Downscaling of CMIP-5 GCMs for Future Climate Projection over the Area of Southeast Asia and Thailand

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RU-CORE
Ramkhamhaeng University
Center of Regional Climate Change and Renewable Energy

Ramkhamhaeng University Center of Regional Climate Change and Renewable Energy (RU-CORE), Bangkok, Thailand

Related activities and projectes

- Projected future changes of mean precipitation and its variability over Thailand from multi-model regional climate simulations of CORDEX Southeast Asia
- A Study of Watershed Management under Climate Change: A Case Study at Sirindhorn International Environmental Park
- A comparative study on the change of hydrological processes and fluxes in the Jiulong River and Chao Phraya River basins under changing climate

Introduction

- SEACLID/CORDEX Southeast Asia is a collaborative work involving many countries from within and outside Southeast Asia region
- A number of GCMs have been downscaled into CORDEX SEA Domain of 25 km x 25 km resolution.
- This presentation focuses on detailed analysis of precipitation over Thailand for historical and projection periods

List of Simulations Carried Out under SEACLID/CORDEX SEA

TABLE 1. List of GCMs downscaled, RCMs used, institutions responsible for the downscaling and the IPCC AR5 RCPs downscaled.

GCM Downscaled	RCMs Used	Downscaled Institution(s)	RCPs Downscaled
ACCESS1.0	CCAM	Commonwealth Scientific and Industrial Research Organisation (CSIRO)	8.5*
CCSM4	CCAM	Commonwealth Scientific and Industrial Research Organisation (CSIRO)	8.5*
CNRM-CM5	CCAM	Commonwealth Scientific and Industrial Research Organisation (CSIRO)	8.5*
CNRM-CM5	RegCM4	University of Science and Technology of Hanoi (USTH)	4.5 & 8.5
CNRM-CM5	RCA4	Swedish Meteorological and Hydrological Institute (SMHI)	4.5 & 8.5
CSIRO-Mk3.6.0	RegCM4	Indonesian Agency for Meteorology, Climatology and Geophysics (BMKG)	4.5 & 8.5
EC-EARTH	RegCM4	Ramkhamheang University, Center of Regional Climate Change and Renewable Energy (RU-CORE)	4.5 & 8.5
GFDL-ESM2M	RegCM4	University Kebangsaan Malaysia (UKM)	4.5 & 8.5
HadGEM2-AO	RegCM4	Manila Observatory (MO)	4.5 & 8.5
HadGEM2-AO	WRF3.5	APEC Climate Center (APCC)	4.5 & 8.5
HadGEM2-ES	PRECIS	Met Office Hadley Centre	8.5
HadGEM2-ES	RCA4	Swedish Meteorological and Hydrological Institute (SMHI)	4.5 & 8.5
IPSL-CM5A-LR	RegCM4	University Kebangsaan Malaysia (UKM)	4.5 & 8.5
MPI-ESM-MR	RegCM4	Ramkhamheang University, Center of Regional Climate Change and Renewable Energy (RU-CORE)	4.5 & 8.5
MRI-AGCM3.2	NHRCM	Meteorological Research Institute (MRI), Japan Meteorological Agency (JMA)	2.6*, 4.5*, 6.5* & 8.5*

*time-sliced run

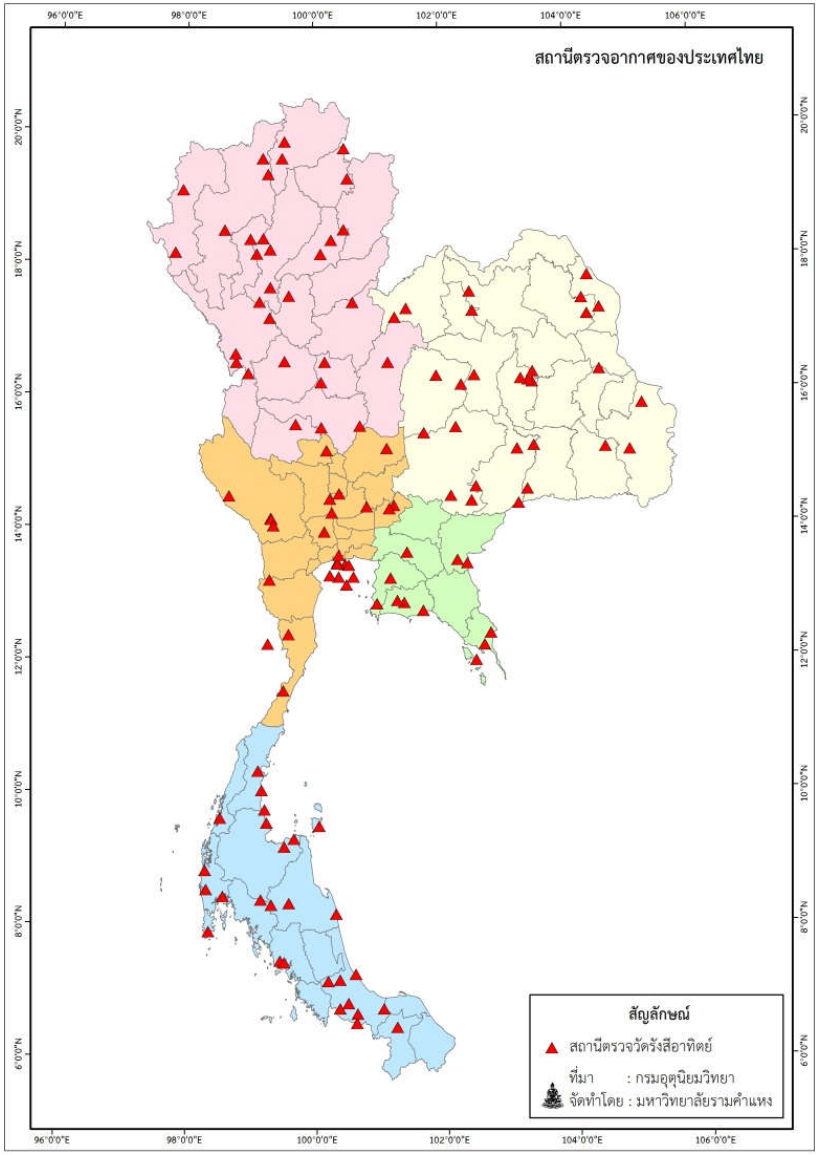
Ensemble (of opportunity) Members considered

Considering only full RCP4.5, RCP8.5 simulation and removing unrealistic simulations of current climate and simulations deviate significantly (drifted) from the future projected by GCMs, the list provided the final ensemble members for this study

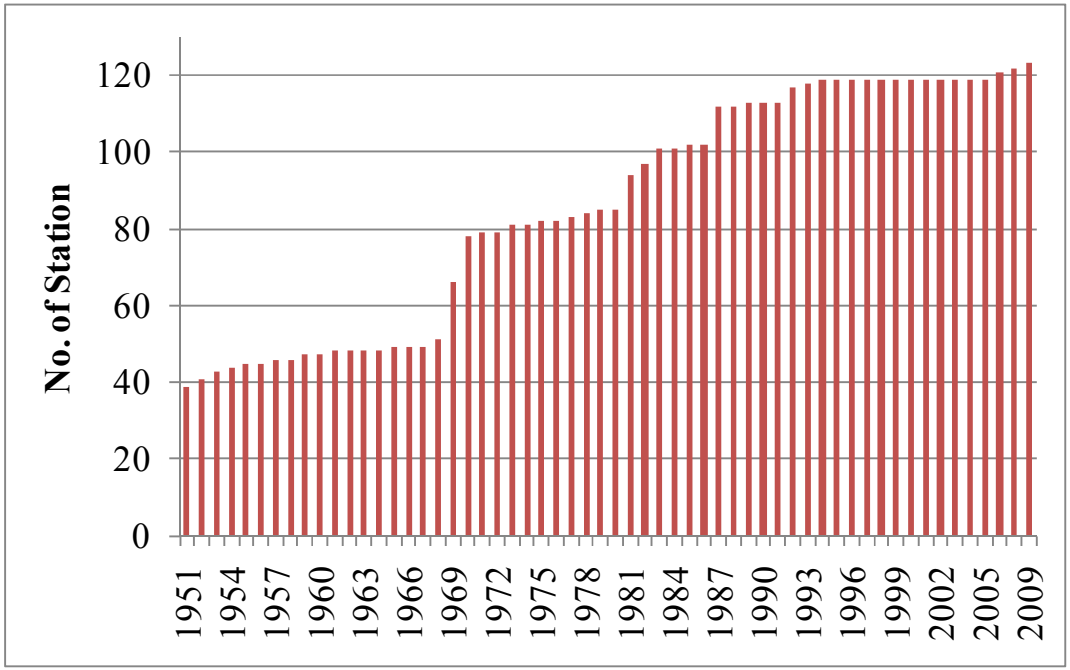
1. CNRM-CM5 (RegCM4)
2. CSIRO-Mk3-6-0 (RegCM4)
3. EC-EARTH (RegCM4)
4. MPI-ESM-MR (RegCM4)
5. CNRM-CM5 (RCA4)
6. HadGEM2-ES (RCA4)
7. HadGEM2-AO (WRF)

the ensemble was created using equal weighting approach.

