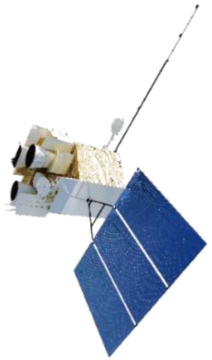
FY-3E/HIRAS and FY-4B/GIIRS performance status and future plans



Lu Lee, Chengli Qi
Panxiang Zhang, Weichu Yu, Qiankun Zhang

National Satellite Meteorological Center (NSMC), CMA

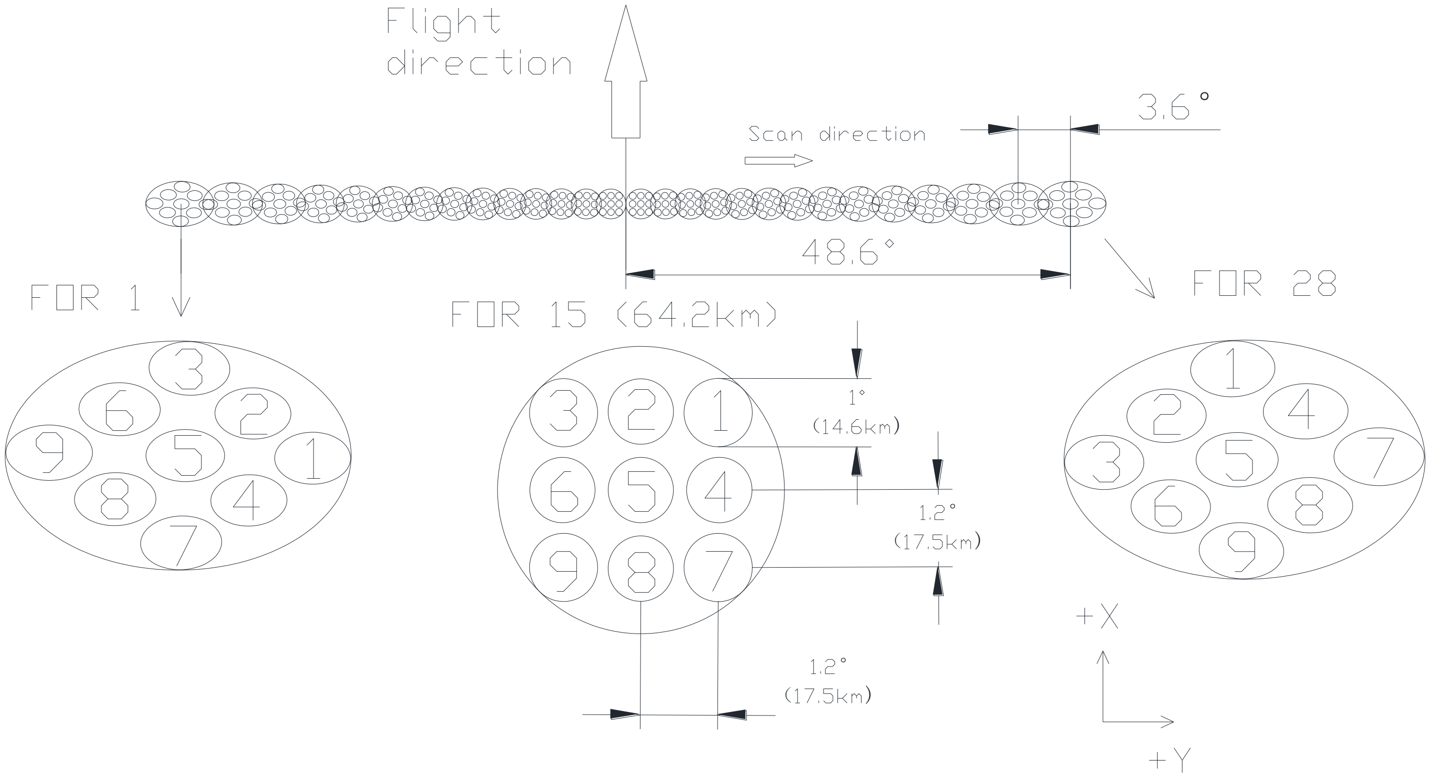
Chapter 1

FY-3E/HIRAS-II performance status

Chengli Qi, **Lu Lee**, Panxiang Zhang

1.1 FY-3E/HIRAS-II instrument temperature field reset

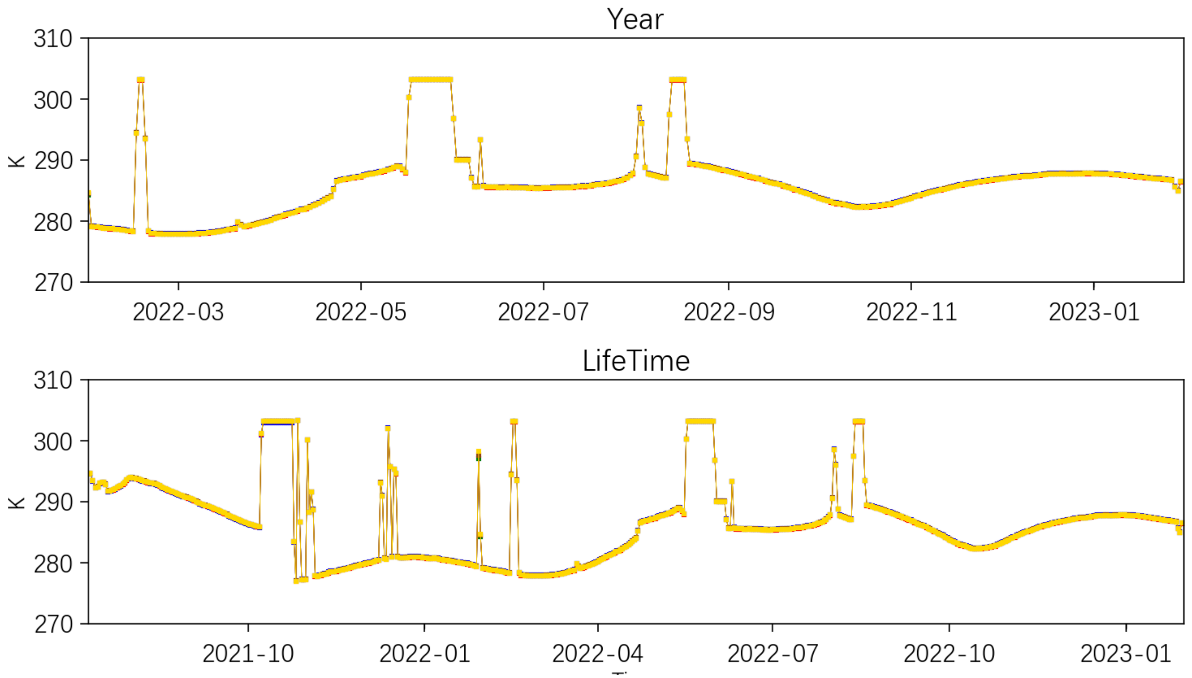
HIRAS-II Scan Pattern



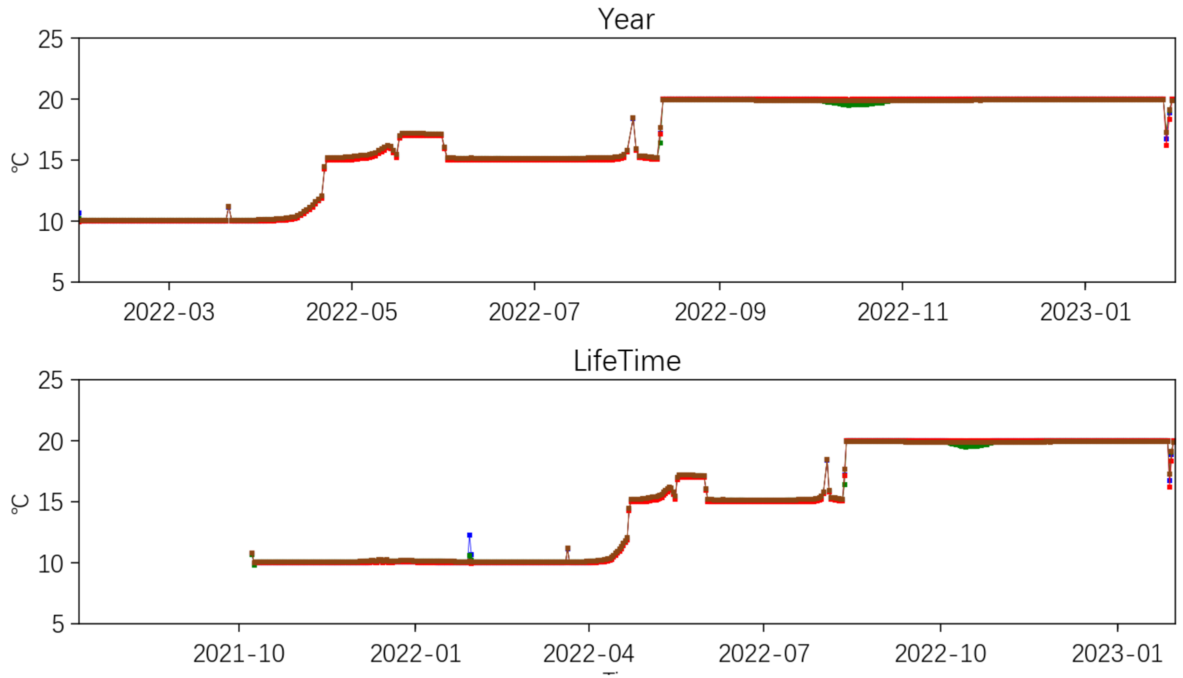
Swath is ~2050 km (FOR-1 to FOR-28)
HIRAS-II 1 FOR includes 9 FOV
HIRAS-II acquires 1 scan line every 8 seconds

FOV – Field OF View
FOR – Field OF Regard

1.1 FY-3E/HIRAS-II instrument temperature field reset



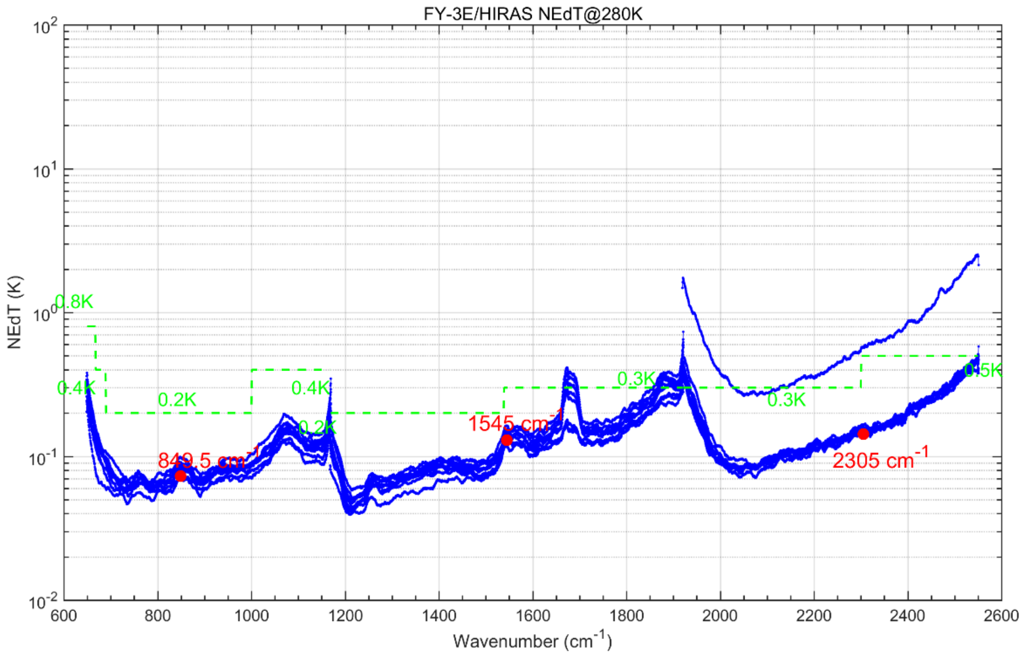
Internal blackbody temperature monitoring



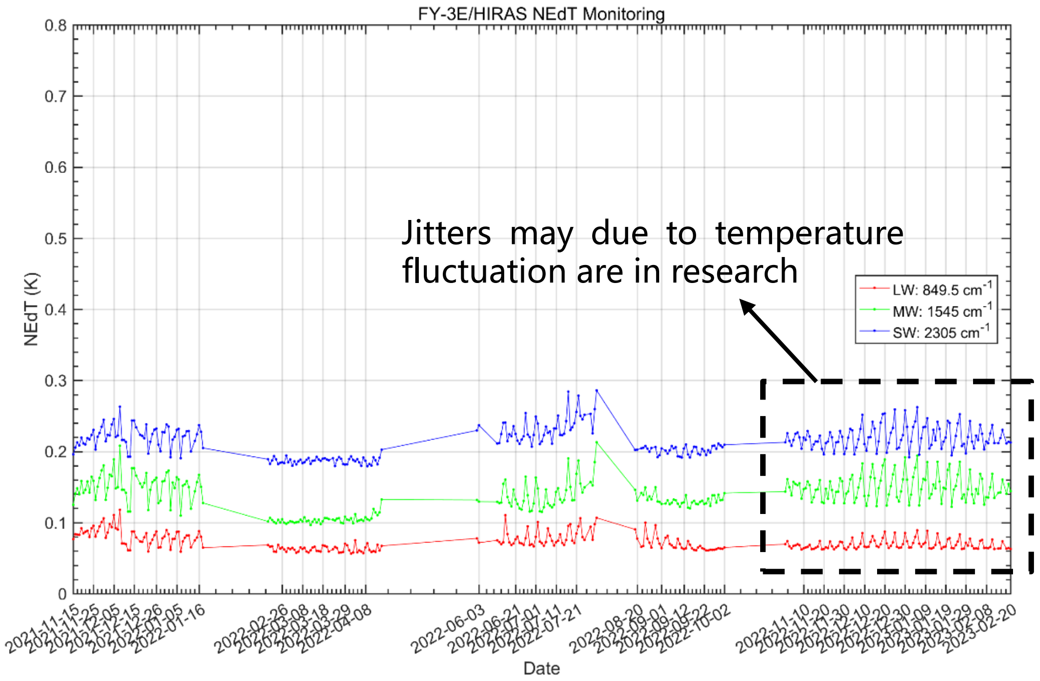
Interferometer temperature monitoring

On 0530 orbit, the instrument temperature fluctuations are intractable due to the sunlight from low solar elevation angles. Therefore, the interferometer temperature was raised from 10 to 20 Celsius degrees on August 18, 2022. The parameters for spectral/radiometric calibration, such as off-axis correction and nonlinear correction coefficients, were also adjusted along with the sounder temperature field reset.

