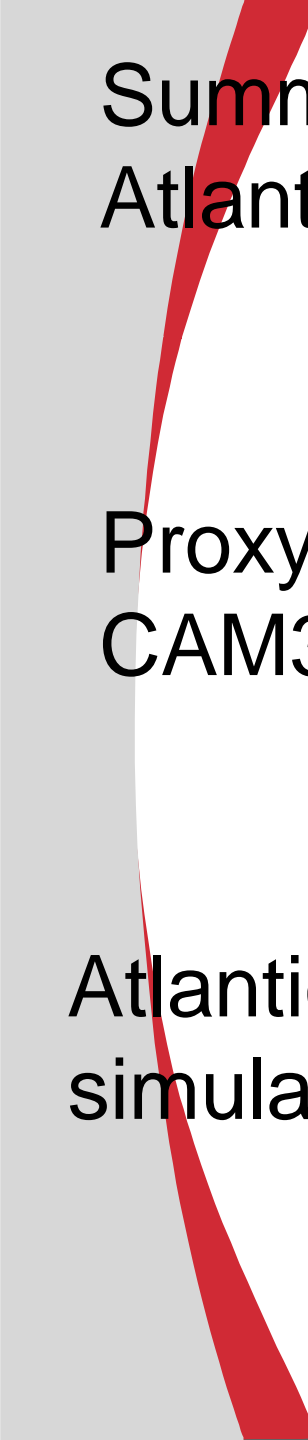


Atlantic SST influences on North American Drought: A case study on the Medieval Warm period

Song Feng, R. J. Oglesby, C.M. Rowe, D.B. Loope and Q. Hu





Summary of statistical relationship between Atlantic SST and North American drought

Proxy drought in North America in MWP.
CAM3.0 Model experiments and results

Atlantic impacts in 500-yr CCSM3.0 control simulation

Statistic relationship: Summary

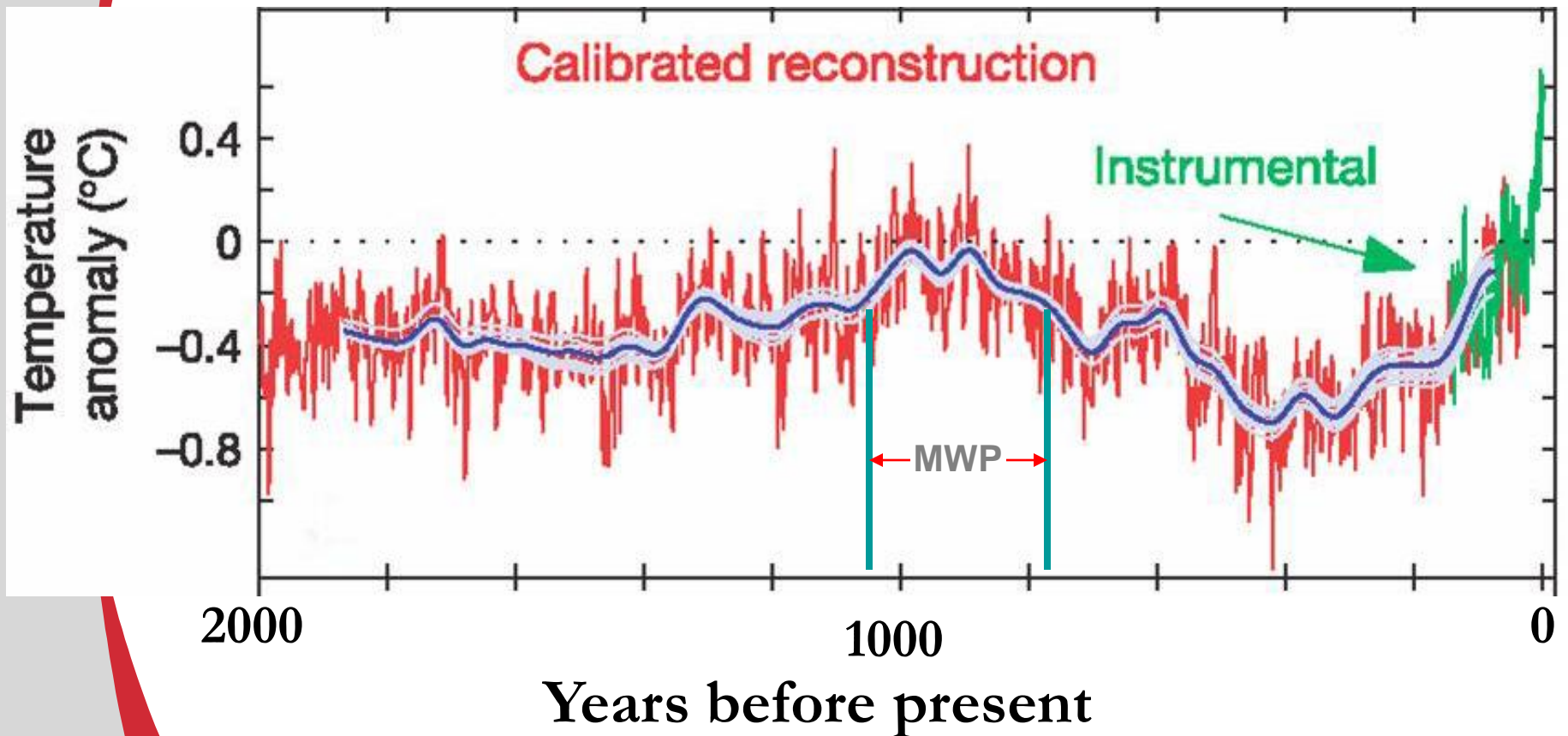
The SST in North Atlantic Ocean varied simultaneously on multidecadal to centennial timescale, i.e. AMO and AMO-like pattern.

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

Such relationship is persistent over the Holocene. Atlantic is a major driver of drought.

