Diurnal Variations of Simulated Precipitation over East Asia in Two Regional Climate Models

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Contents

Presentation List

1. Introduction

- The diurnal cycle of precipitation is an actual phenomenon that is very challenging to model due to the inadequate application of physical processes and computational limitations in resolving details.

- From numerous observational studies, the diurnal variation of precipitation can be somewhat adjusted by regional (Wallace, 1975), geographical (Dai, 2001), and seasonal (Oki and Musiake, 1994) characteristics.

- The previous modeling studies provided a broad agreement with the observed results. However, it also revealed that there remains a significant challenge for numerical weather prediction models:
  1) advanced the time of the maximum precipitation over land
  2) weakened the amplitude of the diurnal cycle in maritime

- Over the East Asian region, the characteristics of the observed diurnal cycle of precipitation have been well investigated; however, modeling studies are very uncommon.

To evaluate the performance of the two RCMs
focusing on the diurnal variation of the precipitation over East Asia

2. Model and experimental setup

2.1. Model descriptions

1) The NCEP Regional Spectral Model (RSM)

- Juang et al. (1997), Hong and Leetmaa (1999)

2) The Weather Research and Forecasting (WRF) model

- Advanced Research WRF (ARW) version 3.0 (Skamarock et al., 2008)

3) The ensemble (ENS) of the two model results

	Dynamics	CP	BL	MP	LS	SW_RAD	LW_RAD
RSM	Spectral	SAS	YSU	WSM0	OSU2	Chou	Chou
WRF (KF/YSU)	Finite difference	KF	"	WSM3	Thermal	Dudhia	RRTM
WRF (BMJ)	"	BMJ	"			"	
WRF (GD)	"	GD	"			"	
WRF (MYJ)	"	KF	MYJ			"	
WRF (ACM2)	"	"	ACM2			"	

2. Model and experimental setup

2.2. Experimental design and data description

Period

Analysis 00Z 01 June 2006 – 00Z 01 September 2006 (JJA)

Three ensemble members starting from 30May, 31May, 01June

Domain

Region The East Asia region centered over the Korean Peninsula

Grid 109 x 86 (50 km), 28-layers

Map projection North polar stereographic

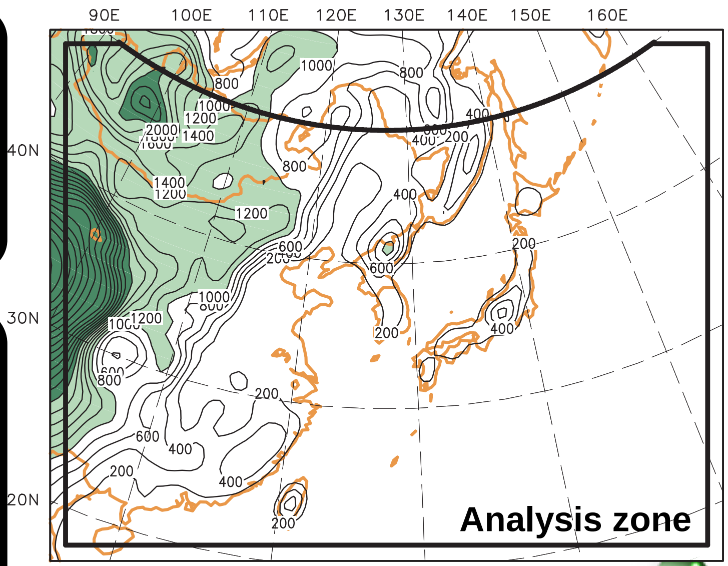
Data

RA2 for synoptic features & lateral boundary

TMPA for precipitation (3hourly)

Analysis method

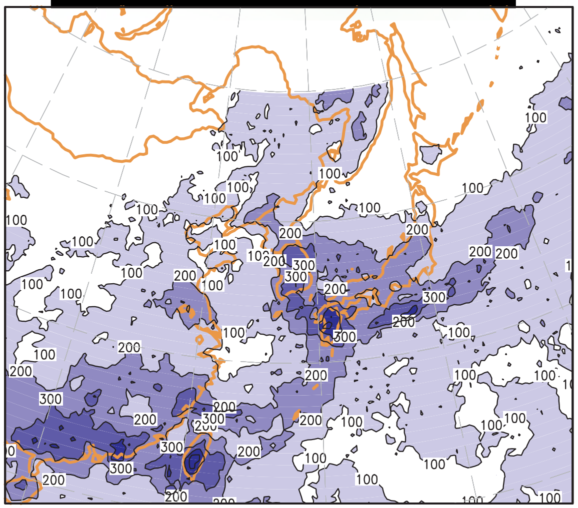
for **amount, frequency, intensity**
under **normalized condition**
using **harmonic analysis**
over **land and oceans**



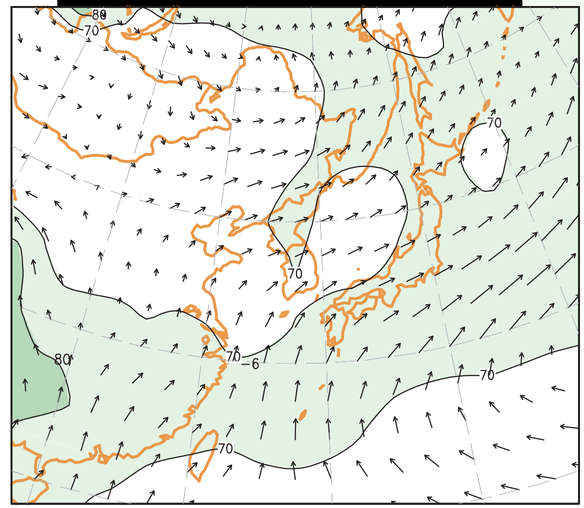
3. Synoptic features and seasonal precipitation

