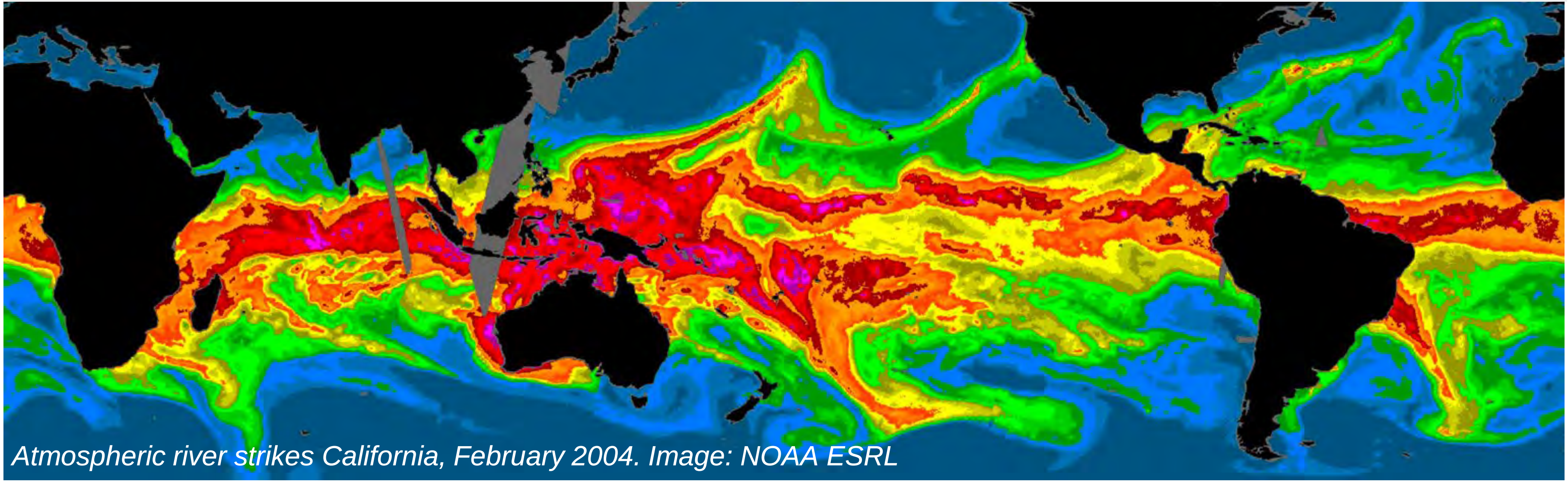
NCAR | NATIONAL CENTER FOR ATMOSPHERIC RESEARCH

NSF

EarthWorks

SIMA

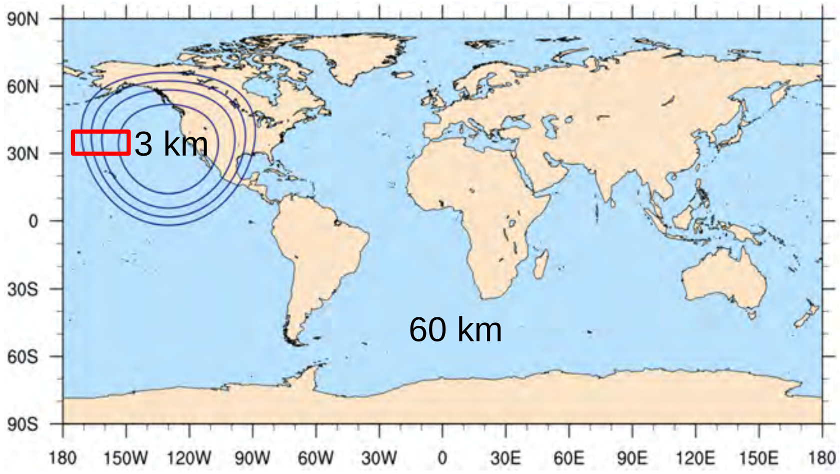
Linking the large-scale processes and the landfalling features of atmospheric rivers in non-hydrostatic CESM simulations



