A Near-Real-Time System Of NICAM-LETKF Assmilating GSMaP

Kaya Kanemaru[1], Masaki Satoh[1], Koji Terasaki[2], Shunji Totsuki[2], Takemasa Miyoshi[2], and Takuji Kubota[3]

1 The University of Tokyo, Atmosphere and Ocean Research Institute (AORI), Kashiwa, Japan

2 RIKEN Advanced Institute for Computational Science (AICS), Kobe, Japan

3 Japan Aerospace Exploration Agency (JAXA), Tsukuba, Japan

Purpose

RIKEN Advanced Institute for Computational Science (AICS) develops a data assimilation (DA) system of Local Ensemble Transform Kalman Filter (LETKF) (Terasaki and Miyoshi 2017, Kotsuki et al., 2017) for the Nonhydrostatic ICosahedral Atmospheric Mode (NICAM) (Satoh et al., 2017). The NICAM-LETKF system is installed on the JAXA Supercomputer System Generation 2 (JSS2). The purpose of the current study is to develop a near-real-time system of the NICAM-LETKF installed on the JSS2. We report a preliminary result of the development.

Summary

We develop the near-real-time system of the NICAM-LETKF installed on the JSS2. The NICAM-LETKF system experimentally operated 8-hour later. Although the current system assimilate only PREPBUFER (Traditional observation), AMSU-A radiance, and GSMaP using gaussian transformation, analysis (temperature/humidity/wind) fields are reasonably reproduced and stably distributed against JRA55 fields except for the systematic differences.

We will conduct ensemble simulation focusing on some extreme weather events by means of the NICAM-LETKF fields.

NICAM-LETKF DA system

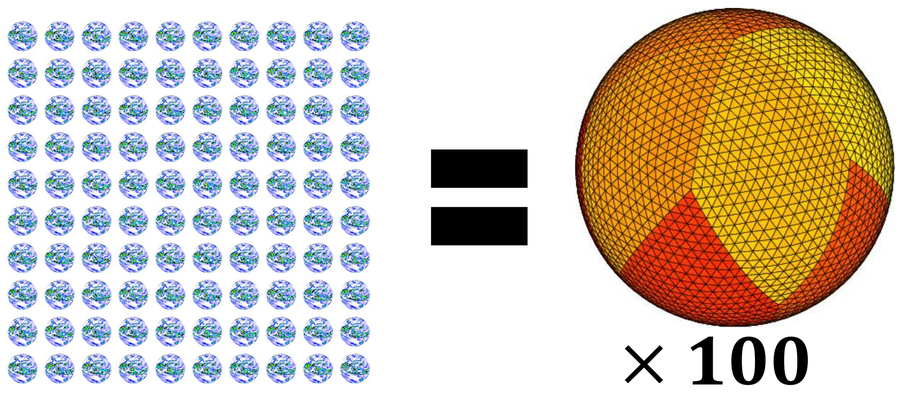


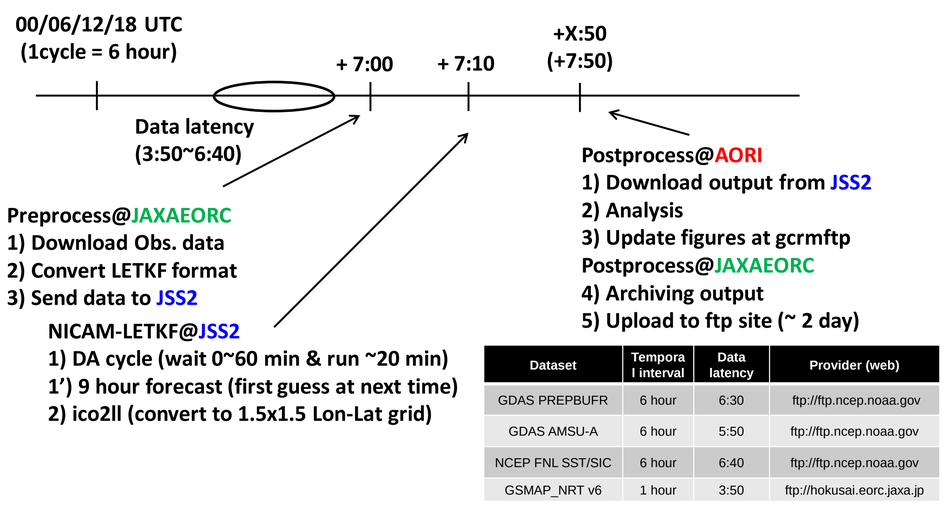
Figure. Concept of NICAM-LETKF. Precipitation is 100-member of NICAM simulation at 2017/07/01 00-24UTC (1 day)

