Operational Use of Scatterometer Winds in the JMA Data Assimilation System

Masaya Takahashi

Numerical Prediction Division,
Japan Meteorological Agency (JMA)

International Ocean Vector Winds Science Team Meeting,
Barcelona, Spain, 18 - 20 May 2010

Outline

1. Background

2. JMA's Numerical Weather Prediction models
   - Status of NWP models
   - usage of scatterometer winds

3. Ongoing development
   - Impact study of ASCAT winds in a regional NWP model

4. Summary

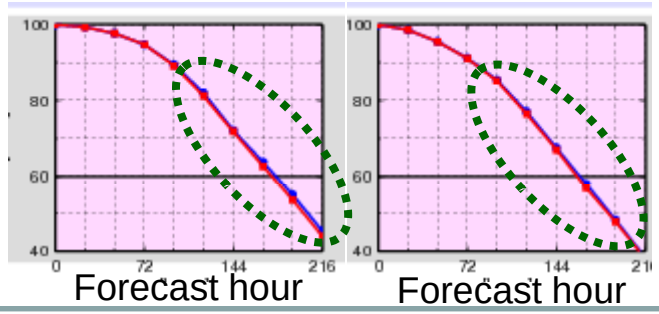
Background

1. Status of the JMA Numerical Weather Prediction models

- JMA operates global and regional deterministic NWP models.
- Operational use of Metop-A/ASCAT winds in the global model has been started in July 2009.

Anomaly correlations (Jan. 2010, S.H.)

Sea level pressure Z500



w/o ASCAT
w/ ASCAT (=operation)

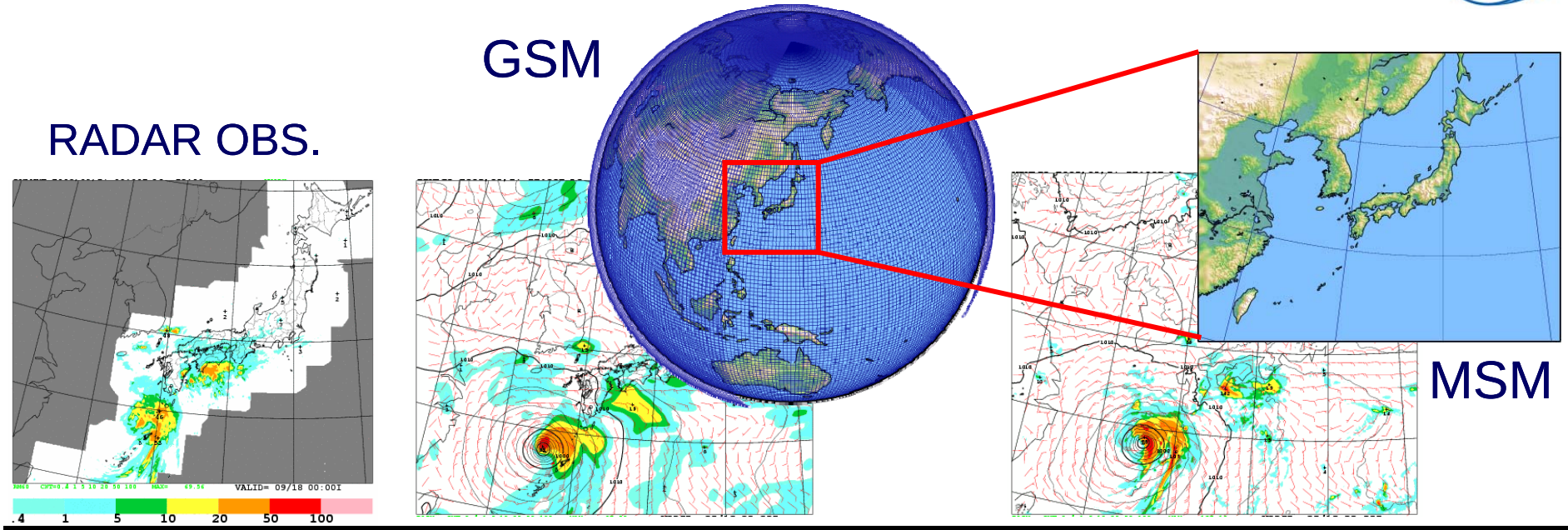
Results of a low resolution global model.

ASCAT data prevent the degradation of forecast scores after the end of QuikSCAT nominal mission.

2. Utilization of ASCAT winds in the regional NWP model

- Observations used in the regional model are less than those in the global model due to a short data cut-off time.
- We conduct Observing-System Experiments (OSEs) to assess the impact of ASCAT winds on the regional model.

