Impact of nudging method in land surface temperature initialization on LS4P simulation

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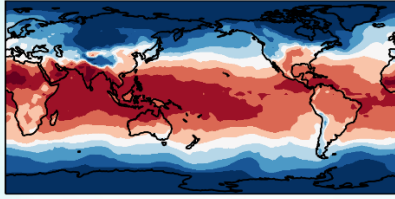LS4P Phase II Kickoff Workshop
Chicago, IL, December 11, 2022

Nudging for AMIP runs to match time-specific obs

- LS4P experiment requires more realistic initial conditions (esp. for land surface)
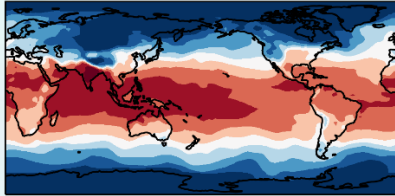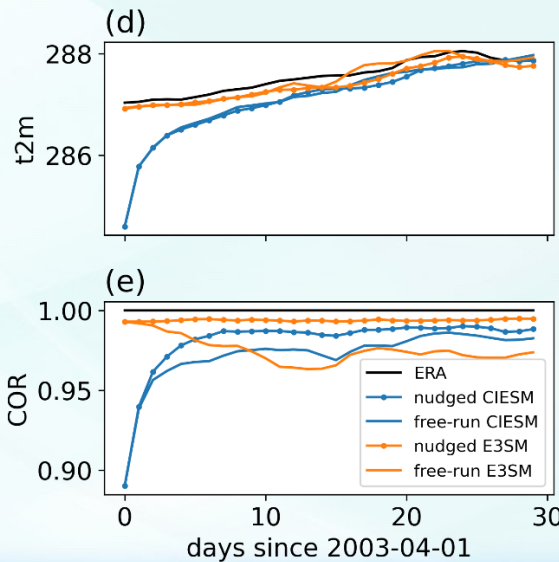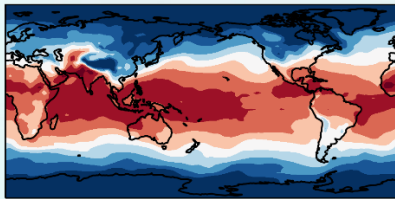- 1-month nudging is applied.
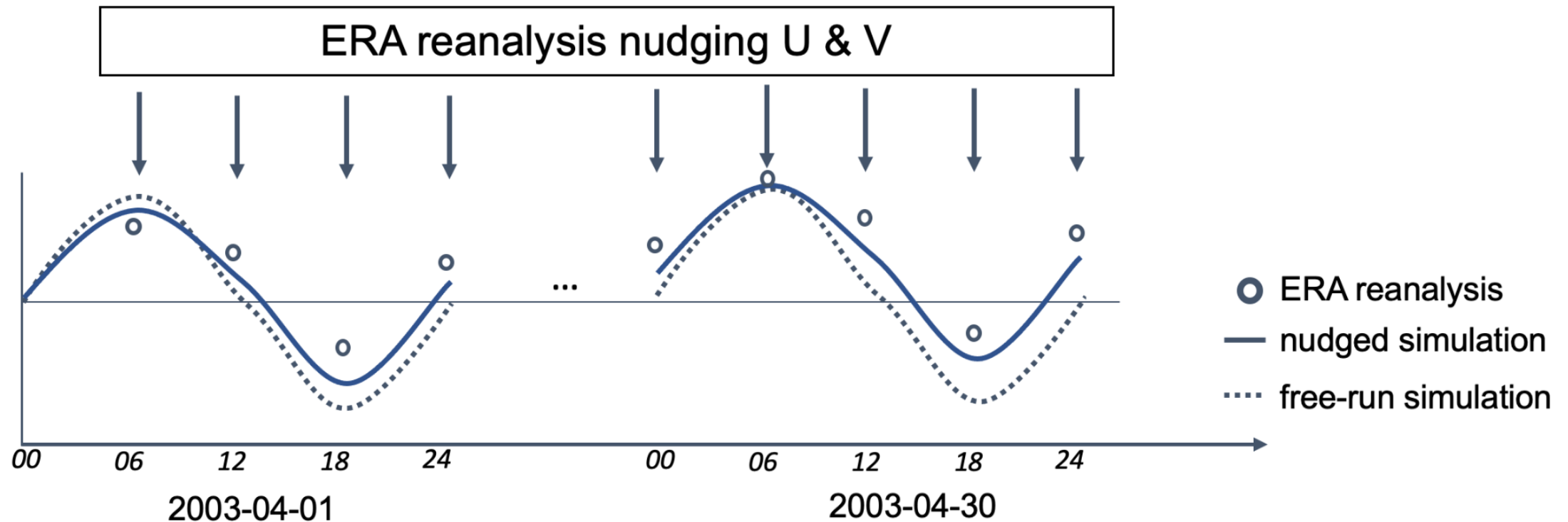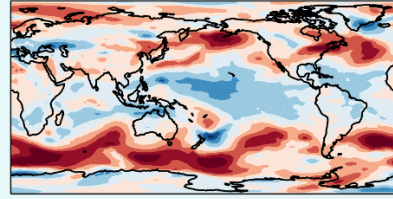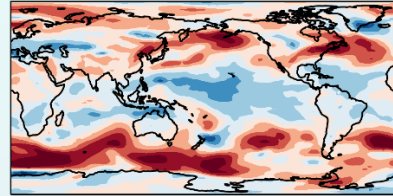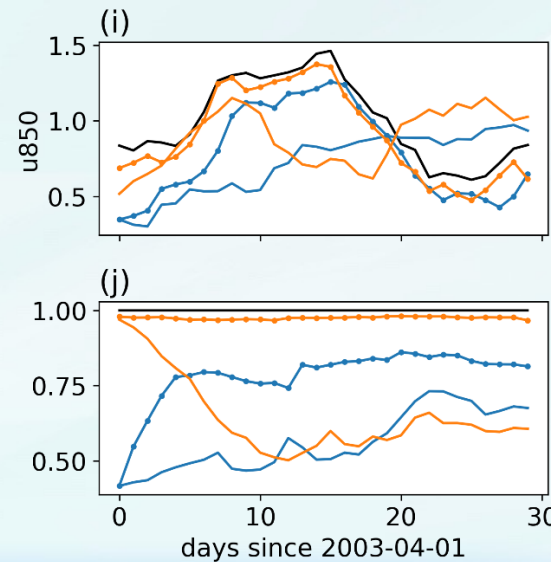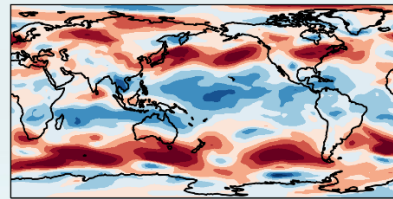
After 1-month nudging, near surface variables in the atmosphere are closer to the observed at the beginning (May 1, 2003) of LS4P-I experiments for climate models, e.g., E3SM and CIESM.

