

53-year downscaling over Japan at 5km coupled with the ECMWF Reanalysis data

26 June 2013

Central Research Institute of Electric Power Industry, JAPAN

Atsushi Hashimoto, Hiromaru Hirakuchi

14th Annual WRF Users' Workshop
Boulder, Colorado

Background Objective :

To evaluate the influence of weather and climate change on electric power facilities, a 53-year downscaling was conducted over Japan. These data-set will apply to make plans for fatigue damage measures and maintenance programs for electric power facilities.



Thermal Power Station

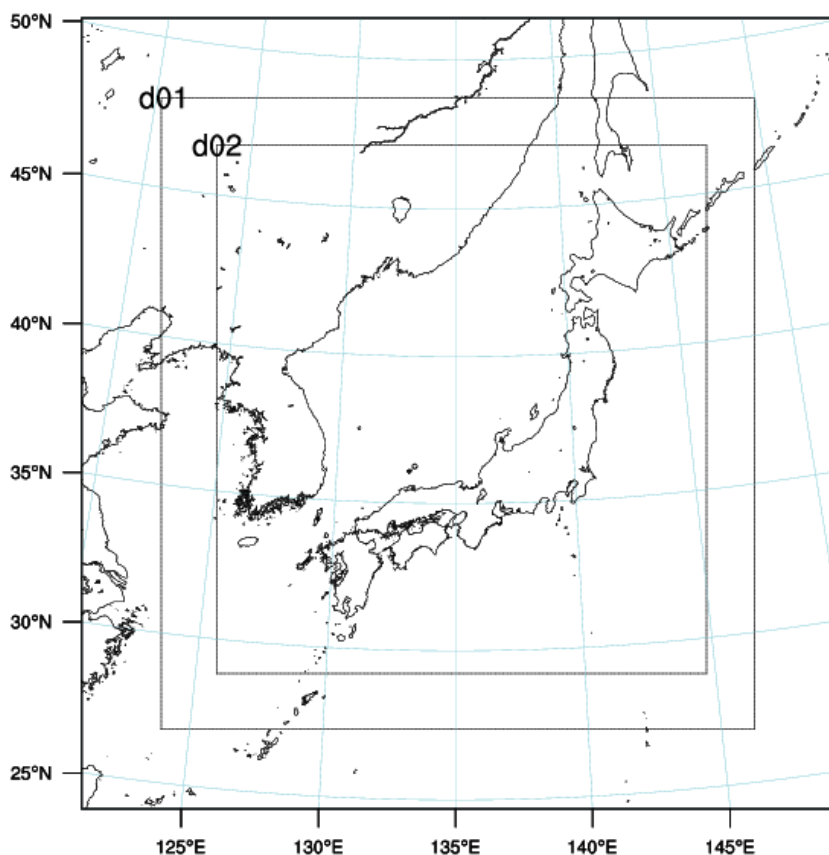


Power Transmission System



Wind Power Station

Model description and calculation environment



Base Model: WRF-ARW3.2.1

Forcing: ECMWF ERA-40
ECMWF ERA-Interim
(6 hourly, 100km horizontal resolution)

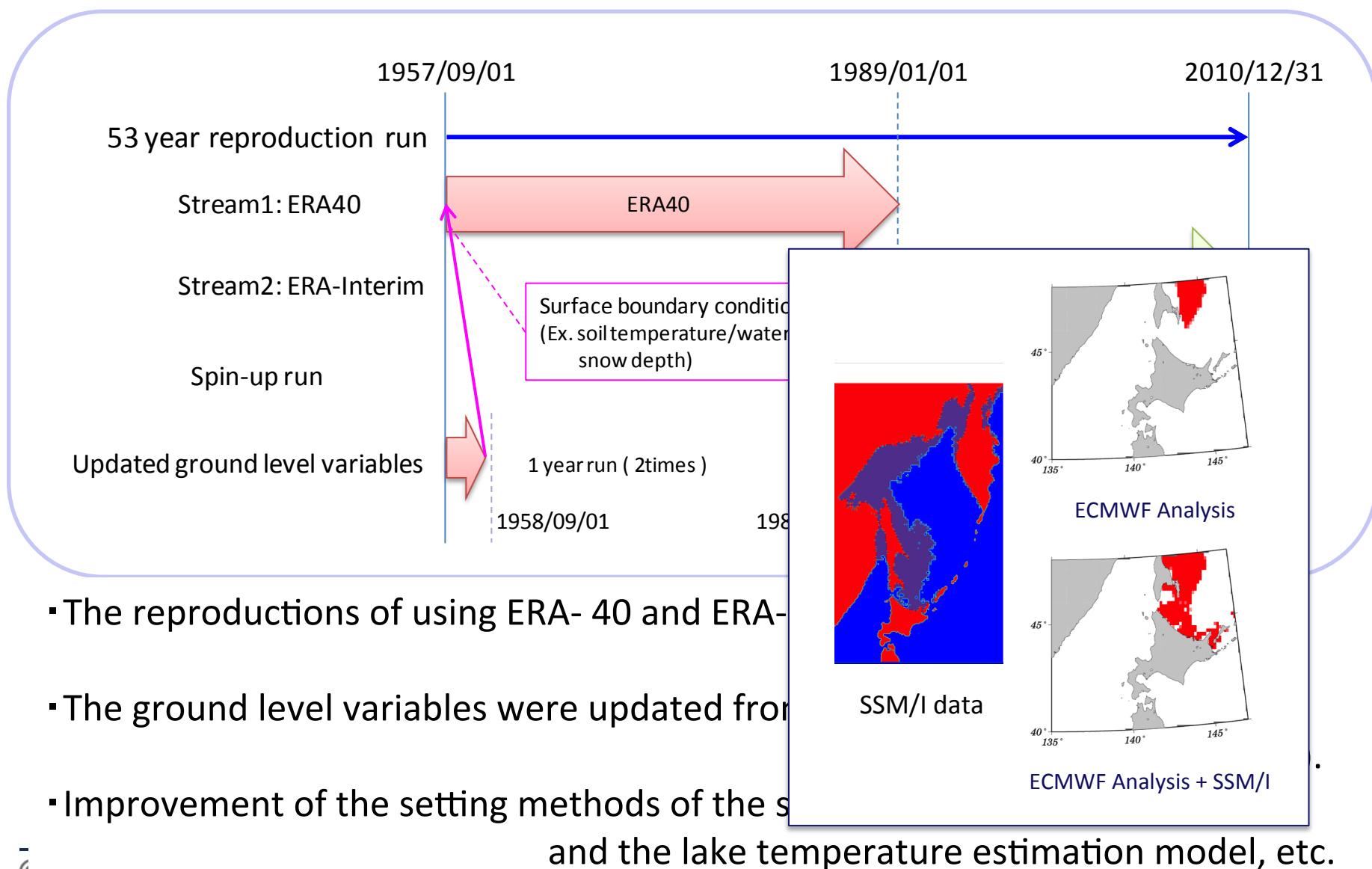
Period: ERA-40 Sep. 1 1957 – Dec. 31 1988
ERA-Interim Jan. 1 1987 – Dec. 31 2010

Out put File: Domain01 3 hour,
/ Domian02 1 hour .

