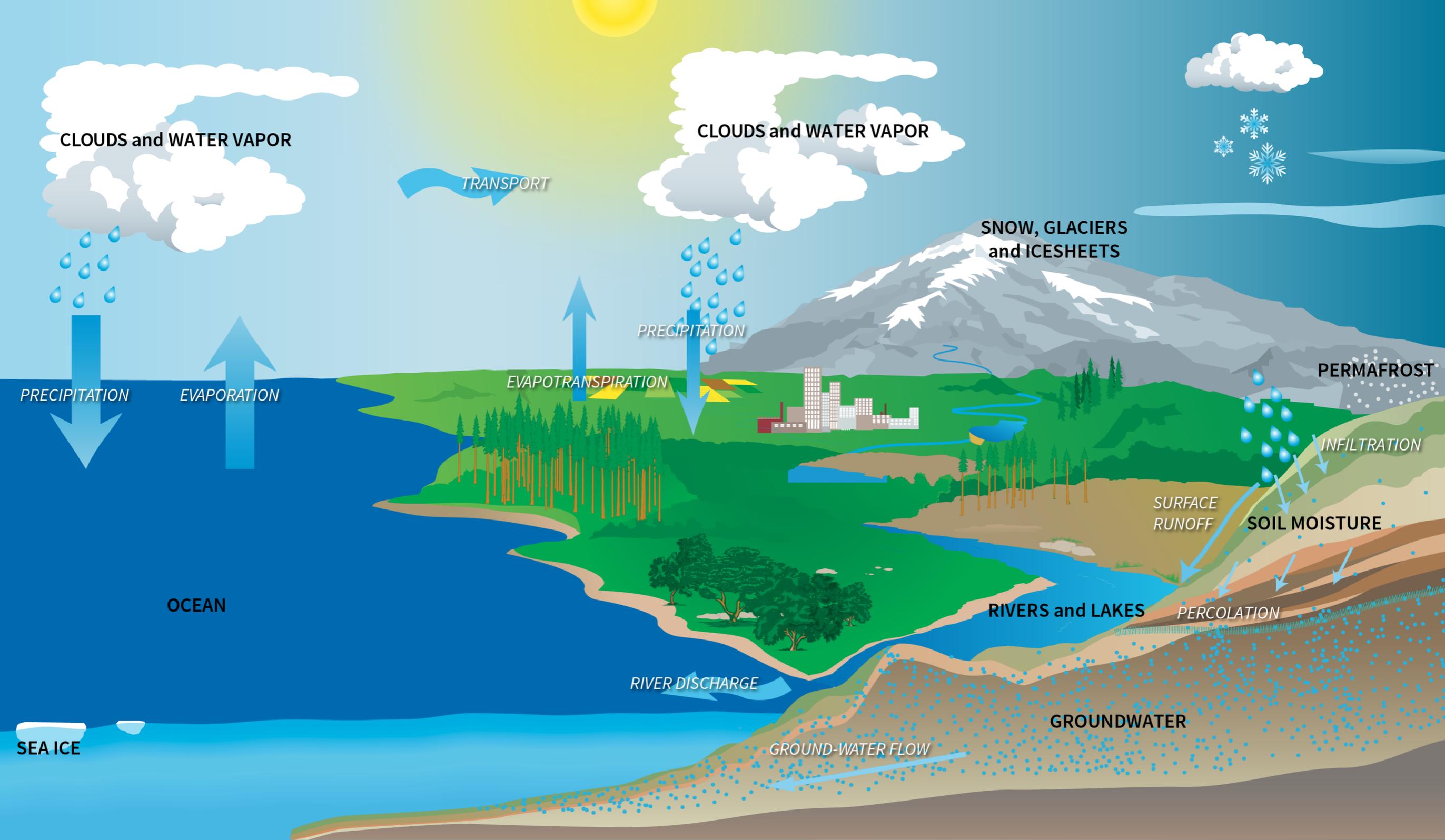




What We Talk About When We Talk About Hydroclimate: Challenges in Model-Data Comparisons



models give us most of this
(yay models!)



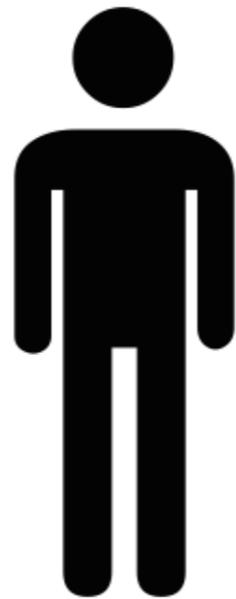


Yesterday (artist's rendering)

How do we translate between?

The models suck!

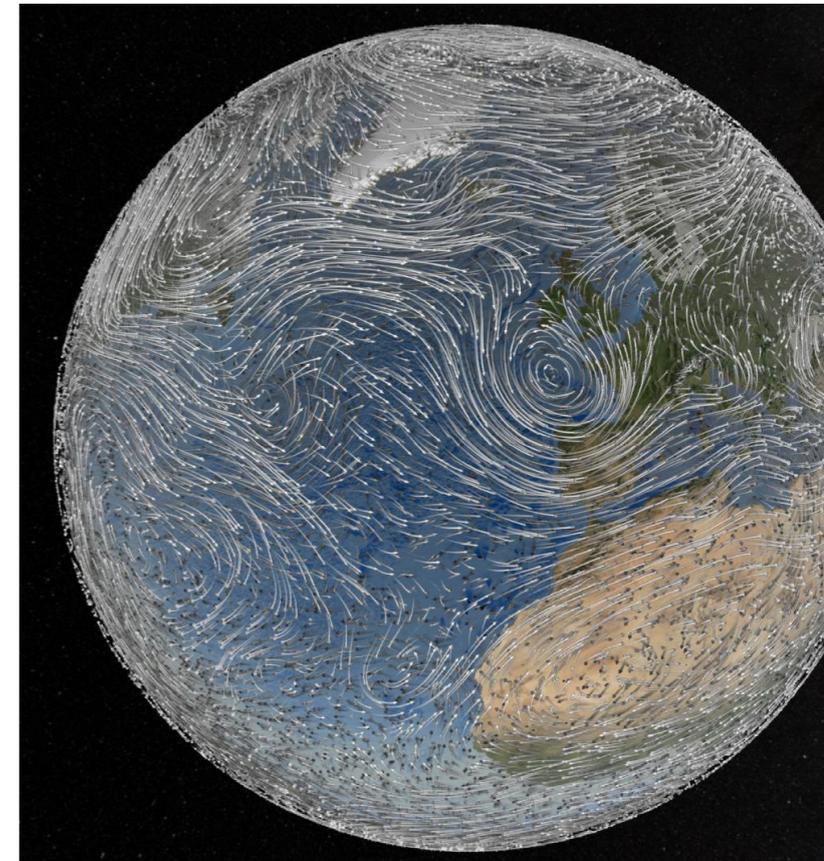
You have a superficial understanding of processes!



e.g., Ed Cook

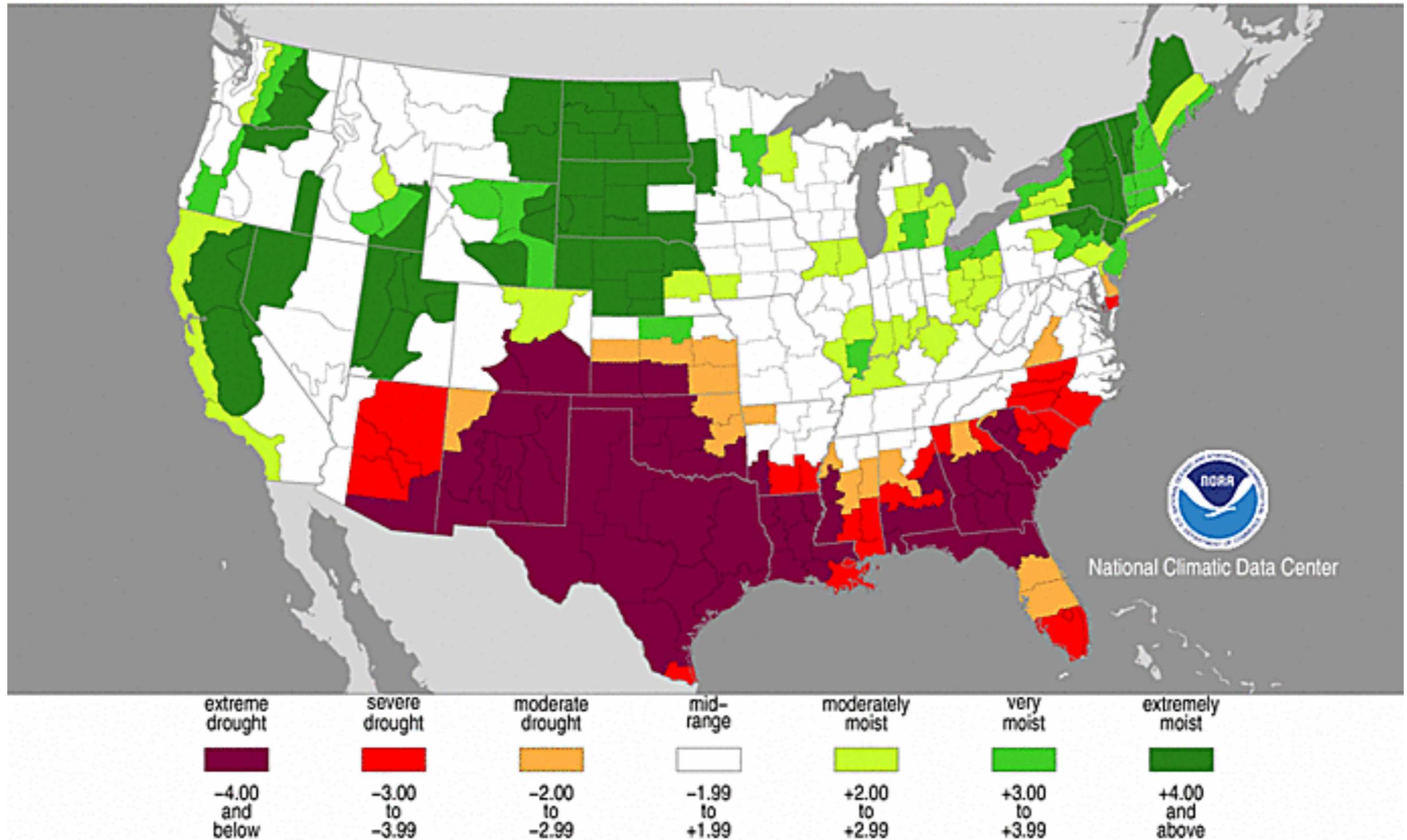


e.g., Me



Palmer Drought Severity Index

August, 2011



Target a common variable that leverages strength of:
proxies, observations, and models

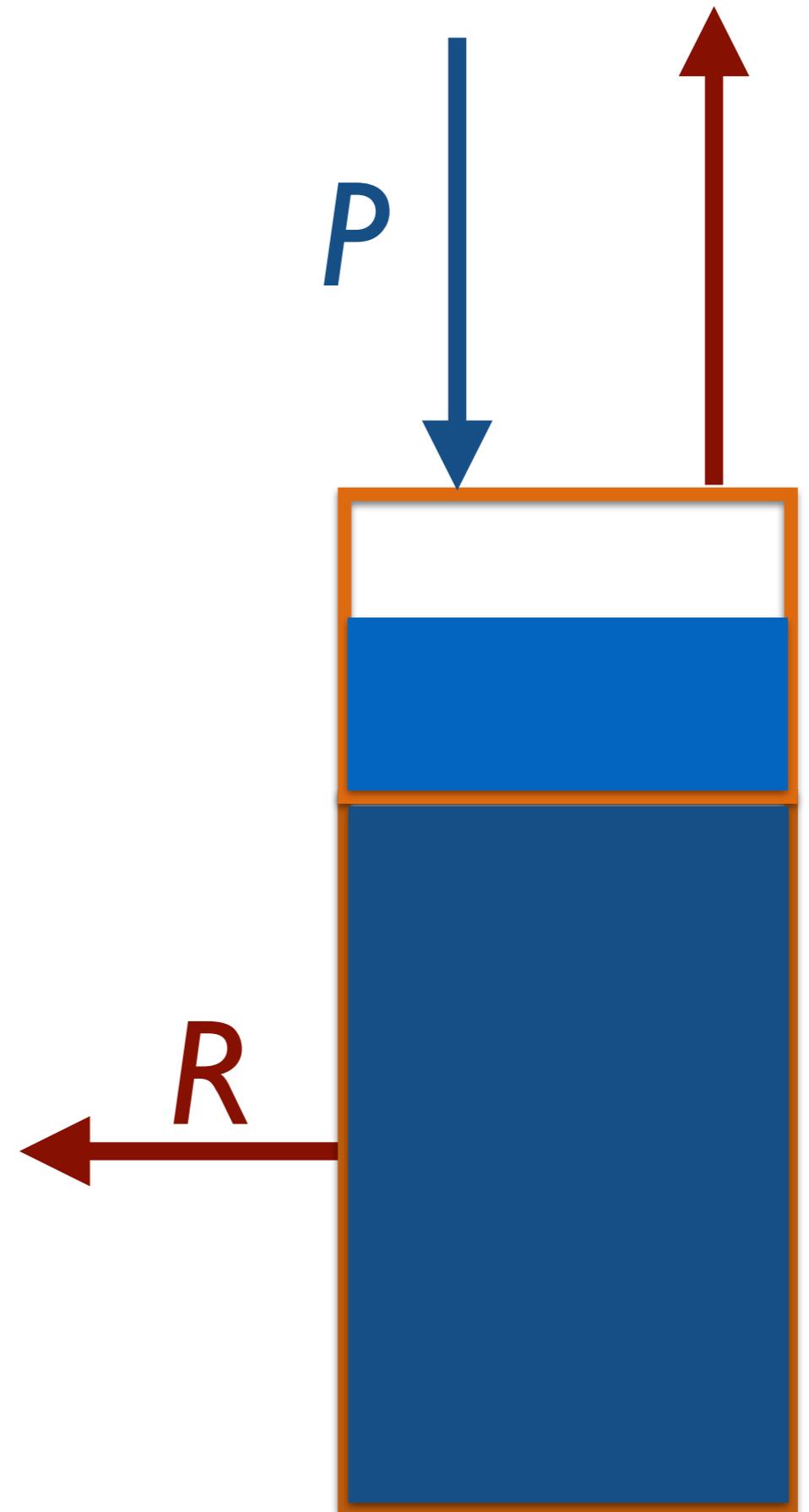
Palmer Drought Severity Index

soil moisture bucket
model

integrates changes in P
and ET over ~ 12
months

widespread use in
drought monitoring,
reconstruction, etc.

