Report from National Space Science Center, CAS

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CAS Key Laboratory of Microwave Remote Sensing
National Space Science Center
Chinese Academy of Sciences

(MiRS,NSSC,CAS)

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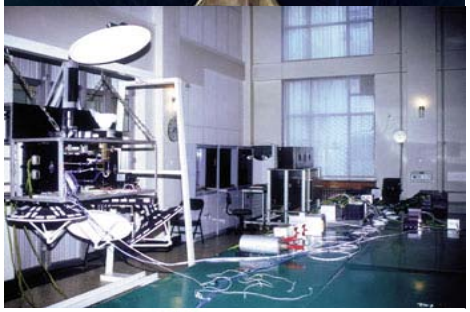
Outline

- NSSC and its participations to Chinese EO missions
- Recent progresses of microwave sensors for FY-3C and HY-2A satellites

NSSC and its participations to Chinese EO missions

- National Space Science Center (formerly Center for Space Science and Applied Research of CAS)
- Started Chinese space programs in 1958 (DFH-1, 1970.7.24)
- Played key role in Chinese human space program (1993-2003) and lunar program (2003-)
- Main participants of development of Chinese meteorological and oceanic satelltes
  - FY-3 MWHS, MWRI, GNOS, TOU
  - HY-2 RA, ACMR, SCAT
  - CFOSAT SCAT
- Lead of Chinese Space Science Programs
  - DSP (with ESA, 2003-2006)
  - Space Science Pioneered Program (2011-)



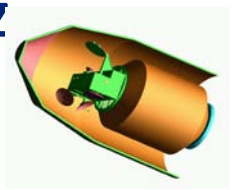
CAS Key Laboratory of Microwave Remote sensing (MiRS, CAS)

- **Founded in 1958, as electronics group participated in the development of China's 1st satellite (DFH-1) in early 1970s.**
- **NMRS developed the telemetry receiver for DFH-1.**
- **From 1973, focuses turned to microwave remote sensing technology.**

- **Research and development priorities:**
  - **Theory and techniques of microwave sounding and imaging;**
  - **Development of microwave remote sensing payloads**
    - **microwave radiometer,**
    - **radar altimeter,**
    - **radar scatterometer**
  - **Calibration, and information techniques for microwave remote sensing.**

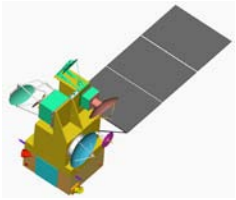
EO Satellite Missions NSSC and MiRS Contributed

- **Multi-Mode Microwave Remote Sensors (M3RS) on SZ 4 Unmanned Spaceship (2002.12-2003.4)**
  - Ku-band scatterometer, altimeter
  - Multi-band microwave radiometer (C~Ka)

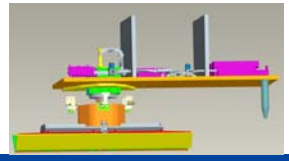



- **FY-3 Polar Orbit Meteorological Satellite**
  - Microwave Humidity Sounder (FY-3A 2008, FY-3B 2010): 150, 183GHz (5 channels)
  - Microwave Humidity and Temperature Sounder (FY-3C 2013): 89, 118, 150, 183GHz (15 Channels)


- **HY-2 Ocean Dynamic Environment Missions (A, 2011)**
  - Radar altimeter (Ku, C)
  - Atmospheric Correction Microwave Radiometer
  - Radar Scatterometer (Ku, Rotation pencil beam, participated)



- **CFOSAT (Chinese-French Oceanography Satellite, 2015)**
  - Radar scatterometer (Ku, rotation fan-beam)

Recent progresses of microwave sensors for FY-3C and HY-2A satellites

- **Lunch and in-orbit test of FY-3C**
- **Operation improvement and Cal/Val of HY-2A**

FY-3C launched on 2013.9.23

	FY-3A/B	FY-3C	
1	VIRR	VIRR	
2	MERSI	MERSI	
3	MWRI	MWRI	
4	MWTS	MWTS(II)	Improved with more channels
5	MWHS	MWHTS	Improved with more channels
6	IRAS	IRAS	
7	ERM	ERM	
8	SIM	SIM	Improved with solar tracking
9	TOU	TOU	
10	SBUS	SBUS	
11	SEM	SEM	
12		GNOS	New payload

Improvement of MWTS

No. of Channels: 4➔13

FY-3A/B/ MWTS		FY-3C/ MWTS(II)	
Channel	Center Freq (GHz)	Channel	Center Freq (GHz)
1	50.30	1	50.3
		2	51.76
		3	52.8
2	53.596±0.115	4	53.596
		5	54.40
3	54.94	6	54.94
		7	55.50
4	57.290	8	57.290344(fo)
		9	fo±0.217
		10	fo±0.3222±0.048
		11	fo±0.3222±0.022
		12	fo±0.3222±0.010
		13	fo±0.3222±0.0045

Improvement of MWHT
(MWHT➔MWHTS, Channels :5➔15)

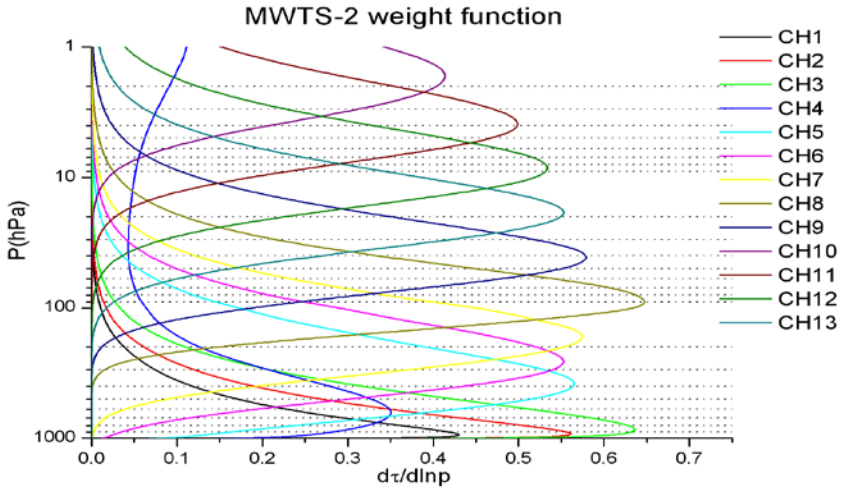
FY-3A/B/ MWHS		FY-3C/ MWHTS	
Channel	**Center Freq (GHz)**	**Channel**	**Center Freq (GHz)**
		1	89.0
		2	118.75±0.08
		3	118.75±0.2
		4	118.75±0.3
		5	118.75±0.8
		6	118.75±1.1
		7	118.75±2.5
		8	118.75±3.0
		9	118.75±5.0
1	150(V)	10	150.0
2	150(H)		
3	183.31±1	11	183.31±1
		12	183.31±1.8
4	183.31±3	13	183.31±3
		14	183.31±4.5
5	183.31±7	15	183.31±7

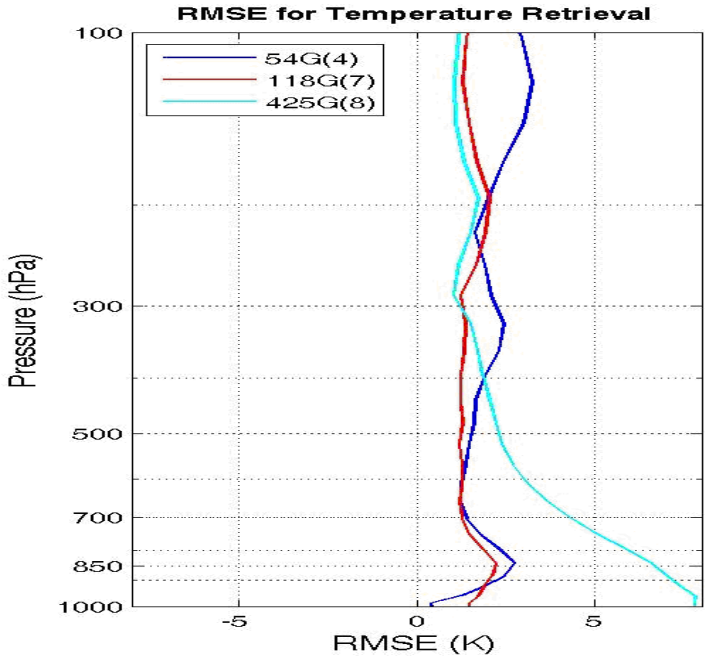
IRAS

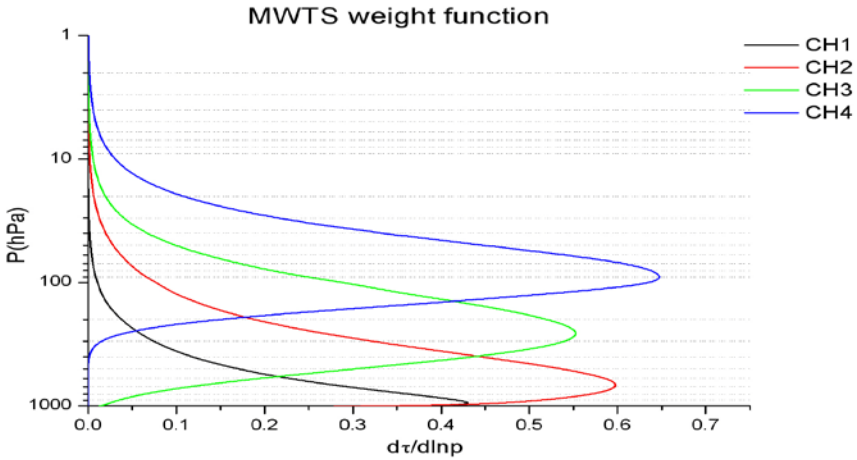
National Space Science Center
Chinese Academy of Sciences

