Influences of large scale circulation and atmospheric rivers (ARs) on US winter precipitation beyond ENSO

Goal 1 : Underlying mechanism of large scale circulation control on atmospheric rivers (AR) and precipitation variability across the US during winter (DJFM) in observations

Goal2: How climate models (CFSV2 and CESM2) replicate these observed processes and mechanisms

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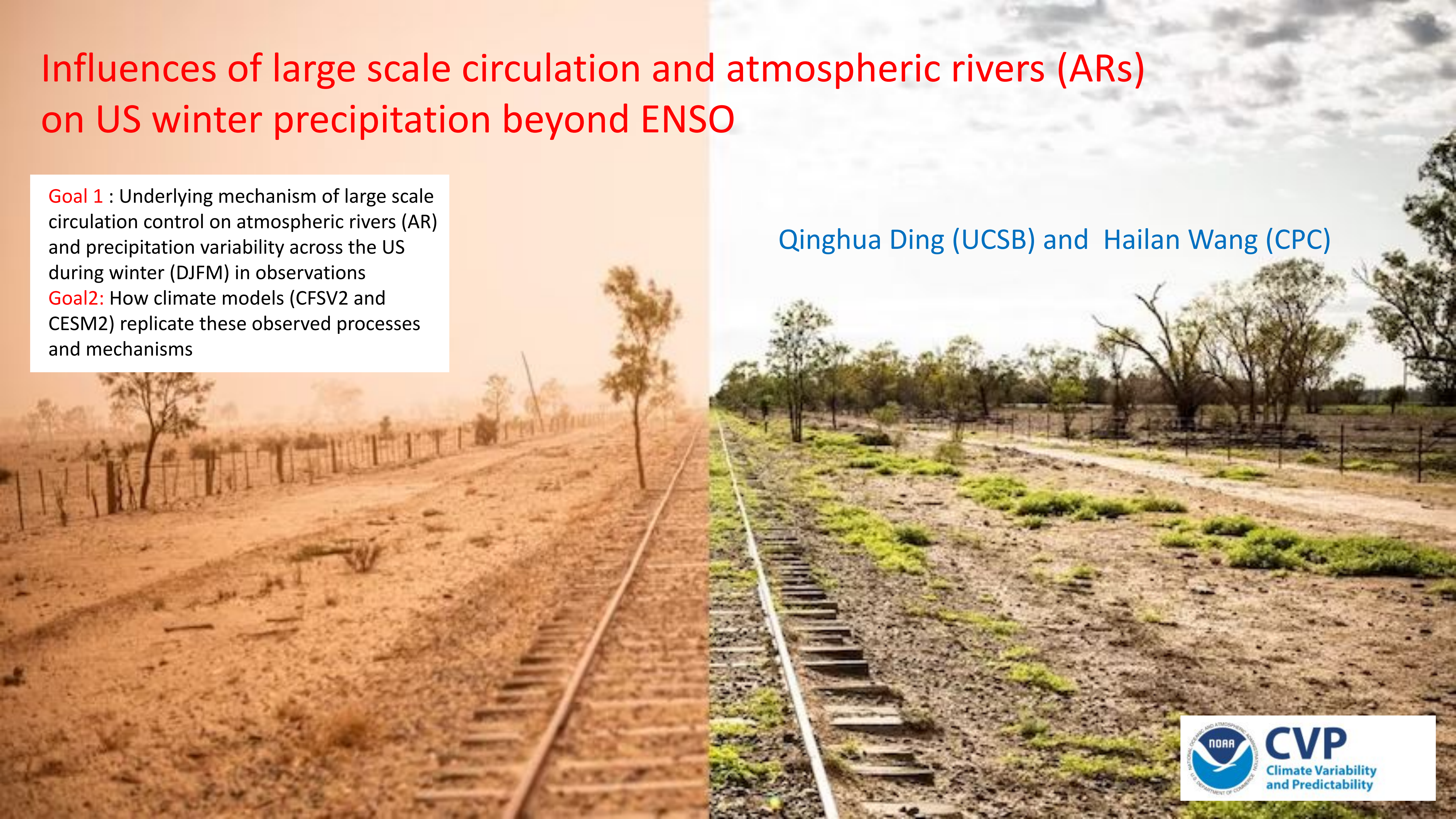
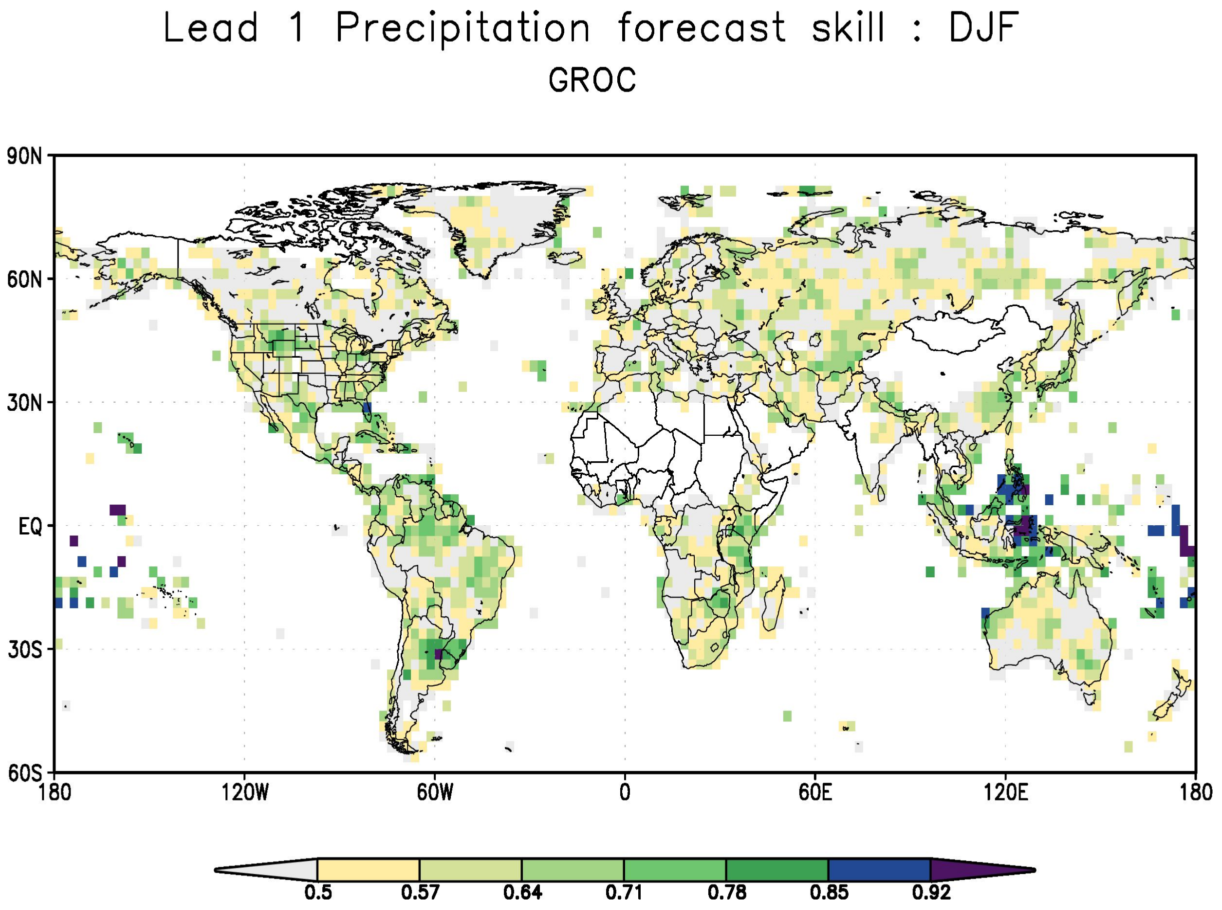
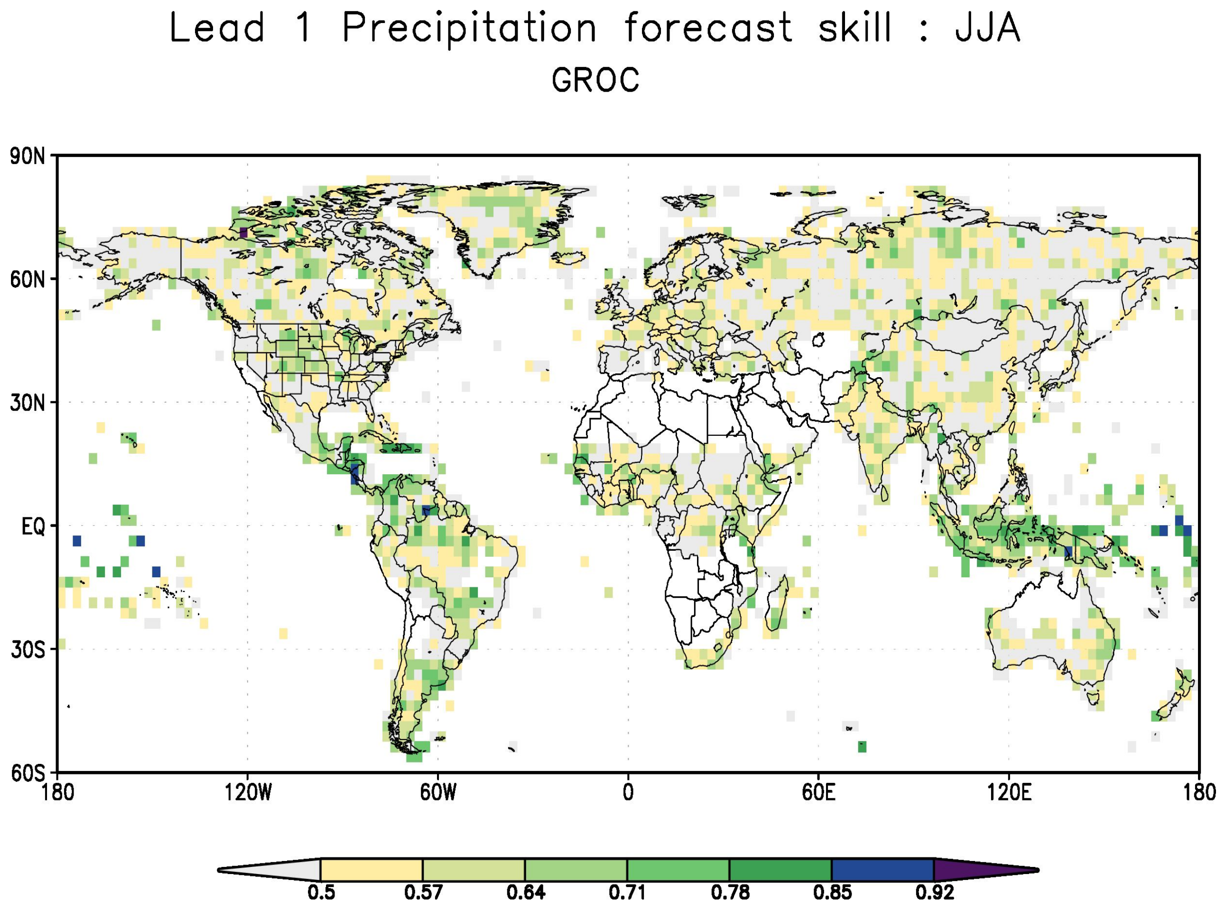