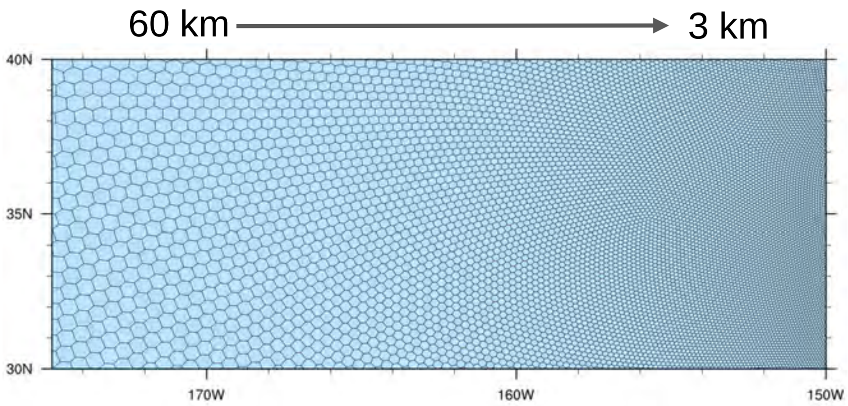
Atmospheric river strikes California, February 2004. Image: NOAA ESRL

Presenter: Xingying Huang (xyhuang@ucar.edu) 27th Annual CESM Workshop; 06/14/2022

Background and motivation



A) Grid mesh configuration in 60-3km experiments

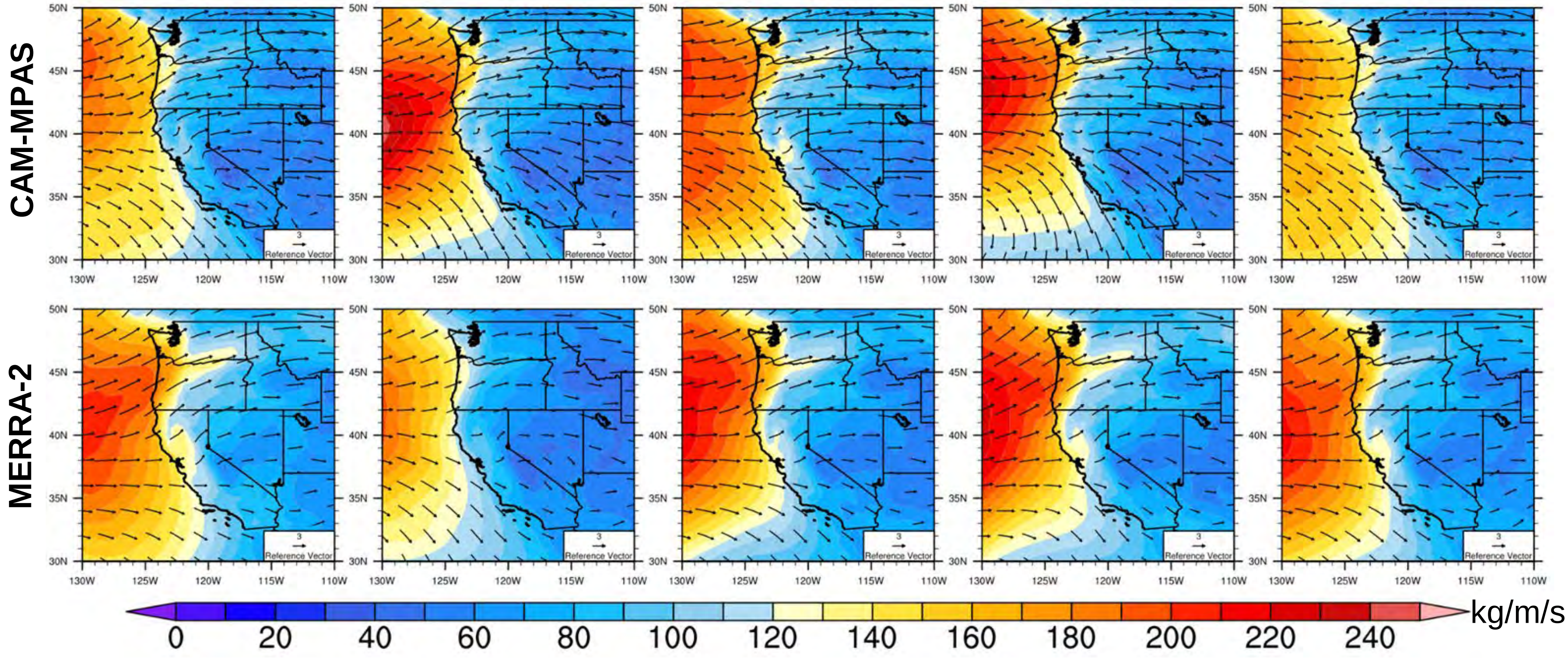


B) Unstructured spherical centroidal Voronoi mesh with a smooth transition mesh densities

