

Performance of fast radiative transfer models in the microwave spectrum

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GSICS Annual Meeting,
Frascati, Italy, March 4 - March 8, 2019

March 6, 2019



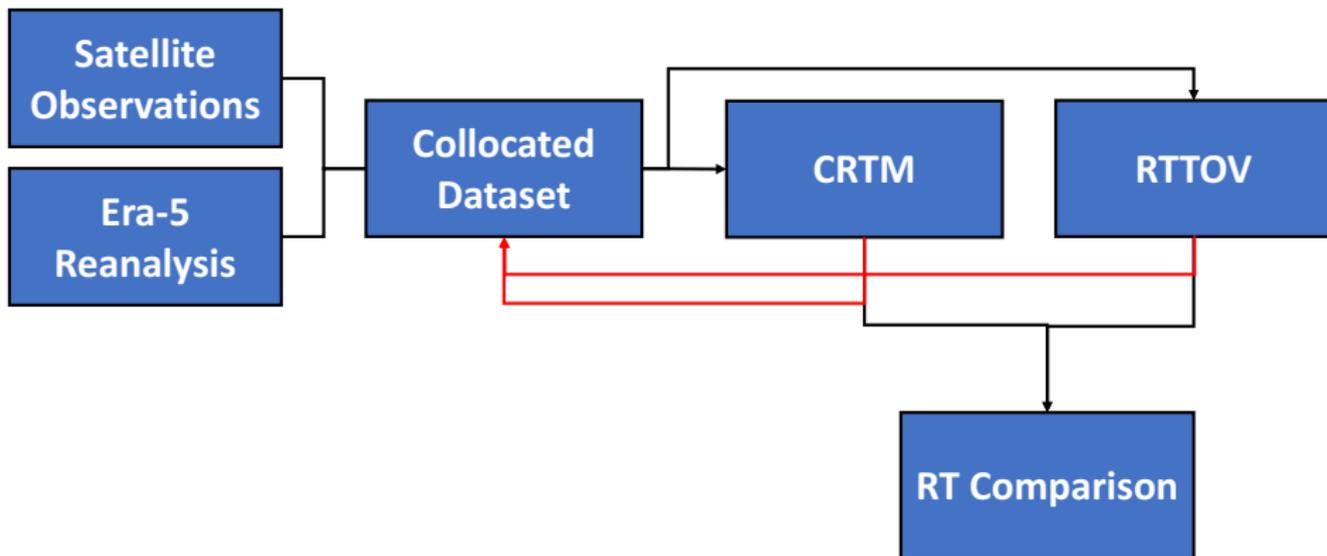
Overview

- Comparing CRTM and RTTOV using similar atmospheric and surface dataset (Era-5)
- Comparing CRTM and RTTOV vs. observations from ATMS onboard NPP and N20
- Comparing CRTM and RTTOV vs. observations from GPM-GMI
- Performance of fast models (CRTM & RTTOV) vs. a LBL model
- Using GRUAN observations to (may be) validate satellite observations

Collocation Technique

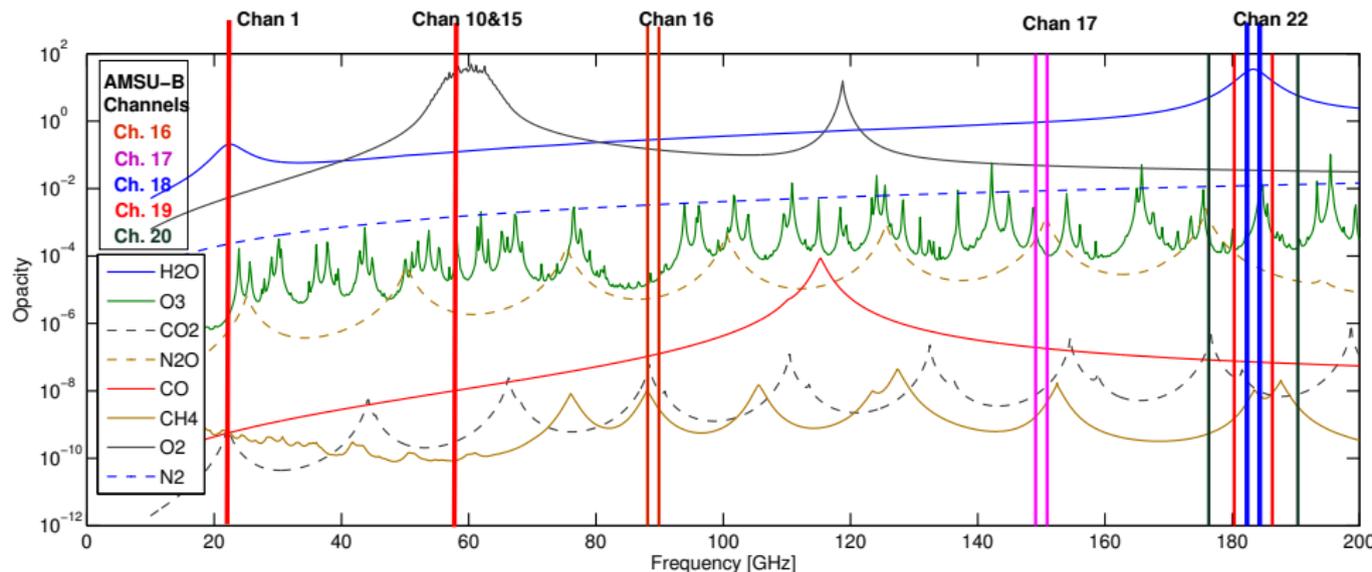
Era-5 Resolution: 0.3 deg and 3 hour

Collocations criteria: 30 km and 60 minutes

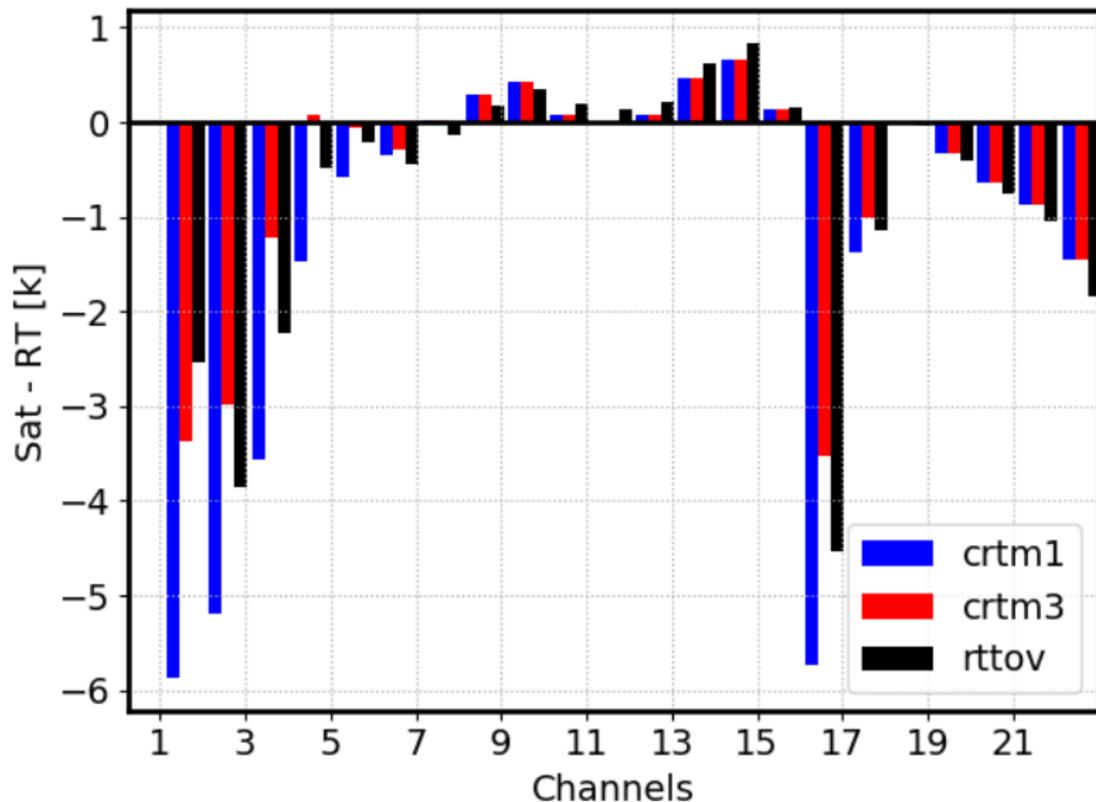


MW Spectrum and ATMS Channels

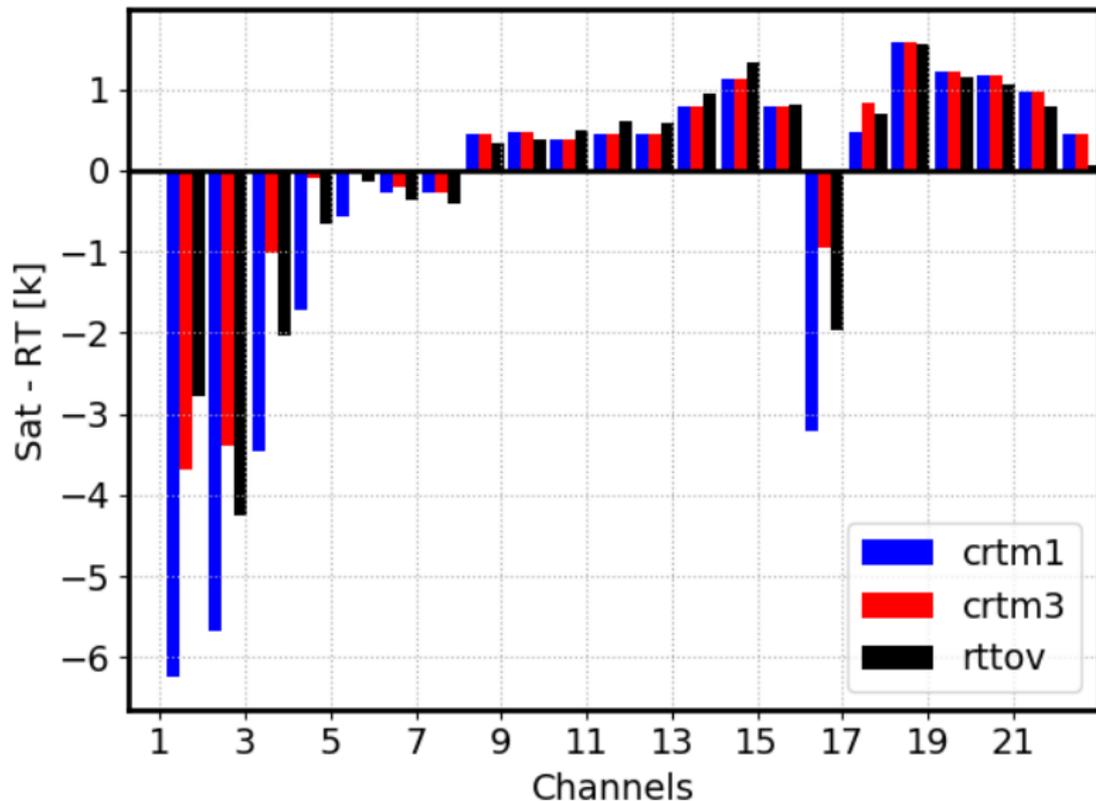
Chan 1: 23.8 GHz, Chan 10: 55.5, Chan 15: $57.290344 \pm 0.3222 \pm 0.0045$
Chan 22: 183.31 ± 1



