UPGRADED USAGE OF AMVS FROM ALL GEOSTATIONARY SATELLITES IN THE OPERATIONAL GLOBAL AND MESOSCALE 4D-VAR ASSIMILATION SYSTEM AT JMA

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Outline

- Major changes of AMV assimilation in the operational NWP system since April 2006 (IWW8)
- Background of upgraded usage of AMVs
- NWP models of JMA
- Upgraded usage of AMVs
  - Upgraded Quality Control (QC) and new data
  - Experimental results in the global 4D-Var assimilation system (GSM-DA)
  - Experimental results in the mesoscale 4D-Var assimilation system (MSM-DA)
- Conclusion
- Future plan

Major changes of AMV assimilation in the operational NWP system since April 2006 (IWW8)

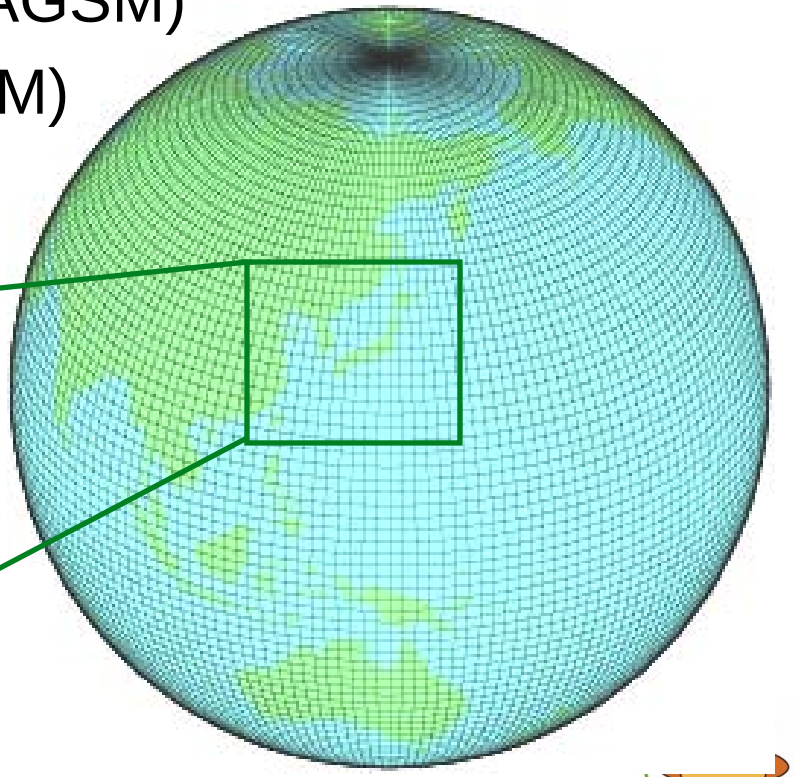
- 14/06/2006 Switch from Meteosat-7 to Meteosat-8 BUFR winds.
- 21/06/2006 Switch from GOES-10 to GOES-11 SATOB winds.
- 18/10/2006 Upgraded usage of AMVs in GSM-DA(T106L40(120 km)).
  Switch from GOES-11/12, MTSAT-1R SATOB to BUFR
  Start using MTSAT-1R hourly winds.
- 05/02/2007 Switch from Meteosat-5 to Meteosat-7 BUFR winds.
- 24/04/2007 Switch from Meteosat-8 to Meteosat-9 BUFR winds.
- 21/11/2007 Global forecast model upgrading
  from T319L40(60km) to TL959L60(20km).
  4D-Var inner resolution upgrading
  from T106L40(120km) to T159L60(80km).
- 07/12/2007 Upgraded usage of AMVs in MSM-DA (inner 20 km).
- 25/03/2008 Start using MTSAT-1R IR4 winds in GSM-DA and MSM-DA.

Background of upgraded usage of AMVs

- Great advantage of BUFR AMVs over SATOB AMVs
- Generation of hourly MTSAT-1R AMVs in JMA/MSC from July 2005
- Migration to Table-driven Code Forms in the Fourteenth WMO Congress (Cg-XIV), held in 2003
- Improvement in thinning scheme

NWP models of JMA

- JMA has been operating two scale models
  - Global Spectral Model (JMAGSM)
  - MesoScale Model (JMAMSM)



JMAMSM

JMAGSM

Specification of NWP models of JMA

Model	JMAGSM (Global Spectral Model)	JMAMSM (nonhydrostatic grid model)
Horizontal res.	60km (Now 20km)	5km
Vertical res. (model top)	40 (Now 60) layers (0.1hPa)	50 layers (21.8km)
Forecast range (Initial time)	84h (00,06,18 UTC) 216h (12 UTC)	15h (00,06,12,18 UTC) 33h (03,09,15,21 UTC)
frequency	4/day	8/day
Target	▪one-week forecast ▪Short-range forecast ▪Aeronautical forecast	▪Disaster prevention information
Data Assimilation (Horizontal res.) <Vertical res.> [Time res. of obs. / Time windows]	4D-Var (120km: Now 80km) < 40 (Now 60) layers > **[about 1 hour / 6 hour]** 6 hour assimilation cycle	4D-Var (20km) < 40 layers > **[1 hour / 6 hour]** 3 hour assimilation cycle

