



# Data Validation of the NASA Time-Resolved Observations of Precipitation structure and storm Intensity with a Constellation of Smallsats (TROPICS) Pathfinder Microwave Radiometer

Amelia Gagnon<sup>1</sup>, Samantha Hasler<sup>2</sup>, Juliana Chew<sup>1</sup>, William Blackwell<sup>3</sup>, Vince Leslie<sup>3</sup>, Kerri Cahoy<sup>1</sup>

<sup>1</sup>Department of Aeronautics and Astronautics, Massachusetts Institute of Technology

<sup>2</sup>Department of Earth, Atmospheric, and Planetary Sciences, Massachusetts Institute of Technology

<sup>3</sup>Lincoln Laboratory, Massachusetts Institute of Technology

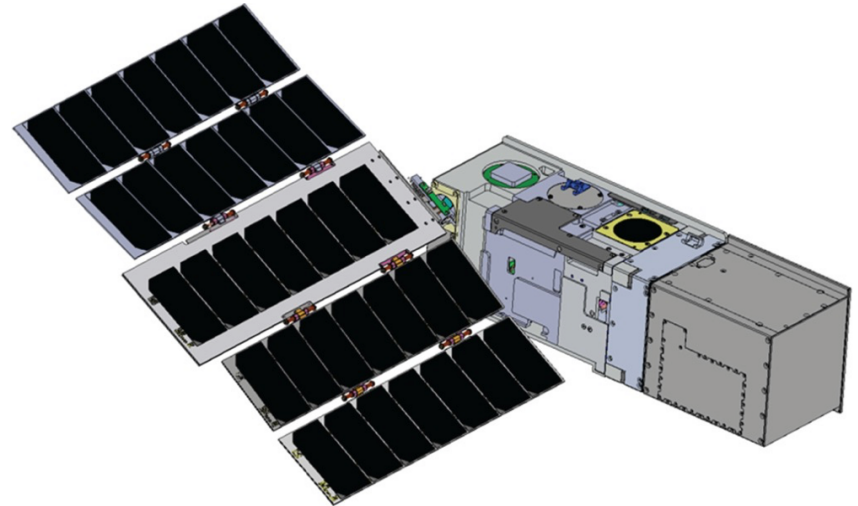
August 6, 2022

36<sup>th</sup> Annual Small Satellite Conference



# The TROPICS Mission

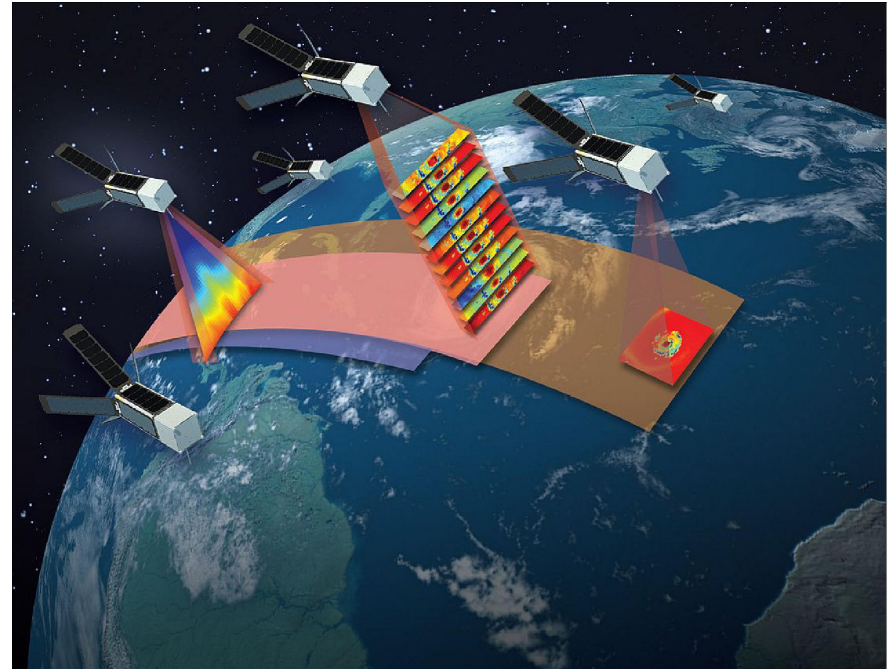
- Constellation of 3U CubeSats
- Observations of temperature, humidity structure, cloud ice, and precipitation structure
- Rapid-refresh MW measurements in 12 channels
- Pathfinder launched June 30, 2021



**TROPICS Space Vehicle**  
Credit: Blackwell et al. 2018

# TROPICS Observation Platform & Objectives

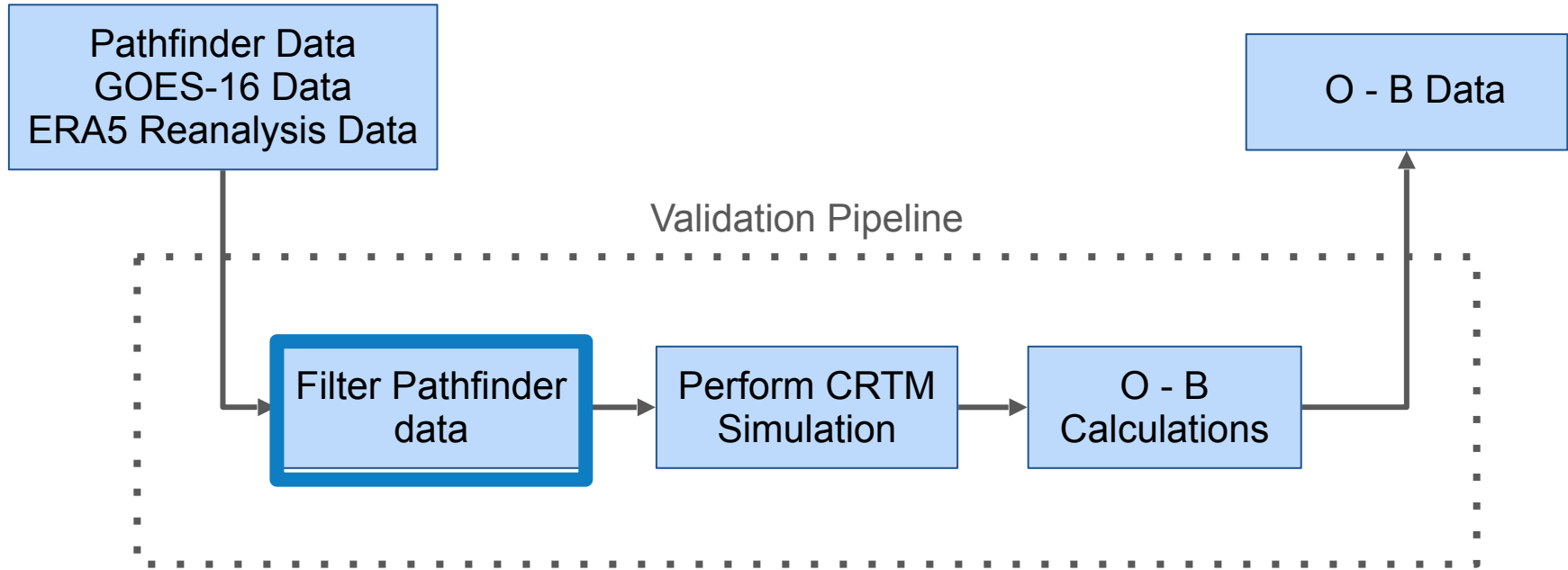
- Passive MW spectrometer
  - Developed at MIT LL
  - 4 groups of channels
    - 1: Window channel
    - 2-8: temperature sounding
    - 9-11: water vapor
    - 12: water vapor, clouds
  
- Data validated with single differencing (O-B)