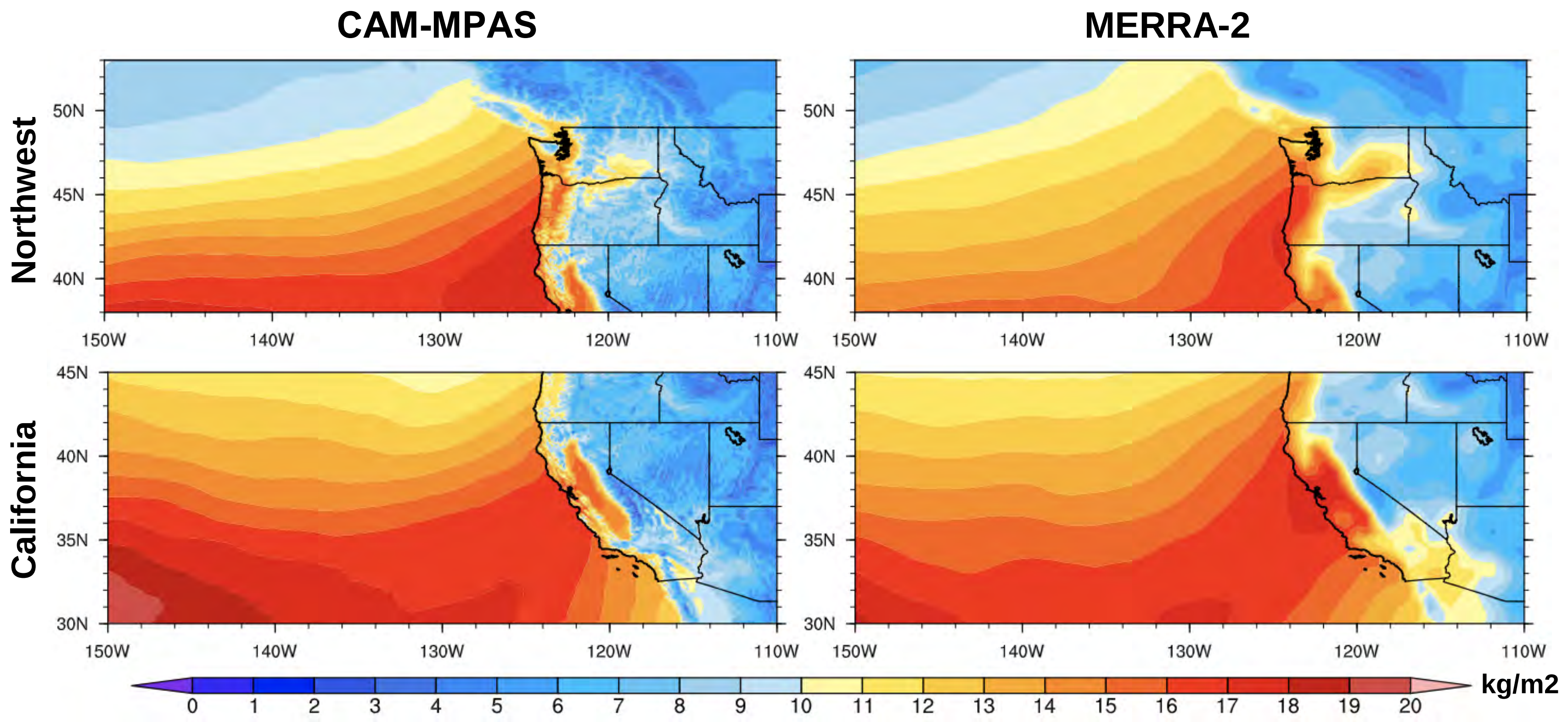
- CESM-MPAS simulations at 60-3km variable resolution over Western US: 58 vertical layers, initialized with CFSR reanalysis data. year 1999-2004 (Nov. to March)
- Large-scale moisture flux transport patterns in terms of thermodynamics and dynamics components
- How that links to the fine-scale landfalling precipitation compared to reanalysis observations.

➔ Mean IVT averaged over all days for each season

From 1999/11 to 2004/03 (NDJFM)

