

Uncertainty and inter-model variations in CORDEX Southeast Asia multi-model simulations of precipitation

F. Tangang et al. (24 co-authors)

The National University of Malaysia



Climate Dynamics

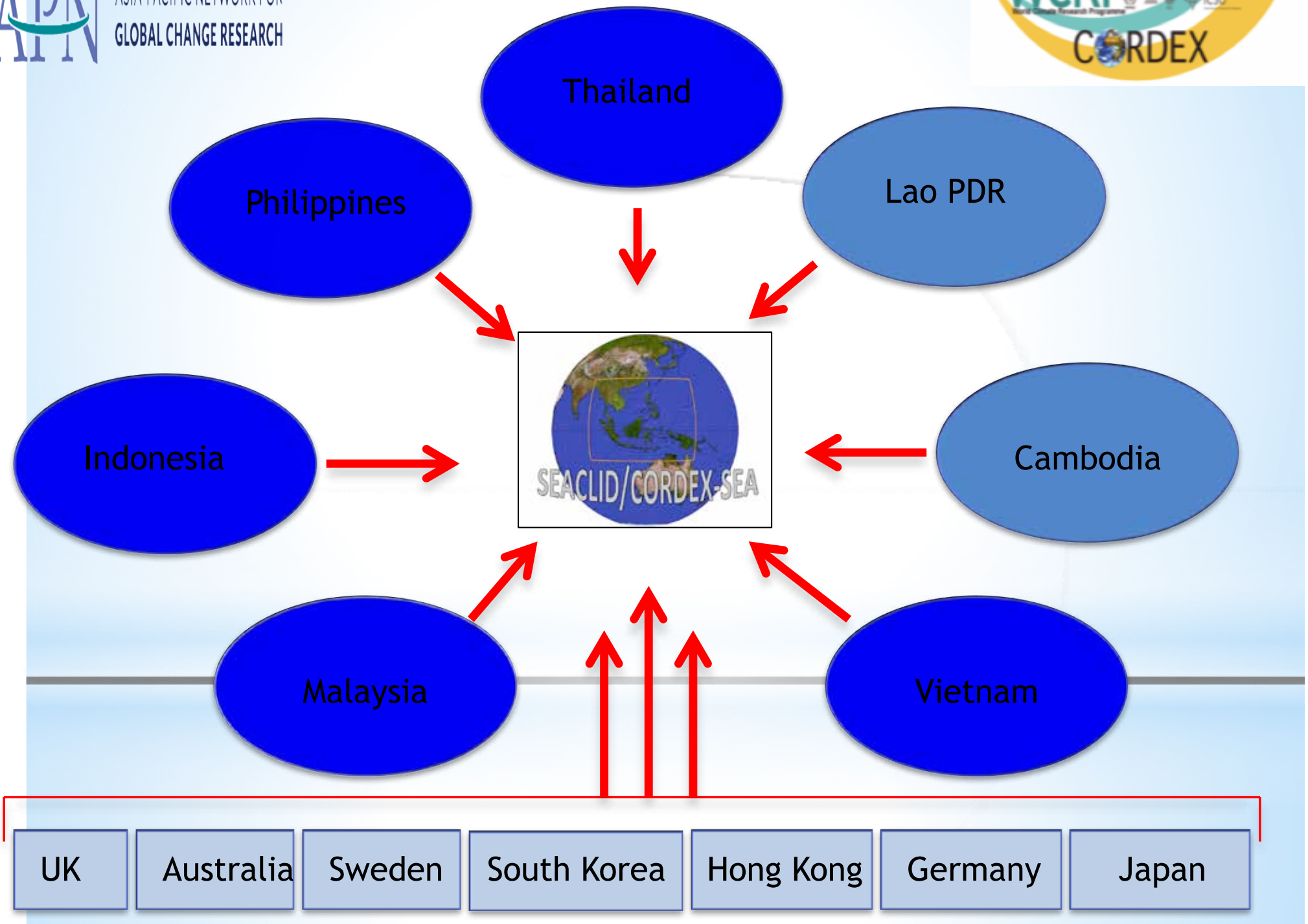
Projected Future Changes in Rainfall in Southeast Asia based on Multi-model Simulations of CORDEX Southeast Asia

--Manuscript Draft--

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Full Title:	Projected Future Changes in Rainfall in Southeast Asia based on Multi-model Simulations of CORDEX Southeast Asia
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Outline:

- Introduction to CORDEX
Southeast Asia
- Key findings and highlights of
uncertainty and inter-model
variations
- Summary

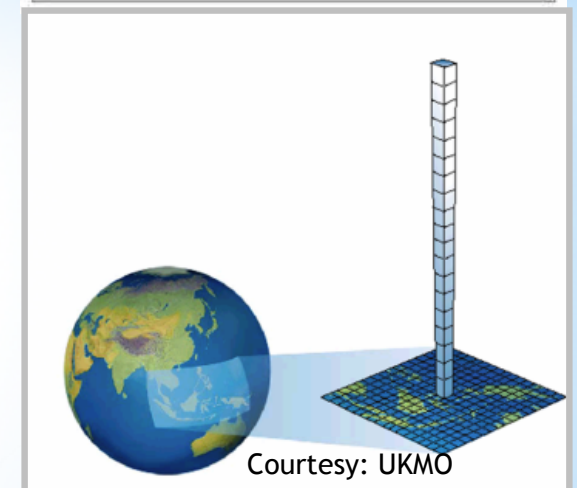
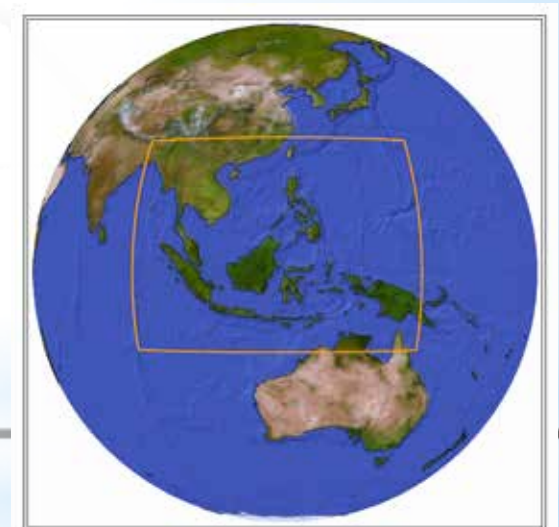


The Southeast Asia Regional Climate Downscaling (SEACLI / CORDEX Southeast Asia Project

Fredolin Tangang

Project Leader, CORDEX Southeast Asia

- 14 Countries, 20 Institutions
- 25 km x 25 km
- ~4yrs [Nov 2013 - June 2018]
- Funded by APN and funds from individual countries
- Second phase 2017 - 2020 (further downscaling to 5 km x 5 km on 5 sub-domains)



Courtesy: UKMO

(<http://www.ukm.edu.my/seaclid-cordex>)

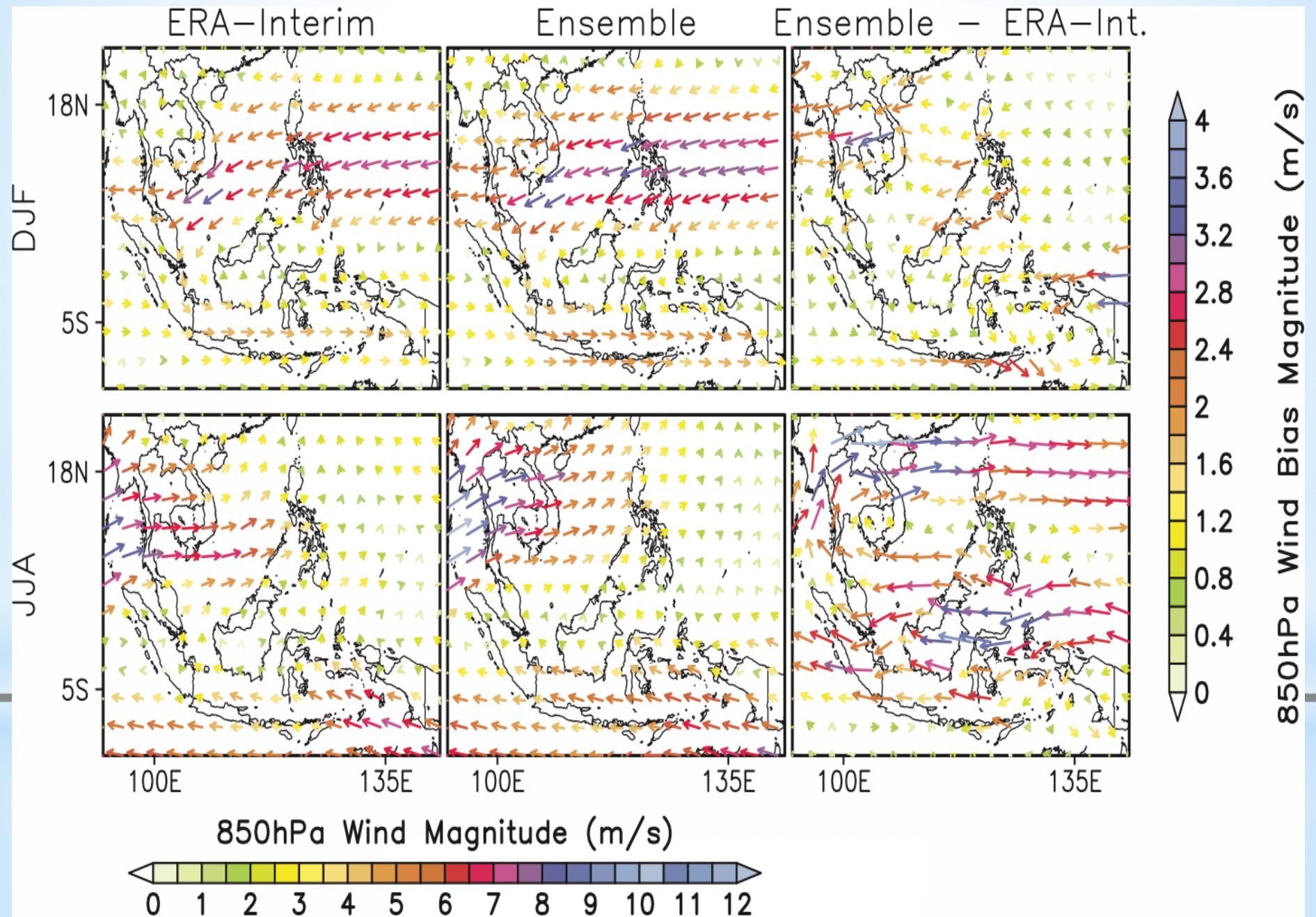
Table 1: The list of simulations carried out in CORDEX-SEA.

Ensemble member	GCM	RCM	Projection Periods of 21st Century			
			Early (2011-2040)	Mid (2041-2070)	End (2071-2100)	
1	IPSL-CM5A-LR (IPSL, France)	RegCM4 (ICTP, Italy)	x	x	x	
2	CNRM-CM5 (CNRM, France)	RegCM4 (ICTP, Italy)	x	x	x	
3	HadGEM2-ES (Hadley Centre, UK)	RegCM4 (ICTP, Italy)	x	x	x	
4	MPI-ESM-MR (MPI-M, Germany)	RegCM4 (ICTP, Italy)	x	x	x	
5	EC-Earth (EC-Earth consortium)	RegCM4 (ICTP, Italy)	x	x	x	
6	CSIRO MK3.6 (CSIRO, Australia)	RegCM4 (ICTP, Italy)	x	x	x	
7	HadGEM2-AO (Hadley Centre, UK)	WRF (NCAR USA)	x	x	x	
8	MPI-ESM-LR(MPI, Germany)	ROM(GERICCS-AWI, Germany) ⁺	x	x	x	
9	HadGEM2-ES (Hadley Centre, UK)	RCA4 (SMHI, Sweden)	x	x	x	
10	HadGEM2-ES (Hadley Centre, UK)	PRECIS (Hadley Centre, UK) [*]	x	x	x	
11	GFDL-ESM2M (GFDL, USA)	RegCM4 (ICTP, Italy)	x	x	x	
12	MRI-AGCM (MRI, Japan)	NHRCM (MRI, Japan) ⁺⁺				x
13	CNRM-CM5 (CNRM, France)	RCA4 (SMHI, Sweden)	x	x	x	
14	ACCESS1.0 (CSIRO, Australia)	CCAM (CSIRO, Australia) [*]		x		
15	CCSM4 (NCAR, USA)	CCAM (CSIRO, Australia) [*]		x		
16	CNRM-CM5 (CNRM, France)	CCAM (CSIRO, Australia) [*]		x		