Credit: MIT LL, NASA

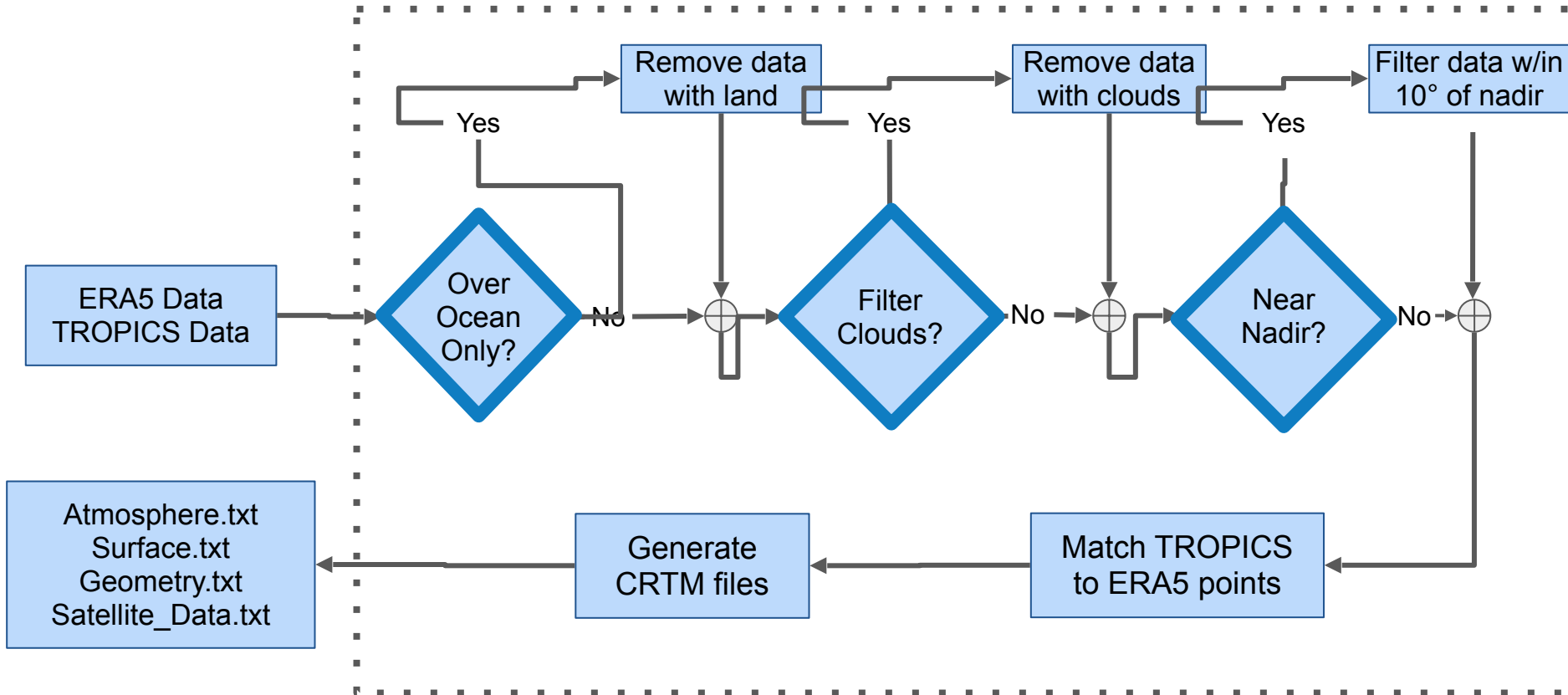


# TROPICS Validation Plan



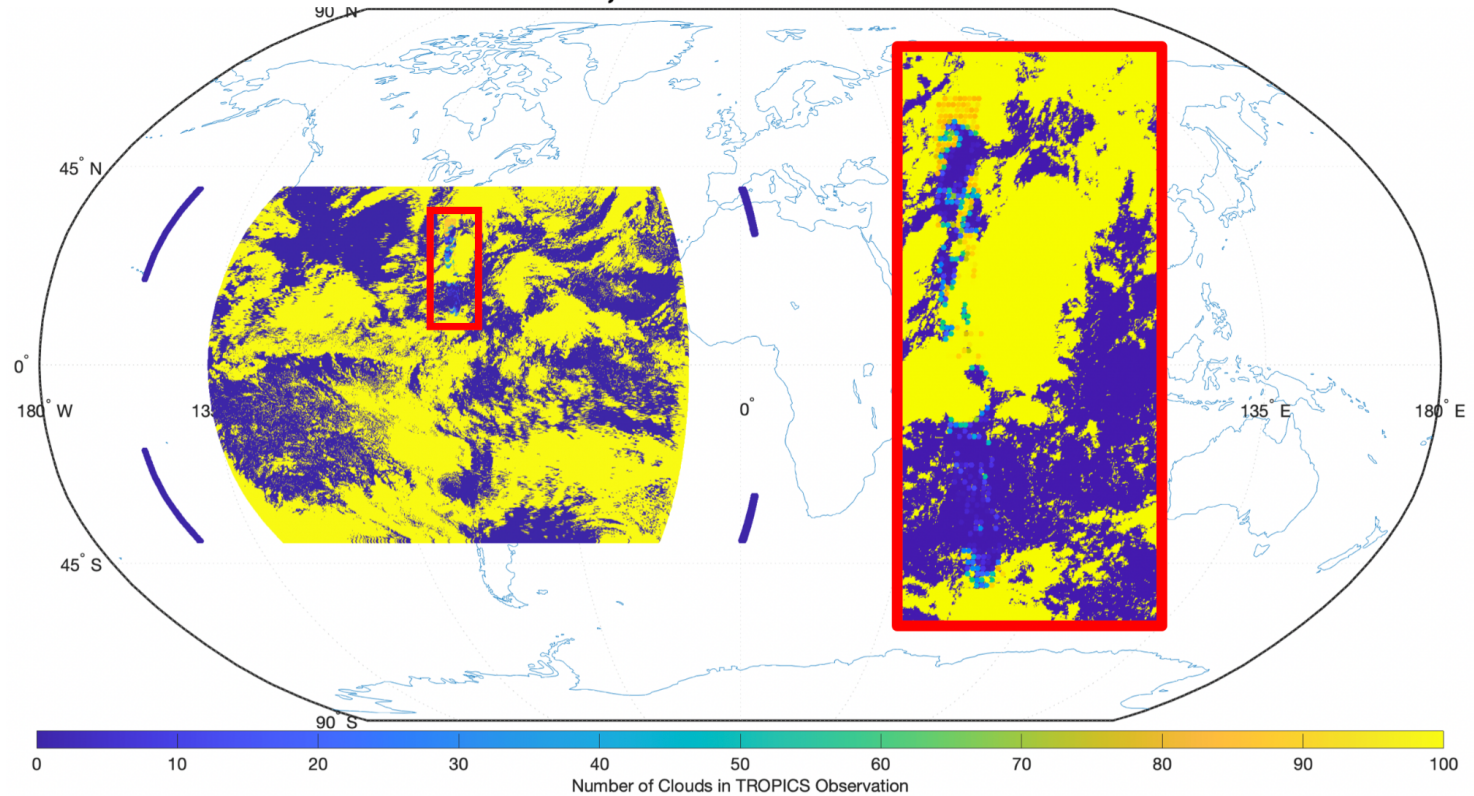


# TROPICS Data Filtering



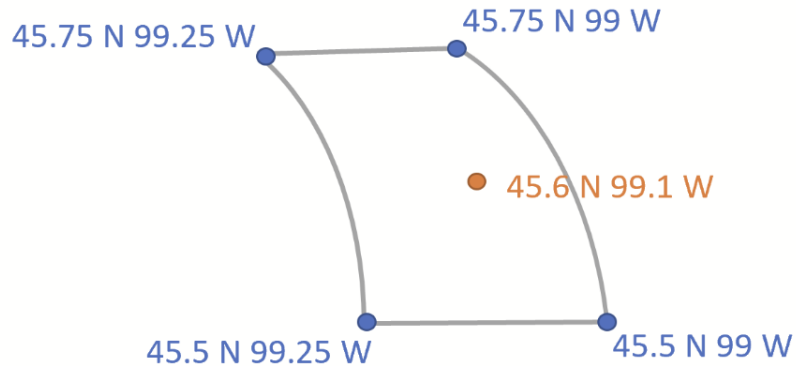
# GOES-16 Cloud Mask

October 10, 2021 GOES-16 and TROPICS





# ERA5 Data Matchups



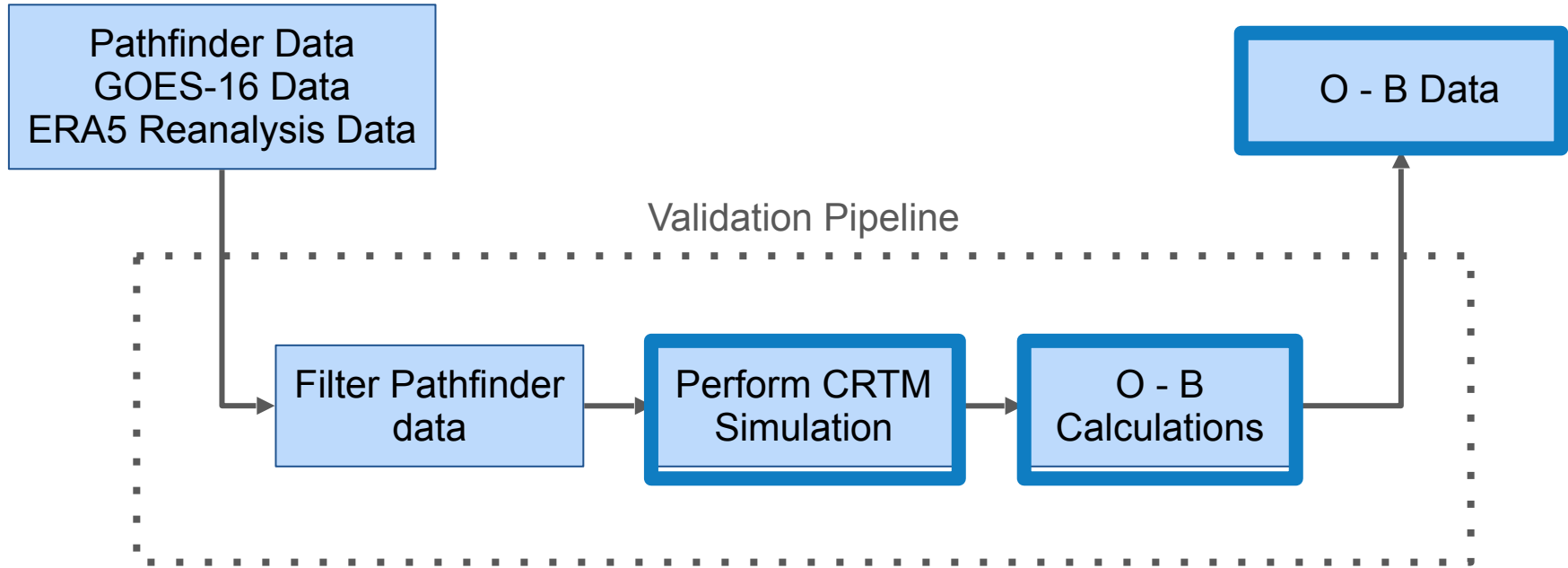
ERA5 Data Points

Pathfinder Observation

Distance is calculated  
between the Pathfinder  
observation and nearby ERA5 points



