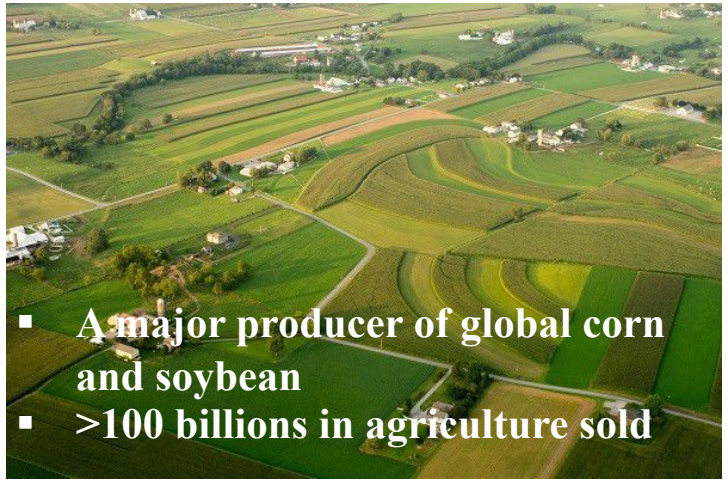
Warming-induced Poleward Circulation Shift Increases Floods and Droughts in the US Midwest

Wenyu Zhou, Ruby Leung and Jian Lu
PNNL

The 1930s Dust Bowl Drought

The Midwest --- Land of farms

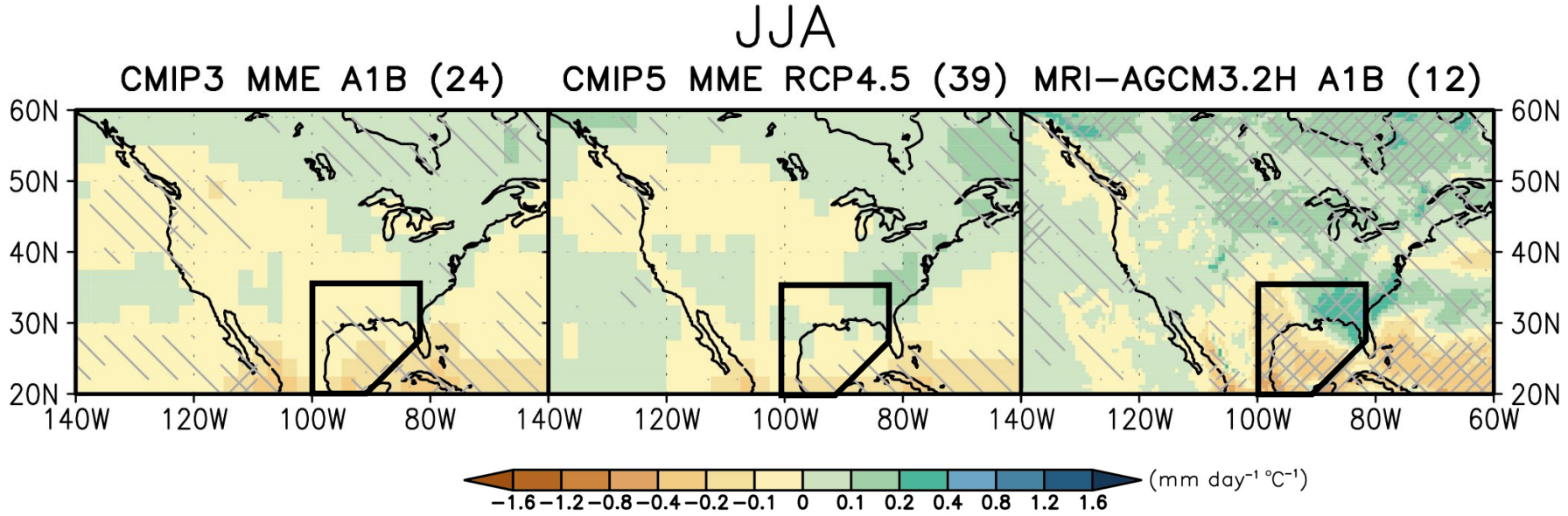


The 1993 Great Flood

How will the Midwest **precipitation climatology and extremes** change under **global warming**?

