The evaluation of GIIRS longwave temperature sounding channels using GRAPES 4D-Var

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IAP/CAS

NWPC/CMA

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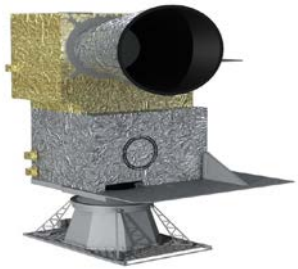
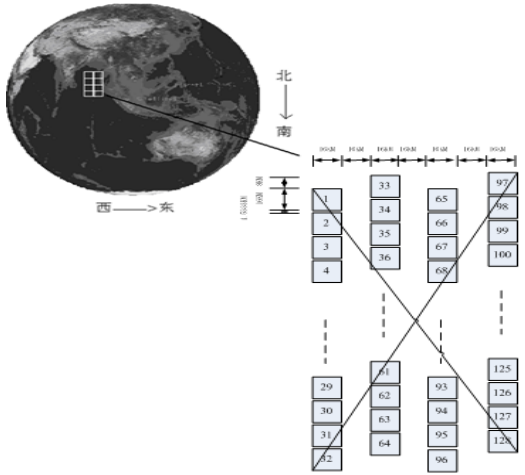
1. Background & GIIRS



◆ **GIIRS** is the first high-spectral-resolution advanced IR sounder on board a geostationary weather satellite. It is very capable of monitoring, warning and forecasting high-impact weather events due to its high temporal and spatial vertical resolutions.



Spectral coverage: LWIR(700-1130cm-1, 689channels)

MWIR(1650-2250cm-1, 961channels)

Spectral resolution: 0.625cm^{-1}

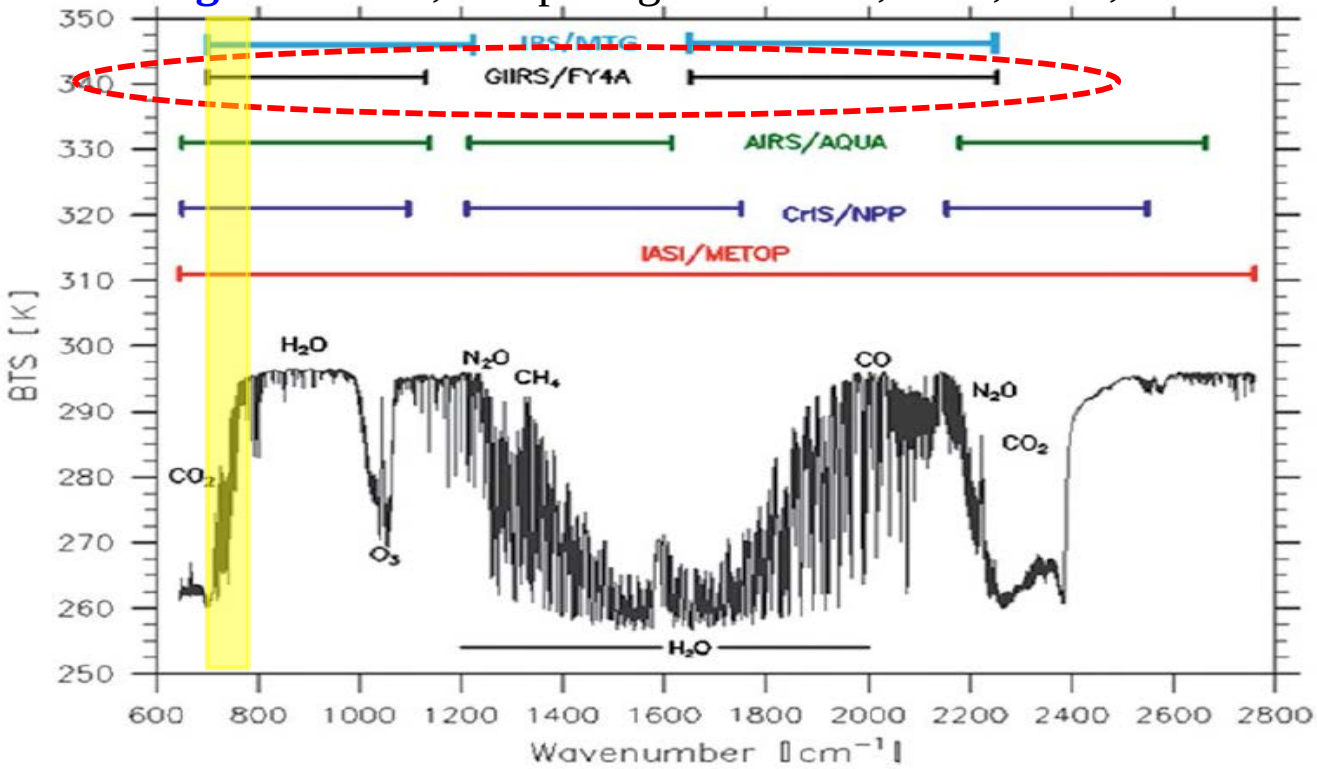
Spatial resolution: 16km

Temporal resolution: 2.5h on August 2017

2h after December 6, 2018 (regional area)

1. Background & GIIRS

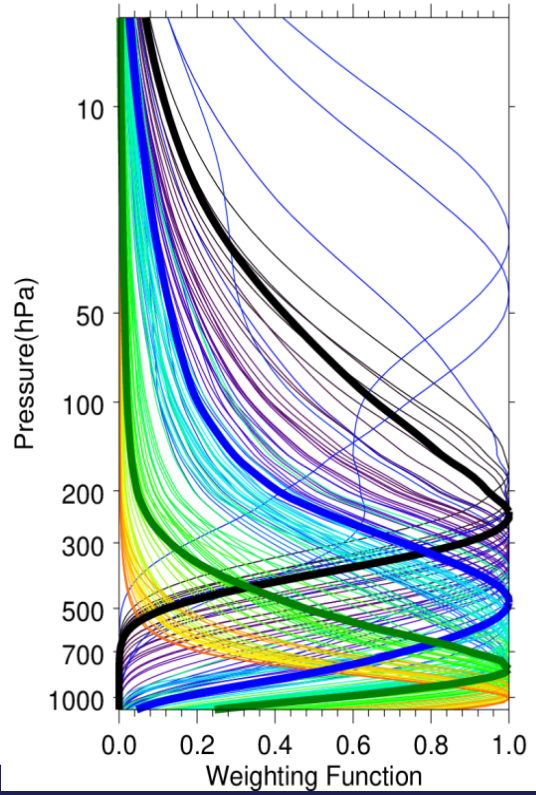
Spectral coverage of GIIRS, comparing with AIRS, CrIS, IASI, IRS

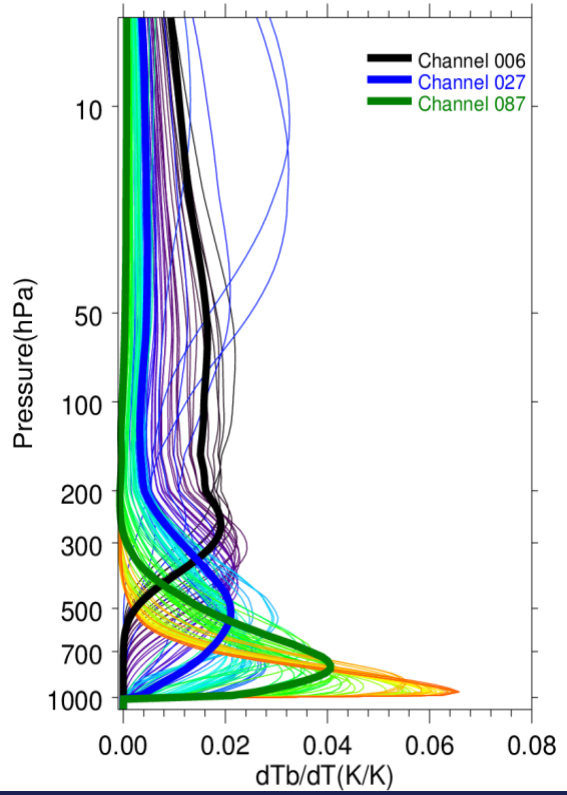


Yang J, Zhang Z, Wei C, et al. Introducing the new generation of Chinese geostationary weather satellites – FengYun 4 (FY-4)[J]. Bulletin of the American Meteorological Society, 2016.

