Application of hourly COMS AMVs in KMA operation

Eunhee Lee

KMA

기상청

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- Introduction of KMA NWP system
- Status of COMS AMV
- Preliminary results for implementation of COMS AMV
- Application of COMS AMV data in NWP
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Introduction of KMA NWP system

- KMA decided to import the Unified Model as a next-gene ration NWP system (Q4 ’07)
- Routine operation of global/regional UM started (Q2 ’08)
- Numerical Model: UM
  - Spatial Resolution: N512(≈25km)L70
  - Target length : 252hr(00, 12UTC), 72hr(06,18UTC)
- Analysis Scheme : 4-DVAR
  - Analysis Time : 00, 06, 12, 18 UTC
  - Cut-off Time : 2 hours 25 minutes for Early Analysis
    6 hours 25 minutes for Update Analysis
  - Spatial Resolution (Inner Model) : N144(≈80km) L70
  - Assimilation Window : -3 hours to +3 hours of Analysis Time
  - Observation : Sonde,Surface,Aircraft,Satwind,Scatwind
    ATOVS,AIRS,IASI,SSMIS,GPSRO

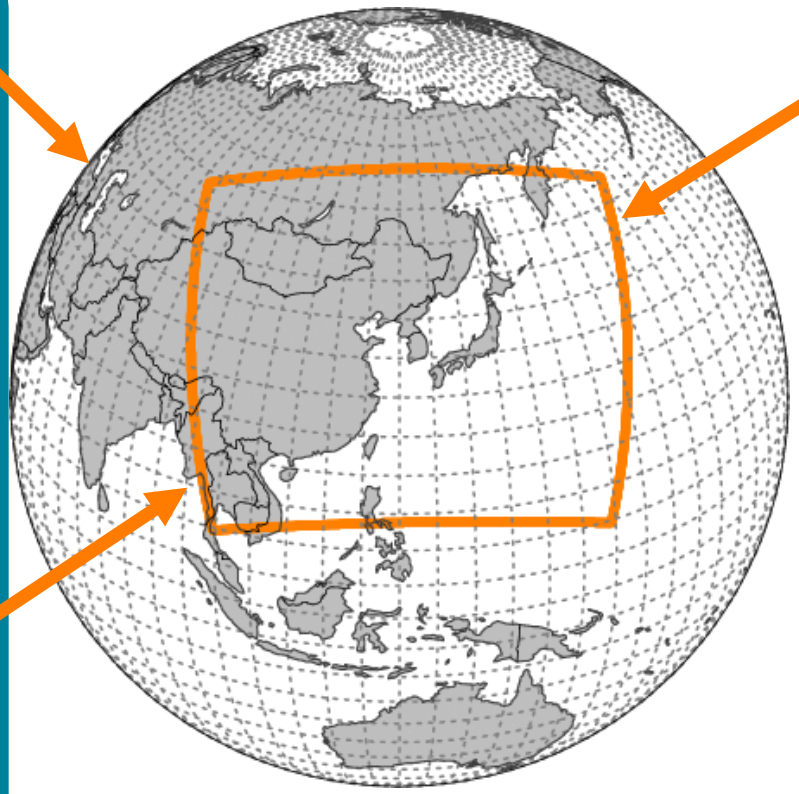
Global & Regional Models

Global (UM)

- Resolution
  N512L70
  (~25km / top = 80km)
- Target Length
  252hrs (00/12UTC)
  72hrs (06/18UTC)
- Initialisation : 4DVAR
- Version : UM 7.7

E.Asia (UM)

- Resolution
  12kmL70
  (0.11°x0.11° / top=80km)
- Target Length
  72hrs (6 hourly)
- Initialisation : 4DVAR
- Version : UM 7.7



E.Asia (WRF)

- Resolution
  10kmL40
  (top ~ 50hPa)
- Target Length
  72hrs (6 hourly)
- Initialisation : 3DVAR
- Version : WRF 3.1

Operational Deterministic UM Systems♪

Status of COMS AMV

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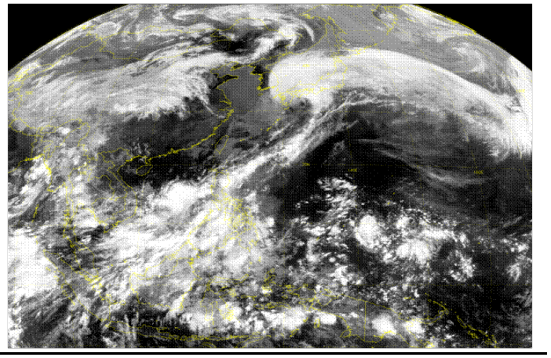
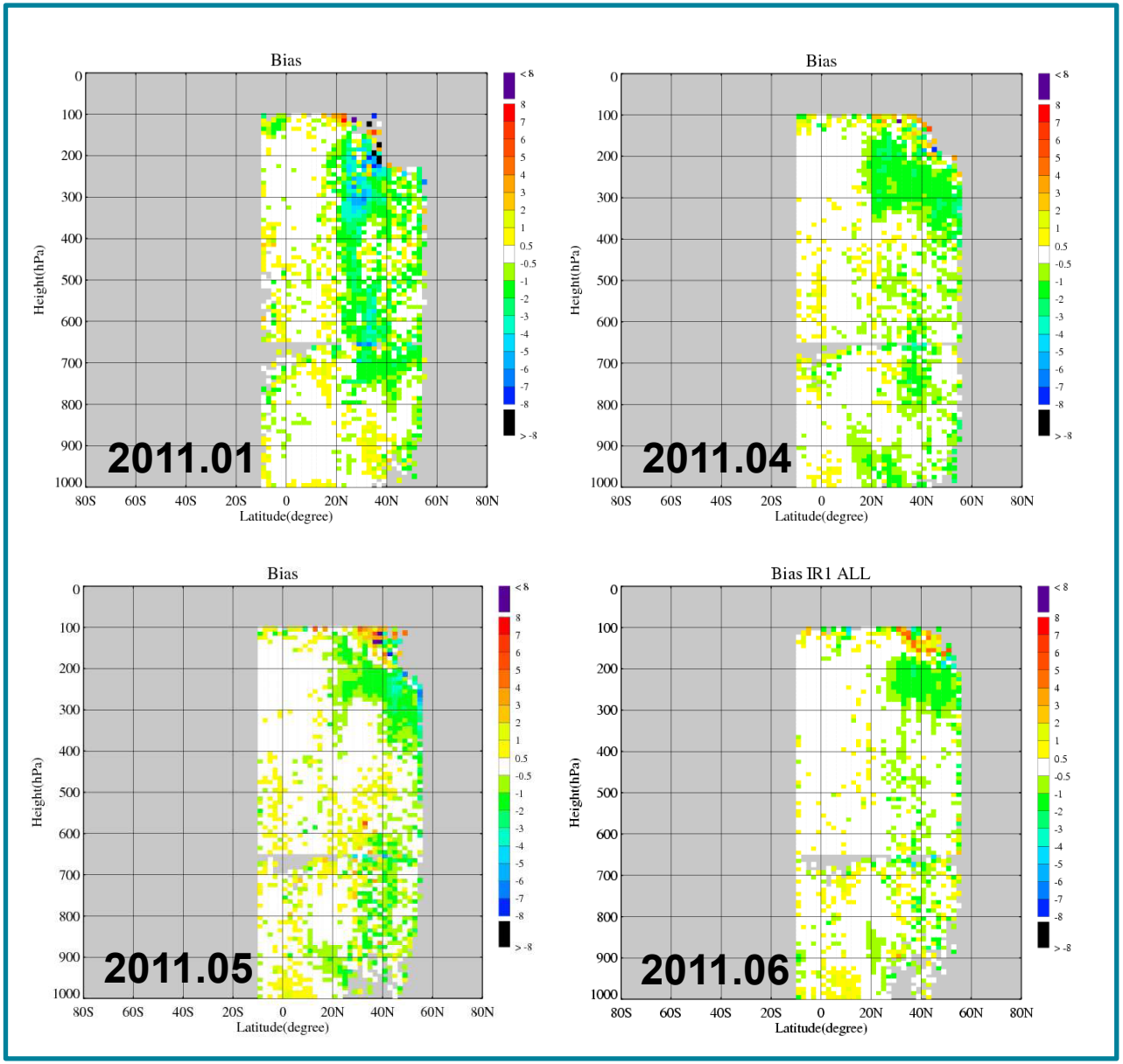
COMS AMV

