

2018 CWB-GSI更新及資料使用 簡介

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黃子茂 鄧雯心 趙子瑩

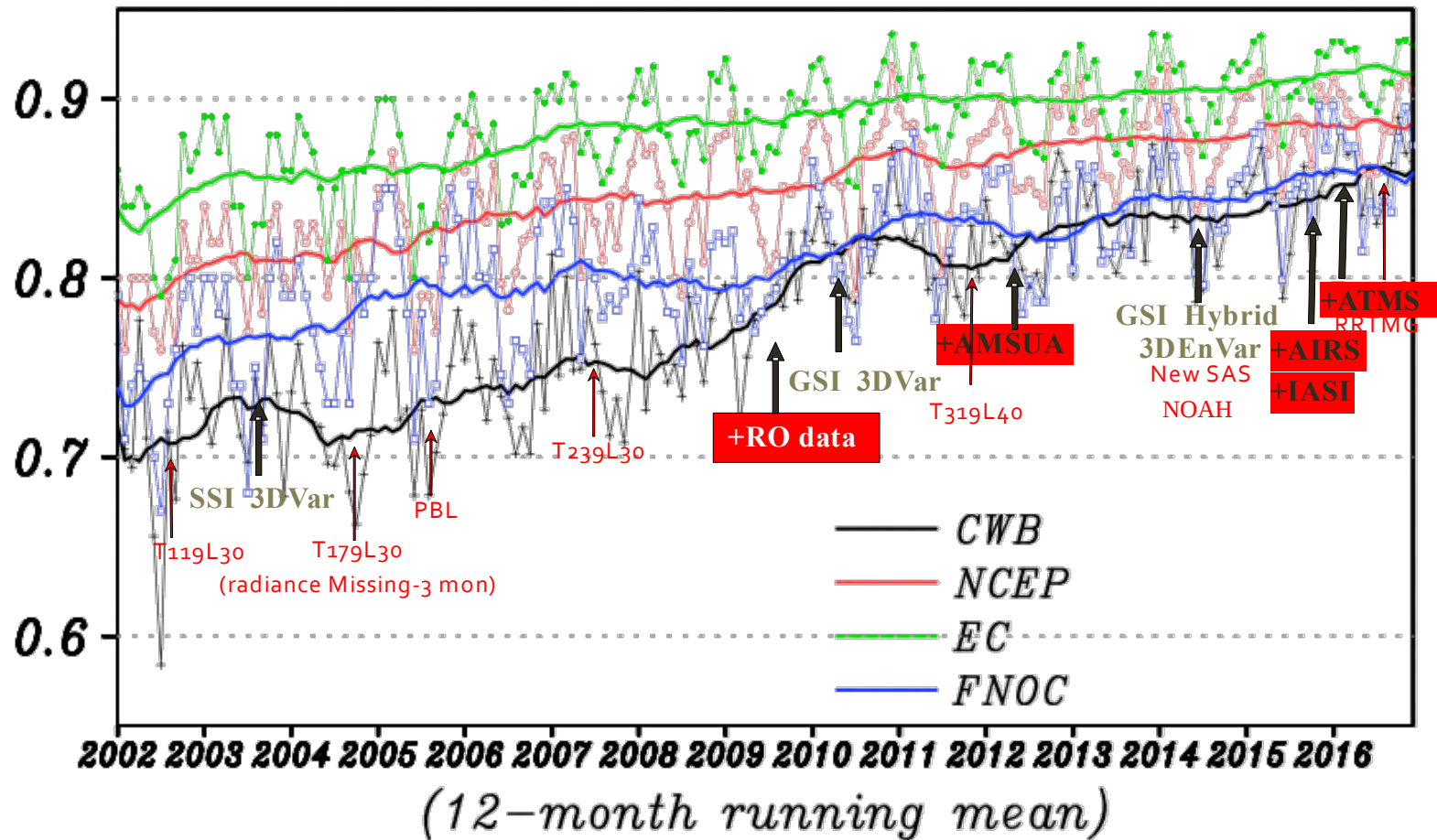
outline

- 目前作業同化資料使用
- GSI 更新說明
- 未來作業同化資料使用
 - GPSRO更新
 - Radiance使用說明
 - 預計上線之衛星資料使用說明
- 實驗結果

CWB GFS 500 Height

AC of Height

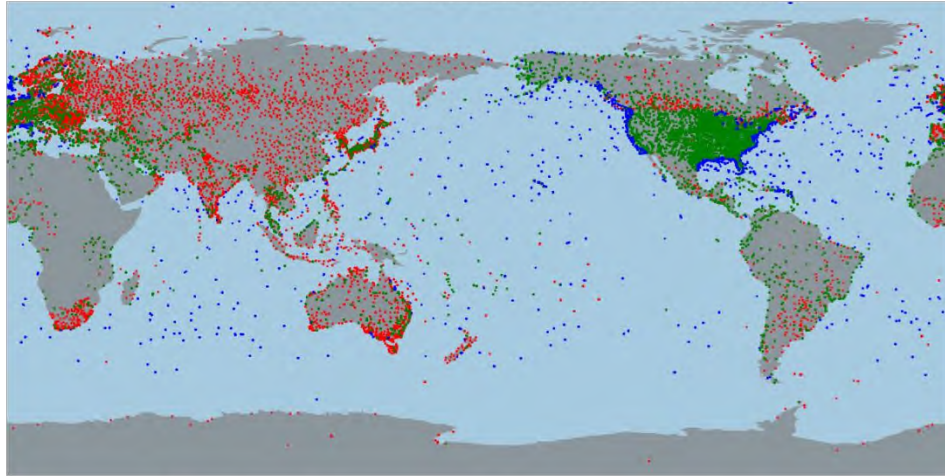
day 5 forecast, 500hPa H AC – N.Hemis.



Wen-Mei Chen

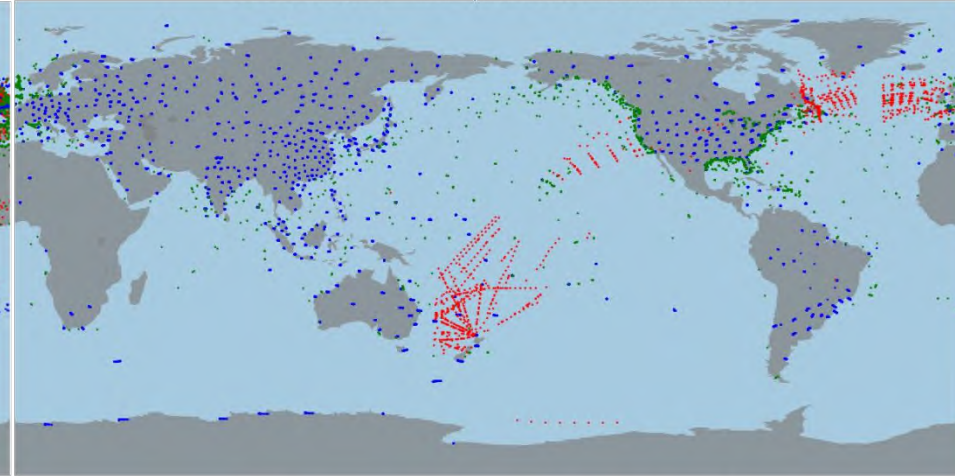
Assimilated Observations - Conventional

2018052000 Surface Pressure Assimilated



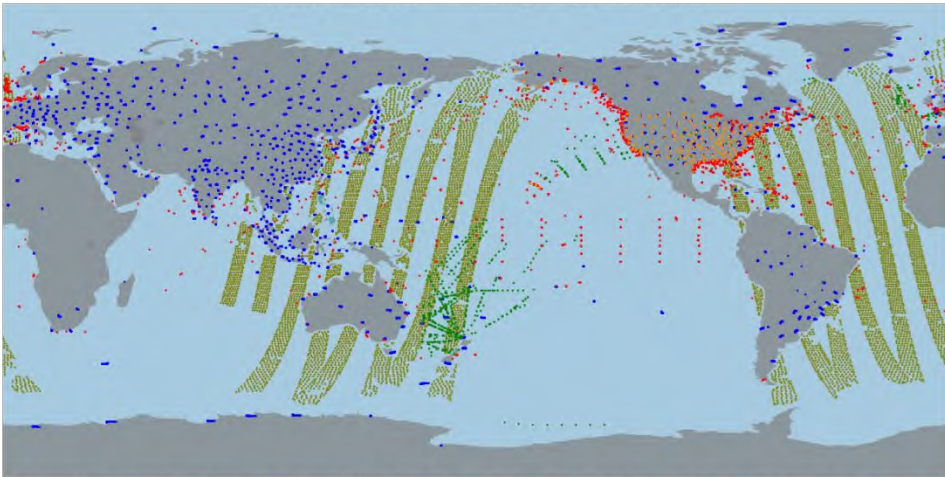
ADPUPA(120) - 636 ADPSFC(181) - 18557 ADPSFC(187) - 44477 SFCSHP(180) - 9090

2018052000 Temperature Assimilated



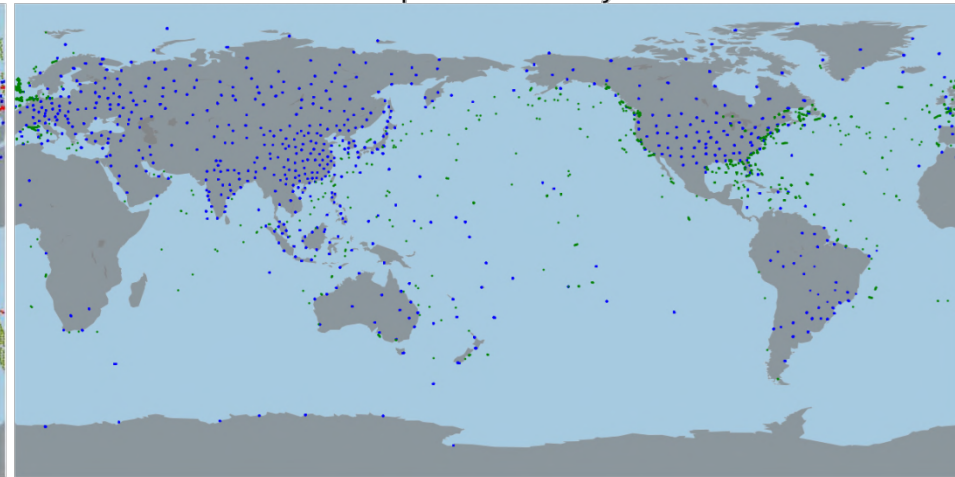
ADPUPA(120) - 31270 SFCSHP(180) - 7164 AIRCFT(130) - 1305

2018052000 V-Wind Assimilated



ADPUPA(220) - 39515 TW(290) - 7656 SFCSHP(280) - 7090 ADPUPA(221) - 537 AIRCFT(230) - 748 PROFILR(229) - 85 VADWIND(224) - 12927 SFCSHP(282) - 222

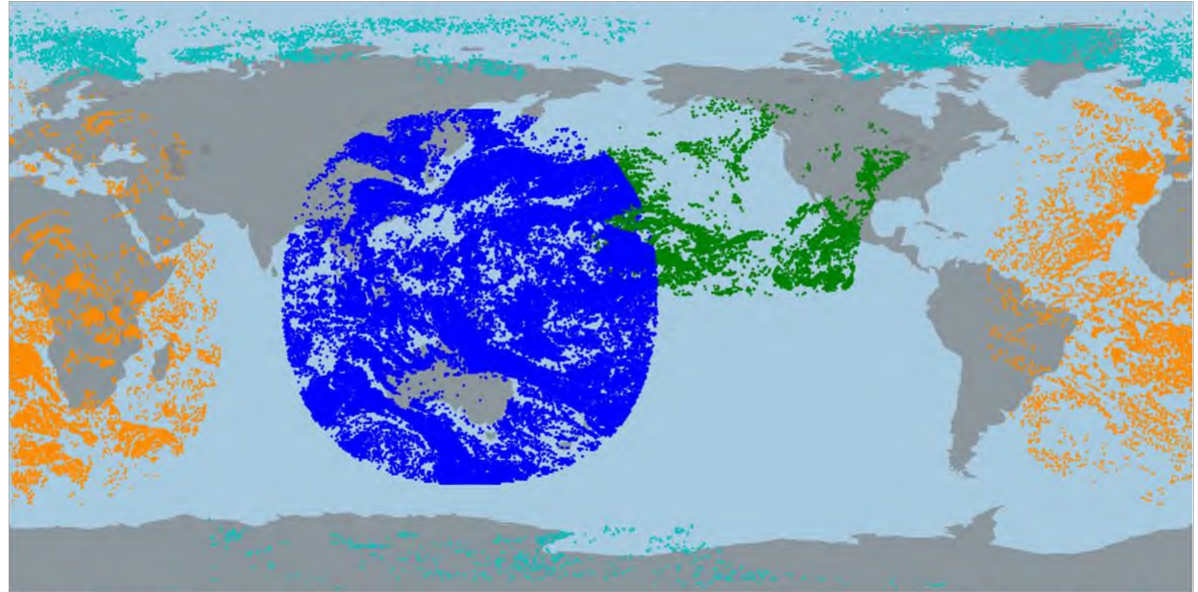
2018052000 Specific Humidity Assimilated



ADPUPA(120) - 14994 SFCSHP(180) - 3254

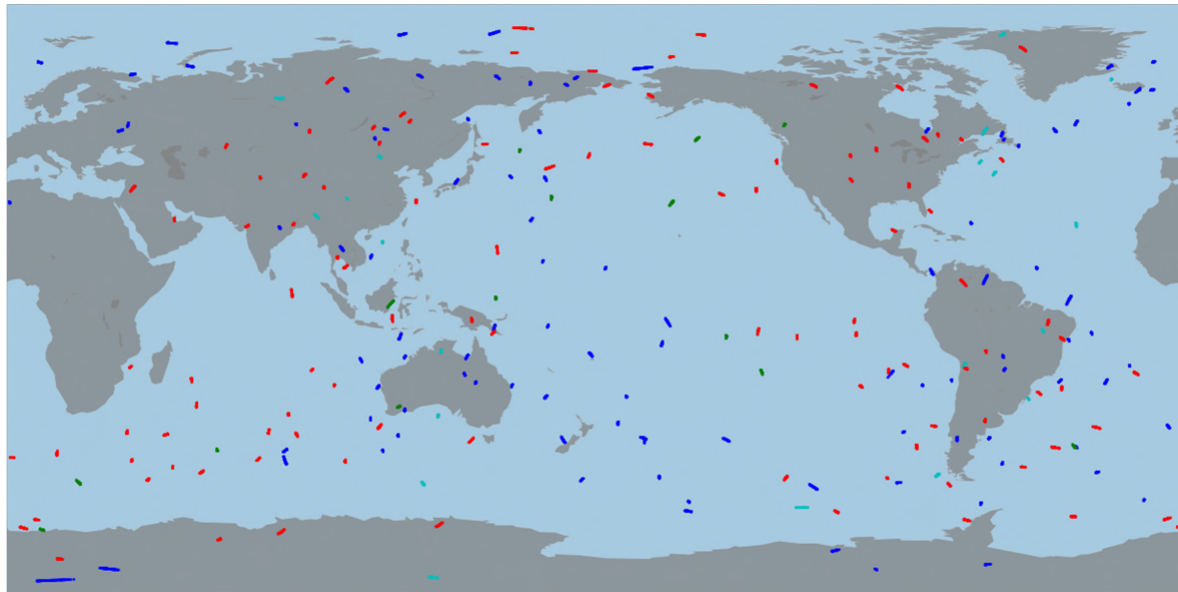
Assimilated Observations - Satellite

2018051312 AMV Assimilated



• HIMAWARI(242) - 6764 • GOES(245) - 5538 • HIMAWARI(250) - 43616 • METEOSAT(253) - 2427 • AQUA(257) - 4008 • AQUA(258) - 148 • AQUA(259) - 148
• METEOSAT(243) - 9862 • GOES(246) - 7087 • HIMAWARI(252) - 24344

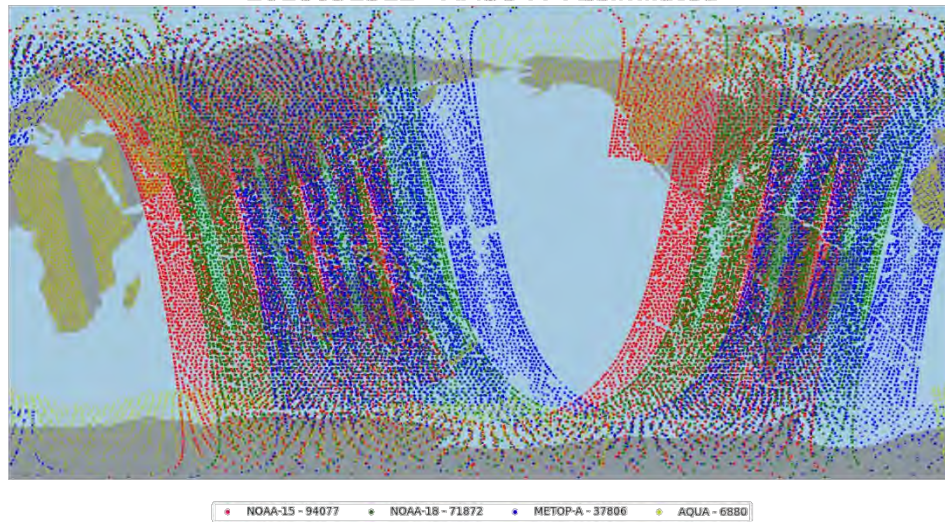
2018051312 GPS Radio Occultation Assimilated



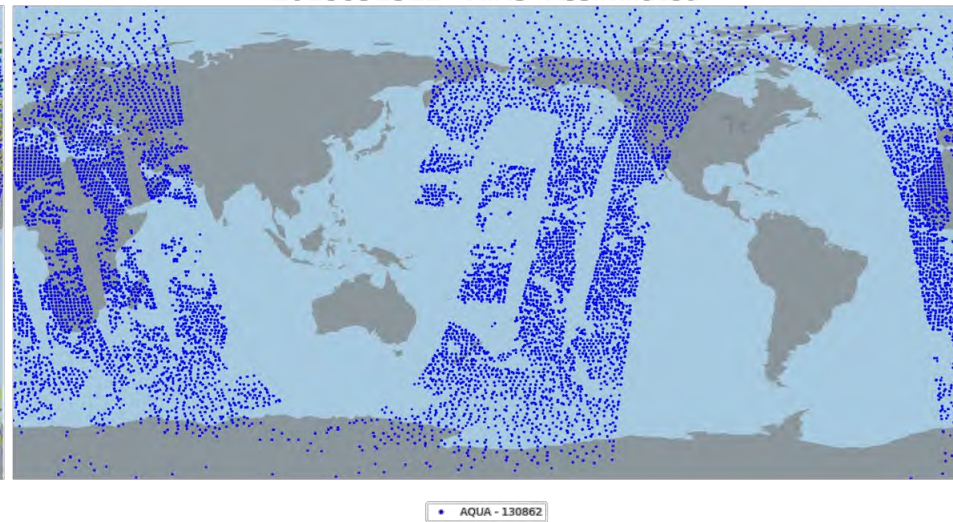
• METOP-A(4) - 12989 • COSMIC-1(740) - 14158 • COSMIC-6(745) - 1924 • TerraSAR-X(42) - 2281

Assimilated Observations - Satellite

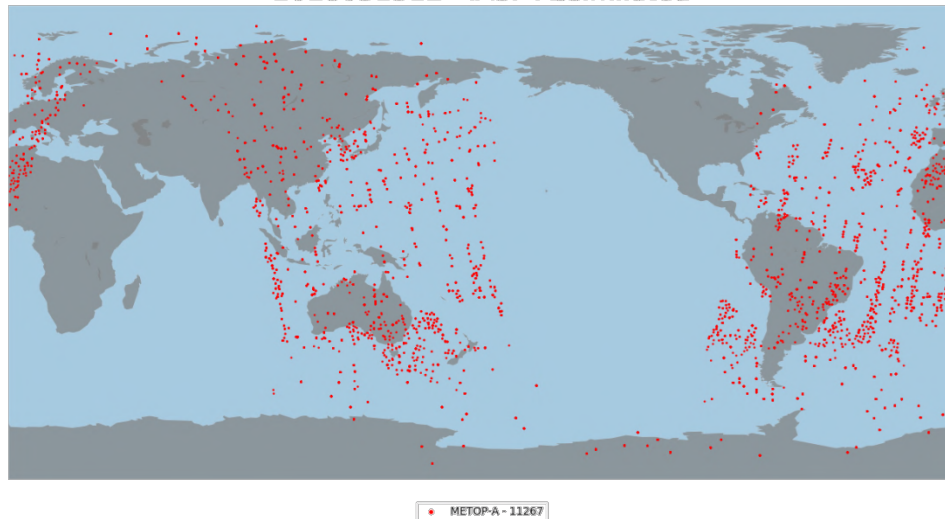
2018051312 AMSU-A Assimilated



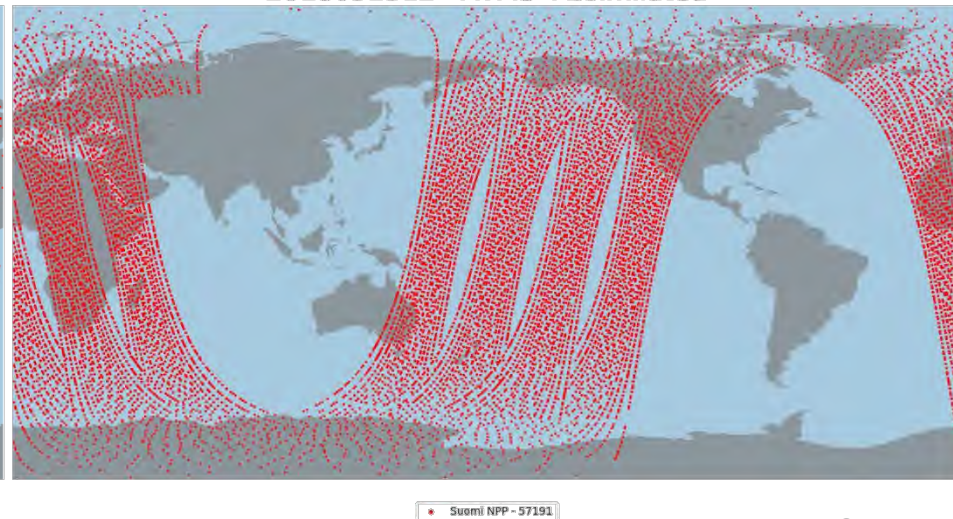
2018051312 AIRS Assimilated



2018051312 IASI Assimilated

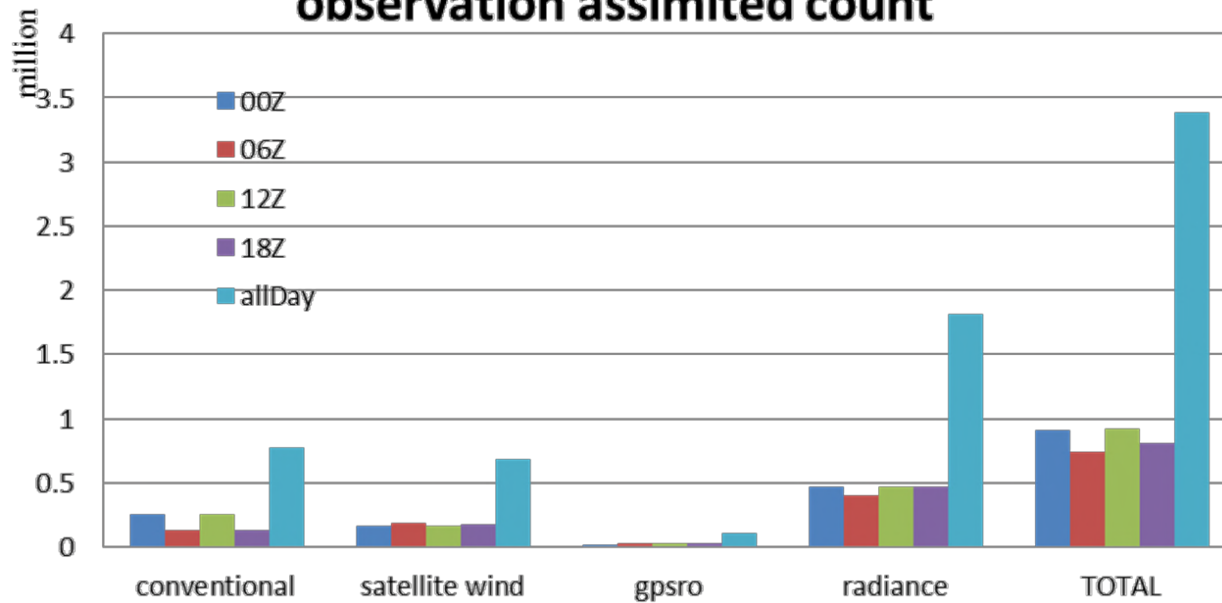


2018051312 ATMS Assimilated

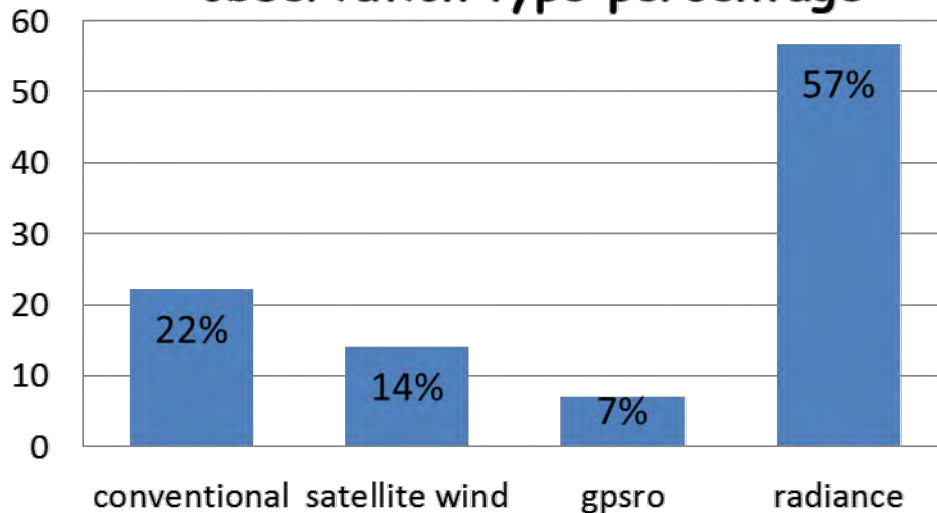


2017 6/11 All Obs.

