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Regional climate projection based on RCP scenarios in the CORDEX East Asia Domain Using RegCM4

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1. Introduction

- Regional climate projection data is essential to the adaptation and risk management strategy for future climate change.
- In this study, we have simulated the regional climate over CORDEX East Asia for 72 years from 1979 to 2050 with a 50 km horizontal resolution using the latest regional climate model version 4, RegCM4, driven by HadGEM2-AO with about 135-km resolution under the Intergovernmental Panel on Climate Change (IPCC) Representative Concentration Pathway (RCP) 8.5/4.5.
- We will present the simulation results of RegCM4 for the present climate (1980-2005). After that the future climate projection of RegCM4 under RCP8.5 (RCP4.5) scenario will be discussed in terms of spatial and temporal variations of the surface climate variables, temperature and precipitation.

2. Models & Experiment Design

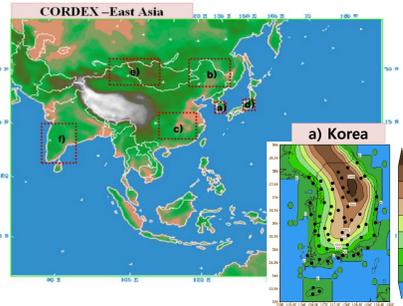


Fig. 1. Domain of CORDEX and topography.

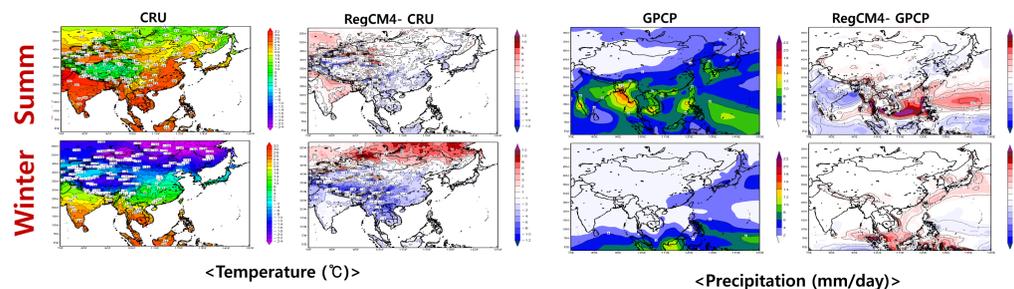
Table 1 Simulation condition of RegCM4

Contents	Description
Model domain	- CORDEX East Asia - 50 km (H. Resolution) - 197 (lat.) x 243 (lon.)
Vertical layers (top)	18 sigma (74 hPa)
PBL scheme	Holtzlag
CPS	MIT-Emanuel
Land Surface Model	NCAR CLM 3.5
Radiation	NCAR CCM3
Boundary Condition	HadGEM2-AO
Simulation period	1. Jan. 1979 ~ Dec. 2005 2. Jan. 2006 ~ Dec. 2050 (RCP8.5, RCP4.5)

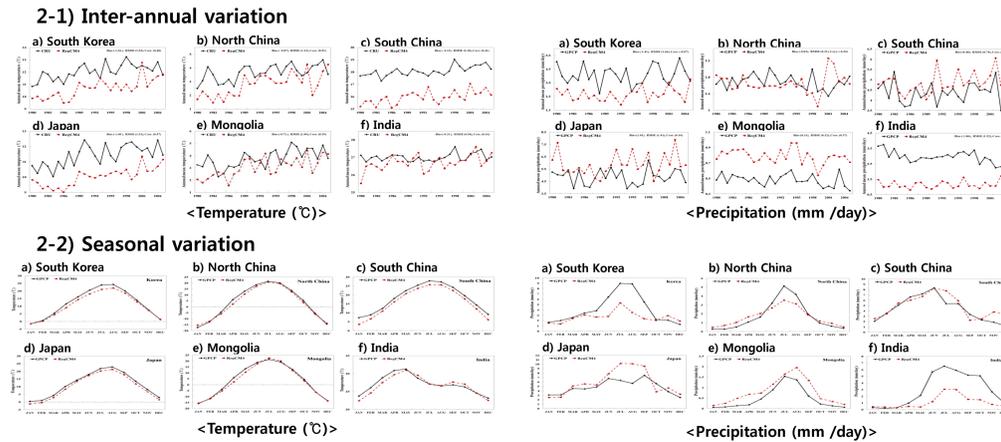
- The RegCM4, used in this work, is the updated version of RegCM3 in the prescription of SST, sea ice, and Community Land Model coupling etc. (ICTP, 2010)
- Fig. 1 and Table 1 show the CORDEX East Asia domain and simulation condition of RegCM4.
- To produce 72 years of regional climate over CRODEX East Asia by using RegCM4 from 1979 to 2050, HadGEM2-AO data (from KMA) under IPCC RCP8.5/4.5 were used.
- Simulation skills of RegCM4 for the present climate (1980-2005, spin up time: 1979) over CORDEX East Asia were evaluated with CRU TS 3.0 and GPCP. And KMA ground observation data was also used for the detailed assessment of RegCM4 over South Korea.

