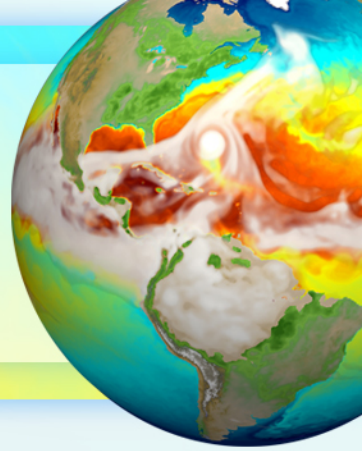
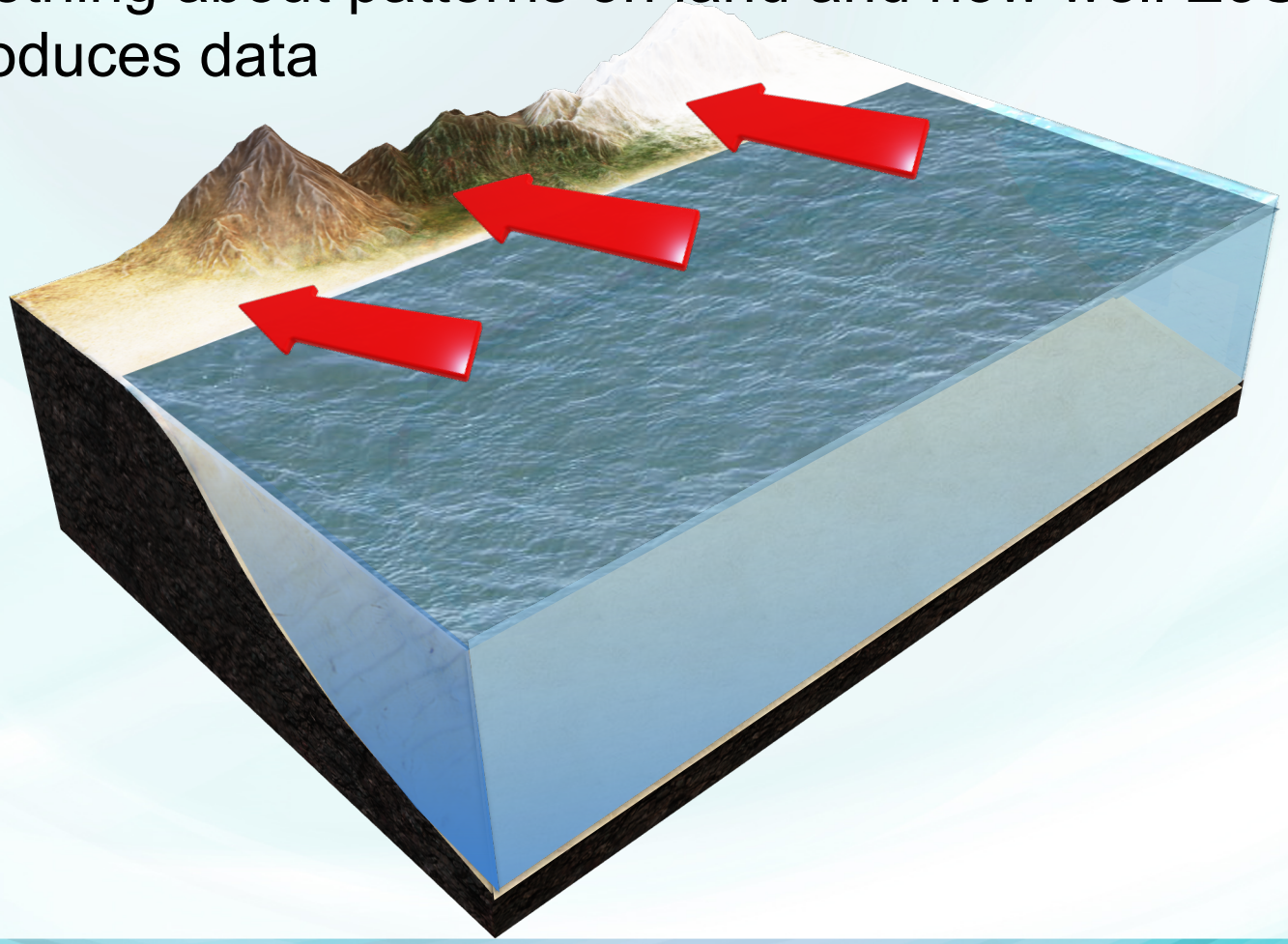


Creation of an SST variability metric for E3SM

LeAnn Conlon, Luke Van Roekel

Can we use sea surface temperature to predict patterns on land in E3SM?

