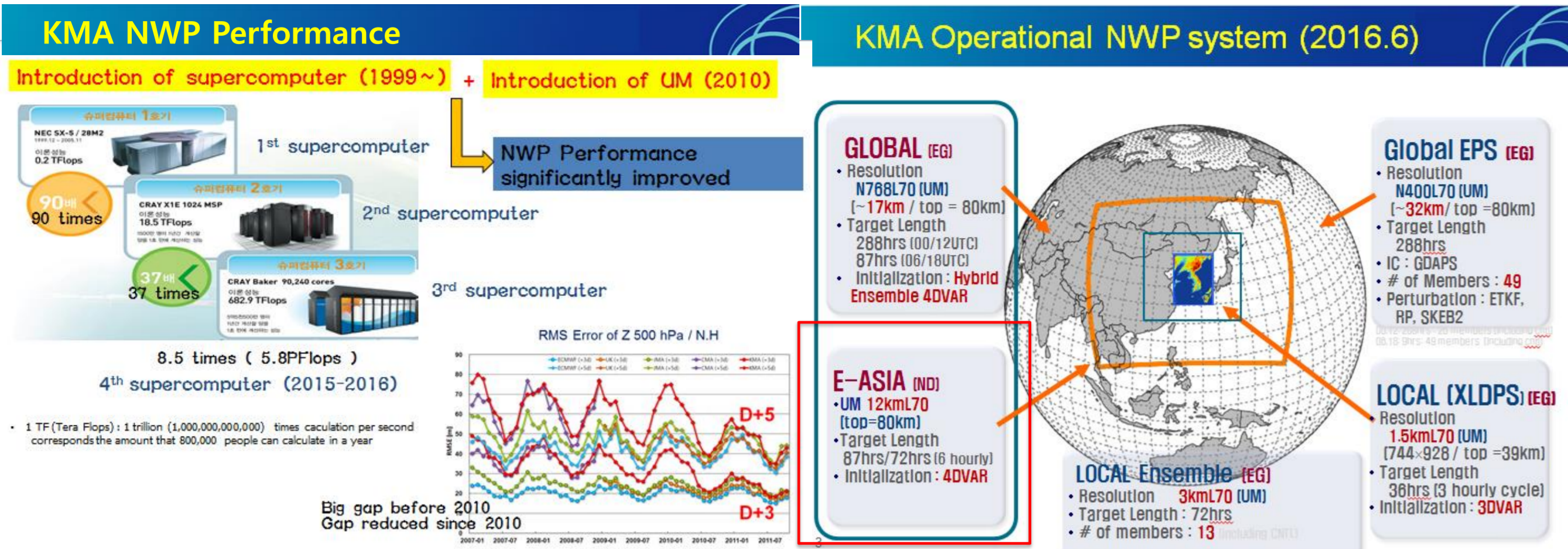


Recent Improvements of KMA Regional Data Assimilation System for better forecast of severe weather over East Asia

Hyun-Cheol Shin, Hae-Mi Noh, Dong-joon Kim, Tae-kyu Jang, Eun-Hee Lee, Sangwon Joo
Korea Meteorological Administration