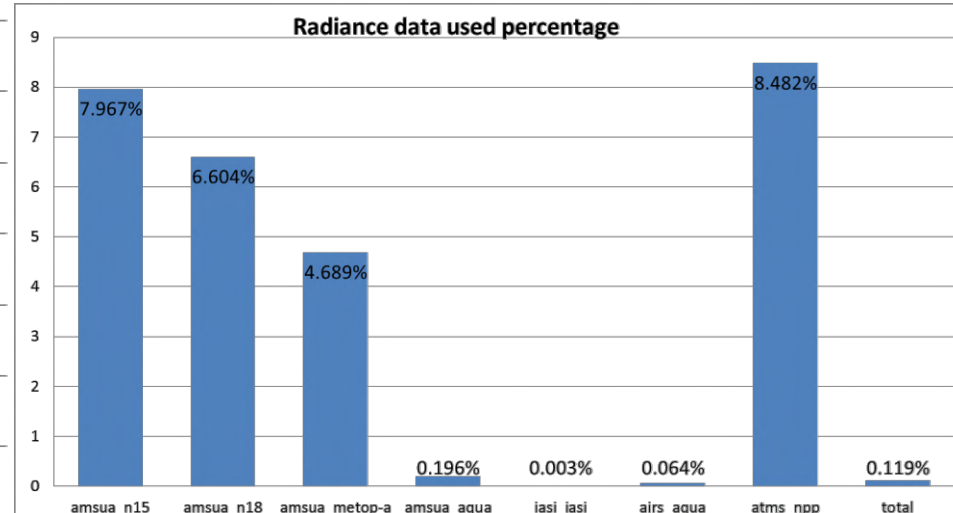
observation assimilated count



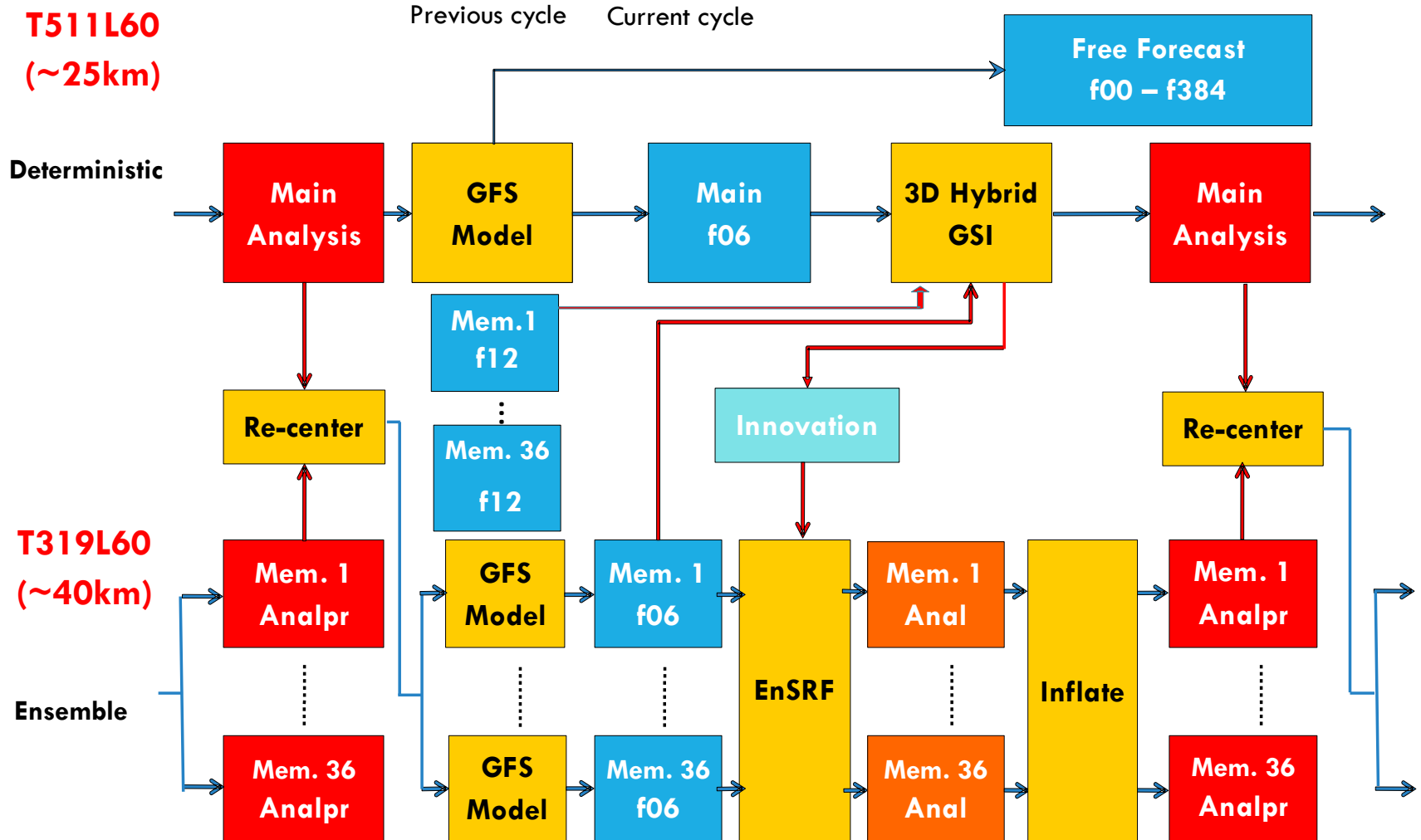
observation type percentage



Radiance data used percentage



CWB – GFS



System configuration

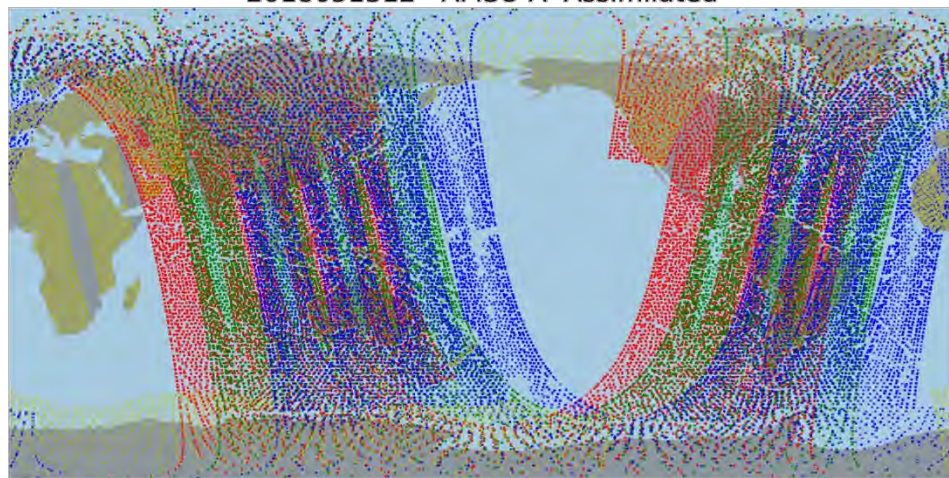
Variational Data Assimilation	GSI Hybrid 3D-EnVar (Wang, 2010 ; Kleist 2016)
Ensemble Data Assimilation	EnSRF (Jeff Whitaker, 2002)
Resolution	T511L60 (~25km)
Ens. Resolution	T319L60 (~40km)
Beta Static Weights	0.25
Beta Ensemble Weights	0.75
Ensemble Member size	72 (36 EnKF + 36 Time lagging)
Additive Inflation	NMC Method
Recentering	Yes
TC and EC bogus data	Yes
Observations from	NCEP and GTS
Horizontal localization	800 km

GSI更新說明

- 目前作業之GSI為NCEP 2012年上線之版本
- 預計上線之GSI為2015年(NCEP EMC trunk r55323) 版本
- 更新說明
 - 2012年
 - Suomi NPP衛星搭載之CrIS
 - METOP-B衛星搭載之MHS、AMSU-A
 - 2015年
 - 程式優化
 - EnKF系統部分更新
 - 飛機溫度觀測資料做偏差校正
 - 雲導風資料(GOES、EUMESAT衛星)
 - METOP-B衛星搭載之GPSRO
- CRTM LIB更新，由CRTM2.0.5更新至2.2.3
- BUFR LIB更新，新版本修正BUFR讀取問題
- 更新可讀取COSMIC-2 QC-FLAG

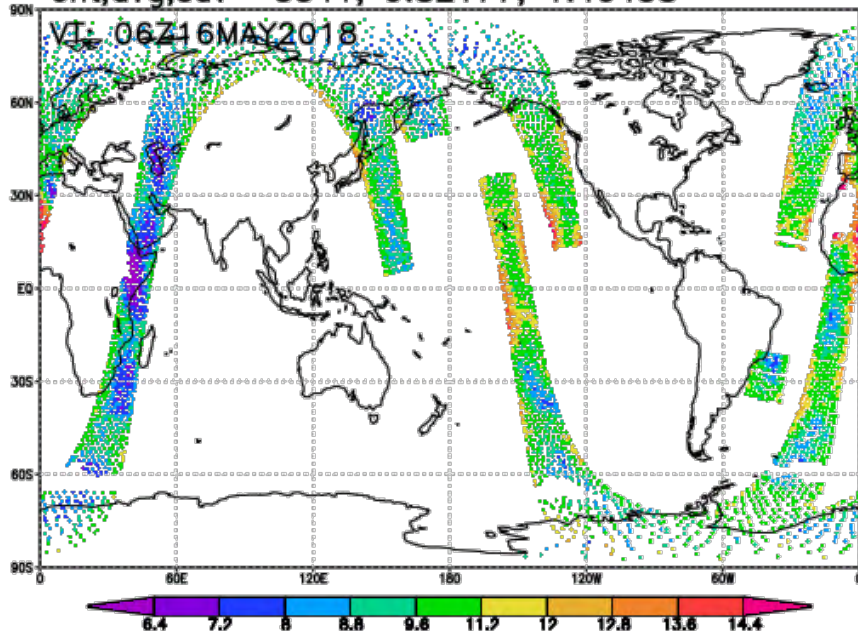
GSI更新說明(續)

2018051312 AMSU-A Assimilated

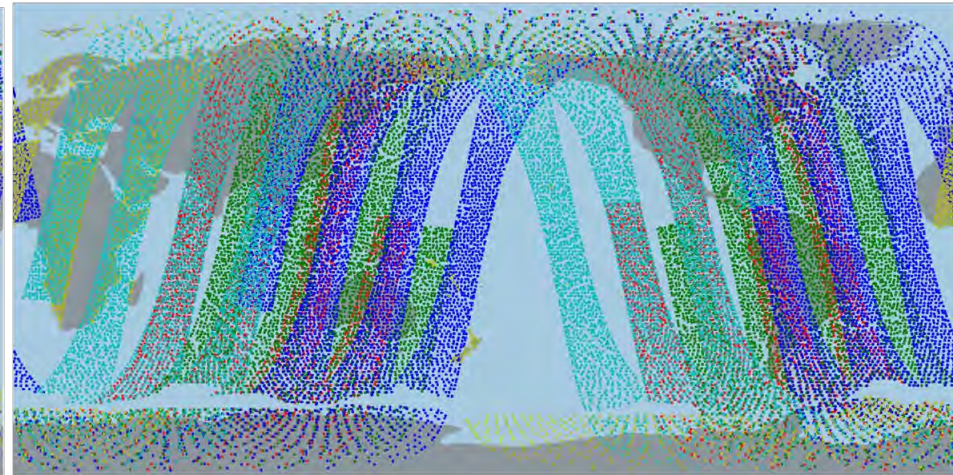


• NOAA-15 - 94077 • NOAA-18 - 71872 • METOP-A - 37806 • AQUA - 6880

platform: amsua n15
variable: channel 13 ges_(w/o bias cor) - obs (K)
cnt,avg,sdv= 5541, 9.82177, 1.40458

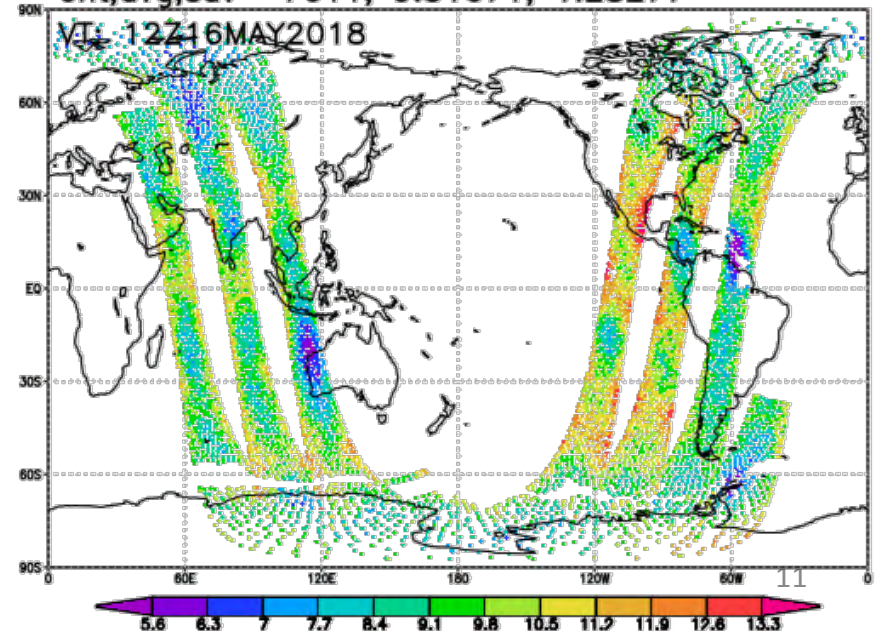


2018052000 AMSU-A Assimilated



• NOAA-15 - 77037 • NOAA-18 - 89914 • METOP-A - 79784 • AQUA - 19006 • NOAA-19 - 80872

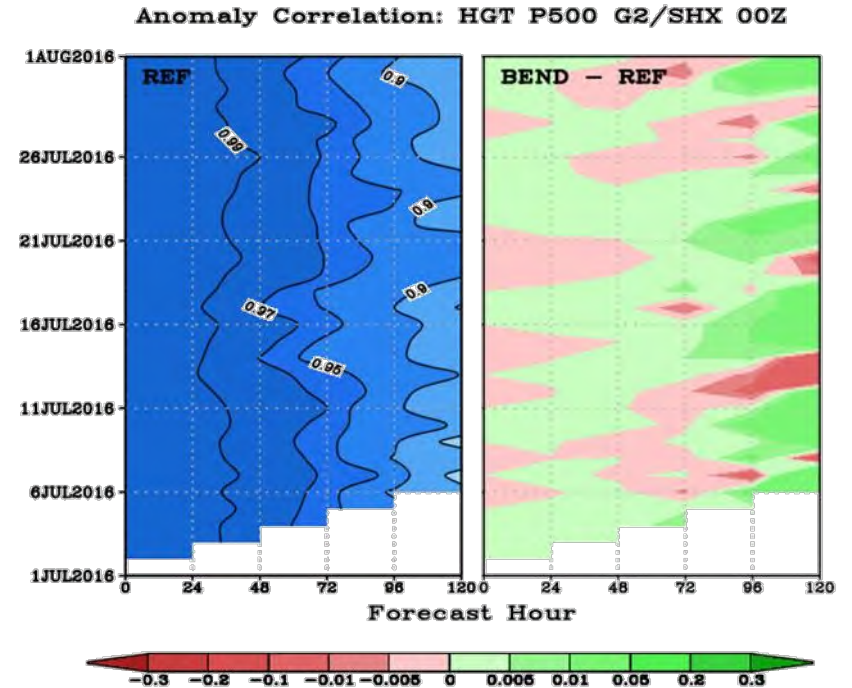
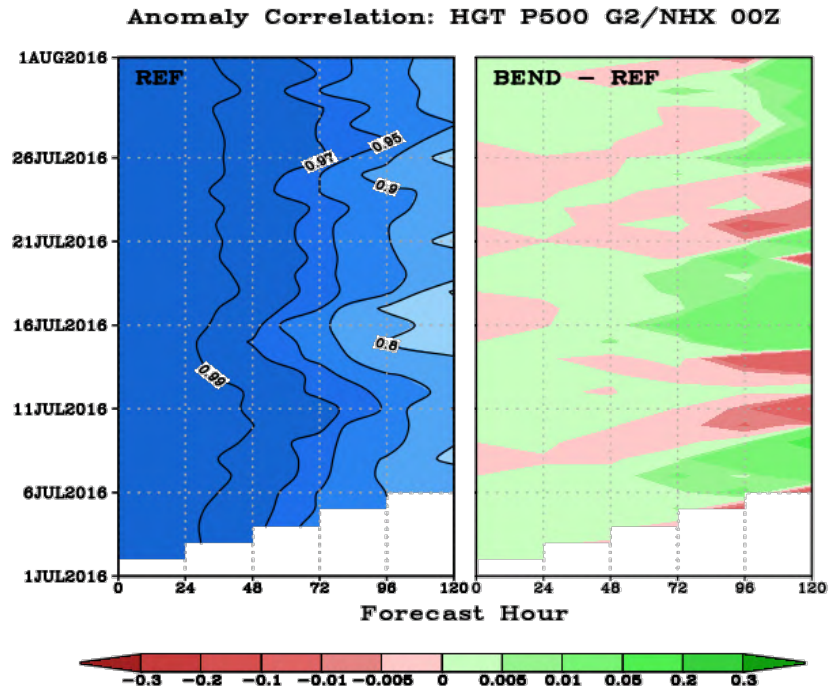
frequency: 57.29 GHz
wavelength: 5232.86 μm
cnt,avg,sdv= 7611, 9.51671, 1.28277



Experiment Design - GPSRO

Resolution	T511L60 (~25km)
Ens. Resolution	T319L60 (~40km)
Beta Static Weights	0.25
Beta Ensemble Weights	0.75
Ensemble Member size	36
Additive Inflation	NMC Method
Re-centering	Yes
TC and EC bogus data	Yes
Observations from	NCEP and GTS
Horizontal localization	800 km
RO data type	Bending angle
Experiment period	2016 7/1 – 7/31

