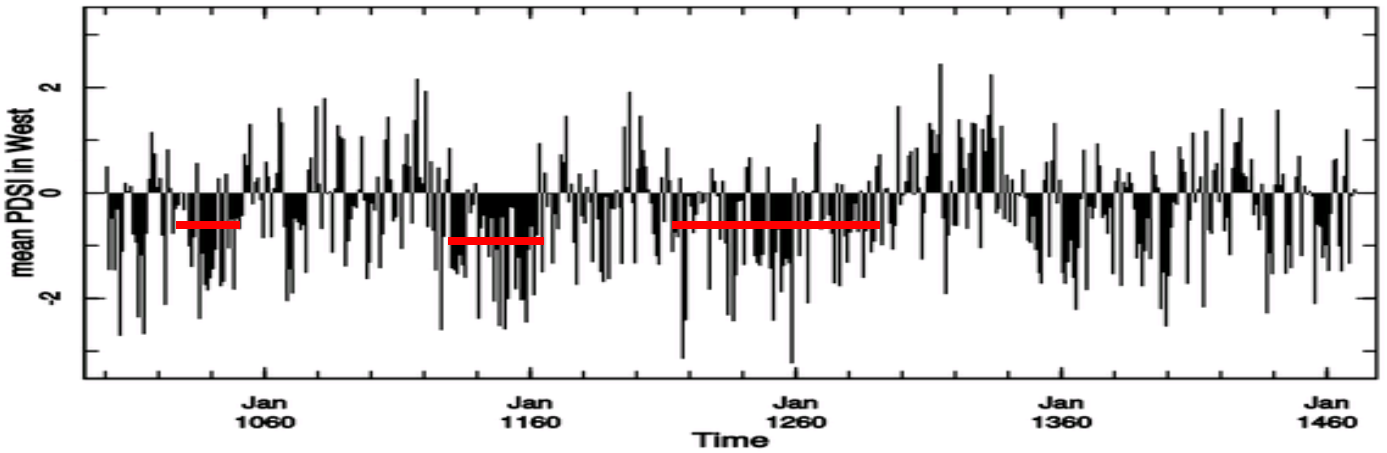
Role of North Atlantic SST on persistent drought in North America

Song Feng
Q. Hu
R. J. Oglesby

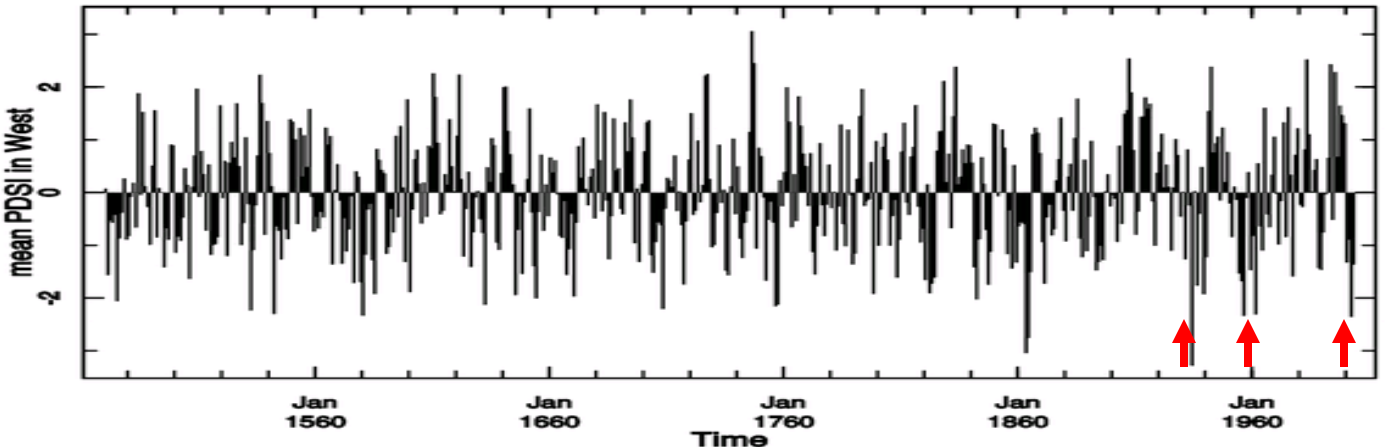
Drought definition: Precipitation below normal, PDSI
Multi-scale drought variations

