



GSICS Annual meeting @ Darmstadt
MW Breakout Session, 03.14.2024



First performance of new generation MWRI onboard FY-3F and FY-3G

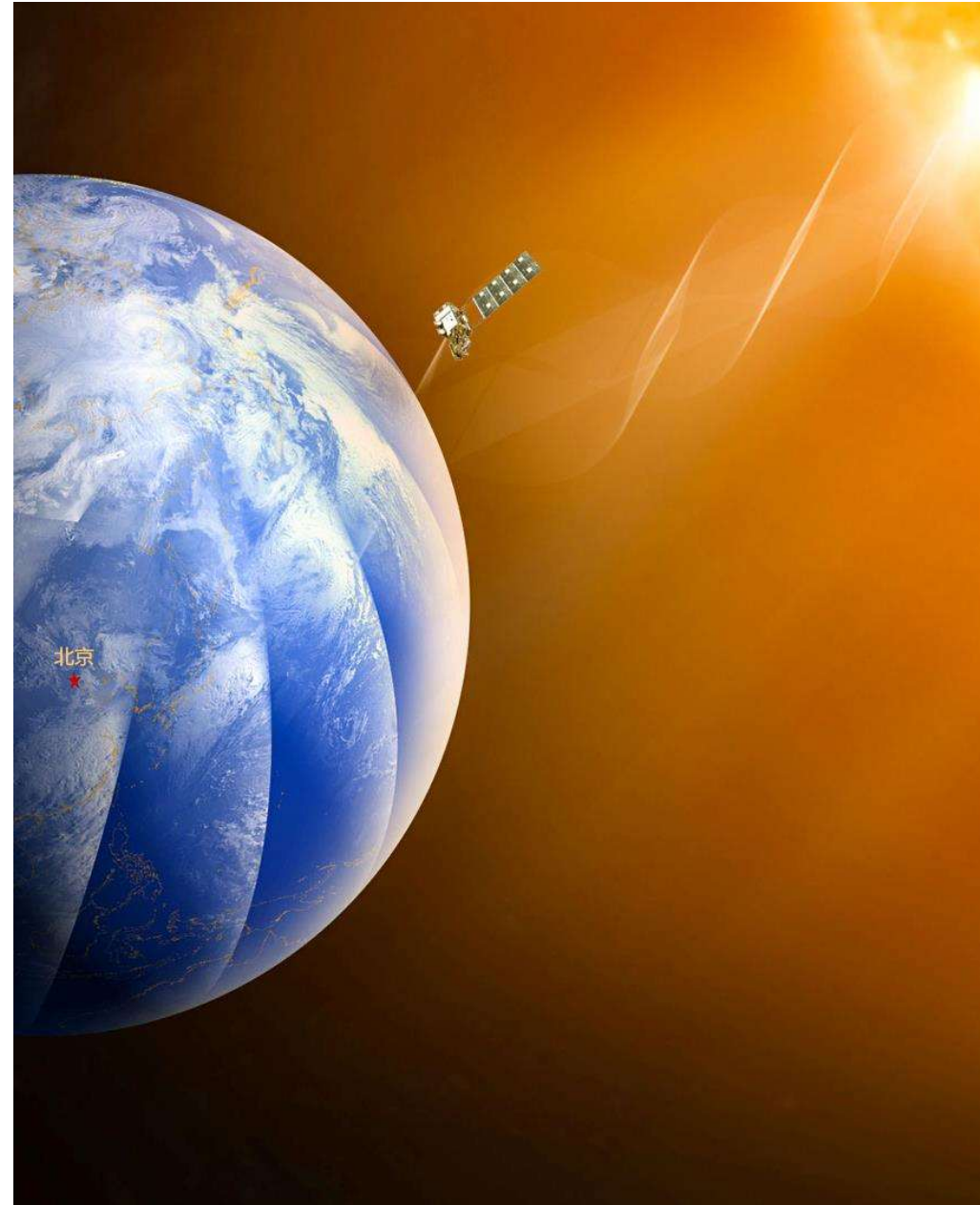


Shengli Wu, Pengjuan Yao, Weiwei Xu (NSMC)
Jiakai He, Kesong Dong, Ruanyu Zhang (SISCT)

01 **Background**

02 Performance

03 Conclusion





Background (MWRI onboard FY-3A/B/C/D)



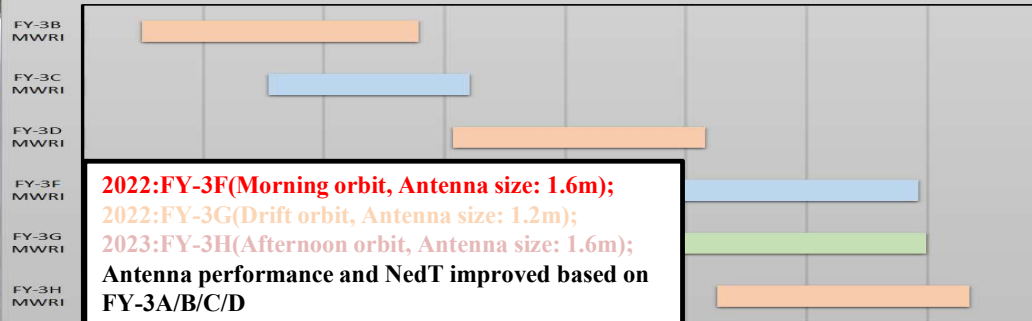
Frequency(GHz)	10.65	18.7	23.8	36.5	89
Polarization	V.H	V.H	V.H	V.H	V.H
Band Width(MHz)	180	200	400	900	2×2300
NeDT(k)	0.5	0.5	0.5	0.5	0.8
Accuracy(k)	2.0	2.0	2.0	2.0	2.0
BT Range(k)	3~340				
Scan Points	266(1.8s)				
Black Body Stability	0.3K				
Nonlinear	<1K				
Main Beam	≥90%				
Resolution ≤(km×km)	51×85	30×50	27×45	18×30	9×15
Beam of different Channel	<0.07°				
Scan	Conic				
Orbit Width(Km)	≥1400				
Antenna angle(°)	45				
Scan Period(s)	1.8±0.1 (1.7/2.0)				
Scan Period Stability(ms)	≤0.36ms* (2 Scan lines)				
	≤1ms(30 minutes)				



MWRI-II/MWRI-RM

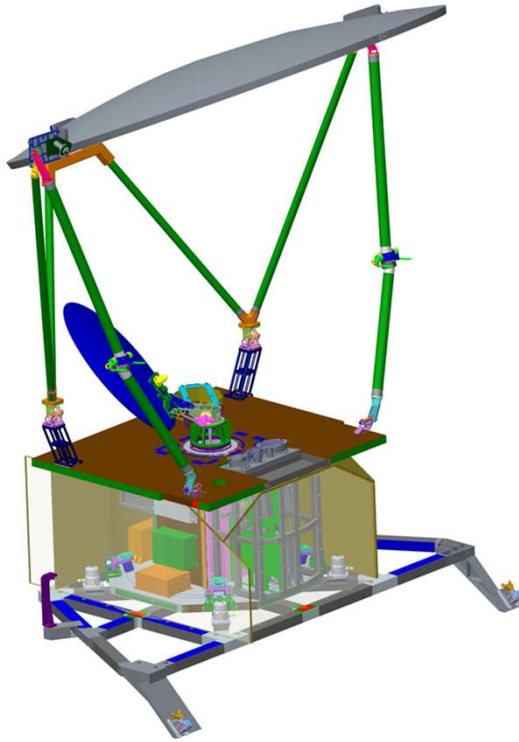


	MWRI	MWRI-II	GMI	AMSR 2	MWI	SSMIS
Nation	China	China	US	Japan	EU	US
Antenna size(m)	0.9	1.8/1.2	1.2	2	0.75	0.6
Main beam(%)	90	95	90	90	90	90
Frequency range(GHz)	10-89	10-118/10-183	10-183	6.9-89	18-183	18-183
Channels	10	22/26	13	16	18	24
NedT	0.8	0.5	0.6-1.5	0.4-1.4	0.6-1.2	0.4-1.9

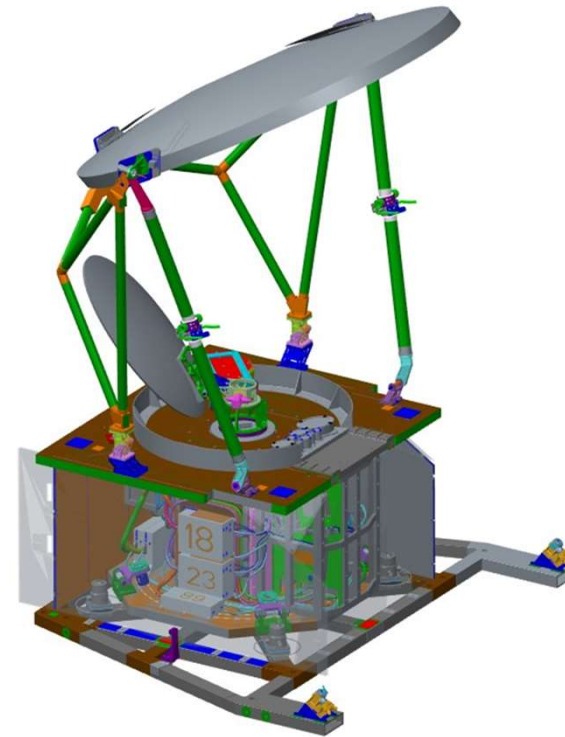




MWRI-II/MWRI-RM



FY-3F/MWRI-II
Morning orbit



FY-3G/MWRI-RM
Drift orbit



MWRI-II/MWRI-RM

	MWRI	MWRI-II	MWRI-RM
	10 ~ 89GHz	10 ~ 118GHz	10 ~ 183GHz
Channels	10.65V/H 18.7V/H 23.8V/H 36.5V/H 89V/H	10.65V/H 18.7V/H 23.8V/H 36.5V/H 89V/H 50.3V/H、52.61V/H、 53.24V/H、53.75V/H、 118.75±3.2GHzV、 118.75±2.1GHzV、 118.75±1.4GHzV、 118.75±1.2GHzV	10.65V/H 18.7V/H 23.8V/H 36.5V/H 89V/H 50.3V/H、52.61V/H、 53.24V/H、53.75V/H、 118.75±3.2GHzV 118.75±2.1GHzV 118.75±1.4GHzV 118.75±1.2GHzV、 165.5±0.75GHzV、 183.31±2.0GHzV、 183.31±3.4GHzV、 183.31±7GHzV



MWRI-II/MWRI-RM

	MWRI	MWRI-II	MWRI-RM
NedT	10 ~ 36GHz: 0.5K	10 ~ 36GHz: 0.5K	10 ~ 36GHz: 0.5K
		50.3-53.75GHz: 0.5K	50.3-53.75GHz: 0.5K
	89GHz: 0.8K	89GHz: 0.5K	89GHz: 0.5K
		118GHz: 0.8K	118GHz: 0.8K
			165.5GHz: 0.8K
			183.31GHz: 0.8K
Accuracy	10 ~ 36GHz: 2.0K	10 ~ 36GHz: 0.8K	10 ~ 36GHz: 0.8K
		50.3-53.75GHz: 0.8K	50.3-53.75GHz: 0.8K
	89GHz: 2.0K	89GHz: 0.8K	89GHz: 0.8K
		118GHz: 1.2K	118GHz: 1.2K
			165.5GHz: 1.2K
			183.31GHz: 1.2K

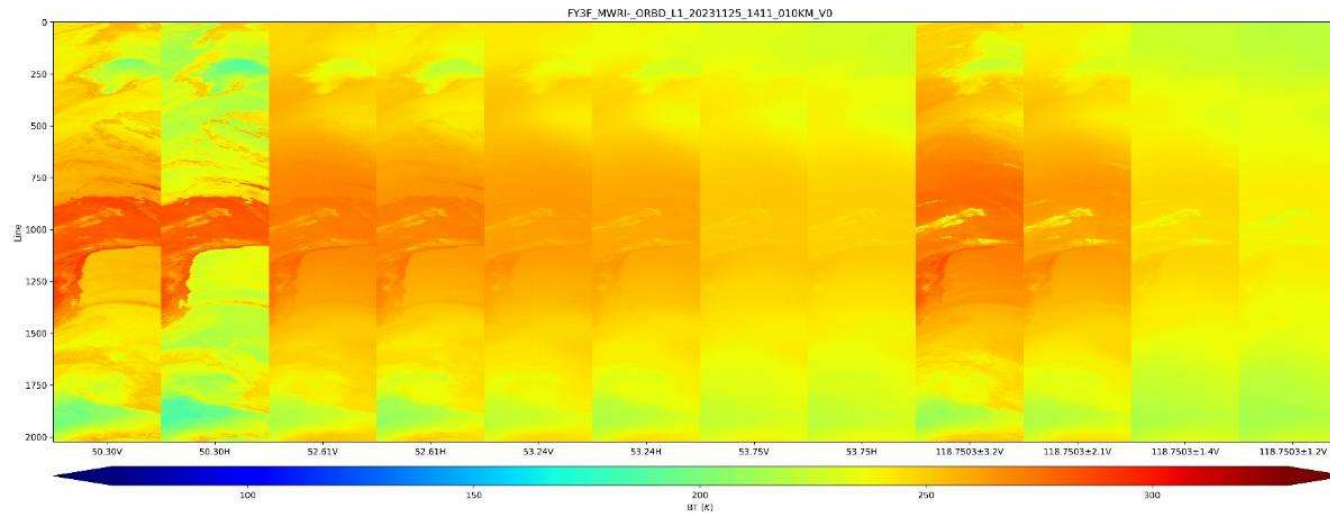
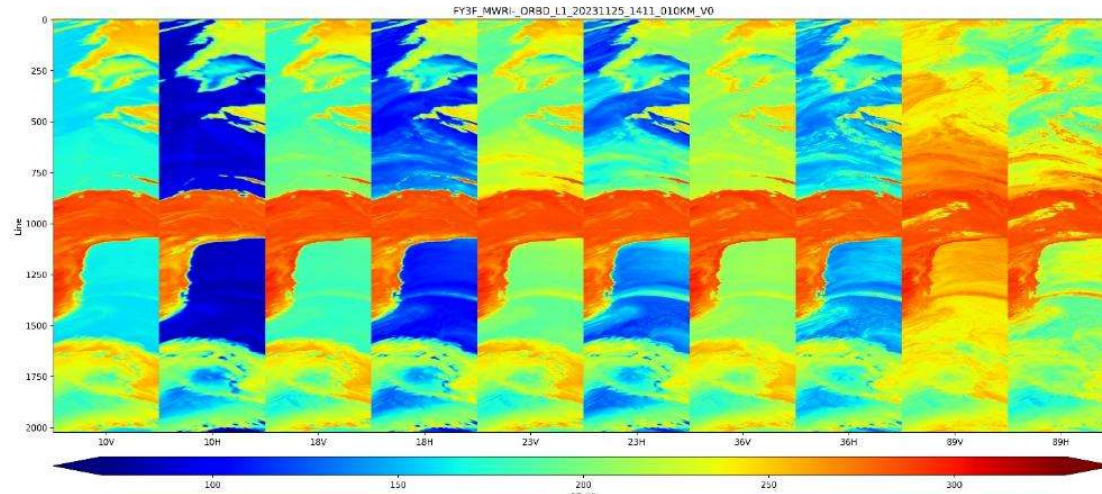


MWRI-II/MWRI-RM

	MWRI	MWRI-II	MWRI-RM
Beam Width	10.65GHz: 2.3	10.65GHz: 1.6	10.65GHz: 2.2
	18.7GHz: 1.3	18.7GHz: 1.0	18.7GHz: 1.4
	23.8GHz: 1.2	23.8GHz: 1.0	23.8GHz: 1.4
	36.5GHz: 0.8	36.5GHz: 0.65	36.5GHz: 0.9
		50.3-53.75GHz: 0.5	50.3-53.75GHz: 0.7
	89GHz: 0.4	89GHz: 0.4	89GHz: 0.5
		118GHz: 0.35	118GHz: 0.5
			165.5GHz: 0.4
			183.31GHz: 0.4
Main Beam efficiency	≥90%	≥95%	≥95%
Co-Geolocation	/	<2.0Km	<2.0Km
Life	5 Years	8 Years	6 Years



