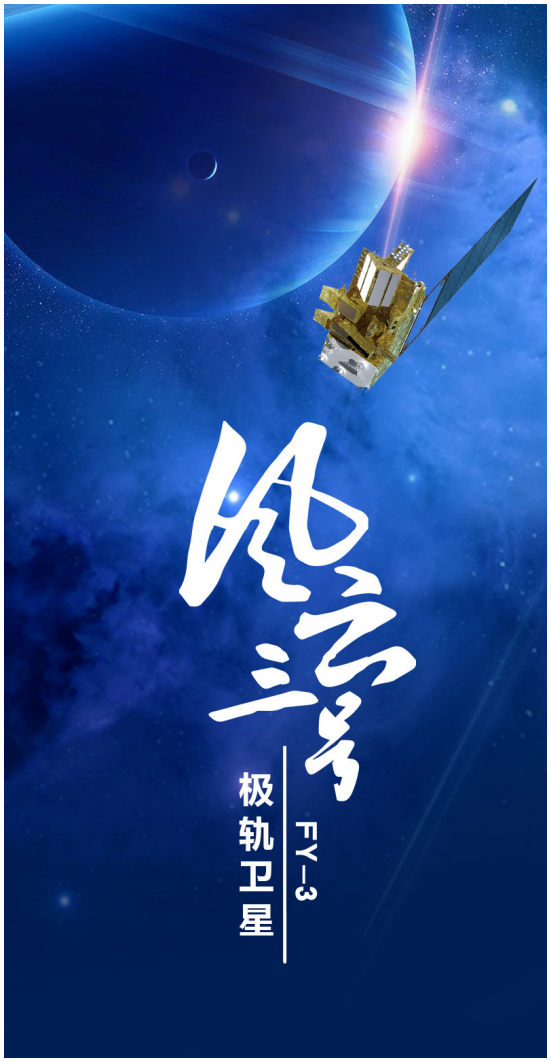
Performance of FY-3D&E/MERSI for IR Channels

Hanlie XU, Xiuqing HU
National Satellite Meteorological Center(NSMC), CMA
Songtao LEI, Yang WANG
Shanghai Institude of Technical Physics(SITP), CAS

May 5, 2022



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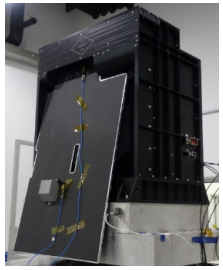
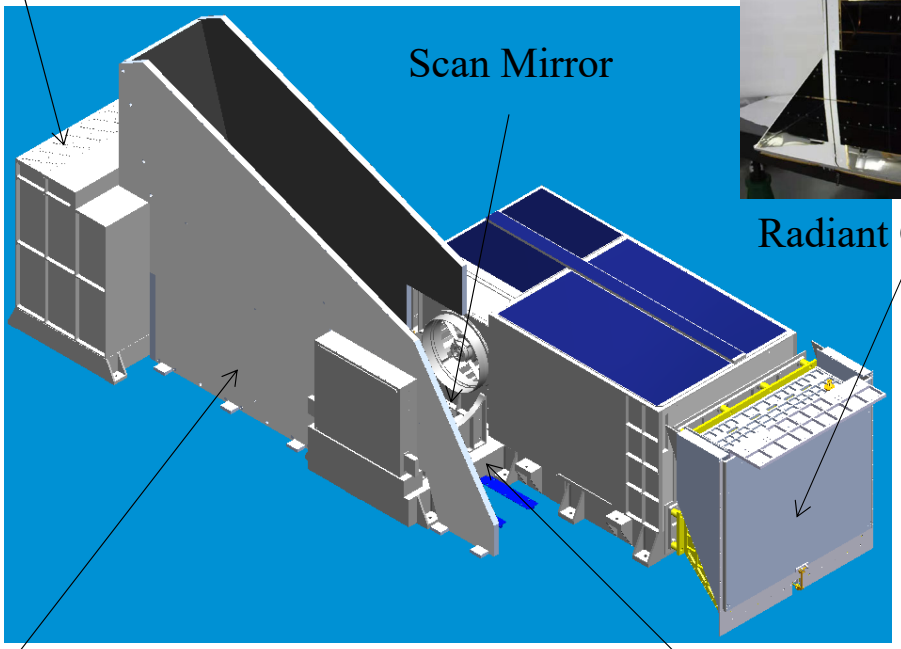