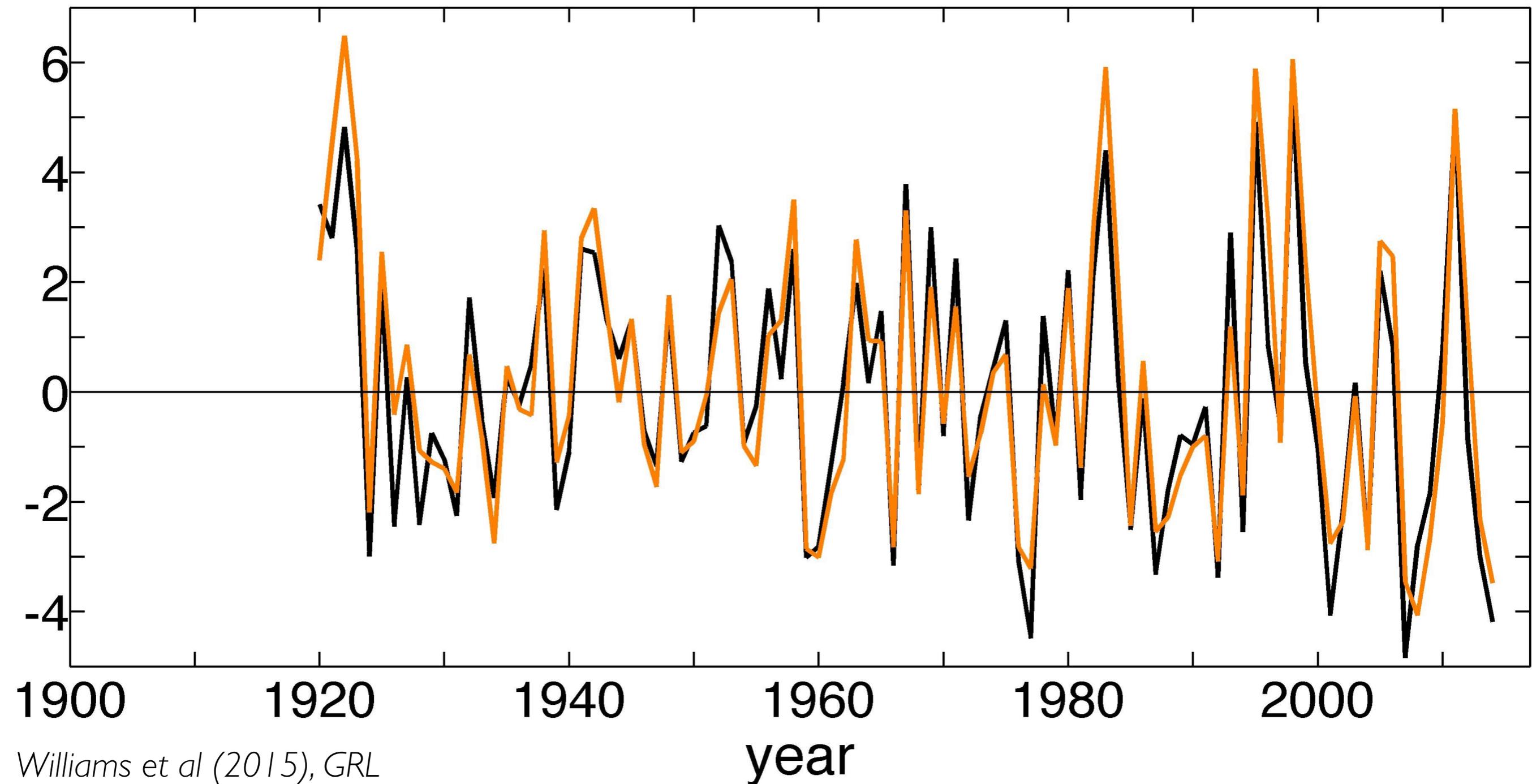
$ET, f(T, q, u, R)$



Palmer Drought Severity Index

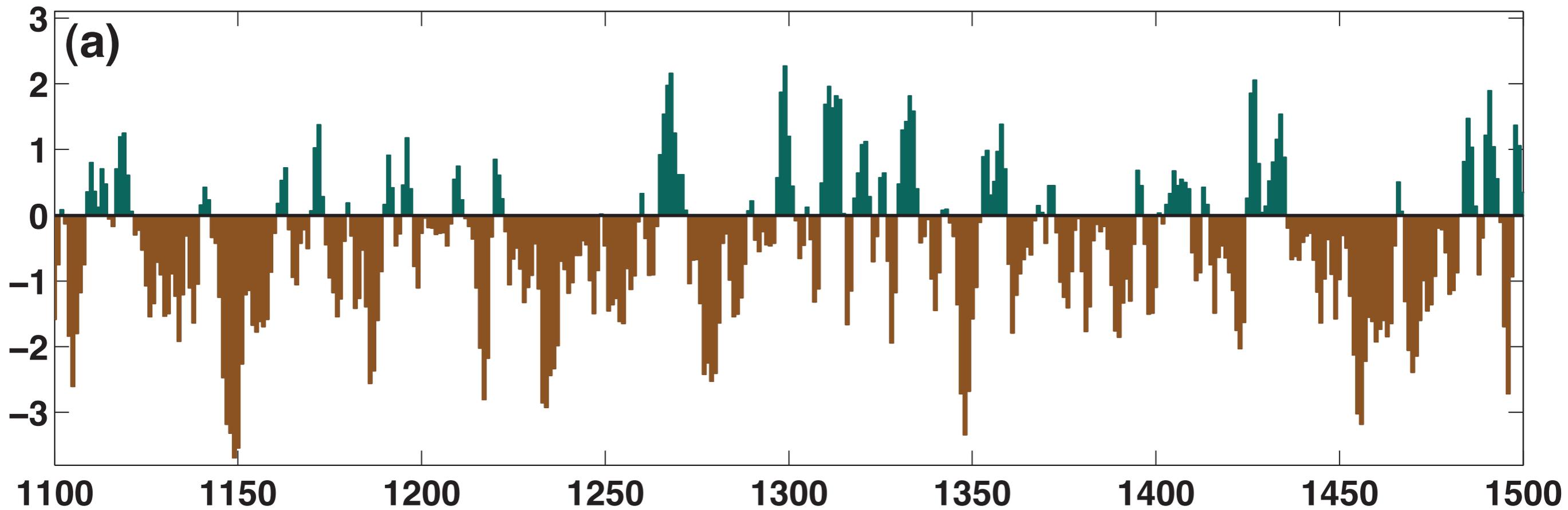
versus *VIC*, Sierra Nevada Mountains

— PDSI_{sc} — VIC model



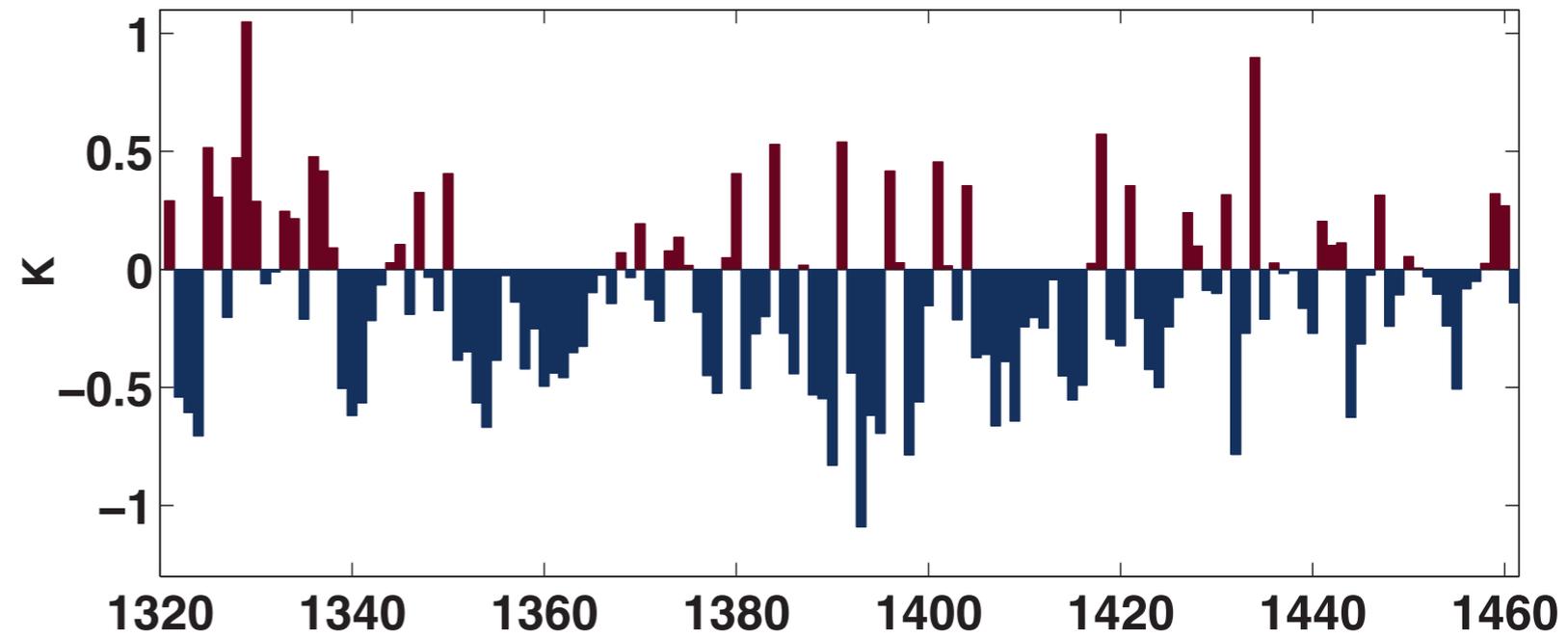
Central Plains Megadroughts

MCA (1100-1500 C.E.)