Domain : domain01 (15km:nx150×ny160),
domain02(5km:nx361×ny391)
Vertical(35 layers, model top=50hPa)

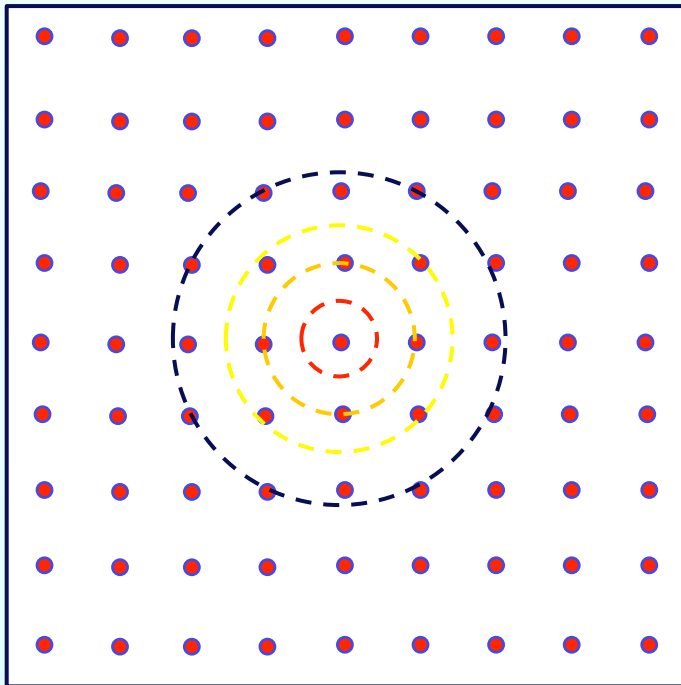
Cumulus parameterization	Kain-Fritsch scheme
	Domain01 (on) / Domain02 (off)
Microphysics scheme	Morrison 2-Moment scheme
PBL scheme	YSU scheme
Land-Surface Model	Noah-LSM scheme
Long Radiation scheme	RRTM scheme
Short Radiation scheme	Dudhia scheme

Simulation Procedures of Long-term Reproduction

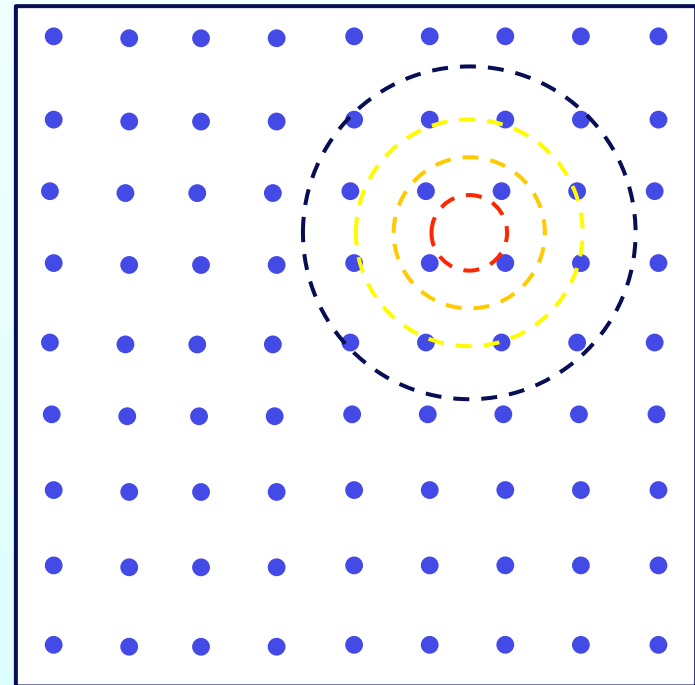


The effect of Lateral Boundary Conditions (LBCs)

WRF 500hPa (wrfout_ncl)



ECMWF 500hPa (met_em)

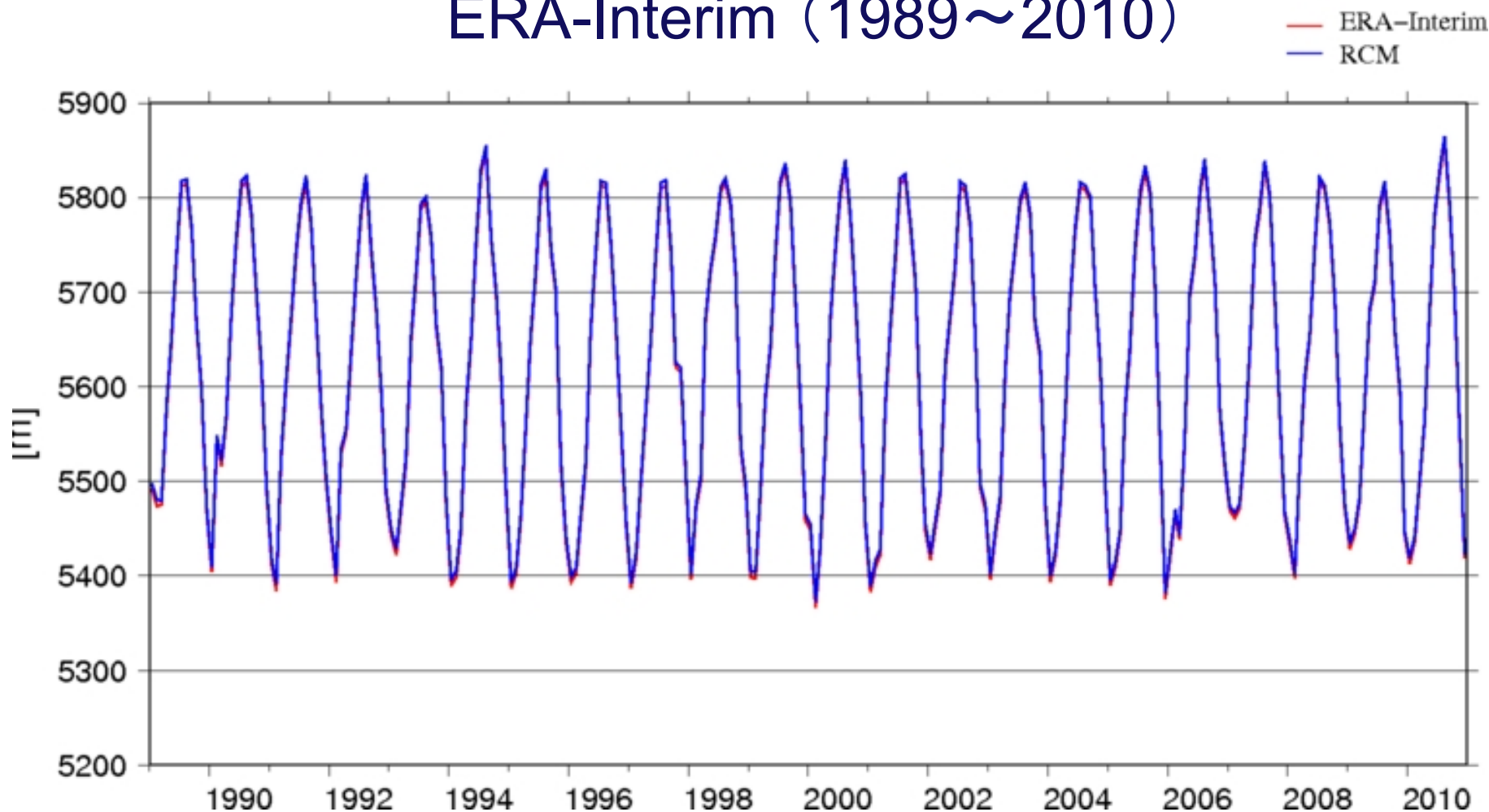


$$\text{RMSE} = \sqrt{\sum \sum (\text{Model}(i, j) - \text{Analysis}(i, j))^2 / (n_x * n_y)}$$

⇒ The geopotential height error in the model did not accumulate.

Monthly averaged Geopotential Height at 500hPa (Domain01)

ERA-Interim (1989~2010)

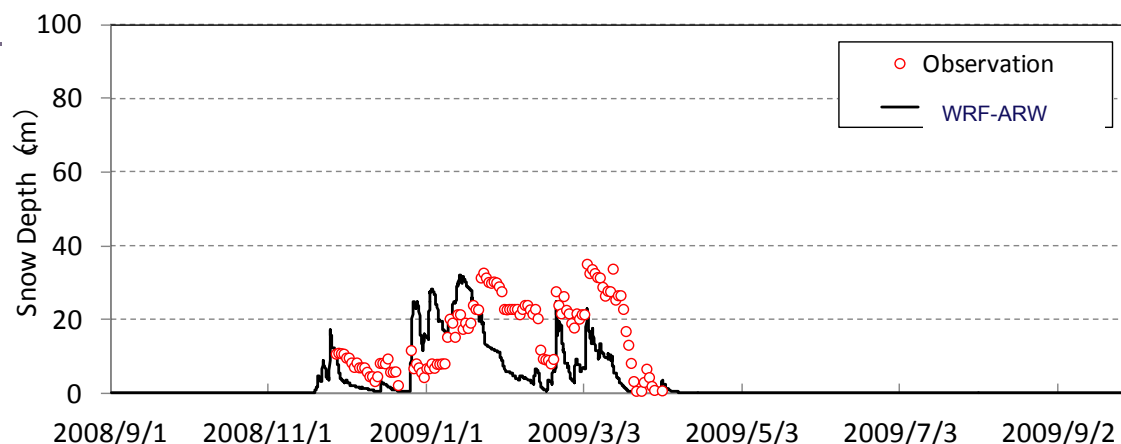


Red line: Forcing data (ECMWF Re-analysis), Blue line: Regional climate model (WRF-ARW)

