Sensitivity experiments for RTPS parameter in the low-resolution ensemble prediction system with KIM

Seokmin Hong, Ja-Young Hong, Kyung-Hee Seol, In-Hyuk Kwon

Korea Institute of Atmospheric Prediction systems (KIAPS)

1 Background

- Korean Integrated Model (KIM) is a global weather prediction model, developed in 2011 by KIAPS.
- Ensemble prediction system(EPS) was constructed using KIM and Local Ensemble Transform Kalman Filter (LETKF).
- We discovered a surface pressure noise problem in analysis as well as forecast data.
- The noise also appears in high-resolution system (KMA semi-operational EPS with 32 km horizontal resolution).
- We analyzed the cause of the nose in surface pressure, and as a result, it was confirmed that Relaxation To Prior Spread (RTPS) parameter value was the cause.
- The RTPS is similar multiplicative inflation method, that uses ensemble spread and RTPS parameter values. The RTPS parameter showed better performance the closer to 1, and the best performance was shown at 0.95 (Whitaker and Hamill, 2011).
- But noise problem disappear the conversion from the cubed-sphere grid to the lat-lon grid (remap process).

2 Objectives

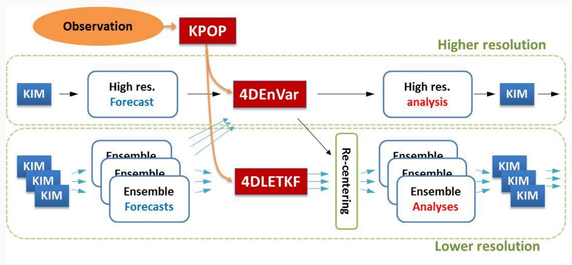
- Through this study, we suggest the optical RTPS parameter value for KIM and hope to hear many advice on noise phenomenon.
- Accumulation of noise is expected to affect KIM performance in the long term, so we checked long-term prediction performance.

3 Methods

- Low-resolution ensemble system

Model	Explanation	Resolution
KIM v3.7	Atmosphere model (cubed-sphere)	Ne045np3(~100km), L91
KPOP v3.7	Observation processing	-
Hybrid-4DEnVAR v3.7	3DVAR with FGAT	Ne045np3(~100km), L91
	LETKF (50 members)	Ne045np3(~100km), L91
Analysis period		6-hourly
Initial state	Atmosphere	ERA5 reanalysis
Simulation periods		00 UTC 15 – 18 UTC 24 July. 2020

- KPOP and DA



- **Observation pre-processing: KIAPS Package for Observation Processing (KPOP)** [Kang et al., 2018]
- **Data assimilation: Hybrid-4DEn Var System (50 ensemble members)** [Kwon et al., 2018]

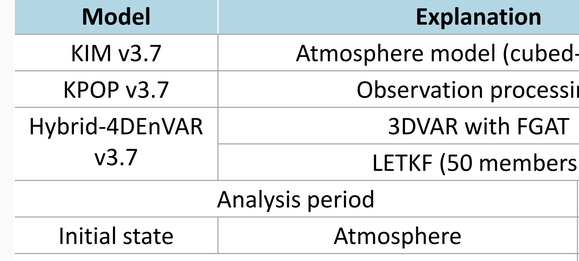
- RTPS sensitivity experiments

Sensitivity experiments	RTPS parameter
CNTL	0.95
RTPS	0.8
	0.7
	0.6
	0.5

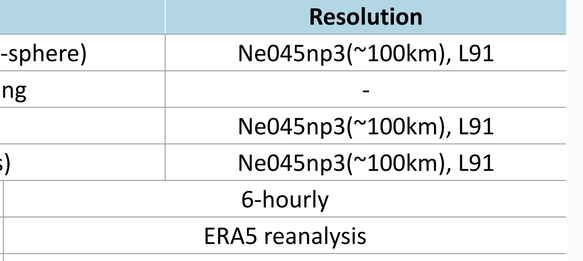
4 Results

Comparison of 6-hour and 7-day forecast field

6-hour forecast surface pressure field(20200715 06 UTC)

