Super High-Resolution Mesoscale NWP with the K-computer

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[3] *University of the Ryukyus*
[4] *Kyoto University*

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Hazardous HIWs

Heavy rainfall

2014 August Hiroshima

Tornado

茨城・栃木で倒壊・損壊300棟

2012 May Tsukuba

2013 October Izu-Oshima

Typhoon

2013 November Philippines

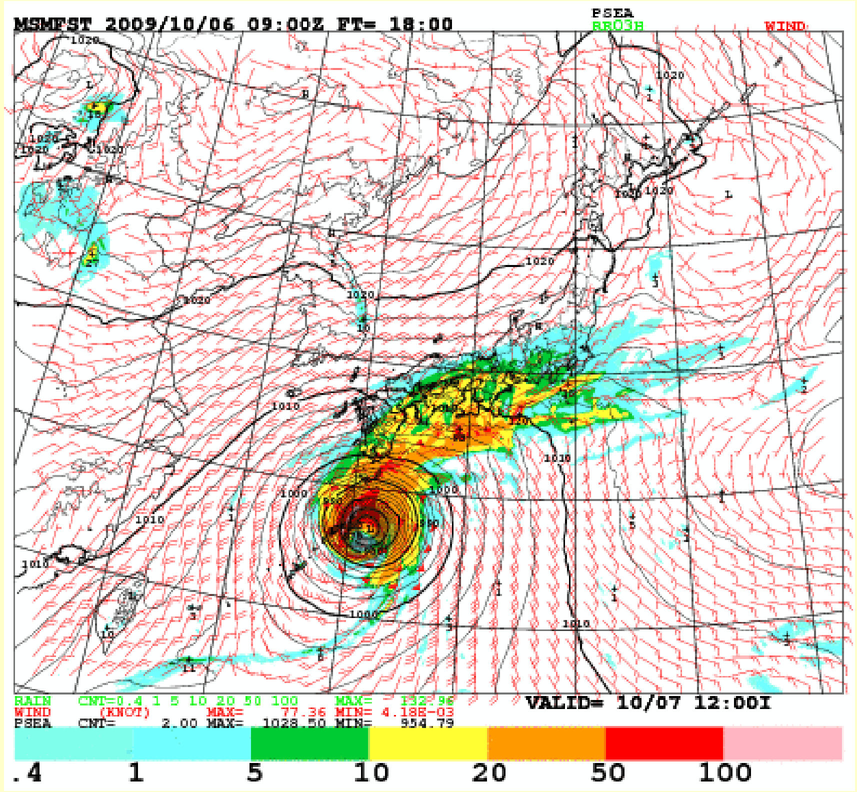
Local HIW

- Scale of Local heavy rainfall (~10km, 1-2 hours)

Local heavy rainfall causes urban floods and influences the functioning of urban life.

Urban flood of Tokyo on 4 July 2000.

Operational mesoscale NWP at JMA



- Started in March 2001 with a spectral hydrostatic model of 10km L40, 6hourly.
- JMA nonhydrostatic model with 5km L50, 3hourly after 2006
- Output is used for:
  - Short-term weather forecast
  - Very short range forecast of precipitation
  - Forecast for aviation (TAF), etc.

•Initial condition: Nonhydrostatic 4DVAR (JNoVA)

•Boundary condition: GSM (TL959) forecasts

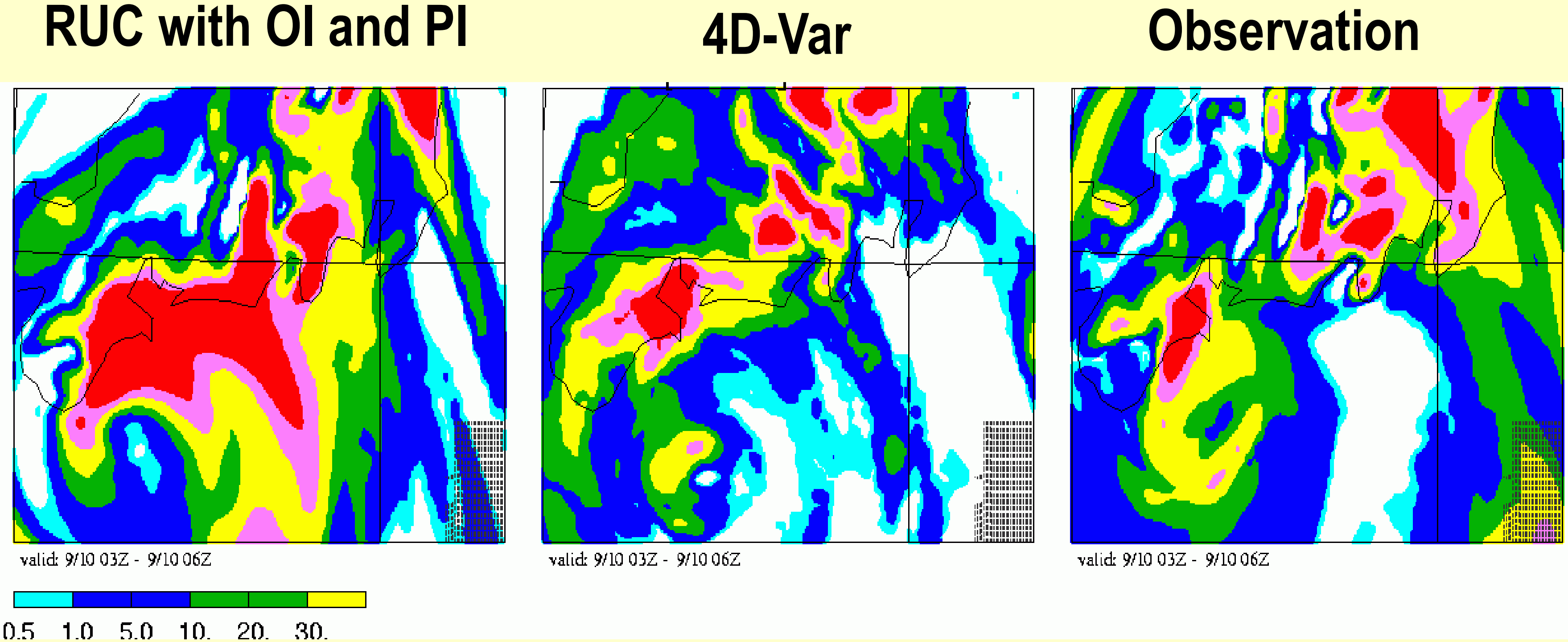
Modifications for operational mesoscale NWP at JMA

- Start of Mesoscale NWP (10kmL40 hydrostatic; Mar. 2001)
- Wind profiler data (Jun. 2001)
- **Meso 4D-Var (Mar. 2002)**
- Domestic ACARS data (Aug. 2002)
- SSM/I microwave radiometer data (Oct. 2003)
- QuikSCAT Seawinds (Jul. 2004)
- **JMA Nonhydrostatic model (Sep. 2004)**
- Doppler radar radial winds (Mar. 2005)
- Enhancement of model resolution to 5kmL50 (Mar. 2006)
- Upgrade of physical processes (May 2007)
- Upgrade of physical processes (Dec 2008)
- **Nonhydrostatic 4D-Var (Apr. 2009)**
- GPS total precipitable water vapor (Oct. 2009)
- 1D-Var retrieved water vapor from radar reflectivity (June 2011)
- Domain expansion (Mar. 2013)
- AMSR2 microwave imager

Meso 4DVAR (Mar. 2002-Apr. 2009)

(Koizumi et al., 2005 ; SOLA)

The world first implementation of regional 4DVAR for operation.
LT and ADJ models based on MSM (a hydrostatic spectral model) of JMA.



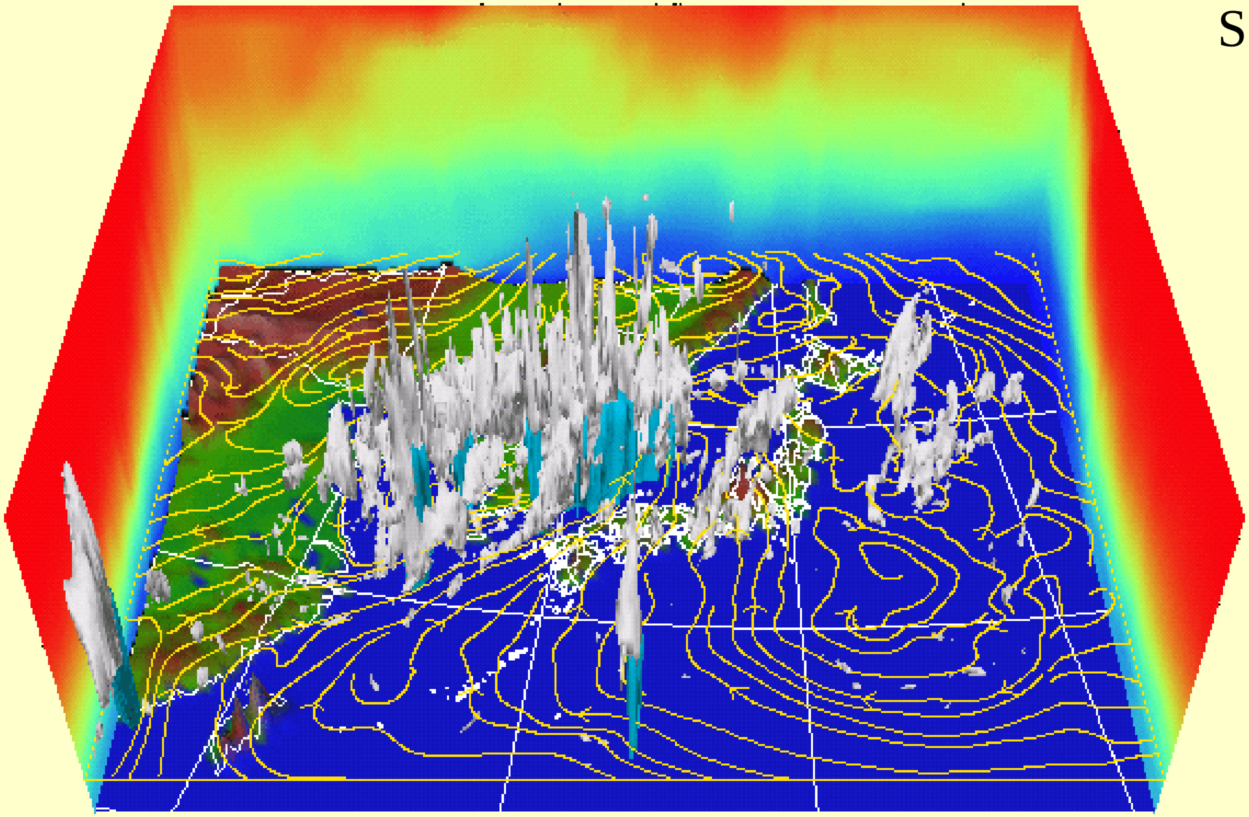
3 hour accumulated rain for FT=18
Initial 12 UTC 9 Sep 2001

Horizontal resolution of analysis: 10 km
Horizontal resolution of inner models: 20 km

JMA Mesoscale Model (MSM)

- *Fully compressible nonhydrostatic model developed by MRI and NPD/JMA (2004-)*
- *3 ice bulk cloud microphysics with the Kain-Fritsch convective parameterization scheme*
- *Mellor-Yamada-Nakanshi-Niino level 3 closure model for boundary layer*
- *Nonhydrostaic 4D-VAR (JNoVA) initial condition*

Saito et al. (2006; 2007)
Saito (2012)

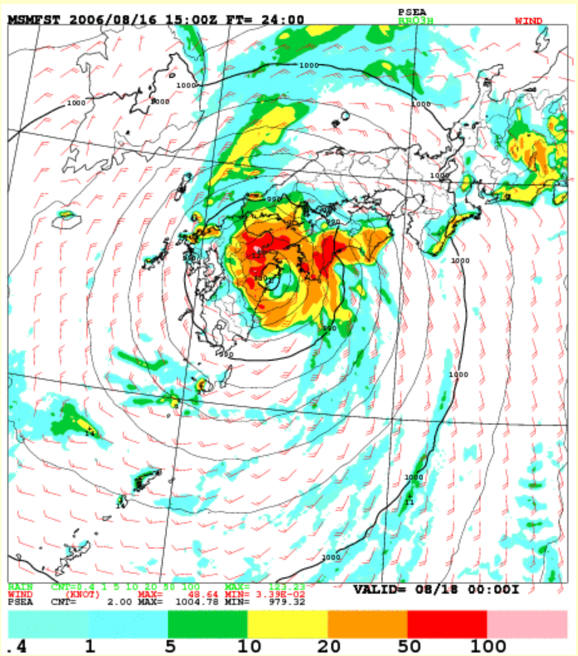


Nonhydrostatic 4DVAR (Apr. 2009-)

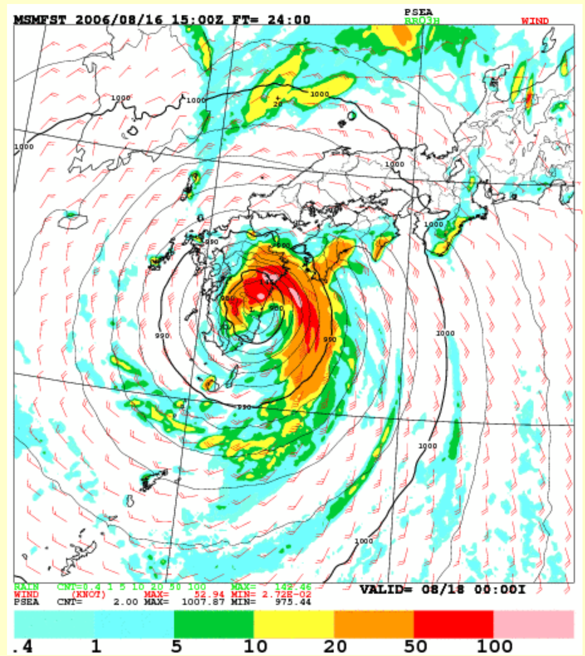
(JNoVA; Honda et al., 2009)

Operation of JMA nonhydrostatic model (JMA-NHM) in 2004
LT and ADJ models based on JMA-NHM

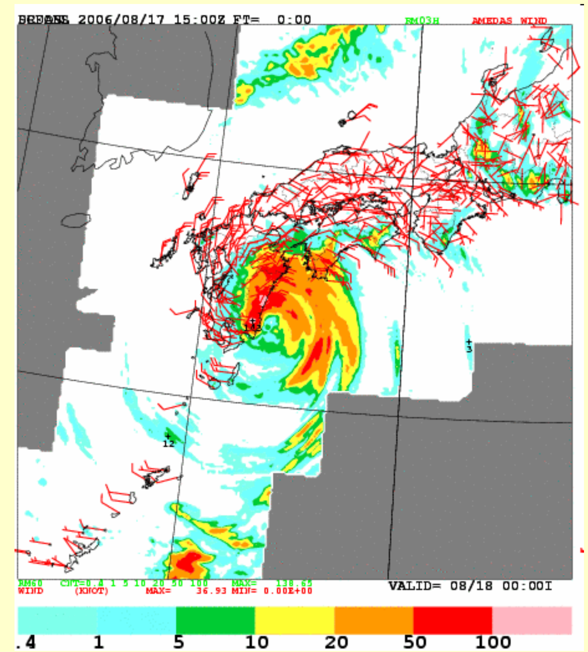
Meso 4DVAR



JNoVA



Observation



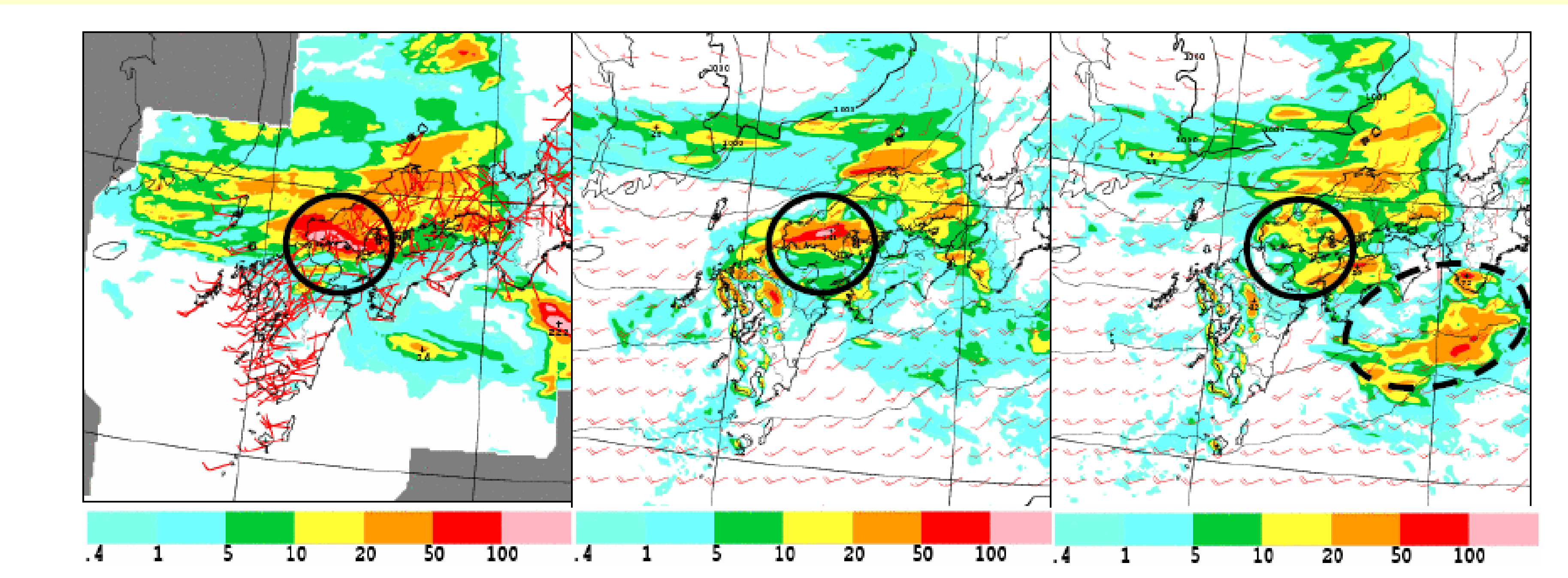
3 hour accumulated rain for FT=24
Initial 15 UTC 17 Aug 2006

Sawada and Honda (2009)

Horizontal resolution of analysis: 5 km
Horizontal resolution of inner models: 15 km

Assimilation of GNSS TPW (Oct. 2009-)

Real time assimilation of TPW data from 1,100 groundbased GNSS stations (GEONET of the Geospatial Information Authority of Japan).

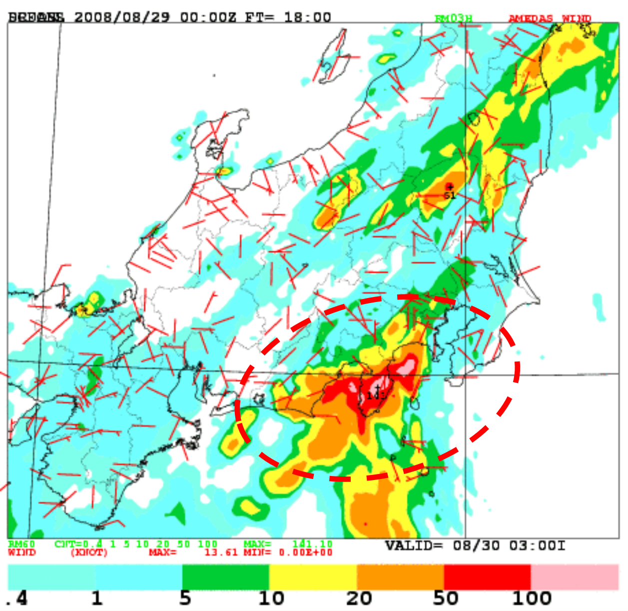


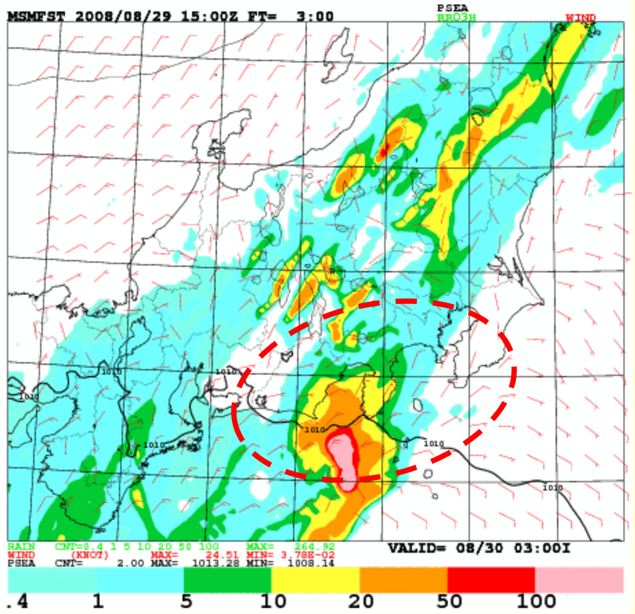
Radar-AMeDAS with GPS TPW without GPS TPW

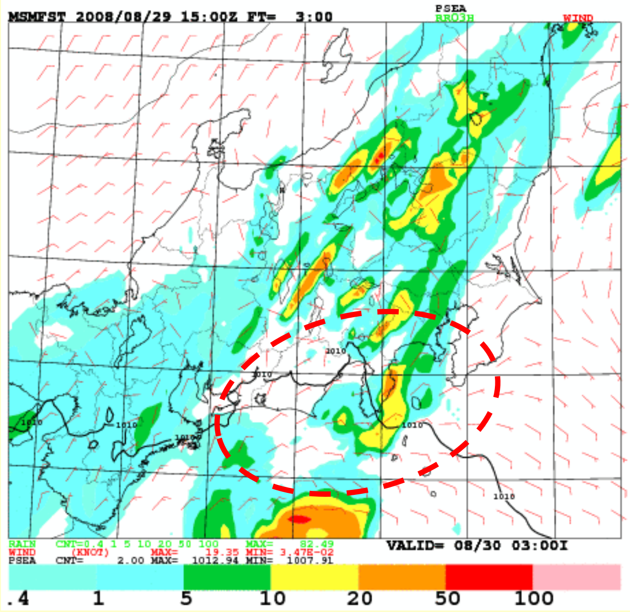
FT=3 from 21 UTC 20 July 2009

Shoji (2009; JMSJ), Ishikawa (2009)

1D-VAR water vapor retrieval from radar reflectivity (June 2011-)







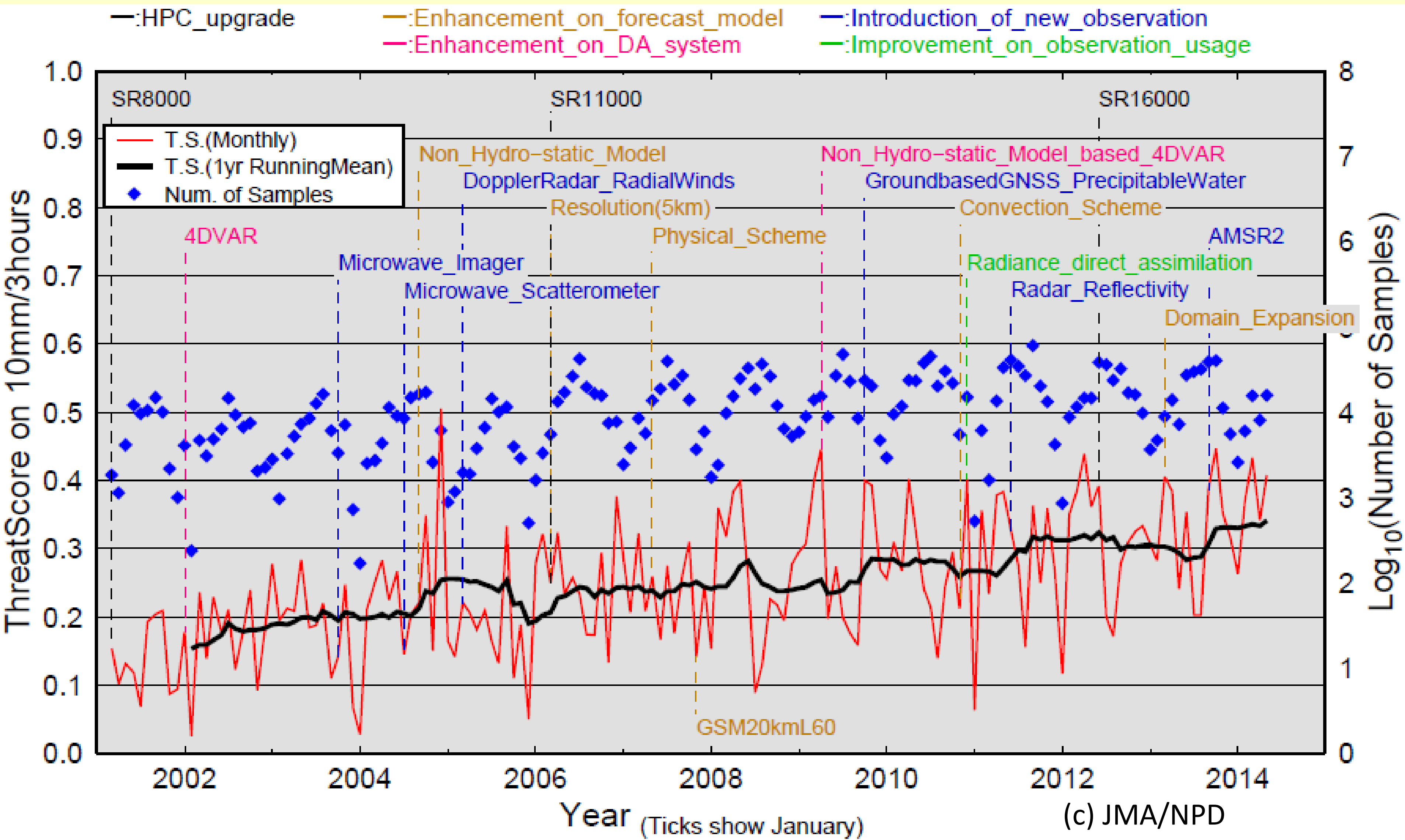
Radar-AMeDAS Obs.
2008/08/29 18UTC

Test FT=3

Control FT=3

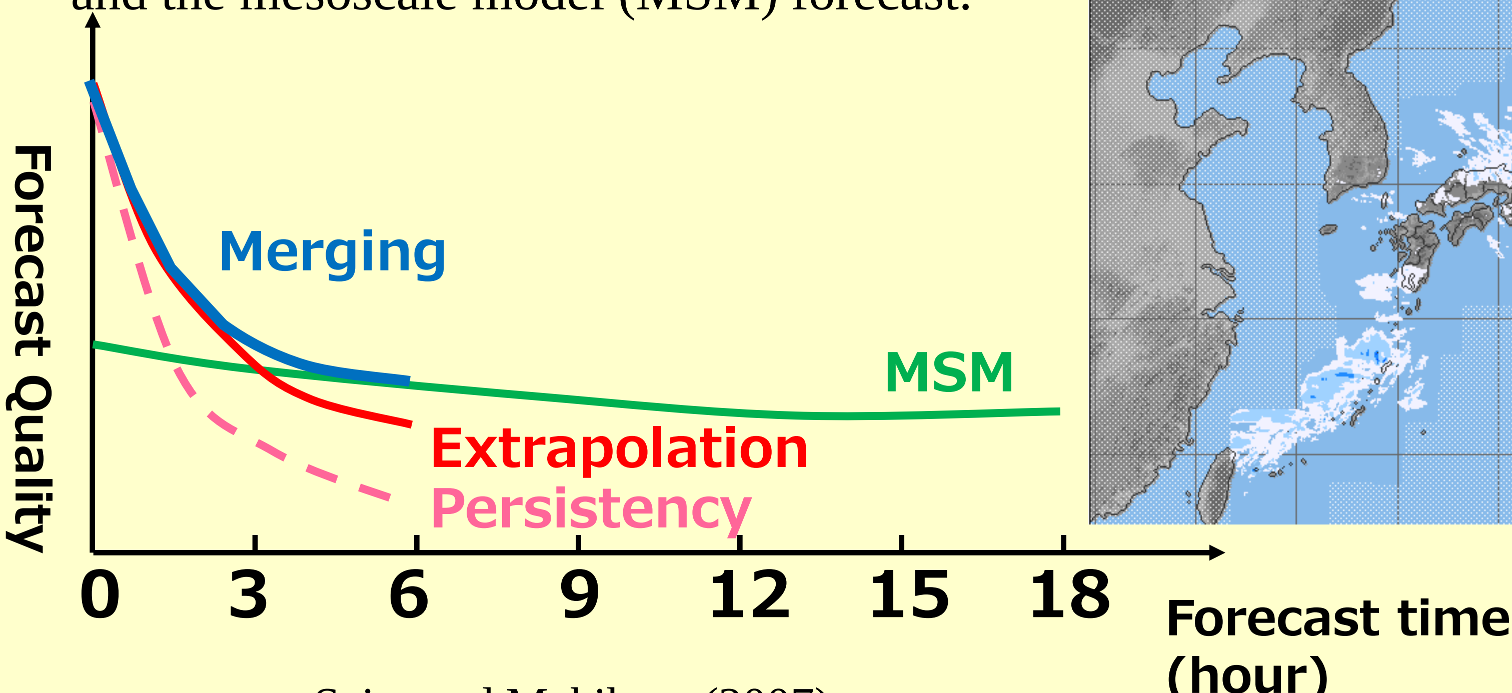
Ikuta (2011)

Threat score of MSM Mar.2001-May.2014 (FT=0-15)

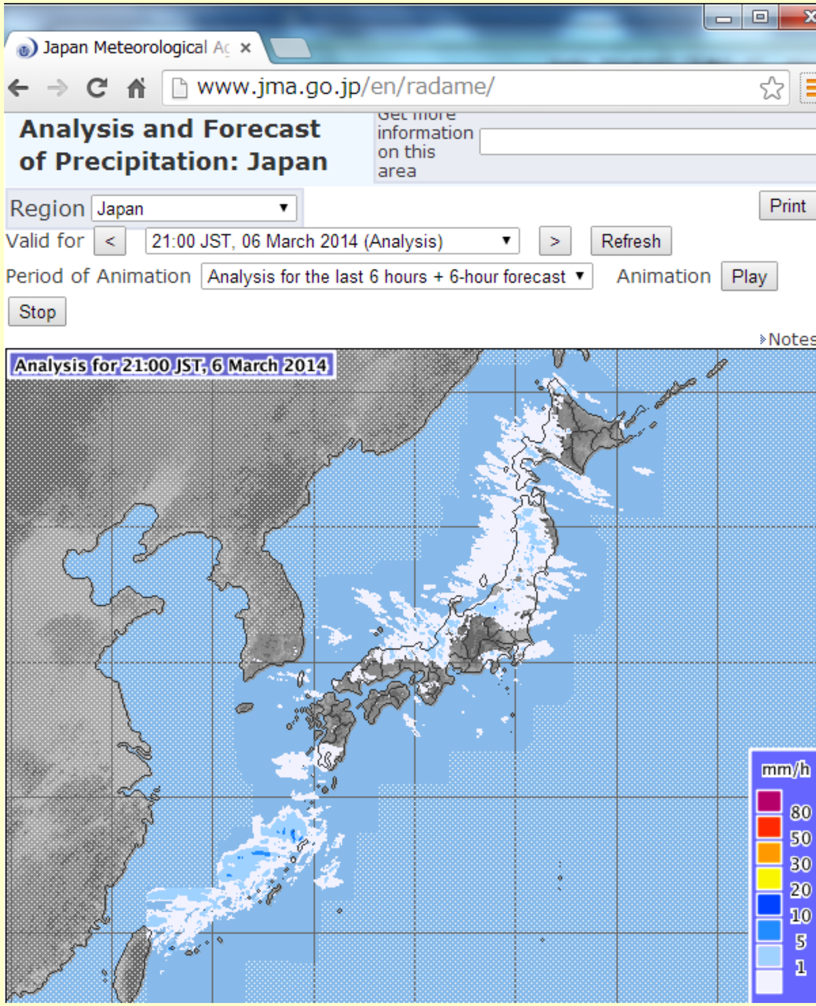


Very Short Range Forecast of Precipitation at JMA

Very short range forecast of precipitation for 6 hours with a spatial resolution of 1 km is operationally provided by JMA at every 30 min., based on merging of kinematic extrapolation of precipitation estimate (Radar/Rain gauge-Analyzed Precipitation) and the mesoscale model (MSM) forecast.