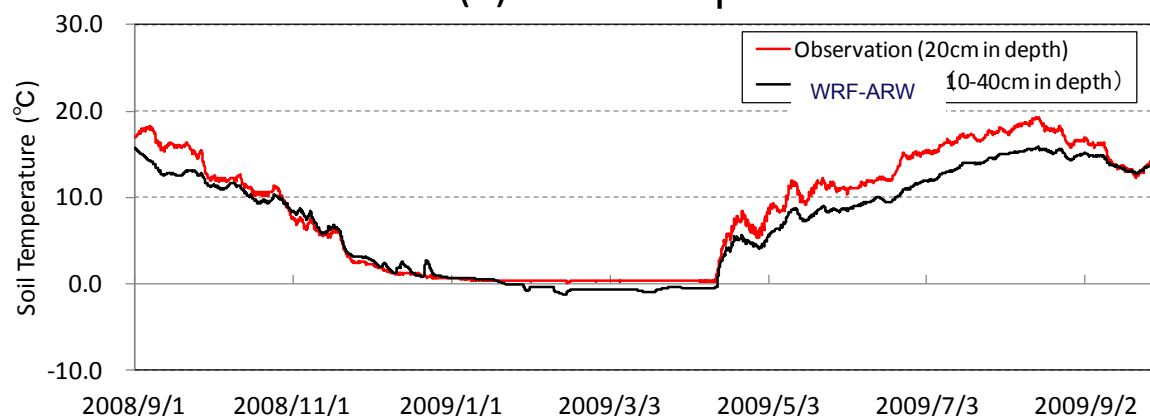
The land surface model evaluation at long-term simulation



Karuizawa Observation Site
The east foot hills of Mt. Asama in Japan
(Height 1,380m)



(a) Snow Depth



(b) Soil Temperature (°C: Centigrade)

Fig. Comparison of Snow Depth and Soil Temperature
at Karuizawa Observation Site.

Evaluating reproduction's accuracies using weather observation stations data

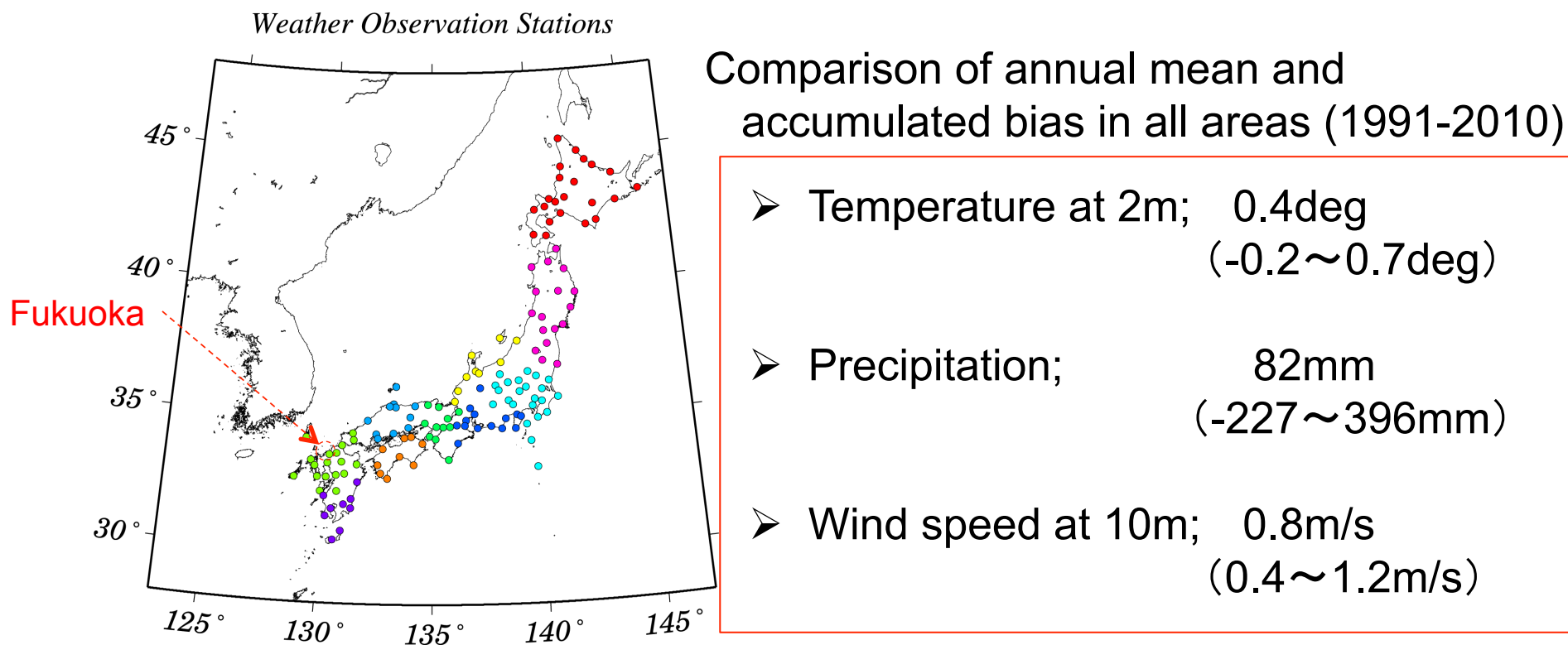
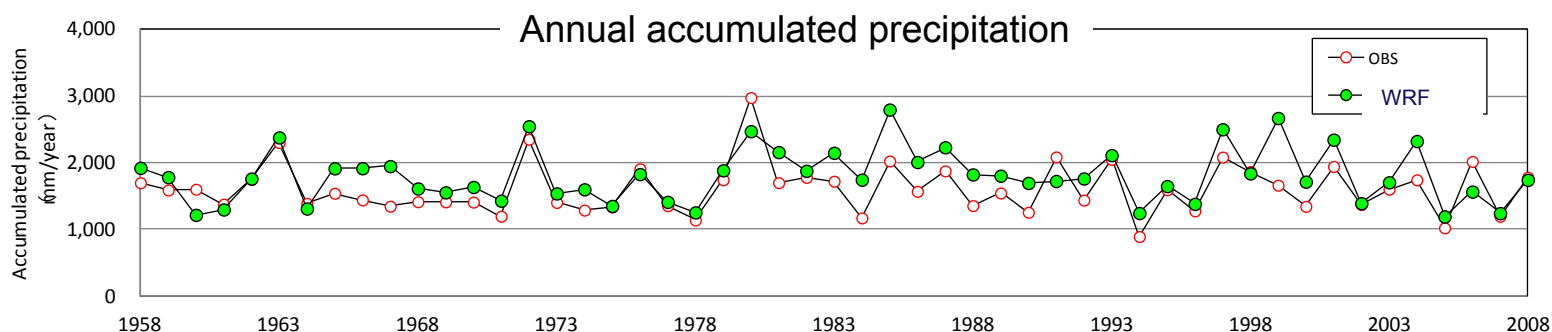
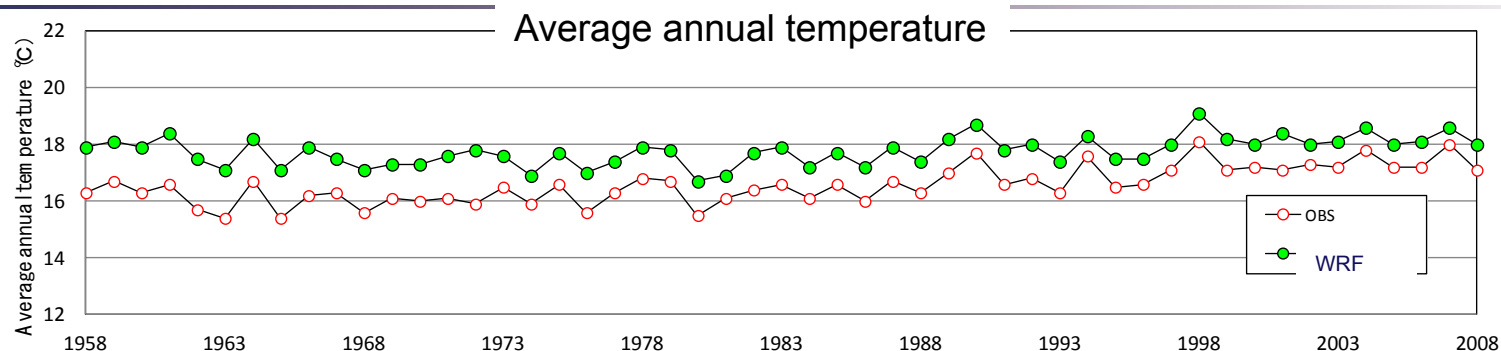