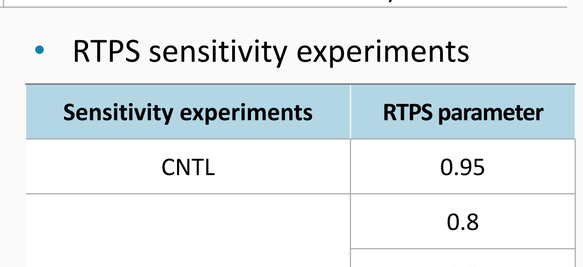


7-day forecast surface pressure field(20200724 00 UTC)



RTPS Surface pressure field(20200715 06 UTC)

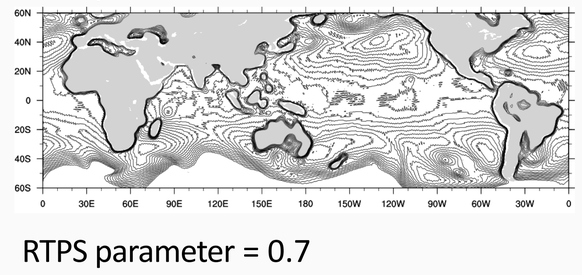
RTPS Surface pressure field(20200724 00 UTC)



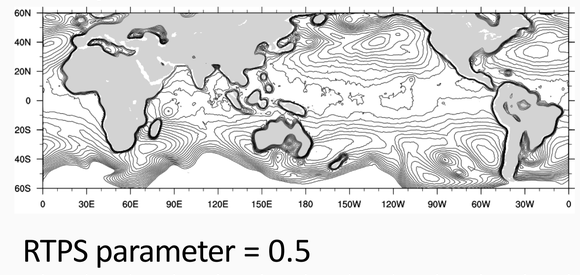
- We confirmed that noise appeared in the surface pressure after about 7 days of prediction.
- The noise is in the shape of a gear, and it shows a different appearance from the general surface pressure.
- In the RTPS surface pressure for ensemble spread amplification, a surface pressure similar to the forecast surface pressure field was checked.

Result of RTPS experiments (Surface pressure)

