Inter-comparison of data characteristics and impact on NWP of FY-3B SNPP and NOAA18 microwave observations

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Outline

- Background
- Cloud detection and quality control
- Inter-comparison of data characteristics
- Data impact on analysis and forecast
- Discussions and Summary

Background

FY3 MWTS/MWHS
(FY-3A,2008; FY-3B,2010; FY-3C,2013)

Suomi NPP ATMS
(SNPP,2010)

- MW sensors
  - AMSUA/MHS, **ATMS, MWTS/MWHS**
- Data assimilation modules in regional NWP
  - WRFDA(ATMS,MWTS/MWHS)
  - GSI (MWTS/MWHS)
  - *GRAPES 3DVAR(*MWTS/MWHS*)*

We are happy to share the modules with the community

- Experiments in WRFDA
  - NOAA18 AMSUA/MHS
  - Suomi NPP ATMS
  - FY3B MWTS/MWHS

3 afternoon orbits

Channels

Channel			Centre Frenquency（GHz）			Polarization		
ATMS	MWTS/ MWHS	AMSU	ATMS	MWTS/ MWHS	AMSU	ATMS	MWTS/ MWHS	AMSU
1		1	23.8		23.8	V		V
2		2	31.4		31.4	V		V
3	1	3	50.3	50.3	50.3	H	V	V
4			51.76			H		
5		4	52.8		52.8	H		V
6	2	5	53.596+/-0.115	53.596+/-0.115	53.596+/-0.115	H	H	H
7		6	54.4		54.4	H		H
8	3	7	54.94	54.94	54.94	H	V	V
9		8	55.5		55.5	H		H
10	4	9	f_0 =57.290344	57.290344	f_0 =57.290344	H	H	H
11		10	f_0 +/-0.3222+/-0.217		f_0 +/-0.217	H		H
12		11	f_0 +/-0.3222+/-0.048		f_0 +/-0.3222+/-0.048	H		H
13		12	f_0 +/-0.3222+/-0.022		f_0 +/-0.3222+/-0.022	H		H
14		13	f_0 +/-0.3222+/-0.010		f_0 +/-0.3222+/-0.010	H		H
15		14	f_0 +/-0.3222+/-0.0045		f_0 +/-0.3222+/-0.0045	H		H
16	1	1	88.2	150.0	89.0	V	V	V
17	2	2	165.5	150.0	157.0	H	H	V
18	5	5	183.31+/-7.0	183.31+/-7.0	190.311	H	H	V
19			183.31+/-4.5			H		
20	4	4	183.31+/-3.0	183.31+/-3.0	183.31+/-3.0	H	H	H
21			183.31+/-1.8			H		
22	3	3	183.31+/-1.0	183.31+/-1.0	183.31+/-1.0	H	H	H

Observation characteristics

Satellite	Sensor	Number of scan	FOV size (Km)	Swatch width (Km)
FY-3A/B	MWTS	15	62	2,250
	MWHS	98	15	2,700
NPP	ATMS	96	75(channel 1-2) 32(channel 3-16) 16(channel 17-22)	2,300
NOAA KLM and METOP	AMSUA	30	48	2,340
	MHS	90	17	2,250

QC and BC

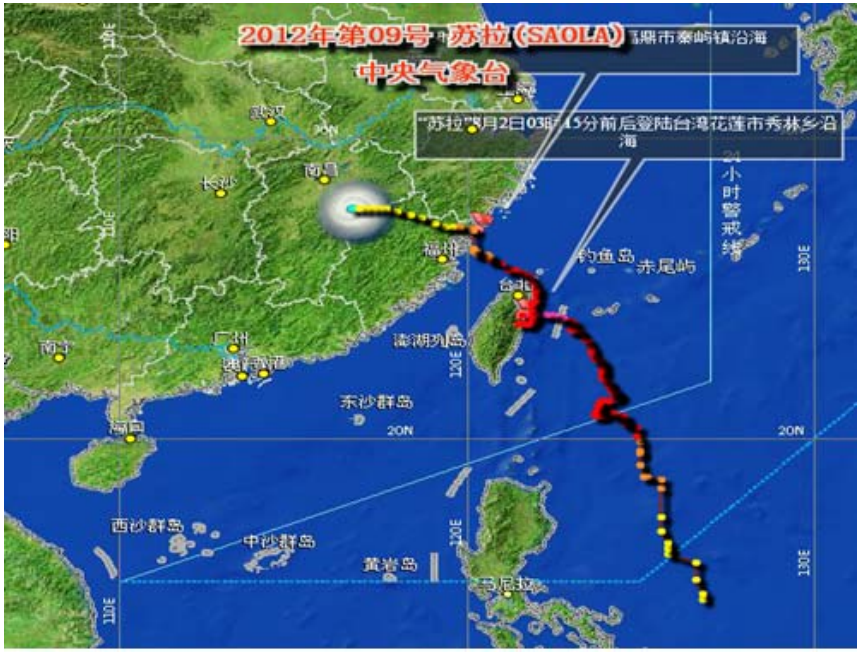
	FY-3A/B MWTS/MWHS	NPP ATMS	NOAA AMSUA/MHS
Noise reducing	none	Neighborhood average	none
Channel selection	1)MWTS 1 and MWHS 1～2 are not used; 2)MWTS 2～3 and MWHS 3～5 are discarded for land, ice and snow; 3) MWTS 2 and MWHS 5 are aborted when Ps<850 hPa and Ps<800 hPa, respectively。	1)ATMS 11～15 and 16～17 are not used 2)ATMS 6～8 and 18～22 are discarded for land, ice and snow; 3) ATMS 6 and 18 are aborted when Ps<850 hPa and Ps<800 hPa, respectively;	1)AMSUA 10～14 and MHS 1～2 are not used 2)AMSUA 5～7 and MHS 3～5 are discarded for land, ice and snow; 3) AMSUA 5 and MHS 5 are aborted when Ps<850 hPa and Ps<800 hPa, respectively;
Cloud detection	1）MWTS 1 dtb, not use MWTS 2～3; 2）MWHS 1 dtb, not use MWHS 3～5.	1）channel 3 abs(dtb), not use 6～8 and 18～22; 2）channel 1 dtb，not use 6～8 (test); 3）Index combined channel 16 and 17, not use 18～22 (test).	1）scattering Index combined AMSUA 1 and 15, not use AMSUA 5～7; 2）scattering Index combined MHS 1 and 2, not use MHS 3～5.
Outermost scan	MWTS 3～13 MWHS 9～89	1～96	AMSUA 4～27 MHS 9～82
Bias correction	VarBC	VarBC	VarBC

