

Development of Limited-Area NWP systems at JMA

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1. Limited-Area NWP systems at JMA

Meso-scale NWP: since Mar. 2001 (full operation)

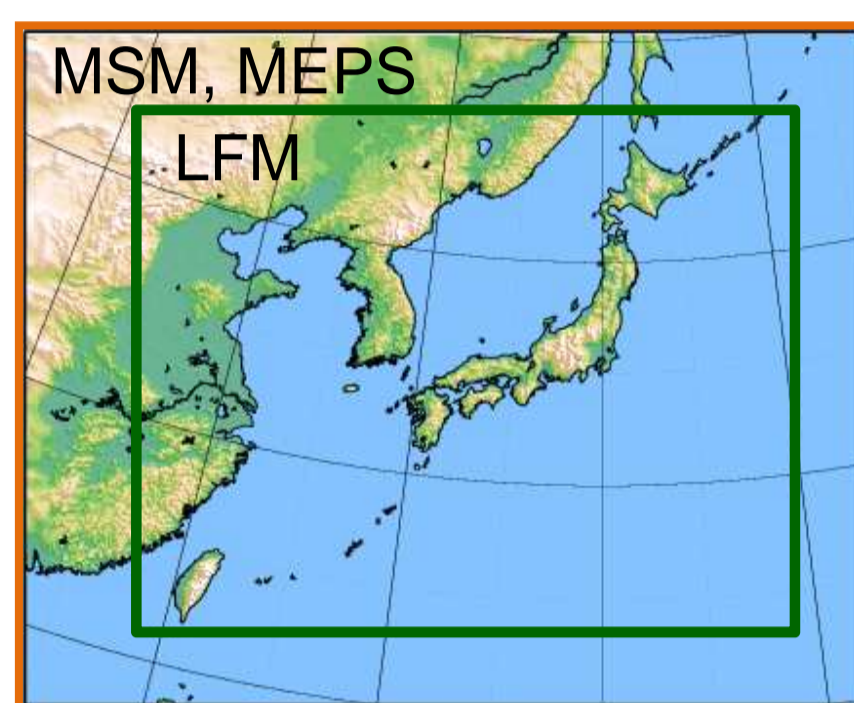
- Meso-Scale Model (MSM) and Meso-scale Analysis (MA)
- supporting disaster prevention and aviation weather forecast
- 8 runs/day, dx = 5km, Domain: Japan and its surroundings
- Forecast Model: ASUCA since Feb. 2017
- Data Assimilation System: JNoVA (JMA-NHM-based 4D-Var)

Local NWP: since May 2013 (full operation)

- Local Forecast Model (LFM) and Local Analysis (LA)
- supporting aviation weather forecast and disaster prevention
- 24 runs/day, dx = 2km, Domain: Japan and its surroundings
- Forecast model: ASUCA since Jan. 2015.
- Data Assimilation system: 3-h analysis cycle iterating ASUCA-3DVar and ASUCA 1h-forecast, using the first guess from MSM

Meso-scale EPS (MEPS): since Mar. 2015 (under trial)

- providing uncertainty and probability information about MSM
- 4 runs/day, dx = 5km, Domain: identical to MSM, 21 members
- Forecast Model: ASUCA since Jul. 2017
- Init. Pert.: SV Blending of Global and Meso-scale (40 and 80km) SVs
- Lateral boundary pert.: Global SV



2. JMA 10th generation supercomputer system

Operation of the JMA new HPC started on 5 Jun. 2018.

Migration of operational suits has completed on schedule (~1 yr).

Effective computer capacity was enhanced about 10 times.

