

# Climate Change Projections using Representative Concentration Pathways and HadGEM2-AO Climate Model



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# Outline

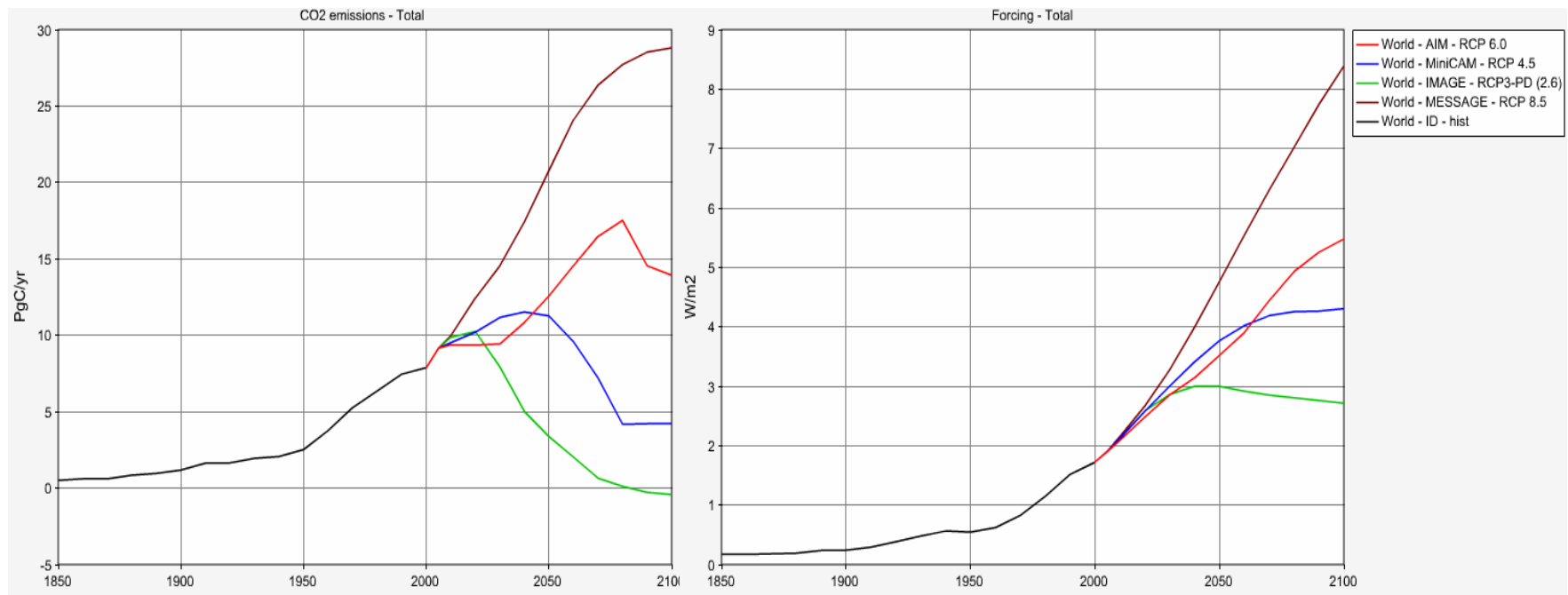
- ✓ RCPs & CMIP5
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- ✓ Summary & Future Plans



# CO<sub>2</sub> Emissions and Radiative Forcing for Historic & RCP scenarios

## CO<sub>2</sub> Emissions

## Radiative Forcing



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# Representative Concentration Pathways(RCPs)

Name	Radiative Forcing	Concentration	Pathway shape
<b>RCP 8.5</b>	<b>&gt;8.5 W/m<sup>2</sup> in 2100</b>	<b>&gt; ~1370 CO<sub>2</sub>-eq in 2100</b>	<b>Rising</b>
RCP 6	~6 W/m <sup>2</sup> at stabilization after 2100	~850 CO <sub>2</sub> -eq (at stabilization after 2100)	Stabilization without overshoot
<b>RCP 4.5</b>	<b>~4.5 W/m<sup>2</sup> at stabilization after 2100</b>	<b>~650 CO<sub>2</sub>-eq (at stabilization after 2100)</b>	<b>Stabilization without overshoot</b>
<b>RCP 3-PD</b>	<b>peak at ~3W/m<sup>2</sup> before 2100 and then decline</b>	<b>peak at ~490 CO<sub>2</sub>-eq before 2100 and then decline</b>	<b>Peak and decline</b>

Moss, J. A. et al., 2010, The next generation of scenarios for climate change research and assessment. Nature 463, 747-756, doi:10.1038/nature08823



# CMIP5 Modeling Groups

Primary Group	Country	Primary Contact	Primary Group	Country	Primary Contact
NERSC	Norway	M. Bentsen, H. Drange	CSIRO & QCCCE	Australia	L. Rotsyayn, J. Syktus, S. Jeffrey
Hadley Centre	U.K.	M. Collins, C. Jones	NCAR	U.S.	J. Hurrell, G. Meehl
GFDL	U.S.	T. Delworth, I. Held, L. Horowitz, R. Stouffer	MRI	MRI	M. Kimoto
IPSL & LMD	France	J.L. Dufresne, S. Bony	<b>NIMR(with Hadley Centre)</b>	<b>Korea</b>	<b>W.T. Kwon</b>
NIES & U. Tokyo	Japan	S. Emori, M. Kawamiya, M. Kimoto	LASG IAP	China	T.Zhou, B. Wang
CCCMA	Canada	G. Flato	NASA GISS	U.S.	G. Schmidt
MPI	Germany	M. Giorgetta	BCC	China	Q. Li, Y. You, Z. Wang, T. Wu, Y. Xu
INGV	Italy	S. Gualdi	INM	Russia	E. Volodin
EC-Earth	Europe	W. Hazeleger	CERFACS&CNRM	France	S. Planton/D Salas Melia
CSIRO & BMRC	Australia	T. Hirst, K. Puri	U. Reading	U.K.	L. Shaffrey
NASA GSFC	U.S.	M. Suarez			



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# HadGEM2-AO Climate Model

- The climate model HadGEM2 was developed by Hadley Centre and improved over HadGEM1 (participated in IPCC AR4)
- Simulation for CMIP5 using HadGEM2-ES by Hadley Centre and HadGEM2-AO by NIMR
- Resolution:
  - atmospheric horizontal resolution of  $1.875^\circ \times 1.25^\circ$  and ocean horizontal resolution of  $1.0^\circ \times 1.0^\circ$ , with latitudinal resolution increasing smoothly from 30 N/S to 0.33 at equator
  - The vertical resolution for atmosphere and ocean are L30 and L40, respectively