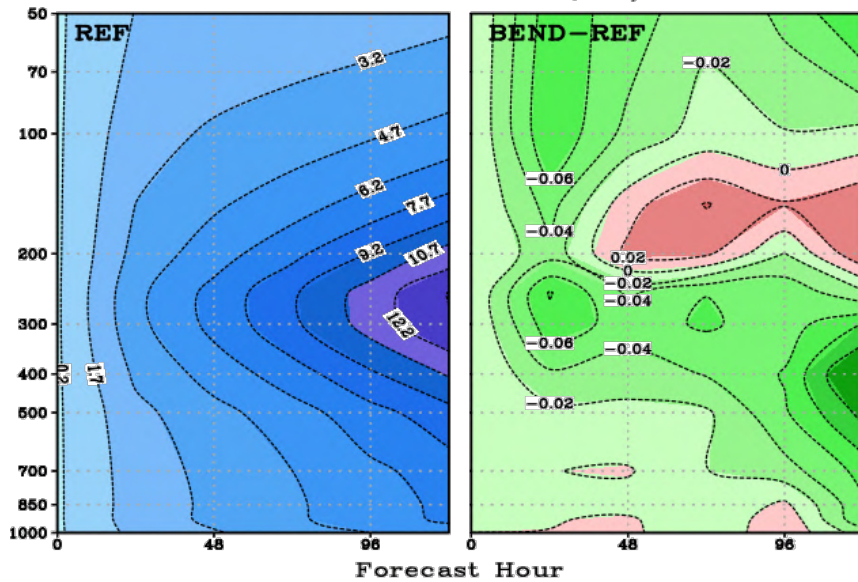
500 hPa AC of Height



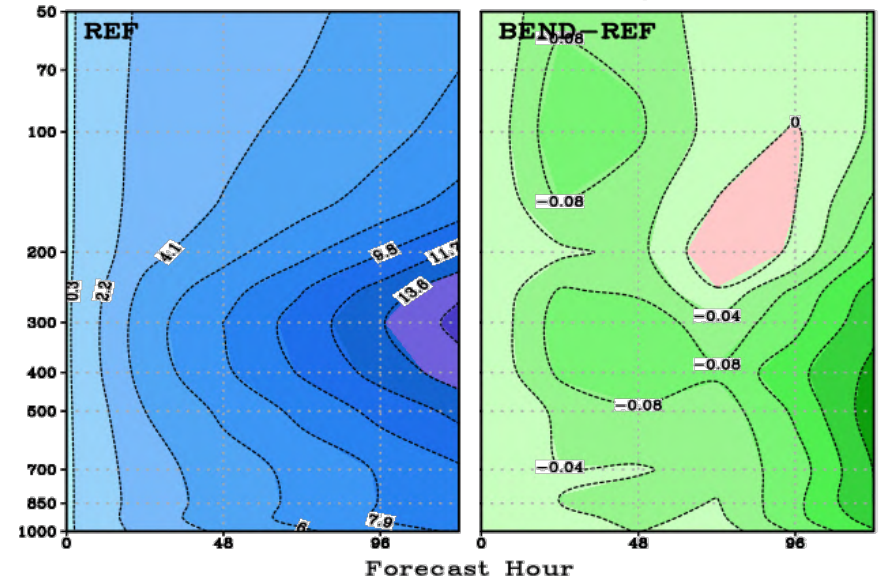
Against self analysis

RMS Error of Wind

WIND: RMSE
20160701-20160801 Mean, G2/NHX 00Z

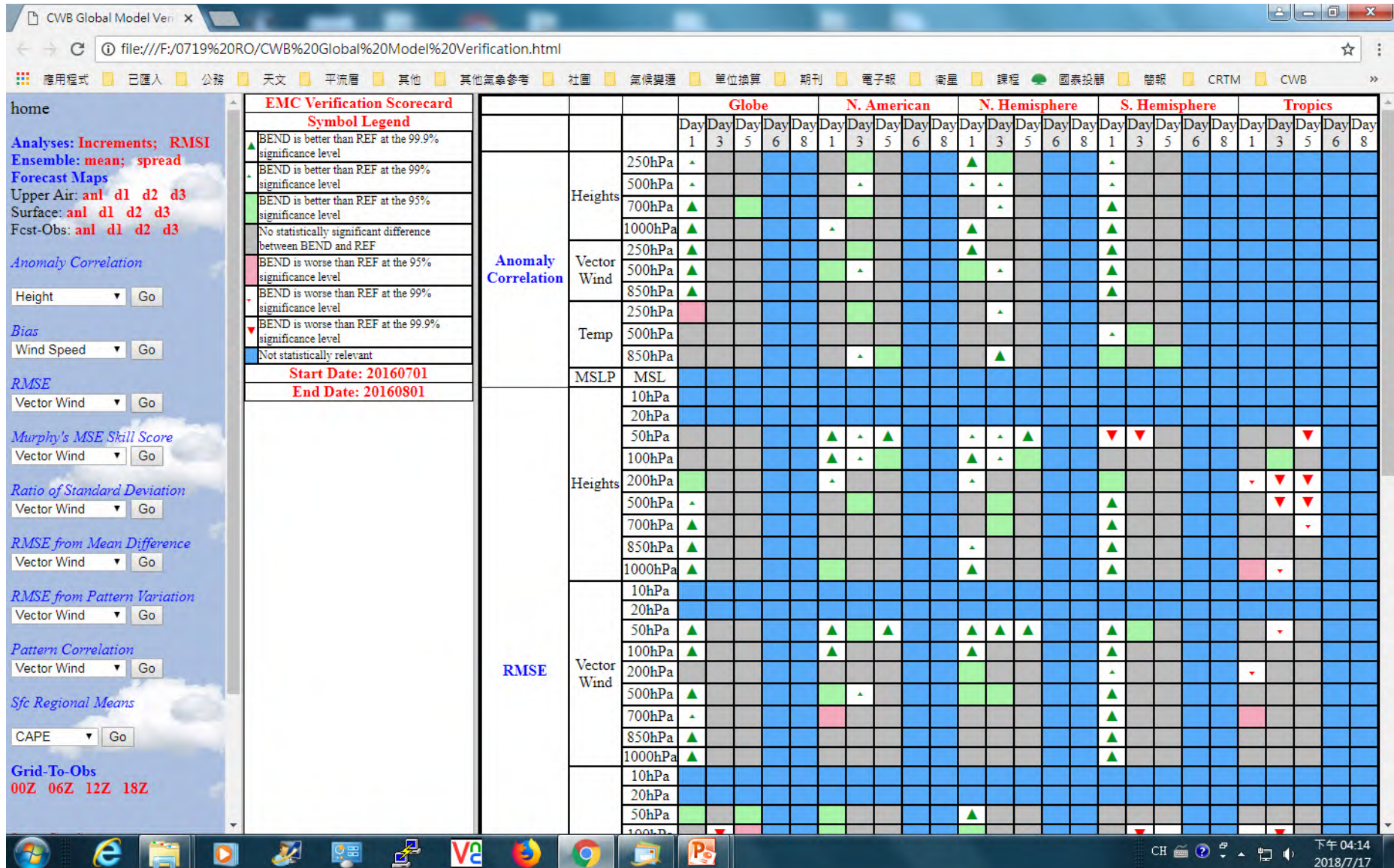


WIND: RMSE
20160701-20160801 Mean, G2/SHX 00Z



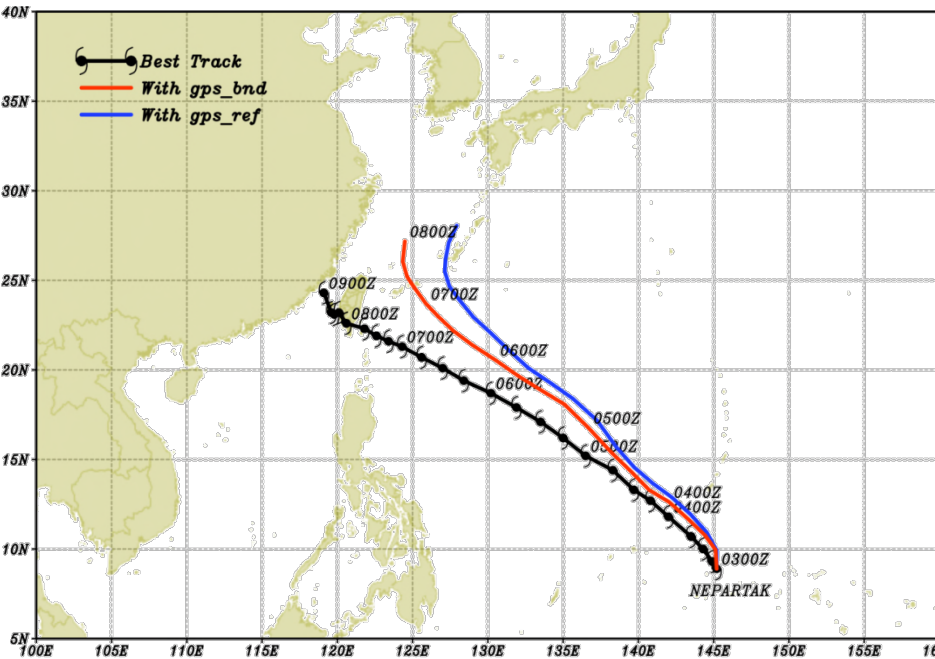
Against self analysis

ScoreCard



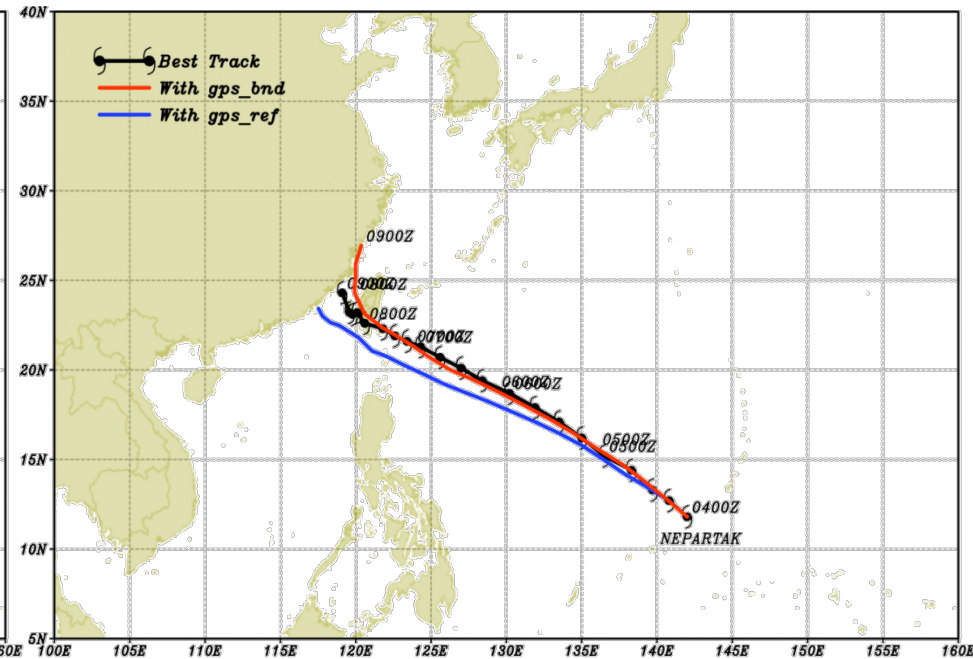
Typhoon track - NEPARTAK

CWB GFS for Typhoon-track
Initial time = 16070300



Central pressure 998mb

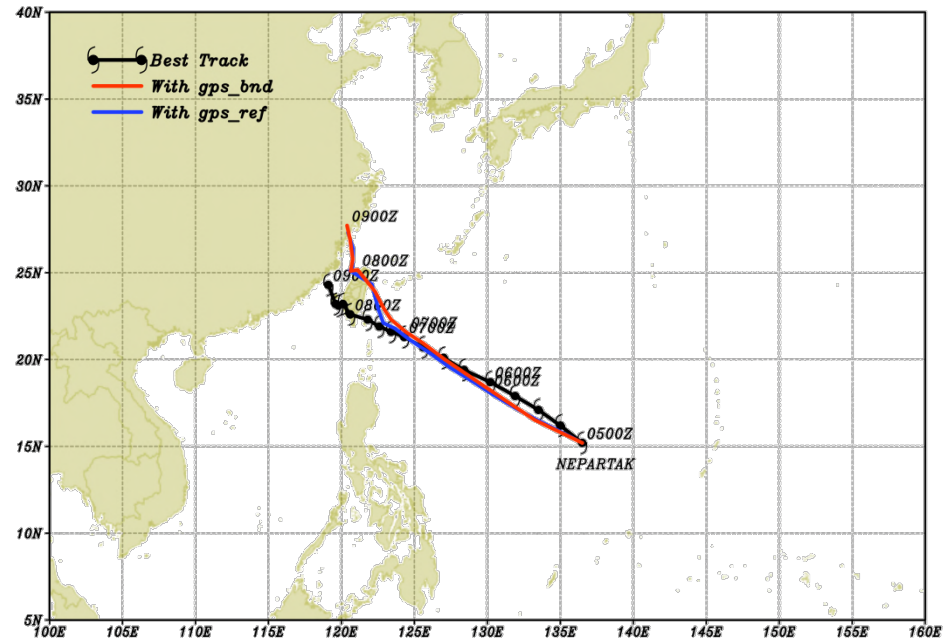
CWB GFS for Typhoon-track
Initial time = 16070400



Central pressure 995mb

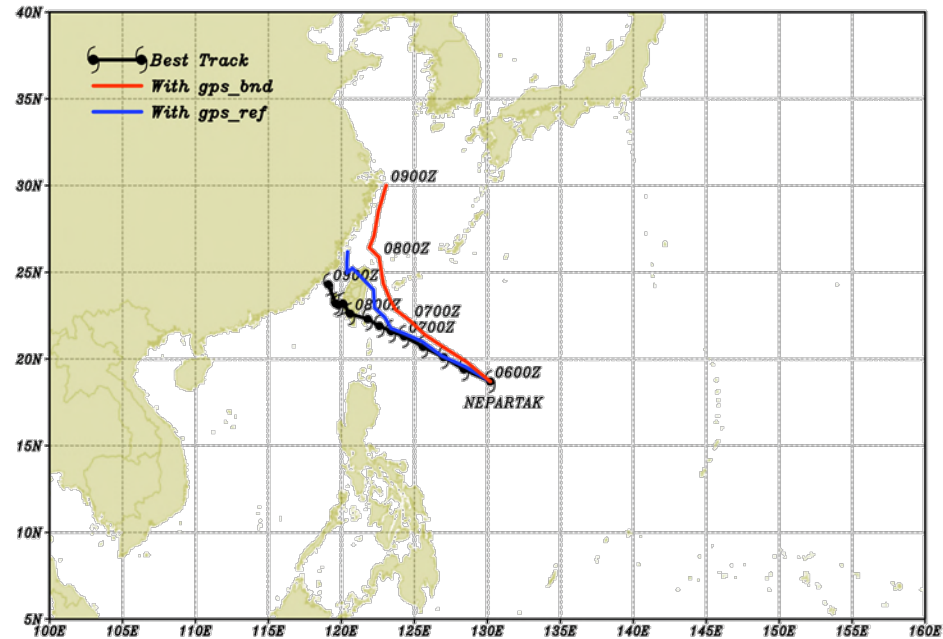
Typhoon track

CWB GFS for Typhoon-track
Initial time = 16070500



Central pressure 970mb

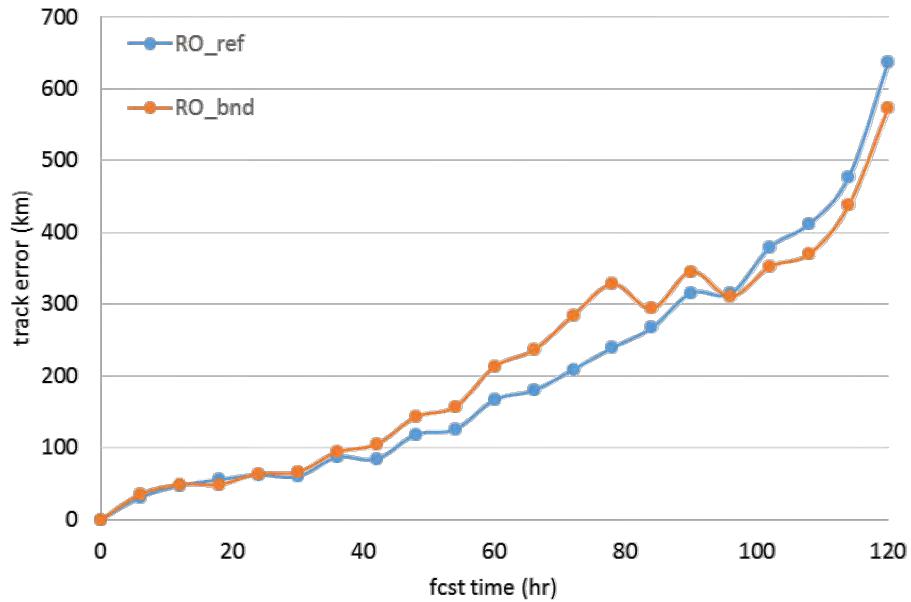
CWB GFS for Typhoon-track
Initial time = 16070600



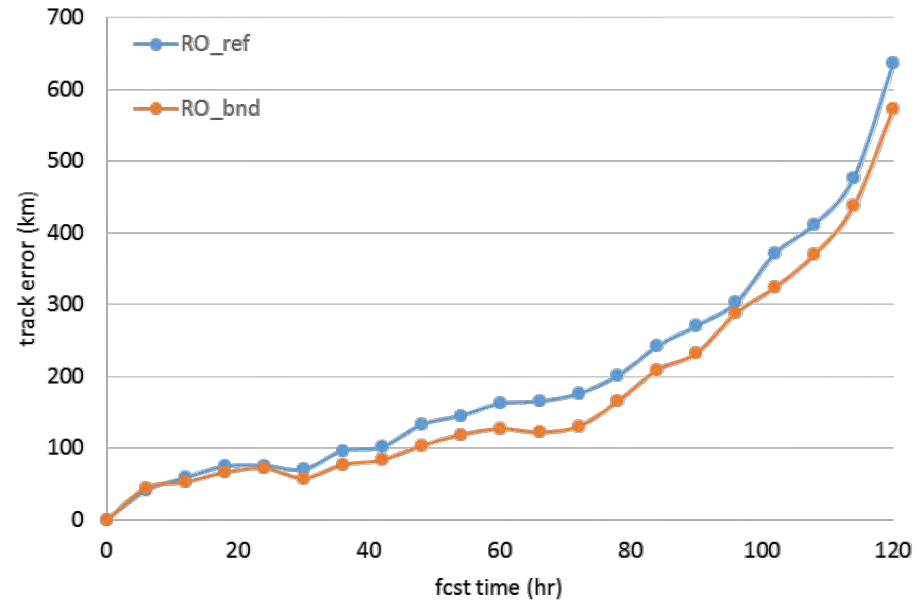
Central pressure 915mb

Typhoon track error

track error 7/3 00Z - 7/7 12z



track error 7/3 00Z - 7/4 12z

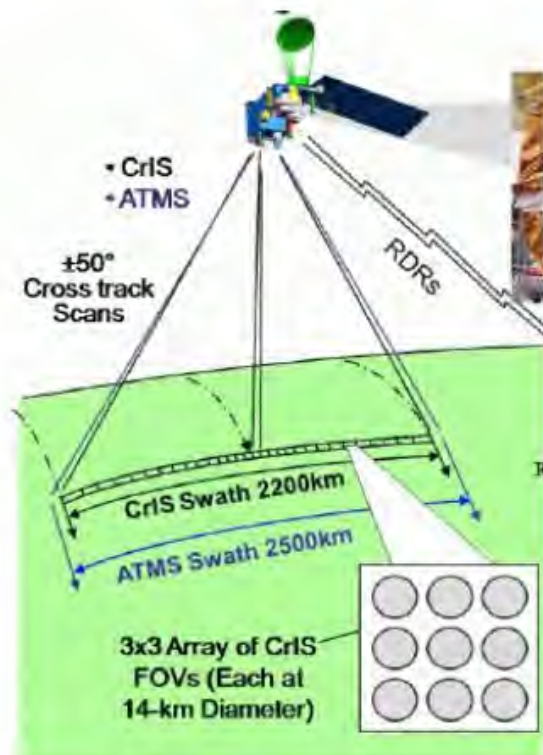


Radiance 資料使用說明

- CrIS – Cross Track Infrared sounder
- HIRS4 - High Resolution Infrared Radiation Sounder
- MHS - The Microwave Humidity Sounder

CrIS assimilation at CWBGFS

(CrIS) : Cross-Track Infrared sounder



- flying on Suomi NPP satellite (2011.10 launched)
- $\pm 50^\circ$ from the nadir
- Width of swath : 2200km
- 30 earth scene fields-of-regard(FOR)
- 3X3 FOVs/FOR with 14km at nadir
- 1305 channels =
 - channel 1-713 long wavelength IR(9.14-15.38 μ m) +
 - channel 714-1142 middle wavelength IR(5.71-8.26 μ m) +
 - channel 1143-1305 short wavelength IR(3.92-4.64 μ m)
- 提供涵蓋全球高垂直解析度溫度、溼度剖面觀測：
對流層垂直解析度 1-2km 、平流層3-4km。

Reference : ECMWF/EUMETSAT NWP-SAF
Satellite data assimilation Training
Course(2015.3)

CrIs : Cross-Track Infrared sounder

Instrument/ Satellite/	No. of Channel	Spectral Range	Spectral Res.	IFOV	Type/ Orbit
AIRS/ Aqua(EOS-PM)/	2378	650- □2760cm ⁻¹	~1cm ⁻¹	13.5k m	Grating Spectrometer/ Polar
IASI/ MetOp/	8461	645- □2760cm ⁻¹	0.5cm ⁻¹	12km	Interferometer /Polar
CrIS/ NPP & JPSS/	1400	635□- 2450cm ⁻¹	1.125□- 4.5cm ⁻¹	12km	Interferometer /Polar

for NWP
No. of channel

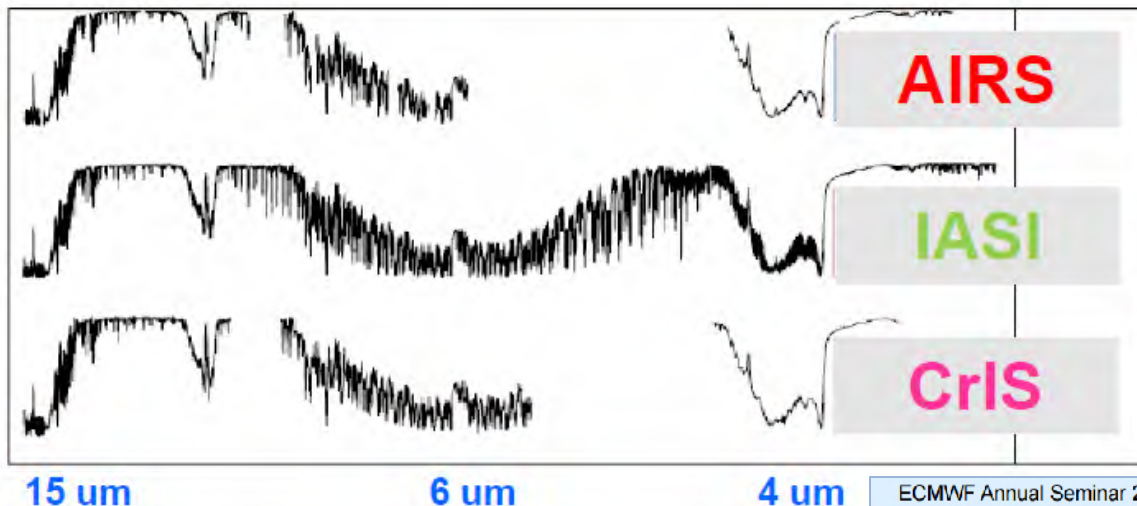
281

616

399

HIRS

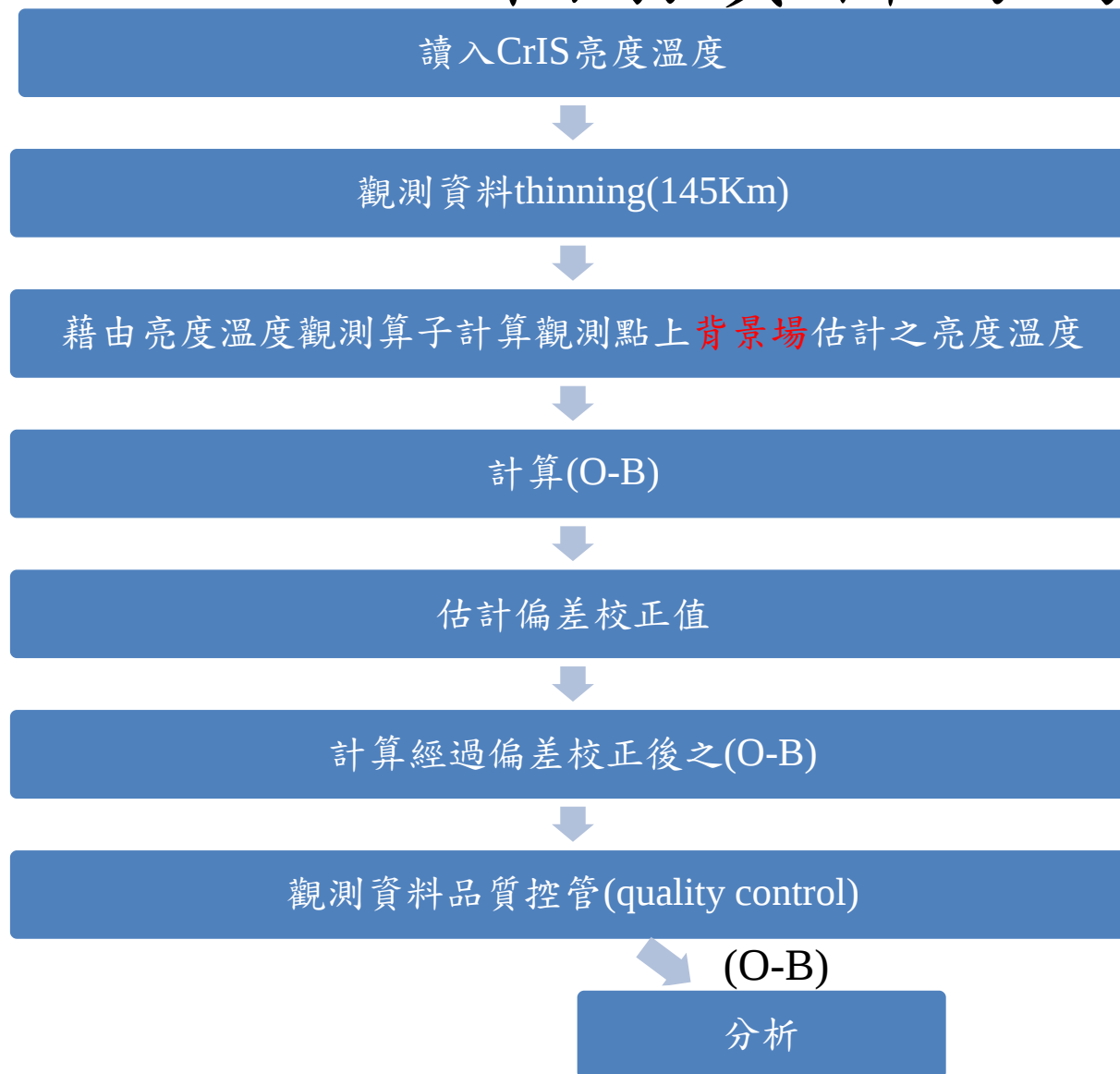
19



ECMWF Annual Seminar 2014

ECMWF assimilate 177 CrIS channels since 2016/11 (instead of 77 channels)
NCEP assimilate 82 CrIS channels