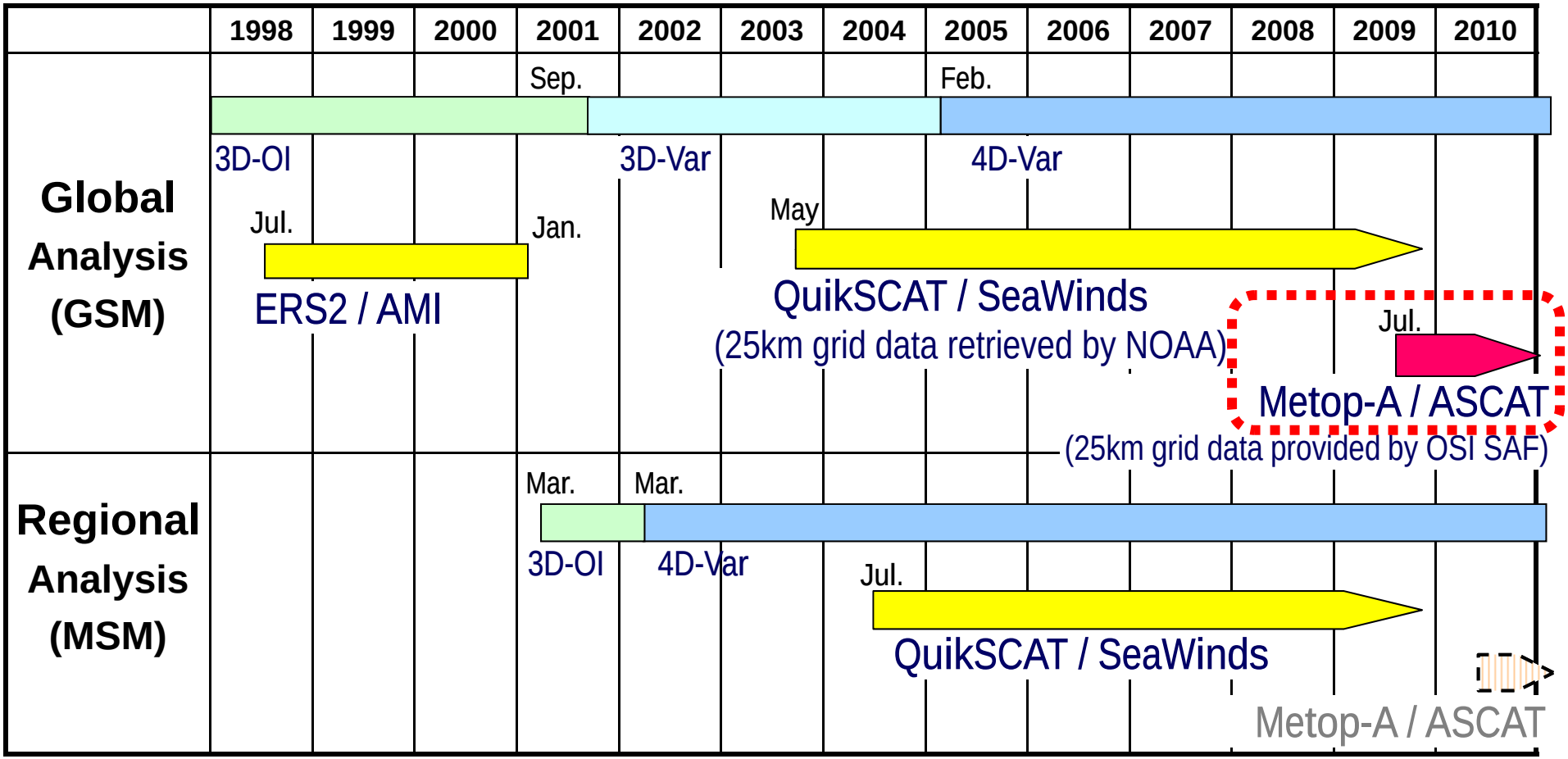
Status of JMA's operational NWP models



Model	Global Spectral Model (GSM)	MesoScale Model (MSM)
Resolution H/V(top height)	**TL959 (20km) / 60 (0.1hPa)**	**5km / 50 (21.8km)**
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** **Aeronautical forecast**	**Disaster prevention information**
Data Assimilation (outer/inner loop)	4D-Var (TL959/T159 or 20km/80km)	4D-Var (5km / 15km)

History of scatterometer wind use in DA system

Operational use of Metop-A/ASCAT in GSM has started in July 2009.

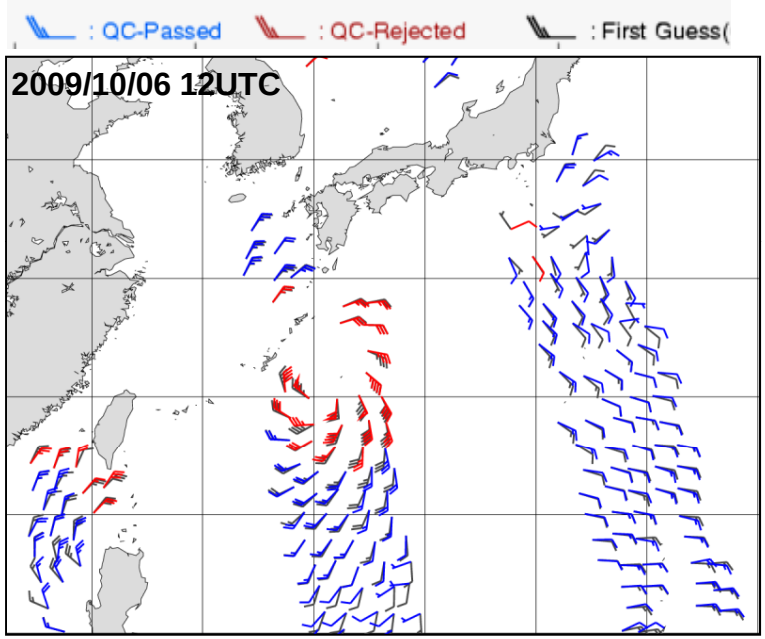


4D-Var, 3D-Var: Four or Three dimensional variational scheme
3D-OI: Three dimensional optimum interpolation

Usage of scatterometer winds in DA

Quality controlled and thinned scatterometer winds are assimilated in 4D-Var DA system.

25km-grid ASCAT winds after preprocessing (QC and data thinning).



Quality Control

- Flag check (Rain, Land/Sea, Sea Ice, etc.)
- Ambiguity removal
  - Select the closest wind to JMA's forecast (implement median filter after nudging)
- Gross error check
  - Reject large **|Obs. – Background (first guess)|** winds w.r.t. wind speed, direction