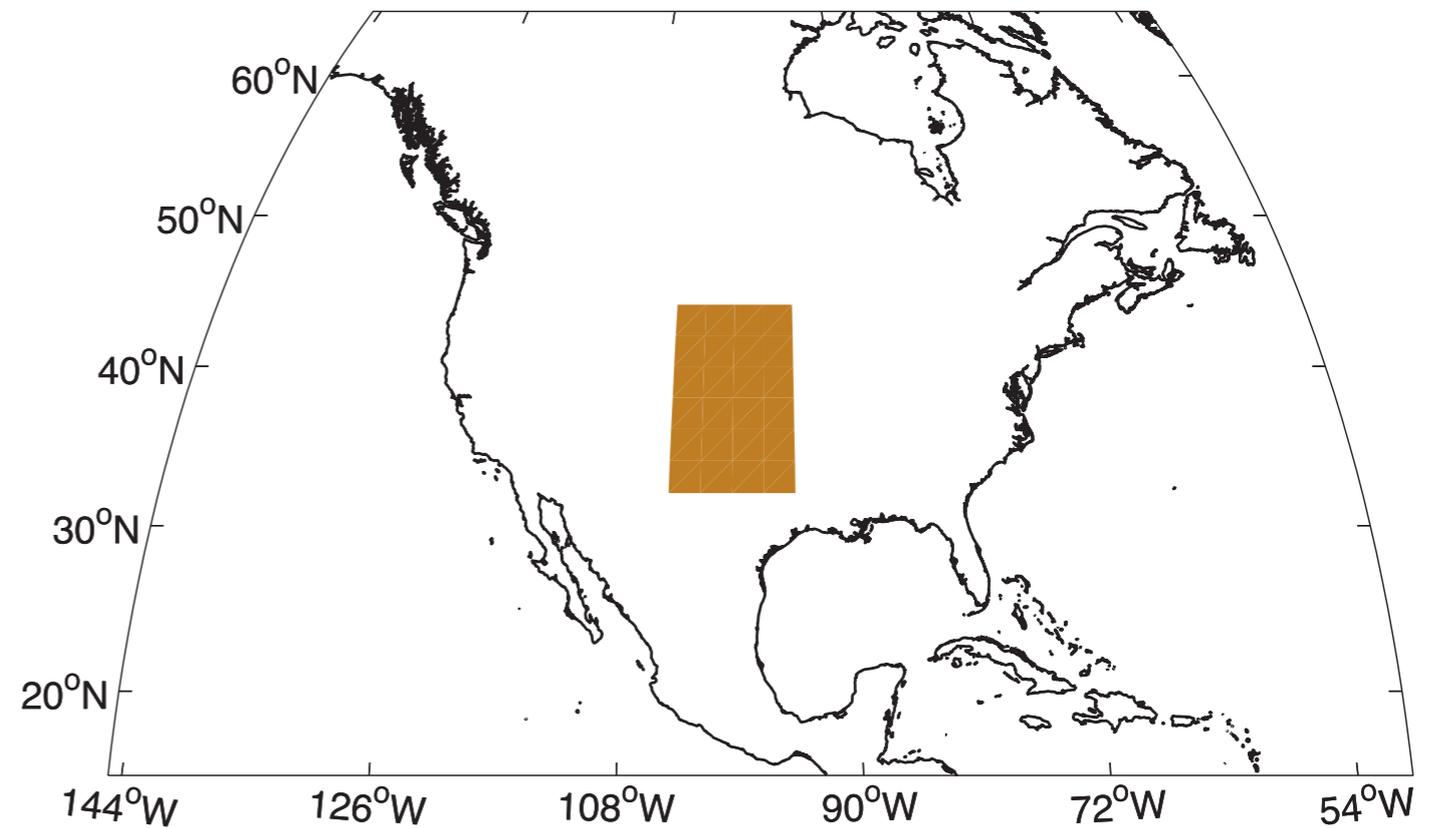


Simulations with the GISS GCM

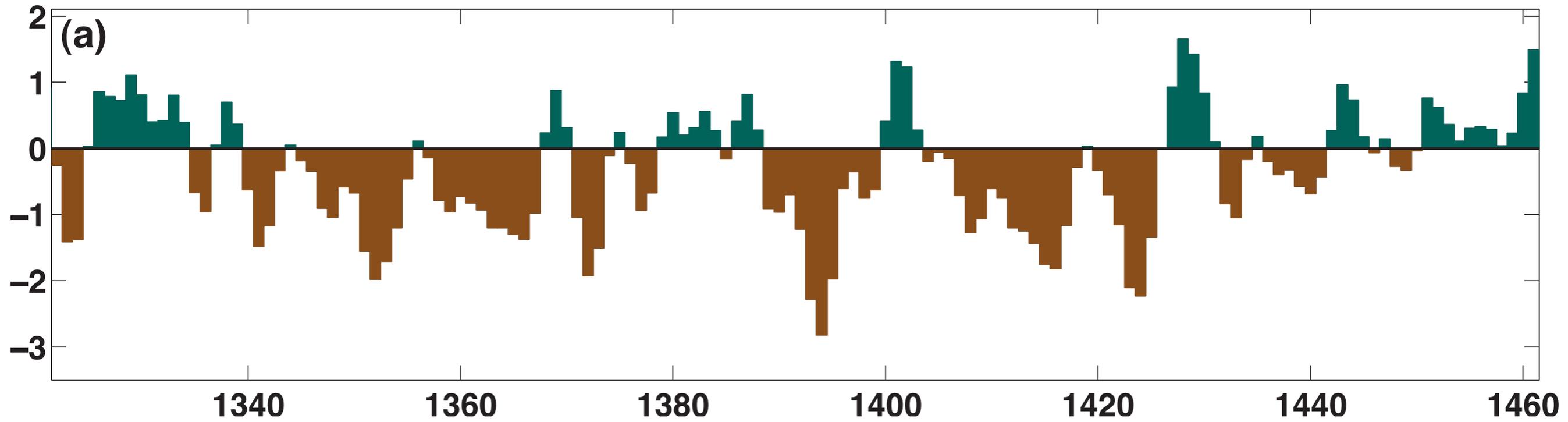
Annual NINO 3.4 Anomalies (MCA)



