

Challenges for high resolution simulation over the Himalayas

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[Introduction]

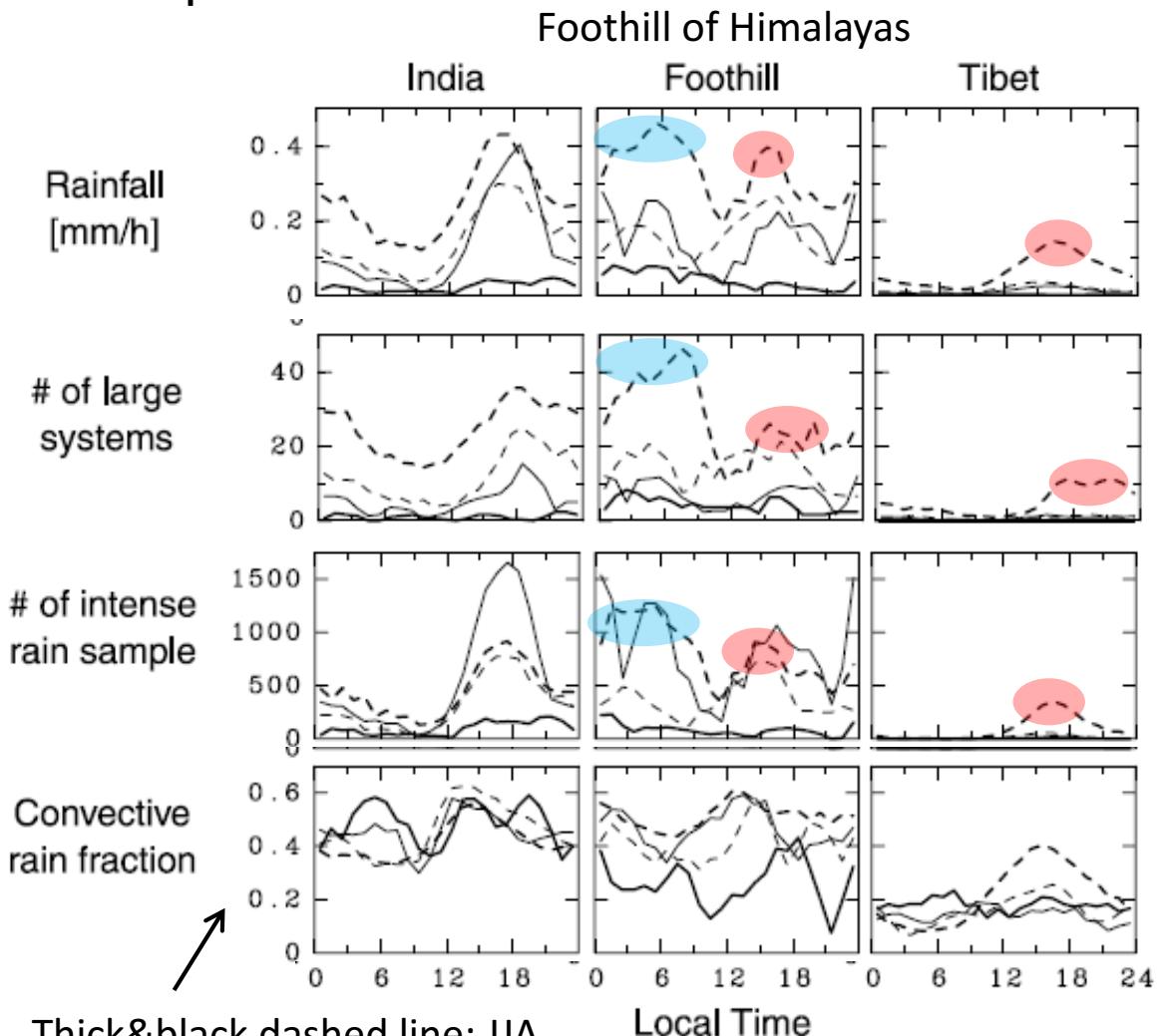
Active diurnal cycle in precip. over & around the Tibet/Himalayas in summer

Tibetan Plateau: Single maximum peak

South of Himalayas: Double maximum peaks

Sugimoto and Takahashi (2016, SOLA) could not simulate the diurnal cycle in precipitation using 5km resolution simulation.

In addition, it is difficult to discuss precipitation process over mountain slopes in the 5km resolution experiments.

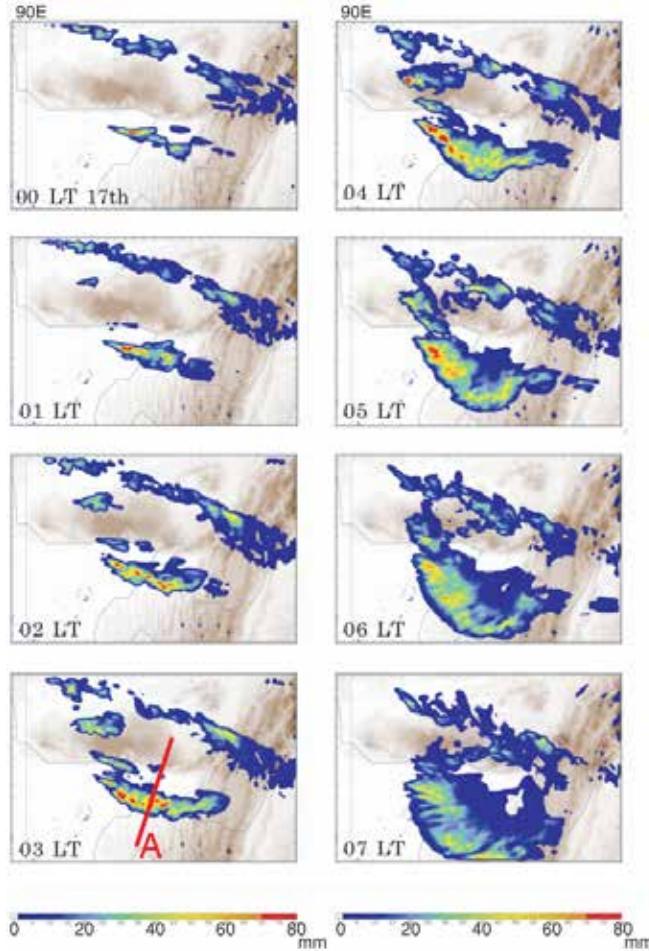


Adapted from Hirose and Nakamura (2005, JGR)

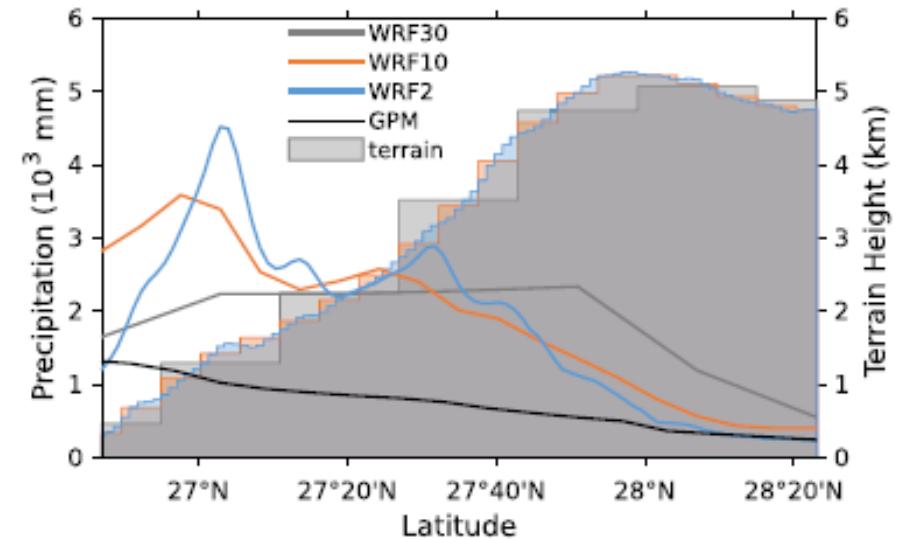
[Introduction]

To understand the diurnal cycle in precipitation and its physical process, we require cloud-resolving simulations.

