State Key Laboratory of Numerical Modelling for Atmospheric Sciences
and Geophysical Fluid Dynamics(LASG)
Institute of Atmospheric Physics Chinese Academy of Sciences

GMMIP for CMIP6

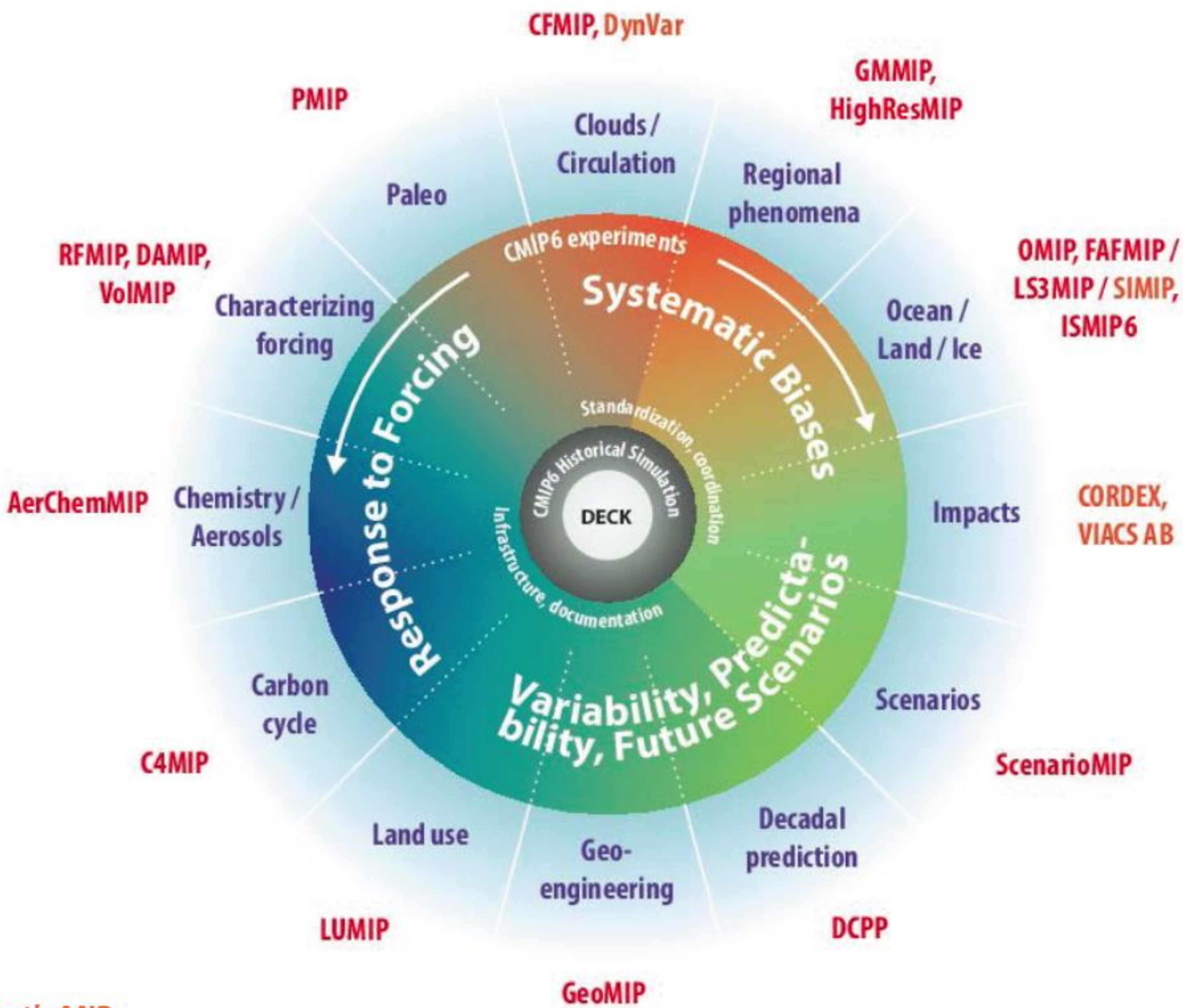
Tianjun ZHOU

zhoutj@lasg.iap.ac.cn

2nd ACAM Training School: Observation & modeling of atmospheric chemistry & aerosols in the Asian monsoon region

10-12 June 2017, Jinan University, Guangzhou China

21 CMIP6-Endorsed MIPs



Diagnostic MIPs

What is GMMIP?

