Down-scaling system applied for representing local climate in Japan

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MoE GERF S-5 Getting a 'Feel' for Future Climate Change!

What is DOWN-SCALING ?

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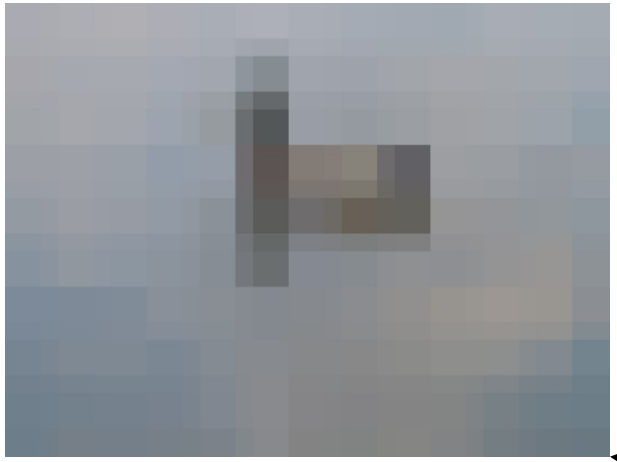


Bridging between the climate model results and the impact studies

Historical review of projects of DD in Japan

- (i) FY2001-2003: Water resources and variability in Asia in the 21st century➔ Drive several 50km RCMs and found the uncertainty from the models.
- (ii) FY2001-2006: ICCAP (The influence of GW on the agriculture in the arid area). ➔ Focusing on users, and co-working with SD (BC) has been done.
- (iii) Climate change Initiative (RCM20). ➔ single 20km RCM of JMA has been used by various users.

Background of the project

Development of Climate model (global warming projection)

There exist a large gap between the GCM's projection and impact studies

★ We need to increase the accuracy of DD

★ We need to derive information for use in IS

Needs for high resolution impact studies

(We need to answer the social request of coping with the problems of global warming)

We have two main funding related with the downscaling around Japan FY2007-2012

(1) “Projection of changes in extremes in the future”, which belongs to the KAKUSHIN program sponsored by MEXT.➔ Reduce uncertainty by using very high resolution (5km, 2km,1km) RCM.

(2) “Multi-method Included Downscaling for Assessment Study”, which belongs to the S-5 project sponsored by MOE. ➔ Estimate uncertainty by using multi RCM ensembles.

Approaches in S-5-3

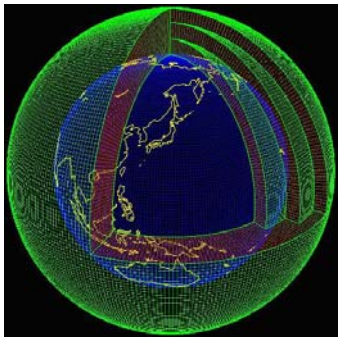
- (i) We need to estimate the uncertainty of DD. ← From modelers side point of view.

- (ii) We need to derive information usable in impact studies.← From user side point of view.

Schematic diagram of S-5-3

Reanalysis(JRA25)

AO-GCM (MIROC)

