# Preliminary Evaluation of FY-4A GIIRS in GRAPES

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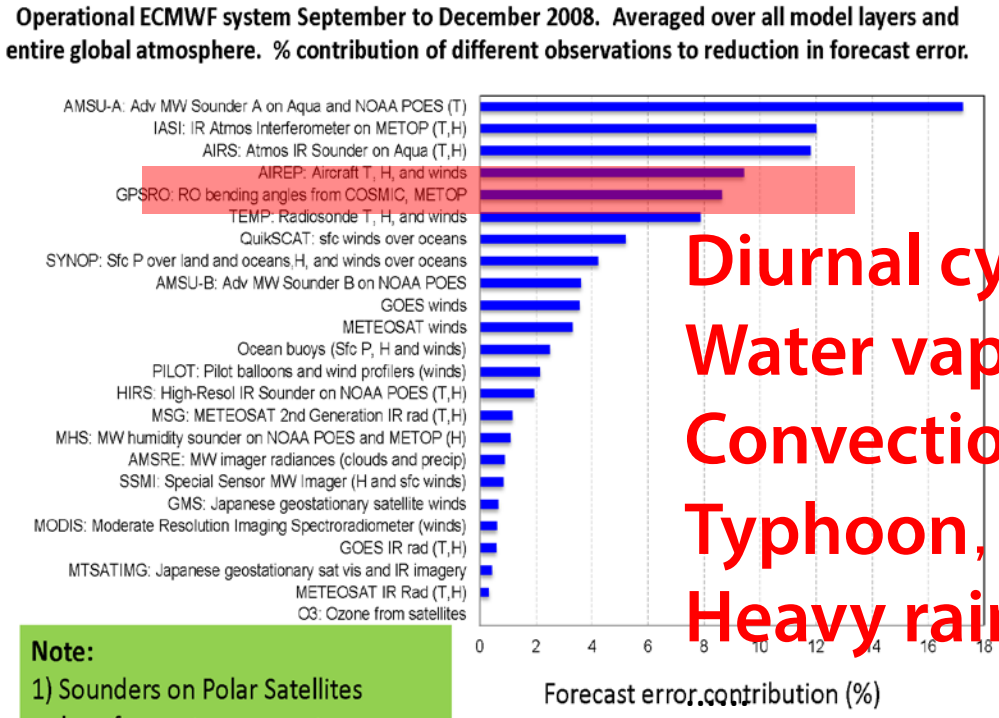
**NWPC/CMA**

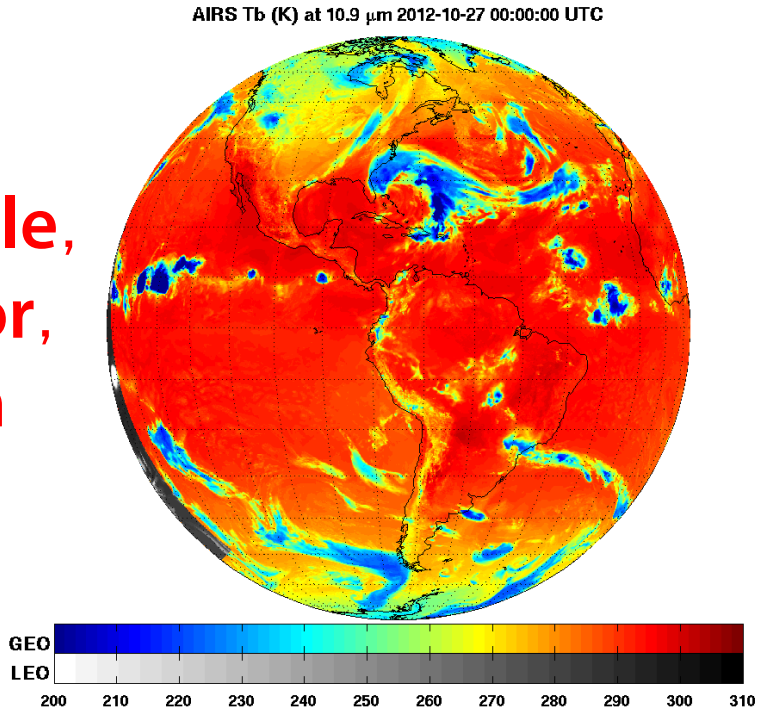
ITSC21
Nov.29-Dec.5, 2017,Damstdat, Germany

# Why do we need GEO hyperspectral IR sounders?




**Note:**
1) Sounders on Polar Satellites reduce forecast error most
2) Results are relevant for other NWP Centers, including NWS/NCEP

**Diurnal cycle, Water vapor, Convection Typhoon, Heavy rain**




Courtesy: Carla Cardinali and Sean Healy, ECMWF

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- Compared with LEO: **Larger spatial coverage** and **higher temporal resolution** for regional models
- Compared with microwave sounders: finer vertical resolution

Q: GEO high temporal resolution observations GEO provide critical information for nowcasting, what is the impact in NWP models, for example, on storm forecasts?

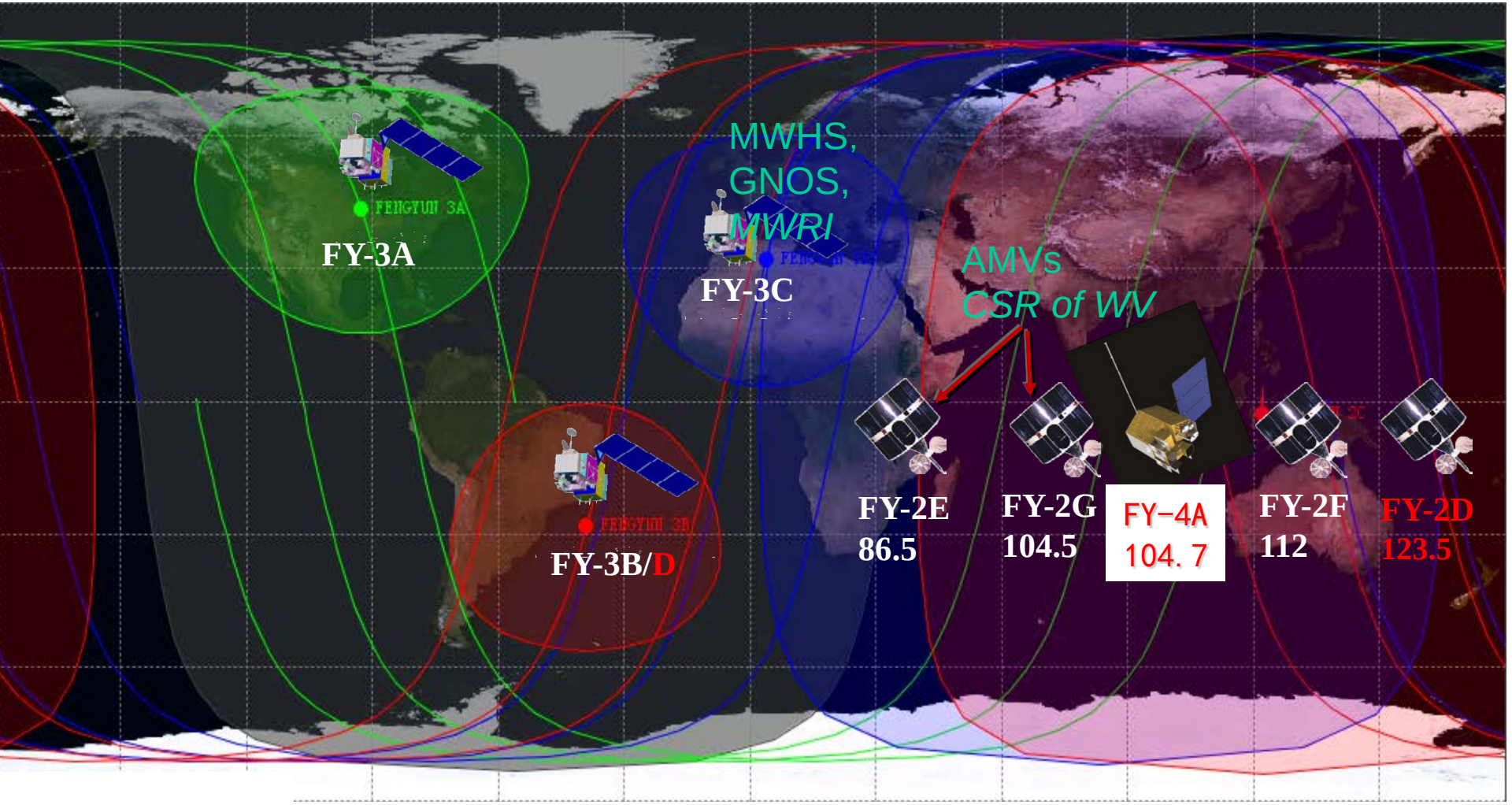
Courtesy of Dr. Jun Li

# Outline

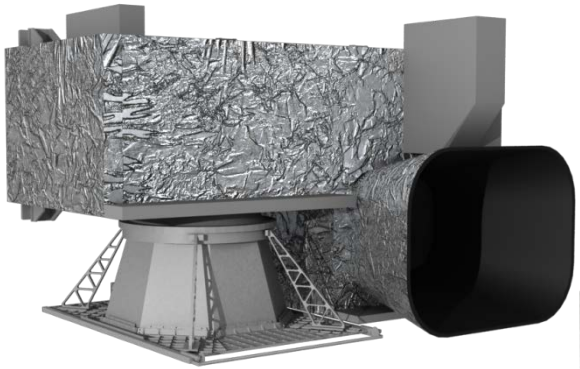
- **Characteristics of FY4A GIIRS**
  - **High Spectral**
  - **High Temporal**
- **Preliminary evaluation of FY4A GIIRS**
  - **NeDT (FOV,FOR)**
  - **Direct assimilation of L1 radiances**
- **Summary and next step**
  - **Calibration**
  - **Refinement of the assimilation**

# Use of Chinese Fengyun satellite data in GRAPES

**8 on the orbit, 6 in operation, 1 in commission test**



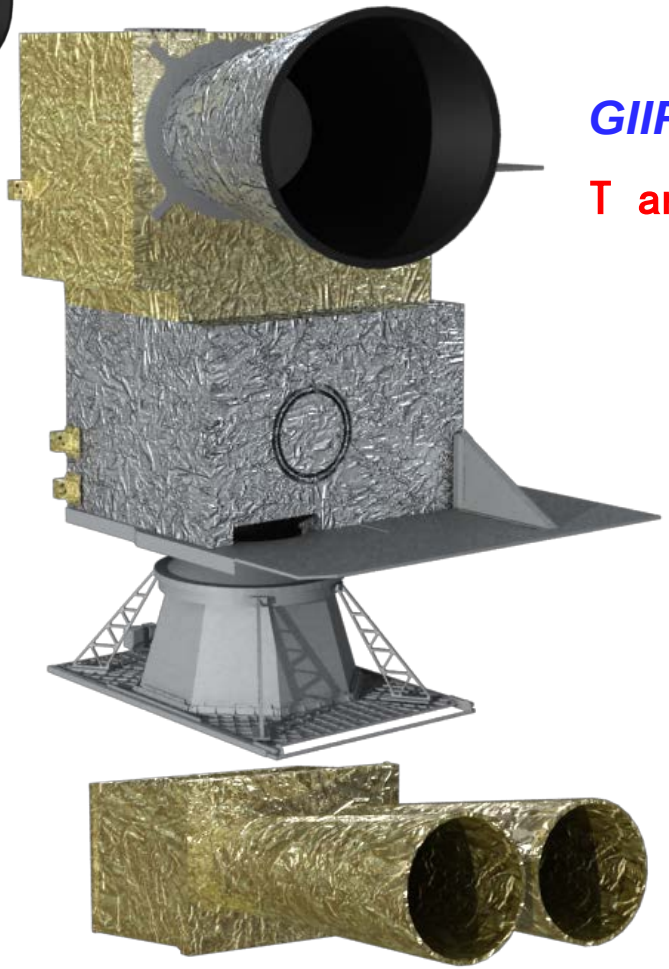
# Use of FY-4A data in NWP



***AGRI :***

CSRs of two water vapor channels,

Cloud Analysis



***GIIRS :***

T and Q sounding

SEP :

Space

LMI :

