中 国 气 象 局
China Meteorological Administration

国家卫星气象中心
National Satellite Meteorological Centre

The on-orbit Performance of FY-3E in an Early Morning Orbit

Peng Zhang, Xiuqing Hu

Contributions from L. Sun, Na Xu, Lin Chen,C. L. Qi, J. Shang, J.Y. Hu, Y. Guo, L. H. Xu, J. Qi, G. L. Yang, T. Mao, C. Huang, J. P. Dun, L. Wang, C. Q. Wu, H. Qiu, F. L. Dou, S. L. Wu, J. W. Li, et al.

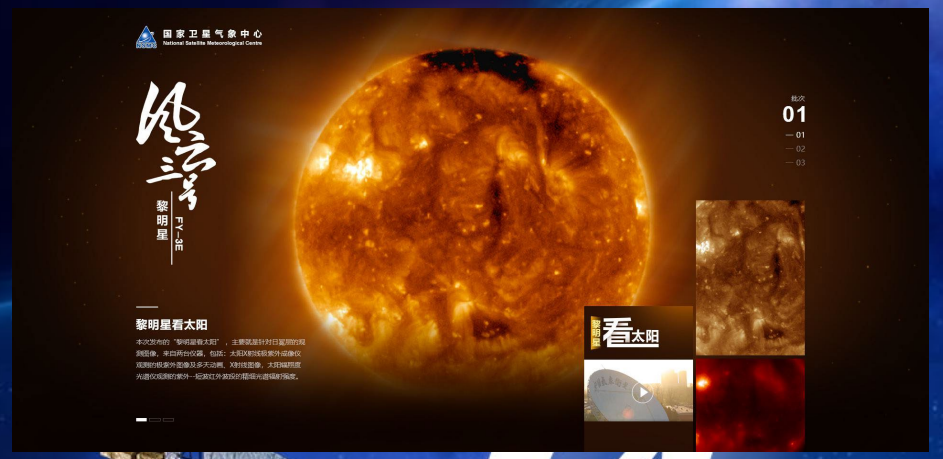
National Satellite Meteorological Center, CMA

ITSC-24: Tromsø, Norway, 16 - 22 March 2023

Outline

PART 01

FY-3E overview

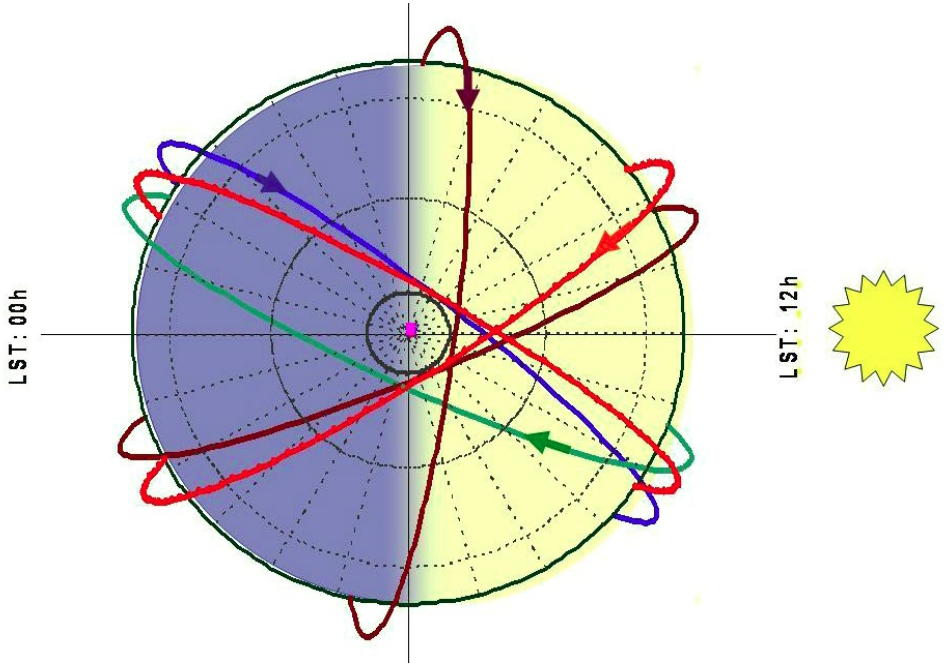


Recalling the Former Discussions

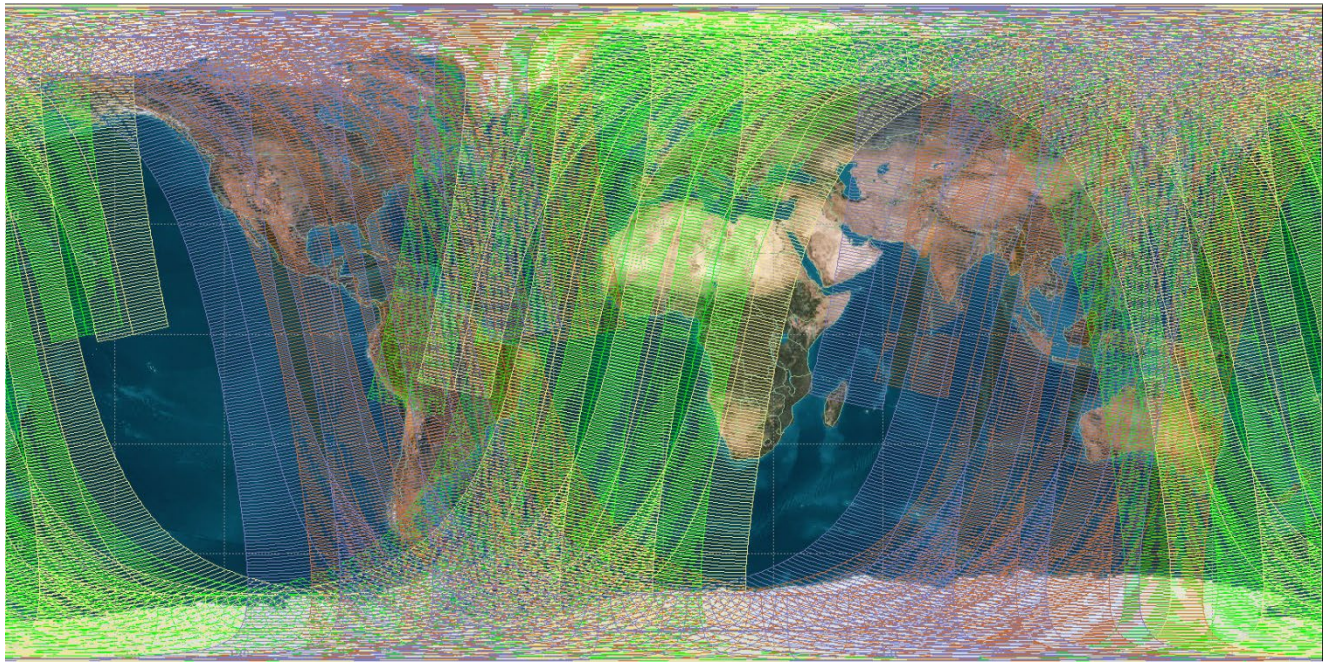
“WMO VISION FOR THE GOS IN 2025”

-- Optimizing the current operational polar-orbiting system

- **Recommendation 39.01**: CGMS agencies are invited to assess the possibility of implementing the mission with sounding capabilities in early morning orbit.



the network of polar-orbiting satellites AM, PM and EM proposed by WMO



Tiger Team Meeting, April 25 ~ 26, 2013, Beijing

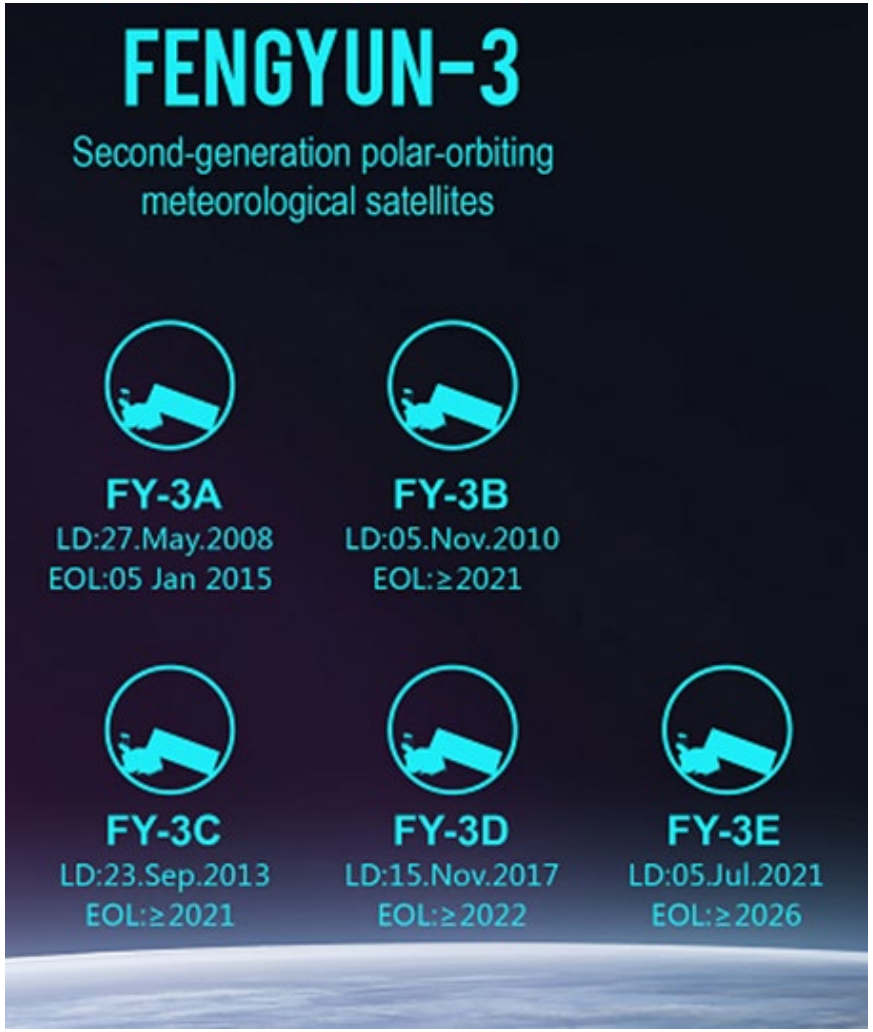
Assessment of the benefits of a satellite mission in an early morning orbit

Report from the WMO-CGMS Tiger Team

April 2013

1. **BENEFITS OF AN EARLY MORNING MISSION FOR NWP**
2. **BENEFITS FOR OTHER APPLICATIONS**
   - **Diurnal cycle and daily operations schedule**
   - **Tropical cyclones and other severe events**
   - **Climate monitoring**
   - **Air quality**
   - **Solar observations**

CMA Official Statement on EM Orbit: from original AM orbit



1. Potential User Workshop
   - Beijing, March 11, 2013
   - CMA Headquarter, NWPC, NNWPC, NCC, CAMS

2. Engineering Feasibility Seminar
   - Shanghai, Nov. 8, 2012
   - Shanghai, Jan. 10, 2013
   - Beijing, March 12, 2013
   - SAST/CAST

3. Financial Support Discussion
   - Jan., 2013
   - CMA, CNSA, NDRC

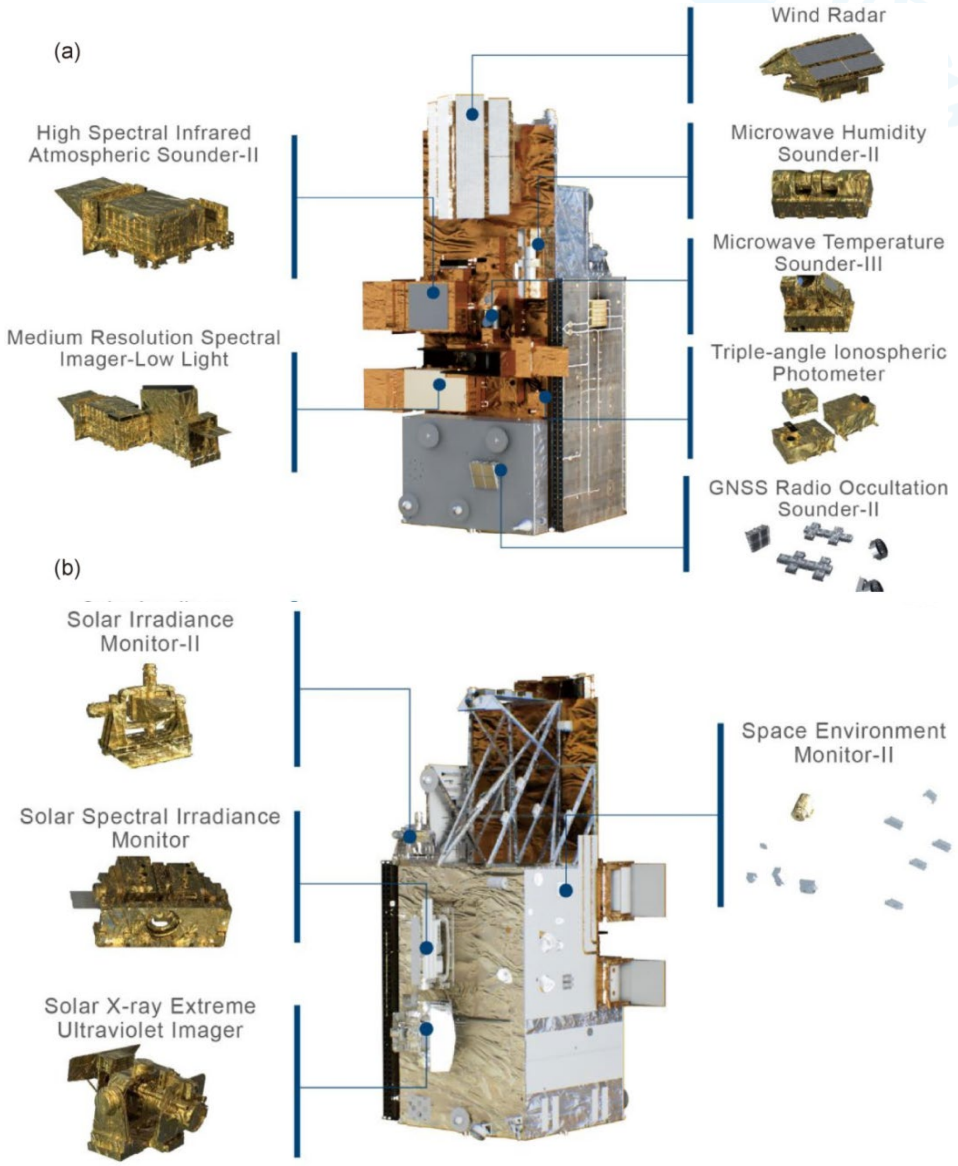
4. Tiger Team Meeting

5. 65th WMO EC: Administrator of CMA statement on E.M

Successful launch of FY-3E on July 5, 2021

Local equator crossing time: 5:40 AM

No.	Group	Instrument
1	Optical Imager	Medium Resolution Spectral Imager-Low Light (MERSI-LL)
2	Passive Microwave Sounder	Microwave Temperature Sounder-III (MWTS-III)
		Microwave Humidity Sounder-II (MWHS-II)
3	GNSS Occultation & Reflection	GNSS Radio Occultation Sounder(GNOS-II)
4	Active Microwave	Wind Radar (WindRAD)
5	Hyperspectral Sounder	High Spectral Infrared Atmospheric Sounder-II (HIRAS-II)
6	Solar Irradiance Observation	Solar Irradiance Monitor-II (SIM-II)
		Solar Spectral Irradiance Monitor (SSIM)
7	Space Weather Sensor	Space Environment Monitor-II (SEM-II)
		Triple-angle Ionospheric Photometer (Tri-IPM)
		Solar X-ray and Ultraviolet Imager (X-EUVI)

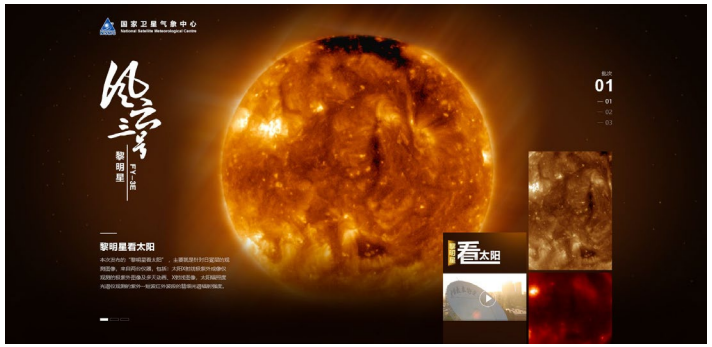


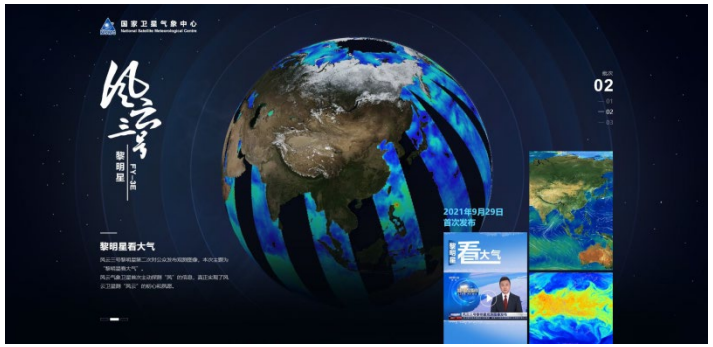
- FY-3E together with the mid-morning and afternoon satellites provides an optimal temporal distribution.
- NWP communities will significantly benefit.
- Further benefits are expected in severe weather/climate events monitoring and climate.

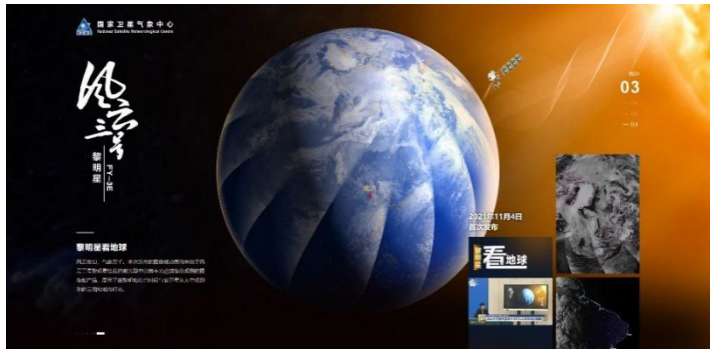
Zhang, P., et al., 2022: Adv. Atmos. Sci., https://doi.org/10.1007/s00376-0211304-7

Schedule of FY-3E in-orbit testing after the launch

The first picture of the third phase was released at a press conference of the CMA







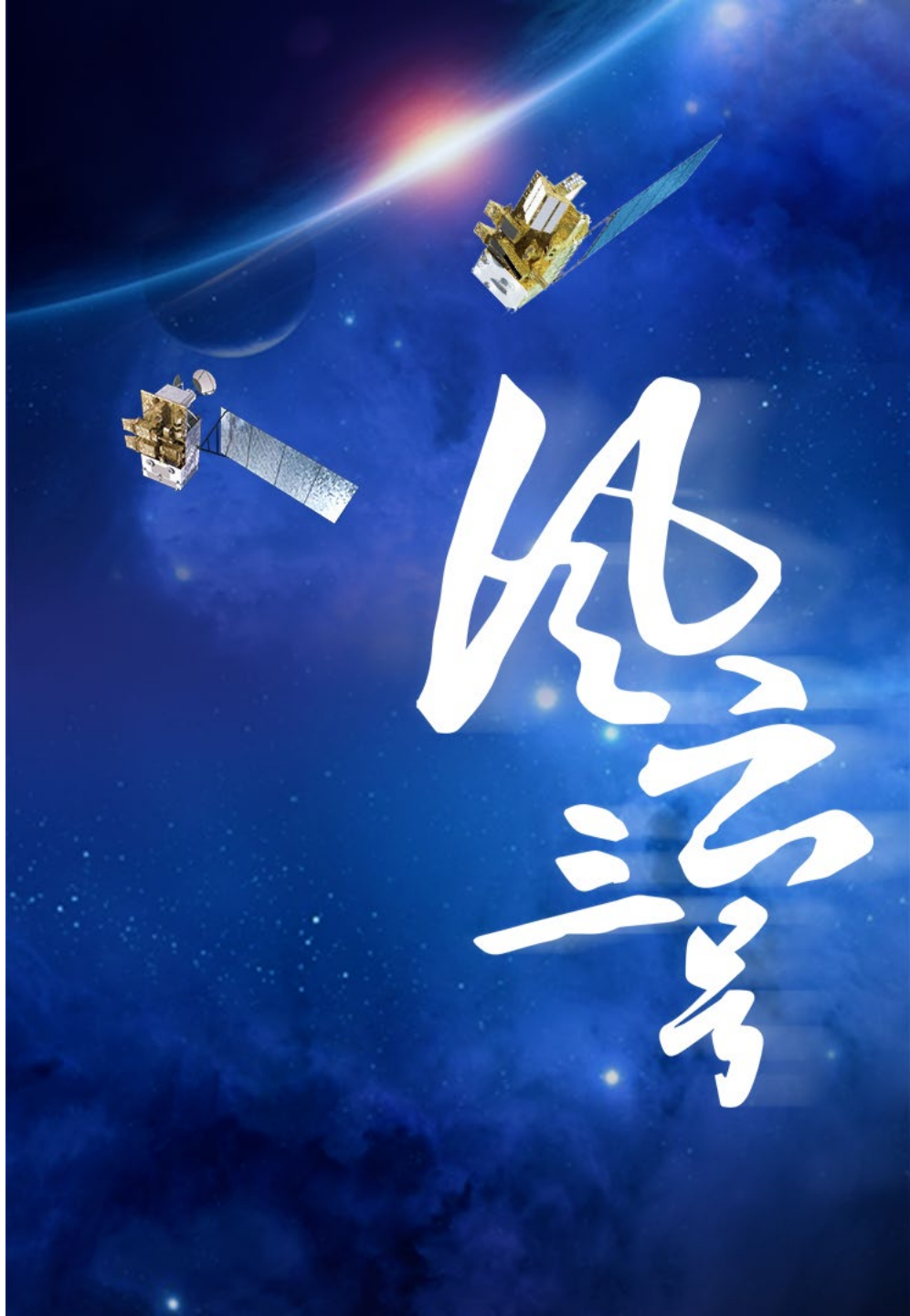
- July 5, 2021 — lunched successfully
- Oct. 15, 2021 ※ — Complete Satellite Platform check out
- Dec. 31 2021 ※ — Complete Instruments Test and Satellite delivery
- March 2022 — Review of L1/L2 provision for trial operation
- June 2022 — Turn into formal operation and data release

- Use requirements
- Test outline
- Test rules
- Scoring & evaluation criteria

※ Test summary phase

PART 02

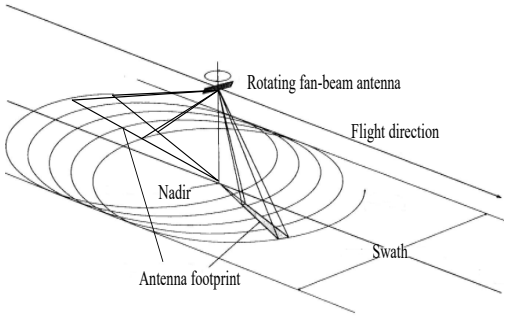
Instrument performance and L1 Quality



Wind Radar (WindRAD)

- The first active remote sensing instrument of Fengyun series.
- Dual-frequency: C & Ku band, both with VV & HH polarizations.
- Advanced rotating fan-beam.

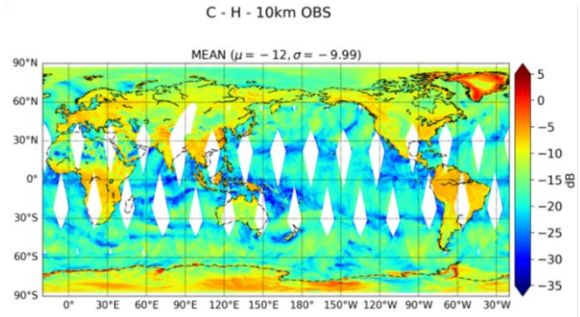
- Powered on time: July 9, 2021
- 10 items were tested including spatial resolution, swath width, minimum detectable wind speed, radiometric resolution, internal calibration accuracy, observation accuracy and important telemetry parameters.
- Instrument status is quite stable.