# TROPICS Validation Plan



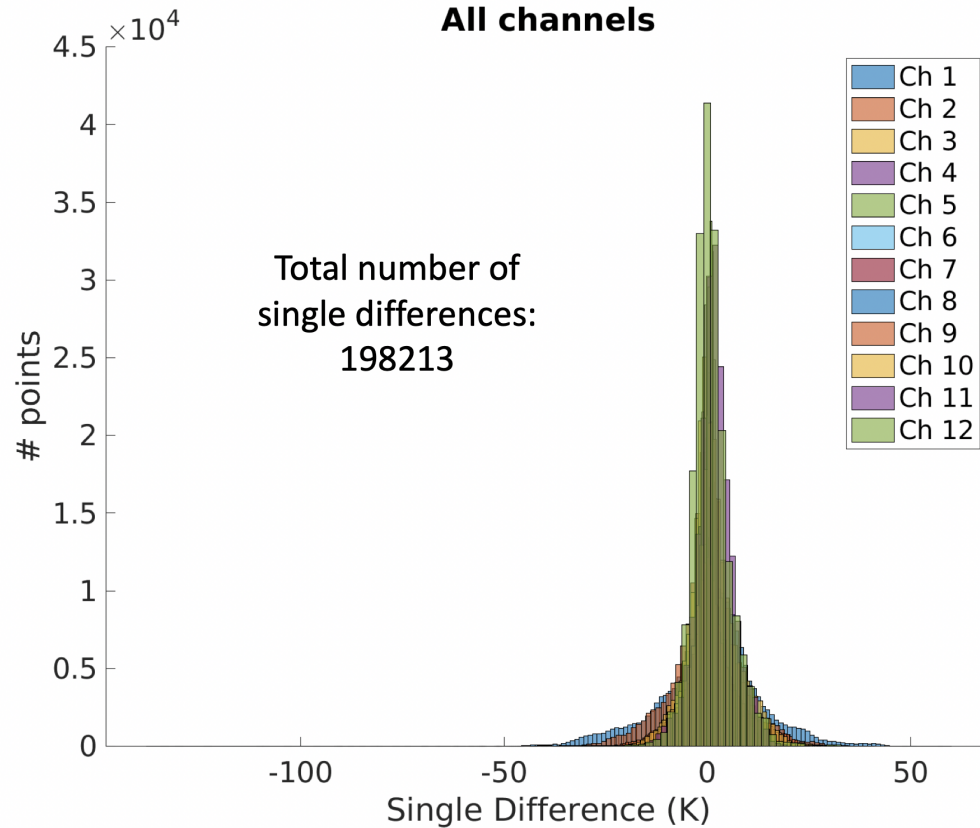


# Pathfinder Data Used in Analysis

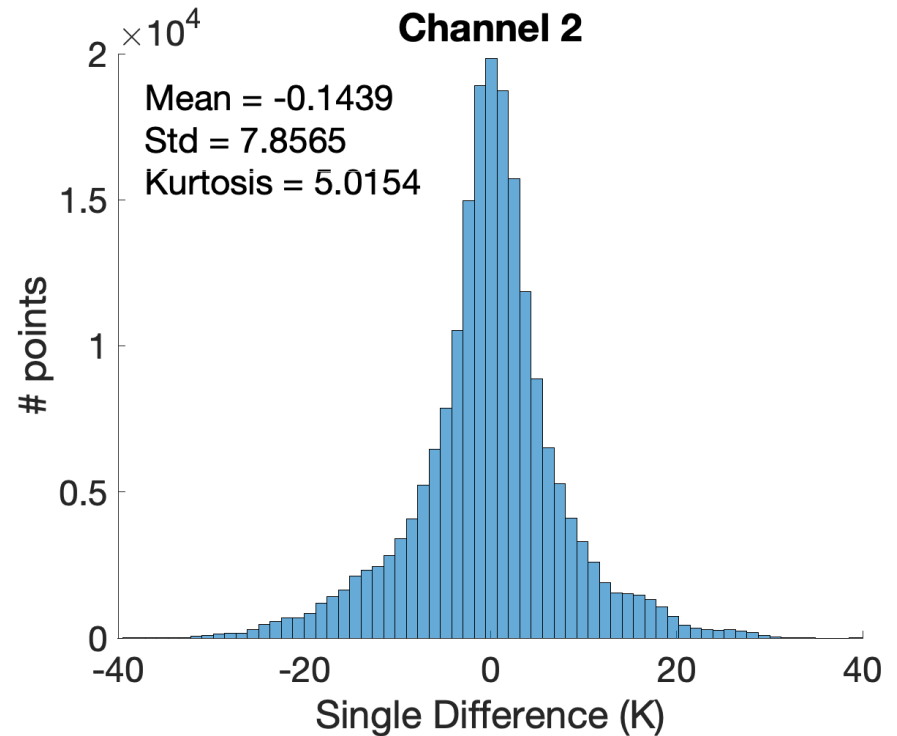
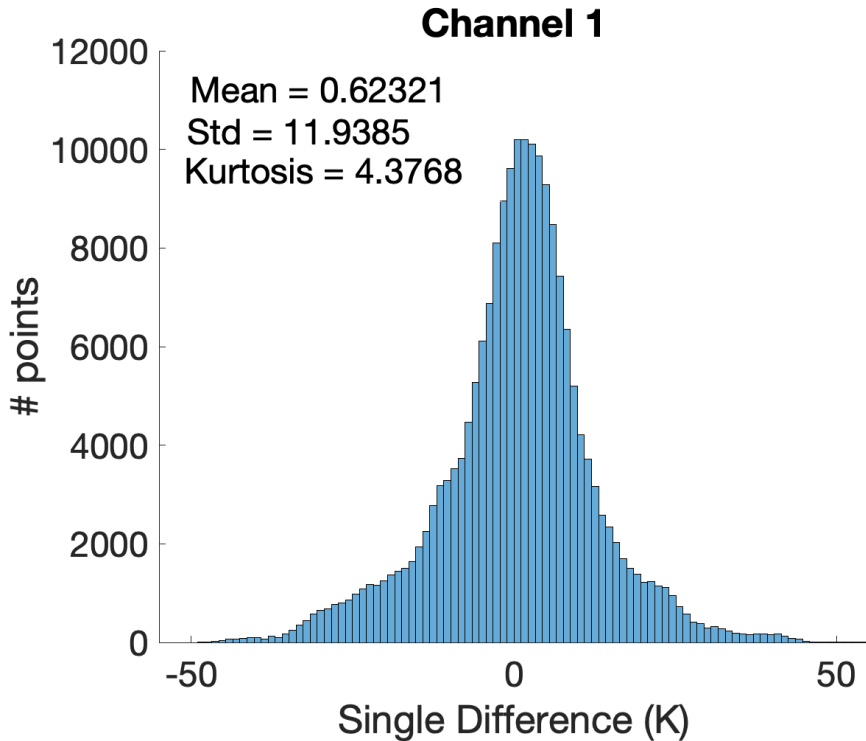
---

Date Range	October 2021
Latitude Range	- 40° through + 40°
Longitude Range	~45° W through ~135° W
Over Ocean	Yes
Clear of Clouds	Yes
Near Nadir: 10°	Yes
Radiance Data	Provisional

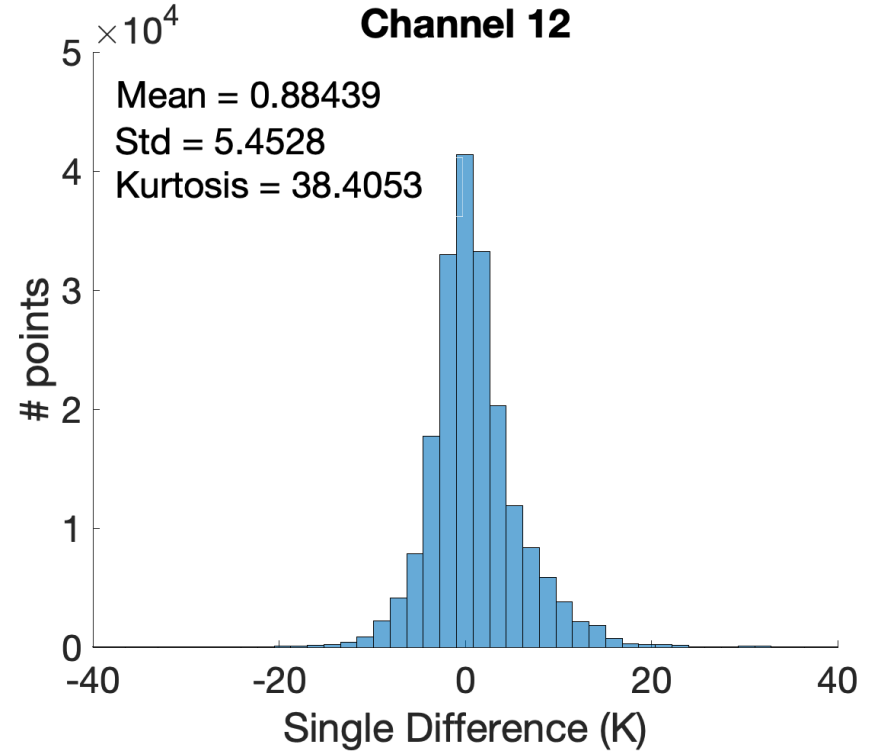
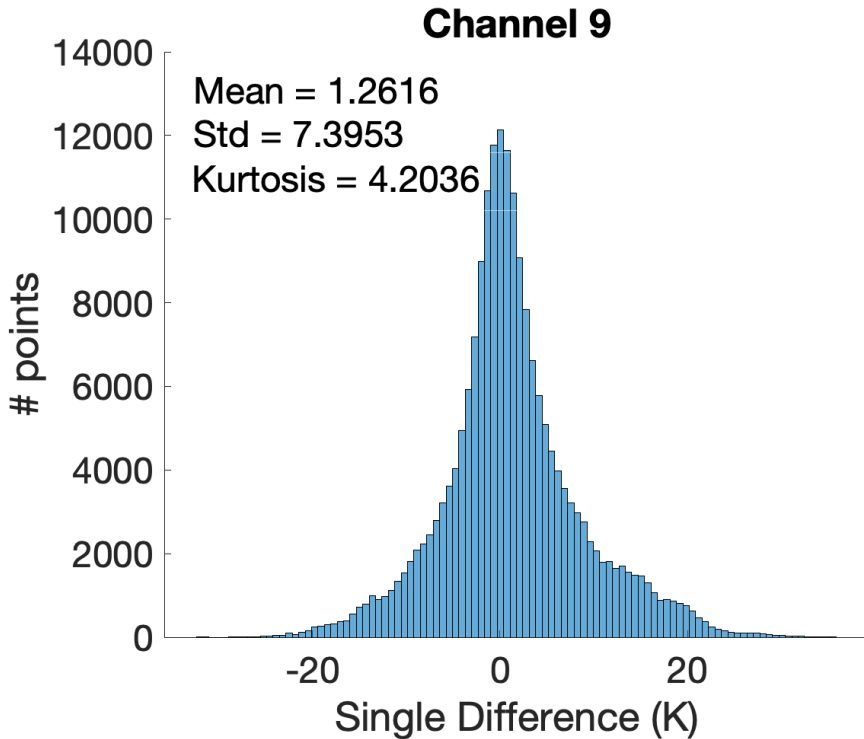
# Results for October 2021