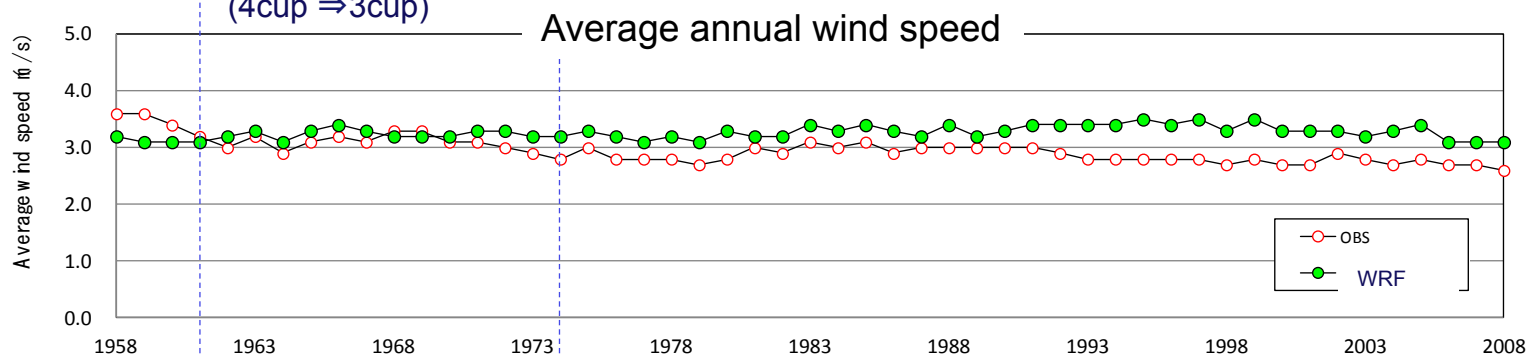
Fig. JMA's surface weather observation stations including Domain02 (Total 143points)

All observation are divided into 10 regions

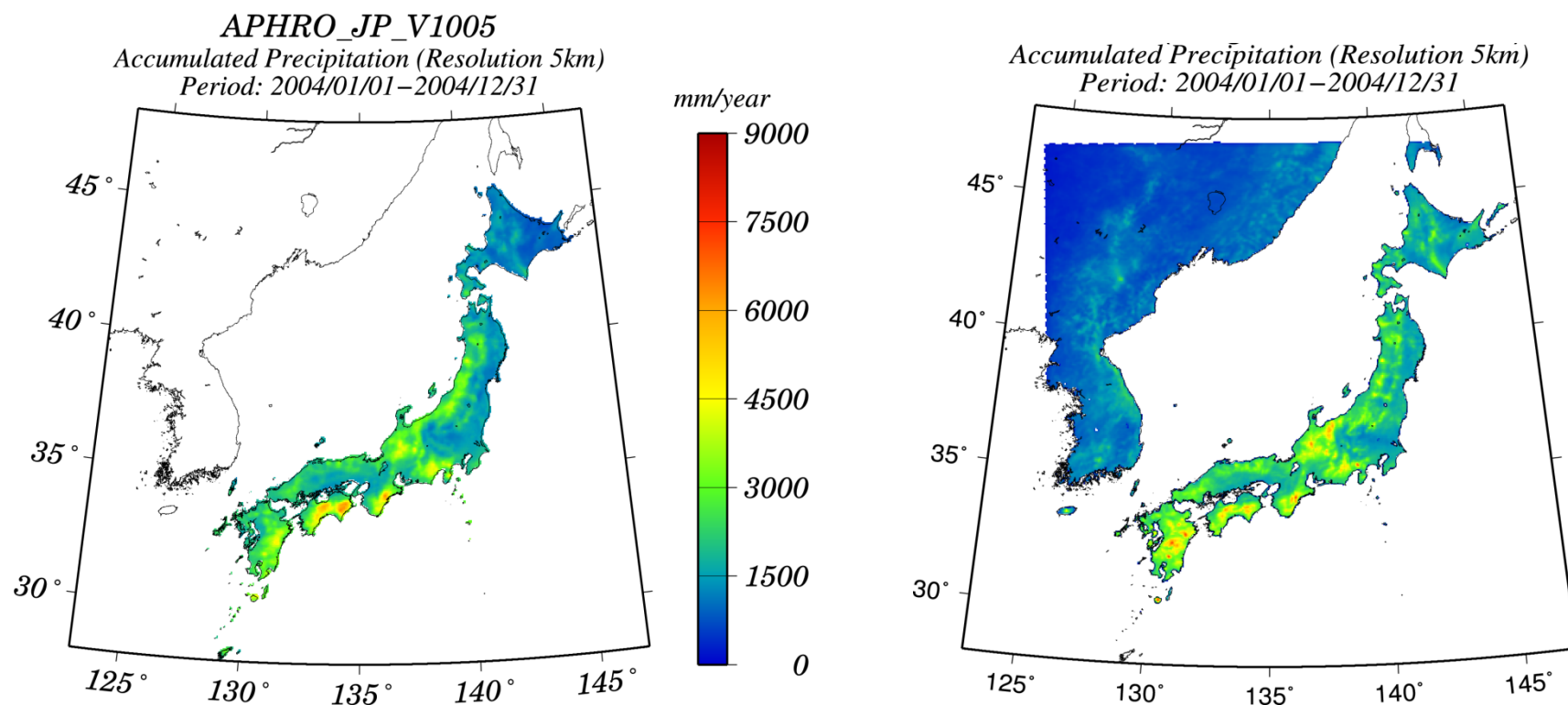
Comparison of temperature, precipitation and wind speed at Fukuoka weather observation station (1958-2008)



Change Cup type anemometer
(4cup \Rightarrow 3cup)



Comparison of one year accumulated precipitation



(a) Analyzed precipitation by Observations

(b) Calculated precipitation by WRF

Fig. Comparison of one year accumulated precipitation in 2004.

⇒ The result of Observation and WRF was corresponding well.

Conclusions

- We conducted 53-year runs over Japan with 5km resolution coupled with the ECMWF reanalysis data from 1958 to 2010.
- The effect of lateral boundary conditions was discussed using GPH at 200 and 500hPa, and it showed that the error in the model did not accumulate.
- The reproduction runs were evaluated using weather observation stations, and the model results were in good agreement with observations.
- WRF well reproduced the accumulated precipitation for one year.
- The WRF has the capability to reproduce weather and climate with high accuracy.

Thank you!

I will stay at NCAR from Sep. 2013 to Sep. 2014.
I am looking forward to seeing you in September.