channel (HIRS)	wavenumber (cm-1)	wavelength (μm)	bandwidth (cm-1)	Sounding	Upper limit (K)	NEΔN (mW/m2 -sr-cm-1)	Peak layer (hPa)
1 (1)	669	14.95	3	CO2	280	4.00	30
2 (2)	680	14.71	10	CO2	265	0.80	60
3 (3)	690	14.49	12	CO2	250	0.60	100
4 (4)	703	14.22	16	CO2	260	0.35	400
5 (5)	716	13.97	16	CO2	275	0.32	600
6 (6)	733	13.84	16	CO2/H2O	290	0.36	800
7 (7)	749	13.35	16	CO2/H2O	300	0.30	900
8 (10)	802	12.47	30	window	330	0.20	surface
9 (8)	900	11.11	35	window	330	0.15	surface
10 (9)	1030	9.71	25	O3	280	0.20	25
11	1345	7.43	50	H2O	330	0.23	800
12 (11)	1365	7.33	40	H2O	285	0.30	700
13 (12)	1533	6.52	55	H2O	275	0.30	500
14 (13)	2188	4.57	23	N2O	310	0.009	1000
15 (14)	2210	4.52	23	N2O	290	0.007	950
16 (15)	2235	4.47	23	CO2/N2O	280	0.007	700
17 (16)	2245	4.45	23	CO2/N2O	266	0.007	400
18 (17)	2388 (2420)	4.19	25	CO2	320	0.007	atmosphere
19 (18)	2515	3.98	35	window	340	0.007	surface
20 (19)	2660	3.76	100		340	0.003	
21 (20)	14500	0.69	1000	window	100%A	0.10%A	cloud
22	11299	0.885	385	window	100%A	0.10%A	surface
23	10638	0.94	550	H2O	100%A	0.10%A	surface
24	10638	0.94	200	H2O	100%A	0.10%A	surface
25	8065	1.24	650	H2O	100%A	0.10%A	surface
26	6098	1.64	450	H2O	100%A	0.10%A	surface