Qin et al., to be submitted

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Tibet Plateau soil temperature profiles
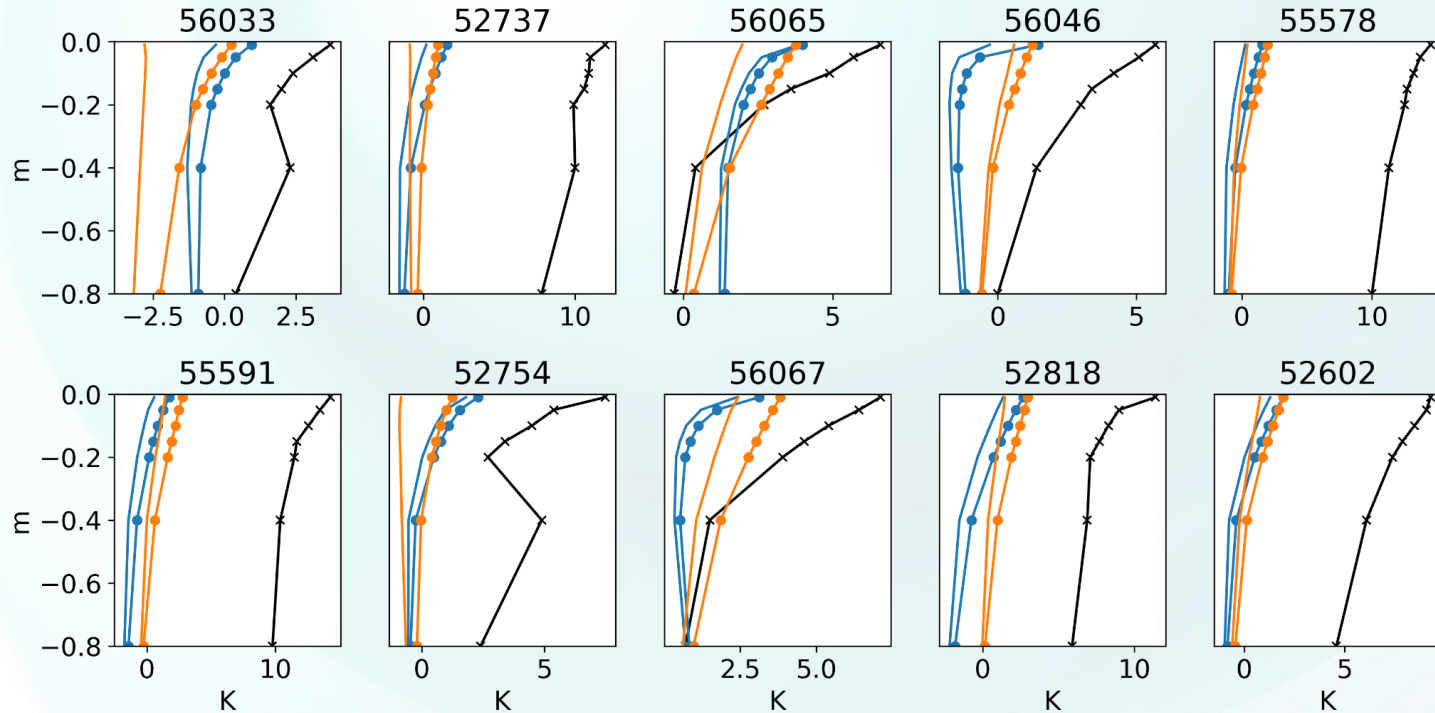

