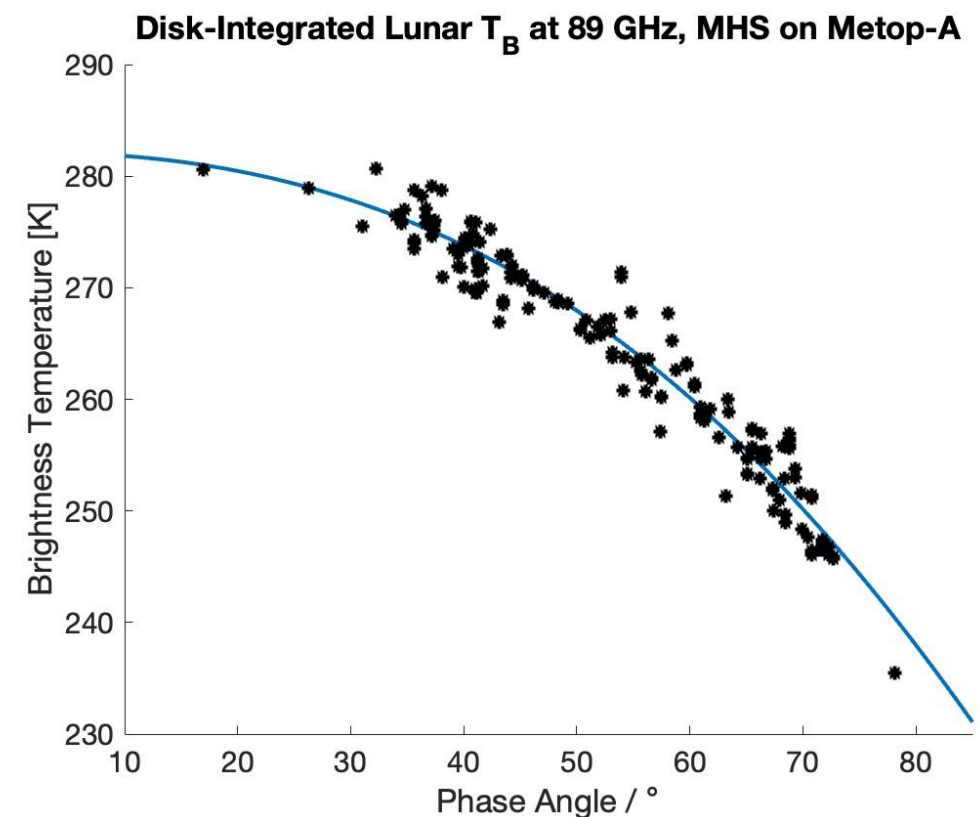
Moon = stand-alone flux reference

Analyze 6373 observations with MHS

Result

Upper limit for cal. trend: 1 K / decade

Method better suited for infrared



<https://www.mi.uni-hamburg.de/en/arbeitsgruppen/s-trahlung-und-fernerkundung/newsarchiv/251218-mwluna.html>

