The new operational high-resolution regional NWP model at JMA

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JMA's new supercomputer system

- The **supercomputer system at JMA** has been upgraded in June 2012, and now in operation.

	Mar. 2006- Jun. 2012	Jun. 2012 –
	HITACHI SR11000 	HITACHI SR16000/M1 
Total Peak Performance	27.584TFlops (134.4GFlops/1node)	847TFlops (980.5GFlops/1node)
Total number of nodes	210 nodes (16CPU/1node)	864 nodes (32CPU/1node)
Memory	64GB/node	128GB/node
Memory Bandwidth	134.4GB/s/1node	612GB/s/1node
Network Bandwidth	8GB/s (one-way)	96GB/s (one-way)
System configuration	80nodes x 2 + 50nodes x 1	432nodes x 2

7.3-times up

4.6-times up

12-times up

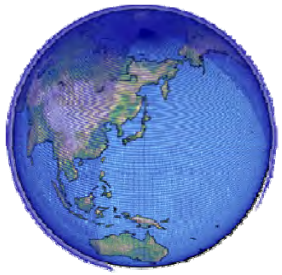
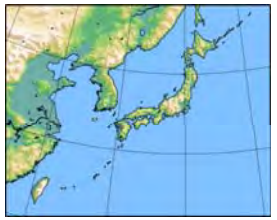
Local NWP system

- Taking advantage of the powerful performance of the new supercomputer system, a high resolution convection-permitting regional NWP system (**Local NWP system**) has been operated since August 2012

- **The purpose** is providing information on aviation weather and disaster prevention.

NWP systems at NPD/JMA

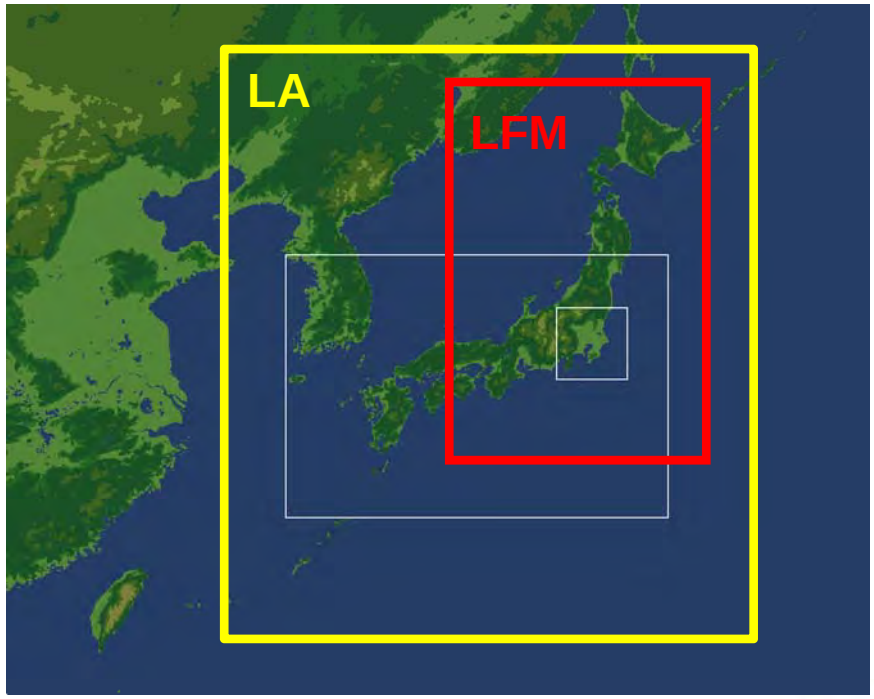
NEW

	Global	Meso	Local
Objectives	Short- and Medium-range forecast	Disaster reduction Short-range forecast	Aviation forecast Disaster prevention
NWP model	Global Spectral Model(GSM)	Meso-Scale Model(MSM)	Local Forecast Model (LFM)
Forecast domain			
Horizontal resolution	TL959 (0.1875 deg)	5 km	2 km
Vertical levels / Top	60 0.1 hPa	50 21.8 km	60 20.2 km
Forecast Hours (Initial time)	84 hours (00, 06, 18 UTC) 216 hours (12 UTC)	15 hours(00, 06, 12, 18 UTC) 33 hours(03, 09, 15, 21 UTC)	9 hours
Initial Condition	Global Analysis (4D-Var)	Meso-scale Analysis (4D-Var)	Local Analysis (3D-Var)