Visible Onboard Calibrator

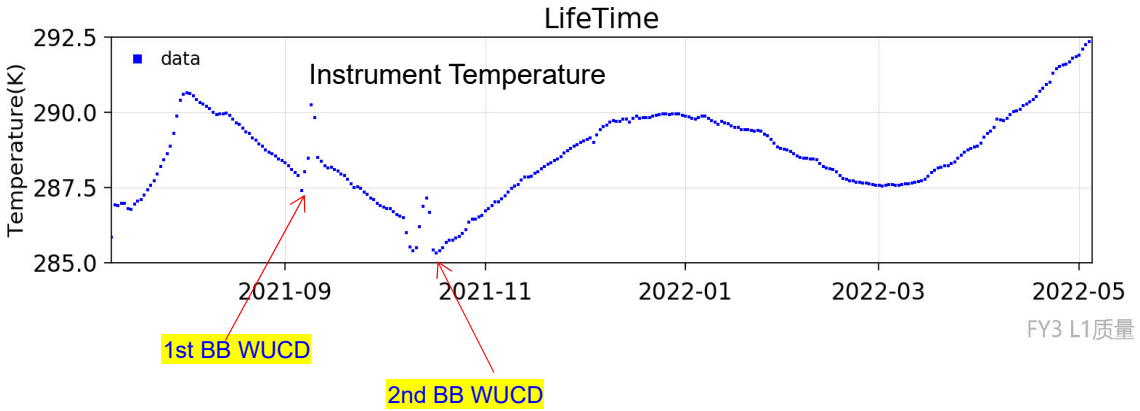


Description

- **Purpose**: Global observations of earth on terminator with high temporal resolution
- **Predecessor Instruments**: FY-3D/MERSI-II
- **Bands**: six infrared channels following FY-3D, one panchromatic low-light channel with a spectral range of 500-900 nm and one shortwave infrared experiments channel
- **Spatial resolution**: 1000m，250m(10.8 and 12 um)
- **Swath Width**: ~2500km
- **EV scan angle range:** -54.665° ~+50.03°

FY-3E/MERSI-LL Band Specification

No.	center wavelength (mm)	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}	calibration accuracy (%/T)
1	0.70	90	3e-5	4e-5(night)	7	50%
				50（day）	200	10%
2	3.8	350K	186K	300K	0.25K	0.4K
3	4.05	380K	185K	300/380K	0.25K	0.4K
4	7.2	270K	186K	270K	0.30K	0.4K
5	8.55	330K	185K	270K	0.25K	0.4K
6	10.8	345K	185K	300K	0.30K	0.4K
7	12.0	345K	185K	300K	0.30K	0.4K