Assimilation

From：NSMC

# The NWP team of FY4A data utilization

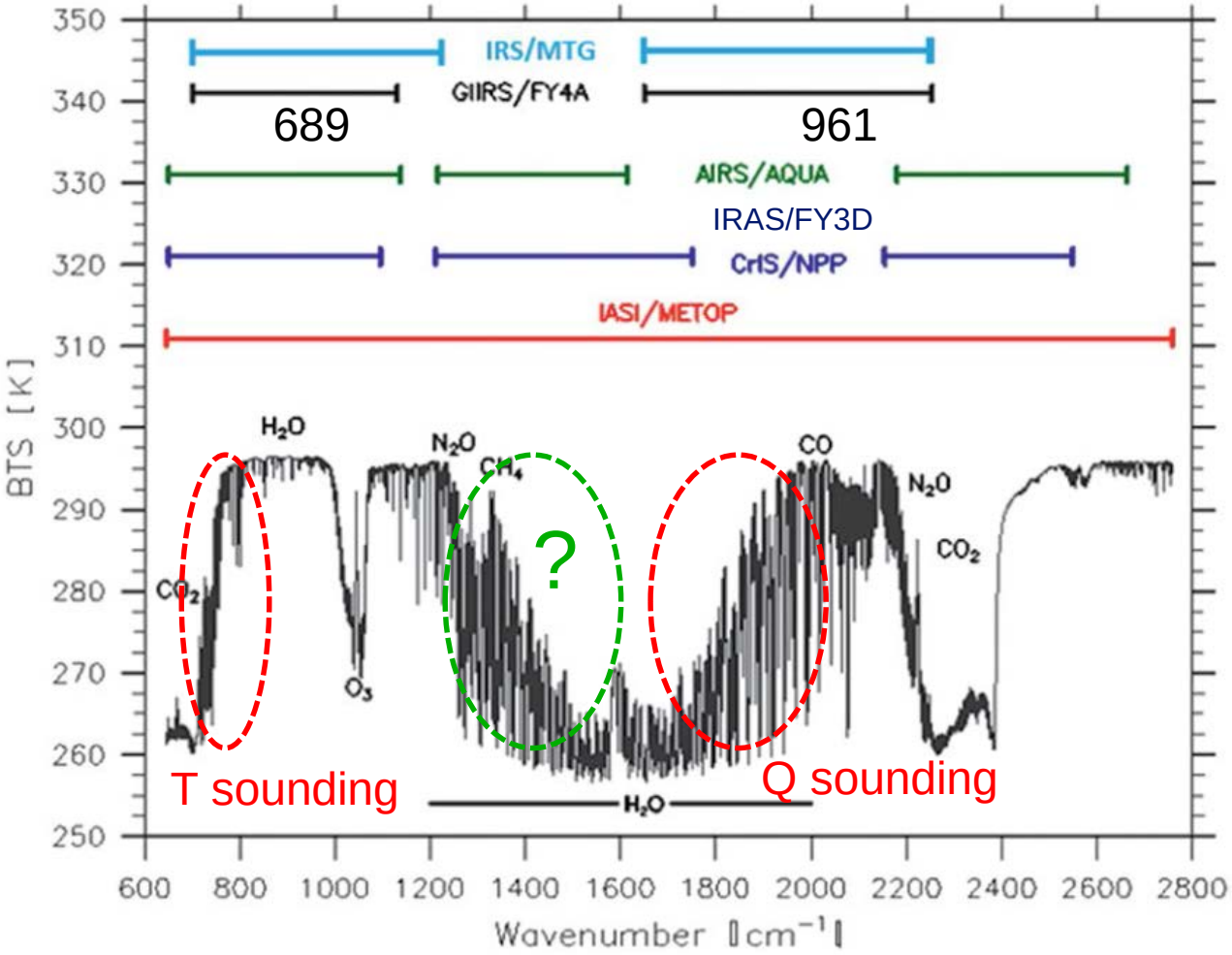
- **Direct assimilation of FY-4A**
  - GIIRS（NWPC、NSMC）
  - AGRI clear CSRs of water vapor channels（NWPC、NSMC）
- **Use of FY-4A L2 products**
  - **AMVs**（NWPC、IUM、IDM）
  - **Q profiles**（GRMC）
  - **T profiles**（STI、IDM）
  - Cloud Analysis（IHR、NWPC）
  - **LMI**（IUM,NWPC）
  - **AOD**（CMAS）
  - Land data assimilation（IUM）

9 tasks

The most important one

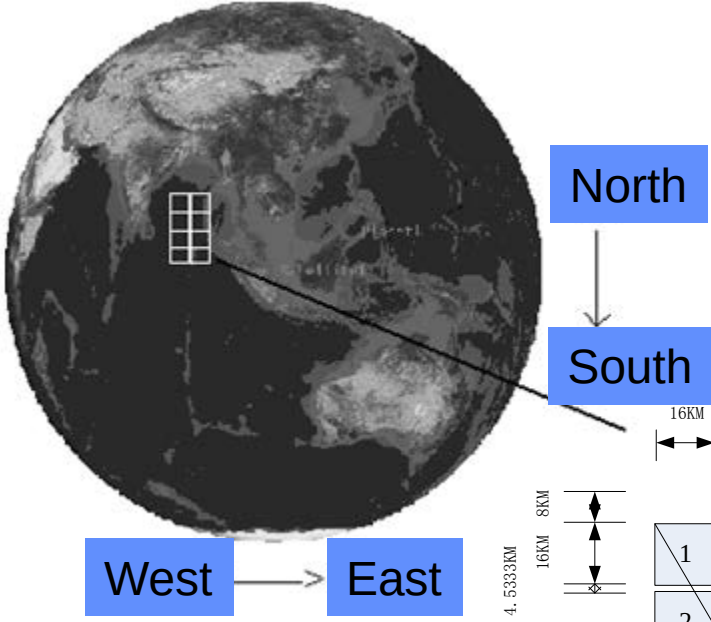
- **Integrate use of FY-4A data**
  - NWPC
  - Beijing、Guangzhou、Shanghai、Wuhan、Xinjiang、Lanzhou、Chengdu
- **Monitoring of FY-4 use in NWP**

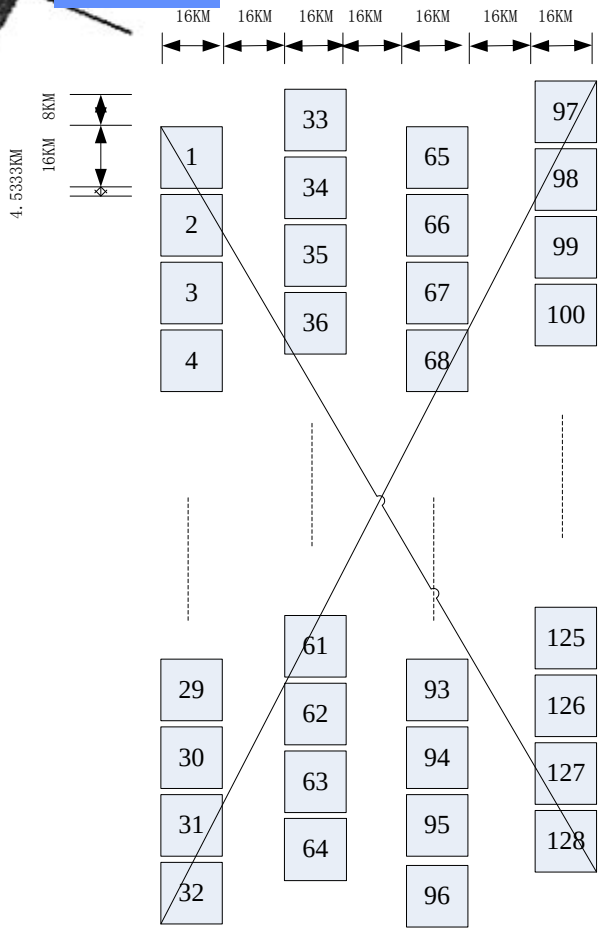
# GIIRS spectral coverage and comparisons with others

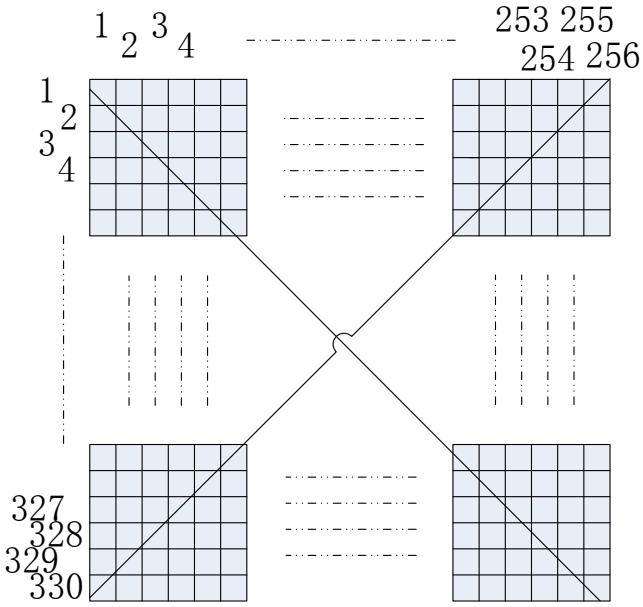



Yang J, Zhang Z, Wei C, Guo Q. : 2017,
Introducing the new generation of Chinese geostationary weather satellites – FengYun 4 (FY-4) [J]. Bulletin of the American Meteorological Society. DOI:10.1175/BAMS-D-16-0065.1