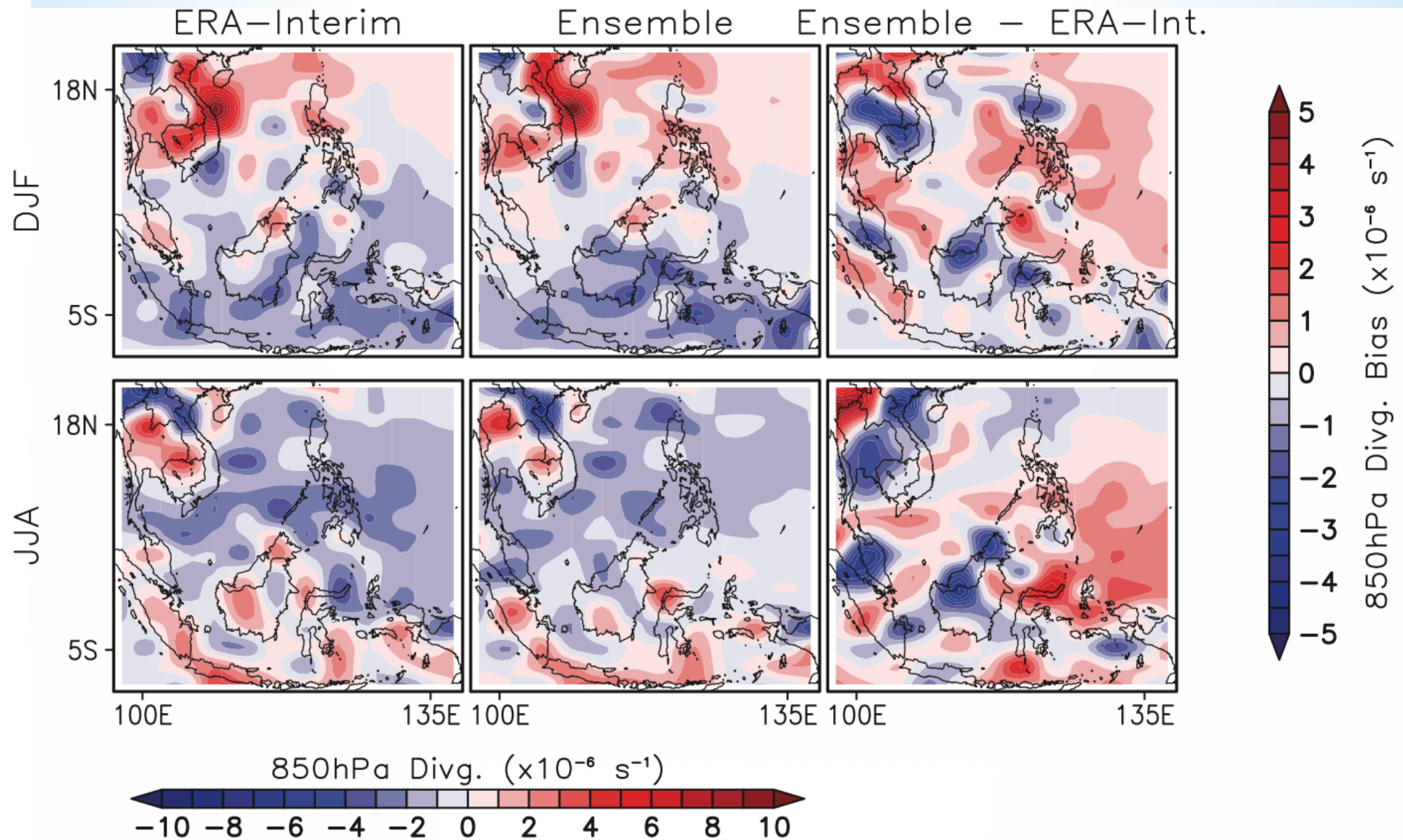
[Note: ^{*}Only RCP8.5, +50 km x 50 km resolution with larger domain size to cover warm pool of western Pacific Ocean, ⁺⁺Baseline period (1981-2000), end of 21st period (2080-2099)]

[13 GCMs, 7RCM, 16 members]

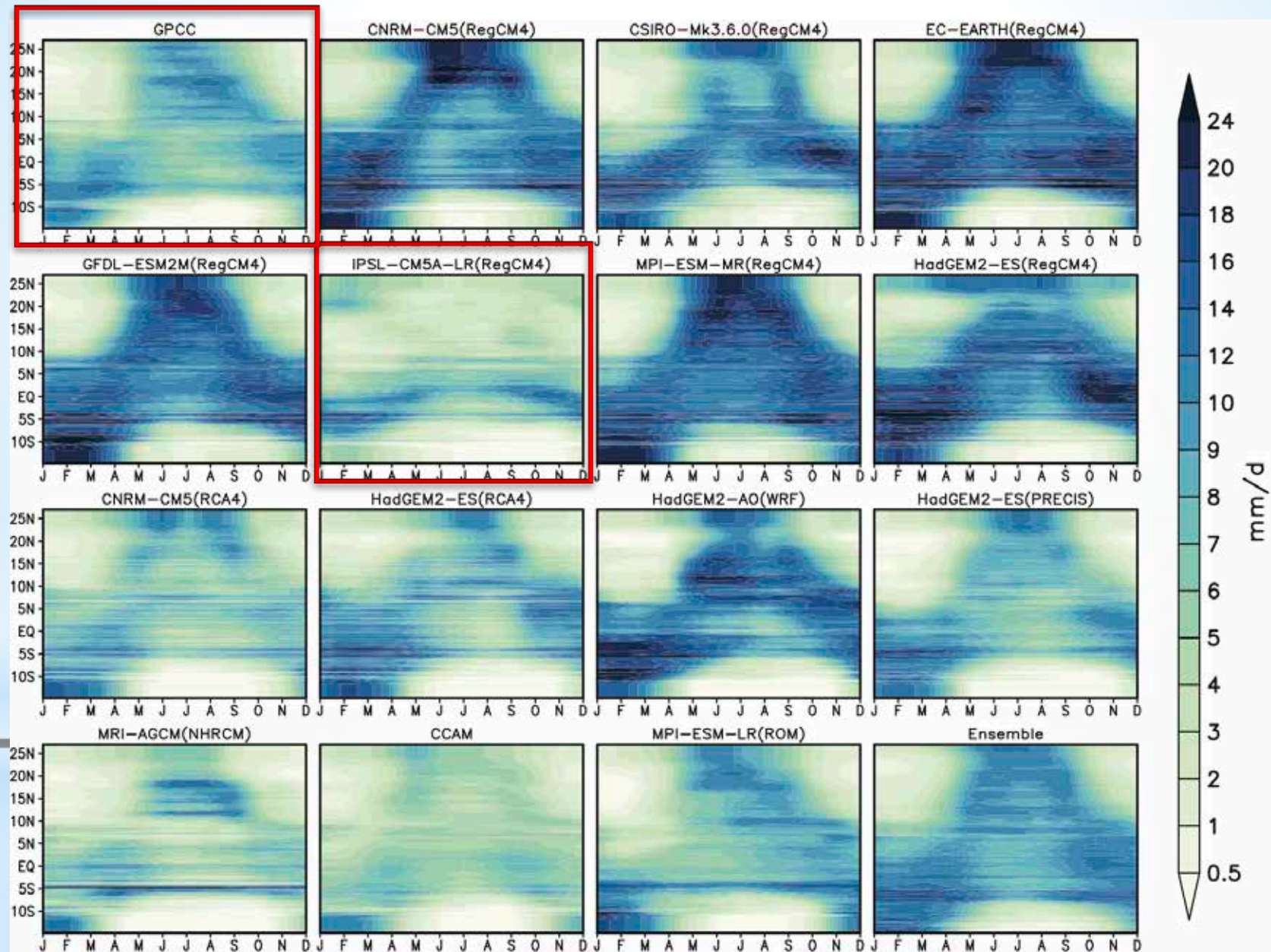
Low-level Wind: ERA-Int vs Model Ensemble



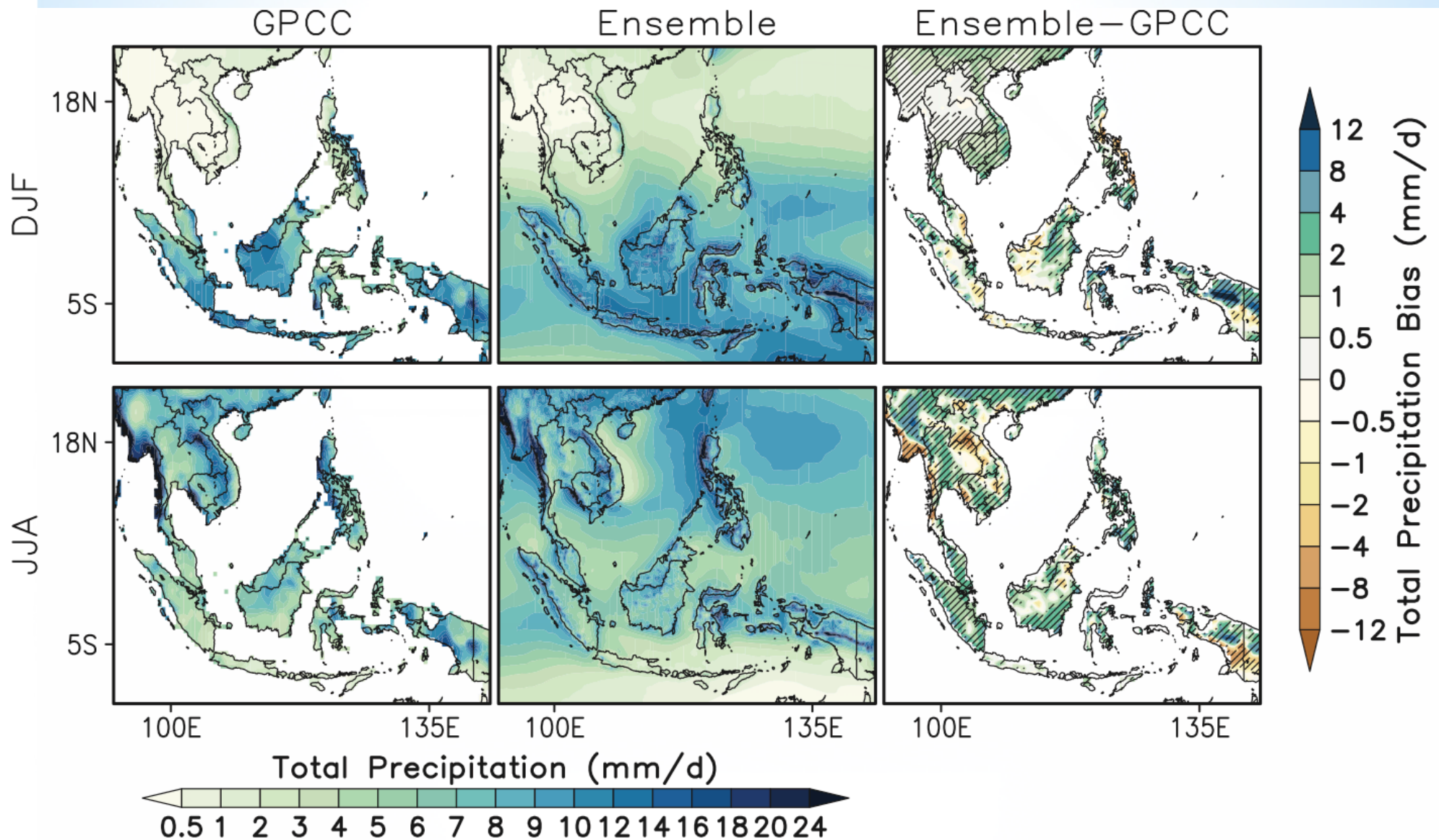
Low-level Divergence: ERA-Int vs Model Ensemble

