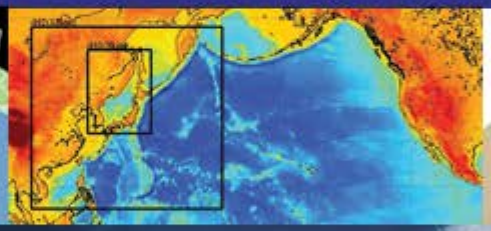
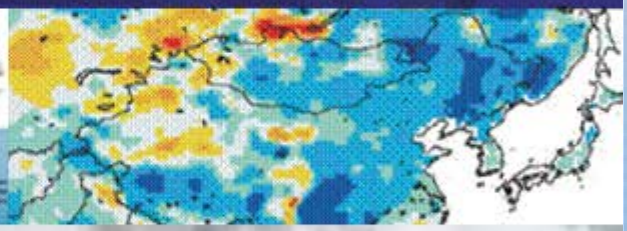
RCM session (S10).21 Oct 2014@PICES Annual Meeting

Regional climate change projection for the western North Pacific by dynamical downscaling

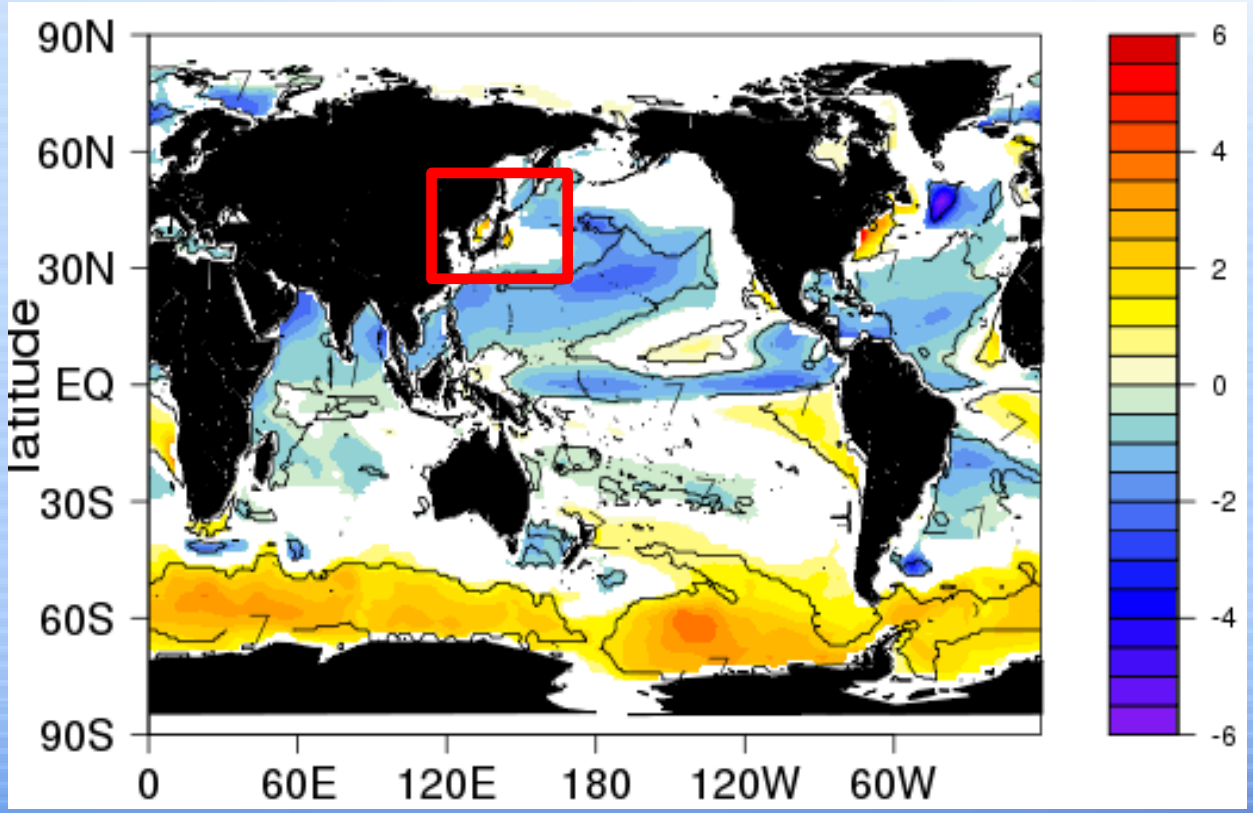



Chul Min Ko, Chan Joo Jang,

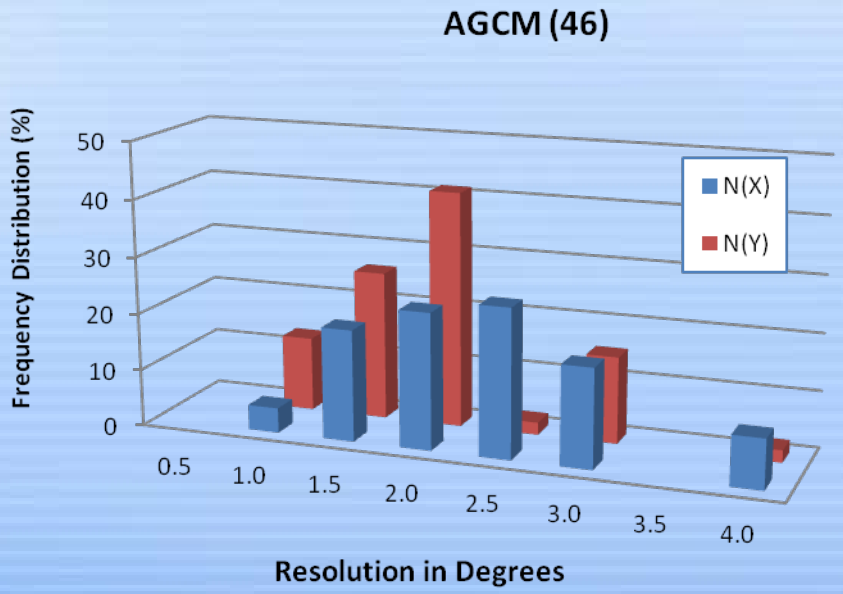
Ho-Jeong Shin and Yong Sun Kim

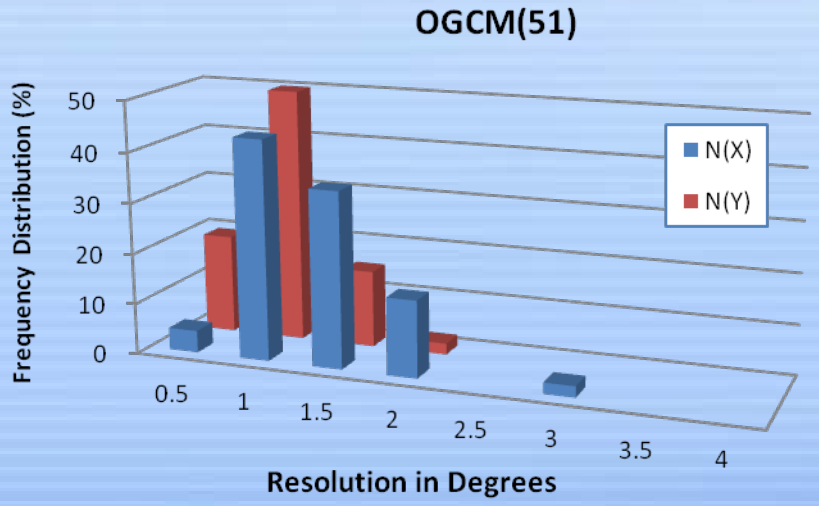
Korea Institute of Ocean Science & Technology

SST Biases (Feb): MME (9)