# Results



# Results

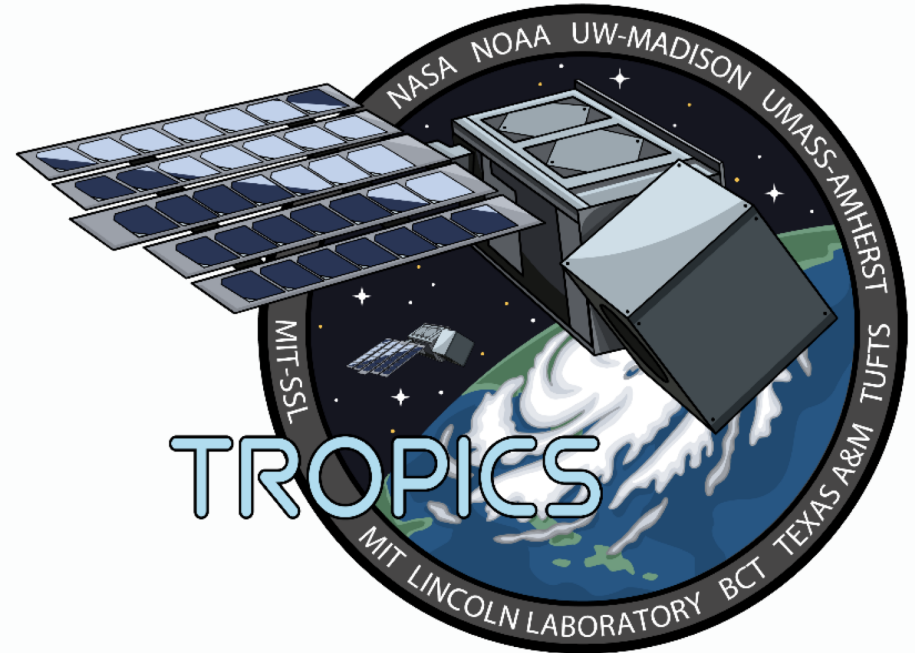






# Future Work

- Double differencing
- Incorporate GOES-17 data
- Tailor scan spot size to specific frequencies
- ERA5 interpolation



Credit: NASA



# Summary and Acknowledgements

---

- October 2021 data, average across channels: 0.67 K
- Respective frequency sensitivity affects O-B
- Future work anticipated to lead to more precise results
- Further analysis will be performed with mature data

This work at MIT was funded by the NASA TROPICS mission

Special thanks to all TROPICS mission affiliates, STAR Lab, Dr. Benjamin Johnson, and Dr. Angela Crews



# Backup Slides

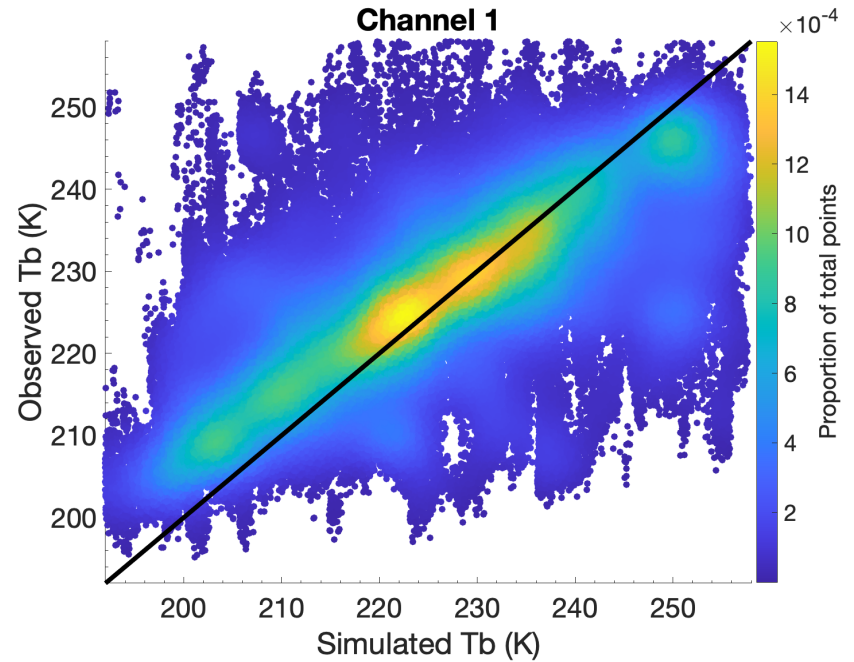
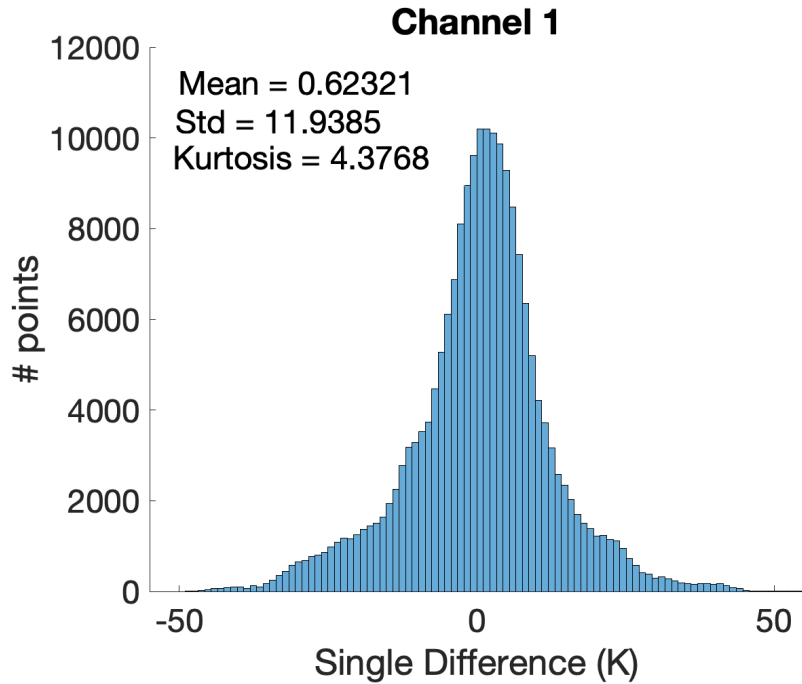


# Channel Frequencies

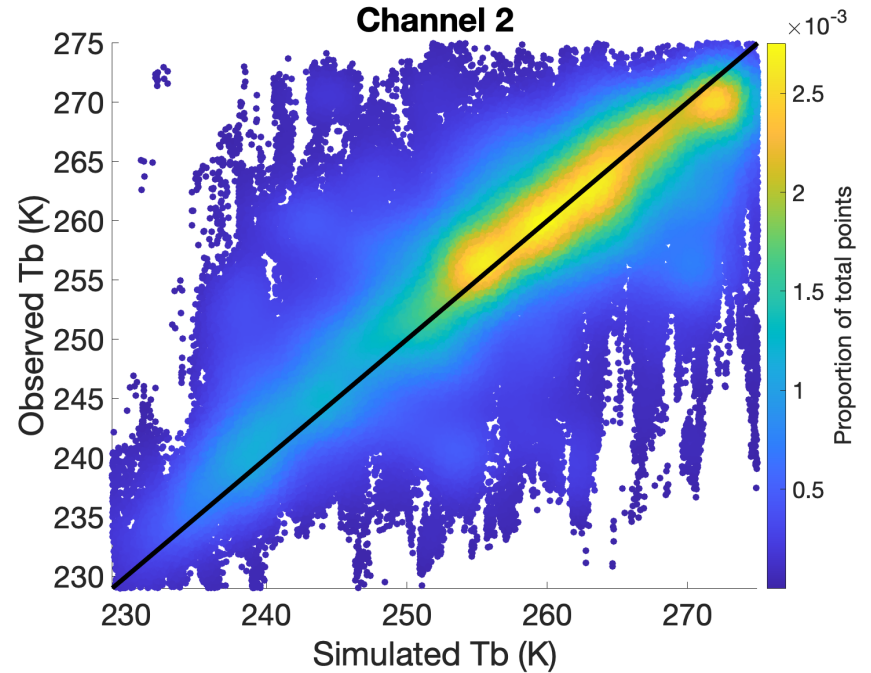
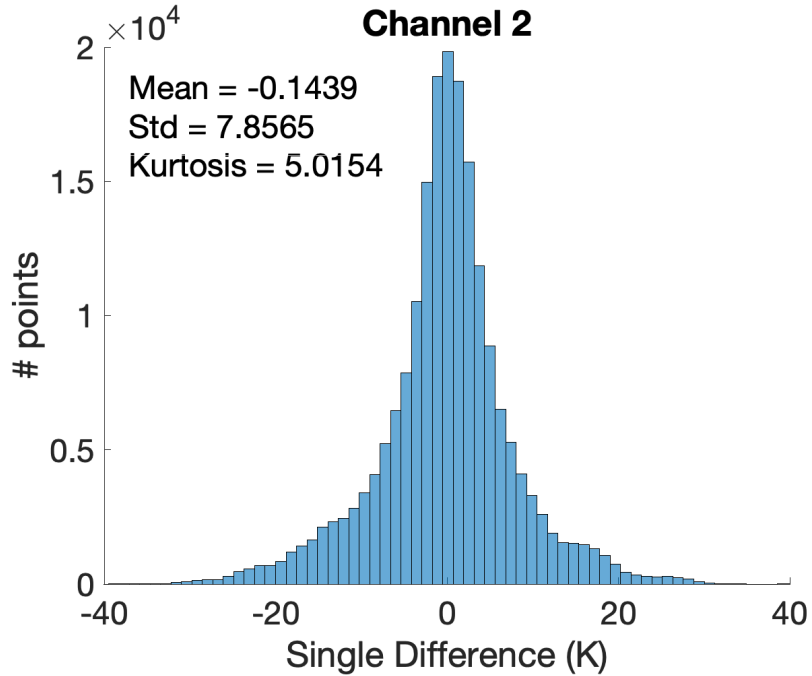
**Table 1 TROPICS spectral and spatial Stats (Footprint from 550-km altitude)**