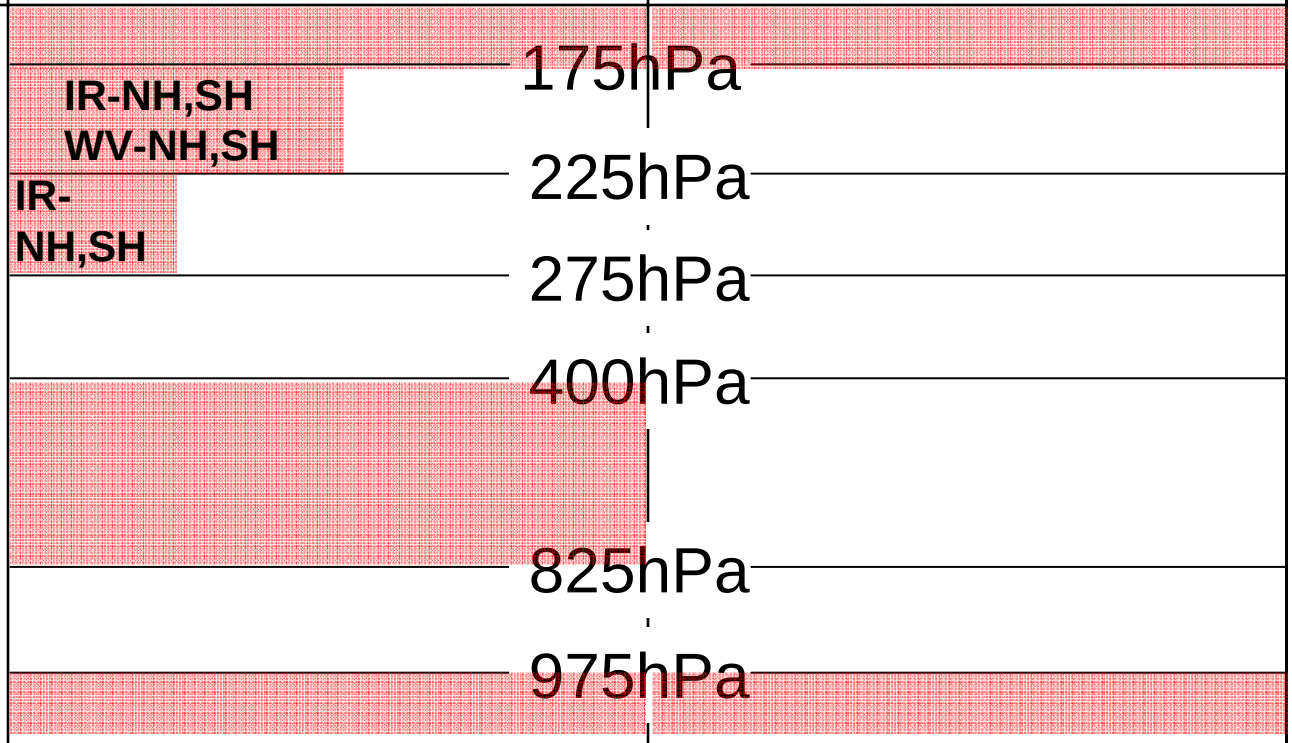
Upgraded usage of AMVs

- Contents
  - Upgraded Quality Control and new data
  - Experimental results in GSM-DA
  - Experimental results in MSM-DA

Upgraded Quality Control and New data (GSM-DA & MSM-DA)

- Contents
  - New data
    - Hourly MTSAT-1R AMVs in JMA/MSC
  - Upgraded QC
    - Restricting usage area to remove statistically unreliable
    - Tightening QI thresholds
    - Upgraded thinning scheme

Upgraded Quality Control and New data (GSM-DA & MSM-DA)

	GSM-DA	MSM-DA
Restricting usage area to remove statistically unreliable data **(Decided from statistical investigation of O-B standard-deviation(SD) and bias)** O: AMVs B: First guess		
Tightening QI thresholds **(Using statistical relation between QI and O-B SD)**	Characteristics: higher QI in the extra tropical region and in the high level winds	