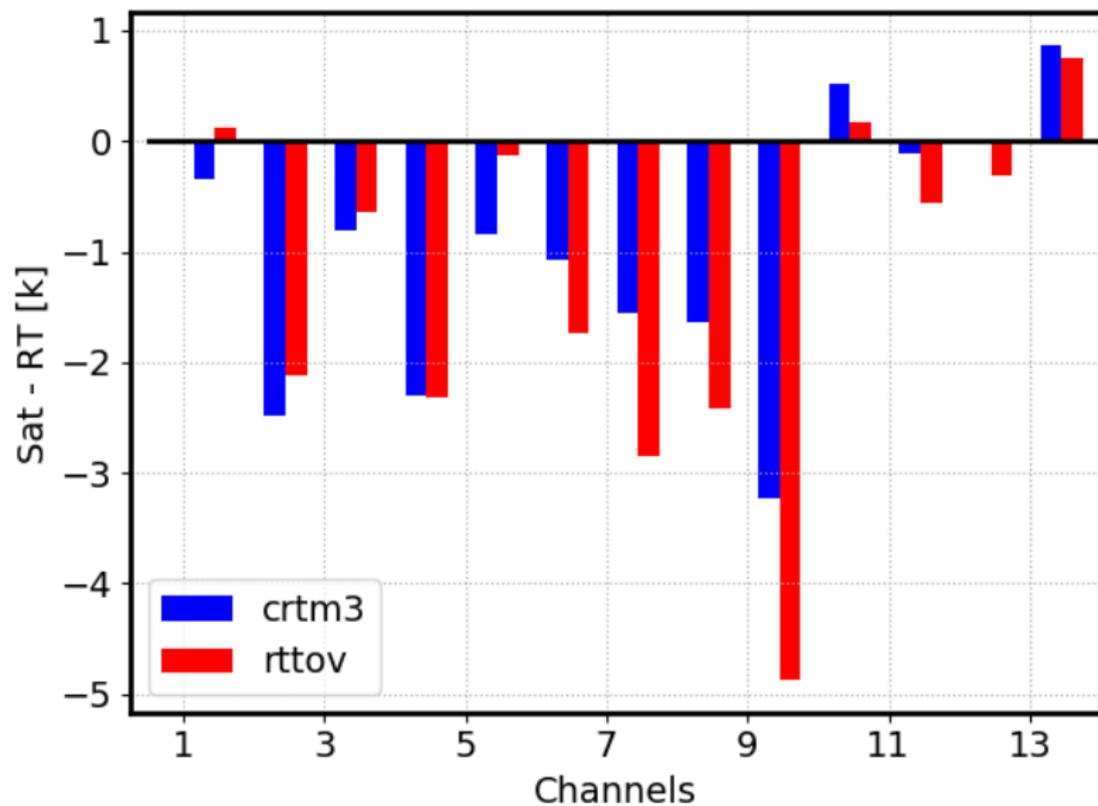
ATMS-N20 Biases vs. different RTMs



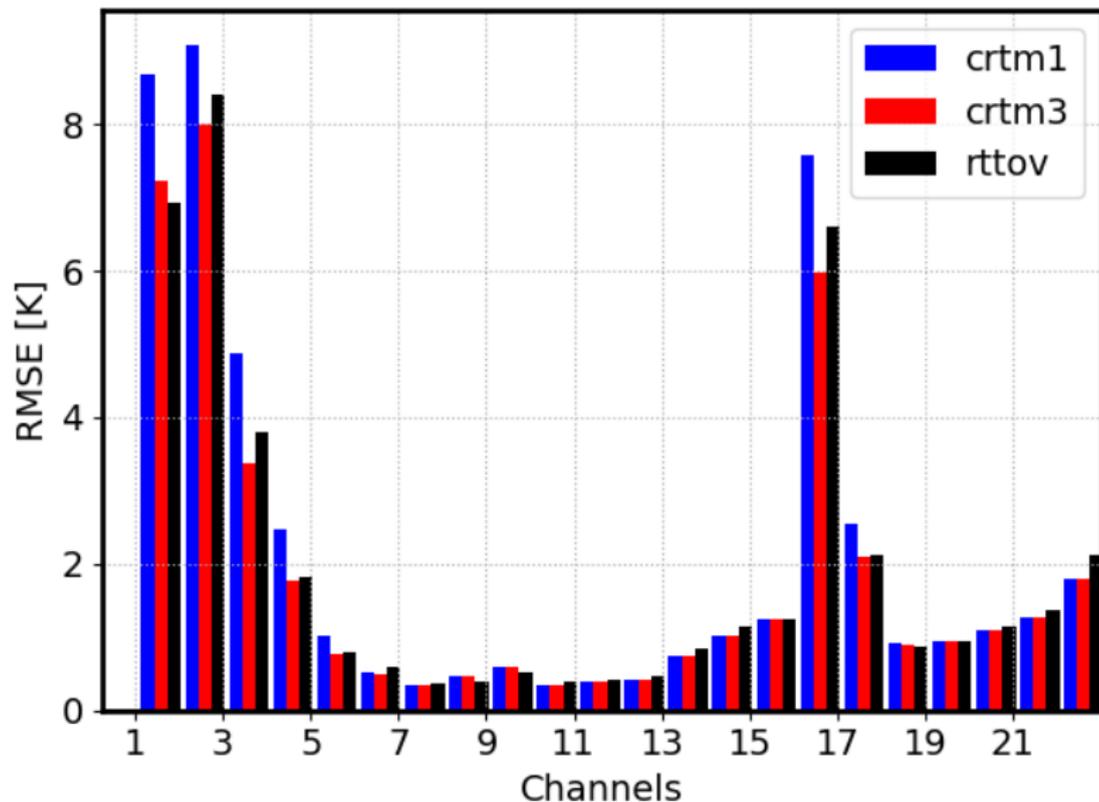
ATMS-NPP Biases vs. different RTMs



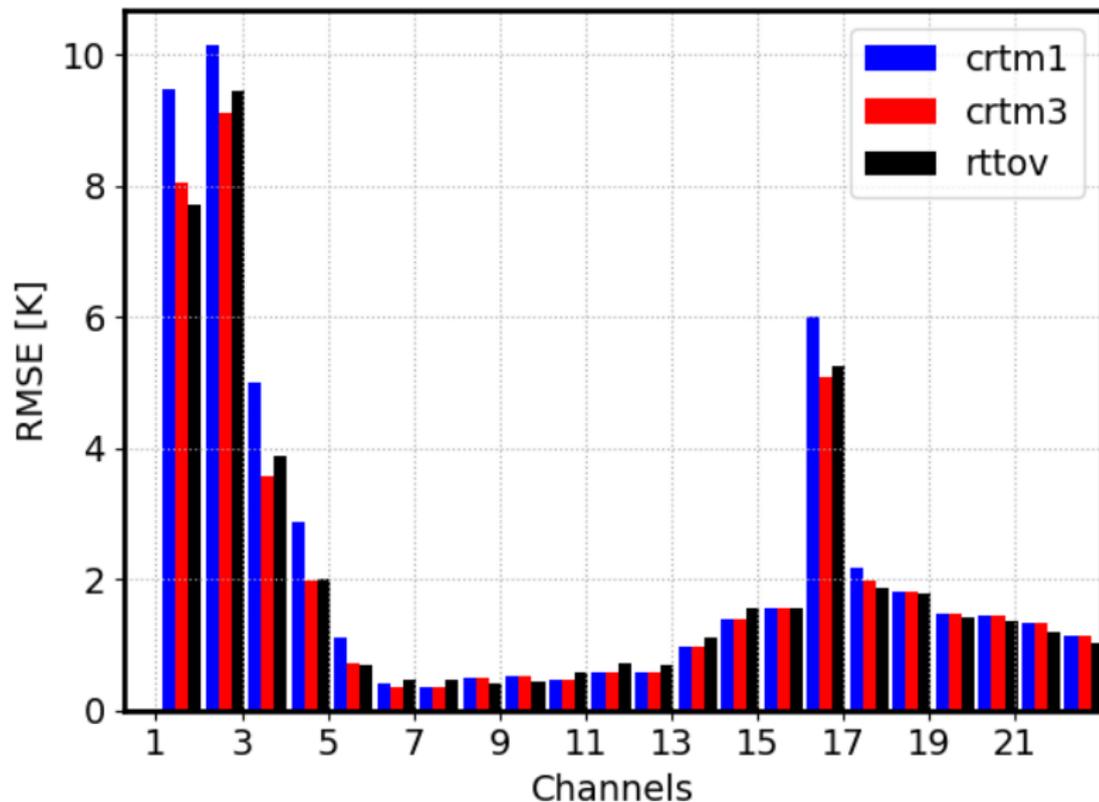
GMI-GPM Biases vs. different RTMs



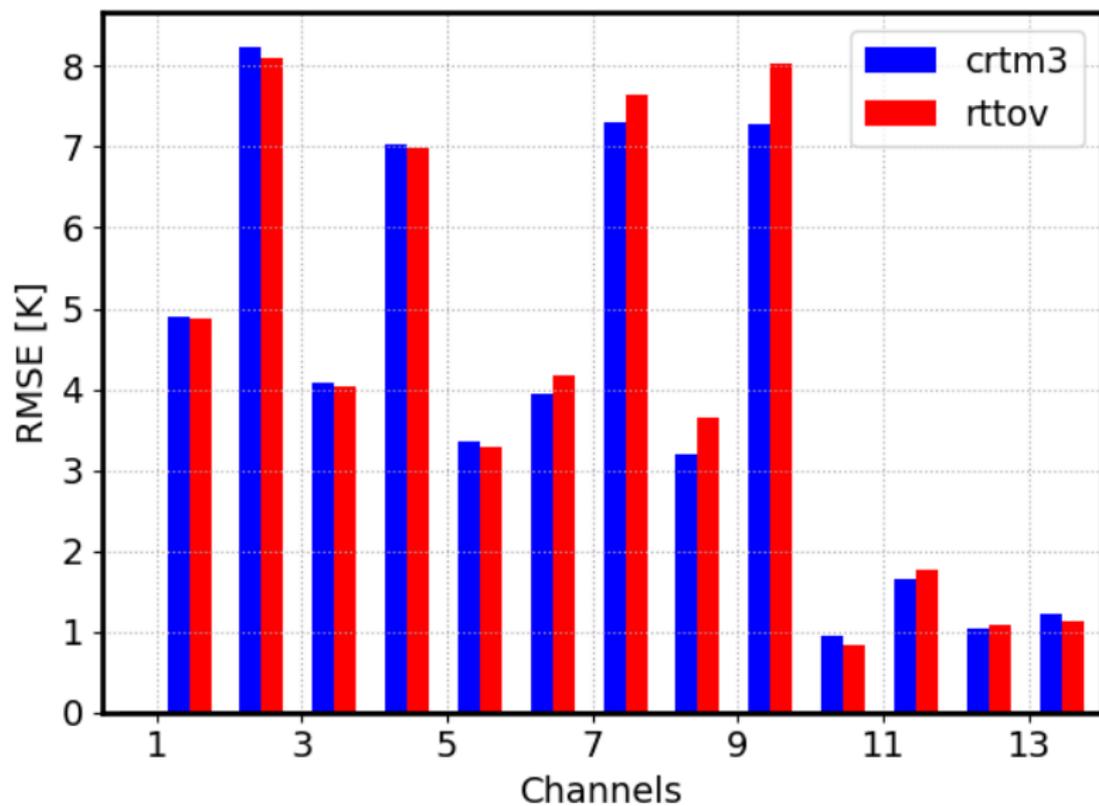
ATMS-N20 RMSE vs. different RTMs



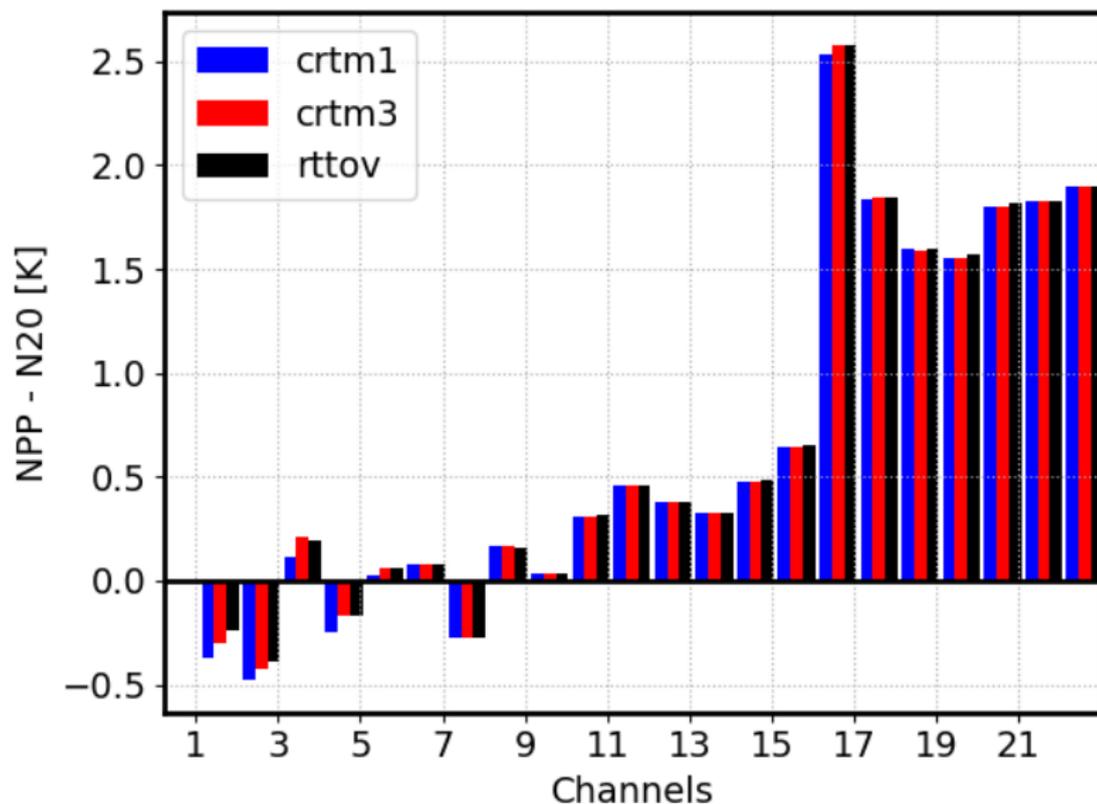
