Regional Climate Modeling for Thailand by JGSEE (2007-2012): Dynamical Downscaling under Multiple Scenarios

Kasemsan Manomaiphiboon

The Joint Graduate School of Energy and Environment (JGSEE),
King Mongkut's University of Technology Thonburi (KMUTT), and
Center for Energy Technology and Environment, Ministry of Education, Thailand

JGSEE
The Joint Graduate School of Energy and Environment

CEE PERDO
Center of Excellence on Energy Technology & Environment

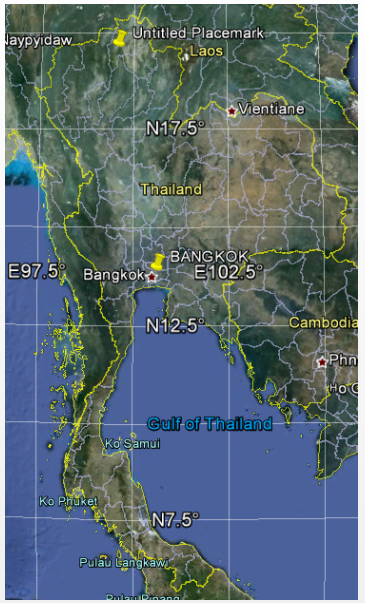
Southeast Asian Regional Downscaling Climate Downscaling Workshop
Aug. 2-3, 2012, Hanoi University of Science, Hanoi, Vietnam

The Joint Graduate School of Energy Environment (JGSEE) is an international graduate education and research school operating as a consortium involving five leading institutions in Thailand KMUTT, KMITNB, PSU, CMU and SIIT-TU as partners. Our vision is to be an internationally recognized premier centre in graduate education and research in the fields of energy and environmental technologies.

JGSEE
The Joint Graduate School of Energy and Environment

CEE PERDO
Center of Excellence on
Energy Technology & Environment

KMUTT KMITNB CMU SIIT-TU PSU



Tropical Climate System Modeling Laboratory (TCSM)

The objective of this laboratory is to do the regional climate modeling and analysis, regional and air quality modeling and analysis, hydrological/oceanic/coastal modeling and analysis, climate-related Energy modeling and analysis. Note that all above topics focus on tropical Southeast Asia in both regional and local scales.

- Research Publication

Activity & Research Program

- Regional climate modeling for Thailand under multiple future scenarios
- Photochemical modeling for Chonburi city
- Air pollutant dispersion modeling over industrial areas
- Wind resource modeling for Thailand and Bangkok
- ENSO-related ascepts through modeling and analysis
- Coastal modeling over Gulf of Thailnad
- Extended renewable energy resource modeling
- Transboundary air pollutant modeling
- Coupled climate and air quality/hydrological modeling
- Toxic air modeling over cities or areas
- Coupled atmoshperic and oceanic modeling

Computational Laboratory

High-Performance Cluster (decommissioned)

Introduction

- **IPCC Fourth Assessment Report (IPCC 2007):**
  "The global average surface temperature has increased"
- **Ongoing climate change not only affects means but also extremes**
- **Increasing awareness of potential future climate conditions**

How to mitigate climate change adverse effects on society, economy, and environment?

Must be resolved at regional level for THAILAND

Thailand's Climate

- Main driver:
  - Southwest monsoon: mid-May to mid-October, brings WET season
  - Northeast monsoon: mid-October to mid-February, brings WINTER and DRY season
- Local topography also modulates climatic patterns:
  - North: valleys and mountains
  - Northeast: broad plateau
  - Central and East: large alluvial plain with sporadic hills
  - South: mix of coastal plains and mountains
- Seasonal and interannual variability are influenced by the Intertropical Convergence Zone (ITCZ) movement and El-Nino Southern Oscillation (ENSO) event

Potential future changes cannot be sufficiently estimated by global climate models (GCMs), →Regional climate model (RCM) is needed

Application of Regional Climate Model RegCM3 to Thailand and Performance Evaluation

MISS MEGA OCTAVIANI

49910207

A THESIS SUBMITTED AS A PART OF THE REQUIREMENTS
FOR THE DEGREE OF MASTER OF PHILOSOPHY
IN ENVIRONMENTAL TECHNOLOGY

LONG-TERM PERFORMANCE OF REGIONAL CLIMATE MODEL REGCM3 ON TEMPERATURE, PRECIPITATION, AND THEIR EXTREMES OVER AN INDOCHINA PENINSULA SUB-REGION

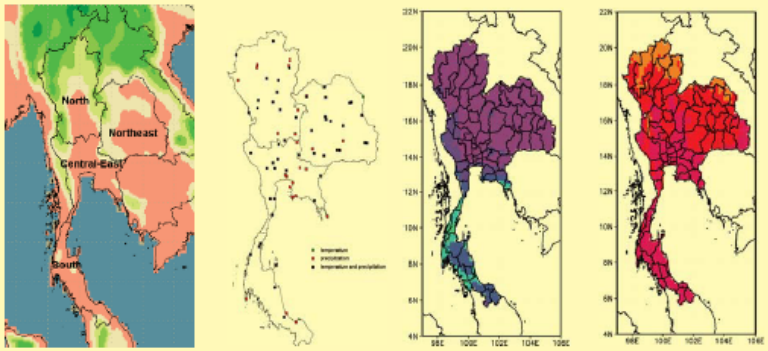
MR. KRITANAI TORSRI

ID: 50910306

A THESIS SUBMITTED AS A PART OF THE REQUIREMENTS
FOR THE DEGREE OF MASTER OF SCIENCE
IN ENVIRONMENTAL TECHNOLOGY

รายงานวิจัยฉบับสมบูรณ์

โครงการ การศึกษาและพัฒนาแบบจำลองสภาพภูมิอากาศ
ระดับภูมิภาค RegCM3 สำหรับประเทศไทย