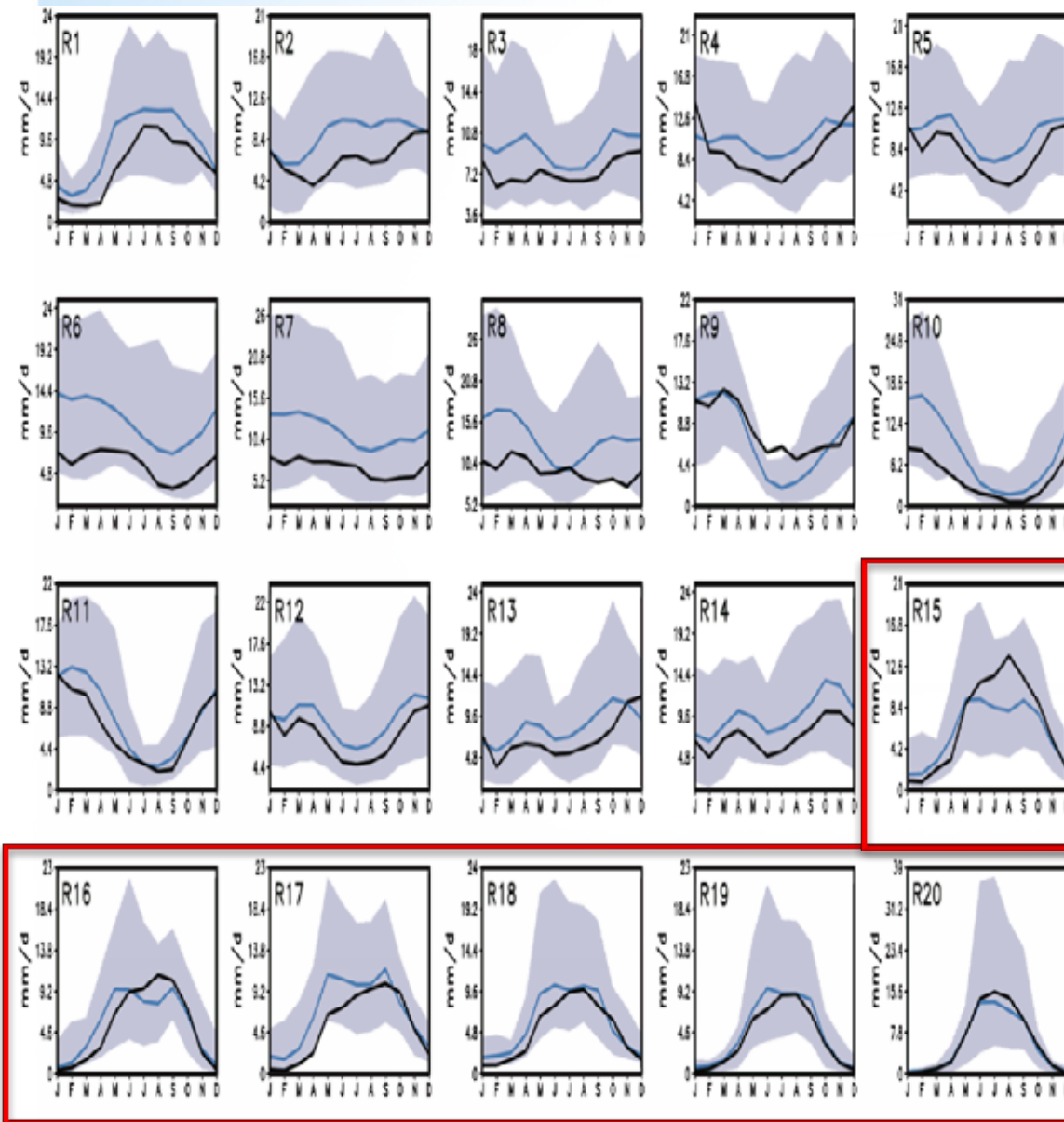


Annual Cycle Zonally Averaged Rainfall

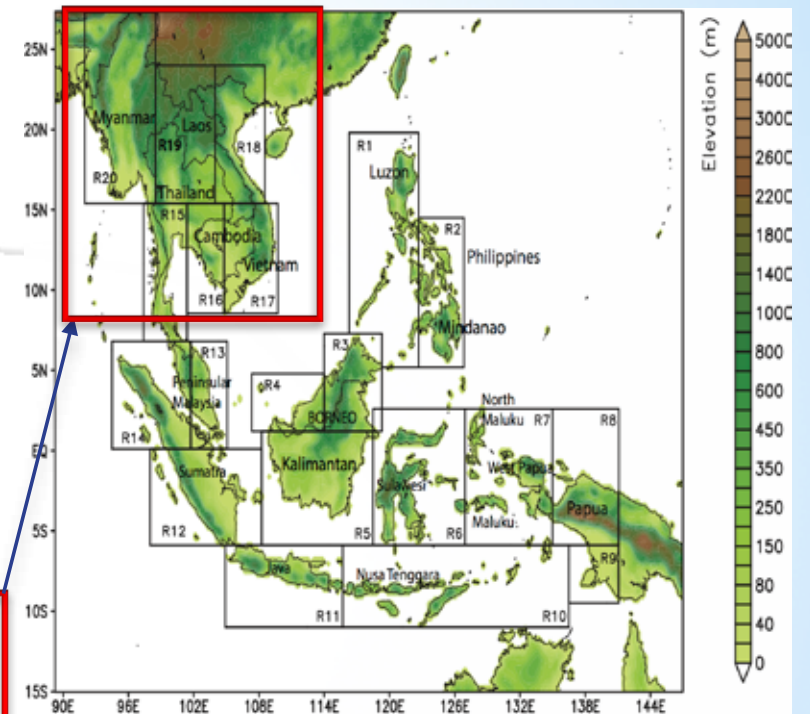


Mean DJF and JJA Rainfall: GPCC vs Model Ensemble

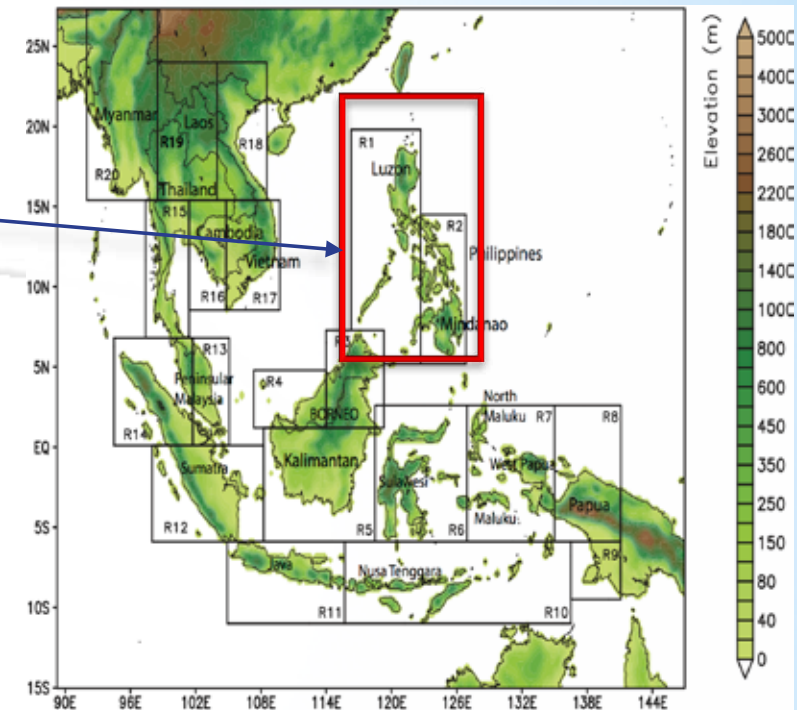
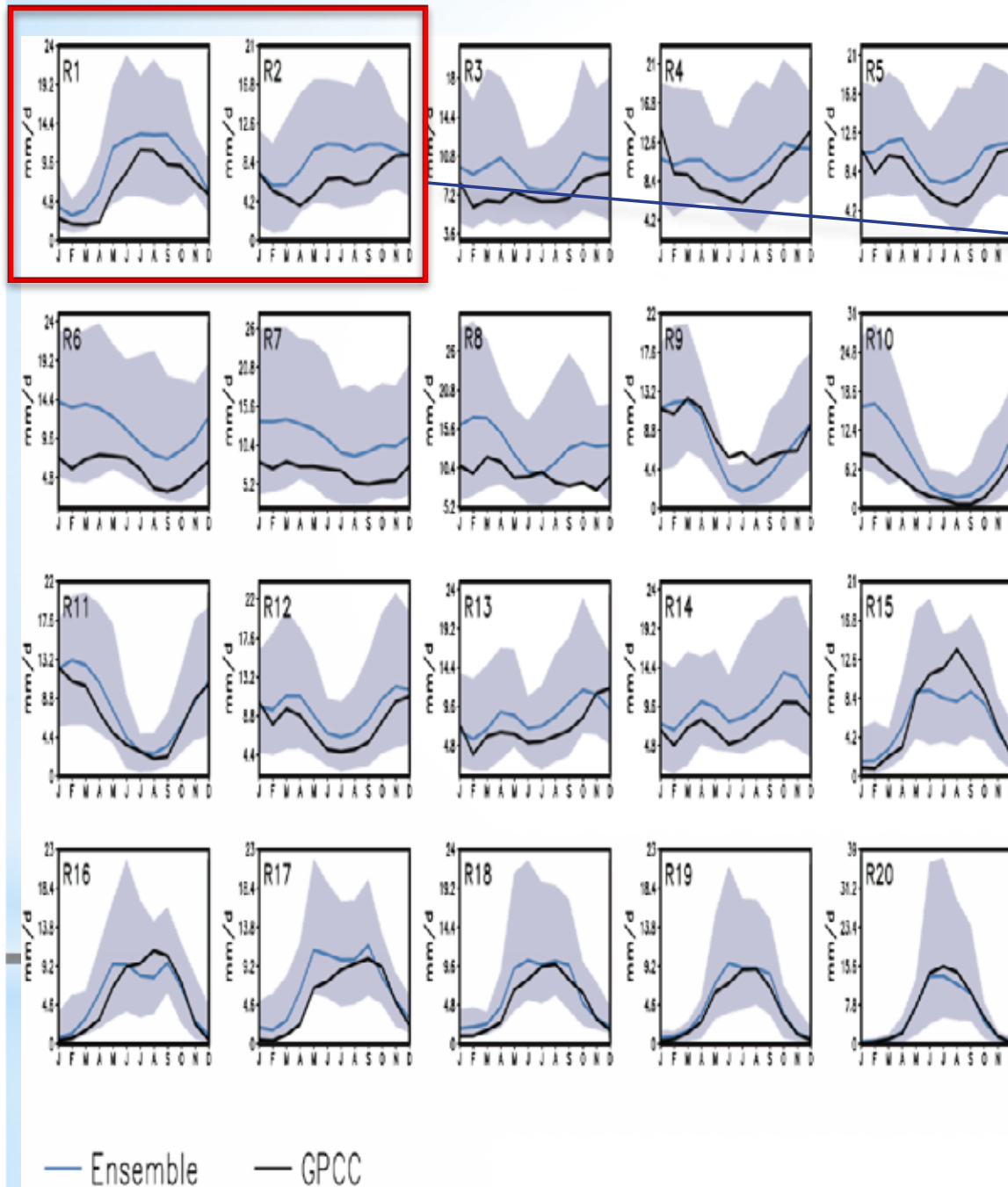




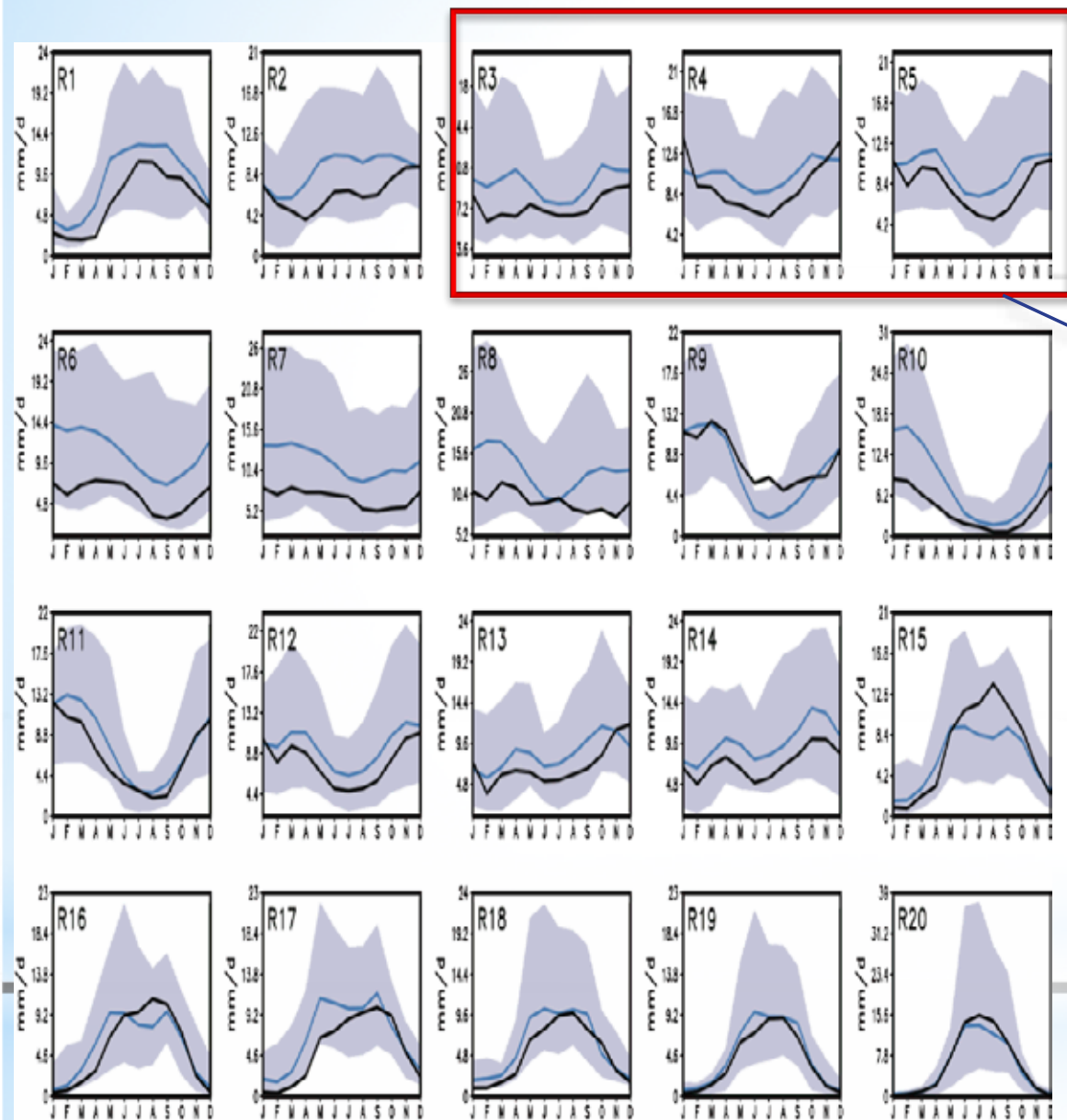
— Ensemble — GPCC



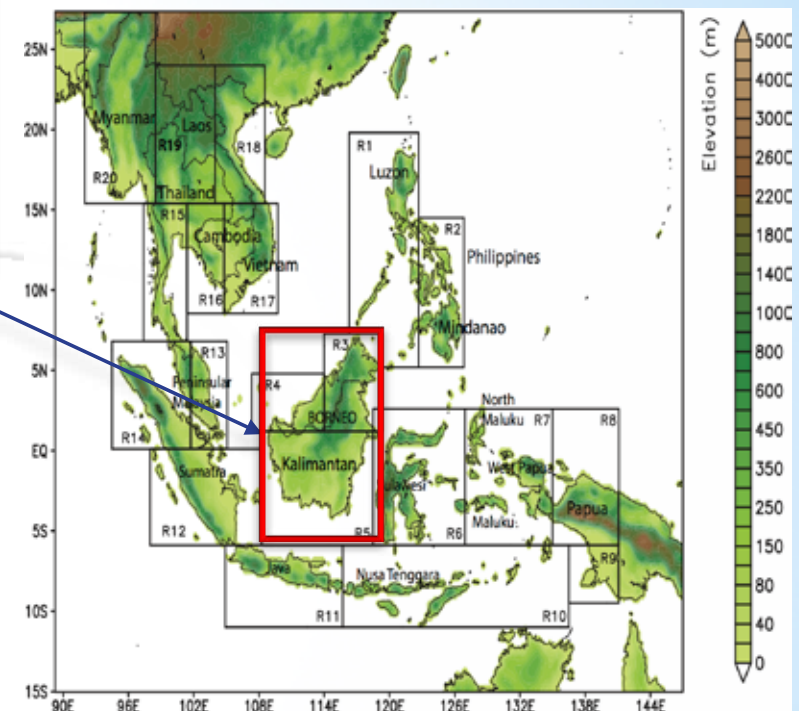
Model ensemble reproduced the observed annual cycle very well over Indochina but inter-model variation is large especially during summer