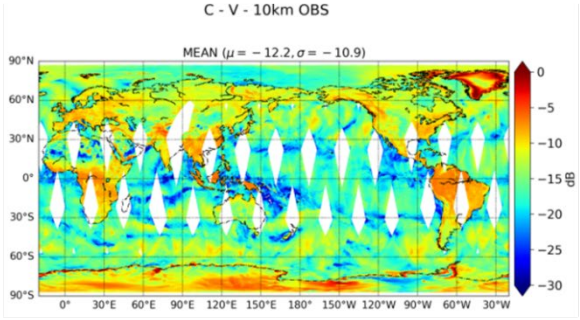


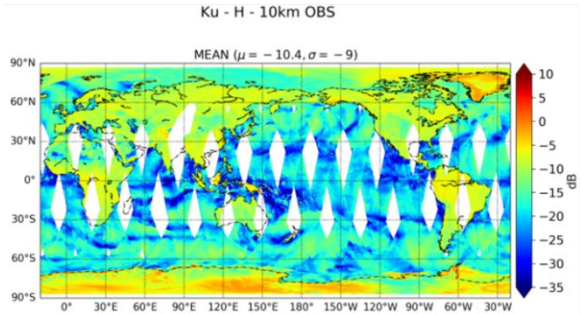
Instrument specification

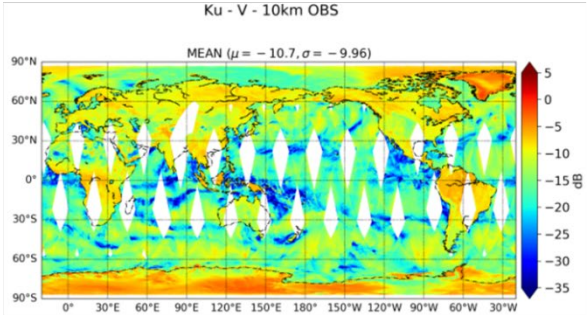
Parameter	Metric	
Frequency	5.4 GHz （C band）	13.256 GHz （Ku band）
Polarization	VV、HH	VV、HH
Spatial resolution (azimuth×range)	25 ×0.5km	10 ×0.5km
Swath	> 1200km	
Scanning mode	360° conical scanning	
Minimum detectable wind speed	3 m/s(-26.2dB)	3 m/s(-30.8dB)
Radiometric resolution	0.5dB （wind speed≥5 m/s） 1.0dB （wind speed = 3 m/s）	
Radiometric accuracy	≤ 0.6dB	

Earth surface backscattering products (20220303)



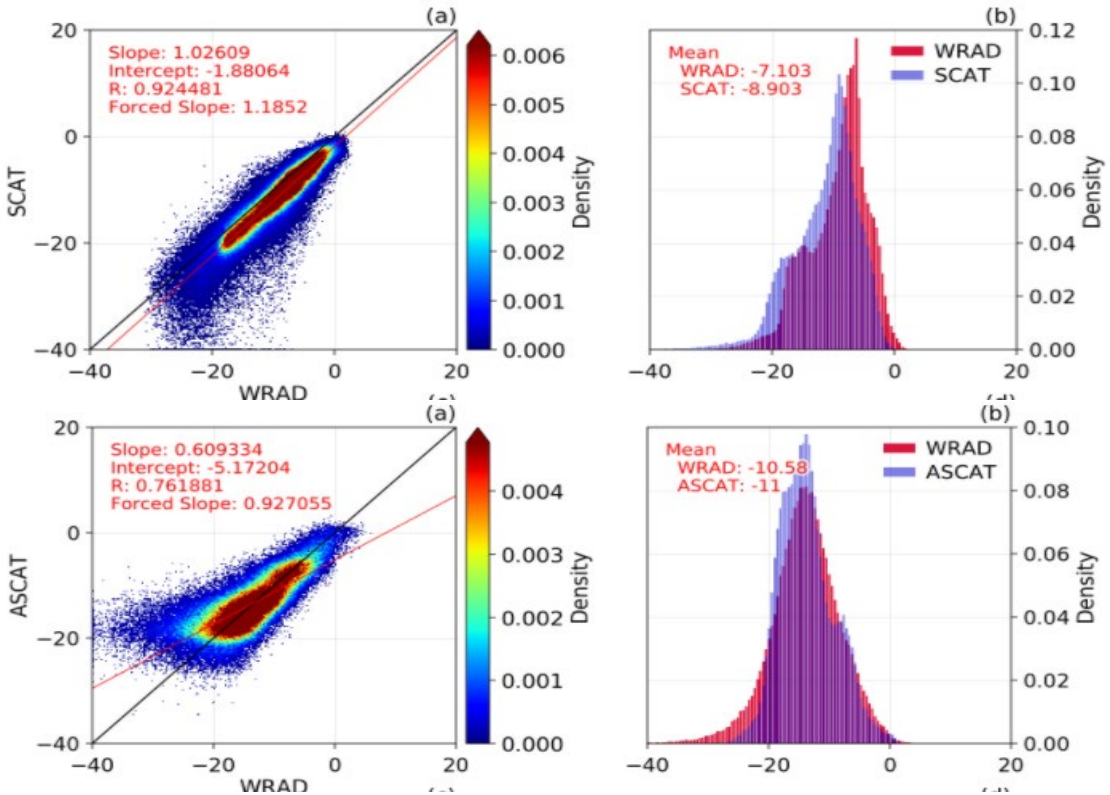






Wind Radar (WindRAD)

Internal calibration: better than 0.3 dB.



Payloads	Operator	band	polarization	Scanning System	Swath	Spatial Resolution
QuikSCAT SeaWinds	NASA/JPL	Ku	VV/HH	Pen beam conical scanning	1600km	25km
ASCAT	ESA	C	VV	Fixed fan beam	550km ×2	Standard Quality:25km
WindRAD	**NSMC, CMA**	**Ku/C**	**VV/HH**	**Conic beam scanning**	**1200km**	**C-band:25km Ku-band:10km**

Frequency	Accuracy of internal calibration (dB)	Specification (dB)
C	0.2399	≤ 0.6
Ku	0.1937	≤ 0.6

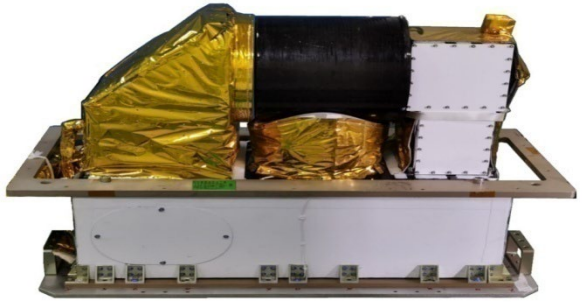
	Correlation coefficient	Bias / dB
Ku HH	0.92	1.80
Ku VV	0.91	1.65
C VV	0.76	0.41

SNO: preliminary results

- **Sigma0 bias of C band is smaller than Ku. Sigma0 of Ku band is relatively large.**
- **Further improvement is under investigation, and external calibration will be carried out.**
- **Detailed SNO and NOC will be carried out.**

Microwave Temperature Sounder-III (MWTS-III)

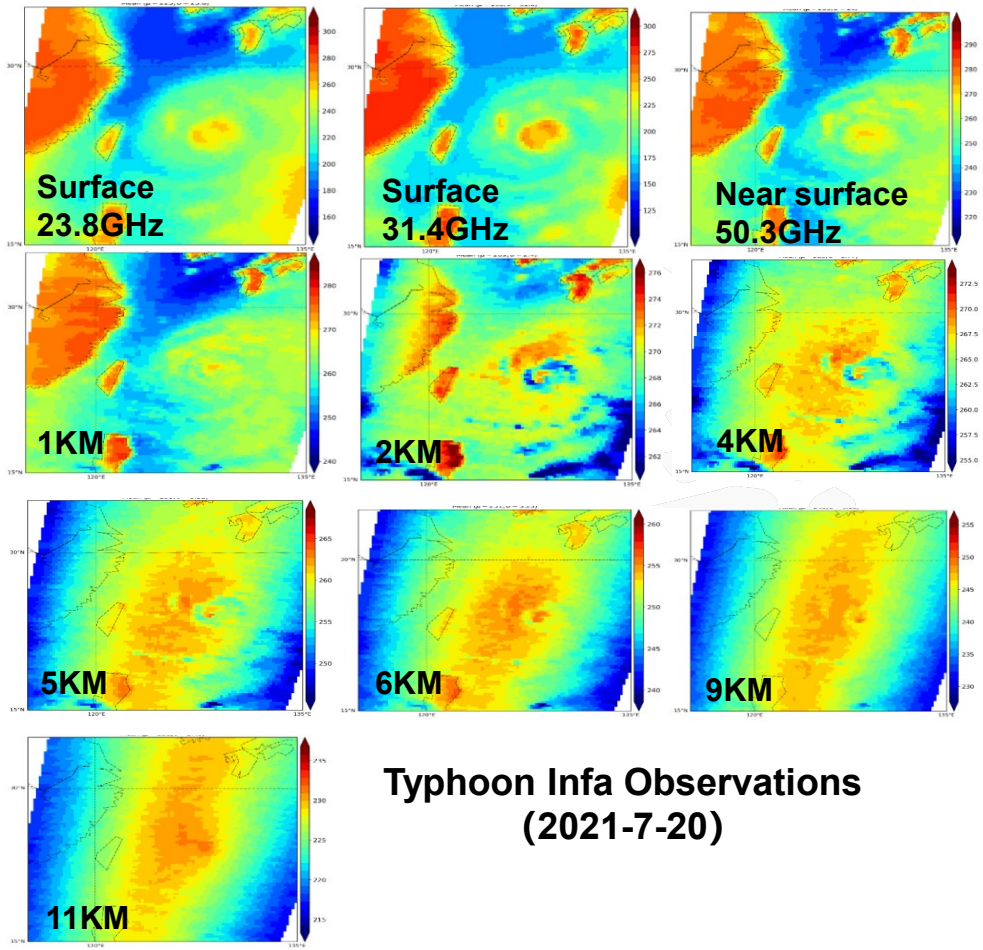
- The third type MWTS with 4 more channels (23.8 GHz, 31.4 GHz, 53.246±0.08 GHz and 53.948±0.081 GHz) and better NEdT requirement.
- Powered on time: July 9, 2021.
- Instrument status is stable.



Instrument specification

CH	Center Frequency (GHz)	Bandpass width (MHz)	NEdT (K)	Polarization	Accuracy* (K)
1	23.8	270	0.3	QH	1.2/0.8
2	31.4	180	0.35	QH	1.2/0.8
3	50.3	180	0.35	QV	1.2/0.8
4	51.76	400	0.3	QV	1.2/0.8
5	52.8	400	0.3	QV	1.2/0.8
6	53.246±0.08	2*140	0.35	QV	1.2/0.8
7	53.596±0.115	2*170	0.3	QV	1.2/0.8
8	53.948±0.081	2*142	0.35	QV	1.2/0.8
9	54.40	400	0.3	QV	1.2/0.8
10	54.94	400	0.3	QV	1.2/0.8
11	55.50	330	0.3	QV	1.2/0.8
12	57.290344(fo)	330	0.6	QV	1.5/1.2
13	fo±0.217	2*78	0.7	QV	1.5/1.2
14	fo±0.3222±0.048	4*36	0.8	QV	1.5/1.2
15	fo±0.3222±0.022	4*16	1.0	QV	1.5/1.2
16	fo±0.3222±0.010	4*8	1.2	QV	1.5/1.2
17	fo±0.3222±0.0045	4*3	2.1	QV	2.5/1.5

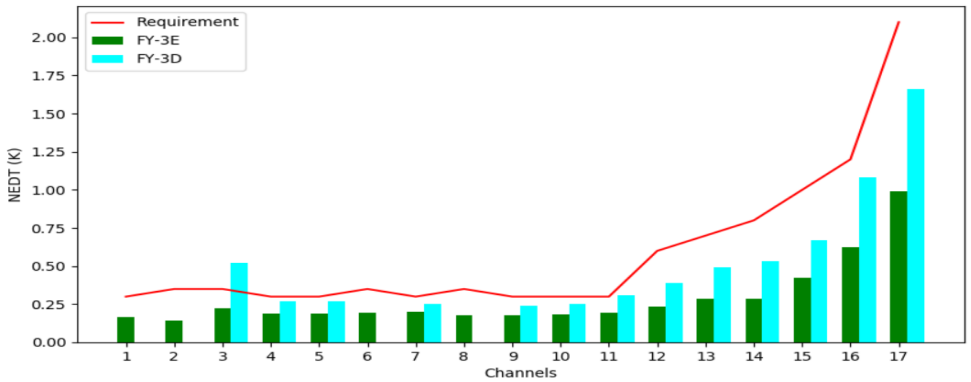
*: Requirements/Expectation



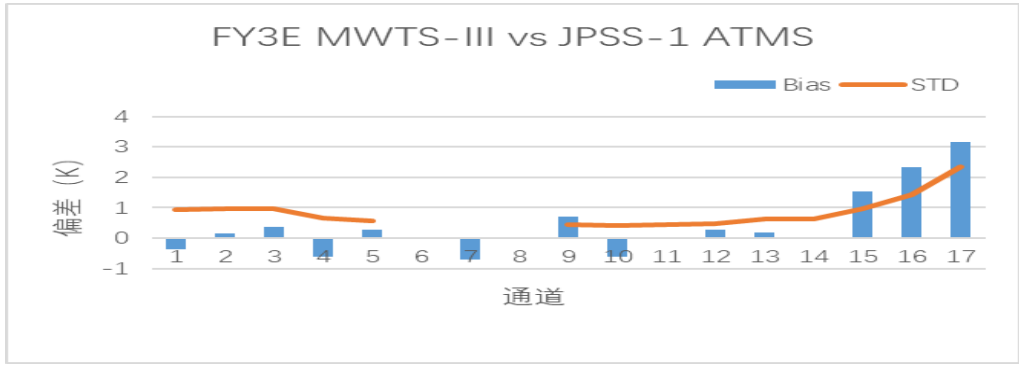
Typhoon Infa Observations (2021-7-20)

Microwave Temperature Sounder-III (MWTS-III)

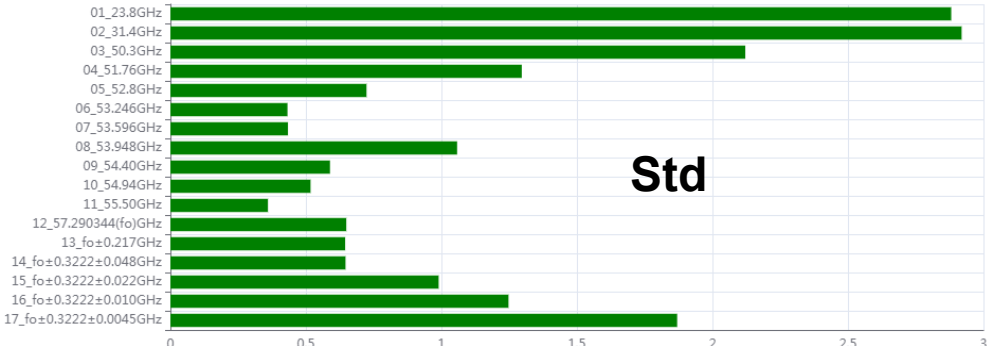
NEdT: better than FY-3D MWTS-II.

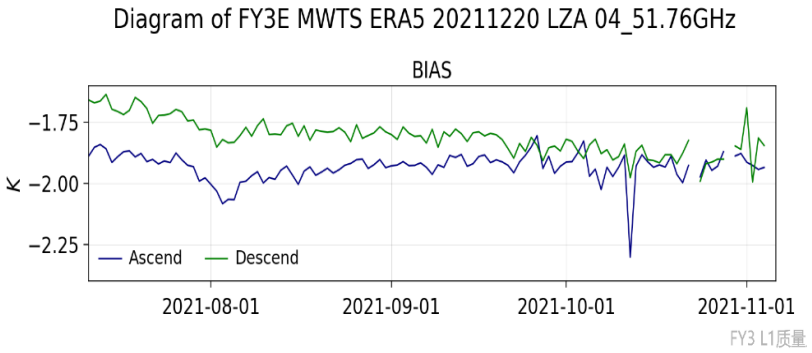


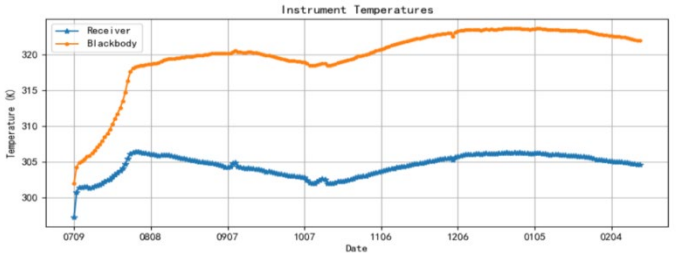
SNO: Std <1K



OMB :





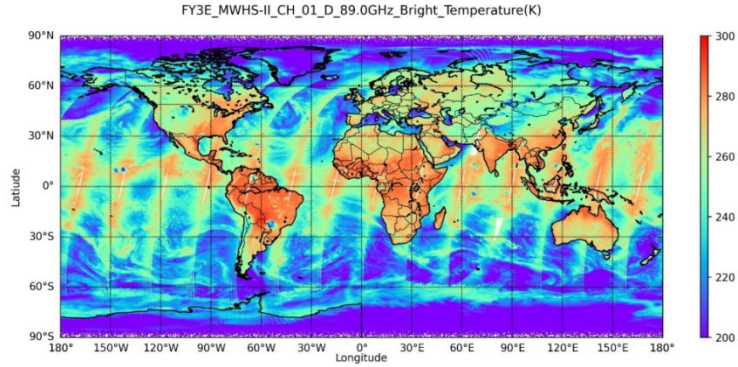


Microwave Humidity Sounder-II (MWHS-II)

- Inherited MWTS with 15 channels with better requirements.

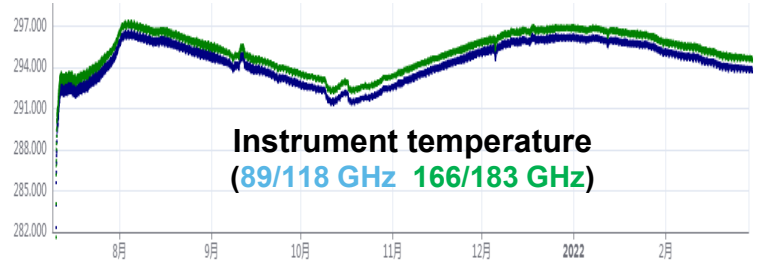
Window channel at 166 GHz instead of 150 GHz.

- Powered on time: July 9, 2021.
- Instrument status is stable.

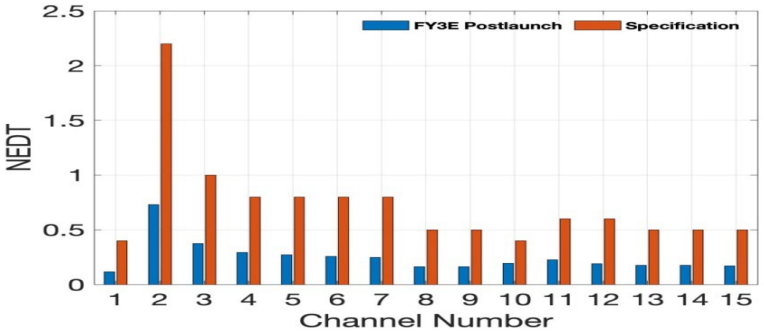


Instrument specification

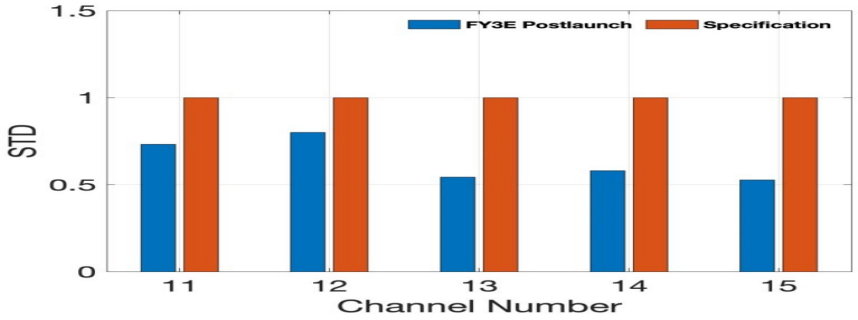
CH	Center Frequency (GHz)	Polarization	Bandpass Width(MHz)	NEdT (K)	Accuracy (K)
1	89.0	QV	1500	0.4	0.8
2	118.75±0.08	QH	20	2.2	2.2
3	118.75±0.2	QH	100	1.0	1.0
4	118.75±0.3	QH	165	0.8	1.0
5	118.75±0.8	QH	200	0.8	1.0
6	118.75±1.1	QH	200	0.8	0.8
7	118.75±2.5	QH	200	0.8	0.8
8	118.75±3.0	QH	1000	0.5	0.8
9	118.75±5.0	QH	2000	0.5	0.8
10	166.0	QV	1500	0.4	0.8
11	183.31±1	QH	500	0.6	0.8
12	183.31±1.8	QH	700	0.6	0.8
13	183.31±3	QH	1000	0.5	0.8
14	183.31±4.5	QH	2000	0.5	0.8
15	183.31±7	QH	2000	0.5	0.8



NEdT: better than specification

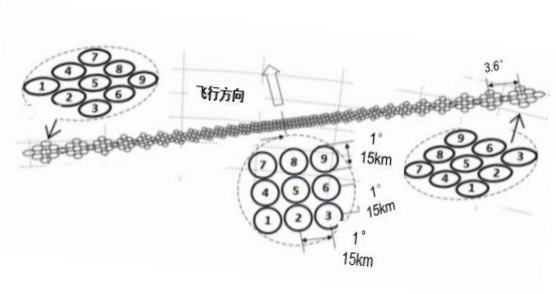


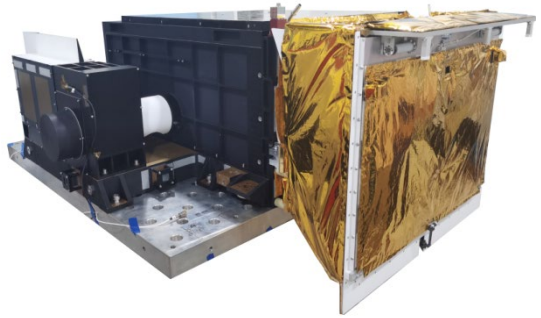
SNO: std <1K for 5 humidity channels



High Spectral Infrared Atmospheric Sounder-II (HIRAS-II)

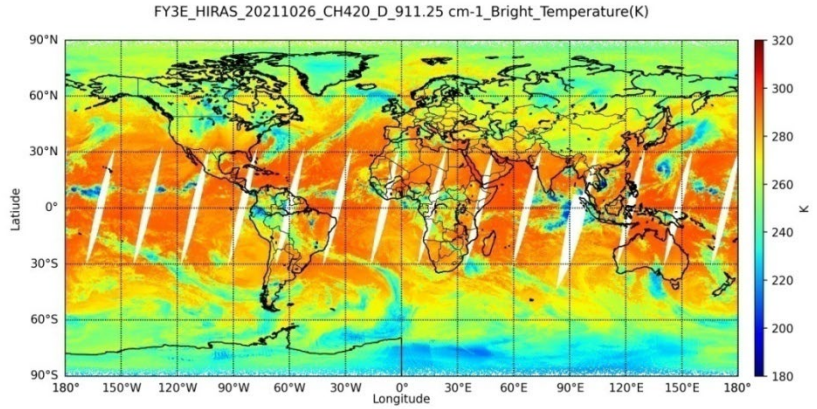
- The second generation HIRAS
- Detectors: 2*2 --> 3*3
- NEdT well improved, especially MW/SW
- Full spectral coverage from 650 to 2550 cm^{-1} without gaps between 3 spectral bands.
- Detectors and interferometer powered on time: Oct. 12, 2021
- Instrument status is stable since August 20, 2022.