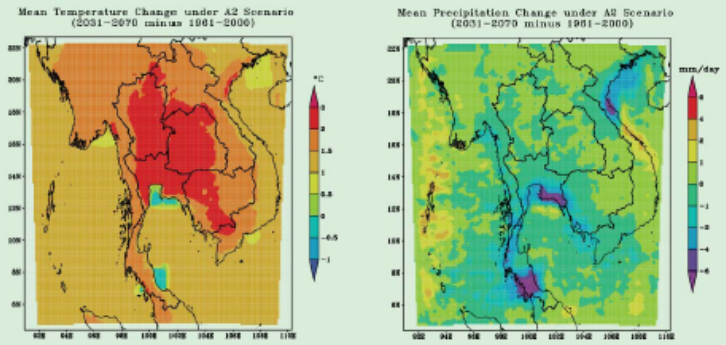
โดย สิรินทรเทพ เต้าประยูร และคณะ
กันยายน 2554

PERDO JGSEE

Final Report

Study of Potential Climate Change for Thailand Using
Regional Climate Model RegCM3 under
Multiple Future Scenarios

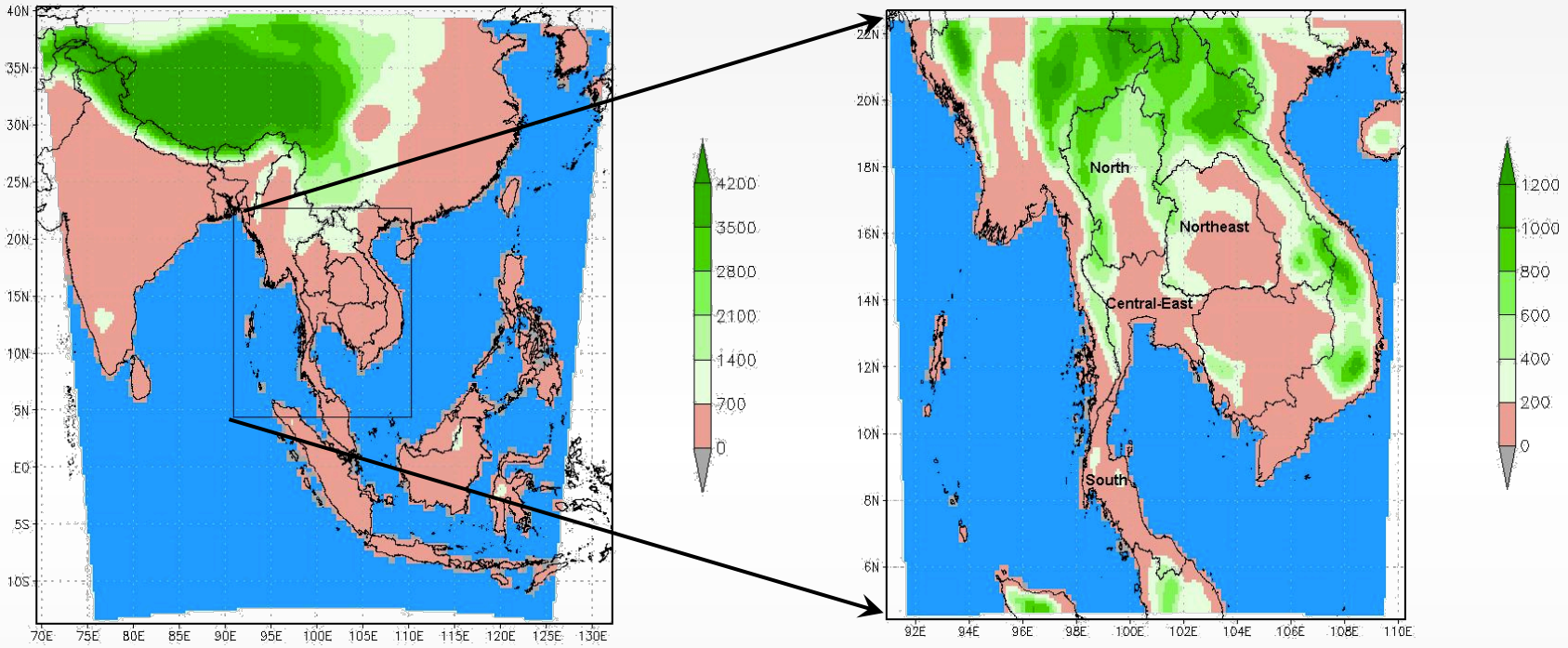
การศึกษาการเปลี่ยนแปลงสภาพภูมิอากาศของประเทศไทย
โดยแบบจำลอง RegCM3 ภายใต้พหุภาพฉายอนาคต



Kasemsan Manomaiphiboon et al.

July 2012

Modeling Domains



Domain 1 (D1)