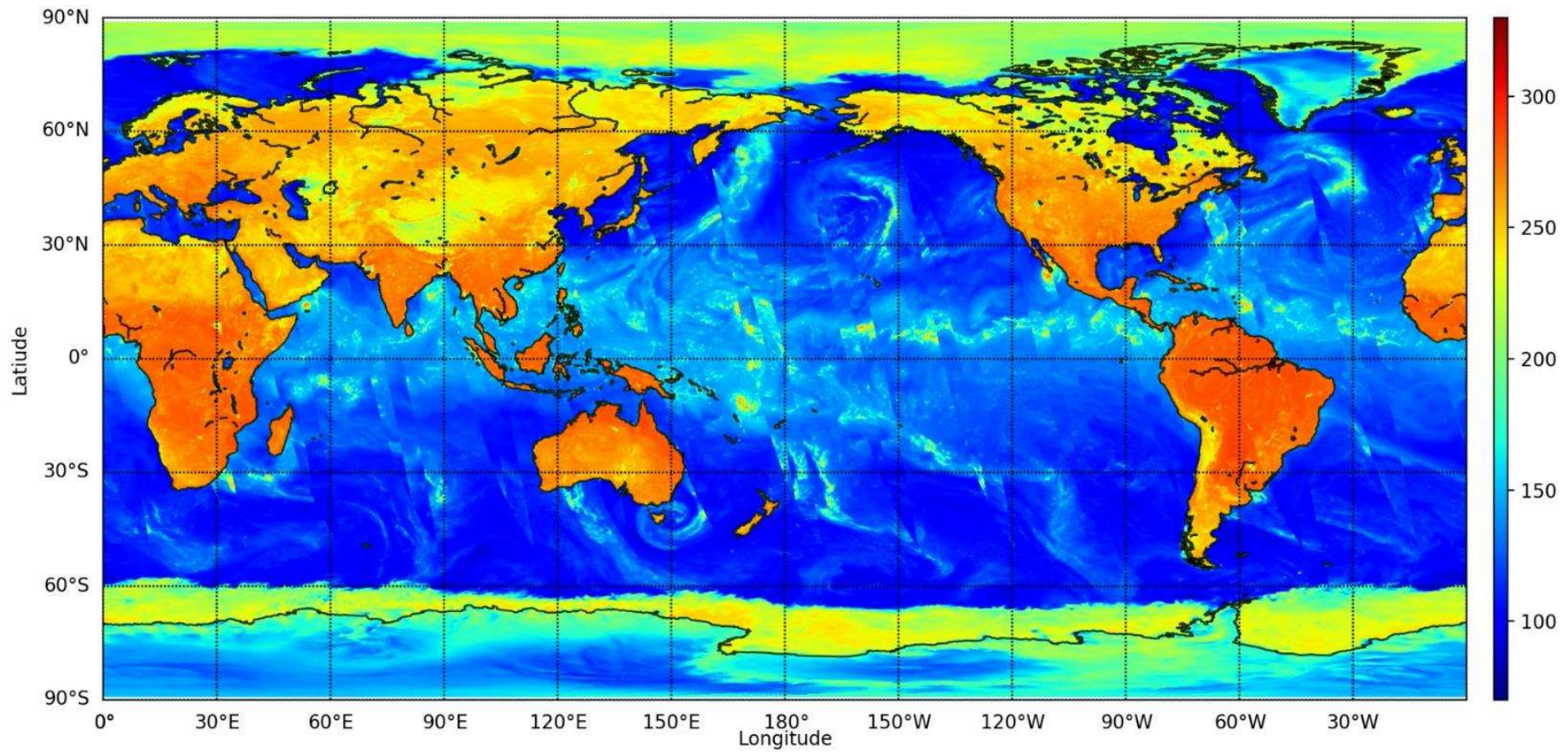
MWRI-II





MWRI-II

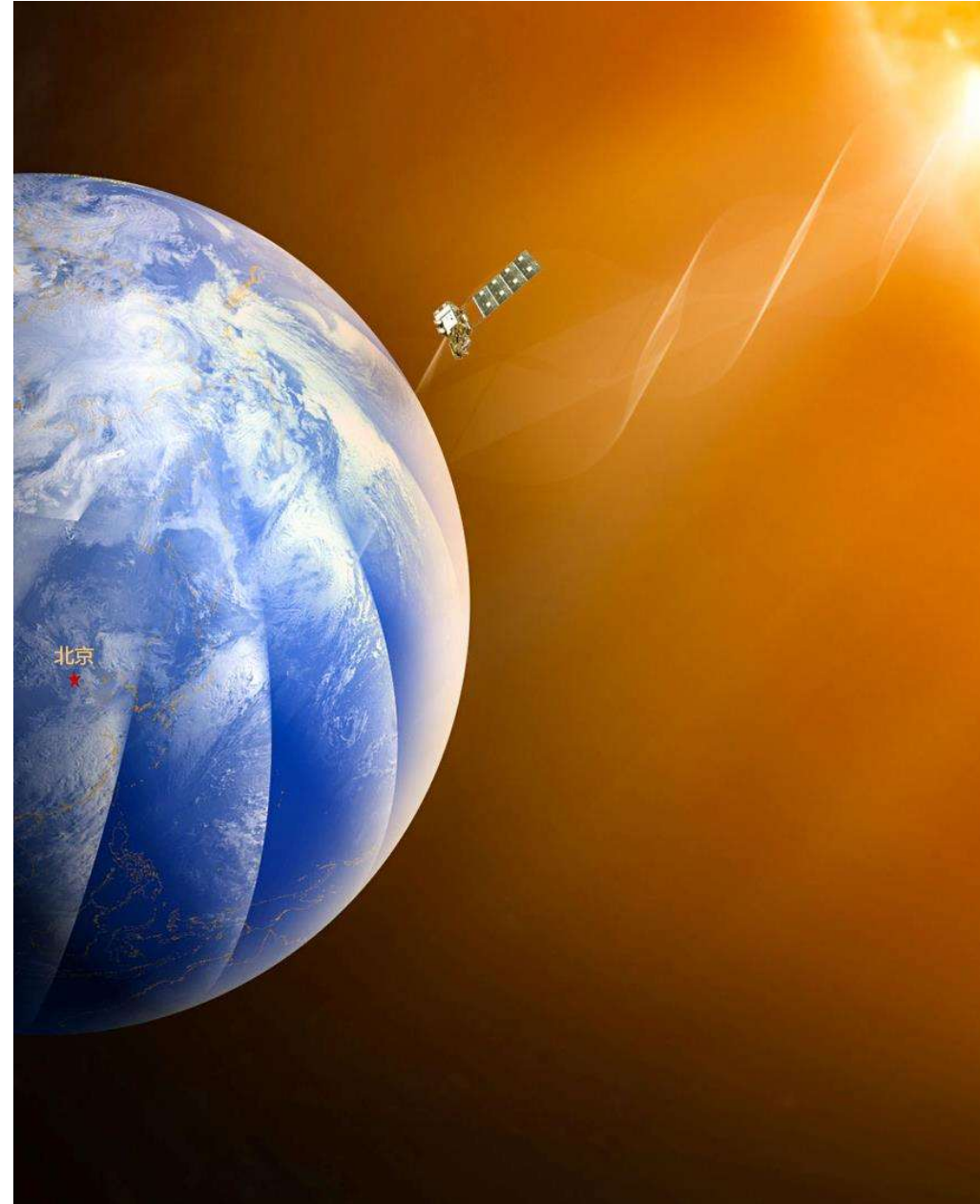
FY3F_MWRI-_Window Channel_CH04_18H_20231020_Bright_Temperature(K)



01 Background

02 **Performance**

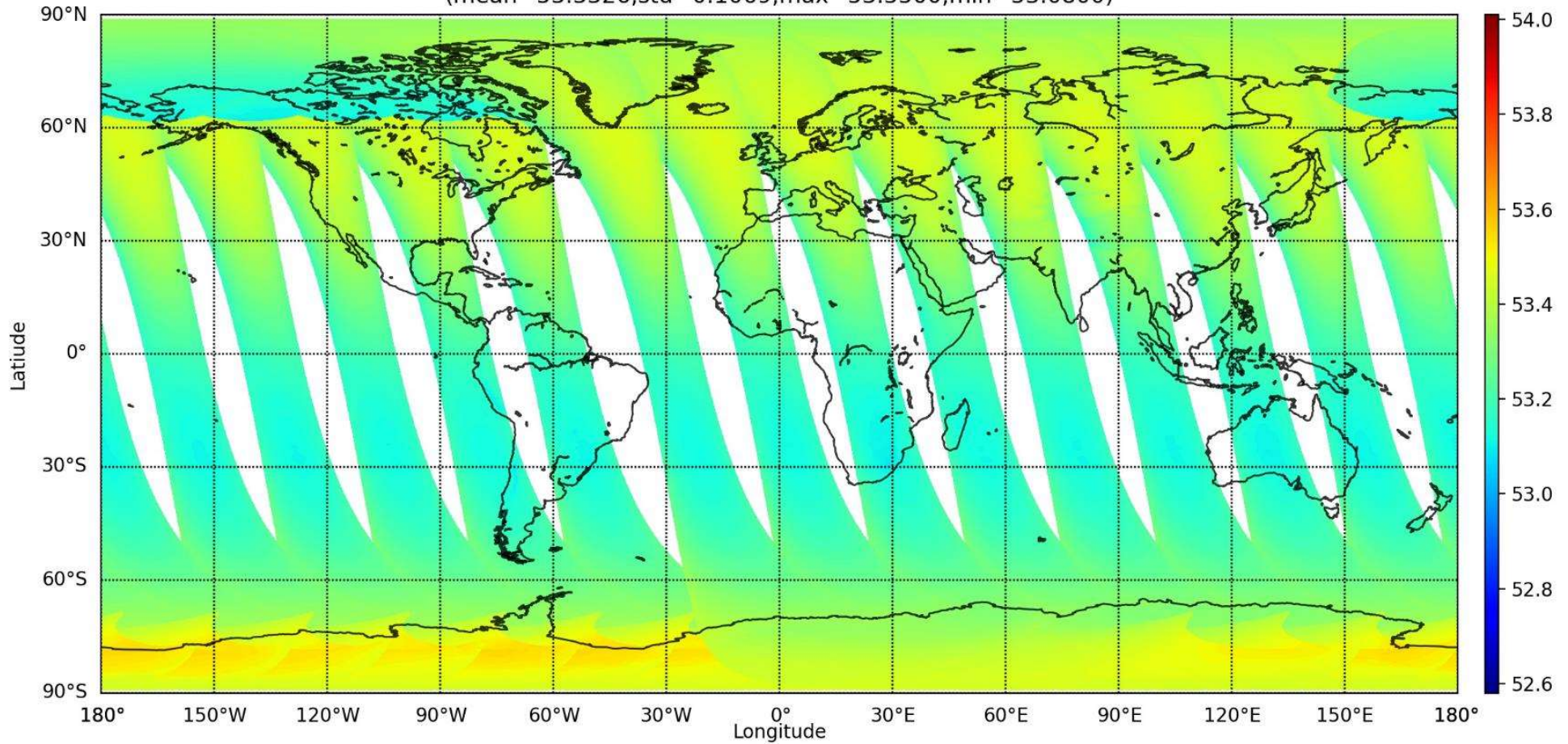
03 Conclusion





Incidence angle

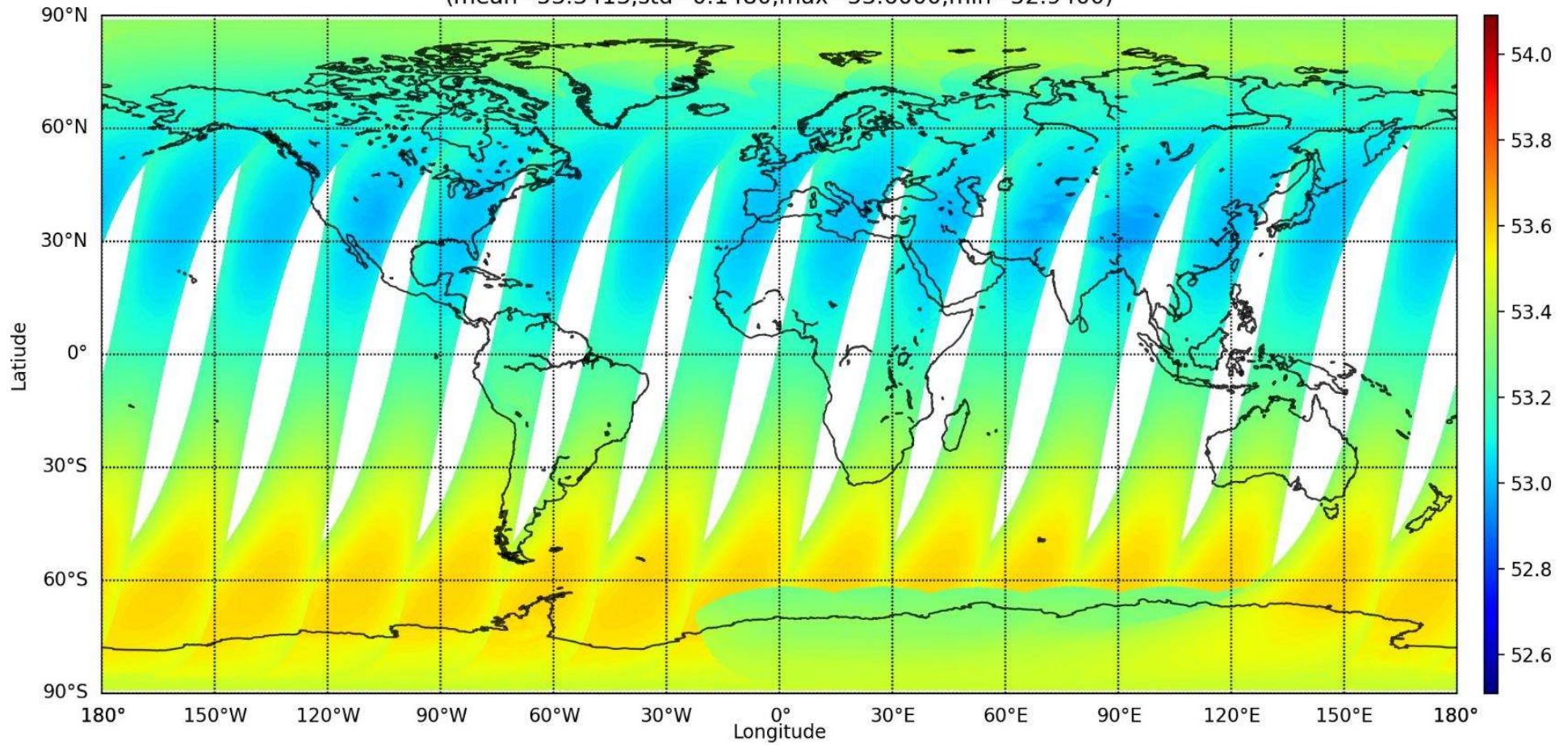
FY3F_MWRI-Sensor_Zenith_20231125_Window Channel
(mean=53.3326, std=0.1069, max=53.5500, min=53.0800)





Incidence angle

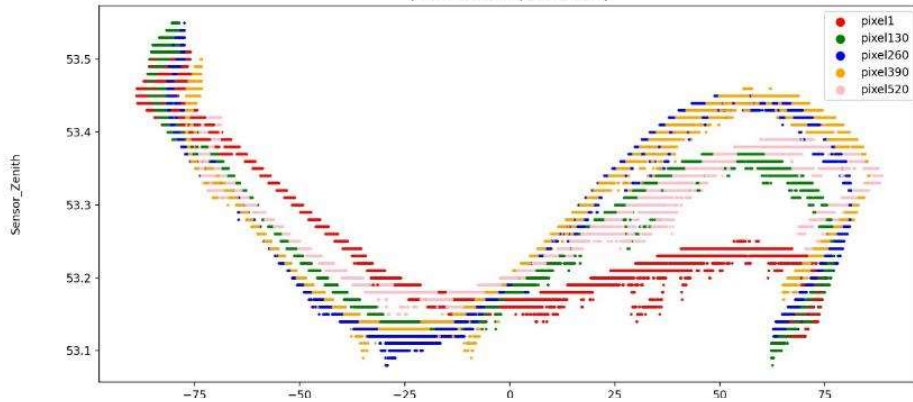
FY3F_MWRI- Sensor_Zenith_20231125_Window Channel
(mean=53.3413,std=0.1480,max=53.6000,min=52.9400)



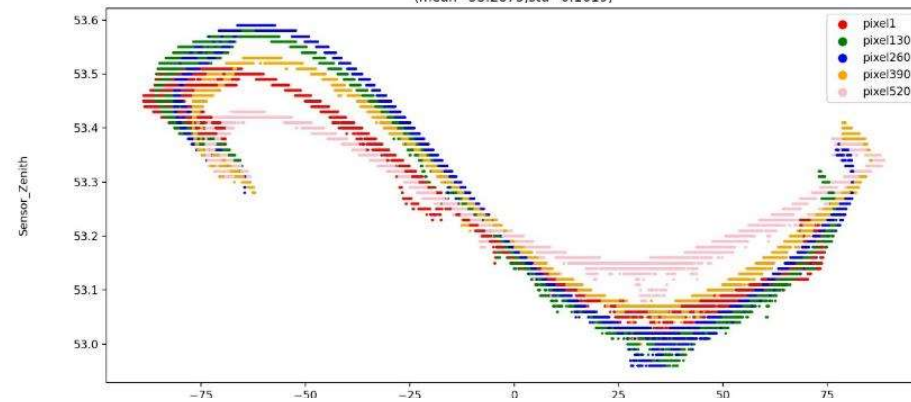


Incidence angle

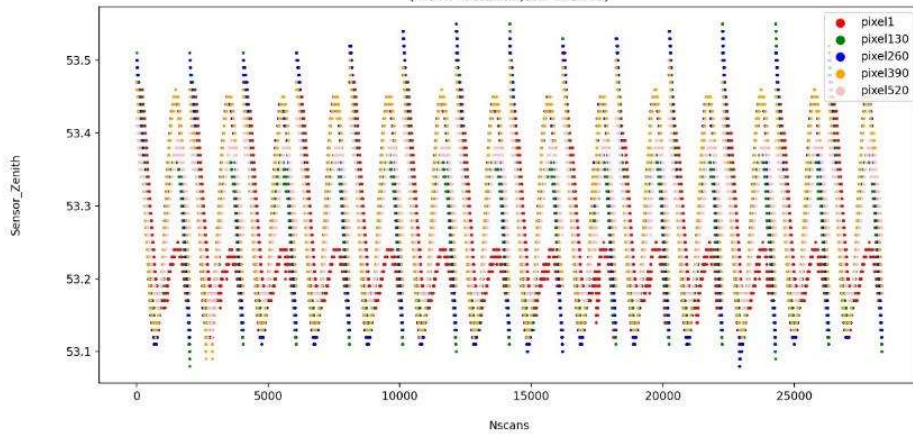
FY3F_MWRI-Sensor_Zenith_20231125_Window Channel
(mean=53.2833,std=0.1041)