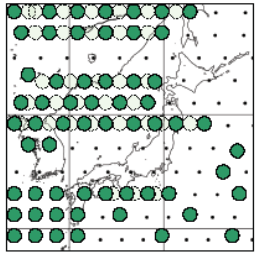
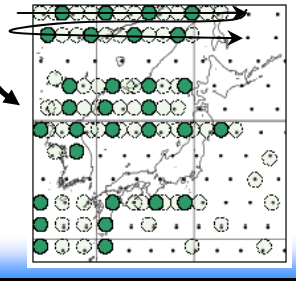
		HL	ML	LL
MTSA T-1R	IR	95	95	86
	VIS	-	-	86
	WV	96	-	-

Upgraded Quality Control and New data (GSM-DA & MSM-DA)

- QI thresholds (GSM-DA)

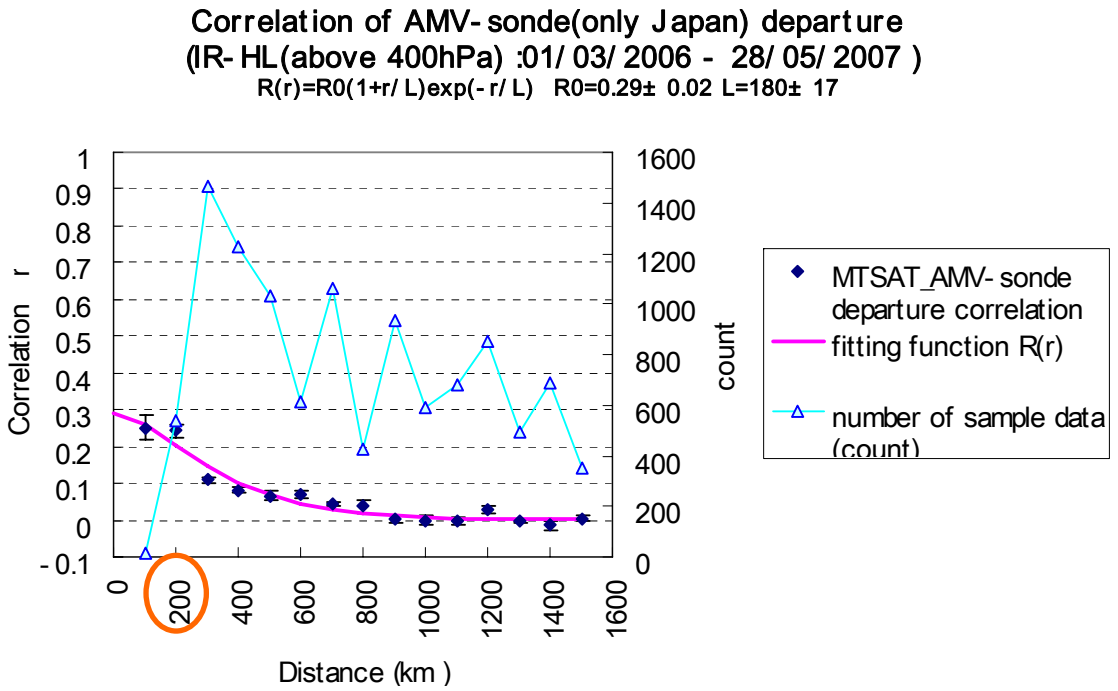
		extratropics(NH/SH)			tropics		
		HL	ML	LL	HL	ML	LL
Meteosat-7	IR	94/94	94/94	86/85	84	88	85
	VIS	-/-	-/-	-/88	-	-	84
	WV	95/95	-/-	-/-	88	-	-
Meteosat-9	IR	94/90	90/90	80/80	82	88	85
	VIS	-/-	-/-	82/82	-	-	82
	WV	94/94	-/-	-/-	84	-	-
GOES-11/12	IR	60/60	60/60	60/60	60	60	60
	VIS	-/-	-/-	60/60	-	-	60
	WV	60/60	-/-	-/-	60	-	-
MTSAT-1R	IR	98/96	96/94	84/84	84	84	85
	VIS	-/-	-/-	84/84	-	-	84
	WV	95/90	-/-	-/-	88	-	-

Upgraded Quality Control and New data (GSM-DA & MSM-DA)

	GSM-DA & MSM-DA
Upgraded Thinning scheme  ※The one-third thinning	Equal-distance thinning method ✓ Choose the data with lowest TQ in each thinning box: ➢Thinning box : 2deg. x 2deg. x 100hPa ➢TQ= (a*TD/180+b*BD/2+c*(100-QI)/100)*100 TD: time difference btw analysis and measurement, BD: spatial distance btw box center and measurement a,b,c : fixed coefficients
Former thinning scheme 	Reported-order thinning method ✓This method is simple, but causes a highly inhomogeneous distribution. 

Why are the AMVs thinned ?

- Previously, we investigated the distance dependency of correlation of departure between MTSAT-1R AMV and Japan radiosonde observations using Hollingworth-Lonnberg method. This result from March 1,2006 to May 28,2007 is shown statistically slight spatial error correlations for distances up to ~200 km. The lower figure is shown.
- JMA 4D-Var systems assume uncorrelated spatial error to reduce computation.