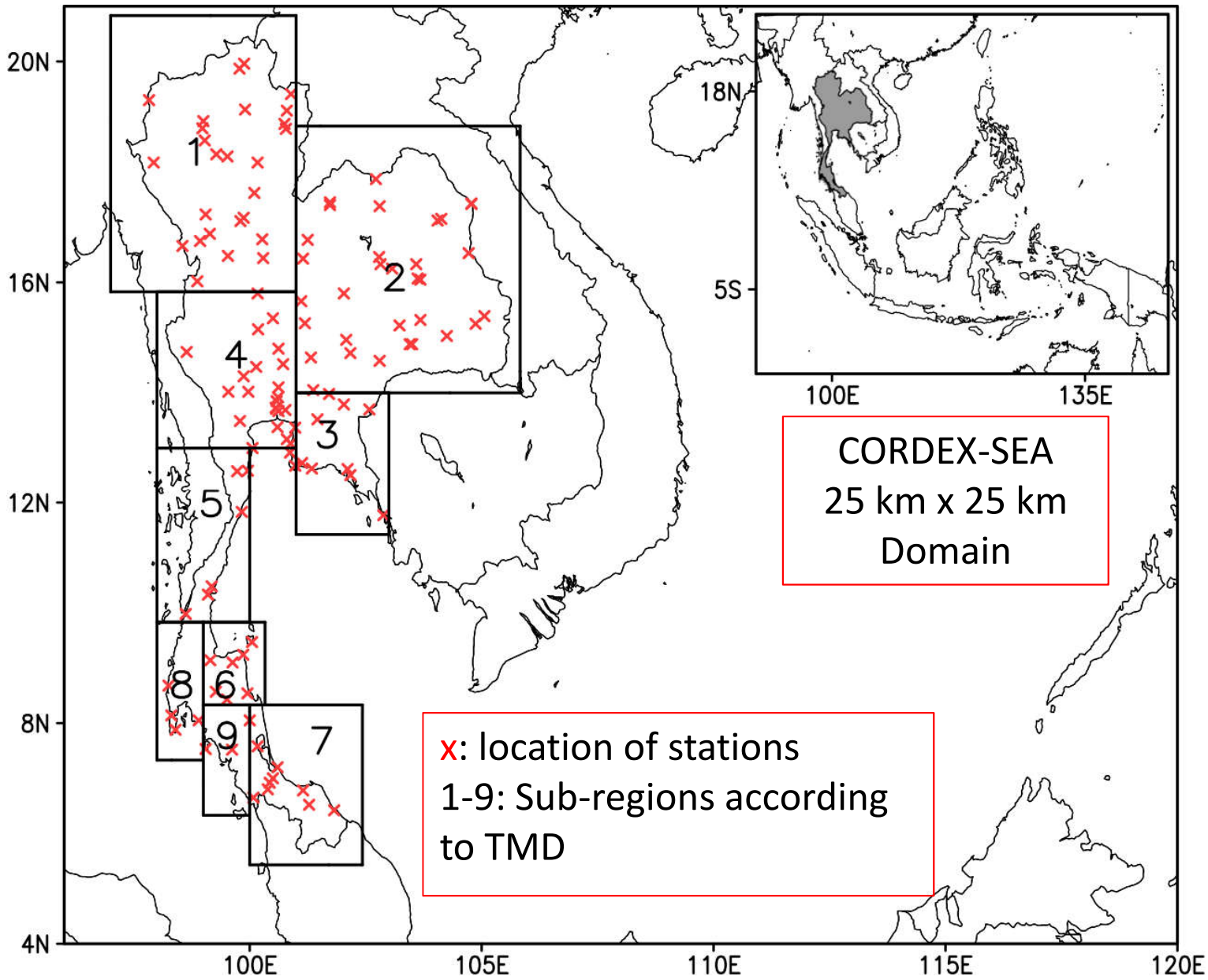
Meteorological stations in Thailand



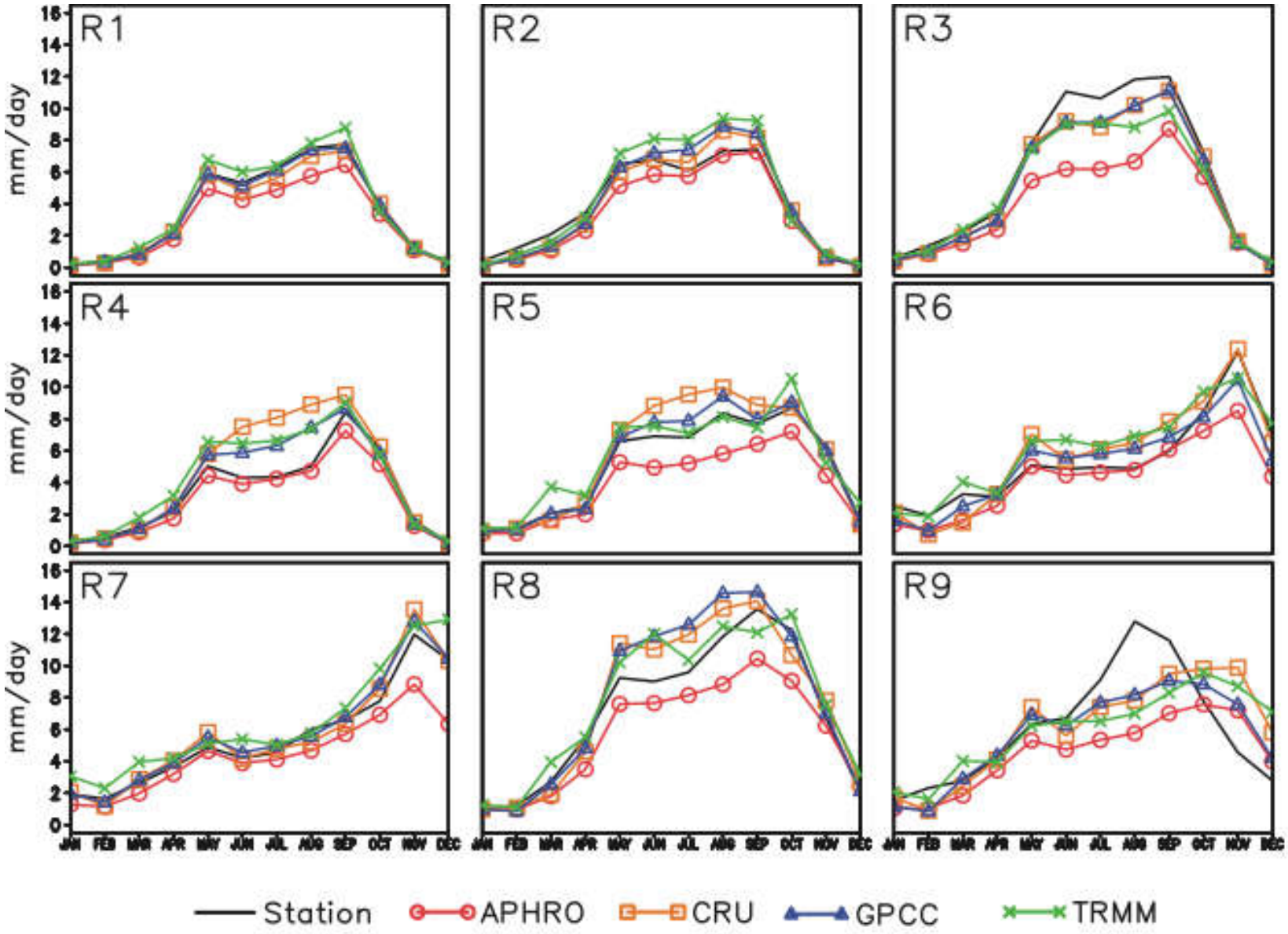
- There are 123 meteorological stations in Thailand
- Based on the definition of Thai Meteorological Department (TMD), there are 5 regions in Thaiand.



Map of Thailand wth 9 sub-regions



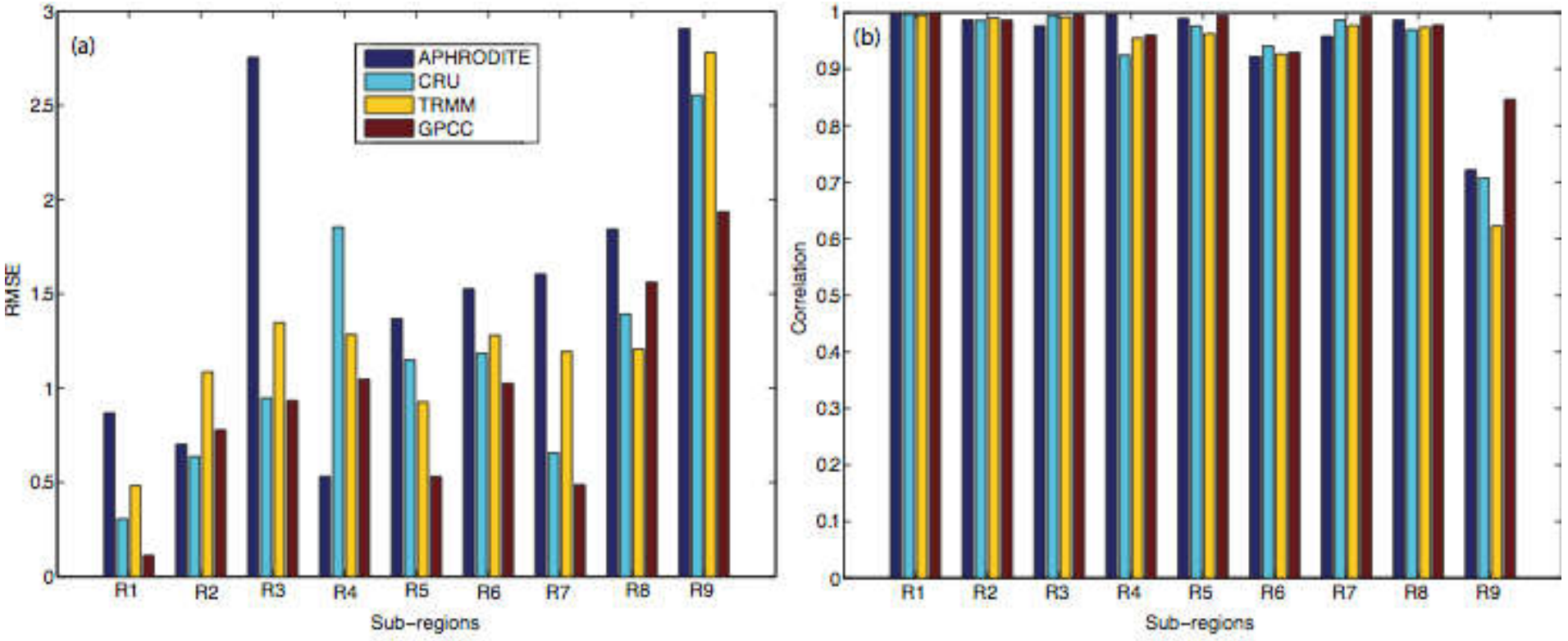
Comparison between station data vs gridded products



RSME and correlation between station averaged data vs gridded products

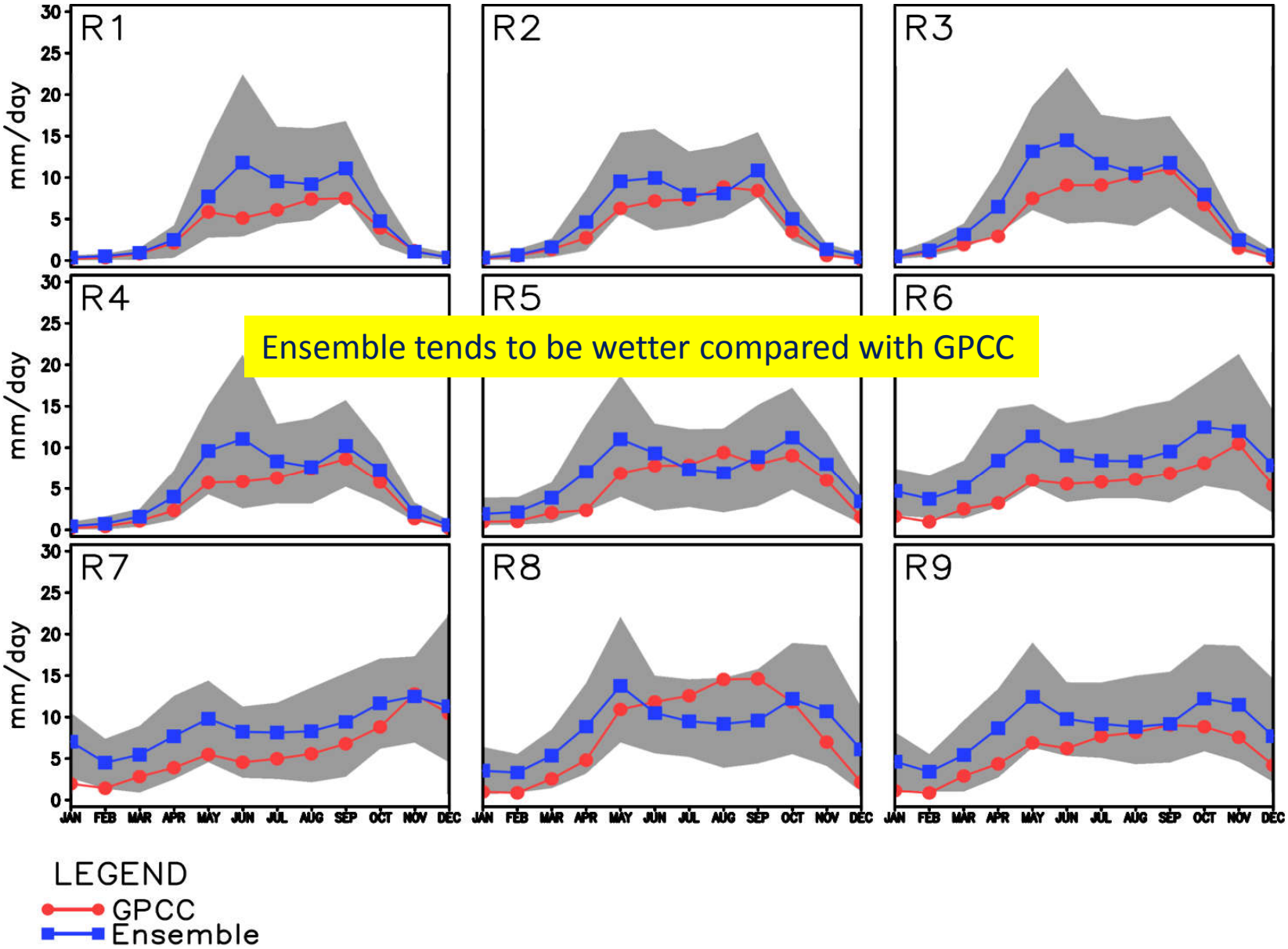
RMSE

Correlation



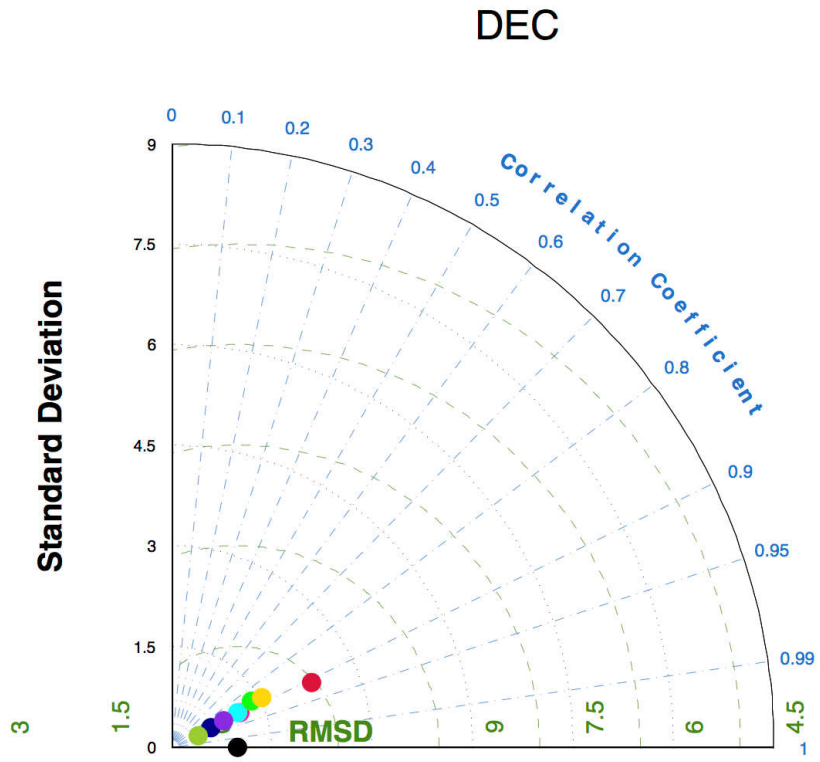
GPCC appears slightly better. GPCC (50 km x 50 km), others (25 km x 25 km)