3.1. Synoptic overview of JJA 2006

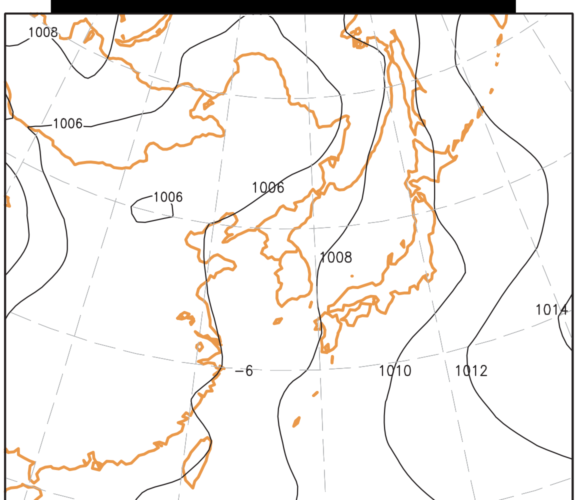
TMPA precipitation



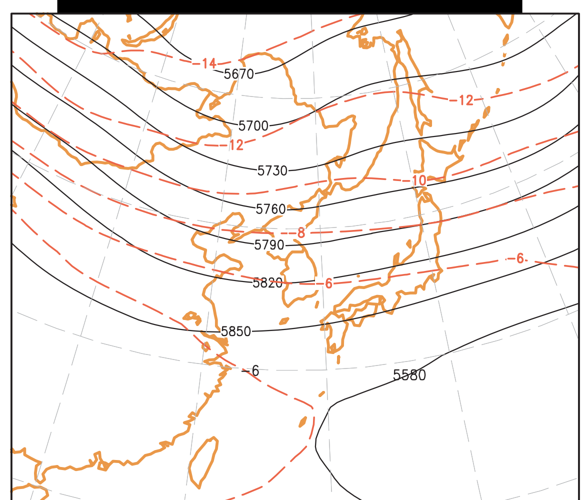
RA2 850 hPa



