GSICS IR Web Meeting for Hyperspectral Sounder Inter-comparison

FY-4A/GIIRS Performance and Inter-comparison Results

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NSMC

Outline

1. Background

2. L1 data (V2) of GIIRS and related assessments

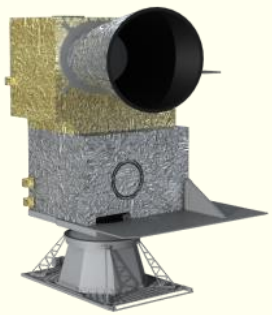
3. GEO-LEO/Sounder intercomparison (GIIRS vs. IASI)

4. Follow-up improvements

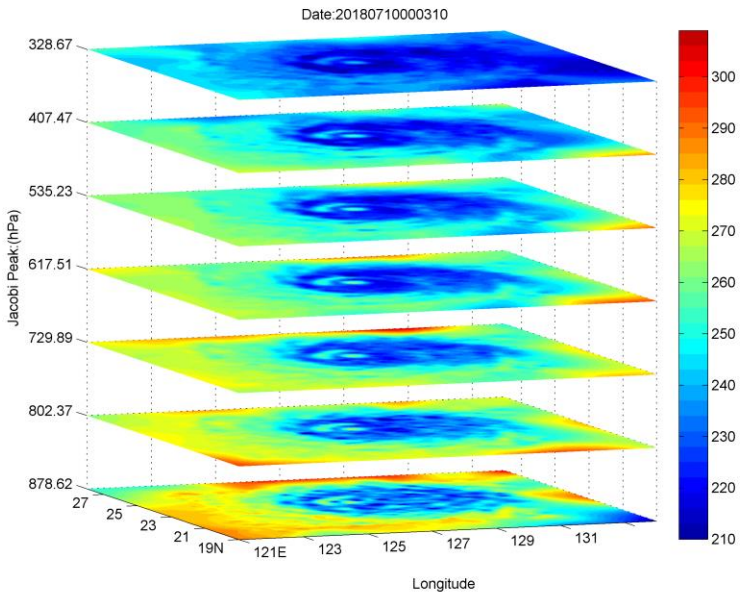
5. Summary

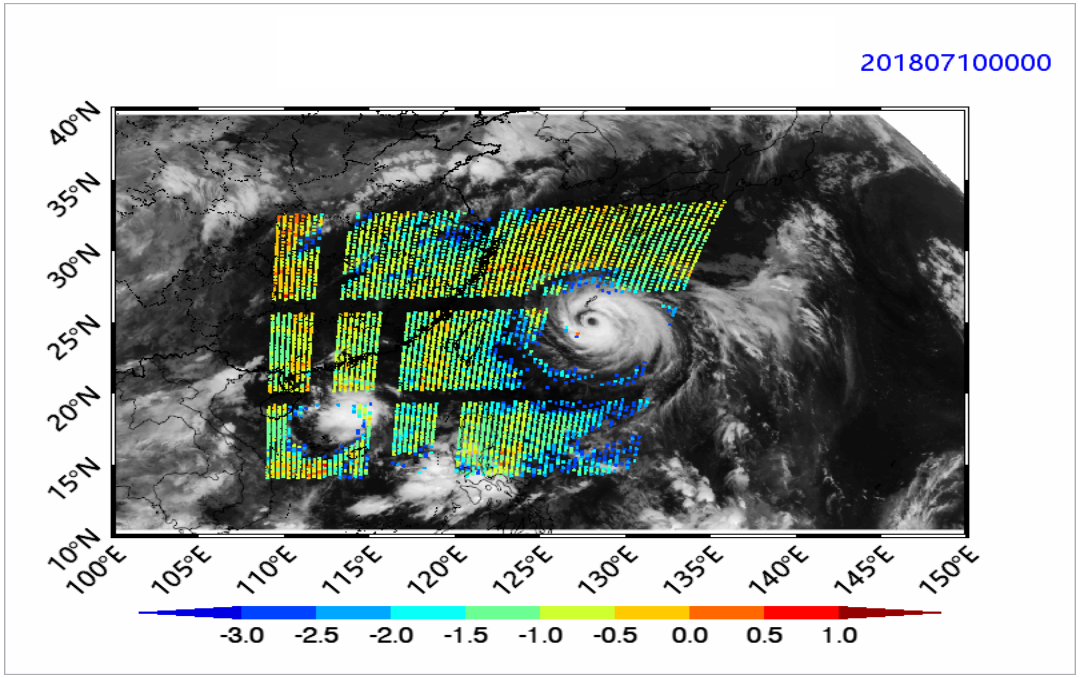
Main Specifications of GIIRS

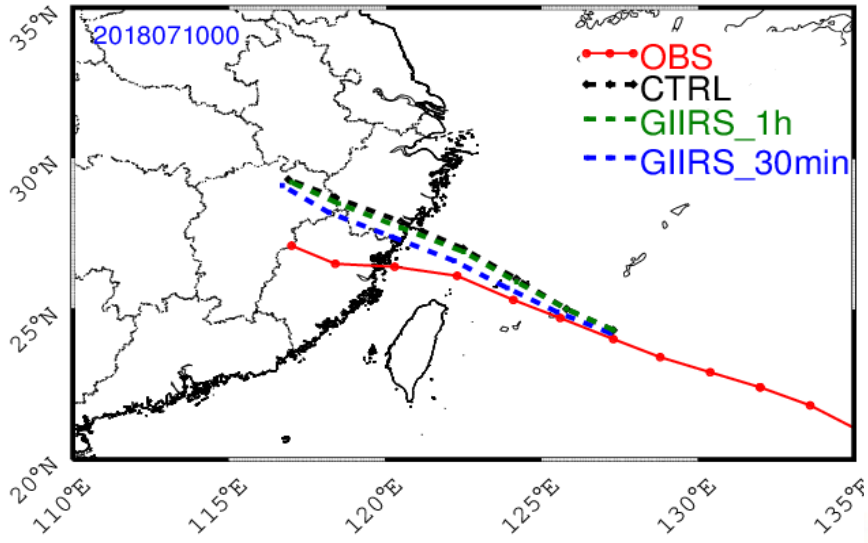
	Range	Resolution	Channels
Spectral Parameters	**LWIR: 700-1130 cm^{-1}**	**0.625^{-1}**	**689**
(Normal mode)	**MWIR:1650-2250 cm^{-1}**	**0.625^{-1}**	**961**
	VIS : 0.55- 0.75 μm		
Spatial Resolution	**LWIR/MWIR : 16 Km @ nadir**		
	VIS : 2 Km @ nadir		
Operational Mode	**China area 5000 × 5000 Km^2**		
	Mesoscale area 1000 × 1000 Km^2		
Temporal Resolution	**China area <1 hr**		
	Mesoscale area <½ hr		
Sensitivity	**LWIR: 0.5-1.1 MWIR: 0.1-0.14**		
(mW/m^2.sr.cm^2)	**VIS: S/N>200(ρ=100%)**		
Radiometric Accuracy	**1.5 K**		
Spectral Accuracy	**10 ppm**		
Quantization Bits	**13 bits**		



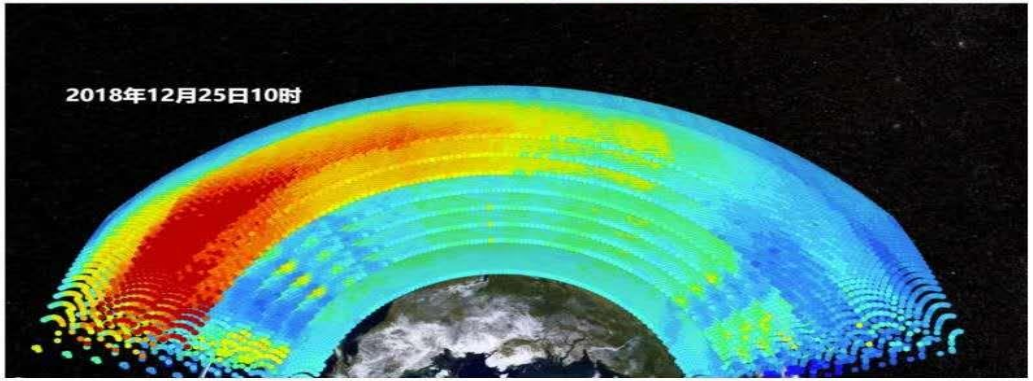
Operational Application in GRAPES since Dec 25,2018







风云四号卫星高光谱探测仪GIIRS，已于2018年12月25日正式在GRAPES全球4D-Var中业务化，GIIRS监测到北极区平流层的爆发性增温和对流层寒潮



风云四号卫星高光谱探测仪GIIRS高时间分辨率三维温度探测信息的同化改进了寒潮预报

Announcement on Level-1 data update of Geostationary Interferometric Infrared Sounder onboard Fengyun-4A satellite

Source: Author: Issued Date:13 August 2019

To increase the observation quality of the Geostationary Interferometric Infrared Sounder (GIIRS) onboard Fengyun-4A (FY-4A) satellite, the related calibration algorithms of the Level-1 (L1) data of FY-4A/GIIRS have been updated completely. The new version L1 data (V2) is scheduled to be broadcast since 12:00 August 13, 2019 (BJT), where the main improvements include:

1. The improved spectral and radiometric calibration algorithms are utilized;

2. The apodisation processing upon GIIRS L1 data with Hamming function is adopted;

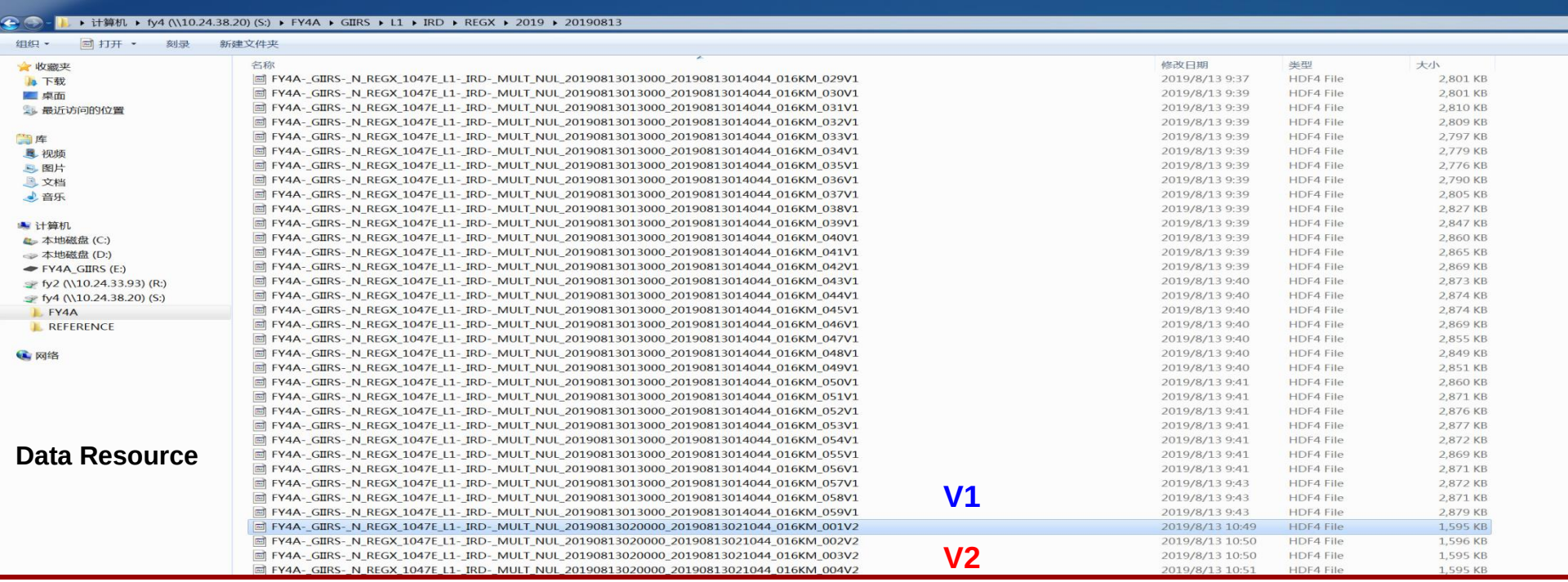
3. The version name of the L1 data file is changed from V1 to V2.

In general, the data format of GIIRS L1 data remains unchanged.

