

Performance of a high resolution regional ocean-atmosphere coupled model over western North Pacific region: Sensitivity to cumulus parameterizations

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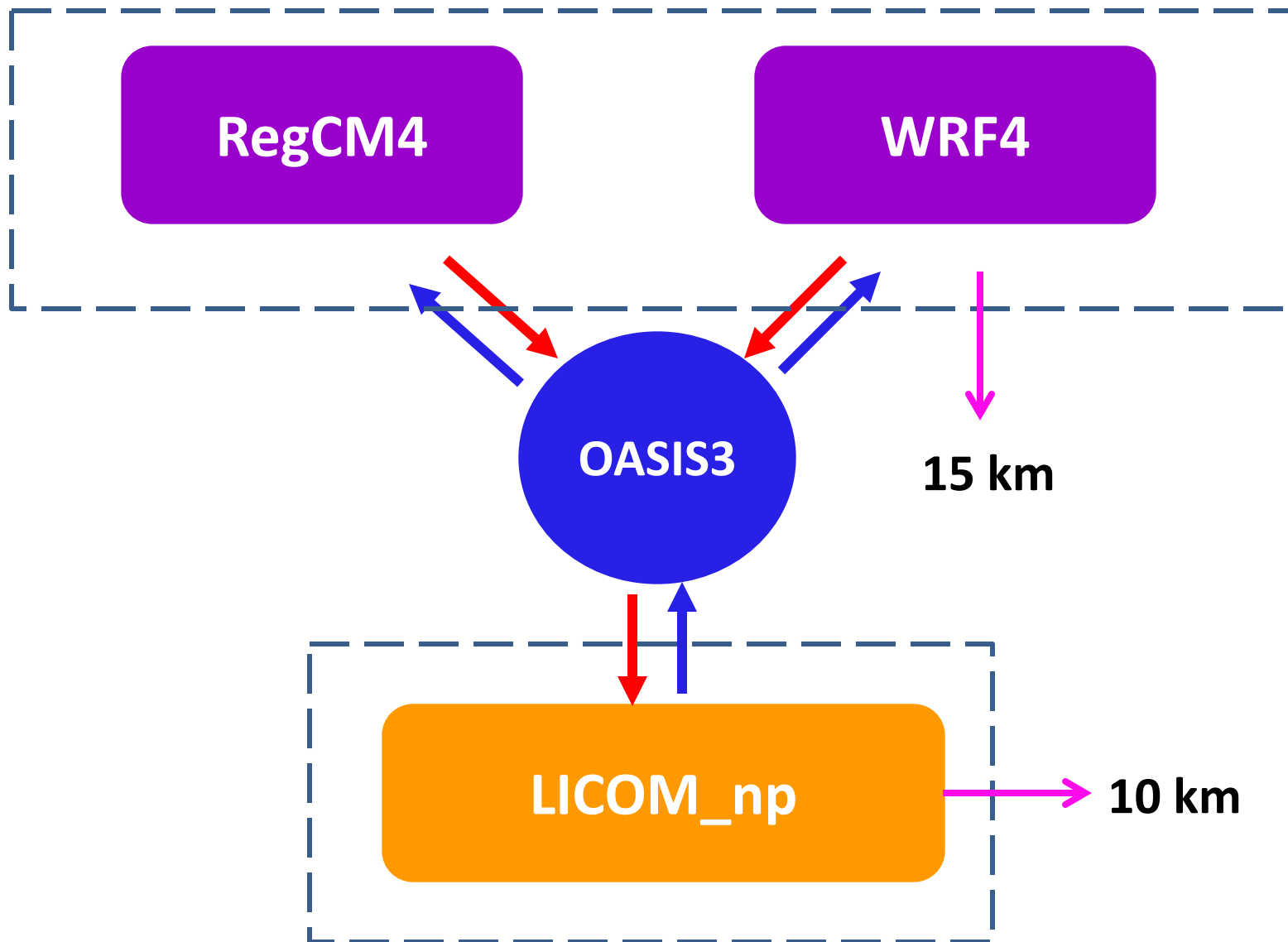
LASG, Institute of Atmospheric Physics, CAS