The specifications for KMA AMV algorithm applied to COMS

Target size (pixels)	24 X 24 (96 x 96 km) (120x120 km over Korea)
Time interval between satellite images	15-minute
Target selection method	Optimal method
Search area	Dynamic range (based on FG)
Height assignment	EBBT, STC, IR/WV int. for IR and VIS AMV EBBT, NTC, NTCC for WV AMV
Area of AMV generation	Extended Northern Hemisphere 

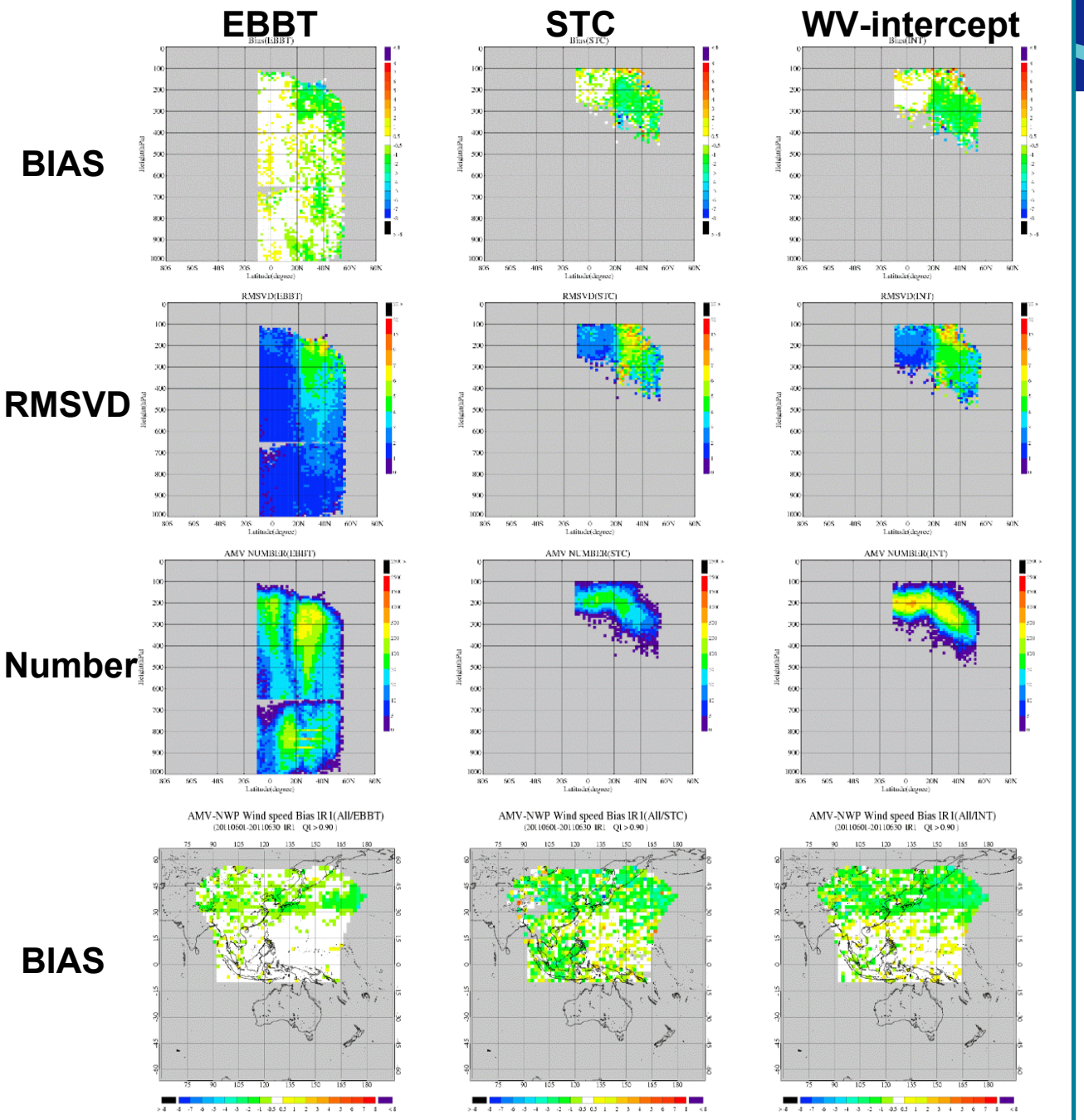
Seasonal variation of COMS AMV bias

- Satwind data
  - Infrared channel
  - HA method: EBBT
- Annual variations
  - Mid-latitude
  - Upper troposphere
  - slow bias in winter



Statistics

- Validation according to…
  - HA
  - Height
  - Latitude
- Different nominal QI
  - EBBT: QI=85
  - STC & WV-int: QI=90