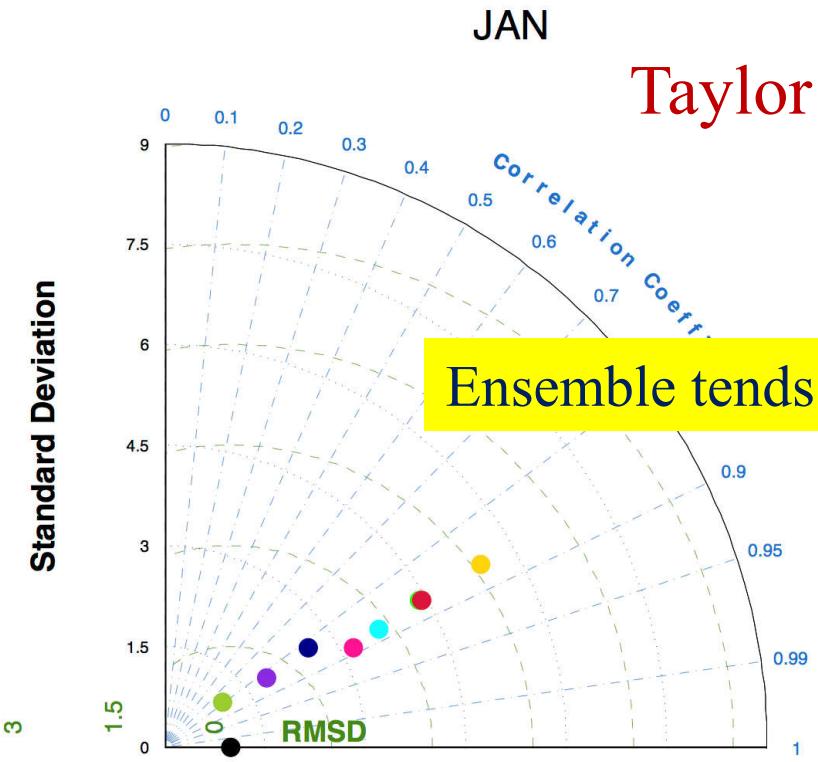
Comparison between GPCC and ensemble for annual cycle during historical period

