Scatterometer Utilization in JMA's global numerical weather prediction (NWP) system

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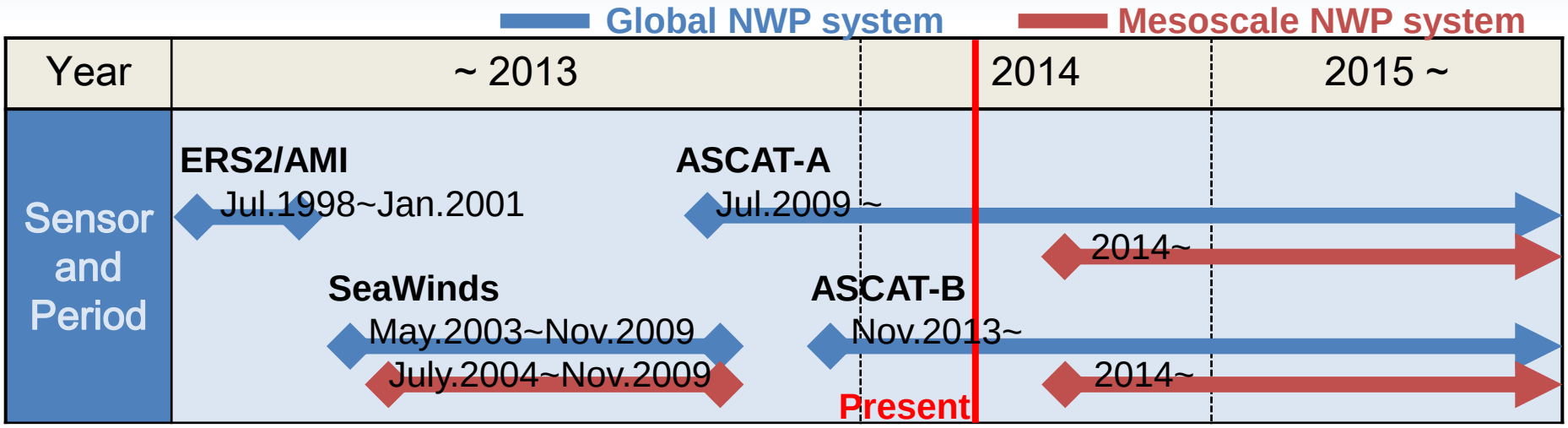
Utilization of ASCAT-B scatterometer in JMA's Global NWP system

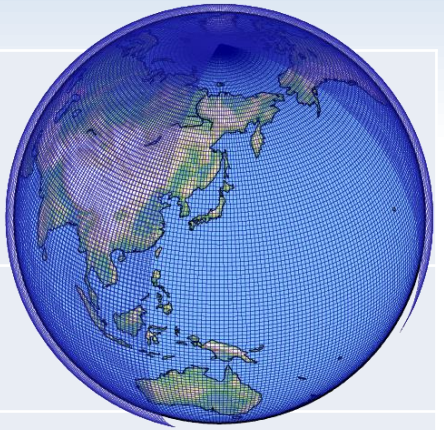
History of scatterometer usage in JMA's NWP systems



- JMA have been utilizing scatterometer OVW data for
  - Disaster prevention information
  - numerical weather prediction (NWP)
    - At present, ASCAT-A and B OVW data retrieved by OSI-SAF have been assimilated only in Global NWP system
    - Utilization in Mesoscale NWP system is planned to start in 2014

JMA's Global NWP system

Forecast model Resolution(H/V)	Global Spectral Model(GSM) TL959 (20km) / 60 (lid at 0.1hPa) TL959 (20km) / 100 (lid at 0.01hPa)
Forecast range (initial time)	84h (00, 06, 18UTC) 264h (12UTC)
Data Assimilation scheme (resolution)	4D-Var (outer TL959(20km), inner TL319(55km))
Data cut off time against analysis time	Cycle analysis +11h50m(00, 12UTC), +7h50m(06, 18 UTC) Early analysis +2h20m(00, 06, 12, 18UTC)



As of Nov. 2013
As of Jun. 2014

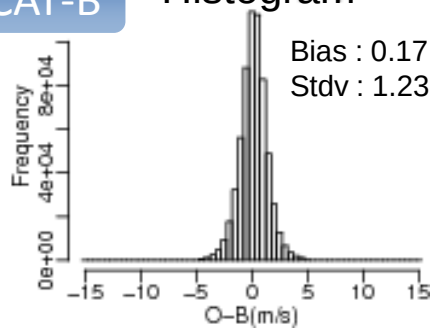
- JMA began to assimilate ASCAT-B OVW data in global NWP system since Nov. 2013

ASCAT-B data quality in JMA's Global NWP system

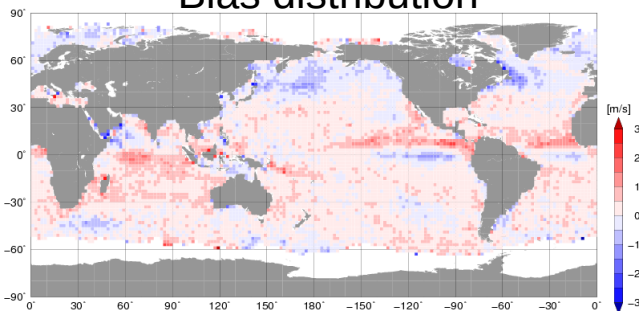
Wind speed First Guess departure (statistical period : Aug. 2013)