Uncertain precipitation changes in the Midwest

- A potential summer drying, but with low confidence



(IPCC AR5, Ch14)

- Nearly 1/3 of the models in fact predict a summer-mean wetting
- What causes the potential drying? Why is there large projection uncertainty?
- Beyond the climatological changes, how will climate extremes respond?

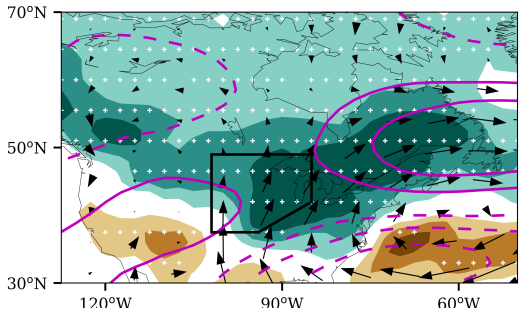
Time-dependent changes with late-spring wetting but late-summer drying

Future Changes

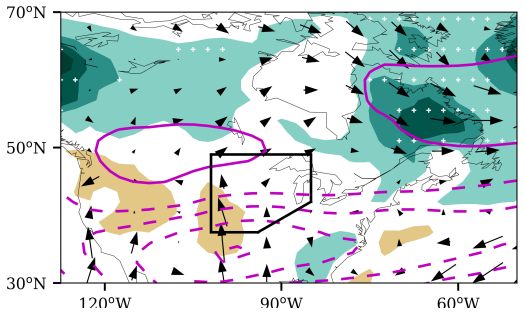
RCP8.5 (2079-2099) minus HIST (1979-1999)