1. Background & GIIRS

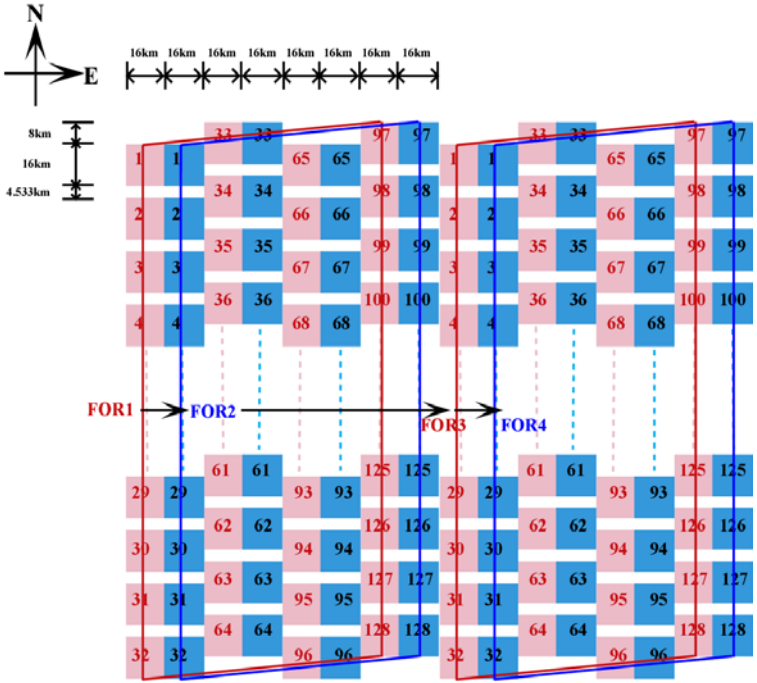
Normalized weighting functions and temperature Jacobians of GIIRS temperature sounding channels