- Goal: create an SST variability metric for E3SM that tells us something about patterns on land and how well E3SM reproduces data



Ocean/ Land relationships

Implications of North Atlantic Sea Surface Salinity for Summer Precipitation over the U.S. Midwest: Mechanisms and Predictive Value

LAIFANG LI, RAYMOND W. SCHMITT, AND CAROLINE C. UMMENHOFER

Department of Physical Oceanography, Woods Hole Oceanographic Institution, Woods Hole, Massachusetts

KRISTOPHER B. KARNAUSKAS

Department of Atmospheric and Oceanic Sciences, and Cooperative Institute for Research in Environmental Sciences, University of Colorado Boulder, Boulder, Colorado

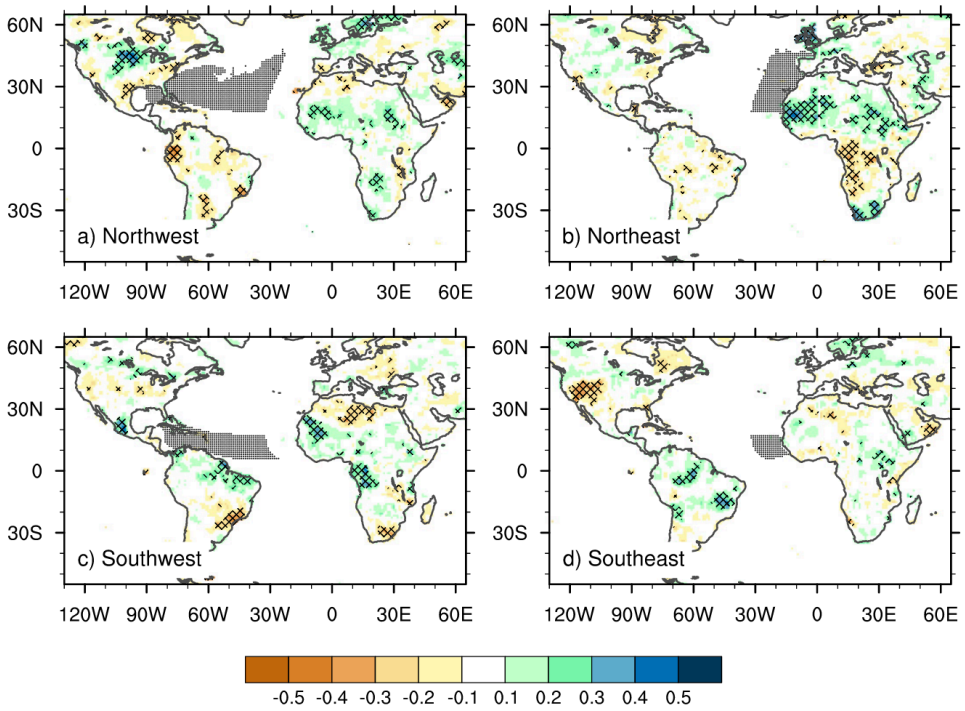
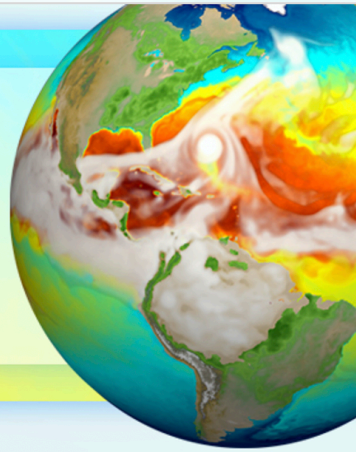


FIG. 3. Correlation between boreal summer (JJA) terrestrial precipitation in the Western Hemisphere (shaded) and springtime North Atlantic SSS indices in the four subdomains of the subtropical basin: (a) NW, (b) NE, (c) SW, and (d) SE. Areas are hatched where the correlation coefficients are significant at the $\alpha = 0.05$ level. The gray-shaded regions in the subtropical North Atlantic are the geographical domains that define the corresponding SSS indices.

Li et al (2016) looked at the relationship between salinity and precipitation

- High SSS over the northwestern subtropical Atlantic coincides with a local increase in moisture. The moisture is then directed toward and converges over the southern United States, which experiences increased precipitation and soil moisture