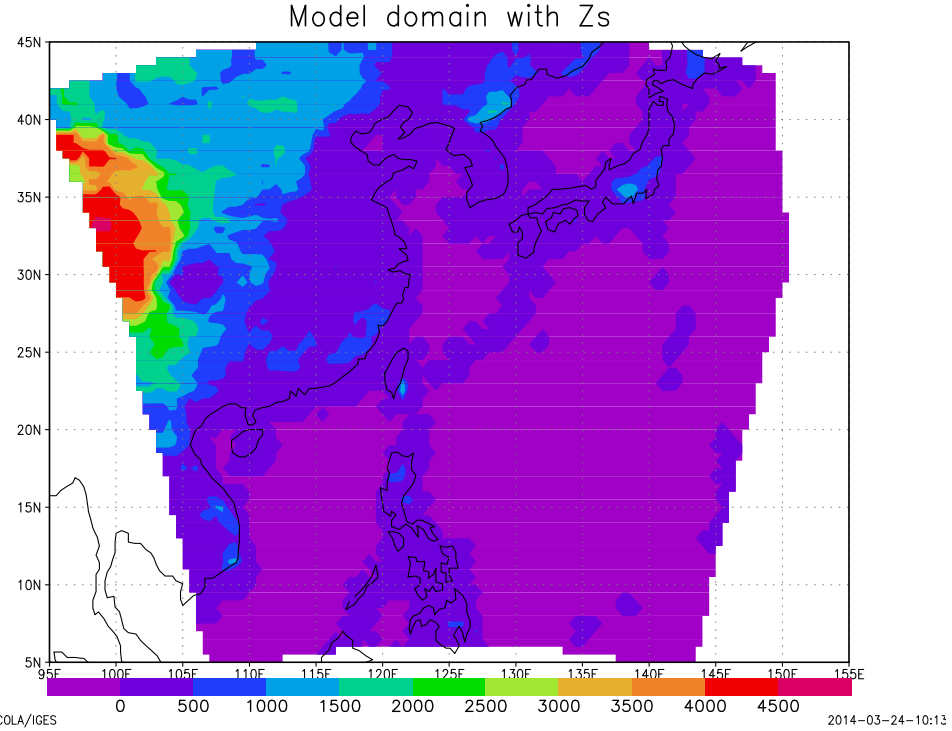
Note：dtb is the bias of observed and simulated brightness temperature and abs is absolute value.

Experiments design

Configuration:

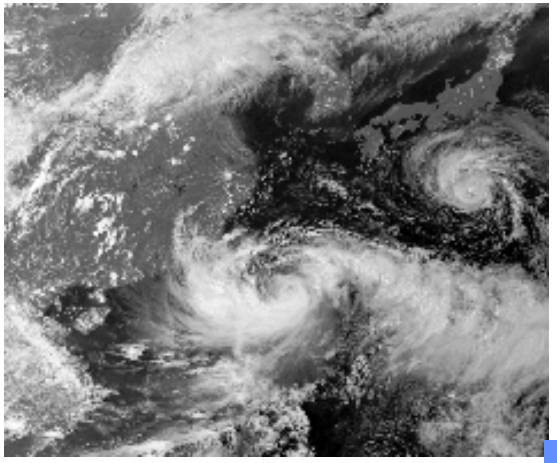
- 161×151 horizontal grid points with 30-km resolution
- 28 vertical levels with model top at 10 hPa
- RT model: **CRTM2.05**
- Period: 2012.07.29--2012.08.06, Background is from NCEP GFS 6h forecast



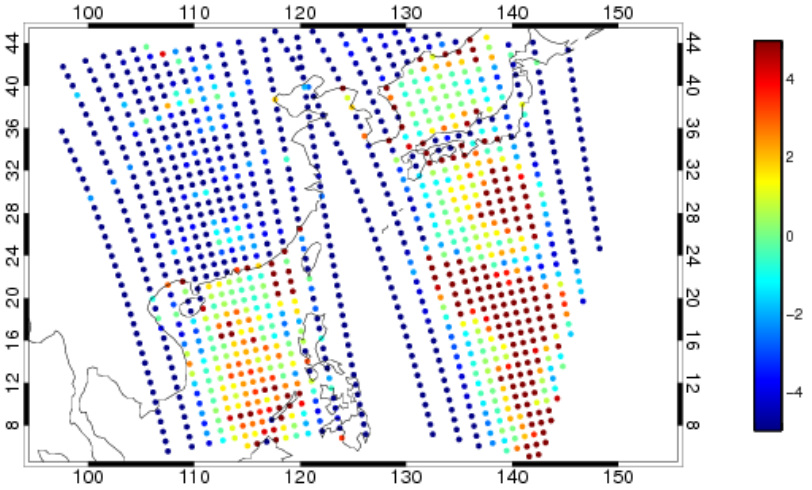


Cloud detection for T sounding channels

FY2E VISSR

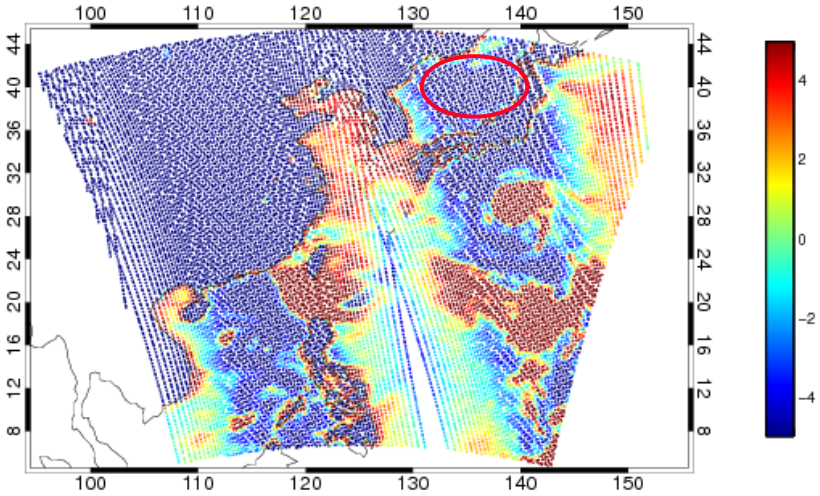


FY3B MWTS, (O-B) ch1,50.3GHz

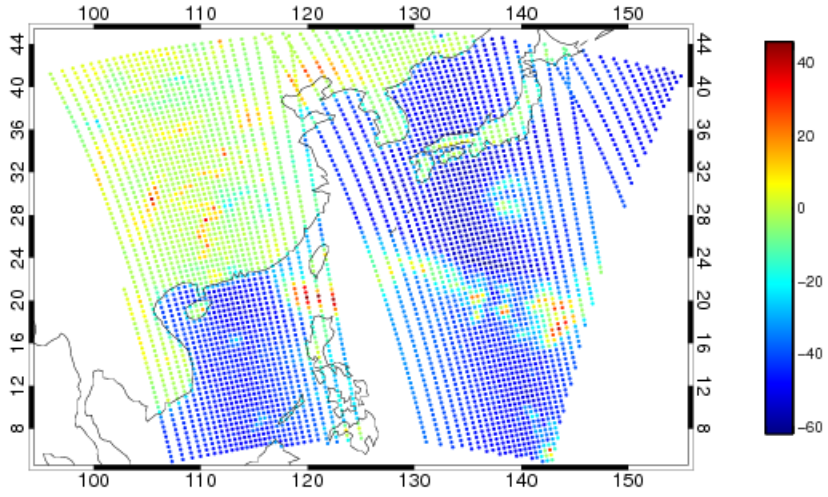


|O-B| >5K
O-B >5K ?