# Design of Field Of Regard (FOR)



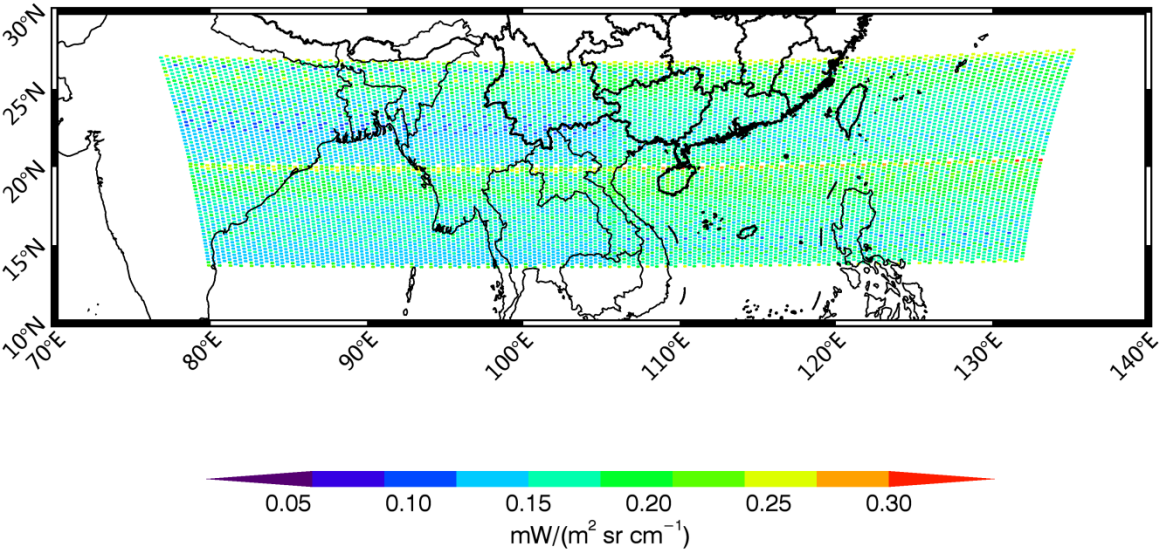



longwav NeDR ( 200 ) Radiation _ IRD

20170815

NeDR

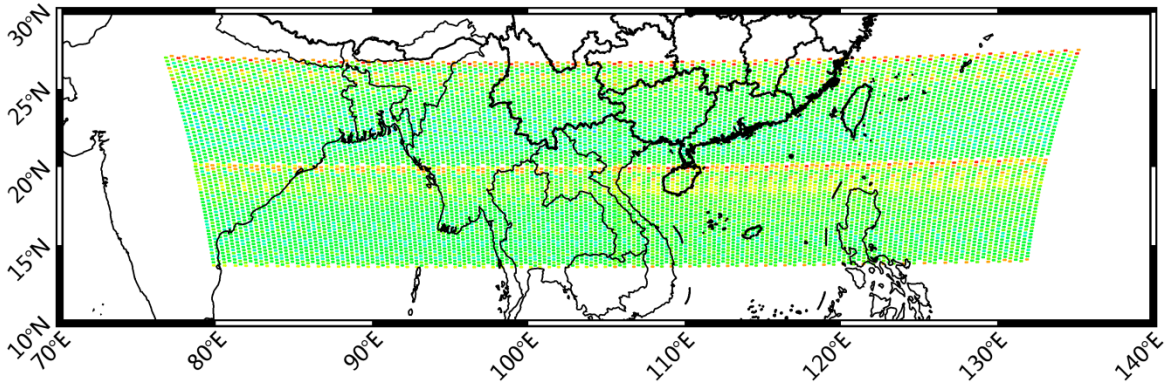


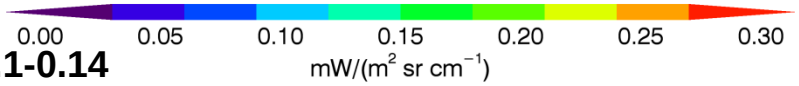




NeDR ( 200 ) Radiation _ IRD

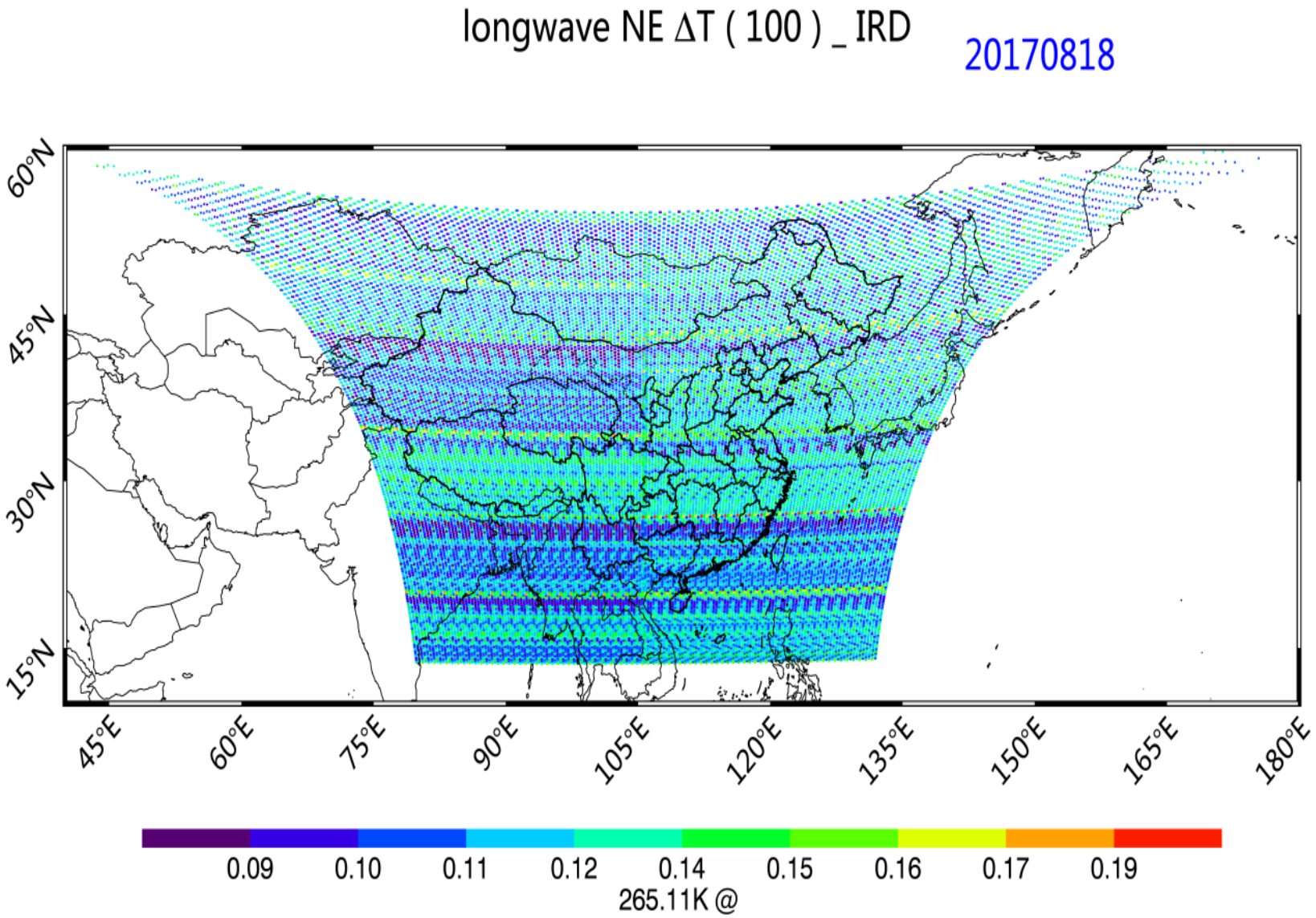
20170822



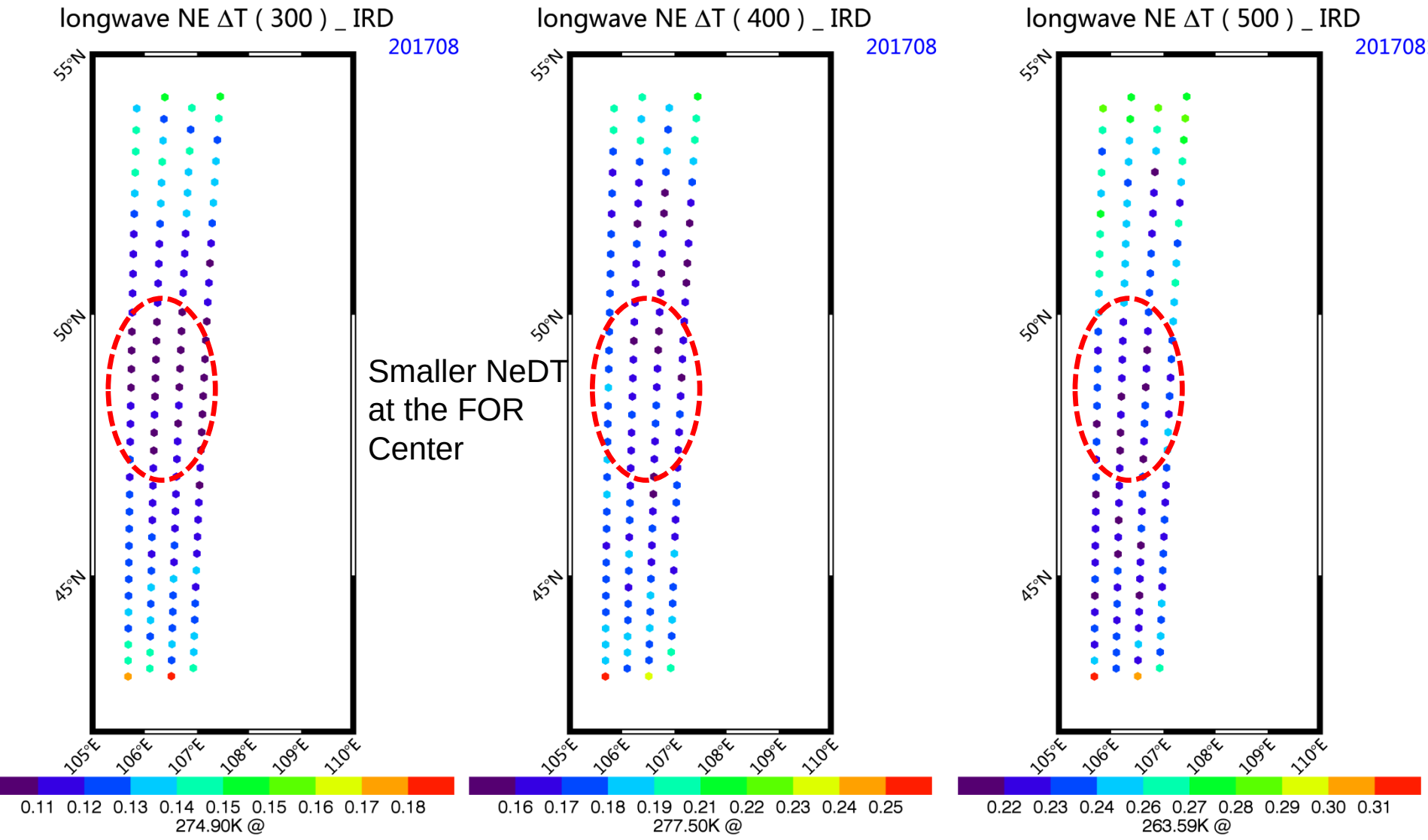




**NEdR design：Long wave: 0.5-1.1　　Middle wave: 0.1-0.14**

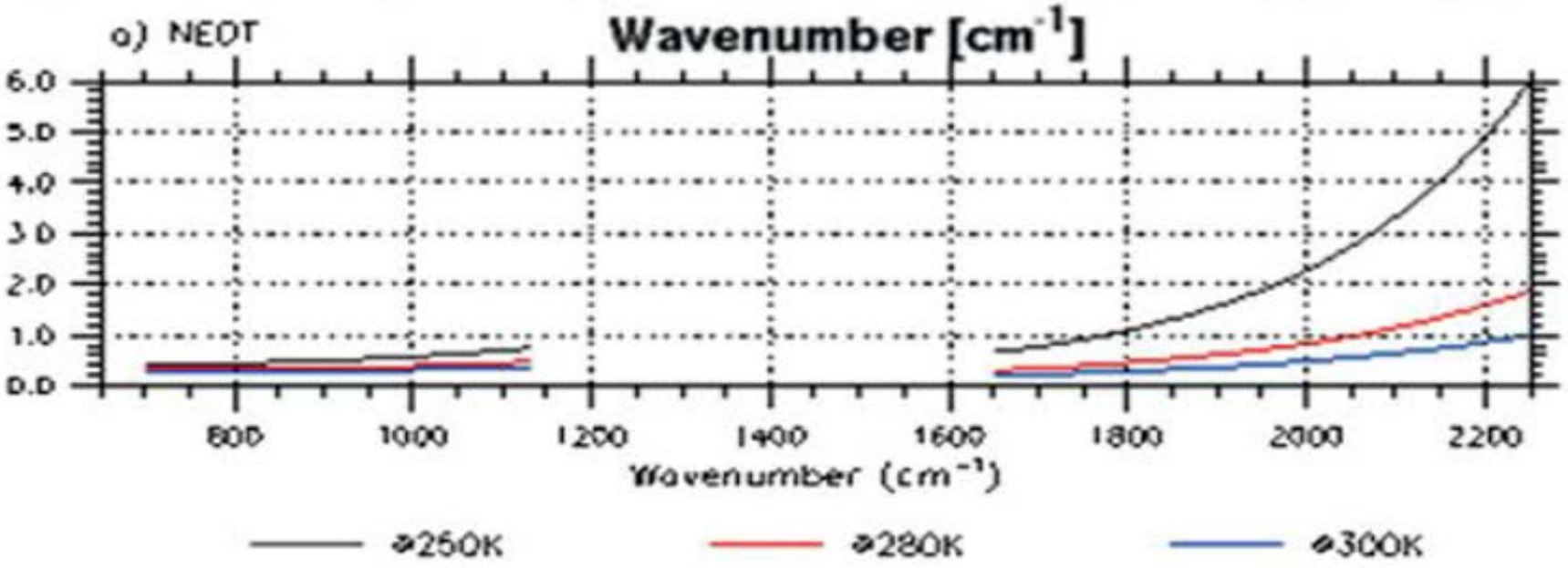
# Variation of NEdT：FOV dependent Obs. Error?

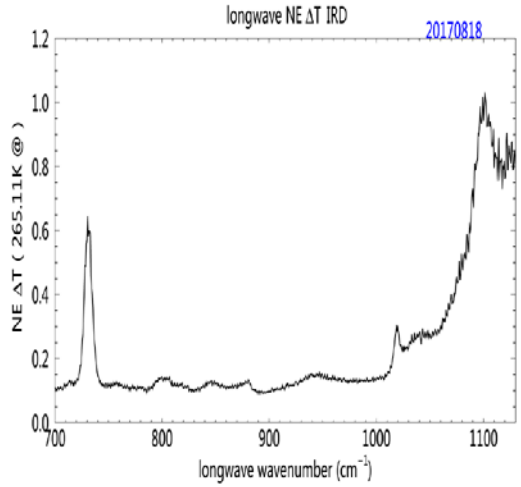


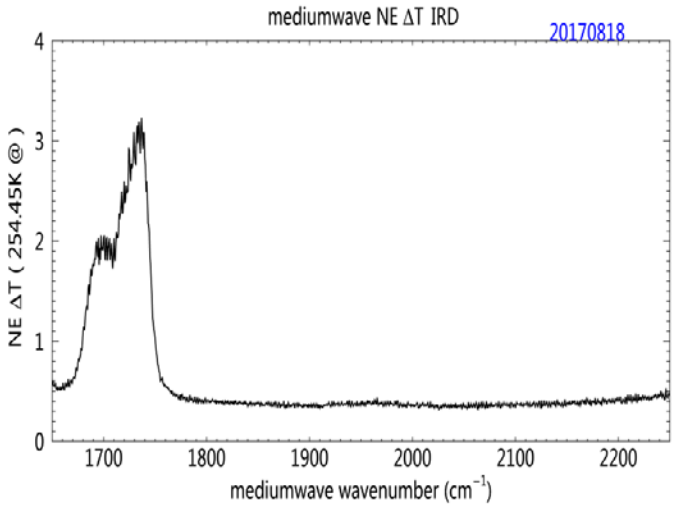
# Mean NEdT of 128 FOV during August 2017