Approach: do something similar for the U.S. in E3SM using SST



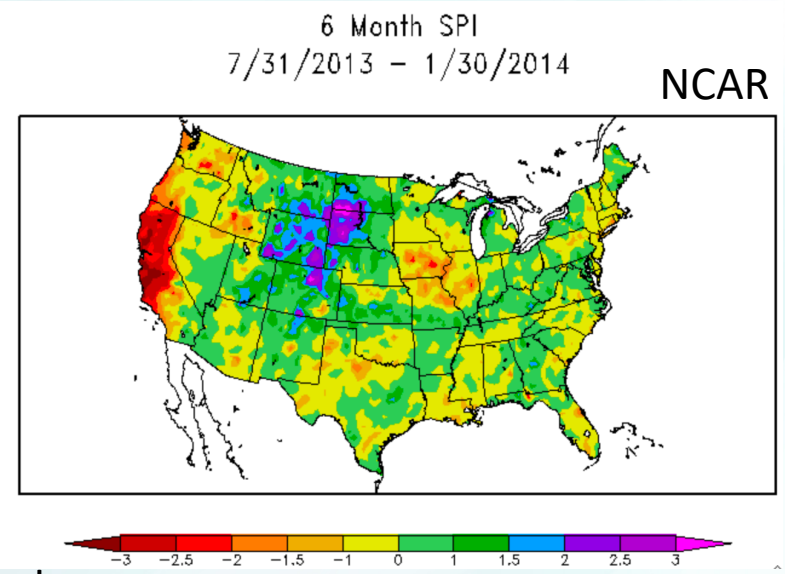
Data Analysis

- Start with low res PI run, SST and precipitation
- Precipitation
  - Standardized precipitation index (SPI)
    - a widely used index to characterize meteorological drought on a range of timescales

$$SPI = (P - P*)/\sigma P$$

Precipitation — Mean Precipitation — Standard Dev.