CVP Climate Variability and Predictability

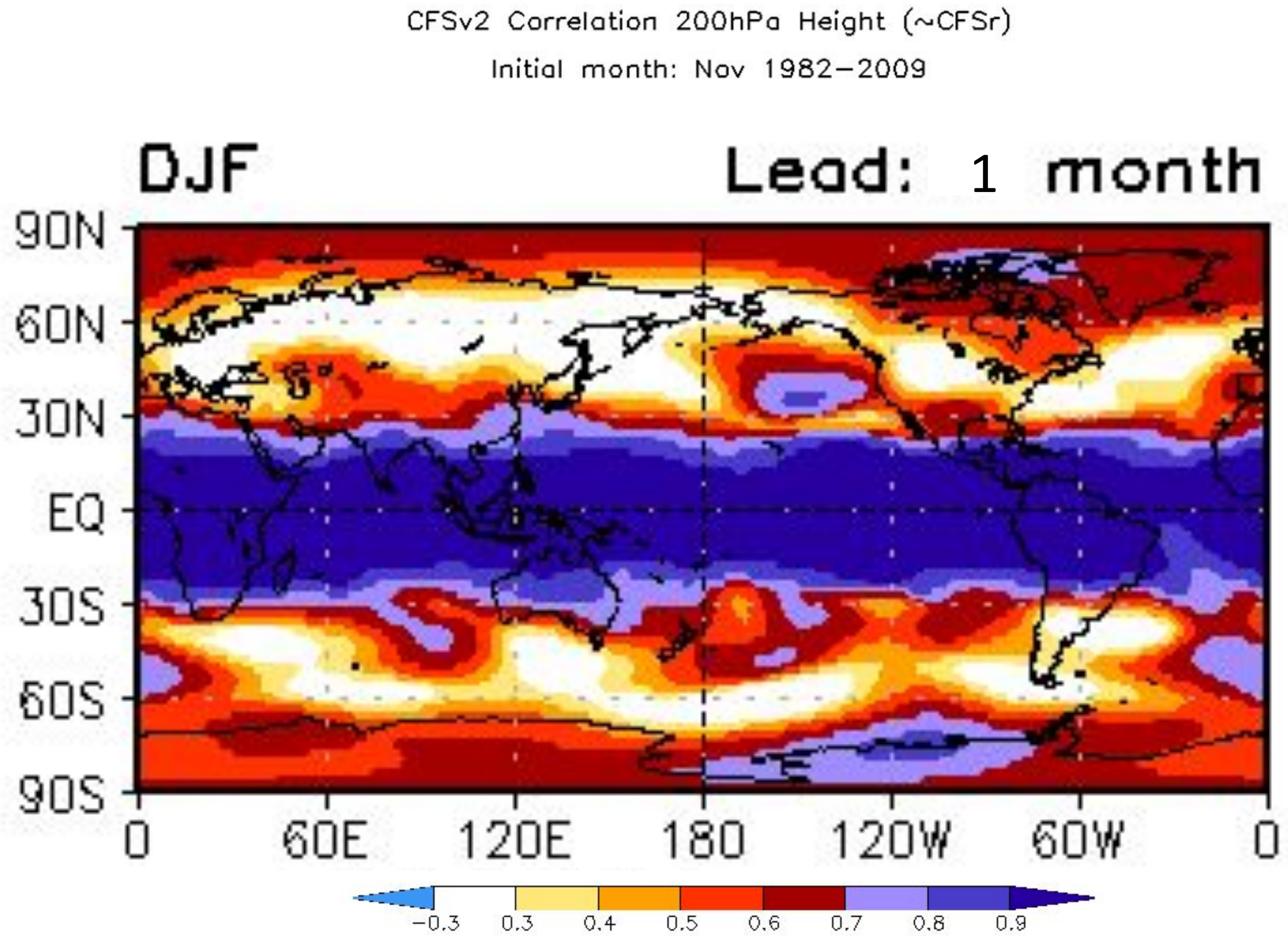
IRI Seasonal Climate Verifications: Precipitation forecast skill