Computing Environment



SGI-IceX(Intel Xeon E5-2670 8core 2.6GHz)
4,032CPU / 3,256core (670.9TFlops)

Calculation time

128CPU: 20min/day, 5.1日/year
256CPU: 14min/day, 3.7日/year
512CPU: 11min/day, 2.8日/year

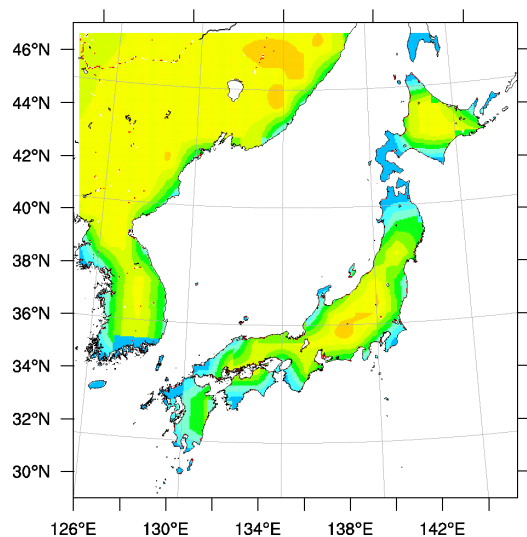
File size:

Domain1 74MB / 1file
Domain2 434MB / 1file

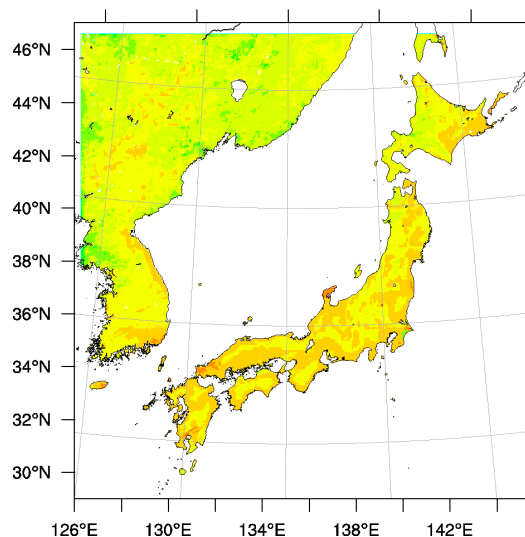
Total:(53year) : 210TB

(History interval:Domain1 180min,
Domain2 60min)

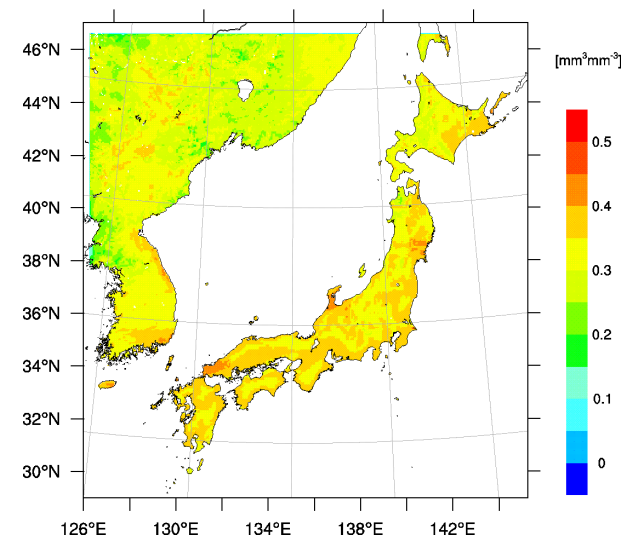
Soil Moisture distribution (Layer=4, 100-200cm)



Start date (1957-09-01)

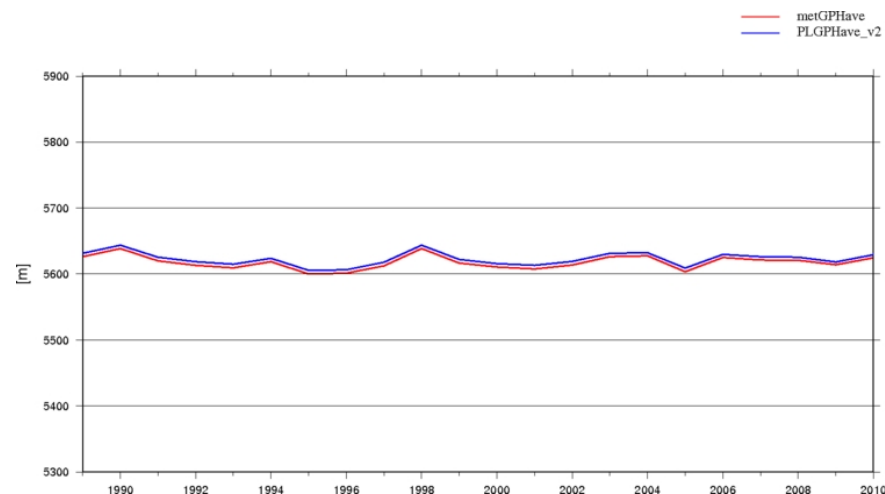
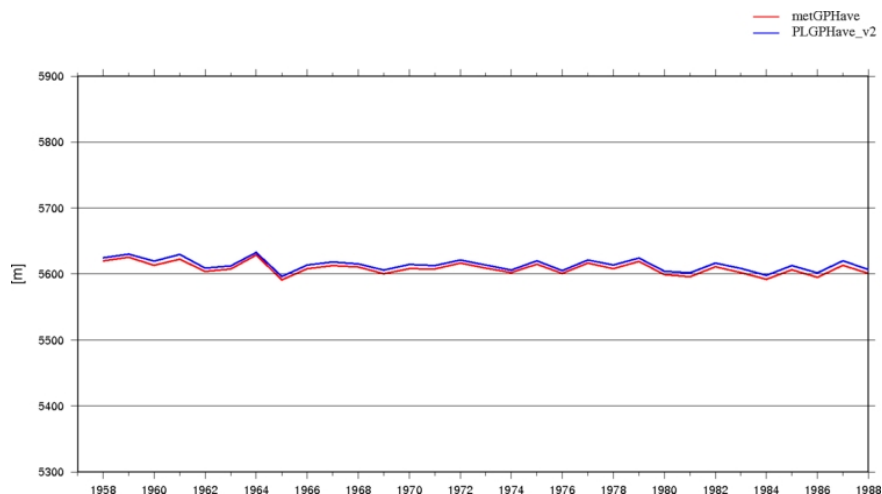


1 time:
Start date (1958-09-01)

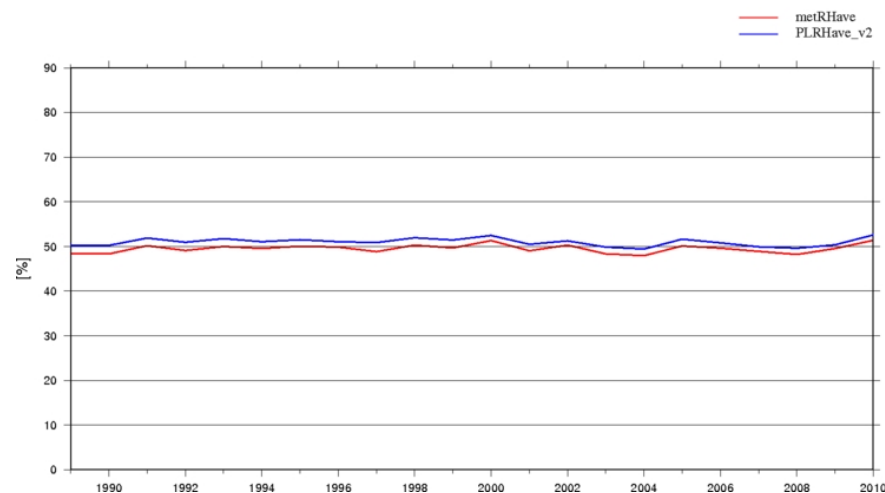
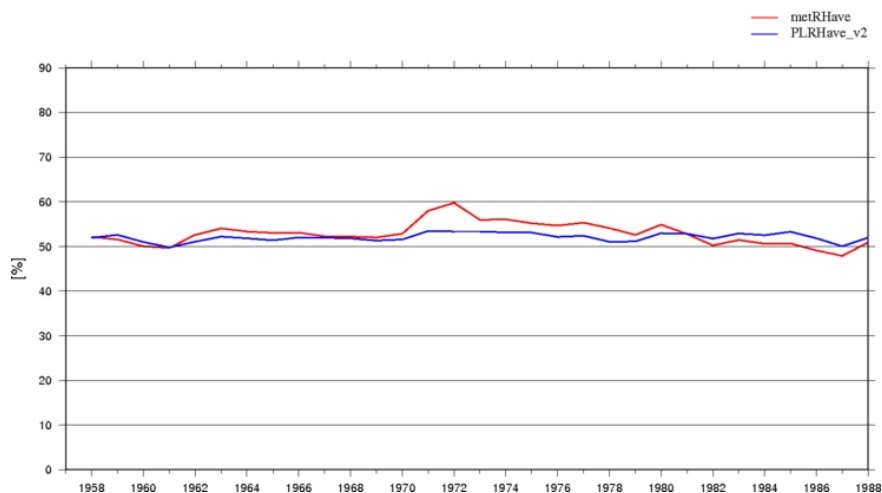