- **GMMIP:**

  Global Monsoons Model Inter-comparison Project

- **One of the 18(21) MIPs for WCRP CMIP6**

- **Proposed by former CLIVAR AAMP, now**

  CLIVAR/GEWEX Monsoons Panel & CLIVAR/C20C+

- **Co-chairs: Tianjun Zhou, Andy Turner, James Kinter III**

- **Secretariat: IAP,CAS**

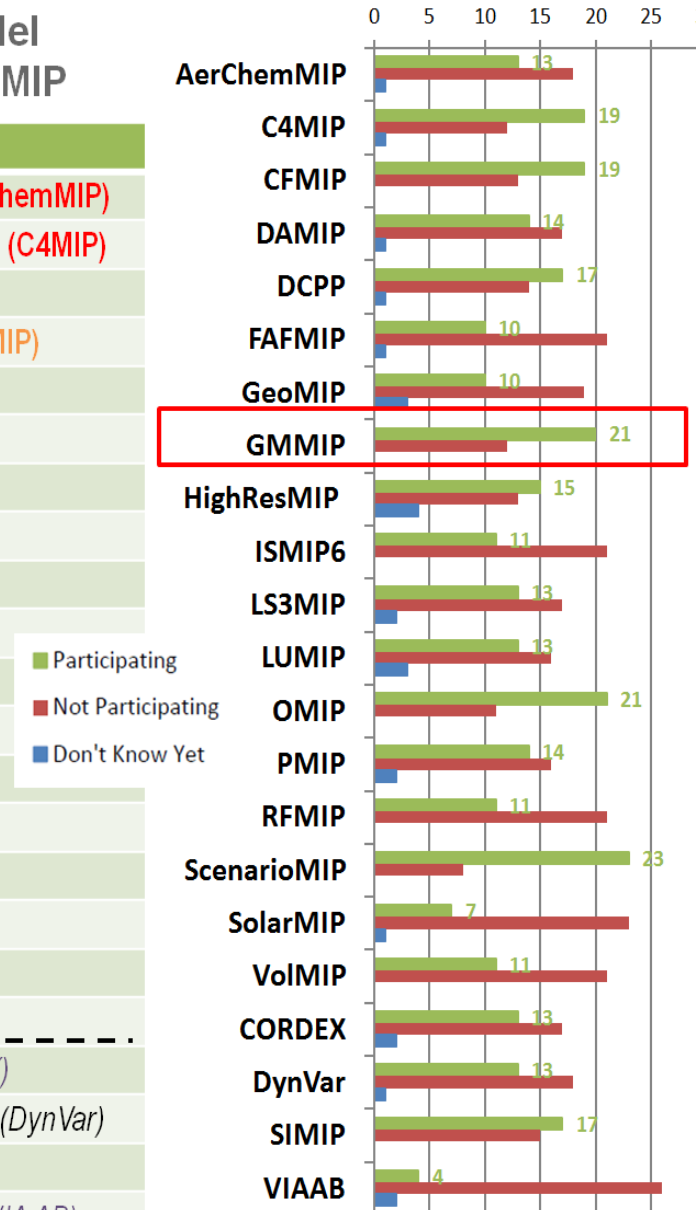
WCRP World Climate Research Programme

cmip Coupled Model Intercomparison Project

Model Groups' Commitments to participate in each MIP

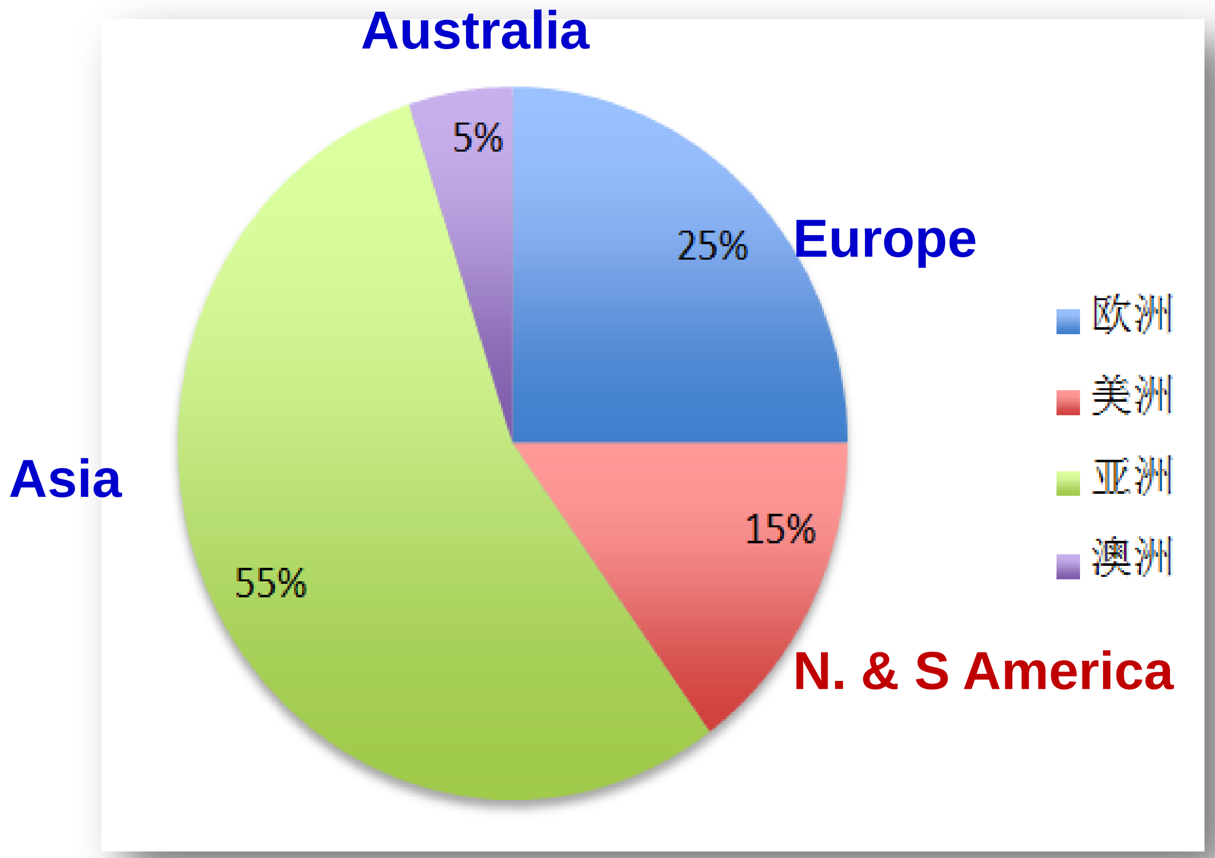
Proposals from CMIP6-Endorsed MIPs & Model Groups' Commitments to Participate in each MIP

	Long Name of MIP (Short Name of MIP)
1	Aerosols and Chemistry Model Intercomparison Project (AerChemMIP)
2	Coupled Climate Carbon Cycle Model Intercomparison Project (C4MIP)
3	Cloud Feedback Model Intercomparison Project (CFMIP)
4	Detection and Attribution Model Intercomparison Project (DAMIP)
5	Decadal Climate Prediction Project (DCPP)
6	Flux-Anomaly-Forced Model Intercomparison Project (FAFMIP)
7	Geoengineering Model Intercomparison Project (GeoMIP)
8	Global Monsoons Model Intercomparison Project (GMMIP)
9	High Resolution Model Intercomparison Project (HighResMIP)
10	Ice Sheet Model Intercomparison Project for CMIP6 (ISMIP6)
11	Land Surface, Snow and Soil Moisture MIP (LS3MIP)
12	Land-Use Model Intercomparison Project (LUMIP)
13	Ocean Model Intercomparison Project (OMIP)
14	Palaeoclimate Modelling Intercomparison Project (PMIP)
15	Radiative Forcing Model Intercomparison Project (RFMIP)
16	Scenario Model Intercomparison Project (ScenarioMIP)
17	Solar Model Intercomparison Project (SolarMIP)
18	Volcanic Forcings Model Intercomparison Project (VolMIP)
19	*Coordinated Regional Climate Downscaling Experiment (CORDEX)*
20	*Dynamics and Variability of the Stratosphere-Troposphere System (DynVar)*
21	*Sea-Ice Model Intercomparison Project (SIMIP)*
22	*Vulnerability, Impacts, and Adaptation Advisory Board for CMIP6 (VIA AB)*



The World Climate Research Programme's Coupled Model Intercomparison Project

Model groups' commitment to participate in GMMIP



21 model groups from 14 countries

The World Climate Research Programme's
Coupled Model Intercomparison Project

GMMIP Partner Institutes

Geosci. Model Dev. Discuss., doi:10.5194/gmd-2016-69, 2016
Manuscript under review for journal Geosci. Model Dev.
Published: 11 April 2016

Geoscientific Model Development Discussions
Open Access
EGU

Table 1. Description of models participating GMMIP

Model	Institute/Country
ACCESS	CSIRO-BOM/Australia
BCC-CSM2-MR	BCC/China
BNU-ESM	BNU/China
CAMS-CSM	CAMS/China
CanESM	CCCma/Canada
CAS-ESM	CAS-IAP/China
CESM	NCAR-COLA/USA
CESS-THU	THU/China
CMCC	CMCC/Italy
CNRM-CM	CNRM-CERFACS/France
FGOALS	IAP-LASG/China
FIO	FIO/China
GFDL	NOAA-GFDL/USA
GISS	NASA-GISS/USA
HadGEM3	MOHC-NCAS/UK
IITM	IITM/India
IPSL-CM6	IPSL/France
MIROC6-CGCM	AORI-UT-JAMSTEC-NIES/Japan
MPI-ESM	MPI-M/Germany
MRI-ESM1.x	MRI/Japan
NUIST-CSM	NUIST/China