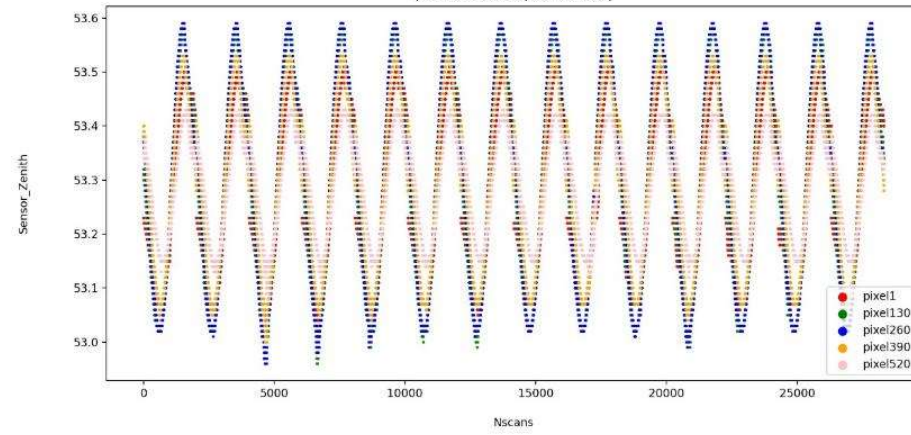
FY3F_MWRI-Sensor_Zenith_20231125_Window Channel
(mean=53.2875,std=0.1619)



FY3F_MWRI-Sensor_Zenith_20231125_Window Channel
(mean=53.2833,std=0.1041)



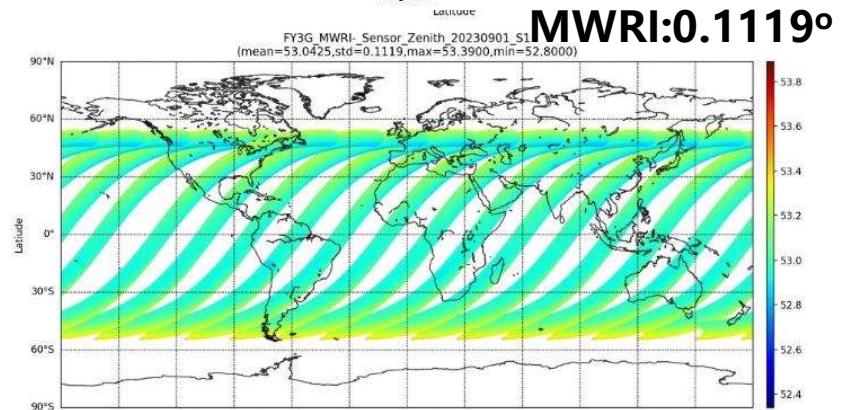
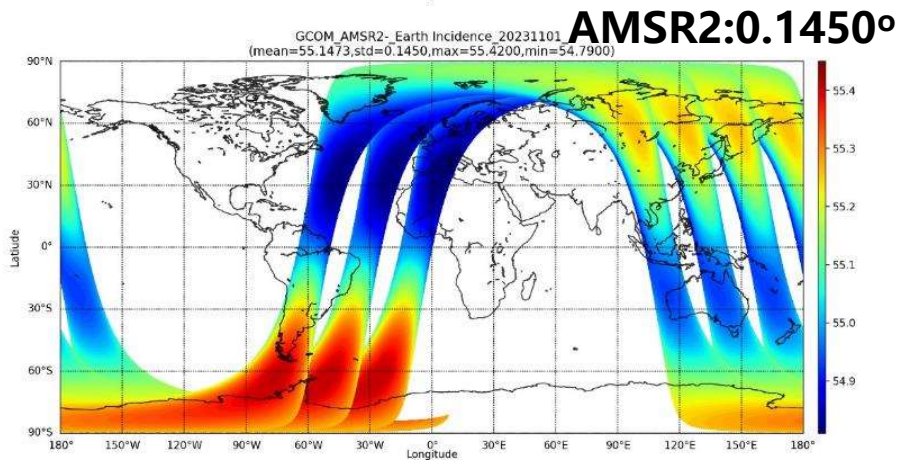
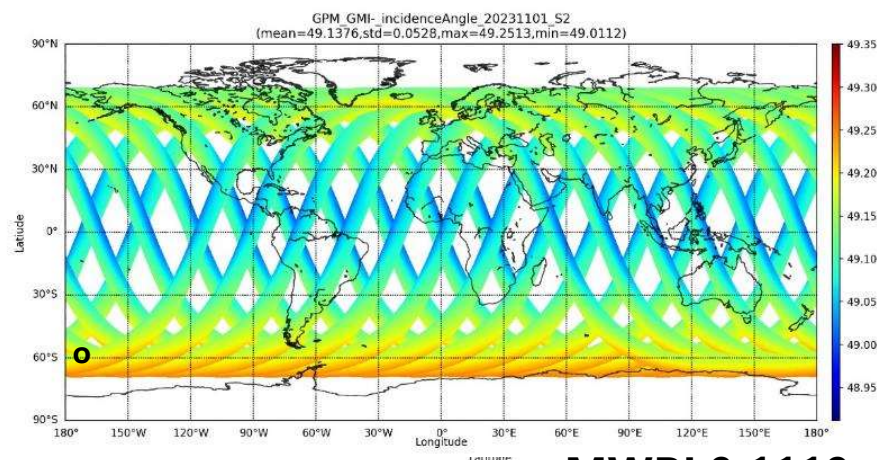
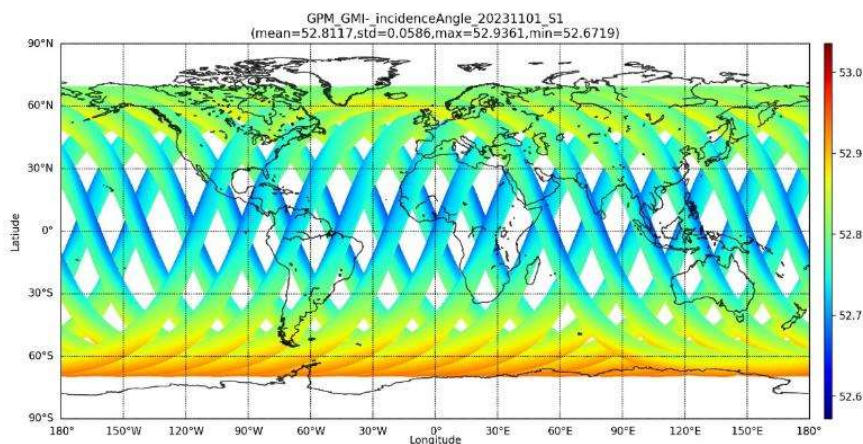
FY3F_MWRI-Sensor_Zenith_20231125_Window Channel
(mean=53.2875,std=0.1619)





Incidence angle

GMI:0.0586° (S1)0.0528° (S2)



最大值与最小值差0.6°，标准差0.1°，优于AMSR2，比GMI略差



Swath width

Freq./GHz	Req./km	Ground Ana./km	Orbit/km
10.65	≥1400	1514	1433.27
18.7		1513	1433.27
23.8		1514	1433.27
36.5		1513	1433.27
54		1422	1445.36
89		1514	1433.27
118		1422	1445.36



Scan period and stability

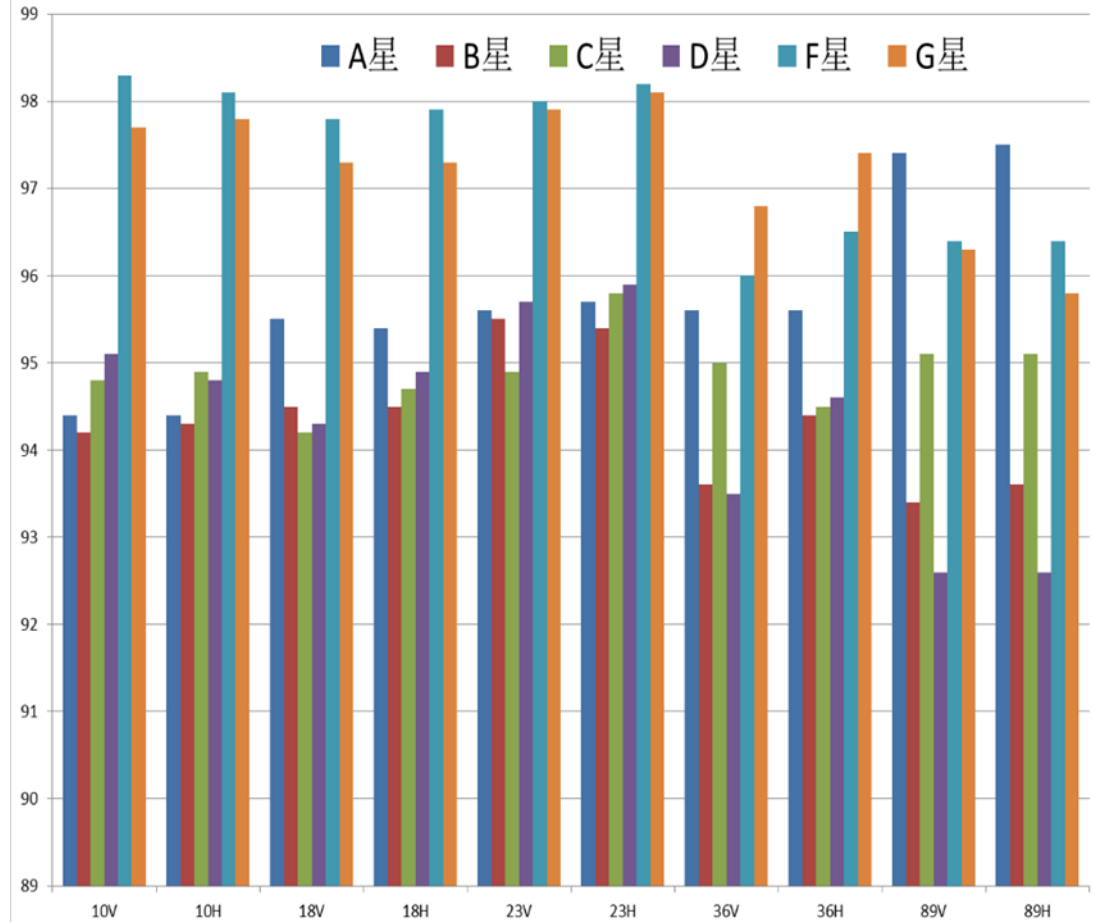
Scan period	Requirement	In-orbit
ms	1800 ± 10	1801.58

Scan period stability	Requirement	In-orbit
ms	1ms (in 30 mins)	0.0621



Main Beam efficiency

No.	Channel	Requirement	Test
1	10.65	$\geq 95\%$	98.11%
2	18.7	$\geq 95\%$	97.80%
3	23.8	$\geq 95\%$	97.99%
4	36.5	$\geq 95\%$	95.99%
5	50.30	$\geq 95\%$	96.34%
6	52.61	$\geq 95\%$	96.34%
7	53.24	$\geq 95\%$	96.34%
8	53.75	$\geq 95\%$	96.34%
9	89.0	$\geq 95\%$	96.38%
10	118.7503 ± 3.2	$\geq 95\%$	97.37%
11	118.7503 ± 2.1	$\geq 95\%$	97.37%
12	118.7503 ± 1.4	$\geq 95\%$	97.37%
13	118.7503 ± 1.2	$\geq 95\%$	97.37%

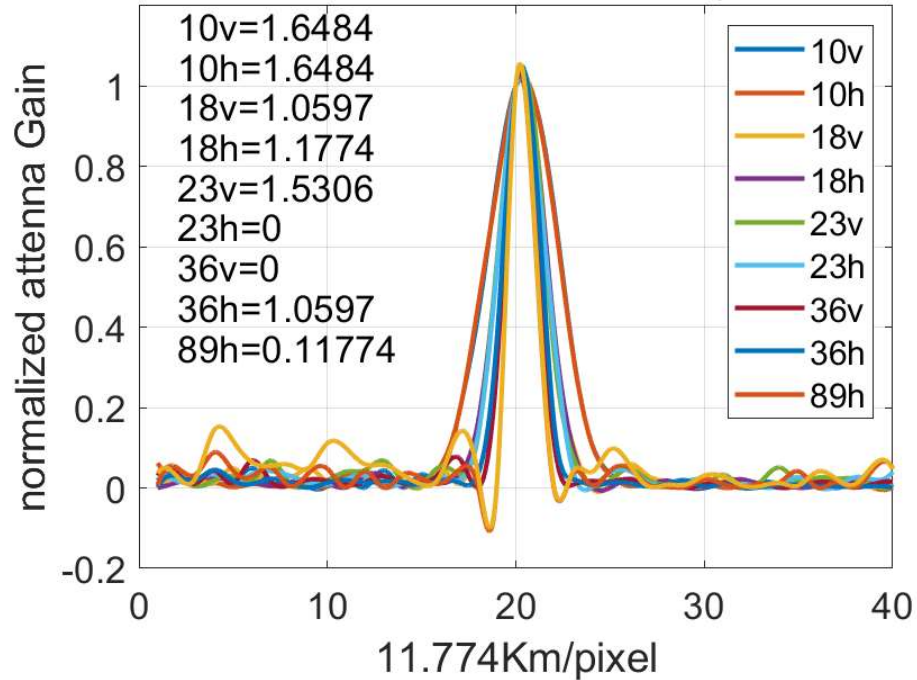




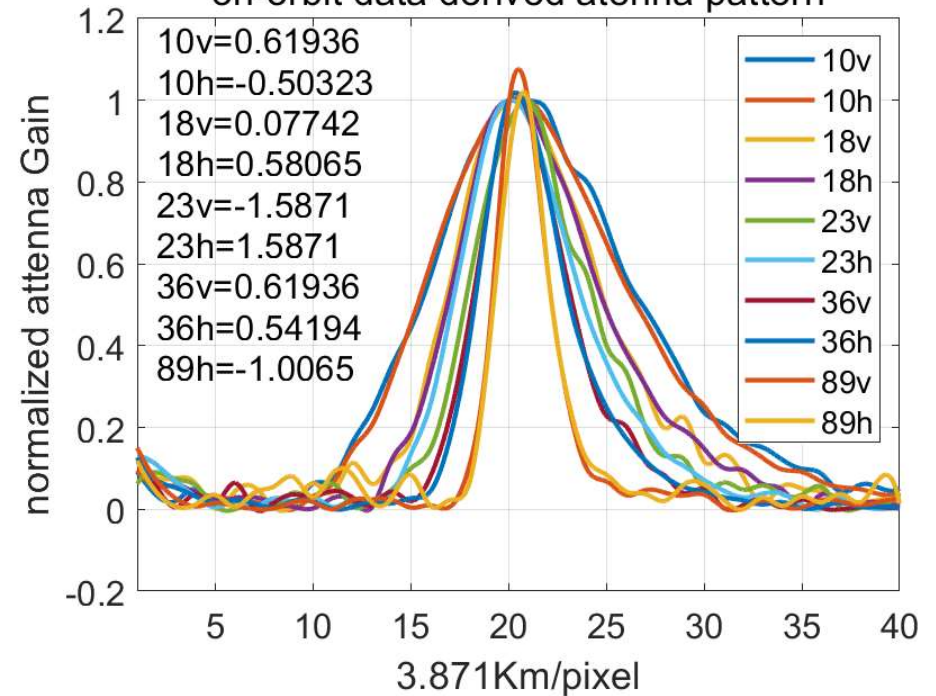
Co-location of different channels

channel	Requ.(Km)	Scan direction/km(before correction)	Scan direction/km(after correction)	Fly direction/km	Co-location error/km
10V	≤ 2	-8.56458	0.432267	1.6464	1.702201
10H		-8.96135	0.167767	1.6484	1.656915
18V		-6.37748	0.341933	1.0598	1.113595
18H		-5.88393	-0.32905	1.1774	1.222516
23V		-2.7968	-0.66453	1.5306	1.668633
23H		-4.8194	0.812917	1.5306	1.733081
36V		-2.99035	0.651617	1.2951	1.449789
36H		-2.86453	0.4258	1.0597	1.142046
89H		0.019375	-0.25807	0.5887	0.642781