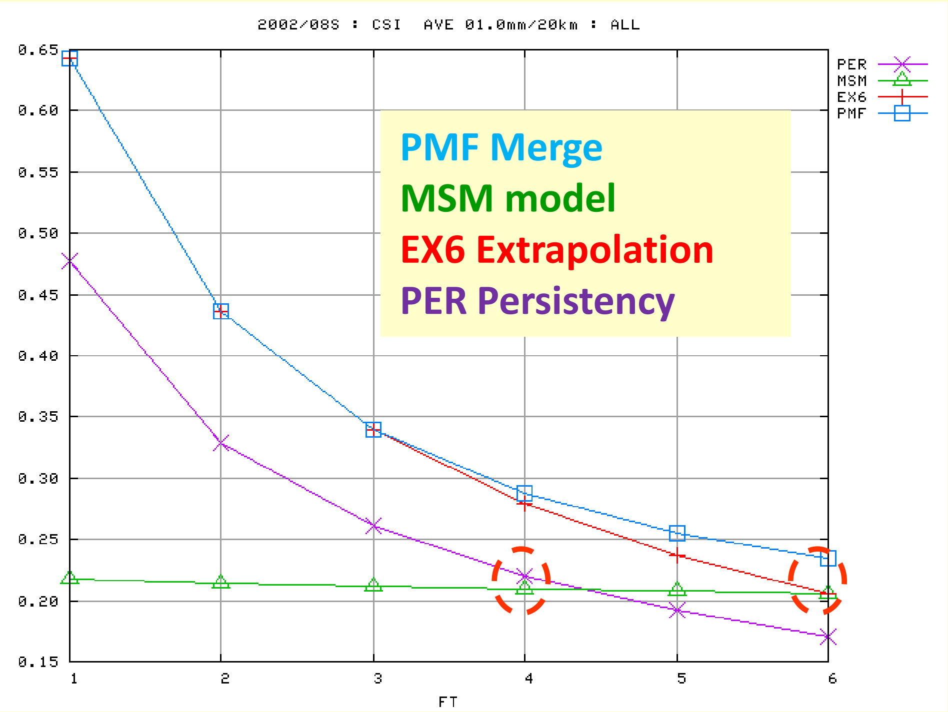


Saito and Makihara (2007)



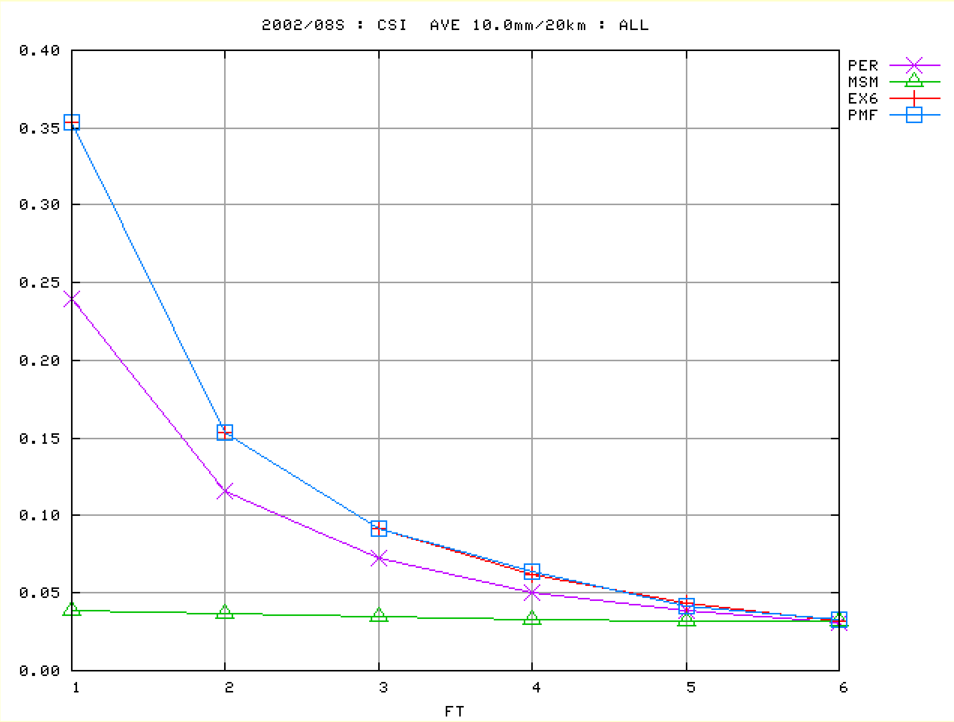
Performance of VSRF of precipitation at JMA

1mm/h



Persistency was better than the model by FT=4.
Extrapolation was better than the model by FT=6.
Merge barely improved the extrapolation after FT=4.

10mm/h （JJA as of 2002）

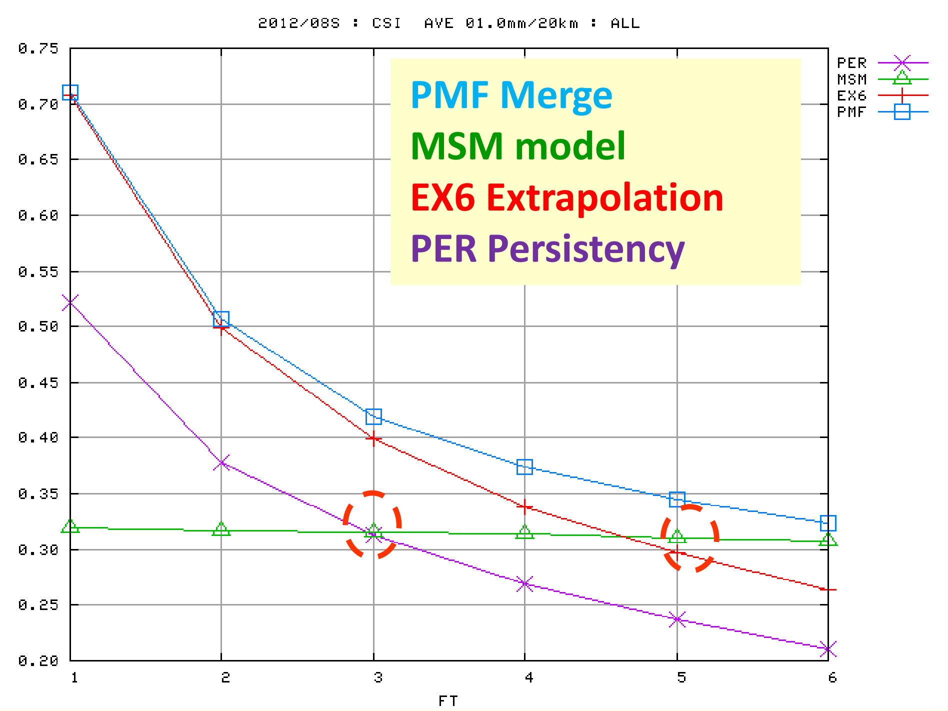


Persistency was better than the model by FT=6.
Merge did not improve the extrapolation at all.

Saito (2013) with courtesy of S. Kumagai, JMA

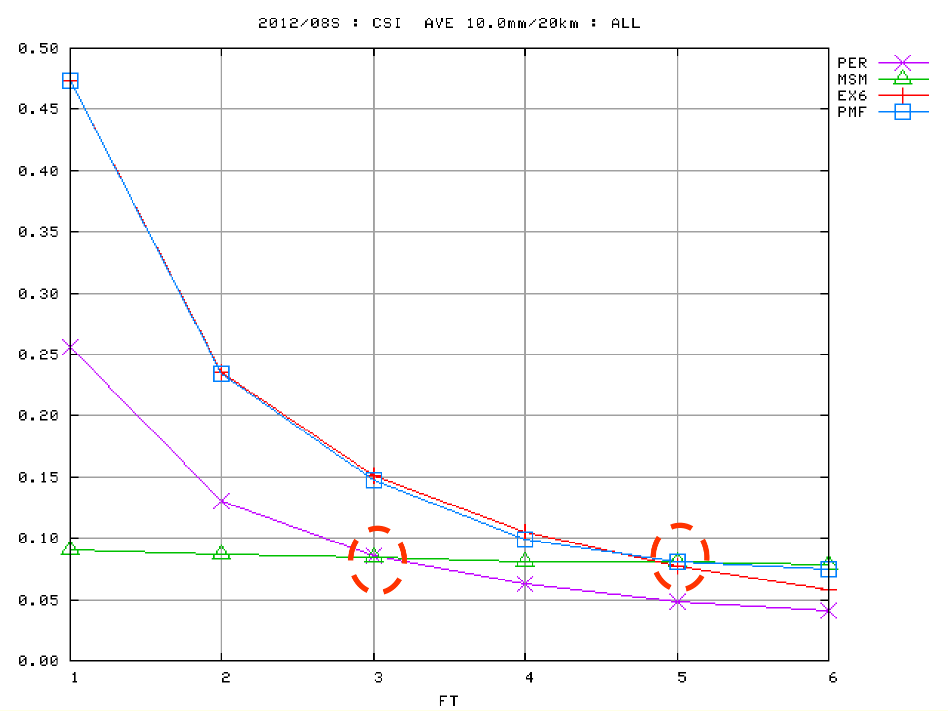
Performance of VSRF of precipitation at JMA

1mm/h



Model is comparable to persistency at FT=3, and outperforms extrapolation at FT=5. Benefit of merge against extrapolation becomes larger.

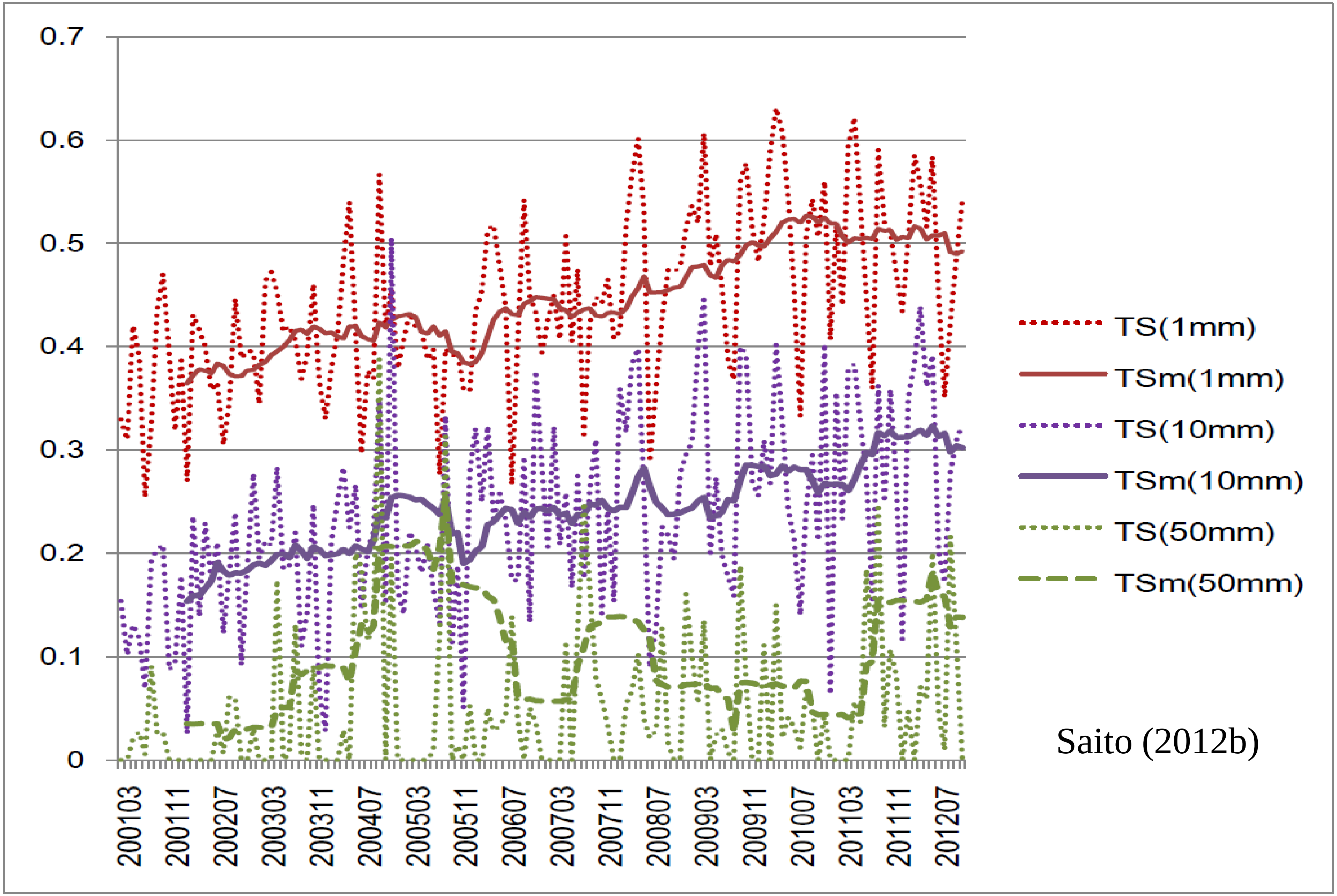
10mm/h (JJA as of 2012)



Model is comparable to persistency at FT=3, and comparable to extrapolation at FT=5. Merge does not improve extrapolation or model.

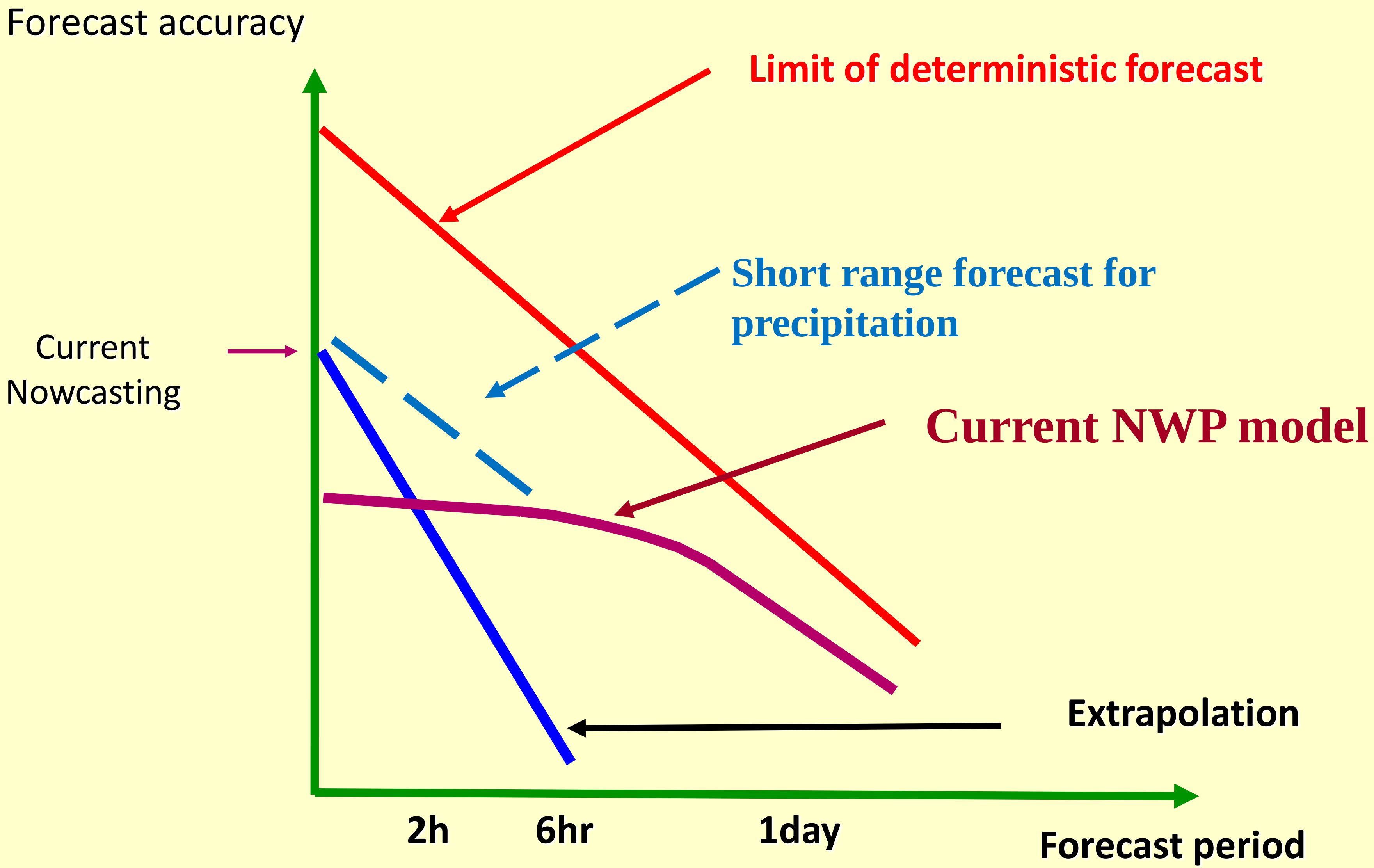
Saito (2013) with courtesy of S. Kumagai, JMA

Threat score of MSM Mar.2001-Nov.2012 (FT=0-15)



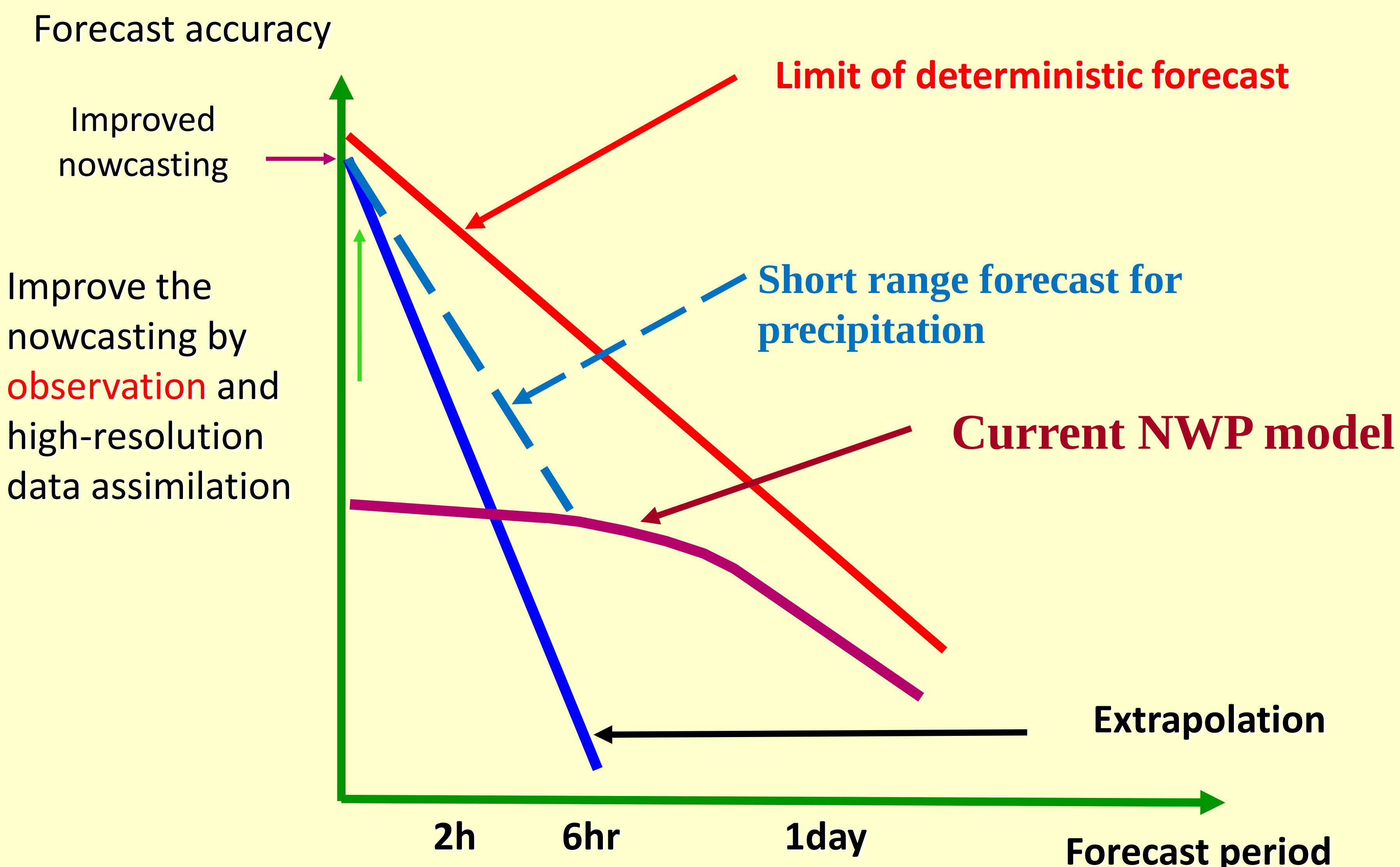
Saito (2012b)

Approaches to predict local heavy rain



Reproduced from Saito (2012)

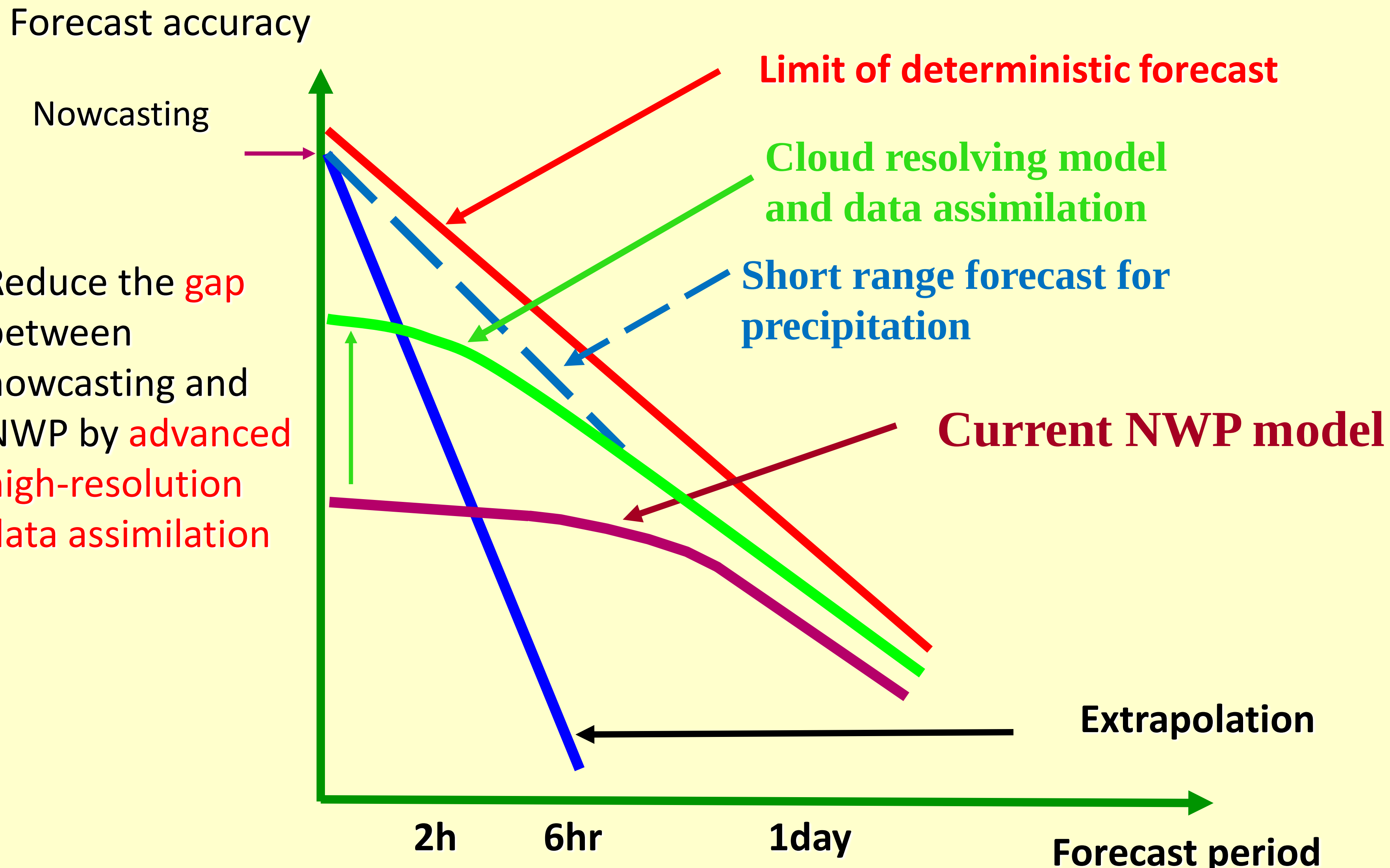
Approaches to predict local heavy rain (1)



Saito (2012)

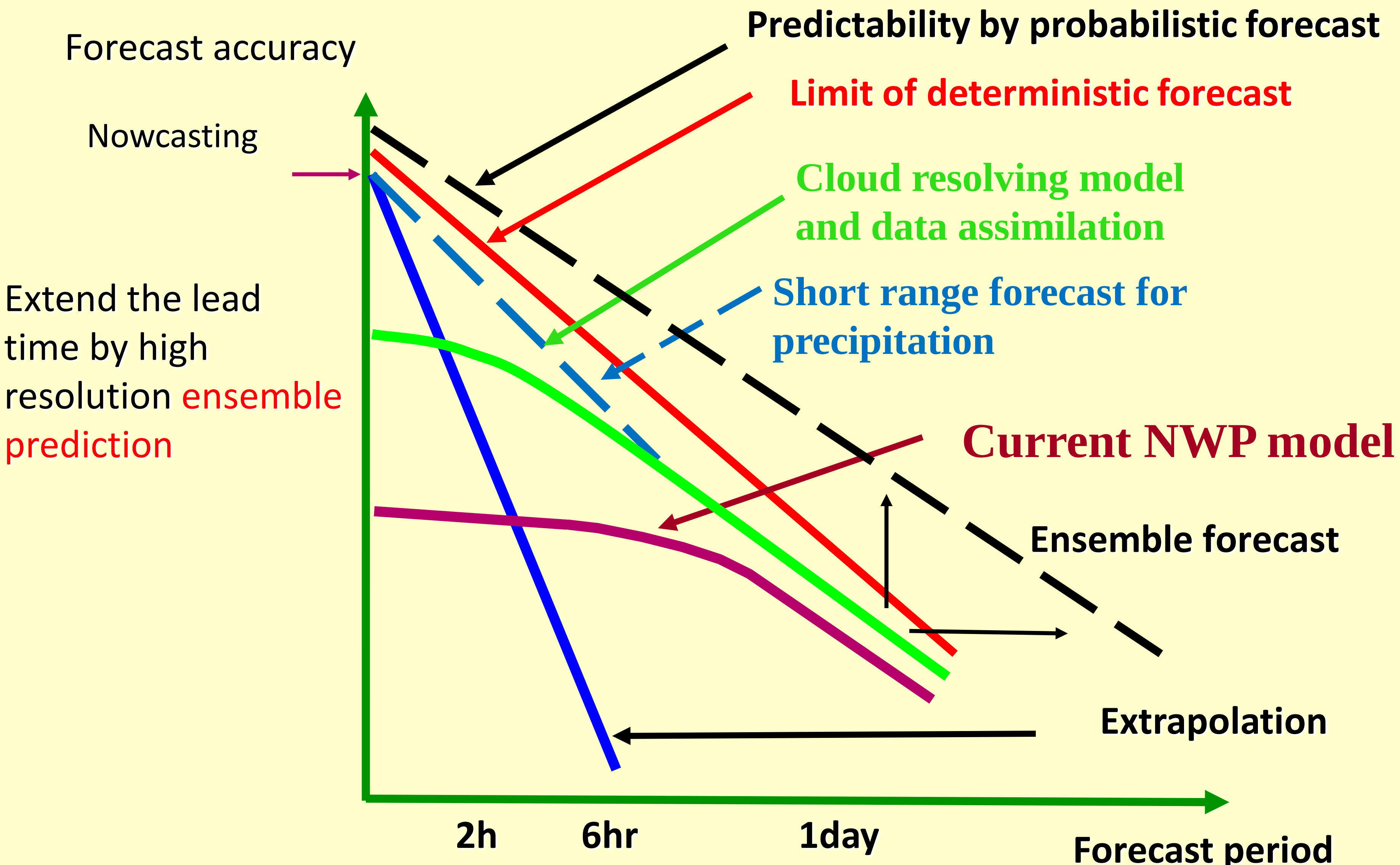
Approaches to predict local heavy rain (2)

Reduce the gap between nowcasting and NWP by advanced high-resolution data assimilation



Saito (2012)