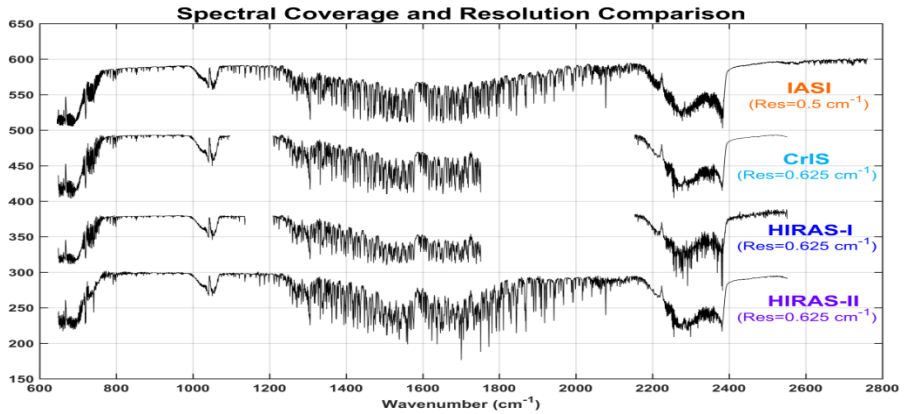




Instrument specification

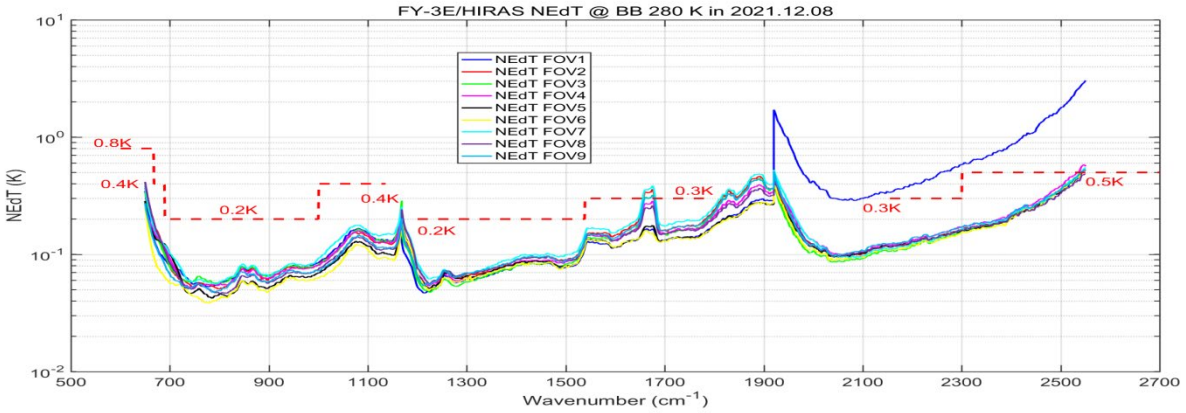
Band	Spectral range (cm^{-1})	Spectral resolution (cm^{-1})	NEΔT@280K		Radiometric accuracy(K)	Spectral accuracy (ppm)
LWIR	650 ~ 1168.125 (15.38 ~ 8.56 μm)	0.625	650 ~ 667 cm^{-1}	0.8K	1K/0.8K	7 ppm /5 ppm
			667 ~ 689 cm^{-1}	0.4K	0.5K/0.4K	
			689 ~ 1000 cm^{-1}	0.2K	0.4K/0.3K	
			1000 ~ 1136 cm^{-1}	0.4K	0.5K/0.4K	
MWIR	1168.75 ~ 1920 (8.55 ~ 5.21 μm)	0.625	1210 ~ 1538 cm^{-1}	0.2K	0.4K/0.3K	
			1538 ~ 1750 cm^{-1}	0.3K	0.5K/0.4K	
SWIR	1920.625 ~ 2550 (5.21 ~ 3.92 μm)	0.625	2155 ~ 2300 cm^{-1}	0.3	0.5K/0.4K	
			2300 ~ 2550 cm^{-1}	0.5	0.6K/0.5K	



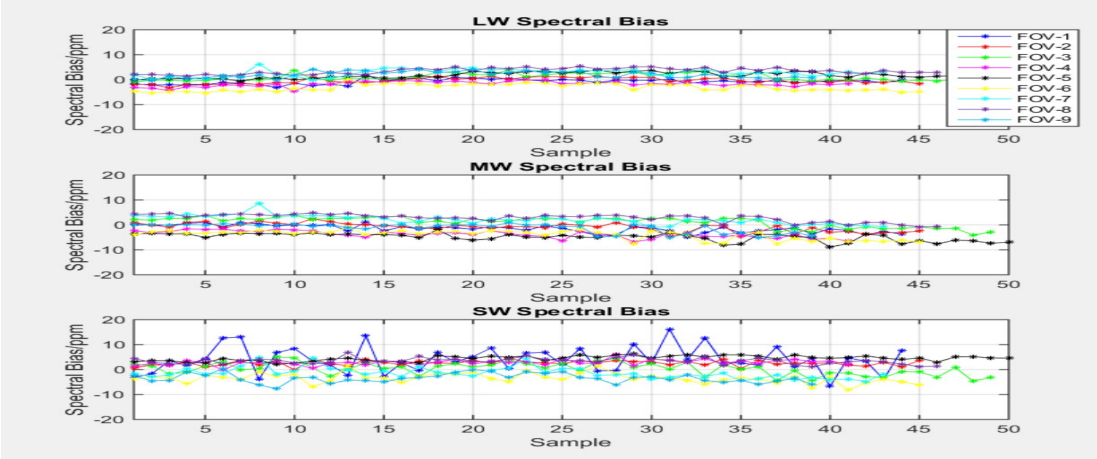


High Spectral Infrared Atmospheric Sounder-II (HIRAS-II)

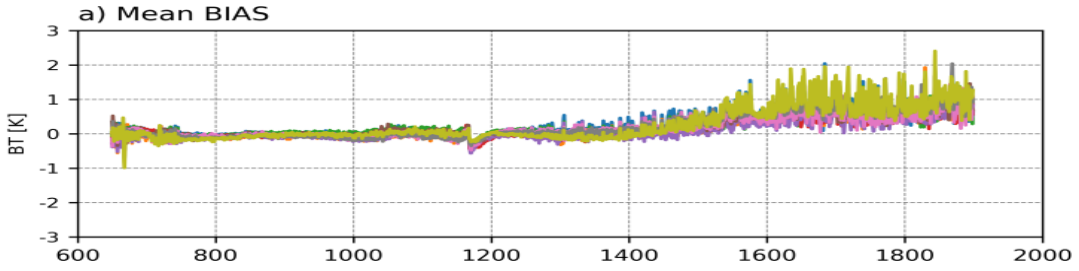
NEdT:Good noise performance in LWIR & MWIR, comparable to CrIS and IASI in LWIR. **SWIR FOV-1 out of family & worser than specification**. Channels around 1700 cm-1 slightly higher.



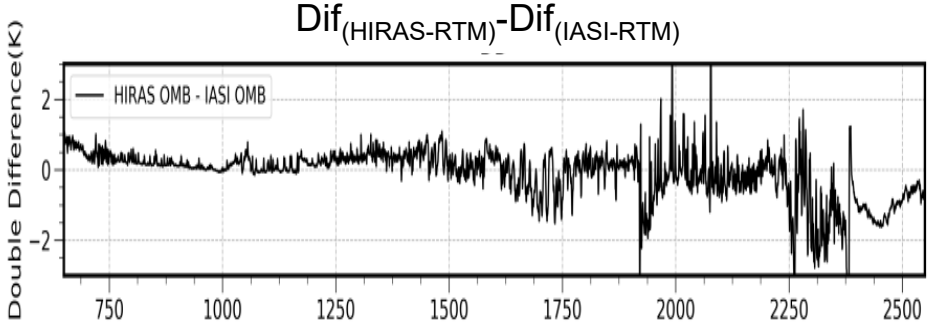
Spectral bias: all within ±5 ppm.



SNO: BT bias in LWIR < 0.3K and most MWIR channels < 0.5 K .

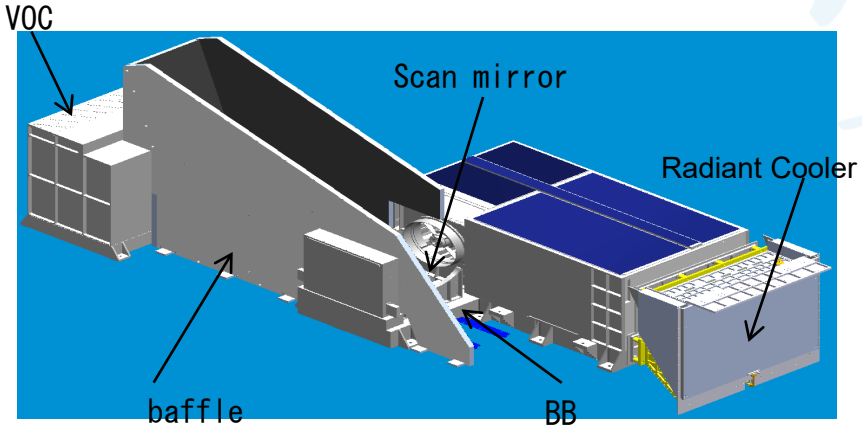


OMB DD: BT bias in LWIR <0.5K, 0.5 to 1.0 K in MWIR.



Medium Resolution Spectral Imager-Low Light (MERSI-LL)

- Optical imager with 6 infrared channels inherited from FY-3D and 1 panchromatic low-light band (500-900nm).
- RBS powered on time: July 9, 2021
- TEB powered on time: Sept. 7, 2021
- Onboard Solar Diffused Transmission Board (SDTB) is used for RSB degradation monitoring.
- Instrument status is stable.



Instrument specification

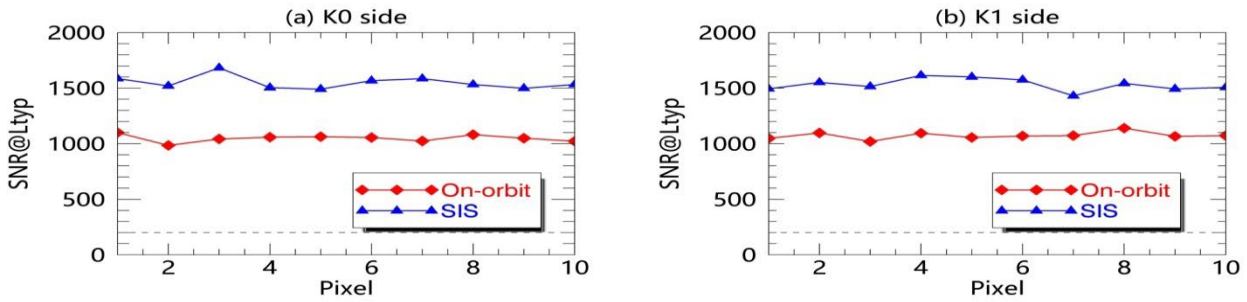
CH	CW (μm)	L_{max}/T_{max} W/m²/sr	L_{min}/T_{min} W/m²/sr	L_{typ}/T_{typ} W/m²/sr	SNR/ NEΔT @L_{typ}/T_{typ}	Accuracy*
1	0.70	90	3e-5	4e-5(night)	7	50%/10%
				50(day)	200	10%/5%
2	3.8	350K	186K	300K	0.25K	0.4K/0.2K
3	4.05	380K	185K	300/380K	0.25K	0.4K/0.2K
4	7.2	270K	186K	270K	0.30K	0.4K/0.2K
5	8.55	330K	185K	270K	0.25K	0.4K/0.2K
6	10.8	345K	185K	300K	0.30K	0.4K/0.2K
7	12.0	345K	185K	300K	0.30K	0.4K/0.2K

*: Requirements/Expectation
250m: 10.8 and 12 um

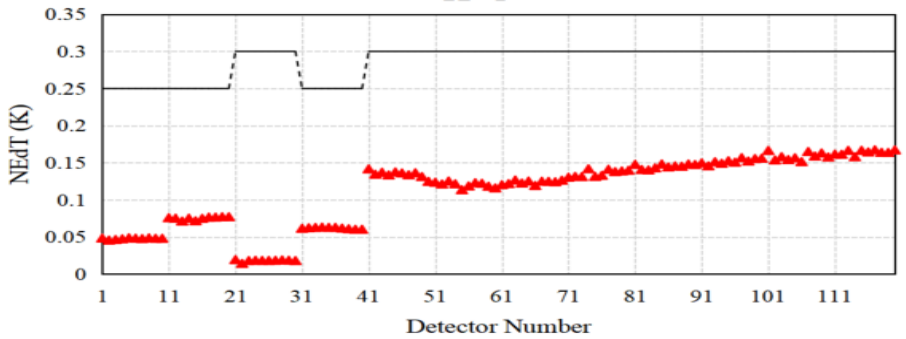
LLB Image Aug. 2, 2021

Medium Resolution Spectral Imager-Low Light (MERSI-LL)

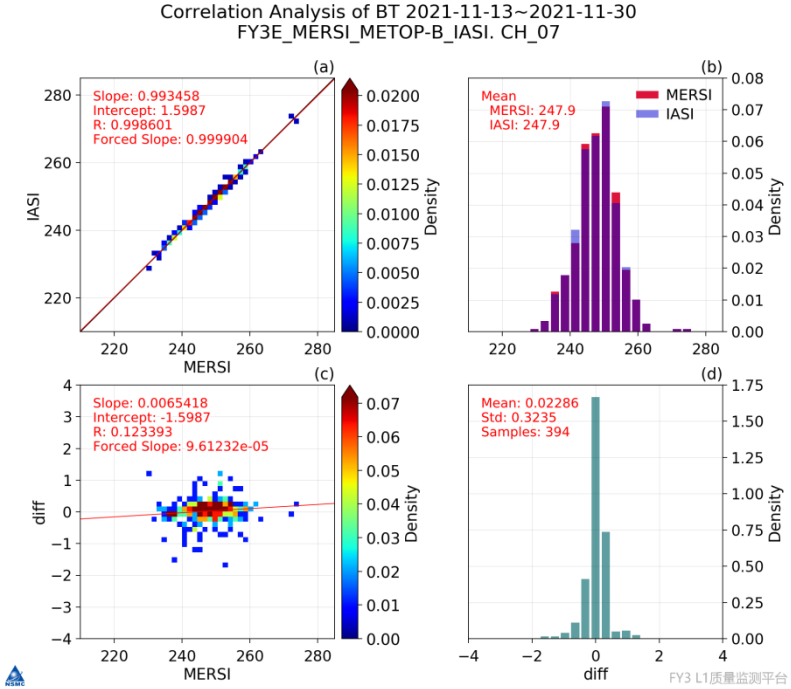
SNR: LL band low gain



NEdT: 1km-channels <0.1K, 250m-channels<0.18K



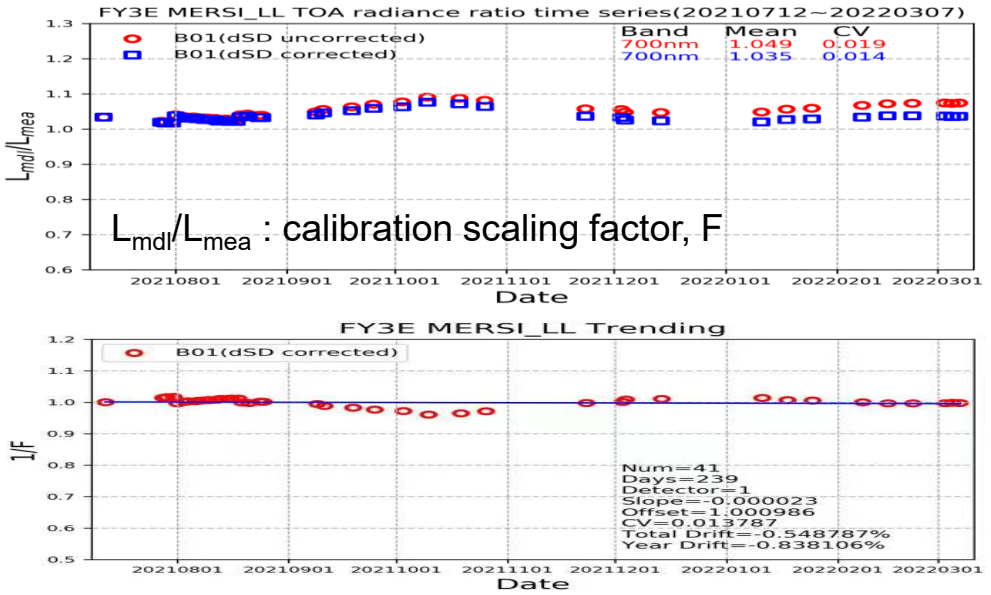
SNO: IR biases within 0.3 K.



IASI-B	Bias
CH2_3.8	-0.394
CH3_4.05	-0.116
CH4_7.2	-0.127
CH5_8.5	0.032
CH6_10.8	-0.039
CH7_12.0	0.023

LLB low gain:

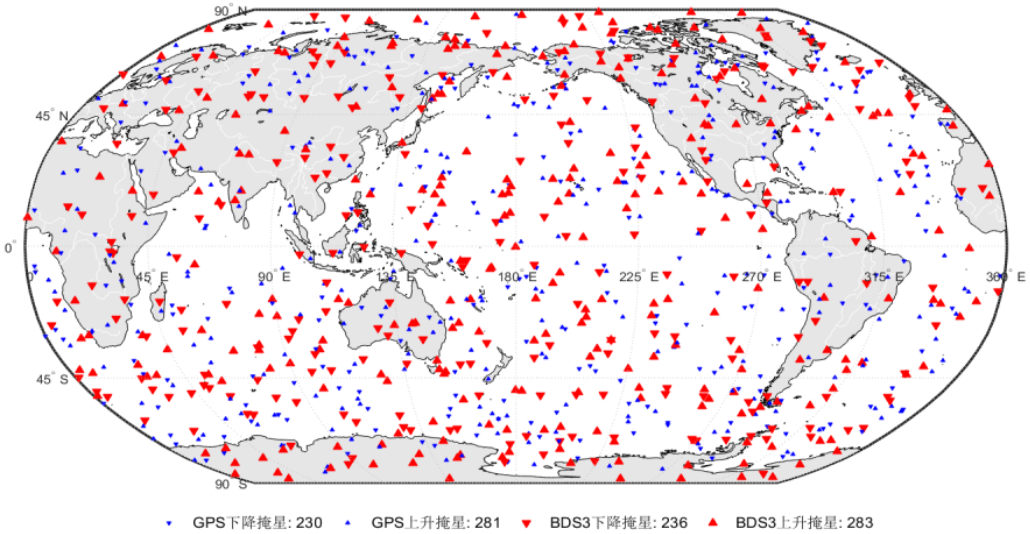
F factor (L_{mdl}/L_{mea}) is around 1.035. 1/F factor trending shows that radiometric response of LLB is stable with total drift <1%.



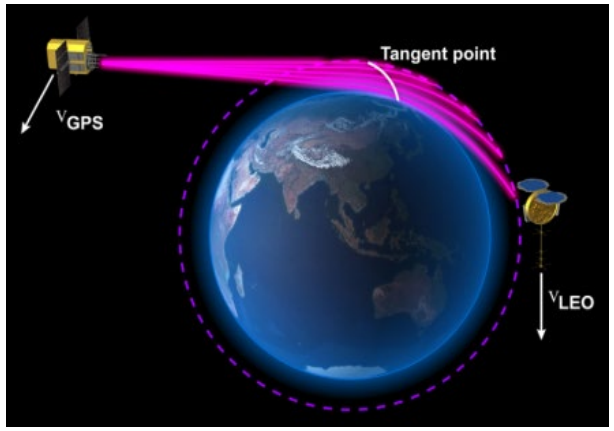
GNSS Radio Occultation Sounder-II (GNOS-II)

- **GNSS Reflectometry (GNSS-R) module added.**
- **GNSS Radio Occultation (GNSS-RO) module including GPS and BeiDou system.**

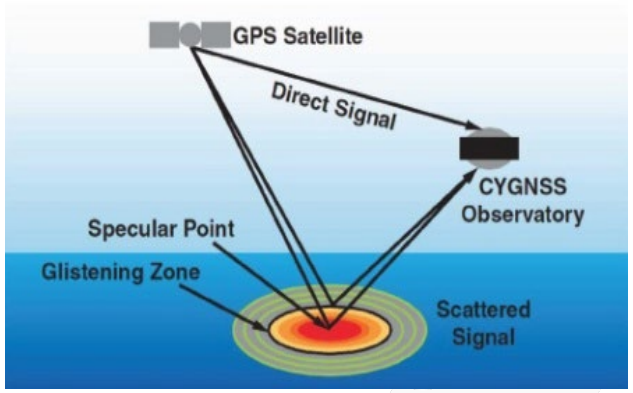
Ionospheric RO distribution



Total number of occultation: more than two times of FY-3D. GPS/BDS atmospheric occultations ＞1000 GPS/BDS ionospheric occultations ＞1200.

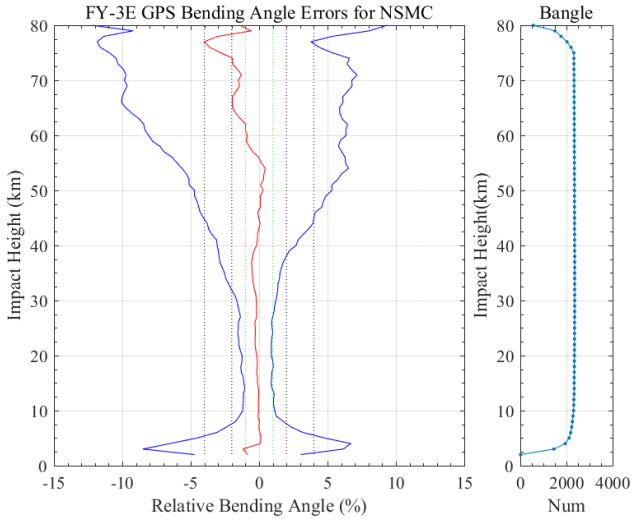


GNSS-RO

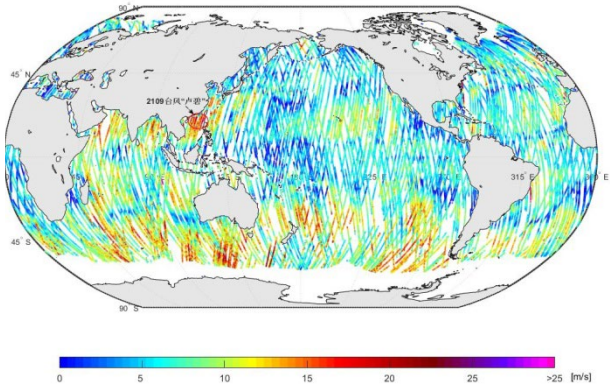


GNSS-R

Bending angle accuracy: std <2 % (10~35km) for atmospheric occultations



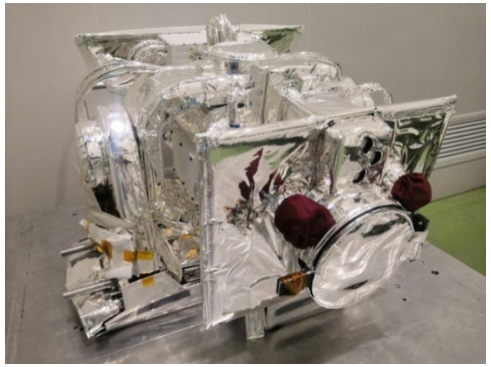
Sea surface wind (20210802-0807)

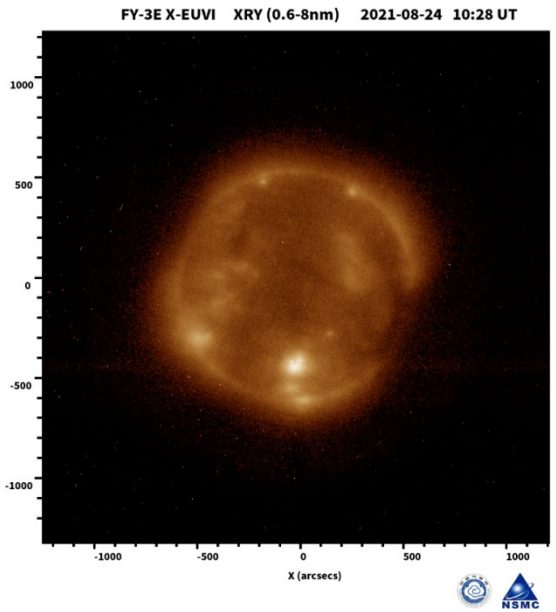


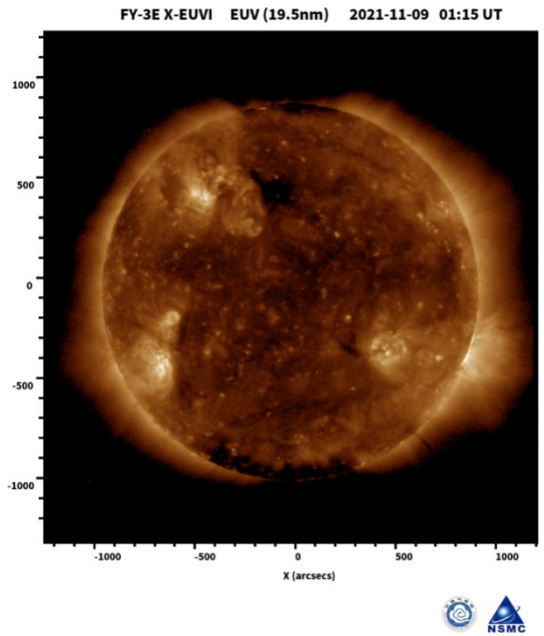
Solar Observation Instruments

Solar X-ray and Ultraviolet Imager (X-EUVI)

- 2 spectral bands:
  X(0.6-8nm), EUV(19.5nm)
- 8 channels:
  X1:0.6-8.0 nm X2:0.6-6.0
  X3:0.6-5.0 nm X4:0.6-2.0 nm
  X5:0.6-1.6 nm X6:0.6-1.2 nm
  EUV1(thin) EUV2(thick)

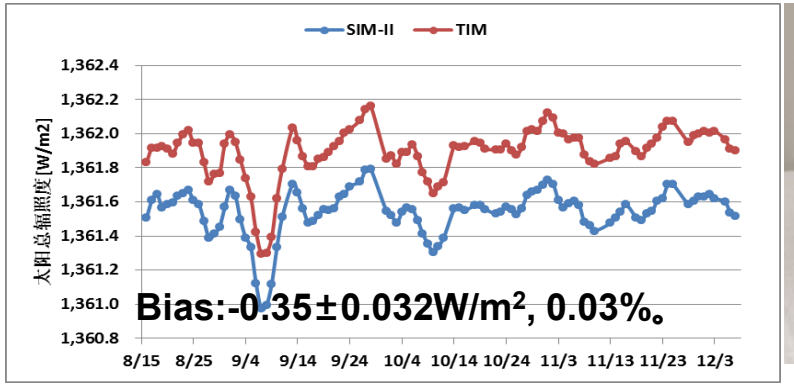


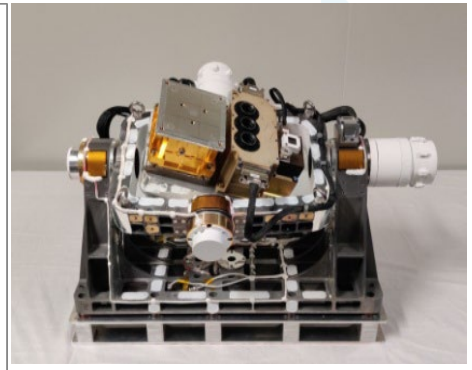




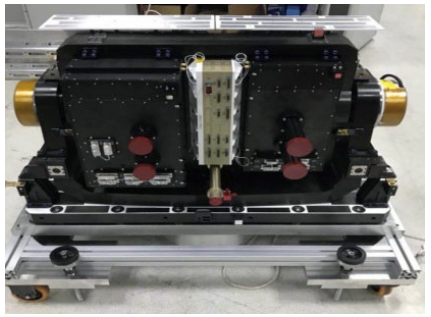
Solar Irradiance Monitor-II (SIM-II)

Total solar irradiance (TSI)

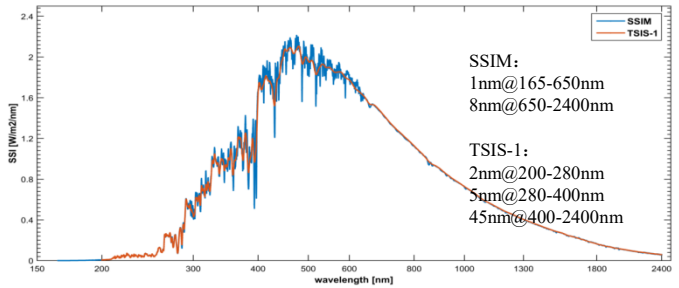




Solar Spectral Irradiance Monitor (SSIM)



Solar spectral irradiance from 165 to 1650nm



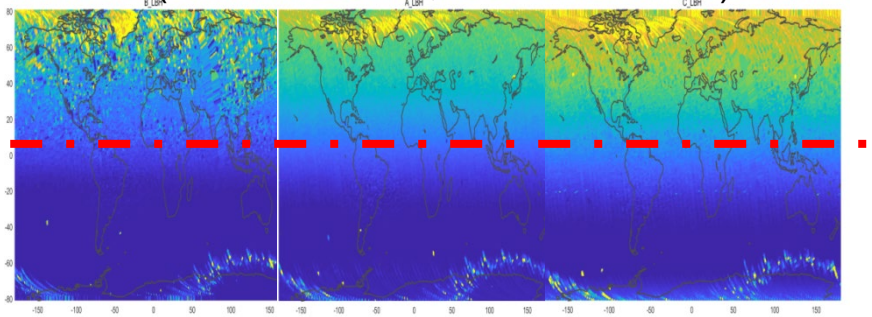
- 3 spectral bands: UV(165-320nm), VIS(285-700nm), NIR(650-1650nm)
- Spectral resolution: UV&VIR:1 nm, NIR <8nm.