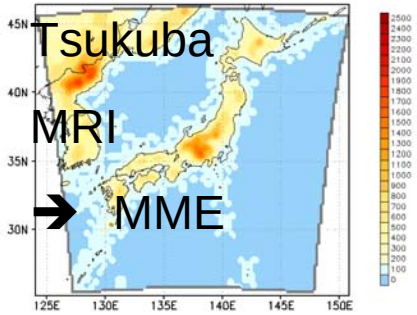


(i)To estimate the uncertainty

nesting

NIED

20km RCMs



Two way nesting system

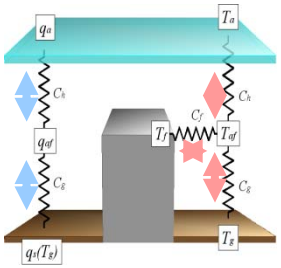
comparison

Model tuning

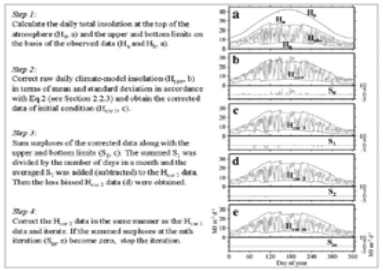
Bias detection system

Further down-scaling

DD for urban area



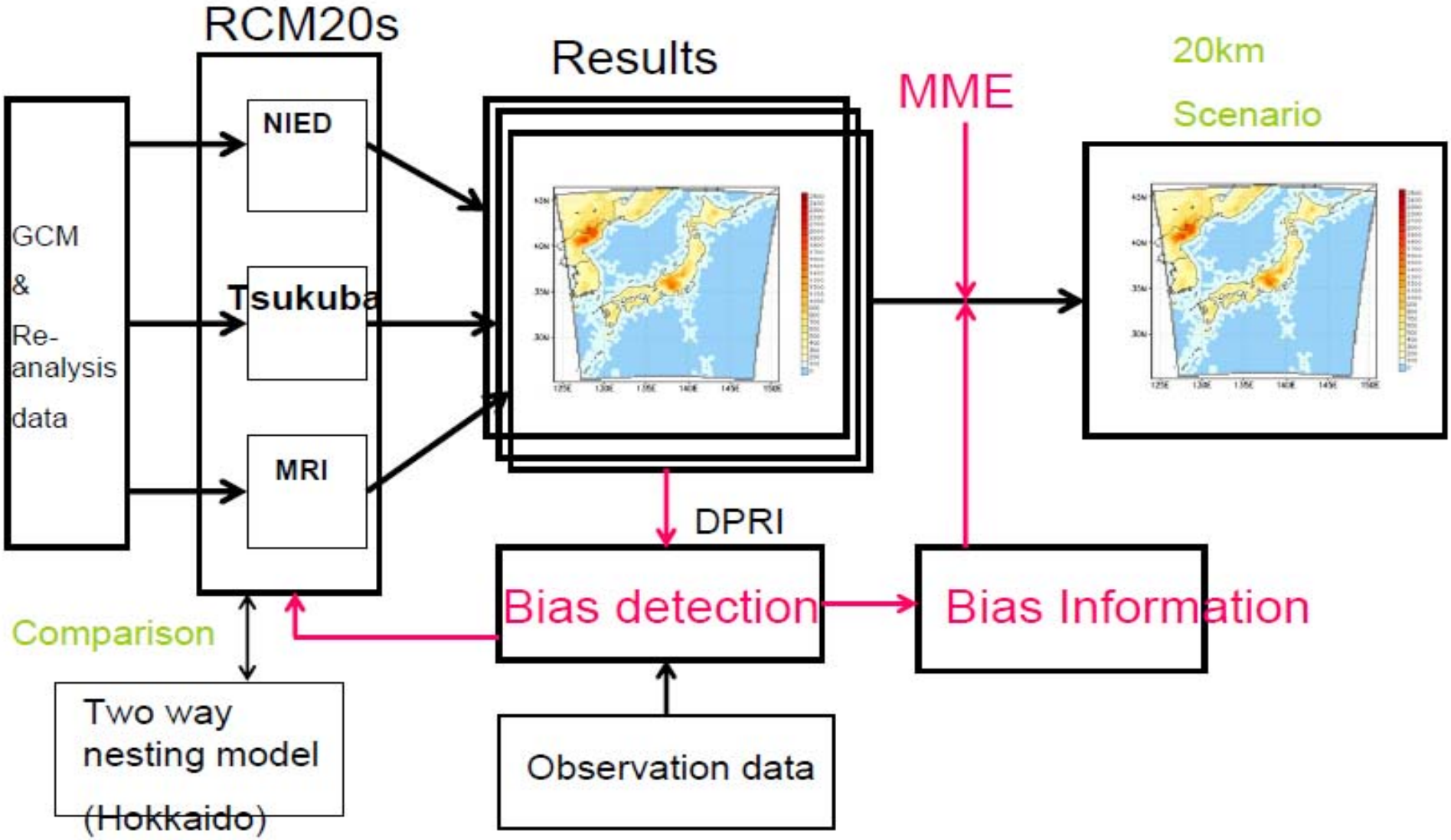
SD for rural area



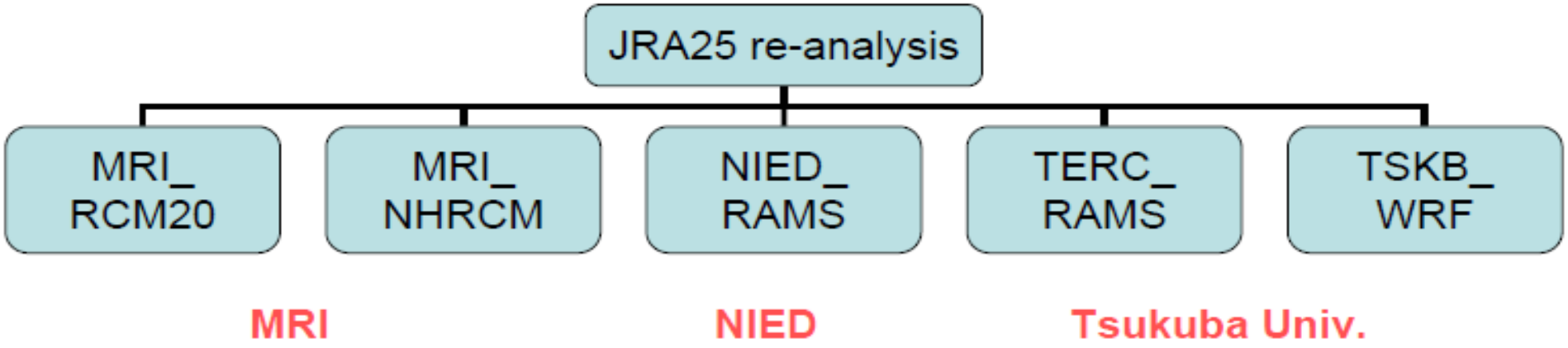
(ii) To derive information for use in impact studies