1.2 FY-3E/HIRAS-II noise performance and instrument responsivity



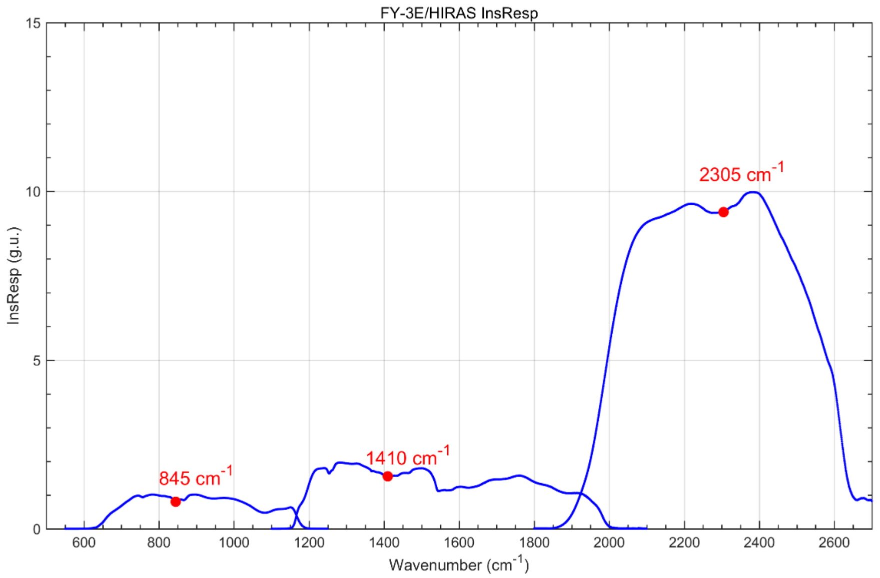
HIRAS-II nine FOVs NEdT@280K BB

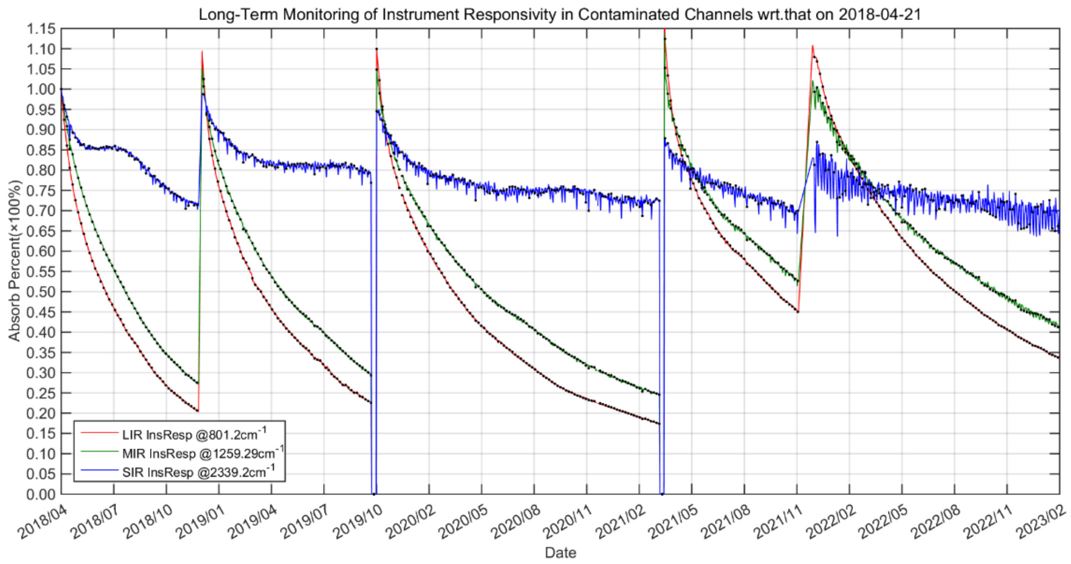


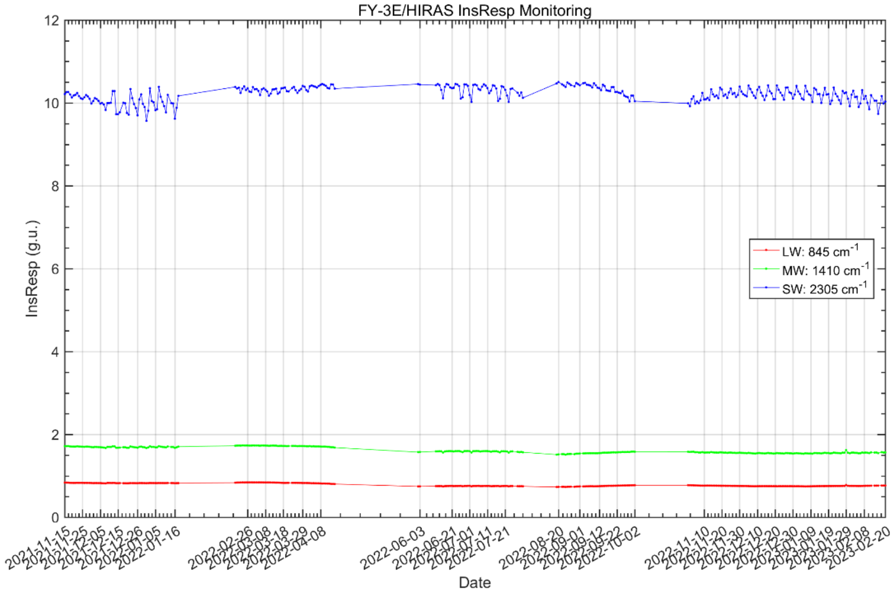
Channel NEdT monitoring

HIRAS-II meets the noise specification in all fields of view (FOV) except FOV-1 in SWIR band, and the NEdT trends are stable, even though the instrument basic temperature field was changed in August 2022.

FY-3E/HIRAS-II instrument responsivity status



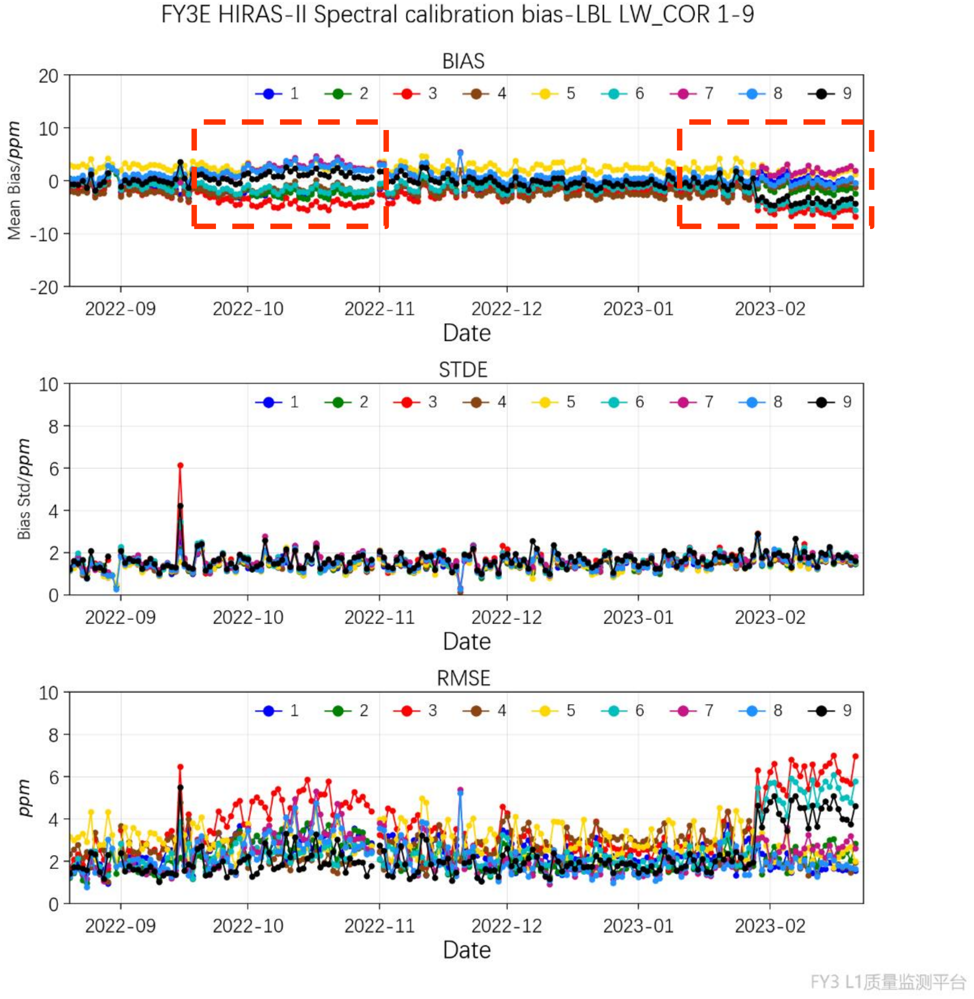


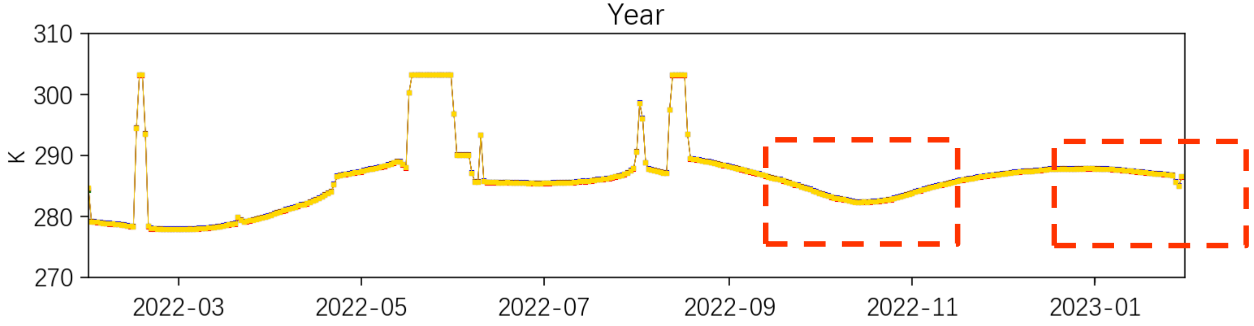


Unlike FY-3D/HIRAS, the responsivity contamination seems have been avoided successfully in FY-3E/HIRAS.

The instrument responsivity trends in all bands were stable for 1.5 years after launch.

