Development of Limited-Area NWP systems at JMA

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1. Operational Limited-Area NWP systems at JMA

JMA has two limited-area deterministic NWP systems and one limited-area EPS.

Meso-scale NWP: since Mar. 2006 (full operation)

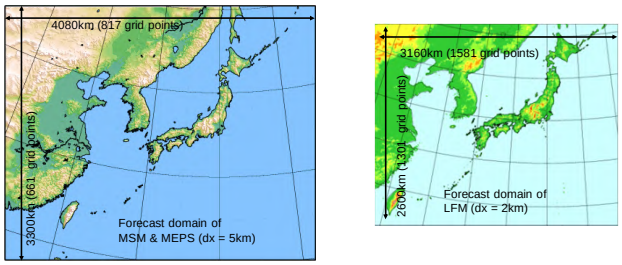
- Meso-Scale Model (MSM) and Meso-scale Analysis (MA)
- Objectives: supporting disaster prevention and aviation weather forecast
- 8 times a day, dx = 5km
- Domain: Japan and its surroundings
- Forecast Model: new non-hydrostatic model ASUCA since Feb. 2017
- Data Assimilation System: JNoVA (JMA-NHM-based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

Local NWP: since May 2013 (full operation)

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

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

- Objectives: providing uncertainty and probability information about MSM
- once a day, dx = 5km (identical to MSM), 11 members
- Domain: Japan and its surroundings (identical to MSM)
- Forecast Model: ASUCA since Jul. 2017
- Initial perturbation: SV
- Blending of Global SV, Meso-scale SV (40km) and Meso-scale SV (80km)
- Lateral boundary perturbation: Global SV
- Physics and lower boundary perturbations: under development

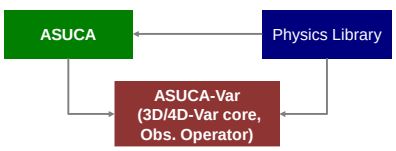


A forecast domain of MSM and MEPS (left) and LFM (right).
Both systems cover Japan and its surrounding region.

2. A New Limited-Area NWP Framework: ASUCA

JMA has been developing a new Forecast/DA system "ASUCA", for operational Limited-Area NWP Systems.

- ASUCA: new dynamical core. (development 2007 -)
- Physics Library: repository of highly-portable physical process routines. (development 2010 -)
- ASUCA-Var: 3D/4D-Var DA system based on ASUCA. (development 2011 -)



A schematic diagram of the new frameworks (ASUCA, Physics Library and ASUCA-Var) for limited-area NWP systems.

Implementation of "ASUCA"-based systems

Jan. 2015	LFM	JMA-NHM => ASUCA
	LA	JNoVA 3D-Var => ASUCA-3DVar
Feb. 2017	MSM	JMA-NHM => ASUCA
Jul. 2017	real-time monitoring analysis (Hourly Analysis)	
		JNoVA 3D-Var => ASUCA-3DVar
Jul. 2017	MEPS	JMA-NHM => ASUCA

Development in progress

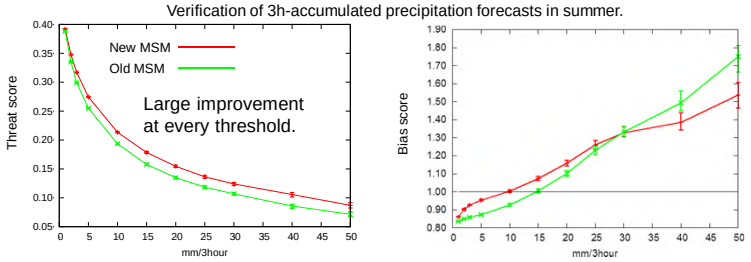
ASUCA-4DVar for MA

ASUCA-SV for MEPS

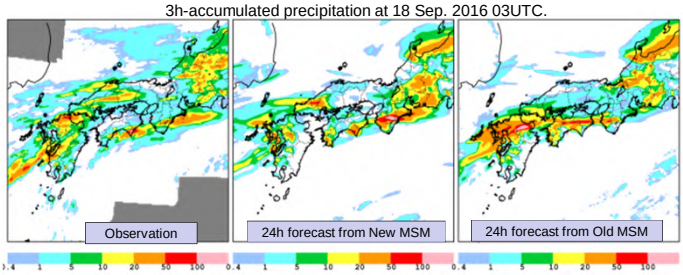
3. Implementation of ASUCA in operational MSM

