MicroWave Group status of CMA *2021*

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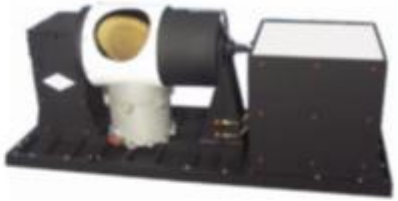
Presentation Overview

- Summary of CMA MW Group
- MWRI
- MWTS
- MWHS
- WindRAD

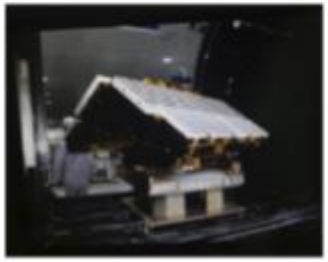
Summary of CMA MW Group

MWRI

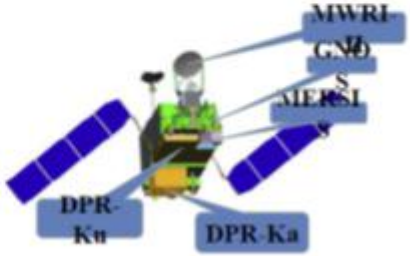
MWHS



MWTS

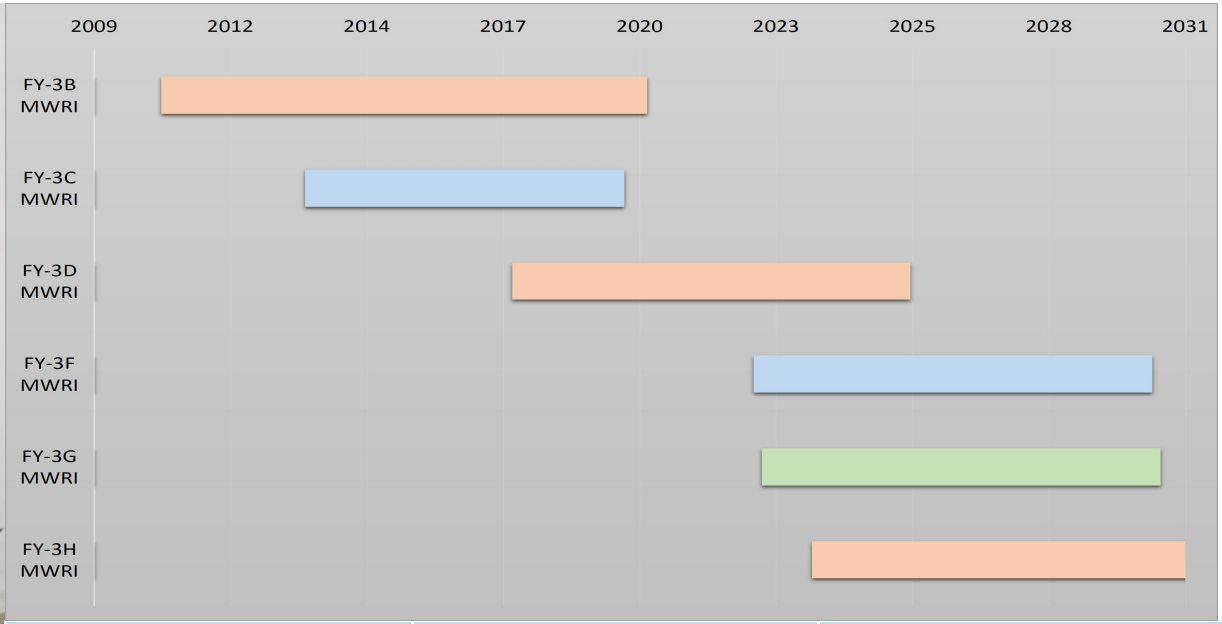


WindRAD



DPR

MWRI



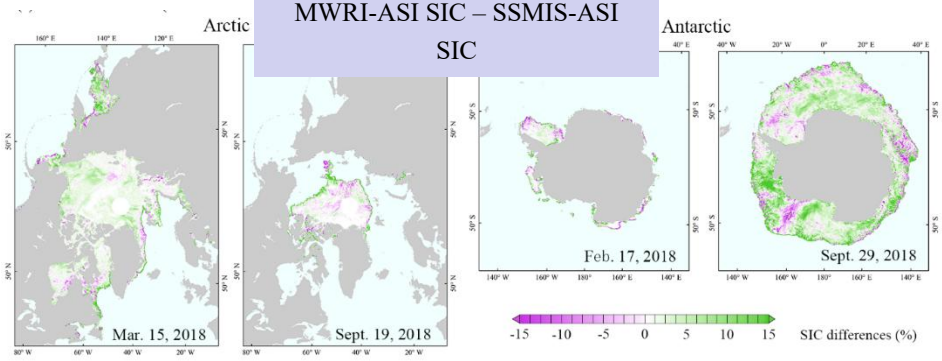
	FY-3A/B/C/D MWRI	FY-3F/G/H MWRI
Frequency（GHz）	10/18/23/36/89	10/18/23/36/50/89/118/166/183
Antenna（m）	1	1.6/1.2
NedT（K）	0.8/1.0	0.5/0.8
Accuracy（K）	2.0	0.8/1.2
Co-location（Km）	/	2
Main beam	0.9	0.95