RA2 SLP

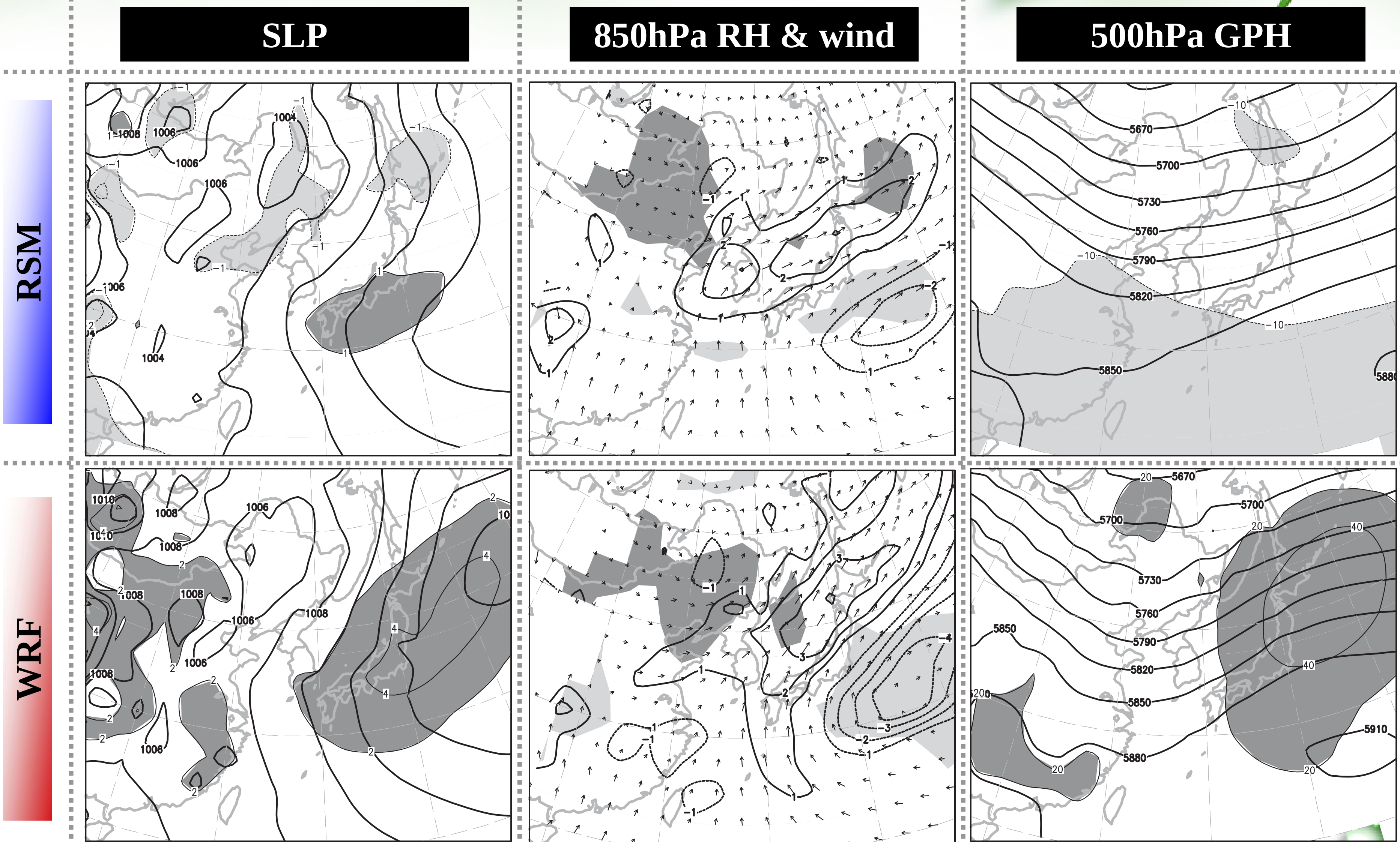


RA2 500 hPa



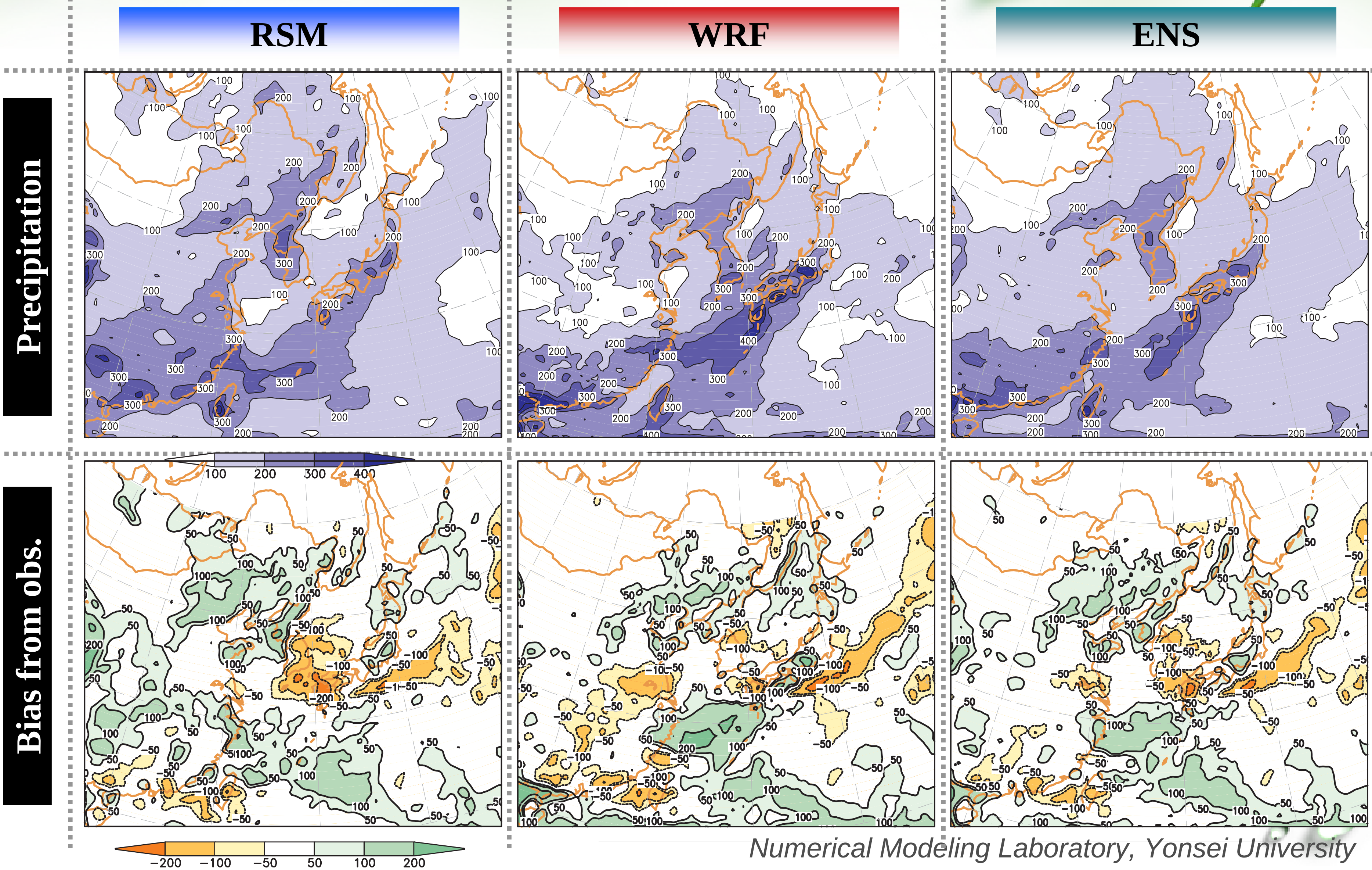
3. Synoptic features and seasonal precipitation