<b>Chan.</b>	<b>Center Freq. (GHz)</b>	<b>Band width (GHz)</b>	<b>RF Span (GHz)</b>	<b>Beamwidth (degrees) Down/Cross</b>	<b>Nadir Footprint Geometric Mean (km)</b>
1	91.655 ± 1.4	1.000	89.756-90.756, 92.556-93.556	3.0/3.17	29.6
2	114.50	1.000	114.00-115.00	2.4/2.62	24.1
3	115.95	0.800	115.55-116.35	2.4/2.62	24.1
4	116.65	0.600	116.35-116.95	2.4/2.62	24.1
5	117.25	0.600	116.95-117.55	2.4/2.62	24.1
6	117.80	0.500	117.55-118.05	2.4/2.62	24.1
7	118.24	0.380	118.05-118.43	2.4/2.62	24.1
8	118.58	0.300	118.43-118.73	2.4/2.62	24.1
9	184.41	2.000	183.41-185.41	1.5/1.87	16.1
10	186.51	2.000	185.51-187.51	1.5/1.87	16.1
11	190.31	2.000	189.31-191.31	1.5/1.87	16.1
12	204.8	2.000	203.8-205.8	1.4/1.76	15.2

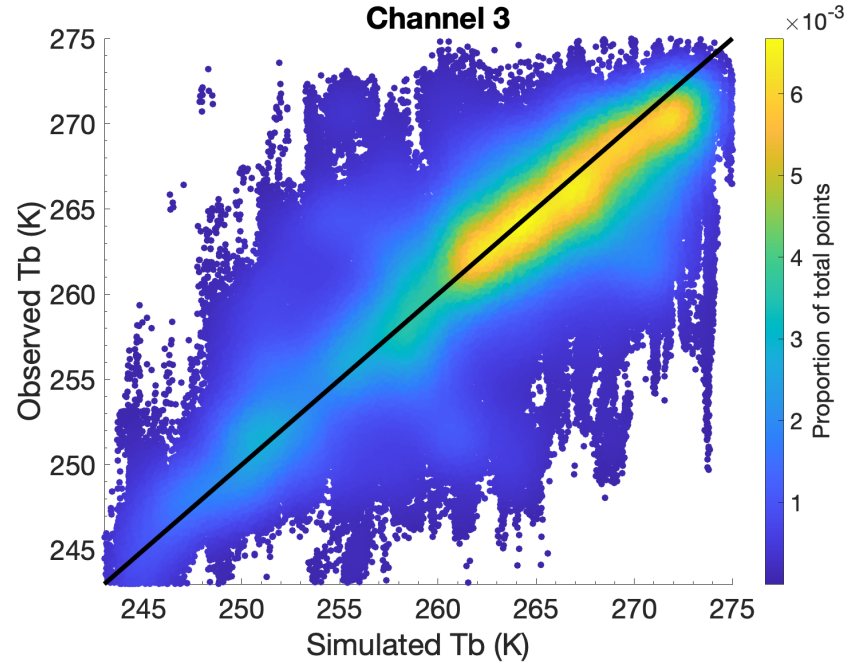
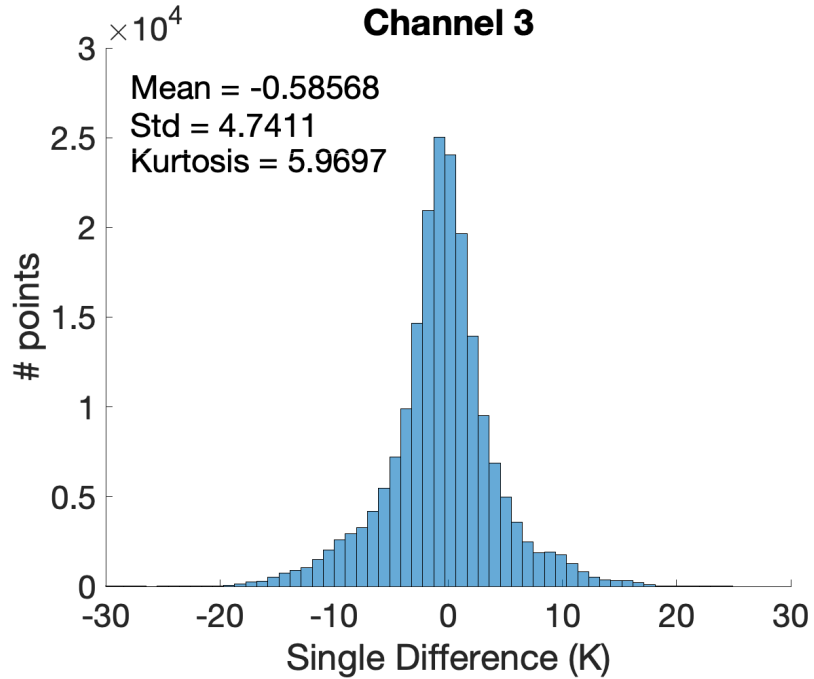
# Channel 1



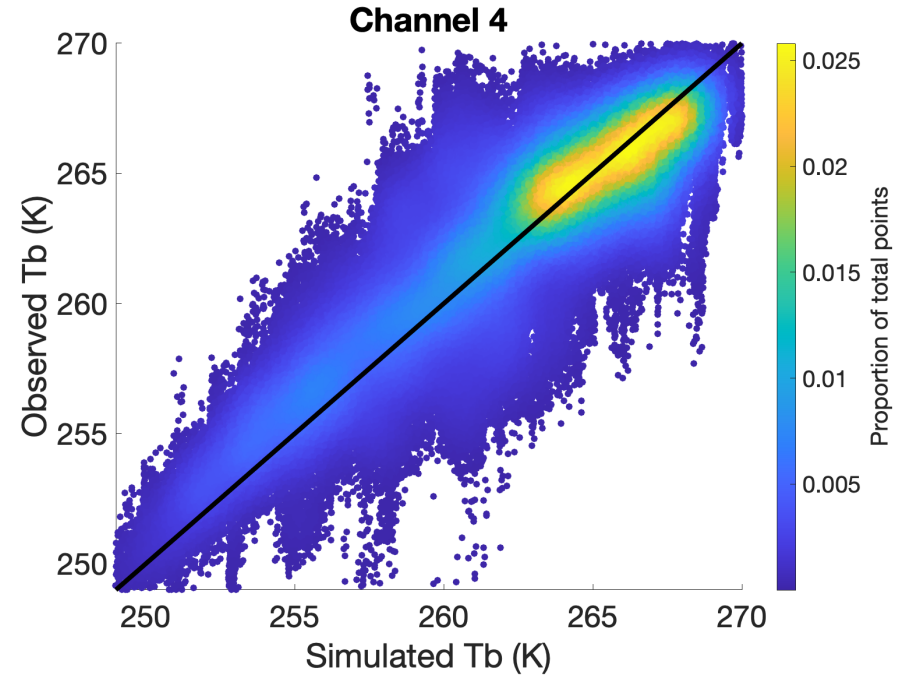
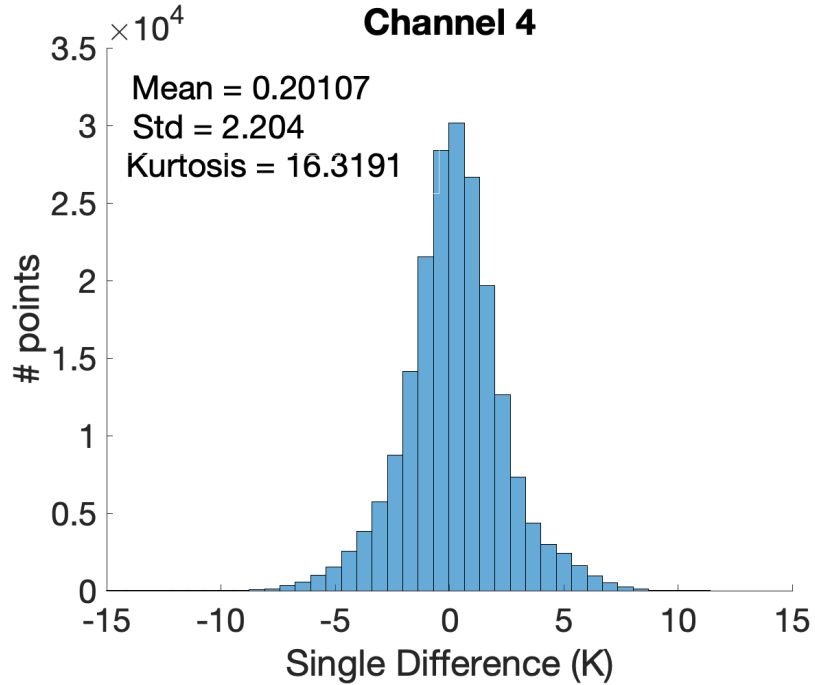
# Channel 2