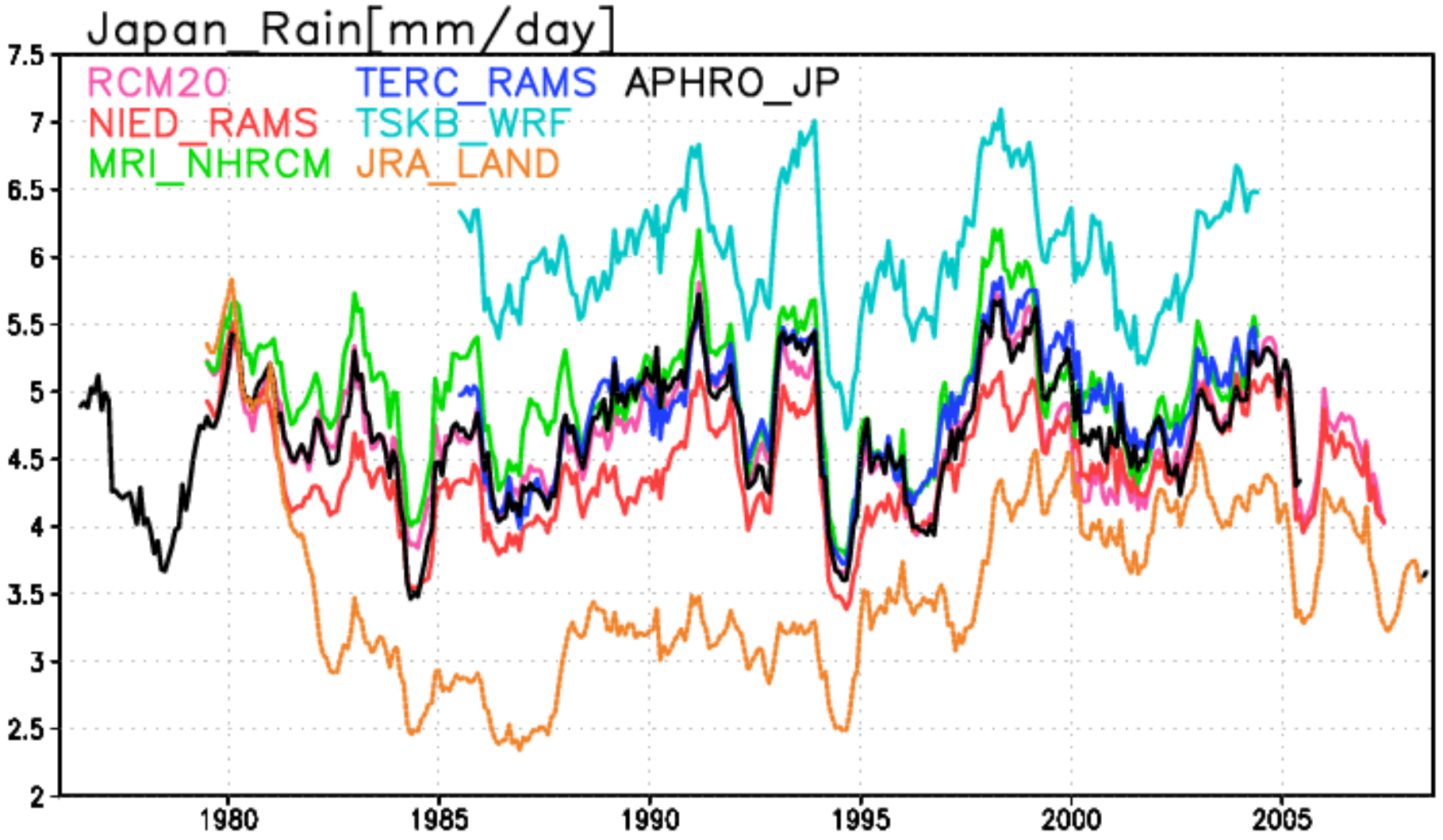
Impact studies

To increase the accuracy of DD

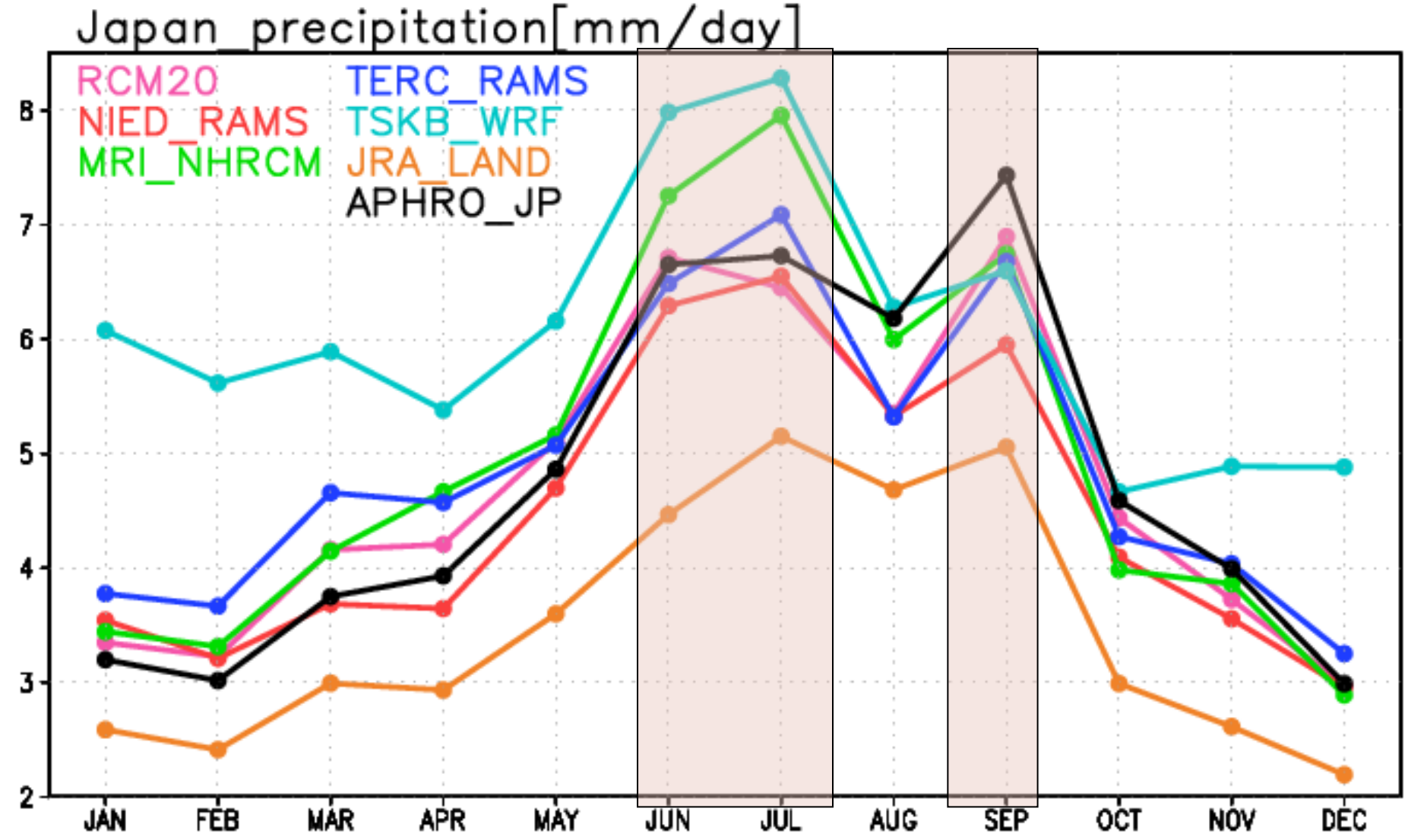


Multi RCMs downscaling experiment

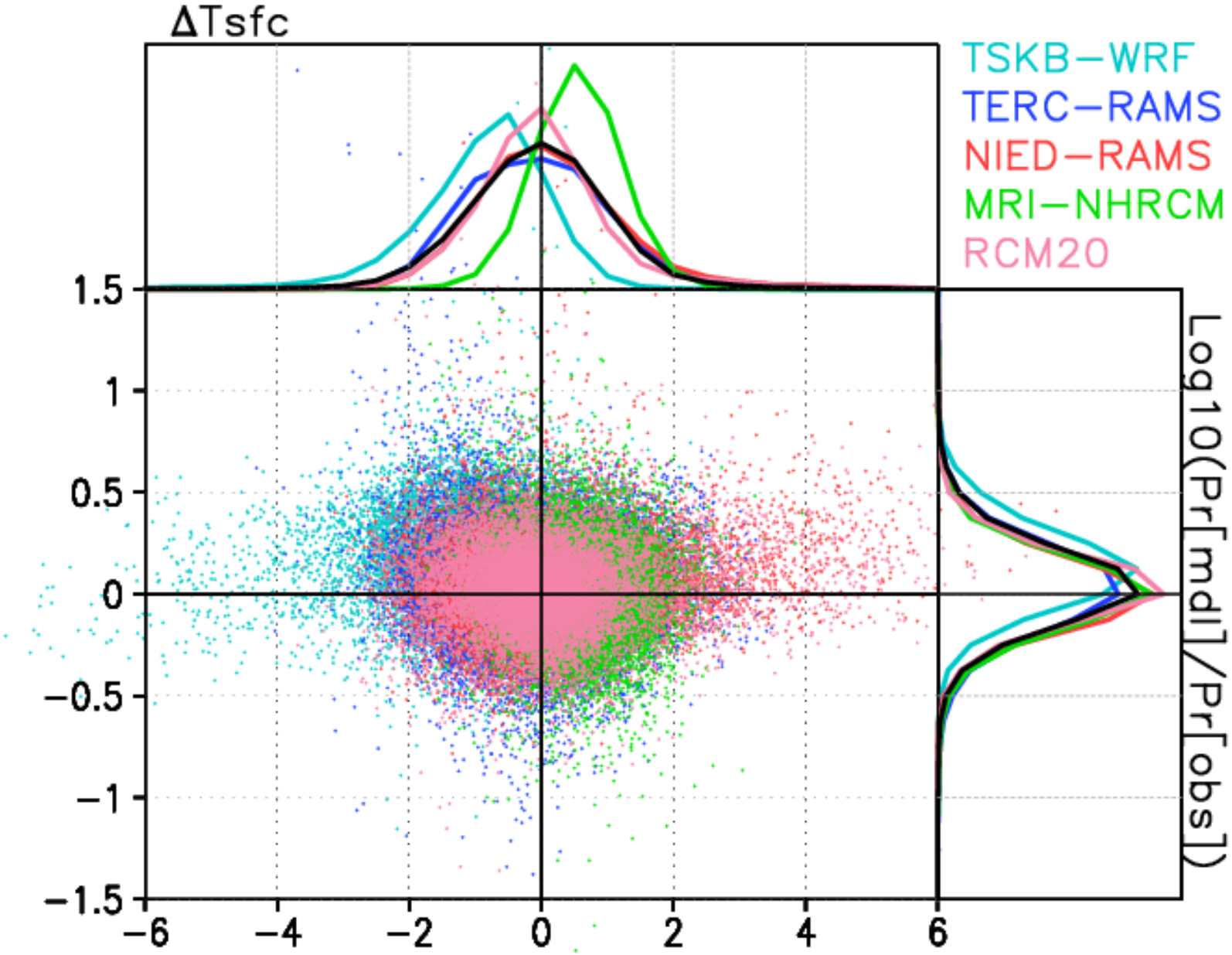




Inter annual variability is well reproduced by using RCMs. The black line in the figure indicates the rain-gauge based 1km grid data (APHRO-JP: Kamiguchi 2009)



Two rainy seasons in Japan are well represented in all RCMs