Preliminary results for imple mentation

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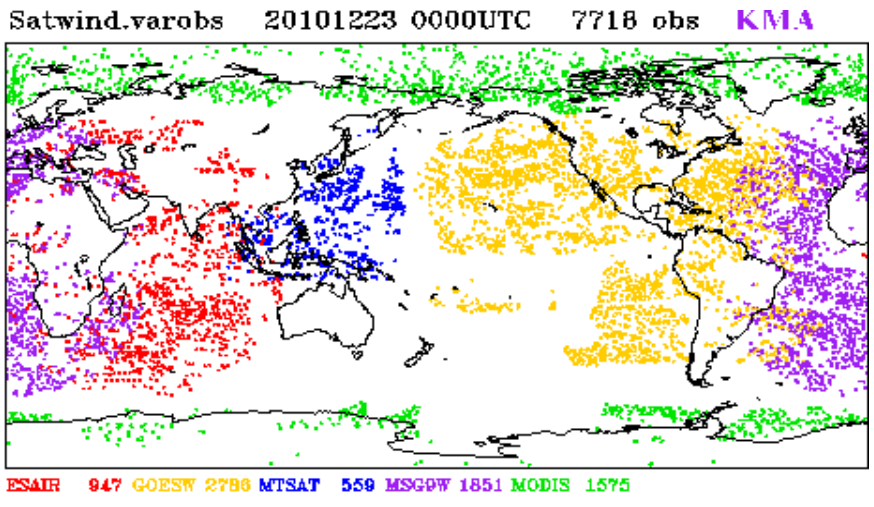
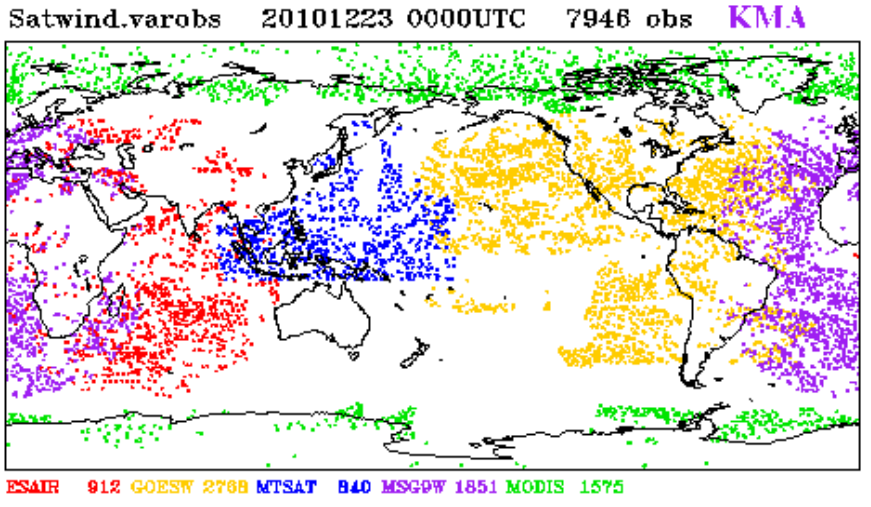
DA Module test

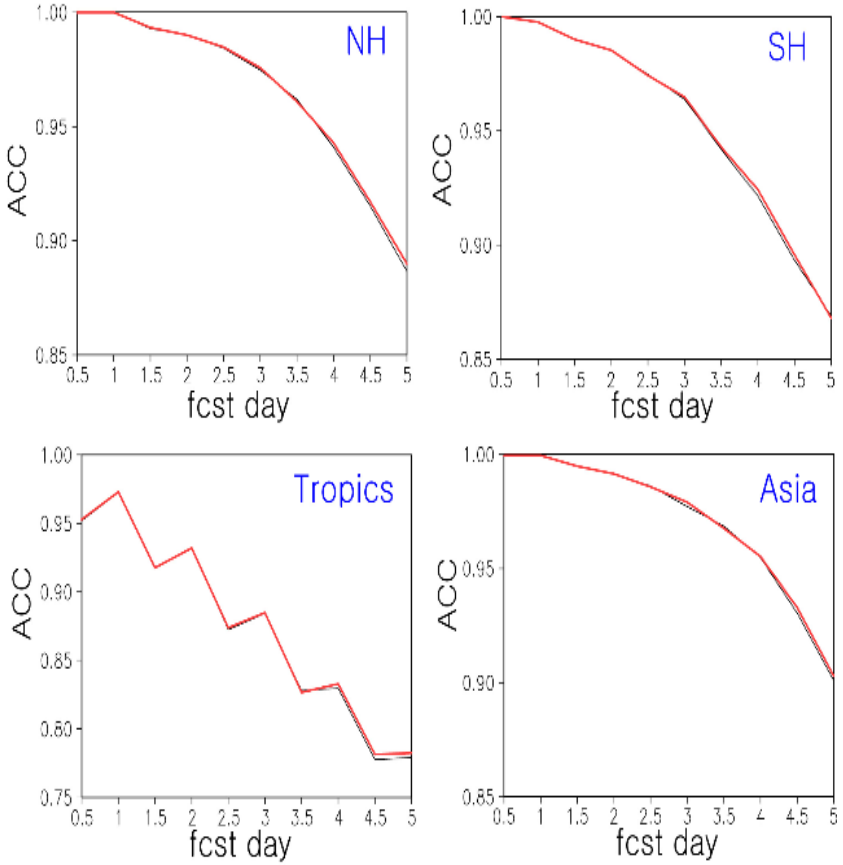
- period : 2010.12.22 ~ 2011.1.7 (sampled during IOT)
- To test DA module for COMS and validate COMS AMV
- COMS: Use 6-hourly AMVs from COMS hourly AMV
- MTSAT: limited area only from MTSAT full disk AMV

COMS AMV (QI>0.85)	MTSAT AMV (QI>0.85)
	

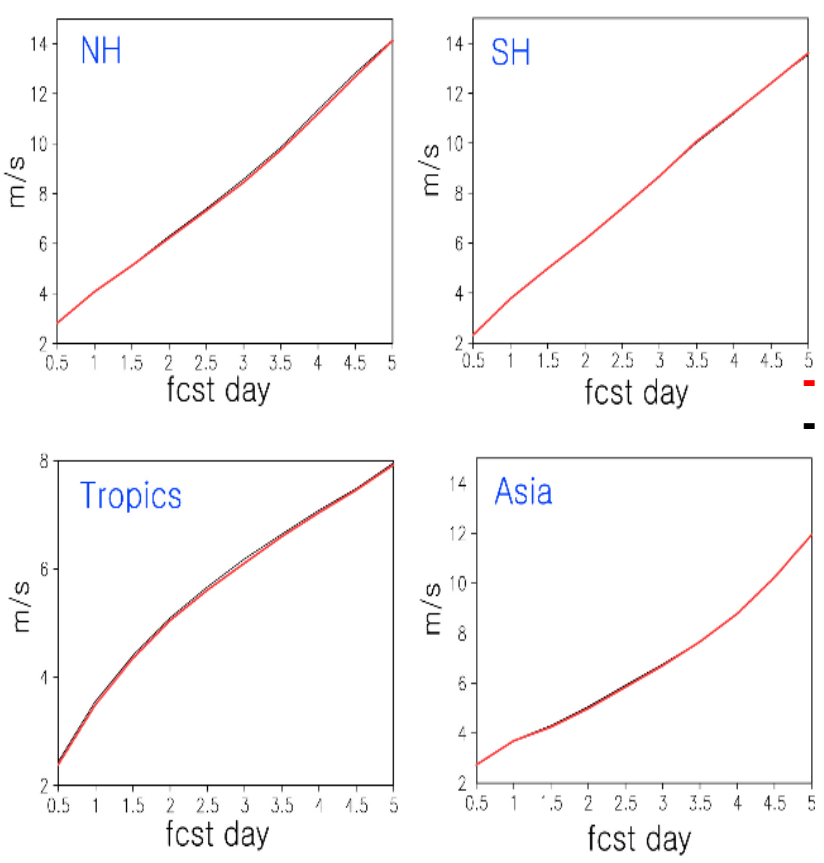
Data coverage plots showing assimilated data