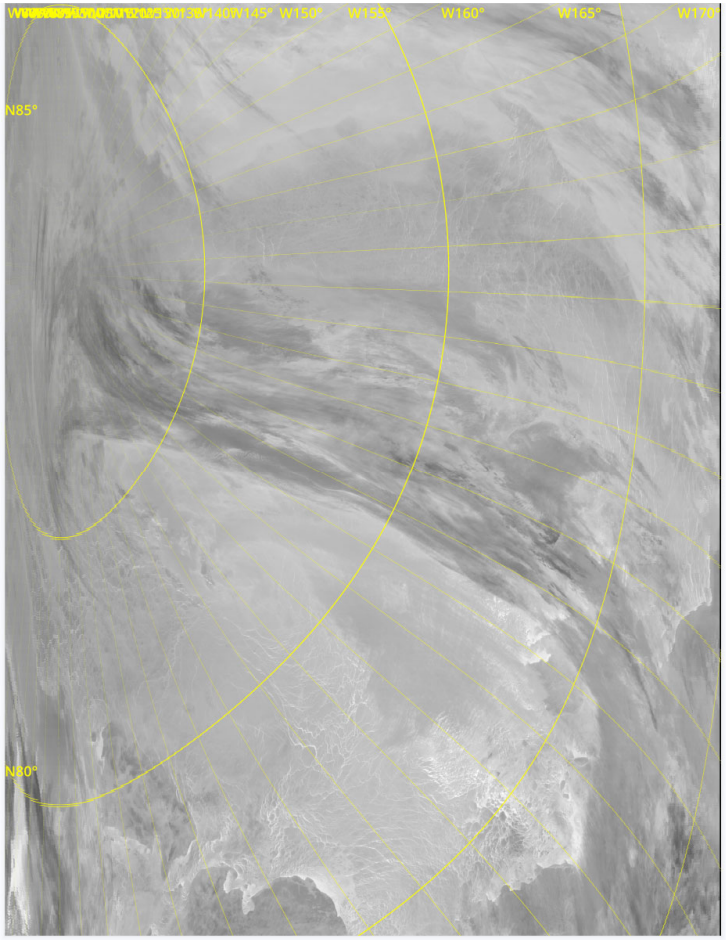


Status

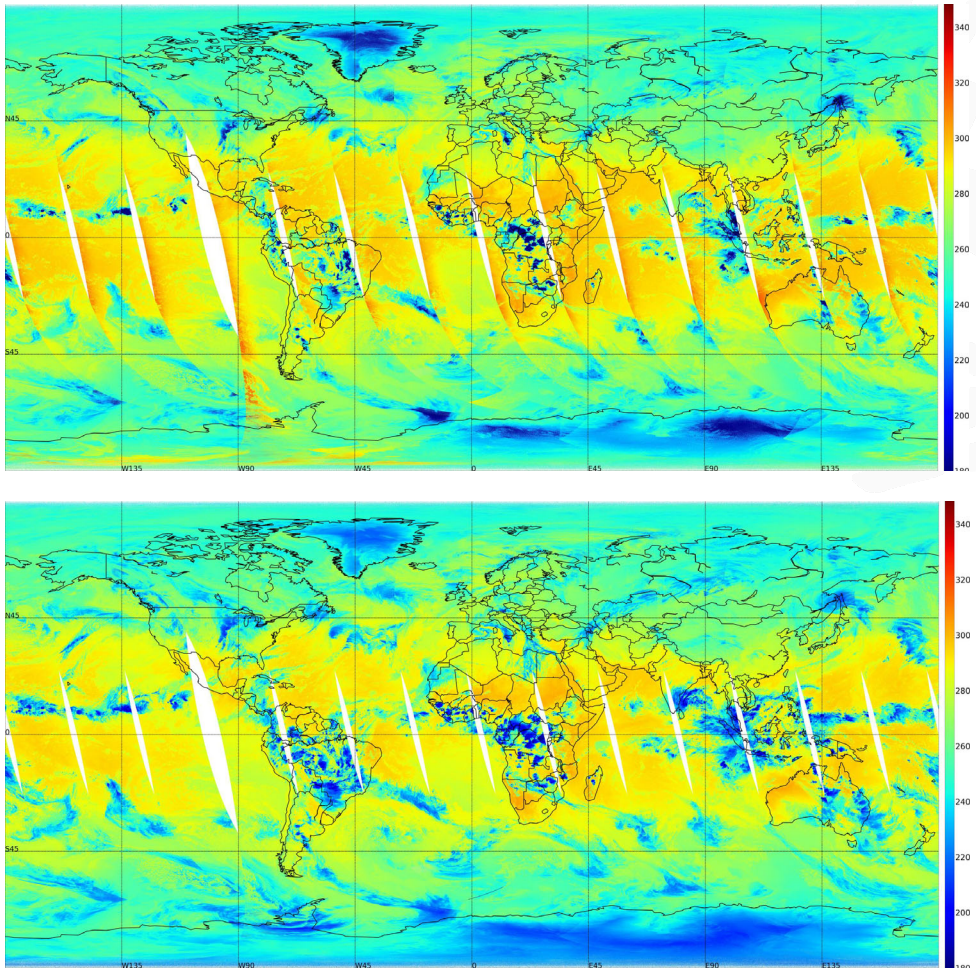
- **Jul. 2021**
  - ✓ Low-light band activity (July 9, 2021)
- **Sep. 2021**
  - ✓ IR channels activity (September 7, 2021)
  - ✓ 1st on-orbit BB WUCD function test (September 9,2021)
  - ✓ IR channels' NEdT test
  - ✓ Pre-launch nonlinear coefficients test
- **Oct. 2021**
  - ✓ 2nd on-orbit BB WUCD function test (October 11,2021)
  - ✓ IR channels' NEdT test
- **Nov. 2021**
  - ✓ On-orbit IR nonlinear coefficients update (November 11,2021)

FY-3E/MERSI-LL on-orbit Performance

Nov. 10, 2021 IR channel image—10.8um

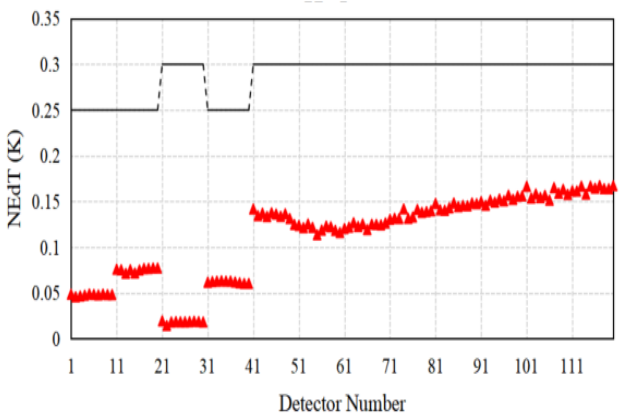


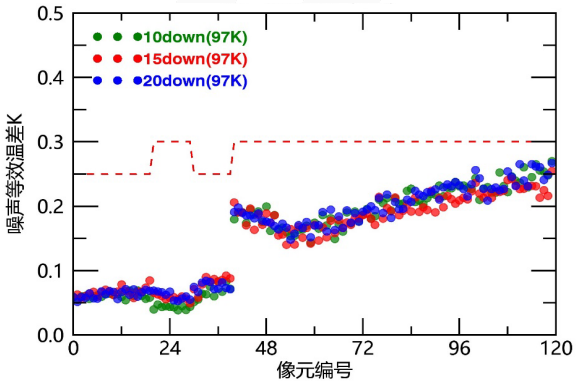
Oct. 10,2021 globle map of IR channels

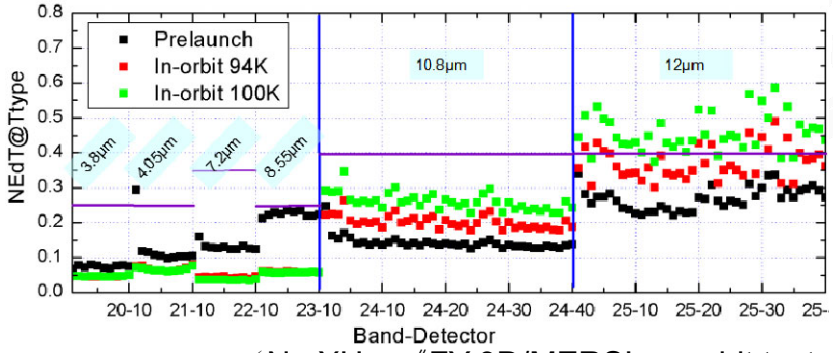


FY-3E/MERSI-LL on-orbit Performance

- ✓ Using the 2nd BB WUCD cool-down data to evaluate the NEdT of FY-3E/MERSI-LL IR channels;
- ✓ Four 1km IR channels'NEdT are less than 0.1K, two 250m channels'NEdT ara less than 0.18K;
- ✓ Because of on-orbit radiant cooling down, the NEdT of IR detectors are better than pre-lanunch vacuum test result;
- ✓ Comparing with FY-3D/MERSI, the sentivity of IR detector has been improved significantly.