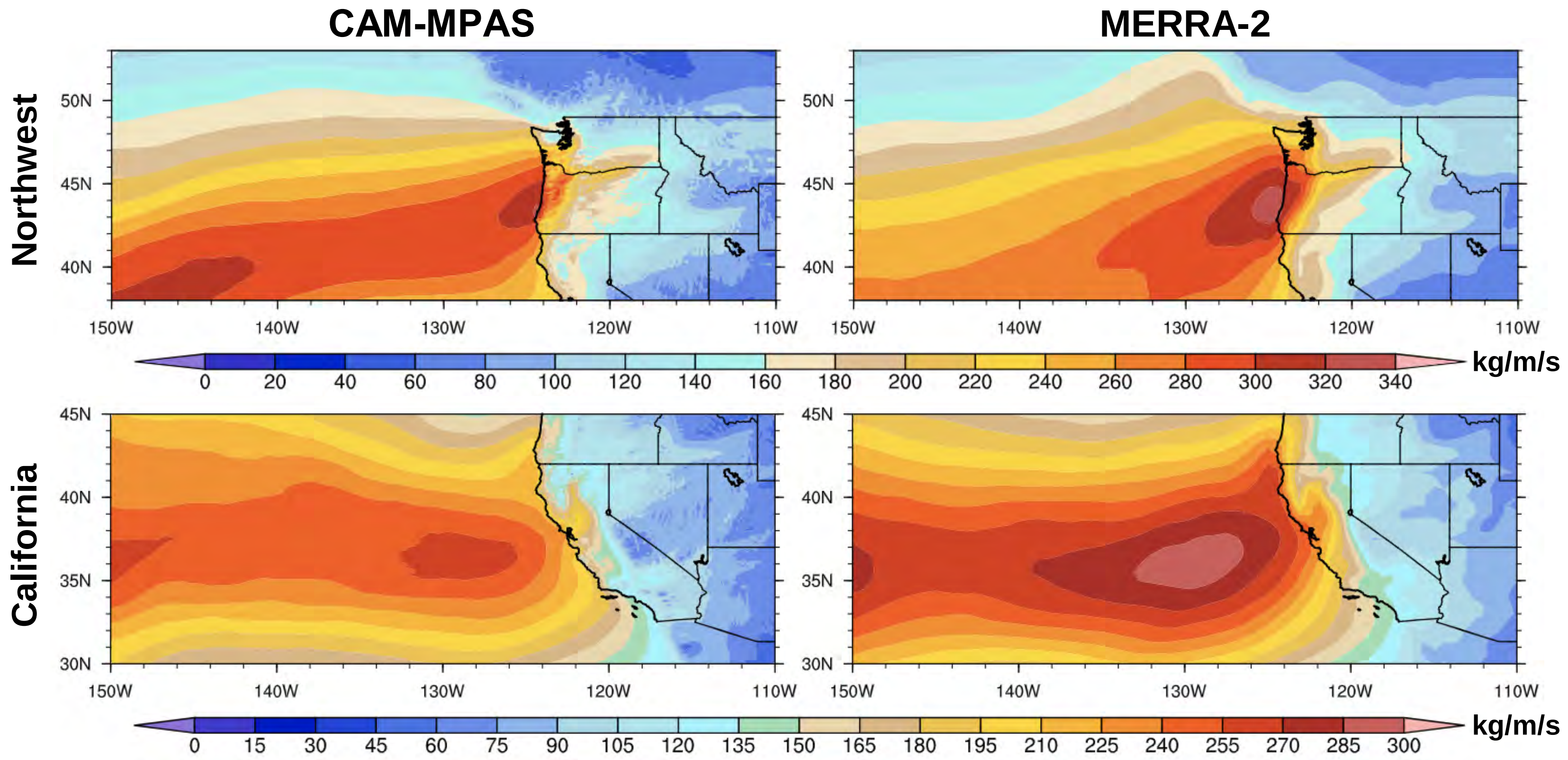


➔ **Thermodynamics component:** TMQ for heavy precipitation days (P75th)