2 time:
Start date (1958-09-01)

Geopotential Height at 500hPa (Domain01)



Relative Humidity at 700hPa (Domain01)



ERA40 (1558~1988)

ERA-Interim (1989~2010)

Red line: Forcing data (ECMWF Re-analysis), Blue line: Regional climate model (NuWFAS-RCM)

Impact of cumulus parameterization at 5km horizontal resolution

Comparison of 24 hour accumulated precipitation
around at Baiu (seasonal rain) frontal zone

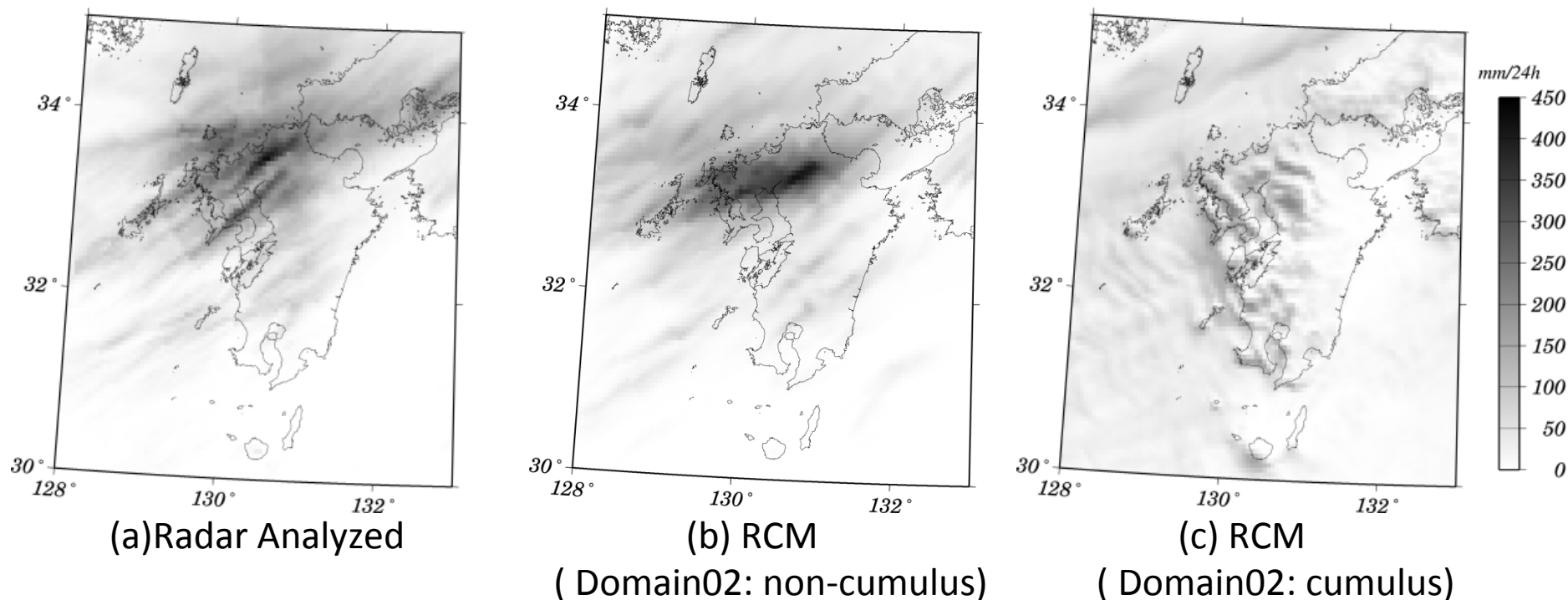
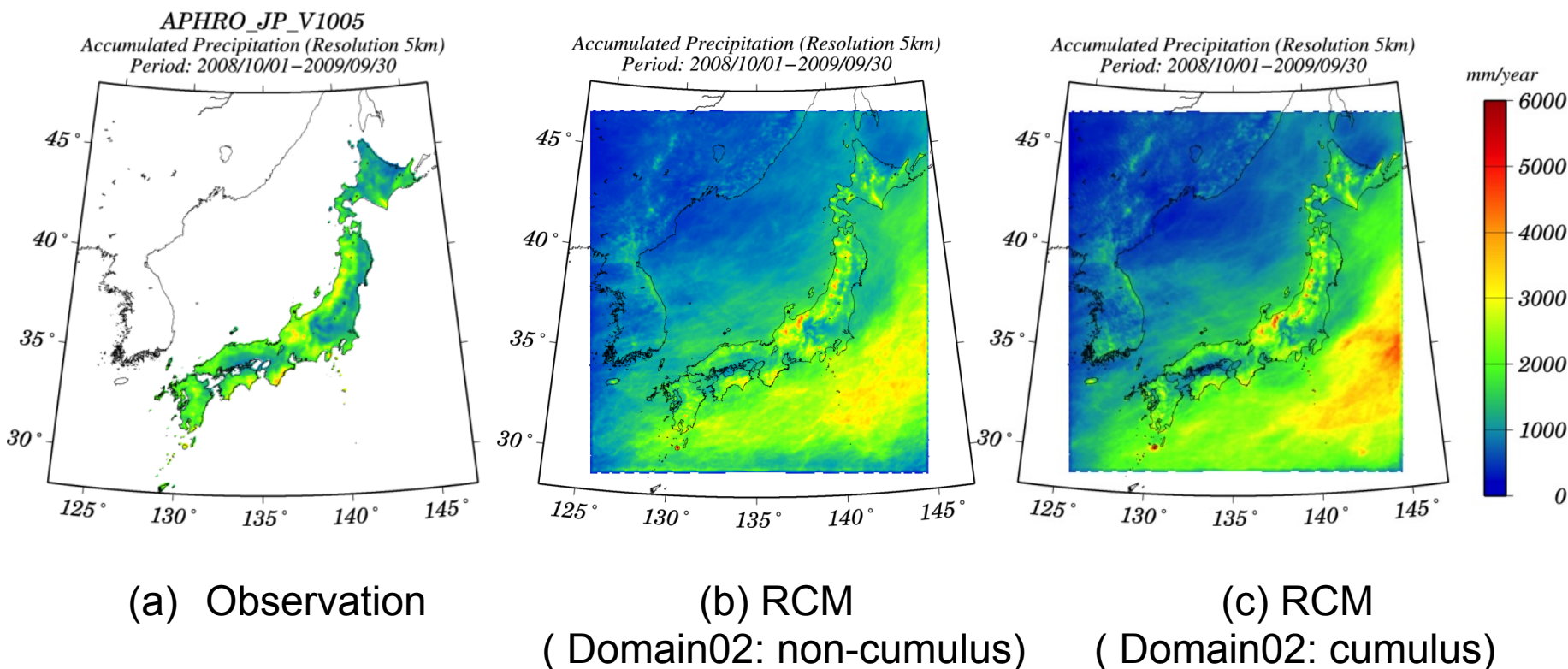
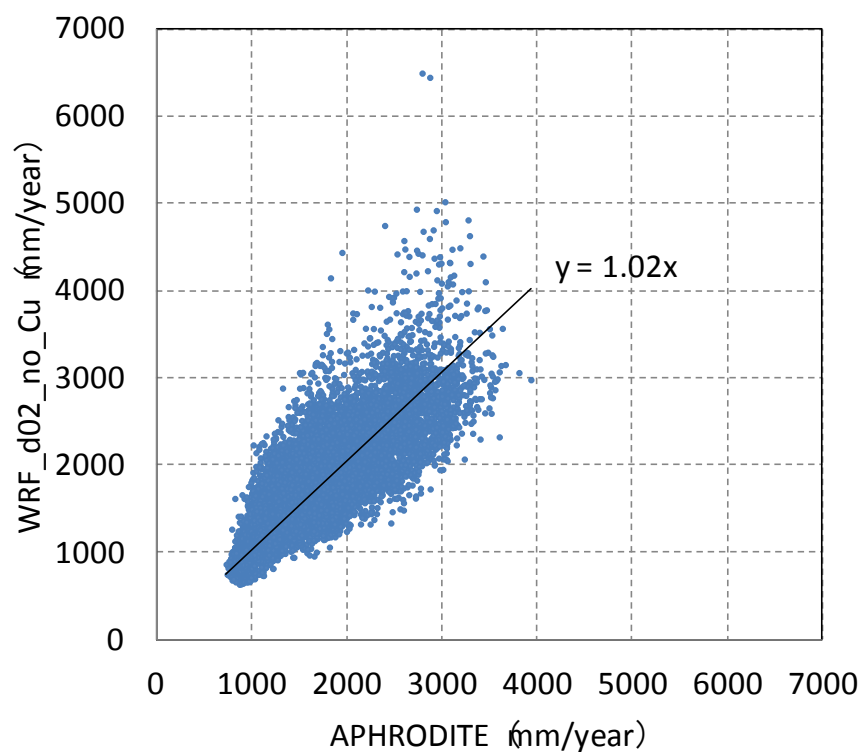


Fig. The local heavy precipitation at the northern part of Kyusyu district in July 2009.
⇒ WRF well reproduced the accumulated precipitation such as
extreme climate events, therefore we selected no cumulus at Domain02.