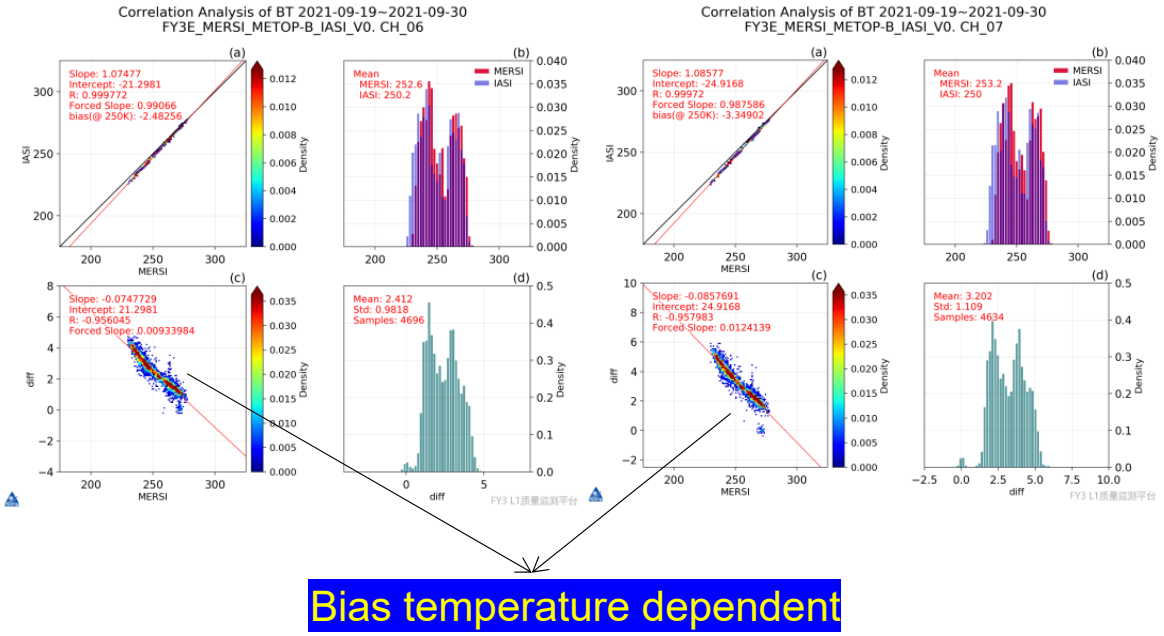




（Na XU，《FY-3D/MERSI on-orbit test report》）

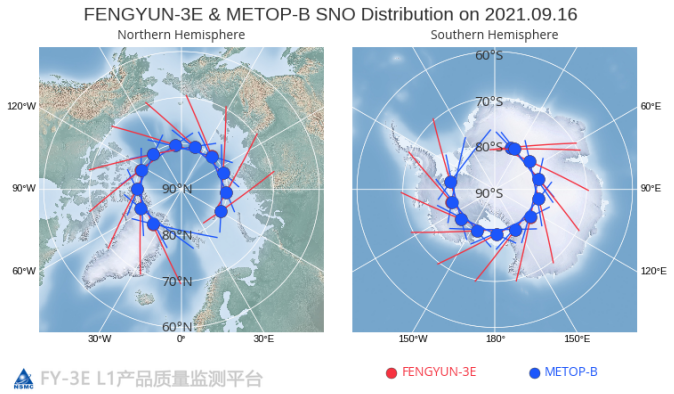
FY-3E/MERSI-LL IR Radiometric Calibration validation

- Period：Sep. 19-30, 2021
- Reference instrument：Metop-B/IASI



Bias temperature dependent

- IR channals calibration bias show temperature dependent characteristic:
- At low temperature sense, the biases are up to 4 K.