Space Weather Instruments

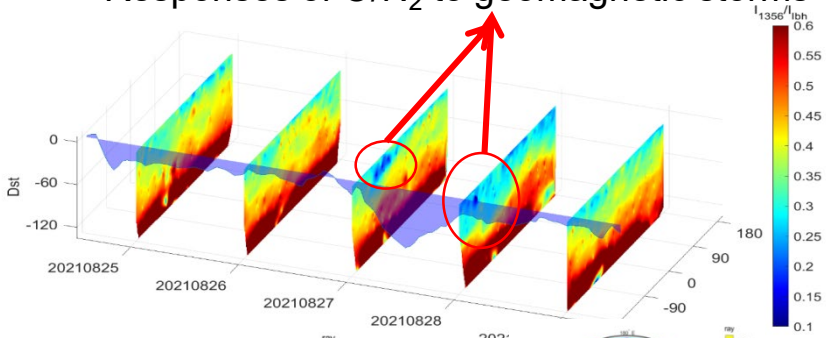
Triple-angle Ionospheric Photometer (Tri-IPM)

Measuring airglow radiation intensity of oxygen atoms and nitrogen molecules with 3 probes, which can inverse the variation of ionosphere/middle and upper atmosphere.

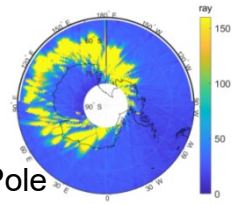
Airglow map with 3 sensors
(local time 17:25, 17:40 and 17:55)



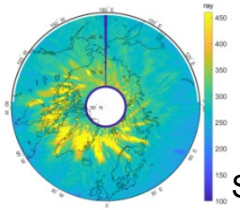
Responses of O/N_2 to geomagnetic storms



Aurora



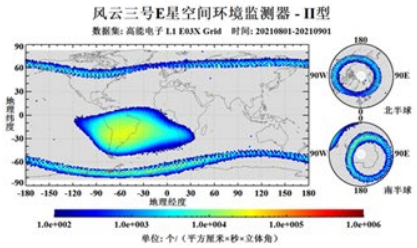
North Pole



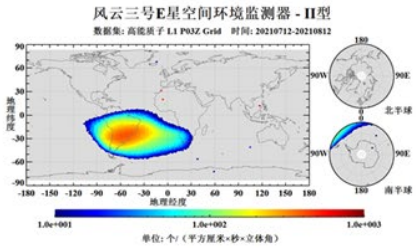
South Pole

Space Environment Monitor-II (SEM-II)

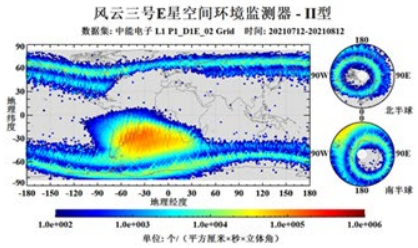
Measuring the space factors (particles, radiation dose, surface potential, magnetic field vectors, etc.) in situ.



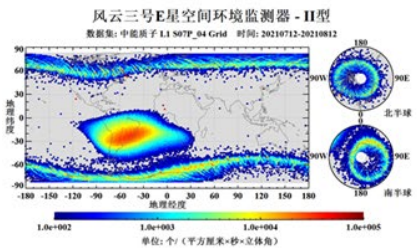
高能电子E3通道
(0.65 MeV ~ 1.20 MeV)



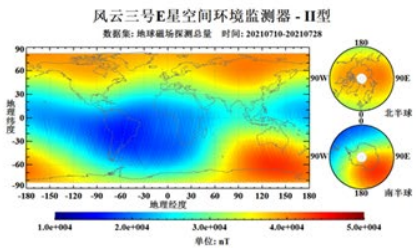
高能质子P3通道
(10 MeV ~ 26 MeV)



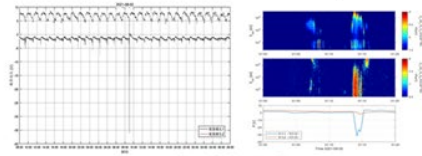
中能电子D1方向E2通道
(40 keV ~ 60 keV)



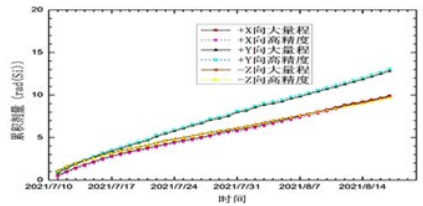
中能质子S7方向P4通道
(120 keV ~ 170 keV)



地球磁场探测总量



电位探测

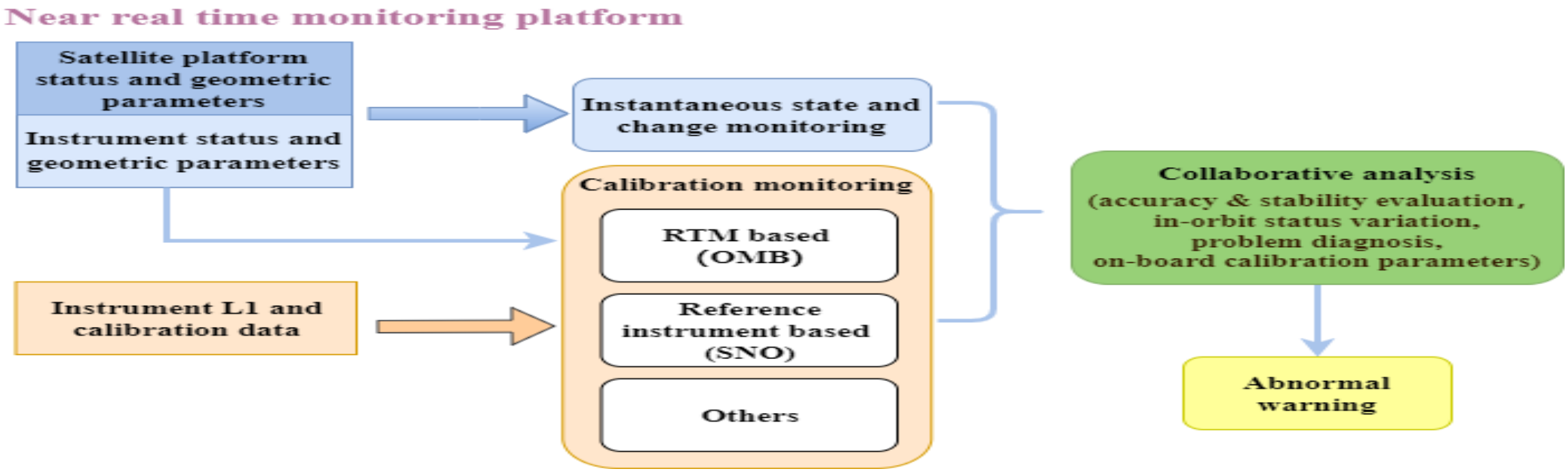


辐射剂量探测

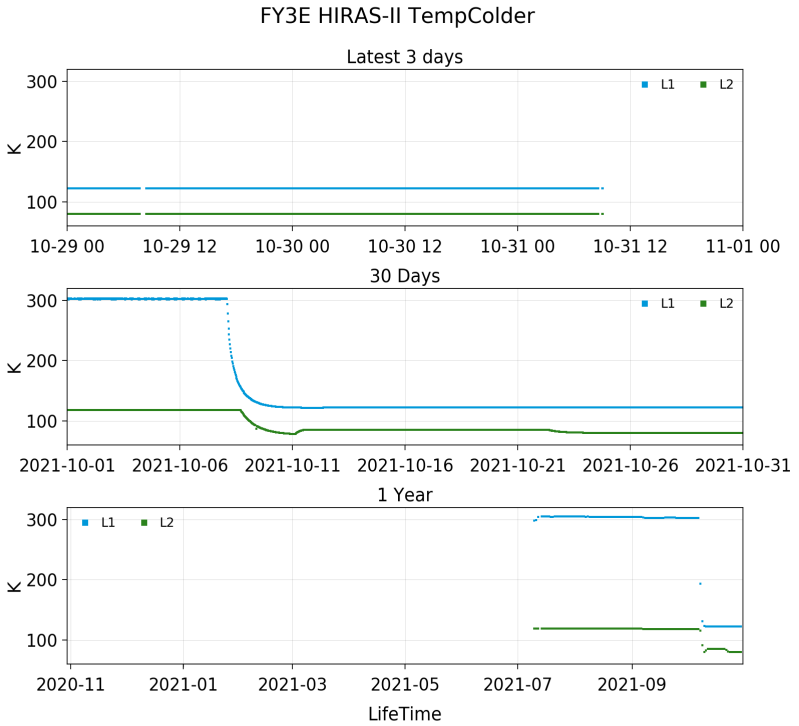
Instrument status and L1 quality monitoring system

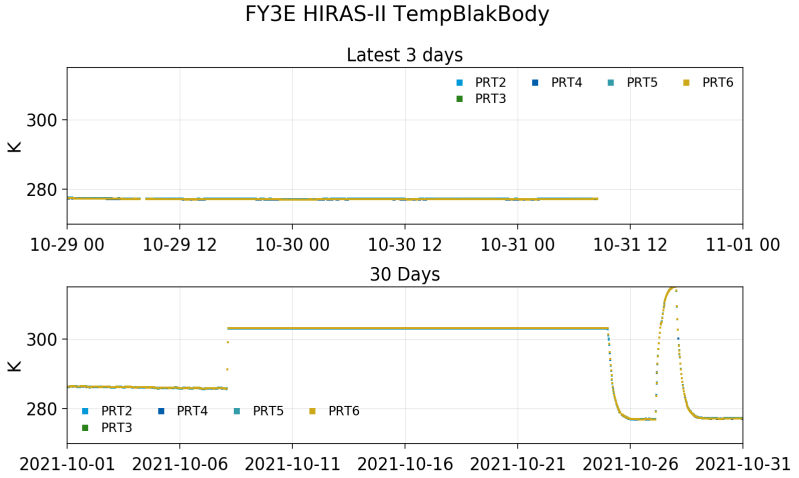
Operational monitoring/alarming:

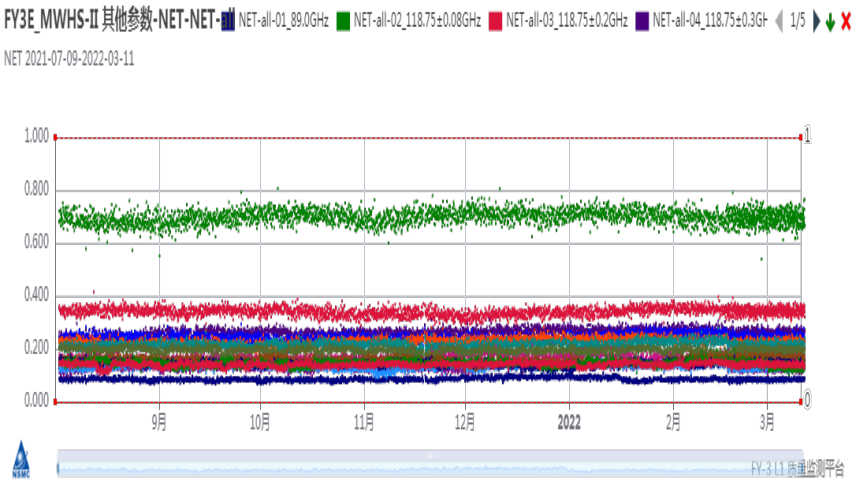
- Platform monitoring: GPS and IOE
- Instrument parameter monitoring: 11 instruments
- L1 calibration accuracy monitoring: based on RTM simulation and reference instruments
- Other calibration analysis



Key instrument telemetry monitoring



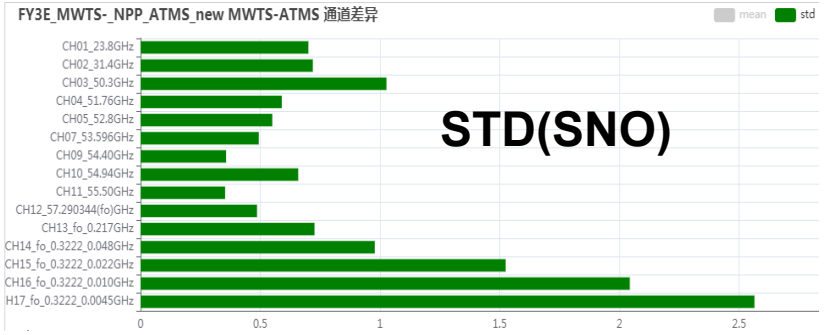




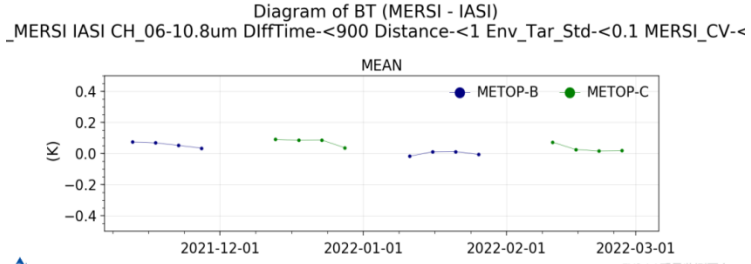
No.	Instrument	Par Num
1	MERSI-LL	30
2	MWHS-II	22
3	MWTS-III	25
4	HIRAS-II	53
5	WindRAD	72
6	GNOS-II	43
7	SIM-II	22
8	SSIM	25
9	SEM-II	34
10	Tri-IPM	18
11	X-EUVI	18

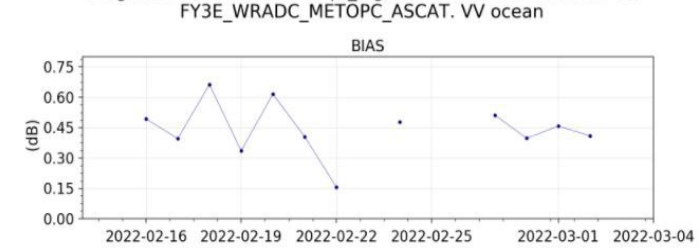
L1 quality monitoring using reference instrument

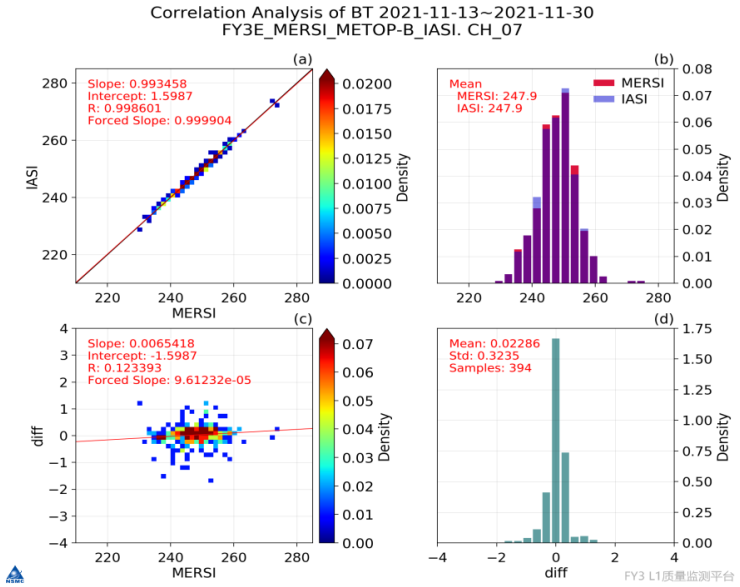
- **MERSI**: vs. IASI
- **HIRAS**: vs. IASI
- **MWTS&MWHS**: vs. ATMS
- **WindRAD**: vs. CFOSAT/SCAT&HY-2/SCAT &Metop/ASCAT

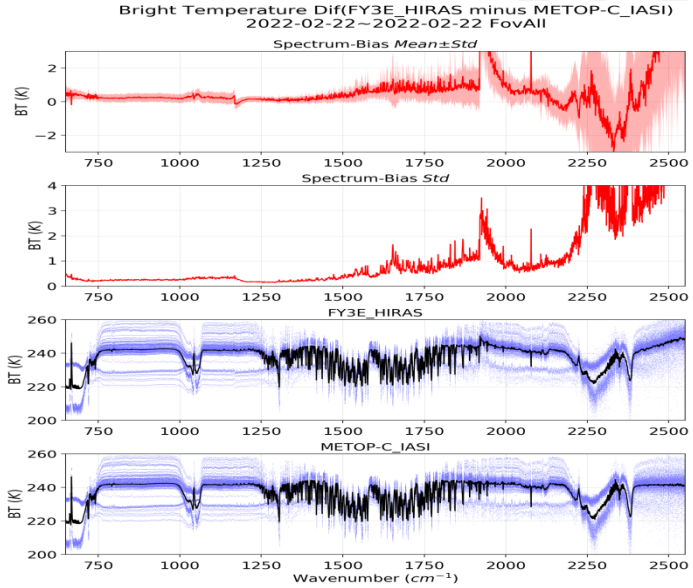


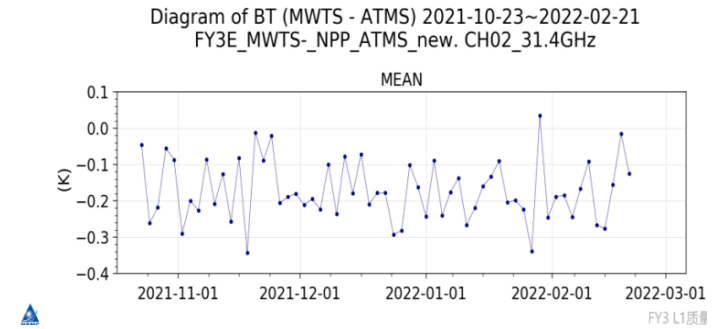
STD(SNO)

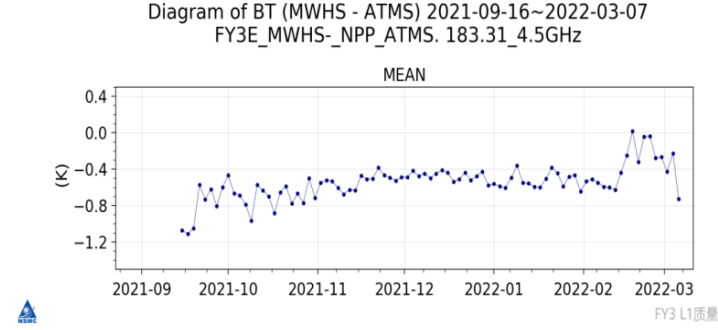


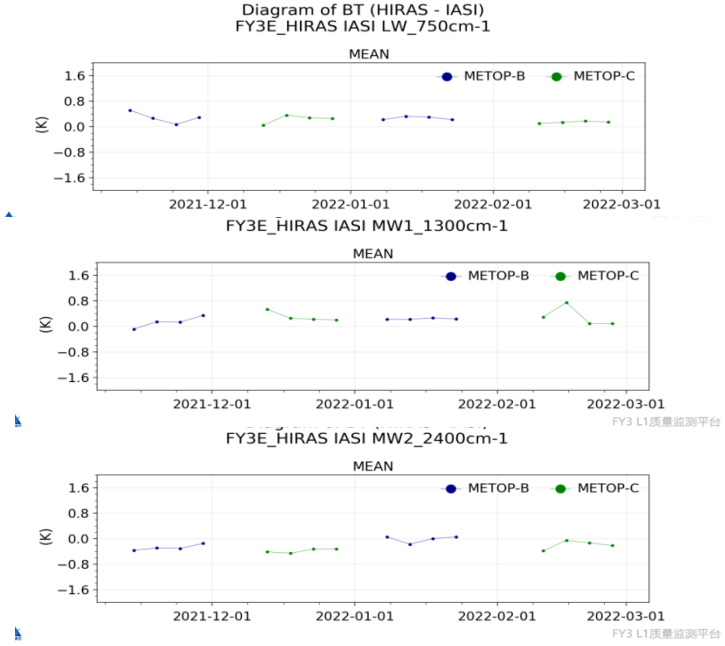






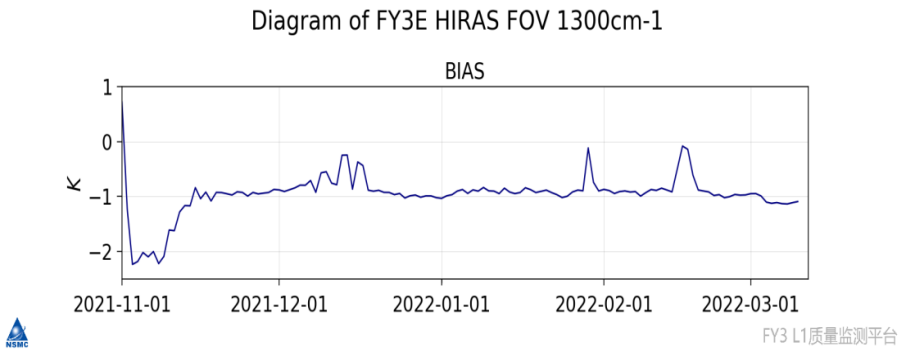


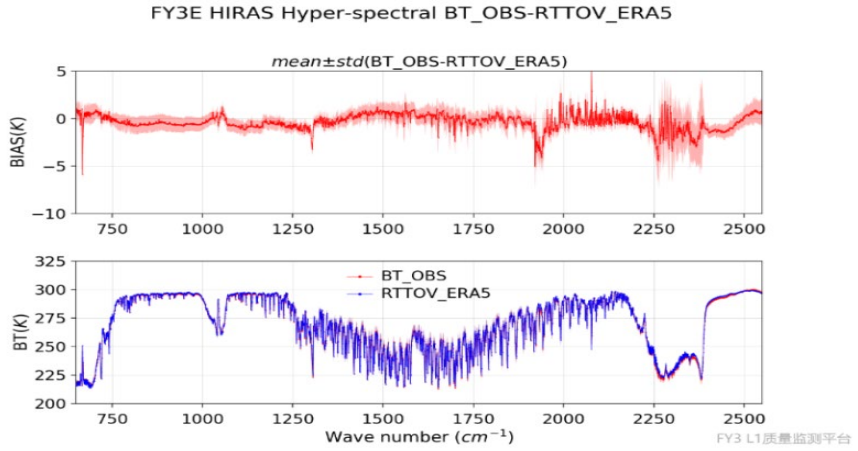


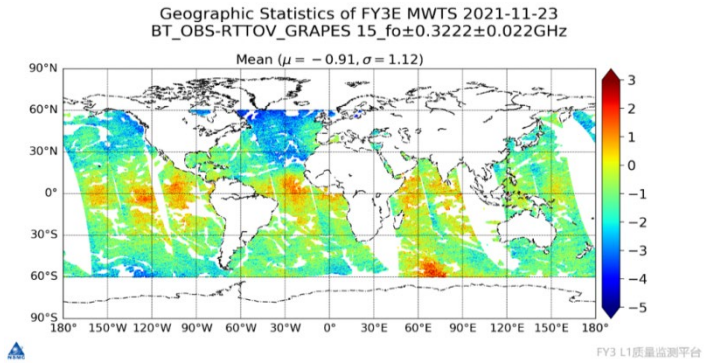


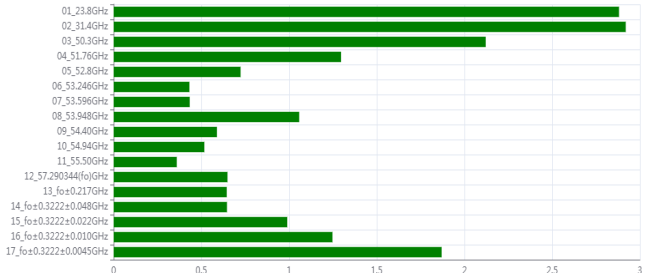
L1 quality monitoring using RTM+NWP

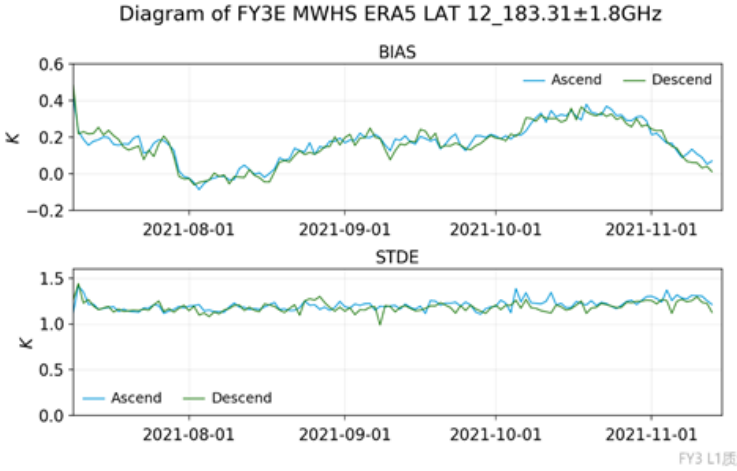
- **NWP data:** Grapes, ERA-5,…
- **RTM:** RTTOV, LBLRTM, GMF,…
- **Infrared:** MERSI, HIRAS
- **Passive MW:** MWTS, MWHS
- **Active MW:** WindRAD