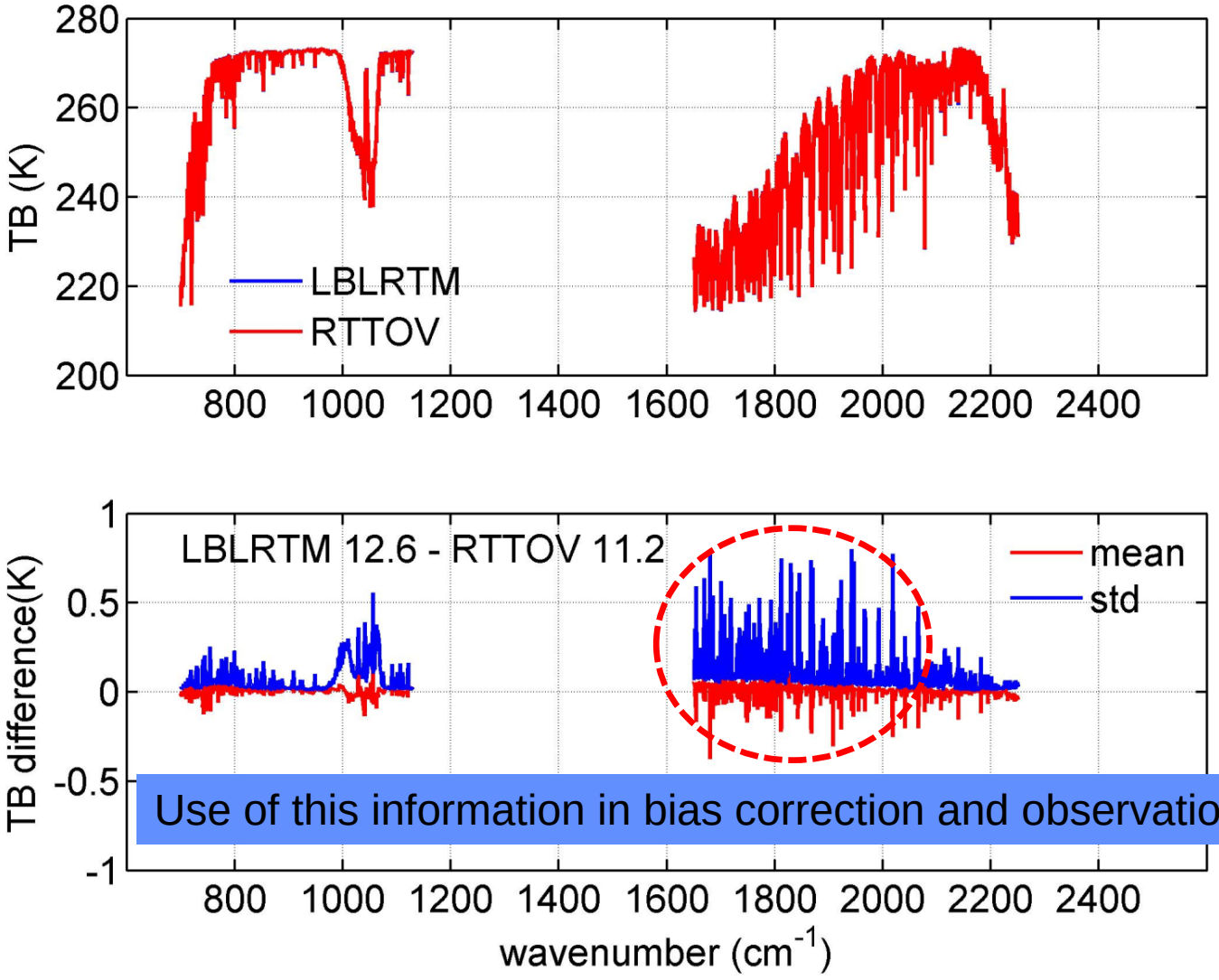
# On orbit NEdT



# Observation operator of FY4A GIIRS：Coef. in RTTOV

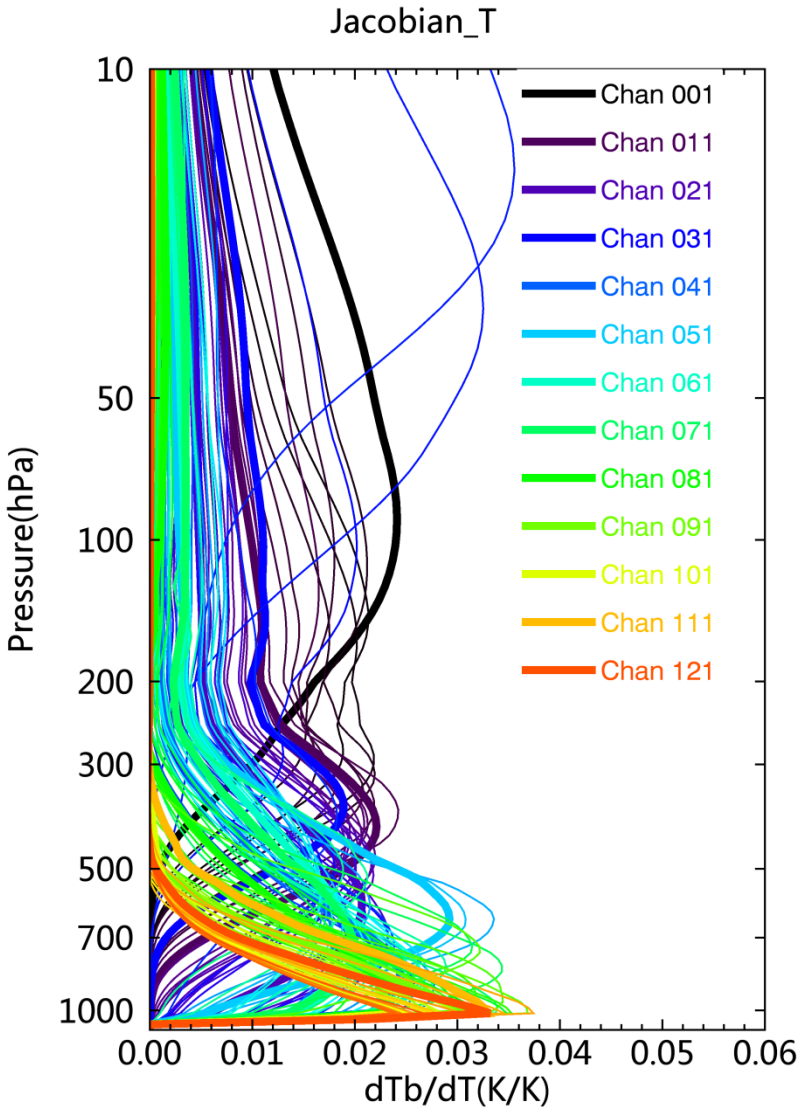



Use of this information in bias correction and observation error

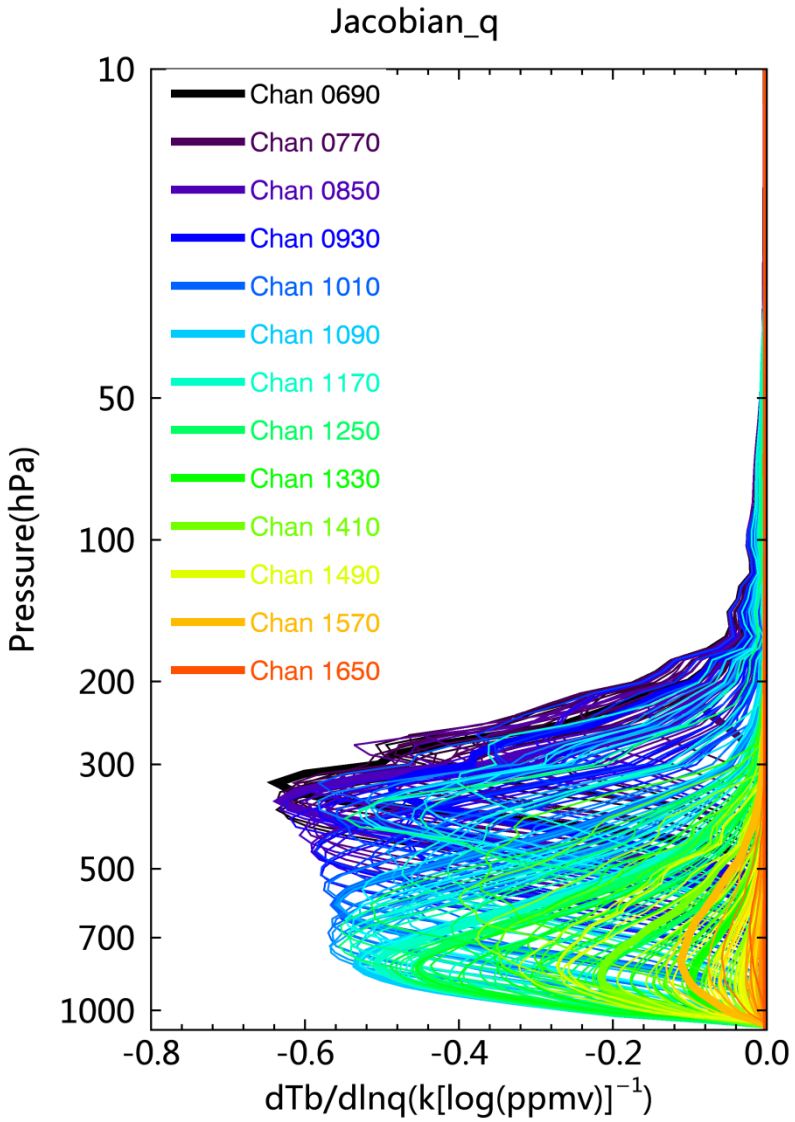
Uncertainty of Fast RT model against LBL RT model