Result of 6hourly COMS AMV

ACC of 500hPa Height



RMSE of winds at 250hPa



- COMS
- MTSAT

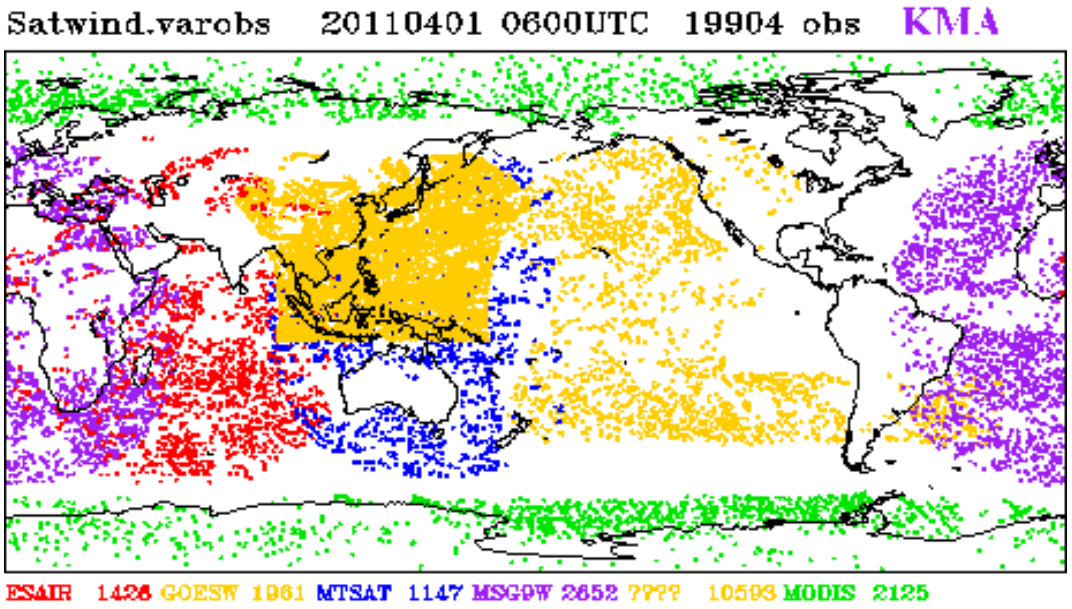
This result verifies COMS module in KMA DA system works normally and COMS data can apply to KMA NWP system

MTSAT+COMS

- According to the result, KMA tried to use COMS AMV with MTSAT
- COMS gives hourly AMVs but its limitation for spatial coverage can be compensated with MTSAT AMV
- To test hourly COMS AMV, 2 different experiments are designed

1. Only using COMS & MTSAT at analysis time

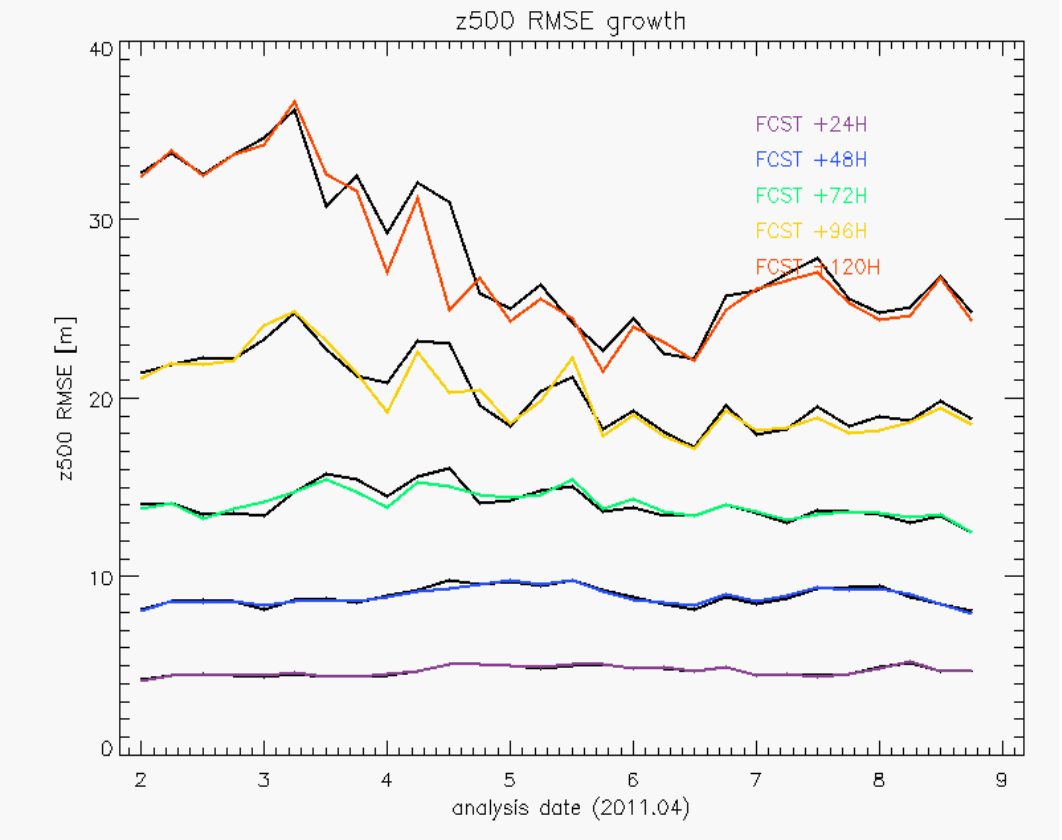
2. Using hourly COMS within assimilation time window