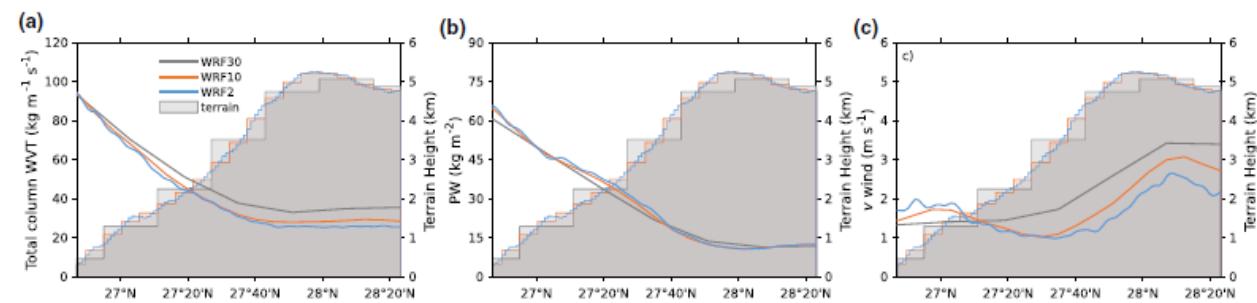
“How about the impact of topography resolution on precip. is??”



Kataoka and Satomura (2005)

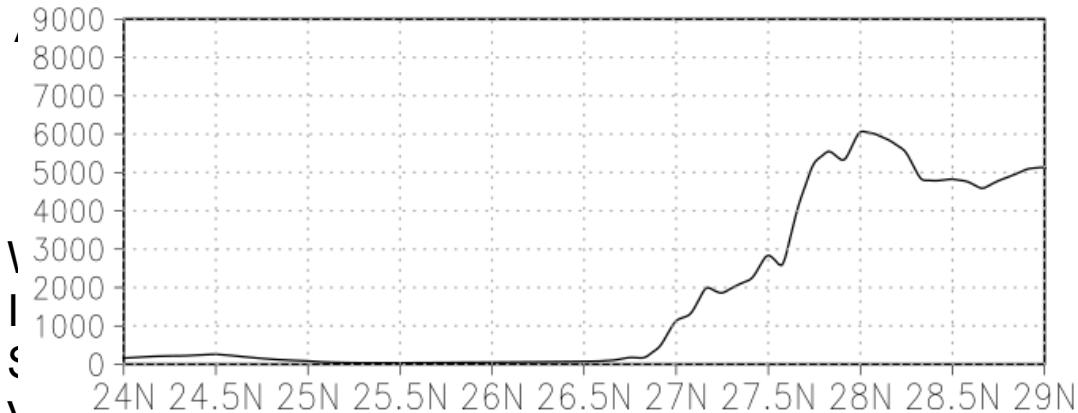


Lin et al. (2018)



[Numerical setup]

We conducted two kinds of higher resolution simulation using 2km grid spacing, (1) CTL exp.



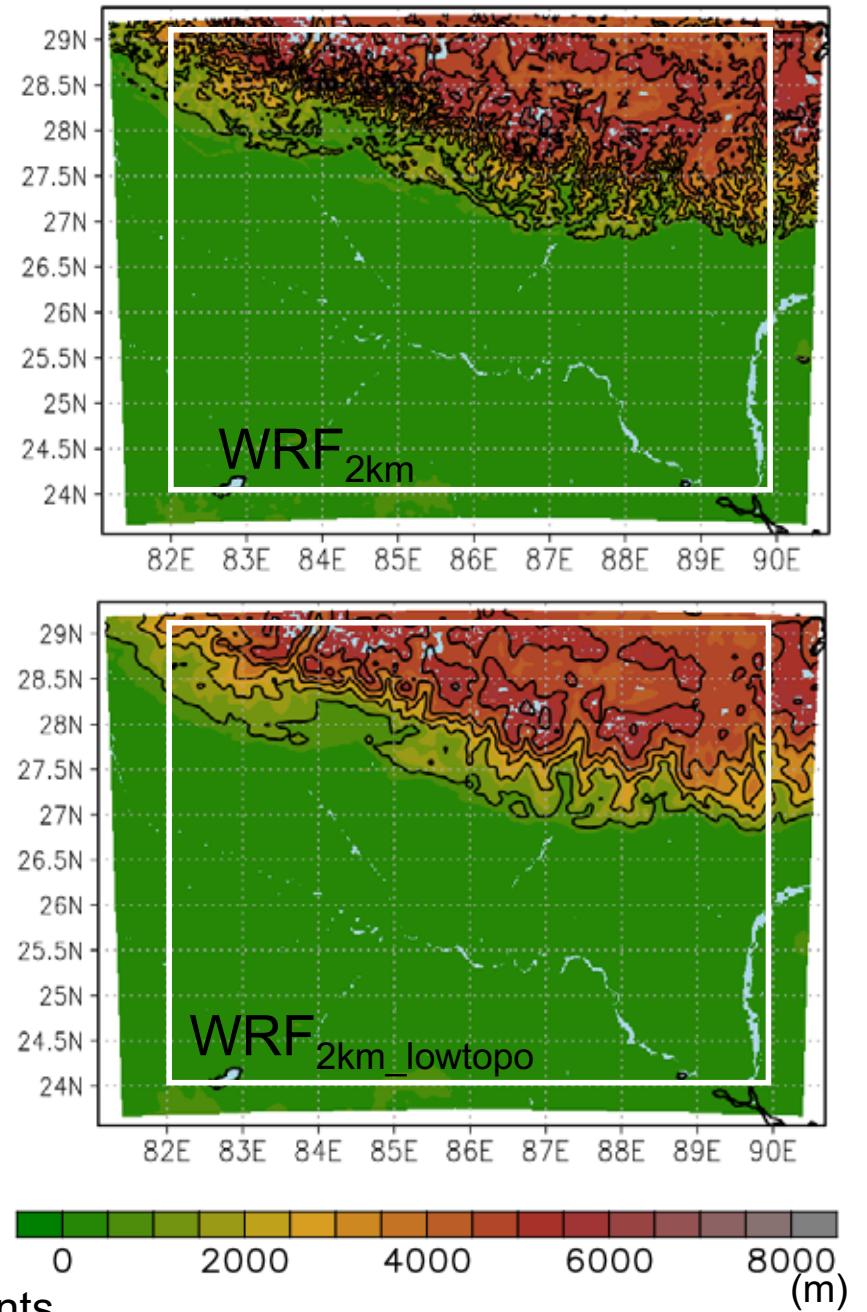
Long-wave rad.: Rapid radiative transfer model