Data Thinning

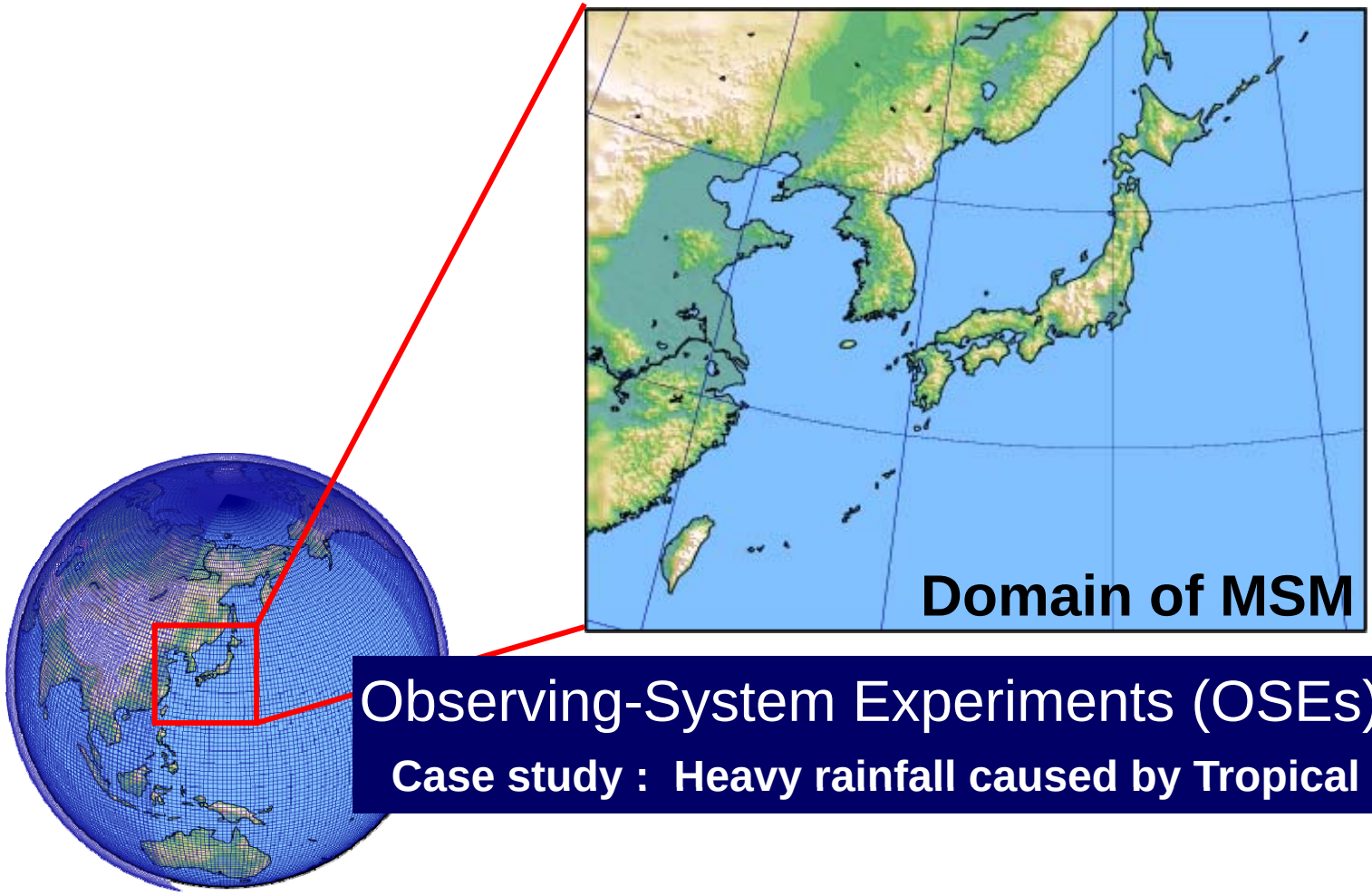
(100km x 100km in GSM, 50km x 50km in MSM)

- To reduce calculation cost in 4D-Var.
- Not to introduce spatial observation error correlation which our current data assimilation algorithm does not deal with.

Ongoing development

- Impact study of ASCAT winds assimilation

(25km grid winds retrieved by KNMI)

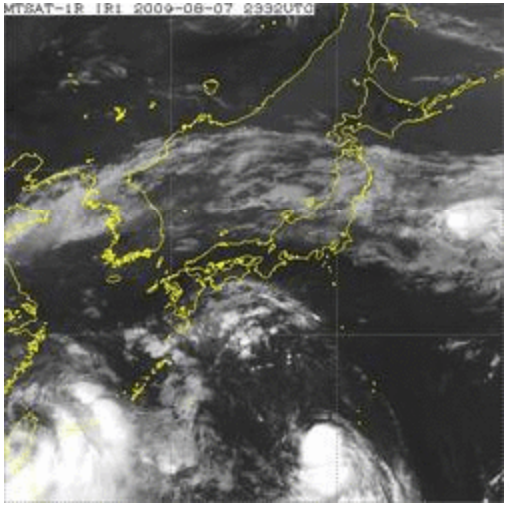


Observing-System Experiments (OSEs) in MSM

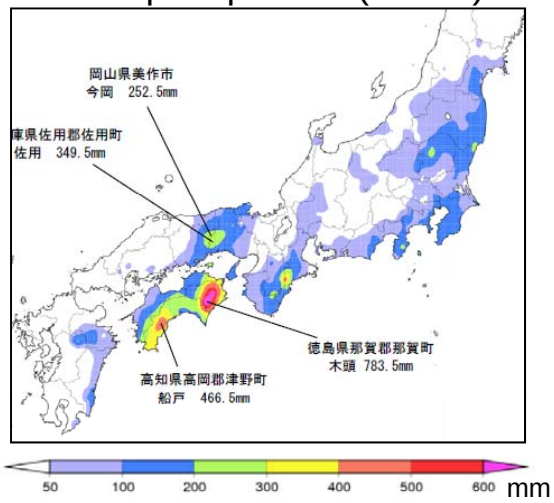
Case study : Heavy rainfall caused by Tropical Storm ETAU

Case study : Heavy rainfall caused by Tropical Storm ETAU

- Warm and moist outflow from TC caused heavy rainfall in Japan.
- Operational MSM did not predict it because of the incorrect TC position.
- Impacts of ASCAT winds on rainfall and TC forecasts have been investigated in OSEs.