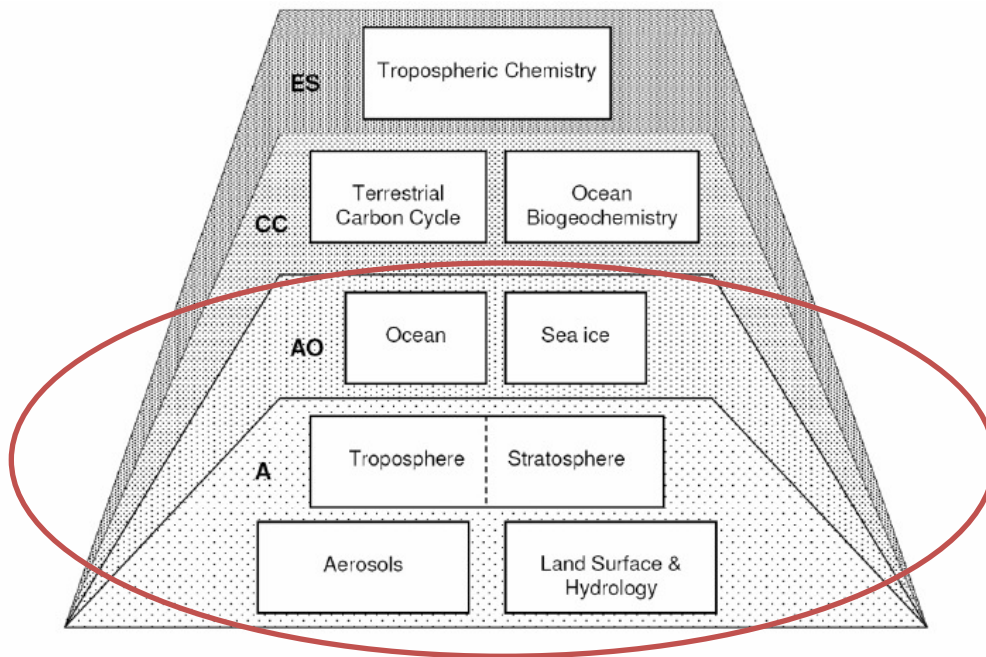
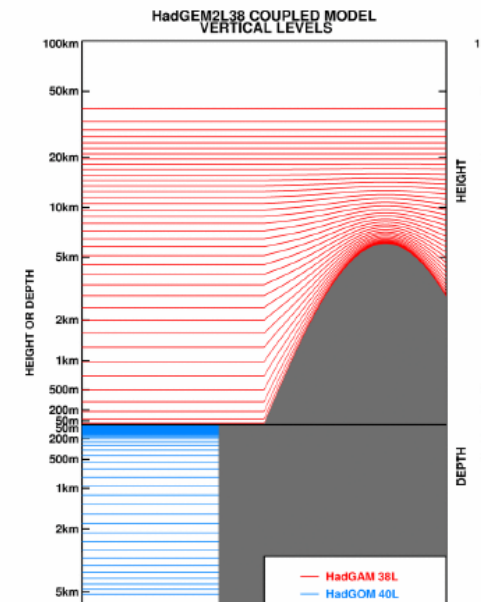
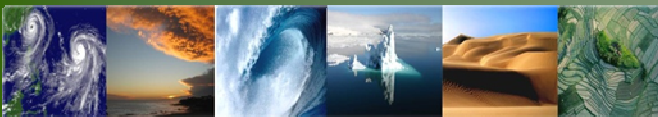


Fig. 1. Processes included in the HadGEM2 model family.

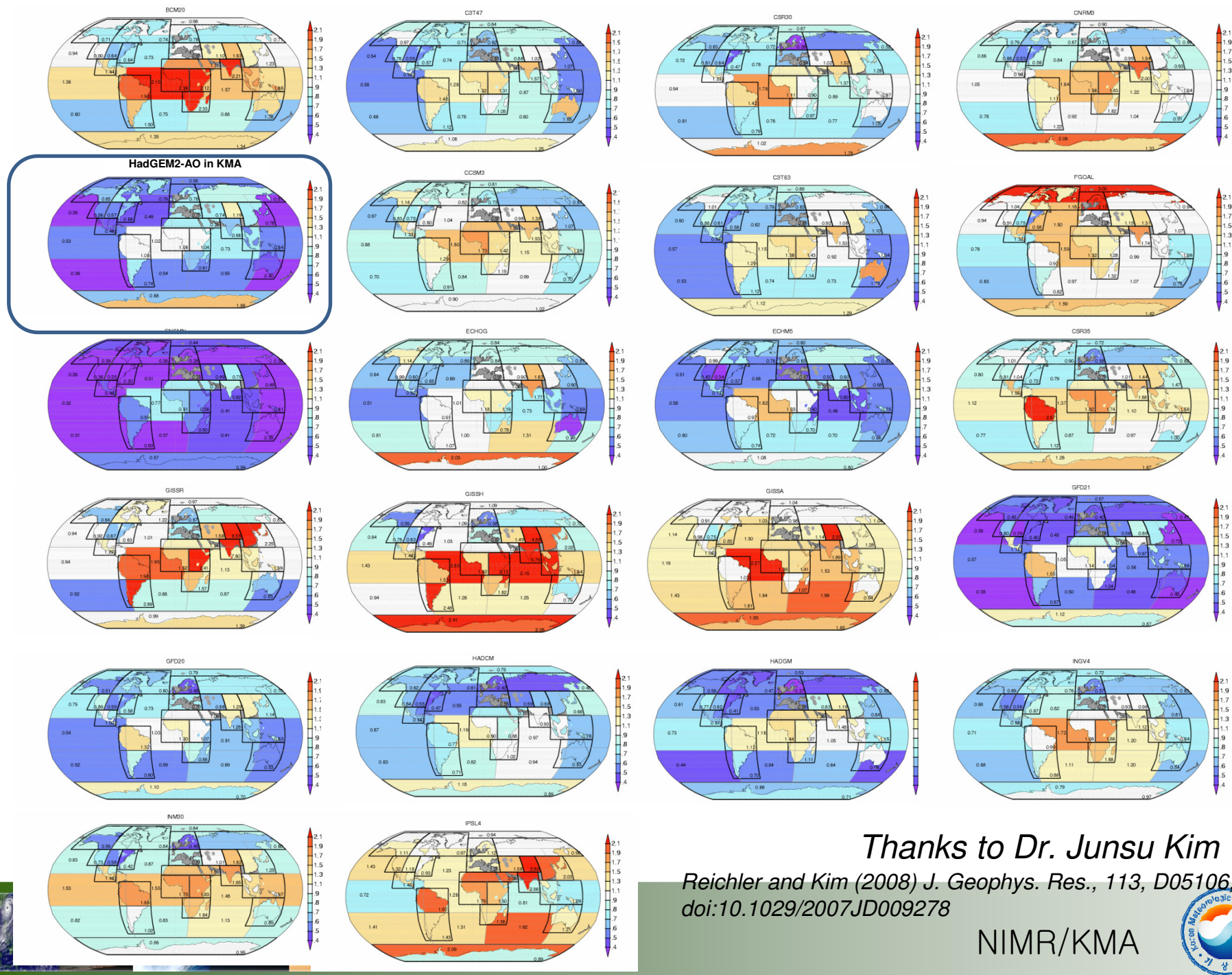


# CMIP5 experiments in NIMR

Experiments		RCP	Progress
Global (~130 km)	Pre-industrial	-	~800 years
	Historical	-	5-member ensembles (IC: 100 <sup>th</sup> , <b>200<sup>th</sup></b> , 300 <sup>th</sup> , 400 <sup>th</sup> , 500 <sup>th</sup> year from Prel run)
	Scenario	<b>4.5</b>	1-member completed (IC: final states of historical run with IC of the <b>200<sup>th</sup></b> year from PI)
		<b>8.5</b>	
		6.0	-
2.6		-	







Thanks to Dr. Junsu Kim

Reichler and Kim (2008) *J. Geophys. Res.*, 113, D05106,  
 doi:10.1029/2007JD009278