Microphysics: Modified Thompson scheme

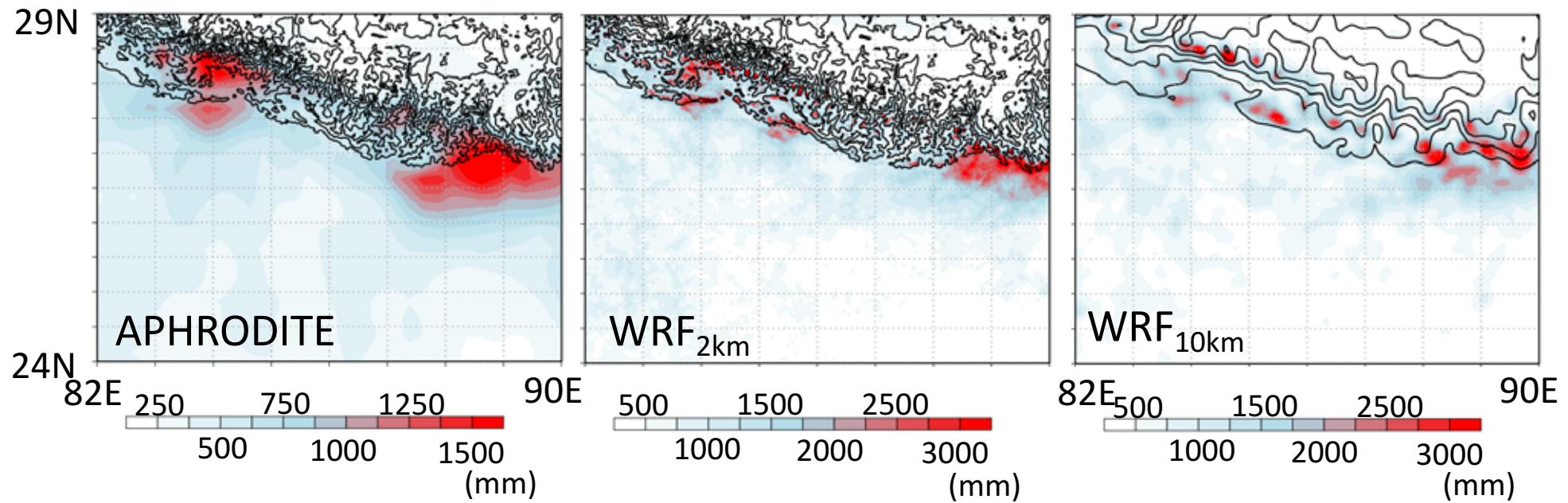
PBL: MYNN 2.5

Land surface: Noah land-surface Model

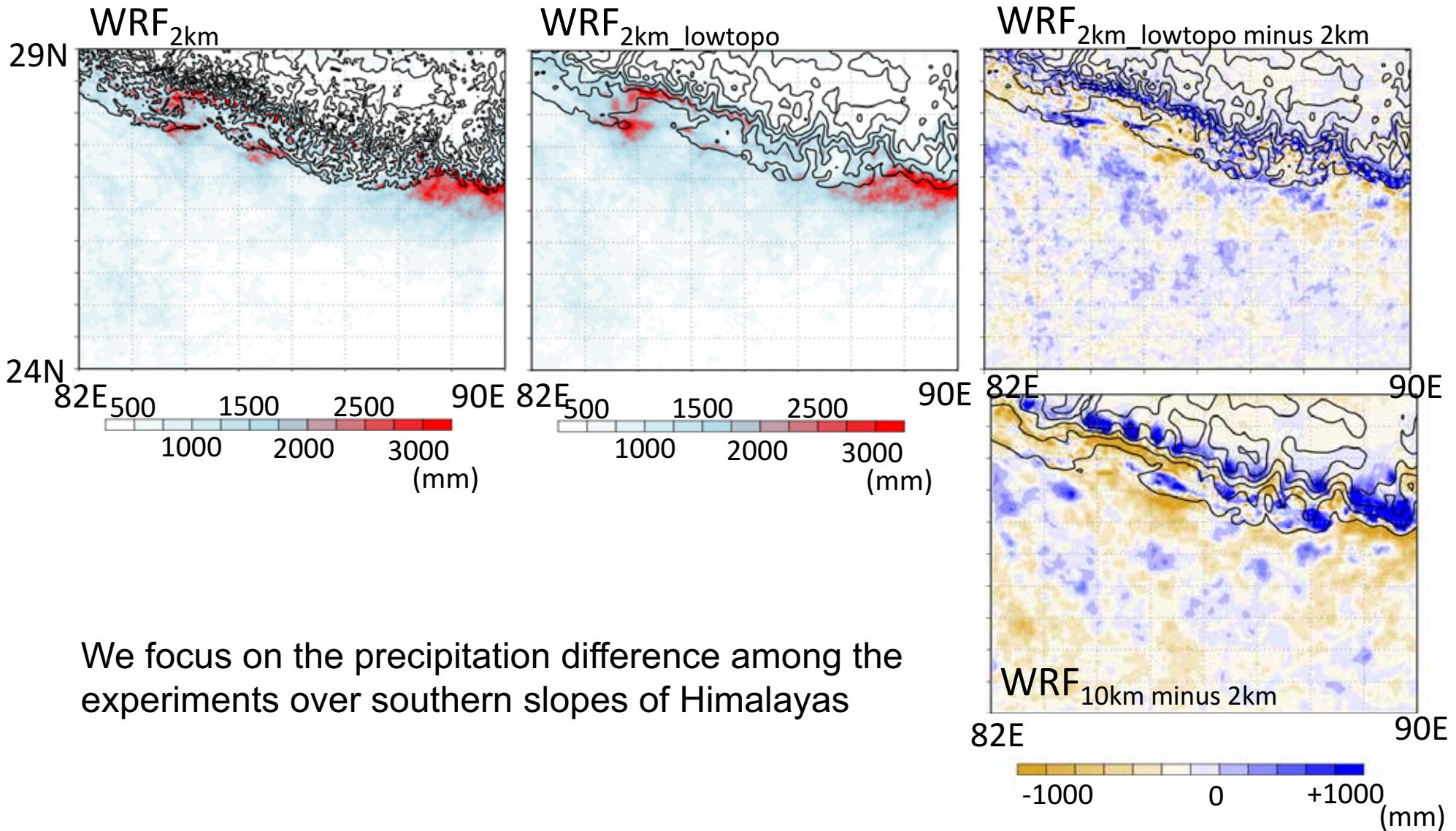
* Without Cumulus parameterization for both experiments



[Precipitation during July and August (mm)]



[Precipitation during July and August (mm)]