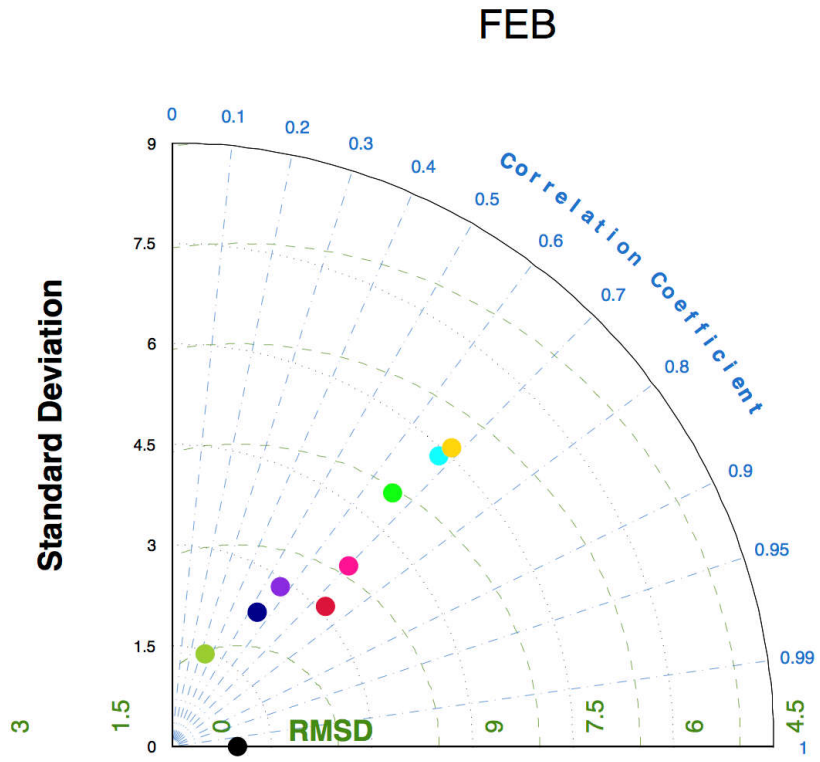


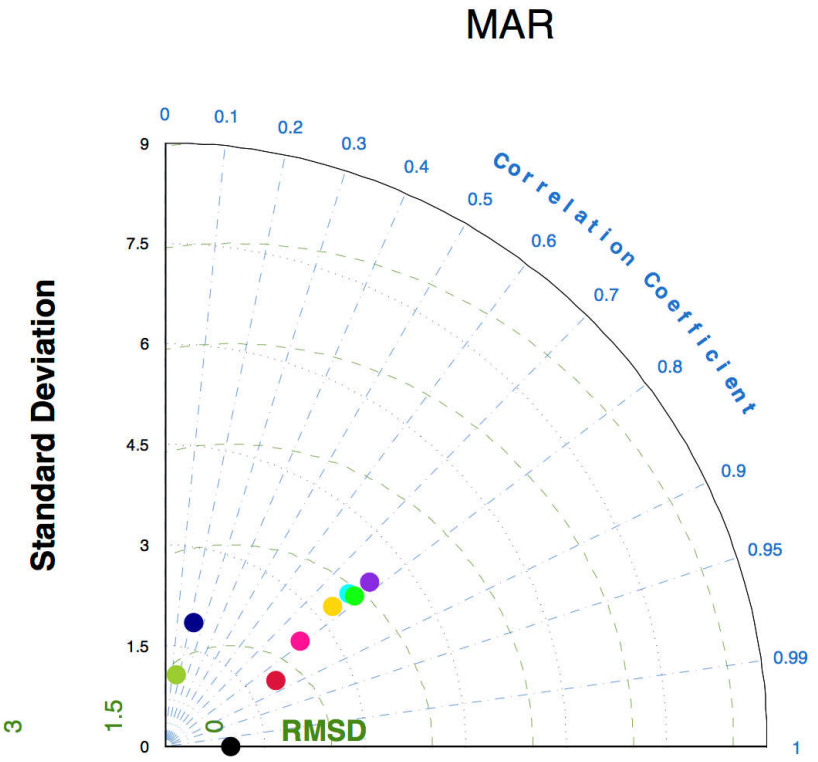
Taylor Diagram for dry month

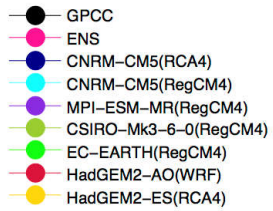
Ensemble tends to be better



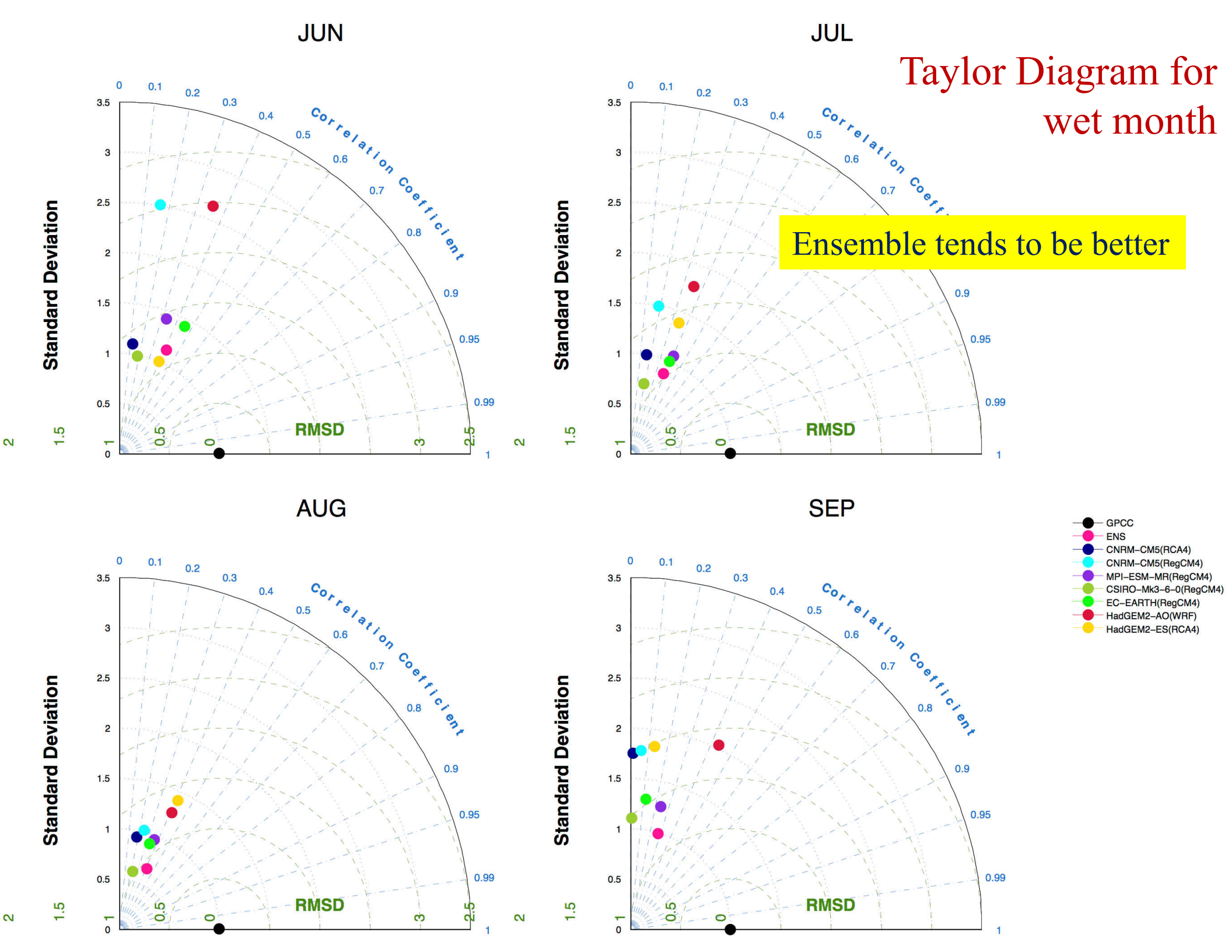




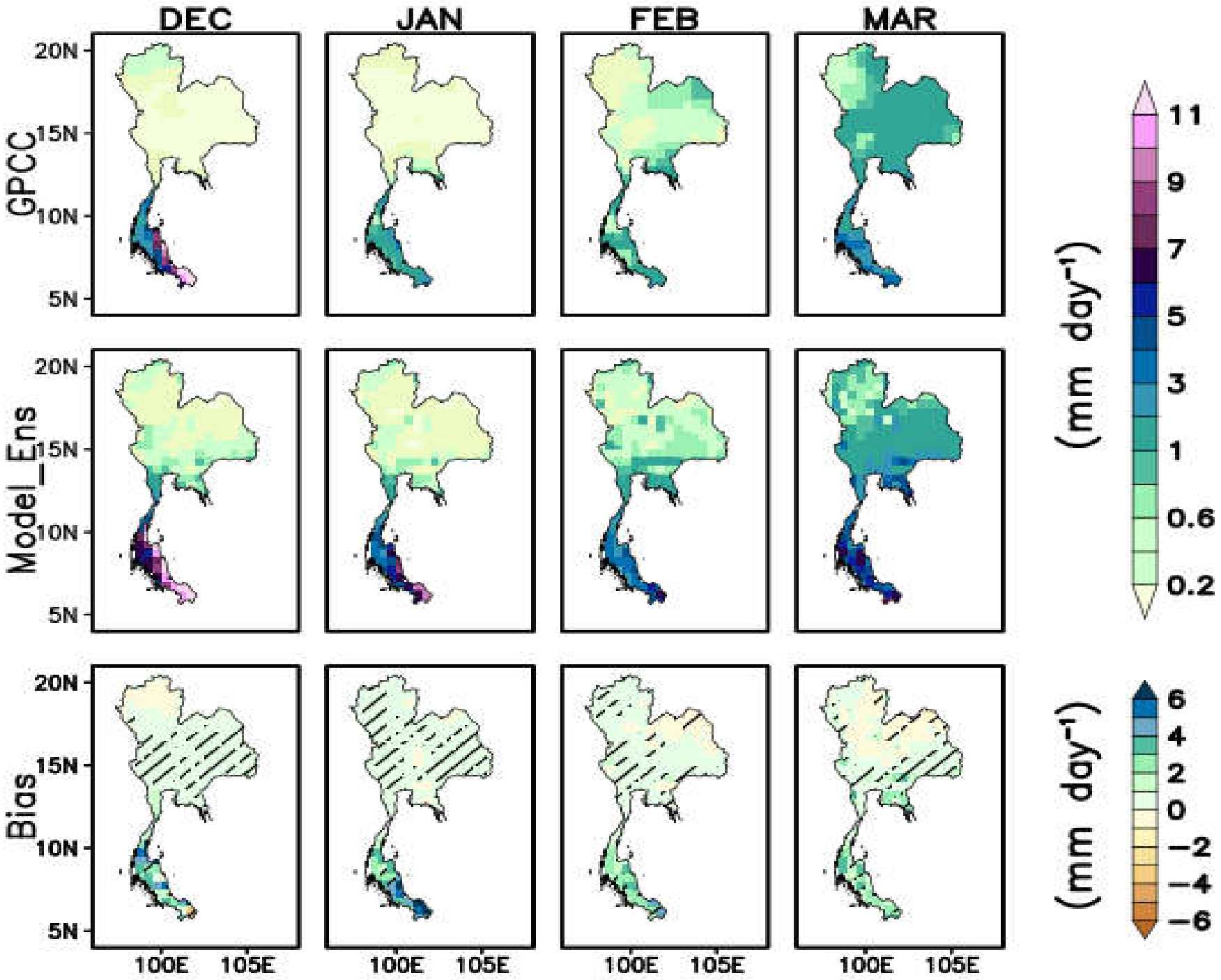




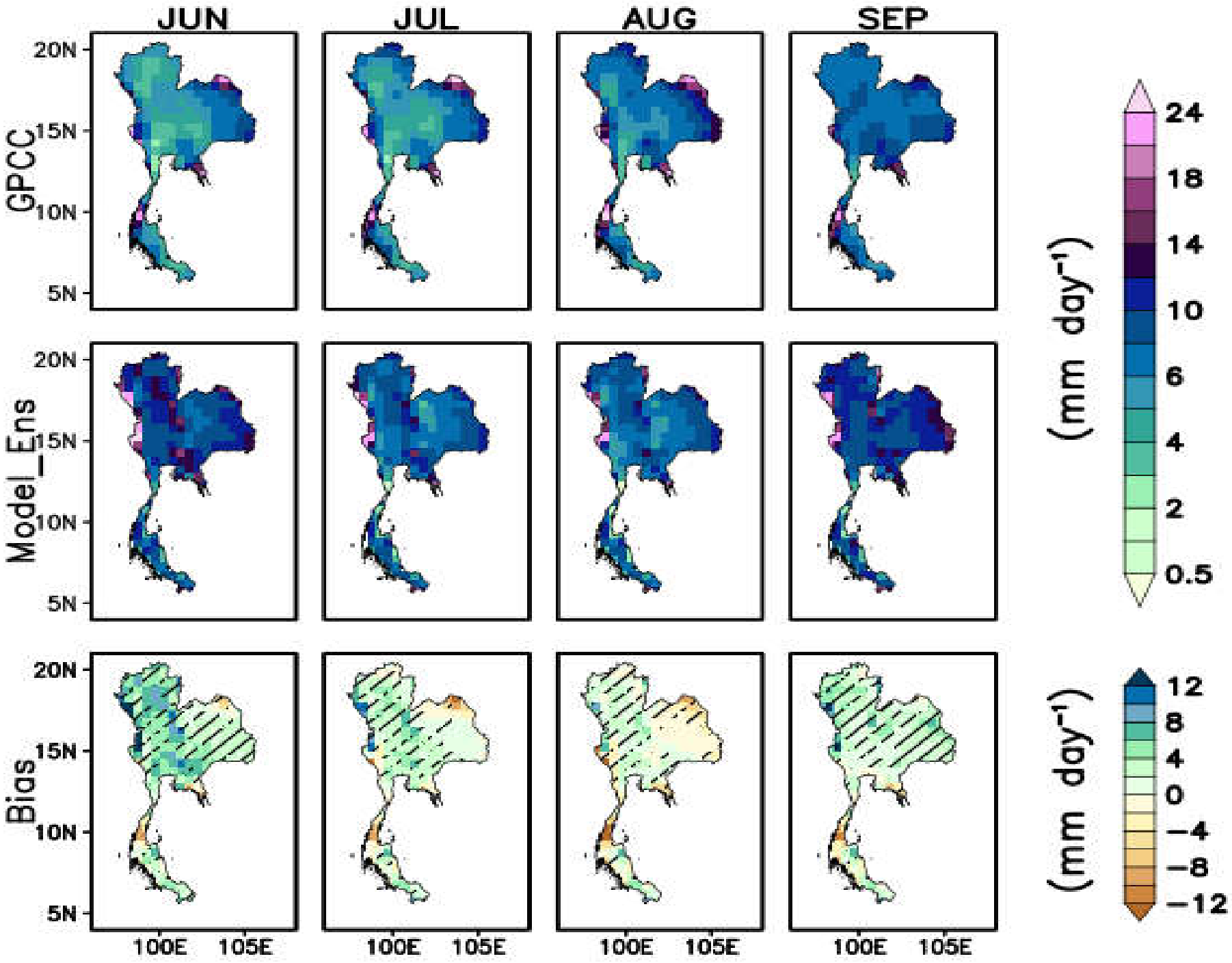
Taylor Diagram for wet month



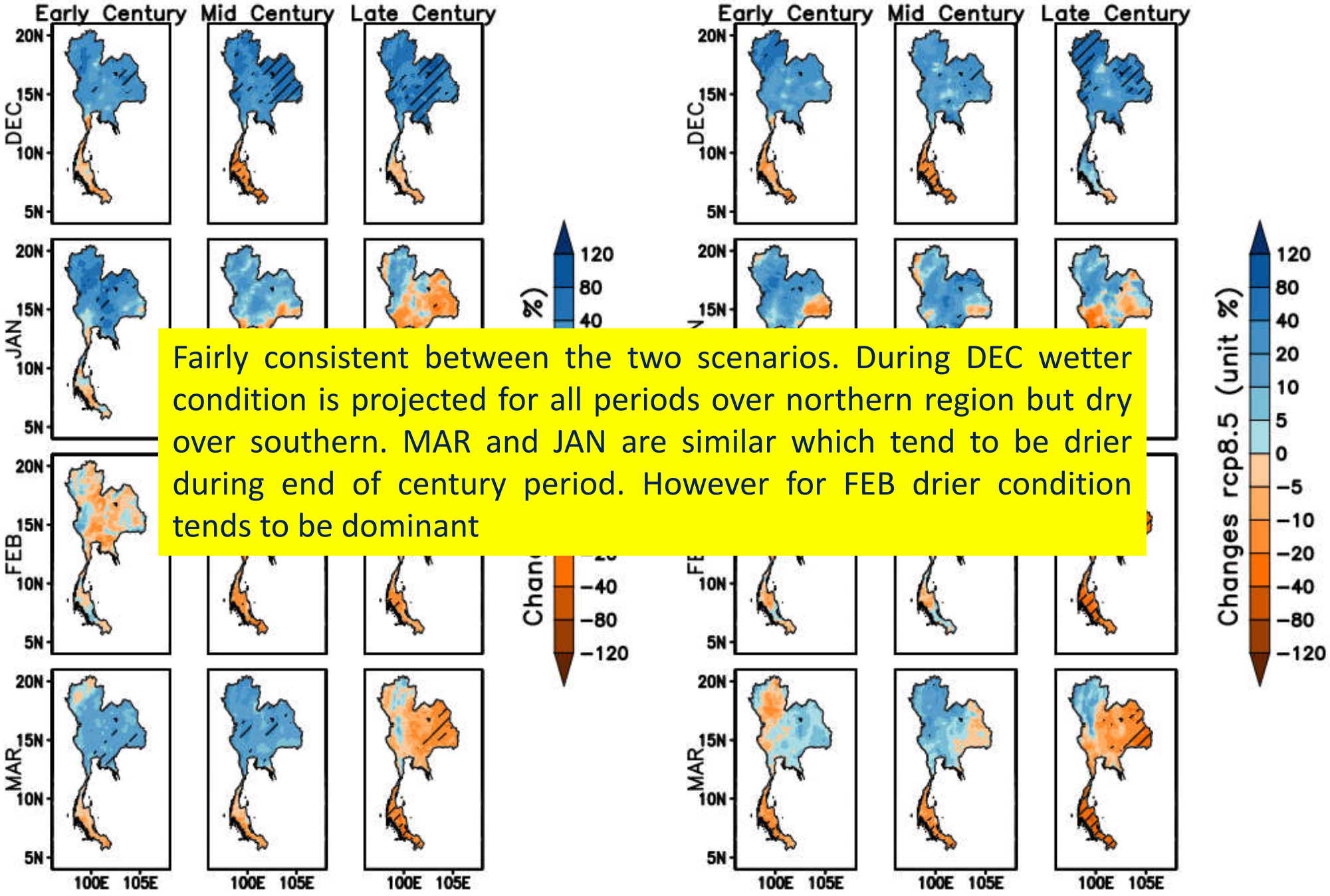
Ensemble tends to be better



Historical period for dry months. More wet biases over the southern region



Historical period for dry months. More wet biases over the northern region

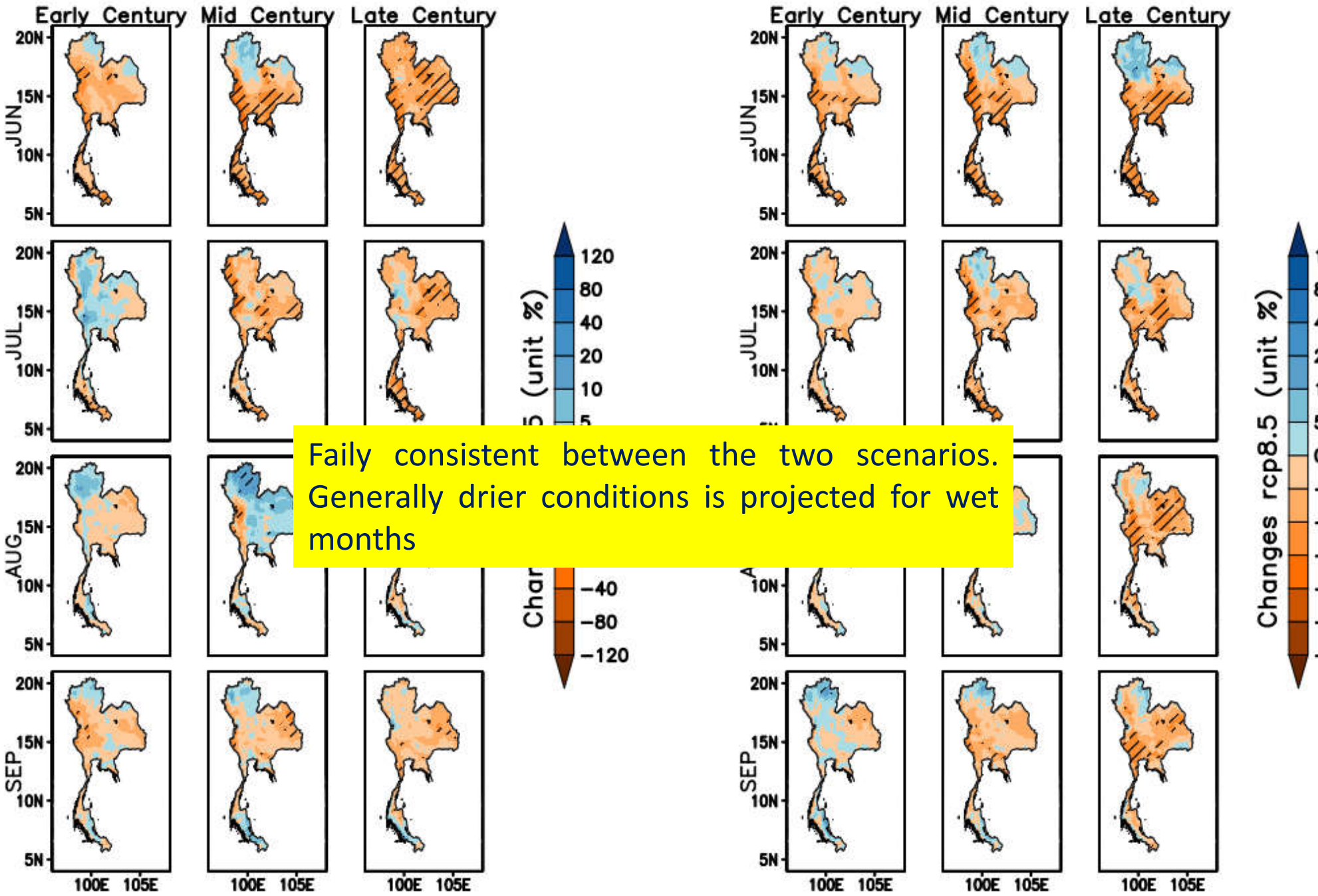


Fairly consistent between the two scenarios. During DEC wetter condition is projected for all periods over northern region but dry over southern. MAR and JAN are similar which tend to be drier during end of century period. However for FEB drier condition tends to be dominant

RCP4.5

Projection for dry month

RCP8.5

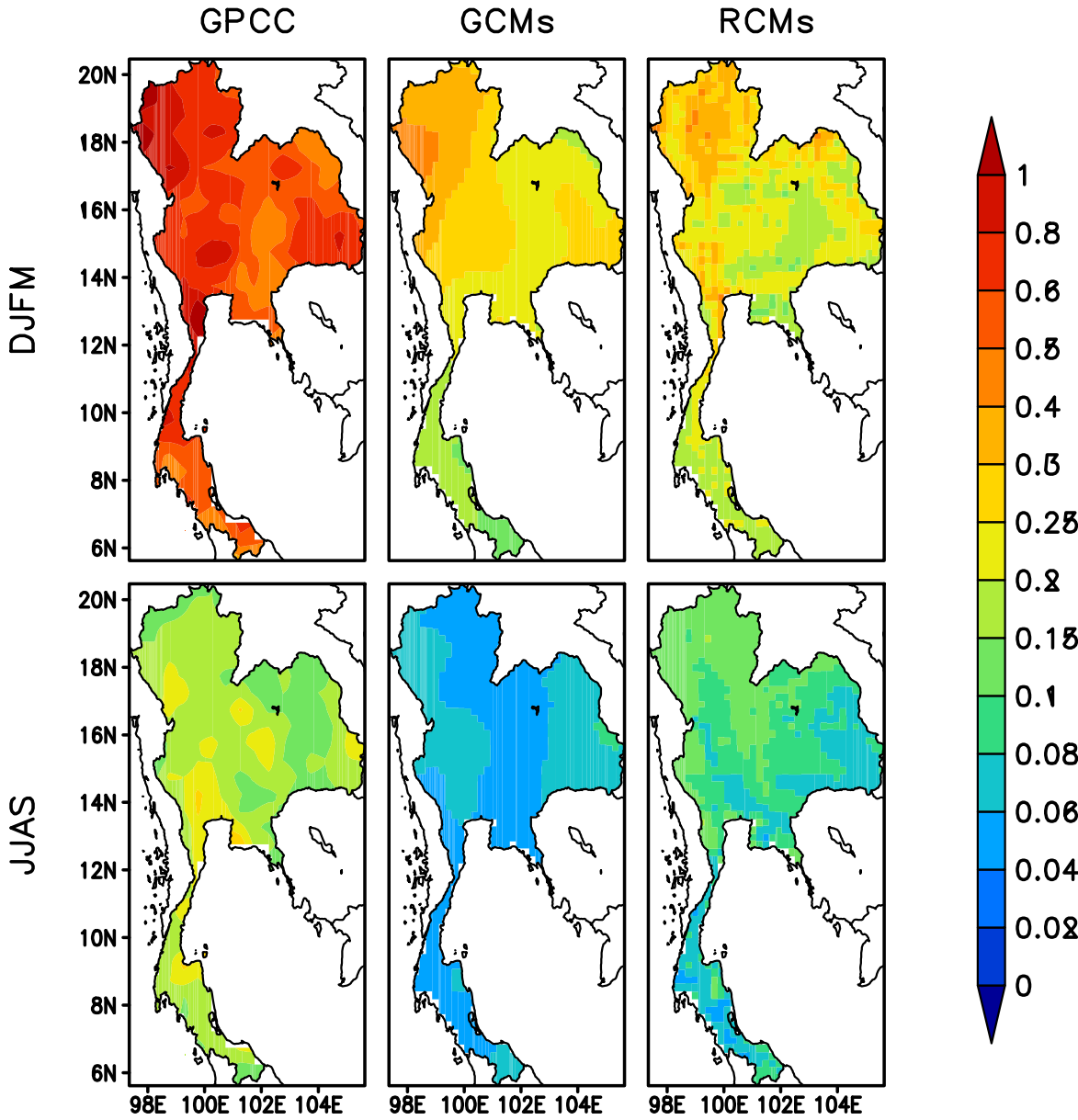


Faily consistent between the two scenarios. Generally drier conditions is projected for wet months