ATMS, O-B,Ch3,50.3GHz

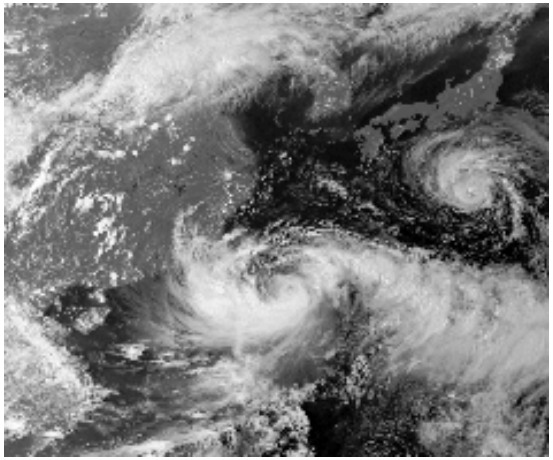


N18 AMSUA, O_ch1-O_ch15

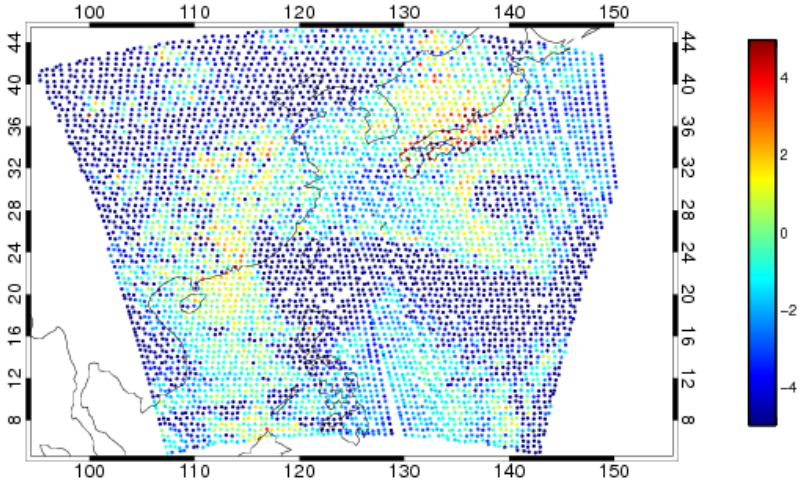


Cloud detection for Humidity sounding channels

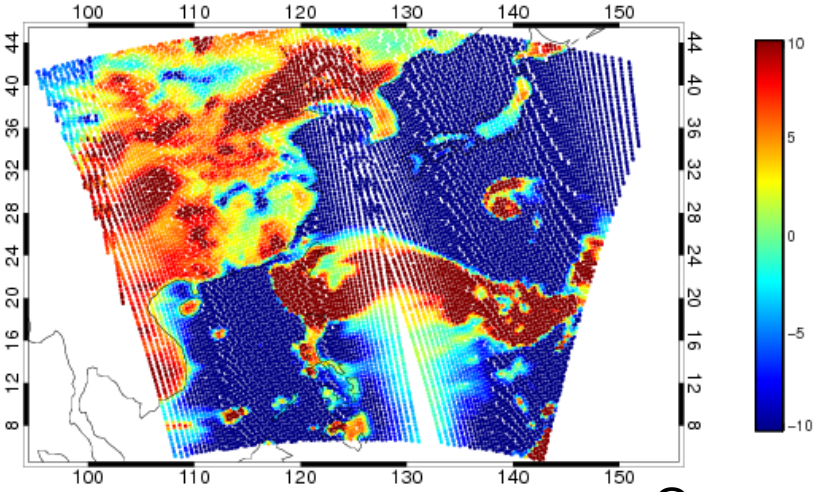
FY2E VISSR



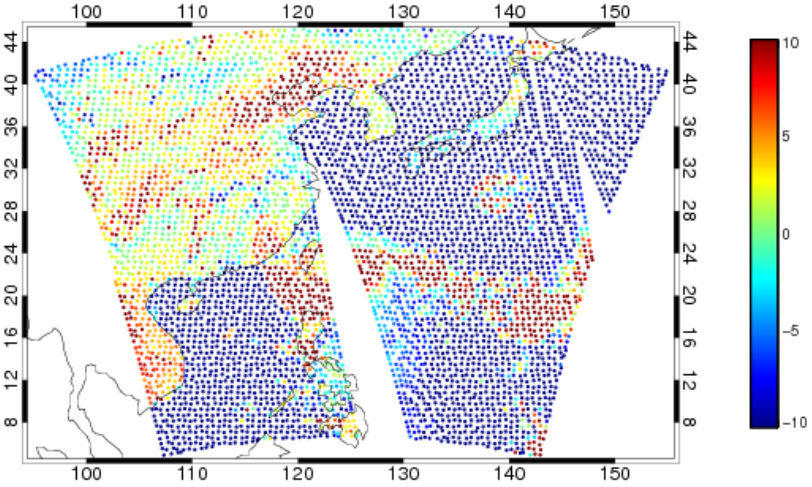
FY3B MWHS, (O-B)_ch1,150GHz,V



ATMS, O_ch16-O_ch17



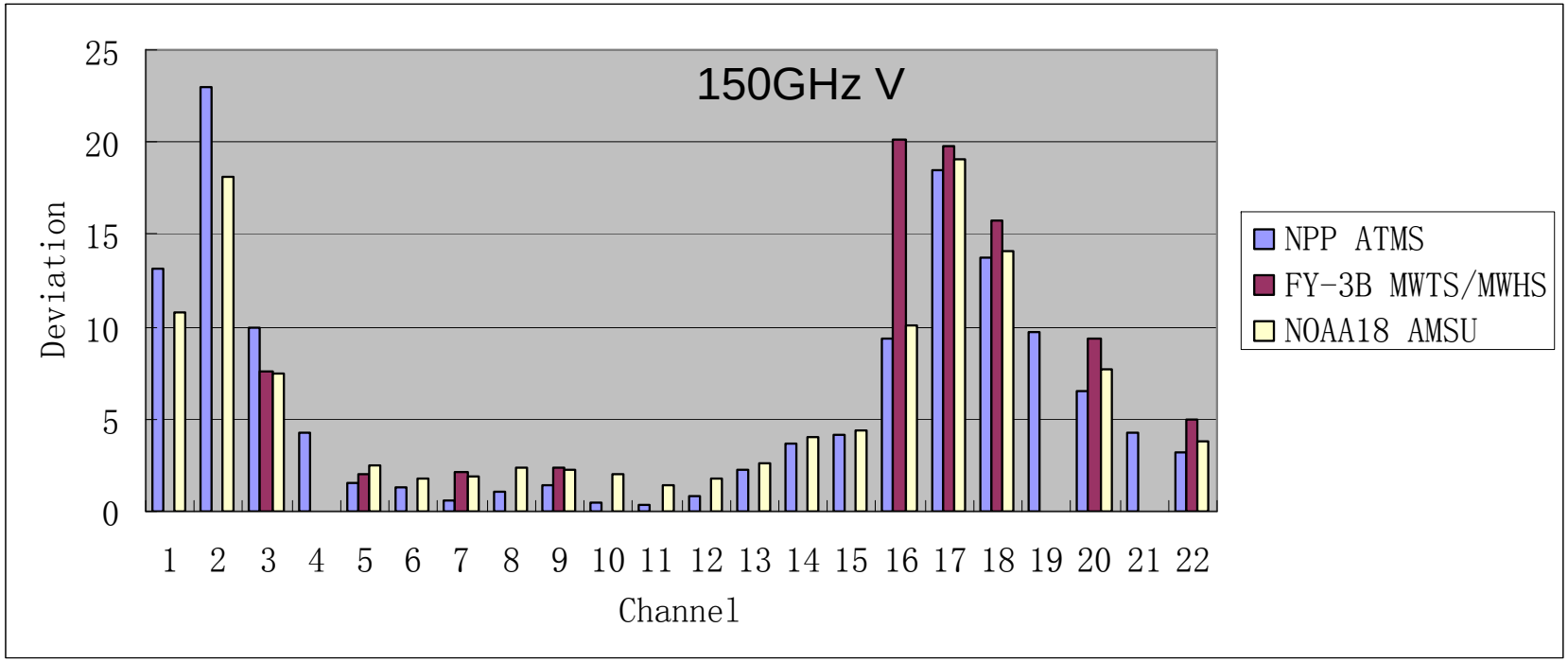
N18 MHS, O ch1-O ch2



Over sea only

RMS of O-B

Overview of the departure statistics of observation against clear-sky simulated (over sea)



It is seen that ATMS is of good quality. MWTS is comparable to ATMS and AMSUA. The bias of MWHS is the largest.