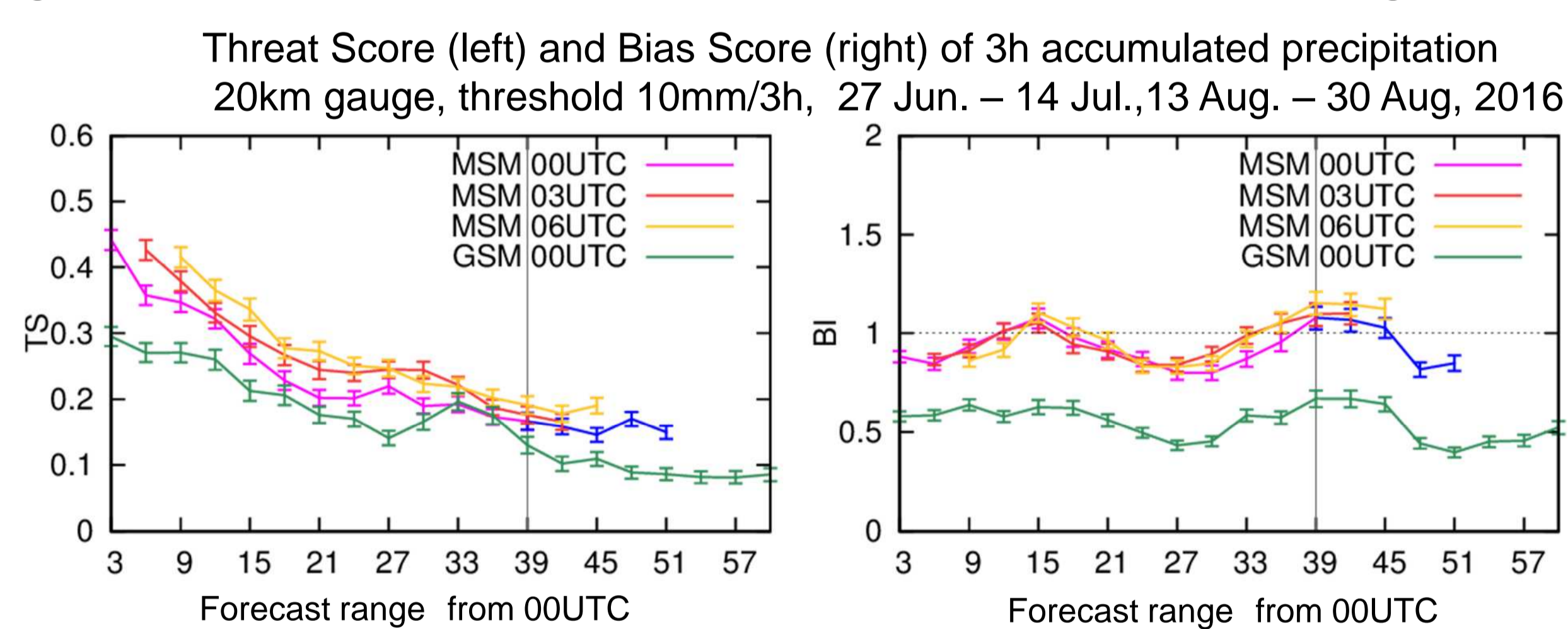
Future major upgrades of the limited-area NWP planned on the new HPC

- Extension of forecast ranges of MSM and LFM
- Full operation of MEPS (21 members 4 runs/day, currently under trial)
- Incorporation of ASUCA-4DVar into MA
- Increasing vertical layers of LFM from L58 to L76
- Increasing vertical layers of MSM from L76 to L96
- Hybrid data assimilation for MSM and LFM

3. Extension of forecast range of MSM

- aimed at an enhanced support of weather forecasters
- 39h => 51h in 2 runs/day (00 and 12UTC)
- Operation is scheduled to start in 2019.

MSM gives precipitation forecasts better than those from the operational global spectral model (GSM) without drastic degradation in its performance over the extended range.