# Channel 3

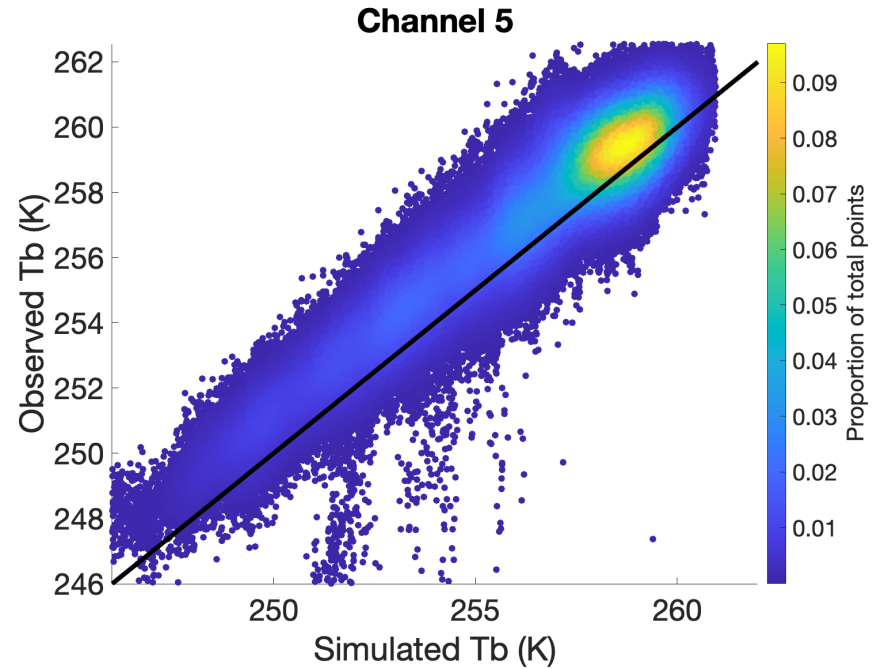
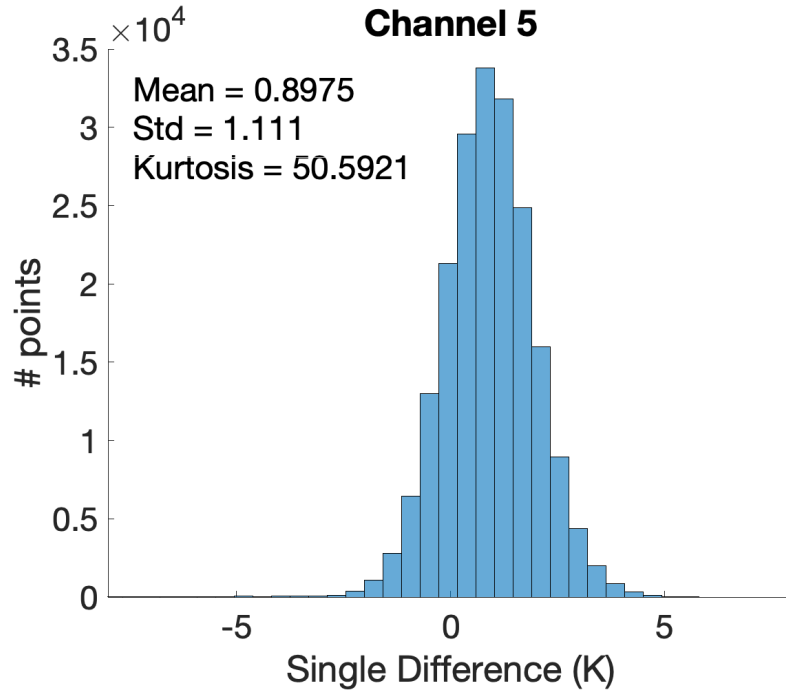


# Channel 4

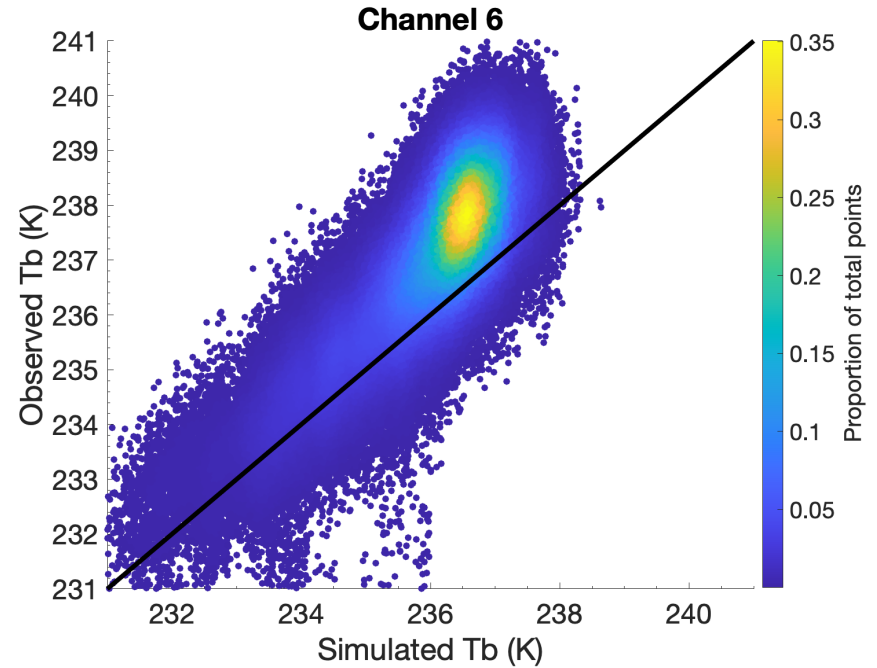
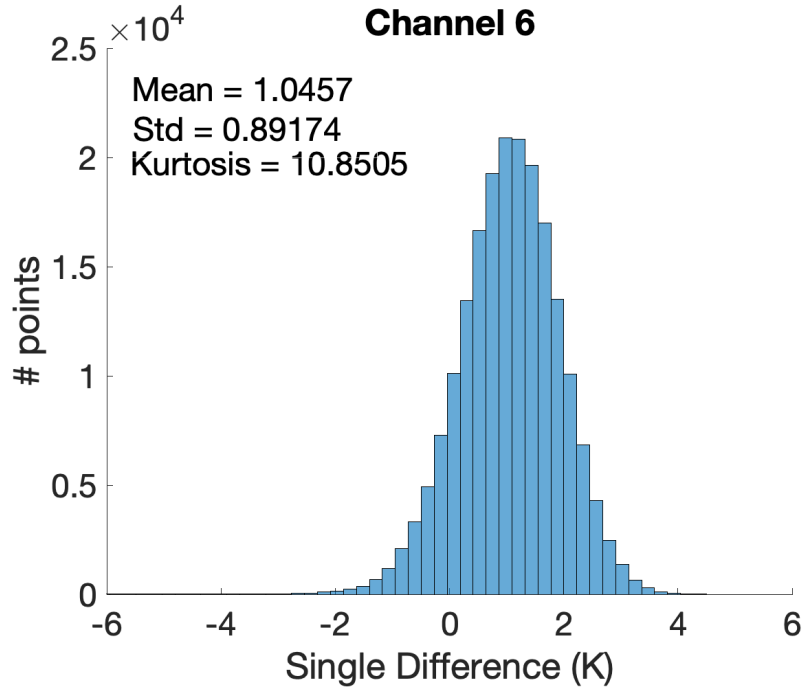




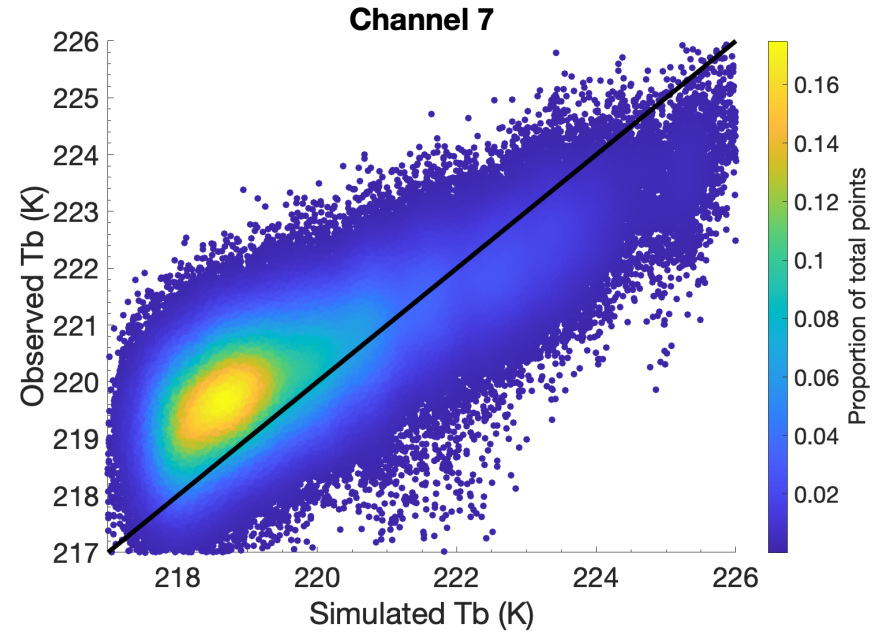
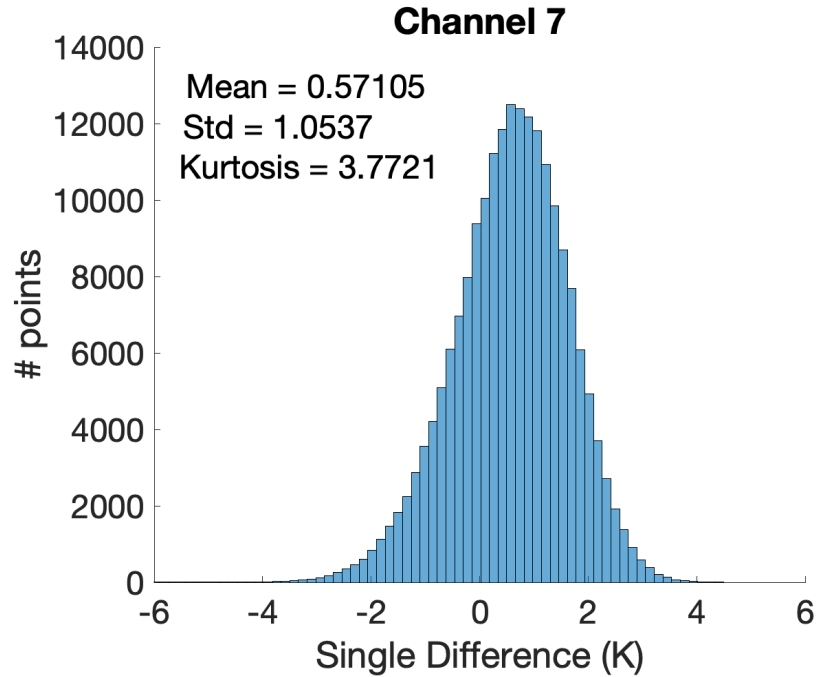
# Channel 5