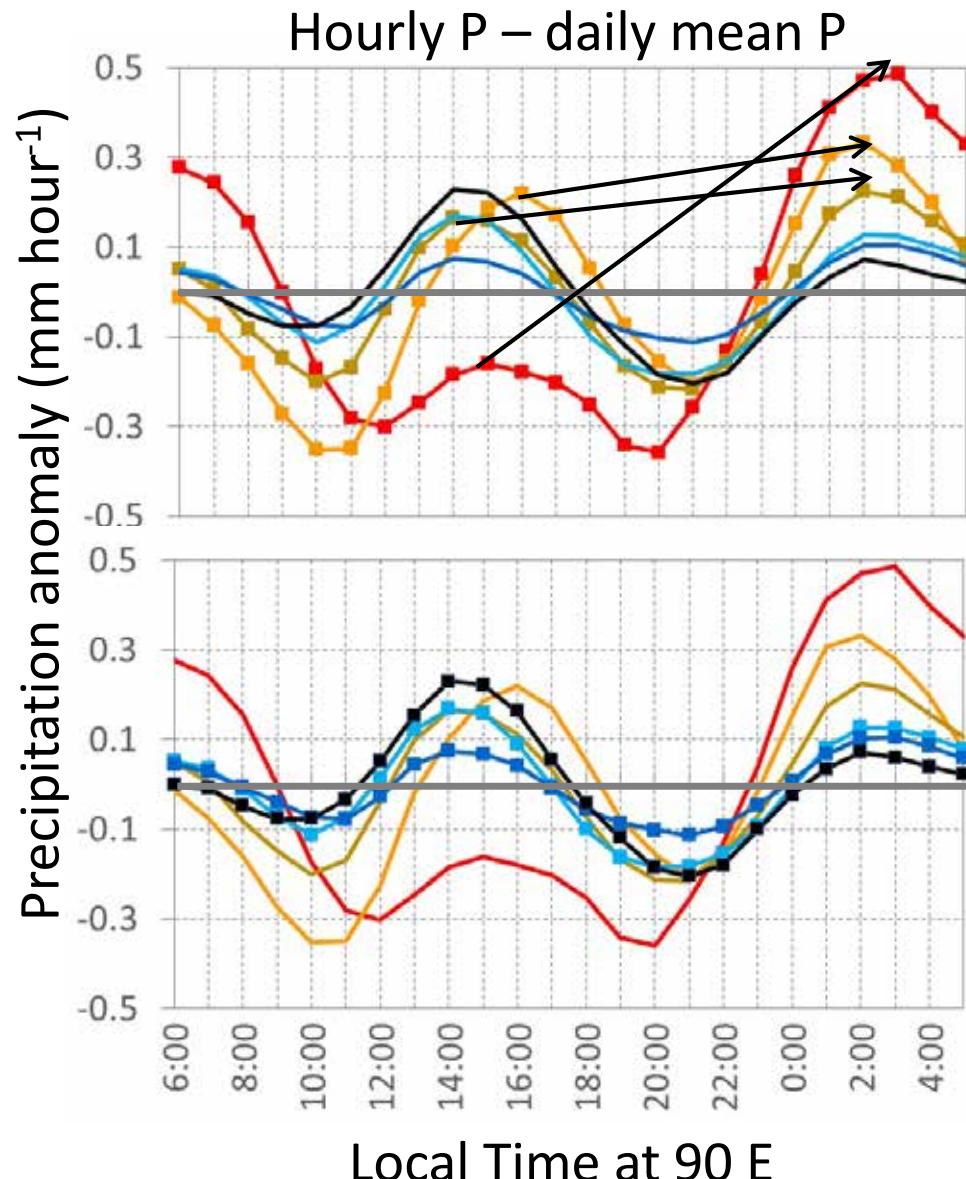


We focus on the precipitation difference among the experiments over southern slopes of Himalayas

[Diurnal variation in P and cloud depending on the altitude]

*using WRF_{2km} topography

1000~1500 m
2000~2500 m
3000~3500 m
4000~4500 m
5000~5500 m
6000~6500 m



?



Composite analysis for cloud top temperature (CTT, K)

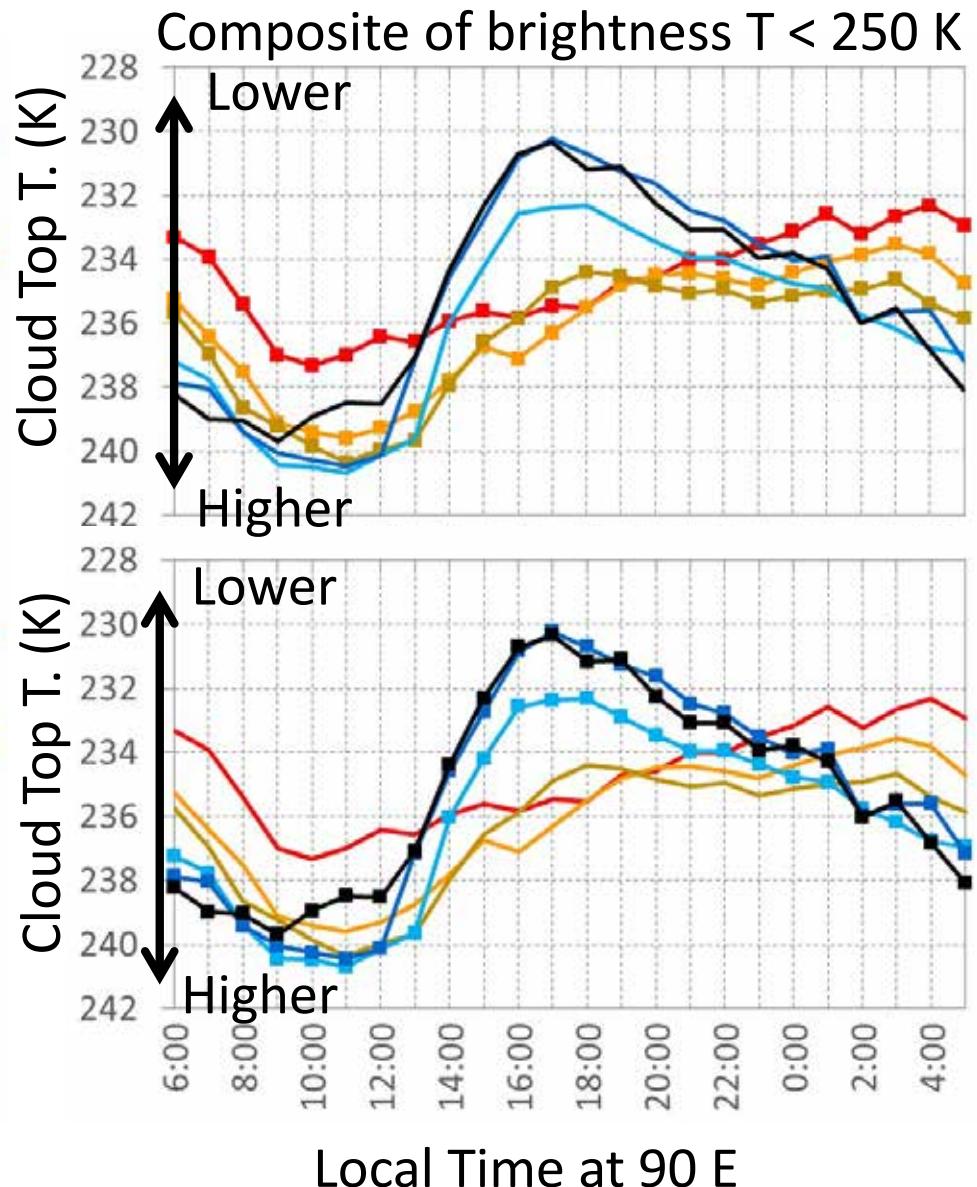
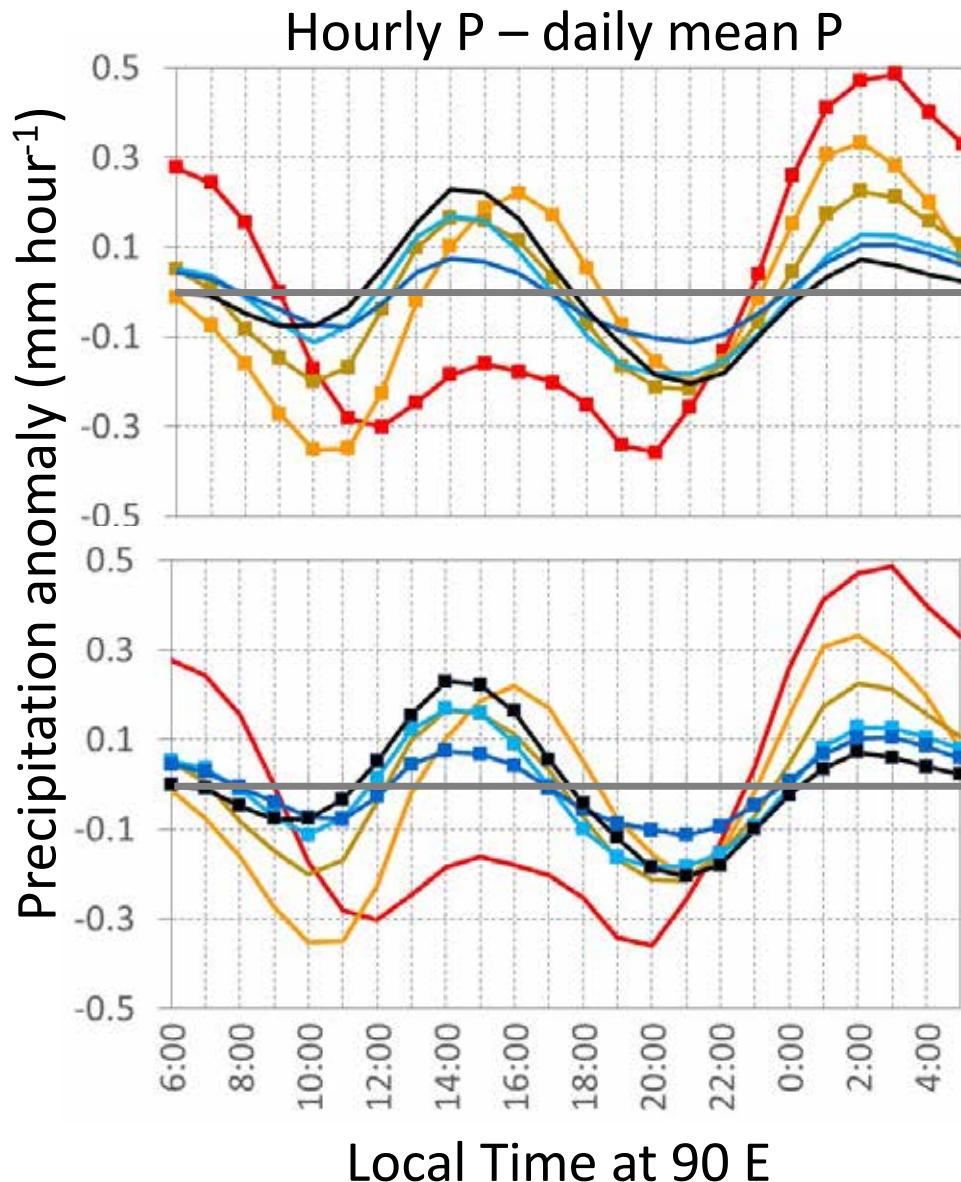
MERGED-IR (Janowiak et al. 2017),
4kmx4km, 30 min. interval

