南京大学
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WCRP CORDEX

Parallel Session A: Advances in regional downscaling
A2: Convection permitting modelling

Sensitivity of Summer Precipitation Simulation to Microphysics Parameterization Over Eastern China: Convection-Permitting Regional Climate Simulation

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Content

- **Motivation**
- **Experimental Design and Data**
- **Results**
  - ✓ *Precipitation statistical*
  - ✓ *Microphysical Hydrometeors*
  - ✓ *Composite of heavy rain cases*
- **Summary and Conclusion**

Motivation

- Some mesoscale convective systems, which contribute much to the extreme events, only can be explicitly resolved at a convection-permitting (CP) (4 km) resolution.

- Since cumulus parameterization schemes are not employed in the CP regional climate models(RCMs), the cloud microphysics parameterization (MP) could be the principal source of uncertainties in CP RCMs

This study focus on:

- How well can the CP RCM simulates precipitation and the associated atmospheric circulations over eastern China?

- What are the contributions of MP schemes to precipitation simulation at CP resolution?

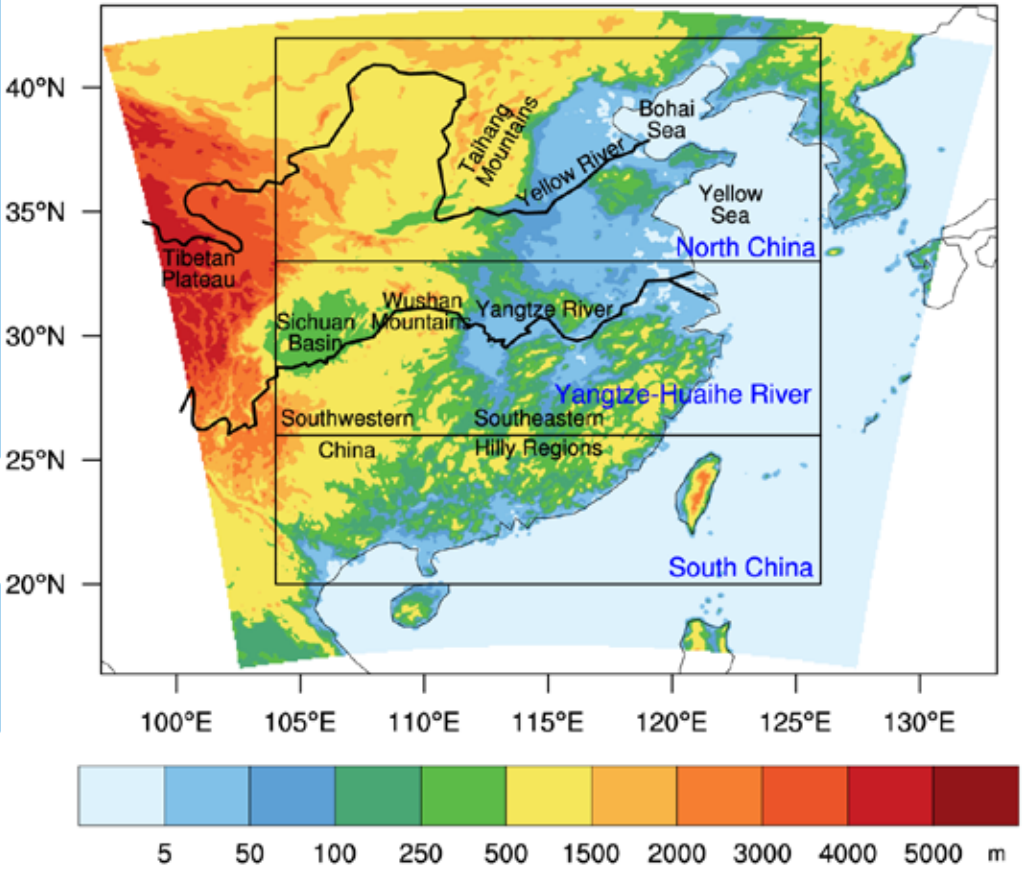
Experimental Design and Data

Model： WRF v3.7.1
Simulation grids: 4 km, 721*721 horizontal grid points
Simulation Period：summer seasons of 2009-2014

Cumulus: **None**
Microphysics: **Lin, WSM5 and Thompson**
Initial and Lateral Boundary Forcing: ERA-interim
Boundary layer physics: YSU
Radiation physics: CAM shortwave and longwave
Land Surface Model: NOAH