Improved soil T profiles as observed, which are better for adding LS4P land T perturbations for sub-seasonal to seasonal (S2S) prediction.
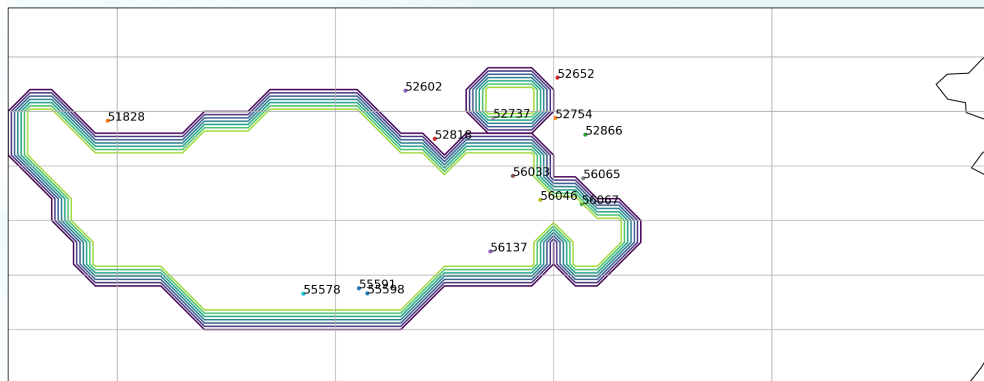
Observational data provided by Ye Liu