3.2. Simulated large-scale features



3. Synoptic features and Seasonal precipitation

3.3. Simulation of seasonal precipitation



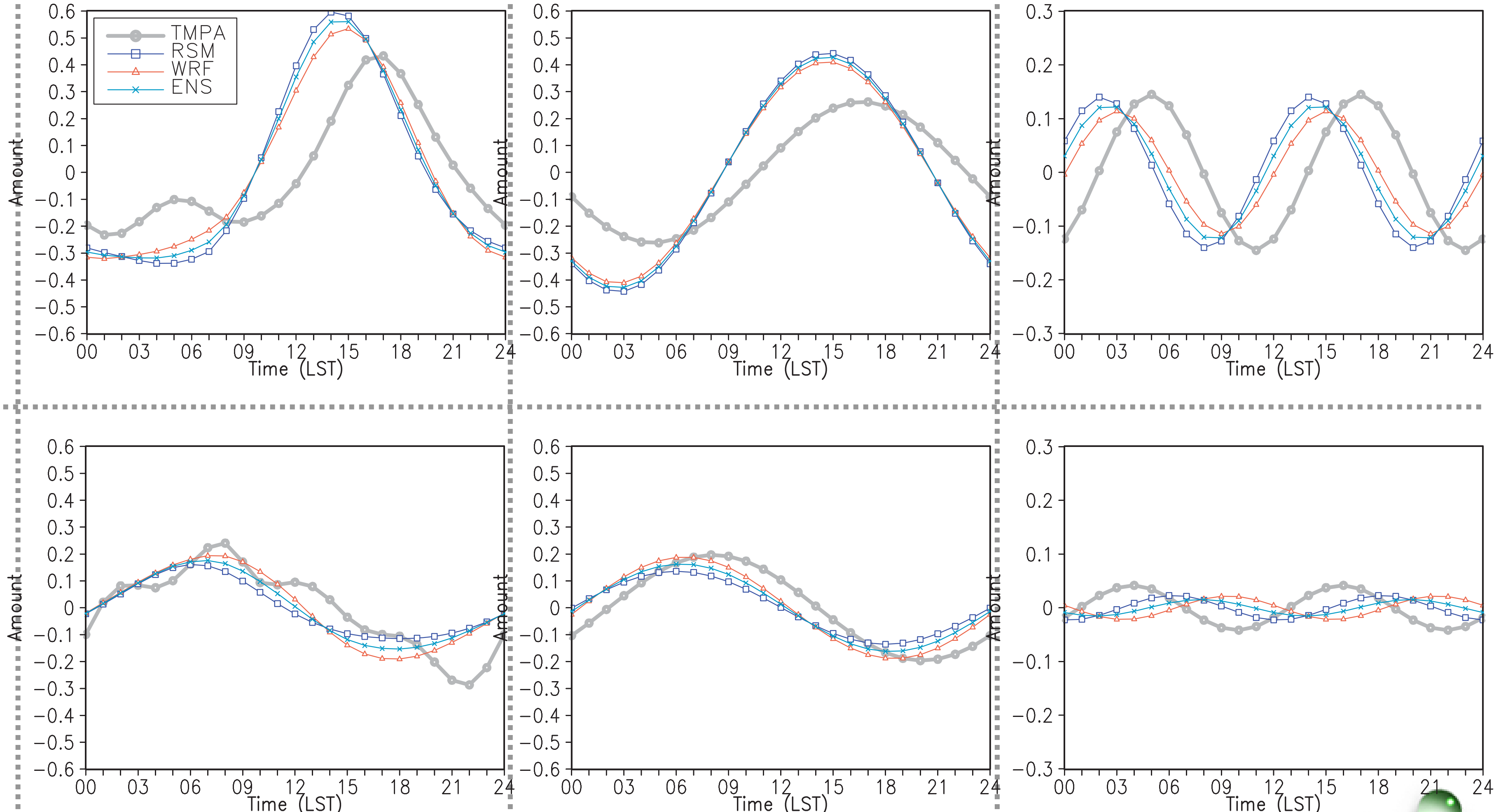
4. Diurnal variation of simulated precipitation