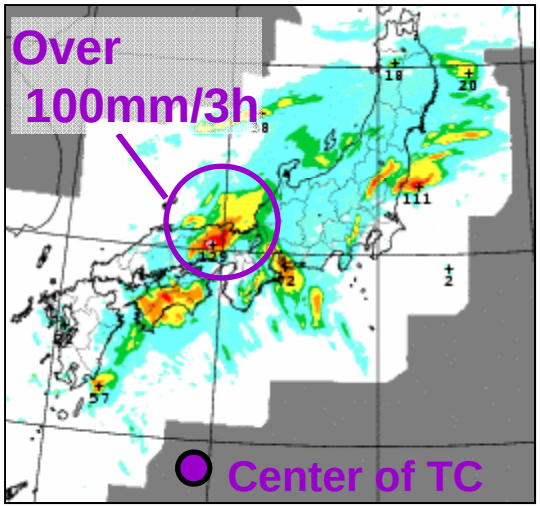


Total precipitation (8/8-11)

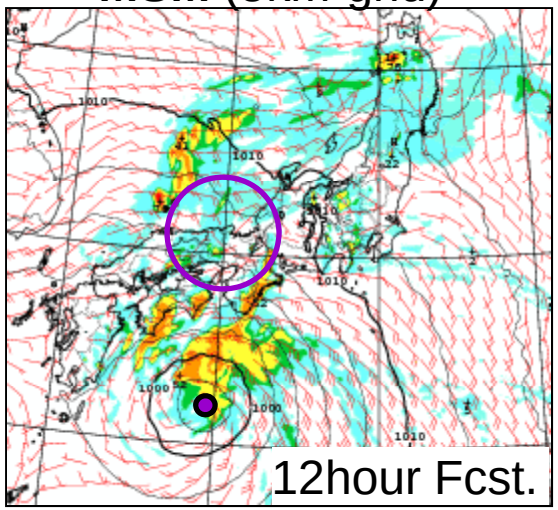


Rainfall forecast of operational NWP models (mm/3h, 2009/08/09 15UTC)

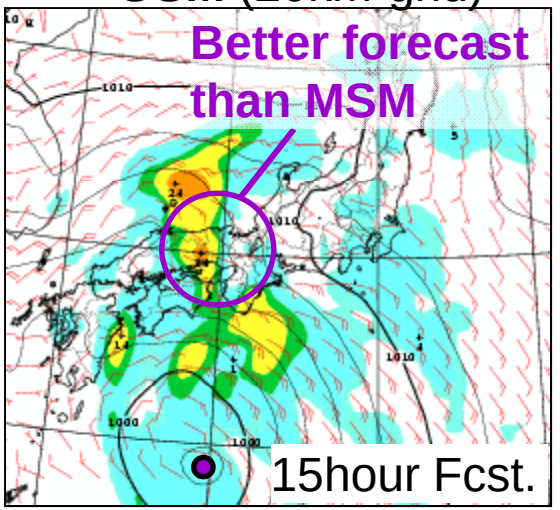
Radar Observation



MSM (5km-grid)



GSM (20km-grid)

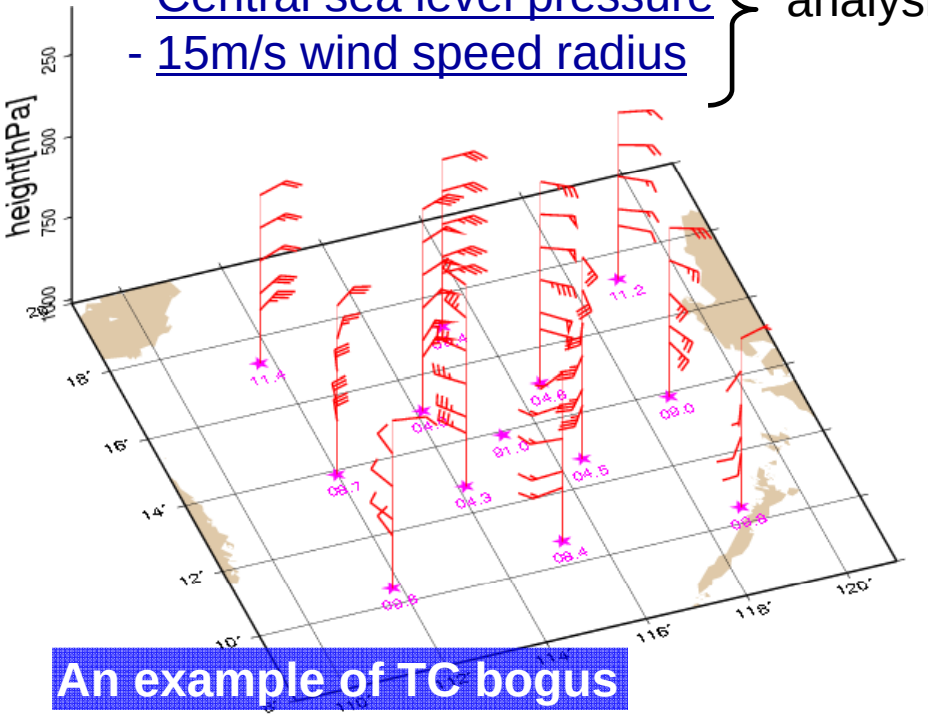


TC bogus over western North Pacific

In the operational GSM and MSM, tropical cyclone bogus data are assimilated to construct a realistic TC structure in the initial fields over western North Pacific.

Parameters to generate TC bogus data
- First guess
- Central position of TC
- Central sea level pressure
- 15m/s wind speed radius

} RSMC Tokyo (JMA) analysis by forecasters



An example of TC bogus

When scatterometer observations exist near the TC, TC bogus indirectly contains those information.

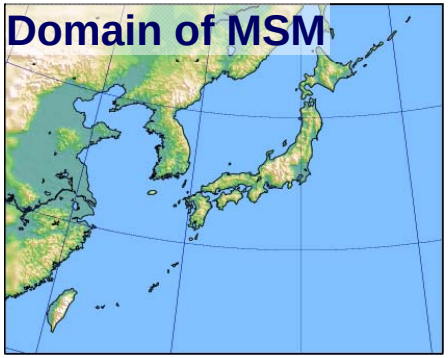
To investigate direct impacts of scatterometer, experiments without TC bogus have been performed.