# Jacobians of FY-4A GIIRS

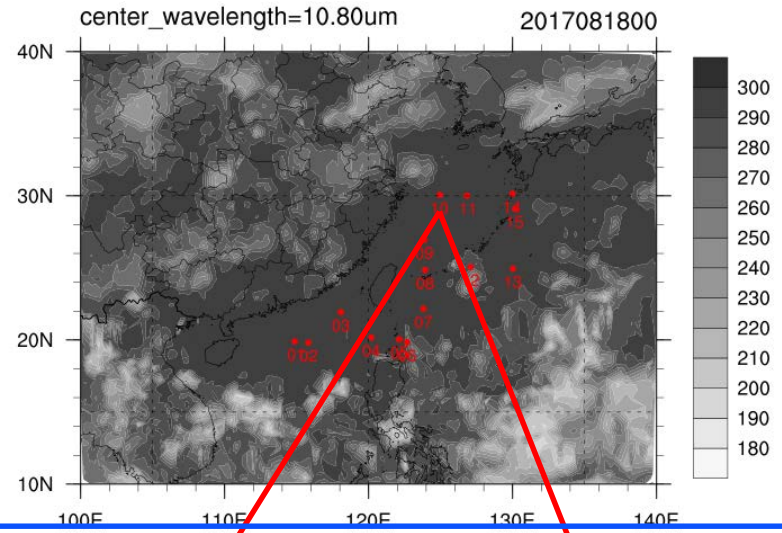
689 channels

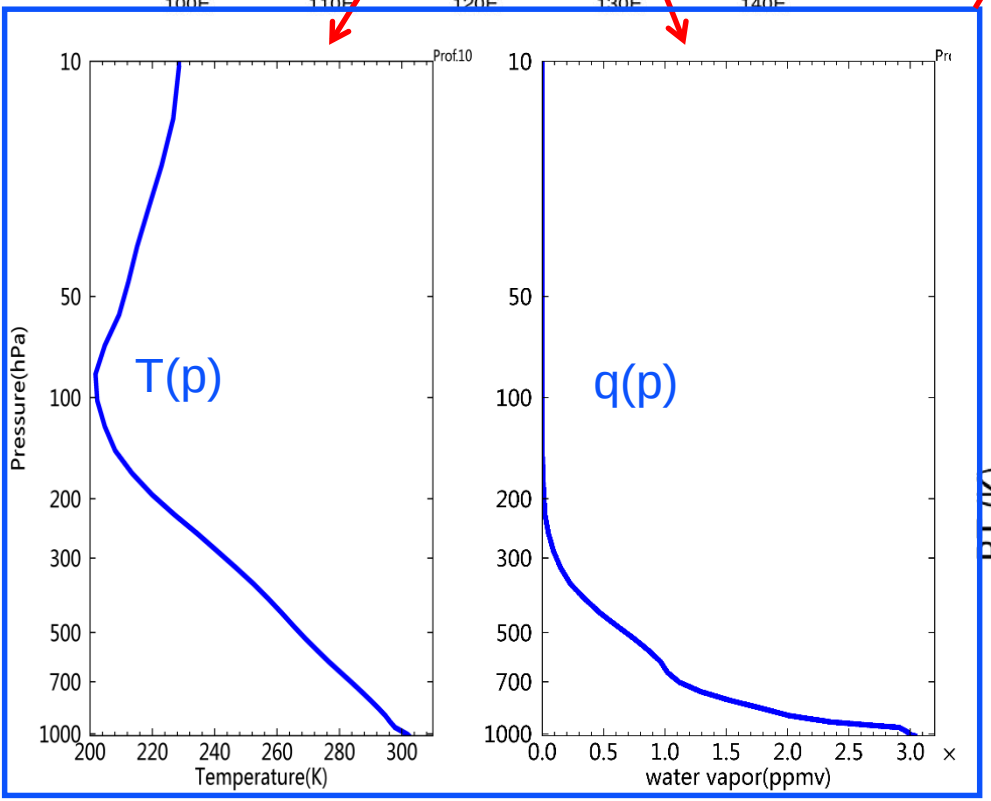


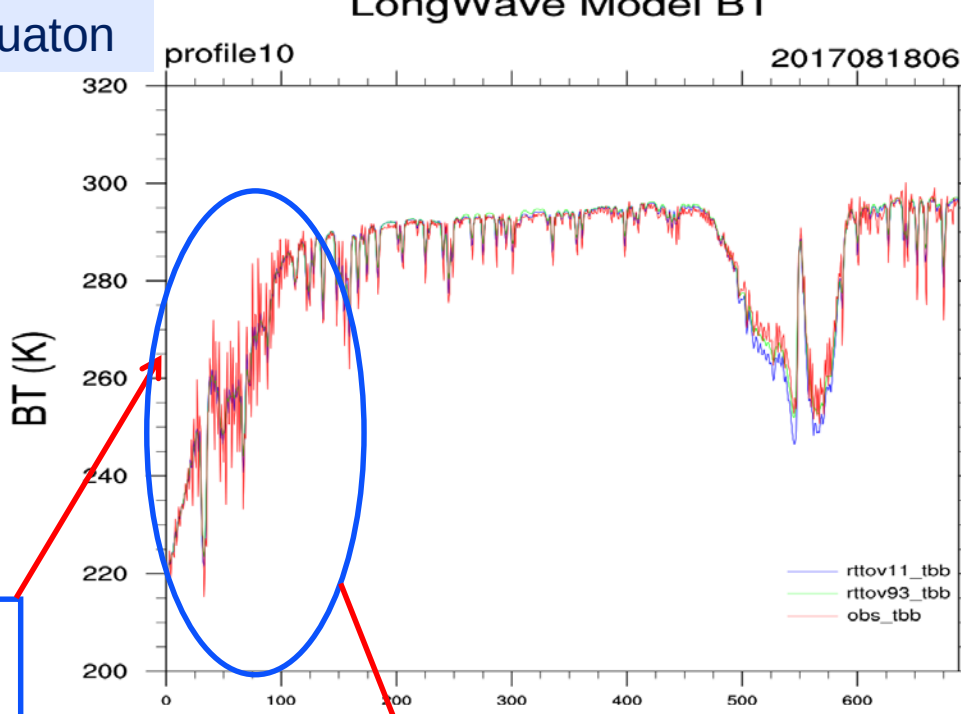

961 channels

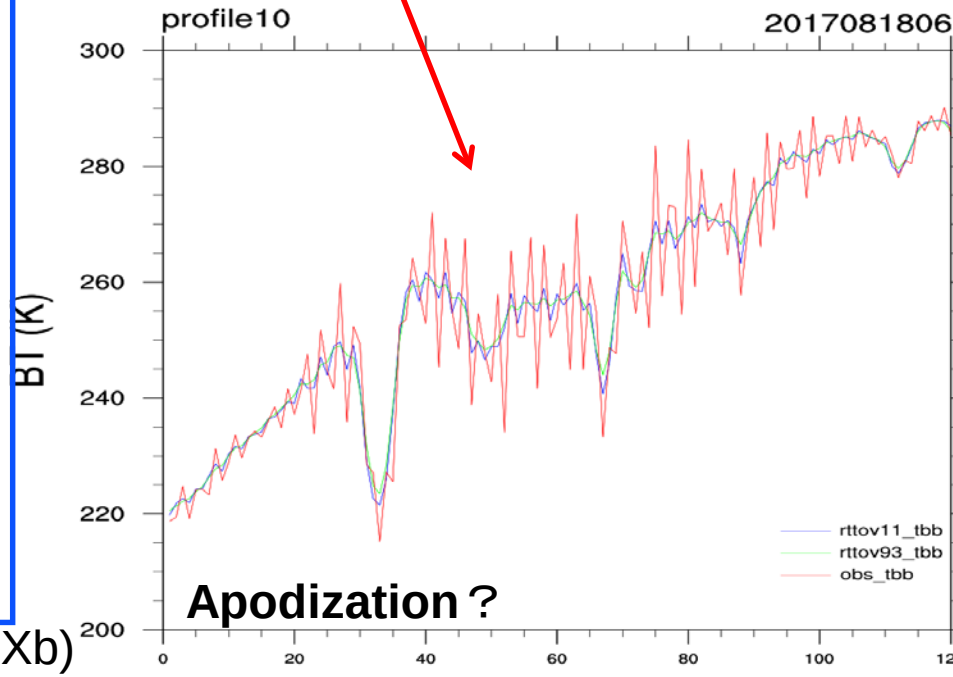


# Single obs. evaluaton

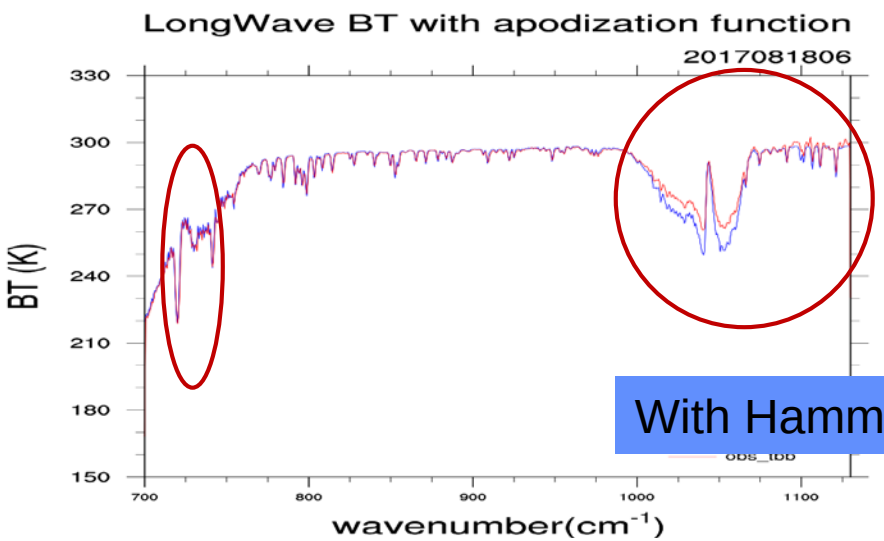


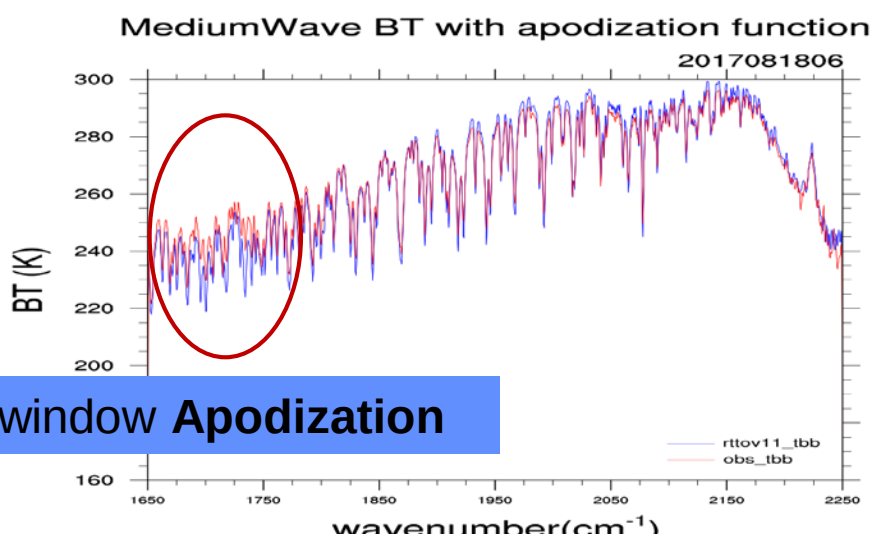



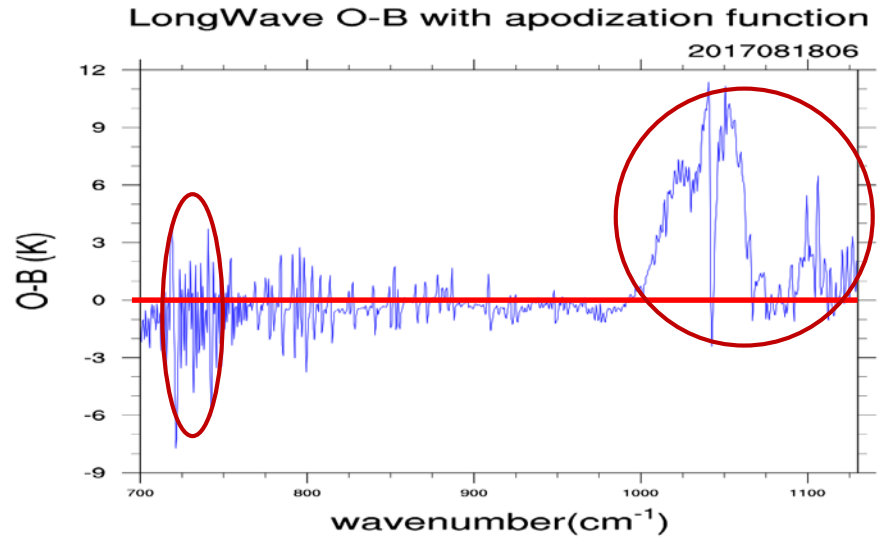



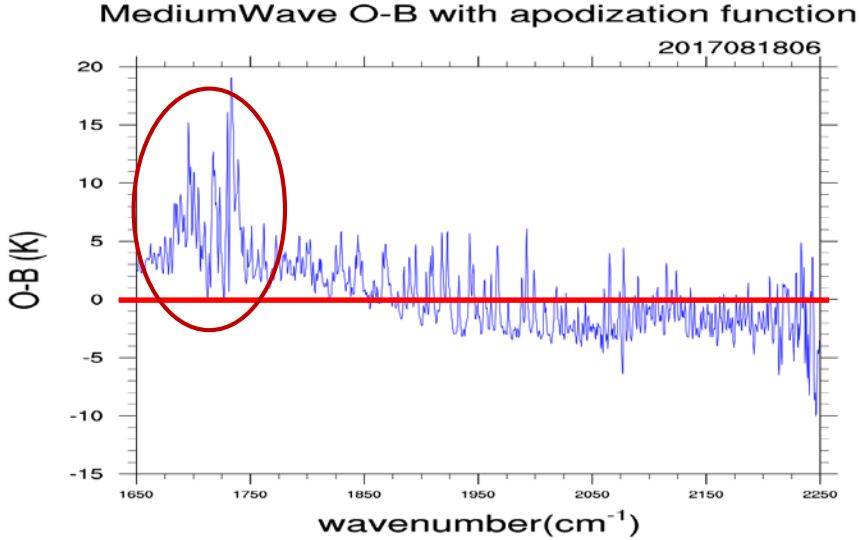

GRAPES 6h forecast (Background,Xb)