Qin et al., to be submitted

200-hPa wave patterns on May 1, 2003
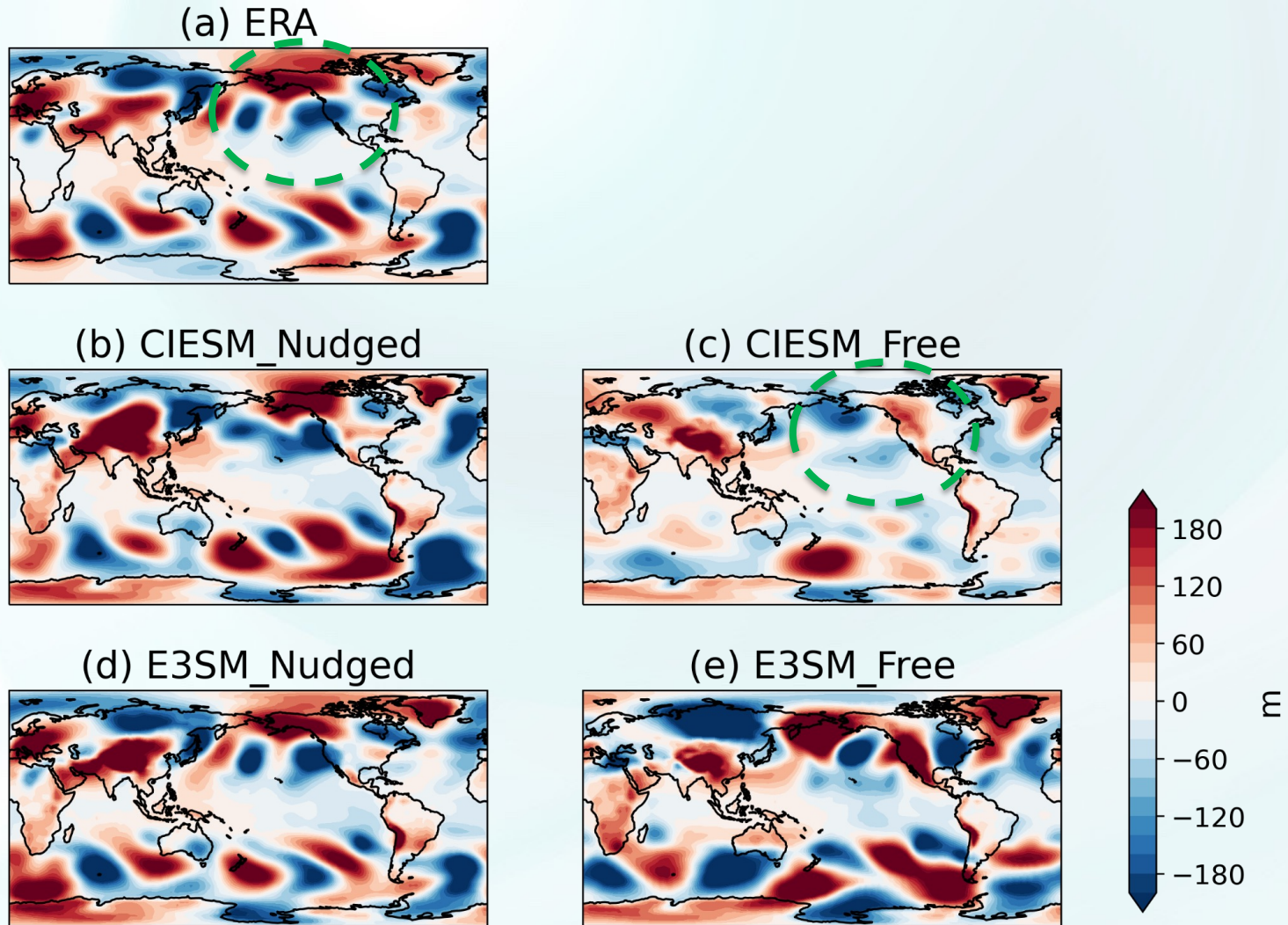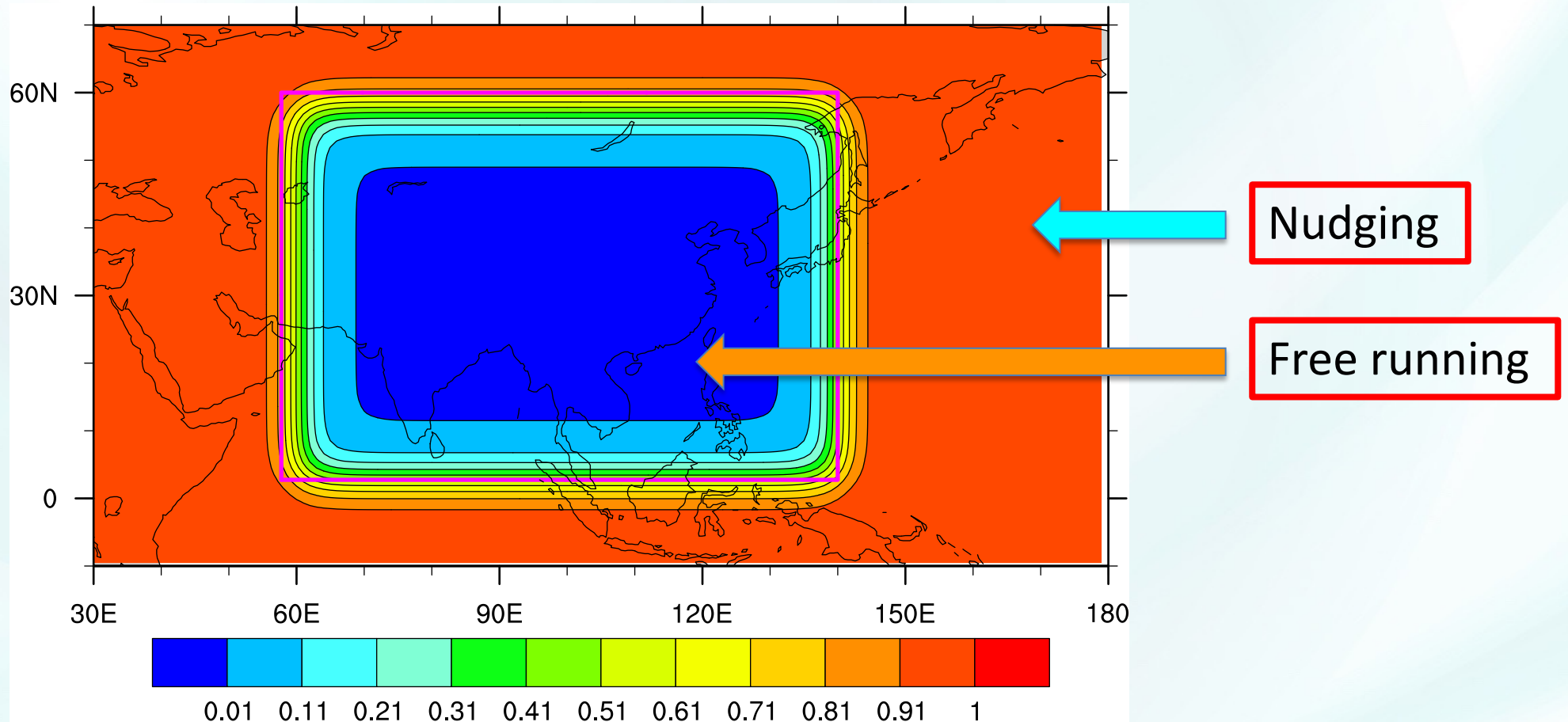## geopotential height (zonal mean removed)

(a) ERA

(b) CIESM_Nudged

(c) CIESM_Free

(d) E3SM_Nudged

(e) E3SM_Free

Large-scale patterns are substantially improved. Important for capturing responses in precipitation globally.

Qin et al., to be submitted

Precip responses flip signs w/o nudging in some regions.