on-orbit data derived antenna pattern

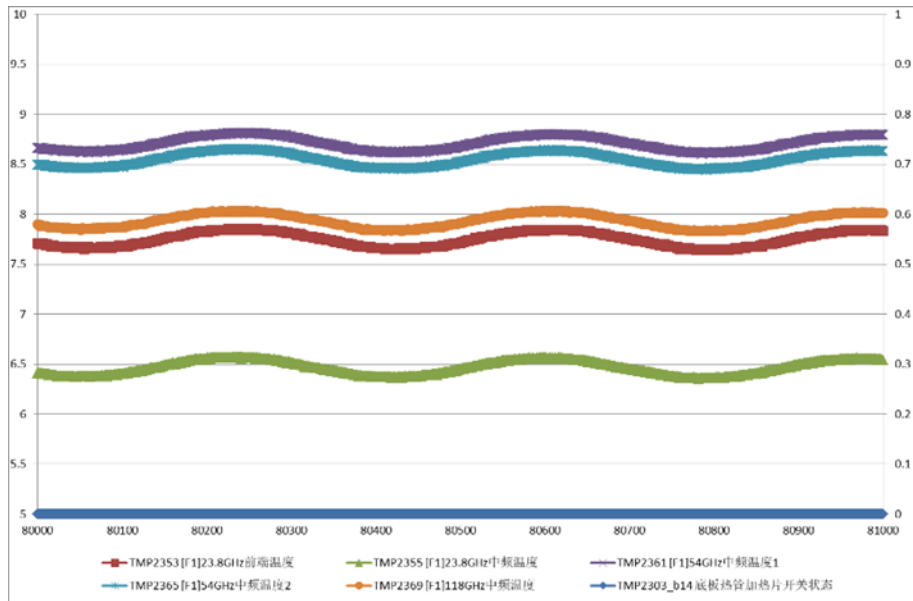


on-orbit data derived antenna pattern

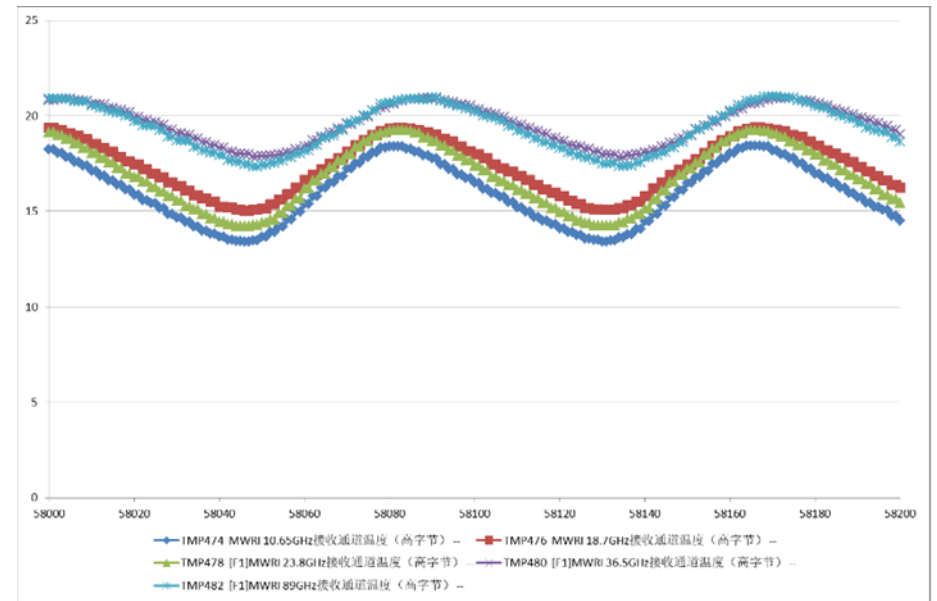




Receiver temperature



FY-3F/MWRI

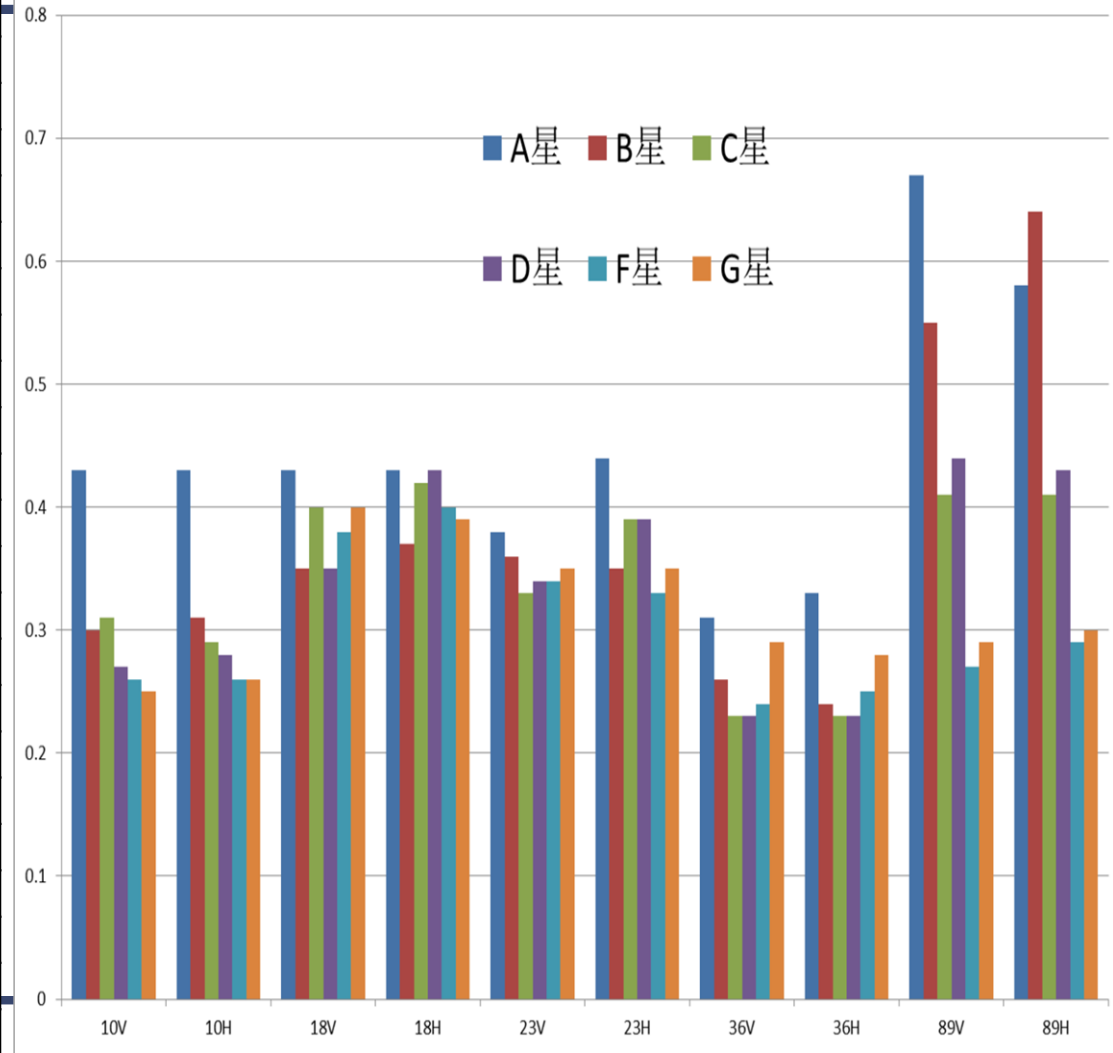


FY-3D/MWRI



NedT

No.	Channels	Requ./K	RMS/K	Allan/K
1	118-4	≤0.8	0.49	0.49
2	118-3		0.50	0.50
3	118-2		0.50	0.50
4	118-1		0.48	0.48
5	89V	≤0.5	0.16	0.16
6	89H		0.18	0.18
7	54H-4		0.30	0.31
8	54H-3		0.29	0.29
9	54H-2		0.28	0.28
10	54H-1		0.29	0.29
11	54V-4		0.33	0.34
12	54V-3		0.33	0.33
13	54V-2		0.33	0.34
14	54V-1		0.32	0.33
15	36V		0.13	0.13
16	36H		0.12	0.12
17	23V		0.18	0.18
18	23H		0.18	0.18
19	18V		0.18	0.18
20	18H		0.20	0.20
21	10V		0.11	0.11
22	10H		0.11	0.11





Accuracy

Data range

2023年8月15日 - 2023年10月14日

SNO Sensors

FY-3F/MWRI-II VS GPM-Core/GMI

Rules

Time: <300s

Location: <0.03°

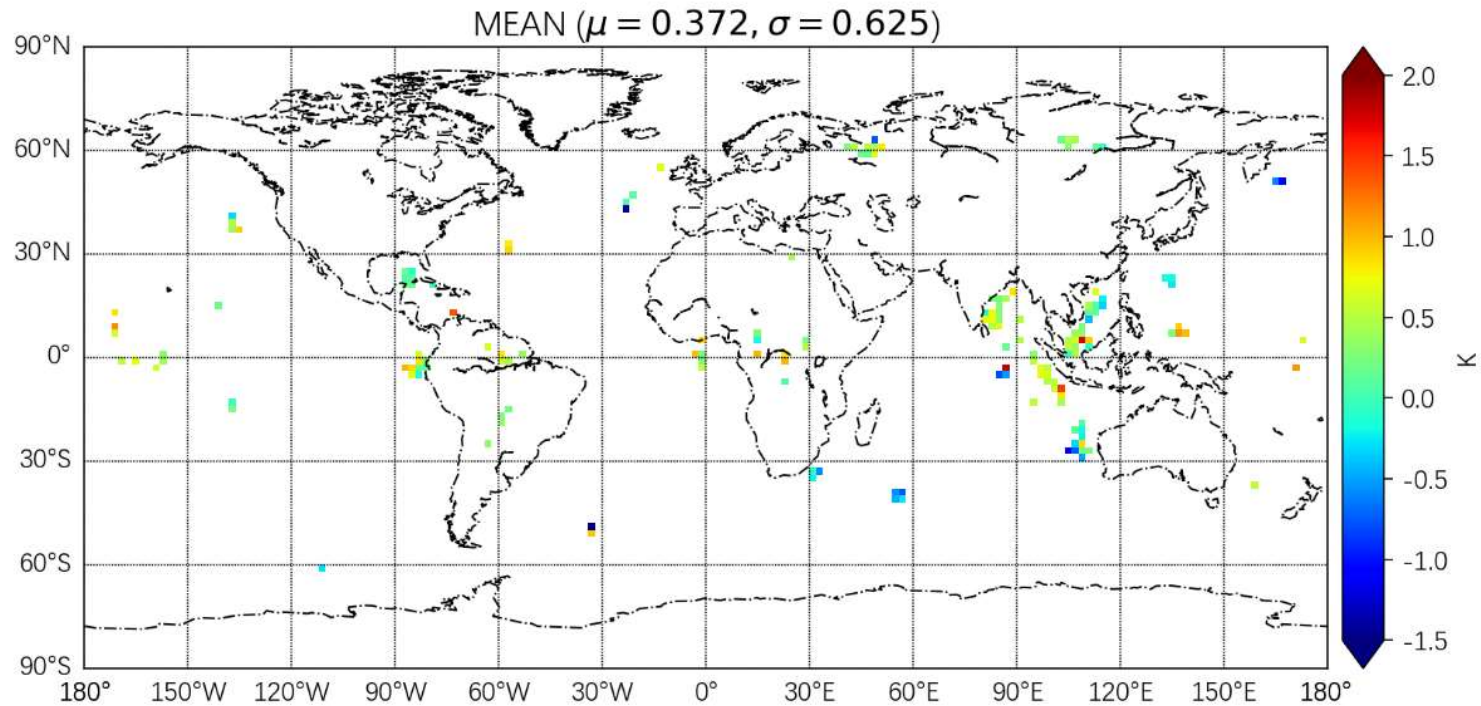
stability: STD<1.0K

MWRI	GMI
10.65V	10.65V
10.65H	10.65H
18.7V	18.7V
18.7H	18.7H
23.8V	23.8V
23.8H	/
36.5V	36.64V
36.5H	36.64H
89V	89V
89H	89H

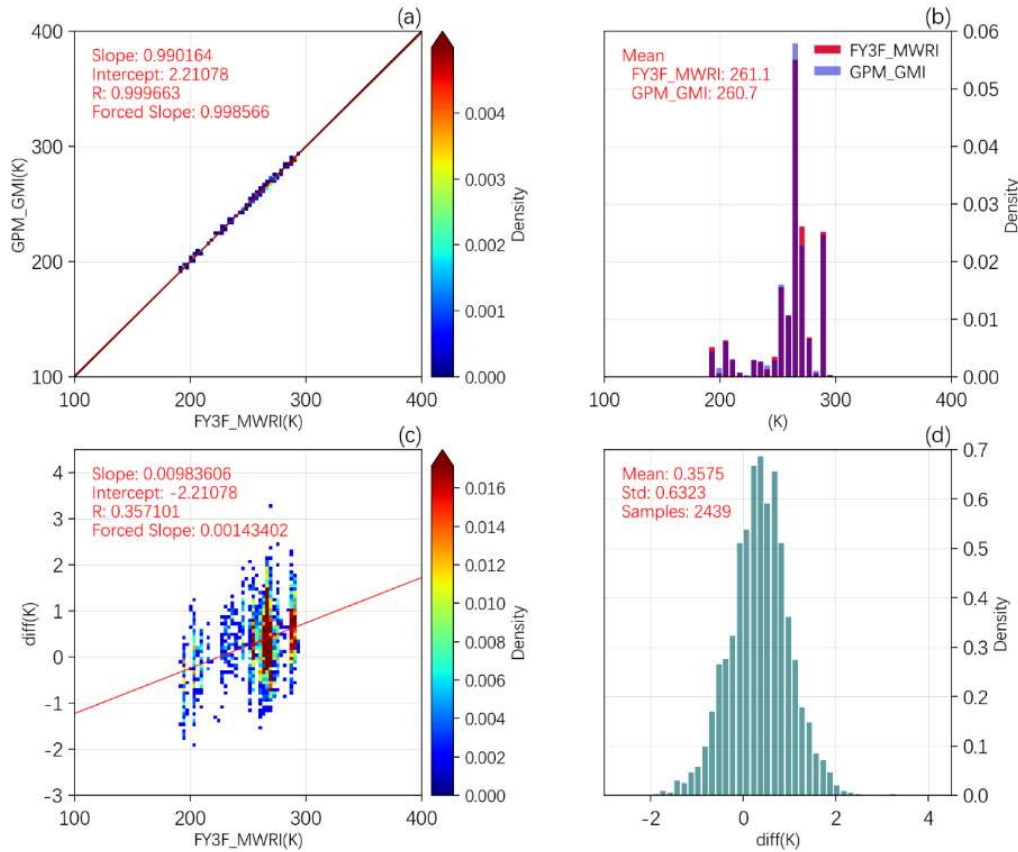


SNO points

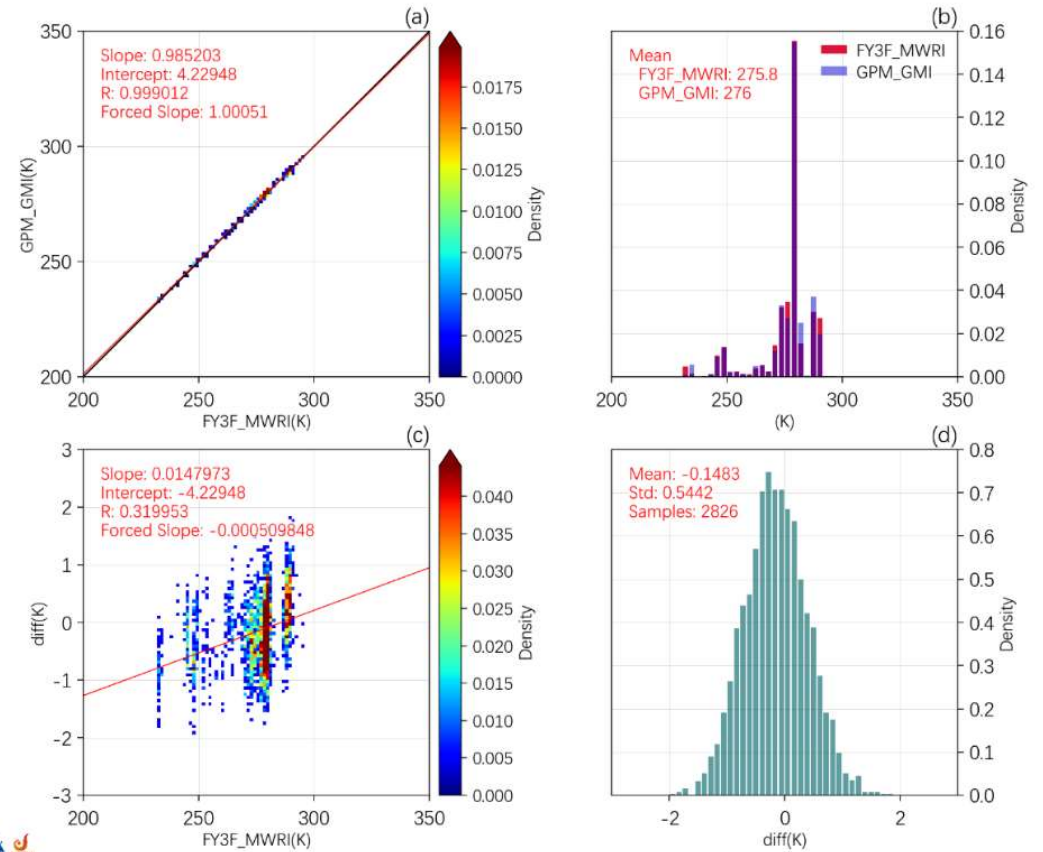
Spatial Distribution of Bright Temperature (FY3F_MWRI-GPM_GMI) 2023-08-20~2023-10-14
FY3F_MWRI_GPM_GMI. 89H



Correlation Analysis of Bright Temperature 2023-08-20~2023-10-14
FY3F_MWRI_GPM_GMI_test. 89H



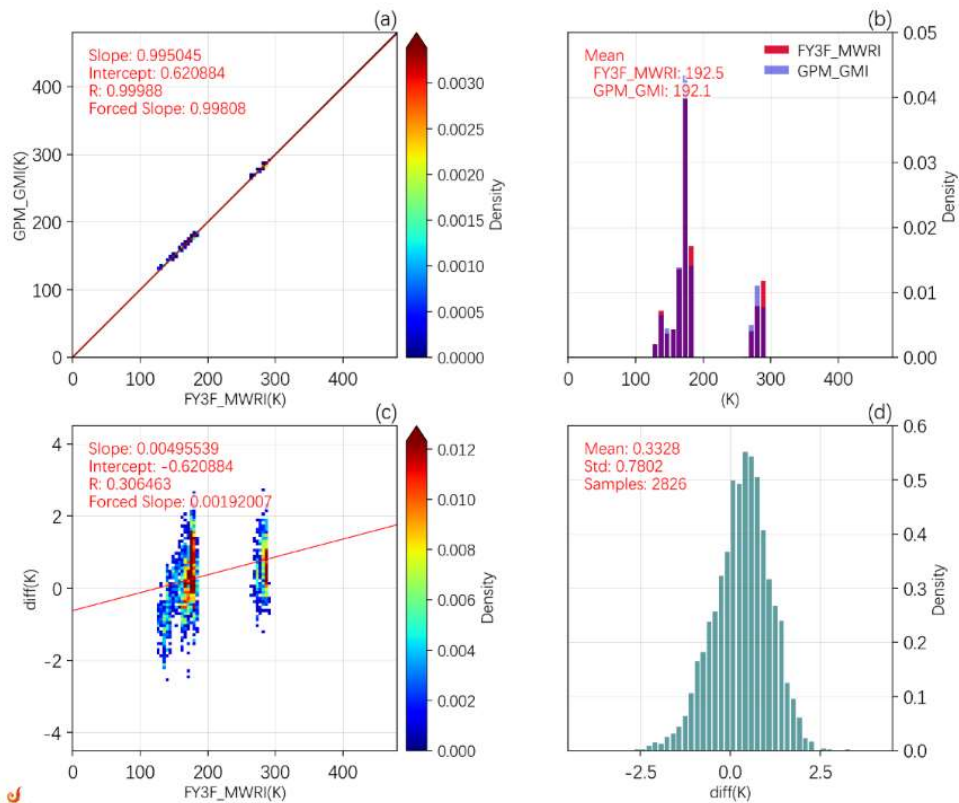
Correlation Analysis of Bright Temperature 2023-08-20~2023-10-14
FY3F_MWRI_GPM_GMI. 89V