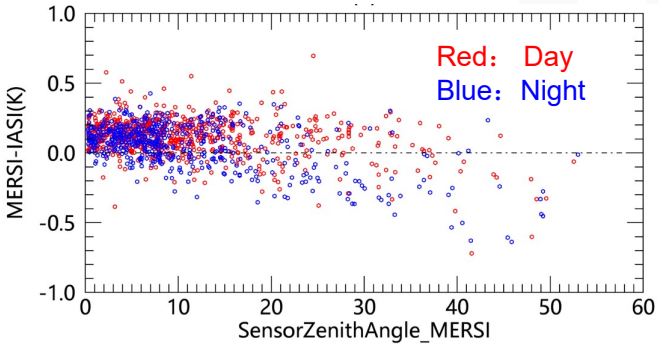


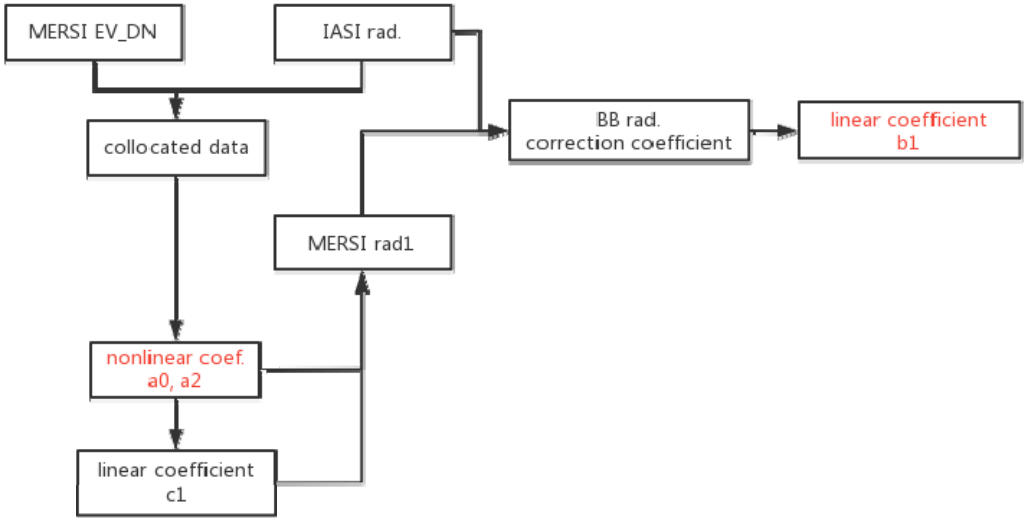
- Secondary radiant cooler temperature measurement out-of work, so radiant cooler temperature control were turned off after IR activity;
- IR detector operating temperature inconsistent with pre-launch test, non-linear coefficients are not suitable ;
- Pre-launch nonlinear coeffcients have not suitable due to on-orbit radiant cooler cooling down;

FY-3E/MERSI-LL IR Radiometric Calibration validation

- Based on SNO collocated data to calculate the nonlinear coefficients on-orbit, using Metop-B/IASI
  - Time difference: 600s
  - Spacial Distance : 1km
  - Geometry difference: |cos(senz1)/cos(senz2)-1| <0.01
  - Uniformity: std/ave < 0.005
  - Observation angle: FY_senz<10°

Bias observation angle dependence





$$L_{IASI} = a_0 + a_1 \cdot dn_{EV} + a_2 \cdot dn_{EV}^2$$

$$L_{BB} = Planck(T_{BB}) + f(T_{BB}) = c_0 + c_1 \cdot Planck(T_{BB})$$

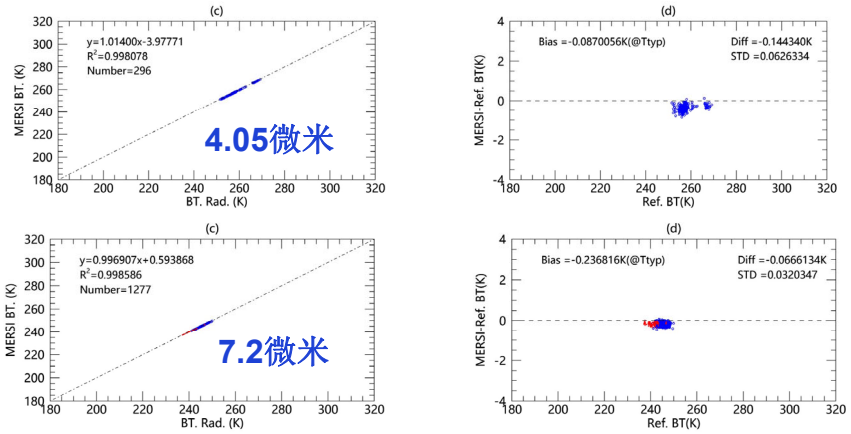
Environment radiation reflected by BB

$$b_1 = \frac{L_{BB} - a_0 - a_2 \cdot dn_{BB}^2}{dn_{BB}}$$

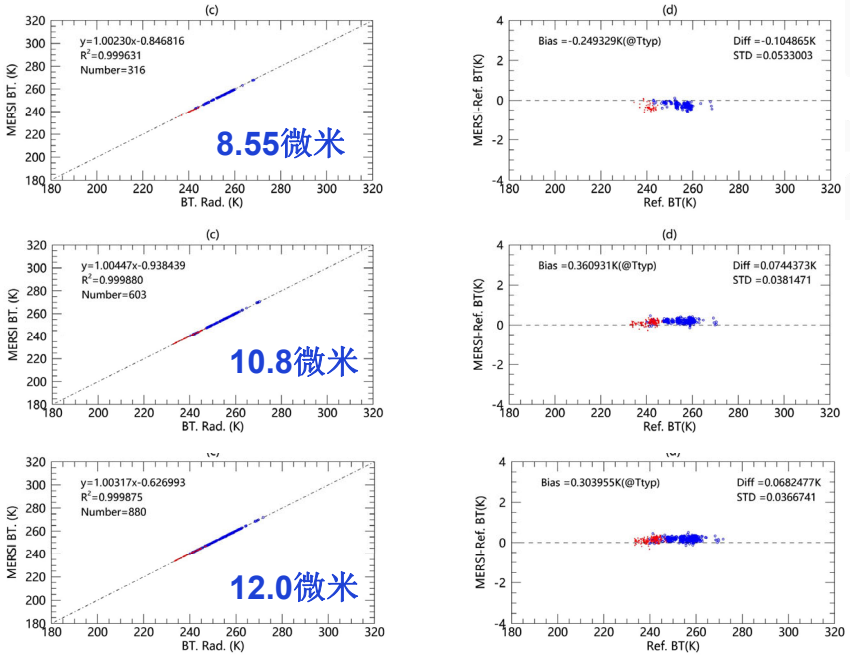
$$L_{EV} = a_0 + b_1 \cdot dn_{EV} + a_2 \cdot dn_{EV}^2$$