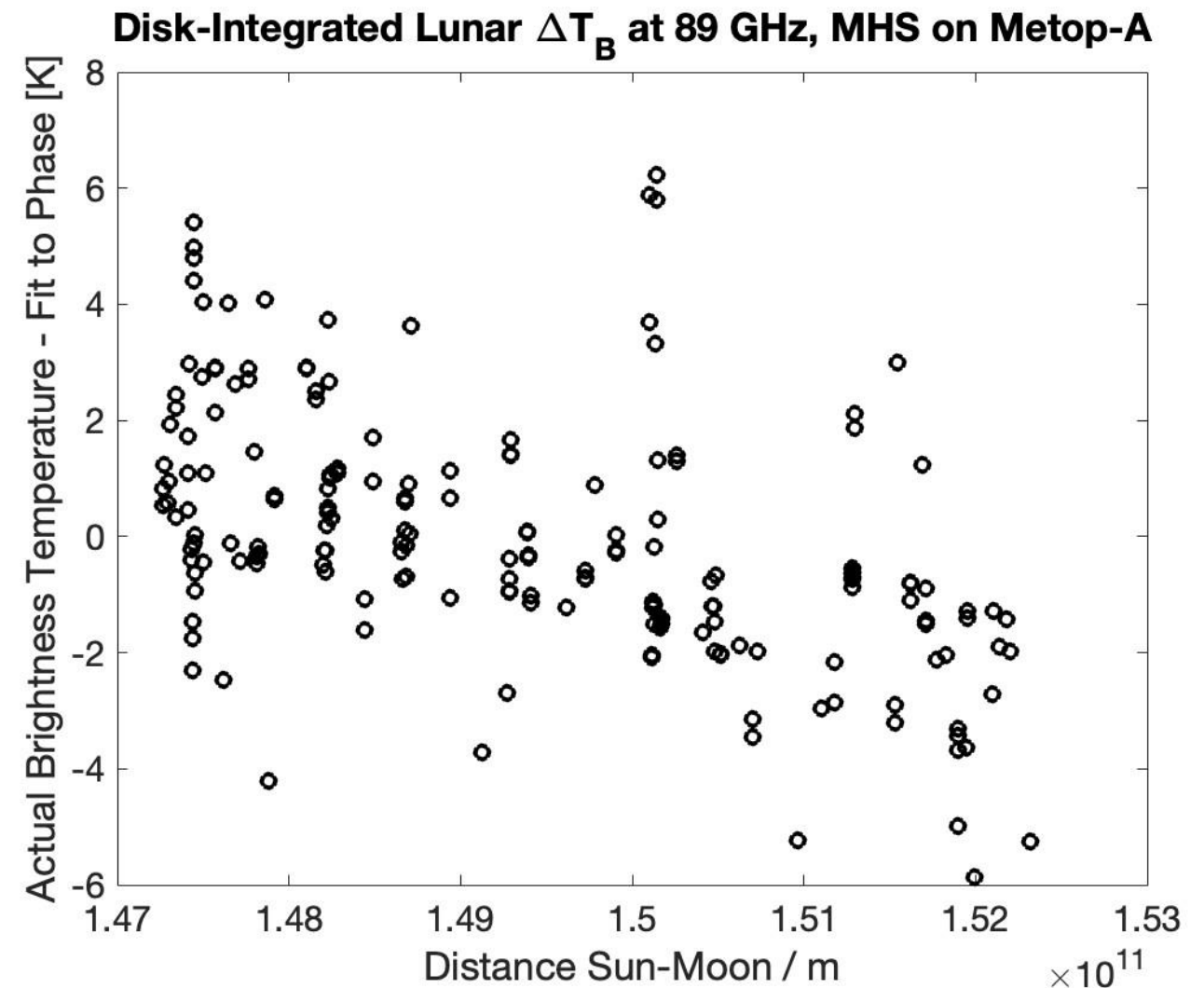
Recent Results on Lunar MW Calibration

TB from observations of Moon with MHS:
DOI 10.5281/zenodo.17733213

$TB_{\max}$ agrees with Keihm et al. (2025)

$\text{Phase}(TB_{\max})$ and $TB_{\text{perihelion}} - TB_{\text{aphelion}}$ agree
with Liu & Jin (2021)