Biases of monthly mean surface air temperature (Tsfc) and precipitation (Pr) of 60 prefectures in Japan. Black lines indicate the mean value of all 5 models.

(ii) To derive information for use in impact studies

- (a) For urban area, because the effect of urbanizing and global warming should be compared, further DD by using urban canopy model is required.
- (b) For rural area, we need to correct biases remaining in the model results by applying SD, because the high accuracy data is requested form the impact study model.

DD of global climate change for urbanizing Kanto Plain

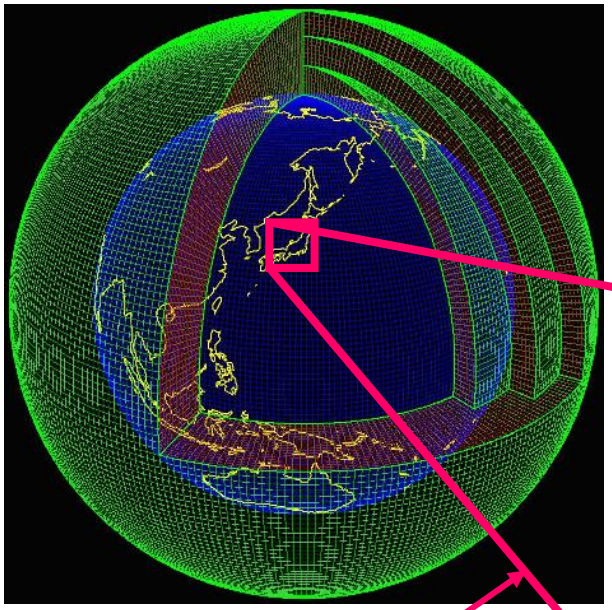
- Model : TERC-RAMS
- Hindcast : JRA25/JCDAS
- Projection : PGW-DS (Pseudo global warming DS)
- 4 AO-GCMs of A1B scenario are used for PGW-DS of 2070s

BCCR-BCM2.0
CGCM3.1(T63)
MIROC3.2(hires)
MRI-CGCM2.3.2

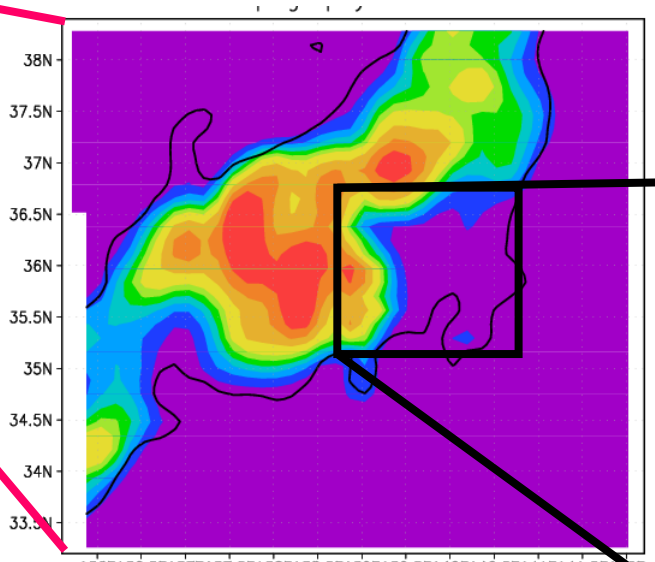
(Kimura and Adachi, 2009)

(a) Design of Urban canopy model exp.

AO-GCMs

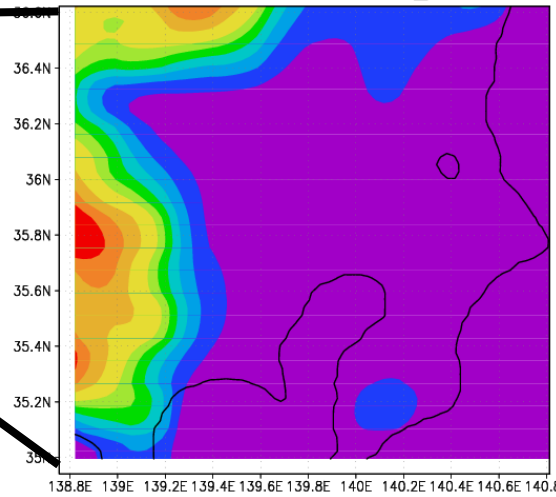


RCM (15km)



