Status and Plans of using the scatterometer winds in JMA's Data Assimilation and Forecast System

Masaya Takahashi[1] and Yoshihiko Tahara[2]

1- Numerical Prediction Division, Japan Meteorological Agency (JMA)

2- Meteorological Satellite Center, JMA

NASA Ocean Vector Wind Science Team Meeting,
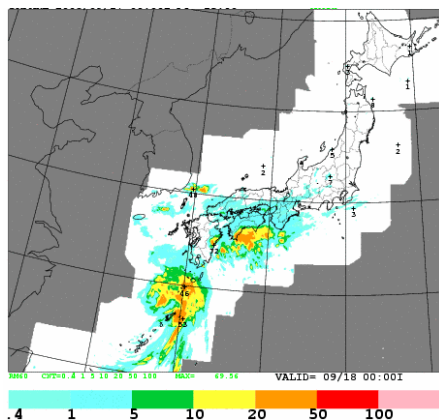Seattle, 19-21 November 2008

Outline

◆ JMA's NWP models

　　− Status of NWP models
　　− History and use of scatterometer winds

◆ Experiment
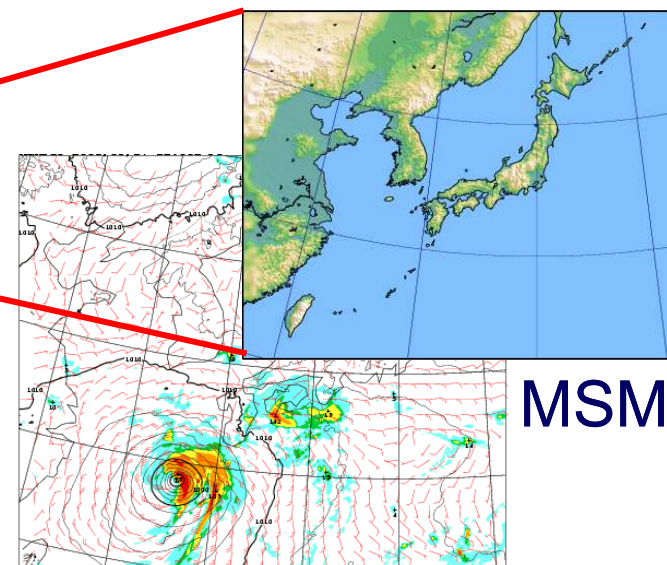　　− Metop-A/ASCAT assimilation

◆ Summary and future plans
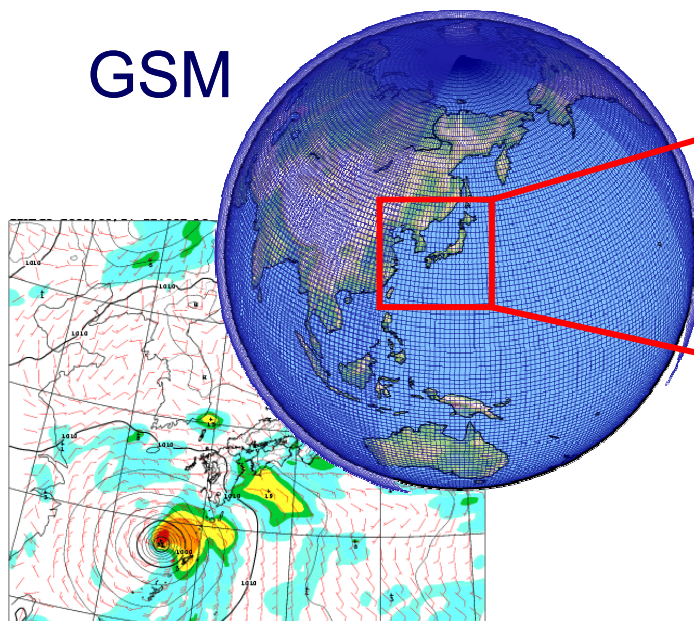
# Status of JMA's Operational NWP Models

GSM

RADAR OBS.

MSM

Model	Global Model (GSM)	Mesoscale Model (MSM)
Resolution H/V(top height)	**T$_L$959 (20km)/60 (0.1hPa)**	**5km/50 (21.8km)**
Forecast range (Initial time)	84h (00,06,18UTC) 216h (12UTC)	15h (00,06,12,18UTC) 33h (03,09,15,21UTC)
Target	**1~7 day forecast Aeronautical forecast**	**Disaster prevention information**
Data Assimilation (outer/inner loop)	4D-Var (T$_L$959/T159 or 20km/80km)	4D-Var (10/20km)

Data Assimilated in Global Model

JMA

Data Coverage Map 2008/10/24 00UTC

SYNOP, Ship, Buoy
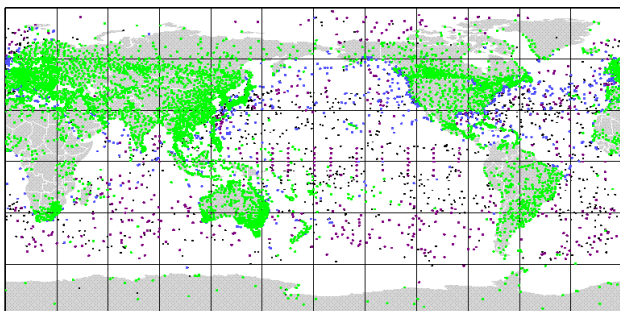
Radiosondes and Wind Profilers

Aviation, Australian BOGUS

MW Scatterometer (QuikSCAT)

Atmospheric Motion Vector

WV ch radiances of geo. sat. imagers

T-Sounder (AMUS-A)

H-Sounder (AMUS-B, MHS)

MW Imager (SSMI, TMI, AMSR-E)
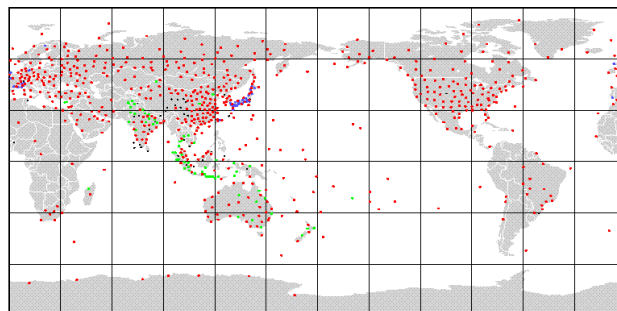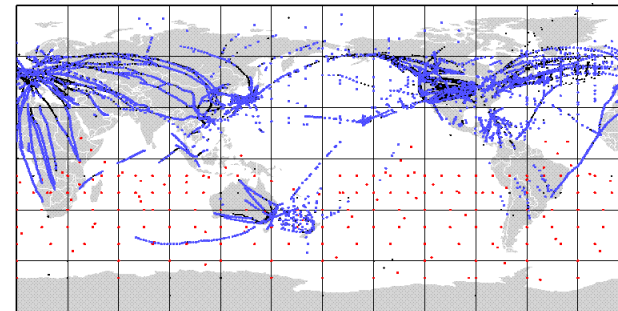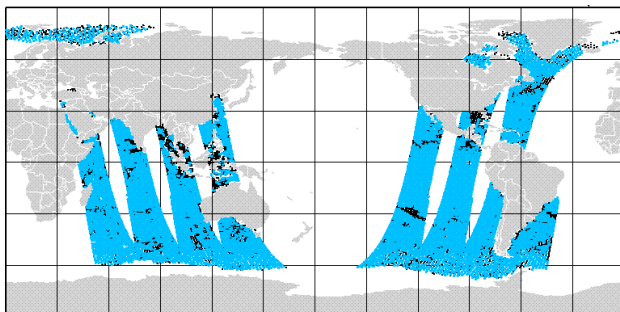
Data Assimilated in Mesoscale Model