46 models in CMIP5/6

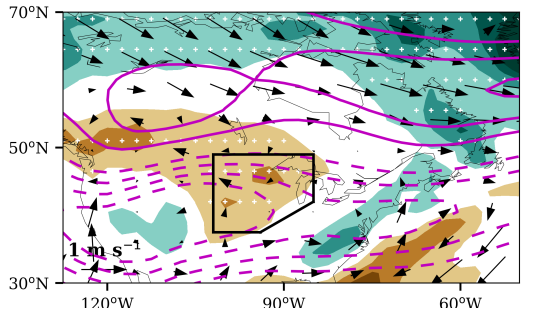
April/May

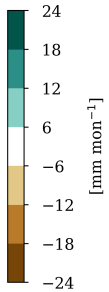


June



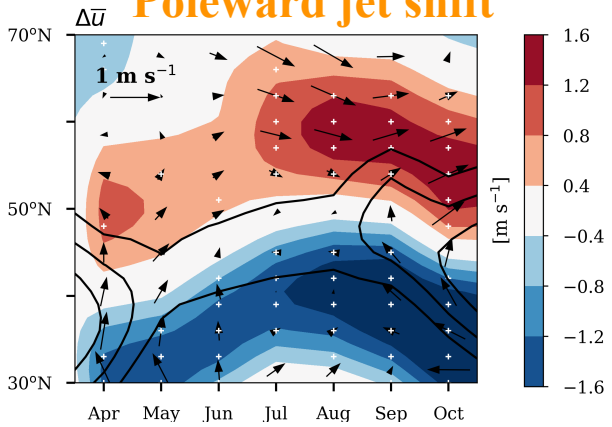
July/August



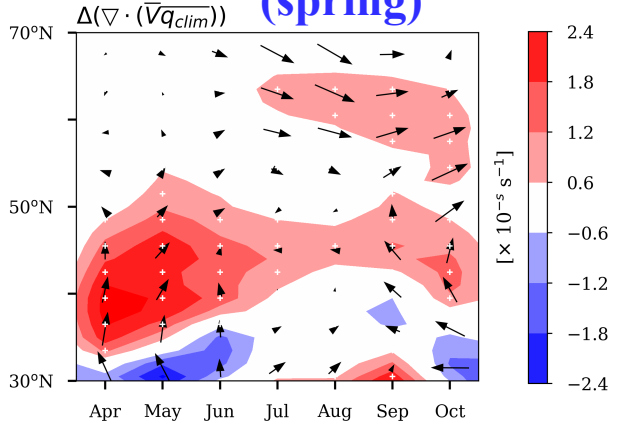


Contour: $\Delta\bar{U}_{250}$
Shading: $\Delta\bar{P}$

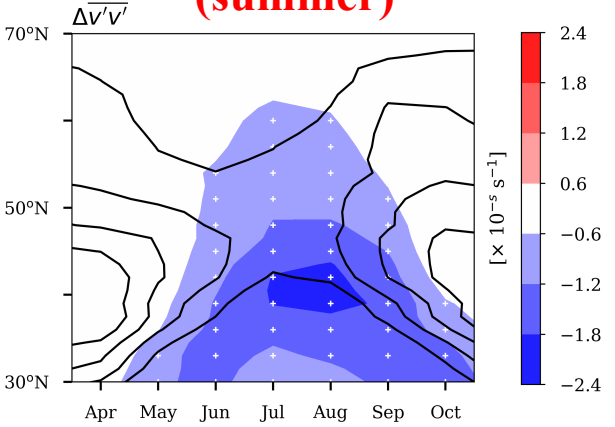
Warming-induced Poleward jet shift



Enhanced moisture convergence (spring)

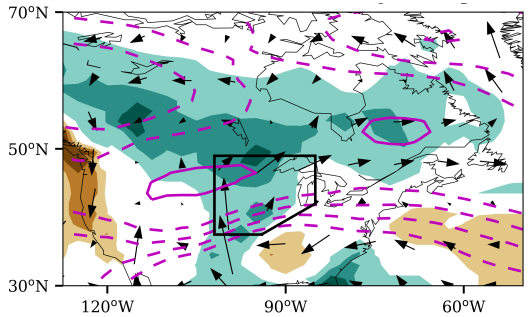


Weakened storm track (summer)