1.3 FY-3E/HIRAS-II spectral calibration monitoring





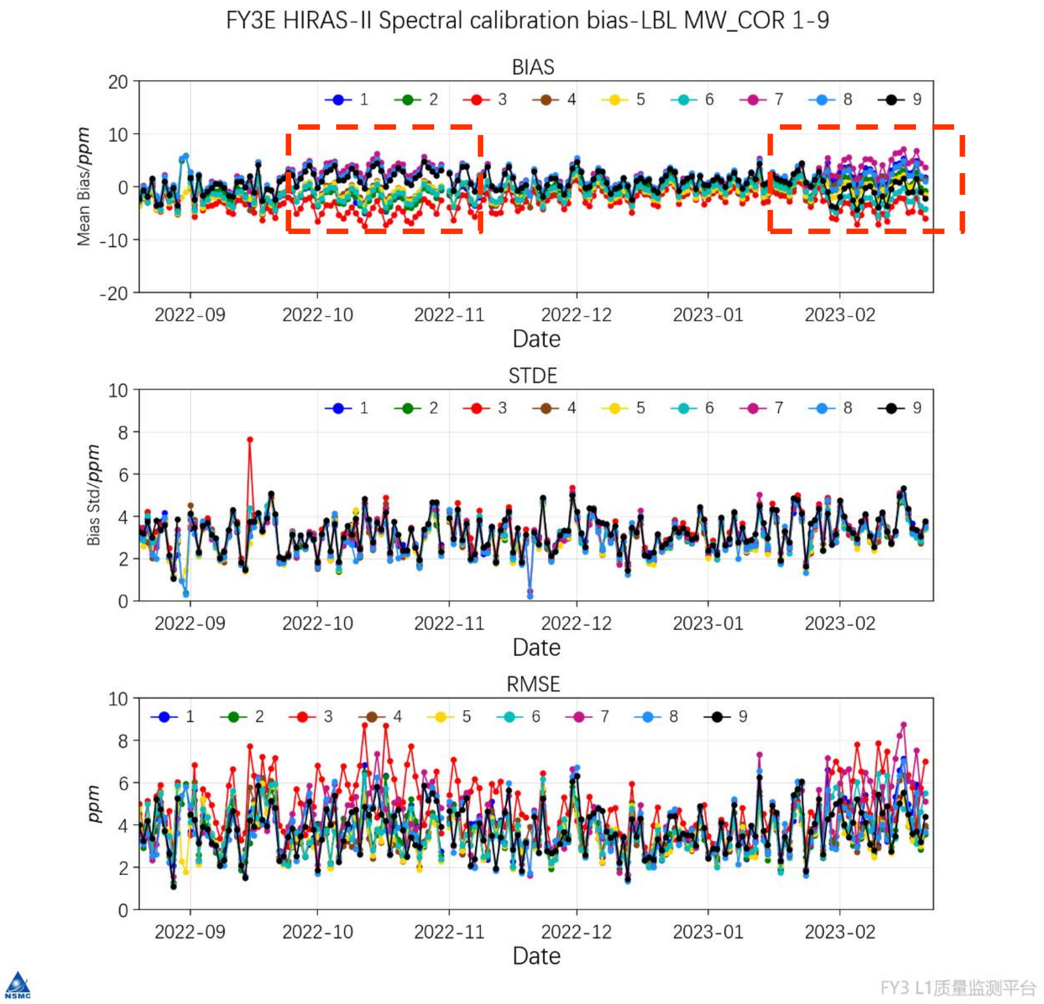
Internal blackbody temperature status

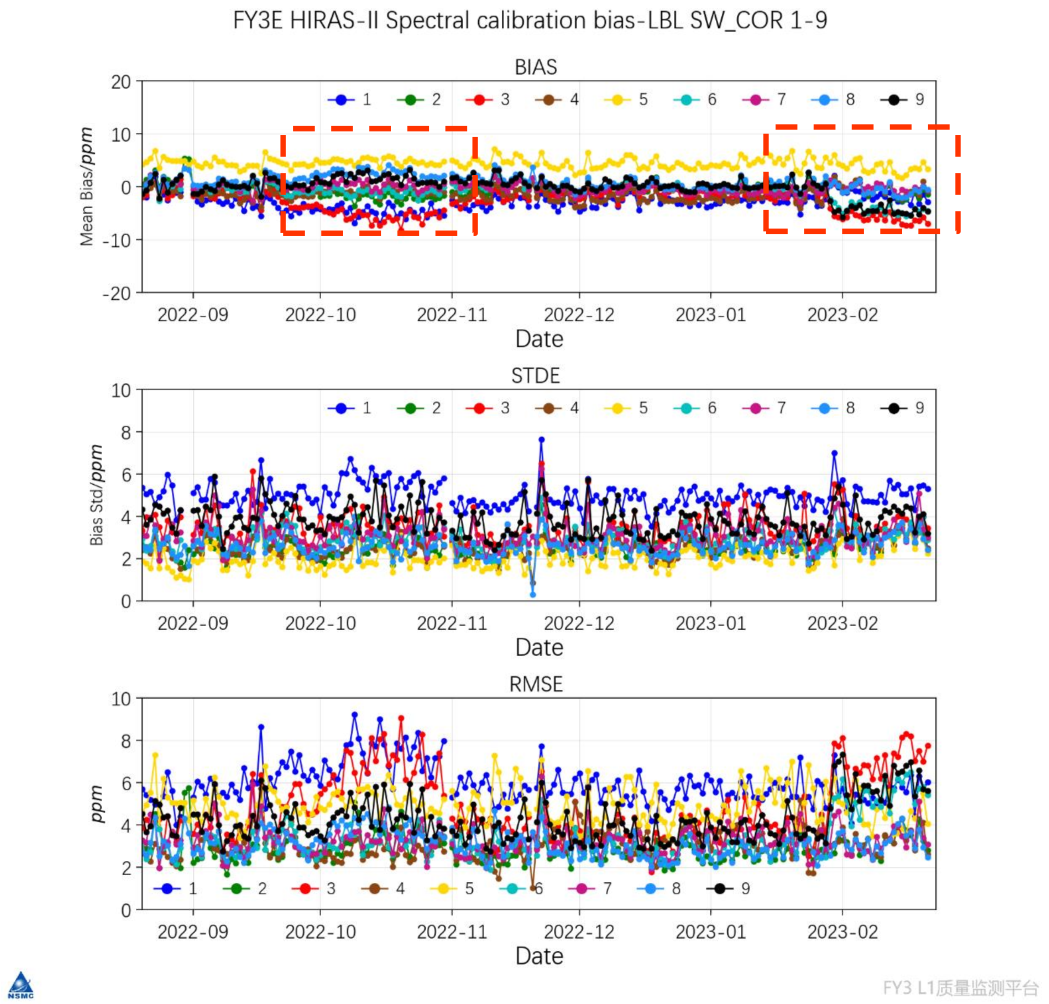
The relative spectral offsets with respect to LBLRTM simulated spectra for three bands are less than 10 ppm in average.

The offsets seem increase along with the sounder seasonal temperature decrease in October 2022 and February 2023.

The longer trending after the sounder temperature field reset need to be traced for a whole year at least.

From August 2022 to February 2023.





The similar trends in MWIR and SWIR bands.

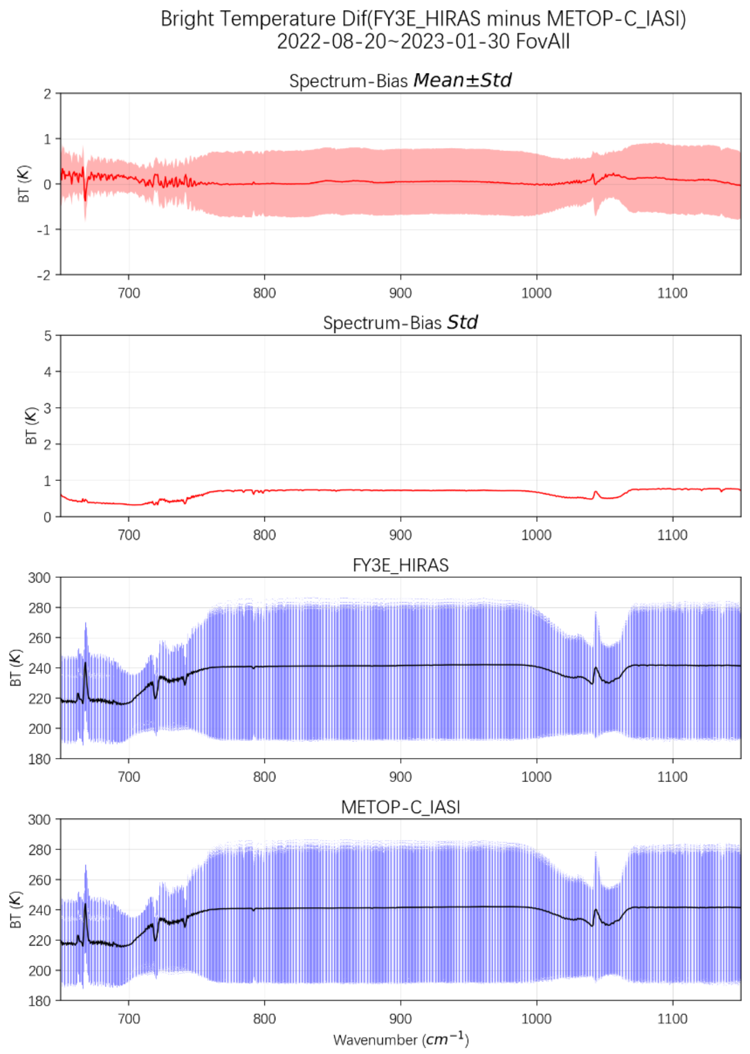
From August 2022 to February 2023.

1.4 Inter-comparisons of FY-3E/HIRAS-II and MetOp/IASI

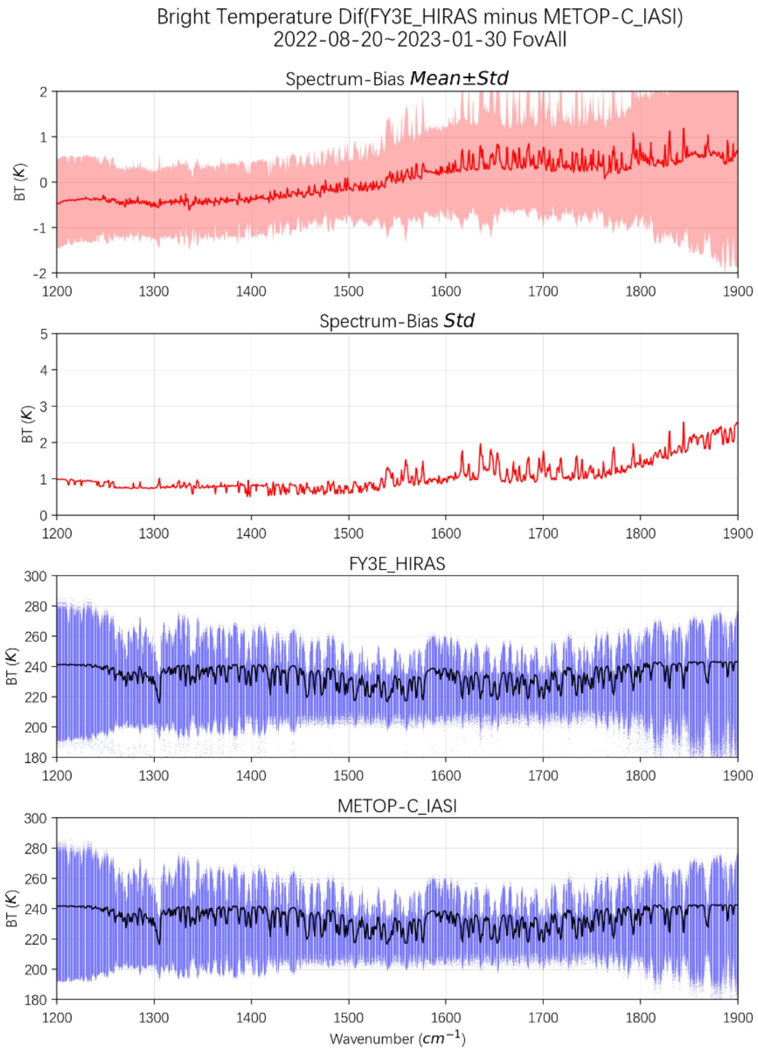
SNO Criteria:
Time difference: <=1200 s
Pixel distance: 10 km
Zenith angle difference: abs[cos(zenith1)/cos(zenith2)-1]<=0.01
FOV homogeneity: stddev(MERSI)/mean(MERSI)<0.01

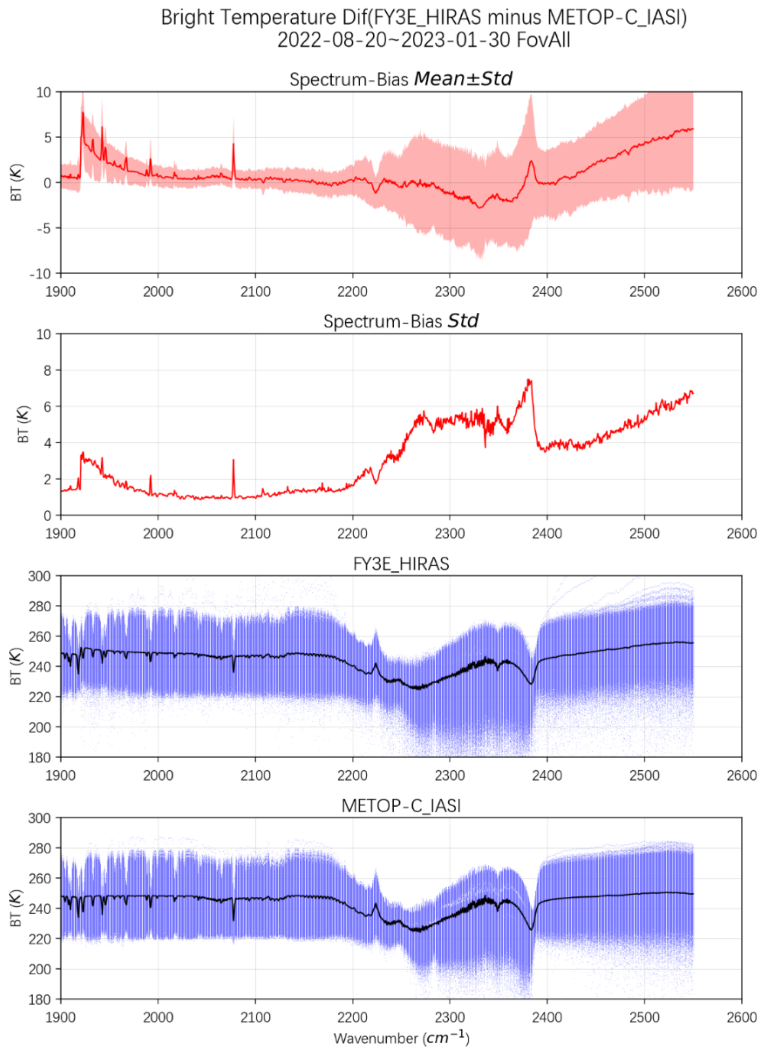
The radiometric uncertainty is mainly assessed through HIRAS-IASI SNOs in the last year.

The HIRAS-IASI BT difference in LWIR band is about 0.5 K (std. dev. ~1 K).