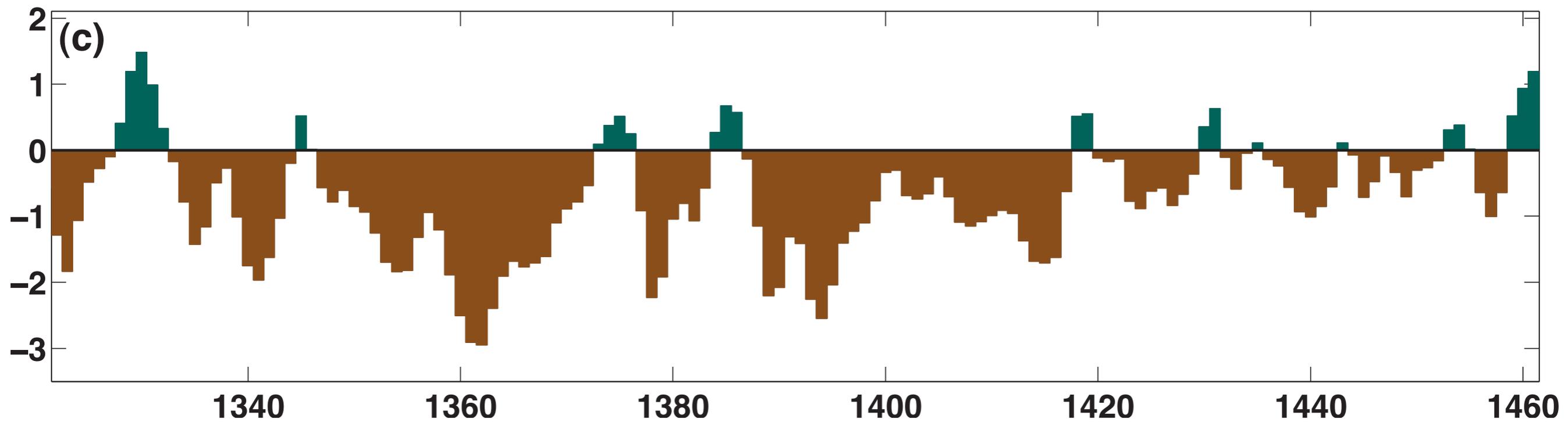
Region of Dune Mobilization



SST-Only

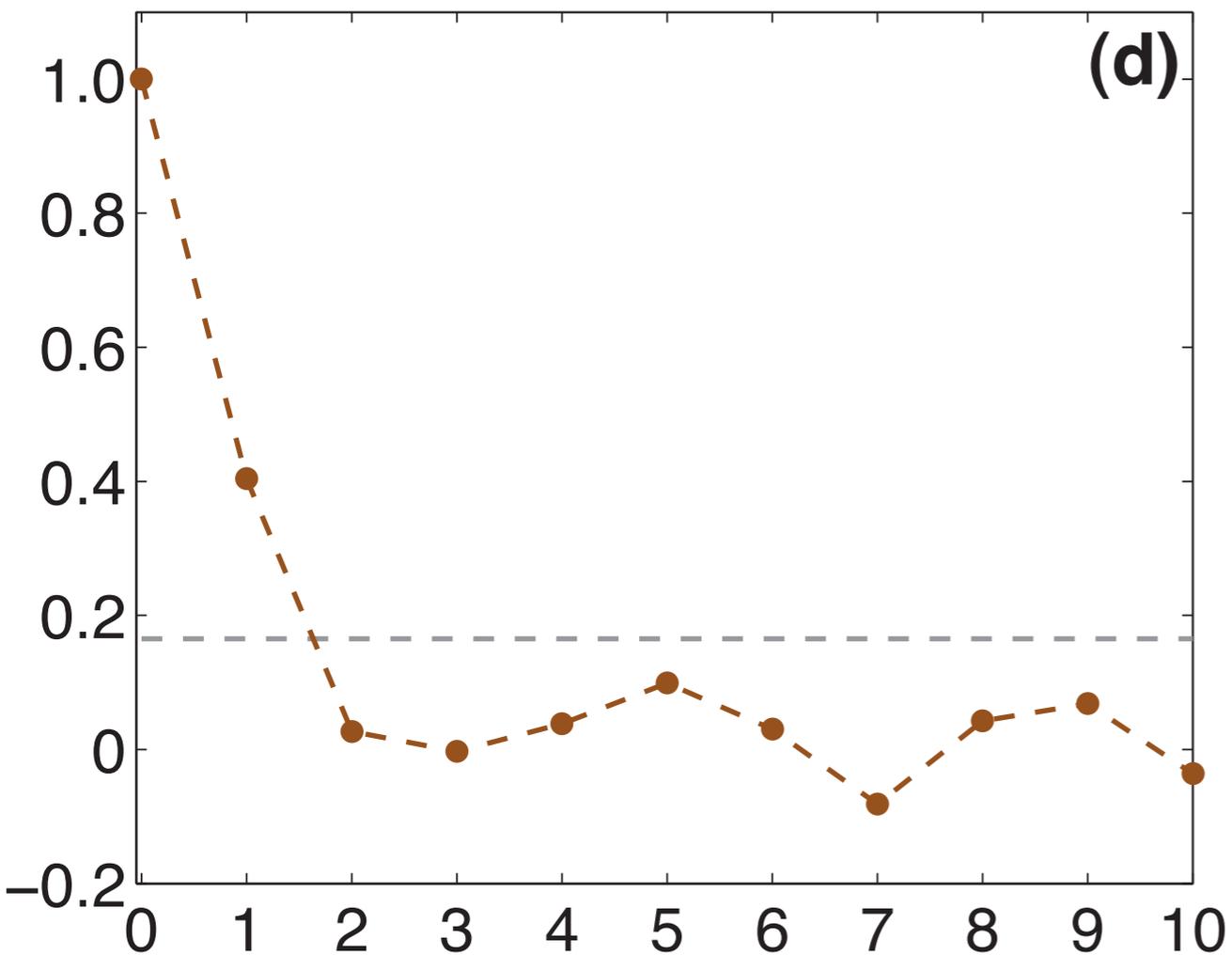


SST+BSOIL+DUST

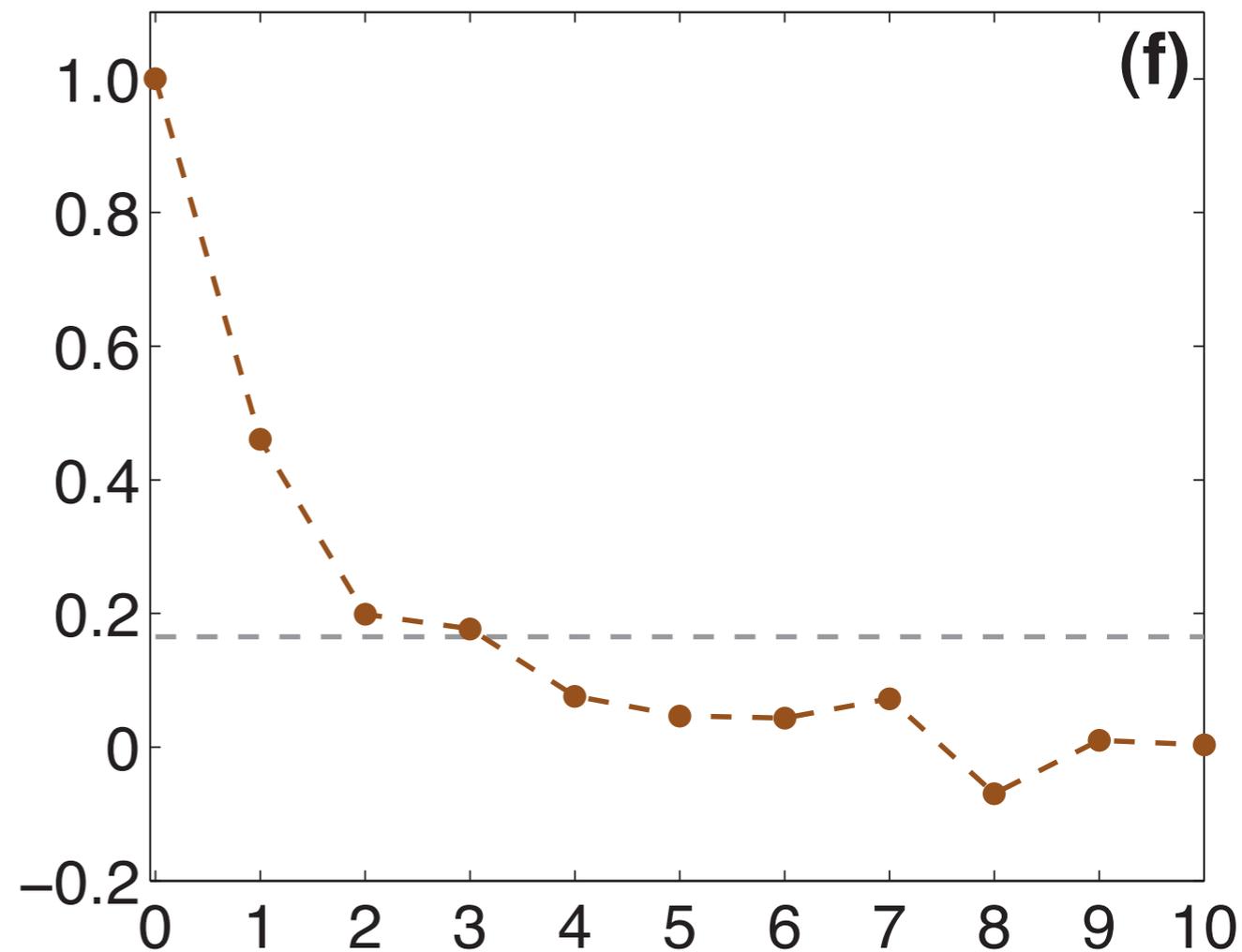


More persistence droughts with
land surface changes

SST-ONLY



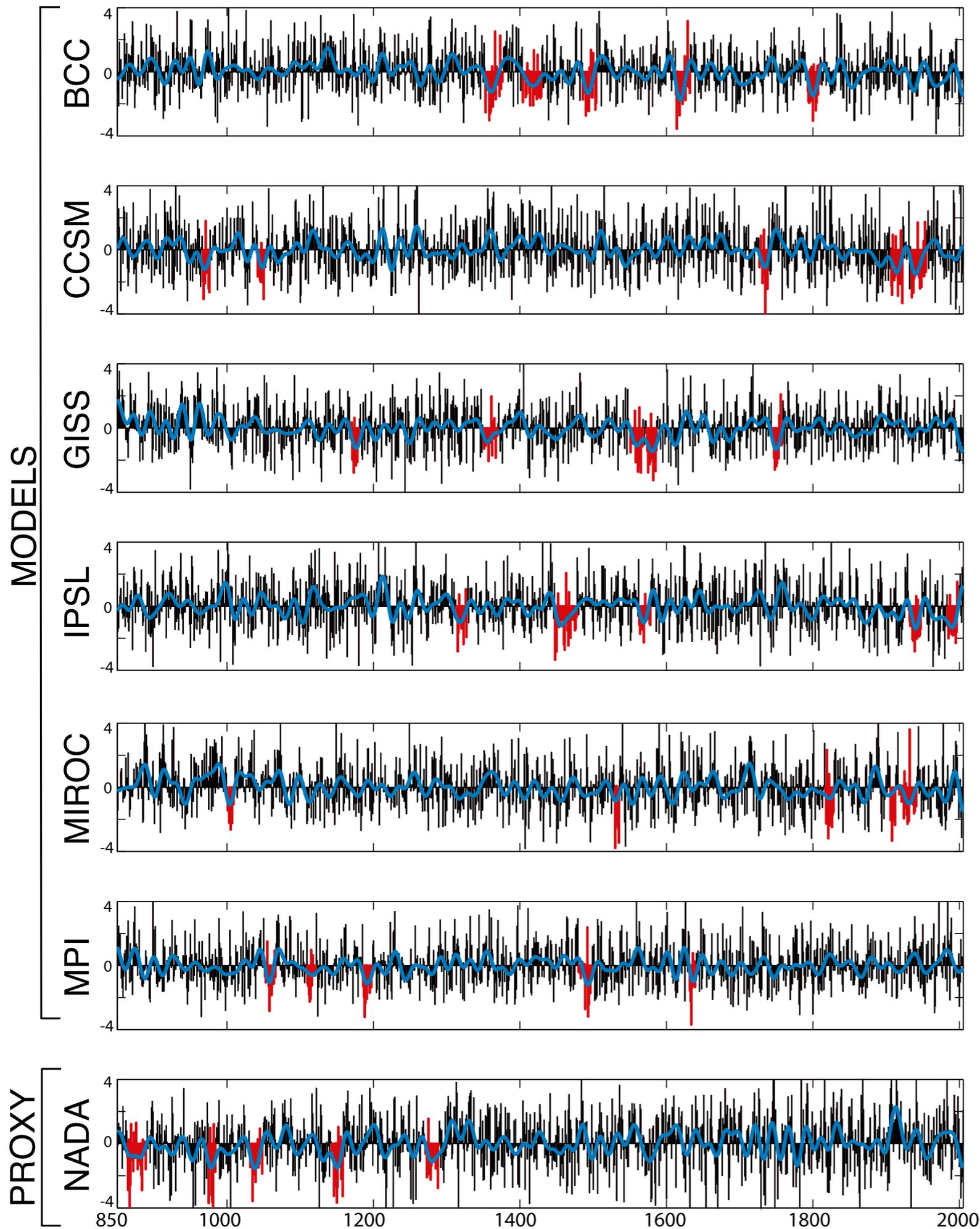
SST+BSOIL+DUST



autocorrelation

More persistent droughts with
land surface changes

North American Southwest Average PDSI

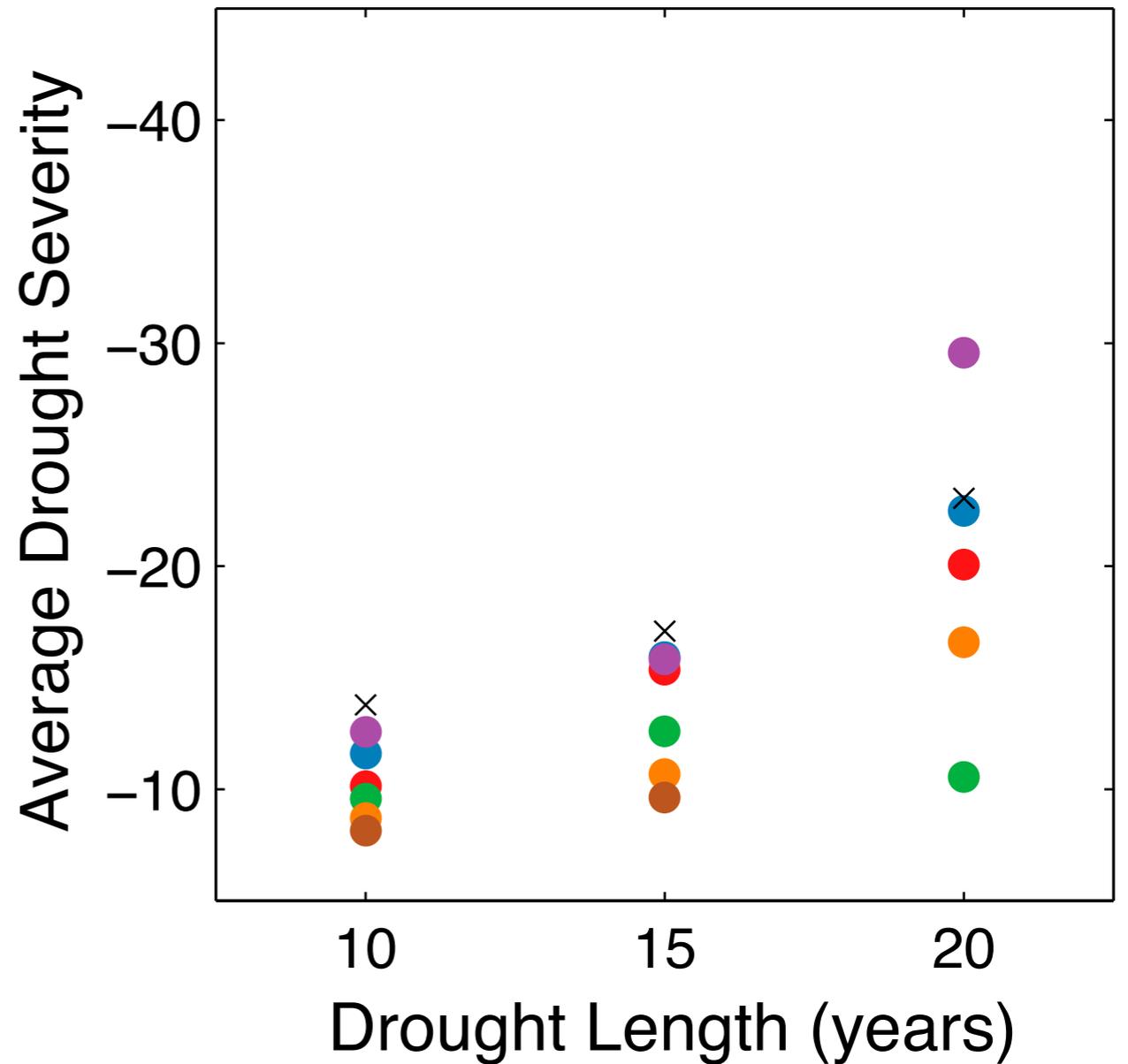
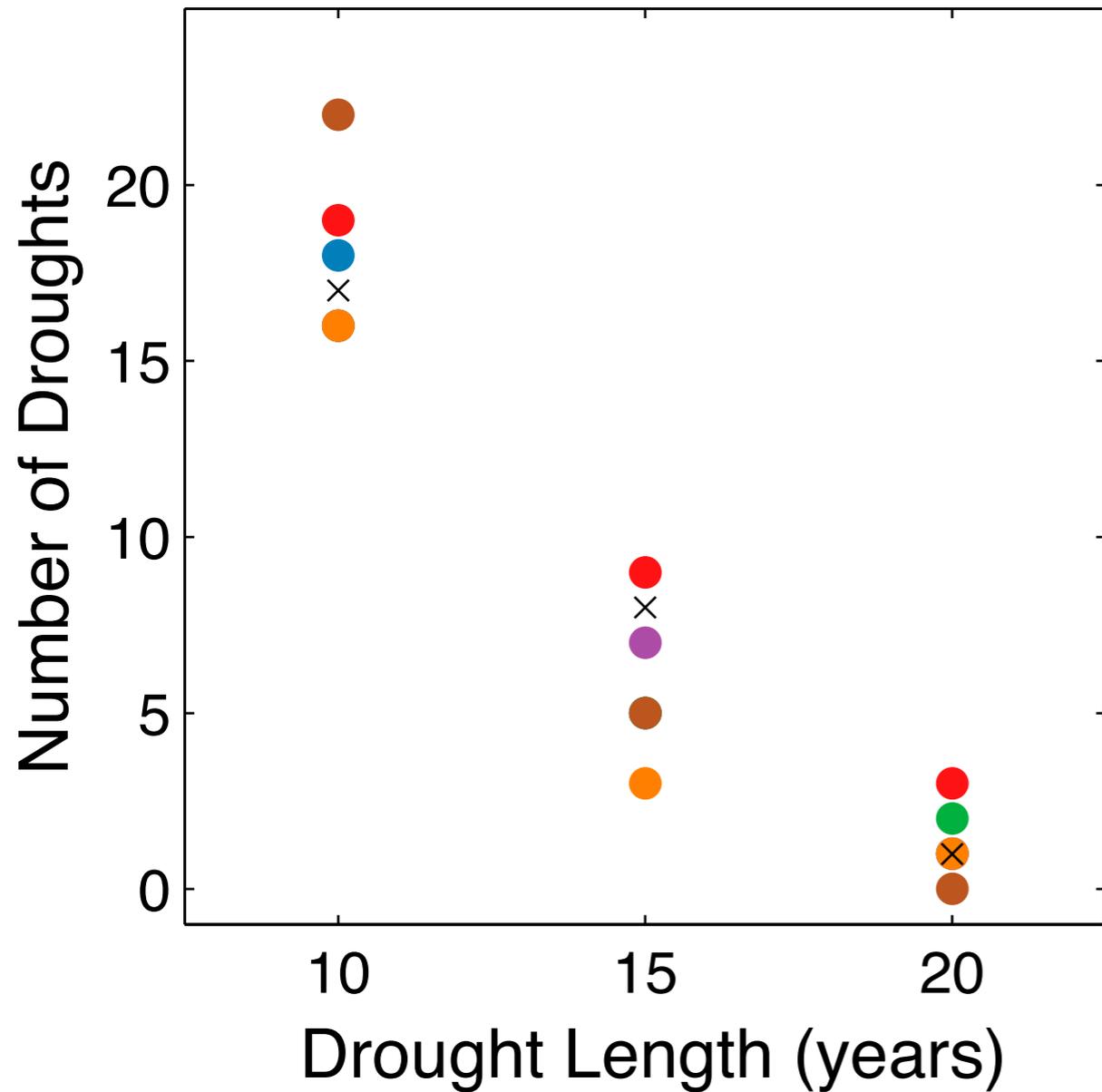