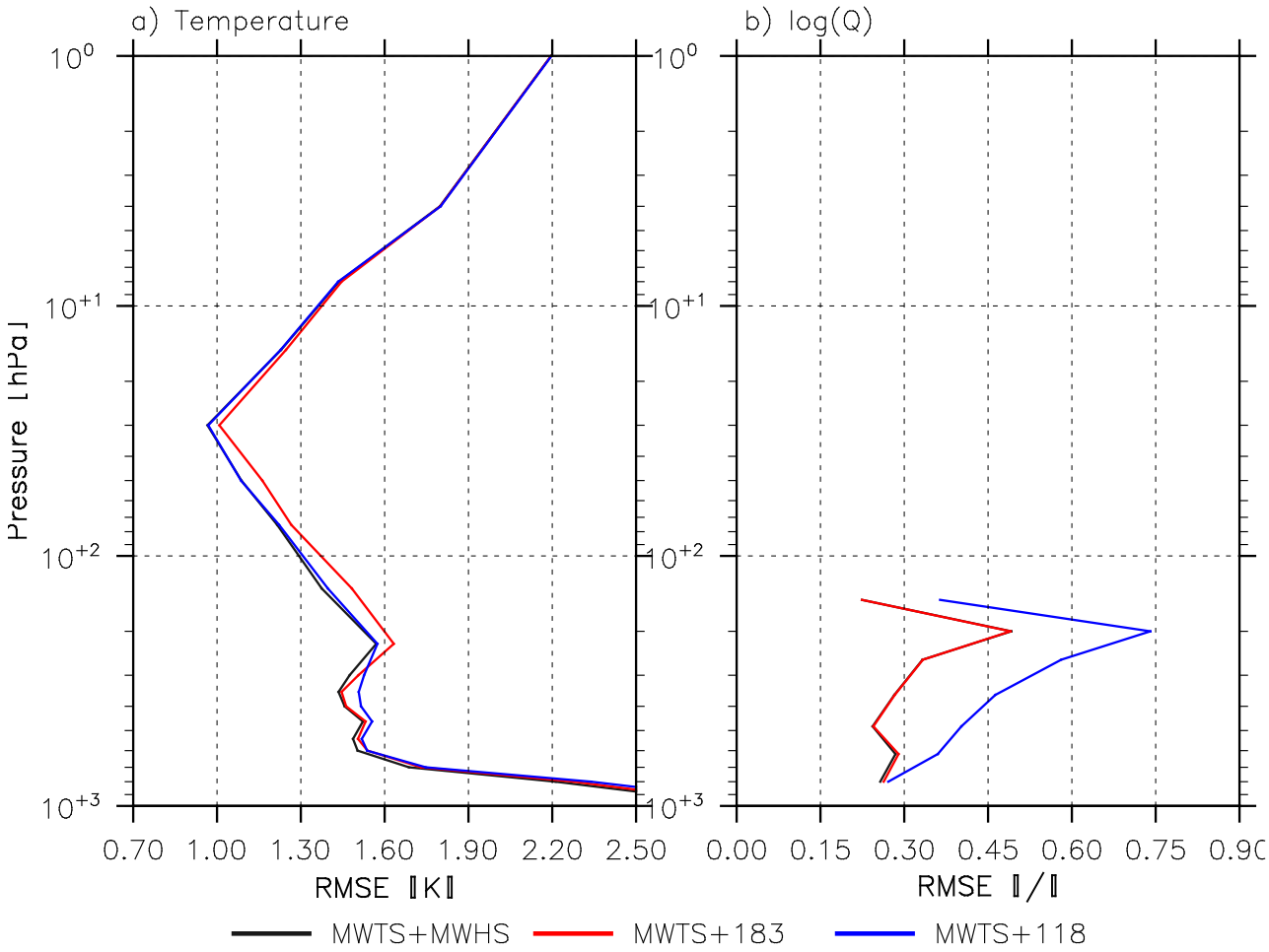
Improvement of temperature sounding





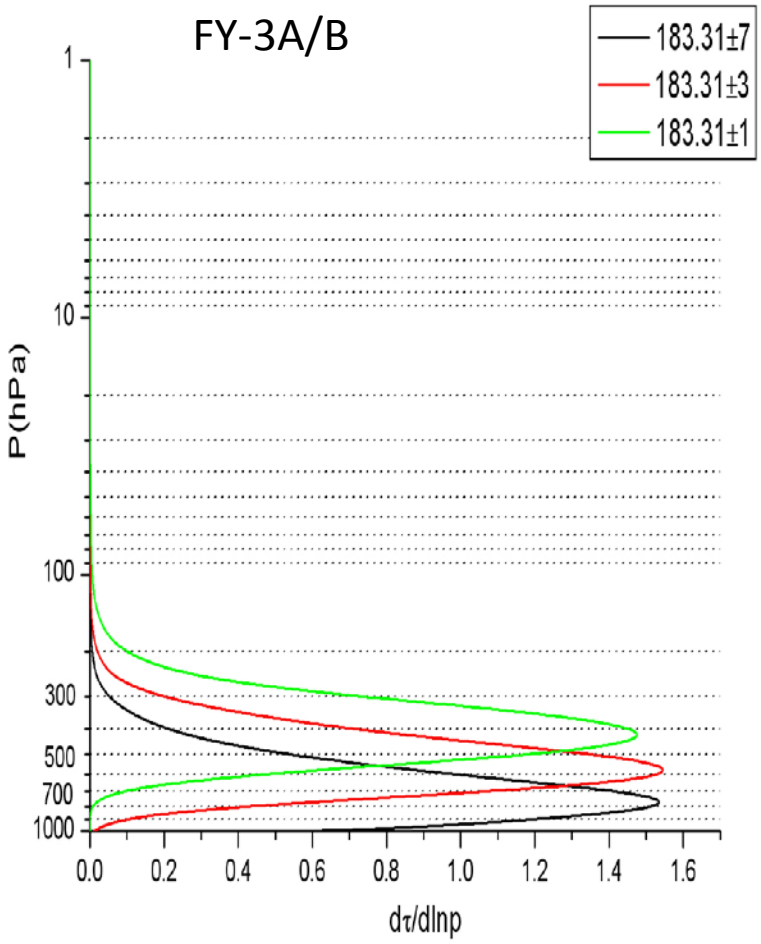


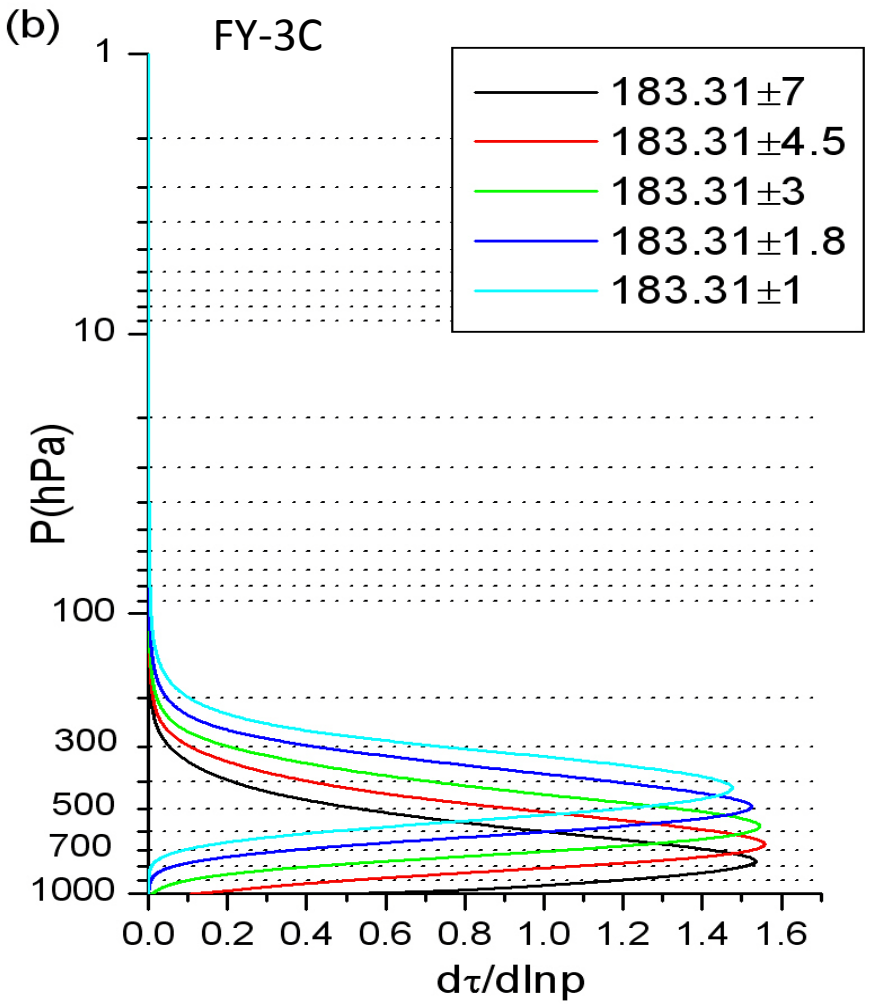
118vs183



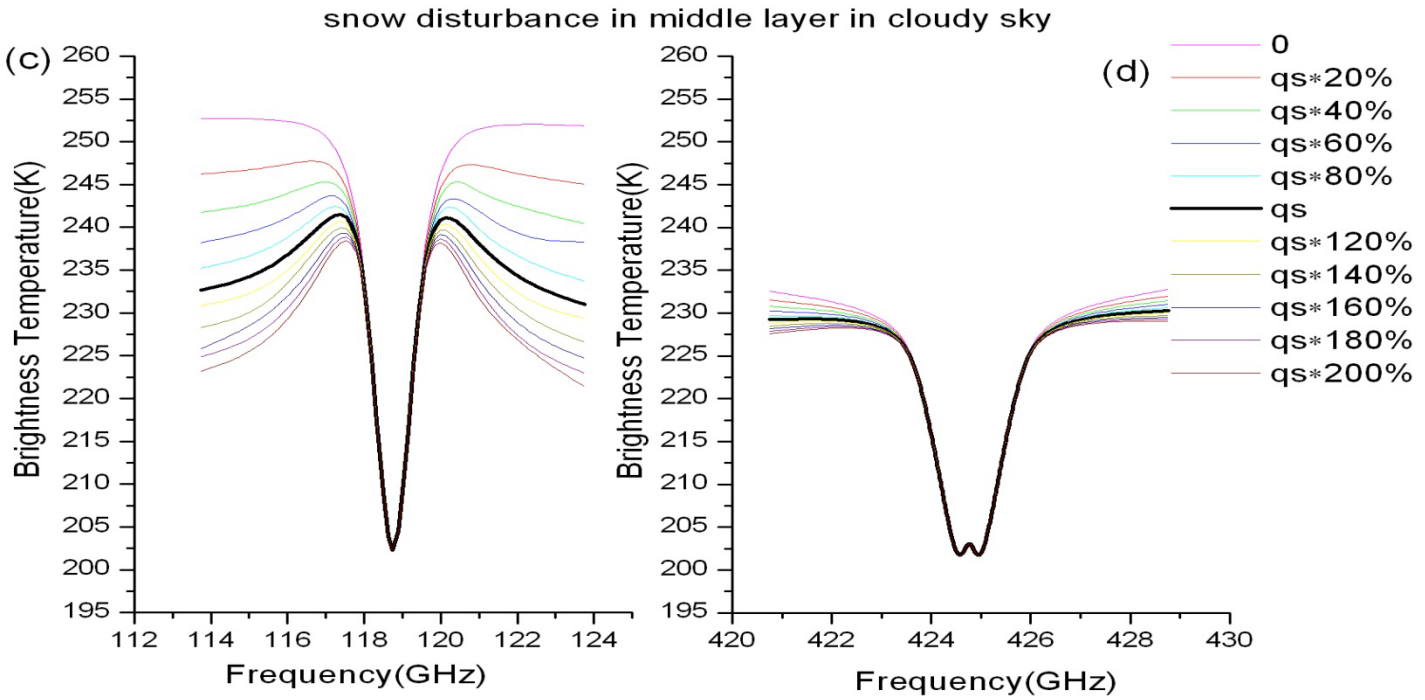
0.1-0.15K

Improvement of humidity sounding



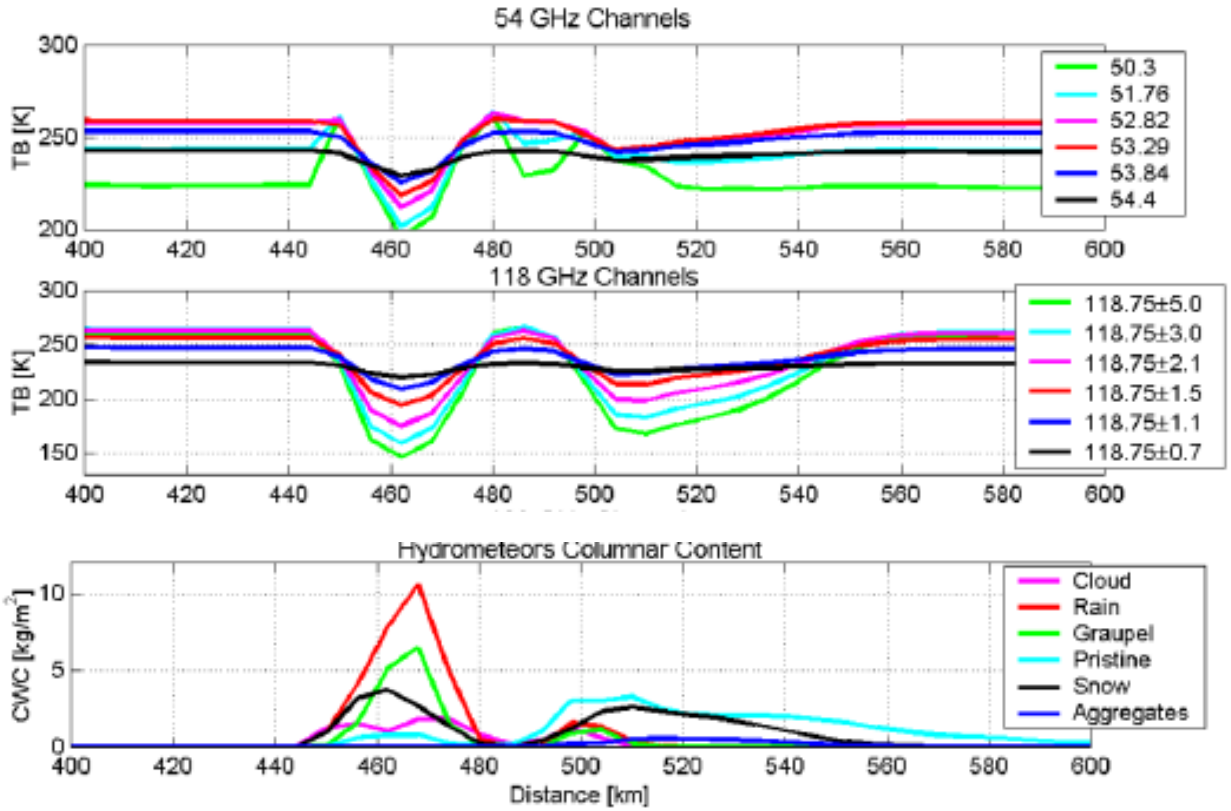


