Brief introduction of the hyper-spectral infrared sounder from FY-4A and FY-3D

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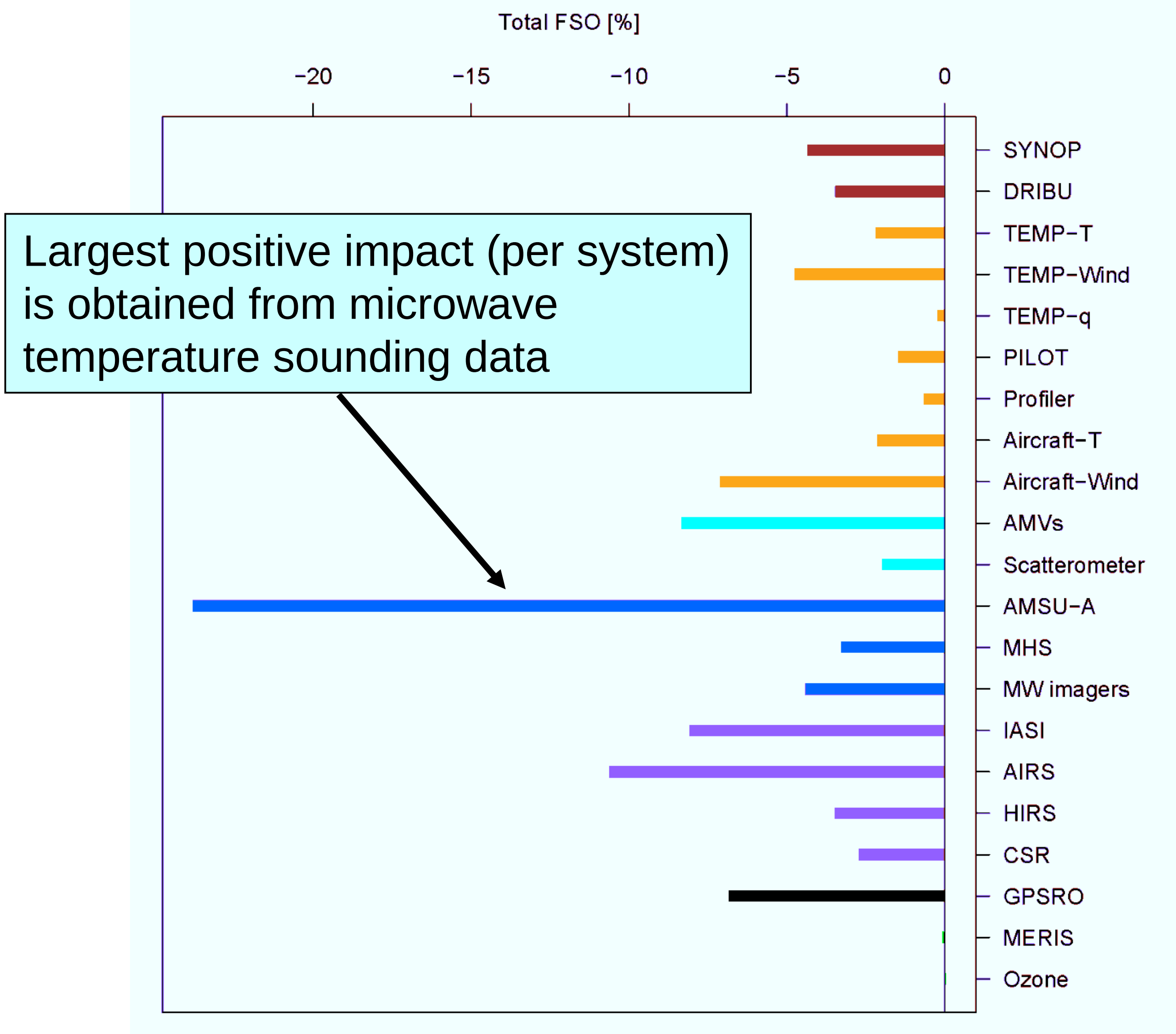
Thanks to all contributors from CMA, ECMWF, UKMO and more to this talk

Outline

- The evolution of FY-3/4 for NWP
- What we are doing to prepare for the interferometer
- The HIRAS of FY-3D
- The GIIRS of FY-4A
- Discussion and possible cooperation

1. The evolution of FY-3/4 for NWP



Forecast sensitivity to observations (FSO) Is an adjoint based technique for assessing the influence of observing systems on forecast accuracy

(from C. Cardinali, ECMWF)

The FY-3A/B/C/D/E Instrument Suites for NWP

Infrared Atmospheric Sounder (IRAS) 20 channels (~HIRS/3)
HIRAS(1370channels)

Microwave Temperature Sounder (MWTS) 4 channel (~MSU)
13 channels
17 channels

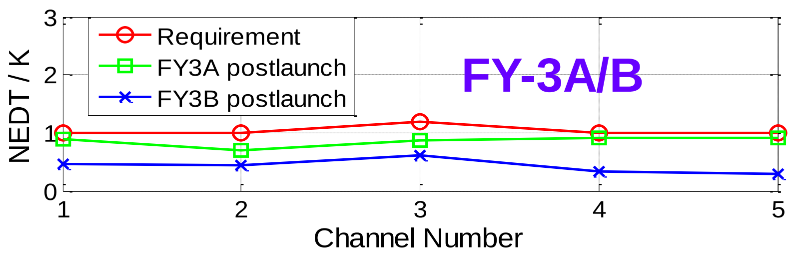
Microwave Humidity Sounder (MWHS) 5 channel (~MHS)
15channels with channels at 118 GHz

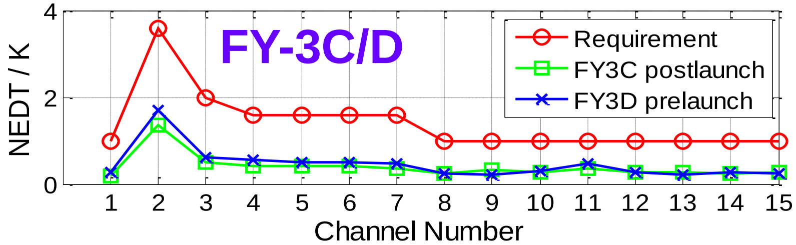
WindRAD
C ,Ku
HH, VV

Microwave Radiation Imager 10 channels (~AMSR-E)

GNSS Radio-Occultation Sounder (GNOS) (~GPS)

Microwave temperature and humidity sounder



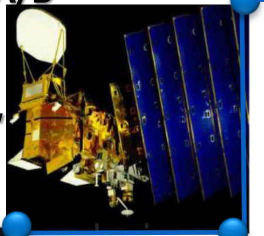


Metop/AMSUA/ MHS
90,150,183GHz,
launched, 2006,
On service.

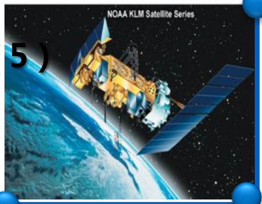
Aqua/ HSB
90,150,183GHz,
launched, 2002,
On service.

Suomi-NPP/ATMS
50-60,90GHz
150,183GHz,
launched, 2009,
On service.

NOAA/ AMSU-A/B
50-60,90GHz
150,183GHz,
launched, 1998,
On service.



DMSP/ SSM/T-2
90,150,183GHz (5)
launched, 1991,
out of service.



TIROS-N/ MSU
50-60GHz,
launched, 1978,
out of service.

DMSP/ SSM/T
50-60GHz (7) ,
launched, 1979,
out of service.

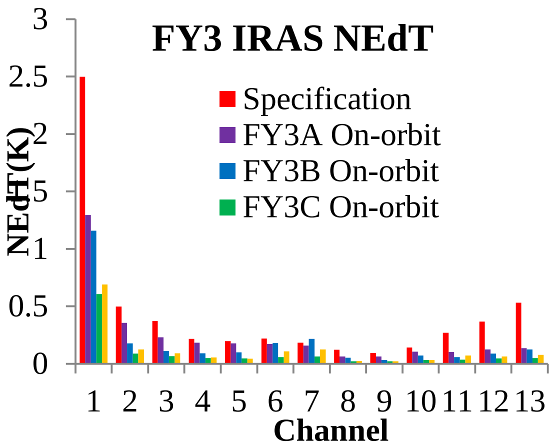
FY3D/ MWTHS
50-60GHz(17)
89GHz(1)
118GHZ(8)
150/166(1)
183GHZ(5)
to be launched in 2017

FY3C/ MWTHS
50-60GHz(13)
89GHz(1)
118GHZ(8)
150/166(1)
183GHZ(5)
launched, 2013

FY3B/ MWTHS
50-60GHz(4)
150 (2)
183GHZ(3)
launched, 2010

FY3A/ MWTHS
50-60GHz(4)
150 (2)
183GHZ(3)
launched, 2008

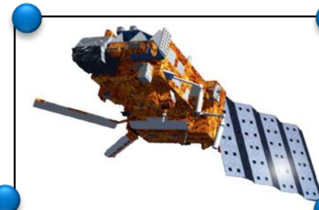
Infrared Sounding Instruments



NIMBUS-3/SIRS-A
1969,
out of service.

TOVS/ HIRS
1978,
out of service.

AQUA/ AIRS
2002
on service.



METOP-A/ IASI、HIRS
2006
On service.

Suomi-NPP/ CrIs
2011
On service

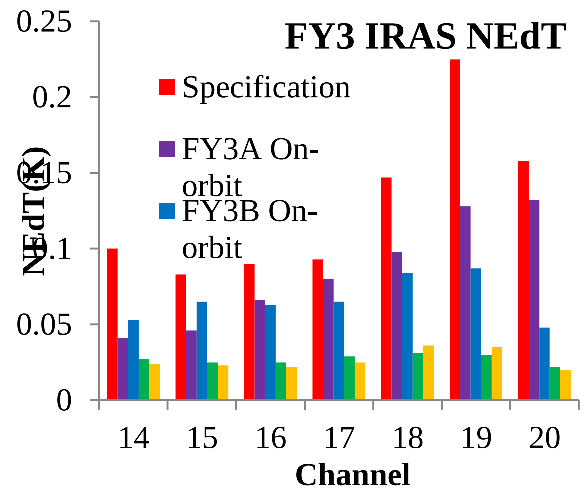
METOP-B/ IASI、HIRS,
2012
On service

FY3A/ IRAS
3.7~15μm(20)
0.69~1.64μm(6)
launched, 2008

FY3B/ IRAS
3.7~15μm(20)
0.69~1.64μm(6)
launched, 2010

FY3C/ IRAS
3.7~15μm(20)
0.69~1.64μm(6)
launched, 2013

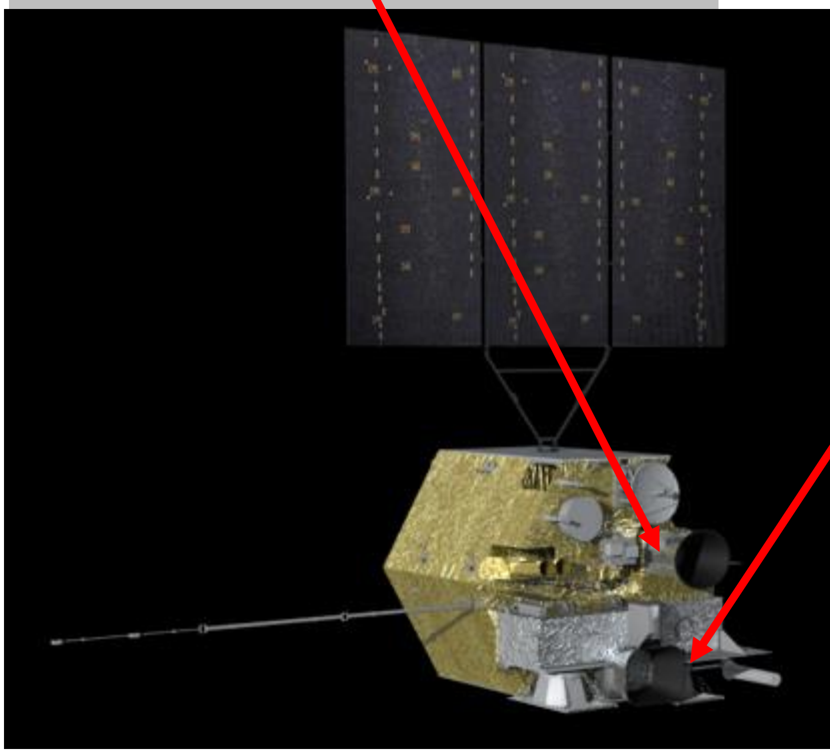
FY3D/ HIRAS
15.38~8.8μm(LW)
8.26~5.71μm(MW1)
4.64~3.92μm(MW2)
to be launched in 2017

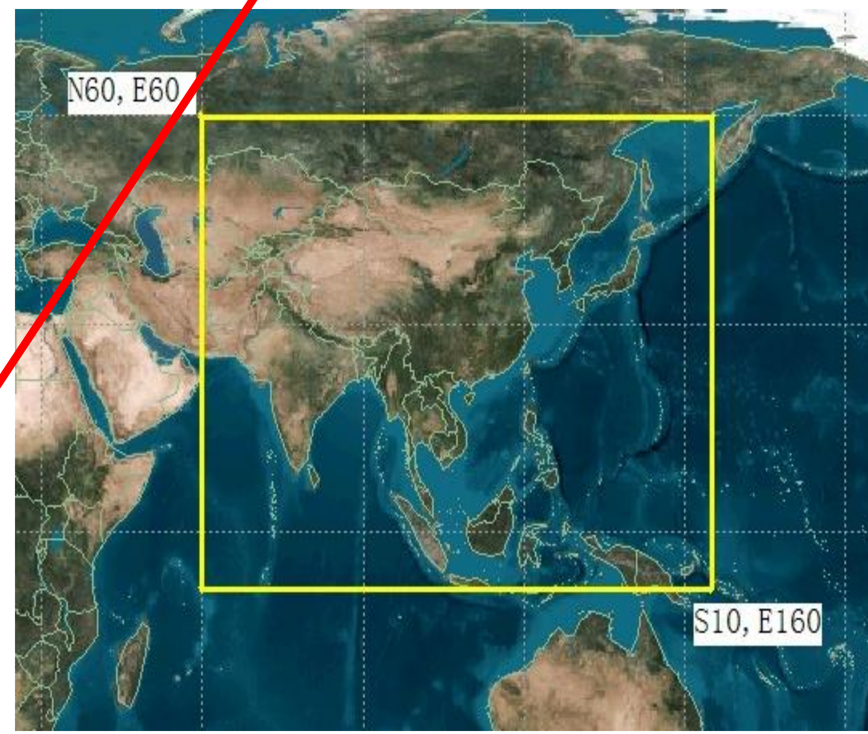


The FY-4A Instrument Suites for NWP

Geo. Interferometric Infrared Sounder(GIIRS)(1650channels) by the Shanghai Institute of Technical Physics of the Chinese Academy of Sciences

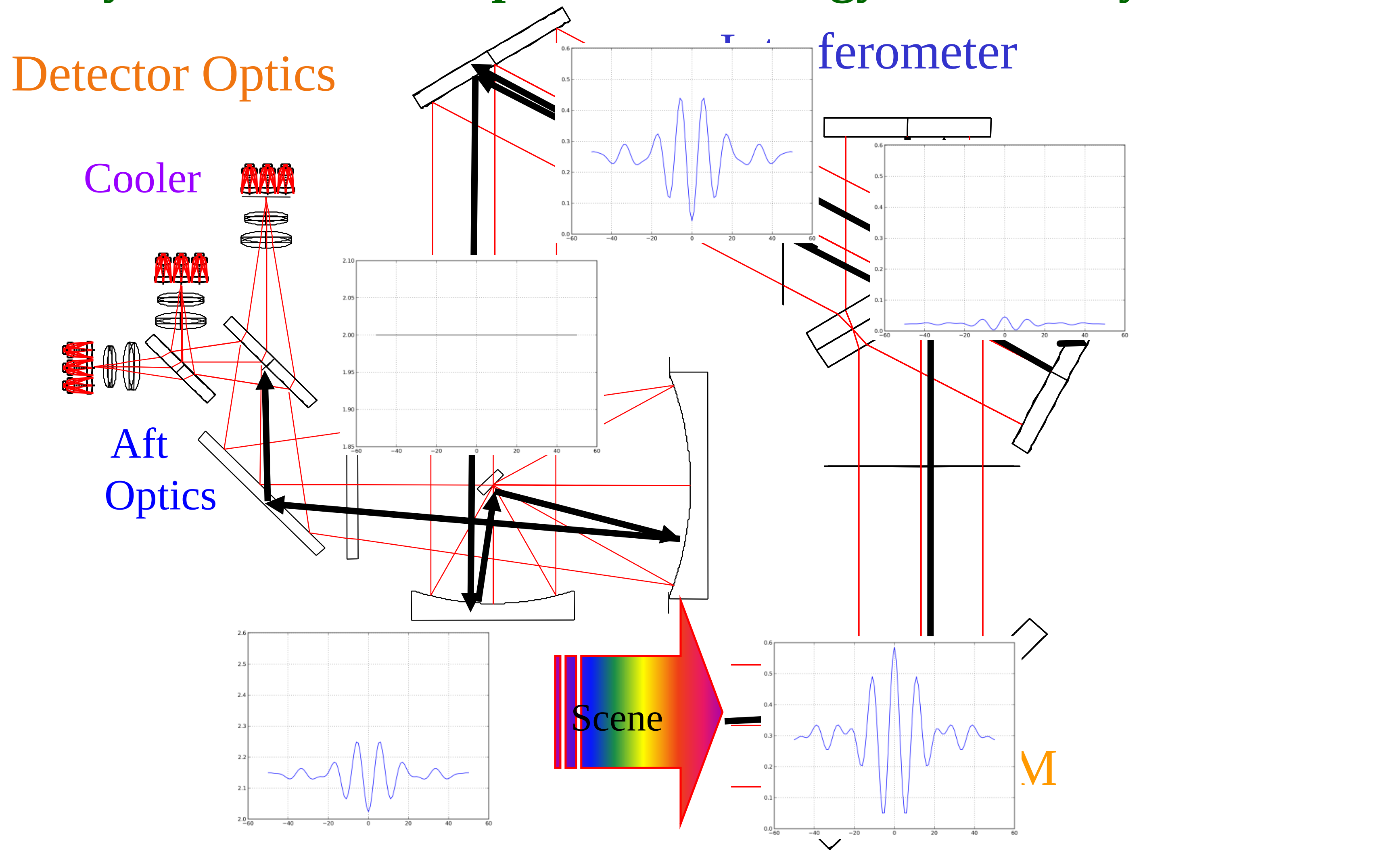
Advanced Geostationary Radiation Imager (AGRI))(16channels)





2. What we are doing for the interferometer

Generally, there are 4 components of energy received by the detector



Optical Diagram of Interferometer

Cold reference: $\widetilde{S}^{C} = A^{in} e^{i\phi^{in}}$

Hot reference: $\widetilde{S}^{H} = A^{H} e^{i\phi^{ext}} + A^{in} e^{i\phi^{in}}$

Scene Measurement: $\widetilde{S}^{S} = A^{S} e^{i\phi^{ext}} + A^{in} e^{i\phi^{in}}$