GROC: the degree of correct probabilistic forecast discrimination

Diagnoses of CFSv2 retrospective forecasts: circulation forecast skill



Path forward

How large scale circulation patterns determine precipitation via Atmospheric Rivers (ARs)?

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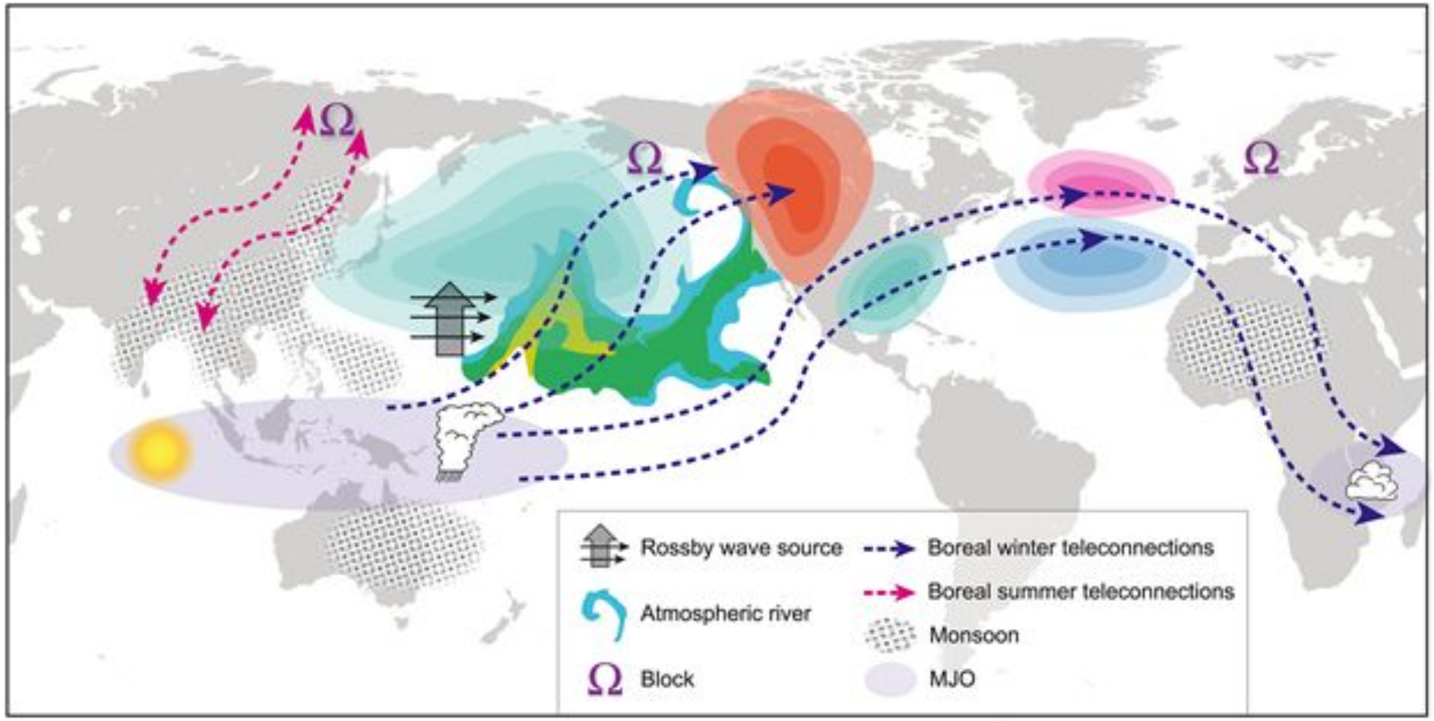
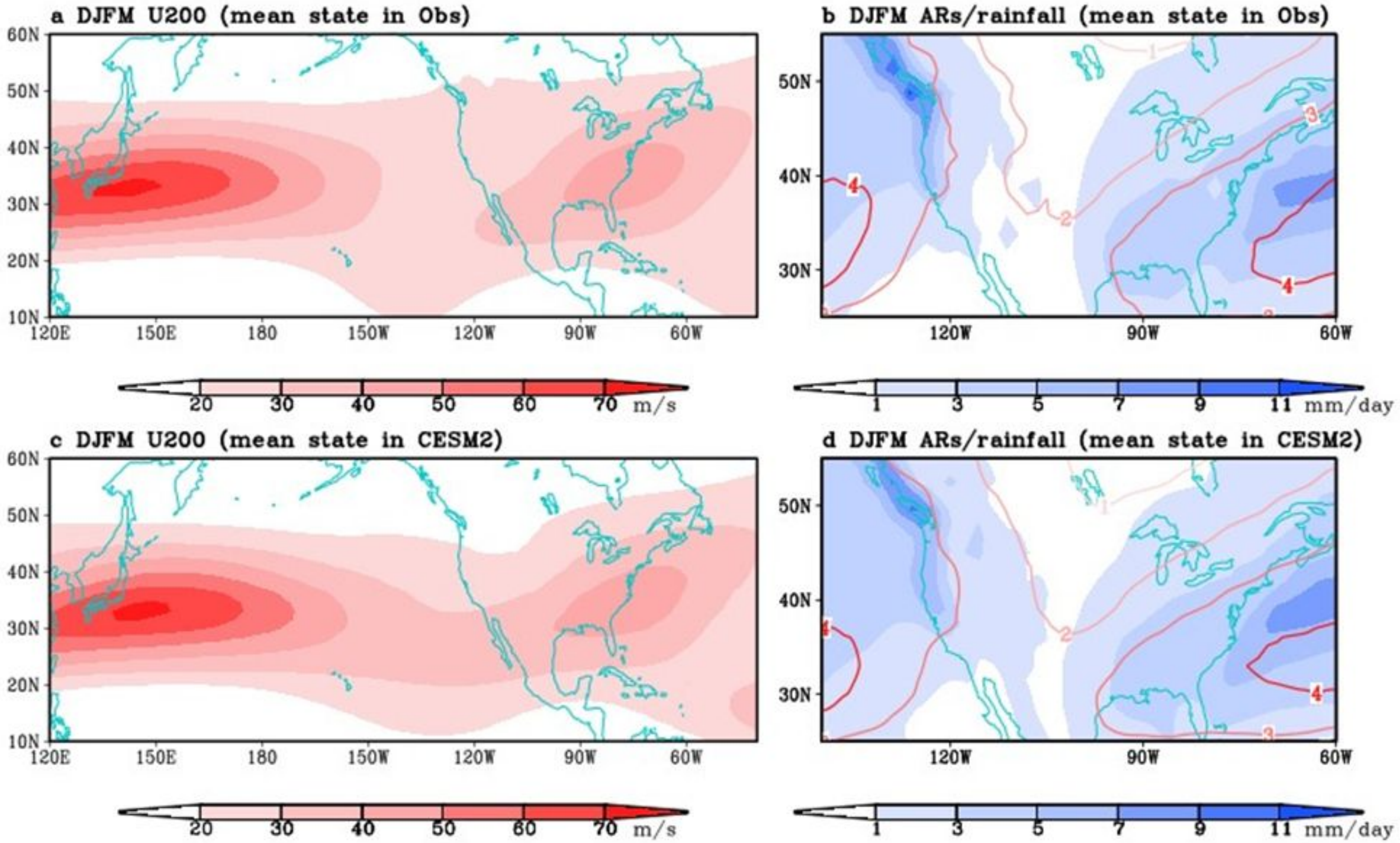
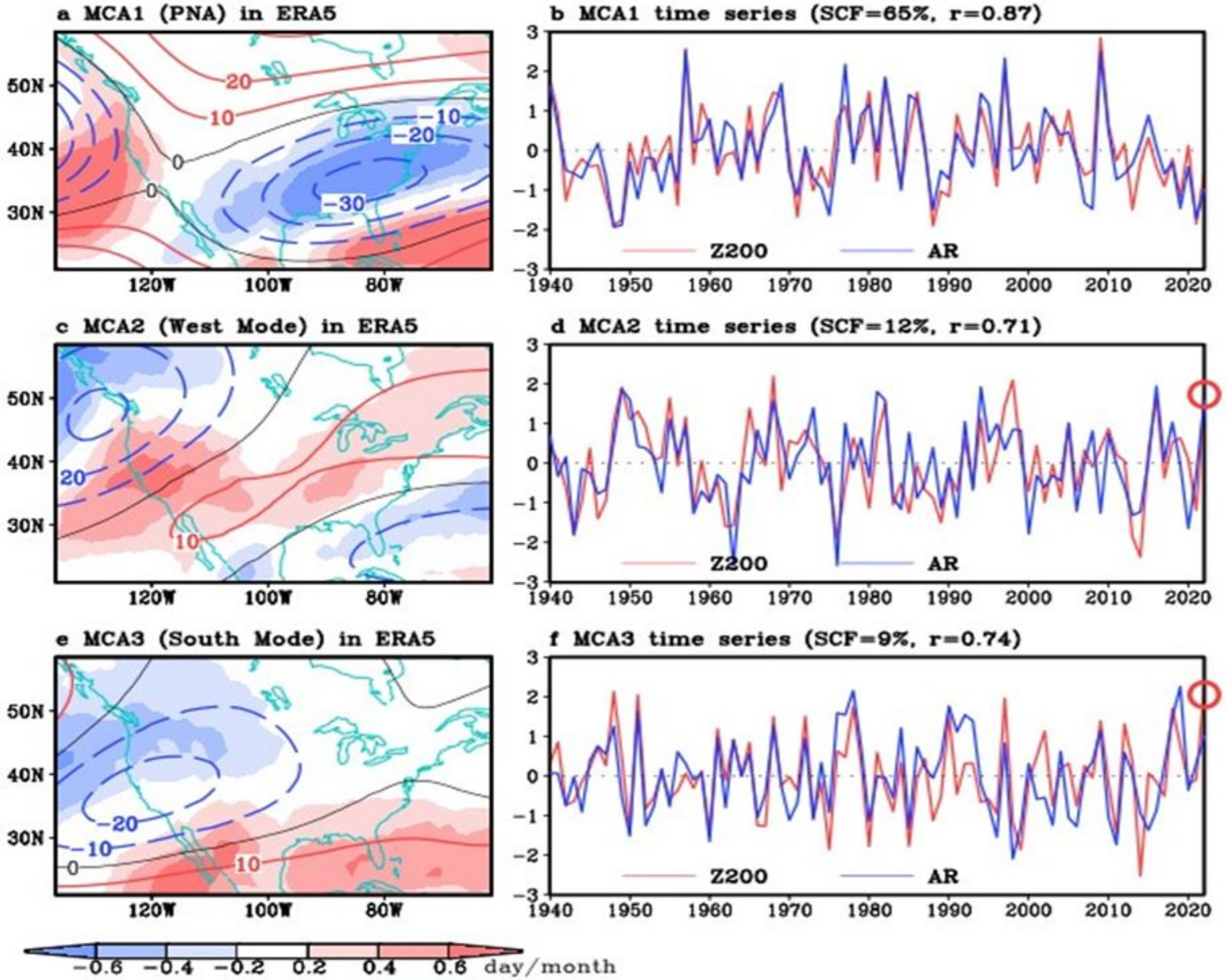