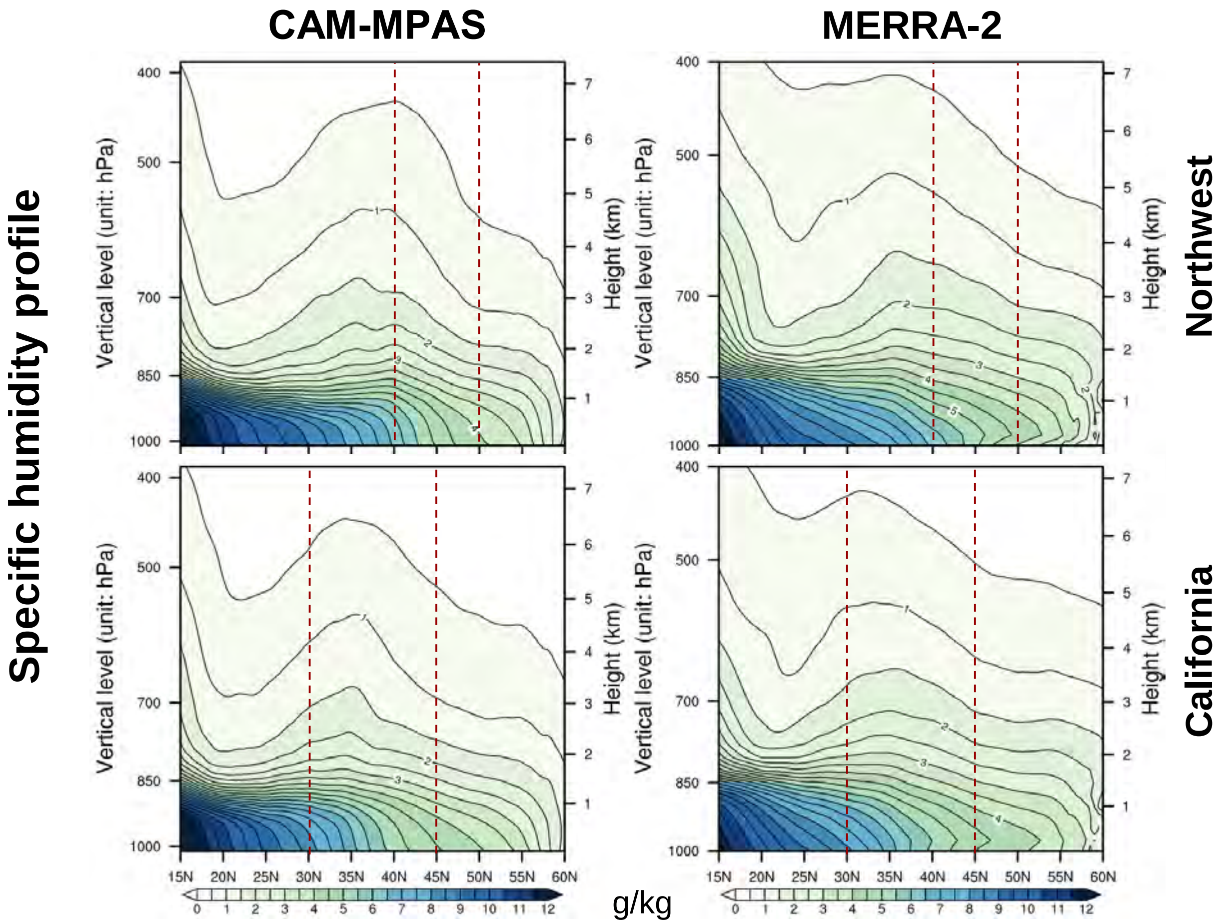
Finer features in CAM-MPAS with well-represented moisture concentration over hitting regions

➔ **Moisture flux transport:** IVT for heavy precipitation days (P75th)



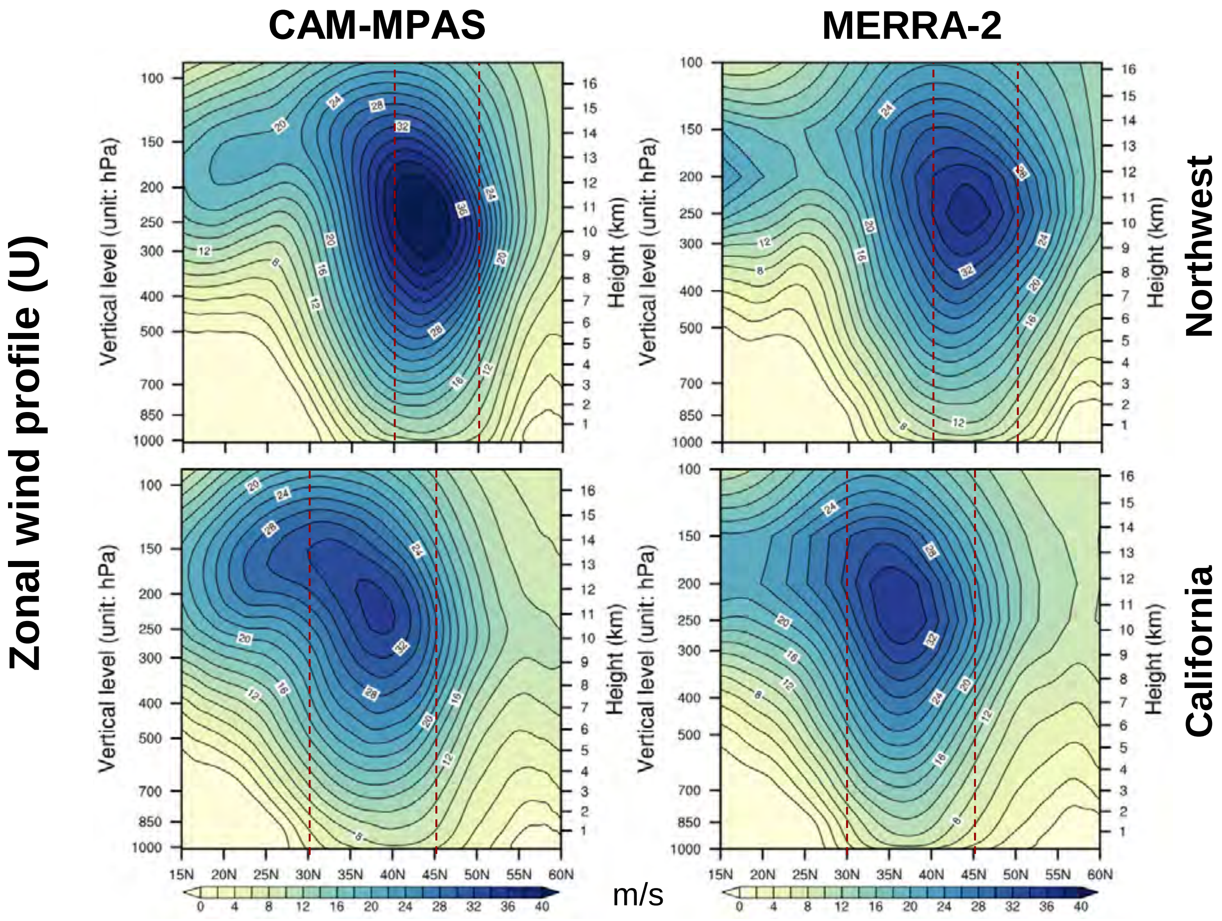
Large-scale moisture flux transport patterns are better simulated over Northwest region; California is seeing underestimated IVT values more notably.