National Satellite Meteorological Center

Contacts: Qiang Guo(guoqiang@cma.gov.cn)

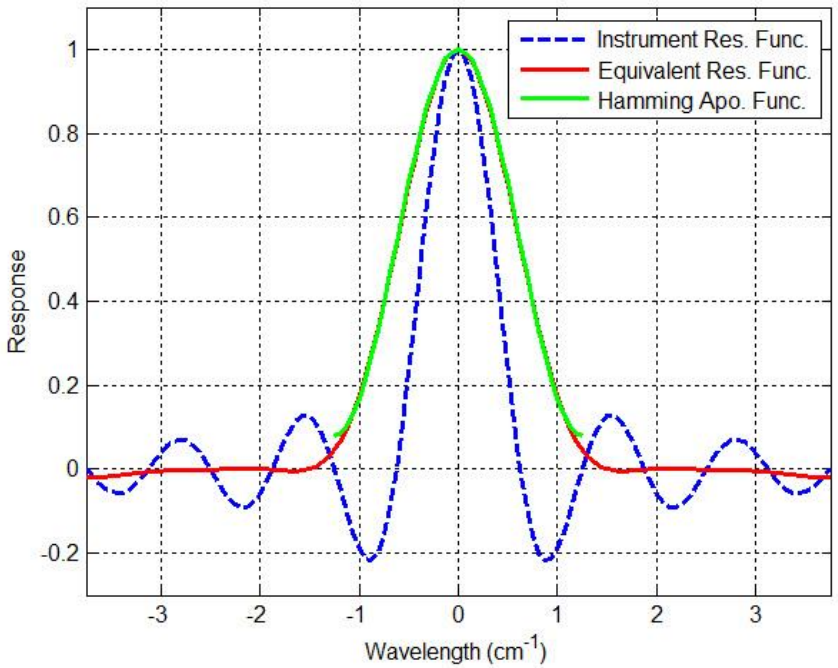
http://www.nsmc.org.cn/en/NSMC/Contents/100327.html

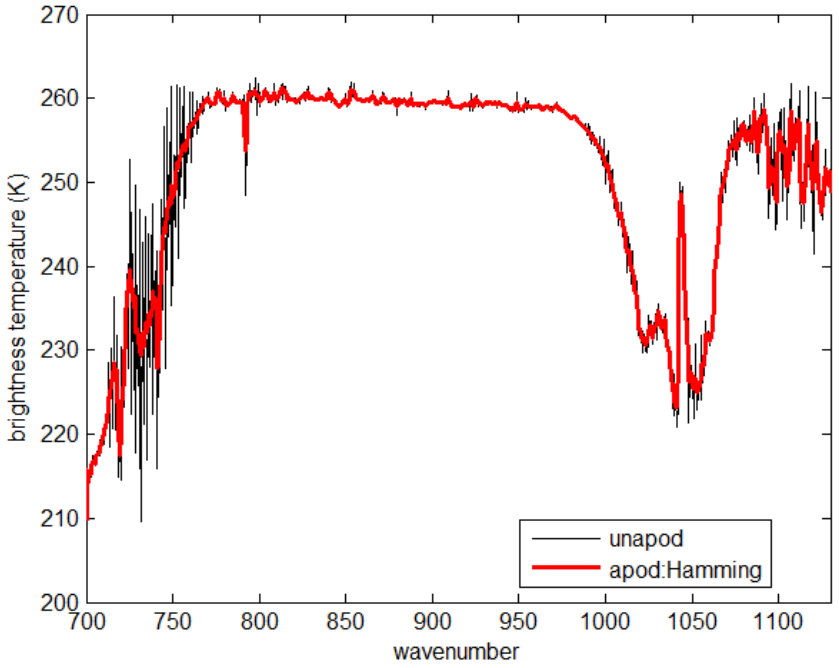


Data Resource

V1

V2

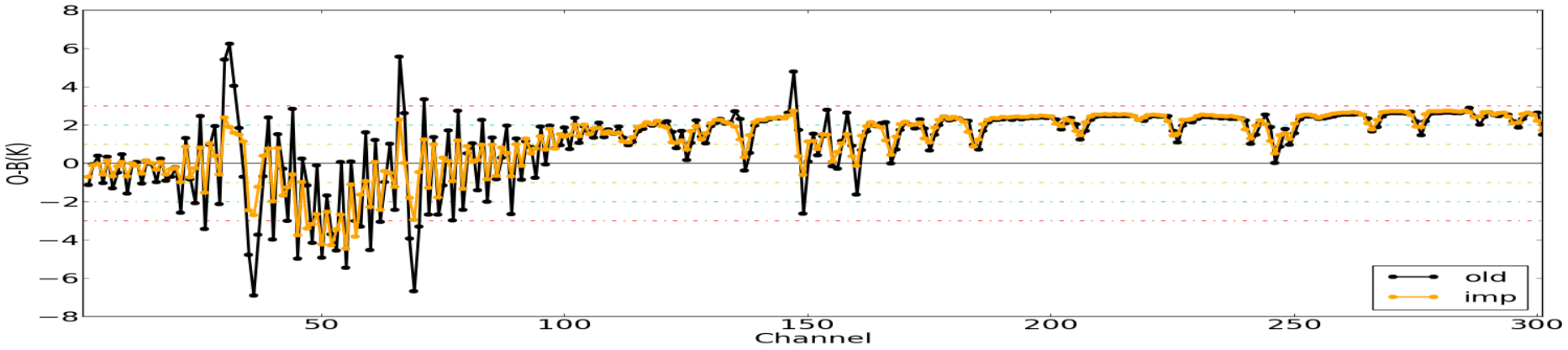


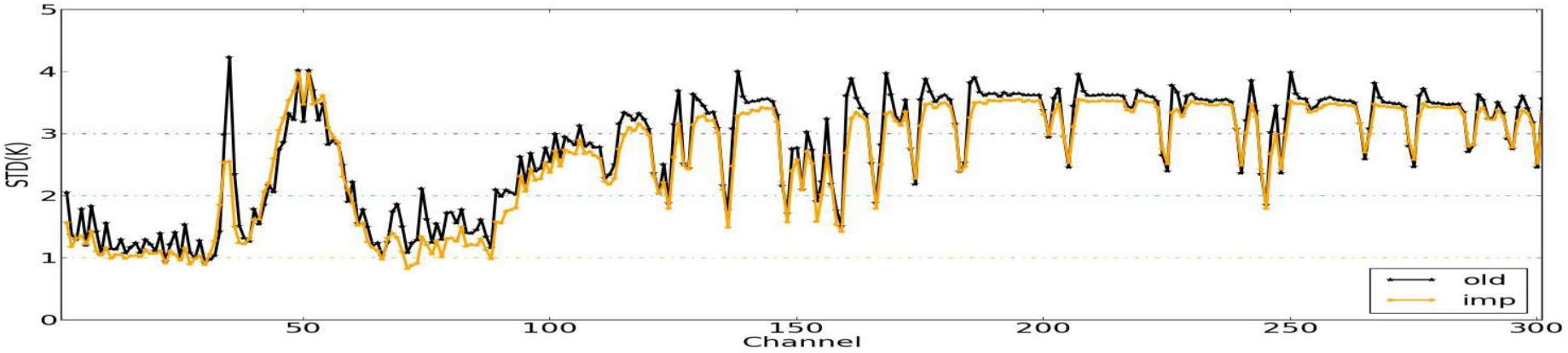


Sample Evaluation from GRAPES+RTTOVS

- ✓ Sample Data: 20181220, 4129files
- ✓ Experts: Ruoyin Ying and Wei Han
- ✓ Reports: 1 document

Effect Samples after QC : 110,000



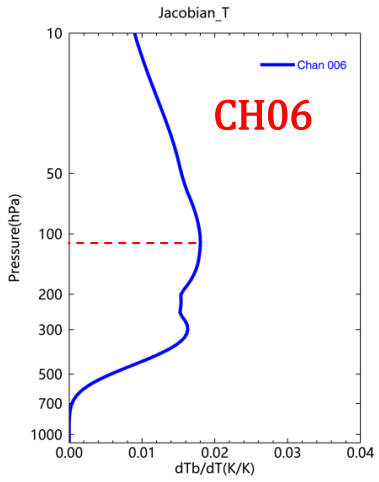


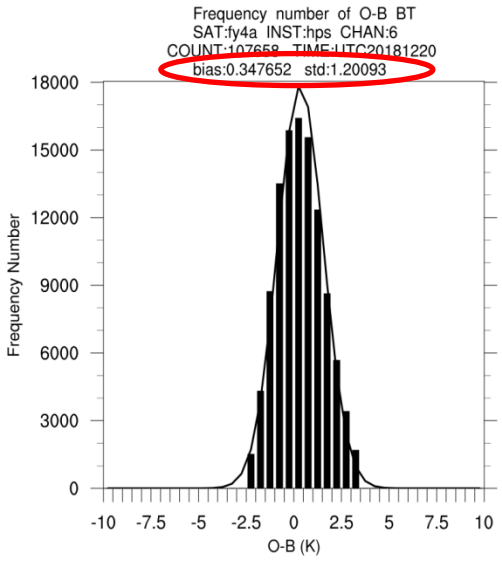
Note: **old(V1); imp(V2)**

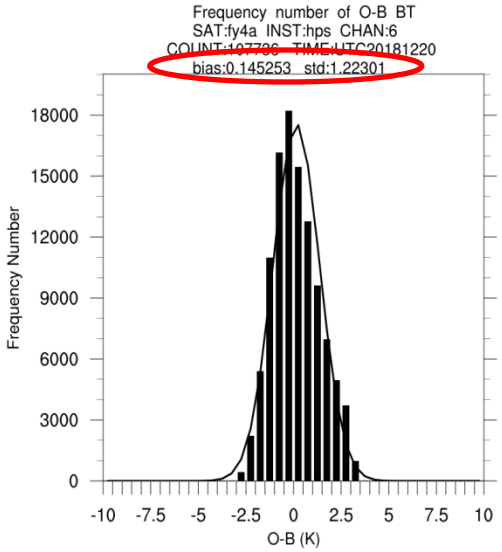
V2 better than V1

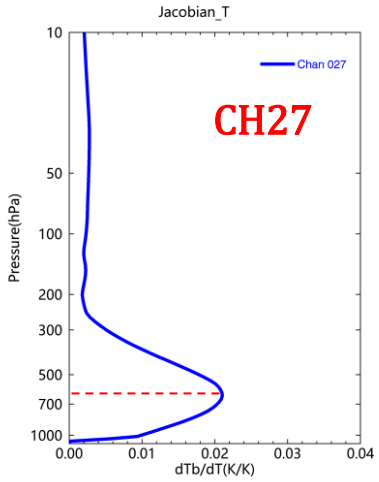
V1

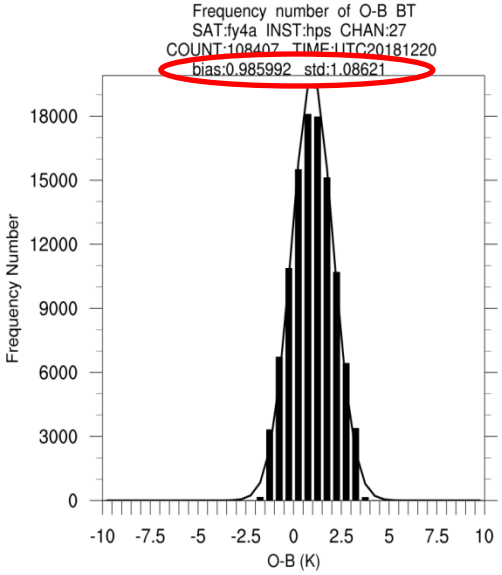
V2

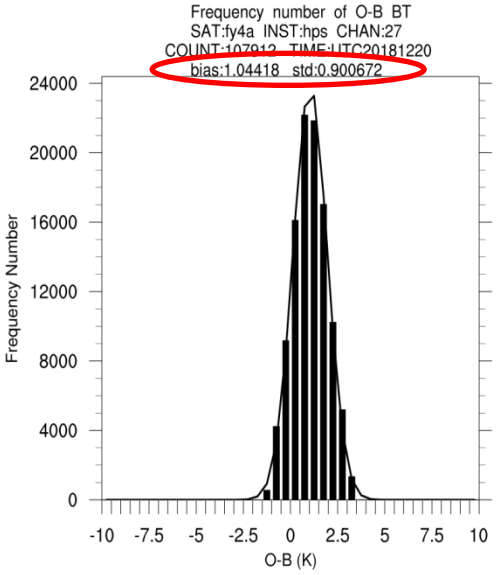




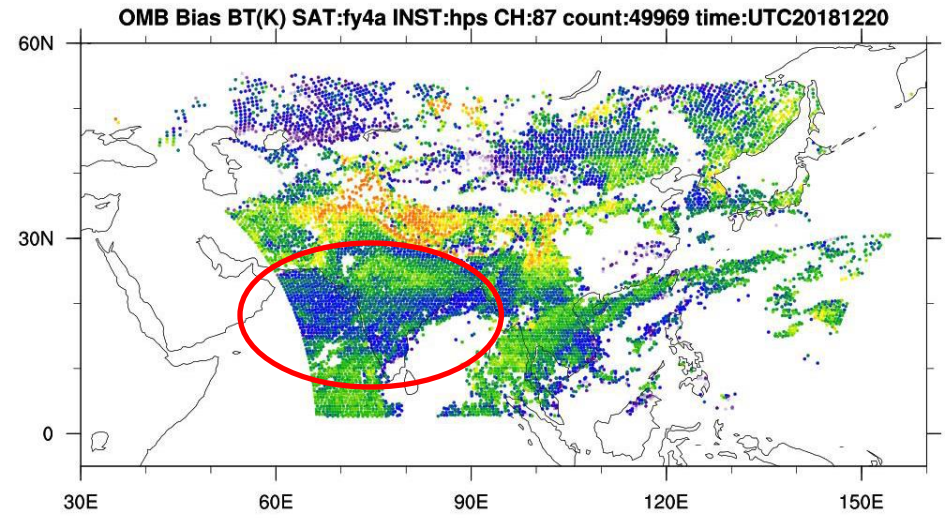




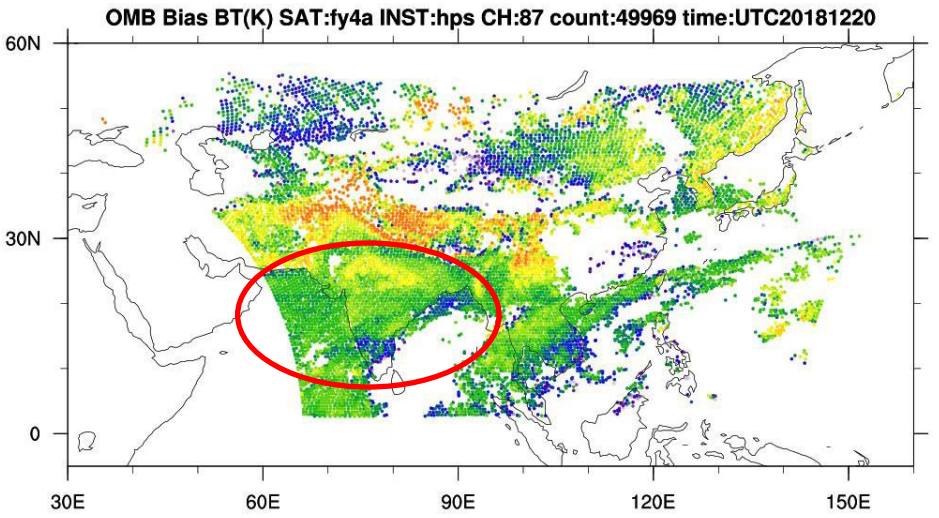




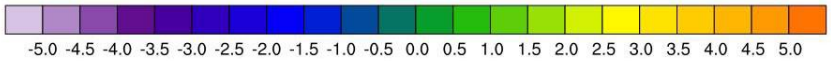
High level channel(ch06): comparable; Low level channel(ch27): V2 better