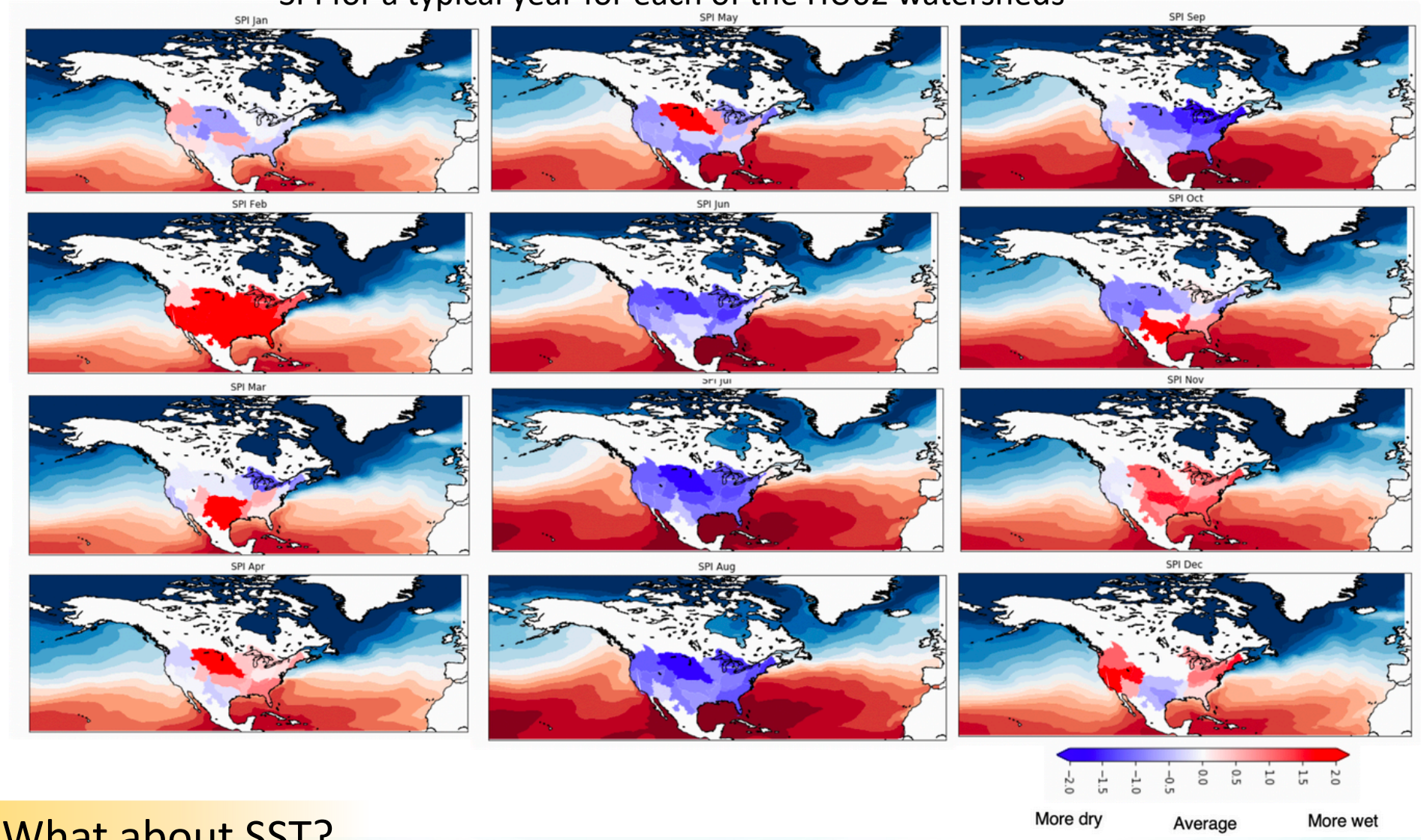
  - Averaged over each HUC02 watershed



USGS

Standardized Precipitation Index

SPI for a typical year for each of the HU02 watersheds



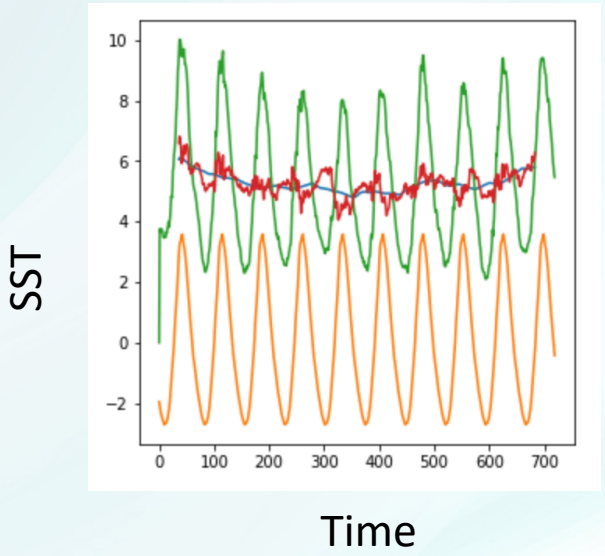
What about SST?

Data Analysis

SST

- Seasonal cycles give spurious correlations (basically relating a seasonal cycle to itself)
  - Holtz-Winters decomposition avoids this

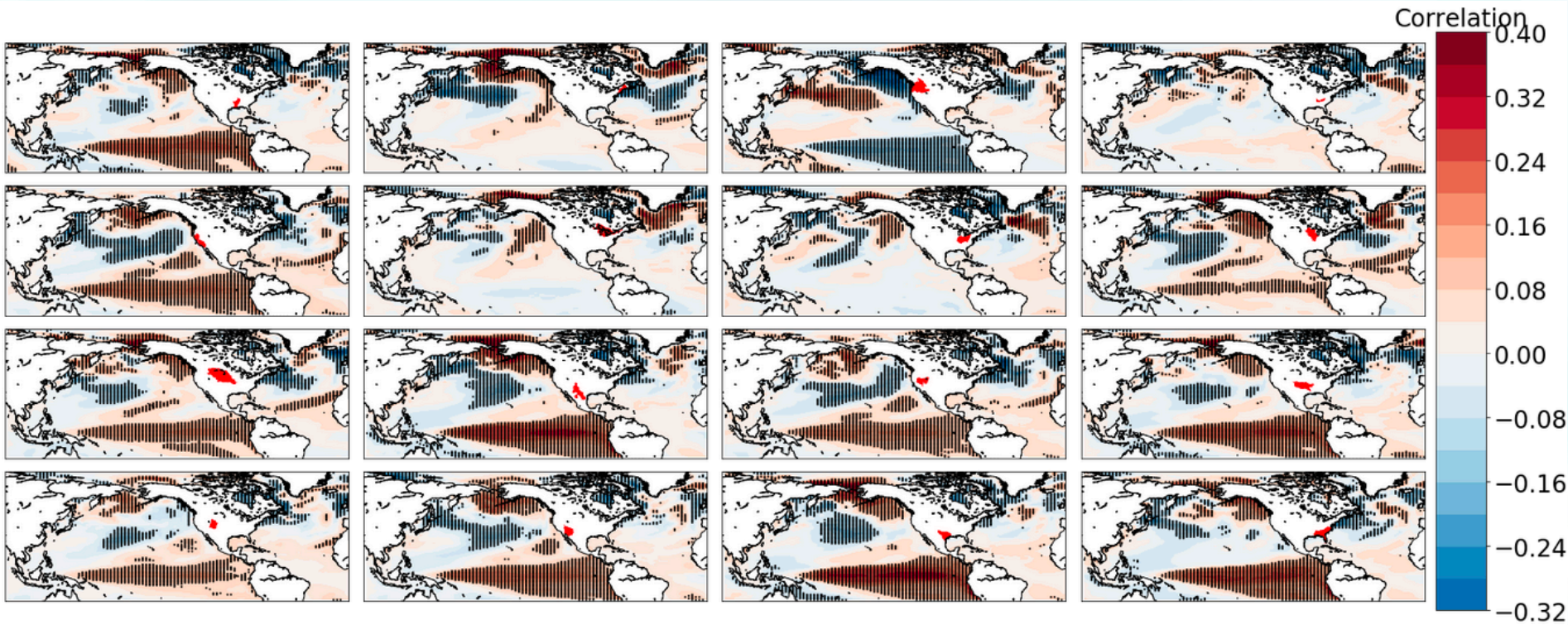
Holtz-Winters decomposition on SST: seasonal, trend, residual, raw data