(c) CIESM_N : May 2003 t2m

No nudging

(d) CIESM_N : June 2003 pre

(e) CIESM_Y : May 2003 t2m

Nudging
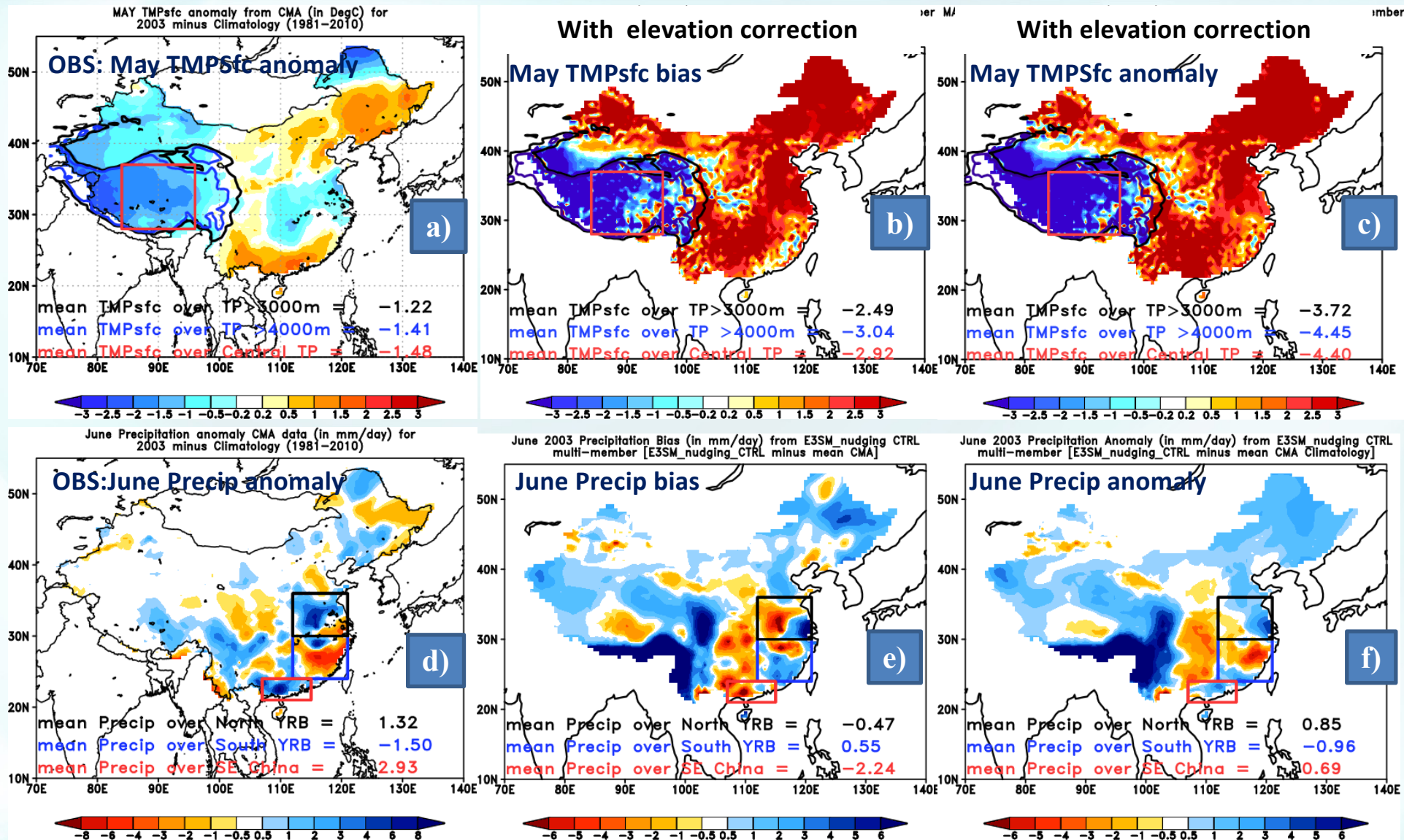
(f) CIESM_Y : June 2003 pre

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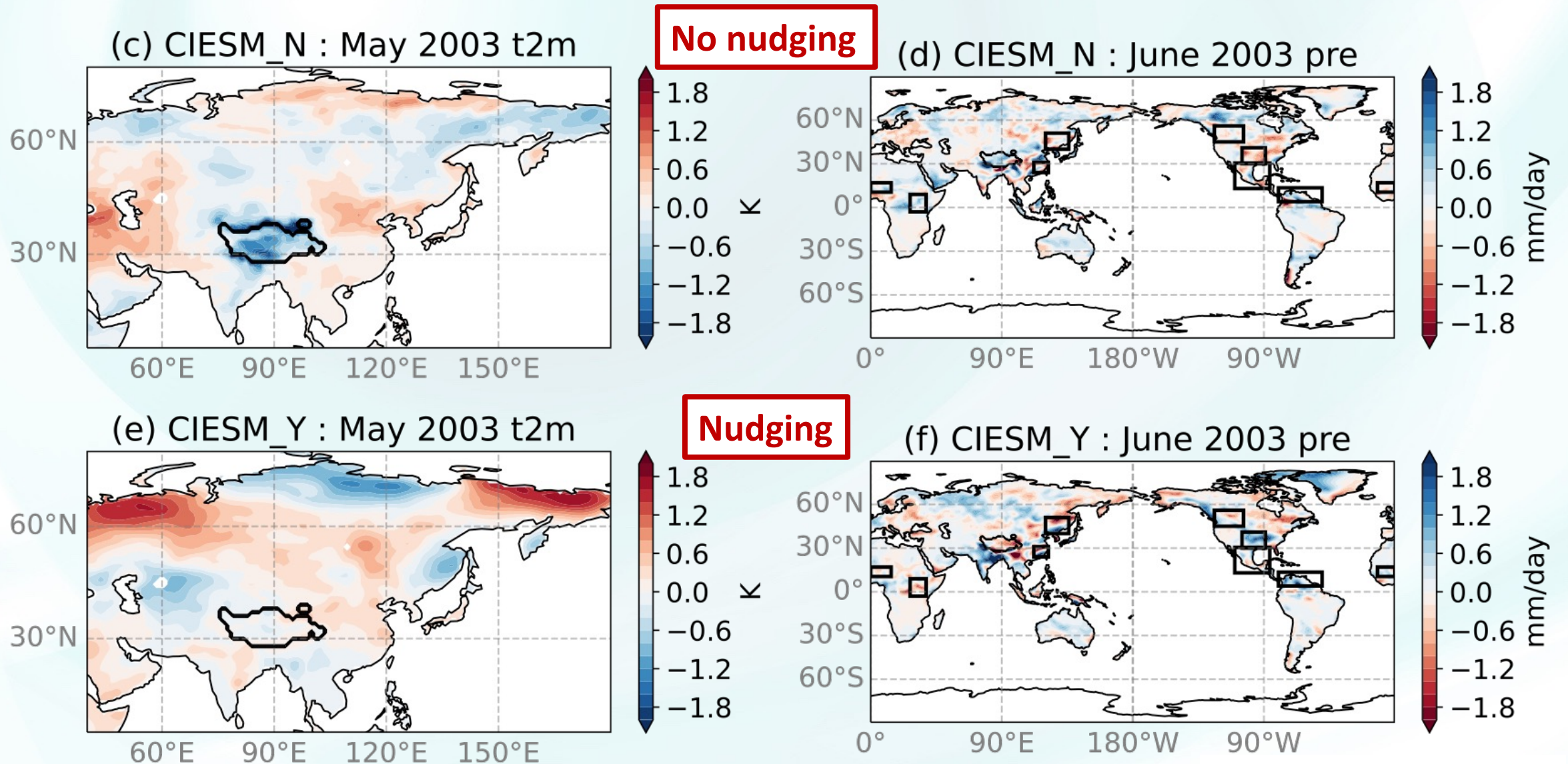
Window nudging in global models improves regional results