CMIP5
Last Millennium

no MCA time
clustering

SST Forcing

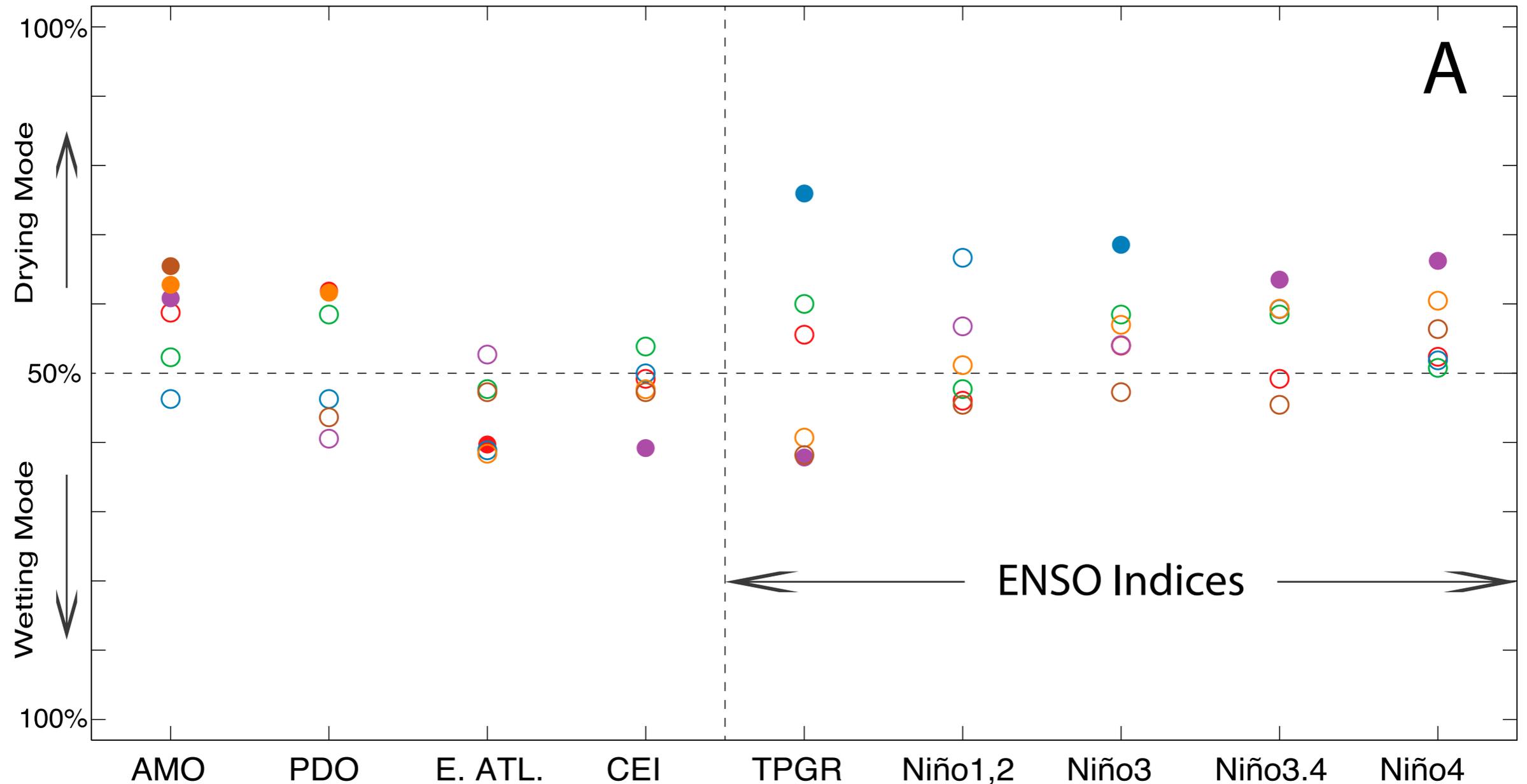
● BCC ● CCSM ● GISS ● IPSL ● MIROC ● MPI × Recon



CMIP5 Last Millennium

SST Forcing

○ BCC
 ○ CCSM
 ○ GISS
 ○ IPSL
 ○ MIROC
 ○ MPI



Only IPSL and CCSM4 have consistently cold tropical Pacific

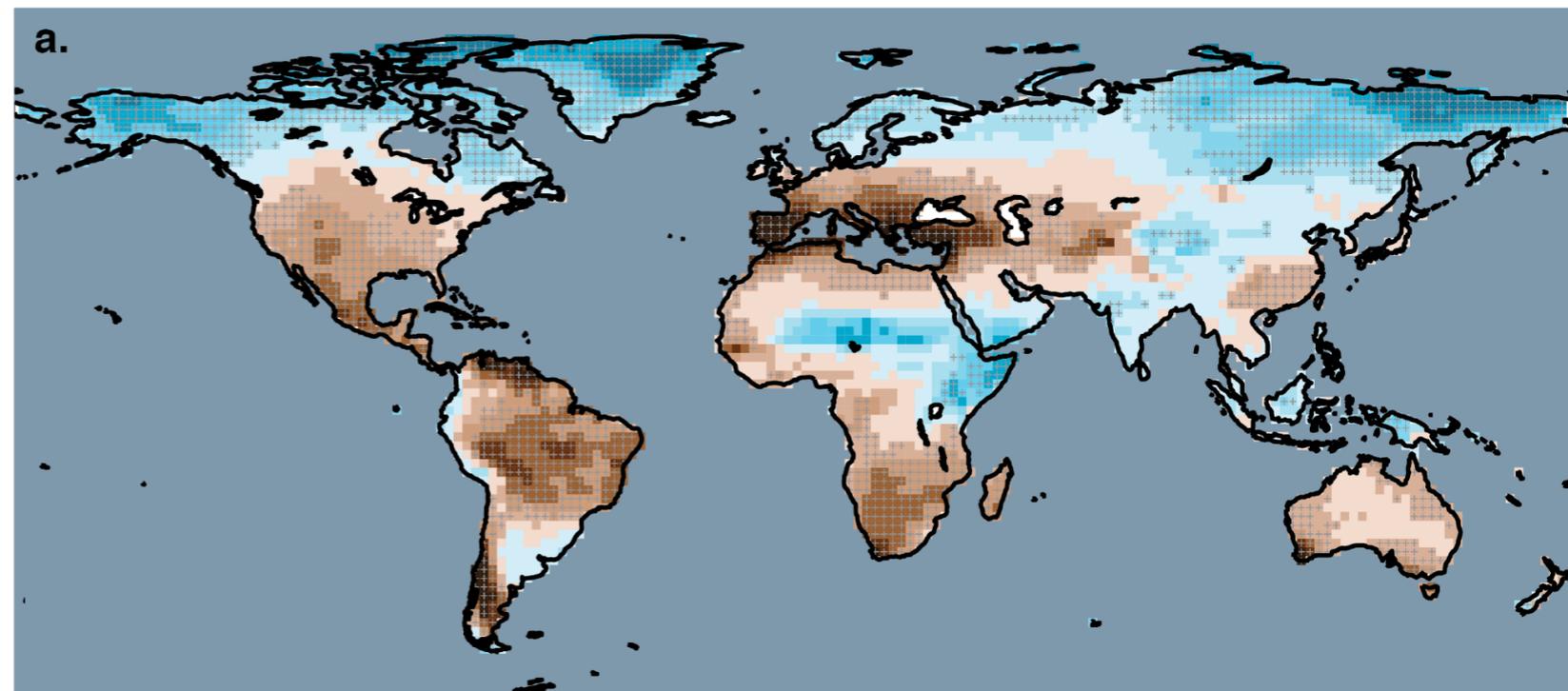
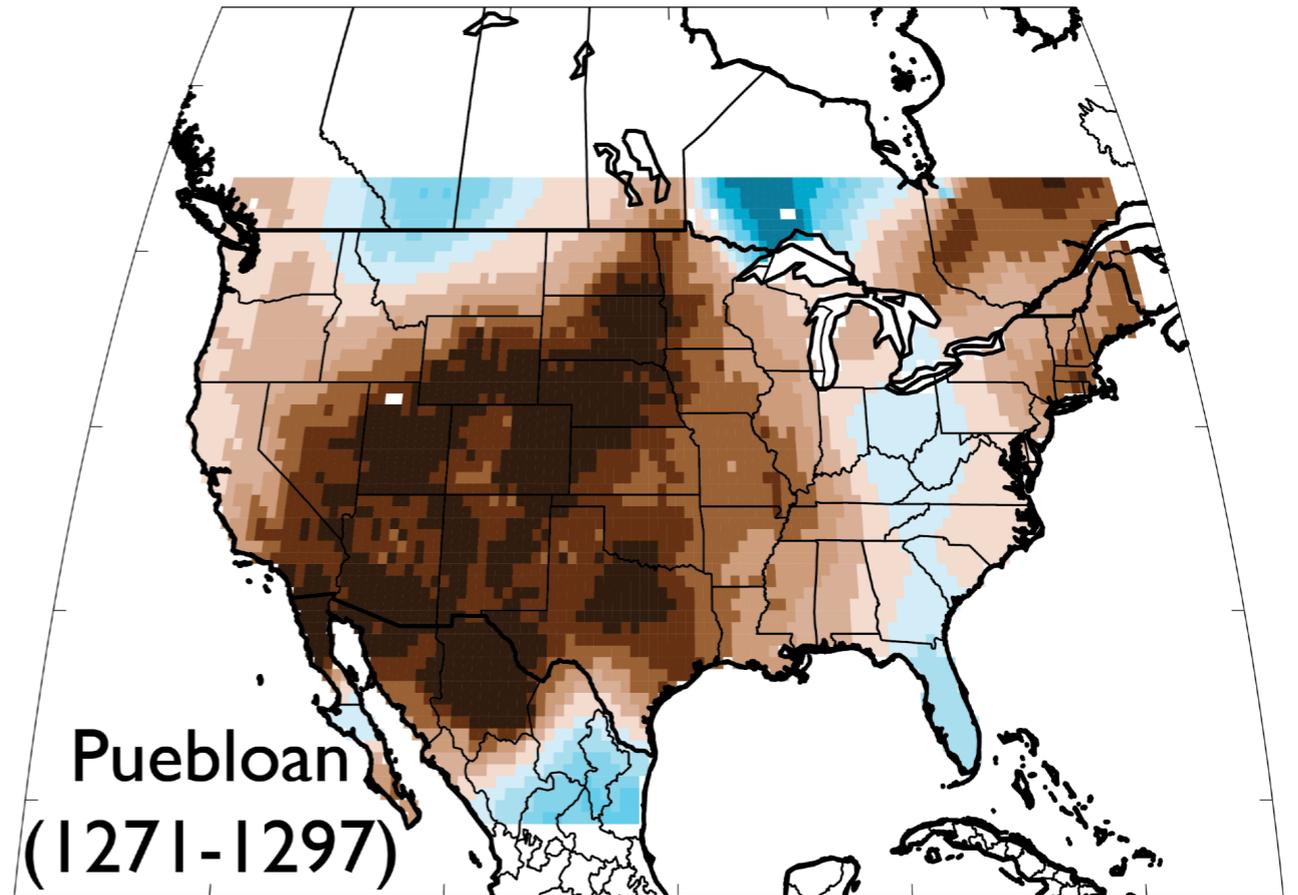
How do drought trends in CMIP5 projections compare to the past?