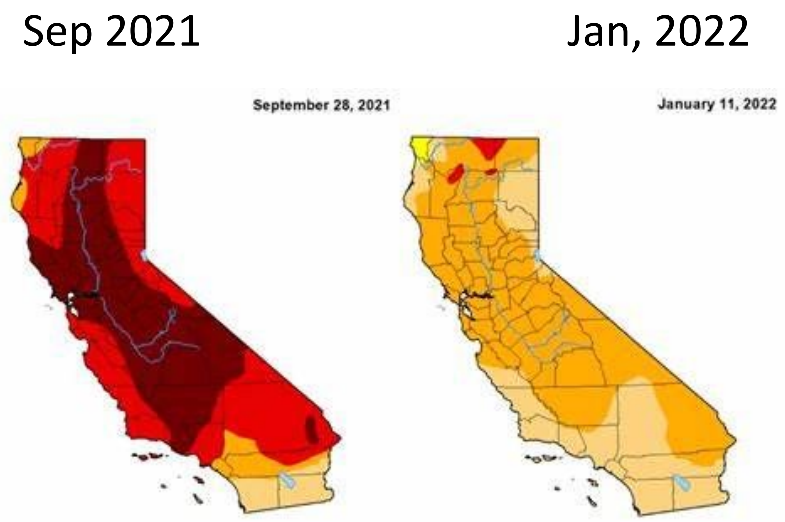
Online sources

Mean states (jet, precipitation and ARs) in ERA5 and CESM2 (1940-2023)