Data Coverage Map 2008/10/23 12UTC

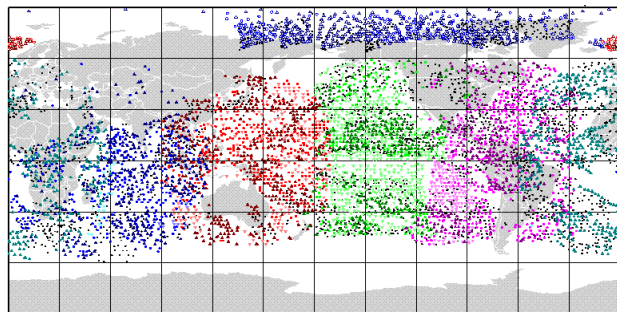**SYNOP, Ship, Buoy**
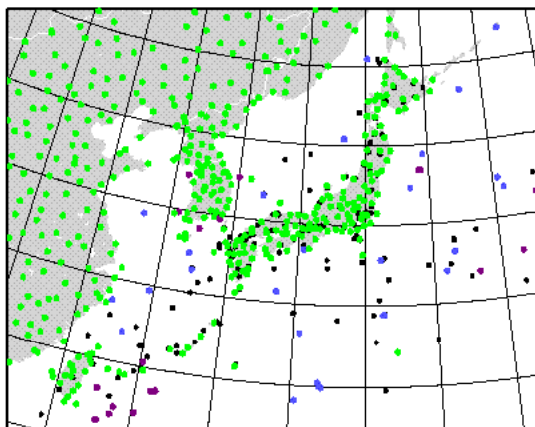
Radiosondes and Wind Profilers
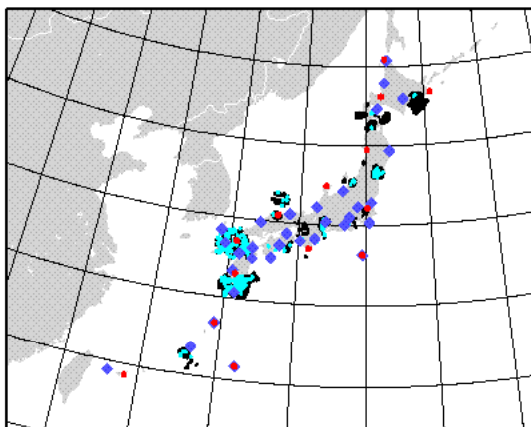
Aviation
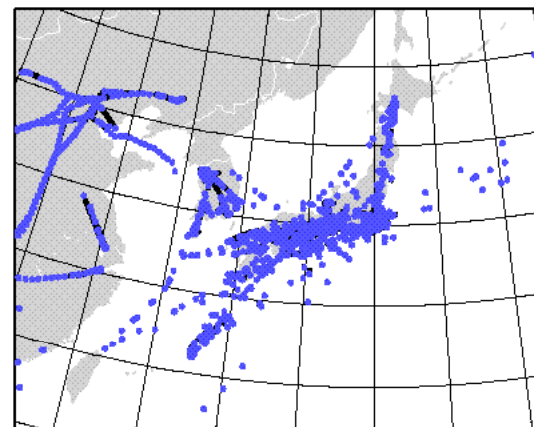
MW Scatterometer / AMV
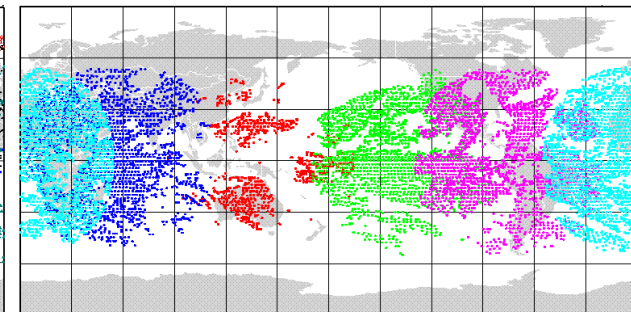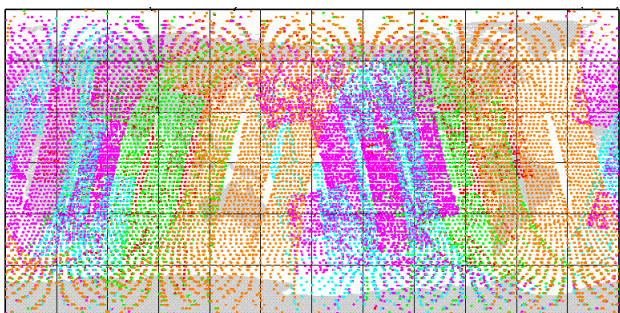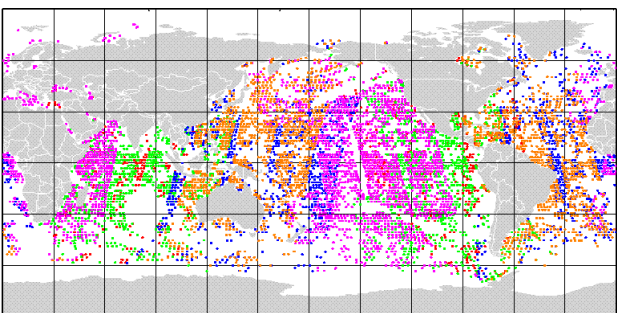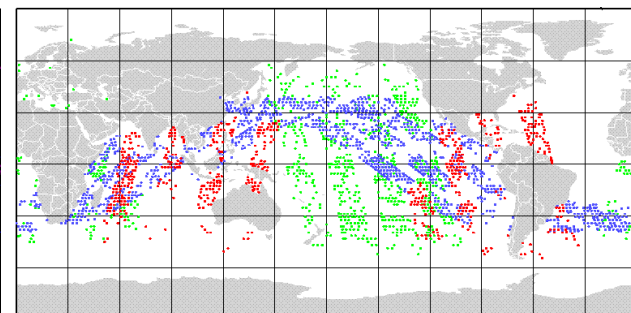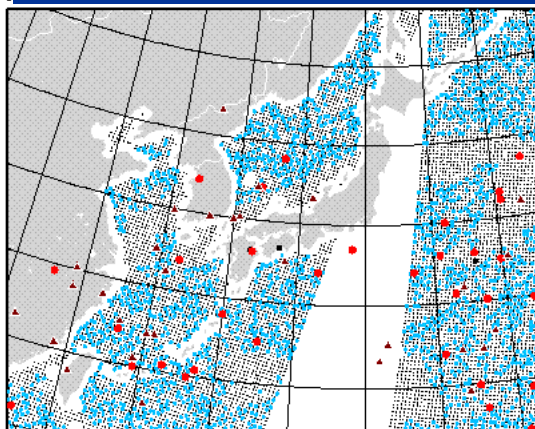
MW-Sounder
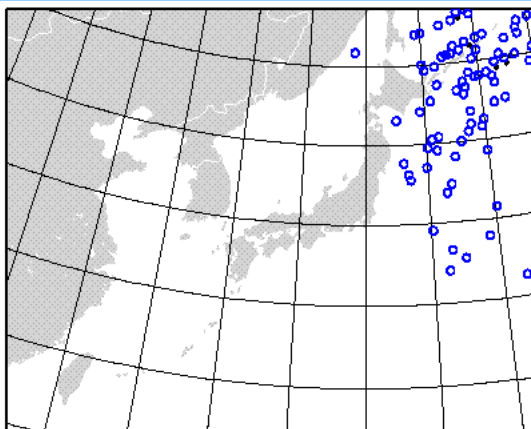
MW-Imager
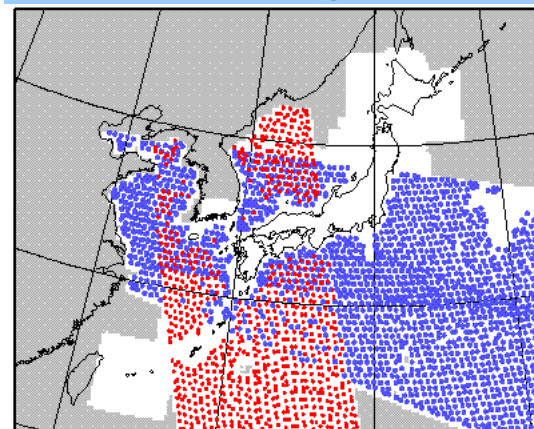
History of OVW Data Use in NWP at JMA