Urban Canopy model

(3km)

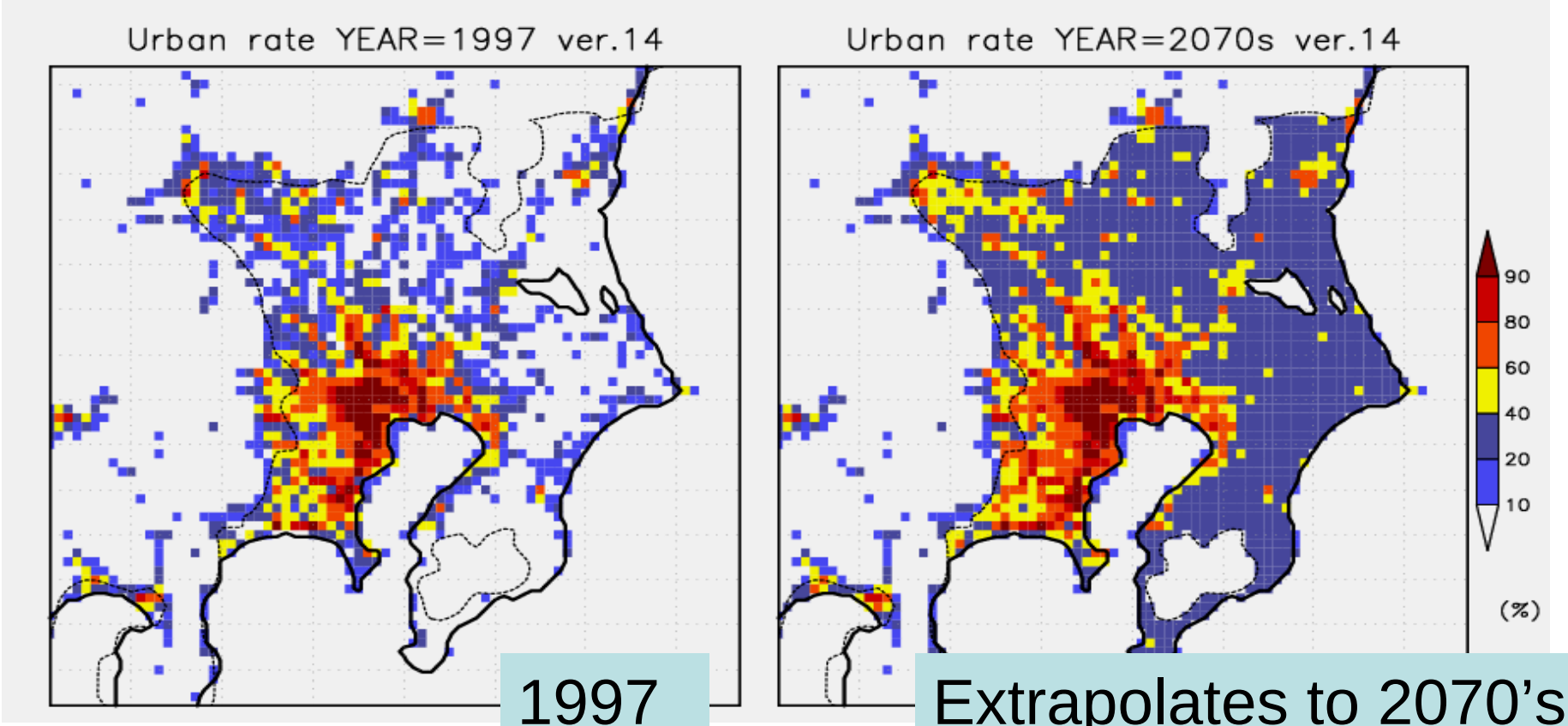


One way nesting

(PGW-DS)