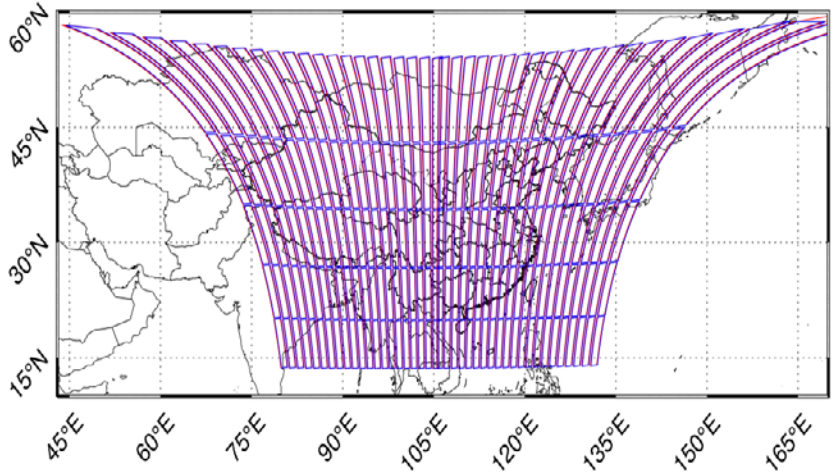




1. Background & GIIRS

Scanning zone of GIIRS





August 2017

2. Quality control

Cloud detection

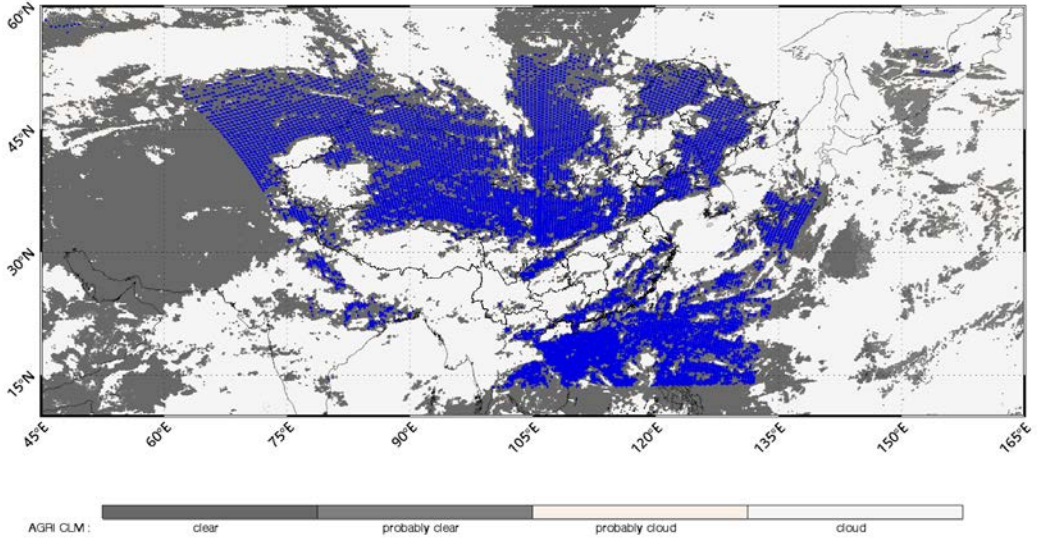
based on collocated AGRI cloud products

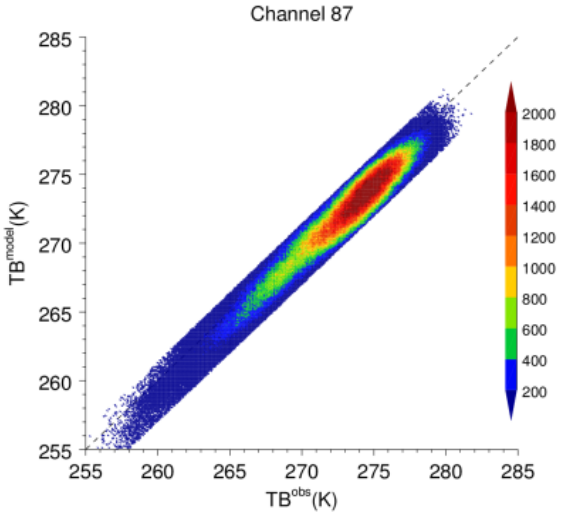
1

2

Outliers elimination

using Bi-weight Check

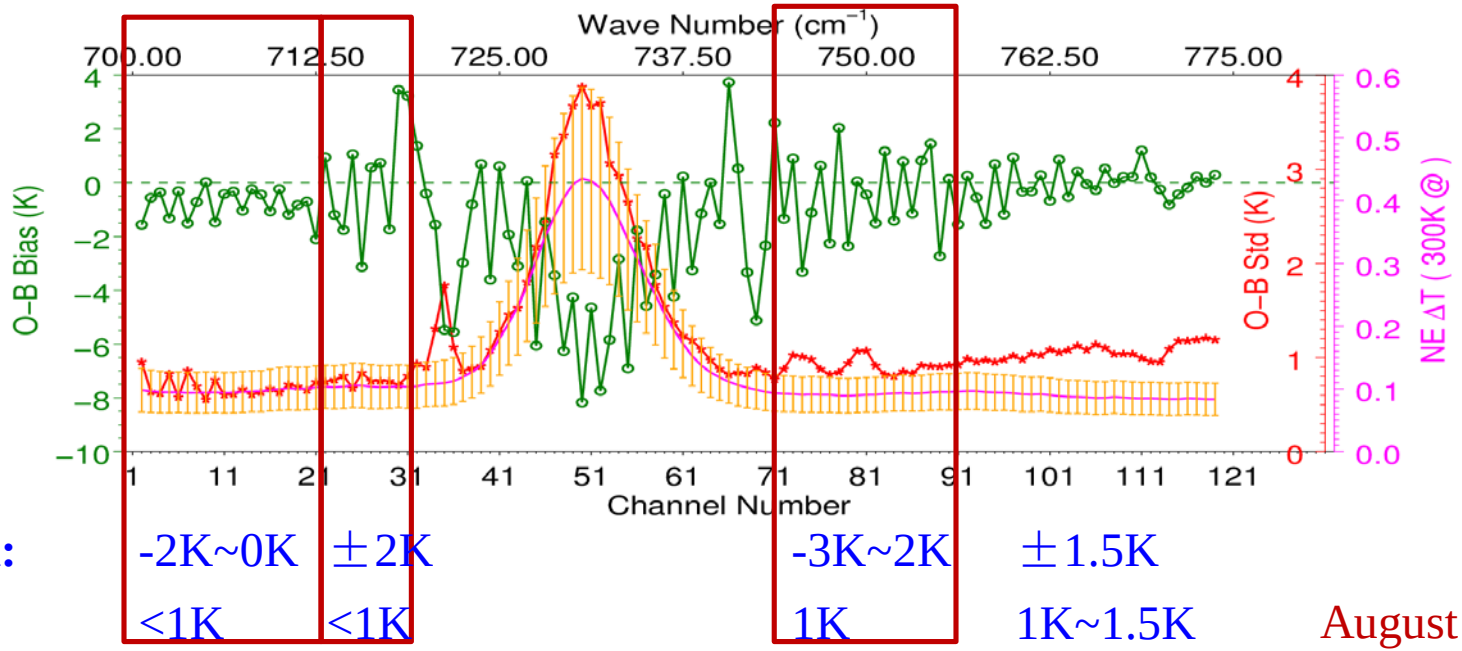




3. Bias characteristics and correction

Observations: brightness temperatures after the hamming apodization.

Simulations: the 6-hour forecast field of GRAPES-GFS as the background field.



Mean: -2K~0K ±2K -3K~2K ±1.5K

STD: <1K <1K 1K 1K~1.5K

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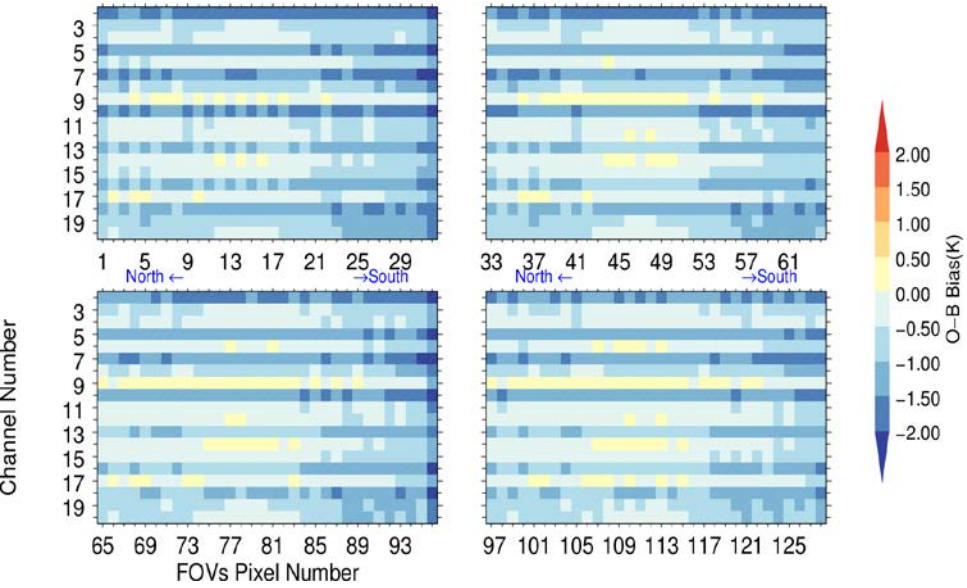
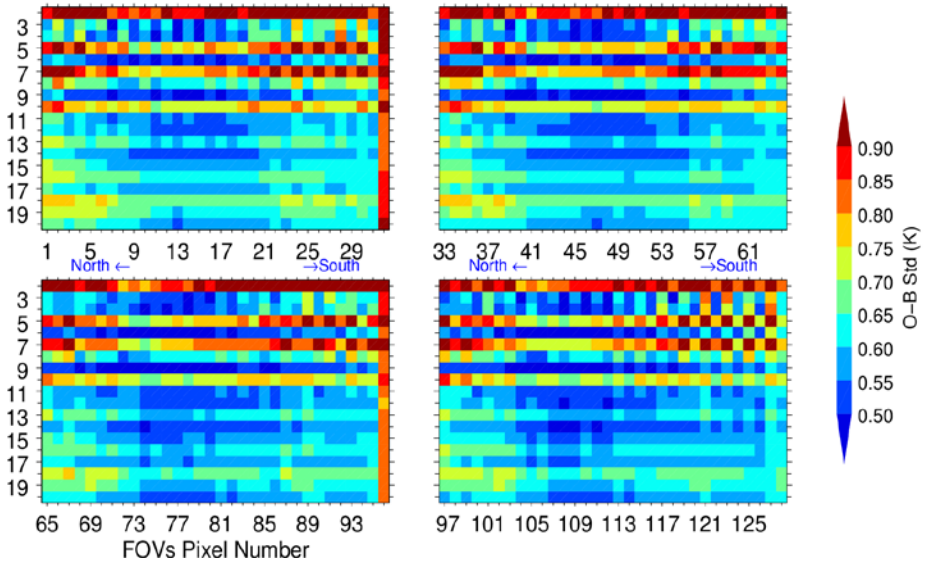
3. Bias characteristics and correction

Upper troposphere





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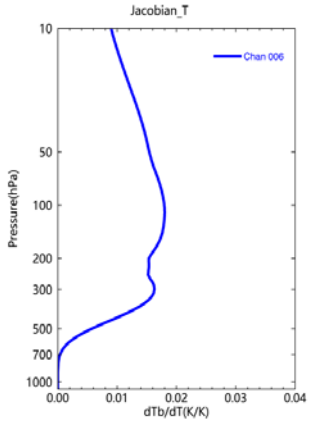
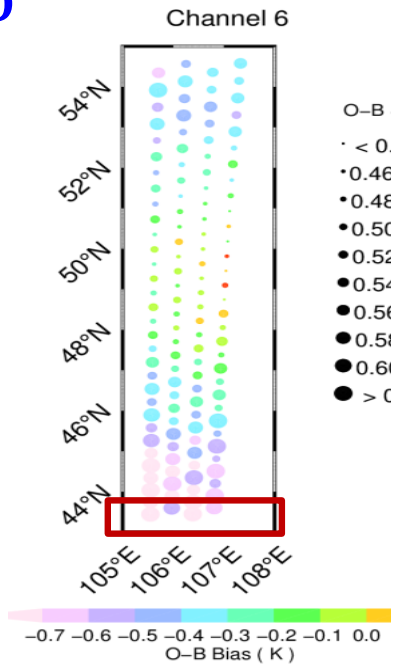
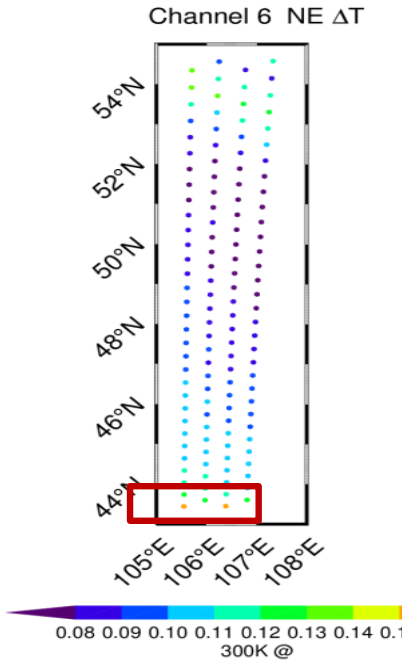
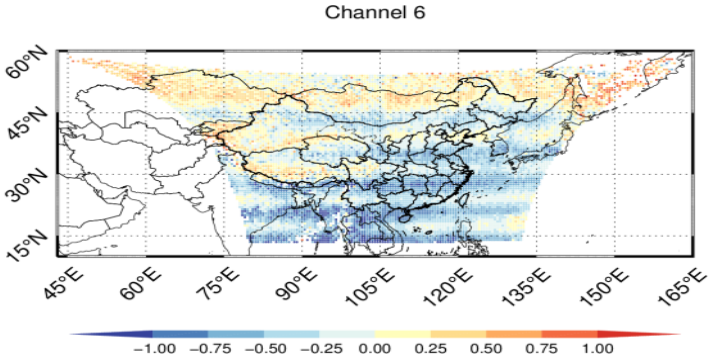
3. Bias characteristics and correction