17 Models

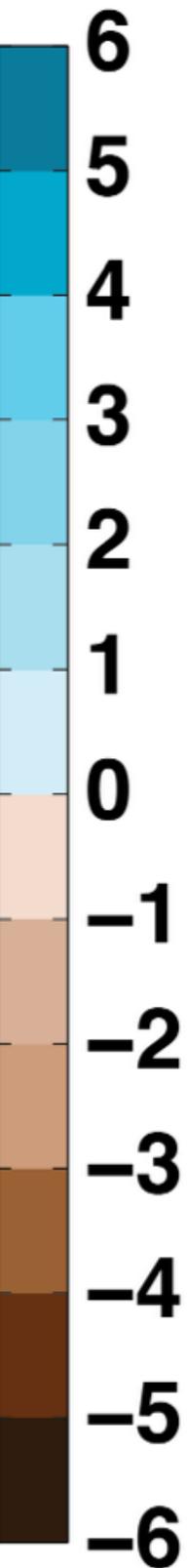
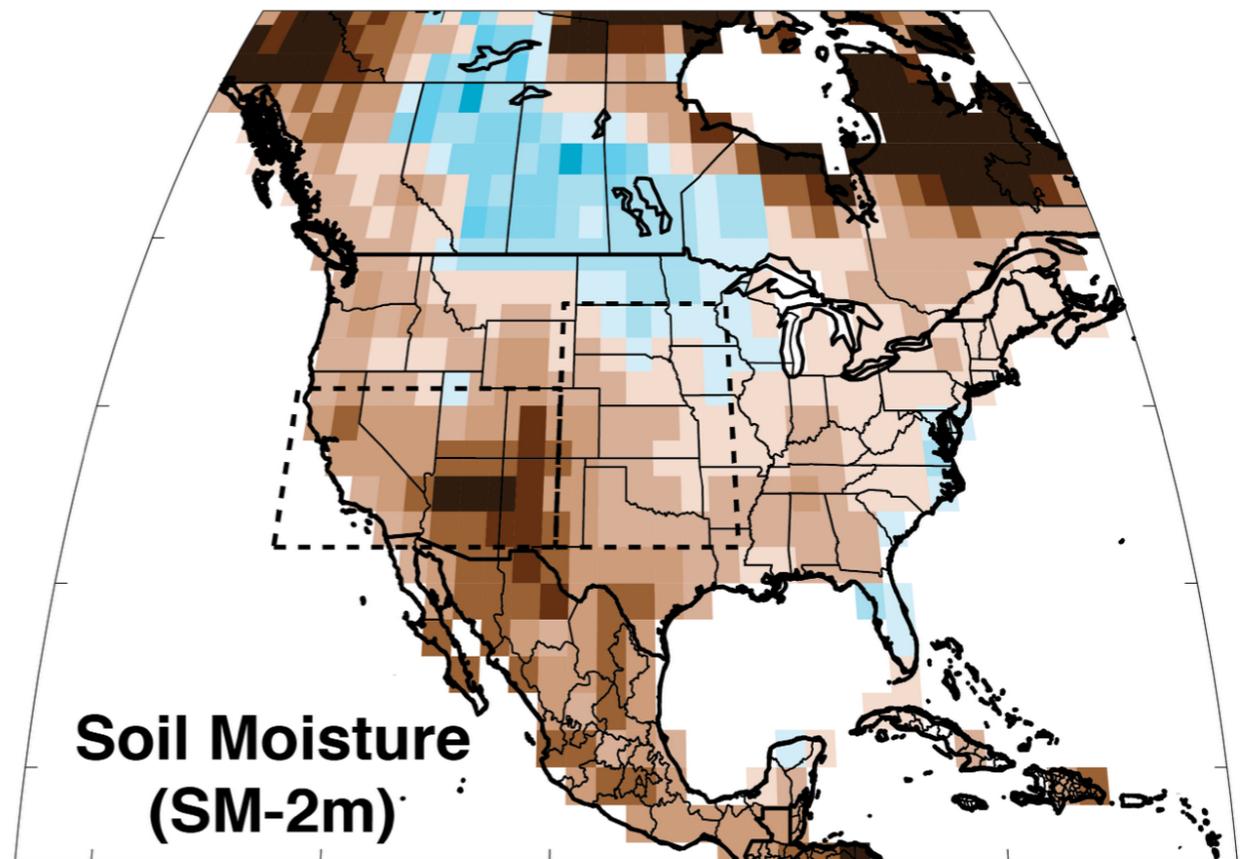
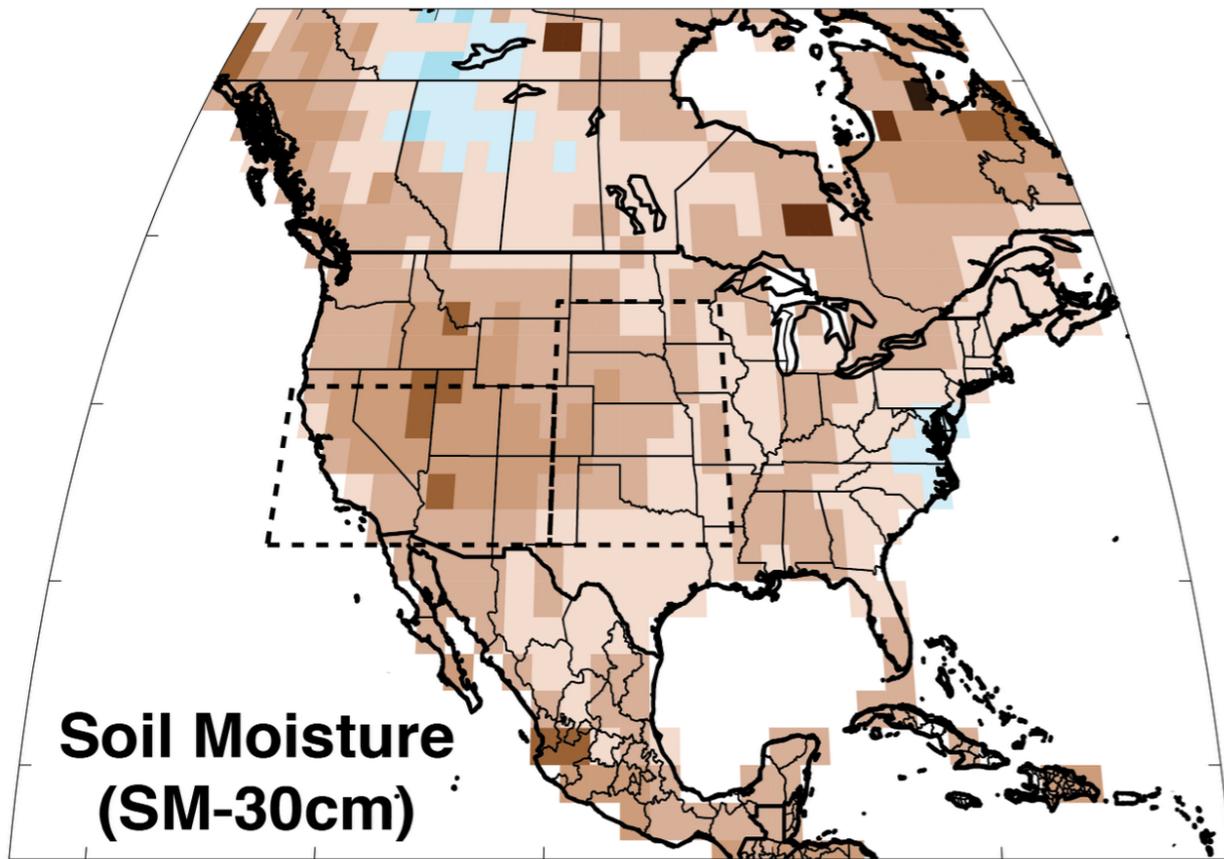
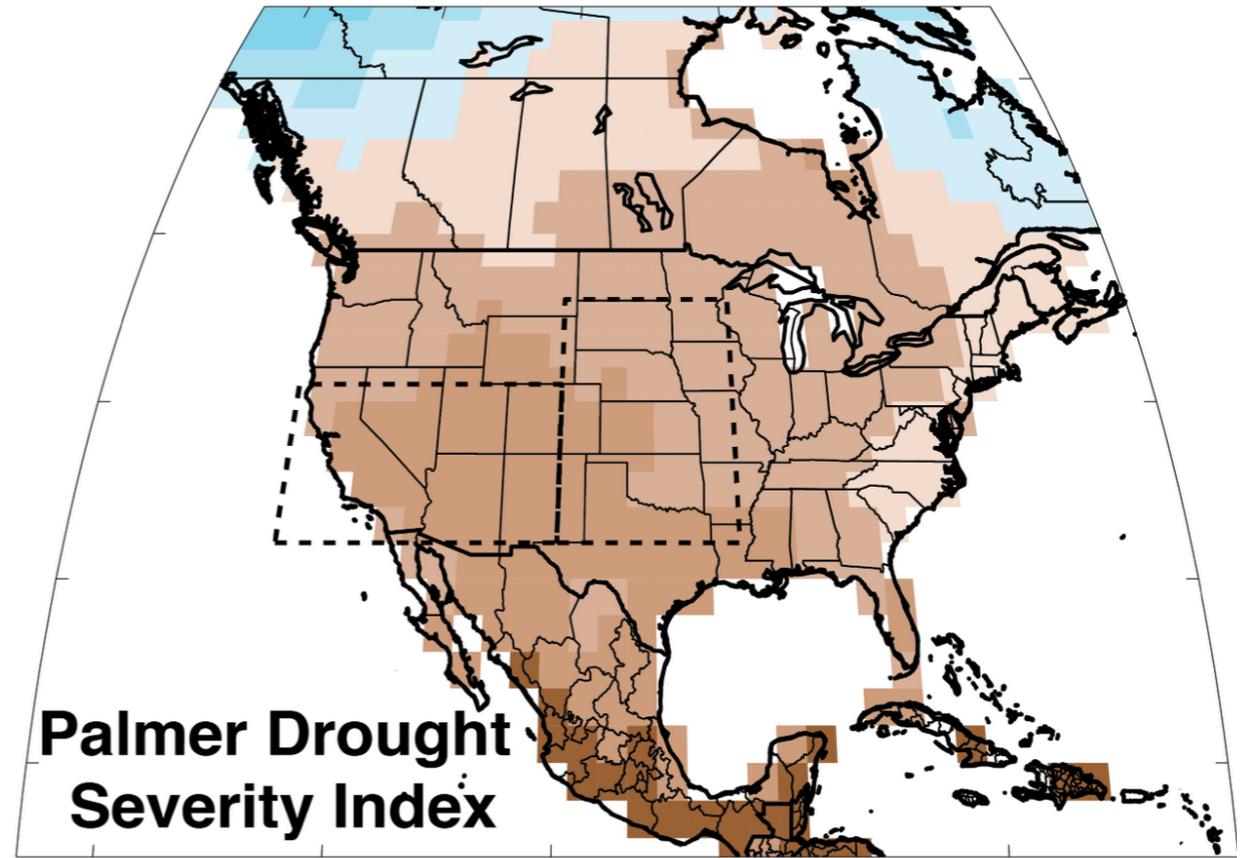
RCP 8.5

PDSI

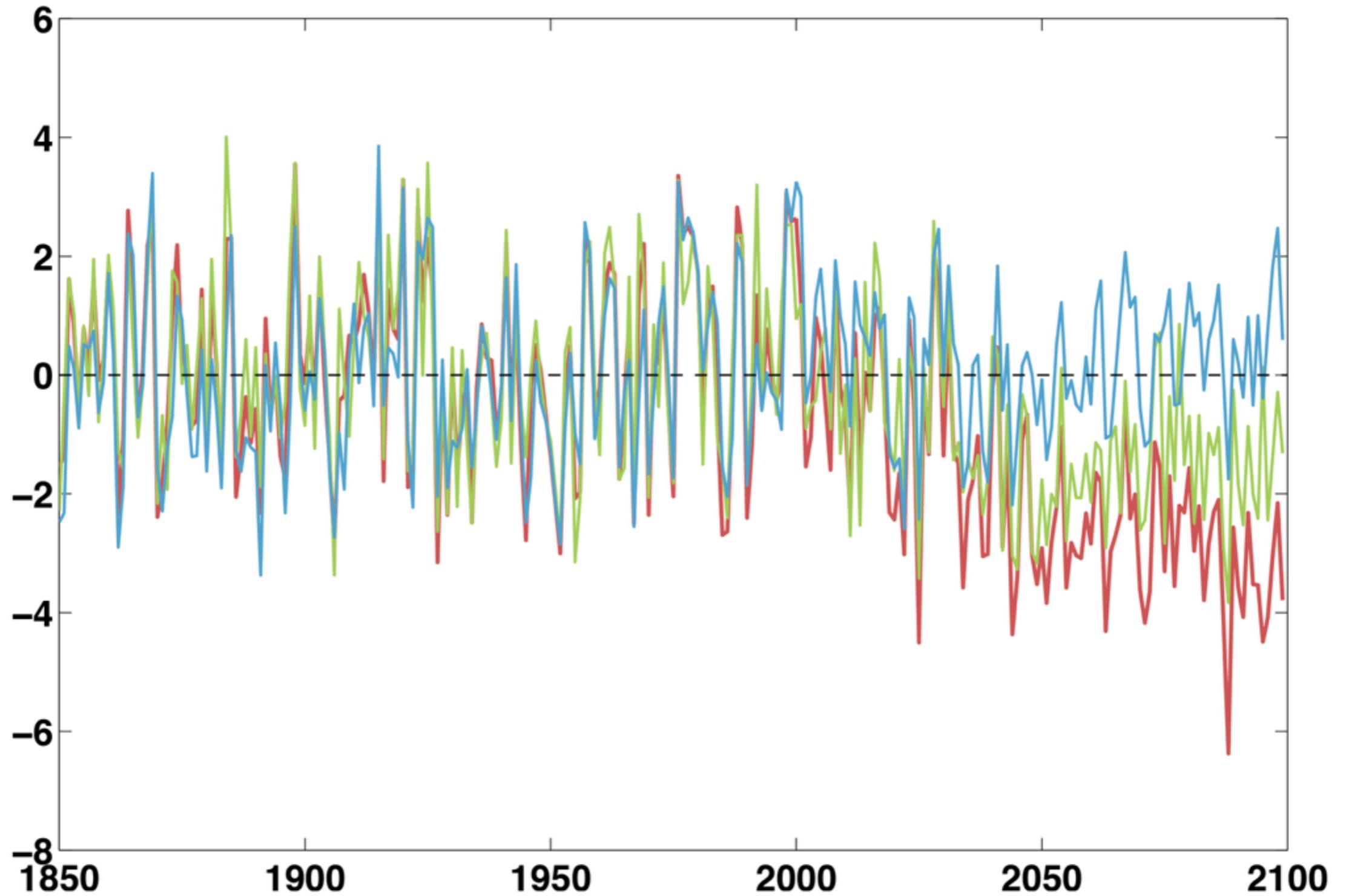
2 soil moisture variables



Soil Moisture (2050-2099)



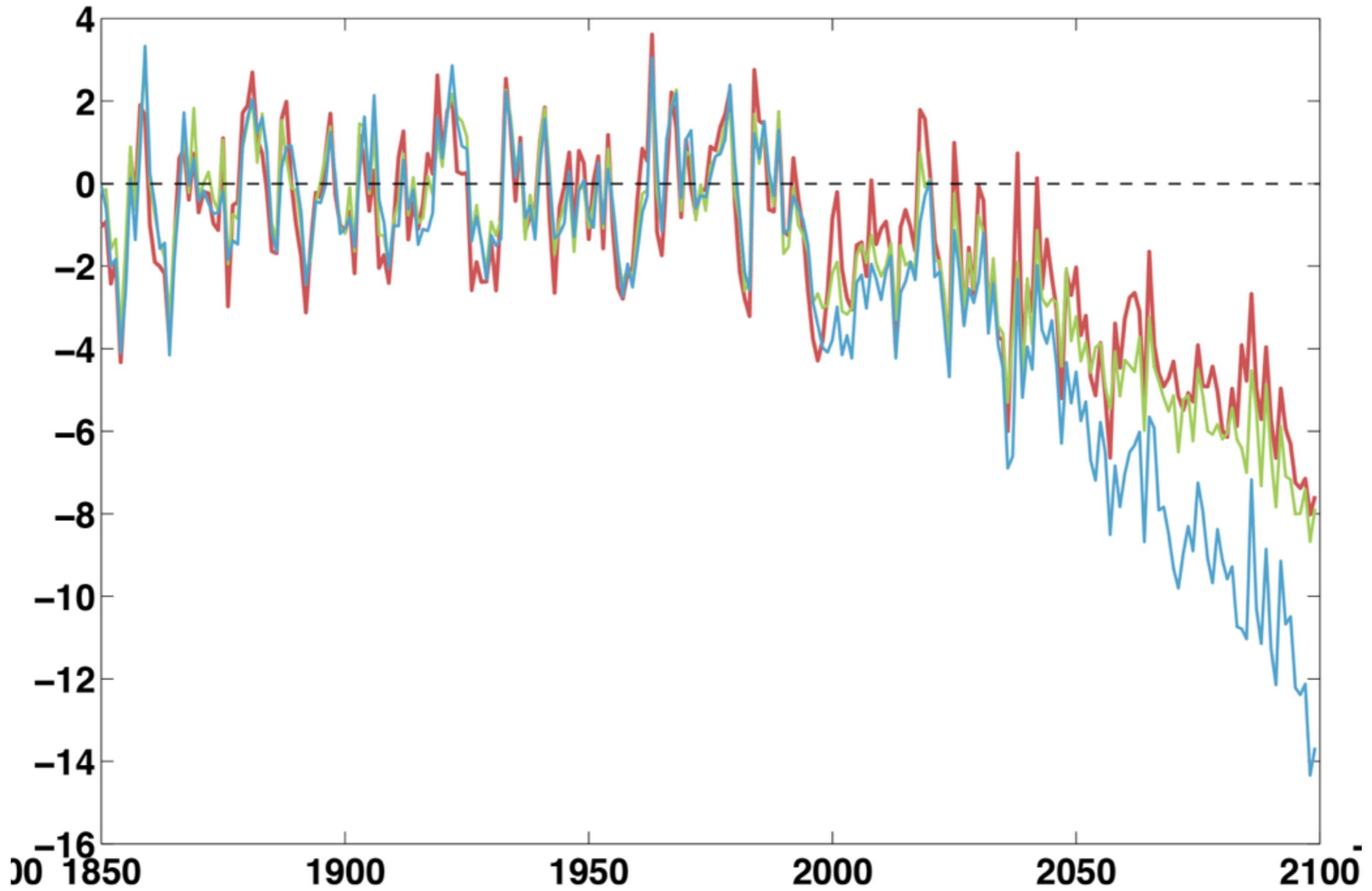
ACCESS1.0



Central Plains
(RCP 8.5)