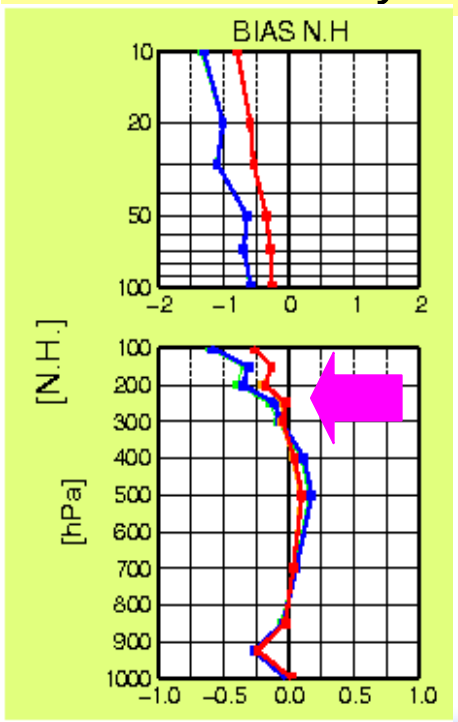


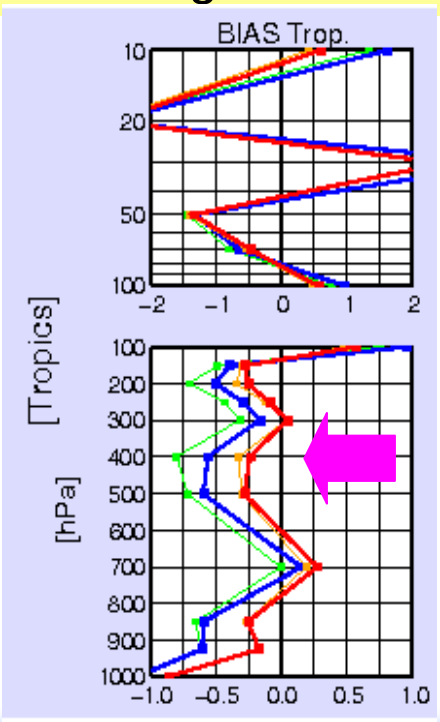
Experimental results for GSM-DA

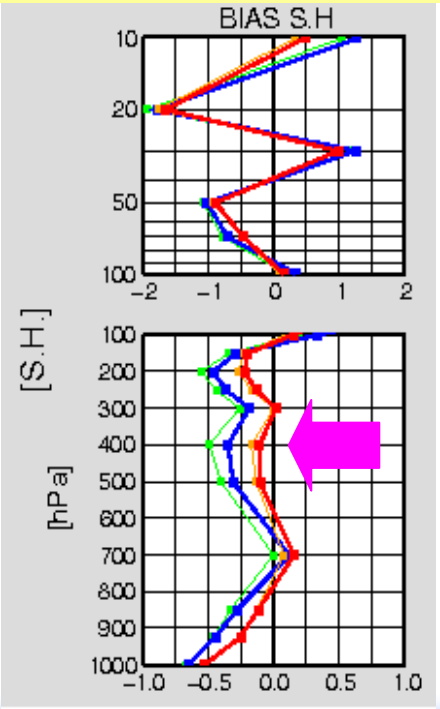
- One-month observation system experiments were performed for January 2006 and September 2005.
- Reducing biases for wind against radiosonde observations in mainly tropical area and southern hemisphere in both seasons.

Ex.

Wind speed biases against radiosonde observations in January 2006
Biases of Analysis / First-guess



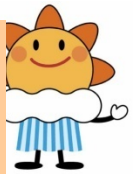




Test : New QC
Cntl : Former scheme

Anal TEST
Anal CNTL
Guess TEST
Guess CNTL

U-component winds (m/s)