Observations: **Station, CMORPH v1.0 and ERA-interim**

Model Domain

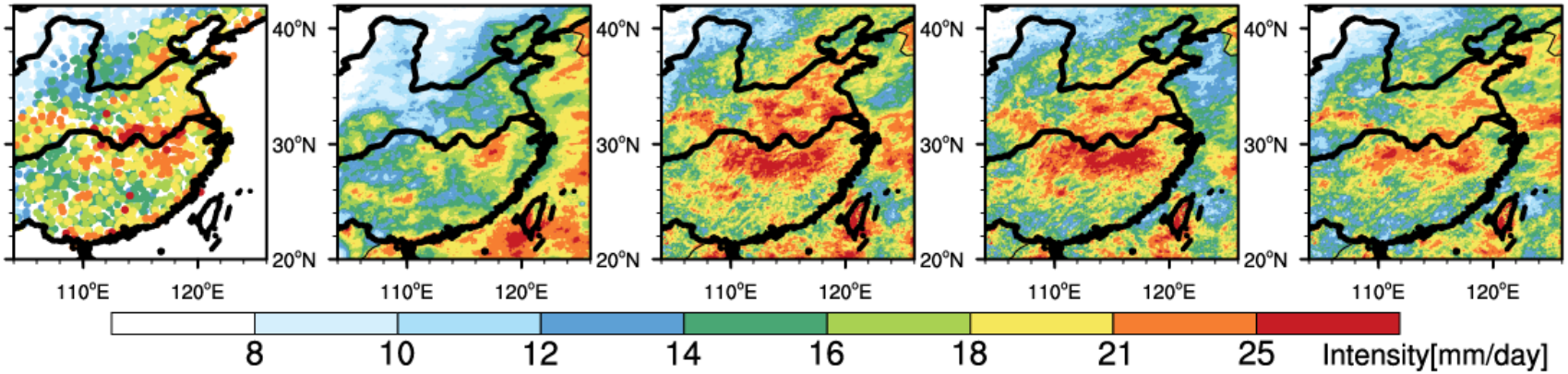


Results – wet day precipitation

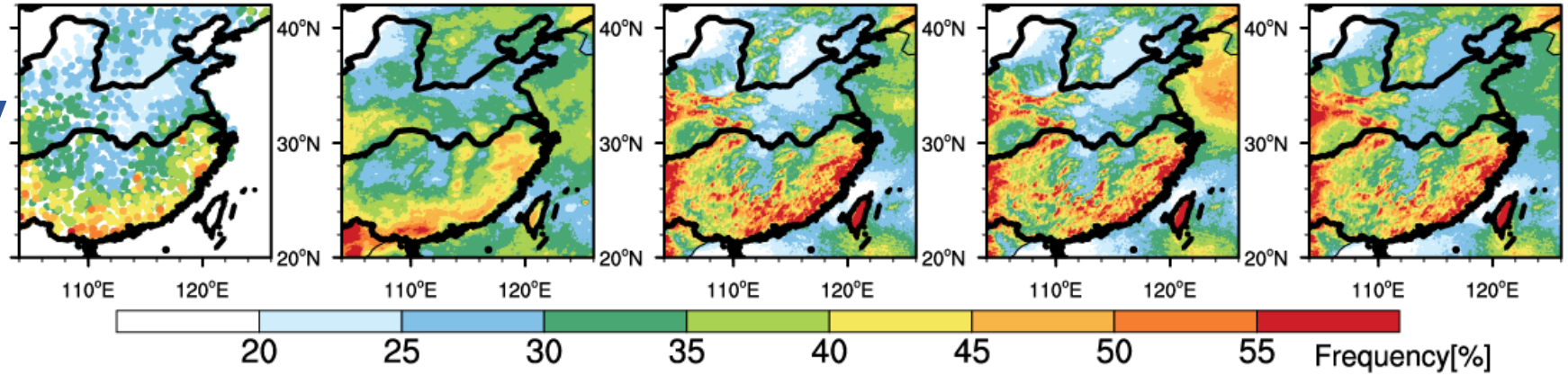
≥1.0 mm/day

Station CMORPH Lin WSM5 Thompson

Intensity



frequency



All experiments all overestimate the wet day intensity over Yangtze-Huaihe River Valley, especially for Lin and WSM5