ICRC-CORDEX 2019, 2019-10-16, Beijing

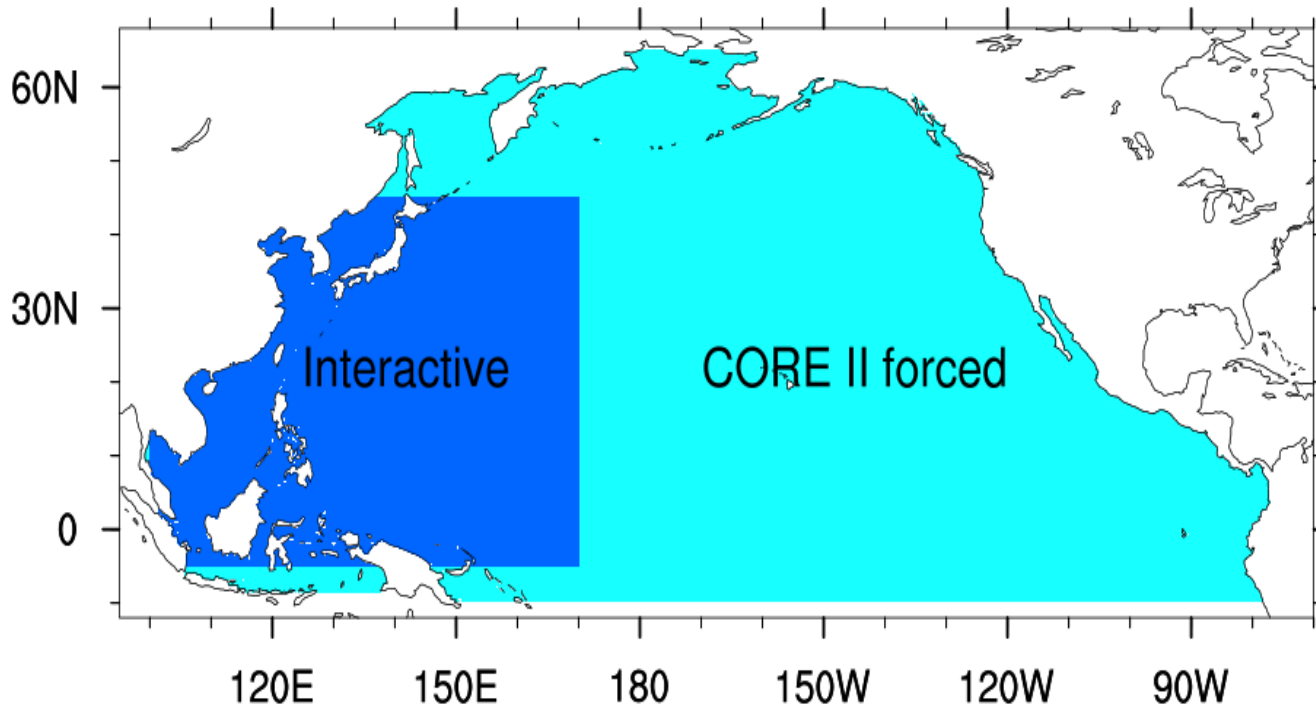
Motivation

- Coupling of the ocean component in RCMs was an important step towards the development of regional earth system models
- Horizontal resolution issue:
 - For atmosphere, we need 10-20 to sufficiently represent topographic effects on climate change
 - For ocean, we need at least 10 km to resolve the ocean mesoscale eddies

Model framework



Experimental design

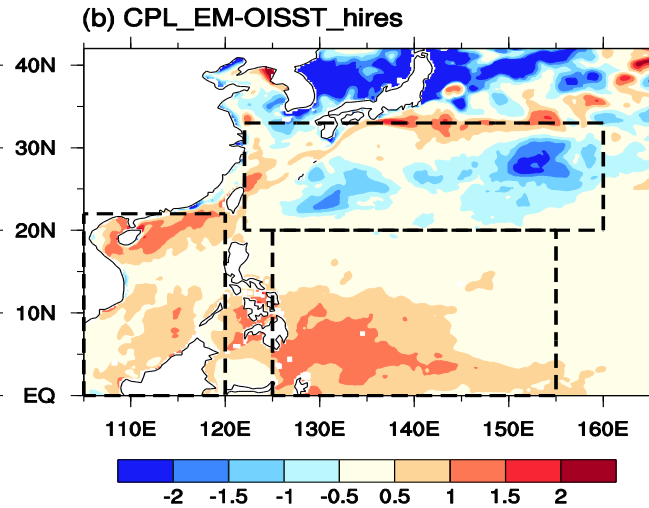
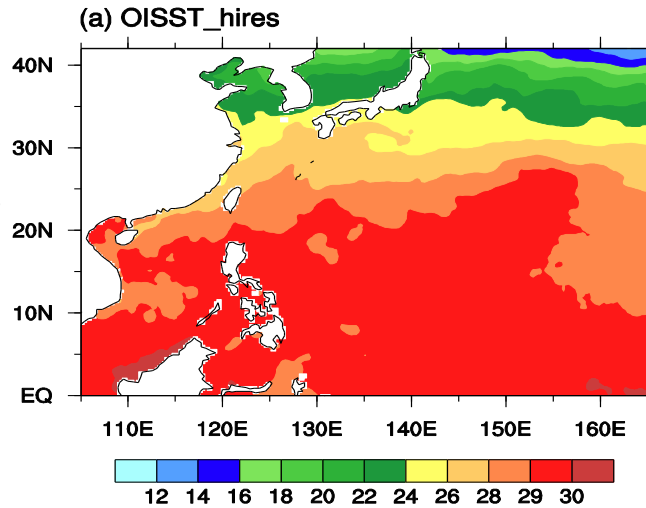


Sensitivity experiments with RegCM4_LICOM: Different cumulus parameterization schemes (Kain-Fritsch, Tiedtke, Emanuel)

Simulation Period: 20041101-20051201

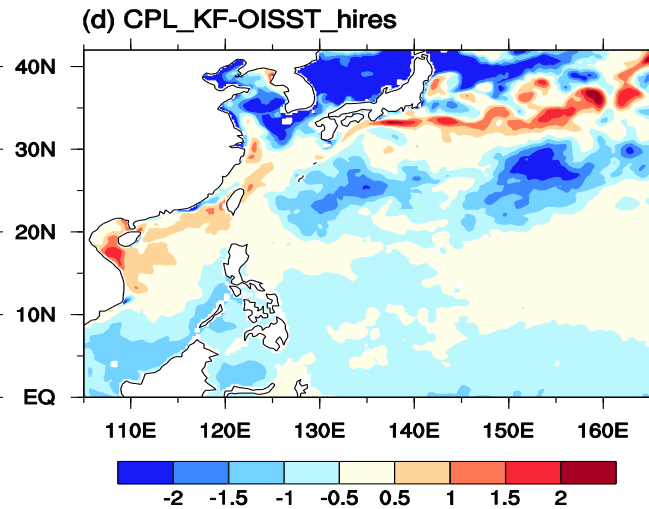
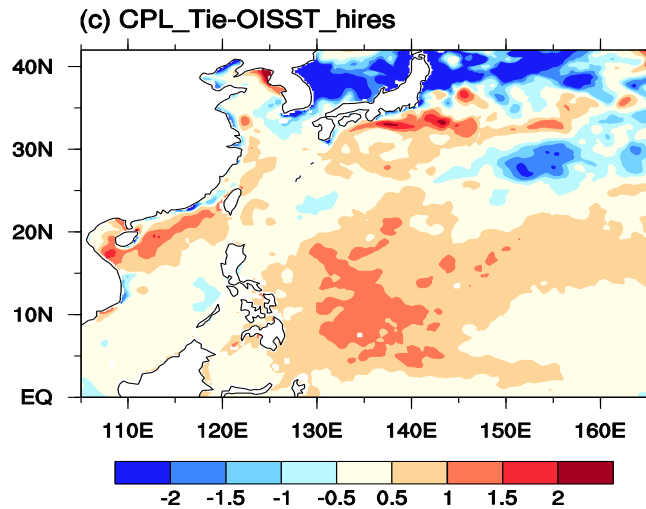
Simulated JJA mean SST biases