Table. Descriptions of NICAM-LETKF

NICAM	
Spatial resolution	G-level 6 (~112 km) & R-level 1
Vertical resolution	38 layer (< 40 km)
Time step	450s
Cumulus parametrization	Arakawa and Schubert (1974)
Cloud microphysics	Large scale condensation

LETKF	
Algorithm	4D-LETKF (Hunt et al., 2007)
Assimilated/ external data	FNL SST/SIC PREPBUFR AMSU-A radiance GSMaP with gaussian transform.

NRT NICAM-LETKF (8-hour delay)



Dataset	Temporal interval	Data latency	Provider (web)
GDAS PREPBUFR	6 hour	6:30	ftp://ftp.ncep.noaa.gov
GDAS AMSU-A	6 hour	5:50	ftp://ftp.ncep.noaa.gov
NCEP FNL SST/SIC	6 hour	6:40	ftp://ftp.ncep.noaa.gov
GSMAP_NRT v6	1 hour	3:50	ftp://hokusai.eorc.jaxa.jp

Figure. Timeline of NICAM-LETKF NRT DA system.

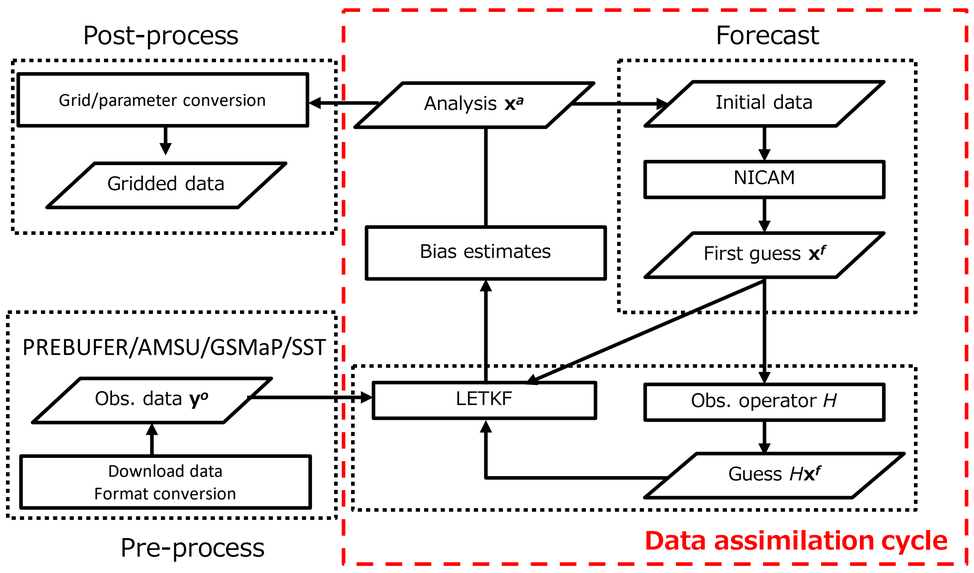


Figure. Schematics of NICAM-LETKF DA cycle and pre(post)-process.