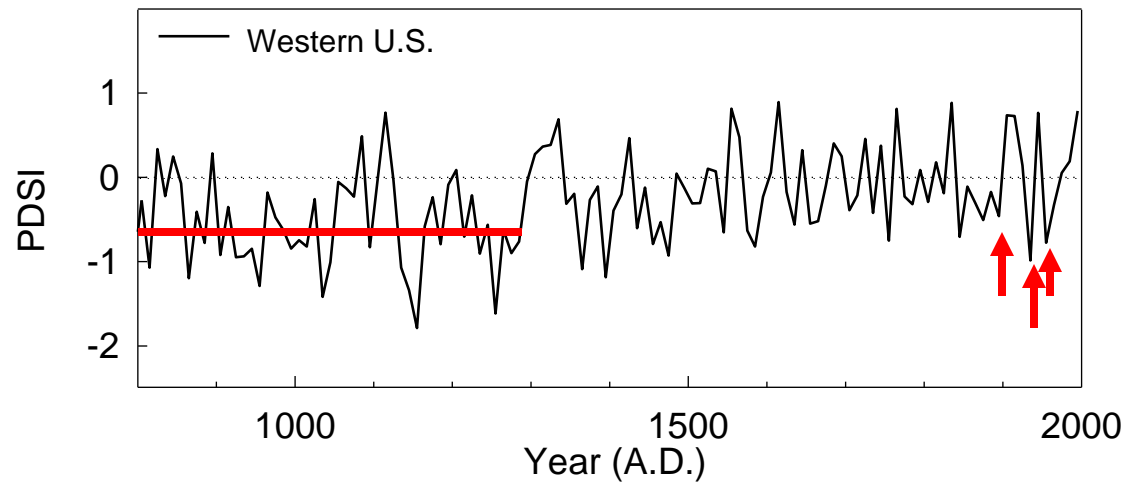
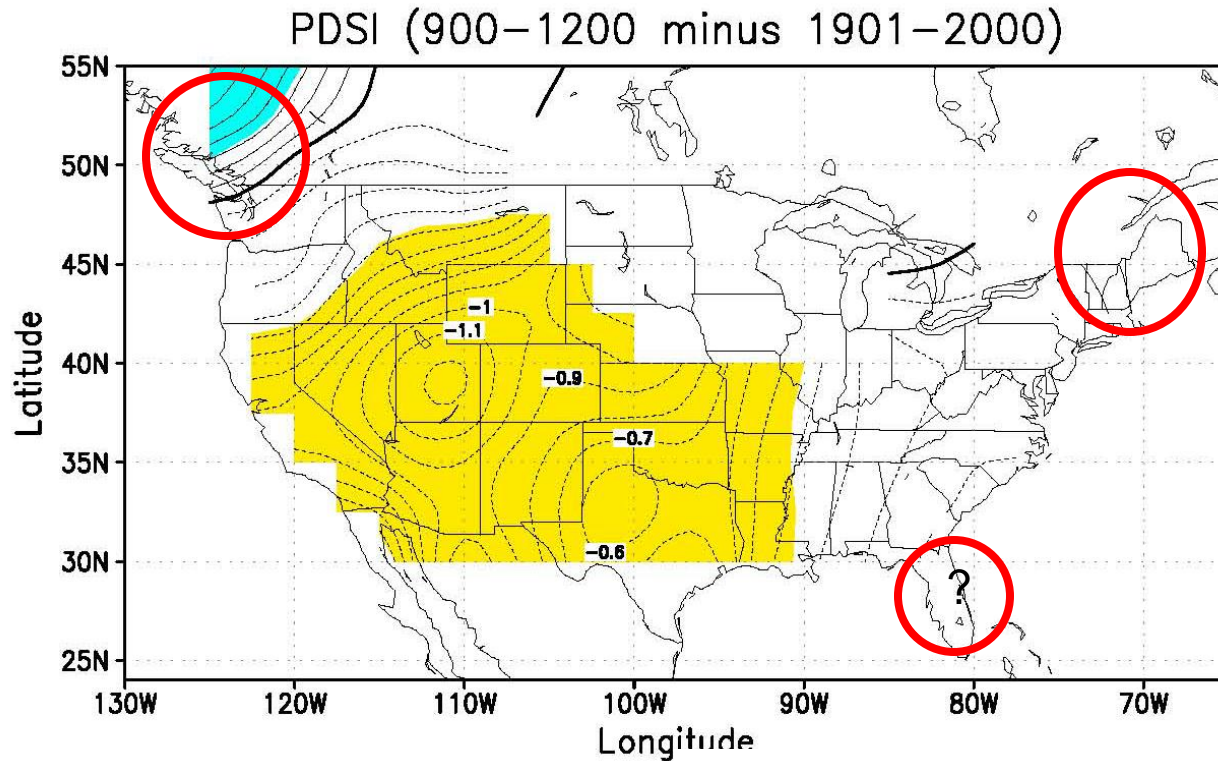
Why MWP is important?

