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CORDEX-SEA Projection of Temperature and Precipitation and their Time of Emergence in Vietnam

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The Global Climate Risk Index 2019

→ Vietnam (& Southeast Asia) most at risk

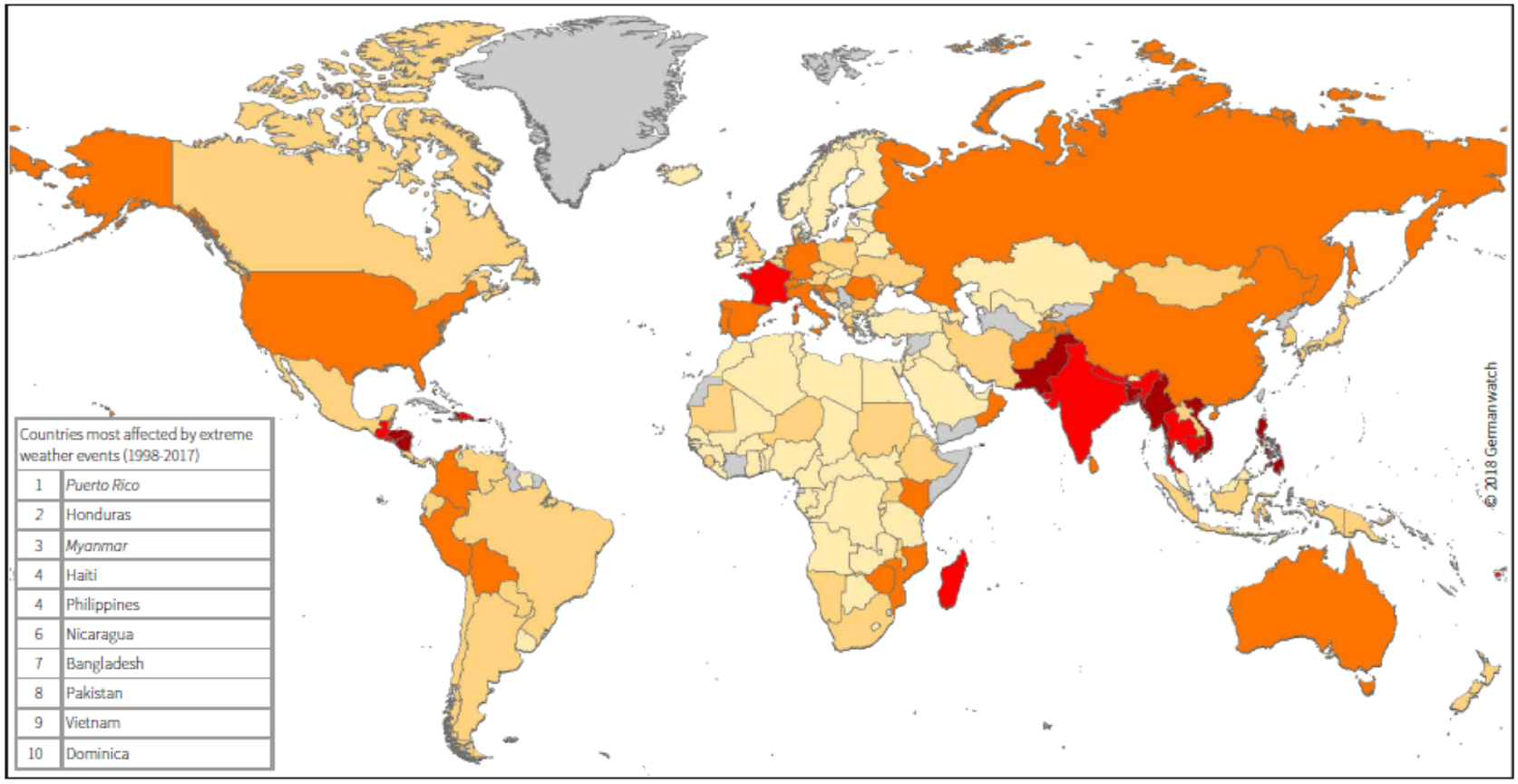
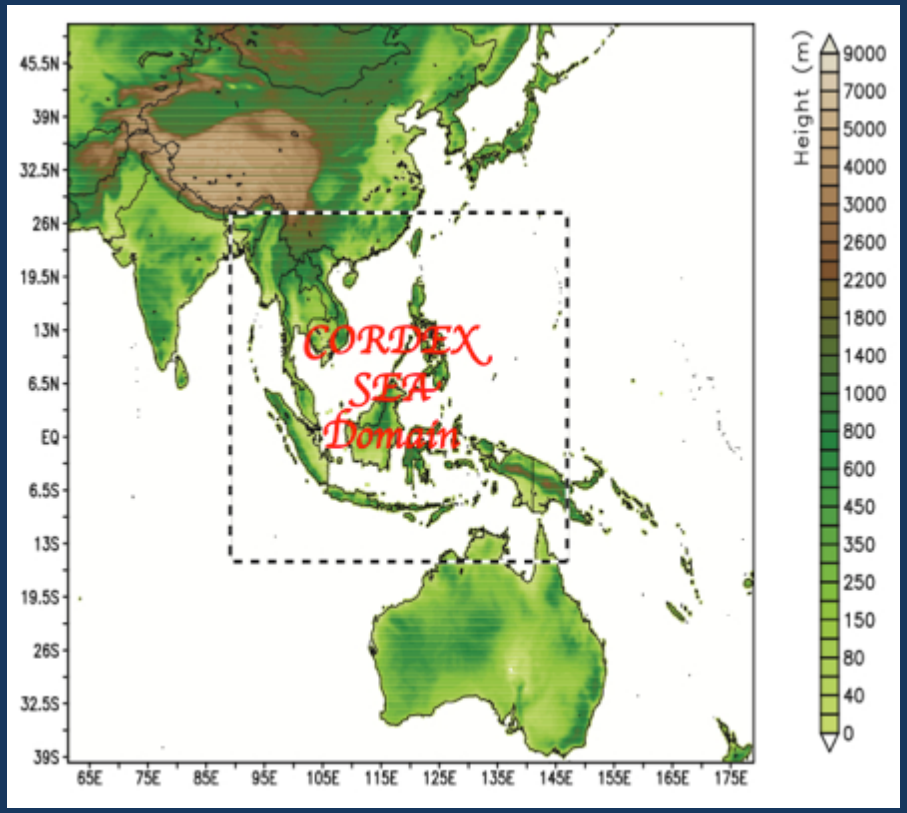


Image from Climate Risk Index 2019, Germanwatch

SEACLID/CORDEX-SEA activities (since 2012)

1. Sensitivity experiments (with reanalysis ICBC data & different physic options)
2. Downscaling CMIP5 GCMs to 25 km (Phase 1), to 5km (Phase 2)
3. Sharing data & resources
4. Capacity building
5. Aims at increasing the number of publications from the SEA region



SEACLID: Southeast Asia Climate Downscaling

- Juneng et al., 2016; Ngo-Duc et al., 2017; Faye et al., 2017
- Tangang et al., 2018, 2019; Trinh et al., 2019; etc.

CORDEX-SEA activities: tasks sharing

E.g.