SST/SPI correlations

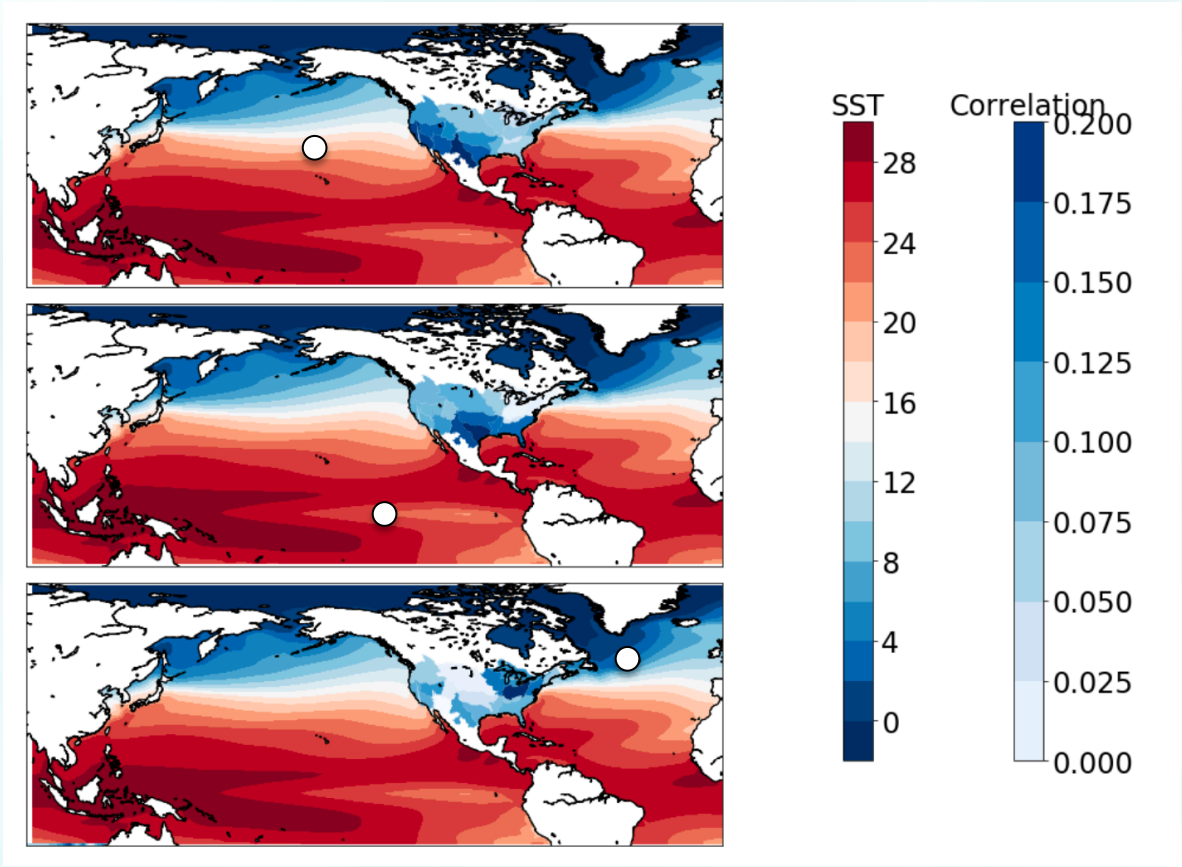
Correlated SST pointwise over much of the global ocean with SPI in each HUC02 watershed

Low resolution, de-seasoned SST (50 years)
Shading indicates significance



A positive correlation indicates that SST increases with SPI (a + SPI indicates more precipitation, a - indicates less). Overall, this means that warmer temperatures along the equator (e.g. an El Nino event) tended to produce significant increases in precipitation in many watersheds; PDO and NAO produce similar results.

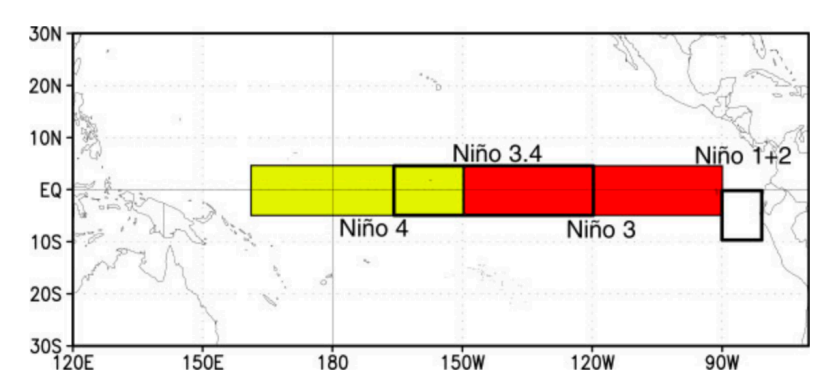
Correlation of timeseries at 3 points, by watershed