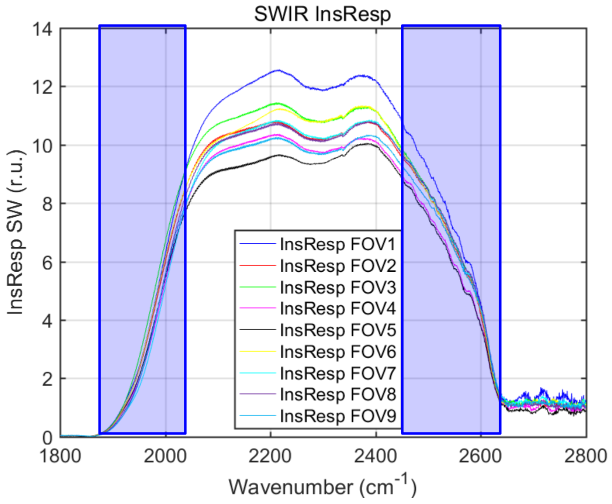
Hamming apodization, Conversion to BT at scene radiance



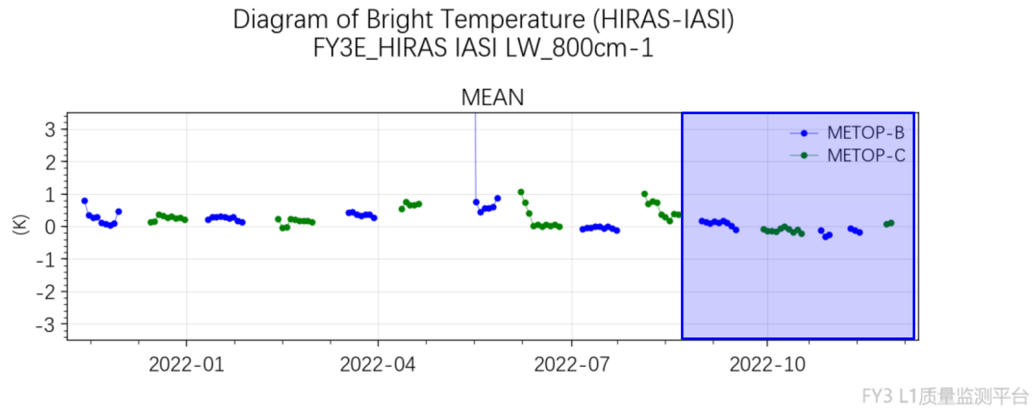


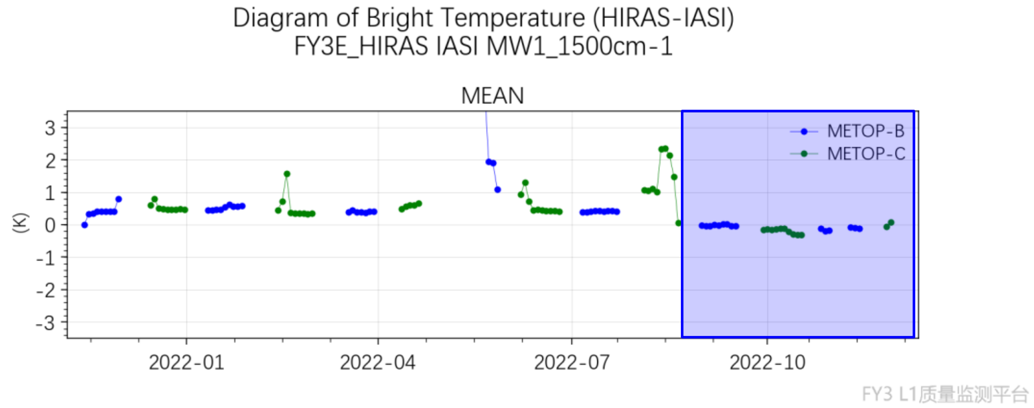
The HIRAS-IASI BT difference in MWIR band varies from 0.5 K to 1 K (std. dev. 1~2 K).

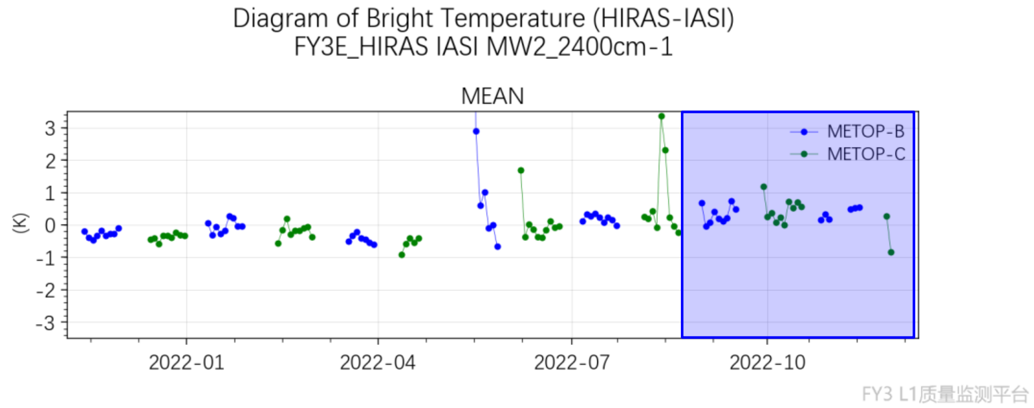
In SWIR band, the difference is more than 5 K in both sides of instrument responsivity roll-off range.



Hamming apodization, Conversion to BT at scene radiance







Since September 2022, the BT differences of HIRAS-IASI are stable for some channels in the three bands.

1.5 Summary

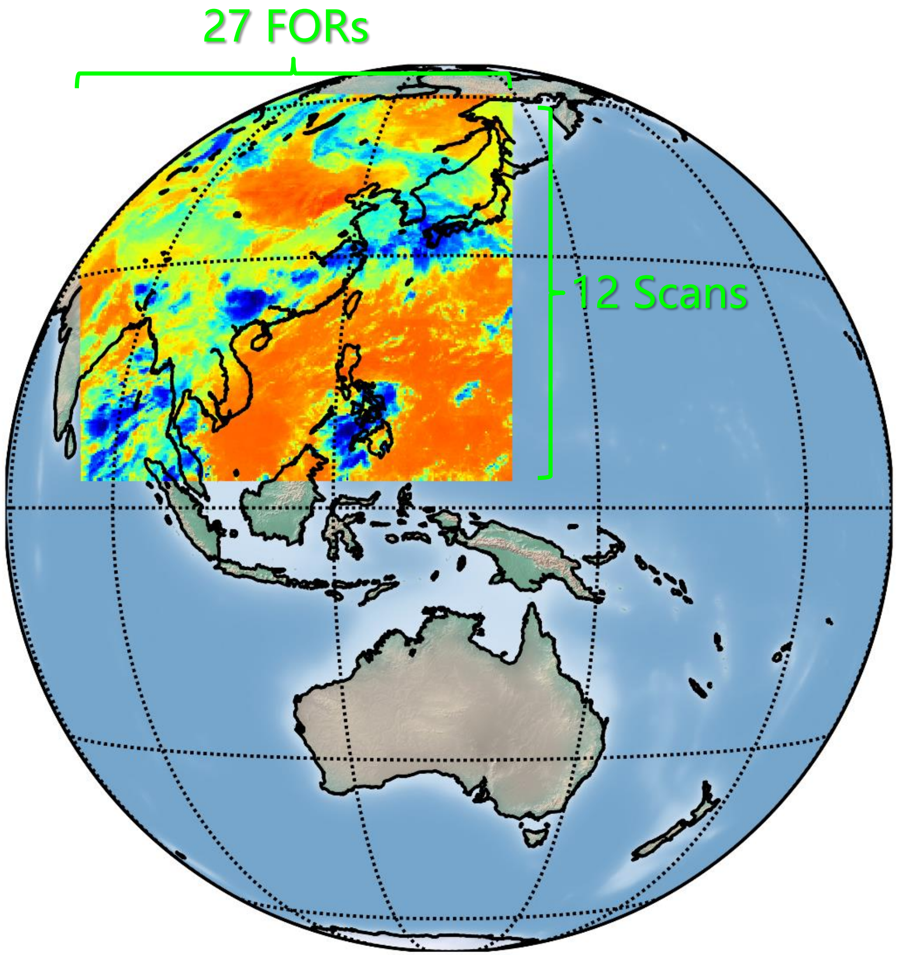
- Due to the sunlight on 0530 orbit, the instrument temperature field of FY-3E/HIRAS-II was reset in August 2022, and the parameters for calibration were adjusted to fit the new state of the sounder.
- The noise and instrument responsivity of HIRAS-II were stable for 1.5 years after launch.
- The spectral calibration with respect to LBLRTM is less than 10 ppm for three bands respectively, but it seems to be affected by the seasonal fluctuations of the sounder internal temperature.
- The radiometric calibration with respect to MetOp-B/C IASI is about 0.5 K in LWIR, 0.5 to 1 K in MWIR.

Chapter 2

FY-4B/GIIRS performance status

Lu Lee, Weichu Yu, Qiankun Zhang

2.1 FY-4B/GIIRS operational observation mode

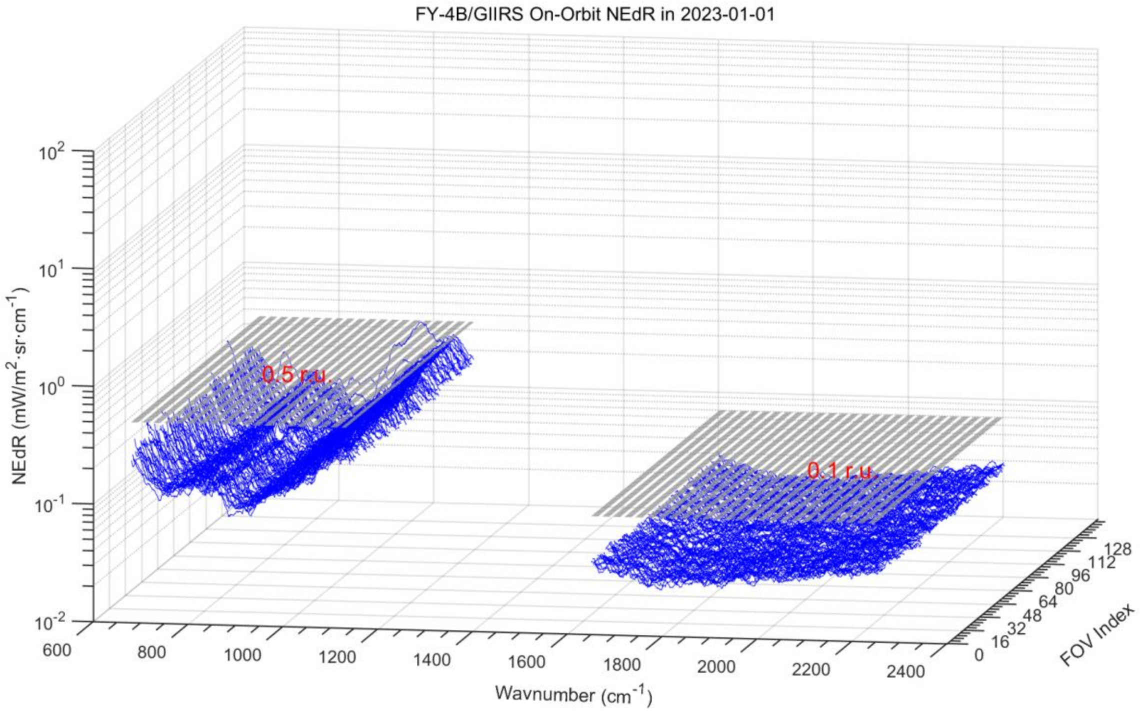


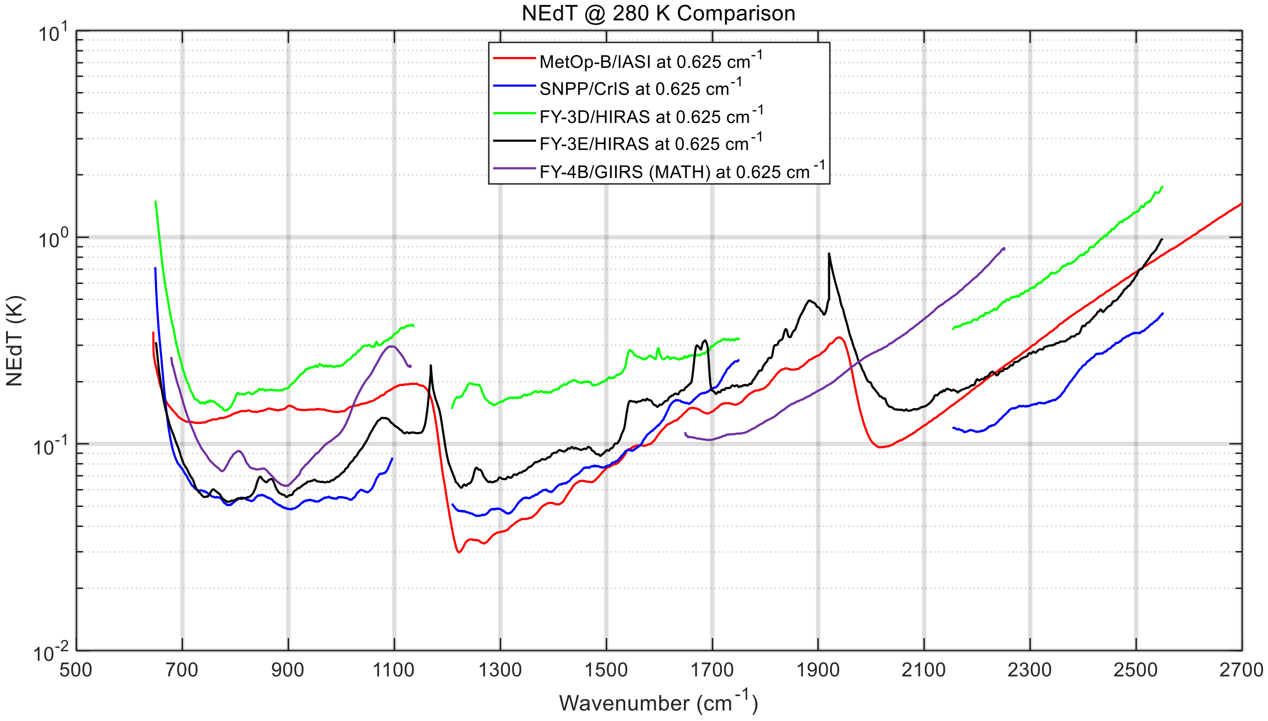
GIIRS scans the Earth in a "step-stare" mode: the sounder will observe the Earth covered by the field of view, collecting 16×8 interferograms in 10.4s, then jumps to the next adjacent dwell.

