Impact of QuikSCAT Loss on JMA Data Assimilation System

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Outline

1. Background
- Status of NWP (Numerical Weather Prediction) models and use of scatterometer winds at JMA

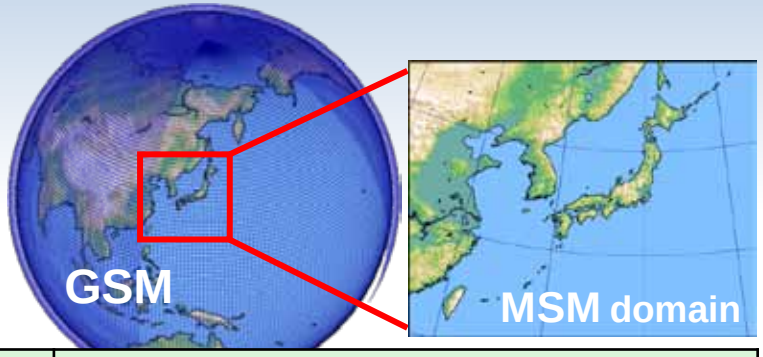
2. OSE(Observing System Experiment) of QuikSCAT winds
- Impact of QuikSCAT loss on JMA regional NWP model

3. OSE of NOAA's new ASCAT retrievals on JMA global NWP model
- Importance of data consistency between observation and NWP for DA (data assimilation)

4. Summary

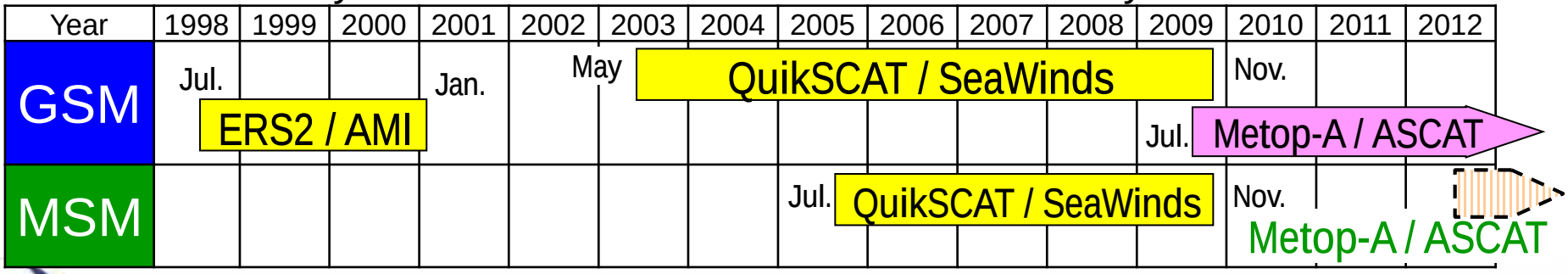
NWP systems and use of scatterometer winds at JMA

- Ø **Global** and **regiona**l deterministic NWP systems
  - ü DA (Data Assimilation) method: **4D-Var**
- Ø **ASCAT** winds are assimilated **in GSM.**
  - ü In the current **MSM**, analysis accuracy is probably degraded due to a lack of ASCAT use...



Model	Global Spectral Model (GSM)	MesoScale Model (MSM)
Resolution H/V (top height)	TL959 (**20**km) / **60** (**0.1**hPa)	**5**km / **50** (**21.8**km)
Forecast range (Initial time)	**84**h (00,06,18UTC), **216**h (12UTC)	**15**h (00,06,12,18UTC),**33**h (03,09,15,21UTC)
Target	1 to 7 day forecast	Disaster prevention information
DA system (outer/inner loop)	4D-Var (TL959/T159)	4D-Var (5km / 15km)

History of scatterometer data use in the JMA DA system

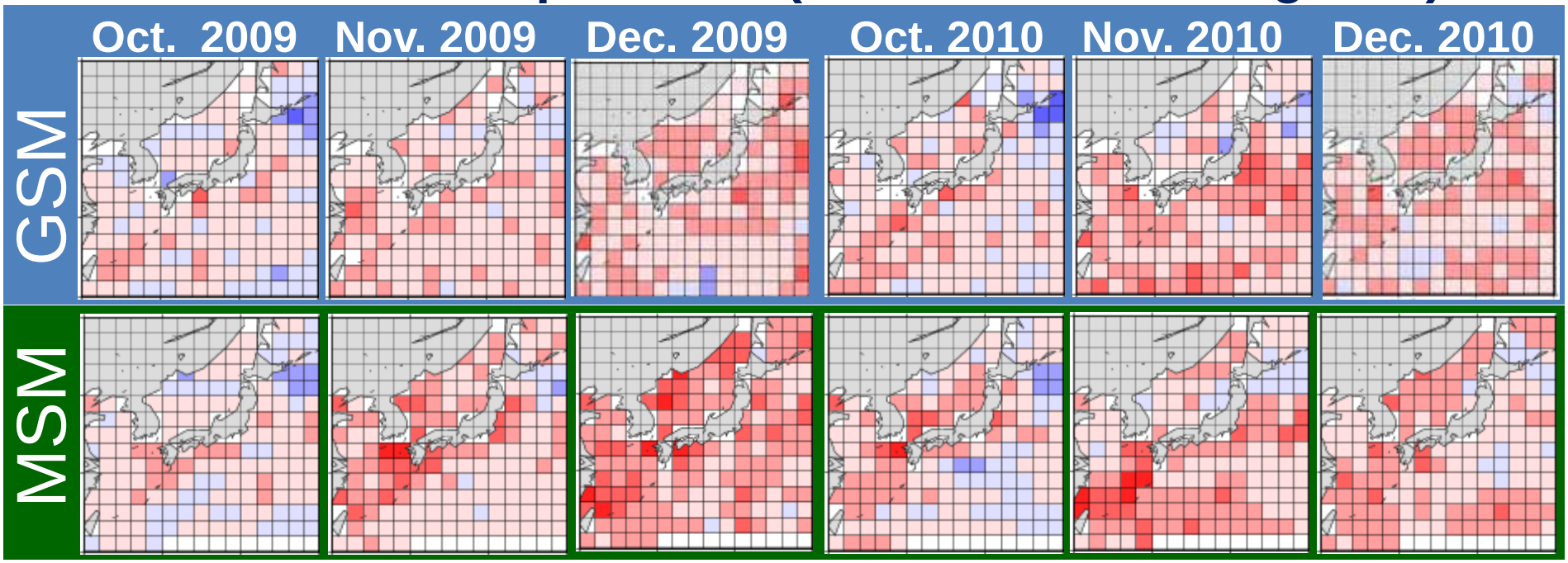


Impact of QuikSCAT loss on **operational** NWP models

Ø No clear difference of wind speed bias between operational GSM and MSM.
- ü The upgrade of NWP system (e.g., introduction of new observation, upgrade of DA system, model physics) makes it difficult to assess the impact of QuikSCAT loss.