4.1. Amount

	Variation	1st harmonic	2nd harmonic

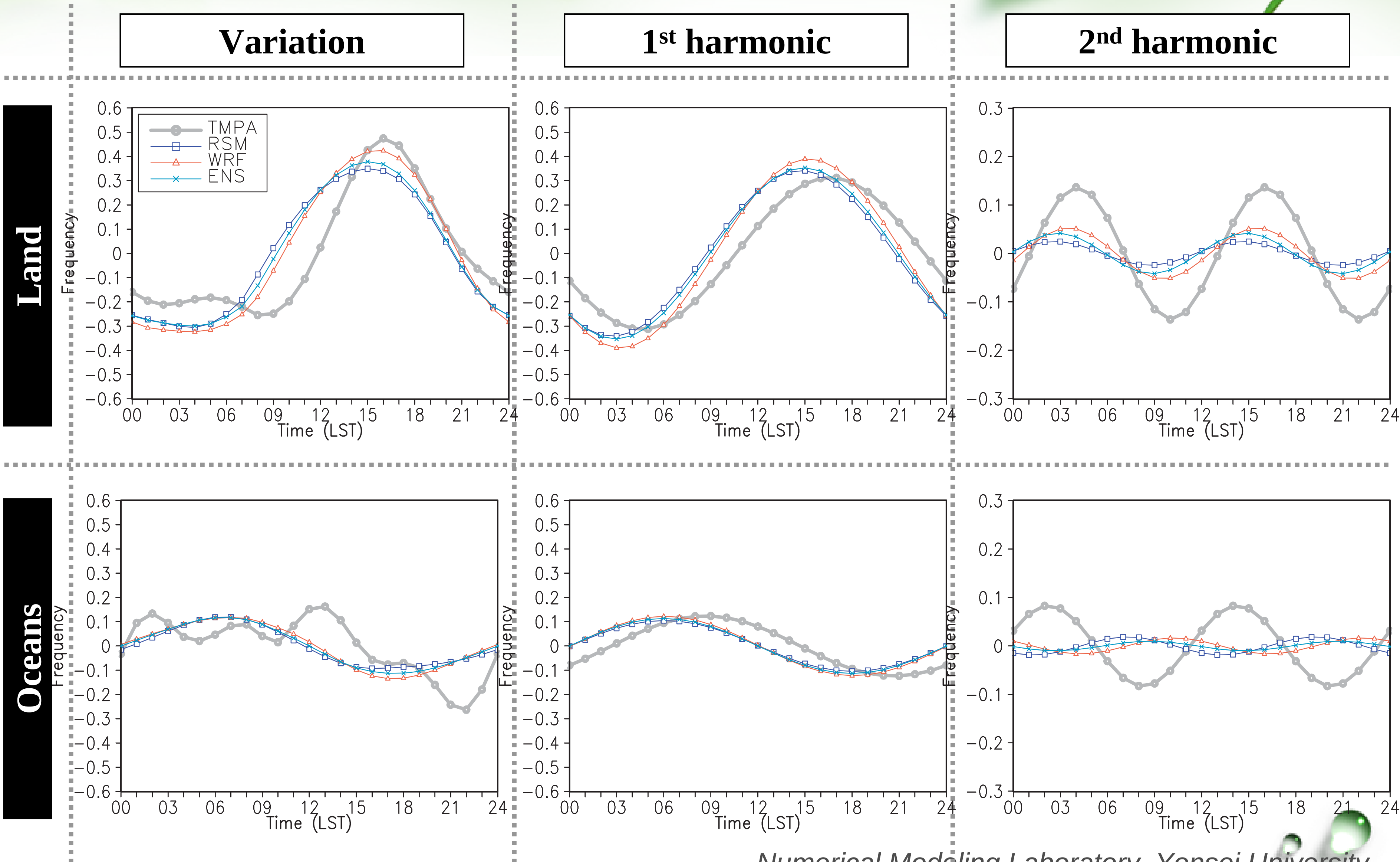
Land

Oceans



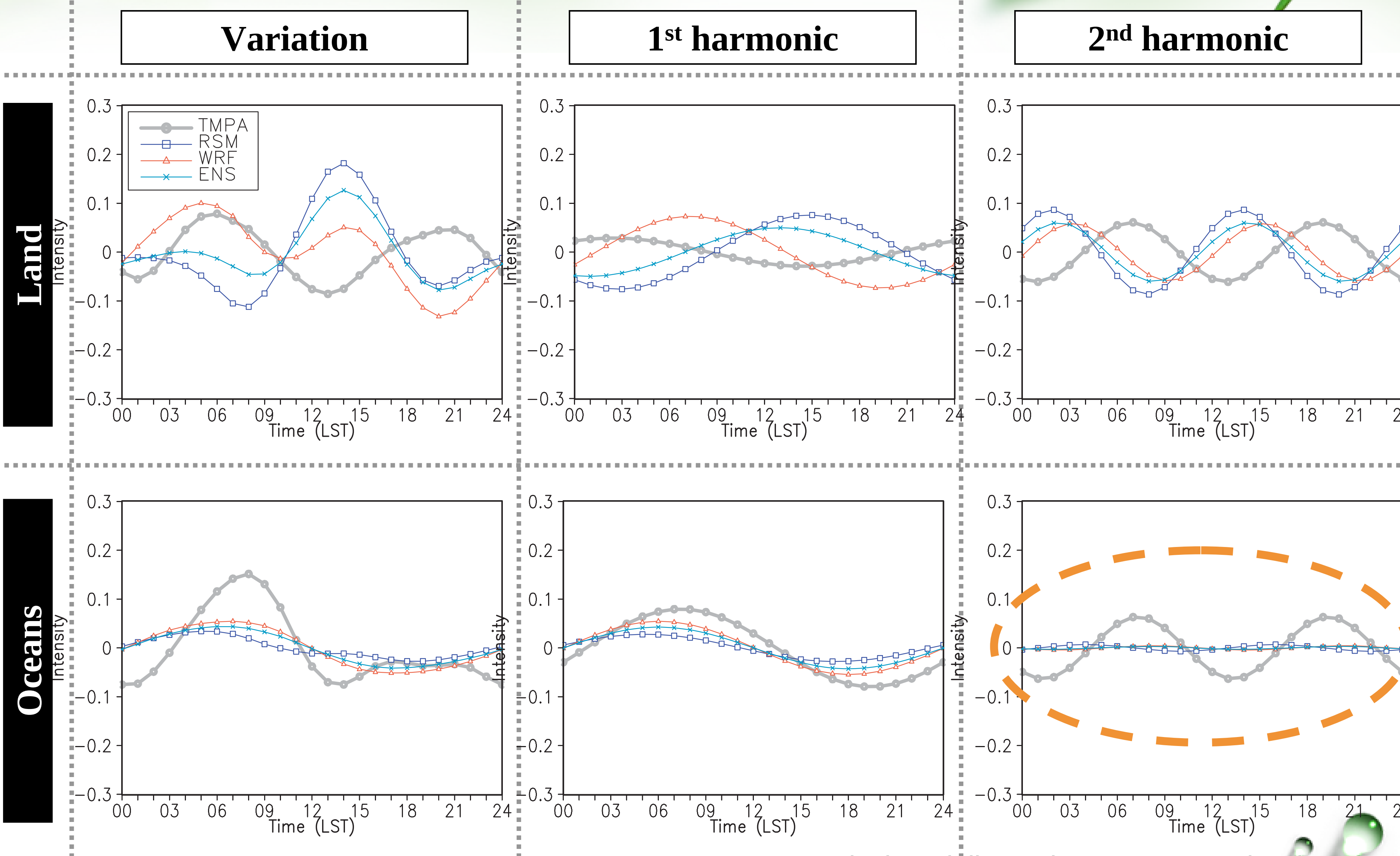
4. Diurnal variation of simulated precipitation