NRT monitoring of Precipitation

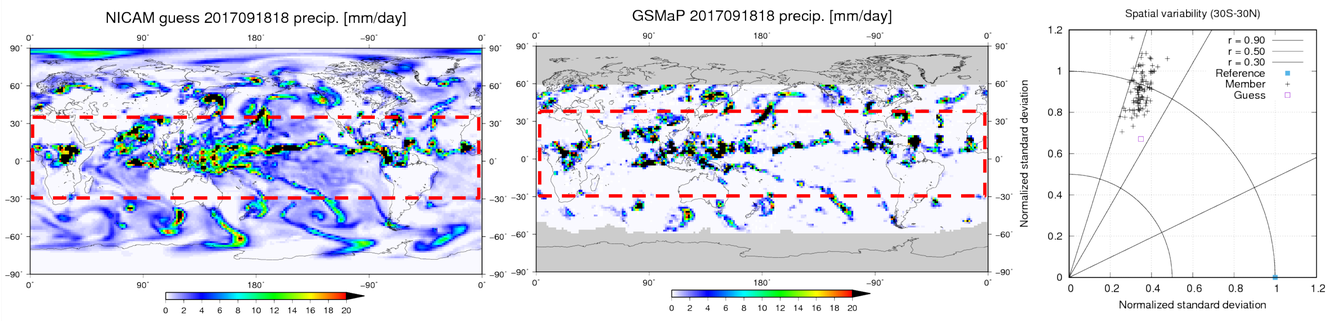


Figure. Comparison between NICAM-LETKF and GSMaP 6 hour averaged precipitation at 2017/09/18 18UTC. **Left)** Guess precipitation (NICAM-LETKF ensemble mean) [mm/day], **Center)** GSMaP [mm/day], **Right)** Taylor diagram (Taylor, 2001) of spatial pattern over 30S-30N.

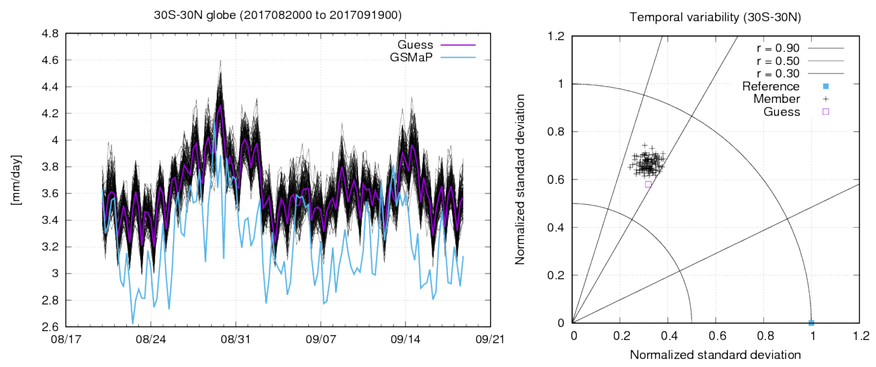


Figure. Left) Time series of precipitation [mm/day] for GSMaP and NICAM member and guess (ensemble mean) over 30S-30N.
Right) Taylor diagram (Taylor, 2001) of time series.

Comparison with re-analysis (JRA55) data

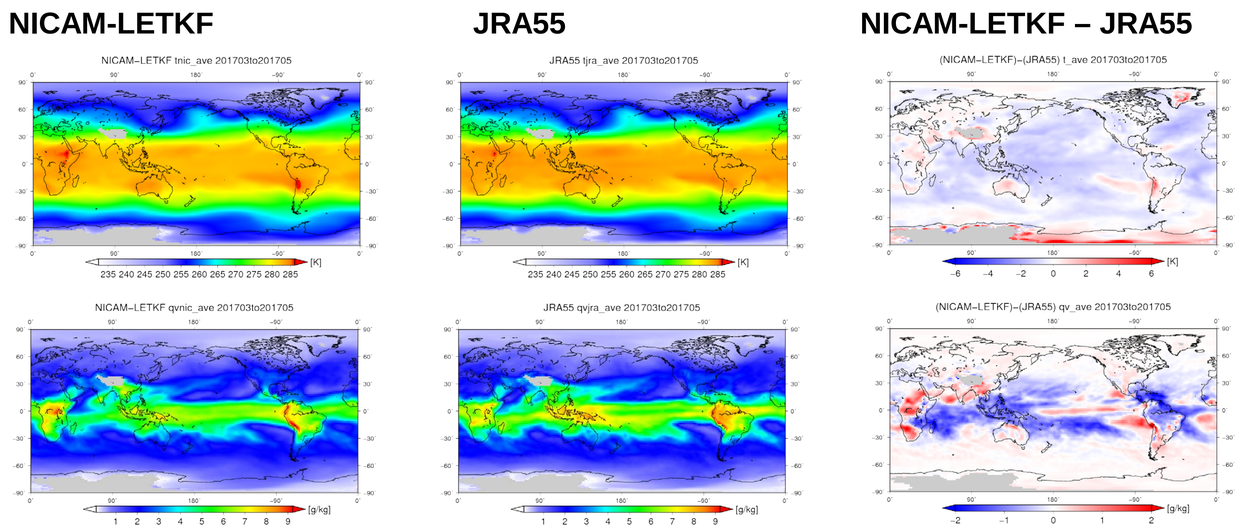


Figure. Global map of the difference between NICAM-LETKF and JRA55 in 2017 MAM. **Top**) Temperature [K] at 700 hPa, **Bottom**) water vapor mixing ratio [g/kg] at 700 hPa.