118GHz contribution to snow crystal sounding

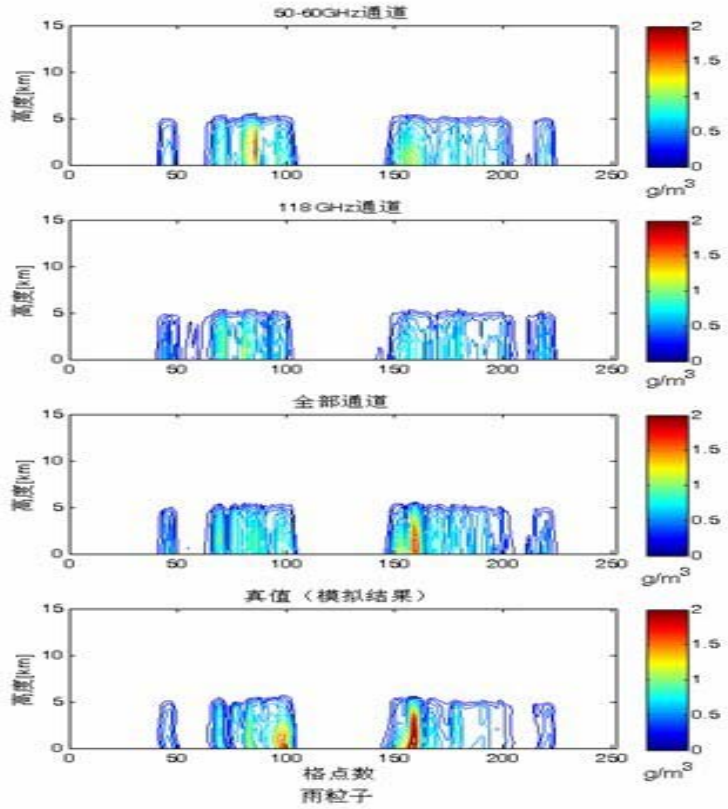


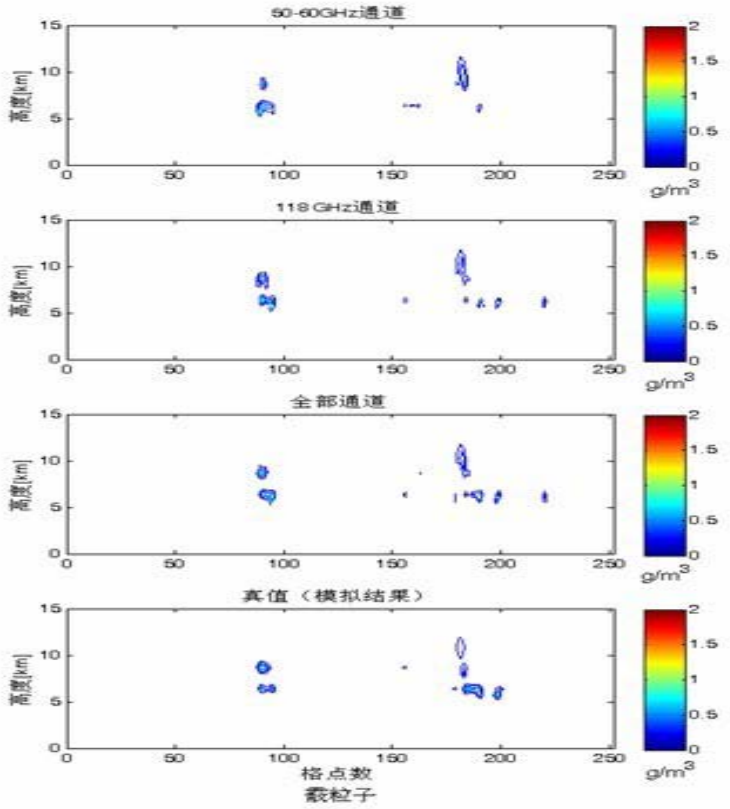
(c) 118.75GHz Oxygen channel (d) 424.763GHz Oxygen channel

Responses to hydrometeor



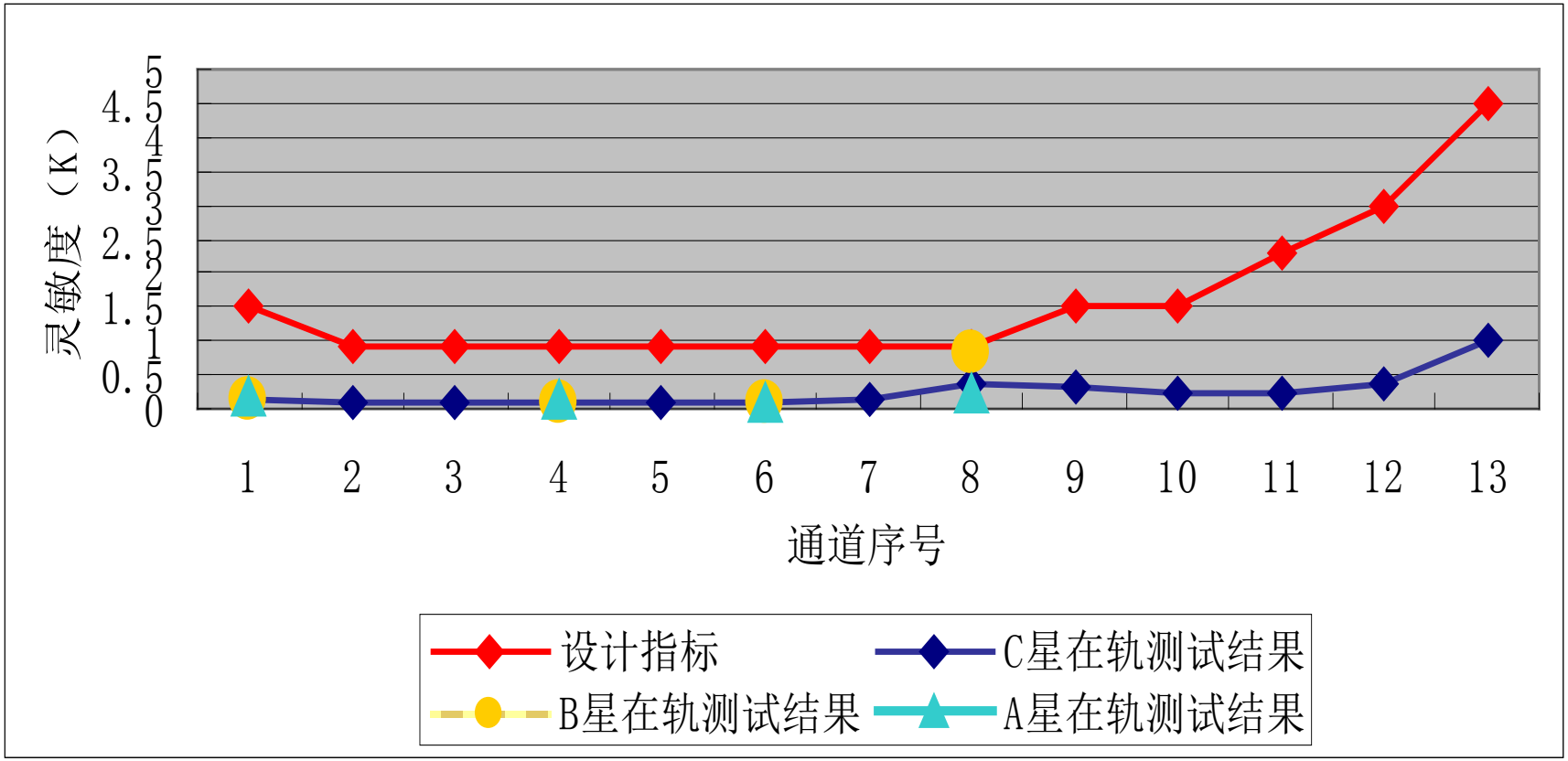
retrieval of vertical profile of hydrometeor