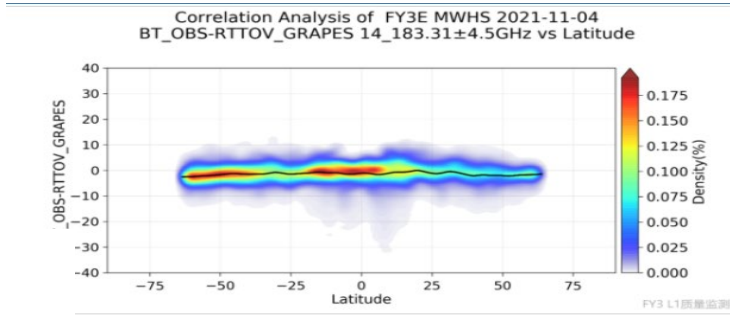


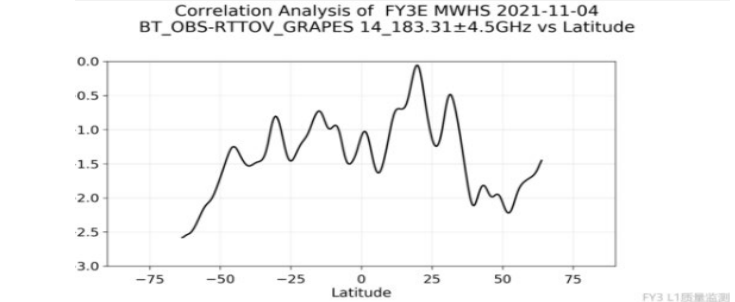








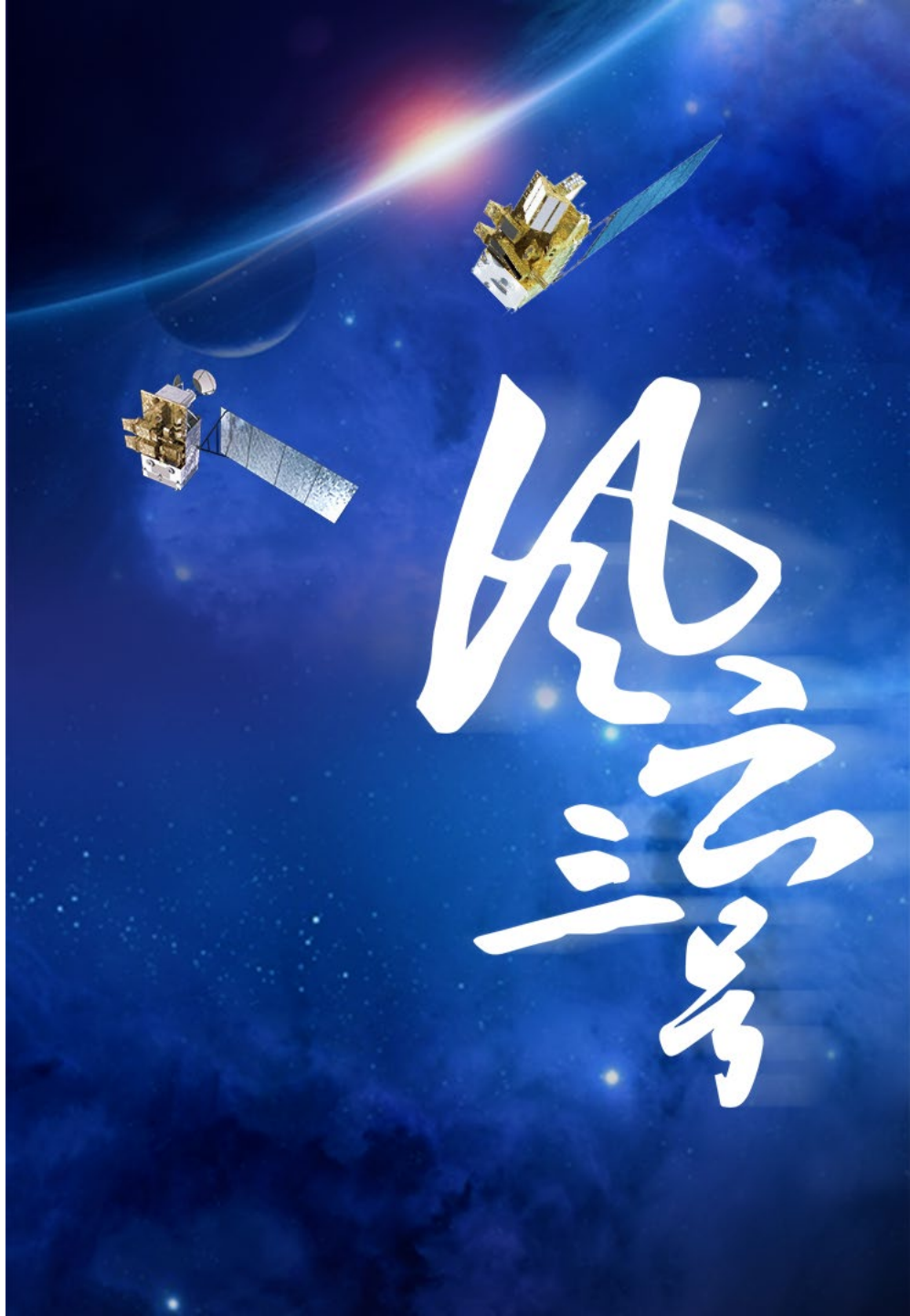




PART 03

FY-3E Typical products and applications

“Test+Application+Service”



FY-3E quantitative product generation testing

Types	Example	Process
Image	Quasi constant contrast image	Complete preliminary product examples，provide service，release first image of the third phase
	City lights	Complete preliminary product examples，provide service，release first image of the third phase
	Global IR mosaic	Complete preliminary product examples
	Vertical sound image	Complete preliminary product examples，release first image of the second phase
Cloud and Radiation	Cloud type	Complete preliminary product examples
	,Outgoing long-wave radiation	Complete preliminary product examples
Atmospheric parameter	Atmospheric temperature and humidity profile	Ongoing
	Atmospheric temperature and humidity profile—Microwave	Complete preliminary product examples，release first image of the second phase，provide service for Beijing 2022 Olympic and national game
	GNOS-II Atmospheric temperature and humidity profile	Complete preliminary product examples，application test in NWP
	MWHS-II rainfall	Complete preliminary product examples
Sea and Land	LST	Complete preliminary product examples，release first image of the third phase，provide service for national game
	WindRAD Sea wind field	Complete preliminary product examples，release first image of the third phase，provide service
	GNOS-II SWS	Complete preliminary product examples
Space weather	GNOS-II Atmospheric Density profiles	Complete preliminary product examples
	Tri-IPM Total Electron Content	Complete preliminary product examples
	SEM products	Complete preliminary product examples
	X-EUVI image	Complete preliminary product examples，release first image of first phase
Cryosphere	WindRAD Sea ice	Complete preliminary product examples

Test context

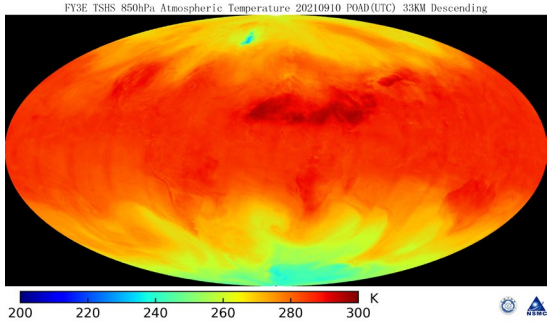
① Example

② Assessment

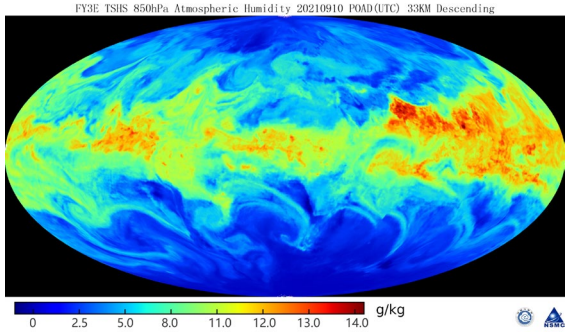
Demonstration of atmospheric, Marine and land surface products

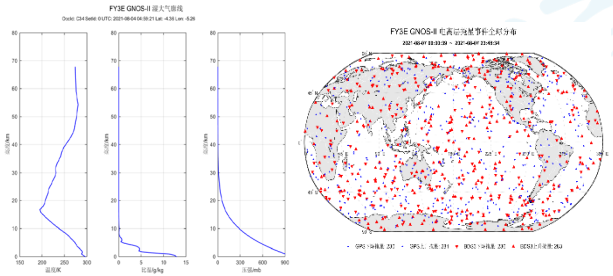
atmosphere

heat



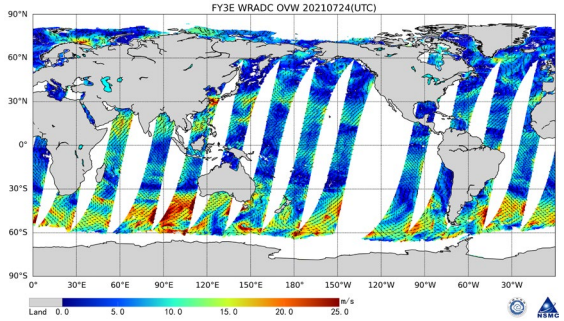
humidity

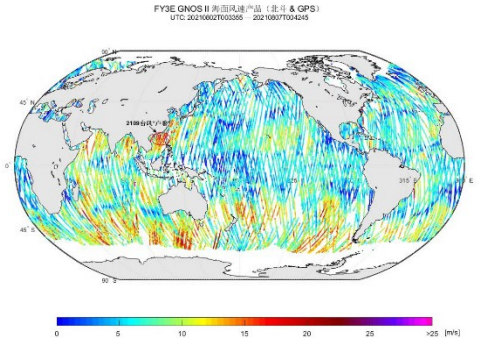




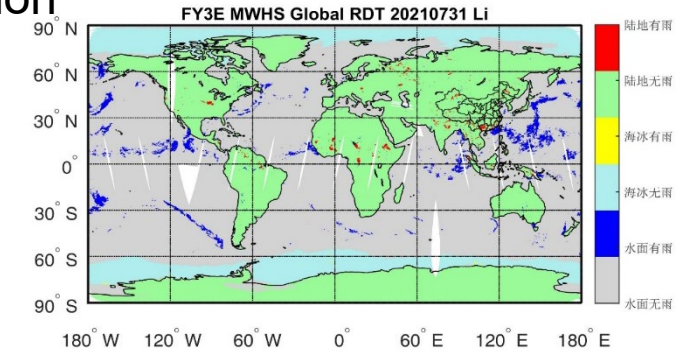
Land and sea surface

motion



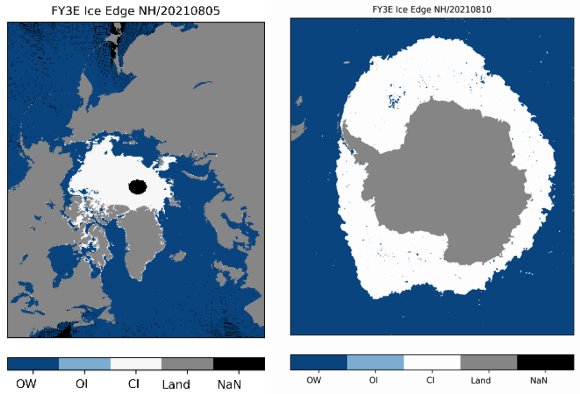


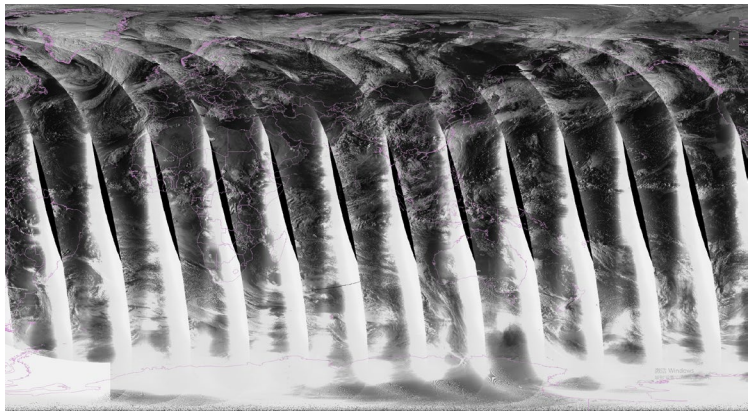
precipitation



Cryosphere

Polar ice



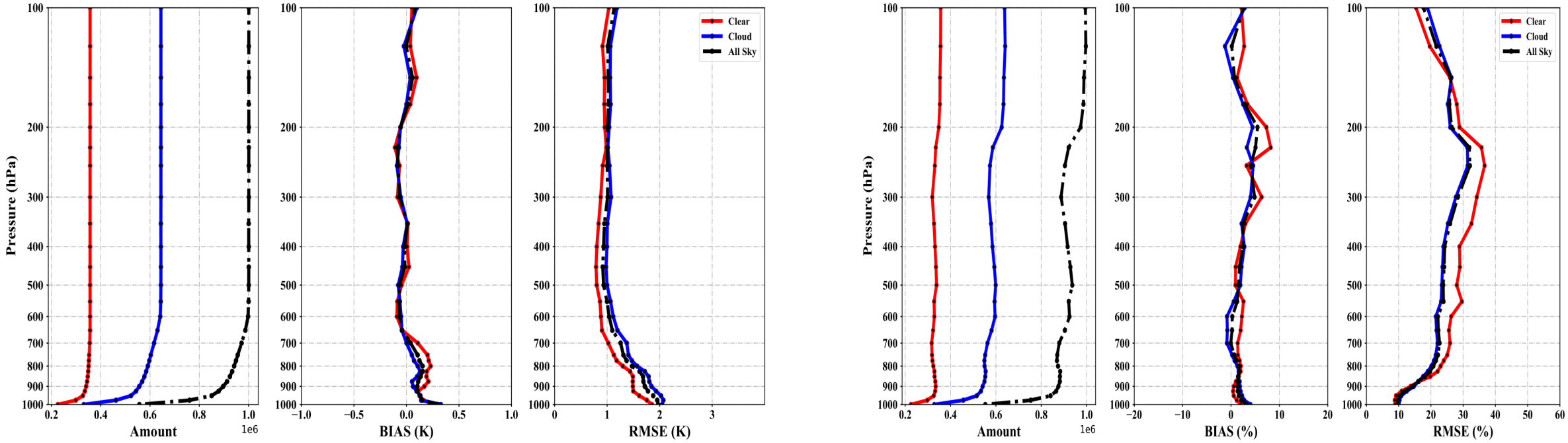


Low light/Infrared images

Atmospheric parameters——Temperature and Humidity

Quality evaluation：

- Compared with ERA5 reanalysis field, the preliminary test conclusion: the precision of clear sky ocean temperature profile & relative humidity is better than 1.5K, and 15%, respectively.



Comparison and verification of FY-3E/VASS temperature and relative humidity profiles with ERA5 reanalysis data

Atmospheric parameter——GNOS-II

Overview：GNOS occultation atmospheric products are atmospheric vertical observation information formed by GNOS detectors receiving navigation satellite GPS and Beidou signals worldwide, including atmospheric Bending Angles, Refractivity profiles, Density profiles, temperature, humidity and other vertical profiles.

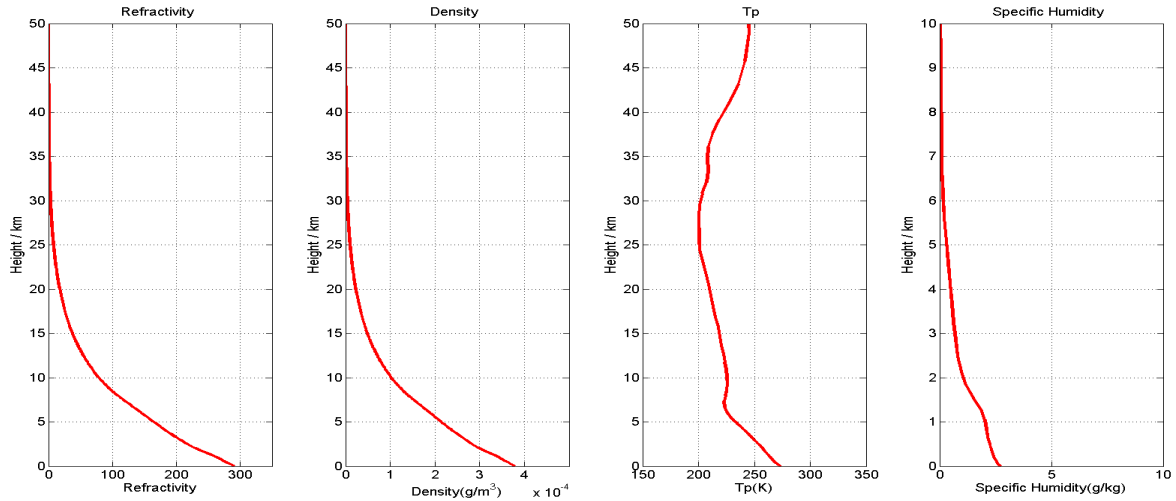
Specifications and indicators

Product	Sensor	Opt./Exp.	Spatial resolution	Accuracy (bias)	Assessment
Bending Angles	GNOS	Opt.	Vertical: 100m， Horizontal: 200-300 km	SD: 2%	0-50km1.98% 5-35km1.65%
Atmospheric Refractivity profiles	GNOS	Opt.	Vertical: 100m， Horizontal: 200-300 km	SD: 2%	0-50km1.69% 5-35km0.87%
Atmospheric Density profiles	GNOS	Opt.	Vertical: 100m， Horizontal: 200-300 km	SD: 2%	0-50km1.68% 5-35km0.87%
temperature	GNOS	Opt.	Consistent with GRAPES Vertical resolution, Horizontal: 200-300 km	SD: 2K	0-50km1.96 5-35km1.27
humidity	GNOS	Opt.	Consistent with GRAPES Vertical resolution, Horizontal: 200-300 km	SD: 20%	0-5km5.73% 5-35km16.16%

Application scenario: NWP, Assimilation, Climate change analysis.
Process: First batch released, complete product demo and quality assessment, application demonstration and service, assimilation test in CEMC.