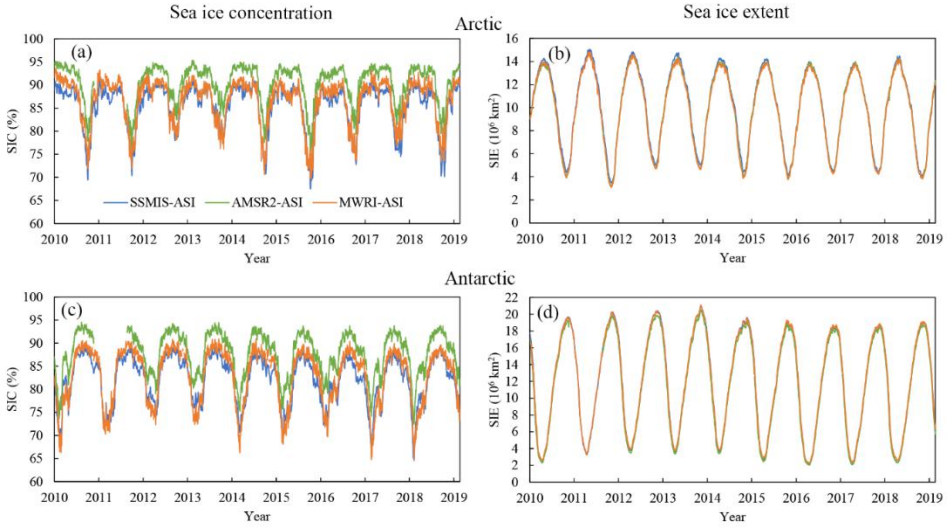
FY-3B/C/D MWRI（FCDR）

channel	Typical BT (K)	Mean of RMSE (K)		
		operational	Recal V1.0	Recal V2.0
FY-3B				
10V	166.2	5.00	5.00	1.15
10H	91.8	5.66	5.68	1.21
18V	119.4	1.91	1.87	1.26
18H	127.5	3.12	3.15	1.34
23V	224	2.51	2.46	1.29
36V	223.5	5.76	5.59	0.94
36H	172.1	1.62	2.03	1.10
89V	268.8	2.13	2.19	1.02
89H	248.8	4.24	3.85	1.34
FY-3C				
10V	166.2	5.85	5.85	0.88
10H	91.8	8.12	8.15	0.91
18V	119.4	2.27	2.72	1.07
18H	127.5	2.13	2.13	1.08
23V	224	1.95	1.95	1.10
36V	223.5	3.69	3.69	1.04
36H	172.1	2.87	2.87	1.26
89V	268.8	1.62	1.62	0.88
89H	248.8	1.38	1.38	1.15
FY-3D				
10V	166.2	5.51	5.51	0.91
10H	91.8	6.80	6.87	1.04
18V	119.4	1.32	1.33	0.93
18H	127.5	1.79	1.80	1.08
23V	224	1.41	1.45	1.02
36V	223.5	4.28	4.24	0.94
36H	172.1	4.41	4.39	1.09
89V	268.8	1.64	1.63	0.93
89H	248.8	1.82	1.76	1.33

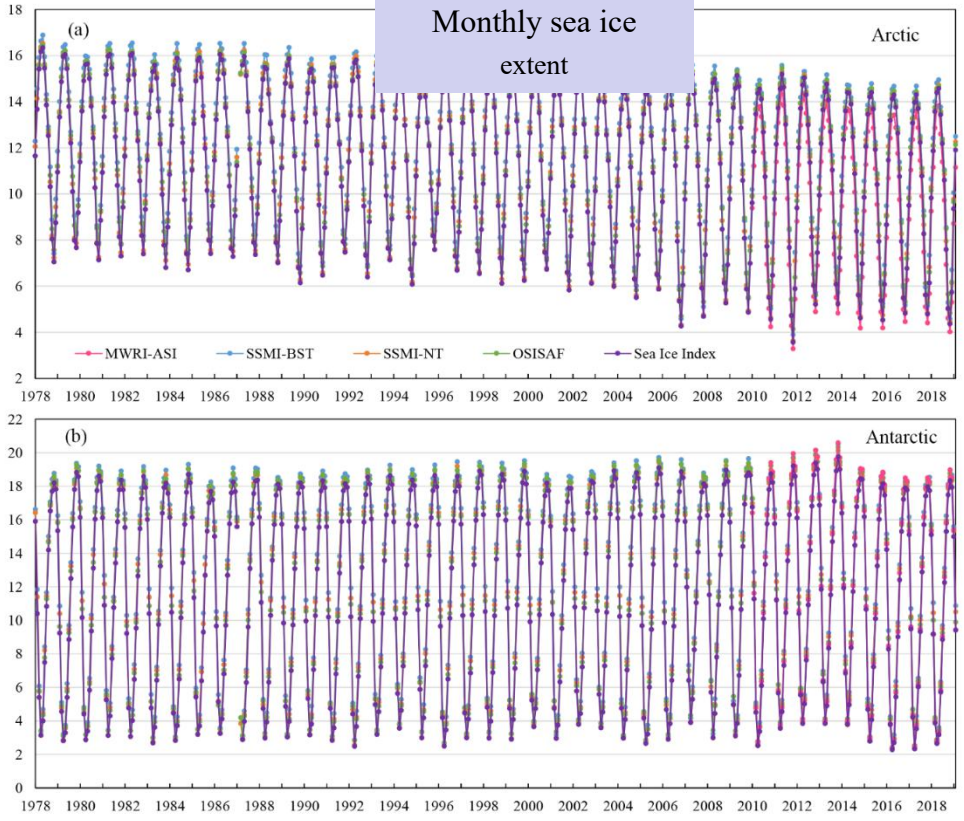
FY-3 MWRI ASI sea ice concentration

MWRI-ASI SIC – SSMIS-ASI SIC





Monthly sea ice extent

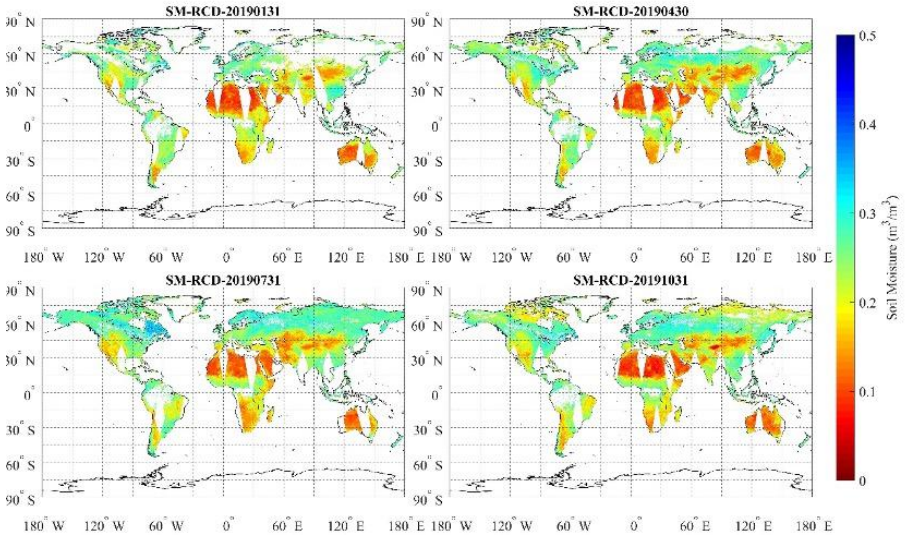


(e)	SIC (%)			
	Arctic		Antarctic	
	SSMI-ASI	AMSR-ASI	SSMI-ASI	AMSR-ASI
Bias	1.1	-4.0	0.8	-4.7
MAD	1.4	4.0	1.7	4.7
Std	1.3	1.4	1.8	1.8
R	0.96	0.97	0.96	0.97

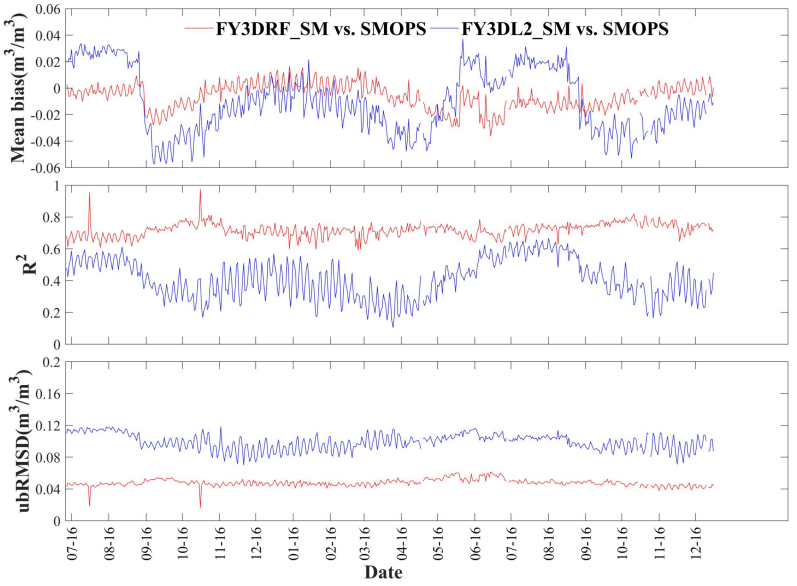
MWRI-ASI SIC has lower difference with SSMI ASI SIC

Zhao, Chen, Wu (In prep.)

