On-orbit characteristics monitoring and analysis of Fengyun-4 AGRI infrared channels

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Presentation Overview

- Brief introduction of FY-4 AGRI
- AGRI On-board performance status
- Calibration accuracy assessment result
- Summary

Brief introduction of FY-4

Fengyun-4 is the second generation of geostationary orbit meteorological satellite in China. The scientific Research and test satellite (FY-4A) was successfully launched on December 11, 2016, and has realized the upgrading of the technical system. FY-4B is an operational satellite and it was launched successfully on June 3, 2021. It was designed to be the first operational satellite of the FY-4 series, and was successfully located at 123.5°E on June 10, 2021, and relocated to 133°E on April 11, 2022, for operational service.

In order to improve the application benefits of satellites, FY-4B is based on scientific research and test satellites, and has been adjusted mainly in terms of payload deployment and performance improvement

The primary payloads onboard FY-4B are Advanced Geostationary Radiation Imager (AGRI), Geostationary Interferometric Infrared Sounder (GIIRS), and Geosynchronous High-speed Imager (GHI) and Space Environment Monitoring Instrument Package (SEP). The main observation capabilities are similar to those of FY-4A, with some significant performance improvements.

AGRI On-board Performance Status

Comparison between FY-4A/AGRI and FY-4B/AGRI

Characteristics of FY4A/AGRI

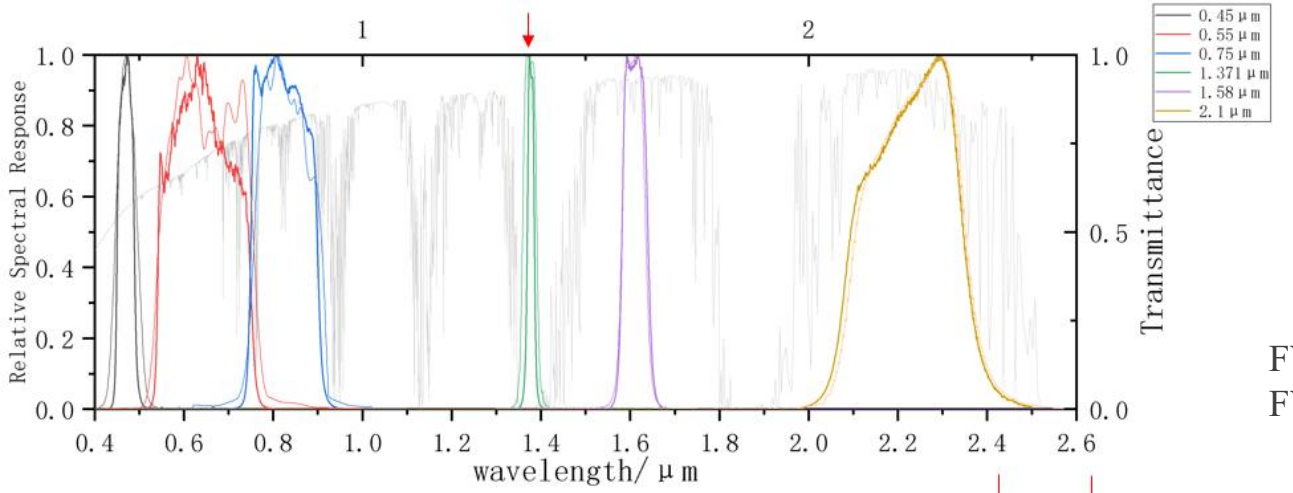
Type	Channel /Band	Range(μm)	Spatial resolution(km)）	Sensitivity/SNR		Primary purpose
Visible & Near-Infrared	1	0.45～0.49	1	S/N≥90 (ρ=100%)		Aerosol
	2	0.55～0.75	0.5～1	S/N≥150 (ρ=100%) @0.5Km	S/N≥3 (ρ=1%) @1Km	Fog, cloud
	3	0.75～0.90	1	S/N≥200 (ρ=100%)	S/N≥3 (ρ=1%)	Vegetation
Short-wave Infrared	4	1.36～1.39	2	S/N≥150 (ρ=100%)	S/N≥3 (ρ=1%)	Cirrus
	5	1.58～1.64	2	S/N≥200 (ρ=100%)	S/N≥3 (ρ=1%)	Cloud, snow
	6	2.1～2.35	2～4	S/N≥200 (ρ=100%)	S/N≥3 (ρ=1%)	Cirrus, aerosol
Mid-wave Infrared	7	3.5～4.0(high)	2	NEΔT≤0.7K (300K)		Fire
	8	3.5～4.0(low)	4	NEΔT≤0.2K (300K)	NEΔT≤2K (240K)	Land surface
Water vapor	9	5.8～6.7	4	NEΔT≤0.2K (300K)	NEΔT≤0.9K (240K)	High level water vapor
	10	6.9～7.3	4	NEΔT≤0.25K (300K)	NEΔT≤0.9K (240K)	Middle level water vapor
Long-wave Infrared	11	8.0～9.0	4	NEΔT≤0.2K (300K)	NEΔT≤0.4K (240K)	Water vapor, cloud
	12	10.3～11.3	4	NEΔT≤0.2K (300K)	NEΔT≤0.4K (240K)	Surface temperature
	13	11.5～12.5	4	NEΔT≤0.2K (300K)	NEΔT≤0.4K (240K)	Surface temperature
	14	13.2～13.8	4	NEΔT≤0.5K (300K)	NEΔT≤0.9K (240K)	Cloud thickness

Characteristics of FY4B/AGRI

Channel/ Band	Center wave length (μm)	Range(μm)	Spatial resolution(km)	Sensitivity/SNR		Primary purpose
1	0.47	0.45~0.49	1	S/N≥90(ρ=100%)		Aerosol
2	0.65	0.55~0.75	0.5	S/N≥150(ρ=100%)@0.5km	S/N≥3(ρ=1%) @1km	Fog, cloud
3	0.825	0.75~0.90	1	S/N≥200(ρ=100%)	S/N≥3(ρ=1%)	Vegetation
4	1.379	1.371~1.386	2	S/N≥120(ρ=100%)	S/N≥2(ρ=1%)	Cirrus
5	1.61	1.58~1.64	2	S/N≥200(ρ=100%)	S/N≥3(ρ=1%)	Cloud, snow
6	2.225	2.10~2.35	2	S/N≥200(ρ=100%)	S/N≥2(ρ=1%)	Cirrus, aerosol
7	3.75	3.50~4.00(high)	2	≤0.7K(315K)		Fire
8	3.75	3.50~4.00(low)	4	0.2K(300K)	2K(240K)	Land surface
9	6.25	5.80~6.70	4	0.2K(300K)	0.9K(240K)	High level water vapor
10	6.95	6.75~7.15	4	0.25K(300K)	0.9K(240K)	Mid level water vapor
11	7.42	7.24~7.60	4	0.25K(300K)	0.9K(240K)	Low level water vapor
12	8.55	8.3~8.8	4	0.2K(300K)	0.4K(240K)	Cloud
13	10.80	10.30~11.30	4	0.2K(300K)	0.4K(240K)	Surface temperature
14	12.00	11.50~12.50	4	0.2K(300K)	0.4K(240K)	Surface temperature
15	13.3	13.00~13.60	4	0.5K(300K)	0.9K(240K)	Cloud thickness