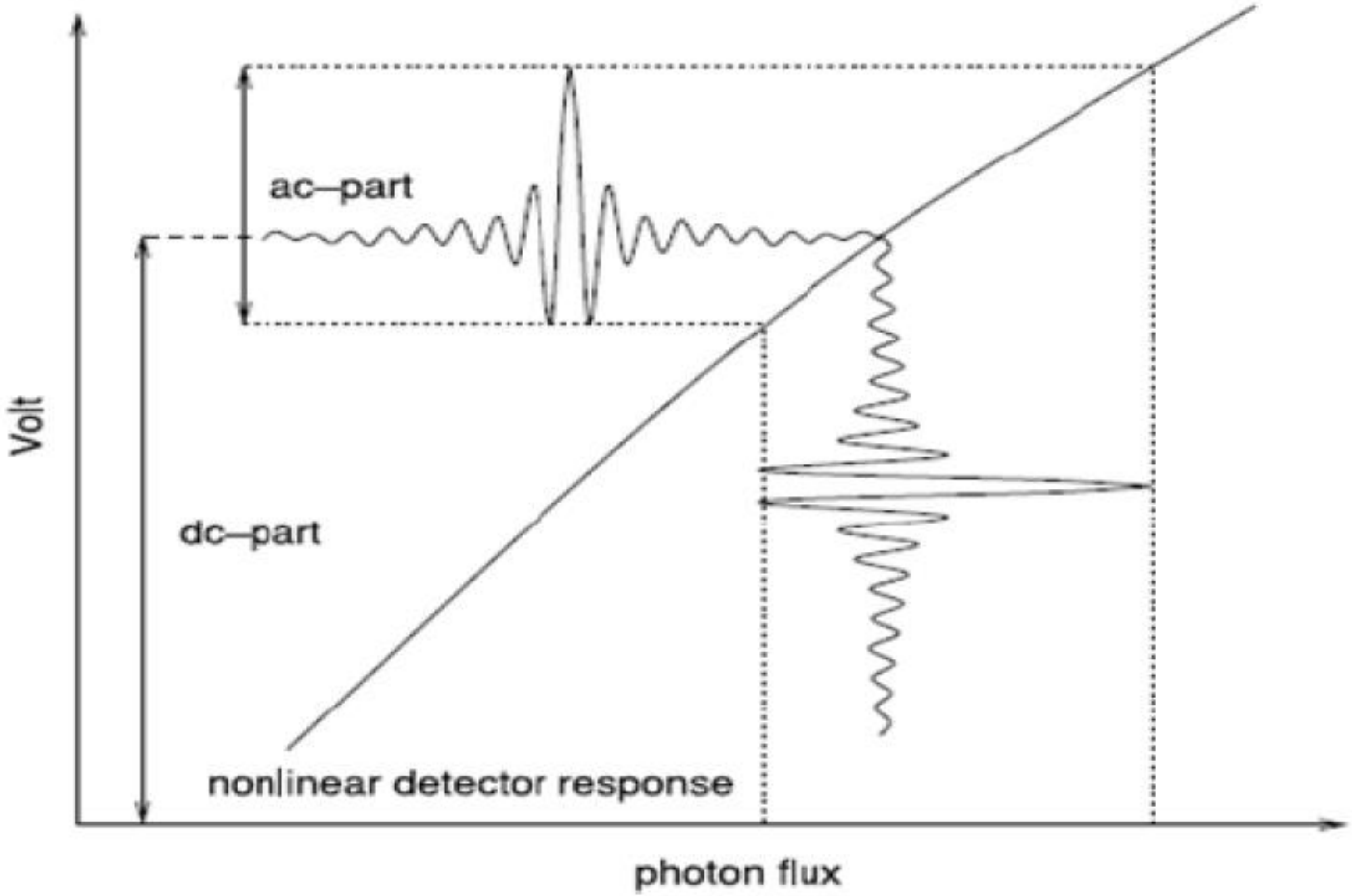
During Calibration, the instrument emission could be removed by abstracting the cold reference signal from Hot reference or scene measurements.

Items affecting calibration precision

Modules that have been or will be incorporated in the ground segment algorithms:

- Interferogram alignment
- Non-linearity correction
- Self apodization correction
- Different calibration equation
- Doppler shift correction
- Polarization correction --- not been incorporated yet

Schematic diagram of nonlinearity



the basis of NL correction based on spectrum

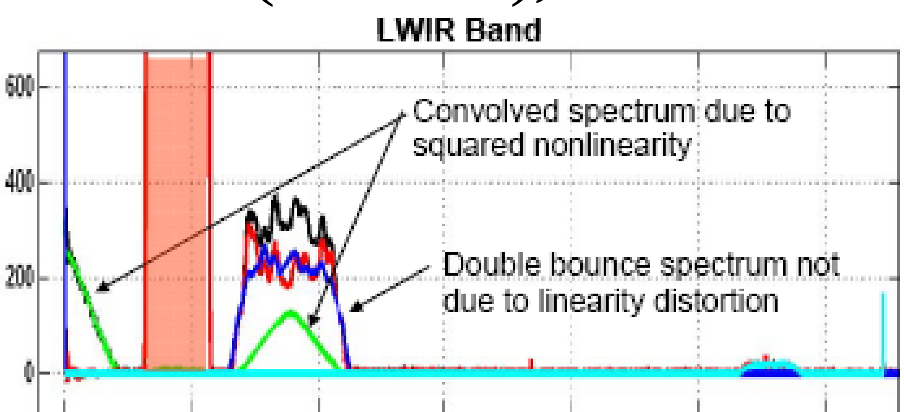
$$IGM_{ideal}+V_{ideal}=(IGM_{measure}+V)+a_2*(IGM_{measure}+V)\verb|^|2+....$$

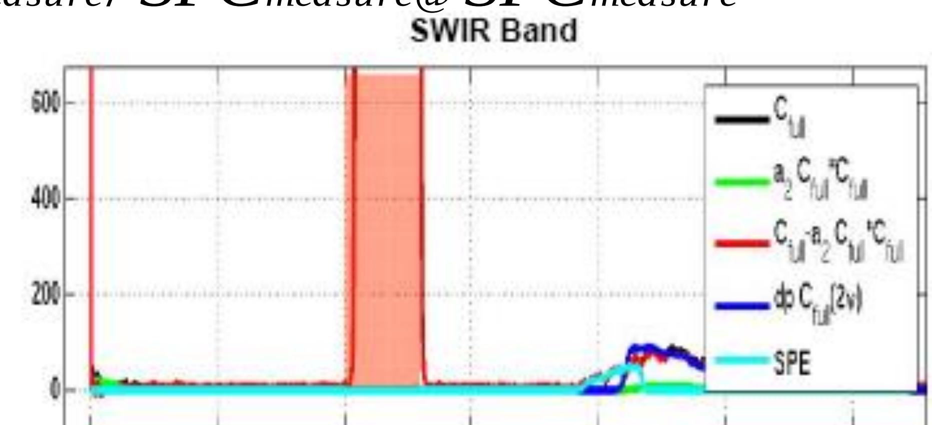
$$IGM_{ideal}=(1+2a_2V)IGM_{measure}+a_2*IGM_{measure}\verb|^|2+V\verb|^|2+V_{ideal}+...$$

$$SPC_{ideal}=(1+2a_2V)SPC_{measure}+a_2*SPC_{measure}@SPC_{measure}$$

$$(1+2a_2V)SPC_{measure}+a_2*SPC_{measure}@SPC_{measure}=0$$

$$a_2=a_2'/(1-2Va_2'),a_2'=-SPC_{measure}/SPC_{measure}@SPC_{measure}$$



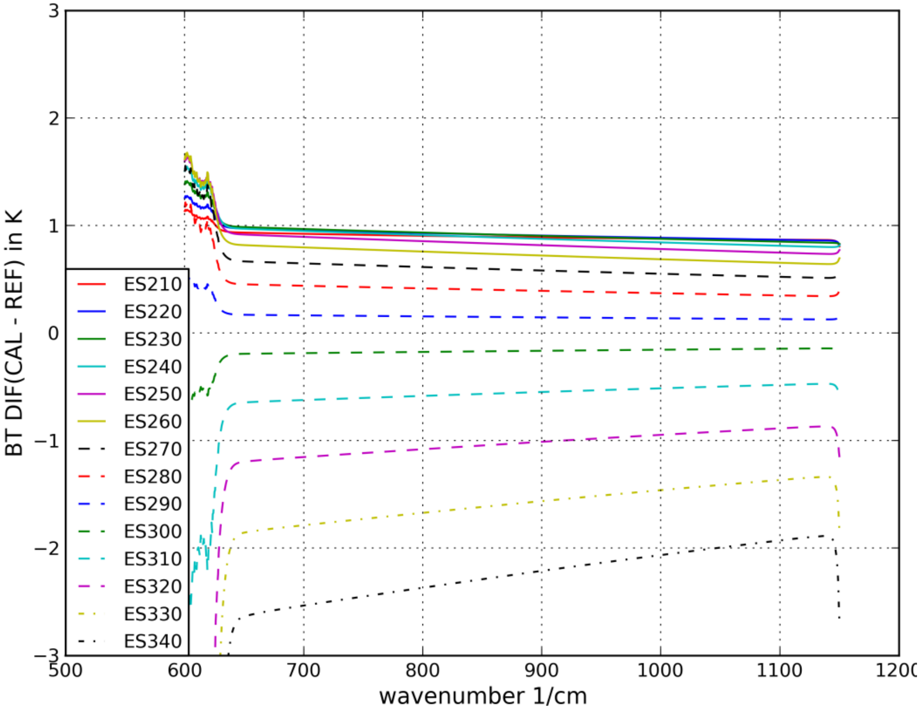


$$IGM_{ideal}+V_{ideal}=(IGM_{measure}+V)+a_2*(IGM_{measure}+V)\verb|^|2+....$$

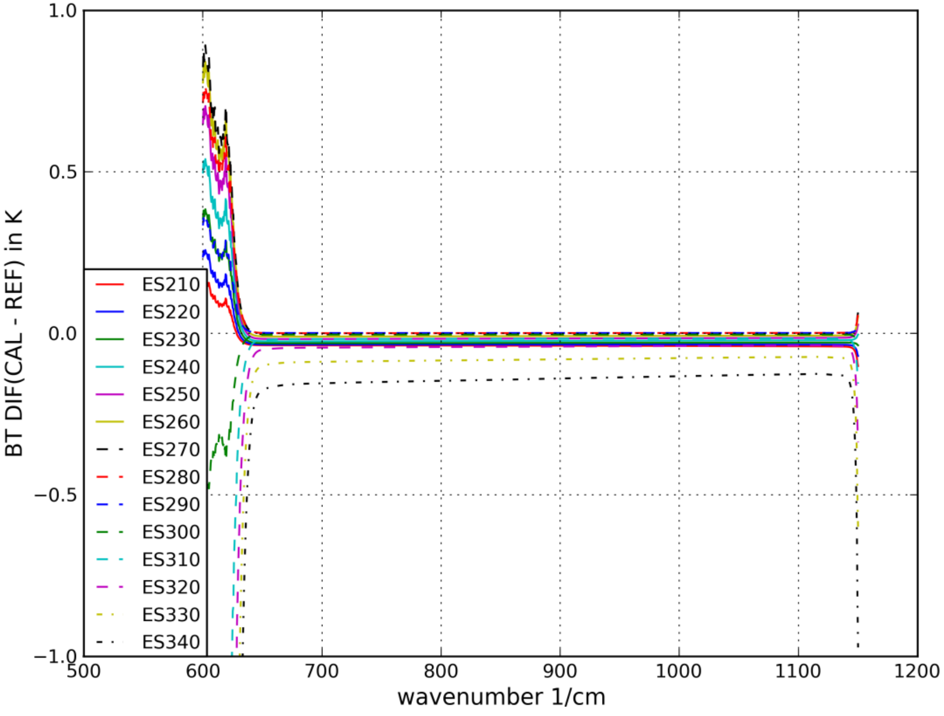
$$SPC_{ideal}=(1+2a_2V)SPC_m$$

Effect of Nonlinear Correction, simulation

Before Correction



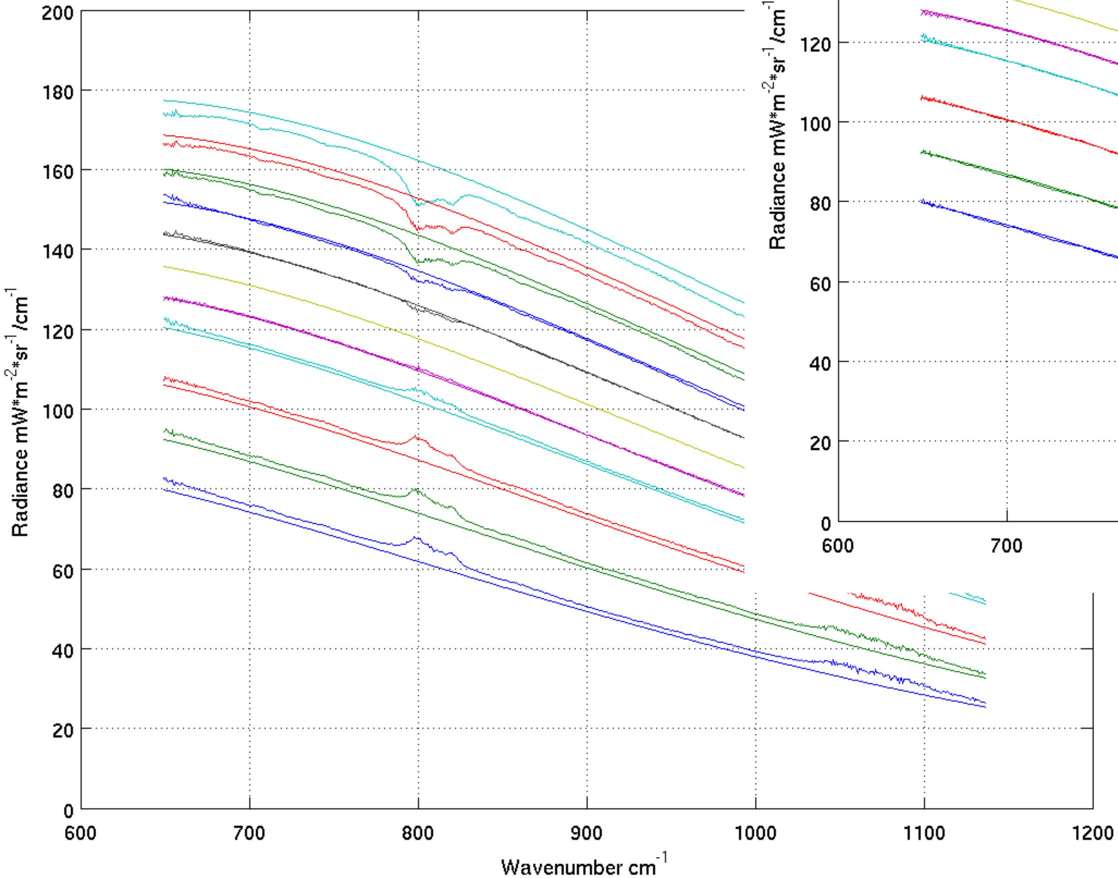
After Correction

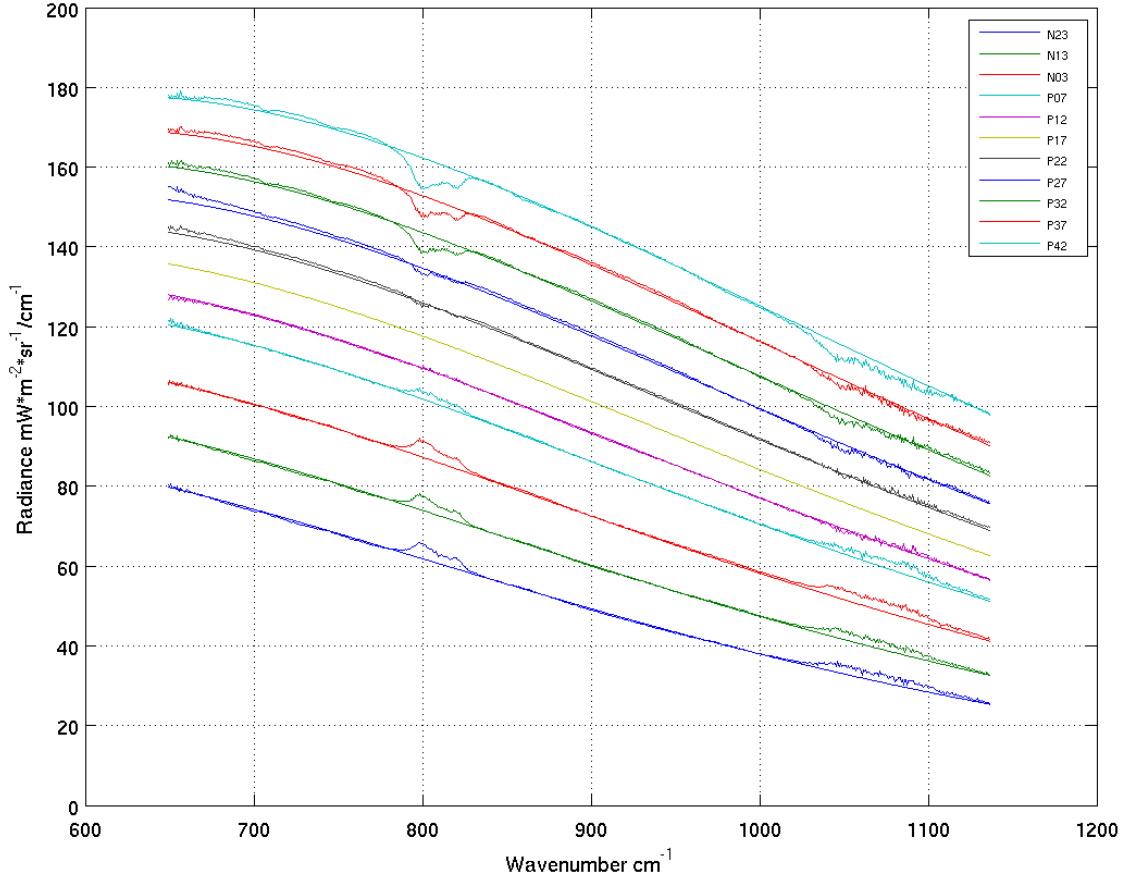


Polynomial

Effect of Nonlinear Correction, TVAC

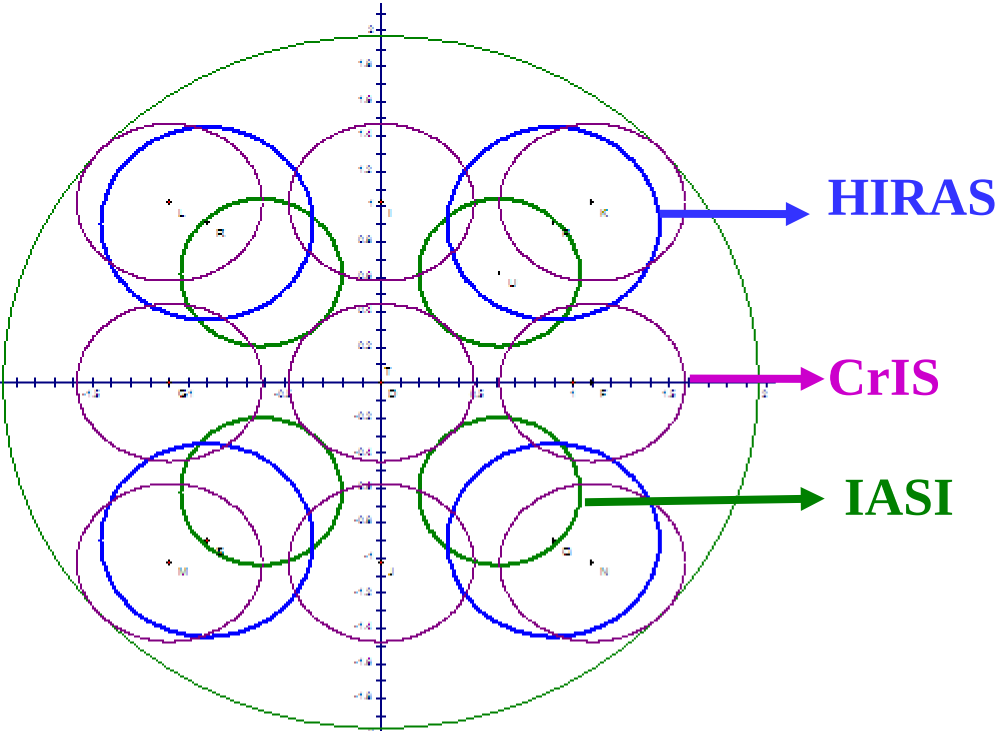
FOV1
Before correction





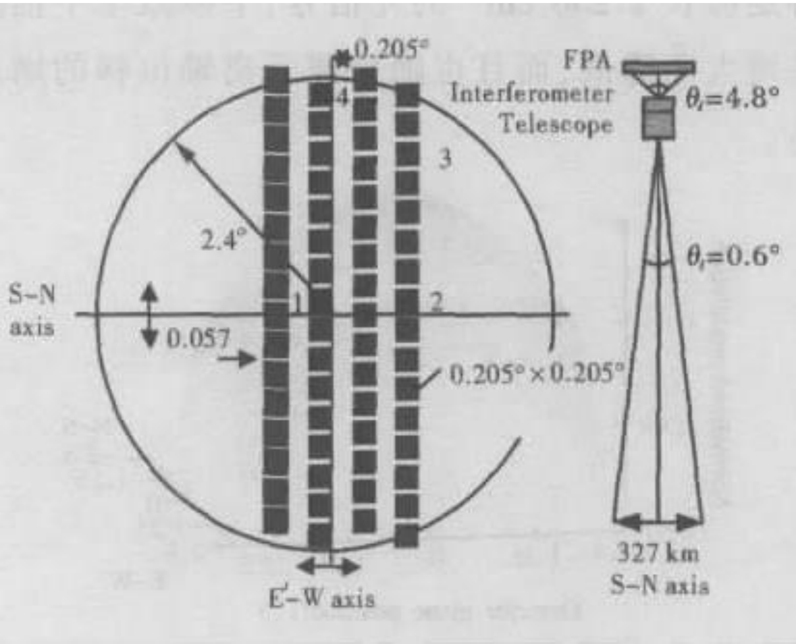
FOV1
After Correction

Self-appodization:
Geometry of focal planes



From the PPT of Dr. Gu Mingjian

FY4A GIIRS



From Jiankun Zhang et al, 2006

Self-apodization correction

Collimating lens.