OISST



Emanuel

Tiedtke

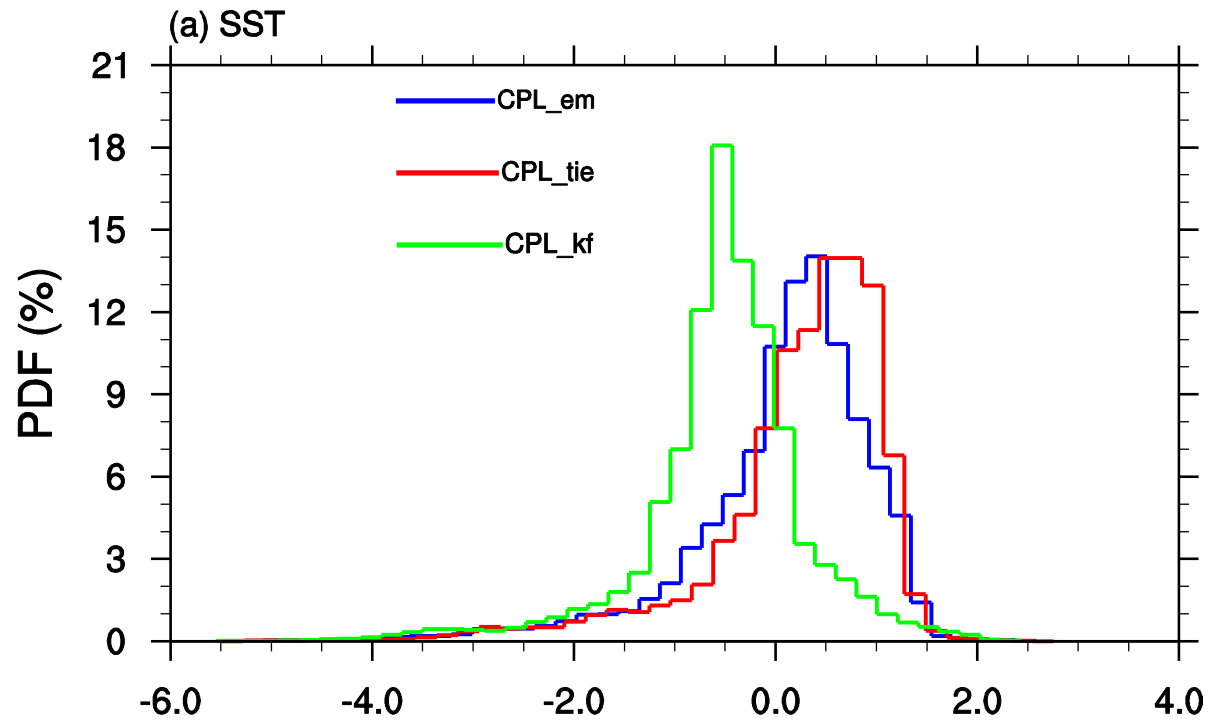


Kain-Fritsch

For SST, the simulation with Tiedtke scheme is comparable to that with Emanuel scheme, but the simulation with KF scheme shows overall cold biases