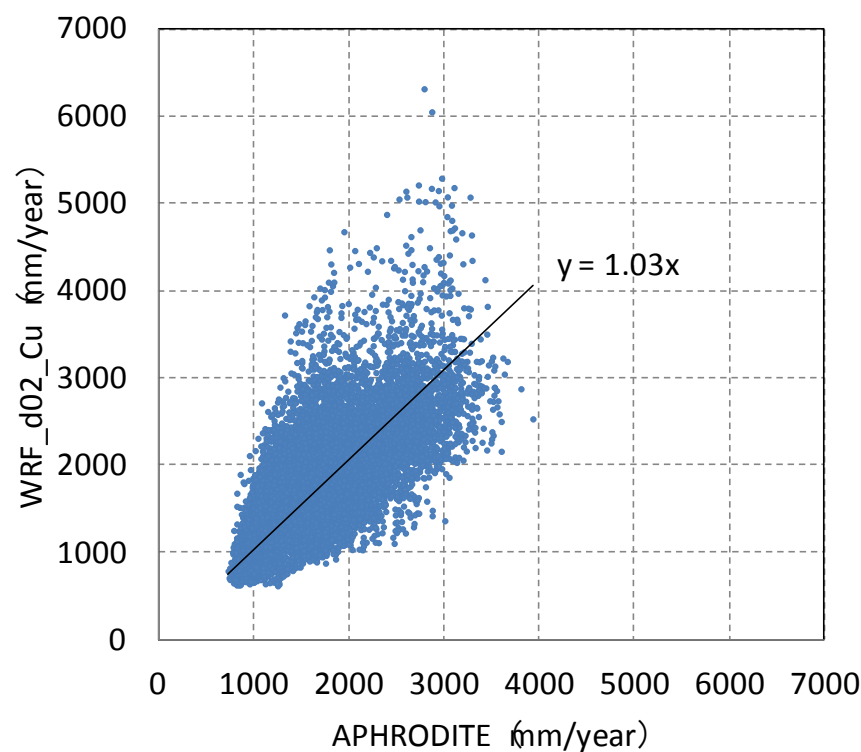
Comparison of one year accumulated precipitation (Oct. 2008 – Sep. 2009.)



Comparison of one year accumulated precipitation using Scatter Diagram (Oct. 2008 – Sep. 2009.)



(a) WRF-RCM
(Domain02: non-cumulus)



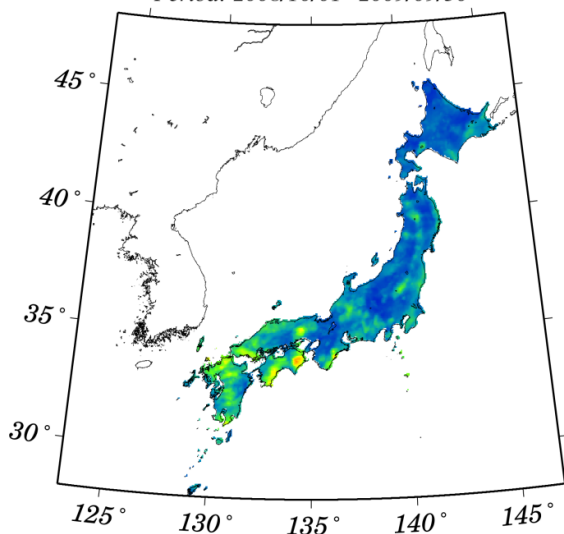
(b) WRF-RCM
(Domain02: cumulus)

APHRODITE: Analyzed precipitation by observations

Comparison of Daily Maximum Rainfall distribution (Period; 2008/10 – 2009/09)

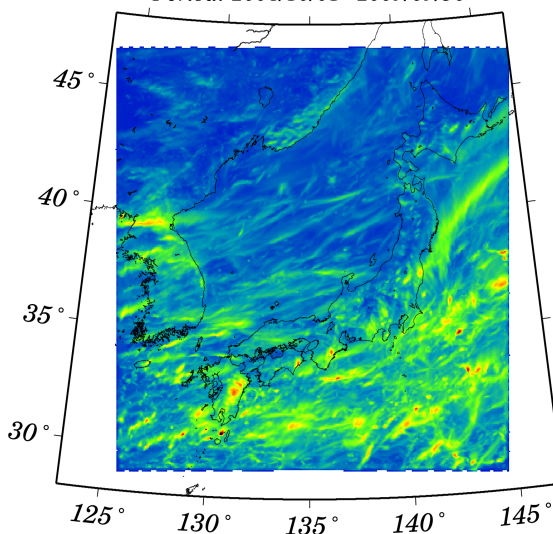
APHRO_JP_V1005

Daily Maximum Rainfall Distribution (Resolution 5km)
Period: 2008/10/01–2009/09/30



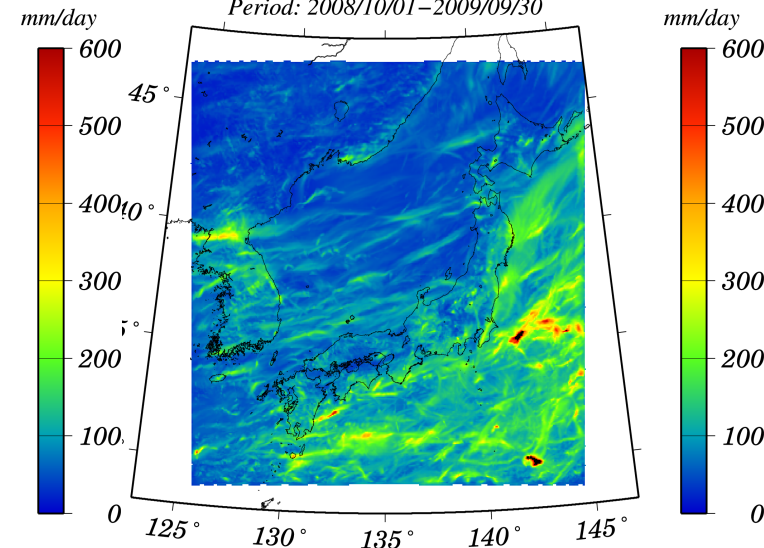
(a) Observation

Daily Maximum Rainfall Distribution (Resolution 5km)
Period: 2008/10/01–2009/09/30