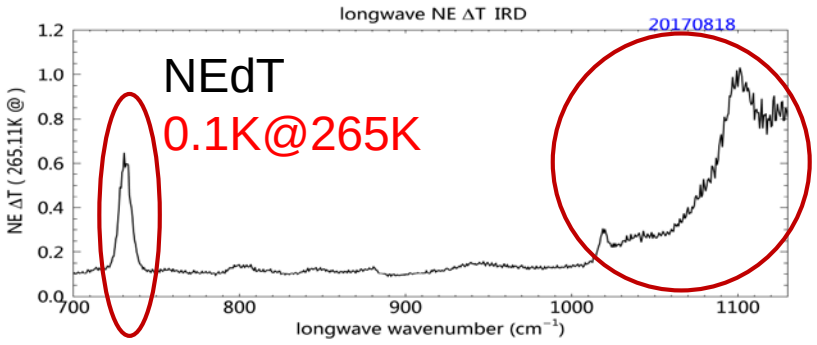


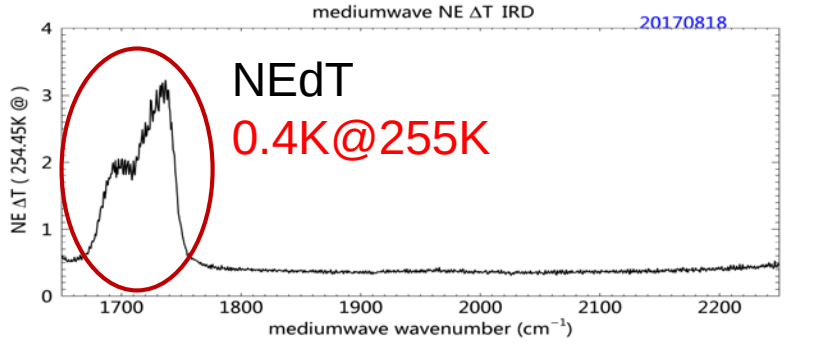



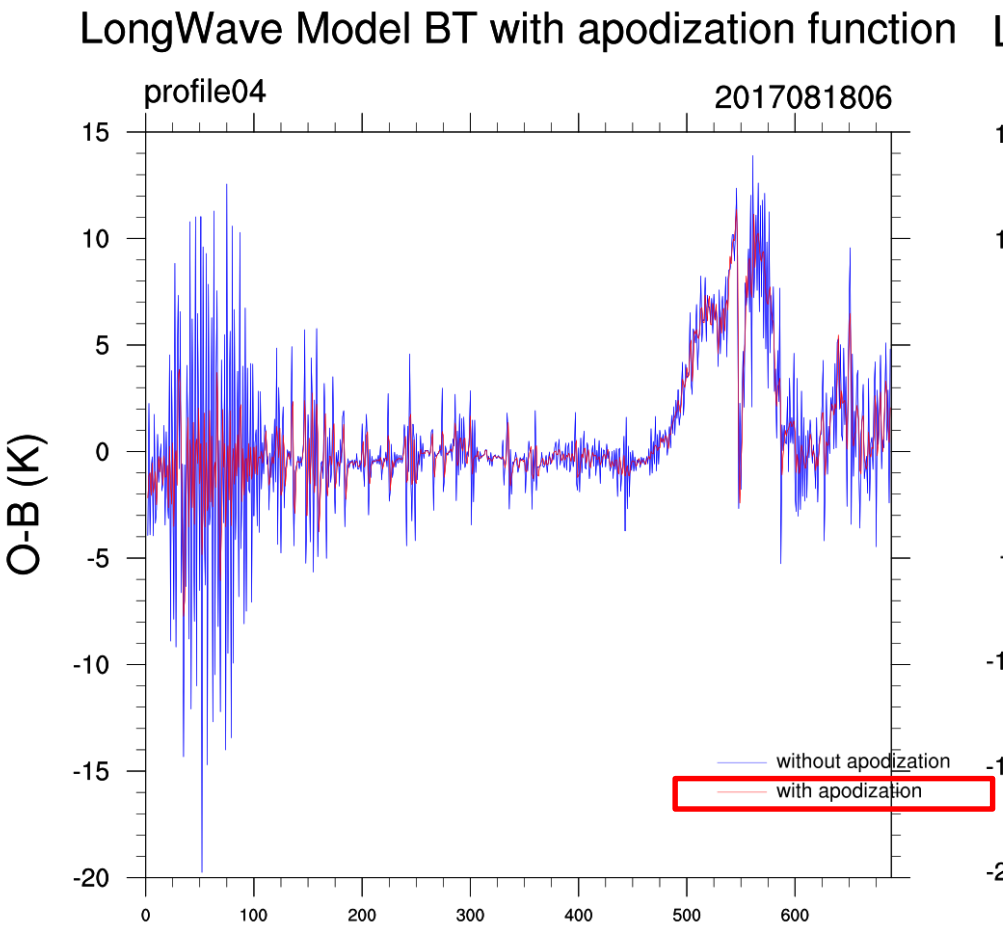

With Hamming window **Apodization**

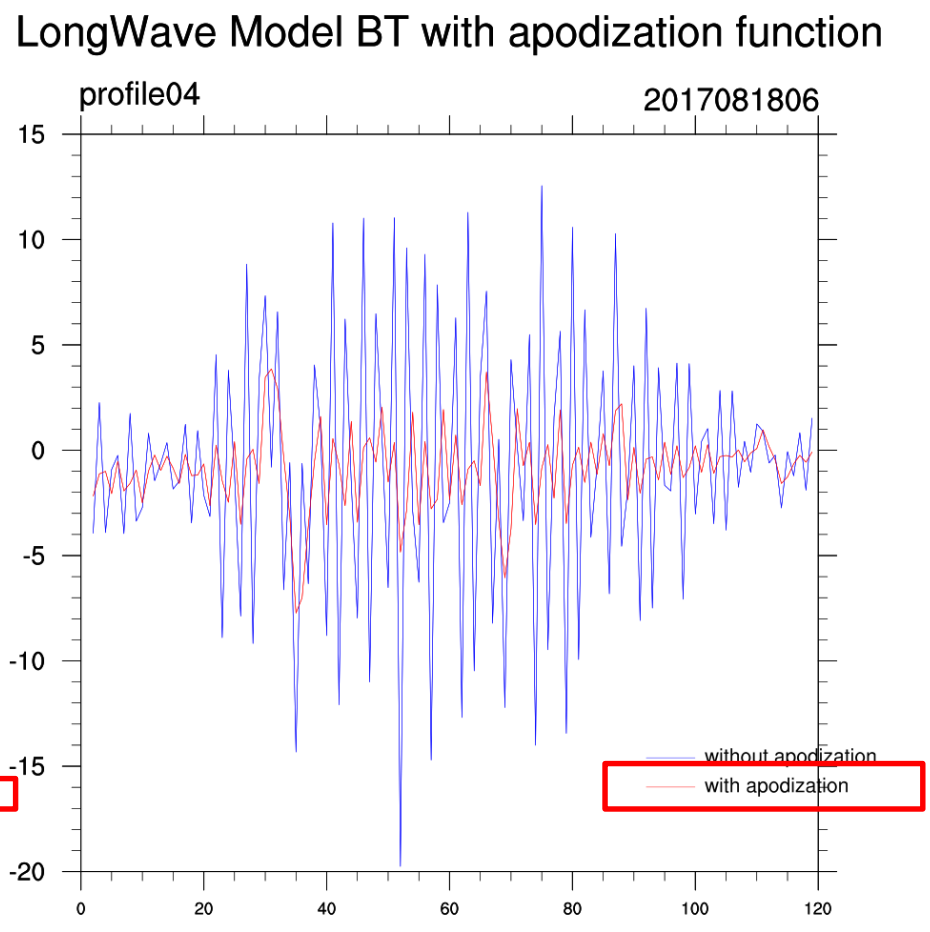


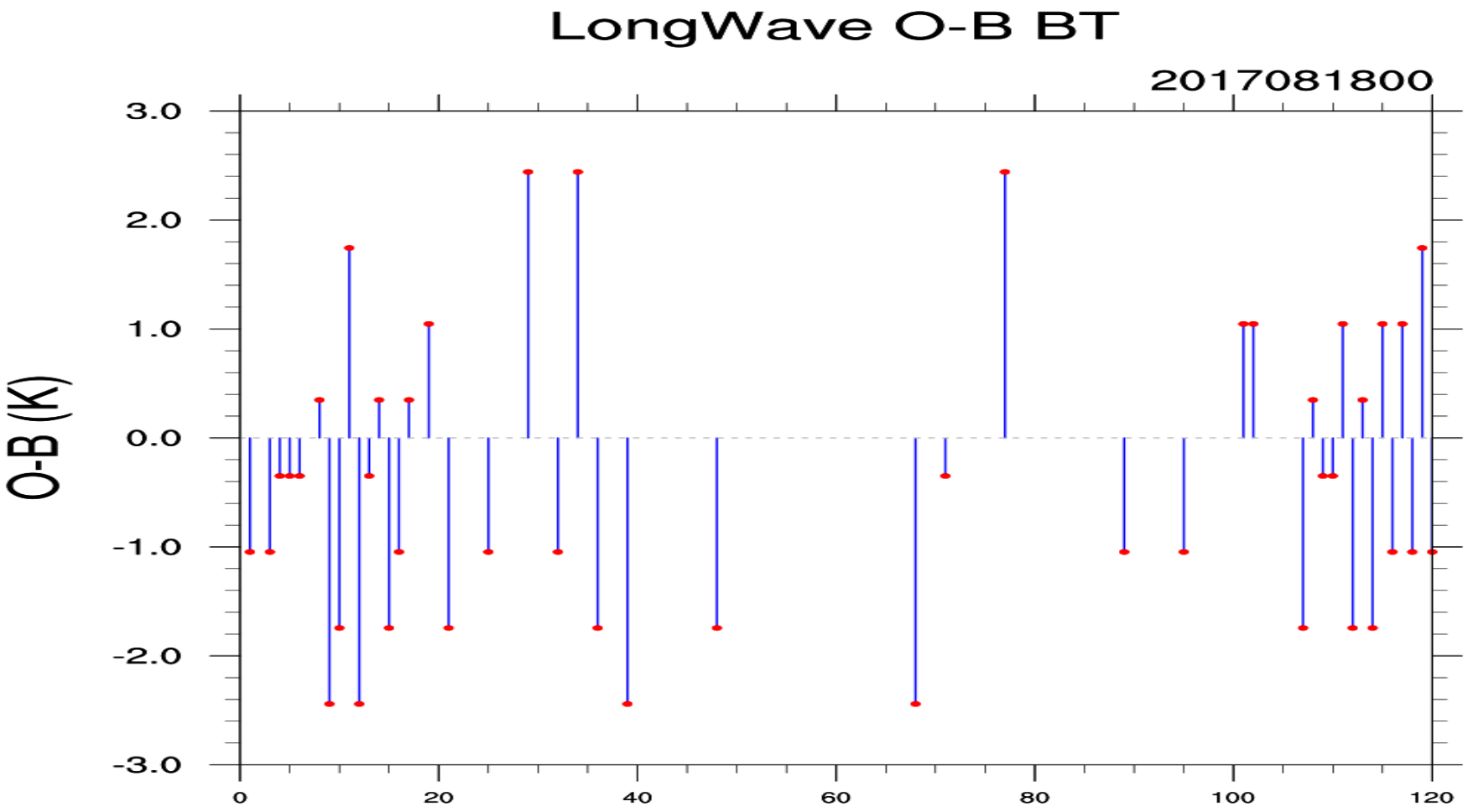




LongWave Model BT with apodization function
profile04
2017081806
O-B (K)
15
10
5
0
-5
-10
-15
-20
0
100
200
300
400
500
600
without apodization
with apodization

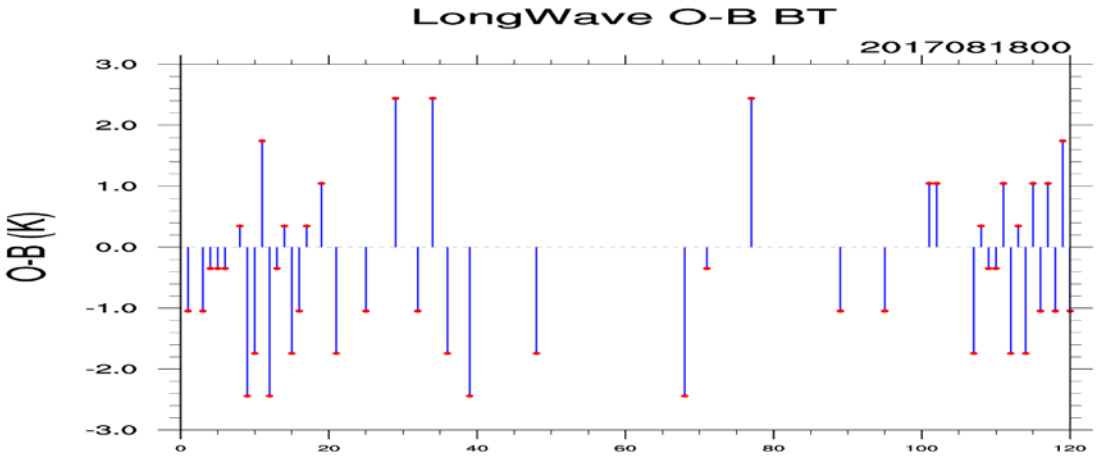

LongWave Model BT with apodization function
profile04
2017081806
15
10
5
0
-5
-10
-15
-20
0
20
40
60
80
100
120
without apodization
with apodization