ATMS-NPP RMSE vs. different RTMs



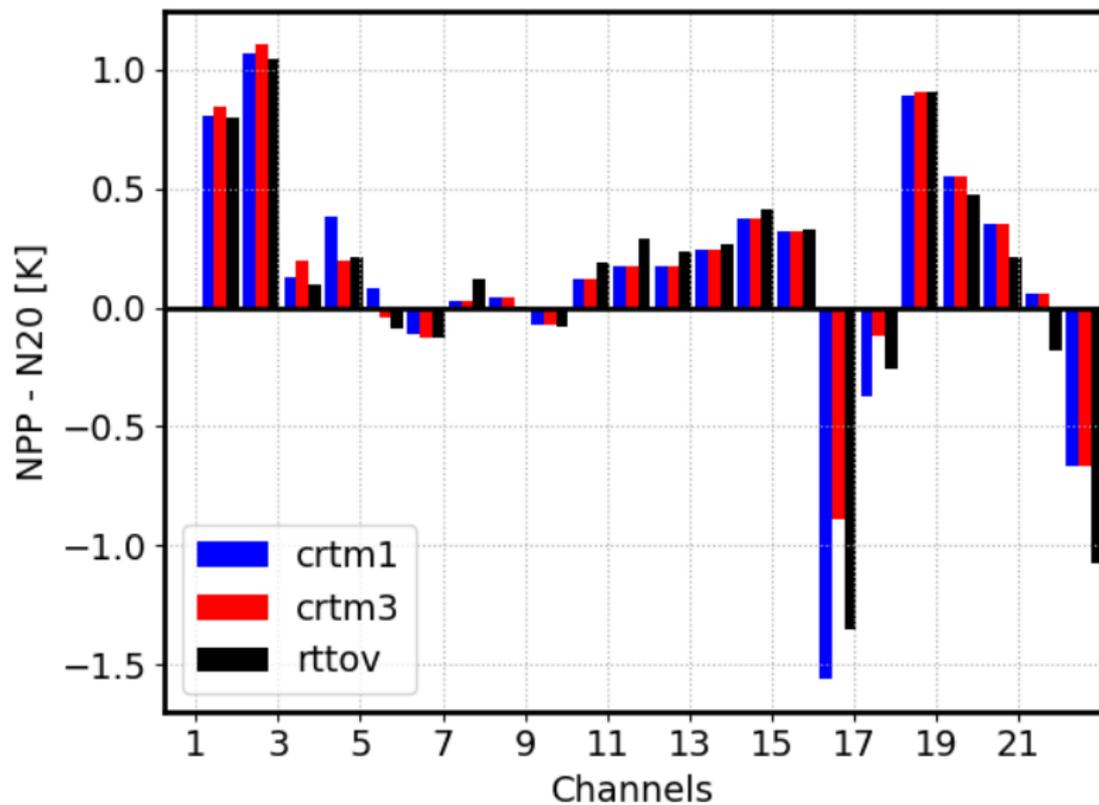
GMI-GPM RMSE vs. different RTMs



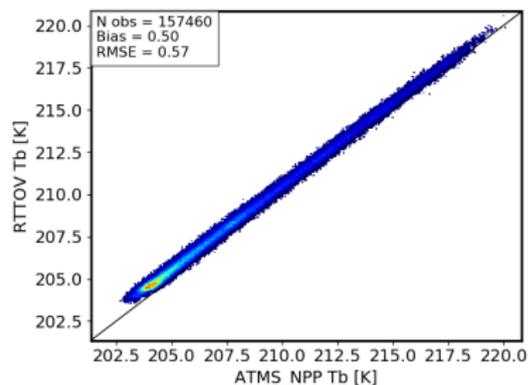
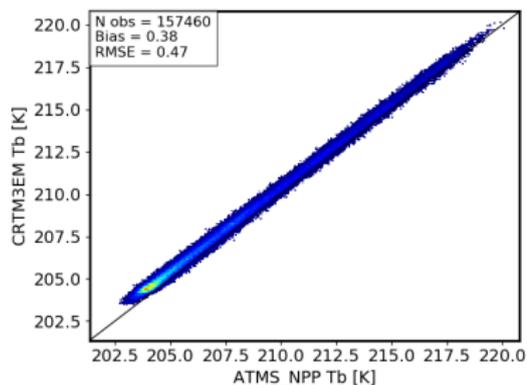
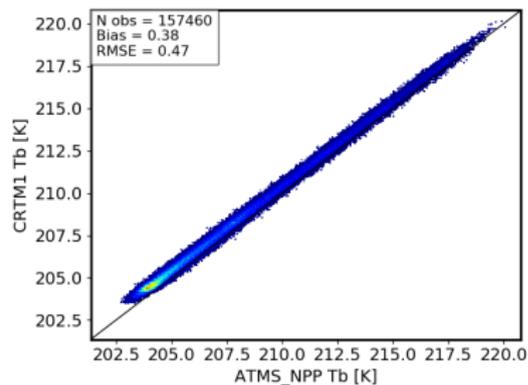
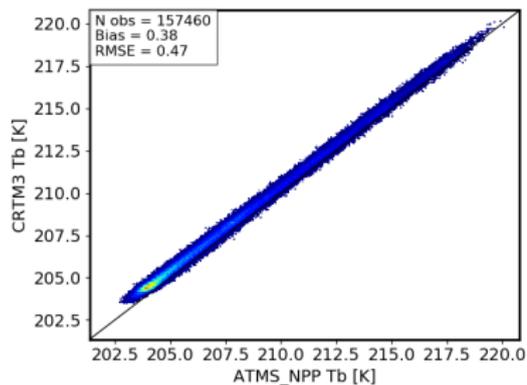
Double difference: [ATMS-NPP - RT] - [ATMS-N20 - RT]