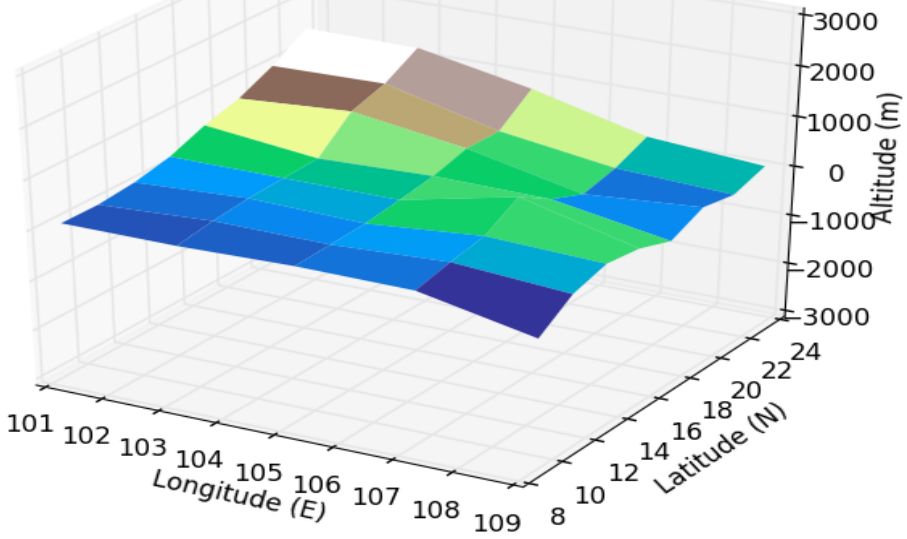
RegCM
- 25 km
- RCP 4.5
- RCP 8.5

CCAM
WRF
PRECIS
REMO

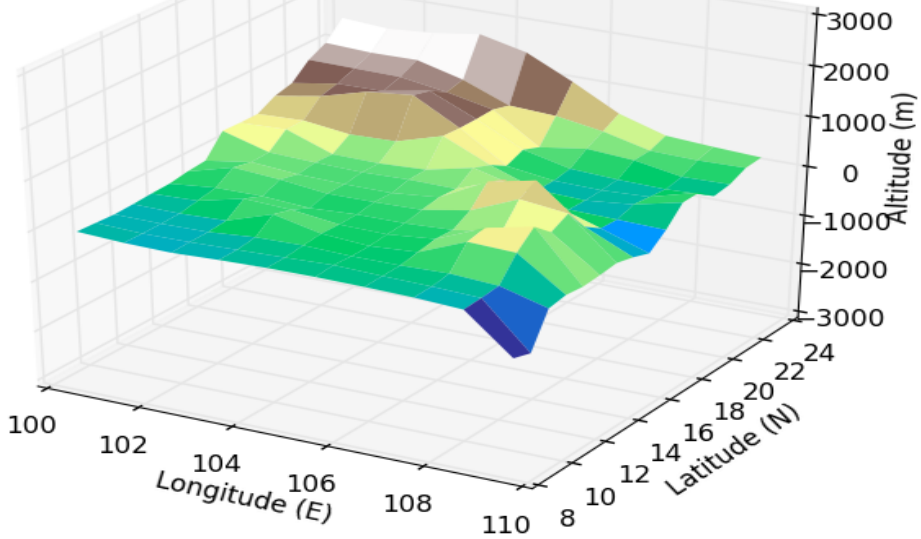
Country	GCMs	Country and Institution developed the GCMs	RCPs
Vietnam	CNRM-CM5	Centre national de Recherches Meteorologiques, France	RCP8.5, 4.5
Philippines	HadGEM2	Hadley Centre, UK	RCP8.5, 4.5
Thailand	MPI-ESM-MR	Max Planck Institute for Meteorology, Germany	RCP8.5, 4.5
Thailand	EC-Earth	EC-Earth consortium	RCP8.5, 4.5
Indonesia	ACCESS1.3	CSIRO, Australia	RCP8.5, 4.5
Malaysia	CanESM2	Canadian Centre for Climate Modeling and Analysis, Canada	RCP8.5, 4.5
Malaysia	IPSL-CM5A-LR	Institute Pierre-Simon Laplace, France	RCP8.5, 4.5
Malaysia	GFDL-ESM2M	GFDL, USA	RCP8.5, 4.5
Australia	CNRM-CM5	Centre national de Recherches Meteorologiques, France	RCP8.5
Australia	CCSM4	NCAR, USA	RCP8.5
Australia	ACCESS1.3	CSIRO, Australia	RCP8.5
Hong Kong SAR	CCSM or CESM	NCAR, USA	RCP8.5, 4.5
United Kingdom	HadGEM2-ES	Hadley Centre, UKMO	RCP8.5, 4.5
South Korea	HadGEM2-AO	Hadley Centre, UKMO	RCP8.5, 4.5