Northern Hemisphere Temperatures From Low and High Resolution Data

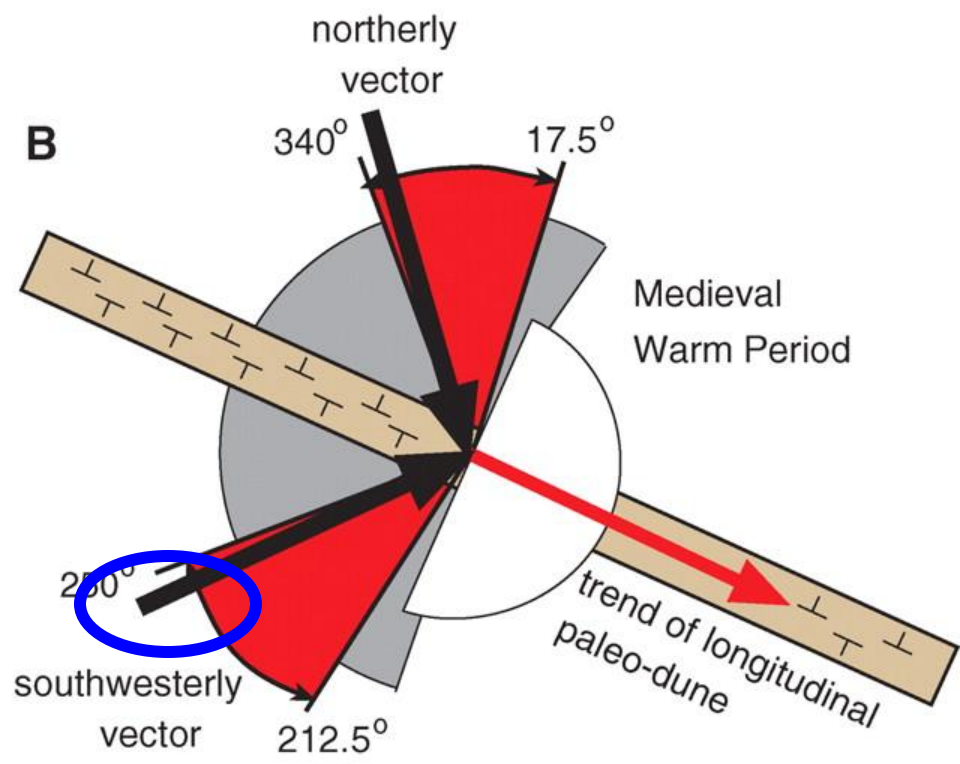
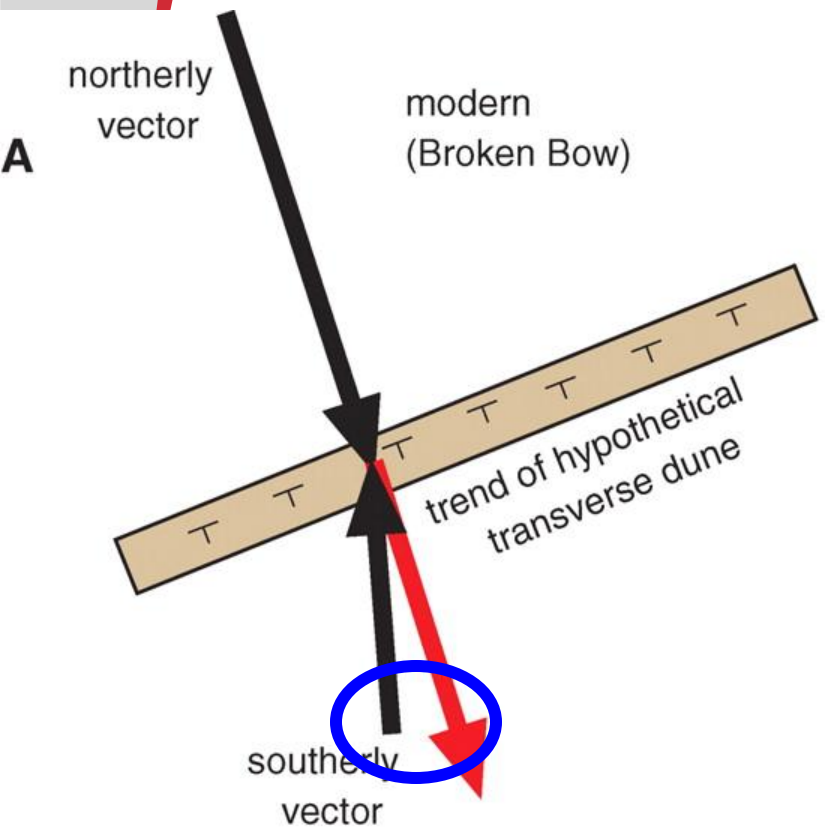


Moberg and others, 2005

Medieval drought: Proxy drought in the U.S.



Medieval drought: Circulation changes in High Plains



Medieval drought: Summary

The North America suffered severe multicentury drought during the MWP.

During the mega drought, the incidence of wildfire in western U.S. increased, and the sand dunes in the Great Plains mobilized.

Regional circulation was quite different from nowadays.



Modeling study:

Modeling strategies.

Proxy SST anomalies in Pacific and the Atlantic Ocean: summary

The proxy records were not in agreement about the SSTA in the eastern TP. Some evidence suggested strong La Nina-like pattern, some show weak La Nina-like pattern, some even show El Nina-like pattern.

There was a basin-wide warming in the NA Ocean.

Modeling study

What was the role of Atlantic Ocean SST on the medieval drought in North America?;

Given the inconsistent proxy SST in Pacific Ocean, what was the role of Pacific Ocean on the MWP drought?

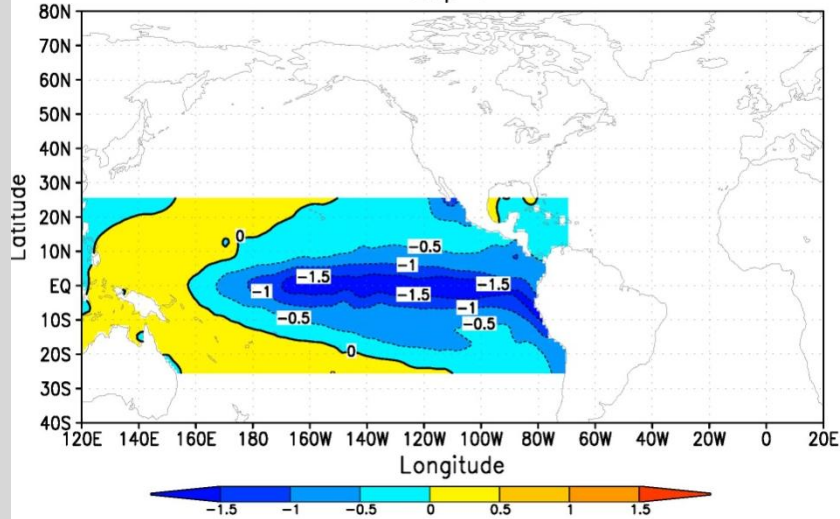
If the North Atlantic and tropical Pacific Oceans both affected drought during medieval times, what were the relative roles of each ocean?