◆ QuikSCAT winds are used in the both global and mesoscale models.
◆ Operational use of Metop-A/ASCAT winds will start in 2009.
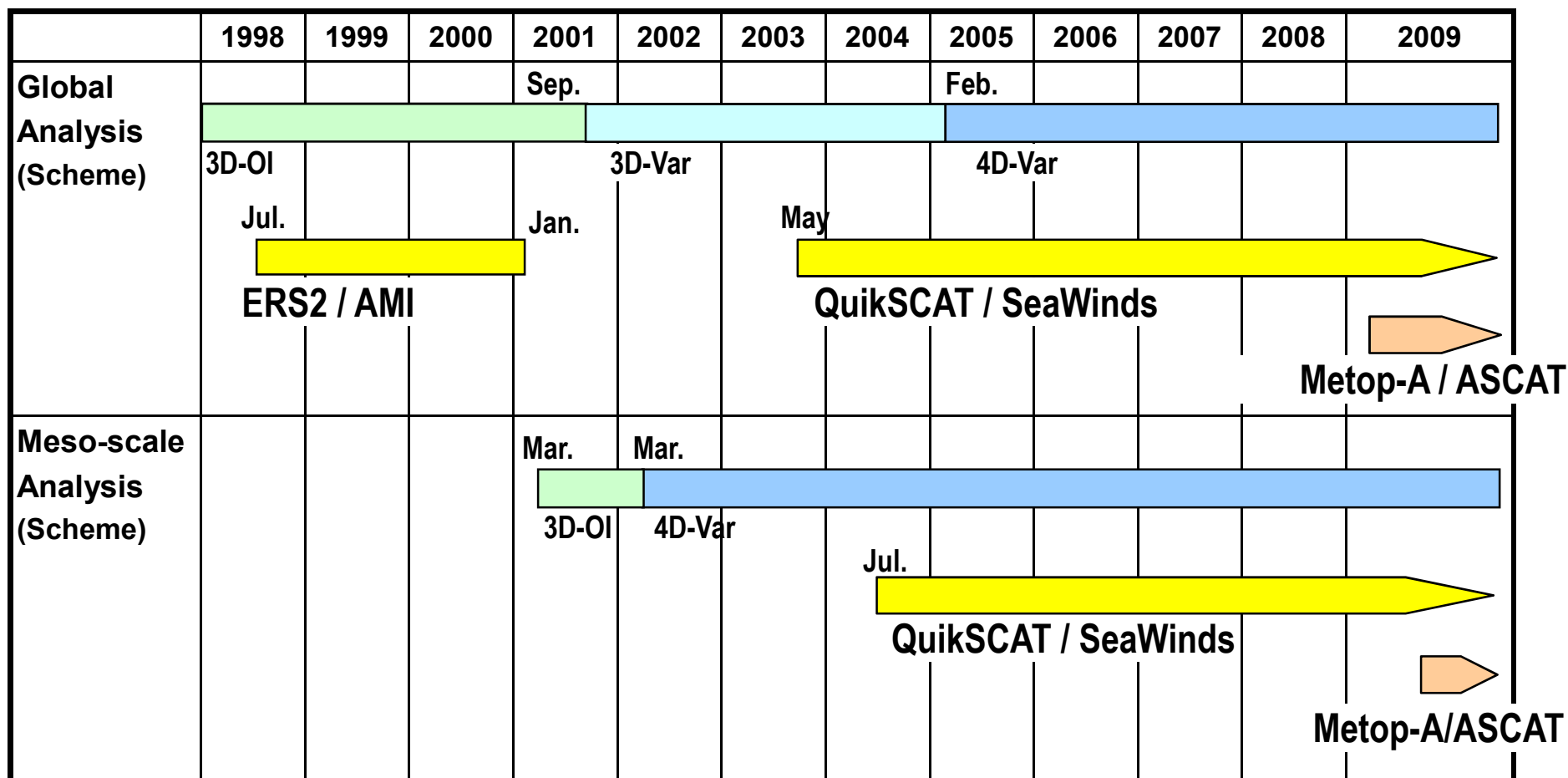
4D-Var, 3D-Var: Four or Three dimensional variational scheme
3D-OI: Three dimensional optimum interpolation

Use of QuikSCAT Winds

◆ Winds that **pass quality control** procedures and are **thinned** are assimilated.