Projection for wet month

Comparison of coefficient of variation among GPCC, GCMs, and RCMs during dry and wet months

- GPCC has high interannual variabilities during dry months buth in GCMs and RCMs were not well simulated.
- During wet months the interannual variabilities is less but not well simulated by GCMs and RCMs.



Summary

- The ensemble simulations during historical period were reasonable but tended to produce wet biases over Thailand
- For projection periods; tendency for wetter condition during dry months and drier during wet months
- The RCMs underestimated the interannual variability during historical. This is due to the underestimation by the GCMs.

A Study of Watershed Management under Climate Change: A Case Study at Sirindhorn International Environmental Park

- A research collaboration NCAR and RU-CORE.
- Funded by the Natioanl Research Council of Thailand.

A Study of Watershed Management under Climate Change: A Case Study at Sirindhorn International Environmental Park

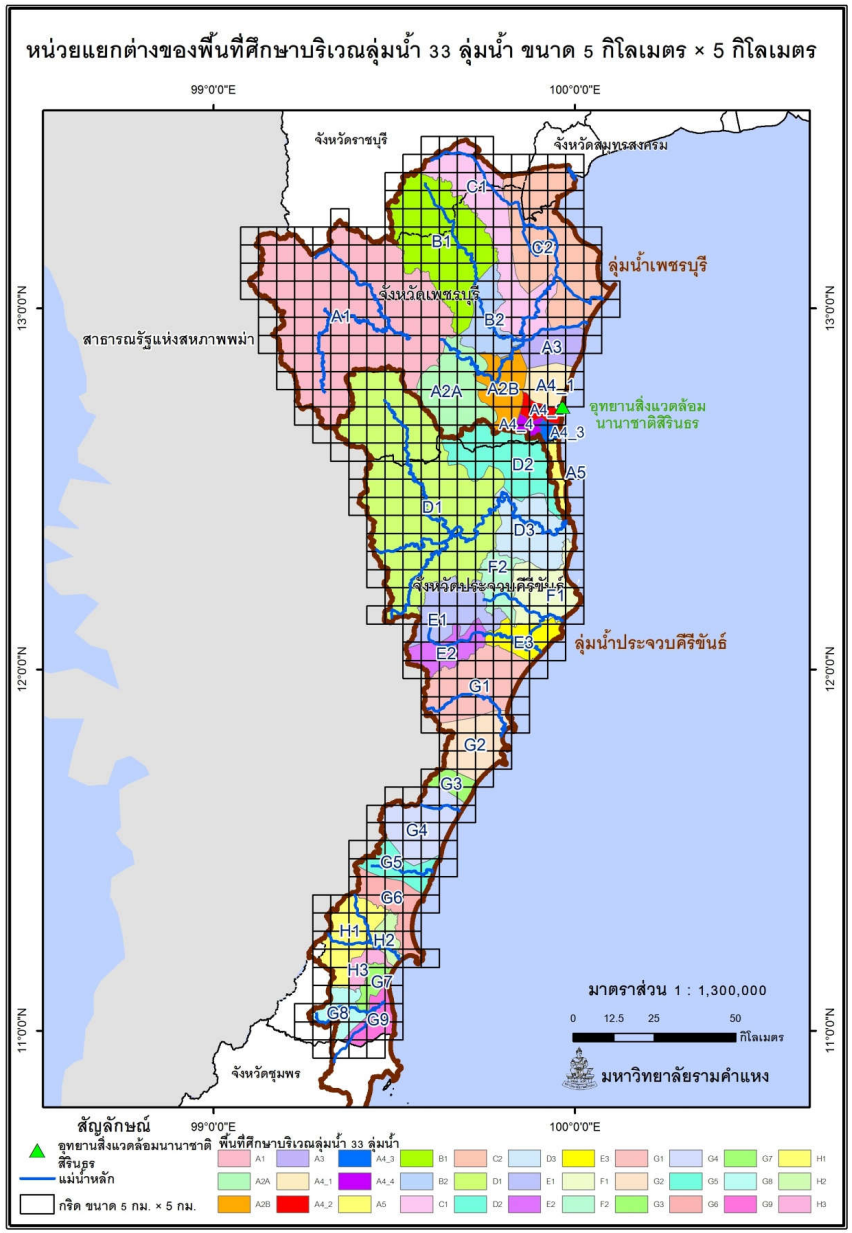
Dynamical downscaling

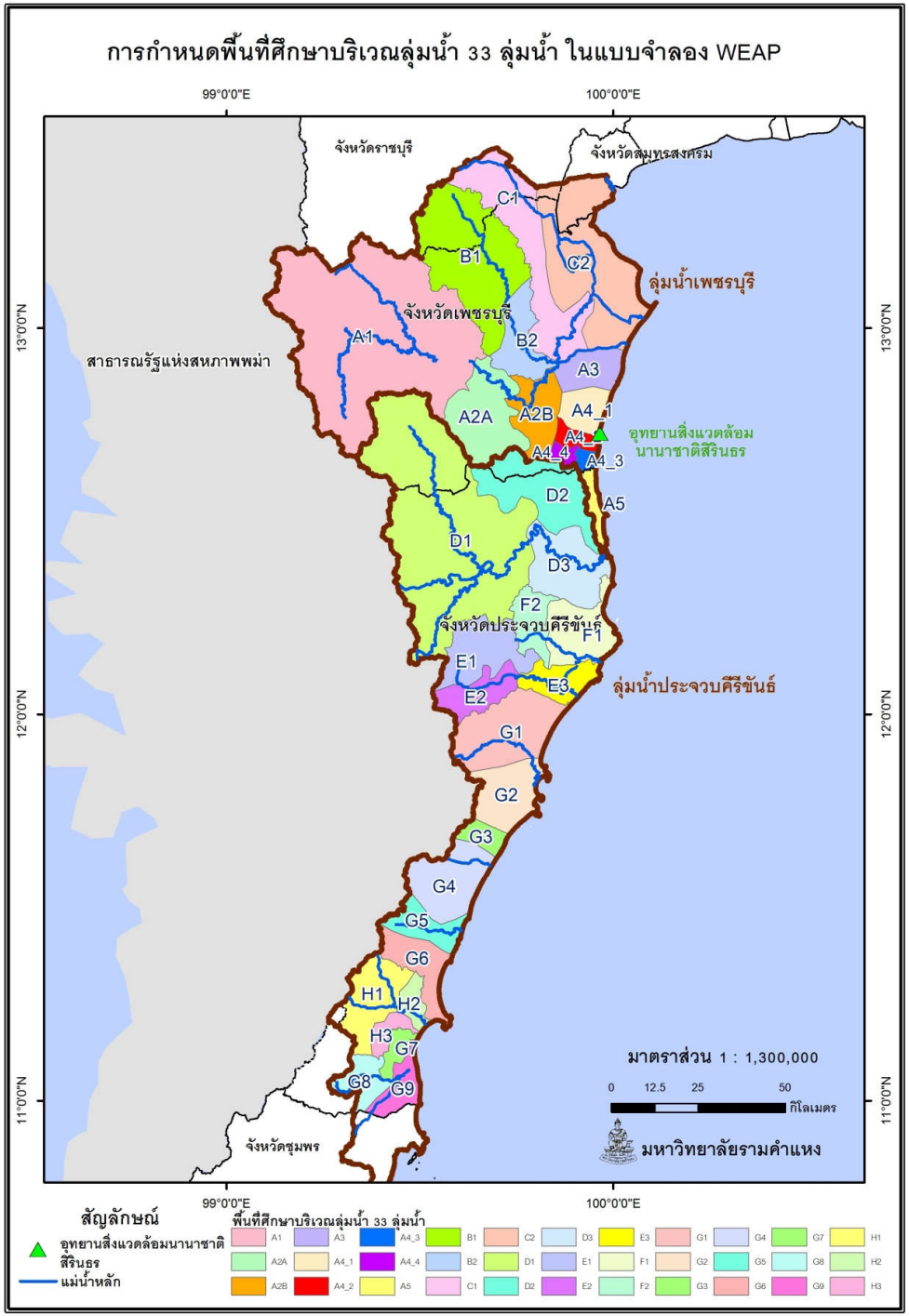
Regional Climate Model : RegCM4
Domain : CORDEX SEA
Baseline : 1970 – 2005
Future projection : 2006 – 2040
Grid resolution : 25 km x 25 km

Statistical downscalig

Transfer function technique : ANN
Area : Two river basins
Grid resolution : 5 km x 5 km

GCM : MPI-ESM-MR
Scenario : RCP4.5 and RCP8.5
Water Evaluation and Planning model (WEAP)