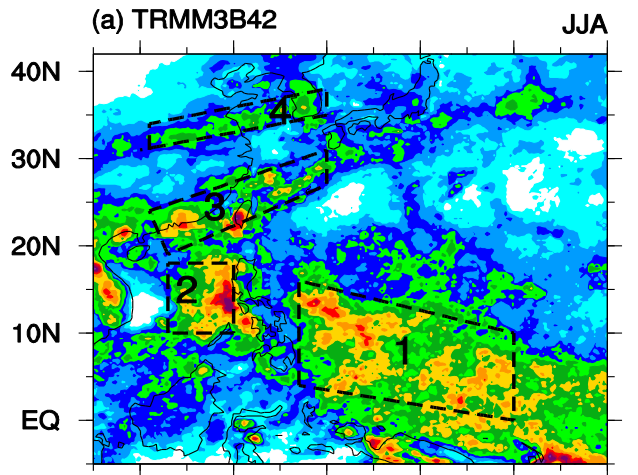
Zou et al. Climate Dynamics, 2019

Probability density function (PDF) distribution of SST biases

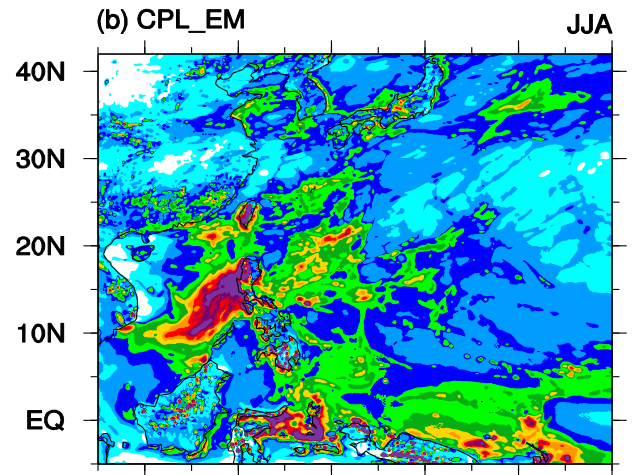


Observed and simulated rainfall averaged from June to August of 2005

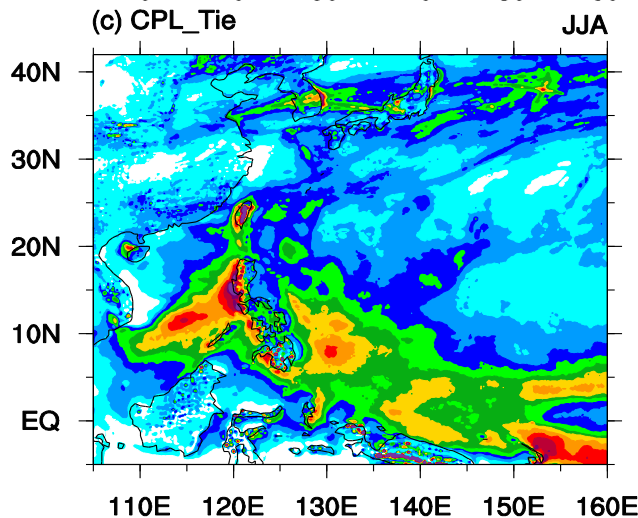
TRMM



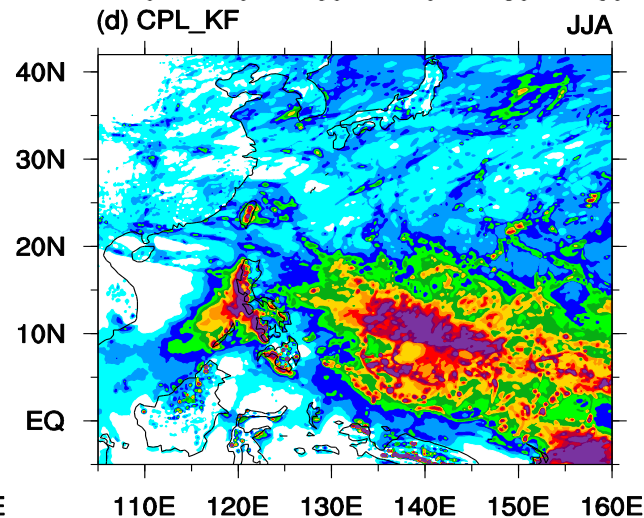
Emanuel



Tiedtke



Kain-Fritsch

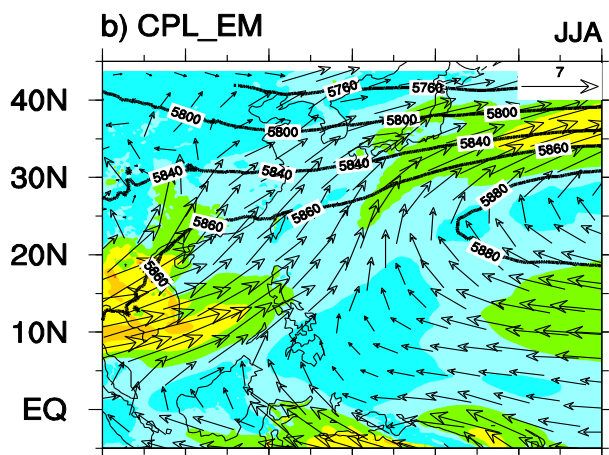
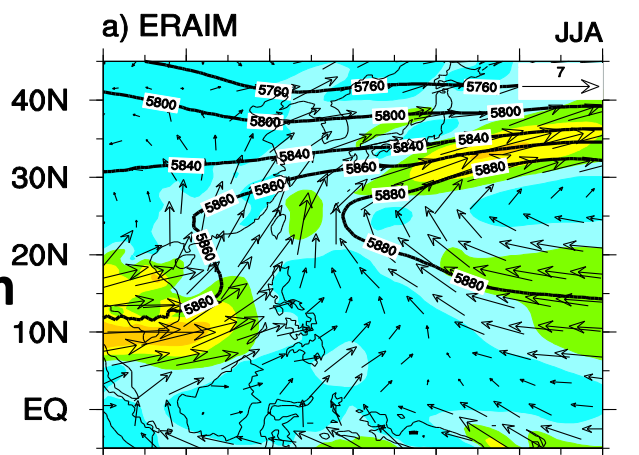


Simulation with Tiedtke scheme exhibits the best performance in the simulation of summer rainfall over WNP, especially over monsoon trough

Zou et al. Climate Dynamics, 2019

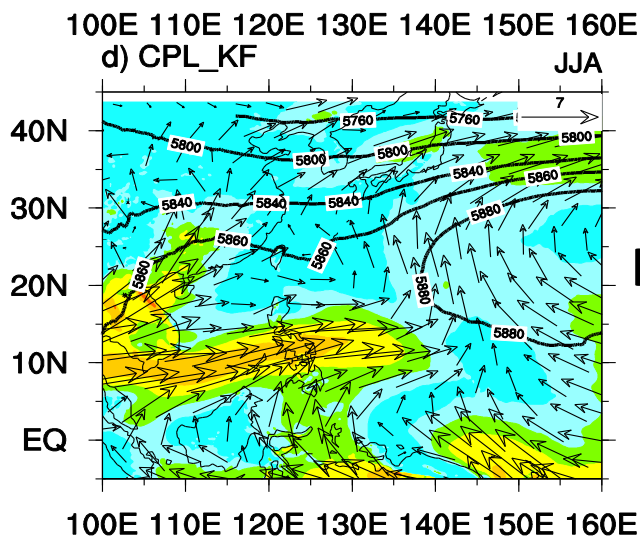
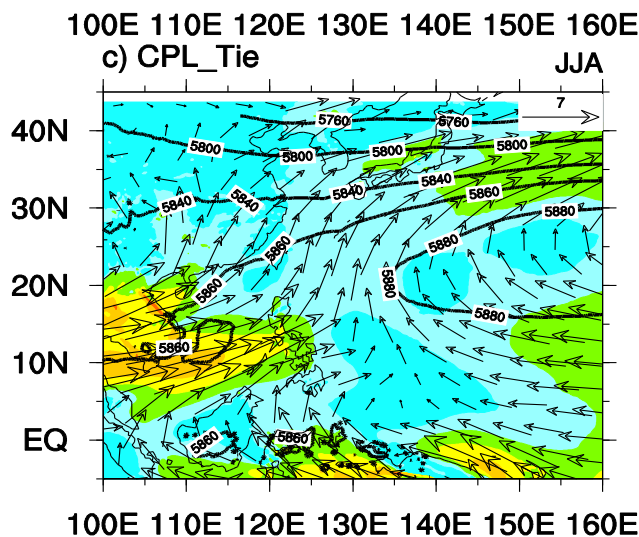
Monsoon circulation (low-level wind, subtropical high)