Could Atlantic and Pacific Ocean SST during medieval times have induced the circulation and wind direction changes revealed by sand dune activity in the central Great Plains?

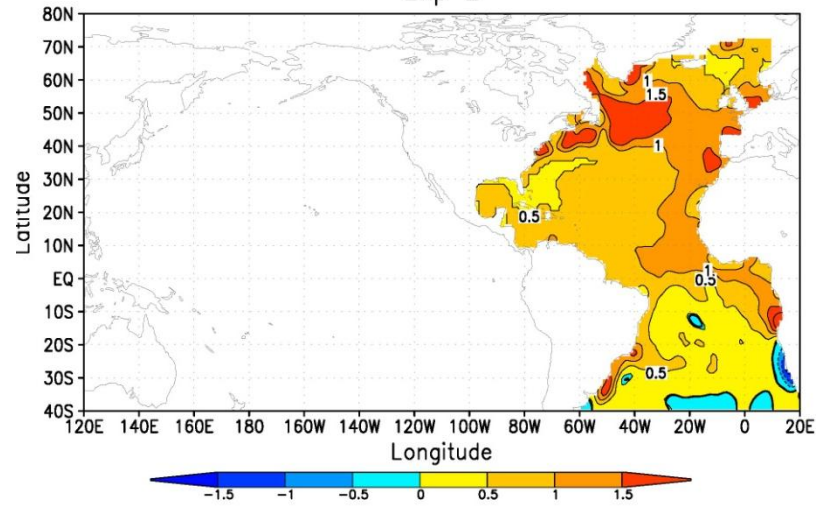
Model experiments:

Possible and idealized SSTA in Pacific and Atlantic Ocean was specified.