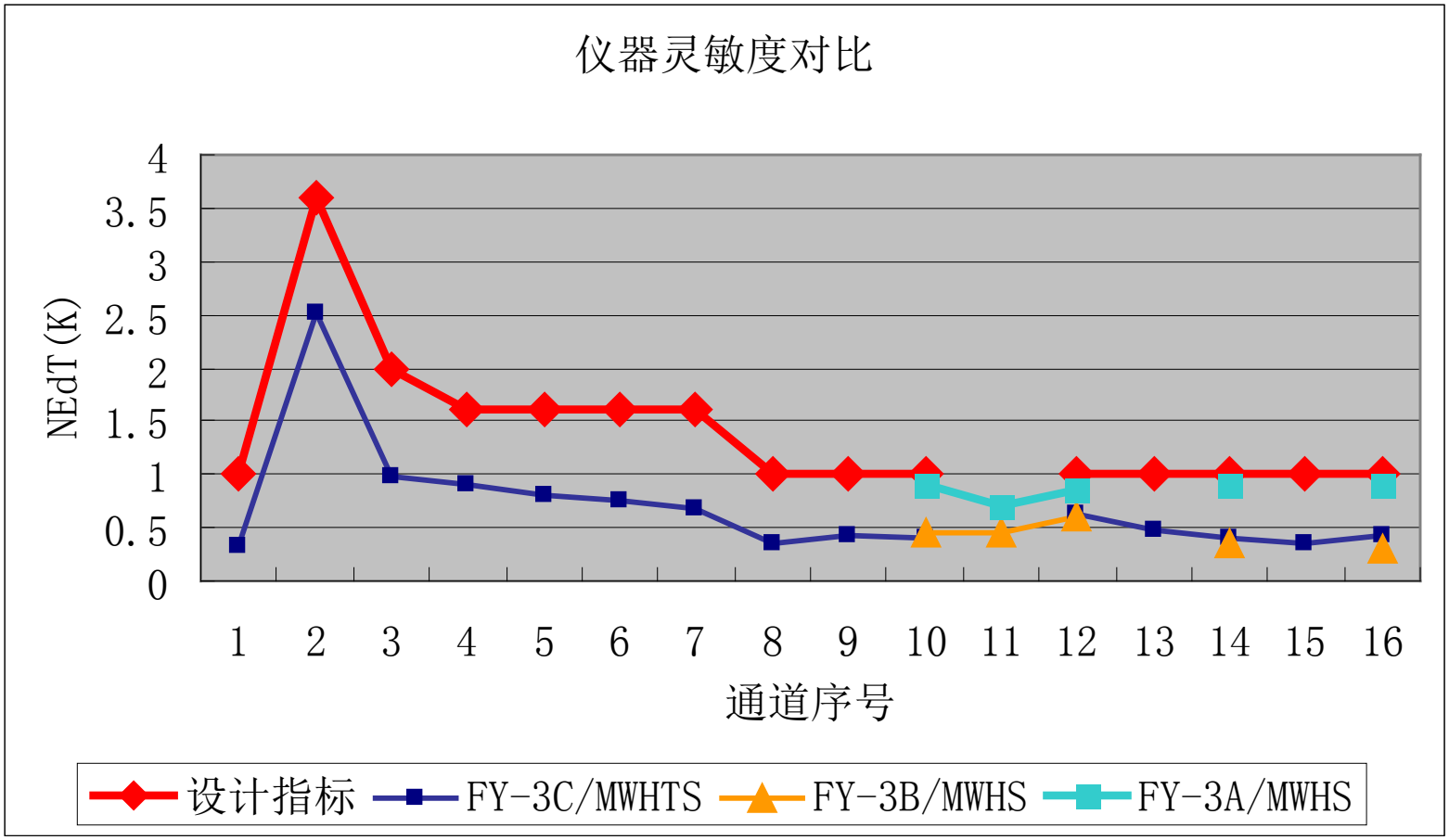


Passive microwave sounding of vertical structure of precipitation

Improvements of sensitivity (MWTS(II))



Improvement of sensitivity of MWHTS



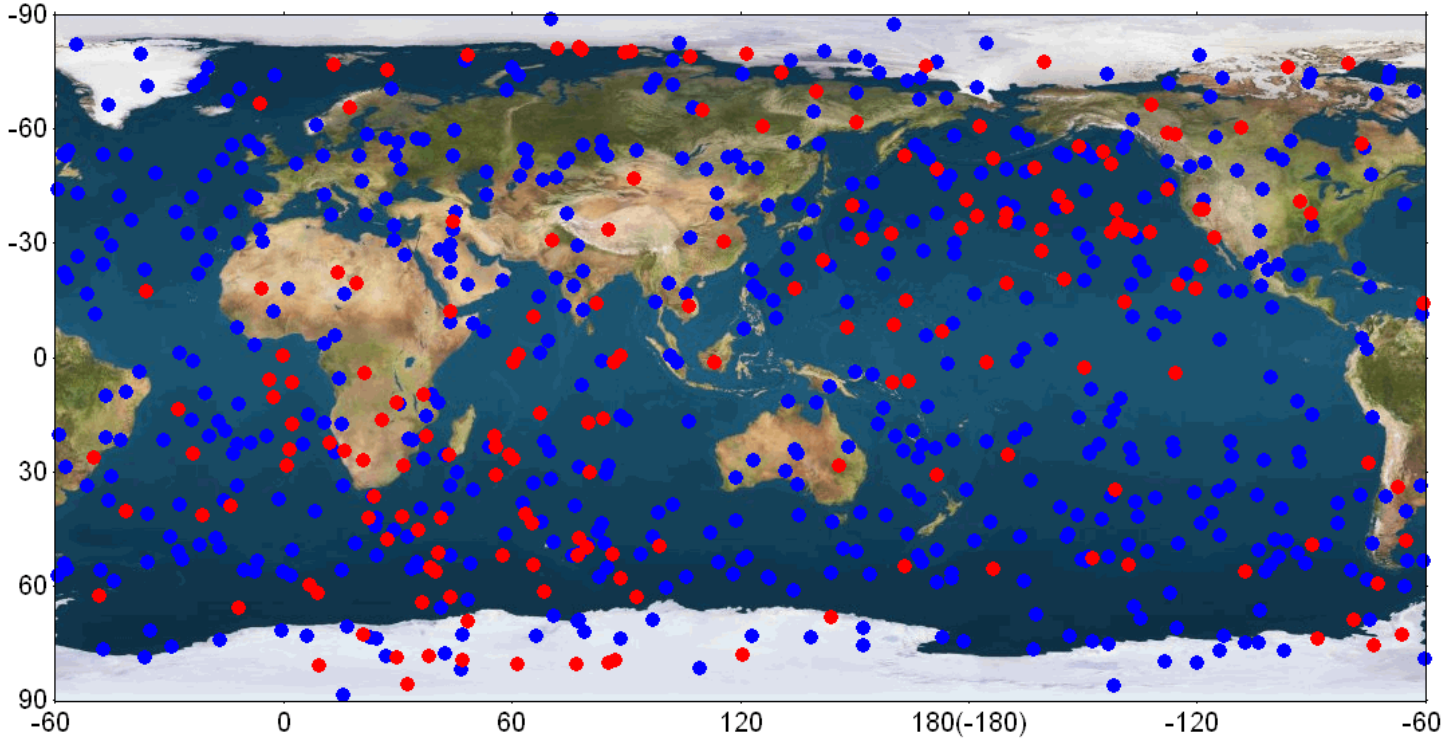
GNOS

- Global Navigation Satellite System Occultation Sounder, GNOS）: for atmospheric and ionospheric sounding;
- Temperature profiling: 0.1K
- Electron density: <20%
- Vertical resolution: 100m
- Compatible with GPS and Beidou, significantly increases opportunity

Global distribution of occultation within 24hrs

Blue: GPS

Red: Beidou



Progresses of HY-2A operation

- **Data product released to public**
  - ➢ **(OSW, SST, Vapor, SSL, SWH)**
- **Cal/val activities continued**

HY-2A satellite introduction

- **HY-2A satellite launched in August 2011, operated by National Satellite Ocean Application Service(NSOAS;P.R. China) .**
- **HY-2A main payloads:**
  - **--Radar altimeter(RA, Ku & C bands)**
  - **--Atmospheric Correction Microwave radiometer(ACMR, 18.7GHz,23.8GHz & 37GHz)**
  - **--Microwave scatterometer(Ku band, 13.256 GHz)**
  - **--Microwave Imager (6.6-37GHz)**
- **Orbit**
  - **sun-synchronous**
  - **descending local time : 6:00 am**
  - **repeat cycle: 14 days**

HY-2A Altimeter CAL/VAL activity

- **HY-2A satellite RA calibration experiments based on transponder.**

HY-2A Altimeter CAL/VAL activity

- Dedicated verification sites for HY-2 altimeter in China south sea areas is underway.
- The work that comparing the zenith wet delay of radiometer against GPS-based estimates as the HY-2A satellite overflew selected GPS ground stations is ongoing.
- HY-2 altimeter SSH absolute calibration is ongoing using Crete island calibration sites(Greece).
- HY-2A global altimeter data analysis and cross calibration against Jason-2 continue to carry out.