Experimental results for GSM-DA

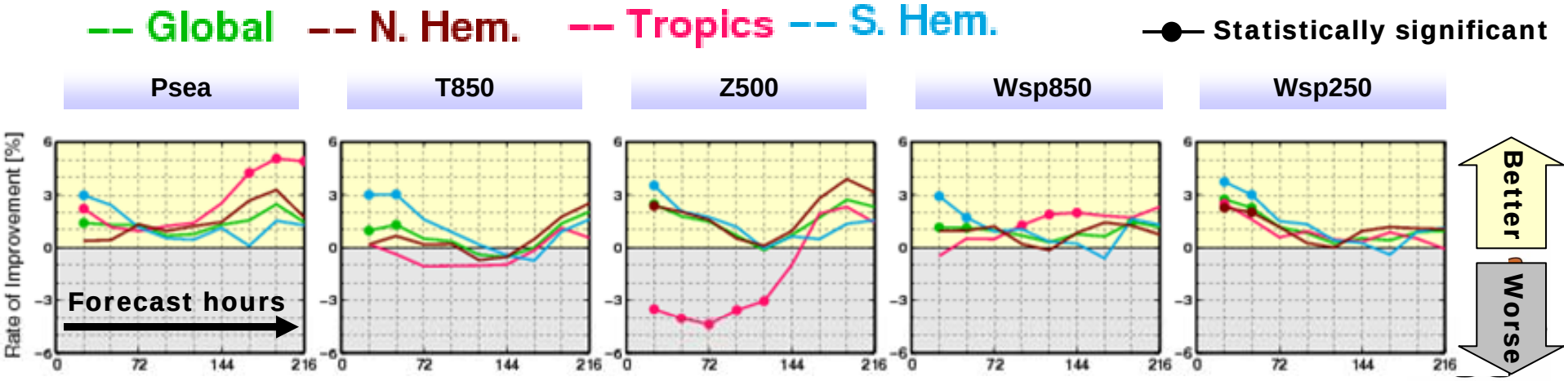
- Significantly positive impacts (maximum ~3%) on two-day forecast in terms of 250hPa winds, 500hPa geopotential heights and 850hPa temperatures especially in southern hemisphere in January 2006
- Slightly positive impacts or neutral on forecast in September 2005

Ex.

Forecast Improvement Rate wrt RMSE for 1-9 day forecasts

(CNTL-TEST)/CNTL TEST : New QC , CNTL : Former scheme

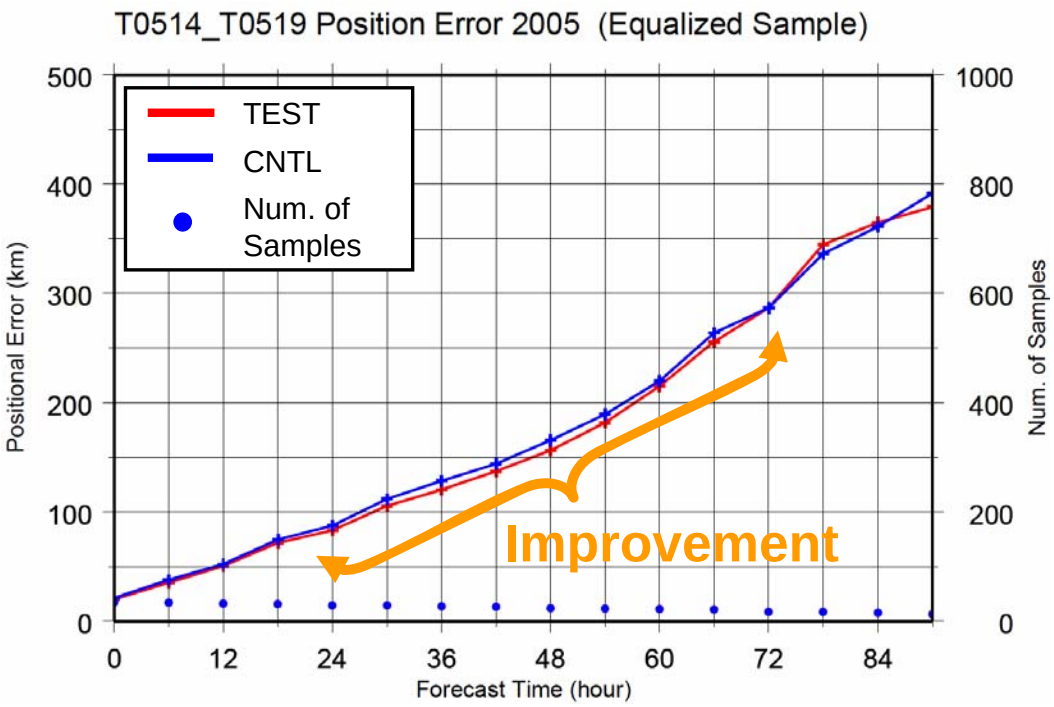
from 1 to 31 January 2006



Experimental results for GSM-DA

- The typhoon track predictions slightly improve in September 2005.

Averaged typhoon track error in September 2005.



Blue dots indicate the number of cases used in this statistics.

Test : New QC (BUFR)
Cntl : Former scheme (SATOB)

Upgraded usage of AMVs in GSM-DA

Experimental results for MSM-DA

- Some days observation system experiments were performed for 25-31 December 2006 , 7-13 June 2007 and 1-15 July 2007.
- To assess the impact of new scheme and correlated spatial error , experiment of 4 types as follows were performed.

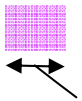
Almost same as GSM-DA Ver.