AGRI On-board Performance Status

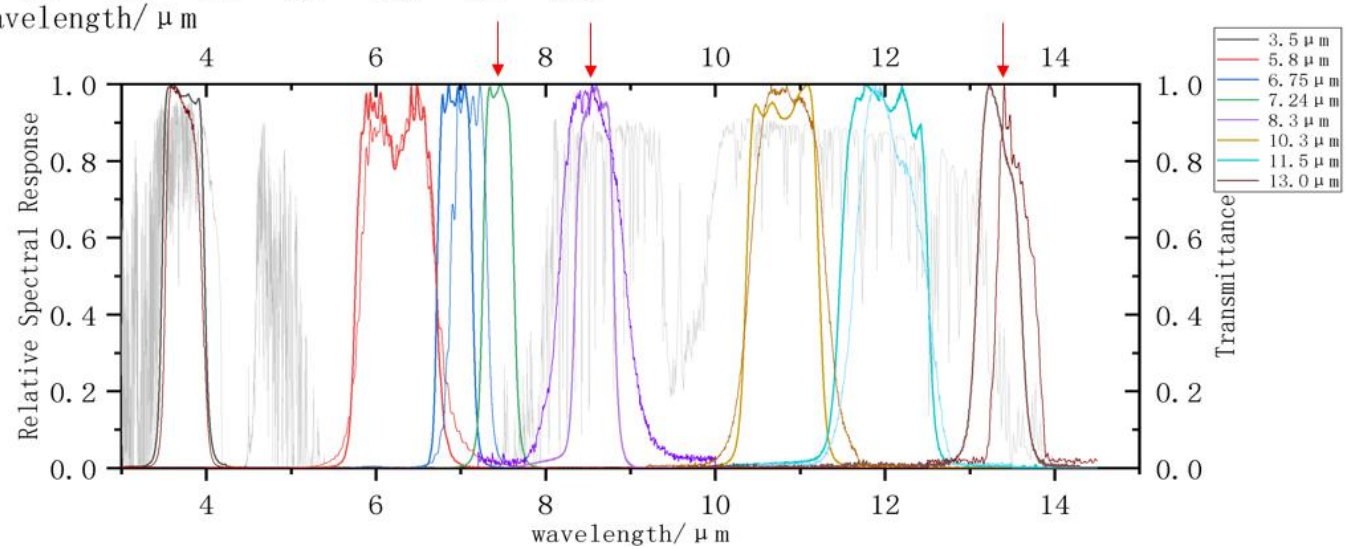
The Spectral Response Function Curve of FY-4A/B AGRI



FY-4A/AGRI Thin line
FY-4B/AGRI **Thick line**

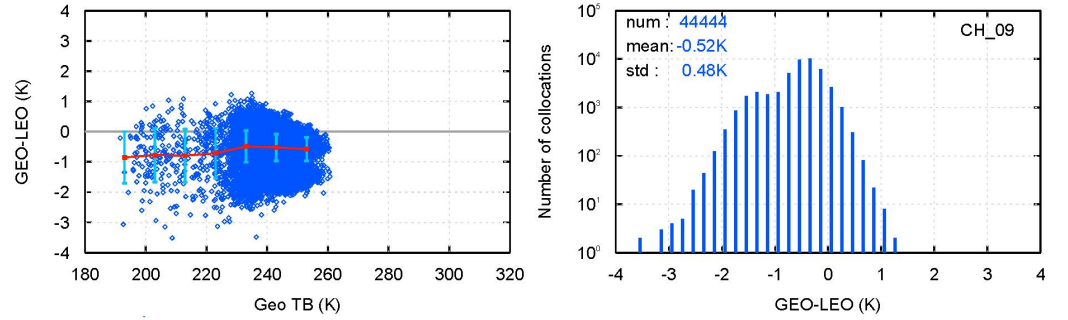
Compared with FY-4A/AGRI, four channels have been optimized and adjusted in FY-4B/AGRI .

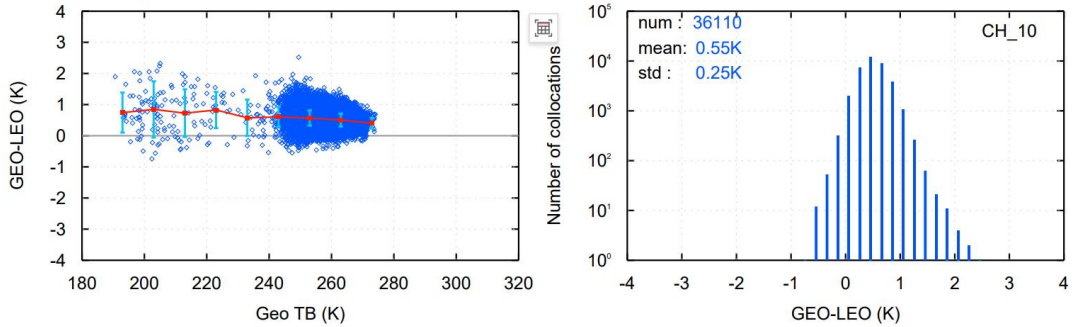
optimized bands:CH_04\10\12\15
addede band:CH_12