CrIS輻射資料的同化

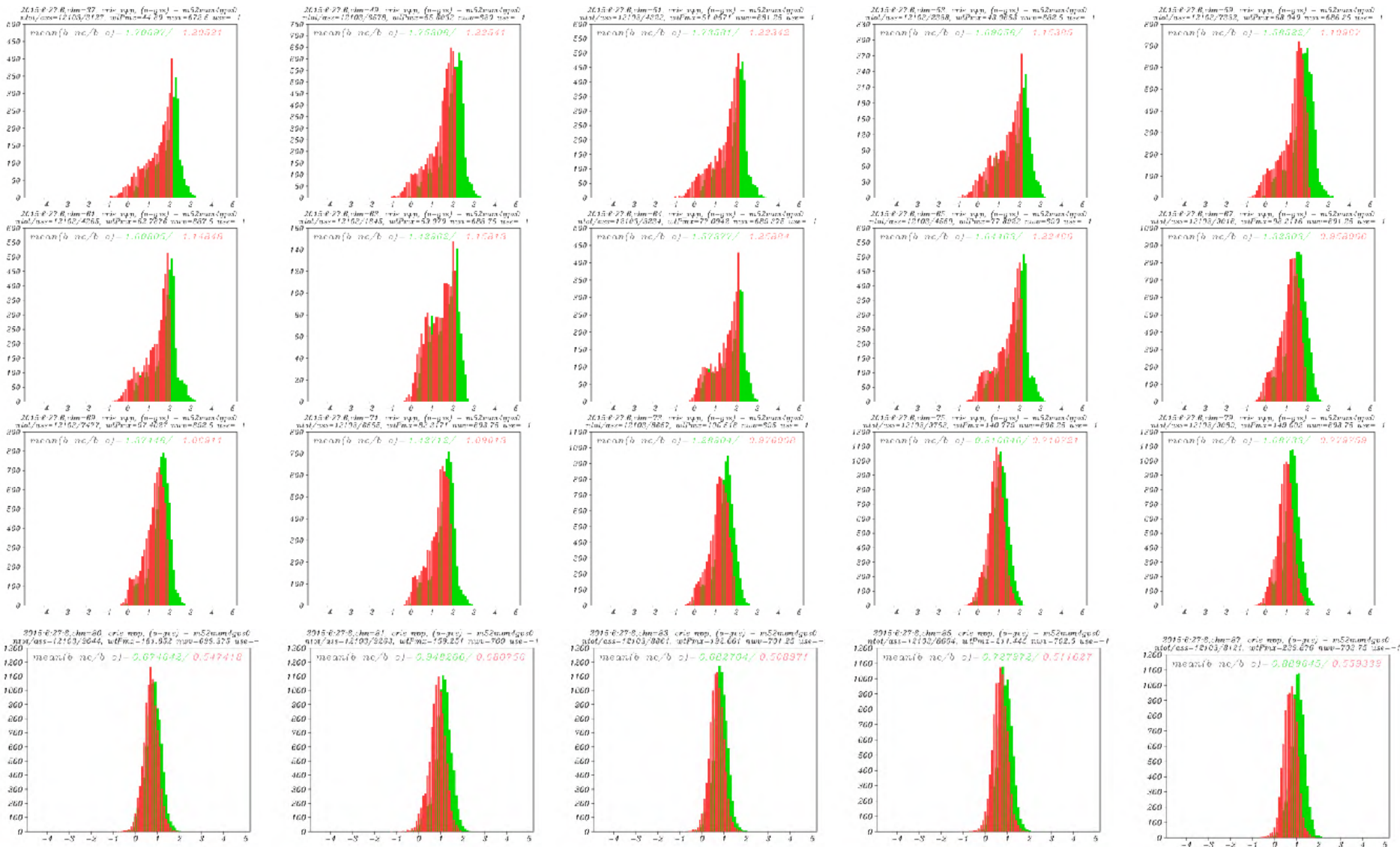


需要背景場的溫度、濕度、
臭氧及地面特性資料，資料的同化與模式的特性密切相關

(O-B)含觀測誤差、背景場誤差及觀測運算子的誤差

觀測偏差及觀測運算子偏差校正(掃描角及氣團校正)→背景場偏差明顯時會影響偏差校正的效果

15062706 , T_b (O-B) v.s. obs count each bin - I

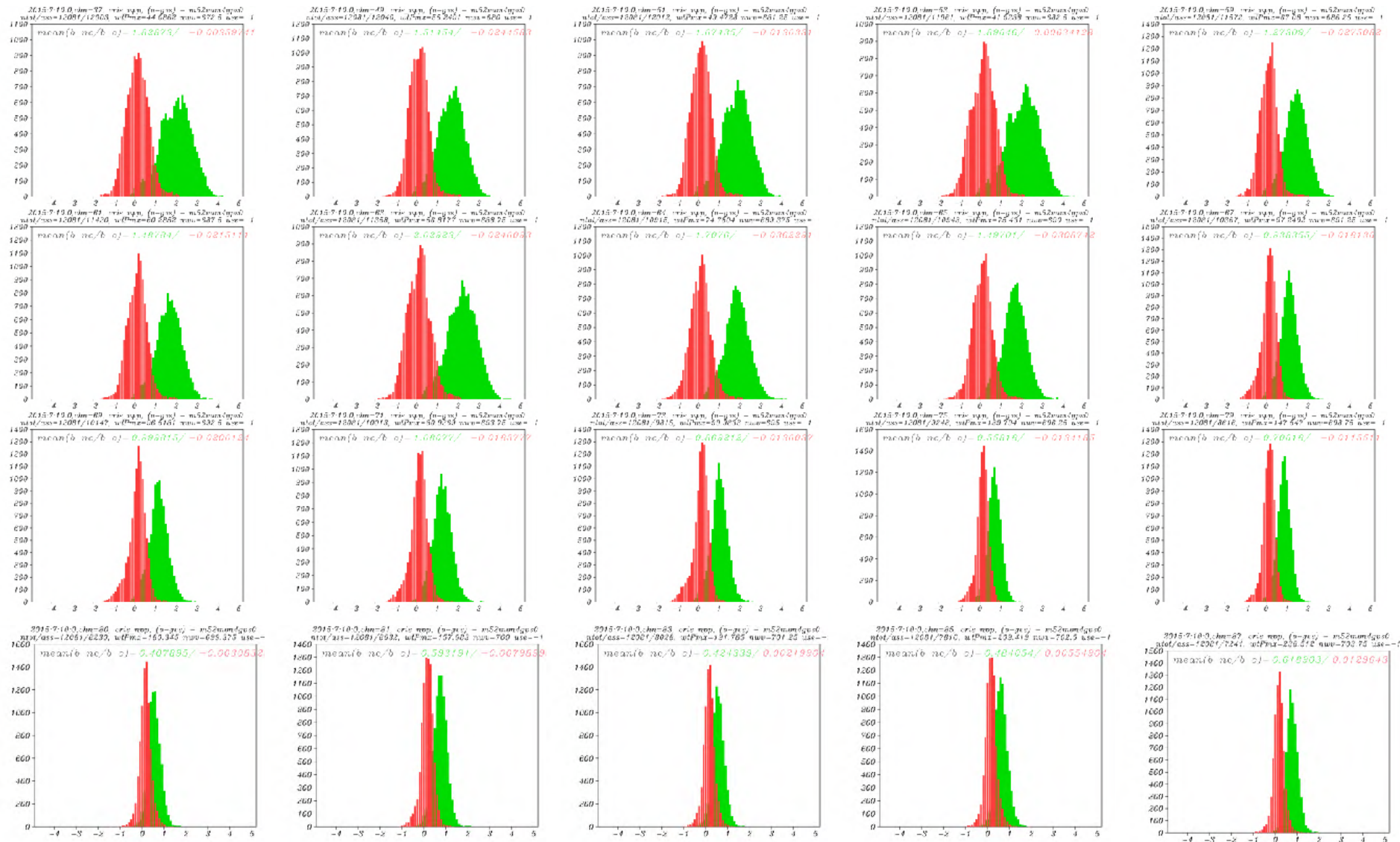


start from 15062700
Bin from -5 ~ 5 with interval=0.1

Not Gaussian distribution for some channels at 1'st run

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15071000 , T_b (O-B) v.s. obs count each bin - I

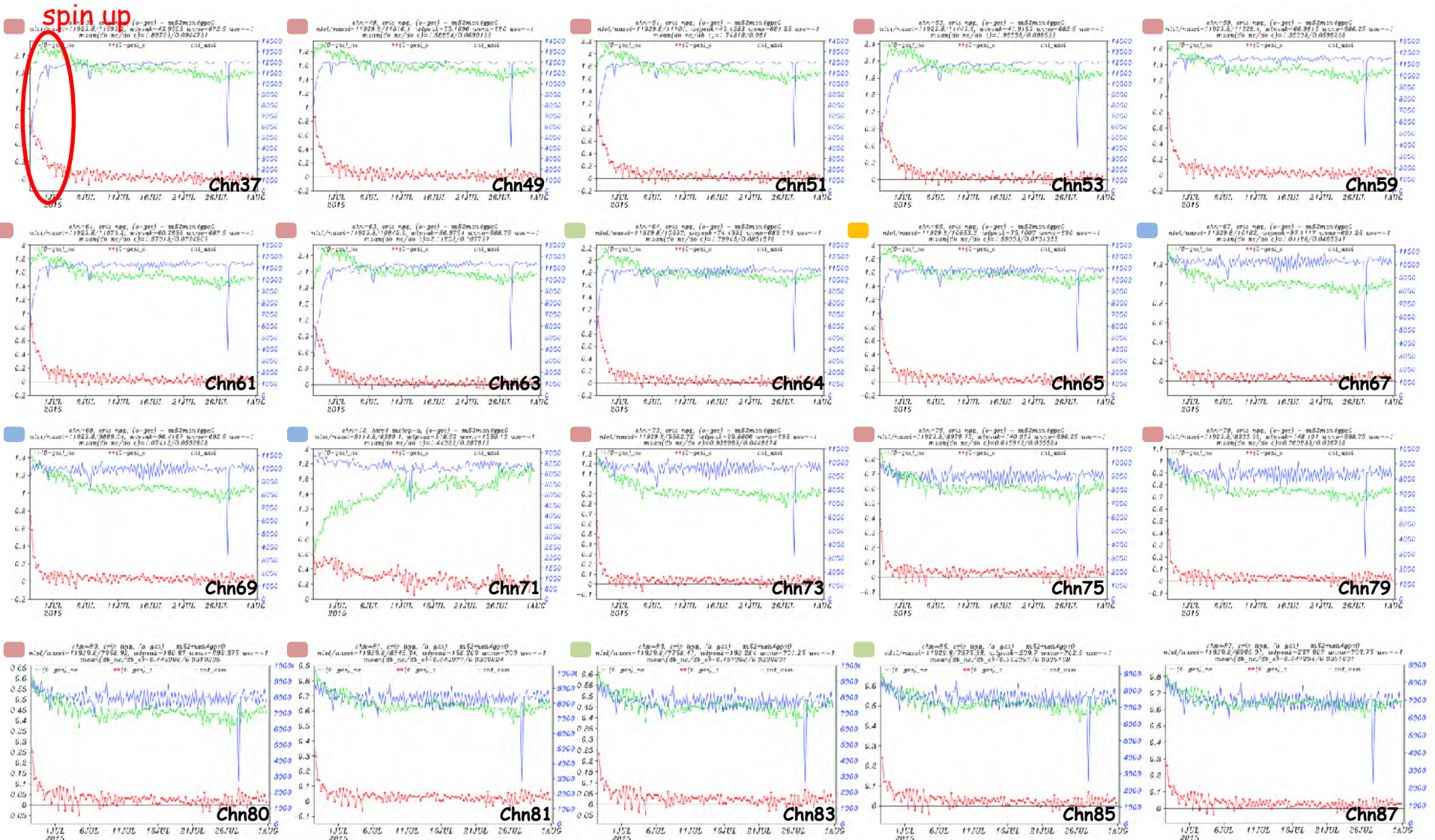


start from 15062700
Bin from -5 ~ 5 with interval=0.1

Gaussian distribution for all channels after 13-day update cycle

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CrIS_npp : (O-B)_nc v.s. (O-B)_c v.s. assimilated count - I



➤ start from 15062700
BIN from -5 ~ 5 with interval=0.1

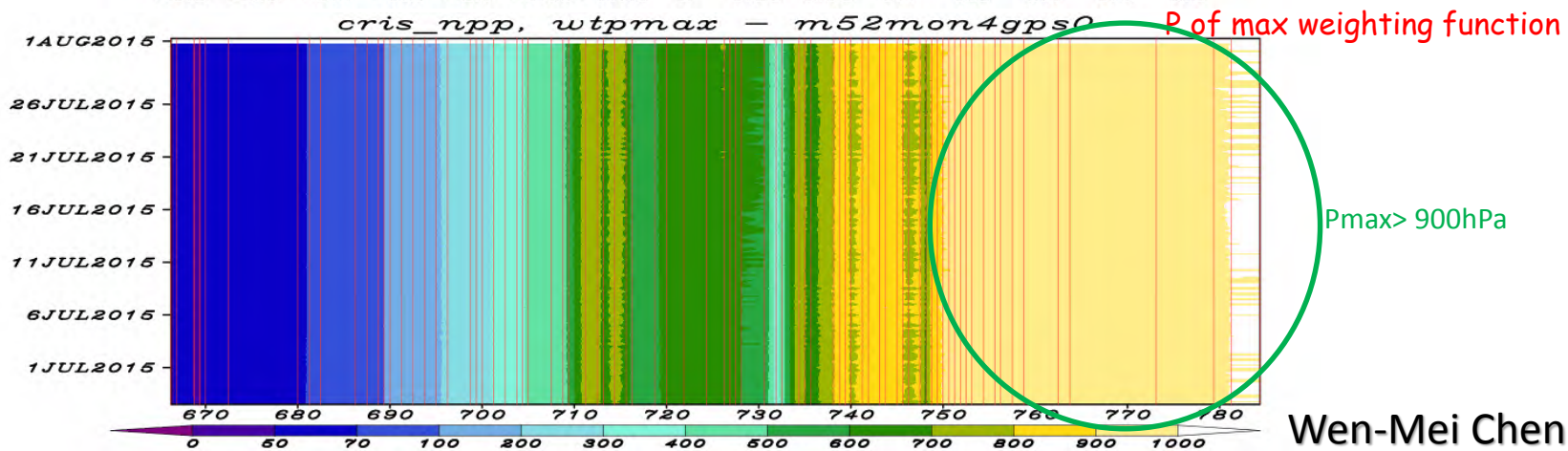
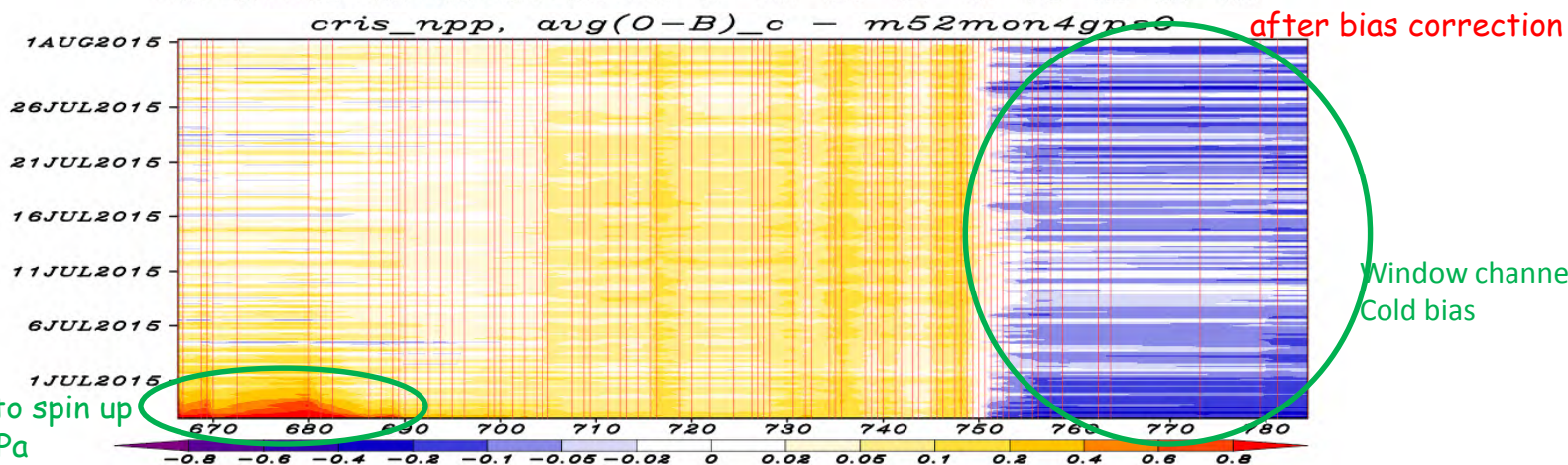
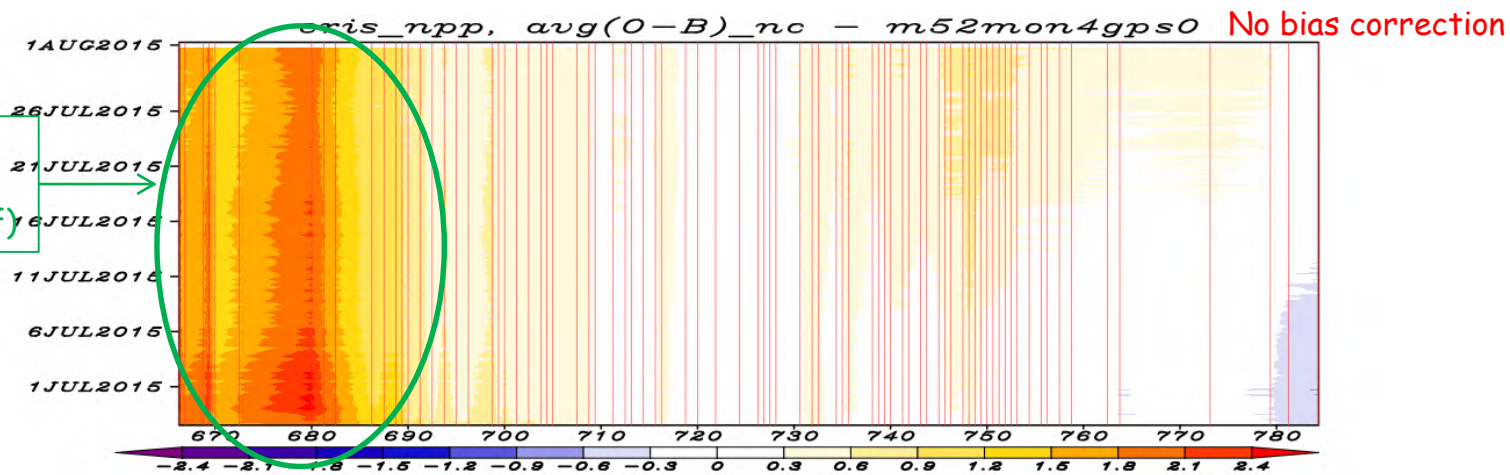
(O-B)_{nc} : (O-B) with no bias correction

(O-B)_c : (O-B) with bias correction

assimilated count : count of assimilated radiance observation

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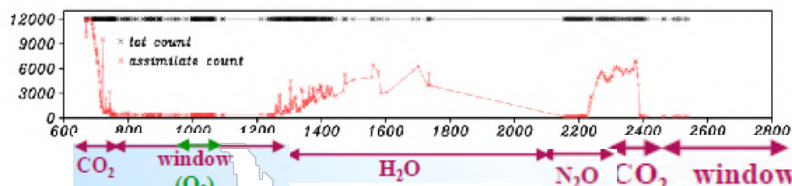
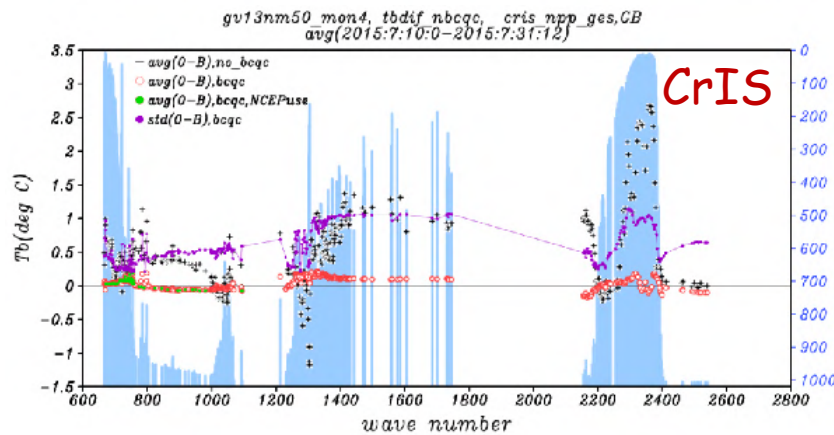
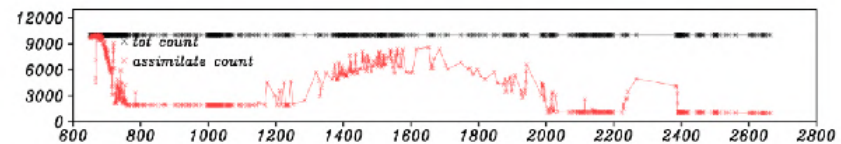
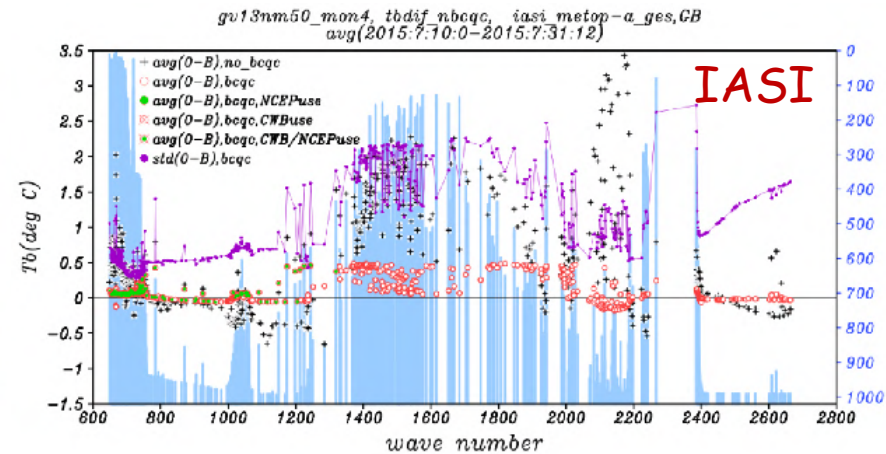
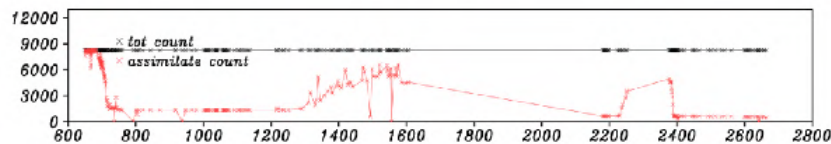
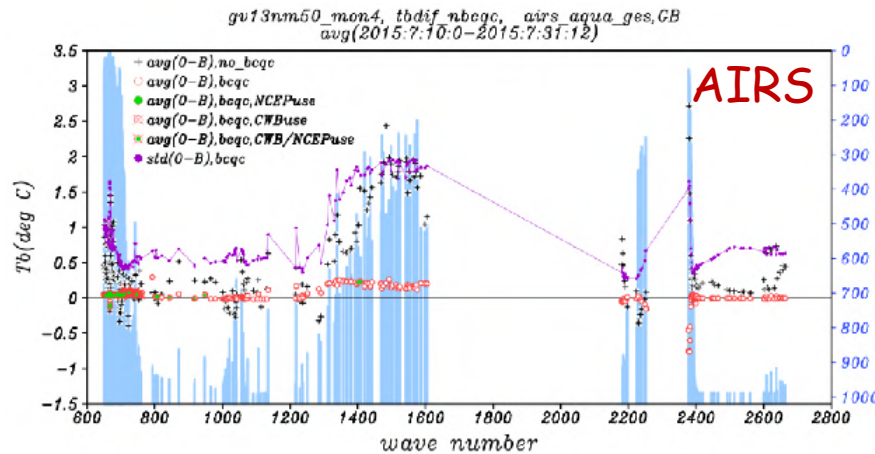
Large (O-f(B)),
From O? B? or
Forward model(f)



CrIS quality by CWBGFS 6hrs forecast
Compare with AIRS and IASI

AIRS/IASI/CrIS data quality - comparison with CWBGFS background

Average : 15071000-15073112



- + **avg(O-B),no_bcqc**
- o **avg(O-B),bcqc**
- **avg(O-B),bcqc,NCEPuse**
- ⊗ **avg(O-B),bcqc,CWBuse**
- ⊗ **avg(O-B),bcqc,CWB/NCEPuse**
- **std(O-B),bcqc**

pressure level at peak of weighting

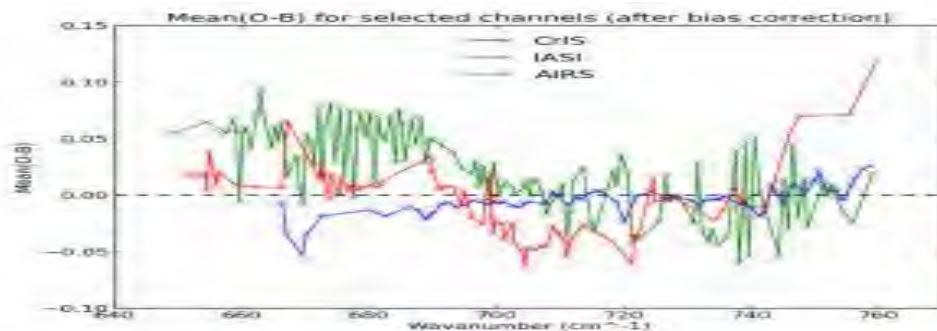
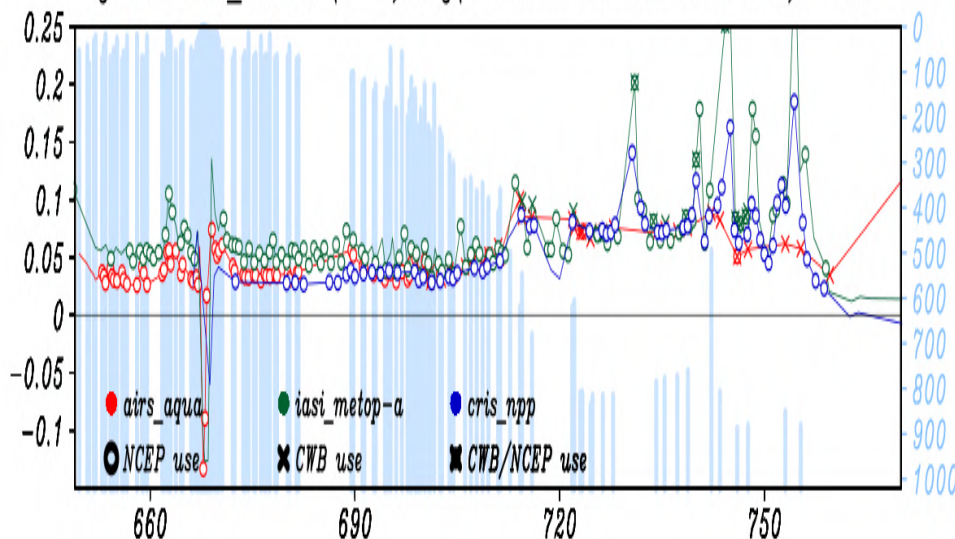
avg (O-B) => 0 for channels NCEP assimilated
=> experiment m52gps0crs1

AIRS/IASI/CrIS data quality - comparison with CWBGFS background

for LW CO₂ /Temperature channels, Average : 15071000-15073112

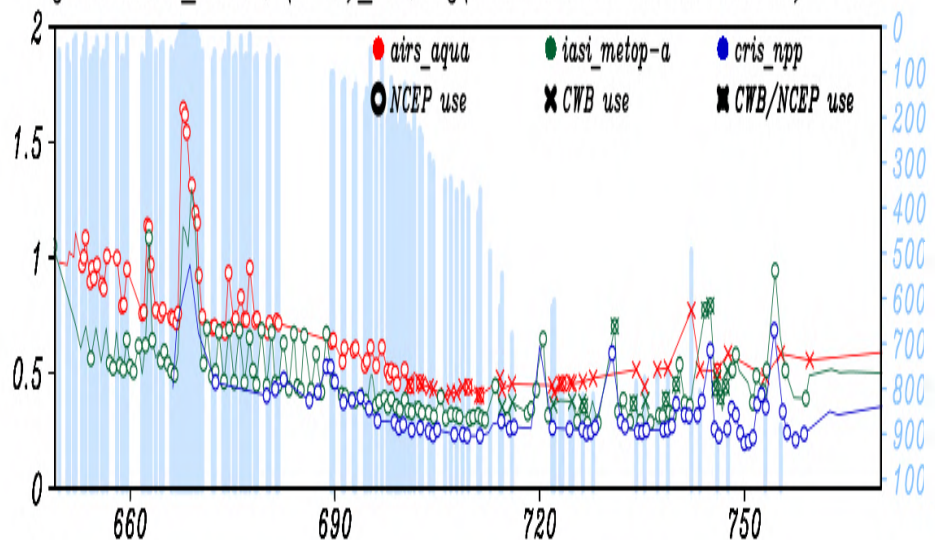
gv13nm50_mon4, (O-B), avg(2015:7:10:0-2015:7:31:12) - GB

UK

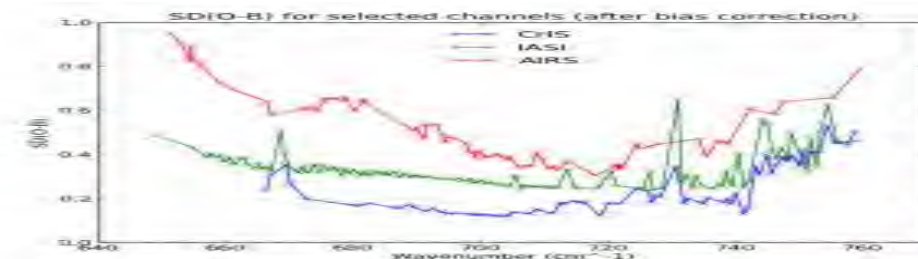


- Bias corrected data aggregated over a 3-month period.

gv13nm50_mon4, (O-B)_std, avg(2015:7:10:0-2015:7:31:12) - GB



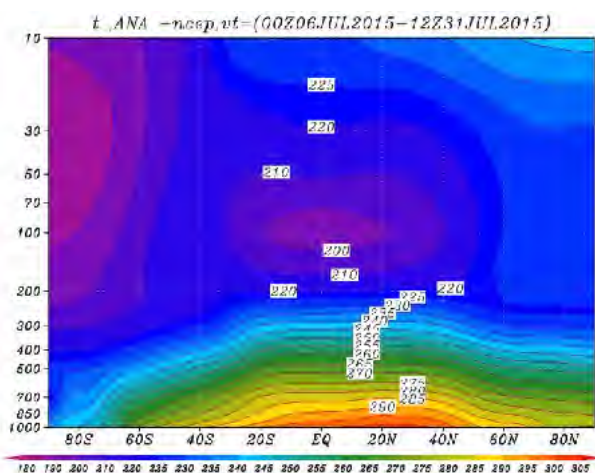
- Very small residual biases
- Unusual negative bias at low wavenumber (upper-level sounding channels)
- O-B as low as 0.15K in some channels, half that of IASI.