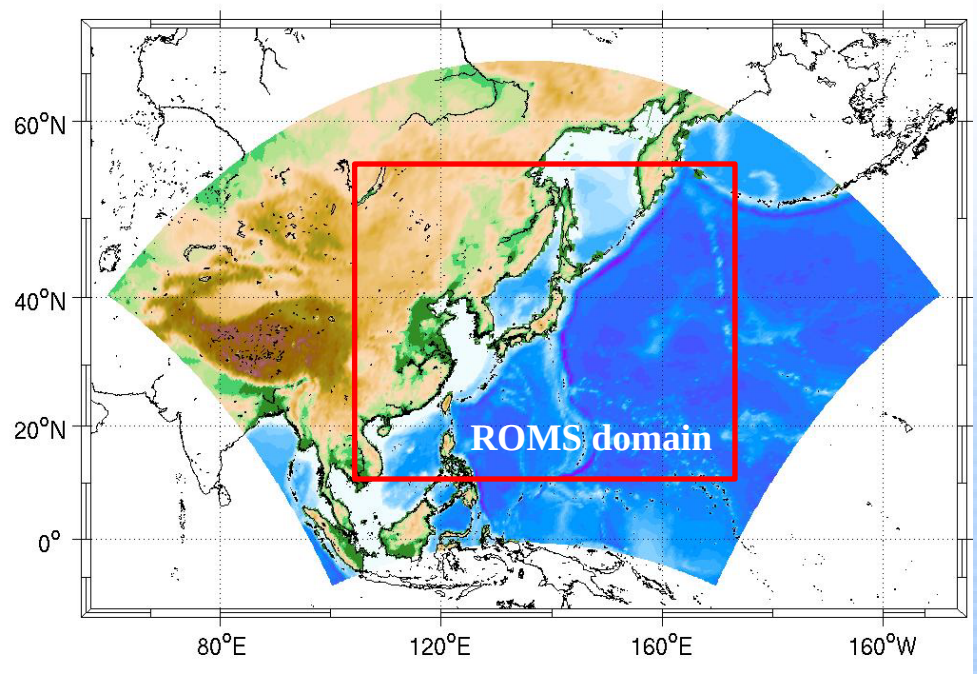


CMIP5
Horizontal resolution Histogram





RCM



ROMS V3.2	
Domain	105°E~175°E, 10°N~55°N
Horizontal resolution	1/12°(≒10km)
Vertical layers	30 layers
I.C & B.C	SODA V2.2.4 monthly mean reanalysis data (u, v, temp. salt. ssh)
	NCEP RA2 daily mean reanalysis with bulk formula and PGW method
Vertical mixing scheme	KPP

CMIP5 Modeling Groups

Reference: Historical Experiment

Modeling Center	Model	Institution	Country
BCC (2)	BCC-CSM1.1 BCC-CSM1.1(m)	Beijing Climate Center, China Meteorological Administration	China
CCCma (2)	CanCM4 CanESM2	Canadian Centre for Climate Modelling and Analysis	Canada
CMCC (3)	CMCC-CESM CMCC-CM CMCC-CMS	Centro Euro-Mediterraneo per I Cambiamenti Climatici	Italy
CNRM-CERFACS (2)	CNRM-CM5 CNRM-CM5-2	Centre National de Recherches Meteorologiques / Centre Europeen de Recherche et Formation Avancees en Calcul Scientifique	France
CSIRO-BOM (2)	ACCESS1.0 ACCESS1.3	CSIRO (Commonwealth Scientific and Industrial Research Organisation, Australia), and BOM (Bureau of Meteorology, Australia)	Australia
CSIRO-QCCCE (2)	CSIRO-Mk3.6.0 CSIRO-Mk3L-1.2	Commonwealth Scientific and Industrial Research Organisation in collaboration with the Queensland Climate Change Centre of Excellence	Australia
EC-EARTH (1)	EC-EARTH	EC-EARTH consortium	Europe
FIO (1)	FIO-ESM	The First Institute of Oceanography, SOA, China	China
GCESS (1)	BNU-ESM	College of Global Change and Earth System Science, Beijing Normal University	China
INM (1)	INM-CM4	Institute for Numerical Mathematics	Russia
IPSL (3)	IPSL-CM5A-LR IPSL-CM5A-MR IPSL-CM5B-LR	Institut Pierre-Simon Laplace	France
LASG-CESS (1)	FGOALS-g2	LASG, Institute of Atmospheric Physics, Chinese Academy of Sciences; and CESS, Tsinghua University	China
LASG-IAP (1)	FGOALS-s2	LASG, Institute of Atmospheric Physics, Chinese Academy of Sciences	China
MIROC (2)	MIROC4h MIROC5	Atmosphere and Ocean Research Institute (The University of Tokyo), National Institute for Environmental Studies, and Japan Agency for Marine-Earth Science and Technology	Japan
MIROC (2)	MIROC-ESM MIROC-ESM-CHEM	Japan Agency for Marine-Earth Science and Technology, Atmosphere and Ocean Research Institute (The University of Tokyo), and National Institute for Environmental Studies	Japan
MOHC (additional realizations by INPE) (3)	HadCM3 HadGEM2-CC HadGEM2-ES	Met Office Hadley Centre (additional HadGEM2-ES realizations contributed by Instituto Nacional de Pesquisas Espaciais)	UK
MPI-M (3)	MPI-ESM-LR MPI-ESM-MR MPI-ESM-P	Max Planck Institute for Meteorology (MPI-M)	Germany
MRI (2)	MRI-CGCM3 MRI-ESM1	Meteorological Research Institute	Japan
NASA GISS (4)	GISS-E2-H GISS-E2-H-CC GISS-E2-R GISS-E2-R-CC	NASA Goddard Institute for Space Studies	USA
NCAR (1)	CCSM4	National Center for Atmospheric Research	USA
NCC (2)	NorESM1-M NorESM1-ME	Norwegian Climate Centre	Norway
NIMR/KMA (1)	HadGEM2-AO	National Institute of Meteorological Research/Korea Meteorological Administration	South Korea
NOAA GFDL (4)	GFDL-CM2.1 GFDL-CM3 GFDL-ESM2G GFDL-ESM2M	Geophysical Fluid Dynamics Laboratory	USA
NSF-DOE-NCAR (5)	CESM1(BGC) CESM1(CAM5) CESM1(CAM5.1, FV2) CESM1(FASTCHEM) CESM1(WACCM)	National Science Foundation, Department of Energy, National Center for Atmospheric Research	USA

Country	Number of Models	# of center
Australia	4	2
Canada	2	1
China	6	5
Europe	1	1
France	5	2
Germany	3	1
Italy	3	1
Japan	6	3
Norway	2	1
Russia	1	1
South Korea	1	1
UK	3	1
USA	14	4
13	**51**	**24**

CMIP5 models

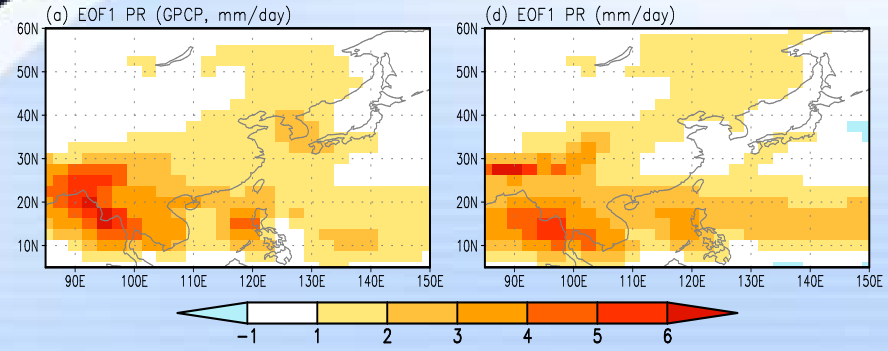
-MVEOF was applied to climatological Asian summer monsoon annual cycle

-obtained from **16 models**

Designation	nz	nt	start year
1. BCC-CSM1-1	17	1956	1850
2. BCC-CSM1-1-M	17	1956	1850
3. BNU-ESM	17	1872	1850
4. CMCC-CESM	33	1872	1850
5. CMCC-CM	17	1872	1850
6. CMCC-CMS	33	1872	1850
7. CNRM-CM5	17	1872	1850
8. CanCM4	22	540	1961
9. CanESM2	22	1872	1850
10. FIO-ESM	17	1872	1850
11. HadCM3	17	1753	Dec 1859
12. MPI-ESM-LR	25	1872	1850
13. MPI-ESM-MR	25	1872	1850
14. MPI-ESM-P	25	1872	1850
15. NorESM1-M	17	1872	1850
16. NorESM1-ME	17	1872	1850