- Only nudge U, V outside the target domain
- May improve results relative to regional models due to two-way coupling

Good regional results

- E3SM shows cold bias/anomaly over TP
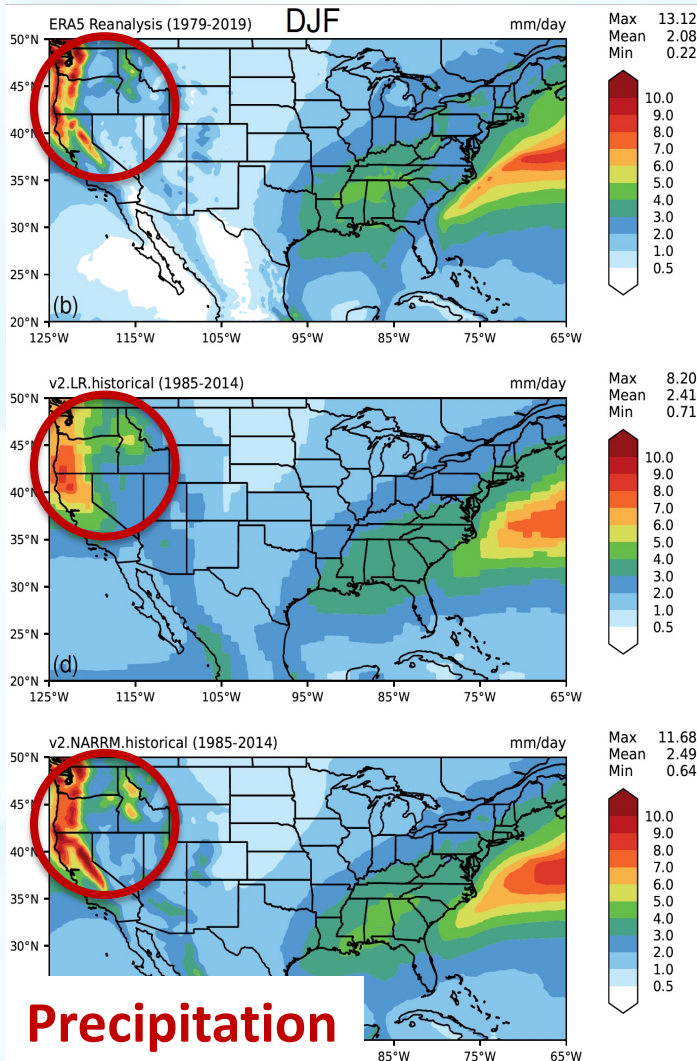- Dry bias/anomaly of precipitation over south of Yangzi River Basin