The need of high resolution climate simulations for Vietnam

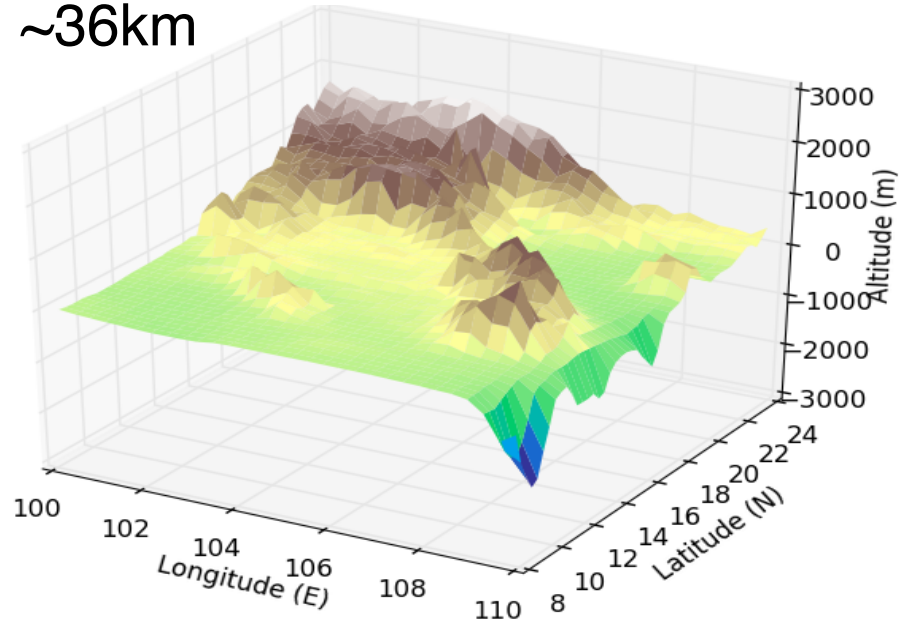
~200km



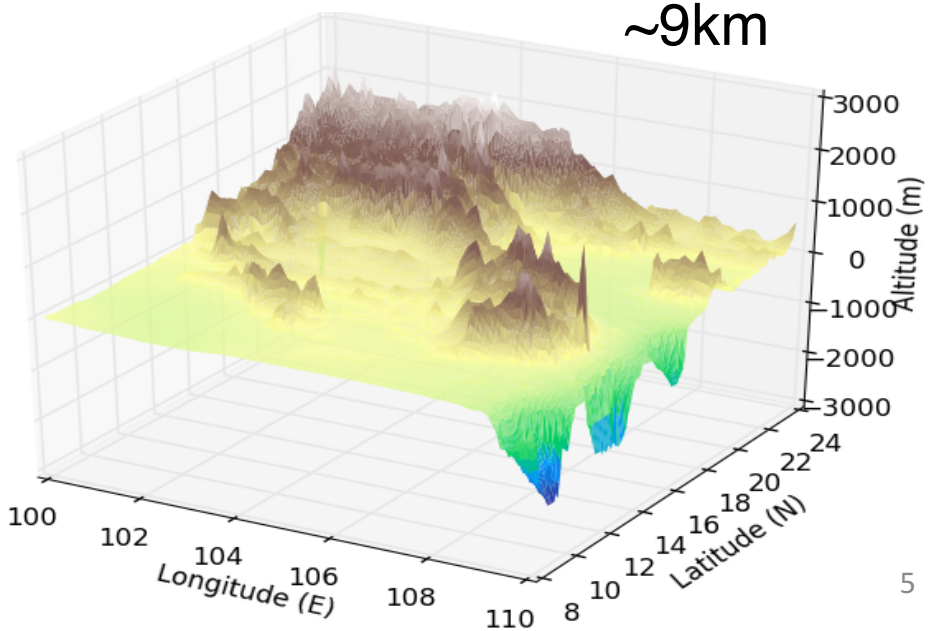
~100km



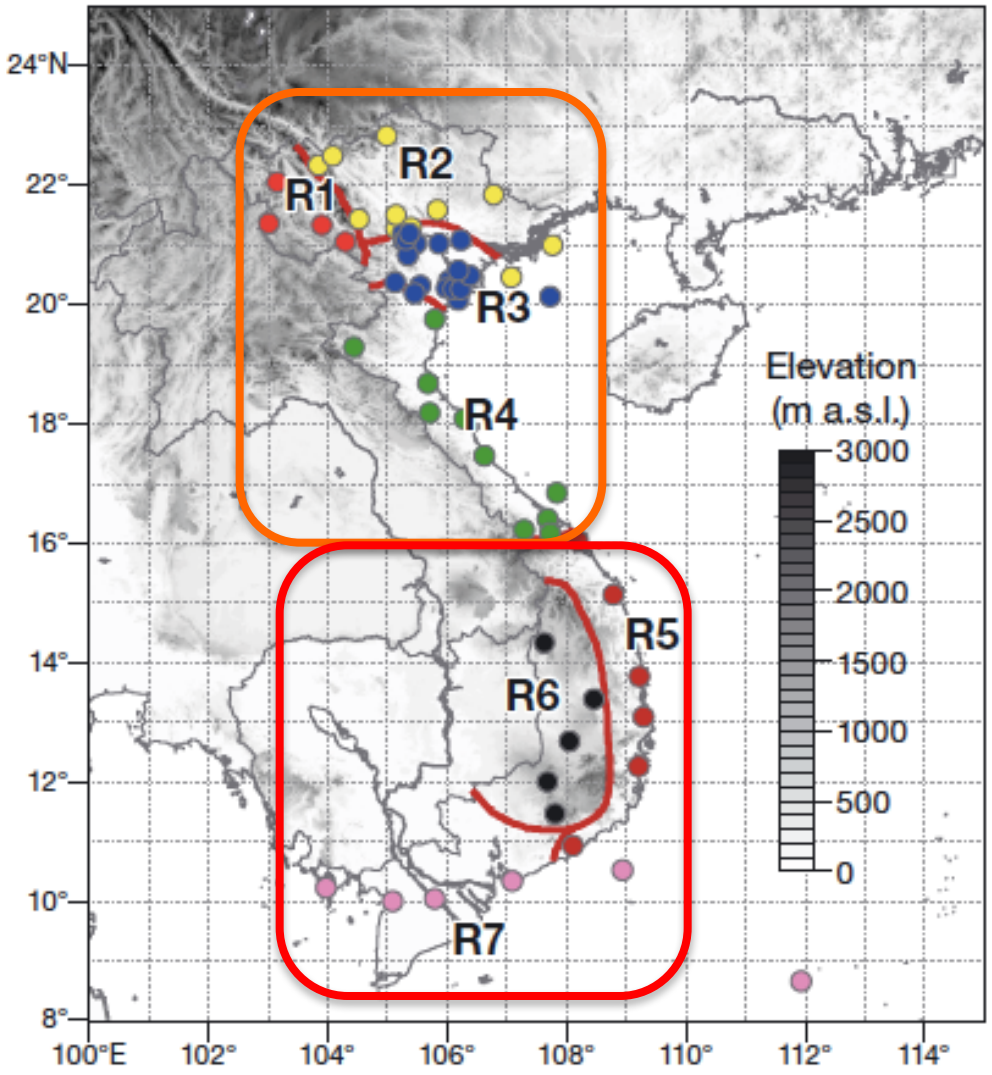
~36km



~9km



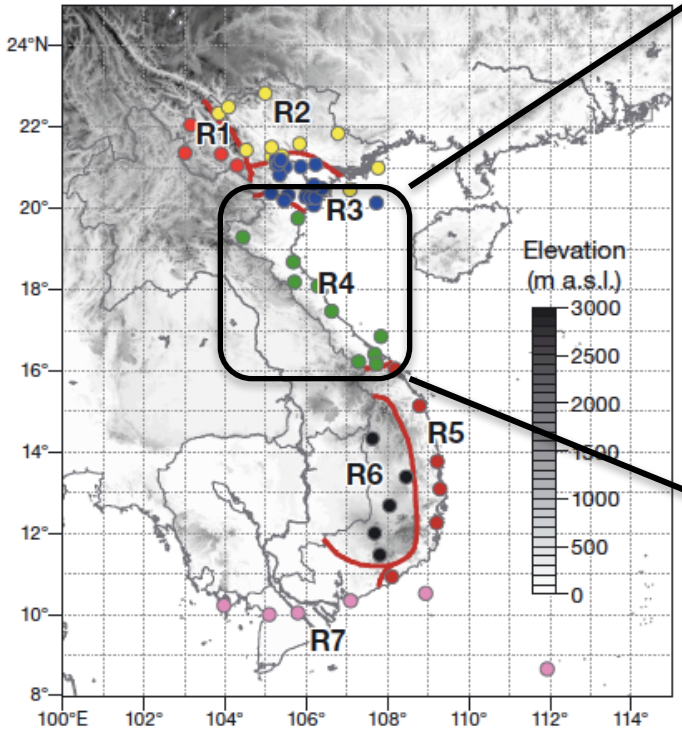
Climate of inland Vietnam

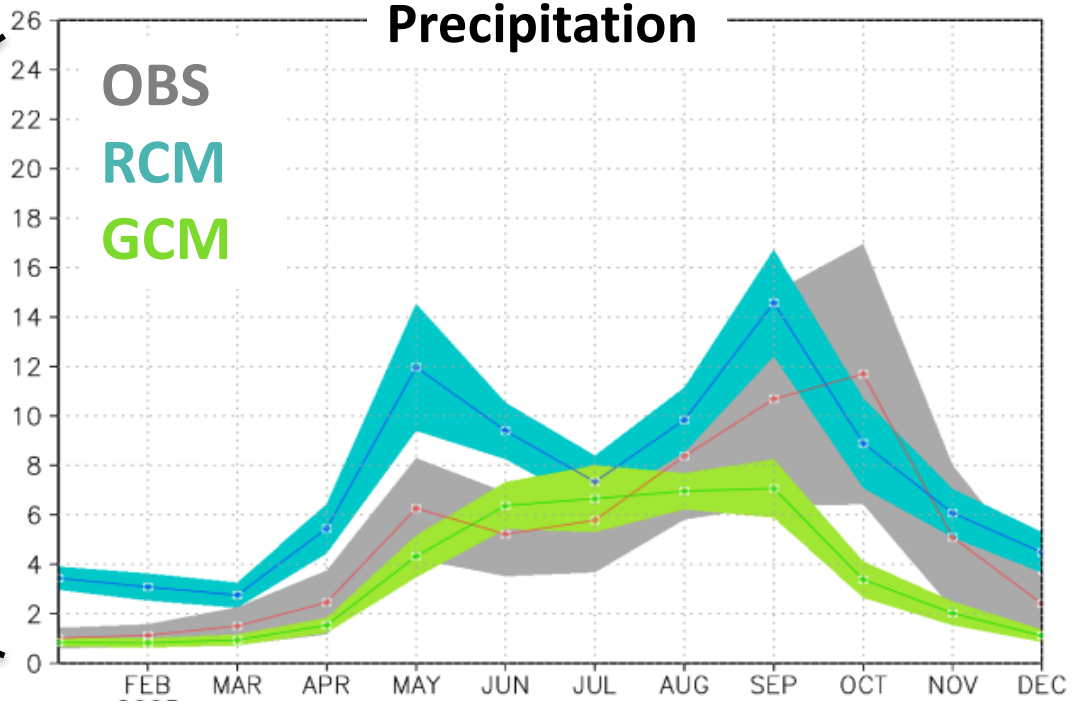


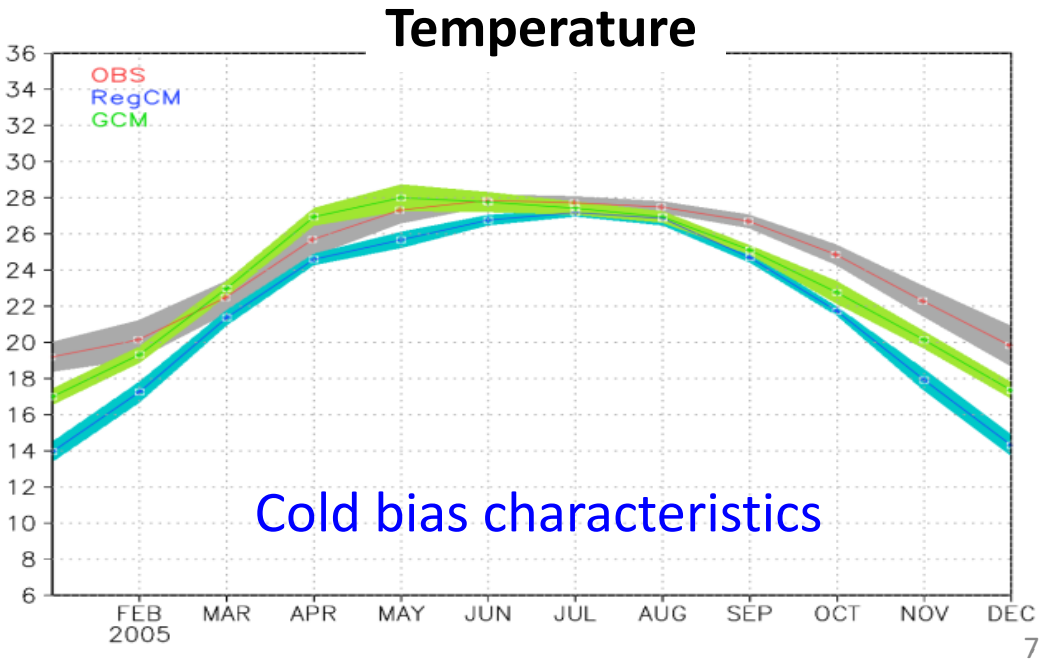
- **North-South** domain: total hours of irradiation & annual temperature range
- Sub-regions: & rainfall regimes