Drought Atlas PDSI in the West

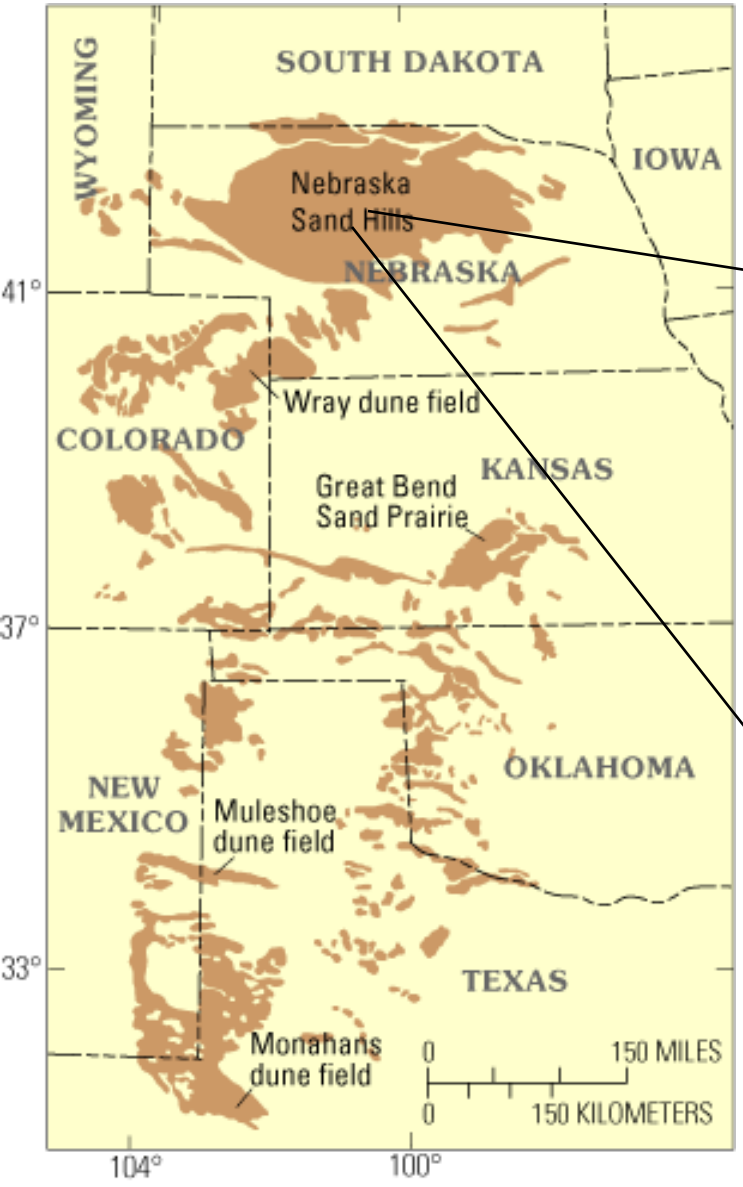
a. AD 1000 to AD 1470



b. AD 1470 to AD 2003



Impact of multidecadal and longer drought

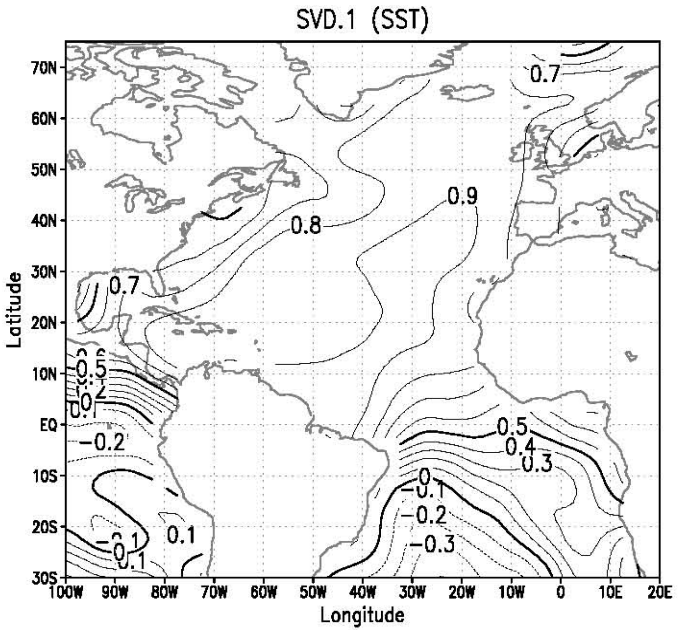


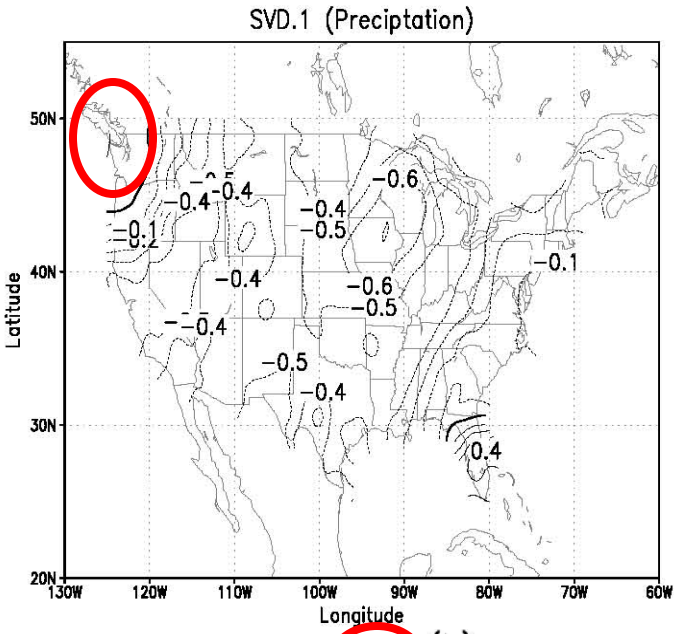
Current time

Medieval warm period ???

Largest sand dune body in the western hemisphere (58,000 km2)

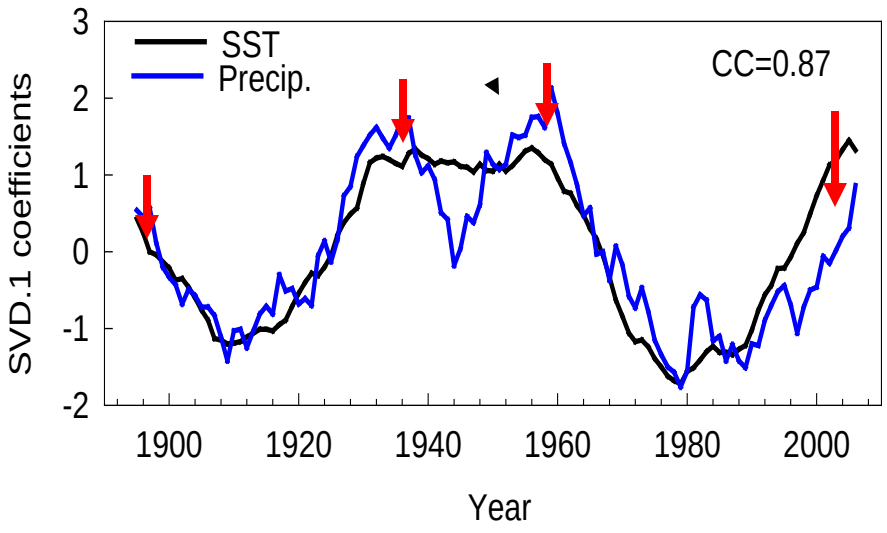
SST influence on drought in the last century: Singular value decomposition