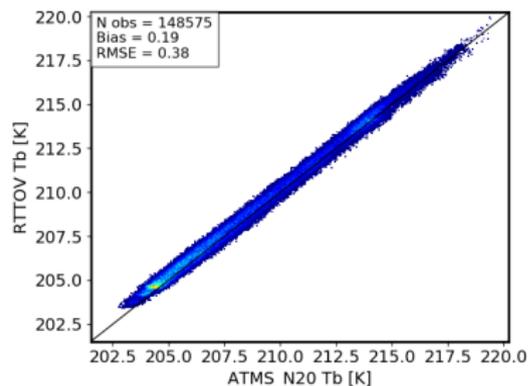
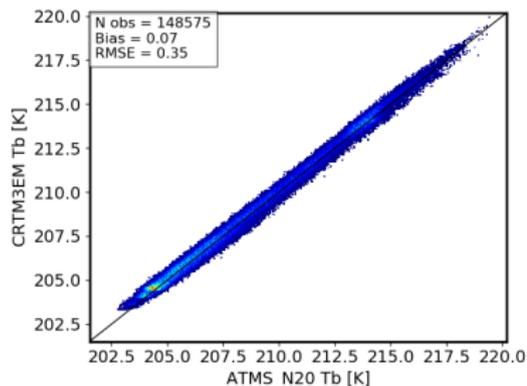
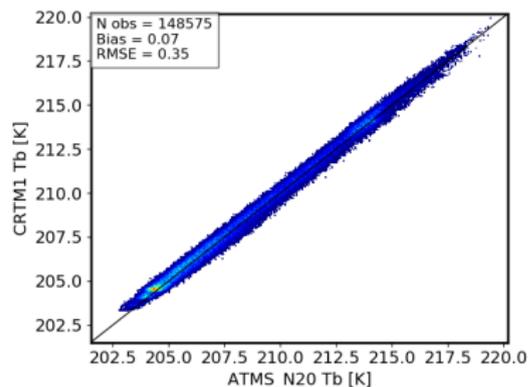
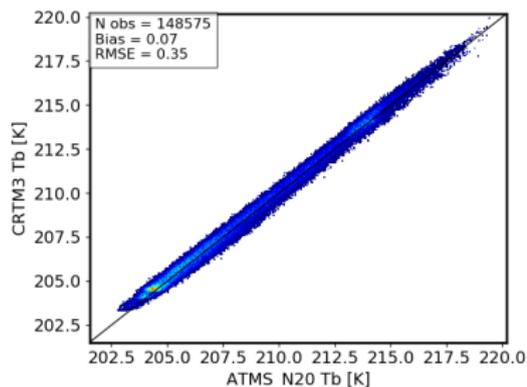
Double difference for RMSEs



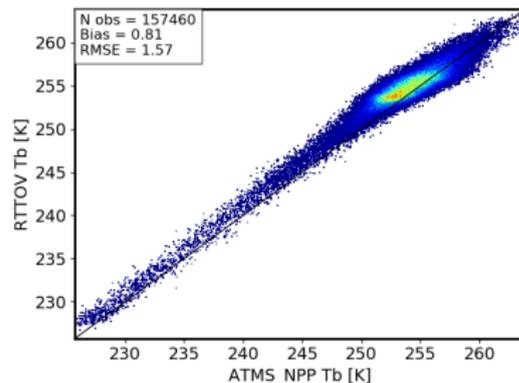
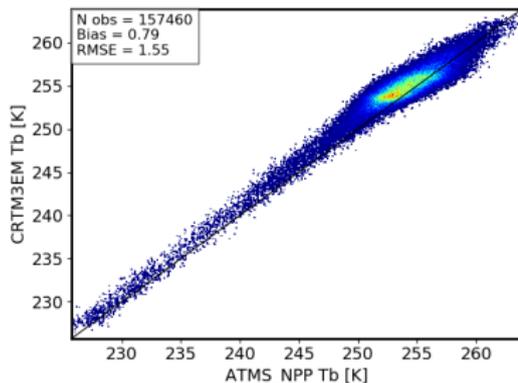
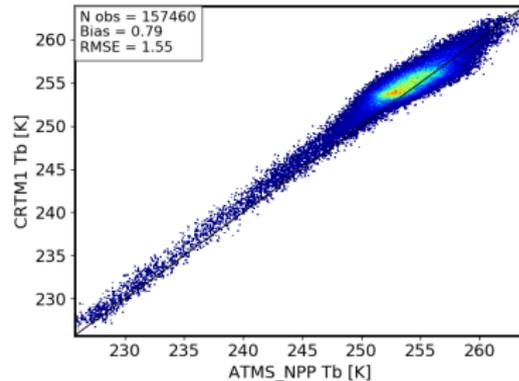
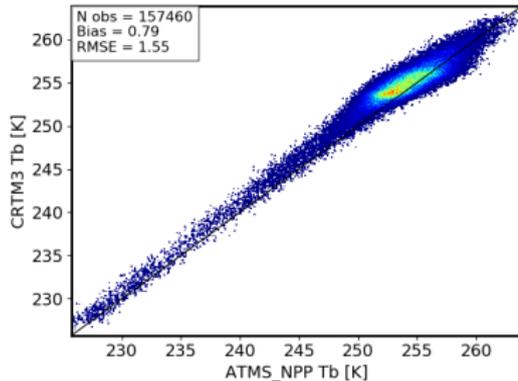
ATMS-NPP Channel 10



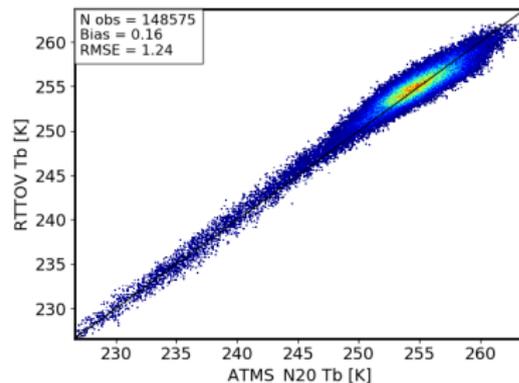
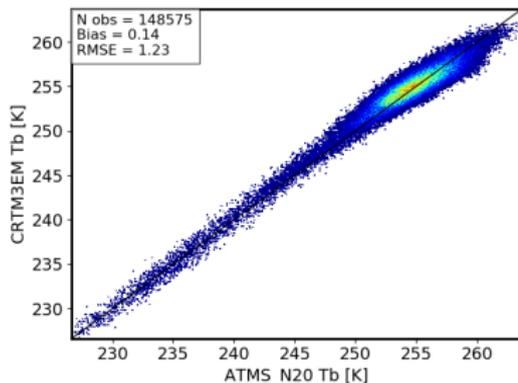
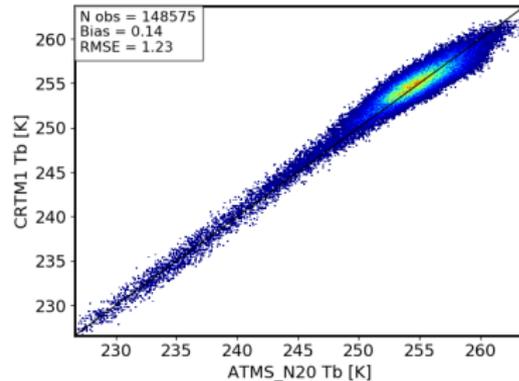
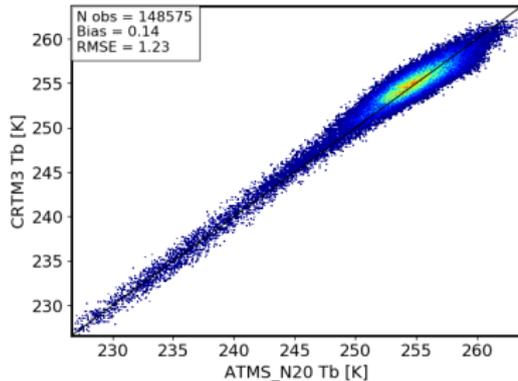
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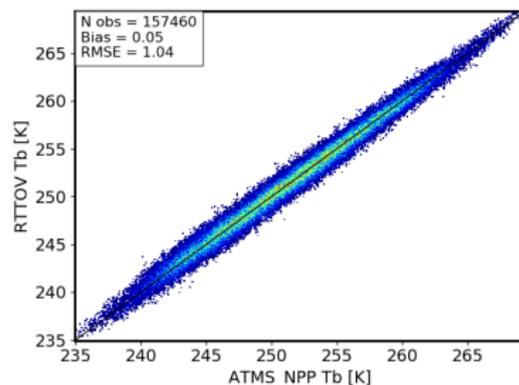
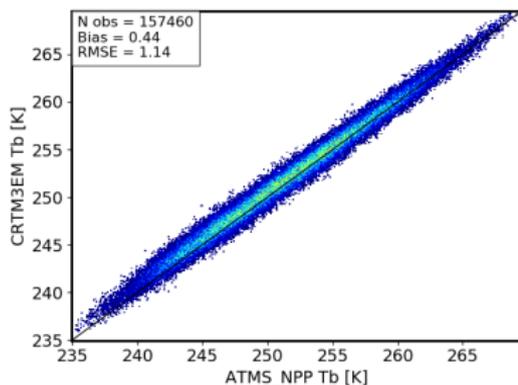
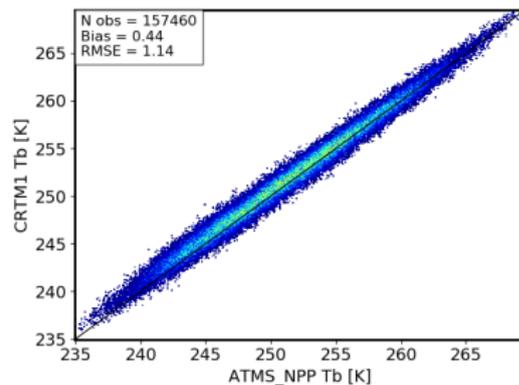
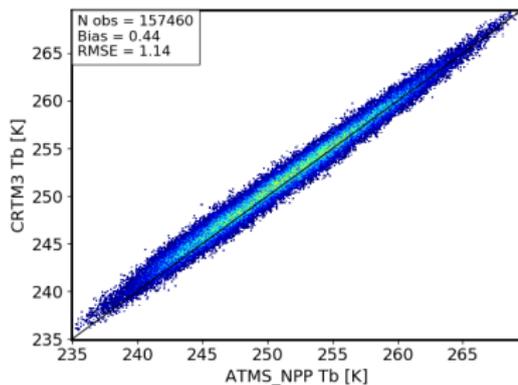
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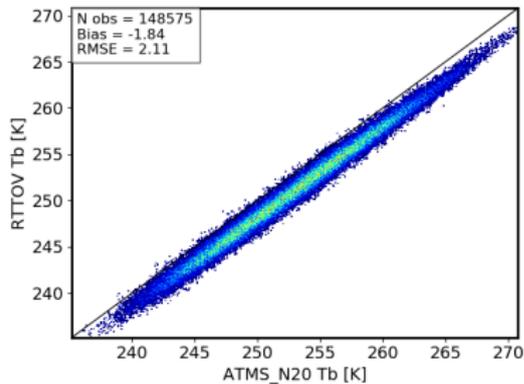
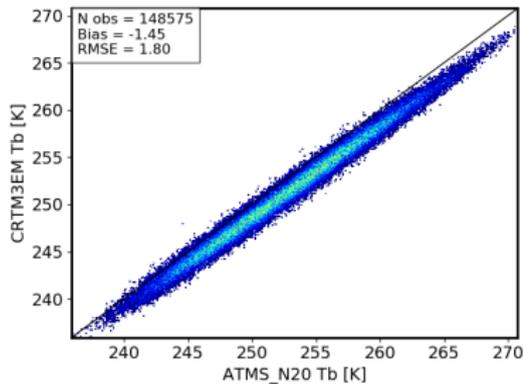
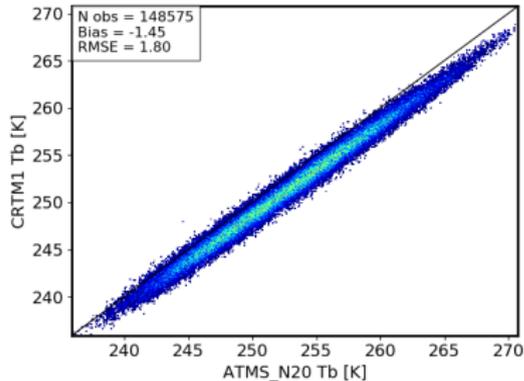
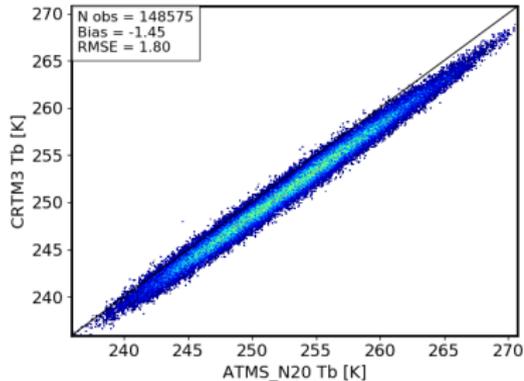
ATMS-N20 Channel 15