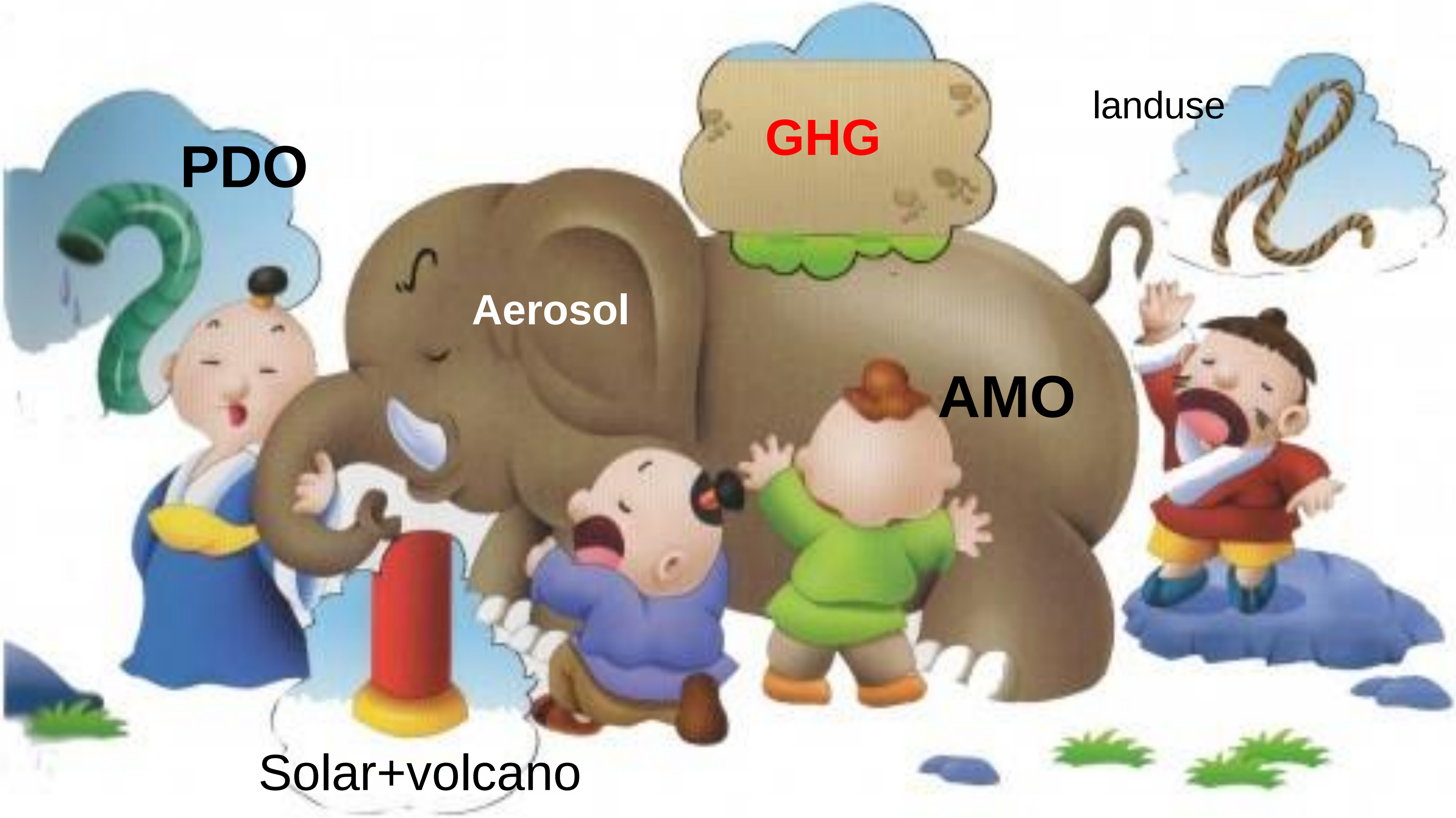
WCRP World Climate Research Programme

cmip Coupled Model Intercomparison Project

Zhou T., A. Turner, J. Kinter, B. Wang Y. Qian et al. 2016, **Geosci. Model Dev.**, 9, 1-16

Why do we propose GMMIP ?

Forcings to GM changes



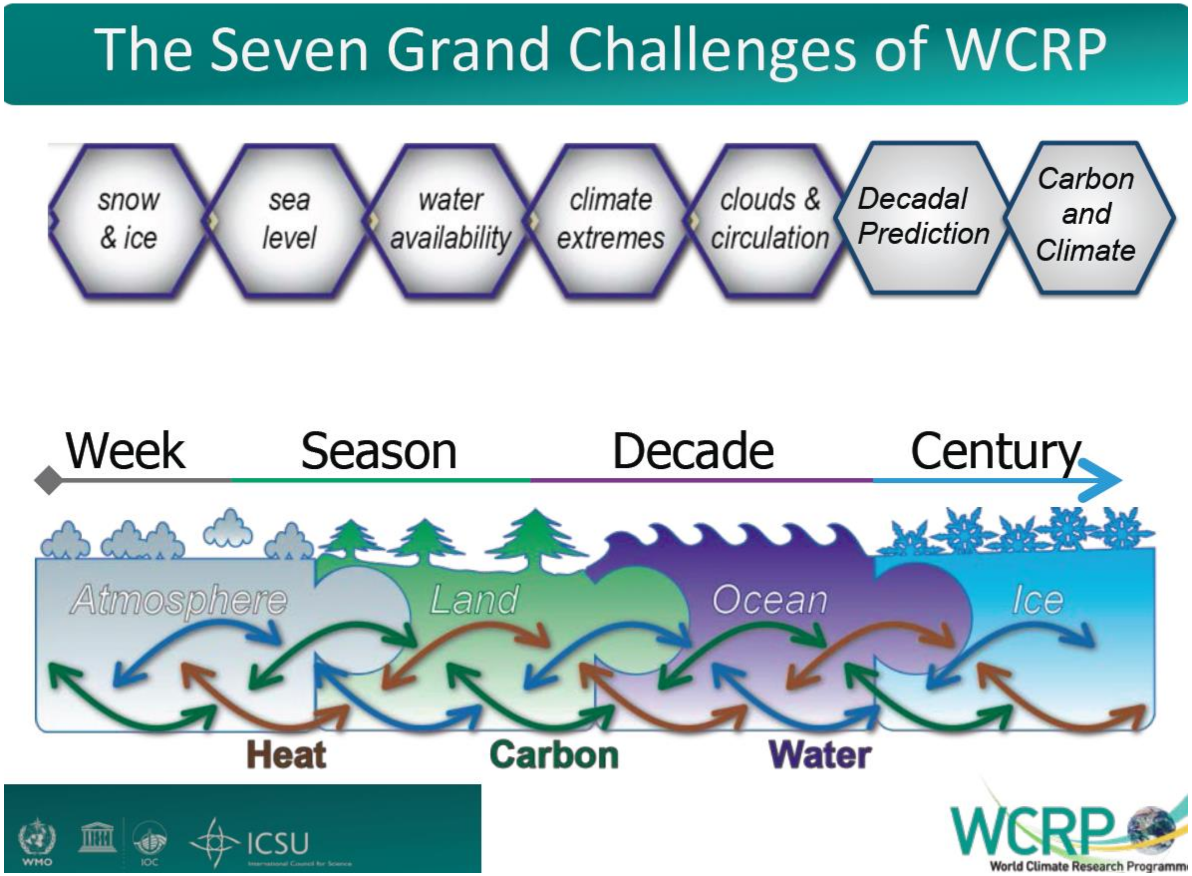
Forcings to Monsoon changes

- Increasing evidences indicate that the observed monsoon changes are driven by both internal (IPO & AMO) and external forcing agents.
- But the understanding of the underlying mechanisms are model-dependent, in particular for precipitation.
- A multi-model inter-comparison is crucial.
- CMIP6 provides an excellent opportunity for the community.

Primary Scientific Questions of GMMIP

1. What are the relative contributions of internal processes and external forcings that have driven the 20th century historical evolution of global monsoons?
2. To what extent and how does the ocean-atmosphere interaction affect the interannual variability and predictability of monsoons?
3. How well can developing high-resolution models and improving model dynamics and physics help to reliably simulate monsoon precipitation and its variability and change?
4. What are the effects of Eurasian orography, in particular the Himalaya/Tibetan Plateau, on the regional/global monsoons?