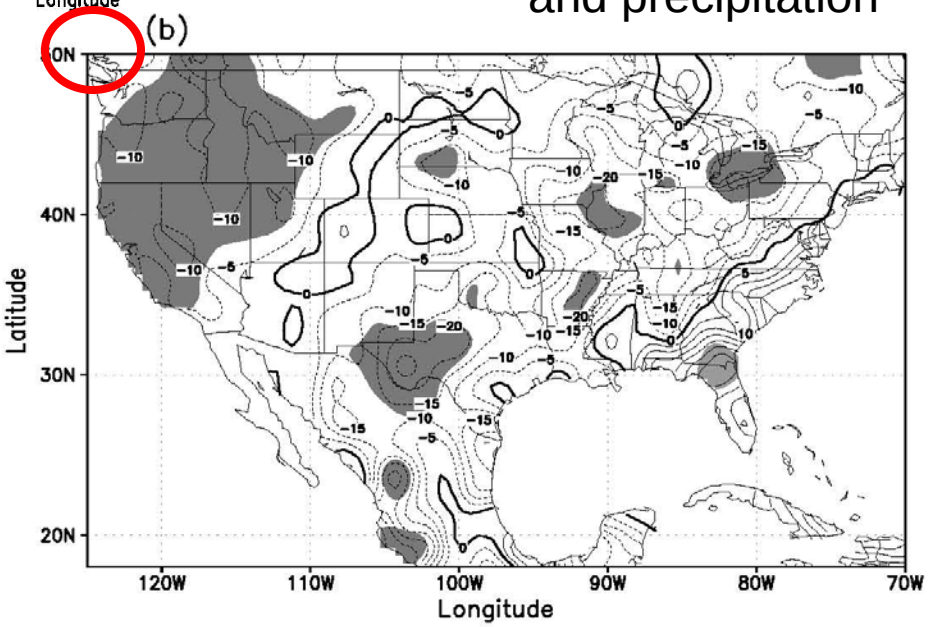




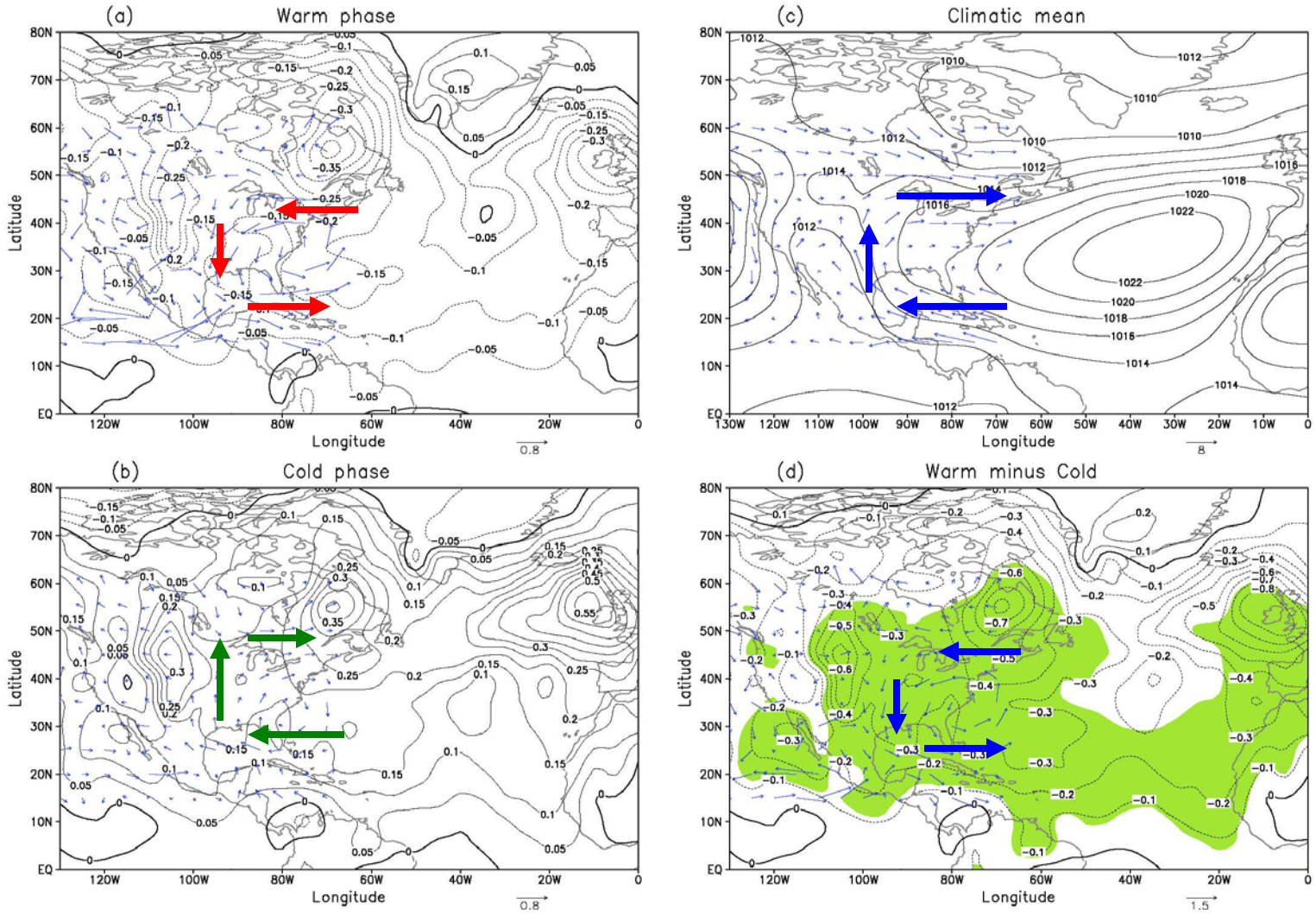
On multidecadal scale, when the Atlantic is warmer (colder), the GP and SW are dryer (wetter)