MTSAT+COMS

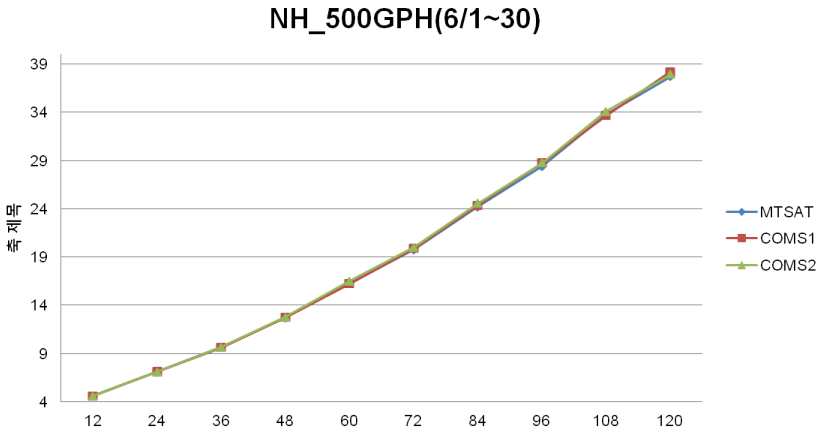
Test of 1 hourly COMS AMV

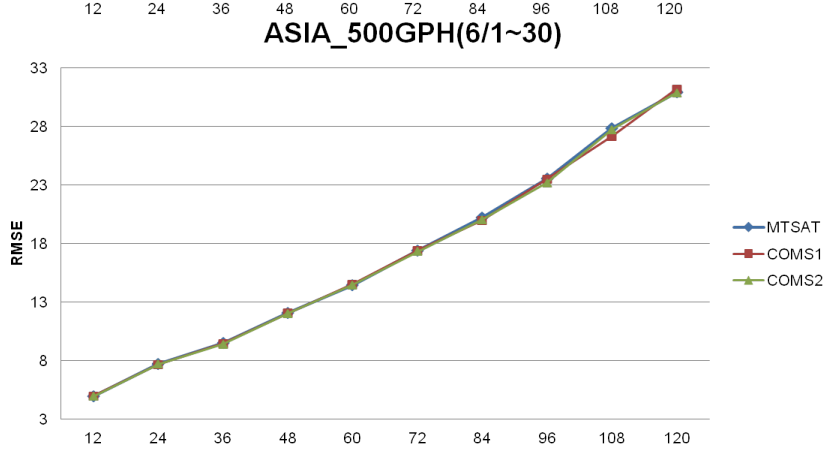
- NMSC/KMA continuously provided COMS data from April 2011.
- Validation of GPH at 500 hPa
  - RMSE of 1~5 day forecast
- MTSAT + COMS AMVs
  - Black line: only using data at analysis time
  - Colored line: hourly COMS with +/- 3 hours
- Preliminary result
  - Decrease of RMSE at the case using hourly COMS AMVs



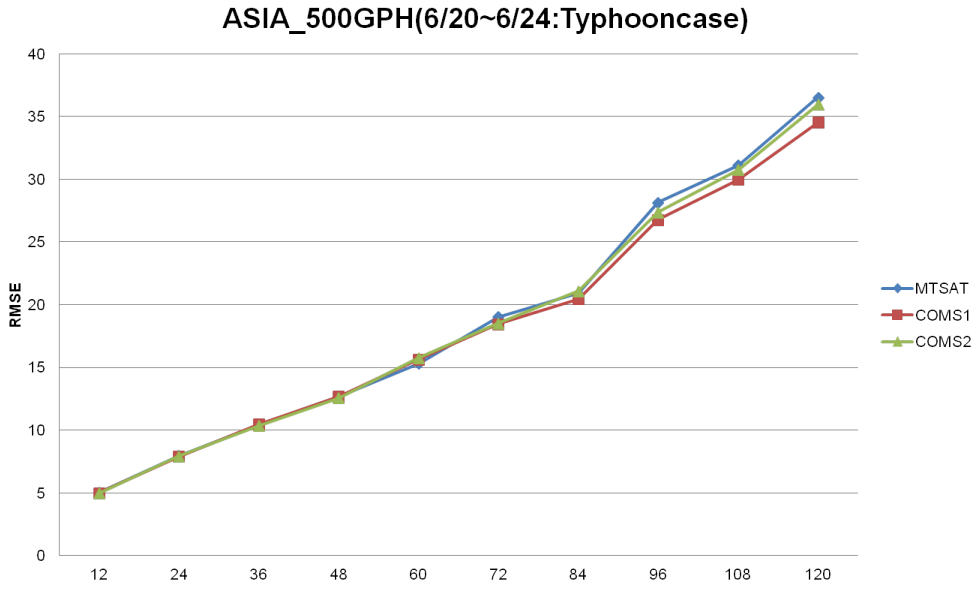
Test for 1 hourly COMS data

- Preliminary validation result
  - Neutral in global, but positive impact in East Asia (typhoon)





Exp. Name	assi. window / temp. thinning	Satellites
CTRL	±00h / -	MTSAT(QI85) only
COMS1	±02h / 7200s	COMS(QI90)+MTSAT(QI85)
COMS2	±03h / 3600s	COMS(QI90)+MTSAT(QI85)



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Application of hourly COMS AMV in operation

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Quality Control

- The AMV assimilation approach at most NWP centres involves apply ing QI thresholds, spatial and temporal blacklisting, thinning the data and removing data which deviate too far from the background.
- At the preliminary results, KMA used the quality control criteria provi ded from UMMO. About COMS data, we set up the criteria same as MTSAT.
- For application of COMS data in operation, we should generate quali ty control basis reflecting COMS data characteristics.
- QC index (based on QI plot and Statistics analysis)
  - IR : EBBT QI1>85, WVint QI1>90
  - WV : EBBT QI1>90, NTC QI1>90
  - VIS : EBBT QI1>87
  - Reject COMS WV below 400hPa
  - Reject COMS VIS and IR low level over land
  - Reject WV intercept below 400hPa

AMV errors

- In UMS, estimating the total AMV obs error allows for both an error in the u/v vector components and an error in the u/v vector components due to a height assignment error (Forsythe & Saunders 2008)
- The error in u/v due to the error in height can be calculated using the model background wind profile and an estimate of the height error
- Height Error Profile during summer