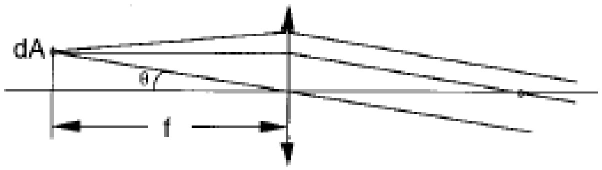


Fig. 4. Collimating lens.

$$r = f\tan\theta, \quad v = v_0\cos\theta$$

$$r = f\left(\frac{v_0^2}{v^2} - 1\right)^{1/2}$$

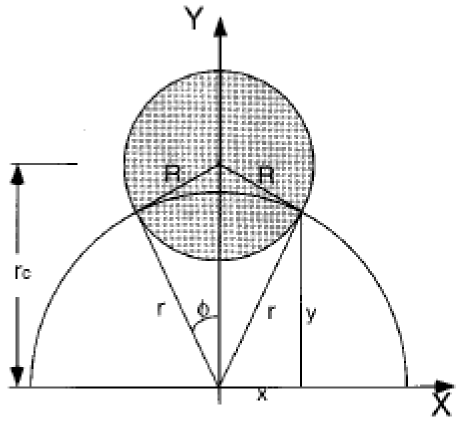


Fig. 6. Geometry for an off-axis circular detector.

$$I_n = \frac{2\phi}{2\pi} = \frac{2\arccos y/r}{2\pi}$$

$$x^2 + (y - r_c)^2 = R^2, x^2 + y^2 = r^2$$

$$\Rightarrow y = ({r_c}^2 + r^2 - R^2)/(2r_c)$$

$$I_n = \frac{2\phi}{2\pi} = \frac{1}{\pi}\arccos\frac{{r_c}^2 + r^2 - R^2}{2rr_c}$$

$$= \frac{1}{\pi}\arccos\frac{{r_c}^2 + f^2(v_0^2/v^2 - 1) - R^2}{2r_c f(v_0^2/v^2 - 1)^{1/2}}$$

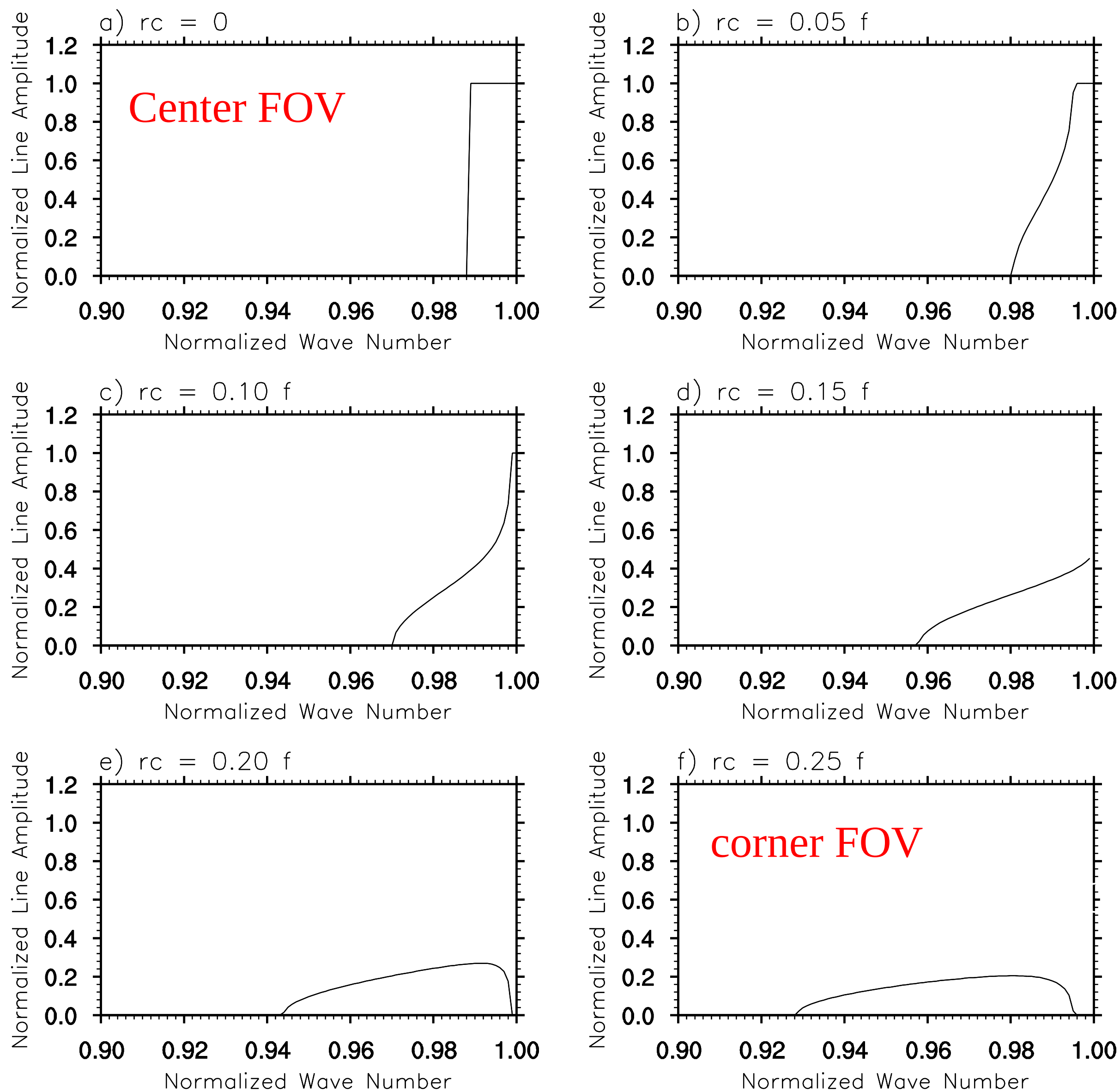
$$ILS = \begin{cases} 0 & v_0/v > (1 + r_{\max}^2/f^2)^{1/2} \\ \dfrac{1}{\pi}\arccos\dfrac{{r_c}^2 + f^2(v_0^2/v^2 - 1) - R^2}{2r_c f(v_0^2/v^2 - 1)^{1/2}} & (1 + r_{\min}^2/f^2)^{1/2} < v_0/v < (1 + r_{\max}^2/f^2)^{1/2} \\ 1 & v_0/v < (1 + r_{\min}^2/f^2)^{1/2}, r_{\min} < 0 \\ 0 & v_0/v < (1 + r_{\min}^2/f^2)^{1/2}, r_{\min} > 0 \end{cases}$$

$$r_{\min} = r_c - R, \qquad r_{\max} = r_c + R,$$

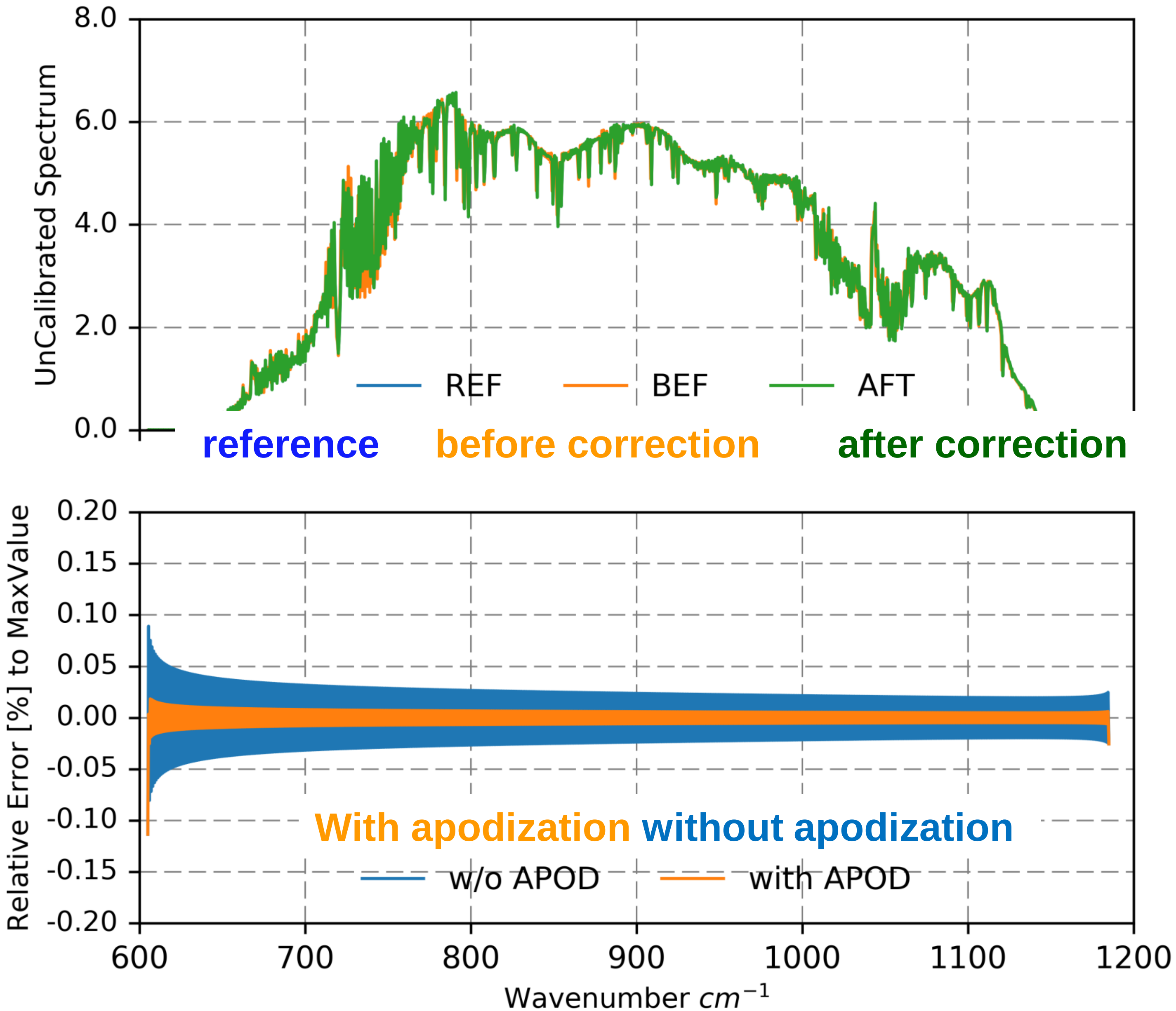
From Genest and Tremblahy 1999

Instrument line shape function

ILS with different ILS parameters

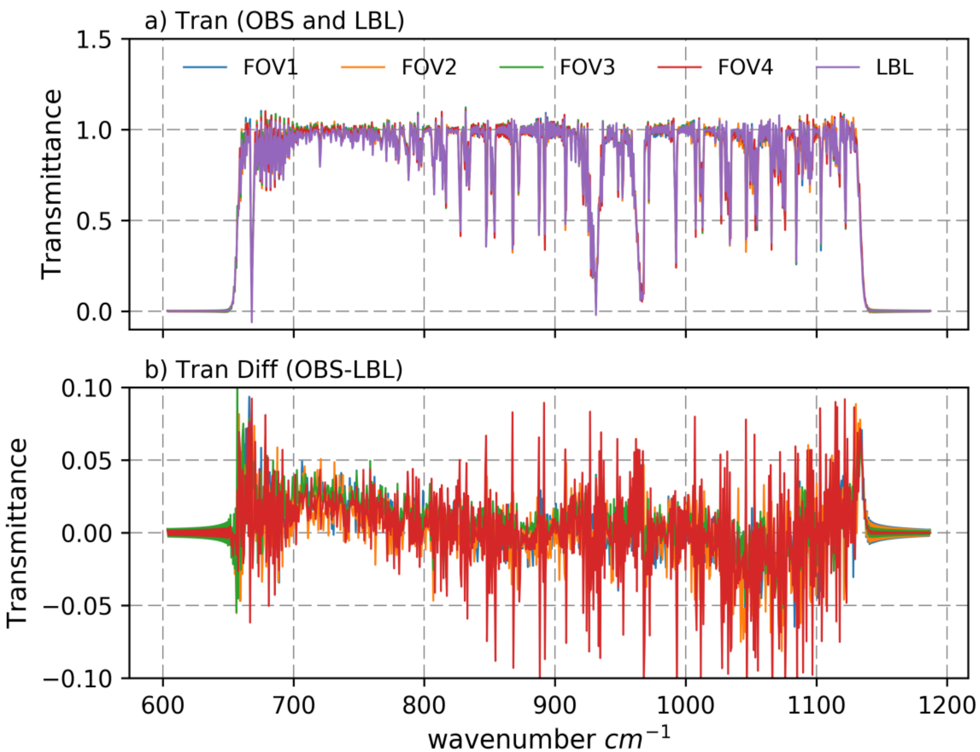


Validation using simulation data

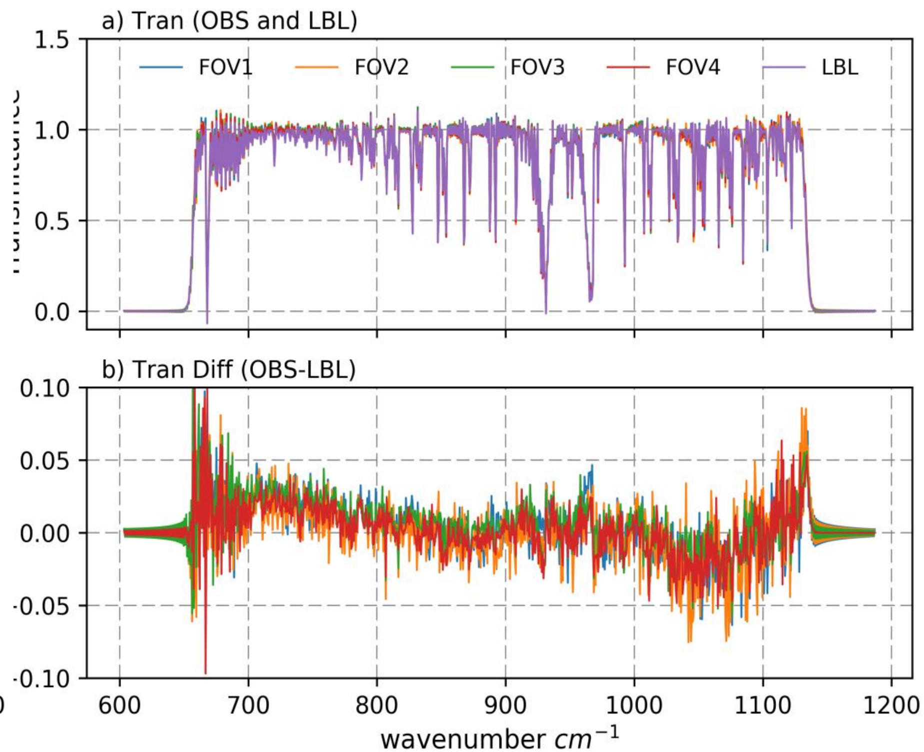


Optimize ILS Parameter Based on TVAC

Before ILS/Sampling frequency adjustment



After ILS/Sampling frequency adjustment



- ◆ The absorption spectrum of NH3 are used.
- ◆ The difference transmittance between OBS and LBL are 2-4 times larger than those of CrIS, which is around 0.01-0.02

Calibration equation

Two major calibration equations implemented in ground segments

$$E1: S_{ES} = F \cdot SA^{-1}\,\mathrm{Re}\{ f_{c1}[n] \frac{\Delta C_{ES}[n]}{\Delta C_{ICT}[n]} \{\eta B_{ICT}(n\Delta\sigma\eta)\}\}$$ Revercomb et al 1988

$$E2: S_{ES} = B_{ICT} \frac{F \cdot SA^{-1} \cdot \mathrm{Re}\{ f_{c2} \frac{\Delta C_{ES}}{\Delta C_{ICT}} |\Delta C_{ICT}|\}}{F \cdot SA^{-1} \cdot (f_{c2} |\Delta C_{ICT}|)}$$ Joe Predina et al 2015

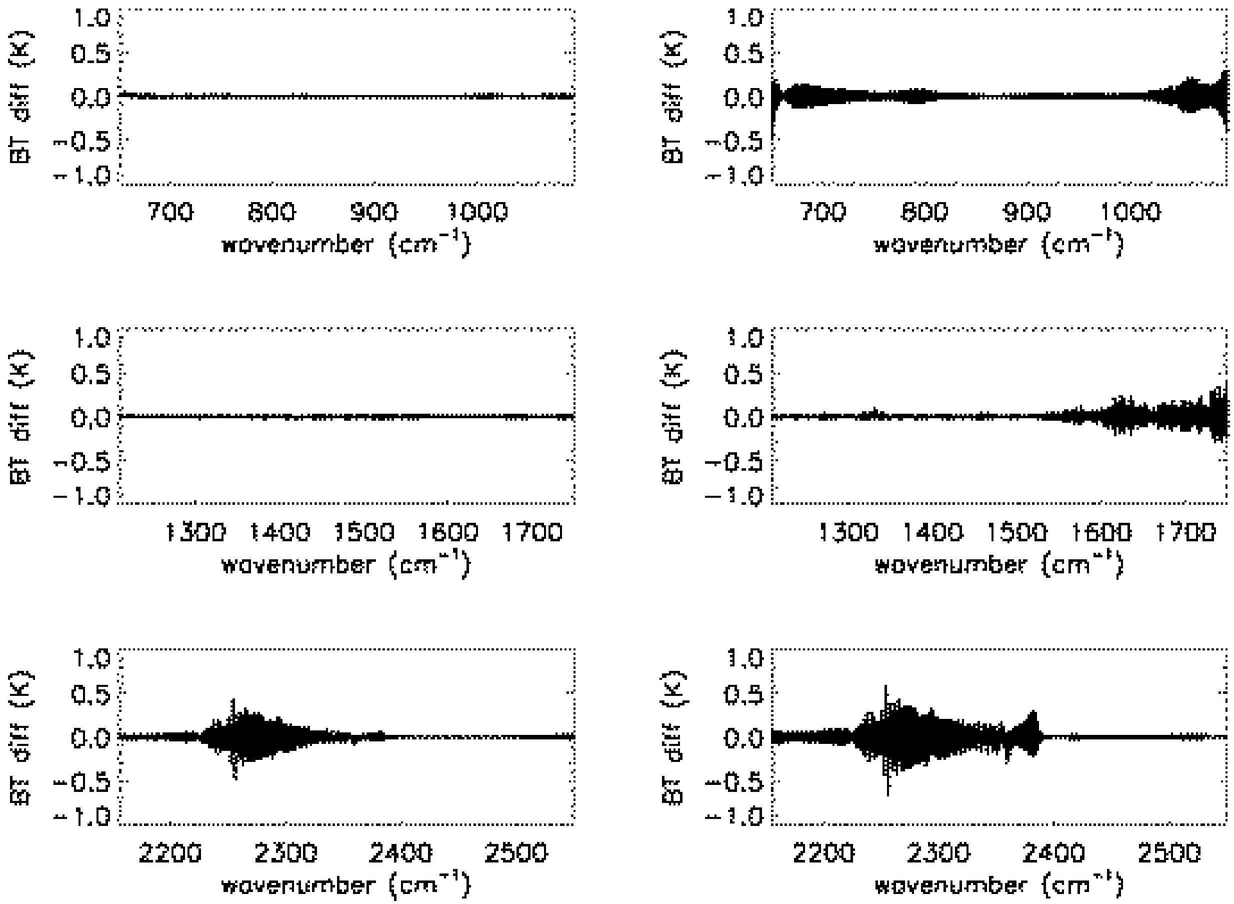
The advantage of latter equation:

1, takes into account the instrument responsivity for the spectral calibration.