7 sub-climatic regions

Added values of RCMs



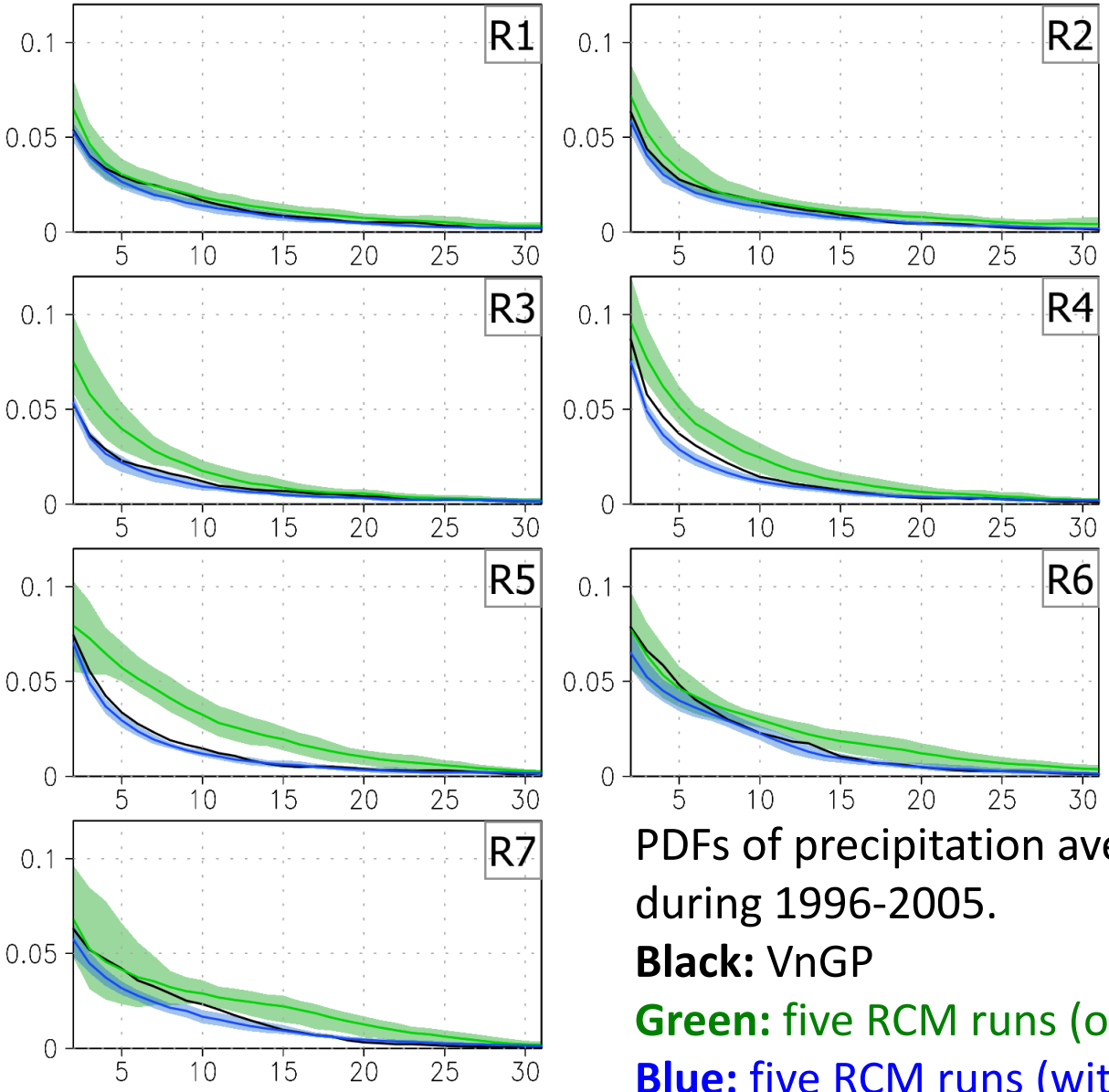


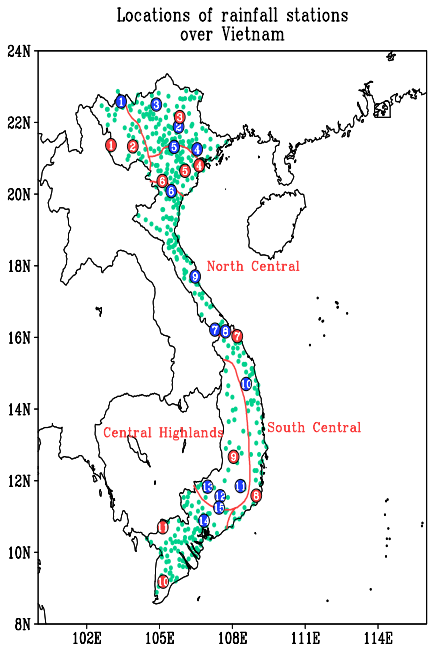


CORDEX-SEA experiments with RegCM and the driving GCMs

Cold bias characteristics

Quantile Mapping Bias Correction





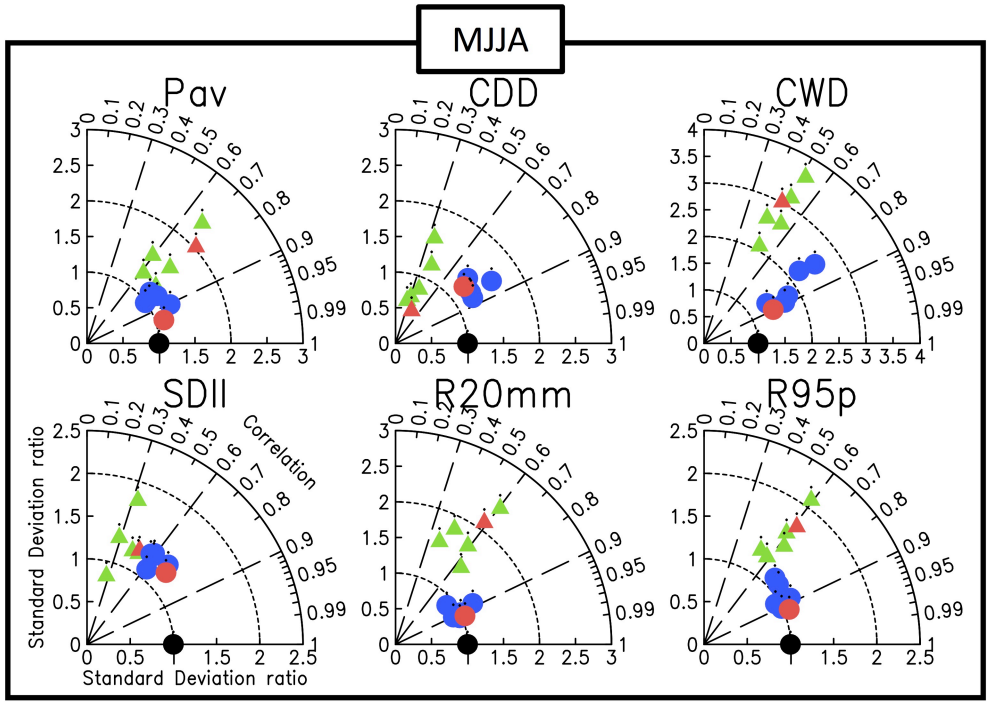
(Trinh et al., 2019)