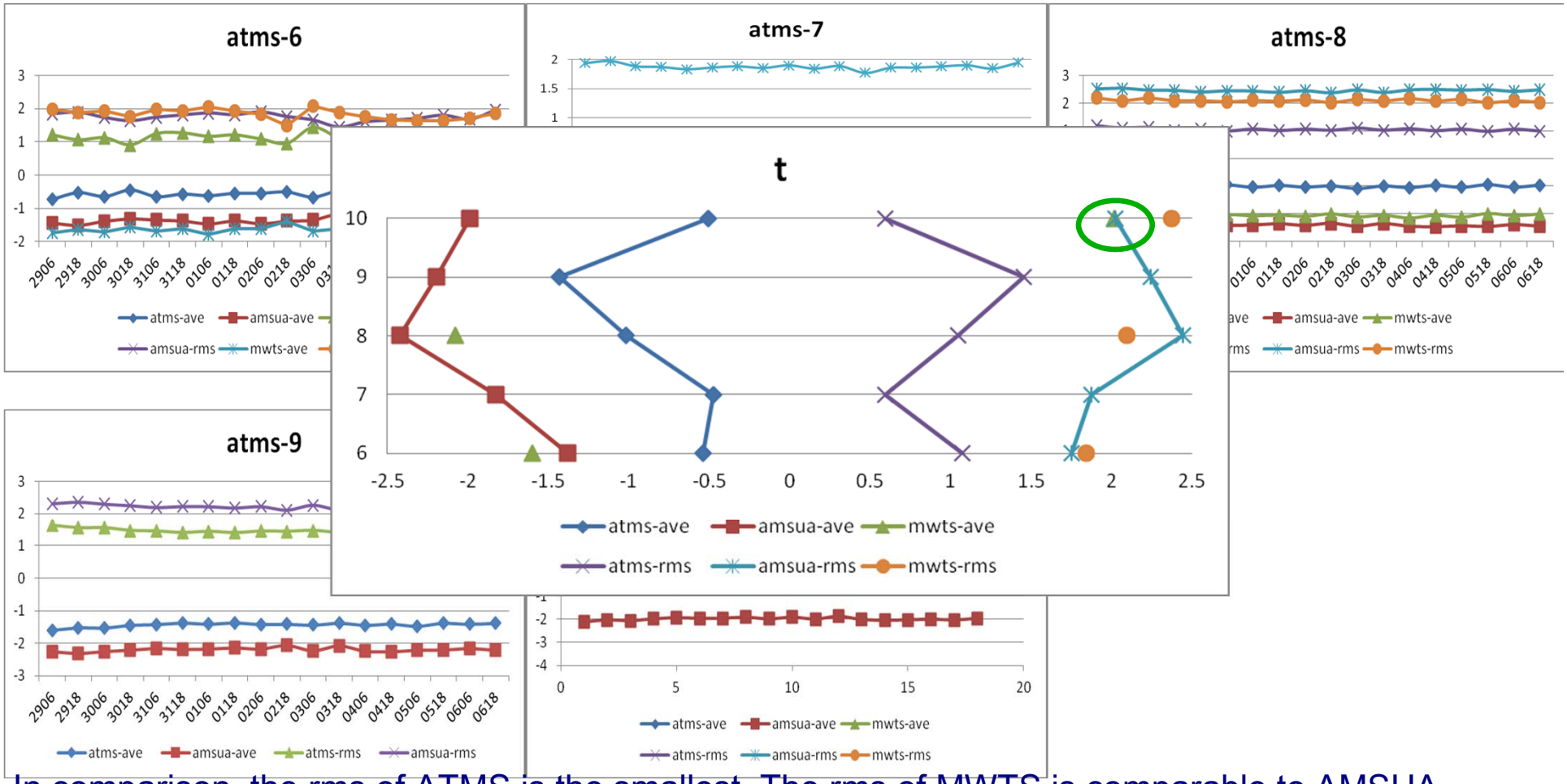
Presently the fundamental channel selection is:

Temperature unit: 2-4 for MWTS, 6-10 for ATMS and 5-9 for AMSUA

Humility unit: 3-5 for MWHS, 18-22 for ATMS and 3-5 for MHS.

Bias and RMS of T sounding channels

The statistics of departure between observed and simulated in temperature unit (over sea)