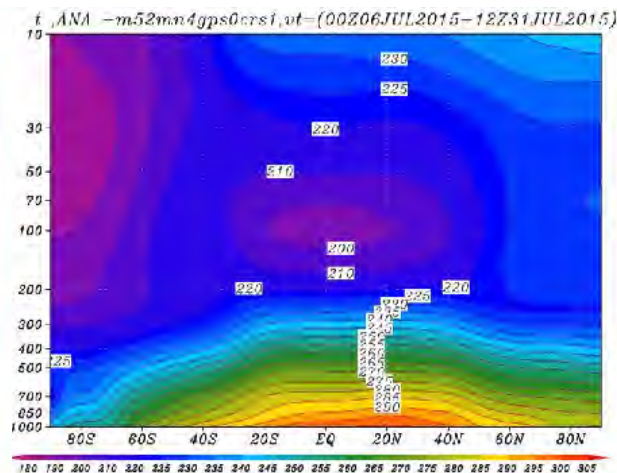
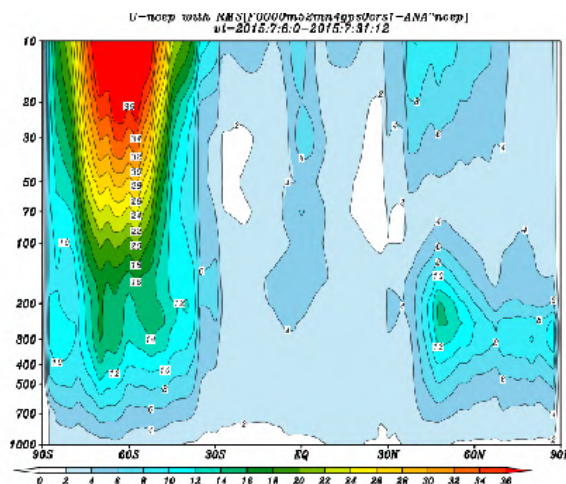
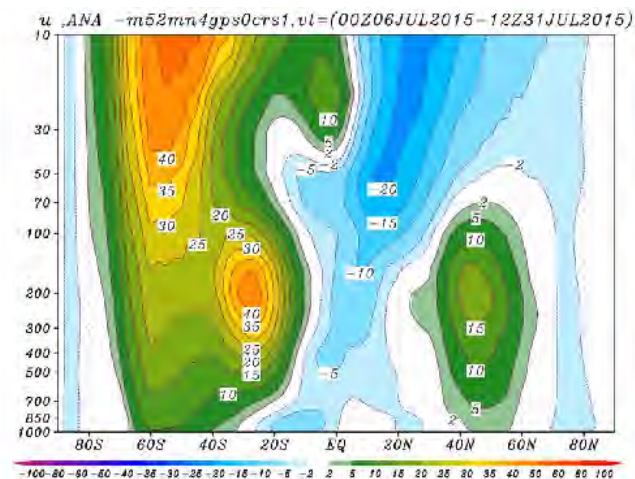
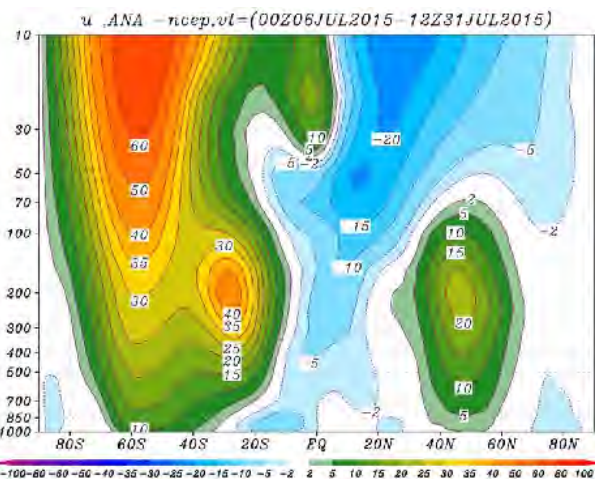
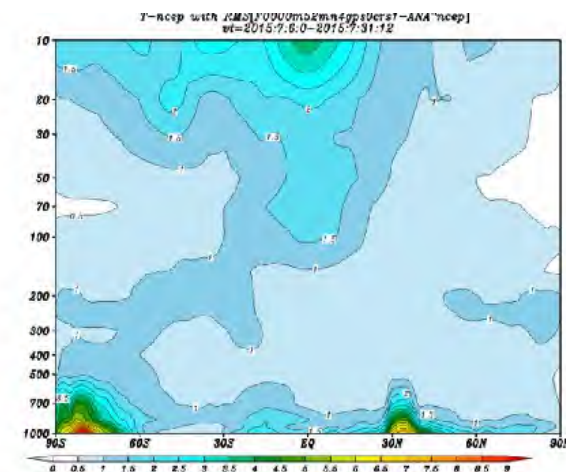
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T/U analysis zonal mean & diff_rms - m52gps0crs1 v.s. NCEP

NCEP analysis



gps0crs1 analysis


$$RMS_{(gp0crs1 \text{ analysis-NCEP})}$$


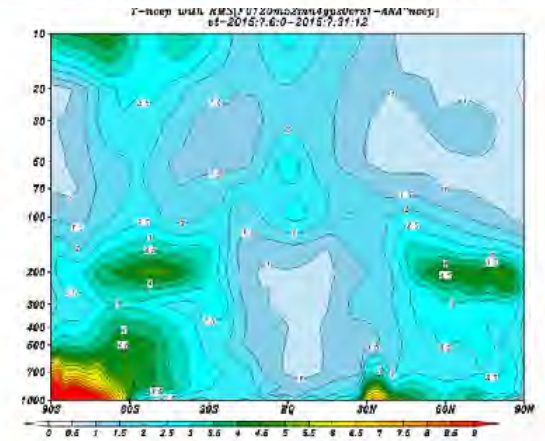
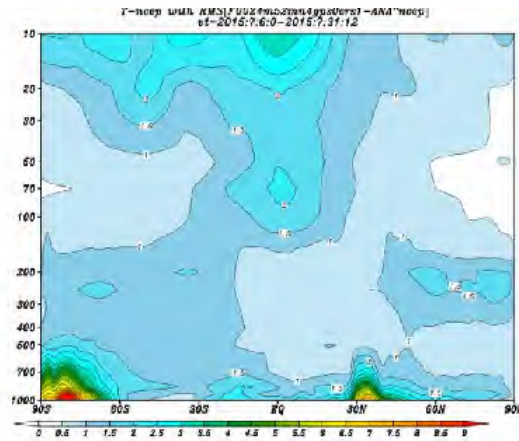
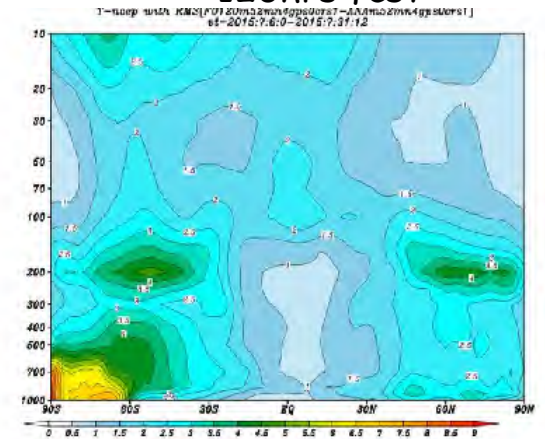
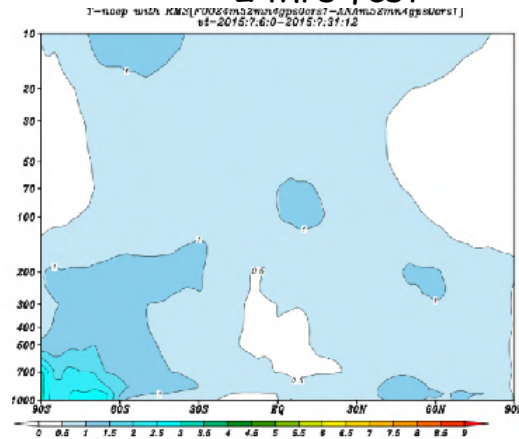
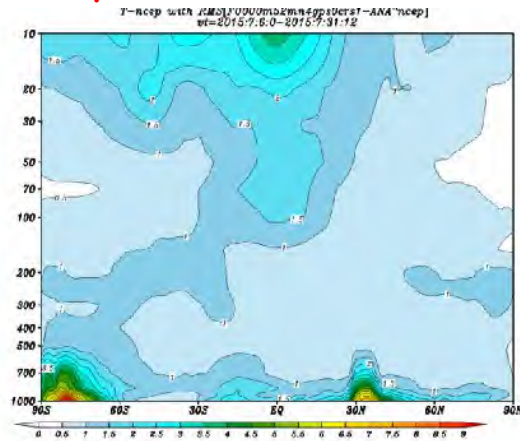
Temperature RMS(m52gps0crs1-ANAncep)

CWBGFS_byCWBana analysis

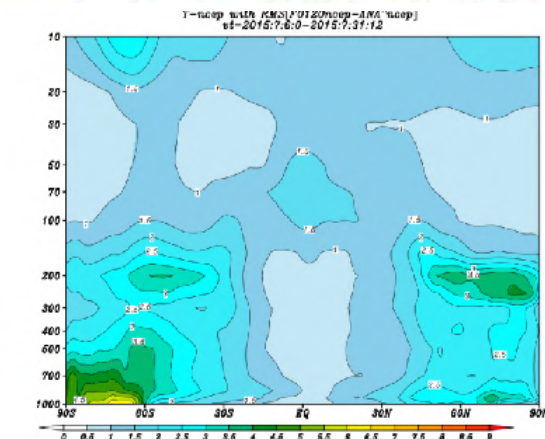
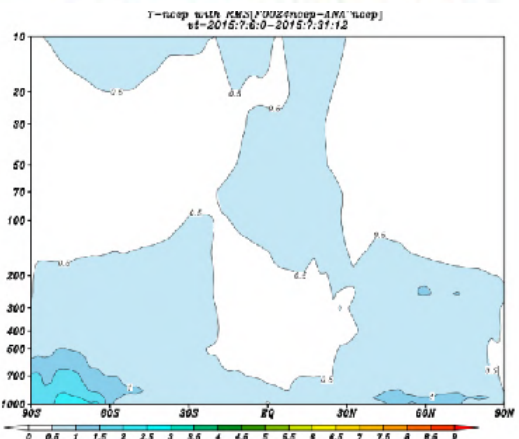
24hrs fcst

120hrs fcst

CWBGFS_byNCEPana



NCEP_byNCEPana

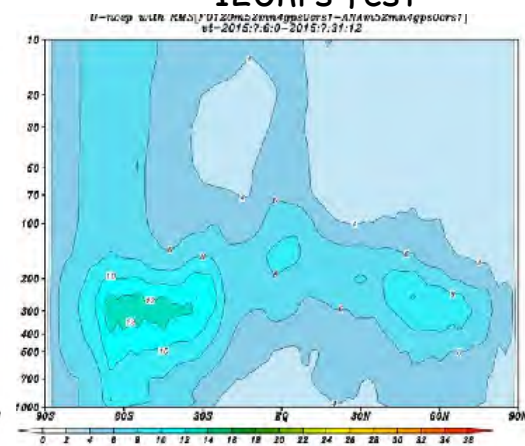
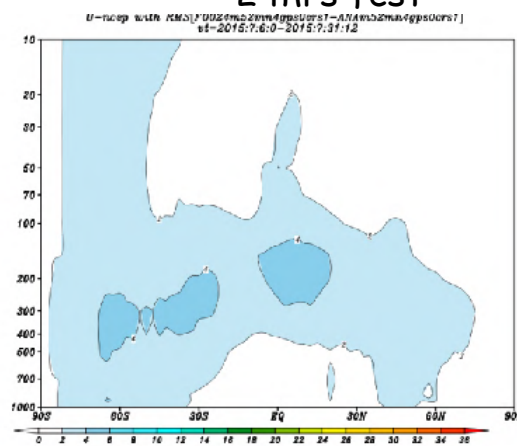


U-comp RMS(m52gps0crs1-ANAncep)

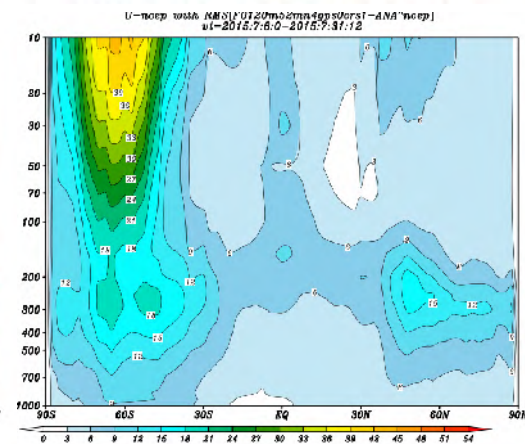
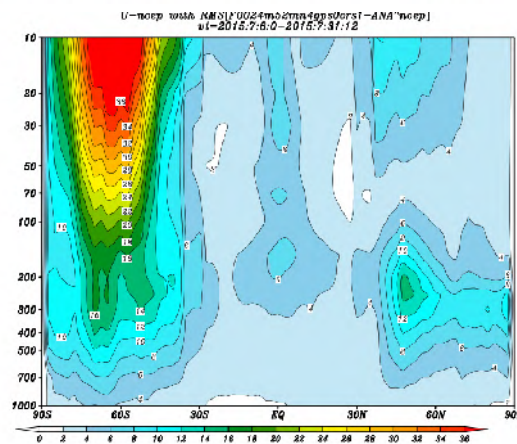
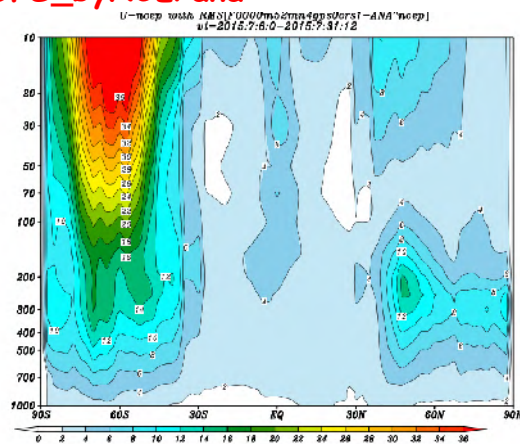
CWBGFS_byCWBana analysis

24hrs fcst

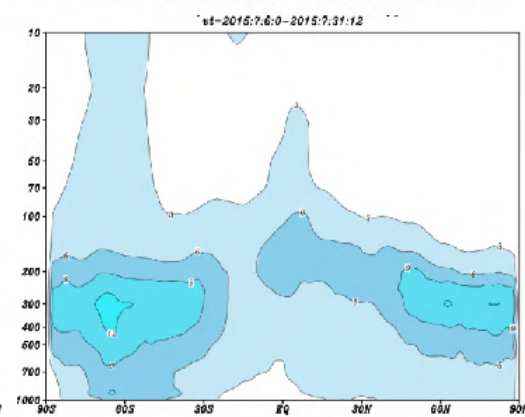
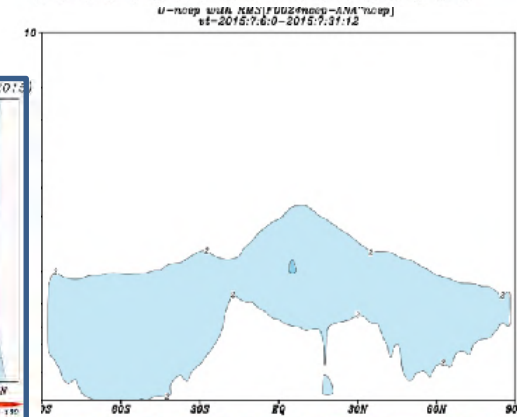
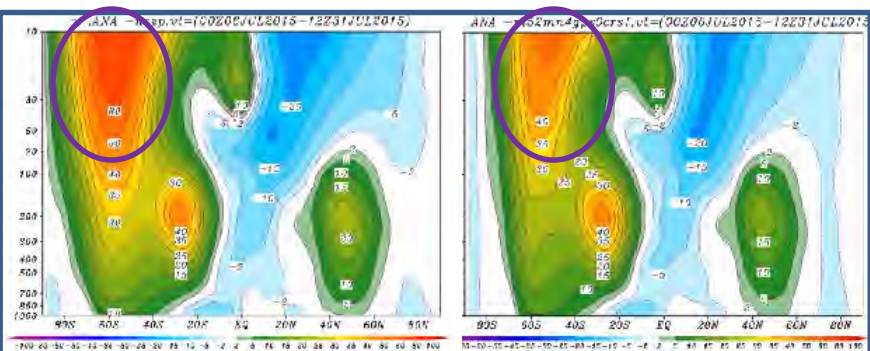
120hrs fcst



CWBGFS_byNCEPana



NCEP_byNCEPana



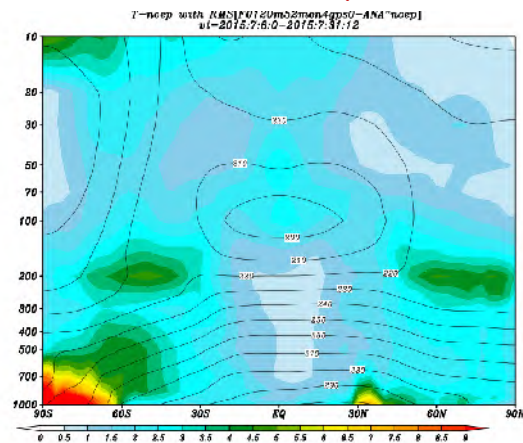
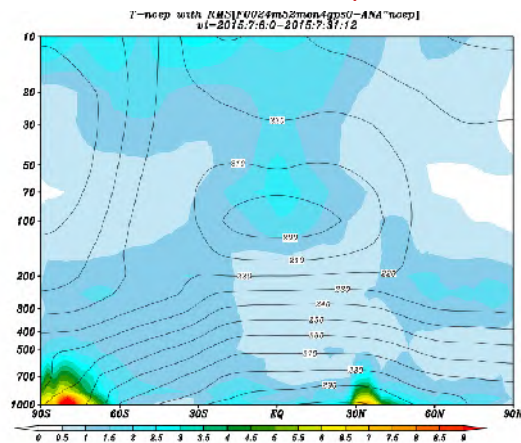
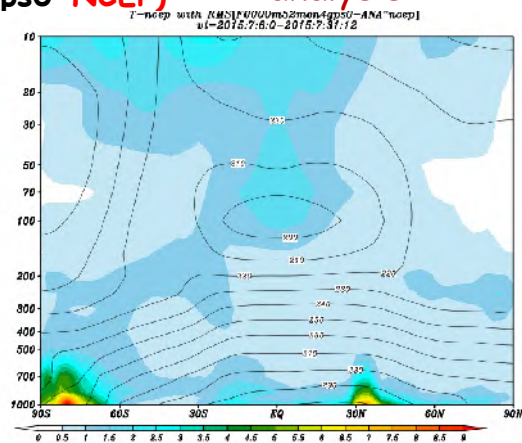
m52mn4gps0crs1 v.s. control run (m52mon4gps0) - Temperature RMS

(m52gps0-NCEP)

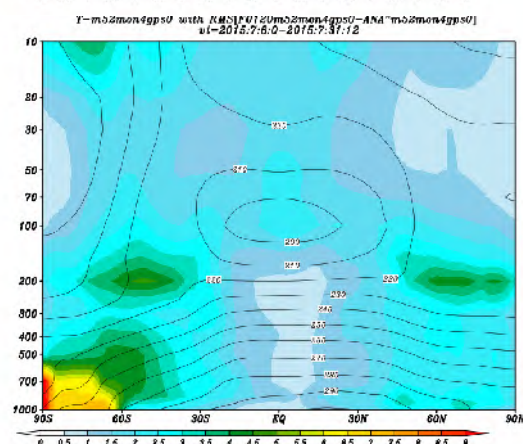
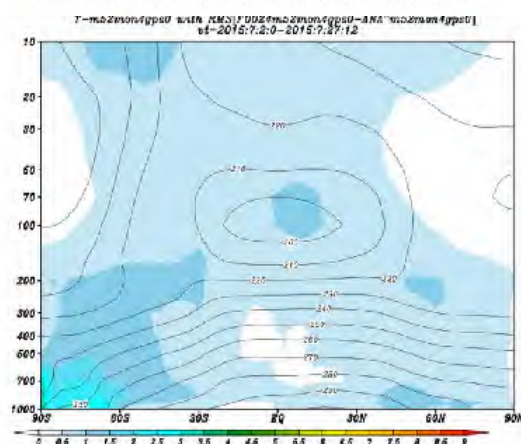
analysis

24hrs fcst

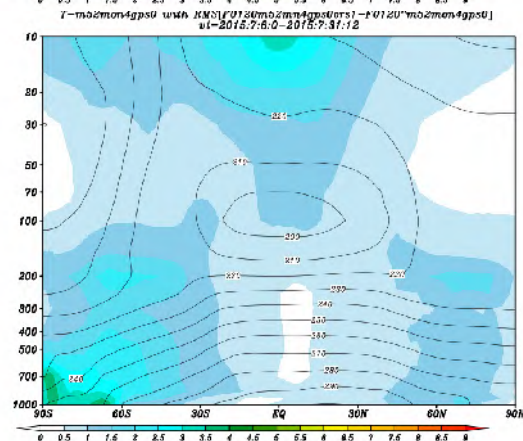
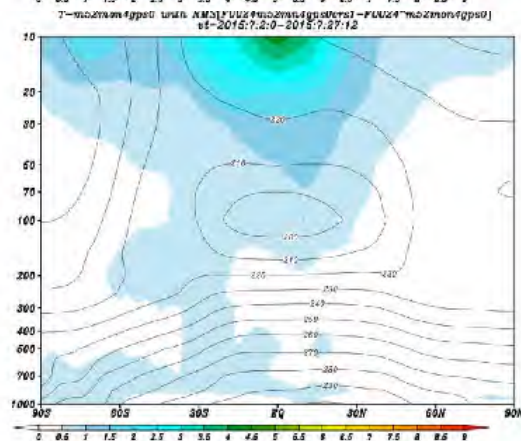
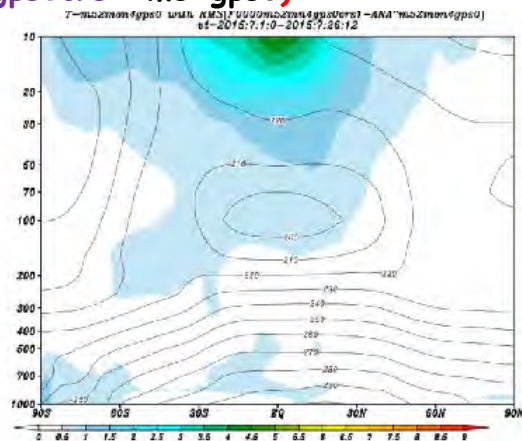
120hrs fcst



m52gps0 (fcst-analysis)