ASCAT-B

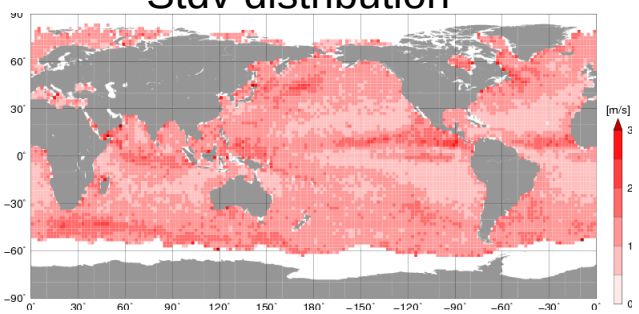
Histogram



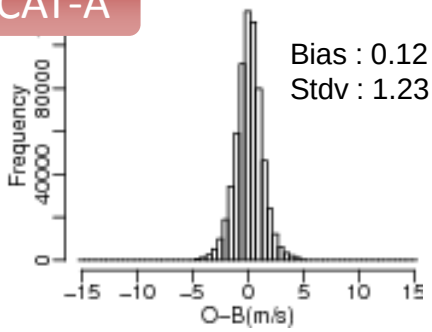
Bias distribution

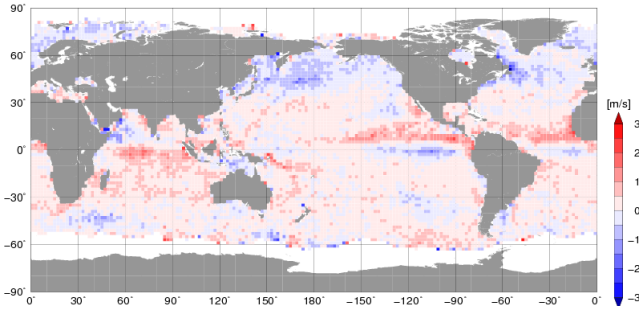


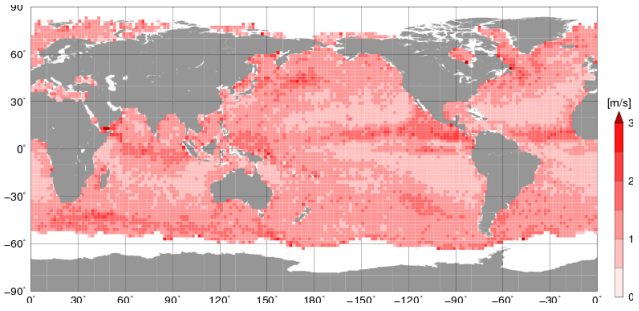
Stdv distribution



ASCAT-A





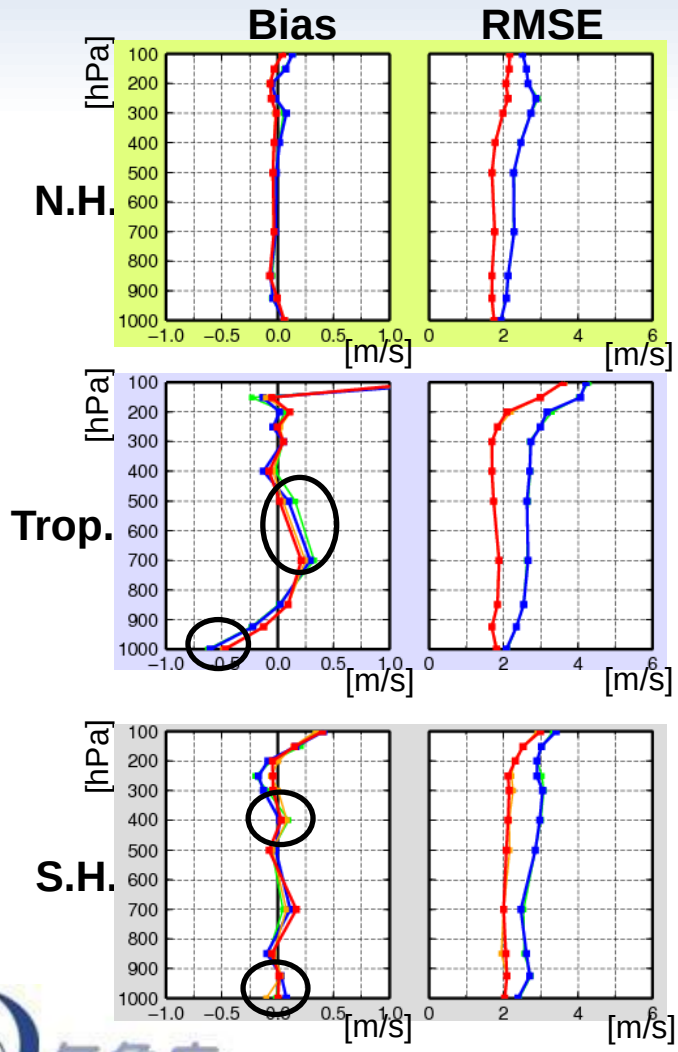


- Similar characteristics were confirmed with both sensors
- Same quality control procedure for ASCAT-A OVW data in global NWP system can be applied to ASCAT-B OVW data

Setup of impact experiment for adding ASCAT-B OVW data

- Names of experiment
  - CNTL : same as operational global NWP system as of Oct. 2013 (vertical resolution is 60-layers (lid at 0.1hPa))
  - TEST : CNTL + ASCAT-B OVW data
- The quality control procedure of ASCAT-B OVW data is completely the same as that of ASCAT-A OVW data
- Assimilation Period
  - 10 Jul. 2013 ~ 11 Sep. 2013
- Forecast period
  - 21 Jul. 2013 ~ 11 Sep. 2013
- Verified period
  - 1 Aug. 2013 ~ 31 Aug. 2013

Wind speed analysis and F.G. field



- In comparison with sonde observation, bias was mitigated on middle and low level layers in the Trop. and S.H.
- RMSE didn't change remarkably in each area

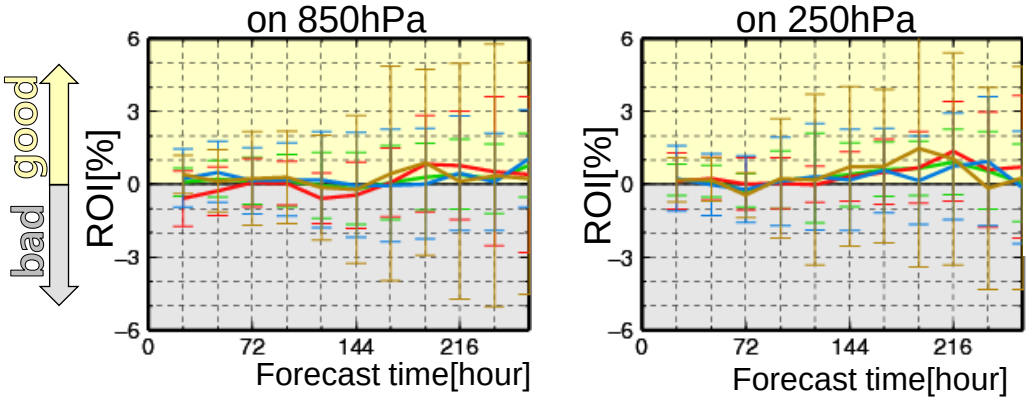
Analysis Test
Analysis Cntl
Guess Test
Guess Cntl