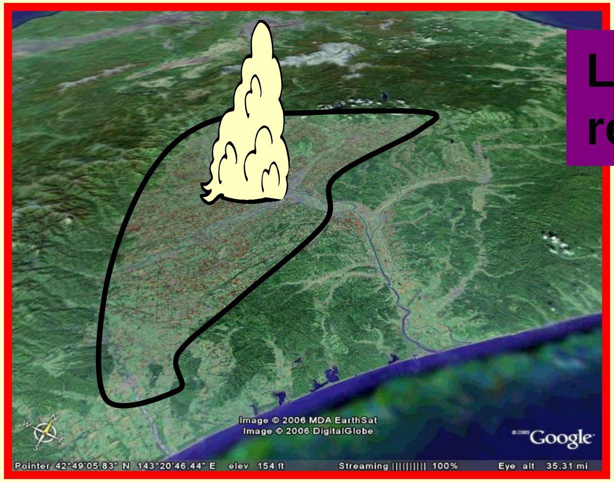
Approaches to predict local heavy rain (3)



Saito (2012)

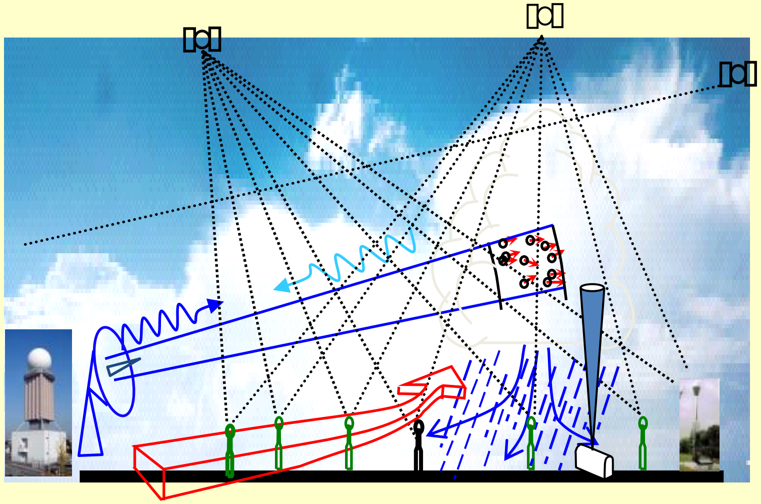
Convective scale data assimilation

Key factor to improve numerical model-based nowcasting and the very short range forecast for local high impact weathers



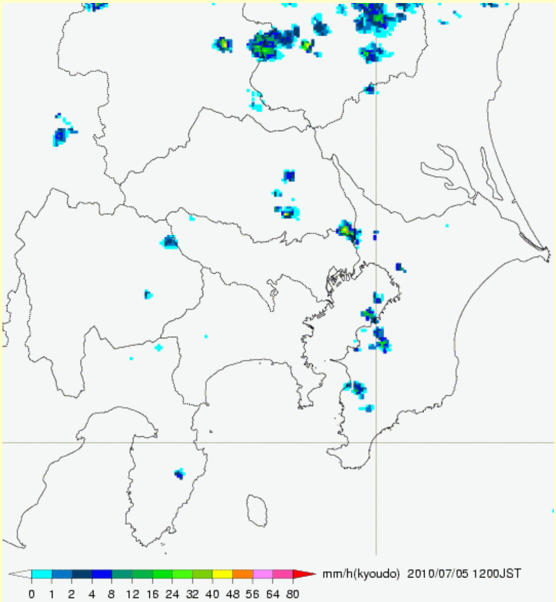
Local high-impact weathers relating to convective systems

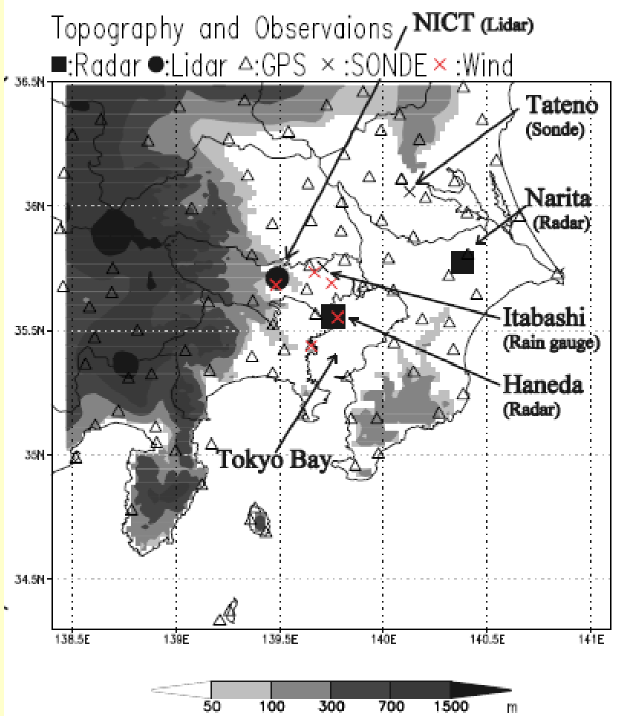
- small horizontal/temporal scales
- phenomena in unstable atmosphere



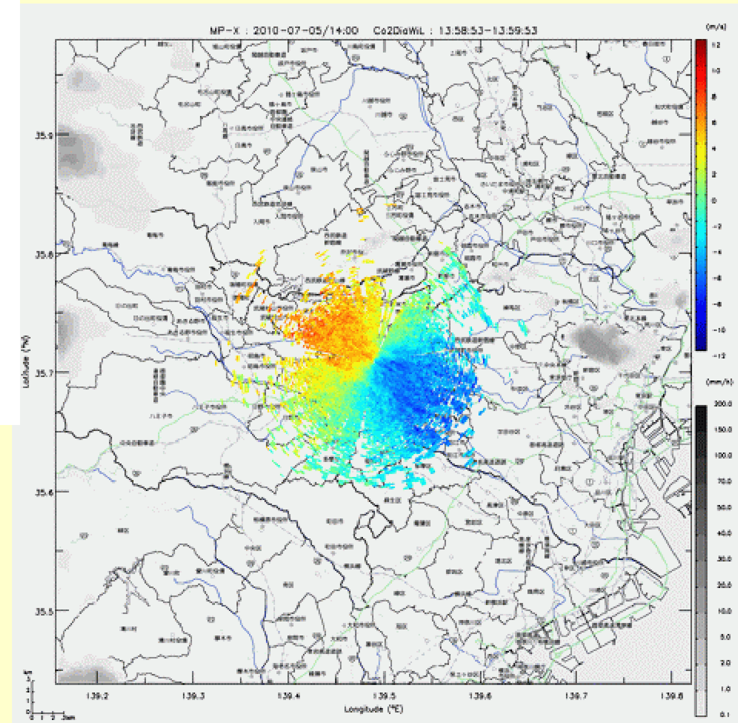
- Cloud resolving advanced DA
- high density high frequency observation data

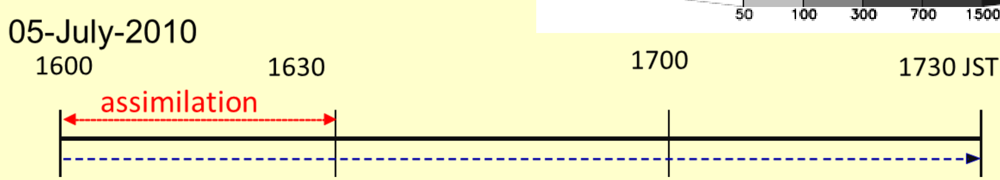
Cloud resolving NHM-4DVAR assimilation of dense observations for local heavy rainfalls





Kawabata et al. (2014; M.W.R.)



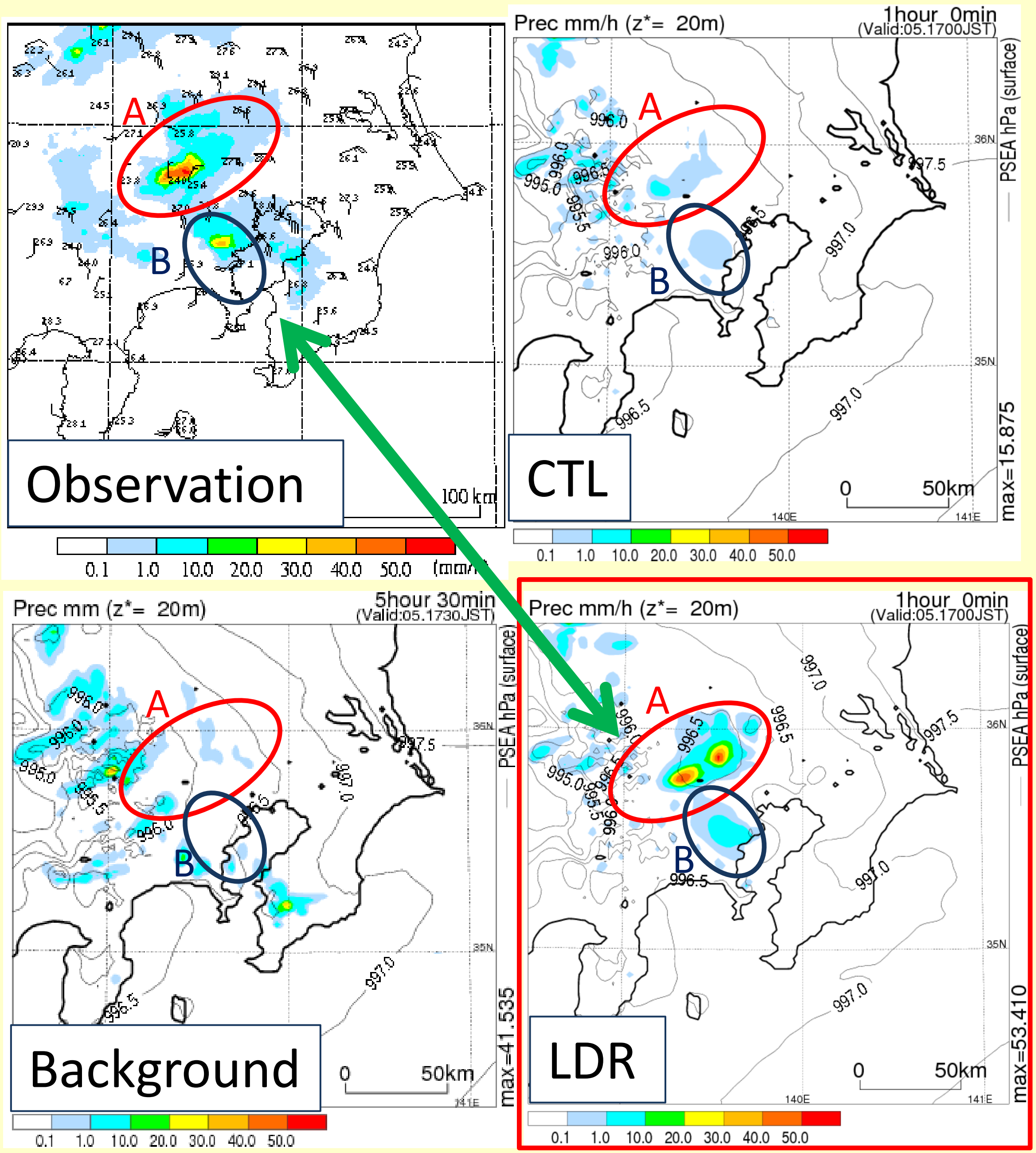


Observation

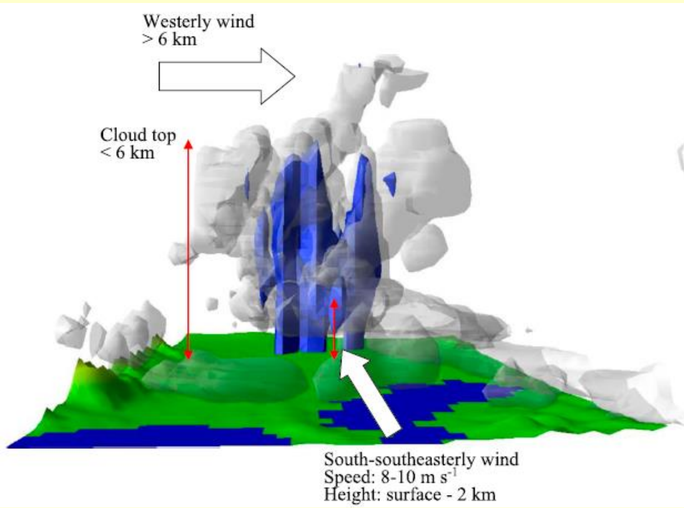
- GPS Precipitable water vapor every 10min
- Radar reflectivity every 1min
- Radial wind by Doppler Radar every 1min
- Radial wind by Doppler Lidar every 1min

Precipitation and observed radial winds; 2010 July 5 14:00 – 21:25 JST

1h accumulated rainfall amount at FT=1h



In Background, there are no strong convective areas.
In CTL, similar rainfall regions (A, B) are seen but their intensity are very weak.
In LDR, both convective areas of A and B are much similar to those in observation.



Reproduced MCS by NHM-4DVAR (Kawabata et al. 2014)

The HPCI Strategic Programs for Innovative Research (SPIRE; 2011.4-2016.3) Field 3: Weather, Climate and Environment Prediction for disaster prevention

www.jamstec.go.jp/hpci-sp/index.en.html

SPIRE | Field 3

Topic

The 4th Research Meeting of Ultra-high Precision Meso-Scale Weather Prediction(KOBE:2014.03.07)

SPIRE Field 3 Introduction Video

New!

- [2014.02.07] New Results of Research was released.(Ultra-high Precision Meso-Scale Weather Prediction)
- [2013.01.17] The 4th Research Meeting of Ultra-high Precision Meso-Scale Weather Prediction. (KOBE:2014.03.07)
- [2013.11.11] THE SPIRE Field 3 Research Overview Introduction Video was

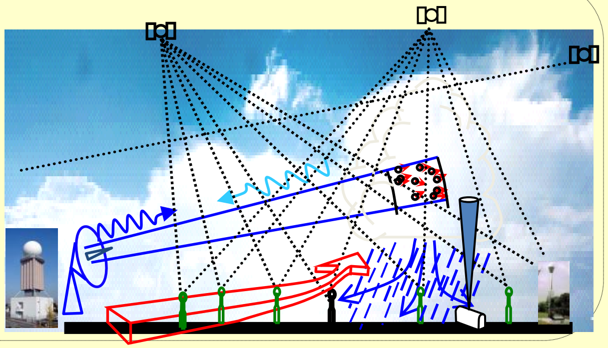
Link

- JAMSTEC
- AORI, The Univ. of Tokyo
- ERI, The Univ. of Tokyo
- III, The Univ. of Tokyo
- MRI, JMA

The HPCI Strategic Programs for Innovative Research (2011.4-2016.3)
Field 3: Weather, Climate and Environment Prediction for disaster prevention

Research subject ②：Super high performance mesoscale NWP

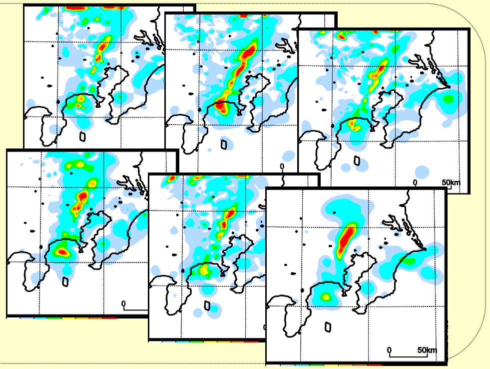
1) Development of cloud resolving 4DDA systems



•feasibility of dynamical prediction of local heavy rainfall in very sort range forecast

MRI, JAMSTEC, DPRI/Kyoto Univ., NIED, ISM

2) Development and validation of a cloud resolving ensemble NWP system



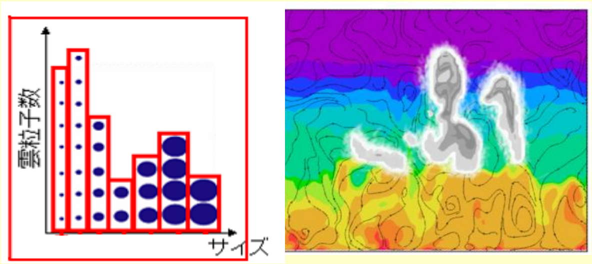
•quantitative prediction of the probability of local heavy fall with a lead time to disaster prevention

JAMSTEC, MRI, JMA, Tohoku Univ., DPRI/Kyoto Univ.

3) High performance atmospheric model

• Evaluation of model's uncertainty through super high resolution numerical experiments using LES and/or BIN models

JAMSTEC, MRI, Tokyo Univ., Nagoya Univ., DPRI/Kyoto Univ., etc.



Bin **LES**

http://www.jamstec.go.jp/hpci-sp/strategy/pamphlet_en.pdf

Ultra-high Precision Meso-Scale Weather Prediction

SPIRE Field 3

Managing Director : Kazuo Saito

Director, Forecast Research Department of MRI

Accuracy of numerical weather prediction (NWP) has been remarkably improved in recent years, but precise prediction of severe meteorological phenomena such as torrential rains and local heavy rainfalls is still a difficult and challenging subject due to the following reasons.

1) Accuracy of initial condition is insufficient for small spatial scale of the severe phenomena.

2) Mesoscale convective systems are often very sensitive to small perturbations of the initial condition and computational conditions.

3) Cumulonimbus is not fully resolvable in the horizontal resolution of the current numerical weather prediction systems.

Data assimilation and the ensemble forecast with the cloud-resolving resolution are required to overcome above problems, and the computational resource is a key to reduce the compromise of the resolutions and the number of ensemble members. In this subject, we will perform following three subjects using the "K Computer" and show feasibility of precise prediction of severe mesoscale phenomena by a cloud-resolving NWP system.

1) Development of cloud resolving 4 dimensional data assimilation systems
(by MRI, JAMSTEC, NIED, ISM, DPRI, NPD)

To dynamically predict deep convection and associated local heavy rainfalls, we apply advanced data assimilation methods such as 4D-VAR and local ensemble transform Kalman filter (LETKF) to cloud resolving models. Dense observation data such as radar reflectivity, Doppler radar radial winds, GPS slant delay data are assimilated in storm scale to obtain more accurate initial conditions. A maximum likelihood ensemble filter using neighbor ensemble and a particle filter based on the nonhydrostatic mesoscale model are also under development.

2) Development and validation of a cloud resolving ensemble analysis and forecast system
(by MRI, JAMSTEC, Tohoku Univ., DPRI, Kobe Univ., NPD)

A full-scale regional analysis and prediction system using an incremental LETF is under development. This ensemble data assimilation system shares observation operators with the JMA's operational nonhydrostatic 4DVAR system, while its target is the quantitative probabilistic forecast for heavy rainfalls using cloud resolving ensemble prediction. Results of the probabilistic forecast are validated and used as the input data for application systems for disaster prevention such as the ensemble river flow model.

3) Basic research using very high resolution atmospheric models
(by JAMSTEC, MRI, AORI, DPRI, NDA, HyARC, NDA, NPD, AICS, etc.)

"K Computer" allows to simulate the physical processes in much more detail than the conventional numerical weather prediction models. Typical examples of the physical processes are the turbulence in the lower atmosphere and the cloud physics in the precipitation systems. The latter process estimates conversion between cloud particles, rain droplets and snowflakes. Since these physical processes were difficult to directly simulate by the past computer systems, the effects of these processes were estimated by the simplified methods, so called 'parameterizations'. Comparing with the detail simulation by K-computer, we are going to evaluate the error in the parameterizations and improve the mesoscale numerical models.

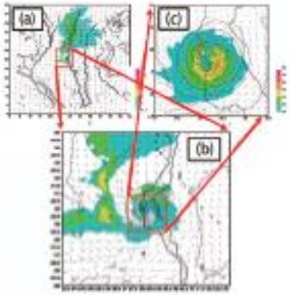
Expected outcome

This study demonstrates feasibility of high precision mesoscale weather prediction using huge computational resources such as the K-computer. Achievements of this study will contribute to progress of future numerical weather prediction and disaster prevention through their technical information.

Development of cloud resolving 4 dimensional data assimilation systems:

Tadashi Tsuyuki
(Meteorological Research Institute)

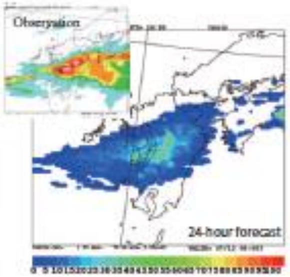
A two-way nested assimilation system of the local ensemble transform Kalman filter was developed, and it was applied to the tornadoes that occurred in the Kanto region on May 6, 2012. Right figures show a result of downscale experiments which was obtained by NHM with a horizontal resolution of 50m. Strong wind over 50 m/s caused by the vortex of tornado was well reproduced.
After Seko et al. (2013)



Development and validation of a cloud resolving ensemble analysis and prediction system:

Hiromu Seko
(Meteorological Research Institute)

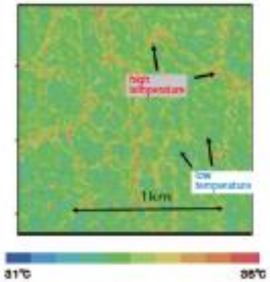
Ensemble forecast experiments based on the LETKF were conducted for the heavy rainfall case occurred on 12 July over Kyushu district. Right figure illustrates the probability of precipitation occurrence over 50 mm per 3 hours with a lead time of 24 hours. This result exhibits remarkable consistency with the corresponding observation, and suggests it should become a reliable data source for future decision-making.
After Kunii (2013)



Basic research using very high resolution atmospheric models:

Fujio Kimura
(JAMSTEC)

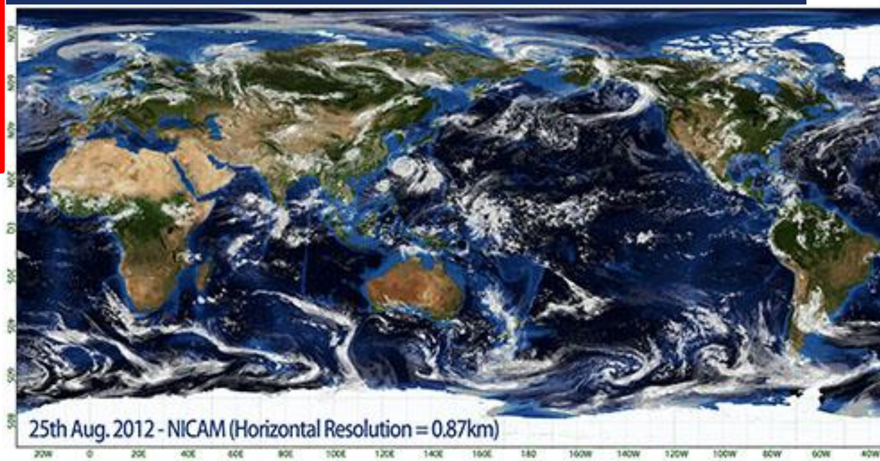
Right figure shows temperature distribution at 2 m high during a sunny day simulated by a LES model. Although the ground surface is uniform, a fish-net-like heterogeneous distribution is formed with the amplitude of about 3 K. We are going contribute to improve the accuracy of the estimation methods for the exchange of heat, moisture and momentum between atmosphere and land/sea surfaces as well as the transport processes in the lower atmosphere.
After Ito et al. (2013)



Results of Research

SPIRE "Field 3"
Advanced Prediction Researches for Natural Disaster Prevention and Reduction

Feb. 7, 2014
Super high-resolution modeling of 3D structures of the sea breeze front head by the Down-Scaling Simulation System(DS3)



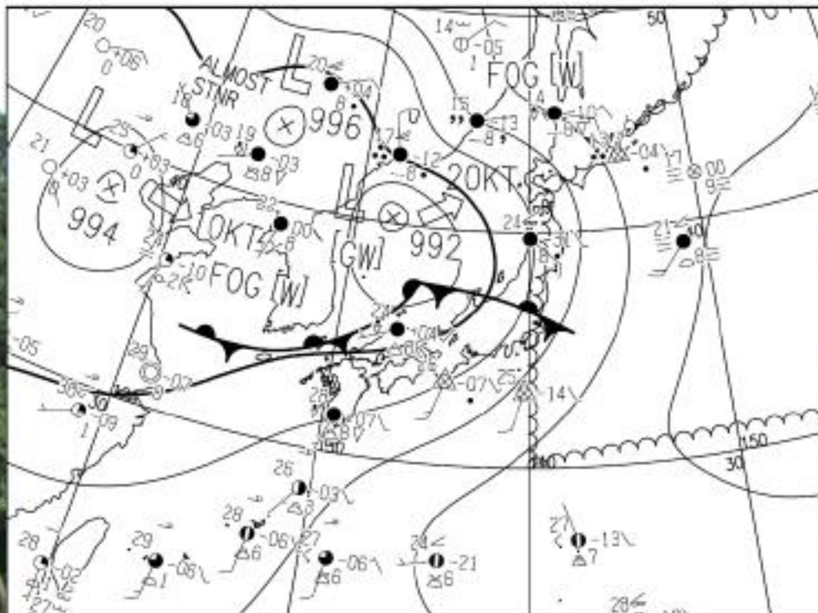
Sep. 20, 2013
The K computer has made is possible to model cumulonimbus clouds in the world's first global simulation model with the super-high-resolution, in a development that will help us understand the mechanism behind the formation of typhoons and torrential rain.(Riken HP)

Aug. 30, 2013
Forecast experiments for the heavy rainfall event in northern Kyushu in July 2012 with the K computer

May 16, 2013
Ensemble forecast experiments on tornadoes that occurred in Tsukuba on May 6, 2012

Forecast experiment for Northern Kyushu heavy rainfalls in July 2012

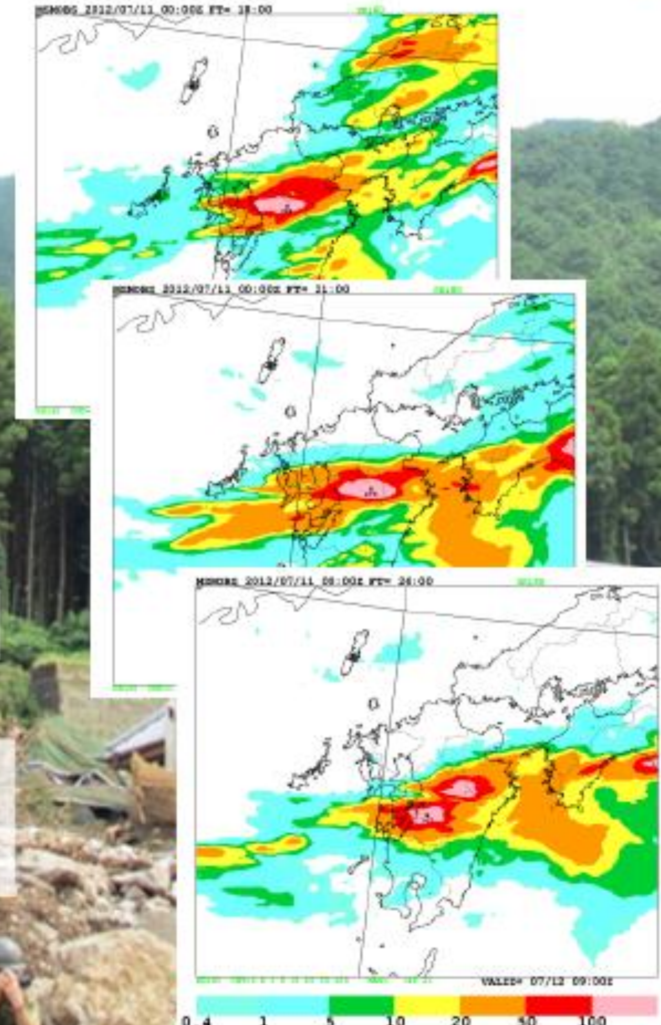
Northern Kyushu heavy rains in July 2012



Surface weather map on 1800 UTC 11 July 2012.

Rainfall totals reached as much as 800 mm over 5 days.

3-h accumulated rainfall (OBS)



Forecast experiment for Northern Kyushu heavy rainfalls in July 2012

SPIRE Field 3

(Kunii, 2014, W&F)

Experimental Settings

- *LETKF settings*

Ensemble size	50
Lateral boundary conditions	JMA Global Forecast (+ PTBs from JMA Global EPS)
Covariance inflation	Adaptive (Miyoshi 2011)
Covariance localization	200 km, 0.2 ln p
Analyzed variables	u, v, w, t, p, qv, qc, qr, qci, qs, qg
Observation data	MA CDA4 (U, V, T, RH, TPW)

- *NHM settings*

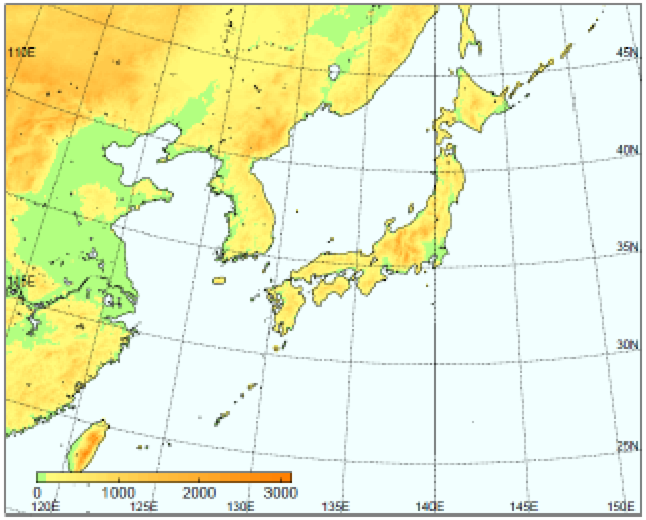
Domain size	241 x 193 x 50
Horizontal grid spacing	15 km
NHM version	JMA NHM as of August 2012

Forecast experiment for Northern Kyushu heavy rainfalls in July 2012

Experimental Settings

- ***EPS settings***

Ensemble size	51 (50 + CNTL)
Lateral boundary conditions	JMA Global Forecast + PTBs from JMA Global EPS
Domain size	721 x 577 x 50
Horizontal grid spacing	5 km



Domain for the EPS experiment

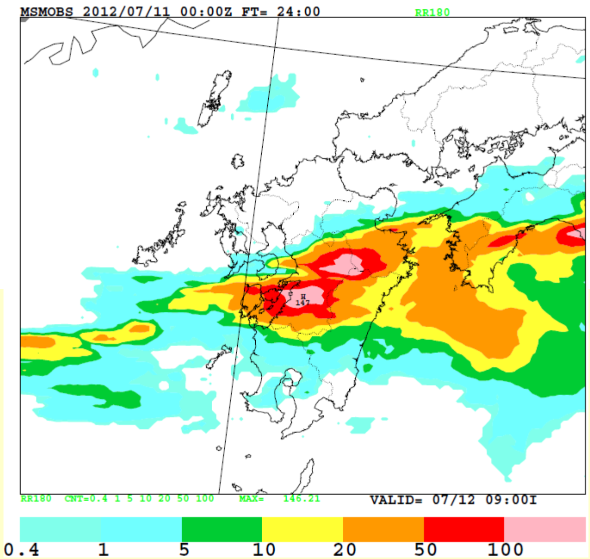
NHM configurations are almost similar to operational one.