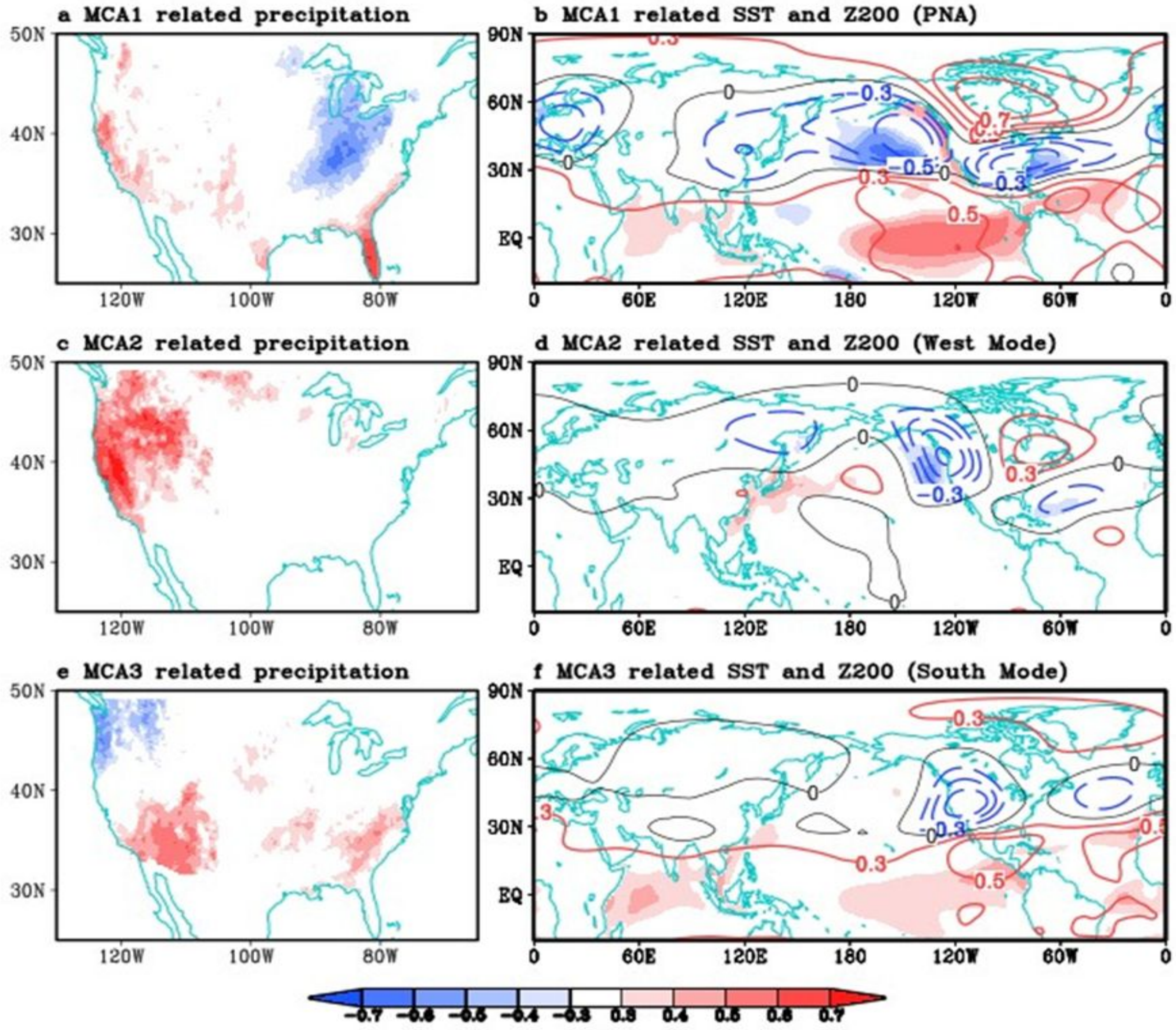


Large scale circulation modes influence precipitation through regulating ARs

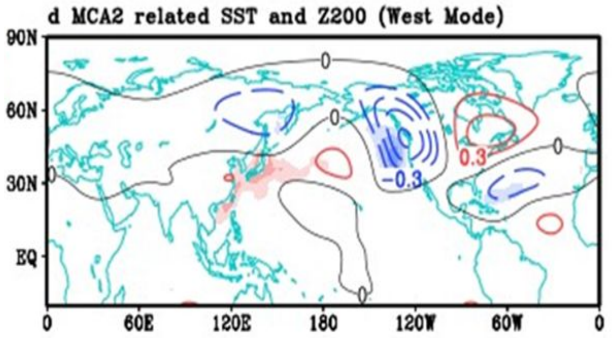


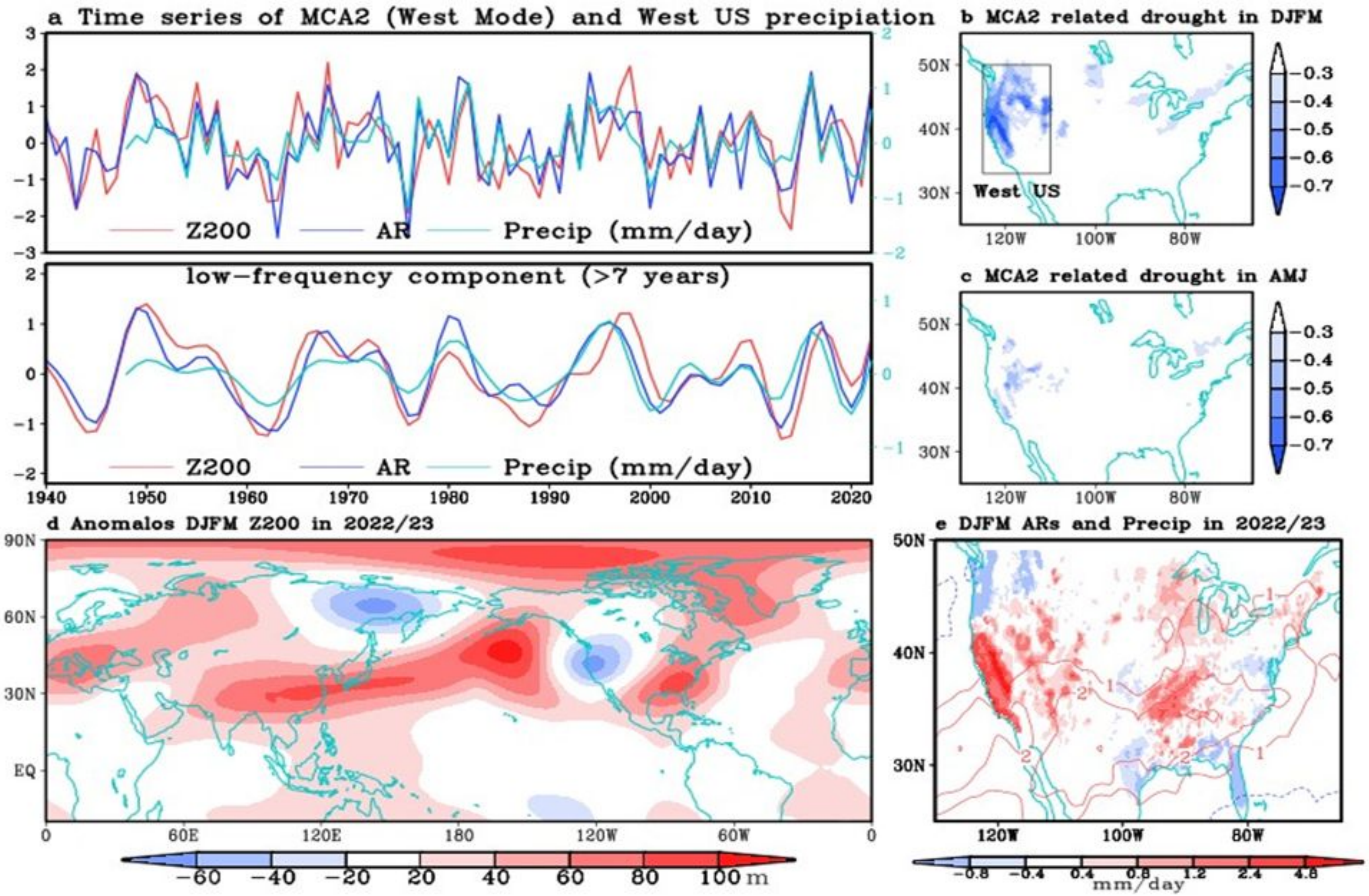