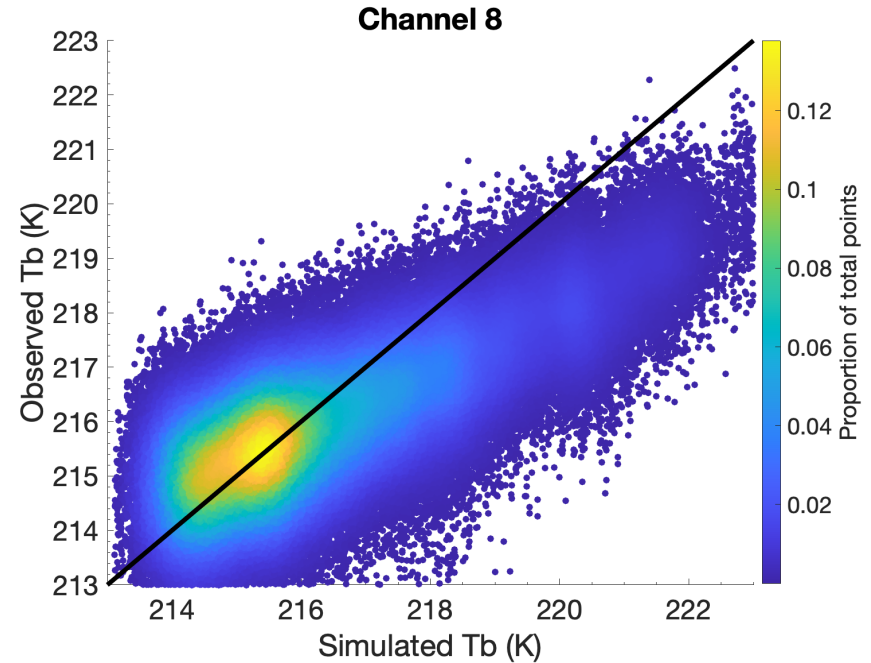
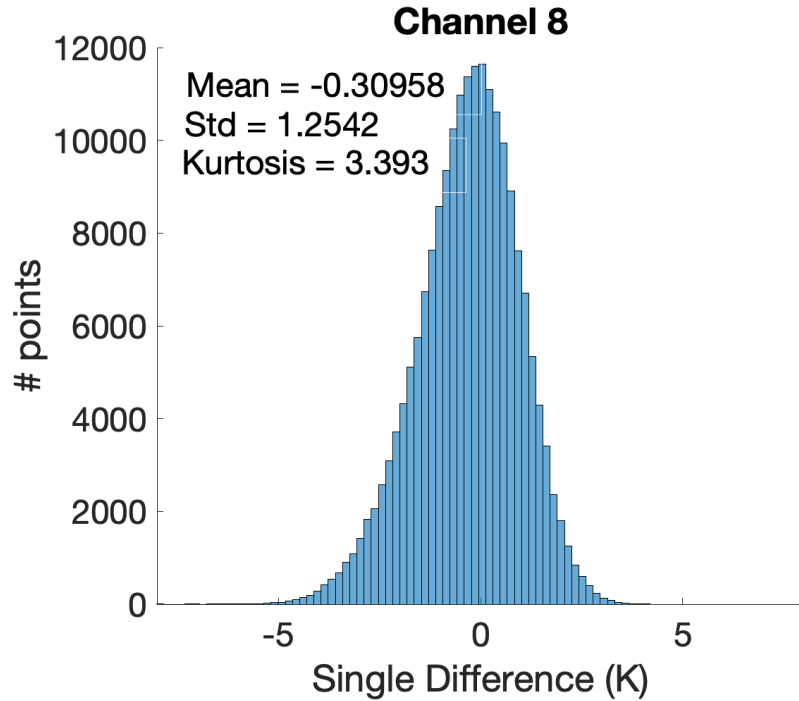
# Channel 6



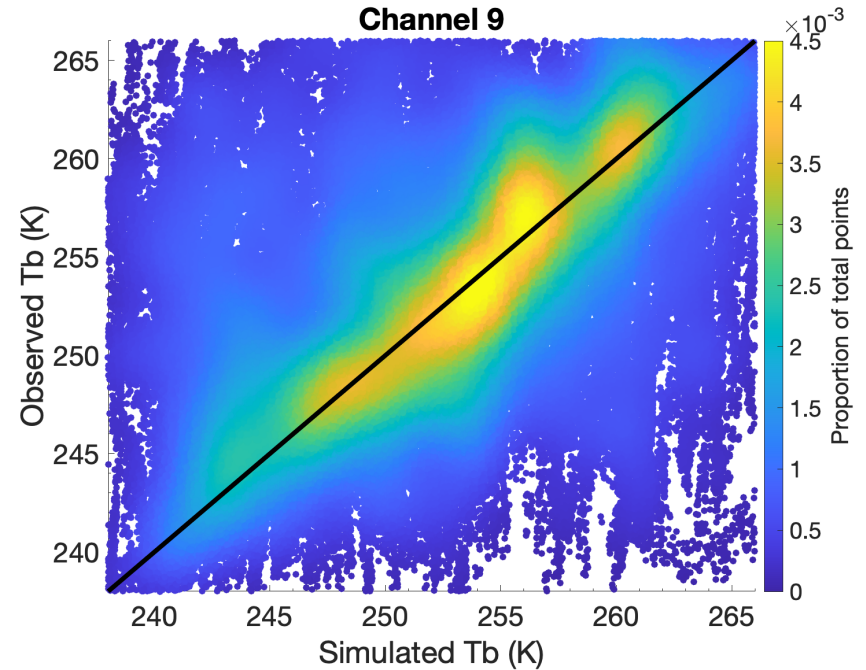
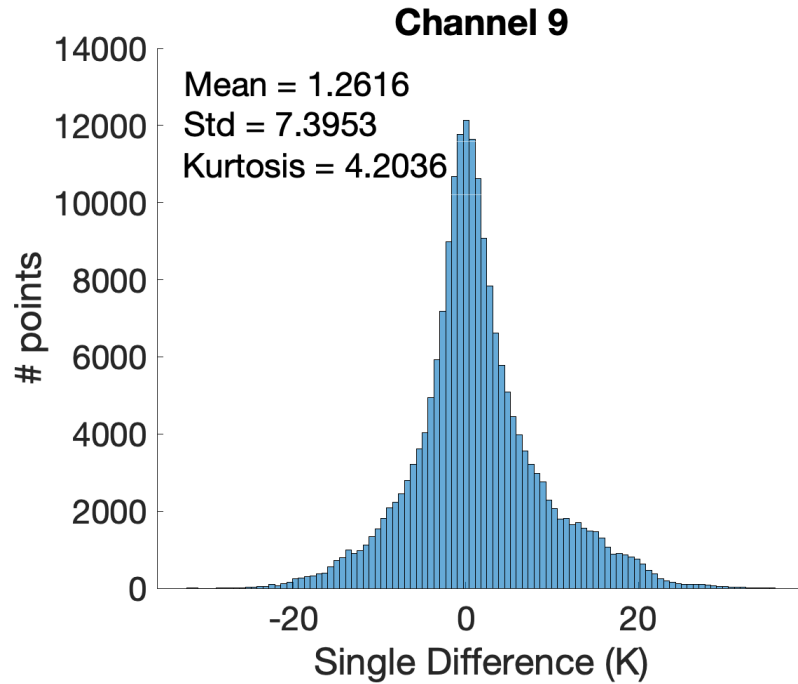
# Channel 7