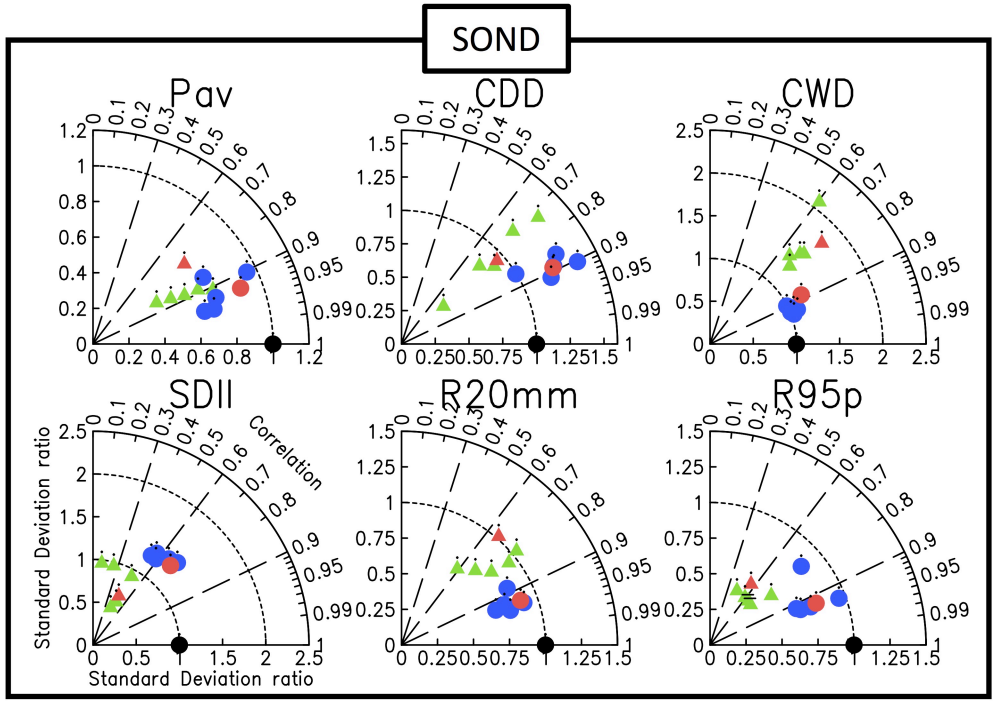
PDFs of precipitation averaged over **7 sub-regions** during 1996-2005.

Black: VnGP

Green: five RCM runs (original)

Blue: five RCM runs (with QM BC)





(Trinh et al., 2019)

Original

Quantile Mapping

Ensemble

- Quantile mapping BC improves model outputs
- The simple ensemble mean performs relatively better than each individual experiment

Some applications of CORDEX-SEA data in Vietnam

- Non-linear Impact of Climate Change on Income and Equality (Marx et al., *submitted*) ← An additional day above 33ºC → a decrease of the yearly income by 1.3%

- Climate analog: Poster: A1-P-21 (Nguyen Tuyet et al., *under revision*)

- Time of Emergence of Temperature and Precipitation in Vietnam (Nguyen Huong et al., *in prep.*)

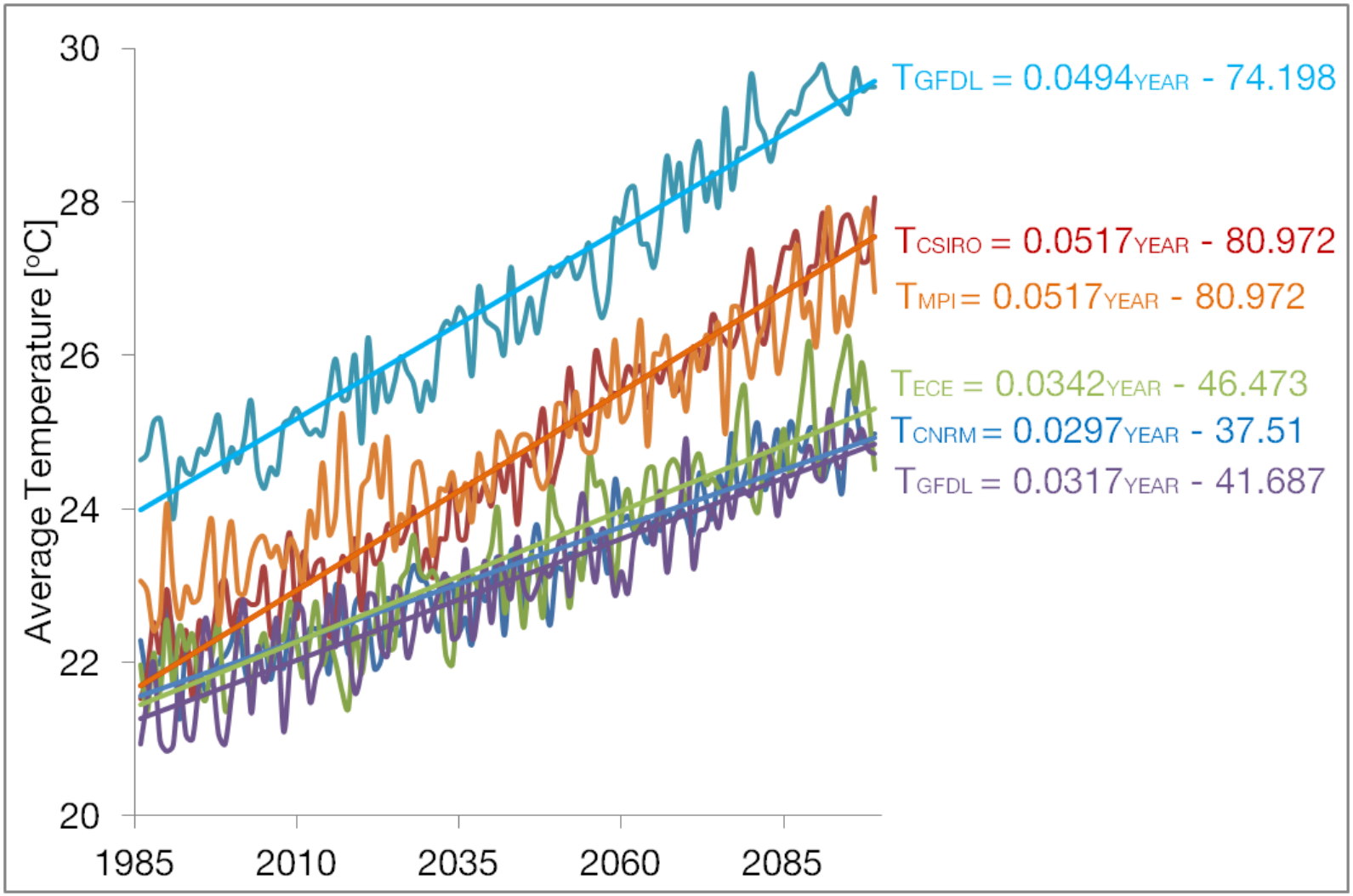
CORDEX-SEA experiments used in the TOE study

- Variable: monthly precipitation (**pr**) and temperature (**tas**)
- RegCM experiments & their driving GCM data

Exp Name	ICBC	Country and Institution developed GCM
1	CNRM-CM5	Centre National de Recherches Meteorologiques, France
2	MPI-ESM-MR	Max Plank Institute for Meteorology, Germany
3	EC-Earth	EC-Earth consortium
4	CSIRO-MK3.6.0	CSIRO, Australia
5	GFDL-ESM2M	GFDL, USA
6	HadGEM2	Hadley Centre, UK

"Time of Emergence" (ToE): when climate change departs from noise range of projection uncertainty

Temperature at: *21°02′54″ N & 105°48′05″E* (my university)