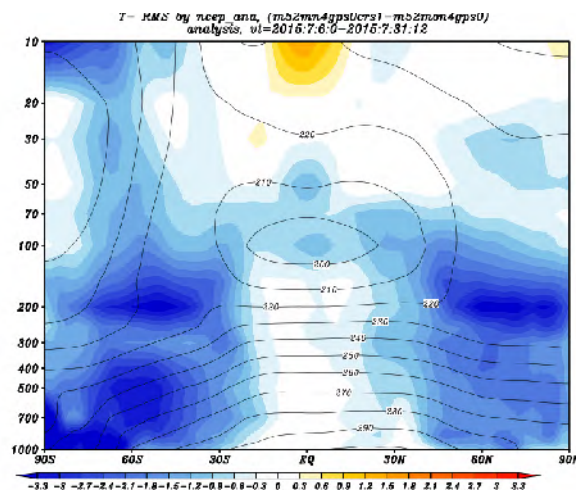


(m52gps0crs1-m52gps0)

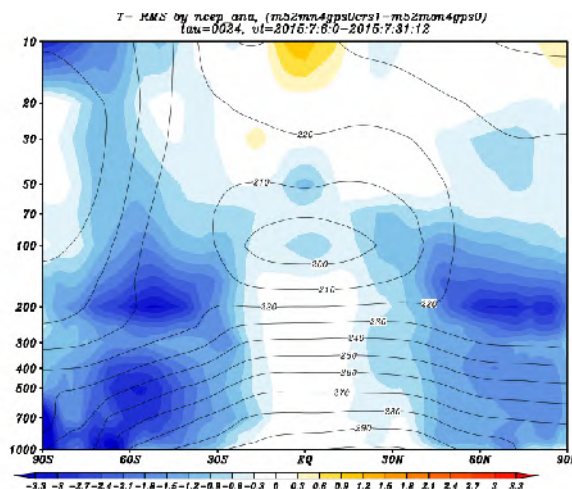


Temperature : (m52gps0crs1-NCEP)_{RMS}-(m52gps0-NCEP)_{RMS}

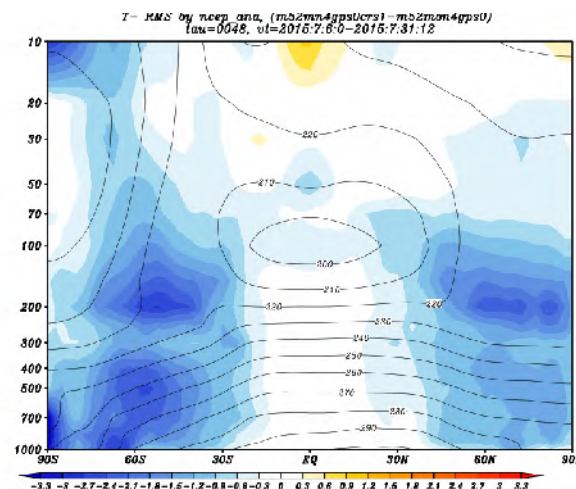
analysis



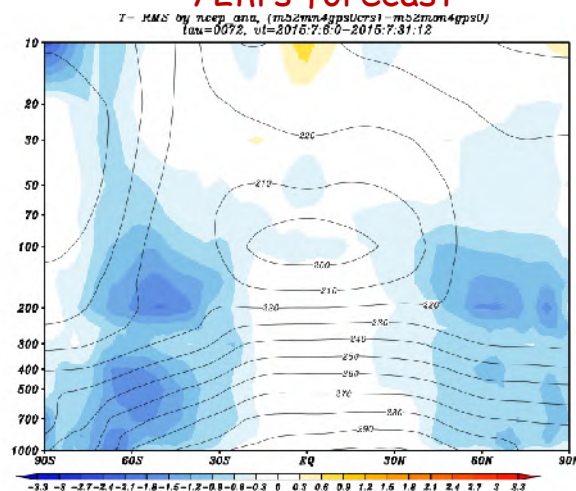
24hrs forecast



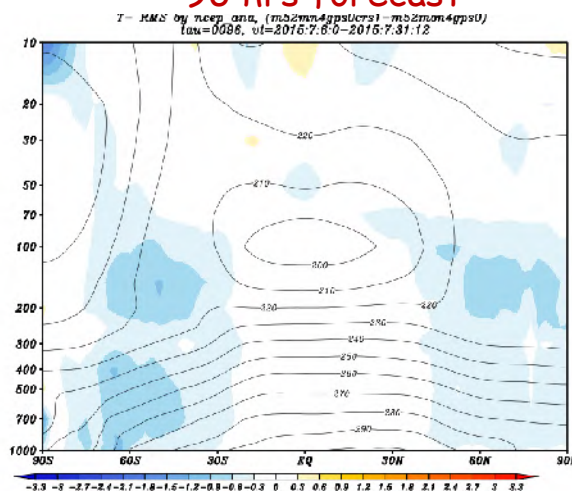
48hrs forecast



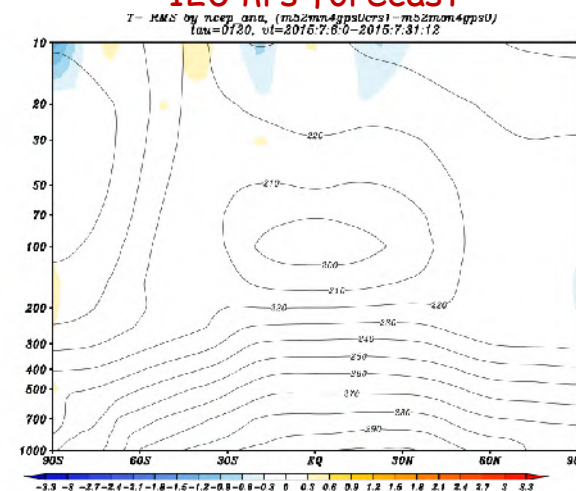
72hrs forecast



96 hrs forecast

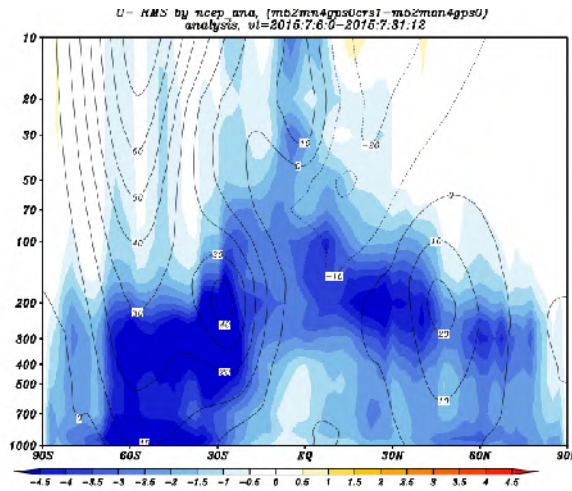


120 hrs forecast

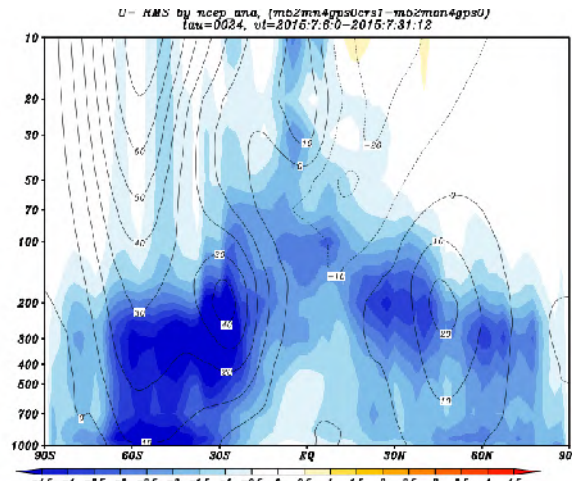


U-comp : (m52gps0crs1-NCEP)_{RMS}-(m52gps0-NCEP)_{RMS}

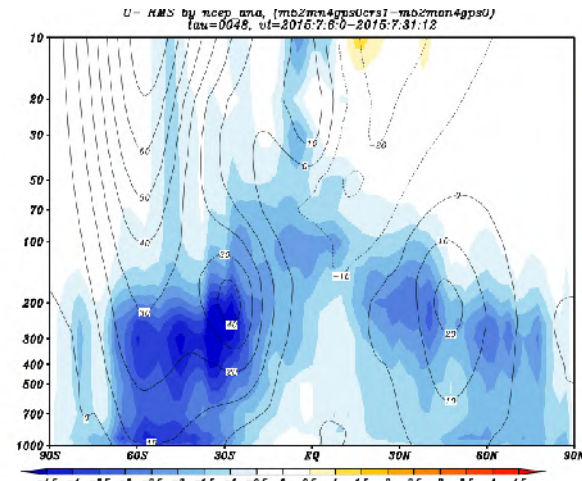
analysis



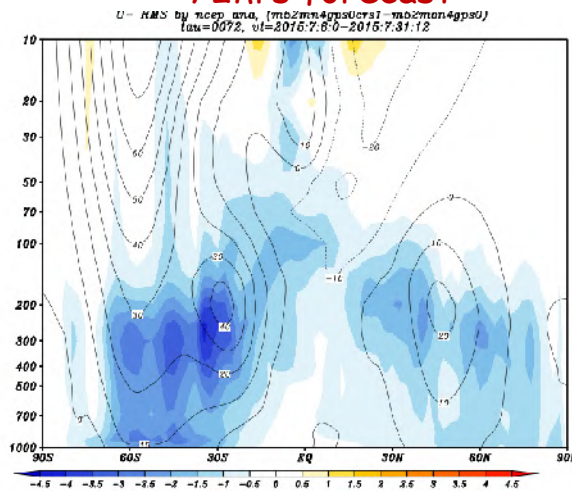
24hrs forecast



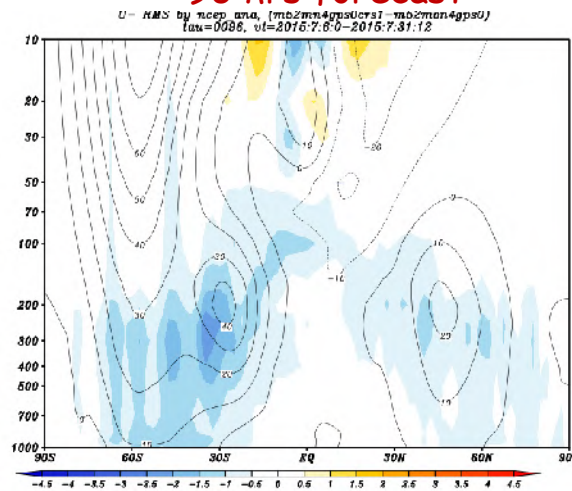
48hrs forecast



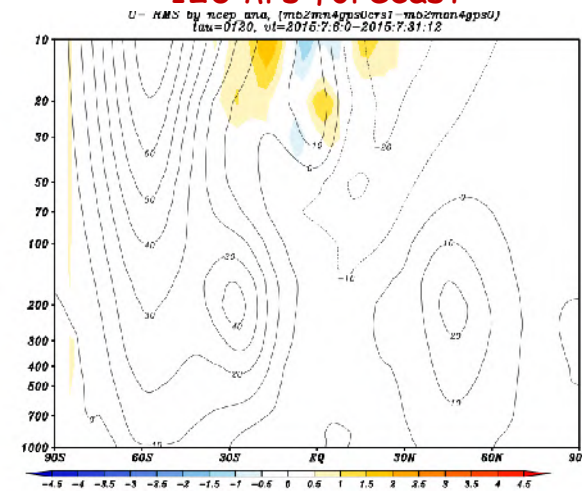
72hrs forecast



96 hrs forecast

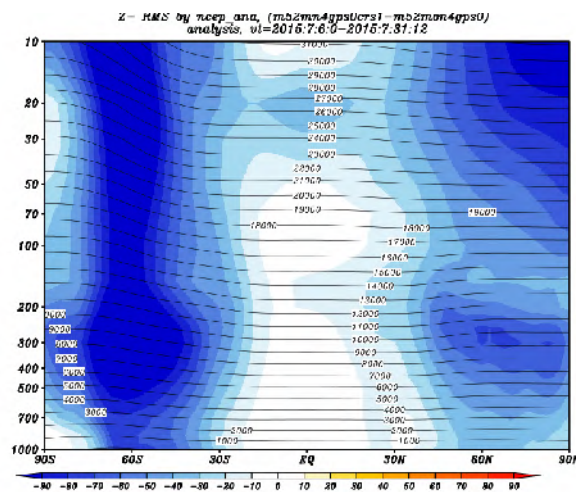


120 hrs forecast

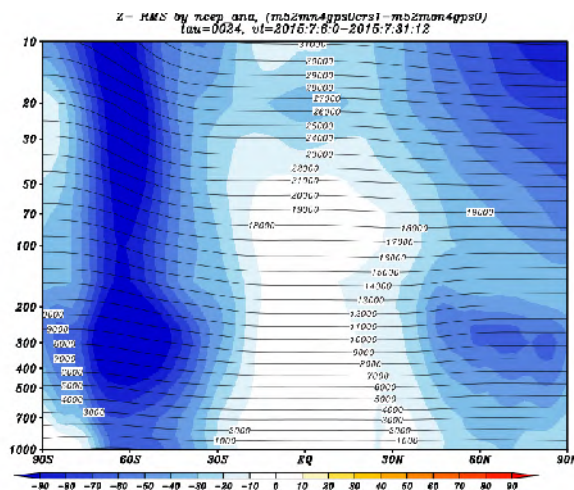


Height : (m52gps0crs1-NCEP)_{RMS}-(m52gps0-NCEP)_{RMS}

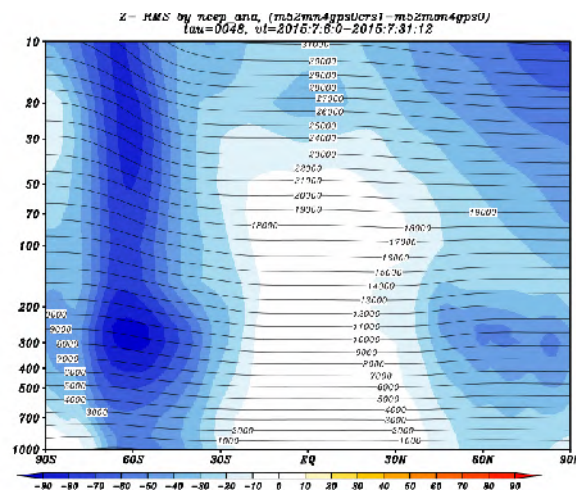
analysis



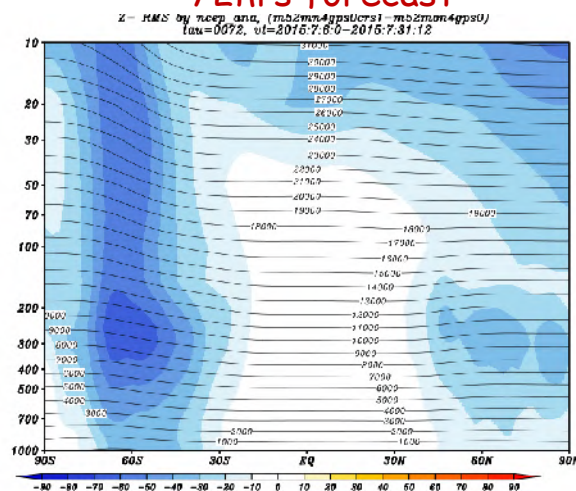
24hrs forecast



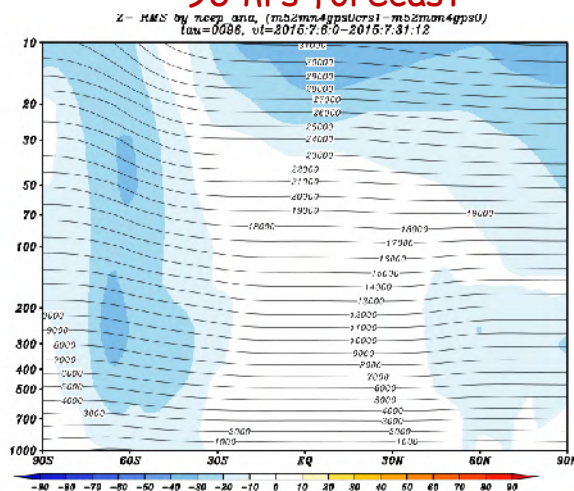
48hrs forecast



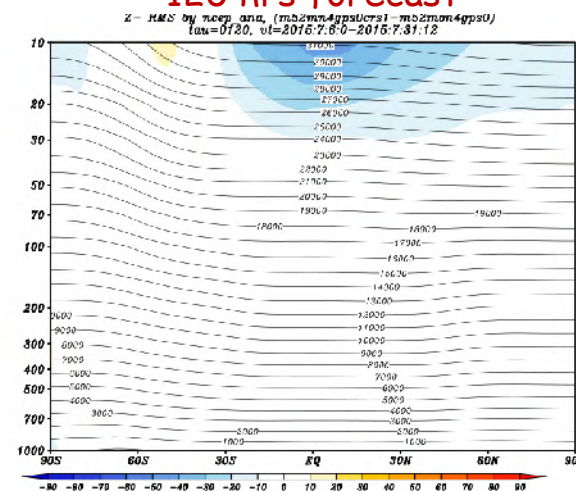
72hrs forecast



96 hrs forecast

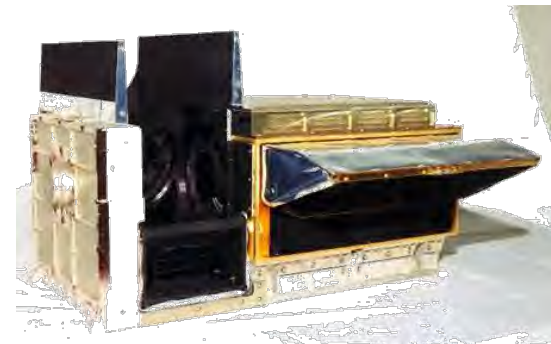


120 hrs forecast



Impact of HIRS4_metop-A on CWB T511L60 system

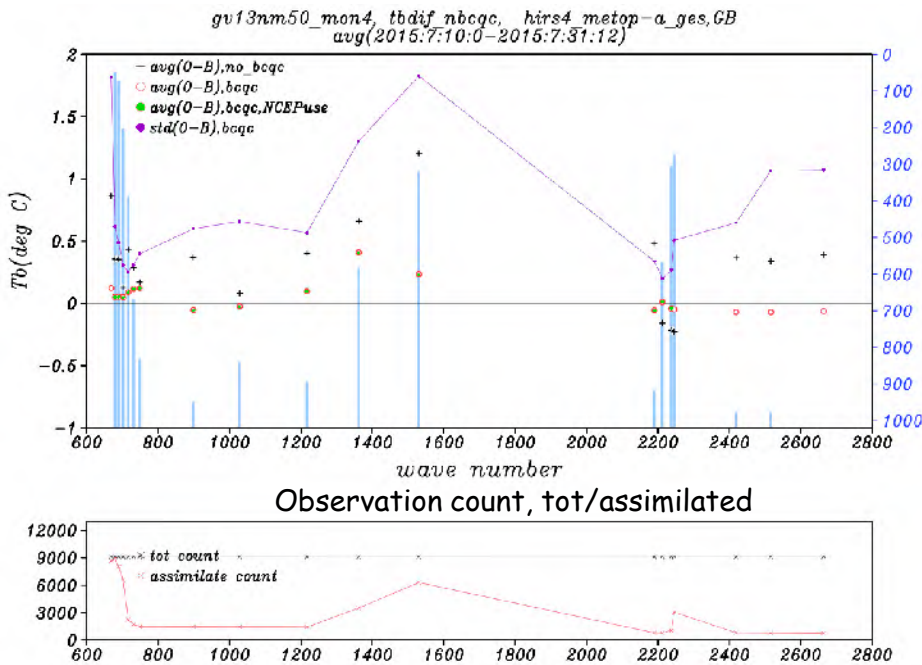
- HIRS4 - High Resolution Infrared Radiation Sounder
- 20 spectral bands
 - one visible channel. IFOV 1.4°
 - 7 shortwave infrared (IR) channels. IFOV 1.4°
 - 12 longwave IR channels. IFOV 1.3°
- Vertical temperature profile and pressure from surface to 40 KM.
- orbital altitude 833KM.
- NOAA18 、 19 , METOP-A/B
- Metop-A (2006/10 launched)



from : EUMETSAT website

Impact of HIRS4_metop-A on CWB T511L60 system

avg(15071000-3118)



Experiments :

1. Temperature

$ABS(avg(O-B)) \leq 0.05$ and $avg(O-B)_{STD} \leq 0.5$
 $\Rightarrow$ chn 3,4,14,15,16 exp m52gps0hr4AT

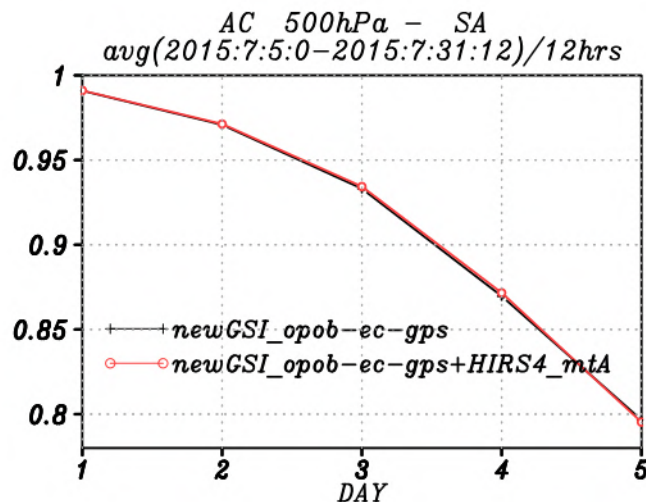
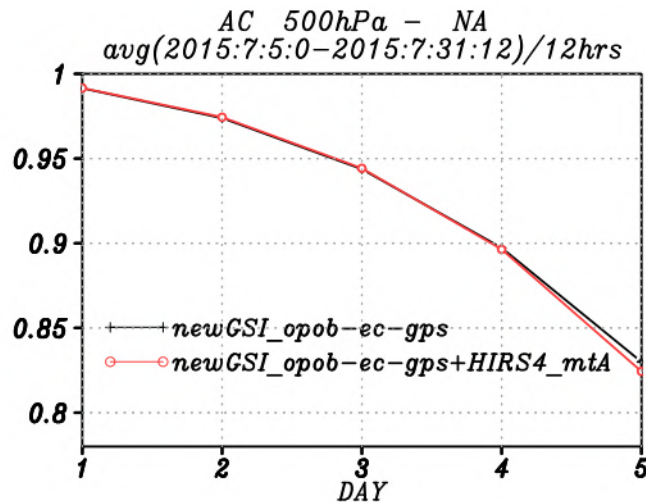
2. Moisture

chn 10,11,12 (exp m52gps0hr4Aq)

(qcmak=0 and $0 < tbobs < 1e+8$) $\Rightarrow$ qcbc

ob	Channel	USE _{ncep}	P _{wmax}	(O-B)	(O-B)_std
T	1	-1	30mb	0.12	1.81
	2	1	60	0.05	0.62
	3	1	100	0.05	0.49
	4	1	400	0.05	0.31
	5	1	600	0.09	0.25
	6	1	800	0.12	0.31
	7	1	900	0.12	0.40
T _s	8	1	surface	-0.05	0.60
O ₃	9	1	25	0.02	0.66
q	10	1	900	0.10	0.57
	11	1	700	0.41	1.30
	12	1	500	0.23	1.83
T	13	1	1000	-0.06	0.34
	14	1	950	0.01	0.20
	15	1	700	-0.04	0.27
	16	-1	400	-0.05	0.51
	17	-1	5	-0.07	0.65
T _s	18	-1	surface	-0.07	1.07
	19	-1	surface	0.49	1.08