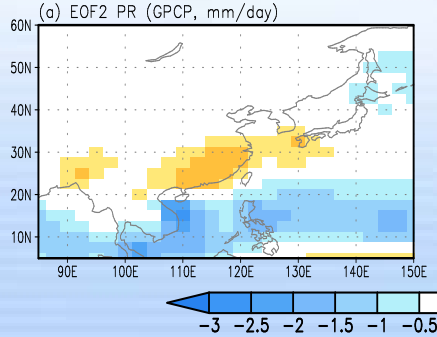
MVEOF for climatological annual cycle
East Asia (85E-150E, 5N-60N)

OBS MVEOF mode 1 (64%)

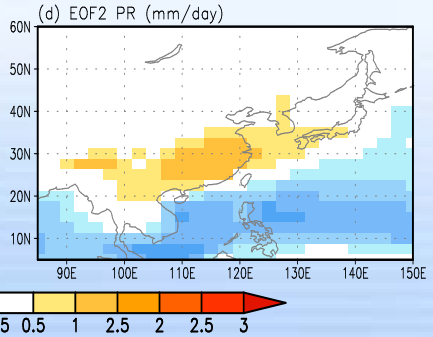


CMIP5 MME mean MVEOF mode 1 (61%)

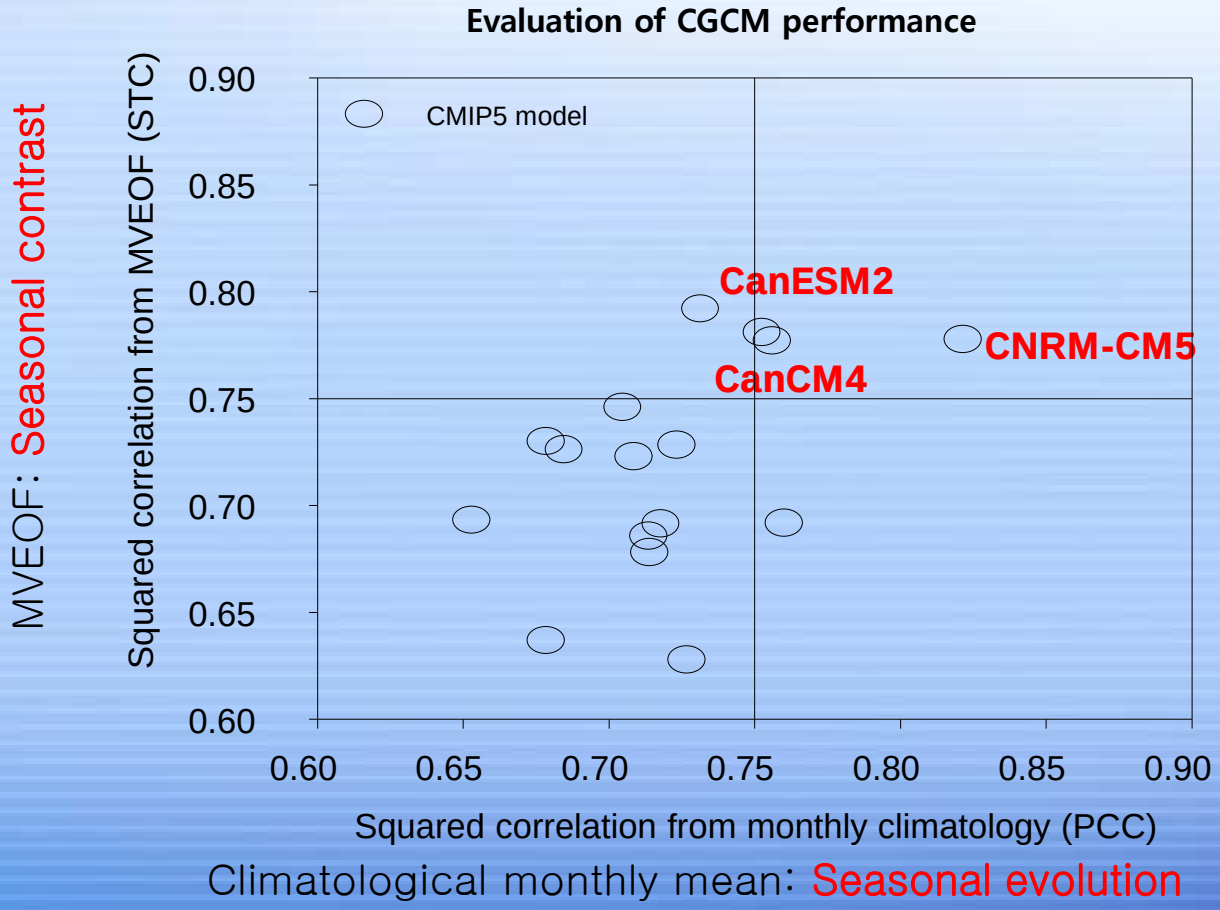
OBS MVEOF mode 2 (22%)



CMIP5 MME mean MVEOF mode 2 (26%)



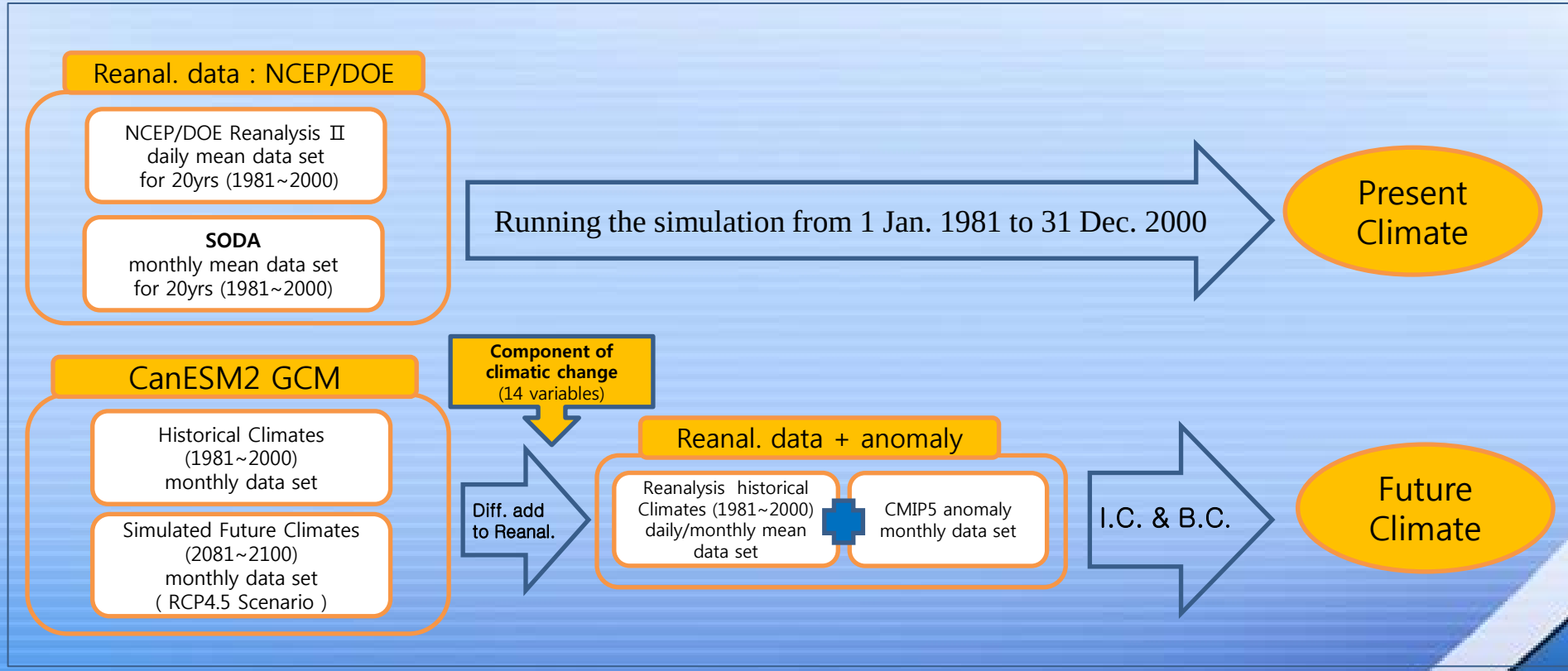
Evaluation of CMIP5 models
(summer precipitation East Asia (85E-150E, 5N-60N))