CNTL（Former scheme：SATOB）
No thinning

THIN_200KM（New QC：BUFR）
Use in a thinning box of every 2deg in six-hour time windows

THIN_100KM（New QC：BUFR）
Use in a thinning box of every 1deg. in six-hour time windows

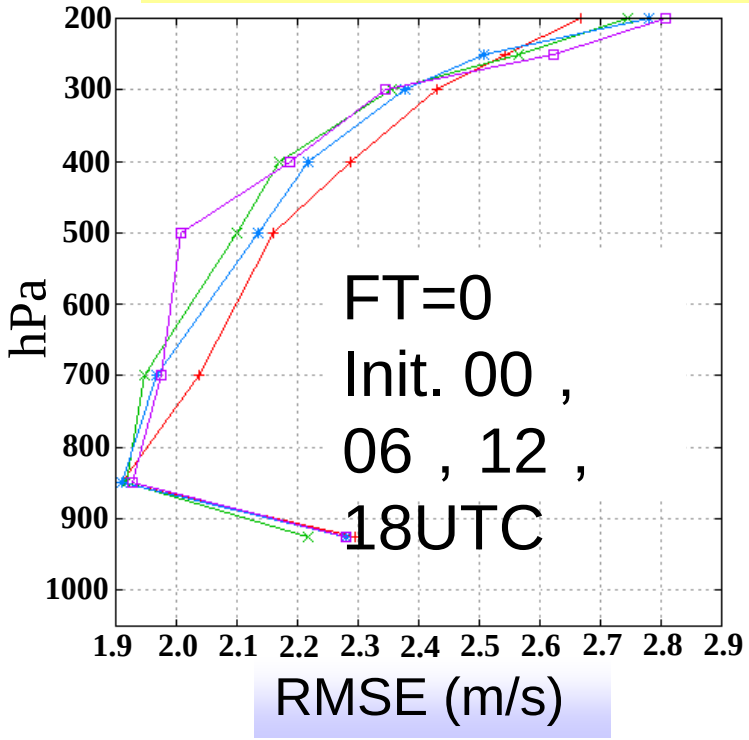
THIN_200KM_EACH（New QC：BUFR）
Use in a thinning box of every 2deg. in each of six-hour time windows

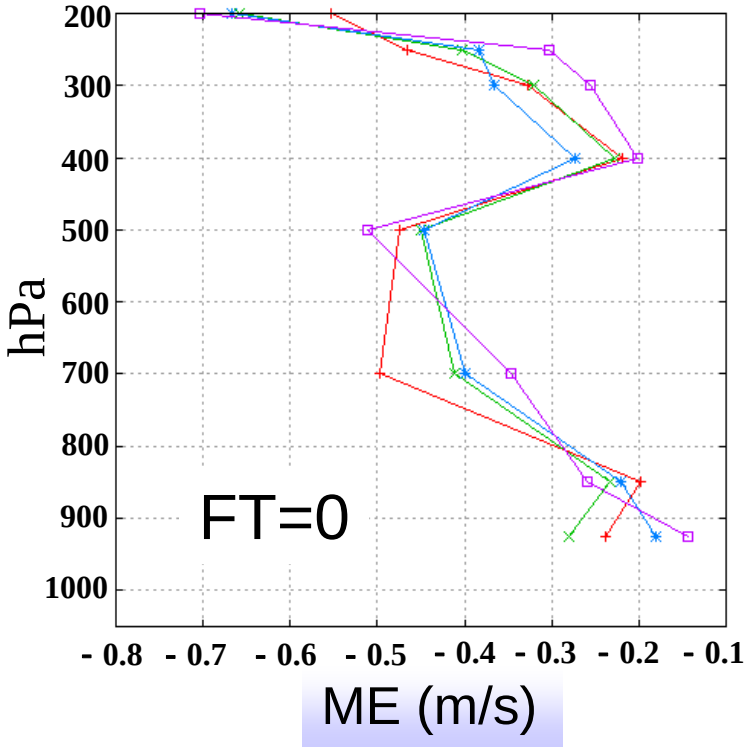


Experimental results for MSM-DA

- RMSE and biases for wind against radiosonde observations in each of schemes are smaller than CNTL.
- Especially **THIN_200KM** or **THIN_200KM_EACH** are better.

Ex. RMSE and ME against Japan Radiosonde Wind speeds from 1 to 15 July 2007 (FT: Forecast time)