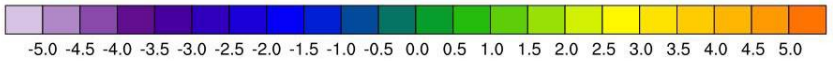


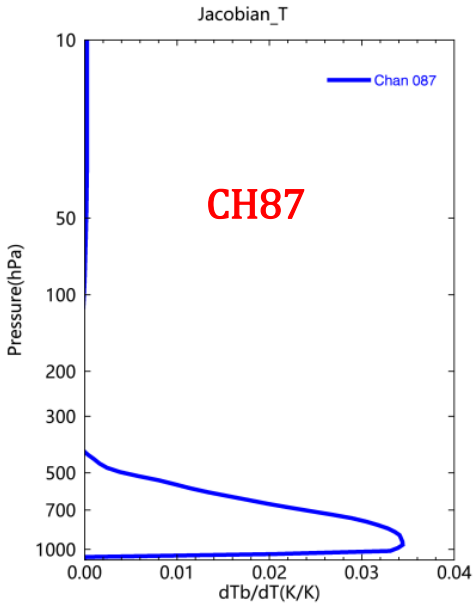
V1



V2







The regional O-B results in some window channel (CH87) from V2 is significantly better than those of V1

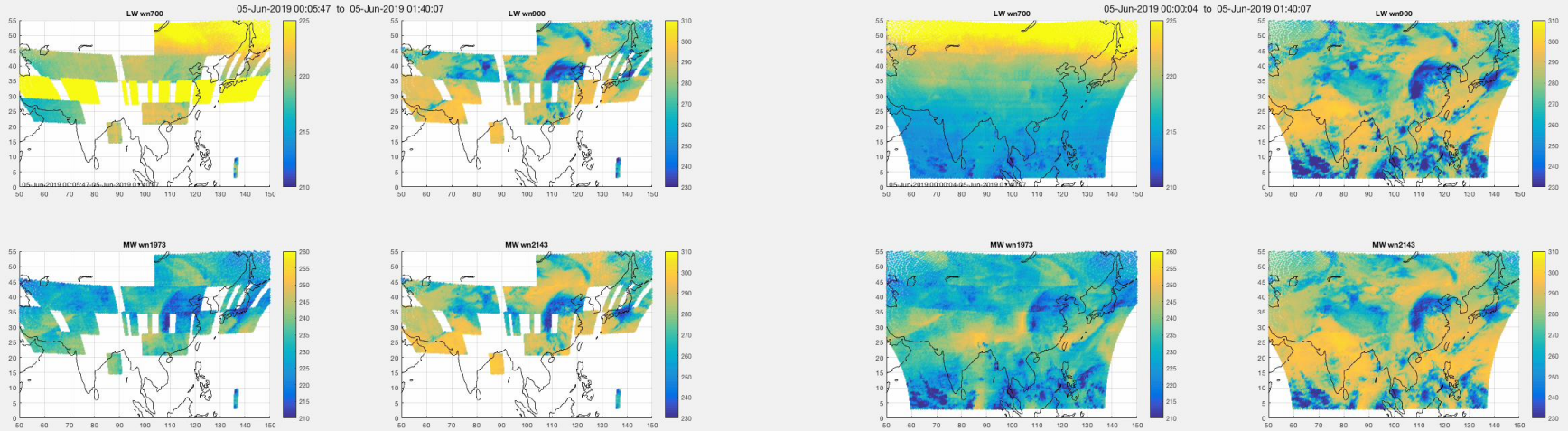
Independent Evaluations from International Counterpart (SSEC/UW)

- ✓ Sample data: 20190530~20190605, V1/V2(30031files for each)
- ✓ Experts: Paul Menzel, Hank Revercomb and Bob Knuteson
- ✓ Reports: 4 documents (doc/xls/mp4)

● Stability of Radiometric Feature

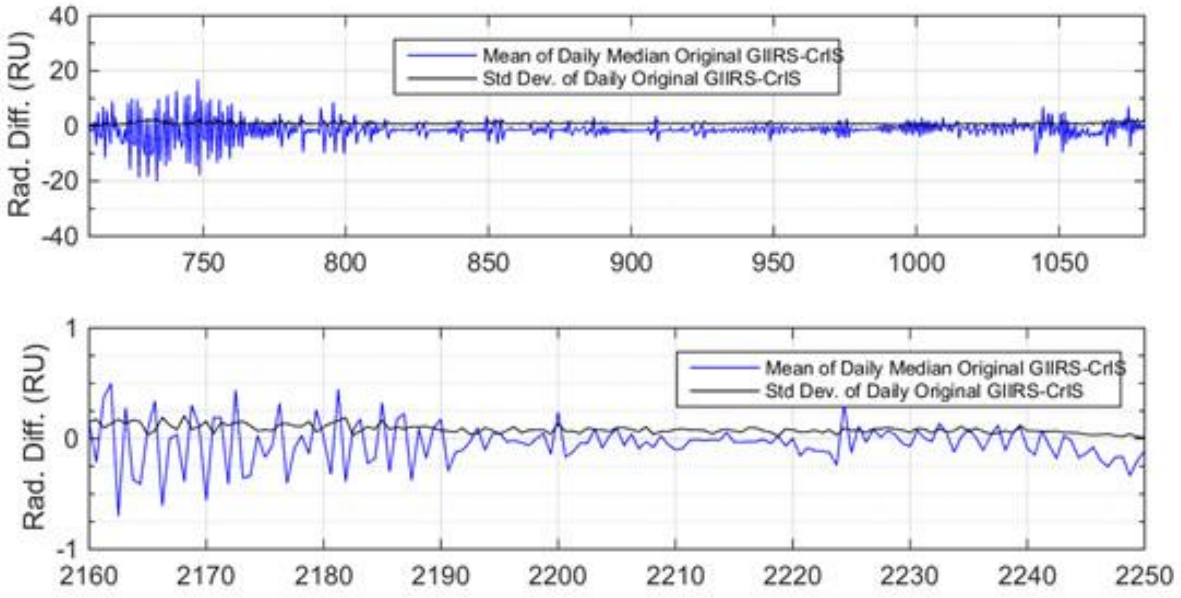
First, we want to acknowledge what appears to be an improvement of Version 2 in **fixing bad granules** from the original Version 1 data to **provide a more realistic regional field**. **Can you explain what improvements you have made to the radiometric calibration between V01 and V02?**

V01 **V02**



• Radiometric Calibration (vs. CrIS)

We do see **similarities** to our CrIS radiometric comparisons. FY4A GIIRS V02 shows a cold bias **relative to CrIS** of about **1 Kelvin** for the warm window channels.

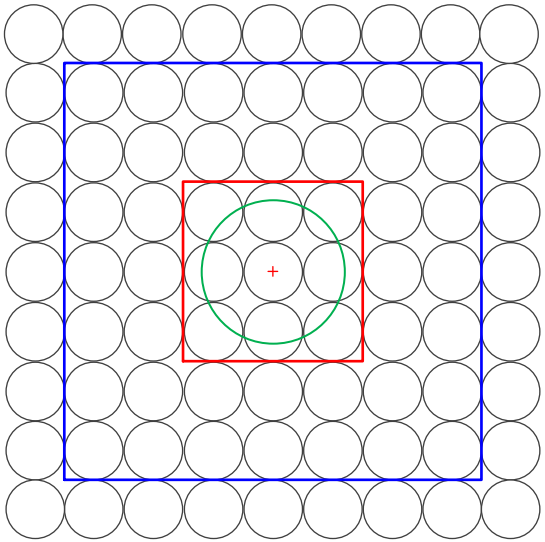


• Spectral Calibration (vs. CrIS)

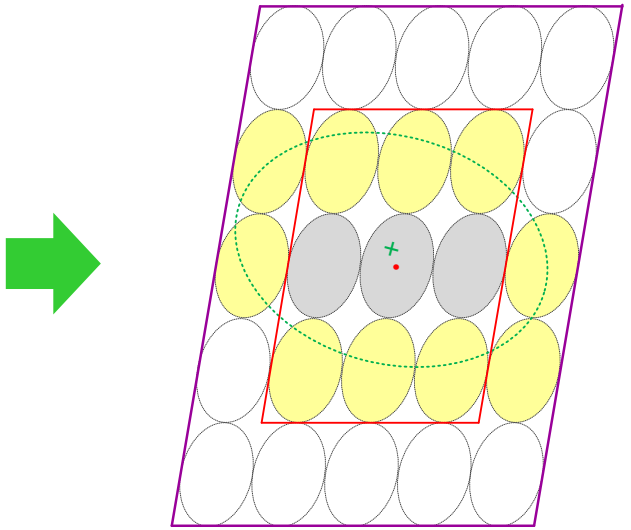
The basic conclusion is that the new version is **improved** in that the **spectral shift** of the longwave and midwave bands are **in better agreement**. The new Version 2 could be **greatly improved by implementing a spectral scale** that is shifted from the current scale..

Spatial Collocation: quasi-full-overlap (QFO) criterion

GEO-LEO/imager

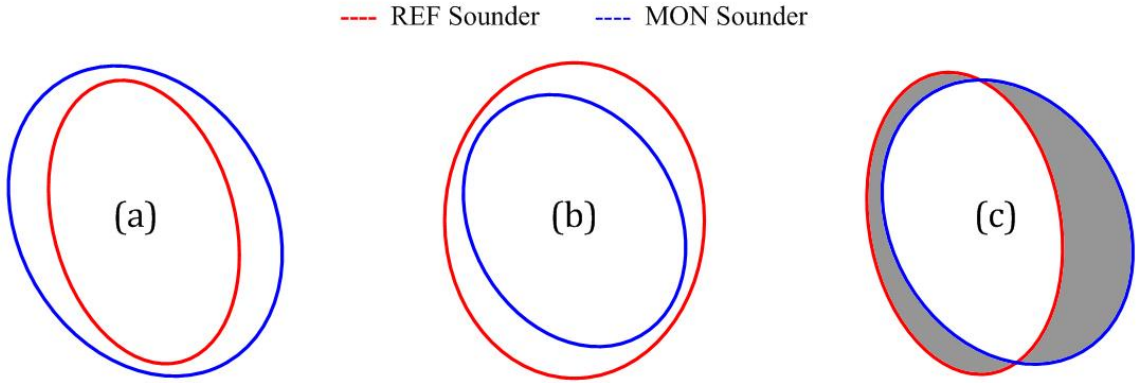


GSICS: recommended overlap pattern (UW)



GeoCAVS: Overlap pattern far away from nadir (VW)