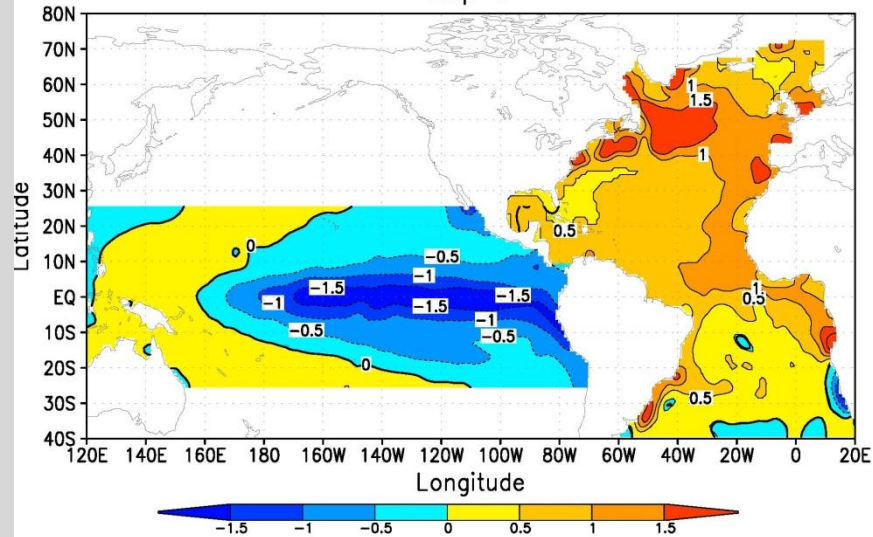
Exp 1



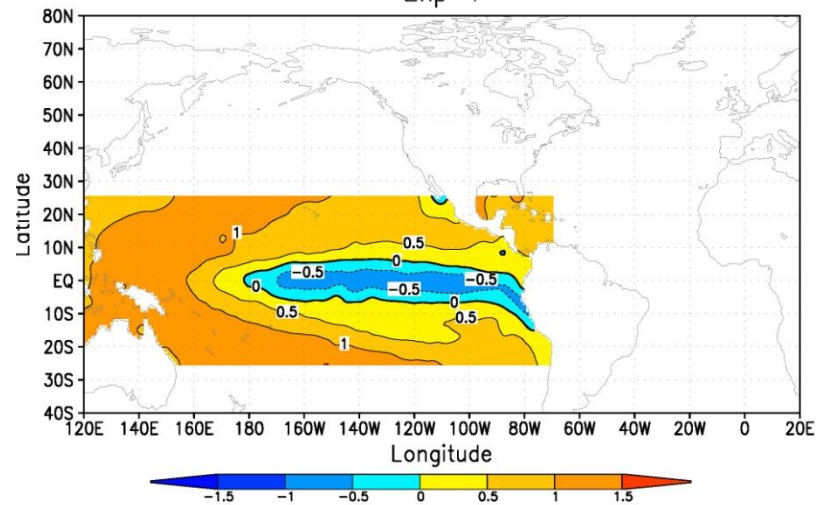
Exp 2



Exp 3



Exp 4



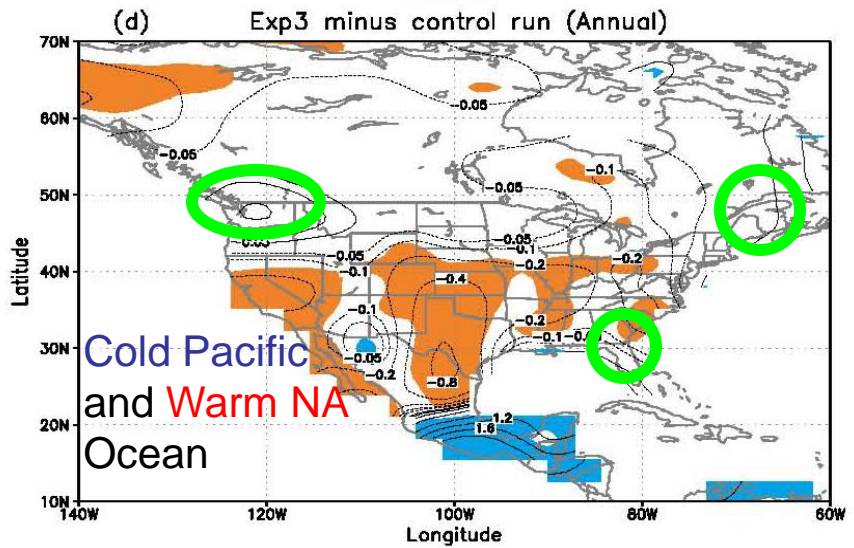
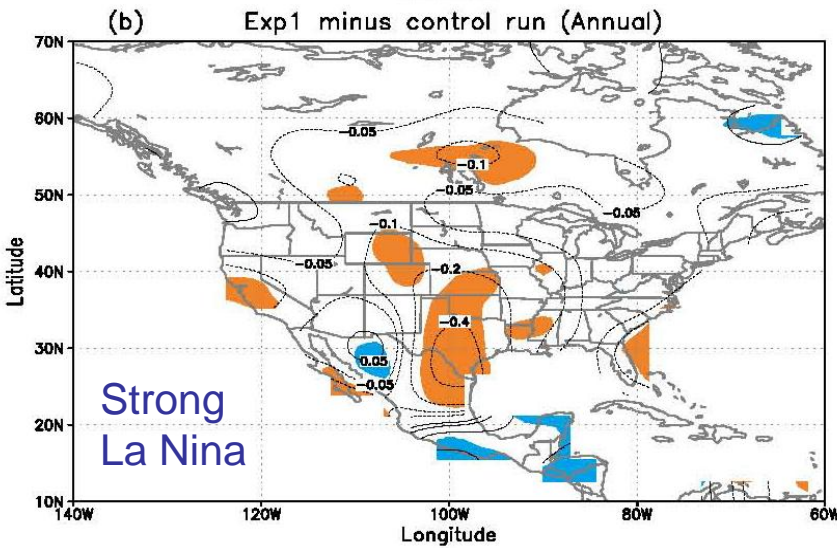
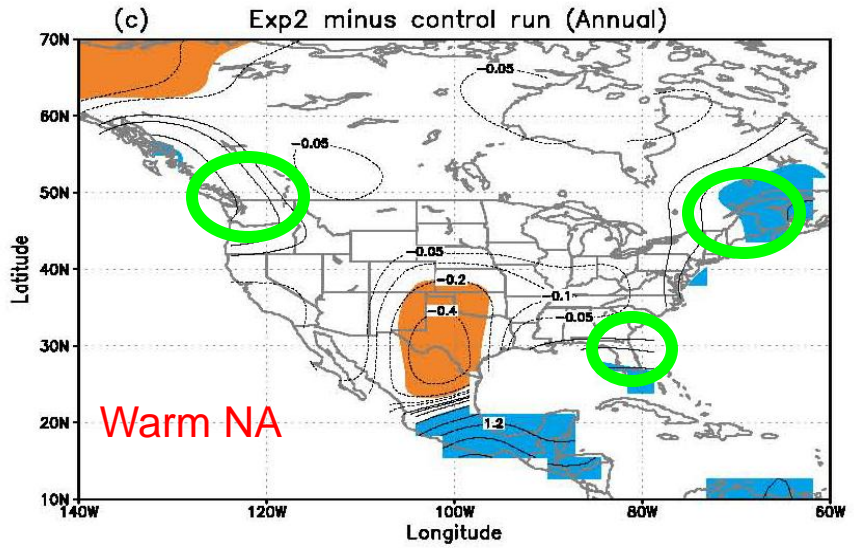
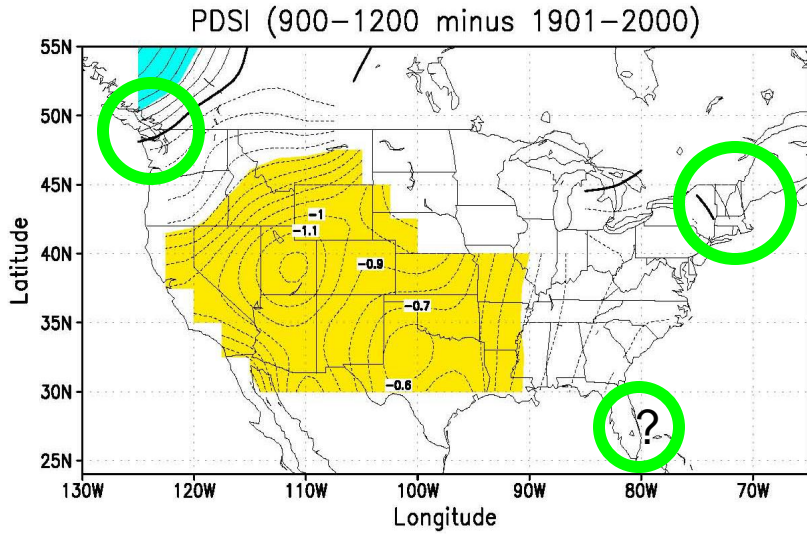
Modeling Study:

CAM3.0 with T42 resolution

The control run and the each model experiment were ran 15 years.