LS4P-II may leverage high-res simulations

Tang et al., 2022, GMDD

e.g., E3SMv2 fully coupled North American regionally refined model (NARRM))

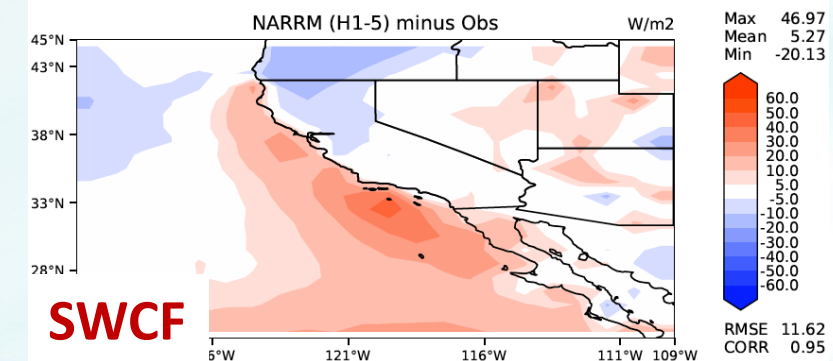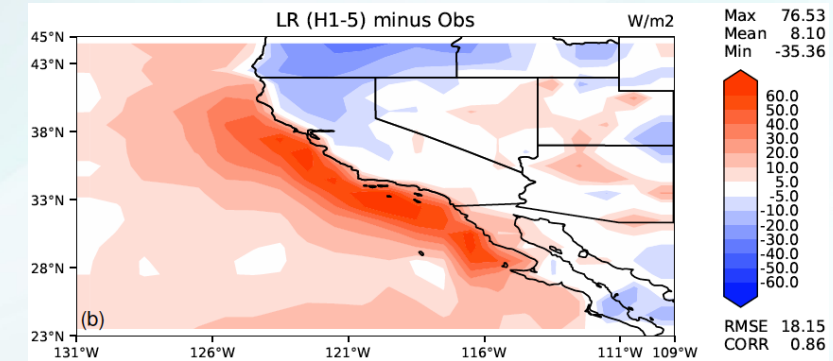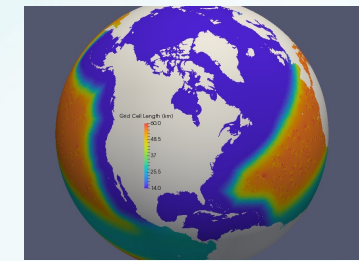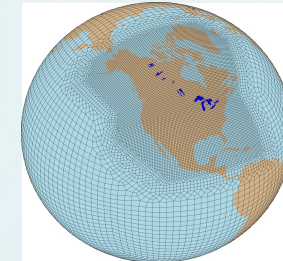Completed CMIP6 production runs with 10+ simulation years per day

Atm, Land (25 -> 100 km)   **Ocean, Sea ice (14 -> 60 km)**

Obs

Low-res 100 km

NARRM 25 km

Precipitation

SWCF

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California RRM w/ finest resolution of ~3-km (extendible to ~1 km)

- 1 simulation month per 3 hours on 120 nodes at quartz.

CA RRM (~3 -> 100 km)

Topography

100 km

25 km

3 km

U (m/s)
Zonal wind

T (K)
Temperature

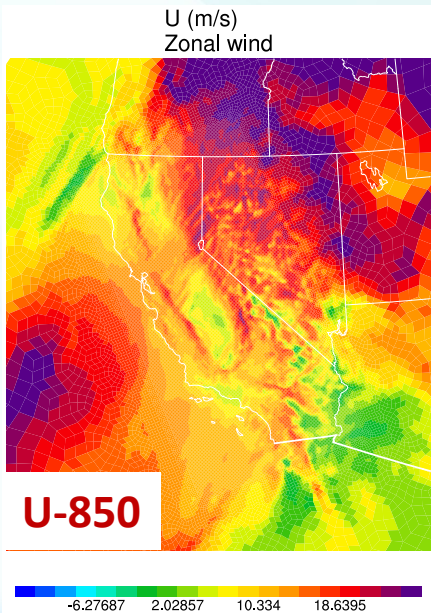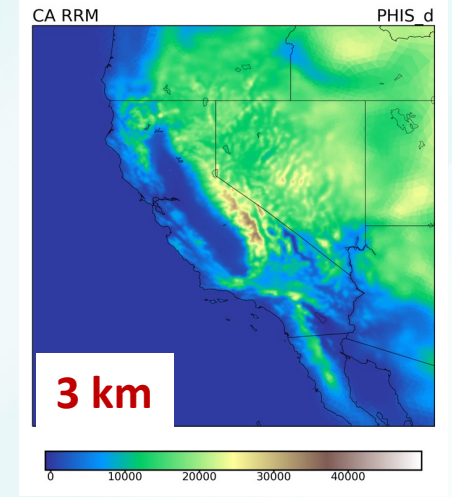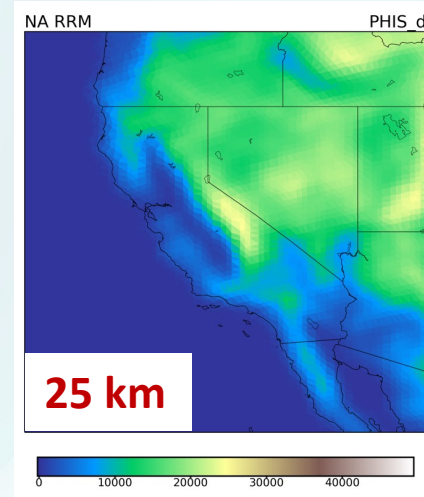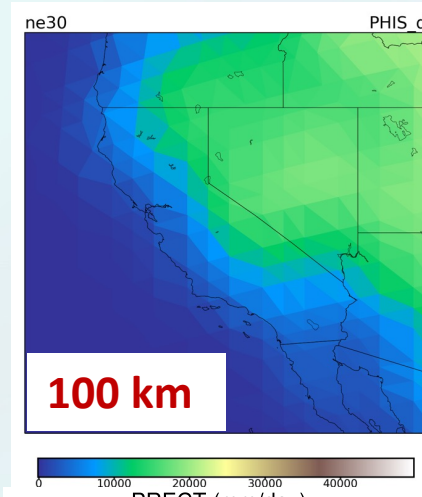PRECT (mm/day)
Precipitation rate