EPS experiment:
20120710 1200 UTC – 20120713 1200 UTC
every 6-hr (13 cases)

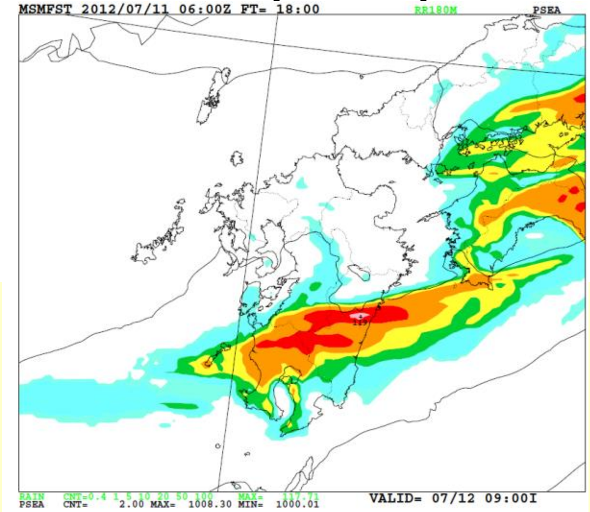
(Kunii, 2014, W&F)

Forecast experiment for Northern Kyushu heavy rainfalls in July 2012

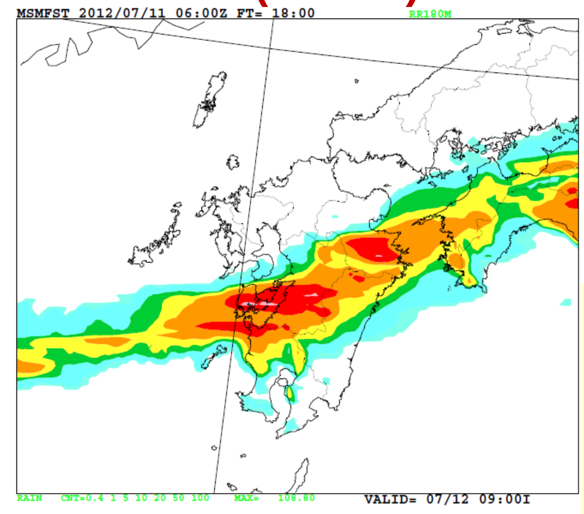
OBS



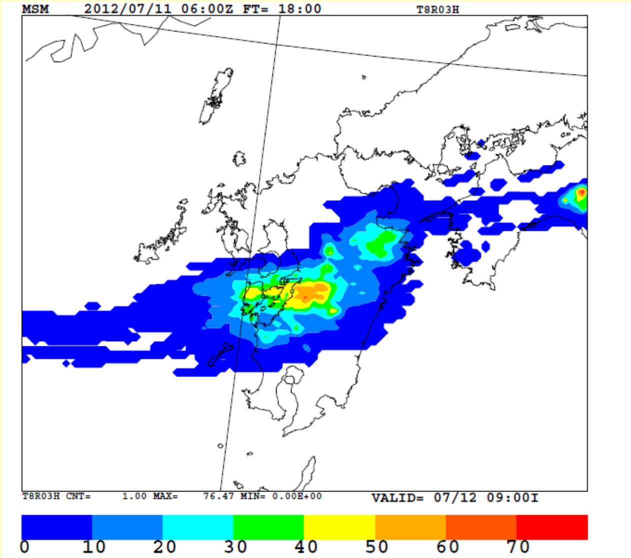
MSM (JNoVA)



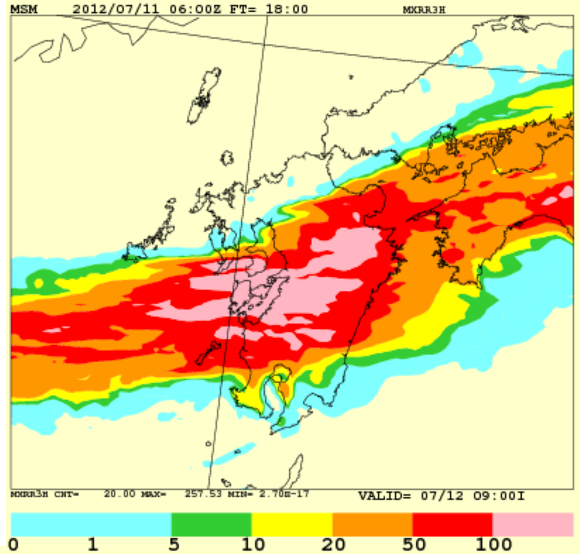
MSM (LETKF)



POP > 50mm/3h



Maximum

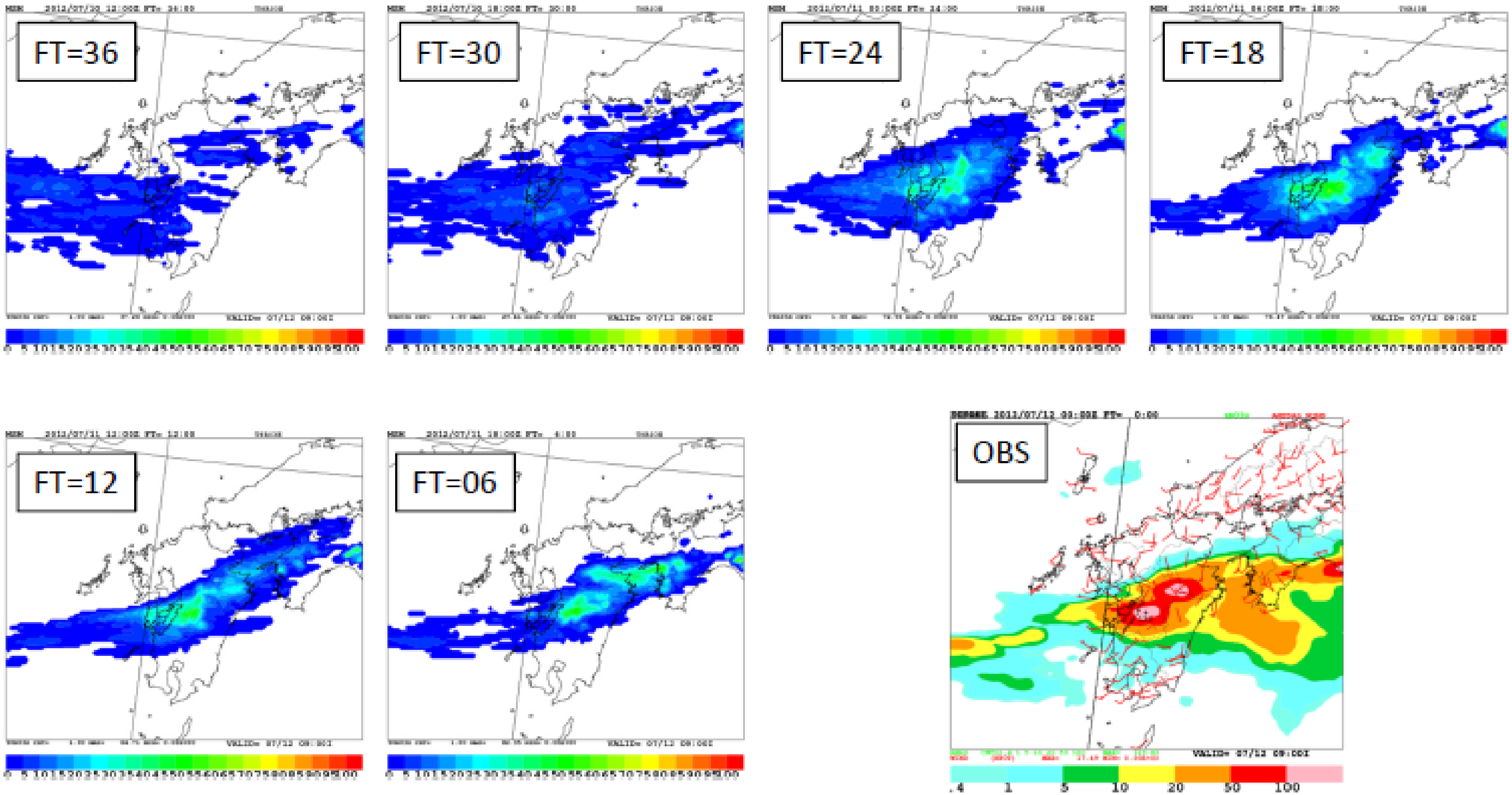


NHM-LETKF Forecast (FT=18)

(Kunii, 2014, W&F)

Probability with longer leads

Probability of precipitation (50 mm > 3-hr) with different lead times

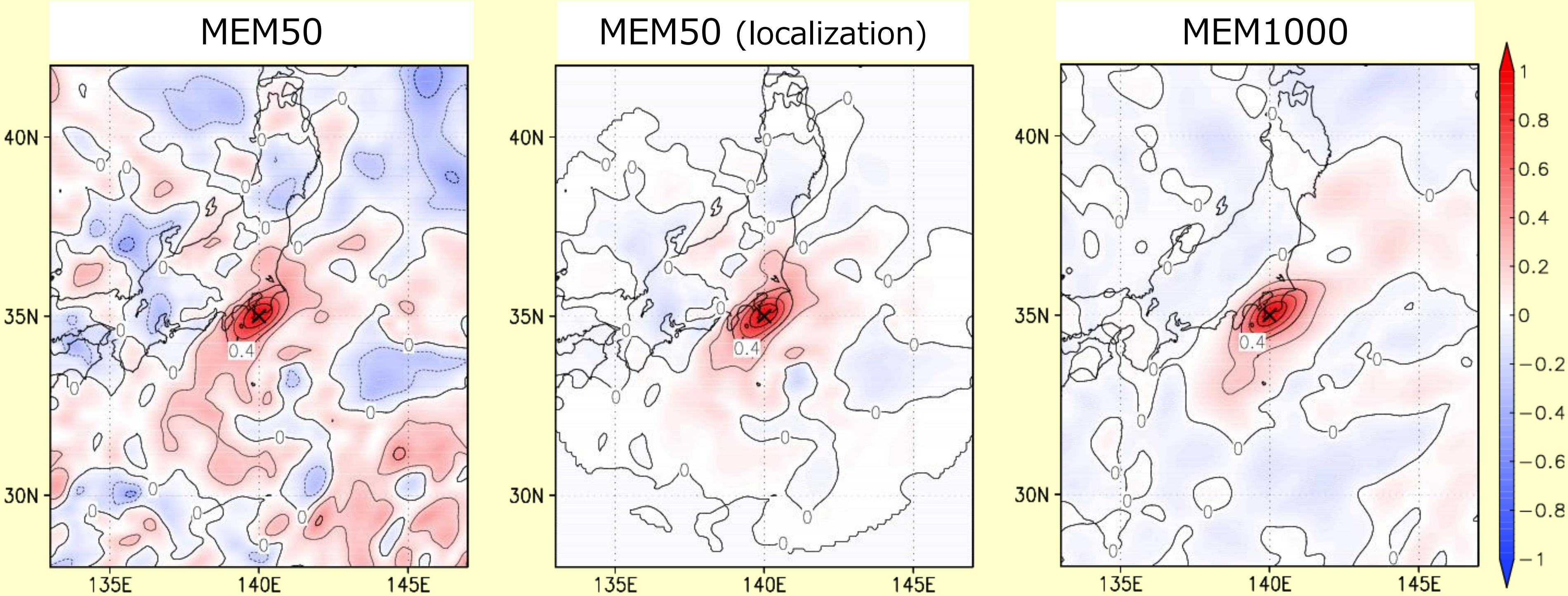


EPS successfully captures the occurrence of the heavy rainfall before 24 hours.

(Kunii, 2014, W&F)

1000 member LETKF with NHM

Horizontal error covariance maps of U at 500 hPa level

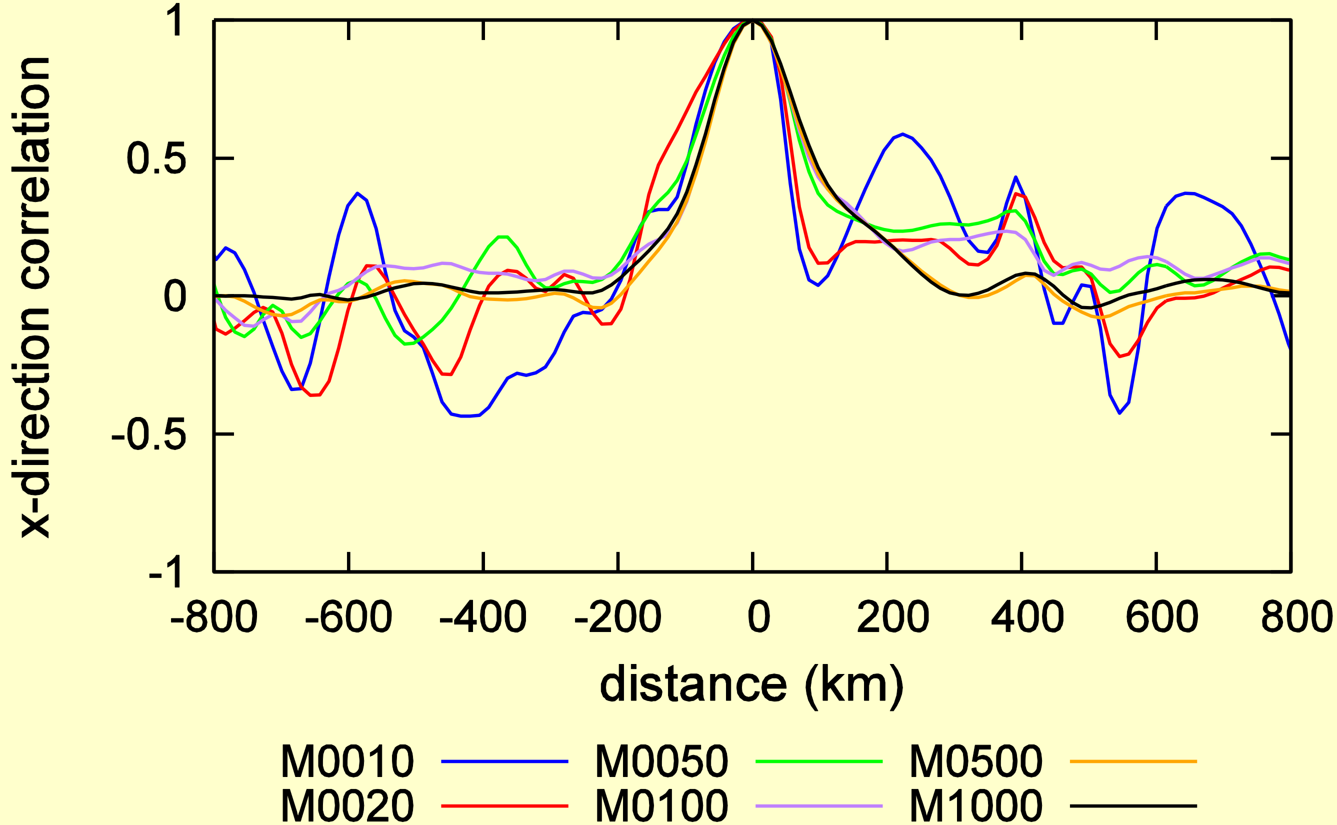


After 5 days cycle

(Kunii, 2014, JMSJ)

Error covariance with different member size

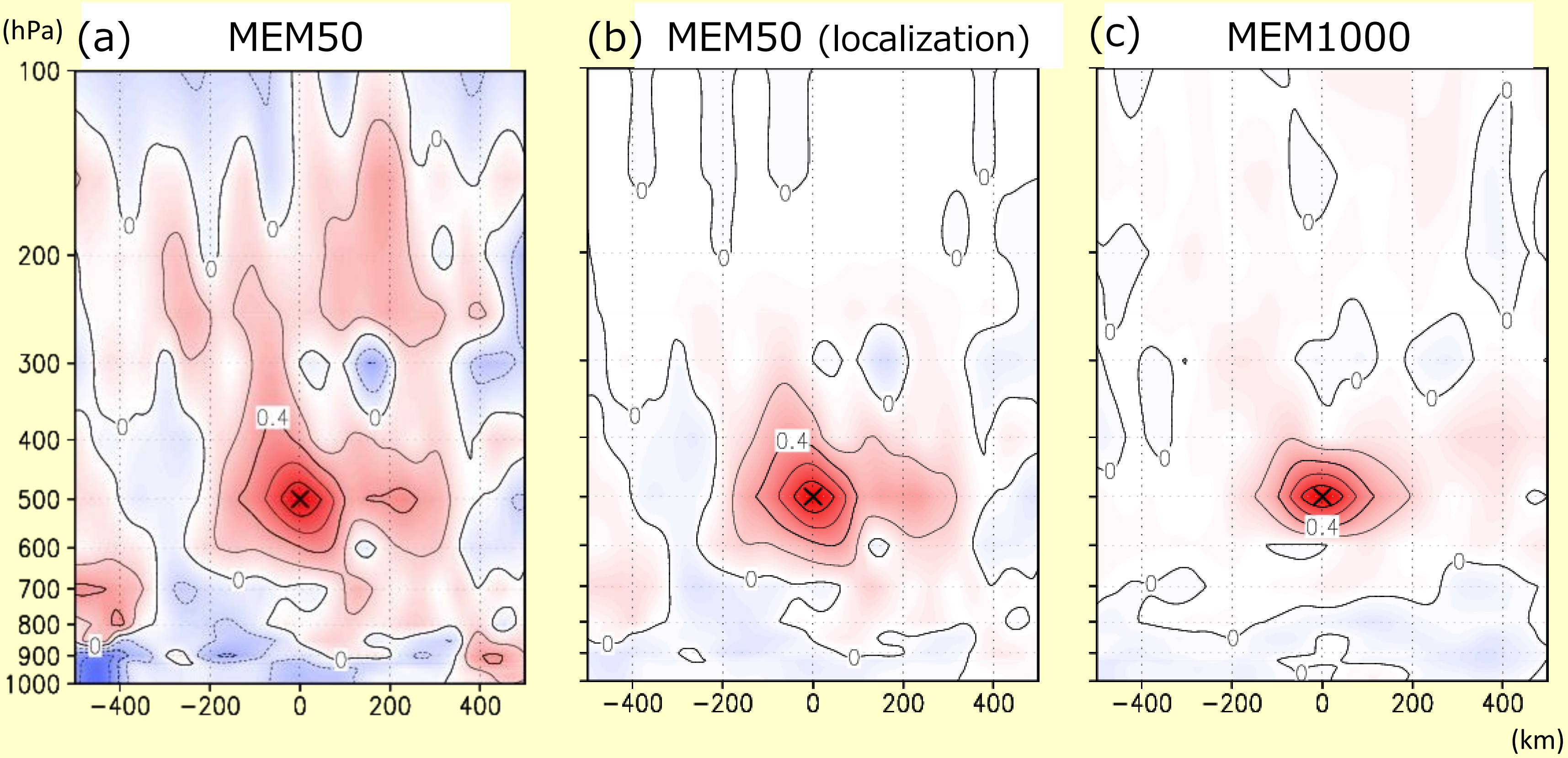
A horizontal cross section of the error covariance of U at 500 hPa level



(Kunii, 2014, JMSJ)

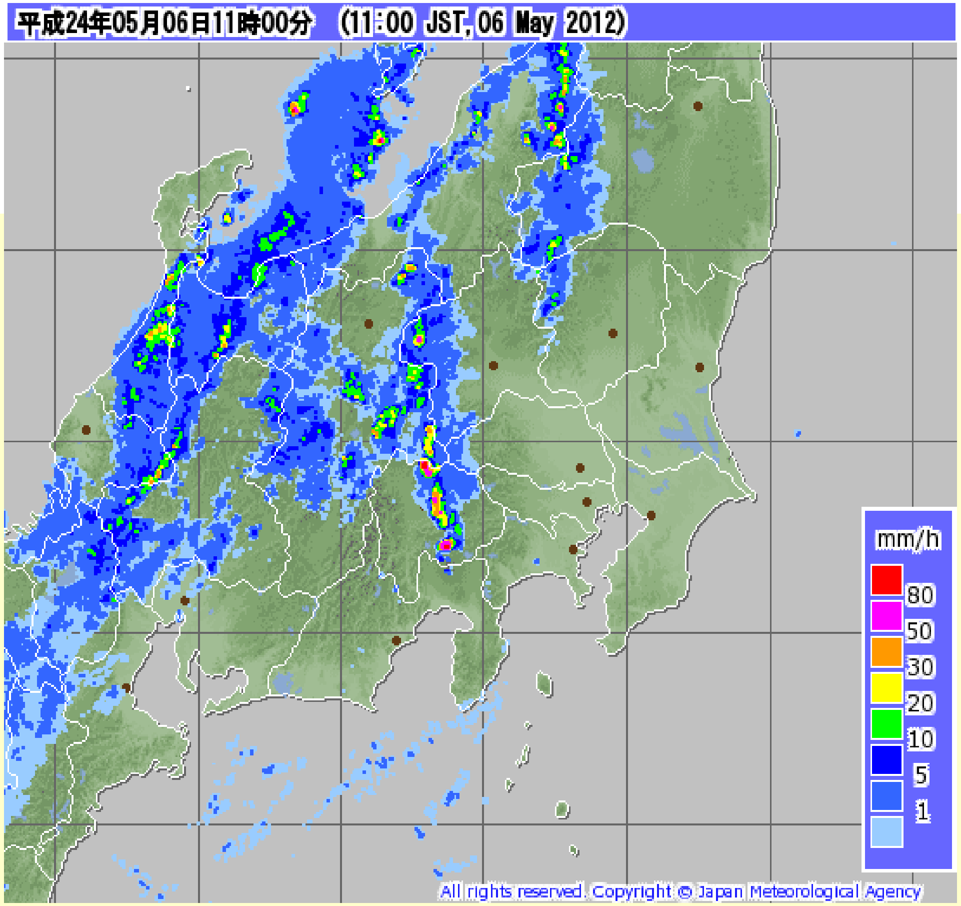
Error covariance structure

Vertical error covariance maps of U



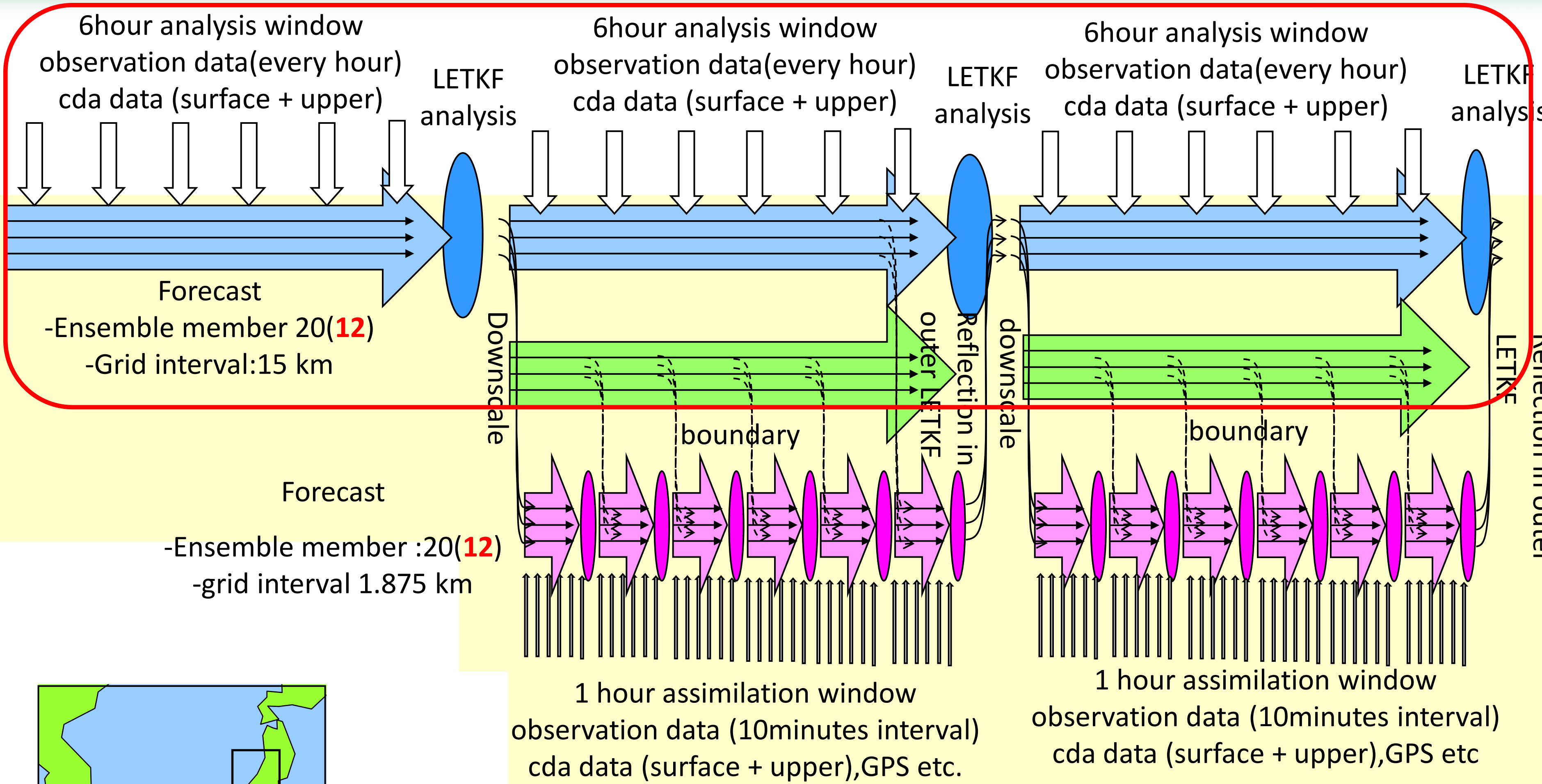
(Kunii, 2014, JMSJ)

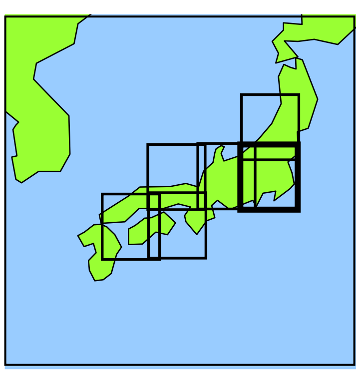
Tornadoes Occurred on 6th May 2012



- *Damage swath; 17km length*
  500m width
- *One person died and 37 injured*
- *More than 1000 houses damaged*

Schematic of the Nested LETKF System





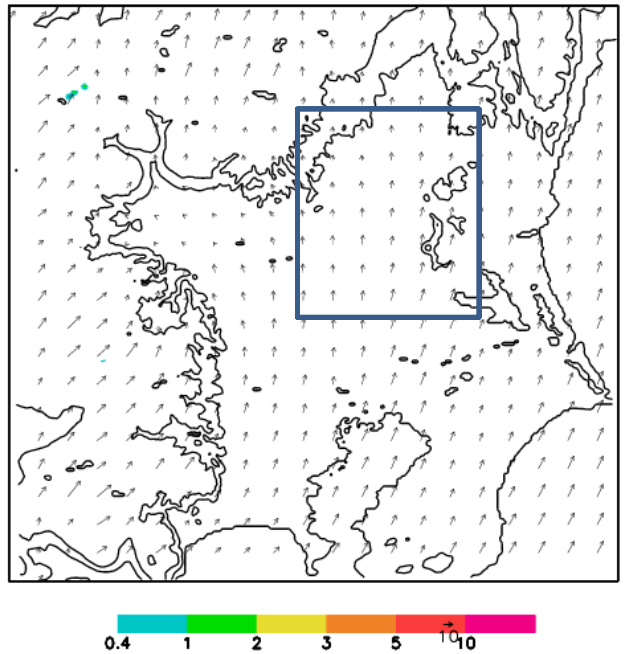
(Seko et al., 2014)

Downscale Experiments with Δx=350m

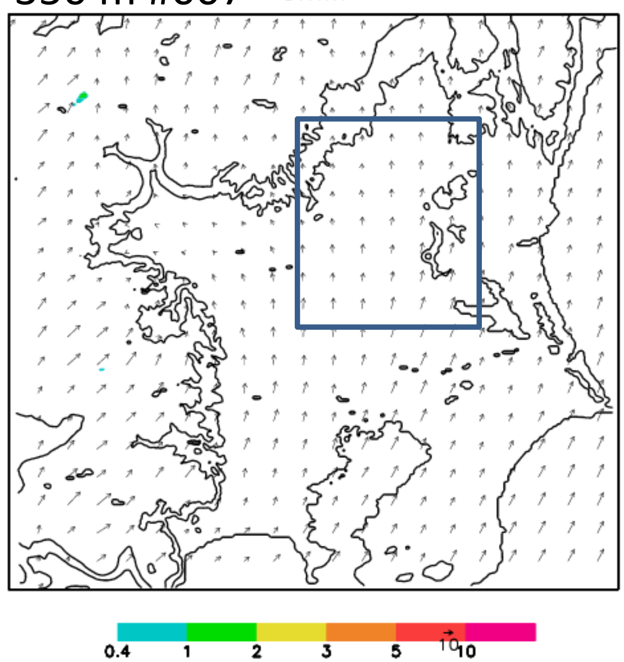
From 1130JST
to 1430JST

#004 :
Intense vortex is reproduced.
#007:
Intense vortex isn't generated.