➔ Near-coastal moisture flux contribution decomposition: Q & UV



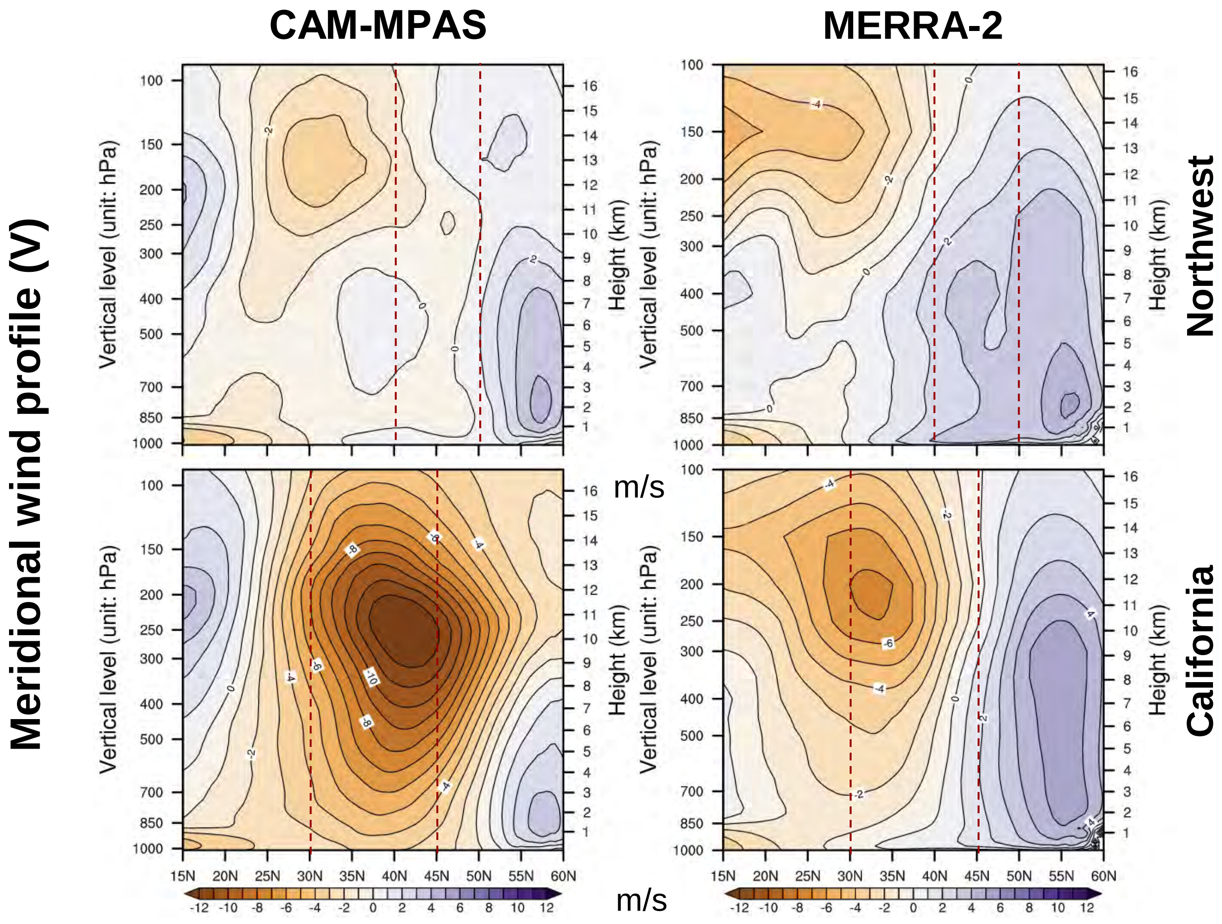
Overall well-captured moisture profile with steeper gradient both horizontally (in latitude direction) and vertically