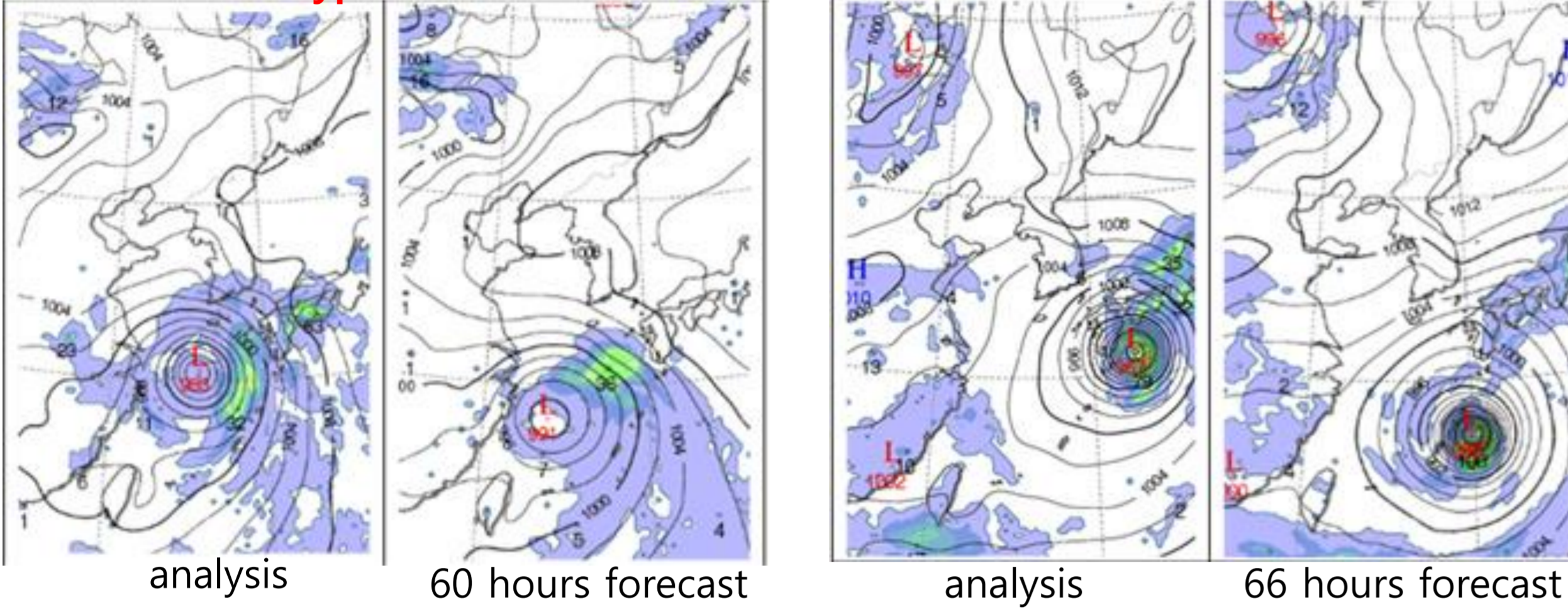
1 Introduction



In spite of general improvement of performance that regional model showed since KMA introduce Unified Model from UKMO in 2010, regional model sometimes produced wrong forecast for the specific severe weather case (Typhoon Nakri and Halong).

<Typhoon Nakri>

<Typhoon Halong>



Several key elements in regional NWP system were reviewed and modified

2 Typhoon Bogus system

KMA Typhoon Bogus

- Fujita's formulas for specifying a bogus SLP field

$$P(r) = P_{\infty} - \frac{P_{\infty} - P_c}{\sqrt{1 + \left(\frac{r}{\sqrt{2}R_0}\right)^2}}$$

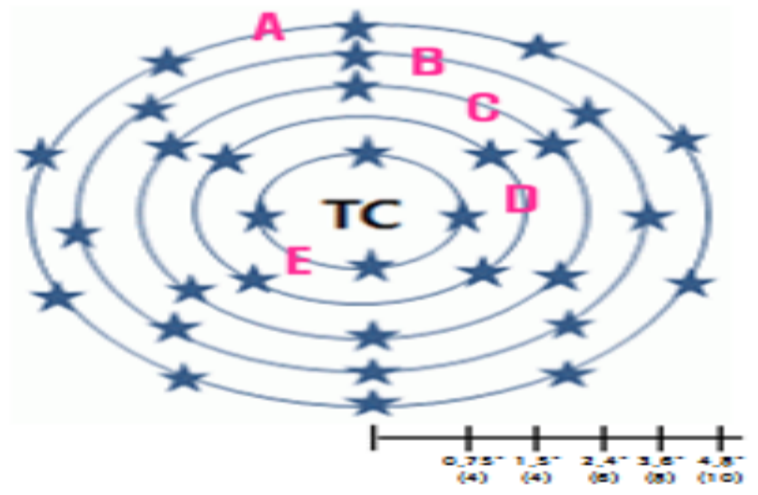
MSLP only used for bogus !

r : the distance from TC central position, P_c : the central SLP of TC.
P_∞ : an estimation of the SLP at an infinite distance,
R₀ : the radius of the maximum gradient of the SLP

- P_c : TC advisory message
- R₀ : 0.4 * R34kt
- P_∞ : Background field (34kt * 3)

- Definition of Bogus observation positions

- Depending on Radius of 34 knot winds(R34)
 - If R34 > 200nm Then use 5rings(A,B,C,D,E)
 - If 120nm ≤ R34 < 200nm Then use 4rings(B,C,D,E)
 - If R34 < 120nm Then use 3rings(C,D,E)
- REDUCE BOGUS OUTER RING IF BOGUS WILL CROSS EQUATOR
- Check If Bogus areas come closer than 2 degrees to each other
 - The outer ring radii are reduced alternately
 - Still too close, no bogus data are generated for the weaker TC.



<What was improved>

- if observed typhoon is weaker (~5hPa) than model typhoon, skip bogus.
- if central pressure of typhoon is larger than 990 hPa, skip bogus.
- More generous QC for bogus data to use more bogus data.