The grid with brightness temperature < 250K is detected for a cloud existing grid and uses for composite analysis.

[Diurnal variation in P and cloud
depending on the altitude]

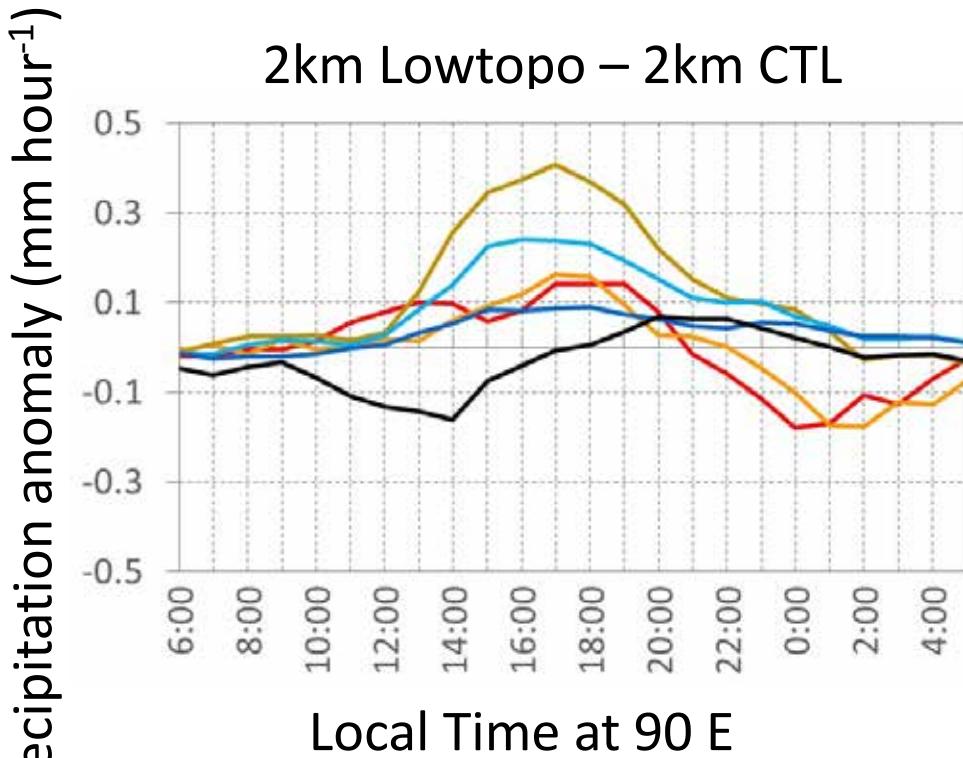
*using WRF_{2km} topography

1000~1500 m 4000~4500 m
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[Diurnal variation in P and cloud
depending on the altitude]

1000~1500 m 4000~4500 m
2000~2500 m 5000~5500 m
3000~3500 m 6000~6500 m



*using WRF_{2km} topography
for detection

[Diurnal variation in P and cloud
depending on the altitude]