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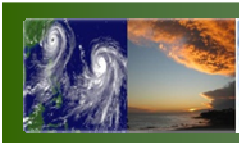
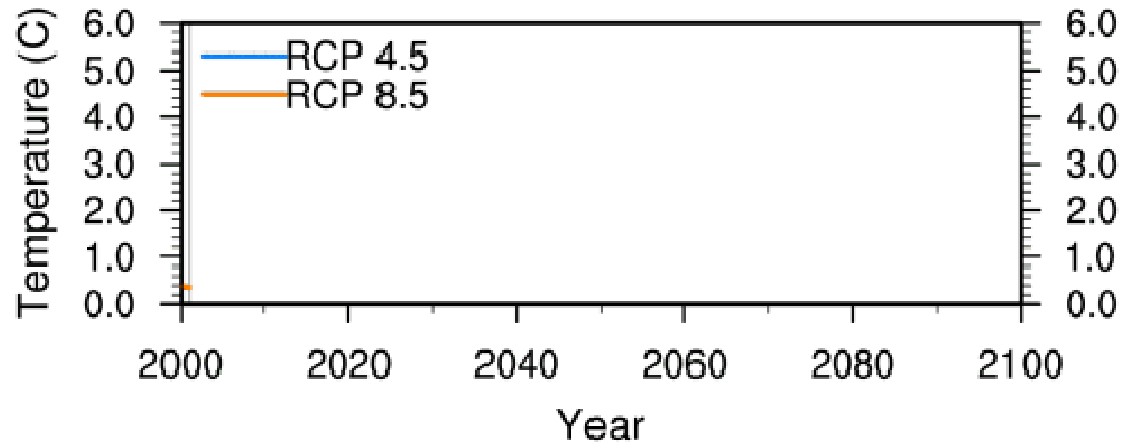
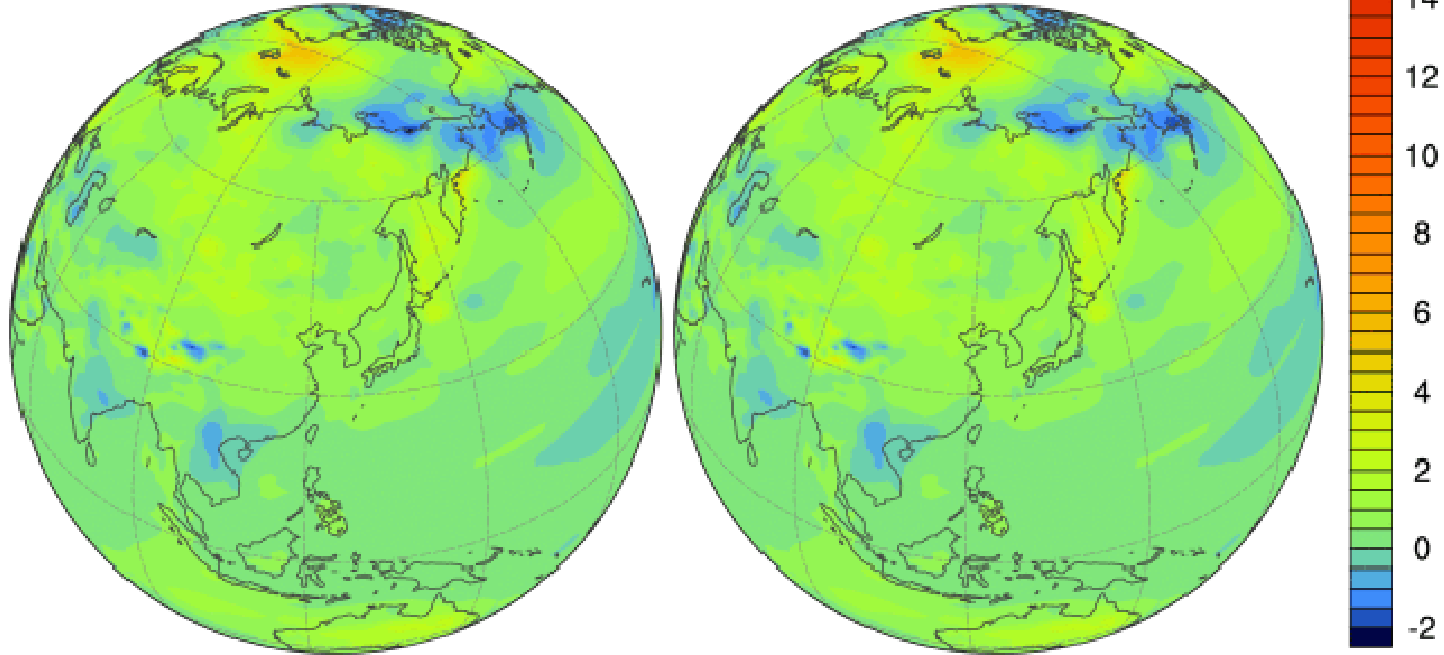
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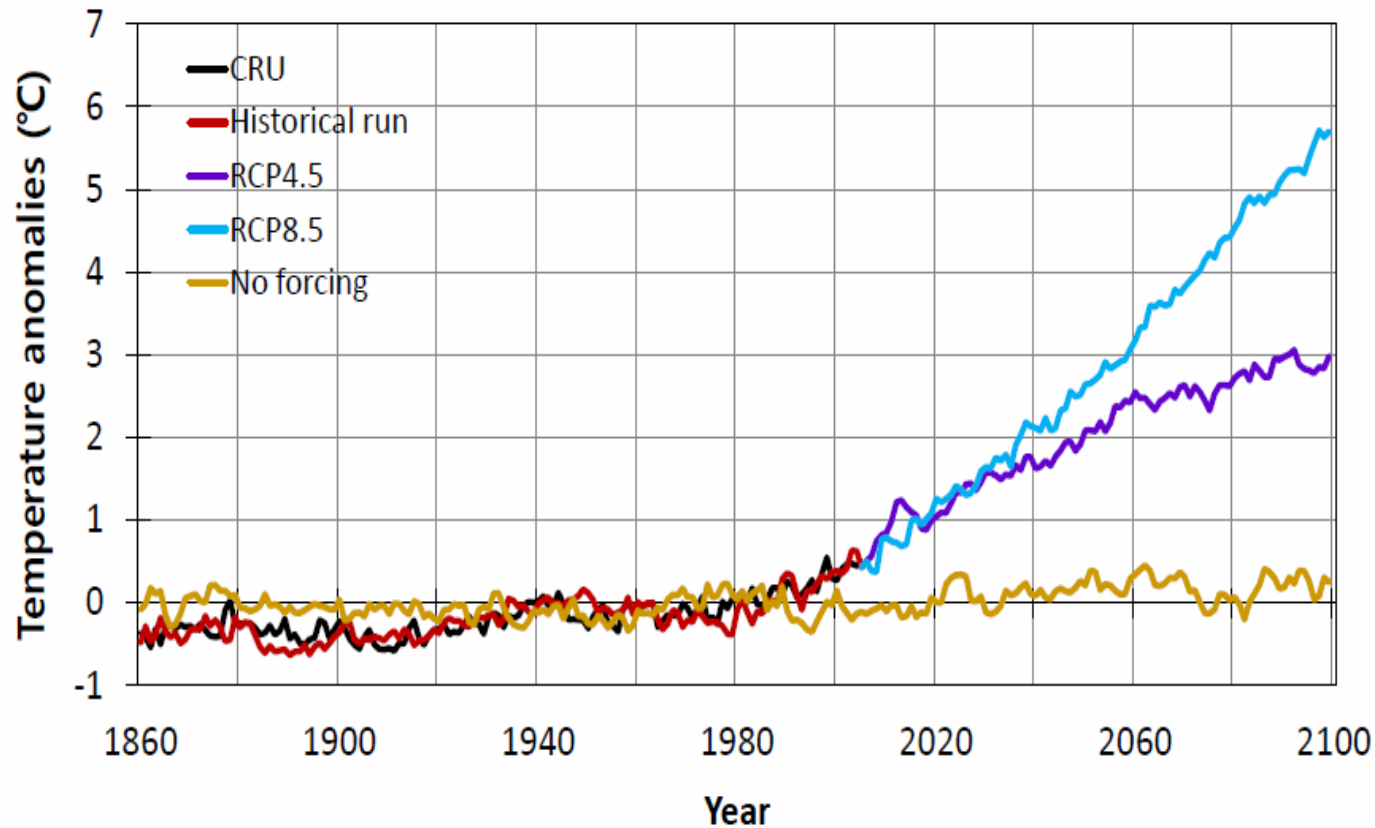
# GLOBAL TEMPERATURE CHANGE (2001-2099)