WCRP Grand Challenges

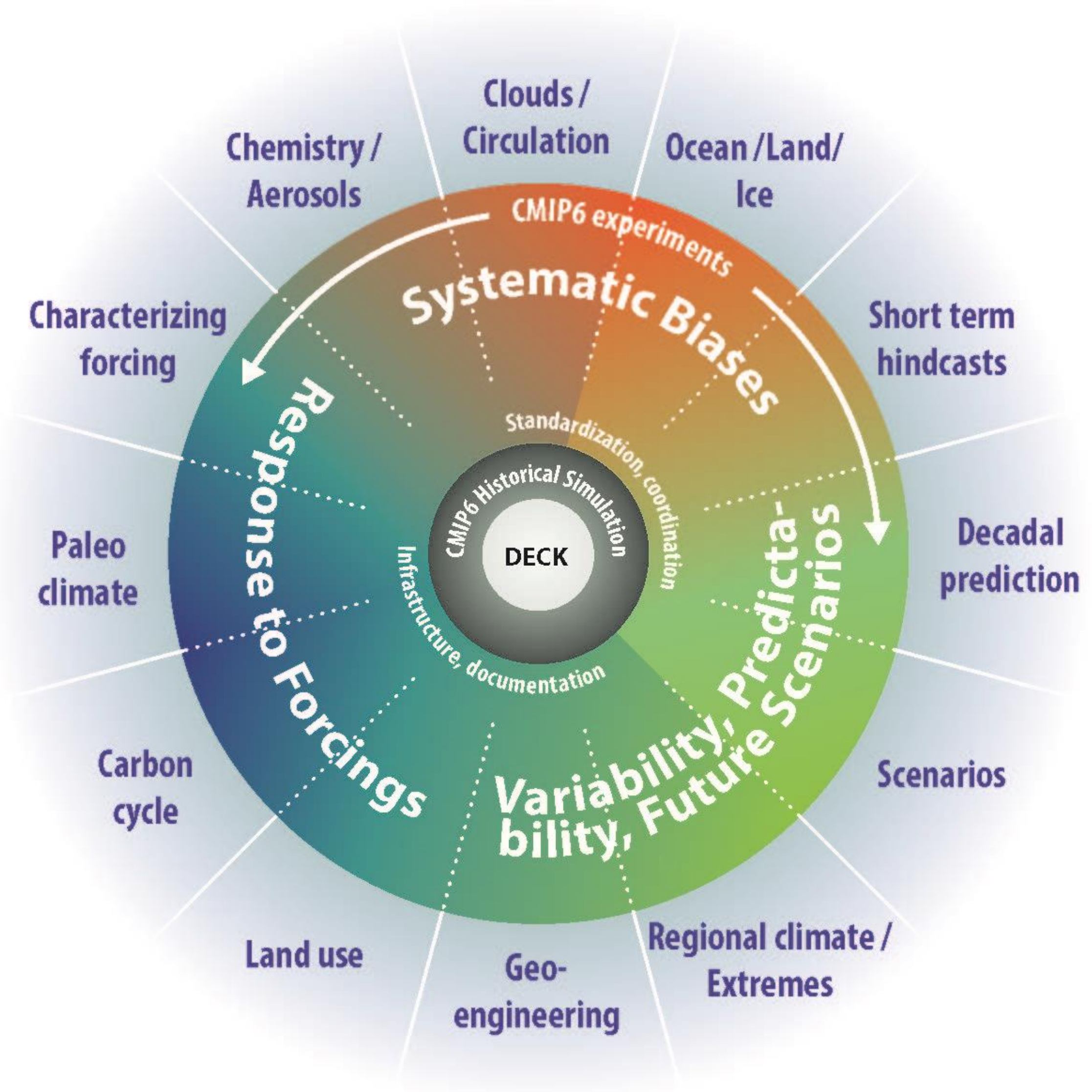


GMMIP will address the WCRP Grand Challenges in the following ways:

1. Water availability *(Rank-1),*
2. Clouds, circulation and climate sensitivity *(Rank-2)*,
3. Climate extremes *(Rank-2)*

Connection with DECK and CMIP6 Historical Simulation

”



Diagnosis, Evaluation, and Characterization of Klima (DECK) Experiments

DECK (entry card for CMIP)

i.AMIP simulation (~1979-2014)

ii.Pre-industrial control simulation

iii.1%/yr CO_2 increase

iv.Abrupt 4xCO_2 run

CMIP6 Historical Simulation

(entry card for CMIP6)

v.Historical simulation using CMIP6 forcings (1850-2014)

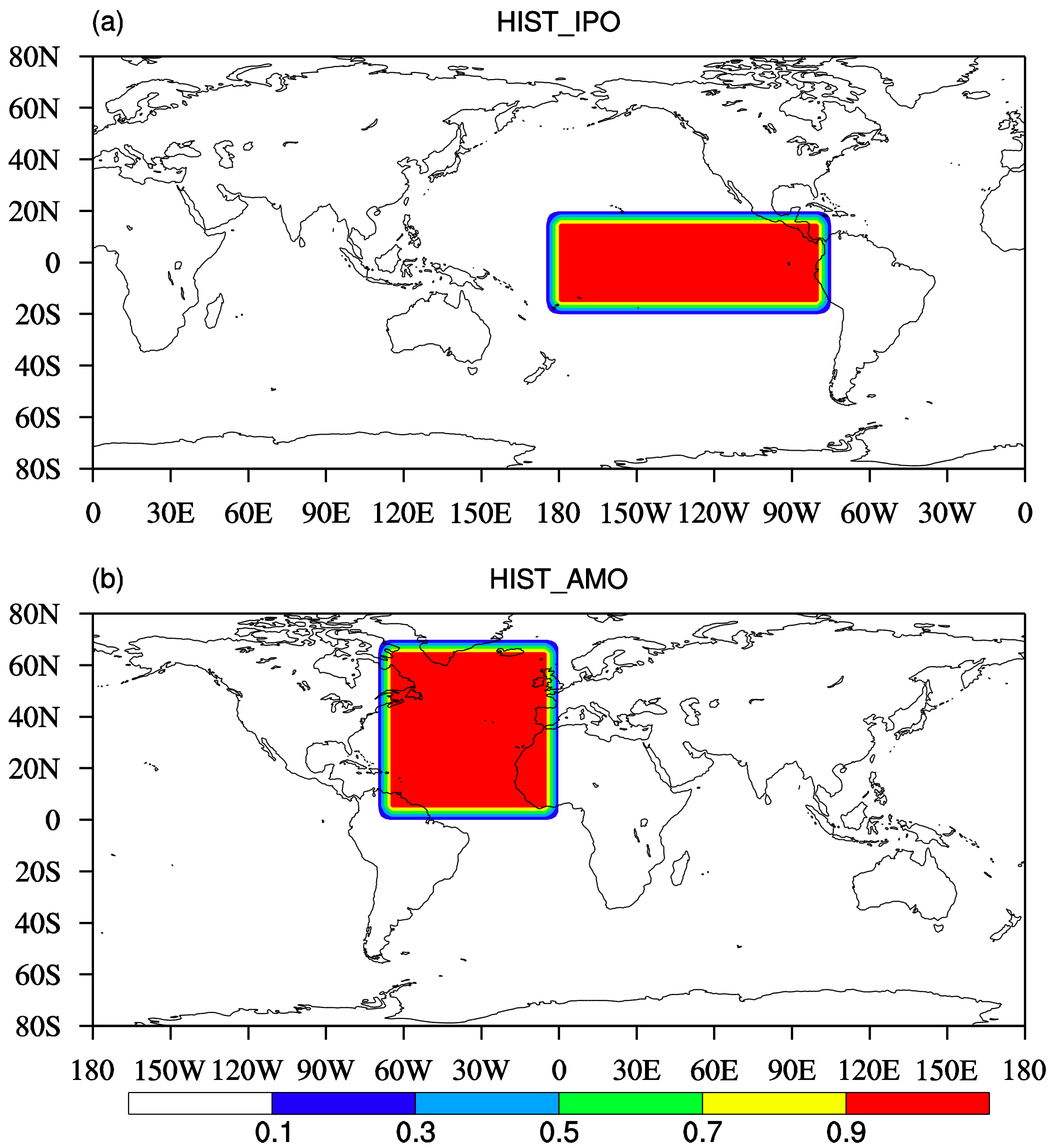
(Courtesy of Veronika Eyring)

Main Experiments

All the GMMIP partners are encouraged to conduct both the Tier-1 and Tier-2 experiments.

	EXP name	Integration time	Description	Model type	Motivation
Tier-1	AMIP 20C	1870-2014	Extended AMIP run that covers 1870-2014.	AGCM run, min realization 3	understand the roles of SST forcing and external forcings
Tier-2	HIST-IPO	1870-2014	Pacemaker 20th century historical run that includes all forcing as used in CMIP6 Historical Simulation, and the observational historical SST is restored in the tropical lobe of the IPO domain (20° S-20° N, 175° E-75° W)	CGCM min realization 3	understand the forcing of IPO-related tropical SST to global monsoon changes.
	HIST-AMO	1870-2014	Same as HIST-IPO, but the observational historical SST is restored in the AMO domain (0° -70° N, 70° W-0°)	CGCM min realization 3	understand the forcing of AMO-related SST to global monsoon changes