2, The noise in the guard bands of the spectrum is depressed more significantly

3, the ICT radiance B_{ICT} is computed on a more realistic spectral grid

Calibration equation

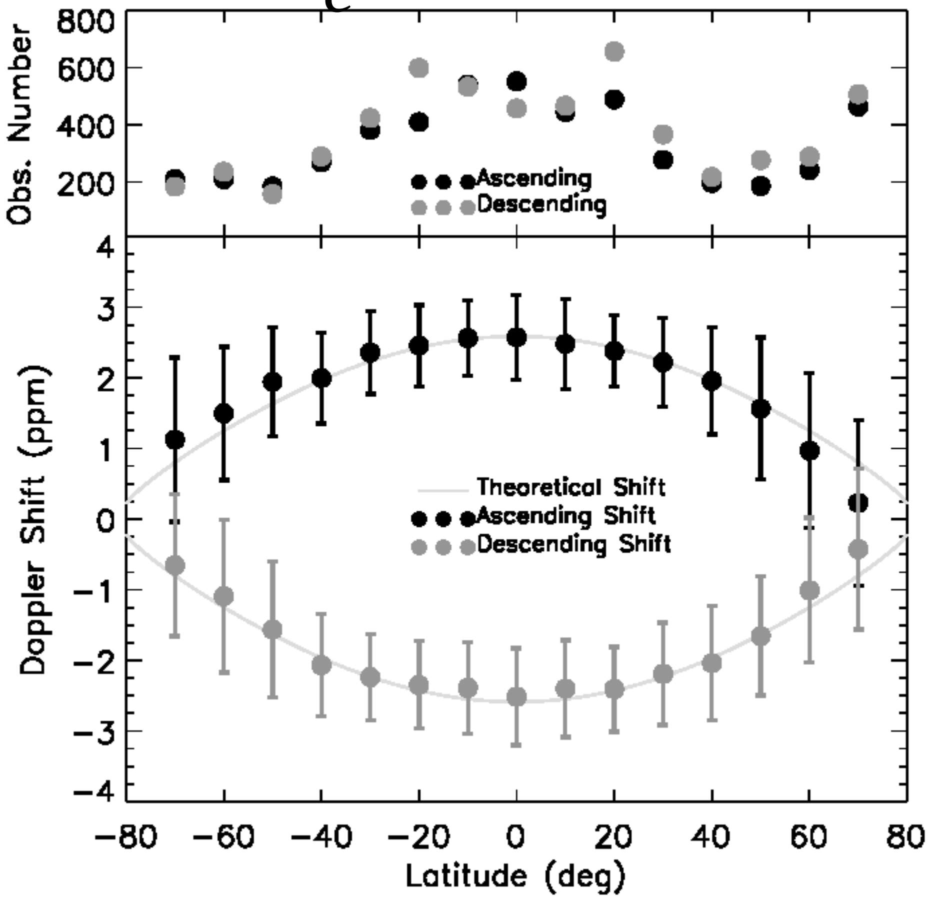


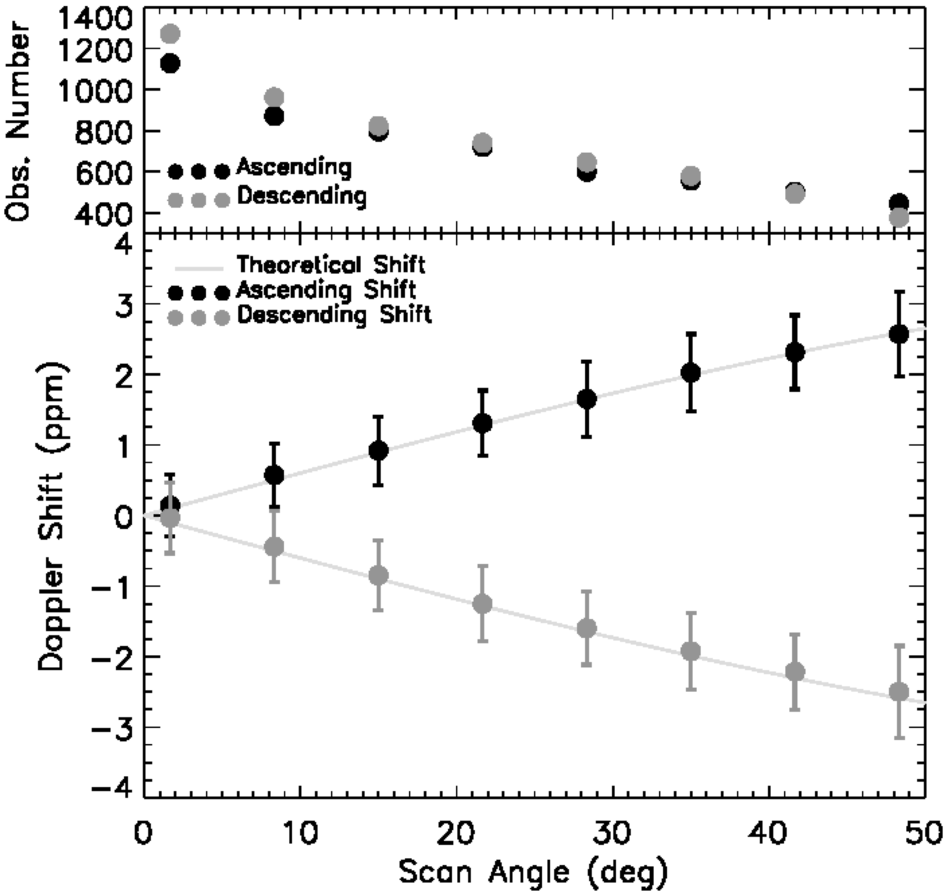
BT differences S_{E2} - S_{truth} (left) and S_{E1} - S_{truth} (right) for the FSR LWIR (top), MWIR (middle) and SWIR (bottom) bands, respectively. **From Yong Han 2016**

Doppler shift correction

Adopt the method from CrIS

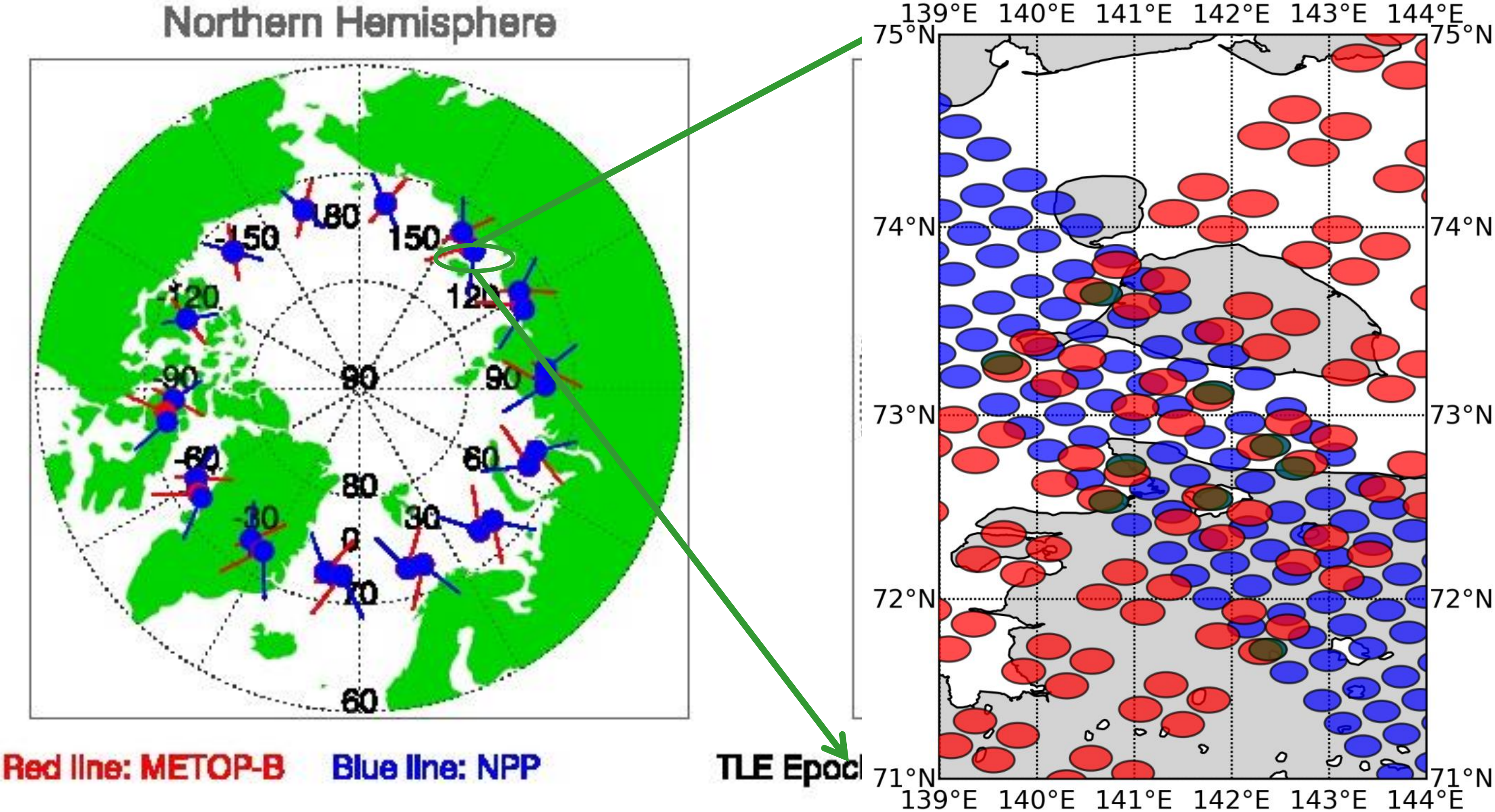
$$\Delta\sigma = \pm\frac{\sigma}{c}\Omega R_s \sin(\theta_{scan})\cos(\mu)\left|\sin(\phi_{azimuth})\right|$$





From Chen 2013

Post-launch validation: SNO



The size of dot is not the size of FOV

3.The HIRAS of FY-3D

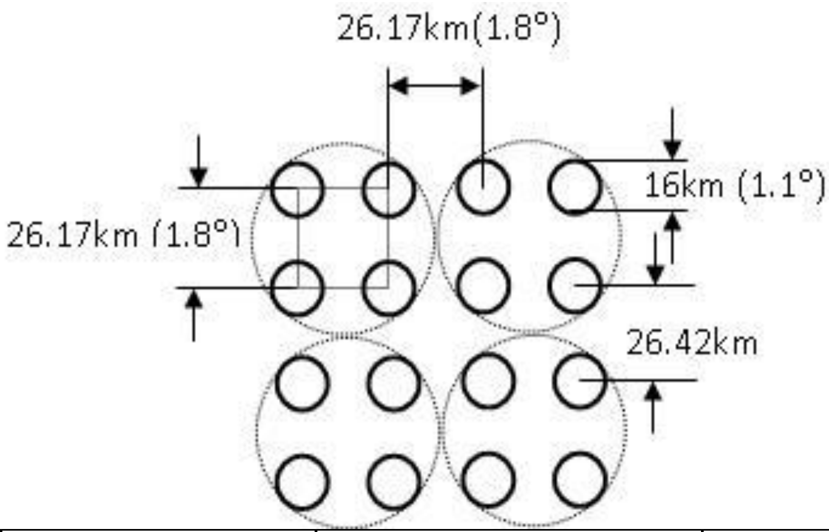
- HIRAS is a Fourier interferometer which posses of high spectral resolution, low radiometric noise and high spectral and radiometric accuracy.

HIRAS instrument characteristics

Parameters	Specification
Scan Period	10s
View angle	1.1°
Pixels per scan line	58
Scan angle	±50.4°
Radiative calibration accuracy	0.7K
Spectral calibration accuracy	7ppm
Direction pointing bias	＜±0.25°

FY-3D/ HIRAS Specifications

- ✓ HIRAS scan, field-of-regard (FOR), field-of-view (FOV)
- ✓ Nadir spatial resolution is 16km

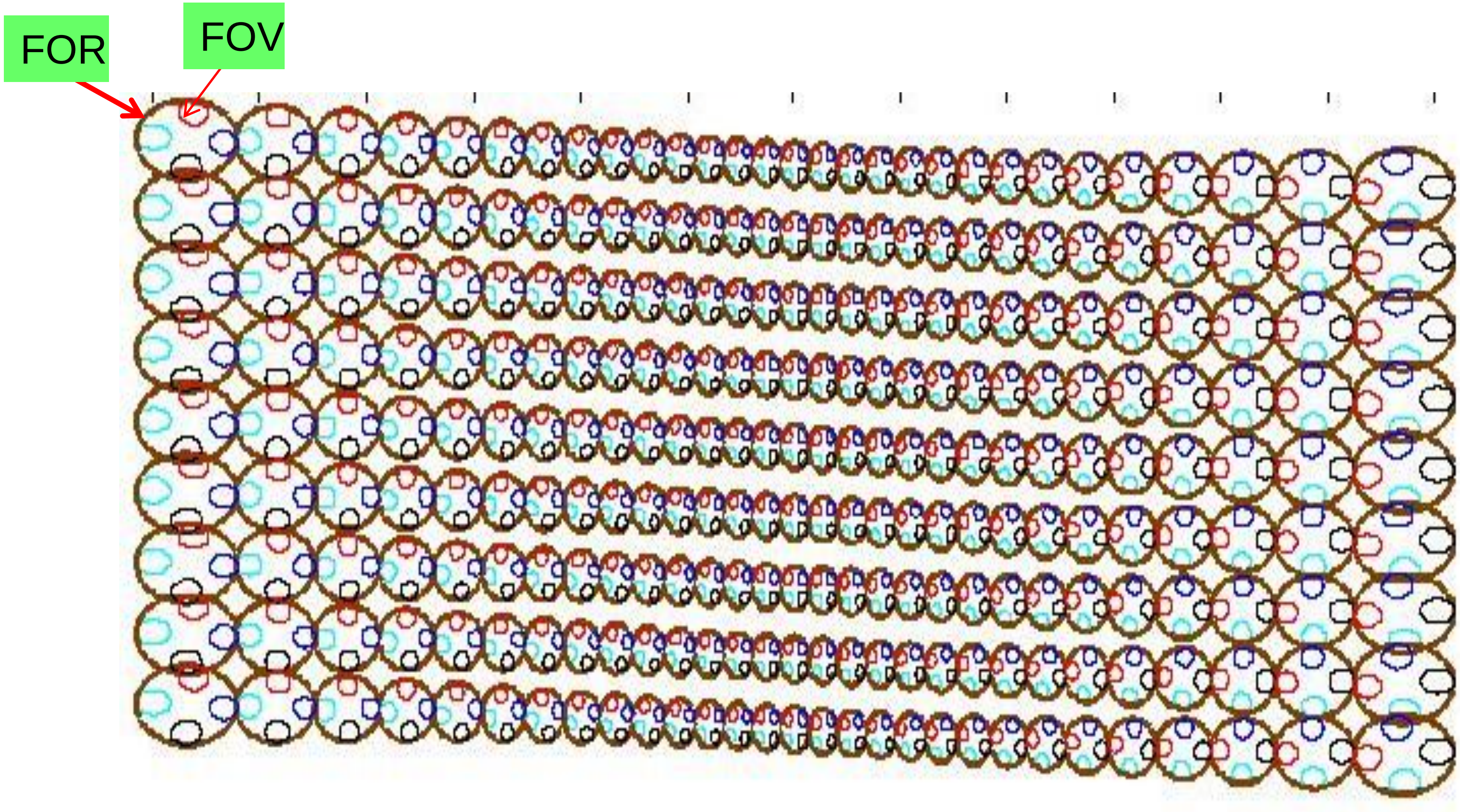


Band	Spectral Range (cm^{-1})	Spectral Resolution (cm^{-1})	Sensitivity (NEΔT@250K)	No of Channels
LWIR	650*～1136 （15.38μm～8.8 μm）	0.625	0.15～0.4K	778
MWIR1	1210～1750 （8.26μm～5.71 μm）	1.25	0.1～0.7K	433
MWIR2	2155～2550 （4.64μm～3.92 μm）	2.5	0.3～1.2K	159