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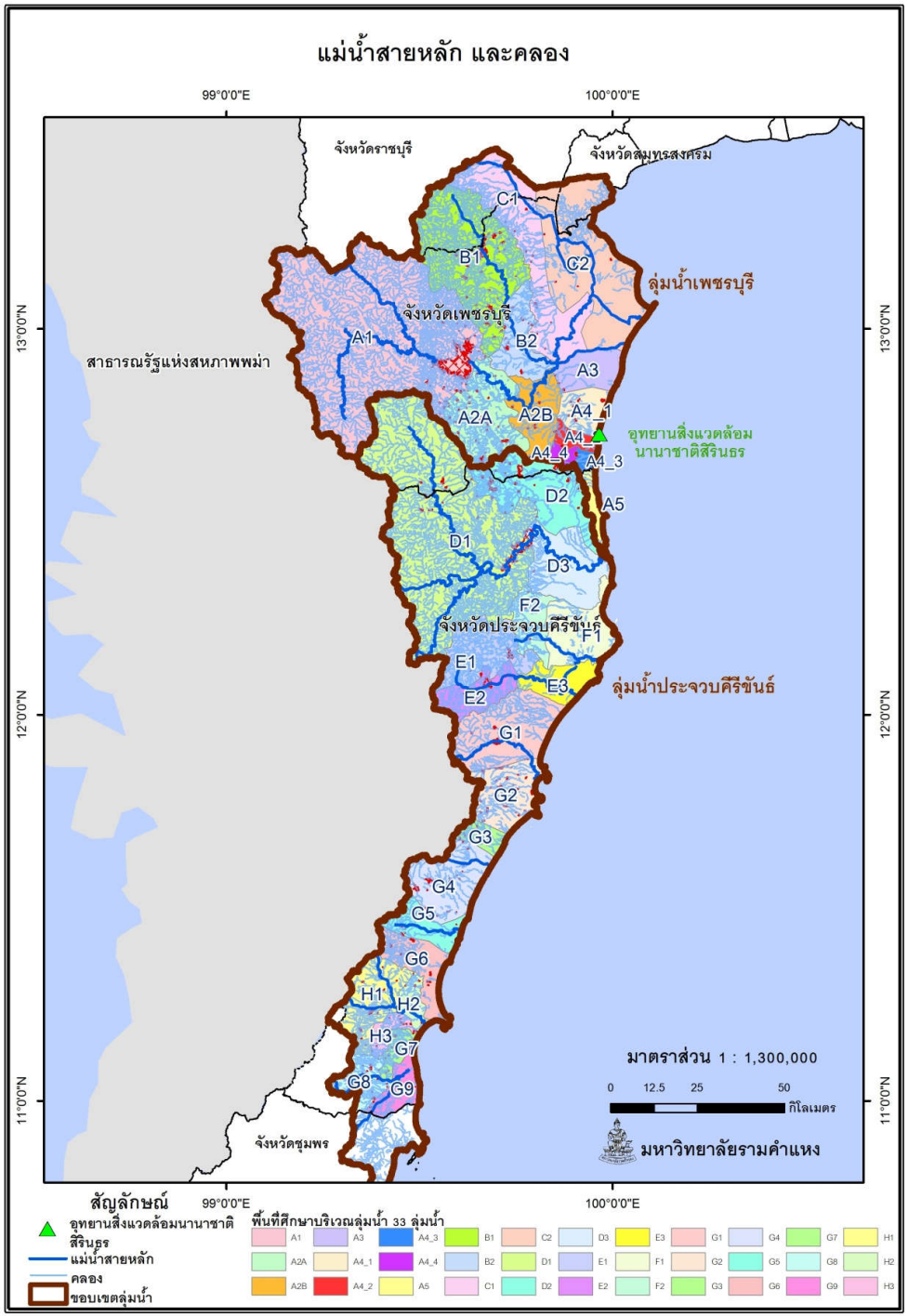
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สัญลักษณ์
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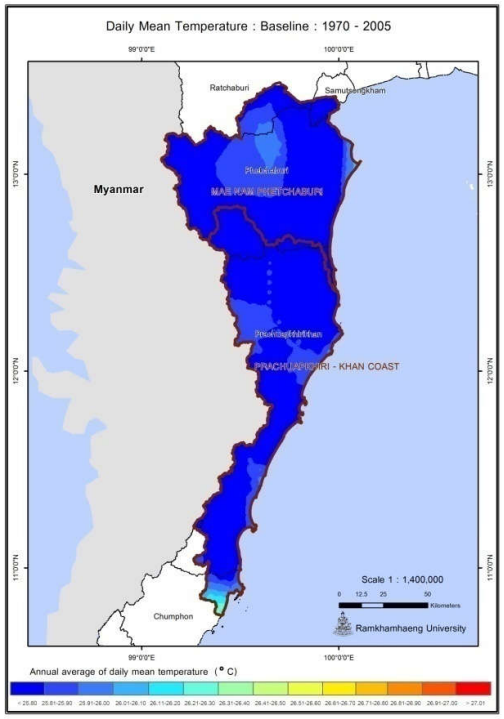
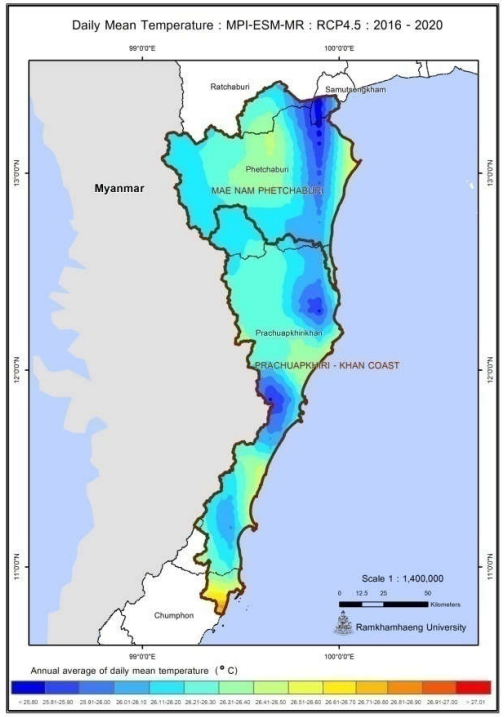
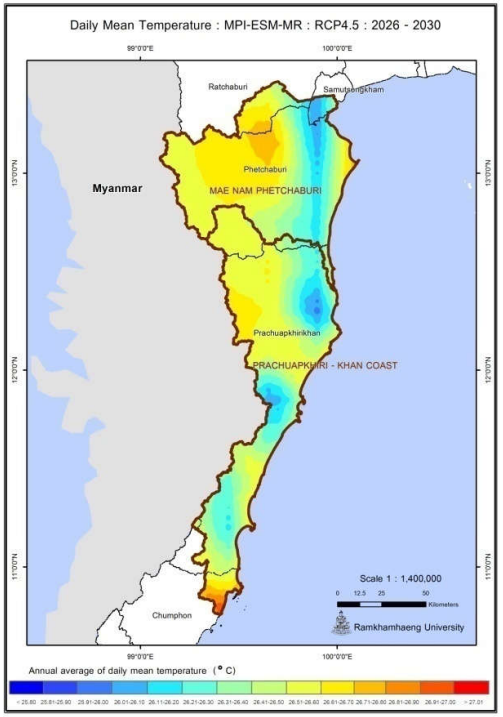
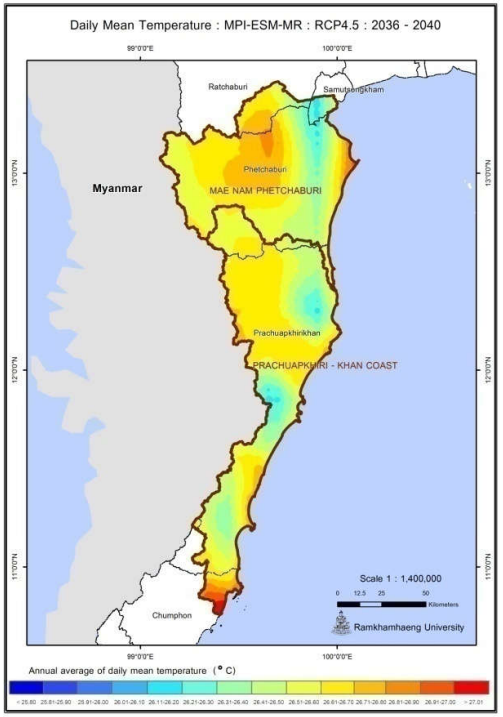
คลอง
ขอบเขตลุ่มน้ำ
พื้นที่ศึกษาบริเวณลุ่มน้ำ 33 ลุ่มน้ำ