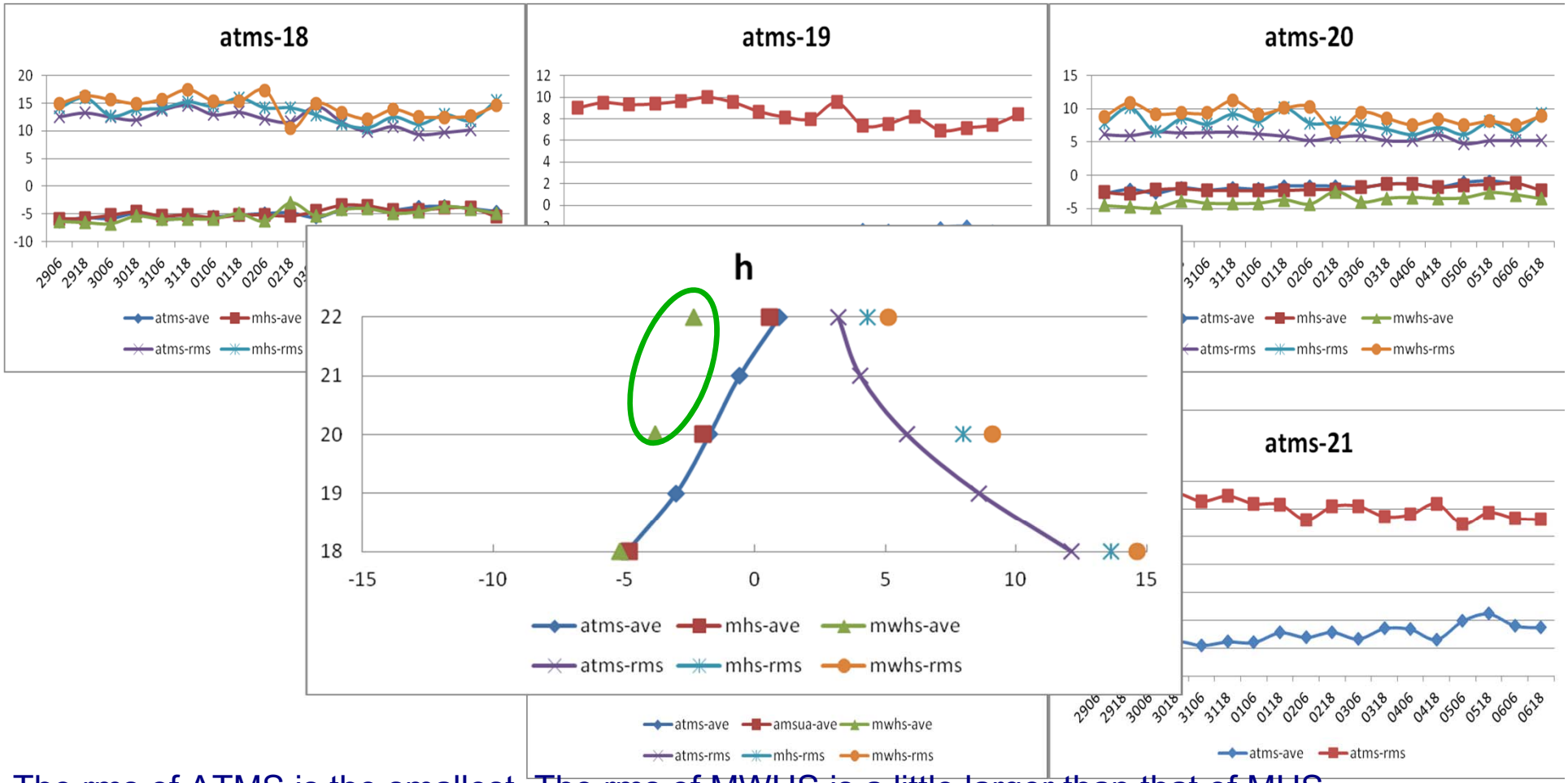


In comparison, the rms of ATMS is the smallest. The rms of MWTS is comparable to AMSUA.

The characteristics of ATMS and AMSUA agree with each other well. ATMS channel 9, corresponding AMSUA channel 8 has the largest rms. MWTS channel 4 has significant positive bias average.

Bias and RMS of humidity sounding channels

The statistics of departure between observed and simulated in humility unit (over sea)

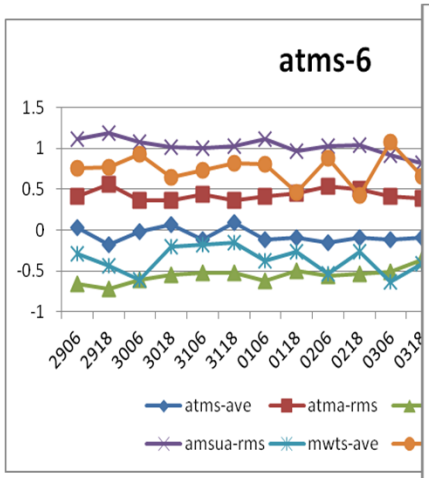


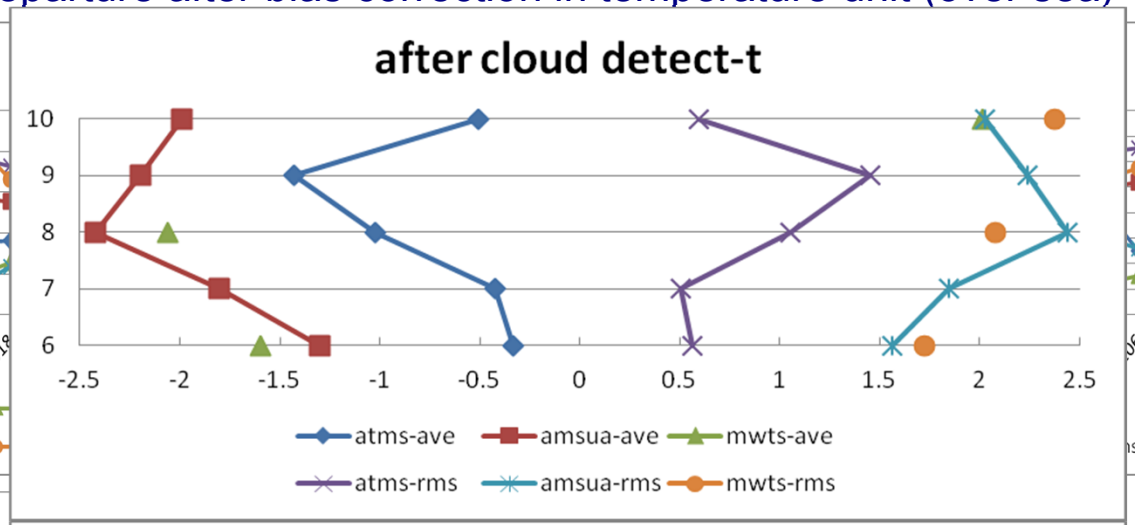
The rms of ATMS is the smallest. The rms of MWHS is a little larger than that of MHS.

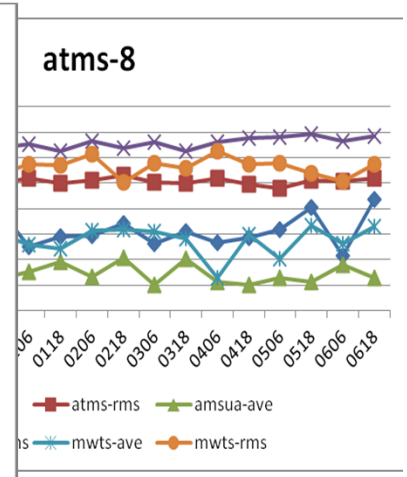
The characteristics of ATMS match that of MHS well. MWHS channel 4 and 3 have obvious negative bias average.

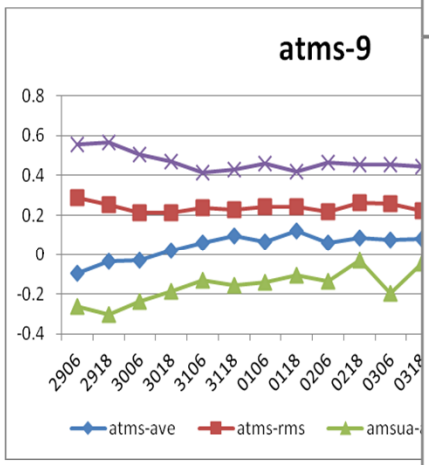
O-B after Bias correction: T sounding channels