U-850

T-850

PRECT
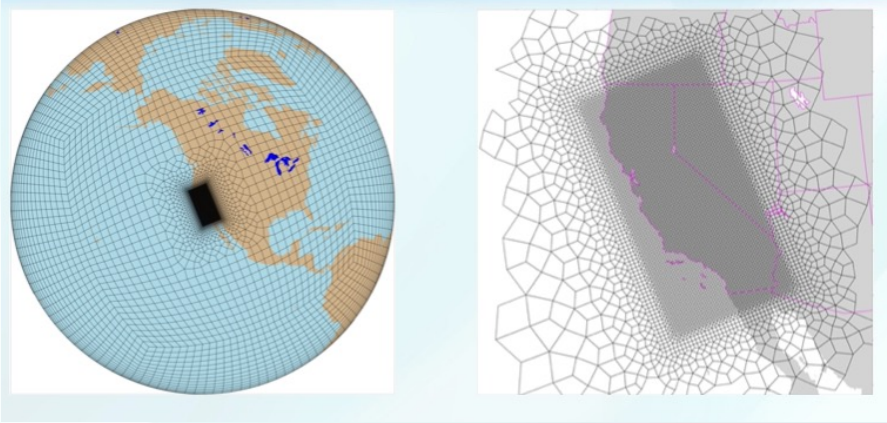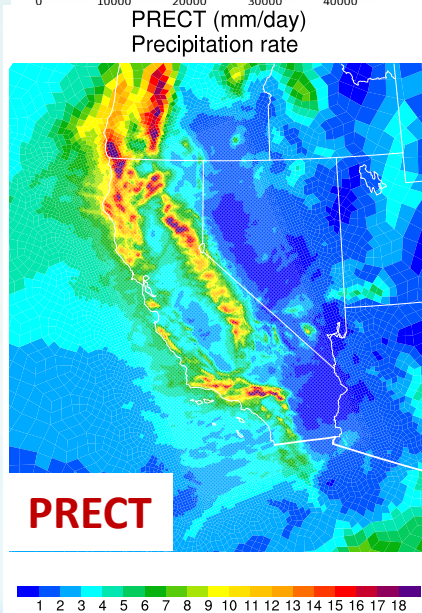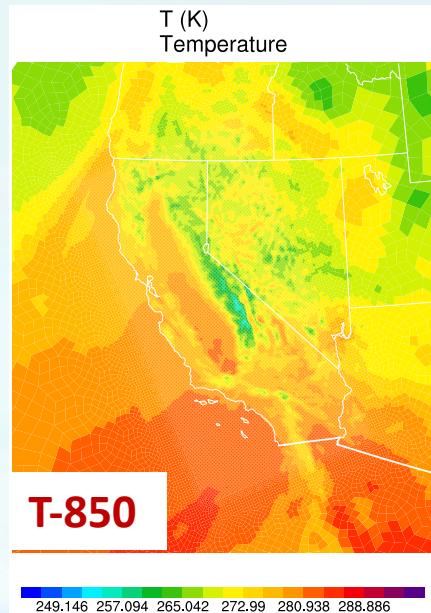
- Processes, e.g., mesoscale convective system, important for NA are greatly improved at km scale.
- Merge with window nudging

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Summary

- Nudging is necessary for global climate models to achieve reasonable initial conditions for sub-seasonal to seasonal (S2S) predictions, e.g., LS4P.

- Window nudging strategy can improve regional results in global models due to two-way coupling.

- LS4P-II can benefit from recent advancement in high-resolution modeling (e.g., E3SM NARRM).

- Convection-permitting (a few km) regionally refined model (RRM) simulations for LS4P-II?
  - Mesoscale convective system over North America (NA)