ASUCA was incorporated as the forecast model of operational MSM in Feb. 2017, replacing the previous JMA-NHM. Besides, vertical layers are increased from 48 to 76. Various upgrades, including improvements in cumulus parameterization and cloud microphysics, contribute to forecasting enhancements, especially in summer precipitation.

Verification of 3h-accumulated precipitation forecasts in summer.



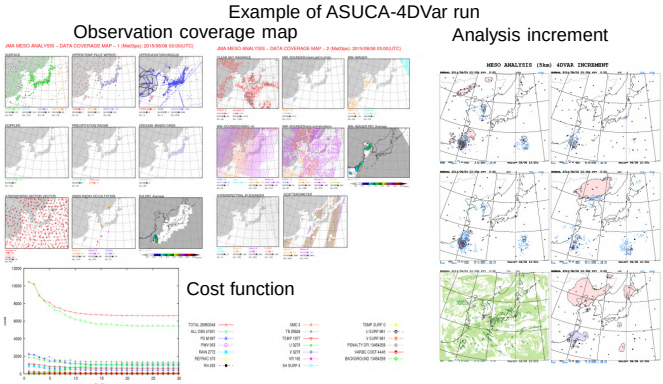
3h-accumulated precipitation at 18 Sep. 2016 03UTC.



4. Development of ASUCA-4DVar

Development of ASUCA-4DVar is in progress for the next DA system of the operational MA. ASUCA-4DVar, including TL/AD based on the ASUCA dynamical core and Physics Library, is currently under experimental performance evaluations, assimilating all the observations currently used in the operational MA.

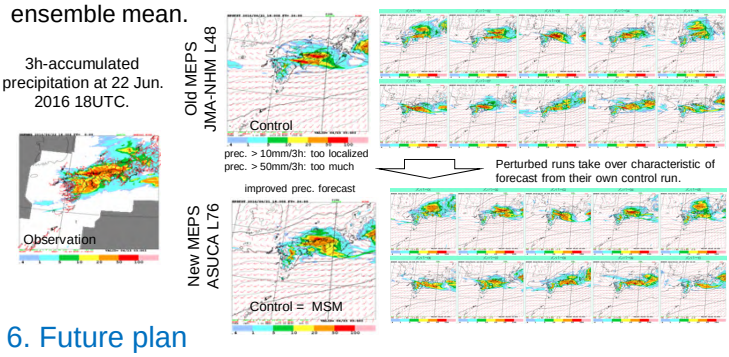
Example of ASUCA-4DVar run



5. Implementation of ASUCA in MEPS

ASUCA (L76) replaced the previous forecast model of MEPS, JMA-NHM (L48), in Jul. 2017. ASUCA in MEPS uses the same configuration with that of the deterministic MSM, evaluating uncertainties in MSM forecasts originating from IC and BC perturbations. The upgrade of the forecast model improves forecast skills from each member and ensemble mean.

3h-accumulated precipitation at 22 Jun. 2016 18UTC.



6. Future plan

- Incorporation of ASUCA-4DVar into MA
- Increasing vertical layers of MSM from L76 to L96
- Increasing vertical layers of LFM from L58 to L76
- Full operation of MEPS (11 mem. 1 run/day => 21 mem. 4 runs/day)
- Incorporation of ASUCA-SV into MEPS
- Hybrid data assimilation for MSM and LFM