Results – different grades precipitation

Little Middle Heavy Torrential

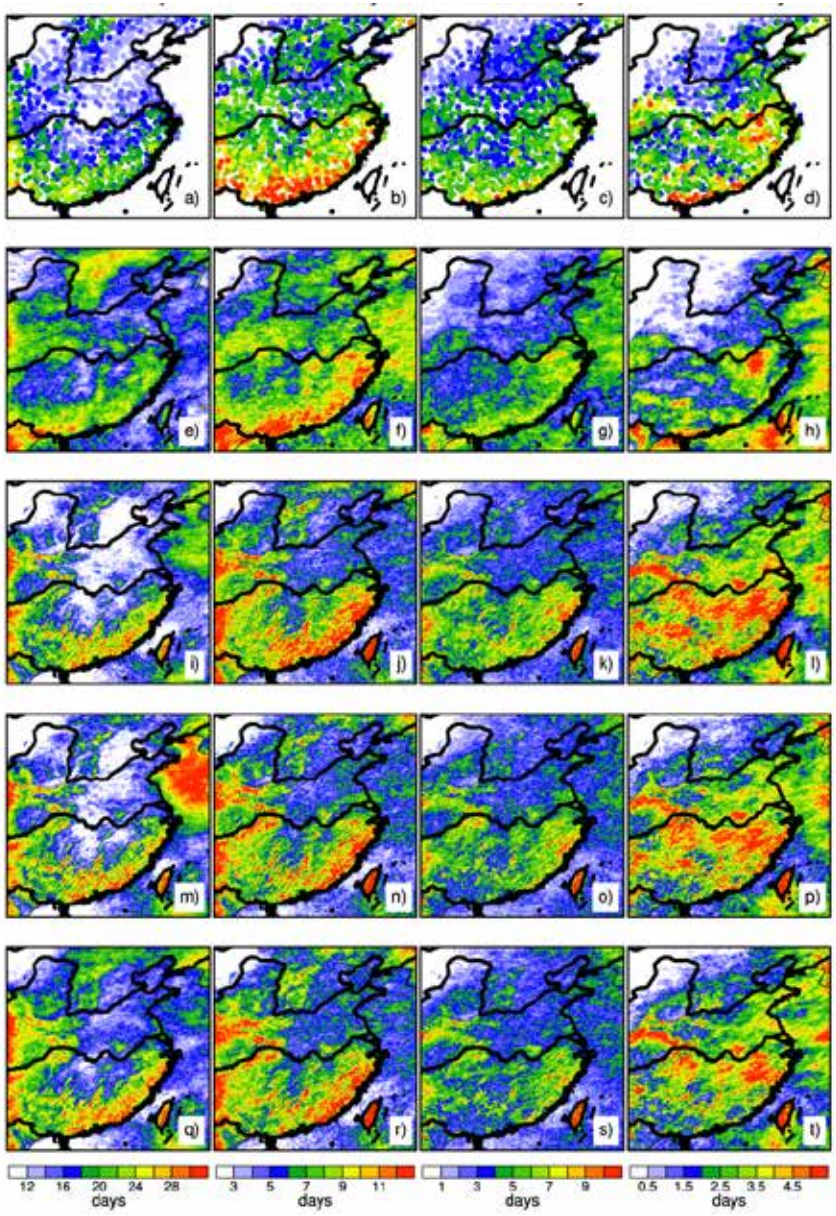
Station

CMORPH

Lin

WSM5

Thompson

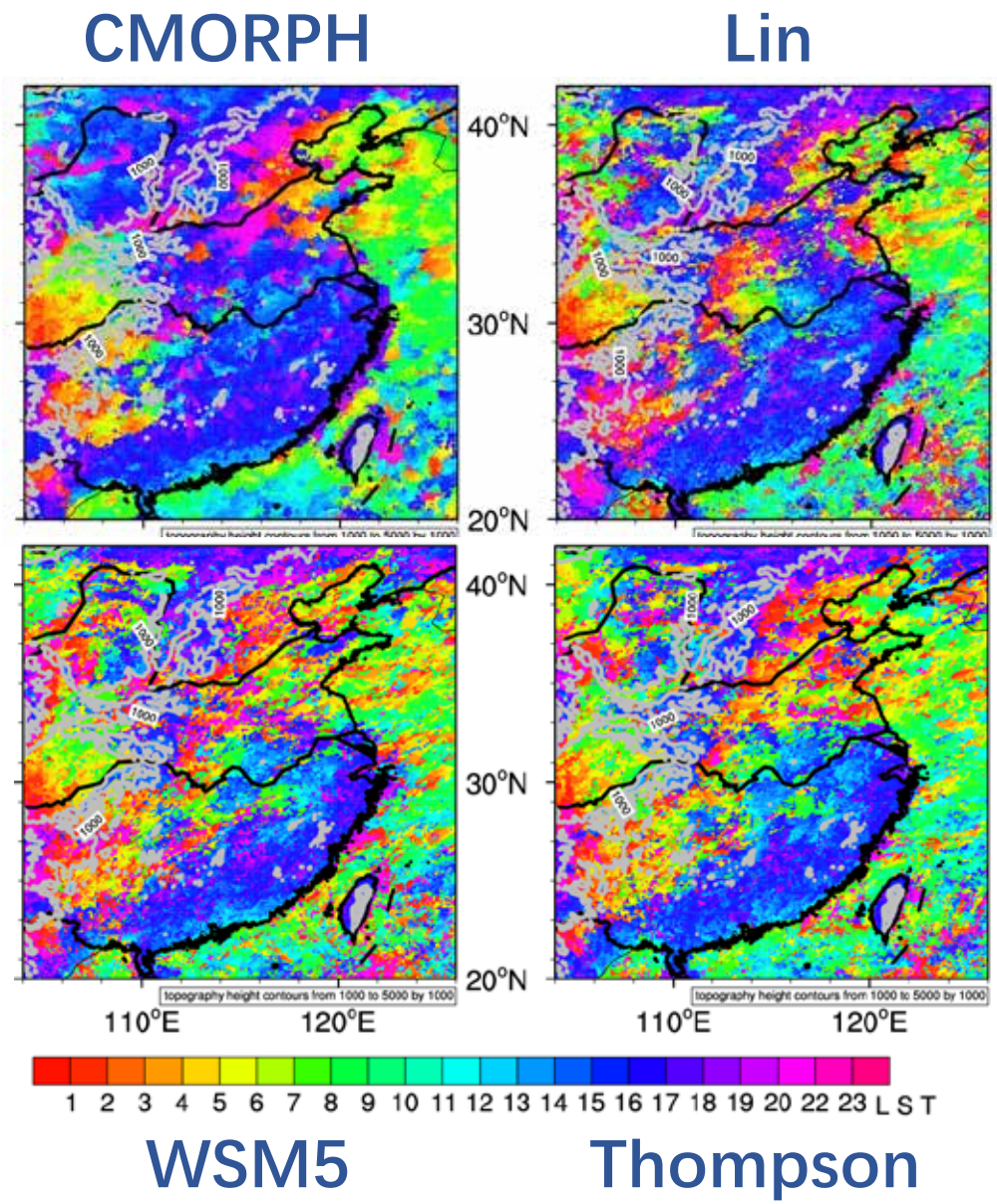


1.0-10.0 mm/day Little
10.0-25.0mm/day Middle
25.0-50.0mm/day Heavy
≥50.mm/day Torrential

Thompson experiment has the lowest RMSEs.