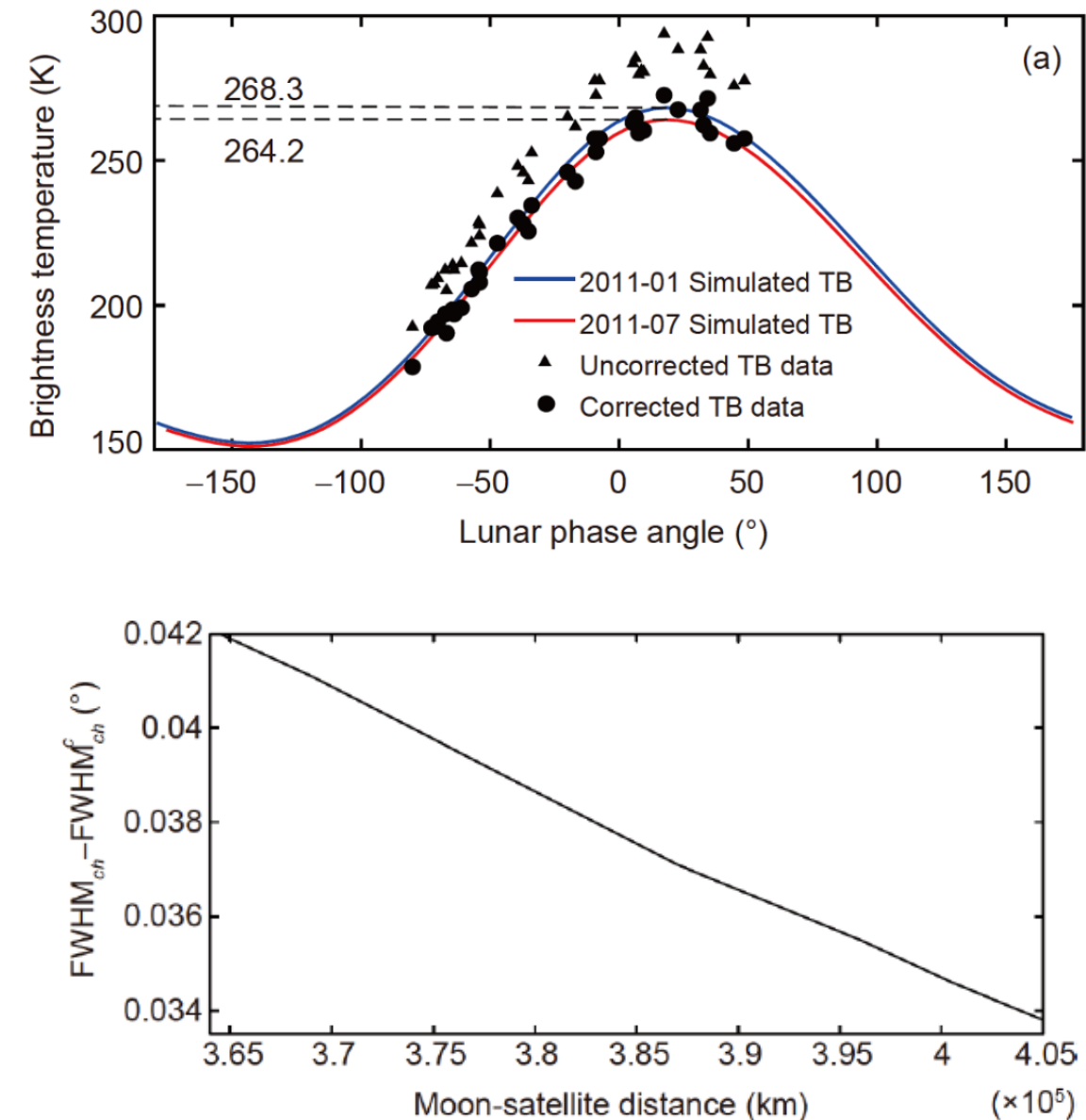
Moon established as MW calibration reference



The influence of Sun-Moon distance on lunar microwave TB

(Niutao Liu)

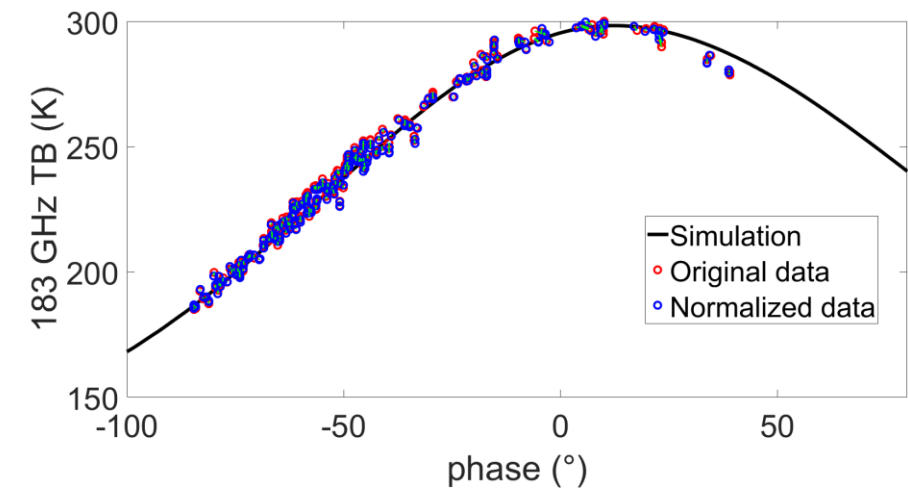
- Simulate the impact of Sun-Moon distance on microwave TB with the real-time model (Liu and Jin, 2021).
- Simulate the difference between the true FWHM and fitted FWHM with lunar intrusion observation for different Moon-satellite distance, FWHM, and lunar phase angles.