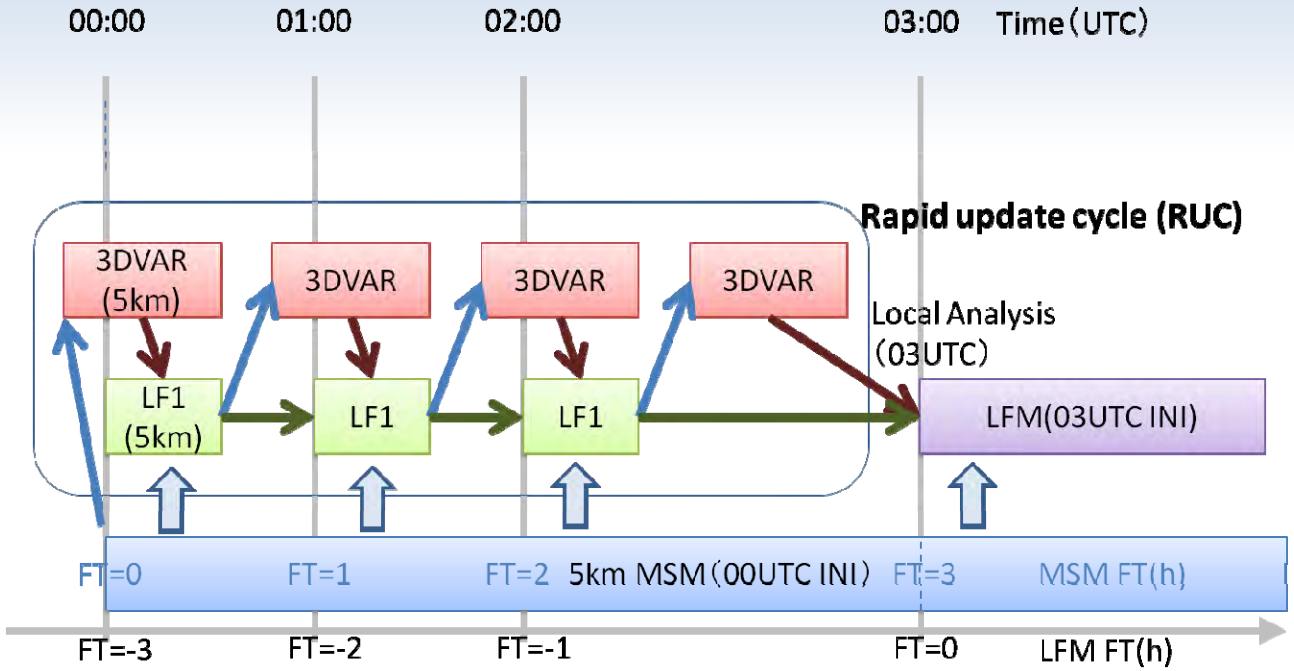
Basic design of the Local NWP system

- The **Local NWP system** currently covers the eastern part of Japan, and provides 9-hour period forecasts every 3 hours.
- In the system design, high resolution to permit explicit convection and frequent updates of forecasts assimilating the latest observation are highly emphasized.

- The Local NWP system consists of two subsystems
  - **NWP model**: The **Local Forecast Model (LFM)** has a 2-km horizontal gridspacing and 60 vertical layers.
  - **Data assimilation system**: The **Local Analysis (LA)** employs an analysis cycle based on the three dimensional variational data assimilation (3D-Var) at a 5-km resolution