FY-3 MWRI Global Soil Moisture (NUIS)



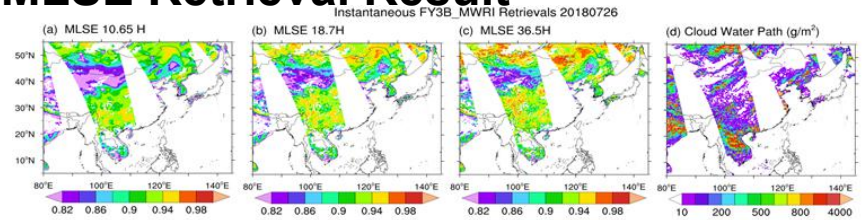
Global soil moisture maps retrieved based on RCD on (a) January 31, (b) April 40, (c) July 31, and (d) October 31, 2019



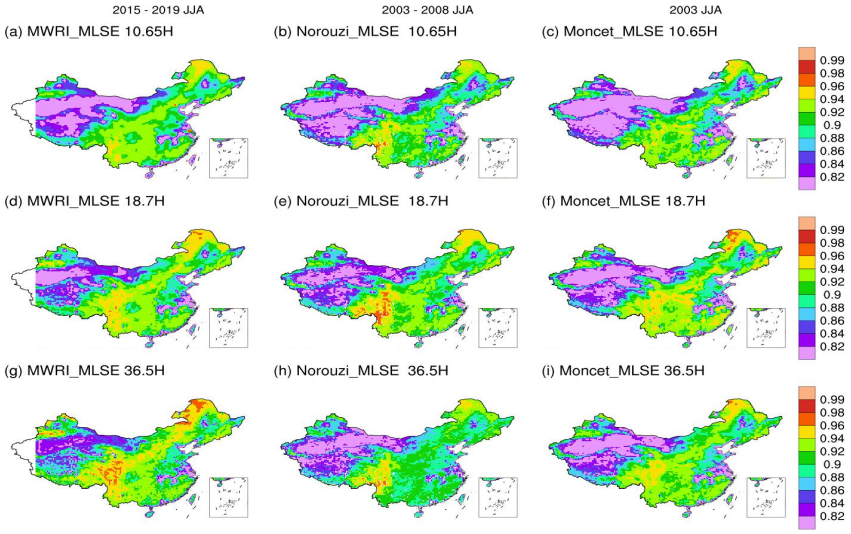
Validation of soil moisture retrieved using RCD (red line) and FY-3D L2 (blue line) based on SMOPS products

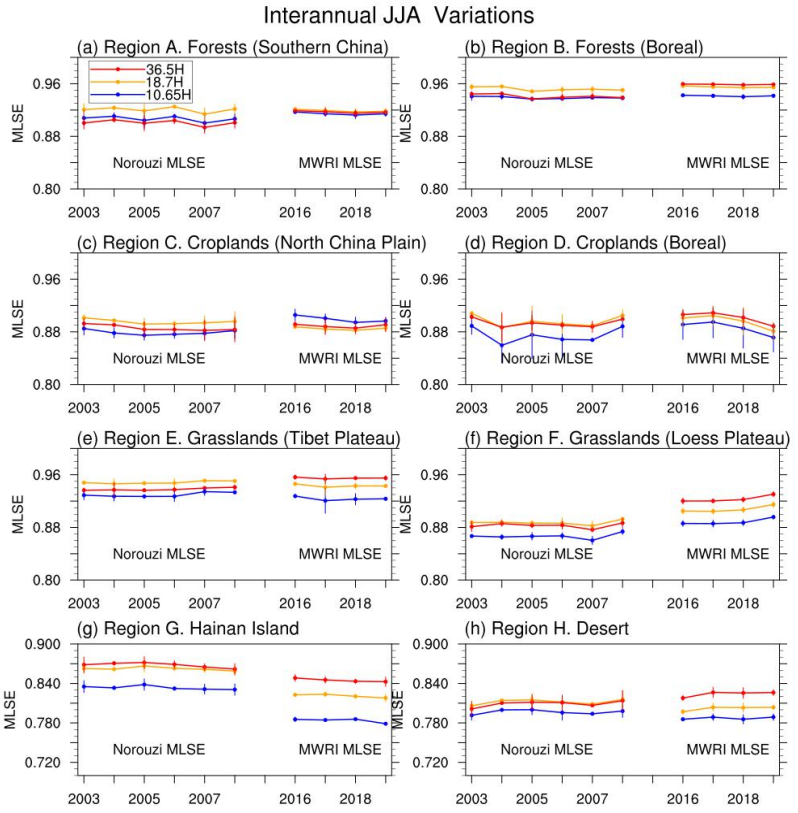
FY-3 MWRI MLSE

MLSE Retrieval Result



MLSE Retrieval Result (average)