HY-2A Altimeter CAL/VAL

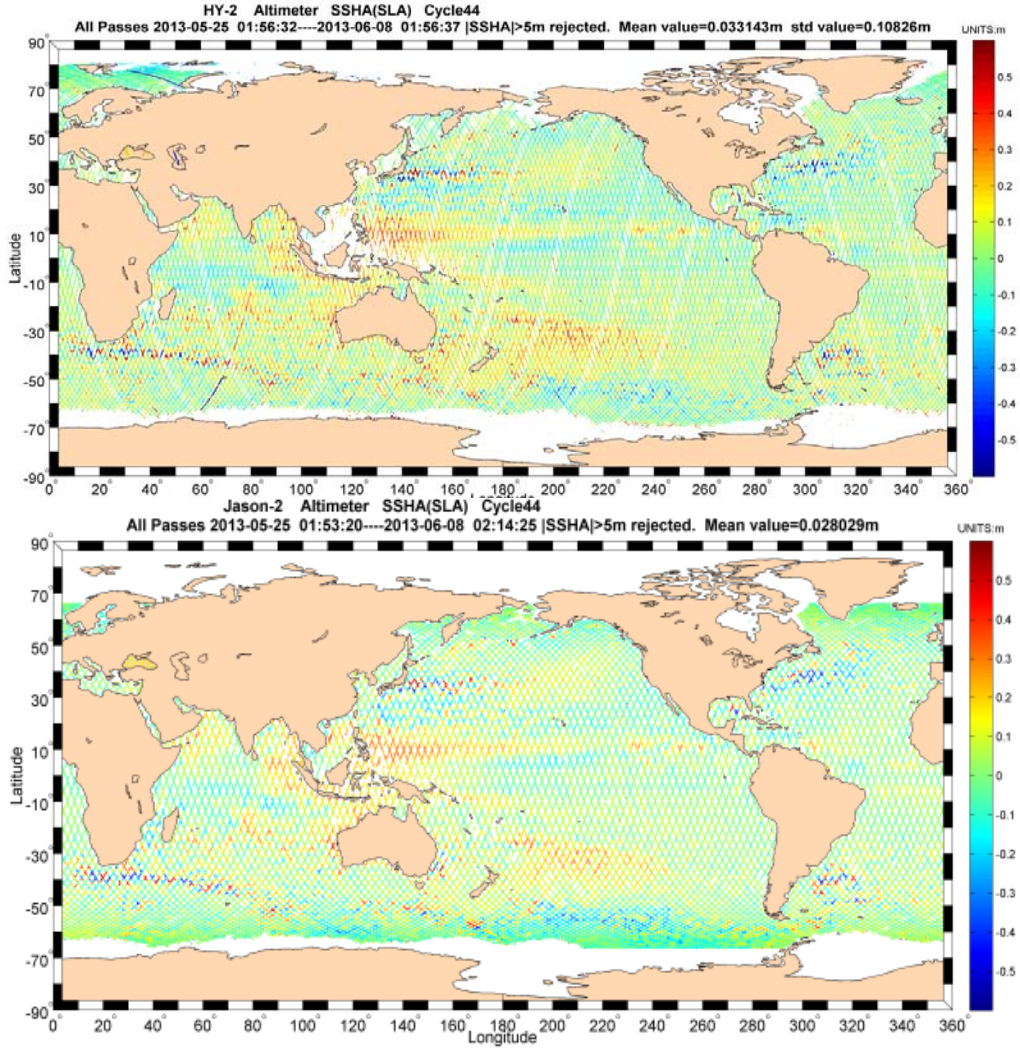
- **Along-track SLA performance:**

HY -2A (top map) and Jason-2(below map) Sea surface height anomalies are displayed.

HY-2A along track SLA performance are close to Jason-2.

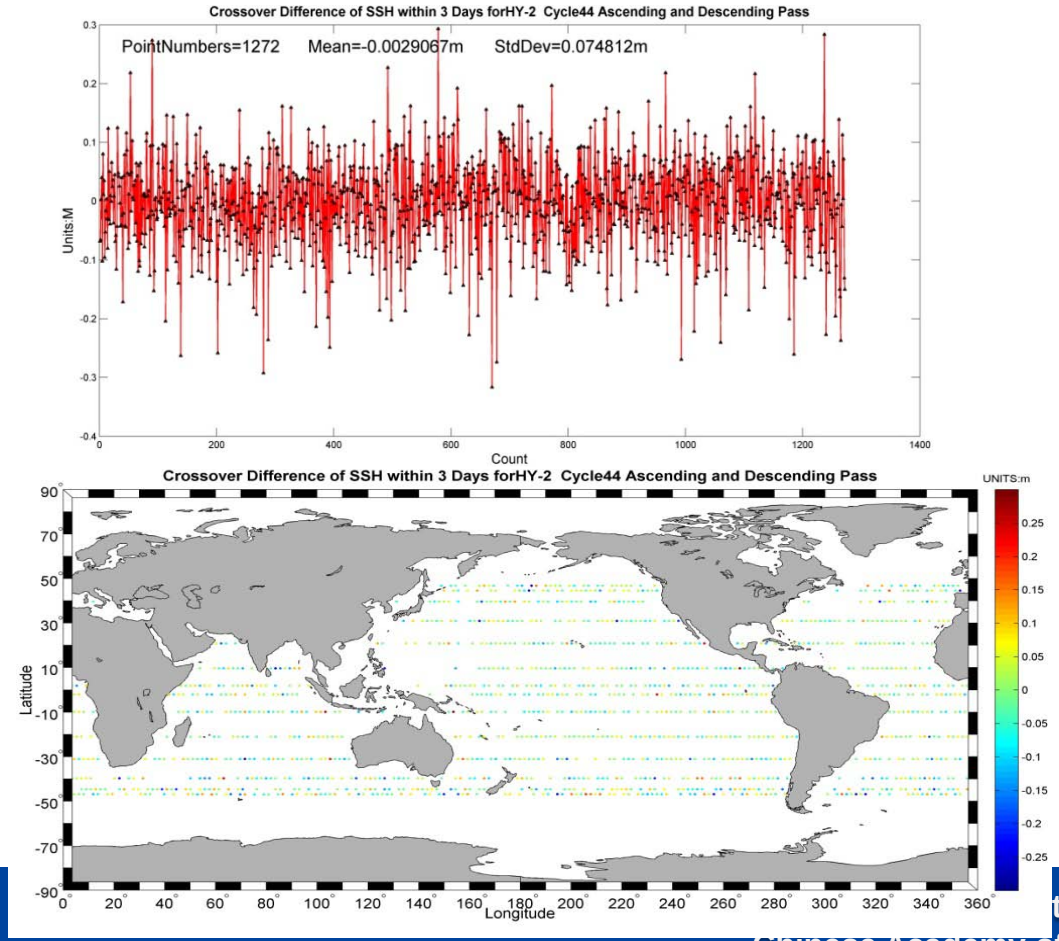
SLA standard deviation:

12.7cm for HY-2A and 11.0cm for Jason-2



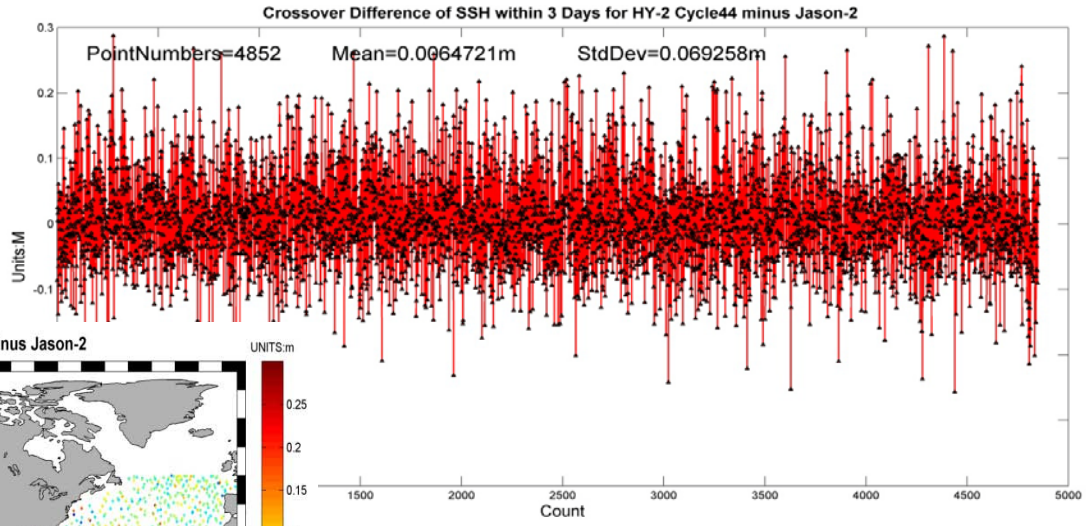
HY-2A Altimeter CAL/VAL

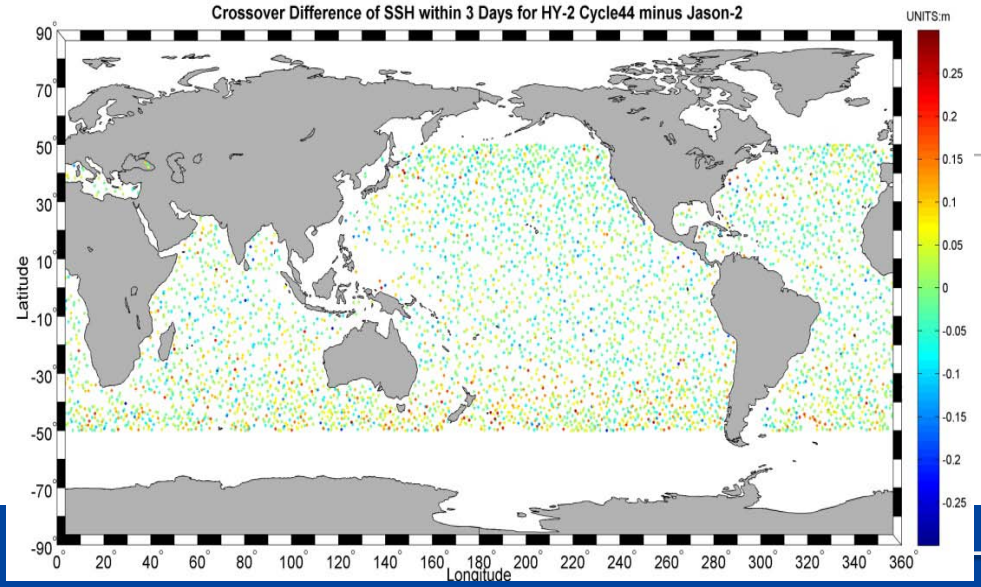
- **SSH Performances based on crossover differences of HY-2A alone.**



HY-2A Altimeter CAL/VAL

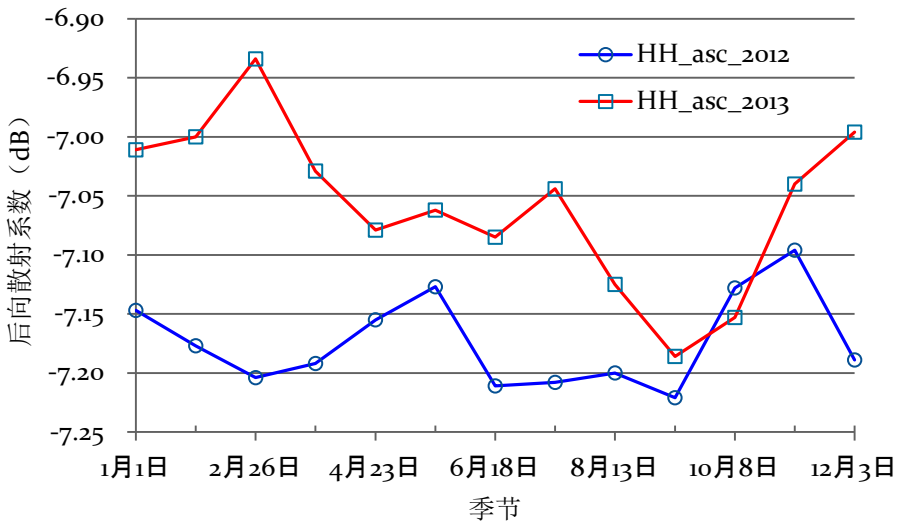
- **SSH Performances Comparison with Jason-2 data based on crossover differences.**



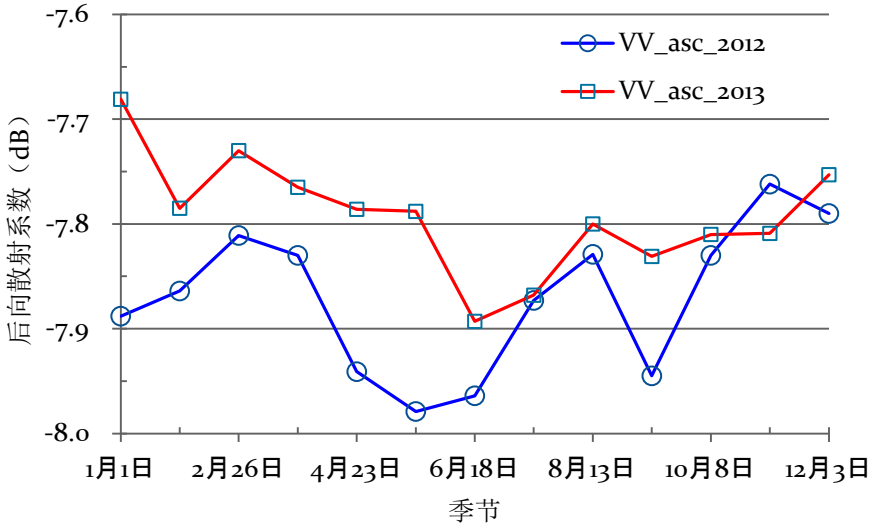


HY-2A Scatterometer CAL/VAL

- **The measurements performance monitoring of HY-2A satellite microwave scatterometer in 2012 & 2013 by Amazon rainforest.**



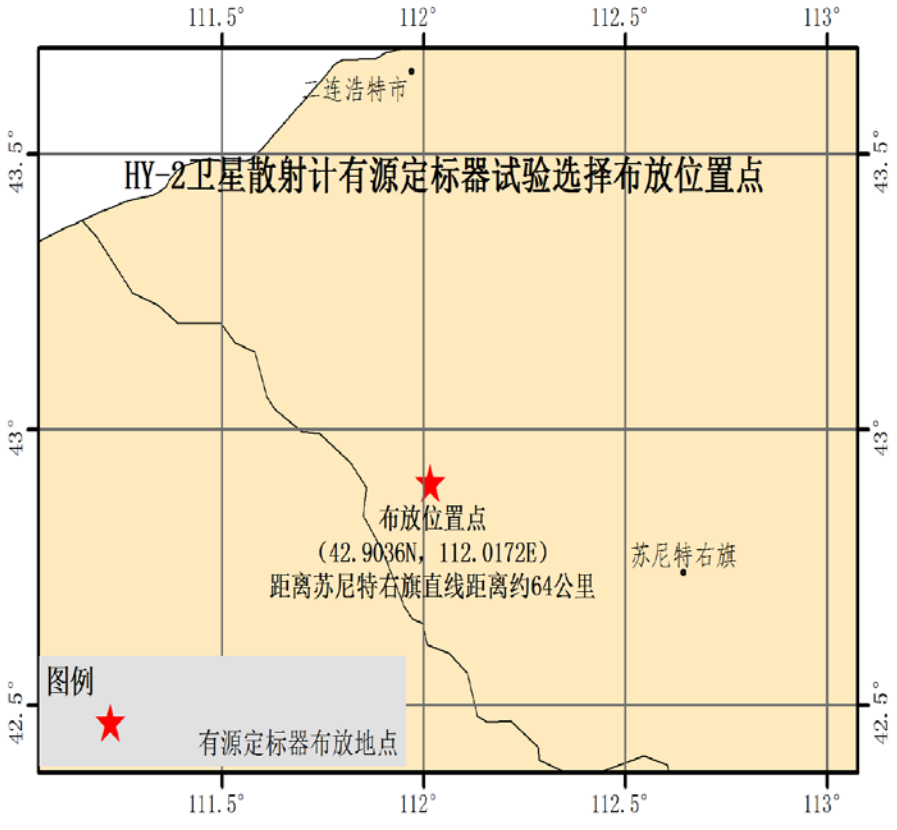
HH polarization ascend passes sigma0 time-variation