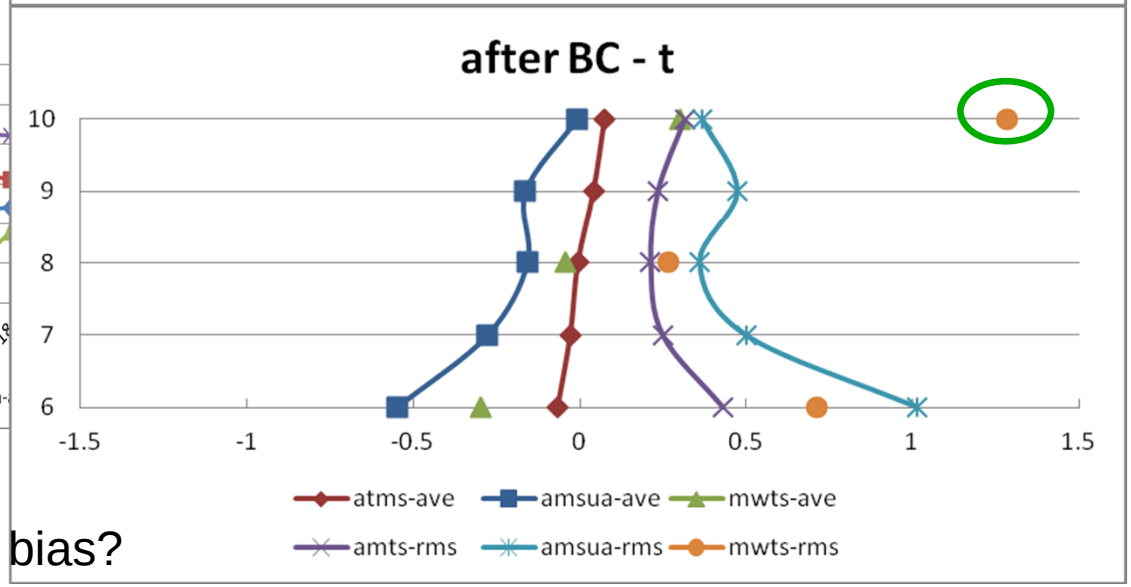
The statistics of departure after bias correction in temperature unit (over sea)









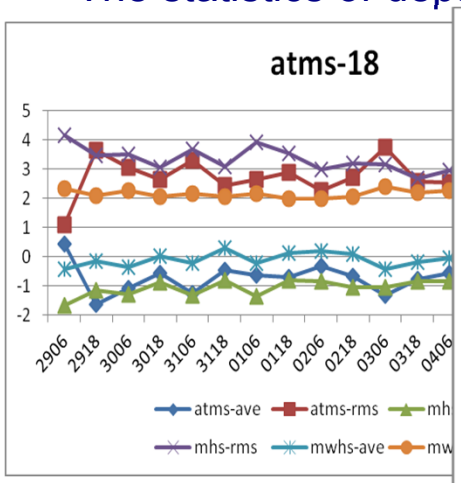


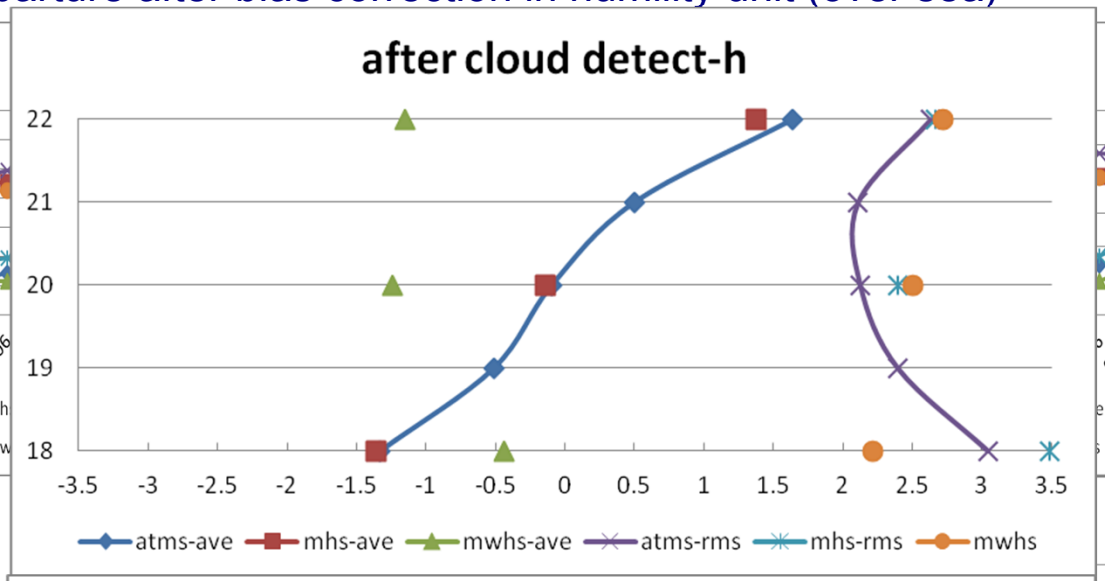
Diurnal cycle bias?

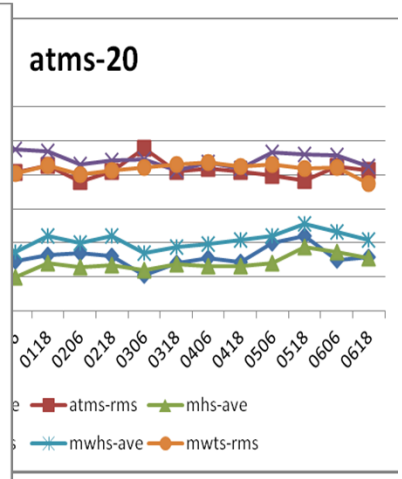
The rms, especially ATMS ch9 and AMSUA ch8, is decreased greatly by bias correction. The rms of MWTS ch4, however is still large.

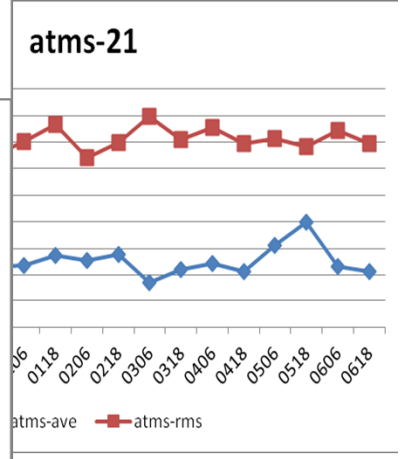
O-B after Bias correction: humidity sounding channels

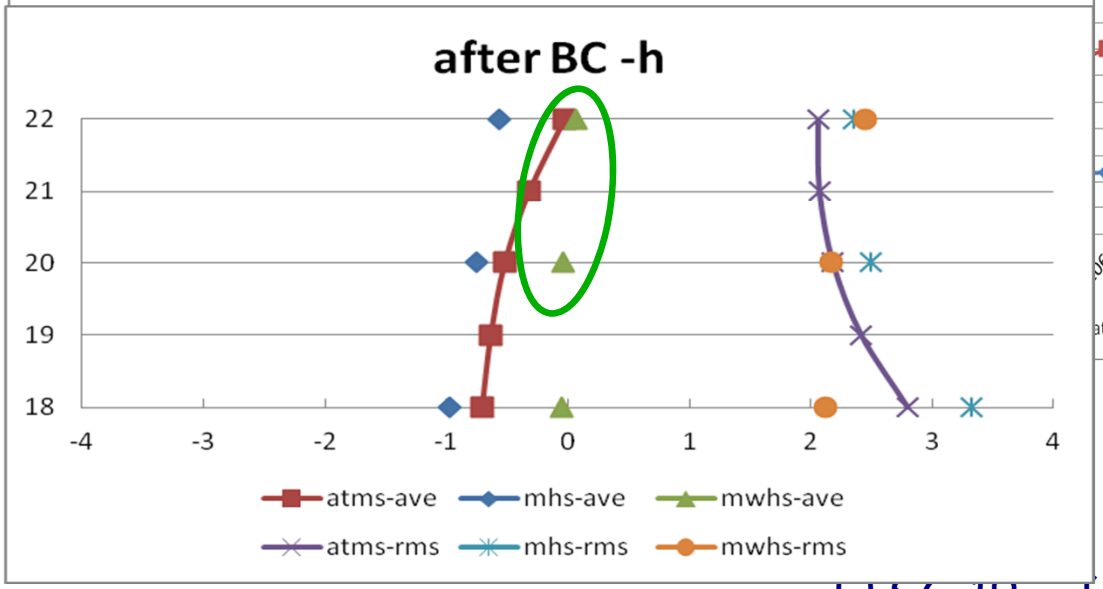
The statistics of departure after bias correction in humility unit (over sea)