GEO-LEO/sounder



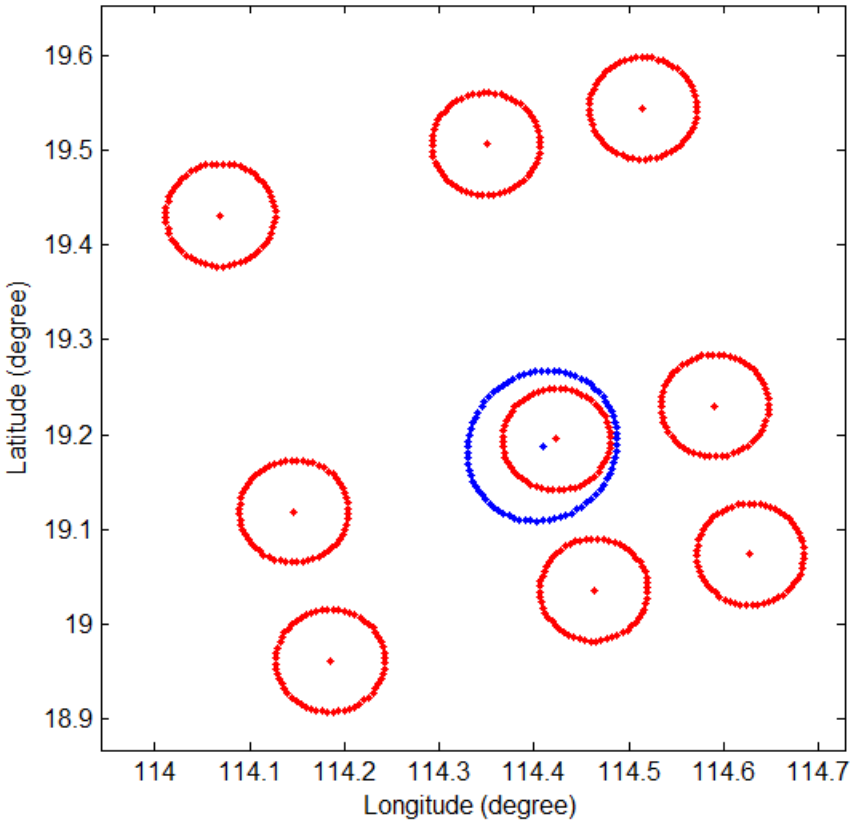
Different overlap relationships of footprints between GEO and LEO sounders

SNO Paired Results in LW band

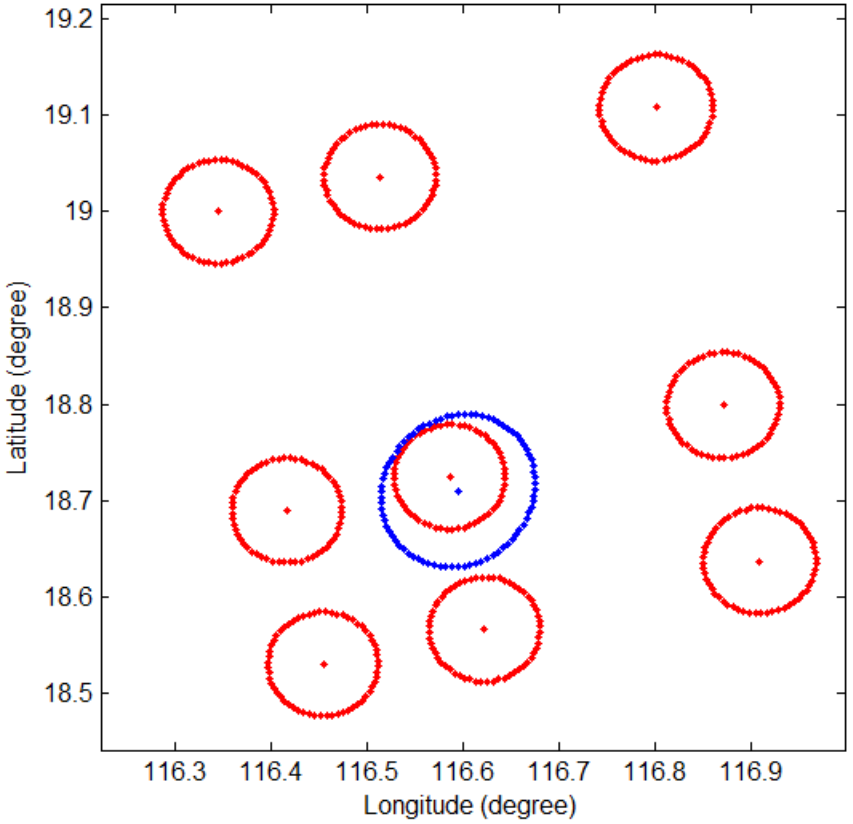
Method	Time	Dwell Order	Detector Order	Time Difference	(LON, LAT)
IMP	13:00	38	56	888s	(114.408958, 19.187902)
		40	85	851s	(116.594940, 18.710238)
	13:15	32	62	3s	(106.880951, 14.252997)
		41	83	162s	(117.416008, 12.304740)
		43	20	191s	(120.543831, 12.543633)
SCC	13:00	38	56	888s	(114.408958, 19.187902)
		40	85	851s	(116.594940, 18.710238)
	13:15	32	62	3s	(106.880951, 14.252997)
		42	101	220s	(118.211487, 9.519010)