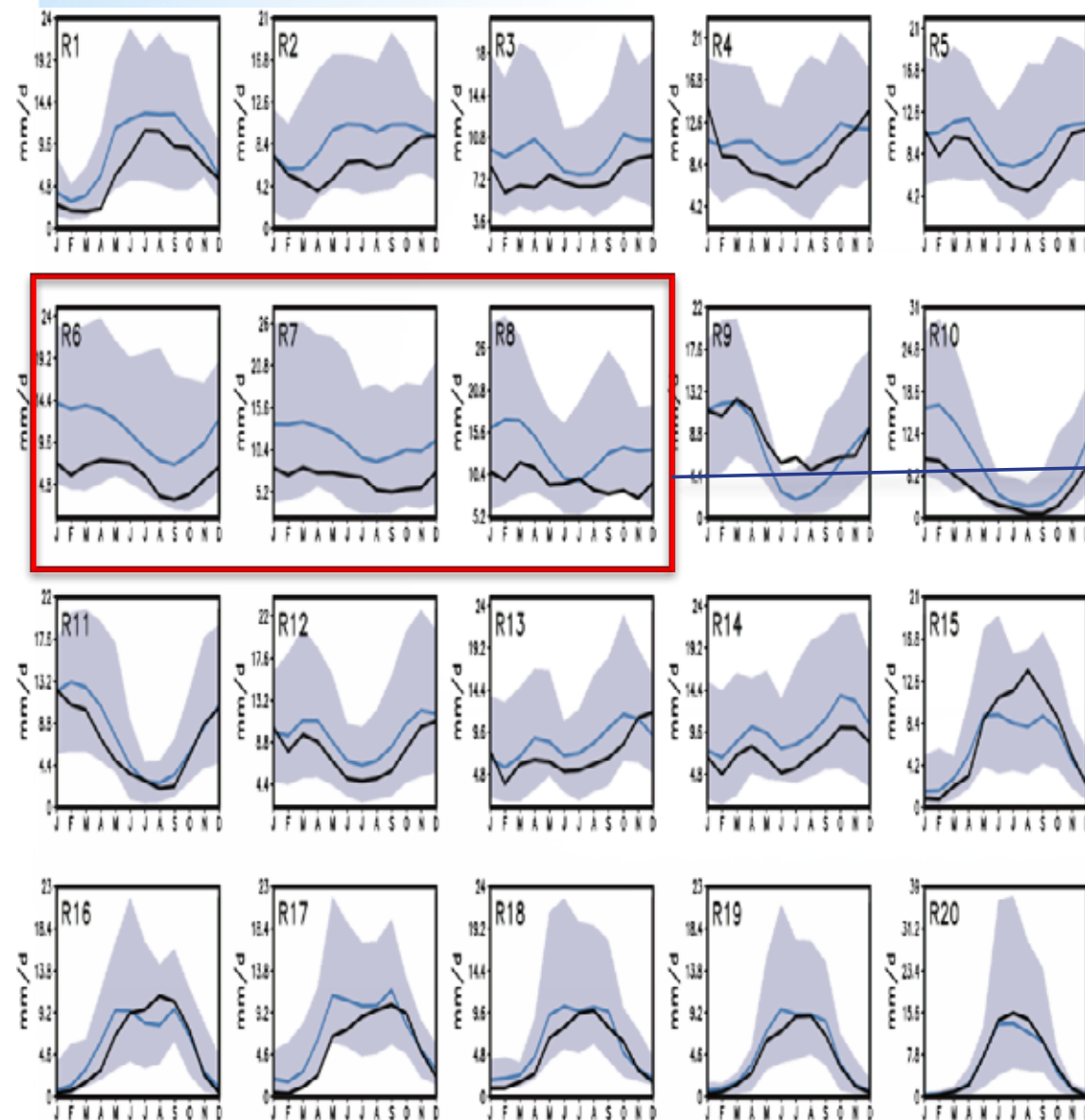
Relatively large bias is present over eastern part of the Philippines, could be due to the model's inability to resolve complex topography and existence of many small islands, 25 km resolution may not sufficient



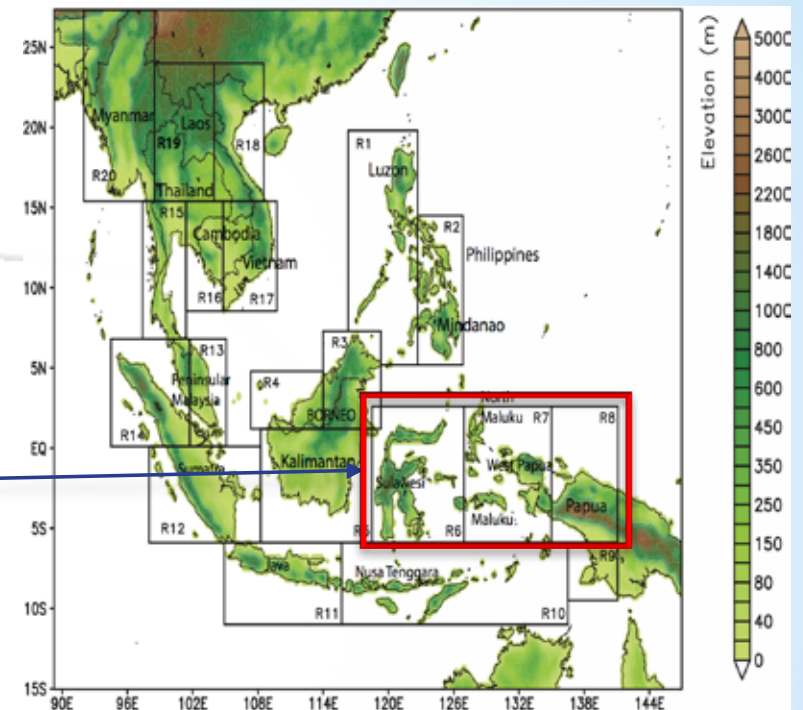
— Ensemble — GPCC



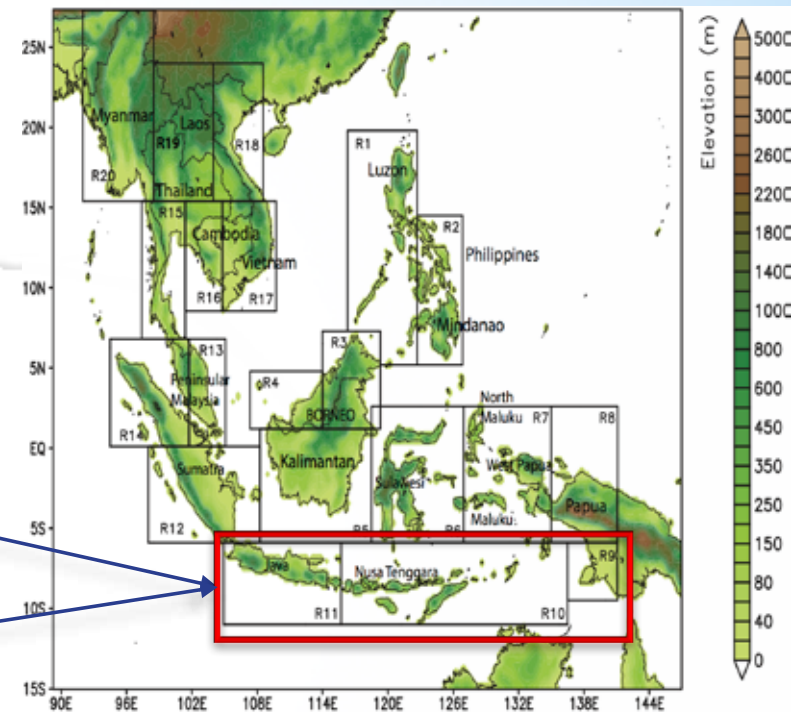
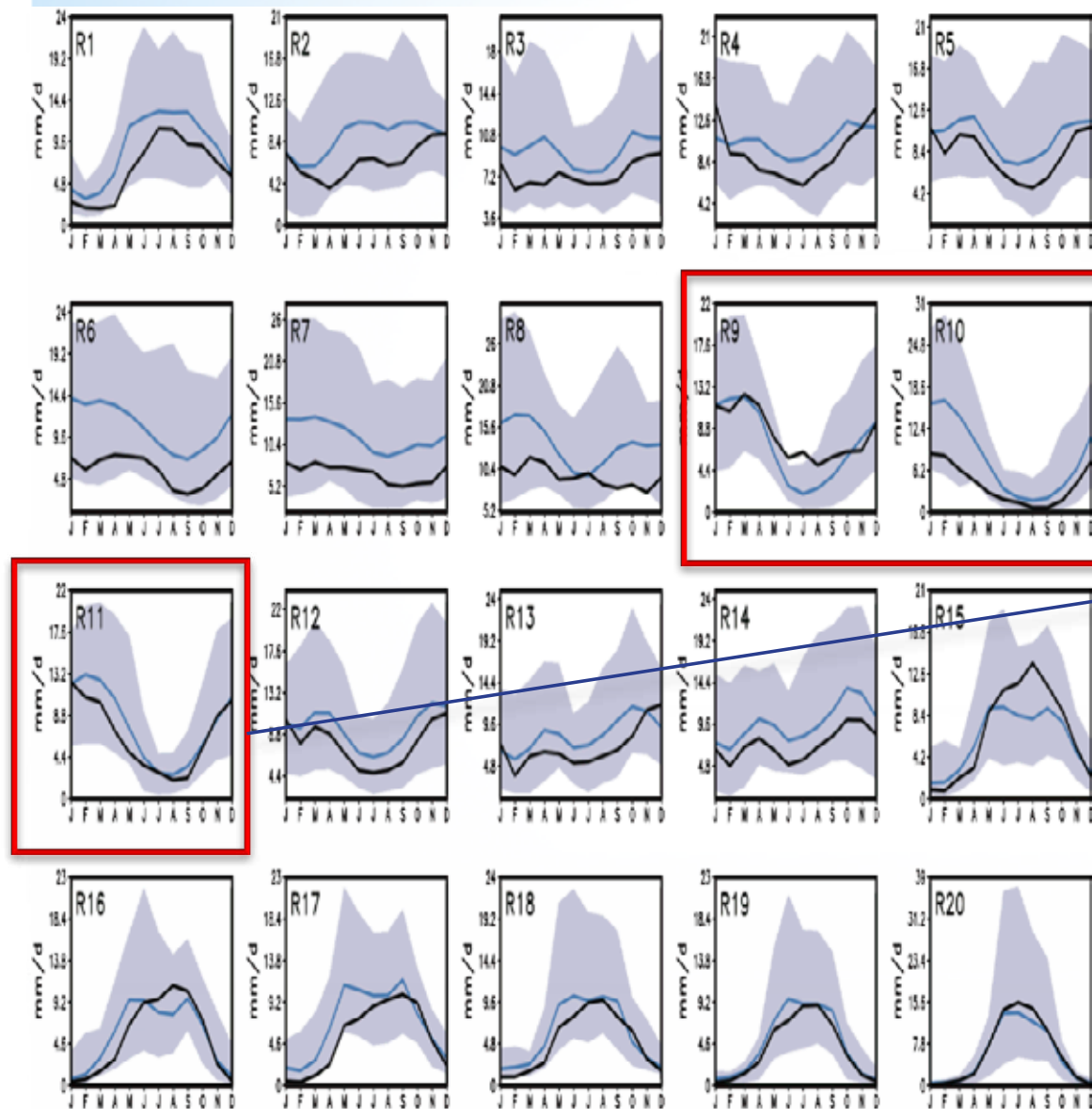
Ensemble mean approximated observed annual cycles but large inter-model variations throughout the year



— Ensemble — GPCC

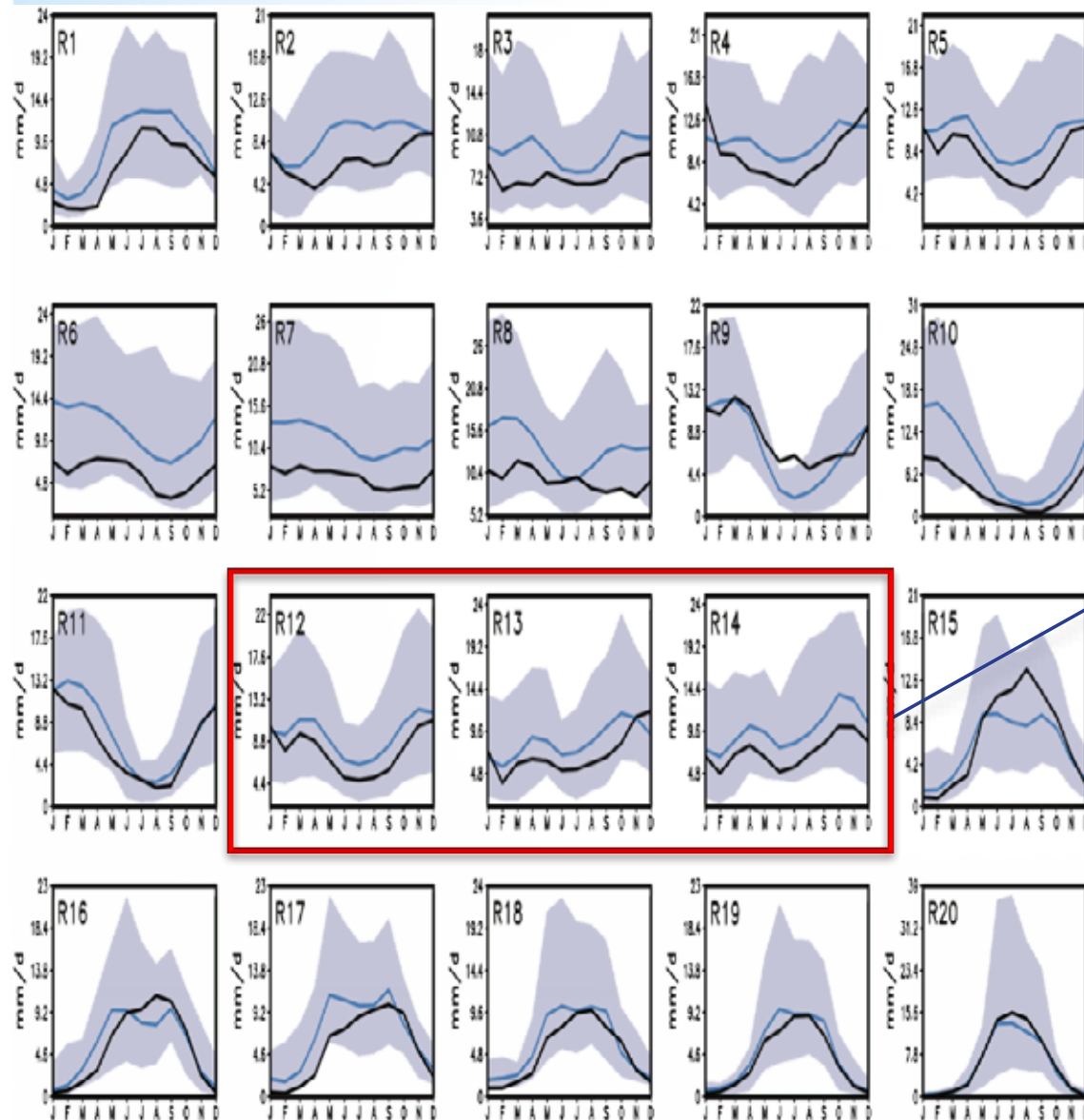


Relatively large biases
especially in Sulawesi, Maluku
- complex topography and
many islands, 25 km is
probably insufficient