ATMS-NPP Channel 22

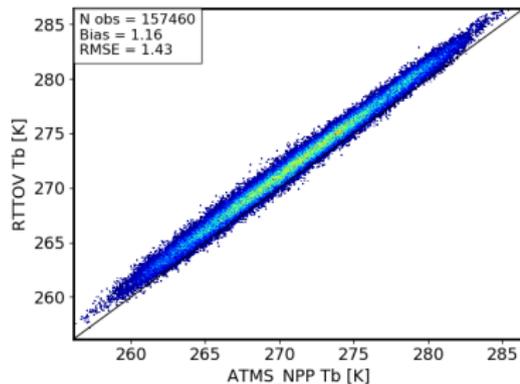


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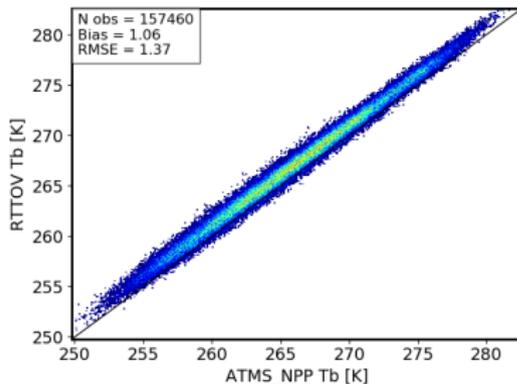


ATMS-NPP Channels 19-22

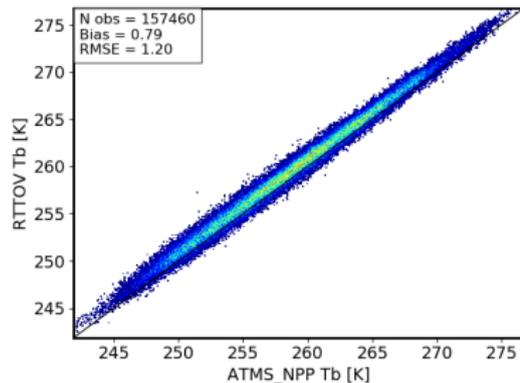
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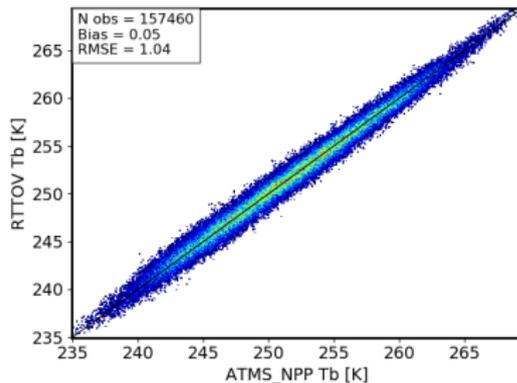
Channel 20



Channel 21

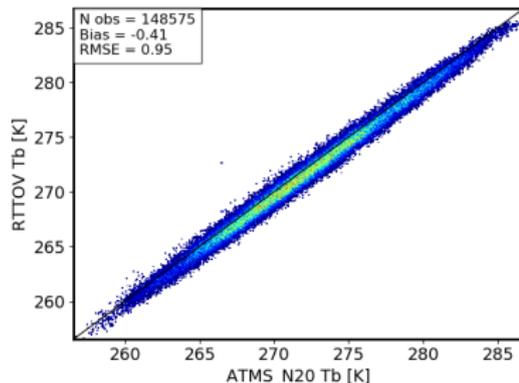


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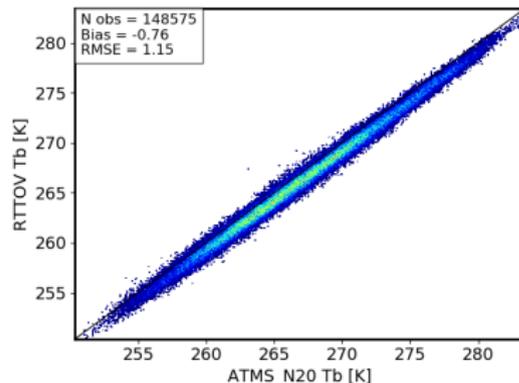