3. Simulation Skills for Present Climate

1) Spatial distribution of seasonal mean temperature (°C) and precipitation (mm/day)



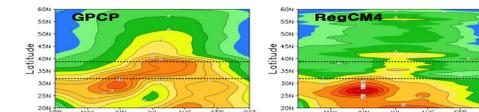
2) Inter-annual and seasonal variations of temperature (°C) and precipitation (mm/day)



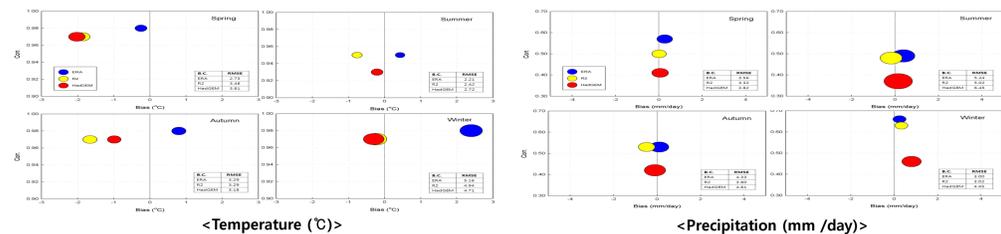
3) Statistical validation for CORDEX East Asia

Statistical valid.	Variable	Annual	Spring	Summer	Autumn	Winter
Bias	Temp.(°C)	-0.9	-1.9	-0.26	-0.97	-0.46
	Precip.(mm/day)	0.22	0.06	0.19	-0.09	0.72
RMSE	Temp.(°C)	3.59	3.74	2.74	3.15	4.74
	Precip.(mm/day)	4.84	3.7	6.47	4.82	4.35
Spatial corr.	Temp.	0.96	0.97	0.93	0.97	0.97
	Precip.	0.42	0.44	0.37	0.42	0.47

5) Time-latitude cross section of precip. (Zonal mean: 126-130°E)



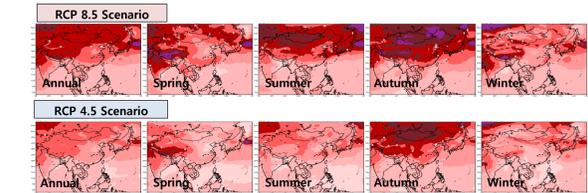
7) Comparison of simulations skills of RegCM4 for temp. and precip. driven by reanalysis data (ERA, R2) and HadGEM2-AO over CORDEX-East Asia for 17 years (1989-2005)



- RegCM4 driven by HadGEM2-AO reasonably simulated the spatial distribution, inter-annual and seasonal variations of surface air temperature and precipitation.
- However, the simulation skills of RegCM4 for temp. and precip. are strongly dependent on the seasons and geographic locations.
- RegCM4 strongly overestimates and underestimates the winter mean temp. in the northern region and southern region, respectively.
- The failure in reproducing the seasonal march of East Asian summer monsoons resulted in strong overestimation and underestimation of precip. in the southern oceanic region and in South Korea, respectively.
- Simulation skills of RegCM4 for temp. driven by the HadGEM2-AO was comparable to that of two re-analyses. However, that for precip. is relatively low, especially in correlation irrespective of the seasons.

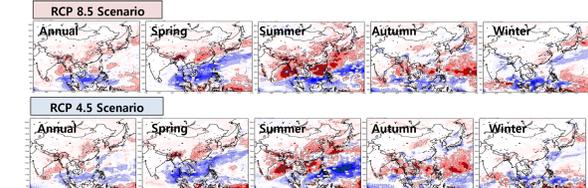
4. Future Climate Projection

1) ΔT(°C) = Future (2021~2050) – Present (1986~2005)