VV polarization descend passes sigma0 time-variation

HY-2A Scatterometer CAL/VAL

- **HY-2A satellite microwave scatterometer sigma naught absolute calibration experiments based on transponder.**



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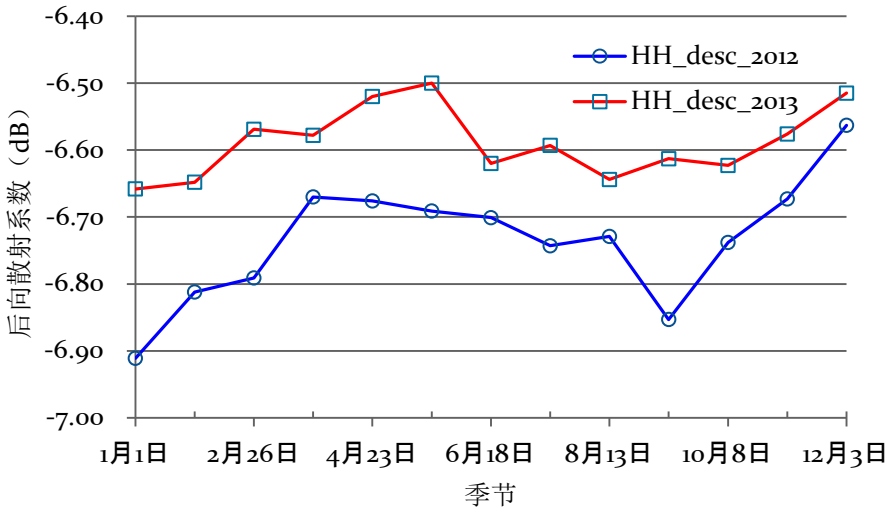

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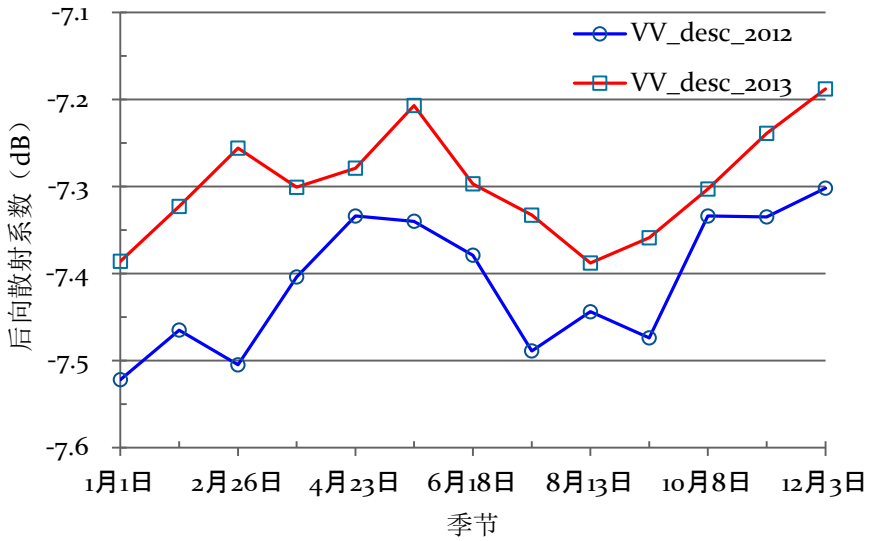
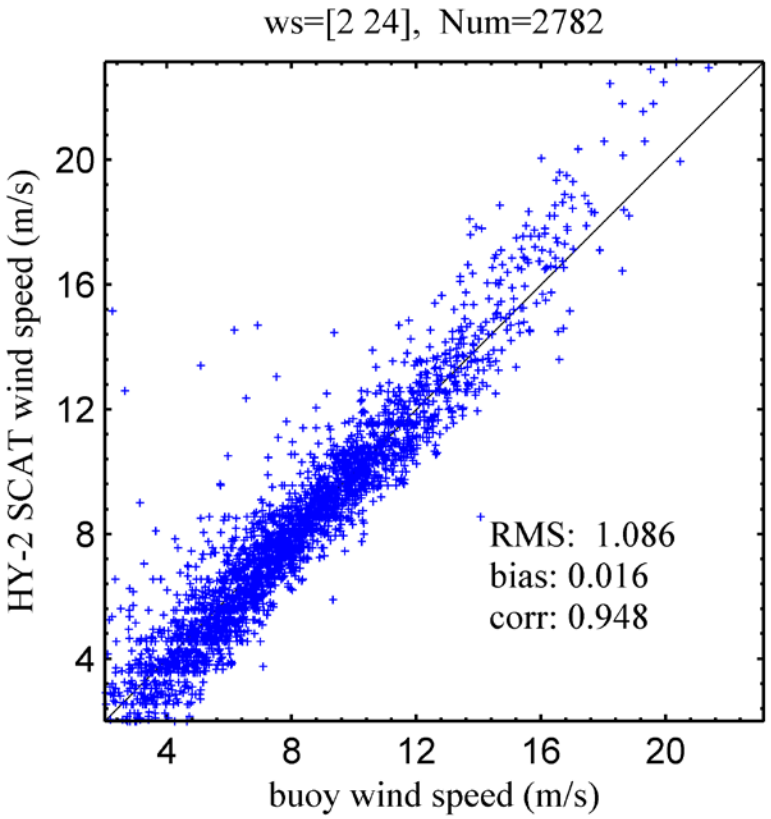
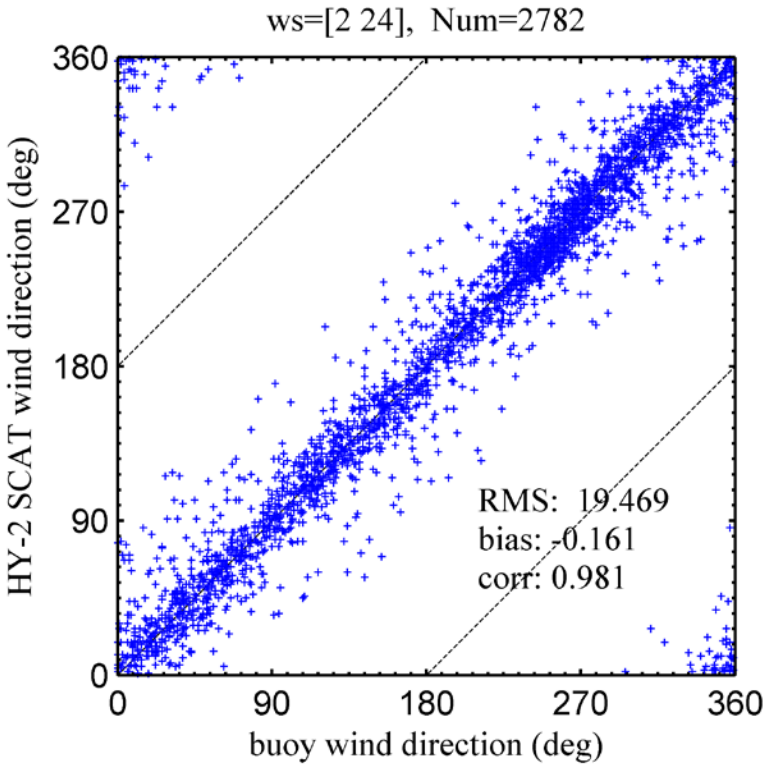


VV polarization ascend passes sigma0 time-variation

HY-2A Scatterometer CAL/VAL

- **Comparison of HY-2A scatterometer vector wind and NDBC buoys10-m neutral stability(Left:wind speed, right:wind direction).**





Summary of HY-2A Cal/Val results

- The measurement performance of HY-2A scatterometer is very stability, STD <0.15dB in 2012 and 2013. The overall accuracy of wind vectors meet application demands of 2 m/s and 20° in direction for wind speed range [2 24] m/s.

- The measurement performance of HY-2A altimeter sea surface height is close to Jason-2, STD is about 7.4cm .

Thank You!