◆ Quality control for QuikSCAT winds
- Rain flag, Land/sea flag check
- Sea ice check
- Ambiguity removal
  ・Select the closest wind to JMA's forecast
- Gross error check
 ・Reject large |**Obs. – Background (forecast)**| winds w.r.t. wind speed, direction

QuikSCAT winds after preprocessing (Global analysis, 12UTC 25 Jul. 2008).
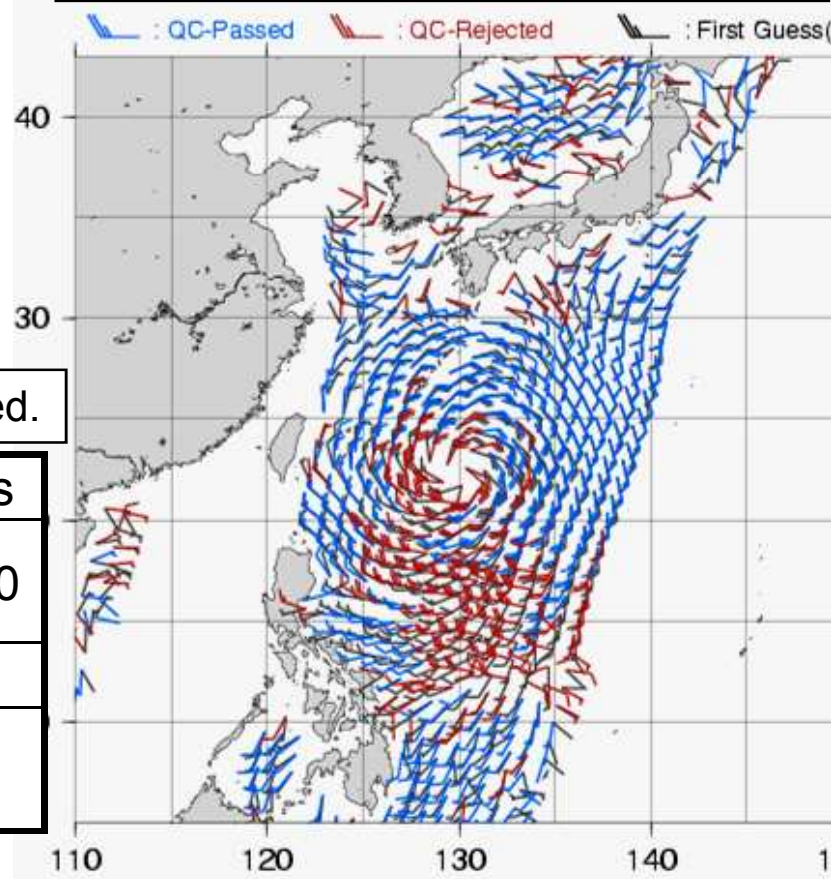
Thinning interval and total QuikSCAT number assimilated.

	Global analysis	Meso analysis
Total number observed	≒200,000	3,000～10,000
Data thinning	100km	50km
Total number assimilated	8,000～12,000	500～1,500

Experiments

Data assimilation with Metop-A/ASCAT winds and forecast experiment in global model

JMA's plan of using scatterometer winds in the operational models

	2008	2009
Global Analysis	QuikSCAT/SeaWinds	METOP-A/ASCAT
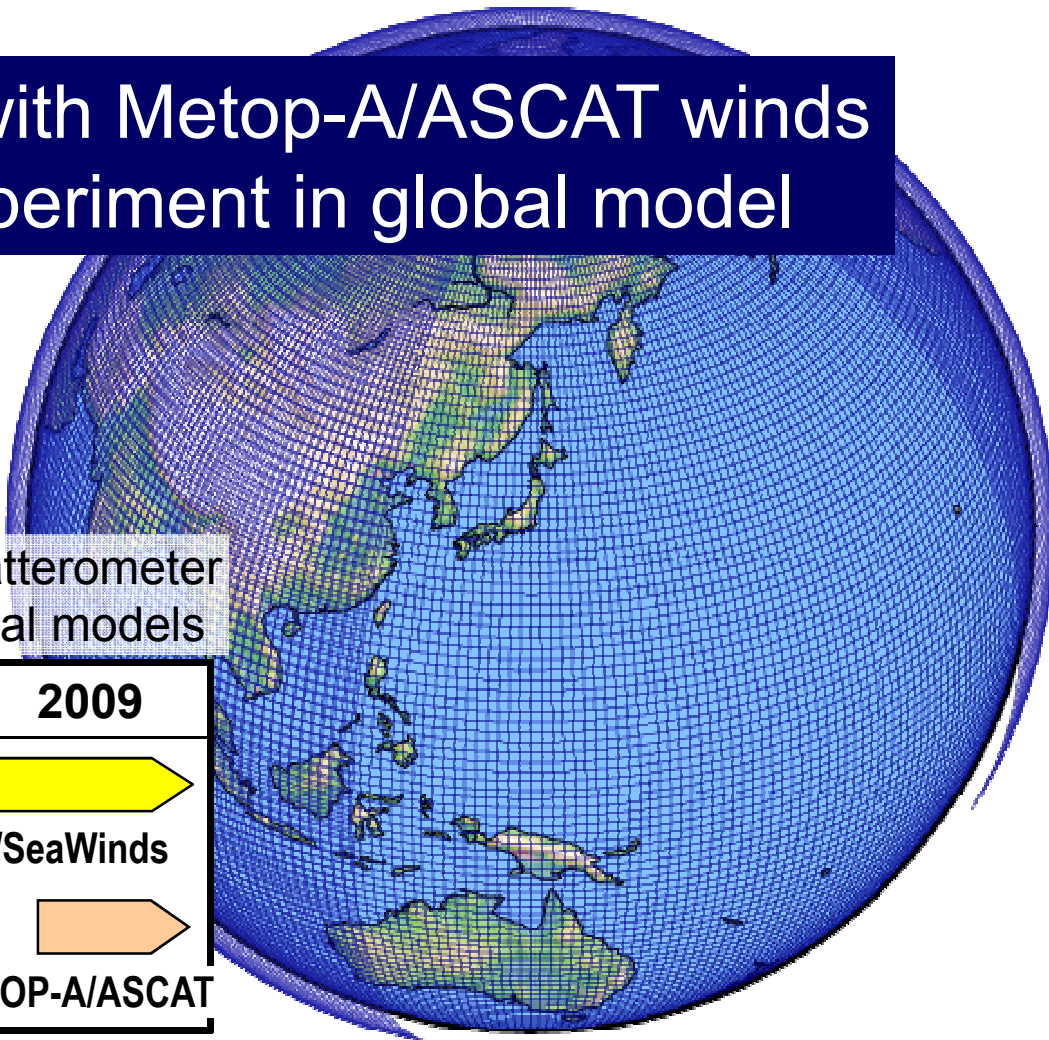
Experimental Setup

◆ **4 experimental runs:**

Assimilated scatt. winds	**QuikSCAT only (nearly operational)**	**ASCAT only**	**Both ASCAT and QuikSCAT**	**No-Scatterometer**
Example of scatt. data used in one analysis				

◆ Low resolution global model:

	Experimental	Operational
Resolution H/V (top height)	**T$_L$319 (60km)** / 60 (0.1hPa)	**T$_L$959 (20km)** / 60 (0.1hPa)
Data Assimilation (outer/inner loop)	4D-Var (TL319/T106 or 60km/110km)	4D-Var (TL959/T159 or 20km/80km)

◆ One month data assimilation experiment (Aug 2007).