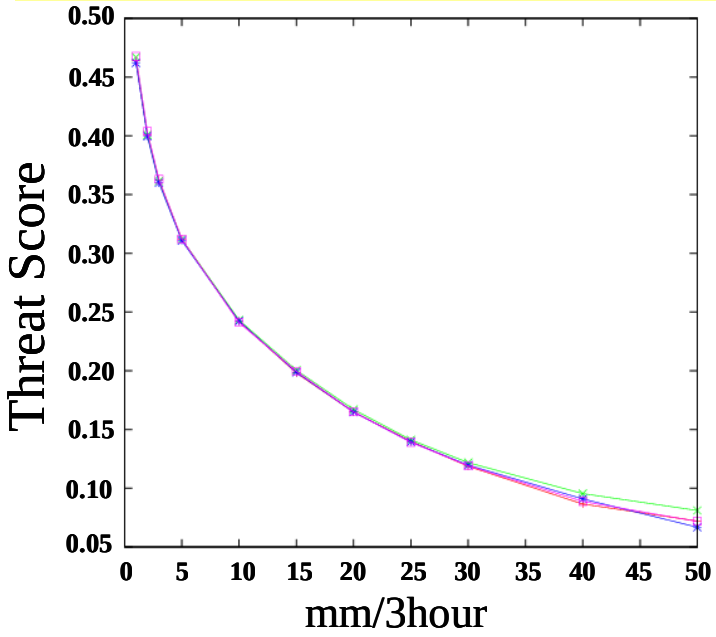


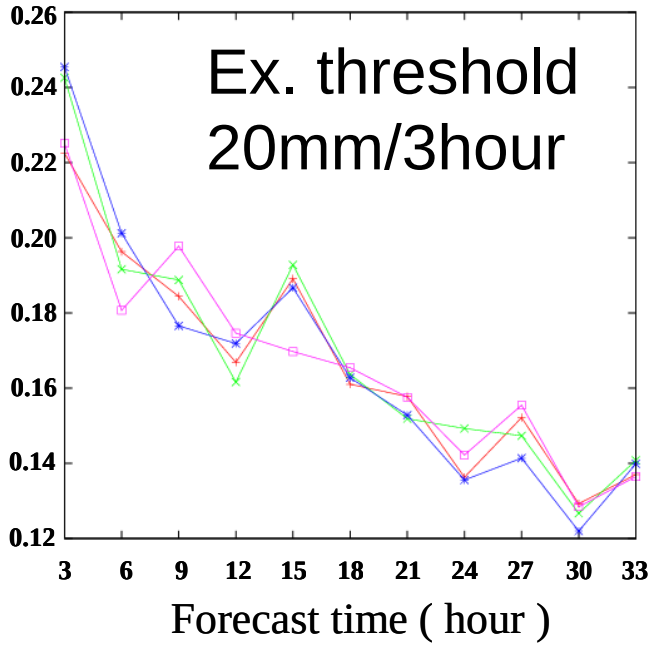
CNTL **THIN_200KM** **THIN_100KM** **THIN_200KM_EACH**

Experimental results for MSM-DA

- There was a slightly improvement in the **THIN_200KM** scheme in one-day forecasting for precipitation over 15 mm per three hours around Japan.

Ex. Threat Score against R/A from 1 to 15 July 2007
(Init. 03,09,15,21UTC)
R/A : Radar-AMeDAS composite precipitation data in Japan
Condition : 20kmgrid around Japan and total-3hour precipitation

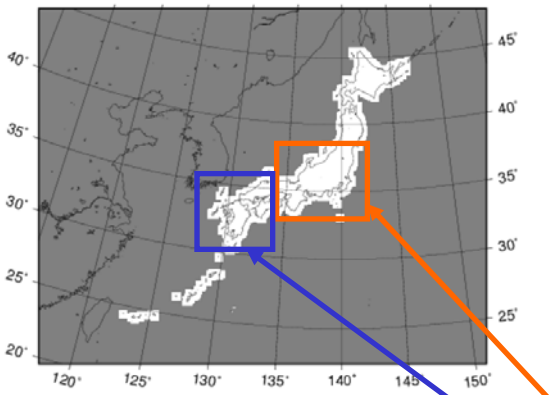




Upgraded usage of AMVs in MSM-DA (**THIN_200KM**)