Design of OSEs

Use of scatterometer in OSEs

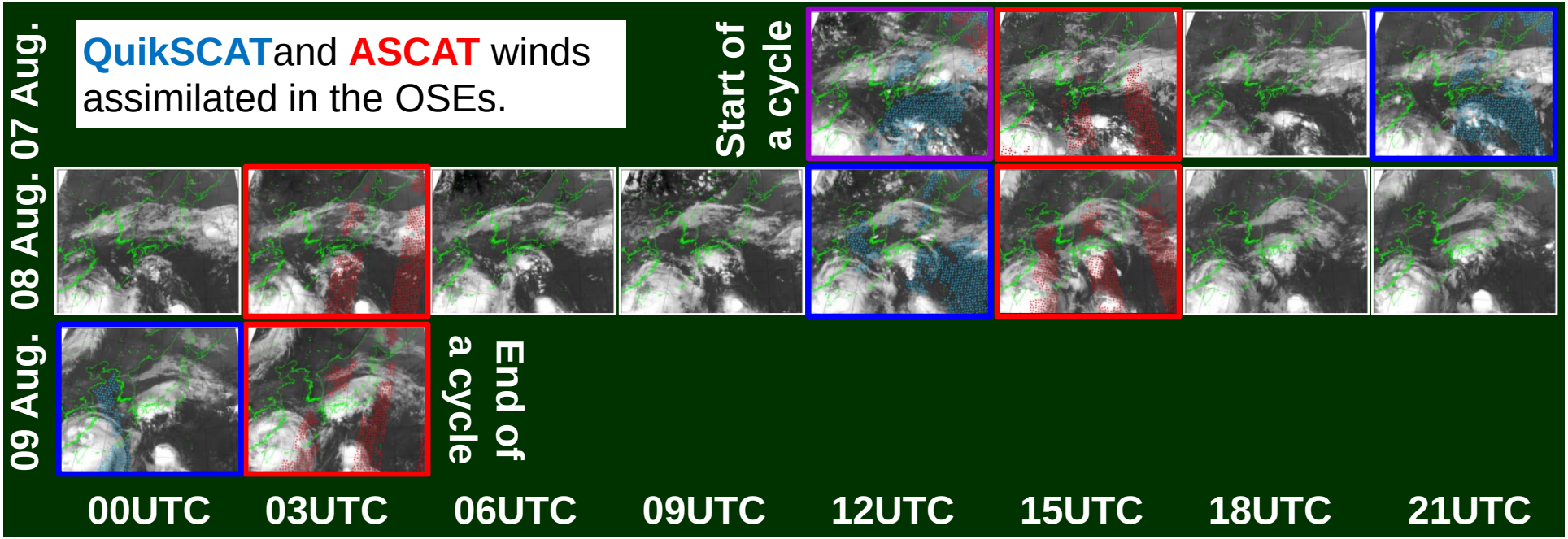
	ASCAT (25km by KNMI)	QuikSCAT (25km by NOAA)
Exp. 1	w/	w/
Exp. 2	w/	w/o
Exp. 3	w/o	w/
Exp. 4	w/o	w/o

- 4 experiments w/ or w/o scatterometer winds (w/o TC bogus)
- Experimental period: 2009/8/7 12UTC - 8/9 03UTC



Specification of MSM

Resolution (H/V)	5km / 50(21.8km)
DA system (H reso. of outer/inner)	4D-Var (5km/15km)
DA conducted time	Every 3 hours
Forecast time	33 hour