◆ 9-day forecasts to see analysis accuracy enhanced.

◆ Assimilated scatterometer: **selected winds by ambiguity removal**

◆ Quality control for ASCAT is the same as that for QuikSCAT.

◆ Assimilated observational data are the same as those of the operational model except for scatterometer winds.
   (satellites data such as AMV, Mw-Sounder, Mw-Imager are used)

Evaluation of QC passed Scatterometer Winds

Comparison of scatterometer winds (after QC) with JMA's 6 hour forecast.
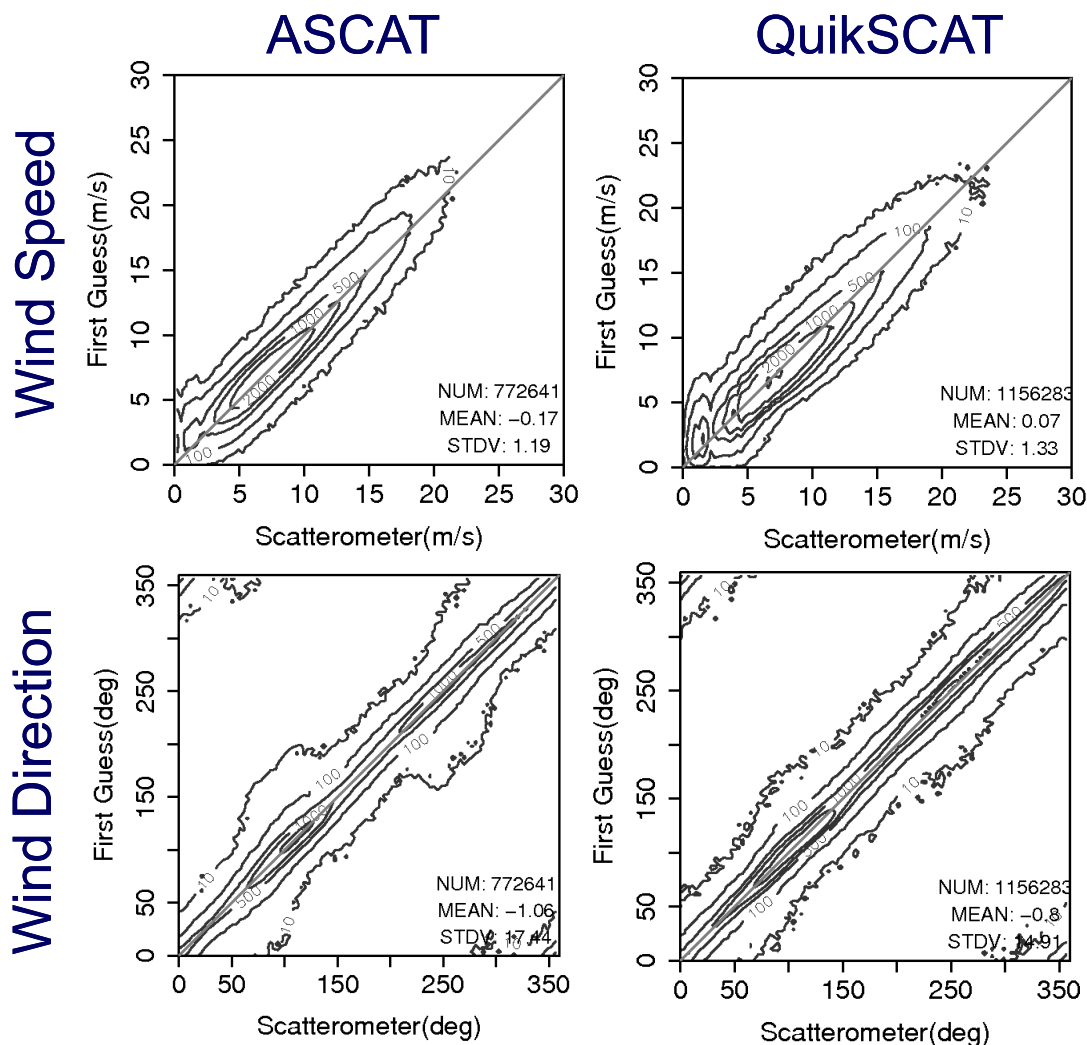
- Both scatterometer winds have high accuracy enough to be assimilated.

- ASCAT winds have low wind speed bias against JMA's forecast at high wind speed (>15m/s).

Standard deviation of wind speed O-B for ASCAT, QuikSCAT, Buoy (period mean)
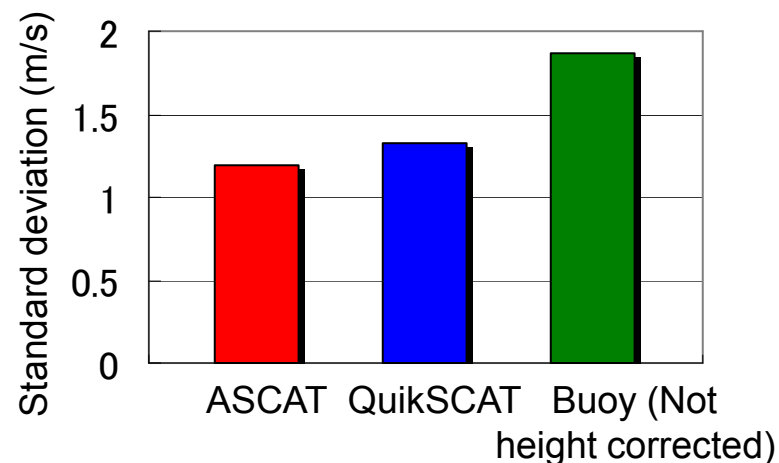
Forecast Improvement Rate Against No-Scatt. Run

$$\text{Rate of Improvement} = \frac{\text{RMSE(No Scatterometer)} - \text{RMSE(Test)}}{\text{RMSE(No Scatterometer)}}[\%]$$

◆ **Best improvement: Both ASCAT and QuikSCAT run**

◆ **Increase of data coverage provides more reliable analysis field, and it leads to improvement of forecast.**