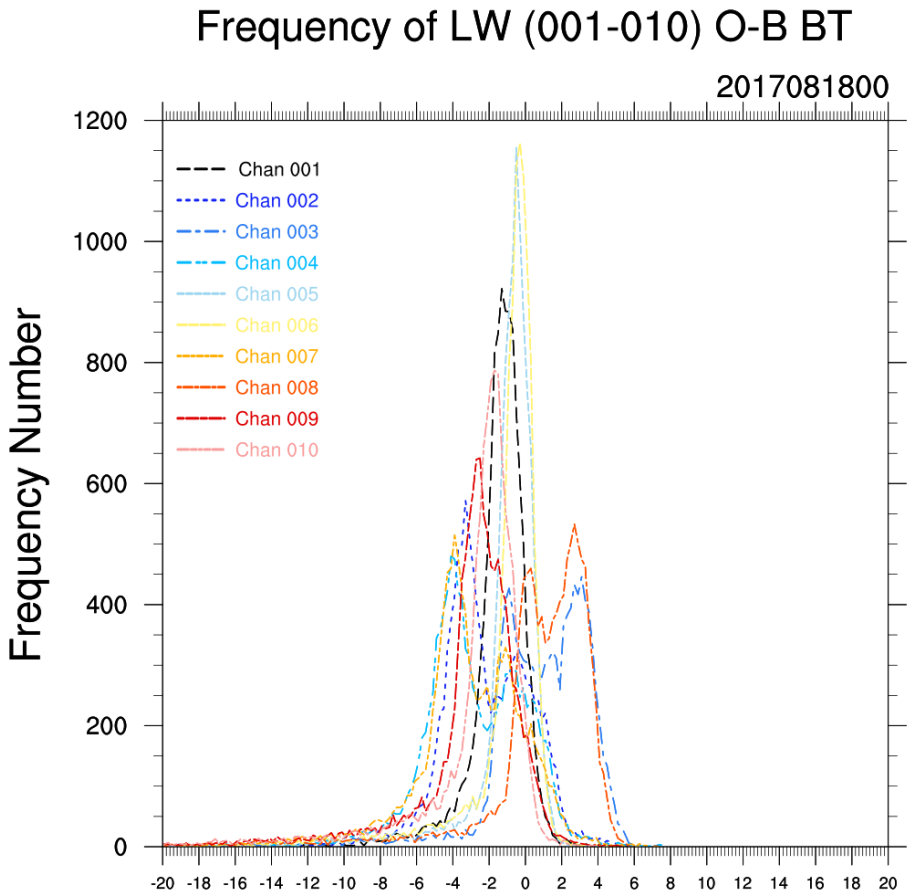
# 45 Temperature sounding channels

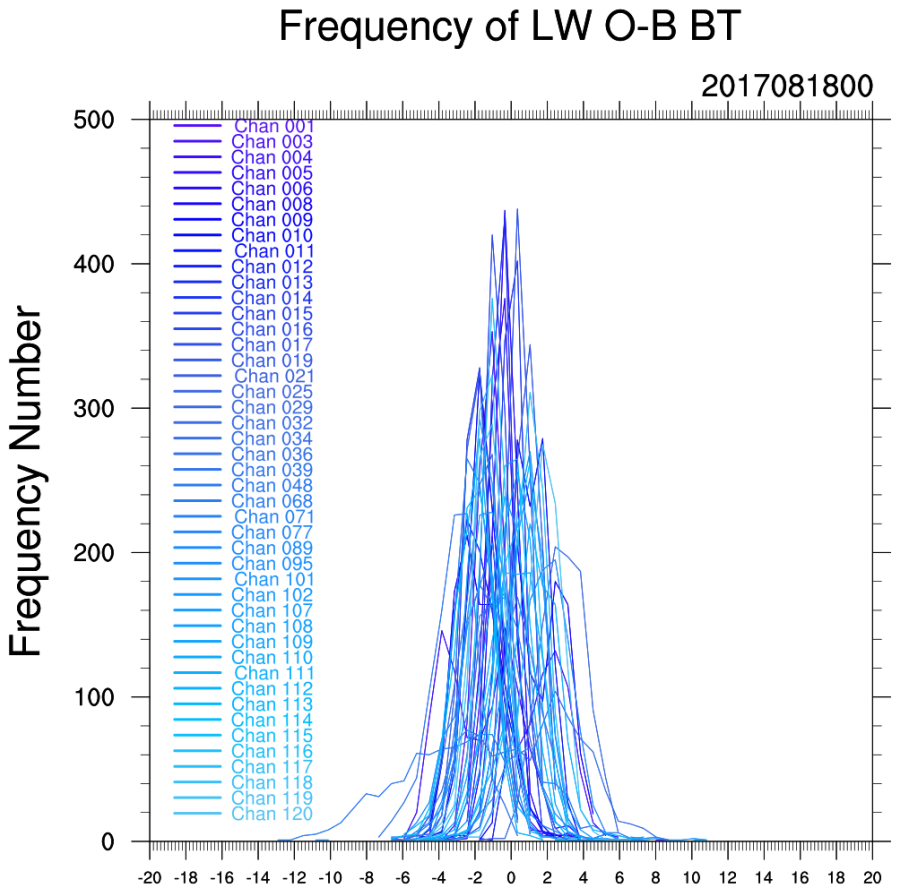
Mean bias



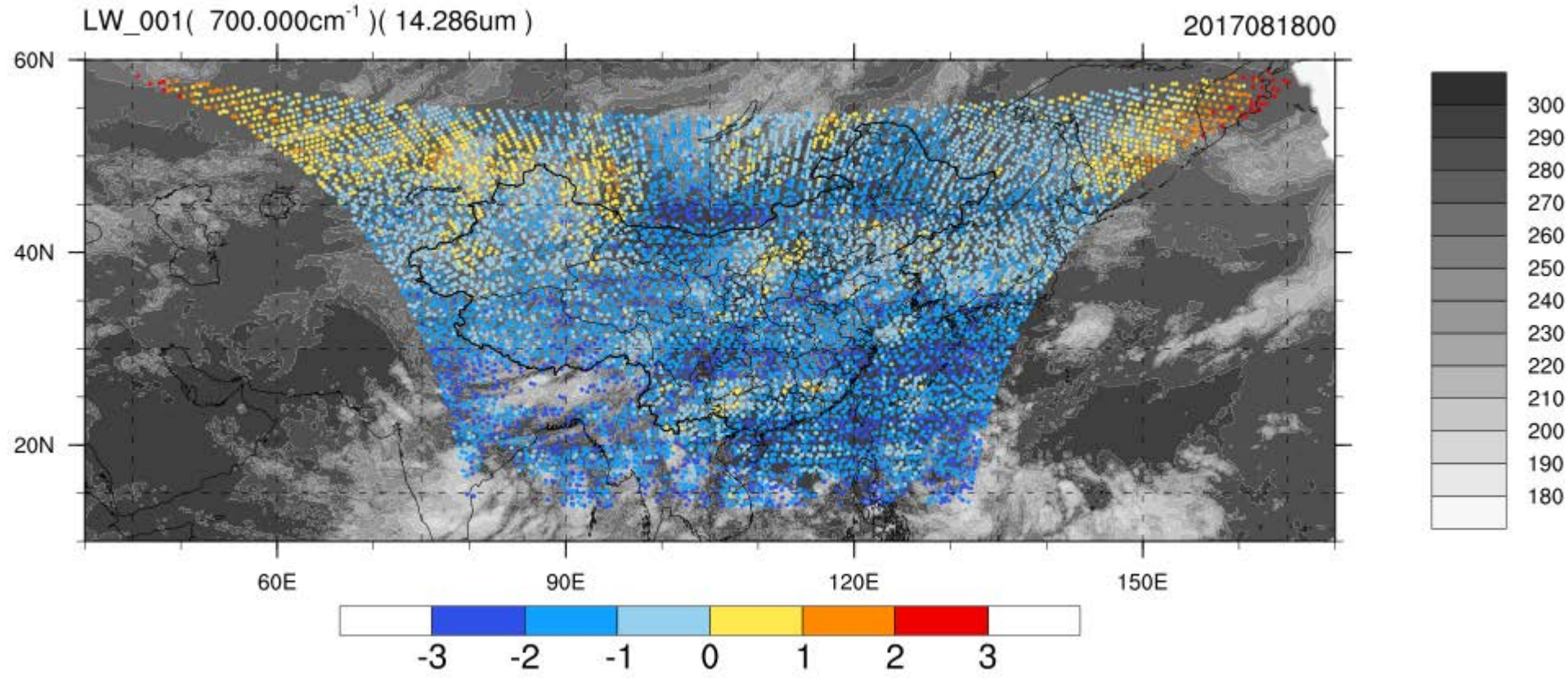
# 45 Temperature sounding channels



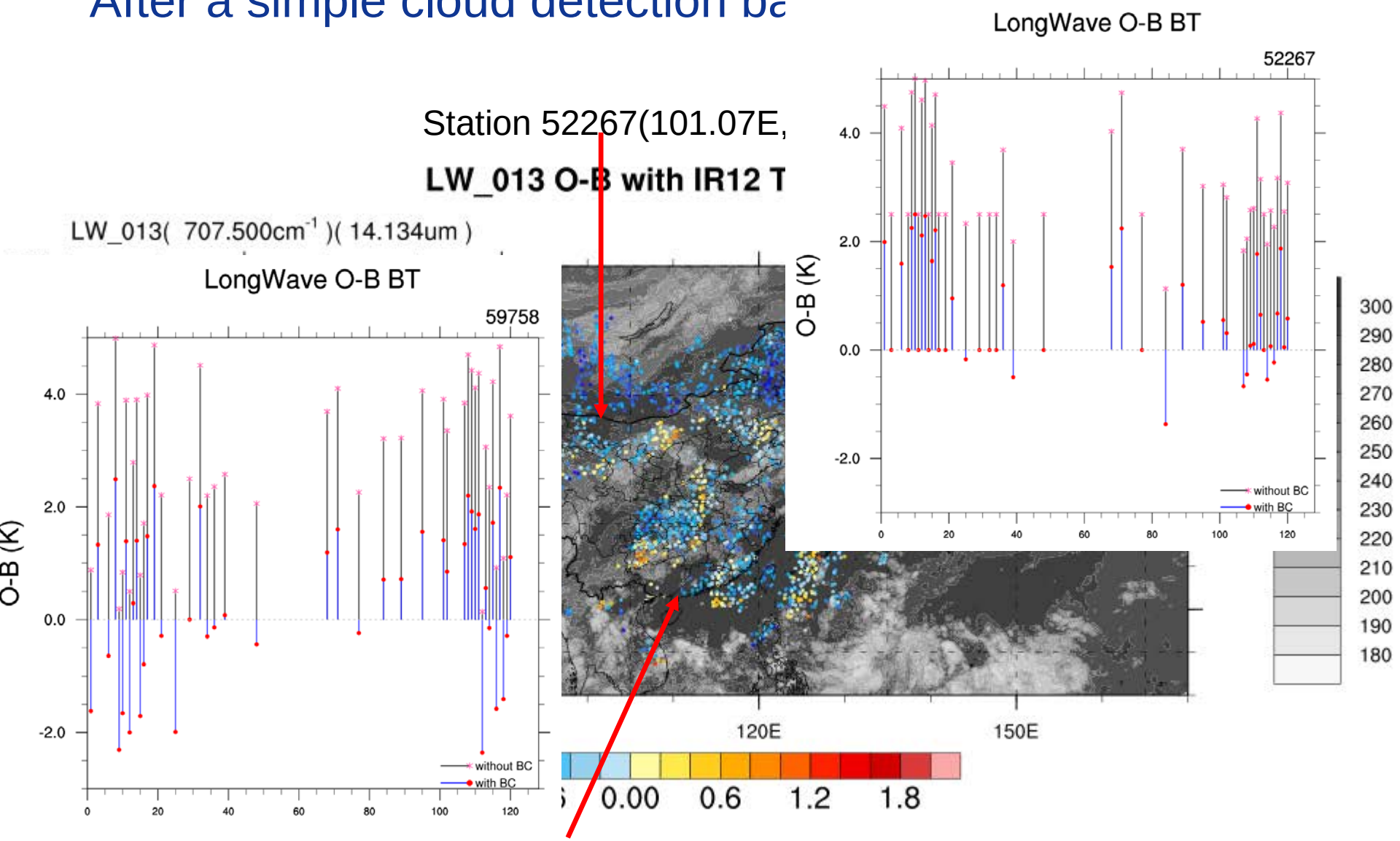



# O-B of GIIRS Channel 1




Background is AGRI (10.8um)

# After a simple cloud detection based on window channel



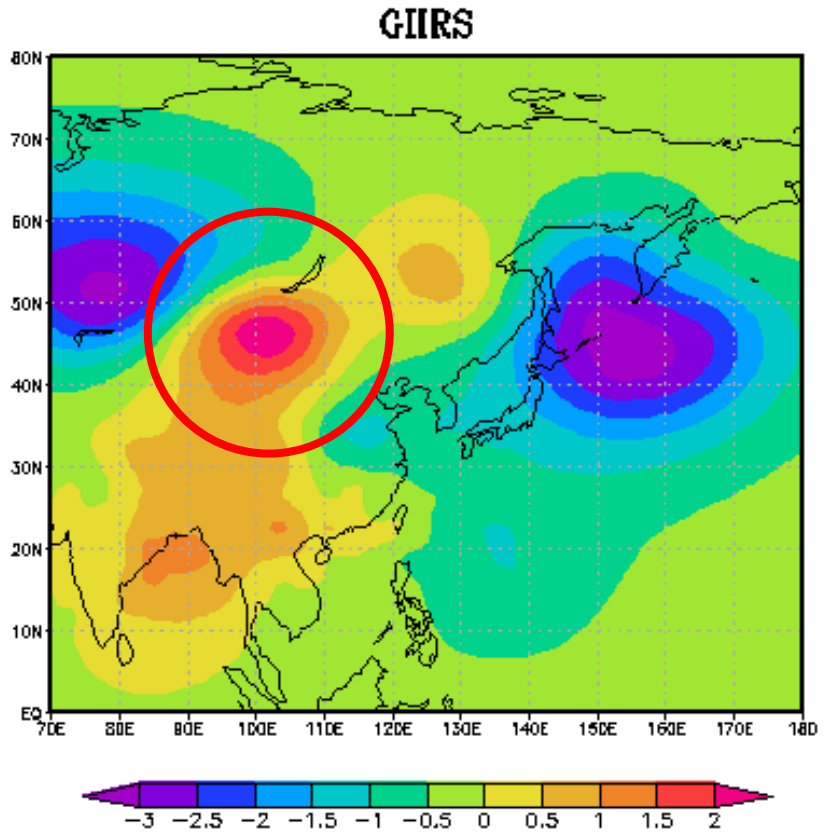

Station:59758(110.25E,20.00N)