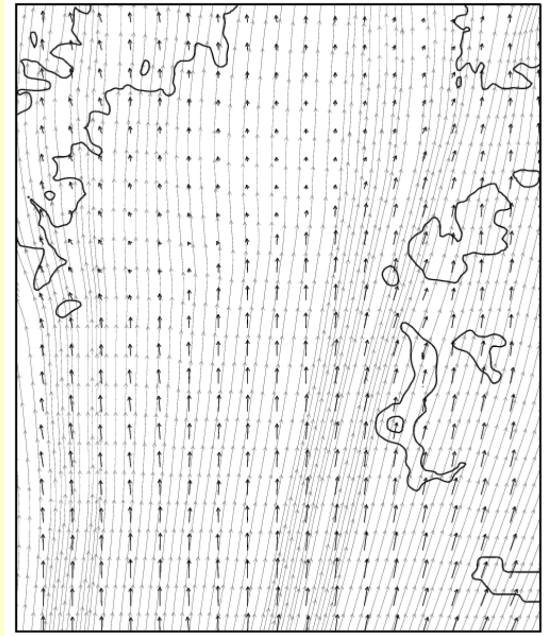
350 m #004 0min



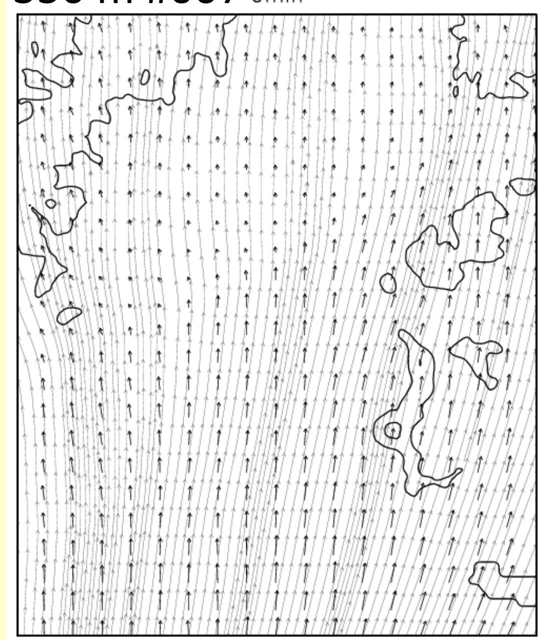
350 m #007 0min



350 m #004 0min

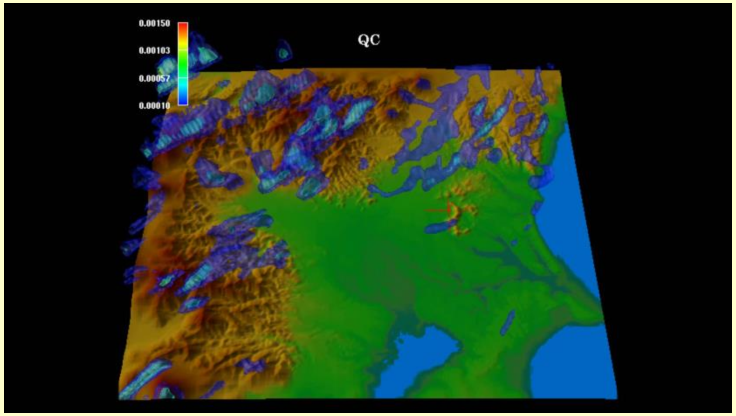


350 m #007 0min

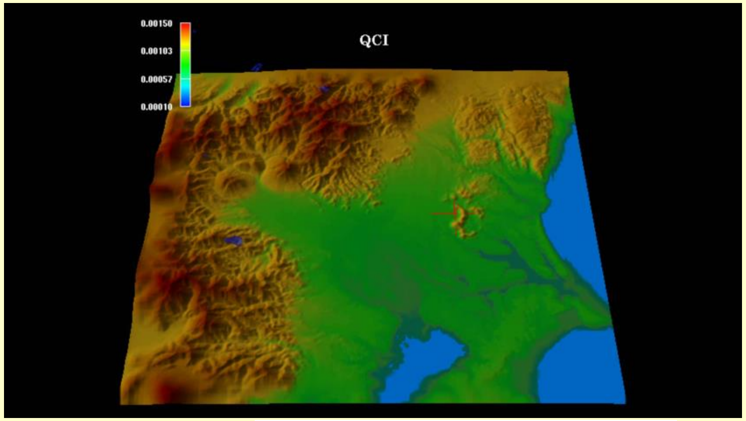


(Seko et al., 2014)

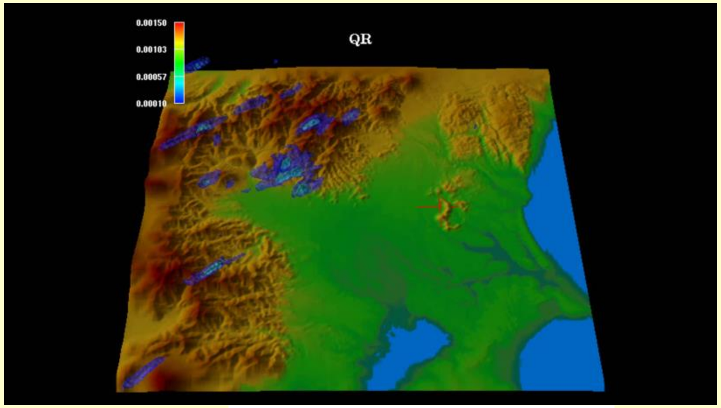
3D Visualization of 350 m simulation of MCS for the 6 May 2012 Tornado case by AVS.



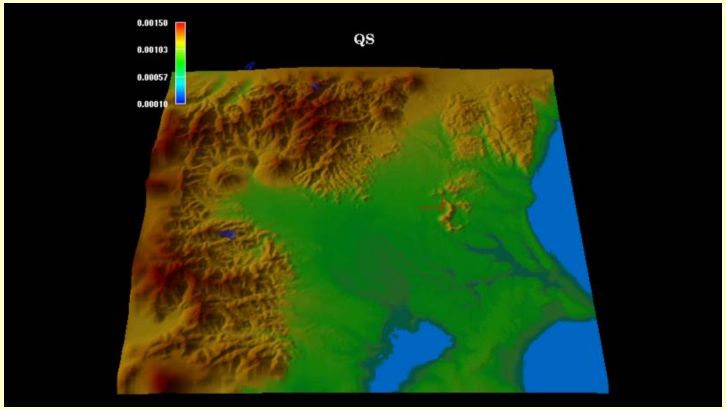
Qc : Could water mixing ratio



Qci : Cloud ice mixing ratio



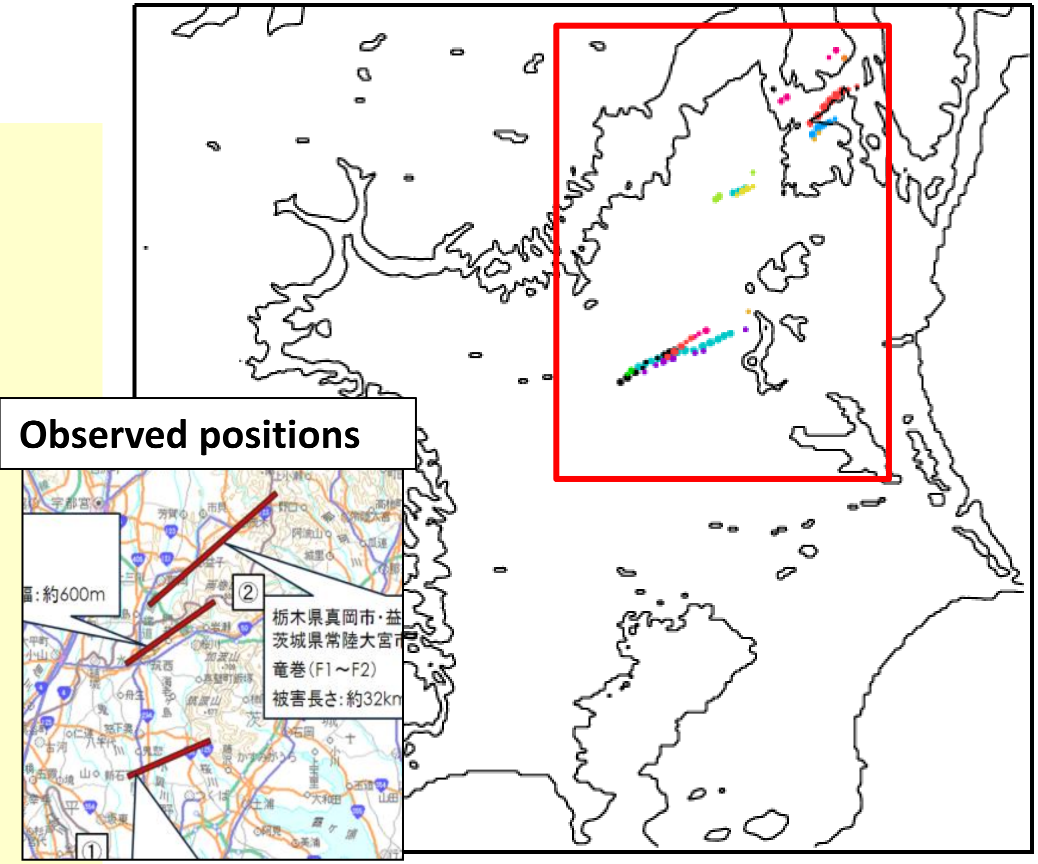
Qr : Rain mixing ratio

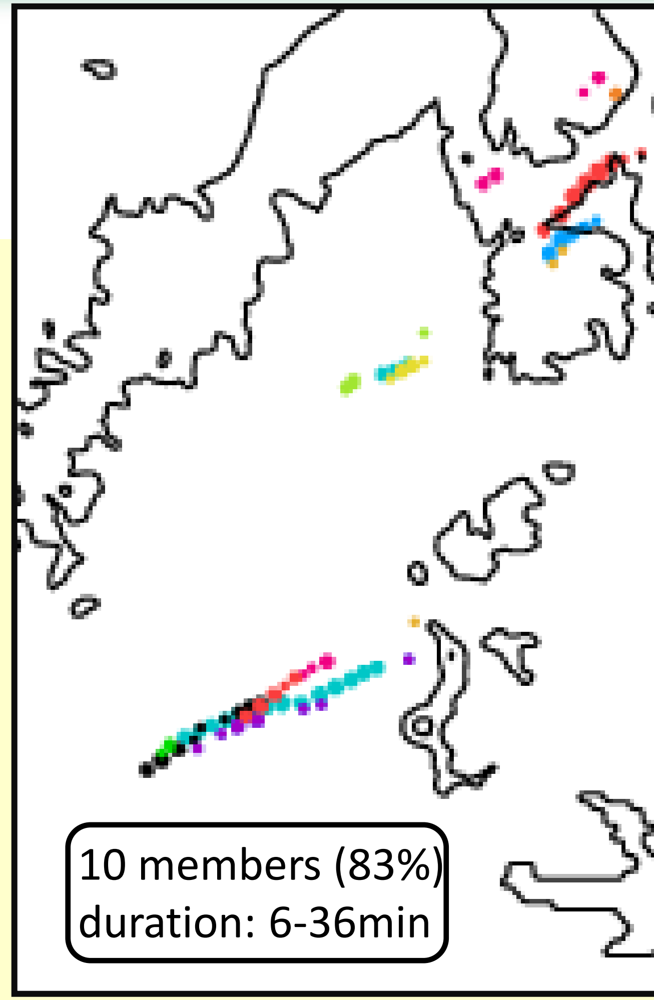


Qs : Snow mixing ratio

Downscale Experiments with Δx=350m

Positions of vortices more than 0.1(1/s)

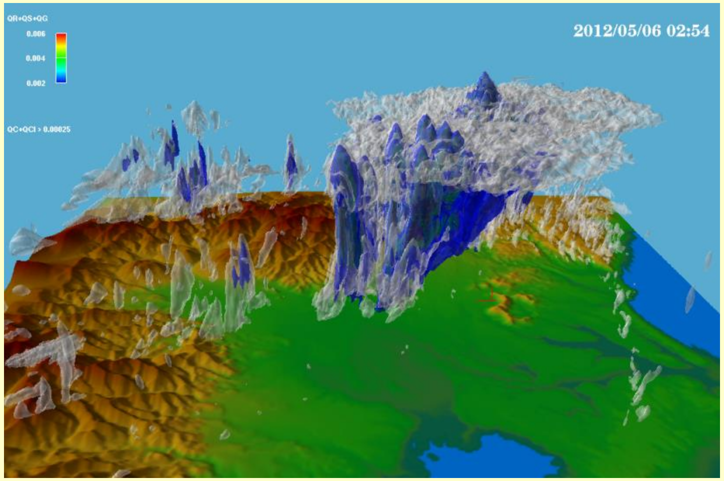




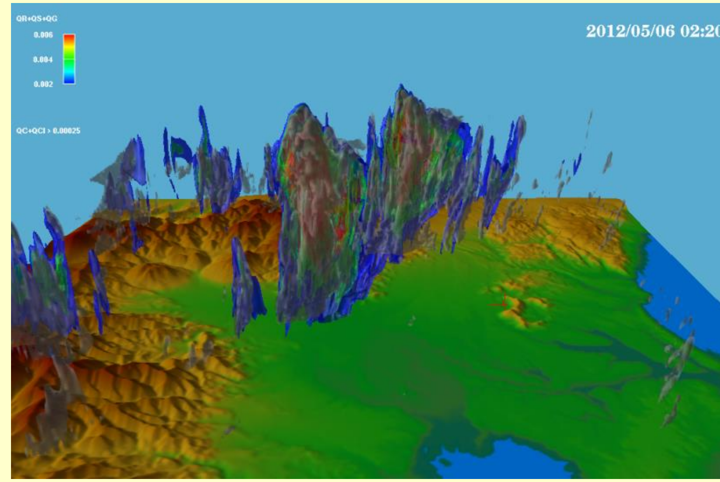
- **Positions and durations differed among the ensemble members.**
- **Tornados occurred in three areas, which were the same as the observations though they were shifted northward by 10 km.**

3D Visualization of 350 m simulation of MCS for the 6 May 2012 Tornado case.

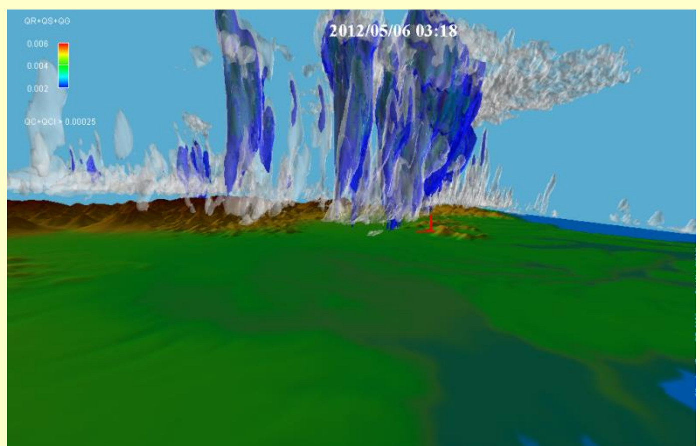
雨混合比(QR+QS+QG)：0.002 ~ 0.006
雲混合比(QC+QCI) : 0.00025



isosurface

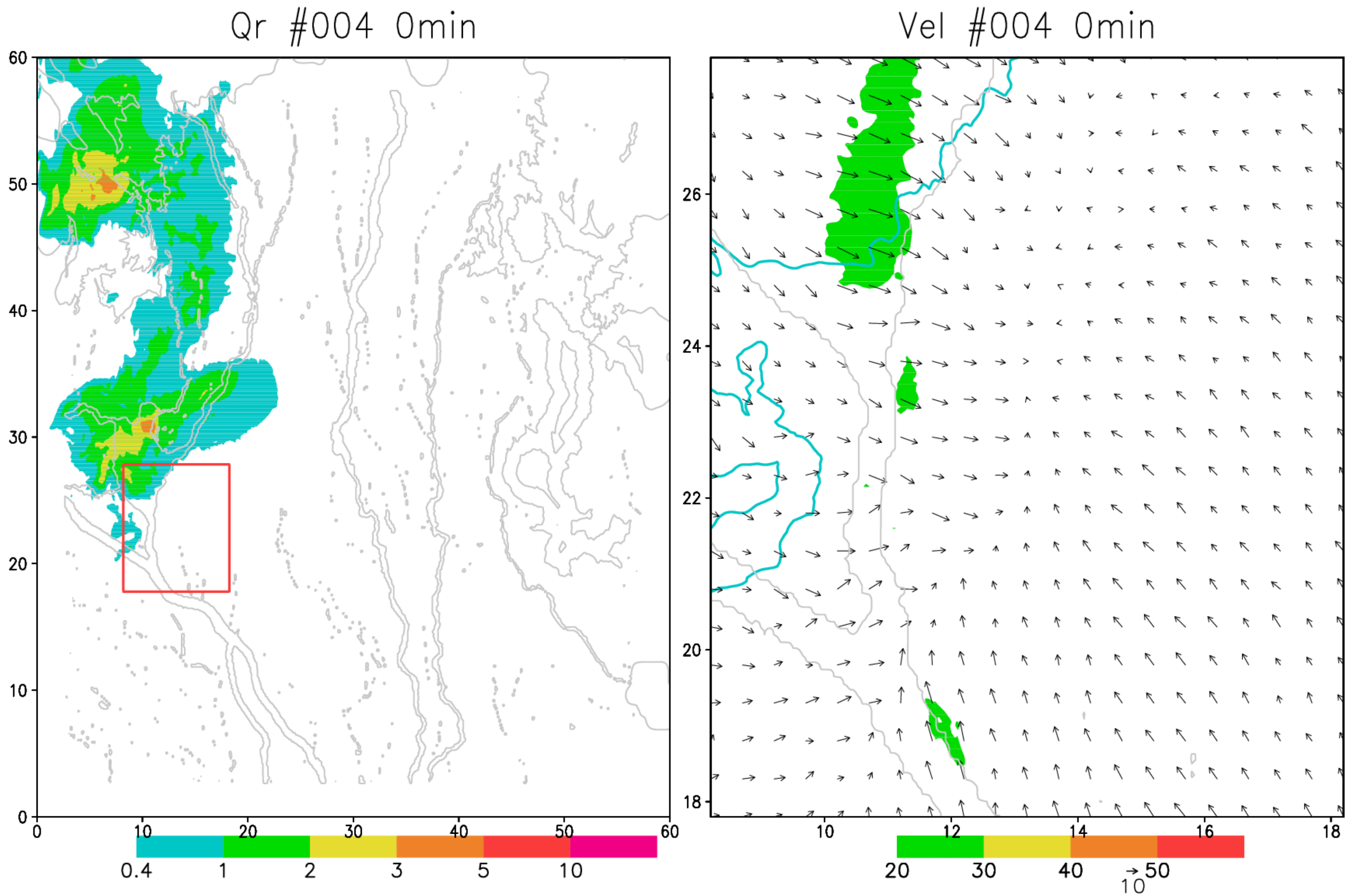


Volume rendering

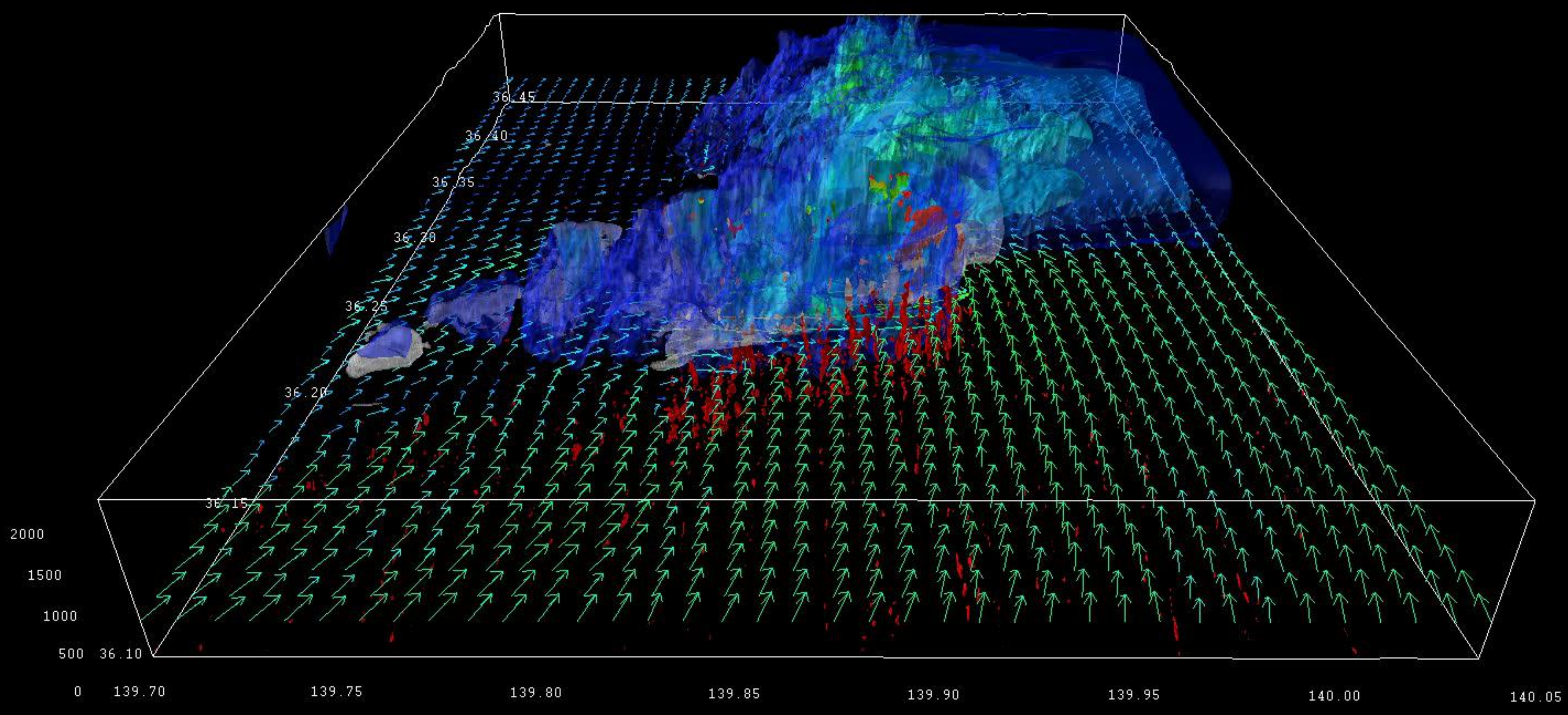


Fly through

Downscale Experiments with Δx=50m



Downscale Experiments with Δx=50m

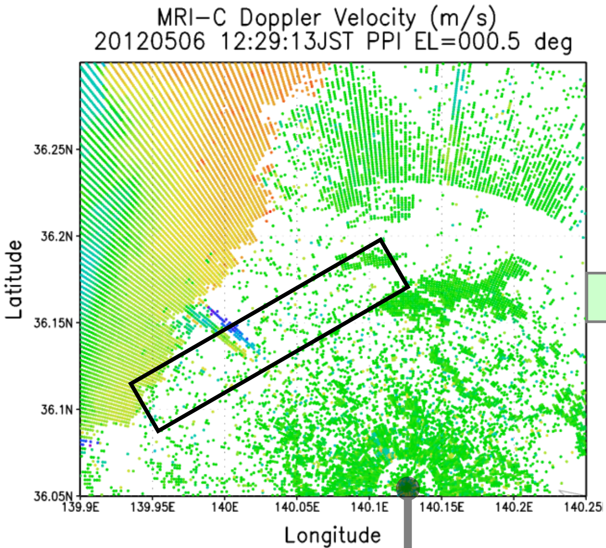


(Produced by Mr. Nishi of Tsukuba Univ.)

2012/5/6 Tsukuba Tornados

MP radar observation at MRI

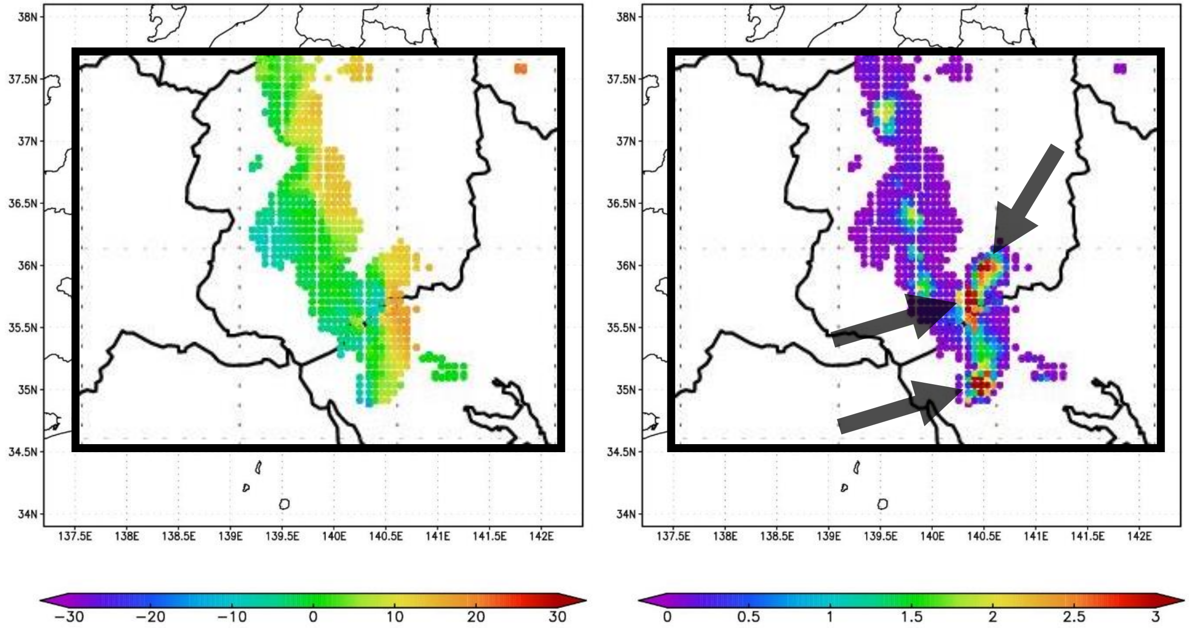
(Yokota et al., 2014)



12:30 JST, elevation 1.0°

Doppler velocity (m s^{-1})

Rain (g m^{-3})
estimated by reflectivity and MP information



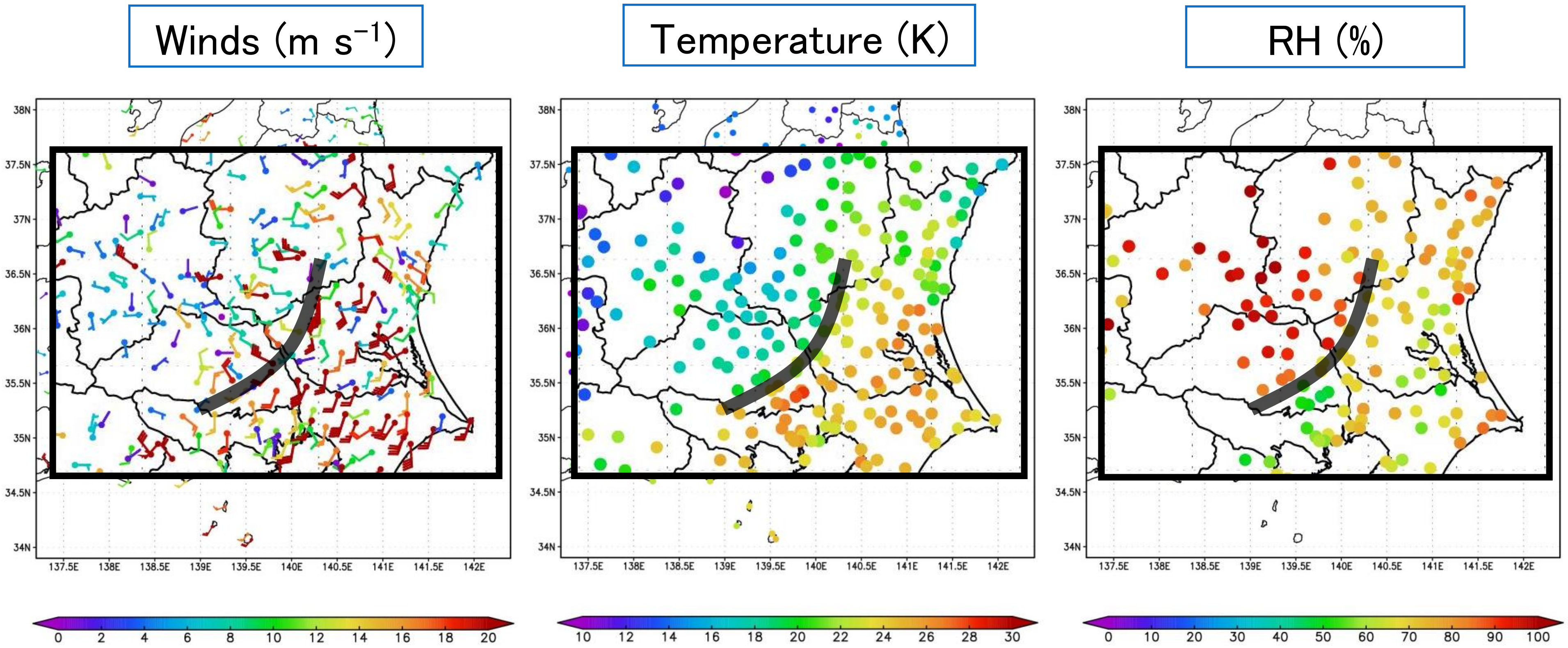
3 peaks corresponding to tornados

MRI MP radar data: courtesy by Meteorological Sattelite and Observation System Research Department of MRI

2012/5/6 Tsukuba Tornados

Surface observations by dense AWS networks

12:30 JST



Shear line is detected

(Yokota et al., 2014)

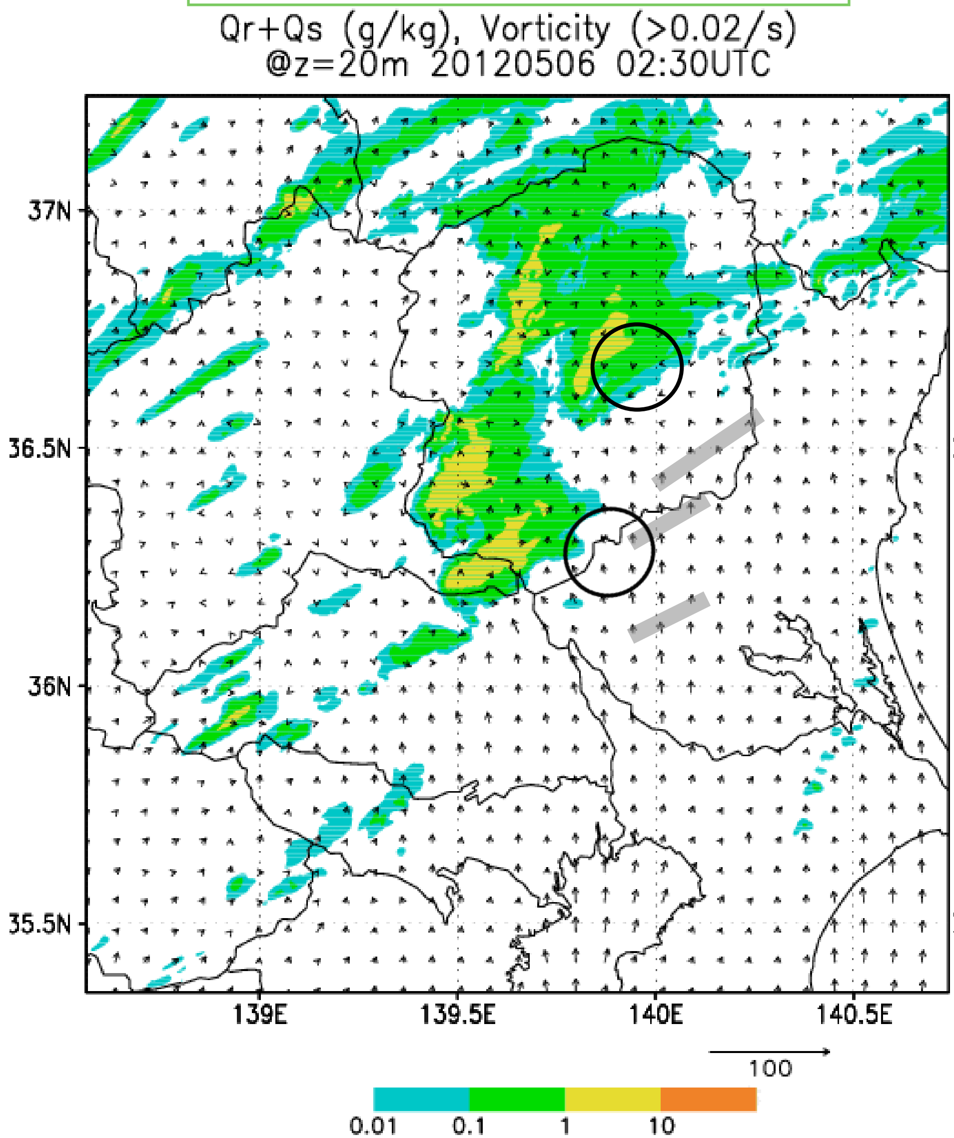
A part of AWS data, courtesy by NTT Docomo