RCP 4.5 : 2001

RCP 8.5 : 2001



# Projected Changes in Global Surface Temperature



reference period: 1971-2000

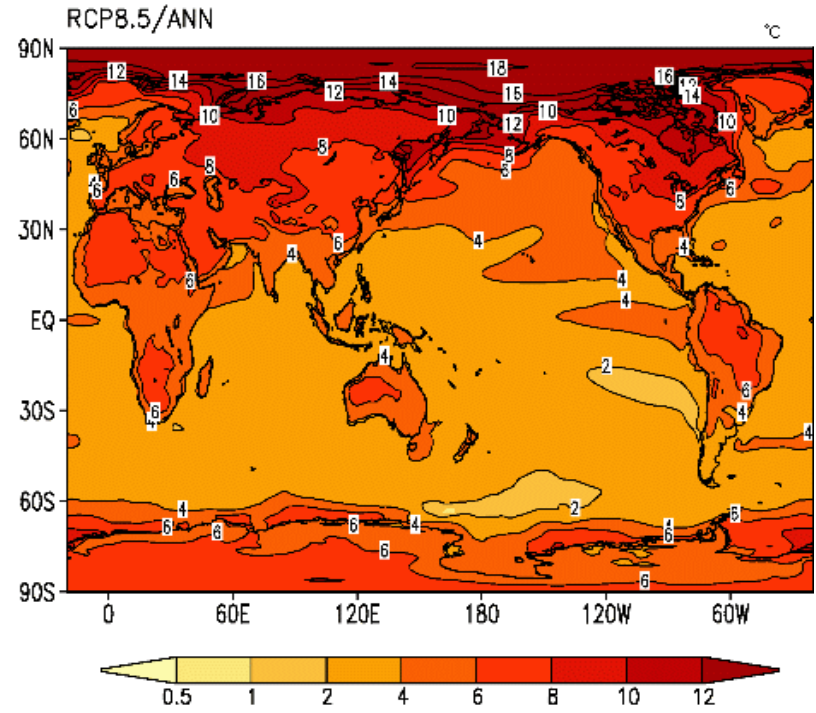
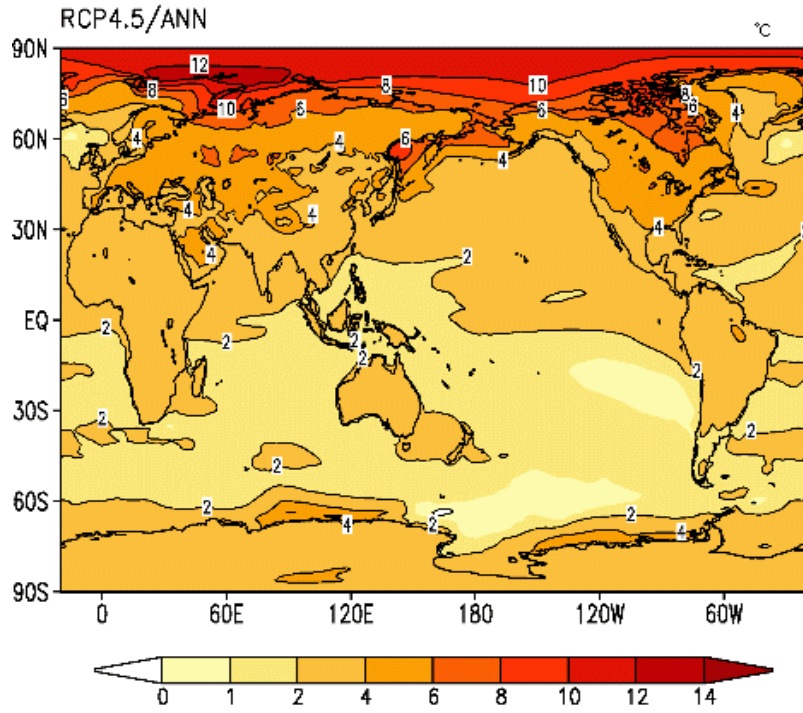
	<b>ANN</b>	<b>JJA</b>	<b>DJF</b>
<b>RCP8.5</b>	<b>4.8</b>	<b>4.6</b>	<b>5.0</b>
<b>RCP4.5</b>	<b>2.8</b>	<b>2.6</b>	<b>2.9</b>



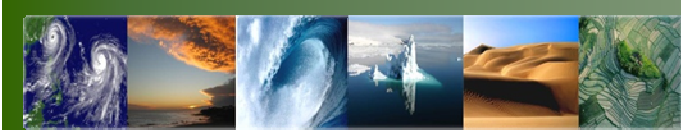
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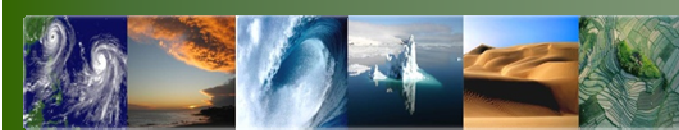
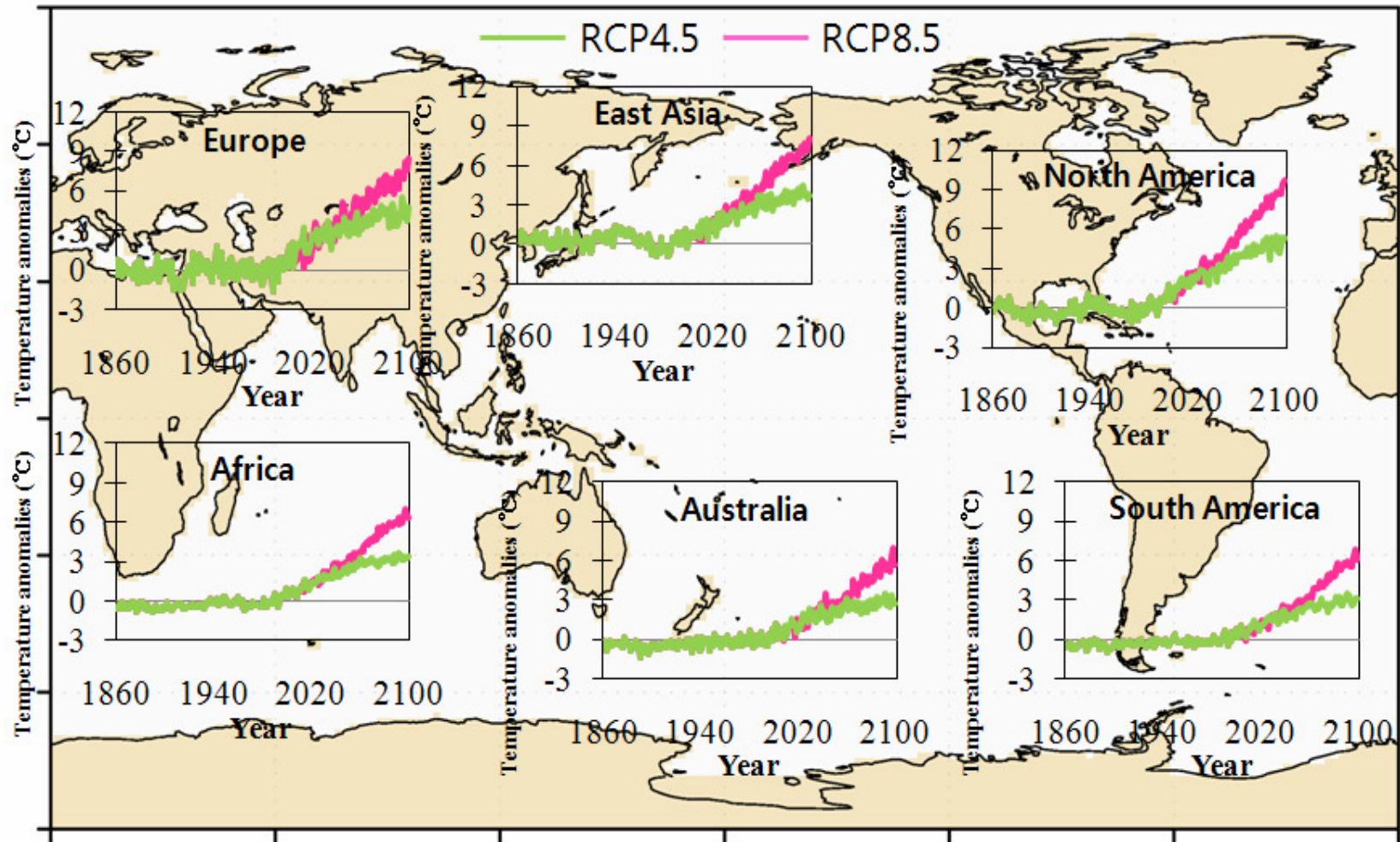
# Projected Changes in Surface Temp (2070-2099)