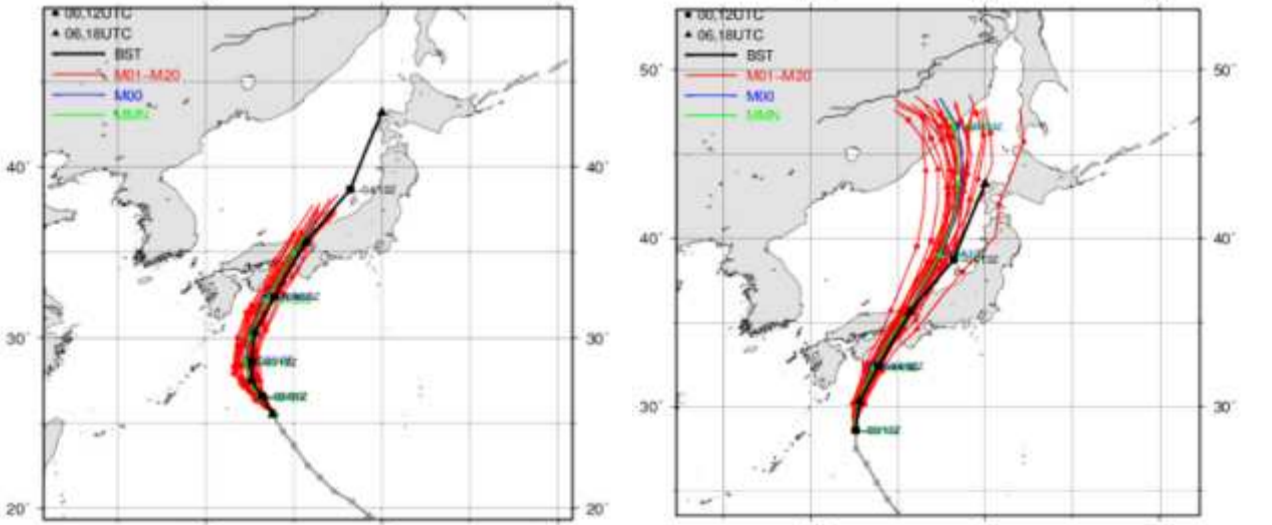


4. Enhancement of MEPS

- Development of MEPS, currently under trial, is in progress to provide uncertainty and probabilistic information of MSM.
- Full operation of MEPS is scheduled to start in 2019.
- Enhancement of MEPS was applied on 5 Jun. 2018 on the new HPC. • 11=>21 members • 1 => 4 runs/day