■ : QuikSCAT (nearly operational)
■ : ASCAT
■ : Both ASCAT and QuikSCAT
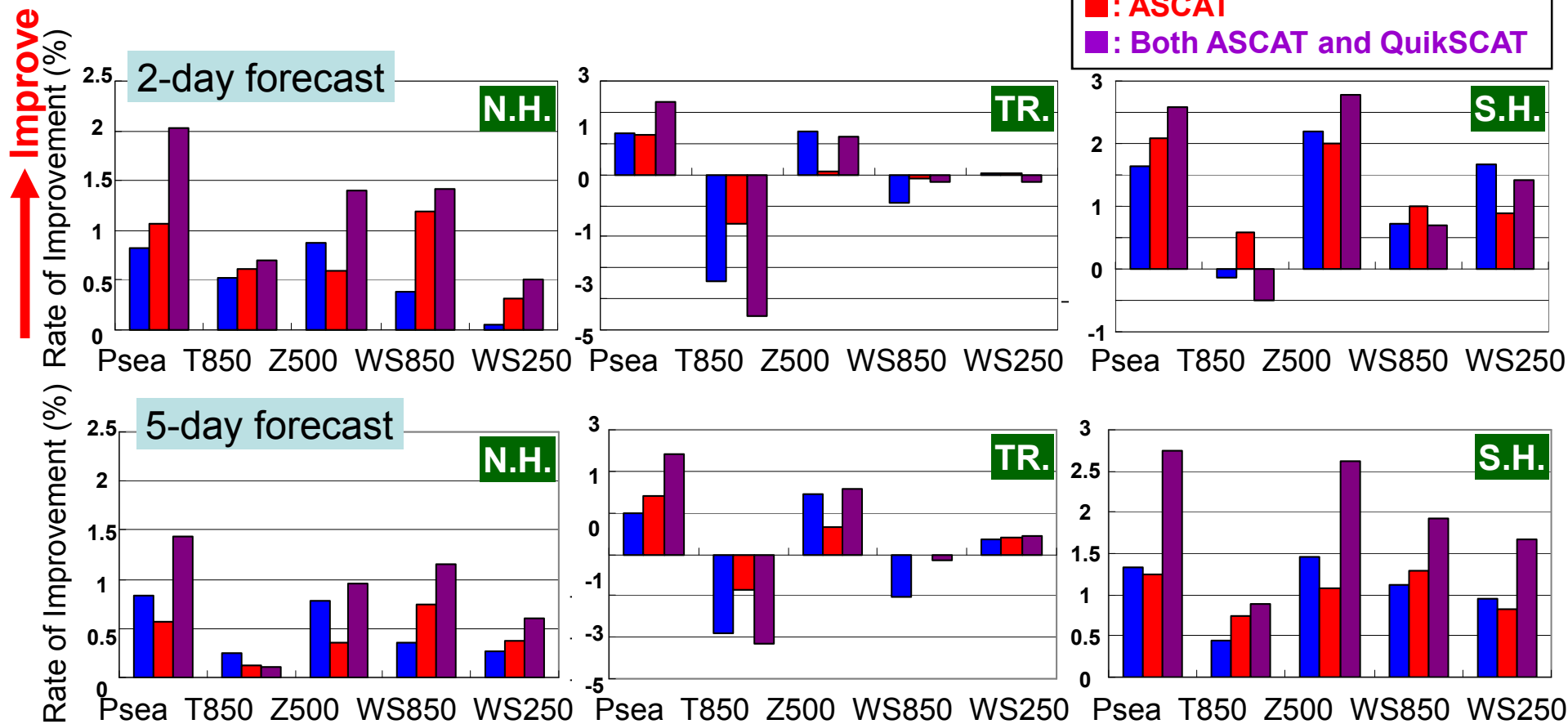
Impact on Typhoon Track Forecasts

◆ In addition to the increase of data coverage, assimilation of less contaminated winds by rainfall has positive impact on typhoon position forecasts.

9-day typhoon position forecast for typhoon FITOW

—: QuikSCAT
—: ASCAT
—: ASCAT and QuikSCAT
—: No Scatterometer
—: Analyzed Track

Initial: 12UTC 07/08/28

Tokyo ★

Assimilated winds
QuikSCAT   ASCAT

QC-**passed** (blue) and **rejected** (red) winds

QuikSCAT (Initial: **06UTC** 07/08/28)

ASCAT (Initial: **12UTC** 07/08/28)
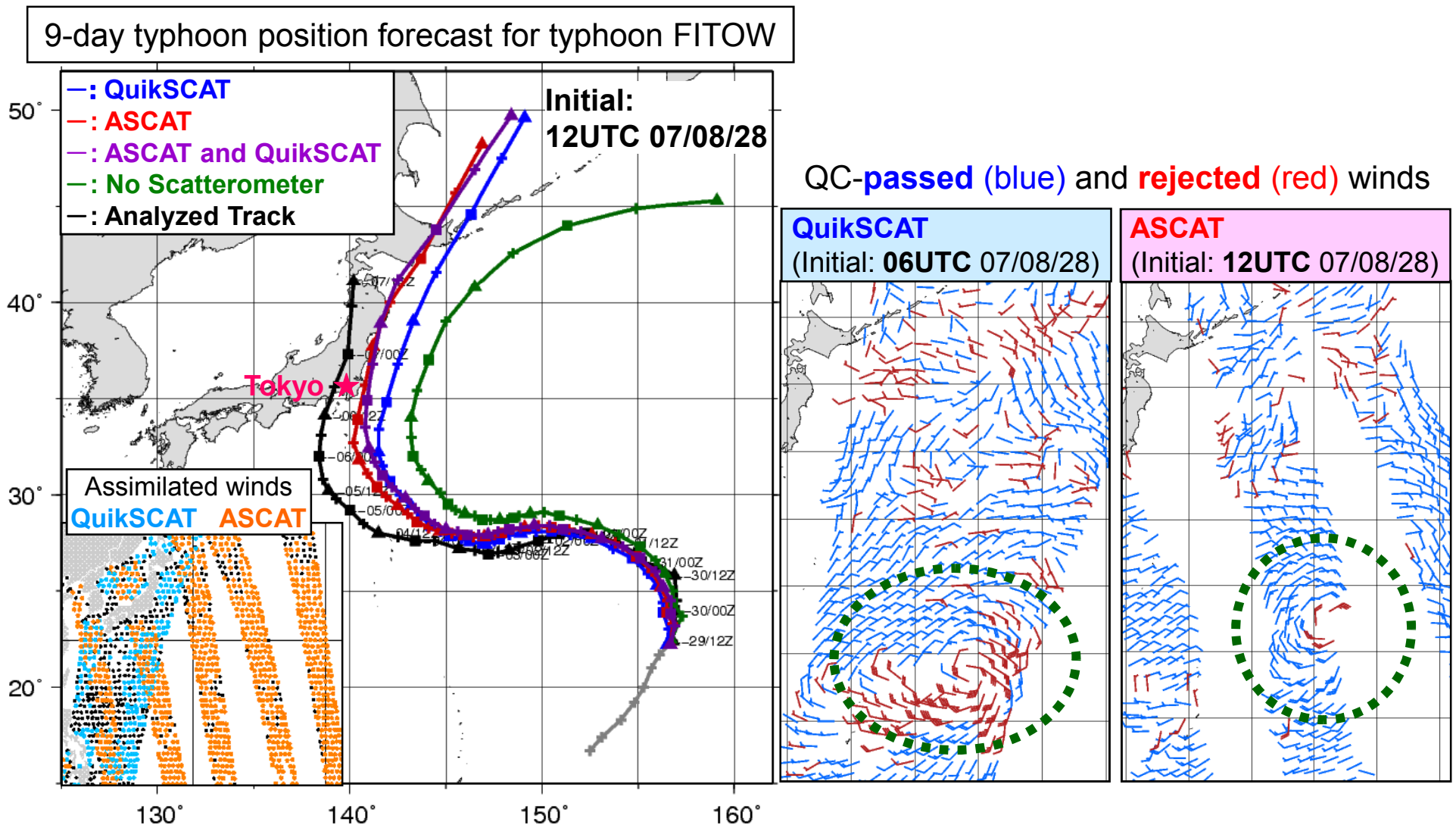
Impact on Typhoon Track Forecasts