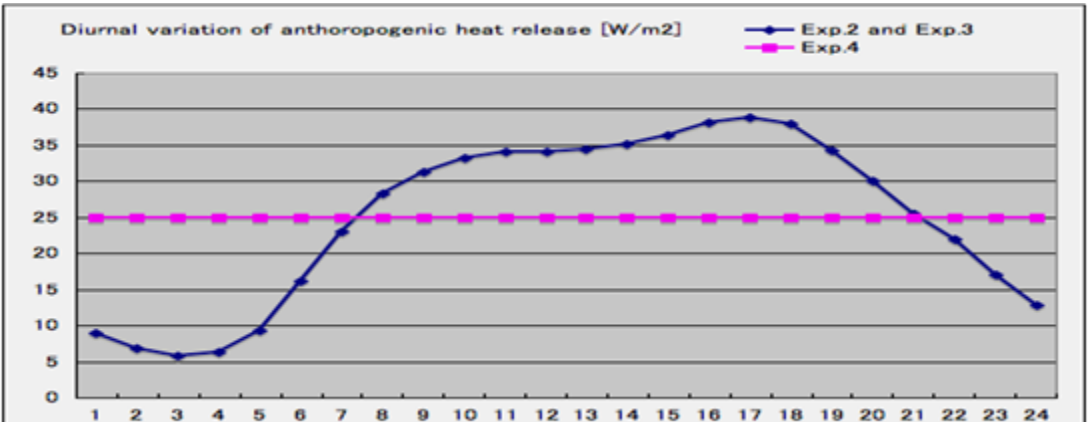
Two way nesting

Urban rate



1997

Extrapolates to 2070's

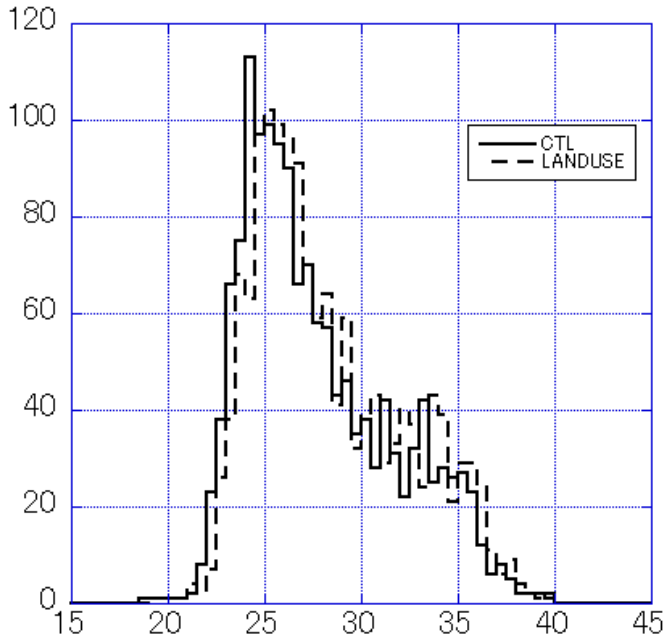


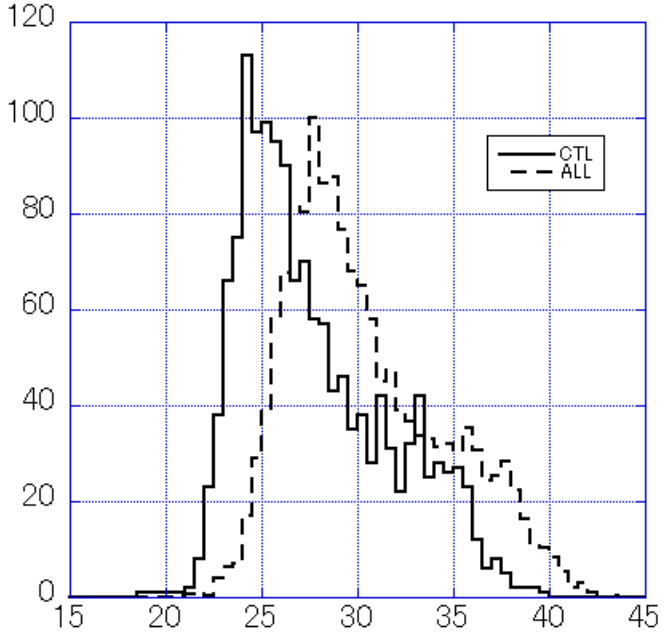
Artificial heat release

25W/m2

(in 100% urban rate)

1997 ➔ 2070's (suburban area)