Wind speed forecast field

Rate of improvement (ROI) against own analysis

$$ROI[\%] = (RMSE_{CNTL} - RMSE_{TEST})/RMSE_{CNTL}$$

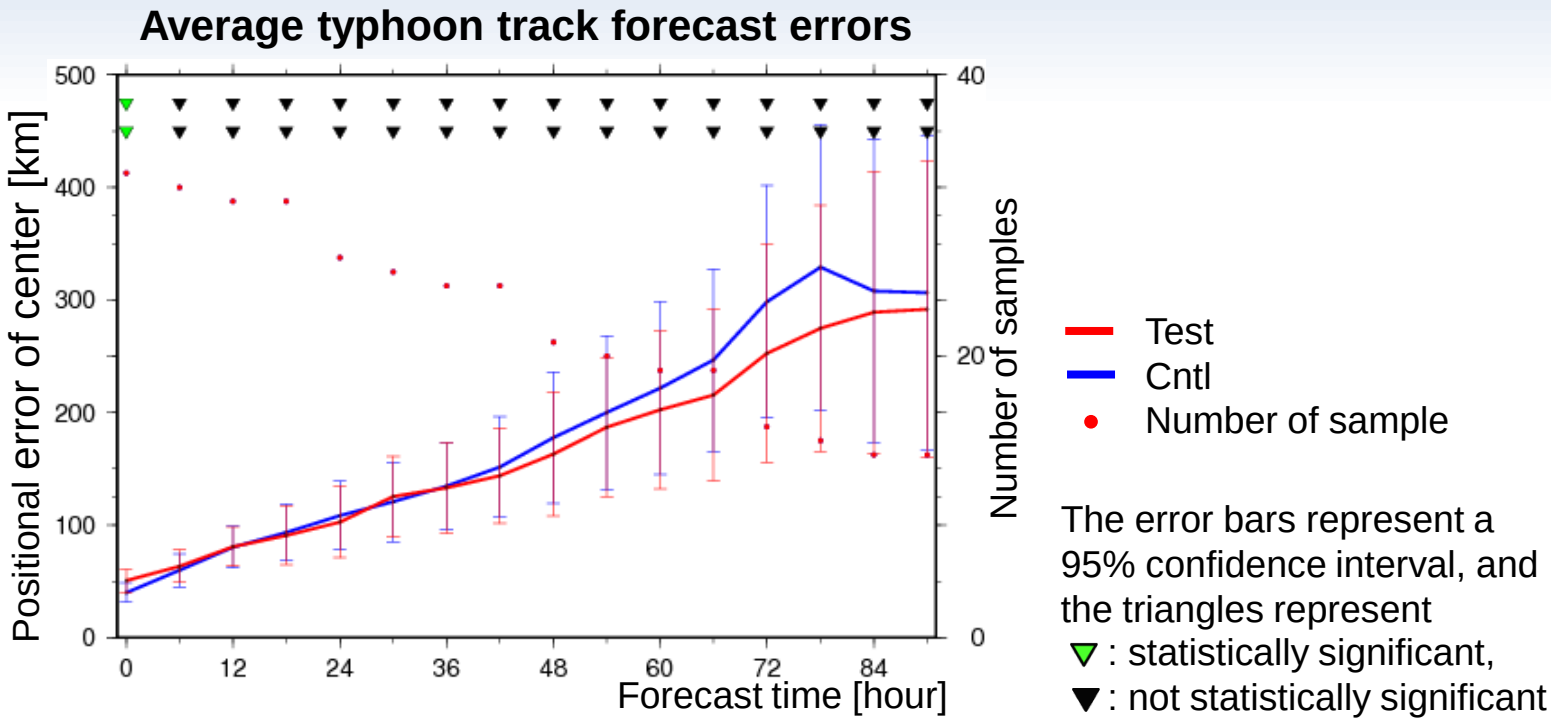
$$(RMSE = \sqrt{\sum (Fcst - Init)^2}/N)$$



The error bars represent a 95% confidence interval

- Forecast accuracy was improved slightly for almost all forecast time
- A slight change for the worse was confirmed only for first half of forecast time in the Trop.

Typhoon forecast



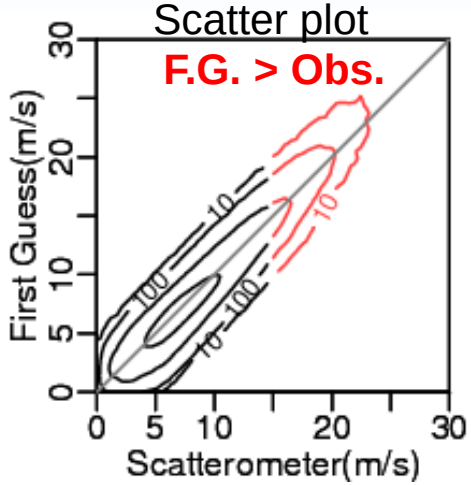
- Utilization ASCAT-B OVW data also brought accuracy of typhoon track forecast
- The neutral or worse result until FT=36 may be related to degradation of wind speed forecast for first half of forecast time in the Trop.