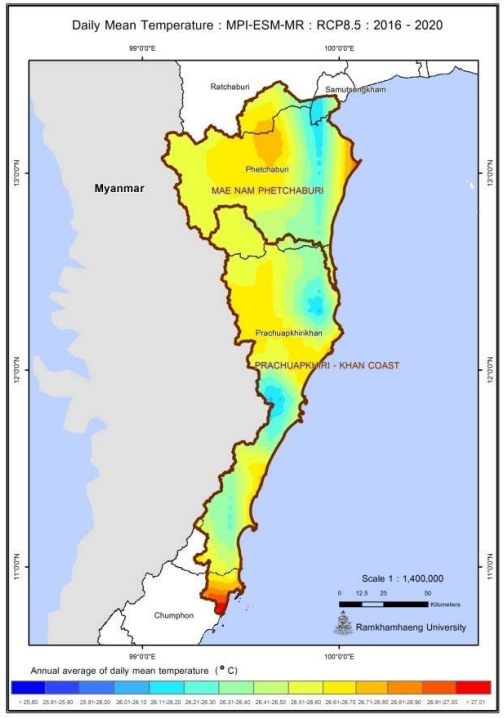
Temperature Projection

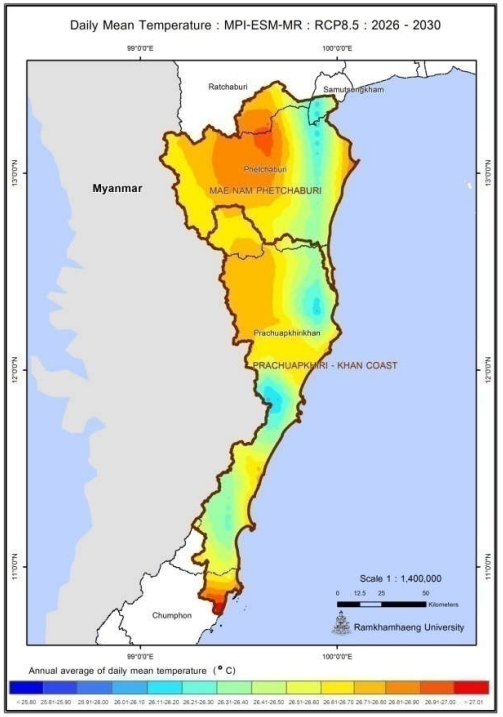


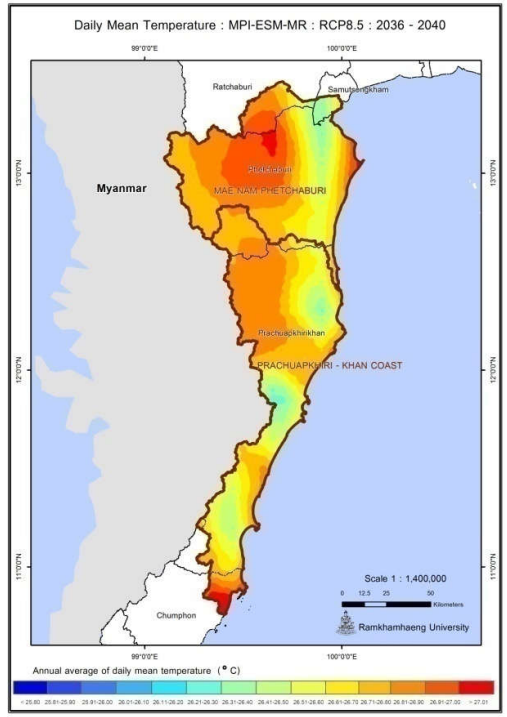




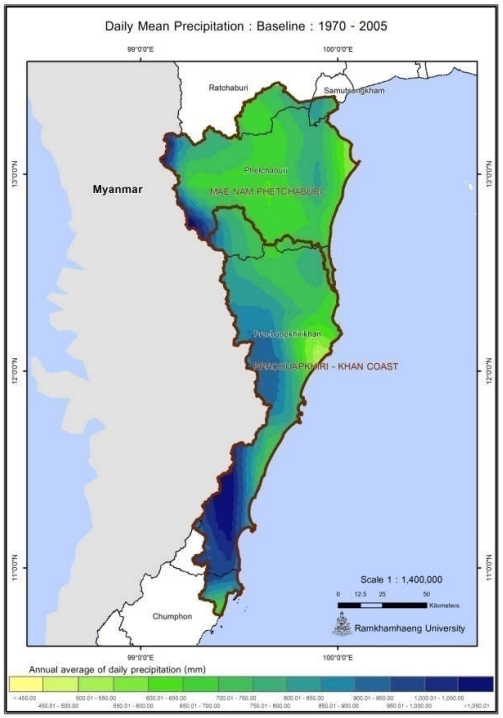


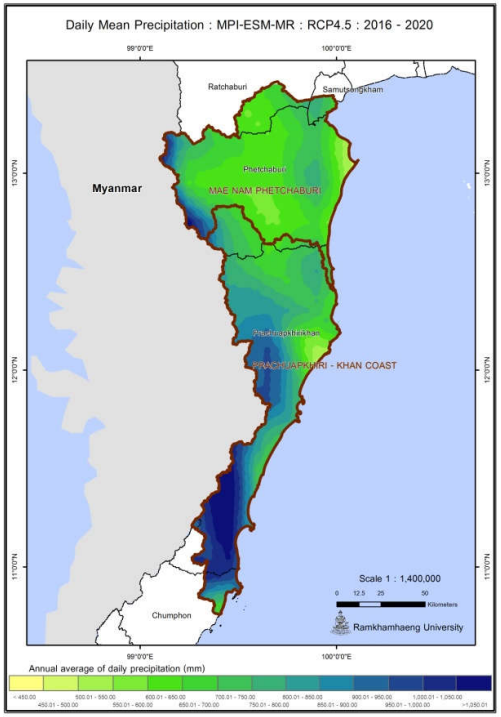


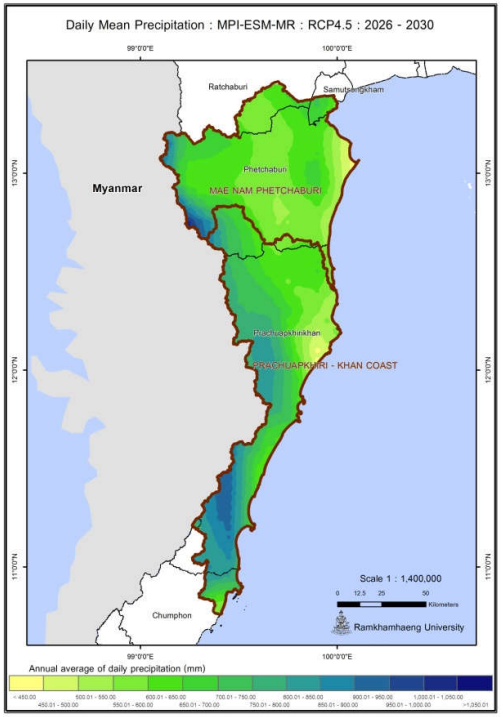


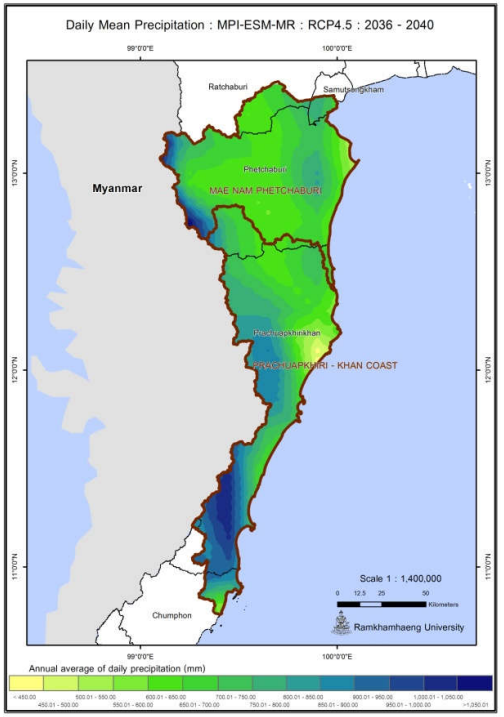


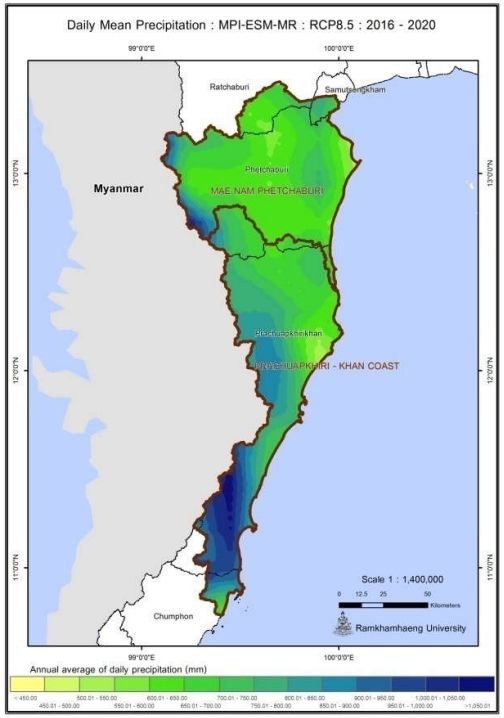
Precipitation Projection

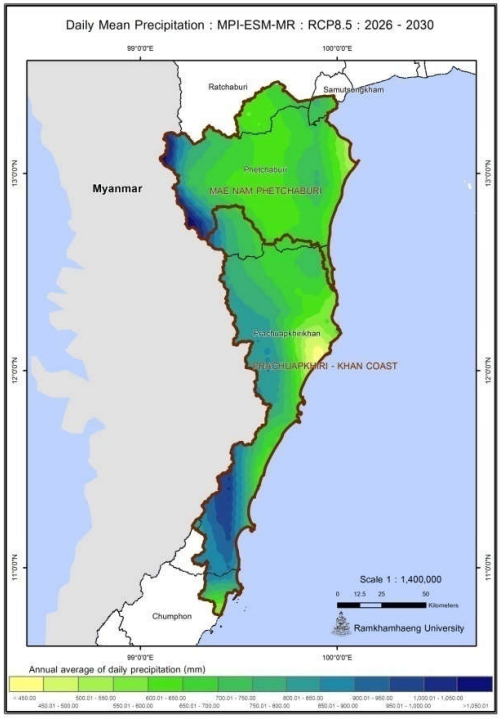


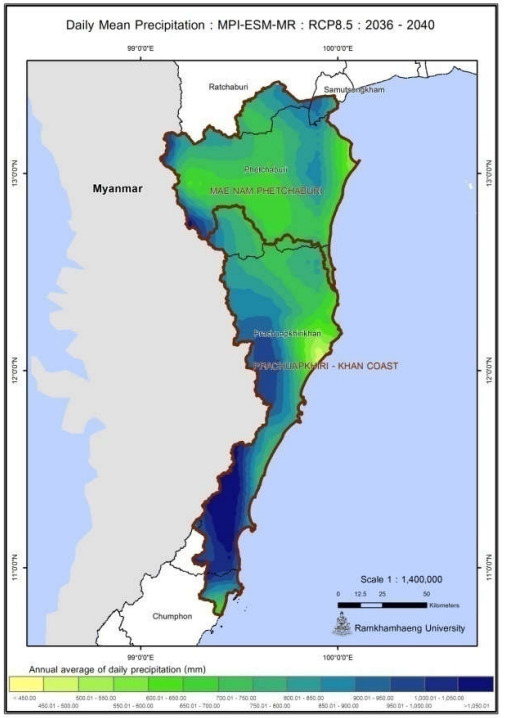






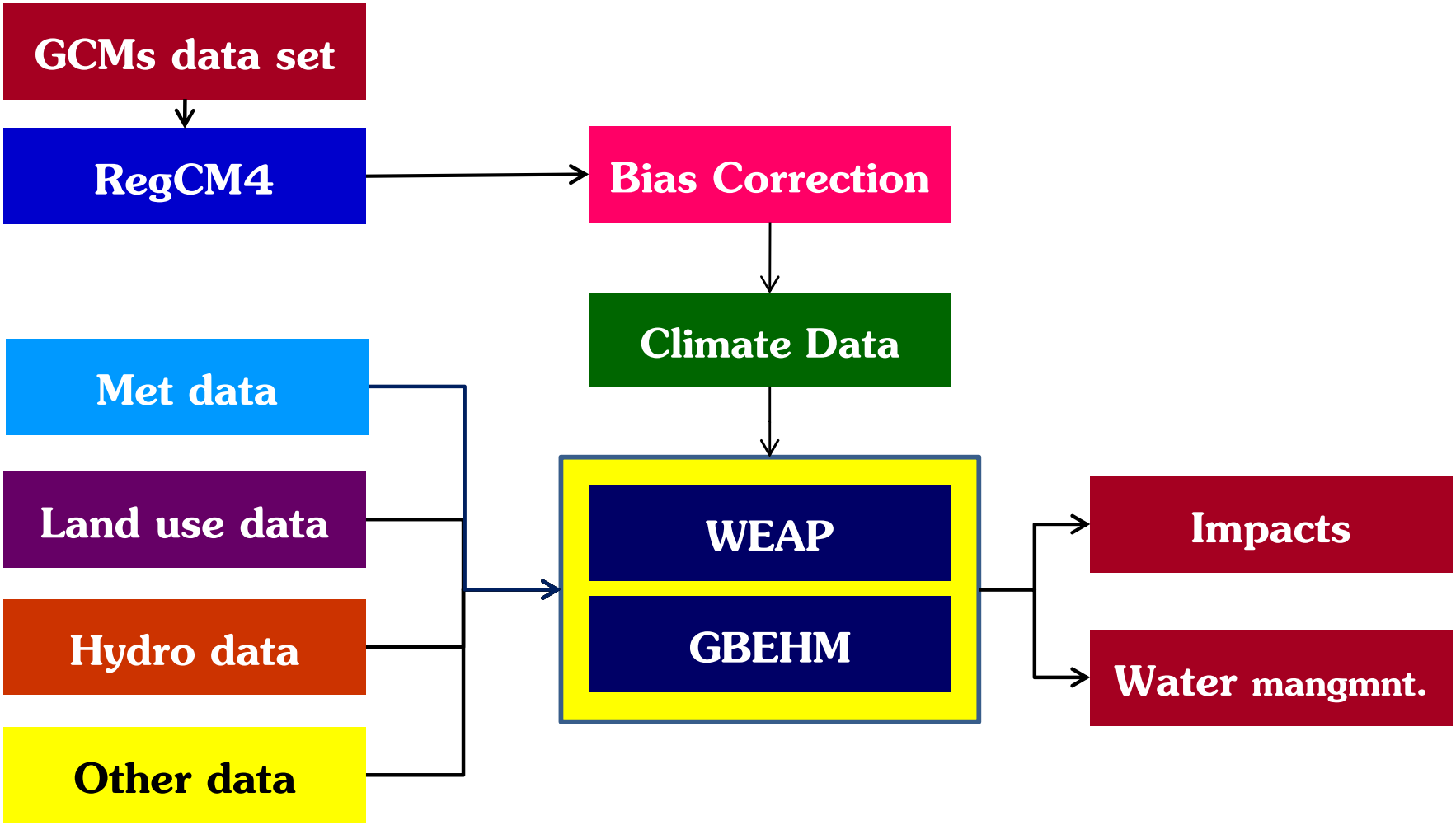




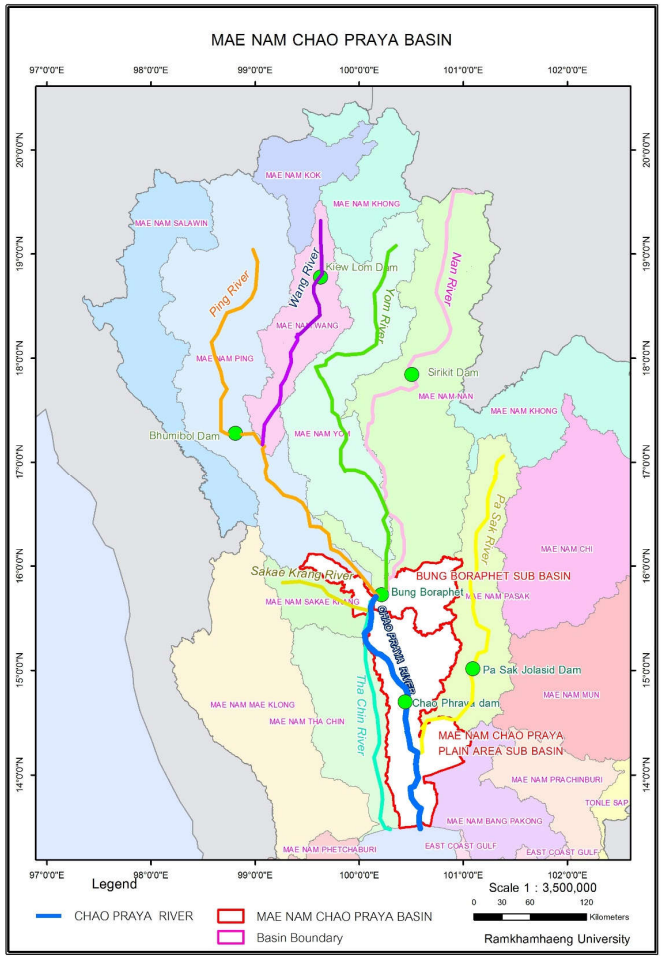


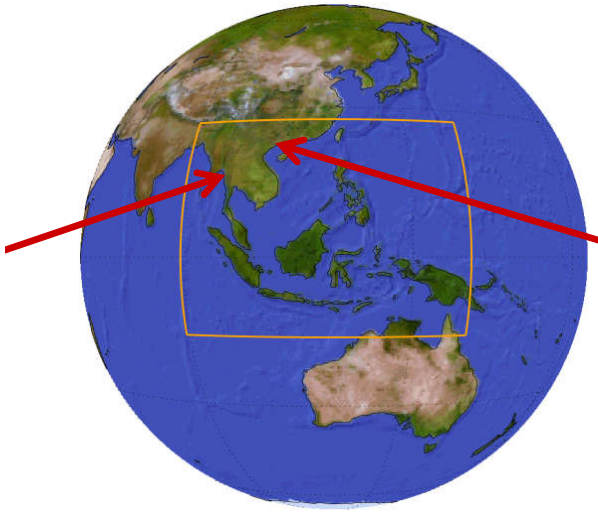
A comparative study on the change of hydrological processes and fluxes in the Jiulong River and Chao Phraya River basins under changing climate

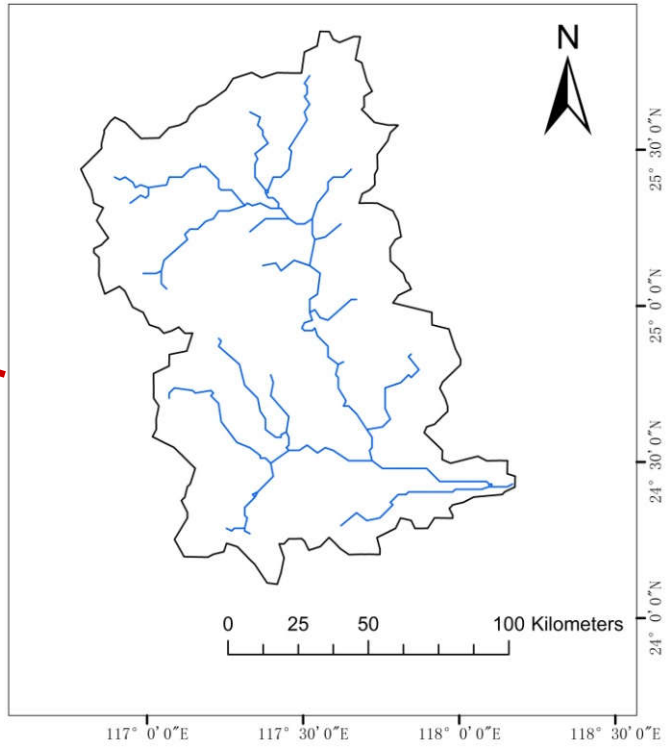
- A research collaboration Tsing hua university and RU-CORE
- Funded by the Natioanl Research Council of Thailand.