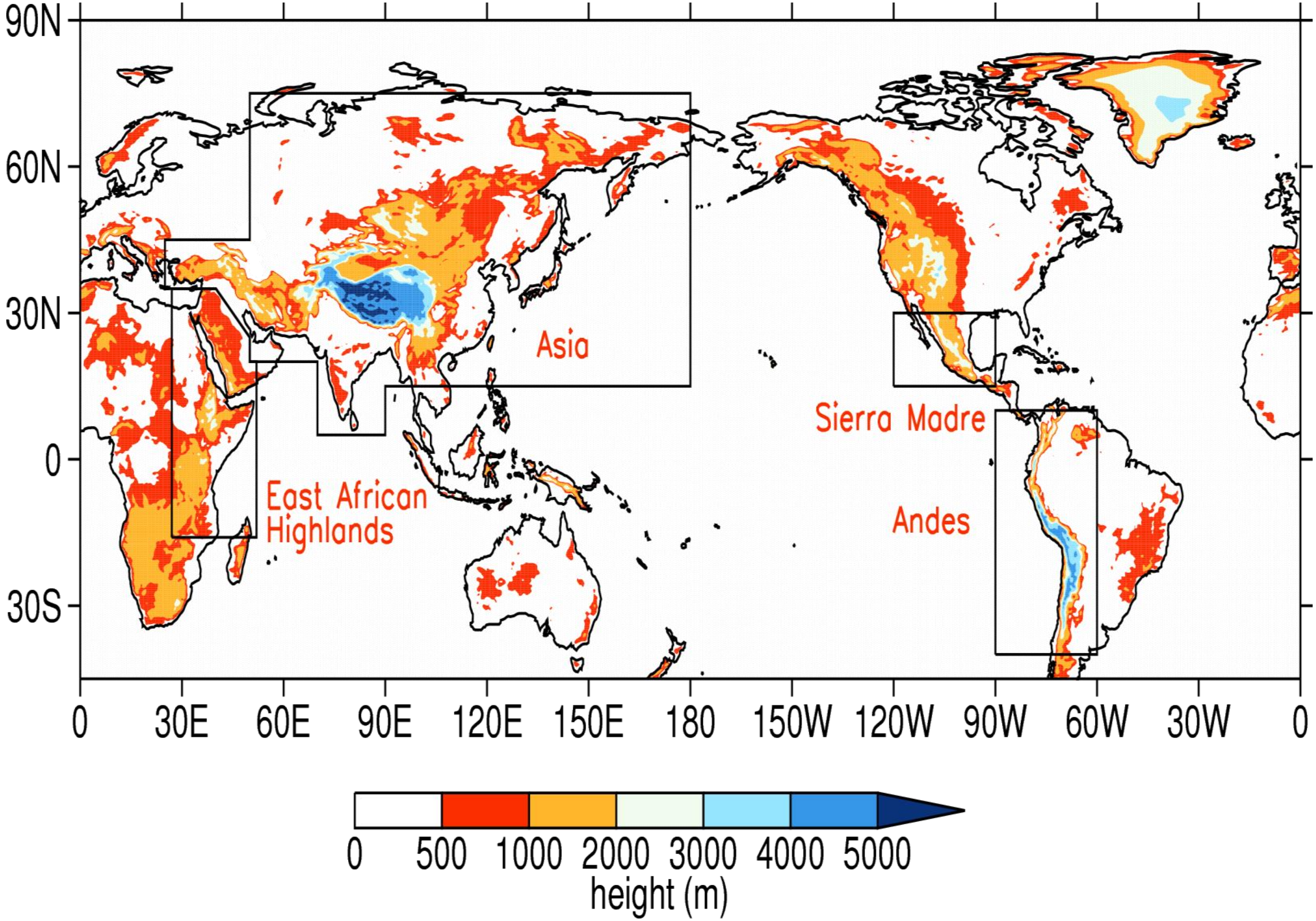
IPO、AMO Pacemaker Exps



Tiered Experiments

	EXP name	Integration time	Description	Model type	Motivation
Tier-3	**DTIP**	1979-2014	The topography of the TIP is modified by setting surface elevations to 500m	AGCM run, min realization 1	Understanding the combined thermal and mechanical forcing of the TIP.
	DTIP-DSH	1979-2014	Surface sensible heat released at the elevation above 500m over the TIP is not allowed to heat the atmosphere	AGCM run, min realization 1	Understanding the thermal forcing of the TIP
	DHLD	1979-2014	The topography of the highlands in Africa, N. America and S. America TP is modified by setting surface elevations to a certain height (500m),	AGCM run min realization 1	Understanding the combined thermal and mechanical forcing of other plateaus except the TIP.

Orography regions specified for the Tier-3 experiments



Connection with other MIPs

- **DAMIP** (understand the contributions from anthropogenic factors and natural forcing)
- **HighResMIP** (understanding the impact of high-resolution in reproducing global monsoon)
- **VolMIP** (understanding the effects of volcanism on global monsoon)
- **DCPP** (skills of global monsoons in decadal climate prediction)

GMMIP Exps and related other MIPs

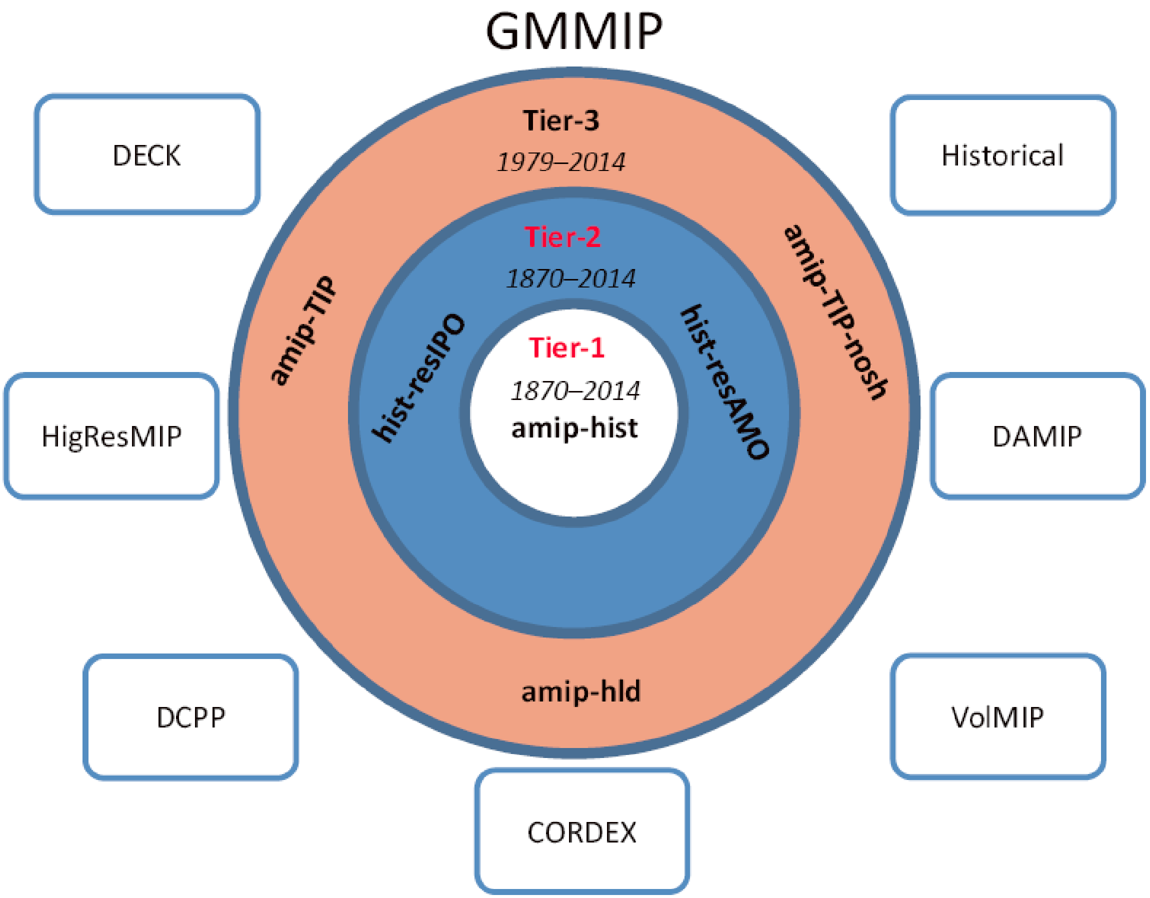
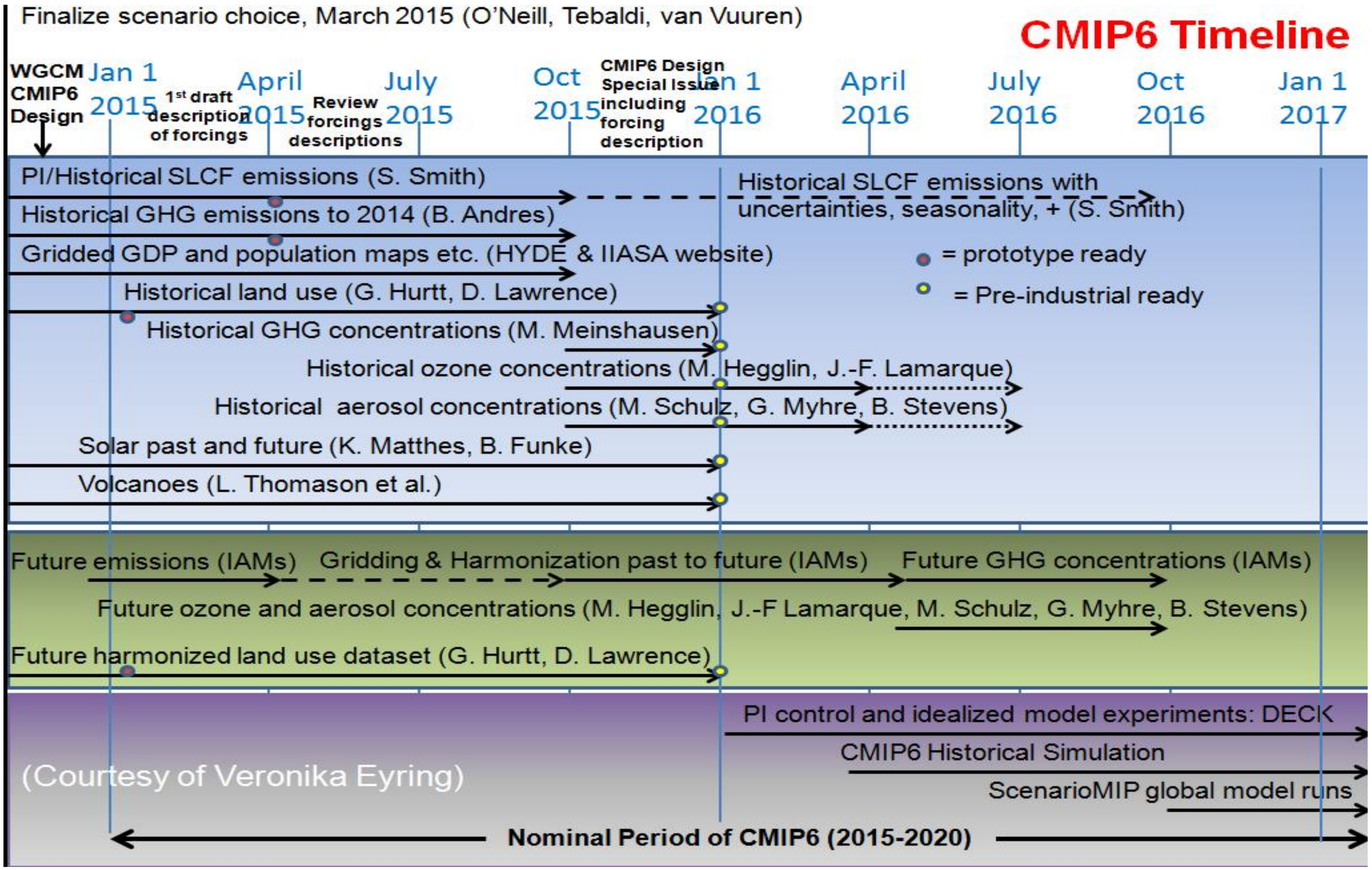