Impact Study of trial wind speed bias correction in JMA's Global NWP system

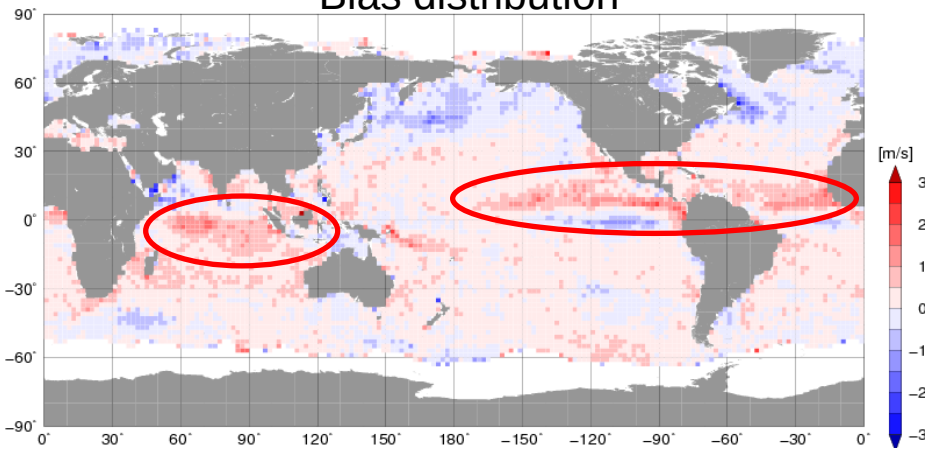
Wind speed bias problems

Wind speed First Guess departure (statistical period : Aug. 2013)

Scatter plot



Bias distribution



- Wind speed bias above 15m/s
  - These data are rejected simply in quality control procedure in operational use
- Positive bias in the tropics
  - Only gross error check is performed in operational use

Trial bias correction

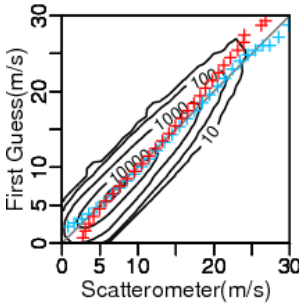
- 3rd order polynomial fitting

$$spd' = C0 + C1(spd)^1 + C2(spd)^2 + C3(spd)^3$$

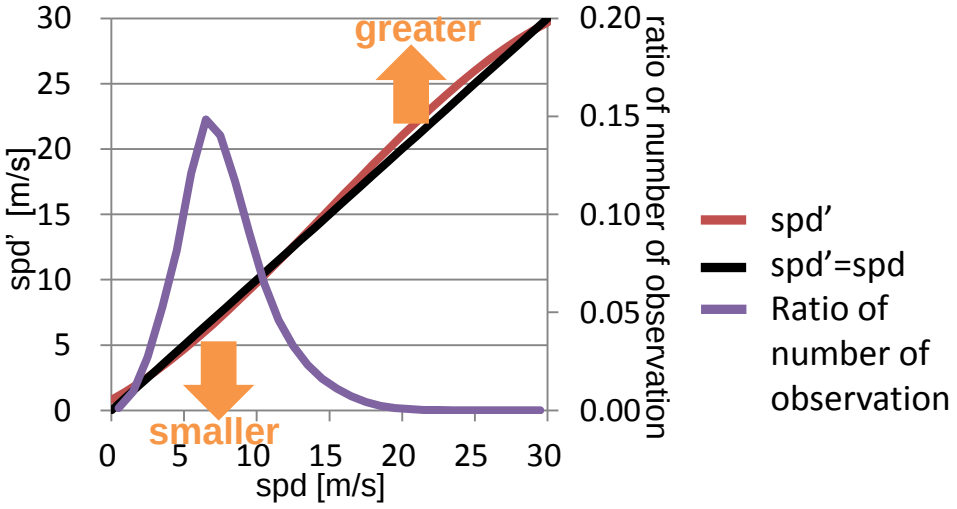
spd':corrected wind speed spd: observed wind speed

(Cotton, J., 2009: A comparison of QuikSCAT with buoy, ship and radar altimeter wind speeds and evaluating the need for a new bias correction. Met Office Forecasting Research Technical Report 538.)

- Pairs of Obs. and F.G. value averaged by both Obs. and F.G. bins are used for fitting samples
- This correction makes observed wind speed
  - greater in high wind speed region
  - slightly smaller in moderate wind speed region
  - smaller as a whole due to ratio of number of observation



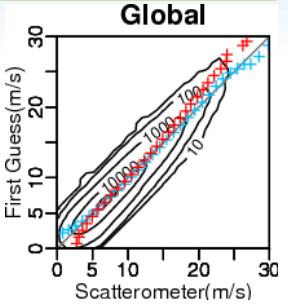
+:Average value for binned by Obs.
+:Agerage value for binned by F.G.



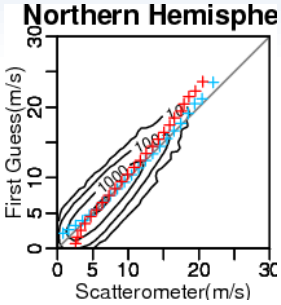
F.G. departure after bias correction

Not applied

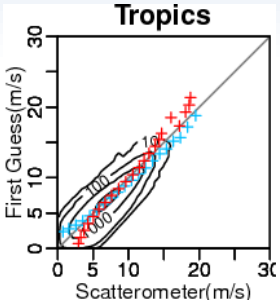
+:average value for binned by Obs. +:average value for binned by F.G.