ERA-interim



Emanuel

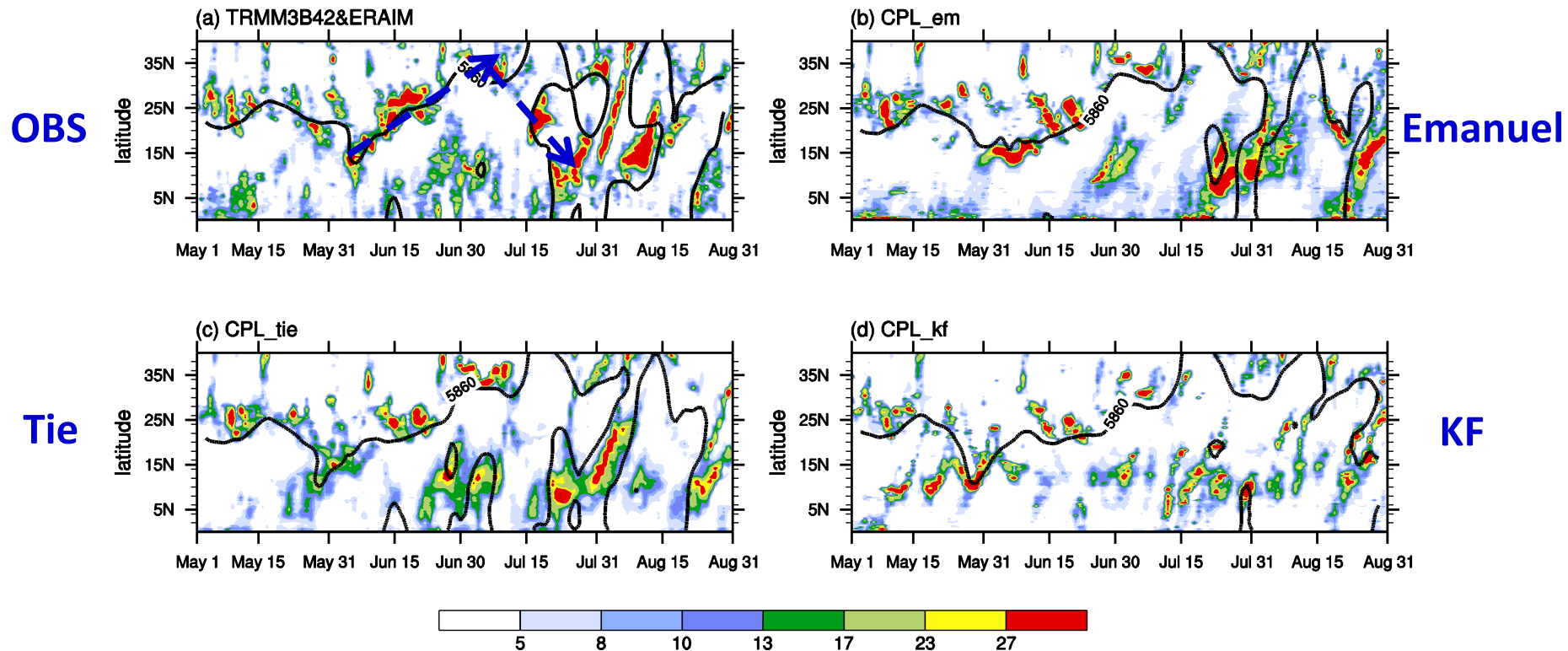
Tiedtke



Kain-Fritsch

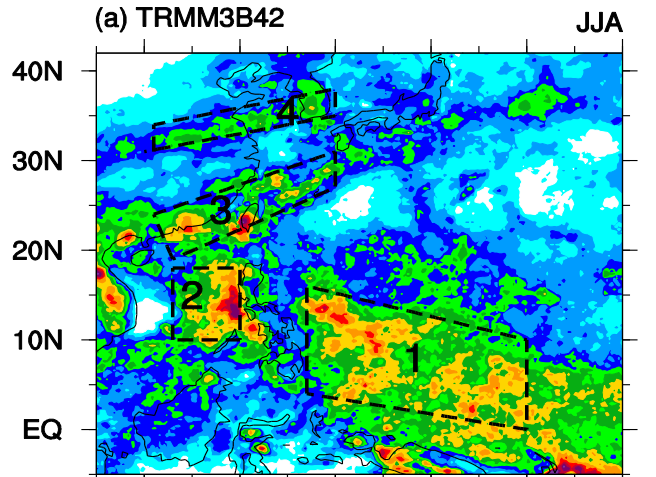


Time evolution of rainfall and subtropical high averaged between 110°E and 130°E from May 1 to August 31

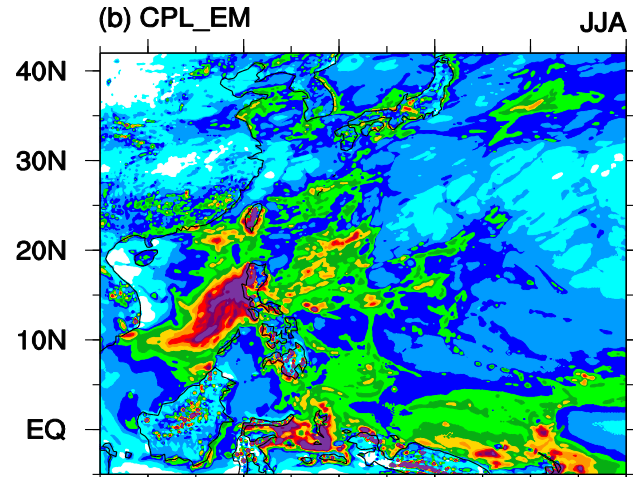


Why does the simulation with the Tiedtke scheme well capture the rainfall over the monsoon trough?