Ø OSEs with and without QuikSCAT on MSM. → *Today's Topic-1*

ASCAT wind speed O-B (Observation - first guess)



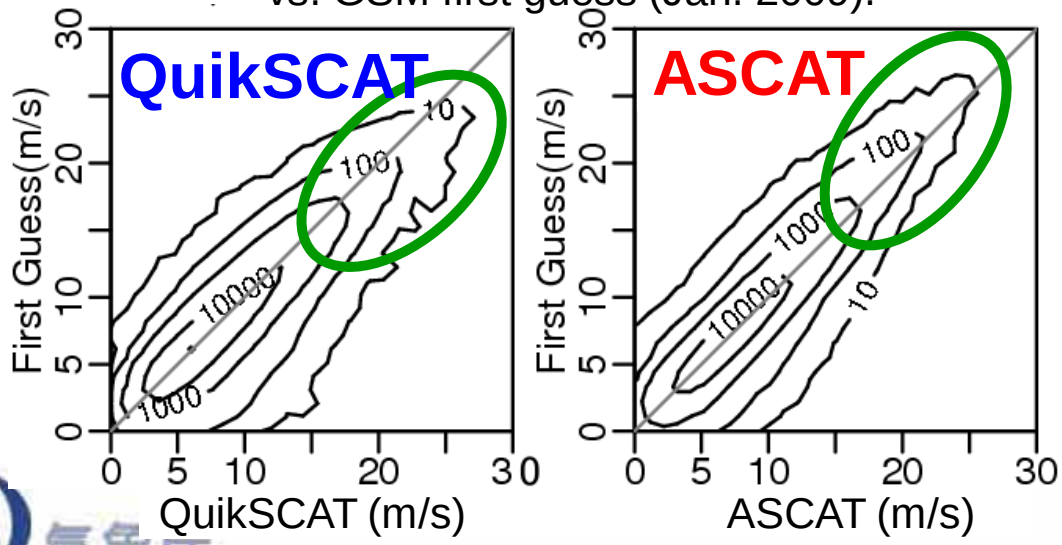
Limitations of ASCAT wind utilization on GSM

- Ø ASCAT has a slow speed bias against GSM first guess above 15m/s.
- Ø Use of less biased data among the same kind of sensors or instruments is very important for DA. If observation has a bias against first guess…
  - ü Apply bias correction
  - ü **Not to use those data** …
- Ø OSE of NOAA's new ASCAT retrievals on GSM → *Today's Topic-2*

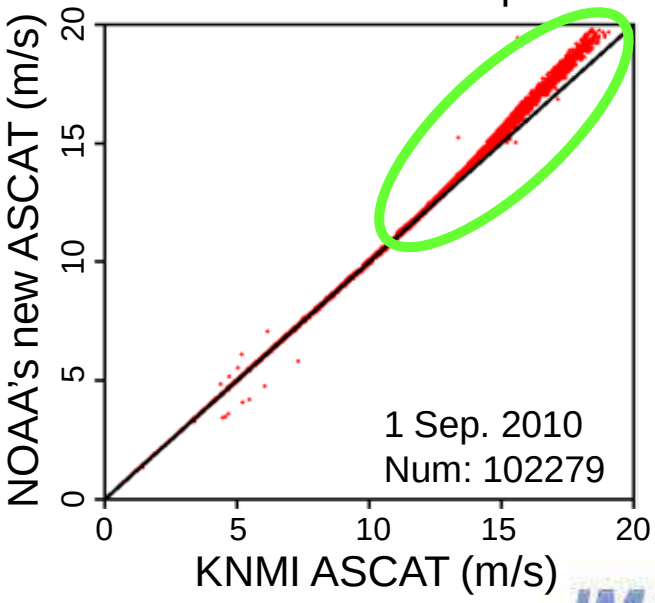
Special thanks to our colleagues at NOAA

ASCAT winds above 15 m/s are not assimilated in GSM.

2-D histogram of scatterometer wind speed vs. GSM first guess (Jan. 2009).

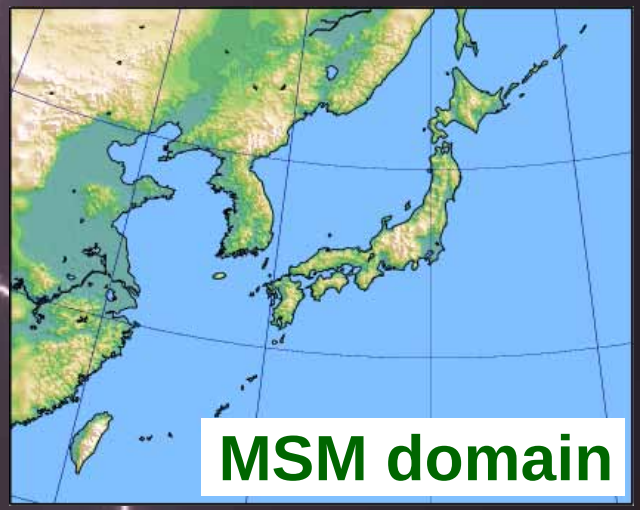


Comparison of ASCAT wind speed between NOAA and KNMI product



OSE of QuikSCAT winds on MSM

Ø To investigate the impact of QuikSCAT winds on MSM, Observing System Experiments (OSEs) were carried out.