CC between AMO and precipitation





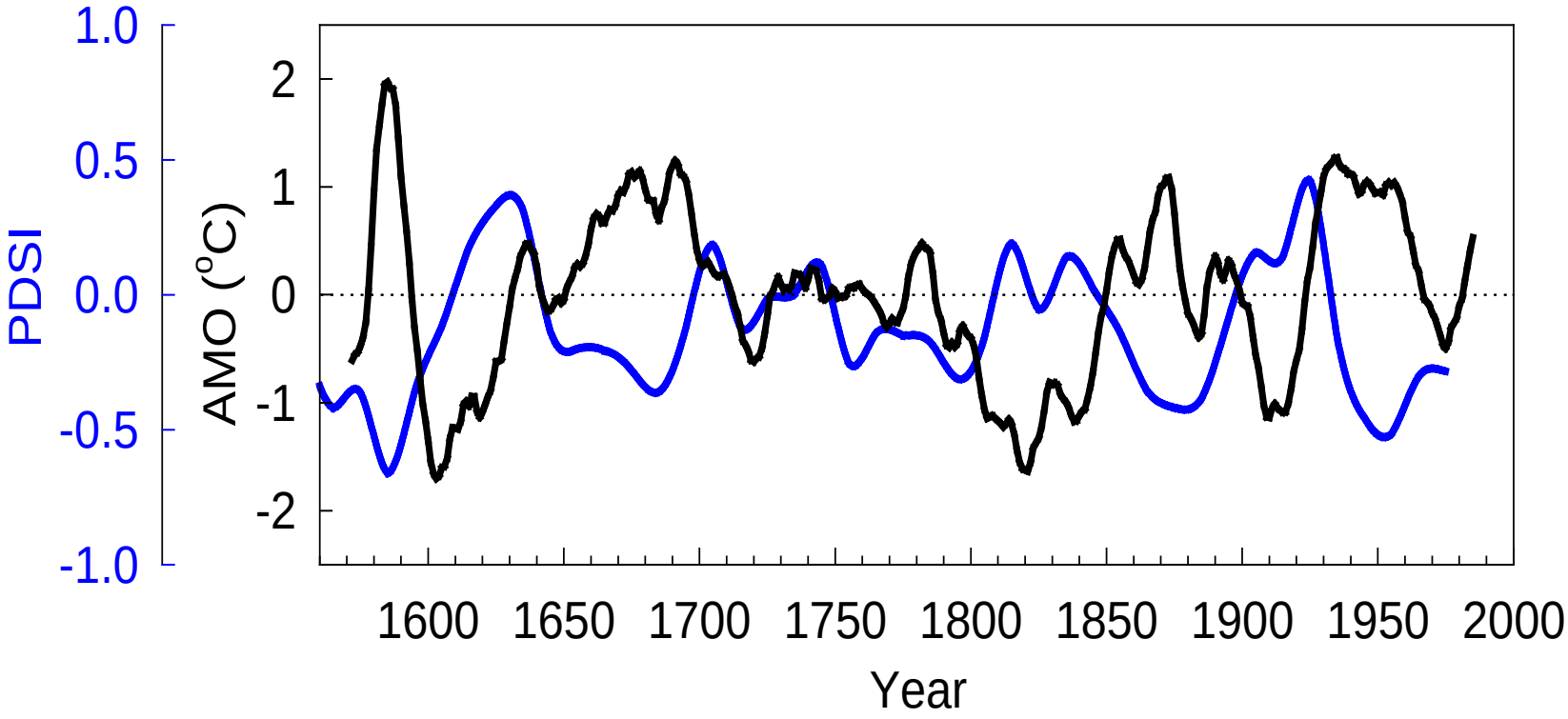
Surface circulation and AMO



AMO → Warm Pool → NASH → Wind Anomalies

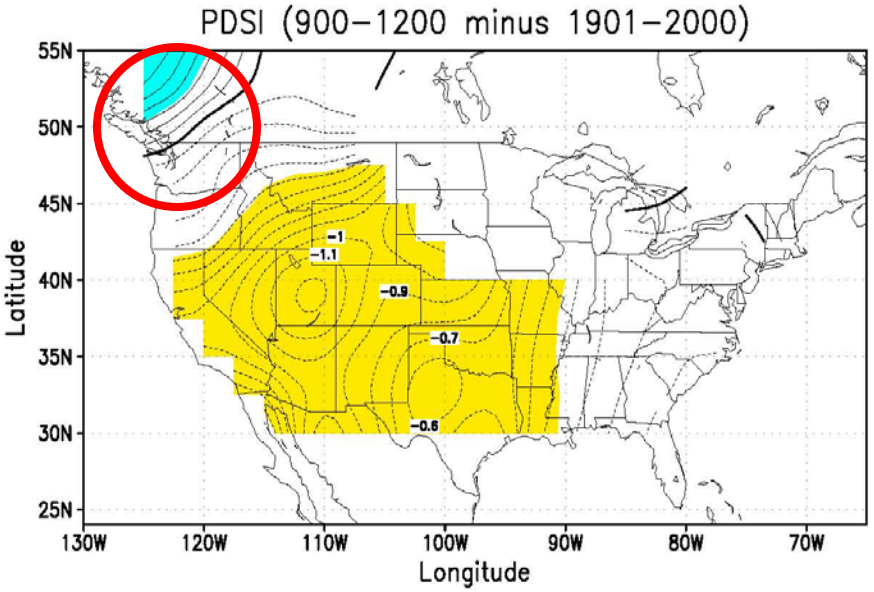
Hu and Feng, 2008, JCLI

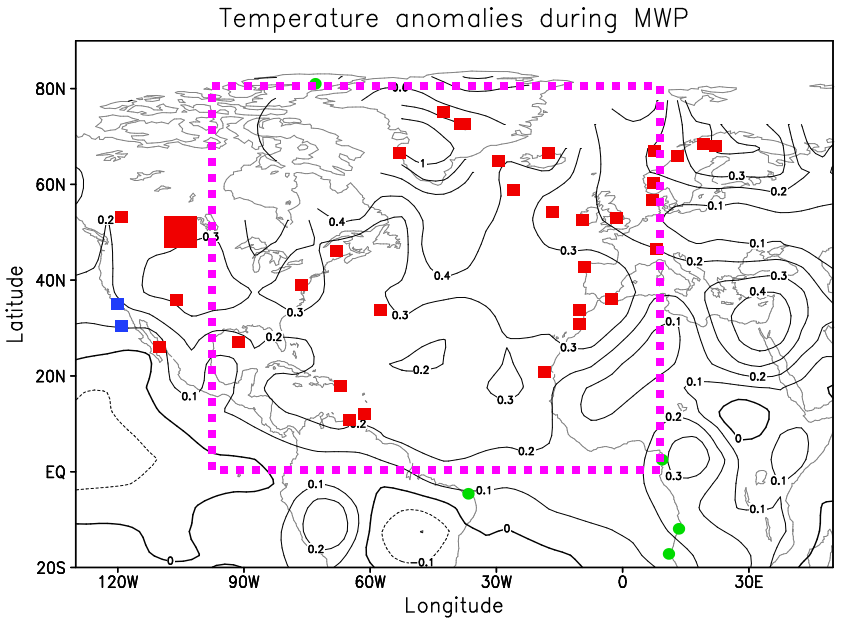
Atlantic SST and drought in the last 450 years