Despite ENSO's dominance, its effects on precipitation remain limited

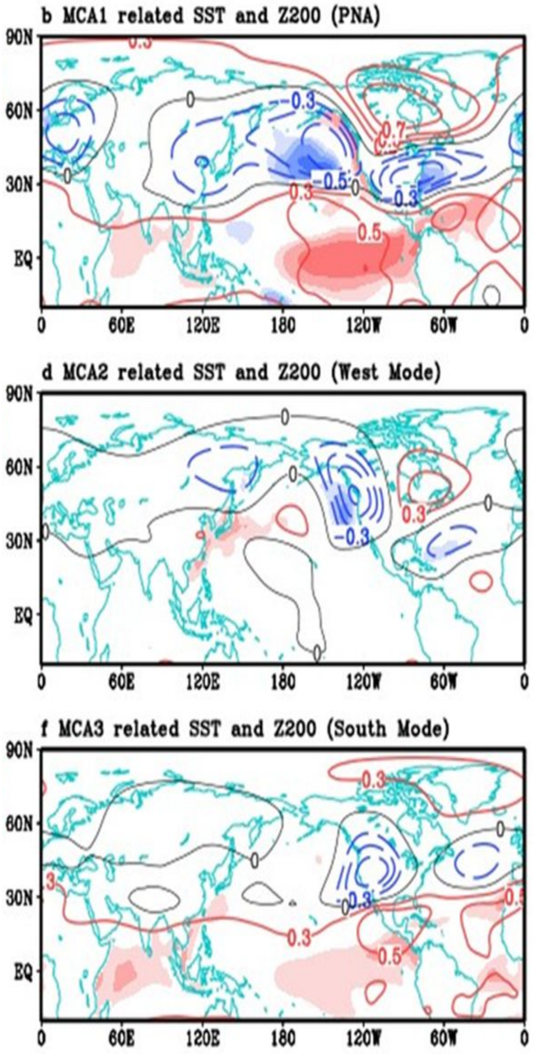


West Mode demanding more attention

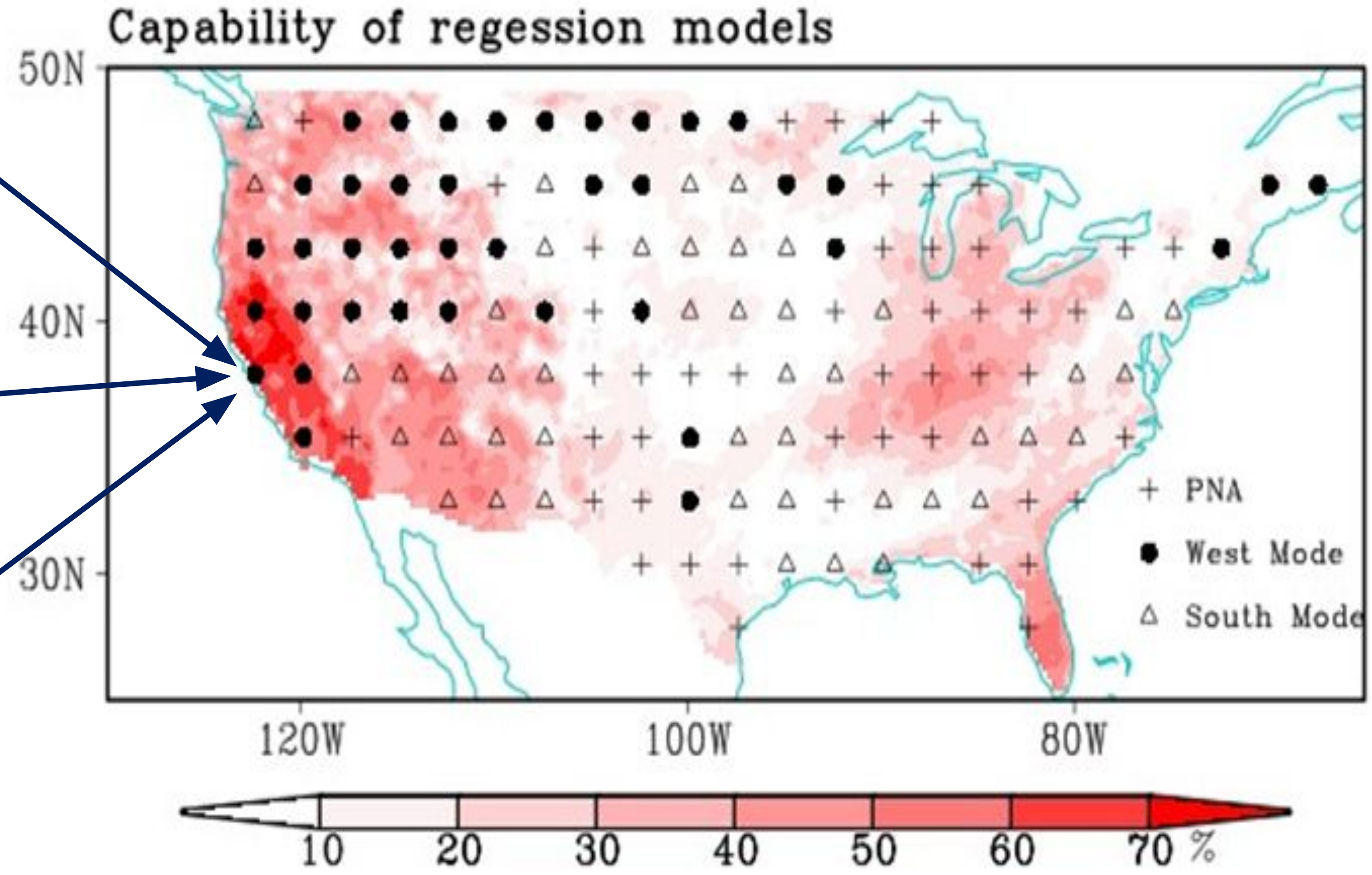




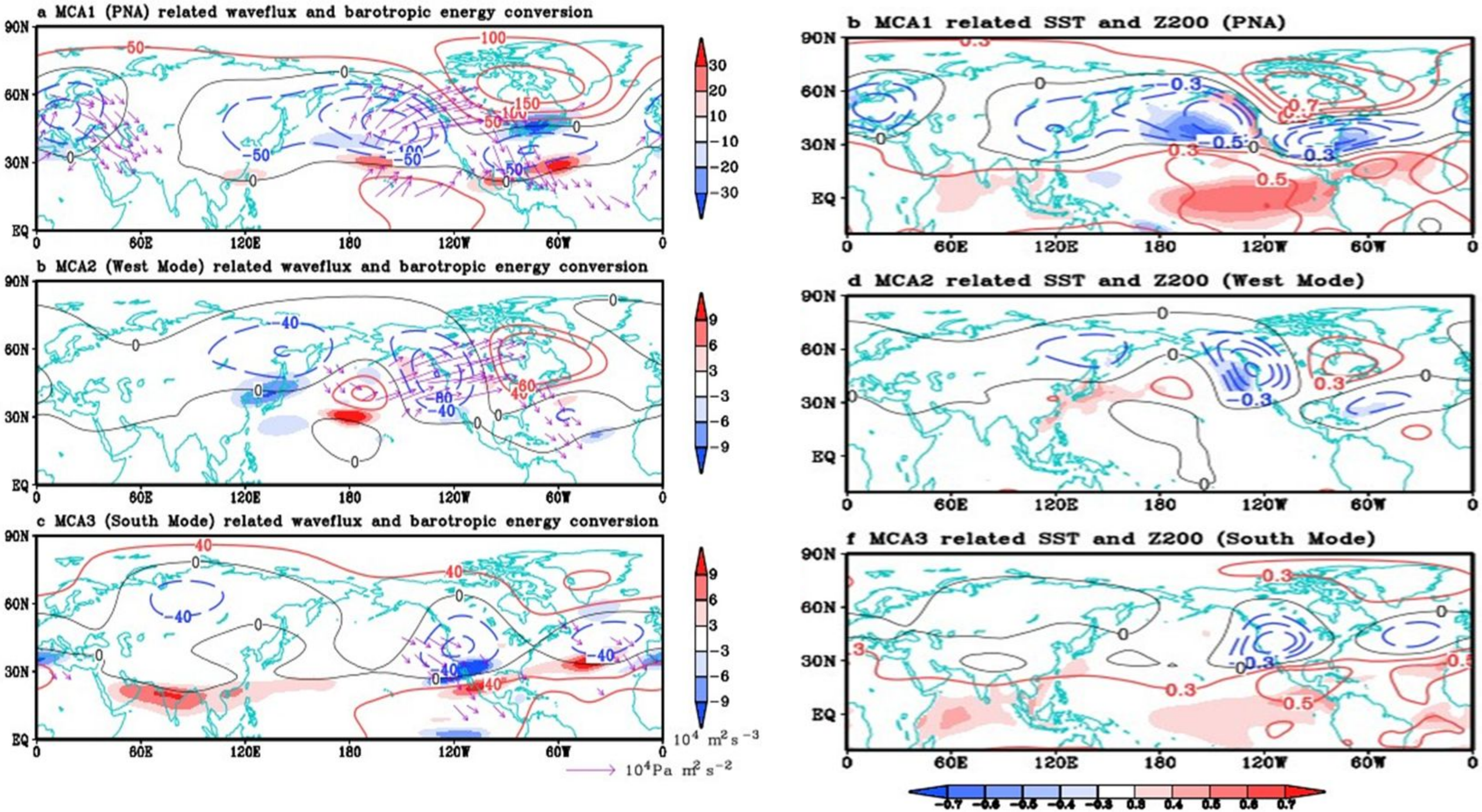