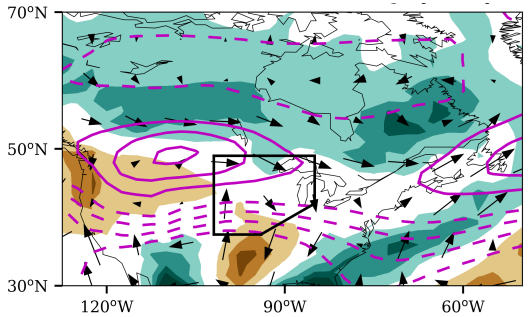


Seasonal Progression

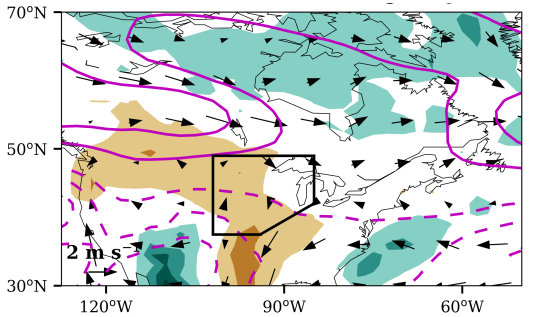
June − April

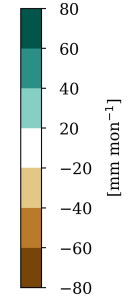


July − May



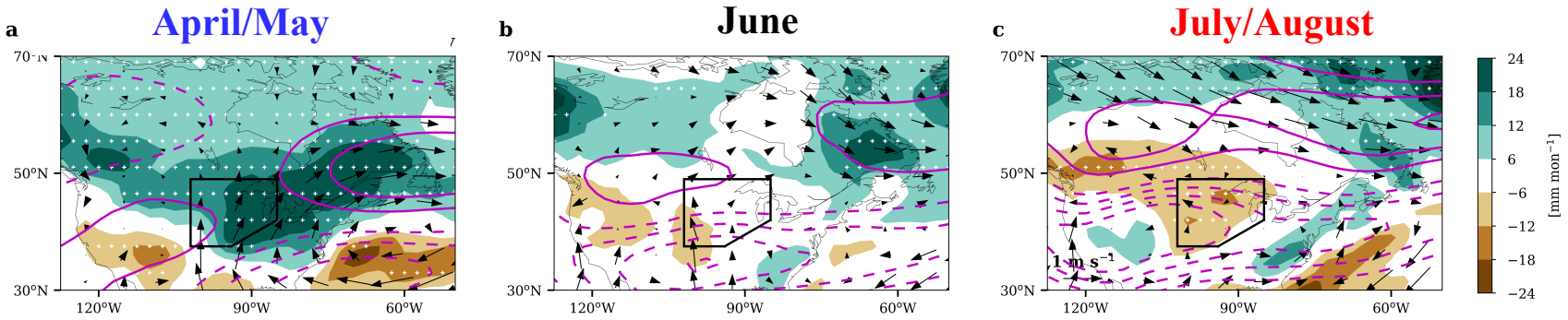
August − June



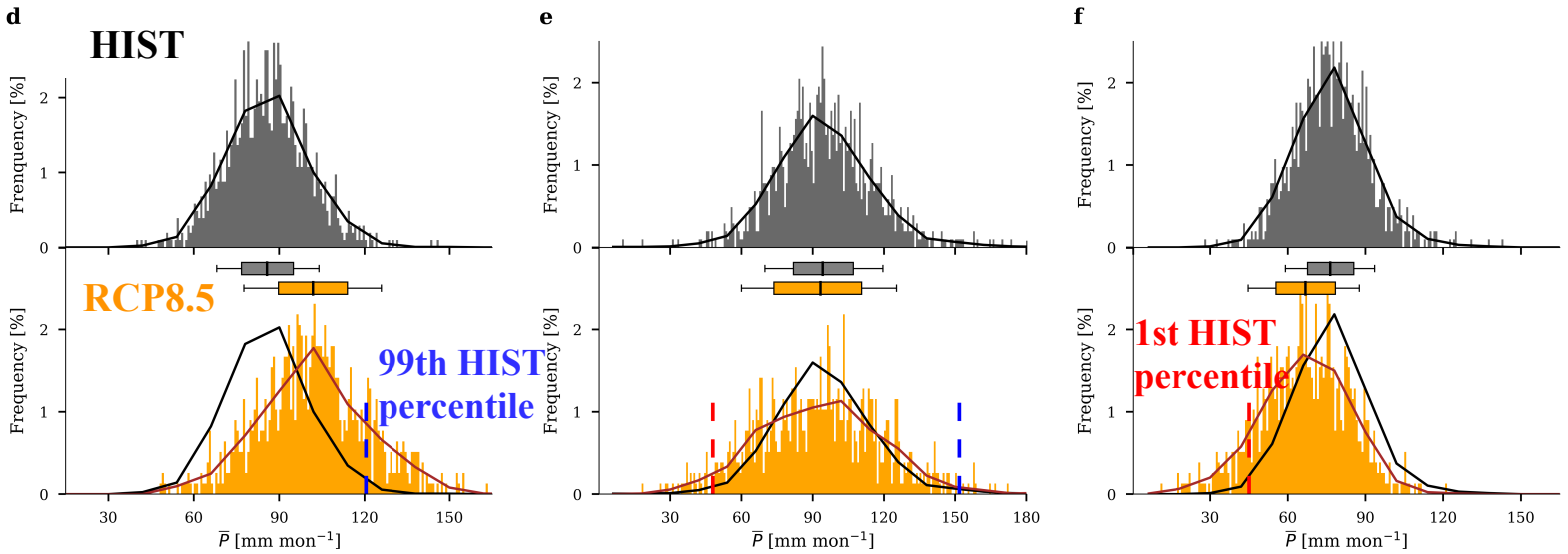


~10 times more late-spring floods and late-summer droughts in the Midwest

Future changes in Climatology



Extremes



15 times increase in extremely wet late-spring ($\bar{P}$>120 mm/mon)

10 times increase in extremely dry late-summer ($\bar{P}$ <43 mm/mon)

***Summary**:* Large-scale poleward circulation shift can cause opposite precipitation changes before and after the peak rainy month, leading to dramatic increases in the monthly-to-seasonal extremes.

Implication: Seasonal-mean projection may overlook robust signals in climatological and extremes changes.

Future Research: Multiscale interactions and predictability sources for regional climate extremes