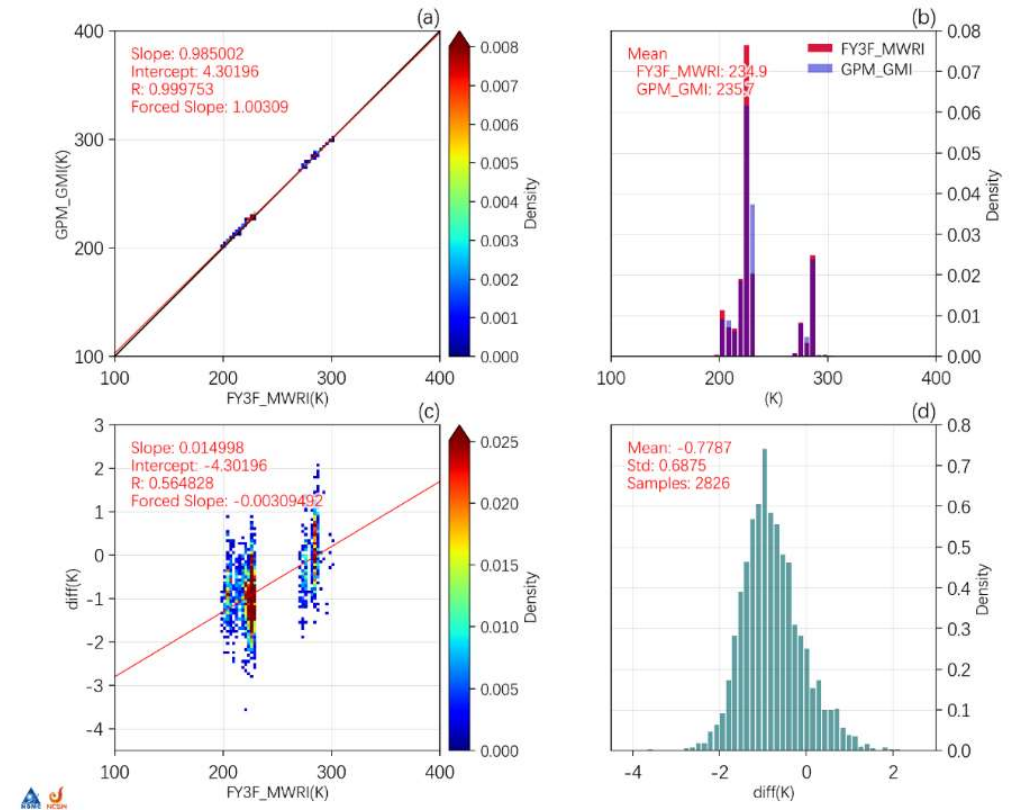


36GHz

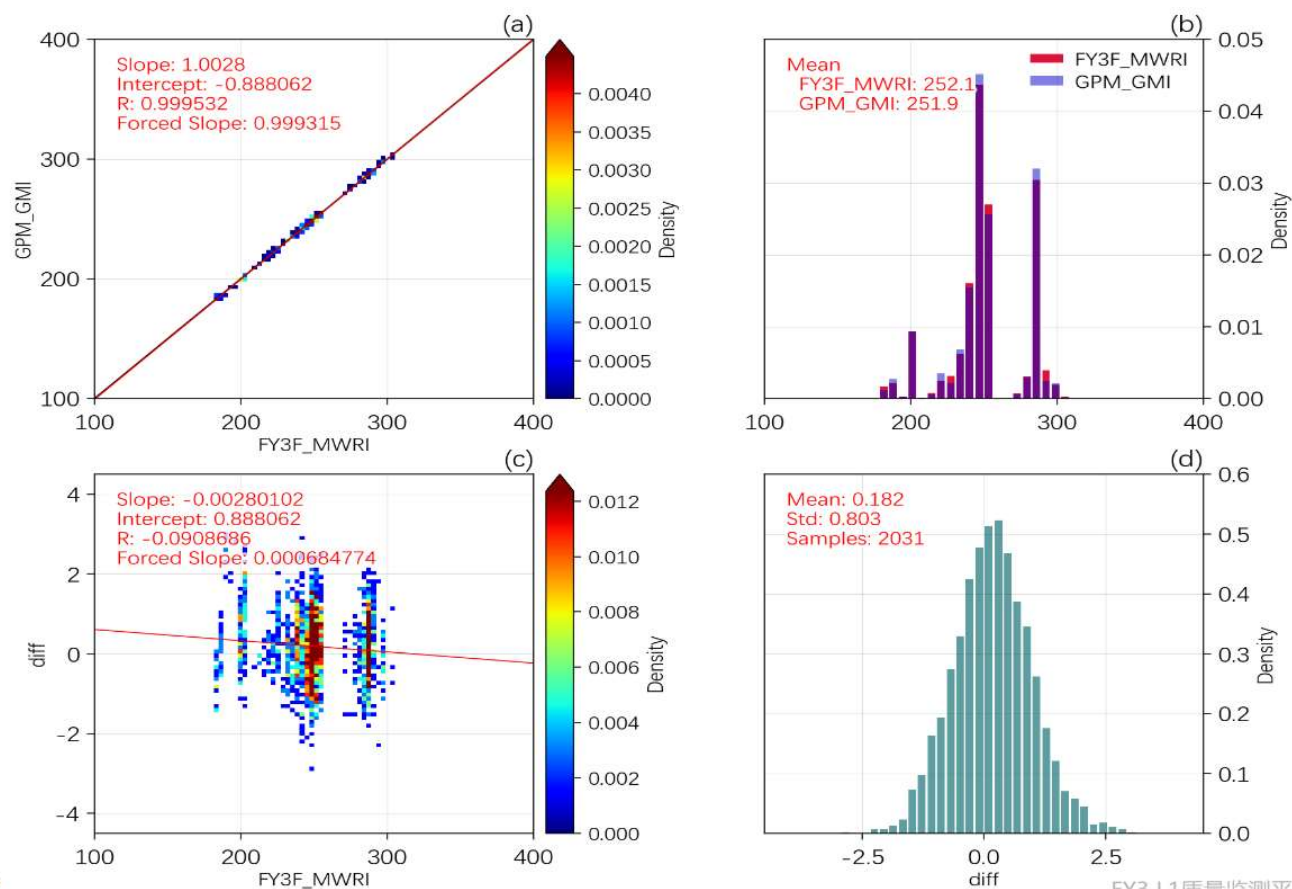
Correlation Analysis of Bright Temperature 2023-08-20~2023-10-14
FY3F_MWRI_GPM_GMI. 36.5H



Correlation Analysis of Bright Temperature 2023-08-20~2023-10-14
FY3F_MWRI_GPM_GMI. 36.5V



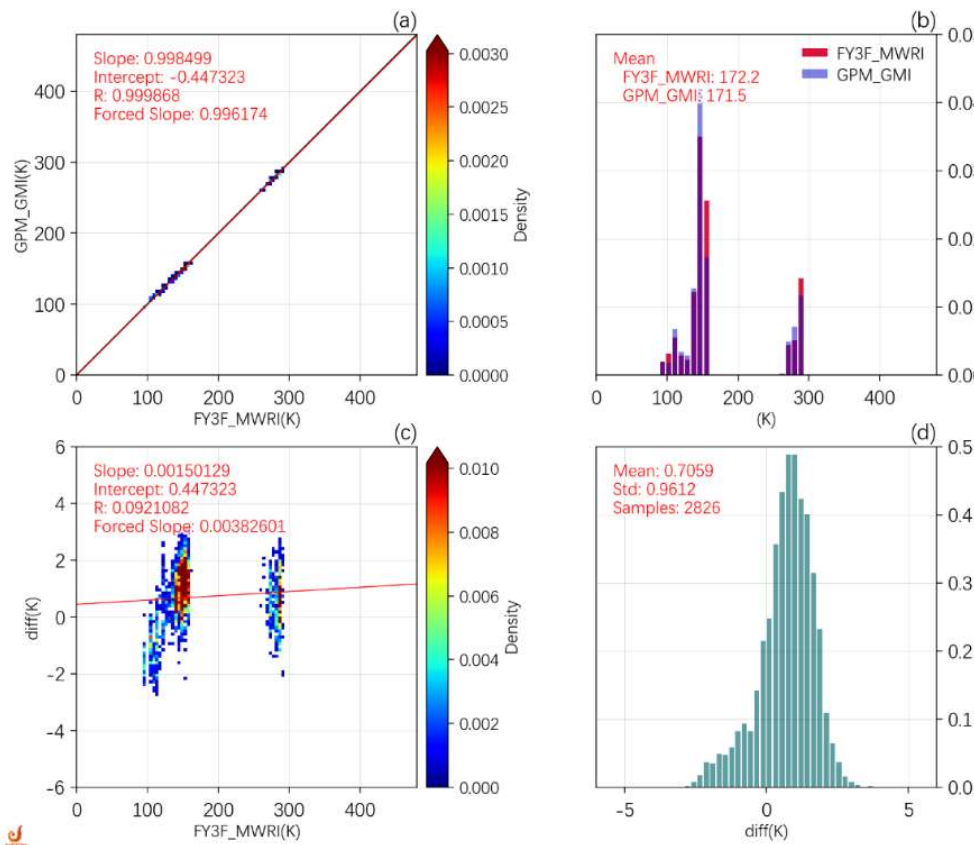
Correlation Analysis of Bright Temperature 2023-08-15~2023-09-20
FY3F_MWRI_GPM_GMI. 23.8V



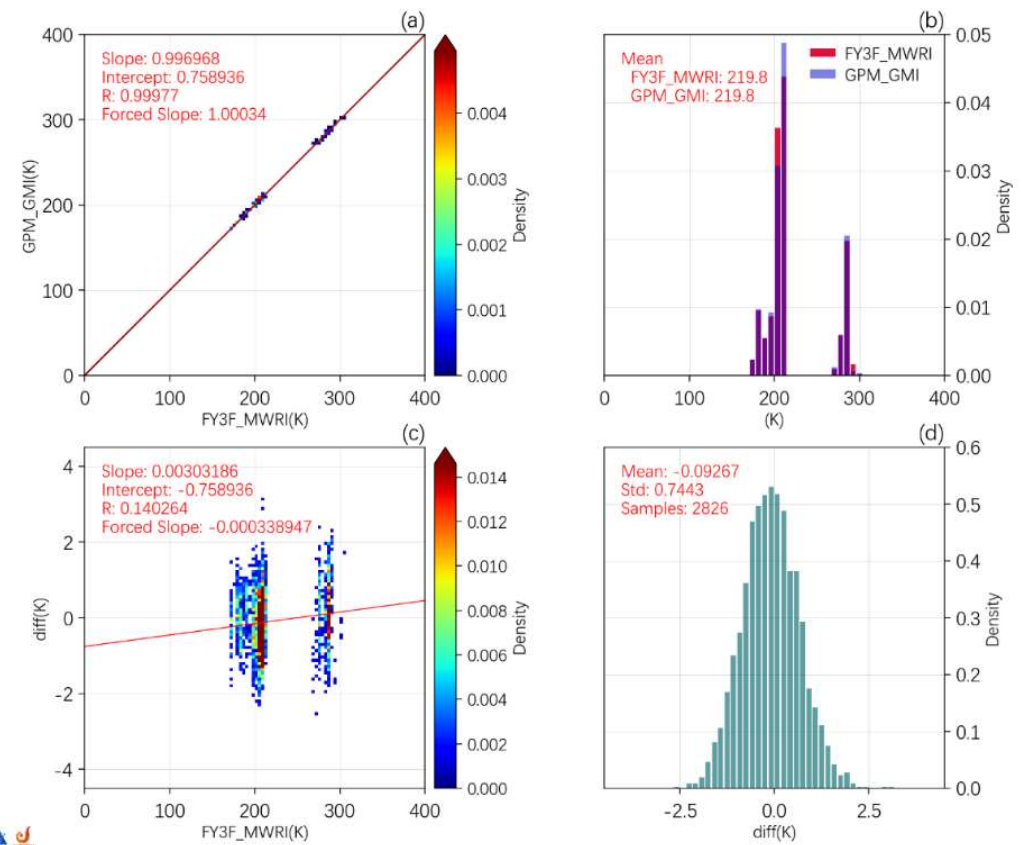


18GHz

Correlation Analysis of Bright Temperature 2023-08-20~2023-10-14
FY3F_MWRI_GPM_GMI. 18.7H



Correlation Analysis of Bright Temperature 2023-08-20~2023-10-14
FY3F_MWRI_GPM_GMI. 18.7V

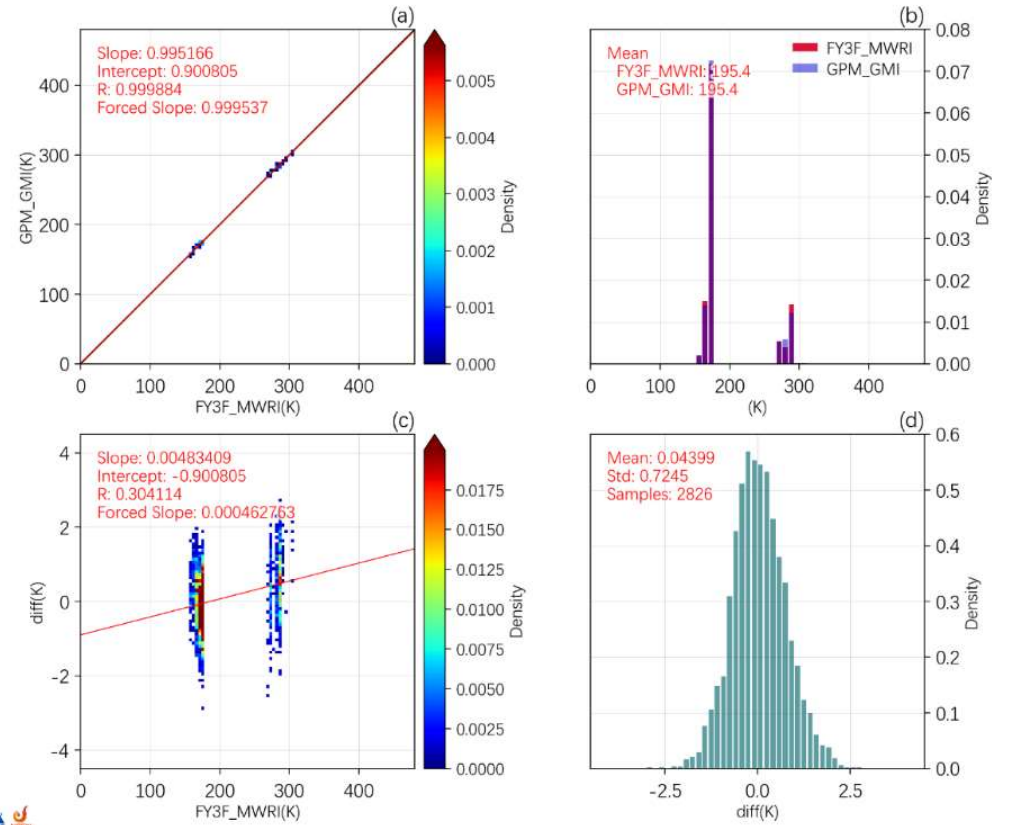
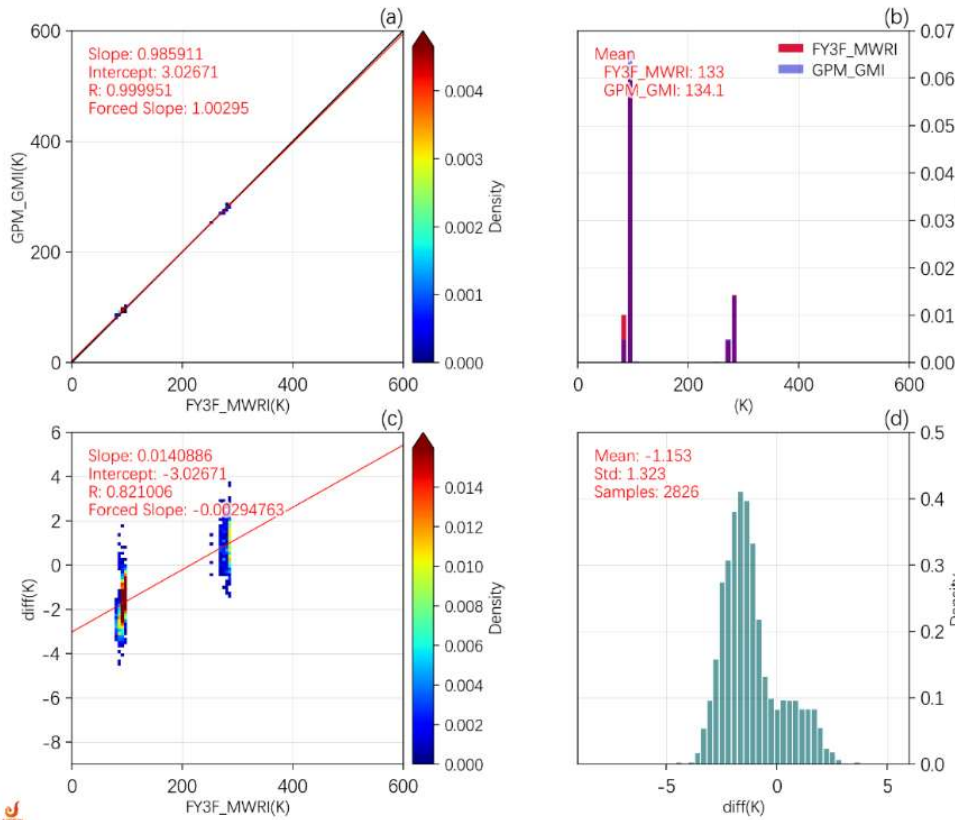