4.2. Frequency



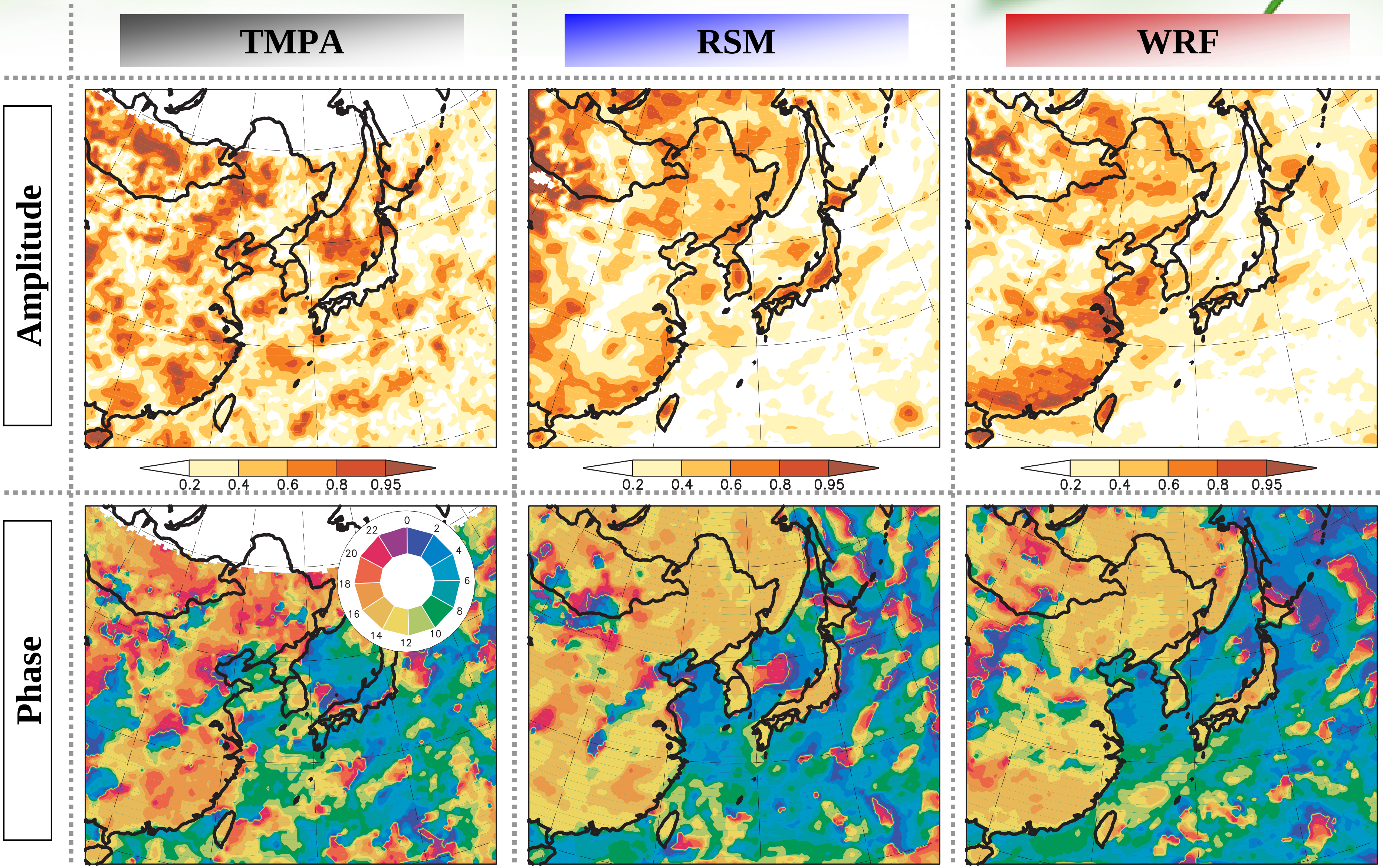
4. Diurnal variation of simulated precipitation

4.3. Intensity



4. Diurnal variation of simulated precipitation

4.4. Regional characteristics



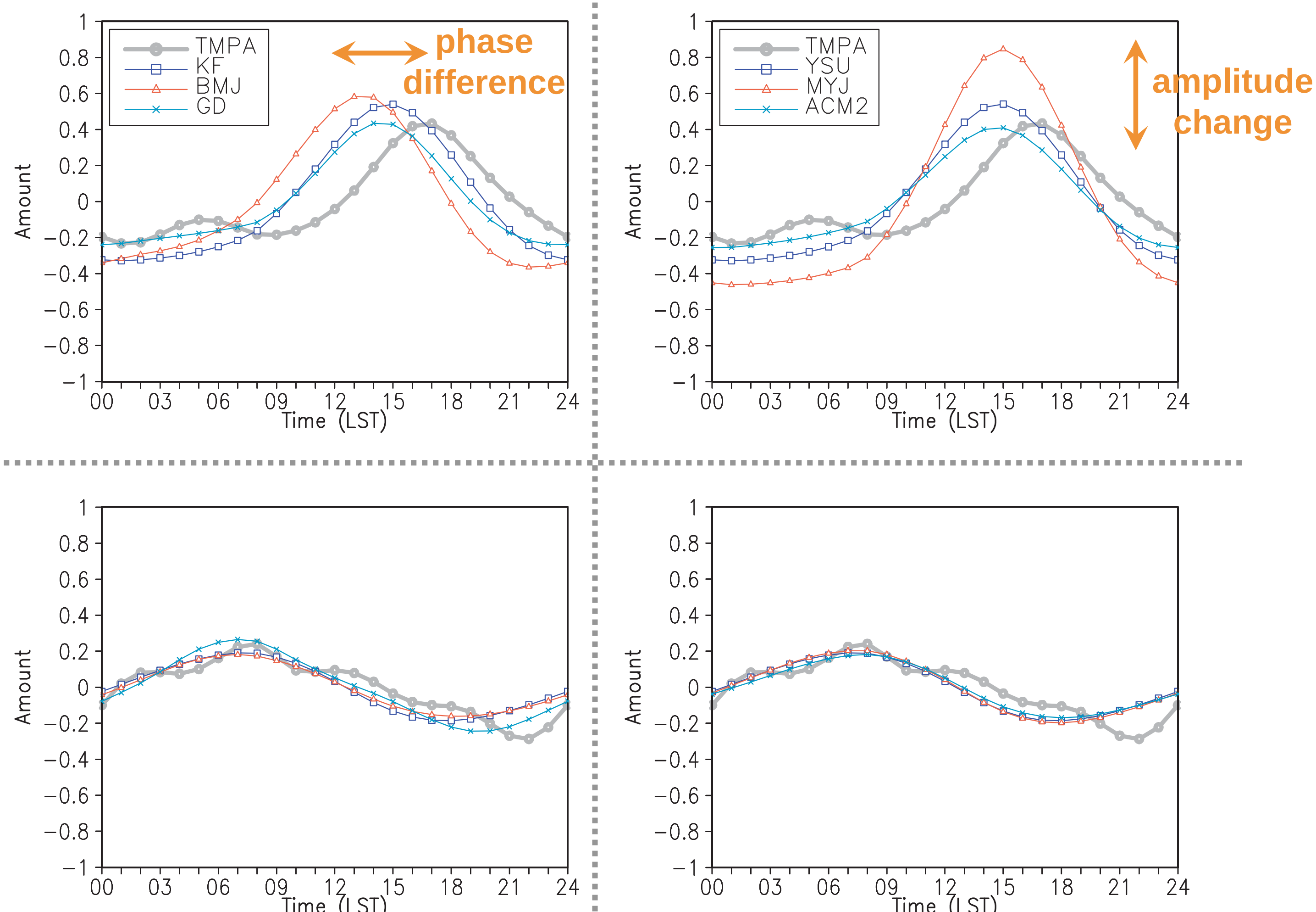
4. Diurnal variation of simulated precipitation