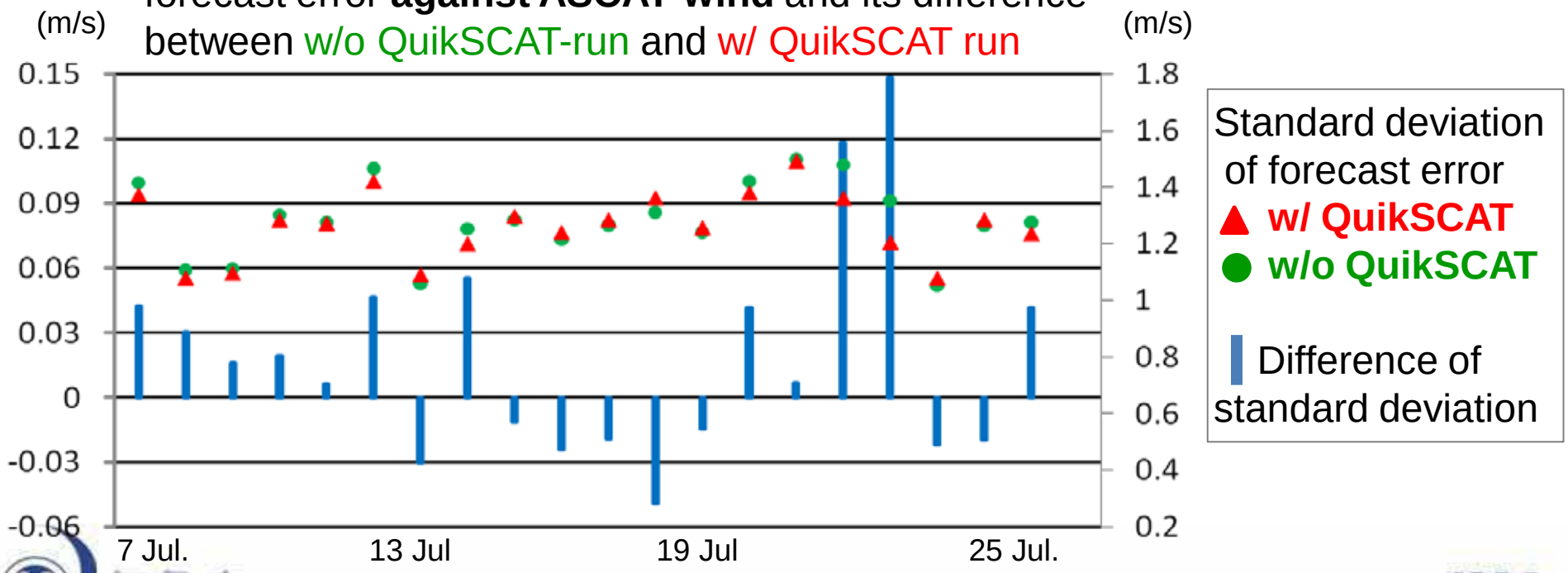
Experimental design

Experimental Period	21days: From 6 Jul. 2009 to 26 Jul. 2009 (East Asia rainy season)
Analysis and Forecast Time	**8times /day** (00, 03, 06, 09, 12, 15, 18, 21UTC)
Use of QuikSCAT winds	Experiment1: **w/ QuikSCAT**, Experiment2: **w/o QuikSCAT**
NWP system configuration	Same as operational MSM as of Oct. 2010 **ASCAT winds are not assimilated**. (Horizontal resolution: **5km**, Number of vertical layer: **50)**

Improvement of **wind field analysis** over the ocean

Ø 3-hour forecast error against ASCAT wind speed.
  üASCAT data: Independent observation in this study (not assimilated)
Ø Positive bar-plot indicates smaller short-range forecast errors in QuikSCAT-run. Error reduction by assimilating is found QuikSCAT (≈ better analysis field).

Time series of standard deviation of wind speed forecast error **against ASCAT wind** and its difference between w/o QuikSCAT-run and w/ QuikSCAT run

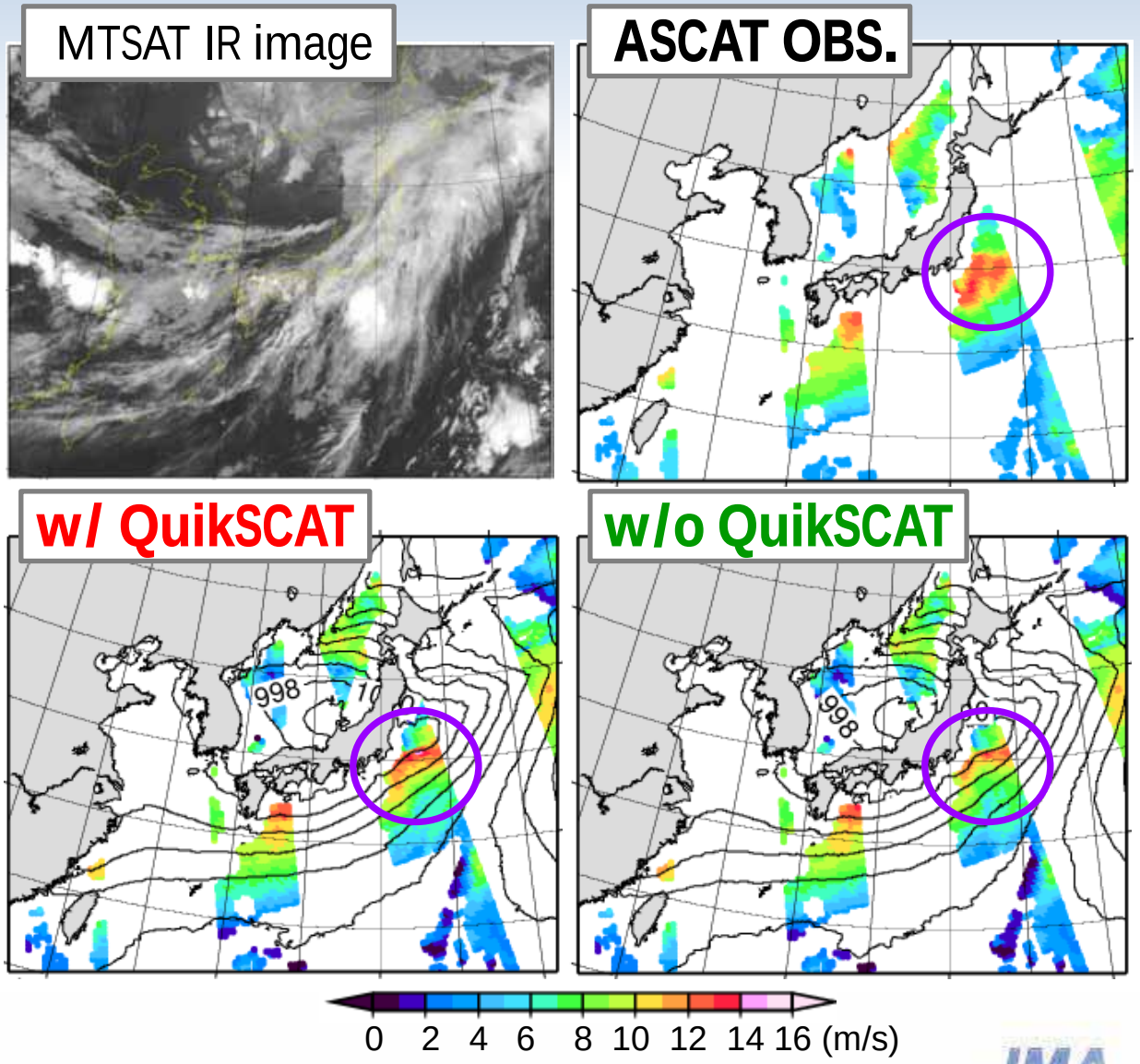


Improvement of **wind field forecast** over the ocean

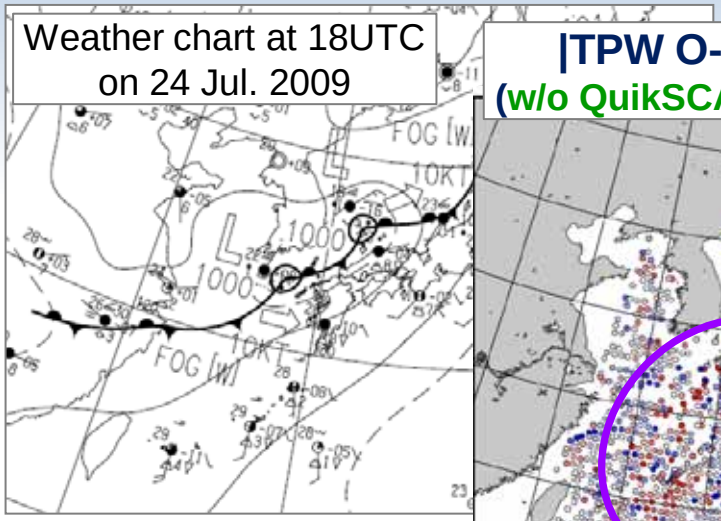
- Comparison of ocean surface wind speed forecast with ASCAT wind speed