- PDSI**
- SM-30cm**
- SM-2m**

MIROC-ESM-CHEM

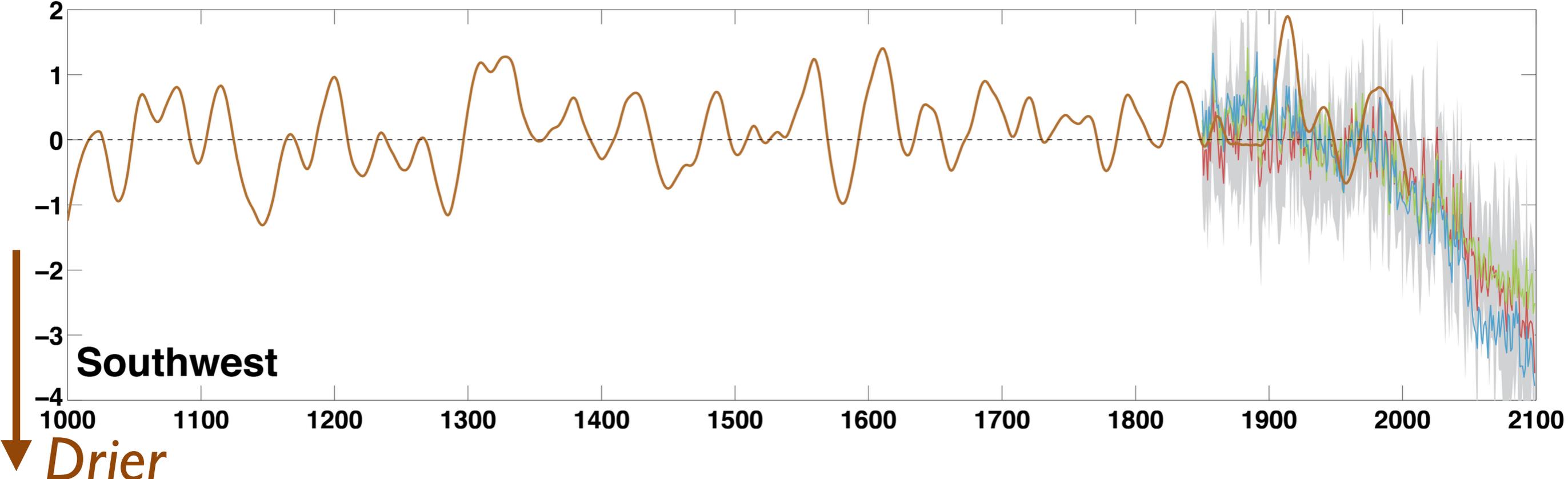
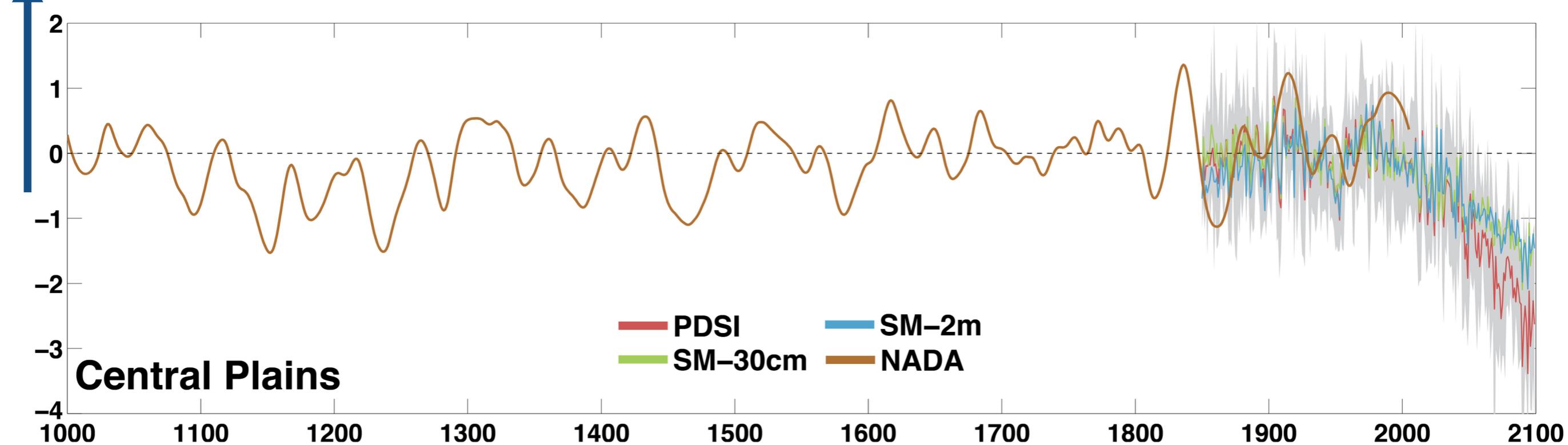


Southwest
(RCP 8.5)

- PDSI**
- SM-30cm**
- SM-2m**

How will future droughts compare to the past?