ATMS-N20 Channels 19-22

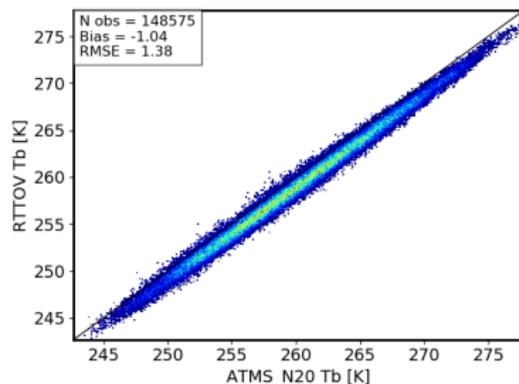
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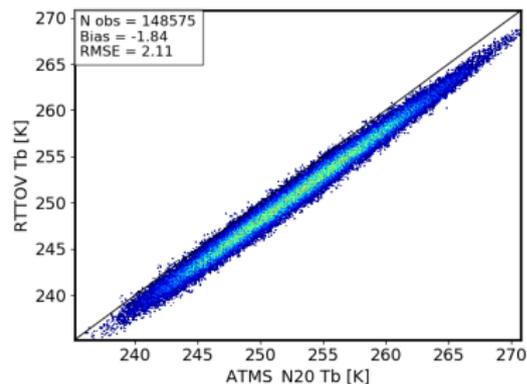
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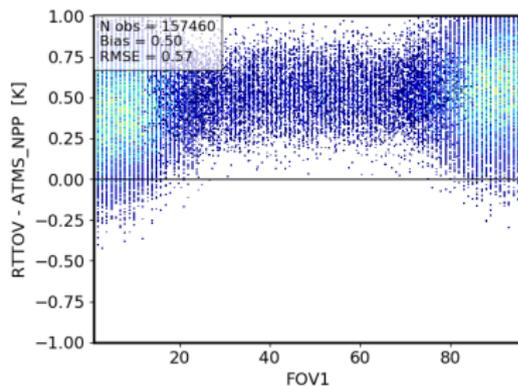
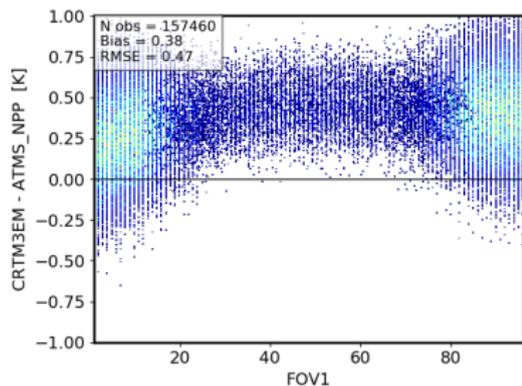
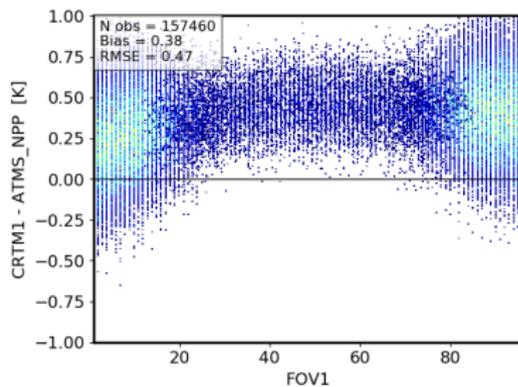
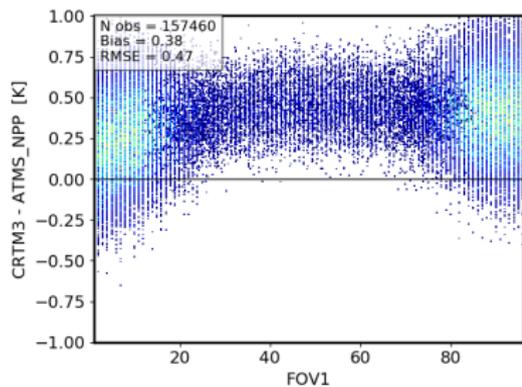
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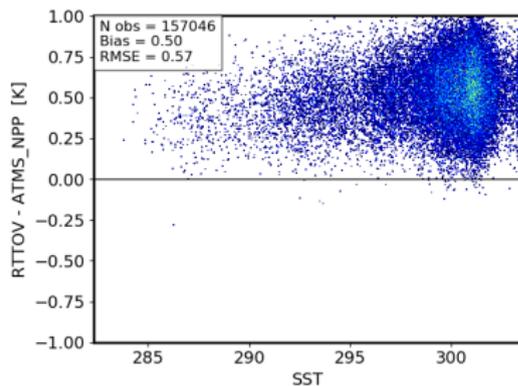
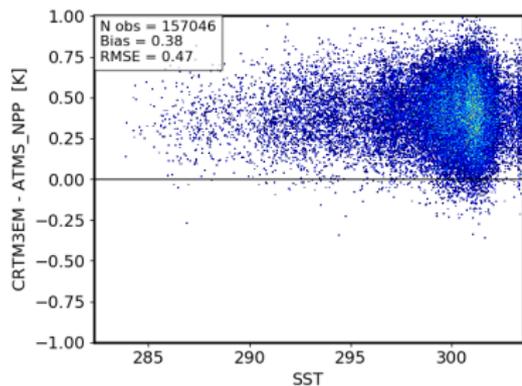
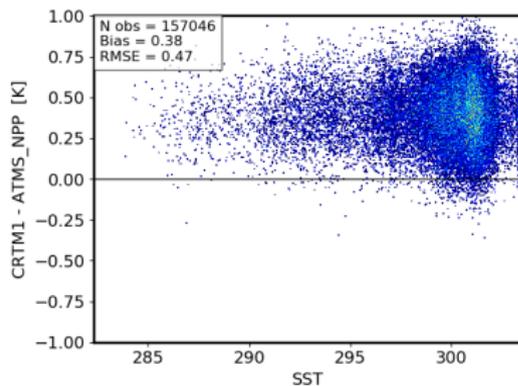
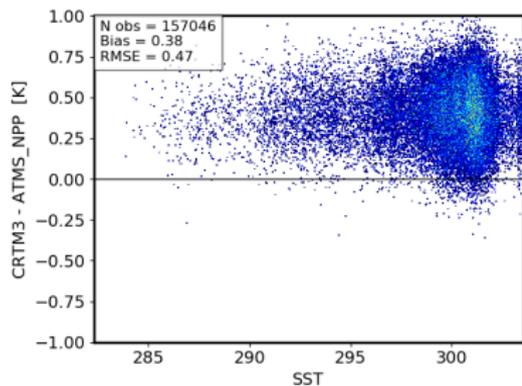
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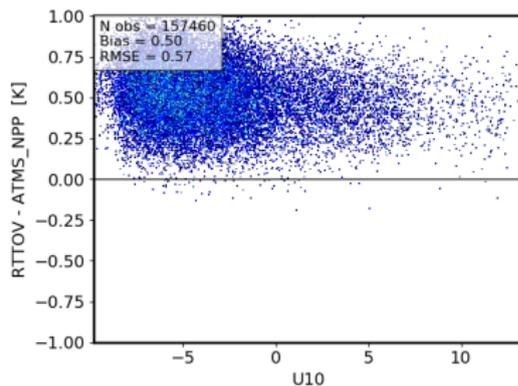
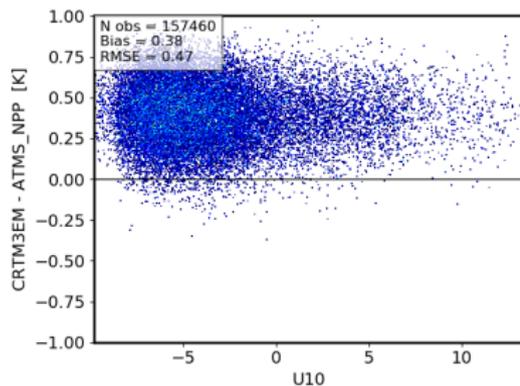
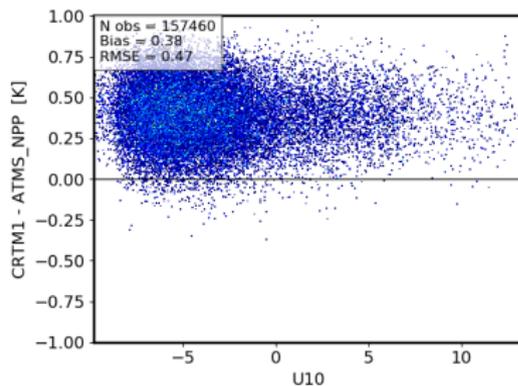
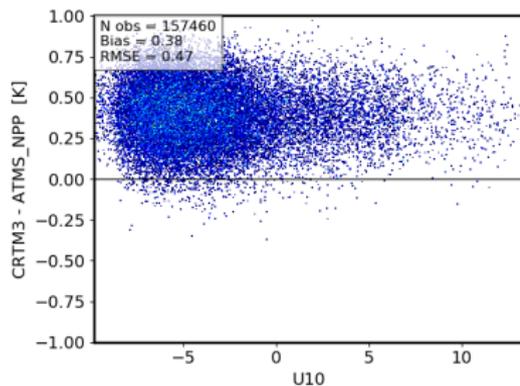
ATMS-NPP Channel 10