RCM projection

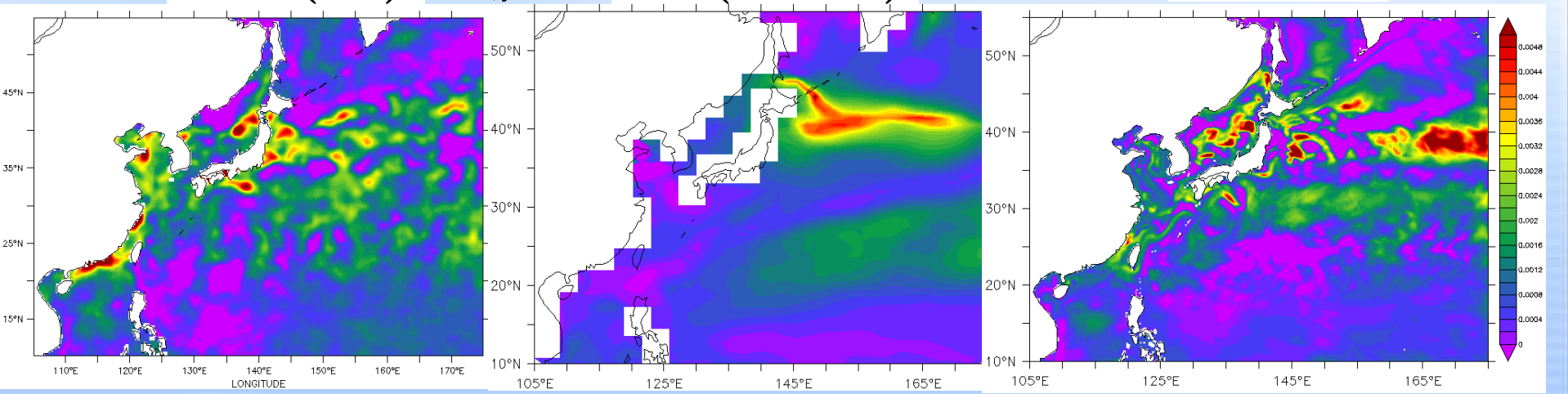
Pseudo Global Warming

Present: 1981-2000, Future: 2081-2100



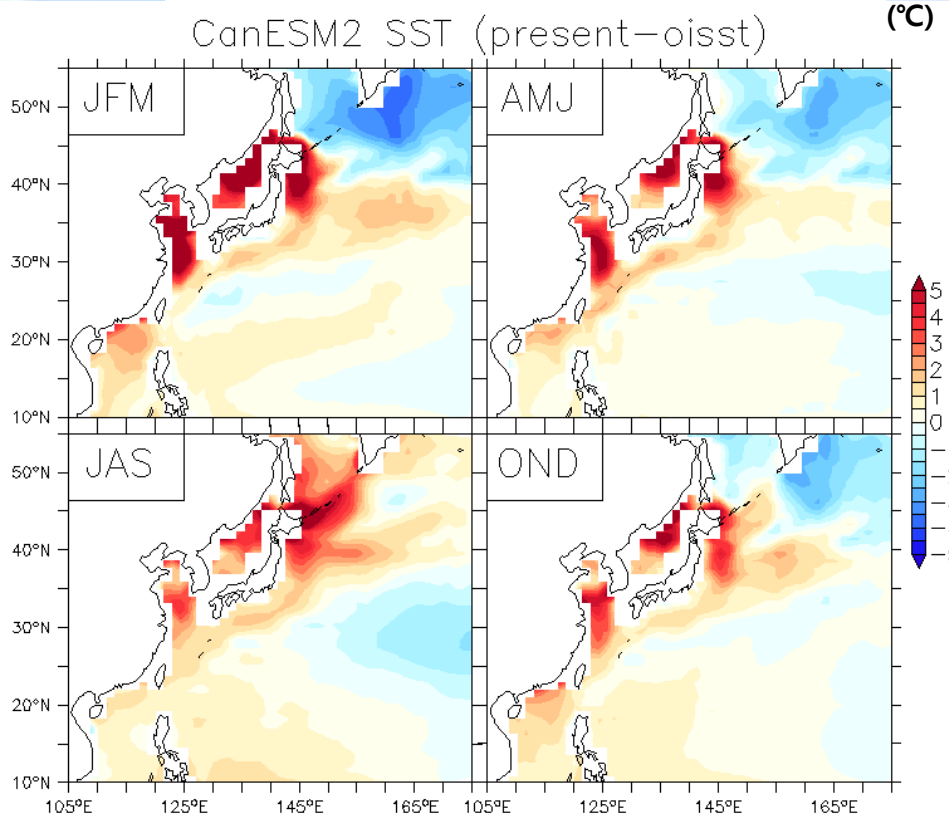
Linear Trends of SST (Feb)

OISST (Obs.) °C/yr **GCM(CanESM2)** **RCM**

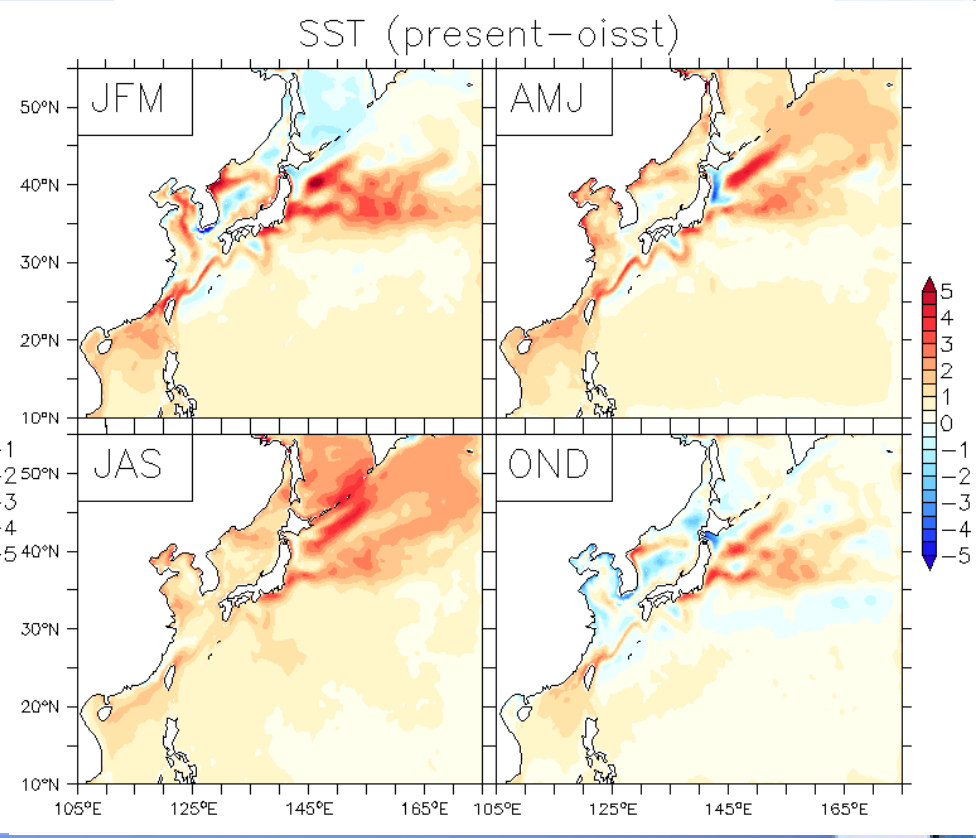


Model Bias (SST)
(model – observation(OISST))

GCM(CanESM2)