The three circulation modes provide us with some capability to "predict" precipitation



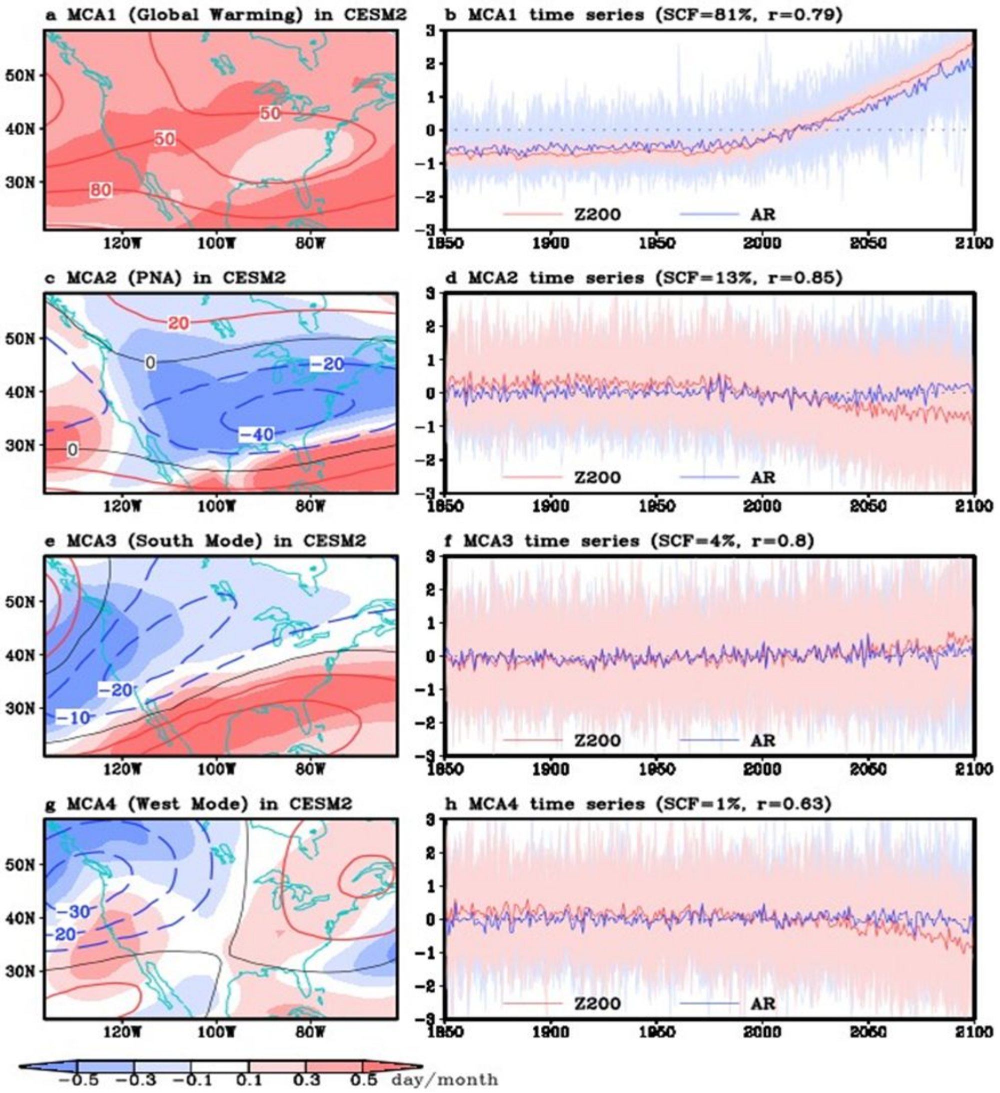
Precipitation (each grid)=a × PNA + b × West Mode + c × South Mode