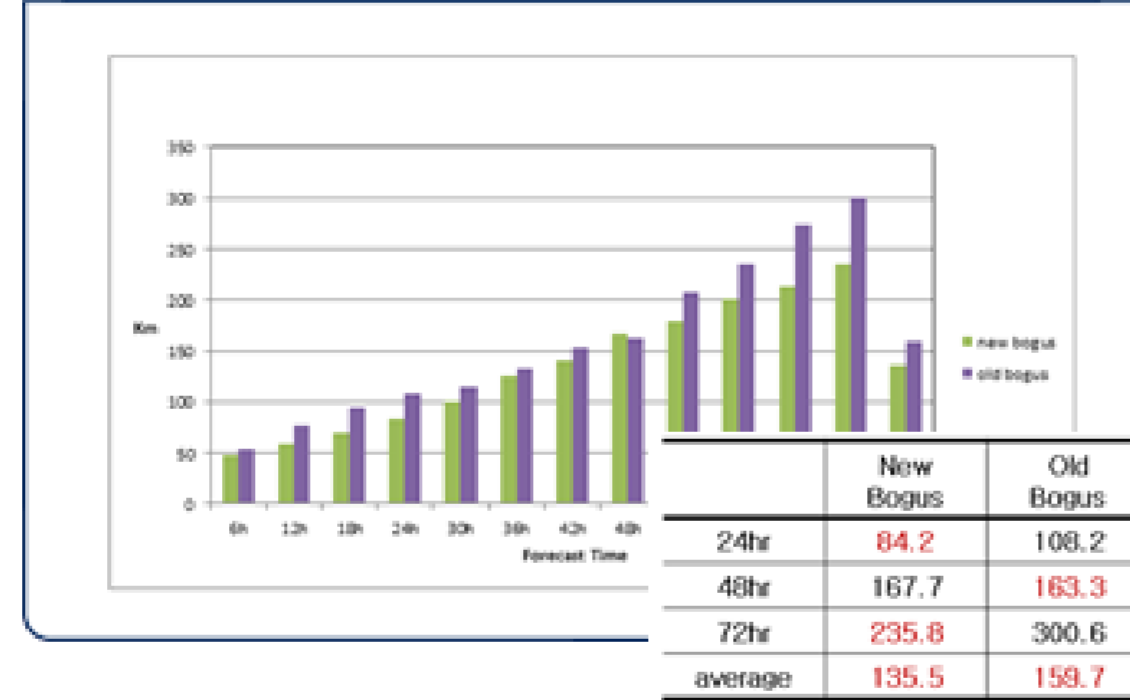
Verification of Model Performance

- RMSE Improvement Rate(%)

$$\left[\frac{(\text{ctl-exp})}{(\text{ctl})} \right] * 100$$

	New Bogus	Old Bogus
Analysis	3.3	1.4
Observation	1.7	0.7

Position Error(km)



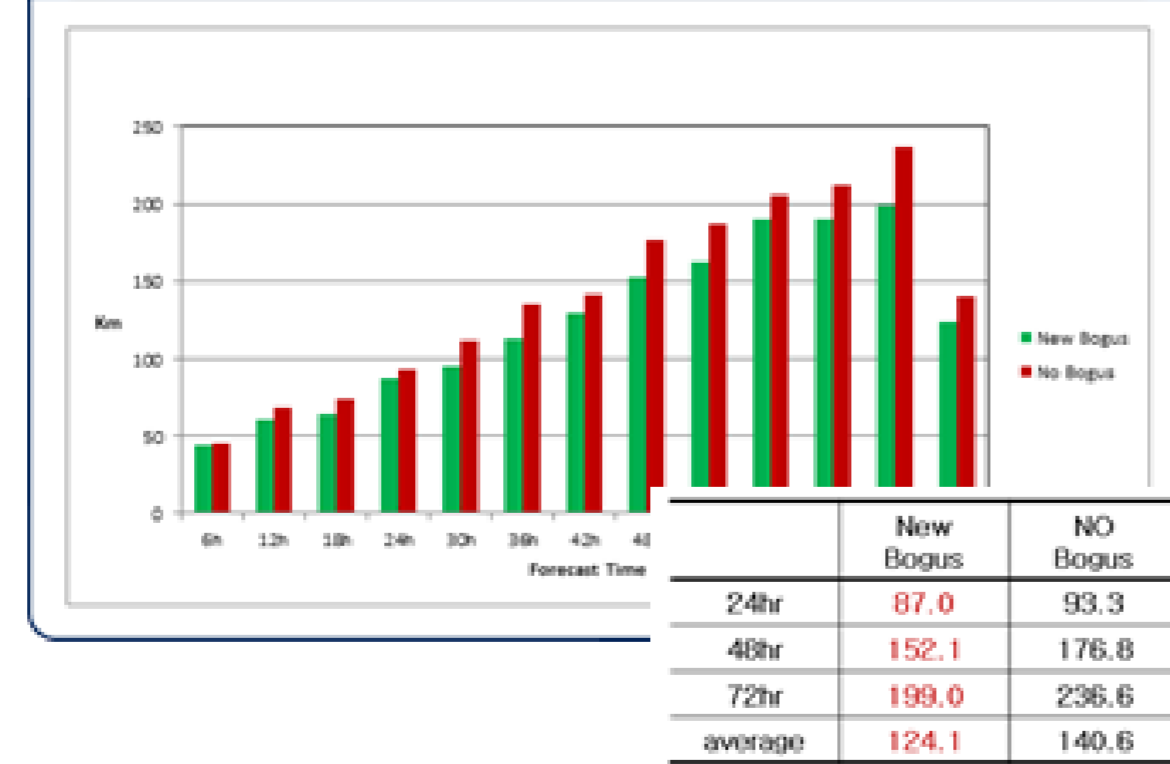
Verification of Model Performance

- RMSE Improvement Rate(%)

$$\left[\frac{(\text{ctl-exp})}{(\text{ctl})} \right] * 100$$

	New Bogus	No Bogus
Analysis	5.0	4.9
Observation	2.3	1.8

Position Error(km)