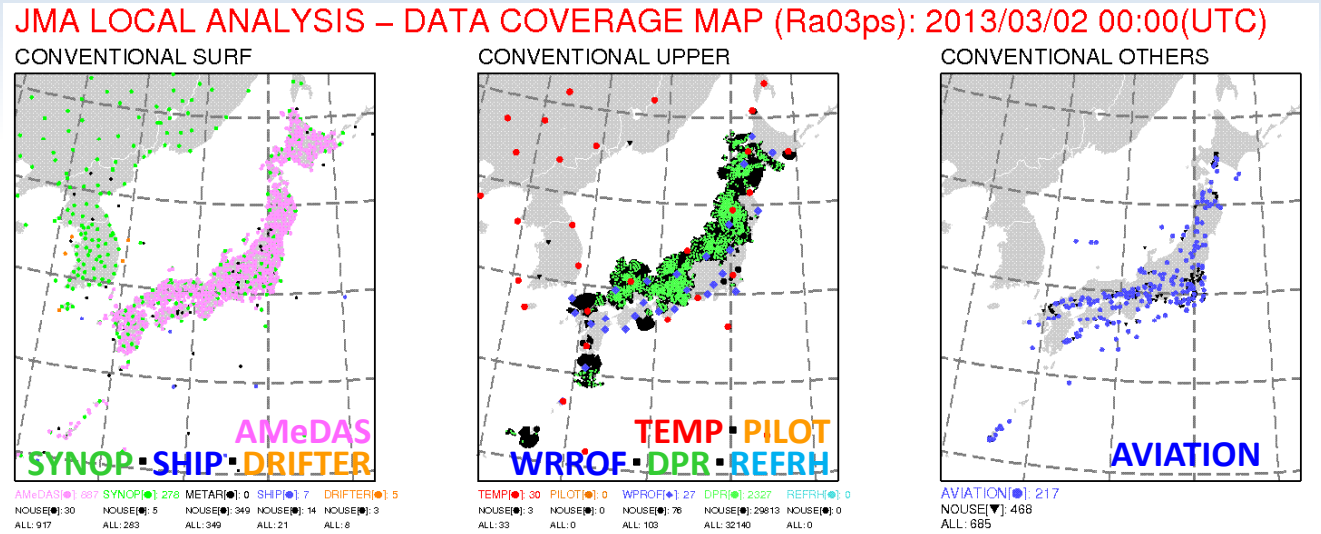


Local Analysis: Rapid update cycle



- Firstly, the first guess of the 3D-VAR at FT=-3 (3 hours before the initial time) comes from forecasts of MSM (5km operational mesoscale model).
- After the analysis at FT=-3 is obtained by assimilating observations around FT=-3,1-hour integration from the analysis is conducted to generate the first guess of the next 3D-VAR at FT=-2.
- The cycle is repeated, then the final analysis is produced by the final 3D-VAR using the first guess obtained from 1-hour forecasts initialized at FT= -1 and observations around FT= 0 (the initial time).

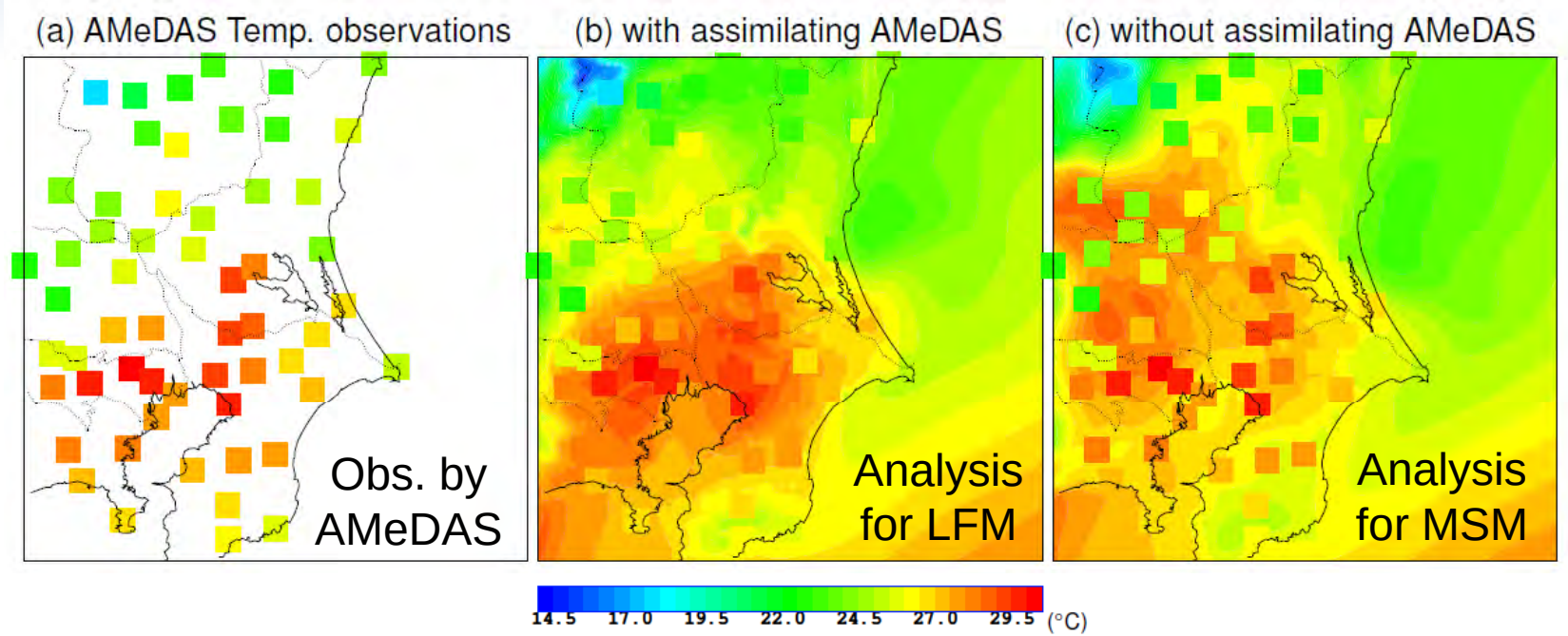
Local Analysis: Assimilated observations