Atmospheric parameter——GNOS-II

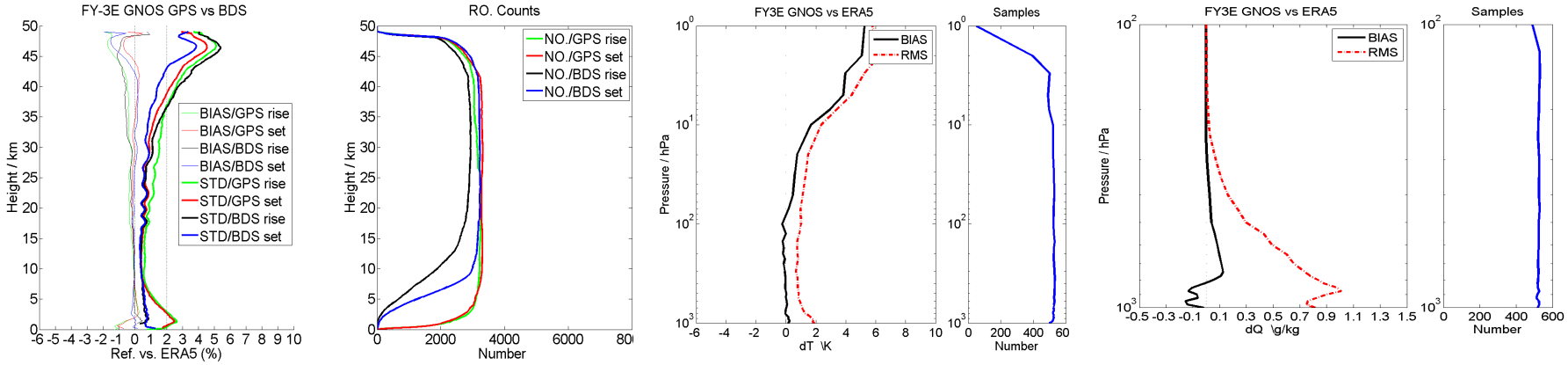
Example：



- Vertical resolution of refractive index
- and density: approximately 100m
- Vertical resolution of Temperature and humidity profiles: Consistent with GRAPES Vertical resolution
- Average number of times a single receiver receives a single navigation constellation is about 550

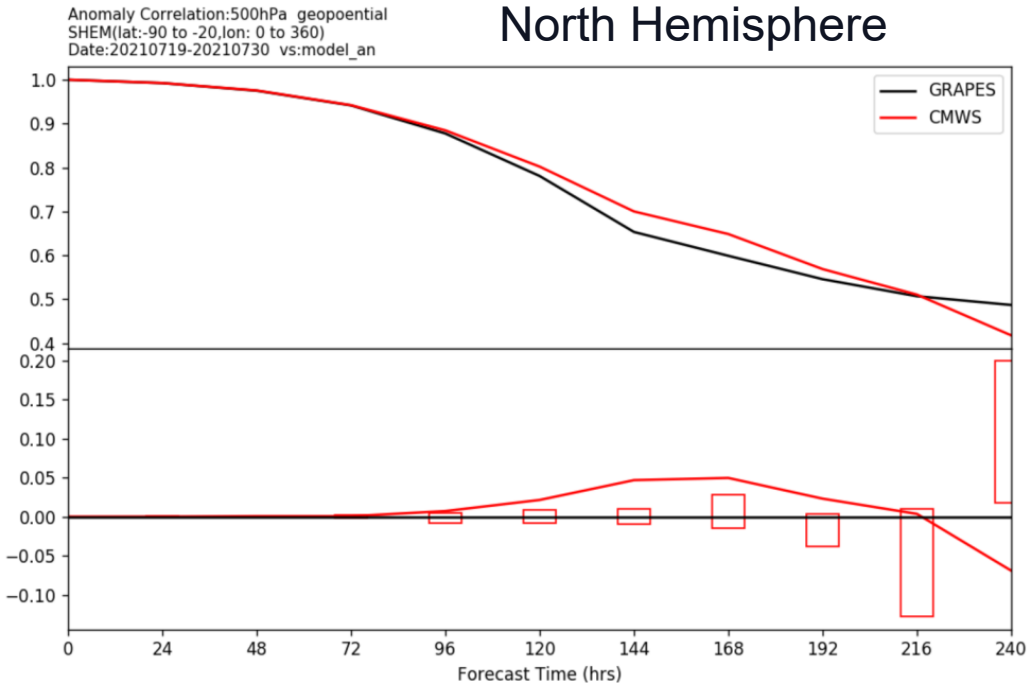
Preliminary assessment：

- Meet he accuracy of refractive index requirements of numerical prediction
- Above 100 hPa, the temperature accuracy is affected not only by the instrument and product algorithm, but also by the background field data

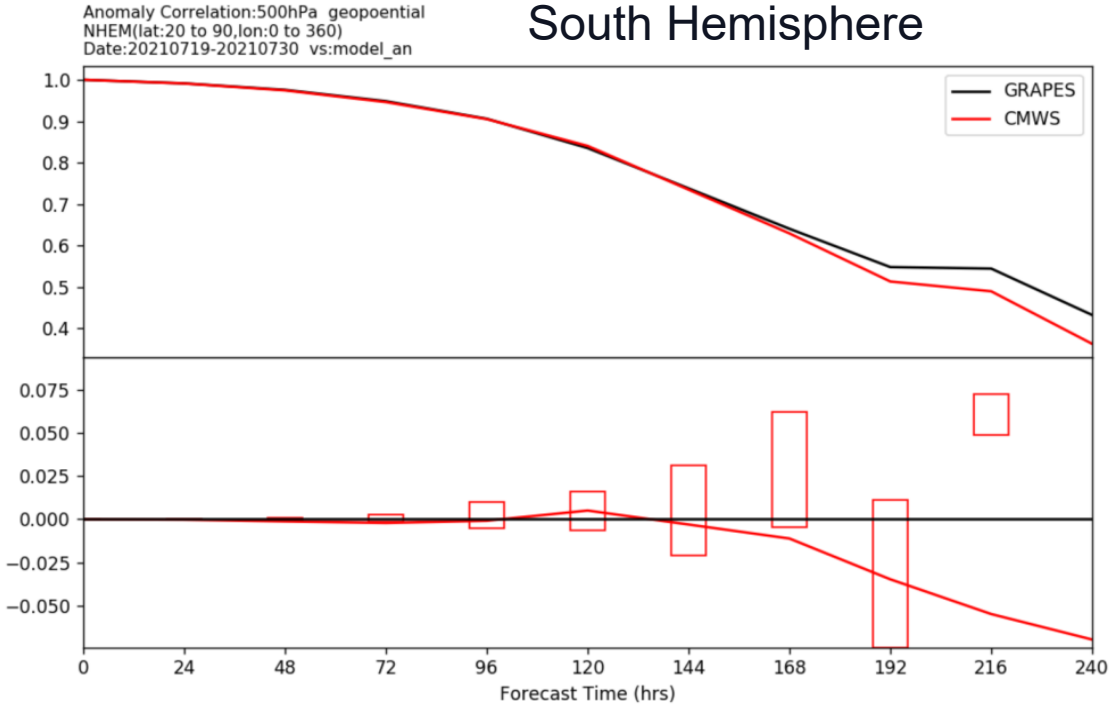


Assimilation effect of FY-3E MWTS/MWHS in CMA_GFS

North Hemisphere



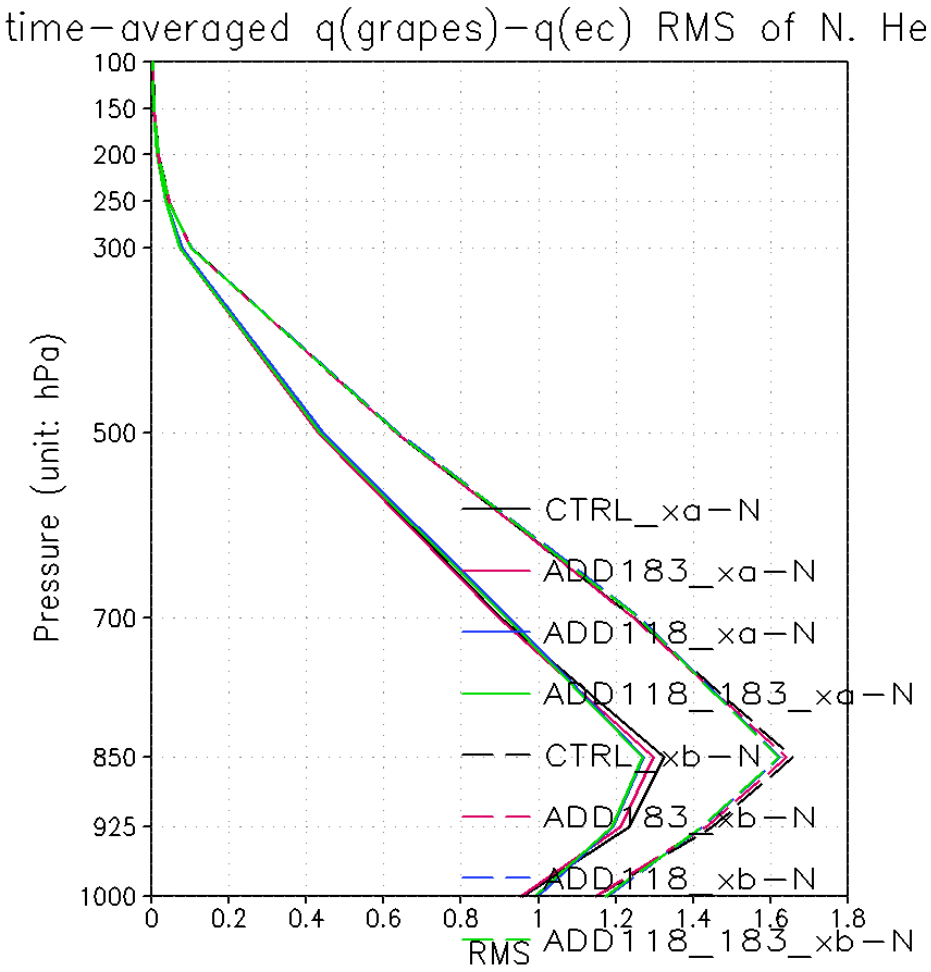
South Hemisphere

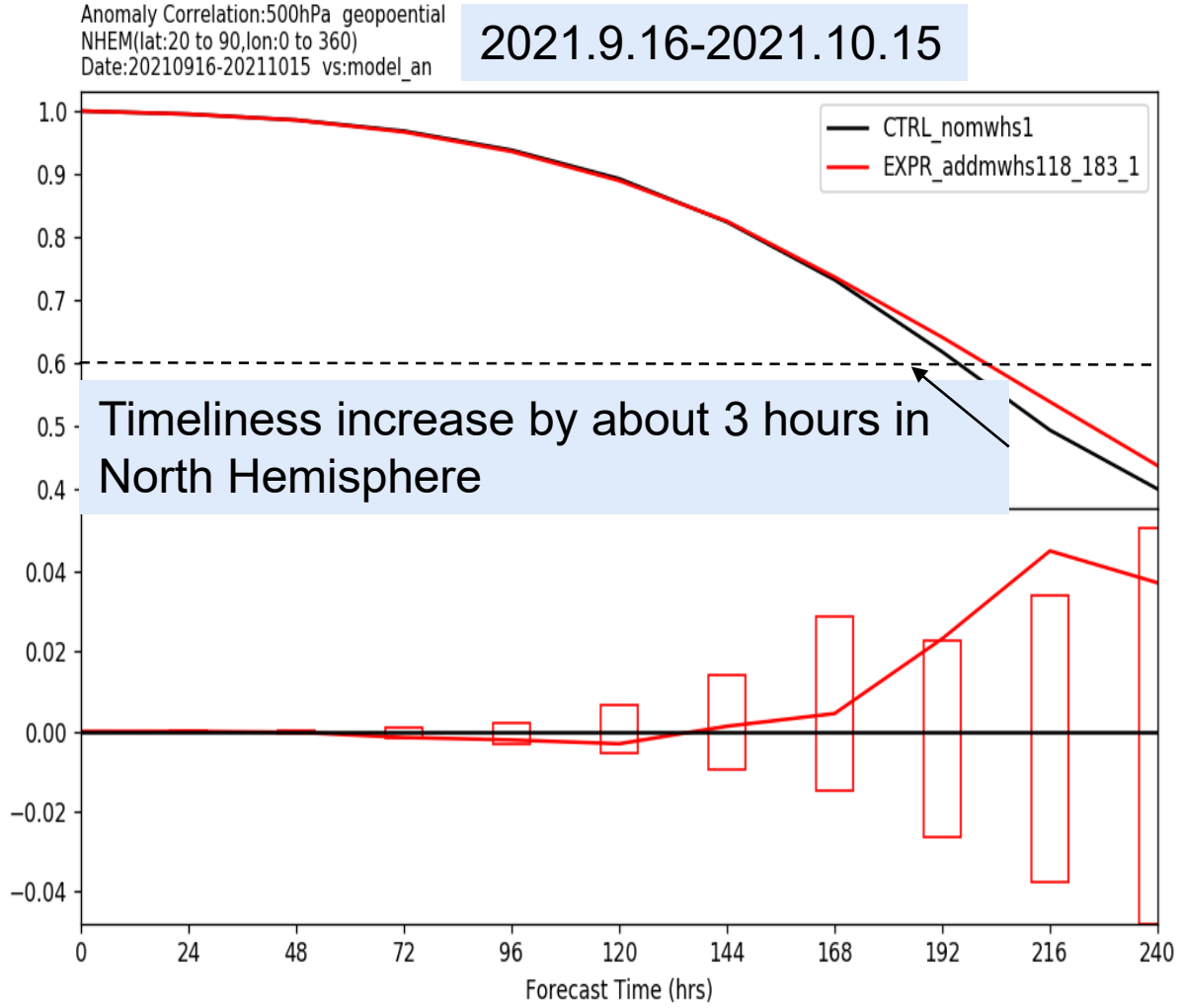


Add FY-3E CMWS data in CMA_ GFS 4dvar system, using ARMS as the observation operator, （CMWS=MWTS+MWHS） Comparison global numerical prediction experiment with control experiment （CMA_GFS） 10 days and 240 hours forecast statistics show significant positive effect in South Hemisphere.

Assimilation effect experiment of FY-3E MWHS in CMA-GFS 4DVAR

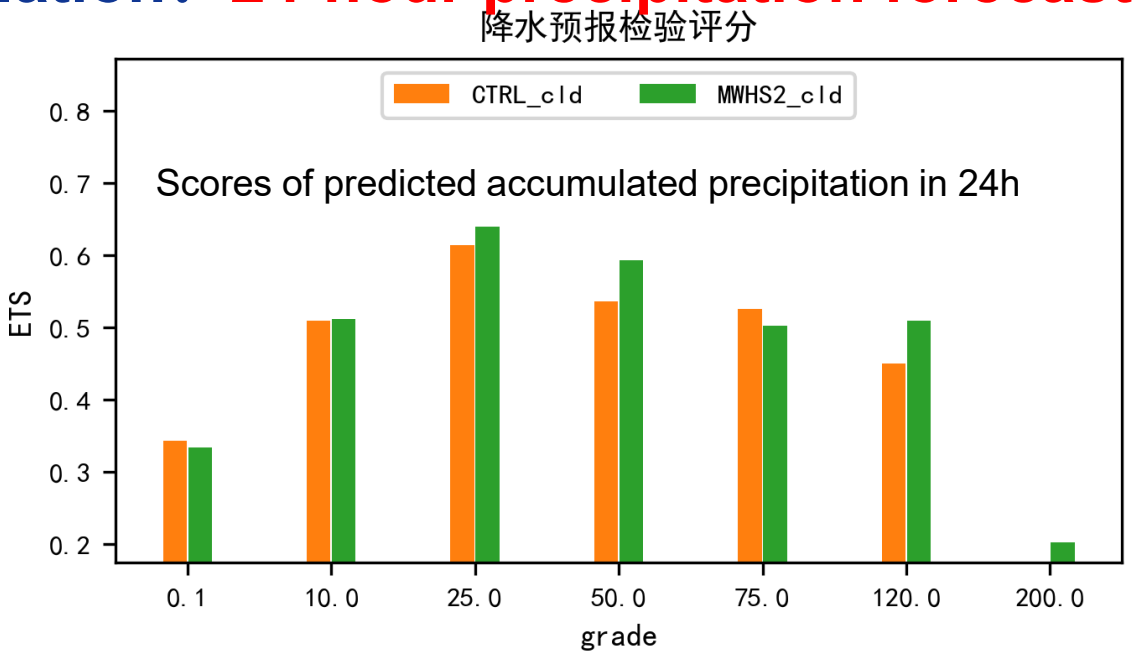
118GHz【5 Channel】+183GHz【5 Channel】

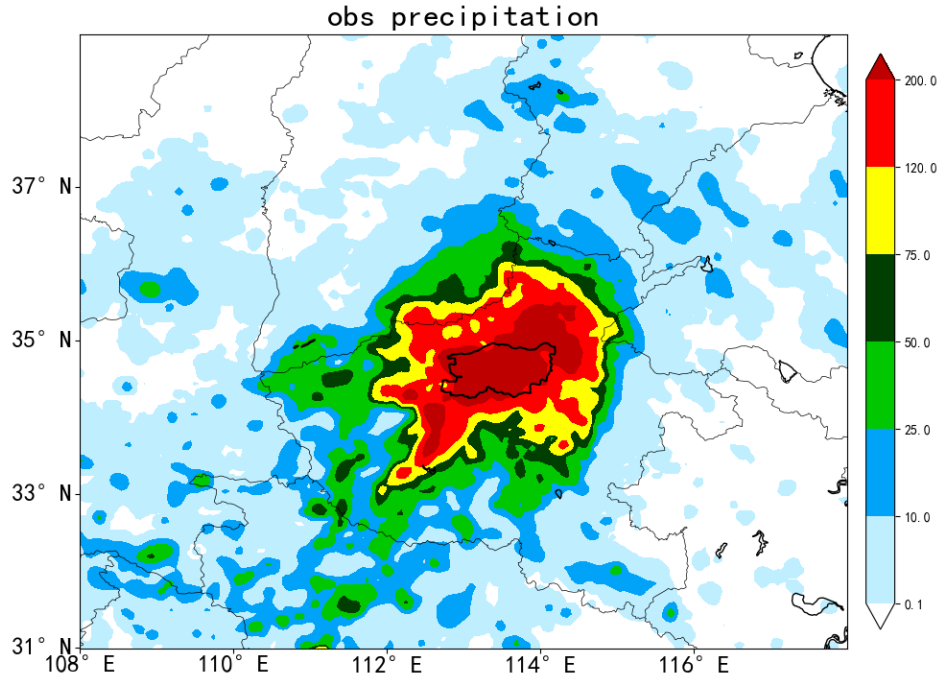




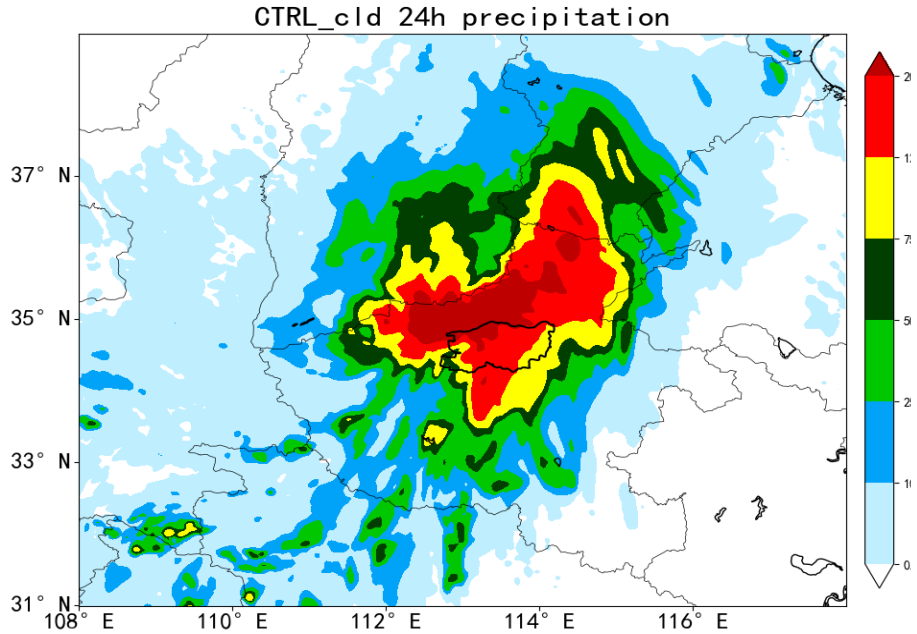
The analysis bias of humidity decrease by 5%, after adding FY-3E MWHS data to CMA-GFS 4DVAR

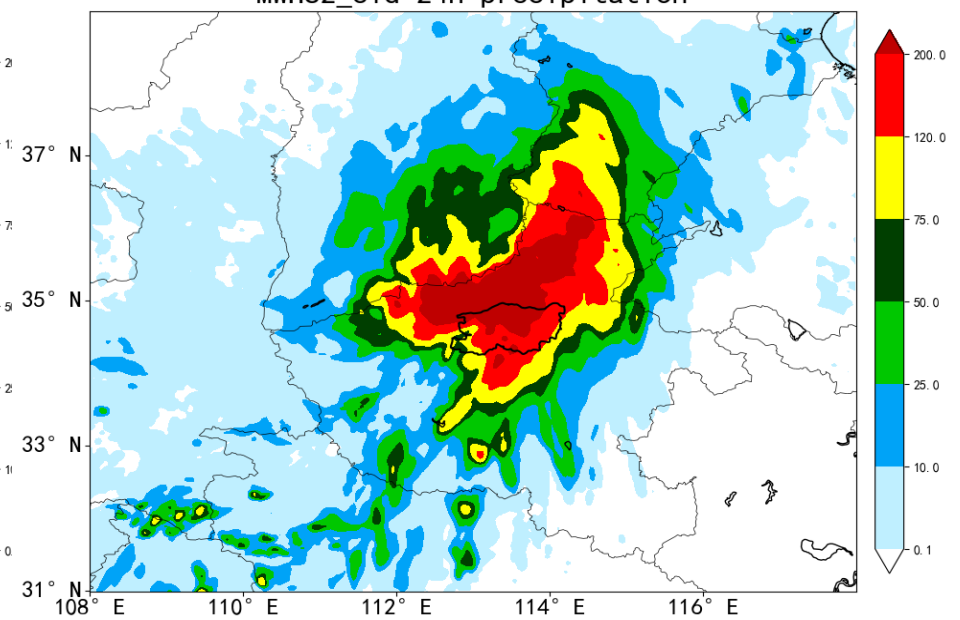
Forecast effect on the “7.21”extreme rain in Zhengzhou of FY-3E MWHS data assimilation： 24-hour precipitation forecast





Compensate the deficiency of vertical observation of humidity in early morning, improves the humidity analysis, and the prediction accuracy of extreme precipitation, and has a positive contribution to the "21.7" rainstorm forecast in Zhengzhou.





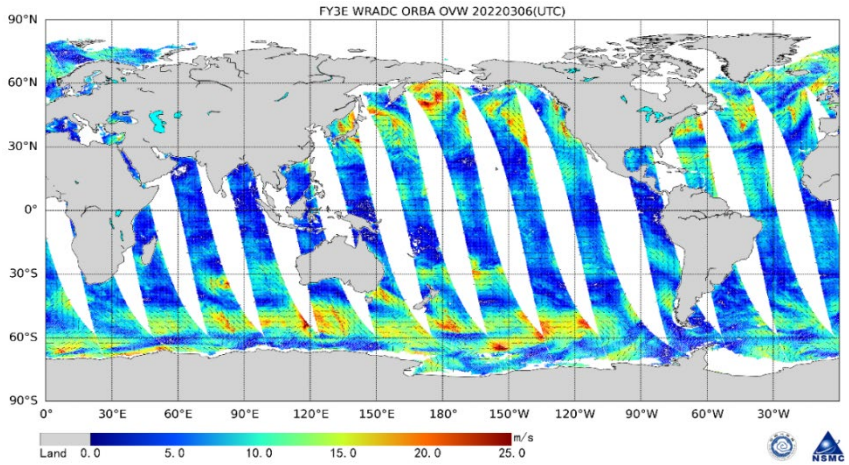
Sea&Land surface products — Sea Wind vector

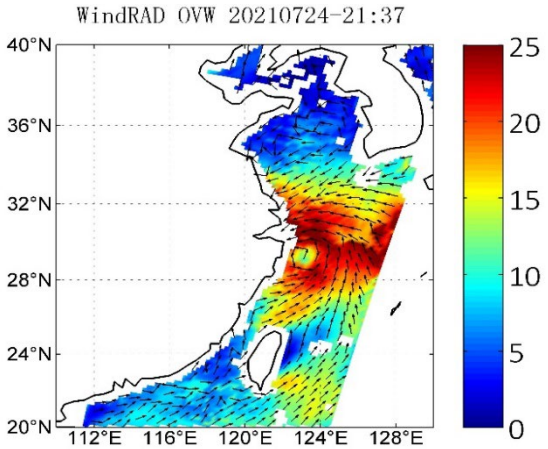
Overview：Equivalent wind at 10m above the sea surface observed by WindRad, including Speed and direction

Specification and indicators：

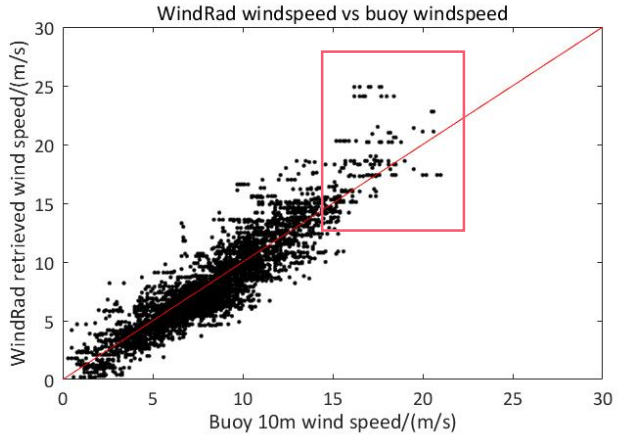
Product	Sensor	Opt./Exp.	Resolution	Accuracy（Bias）	Assessment
sea wind vector	WindRad	Opt.	20km（Grid spacing）	RMSE of **Speed ≤2m/s**, RMSE of **Direction ≤25°**（3-20m/s）	Compared with buoy data **RMS1.64m/s RMSE23.39°**

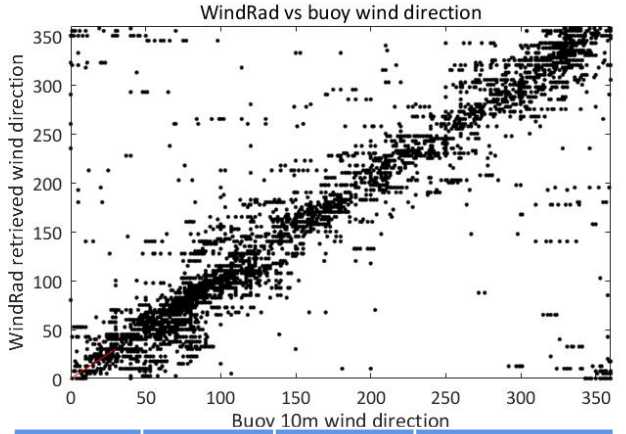
Example:





Assessment：





	匹配数	偏差	均方根误差
风速	4640	-0.26	1.64
风向	4640	1.61	23.39
U分量	4640	-0.36	2.60
V分量	4640	0.14	2.61

Main process：First batch product online; Complete sample data and assessment, application demonstration, first image of the second phase released， Carry out the assimilation test in CEMC. Complete the algorithms for C-band products, daily and monthly products； Form the global and regional demonstration ability； Complete the accuracy verification. Update the operational algorithm; Optimized Ku band and dual frequency inversion algorithm.