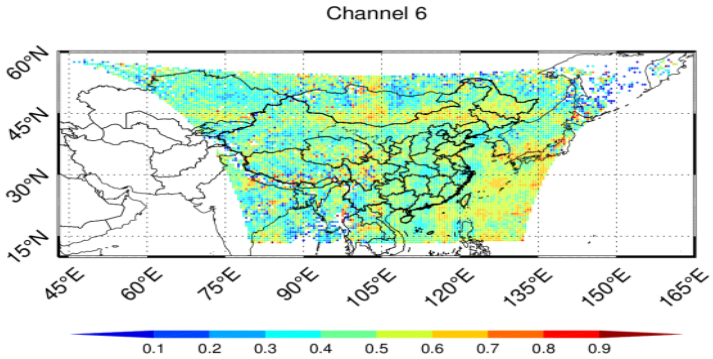
Channel 6 (235hPa)











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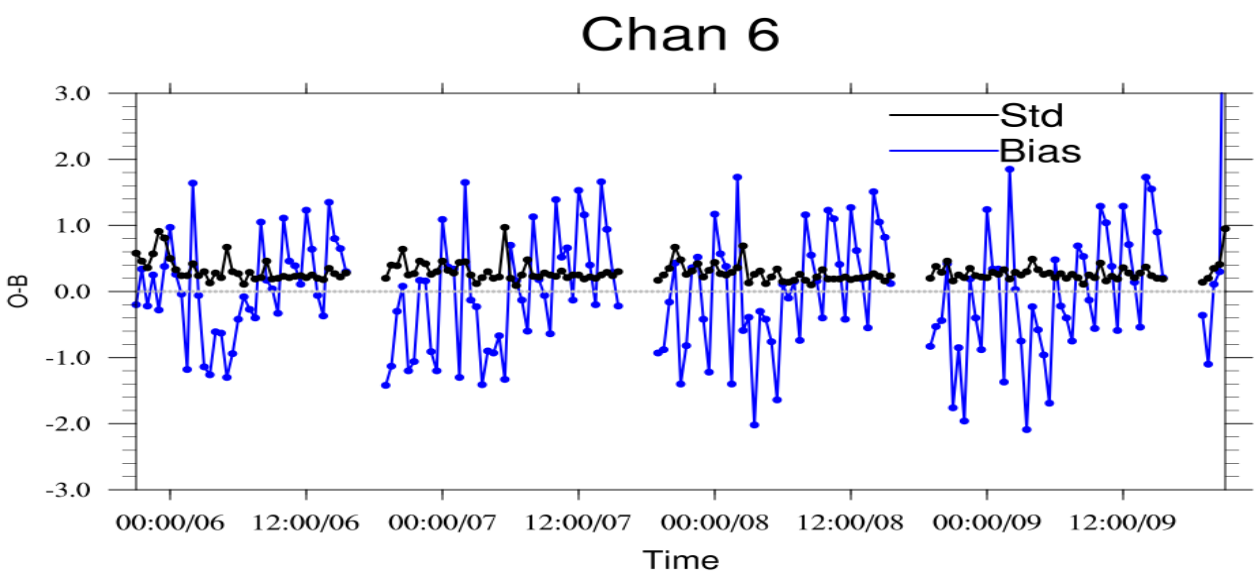
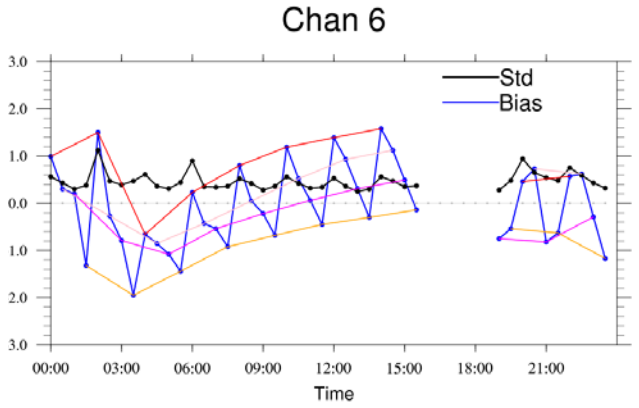
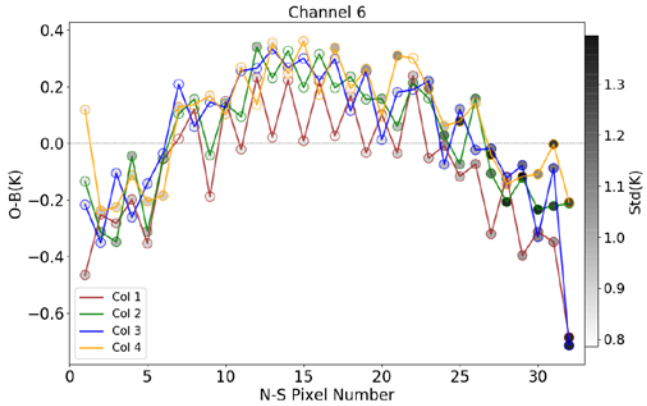
3. Bias characteristics and correction