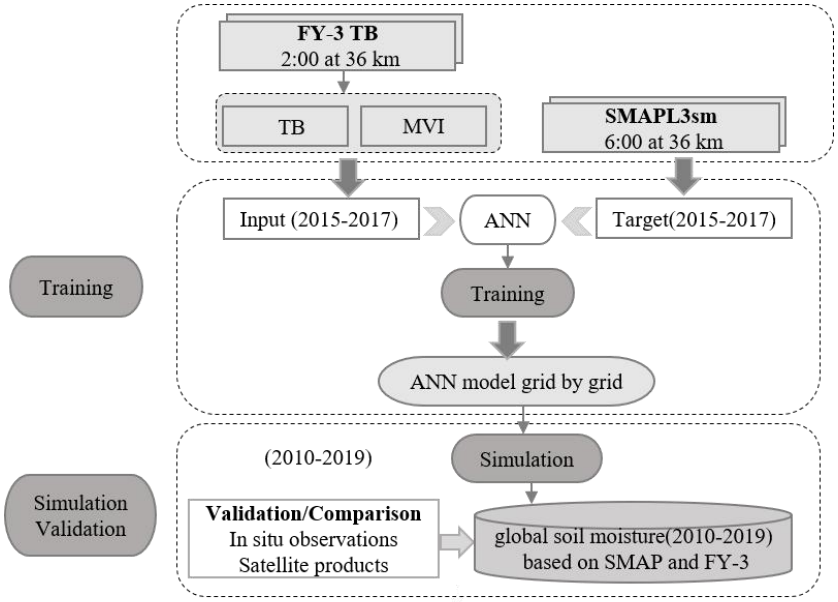


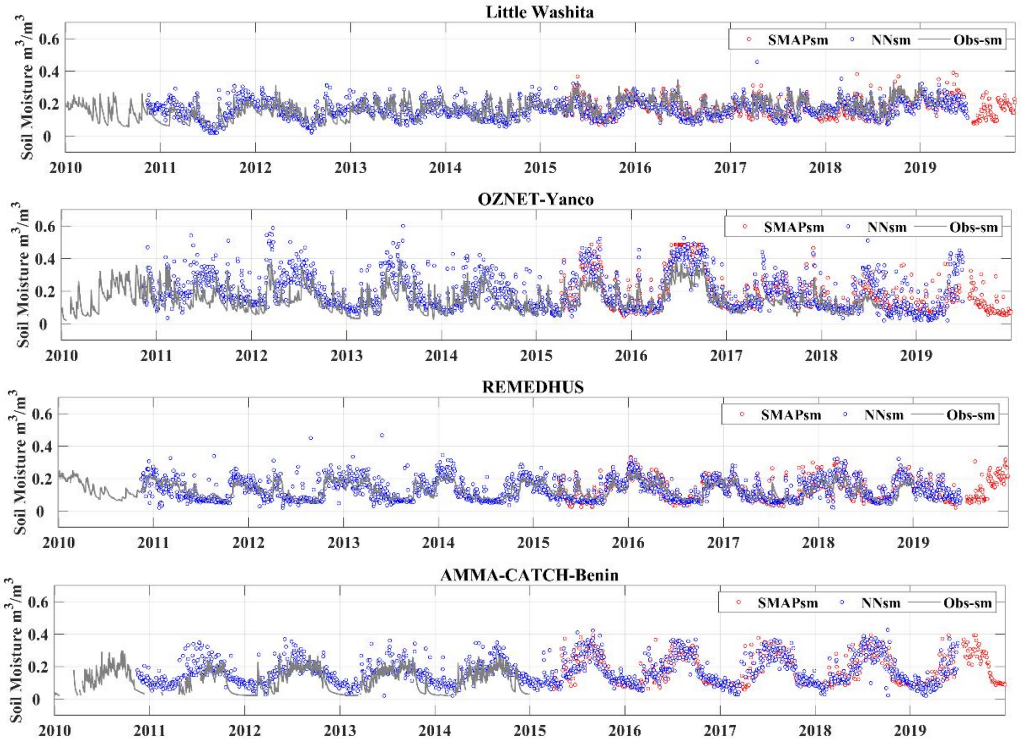
Hu et al., 2021, Satellite Retrieval of Microwave Land Surface Emissivity under Clear and Cloudy Skies in China Using Observations from AMSR-E and MODIS. Remote Sensing. https://doi.org/10.3390/rs13193980

Li et al., 2021, Spatiotemporal Variations of Microwave Land Surface Emissivity (MLSE) over China derived from 4-Year Recalibrated Fengyun 3B MWRI data. Advances in Atmospheric Sciences (minor revision)

A global daily soil moisture dataset derived from FY-3B MWRI and SMAP(2010-2019)

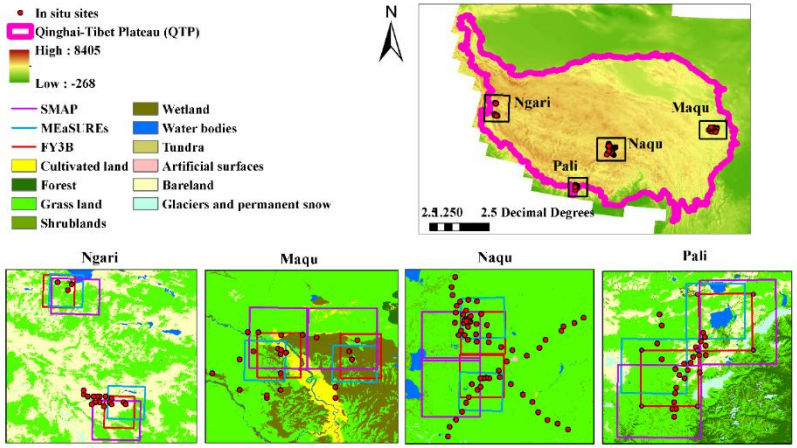
- Selected SMAP SSM as reference， using artificial neural networks (ANN)approach, and FY-3B MWRI TB data with as input, intend to transfer high accuracy in soil moisture of L band to C/X band





- The trend of FYNNsm(Blue) is consistent with that of SMAPsm(red)and in situ SM (Obs-sm,grey), and FYNNsm well capture the temporal dynamic and annual variation of in situ SM. The performance of FYNNsm relative to Obs-sm is similar to SMAP as shown over most sites.

F/T detection Using MWRI



Study area	Time range	F/T products	Time range
Ngari	2010.7-2019	AMSR	2010.1-2019.12
Mqau	2008.6-2019	FY-3B(3D)	2010.11-2019.6 2017.12-2019.12
Naqu	2010.8-2016.12, 2017.12-2019.12	MEaSUREs	2010.1-2019.12
Pali	2015.6-2016.12, 2017.12-2019.12	SMAP	2015.4-2019.12

➢ Accuracy and performance:

F/T algorithm	Seasons				Overall
	Spring	Summer	Autumn	Winter	
New (FY-3D)	68%	97%	77%	91%	83.49%
AMSR2	56%	92%	69%	89%	76.74%
SMAP	67%	87%	85%	93%	83.03%
MEaSUREs	37%	85%	45%	94%	65.99%

Evaluation： **New (FY-3D)>SMAP>AMSR2>MEaSUREs**

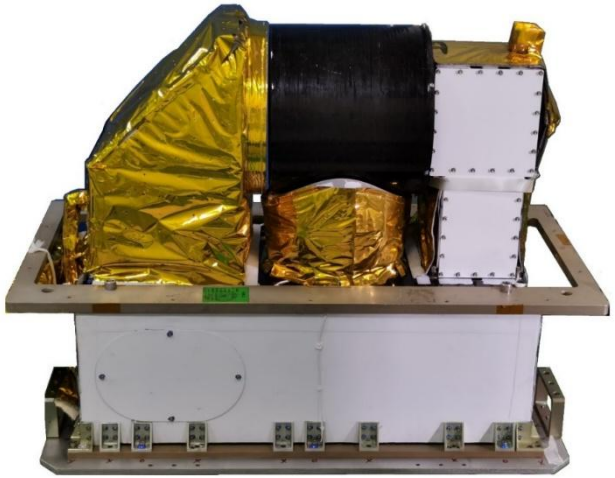
- **L-band is more sensitive to F/T detection;**
- **The new algorithm developed in this study improves the F/T monitoring capability with high frequencies.**

FY-3E Microwave Temperature Sounder-III (MWTS-III)

MWTS – III is the third generation microwave sounder for atmospheric temperature profiles.