CORDEX SEA Domain and Study area

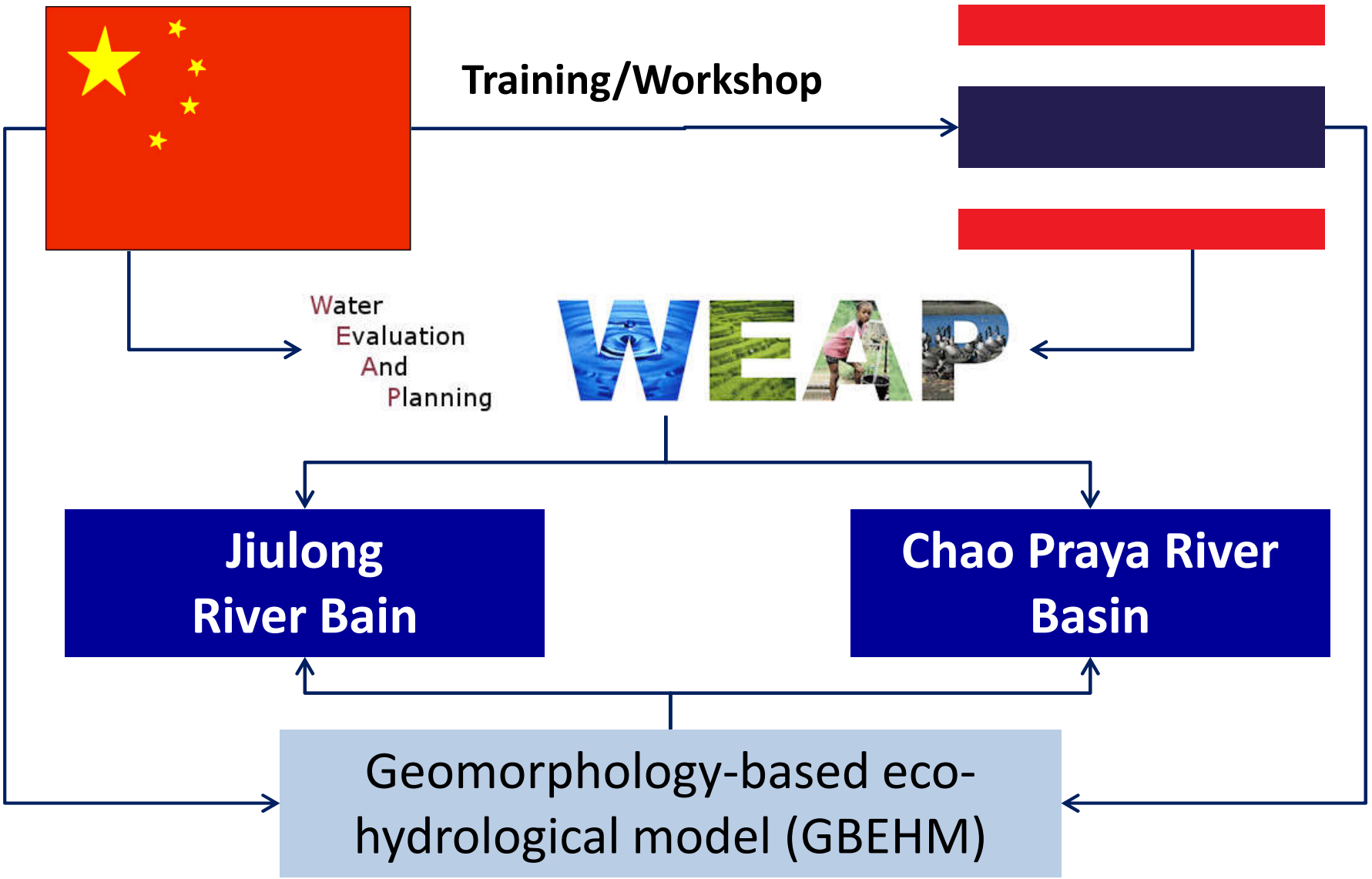




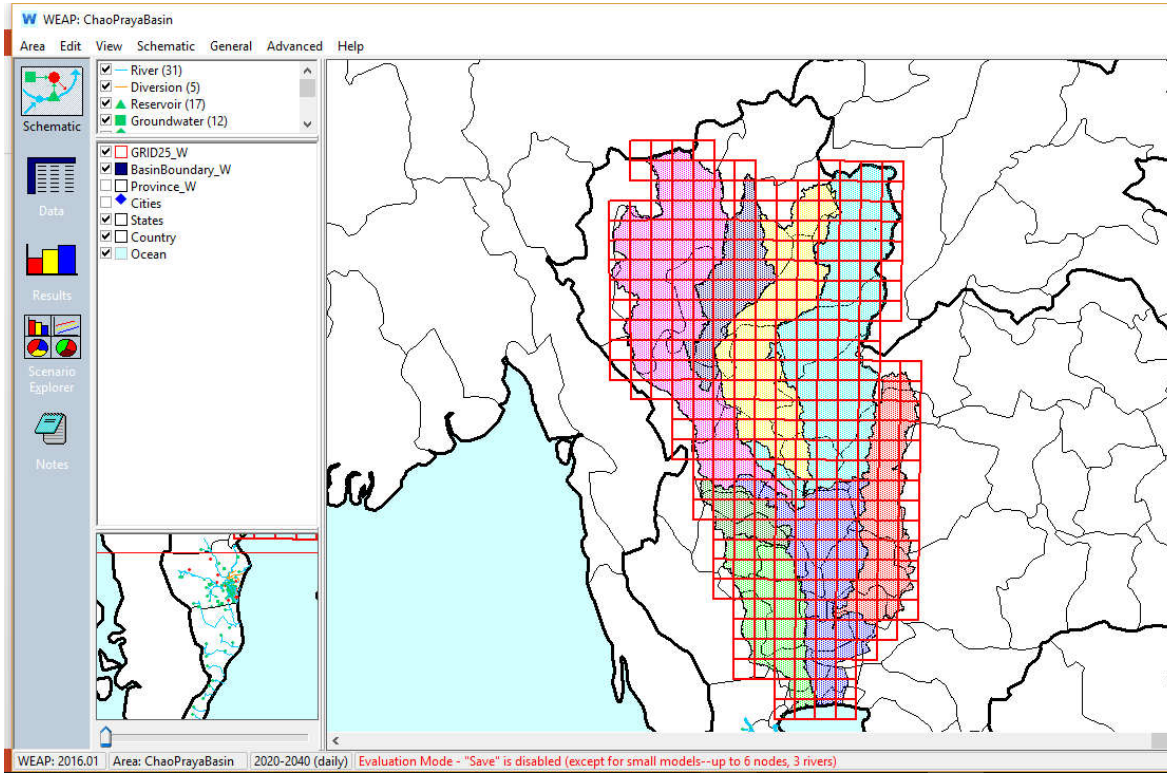


Climate data set

- Dynamical Downscaling — RegCM4
- Domain — CORDEX-SEA
- Base line — 1970 – 2005
- Projection — 2006 - 2060
- Resolution — 25 km x 25 km
- GCMs
  - MPI-ESM-MR — Max Planck Institure for Meteorology
  - EC-Earth — EC-Earth consortium
  - GFDL-ESM-2M — GFDL, USA
- Scenario — RCP4.5 and RCP8.5


Training/Workshop
Water
Evaluation
And
Planning
WEAP
Jiulong
River Bain
Chao Praya River
Basin
Geomorphology-based eco-
hydrological model (GBEHM)

WEAP Chao Phraya Model



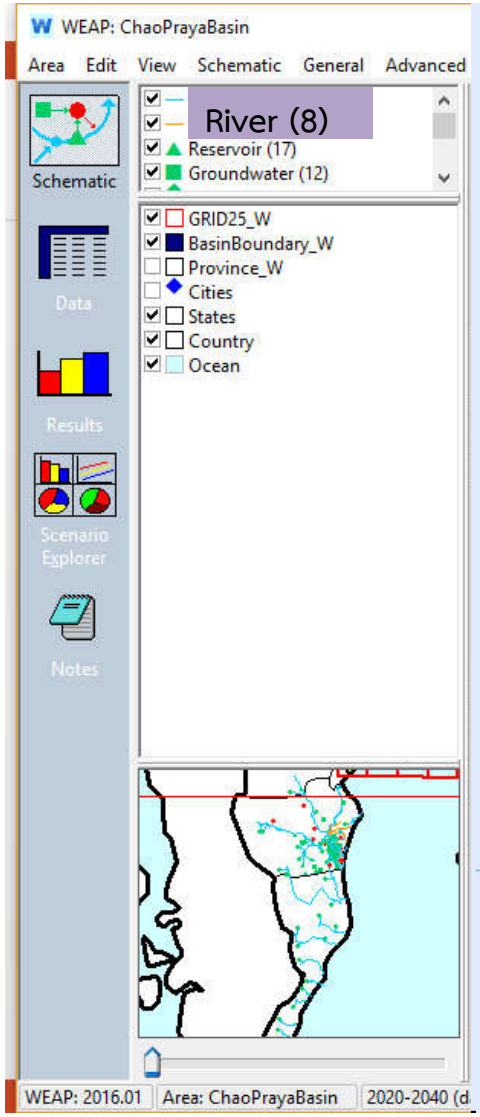
- No. of provinces : 29
- Total area : 158,586 km^2
- Grid resolution : 25 km x 25 km
- No. of grid : 316

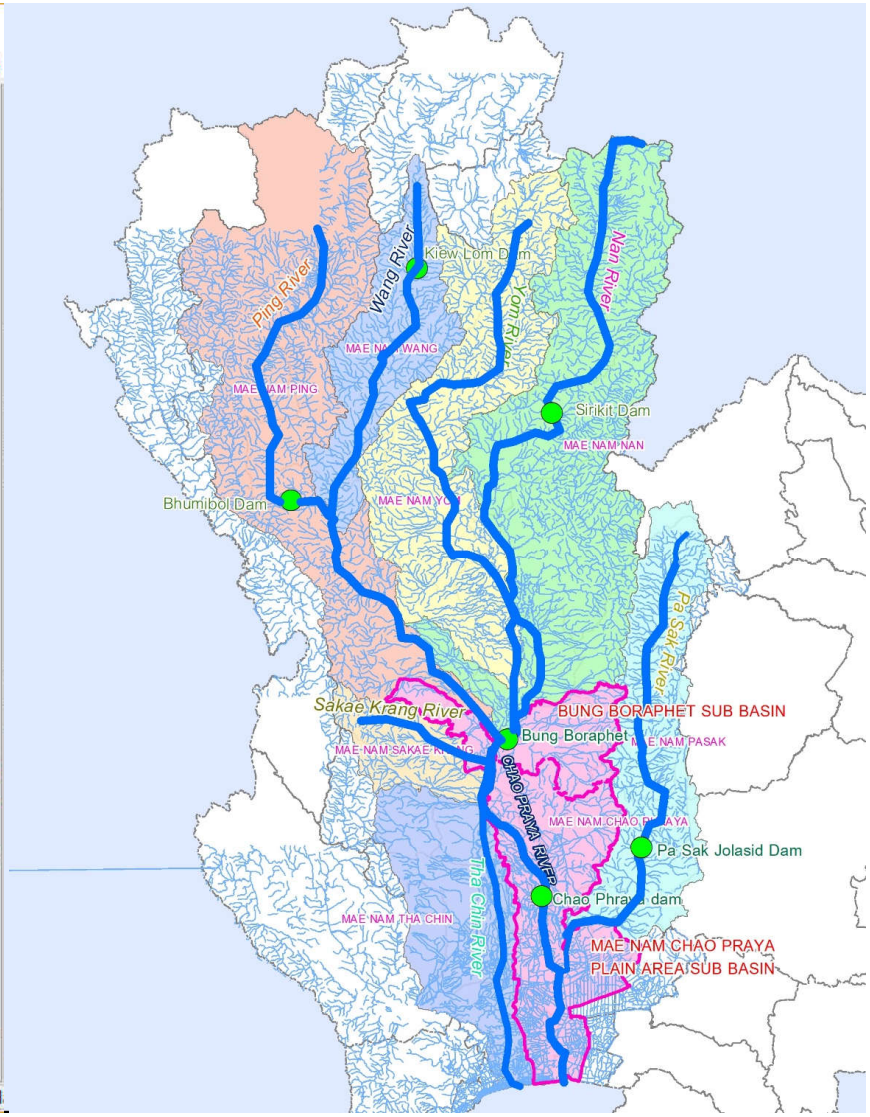
Main rivers and canels

8 main rivers

- Ping river
- Wang river
- Yom river
- Nan river
- Sakae Krang river
- Pa Sak river
- Tha Chin river
- Chao Praya

16,412 branch rivers and canels





Mae Ngat Somboon Chon Dam

- A earthen Dams on the Mae Ngat River, a tributary of the Ping River
- Chiang Mai Province, Thailand
- Total capacity 265,000,000 m³

Mae kuang Dam

- A earthen Dams
- Chiang Mai Province, Thailand.
- Total capacity 263,000,000 m³

Bhumibol Dam

- A concrete arch dam on the Ping River
- A tributary of the Chao Phraya River
- Tak Province, Thailand
- Total capacity 13,462,000,000 m³

Bueng Boraphet

- The largest freshwater swamp and lake in central Thailand. It covers an area of 224 km2

Pak Nam Pho

- The path of two rivers converge Between Ping River and Nan River. Merge into the Chao Phraya River.

Chao Phraya Dam

- A barrage dam in Chai Nat, Thailand.
- It regulates the flow of the Chao Phraya River as it passes into lower central Thailand.

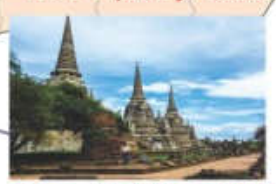
Sirikit Dam

- An embankment dam on the Nan River, a tributary of the Chao Phraya River
- Tha Pla district of Uttaradit Province, Thailand.
- Total capacity 9,510,000,000 m³

Pa Sak Jolasid Dam

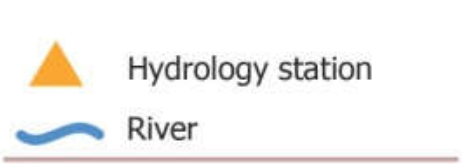
A earthen Dams on the Pa Sak River, It is the biggest reservoir in central Thailand.

- Phatthana Nikhom District, Lopburi Province, Thailand.
- Total capacity 960,000,000 m³



Phra Nakhon SI Ayutthaya

As a former capital of the Thailand for 417 years from 1351 - 1768. Evidence of is a town in the Chao Phraya River Basin.



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Center of Regional Climate Change and Renewable Energy

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2XXX ?!

Past

Now

THANK YOU