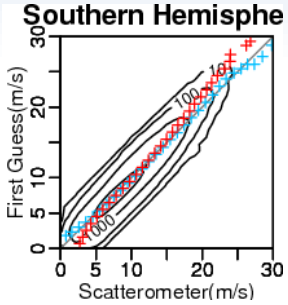
Bias:0.14 Stdv:1.24



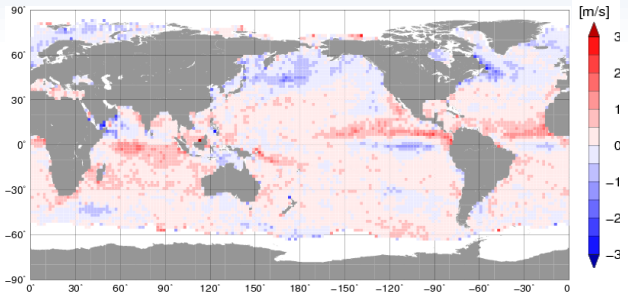
Bias:-0.1 Stdv:1.18



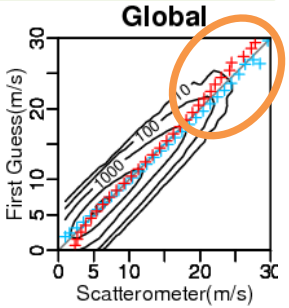
Bias:0.29 Stdv:1.17



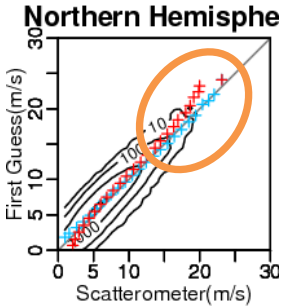
Bias:0.17 Stdv:1.30



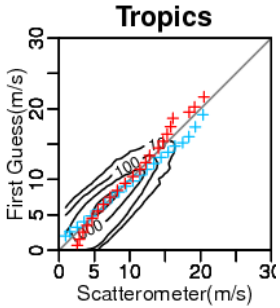
Applied



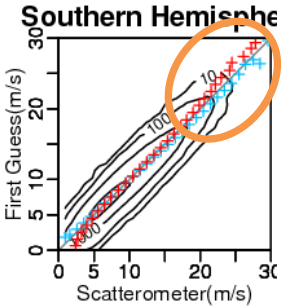
Bias:-0.11 Stdv:1.22



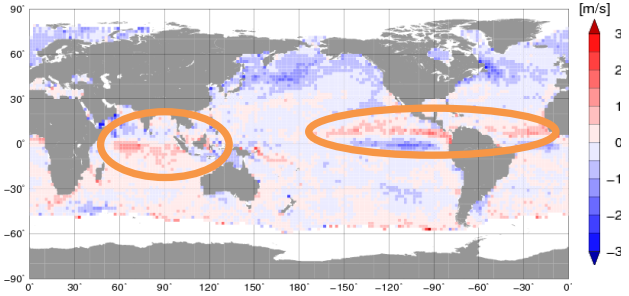
Bias:-0.4 Stdv:1.16



Bias:**-0.03** Stdv:1.18



Bias:**0.02** Stdv:1.26

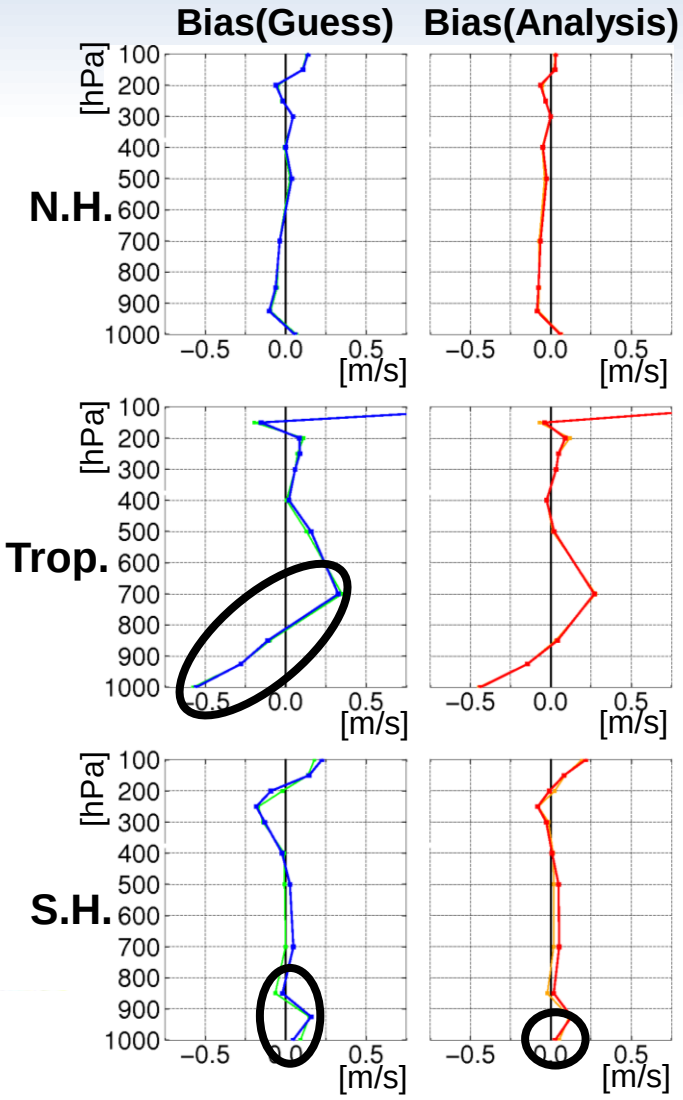


- F.G.>Obs. bias in high speed region is mitigated
- Obs.>F.G. bias in the tropics is also mitigated

Setup of impact experiment for bias correction

- Names of experiments
  - CNTL : same as operational Global NWP system as of Dec.2013 (vertical resolution is 60 layers (lid at 0.1hPa))
  - TEST : CNTL + wind speed Bias correction for scatterometer OVW + observational error inflation (1.5 times) in the N.H.
- 3rd order polynomial fitting was applied for wind speed bias correction
- Assimilation Period
  - From 10 Jul. 2013 to 11 Sep. 2013
- Forecast period
  - From 21 Jul. 2013 to 11 Sep. 2013
- Verified period
  - From 1 Aug. 2013 to 31 Aug. 2013