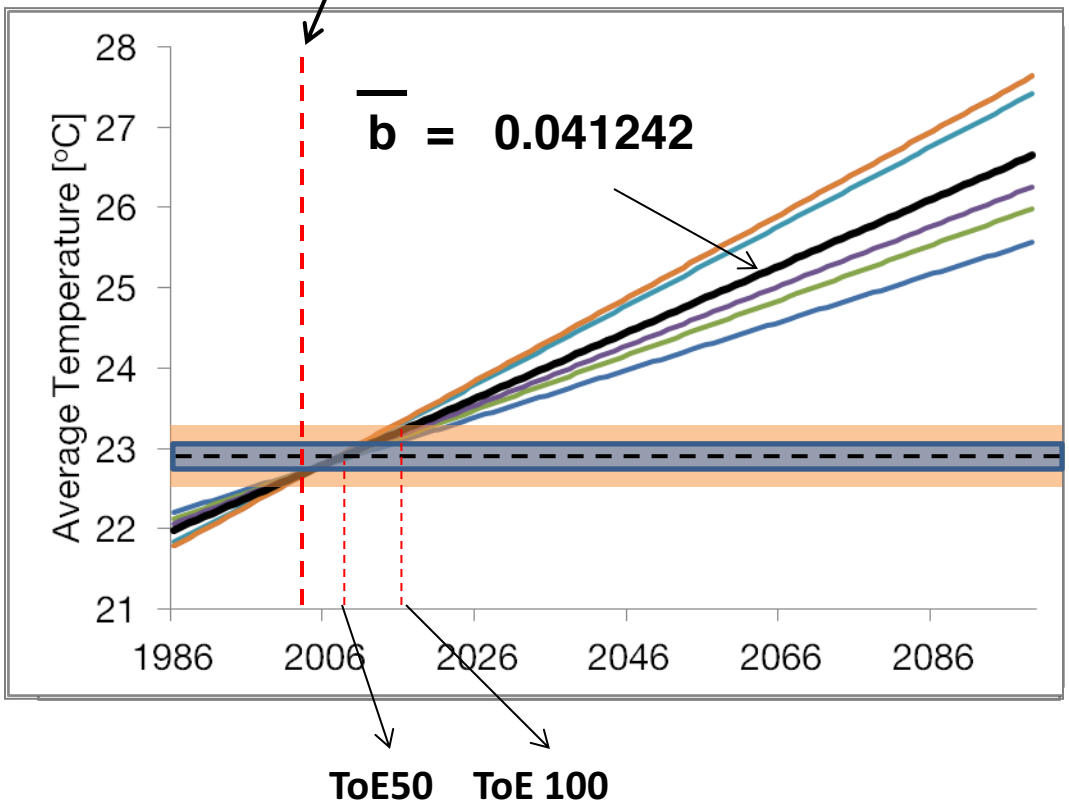
ToE calculation (Maraun, 2013)