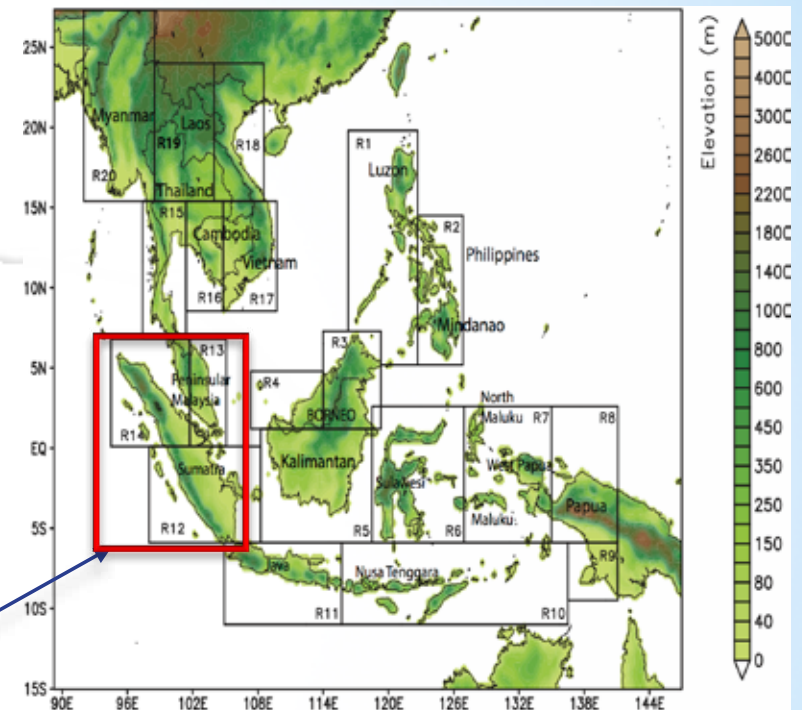


The ensemble mean approximated the observed annual cycles except noticeably large bias over Nusa Tenggara (R10), due to many islands

— Ensemble — GPCC

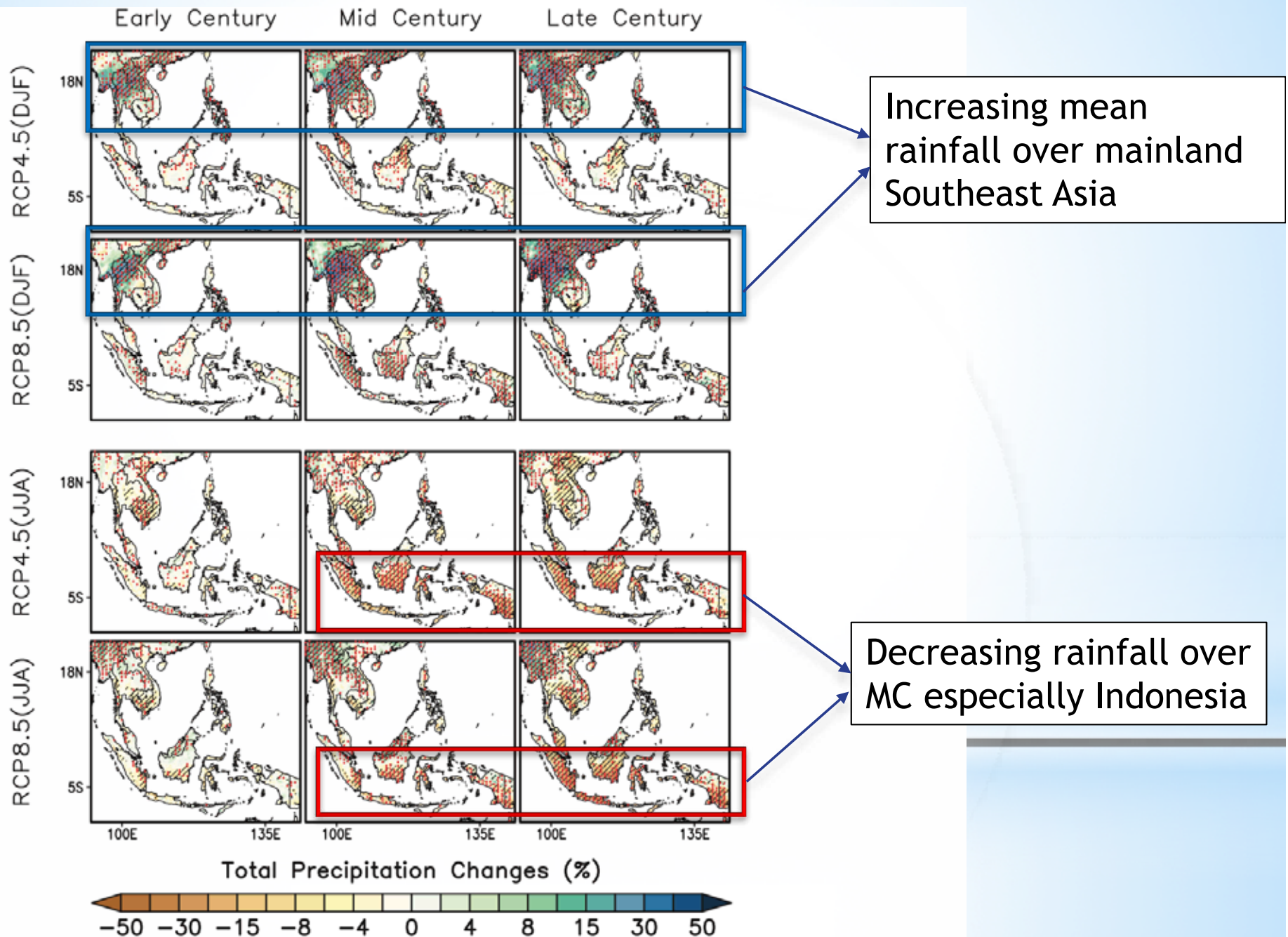


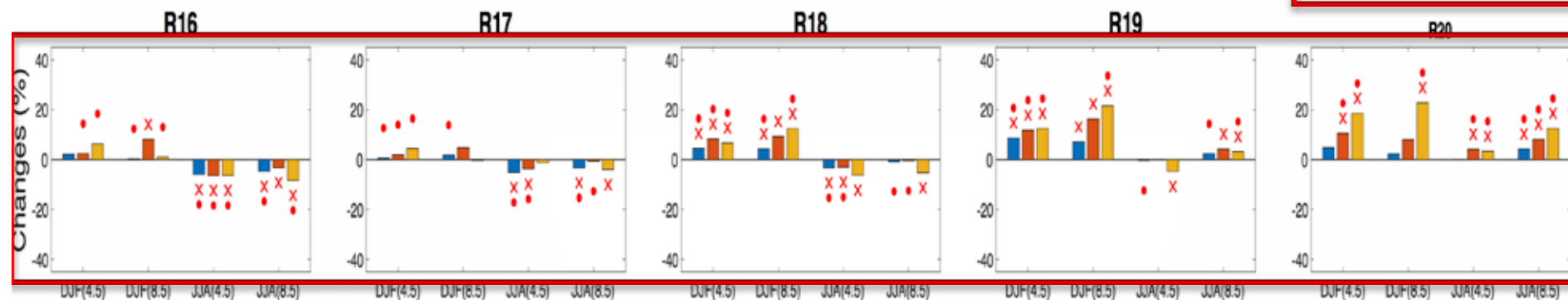
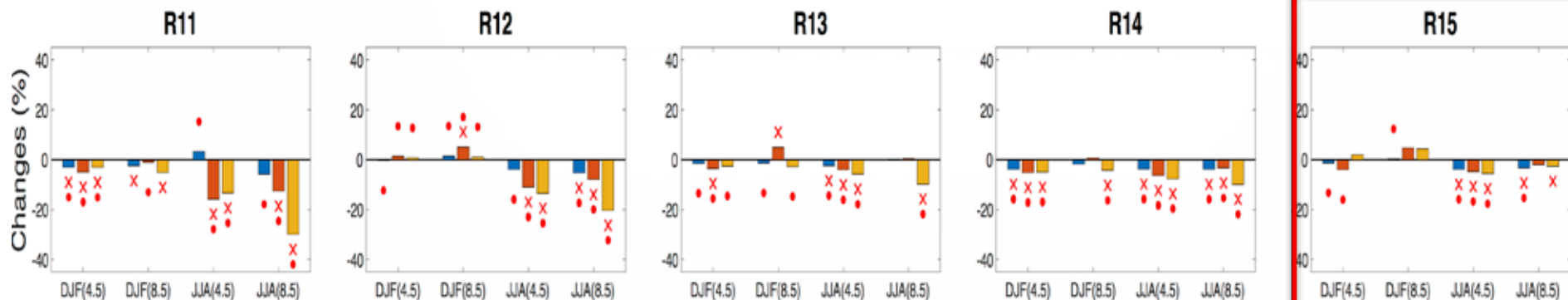
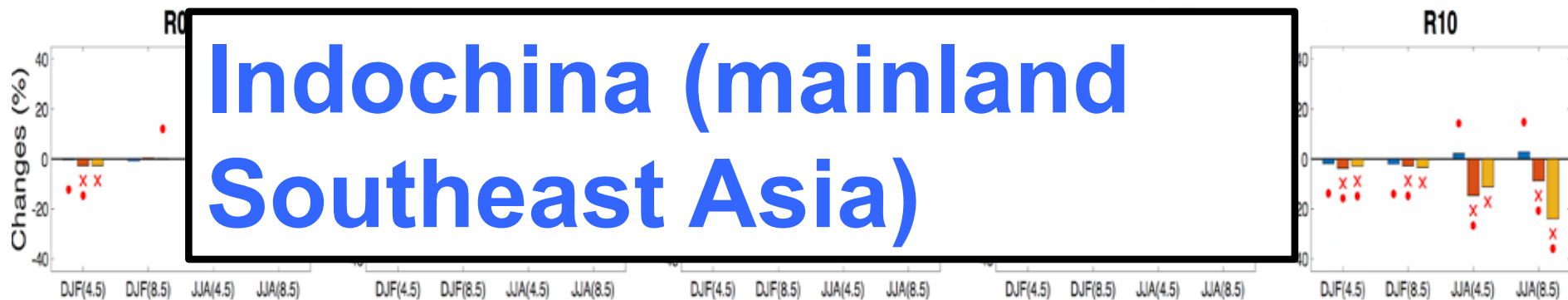
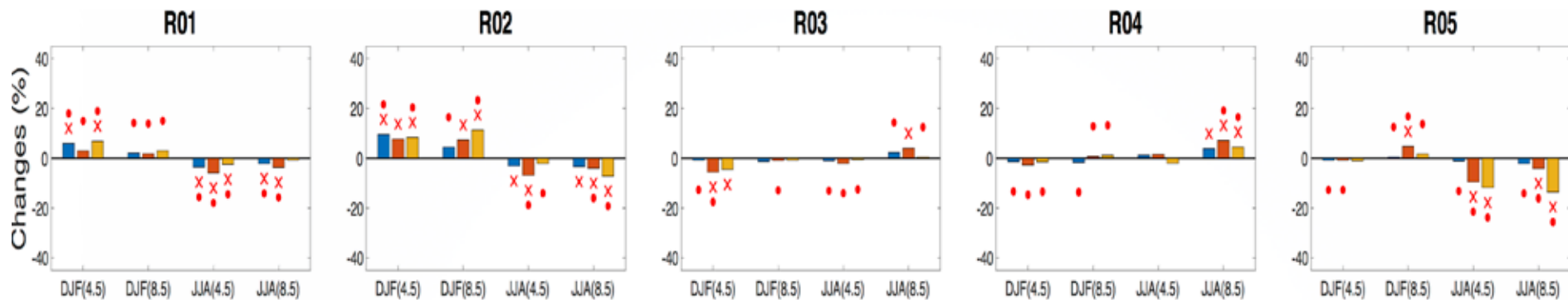
— Ensemble — GPCC



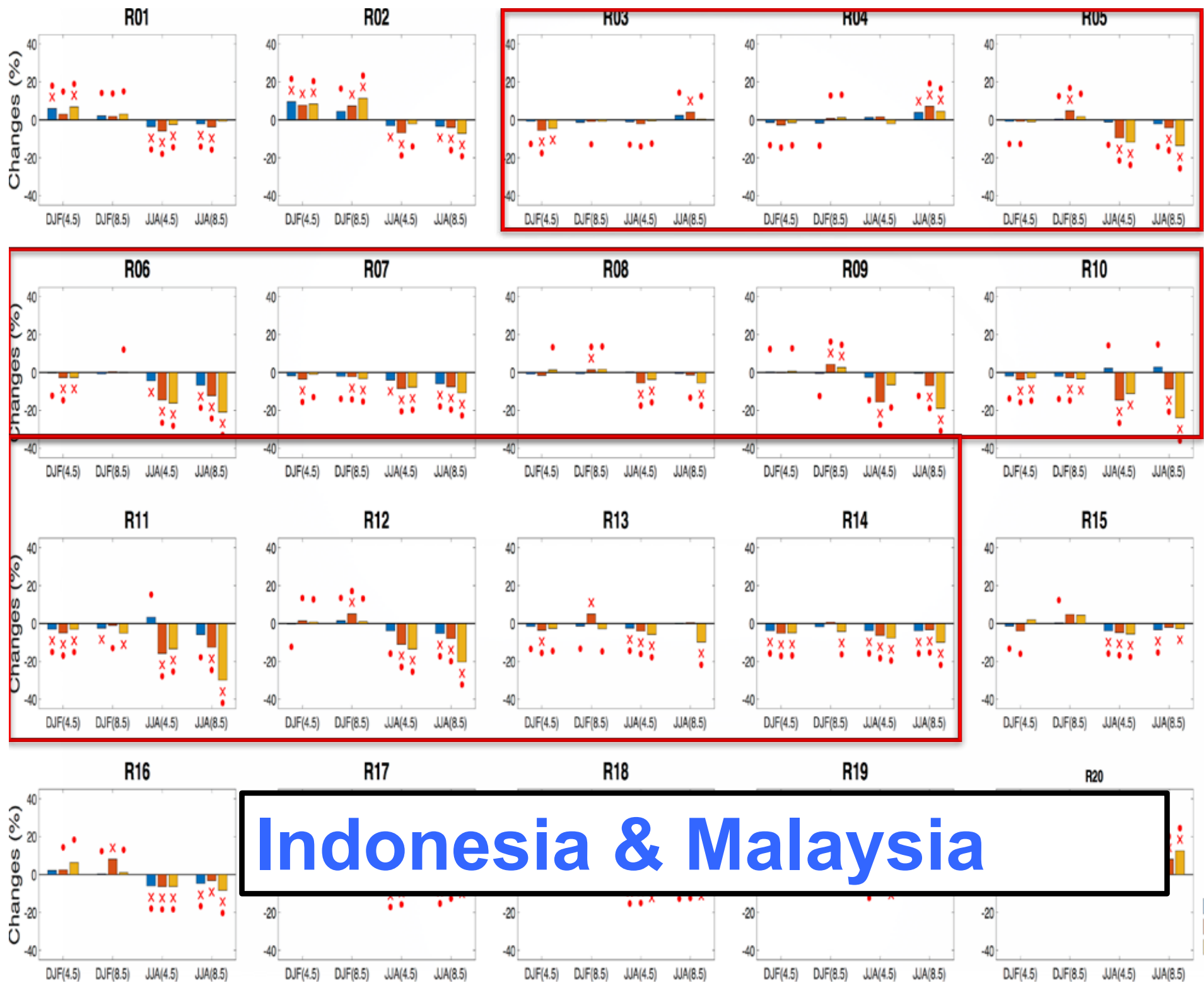
The ensemble mean approximated the observed annual cycles but inter-model variation exists