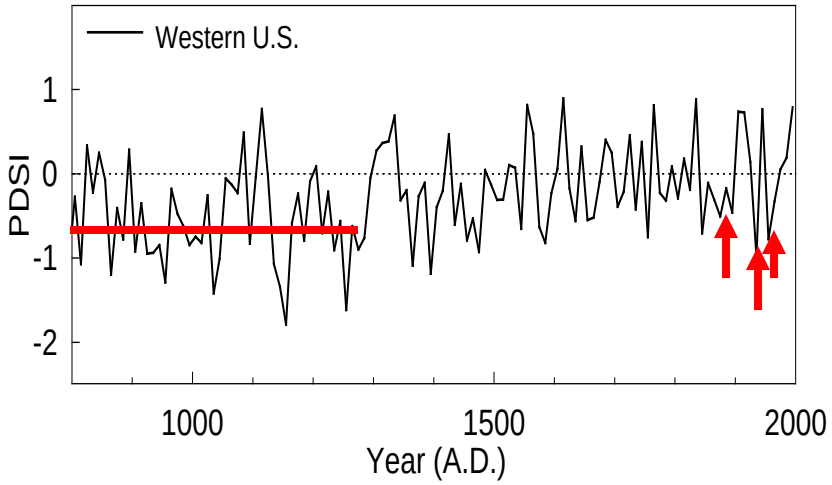


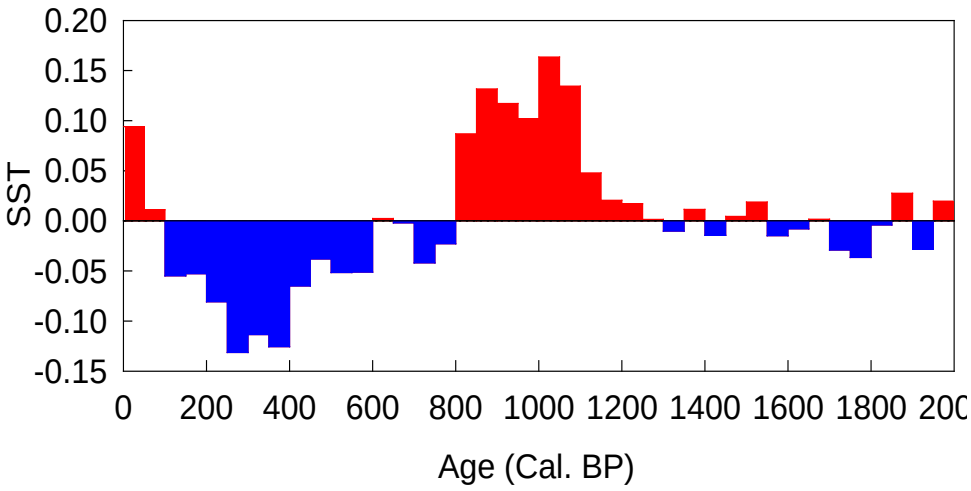
When the Atlantic is warmer (colder), the GP and SW are dryer (wetter)

Atlantic SST and drought in the medieval times





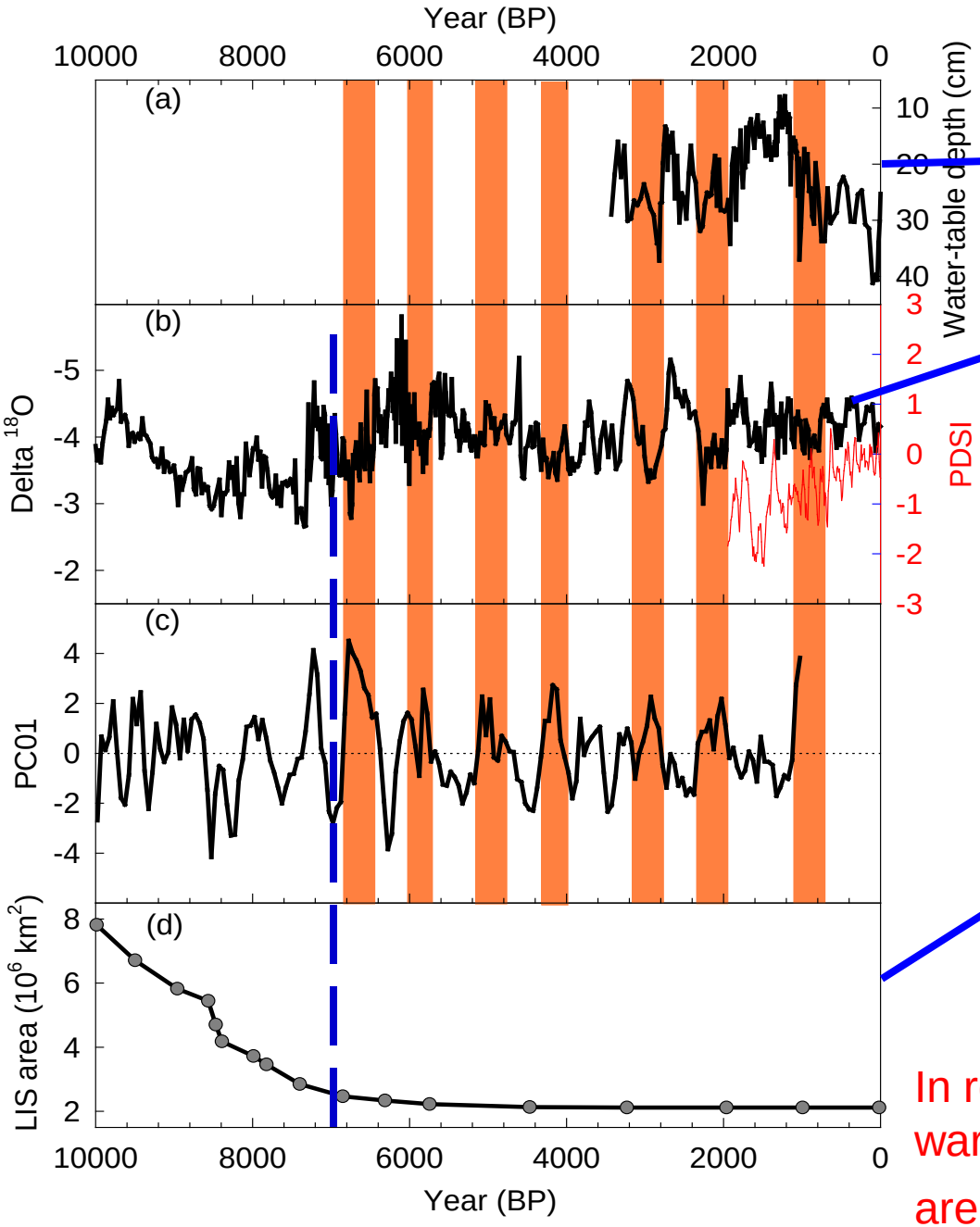


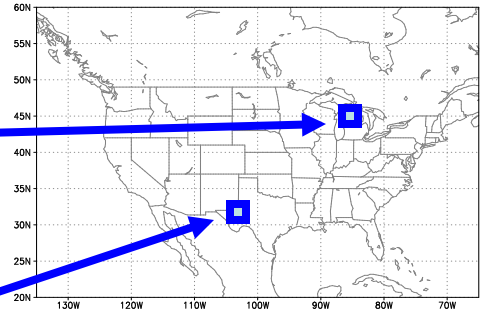


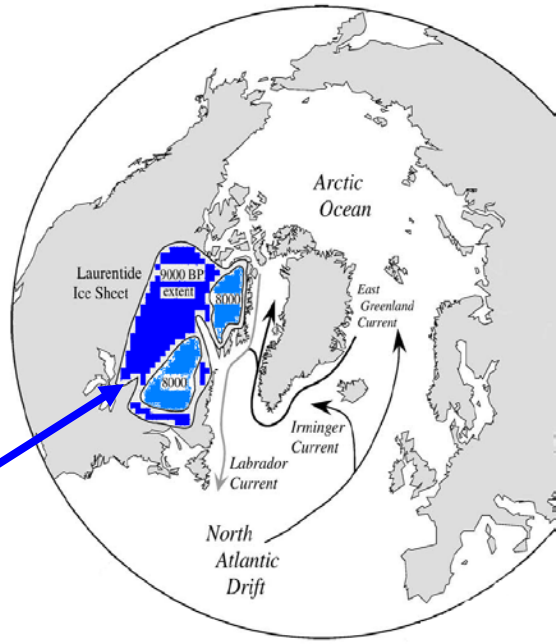
In MWP, the Atlantic is warm, the GP and SW are dry