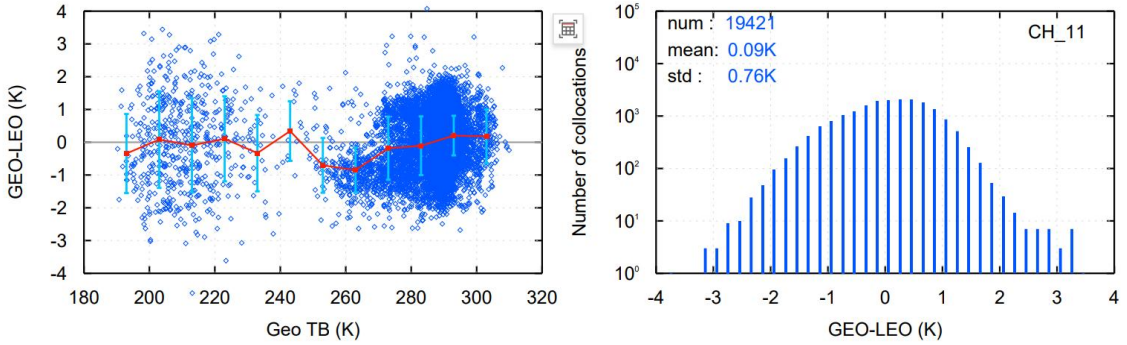


Calibration accuracy_TB bias

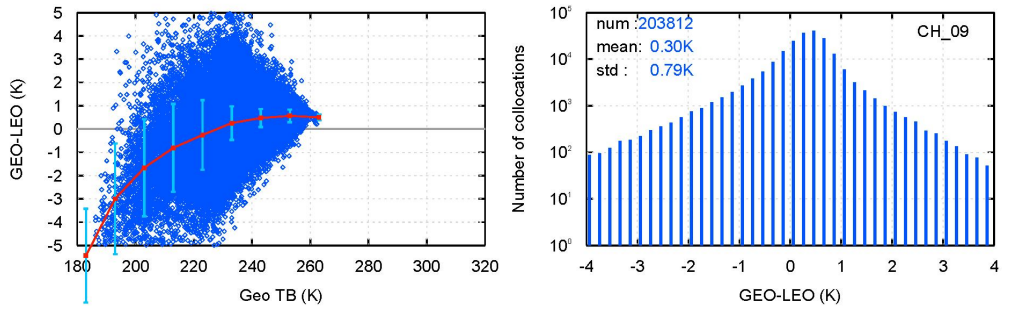
FY-4A

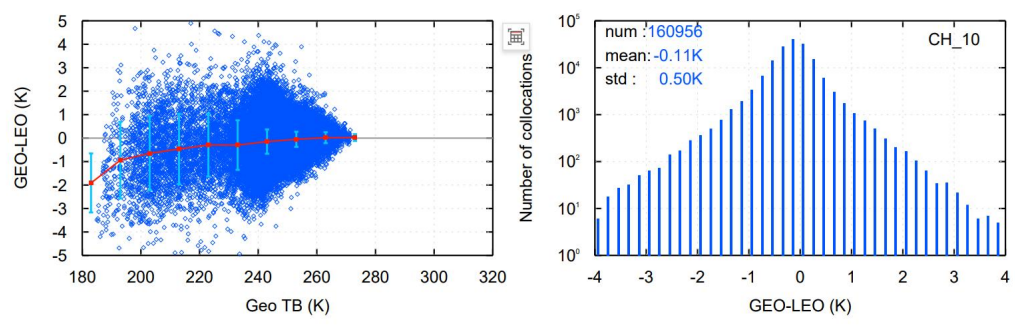


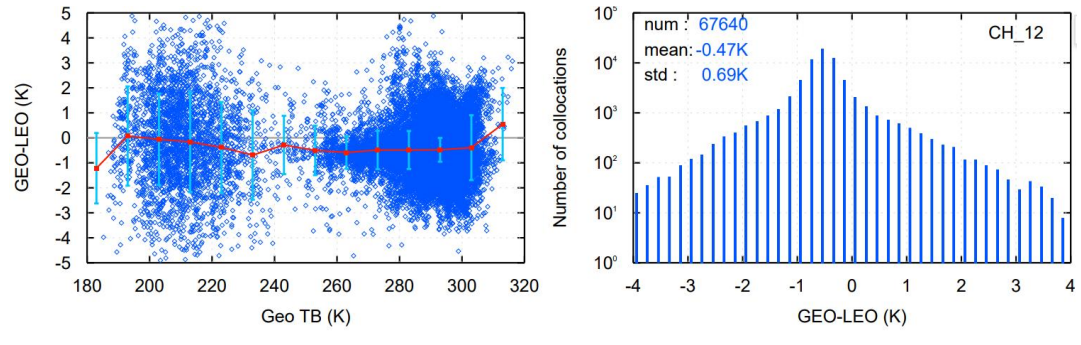




FY-4B







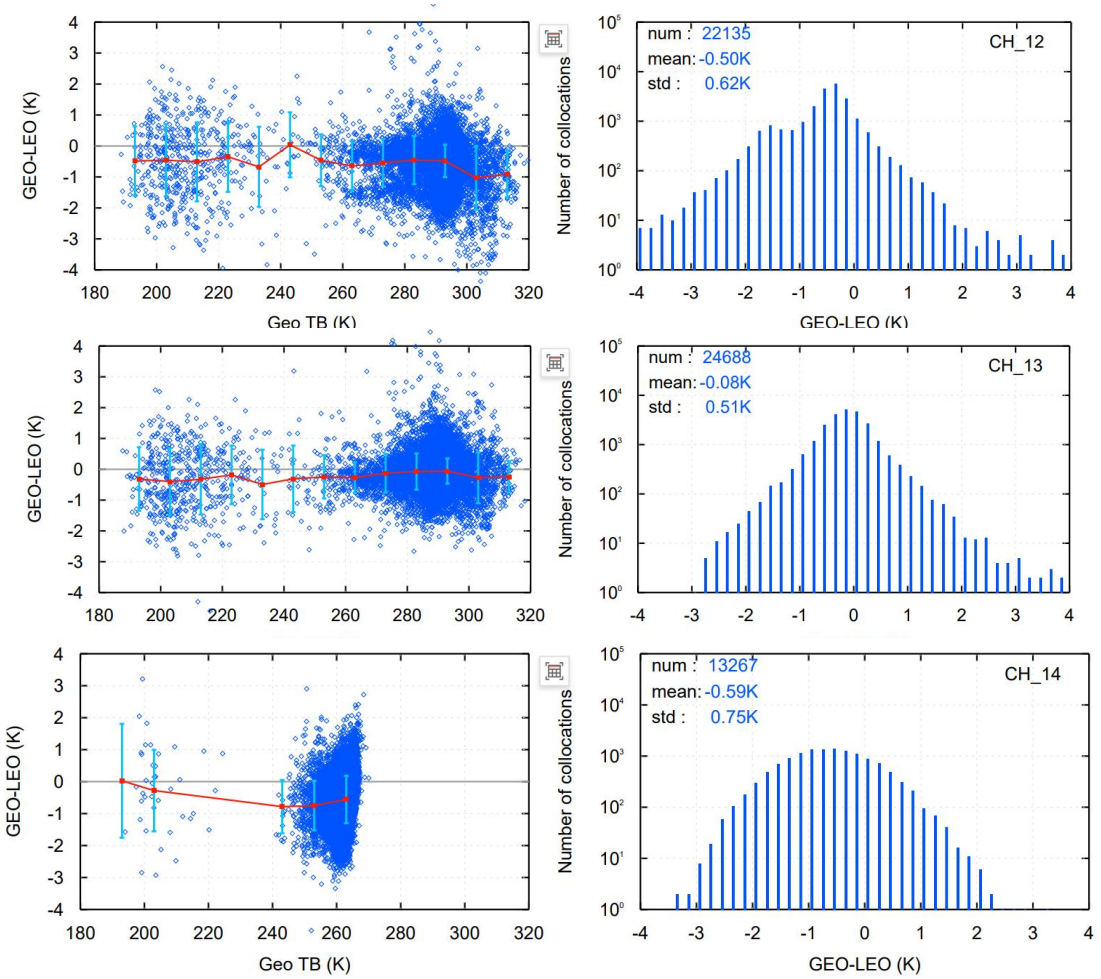
6.25μm

6.95μm

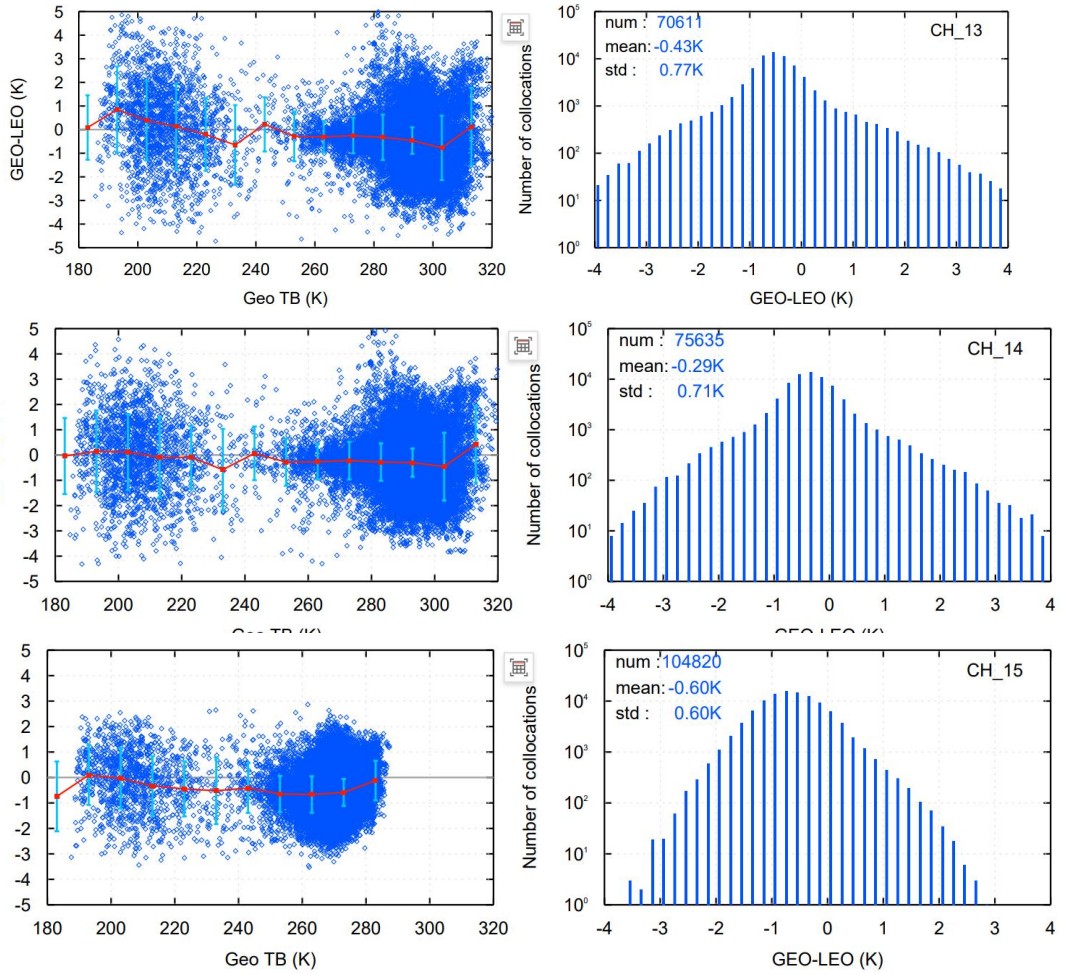
8.55μm

Calibration accuracy_TB bias

FY-4A



FY-4B



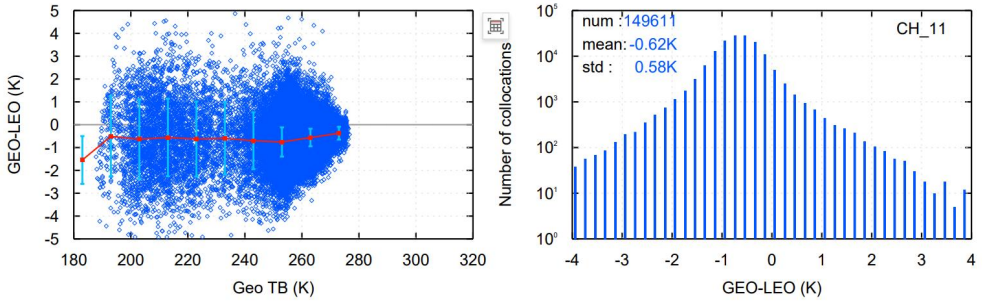
10.8μm

12.0μm

13.5μm

Calibration accuracy_TB bias

FY-4B

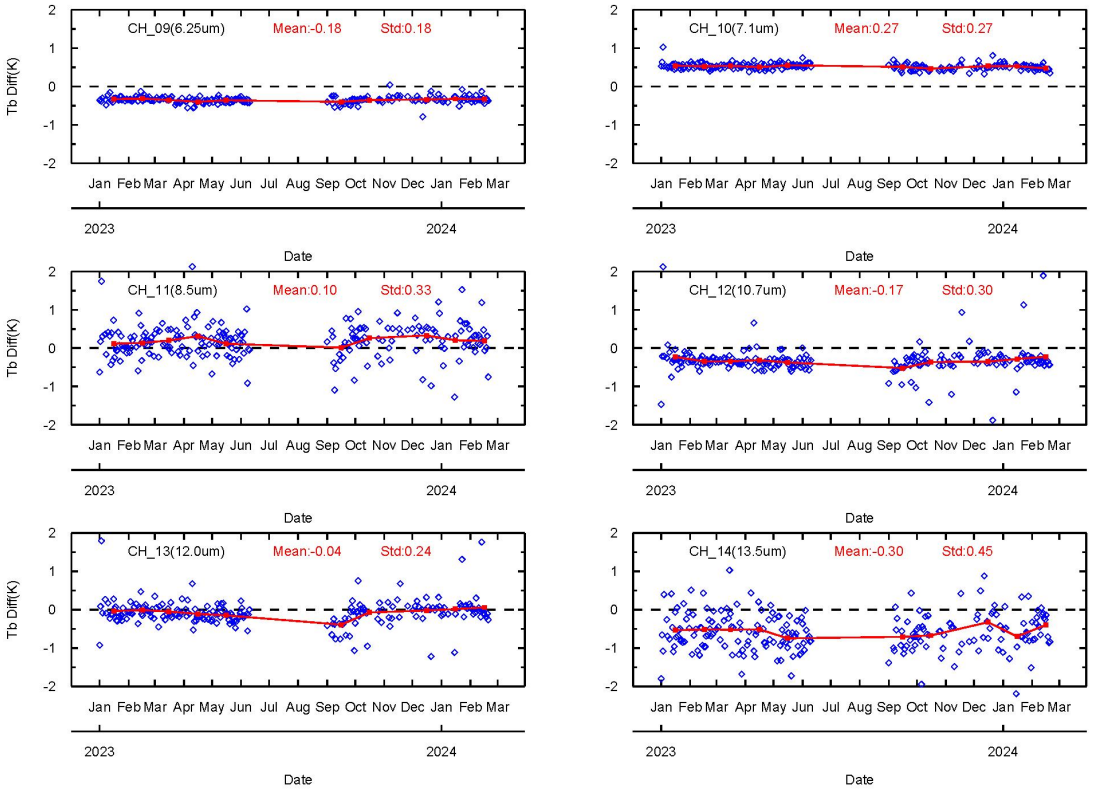


7.42μm

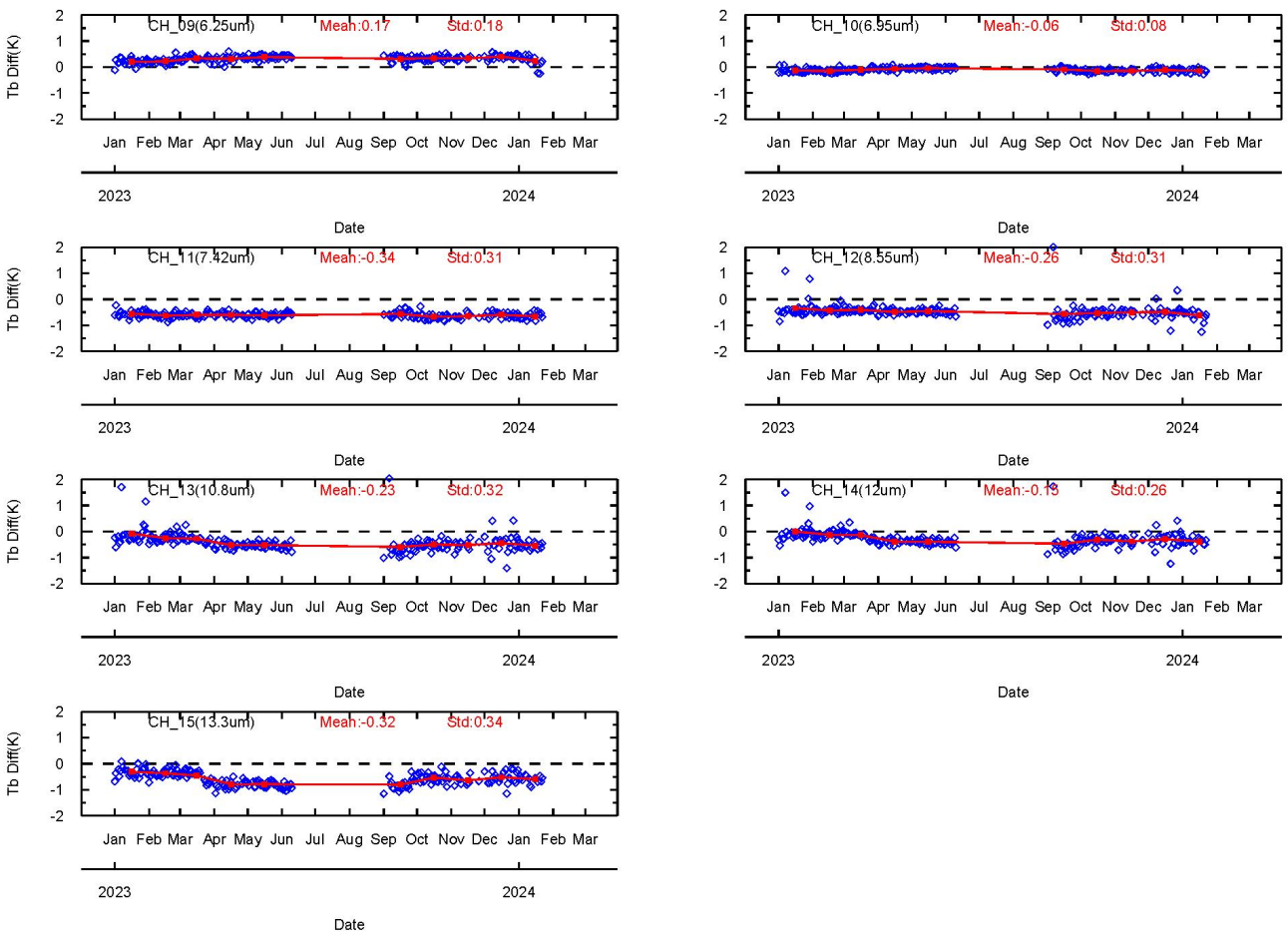