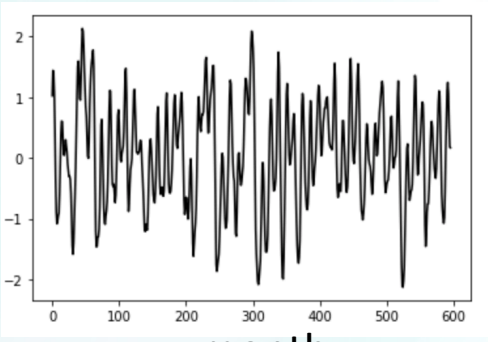
ENSO Comparison with NOAA

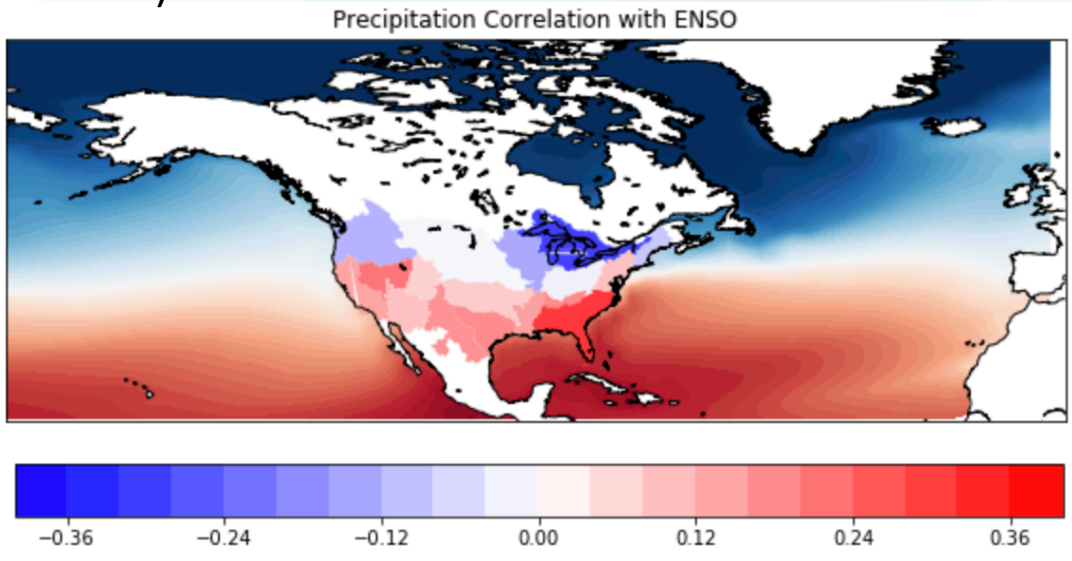
Instead of examining SST where it looks like ENSO is occurring, we can calculated ENSO itself and see how it relates to precipitation

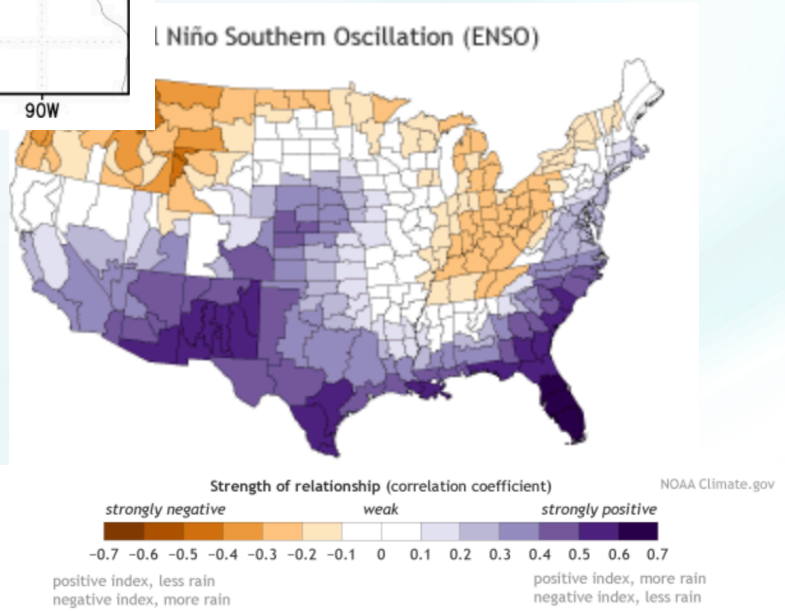
ENSO is calculated based on the NOAA Oceanic Nino Index= surface temperature anomaly for Nino 3.4 (5N to 5S, 170W to 120W)