Figure 3. Three-tier experiments of GMMIP and its connections with DECK, historical simulation and endorsed MIPs.

Data to be available in middle 2017



CMIP6 Timeline

Concluding Remarks

- Global monsoons have undergone significant long term changes in the past century.
- Both the internal (IPO and AMO) and the external forcing (GHG, aerosol) contributes to the changes, but their relative contributions are still unclear.
- GMMIP will focus on the understanding of dynamical & physical processes dominating the changes of global monsoon systems.
- It provides a good platform for the climate modeling community in monsoon studies.

Geosci. Model Dev., 9, 1–16, 2016
www.geosci-model-dev.net/9/1/2016/
doi:10.5194/gmd-9-1-2016

Geoscientific Model Development
Open Access
EGU

GMMIP (v1.0) contribution to CMIP6: Global Monsoons Model Inter-comparison Project

Tianjun Zhou[1], Andrew G. Turner[2], James L. Kinter[3], Bin Wang[4], Yun Qian[5], Xiaolong Chen[1], Bo Wu[1], Bin Wang[1], Bo Liu[1,6], Liwei Zou[1], and Bian He[1]

[1]LASG, Institute of Atmospheric Physics, Chinese Academy of Sciences, Beijing 100029, China
[2]NCAS-Climate and Department of Meteorology, University of Reading, Reading, UK
[3]Center for Ocean-Land-Atmosphere Studies & Dept. of Atmospheric, Oceanic & Earth Sciences, George Mason University, Fairfax, Virginia, USA
[4]Department of Meteorology, School of Ocean and Earth Science and Technology, University of Hawaii at Manoa, Honolulu, Hawaii, USA
[5]Atmospheric Sciences & Global Change Division, Pacific Northwest National Laboratory, Richland, Washington, USA
[6]College of Earth Science, Graduate University of the Chinese Academy of Sciences, Beijing 100049, China

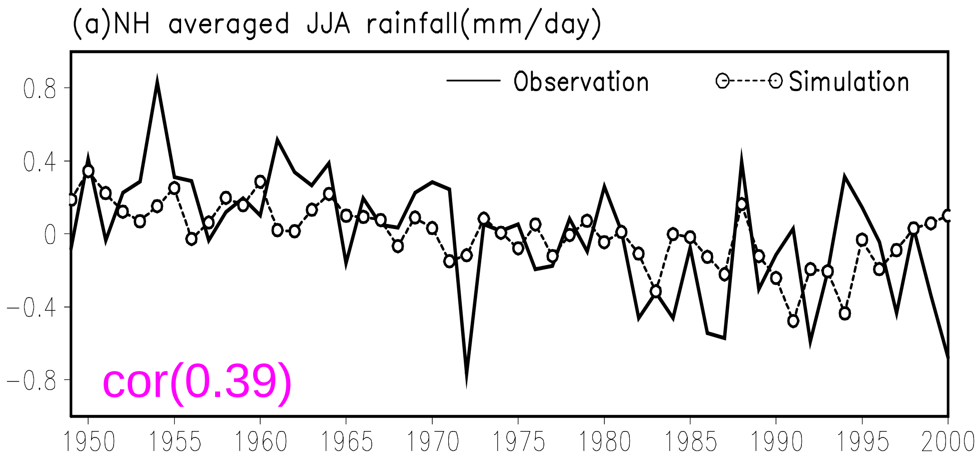
Correspondence to: Tianjun Zhou (zhoutj@lasg.iap.ac.cn)

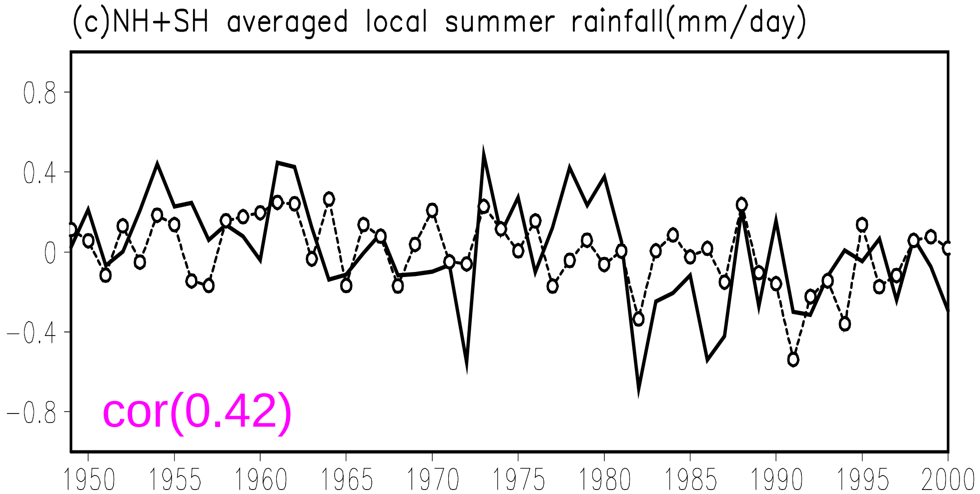
Received: 30 March 2016 – Published in Geosci. Model Dev. Discuss.: 11 April 2016
Revised: 3 September 2016 – Accepted: 14 September 2016 – Published:

THANKS

http://www.lasg.ac.cn/gmmip

The time evolution of land monsoon precipitation in the observation and the simulation





- ◆ The observed monsoon index show a decreasing trend across the entire 50 years, and particularly before 1980s.