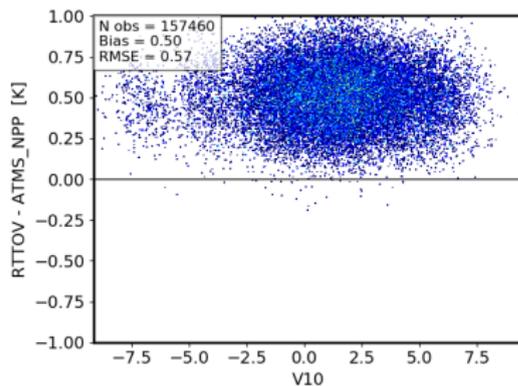
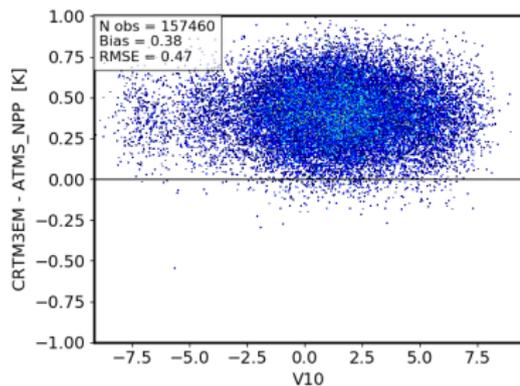
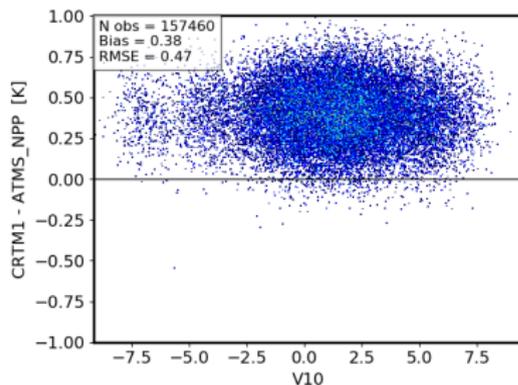
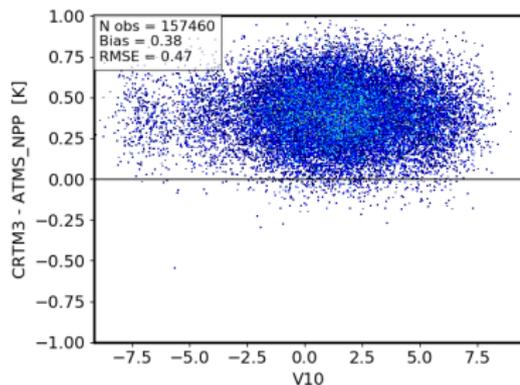
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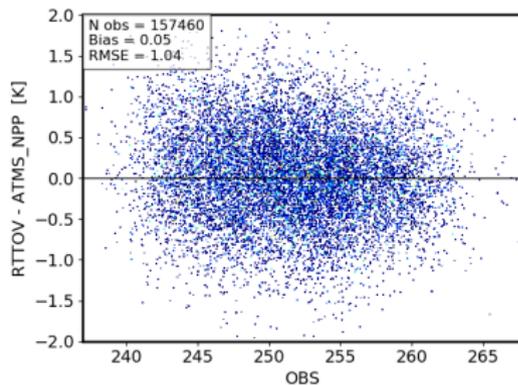
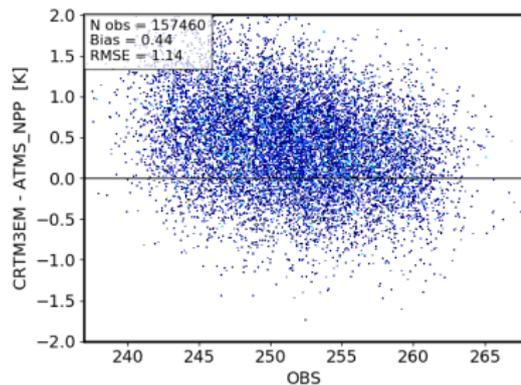
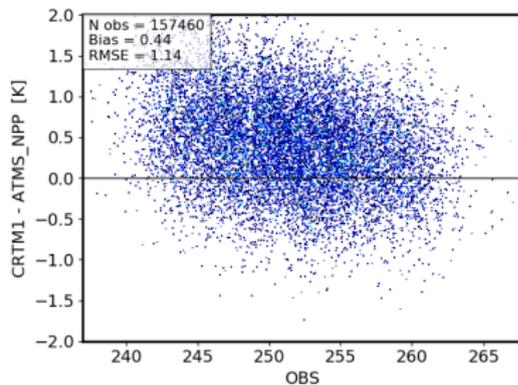
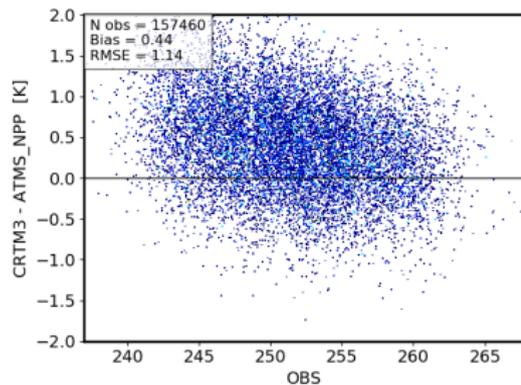
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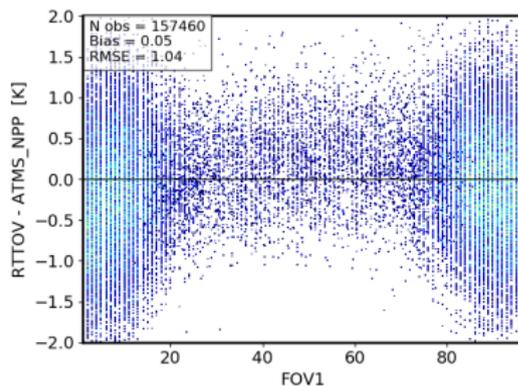
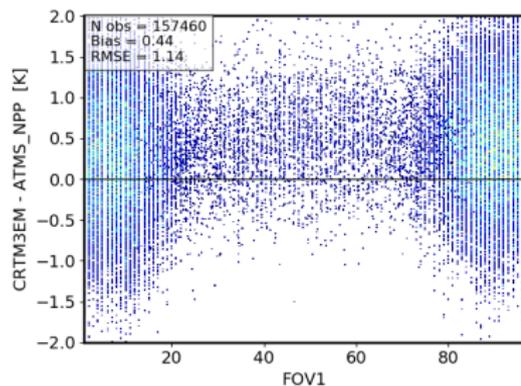
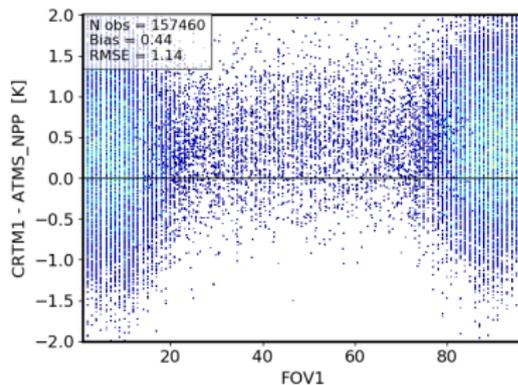
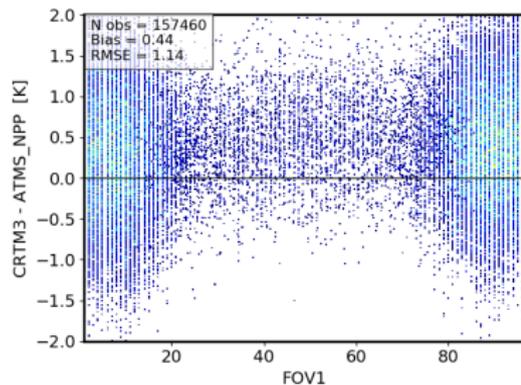
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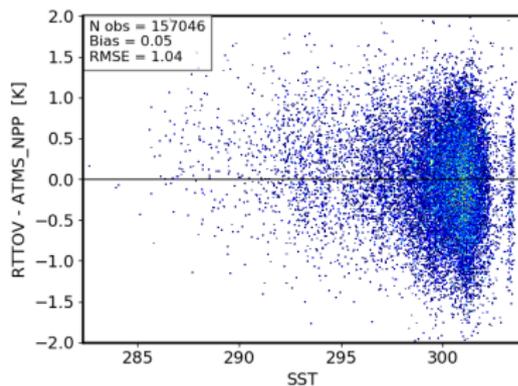
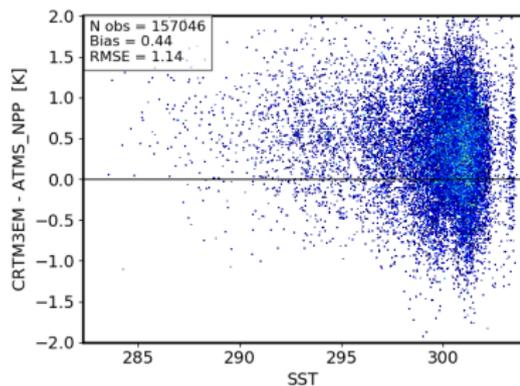
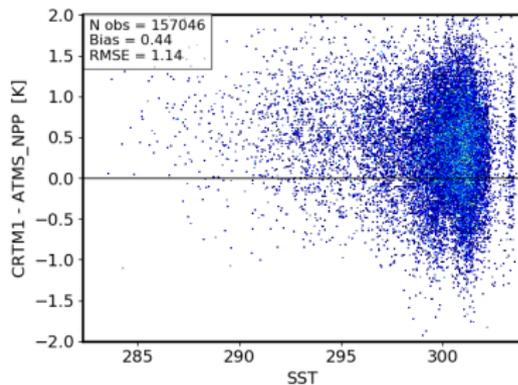
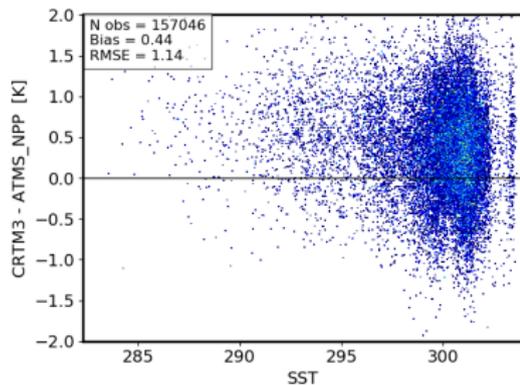
ATMS-NPP Channel 22



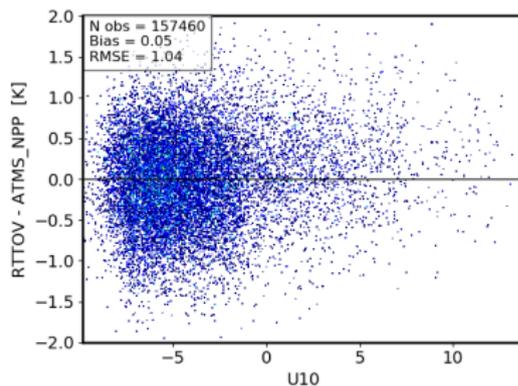
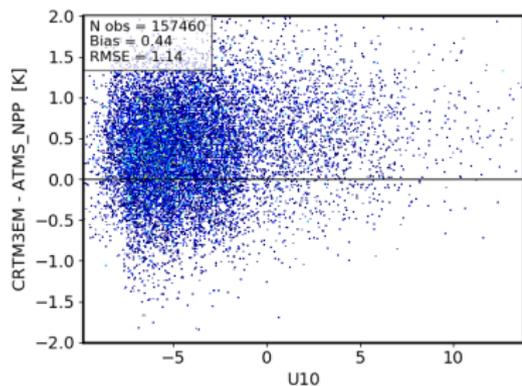
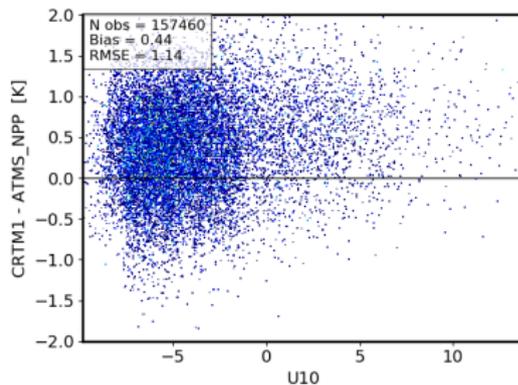
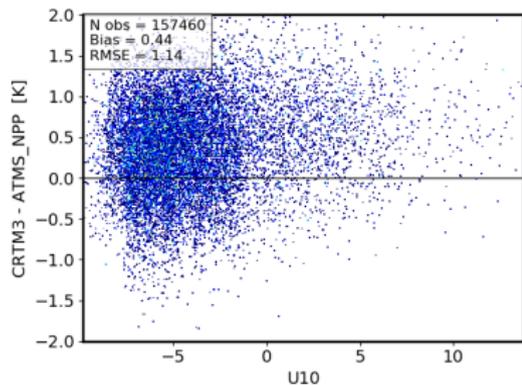
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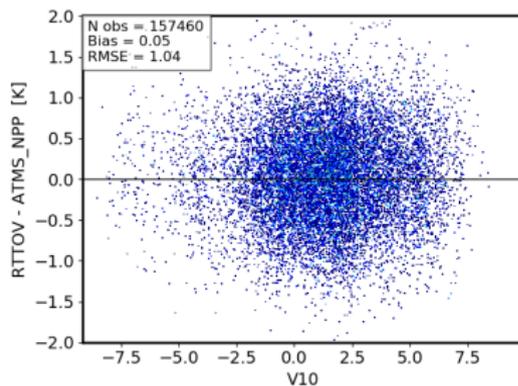
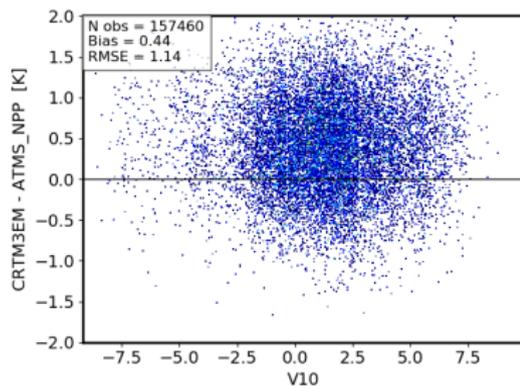
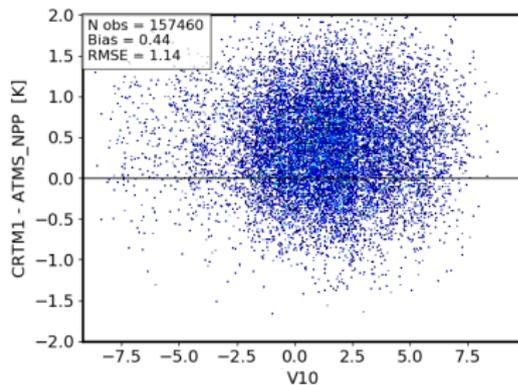
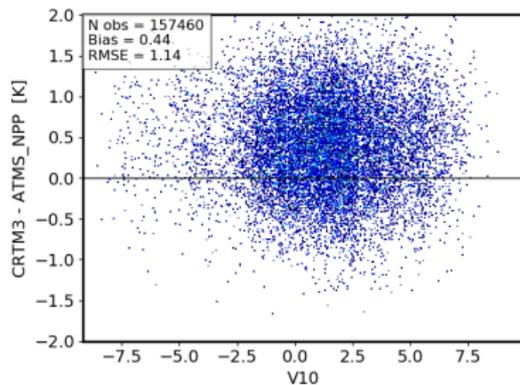
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ATMS-NPP Channel 22