- For 09\10, TB bias depends on the target temperature; it is smaller and more stable for higher Tb and increased for lower Tb. Othe Channels, the variation of bias with TB is not obvious.
- The Tb of AGRI is lower than that of IASI in most channels, and the Tb bias is negative.
- The band dynamic range of FY-4B is larger, and the number of samples is more than 4A

Long-term time series of bias

4A:2023.01.01-2024.02.20



4B :2023.01.01-2024.01.22



IASI data was not obtained in July and August, so there is no result.

Long-term time series of bias

satellite	Channel 4B	CH_09 (6.25μm)	CH_10 (6.95μm)	CH_11 (7.42μm)	CH_12(8.55μm)	CH_13 (10.8μm)	CH_14 (12μm)	CH_15 (13.3μm)
4B	Bias/K	0.17	-0.06	-0.34	-0.26	-0.23	-0.13	-0.32
	Std/K	0.18	0.08	0.31	0.31	0.32	0.26	0.34
	Channel 4A	**CH_09 (6.25μm)**		**CH_10 (7.1μm)**	**CH_11 (8.5μm)**	**CH_12 (10.7μm)**	**CH_13 (12.0μm)**	**CH_14 (13.5μm)**
4A	Bias/K	-0.18		0.27	0.1	-0.17	-0.04	-0.3
	Std/K	0.18		0.27	0.33	0.3	0.24	0.45

4A:

Tb bias are less than 0.3K for all chanels.

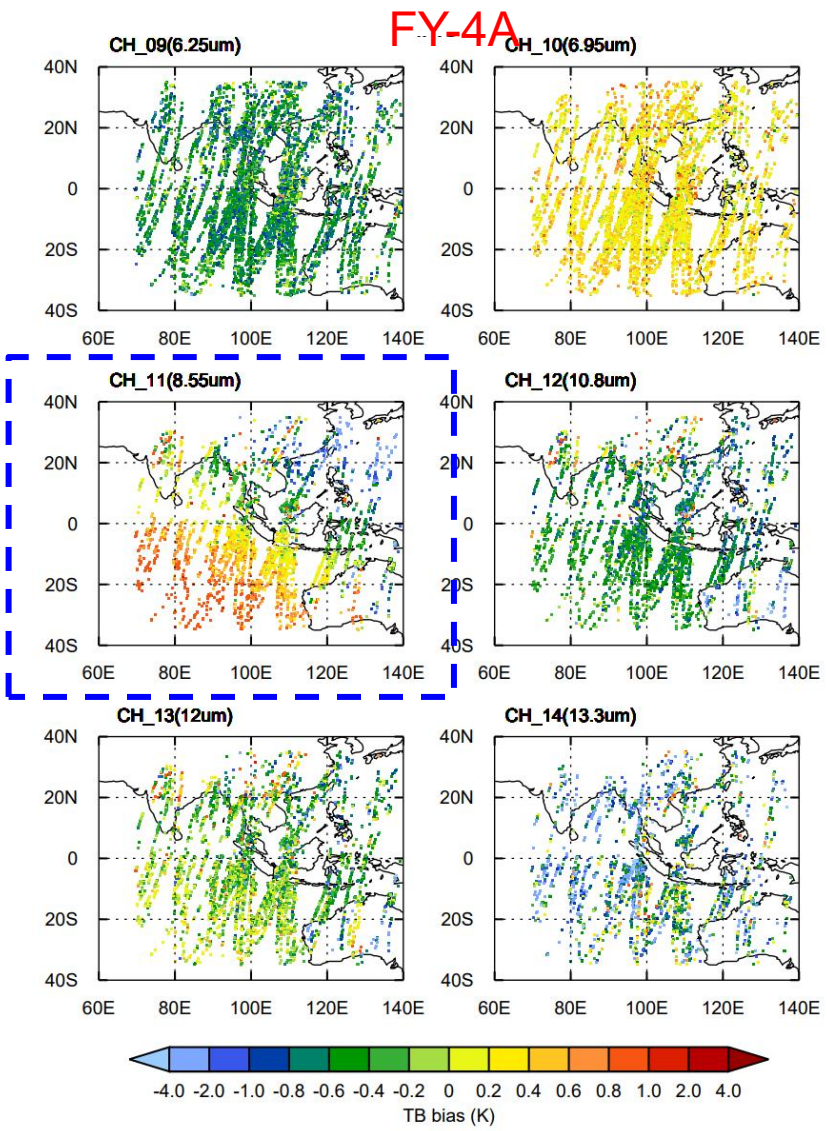
The time sequence of TB bias of CH_11\14 are not stable.