  - The height errors of COMS AMV are divided by *channel, HA method and surface type*

```
! JMA geostationary (MTSAT)
&ErrorProfile Name='jmair',Profile(1:9)=
 90.0, 70.0, 120.0, 150.0, 120.0, 90.0, 70.0, 50.0, 40.0
&ErrorProfile Name='jmavis',Profile(1:9)=
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&ErrorProfile Name='jmawv',Profile(1:9)=
 200.0, 200.0, 200.0, 200.0, 200.0, 150.0, 85.0, 50.0, 40.0
```

```
! KMA geostationary(COMS)
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```
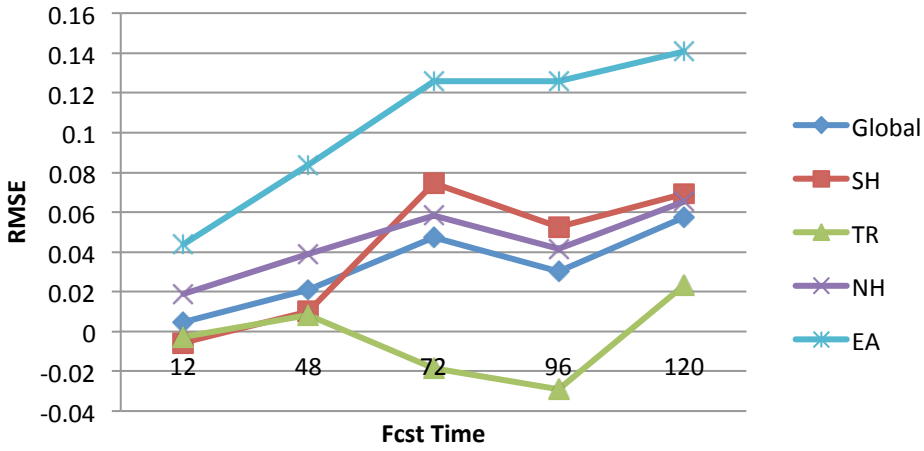

기상청 Acknowledgment: UKMO

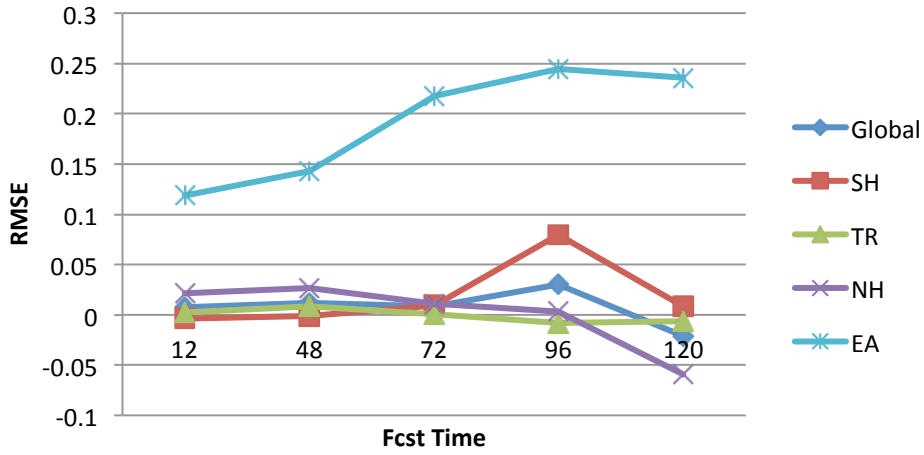
Results of hourly COMS AMV

- The QC criteria of COMS is applied to COMS experiment.
- result compared with operation(without COMS:Cntl)
- period: 2011.9.1 ~ 2011.10.31
- time window: ±120 min
- Difference of RMSE (positive means improvement)
- Overall positive & especially in East Asia

500GPH RMSE diff(Cntl-COMS)-00UTC

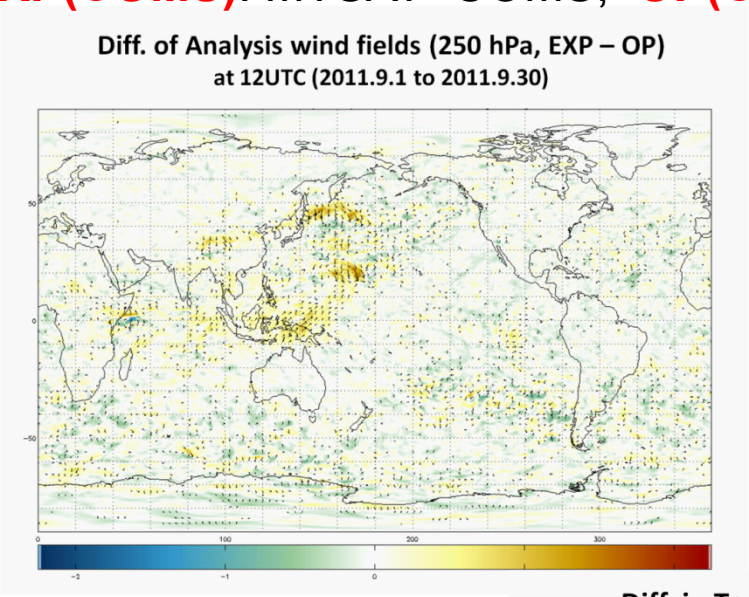


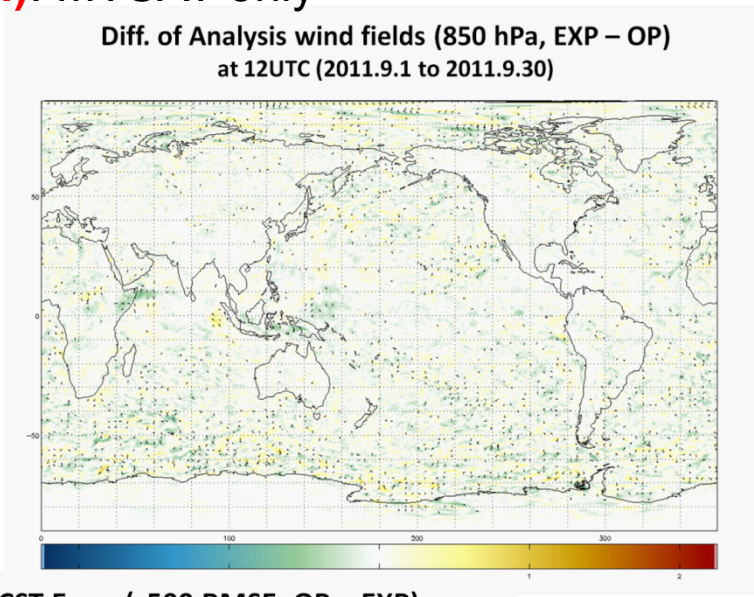
500GPH RMSE diff(Cntl-COMS)-12UTC



Analysis increment

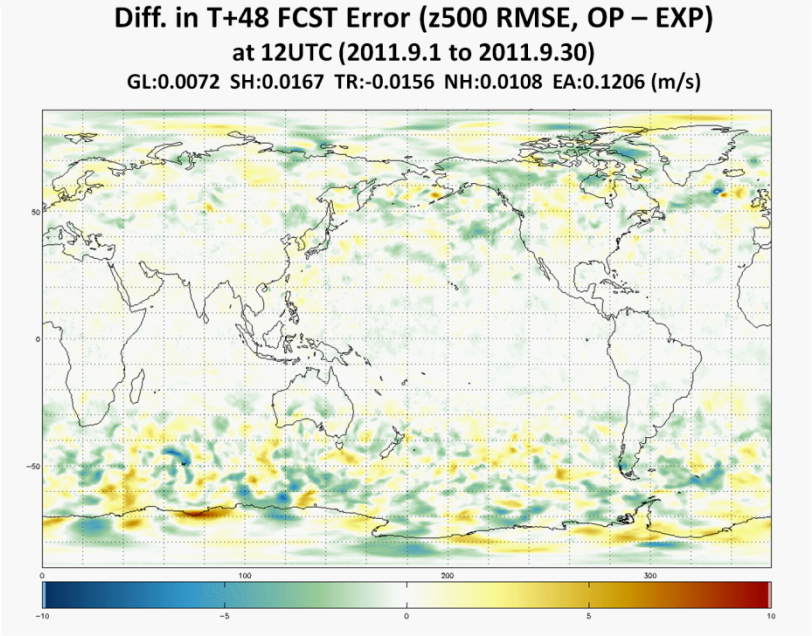
EXP(COMS): MTSAT+COMS, **OP(Cntl)**: MTSAT only





Result in T+48 FCST

Diffrence of z500 RMSE
at T+48 12UTC



Summary

- According to the result using COMS data replacing MTSAT, *the module for COMS in UMS works normally*.
- At the preliminary results of hourly COMS AMVs **within ±2hours** from analysis time show a small improvement in East Asia(using default error and QC index same as MTSAT).
- Using UKMO monitoring system, COMS AMV statistics were produced during summer 2011.
- After application of hourly COMS AMV *with it's own height error and QC index*, the experiment results showed **general improvement** except for TR and **especially positive impact in East Asia**.
- KMA started operation with hourly COMS AMV in last December.