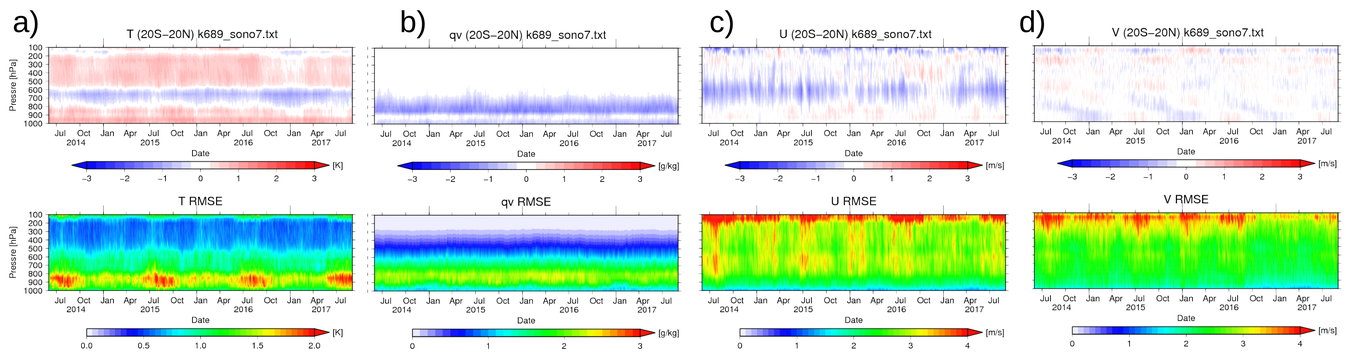


Figure. Time-pressure cross section of difference and root-mean-square (RMS) between NICAM-LETKF and JRA55 (NICAM-LETKF – JRA55) over 20S-20N average.
a) Temperature difference [K] and RMS, **b)** Water vapor mixing ratio difference [g/kg] and RMS, **c)** Zonal wind difference [m/s] and RMS, **d)** Meridional wind difference [m/s] and RMS.

References

1) Hunt, B. R., E. J. Kostelich and I. Szunyogh, 2007: Efficient Data Assimilation for Spatiotemporal Chaos: A Local Ensemble Transform Kalman Filter. Physica D, 230, 112-126, 2) Kobayashi, S., Y. Ota, Y. Harada, A. Ebita, M. Moriya, H. Onoda, K. Onogi, H. Kamahori, C. Kobayashi, H. Endo, K. Miyaoka, and K. Takahashi, 2015: The JRA-55 Reanalysis: General specifications and basic characteristics. *J. Meteor. Soc. Japan*, **93**, 5-48, doi:10.2151/jmsj.2015-001. 3) Kotsuki, S., T. Miyoshi, K. Terasaki, G.-Y. Lien, and E. Kalnay, 2017: Assimilating the Global Satellite Mapping of Precipitation Data with the Nonhydrostatic Icosahedral Atmospheric Model NICAM. J. Geophys.Res. Atmos., 122, 1-20. doi:10.1002/2016JD025355, 4) Kotsuki, S., Y. Ota, T. Miyoshi, 2017: Adaptive covariance relaxation methods for ensemble data assimilation: Experiments in the real atmosphere. Quart. J. Roy. Meteorol. Soc., 143, 2001-2015. doi:10.1002/qj.3060, 5) Terasaki, K., and T. Miyoshi, 2017: Assimilating AMSU-A radiances with the NICAM-LETKF. J. Meteor. Soc. Japan, 95, http://doi.org/10.2151/jmsj.2017-028., 6) Satoh, M., Tomita, H., Yashiro, H., Kajikawa, Y., Miyamoto, Y., Yamaura, T., Miyakawa, T., Nakano, M., Kodama, C., Noda, A. T., Nasuno, T., Yamada, Y., Fukutomi, Y., 2017 Outcomes and challenges of global high-resolution non-hydrostatic atmospheric simulations using the K computer. Progress in Earth and Planetary Science, 4, 13, doi:10.1186/s40645-017-0127-8, 7) Taylor, K. E. (2001), Summarizing multiple aspects of model performance in a single diagram, J. Geophys. Res., 106(D7), 7183–7192, doi:10.1029/2000JD900719.