Three experiments perform well for frequencies of heavy and torrential precipitation.

Results –diurnal phase



the late afternoon-to-evening peak can be well simulated.

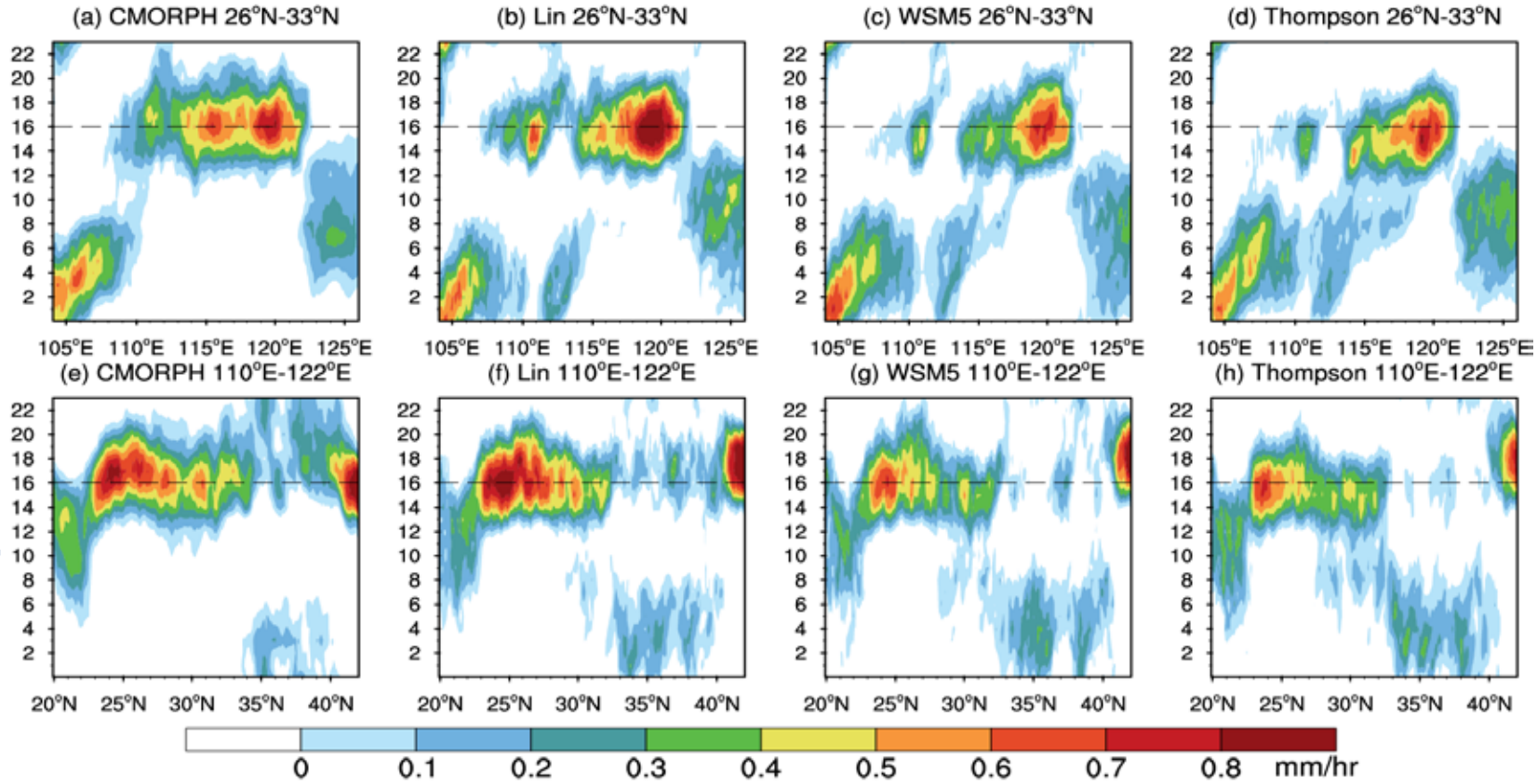
Simulated phase is shifting over complex terrain areas.