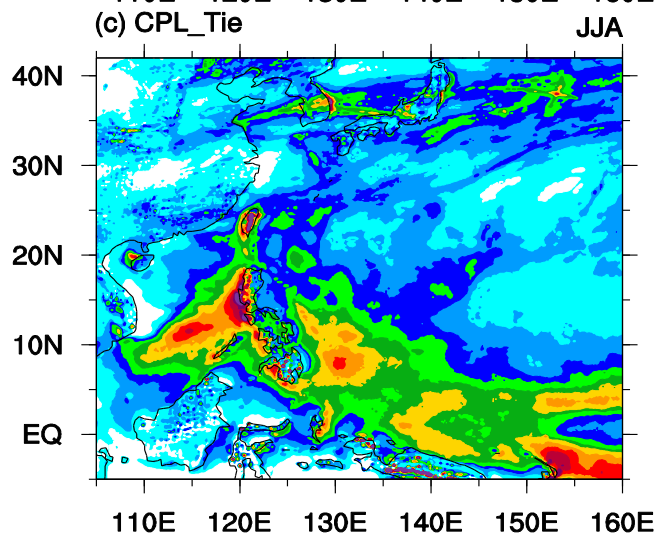
TRMM



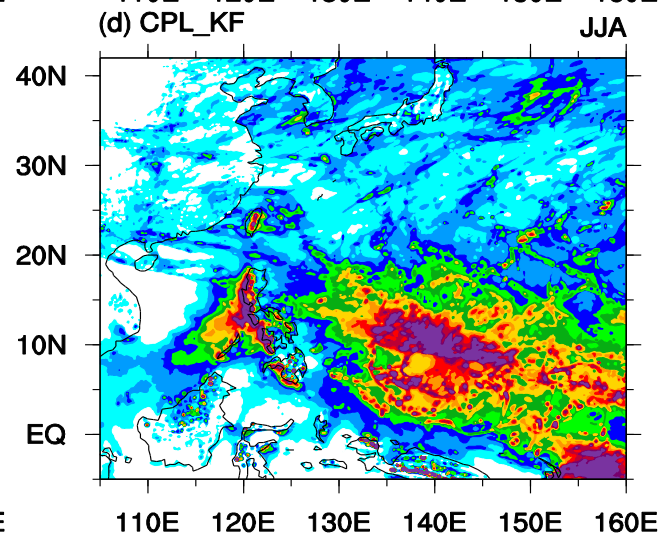
Emanuel



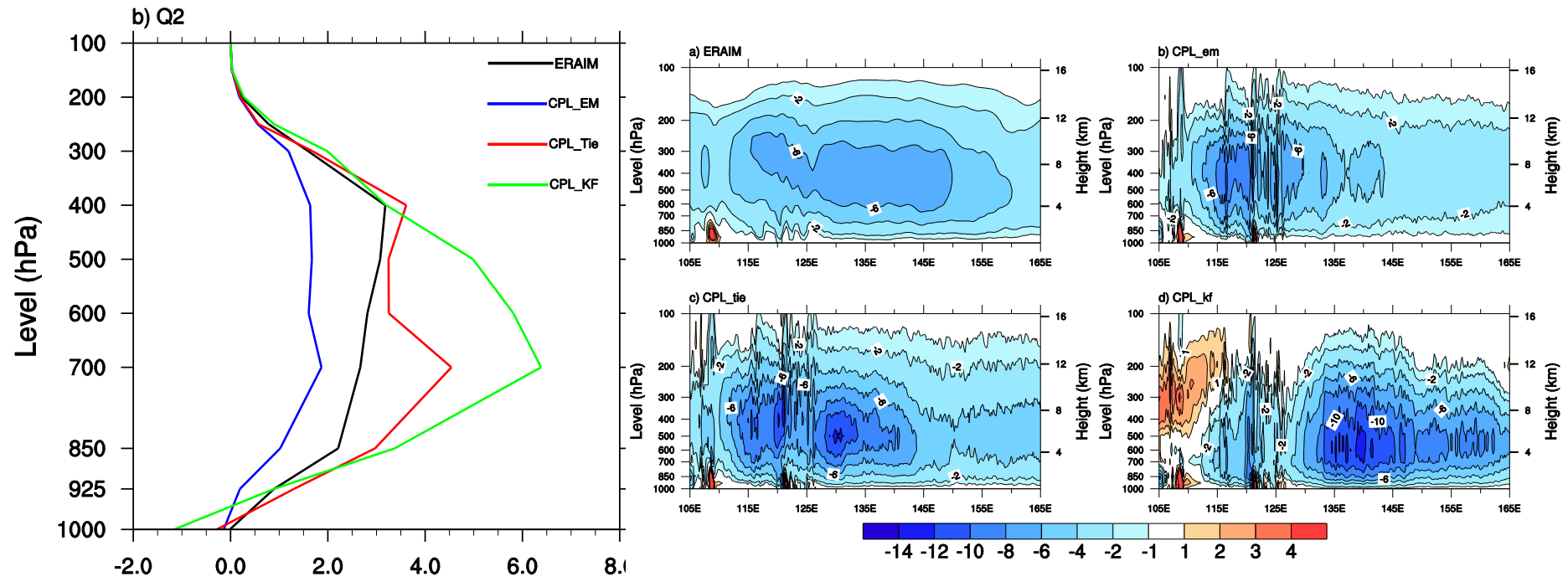
Tiedtke



Kain-Fritsch

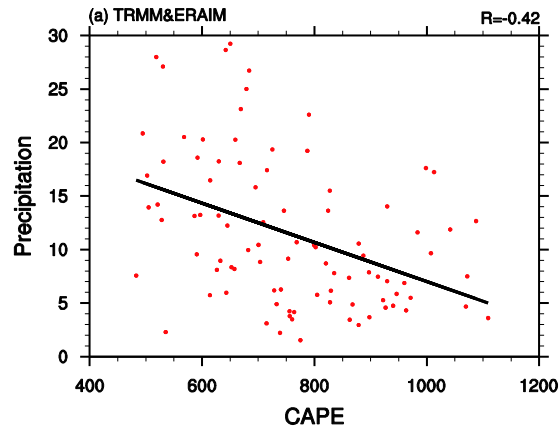


Condensation heating (apparent moisture sink)