➔ **Near-coastal moisture flux contribution decomposition:** Q & <u>U</u>V



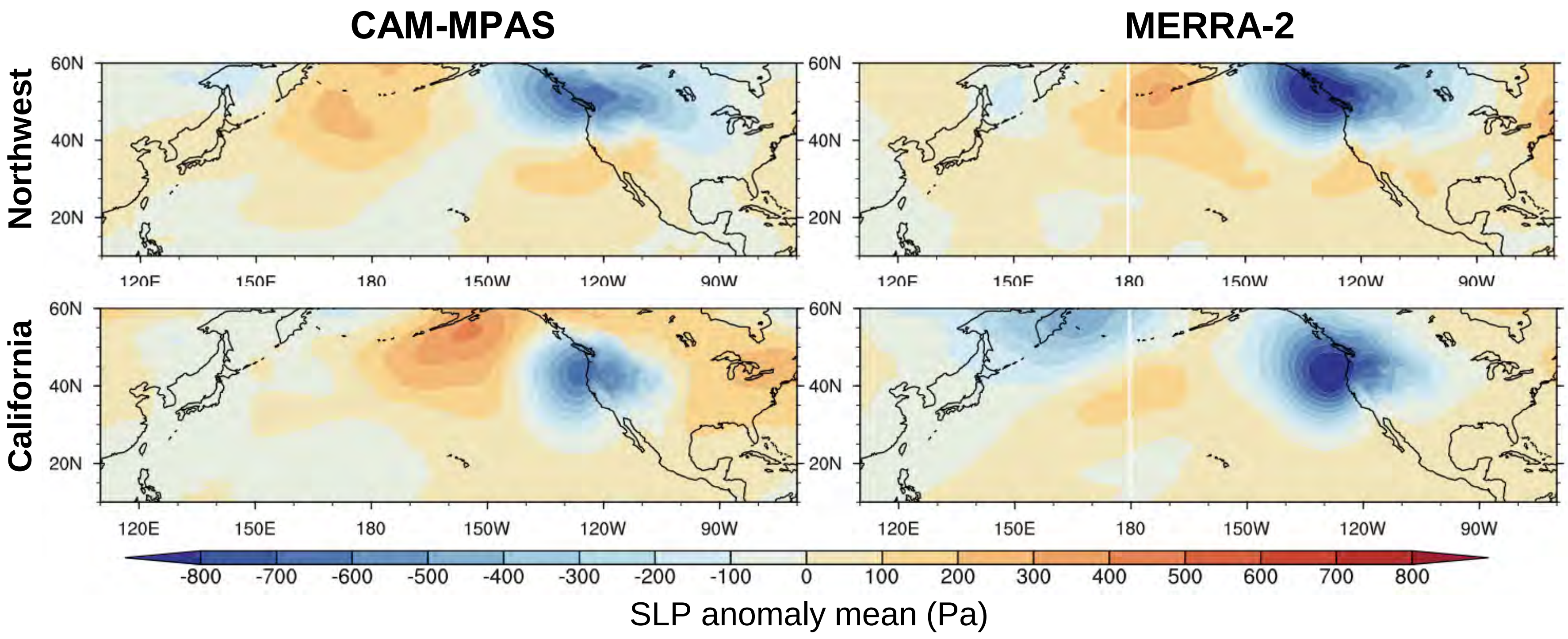
Overall well-captured wind profile with jet stream location shifted some northward in CAM-MPAS for the California region, and stronger zonal wind over the Northwest region