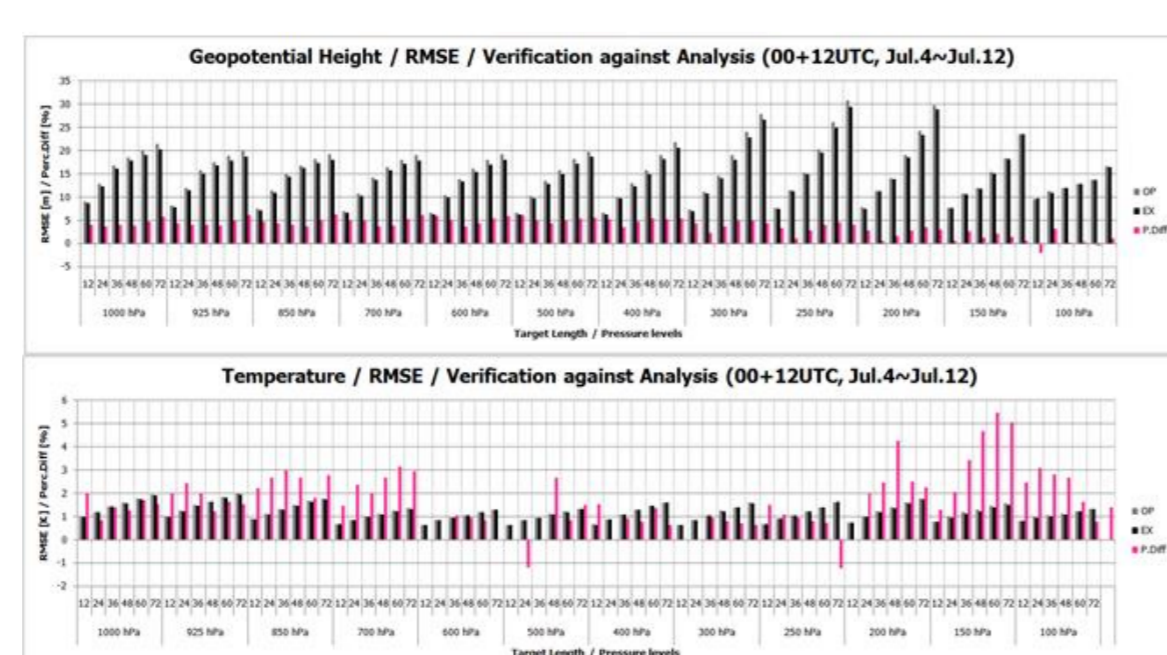


3 Ancillary Data (Aerosol)

<Improvement of Ancillary data> (Climatological Aerosol)

- Climatological Aerosol information for global model was introduced into regional model
- It is related with long wave radiance parameterization