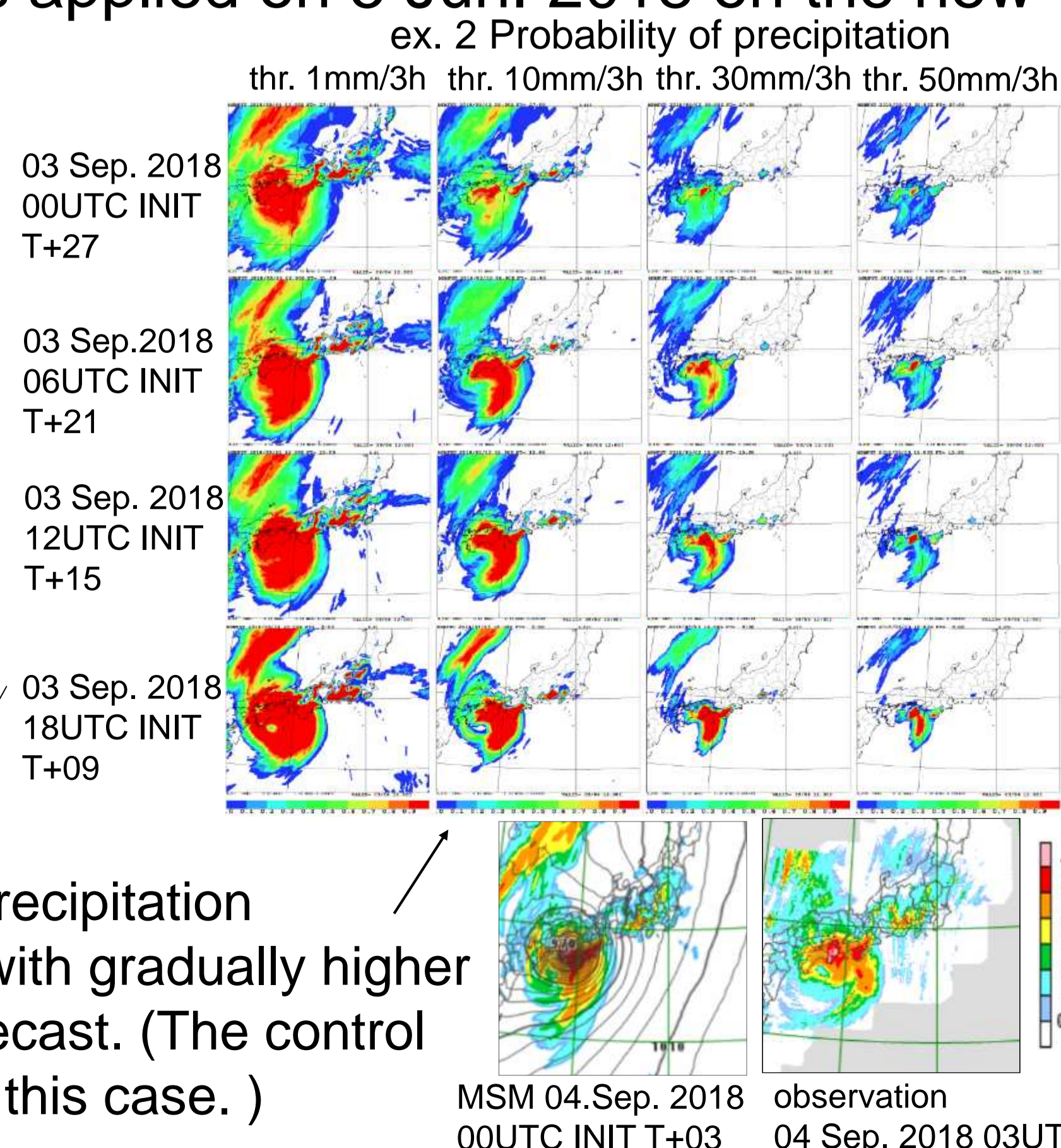
ex. 1 Typhoon track forecasts

02 Sep. 2018 18UTC INIT 03 Sep. 2018 12UTC INIT



Smaller deviation from the analysis => smaller dispersion
Larger deviation from the analysis => larger dispersion
MEPS members, Control (MSM), MEPS ensemble mean, analysis

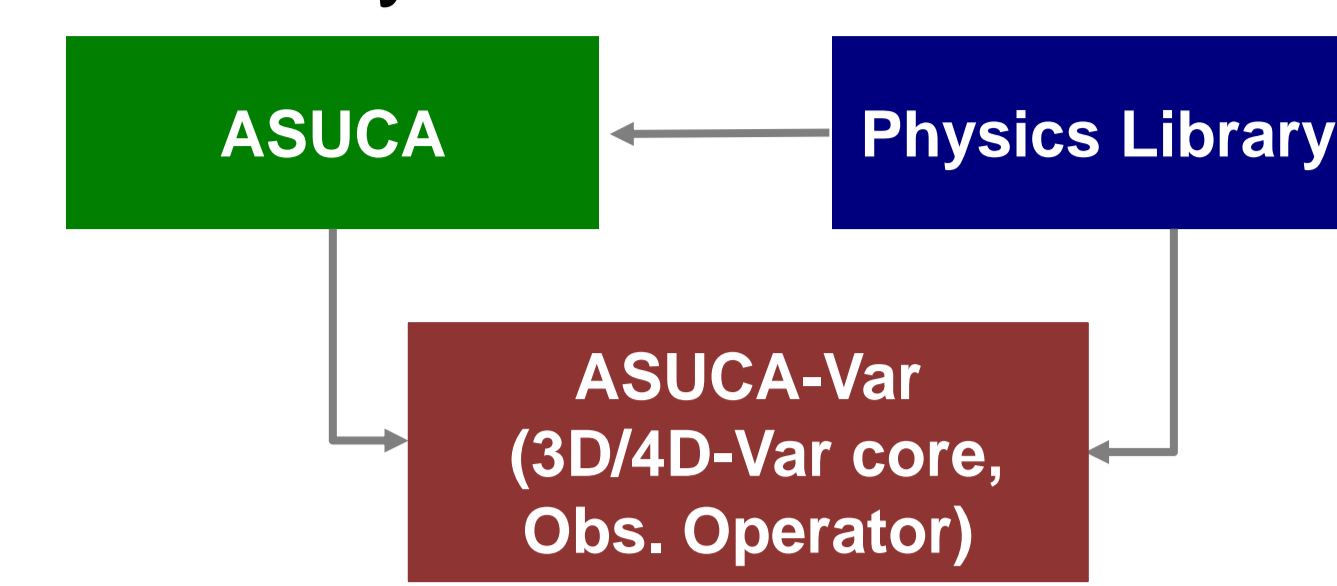
MEPS predicts regions of intense precipitation corresponding to the observations with gradually higher probabilities through updates of forecast. (The control run (MSM) gives a good forecast in this case.)