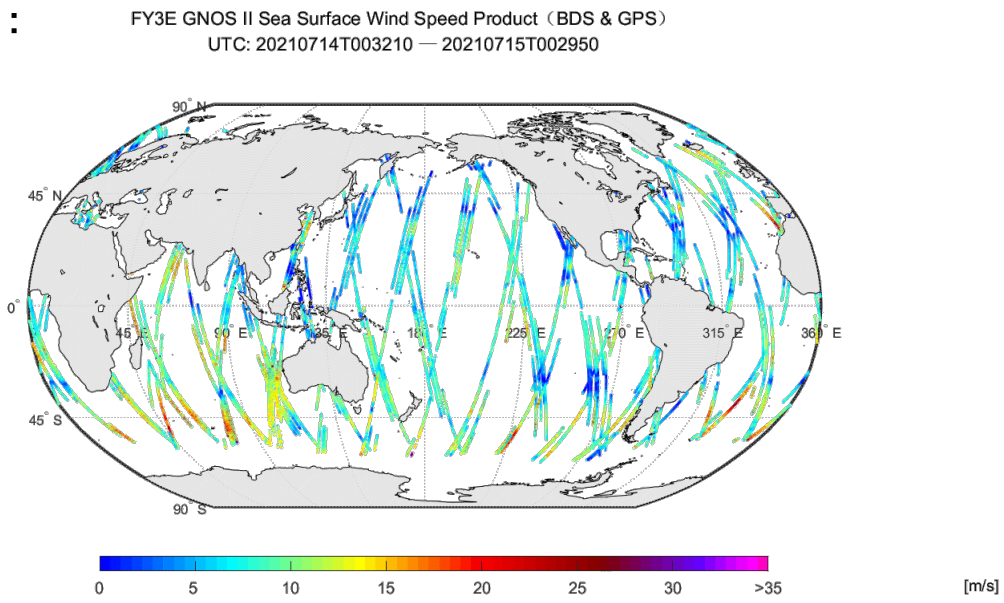
Sea&Land surface products — Sea Wind speed

Overview： Sea surface wind speed (SWS) of FY-3E GNOS Ⅱ is the sea surface wind speed at 10m height retrieved from the reflected signal of global navigation satellite (GNSS-R). it can be observed all day and all weather, and not affected by heavy rainfall due to using L-band navigation signals.

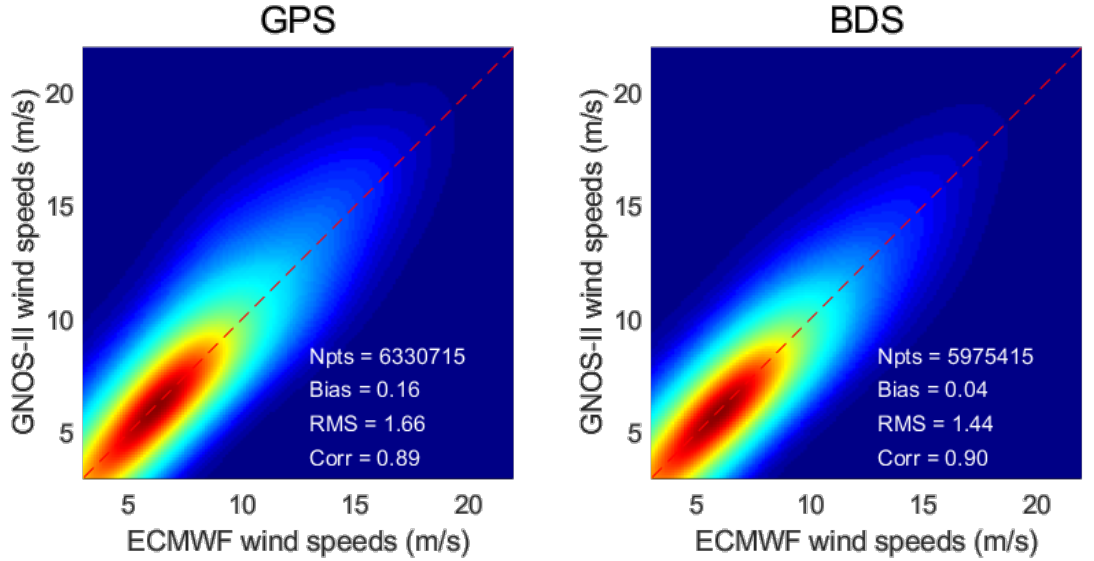
Specification and indictor：

Product	Sensor	Opt./Exp.	Resolution	Accuracy（Bias）	Assessment Accuracy
SWS	GNOS-II	Opt.	25 km	RMSE < 2 m/s	RMSE < 1.6 m/s，meet the requirement

Example：

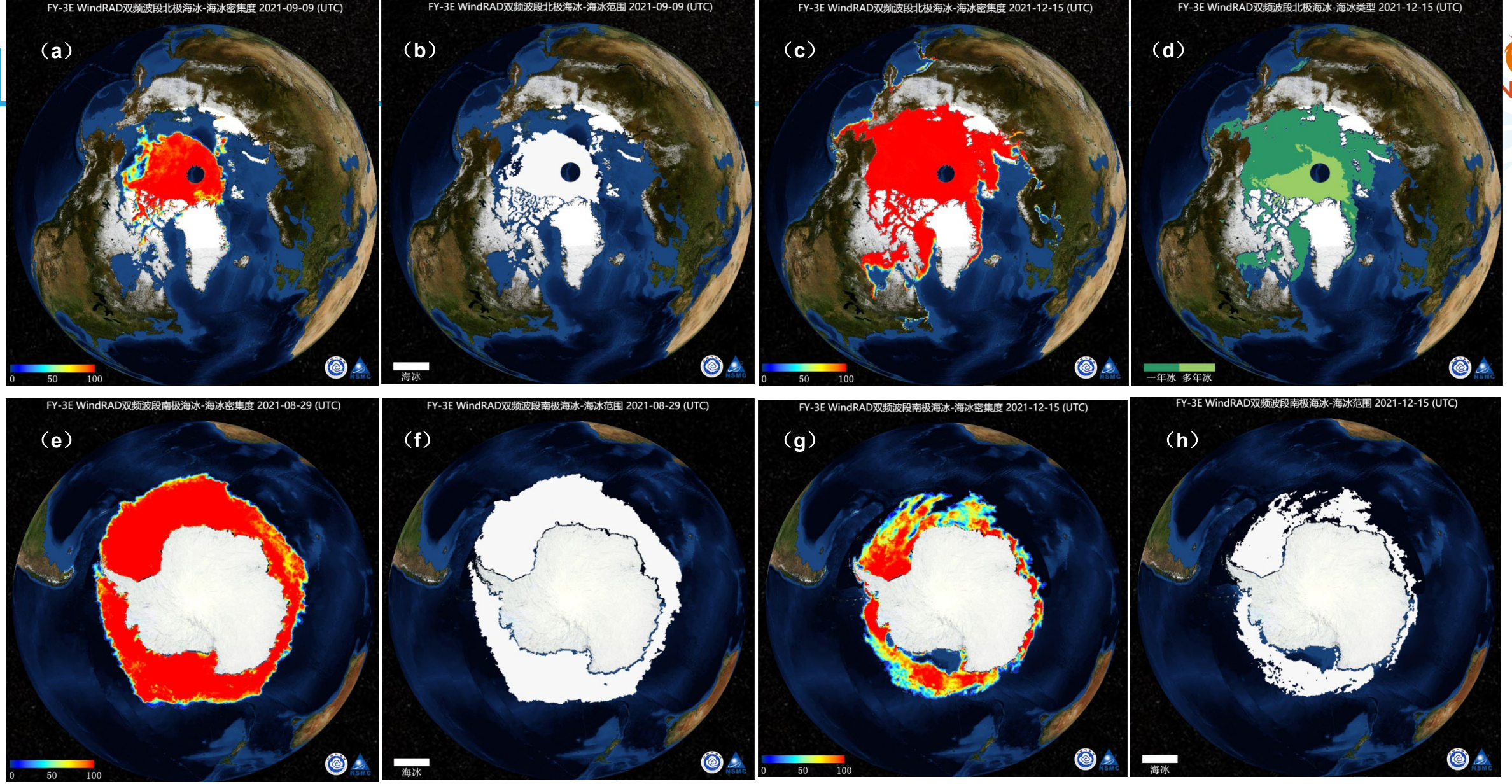


Quality assessment：



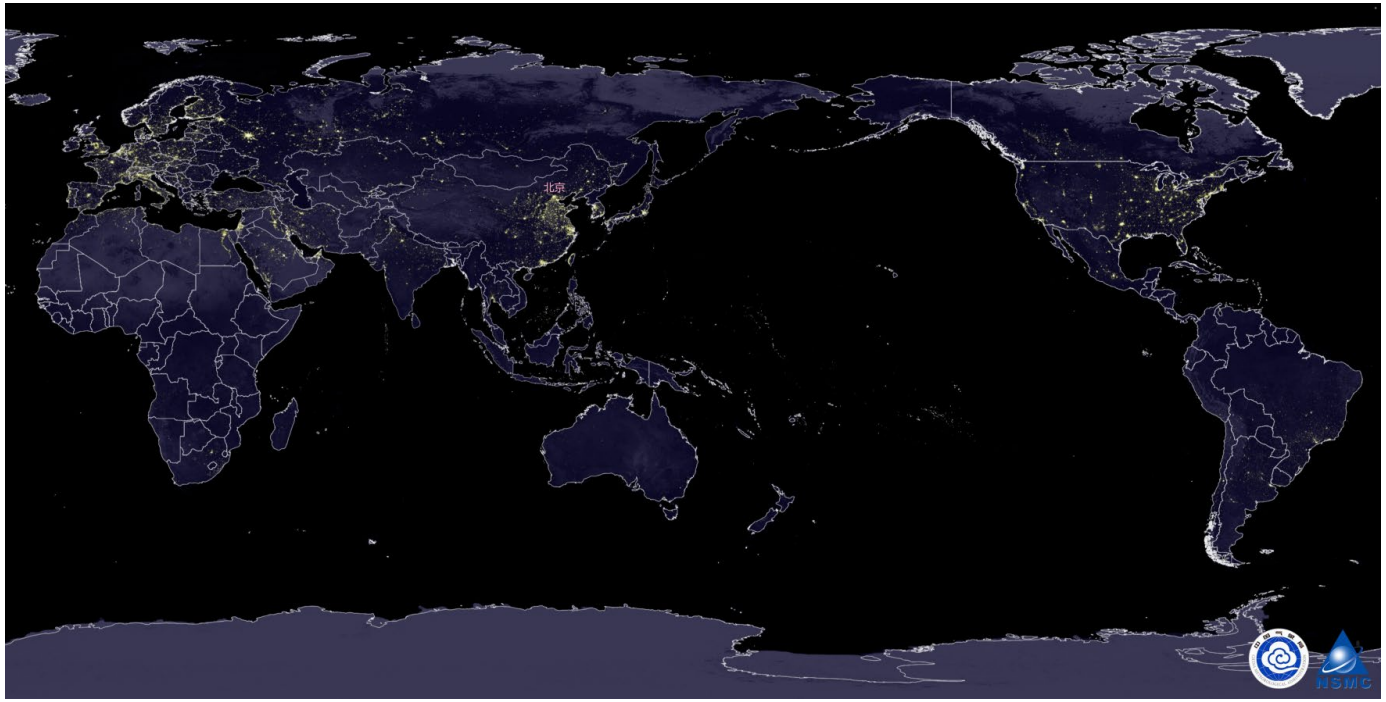
Main process： First batch online; Complete sample product, assessment and application, first image of the second phase released, carry out the assimilation test in CEMC.

Accuracy assessed based on ECMWF reanalyzed data（2021.7.10 - 2021.12.31）



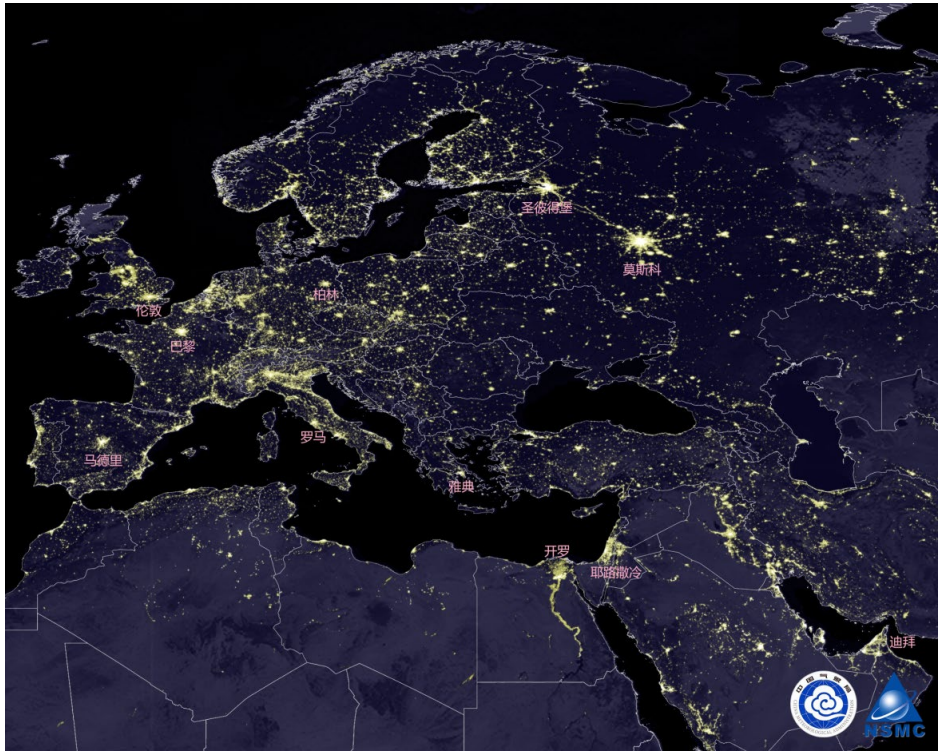
Global sea ice parameter products retrieved by combined FY-3E WindRAD and FY-3D MWRI.（a）2021-09-09 Arctic sea ice concentration（b）2021-09-09 Arctic sea ice extent（Minimum）（c）2021-12-15 Artic Sea Ice Concentration（d）2021-12-15Artic sea ice type（e）2021-08-29 Antarctic sea ice concentration（f）2021-08-29 Antarctic sea ice extent（Minimum）（g） 2021-12-15 Antarctic sea ice concentration（h） 2021-12-15 Antarctic sea ice extent

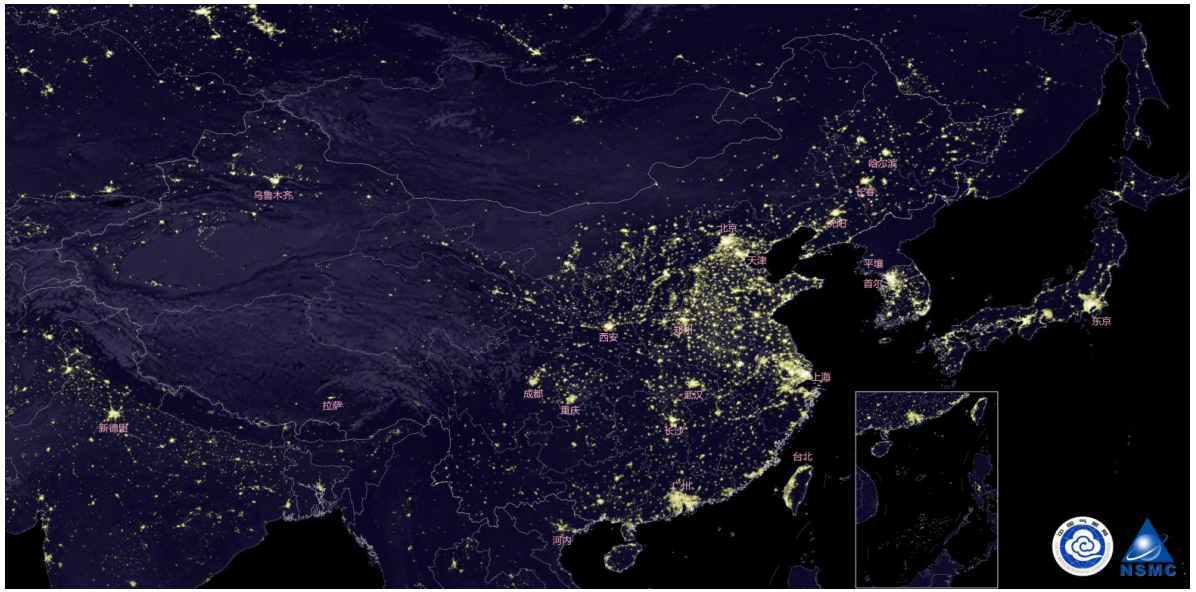
Nighttime Light of FY-3E



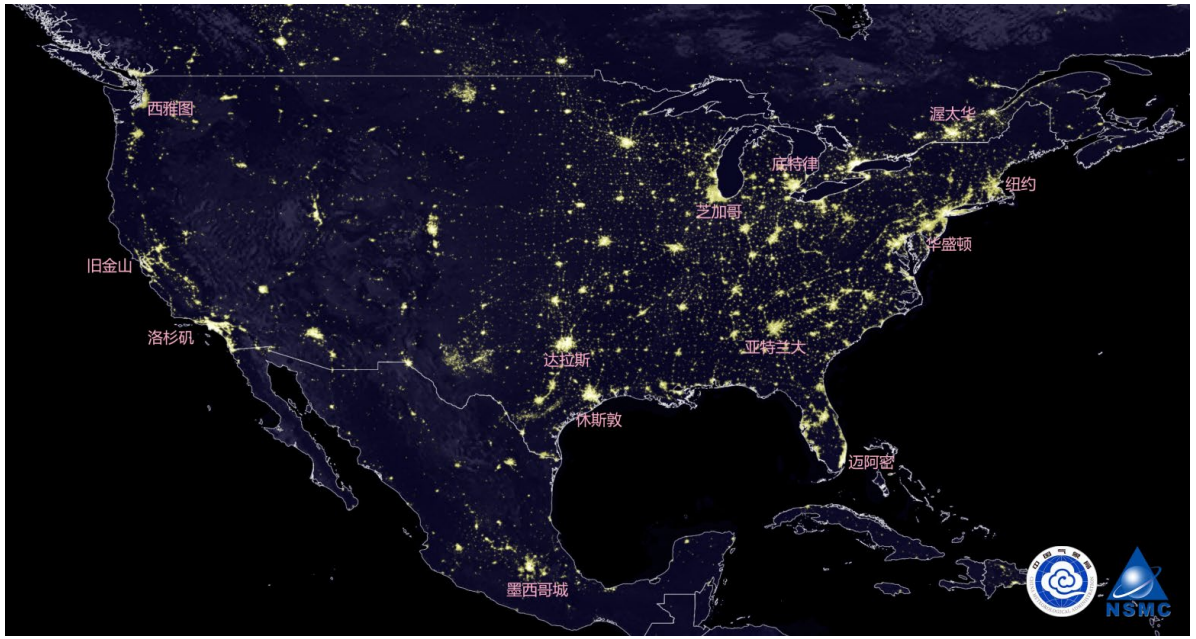
FY3E is equipped with a low light channel, which can detect weak visible light sources at night, greatly improving China's ability to monitor weather and climate conditions and human activities. City lights can reflect the infrastructure construction level and energy consumption, as well as the economic development level and population. Its changes can be used to assess the impact of urban development, natural disasters and war. The city light thematic map of FY-3E shows China, USA and Europe are obviously regions.

City lights in Europe are very dense, especially in the area from Western Europe to Central Europe. Moscow and St. Petersburg are particularly dazzling in Eastern Europe. In addition, Nile Valley in Egypt along the river has high dense lights.



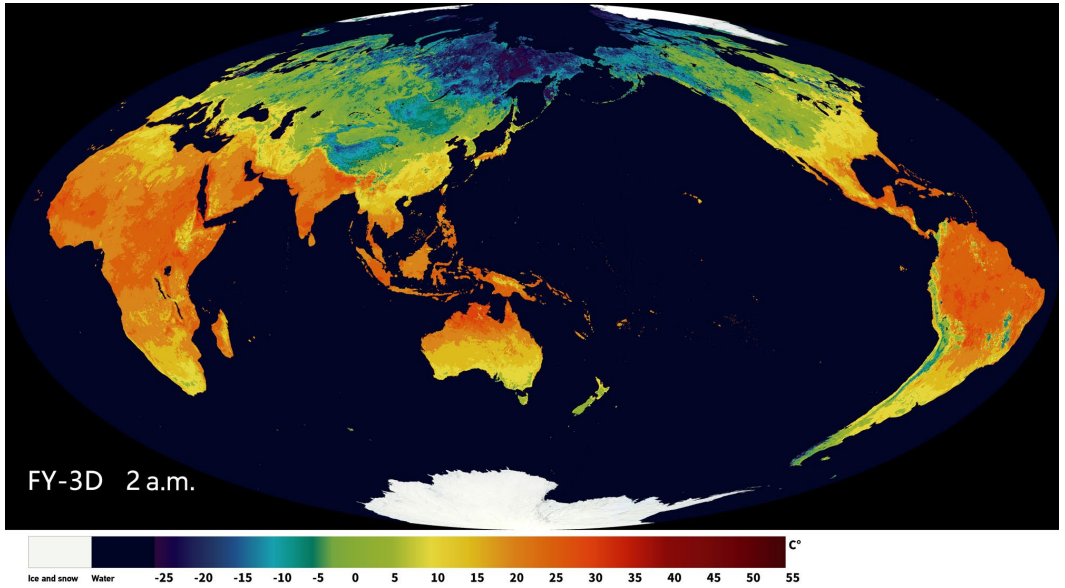


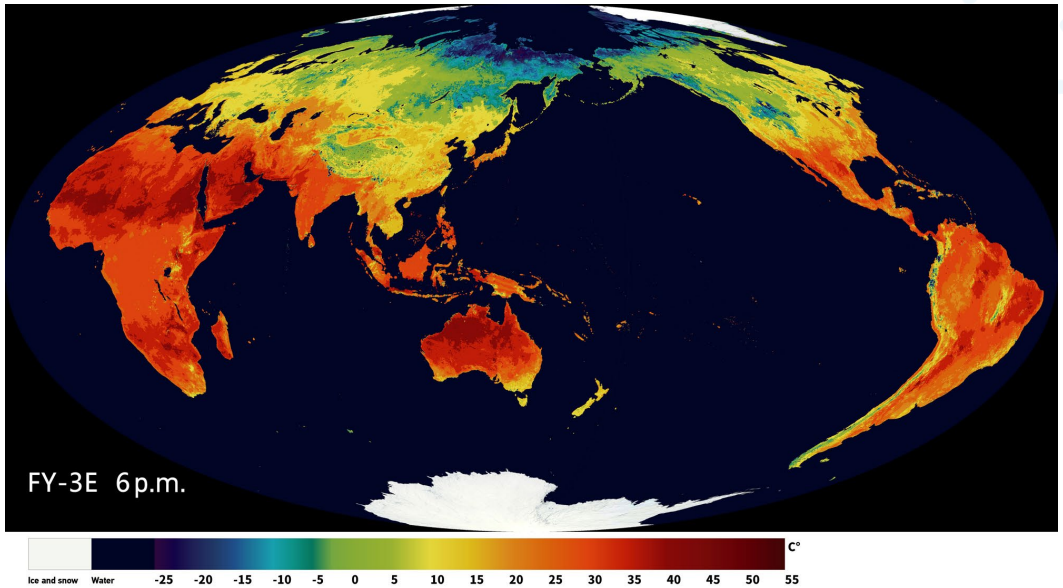
City lights in China are mainly distributed in the east, especially in the Beijing Tianjin Hebei, Yangtze River Delta and Pearl River Delta regions. Provincial capitals are outstanding in the central and western regions. Strong contrast between South Korea and North Korea on the Korean Peninsula.