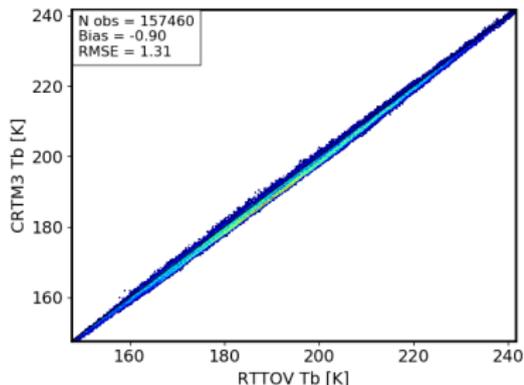


ATMS-NPP Channel 22

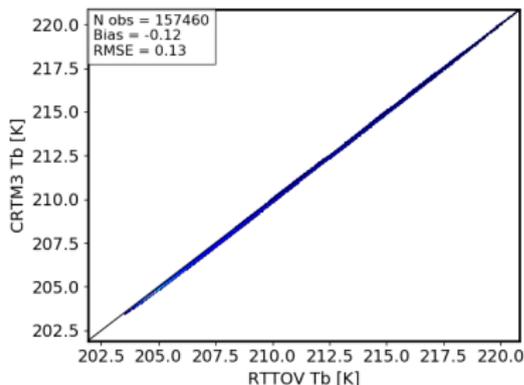


RT Model Intercomparison

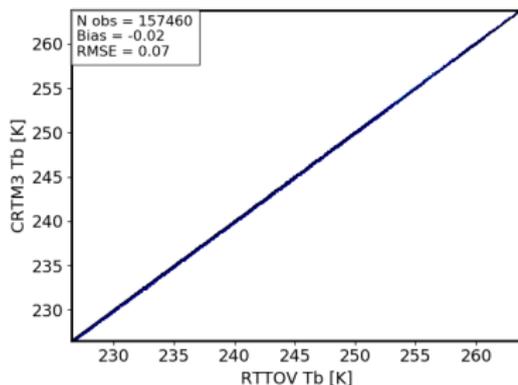
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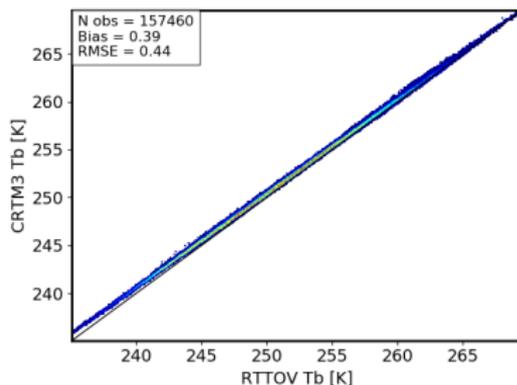
Channel 10



Channel 15

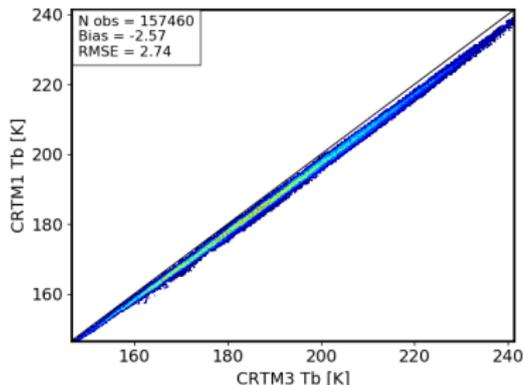


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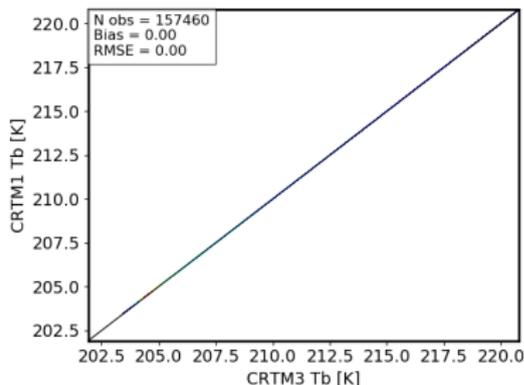


RT Model Intercomparison

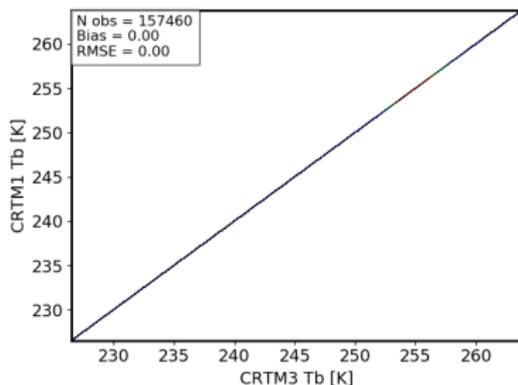
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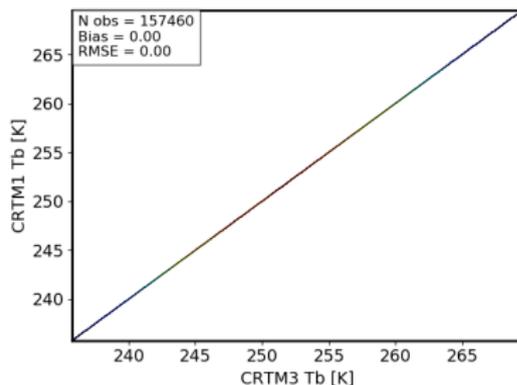
Channel 10



Channel 15



Channel 22



Conclusions

- CRTM version 2.3 is slightly improved compared to V2.1 for the window channels but the sounding channels remain the same given no change in transmittance coefficients
- The difference between RTTOV and CRTM simulations for most ATMS temperature sounding channels is very small, but the differences are larger for the water vapor and window channels
- ATMS N20 measurements better agree with Era-5 reanalysis, though not possible to comment on the absolute accuracy of ATMS observations because of methodological errors
- The LBL simulations are underway to be able to cross compare two fast RT models vs. a LBL model
- GRUAN sondes collocated with ATMS measurements will be used to validate ATMS measurements compare to high quality radiosonde data

RT Model Intercomparison - ATMS-NPP

Channel	Center Freq.(GHz)	Polarization	Max Bandwidth (GHz)	Temperature Sensitivity(K) NE Δ T
1	23.8	QV	0.27	0.9
2	31.4	QV	0.18	0.9
3	50.3	QH	0.18	1.20
4	51.76	QH	0.40	0.75
5	52.8	QH	0.40	0.75
6	53.596 \pm 0.115	QH	0.17	0.75
7	54.40	QH	0.40	0.75
8	54.94	QH	0.40	0.75
9	55.50	QH	0.33	0.75
10	57.29034	QH	0.33	0.75
11	57.29034 \pm 0.217	QH	0.078	1.20
12	57.29034 \pm 0.322 \pm 0.048	QH	0.036	1.20
13	57.29034 \pm 0.322 \pm 0.022	QH	0.016	1.50
14	57.29034 \pm 0.322 \pm 0.010	QH	0.008	2.40
15	57.29034 \pm 0.322 \pm 0.0045	QH	0.003	3.60
16	88.20	QV	2.0	0.5
17	165.5	QH	3.0	0.6
18	183.31 \pm 7	QH	2.0	0.8
19	183.31 \pm 4.5	QH	2.0	0.8
20	183.31 \pm 3.0	QH	1.0	0.8
21	183.31 \pm 1.8	QH	1.0	0.8
22	183.31 \pm 1.0	QH	0.5	0.9

RT Model Intercomparison - ATMS-NPP

Channel No	Central Frequency (Ghz)	Central Frequency Stabilization (\pm MHz)	Bandwidth (Mhz)	<u>Polarization</u>	Integration time (ms)	NEDT (K)	Antenna beamwidth @ 3dB ($^{\circ}$)
1	10.65	10	100	V	9.7	0.96	1.75
2	10.65	10	100	H	9.7	0.96	1.75
3	18.70	20	200	V	5.3	0.84	1.00
4	18.70	20	200	H	5.3	0.84	1.00
5	23.80	20	400	V	5.0	1.05	0.90
6	36.50	50	1000	V	5.0	0.65	0.90
7	36.5	50	1000	H	5.0	0.65	0.90
8	89.00	200	6000	V	2.2	0.57	0.40
9	89.00	200	6000	H	2.2	0.57	0.40
10	166.0	200	3000	V	3.6	1.5	0.40
11	166.0	200	3000	H	3.6	1.5	0.40
12	183.31 \pm 3	200	3500	V	3.6	1.5	0.4
13	183.31 \pm 7	200	4500	V	3.6	1.5	0.4