4.5. Physics sensitivity test (1)

Cumulus Parameterization | **Boundary Layer**

Land

Oceans



4. Diurnal variation of simulated precipitation

4.5. Physics sensitivity test (2)

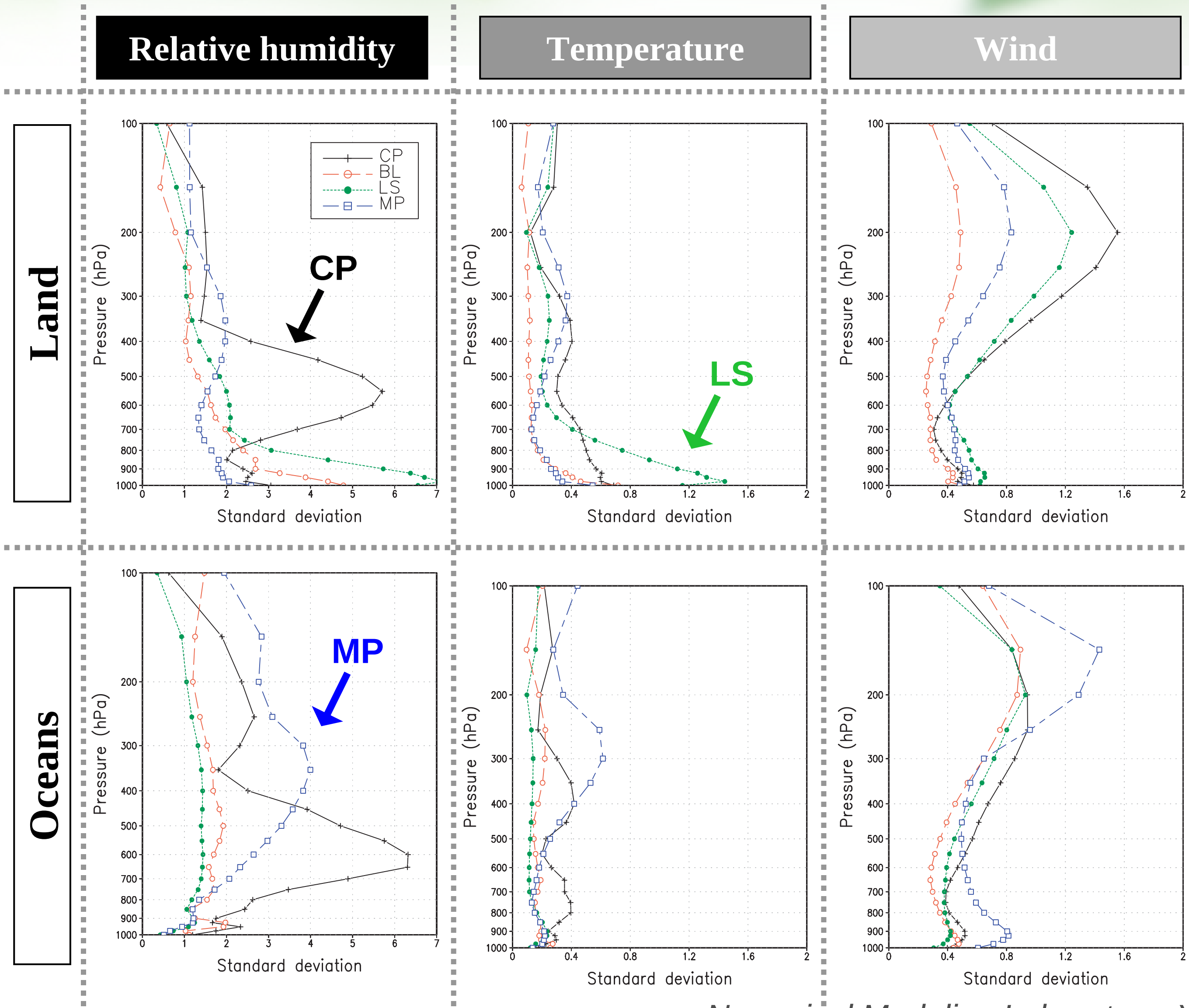
Experimental Design

Model the WRF V3.1
Map projection Lambert conformal
Forced by NCEP final analysis (1-degree)
Not under the normalized condition