5. A New Non-hydrostatic NWP Framework: ASUCA

JMA has been developing a new Forecast/DA system "ASUCA".

- ASUCA: a new non-hydrostatic dynamical core.
- Physics Library: a repository of highly-portable physical process routines.
- ASUCA-Var: a 3D/4D-Var DA system based on ASUCA.



Operational implementation of the ASUCA-based systems

ASUCA: LFM (Jan. 2015), MSM (Feb. 2017), MEPS (Jul. 2017)

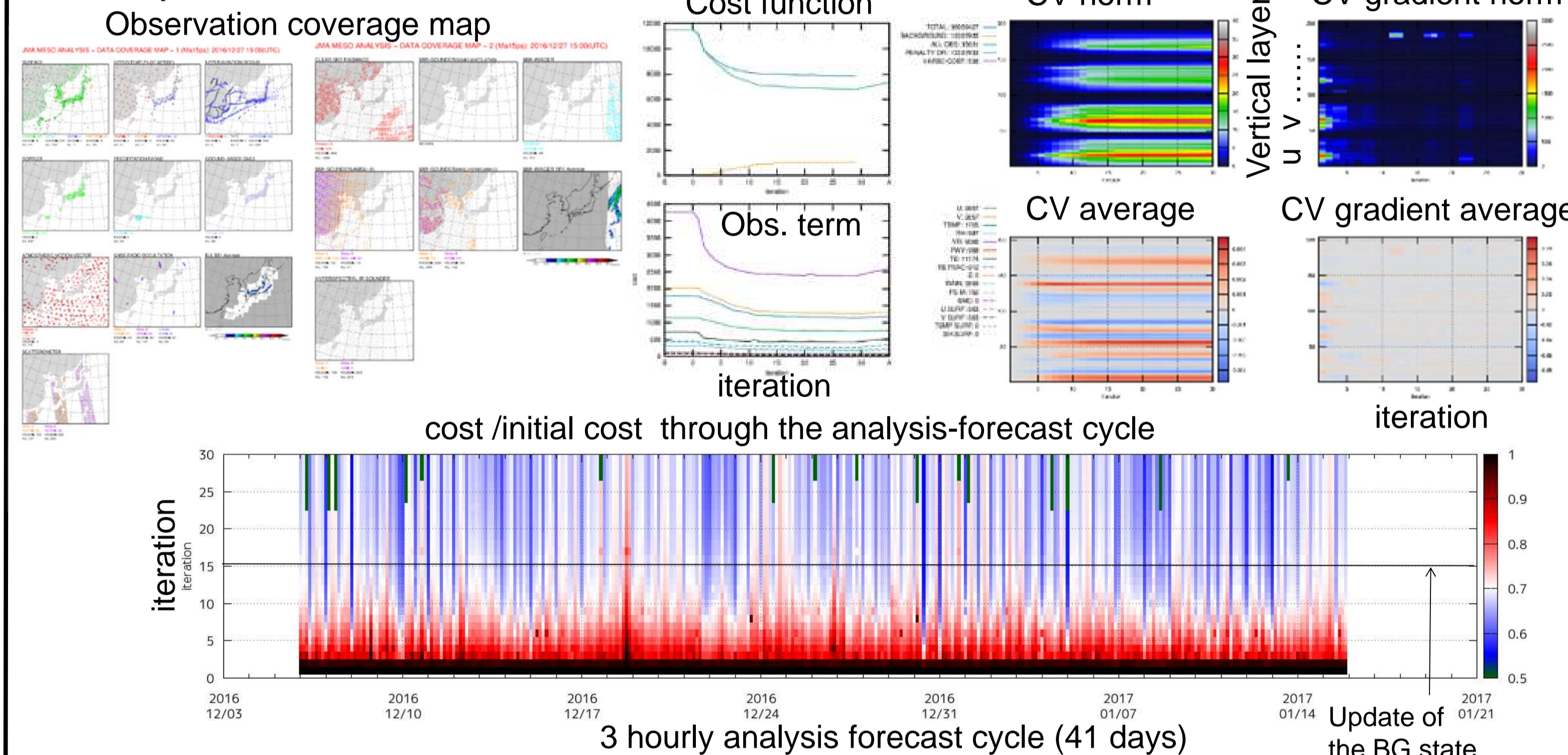
ASUCA-3DVar: LA (Jan. 2015), Hourly Analysis (Jul. 2017)