With more channels and higher requirements than before, MWTS-III onboard FY-3E in dawn-dusk orbit, can provide valuable data for NWP, climate analysis and other environment studies.

MWTS-III calibration data have been fully processed at the NSMC CMA, since the instrument was turned on July 9, 2021.

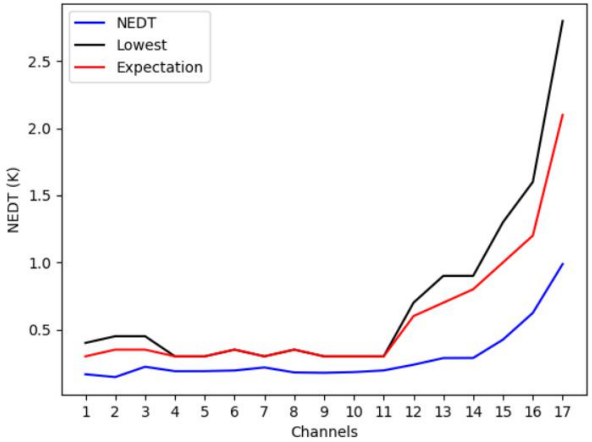


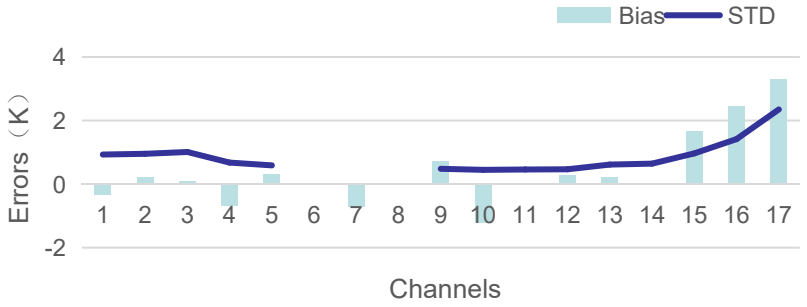
MWTS-III Instrument specifications

No.	Center frequency (GHz)	Band width (MHz)	NEDT (K)	FY-3D NEDT	Main Beam efficient	Polarization
1	23.8	270	0.3		≥95%	QH
2	31.4	180	0.35		≥95%	QH
3	50.3	180	0.35	1.2	≥95%	QV
4	51.76	400	0.3	0.75	≥95%	QV
5	52.8	400	0.3	0.75	≥95%	QV
6	53.246±0.08	2*140	0.35		≥95%	QV
7	53.596±0.115	2*170	0.3	0.75	≥95%	QV
8	53.948±0.081	2*142	0.35		≥95%	QV
9	54.40	400	0.3	0.75	≥95%	QV
10	54.94	400	0.3	0. 75	≥95%	QV
11	55.50	330	0.3	0. 75	≥95%	QV
12	57.290344(fo)	330	0.6	0. 75	≥95%	QV
13	fo±0.217	2*78	0.7	1.2	≥95%	QV
14	fo±0.3222±0.048	4*36	0.8	1.2	≥95%	QV
15	fo±0.3222±0.022	4*16	1.0	1.7	≥95%	QV
16	fo±0.3222±0.010	4*8	1.2	2.4	≥95%	QV
17	fo±0.3222±0.0045	4*3	2.1	3.6	≥95%	QV