Generally improved



4 Soil Moisture Update

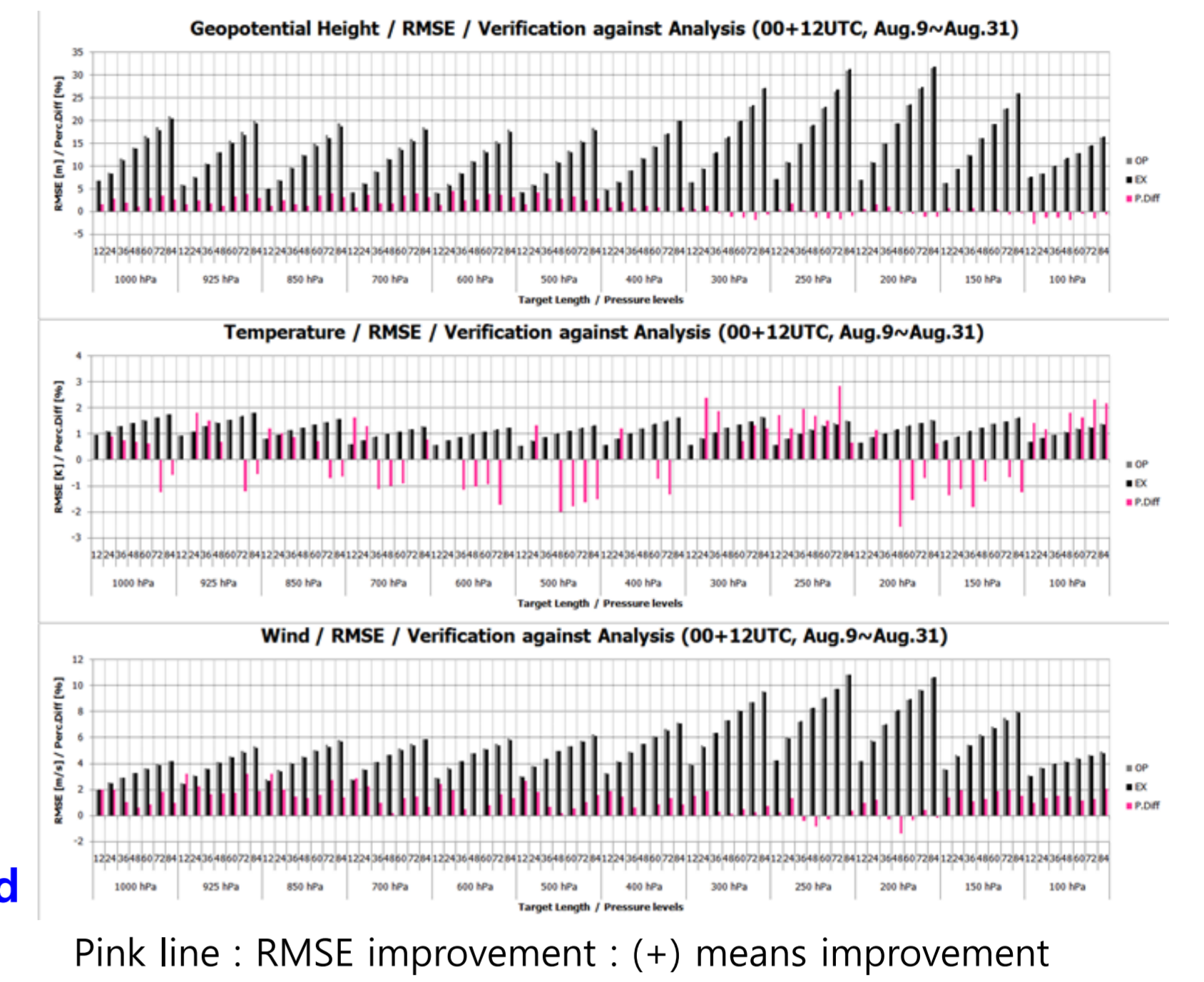
Soil moisture contents(SMC) information was updated more frequently from global cycle