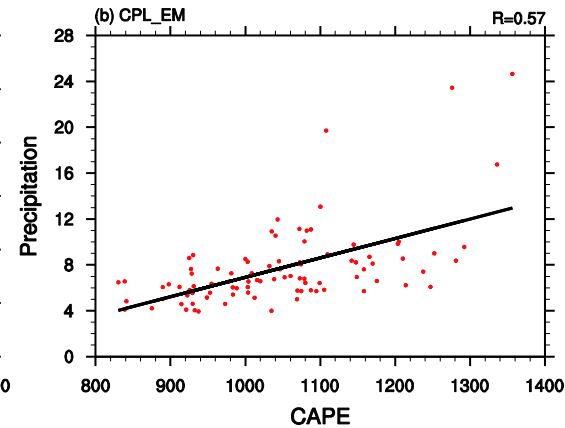


Relationship between the daily convective available potential energy and the precipitation over the monsoon trough from June 1 to August 31

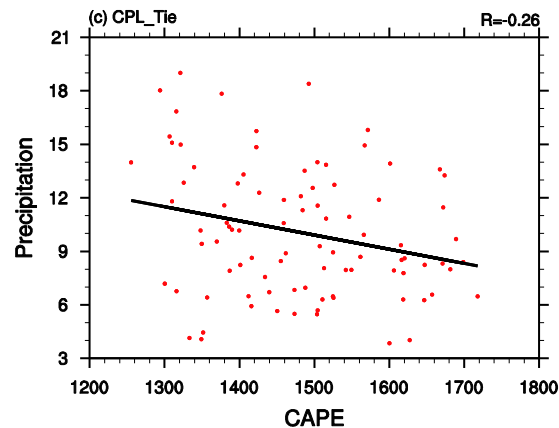
OBS



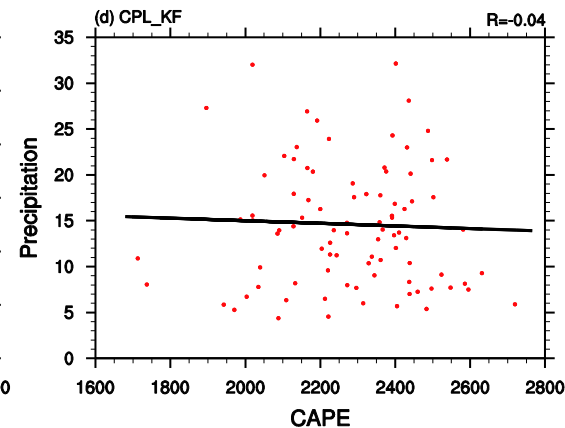
Emanuel



Tie



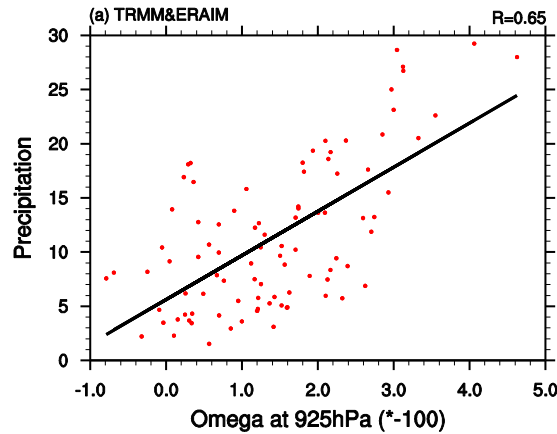
KF



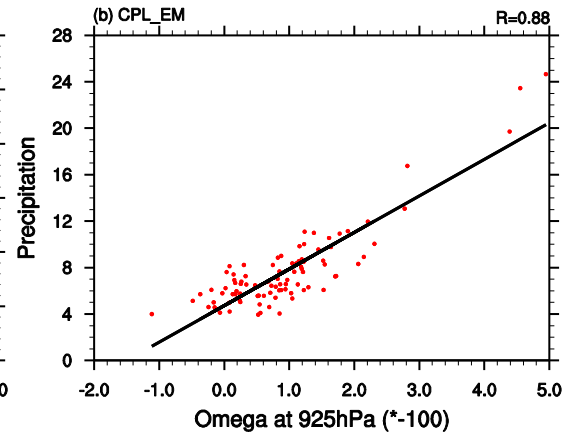
Negative correlation suggests that the convection over the monsoon trough is more closely tied to the tropospheric large-scale forcing rather than the boundary layer forcing

Relationship between the vertical velocity at 925hPa and the precipitation over the monsoon trough