Results – transition features

CMORPH Lin WSM5 Thompson

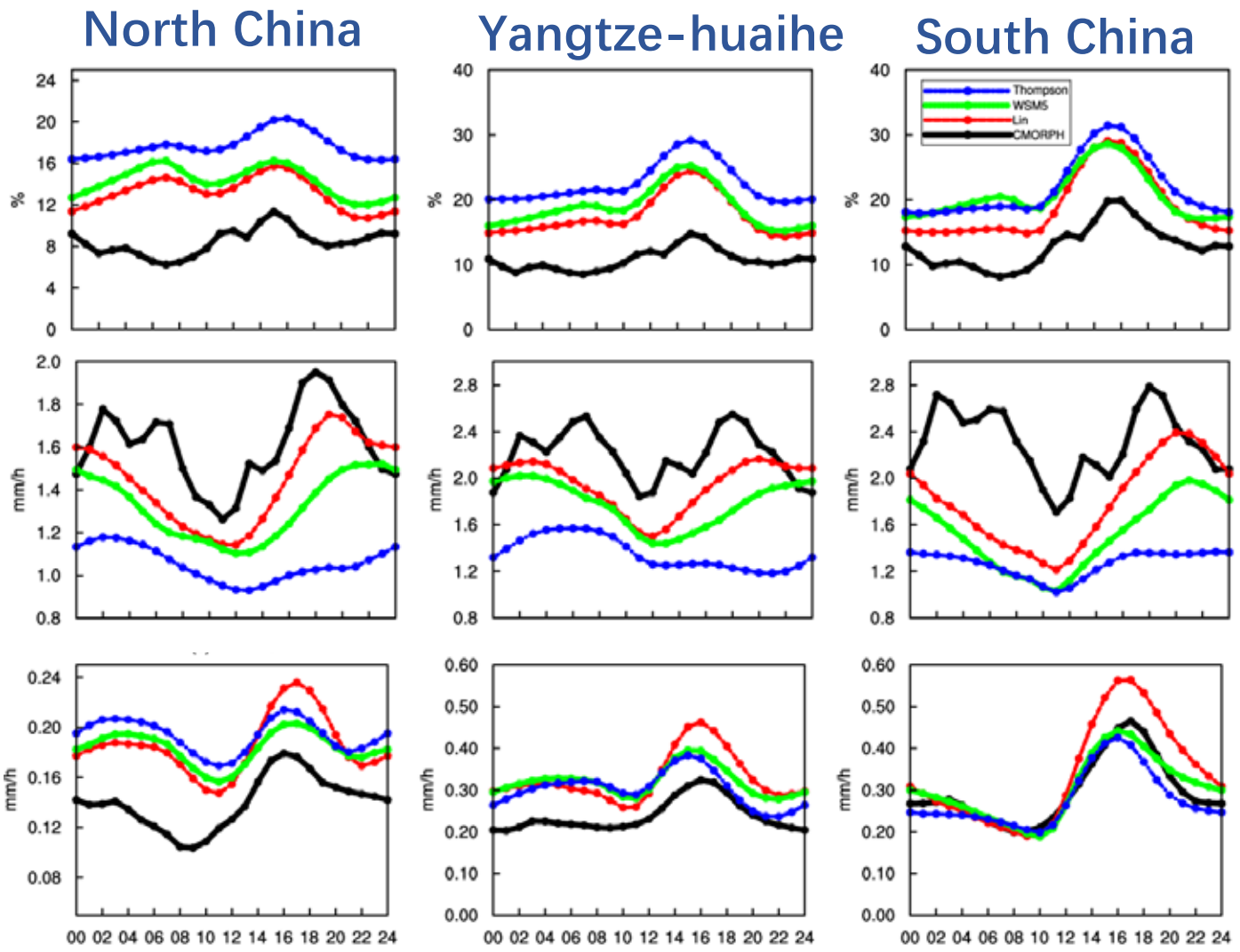
26°-33°N

110°-122°E



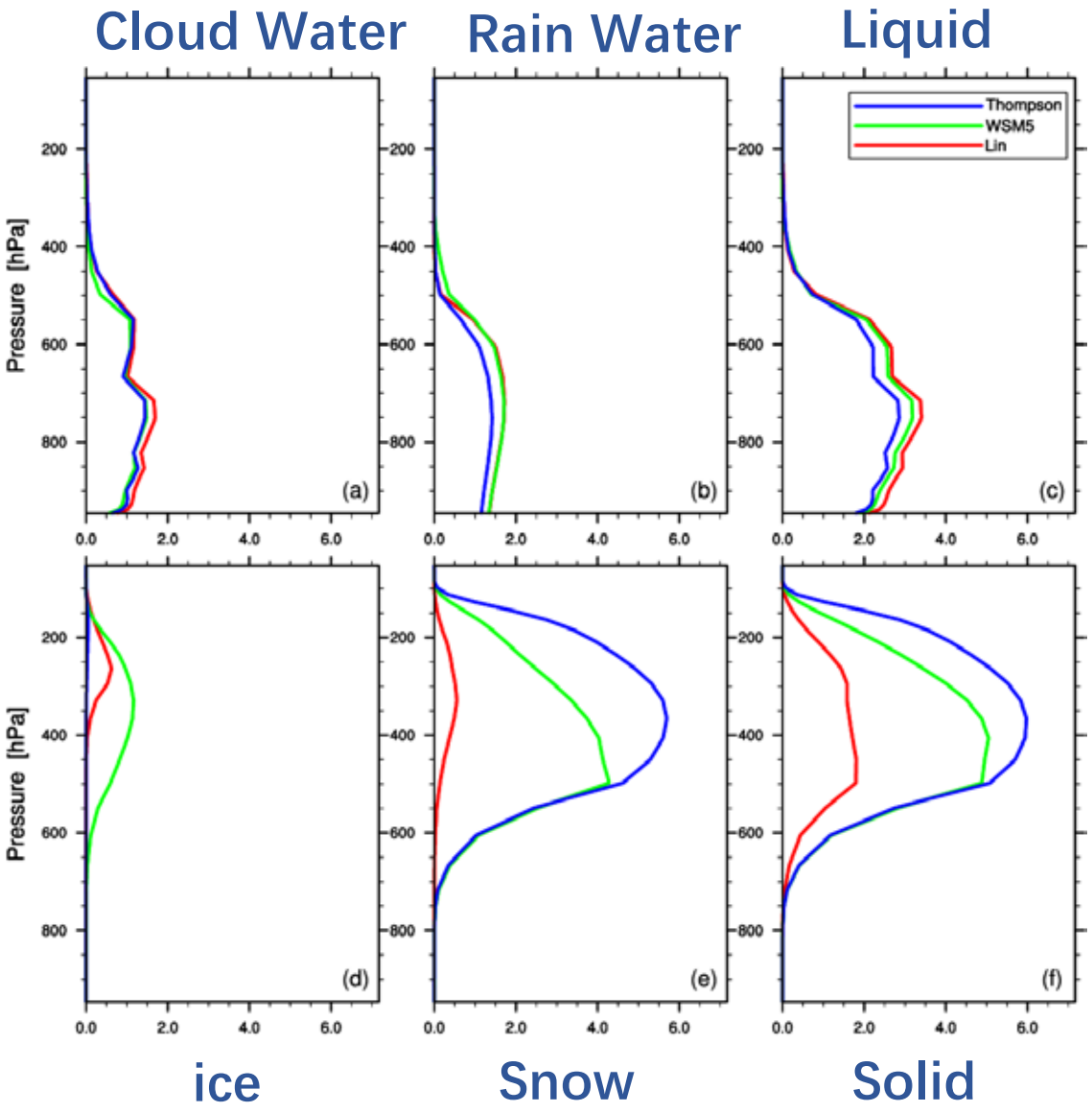
Eastward transitions can be well captured by the simulations.
But three experiments simulate false morning precipitaition

Results – diurnal cycles



Overestimate precipitation frequency and underestimate the precipitation intensity.