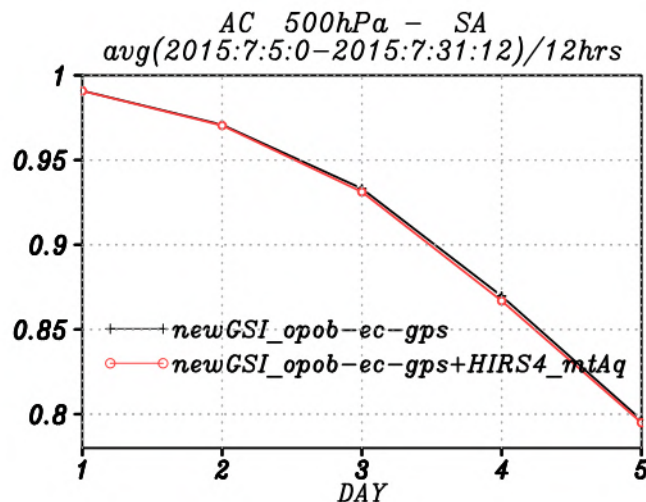
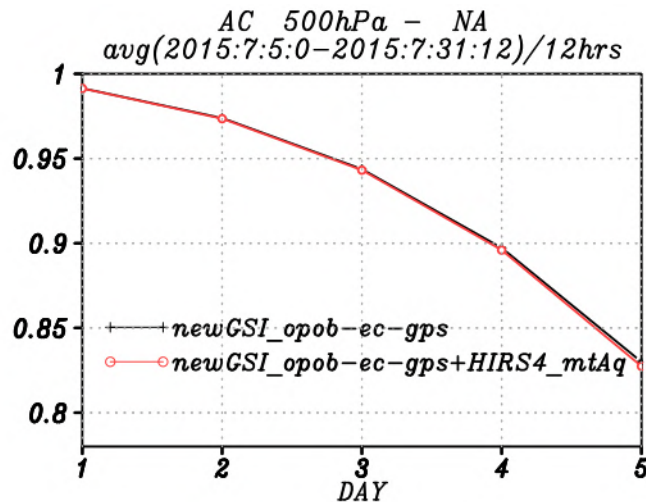
impact of **HIRS4_metop-AT** on T511L60 system(newGSI) - I



- Observations assimilated for control run (newGSI_opob-ec-gps):
assimilated by operation except ECgrid and gpsro_ref
(i.e. conventional observation + radiance(AMSU-A+IASI+AIRS+ATMS))
- GSI : new GSI (NCEP 1605 operated)
- GFS system : T511L60 (gfsv5.2)
- experiment period : 15062700-15073112
verified preiod : 15070200-15073112 (by own analysis)
- results :
N. Hemisphere : slightly negative impact for day5 forecast.
S. Hemisphere : neutral

experiment	description
newGSI_opob-ec-gps	newGSI, no gps_ref
newGSI_opob-ec-gps+HIRS4_mtA	same as newGSI_opob-ec-gps with HIRS4_metopA obs assimilated (temperature channels : chn3,4 and 14,15,16 assimilated)

impact of **HIRS4_metop-Aq** on T511L60 system(newGSI) - I

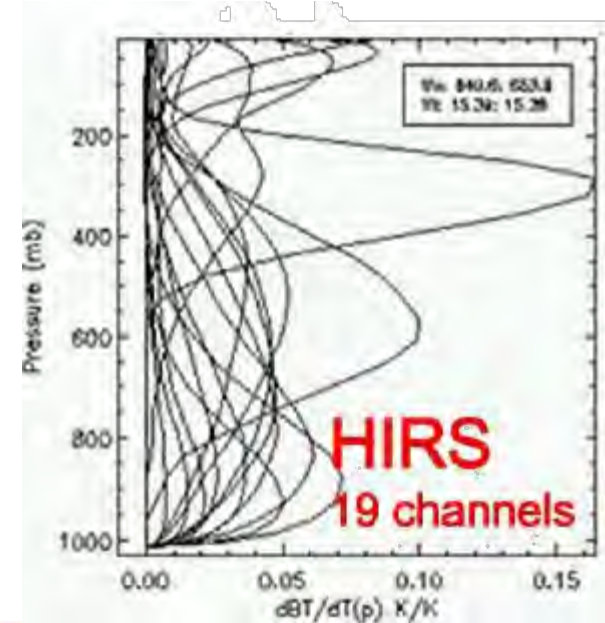


- Observations assimilated for control run (newGSI_opob-ec-gps):
assimilated by operation except ECgrid and gpsro_ref
(i.e. conventional observation + radiance(AMSU-A+IASI+AIRS+ATMS))
- GSI : new GSI (NCEP 1605 operated)
- GFS system : T511L60 (gfsv5.2)
- experiment period : 15062700-15073112
verified preiod : 15070200-15073112 (by own analysis)
- results :
neutral

experiment	description
newGSI_opob-ec-gps	newGSI, no gps_ref
newGSI_opob-ec-gps+HIRS4_mtAq	same as newGSI_opob-ec-gps with HIRS4_metopA obs assimilated (moisture channels : chn10,11,12 assimilated)

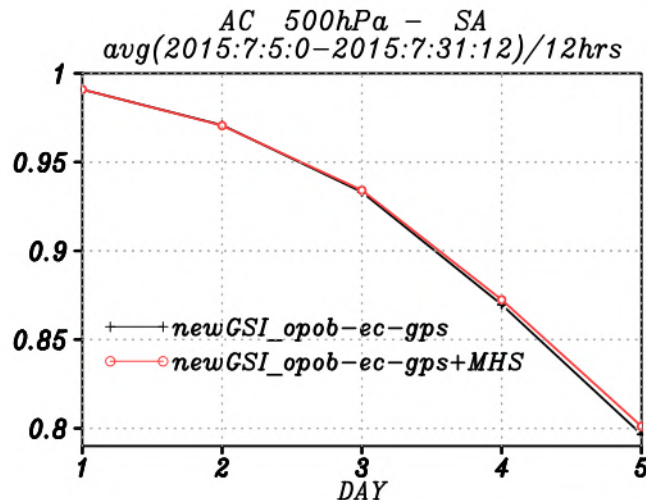
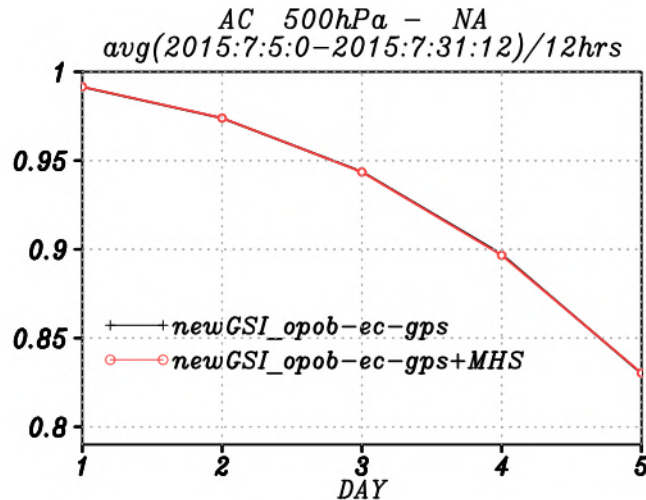
Impact of MHS on CWB T511L60 systemnewGSI (exp **m52gps0mhs**, **satellite n18/n19/metop-a/metop-b**)

- MHS - The Microwave Humidity Sounder
- cross-track scanning
 - five-channel microwave
 - full-power radiometer
 - operating in the 89 to 190 GHz region
- $\pm 49.44^\circ$ from the nadir
- Width of swath : $\pm 1089\text{km}$
- IFOV size at Nadir : 16 km



impact of **MHS** on T511L60 system(newGSI) – I

Summer month(1507)



- Observations assimilated for control run (newGSI_opob-ec-gps):
assimilated by operation except ECgrid and gpsro_ref
(i.e. conventional observation + radiance(AMSU-A+IASI+AIRS+ATMS))
- GSI : new GSI (NCEP 1605 operated)
- GFS system : T511L60 (gfsv5.2)
- experiment period : 15062700-15073112
verified preiod : 15070500-15073112 (by own analysis)
- results :
neutral

experiment	description
newGSI_opob-ec-gps	newGSI, no gps_ref
newGSI_opob-ec-gps+MHS	same as newGSI_opob-ec-gps with MHS obs assimilated (noaa18/noaa19/metop-a/metop-b)

小結

- 使用GPSRO偏折角在36組成員3d EnVar下南北半球positive，但熱帶地區高度場RMSE則為negative
- CrIS需要spin up 之時間，資料品質相對於IASI與AIRS較穩定，在pure 3dvar下對預報為中性略positive
- HIRS使用水氣頻道，在pure 3dvar下對預報為中性，溫度頻道則北半球中性略negative
- MHS在pure 3dvar下對預報為中性

CWB GFS使用資料種類

Cases	Operational	Operational + Rest	Operational + Rest + Extra
No. of Bufr Files	6	10	17
List of Bufr Files	<pre> prepbuf amsuabuf gpsrobuf airsbuf iasibuf Atmsbuf </pre>	<pre> prepbuf amsuabuf gpsrobuf airsbuf iasibuf atmsbuf hirs4buf mhsbuf gsnd1buf sbuvbuf </pre>	<pre> prepbuf amsuabuf gpsrobuf airsbuf iasibuf atmsbuf hirs4buf mhsbuf gsnd1buf sbuvbuf crisbuf hirs3buf gomebuf satwndbuf seviribuf ssmisbuf gingrbuf </pre>

預計上線之衛星資料使用說明

預計上線之衛星資料使用說明

衛星風

	operation	2018 plan	channels
satwnd	HIMAWARI-8 METEOSAT-9	HIMAWARI-8、9 METEOSAT-8、11	IR,VIS,WV VIS,WV
	GOES-13、15 AQUA TERRA	GOES-15、16 AQUA TERRA METOP-2(A) METOP-1(B) NOAA-15、16、18 19	IR,WV IR,WV IR,WV IR IR IR

預計上線之衛星資料使用說明

Radiance

	Operation	2018 plan
AMSU-A(MW)	NOAA-15、18、19 METOP-A AQUA	NOAA-15、18、19 METOP-A METOP-B AQUA
ATMS(MW)	Suomi NPP	Suomi NPP
AIRS(IR)	AQUA(only use 35 chan.)	AQUA(use 118 chan.)
IASI(IR)	METOP-A(only use 23 chan.)	METOP-A(use 165 chan.) METOP-B(use 165 chan.)

預計上線之衛星資料使用說明

Radiance(續)

	Operation	2018 plan
CrIS(radiance)	X	Suomi NPP
SEVIRI(radiance)	X	METEOSAT-10
GOES-sndrd1-4(radiance)	X	GOES-15
SSMIS(radiance)	X	F17 、 F18
MHS(Microwave humidity Sounder)	X	METOP-A 、 B NOAA-18 、 19

臭氧的使用

	operation	2018 plan
GOME(ozone)	X	METOP-A、B
SBUV/2(ozone)	X	NOAA-19

- 臭氧資料資訊，為radiance data thinning、偏差訂正重要資訊

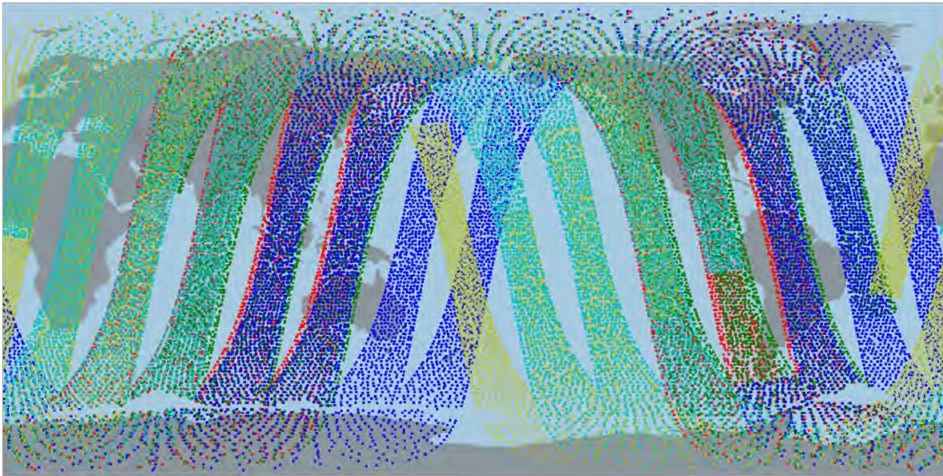
預計上線之衛星資料使用說明

GPSRO

	operation	2018 plan
RO data type	refractivity	Bending Angle
Altitude	30Km	50Km
GPSRO	METOP-A COSMIC TerraSAR-X	METOP-A METOP-B COSMIC TerraSAR-X COSMIC-2 GRACEB TanDEM-X

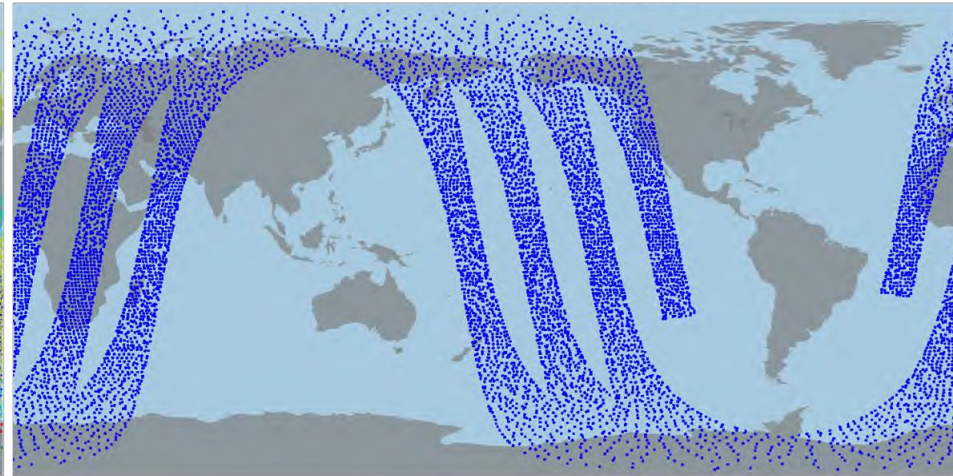
Assimilated Observations - Satellite

2017043000 AMSU-A Assimilated



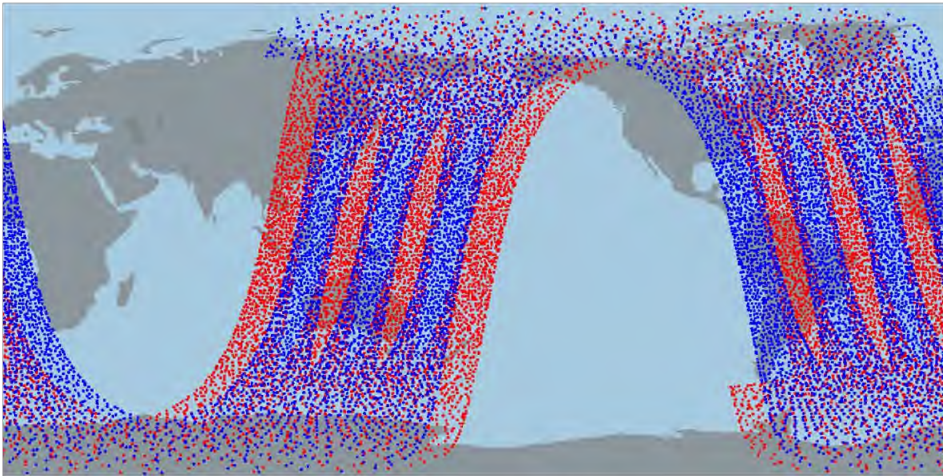
• NOAA-15 - 77604 • NOAA-18 - 90528 • METOP-A - 82409 • AQUA - 51911 • NOAA-19 - 84735

2017043000 AIRS Assimilated



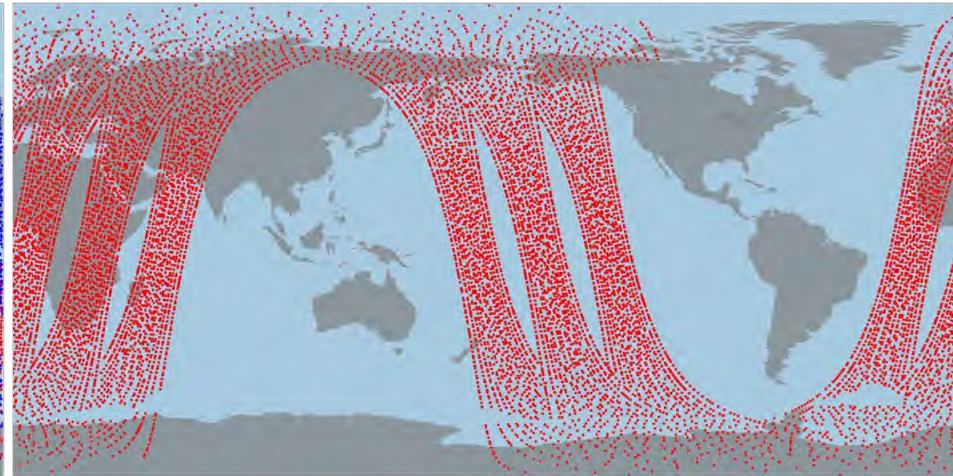
• AQUA - 542067

2017043000 IASI Assimilated



• METOP-A - 949181 • METOP-B - 920537

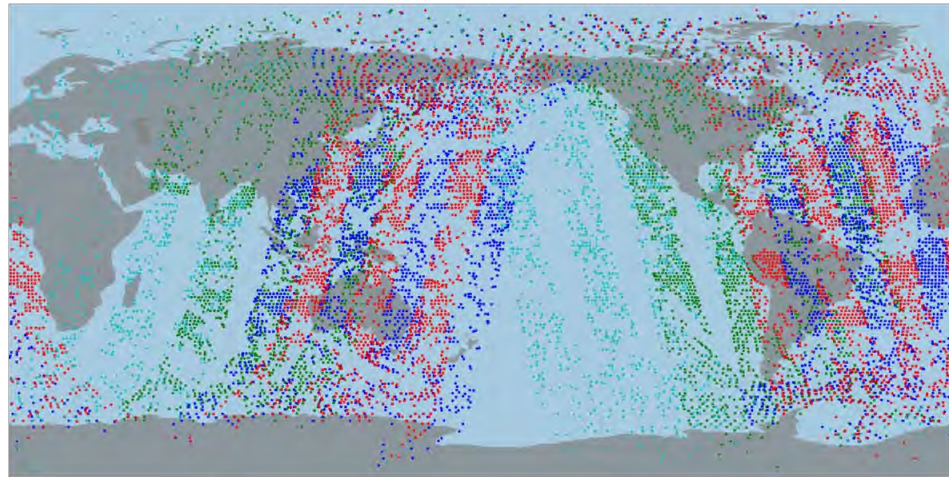
2017043000 ATMS Assimilated



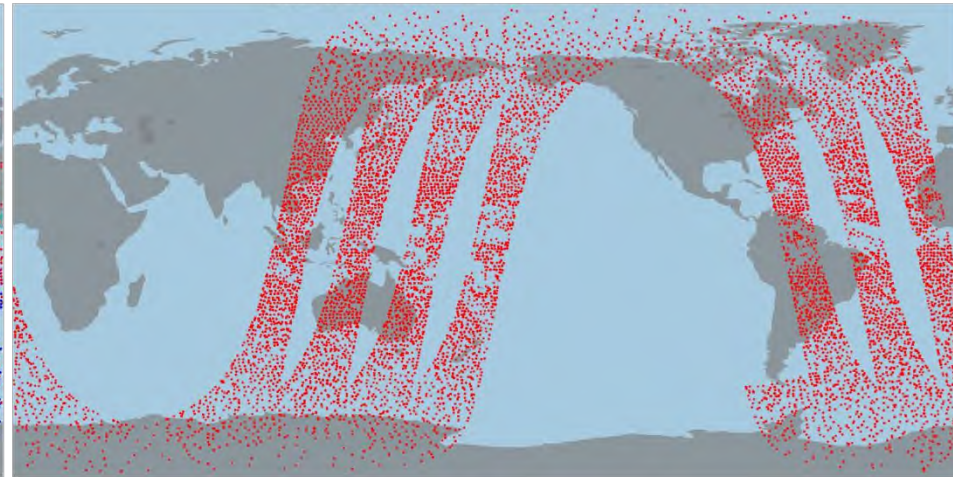
• Suomi NPP - 139427

Assimilated Observations - Satellite

2017043000 MHS Assimilated



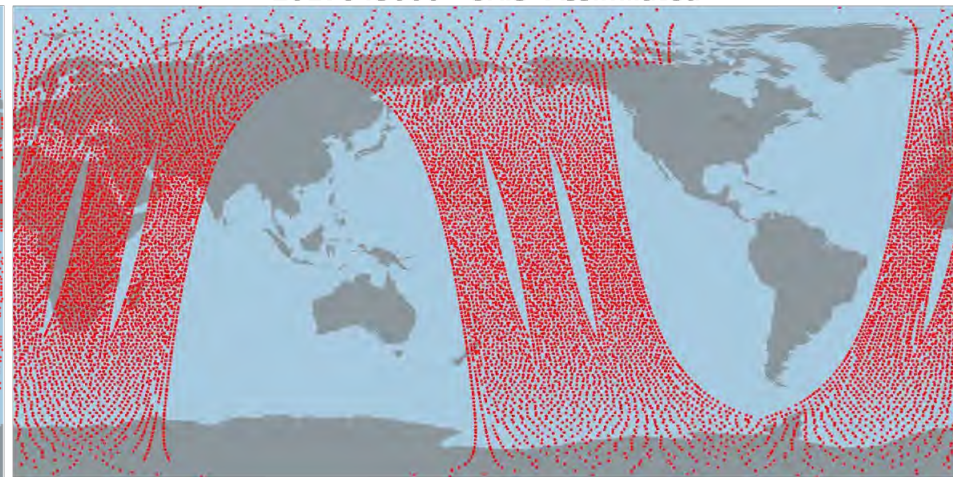
2017043000 HIRS4 Assimilated



2017043000 SEVIRI Assimilated

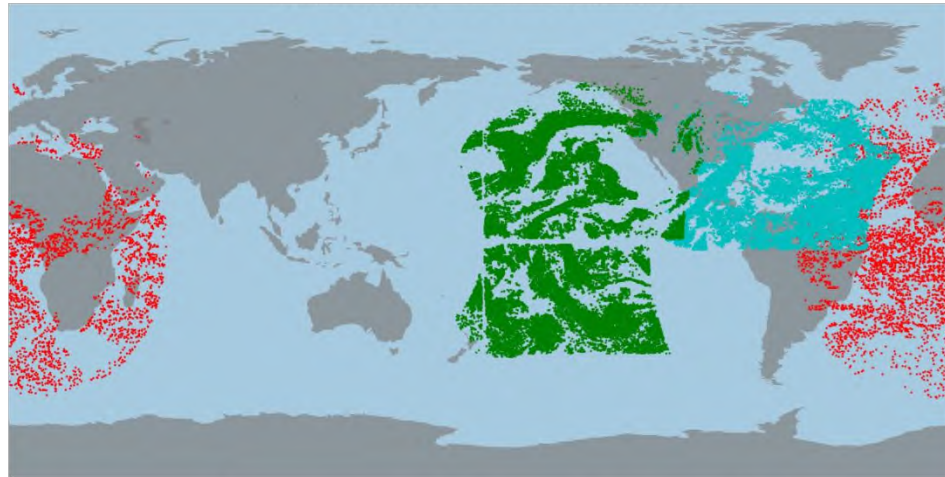


2017043000 CRIS Assimilated



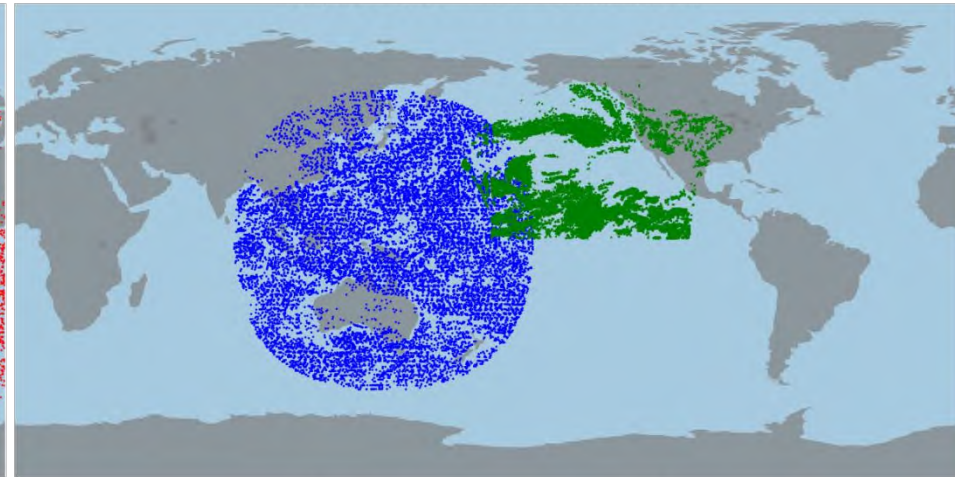
Assimilated Observations – Satellite Wind