Feng et al., 2008, 2009

Atlantic SST and drought during the Holocene

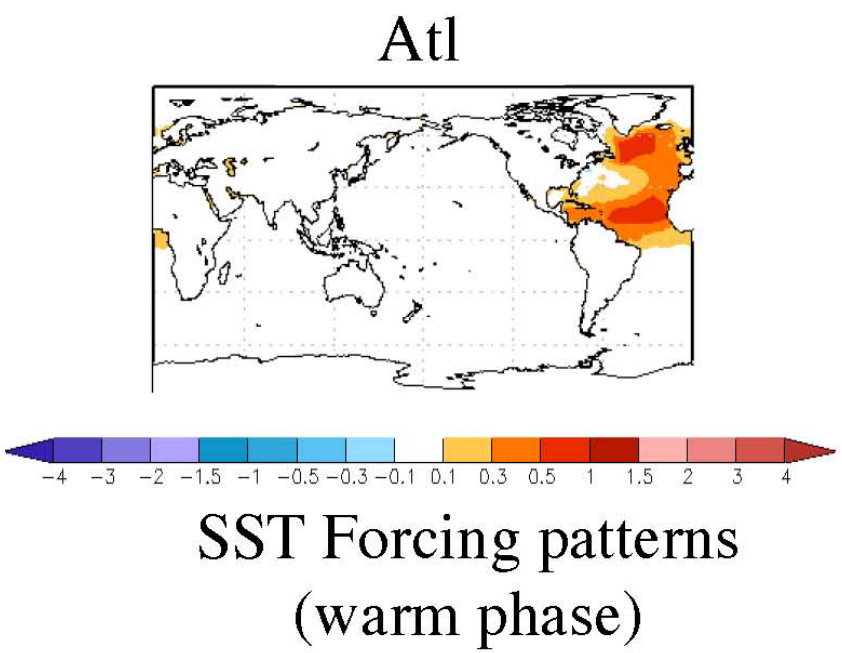






In recent 7.0ka, when Atlantic is warmer (colder), the GP and SW are dryer (wetter).

Multiple AGCM simulations



SST Forcing patterns
(warm phase)

NSIPP1 model from NASA
50-year simulations

GFS model from NCEP
36-year simulations

CCM3 model from LDEO/NCAR
51-year simulations

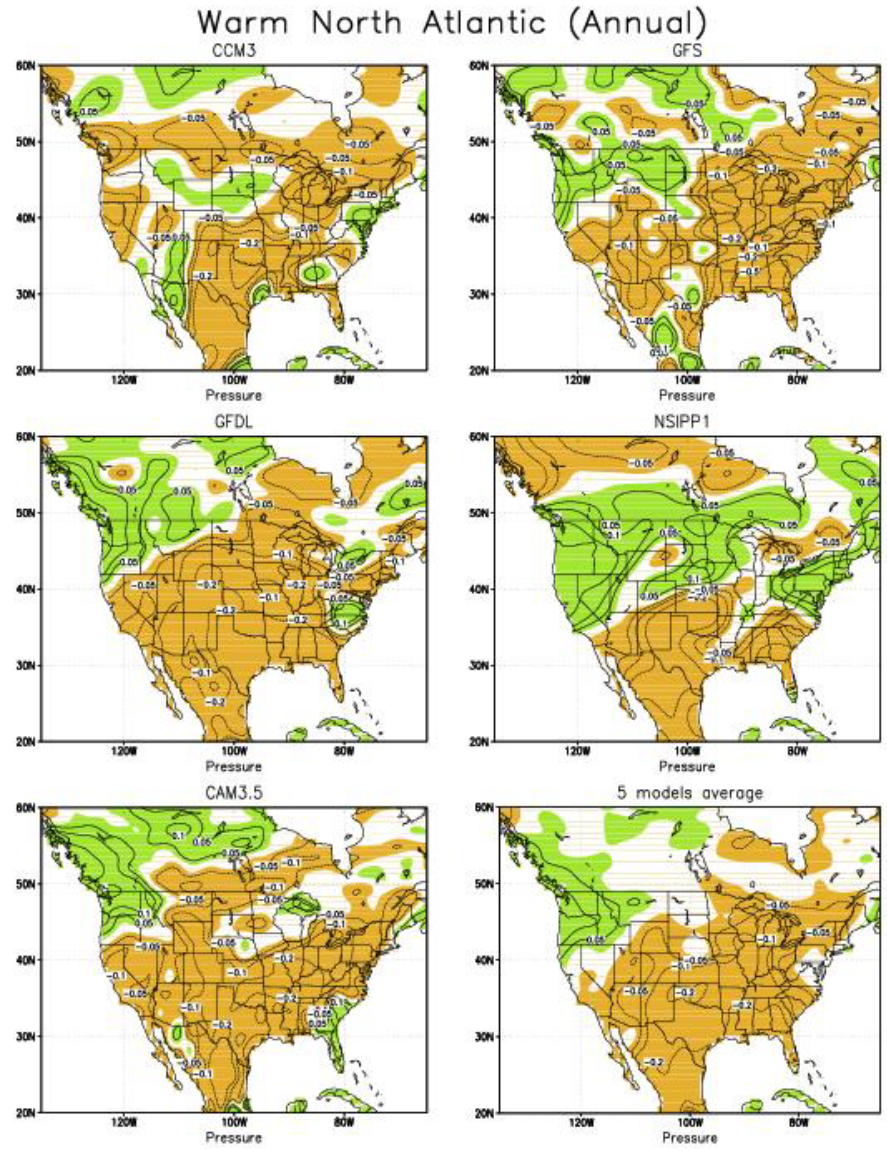
CAM3.5 model from NCAR
50-year simulations