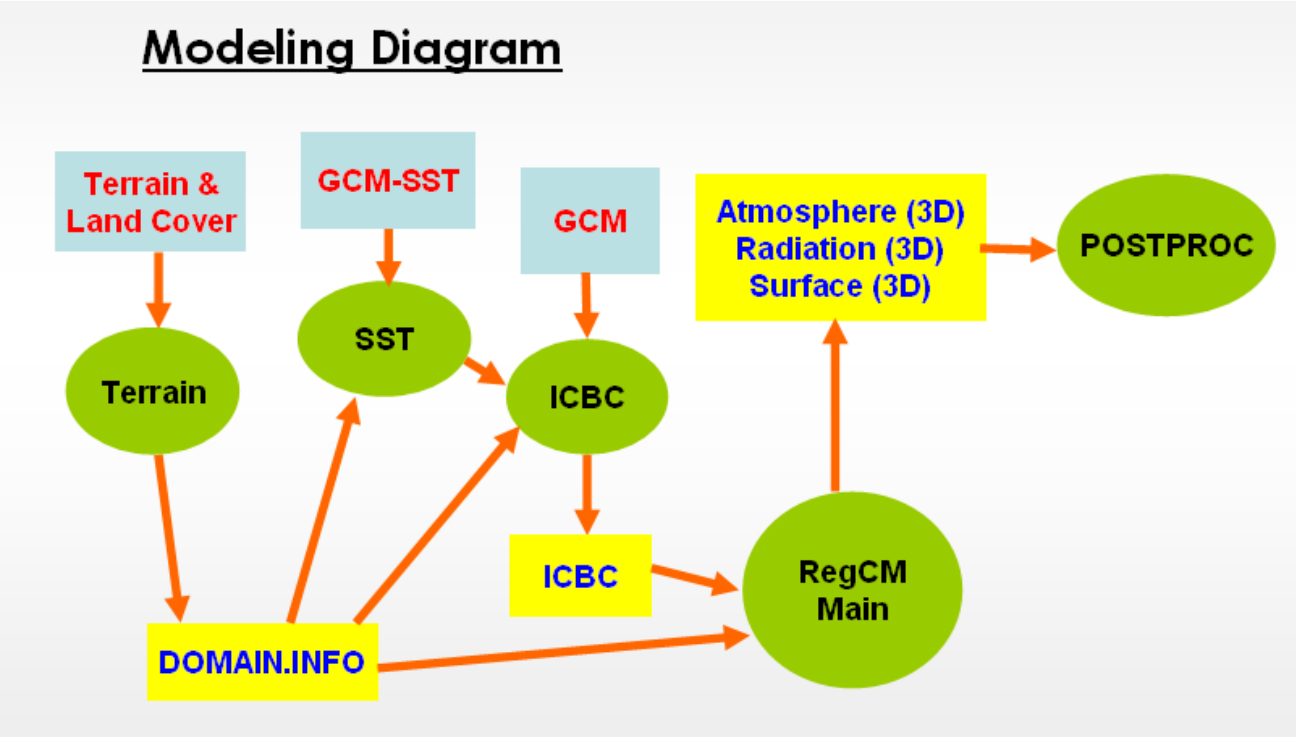
Domain 2 (D2)

Color shading is terrain elevation (m msl), with blue being sea water

- **Horizontal Resolution: 60 km (D1) and 20 km (D2)**
- **23 Vertical levels with top pressure of 10 hPa**
- **100x100 grid cells**

RegCM3

- 3rd version of the original National Center for Atmospheric Research (NCAR) RegCM
- Abdus Salam International Center for Theoretical Physics (ICTP), Italy
- Community model, User support: RegCNET



Simulation Periods

1. Present climate:
   - Full period: 1960-2000
   - Spin-up: Jan. – Dec. 1960
2. Future climate:
   - Full period: 2030-2070
   - Spin-up: Jan. – Dec. 2030

Climate Variables

1. Daily mean temperature
2. Daily accumulated precipitation
3. Climate extreme indices

Model setup

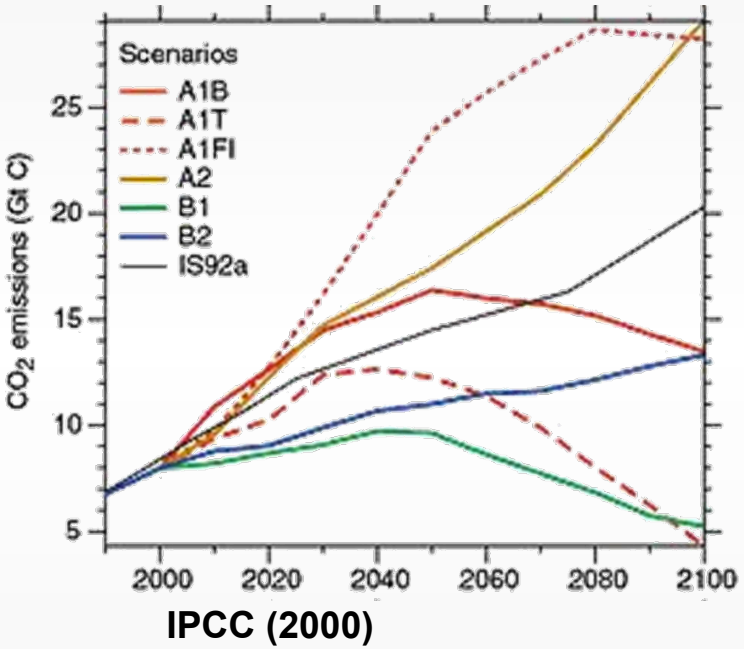
- Driving GCM: ECHAM5/OM

  (T63 horizontal resolution, 192x96 cells, 17 vertical levels)
  - Initial and Boundary Condition (ICBC) and SST for D1
  - Three experiments :

    a. 20C3M (1941-2000, Historical GHG Forcings)

    b. A2, A1B, and B1 scenarios
- Terrain:
  - GTOPO30 (elevation data)
  - GLCC (land cover data)
- Physics Options:
  - Convective parameterization scheme: Grell-AS
  - Ocean flux scheme: BATS
  - Based on Octaviani and Manomaiphiboon (2011)