IMP: V2 without Spectral Correction
SCC: V2 with Spectral Correction

Footprint Size: IASI < GIIRS

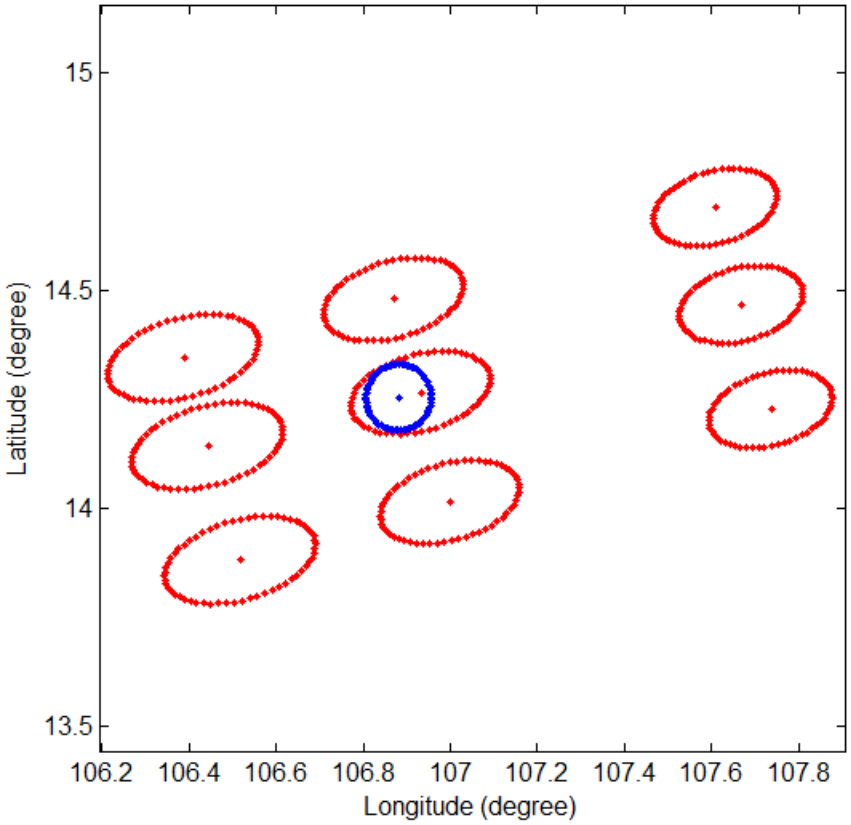


13:00/38/56



13:00/40/85

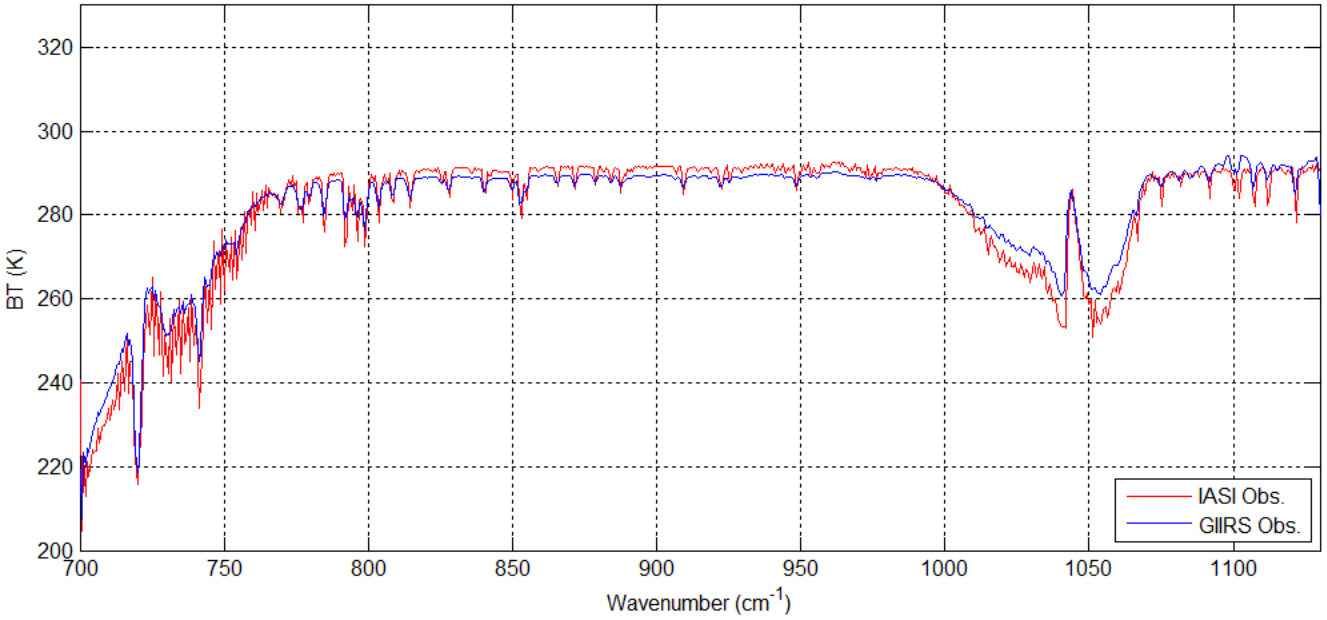
Footprint Size: IASI > GIIRS



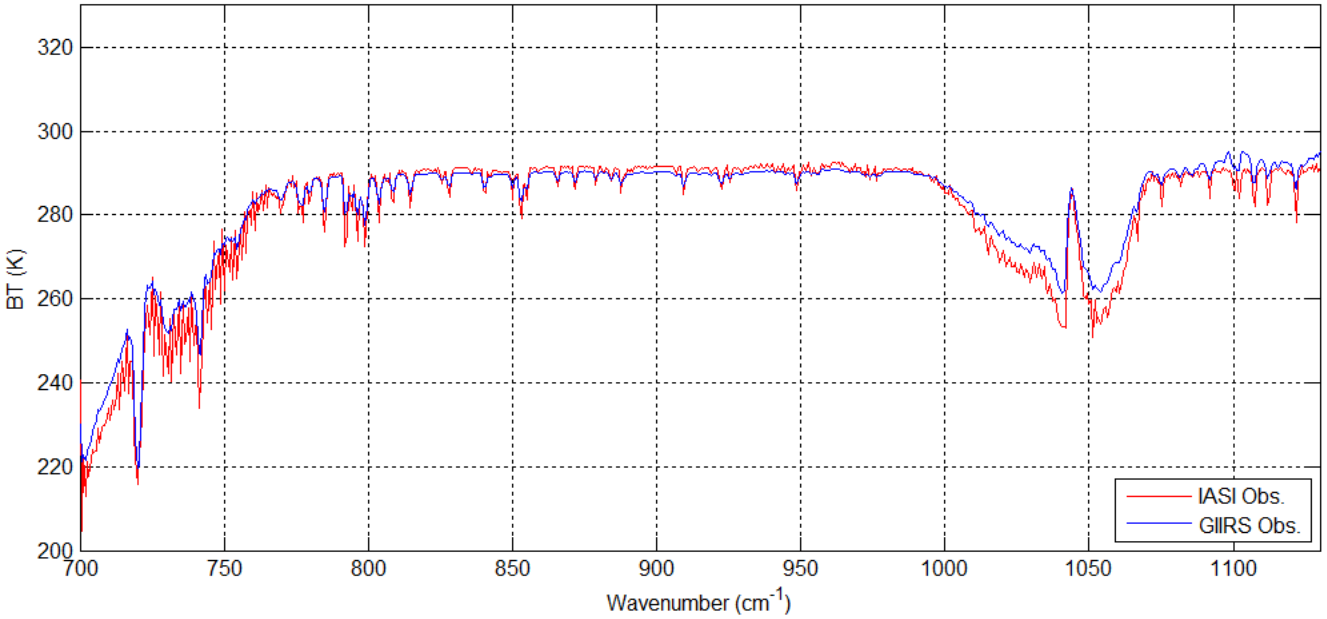
13:15/32/62

Example: 13:15/32/62

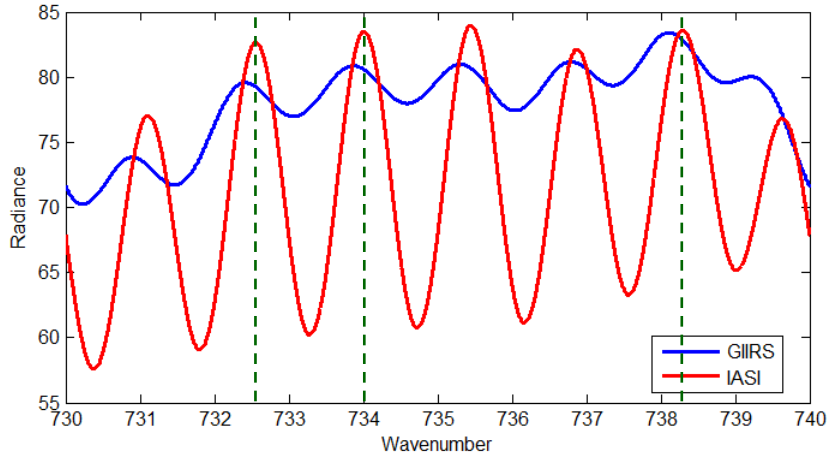
IMP



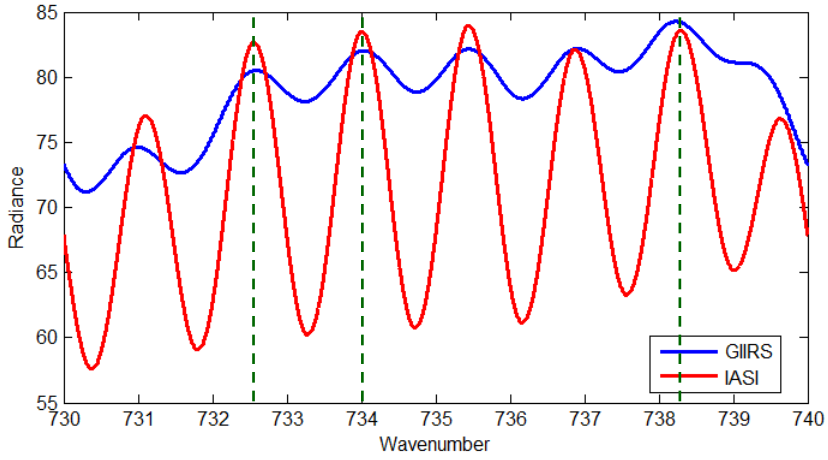
SCC

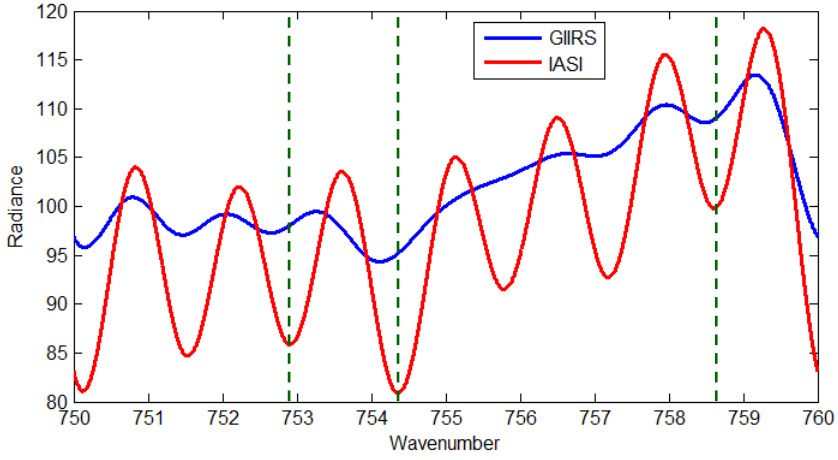


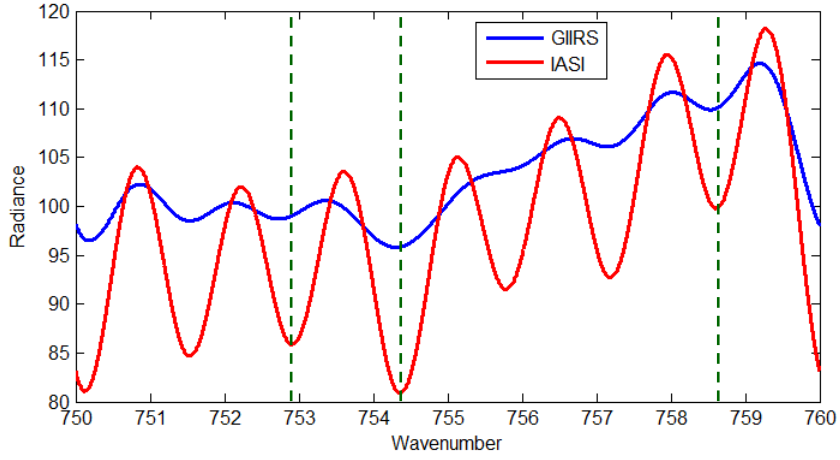
IMP


Radiance
Wavenumber
GIIRS
IASI

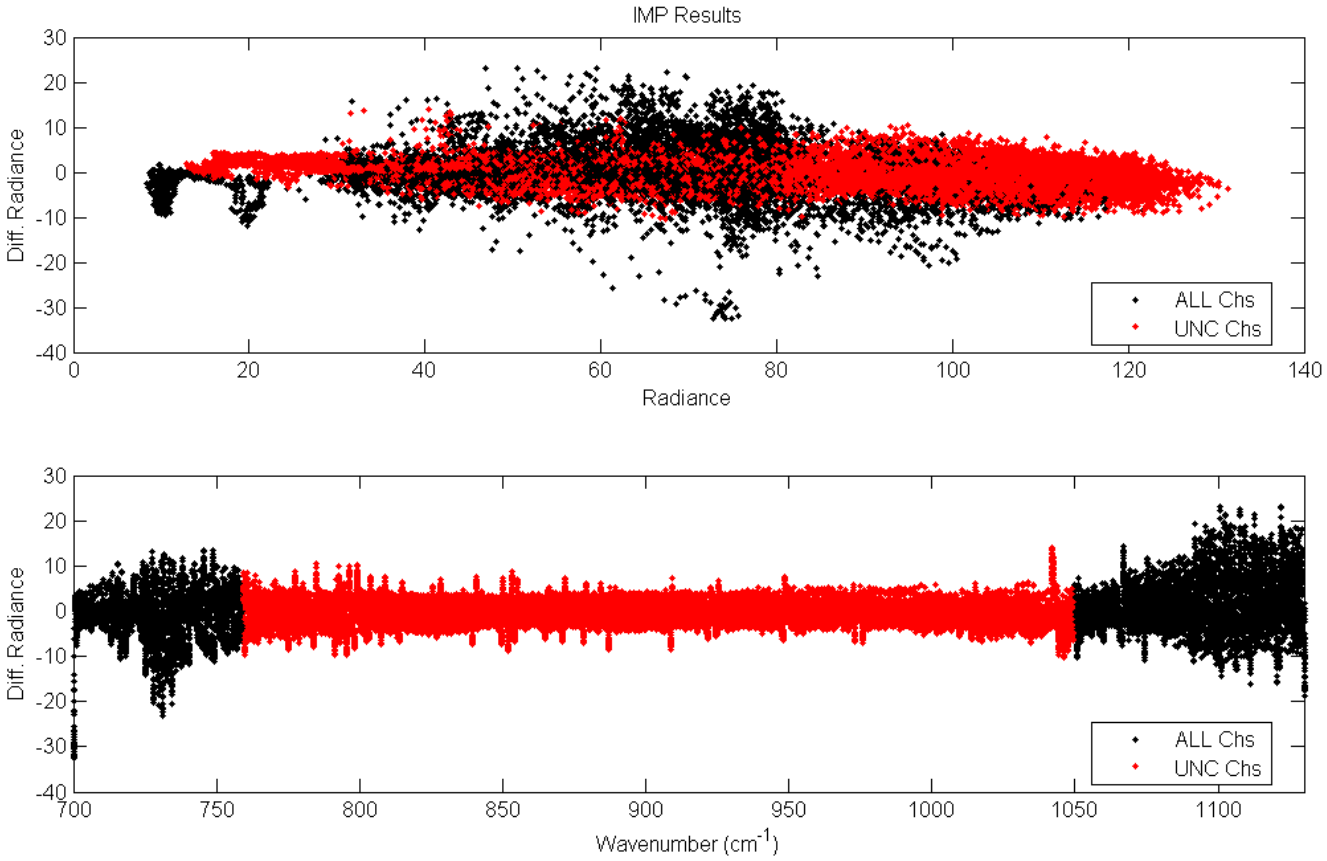
SCC


Radiance
Wavenumber
GIIRS
IASI

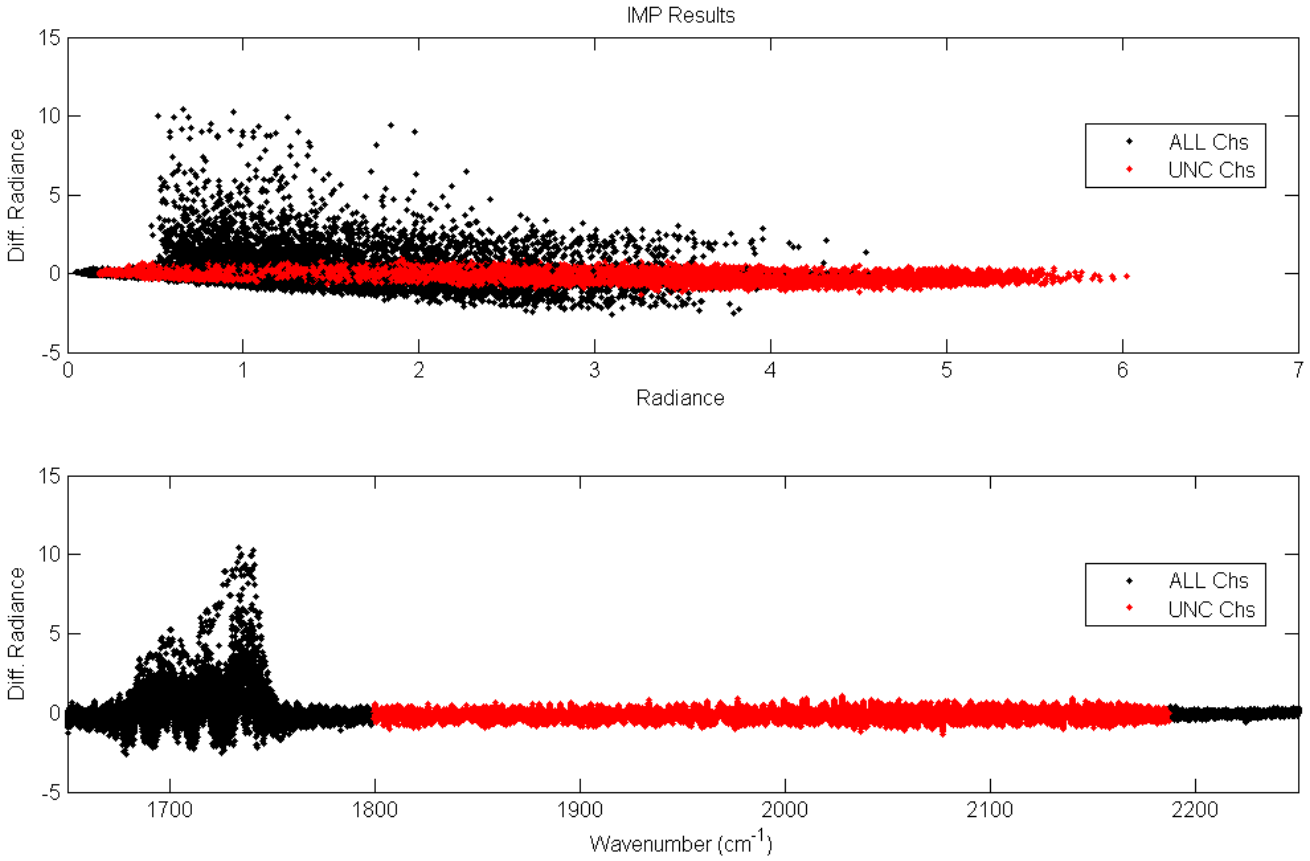

Radiance
Wavenumber
GIIRS
IASI


Radiance
Wavenumber
GIIRS
IASI

（20190530-20190605 vs IASI ）in LW band

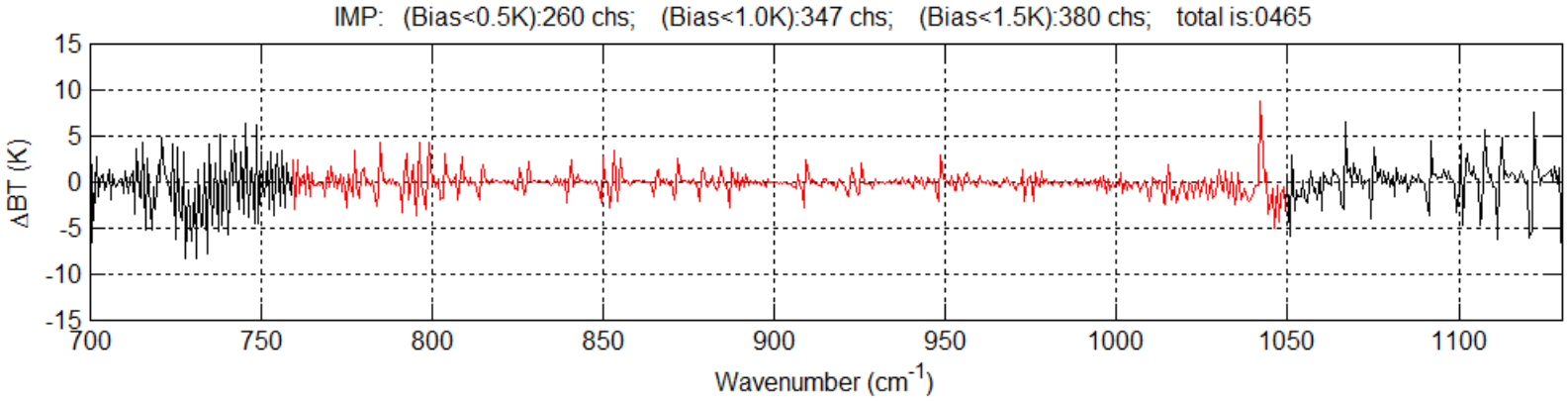


（20190530-20190605 vs IASI ） in MW band

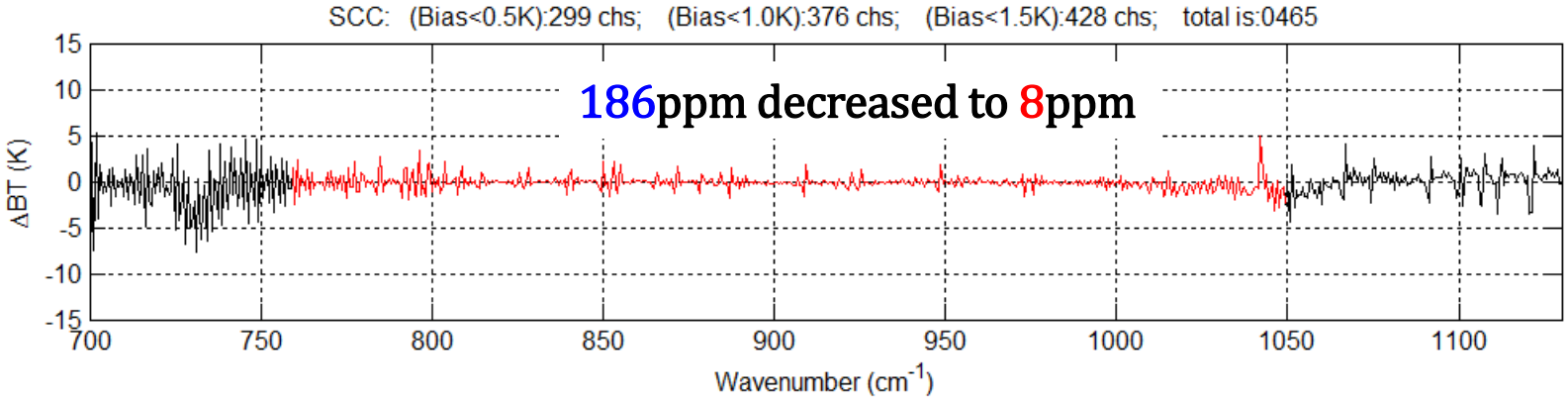