➔ Near-coastal moisture flux contribution decomposition: Q & U<u>V</u>

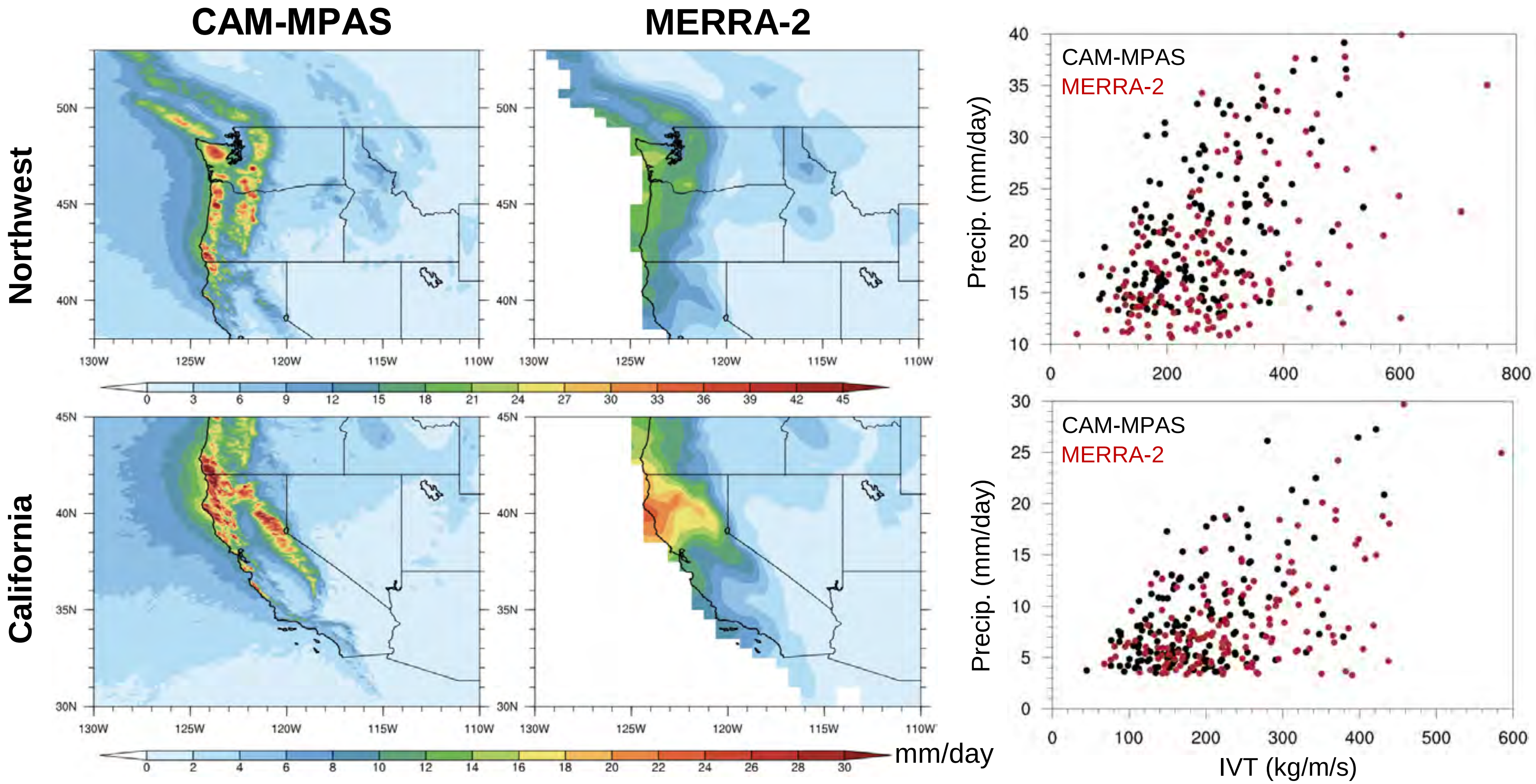


V-wind component is secondary relative to the dominant U-wind in IVT contribution. However, CAM-MPAS shows stronger southward wind over the California region, which could affect the precipitation spatial distribution directly.

➔ **Surface pressure anomaly pattern:** SLP(p75) - SLP(all)



➔ Landfalling precipitation features (p75): IVT → precipitation



Summary and plans

- In the scope of EarthWorks, this study explores large-scale thermodynamics and dynamics for the AR-driven heavy precipitation over the western US coastal regions, built upon the open-source Community Earth System Model (CESM) with a non-hydrostatic dynamical core, the Model for Prediction Across Scales (MPAS).

- Compared to MERRA-2 reanalysis, results show a realistic representation of large-scale moisture flux features in terms of distributions and intensity.

- It is promising to study ARs and landfalling precipitation linking different scales using this new-generation model framework, to improvements our understanding of ARs' multi-scale mechanisms and current limitations.

- More aspects remain to be examined and diagnosed to advance the understanding and prediction of climate and weather extremes across scales.

Thank you! Questions/Comments/Inquiries? (contact at *xyhuang@ucar.edu (Xingying Huang))*