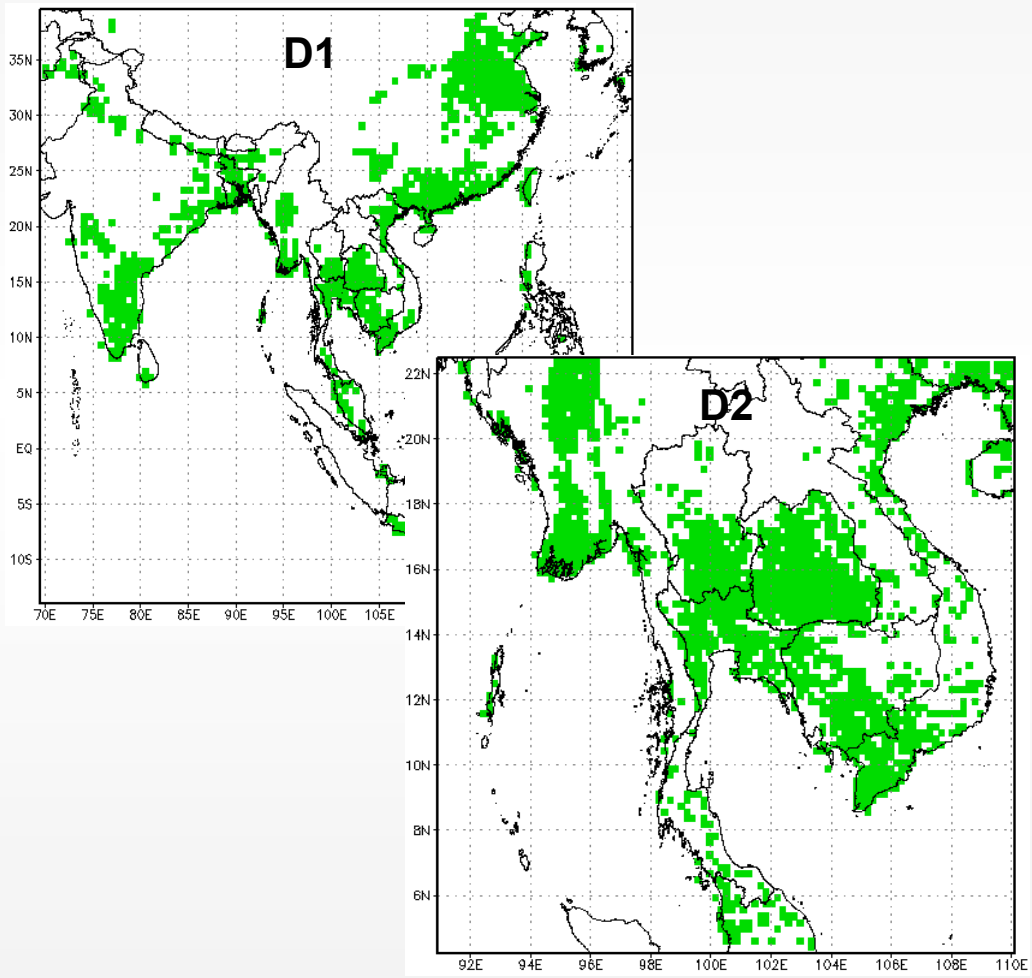
Emissions Scenarios



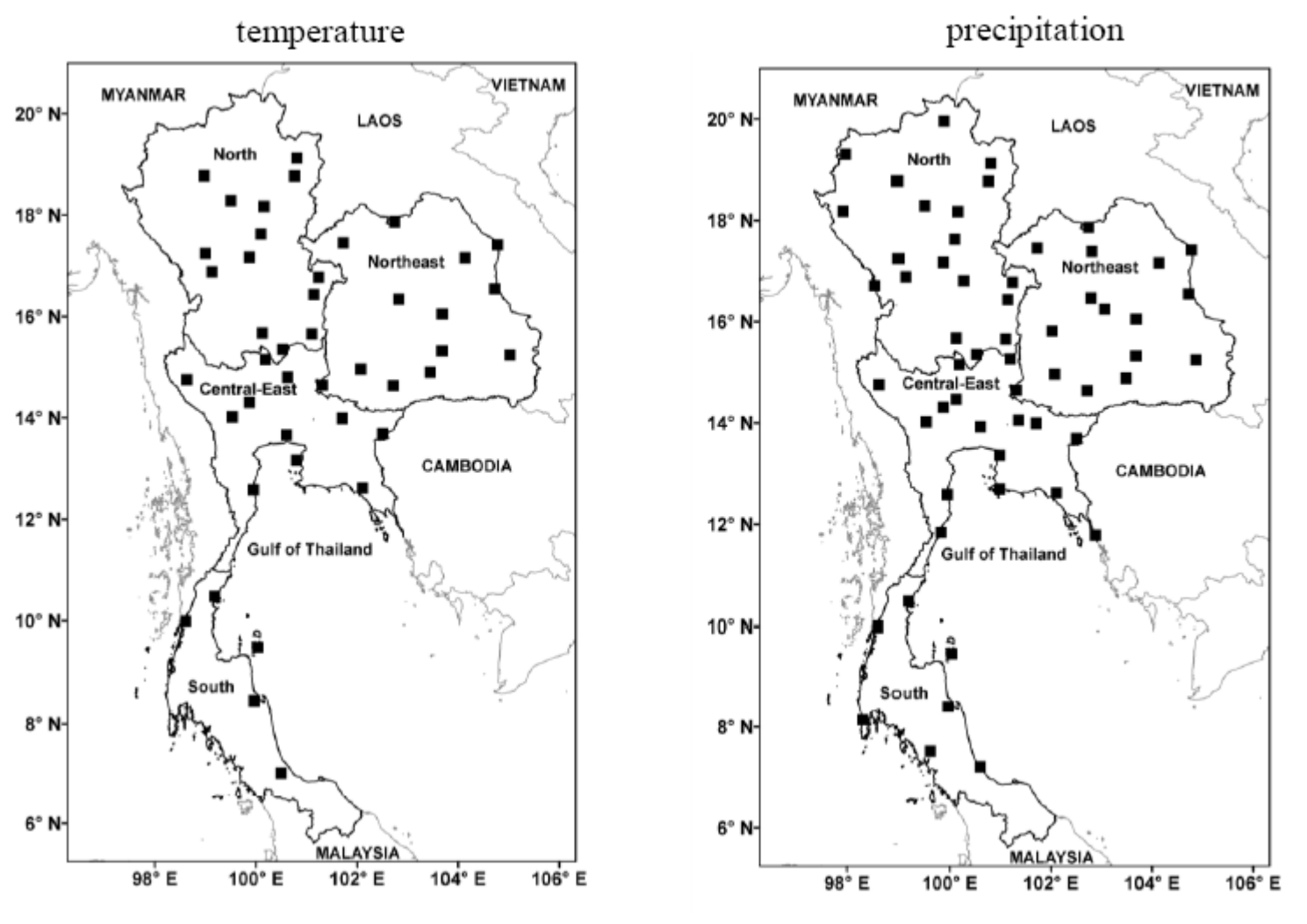
IPCC (2000)