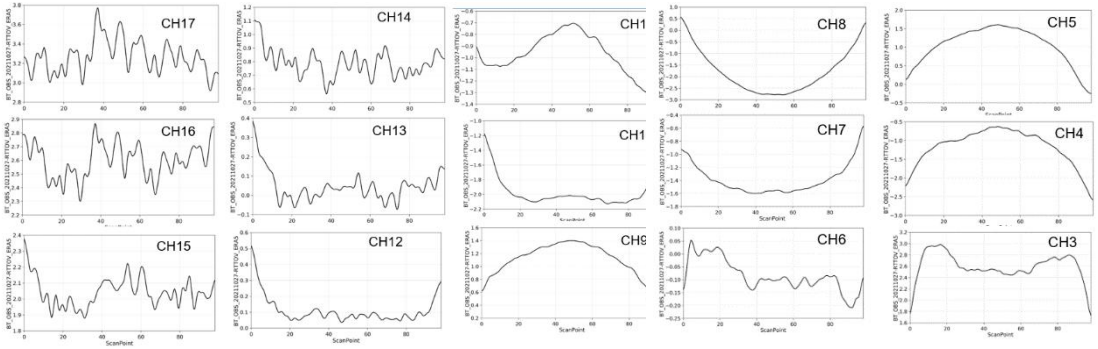
In-orbit Performance of MWTS-III

NEDT

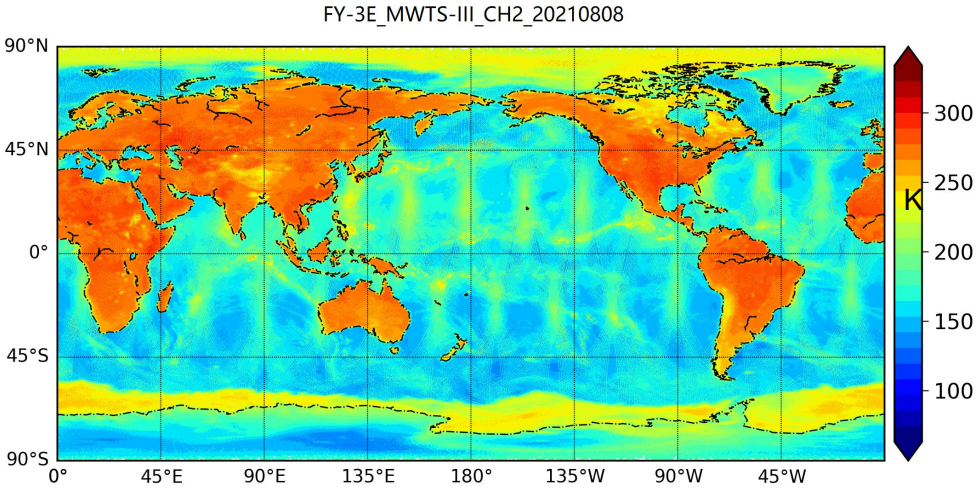




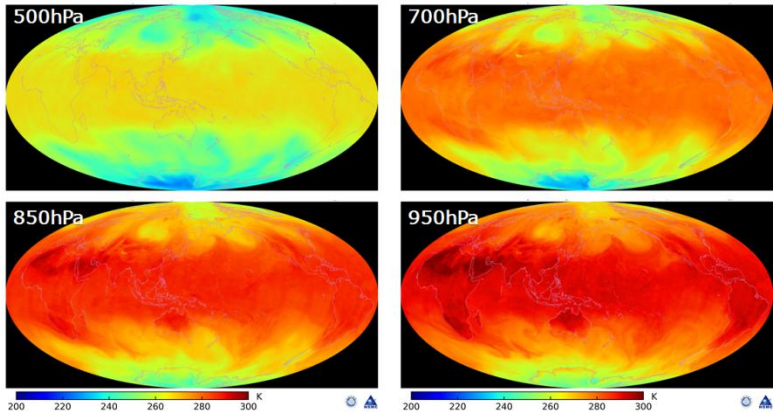
Scan-angle dependent bias

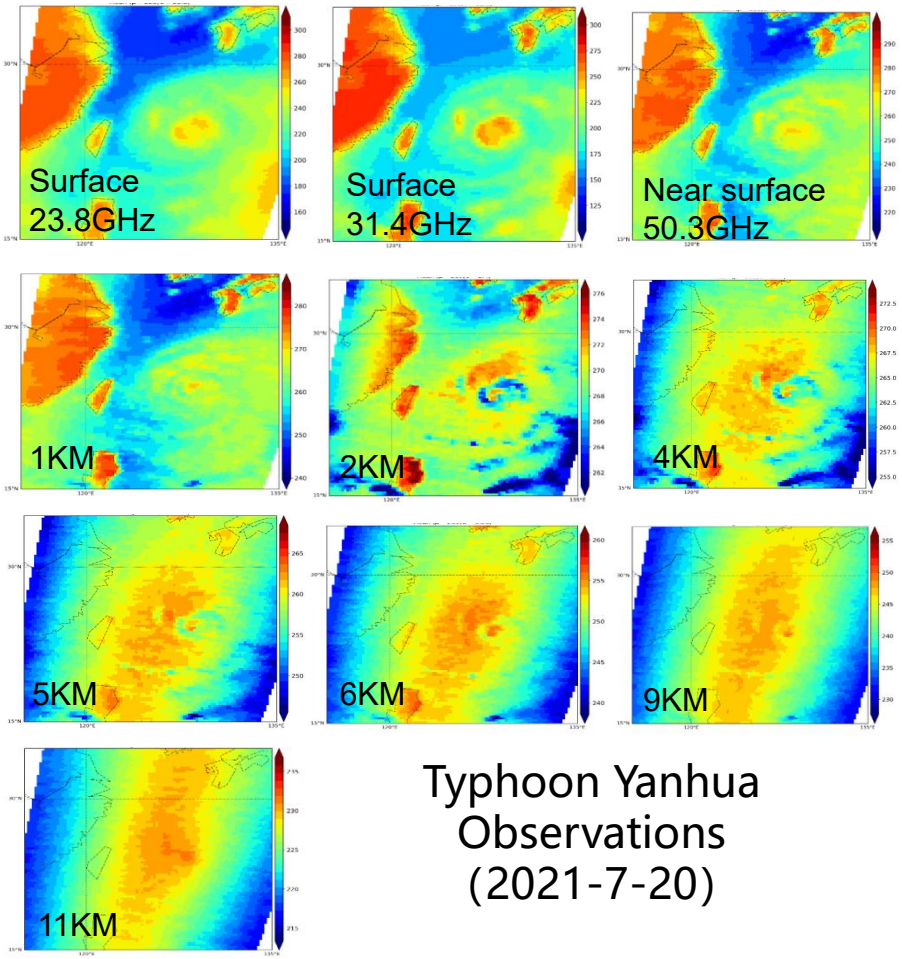


Brightness temperature and L2 product



Vertical section of atmospheric temperature

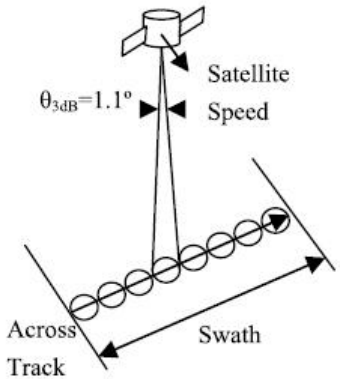




Typhoon Yanhua Observations (2021-7-20)