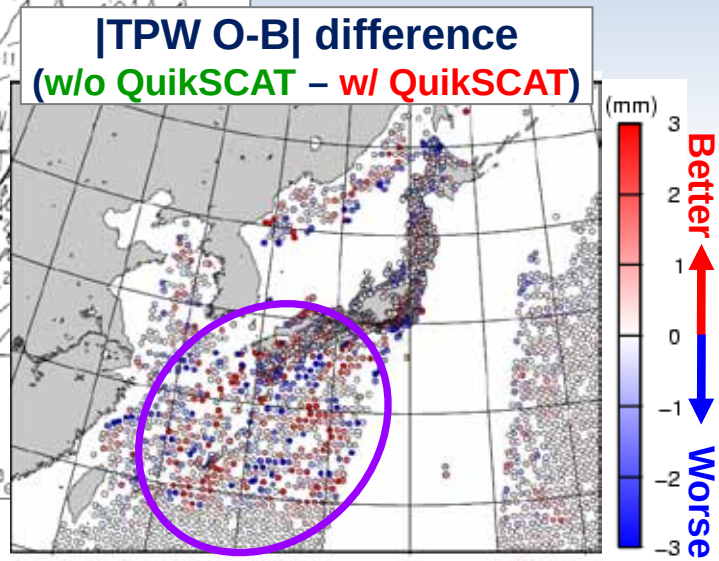
- 15-hour forecast from 21UTC on 20 Jul. 2009
  - ü Shade: Ocean surface wind speed (m/s)
  - ü Contour: Sea level pressure (hPa)

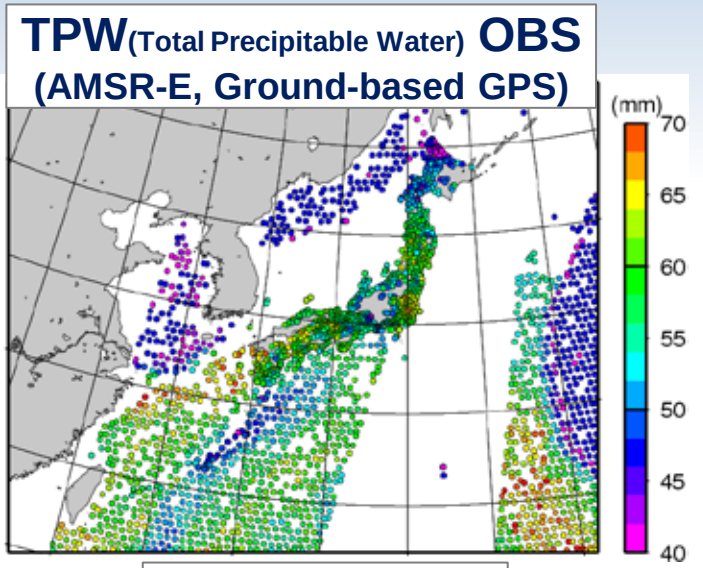
- Wind field around a low pressure system was strengthened in QuikSCAT-run.



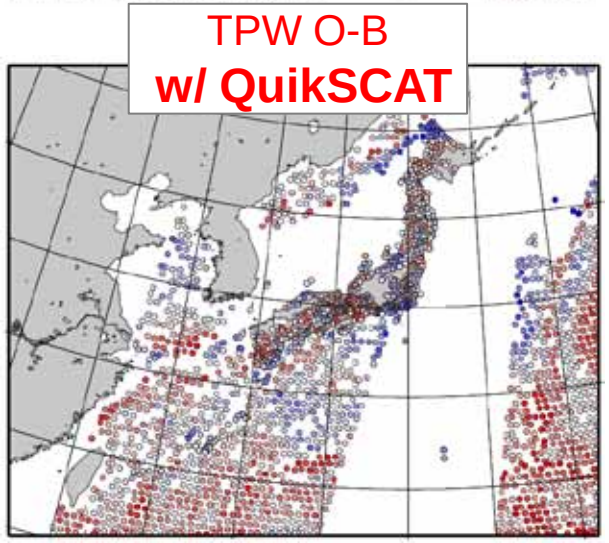
Improvement of **moisture field analysis** over the ocean

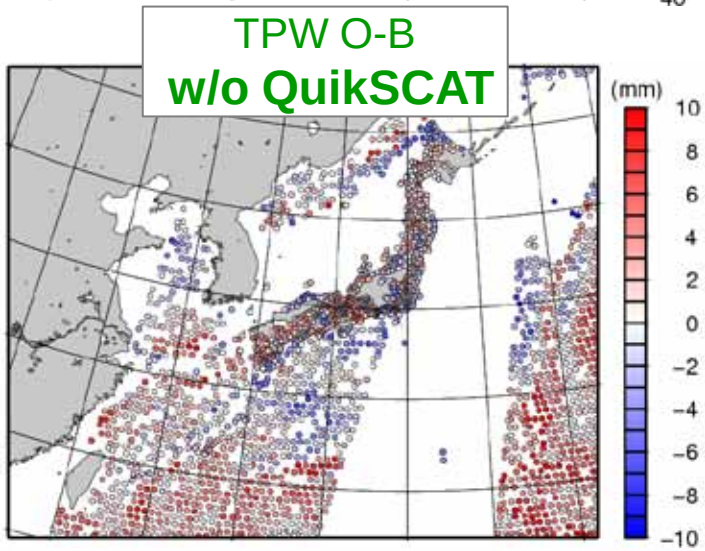






- Positive O-B difference: Error reduction against observation in QuikSCAT-run.
- Slight improvement of moisture field in QuikSCAT-run.

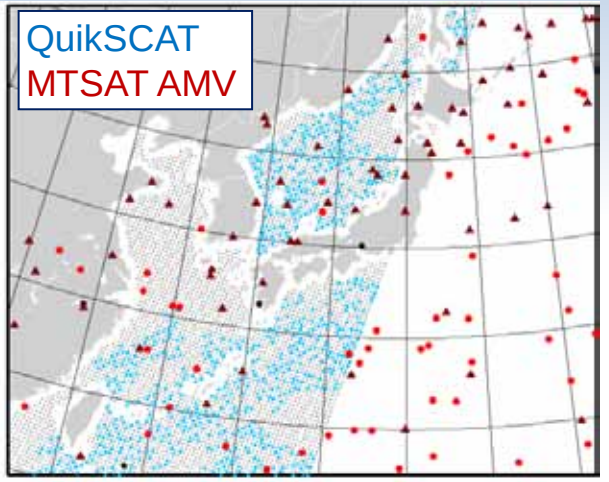




MSM analysis at 18UTC on 24 Jul. 2009

Impact of QuikSCAT winds on **precipitation forecast**

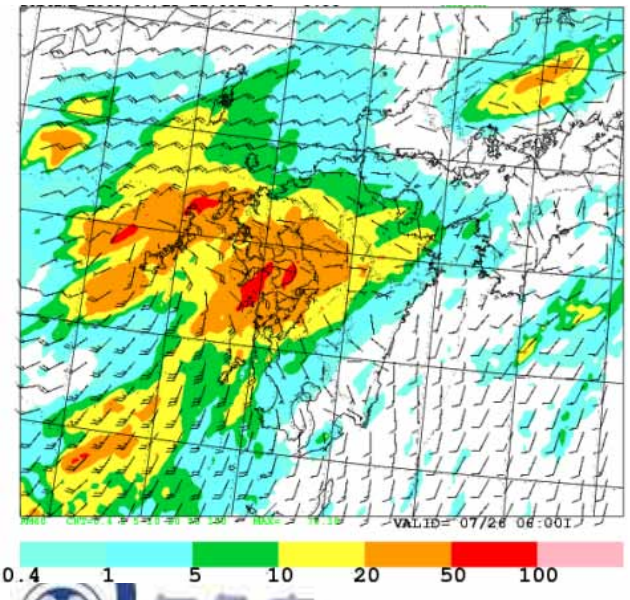
Assimilated QuikSCAT data at 12UTC on 25 Jul. 2009