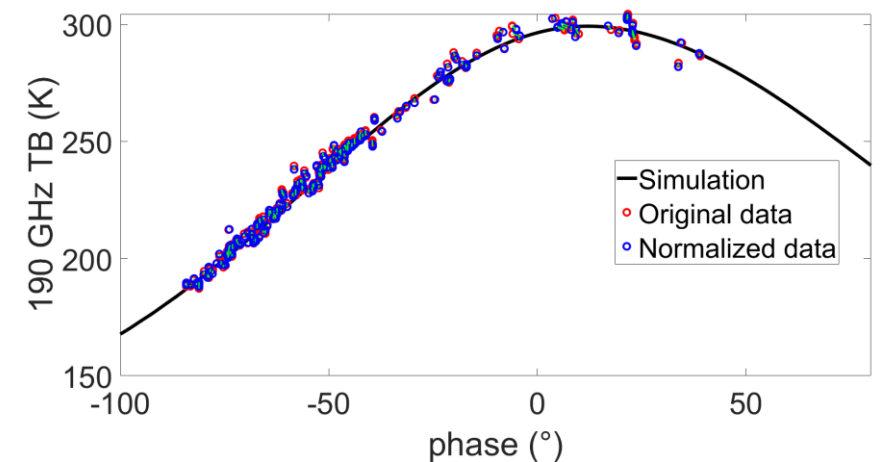
The influence of Sun-Moon distance on lunar microwave TB

(Niutao Liu)

- Remove the effect of Sun-Moon distance on lunar microwave TB with the model.
- For 183 GHz Channel1, the std difference before correction is 3.64 K, and the mean two-temperature difference after correction is 3.30 K, a decrease of 0.34K.
- For 190 GHz, the std difference before correction is 3.75 K, and the mean two-temperature difference after correction is 3.39 K, a decrease of 0.36 K.



NOAA-18 MHS 183GHz CH1
(Data from Martin)

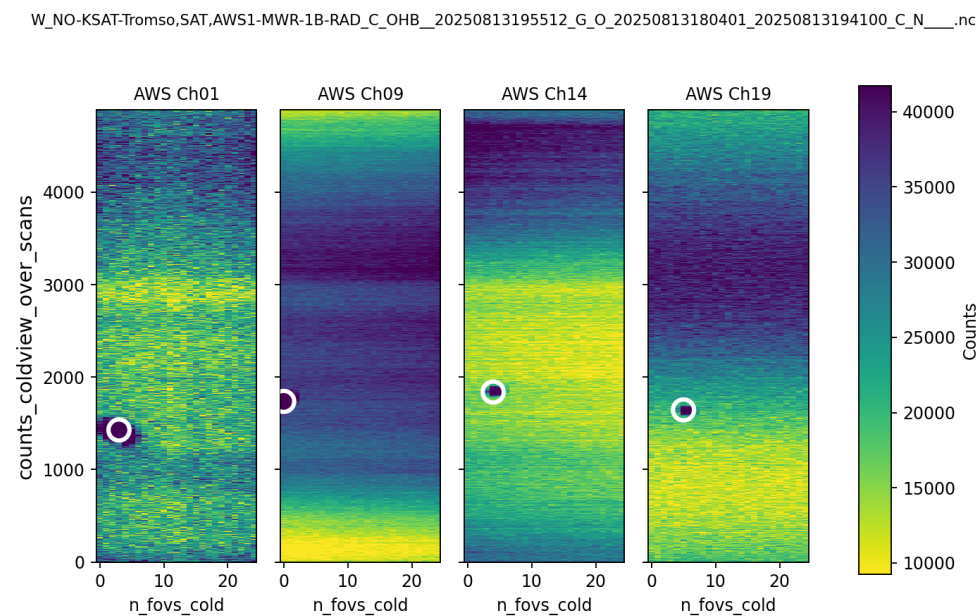


NOAA-18 MHS 190GHz
(Data from Martin)