Future Plan

- For regional DA, COMS AMV with **reduced target size**(16 x 16) are producing now. After impact test, it will be applied to KMA NWP system.
- Additionally, KMA will test **1km VIS** data from COMS for regional, local area model.
- **Quality control file reflecting seasonal variation** will be generated and validated.
- Advanced usage will be tested considering various HA method and QI.

Thank you!

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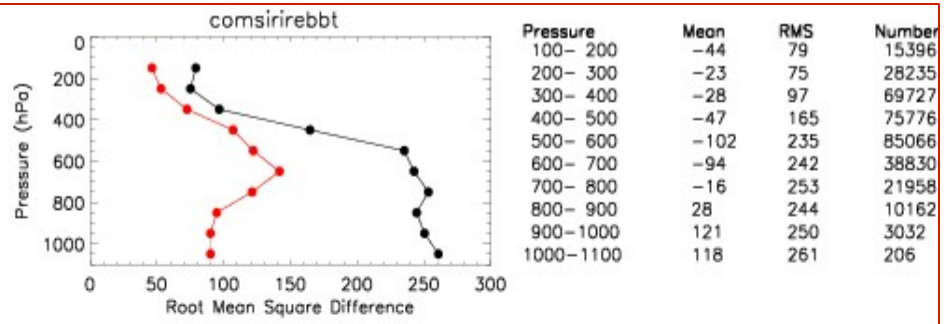
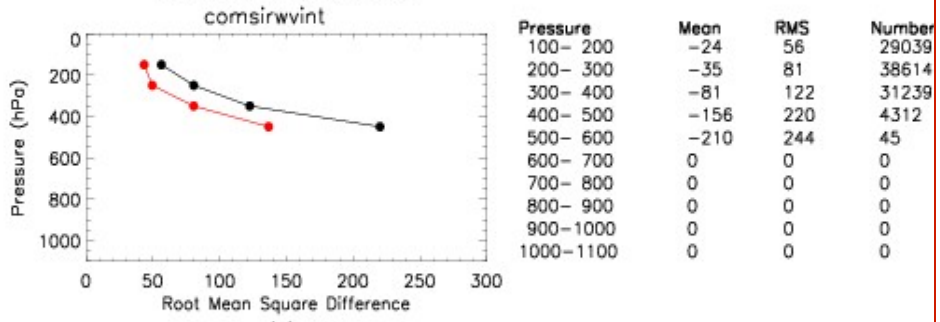
Best-fit Pressure (QI2>85, Jan 2012)

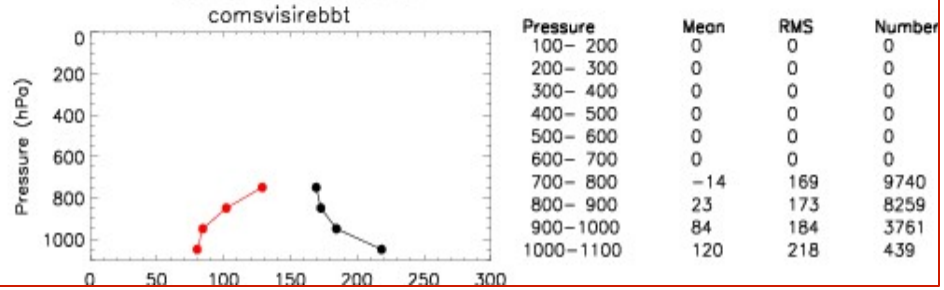
All Lat over Land



Pressure	Mean	RMS	Number
100– 200	−44	79	15396
200– 300	−23	75	28235
300– 400	−28	97	69727
400– 500	−47	165	75776
500– 600	−102	235	85066
600– 700	−94	242	38830
700– 800	−16	253	21958
800– 900	28	244	10162
900–1000	121	250	3032
1000–1100	118	261	206

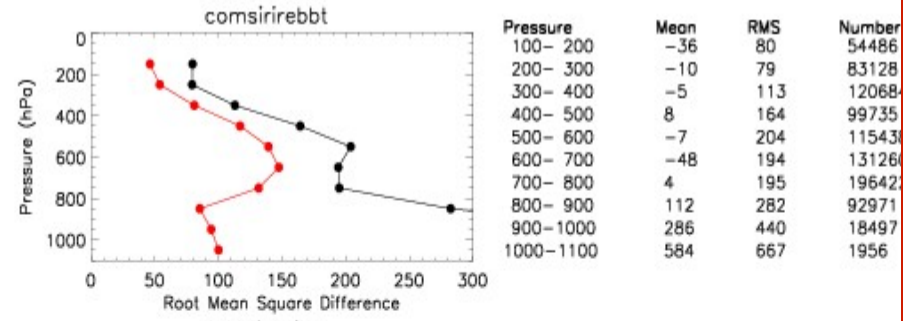


Pressure	Mean	RMS	Number
100– 200	−24	56	29039
200– 300	−35	81	38614
300– 400	−81	122	31239
400– 500	−156	220	4312
500– 600	−210	244	45
600– 700	0	0	0
700– 800	0	0	0
800– 900	0	0	0
900–1000	0	0	0
1000–1100	0	0	0

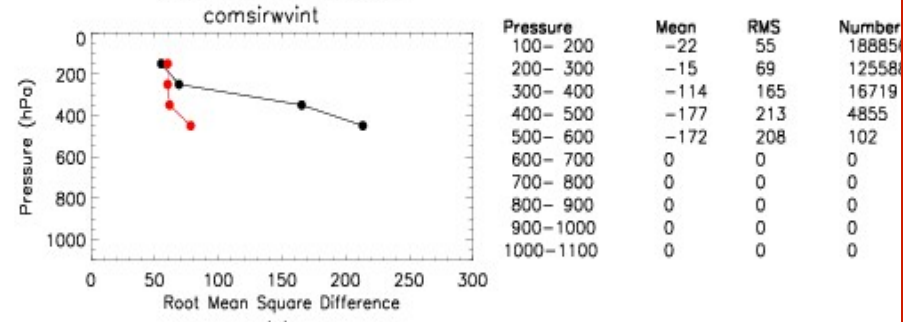


Pressure	Mean	RMS	Number
100– 200	0	0	0
200– 300	0	0	0
300– 400	0	0	0
400– 500	0	0	0
500– 600	0	0	0
600– 700	0	0	0
700– 800	−14	169	9740
800– 900	23	173	8259
900–1000	84	184	3761
1000–1100	120	218	439

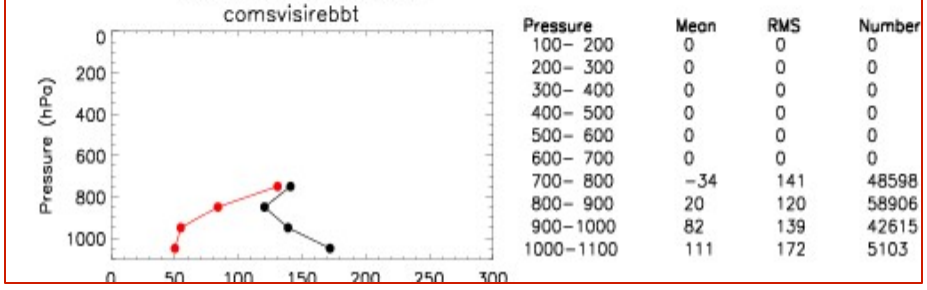
All Lat over Sea



Pressure	Mean	RMS	Number
100– 200	−36	80	54486
200– 300	−10	79	83128
300– 400	−5	113	12068
400– 500	8	164	99735
500– 600	−7	204	11543
600– 700	−48	194	13126
700– 800	4	195	19642
800– 900	112	282	92971
900–1000	286	440	18497
1000–1100	584	667	1956



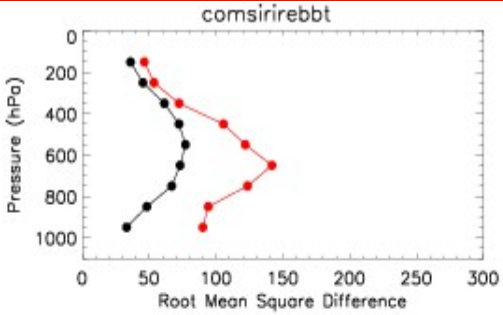
Pressure	Mean	RMS	Number
100– 200	−22	55	18885
200– 300	−15	69	12558
300– 400	−114	165	16719
400– 500	−177	213	4855