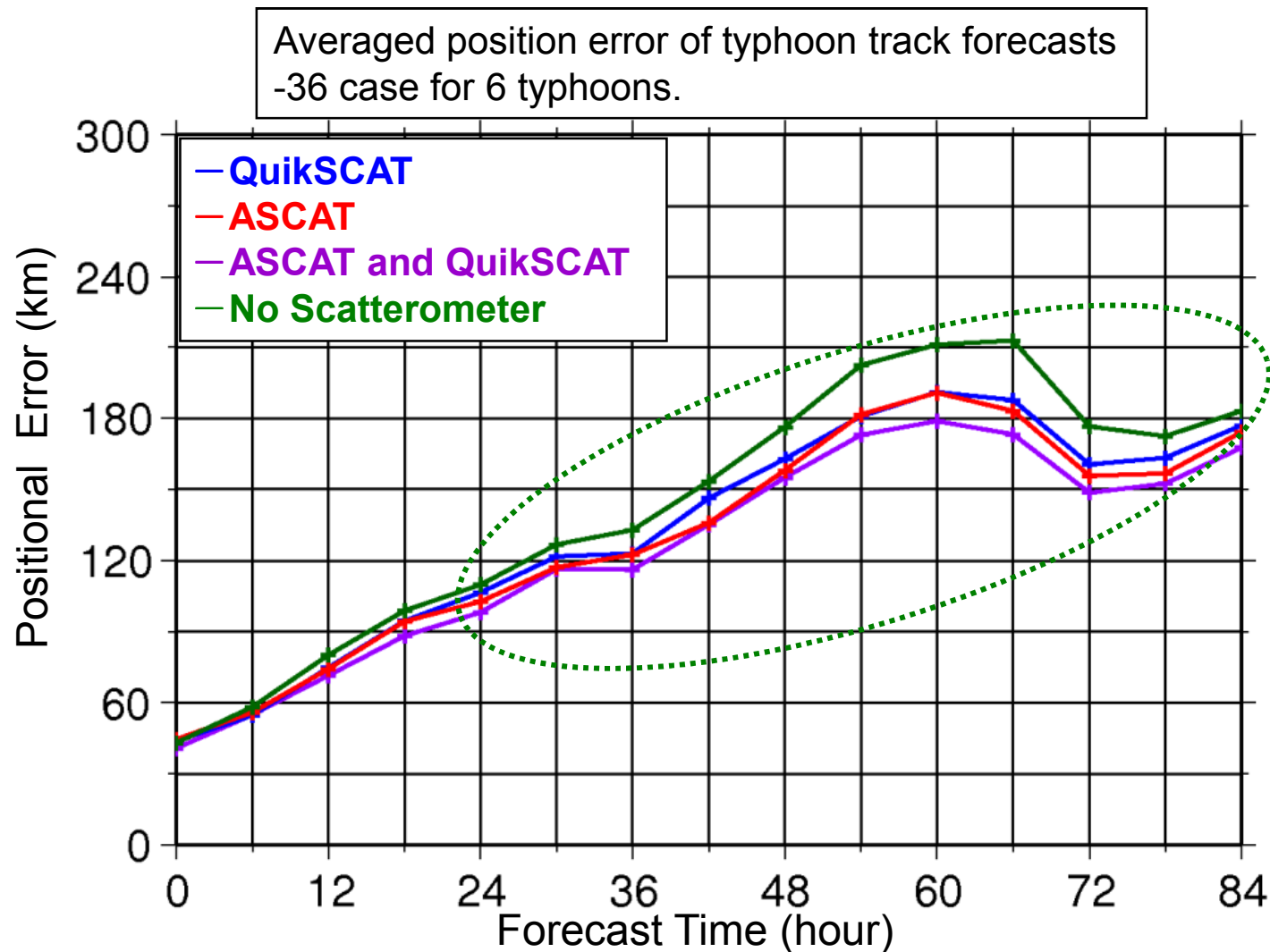◆ Scatterometer winds provides significant improvement for typhoon track forecasts.

Averaged position error of typhoon track forecasts -36 case for 6 typhoons.

Summary and Future Plans

◆ JMA has used scatterometer winds in the operational global and meso-scale models.

◆ Metop-A/ASCAT data assimilation and forecast experiments have been carried out to evaluate the impact of scatterometer winds. Both ASCAT and QuikSCAT assimilated run provided the best improvement.

◆ After the evaluation of the experiments with high resolution global model, ASCAT will be used at JMA.

Thanks for your attention.

Background

Use of scatterometer data at JMA

Numerical Weather Prediction, wave analysis, …

Weather map analysis

Weather Forecast

Wave Analysis (Wave Chart)

Typhoon Track Forecasts
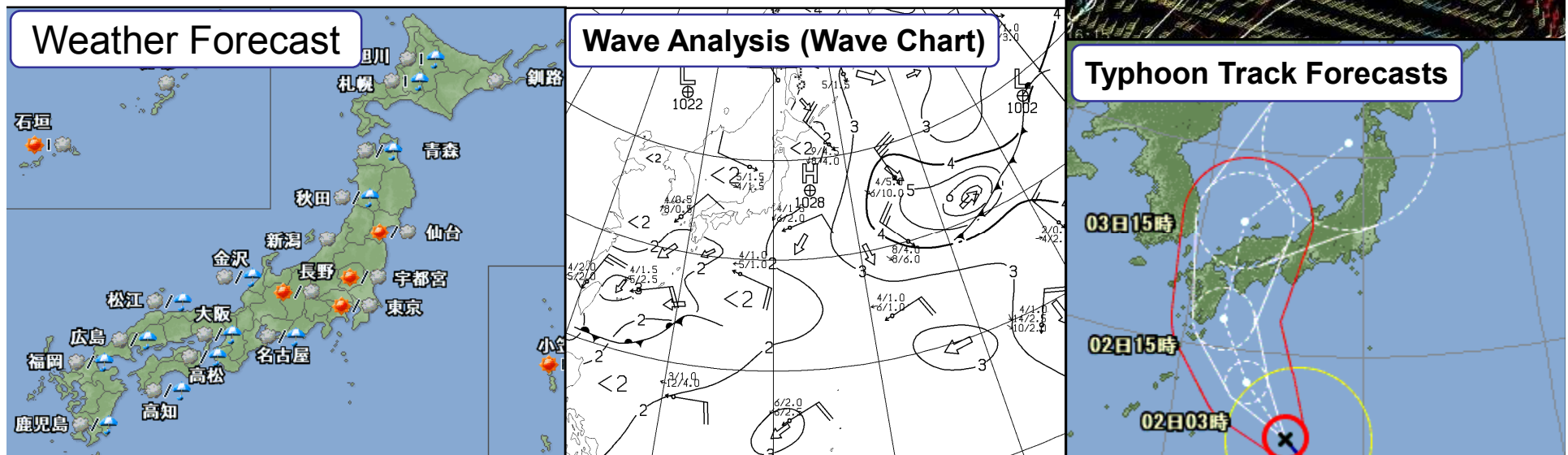
In particular, scatterometer winds give positive impacts on our analyses and forecasts.
To improve them further, JMA has plans to