FY-3E/MERSI-LL IR Radiometric Calibration validation

After calibration update：

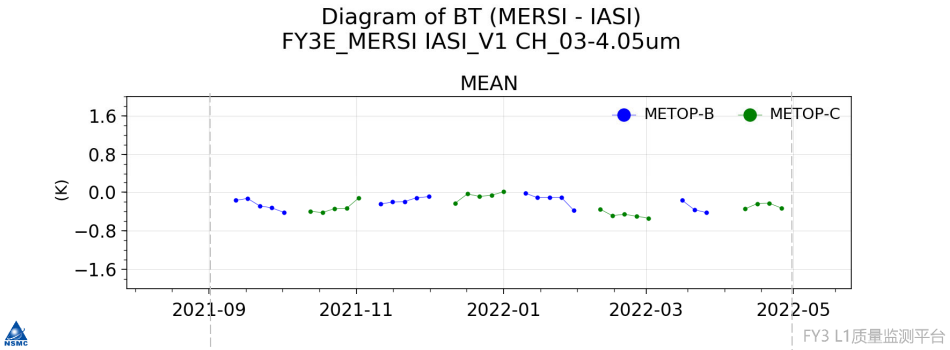


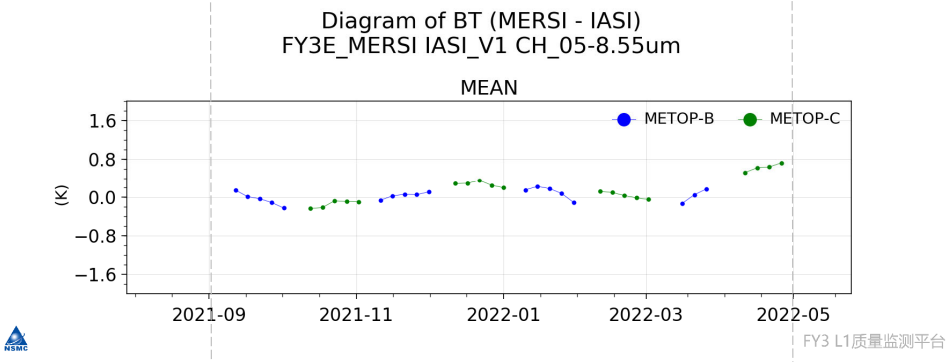
- Period：Oct. 6-10, 2021
- Reference instrument：Metop-A/IASI

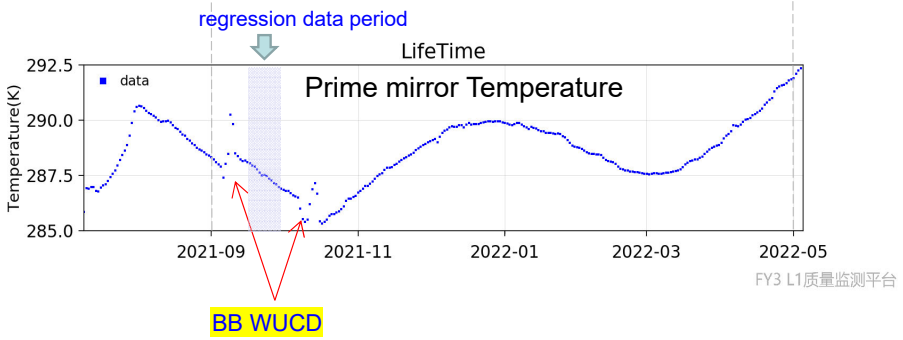


Reference		CH3	CH4	CH5	CH6	CH7
A-IASI (Oct,6-10,2021)	mean bias	-0.144	-0.067	-0.105	0.074	0.068
	STD	0.063	0.032	0.053	0.038	0.037