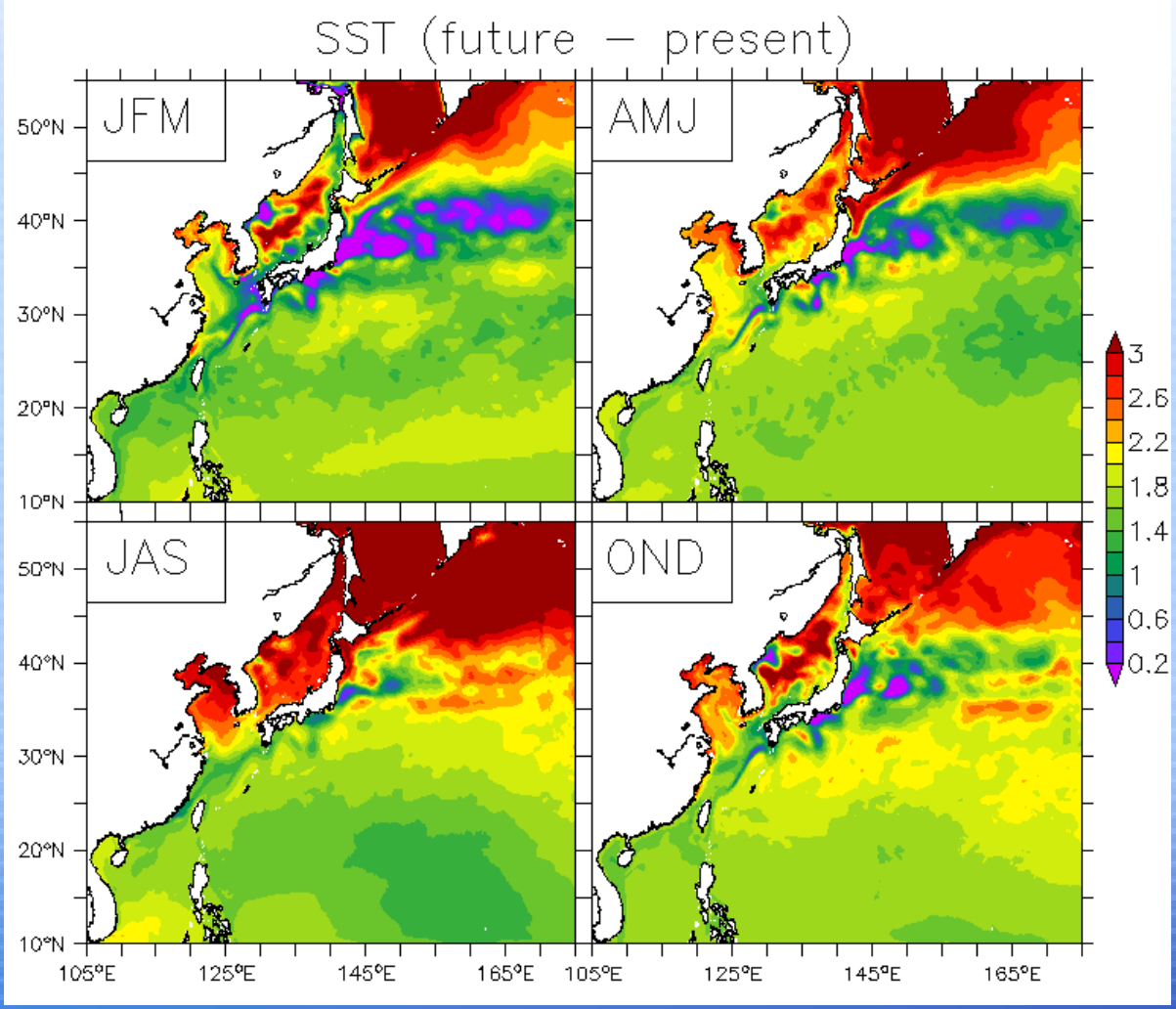


RCM

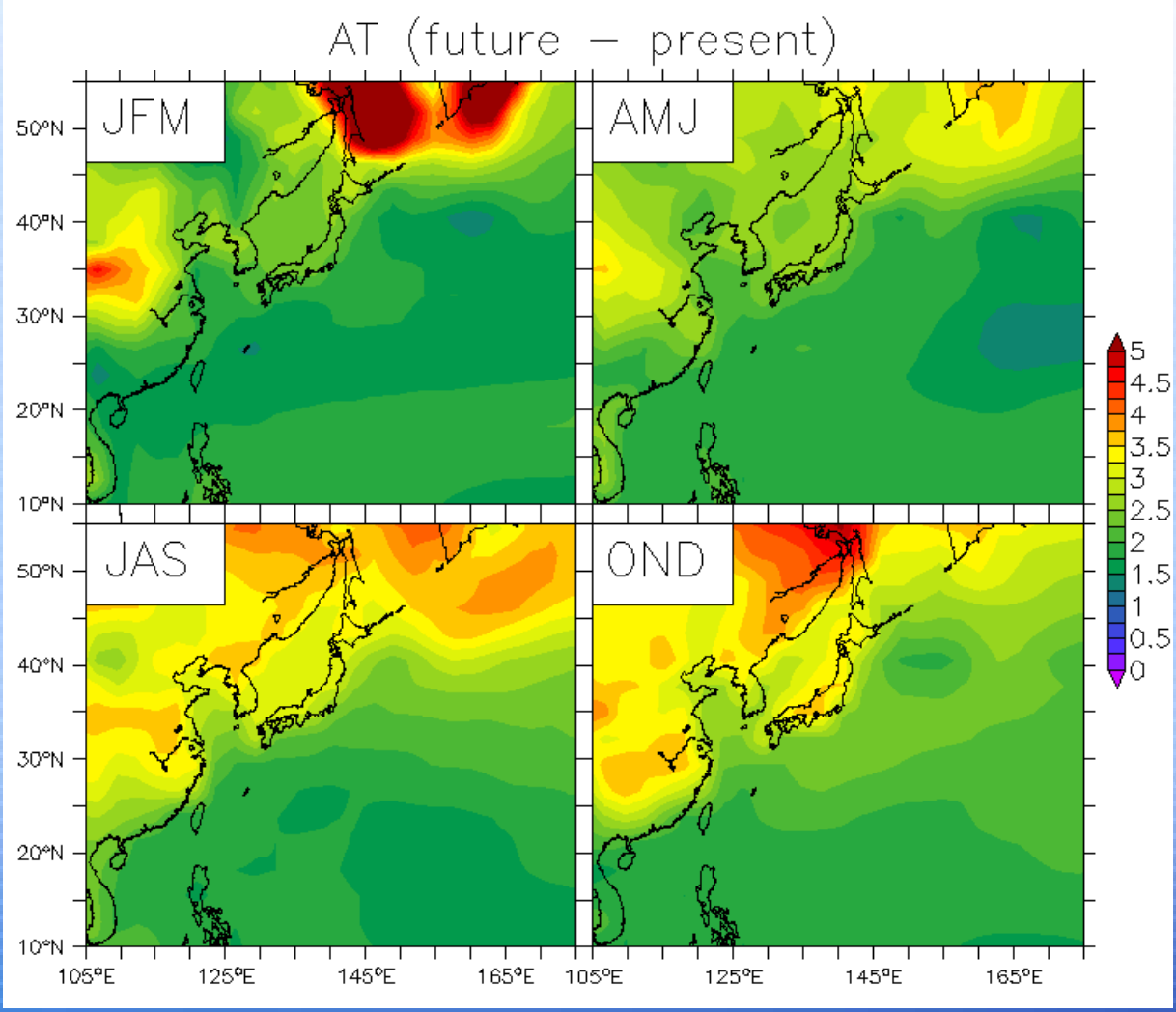


RCM Projected Changes: Preliminary Results

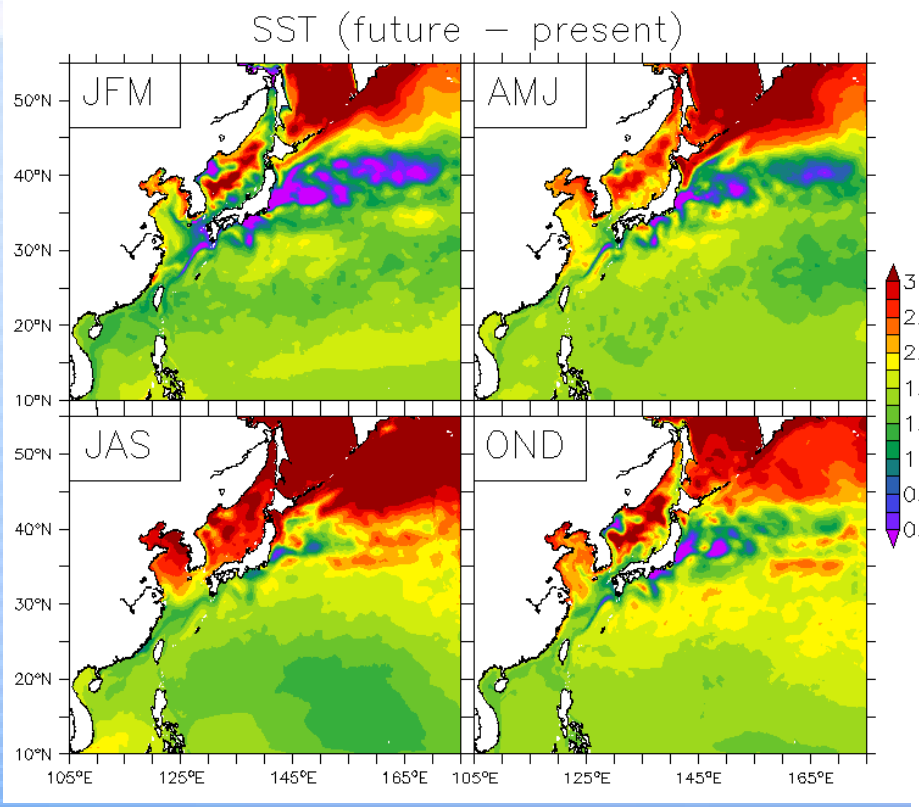
Projected SST changes

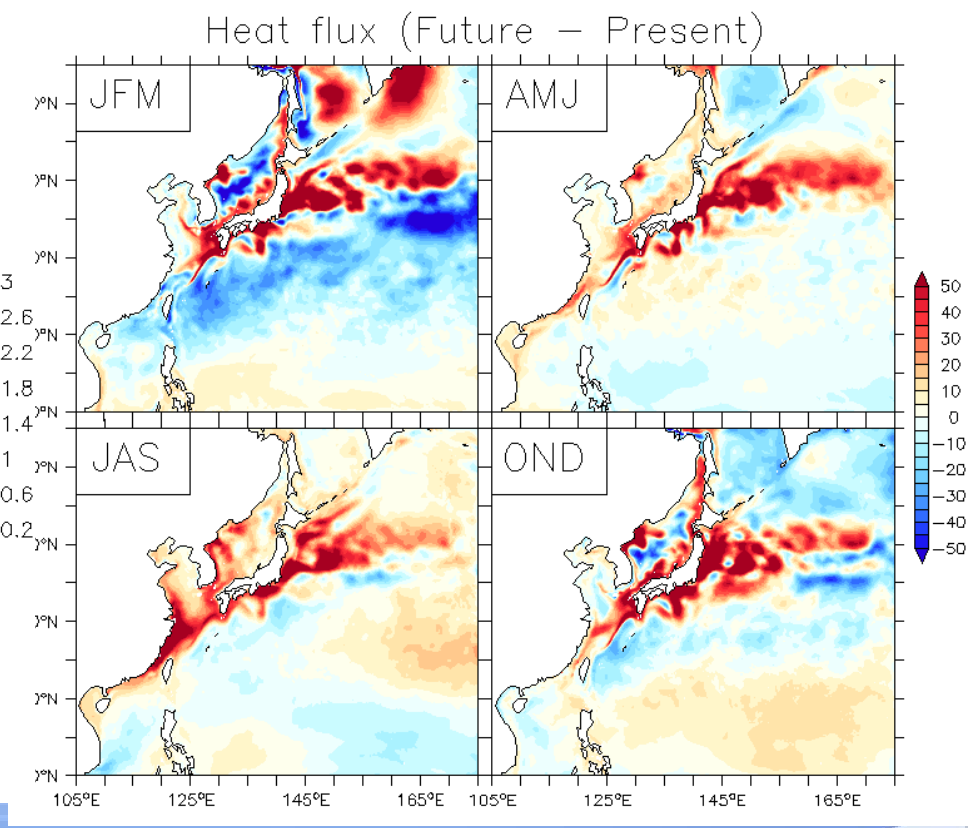