10GHz

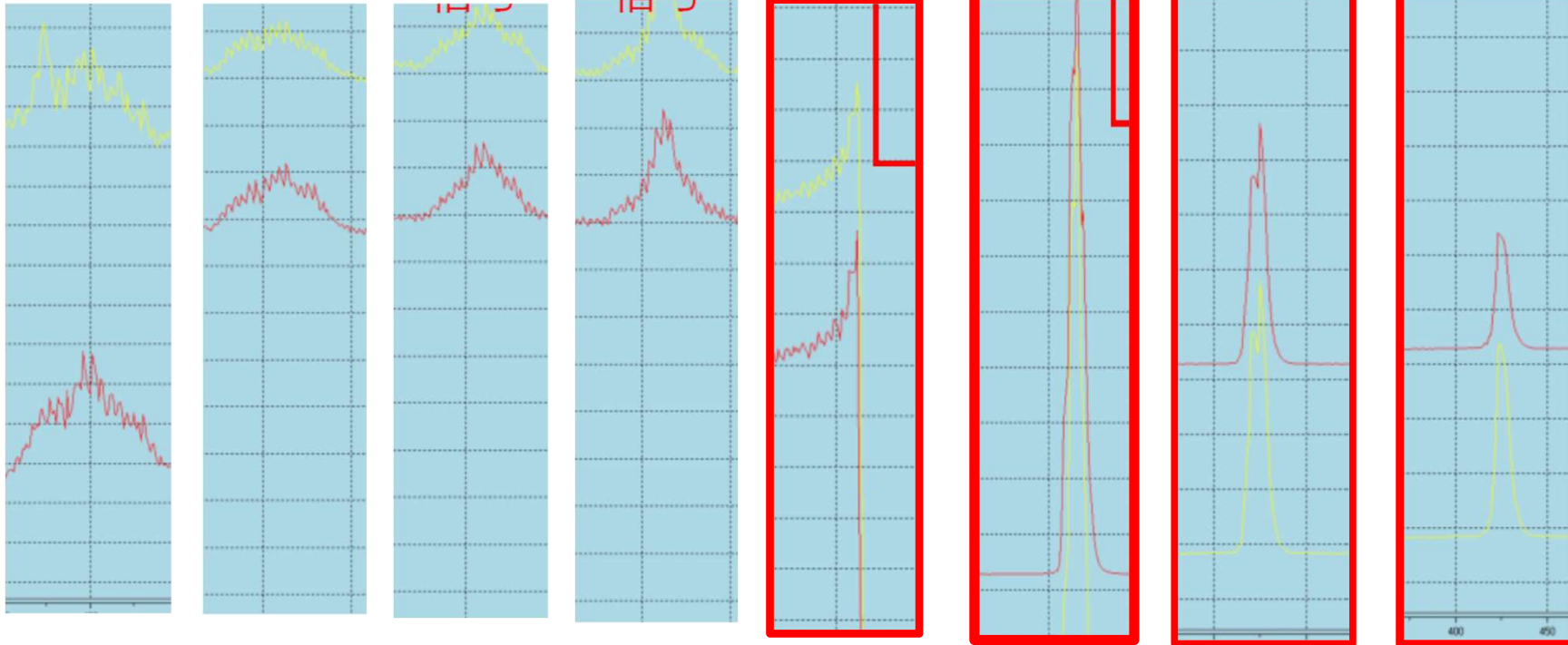
Correlation Analysis of Bright Temperature 2023-08-20~2023-10-14
FY3F_MWRI_GPM_GMI. 10.65H

Correlation Analysis of Bright Temperature 2023-08-20~2023-10-14
FY3F_MWRI_GPM_GMI. 10.65V





RFI like intrusion for 36GHz Channel



36V:225K	36V:230K	36V:235K	36V:245K	36V:10e4K	36V:10e5K	36V:265K	36V:240K
36H:175K	36H:180K	36H:185K	36H:195K	36H:10e4K	36H:10e5K	36H:215K	36H:190K

RFI like intrusion for 36GHz Channel

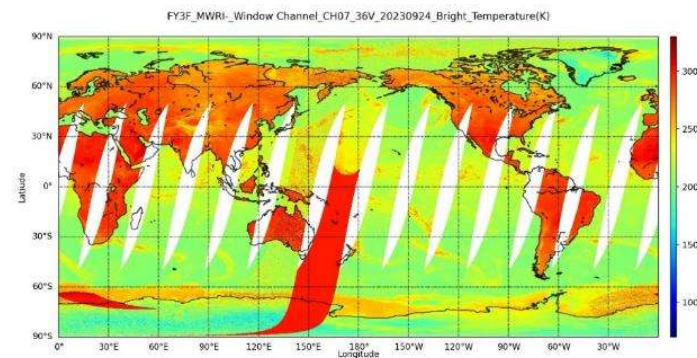
2023.09.24 22:11; 2023.11.11 22:03; 2023.11.26 22:45
 (167.6°E, 9.4°N); (167.5°E, 9.3°N); (168.6°E, 8.9°N)

Very high energy intrusion into the receiver of 36Ghz (>10e5 K)

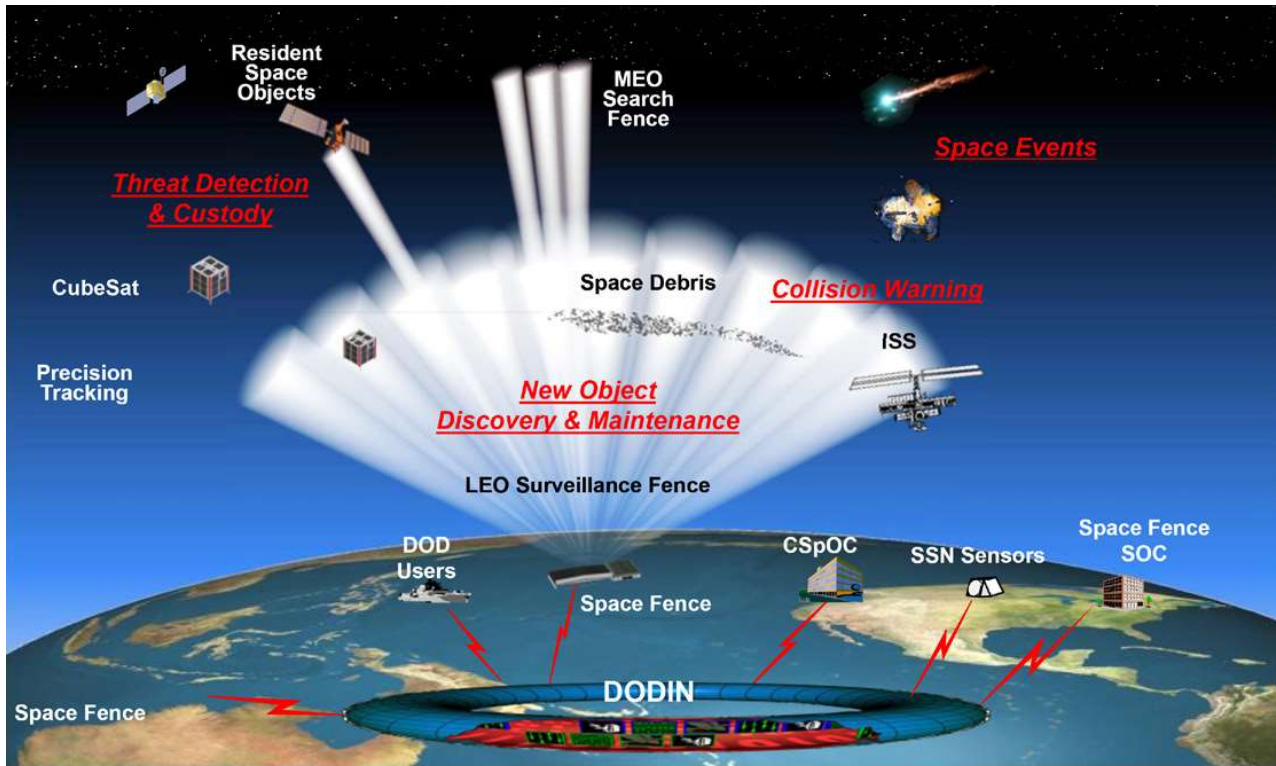
The receiver cannot automate recover.
 Need to reboot the receiver manually.

Marshall Islands

Kwajalein Atoll



Space Fence



Legend

- CSPOC - Combined Space Operations Center
- DOD - Department of Defense
- DODIN - Department of Defense Information Network
- ISS - International Space Station
- LEO - Low Earth Orbit
- MEO - Medium Earth Orbit
- SOC - Space Fence Operation Center
- SSN - Space Surveillance Network

The Space Fence will use [S-band](#) radar and will track a larger number of small objects than previous space radars: "about 200,000 objects and make 1.5 million observations per day, about 10 times the number" made by existing or recently retired US assets.^[1] The initial space fence facility was to be located at [Kwajalein Atoll](#) in the [Marshall Islands](#),^[1] along with an option for another radar site in [Western Australia](#).^{[2][3]} The [U.S. Space Force](#) declared the system operational on March 28, 2020.^[4]

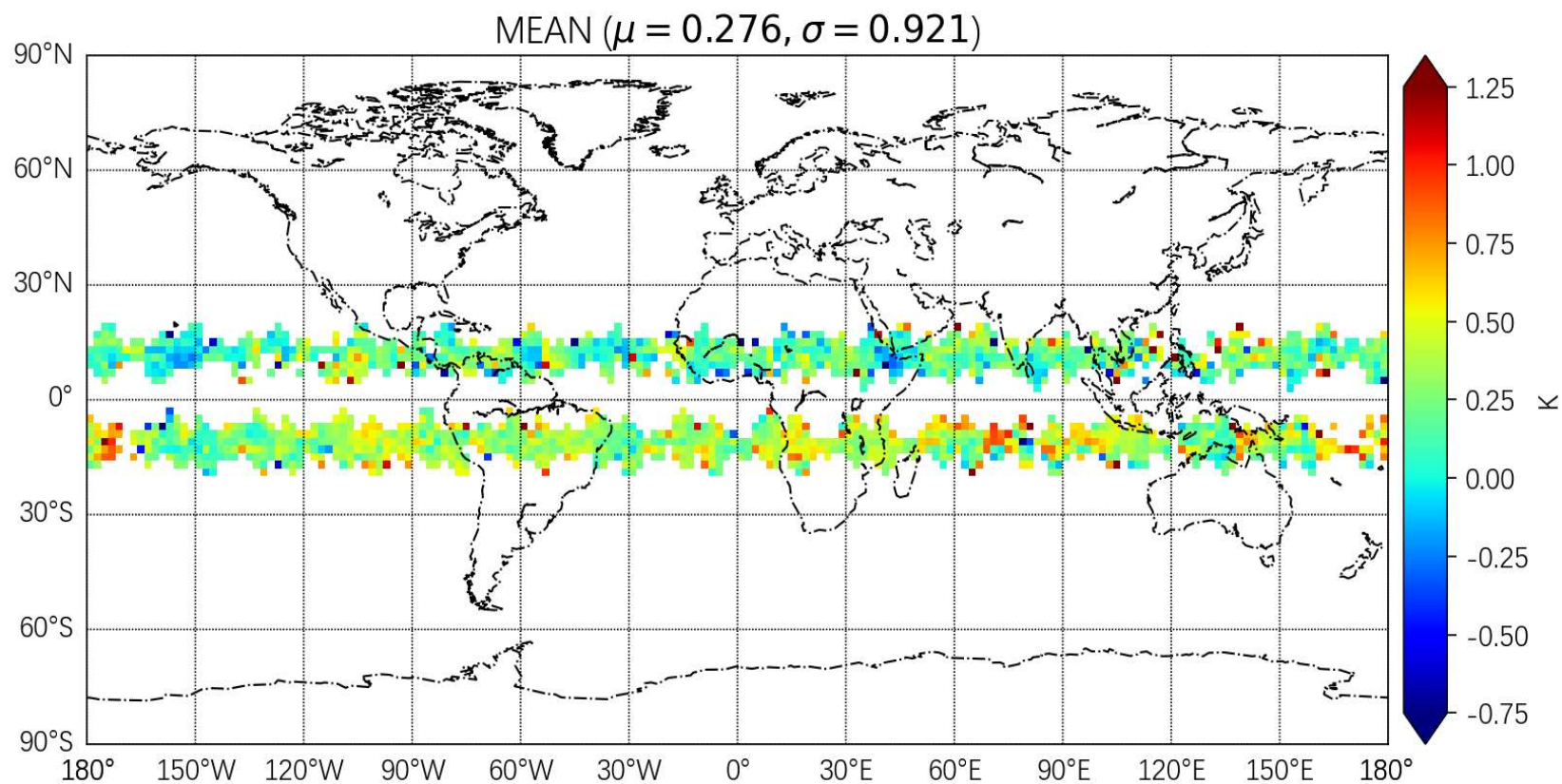
[1] Gruss, Mike (2014-11-21). "[Haney: U.S. Partners To Have Indirect Access to Space Fence Data](#)". Space News. Archived from [the original](#) on December 1, 2014. Retrieved 2014-12-01.

[2] by Debra Werner — April 11, 2019, SpaceNews.com

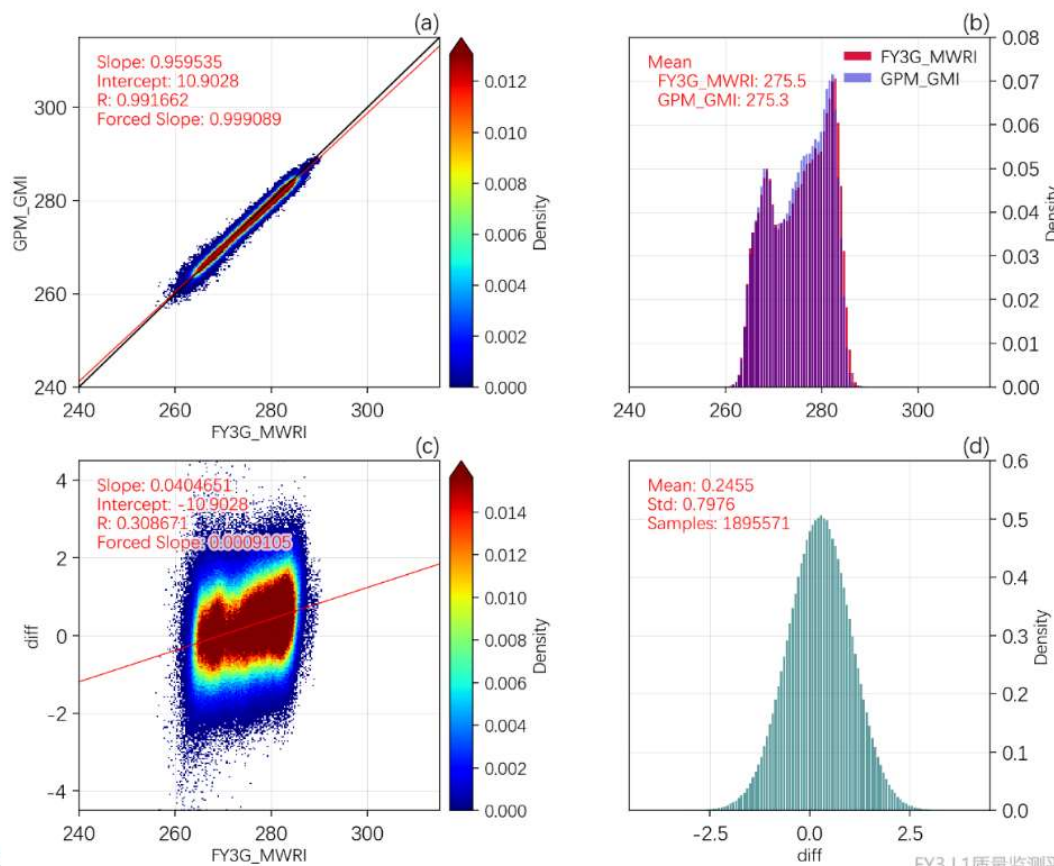
[3] Clark, Stephen (2014-06-02). "[Lockheed Martin wins contract for Space Fence](#)". Spaceflight Now. Retrieved 2014-12-01.

[4] Erwin, Sandra (March 28, 2020). "[Space Fence surveillance Radar Site Declared Operational](#)". Retrieved March 29, 2020.