Long-term stability of FY-3E/MERSI IR channels



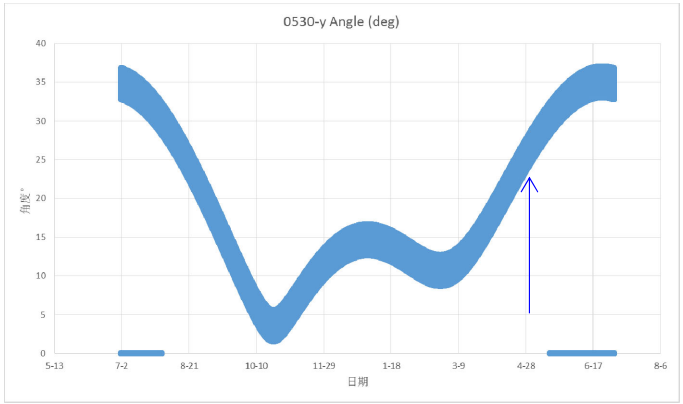




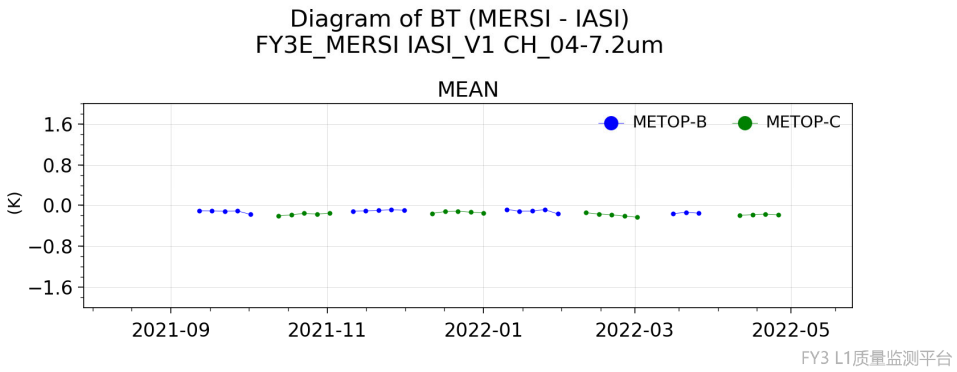
- Mean bias of 4.05 and 8.55 um channels shows periodical variation;
- 4.05um calibration bias variation matched with instrument temperature, the bias has to about 0.8K at the end of April;

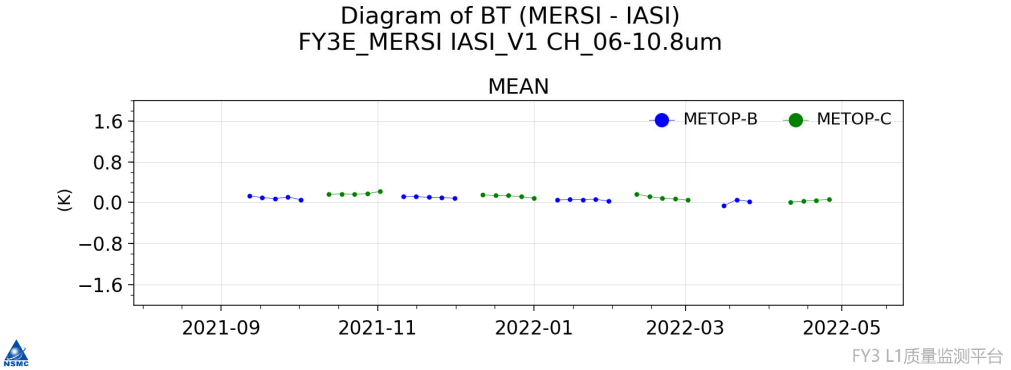
$$L_{BB} = Planck(T_{BB}) + f(T_{BB}) \Leftarrow$$
$$= c_0 + c_1 \cdot Planck(T_{BB})$$