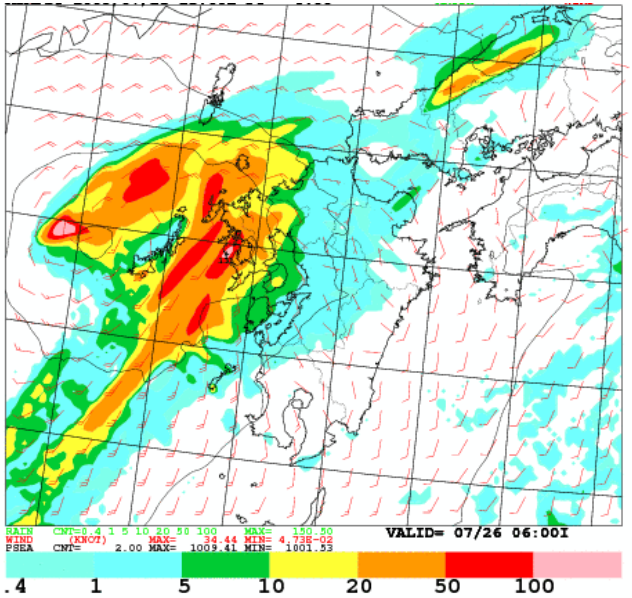


- Ø 6-hour forecast from 15UTC on 25 Jul. 2009
  Shade: **Accumulated precipitation (mm/3h)**
- Ø Position of low pressure system and its rainfall was improved in QuikSCAT-run.

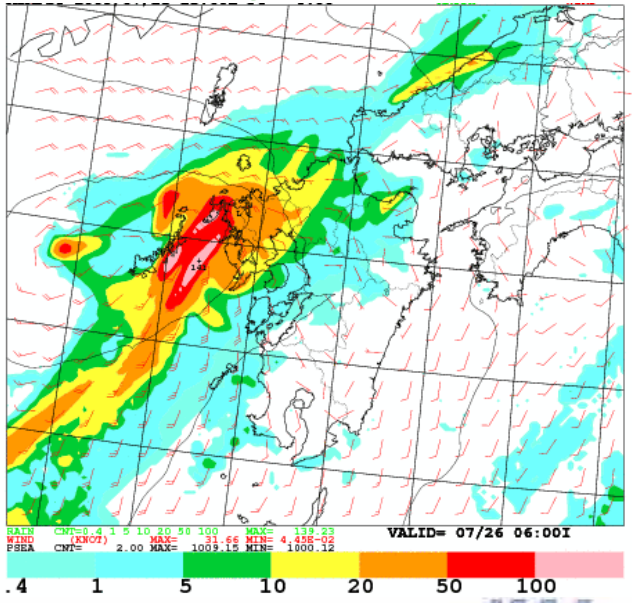
Radar/Raingauge-Analyzed Precipitation and surface vector winds of MSM analysis at valid time

w/ QuikSCAT



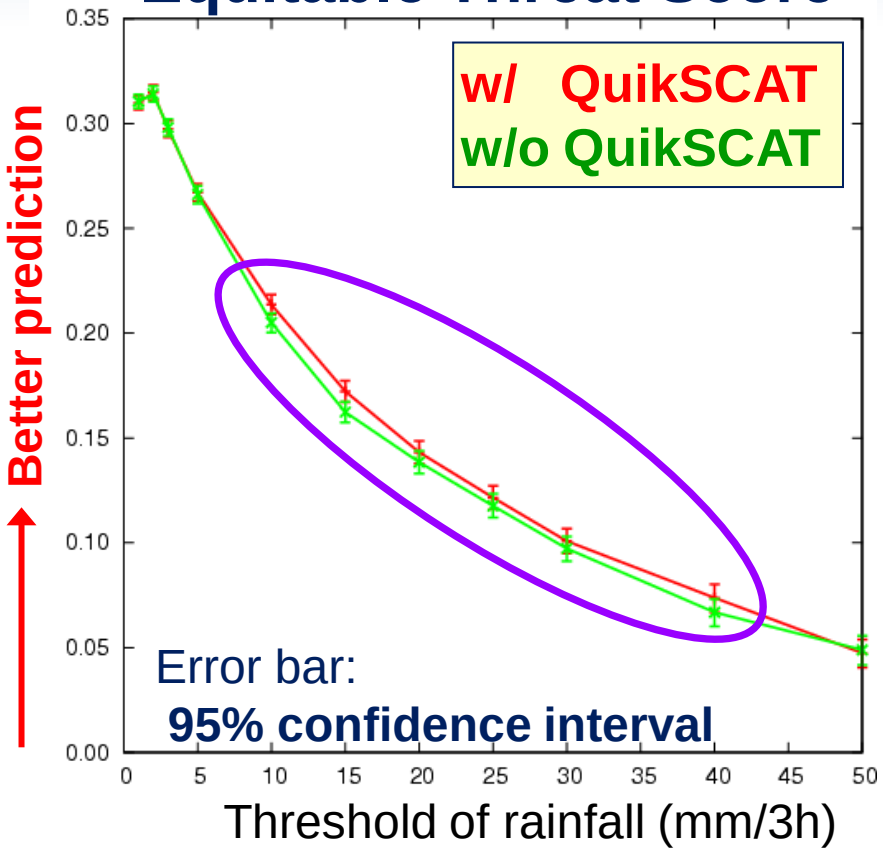


w/o QuikSCAT



Improvement of **precipitation forecast score**

Equitable Threat Score



Ø Correction of wind field by QuikSCAT winds improves moisture field and convective rain over the ocean.

Ø Better forecast score especially for moderate to heavy rain cases.