HIRAS instrument specification improvement from FY-3D to FY-3E

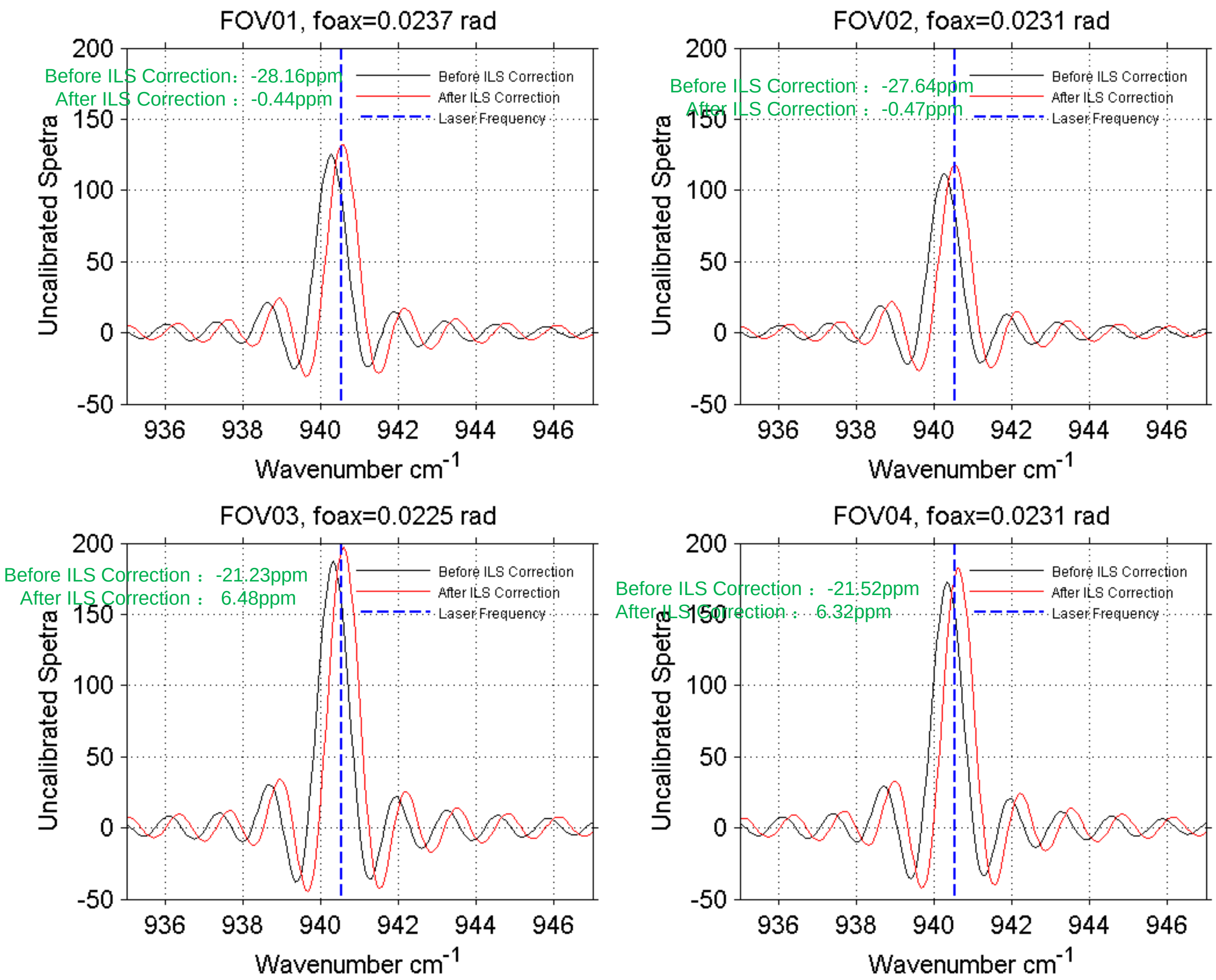
Band	Spectral Range (cm^{-1})	Spectral Resolution (cm^{-1})	Sensitivity (NEΔT@280K) FY-3D	Sensitivity (NEΔT@280K) FY-3E		Num of Channels
LWIR	650～1136 （15.38μm～8.8 μm）	0.625	0.15(Expectation) 0.4K(Requirement)	650 ～667 cm^{-1}	0.8K	778
				667～689 cm^{-1}	0.4K	
				689～1000 cm^{-1}	0.2K	
				1000～1136 cm^{-1}	0.4K	
MWIR1	1210～1750 （8.26μm～5.71 μm）	1.25	0.1(Expectation) 0.7K(Requirement)	1210～1538 cm^{-1}	0.2K	433
				1538～1750 cm^{-1}	0.3K	
MWIR2	2155～2550 （4.64μm～3.92 μm）	2.5	0.3(Expectation) 1.2K(Requirement)	2155～2300 cm^{-1}	0.3	159
				2300～2550 cm^{-1}	0.5	

- Four detectors on each focal planes are arranged into a 2×2 grid which define the field of regard (FOR)
- One complete scan consists of 33 interferogram sweeps, including 29 Earth View (ES), 2 Deep Space (DS), 2 Internal Calibration Target (ICT) measurements

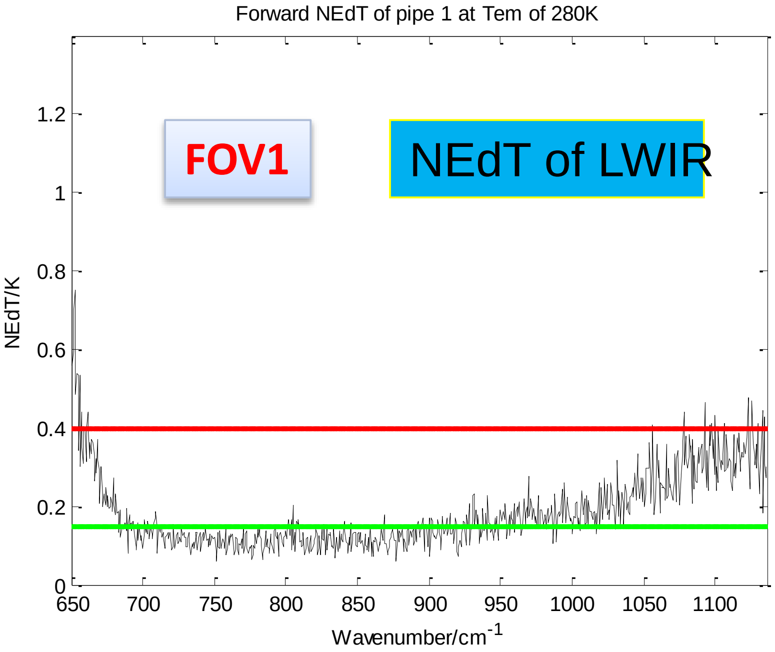


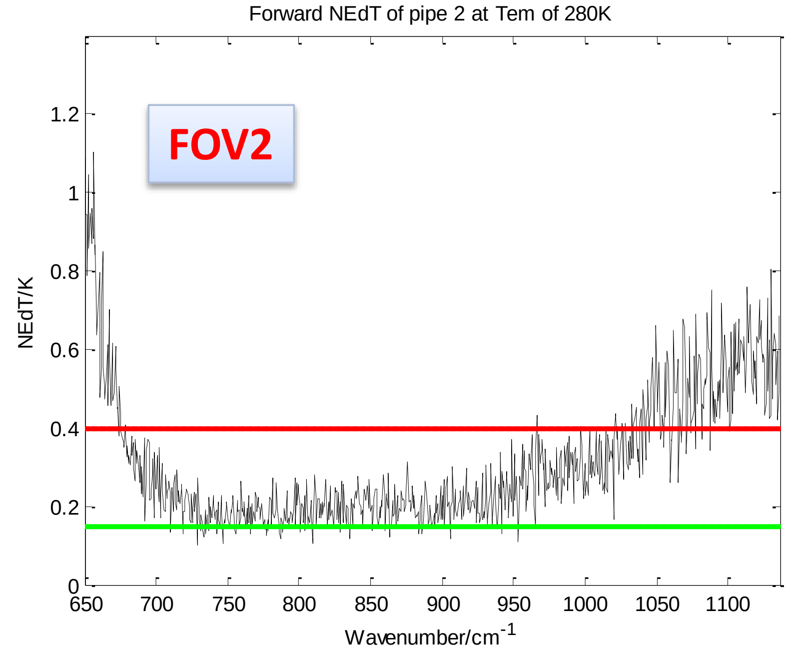
10s scan model earth view projection sketch map

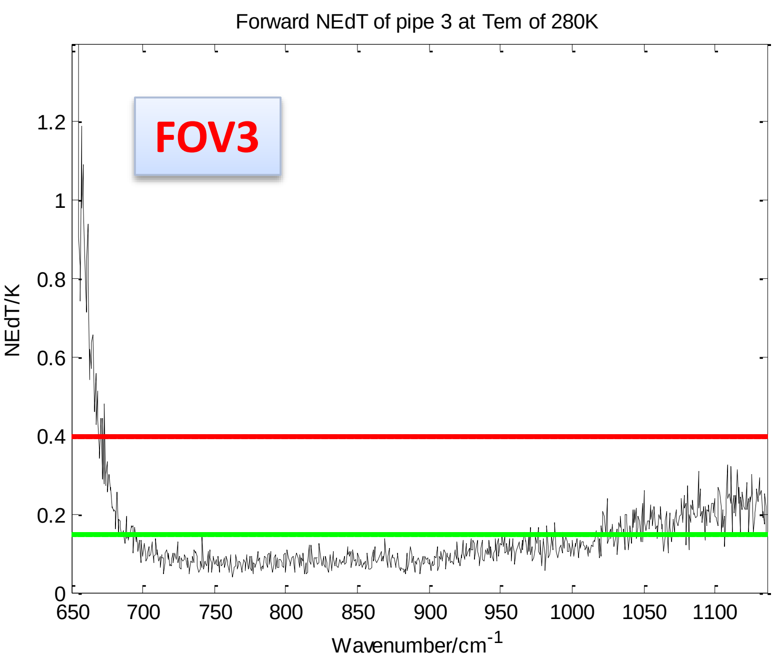
Pre-launch instrument characteristics

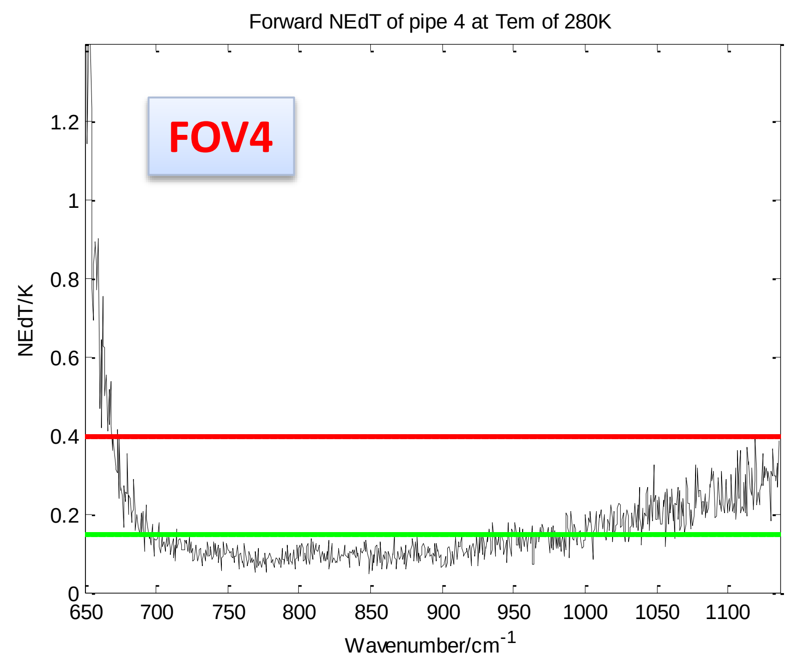


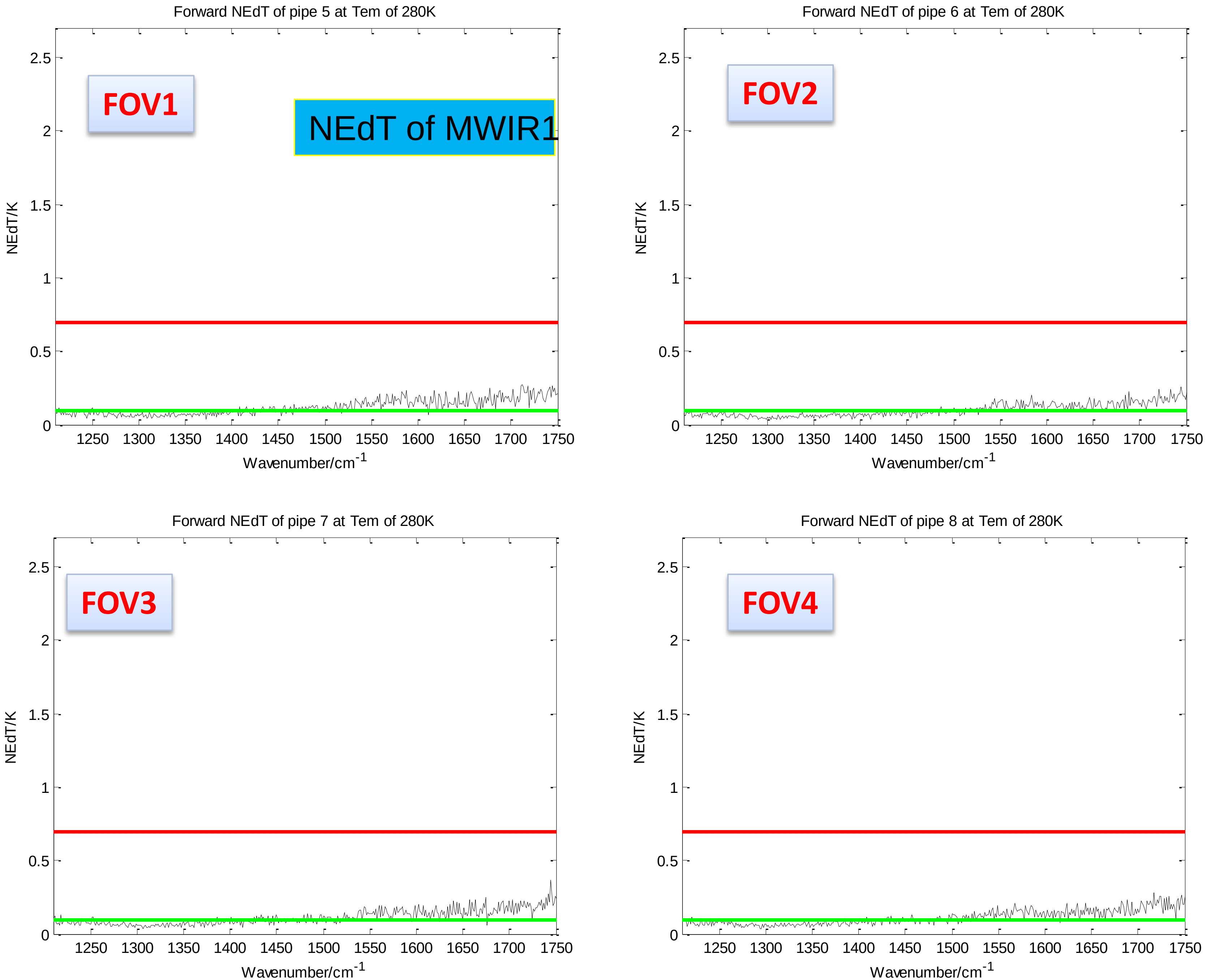
Spectral position bias of LWIR band laser measurement


Forward NEdT of pipe 1 at Tem of 280K
FOV1
NEdT of LWIR
NEdT/K
0
0.2
0.4
0.6
0.8
1
1.2
650
700
750
800
850
900
950
1000
1050
1100
Wavenumber/cm-1

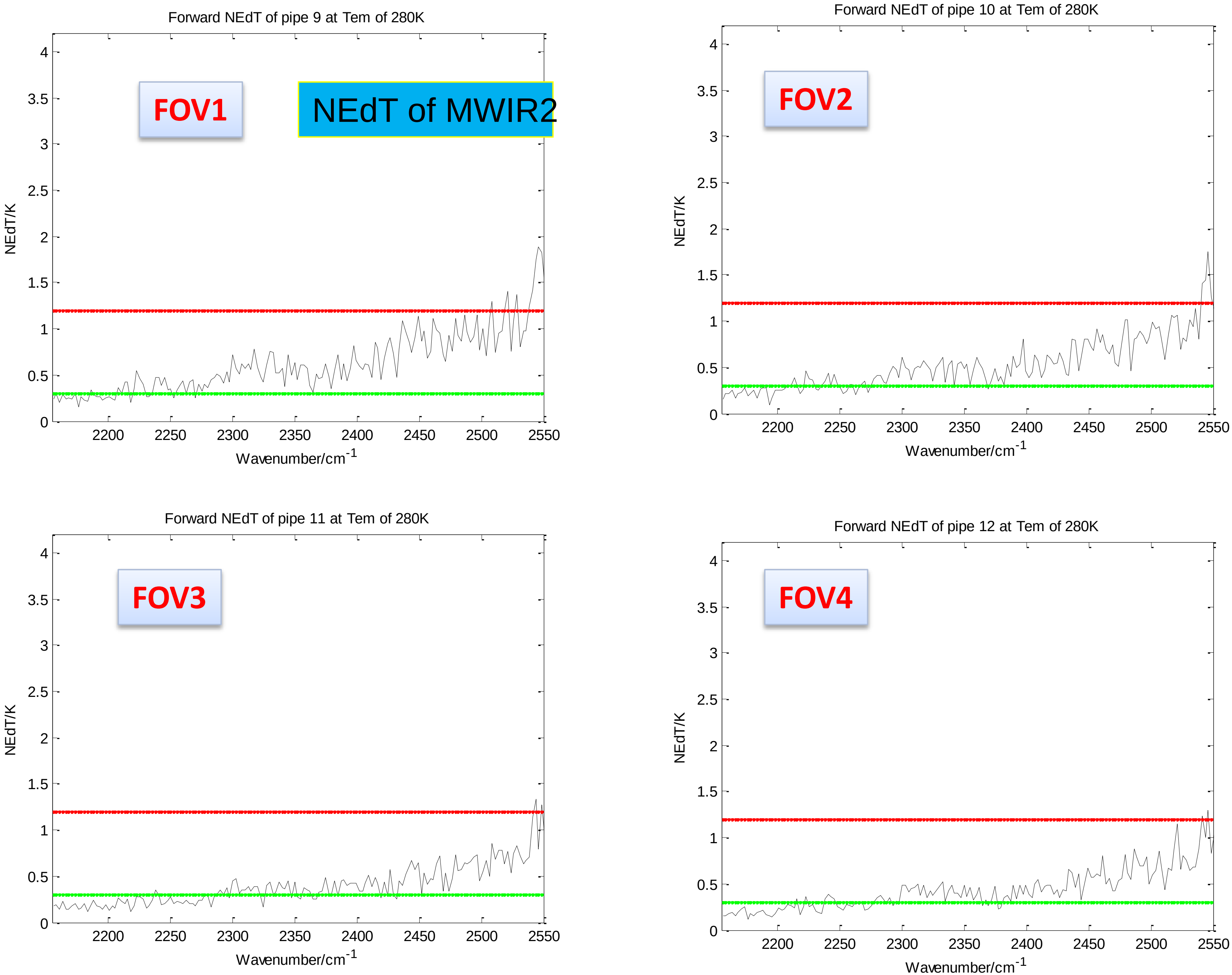

Forward NEdT of pipe 2 at Tem of 280K
FOV2
NEdT/K
0
0.2
0.4
0.6
0.8
1
1.2
650
700
750
800
850
900
950
1000
1050
1100
Wavenumber/cm-1


Forward NEdT of pipe 3 at Tem of 280K
FOV3
NEdT/K
0
0.2
0.4
0.6
0.8
1
1.2
650
700
750
800
850
900
950
1000
1050
1100
Wavenumber/cm-1


Forward NEdT of pipe 4 at Tem of 280K
FOV4
NEdT/K
0
0.2
0.4
0.6
0.8
1
1.2
650
700
750
800
850
900
950
1000
1050
1100
Wavenumber/cm-1