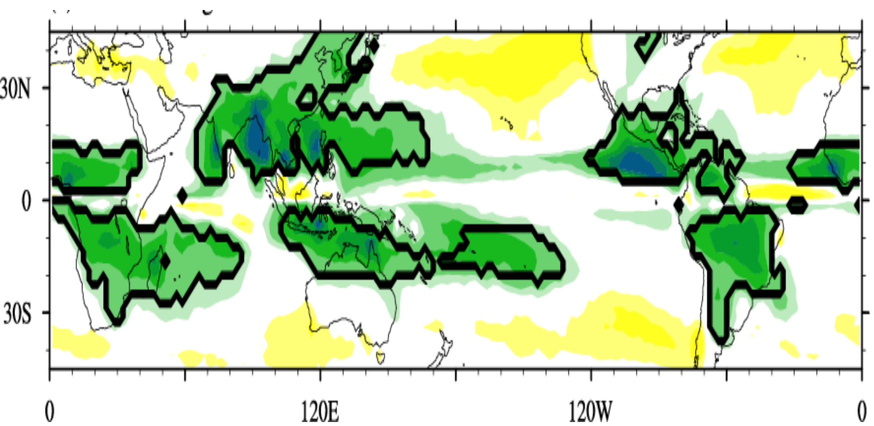
- ◆ The observed decreasing trend is found in the simulation, although slightly weaker than the observation.

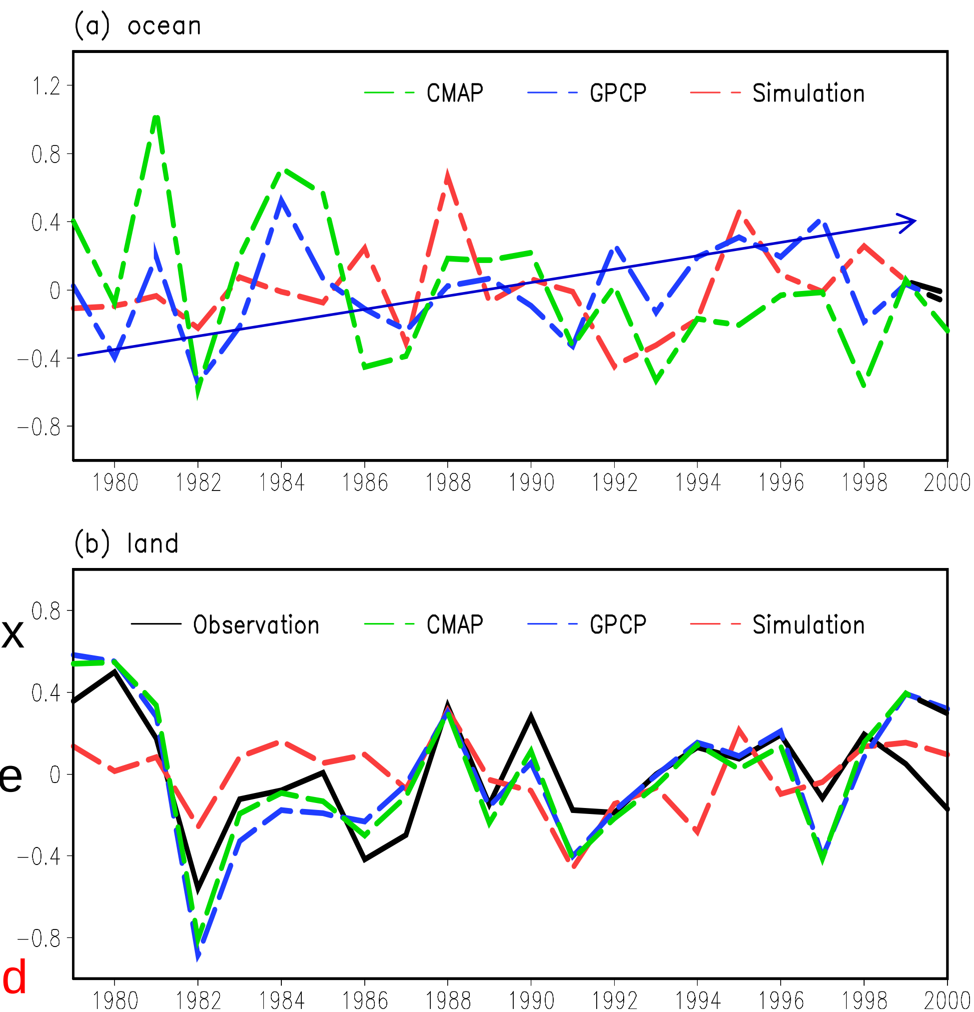
-0.36mm/day/50year in simulation

-0.59mm/day/50year in observation

Zhou et al. 2008 Ocean forcing to changes in global monsoon precipitation over the recent half century, ***Journal of Climate***, **21** (15), 3833–3852

Monsoon precipitation changes in global land and ocean areas





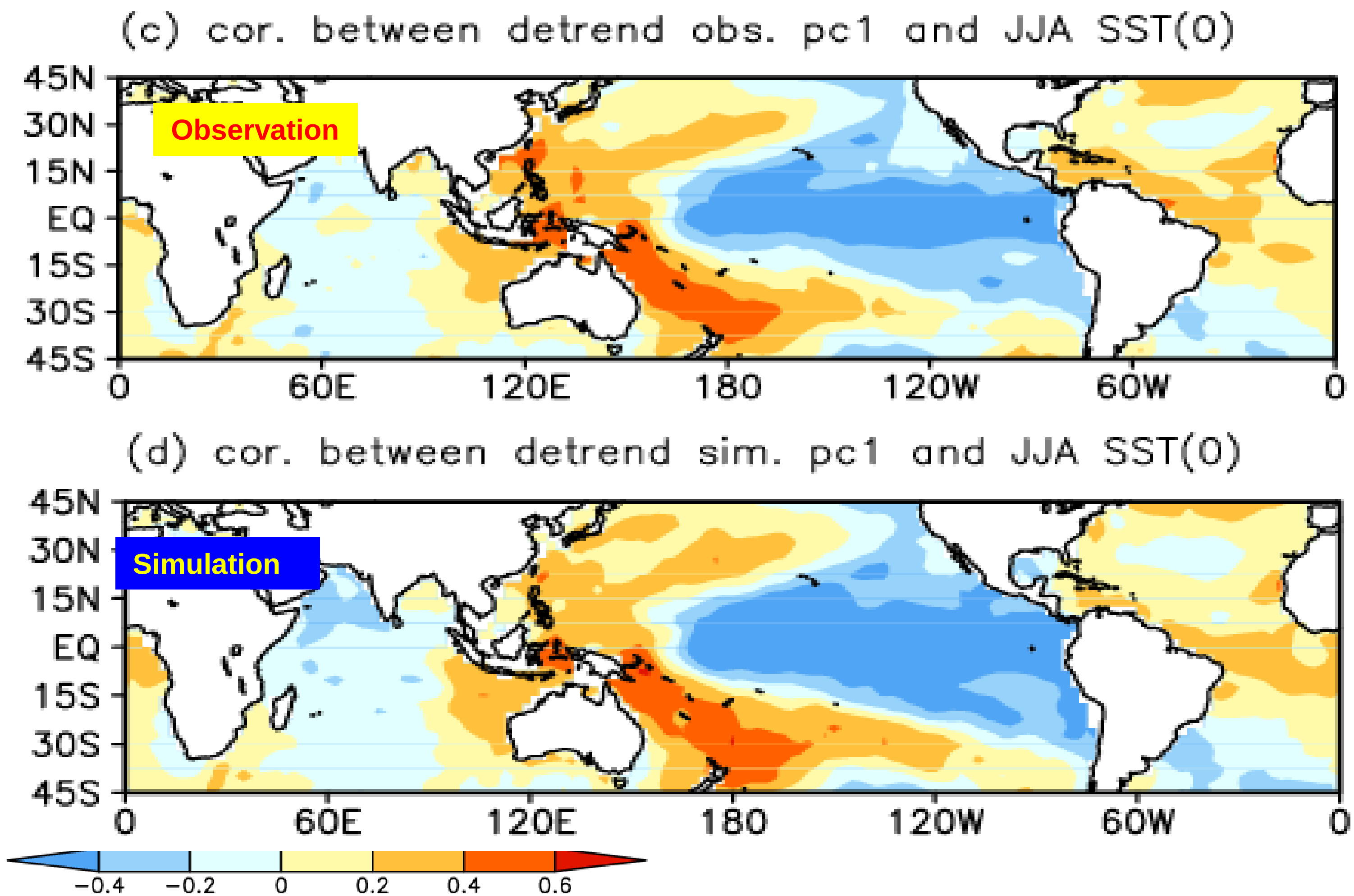
◆ There is barely any correspondence between the simulation and the observation in the global monsoon index over the ocean area.