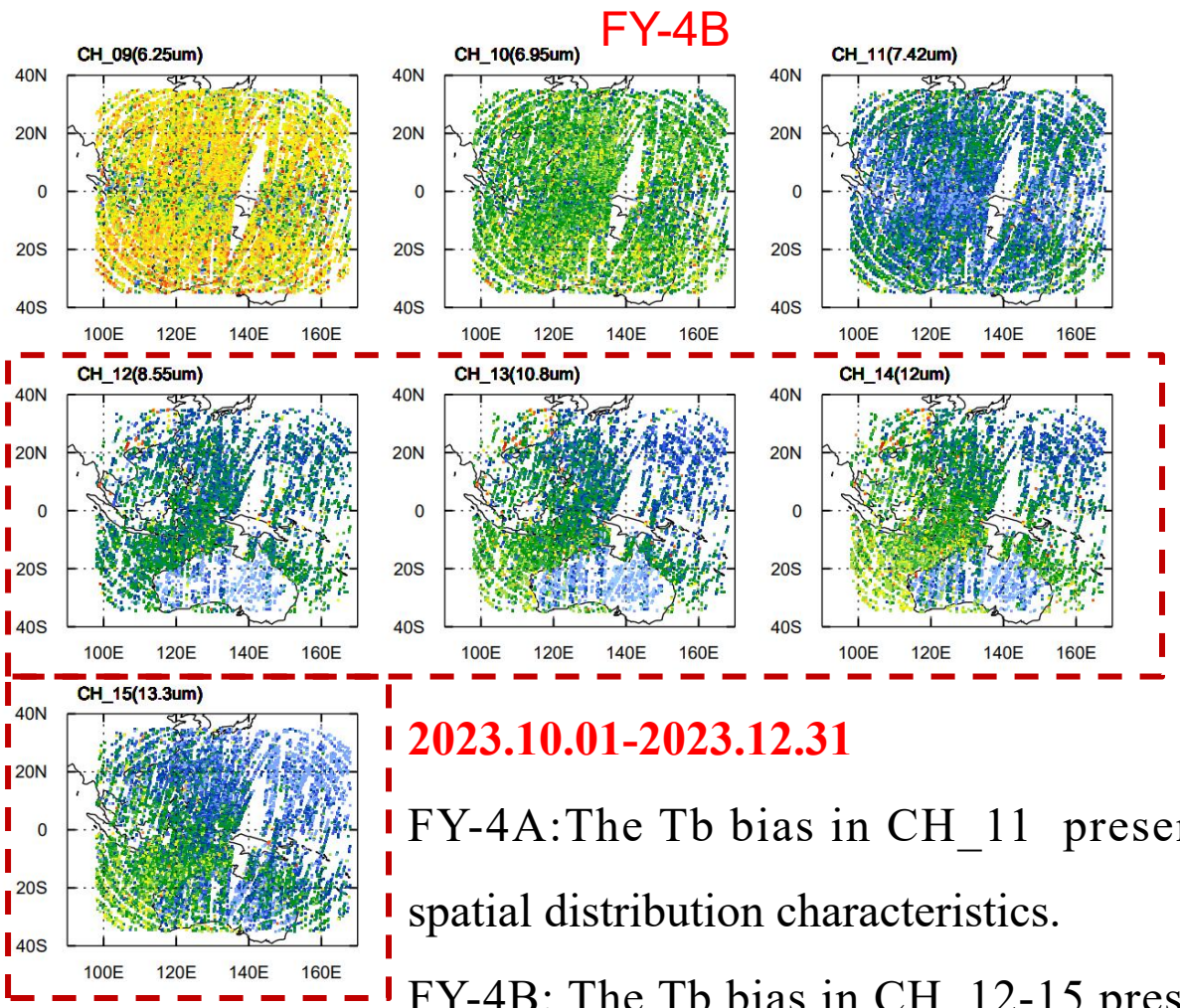
4B:

Tb bias are less than 0.3K for CH_09-10\12-14 and about 0.4K for CH_11 and CH_15.

The time sequence of TB bias is stable.