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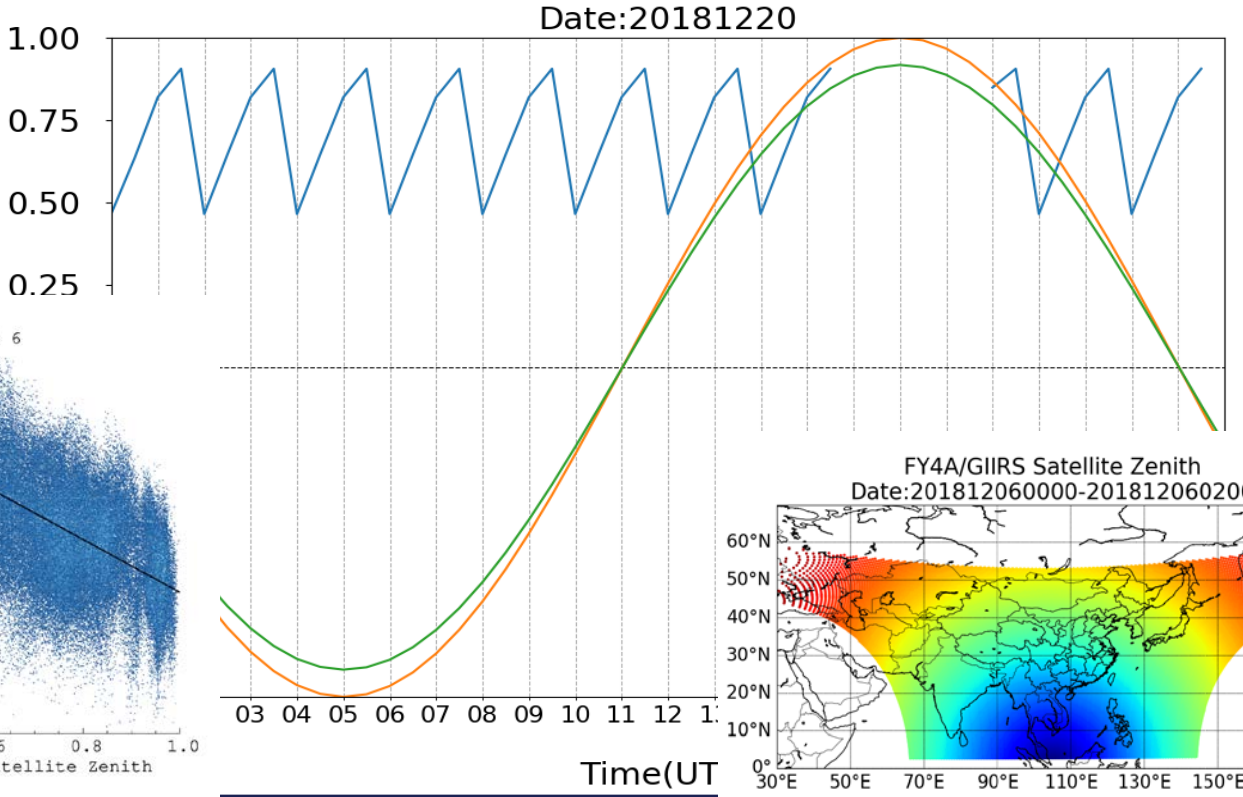
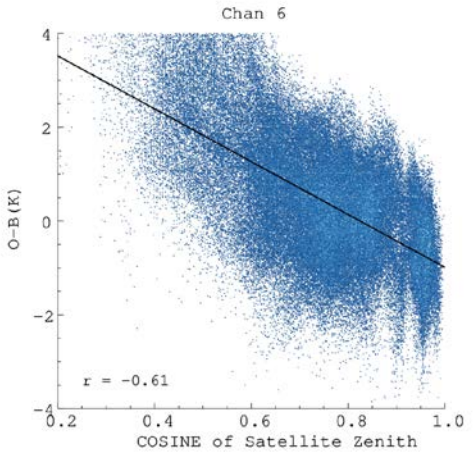
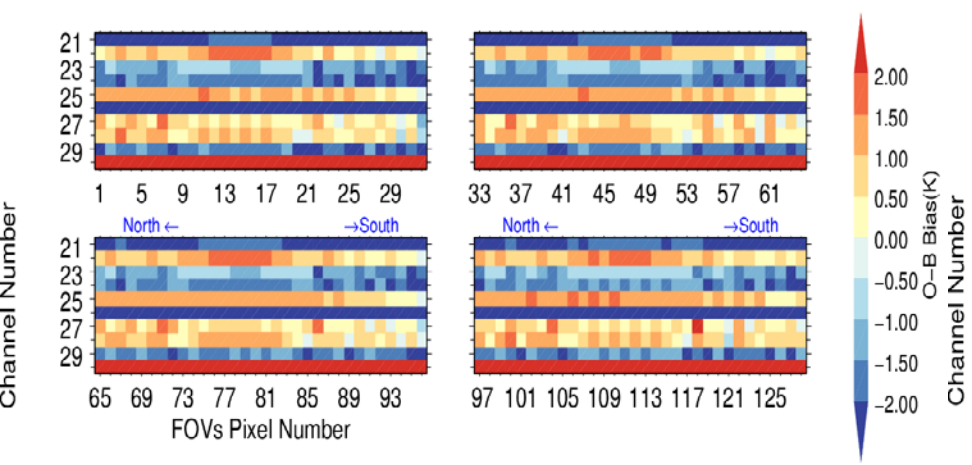
3. Bias characteristics and correction

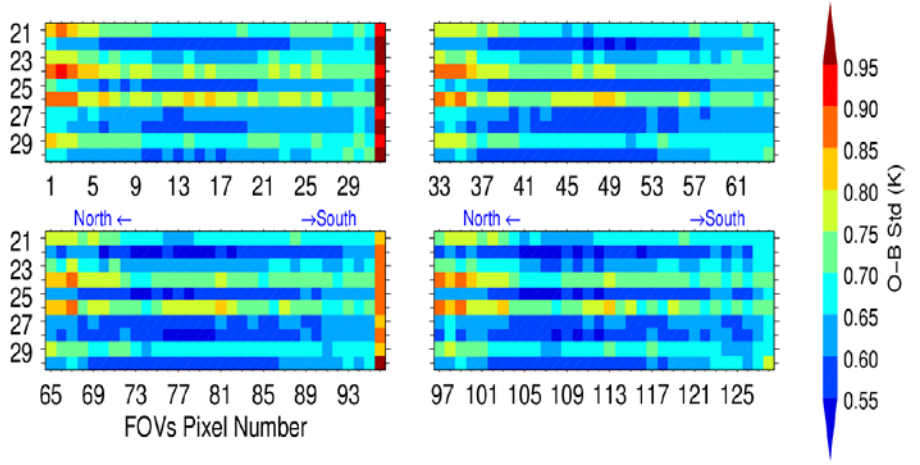




3. Bias characteristics and correction

Middle troposphere





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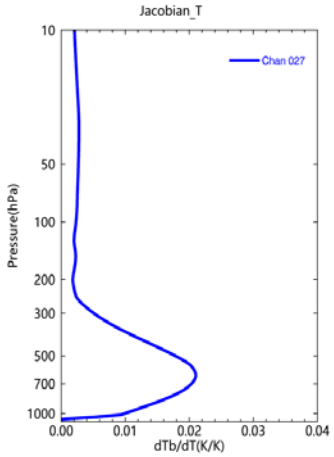
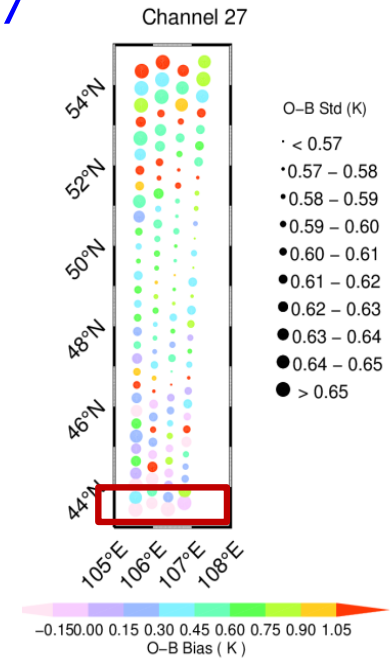
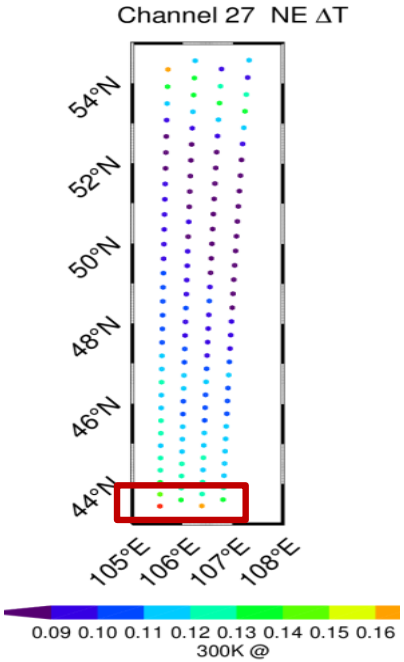
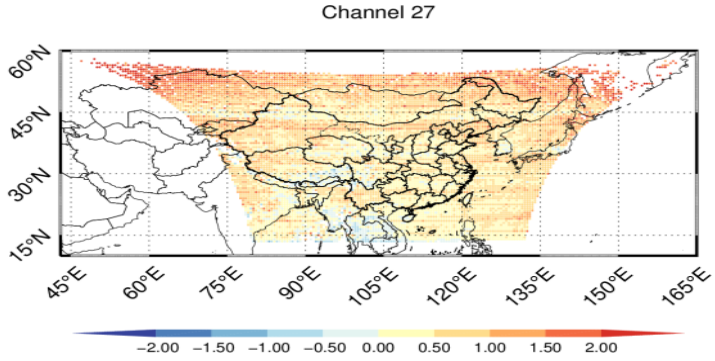
3. Bias characteristics and correction