$$TOE_x = 2005 + x \cdot \left| \frac{S_{int}}{\overline{b}} \right|$$

Reference year

ToE : Time of Emergence

$\overline{b}$: Normalized multi-model mean trend

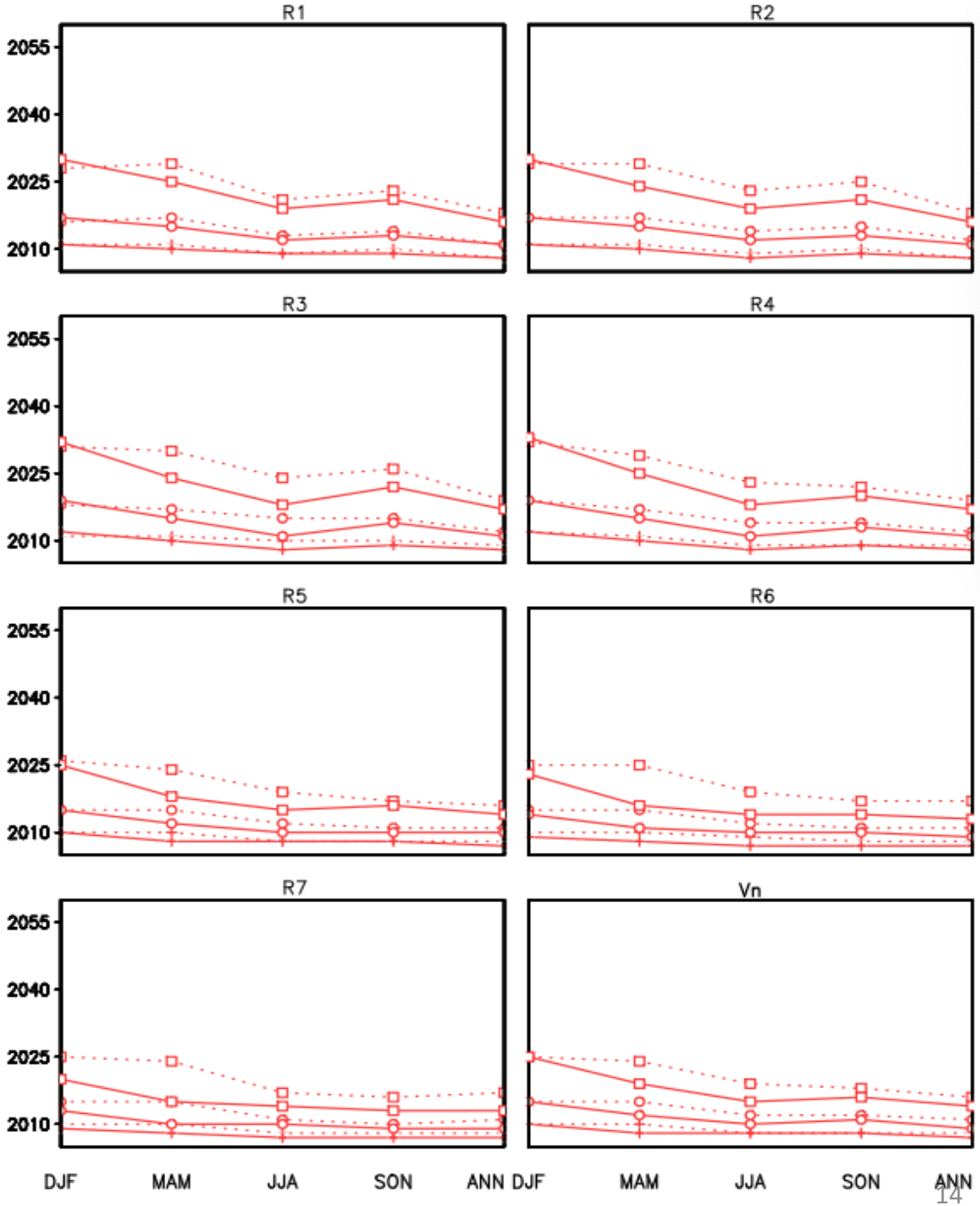


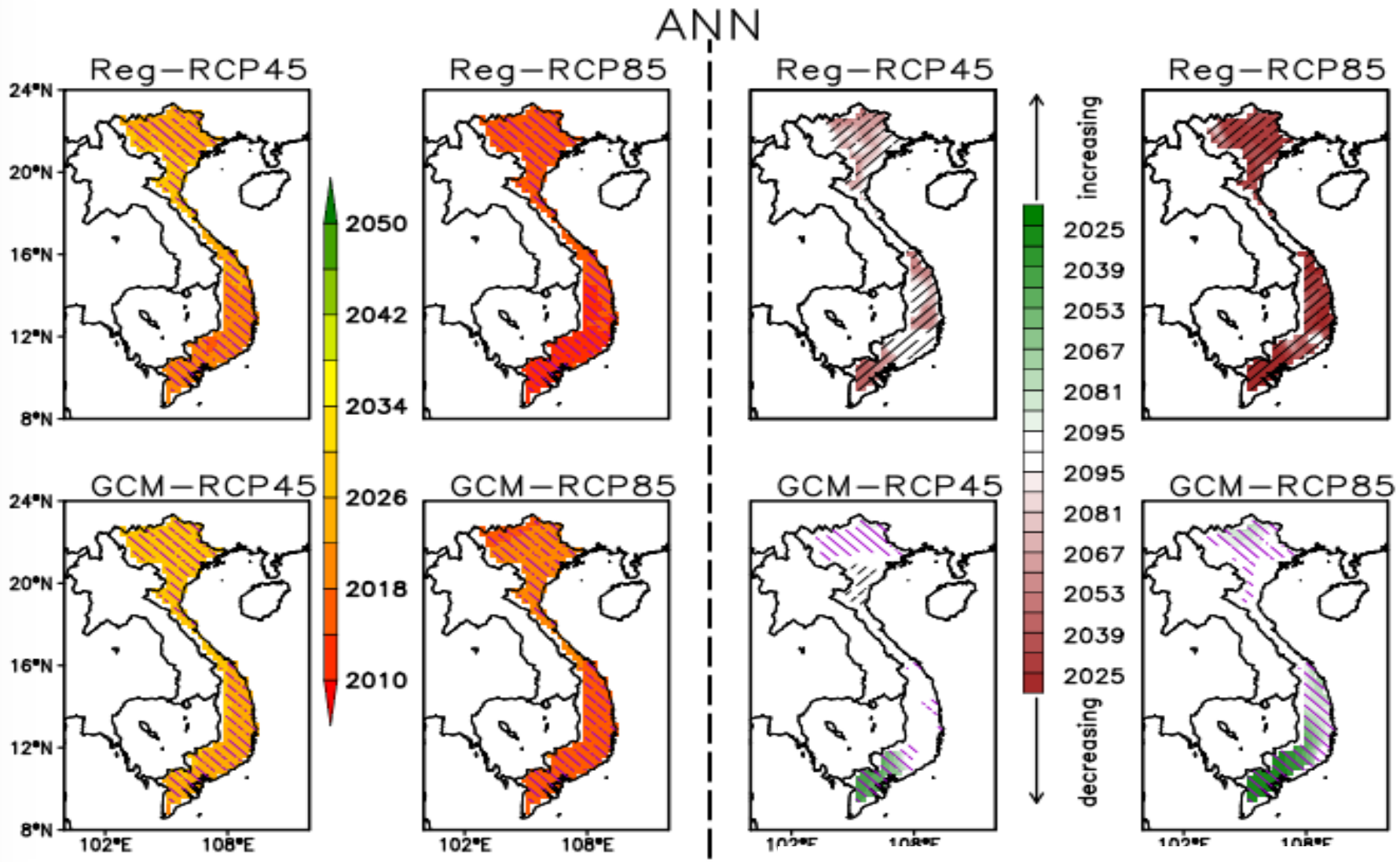
Sint : Internal variability the multi-model ensemble

x : Emergence threshold (in this study =100% for temperature and 25% for precipitation)

Comparisons of multi-model ToE for **temperature** between the **GCMs** (dotted lines) and **RCMs** (solid lines) under the RCP8.5.

x=0.25, plus mark
x=0.5 circle mark
x=1.0 square mark





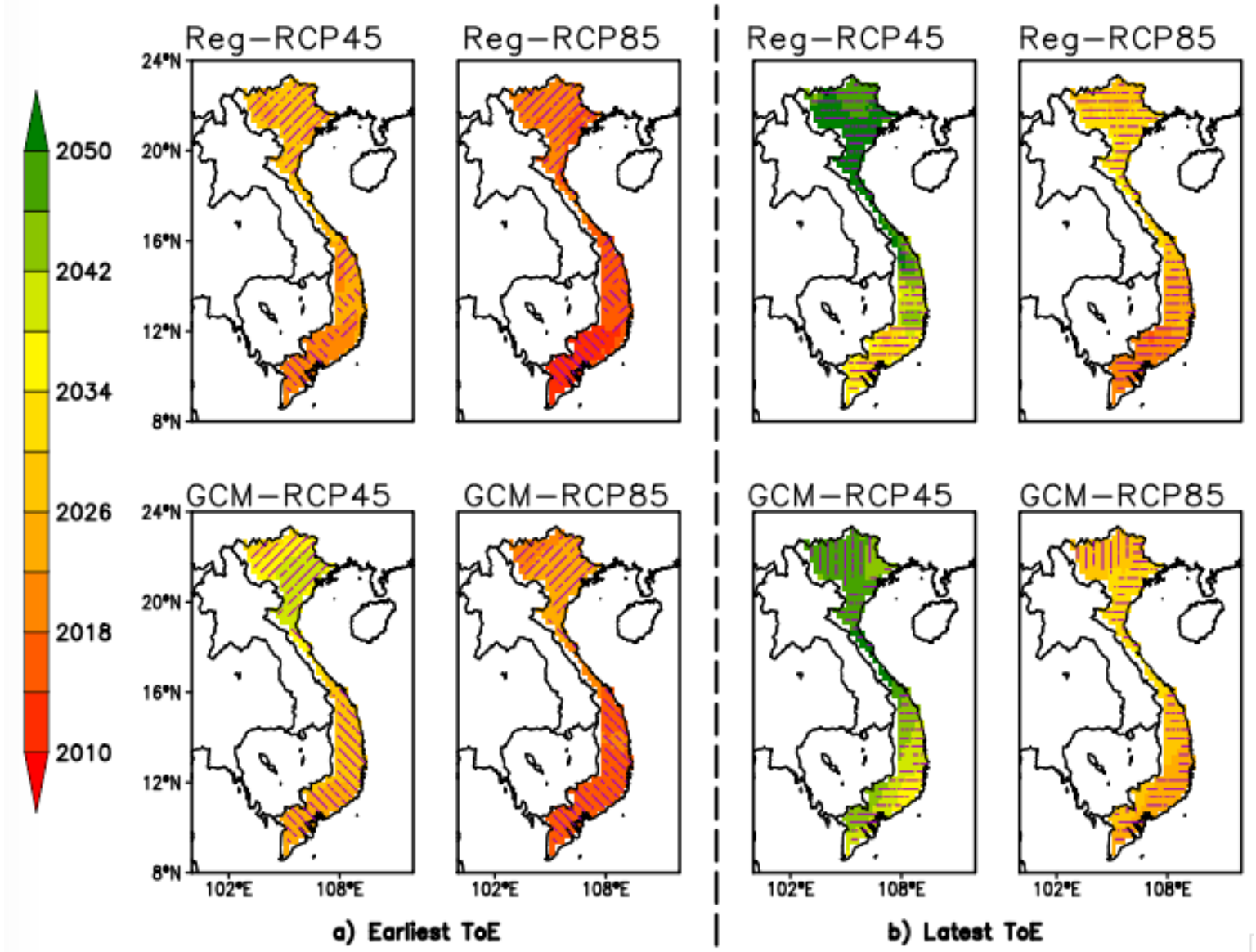
TEMPERATURE TOE

RCM-based ToEs are earlier than GCM-based ToEs

PRECIPITATION TOE

GCMs: increasing trend; ~50% (80%) of regions under RCP4.5 (RCP8.5)

RCMs: decreasing trend; ~90% (100%) of regions under RCP4.5 (RCP8.5)