Radiometric Comparison Before and After Spectral Shift Correction for GIIRS V02 in LW Band

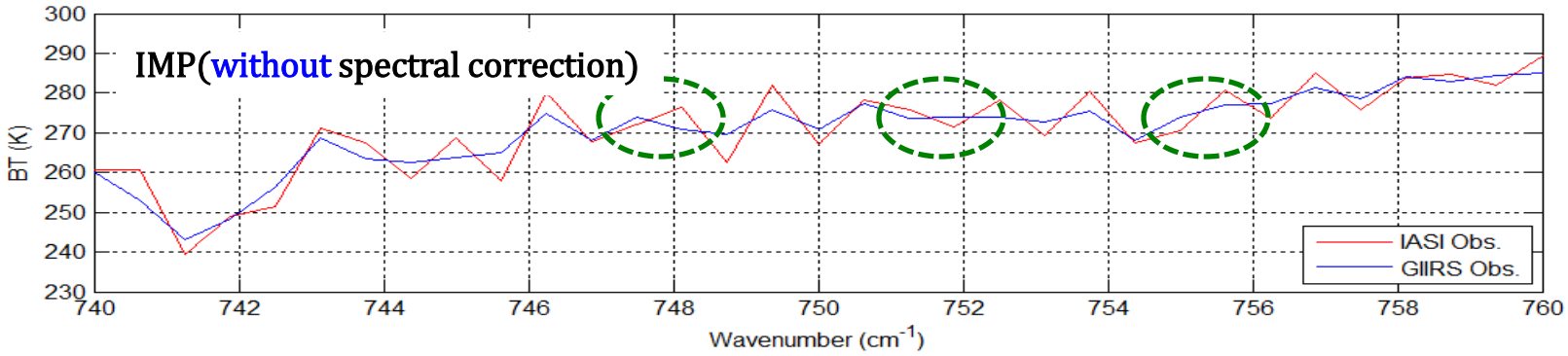
Before

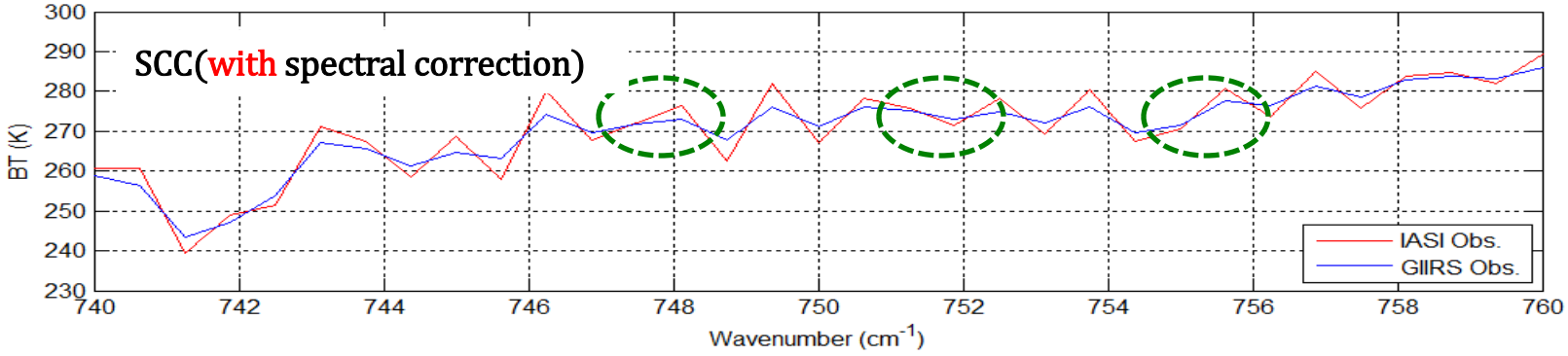


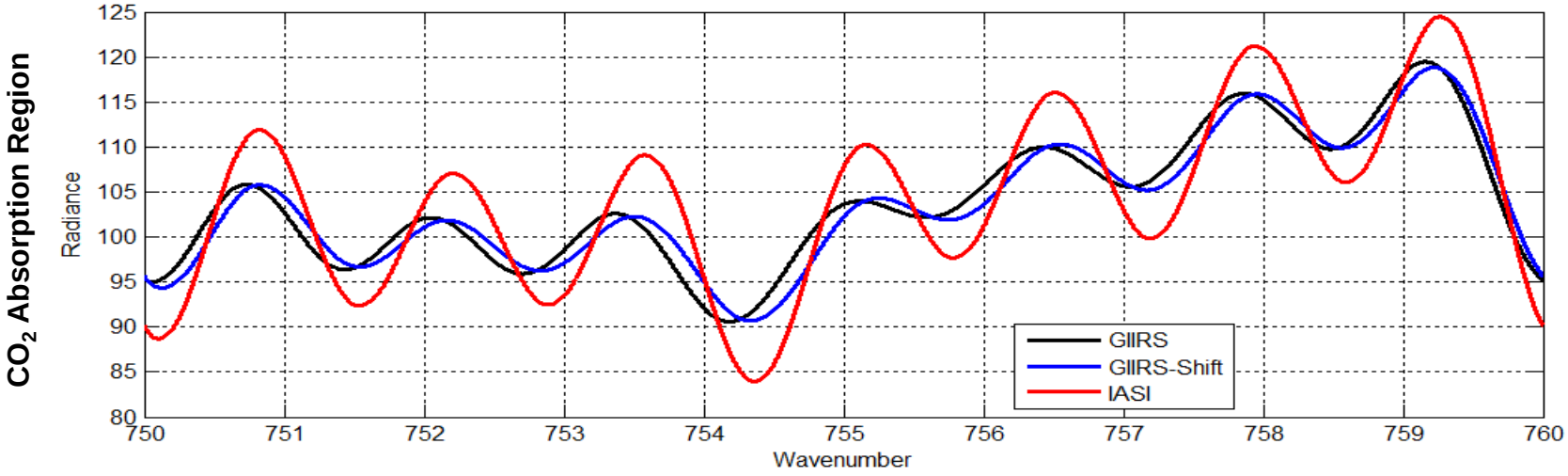
After: corrected with averaged 186ppm



Radiometric Bias	IMP: V02 Before Correct (Channels/Percentage)	SCC: V02 After Correct (Channels/Percentage)
≤0.5K	260/55.9%	299/64.3%
≤1.0K	347/74.6%	376/80.9%
≤1.5K	380/81.7%	428/92.0%

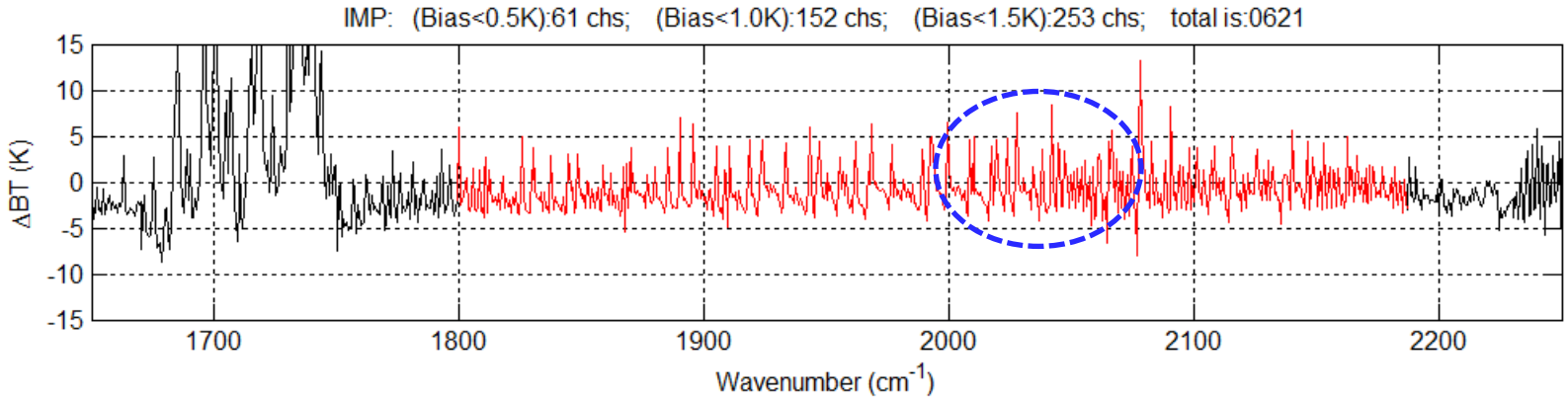

IMP(without spectral correction)
BT (K)
Wavenumber (cm-1)
IASI Obs.
GIIRS Obs.


SCC(with spectral correction)
BT (K)
Wavenumber (cm-1)
IASI Obs.
GIIRS Obs.

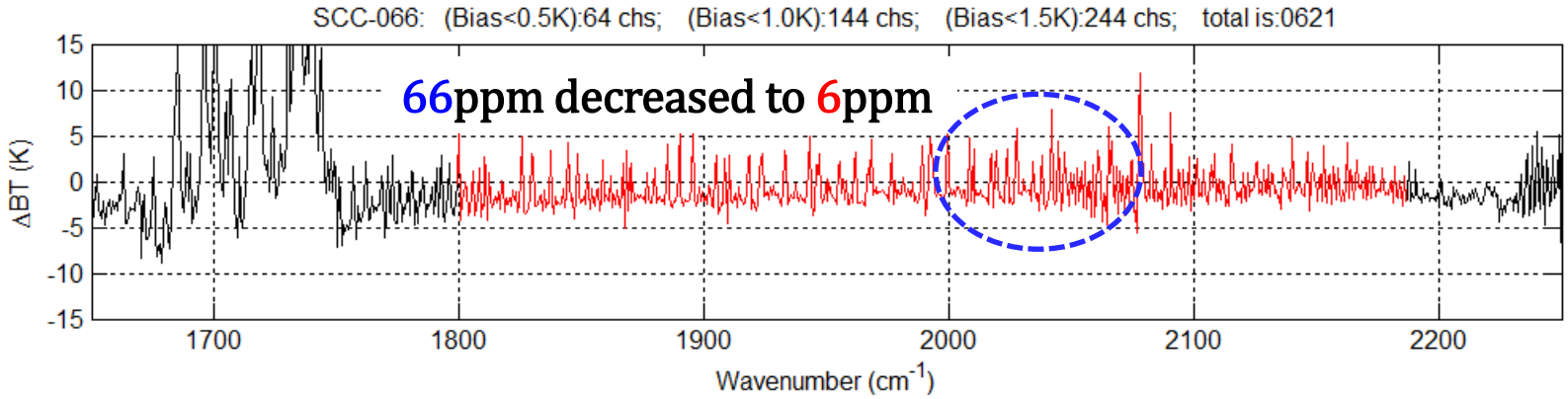

CO2 Absorption Region
Radiance
Wavenumber
GIIRS
GIIRS-Shift
IASI

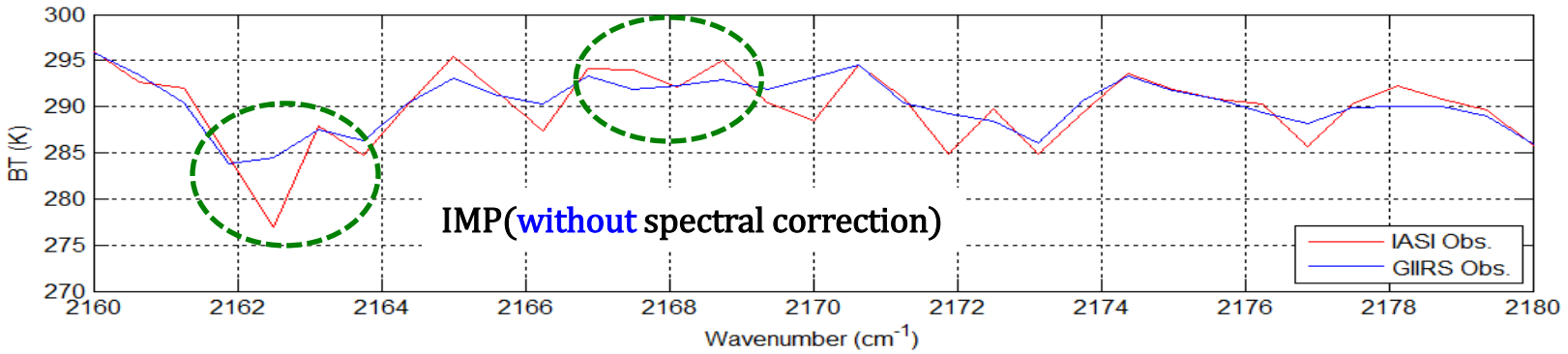
Radiometric Comparison Before and After Spectral Shift Correction for GIIRS V02 in MW Band