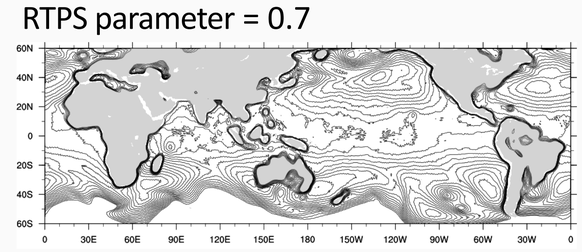
RTPS parameter = 0.8



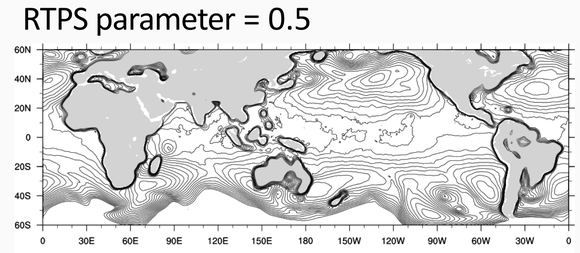
RTPS parameter = 0.6



RTPS parameter = 0.7

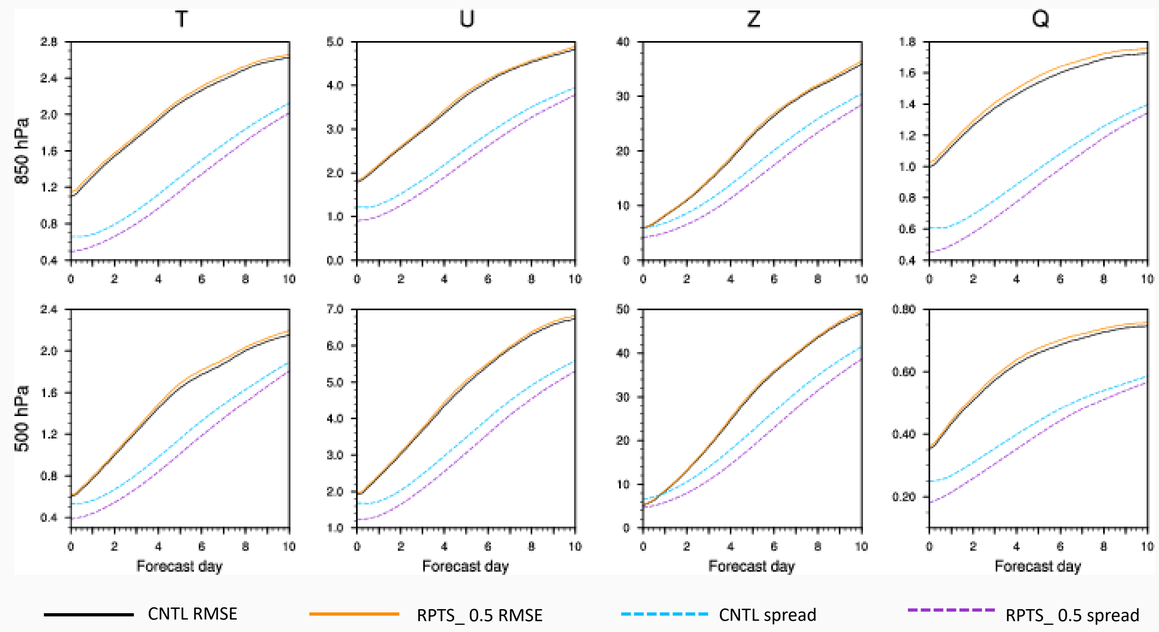


RTPS parameter = 0.5



- We conducted the experiment by adjusting the RTPS parameter value from 0.5 to 0.8.
- As a result, It was confirmed that the noise appeared clearly up to 0.7, and the noise disappeared at 0.5.
- We considered adjusting the RTPS parameter, but we needed to check the performance difference compare to 0.95.

Result of RTPS experiments (Other vertical variables)



- Except for the geopotential height, noise did not appear the same noise as the surface pressure in the 2-dimensional field.
- For all variables of 850 hPa and 500 hPa, the RMSE of CNTL(0.95) was lower than 0.5.
- For all variables of 850 hPa and 500 hPa, the spread of CNTL(0.95) was higher than 0.5
- CNTL performs better for ensemble prediction than 0.5.

5 Summary and discussion

- KIAPS has developed KIM of the cubed-sphere grid system and constitutes an EPS based on LETKF.
- Found the noise in surface pressure through low-resolution EPS data.
- It is confirmed that the noise appears clearly after about 7-day of prediction and is amplified by the RTPS parameter value.
- As a result of a sensitivity experiment by adjusting the RTPS parameter, it was confirmed that the surface pressure noise disappeared at 0.5.
- Noise did not appear in other variables except pressure, and it was confirmed that the performance was better at 0.95 than at 0.5 in the vertical layer.
- At 0.5, the noise of the surface pressure disappeared, but it is difficult to adjust the RTPS parameter because the performance is poor.
- Using 0.95 is expected to accumulate noise and affect long-term predictions.
- I would like to hear your opinion on how to resolve surface pressure noise and improve performance.

6 Reference

- Whitaker and Hamill, 2011 : Evaluating Methods to Account for System Errors in Ensemble Data Assimilation. *Mon. Wea. Rev.,* **140***, 3078-3089.*
- Kang, J.-H.; Chun, H.-W.; Lee, S.; Ha, J.-H.; Song, H.-J.; Kwon, I.-H.; Han, H.-J.; Jeong, H.; Kwon, H.-N.; Kim, T.-H., 2018: Development of an Observation Processing Package for Data Assimilation in KIAPS, *Asia-Pac. J. Atmos. Sci., **54(s)**, 303-318.*
- Kwon, I.-H.; Song, H.-J.; Ha, J.-H.; Chun, H.-W.; Kang, J.-H.; Lee, S.; Lim, S.; Jo, Y.; Han, H.-J.; Jeong, H.; et al., 2018: Development of an Operational Hybrid Data Assimilation System at KIAPS, *Asia-Pac. J. Atmos. Sci.,* **54(s)***, 319-335.*