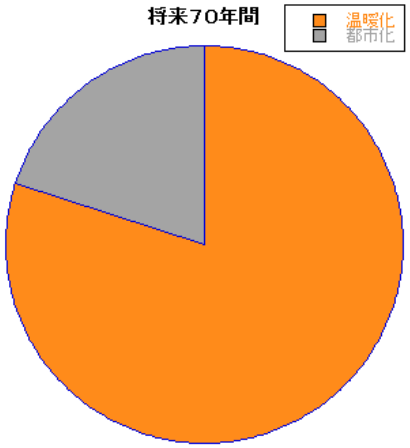




The effect of

Land-use change

0.5 – 1 C



The effect of

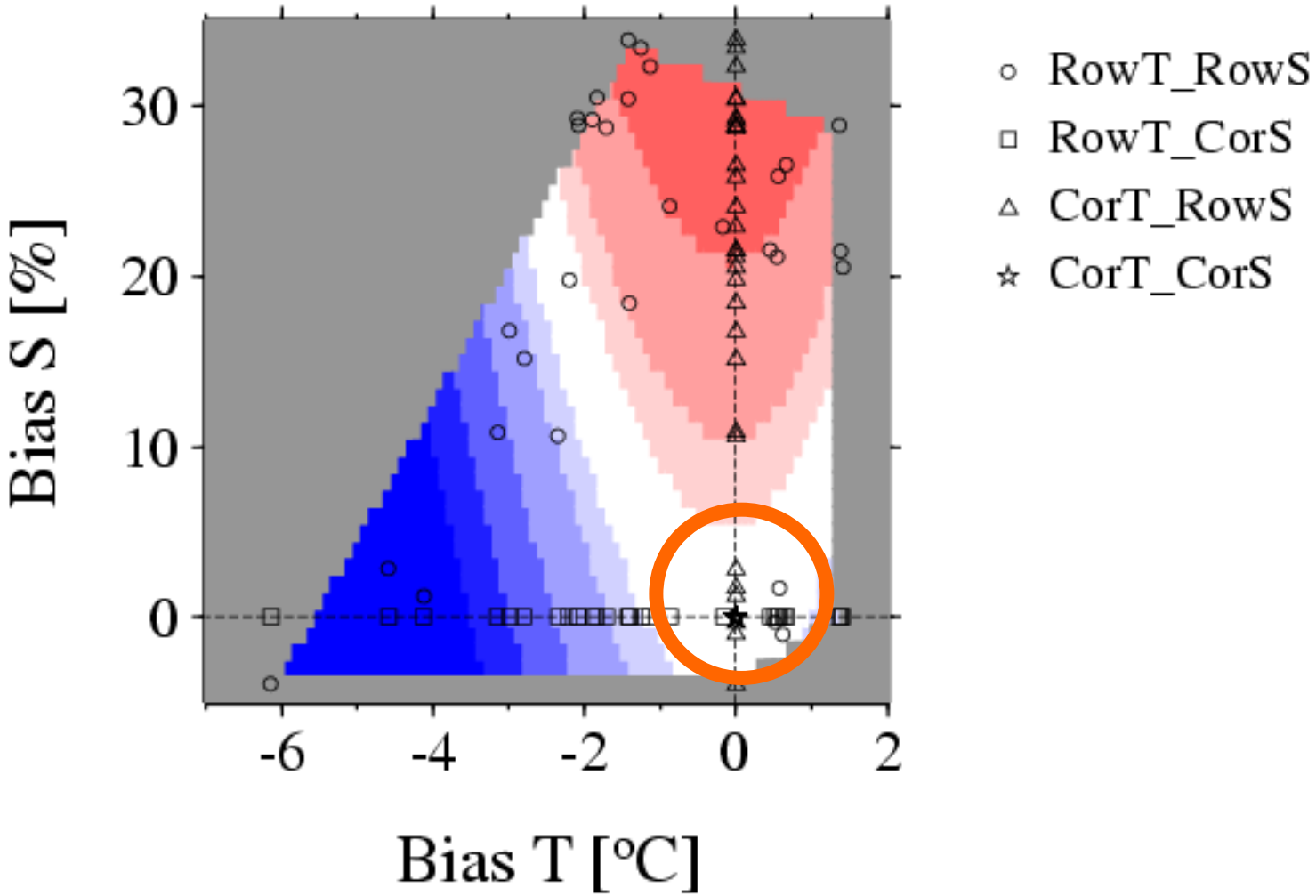
Global warming

3 C

(b) Correct bias, to use the data for crop yielding model (PRYSBI).

Table 1. List of names, number of ensemble members, spatial resolutions, institutes, countries, and references of climate model outputs used.

Name of CGCM, RCM, and reanalysis	# of members	Spatial resolution	Institutes	Country	Reference
CGCM3.1	3	3.8° x 3.8°	CCCma	Canada	Flato and Boer (2000)
CSIRO-Mk3.0	1	1.9° x 1.9°	CSIRO	Australia	Gorden et al. (2002)
CSIRO-Mk3.5	1	1.9° x 1.9°	CSIRO	Australia	Gorden et al. (2002)
GFDL-CM2.0	1	2.5° x 2.0°	GFDL	USA	Delworth et al. (2006)
MIROC2.3-MED	1	2.8° x 2.8°	CCSR/NIES/FRCGC	Japan	K-1 model developers (2004)
MIROC2.3-HI	1	1.1° x 1.1°	CCSR/NIES/FRCGC	Japan	K-1 model developers (2004)
MRI-CGCM2.3.2A	1	2.8° x 2.8°	MRI	Japan	Yukimoto and Noda (2002)
MRI-RCM20	1	20 km x 20 km	JMA/MRI	Japan	Kurihara et al. (2005)
JRA25	1	1.1° x 1.1°	JMA/CRIEI	Japan	Onogi et al. (2007)



To drive the Process-based Regional-scale Rice Yield Simulator with Bayesian Inference (PRYSBI) model with the error less than 5%, we need the data with the surface temperature bias less than 1C and insolation bias in rate less than 5%. To satisfy this accuracy, we need to correct the data before applying the PRYSBI model.

Summary (1)

- We need to estimate the uncertainty of DD
  - We drive several RCMs to estimate the uncertainty of the DD results.
    - JRA-25/JCDAS reanalysis data's DD (1979-2007) has been done.
    - MIROC3 AO-GCM's A1B DD（1980－2000, 2080-2100) has been done.
    - We are now planning to downscale MIROC5 RCP 4.5W scenario.

Summary (2)

- To derive information for use in impact studies
  - For urban area, we apply further dynamical downscaling method, by using urban canopy models.
  - For rural area, we use statistical downscaling method, to correct the biases in the model results.

Problems left in future (1)

- To estimate the uncertainty, we perform only single GCM x multi RCMs DS.
- It is believed that the uncertainty of GCMs are much larger than RCMs.
- Here we try to estimate the uncertainty of GCMs by using inflation method.
- However, multi GCM x multi RCM DS is left in future.

Problems left in future (2)

- Here we adopt 20km grid model as multi model DD.
- However in GCM research, adopting of cloud resolving model is now considered.
- For considering mitigation of global warming in the local scale, we need much higher resolution DS data.

Problems left in future (3)

- In this project, the development of RCM is not planned. The system has been constructed by using only completed version of the model.
- Considering the usability, we try to DS to much higher resolution by using DD or SD.
- DD directly by using the cloud resolving model is left for another project.

Thank you