2012/5/6 Tsukuba Tornados

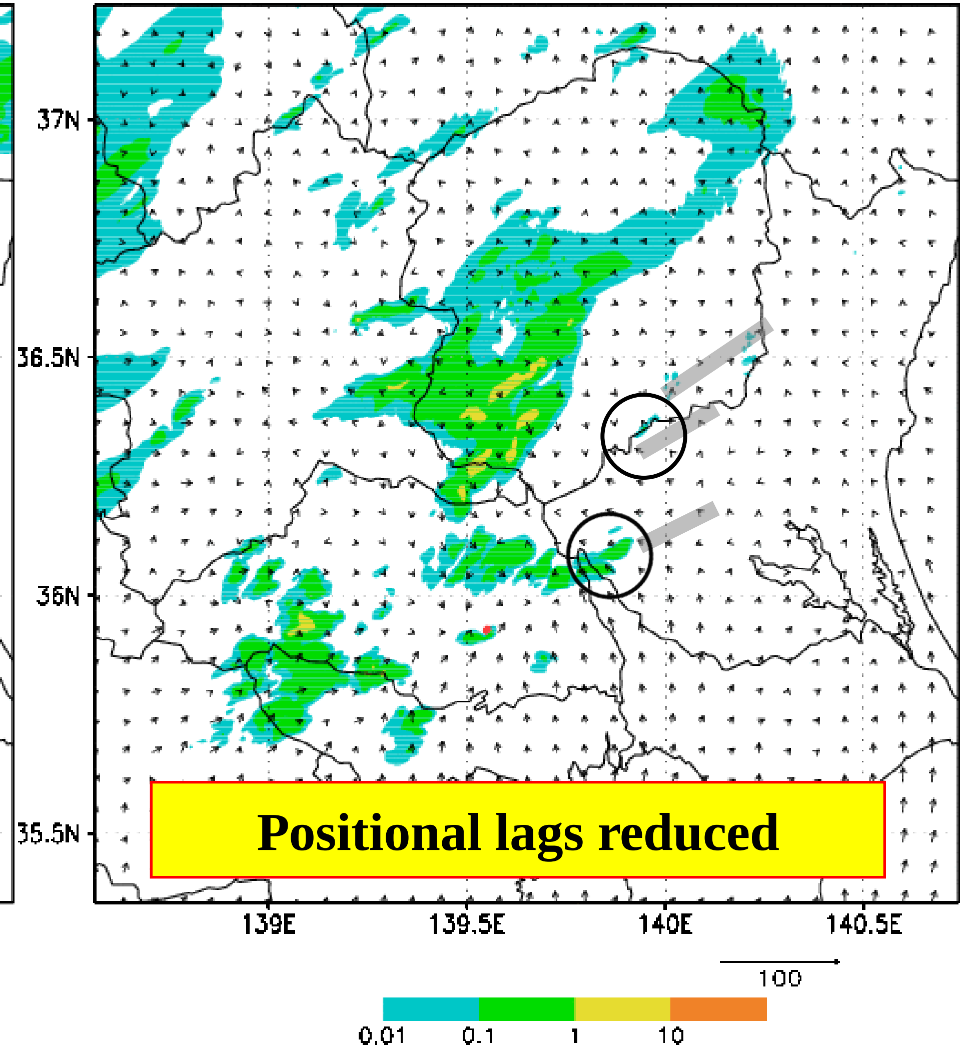
(Yokota et al., 2014)

Impact of high resolution observations

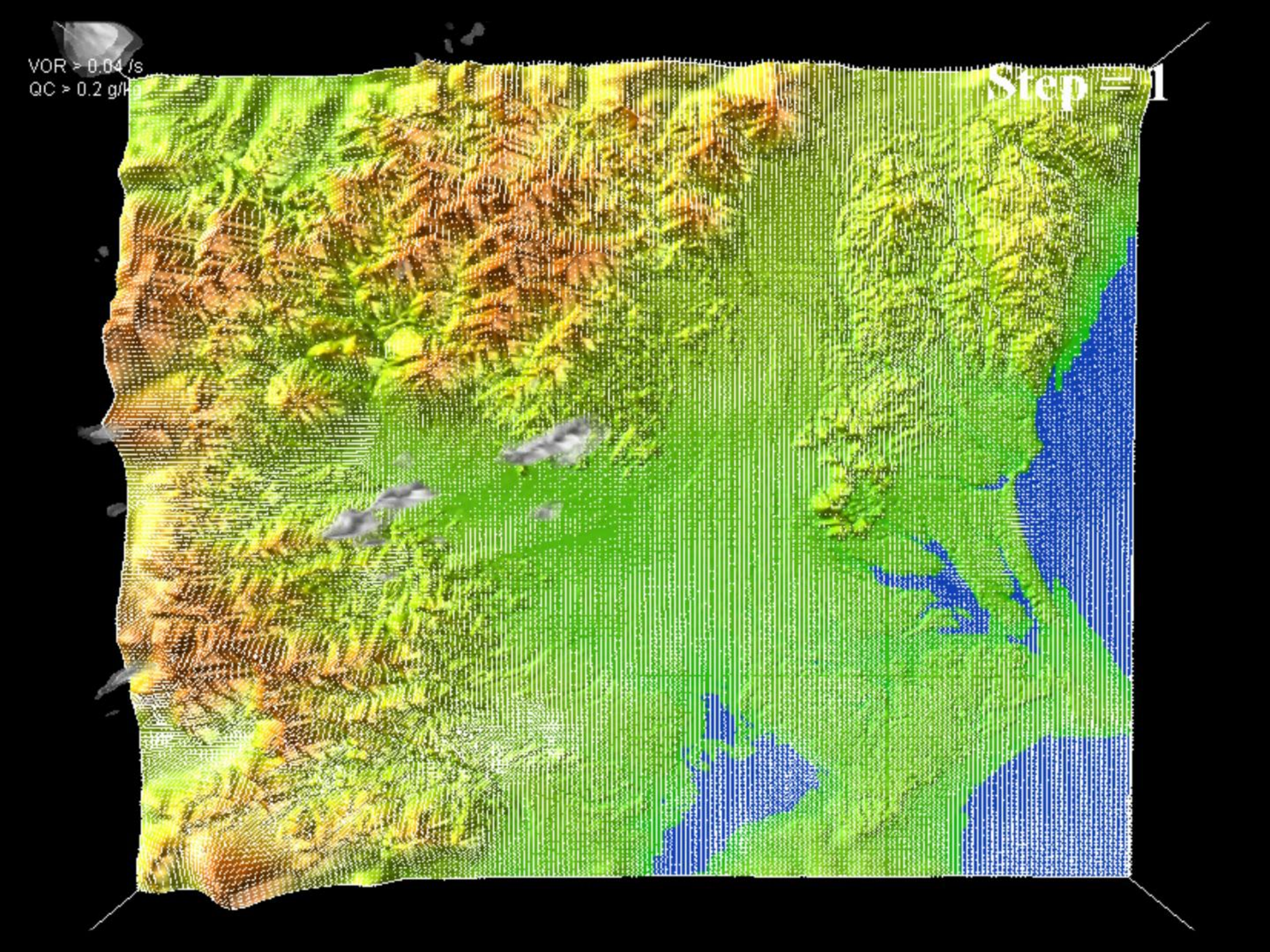
Conventional data only



MRI MP radar and surface AWS networks



Positional lags reduced

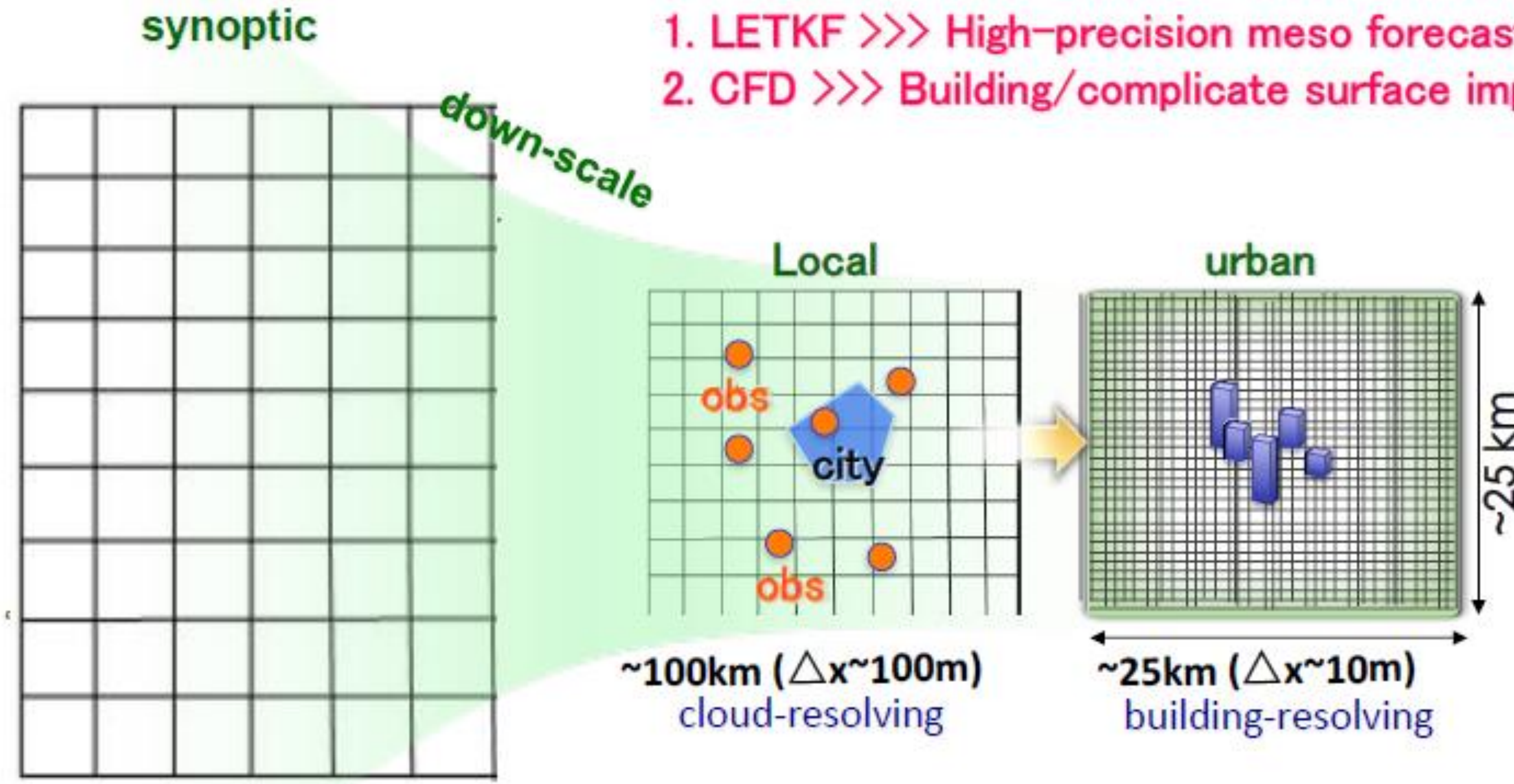

VOR > 0.04 /s
QC > 0.2 g/kg
Step = 1

Amazing pictures of buildings impact

DS^3: 10m-mesh for a urban domain

Chen et al. (2015a; 2015b; Mon. Wea. Rev. in press)

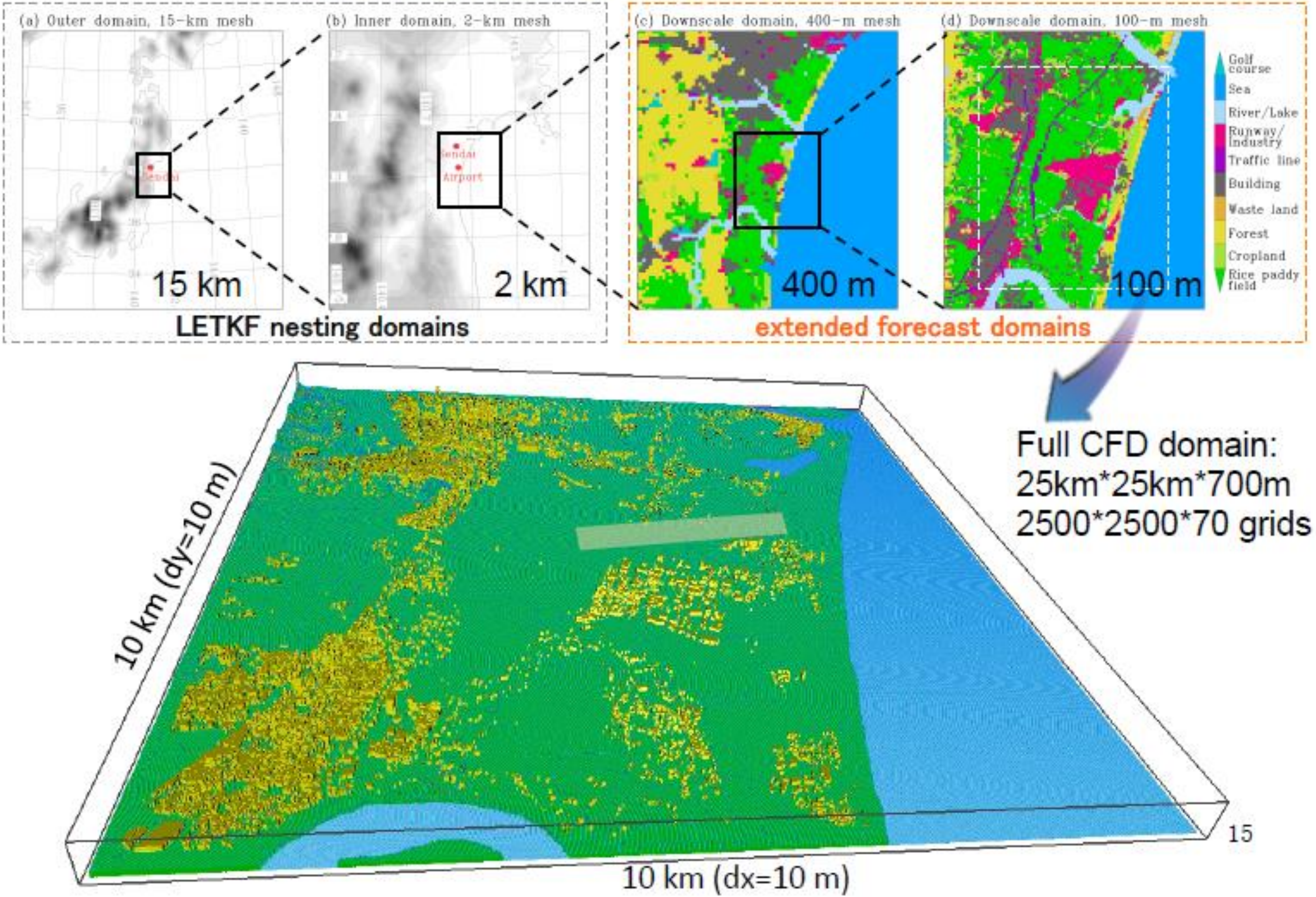
1. LETKF >>> High-precision meso forecast
2. CFD >>> Building/complicate surface impact



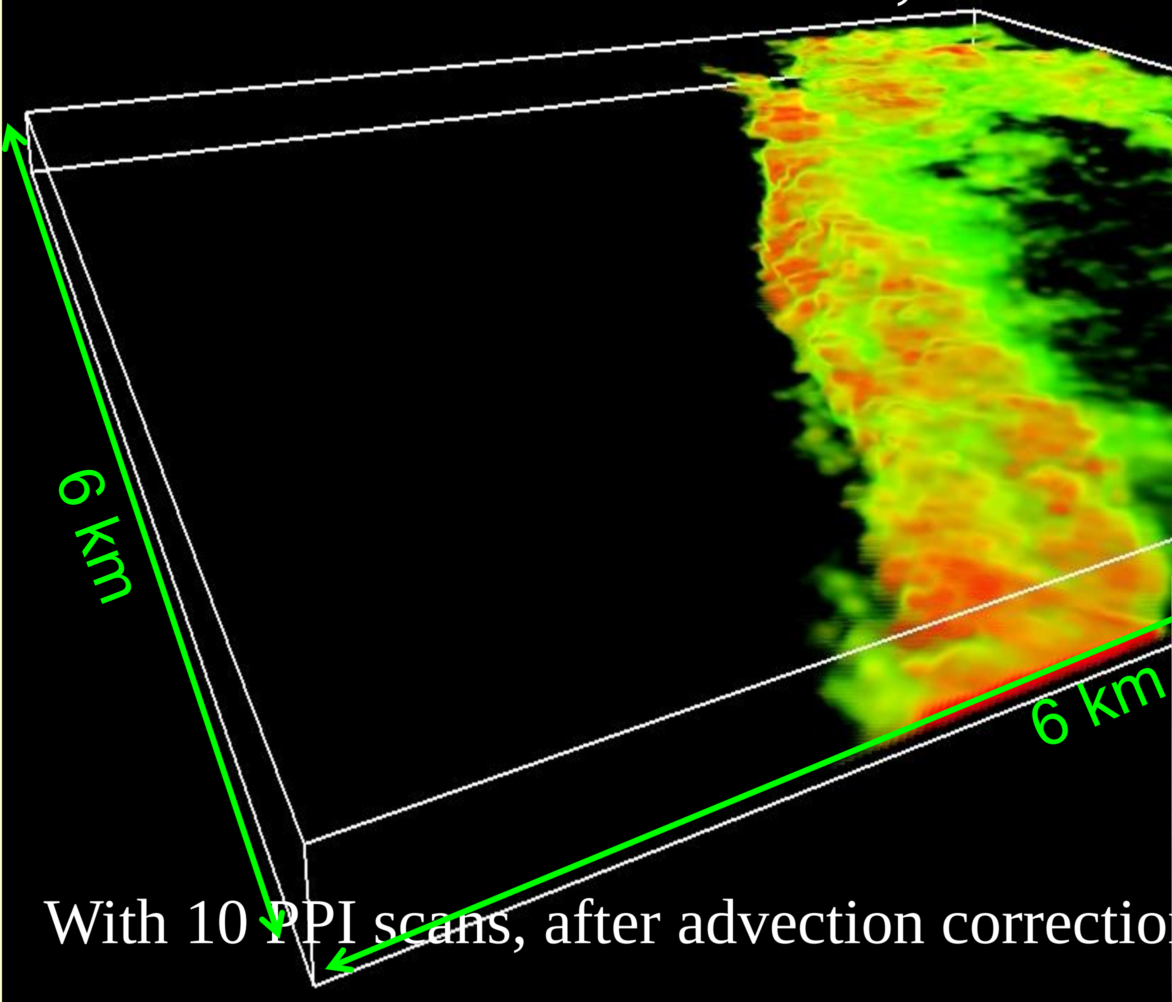
Down-Scaling Simulation System (DS^3) combines JMA-NHM (Saito et al. 2007) + SIMPLERgo (Sha 2008).

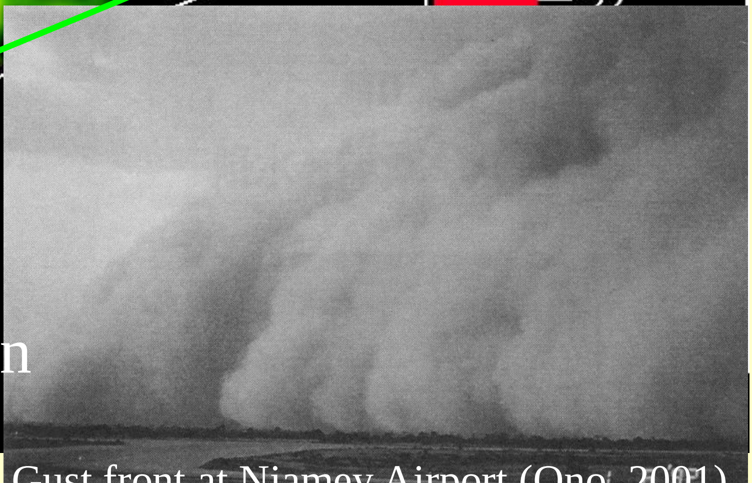
JMA-NHM: JMA Non-Hydrostatic Model
SIMPLERgo: Semi-Implicit Method for Pressure-Linked Equations Revised, Version-1 Code

Domain Setting of DS^3



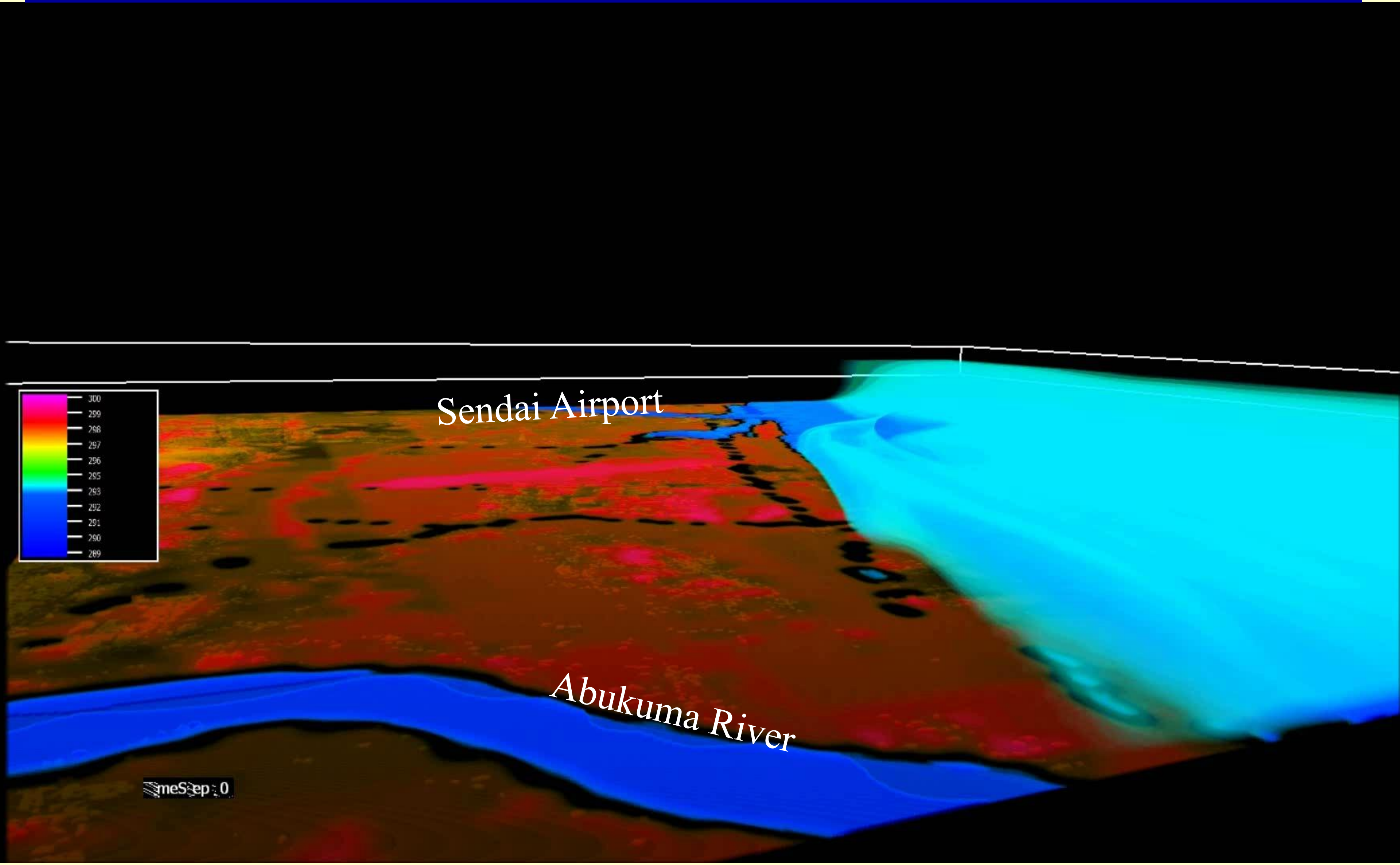
Aerosol concentration (SNR) over Sendai Airport at 16 JST, June 15, 2007




Gust front at Niamey Airport (Ono, 2001)

Chen et al. (2015a; 2015b; Mon. Wea. Rev. in press)

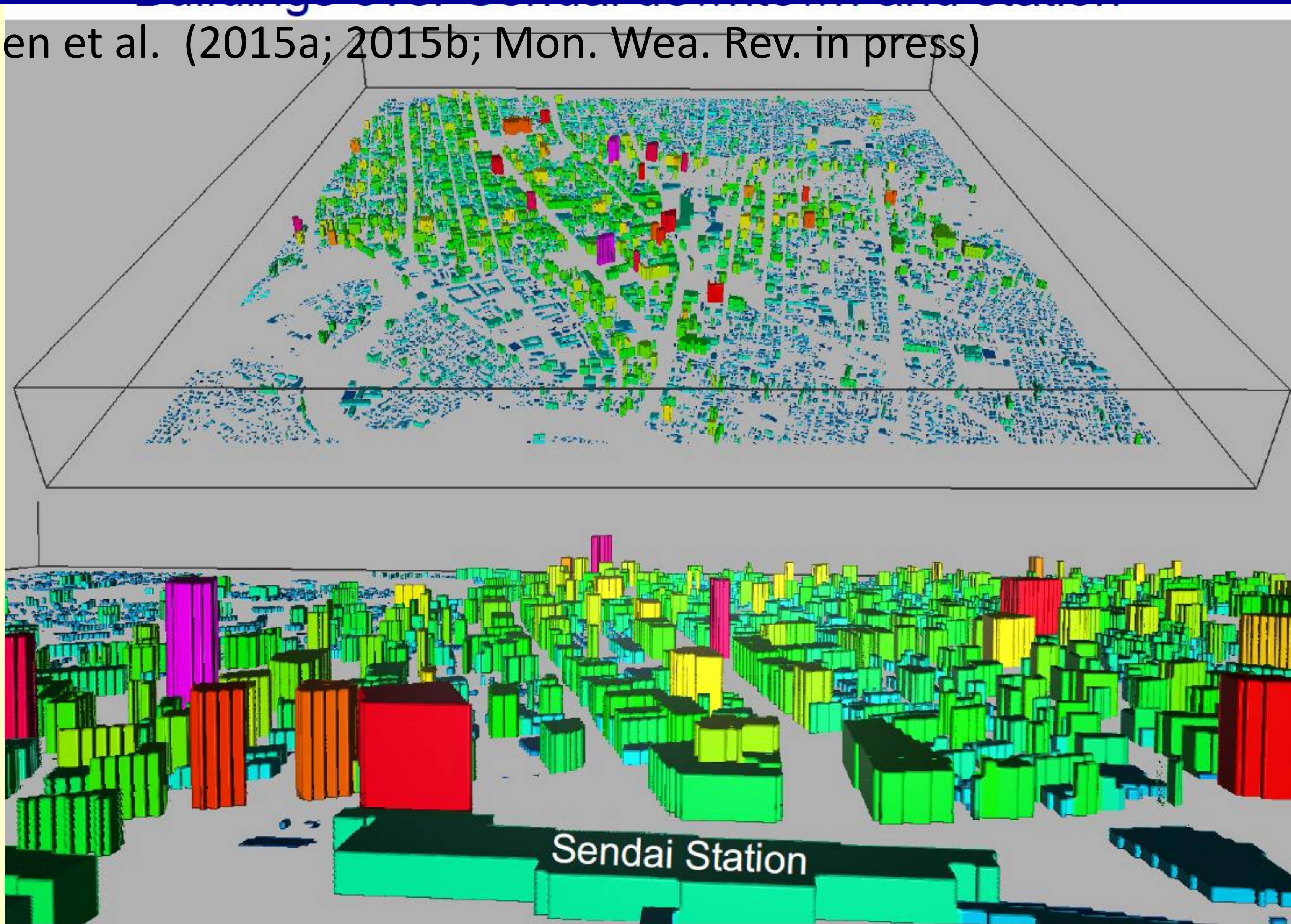
DA assimilation system nested LES with a horizontal resolution of 10 m



Chen et al. (2015a; 2015b; Mon. Wea. Rev. in press)

Building resolving LES with a horizontal reolsution of 3 m

Chen et al. (2015a; 2015b; Mon. Wea. Rev. in press)