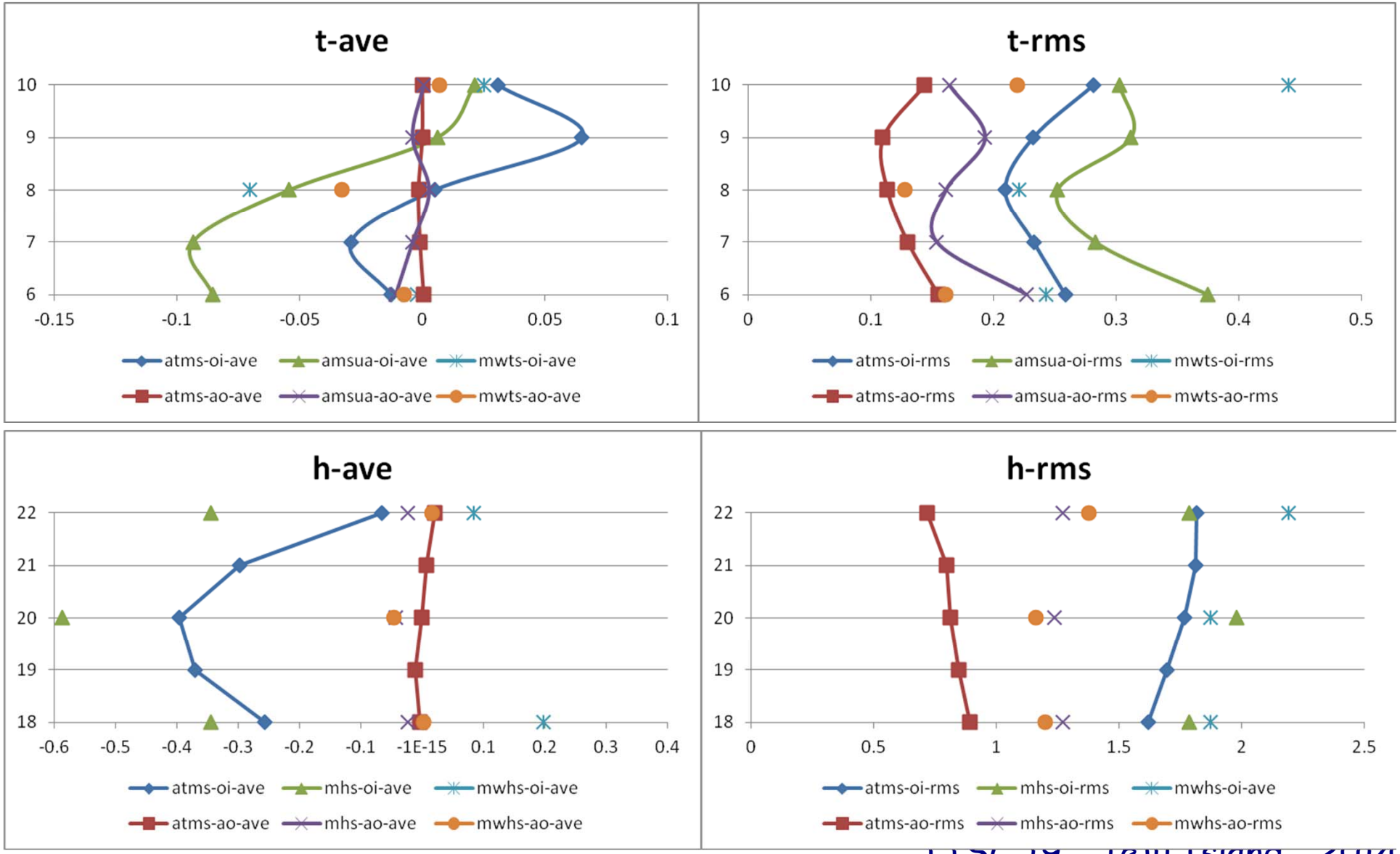




The rms is less affected by bias correction. Bias correction makes the bias average approach to zero, in particular for MWHS channel 4 and 3.

O-A and O-B

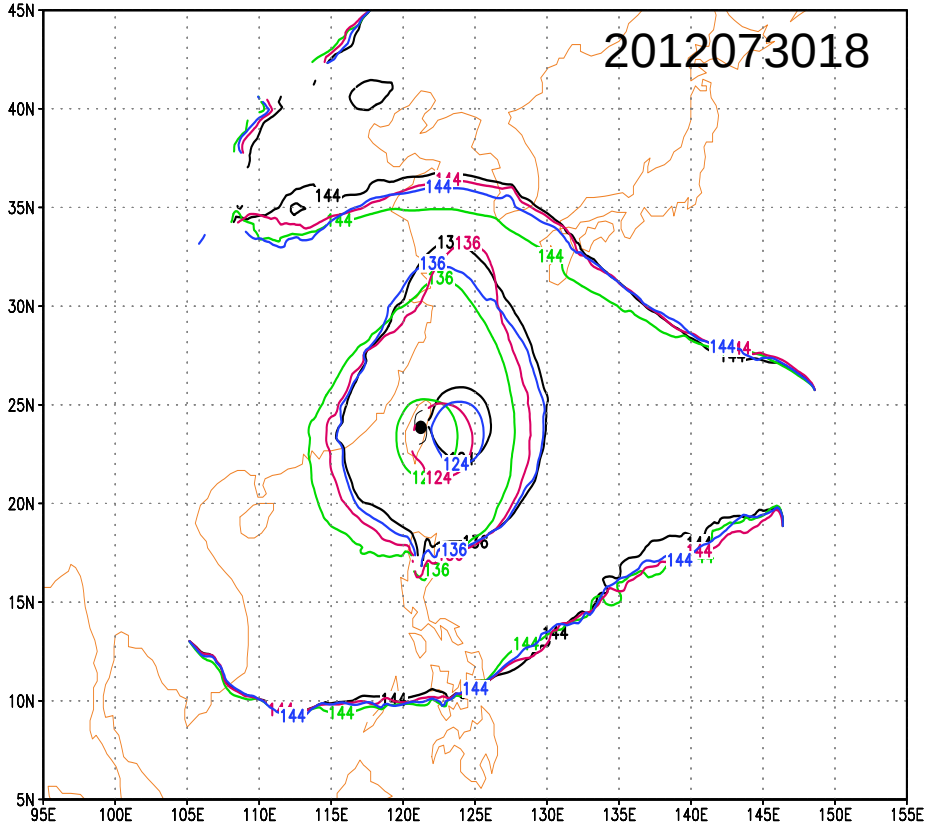
The statistics of departure before (oi) and after (ao) data assimilation (whole domain)