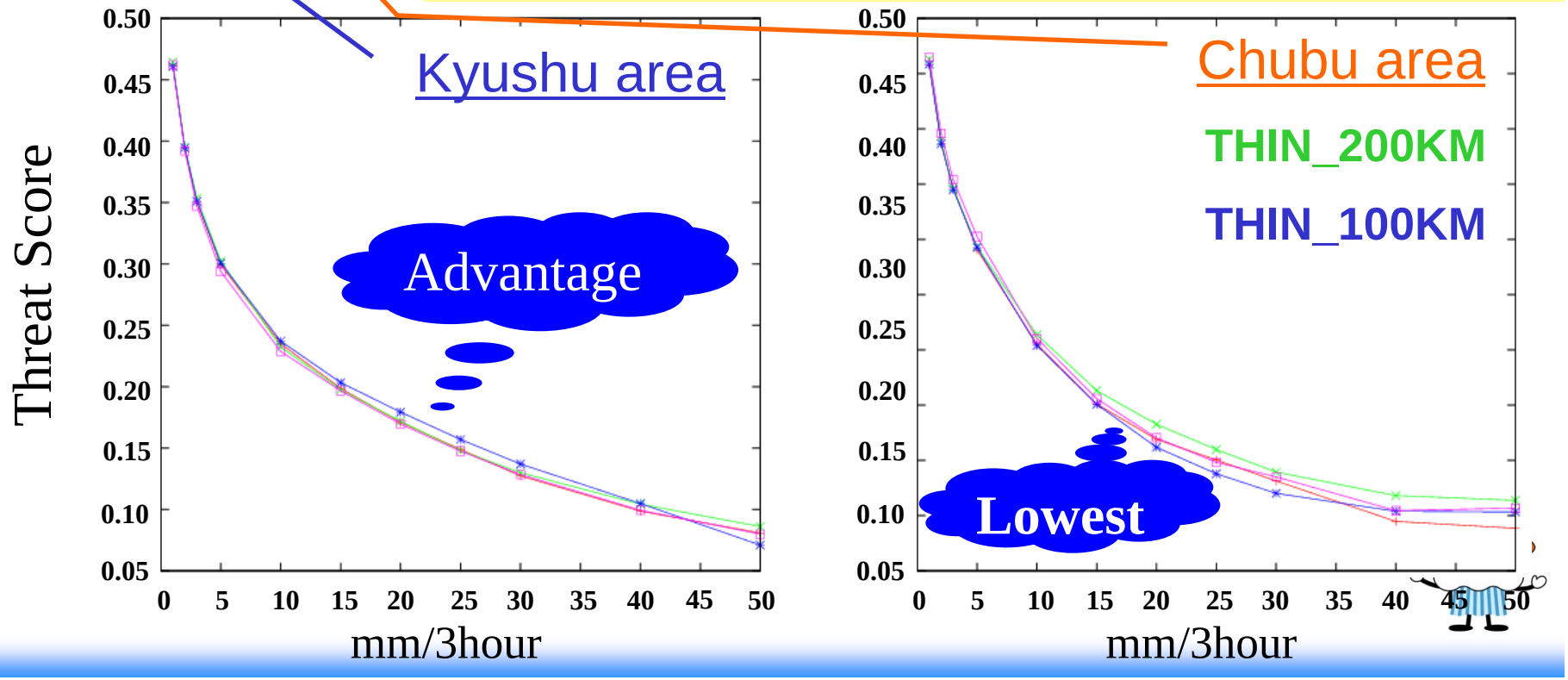
CNTL **THIN_200KM** **THIN_100KM** **THIN_200KM_EACH**

Experimental results for MSM-DA



- **THIN_100KM** of the left side figure brought advantage of high-resolution winds in this case but the right side figure brought lowest threat score. This bad score may show the effect of correlated spatial error. But we are investigating this cause.

Threat Score against R/A from 1 to 15 July 2007
(Init. 03,09,15,21UTC)



Conclusion 1/3

- Upgraded usage of AMVs in GSM-DA and MSM-DA
  - Upgraded Quality Control and New data contents
    - **Start using new data of hourly MTSAT-1R AMVs**
    - **Restricting usage area to remove statistically unreliable**
    - **Set to tightening QI thresholds**
    - **Upgraded thinning scheme in JMA**
      - To take into account correlated spatial error
      - Winds thinned in 2deg. by 2deg. by 100hPa boxes.
      - Only one wind selected per box in six-hour time windows.

Conclusion 2/3

- Experimental results for GSM-DA
  - Reducing biases for wind against radiosonde observations in mainly tropical area and southern hemisphere
  - Significantly positive impacts on two-day forecast in terms of 250 hPa winds, 500 hPa geopotential heights and 850 hPa temperatures especially in southern hemisphere
  - The typhoon track predictions slightly improve.

  ⇒ Upgraded usage of AMVs from 18 October, 2006

- Experimental results for MSM-DA
  - Reducing RMSE and biases for wind against radiosonde observations
  - There was a slightly improvement in one-day forecasting for precipitation over 15 mm per three hours around Japan.

  ⇒ Upgraded usage of AMVs from 7 December, 2007

Conclusion 3/3

- Additional experimental results for MSM-DA
  - Advantage of high-resolution winds seen in only Kyushu, Japan
  - Disadvantage of ones seen in Chubu, Japan
  - If including much AMVs and thinning interval of AMVs assimilated in the only small area are smaller than 200km, it may be able to bring good impacts for forecast in only assimilated area.

Future Plan

Operational change

- Switch from CIMSS MODIS winds to NESDIS MODIS winds in GSM-DA in March 2009
- Start using the MODIS direct broadcast winds in GSM-DA in March 2009

Possible new data sources

- Rapid scan AMVs from MTSAT-2
  (response to THOPEX)
- Future satellites AMVs
  (ADM-Aeolus wind etc.)

Challenge

- Try to assimilate AMVs in the smaller area than MSM-DA and forecast

ありがとうございました

Thank you for your attention