	ANN	JJA	DJF
RCP8.5	4.8	4.6	5.0
RCP4.5	2.8	2.6	2.9



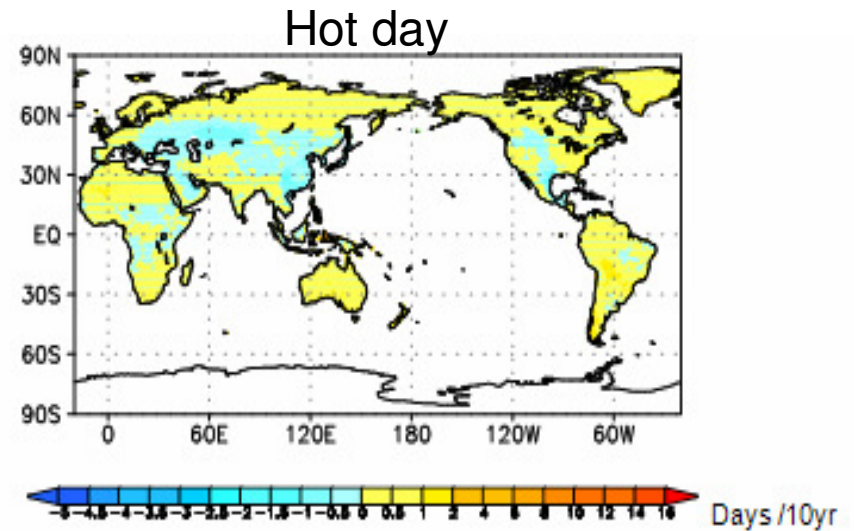
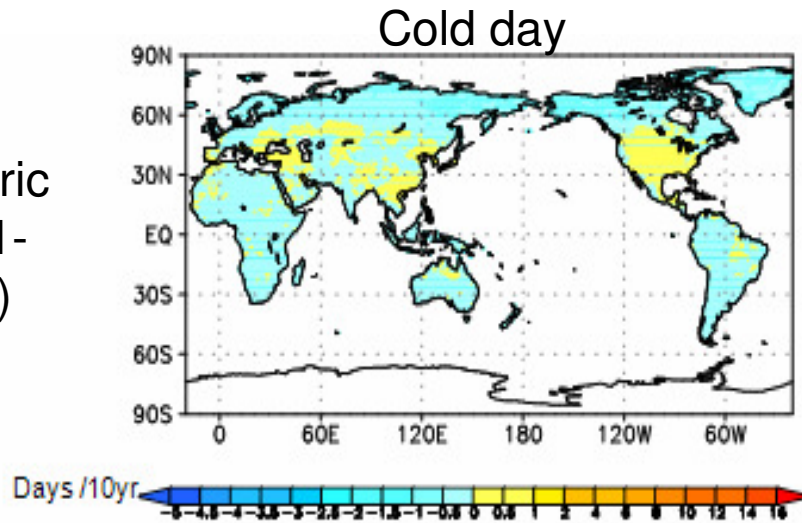
# Projected Changes in Regional Surface Temperature



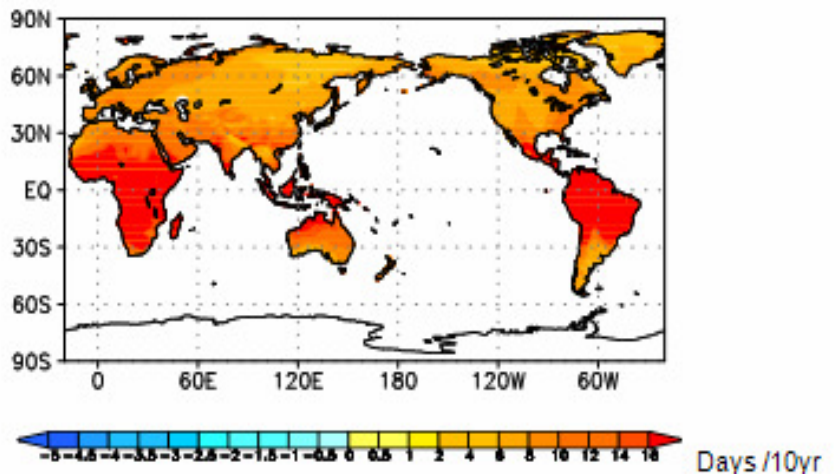
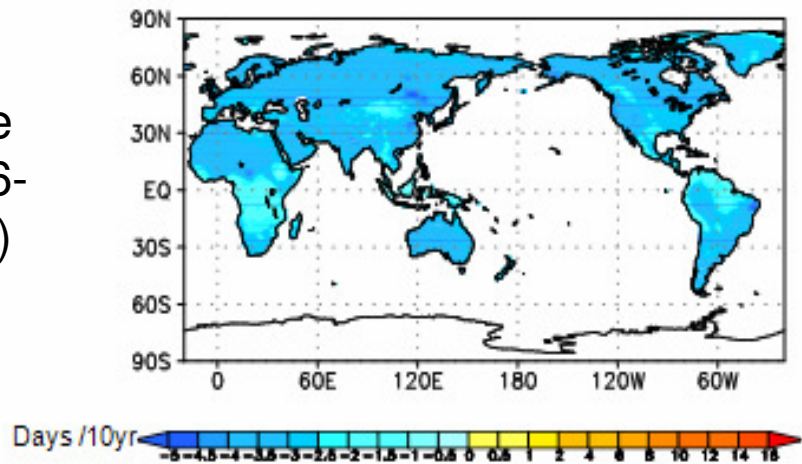


# Trends in Temperature Indices

Historic  
(1861-  
2005)



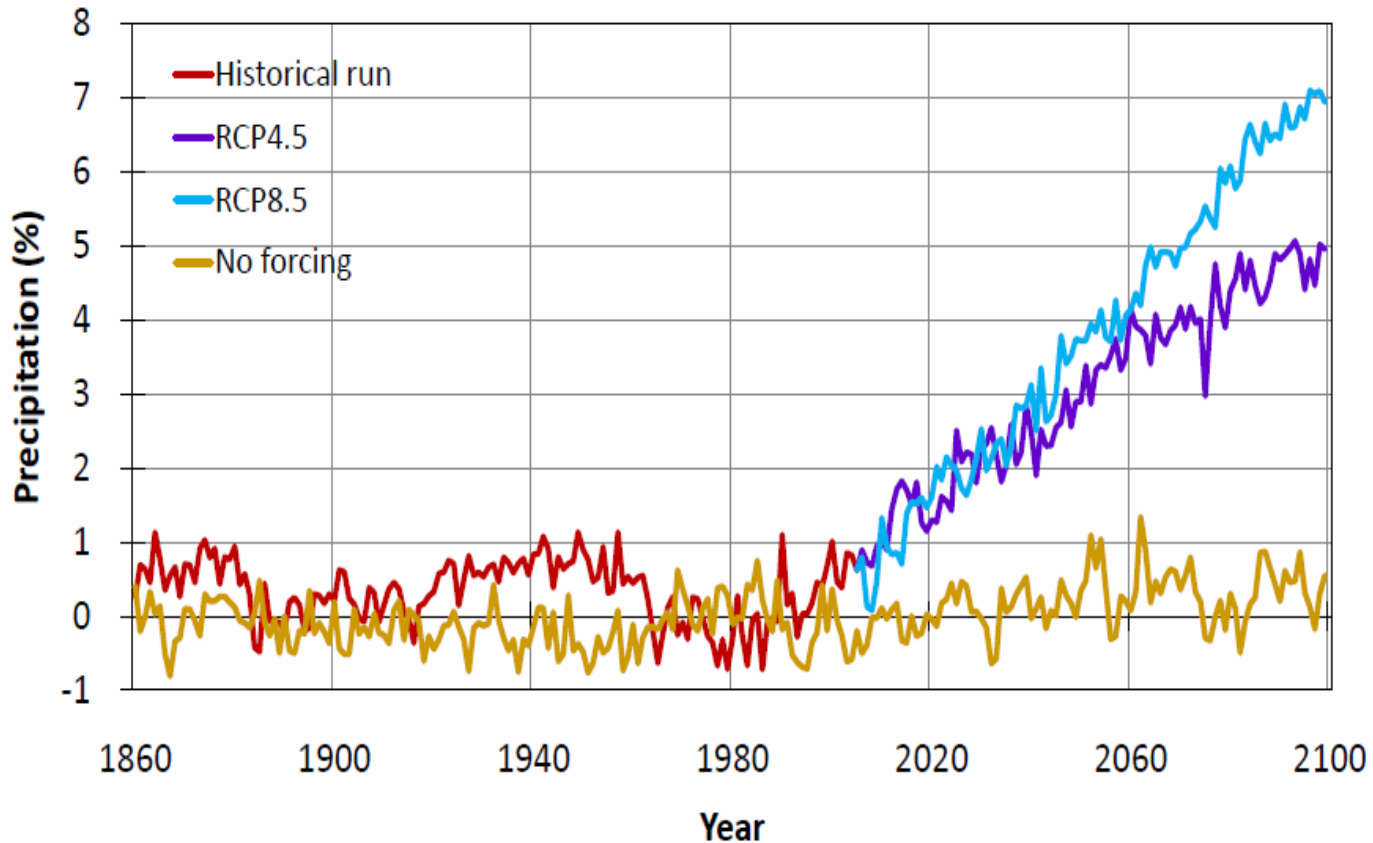
future  
(2006-  
2099)