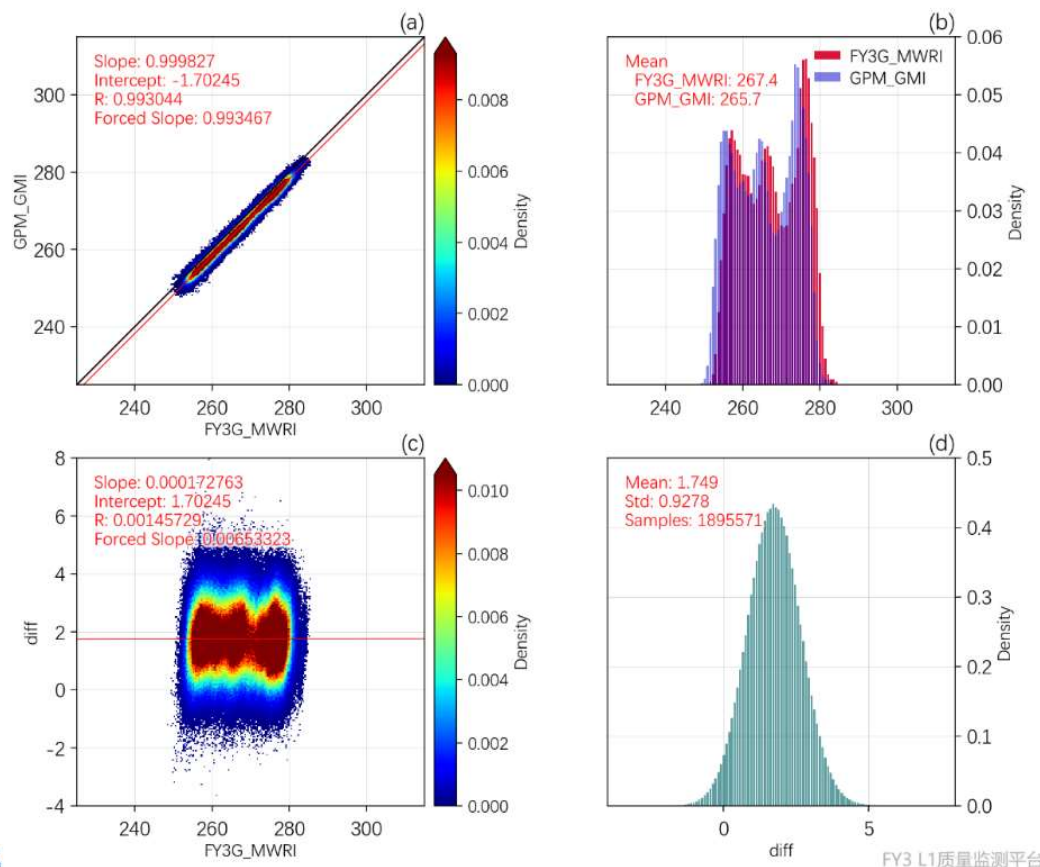
Spatial Distribution of Bright Temperature (FY3G_MWRI-GPM_GMI) 2023-06-26~2023-07-24
FY3G_MWRI_GPM_GMI. 166-1V



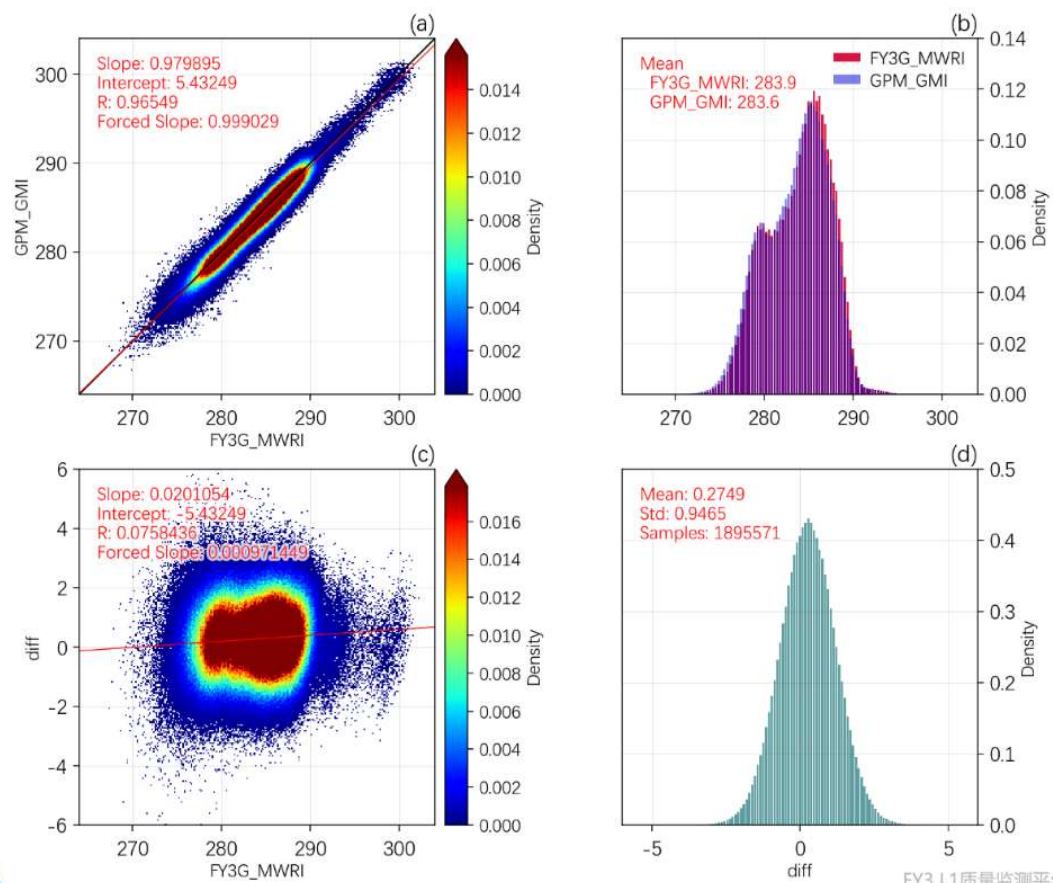
Correlation Analysis of Bright Temperature 2023-06-26~2023-07-24
FY3G_MWRI_GPM_GMI. 183-3V



Correlation Analysis of Bright Temperature 2023-06-26~2023-07-24
FY3G_MWRI_GPM_GMI. 183-2V



Correlation Analysis of Bright Temperature 2023-06-26~2023-07-24
FY3G_MWRI_GPM_GMI. 166-1V

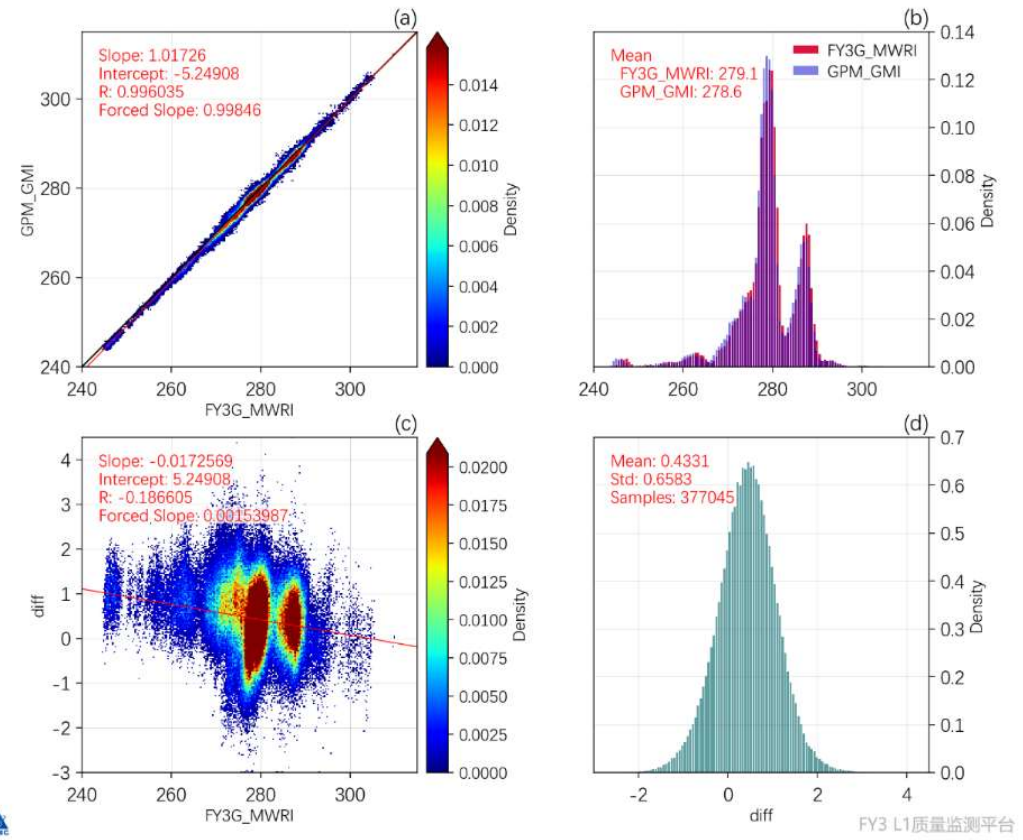
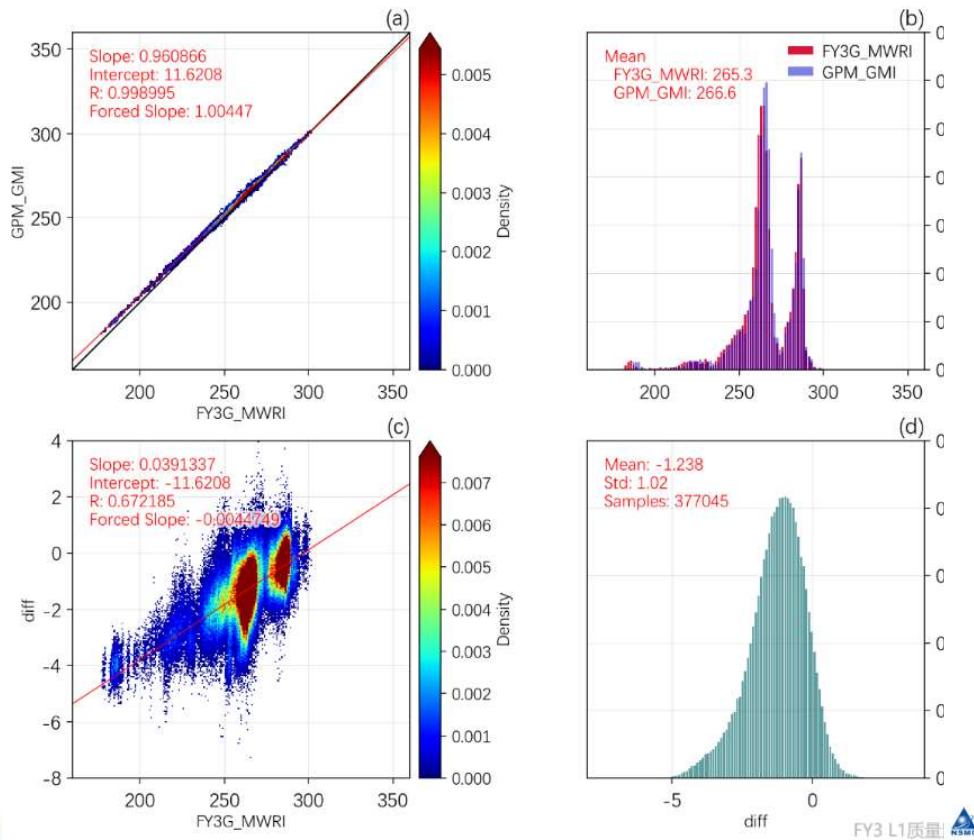




89GHz

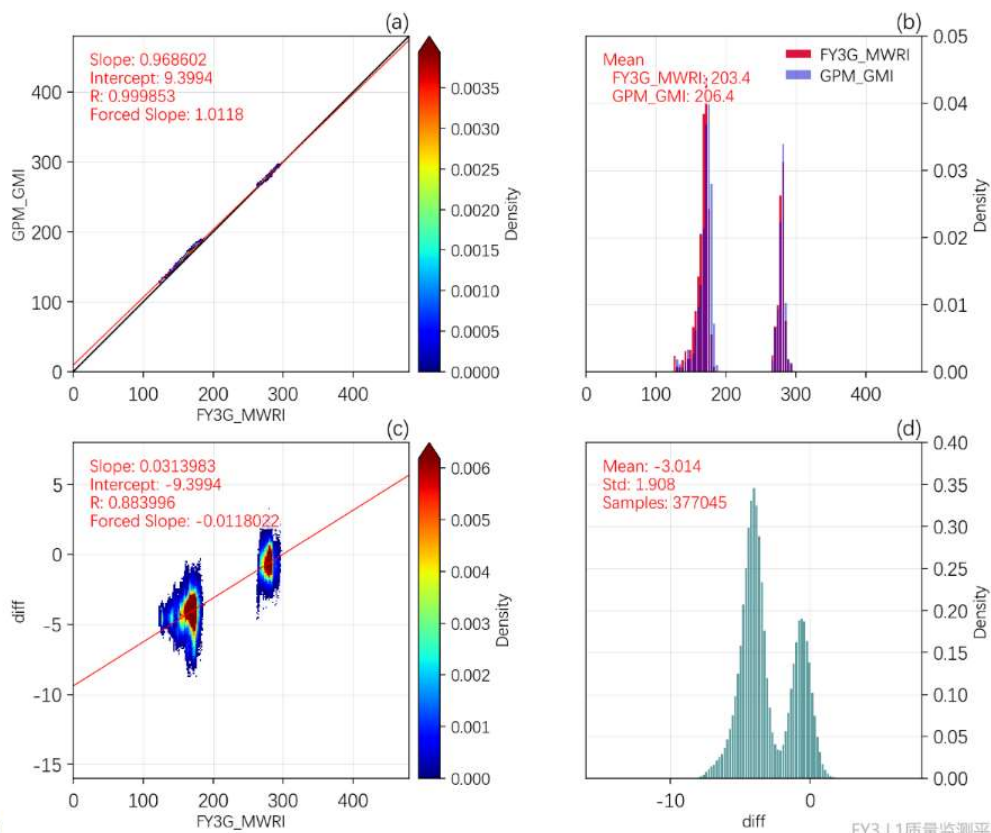
Correlation Analysis of Bright Temperature 2023-06-26~2023-07-24
FY3G_MWRI_GPM_GMI. 89H

Correlation Analysis of Bright Temperature 2023-06-26~2023-07-24
FY3G_MWRI_GPM_GMI. 89V

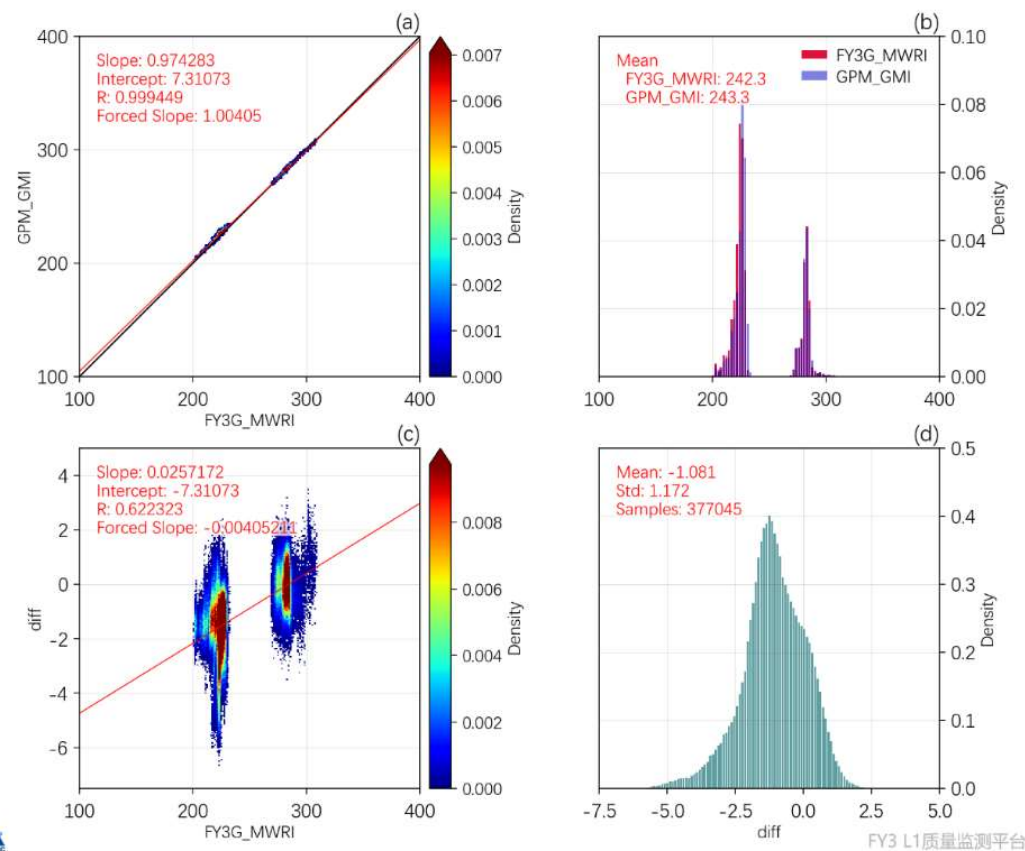


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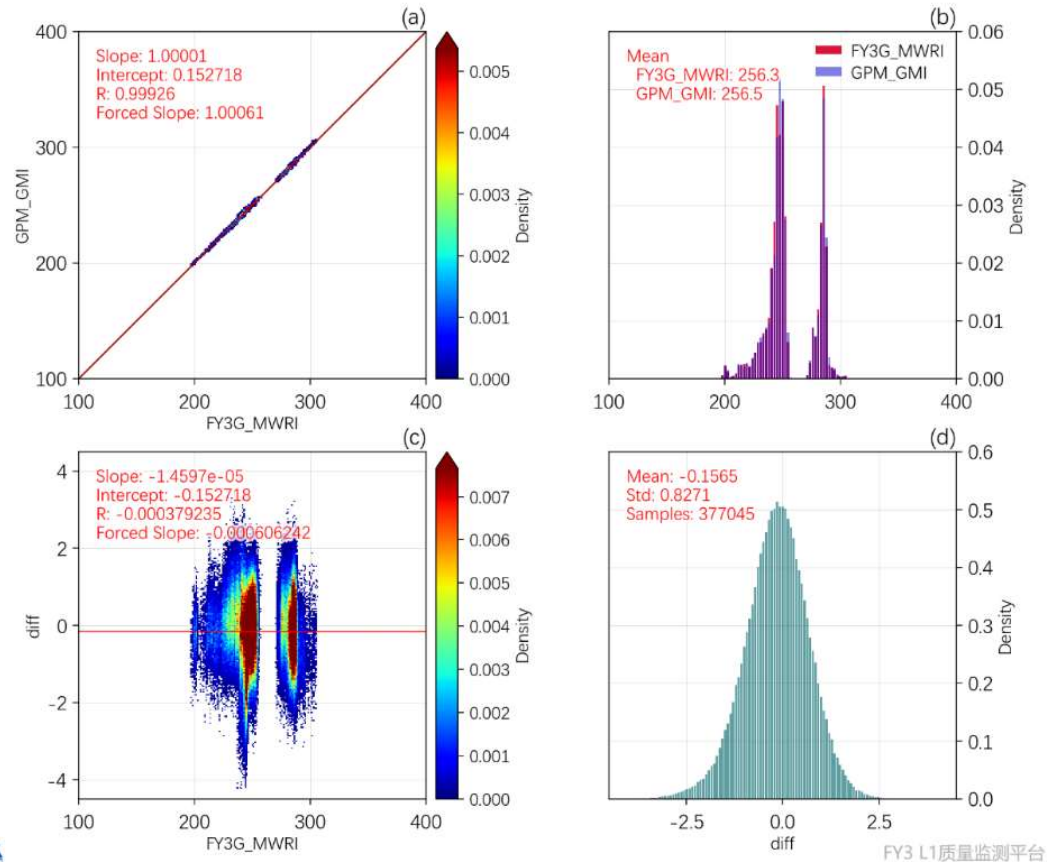
Correlation Analysis of Bright Temperature 2023-06-26~2023-07-24
FY3G_MWRI_GPM_GMI. 36.5H