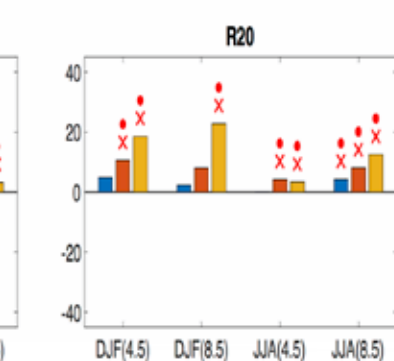
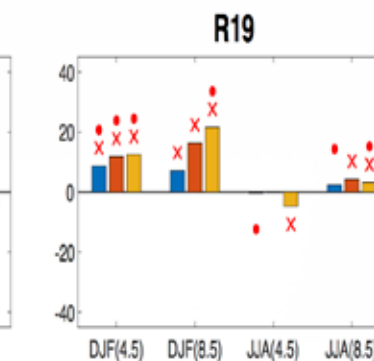
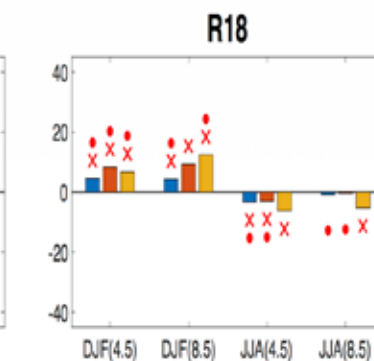
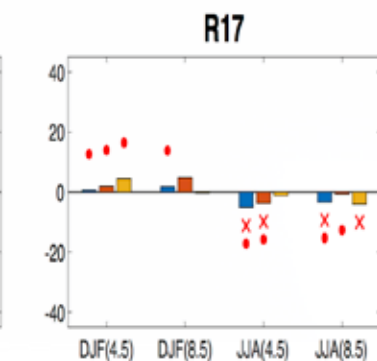
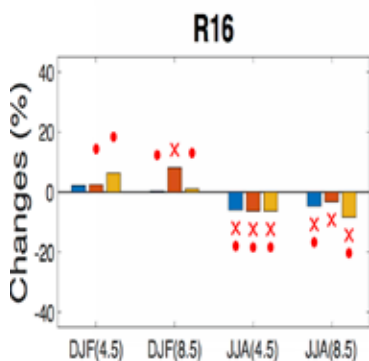
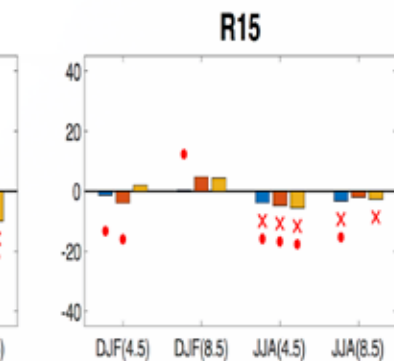
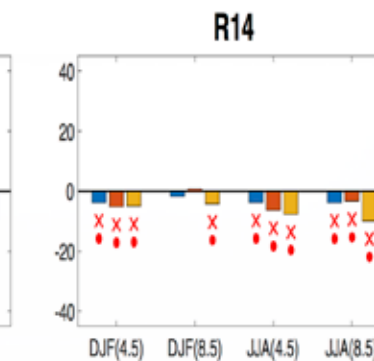
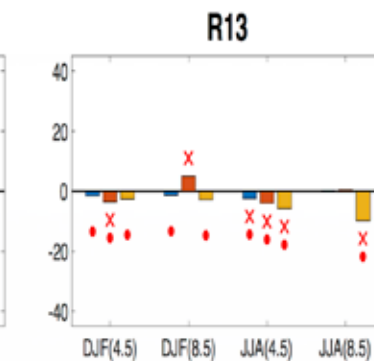
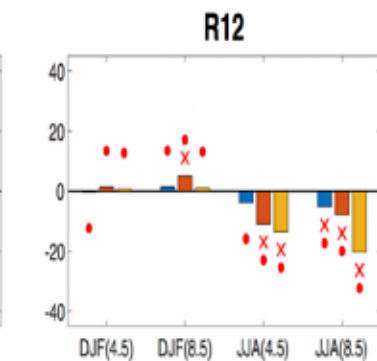
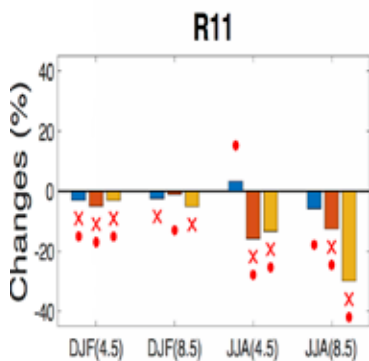
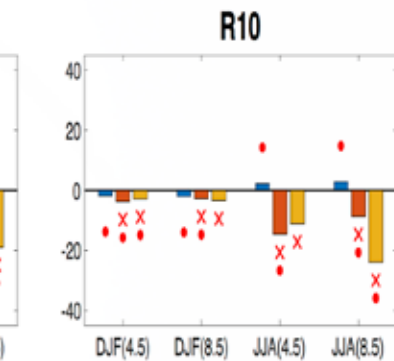
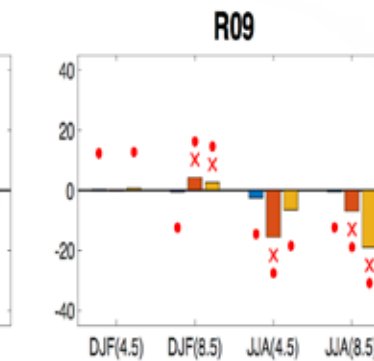
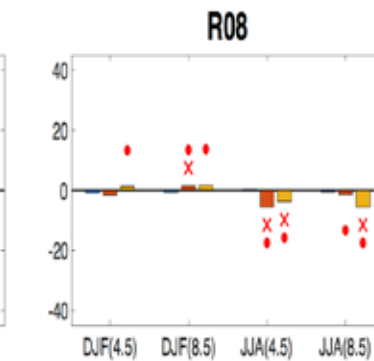
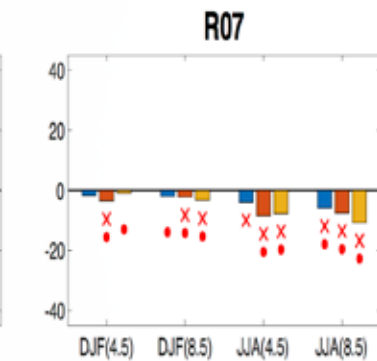
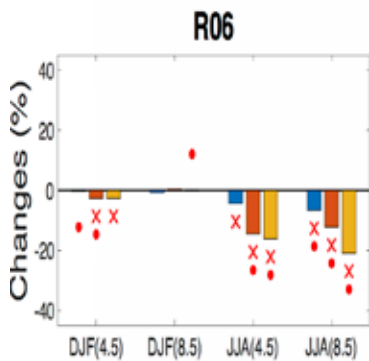
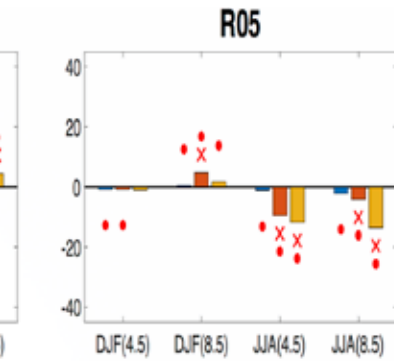
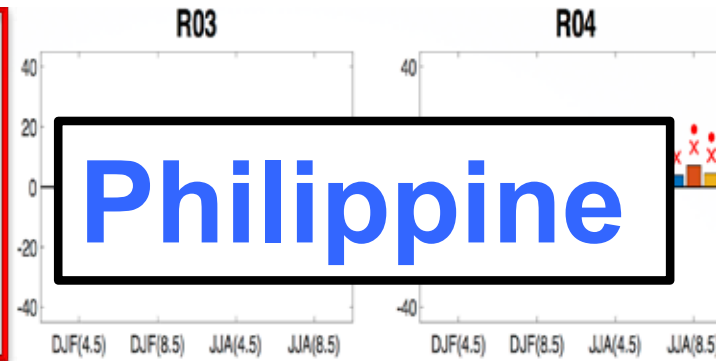
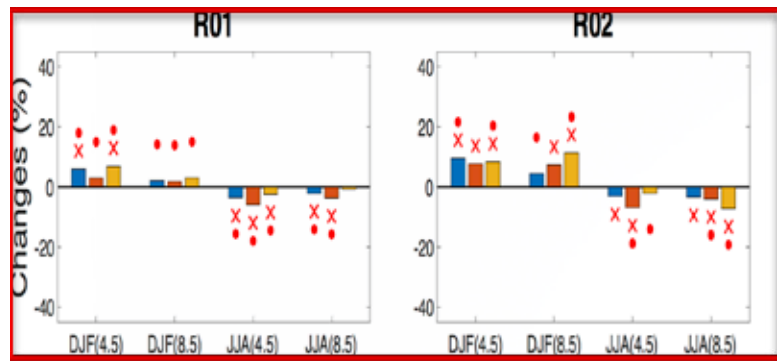
Changes in Projected DJF and JJA Rainfall