Microwave Humidity Sounder-II

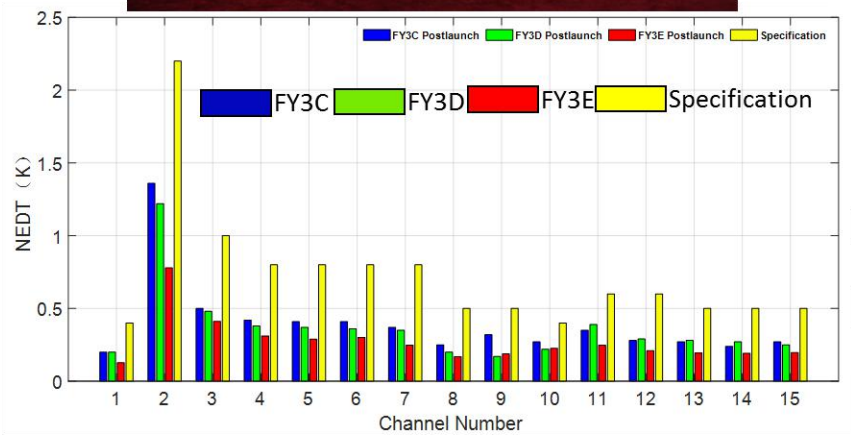
Instruments Introduction

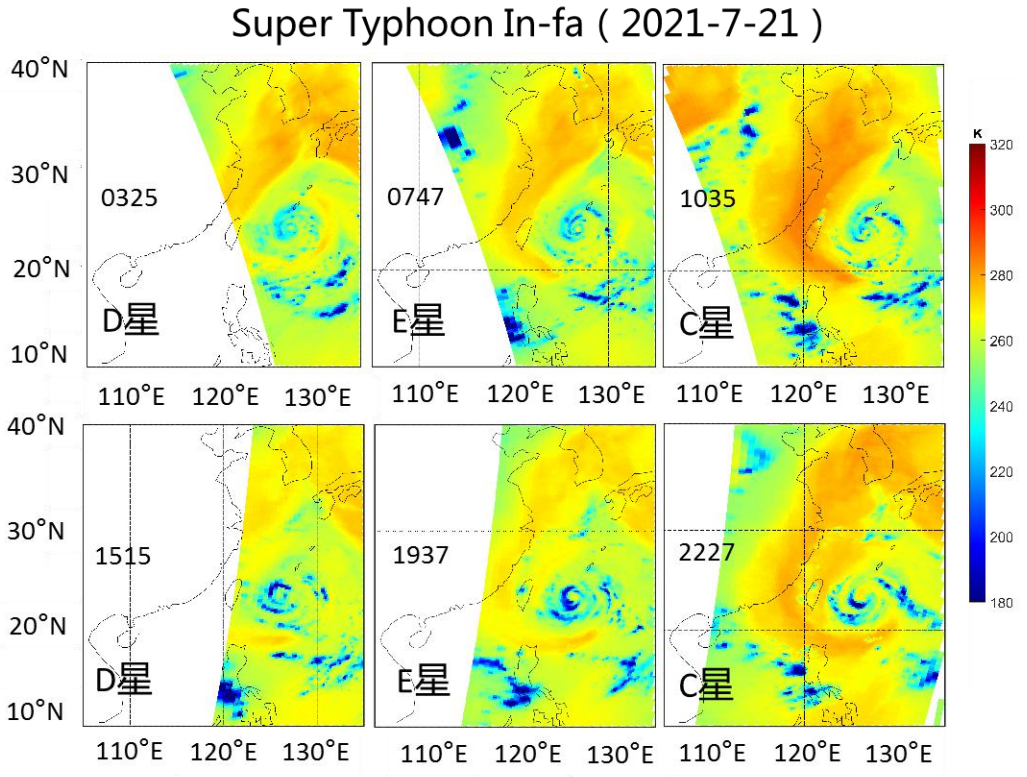


CH	Center Frequency (GHz)	Pol	Bandpass Width (MHz)	Frequency Stability (MHz)		NEDT (K)		Accuracy* (K)		3-dB Beamwidth
				C/D	E	C/D	E	C/D	E*	
1	89.0	V	1500	50	50	1.0	0.4	1.3	1.0/0.8	2.0°
2	118.75±0.08	H	20	30	20	3.6	2.2	2.0	2.4/2.2	2.0°
3	118.75±0.2	H	100	30	20	2.0	1.0	2.0	1.2/1.0	2.0°
4	118.75±0.3	H	165	30	20	1.6	0.8	2.0	1.2/1.0	2.0°
5	118.75±0.8	H	200	30	20	1.6	0.8	2.0	1.2/1.0	2.0°
6	118.75±1.1	H	200	30	20	1.6	0.8	2.0	1.0/0.8	2.0°
7	118.75±2.5	H	200	30	20	1.6	0.8	2.0	1.0/0.8	2.0°
8	118.75±3.0	H	1000	30	20	1.0	0.5	2.0	1.0/0.8	2.0°
9	118.75±5.0	H	2000	30	20	1.0	0.5	2.0	1.0/0.8	2.0°
10	**166.0**	V	1500	50	50	1.0	0.4	1.3	1.0/0.8	1.1°
11	183.31±1	H	500	30	30	1.0	0.6	1.3	1.0/0.8	1.1°
12	183.31±1.8	H	700	30	30	1.0	0.6	1.3	1.0/0.8	1.1°
13	183.31±3	H	1000	30	30	1.0	0.5	1.3	1.0/0.8	1.1°
14	183.31±4.5	H	2000	30	30	1.0	0.5	1.3	1.0/0.8	1.1°
15	183.31±7	H	2000	30	30	1.0	0.5	1.3	1.0/0.8	1.1°

*: requirements/expectation

In-orbit Performance of MWHS-II

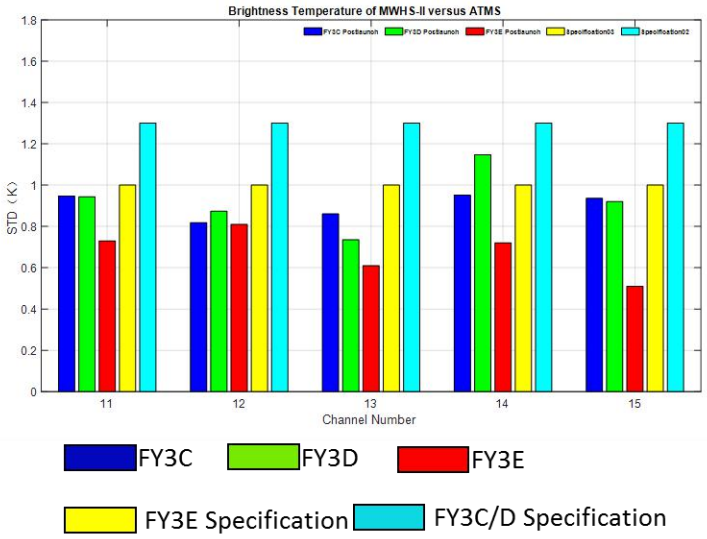




The noise equivalent delta temperature (NEDT) of MWHS-II onboard FY-3 indicates the performance of MWHS-II has been improved gradually from FY-3C to FY-3E

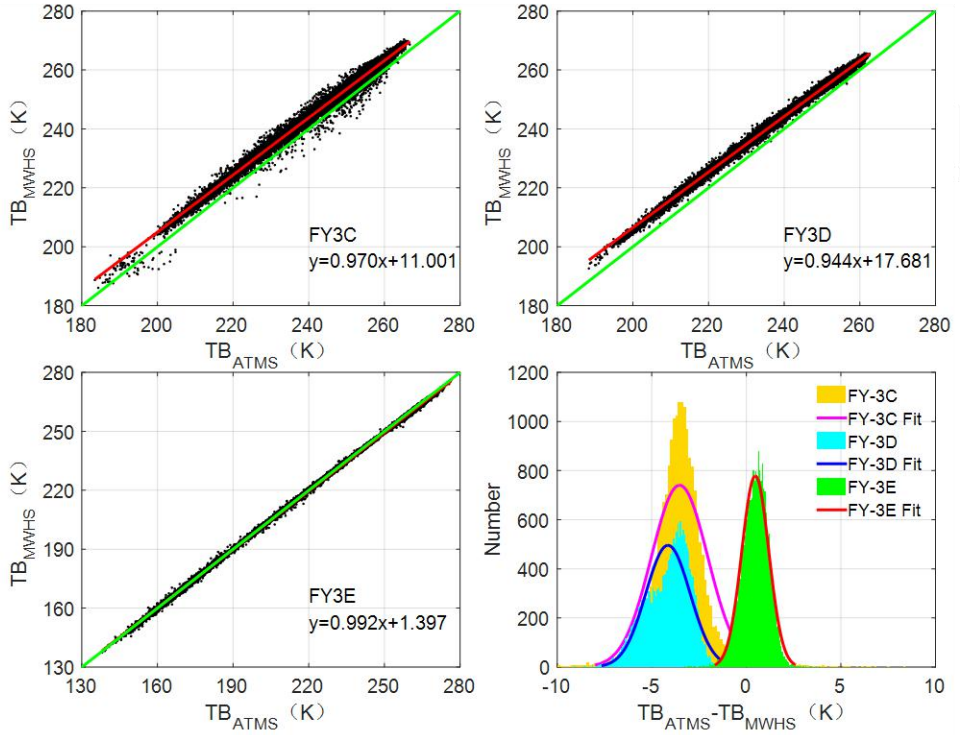
In-orbit Performance of MWHS-II (Continue)

The SNO results



The standard deviations for FY-3E five humidity sounding channels are less than 1K.