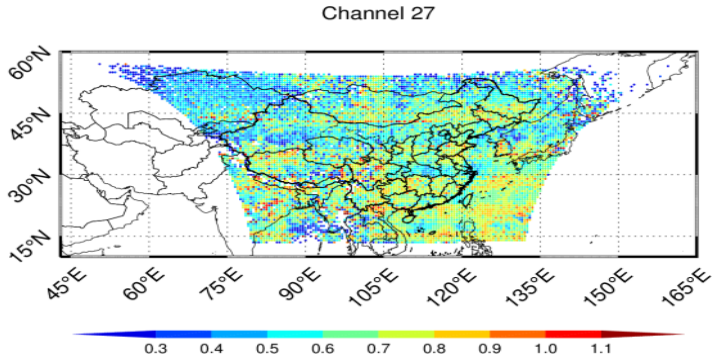
Channel 27 (478hPa)











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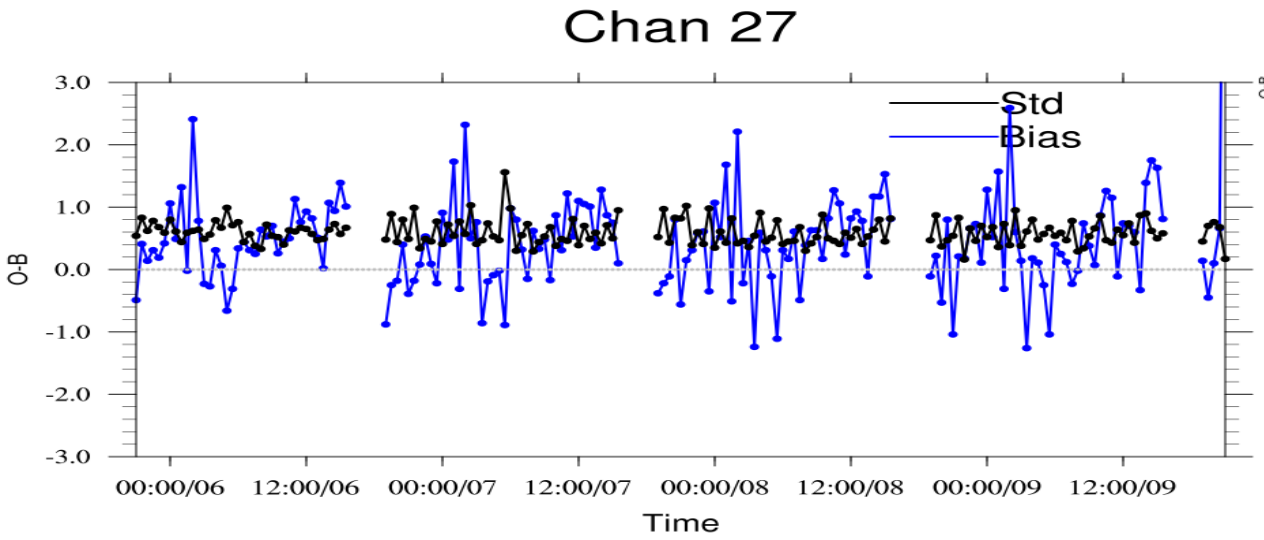
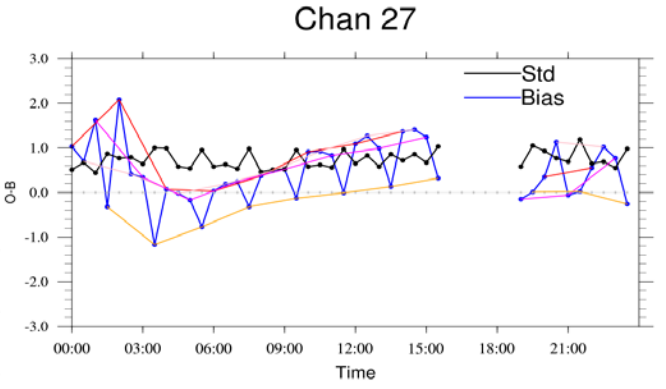
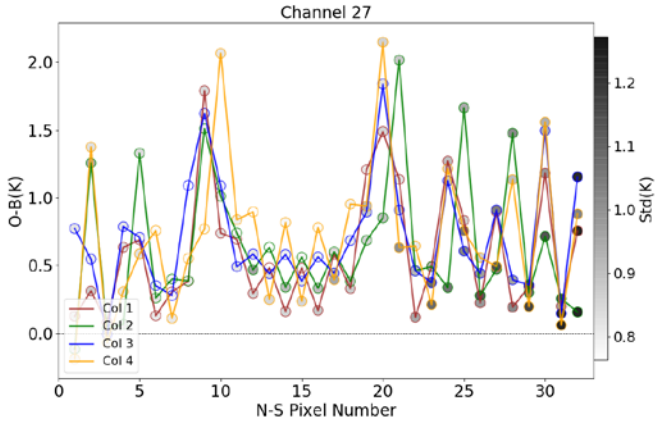
3. Bias characteristics and correction







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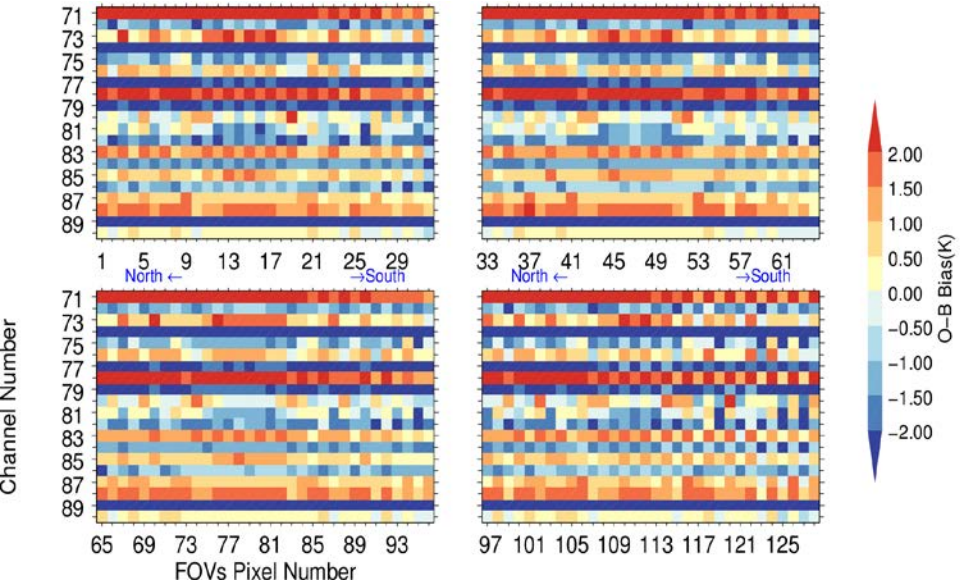
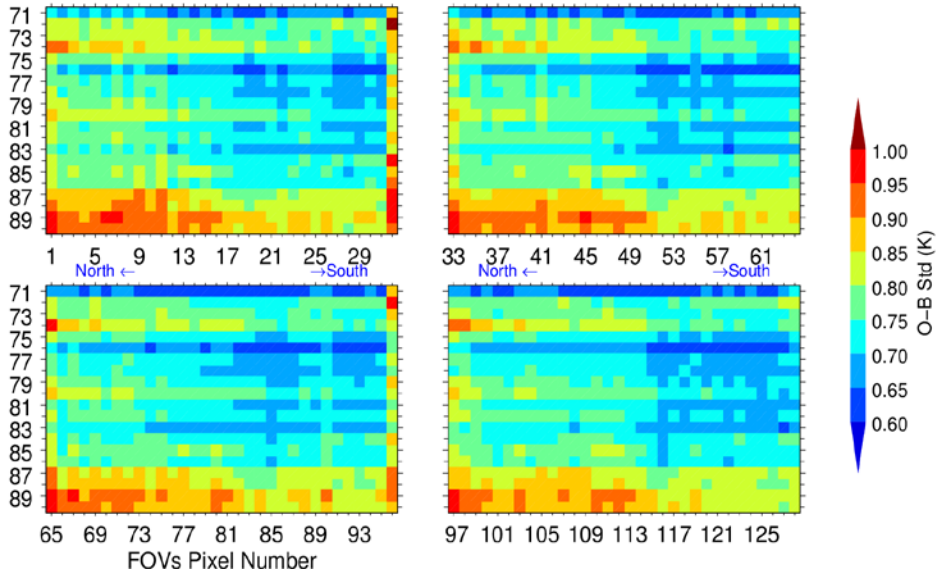
3. Bias characteristics and correction