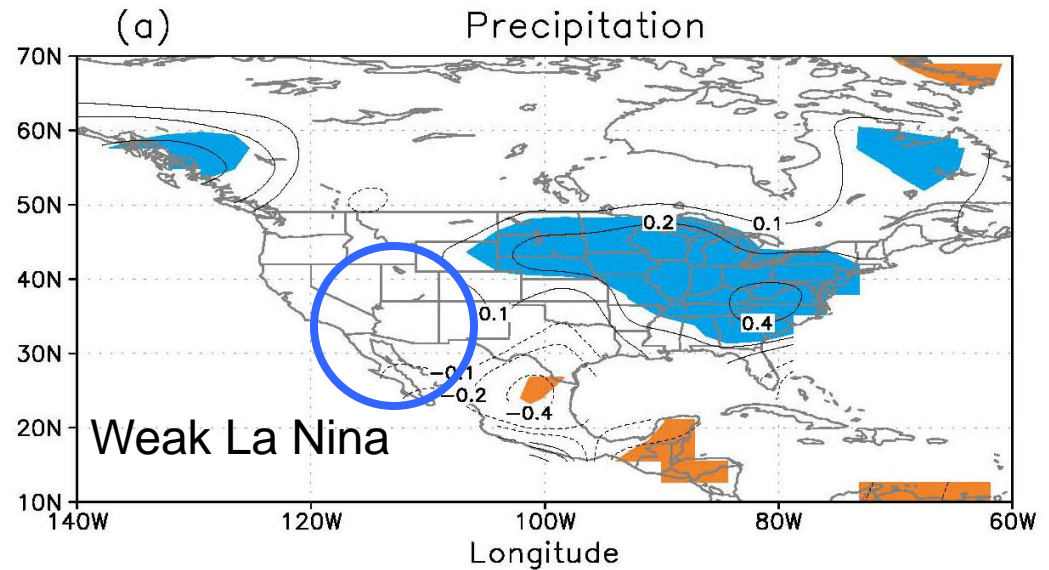
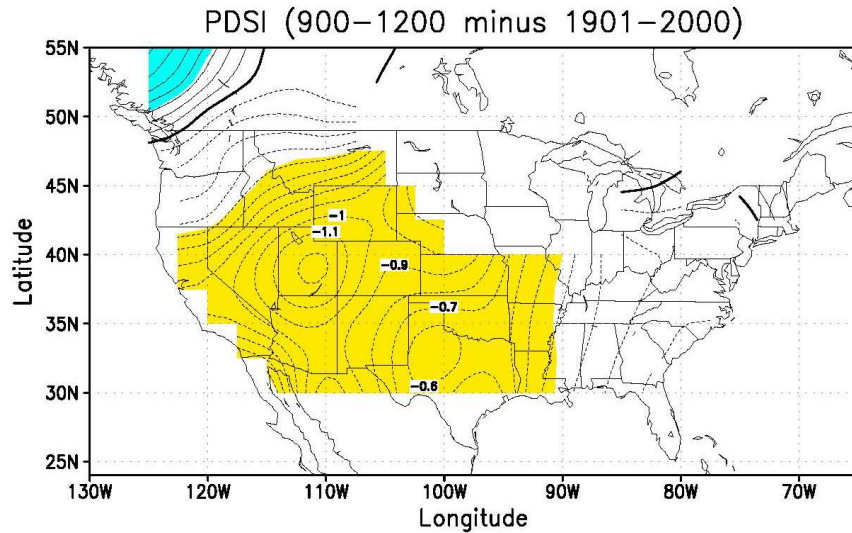
Model results: Annual precipitation

Cold TP alone can simulate drought intensity, warm NA alone can simulate the drought areal extent. The two work together can better simulate the drought

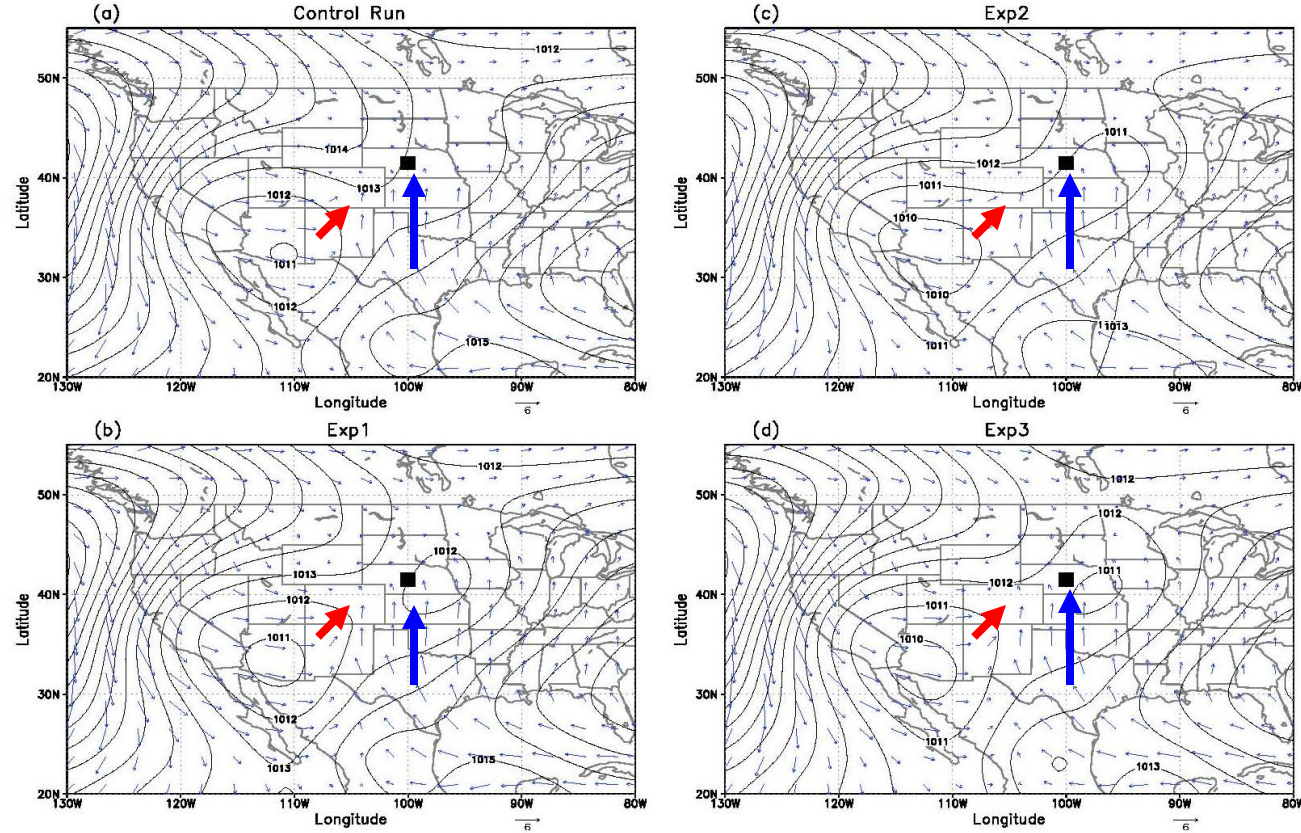


Model results: Annual precipitation (EXP4)