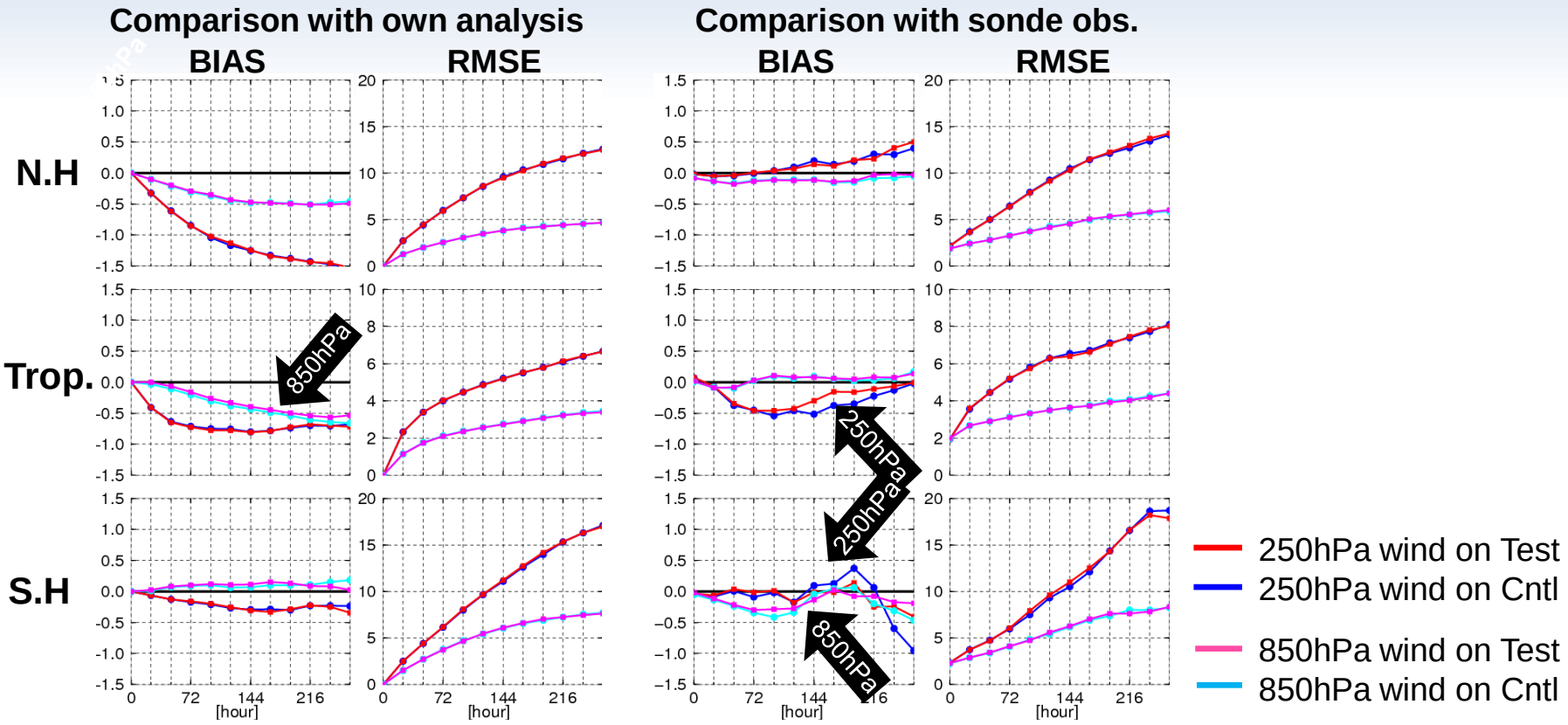
Wind analysis field



- In comparison with radio sonde observation, wind speed bias of wind analysis and guess field on low level layers was improved
  - In the Trop. slightly
  - In the S.H.
- But, we can also see bias change for the worse in the S.H. on around 600 hPa layer

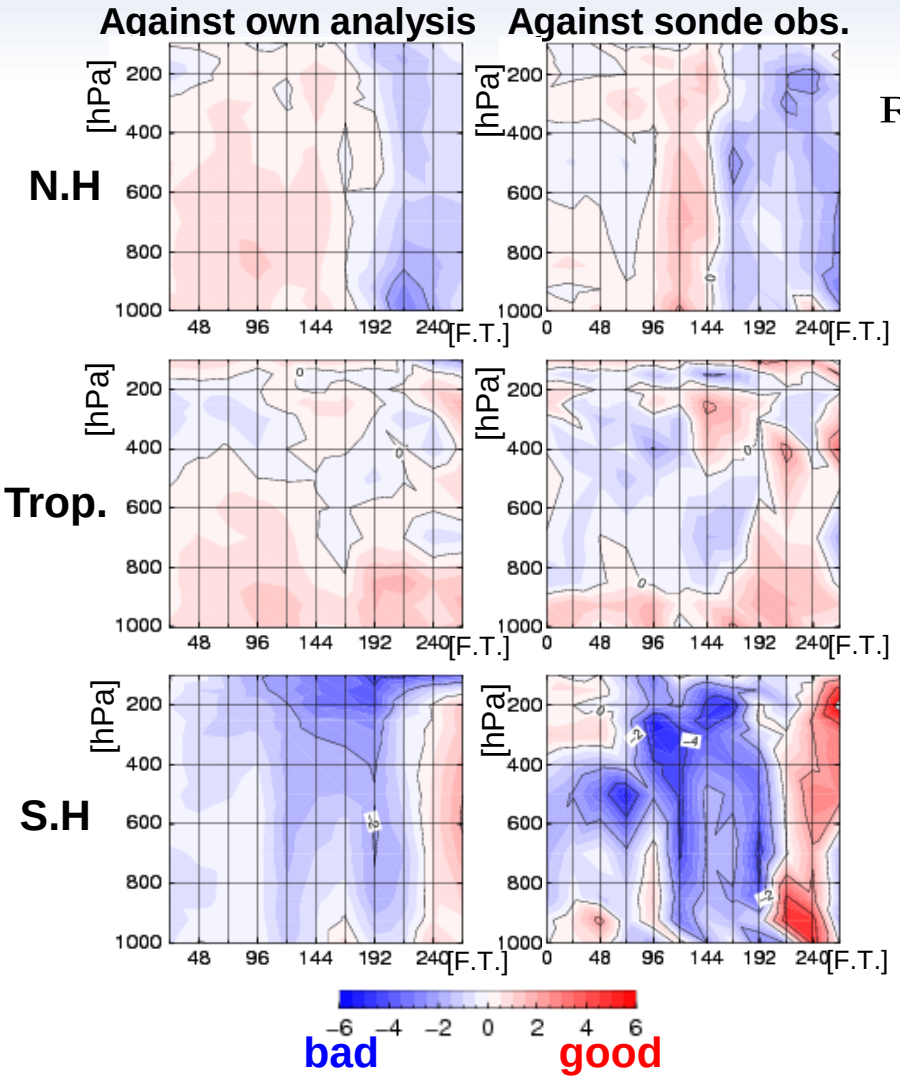
Guess Test
Guess Cntl
Analysis Test
Analysis Cntl