2017043000 AMV Assimilated



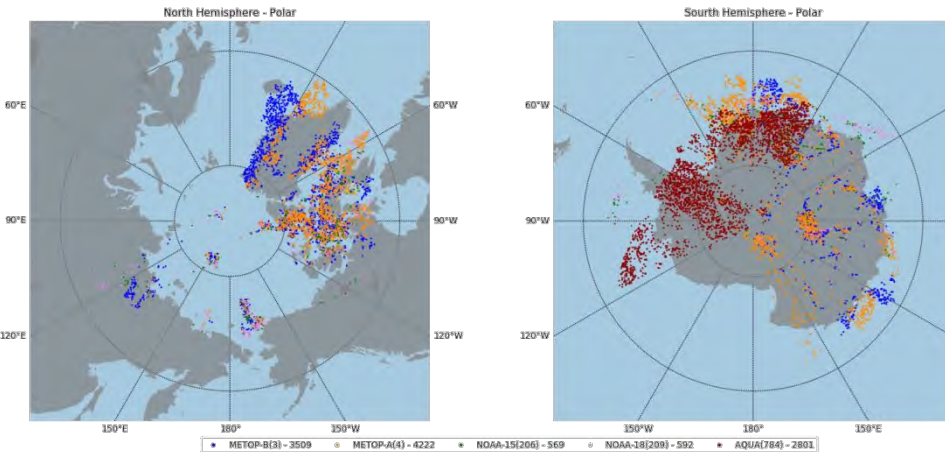
• METEOSAT-10(57) - 6603 • GOES-13(257) - 28620 • GOES-15(259) - 45169

2018052000 AMV Assimilated



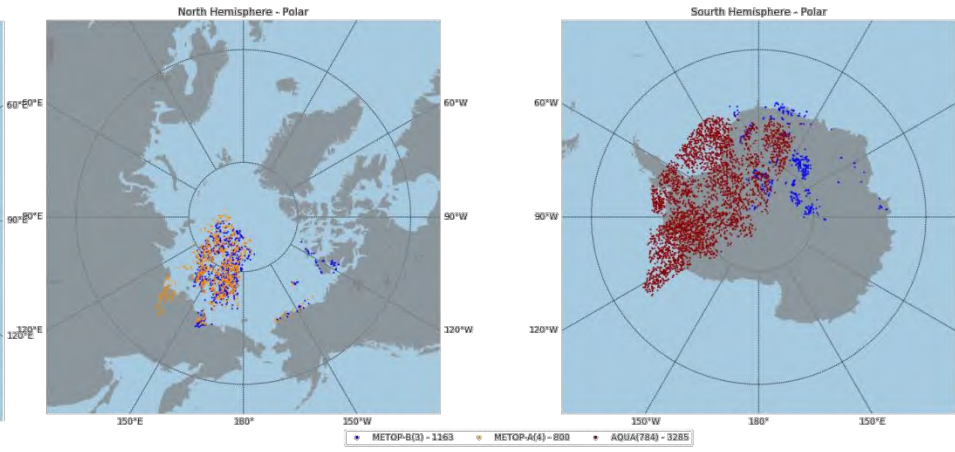
• HIMAWARI-8(173) - 18082 • GOES-15(259) - 22150

2017043000 AMV Assimilated



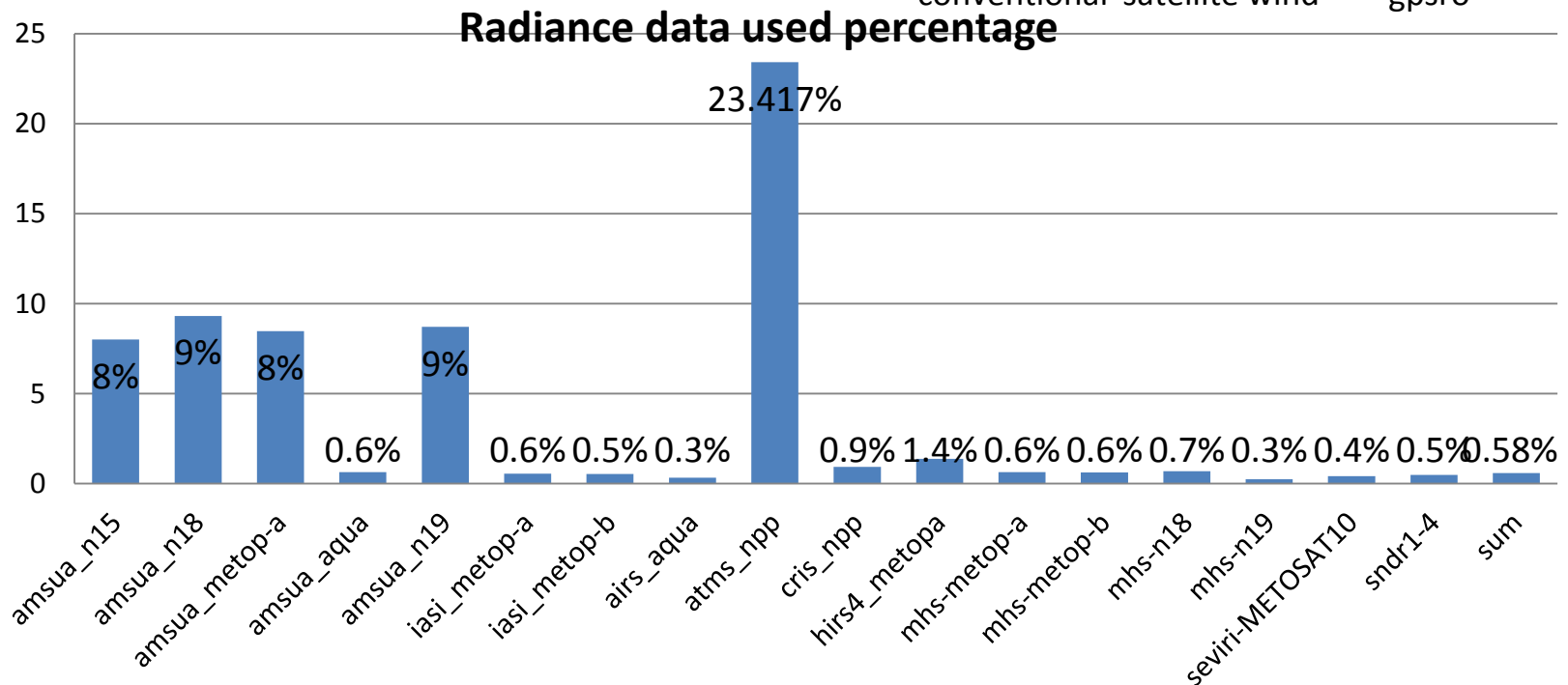
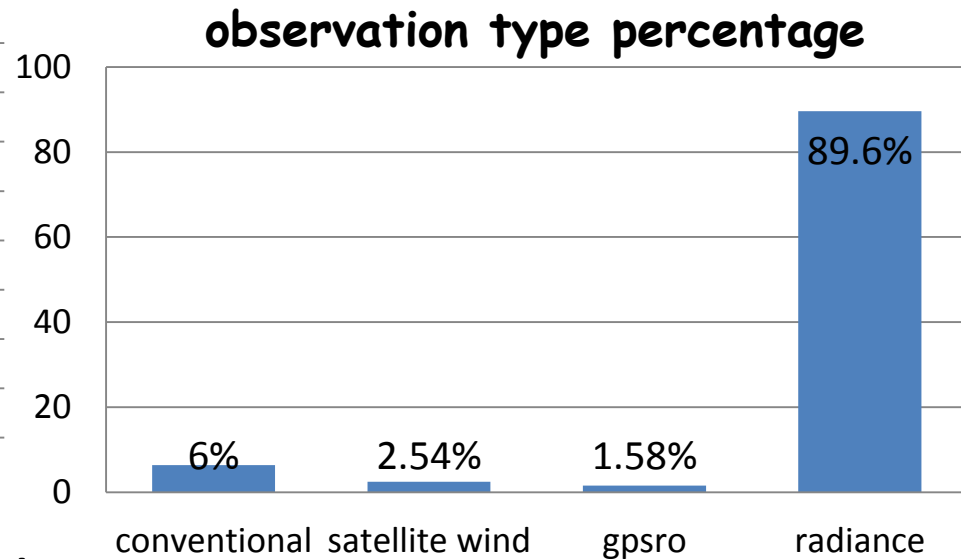
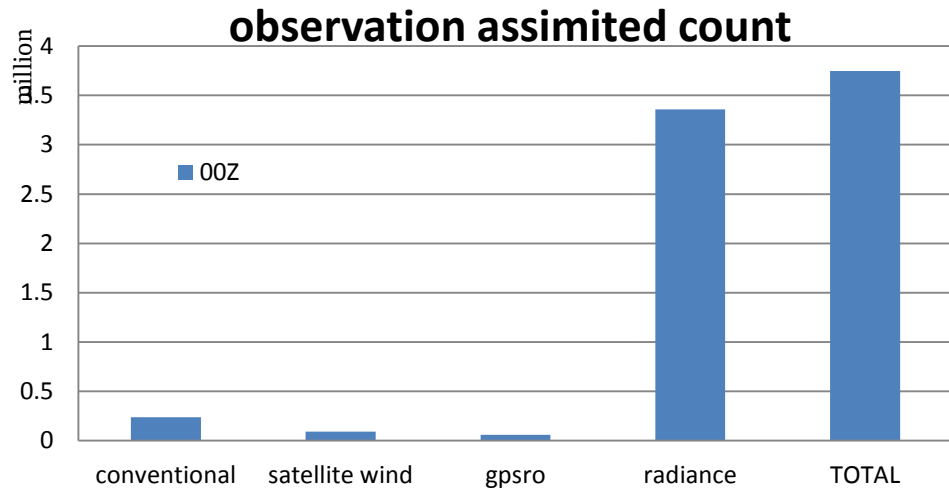
• METOP-B(3) - 3509 • METOP-A(4) - 4222 • NOAA-15(206) - 569 • NOAA-18(208) - 592 • AQUA(784) - 2801

2018052000 AMV Assimilated



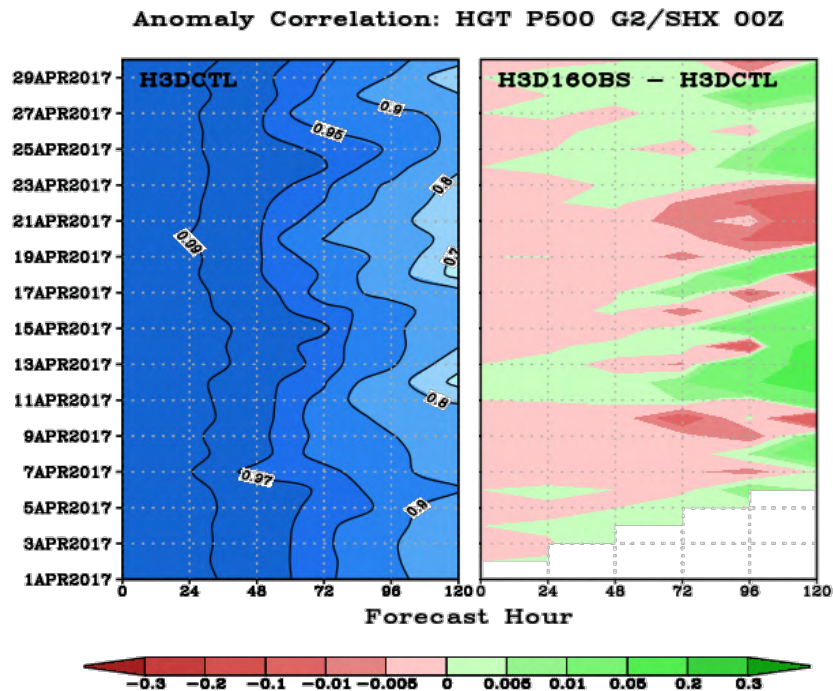
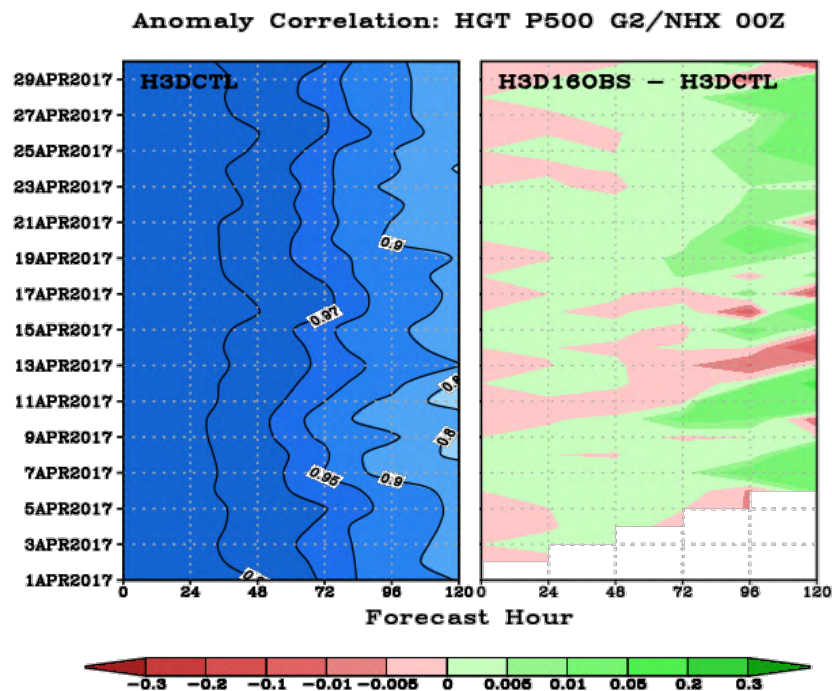
• METOP-B(3) - 1163 • METOP-A(4) - 608 • AQUA(784) - 9285

2017 4/30 00 All Obs.



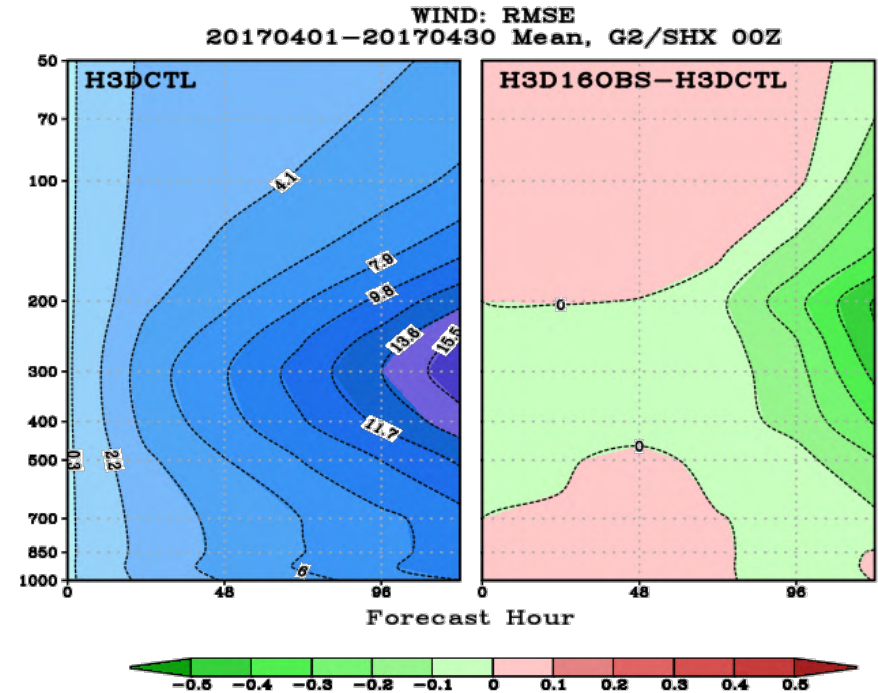
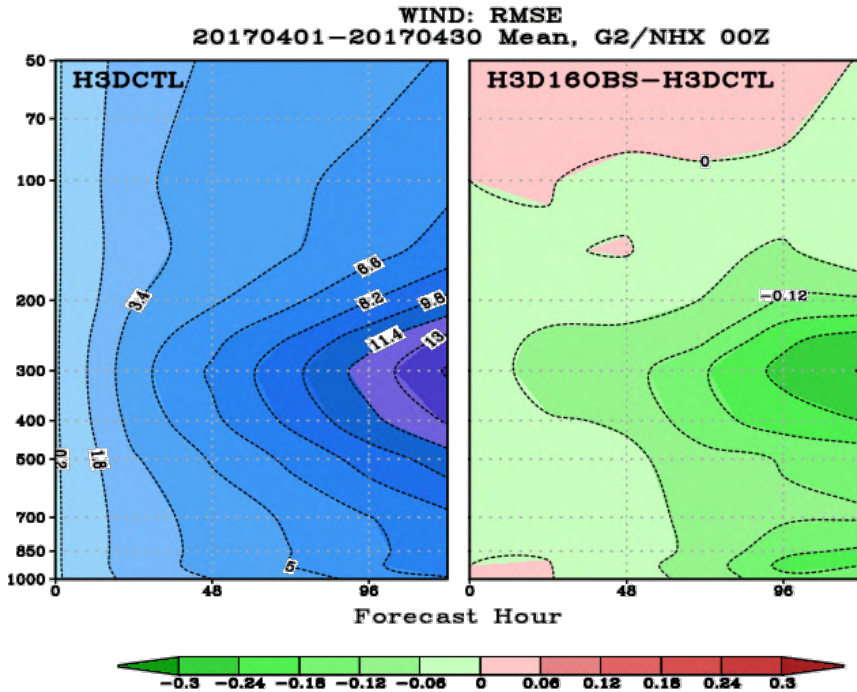
2018 plan Exp. Result

Score of Height



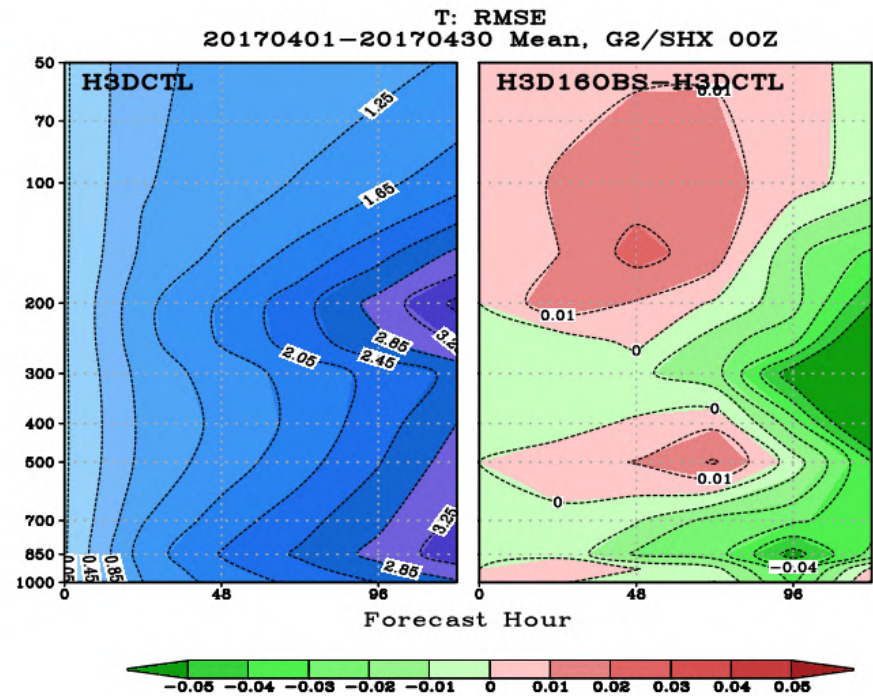
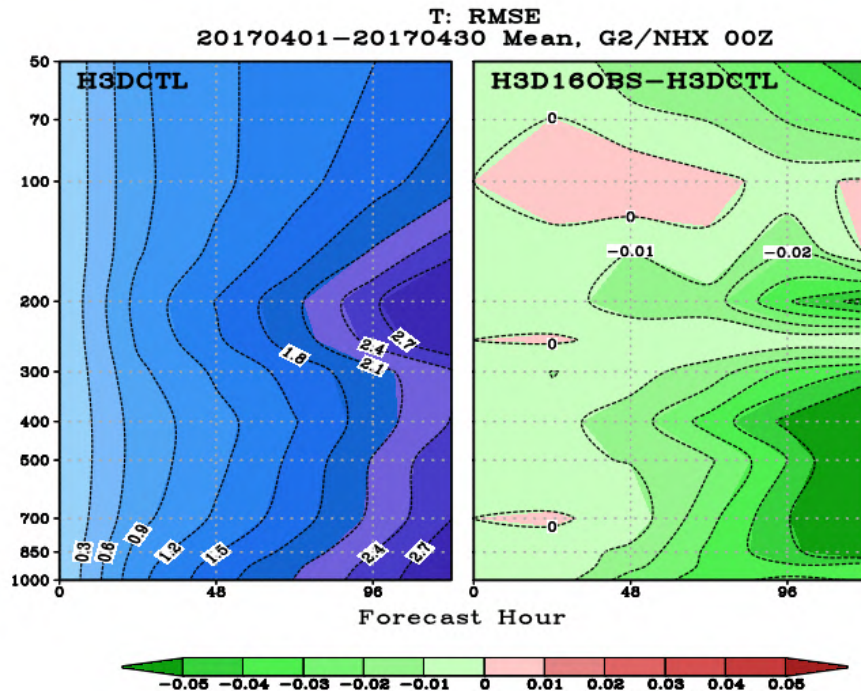
Against self analysis

RMS Error of Wind



Against self analysis

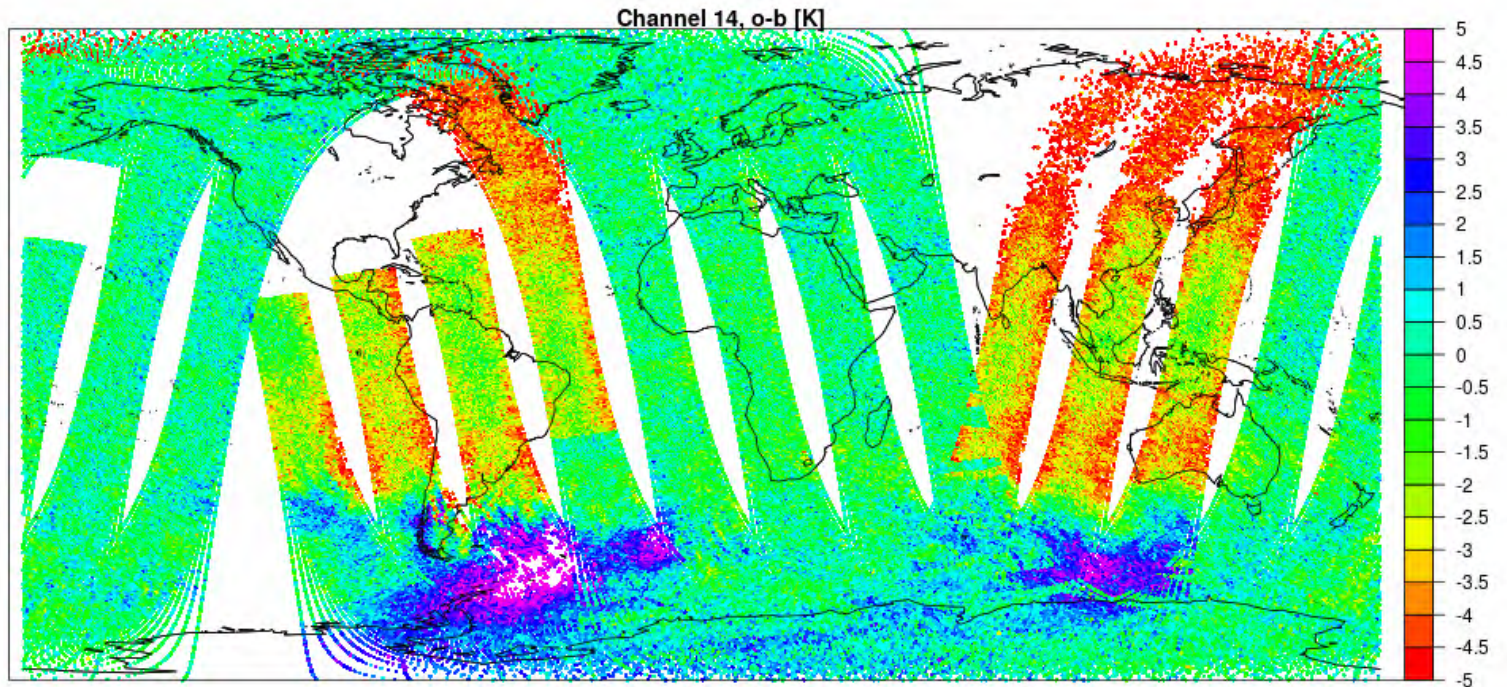
RMS Error of T



Against self analysis

Radiance data monitor

channel 14 of the Aqua AMSU-A



from : Earth System Assimilation Section
ECMWF working group

結論

- 衛星資料數量占約90%，偏差訂正，衛星頻道監控十分重要(子茂)
- 衛星資料至少需要半個月spin up
- GPSRO、臭氧觀測，為衛星偏差訂正與資料稀疏化重要依據
- 未來工作
 - 衛星風使用
 - COSMIC-2 QC process
 - 尺度相依權重(登舜)

Radiance data monitor

platform: airs_aqua
valid : 00Z02DEC2015 - 00Z01JAN2016