- Currently, observations assimilated in the LA come from the following: aircrafts (wind and temperature),wind profilers (wind), the ground-based GNSS receivers(precipitable water vapor), radars (radial velocity, RH retrieved from reflectivity), land surface observatory stations(pressure) and radiosondes (wind, temperature, pressure, and humidity).
- Additionally, **1.5-m temperature** and **10-m wind velocity** obtained from the automated surface observation network (called AMeDAS, placed all over Japan).
  - –The grid-spacing is small enough to represent locality these observations have.
- Plan to assimilate more satellite observations (AMV, radiance)

Effects by assimilating observations near the surface

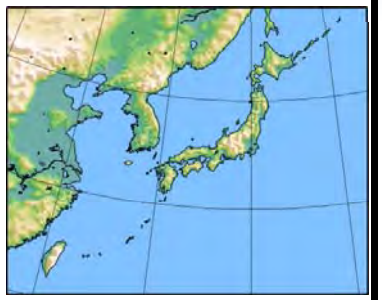
1.5 m-temperature fields



- Features of observed temperature are well represented by an analysis field for the LFM assimilating the surface observations.
- More realistic representations in the lower layer could give considerable impacts to forecast of severe phenomena because temperature and winds at the lower layer are important to generate unstably stratified layers and initiate convection