Global SMC

OLD : Once a day
New : 4 times a day

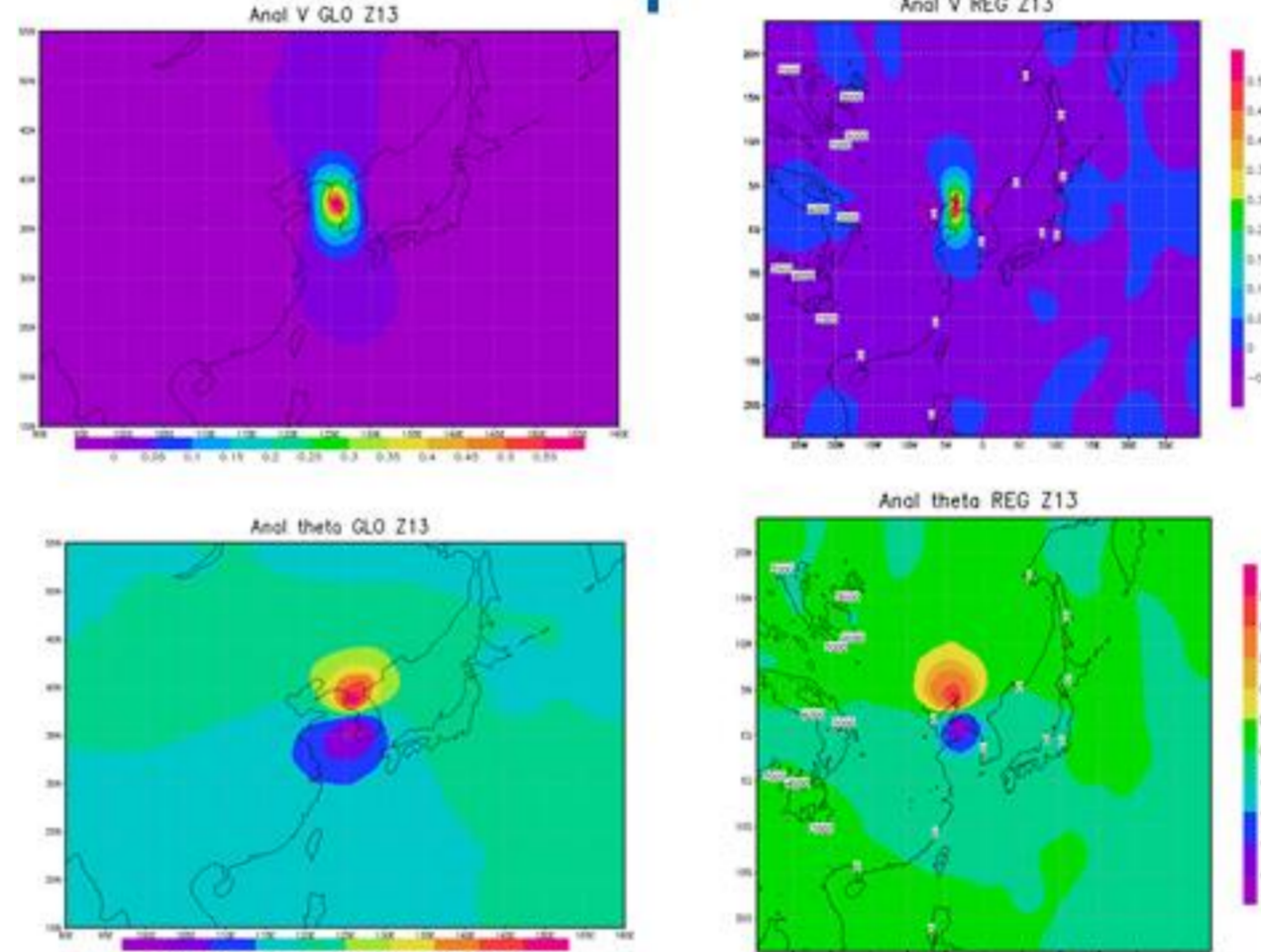
Regional SMC

Generally improved



5 Satellite Data Thinning

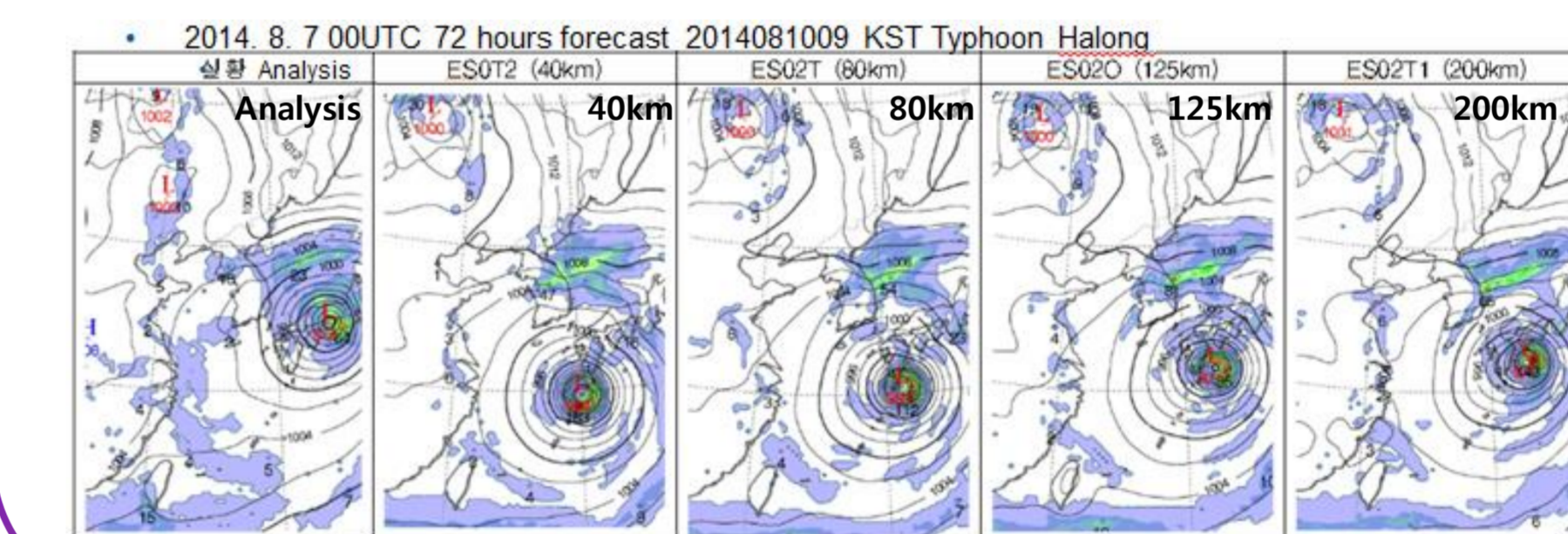
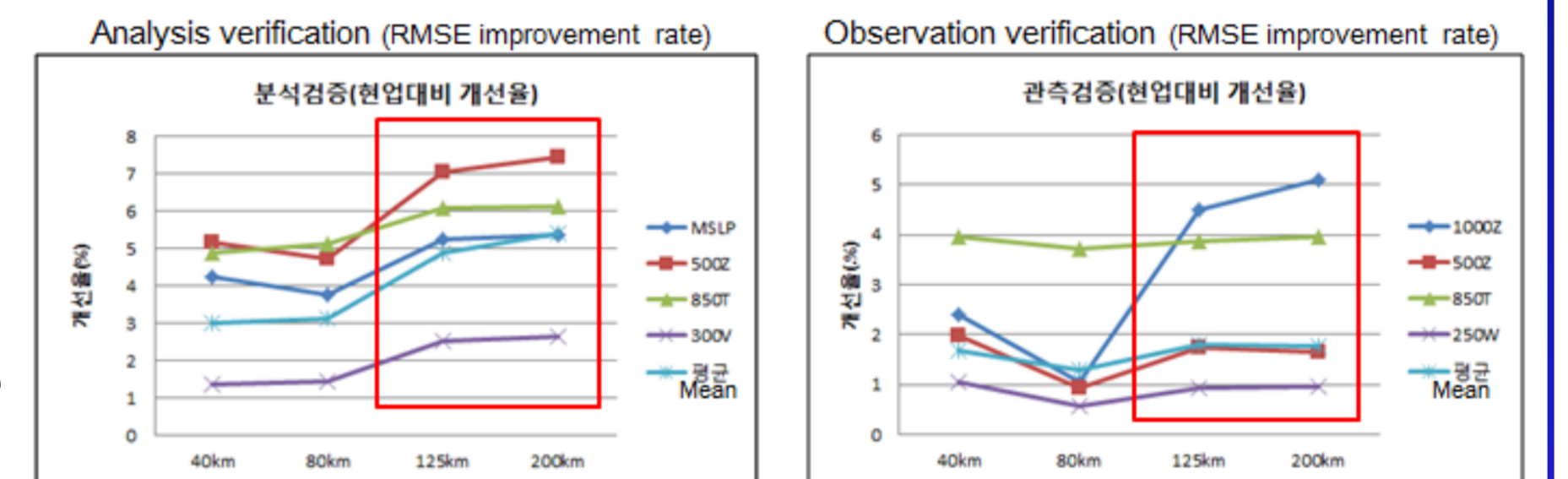
- Thinning Range of Satellite data (ATOVS, IASI, AIRS) was tuned
- Global thinning range applied
 - 80(Extra Tropics) / 100km(Tropics) → 125(ExTR) / 154km(TR)