	Cumulus parameterization	Boundary Layer	Land Surface	Microphysics
CTL	KF	YSU	NOAH	WSM3
CP1	BMJ	YSU	NOAH	WSM3
CP2	GD	YSU	NOAH	WSM3
BL1	KF	MYJ	NOAH	WSM3
BL2	KF	ACM2	NOAH	WSM3
LS1	KF	YSU	RUC	WSM3
LS2	KF	YSU	PX	WSM3
MP1	KF	YSU	NOAH	Lin
MP2	KF	YSU	NOAH	Morrison

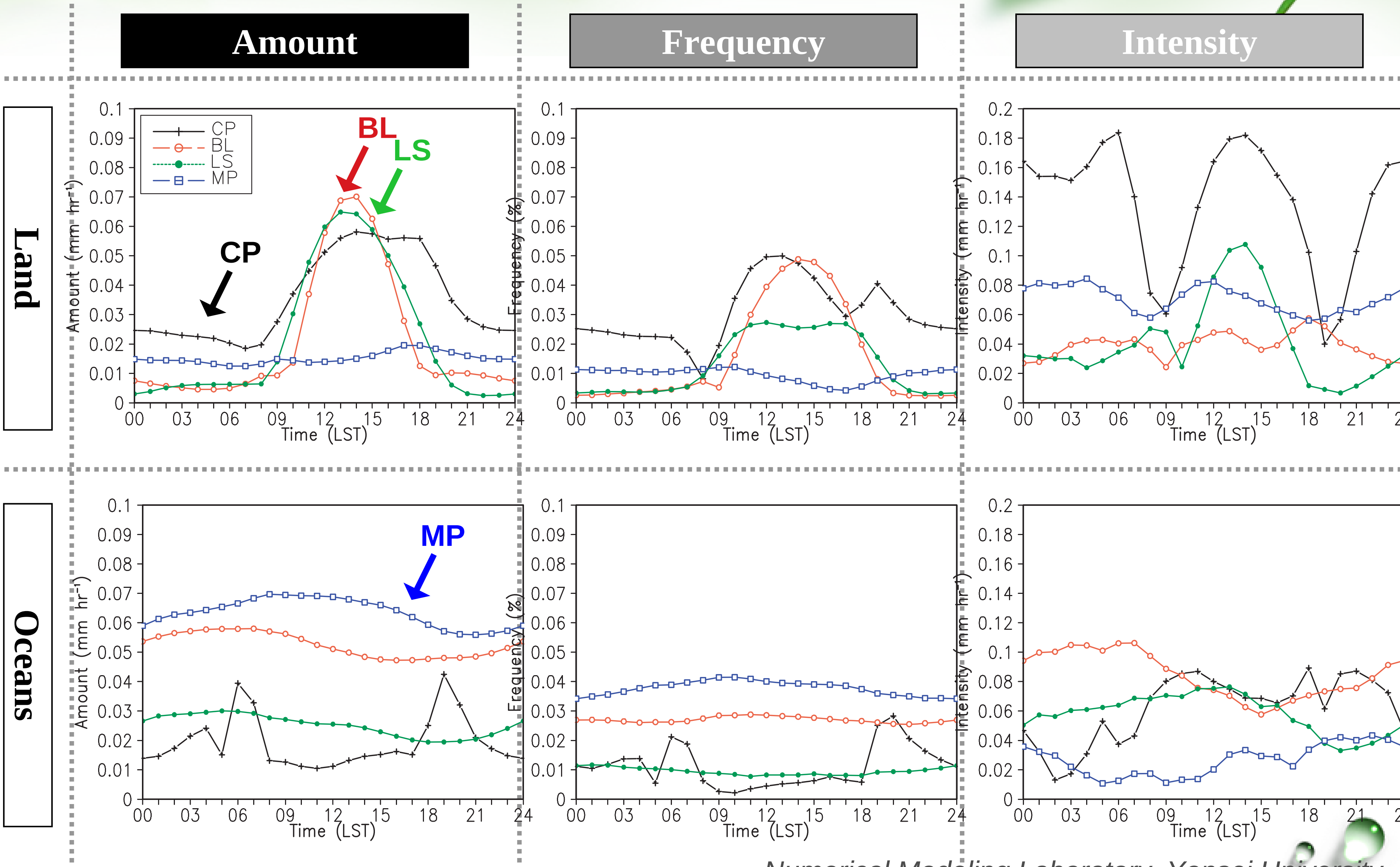
4. Diurnal variation of simulated precipitation

4.5. Physics sensitivity test (3)



4. Diurnal variation of simulated precipitation

4.5. Physics sensitivity test (4)



5. Summary

Large-scale features

- highly comparable to the RA2 data
- **common biases** with a slight outperformance
  at high altitude in the RSM
  at low altitude in the WRF

Seasonal precipitation

- **wetter** in the northern and southern regions
  drier in the central region (Korea-Japan)
- exaggerated oceanic precipitation in the WRF

+) The ensemble result of the two models provided improved performance in simulating seasonal precipitation as well as large-scale features.

Both models adequately described the observed characteristics of the diurnal variation of precipitation; However,
1) Difficulty in capturing the observed phase
2) The weakened amplitude over oceans
3) No advantage of model ensemble

Physics sensitivity test revealed that the phase (hour of maximum precipitation) and amplitude (ratio of the daily mean) over land were sensitive to the choice of CP and BL schemes:
1) CP : phase difference
2) BL : amplitude change
It also demonstrated that CP scheme is the most important trigger to simulate diurnal cycle of precipitation over land, whereas over the oceans it is strongly governed by MP. Afternoon peak is largely controlled by BL or LS.

Various indications of the deficiency of the diurnal cycle of oceanic precipitation such as weakened amplitude necessitate the incorporation of the diurnal variation of SST.
➔ The ocean mixed layer model incorporating the diurnal variation of SST can be an alternative to improve it.

Thank You !

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