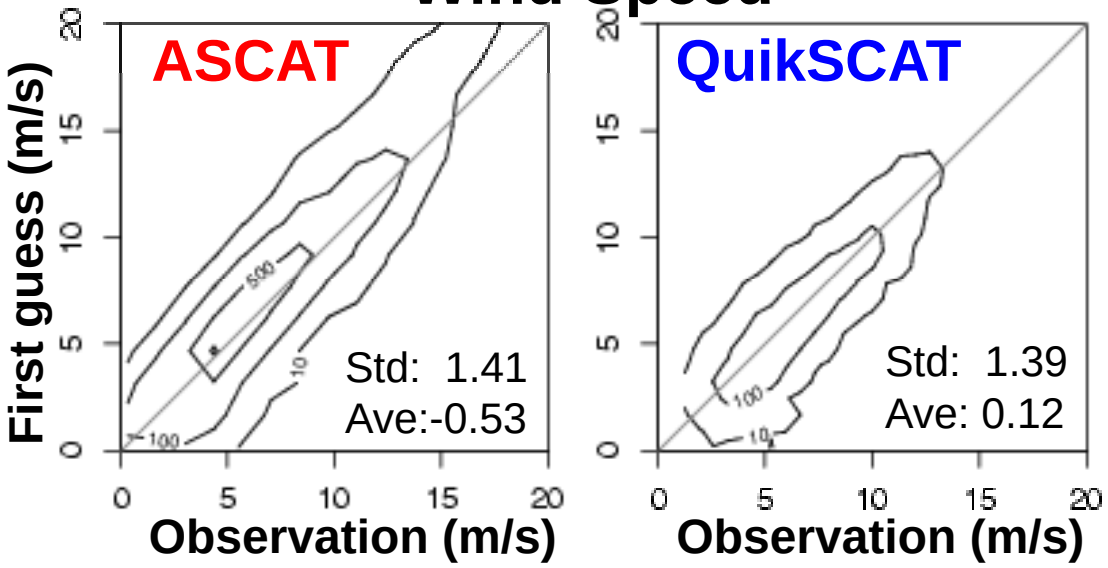
Wind comparison with OBS and MSM

- Data period:
  2009/8/7 12UTC – 8/9 03UTC

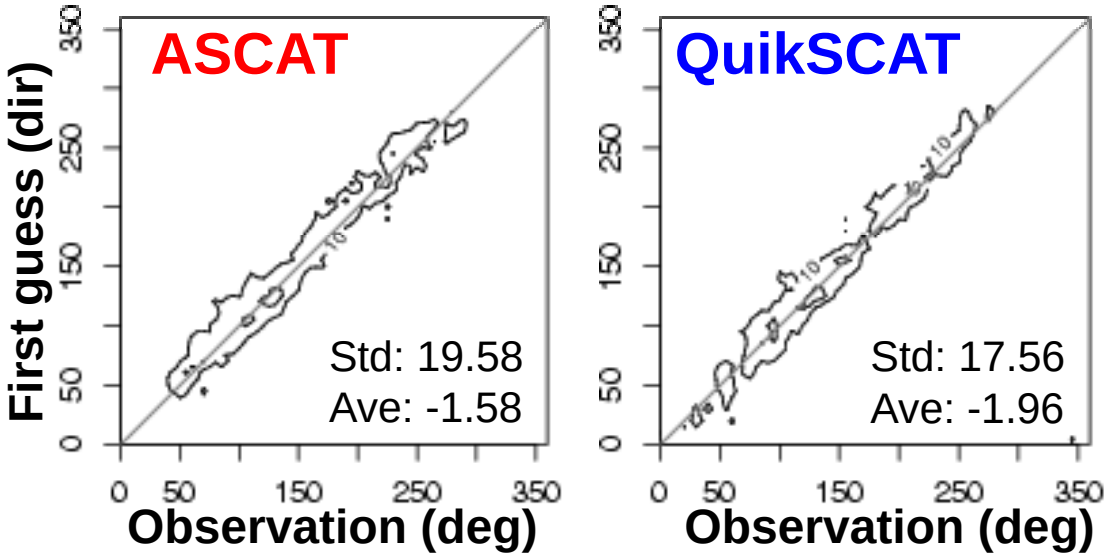
- Although high speed ASCAT data has slow speed bias against first guess, directions closely match the NWP winds.

-At high speed, less QuikSCAT data are used than ASCAT due to rain contamination.

Wind Speed



Wind Direction

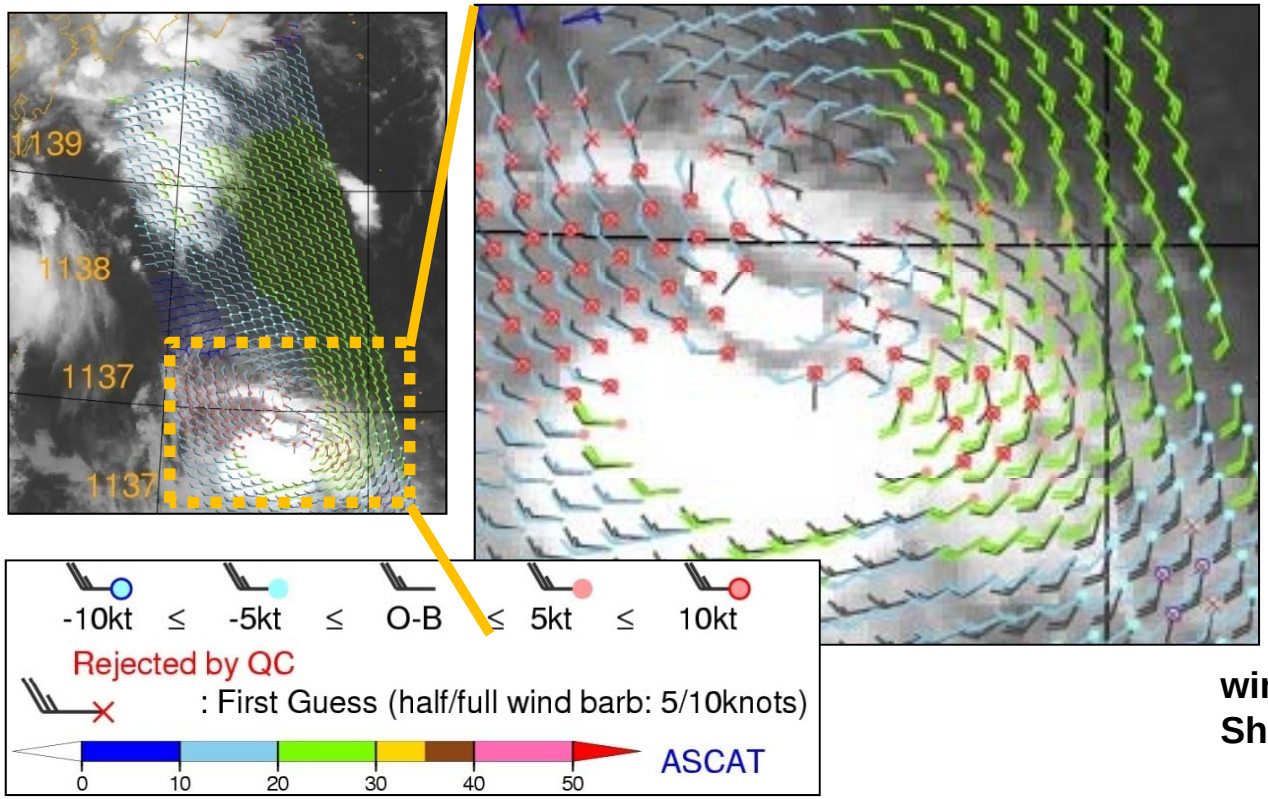


Impact of ASCAT winds on analysis

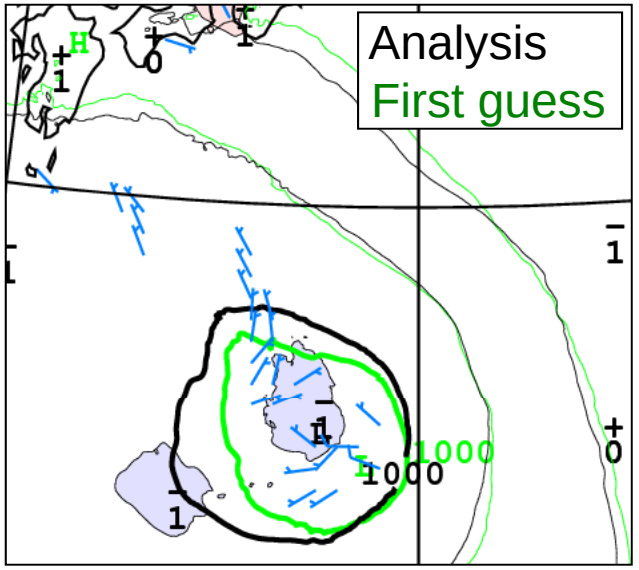
- ASCAT winds corrected first guess wind field around the TC and strengthened its intensity.