<Single Observation test : Single V given>

- horizontal length scale of observation spread similar between global and regional model
- How observation impact spreads into model decided by the background error covariance(BE)
- Regional BE produced by averaging global BE over the model domain → Basically same BE as global one
- So, may be reasonable to use similar thinning range between global and regional DA

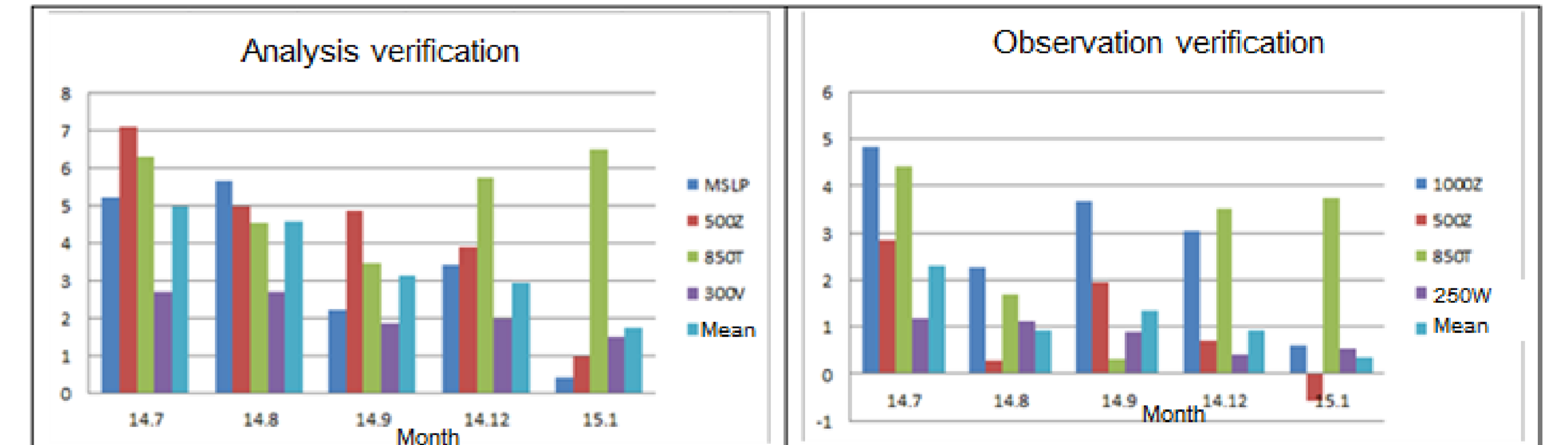
Comparison of cycles with different thinning range (The optimal density of atmospheric sounder observations in the Met Office NWP system, M.L Dando, A.J. Thorpe and J.R.Eyre)
2014. 7 case : 4 thinning ranges (40, 80, 125, 200 km)
125km range showed better performance than 80km generally
Optimal thinning range → 125km