ü MSM precipitation vs. Radar OBS
ü Verification grid size: 20 km
ü Score of 3-hour accumulated maximum rainfall in a verification grid
ü 15-hour forecast
ü Statistics for 7 Jul. 2009 to 26 Jul. 2009

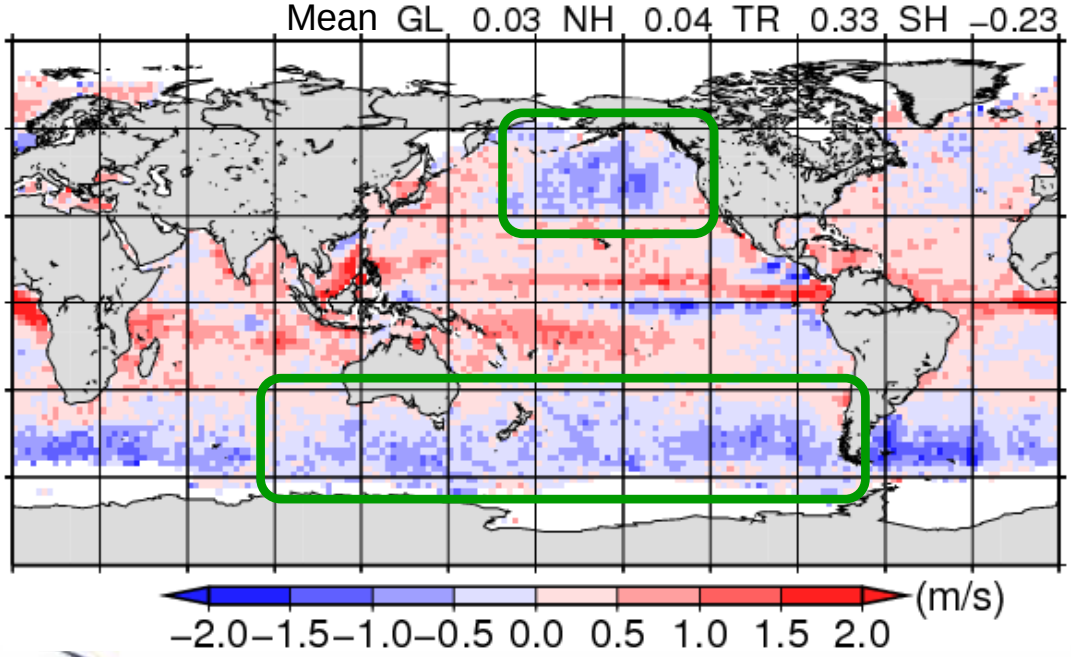
OSE of NOAA's new ASCAT retrievals on GSM

- **Three experiments**
  - **w/ NOAA** ASCAT
  - **w/ KNMI** ASCAT
  - **w/o** Scatterometer (ASCAT)
- **ASCAT wind usage**
  - **Assimilate wind speed up to 30m/s**
- **NWP model**
  - **Low resolution GSM (60km horizontal resolution)**
- **Experimental Period**
  - **Analysis: from 20 Dec. 2010 to 9 Feb. 2011 (4 analyses / day)**
  - **Forecast: from 1 Jan. 2011 to 31 Jan 2011 (1 forecast at 12UTC/ day)**
  - **Lack of NOAA ASCAT from 28 Jan. 2011 to 07 Feb. 2011**

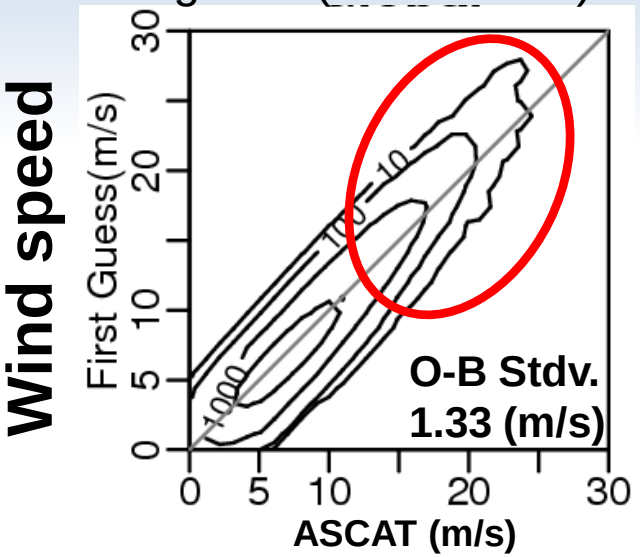
Wind speed comparison of **KNMI** ASCAT with first guess

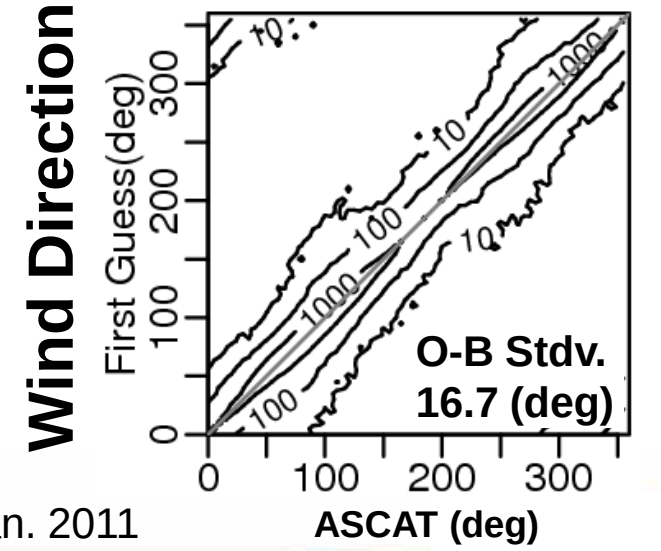
- Negative wind speed O-B bias over the North Pacific Ocean and the Southern Ocean.
- Slow speed bias against first guess at high speed regime.

Wind speed O-B (average in 2x2 deg grid)



2-D Histogram of ASCAT vs. first guess (Global data)