Analysis at 2009/08/08 15UTC

First guess and ASCAT winds



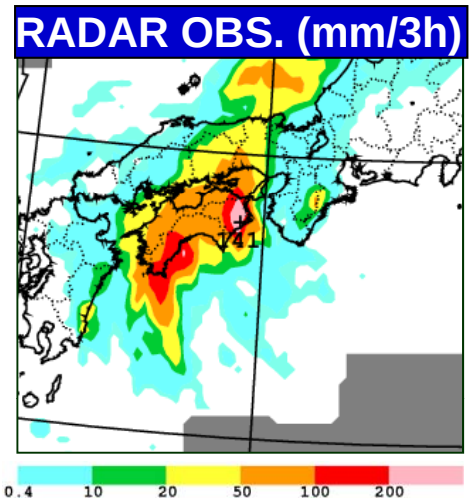
First guess and Analysis of SLP

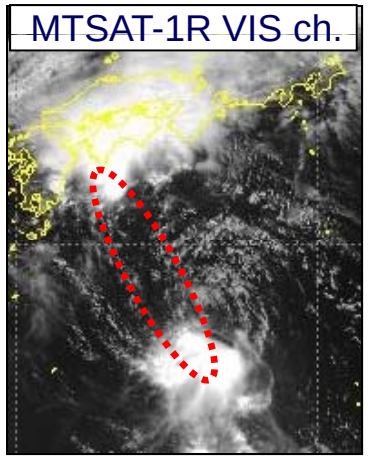


wind barb: Anl. increment of surf. wind
Shade: Anl, increment of SLP

Impact of scatterometer winds on analysis

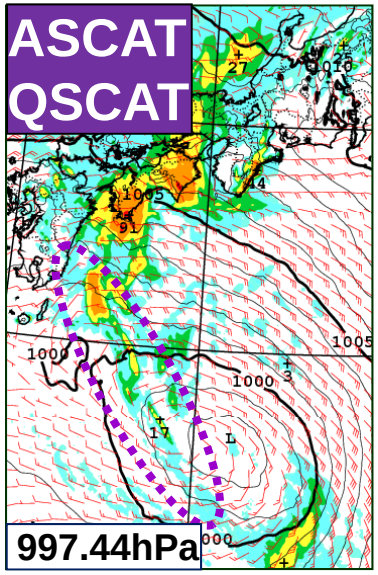
- As compared to RADAR, all experiments well analyzed the rainfall on islands.
- A Clear shear line was analyzed in **ASCAT**, **QSCAT** and **NoScatt** run.
- Frequent use of scatterometer winds in DA is important to analyze TC structure.

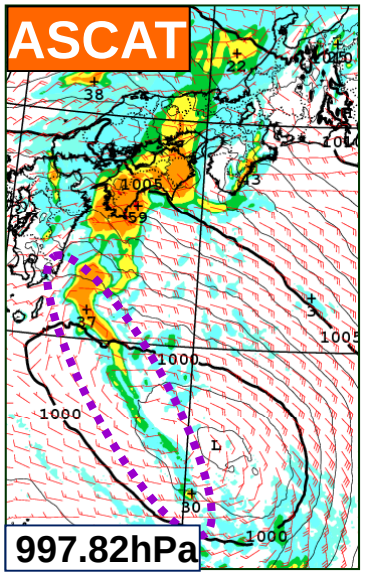


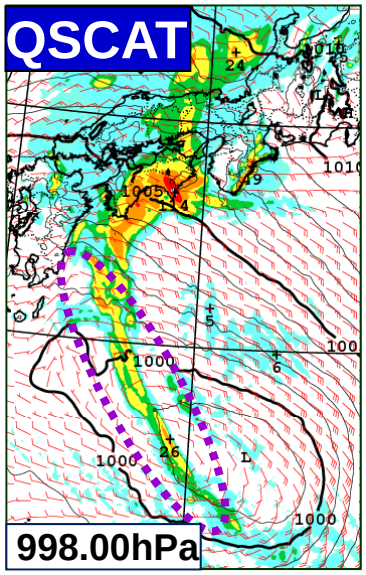


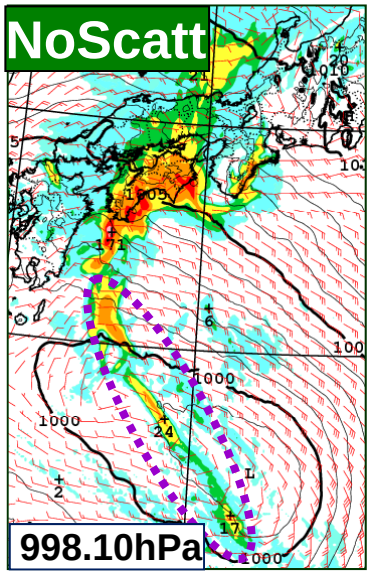
Anl. by RSMC Tokyo:
996hPa (8/9 00UTC)

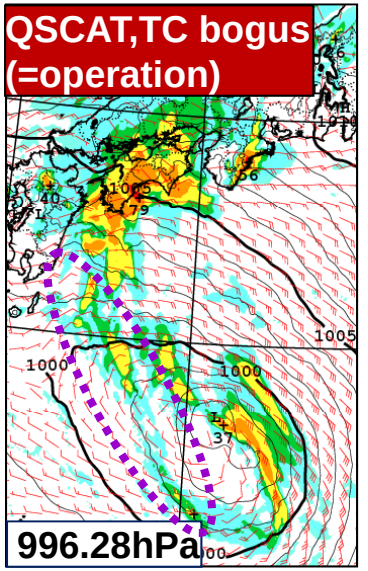
Analysis field of rainfall(mm/3h), SLP, surf. wind (2009/8/9 03UTC, end of the OSE cycle)