Development in progress: ASUCA-4DVar (MA), ASUCA-SV (MEPS)

6. Development of ASUCA-4DVar

- Development is in progress, using TL/AD based on ASUCA, for the next DA system of the operational MA.
- Current status: close systematic examinations and updates to enhance robustness and stability in operational situation.

Example of ASUCA-4DVar run



7. Development of ASUCA-SV

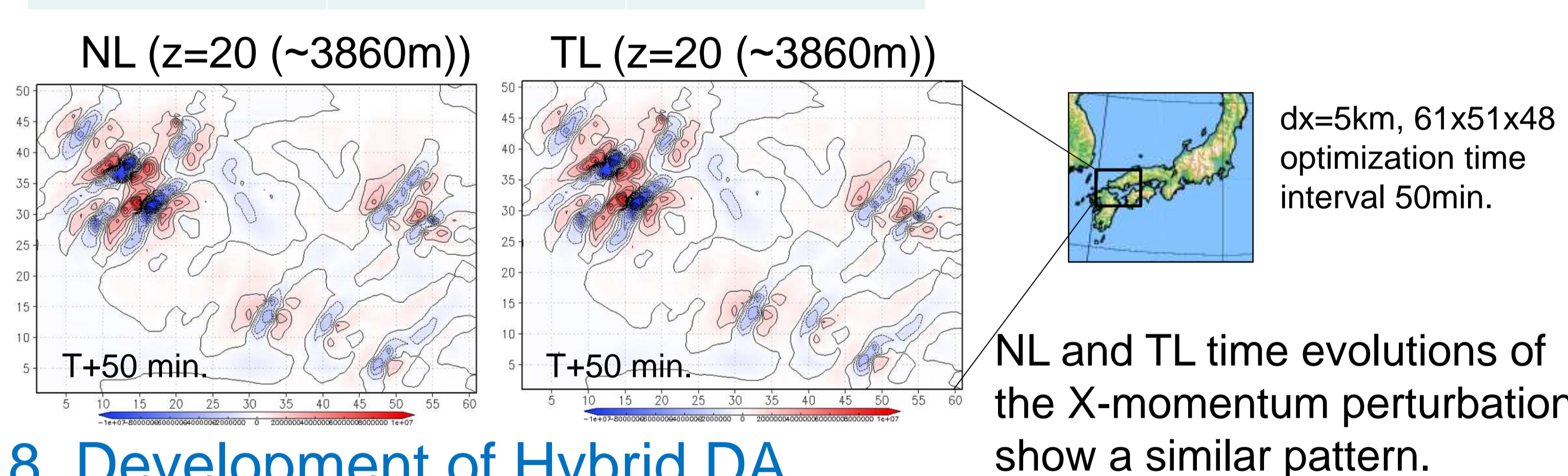
Development of ASUCA-SV, using TL/AD based on ASUCA, is in progress for an upgrade of MEPS initial perturbations.

Example of a perturbation from ASUCA-SV

The leading SV calculated from the Lanczos algorithm with 4 iterations using a kinetic energy norm.

Singular Value	NL growth rate	TL growth rate
5.1972	5.1815	5.1972

Singular value well coincides with NL and TL growth rates.