- **Start the use of Metop-A/ASCAT winds in 2009.**
- Upgrade assimilation method (use ambiguous winds instead of selected winds by an ambiguity removal).
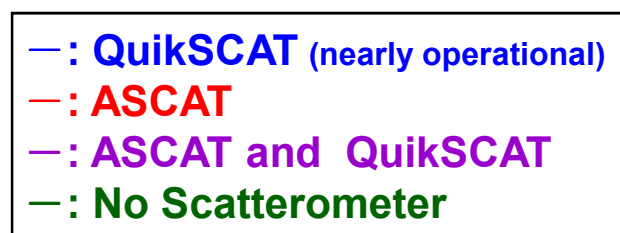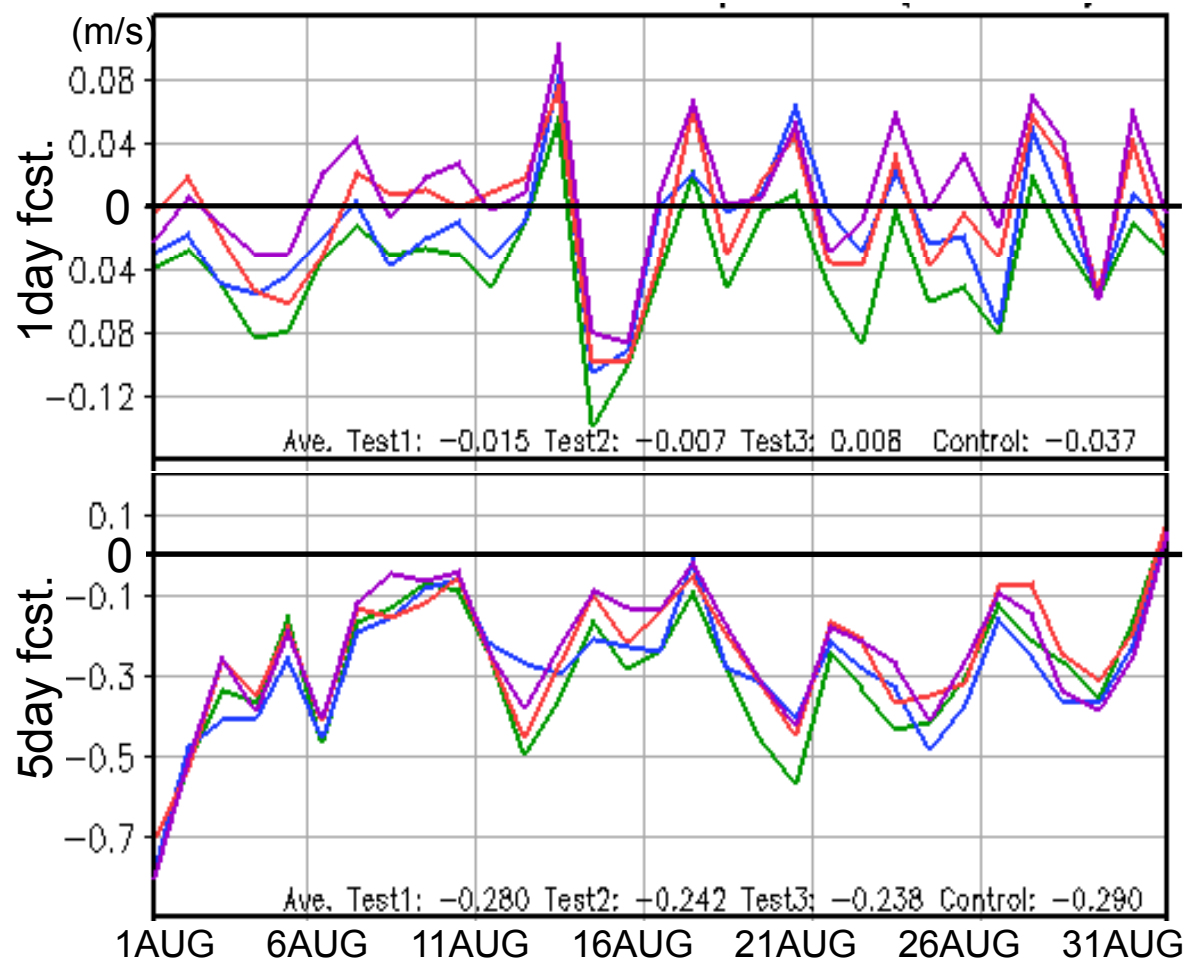
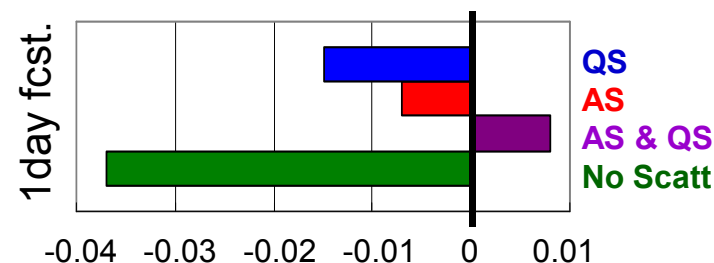# Reduction of Lower Forecast Bias (against initial)

◆ Scatterometer winds **reduce the bias** of JMA's wind speed at lower troposphere.
◆ **Both ASCAT and QuikSCAT run** provides the best improvement.

Time series of wind speed bias at 850hPa (global mean)

— : **QuikSCAT** (nearly operational)
— : **ASCAT**
— : **ASCAT and QuikSCAT**
— : **No Scatterometer**

Ave. Test1: −0.015 Test2: −0.007 Test3: 0.008 Control: −0.037

Ave. Test1: −0.280 Test2: −0.242 Test3: −0.238 Control: −0.290

Period mean.

Better