◆ This discrepancy might arise from the uncertainty of observational data.

◆ The CMAP and GPCP data show confusing results on the increasing trend of oceanic monsoon index.

Zhou et al. J. Climate (2008)

Correlation at interannual time scale



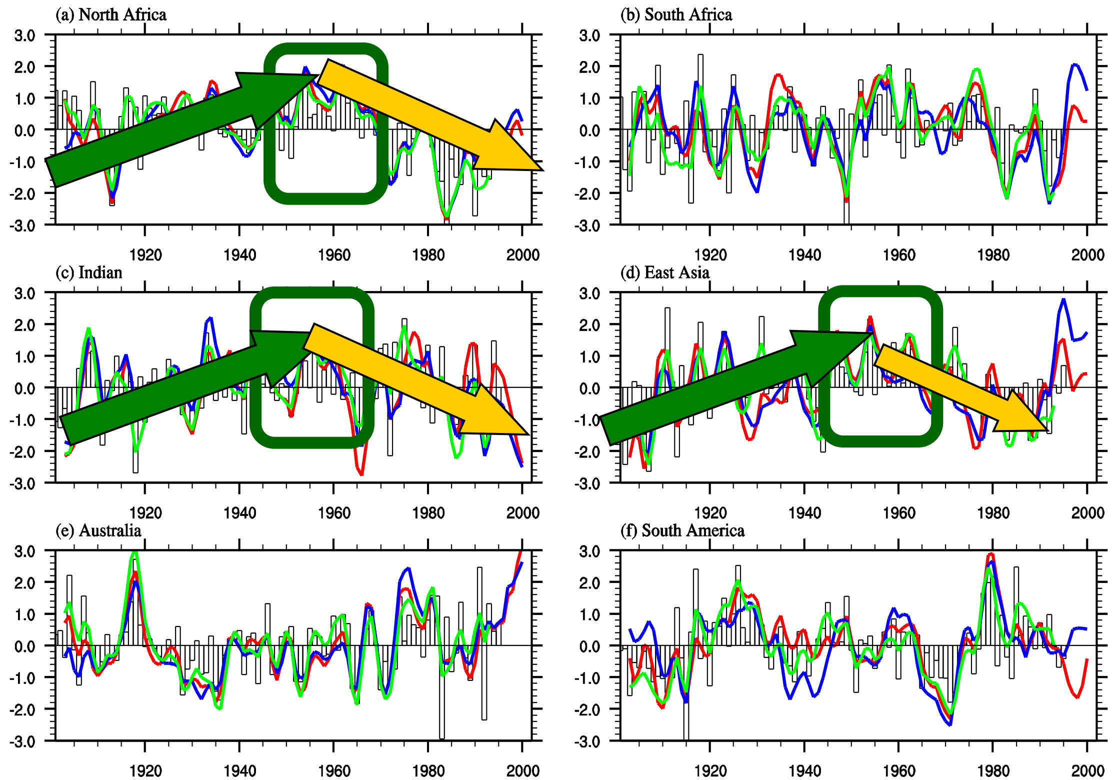
Zhou et al. 2008 Ocean forcing to changes in global monsoon precipitation over the recent half century, ***Journal of Climate***, **21** (15), 3833–3852

Precipitation changes for regional monsoons

N African

Indian

Australian



S African

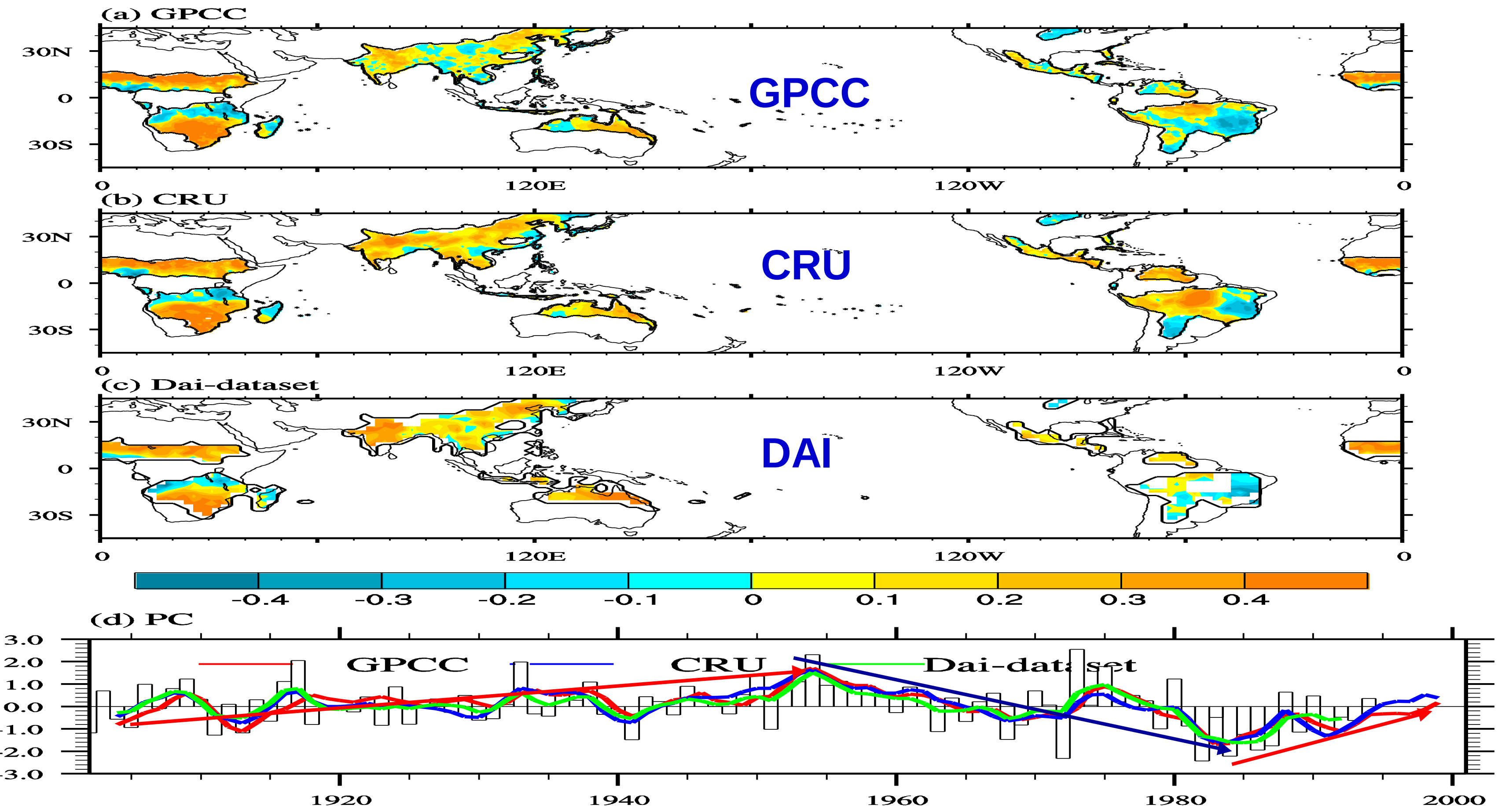
East Asian

S. American

- Wetter around 1950: North African, Indian and East Asian monsoon.
- 1901-1955: upward trend the North African monsoon, Indian monsoon and East Asian monsoon.
- 1955-2001: decreasing trends North African, Indian and EA monsoon.

Zhang Lixia, and Tianjun Zhou, 2011: An assessment of monsoon precipitation changes during 1901–2001, ***Climate Dynamics***, , 37, 279-296, DOI 10.1007/s00382-011-0993-5

EOF1 of Global land Monsoon Precipitation



- Majority of global land monsoon precipitation show coherent change.
- PC: increasing trend during 1901-1955, decreasing trend since the 1950s, and followed by a recovery since the 1980s.

Zhang Lixia, and **Tianjun Zhou**, 2011: ***Climate Dynamics***, , 37, 279-296