AM2.1 model from GFDL
50-year simulations

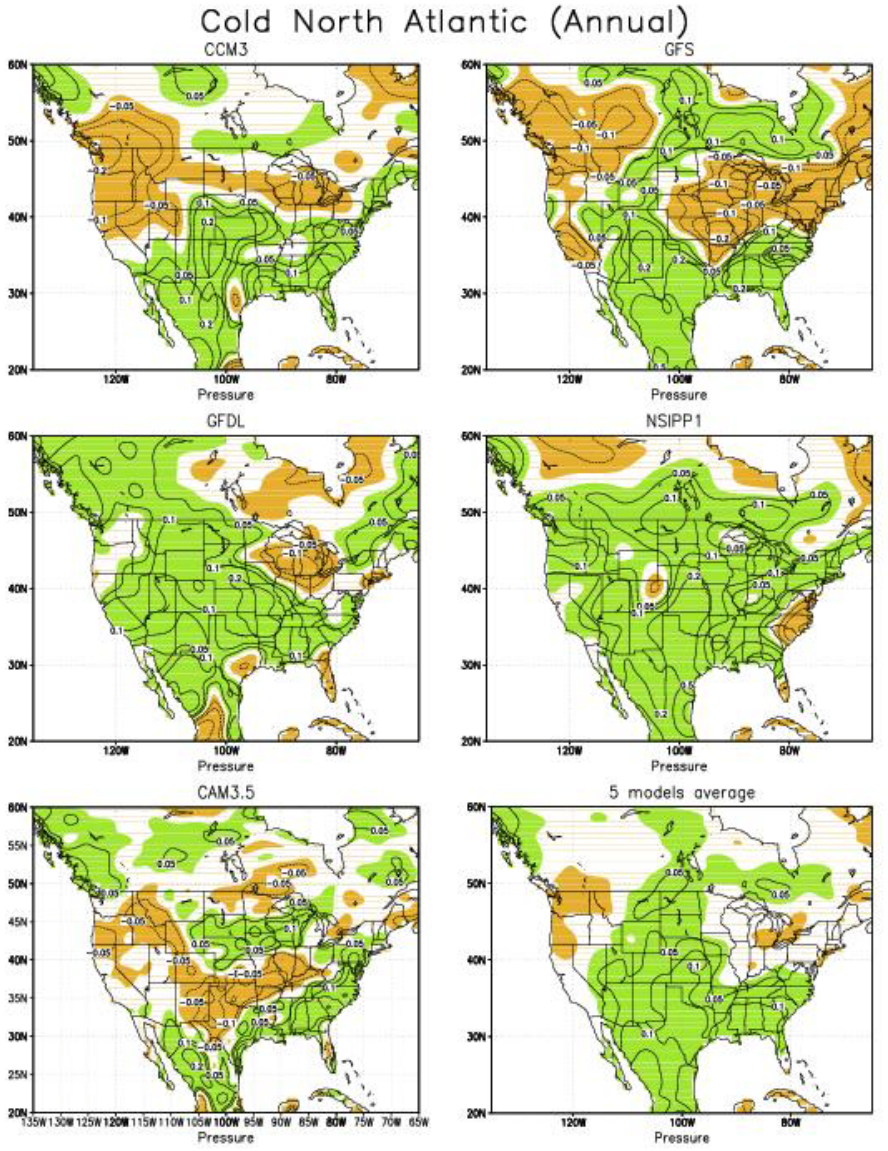
The last 35-year model simulations were analyzed in this study.