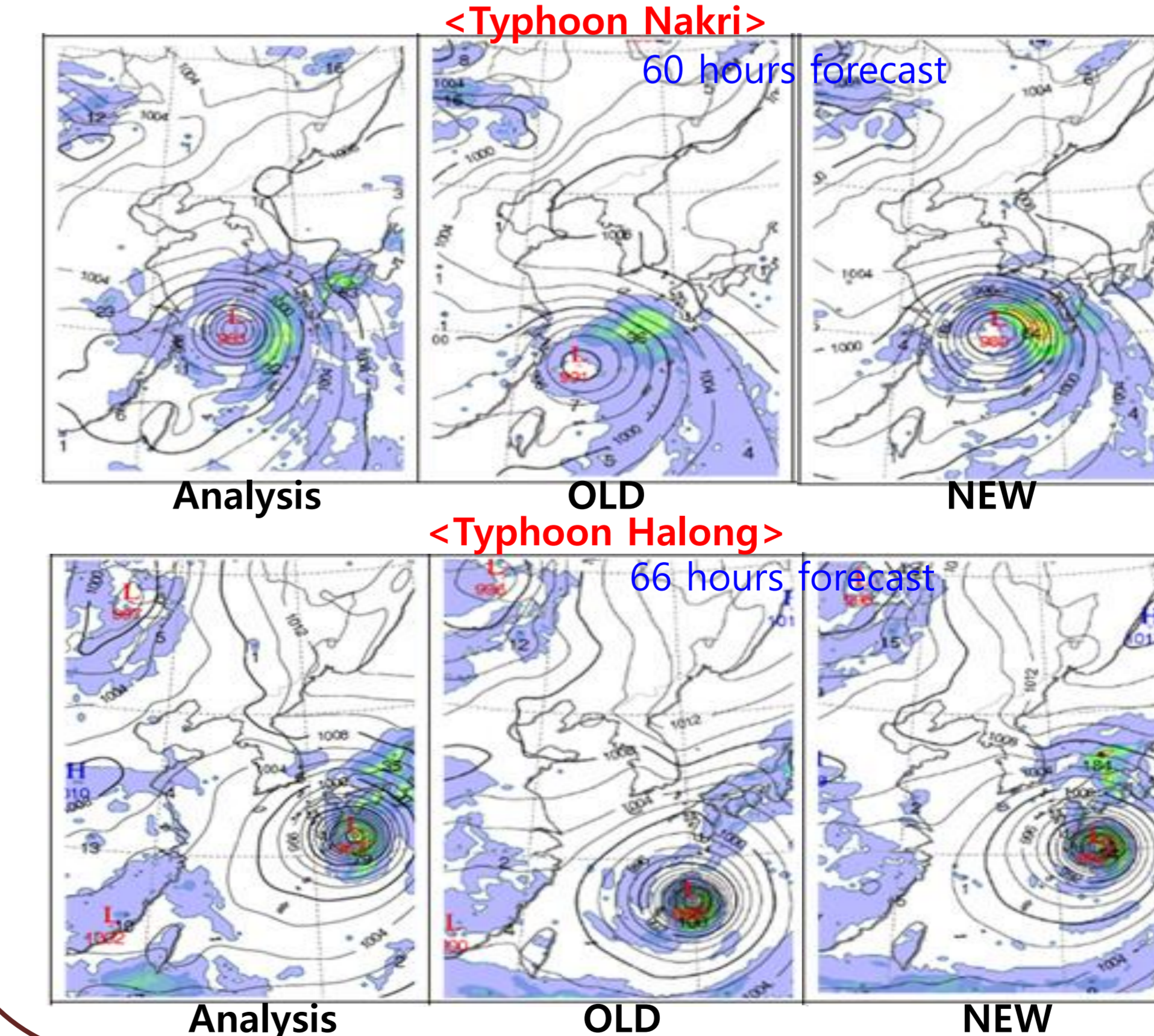
- Typhoon Halong case surveyed for 4 different thinning range
- The forecast for typhoon Halong was significantly improved with 125 km and 200 km
- Slow bias of typhoon not solved in 40km and 80 km
- More satellite data caused slow bias of typhoon

6 Total Improvements

RMSE Improvement rate (%)



Remarkable improvement for most cases (+ : means improvement)



- ### <Improvements>
- Typhoon bogus system
 - Ancillary (Aerosol)
 - Soil moisture update
 - Satellite data thinning

< Impact Test Run >

- Summer : 2014.7-9
- Winter : 2014.12 - 2015.1

< Main cases >

- Typhoon Nakri, Halong

7 Summary & Plan

- [Summary] 4 key elements (typhoon bogus, aerosol ancillary, soil moisture update, satellite data thinning) of KMA 12km regional model were improved giving better model performance.
- [Plan] KMA 12km Regional model will be replaced by 1.5km local model or 4km regional model by 2019 when 12km global model will be installed.