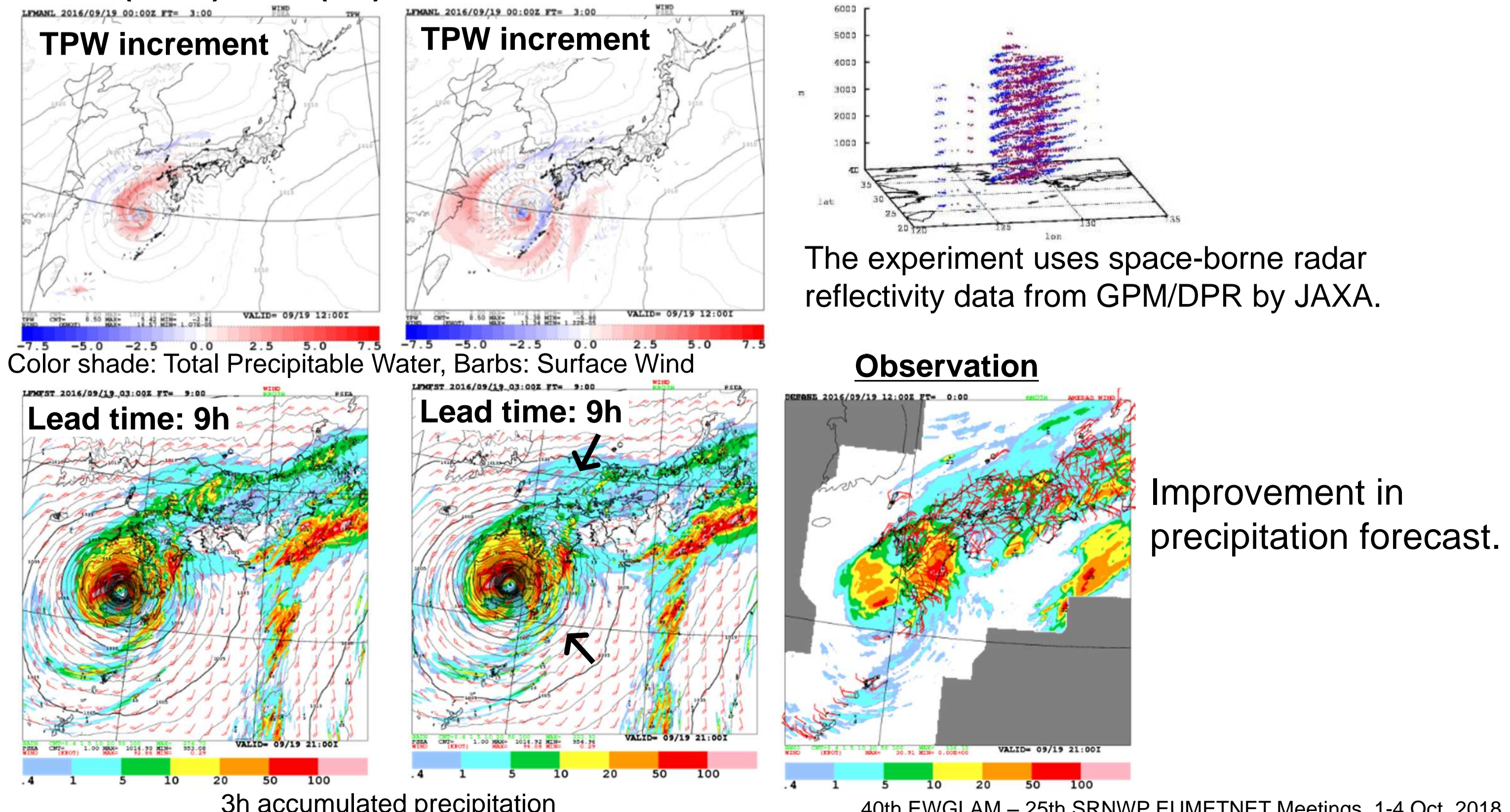
8. Development of Hybrid DA

Development of a hybrid 4D-Var system is in progress, for future enhancement of MA.

Flow dependent background error from ensemble forecasts.

The hybrid 4D-Var with an extension of control variables including hydrometeors and TL/AD of cloud-microphysics scheme enables direct assimilation of radar reflectivity data.

Traditional DA Clim. (100%)+Ens. (0%) vs Hybrid DA (Nens=12+1, Localization radius 300km) Clim. (50%)+Ens. (50%)



The experiment uses space-borne radar reflectivity data from GPM/DPR by JAXA.

Improvement in precipitation forecast.