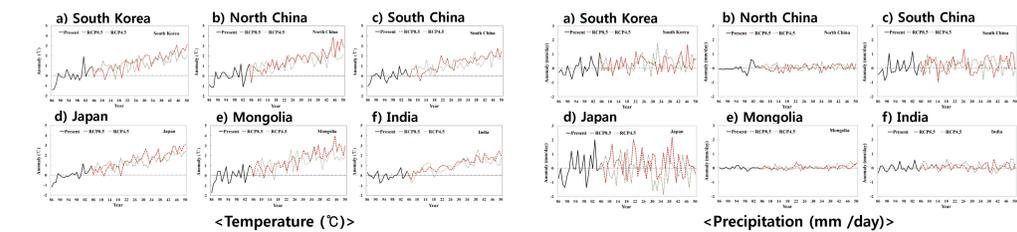
Analysis region	Scenarios	Annual	Spring	Summer	Autumn	Winter
CORDEX-EA	RCP8.5	1.82	1.80	1.82	2.03	1.63
	RCP4.5	1.47	1.35	1.39	1.79	1.36
South Korea	RCP8.5	1.87	1.55	2.17	2.10	1.66
	RCP4.5	1.47	1.11	1.49	1.61	1.67
India	RCP8.5	1.46	1.67	1.44	1.29	1.43
	RCP4.5	1.23	1.26	1.31	1.13	1.20
Mongolia	RCP8.5	2.12	1.63	2.46	2.68	1.72
	RCP4.5	1.66	1.14	1.59	2.47	1.44
South China	RCP8.5	1.69	1.65	1.60	2.00	1.51
	RCP4.5	1.35	1.22	1.32	1.71	1.15
North China	RCP8.5	2.11	1.95	2.17	2.60	1.72
	RCP4.5	1.63	1.15	1.46	2.19	1.72

2) ΔP(mm/day) = Future (2021~2050) – Present (1986~2005)

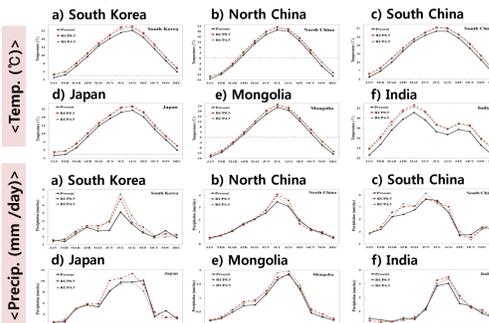


Analysis region	Scenarios	Annual	Spring	Summer	Autumn	Winter
CORDEX-EA	RCP8.5	0.05	-0.04	0.16	0.10	-0.01
	RCP4.5	0.02	-0.08	0.01	0.15	0.00
South Korea	RCP8.5	0.43	0.37	0.98	0.16	0.19
	RCP4.5	0.43	0.27	1.56	0.24	0.14
India	RCP8.5	0.09	0.01	0.23	0.22	-0.12
	RCP4.5	0.09	0.02	0.13	0.15	0.06
Mongolia	RCP8.5	0.08	0.13	0.06	0.10	0.04
	RCP4.5	0.10	0.10	0.14	0.09	0.04
South China	RCP8.5	0.30	0.88	0.21	-0.28	0.41
	RCP4.5	0.23	0.79	0.17	-0.19	0.13
North China	RCP8.5	0.10	-0.01	0.45	-0.09	0.05
	RCP4.5	0.09	0.06	0.25	0.01	0.02

3) Changes in Temporal Variation

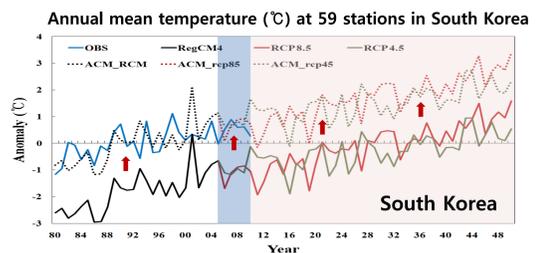


4) Changes in Seasonal Variation



5) Future Climate Projection- Bias Correction Method

Assumption:
- Stationarity of simulation skills of RCM for a changing climate



- In general, temp. increases in the future climate simulations are very consistent and stronger in RCP8.5 than RCP4.5 scenarios (Northern region than southern region, autumn than other seasons).
- Precip. changes in the future climate simulations under RCP8.5 and RCP4.5 are clearly dependent on the seasons and geographic locations. Increases are dominant in the mid-to-northern land region especially during summer, whereas, strong decreases are concentrated in the southern oceanic region, irrespective of the RCP scenarios. In the case of South Korea, summer precipitation is expected to increase with +0.98 (+1.56) mm/day.

Reference:
ICTP Portal, 2010, RegCM4, <http://esp.ictp.it/research/esp-models/regcm3>

ACKNOWLEDGEMENTS:
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