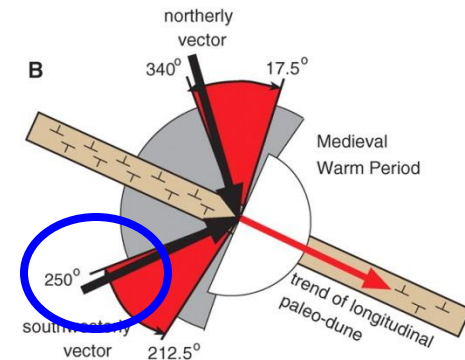
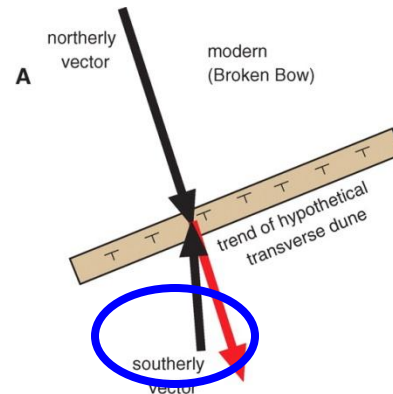
Weak cooling in TP likely can not cause the drought.



Model results: summer wind directions

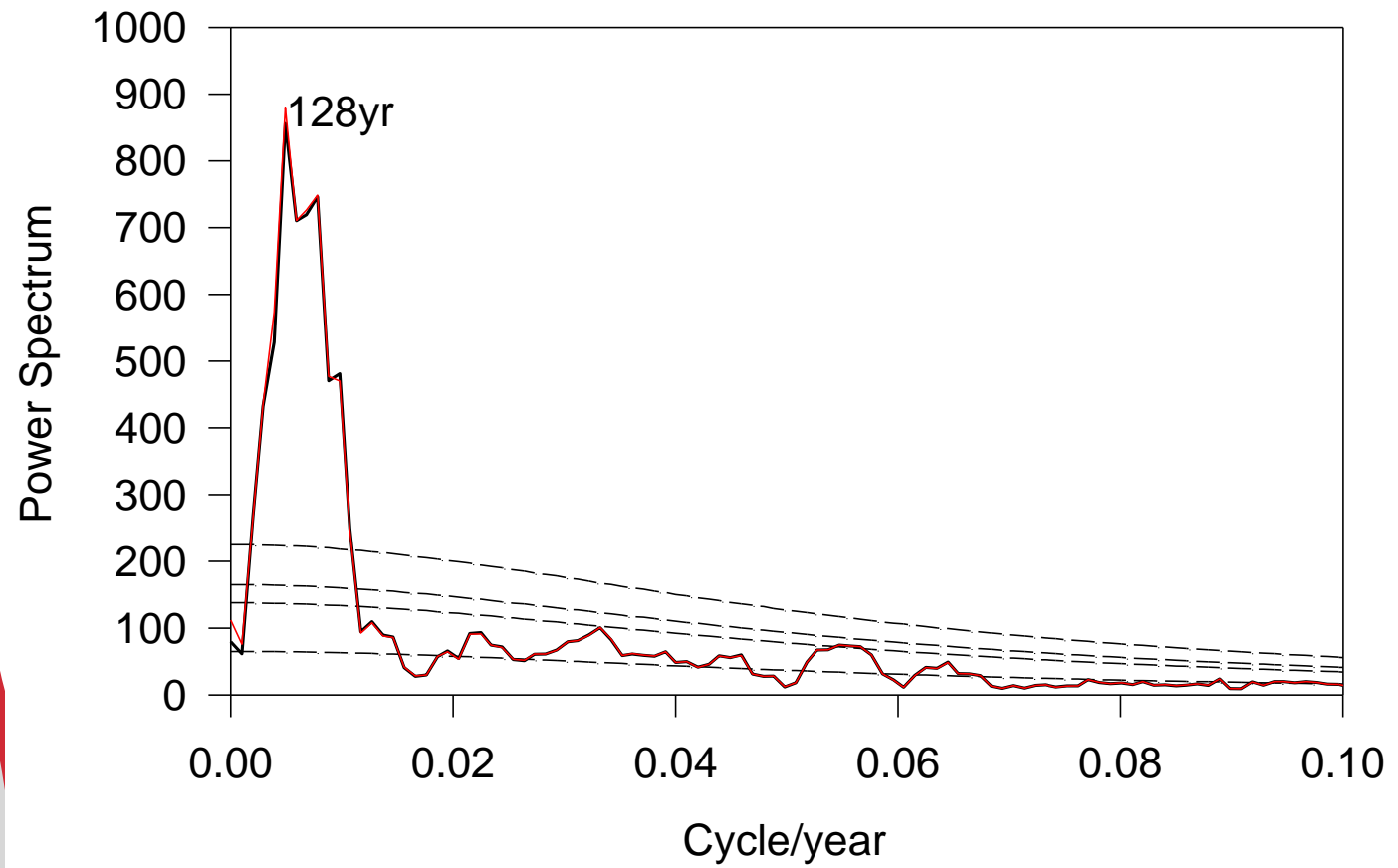


The model can not simulate the wind direction change



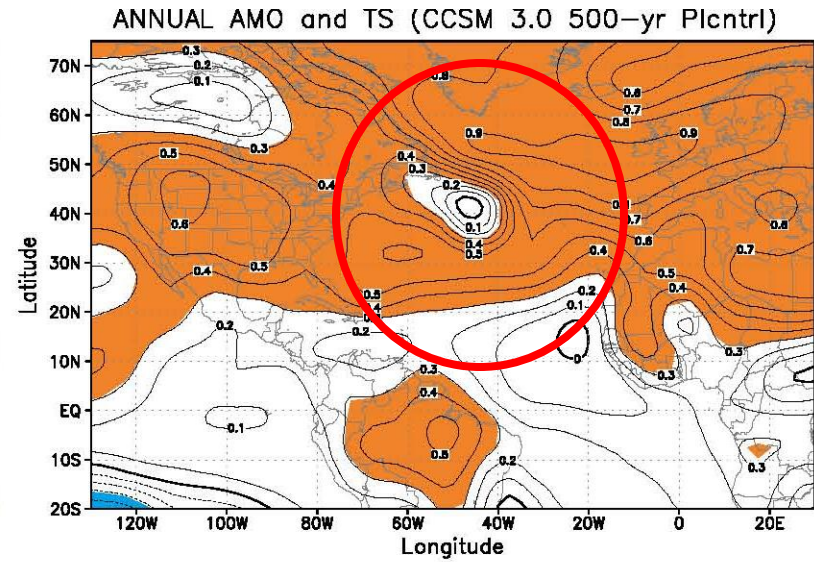
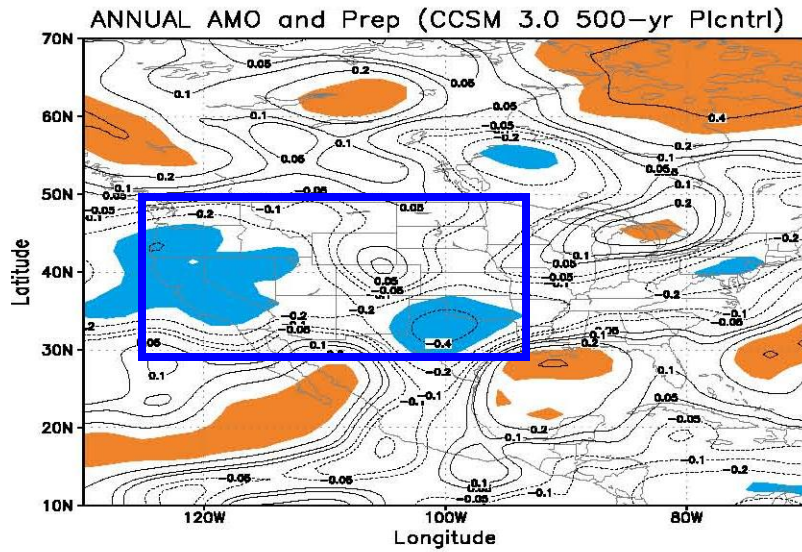
Atlantic impacts in 500-yr CCSM3.0 control simulation

CCSM3.0 (Picntrl)

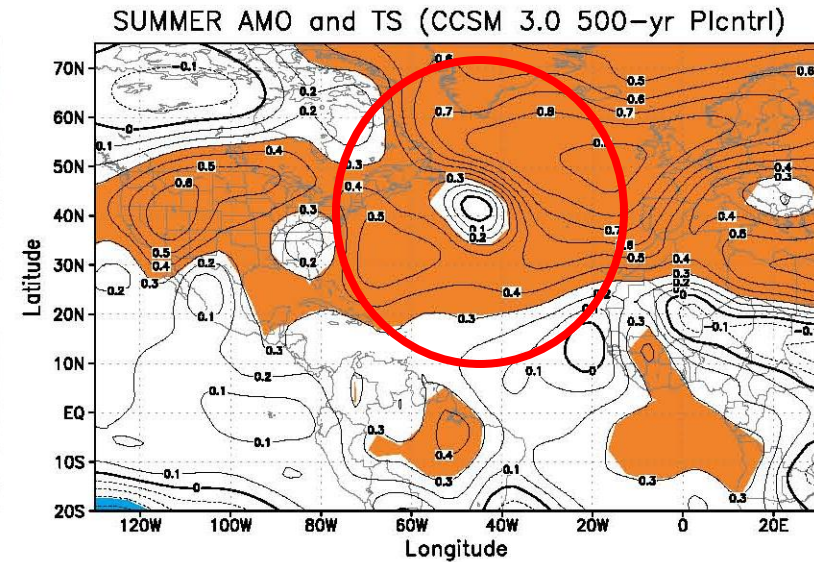
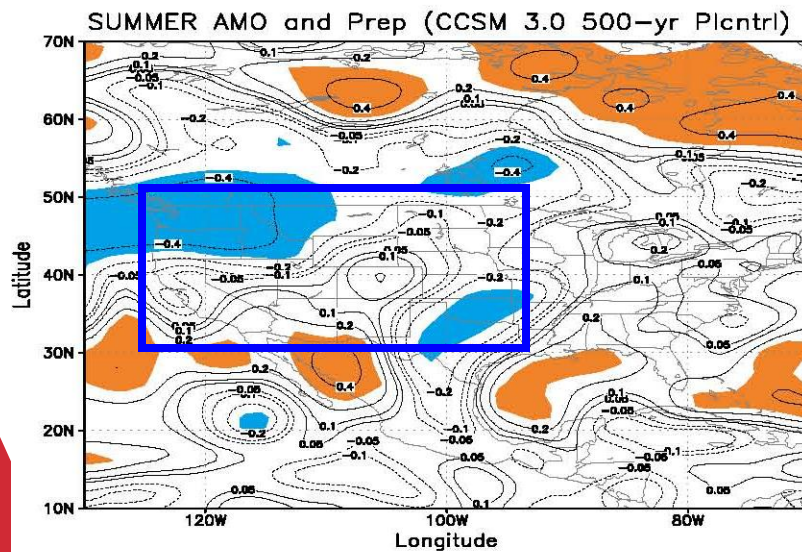


Atlantic impacts in 500-yr CCSM3.0 control simulation

Annual



Summer



Summary

The multidecadal to centennial timescale variations of NA SST are closely and persistently related the drought in North America. Warmer North Atlantic is associated with drought and cooler North Atlantic is associated with wetter condition.

North America suffered from mega-drought in MWP.

Both cold TP and warm NA could cause the drought, but weak cooling (and possible warming) in TP may not cause the drought. The NA likely played a more important role on the drought.

The fully coupled CCSM3.0 control run can capture a centennial-scale AMO-like SST pattern in NA. This pattern is also closely related to dry or drought in North America.