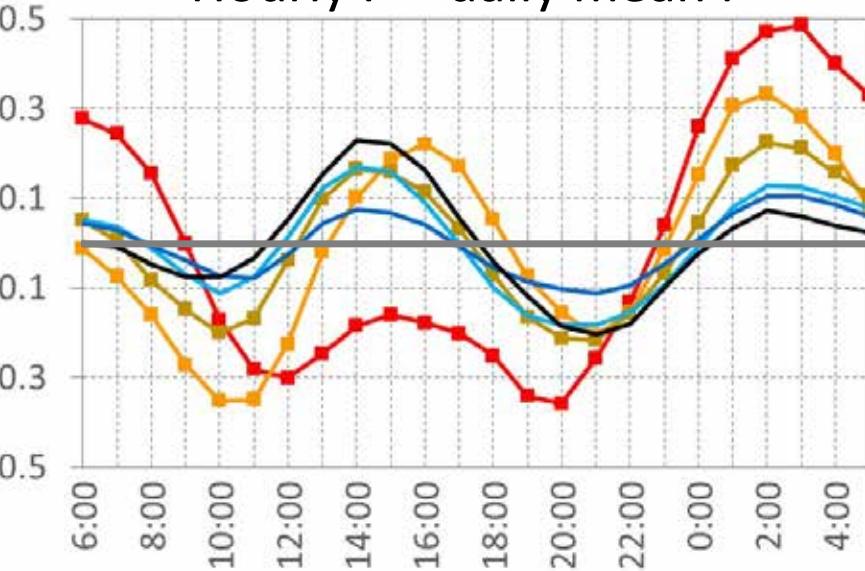
*using WRF_{2km} topography

1000~1500 m 4000~4500 m
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Precipitation anomaly (mm hour⁻¹)

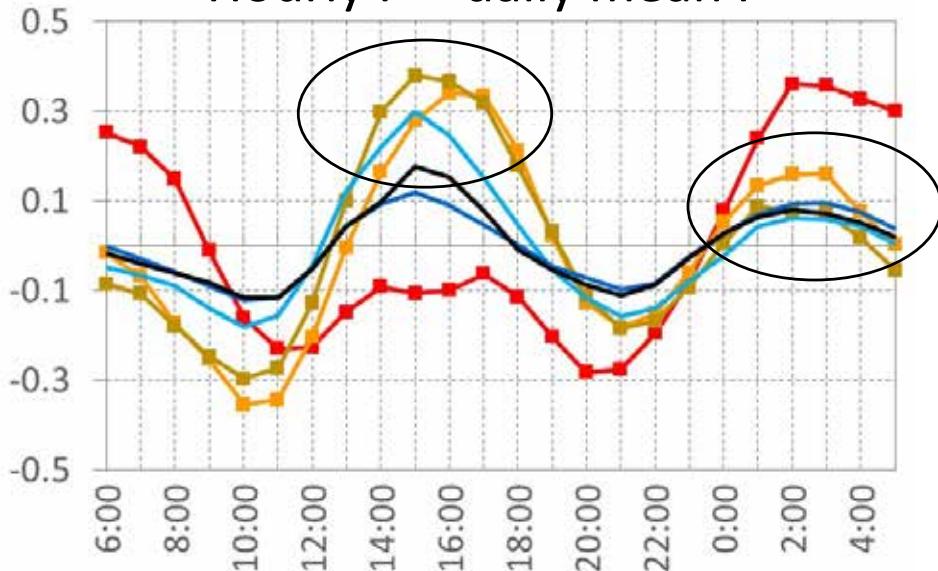
WRF_{2km}

Hourly P – daily mean P



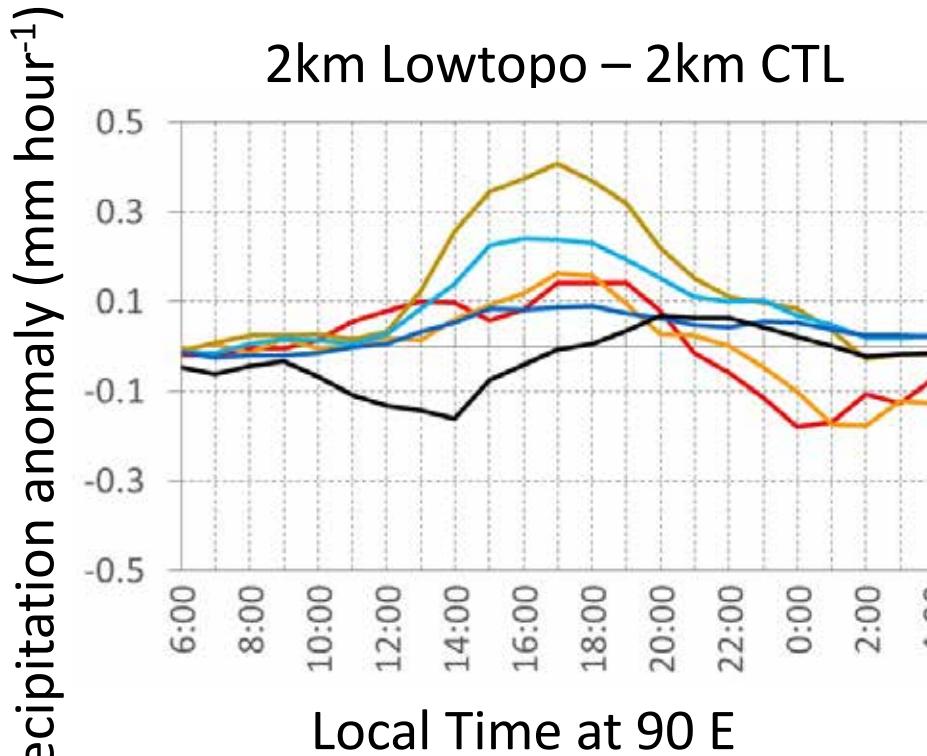
WRF_{2km_lowtopo}

Hourly P – daily mean P

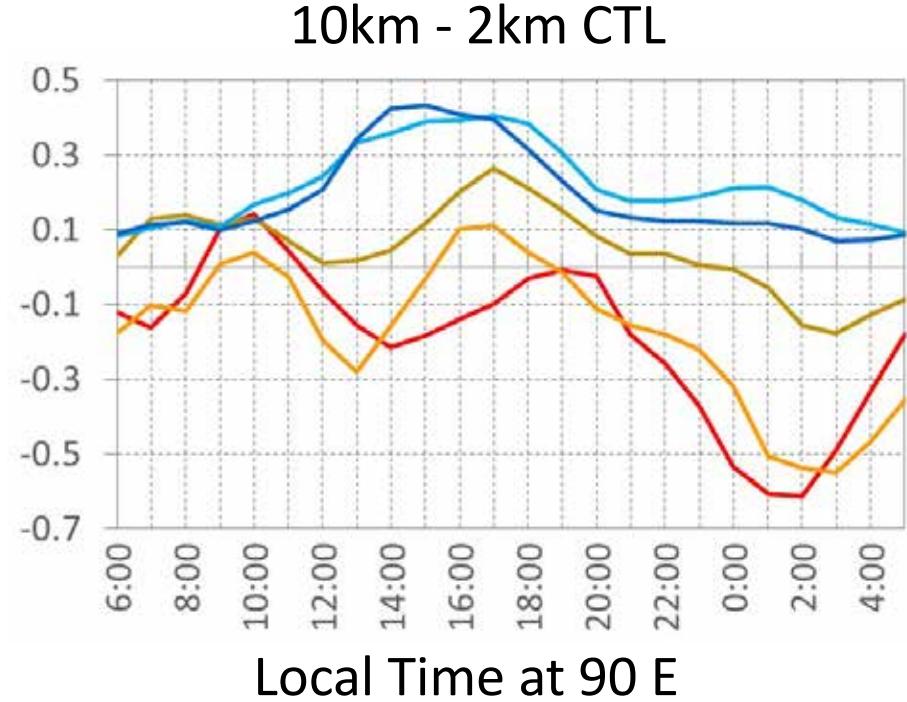


[Diurnal variation in P and cloud
depending on the altitude]