Land Cover Modification

(Irrigated crop → Crop/mixed farming)



Surface Stations



Vol. 47: 171–186, 2011
doi: 10.3354/cr00990

CLIMATE RESEARCH
Clim Res

Published online June 29

Performance of Regional Climate Model RegCM3 over Thailand

Mega Octaviani[1, 2], Kasemsan Manomaiphiboon[1, 2,*]

Short-Term Simulations & Sensitivity Test

Table 1. Experiment design. CPS: convective parameterization schemes; OFS: ocean flux parameterization schemes; E1–E8: 8 experiments conducted on a coarse resolution domain (D1); E1N–E8N: 8 experiments conducted on a finer-resolution domain (D2); CPSs: Anthes-Kuo (AK), Grell-Arakawa-Schubert (GAS), Grell-Fritsch-Chappell (GFC), MIT-Emanuel (EMU); OFSs: Biosphere-Atmosphere Transfer Scheme (BATS), Zeng scheme (Zeng et al. 1998)

No.	Experiment	CPS	OFS
Resolution: 60 km			
1	E1	AK	Zeng
2	E2	AK	BATS
3	E3	GAS	Zeng
4	E4	GAS	BATS
5	E5	GFC	Zeng
6	E6	GFC	BATS
7	E7	EMU	Zeng
8	E8	EMU	BATS
Resolution: 20 km			
9	E1N	AK	Zeng
10	E2N	AK	BATS
11	E3N	GAS	Zeng
12	E4N	GAS	BATS
13	E5N	GFC	Zeng
14	E6N	GFC	BATS
15	E7N	EMU	Zeng
16	E8N	EMU	BATS