Building resolving LES with a horizontal reolsution of 3 m

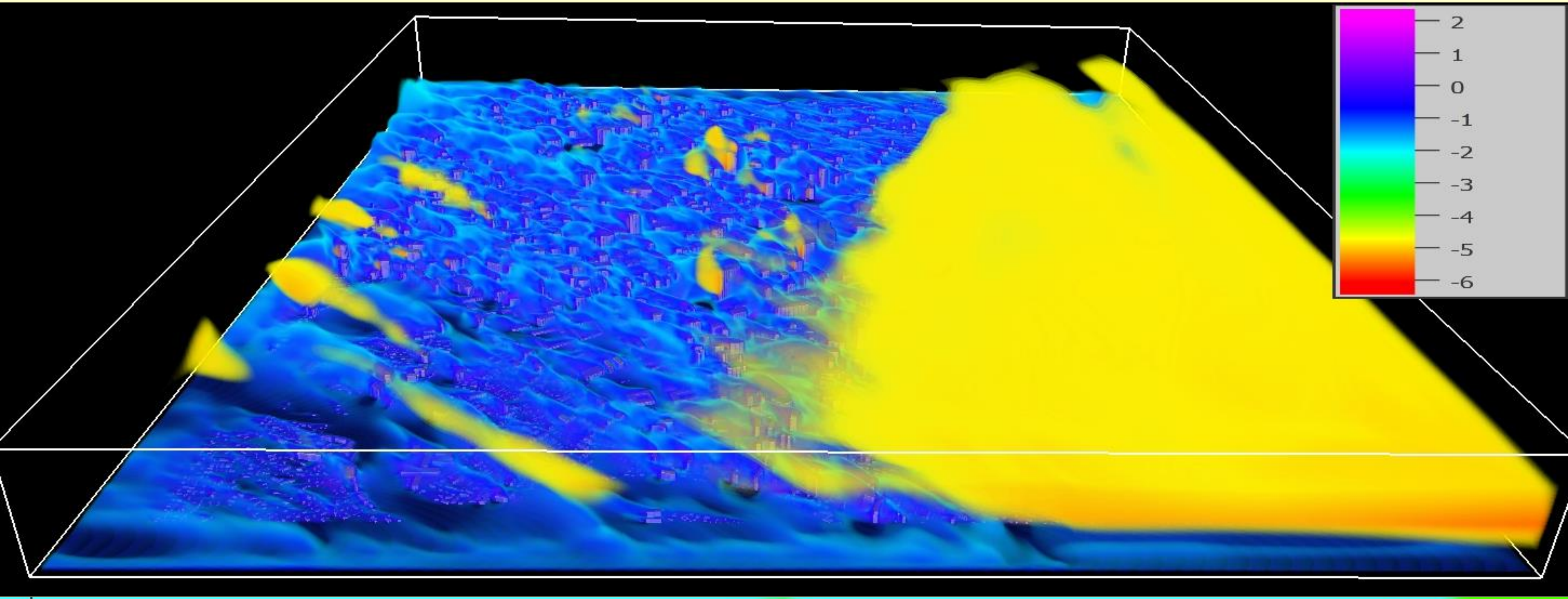
Experiment Settings

Grids: 5000x5000x200 (5 billion)
Resolution: 3 m
Forecast time: 520 sec
Output step: 20 sec (93GB per step)
Initiation/boundary conditions:
Forecast fields at 9:50 JST, June 19, 2007.
Test cycle: 2 (w/o buildings) x 2 (initial times)

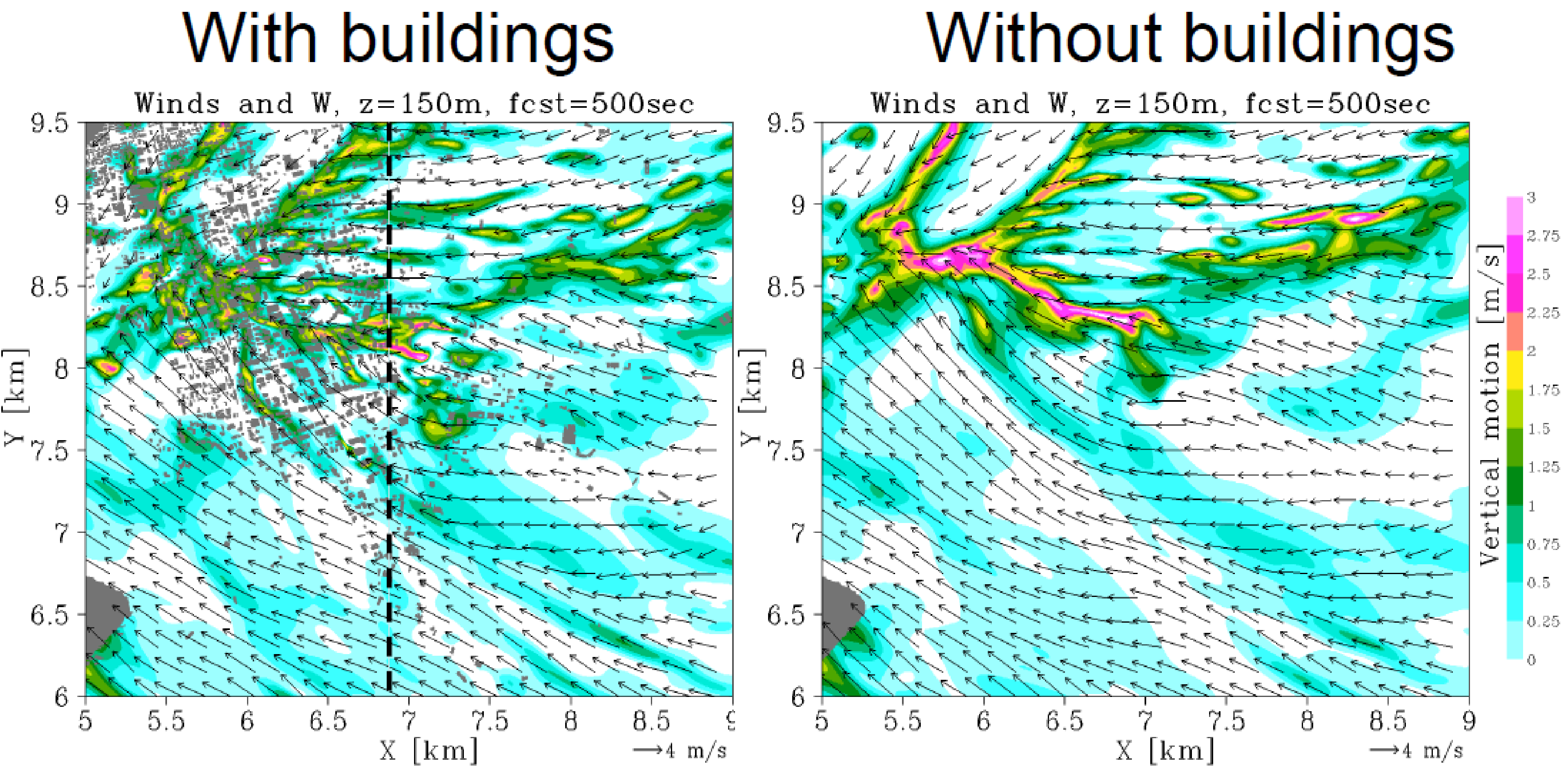
Maximum Node: 4608 (400) on K computer
Elapse time: 7 h (18 h)

Chen et al. (2015a; 2015b; Mon. Wea. Rev. in press)

Top: U wind over downtown; Bottom: Temperature near station



Wind fields at z=150 m ASL, fcst=500 sec

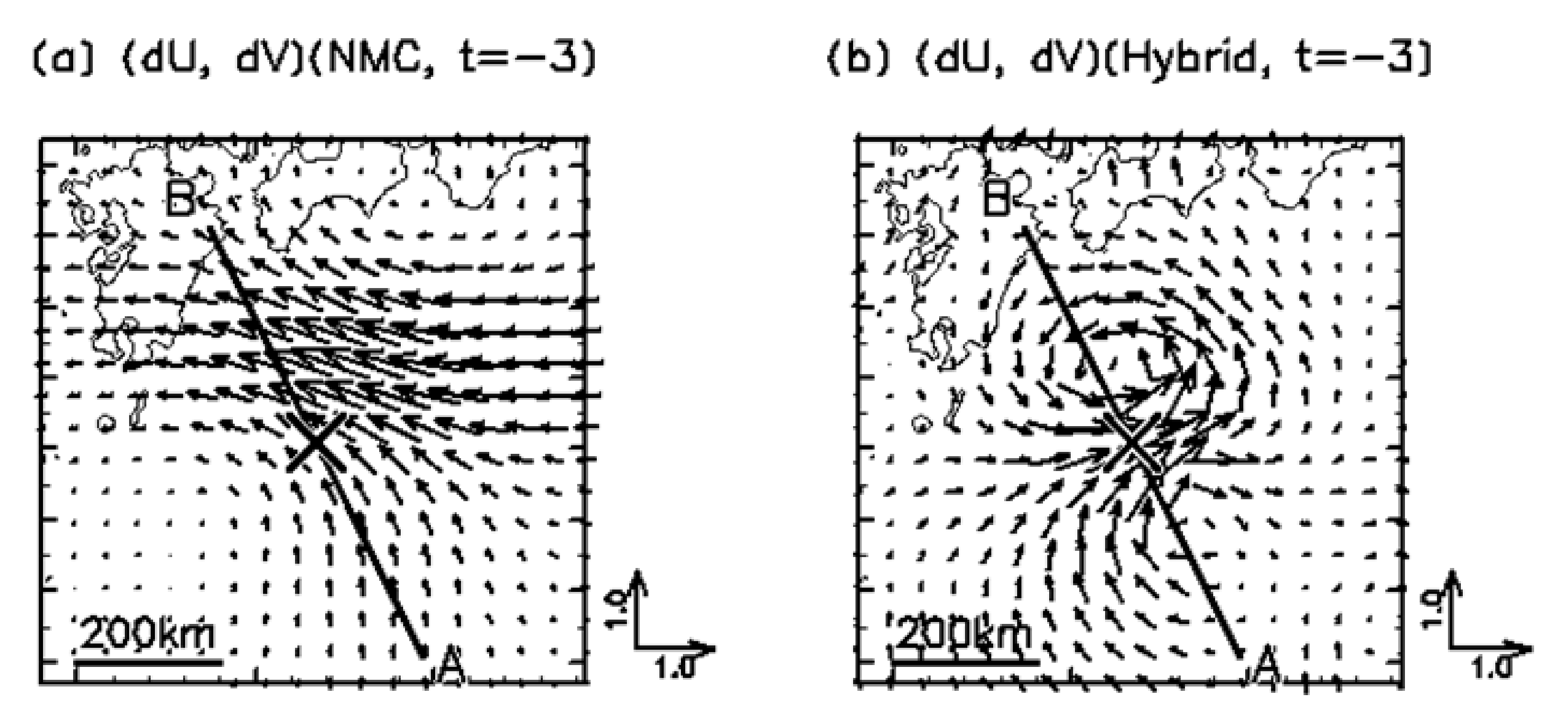


Chen et al. (2015a; 2015b; Mon. Wea. Rev. in press)

Hybrid NHM-4DVAR (Ito et al. 2015; MWR submitted)

・Response to a single easterly wind observation in the north of a typhoon

・Analysis increment of horizontal wind(t=0, z=1120m)

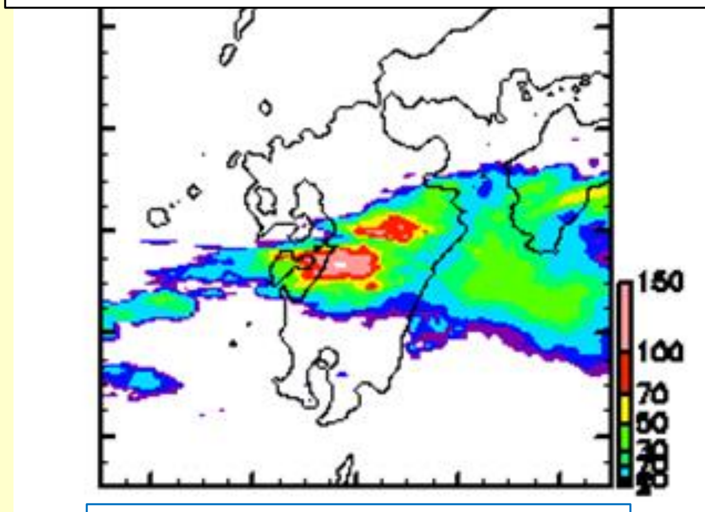


Analysis increment independent from typhoon structure vortex

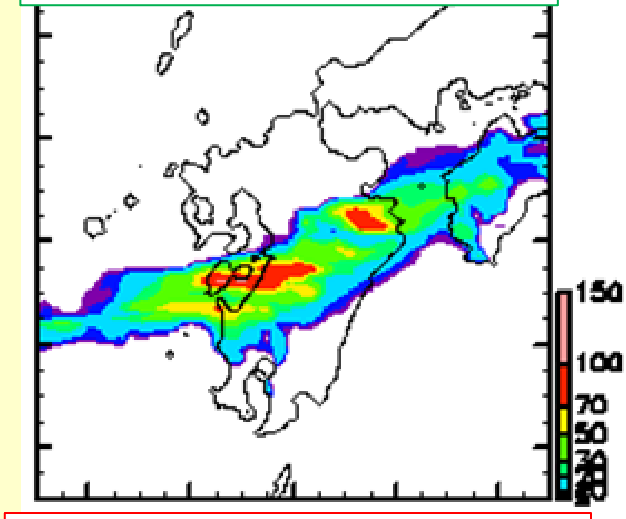
Analysis increment to shift the typhoon vortex southward

Hybrid 4DVAR for 2011 Northern Kyushu heavyrainfall case (Ito et al., 2015)

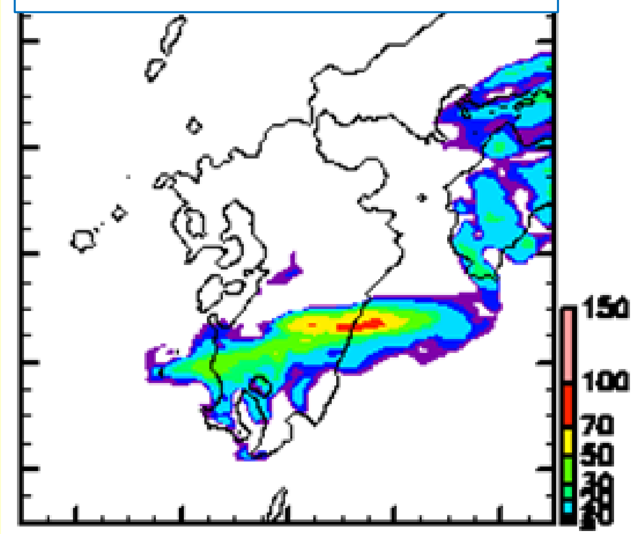
Observation (7/12 06-09LST)



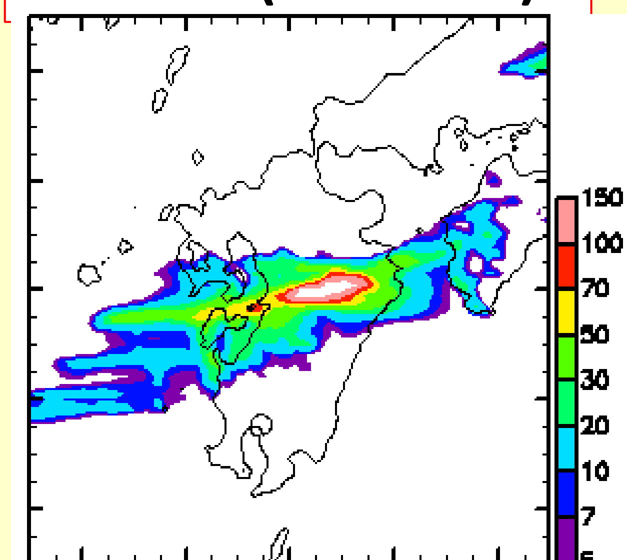
LETKF(FT=15-18)

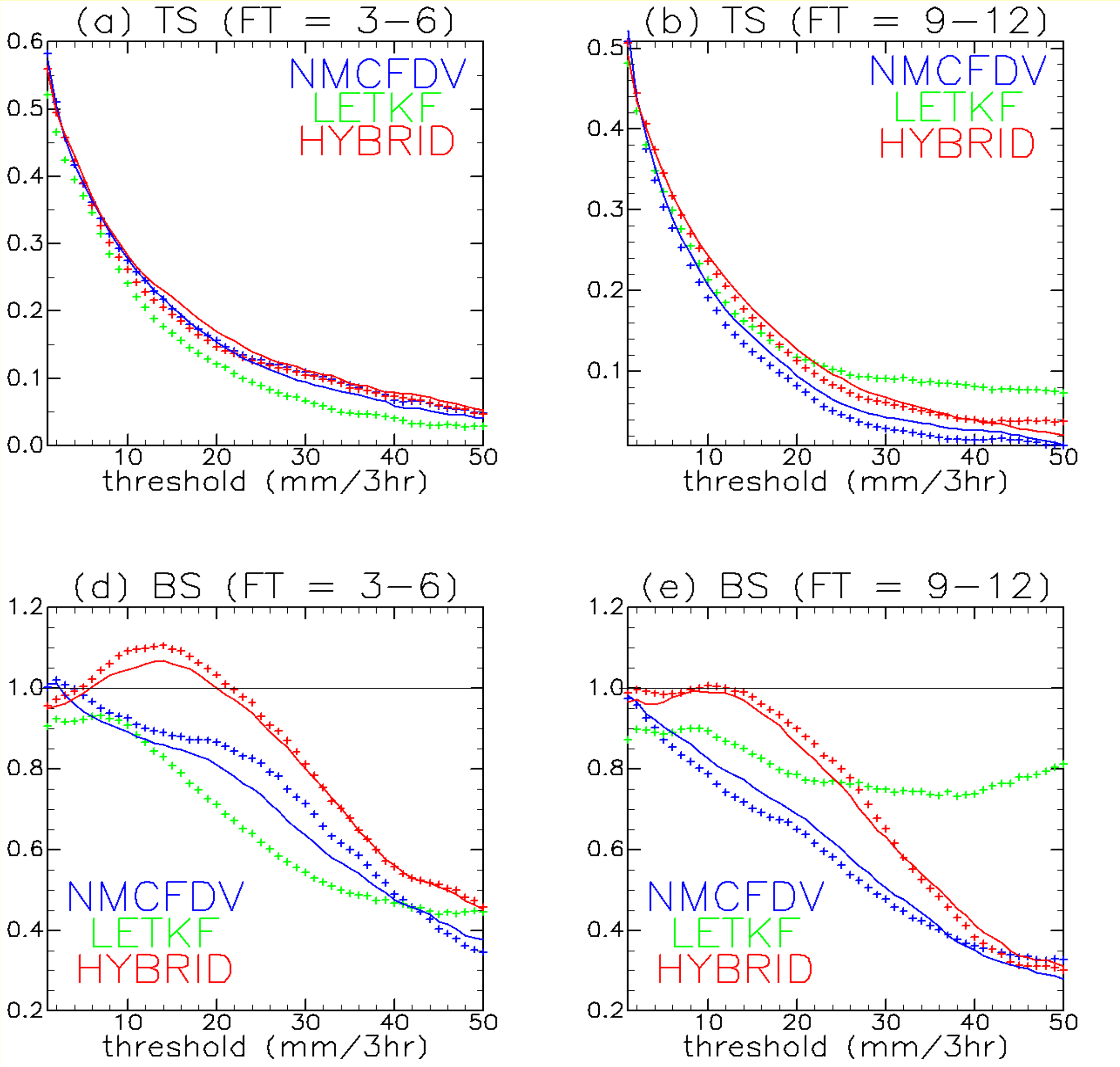


NMC(FT=15-18)



HYBRID(FT=15-18)





Ito et al. 2015; MWR submitted

Presentation [6-4] by Kosuke Ito

Cloud resolving data assimilation systems at SPIRE

NHM-4DVar (MRI, JAMSTEC)

NHM-LETKF (MRI, NPD, JAMSTEC)

NHM-EnsVar (MRI) posters ([p-17]Yokota, [p-31]Origuchi)

NHM-Hybrid EnKF-4DVar (MRI, JAMSTEC)

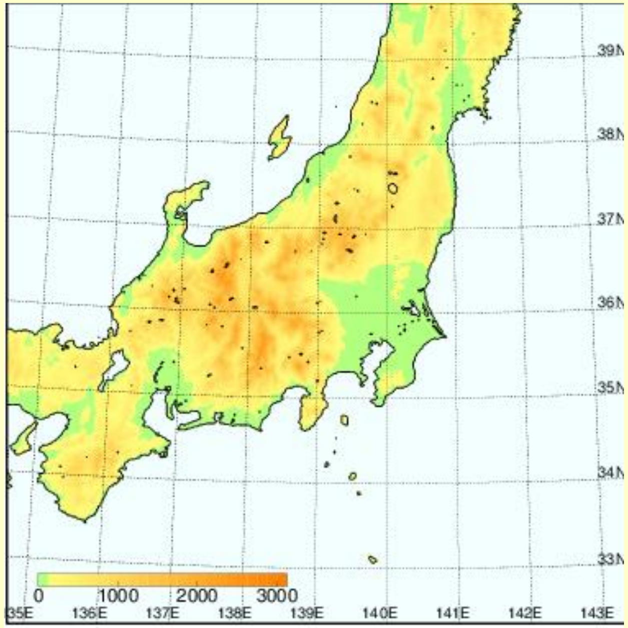
CReSS-Hybid 3DVAR (NIED)

NHM-perticle Filter (ISM)

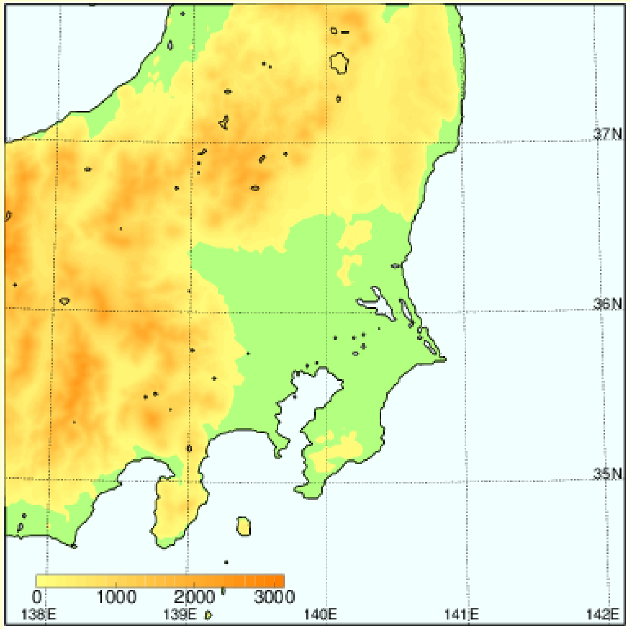
	Adjoint model	**Cost function**	**Ensemble**
3DVAR	No need	minimize	No use
4DVAR	necessary	minimize	No use
EnsVAR	No need	minimize	use
LETKF	No need	No need	use
Hybrid 3DVAR	No need	minimize	use
Hybrid 4DVAR	nesessary	minimize	use

DA intercomparison

- 2 km horizontal resolution
- 200x200 grid for data assimilation domain
- Initial guess JMA Mesoscale analysis
- Lateral boundary condition from 2 km NHM downscaling using JMA Msoscale analysis and global model (GSM) forecast
- Rainfall event in TOMACS IOP case (e.g., 18 July 2013)



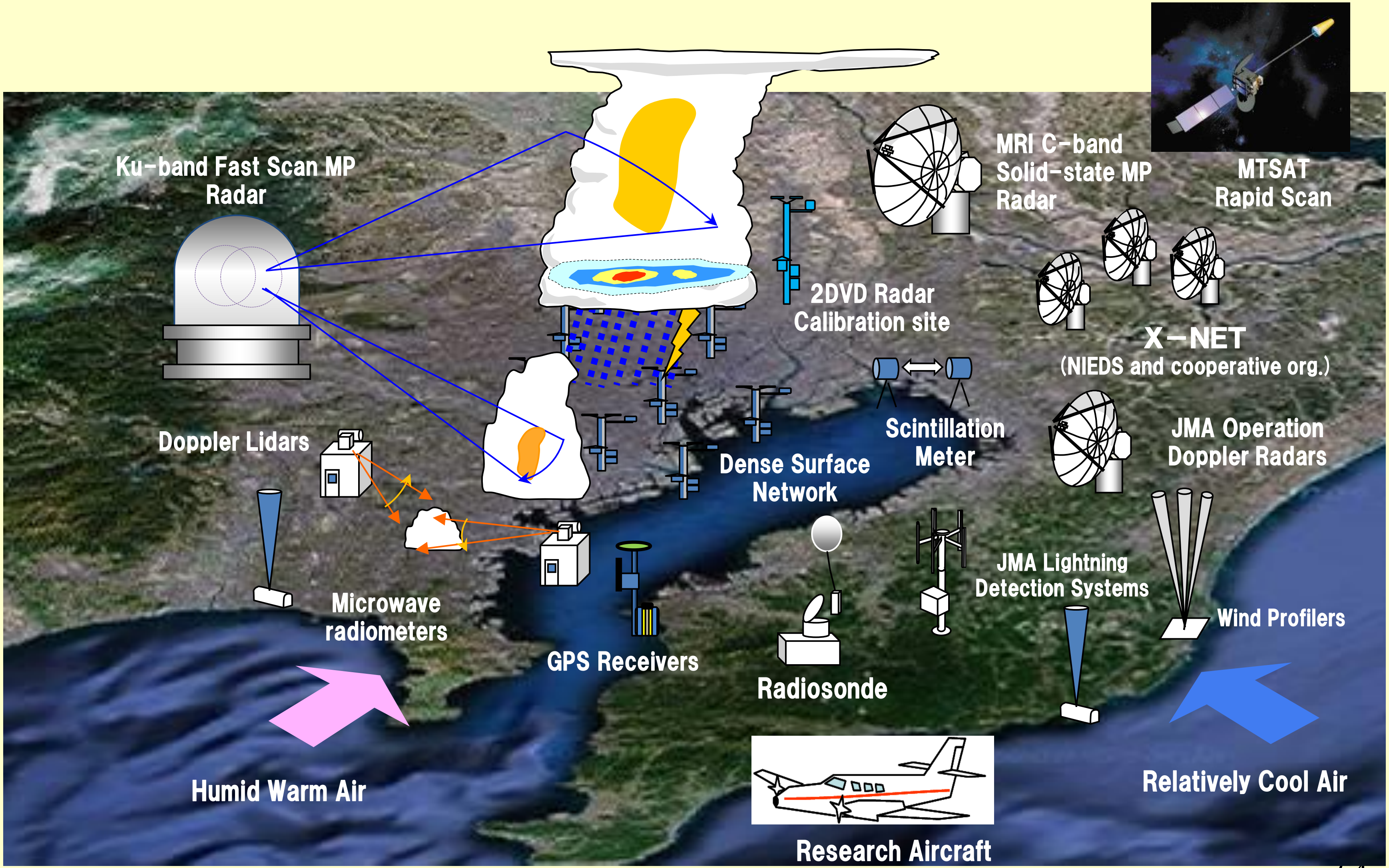
Lateral boundary condition : 400x400



First guess : 200x200

Tokyo Metropolitan Area Convection Study

A field campaign in the Tokyo metropolitan area with a dense observation network (TOMACS) was conducted by MRI, NIED and 12 research groups for the summers of 2011-2013.



WWRP RDP proposal

In July 2013, a part of the project was endorsed as a new RDP of WWRP.