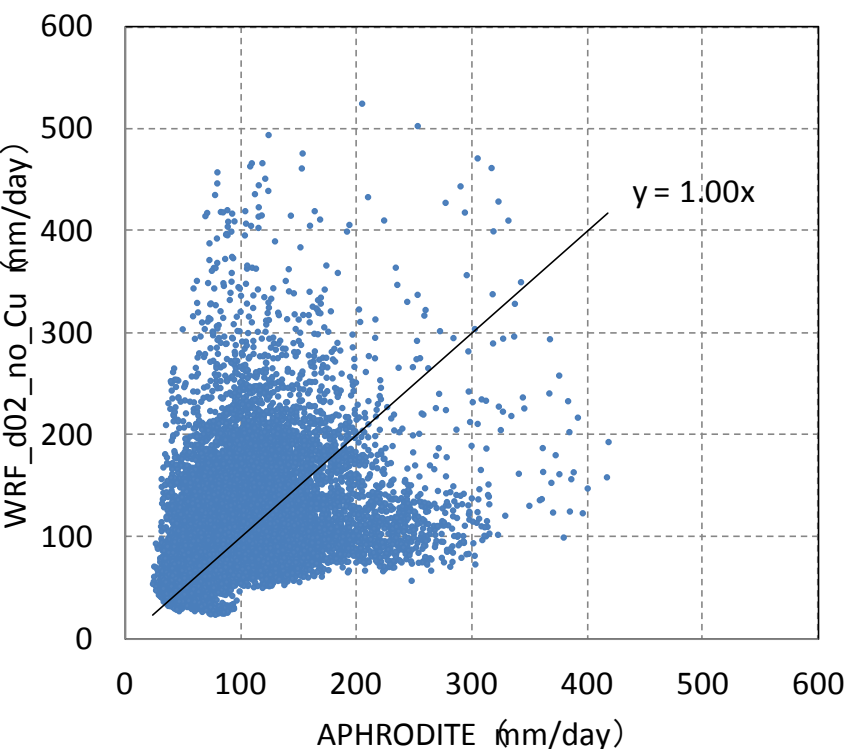
(b) RCM
(Domain02: non-cumulus)

Daily Maximum Rainfall Distribution (Resolution 5km)
Period: 2008/10/01–2009/09/30

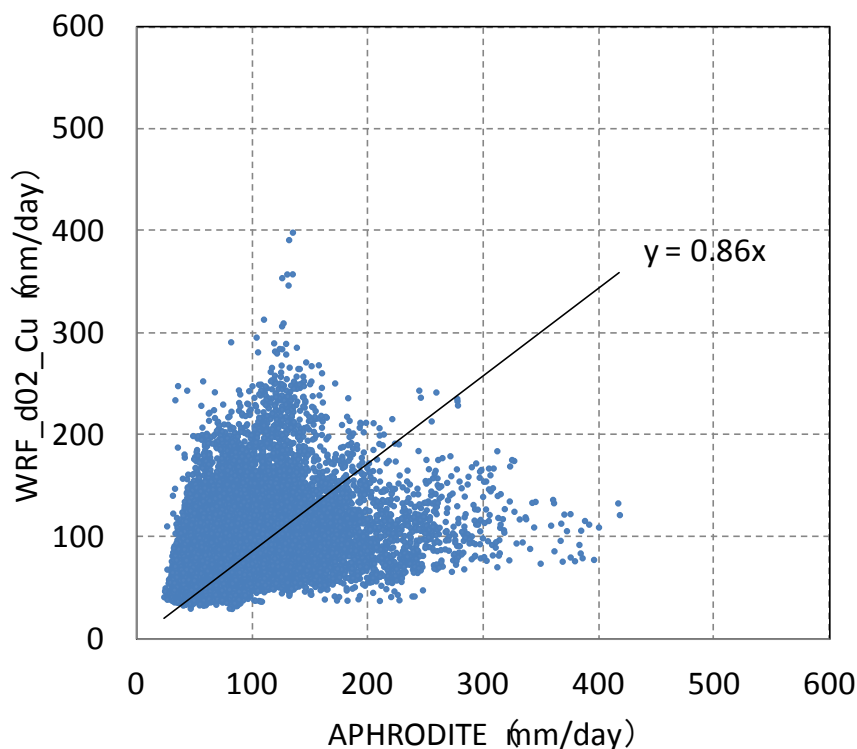


(c) RCM
(Domain02: cumulus)

Comparison of one year accumulated precipitation using Scatter Diagram (Oct. 2008 – Sep. 2009.)

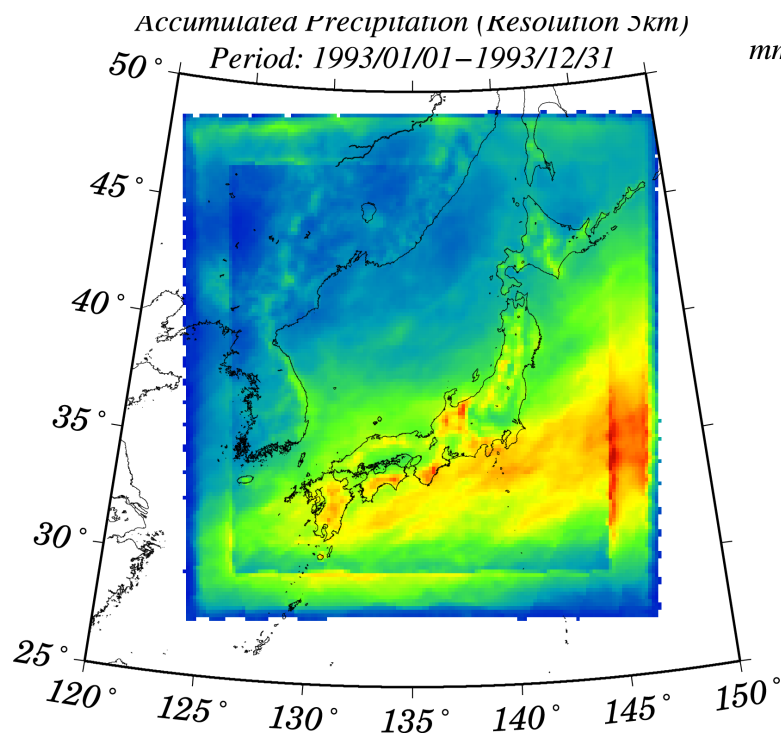


(a) 第2領域積雲あり

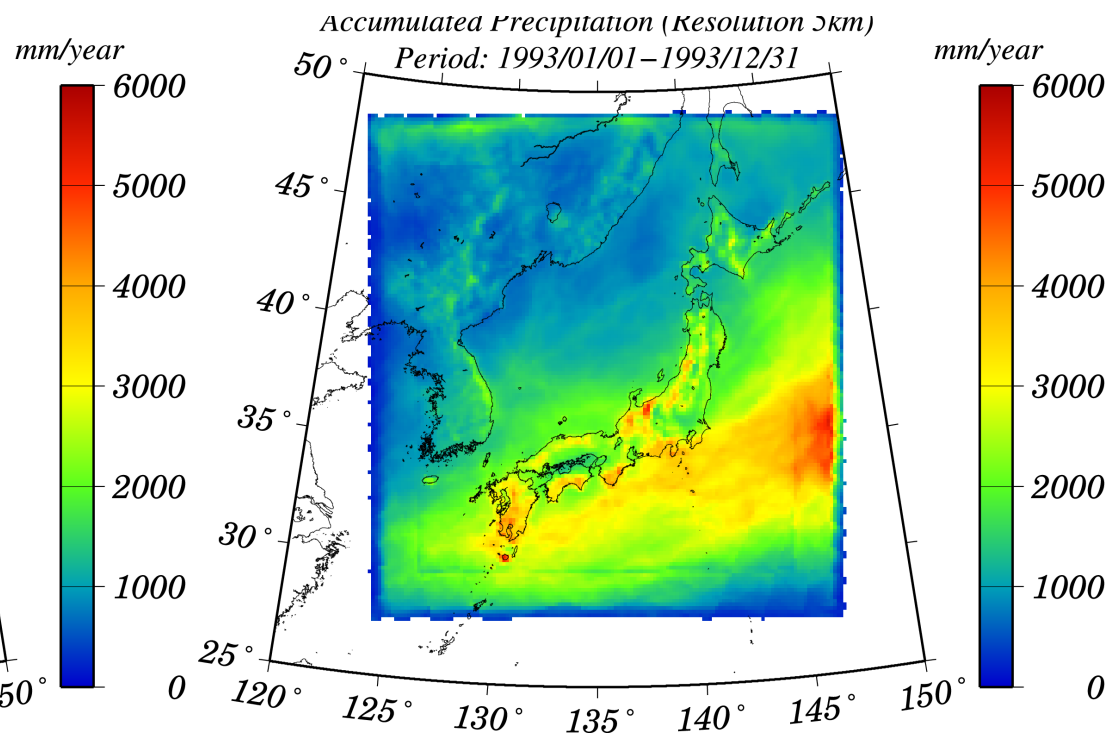


(a) 第2領域積雲なし

Comparison of one year accumulated precipitation (ERA-Interim, 2003)



(a) RCM
(Domain02: non-cumulus)



(b) RCM
(Domain02: cumulus)