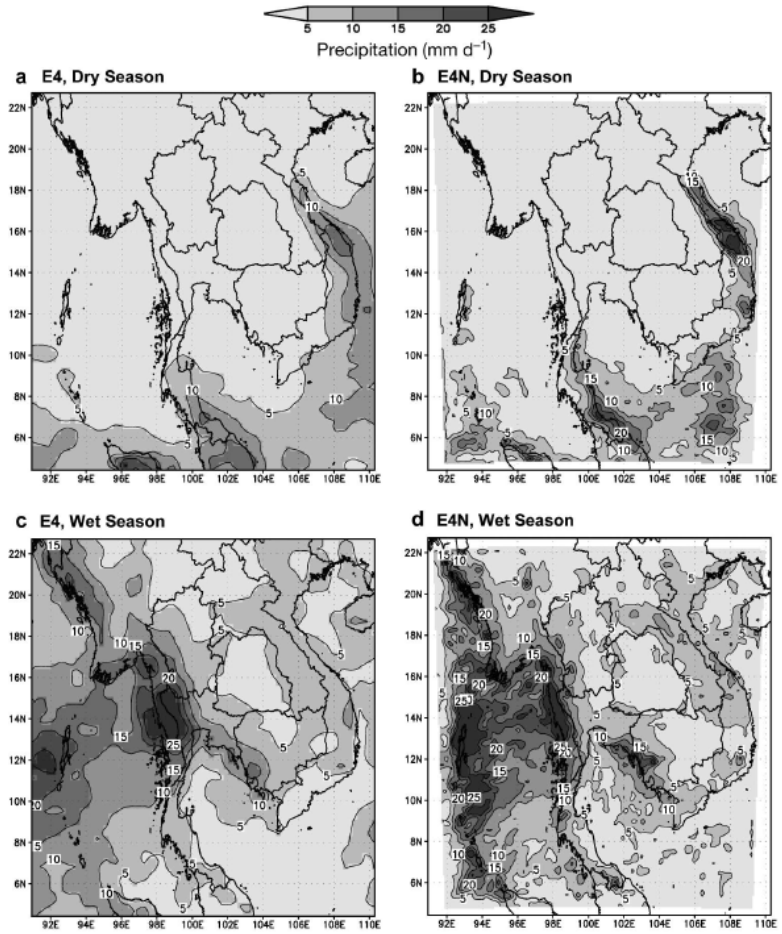
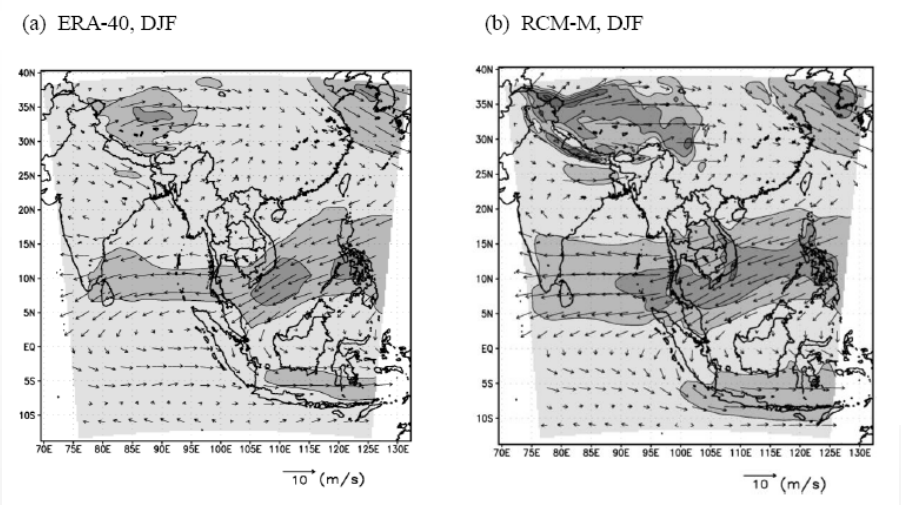
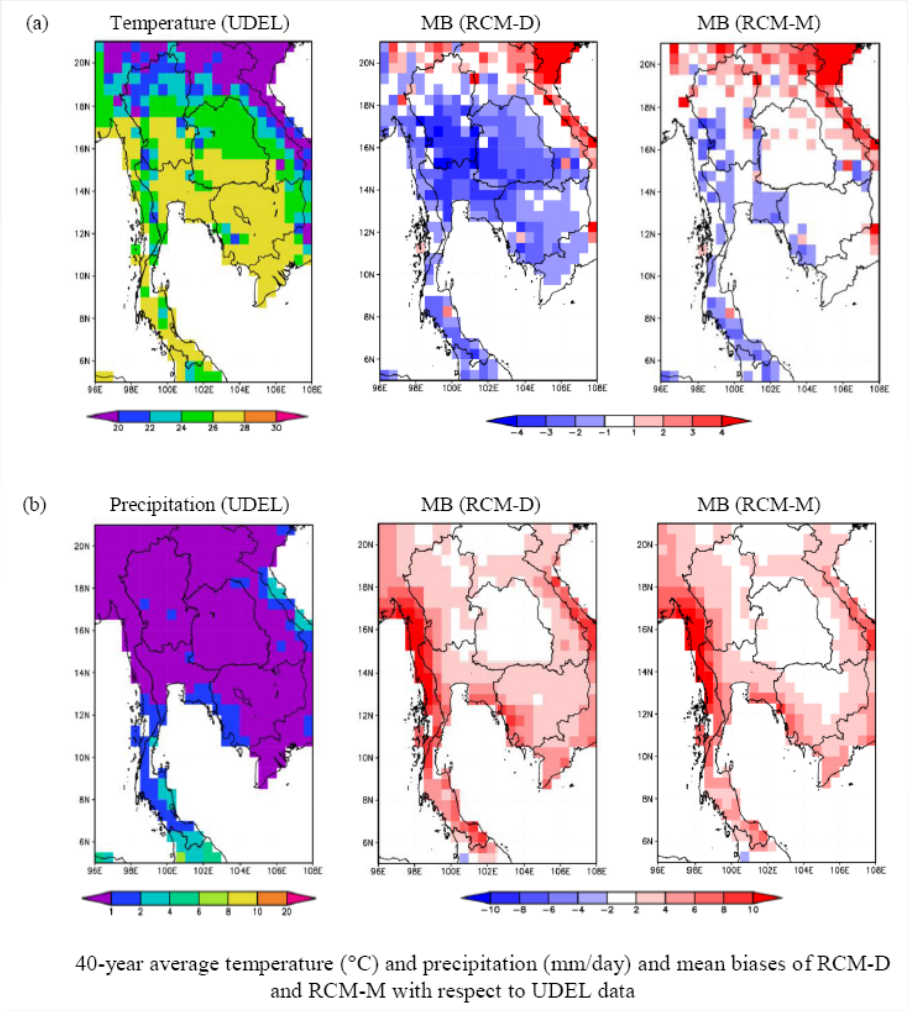


Fig. 5. Spatial distributions of simulated precipitation in (a,b) the dry season and (c,d) the wet season for 2 selected experiments: (a,c) E4, (b,d) E4N

Regional Mean and Variability: Simulations 40 years, 1961-2000, forced by ERA-40

(Torsri et al., under review)