Spatial distribution of bias





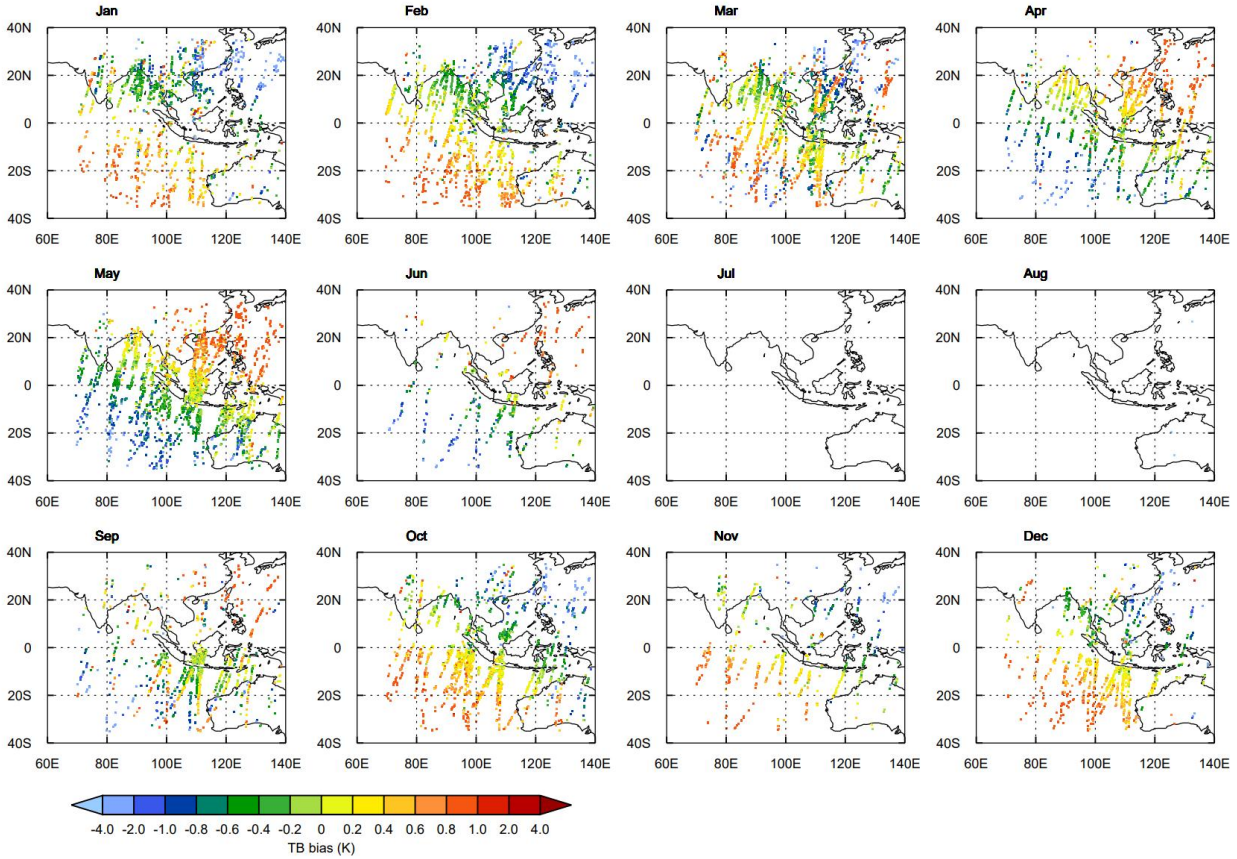
2023.10.01-2023.12.31

FY-4A:The Tb bias in CH_11 presents obvious spatial distribution characteristics.

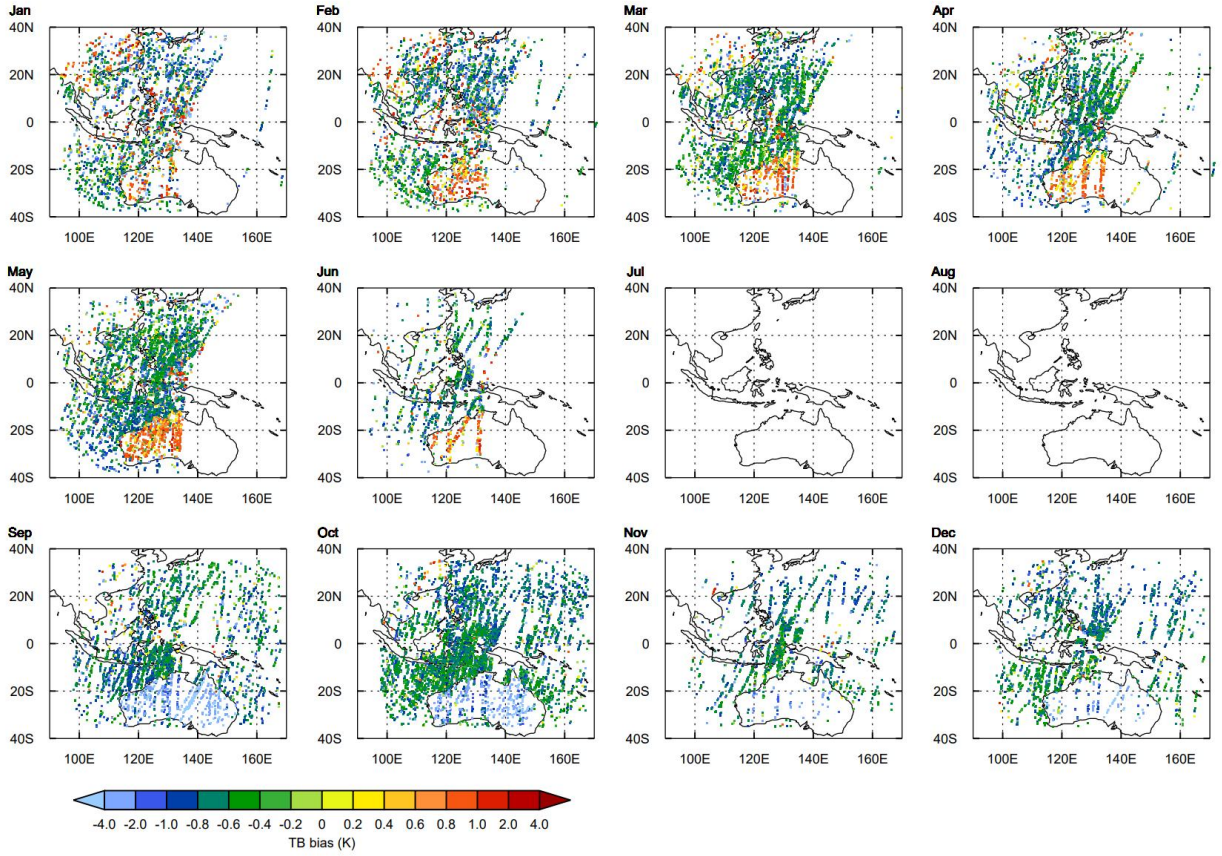
FY-4B: The Tb bias in CH_12-15 present obvious spatial distribution characteristics.

Spatial distribution of bias

4A CH_11(8.55μm)



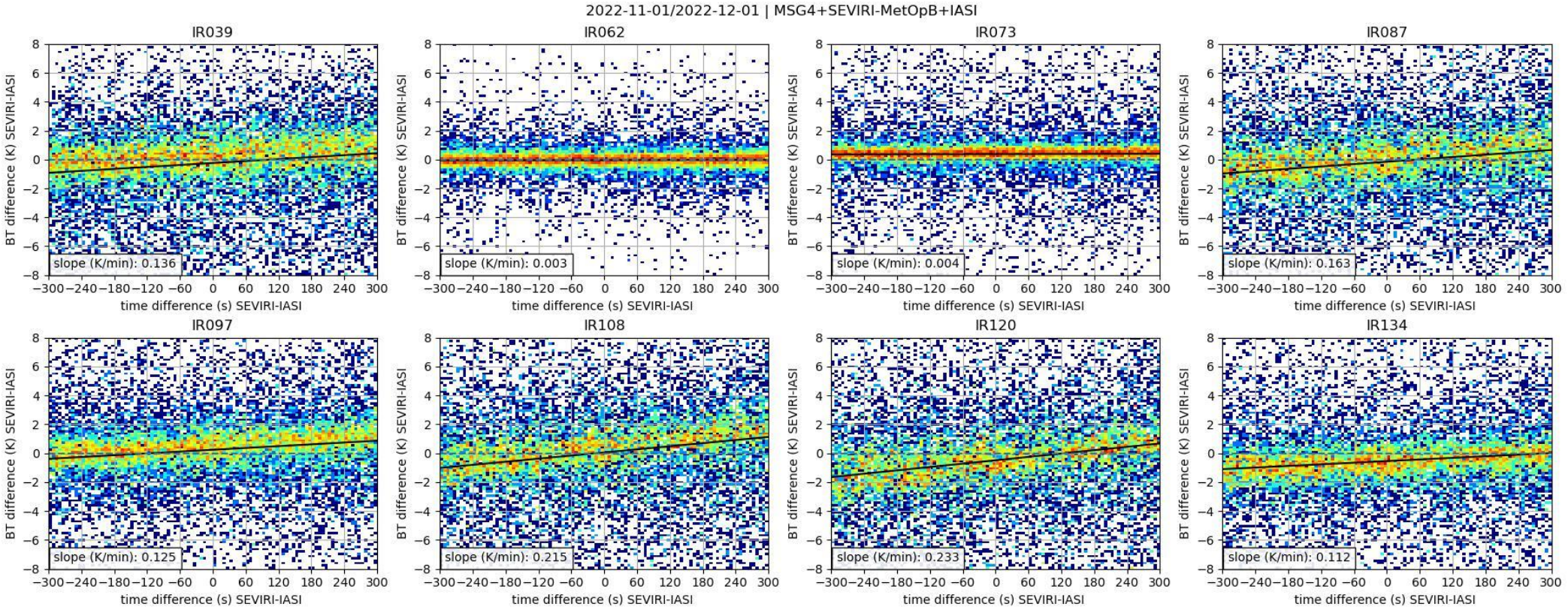
4B CH_12(8.55μm)