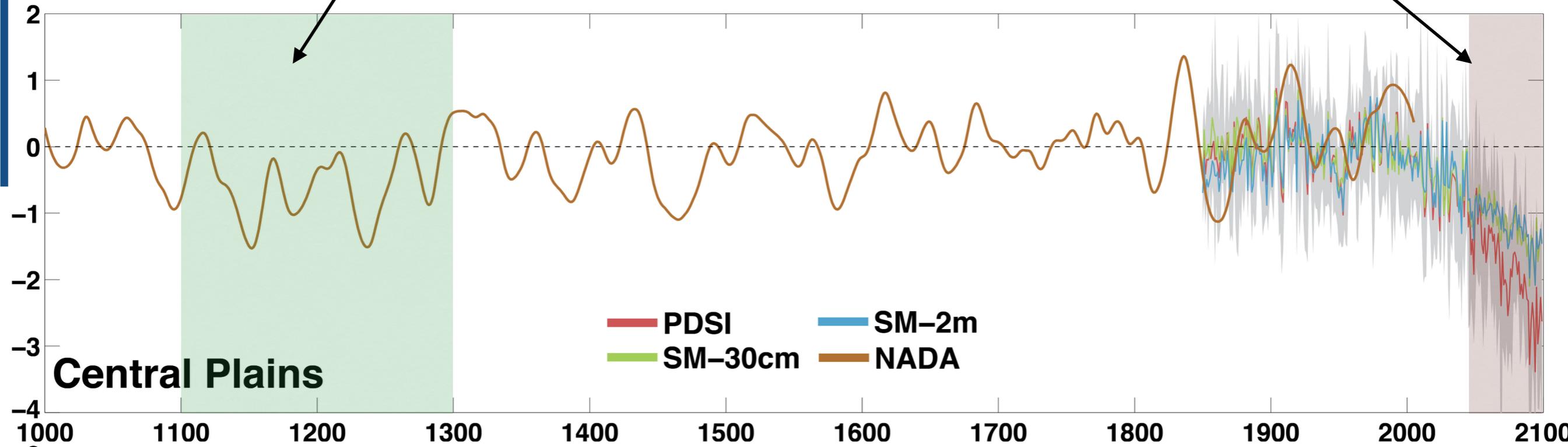
Wetter



Megadrought
Centuries

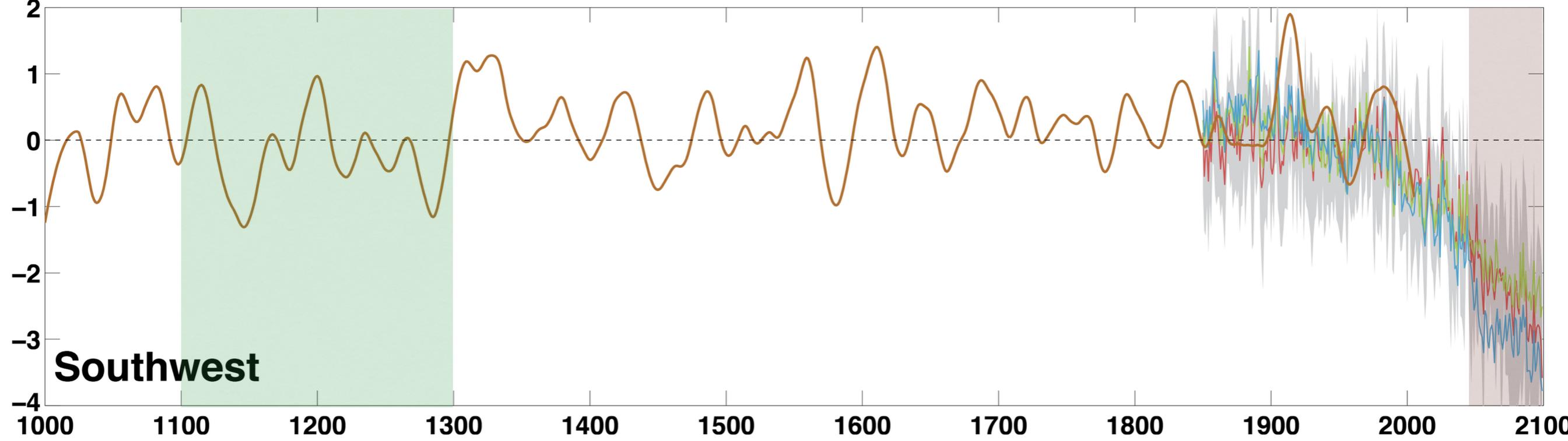
2050-2099

Wetter



Central Plains

PDSI SM-2m
SM-30cm NADA



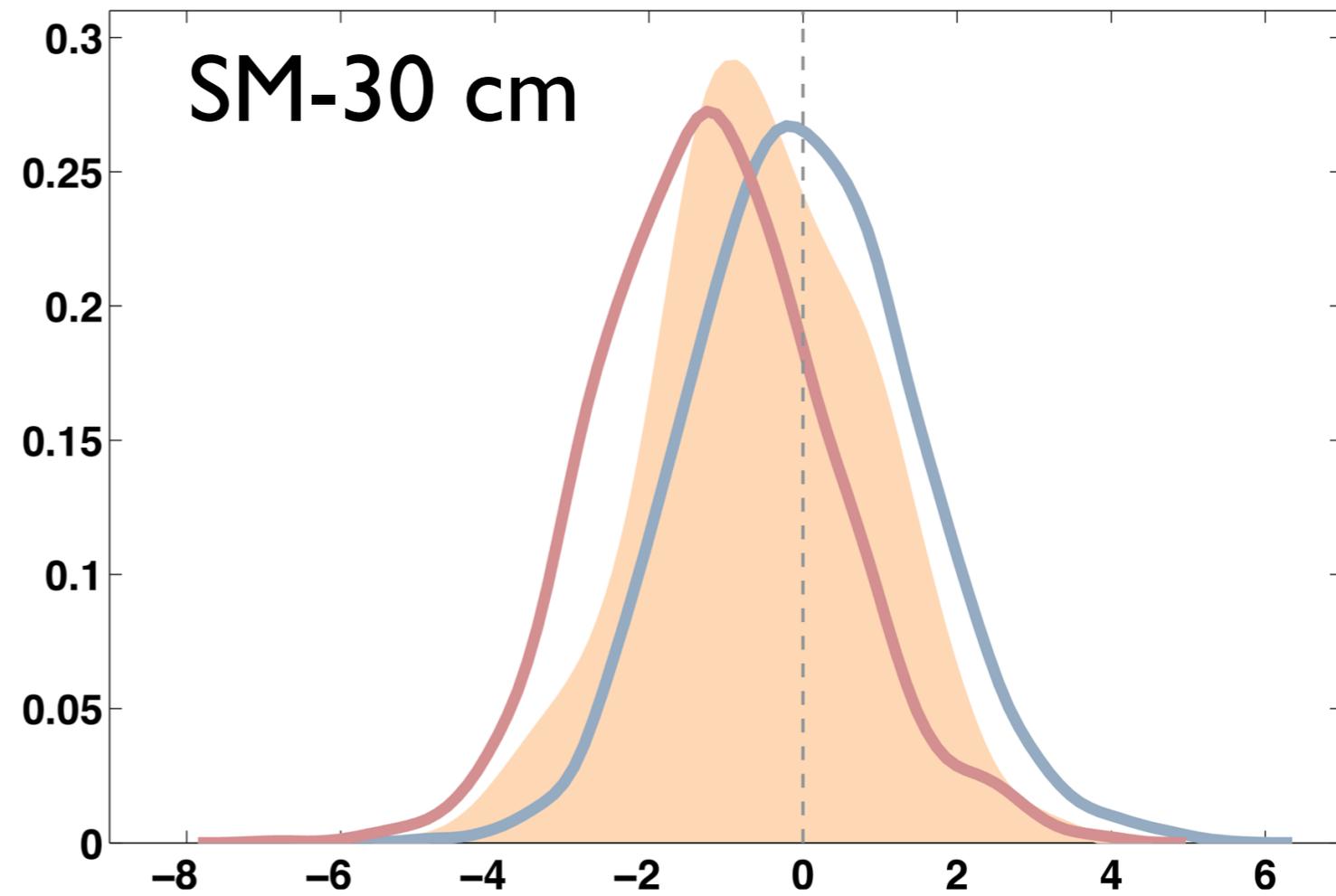
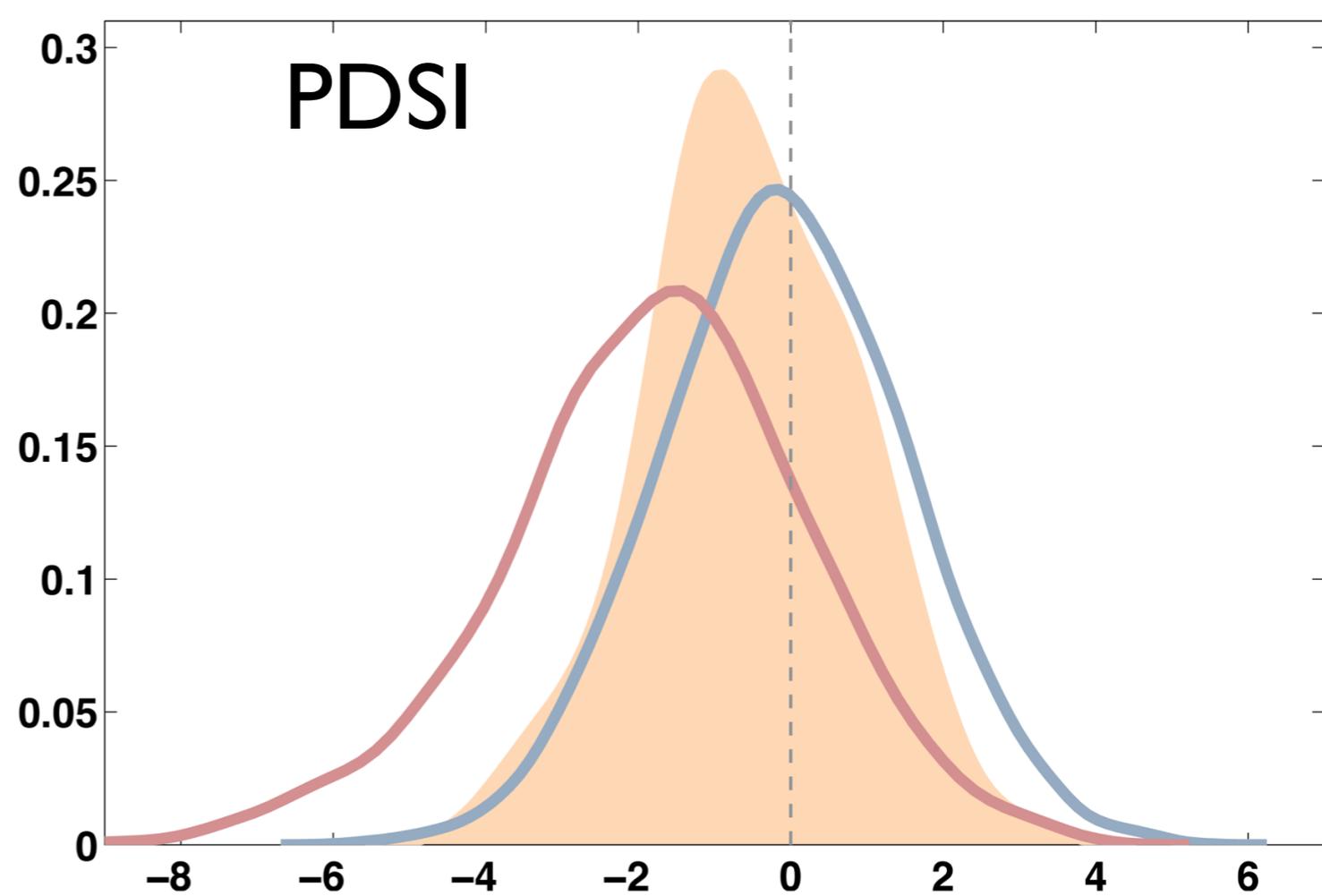
Southwest

Drier

Central Plains

Most drying from increased evaporation

-  **NADA (1100–1300)**
-  **Model (1850–2005)**
-  **Model (2050–2099)**



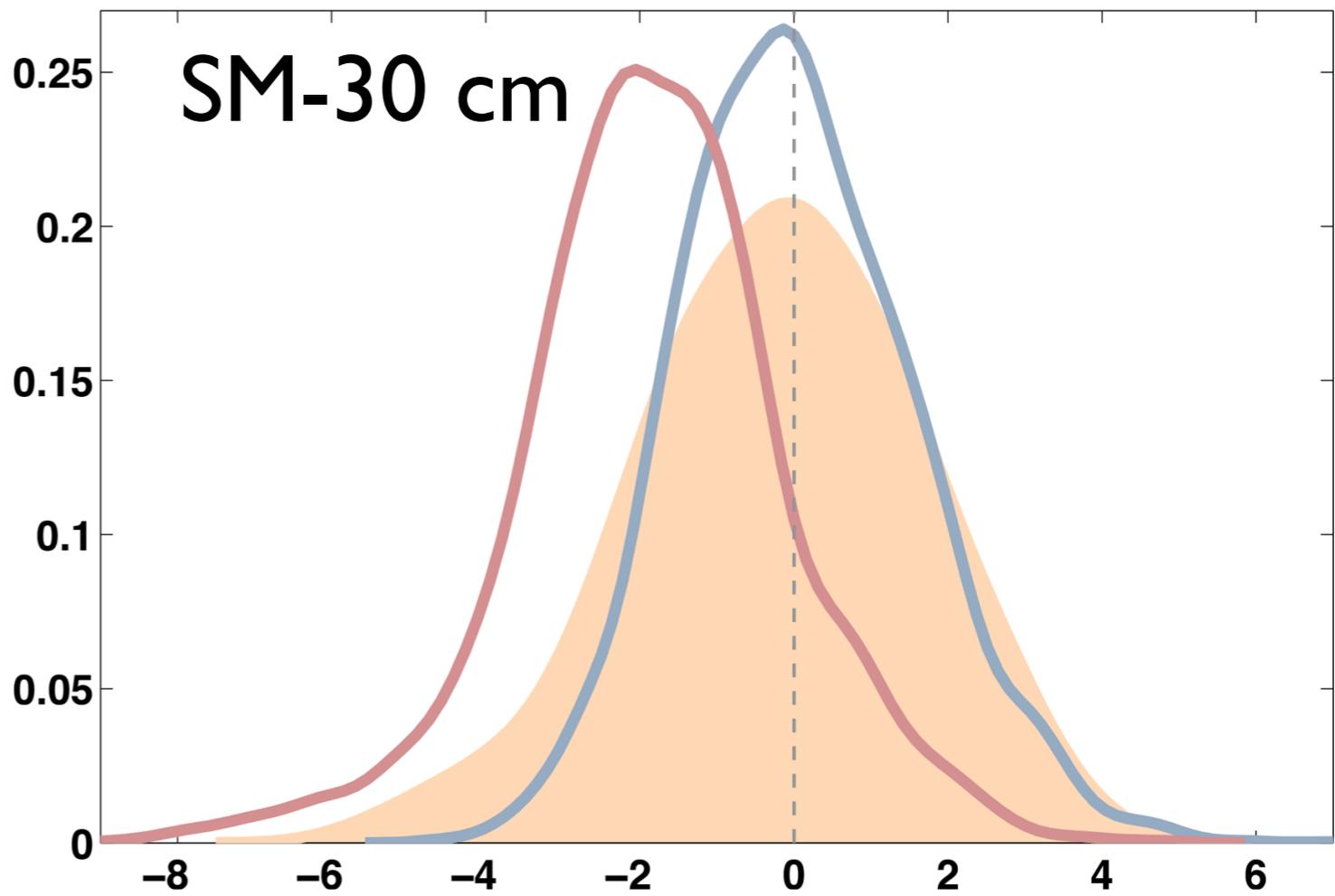
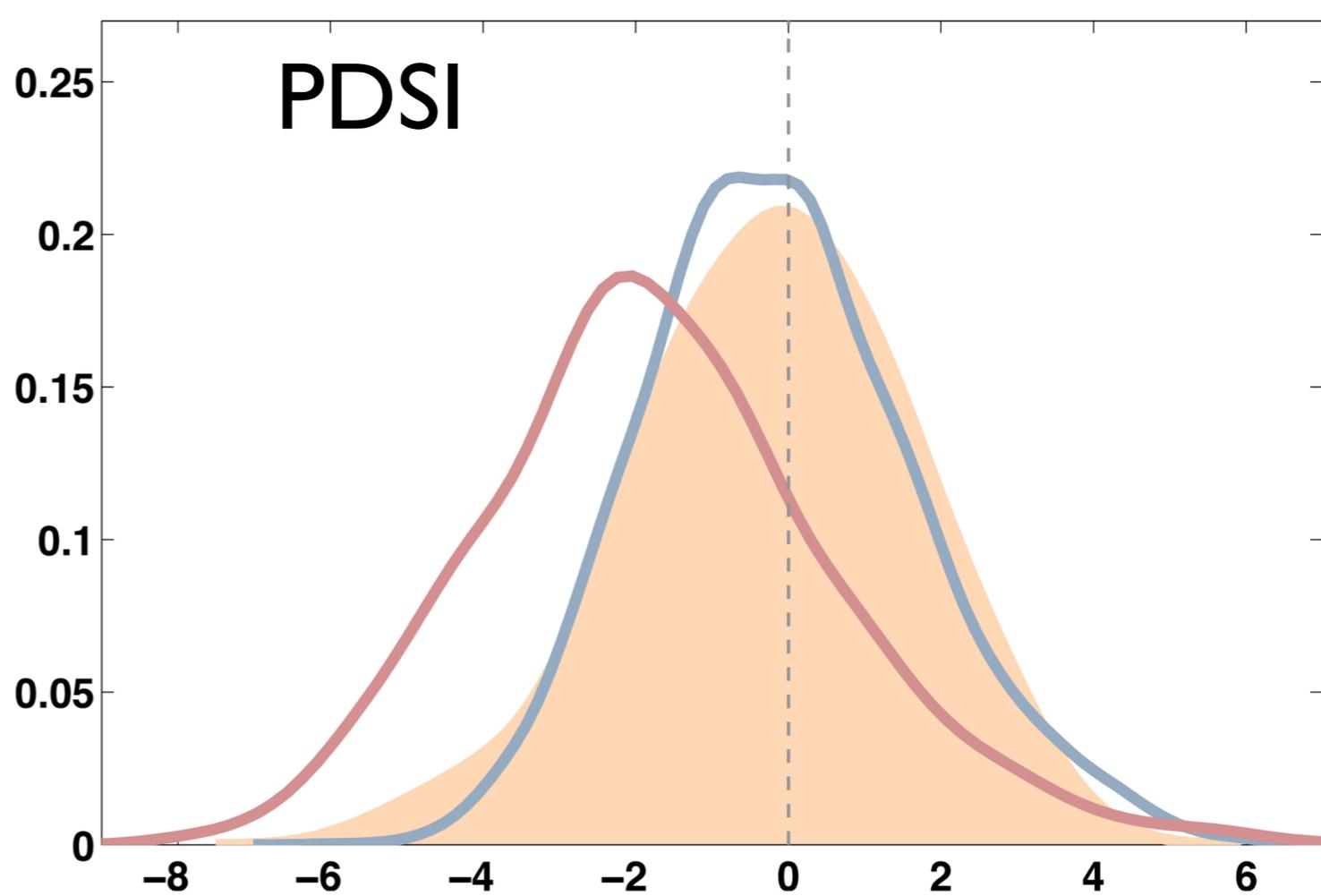
Southwest

Doubly hit by
increased
evaporative demand
AND reduced
precipitation

 **NADA (1100–1300)**

 **Model (1850–2005)**

 **Model (2050–2099)**





Seasonality differences in instrumental versus reconstructed PDSI?



Uncertainties in reconstructions?



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