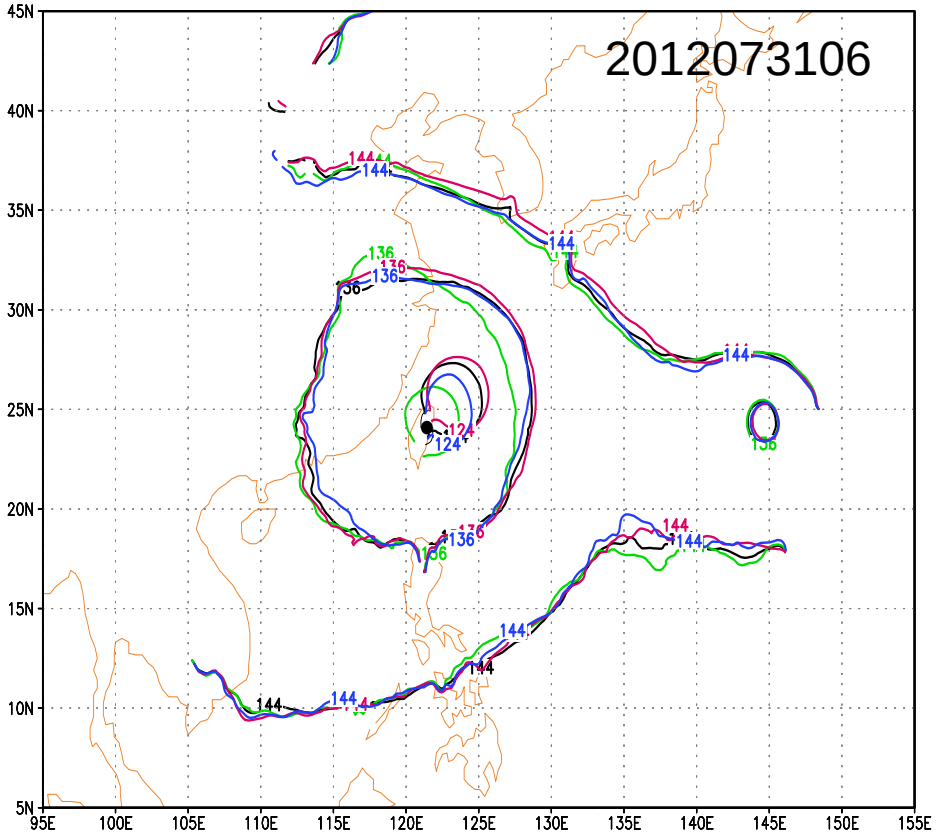
Data impact on analysis and forecast

Investigation on Typhoon case

54 h Height Forecast@850 hPa



54 h Height Forecast@850 hPa



black: Control; green: ATMS; red: FY-3B MWTS/MWHS;

blue: NOAA18 AMSUA/MHS

Discussions: cloud detection

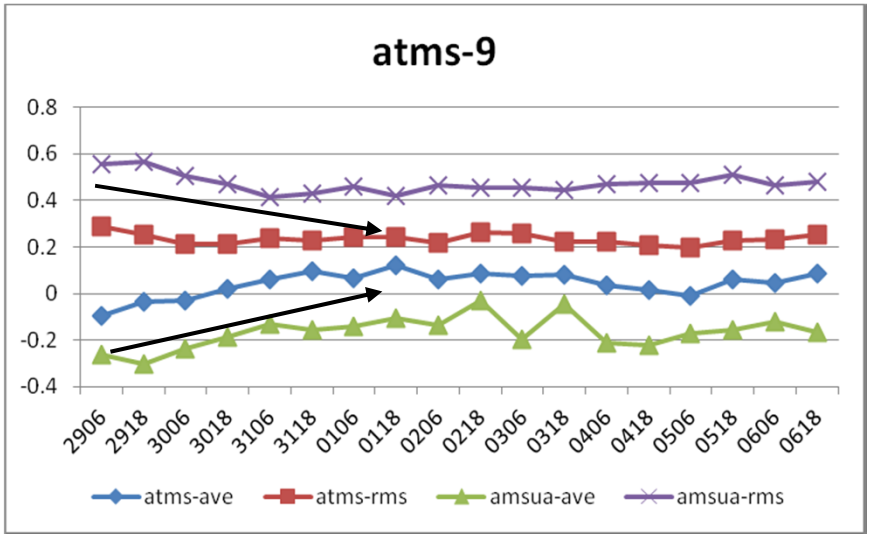
- **Cloud detection**
  - **Emission based**
  - **Scattering based**
- **Cloud detection issues for microwave sounding channels**
  - **O-B based: |O-B| or O-B ?**
  - **Obs. channel difference based**
  - **Retrieval based (LWP,IWP)**

Threshold value

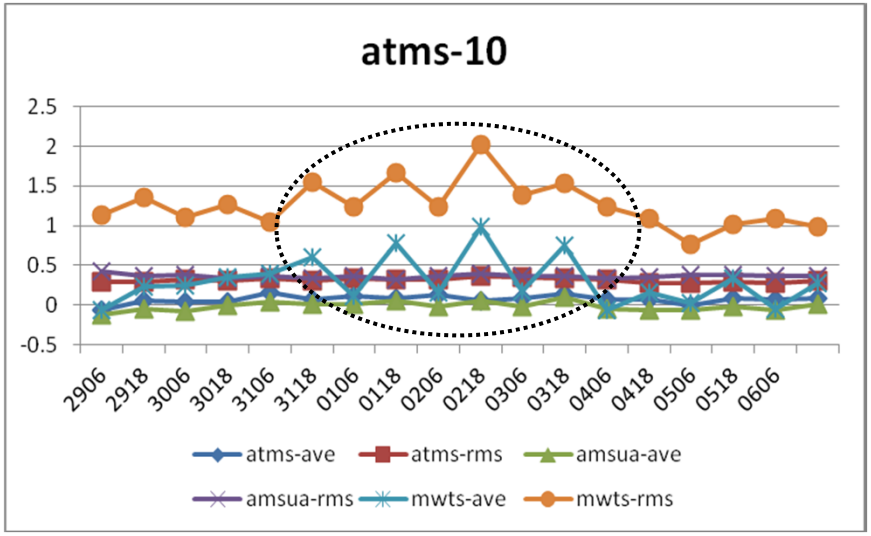
- **Inter-comparison of cloud detection among NWP centers**
  - **Same period, Same sensors**
  - **Independent validation observations**
  - **Could it be conducted by ITWG?**

Discussions: bias correction in regional NWP

- **Spin-up of VarBC coefficients**



- **O-B diurnal bias: B or O ?**



Summary

- **NPP ATMS agree with that of NOAA AMSUA/MHS well. ATMS data is of good quality.**
  - Good coverage
  - Small biases and std of O-B after bias correction
- **FY-3B MWTS/MWHS has some unique features.**
  - Similar channels of MWTS and MWHS are of similar quality of AMSUA and MHS.
  - MWTS channel 4 has significant positive bias.
  - It is expected to be enhanced by using the updated MWTS/MWHS on broad **FY-3C**.
- **Cloud detection scheme need to be refine for NPP ATMS and FY3 MWTS and MWHS.**