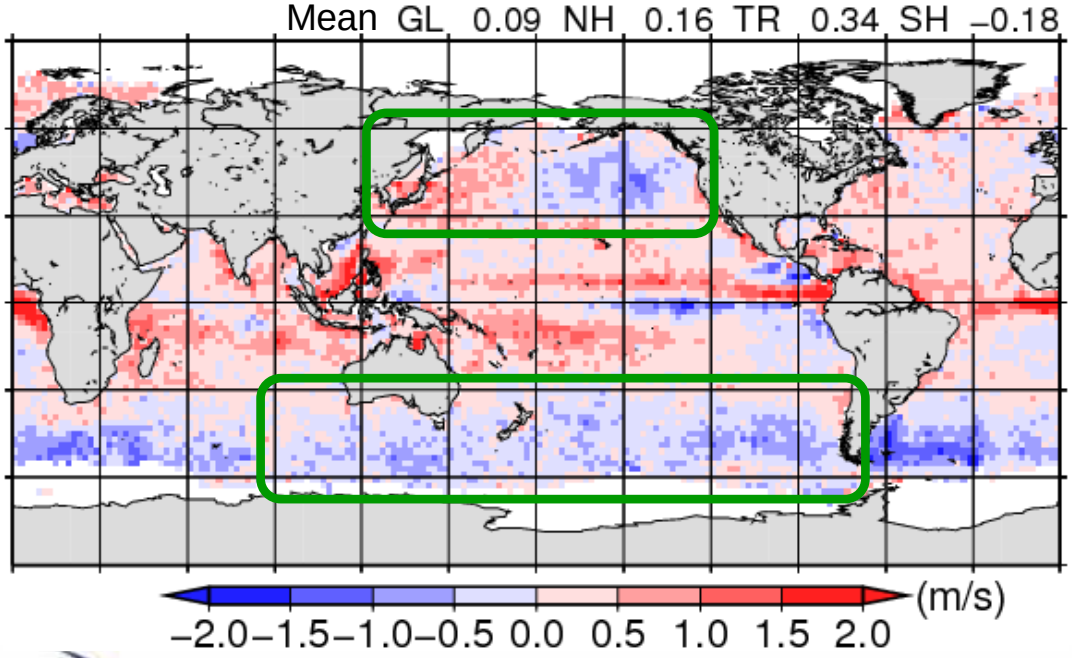


statistics for 27 Dec. 2010 to 26 Jan. 2011

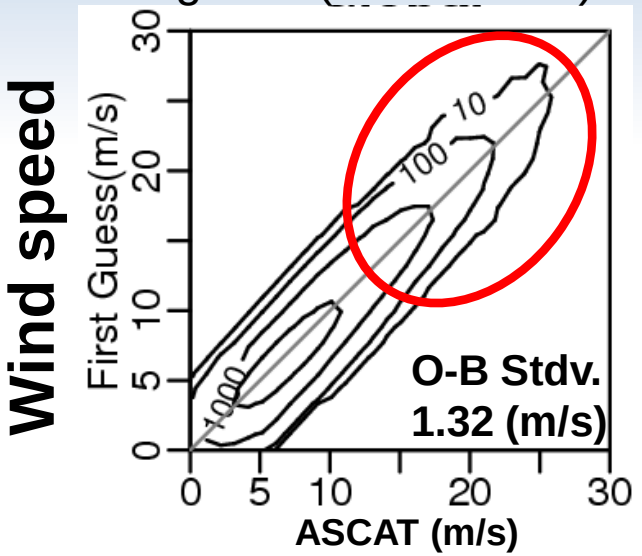
Wind speed comparison of **NOAA** ASCAT with first guess

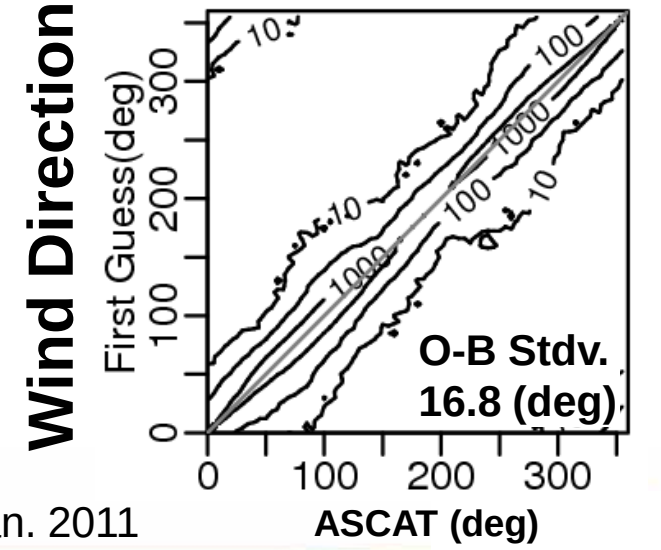
- Negative wind speed O-B bias was decreased.
- Positive bias over the North Western Pacific Ocean.

Wind speed O-B (average in 2x2 deg grid)



2-D Histogram of ASCAT vs. first guess (Global data)



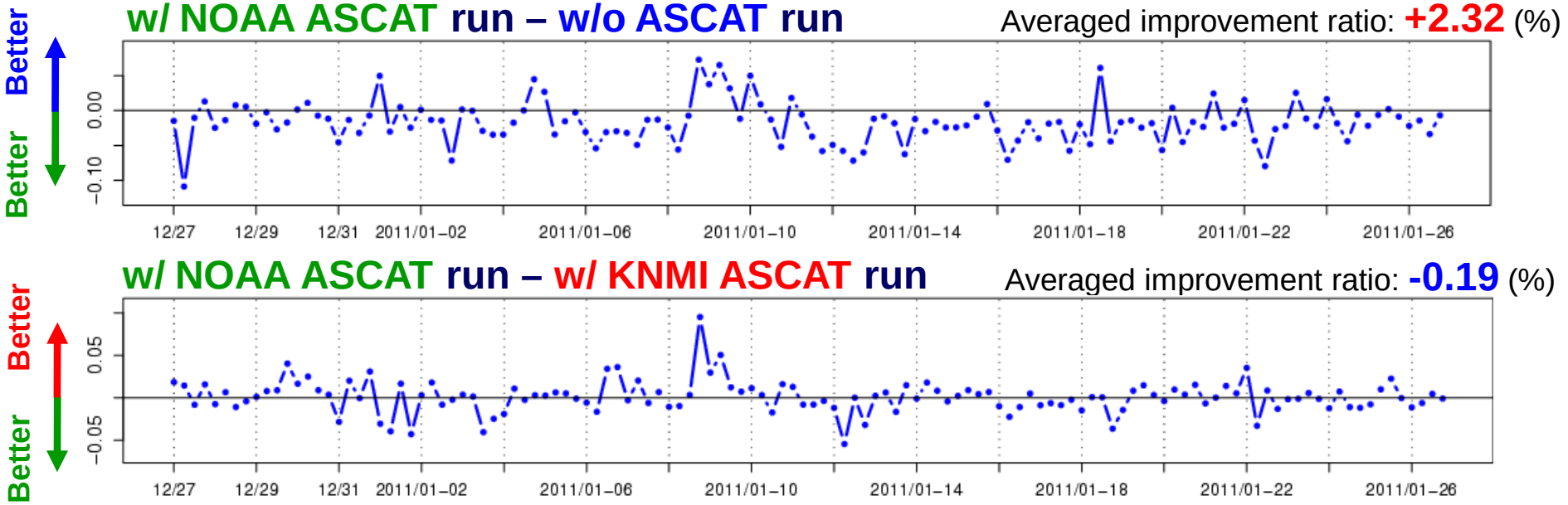


statistics for 27 Dec. 2010 to 26 Jan. 2011

Fitting of first-guess against buoy observation

- Ø Negative O-B difference indicates smaller first guess errors in NOAA ASCAT run. Significant error reduction by assimilating ASCAT is found.
- Ø Impact of NOAA ASCAT and KNMI ASCAT is comparable.