Since March 26, 2022, GIIRS positions at 133°E, and the observation zone comprises 27 FORs × 12 Scans (53°E~148°E, 2.2°N~66°N), and one coverage takes about 1.5 hours.

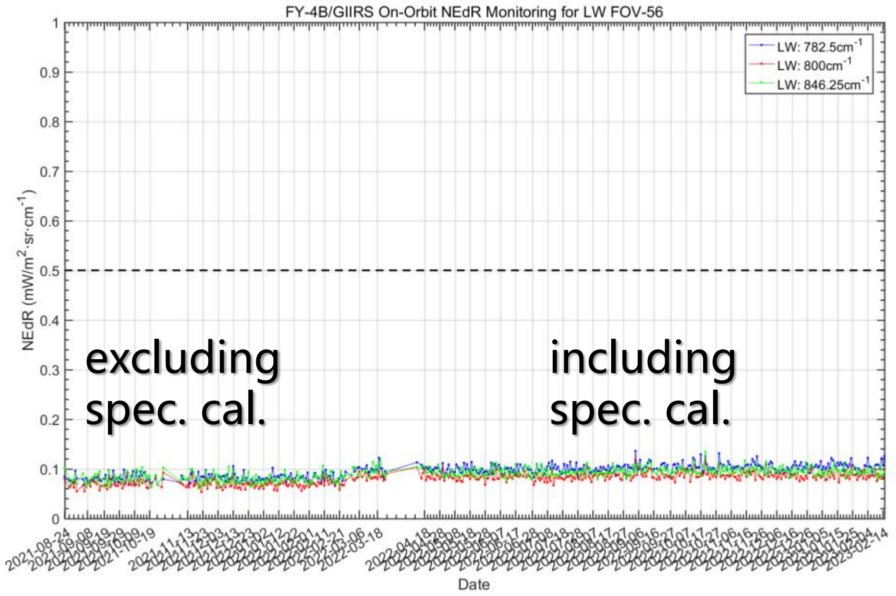
The FY-4B/GIIRS L0~L1 data processing algorithm was delivered on June 29, 2022, and the L1 radiance products were operationally disseminated at the same time.

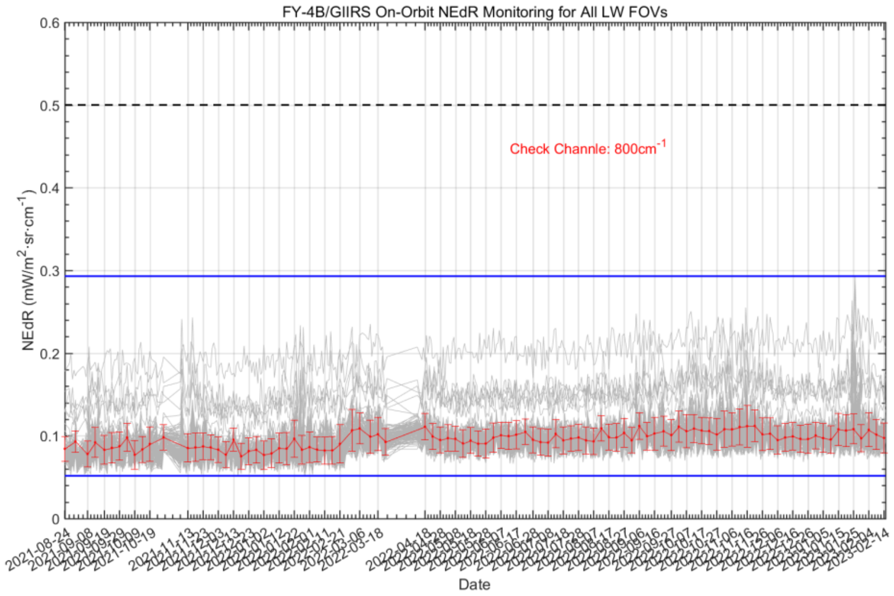
2.2 FY-4B/GIIRS onboard noise performance status

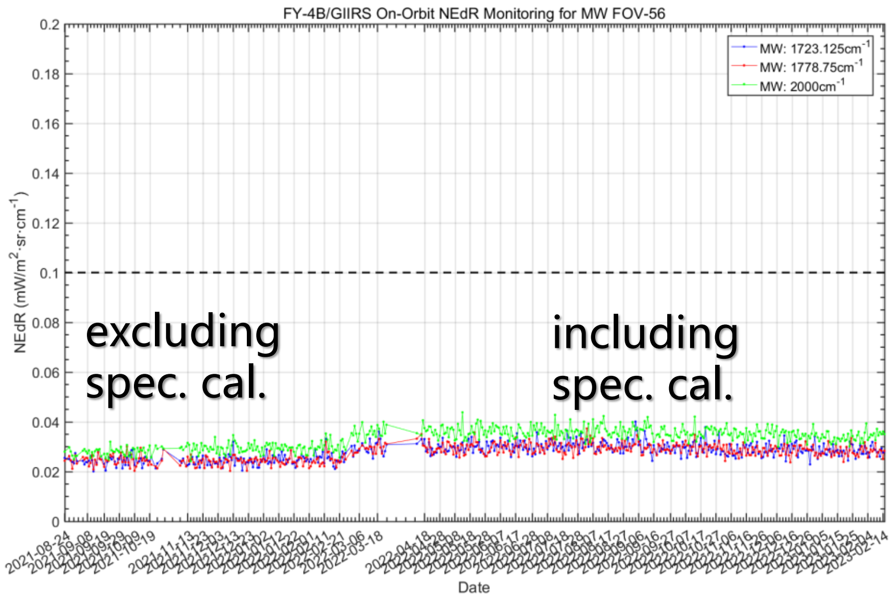


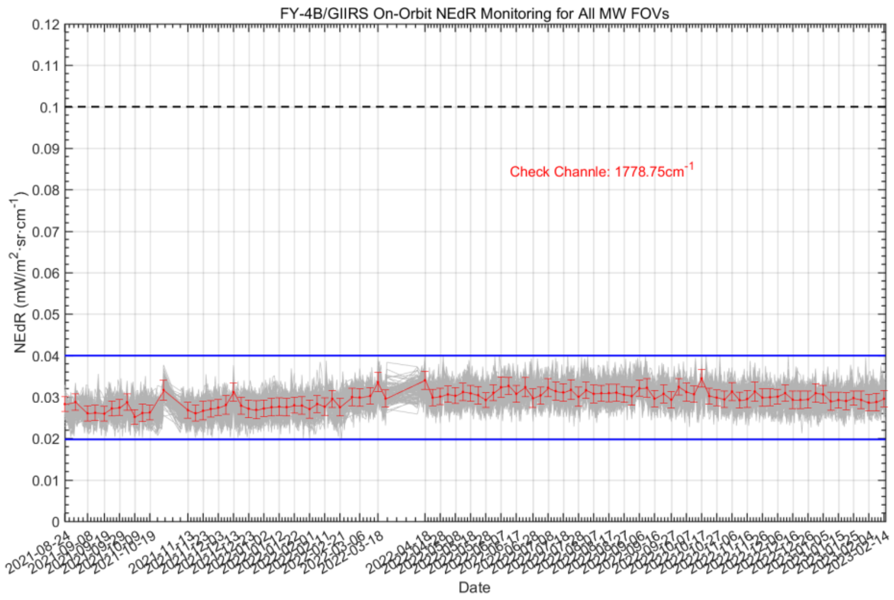


GIIRS meets the noise specification in all FOVs in both LWIR and MWIR band.





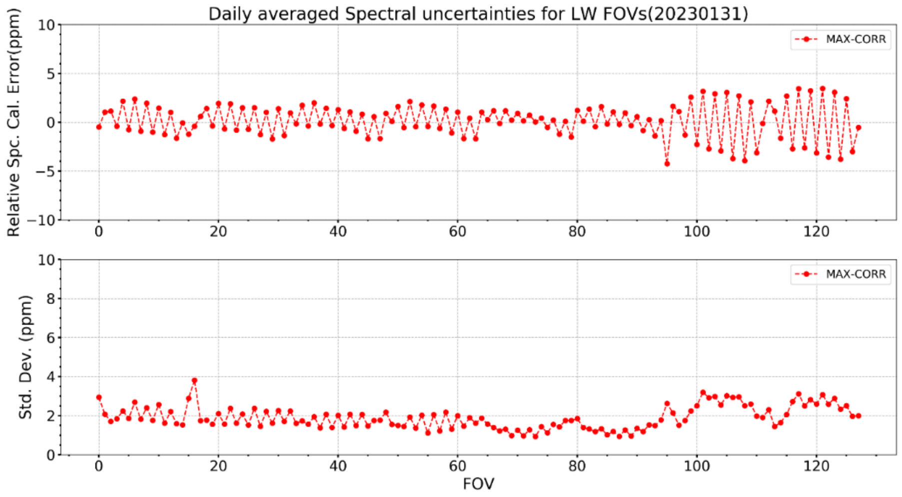


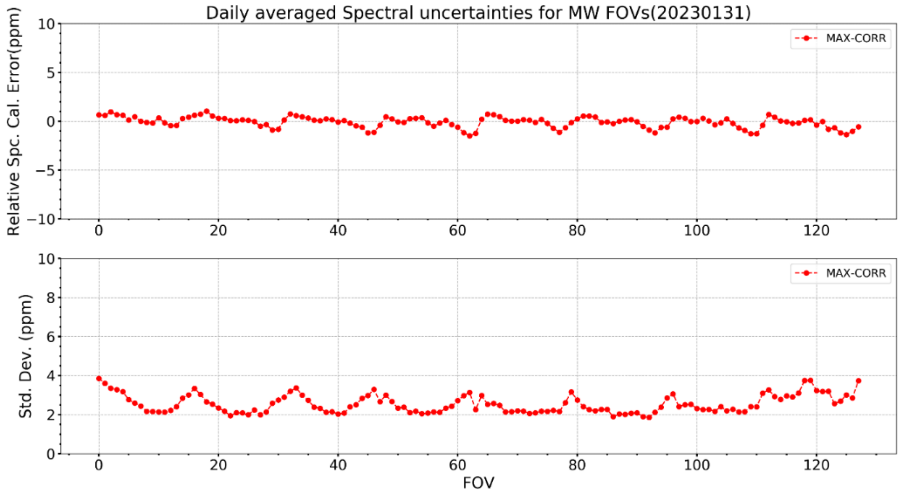


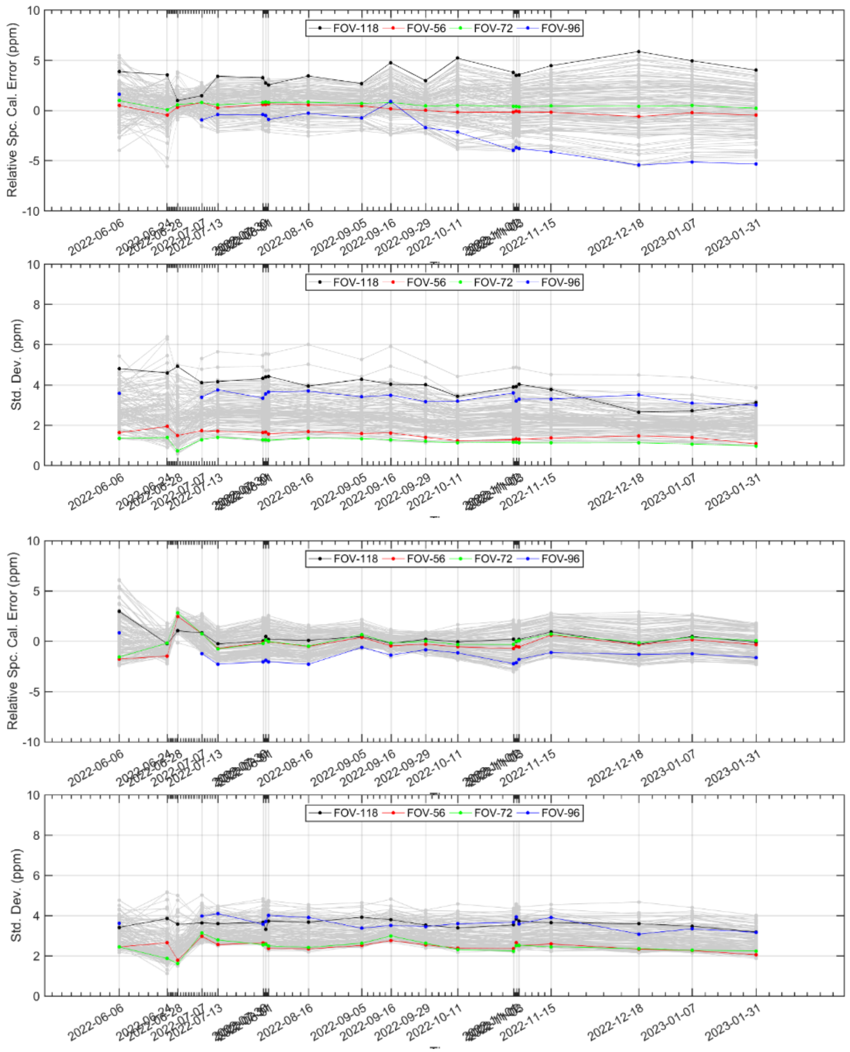
GIIRS NEdR trends in both bands were stable for more than 1.5 years after launch.

In LWIR, the NEdRs at FOV-4, 16, 17, 96 are large, but still meet the specification. That is a know issue before launch.