Wind forecast field



- Both in the Trop. and the S.H., wind speed bias was mitigated in comparison with own analysis and sonde observation
- This result is consistent with bias mitigation at F.G. departure statistics

Rate of improvement of Wind speed



$$ROI[\%] = (RMSE_{CNTL} - RMSE_{TEST})/RMSE_{CNTL}$$

$$(RMSE = \sqrt{\sum (Fcst - ref.)^2}/N$$

$$ref.: own\ analysis\ or\ sonde\ obs.)$$

- In the N.H., wind field on almost all layers were improved in first half forecast time
- In the Trop., wind field on low level layers were improved
- In the S.H., worse result was noticeable. It may be due to the bias change for worse on middle level layers

Summary

- JMA began to utilize ASCAT-B OVW data in its global NWP system, and it improved analysis and forecast fields
- Effects of trial wind speed bias correction were confirmed
  - Departure statistics
    - Negative F.G. departure bias above 15m/s was mitigated
    - Positive F.G. departure bias in the Trop. was mitigated
  - Analysis field
    - Wind speed bias on low level layers was mitigated mainly in the Trop. and S.H.
  - Forecast field
    - Wind speed bias on low level layers was also mitigated mainly in the Trop. and the S.H.
    - Wind speed forecast accuracy in the N.H. and the Trop. Was improved, but that in the S.H. changed for the worse

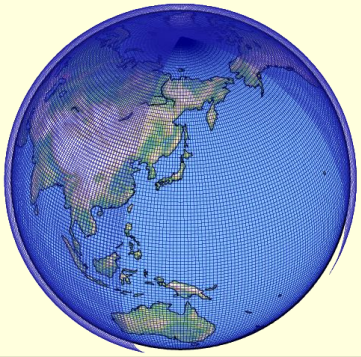
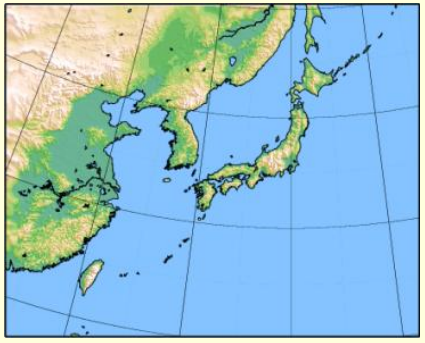

THANK YOU

Utilization of scatterometer data in JMA

- For numerical weather prediction(NWP)
  - JMA have operated 3 kinds of deterministic NWP systems, depending on target domain
    - Global NWP system (Global)
    - Mesoscale NWP system (Japan and its surroundings area)
    - Local NWP system (Japan area)
  - Scatterometer OVW data are assimilated in Global NWP system to provide initial field for Global forecast model
  - Utilization in Mesoscale NWP system is under development
- For disaster prevention information
  - Typhoon analysis
  - Monitoring weather condition