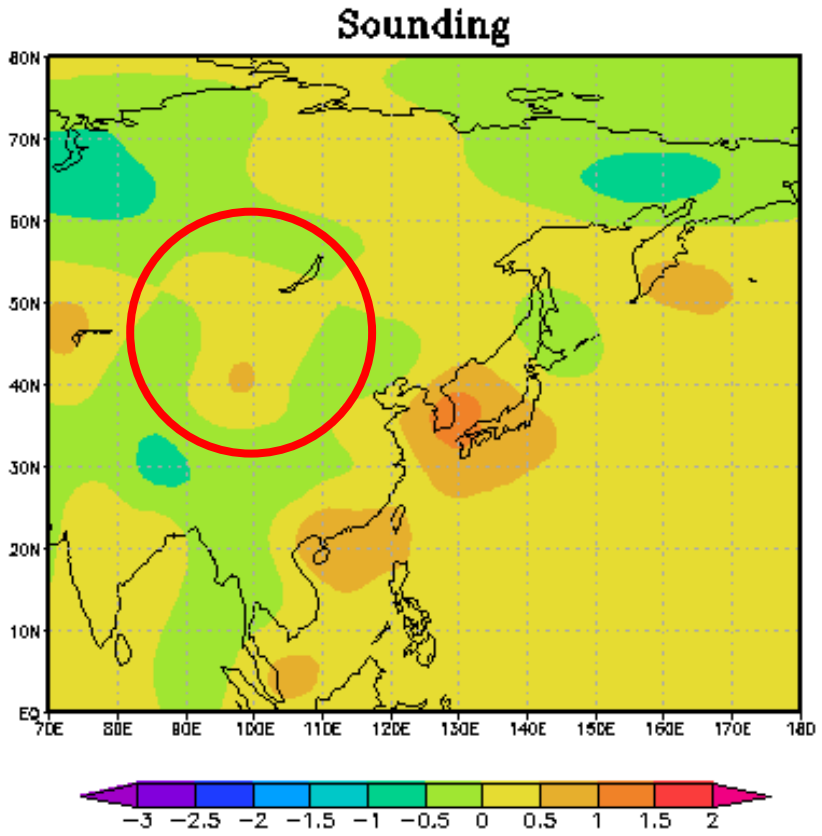
Window channel test（-3K~3K）

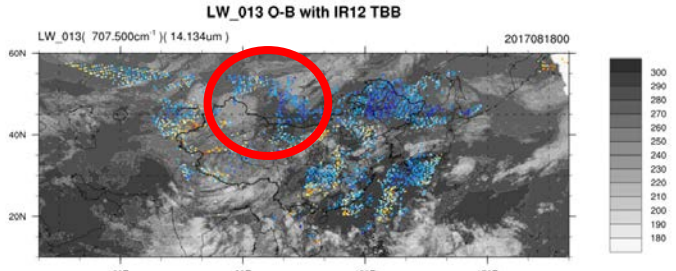
# Analysis increments: comparison with radiosonde DA

2017111800

Z=21（647hpa）

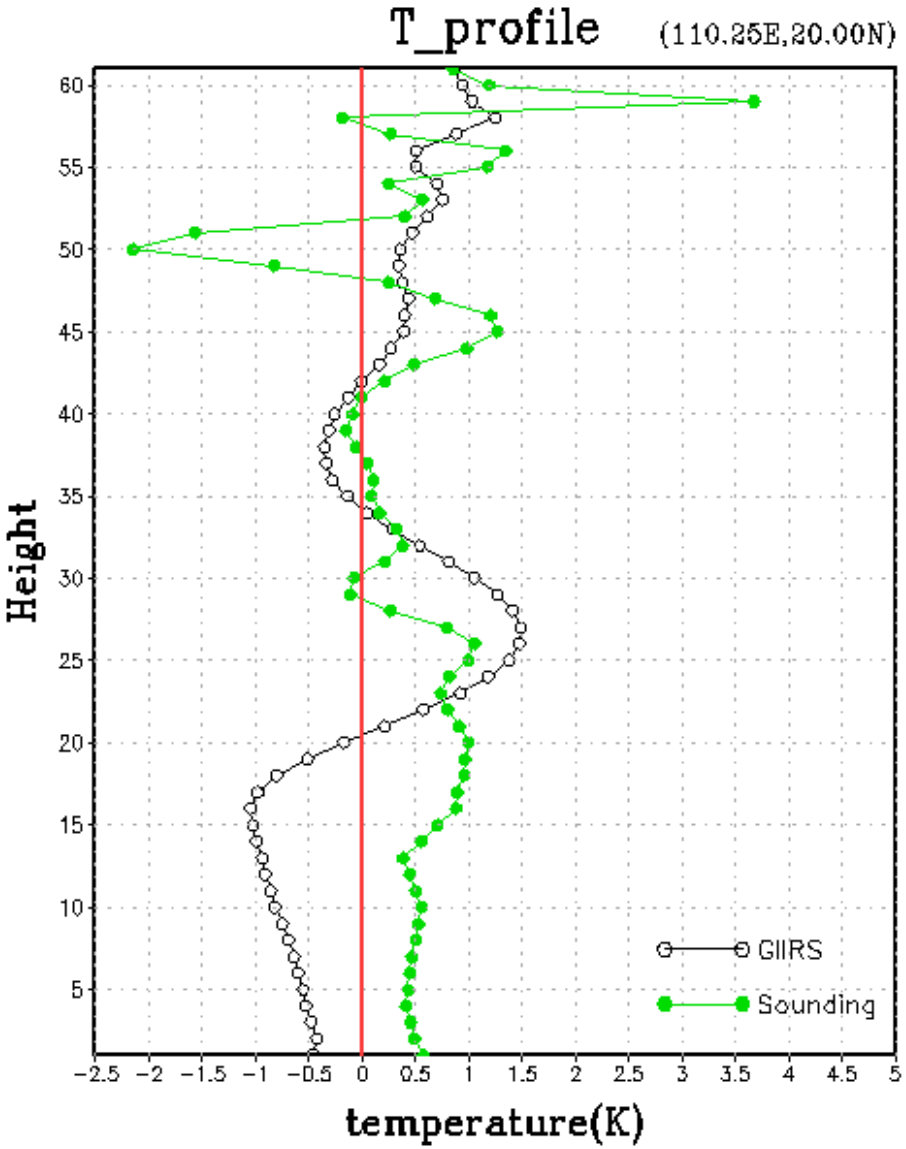


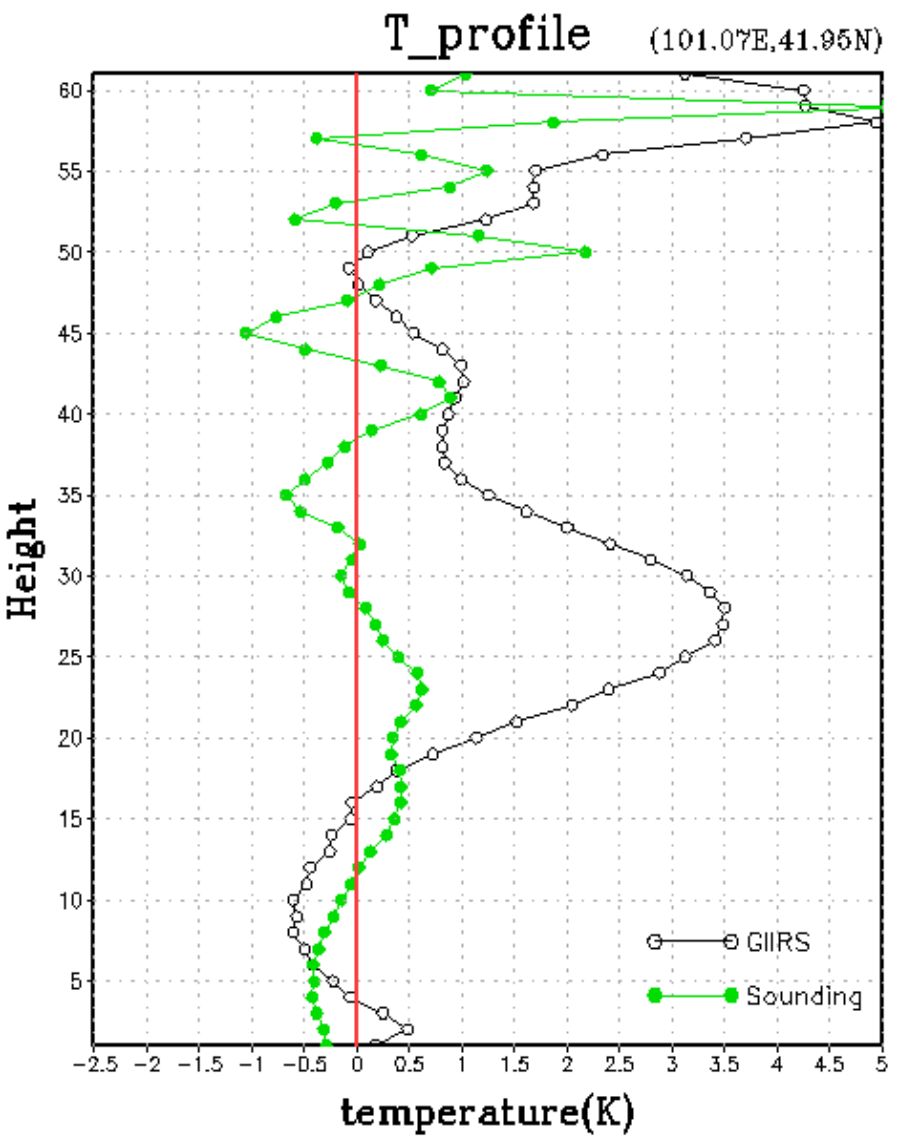



# Analysis increments: comparison at radiosonde stations

Station:59758(110.25E,20.00N)

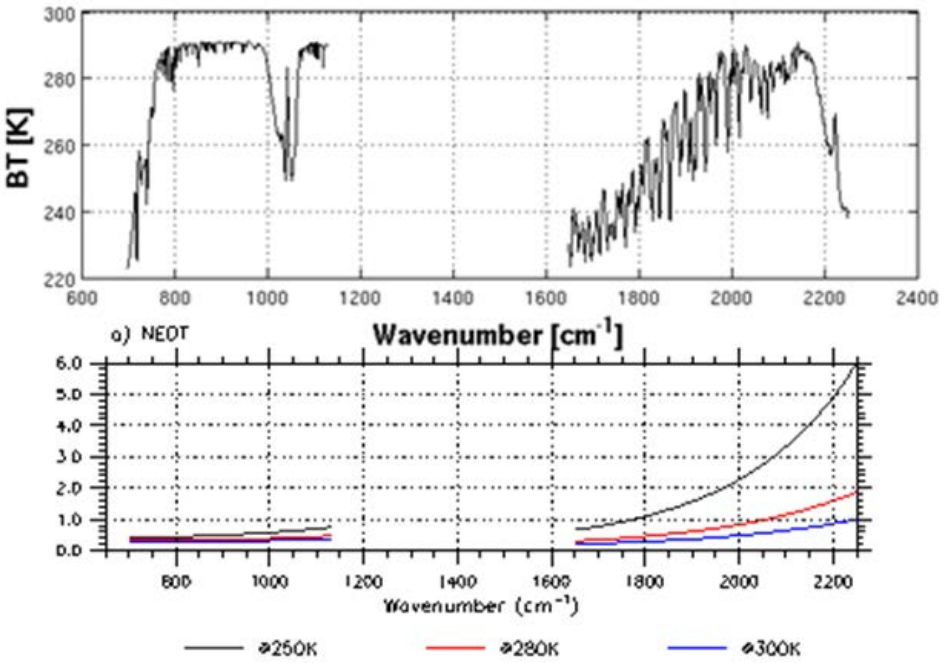



Station 52267(101.07E,41.95N)



# Observation Error Estimation of GIIRS

- **NeDT**
- **Uncertainty of RT model**
- **Error of Jacobian**
- **Linearization**
- **Uncertainty of Calibration**
- **Desrozier's  Triangle and INFLATON**



# Summary and outlook

- **Preliminary Evaluation fo FY-4A GIIRS**
  - O-B of GIIRS in GRAPES:
    - **It is VERY PROMISONG**
  - Monitoring of FY-4A using GRAPES is ready

- **Next step and outlook**
  - **Calibration (Spectral calibration, radiance calibration, … )**
  - **GIIRS O-B (Apodization, RTTOV coefficients, …)**
  - **GIIRS channel selection(B, R, H)**
  - **QC and BC ( Cloud detection, thinning, bias correction)**
  - **Observation mode experiments( trade-off of coverage, time, accuracy)**
  - **4DVAR experiments in GRAPES**

# Suggestions on FY4A GIIRS observation mode

- **Big step**
  - **Long wave and Middle wave with different position**

**Could be used as TWO instruments**

  - **Big step+Small step … TEMPORAL resolution disap…**

- **"Smart Obse…**
  - **Clear sky sc…**
  - **Mainly for sou…**
  - **Target observation…**
    - Use of AGRI cloud detection
    - Use of NWP cloud forecast（12h,24h)

THANK YOU

^ ^

谢 谢

- **HIGH temporal sounding is the first priority of GIIRS**