2.3 FY-4B/GIIRS spectral calibration status

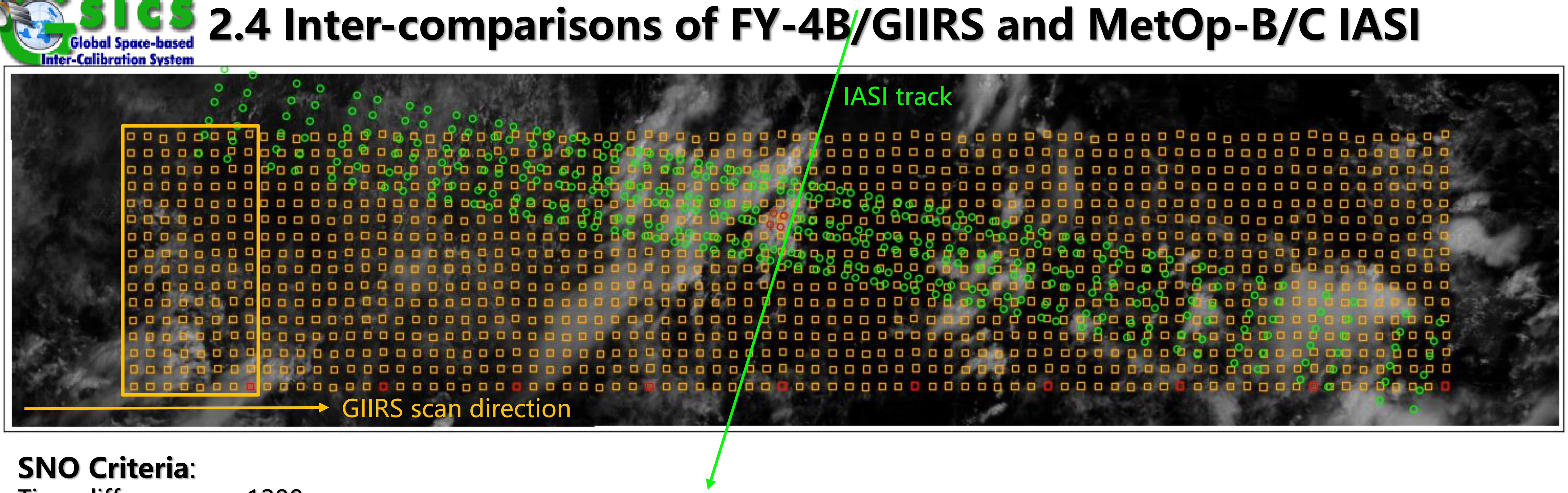






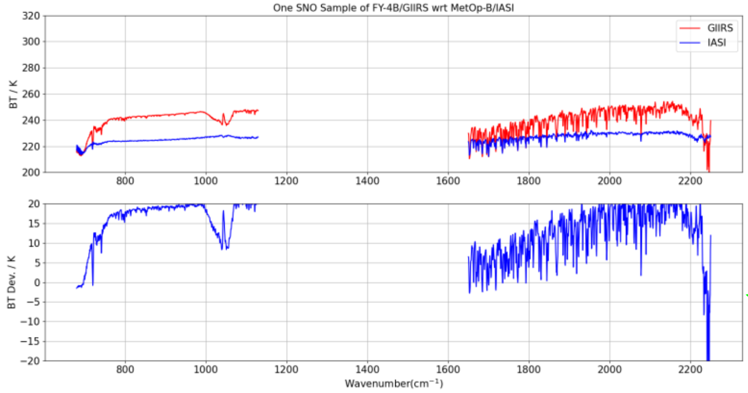
GIIRS spectral calibration with respect to LBLRTM simulated spectra for three bands are about 5 ppm in average (meet requirement of <7 ppm).

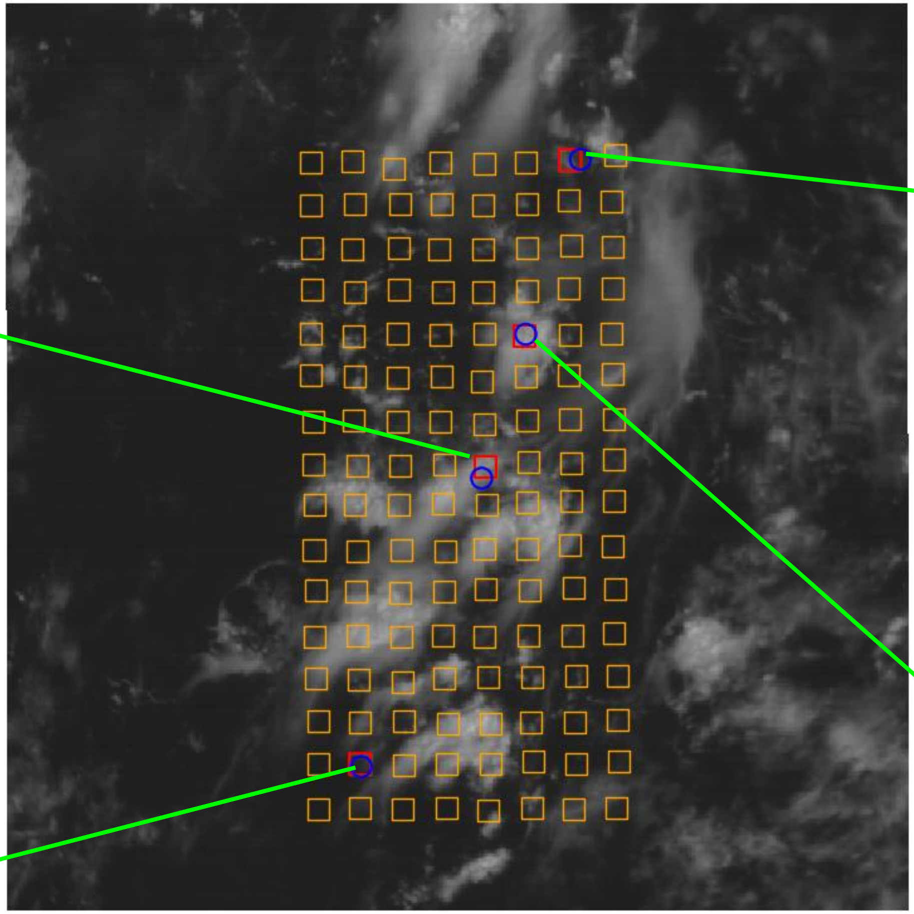
2.4 Inter-comparisons of FY-4B/GIIRS and MetOp-B/C IASI

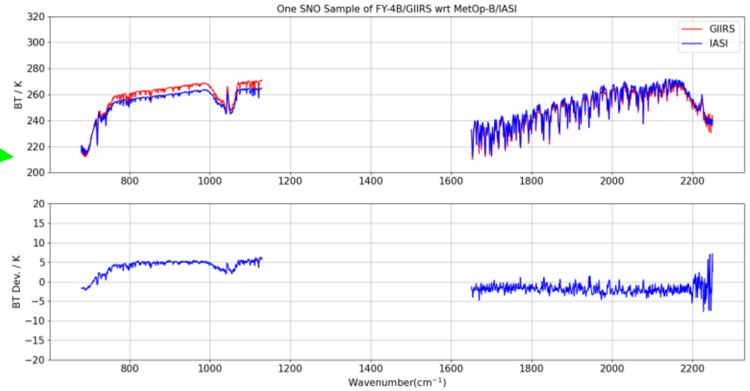


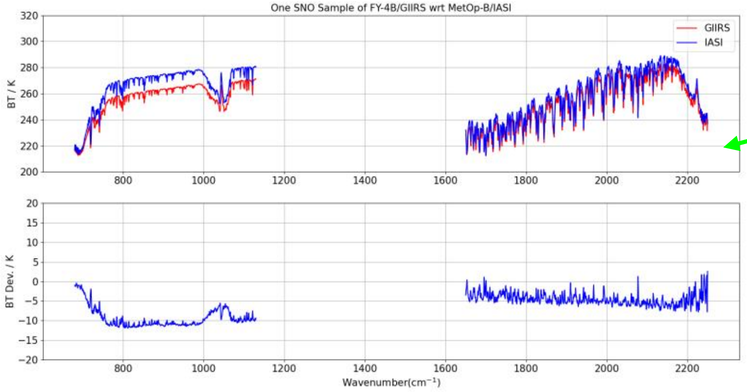
SNO Criteria:
Time difference: <=1200 s
Pixel distance: <=12 km
Zenith angle difference: abs[cos(zen1)/cos(zen2)-1]<=0.01
Scene homogeneity: in research

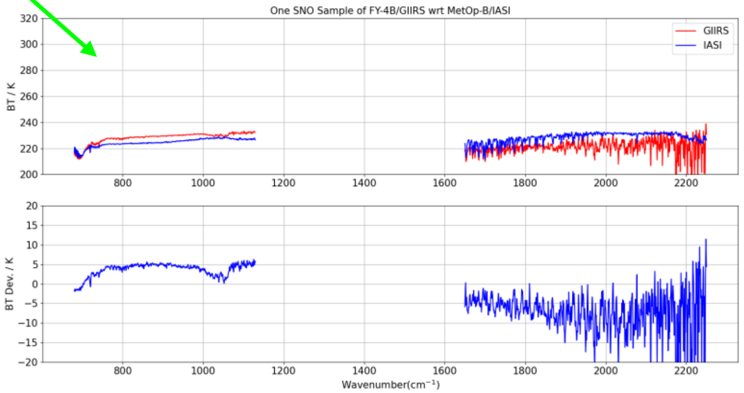
An example of a SNO event of FY-4B/GIIRS and MetOp-B/IASI at 02:10:40~02:12:24 UTC on Oct.1, 2022. The green circles indicate the IASI PNs and the yellow squares indicate the GIIRS FOVs (Row-10, FOV-007~016). The image of GIIRS visible light Integrated Imager is superimposed as the background. IASI track and GIIRS scan crossed each other at the region of South China Sea.







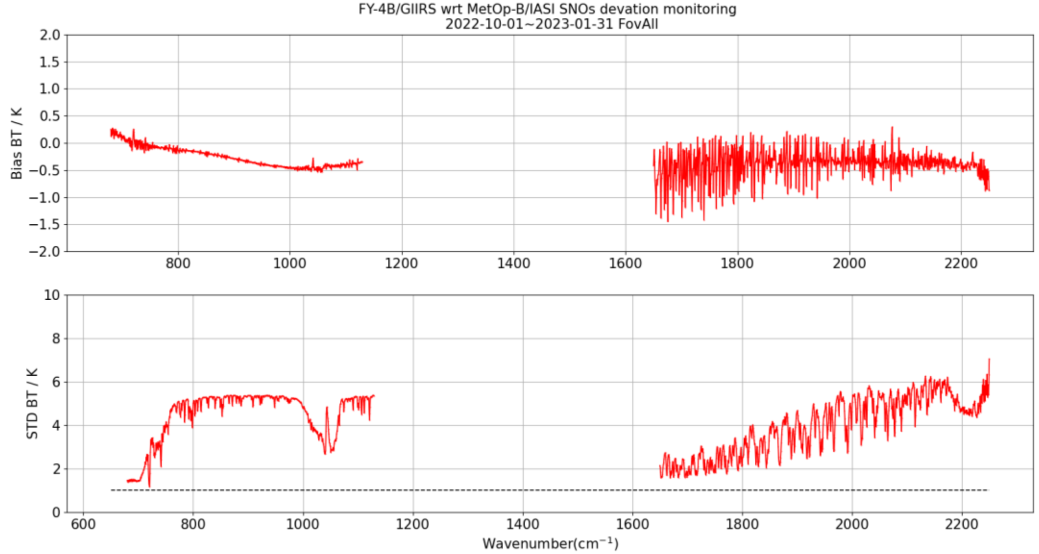


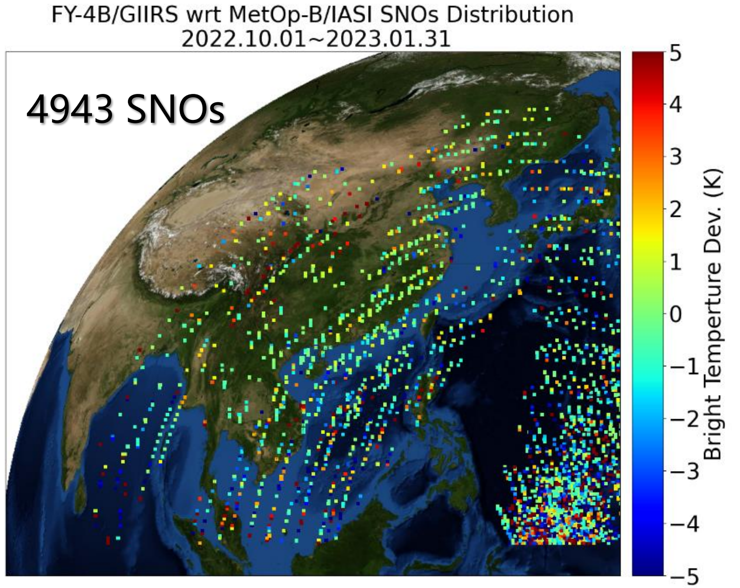


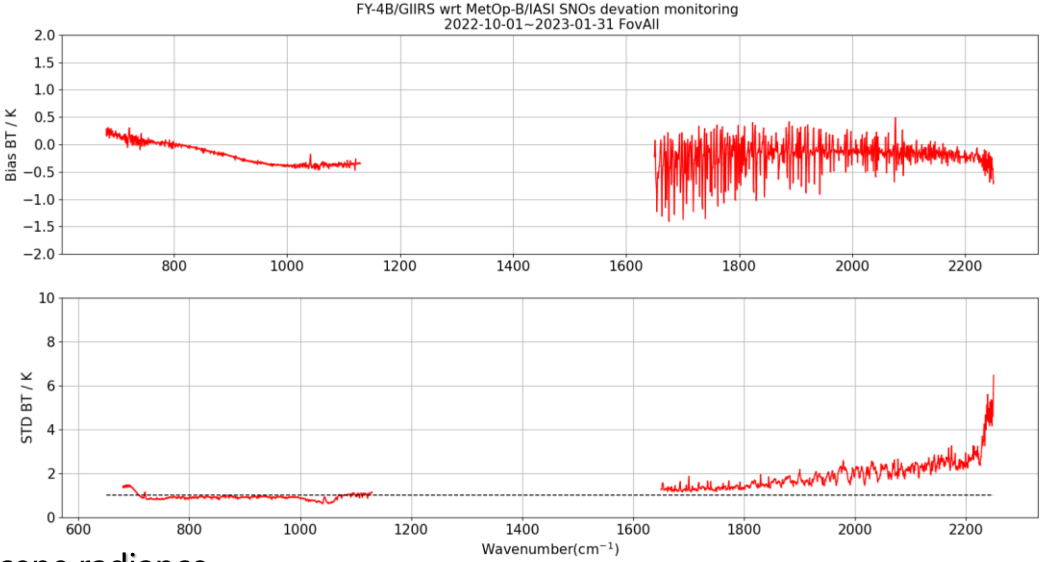
We try to filter out the SNOs over cloudy scenes in day-time using the images of the Integrated Imager.