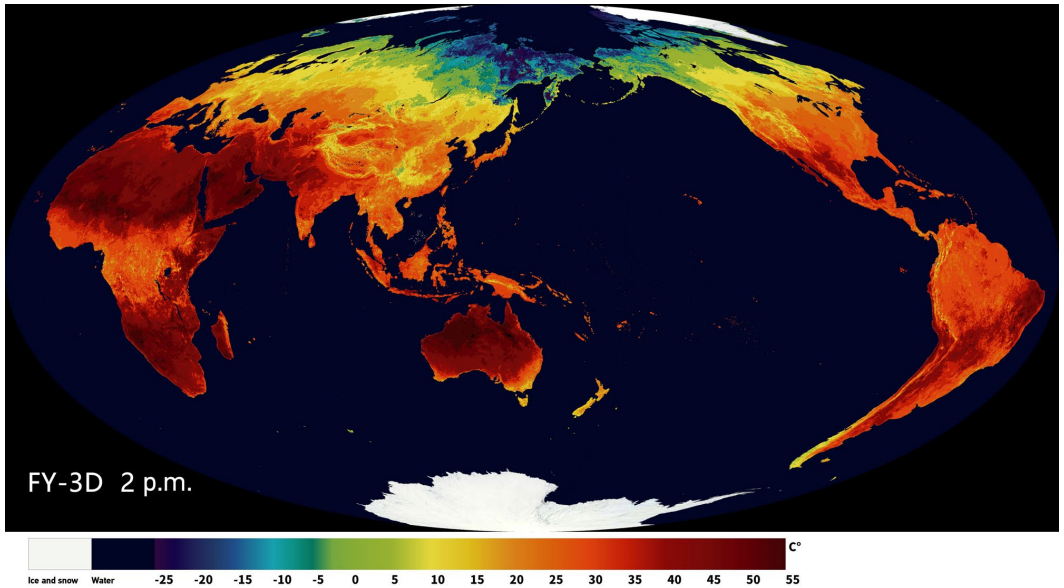


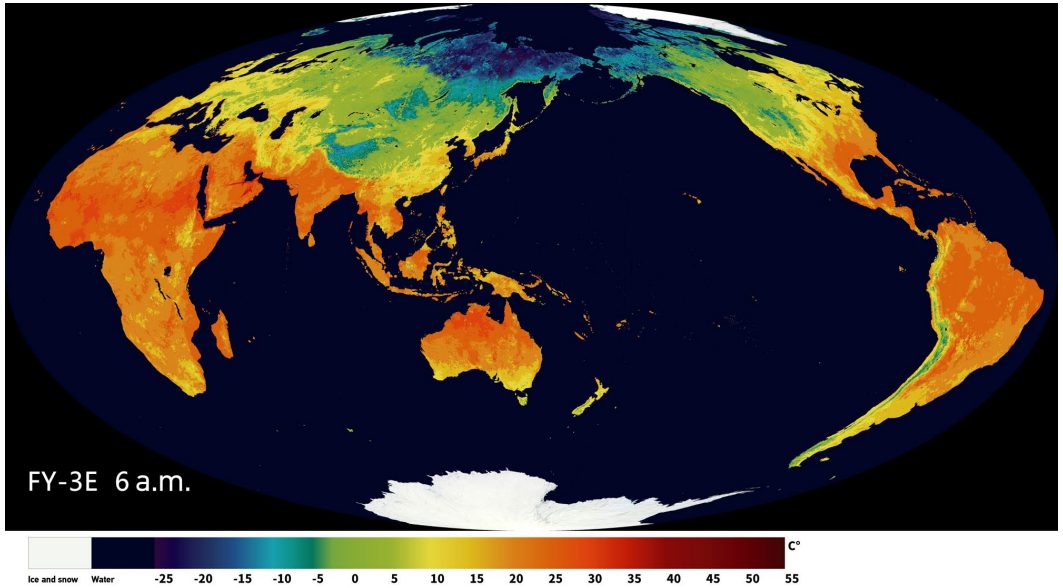
Lighting areas on the east coast and the Great Lakes region of USA. Several major cities in the central and western regions have extended traffic routes, small cities regularly distributed, forming into a city network. In contrast, there is little light in the west, especially in several large cities such as Los Angeles, San Francisco, Seattle, etc.

Land surface Daily variation from FY-3E and FY-3D (2021.10)

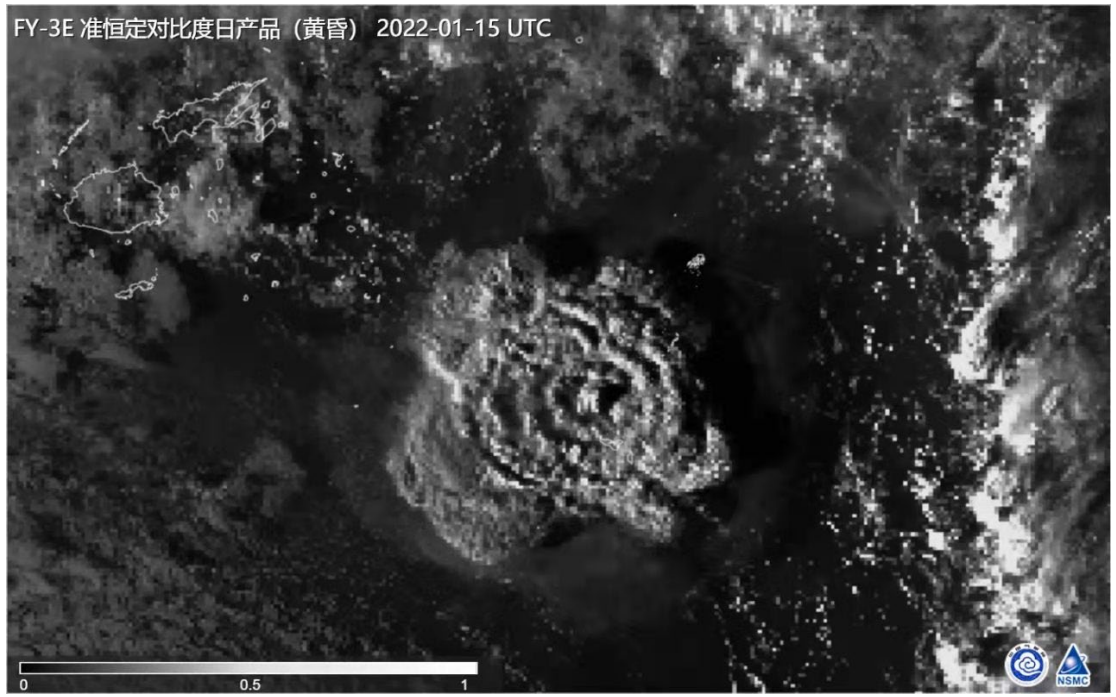


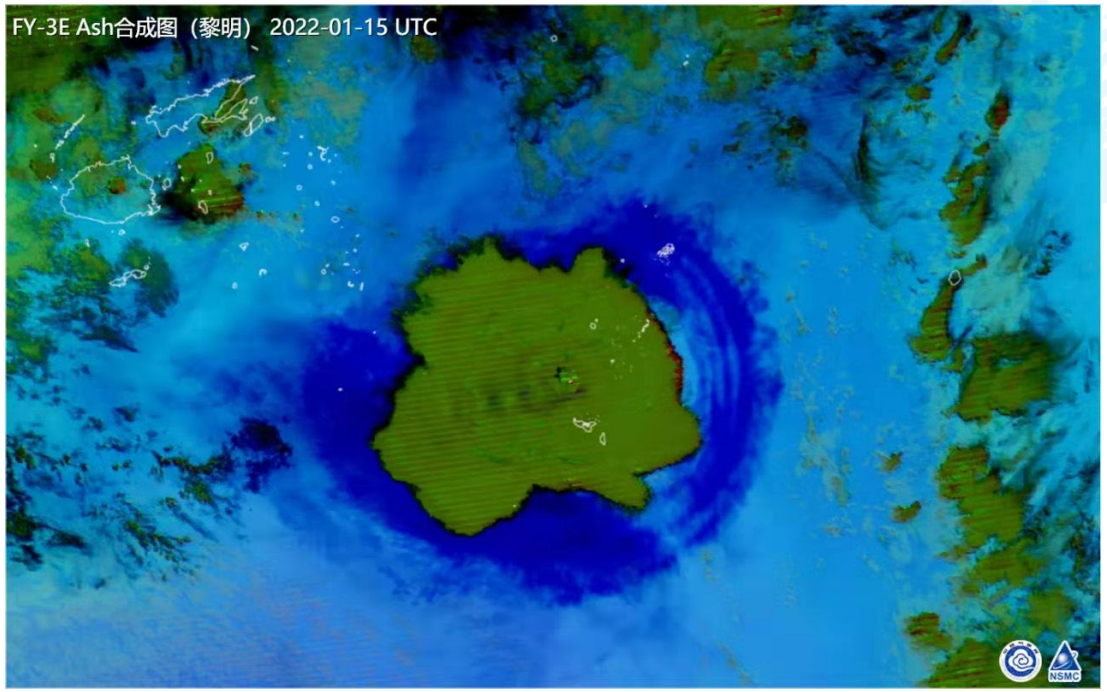


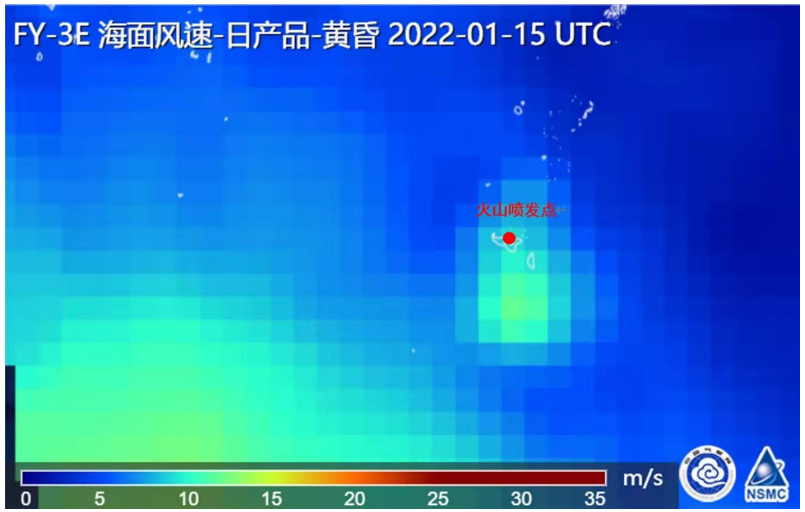


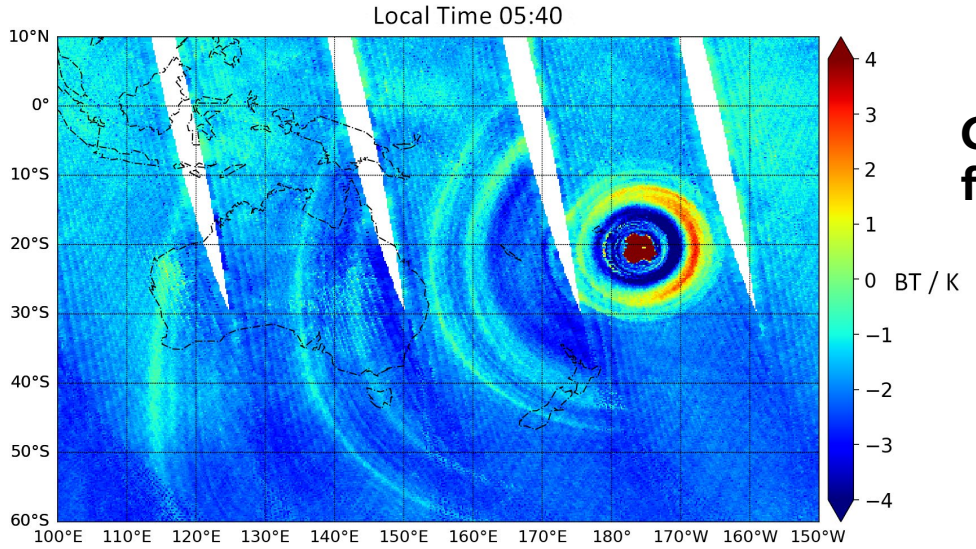


FY-3E Tonga Volcano emergency response



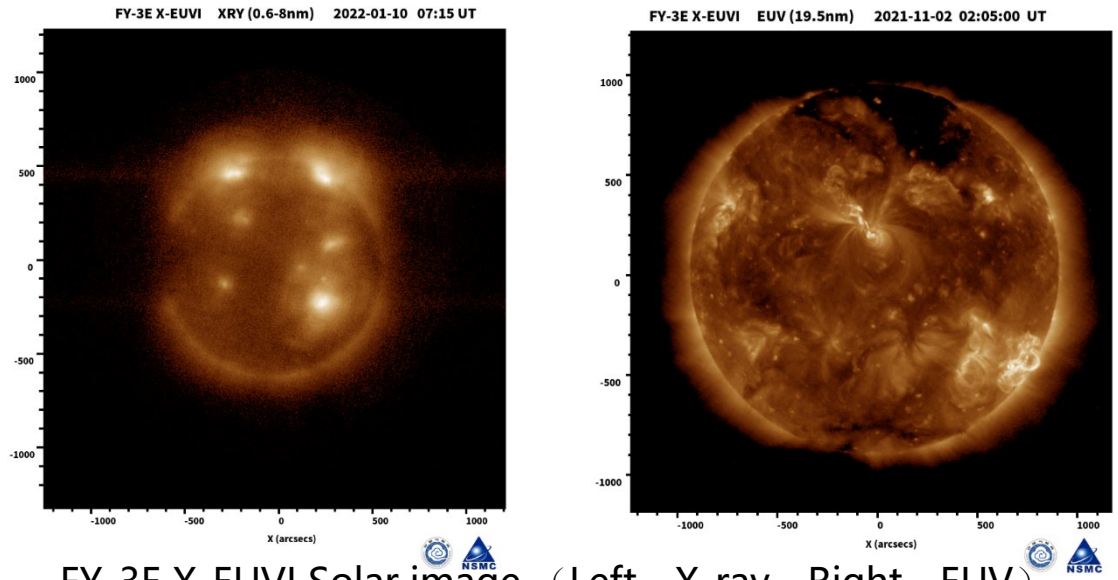






Gravity wave from HIRAS-II

Space weather monitoring — Solar (X-EUVI) image



FY-3E X-EUVI Solar image （Left：X-ray，Right：EUV）

Product overview:

Solar image of **X-EUV channels. EUV reflects the active regions and coronal holes in the corona. The X-ray bright spot is the situation above the active area, which is the part in the corona with higher temperature than EUV.**

- **Wavelength: X-ray（0.6-8nm）；EUV 19.5nm**
- **Spatial resolution: X-ray: 4.1 arcsec；EUV：2.5 arcsec**
- **Time resolution: single channel: ~7 sec; all-channel: ~2 min**
- **Plan：Image processing needs to be optimized, including rotation, attenuation, noise, etc**

Application Scenario:

（1）Scientific study：Study on the mechanism of solar activity eruption

（2）Operational application: Identification of solar activity features, such as flares and their precursors, active regions, coronal holes, EUV waves, etc; Early warning and forecast of solar activity

（3）Popularization of Science

Main Process:

First batch of product online；complete the application and demonstration, released the first mage

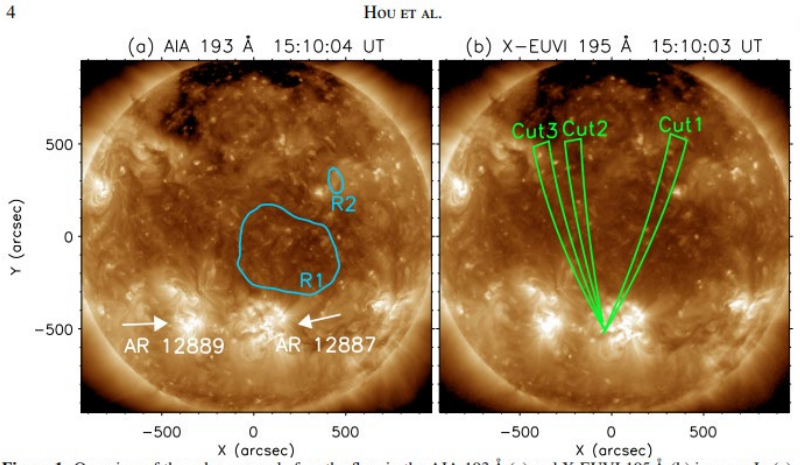


Figure 1. Overview of the solar corona before the flare in the AIA 193 Å (a) and X-EUVI 195 Å (b) images. In (a),

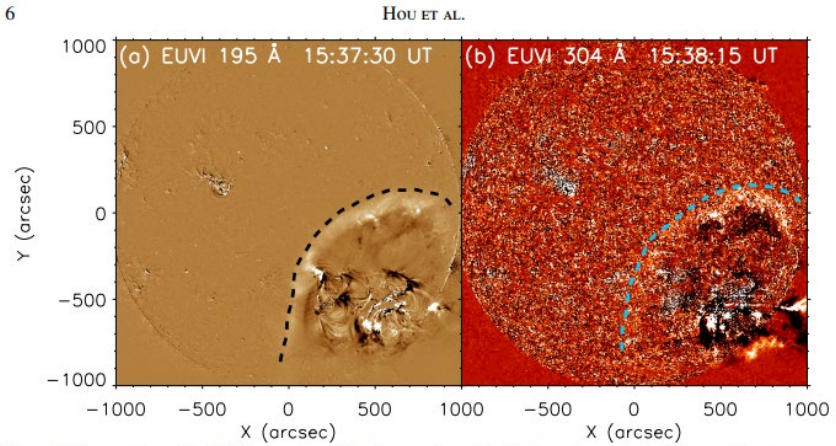
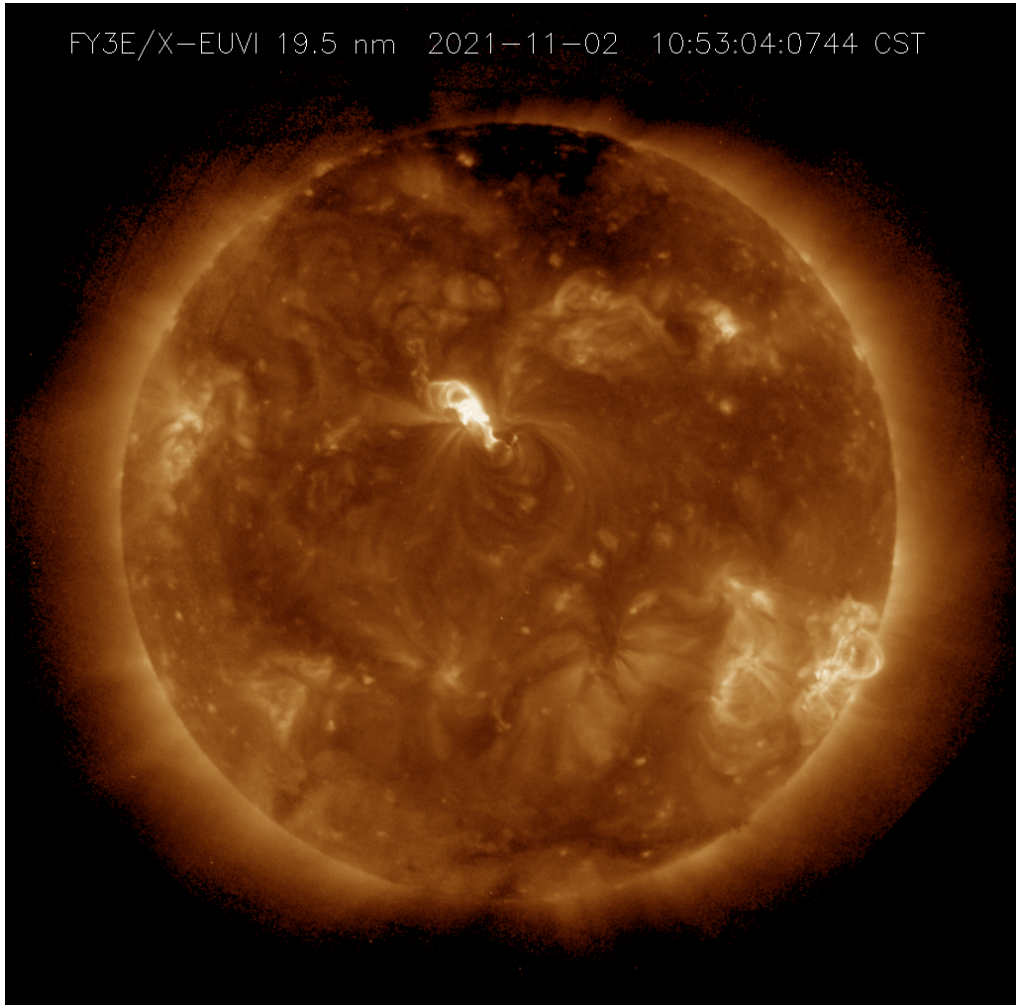


Figure 3. Propagation of the EUV wave from the edge-on view. The black and cyan dashed lines outline the wave-fronts obtained from the EUVI 195 Å (a) and 304 Å (b) running-difference images. An animation of this figure is

FY-3E X-EUVI Solar image（ Solar change of EUV Waveband ）

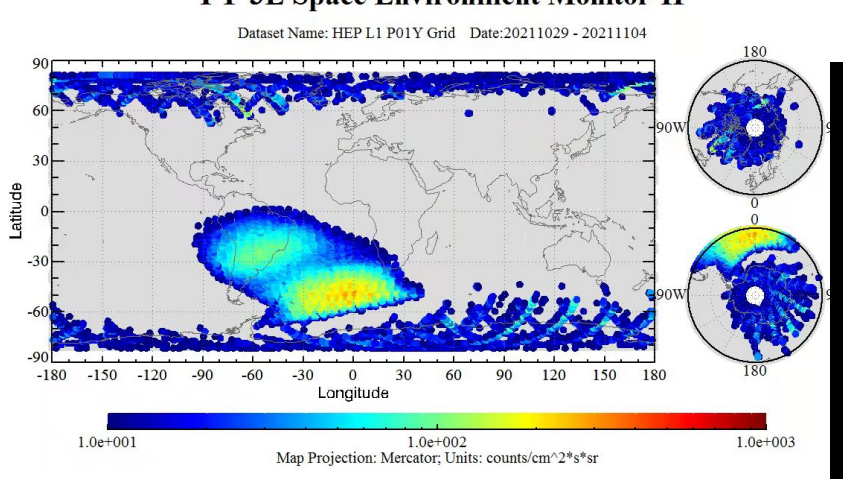
Space Weather Service—First monitoring of solar storms by China

(2021.11.02-04)

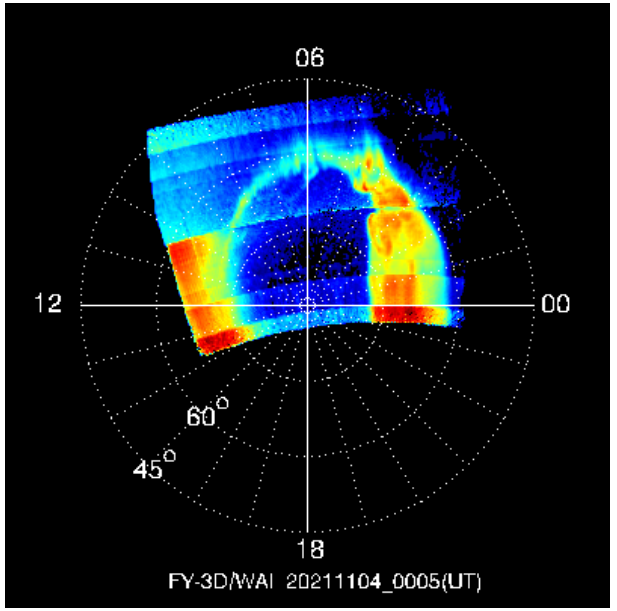


WAI brightness and range of aurora have obviously increased, and more complex fine structures have also been produced inside

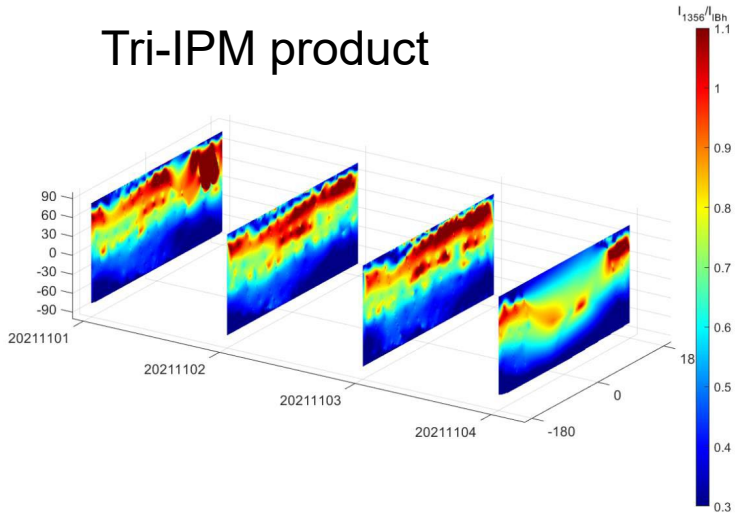
Strong magnetic storms lead to an increase in the flow of high-energy electrons (HEP_E01，0.15～0.35MeV) in the outer radiation belt (high latitude region)， an increase in high-energy protons (HEP_P01，3～5MeV) in the polar cap region



Ground aurora observation source in Canada

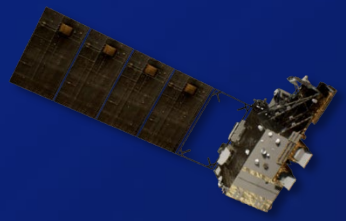


Tri-IPM product



Summary

- FY-3E Satellite platform and instrument tests are completely finished and transition into operation. Instrument status and performance are monitored operationally. L1 products were available since Mar. 2022, and L2 products started operationally to be released since June, 2022.
- FY-3E is used to optimize the current global operational polar-orbiting systems for providing better distribution of sounding data in the 6-hour NWP assimilation window. The data assimilation in global models show that the significant benefits have been achieved by the different NWP communities from the improved temporal distribution of observations provided by FY-3E. (The example from ECMWF by Niels Bormann has consistently shown a significant benefit from the added observations and confirmed good data quality, with better noise characteristics for the 118 GHz channels compared to earlier MWHS-2).
- Further benefits are expected in a number of application areas including severe weather event monitoring, improved sampling of the diurnal cycle for accurate climate data records, more efficient air quality monitoring in thermal infrared, and quasi-continuous monitoring of the Sun for space weather and climate.



Thank you for your attention.

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