Results – vertical profiles



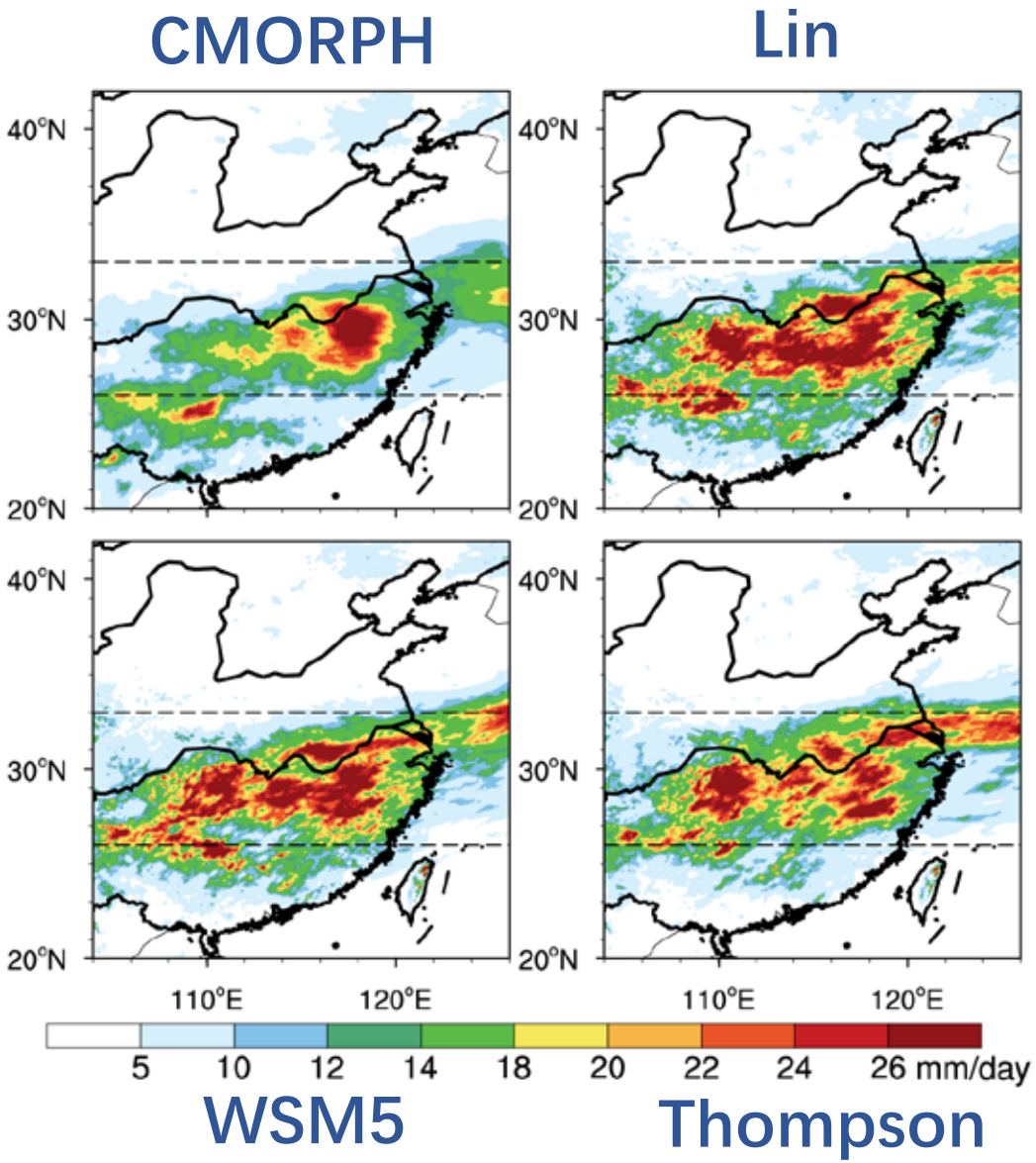
Units: 10^-2 g kg-1

The vertical profiles of solid hydrometeors, especially the snow and graupel particles, significantly affect the precipitation amount.

Results – Composite of heavy rain cases

mean

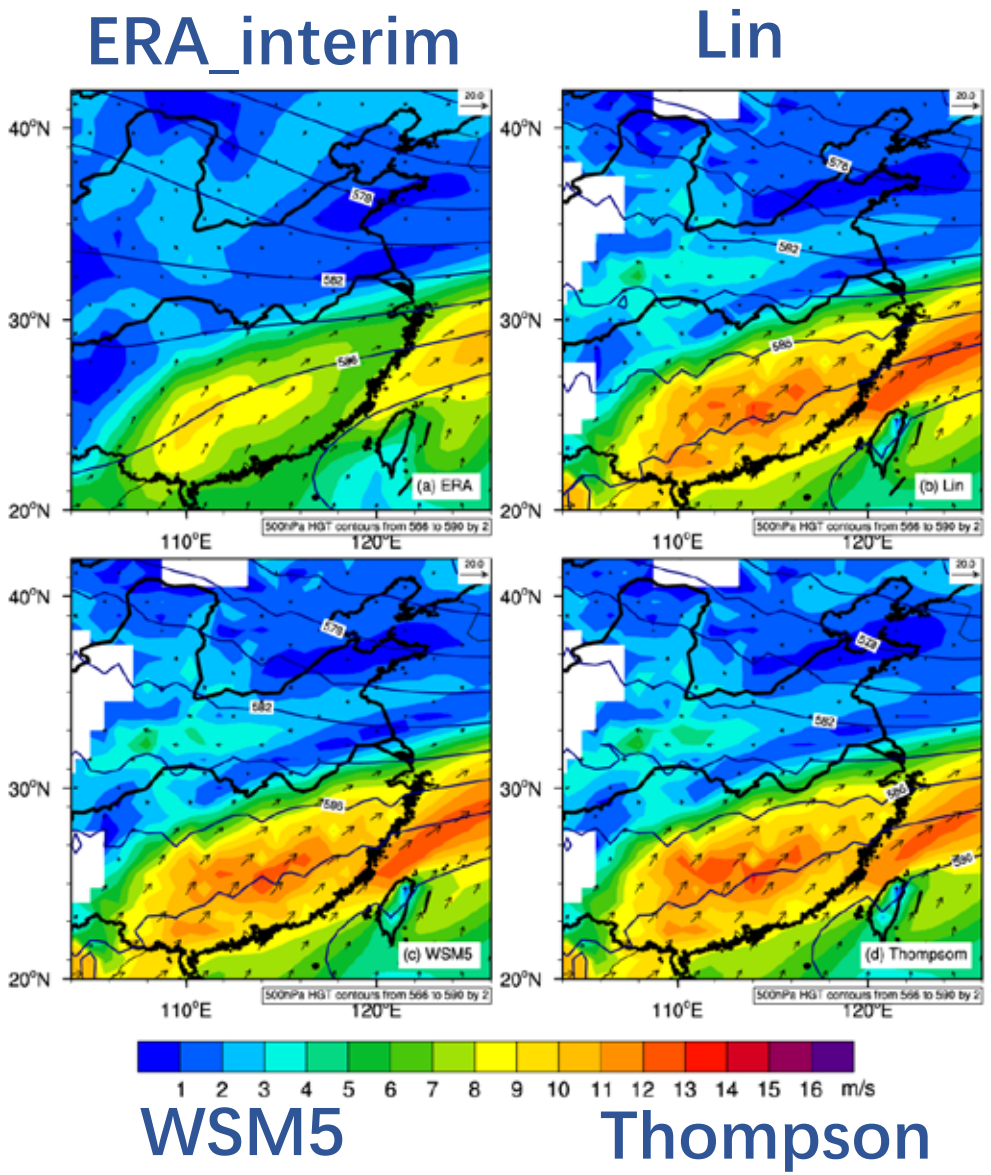
Overestimations over Yangtze-huaihe River are the systematic biases.
Thompson best matches the CMORPH