Lower troposphere





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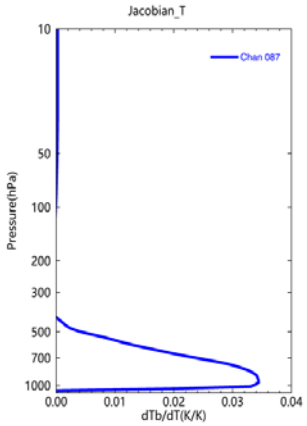
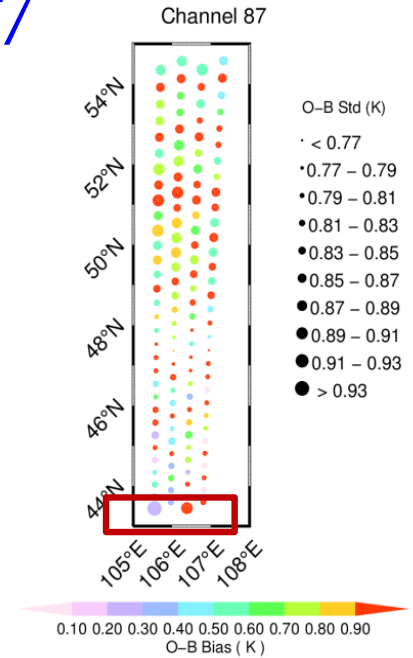
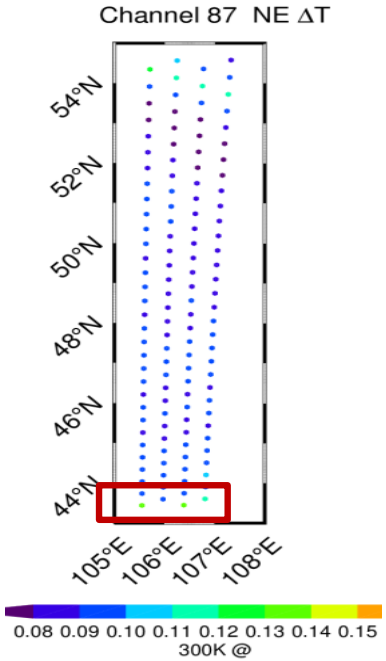
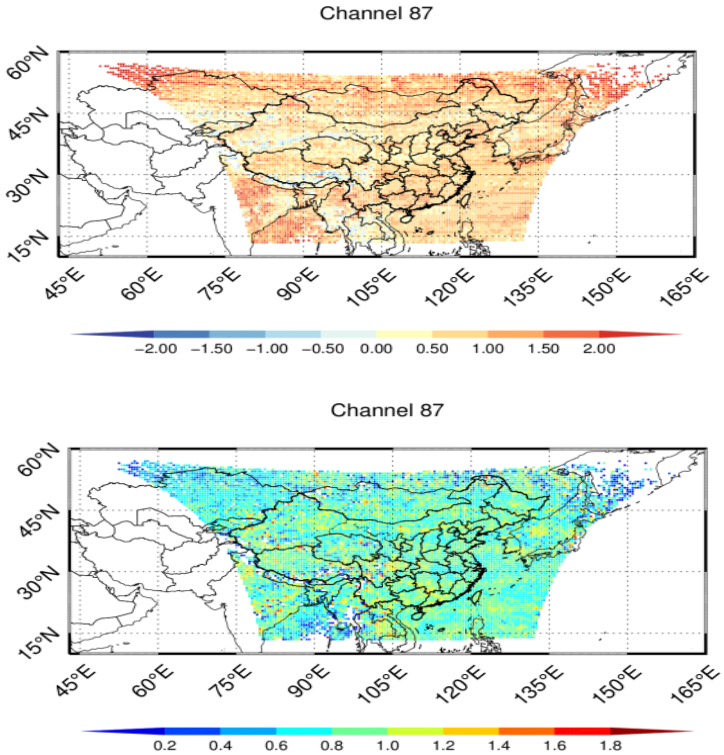
3. Bias characteristics and correction

Channel 87 (850hPa)









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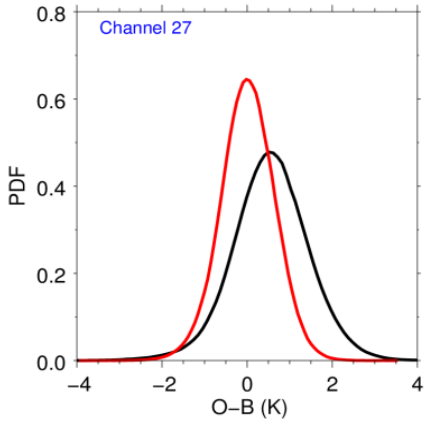
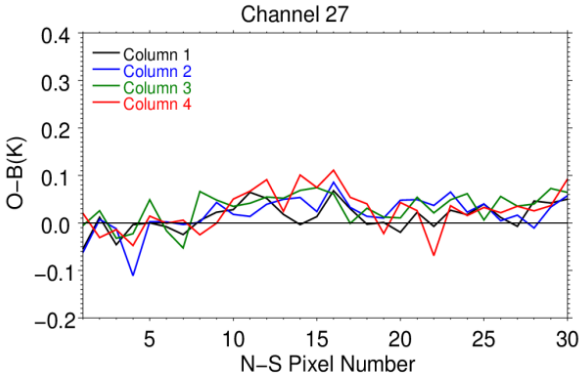
3. Bias characteristics and correction

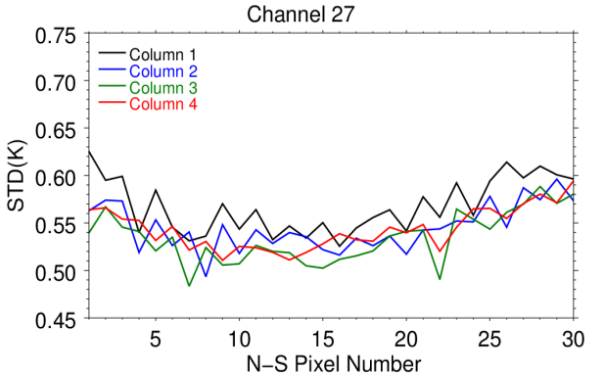
FOV & Air mass bias correction

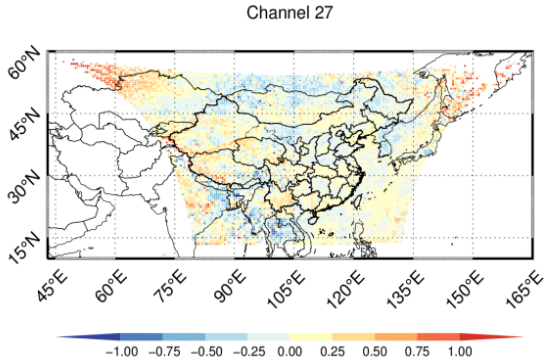
Prediction factors: 1000-300hPa, 200-50hPa and 50-10hPa; the surface temperature of the model and the satellite zenith angle for GIIRS observations.