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# Projected Changes in Global Precipitation



reference period: 1971-2000

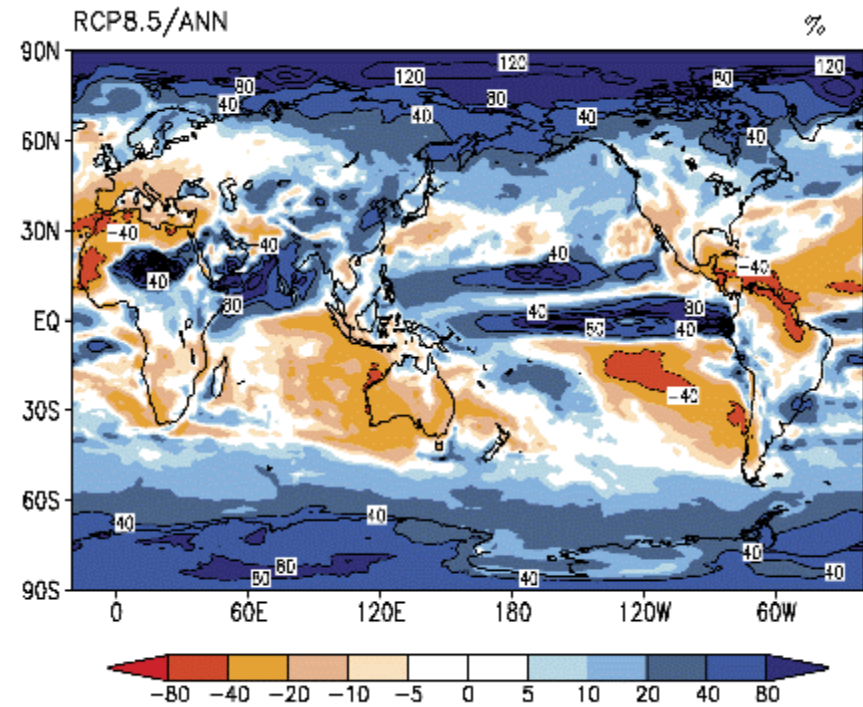
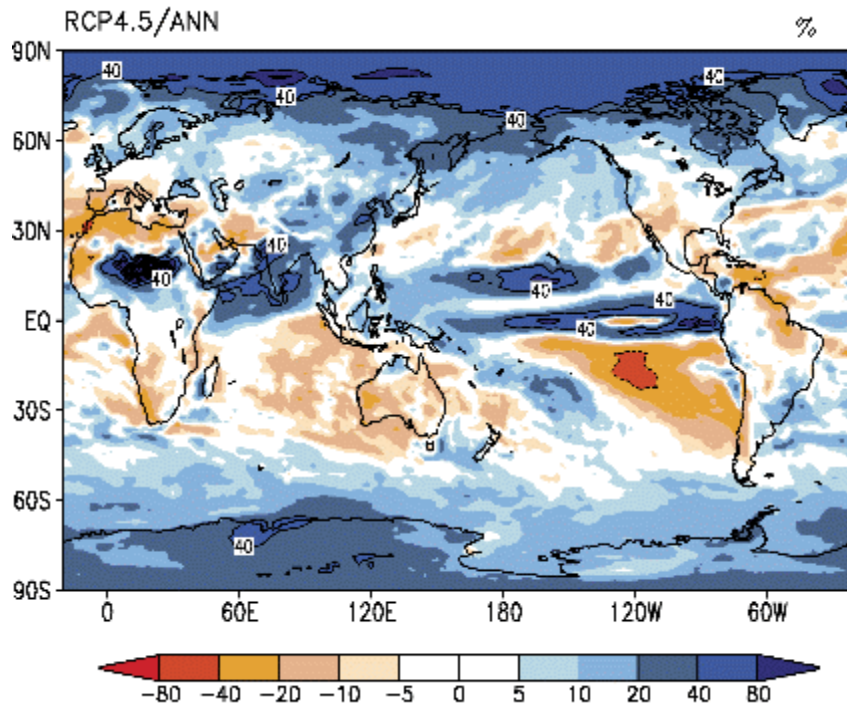
	<b>ANN</b>	<b>JJA</b>	<b>DJF</b>
<b>RCP8.5</b>	<b>6.2</b>	<b>4.9</b>	<b>7.3</b>
<b>RCP4.5</b>	<b>4.5</b>	<b>3.9</b>	<b>4.9</b>



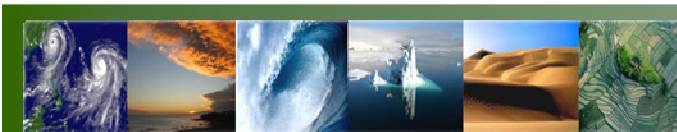
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# Projected Changes in Precipitation (2070-2099)