Projected AT changes



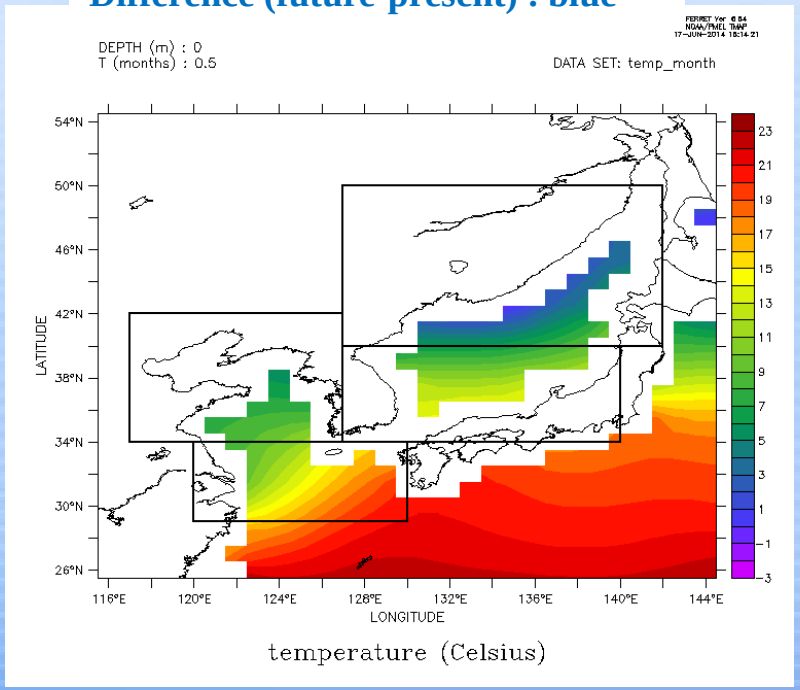
Changes: SST vs. Heat flux

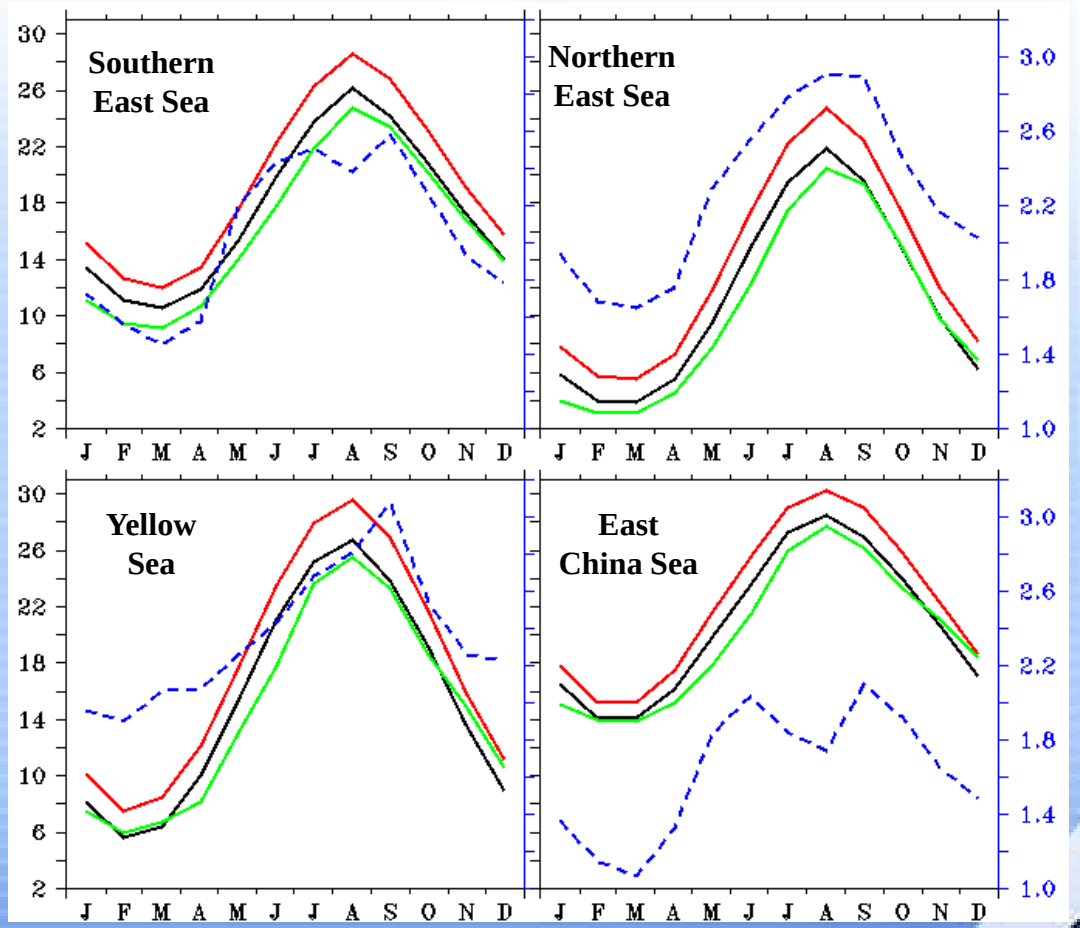




SST changes

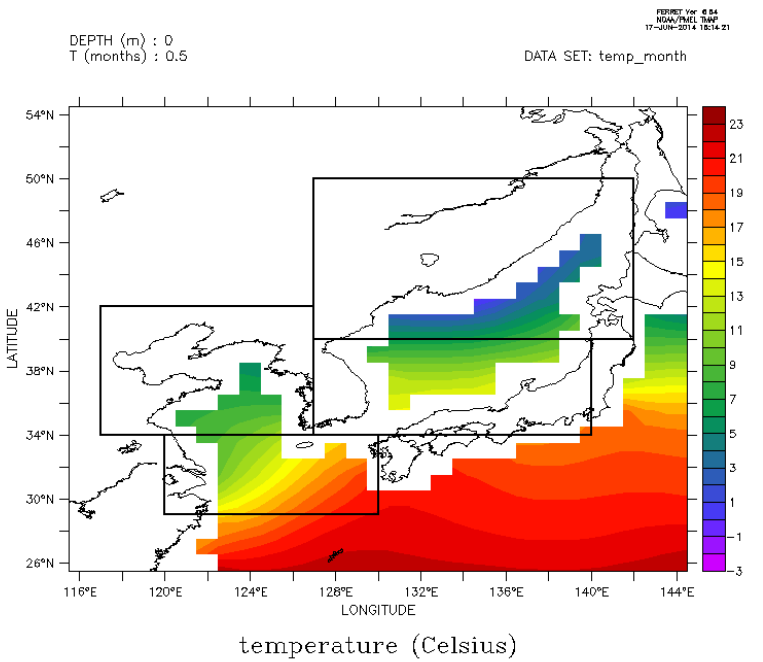
Future : red
Present : black
Observation : green