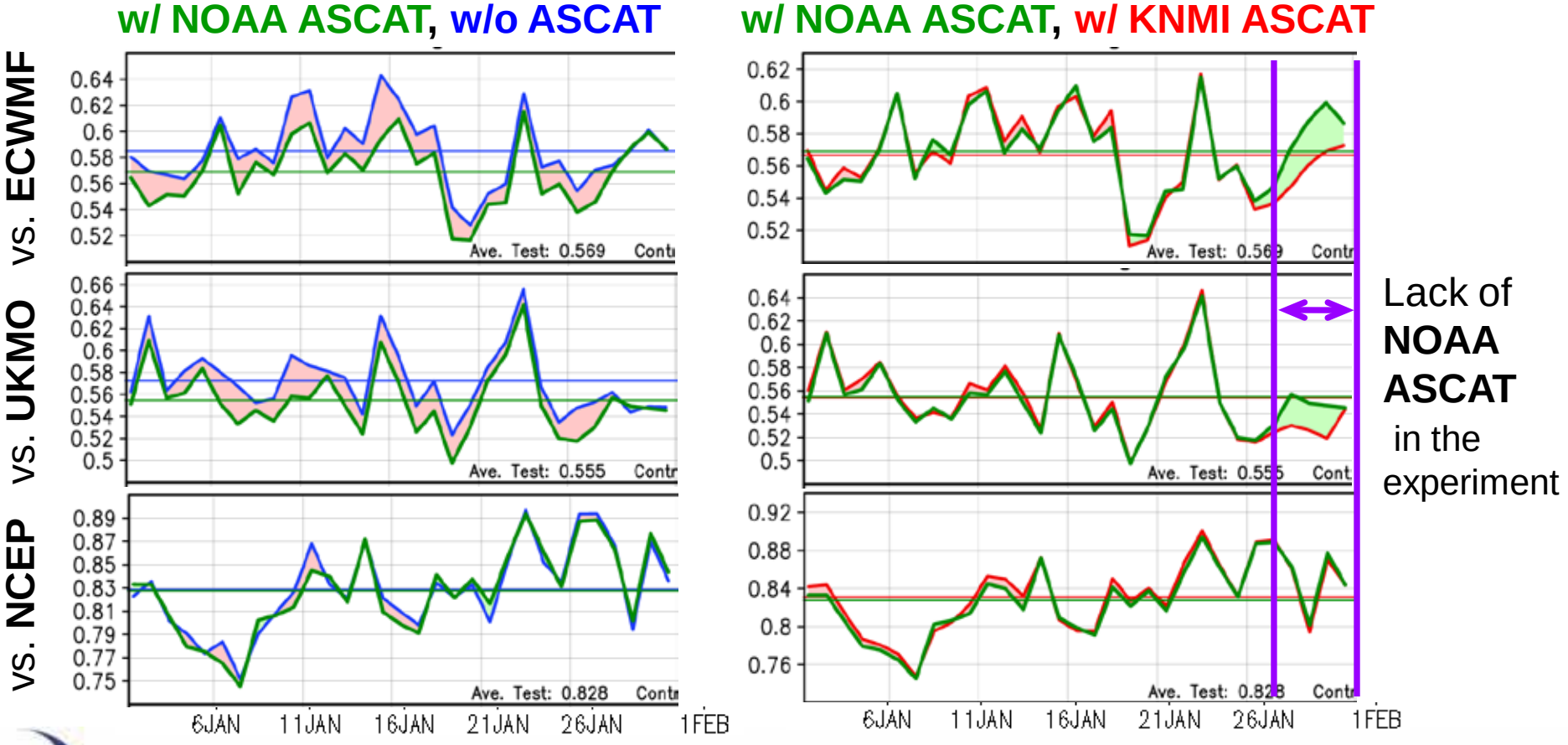
Time series of averaged standard deviation of buoy O-B difference for sea level pressure at every analysis (S80 °< lat < S40)°



Comparison of the initials with other NWP centers

ØRMS difference against initials for sea level pressure (global statistics)

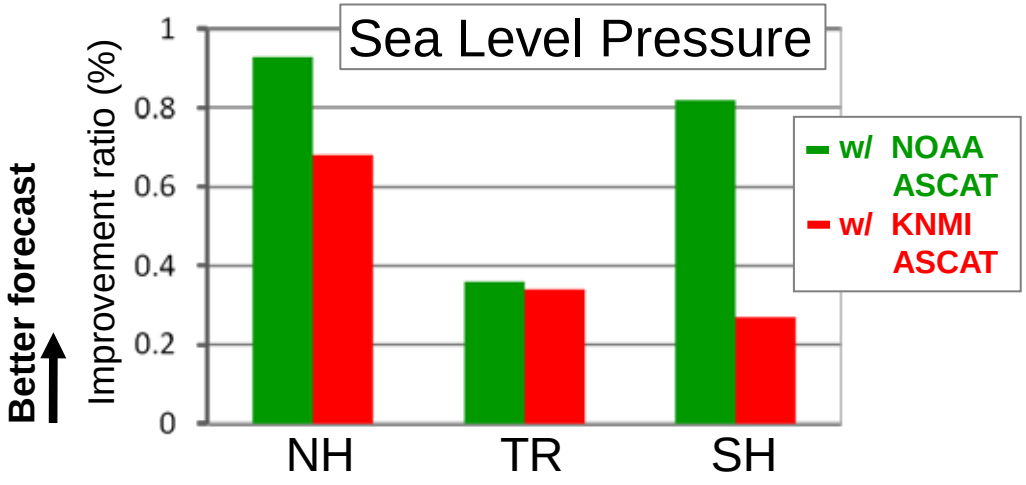
- ü Smaller RMS difference: Initial of GSM is closer to that of other NWP center.
- ü Neutral impact of NOAA ASCAT on analyses, compared to KNMI ASCAT.



Impact of ASCAT winds on forecast

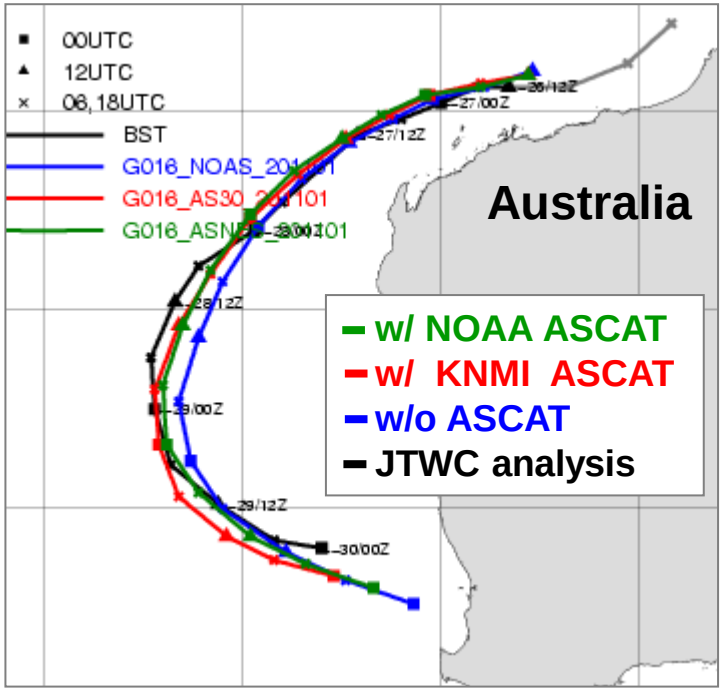
Ø ASCAT winds improve forecast field.
Ø Impact of NOAA ASCAT is slightly positive than that of KNMI ASCAT.

Improvement ratio of 2-day forecast against w/o ASCAT-run



$$\text{Improvement ratio (RMSE against the initials)} = \frac{\text{RMSE(w/o ASCAT)} - \text{RMSE(w/ ASCAT)}}{\text{RMSE(w/o ASCAT)}}$$

Track forecast of TC BIANCA
Initial: 12UTC on 26 Jan. 2011



Summary

OSE of QuikSCAT winds on MSM

- Ø Positive impact of QuikSCAT winds on analyses over the ocean.
- Ø Improvement of moisture field by using QuikSCAT leads to better precipitation forecasts.
- Ø Smaller impact than that previously obtained. It is due to
  - ü Upgrade of DA system
  - ü Increase of observation assimilated

OSE of NOAA's new ASCAT winds on GSM

- ØWind speed O-B with NOAA ASCAT is generally smaller than that with KNMI ASCAT run.
- ØNeutral or slightly positive impact on analyses and forecasts
  - ü Further investigation is needed to assess the impact of NOAA ASCAT.

Thank you for your attention.