WWRP RDP Science Plan: Tokyo Metropolitan Area Convection Study for Extreme Weather Resilient Cities (TOMACS)

Proposers:

T. Nakatani[1], Y. Shoji[2], R. Misumi[1], K. Saito[2], N. Seino[2], H. Seko[2], Y. Fujiyoshi[3] and I. Nakamura[4]

Institutions

[1] National Research Institute for Earth Science and Disaster Prevention

[2] Meteorological Research Institute

[3] Hokkaido University

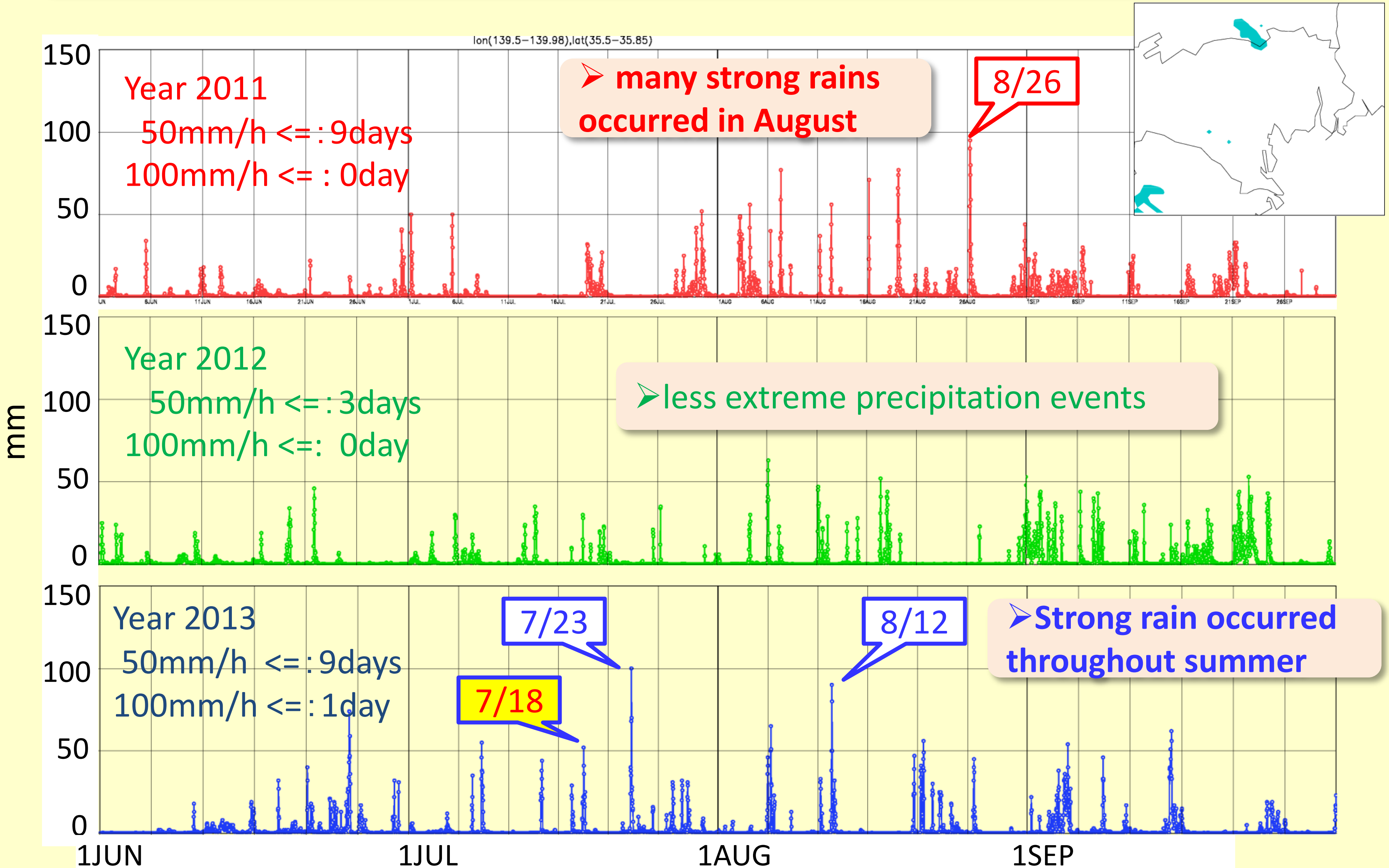
[4] Toyo University

1. Project Summary

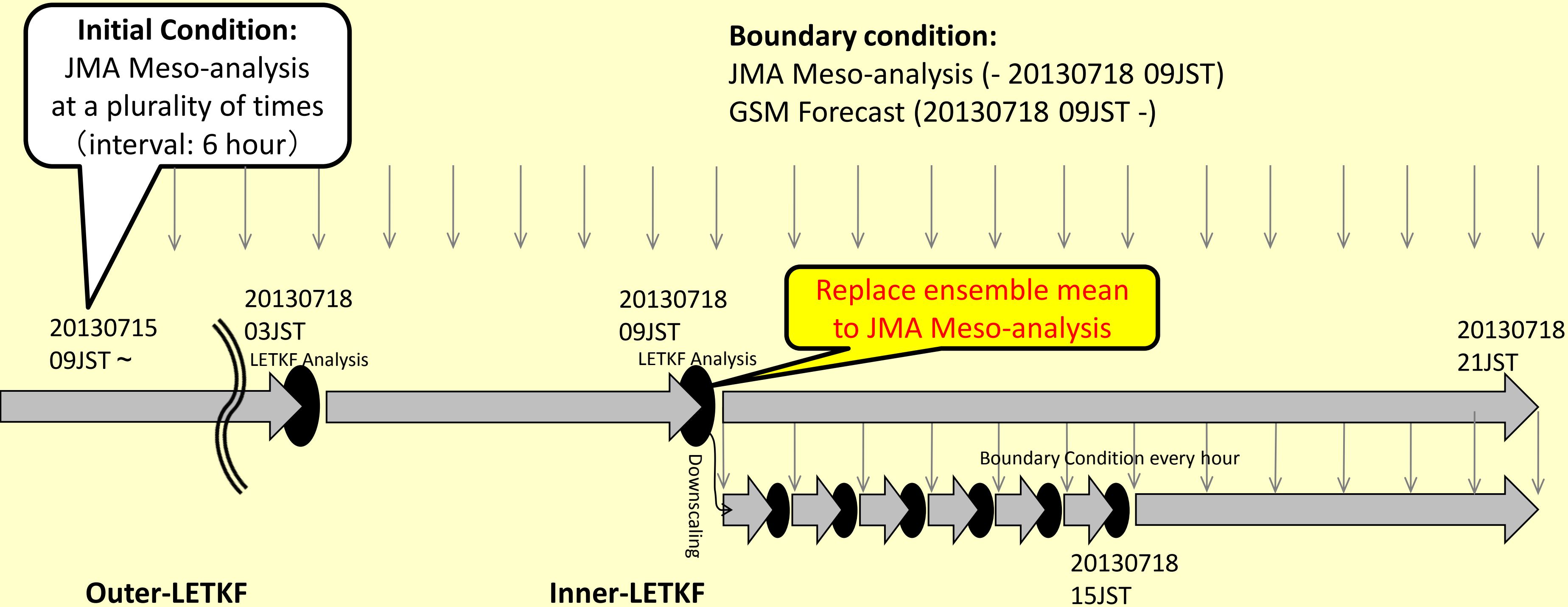
An unprecedented dense observation campaign and relevant modeling and societal studies have been conducted since April 2010 by the National Research Institute for Earth Science and Disaster Prevention (NIED), Meteorological Research Institute (MRI), and more than 25 national institutions and universities in Japan that target local high-impact weather (LHIW) in the Tokyo metropolitan area. The objectives of the project, the Tokyo Metropolitan Area Convection Study for Extreme Weather Resilient Cities (TOMACS), include the 1) elucidation of the mechanism of LHIW in urban areas (e.g., local torrential rain, flash flood, strong wind, lightening), 2) improvement of nowcasting and forecasting techniques of LHIW, and 3) the implementation of high resolution weather information to end-users through social experiments. This proposal describes a science plan of the project as the Research and Development Project (RDP) of the World Weather Research Programme (WWRP) of the World Meteorological Organization (WMO).

http://www.wmo.int/pages/prog/arep/wwrp/new/documents/Doc4_6_TOMACS_RDP_proposal_20130704.pdf

Maximum 1 hour precipitation during TOMACS IOP



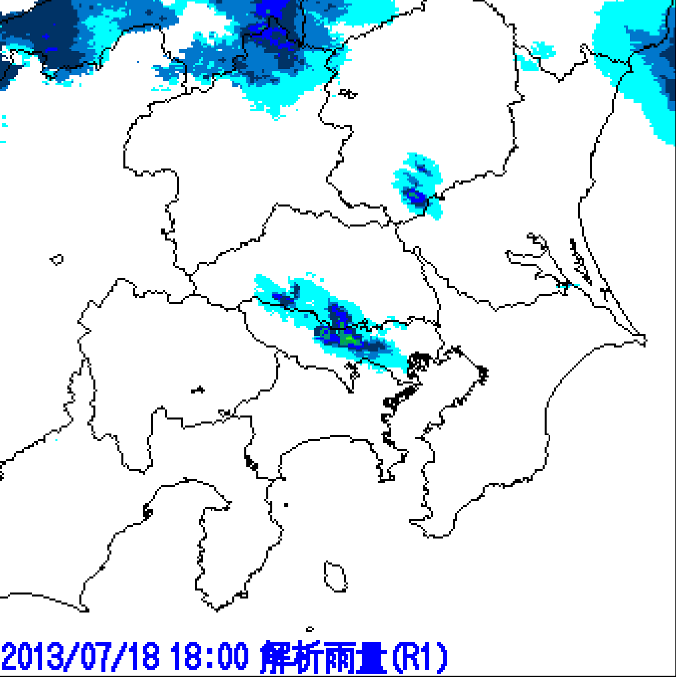
Preliminary experiments using NHM-LETKF for the 18 Jul 2013 case by Sho Yokota

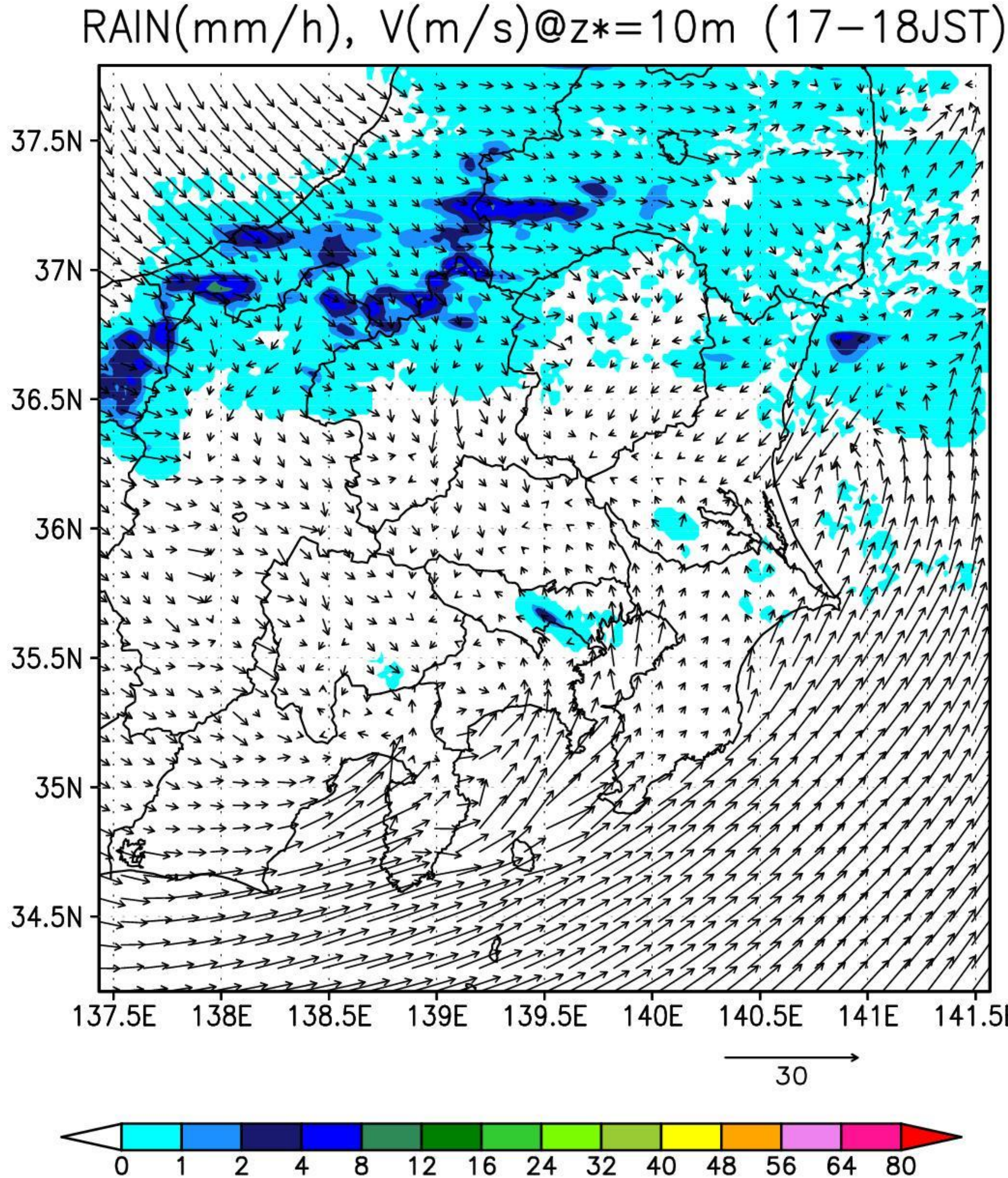


Outer-LETKF
Grid interval: 15 km
Grid number: 80x80x40
Ensemble size: 32
Horizontal localization scale: 75km
Inflation parameter: 1.2
Analysis window: 6 hour
(Operational Observations used in JMA Meso-analysis every hour)

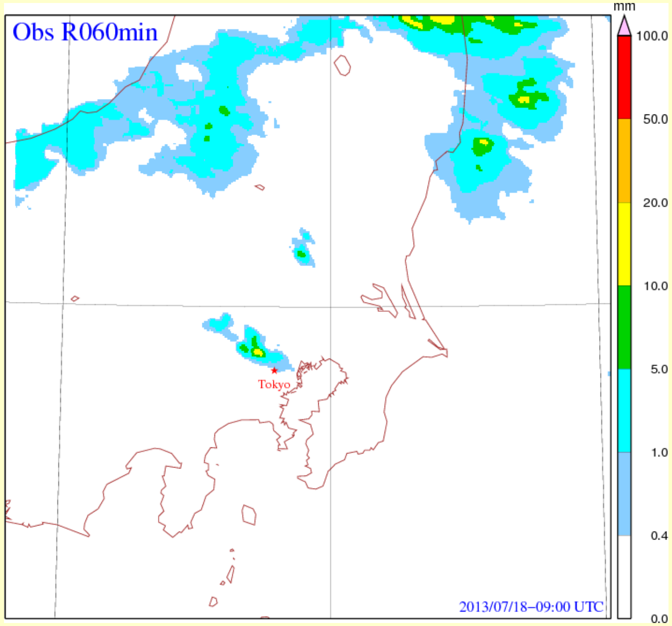
Inner-LETKF
Grid interval: 2 km
Grid number: 200x200x40
Ensemble size: 32
Horizontal localization scale: 10 km
Inflation parameter: 1.2
Analysis window: 1 hour
(Observations prepared by Kawabata-san every 10 minutes except WPR and DRAW)

Target:
Local rain near Tokyo
in 20130718 17-21JST

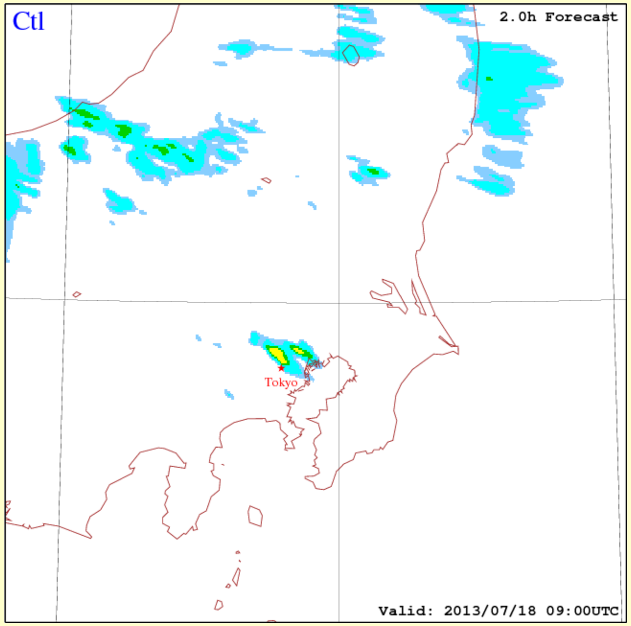

2013/07/18 18:00 解析雨量(R1)


RAIN(mm/h), V(m/s)@z*=10m (17−18JST)
37.5N
37N
36.5N
36N
35.5N
35N
34.5N
137.5E
138E
138.5E
139E
139.5E
140E
140.5E
141E
141.5E
30
0
1
2
4
8
12
16
24
32
40
48
56
64
80

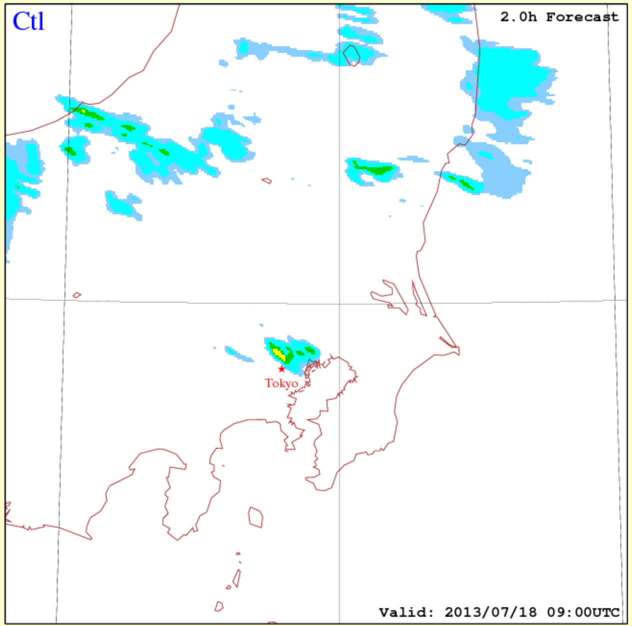
Hybrid NHM-4DVAR by L. Duc 2-hour forecasts



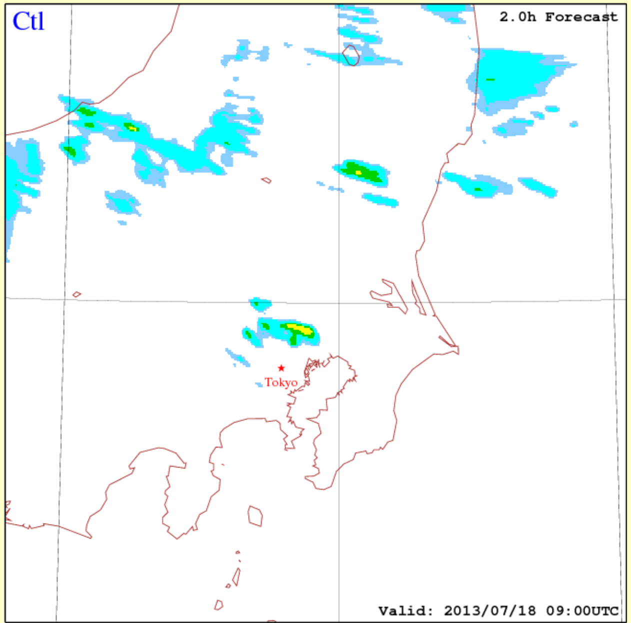
Obs



100% Bclim, 0% Bens



50% Bclim, 80% Bens



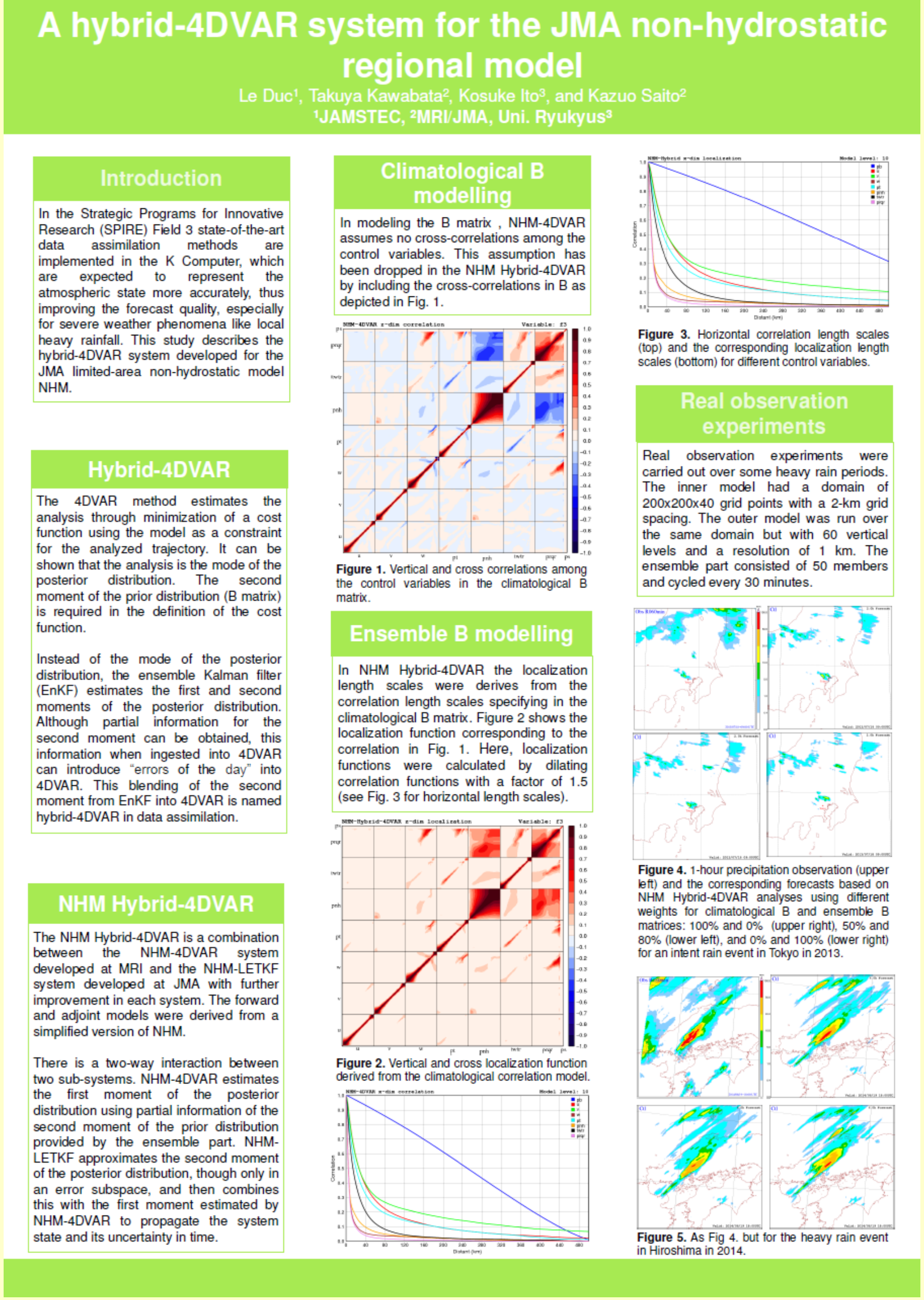
0% Bclim, 100% Bens

Lessons from the preliminary DA intercomparison experiments

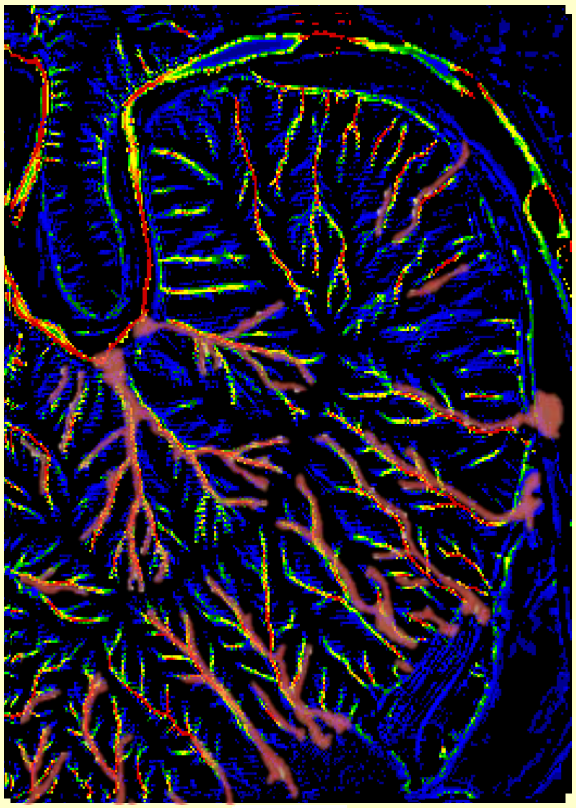
- LETKF systems well reproduce the moderate rainfall in west Tokyo at 17-18 JST, while intense rains around 21-22 JST is hard to predict unless the mesoscale analysis is used for the lateral boundary condition.
- Influence of the lateral boundary condition is dominant when forecast time exceeds 6 hours, especially in the small domain experiment.
- Above results may suggest the necessity to shift the targeted times for analysis (currently 09 JST) later.
- Different events other than 18 July 2013 may be considered..

Hybrid-4DVAR experiments by the K-computer for the 2014 Hiroshima debris flash flood case

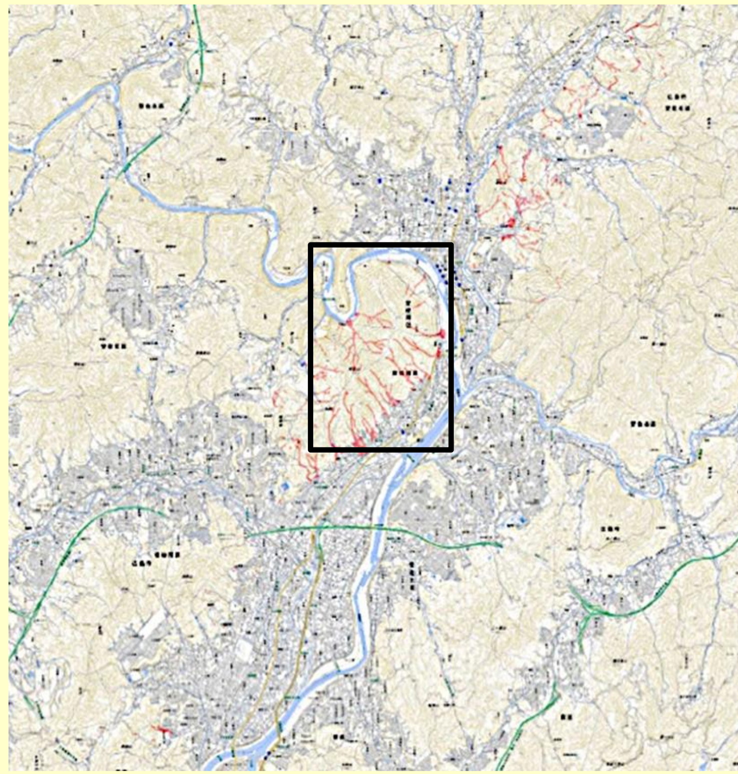
by Duc et al. Poster [p-43]



Debris flash flood model simulation with the K-computer by Kyoto Univ.



2時



Yamashiki (2015)

Summary

- Performance of sate of the art mesoscale NWP has been remarkably improved in recent years , but prediction of LHIW is still challenging.
- Observation data, computational resources and data assimilation methods for high resolution are key issues.
- The K-computer reduces compromise of resolutions and ensemble members, and shows a prototype of the future NWP system.
- Intercomparion of different DA schemes for CRM is proposed.

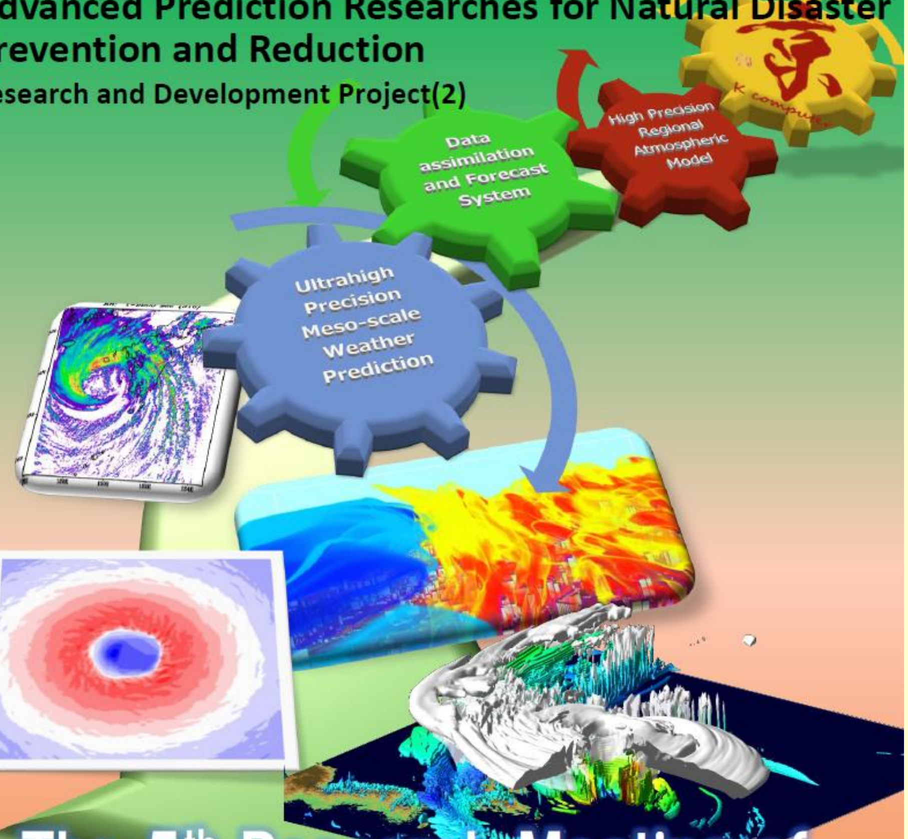
Acknowledgments:
A part of this research has been funded by MEXT Strategic Programs for Innovative Research (SPIRE). A part of results is obtained by using the K-computer at the RIKEN Advanced Institute for Computational Science (Proposal number hp140220).

The 5th research meeting at Nagoya, 9th March)

HPCI Strategic Programs for Innovative Research (SPIRE) Field 3

Advanced Prediction Researches for Natural Disaster Prevention and Reduction

Research and Development Project(2)



The 5th Research Meeting of Ultra-high Precision Meso-scale Weather Prediction

March 9, 2015 (Mon)

•Venue: Nagoya University, Higashiyama Campus, E&S Hall (E&S Building)

•Registration fee: No fee

JAMSTEC, MRI/JMA, HyARC/Nagoya Univ.

HPCI Strategic Programs for Innovative Research, Field 3
Research and Development Project (2)

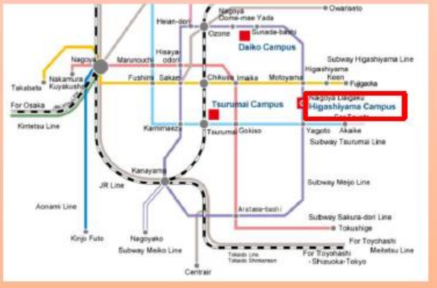
The 5th Research Meeting of Ultrahigh Precision Meso-scale Weather Prediction Program

Mar. 9 (Mon) 09:00-09:30	Opening Address — Masashi Nagata (MRI) Introduction — Tatsushi Tokioka (JAMSTEC), Kazuo Saito (MRI/JAMSTEC)
09:30-11:00	Development of cloud-resolving data assimilation systems Chair: Tadashi Tsuyuki (MRI)
11:00-12:30	Development of a regional cloud-resolving ensemble analysis and forecasting systems Chair: Hiromu Seko (MRI/JAMSTEC)
14:00-14:30	Keynote Speech Prof. David Stensrud (Pennsylvania State Univ.)
14:40-17:00	Development and basic research for the ultrahigh precision regional models Chair: Fujio Kimura (JAMSTEC)
17:00-17:30	General Discussion

Venue

E&S Hall, Nagoya University, Higashiyama Campus, E&S Building

From Nagoya Station to Higashiyama Campus;
Take the Subway Higashiyama Line to Motoyama Sta. (15 minutes), then transfer to the Subway Meijo Line to Nagoya Daigaku Sta. (Higashiyama Campus is just off the subway exit.).



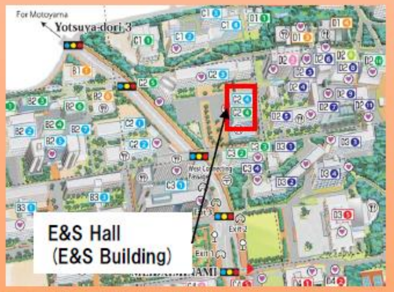
Banquet

Conference banquet is held at French restaurant 'Chez Jiroud' from 18:00.

Registration

Those who are interested in participation are required to send an e-mail to the following address by March 2. Participants in the banquet also need to be registered in advance.

Kazuo Saito, Forecast Research Department, MRI.
TEL: 029-853-8630, FAX: 029-853-8649
E-mail: ksaito@mri-jma.go.jp



Cover illustrations (in order from back to front):
(1) Rainfall regions of T0613 simulated by CRESS with the horizontal resolution of 75 m (K. Tsuboki, HyARC/Nagoya Univ.)
(2) See breeze front around the Sendai station reproduced by DS³ (Guixing Chen, Tohoku Univ.)
(3) Near surface wind speed in large eddy simulation on whole tropical cyclone (dx=100 m)(J. Ito, AORI/Tokyo Univ.)
(4) Rainfall and cloud distributions of Isewan Typhoon reproduced by CRESS. (K. Tsuboki, HyARC/Nagoya Univ.)

Thank you

Chen, G., X. Zhu, W. Sha, T. Iwasaki, H. Seko, K. Saito, H. Iwai, and S. Ishii, 2015: Toward Improved Forecasts of Sea-Breeze Horizontal Convective Rolls at Super High Resolutions. Part I: Configur ation and Verification of a Down-Scaling Simulation System (DS3). Mon. Wea. Rev. doi: 10.1175/MWR-D-14-00212.1. (in press)

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