Difference (future-present) : blue

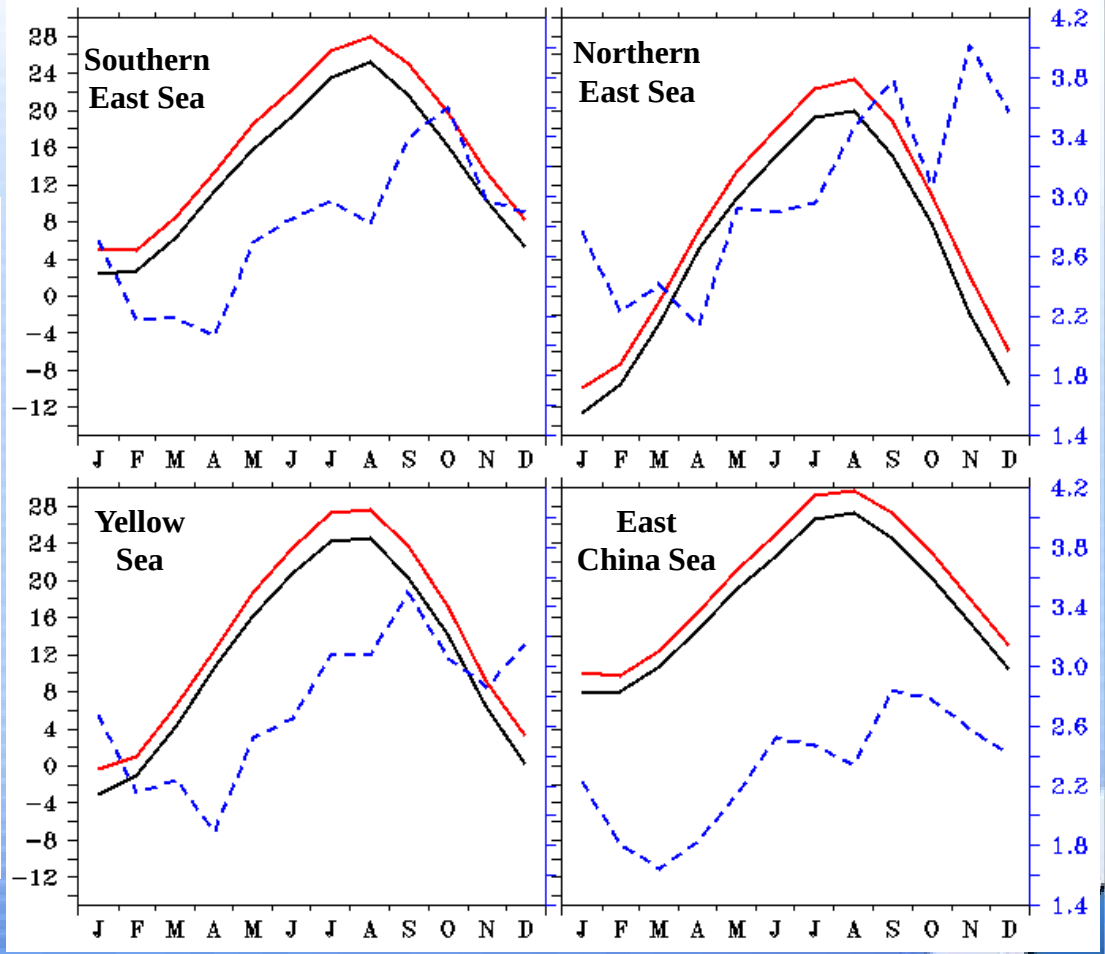




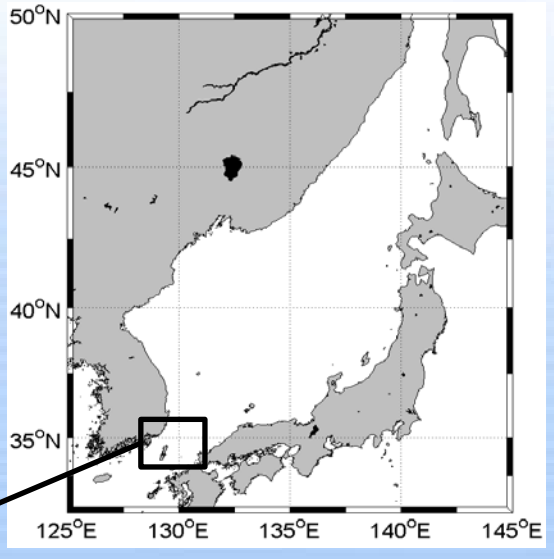
Surface Air Temp. Changes

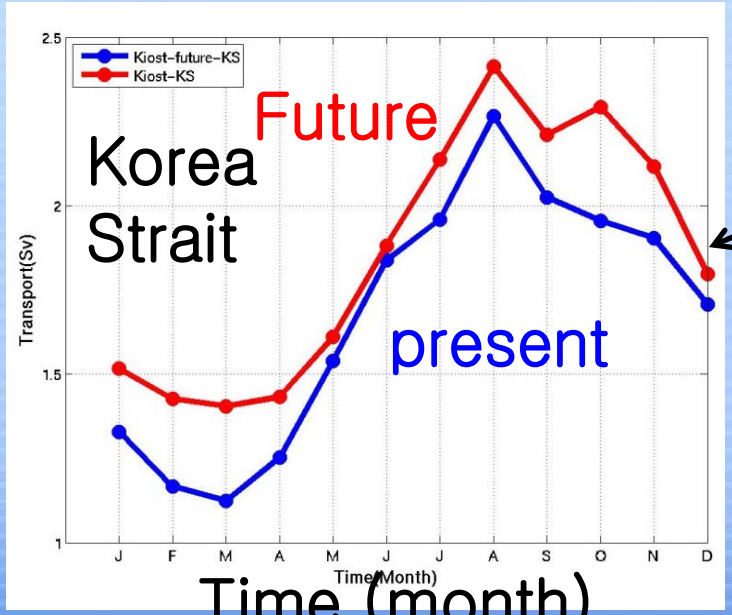
Future : red
Present : black
Difference (future-present) : blue