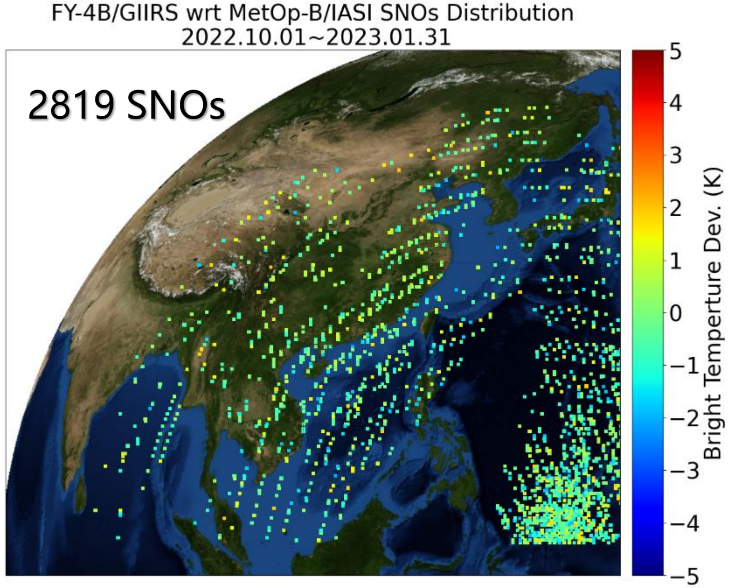
GIIRS/IASI SNO locations

For clear sky in day-time, GIIRS-IASI BT difference in LWIR band is about 0.5 K (std. dev. 1~2 K), while in water vapor absorption region of MWIR band is about 1 K. In N_2O region (2000~2250 cm^{-1}), the signal-to-noise ratio is too small, and the std. dev. has a sharp rise.

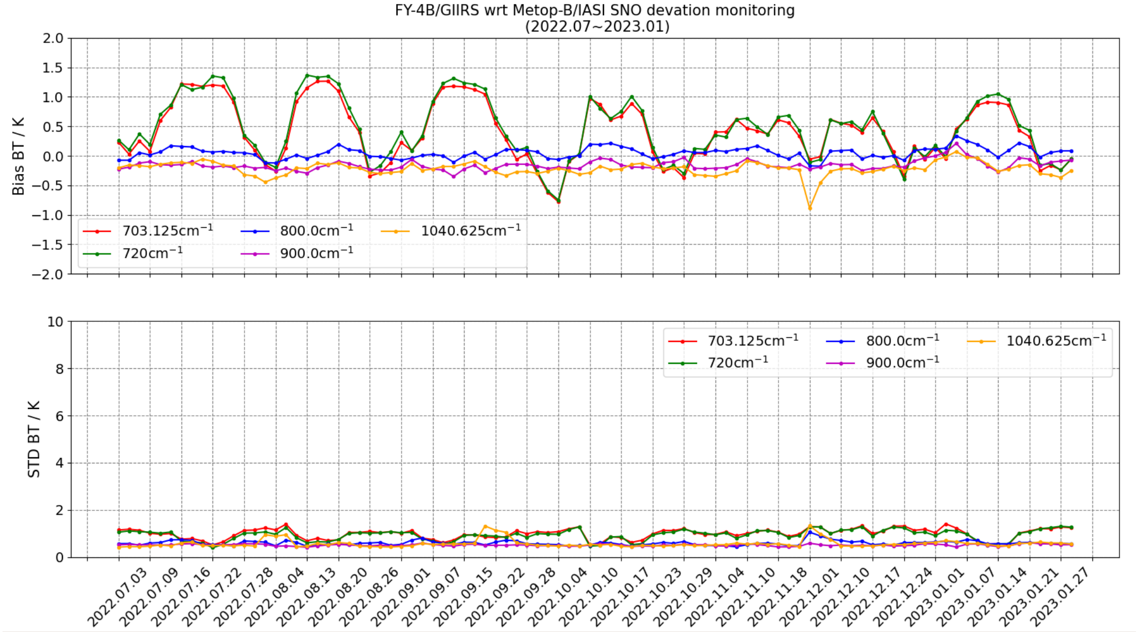


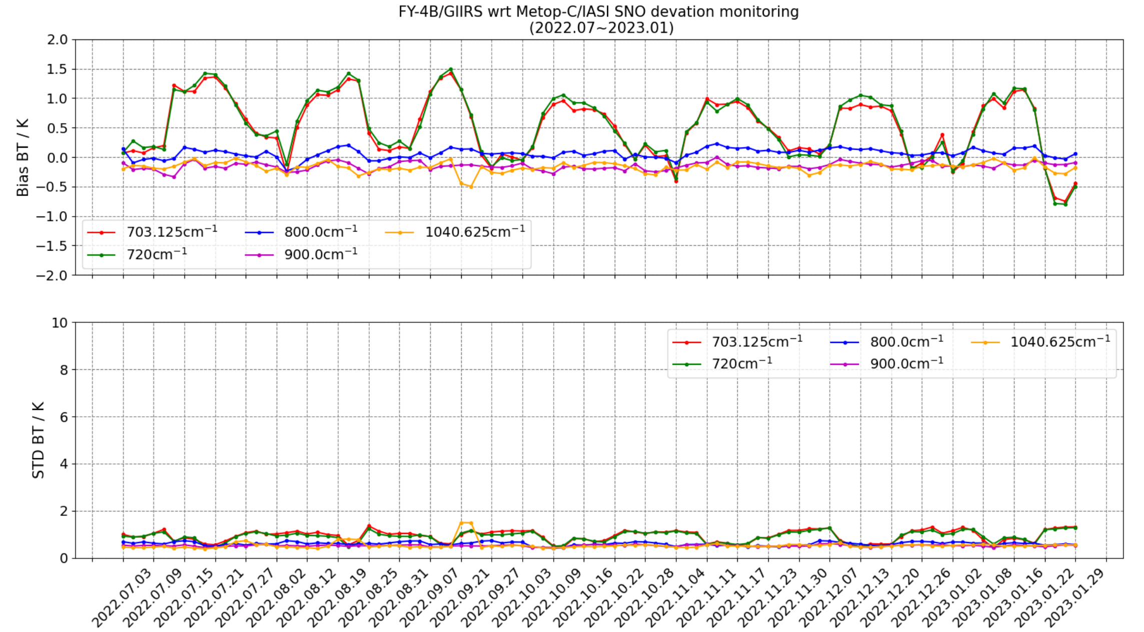






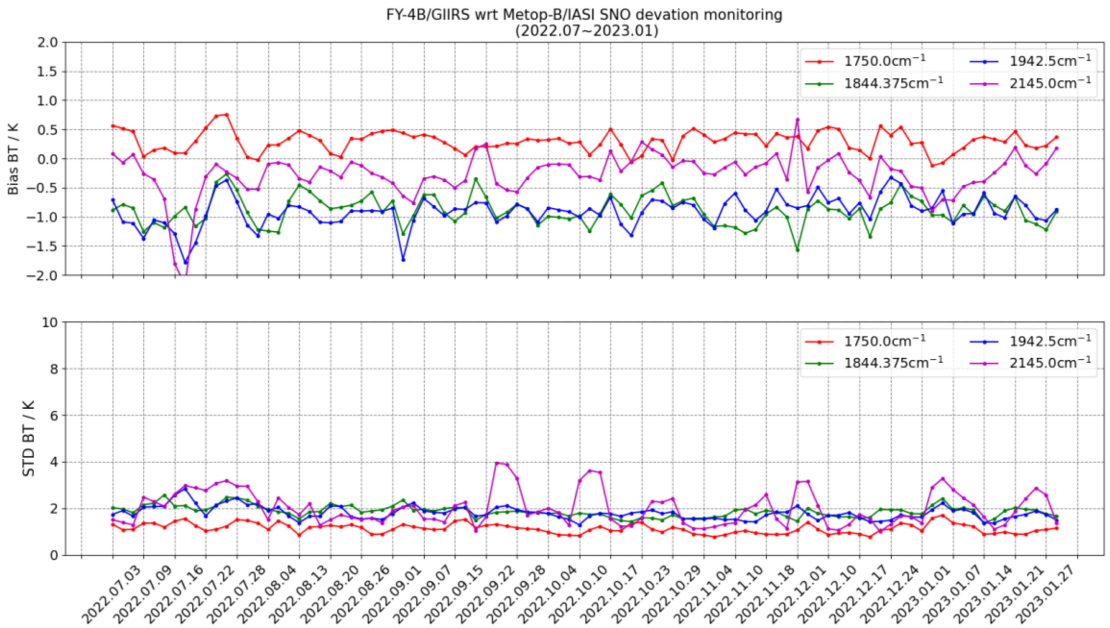
Hamming apodization, Conversion to BT at scene radiance

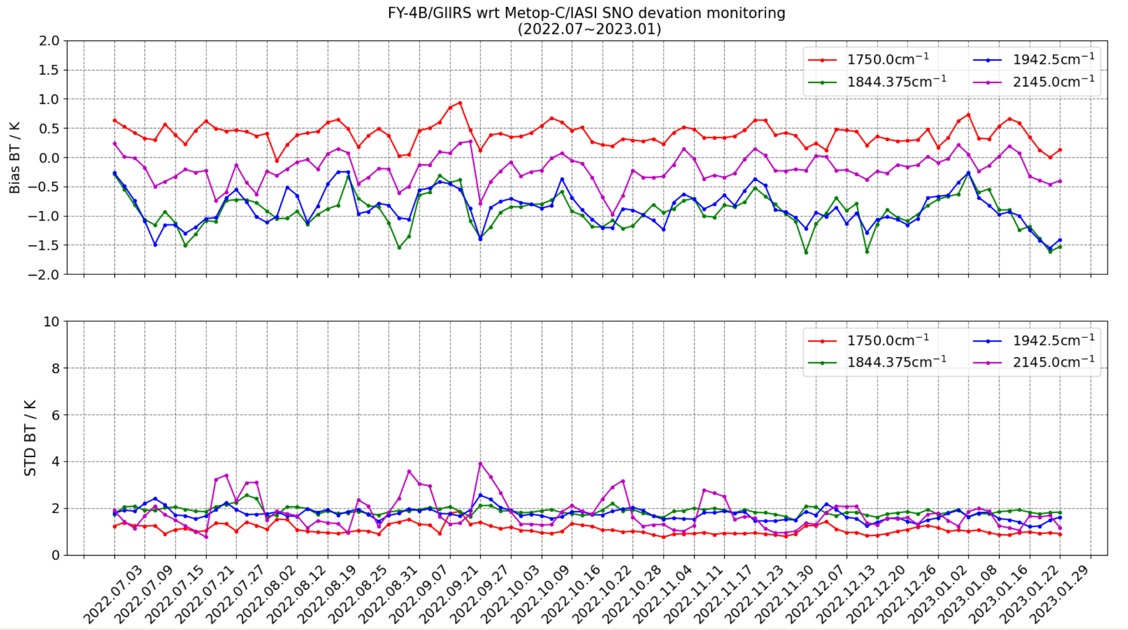




For GIIRS and IASI (B & C) inter-comparison, the LWIR BT difference results from GIIRS/IASI-B and GIIRS/IASI-C are consistent.

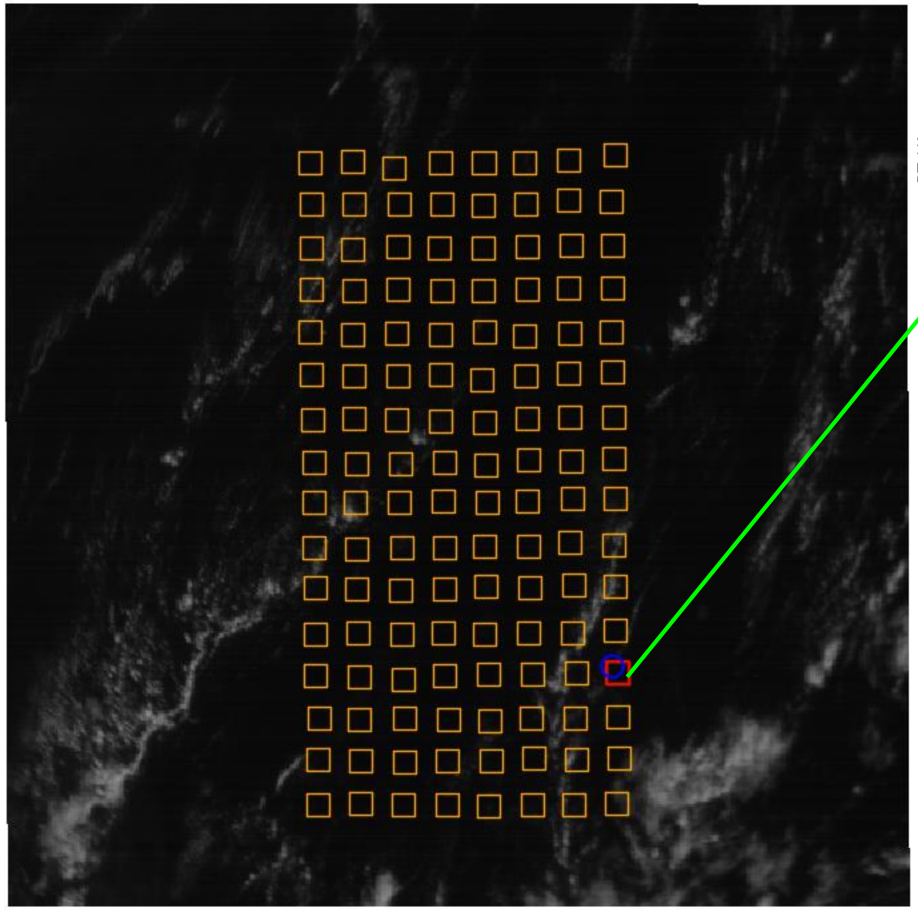
In CO_2 temperature channels (700~800 cm^{-1}), a monthly cycle (actually results from diel cycle) of BT difference is revealed from the 8 month monitoring.