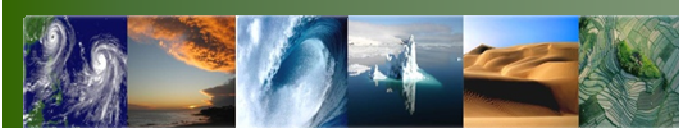
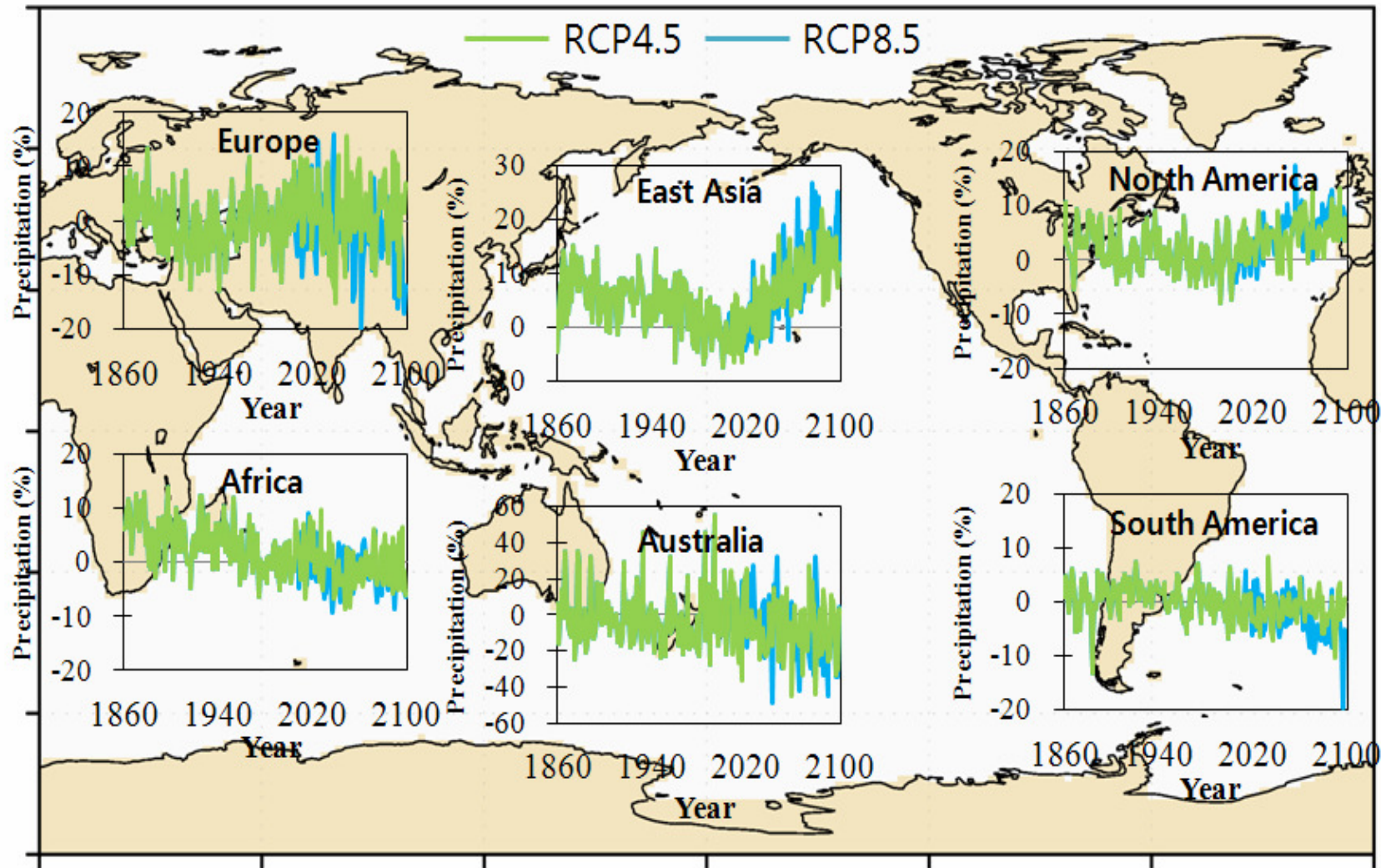


	ANN	JJA	DJF
RCP8.5	6.2	4.9	7.3
RCP4.5	4.5	3.9	4.9





# Projected Changes in Regional Precipitation



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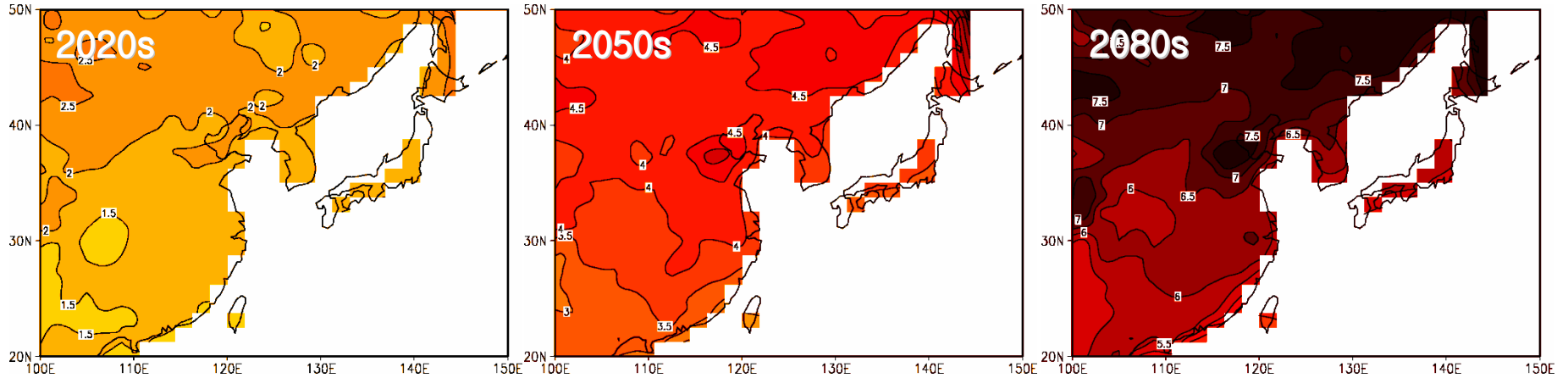
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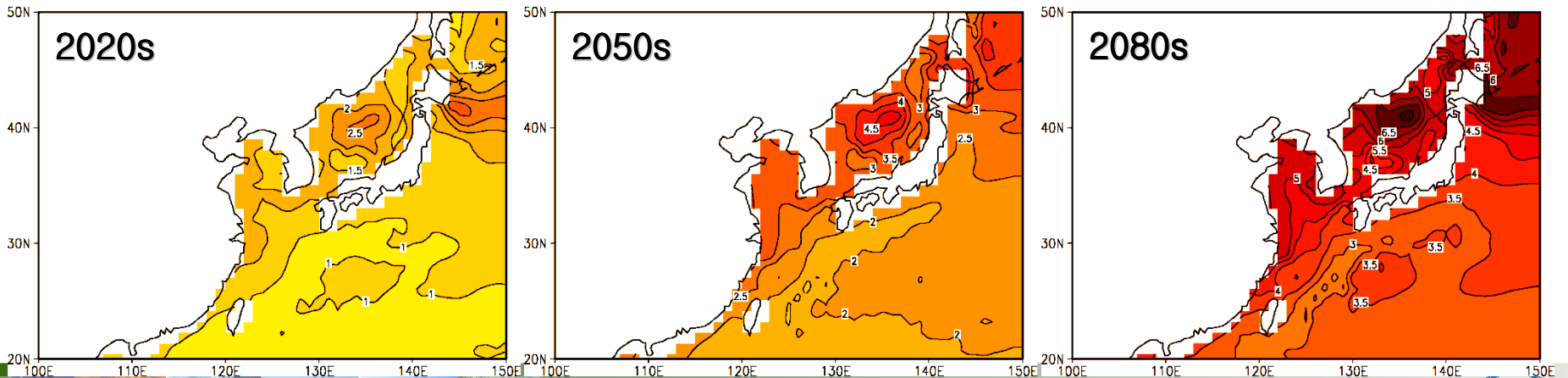


# Surface Air Temperature Change (°C)

## RCP8.5



# Sea Surface Temperature Change (°C)

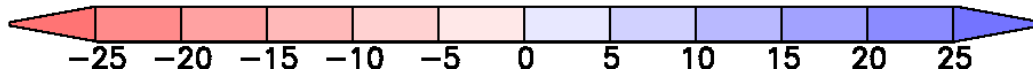
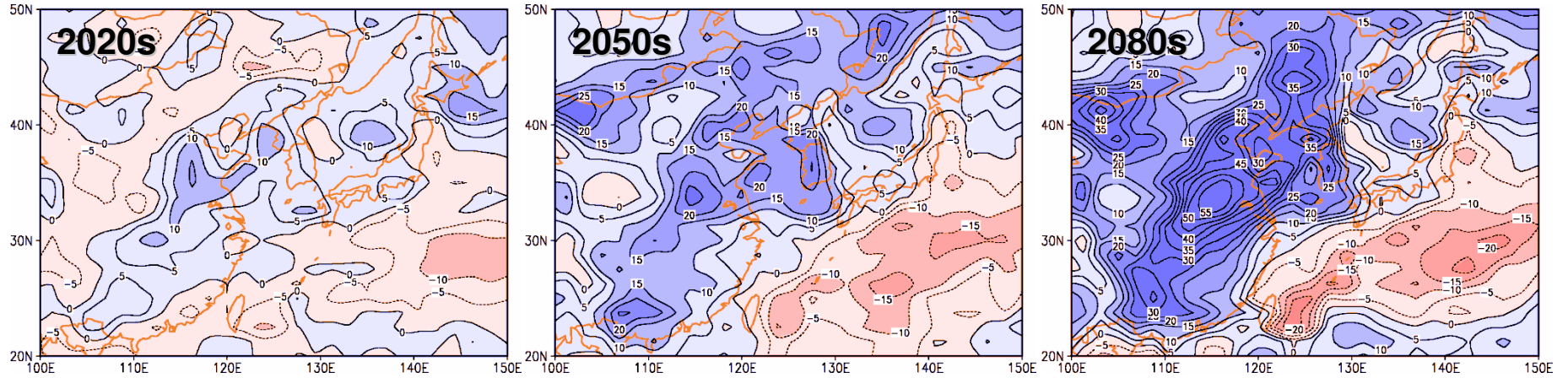