ENSO index

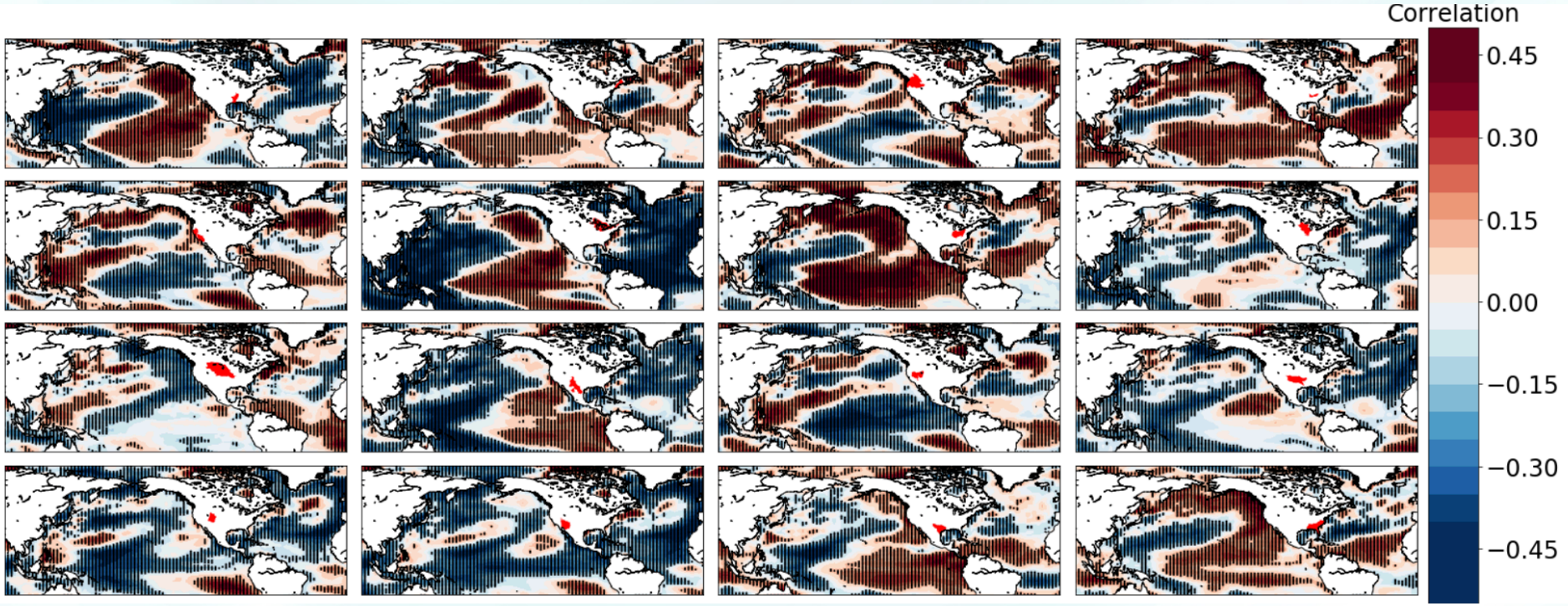






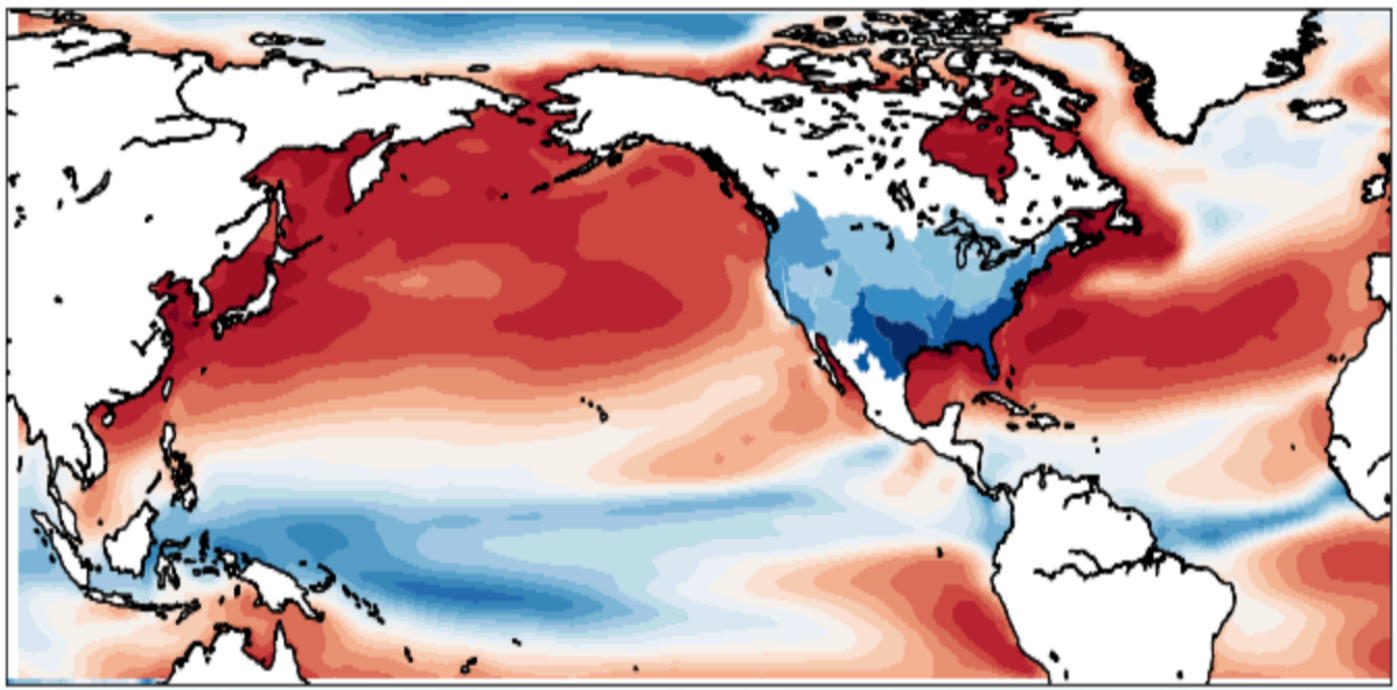
A SST metric

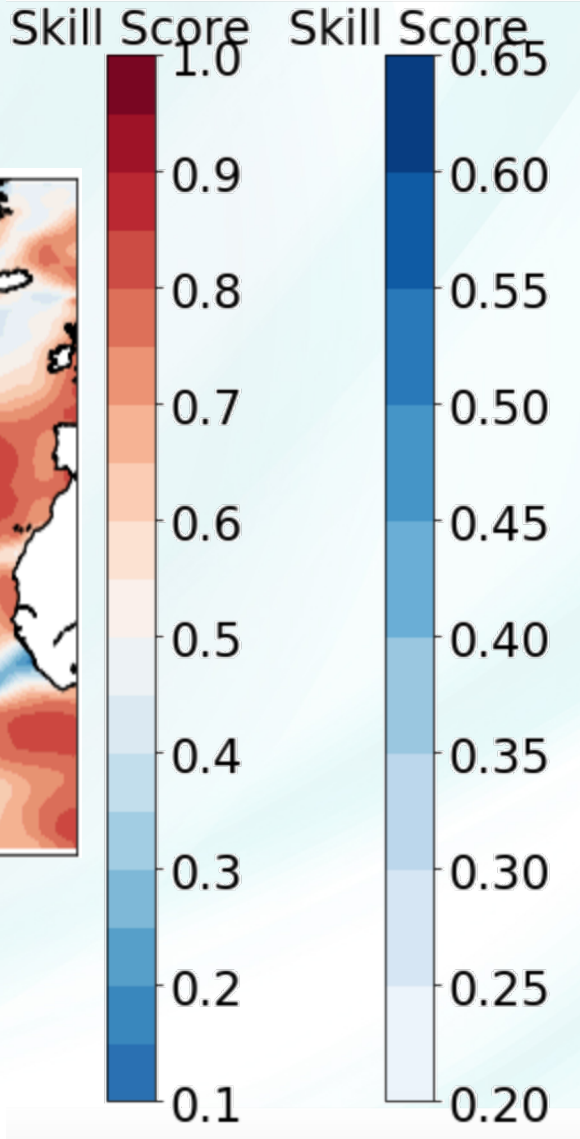
- Can we come up with a metric that judges how well E3SM is predicting this relationship?
  - Approach: calculate the same relationships for observations (1980-2010), compare relationships between E3SM output and observations with a model skill score



$$Skill = 1 - \frac{\sum \left| X_{model} - X_{obs} \right|^2}{\sum \left(\left| X_{model} - \bar{X}_{obs} \right| + \left| X_{obs} - \bar{X}_{obs} \right| \right)^2}$$