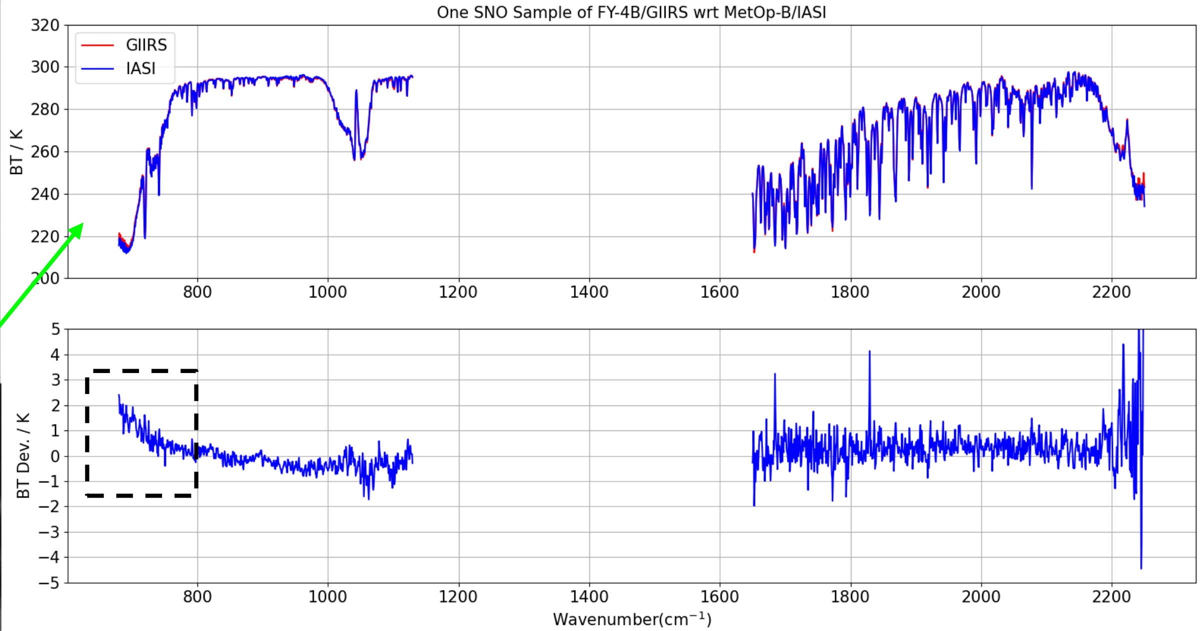


For GIIRS and IASI (B & C) inter-comparison, the MWIR BT difference results from GIIRS/IASI-B and GIIRS/IASI-C are consistent. No monthly cycle was observed in the MWIR channels.

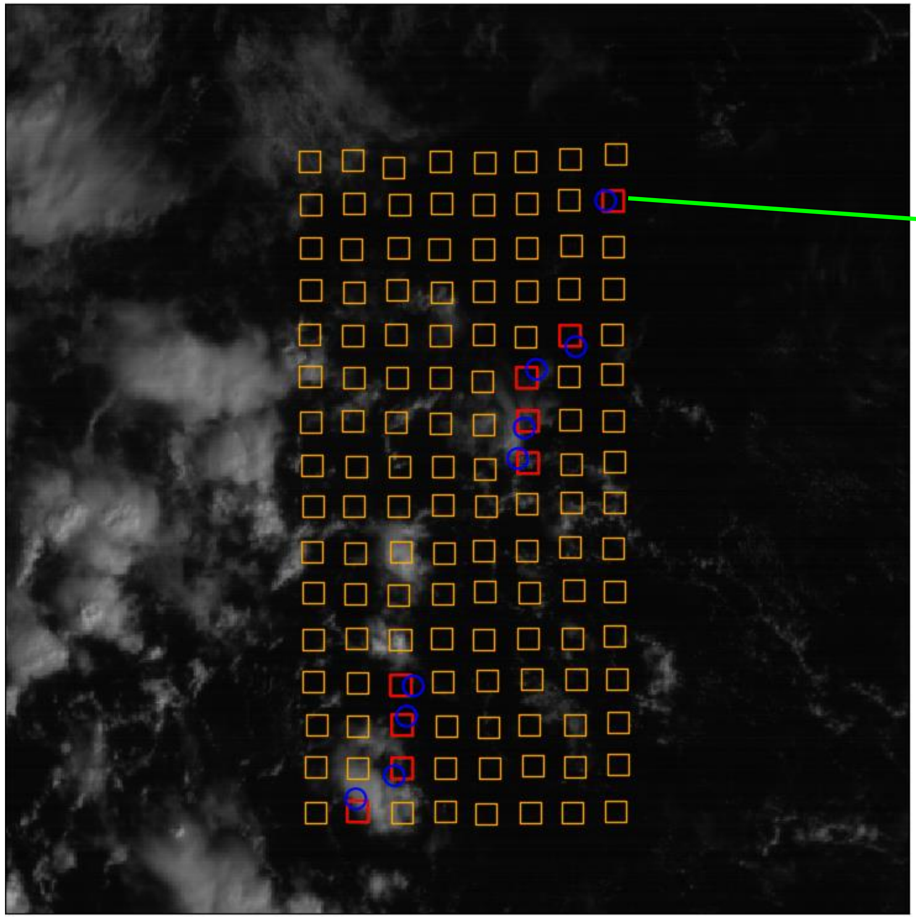
Monthly cycle of GIIRS-IASI BT difference in LWIR



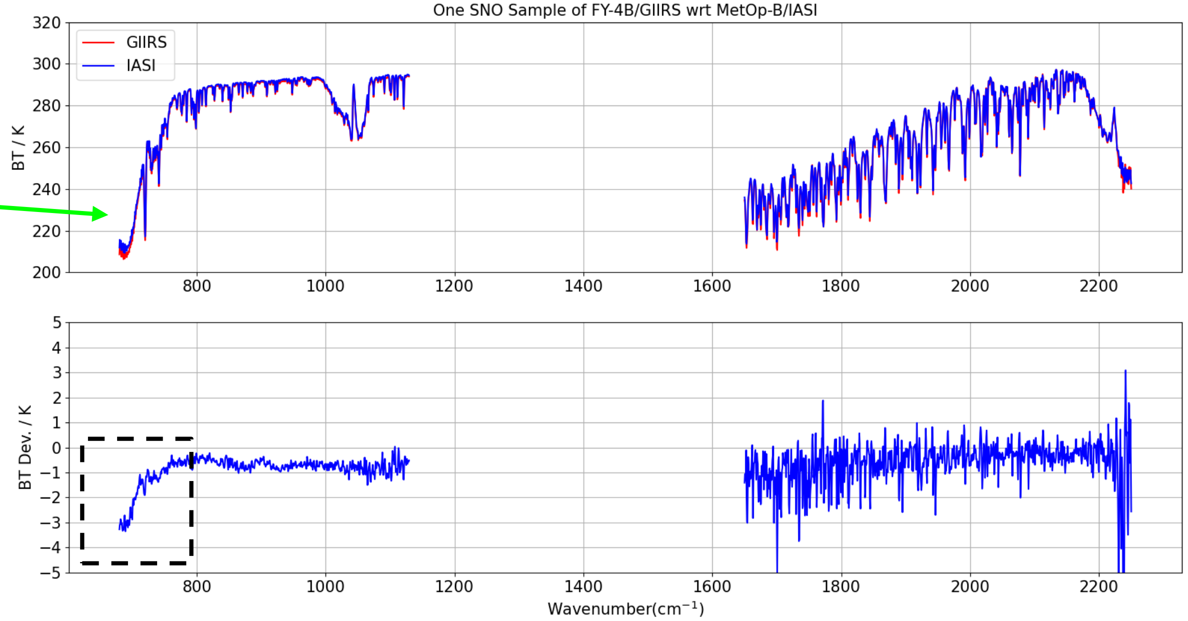
FOR-03 at 04:09:37 UTC on Jan.10, 2023



At noon time, the GIIRS is warmer than IASI in LWIR CO_2 region.



FOR-27 at 00:09:37 UTC on Jan.25, 2023



At morning time, the GIIRS is colder than IASI in LWIR CO_2 region.

Lee's opinion:
Thermal ambiance of geo-sounder & GIIRS calibration path.

GIFTS (R. Knuteson et. al., 2004~2006)
MTG/IRS (D. Lamarre, et. al. 2010~2011; D. Coppens, 2016~2017)

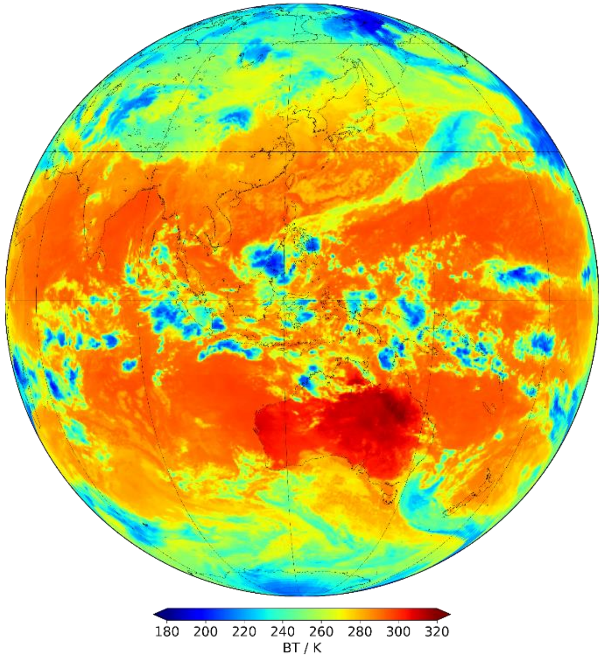
2.5 Summary

- The noise of FY-4B/GIIRS is stable for 1.5 years after launch.
- The spectral calibration with respect to LBLRTM is less than 10 ppm for both bands respectively.
- The radiometric calibration with respect to MetOp-B/C IASI is about 0.5 K in LWIR, 1 K in MWIR.
- The diel cycle or monthly cycle of LWIR radiometric calibration should be consider.

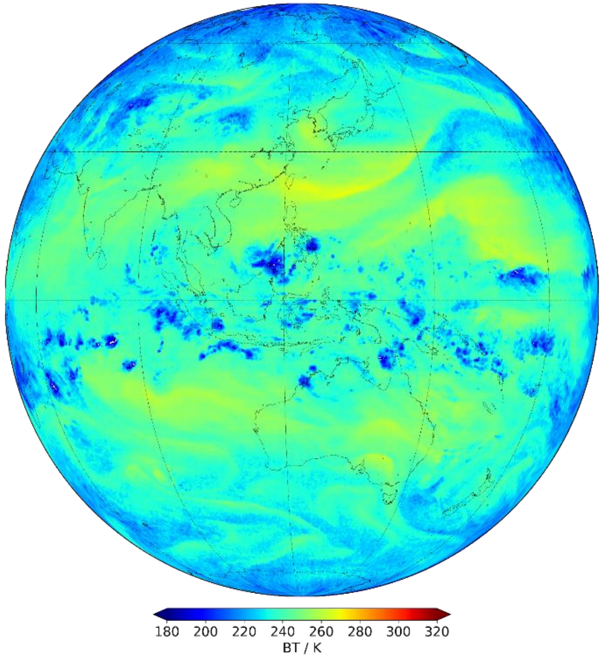
Chapter 3

FY-3/HIRAS and FY-4/GIIRS future plans

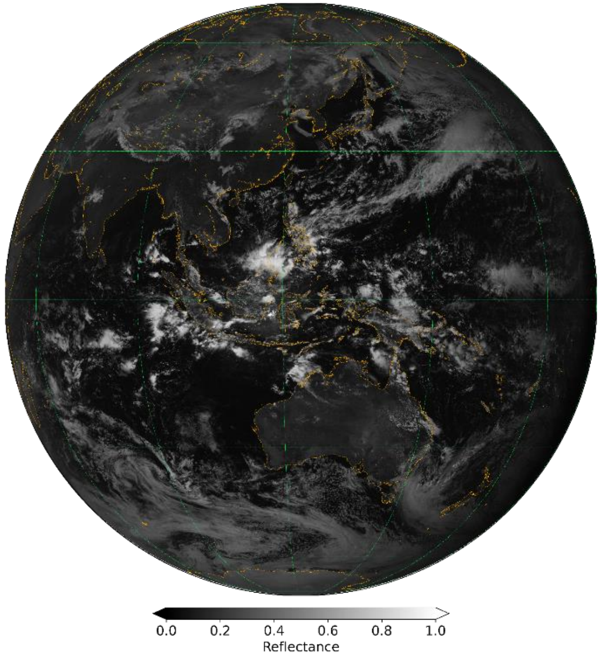
- FY-3F/HIRAS TVAC test has been completed, and is scheduled for launch in August 2023.
- FY-4C/GIIRS is in the design phase. It maybe still a sounder other than an imaging sounder.



900 cm^{-1}



1870 cm^{-1}



Visible

Full Earth disk observed by FY4B-GIIRS in 2022/03/09.