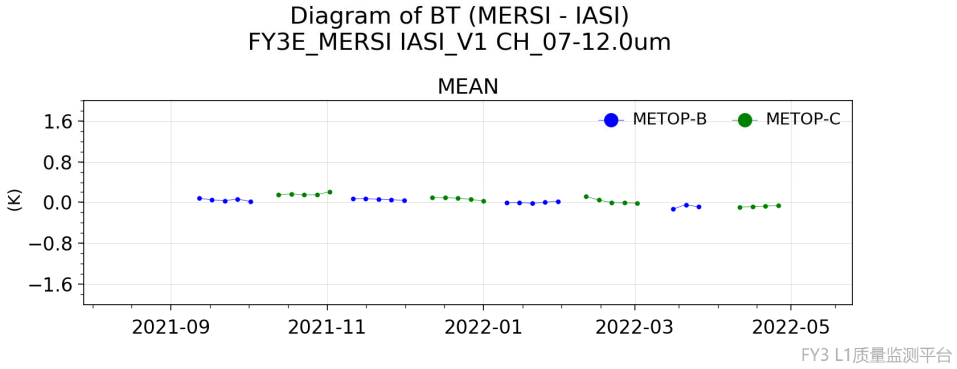
Environment radiation reflected by BB



Long-term stability of FY-3E/MERSI IR channels

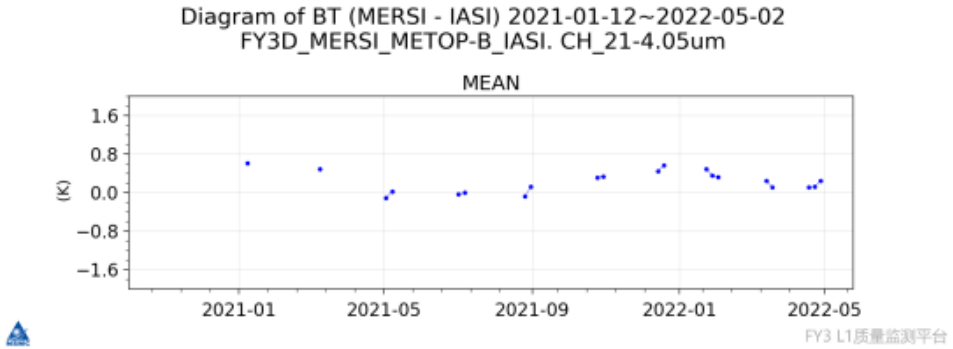


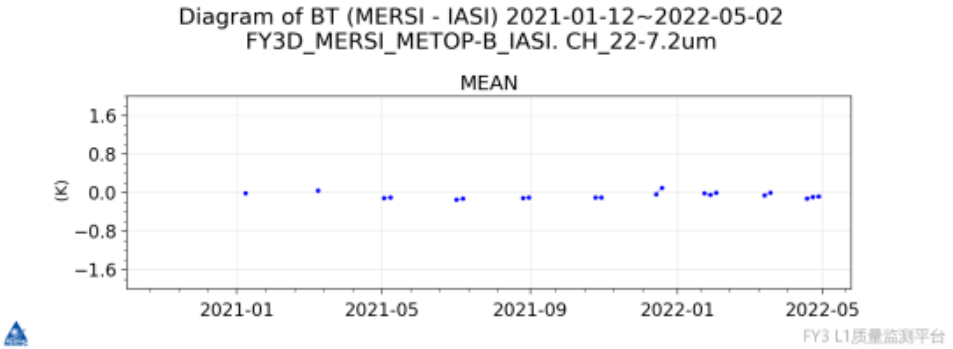


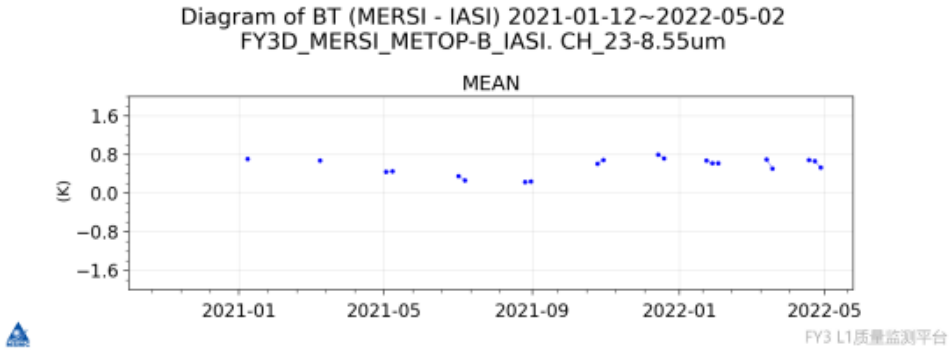


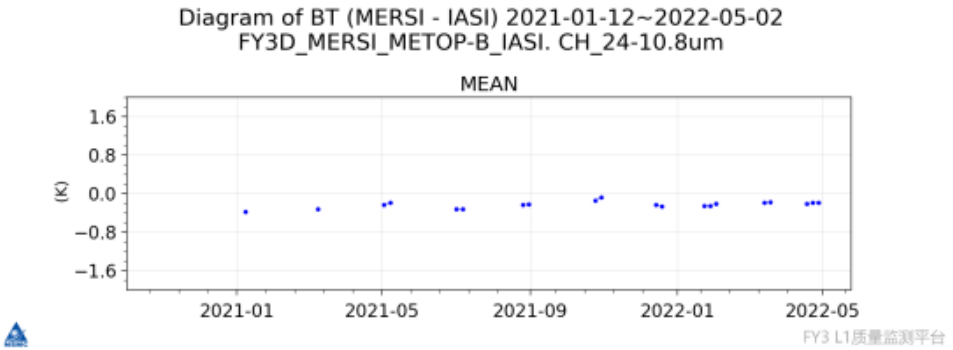
- Mean bias of 7.2,10.8 and 12.0 um channels are stable after IR activity, the mean biases are less than 0.4K during life time until now;

Long-term stability of FY-3D/MERSI IR channels

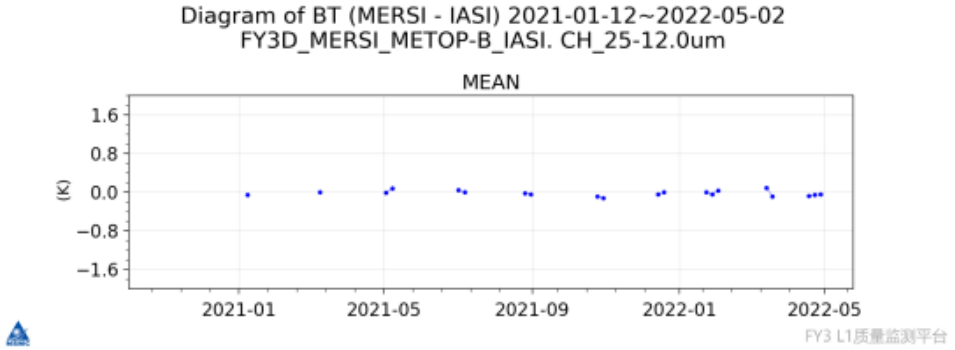








- Mean bias of 4.05 and 8.55 um channels shows periodical variation;
- Mean bias of 7.2,10.8 and 12.0 um channels are stable until now;



Summary and discussion

- ✓ FY-3E/MERSI-LL IR channels' sentivity has been improved significantly comparing with FY-3D/MERSI, four 1km IR channels'NEdT are less than 0.1K, two 250m channels'NEdT ara less than 0.18K;
- ✓ Due to FY-3E/MERSI-LL radiant on-orbit cooling down, non-linear coefficients need to be derived in orbit. Using IASI as reference instrument, and considering the effect of environmental radiation in on-orbit calibration model, during the on-orbit test we derive the non-linear coefficients and blackbody radiance correction coefficients.
- ✓ Calibration validation results and Lifetime calibration bias monitor show the new coefficients have worked well, 2 channels' biases show periodical variation, maybe due to the instrument temperature changes and the environmental radiant reflected by BB is not corrected very well .

NSMC

Thank you