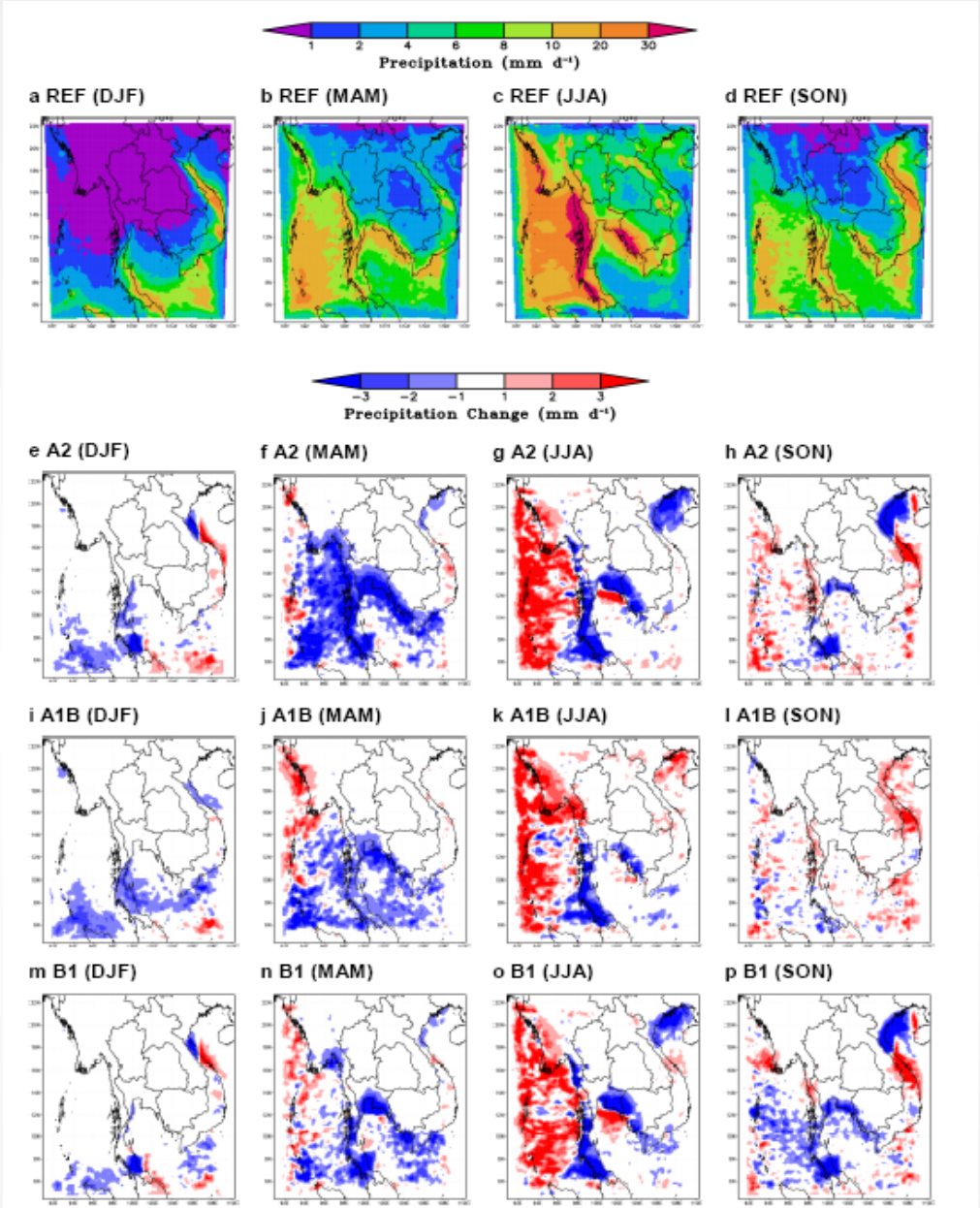




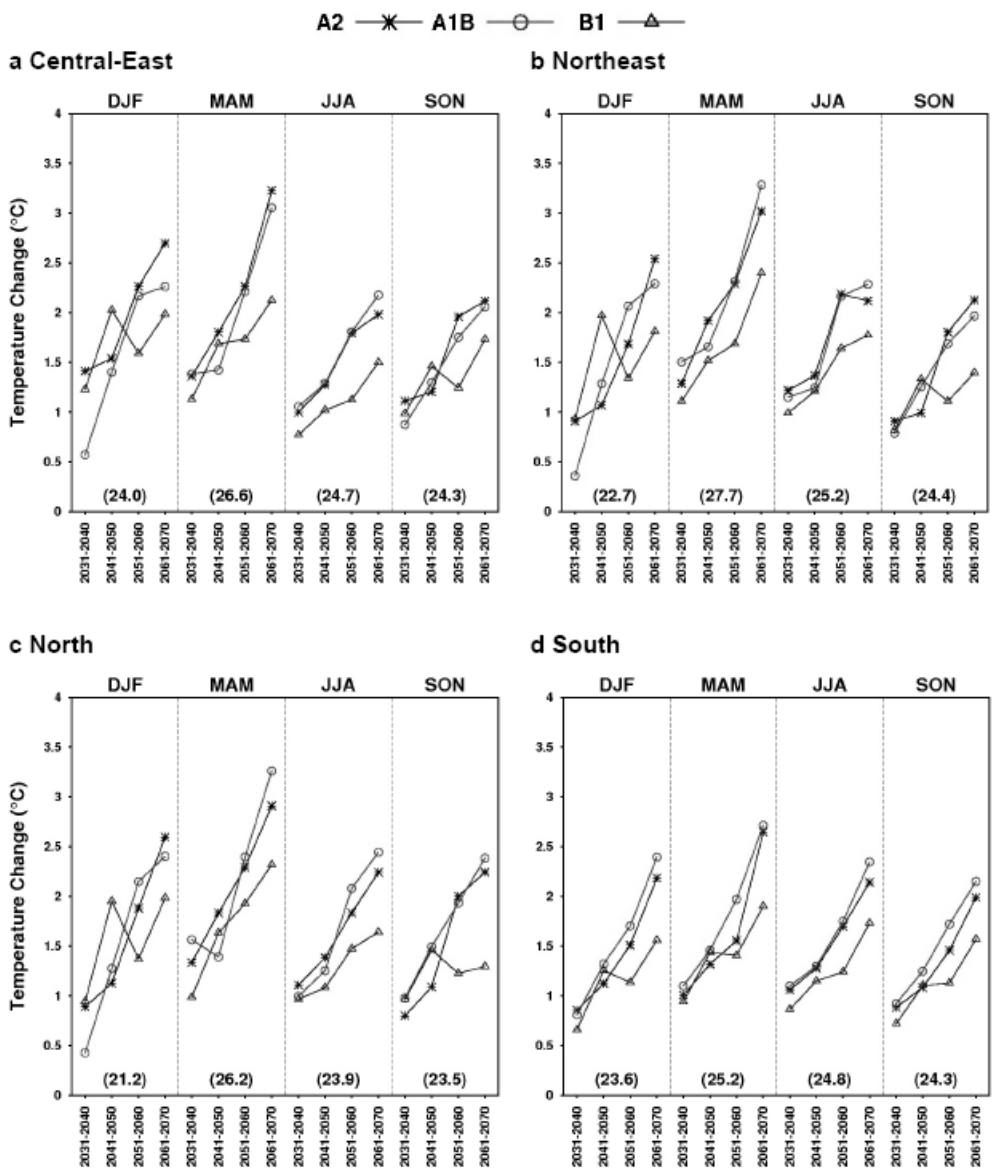
40-year average temperature (°C) and precipitation (mm/day) and mean biases of RCM-D and RCM-M with respect to UDEL data