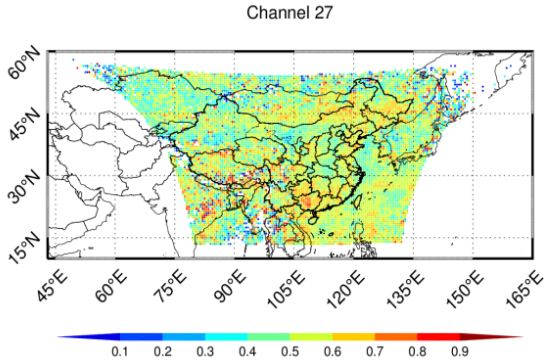


After bias correction



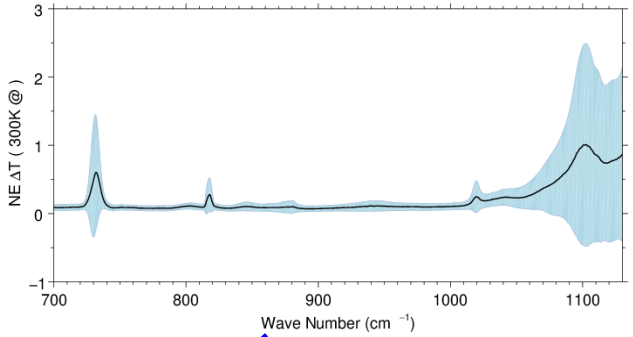


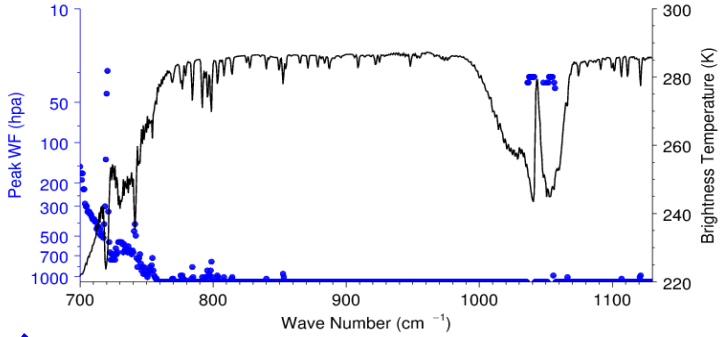




4. Channel selection

Channel Blacklist



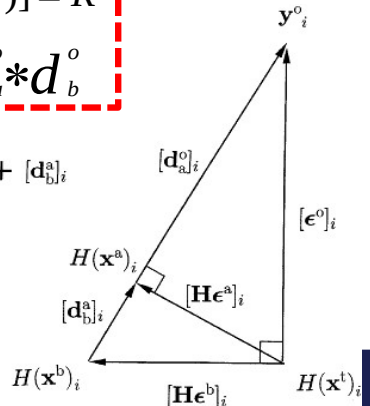


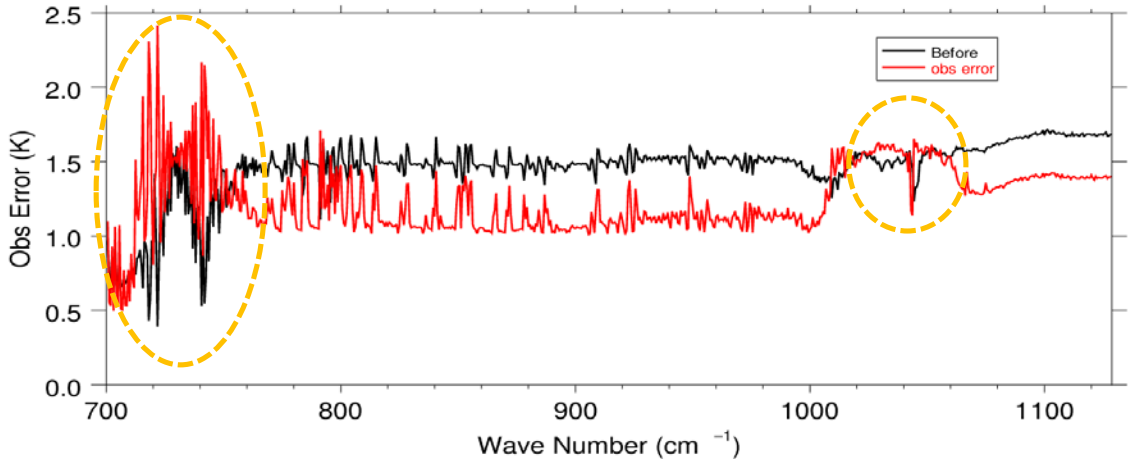
Observation error（Desroziers，2005：Triangle）

$$E[d_a^o (d_b^{oT})] = R$$

$$(\varepsilon^o)^2 = d_a^o * d_b^o$$

$$[\mathbf{d}_b^o]_i = [\mathbf{d}_a^o]_i + [\mathbf{d}_b^a]_i$$





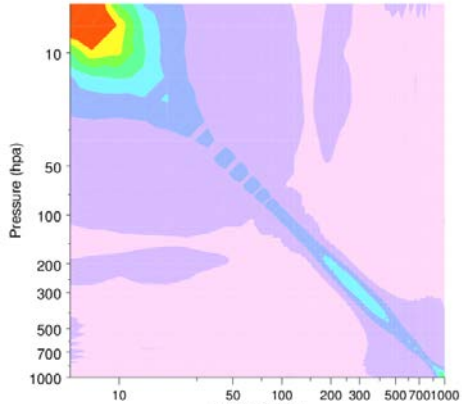
4. Channel selection

Entropy reduction：

$$ER = \frac{1}{2}\log_2\left(\frac{|\mathbf{B}|}{|\mathbf{A}|}\right)$$

$$\mathrm{A}_i = \mathrm{A}_{i-1}\left(\mathrm{I} - \frac{h_i\left(\mathrm{A}_{i-1}h_i\right)^{\mathrm{T}}}{1+\left(\mathrm{A}_{i-1}h_i\right)^{\mathrm{T}}h_i}\right)$$

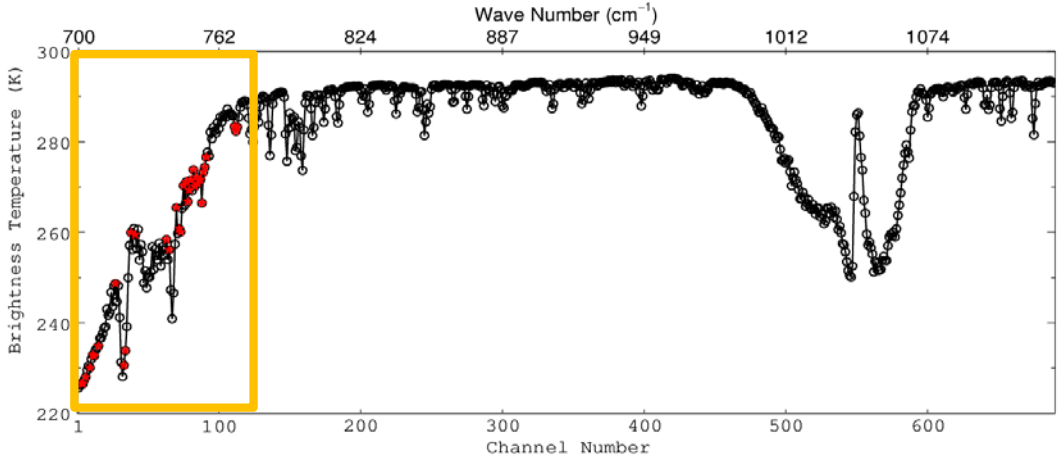
$$\mathrm{A}^{-1} = \mathrm{B}^{-1} + \mathrm{H}^{\mathrm{T}}\mathrm{R}^{-1}\mathrm{H}$$
$$\mathrm{K} = \mathrm{A}\mathrm{H}^{\mathrm{T}}\mathrm{R}^{-1}$$
$$x_a = x_b + \mathrm{K}\left(y - y_b\right)$$



B matrix

NMC method

Sample : GIIRS observation areas rather than global sample



5. Conclusions

1.The mean biases: ±2K after quality control and ±0.02K after bias correction except for the contaminated channels.

2.FOVs dependencies: smaller near the center of FOR, maximum values in the 32nd and 96th FOVs.

3.Latitudinal dependences: due to the FOVs array observation model and satellite zenith angle.

4.Diurnal variation: significant, may related to the solar elevation angle.

5.Channel selection: GIIRS longwave sounding channels.

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Thank you for your attention!