The spatial distribution clearly varies with month

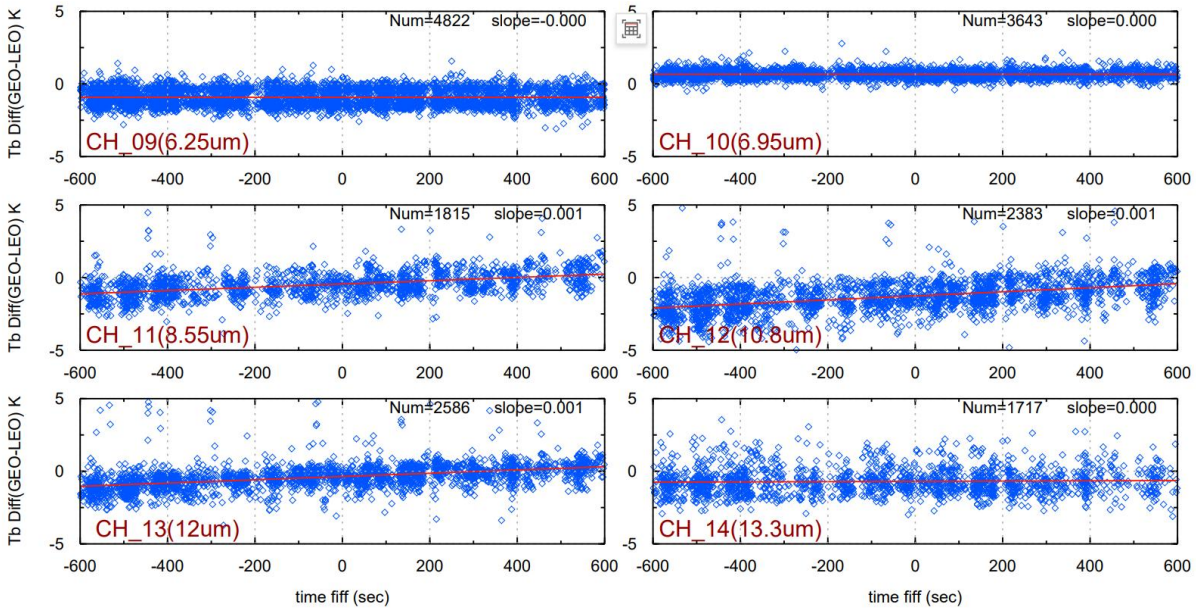
Bias analysis of hot land

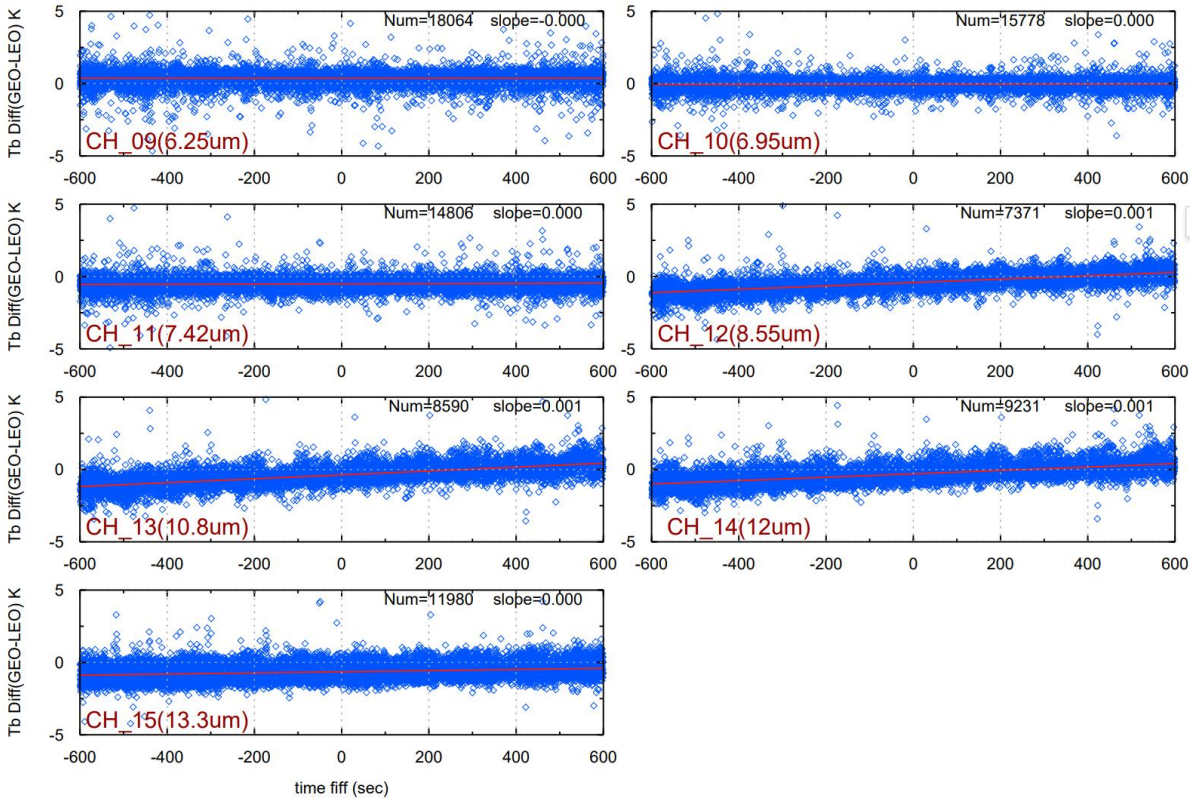
Asymmetric time differences



Ref:Tim Hewison et.al, “GEO-LEO & LEO-LEO IR Hot land Analysis Importance of Collocations’ Symmetric Time Difference”,GSICS Web meeting 2023-07-06

Bias analysis of hot land





Collocations' time difference are not symmetrically distributed over hot land for channels of 8.55,10.8 and 12μm

Summary

- **AGRI and IASI inter-comparison**

➢ For FY-4A, Bias are less than 0.3K for all channels.

➢ For FY-4B, Bias are less than 0.3K except for 0.4K of 10.8μm and 13.3μm.

➢ The time sequence of TB bias is stable.No significant degradation occurred for all Channel.

- **Abnormal spatial distribution of bias for 8.55μm.**

➢ For FY-4A,anomaly spatial distribution with seasons.

➢ For FY-4B,anomaly spatial distribution in Australia with seasons.

- **Bias analysis of hot land**

➢ Collocations' time difference are not symmetrically distributed over hot land for channels of 8.55,10.8 and 12μm.

Thank you

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