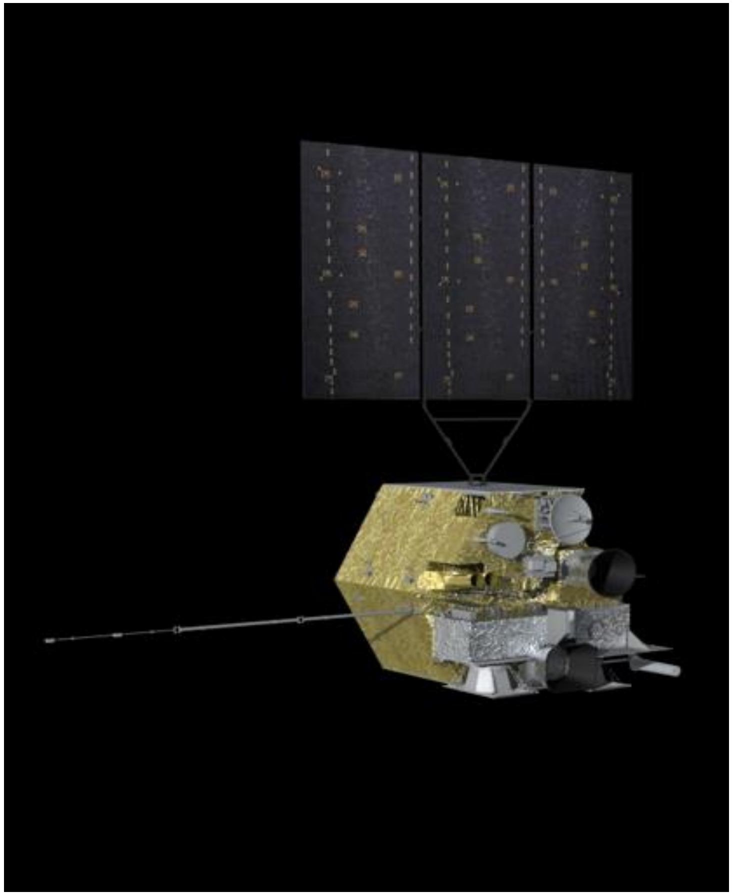
NEdT of MWIR1
Forward NEdT of pipe 5 at Tem of 280K
FOV1
Forward NEdT of pipe 6 at Tem of 280K
FOV2
Forward NEdT of pipe 7 at Tem of 280K
FOV3
Forward NEdT of pipe 8 at Tem of 280K
FOV4
NEdT/K
Wavenumber/cm-1
0
0.5
1
1.5
2
2.5
1250
1300
1350
1400
1450
1500
1550
1600
1650
1700
1750

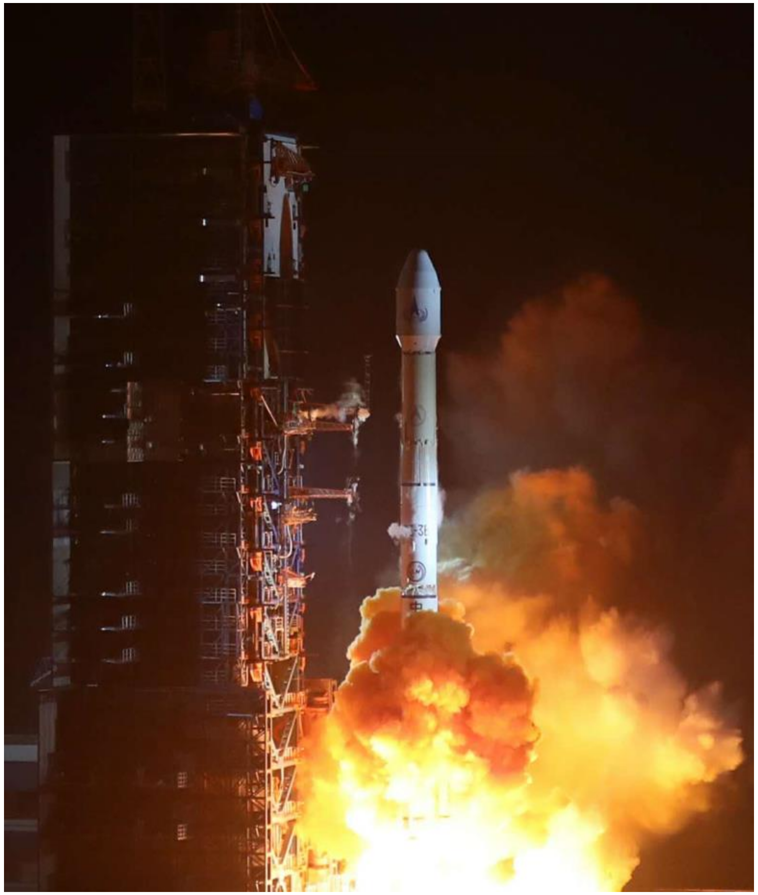

NEdT of MWIR2
Forward NEdT of pipe 9 at Tem of 280K
FOV1
NEdT/K
Wavenumber/cm-1
Forward NEdT of pipe 10 at Tem of 280K
FOV2
NEdT/K
Wavenumber/cm-1
Forward NEdT of pipe 11 at Tem of 280K
FOV3
NEdT/K
Wavenumber/cm-1
Forward NEdT of pipe 12 at Tem of 280K
FOV4
NEdT/K
Wavenumber/cm-1
0
0.5
1
1.5
2
2.5
3
3.5
4
2200
2250
2300
2350
2400
2450
2500
2550

4.The GIIRS of FY-4A

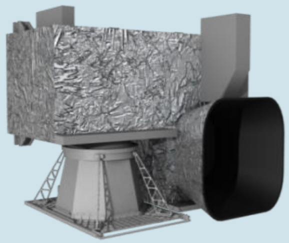
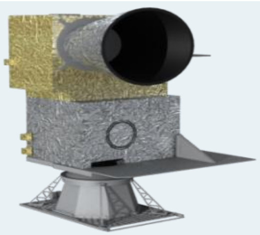
NEW ERA

FY-4A, the first of new generation geostationary orbit meteorological satellite, was successfully launched by the Long March-3B rocket in Xichang at 0:11 on December 11, 2016.



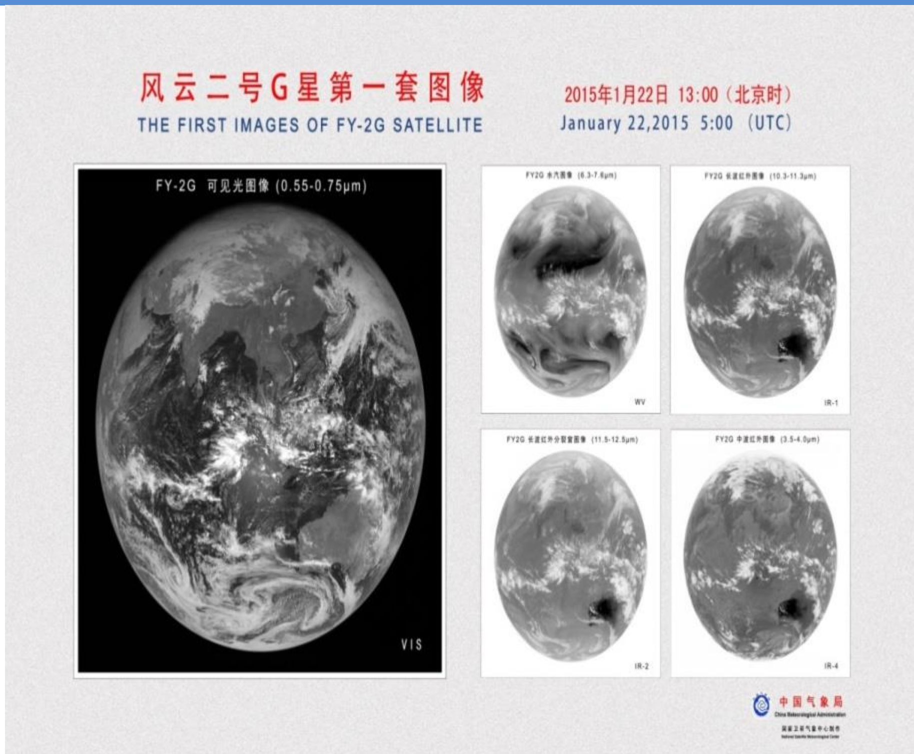


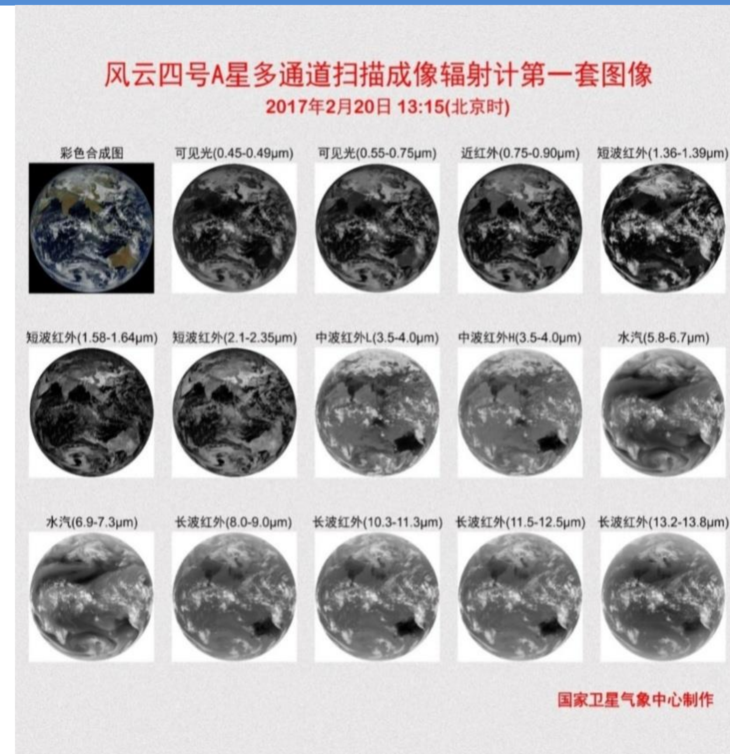
Four instruments on FY-4A

Instruments		Purpose
	*Advanced Geostationary Radiation Imager (AGRI)*	Observe the atmosphere, surface and cloud
	*Geostationary Interferometric Infrared Sounder (GIIRS)*	Profile the atmosphere for weather and climate
	*Lightning Mapping Imager (LMI)*	map the lightning in the region of Asia and Oceania
	*Space Environment Package (SEP)*	Obtain the information of space EM

	FY-4	FY-2
Satellite stabilization	three-axis stabilization	spin stabilization
Expect life	**7** year	**3** year
Observation efficiency	Better than 85％	About 5％
Observation mode	imager＋**profiles**	imager
Payloads	**14-ch Advanced Geostationary Radiation Imager (AGRI)** Spectral： 0.45~13.8um Spatial res： 0.5~4Km Time (Full disk)： 15min Observation region： flexible	**-5ch Visible and Infrared Spin-Scan Radiometer** Spectral： 0.55~12.5um Spatial res： 1.25~5Km Time (Full disk)： 30min Observation region： fixed
	Geostationary Interferometric Infrared Sounder (GIIRS) Spectral: 700~1130, 1650~2250cm^{-1} Spectral res:0.8, 1.6cm^{-1} (real: 0.625 cm-1) Spatial res:16Km	**no**
	Lightning Mapping Imager (LMI) Spectral： 777.4±0.5nm Spatial res:7.8Km	**no**
	Space Environment Package (SEP) Space particles＋**magnetic field**	**Space Environment Package (SEP)** Space particles

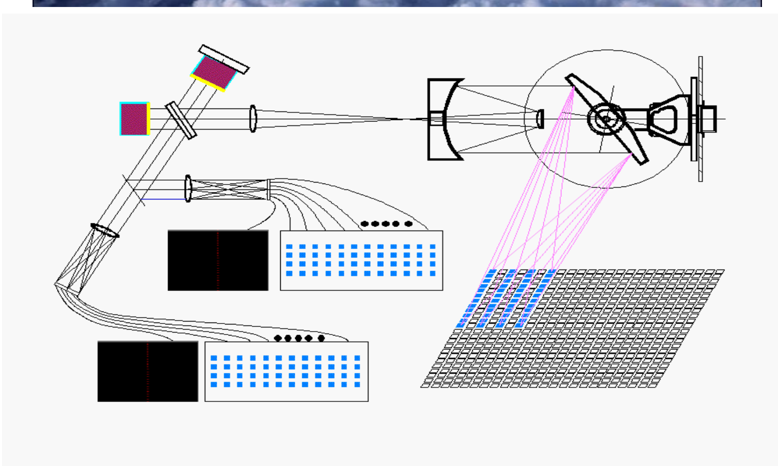
Multichannel scanning imaging radiometer

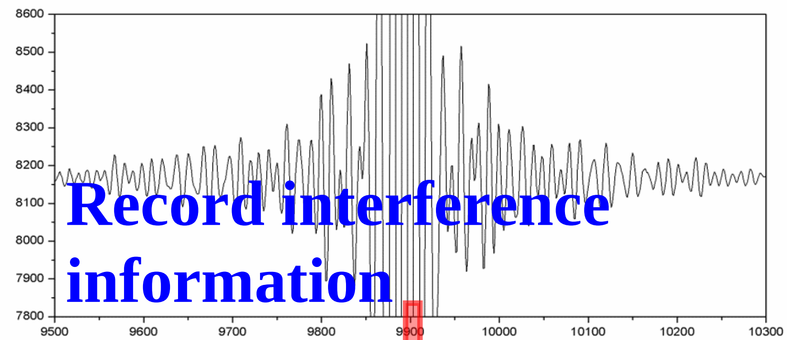


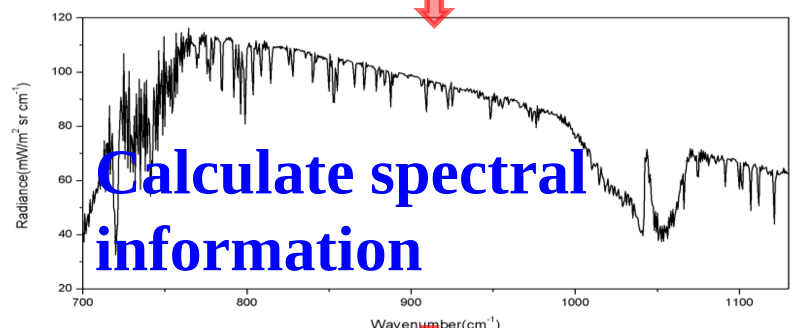


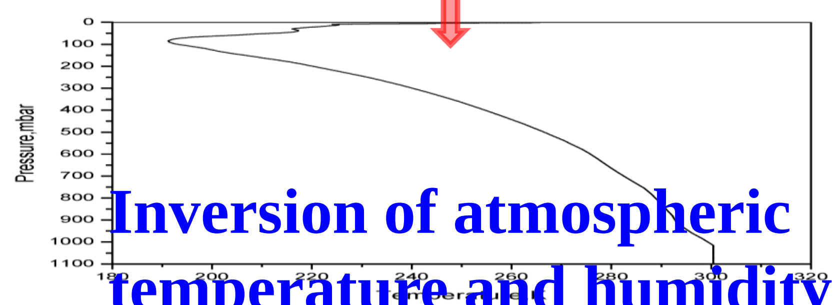
- The imaging observation channel extends from 5 to 14;
- The radiation accuracy increases from 0.3-0.5K to 0.1K;
- More and more accurate quantitative products can be generated.

Principle of Atmospheric Interferometer









Technical details of GIIRS

Spectrum Parameters	Spectral range / spectral resolution / channels LWIR: 700-1130 cm^{-1} / 0.625(sp0.8) cm^{-1} / 689(538) MWIR: 1650-2250 cm^{-1} / 0.625(sp1.6) cm^{-1} / 961(375) VIS: 0.55- 0.75 μm
spatial resolution	LWIR/MWIR: 16 Km VIS : 2Km
work mode	China and its surrounding areas： 5000×5000 Km^2 small-scale region： 1000×1000 Km^2
time resolution	China and its surrounding areas： <1 hr small-scale region： <½ hr
Radiation sensitivity (mW/m^2 sr cm^2)	LWIR: 0.5-1.1 MWIR: 0.1-0.14 VIS: S/N>200（ρ=100% ）
Radiation cali accuracy	1.5 K (3σ)
Spectral cali accuracy	10 ppm (3σ)

■ With recommendations for sounder from Zhiqing Zhang

		FY-4A	FY-4B	FY-4C	MTG IRS
Spectral range (cm^{-1})	LWIR	**700 – 1130**	**680 – 1130**	650 – 1130	700-1210
	MWIR	**1650 –2250**	**1650 –2250**	1650 –2250	1600-2175
Spectral resolution (cm^{-1})	L	**0.8(0.625)**	**0.8**	0.625	0.625
	M	**1.6(0.625)**	**0.8**	0.625	0.625
Sensitivity mW/m^2 sr cm^{-2}	L	**0.5-1.1**	**0.5**	0.3	0.2-0.3K @280K
	M	**0.1-0.14**	**0.1**	0.06	
Spatial resolution (Km)		**16**	**16**	4-8	4
Planned Launch		**2016**	**2018**	2020	2020
Status		**R&D**	**Op.**	Op.	R&D
Name		GIIRS →	GIIRS+ →	GIIRS++	

More Compatible

Working mode of GIIRS （**flexible configuration**）

- **Detection mode：**

region location、region size

Resident frames （time）、motion model（time）

- **Calibration model：**

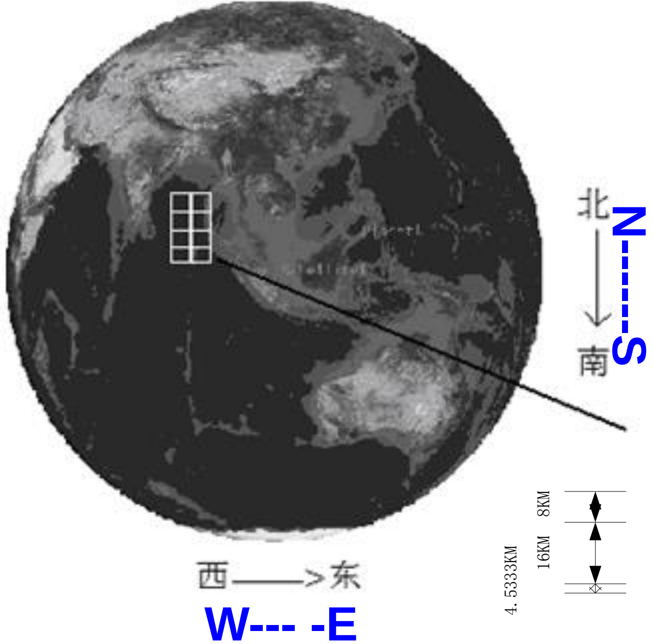
Stellar sensitivity 、 Blackbody calibration 、 Cold space calibration and Spectral calibration