500– 600	−172	208	102
600– 700	0	0	0
700– 800	0	0	0
800– 900	0	0	0
900–1000	0	0	0
1000–1100	0	0	0



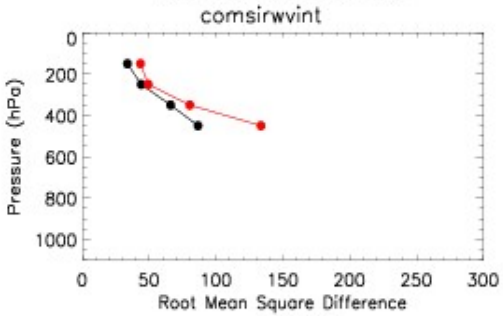
Pressure	Mean	RMS	Number
100– 200	0	0	0
200– 300	0	0	0
300– 400	0	0	0
400– 500	0	0	0
500– 600	0	0	0
600– 700	0	0	0
700– 800	−34	141	48598
800– 900	20	120	58906
900–1000	82	139	42615
1000–1100	111	172	5103

Best-fit Pressure (QI1>85, Jan 2012)

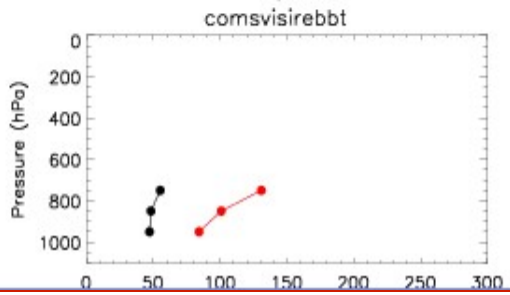
All Lat over Land



Pressure	Mean	RMS	Number
100– 200	−18	36	6777
200– 300	−15	45	15388
300– 400	−23	61	39027
400– 500	−4	72	27662
500– 600	−15	77	18189
600– 700	−20	73	7279
700– 800	3	67	3052
800– 900	−9	48	921
900–1000	−4	33	332
1000–1100	27	44	39

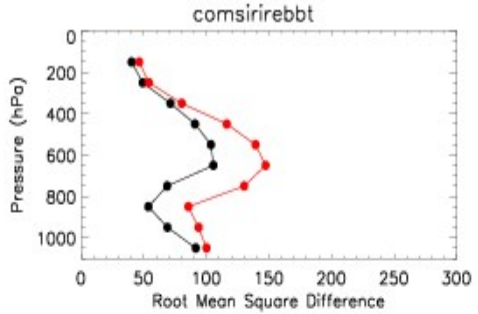


Pressure	Mean	RMS	Number
100– 200	−13	34	18161
200– 300	−13	44	22140
300– 400	−39	66	17662
400– 500	−49	86	1781
500– 600	0	0	7
600– 700	0	0	0
700– 800	0	0	0
800– 900	0	0	0
900–1000	0	0	0
1000–1100	0	0	0

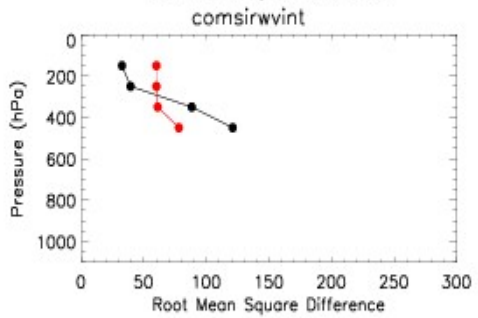


Pressure	Mean	RMS	Number
100– 200	0	0	0
200– 300	0	0	0
300– 400	0	0	0
400– 500	0	0	0
500– 600	0	0	0
600– 700	0	0	0
700– 800	1	55	1972
800– 900	−3	48	1273
900–1000	4	47	679
1000–1100	26	47	98

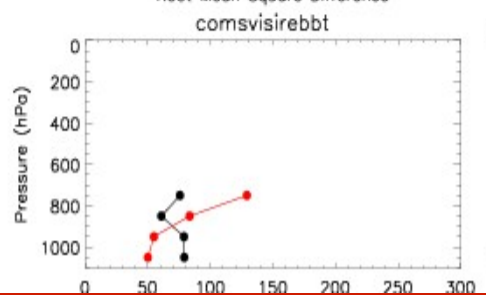
All Lat over Sea



Pressure	Mean	RMS	Number
100– 200	−16	40	25897
200– 300	−11	49	46929
300– 400	−17	71	62464
400– 500	−14	91	41515
500– 600	−40	104	40918
600– 700	−64	105	38461
700– 800	−42	69	93736
800– 900	−5	54	52535
900–1000	23	69	6155
1000–1100	55	91	322



Pressure	Mean	RMS	Number
100– 200	−11	33	11417
200– 300	−7	39	77861
300– 400	−48	88	8272
400– 500	−75	121	1152
500– 600	−104	157	28
600– 700	0	0	0
700– 800	0	0	0
800– 900	0	0	0
900–1000	0	0	0
1000–1100	0	0	0



Pressure	Mean	RMS	Number
100– 200	0	0	0
200– 300	0	0	0
300– 400	0	0	0
400– 500	0	0	0
500– 600	0	0	0
600– 700	0	0	0
700– 800	−38	76	22613
800– 900	5	61	38747
900–1000	46	79	24563
1000–1100	53	79	2697