— 1000~1500 m — 4000~4500 m
— 2000~2500 m — 5000~5500 m
— 3000~3500 m — 6000~6500 m



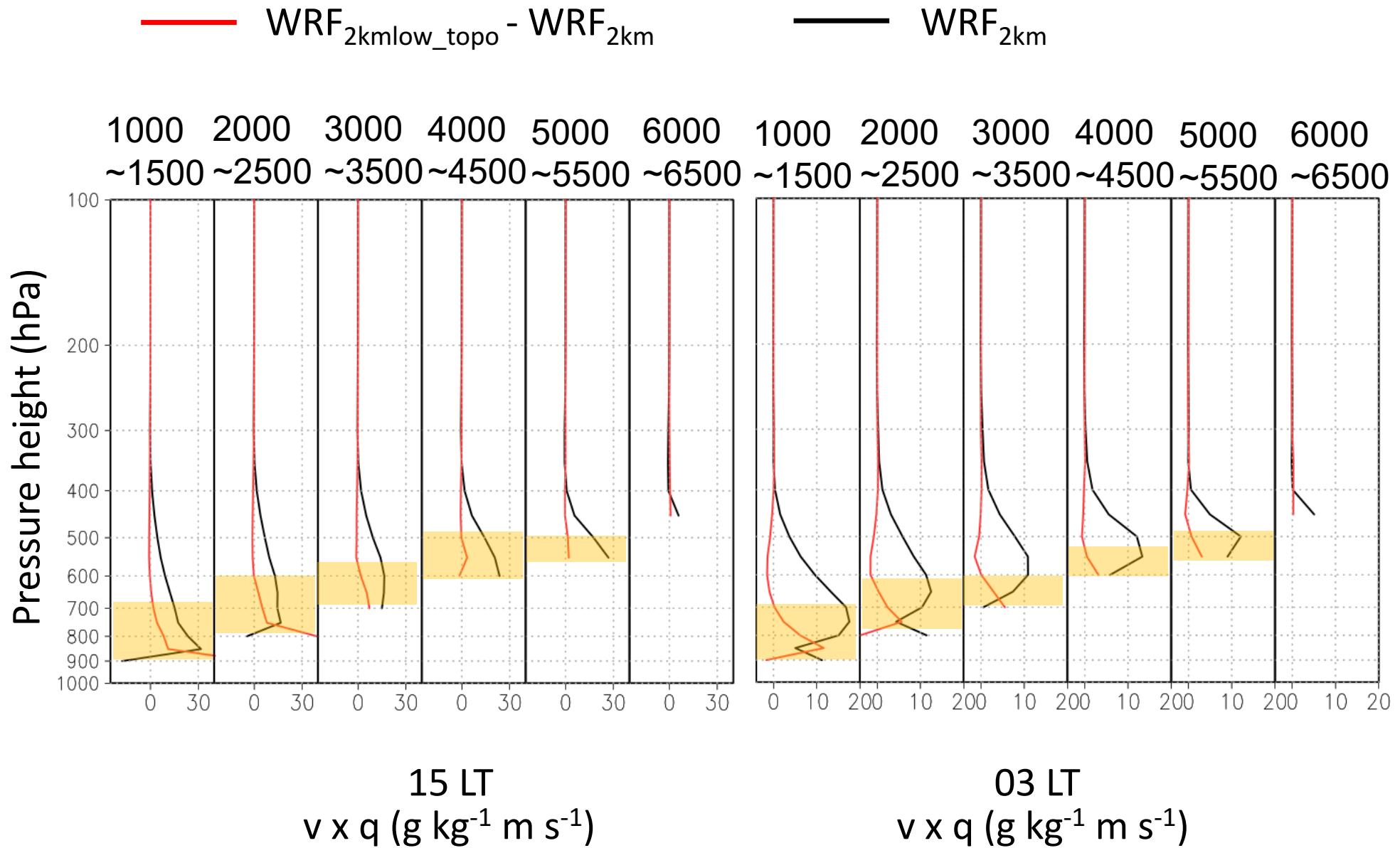
*using WRF_{2km} topography
for detection



*using WRF_{10km} topography
for detection

We suggest that diurnal cycle in precipitation over the Himalayas are strongly affected by the topography resolution

[Moisture transport from south to north]



[Summary]

We have conducted 2km resolution simulation over and around the Himalayas. Although it was one year simulation,

Lower flat area

Even though atmospheric resolution is 2km, the lower resolution topography increase daytime and nighttime precipitation over the area close to the Himalayas. However, this precipitation anomaly differs with the 10km resolution experiment, suggesting large influence of atmospheric coarse resolution on precipitation.

Mountain slopes

Lower topography increase afternoon precipitation at the mid-altitude of Himalayas because of enhancement of moisture transport. It decrease midnight precipitation at the lower-altitude of Himalayas.

The understanding of physical process causing nighttime difference in precipitation depending on the topography resolution would be my first target on the FPS. This study would contribute to the understanding of the moisture transport process to the Tibetan Plateau.