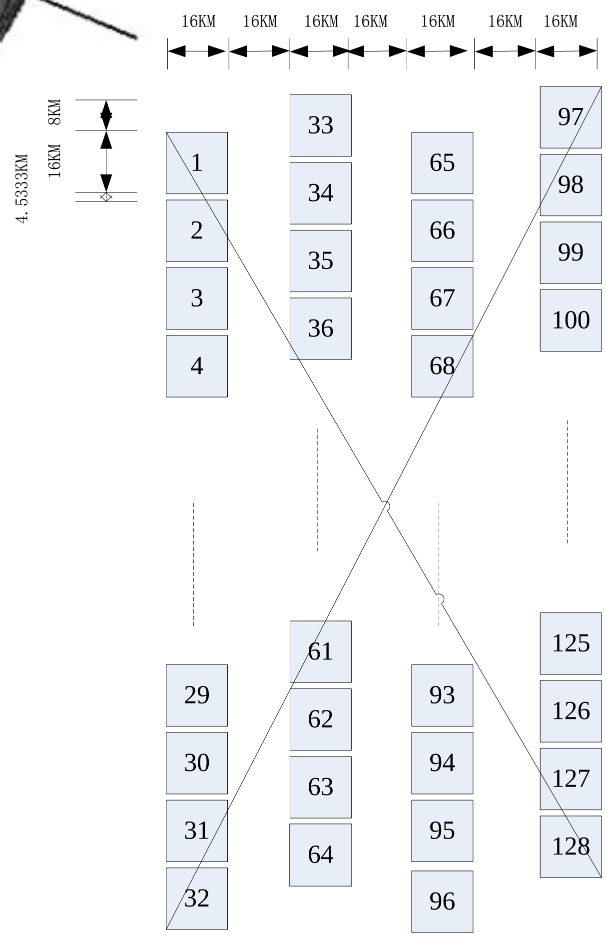
- **pointing mode:**

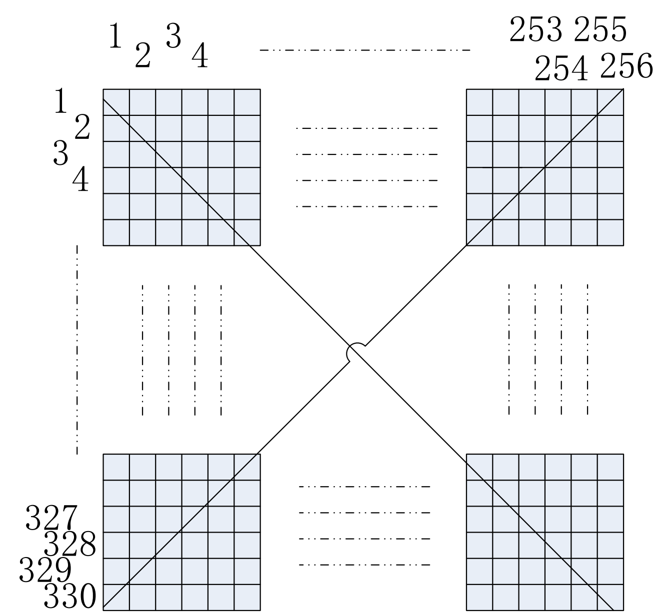
Quick to point to a position

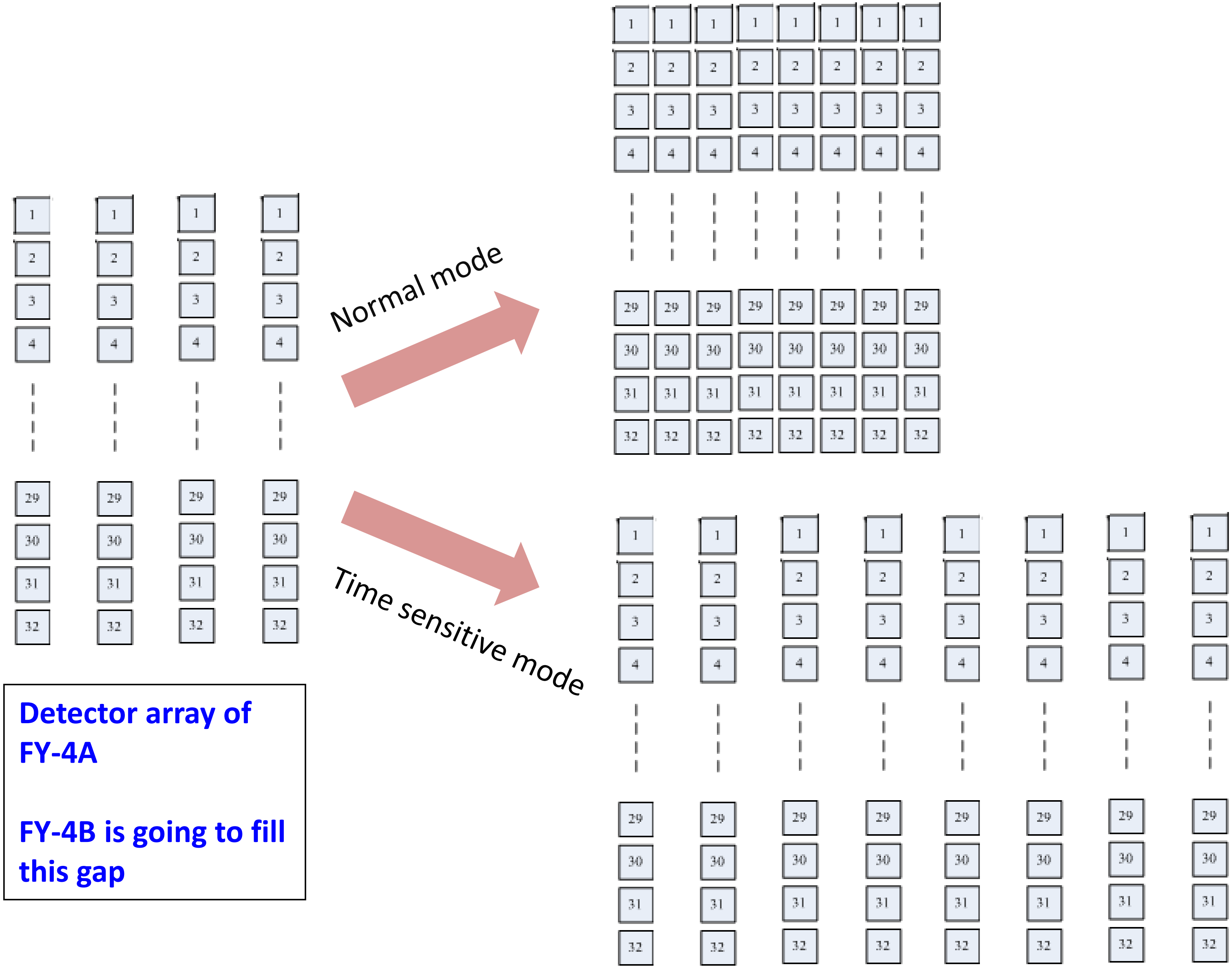
Dwell point

- **Ir_band 32(line) x 4(row)**
- **Vis_band: geo-location (Matrix: 330x256)**







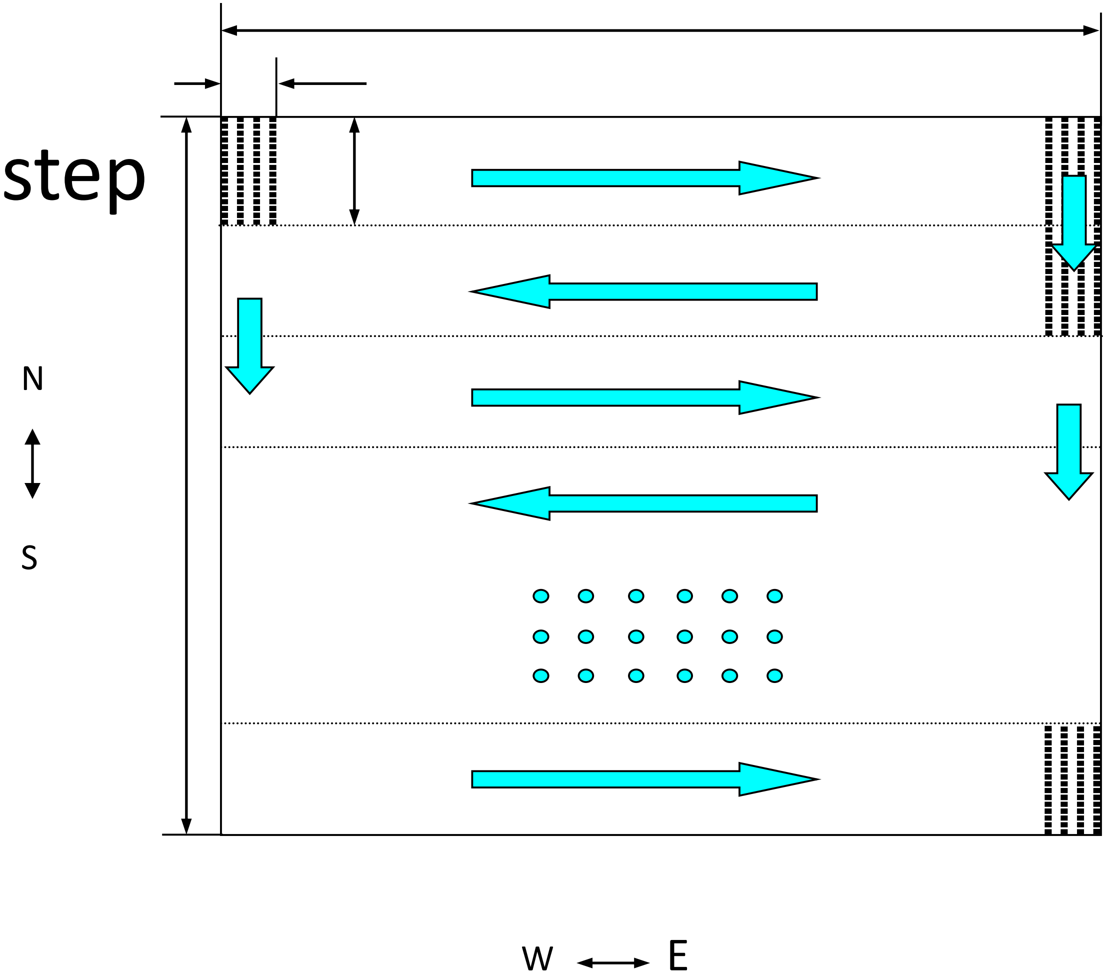


Detector array of FY-4A

FY-4B is going to fill this gap

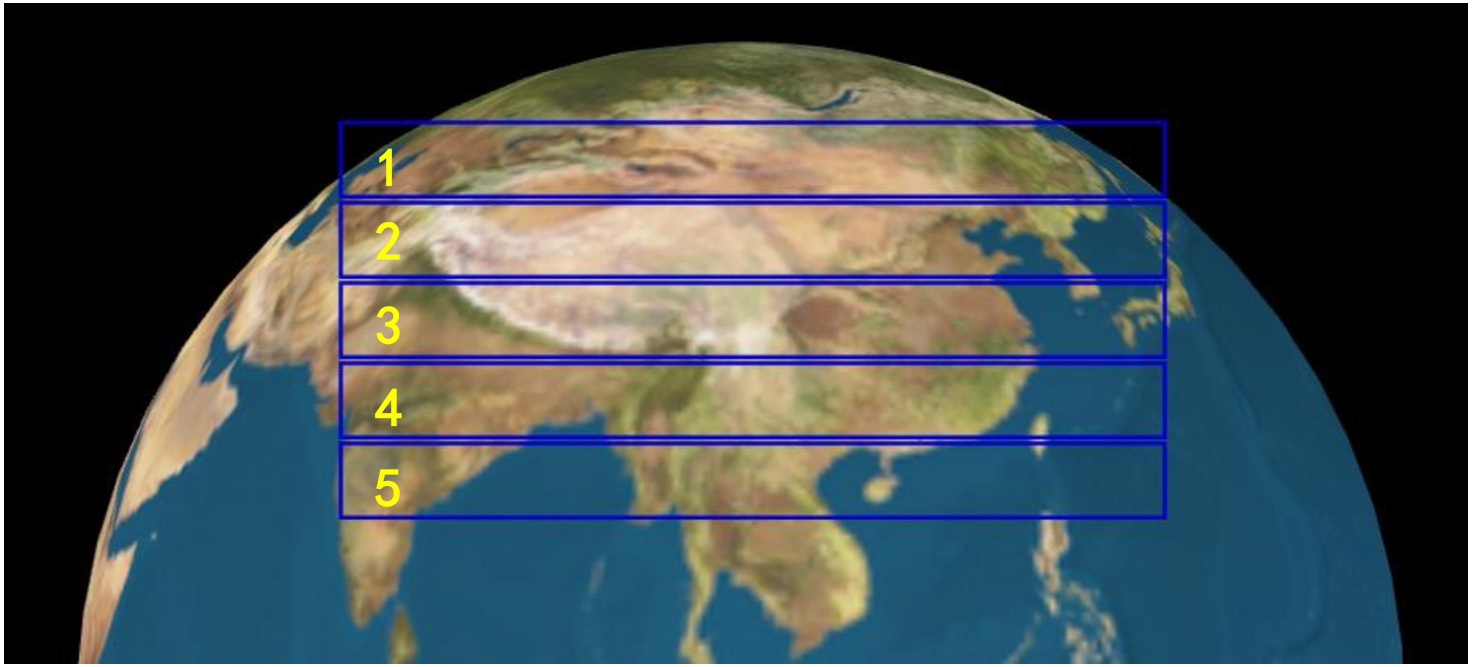
motion mode

- Big step
- big/small step



Sample data

15ºN~55ºN， 70ºE~140ºE:China and its surrounding areas

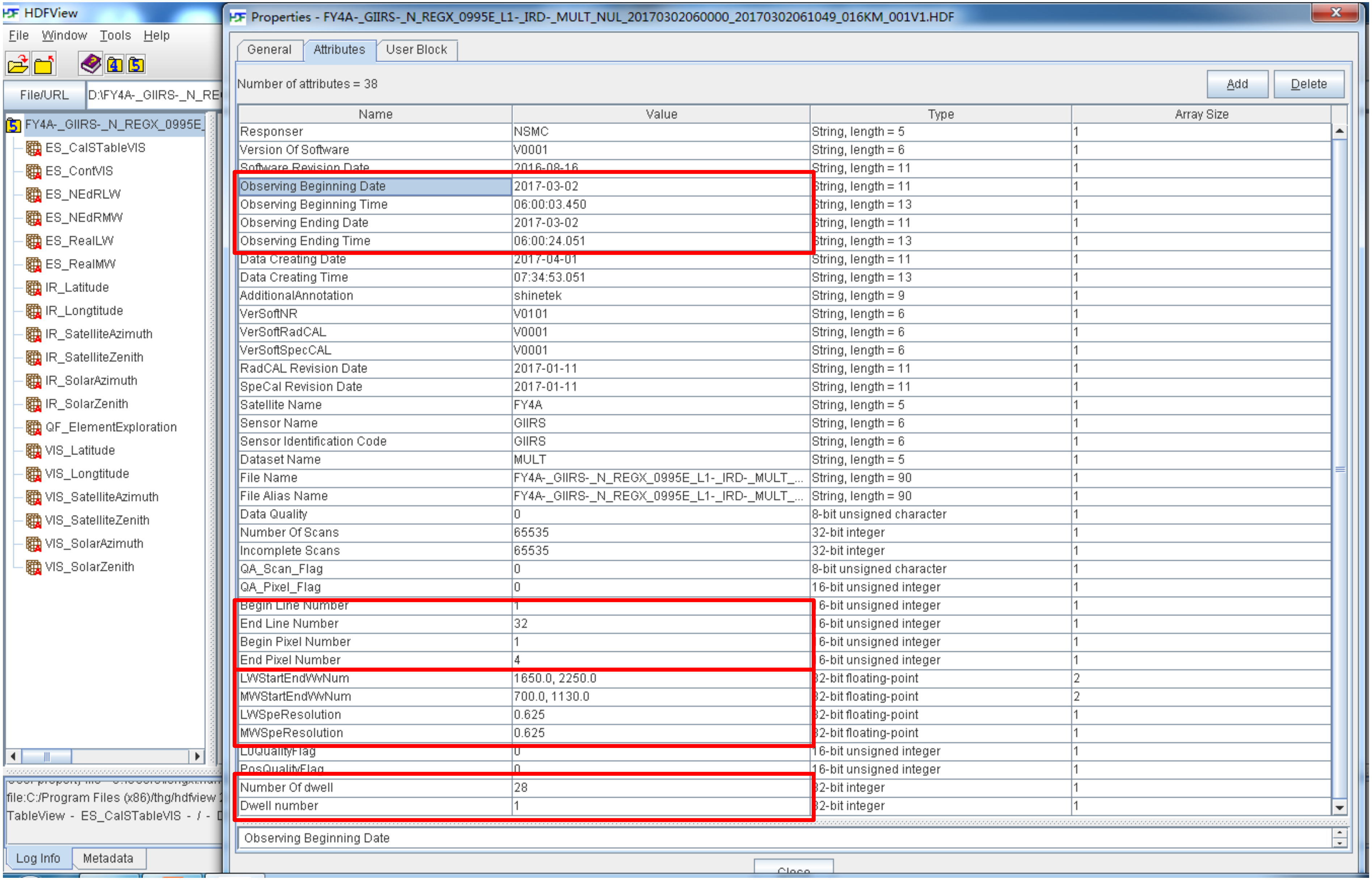


- atmospheric sounding interferometer’s motion mode is “big step”: There are 5 lines, every lines has 54 dwell points, altogether 270 dwell points;
- Each line is divided into two tasks, the first tasks has 28 dwell points, and the second task has 26 dwell points;
- Each dwell point resident 16 frames ,each frame has 1.3 sec， altogether 21 sec;
- There are 5 lines , 10 tasks. Every task takes 15 minutes,2.5hours。

Naming rules

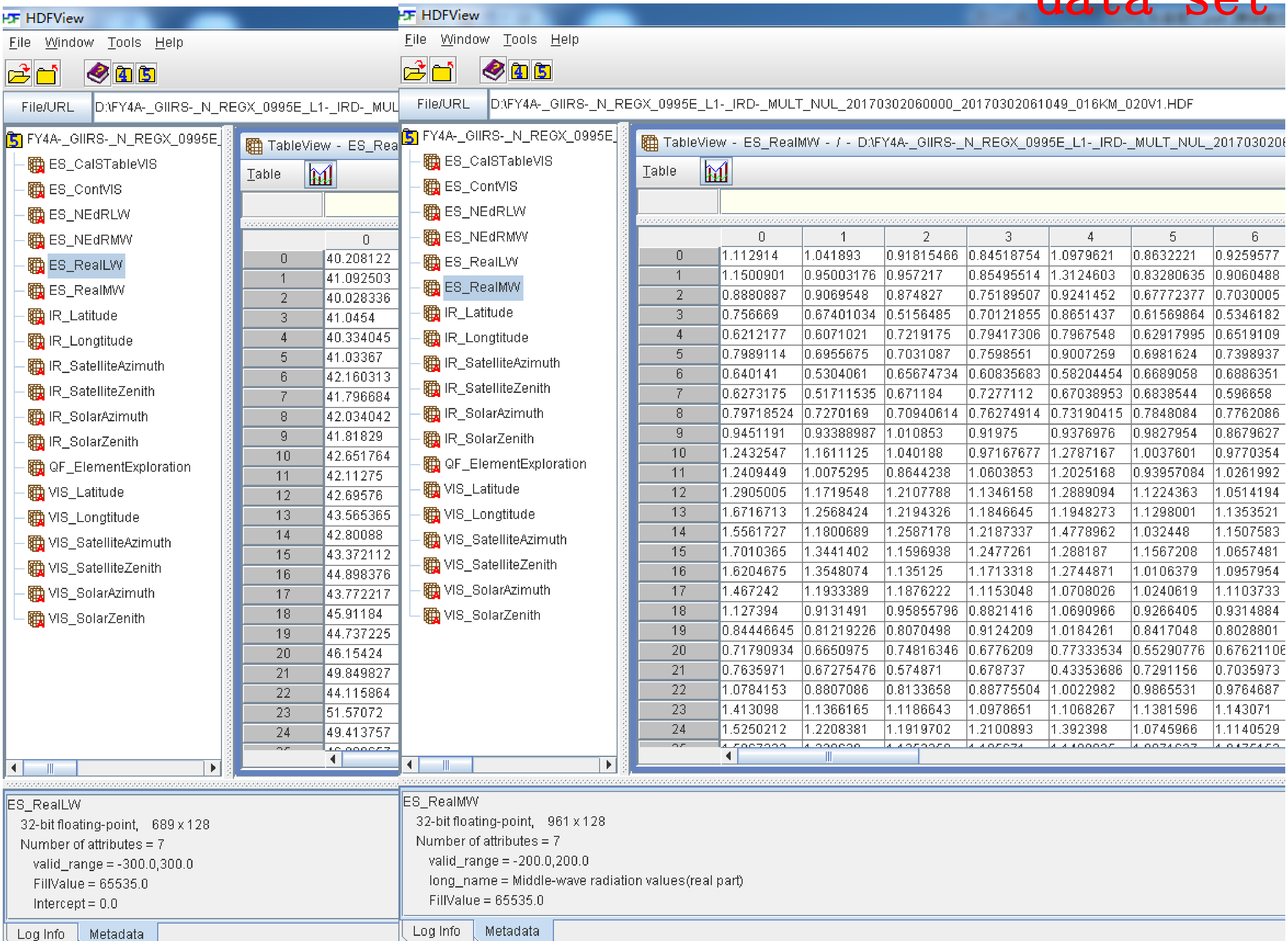
FY4A-_GIIRS-_N_REGX_0995E_L1-_IRD_MULT_NUL_YYYYMMDDHHMMSS_YYYYMMDDHHMMSS_016KM_001V1.HDF		
items	value	Sample
		FY4A-
		GIIRS-
Observation model	1character，regular observation：N	N
Data area type	Region observation，REGn(n=0-9)	
ground longitude	5 characters，Satellite ground longitude position	1050E
Data level		L1-
Data name	4 characters，Abbreviation of Observation, process or Product name，IRD means infrared data	IRD
Instrument channel name	4 characters	MULT
Projection mode	3 characters	NUL
Observation start time	12 characters，observation start time，Using（UTC）time，YYYYMMDDhhmmss	
Observation end time	12 characters，Observation end time ，Using（UTC）time，YYYYMMDDhhmmss	
spatial resolution	16KM	016KM
Data format	DAT	binary data
Blocking mode	Dwell point	
Single file data size	4MB	