Correlation Analysis of Bright Temperature 2023-06-26~2023-07-24
FY3G_MWRI_GPM_GMI. 36.5V



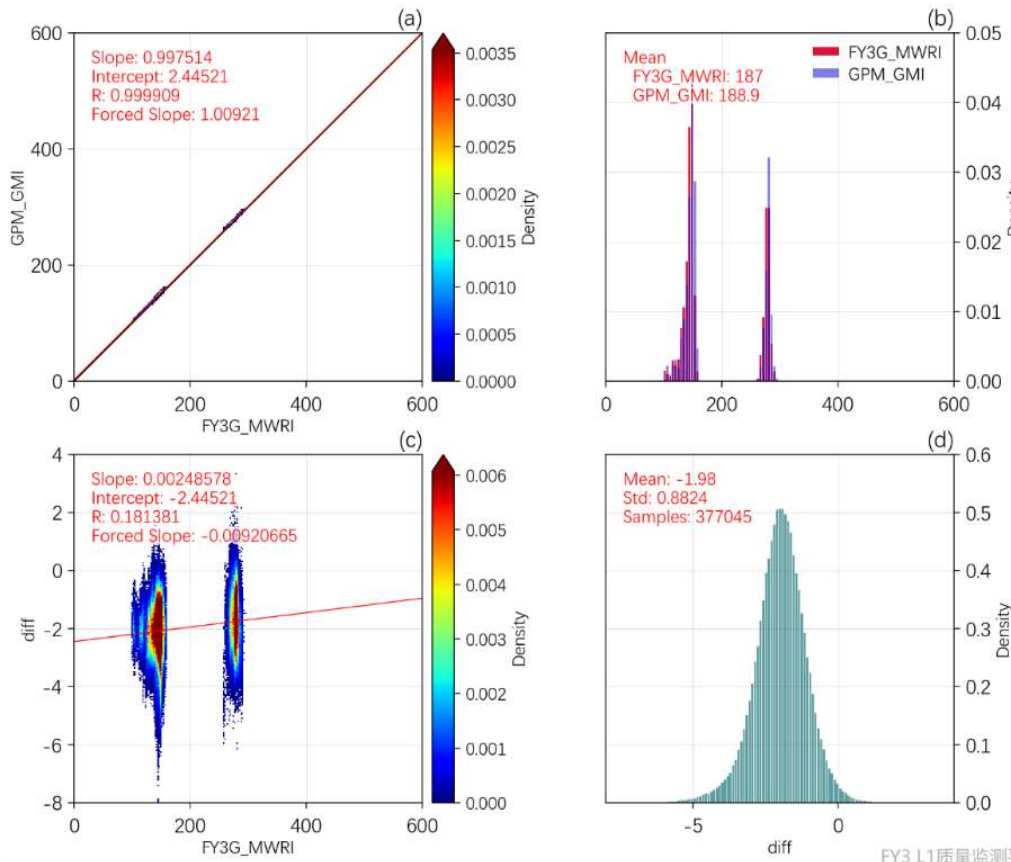
Correlation Analysis of Bright Temperature 2023-06-26~2023-07-24
FY3G_MWRI_GPM_GMI. 23.8V



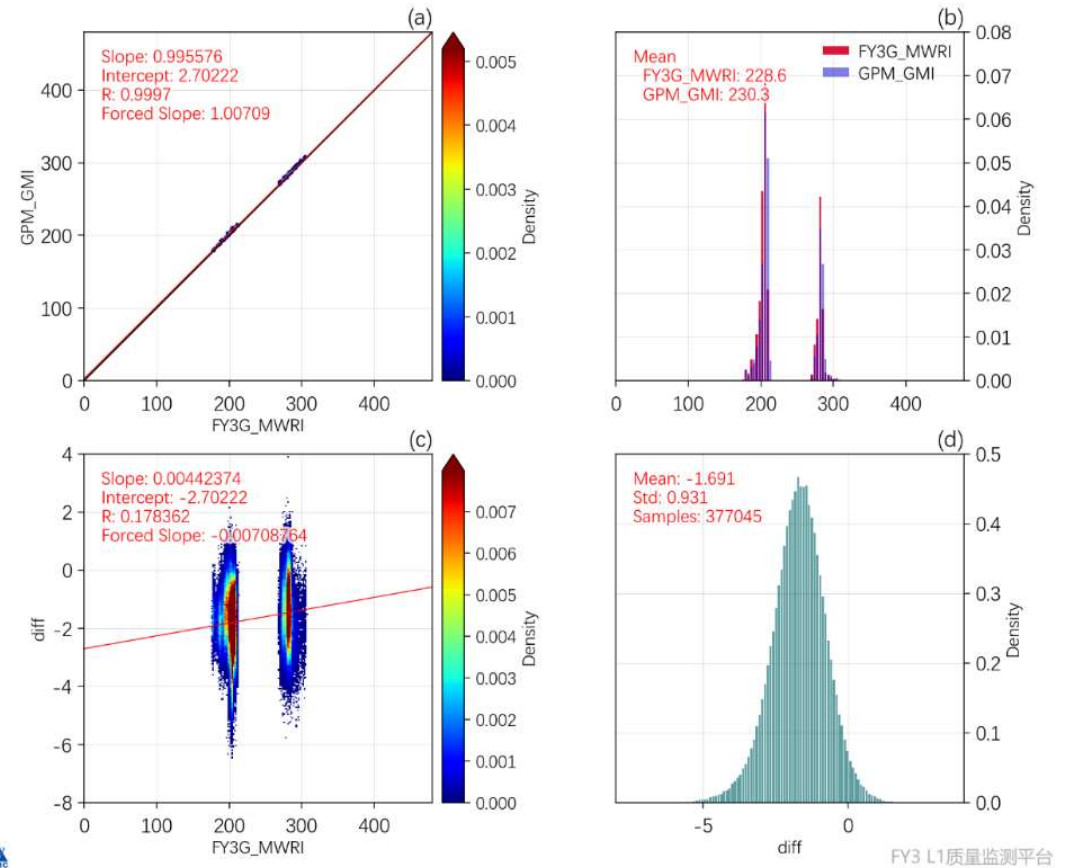


18GHz

Correlation Analysis of Bright Temperature 2023-06-26~2023-07-24
FY3G_MWRI_GPM_GMI. 18.7H



Correlation Analysis of Bright Temperature 2023-06-26~2023-07-24
FY3G_MWRI_GPM_GMI. 18.7V

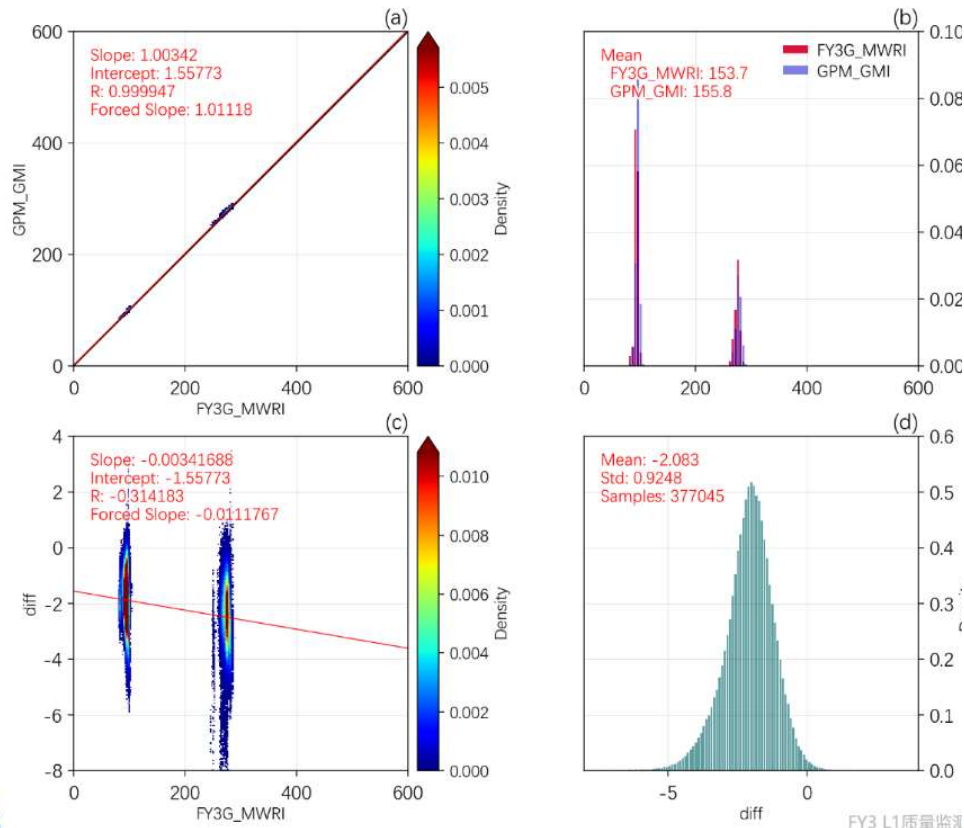




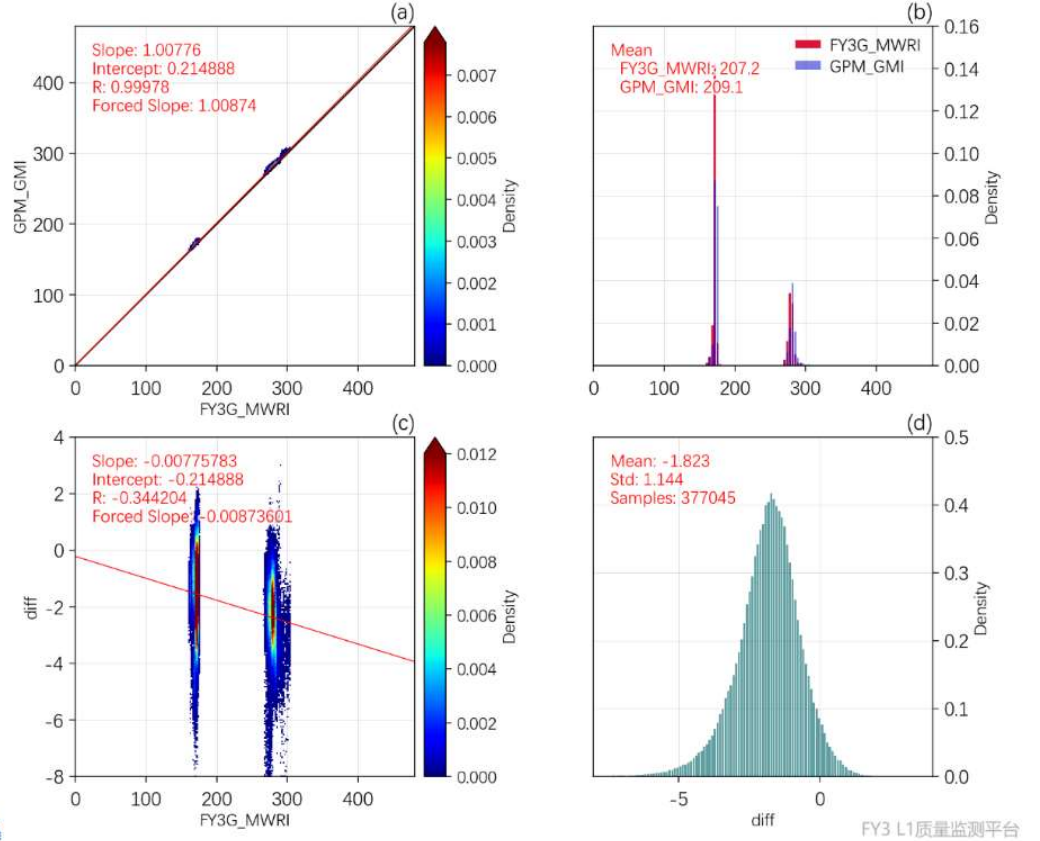
10GHz

Correlation Analysis of Bright Temperature 2023-06-26~2023-07-24
FY3G_MWRI_GPM_GMI. 10.65H

Correlation Analysis of Bright Temperature 2023-06-26~2023-07-24
FY3G_MWRI_GPM_GMI. 10.65V

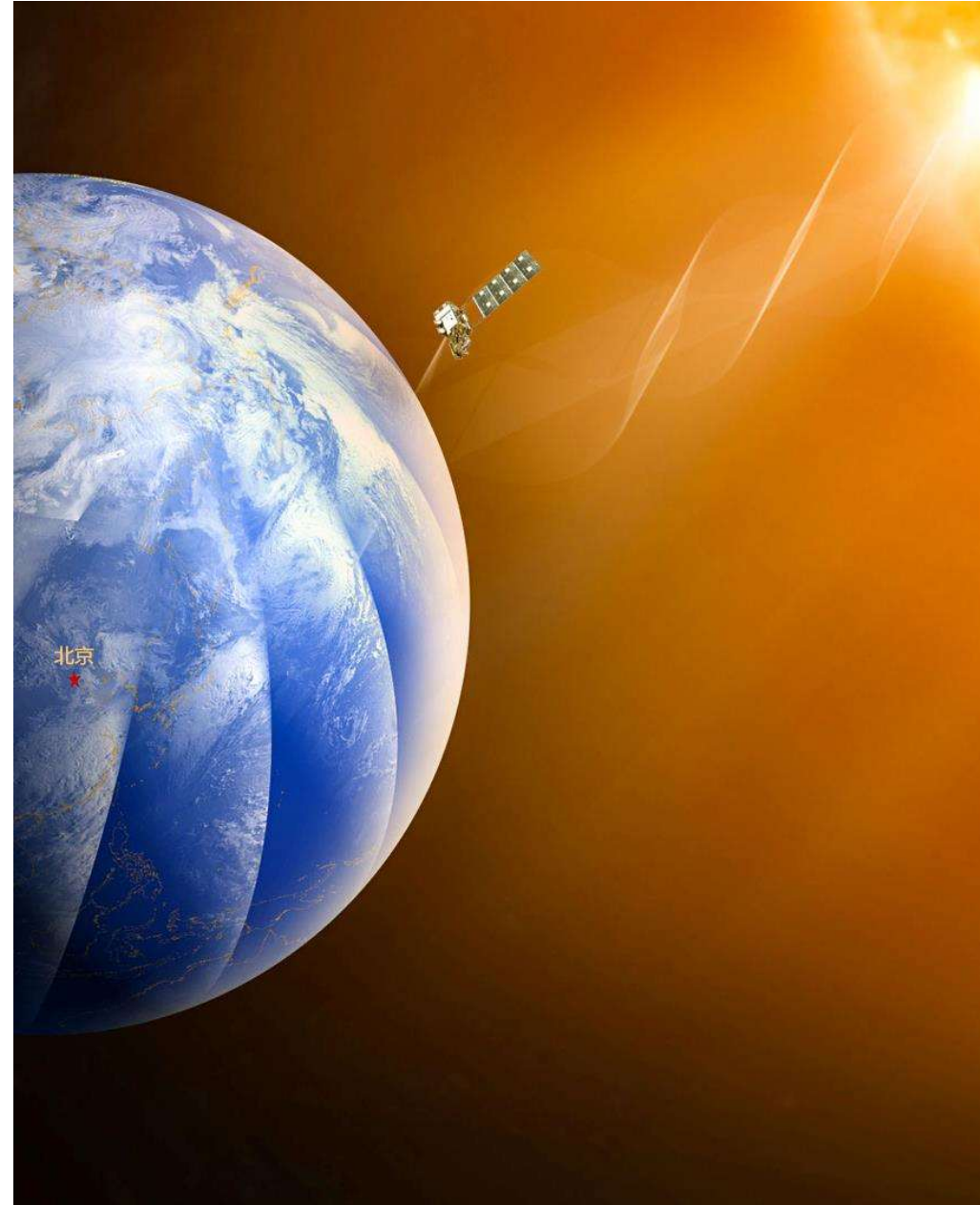


FY3 L1 质量监测



FY3 L1 质量监测平台

- 01 Background
- 02 Performance
- 03 **Conclusion**





Conclusion

- **MWRI-II onboard FY-3F and MWRI-RM onboard FY-3G have been successfully launched in 20230803 and 20230416;**
- **FY-3F/MWRI-II is a 22 channels morning orbit microwave imager;**
- **FY-3G/MWRI-RM is a 26 channels drift orbit microwave imager;**
- **Both 2 sensors have good condition and excellent performance (compared with MWRI onboard FY-3A/B/C/D);**
- **The RFI like intrusion of 36GHz receiver mounted on MWRI-II in Kwajalein Atoll is still under research.**



Thanks