MWHS-II .VS. ATMS @ 183.31±4.5 GHz



FY302：
-3.58K/-4.13K

FY3E： 0.46K

Introduction

Wind measuring Radar (WindRAD)

- Detecting global sea surface wind vector, including wind speed and wind direction.
- Working all-weather, all-time, with high precision and high spatial resolution.

Spectrum Metrics

parameter	metric	
Frequency	5.4 GHz (C band)	13.256 GHz (Ku band)
Polarization	VV、HH	VV、HH

Observing Geometric Metrics

parameter	metric	
	C band	Ku band
Spatial resolution (azimuth×range)	25 ×0.5km	10 ×0.5km
Swath	> 1200km	
Scanning mode	360° conical scanning	

Radiometric Metrics

parameter	metric	
	C band	Ku band
Minimum detectable wind speed	3 m/s(-26.2dB)	3 m/s(-30.8dB)
Radiometric resolution	0.5dB (wind speed≥5 m/s) 1.0dB (wind speed = 3 m/s)	
Radiometric accuracy	≤ 0.6dB	

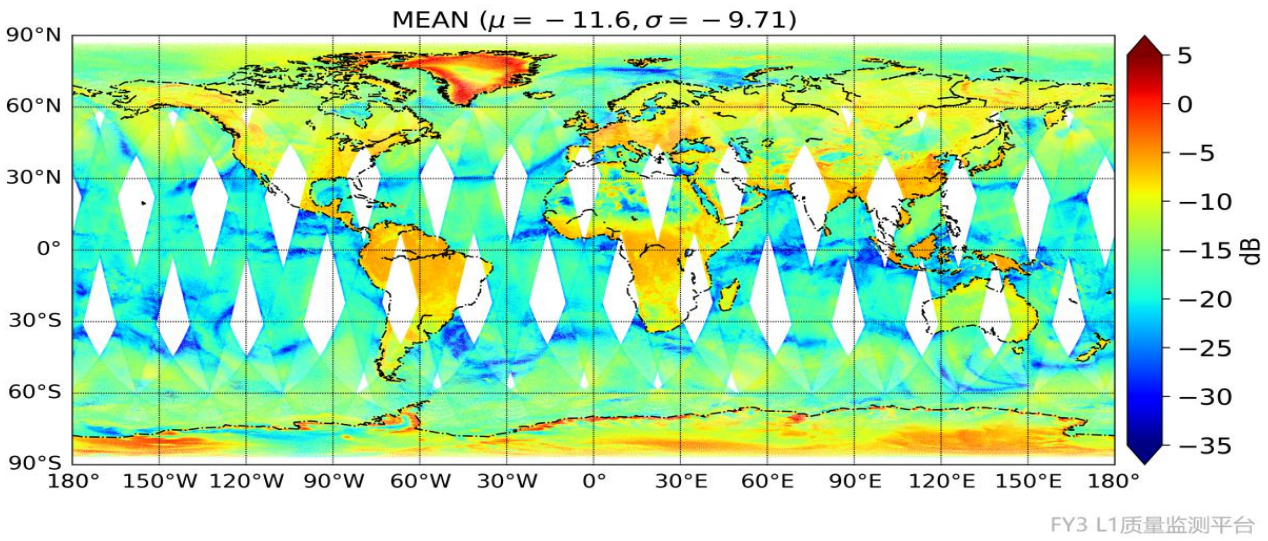
WindRAD in-orbit test

In-orbit test progress

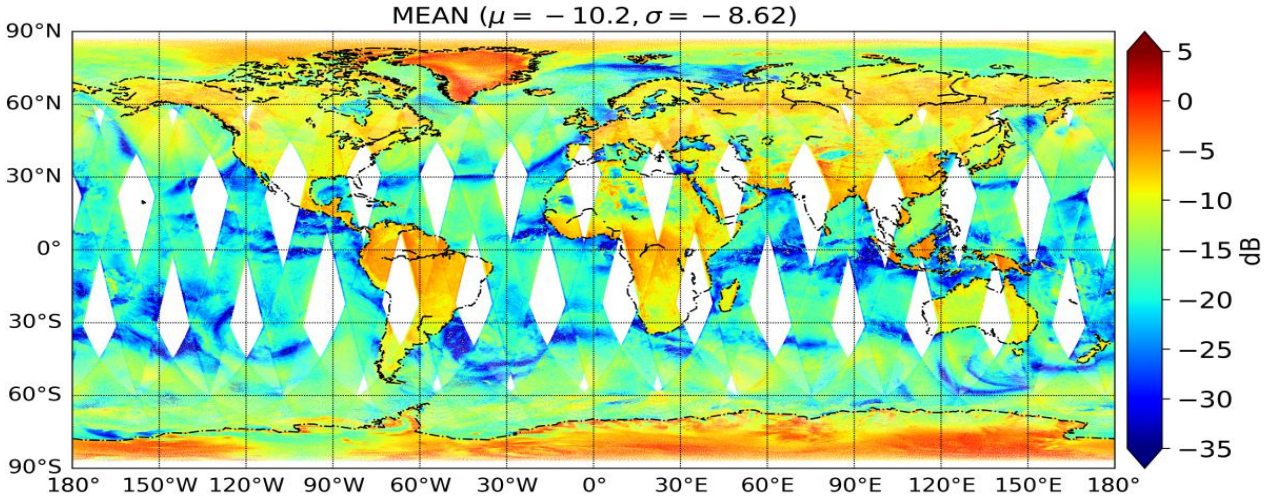
No.	Category	Test Item	Test Phase		Compliance of Metrics
			Prelaunch	In-orbit Test	
1	Spectrum Metrics	central frequency	√		Yes
2		polarization mode	√		Yes
3		polarization isolation	√		Yes
4		operation mode		√	Yes
5	Observing Geometric Metrics	spatial resolution	√	√	Yes
6		swath	√	√	Yes
7		incidence angle		√	Yes
8		scanning mode		√	Yes
9		beam pointing accuracy	√		Yes
10		beam matching accuracy	√		Yes
11	Radiometric Metrics	minimum detectable wind speed		√	Yes
12		radiation resolution		√	Yes
13		radiation accuracy	√	√	Yes
14		ambiguity	√		Yes
15		observation accuracy		√	In evaluation (with ARC)
16	Telemetry Parameter	key telemetry characteristic parameters		√	Yes

In-orbit Performance of WindRAD

C - H - 10km OBS



Ku - H - 10km OBS



Summary

- FY-3D (2017-~) Afternoon orbit
  - MWRI, MWTS and MWHS are in good condition;
  - FCDR of MWRI has been released to some scientific users for evluation;
- FY-3E (2021-~) Early morning orbit
  - Launched in July 5th, 2021;
  - MWHS, MWTS and WindRAD show good performace;
  - In-orbit test of MWHS, MWTS and WindRAD are still ongoing;
- FY-3F (2022-~) Morning orbit
  - Ground test of Flight model (MWRI-II, MWHS and MWTS);
- FY-3G (2022-~) Drift orbit
  - Ground test of Flight model (MWRI-II and DPR).

Thank you for your attention