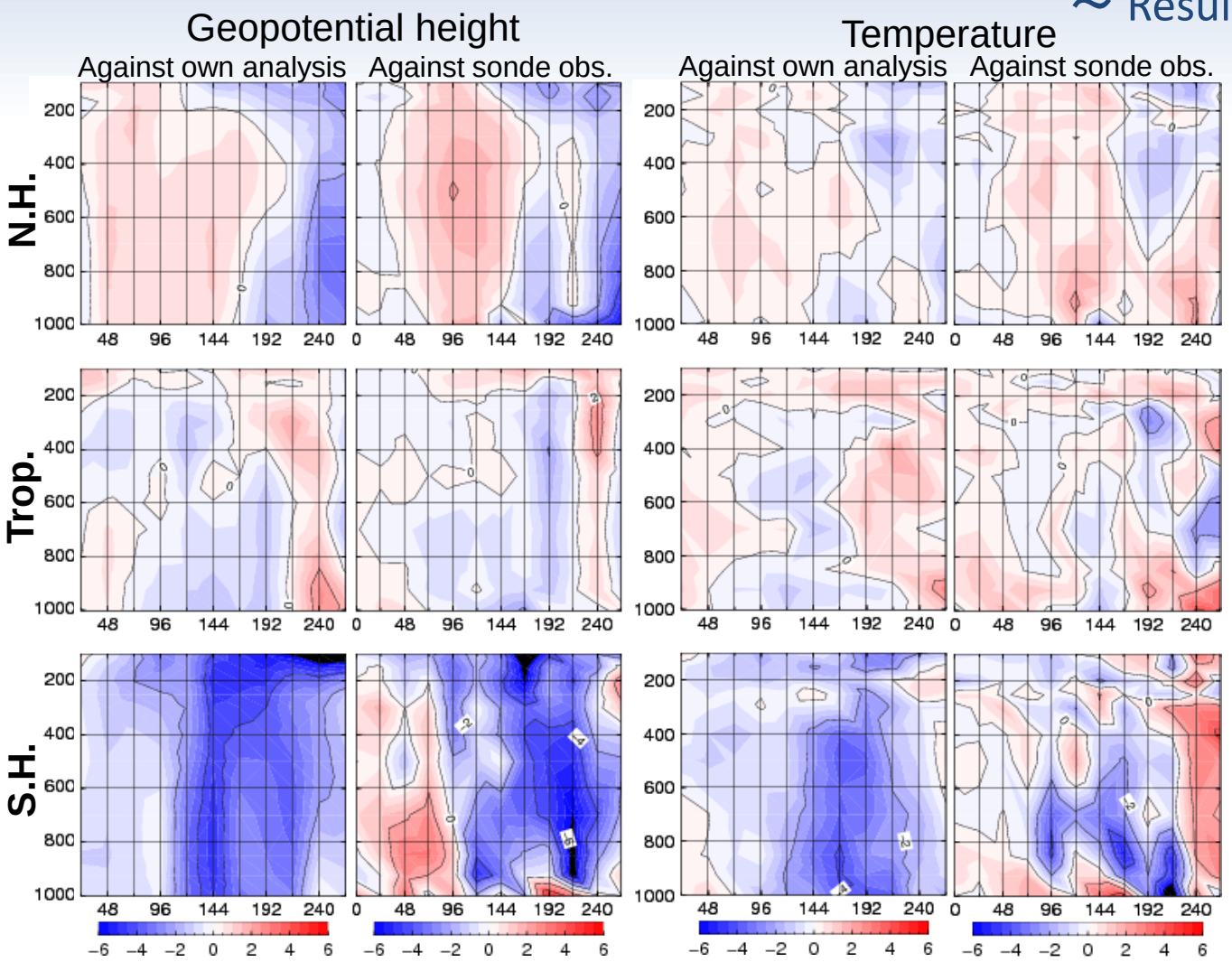
Operational NWP systems in JMA

As of 8 May 2013

NWP system	Global NWP system	Meso NWP system	Local NWP system
Purpose	**short-range forecast** **one-week forecast**	**Disaster prevention information**	**Disaster prevention information** **Aviation services**
Forecast model Resolution(H/V)	**Global Spectral Model(GSM)** **TL959 (20km) / 100 (0.01hPa)**	**Meso Scale Model(MSM)** **5km / 50 (21.8km)**	**Local Forecast Model(LFM)** **2km/60(20.2km)**
Forecast range (Initial time)	**84h** (00,06,18UTC) **264h** (12UTC)	**39h**	**9h**(on the hour)
Data Assimilation (resolution)	**4D-Var** (outer TL959(20km) inner TL319(55km))	**4D-Var** (outer 5km inner 15km)	**3D-Var** (5km)
Cut off time of observational data against initial time	**Cycle analysis** **+11h50m(00,12UTC)** **+ 7h50m(06,18 UTC)** **Early analysis** **+ 2h20m(00,06,12,18UTC)**	**+ 0h50m**	**+ 0h30m**
Area			

Rate of improvement of other elements

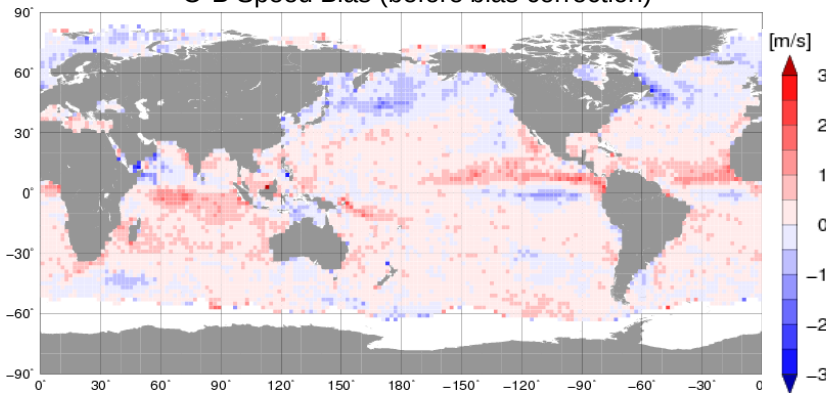
~ Result of bias correction ~

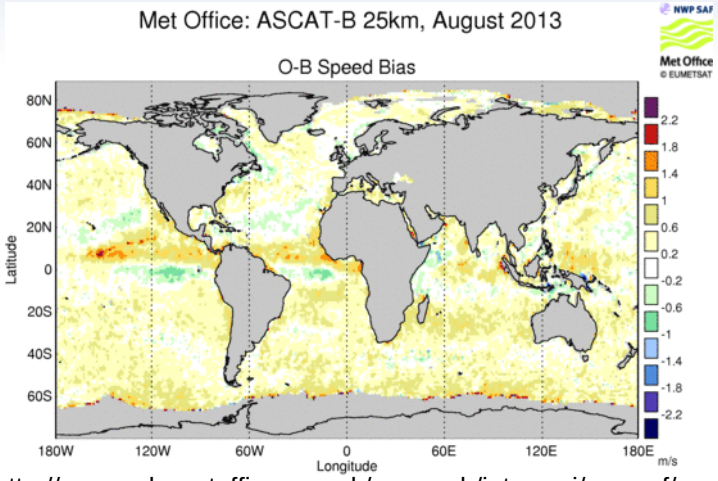


- Results were similar as wind field
  - In the N.H., forecast in first half time is improved
  - the improvement of analysis field didn't result in good forecast
- Overall, the improvement of analysis field didn't last in the later half of forecast time

Bias in the Trop.

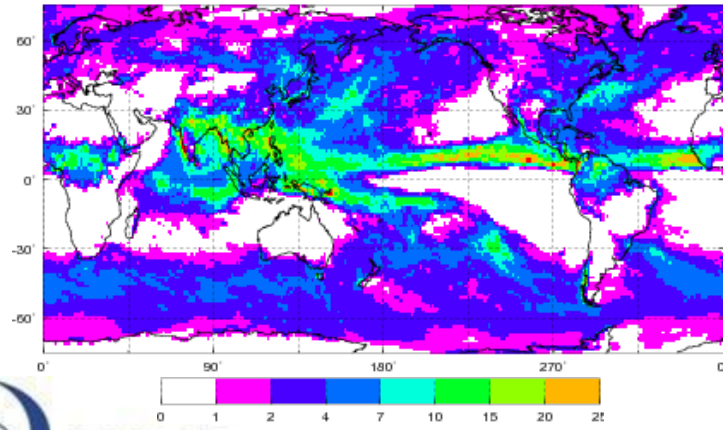
JMA ASCAT-A,B 25km, August 2013
O-B Speed Bias (before bias correction)





http://research.metoffice.gov.uk/research/interproj/nwpsaf/scatter_report/monthly_mon.html

Precipitation[mm/day], August 2013 in Test experiment



- Positive bias in the Trop. exist in both JMA's and Met Office's O-B statistics.
- This areas are corresponding to heavy rain areas.
- Probably, bias correction formula should include terms related to precipitation.