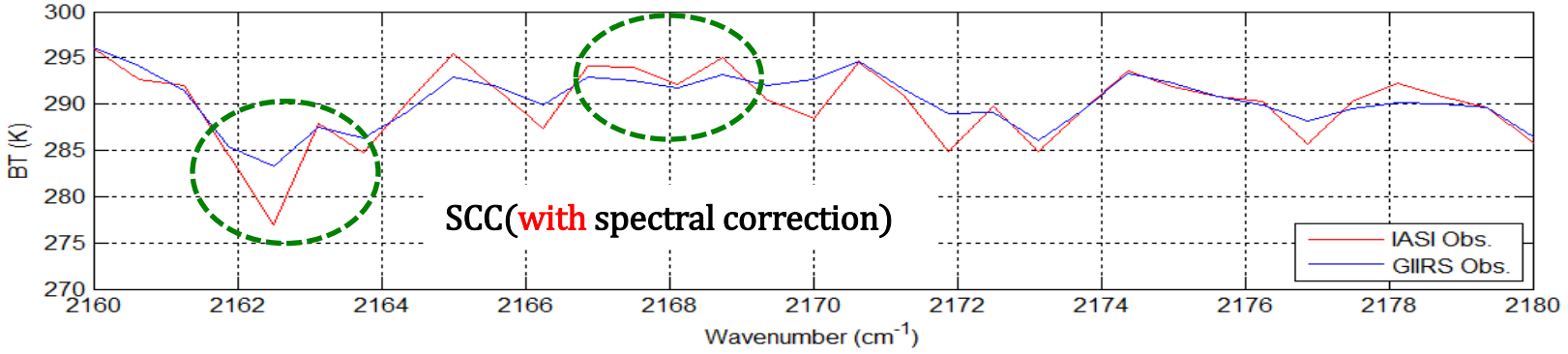
Before



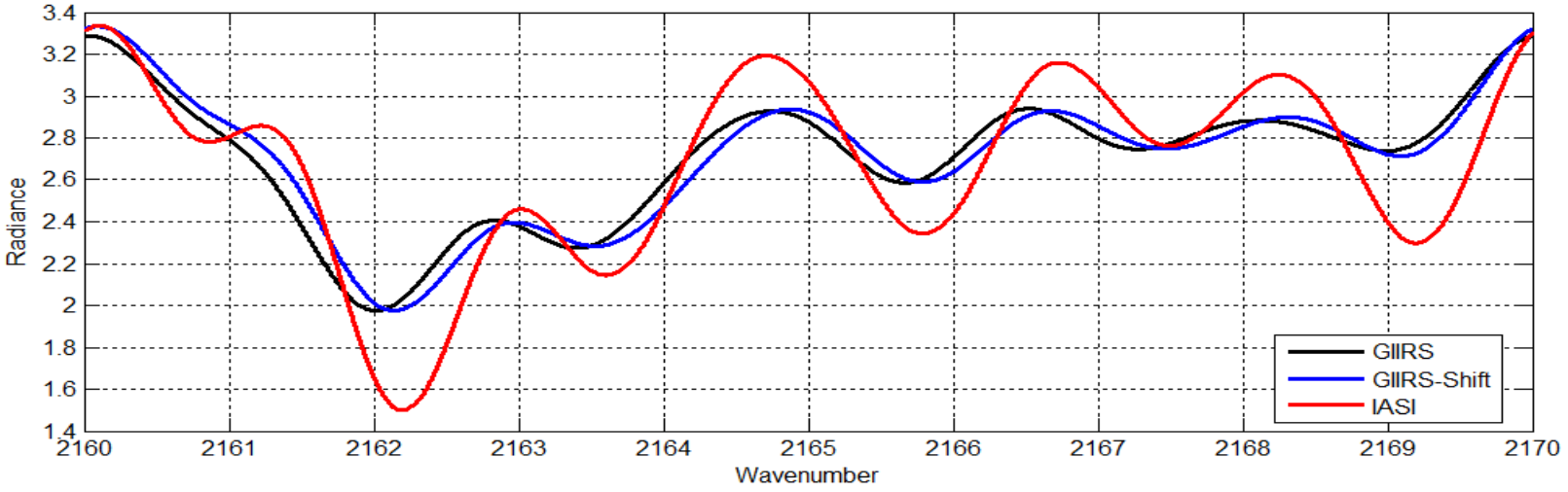
After: corrected with 66ppm



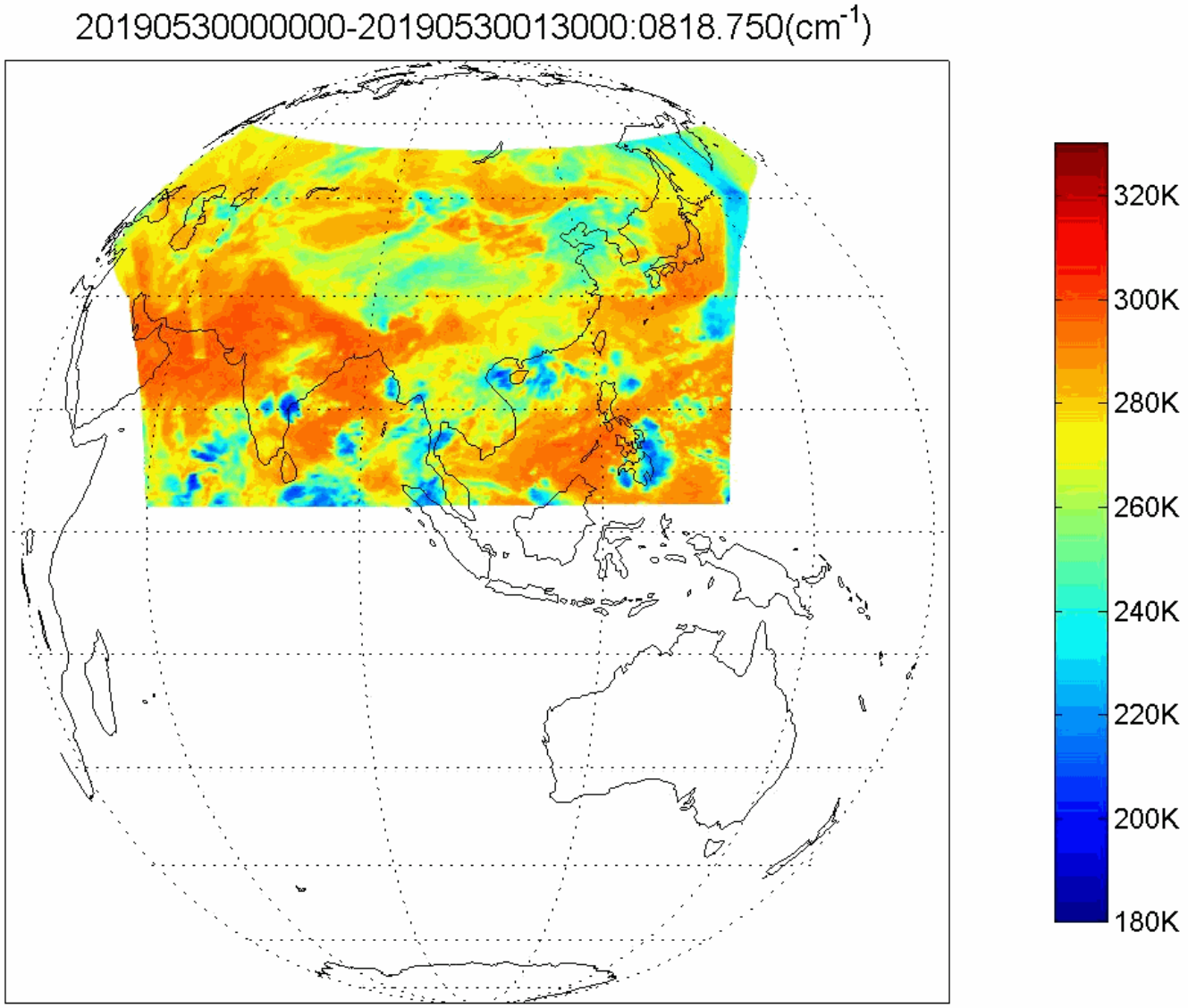




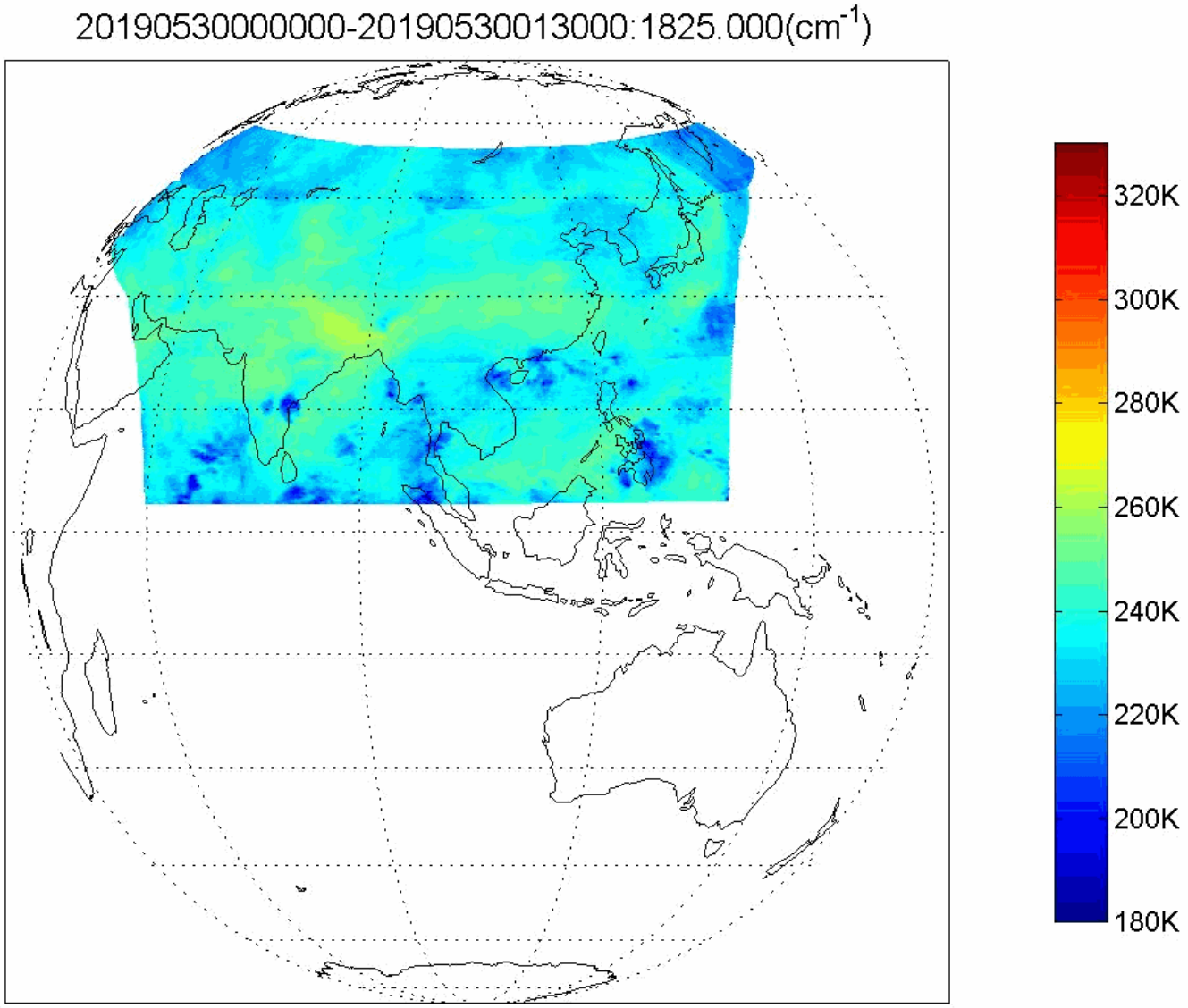
CO Absorption Region



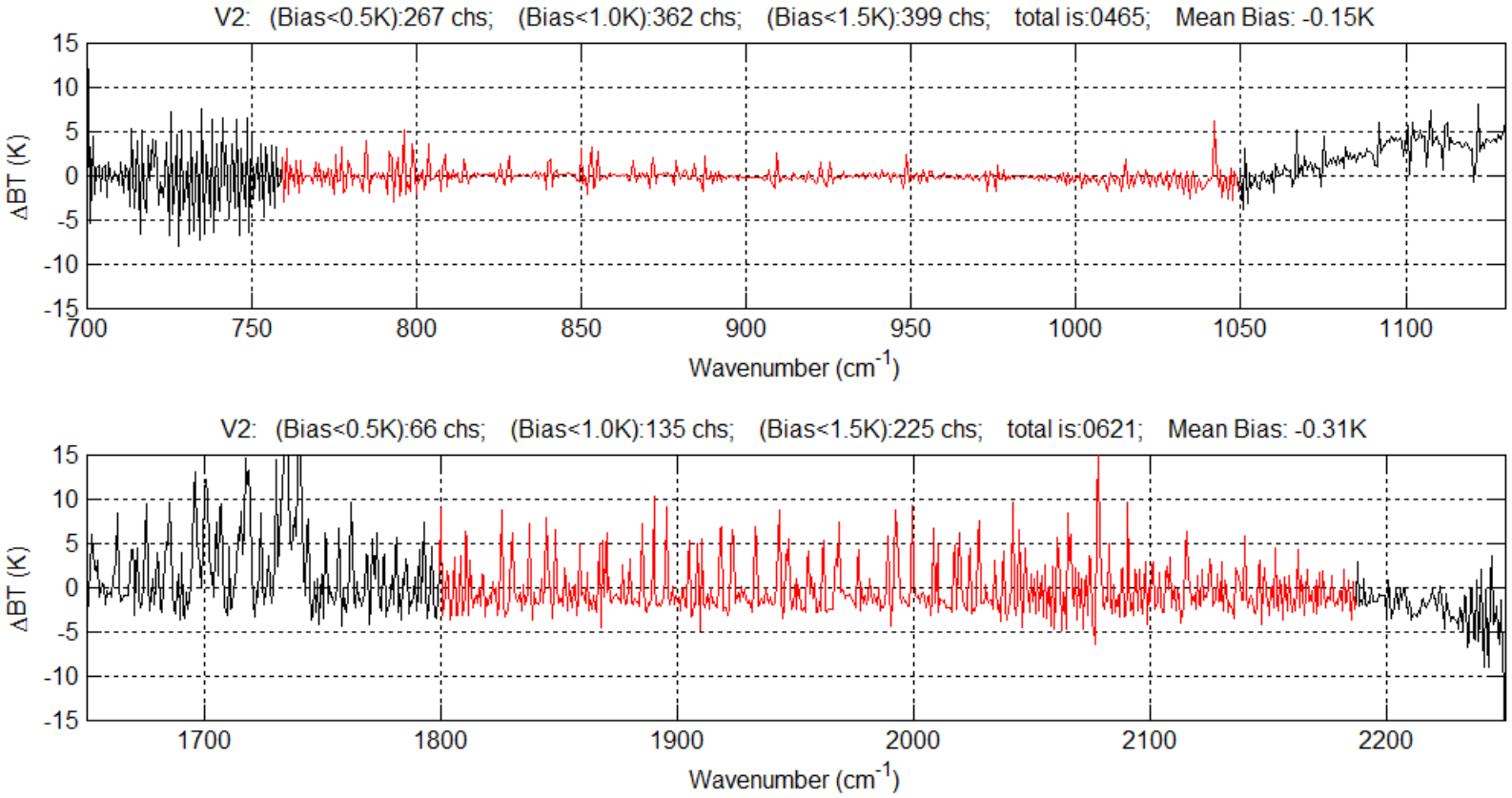
15-day Animation (LW: 0818.750cm^{-1})



15-day Animation (MW: 1825.000cm^{-1})

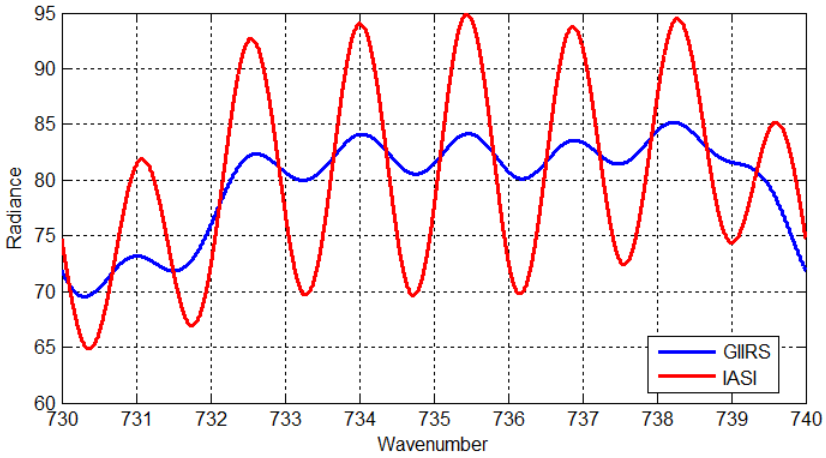


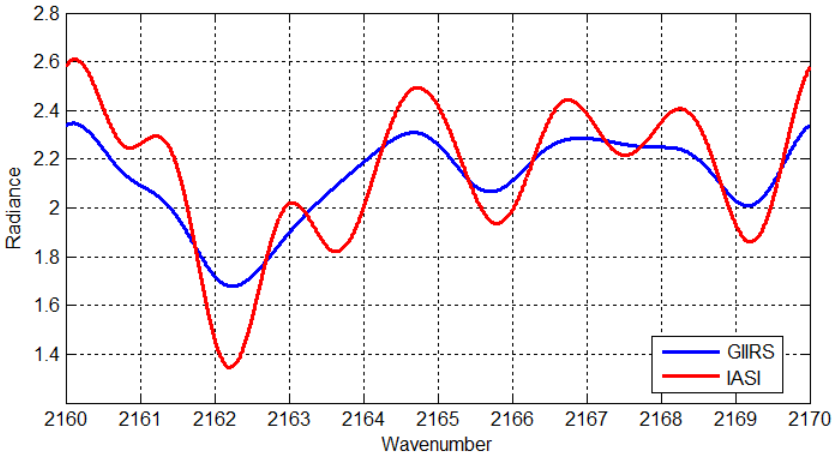
Inter-comparison between GIIRS and IASI (20190814~20190818)



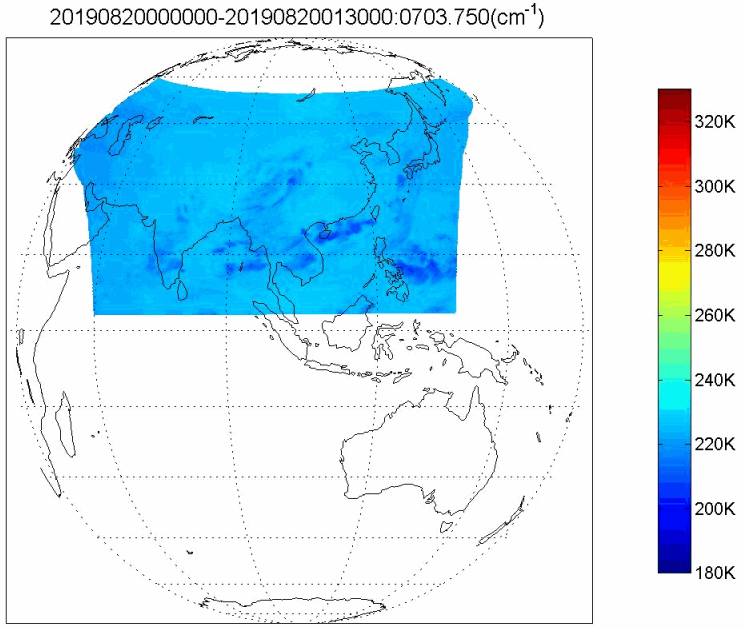
band	Radiometric Calibration				Spectral Calibration	
	≤0.5K	≤1.0K	≤1.5K	Mean Bias	Mean	STD
LW	267/465	362/465	399/465	-0.2K	6ppm	13ppm
MW	66/621	135/621	225/621	-0.3K	4ppm	15ppm

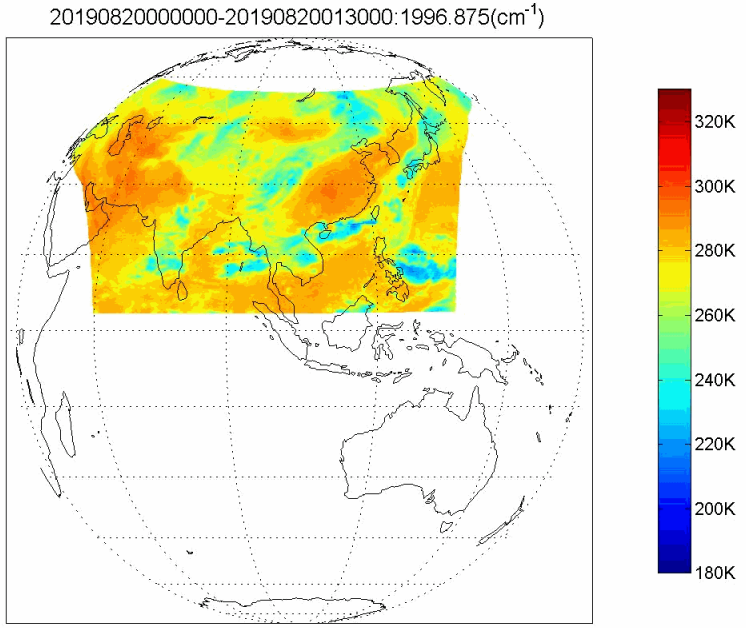
Results of Spectral Shifts Comparison





Latest 48h Animations of typical channels in both LW and MW bands

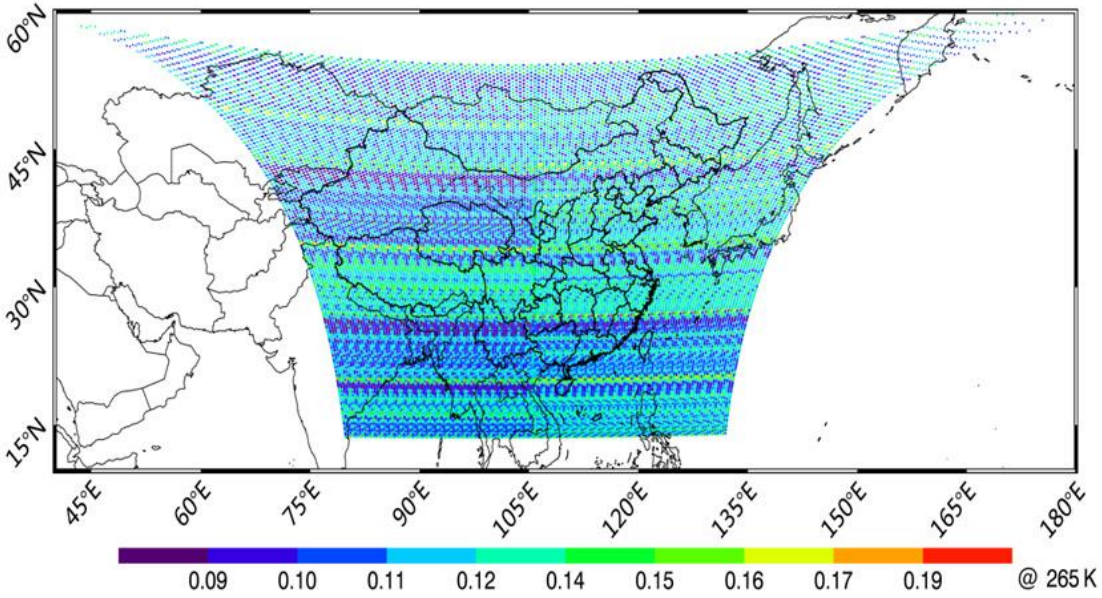




Follow-up Improvements

- **Nonlinearity** correction for atmospheric absorption channels;
- **Diurnal** variation radiometric biases correction;
- **Angle-dependent** variation radiometric biases correction;

……



Summary

- ✓ The new version (V2) L1 data of FY-4A/GIIRS is available since 0400 August 13, 2019 (UTC), where the improved spectral and radiometric calibration method are utilized.
- ✓ The Hamming apodization function is adopted in V2 L1 data of FY-4A/GIIRS.
- ✓ Compared with IASI, the radiometric biases of GIIRS are less than 0.5K for warm window channels, and its spectral shifts of both LW and MW bands are less than 8ppm.
- ✓ More improvements, i.e. nonlinearity, diurnal and angle-dependent bias corrections, will be done in the near future.
- ✓ The proposed spatial collocation method (QFO) is widely suitable for two Fourier Transfer Sounders (FTSs) intercomparison with not only GEO-LEO but also LEO-LEO modes, and is believed to be benefit to GSICS community for the relevant applications.

Thanks for your attention

Question?