Global properties



Name	Value	Type	Array Size
Responser	NSMC	String, length = 5	1
Version Of Software	V0001	String, length = 6	1
Software Revision Date	2016-08-16	String, length = 11	1
Observing Beginning Date	2017-03-02	String, length = 11	1
Observing Beginning Time	06:00:03.450	String, length = 13	1
Observing Ending Date	2017-03-02	String, length = 11	1
Observing Ending Time	06:00:24.051	String, length = 13	1
Data Creating Date	2017-04-01	String, length = 11	1
Data Creating Time	07:34:53.051	String, length = 13	1
AdditionalAnnotation	shinetek	String, length = 9	1
VerSoftNR	V0101	String, length = 6	1
VerSoftRadCAL	V0001	String, length = 6	1
VerSoftSpecCAL	V0001	String, length = 6	1
RadCAL Revision Date	2017-01-11	String, length = 11	1
SpeCal Revision Date	2017-01-11	String, length = 11	1
Satellite Name	FY4A	String, length = 5	1
Sensor Name	GIIRS	String, length = 6	1
Sensor Identification Code	GIIRS	String, length = 6	1
Dataset Name	MULT	String, length = 5	1
File Name	FY4A-_GIIRS-_N_REGX_0995E_L1-_IRD-_MULT_...	String, length = 90	1
File Alias Name	FY4A-_GIIRS-_N_REGX_0995E_L1-_IRD-_MULT_...	String, length = 90	1
Data Quality	0	8-bit unsigned character	1
Number Of Scans	65535	32-bit integer	1
Incomplete Scans	65535	32-bit integer	1
QA_Scan_Flag	0	8-bit unsigned character	1
QA_Pixel_Flag	0	16-bit unsigned integer	1
Begin Line Number	1	16-bit unsigned integer	1
End Line Number	32	16-bit unsigned integer	1
Begin Pixel Number	1	16-bit unsigned integer	1
End Pixel Number	4	16-bit unsigned integer	1
LWStartEndWNum	1650.0, 2250.0	32-bit floating-point	2
MWStartEndWNum	700.0, 1130.0	32-bit floating-point	2
LWSpeResolution	0.625	32-bit floating-point	1
MWSpeResolution	0.625	32-bit floating-point	1
LUQualityFlag	0	16-bit unsigned integer	1
PosQualityFlag	0	16-bit unsigned integer	1
Number Of dwell	28	32-bit integer	1
Dwell number	1	32-bit integer	1

data set


HDFView
File Window Tools Help
File/URL
D:\FY4A-_GIIRS-_N_REGX_0995E_L1-_IRD-_MULT_NUL_20170302060000_20170302061049_016KM_020V1.HDF
FY4A-_GIIRS-_N_REGX_0995E_
ES_CalSTableVIS
ES_ContVIS
ES_NEdRLW
ES_NEdRMW
ES_RealLW
ES_RealMW
IR_Latitude
IR_Longtitude
IR_SatelliteAzimuth
IR_SatelliteZenith
IR_SolarAzimuth
IR_SolarZenith
QF_ElementExploration
VIS_Latitude
VIS_Longtitude
VIS_SatelliteAzimuth
VIS_SatelliteZenith
VIS_SolarAzimuth
VIS_SolarZenith
TableView - ES_Rea
Table
0
0 40.208122
1 41.092503
2 40.028336
3 41.0454
4 40.334045
5 41.03367
6 42.160313
7 41.796684
8 42.034042
9 41.81829
10 42.651764
11 42.11275
12 42.69576
13 43.565365
14 42.80088
15 43.372112
16 44.898376
17 43.772217
18 45.91184
19 44.737225
20 46.15424
21 49.849827
22 44.115864
23 51.57072
24 49.413757
ES_RealLW
32-bit floating-point, 689 x 128
Number of attributes = 7
valid_range = -300.0,300.0
FillValue = 65535.0
Intercept = 0.0
Log Info Metadata
TableView - ES_RealMW - / - D:\FY4A-_GIIRS-_N_REGX_0995E_L1-_IRD-_MULT_NUL_2017030206
Table
0 1 2 3 4 5 6
0 1.112914 1.041893 0.91815466 0.84518754 1.0979621 0.8632221 0.9259577
1 1.1500901 0.95003176 0.957217 0.85495514 1.3124603 0.83280635 0.9060488
2 0.8880887 0.9069548 0.874827 0.75189507 0.9241452 0.67772377 0.7030005
3 0.756669 0.67401034 0.5156485 0.70121855 0.8651437 0.61569864 0.5346182
4 0.6212177 0.6071021 0.7219175 0.79417306 0.7967548 0.62917995 0.6519109
5 0.7989114 0.6955675 0.7031087 0.7598551 0.9007259 0.6981624 0.7398937
6 0.640141 0.5304061 0.65674734 0.60835683 0.58204454 0.6689058 0.6886351
7 0.6273175 0.51711535 0.671184 0.7277112 0.67038953 0.6838544 0.596658
8 0.79718524 0.7270169 0.70940614 0.76274914 0.73190415 0.7848084 0.7762086
9 0.9451191 0.93388987 1.010853 0.91975 0.9376976 0.9827954 0.8679627
10 1.2432547 1.1611125 1.040188 0.97167677 1.2787167 1.0037601 0.9770354
11 1.2409449 1.0075295 0.8644238 1.0603853 1.2025168 0.93957084 1.0261992
12 1.2905005 1.1719548 1.2107788 1.1346158 1.2889094 1.1224363 1.0514194
13 1.6716713 1.2568424 1.2194326 1.1846645 1.1948273 1.1298001 1.1353521
14 1.5561727 1.1800689 1.2587178 1.2187337 1.4778962 1.032448 1.1507583
15 1.7010365 1.3441402 1.1596938 1.2477261 1.288187 1.1567208 1.0657481
16 1.6204675 1.3548074 1.135125 1.1713318 1.2744871 1.0106379 1.0957954
17 1.467242 1.1933389 1.1876222 1.1153048 1.0708026 1.0240619 1.1103733
18 1.127394 0.9131491 0.95855796 0.8821416 1.0690966 0.9266405 0.9314884
19 0.84446645 0.81219226 0.8070498 0.9124209 1.0184261 0.8417048 0.8028801
20 0.71790934 0.6650975 0.74816346 0.6776209 0.77333534 0.55290776 0.67621106
21 0.7635971 0.67275476 0.574871 0.678737 0.43353686 0.7291156 0.7035973
22 1.0784153 0.8807086 0.8133658 0.88775504 1.0022982 0.9865531 0.9764687
23 1.413098 1.1366165 1.1186643 1.0978651 1.1068267 1.1381596 1.143071
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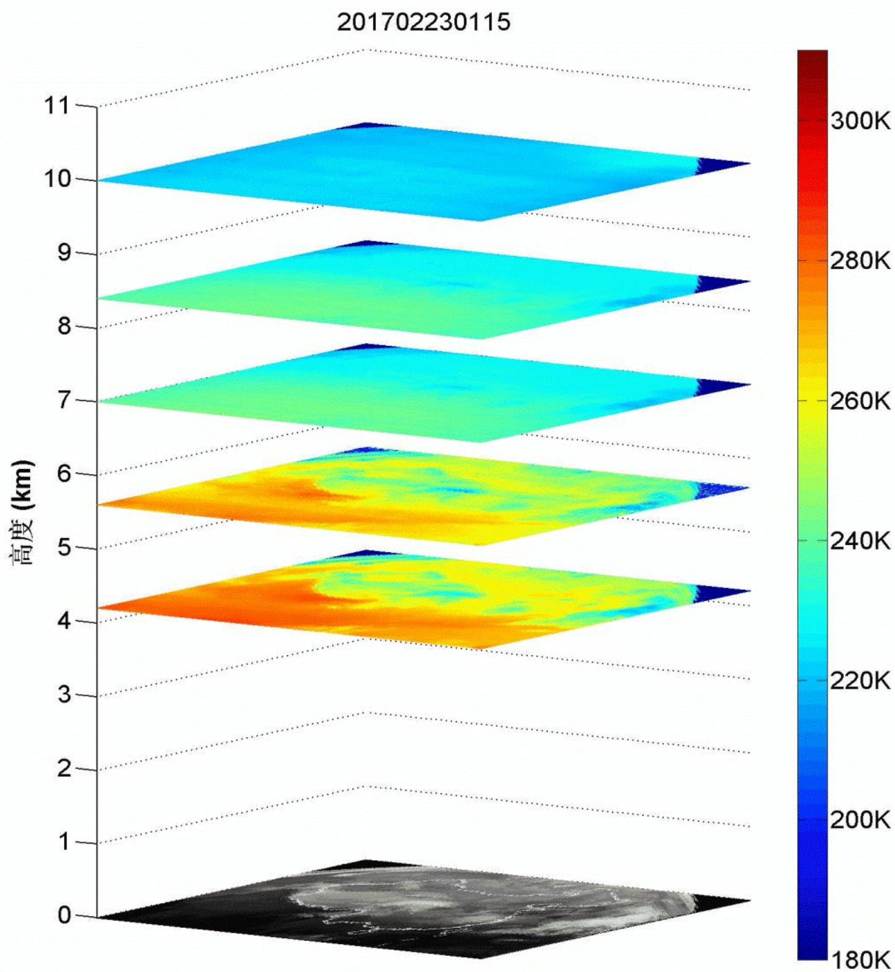
FillValue = 65535.0
Log Info Metadata

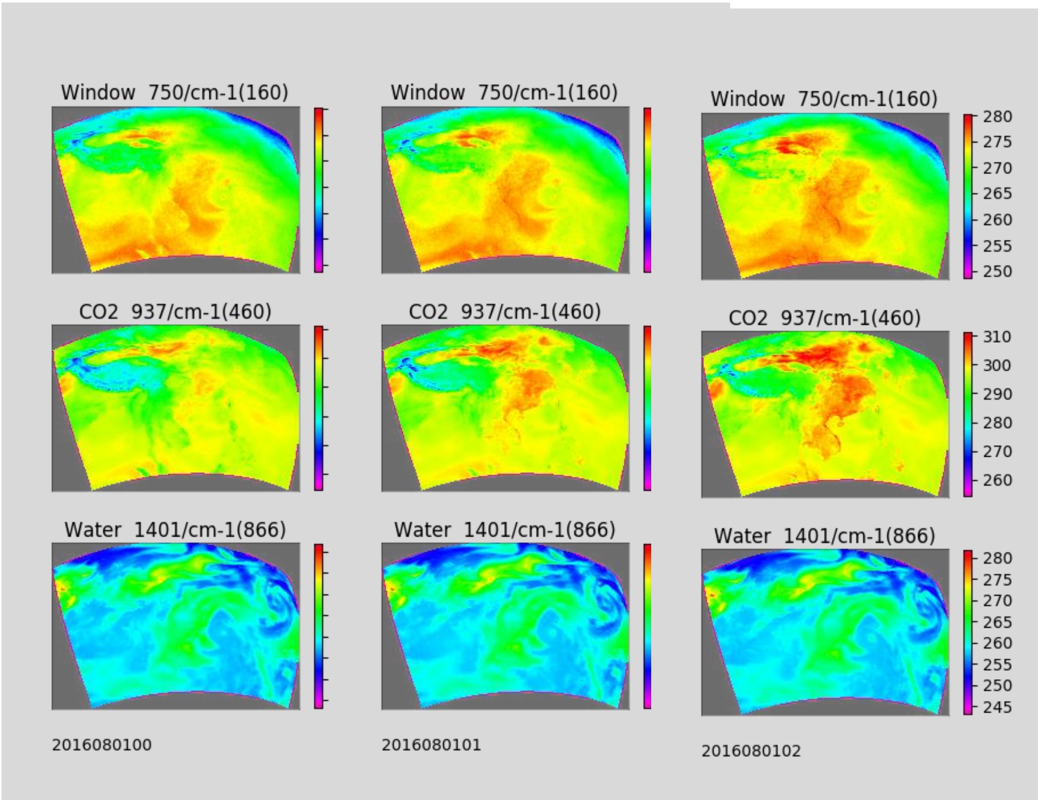
The initial Brightness temperature form GIIRS

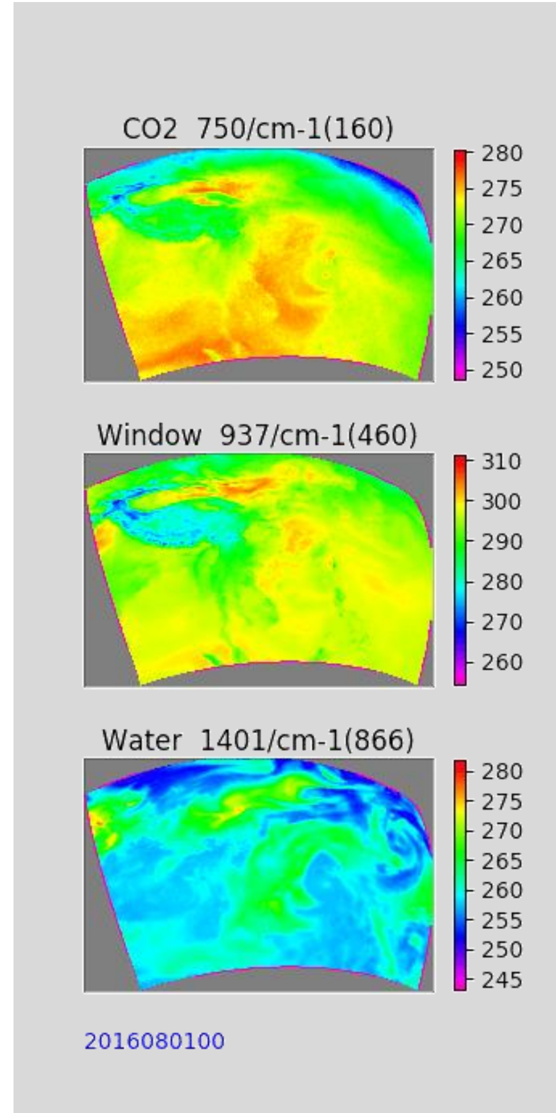


Vertical distribution of BT

The GIIRS has 1650 channels to profile the structure of temperature and humidity.

Simulation of the GIIRS





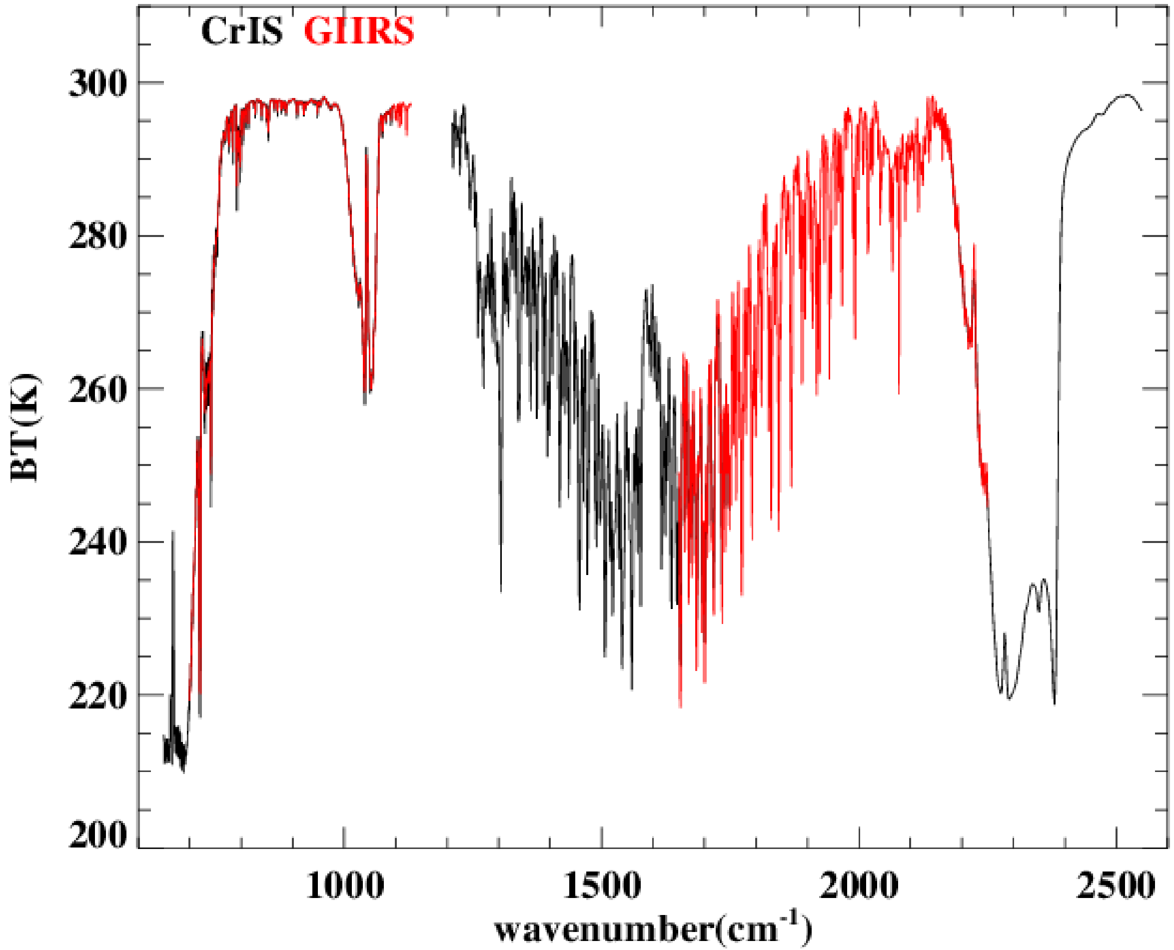
RTM：RTTOV

NWP field：WRF

date：20160801~20160823

Simulation of the GIIRS

The comparison of CRIS and GIIRS



5.The Discussion and possible cooperation

- Start the cooperation from the simulated data
- Cooperation on the RTM
- Cooperation on the calibration improvement
- Cooperation on the data assimilation aspects (cloud detection, channel selection, bias correction, quality control)
- And more ……