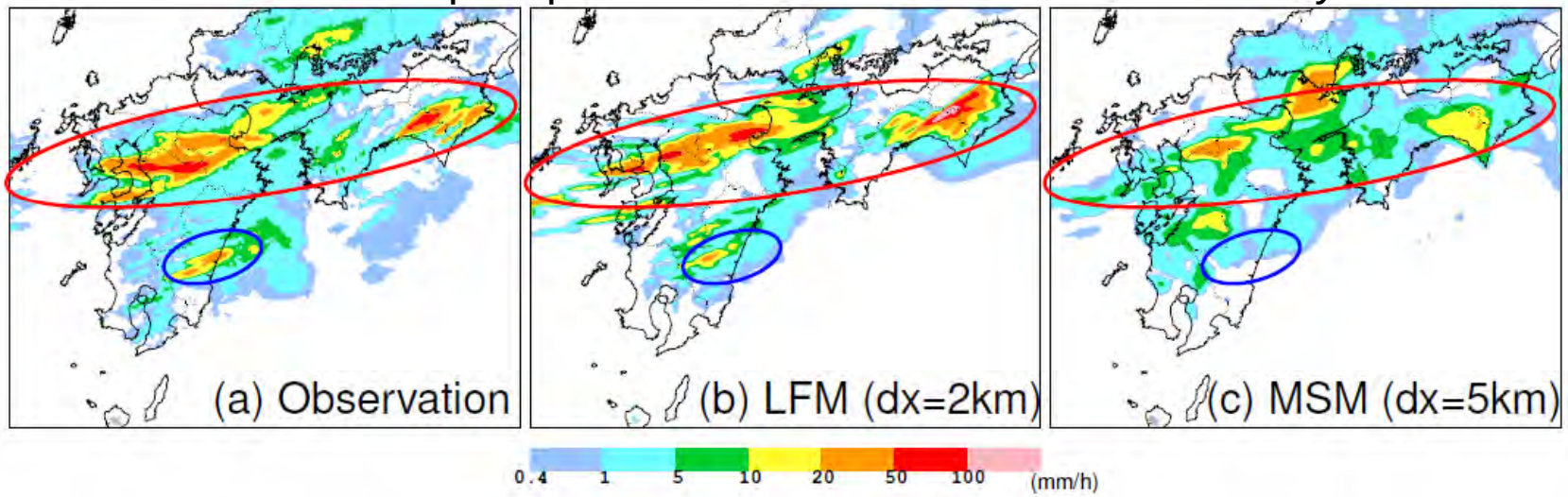
Model specification

- LFM employs the JMA-NHM as its NWP model.
  - The same model package as 5-km operational mesoscale model (MSM).
- **No convective parameterizations**
  - It is expected to represent convective transport by the grid mean vertically velocity, avoiding uncertainty coming from the parameterization.
- Some modifications have been made in physical processes which depend on scales
  - Made a PDF to diagnose cloud fraction narrower because inhomogeneity is smaller as the grid-spacing is smaller.

	LFM	MSM
Horizontal Resolution/ Forecast Domain	2km (551x801) 	5km (721x577) 
Vertical Layers	60 Layers, up to 20km	50 Layers, up to 22km
Integration Time Step	8 second	20 second
Initial Condition	3D-Var RUC	4D-Var
Boundary Condition	MSM	GSM
Forecast hours	9 hours	33/15 hours
Cloud Physics	Qc, Qr, Qi, Qs, Qg	Qc, Qr, Qi, Qs, Qg and Ni
Cumulus convective paramete-rization	Not Used	Kain-Fritsch scheme