Initial analysis of AWS lunar intrusion

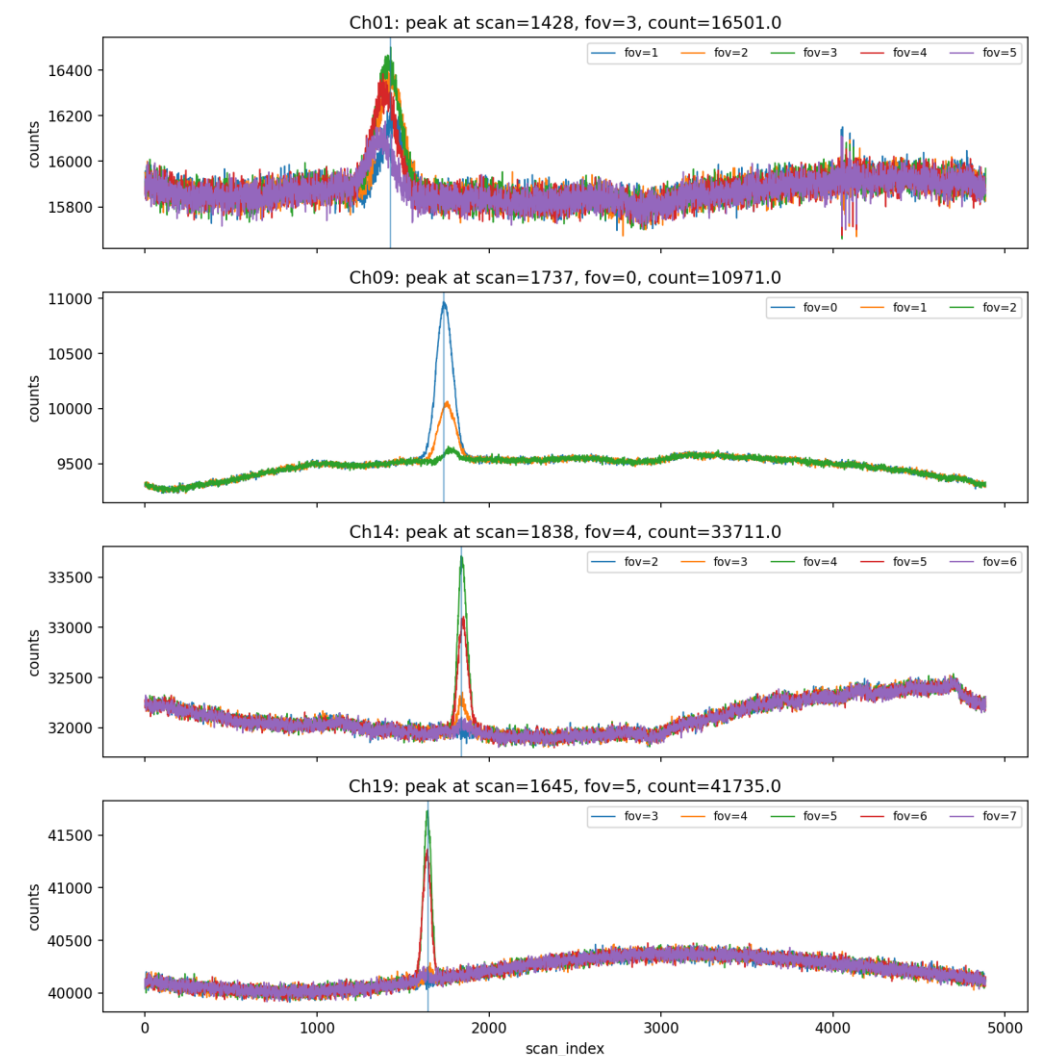
(Dezhang Li, Niutao Liu)

To improve the model, it is necessary to find out more factors that will influence the lunar observation. The lunar intrusions in AWS microwave radiometer observation are analyzed initially.



Peak Structure Along Scan

- Count series plotted versus **scan index**
- Extracted the data of lunar intrusion



AWS data

(Website of AWS is provided by Tim)

Thank you for your attentation