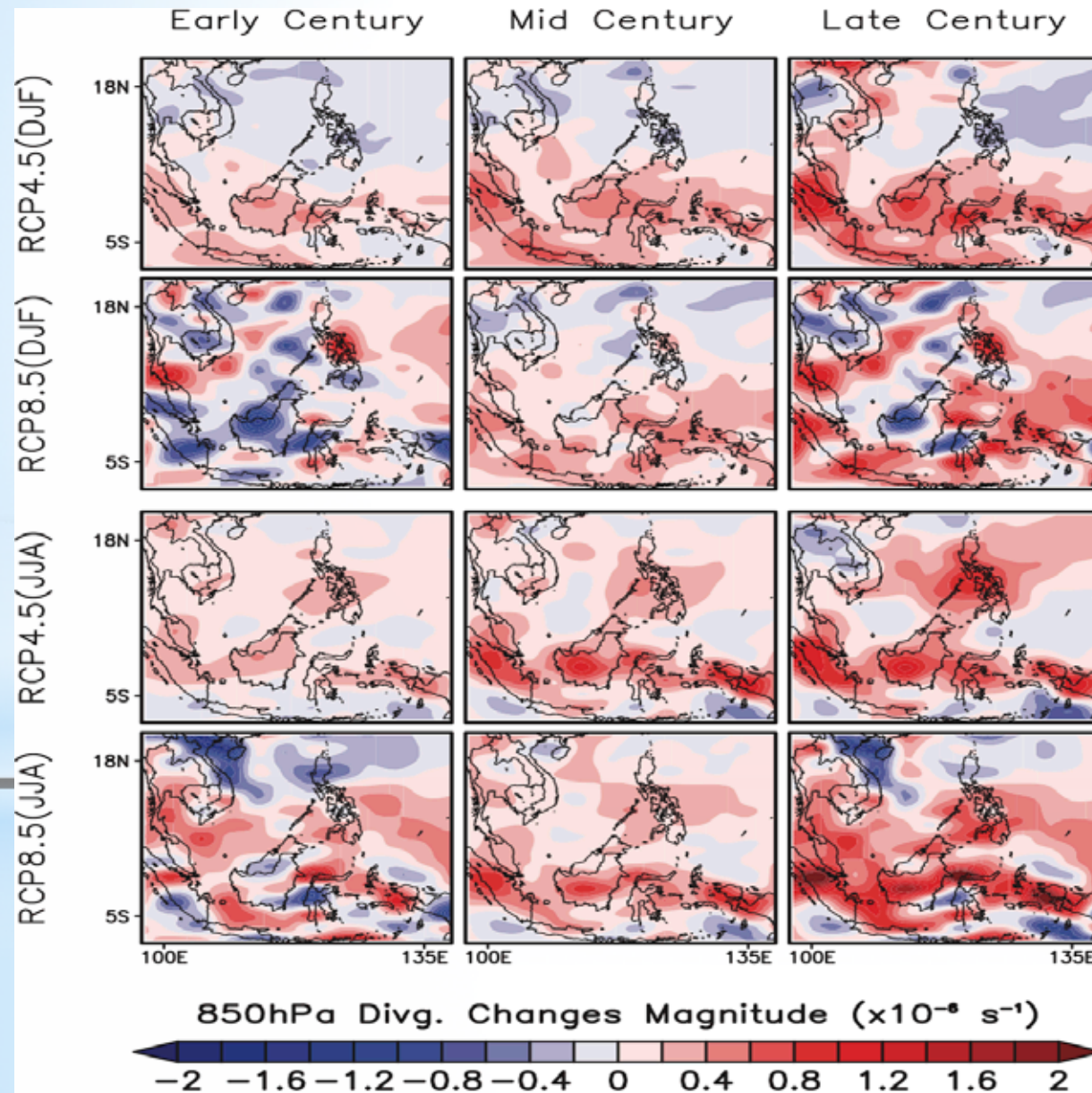
Early Century
Mid Century
Late Century



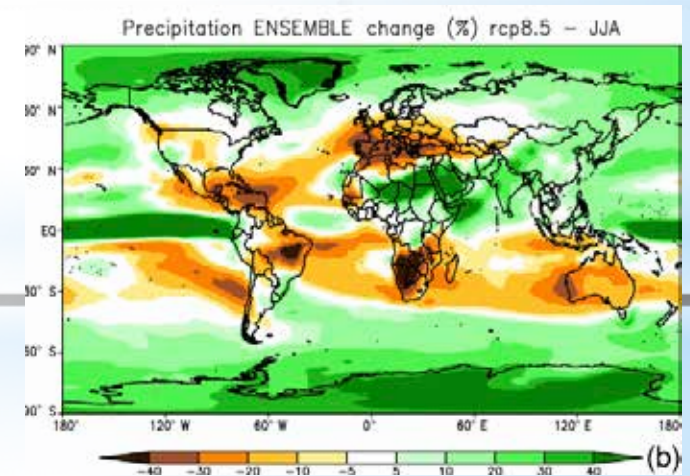


Early Century
Mid Century
Late Century

Projected Changes in Low-Level Divergence

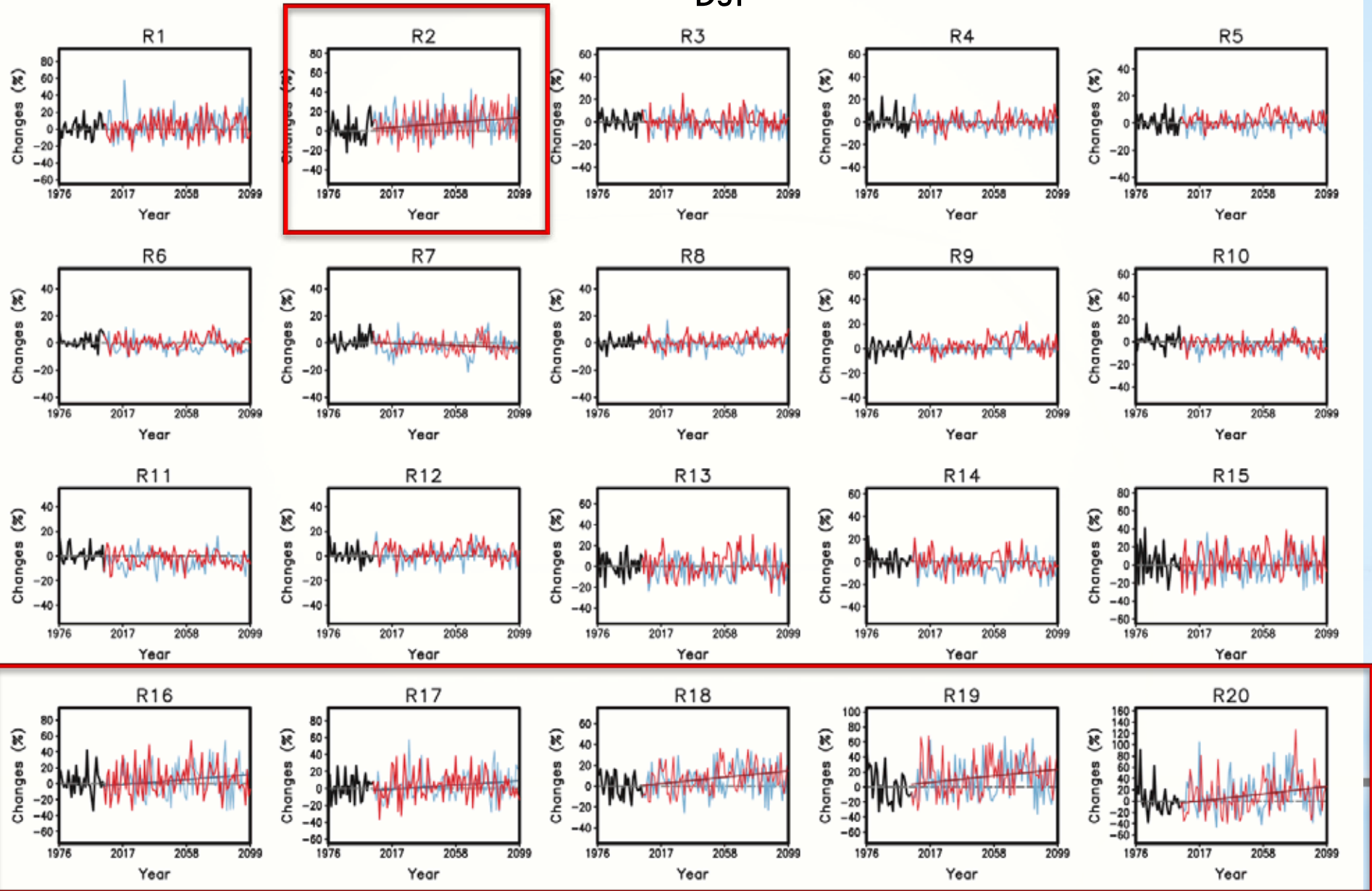


Enhanced
convergence
(divergence)
corresponds to
enhanced
(decreasing) rainfall



Giorgi et al. (2019)

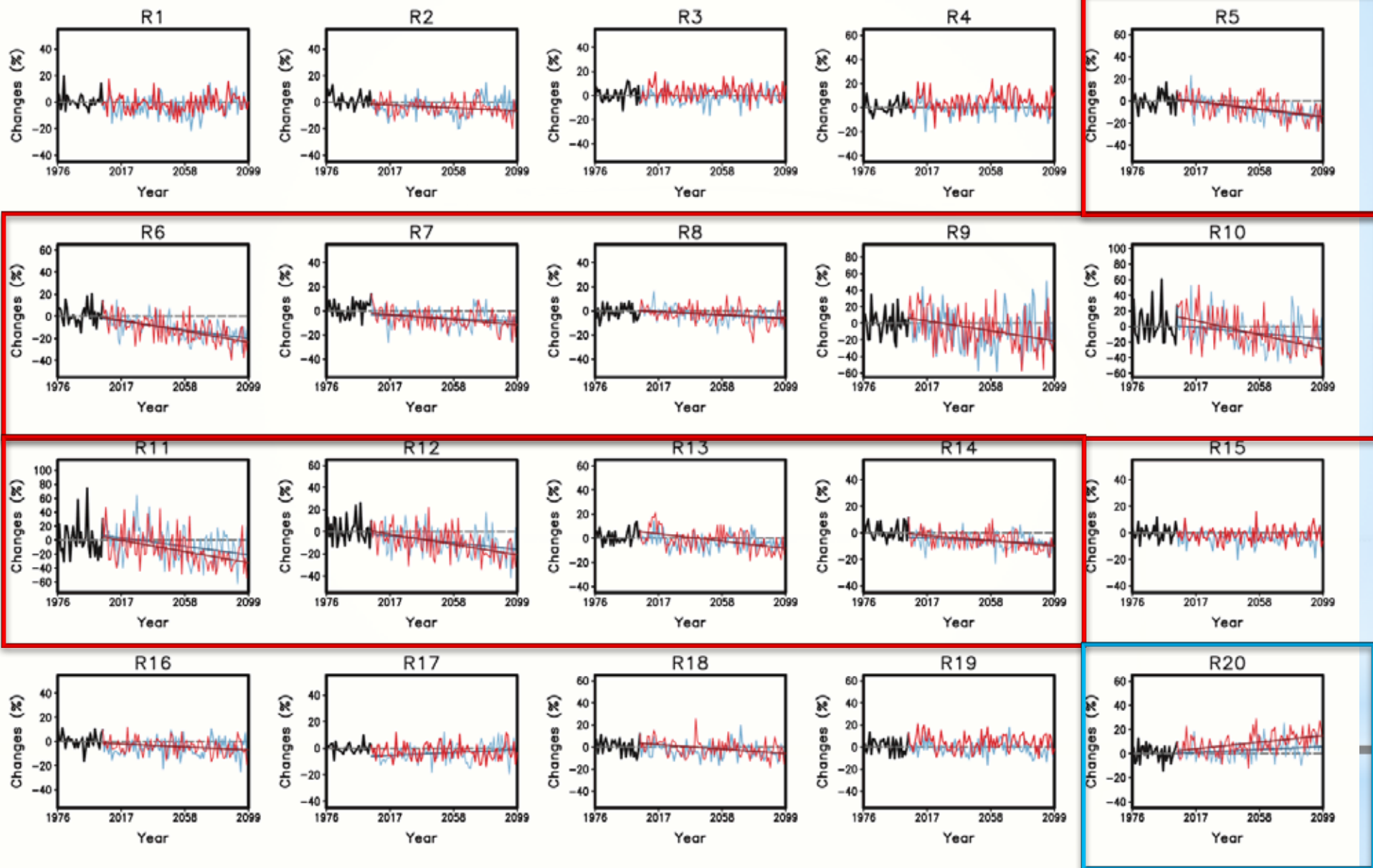
DJF



— Historical

— RCP4.5

— RCP8.5

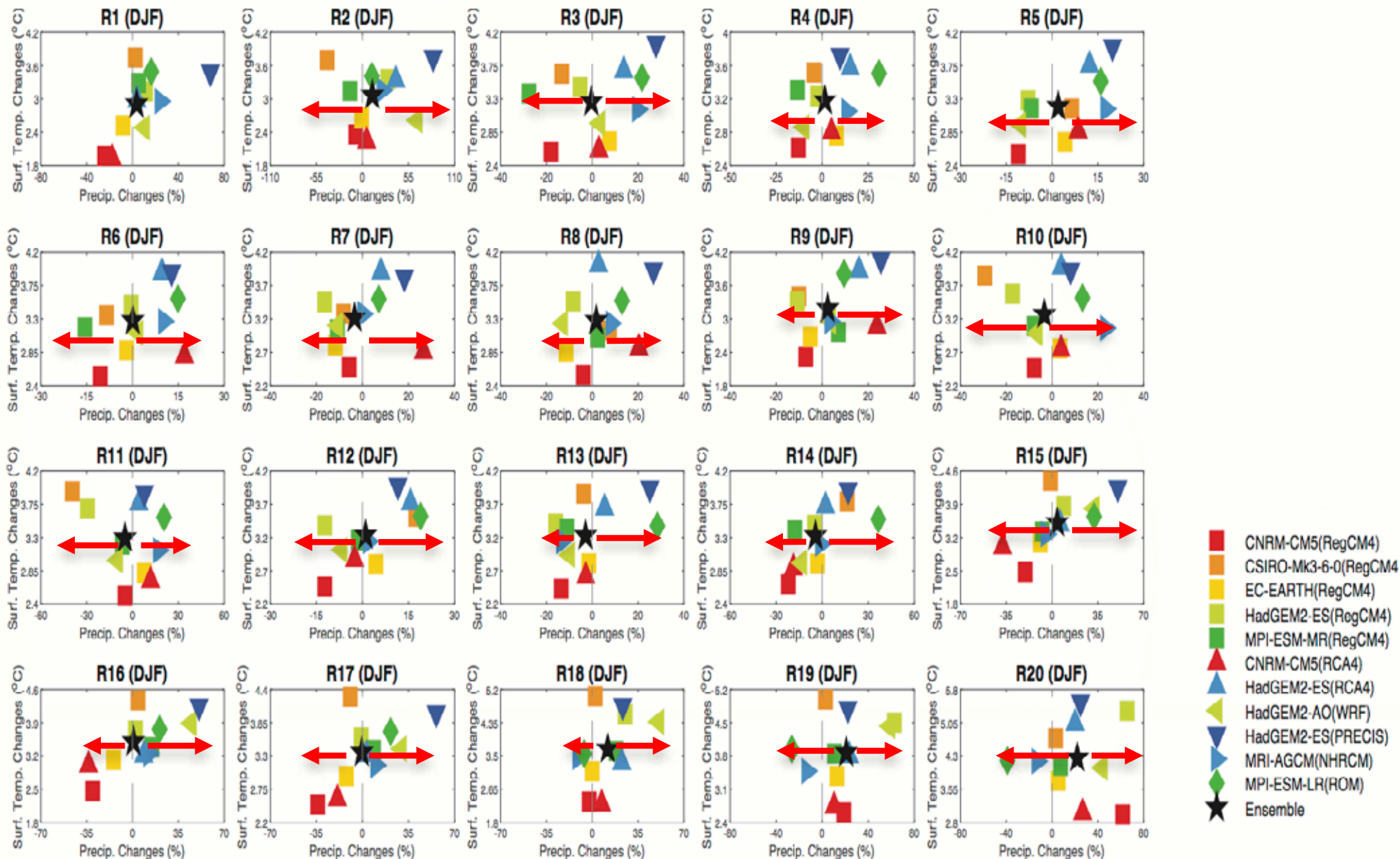


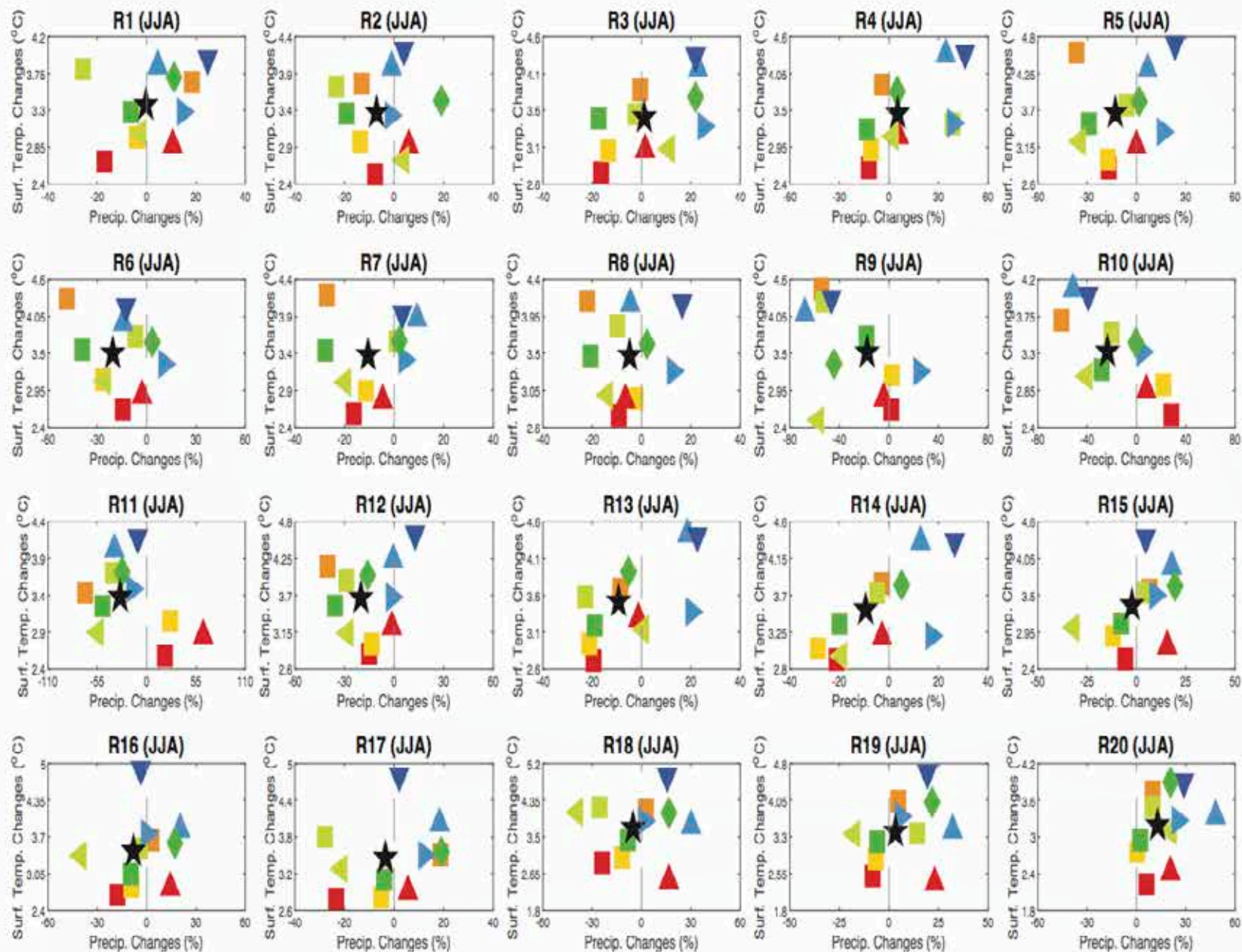
— Historical

— RCP4.5

— RCP8.5

Uncertainty in the Rainfall Projection (DJF)