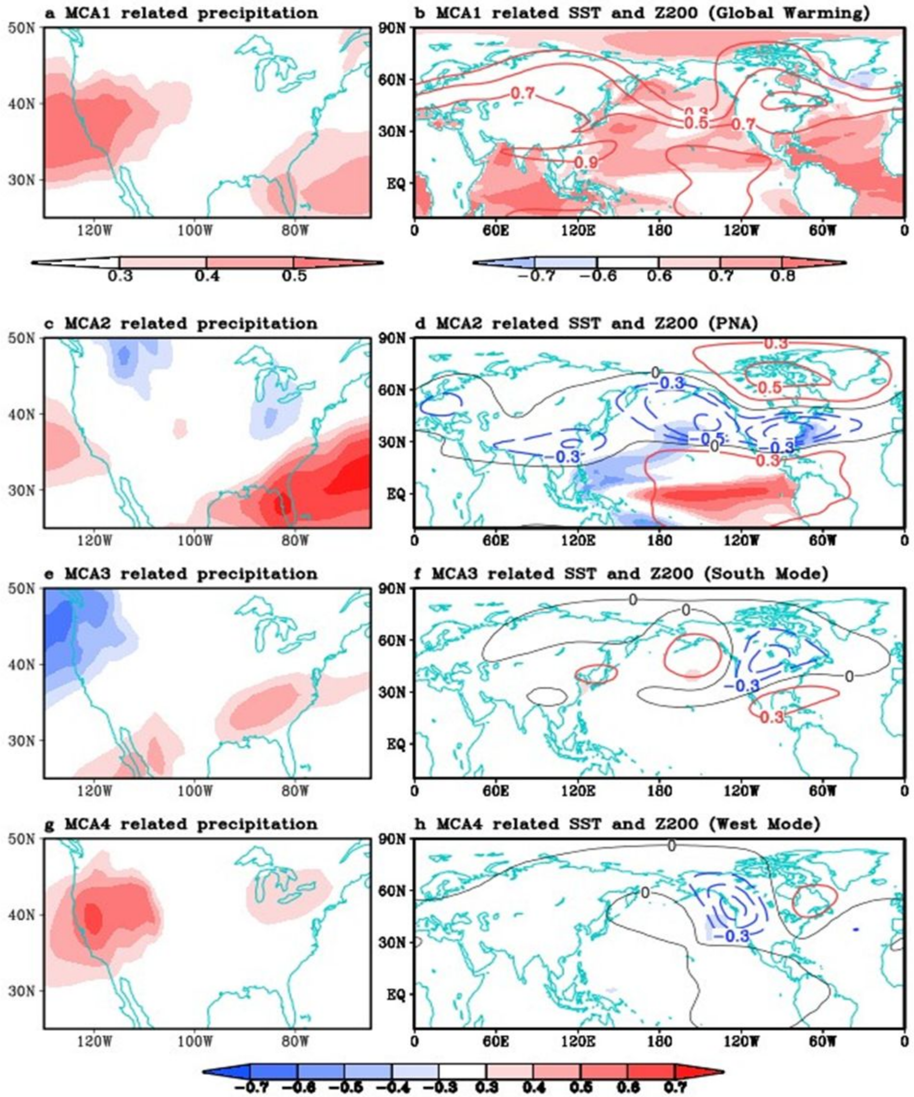


West Mode : Internally driven



Future precipitation changes have some degree of climate resilience





Limitation of CFSv2 in replicating the observed circulation-AR relationship

CFS2

ERA5

69%

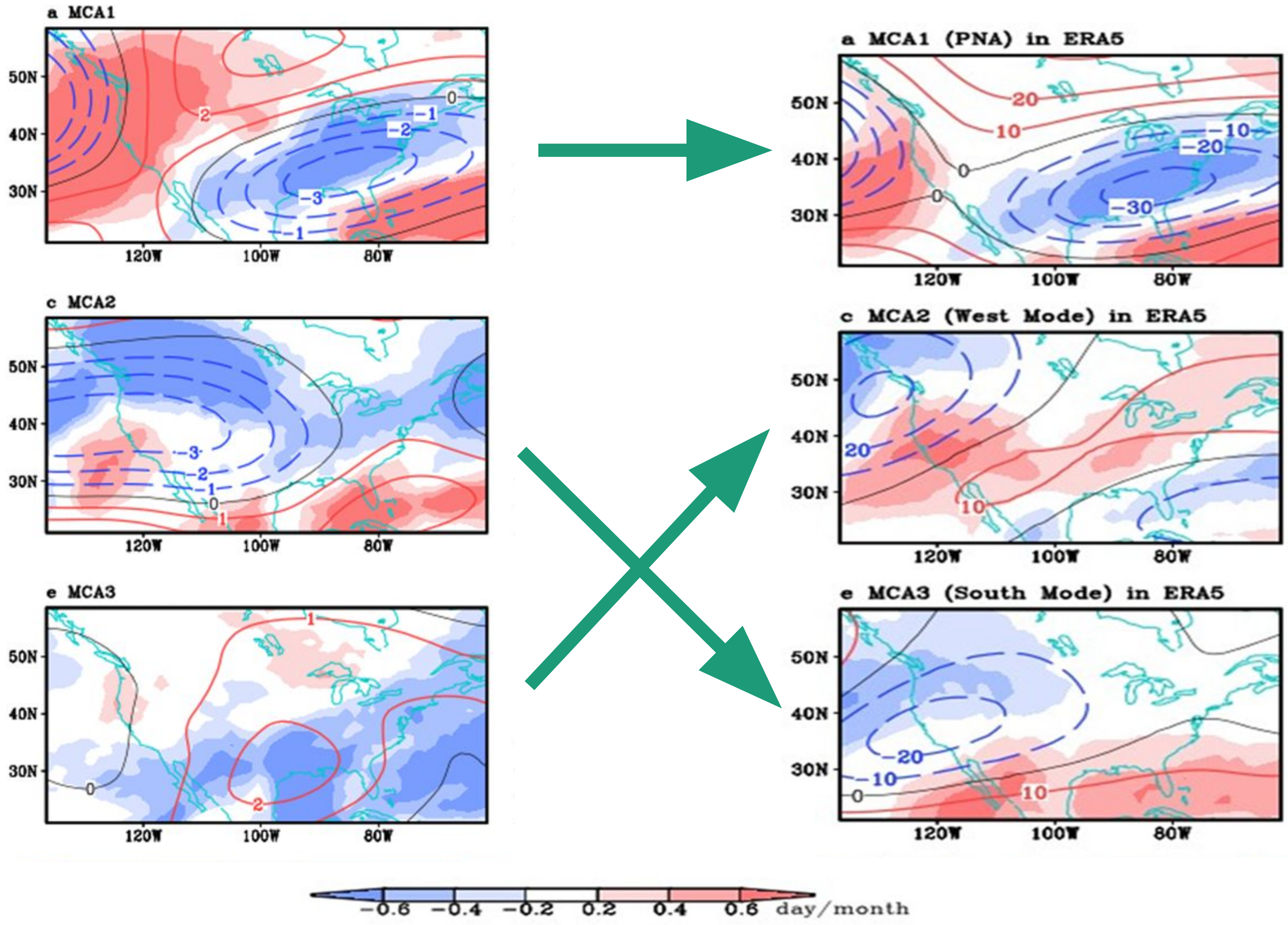
65%

23%

12%

3%

9%



Take-home messages

Two leading circulation modes in winter together explain almost 70% of CONUS precipitation in the Western US and 30% in the Central and Eastern US.

One of these modes is a well-known teleconnection modulated by ENSO, and the other reflects internal variability related to jet stream dynamics.

This internal mode is more critical than the ENSO-driven one in regulating precipitation changes through mediating ARs over the CONUS, particularly in the West.

Precipitation changes over the CONUS may be partially stochastically driven and, therefore, own some resistance to global warming in the decades to come.