Ability of the LFM to accurately predict peak amount of precipitation

1-hour accumulated precipitation amounts until 1700UTC on July 11 2012

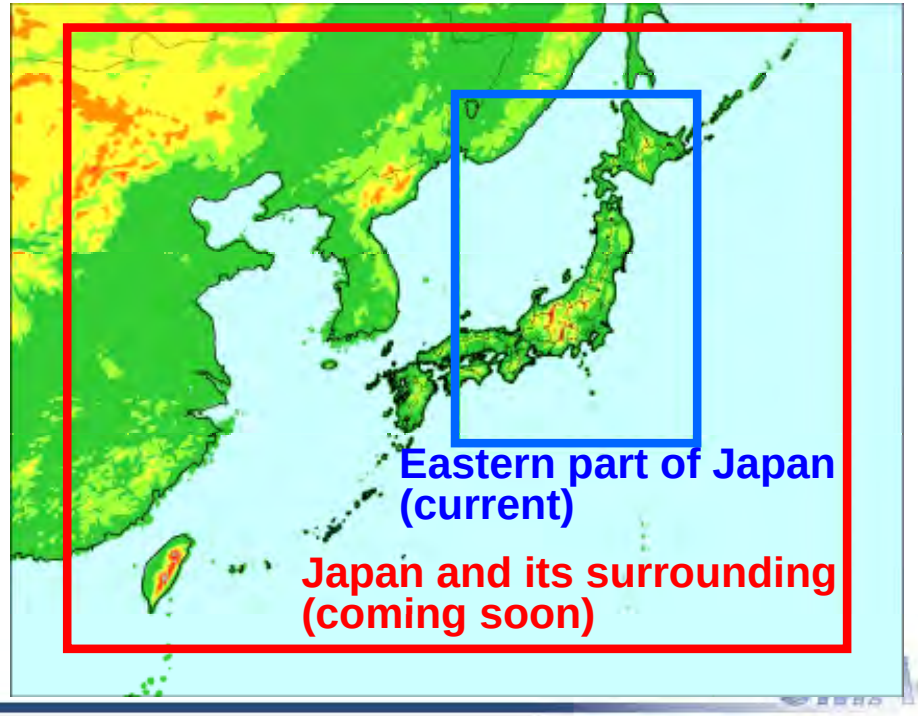


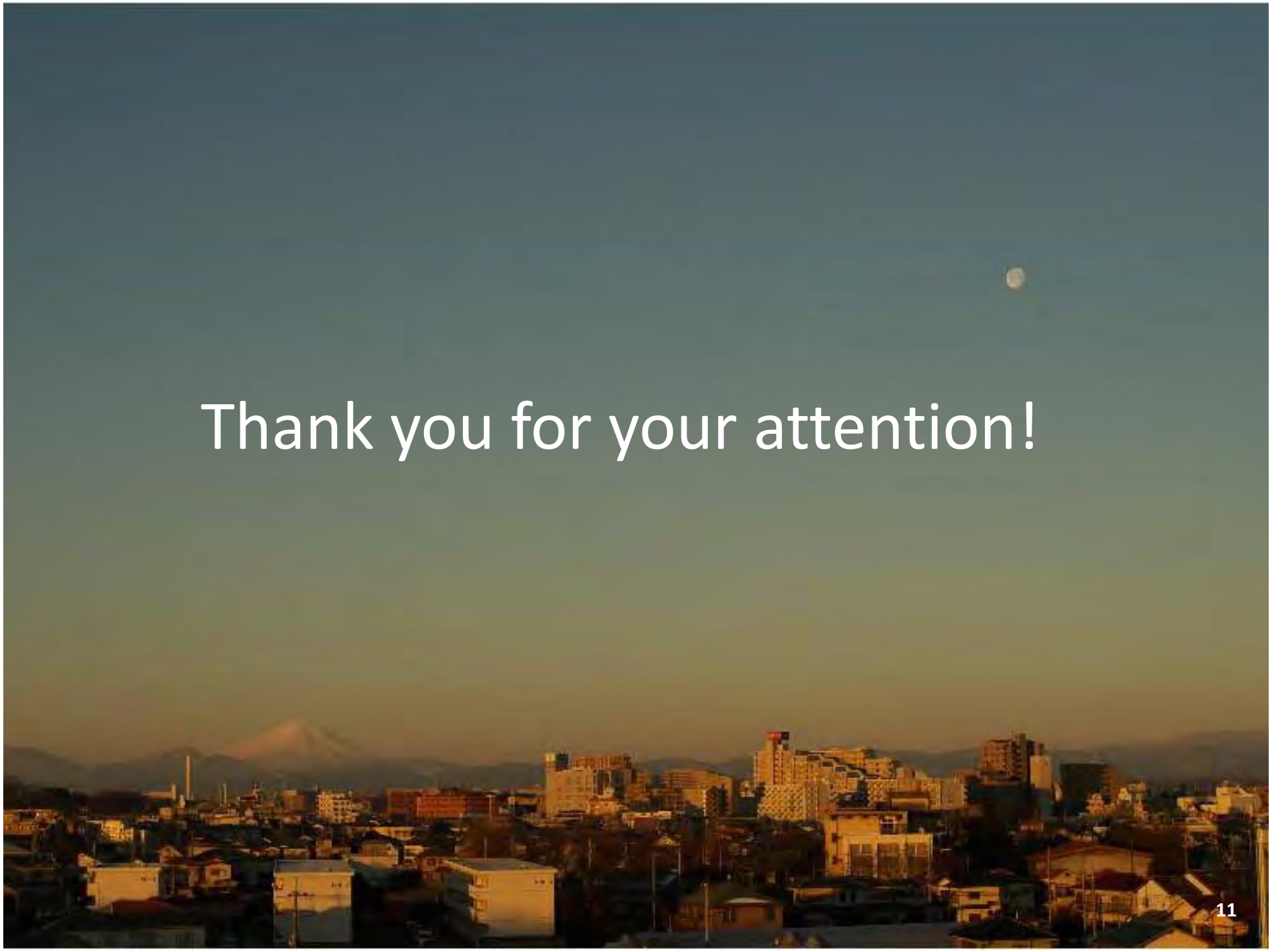
- The **LFM** produced the line-shaped precipitation and the peak strength of the precipitation is well predicted.
- While the **MSM** predicted the position of the front correctly, the line-shaped precipitation area was not generated enough and the peak value of the precipitation is much smaller than the corresponding observation.
- As long as the boundary conditions (i.e. the MSM forecasts in the system), which considerably control synoptic fields in the LFM, give reliable fields, the **LFM** has considerable potential to reproduce peak values more precisely.

Summary

- The JMA launched the new operational NWP system (**Local NWP system**) at a convection-permitting resolution.
  - The latest observations are quickly assimilated and forecasts are updated frequently.
  - Some physical processes were modified from the coarser operational model considering their dependency on the resolutions.
  - The LFM shows its potential to predict peak values of precipitation more appropriately.

- The forecast domain will be expanded so that the Japan and its surrounding areas can be covered and the update frequency will be enhanced to every hour in 2013.




Thank you for your attention!