List of GCMs and RCMs used in SEACLID/CORDEX
Southeast Asia Simulations

Contributor by country	General Circulation Model (GCM)	Representative Concentration Pathway (RCP)	Regional Climate Model (RCM)
Vietnam	CNRM-CM5 (CNRM, France)	RCP8.5, 4.5	RegCM4 (ICTP, Italy)
Philippines	HadGEM2 (Hadley Centre, UK)	RCP8.5, 4.5	RegCM4 (ICTP, Italy)
Thailand	MP-E5M4R (MPI-M, Germany)	RCP8.5, 4.5	RegCM4 (ICTP, Italy)
Thailand	EC-Earth (EC-Earth consortium)	RCP8.5, 4.5	RegCM4 (ICTP, Italy)
Indonesia	CSIRO Mk3.5 (CSIRO, Australia)	RCP8.5, 4.5	RegCM4 (ICTP, Italy)
Malaysia*	CanESM2 (CCCMA, Canada)	RCP8.5, 4.5	RegCM4 (ICTP, Italy)
Malaysia	IFS-CM4.5R (IFS, France)	RCP8.5, 4.5	RegCM4 (ICTP, Italy)
Malaysia	GFDL ESM2M (GFDL USA)	RCP8.5, 4.5	RegCM4 (ICTP, Italy)
South Korea	HadGEM2 AO (Hadley Centre, UK)	RCP8.5, 4.5	WRF (NCAR USA)
Sweden	CNRM-CM5 (CNRM, France)	RCP8.5, 4.5	RCM4 (SMHI, Sweden)
Sweden	HadGEM2 ES (Hadley Centre, UK)	RCP8.5, 4.5	RCM4 (SMHI, Sweden)
Australia**	CNRM-CM5 (CNRM, France)	RCP8.5	CCAM (CSIRO, Australia)
Australia**	CCSM (NCAR USA)	RCP8.5	CCAM (CSIRO, Australia)
Australia**	ACCESS1.3 (CSIRO, Australia)	RCP8.5	CCAM (CSIRO, Australia)
Hong Kong SAR***	ESM2M/GFDL USA	RCP8.5, 4.5	RegCM4 (ICTP, Italy)
United Kingdom	HadGEM2-ES (Hadley Centre, UK)	RCP8.5	FRCOS (Hadley Centre, UK)
Germany***	MP-E5M4R (MPI-M, Germany)	RCP8.5, 4.5	RCM (MPI-M Germany)
Japan**	MIROC-M2 (MRI, Japan)	RCP8.5, 4.5	MIROC (MRI, Japan)

(Note: * yet to be completed, ** time-slice runs, *** 50 km x 50 km and slightly different domains to cover Western Pacific warm pool)

For more information about this project: www.mindgarden.com/learn/learn-about-us

- ▶ <http://www.ukm.edu.my/seacld-cordex/>
- ▶ <http://www.rucore.ru.ac.th>
- ▶ <http://www.cordex.org>
- ▶ <http://www.apn-gcr.org/resources/items/show/1886>
- ▶ <http://www.apn-gcr.org/resources/items/show/2048>

Institutions of Scientists/Funding Agencies



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for **SOCIETY**

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 Informasi iklim untuk masyarakat
 Impormasyon sa Klima para sa lipunan
 Thông tin Khí hậu phục vụ Xã hội
 ព័ត៌មានអាកាសធាតុសម្រាប់សង្គម
 ខ្ញុំបង្កើតឡើងនូវគម្រោង
 បង្កើតឡើងនូវគម្រោង

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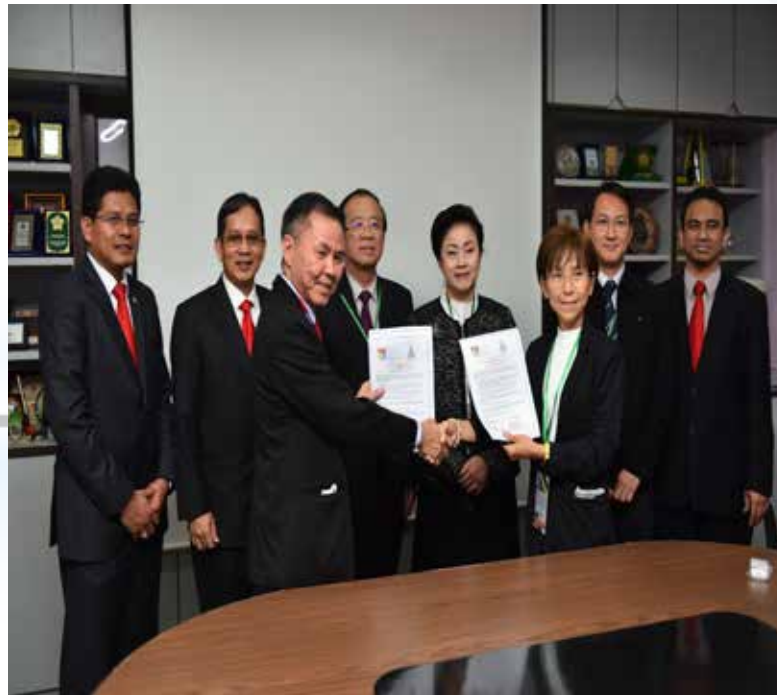


► <http://www.rucore.ru.ac.th/SARCCIS>

*The SARCCYS logo was designed and graciously donated by Assoc. Professor Visut Udompitakap, VR Digital Company Limited, Thailand



Launching of
SARCCIS and
LOI signing
between
UKM & RU,
May 7, 2018





**SARCCIS is jointly
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<http://www.rucore.ru.ac.th/SARCCIS>



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CLIMATECHANGE
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SubMenu >>

SARCCIS

SEALID/CORDEX Southeast Asia

ESGF-Node

Data Visualization

Climate Information for SOCIETY

SARCCIS serves as a one-stop datacenter that:

- a) freely disseminates high-resolution, multi-model and multi-scenarios simulated data;
- b) provides guidance on data usage and reliability, including uncertainty and;
- c) conducts trainings to users on how to access, analyze and interpret the data

SARCCIS is a product of the Southeast Asia Regional Climate Downscaling (SEALID) /

Coordinated Regional Downscaling Experiment (CORDEX) Southeast Asia Project

Model simulated data in SARCCIS is archived as part of the Earth System Grid Federation (ESGF) Peer-to- Peer (P2P) Enterprise System

In the long run, SARCCIS is envisioned to archive other products including bias-corrected model data, data from statistical downscaling, observed data and information on impacts of climate change in the region

SARCCIS champions climate services in the Southeast Asia region



More information about this project can be obtained from these websites:

www.ukm.edu.my/seaclid-cordex/

<http://www.rucore.ru.th/SARCCIS>

ESGF worldwide data node



SEACLID/CORDEX Southeast Asia

Gridded
Observed
products &
Other useful
resources from
various data

Bias
Correcti
on

High-
resolution
(25 km x
25 km, 5
km x
5km),
multi-
model and
multi-
scenario
model
outputs

Case
Studies

Southeast Asia Regional Climate Change
Information System (SARCCIS)



Free data dissemination to user community, prepare documentation on data reliability including uncertainties, provides training on how to access, analyze and interpret the data

IAV Groups



SARCCIS supports Robust Policy Development & Decision-Making Process in Southeast Asia



Robust Climate Information

Detailed information at local scales

Free access to user IAV community

Assessment of impacts of future climate change

Assessment of risk

Together with information on exposure & vulnerability, risk of assets, critical sectors, community can be determined

Policy development , Decision-making process, Robust policy, Adaptation measures, SDGs, SFDRR

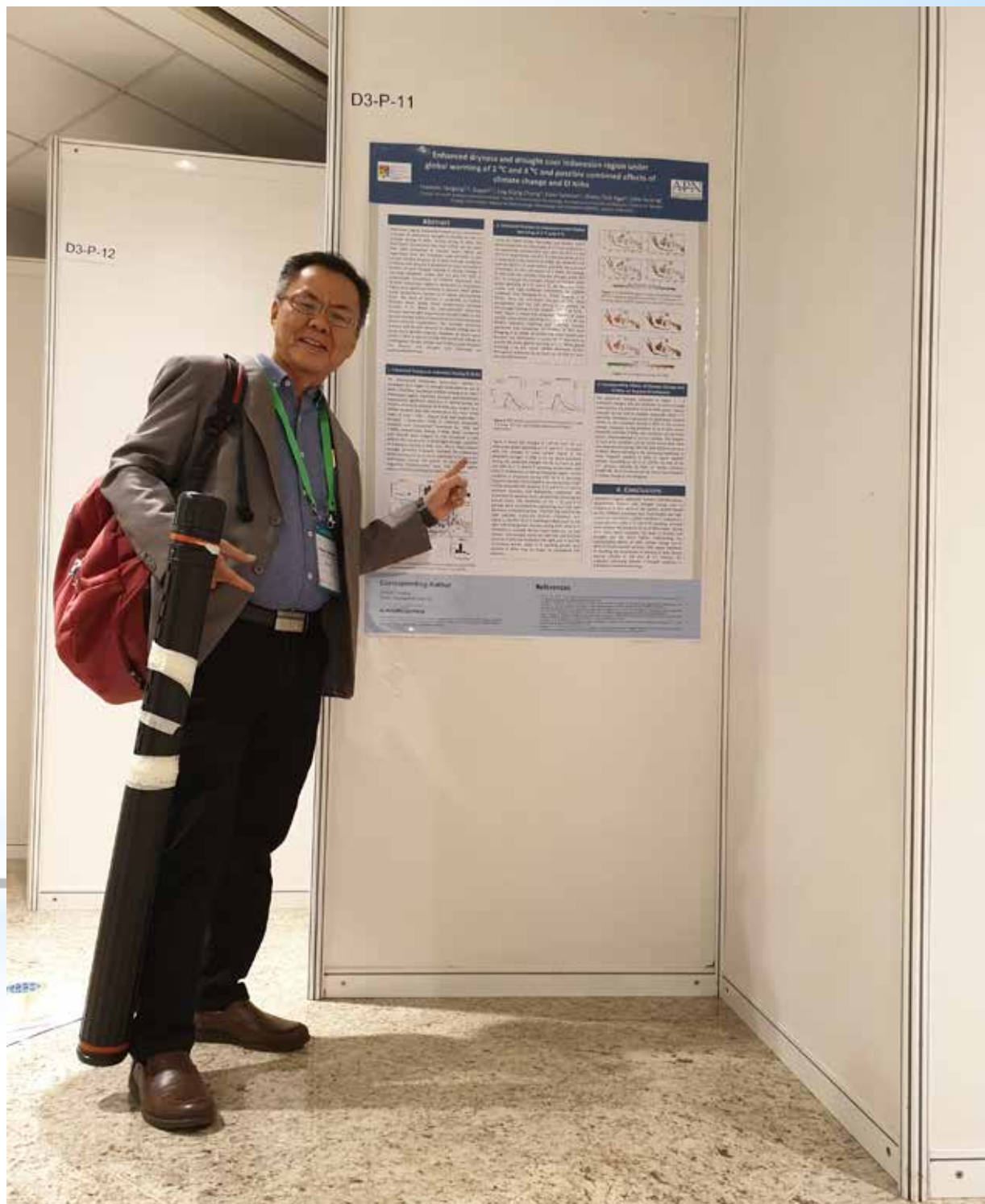


Summary

- ◆ CORDEX Southeast Asia simulation comprises of 14 members (11 GCMs, 7 RCMs) of 25 km x 25 km resolution
- ◆ Ensemble mean reasonably approximated the climatology but inter-model variation exists
- ◆ Wetter (Drier) condition is projected over mainland Southeast Asia (Maritime Continent) during DJF (JJA)
- ◆ Uncertainty exist in the projected rainfall. In most cases where no change is indicated in the ensemble mean, inter-model variation of positive and negative changes can be present.

Enhanced dryness and drought over Indonesia under 2°C and 4°C global warming and possible combined effects of Climate Change and El Nino

(D3-P-11)



Projected Future Changes in Rainfall in Southeast Asia based on Multi-model Simulations of CORDEX Southeast Asia

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Ahmad Fairudz Jamaluddin^{1,4}, Mohd Syazwan Faisal Mohd⁵, Faye Cruz⁶, Gemma Narisma^{6,7}, Jerasorn
Santisirisomboon², Thanh Ngo-Duc⁸, Phan Van Tan⁹, Patama Singhruck¹⁰, Dodo Gunawan³, Edwin
Aldrian¹¹, Ardhasena Sopaheluwakan¹², Nikulin Grigory¹³, Armelle Reca C. Remedio¹⁴, Dmitry V.
Sein^{15,16}, David Hein-Griggs^{17,18}, John L. McGregor¹⁹, Hongwei Yang^{20,21}, Hidetaka Sasaki²², Pankaj
Kumar²³

Acknowledgement to all authors

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