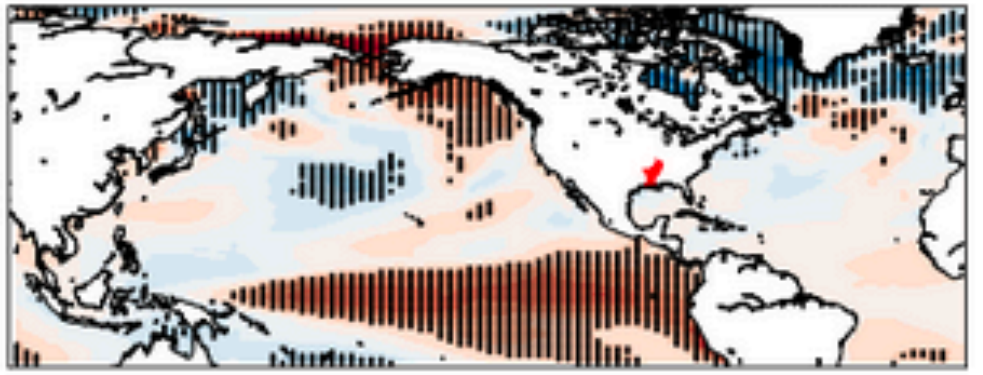
Model Skill




Skill Score
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
Skill Score
0.65
0.60
0.55
0.50
0.45
0.40
0.35
0.30
0.25
0.20

Summary

- We can now pinpoint specific locations where SST affects drought/wetness across the U.S. in E3SM
  - E3SM shows that most watersheds across the U.S. are influenced primarily by variability in decadal oscillations



- We now can objectively determine how well patterns match observations with a model skill score