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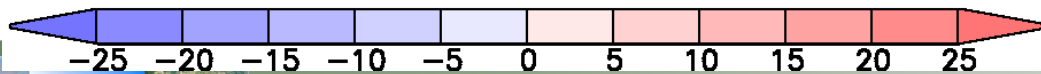
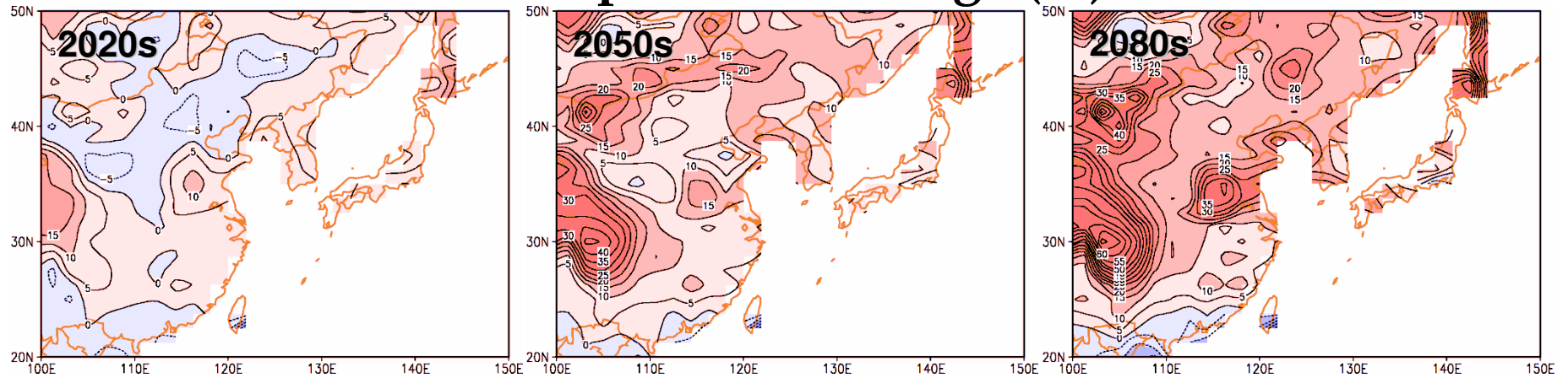


RCP8.5

# Precipitation Change (%)



# Evaporation Change (%)



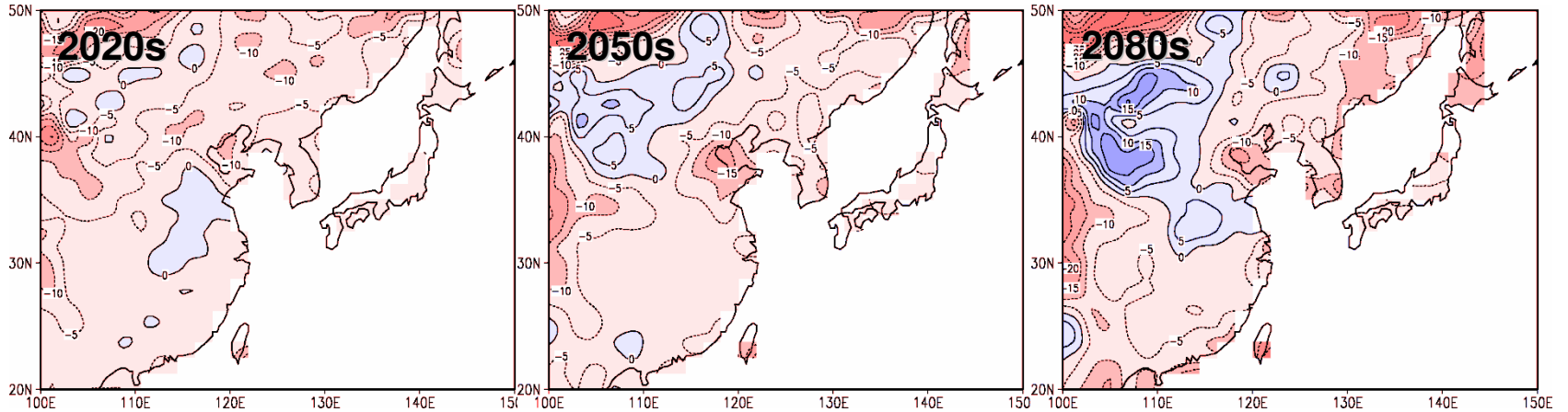
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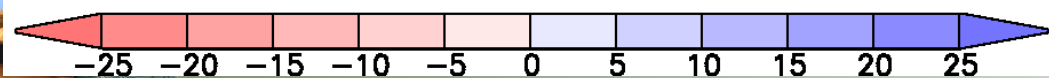
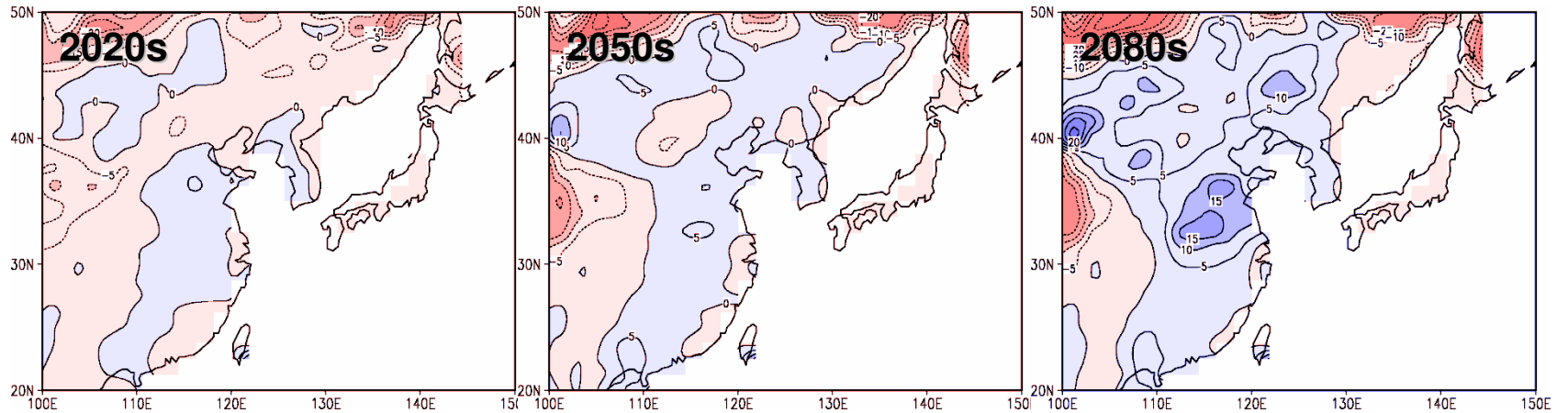
# Soil Moisture Content Change (%)

RCP8.5

0~10cm



25~65cm



R/KMA



# Summary & Future Plan

- Control and historical runs, and two RCPs(4.5, 8.5) for future projection are now very well progressed (~1400 years)
- RCPs are complete to 2100. RCP4.5/8.5 reaches 2.8/4.8°C
- East Asian temperature and precipitation in the 21<sup>st</sup> century will increase with larger amplitude than global mean
- We hope to complete simulation using RCP 2.6 and RCP 6.0 by May 2012
- We will submit output to BADC or PCMDI server for CMIP5 & IPCC AR5



**Thank you!**