Transport changes

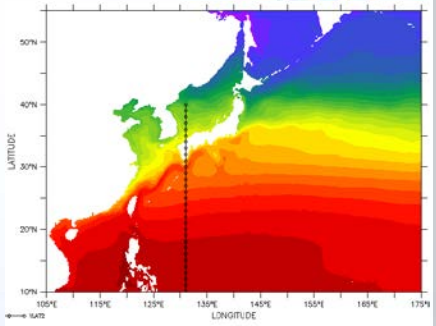




Transport (Sv)

Time (month)

Temperature Changes 131°E

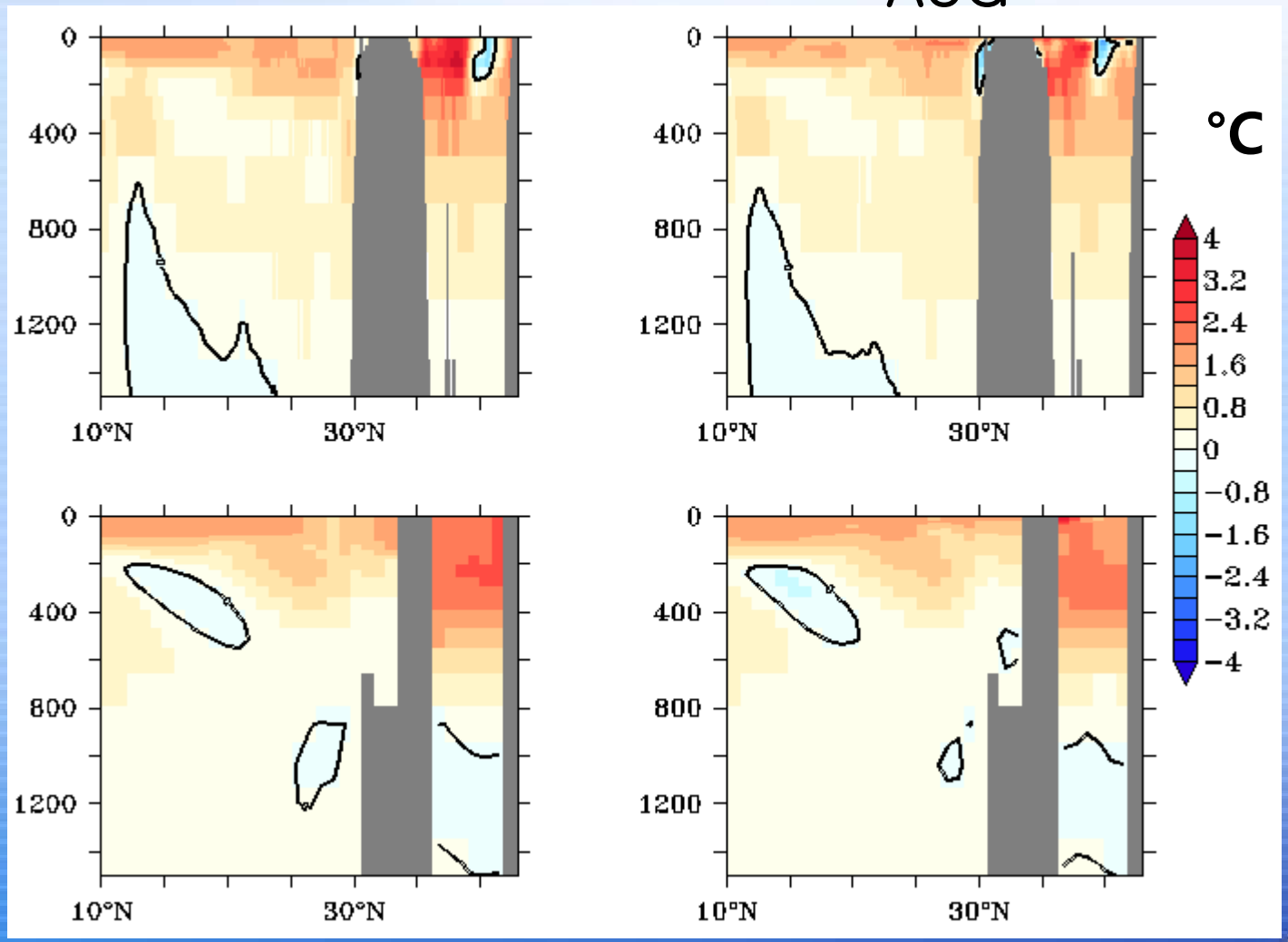


Feb

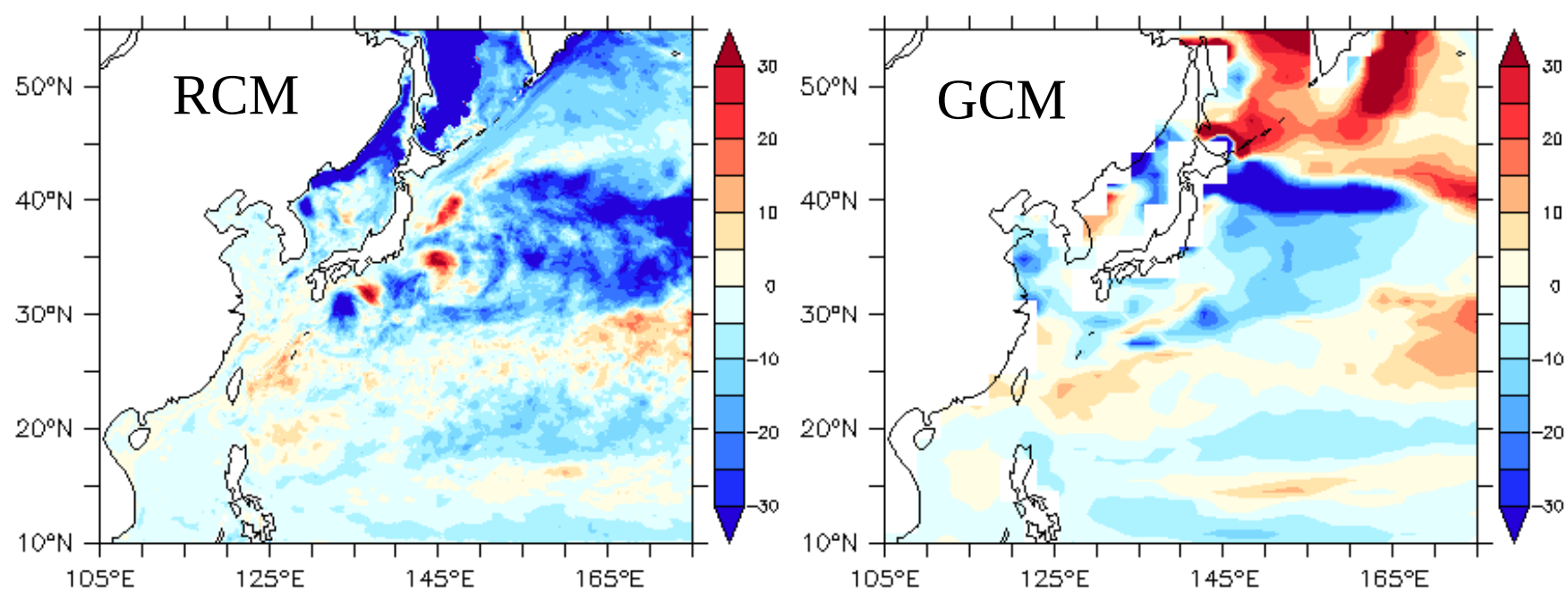
AUG

RCM

GCM



MLD change (March)
RCM vs. GCM



Conclusion

- With a RCM downscaling forced with a GCM projected changes, we found that a local maximum warming in the Okhotsk Sea and a minimum warming in the mixed water region between the Kuroshio and the Oyashio Current.
- This warming pattern appears to be highly related with the GCM projection used for downscaling, suggesting that a multi-GCM forcing approach is essential for RCM downscaling for the western North Pacific Ocean.

Thanks