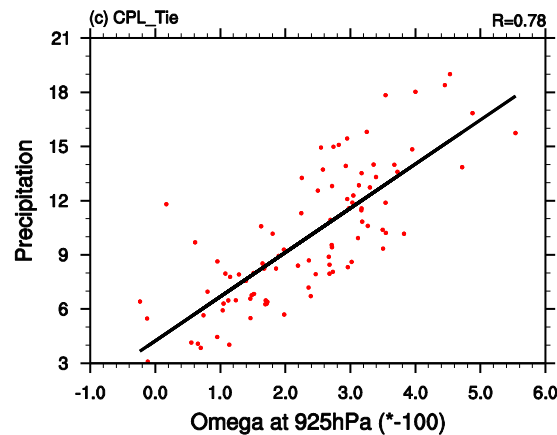
**OBS
(0.65)**



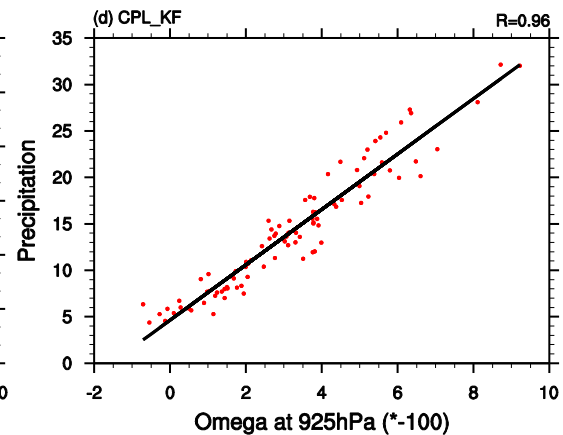
**Emanuel
(0.88)**



**Tie
(0.78)**



**KF
(0.96)**



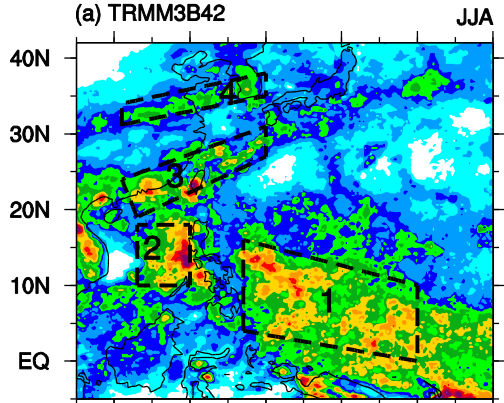
In CPL_KF, the response to the low-level vertical velocity was too strong

RegCM4_LICOM with Tiedtke scheme shows reasonable performance in the simulation of WNP summer monsoon

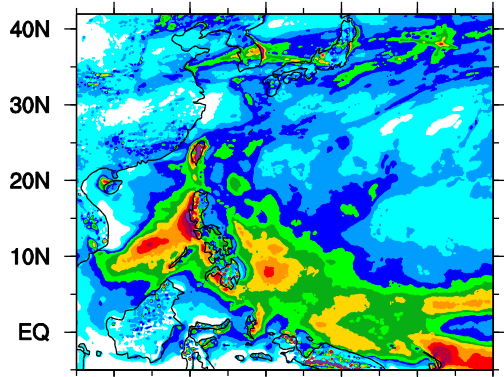
How about the performance of WRF4_LICOM? Regional ocean-atmosphere coupled Model intercomparison...

Physics	RegCM4	WRF4
Dyn Core	Hydrostatic MM5	Non-hydrostatic WRF
Horizontal res.	15km	15km
Vertical res.	23L	35L
PBL	Holtslag	YSU
Rad	CCM3	RRTM
Cloud	CCM3	Xu and Randall
Cumulus	Tiedtke	Tiedtke
Microphysics	SUBEX	WSM6
LSM	CLM3.5	Noah-MP

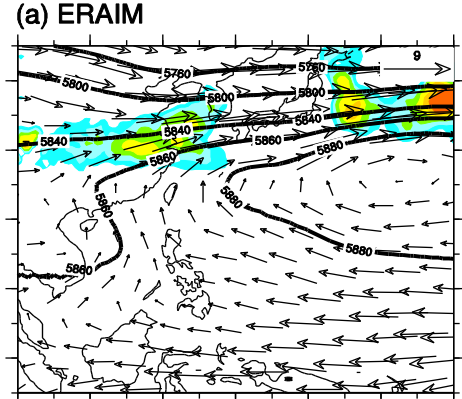
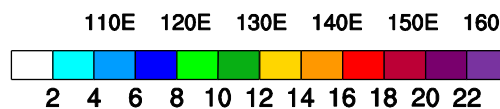
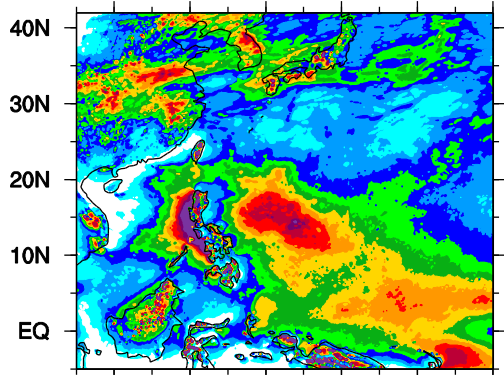
OBS



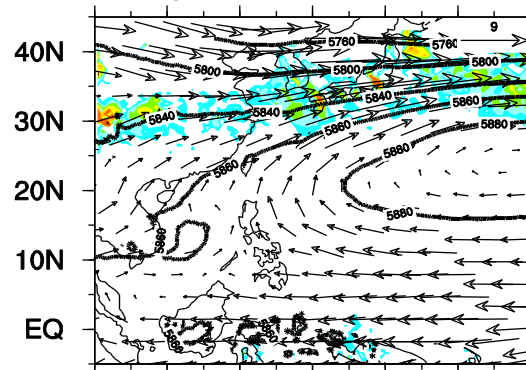
(b) RegCM4_LICOM JJA



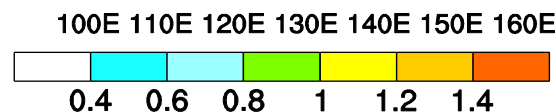
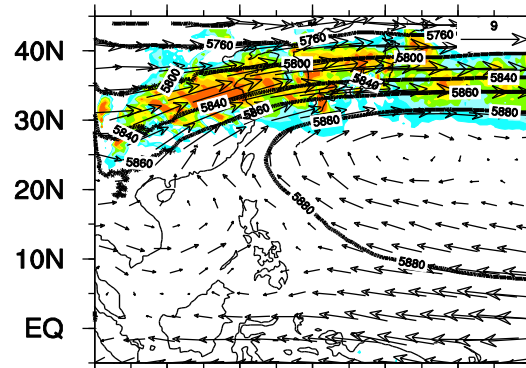
(c) WRF4_LICOM JJA



(b) RegCM4_LICOM



(c) WRF4_LICOM



Zou et al. JAMES,
submitted

Concluding Remarks

- ◆ Apply the regional ocean-atmosphere coupled model to CORDEX domain
- ◆ Coordinate the regional coupled model inter-comparison

A blue globe with a pink-to-white gradient background. The globe is centered and shows the outlines of continents. The background transitions from a deep blue at the top to a bright orange at the bottom.

Thank You !