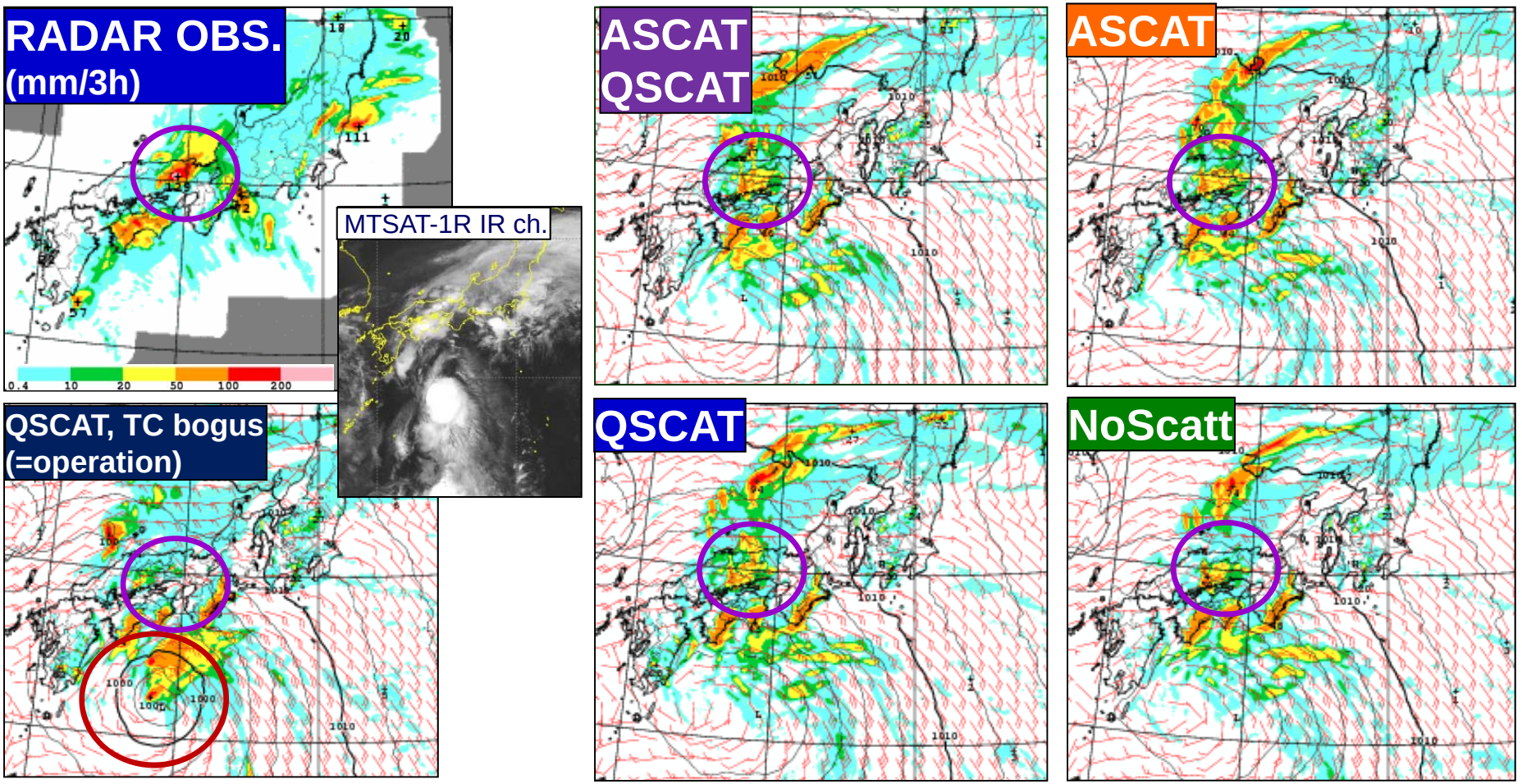




Impact of scatterometer on forecast (12hr fcst.)

- No apparent difference among the experiments in this case.
- TC bogus has large impacts (necessary in the current MSM).

SLP and 3-hr accumulated rainfall at 2009/8/9 15UTC (Initial time: 8/9 03UTC)



Summary

- JMA has used scatterometer winds in the operational GSM and MSM. In July 2009, we have started to use Metop-A/ASCAT winds in GSM.

- OSEs of scatterometer winds showed that ASCAT winds have positive impact on analyses of TC. After a longer period (a few weeks in summer and winter) experiments and verification, operational use of ASCAT in MSM will be started in 2010.

Thanks for your attention.

Satellite data assimilated in GSM and MSM

(will be used)

	Satellite / Sensor	Global Analysis (GSM)	Regional Analysis (MSM)
Scatterometer	**Metop-A/ASCAT**	**Wind**	**(Wind, planned in 2010)**
Atmospheric Motion Vector	MTSAT-1R, Meteosat-7,9, GOES-11,(13), Aqua,Terra/MODIS	Wind	Wind (MTSAT-1R)
Clear Sky Radiance	MTSAT-1R, Meteosat-7,9, GOES-11,(13)	Radiance	X
GPS Radio Occultation	GRACE/Black Jack	Refractivity	X
	Metop-A/GRAS	Refractivity	X
	(COSMIC)	(Refractivity)	X
Ground based GPS		X	Total Column Water Vapor
MW Imager	TRMM/TMI	Radiance	TCWV, Precipitation
	Aqua/AMSR-E	Radiance	TCWV, Precip.
	DMSP16,17/SSMIS	Radiance	(TCWV, Precip.)
Sounder	NOAA15-17/AMSU-A,-B	Radiance	Temperature (Radiance)
	NOAA18,19, Metop-A/AMSU-A,MHS	Radiance	Temperature (Radiance)
	Aqua/AMSU-A	Radiance	(Radiance)
	DMSP16,17/SSMIS	Radiance	(Radiance)
	(Aqua/AIRS, Metop/IASI)	(Radiance)	X

O-B of Total Column Precipitable Water (TCPW)