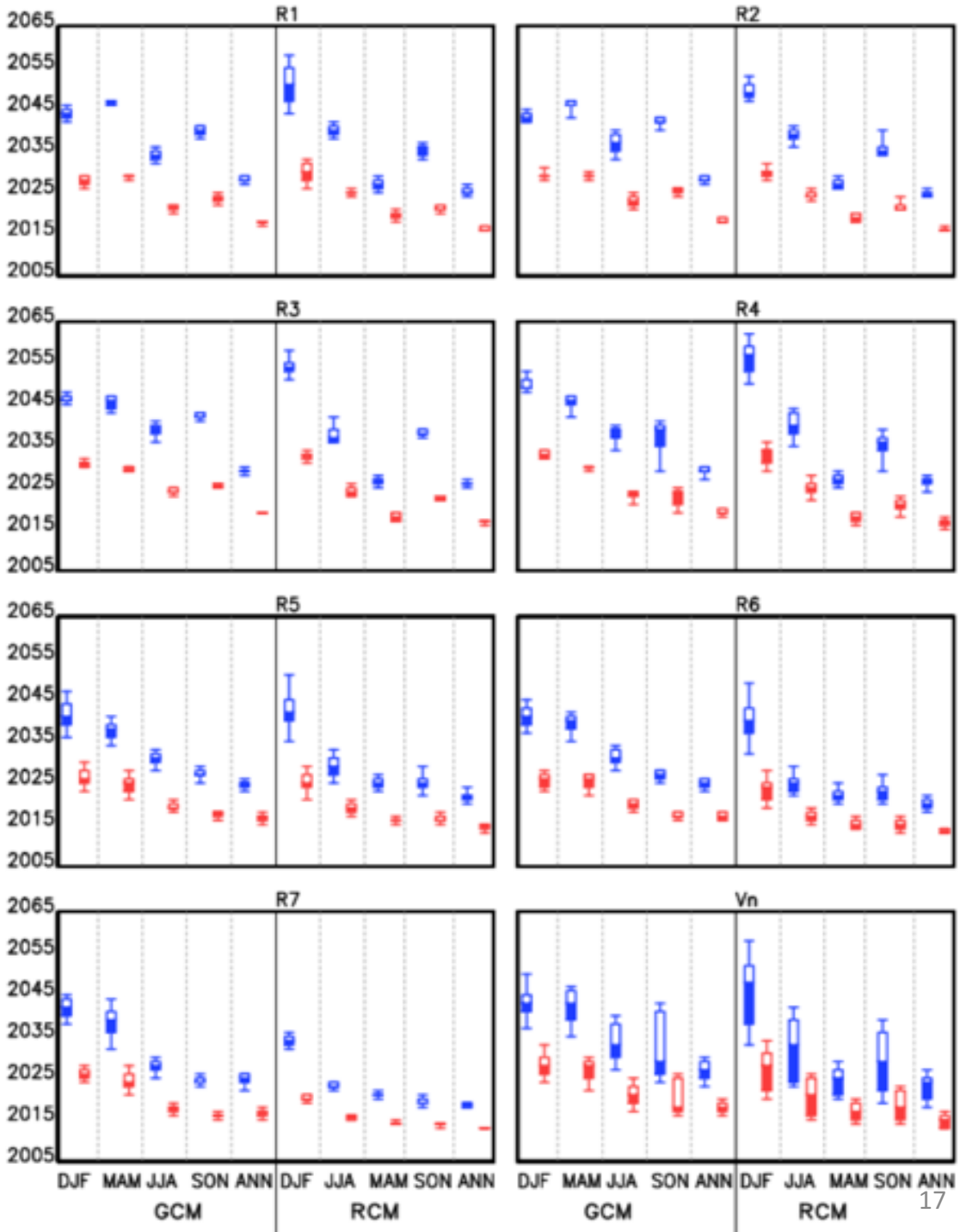
→ Summer, Autumn

→ Winter, Spring

The (a) earliest and (b) latest **seasonal ToE of temperature**

Multi-model ToE for the 7 sub-regions of Vietnam between the GCMs and RCMs under the **RCP4.5 (blue)** and the **RCP8.5 (red)** scenarios - **TEMPERATURE**

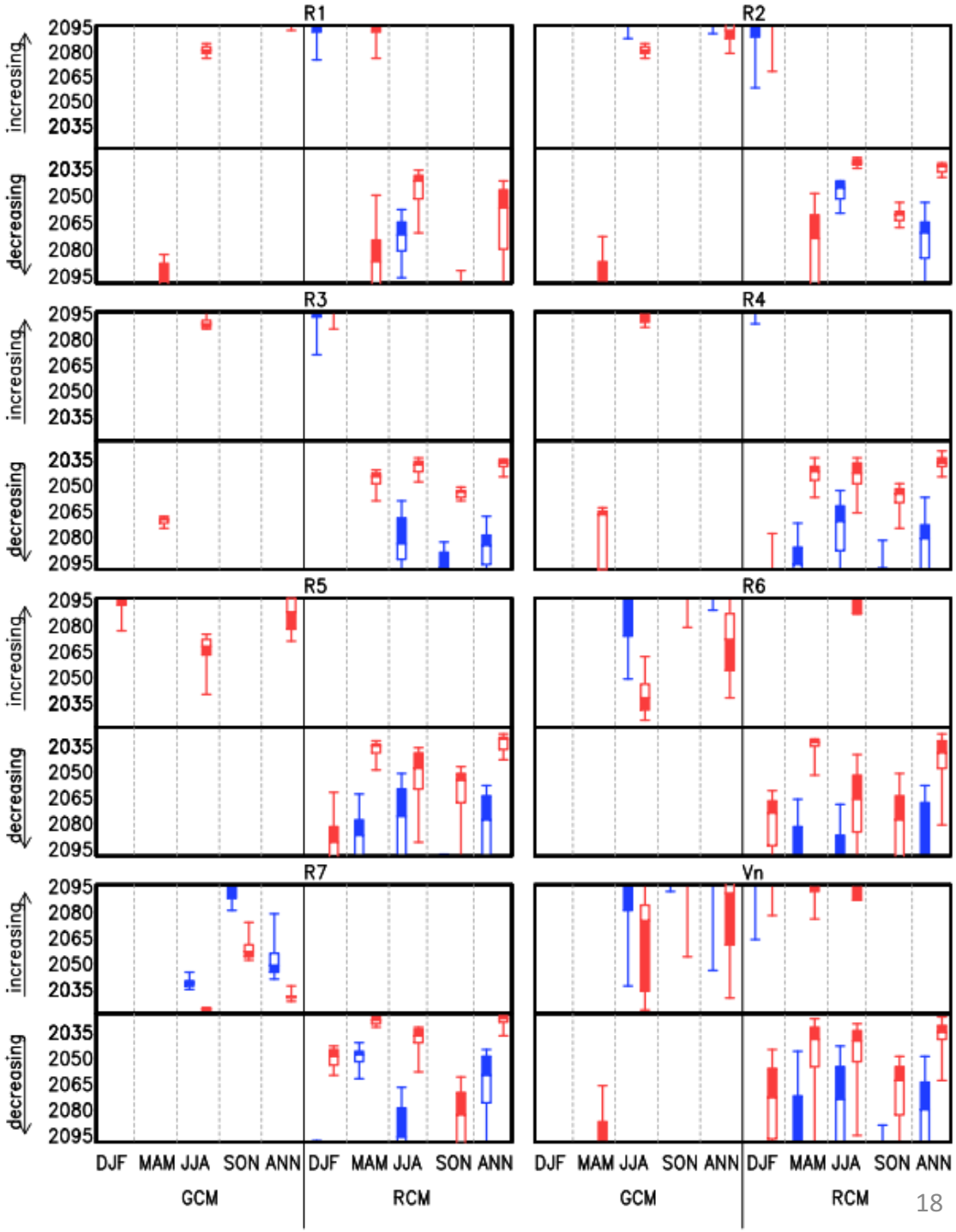
- ANN-ToE: earlier than seasonal ToE
- Higher ToE variance in the Northern part
- Ealier ToE in the South
- DJF TOE has the largest difference between the scenarios ← winter warm fasters
- Larger difference between RCM & GCM in the North



Multi-model ToE for the 7 sub-regions of Vietnam between the GCMs and RCMs under the **RCP4.5 (blue)** and the **RCP8.5 (red)** scenarios - **PRECIPITATION**

- RCM-ToE occurs earlier than GCM-ToE
- GCM-ToE does not appear in the North under both RCPs until the end of 21st century while RCM-ToEs start to emerge in the middle of 21st century
- Opposite wetter/dryer trends in GCMs/RCMs

High uncertainty of global warming impact on hydrological change over Vietnam



Conclusions

- Similar ToEs assessed by both RCMs and GCMs for temperature but opposite trend ToEs for precipitation
- Spatial variability and seasonal dependence of TOE
- The result of opposite trend in precipitation of GCMs vs. RCMs under similar increasing temperature implies the uncertainty of impact of warming on hydrological cycle for Vietnam → further investigation

International Conference on:
Climate Change in the Asia-Pacific Region

30 March – 03 April, 2020, Quy Nhon, Vietnam

www.icisequynhon.com/conferences/2020/climate-change/

Keynote speakers

- **Kathryn Bowen**, *IAAS*, Germany / *ANU*, Australia
- **Jean-Pierre Gattuso**, *CNRS, Sorbonne Univ., Iddri*, France
- **Stephane Hallegatte**, *World Bank*, USA
- **Jochen Hinkel**, *Global Climate Forum*, Germany
- **Zelina Zaiton Ibrahim**, *University Putra Malaysia*, Malaysia
- **Gemma Narisma**, *Manila Observatory*, Philippines
- **Dang Kieu Nhan**, *Can Tho University*, Vietnam
- **Taikan Oki**, *University of Tokyo*, Japan
- **Debra Roberts**, *Sustainable and Resilient City Initiatives Unit*

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South Central Vietnam

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