Results – Composite of heavy rain cases

Large-scale circulations

Large-scale atmospheric circulations are insensitive to the microphysics, which do not clearly reduce the systematic biases



Results – Composite of heavy rain cases

Hydrometeors

Prep

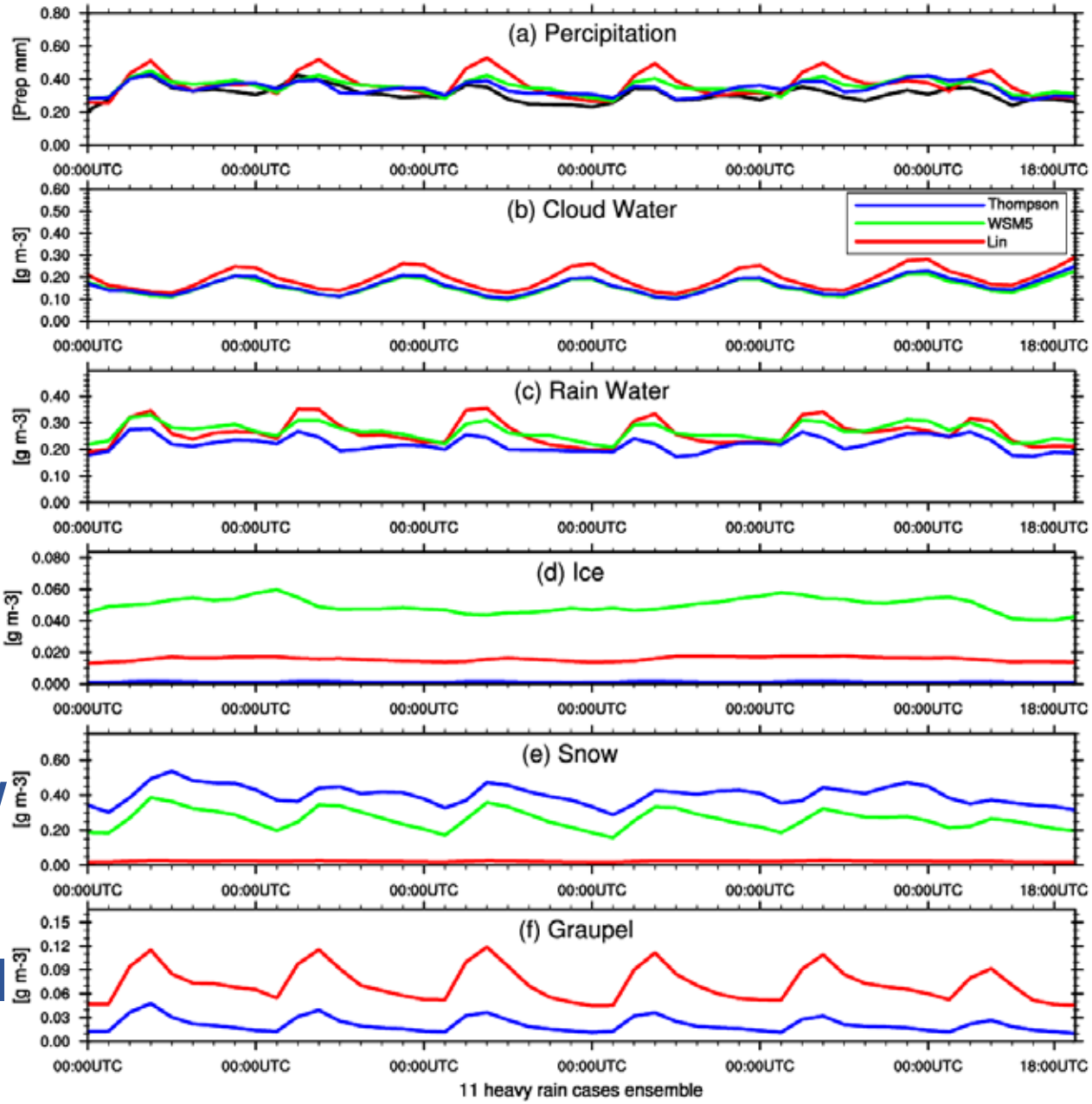
Cloud water

Rain

ice

snow

graupel



Thompson scheme creates more snow particles (less graupel) than WSM5 (Lin) scheme, and produces the least precipitation amount that best matches the CMORPH

Summary

- ✓ CPM can reasonably reproduce the precipitation frequencies for different grades. But it overestimates the precipitation amount, especially for the heavy rain
- ✓ CPM provides more information over complex terrain areas.
- ✓ Large-scale atmospheric circulations are insensitive to the microphysics parameterization, which do not significantly reduce the systematic biases.
- ✓ CPM can capture the afternoon diurnal phase and transition characteristics.
- ✓ CPM overestimates precipitation frequency and underestimates the precipitation intensity.
- ✓ The vertical profiles of solid hydrometeors, especially the snow and graupel particles, play important roles in precipitation amount simulations.

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The End,
Thank you for listening!