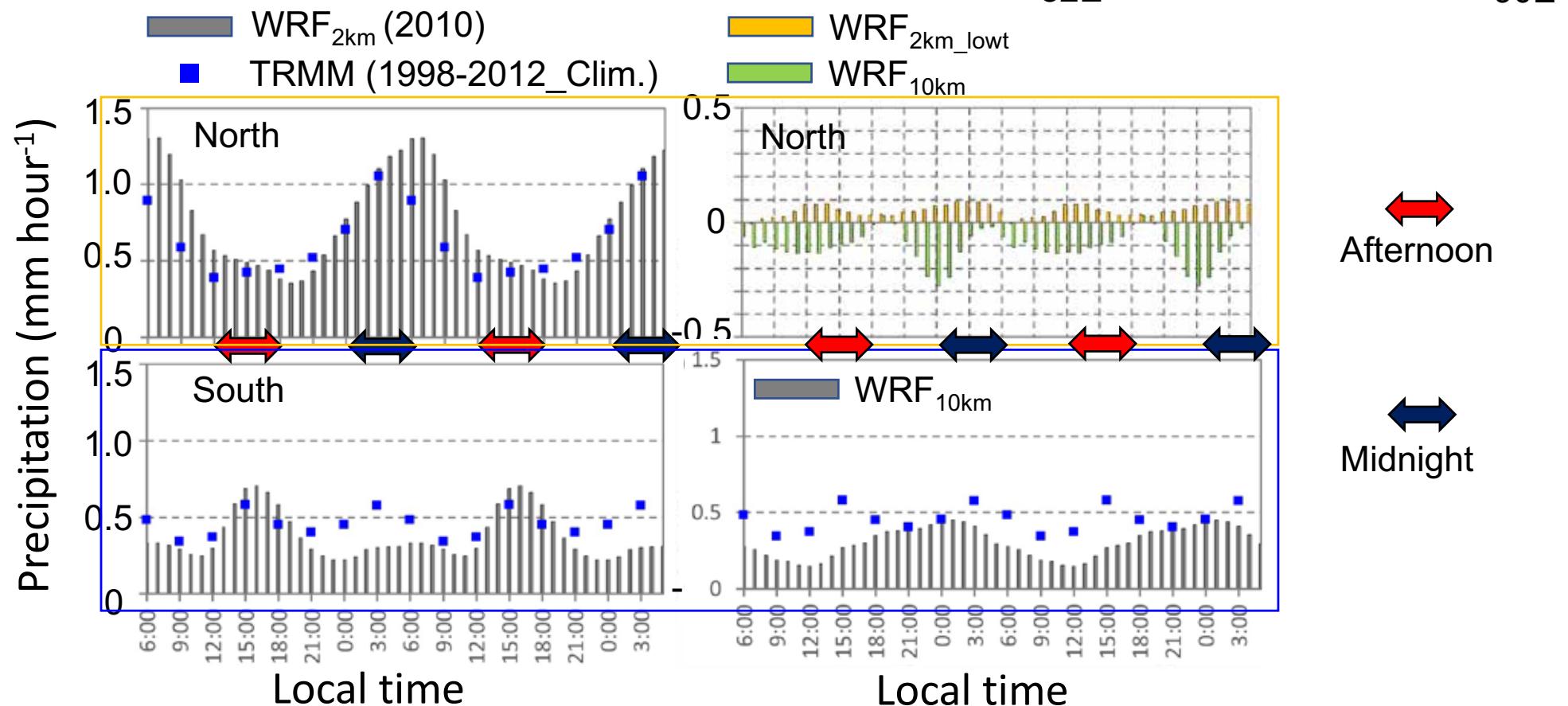
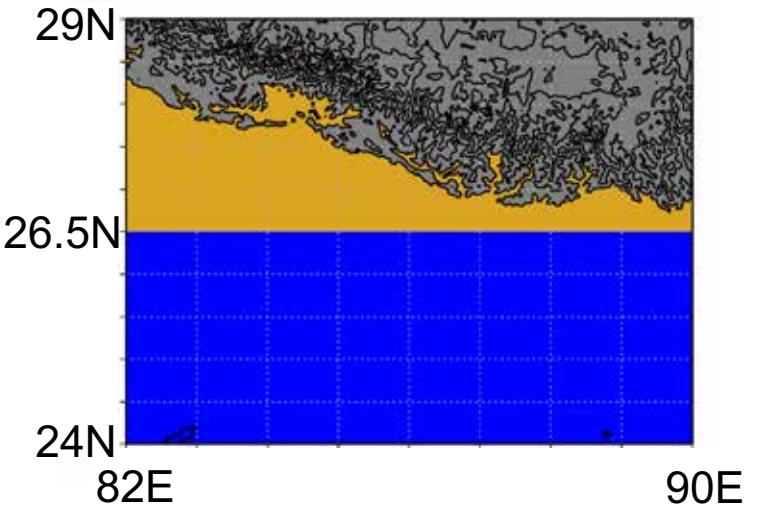
[Area-averaged precipitation during July-August]

The area close to the Himalayas

Early morning maximum peak in precipitation

The southern part of flat area

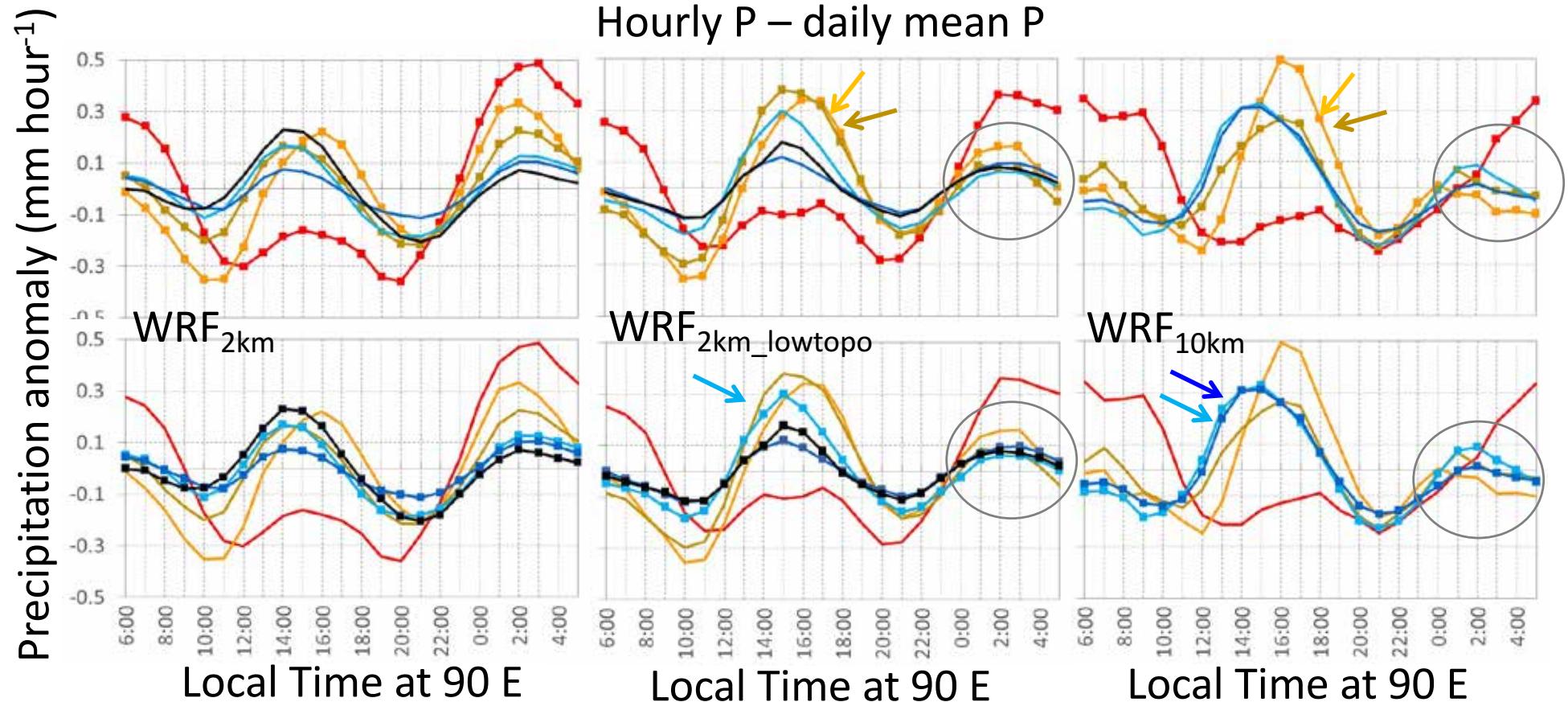
Daytime and Nighttime maximum peak



[Diurnal variation in P and cloud
depending on the altitude]

*using WRF_{2km} topography

1000~1500 m 4000~4500 m
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 3000~3500 m 6000~6500 m



Composite analysis for cloud top temperature (CTT, K)

Satellite (observation)

MERGED-IR (Janowiak et al. 2017), 4kmx4km, 30 min. interval

The grid with brightness temperature < 250K is detected for a cloud existing grid and uses for composite analysis.

WRF (output for 21 pressure levels), 30 min. interval

The grid with Hydrometeors($qc+qi+qr+qg+qs>0.00015 \text{ kg kg}^{-1}$) is detected for a cloud existing grid, and the temperature of top layer with cloud is defined as the cloud top temperature.

If the cloud top temperature < 250K, the data is used for composite analysis.