Multiple AGCM simulations

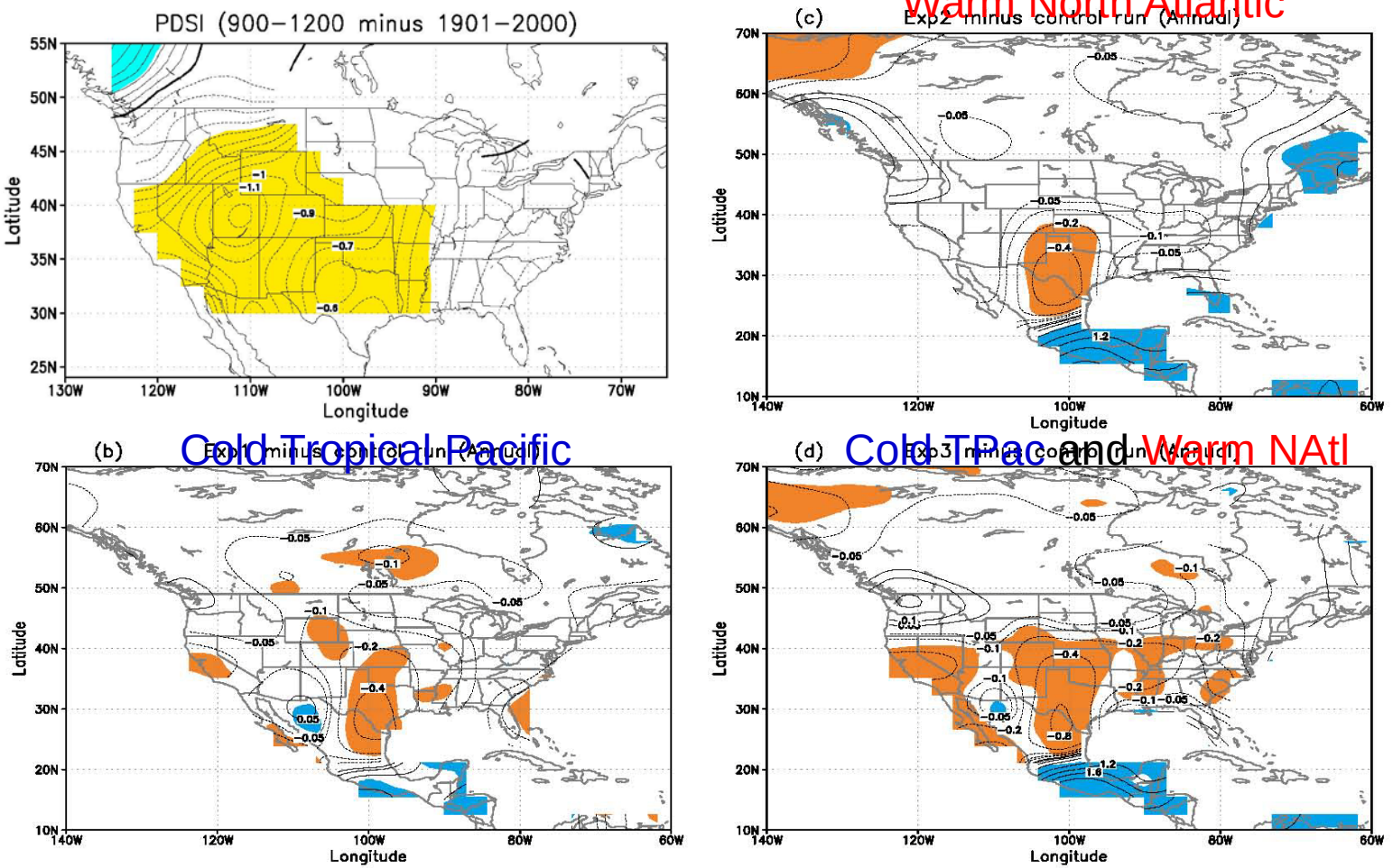
Warm North Atlantic



Cold North Atlantic



Influence of Atlantic and Pacific SST on droughts



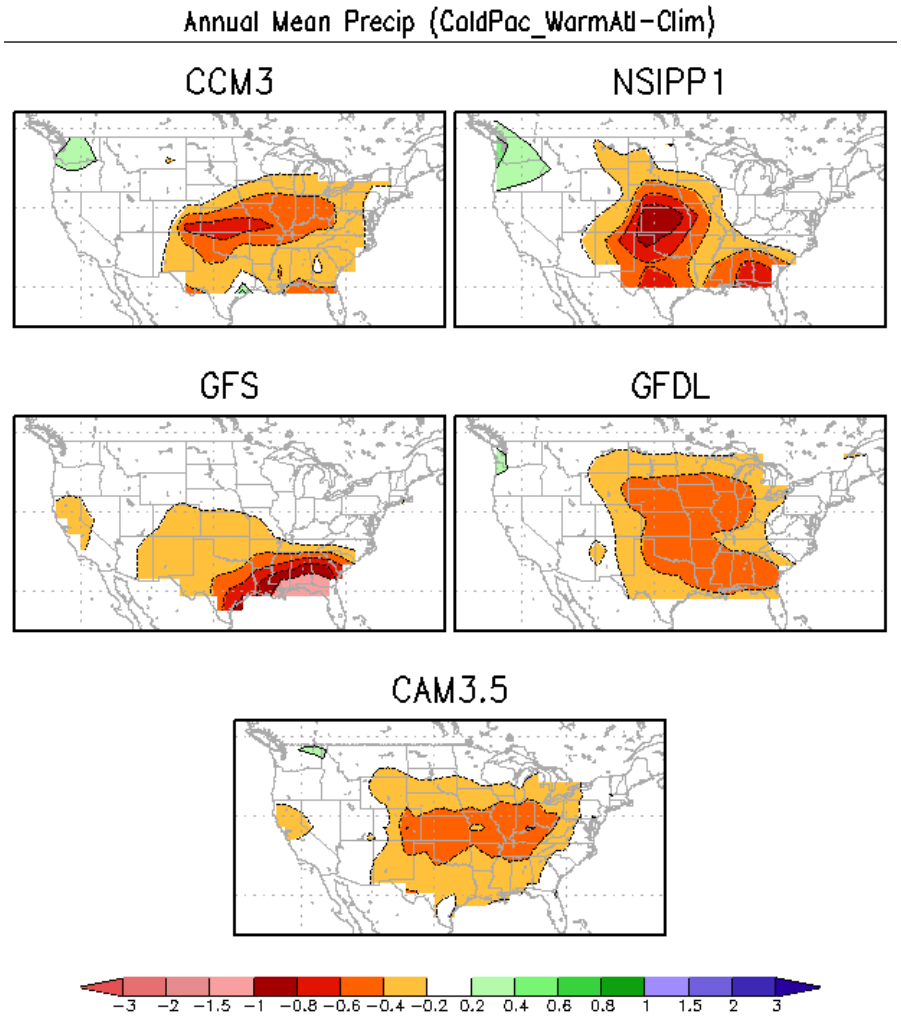
Cold tropical Pacific and warm North Atlantic alone could cause the drought, but the two work together could better simulate the drought

Feng et al., 2008, JGR

Multiple AGCM simulations

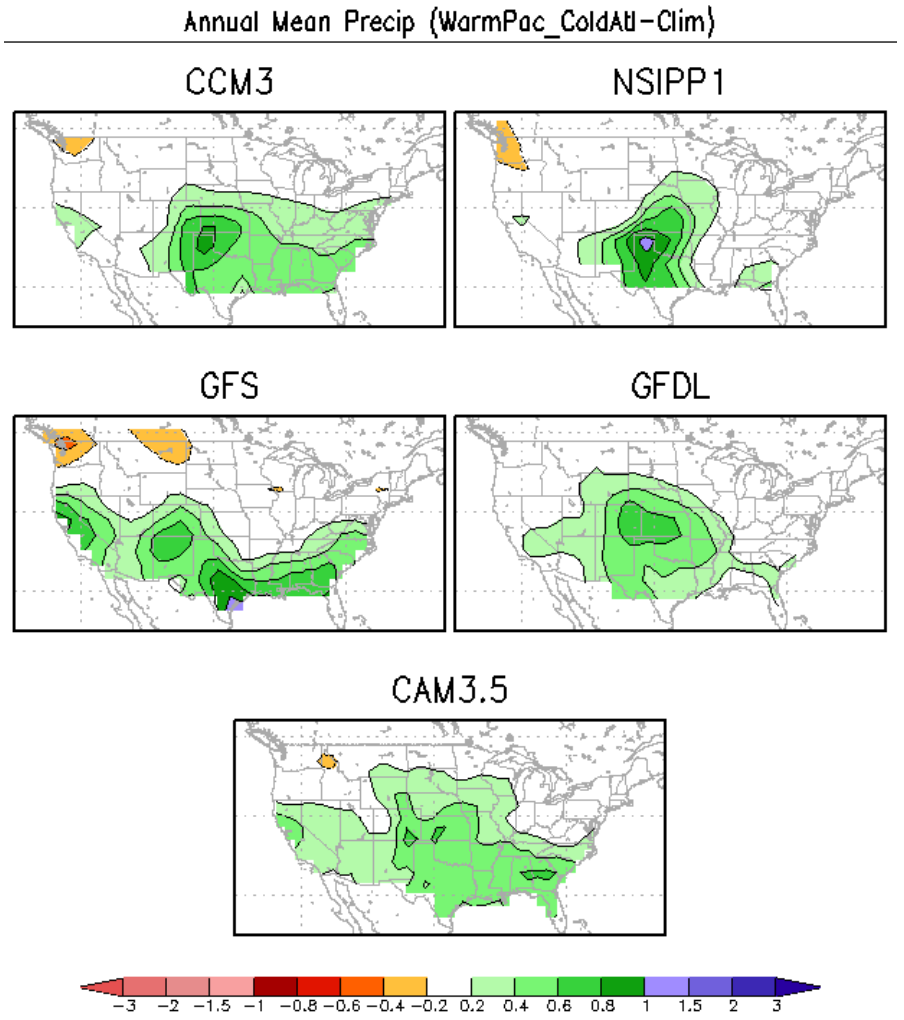
Annual Precipitation (mm/day)

Pacific Cold+Atlantic Warm



US Drought!

Pacific Warm+Atlantic Cold



US Pluvials!

(Schubert et al., 2009)

Summary

The SST in North Atlantic Ocean varied simultaneously on multidecadal to centennial timescale, i.e. AMO and AMO-like pattern.

AMO/AMO-like SST pattern is closely related the drought in GP and SW. Warmer North Atlantic is associated with dry/drought and cooler North Atlantic is associated with wetter condition.

Warm Atlantic is associated with larger warm pool and weaker NASH, which causes weaker moisture transport to the GP.

Such relationship also related to MWP drought and persistent over the last several thousand years.

Summary continue

Atmospheric model forced by SST in N.Atl could simulate the drought, circulation changes and moisture transport to north America.

Cold tropical Pacific and warm North Atl. are ideas conditions for North America drought.

The IPCC AR4 models project a more arid climate in Southwest and a neutral conditions in GP. If the models are correct, the N. Atl. could play a more important role on drought in the SW, and the N.Atl. and T.Pacific play equal role on drought in the GP.