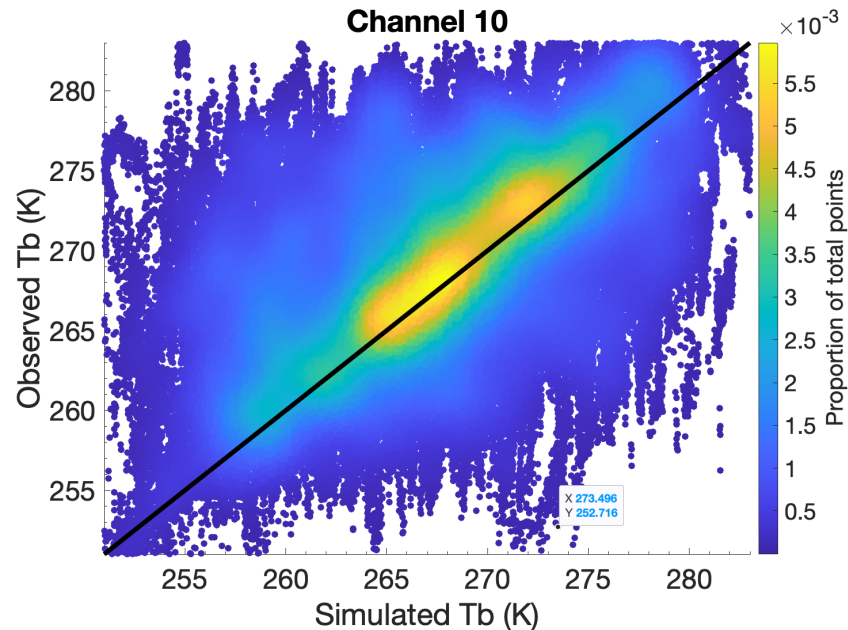
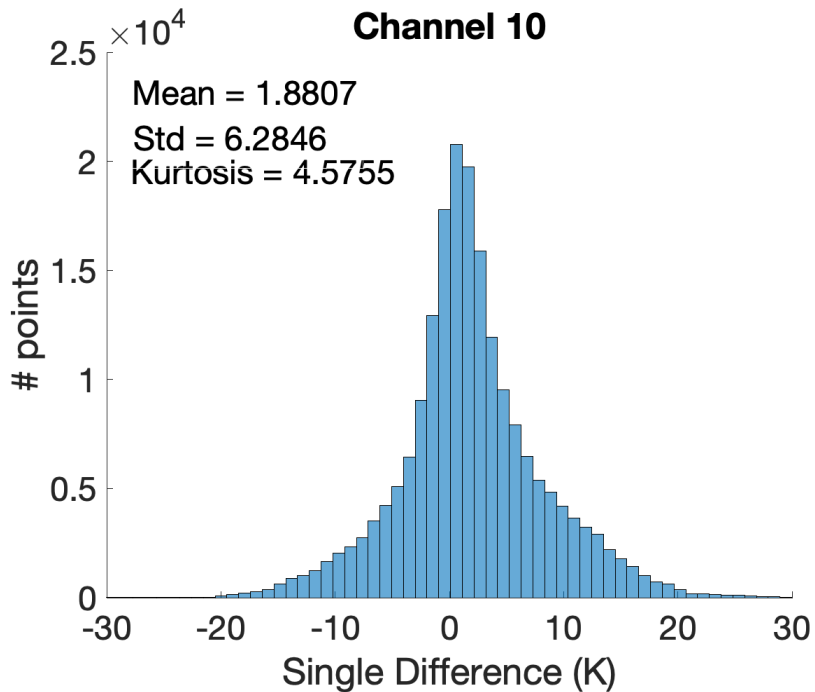
# Channel 8



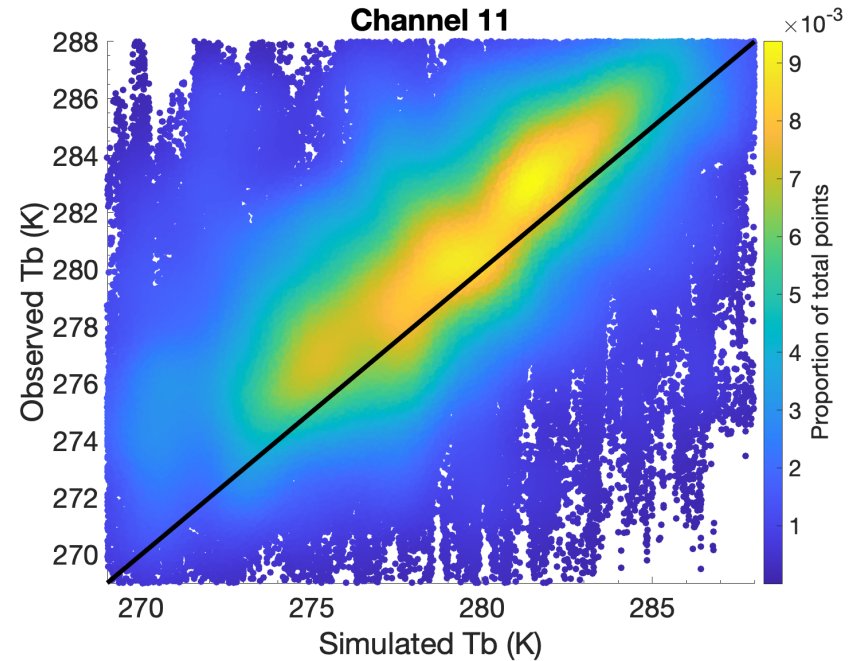
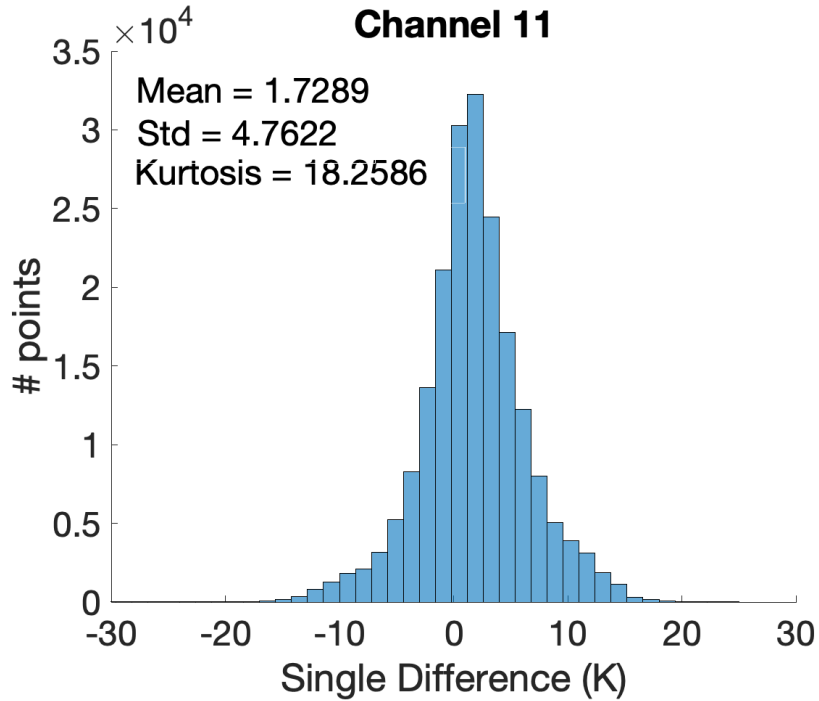
# Channel 9



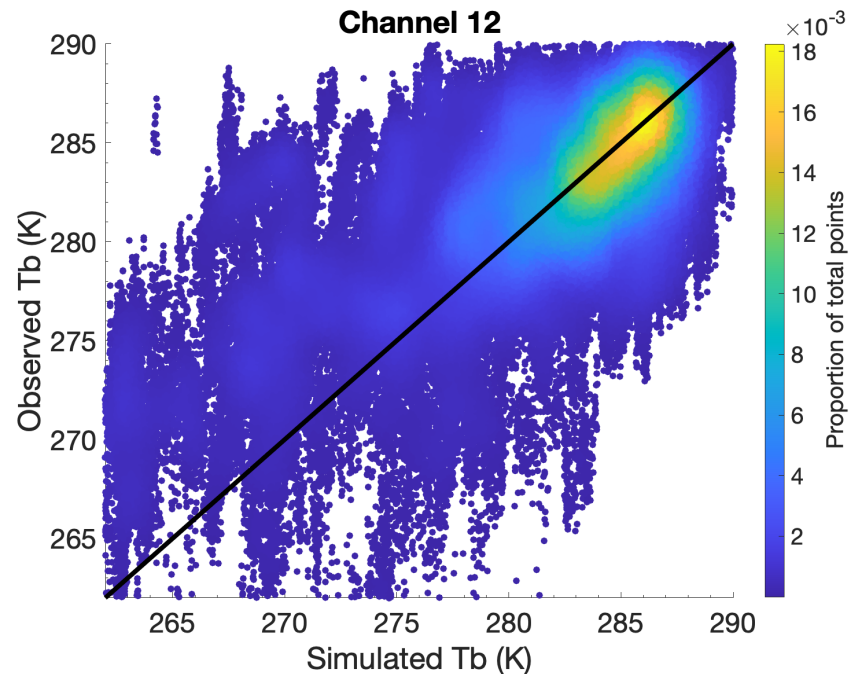
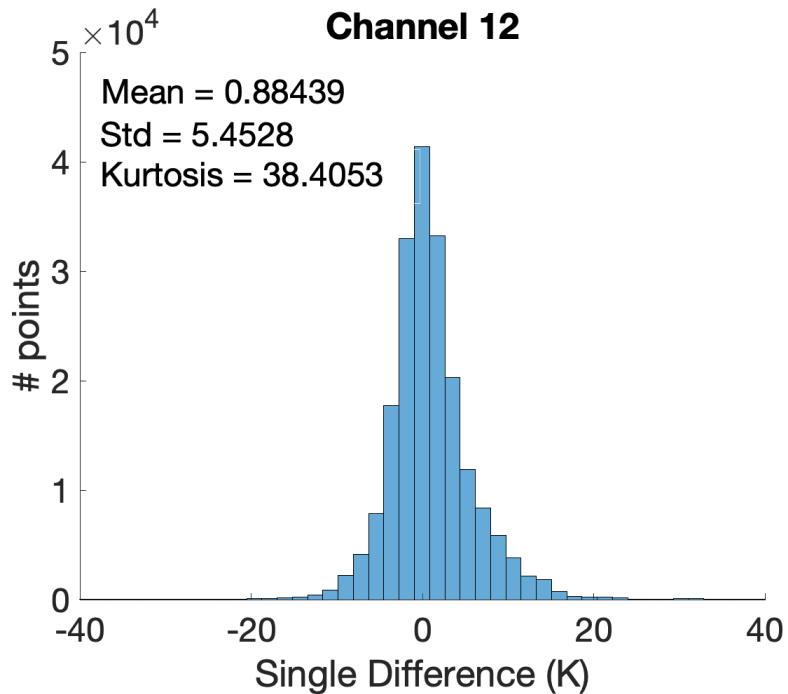
# Channel 10



# Channel 11



# Channel 12







# GOES-16 BCM Coverage

GOES BCM - Date: 10-15-2021 Time: 01:30:20-01:39:51