Projected Changes through ECHAM/ OPI-Driven Simulations under A2, A1B, and B1

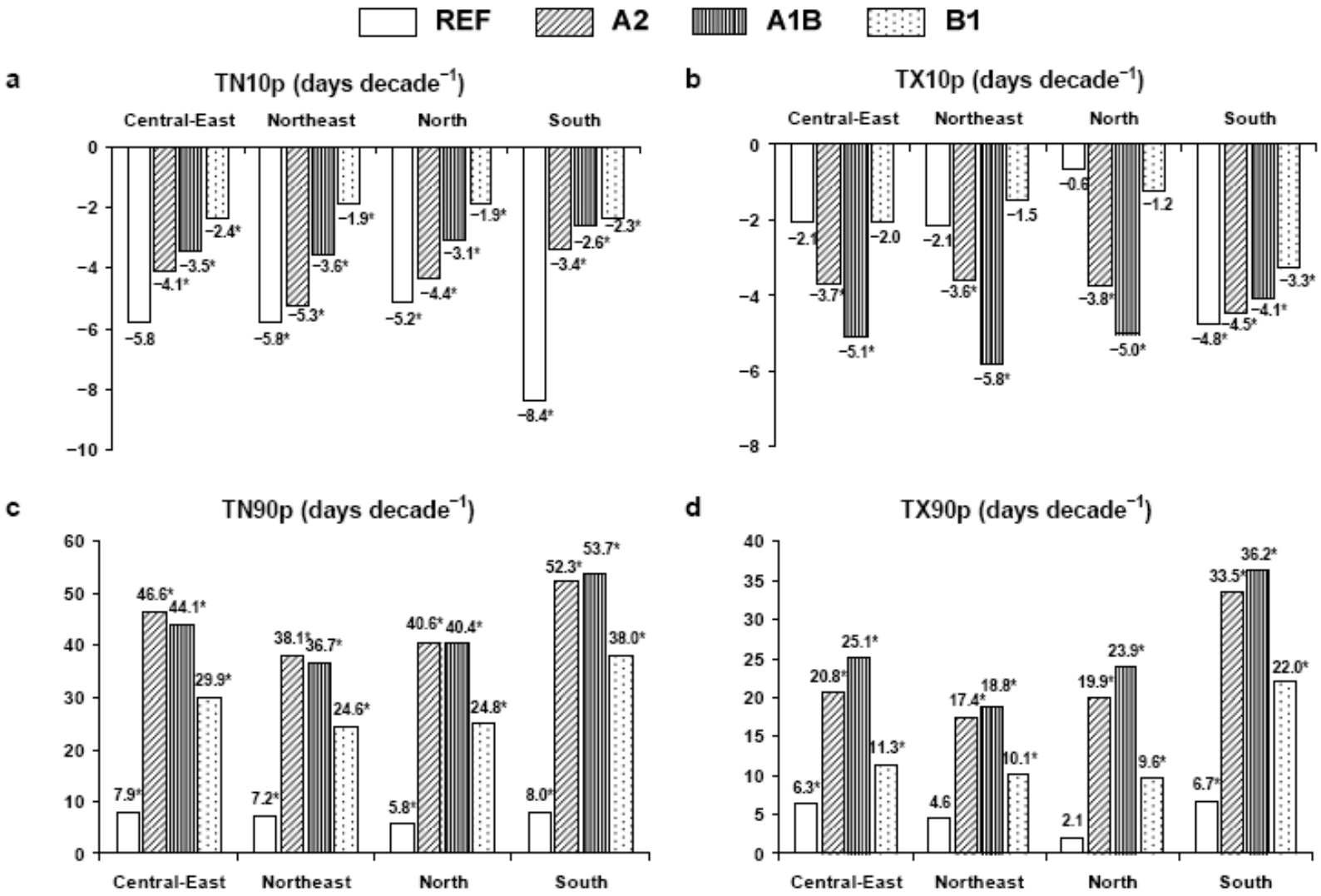
(Manomaiphiboon et al., under review)



(a-d) Simulated 40-year (1961-2000; REF) average daily precipitation, and (e-p) its changes under different scenarios over 2031-2070 with respect to the present-year averages.



Decadal changes in daily mean temperature under different scenarios by season and by sub-region. The changes were calculated with respect to 1961-2000 averages. Parenthesized values denote averages over the present-year period.



Trends in TEIs over the present-year period (REF) and the future-year period under different scenarios by sub-region. Asterisks denote "statistically significant at a 5% level".

Acknowledgements

- RCM research supported by
  - Joint Graduate School of Energy and Environment
  - Postgraduate Education and Research Development Office
  - Thailand Research Fund
- Hanoi trip sponsored by JGSEE
- Key member: Mega Octaviani
- JGSEE Computational Laboratory

APN Collaboration

- Glad to learn about this SE-ASIA RCM initiative/effort
- Thank you for invitation
- JGSEE hopes to find a suitable role for our capacity to strengthen to this Initiative.
- JGSEE Director's encouragement

THANK YOU