

Oceans and Drought

Martin Hoerling, NOAA Earth System Research Laboratory



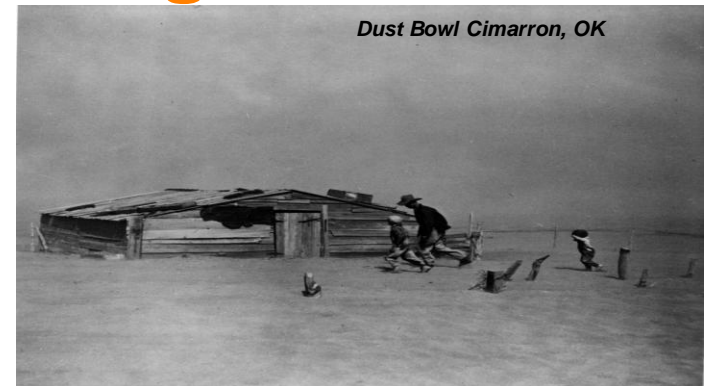
Earth's Dry and Wet Seasons

- ° *Prelude to understanding ocean-drought links*
- ° *Monsoon pulse tied to ocean's seasonality*



The Interannual-Decadal Droughts

- ° *Oceans boost drought variability*
- ° *TOGA-TAO: drought early warning*
- ° *Non-ENSO ocean states & drought*
- ° *The Dust Bowl and Sahel*

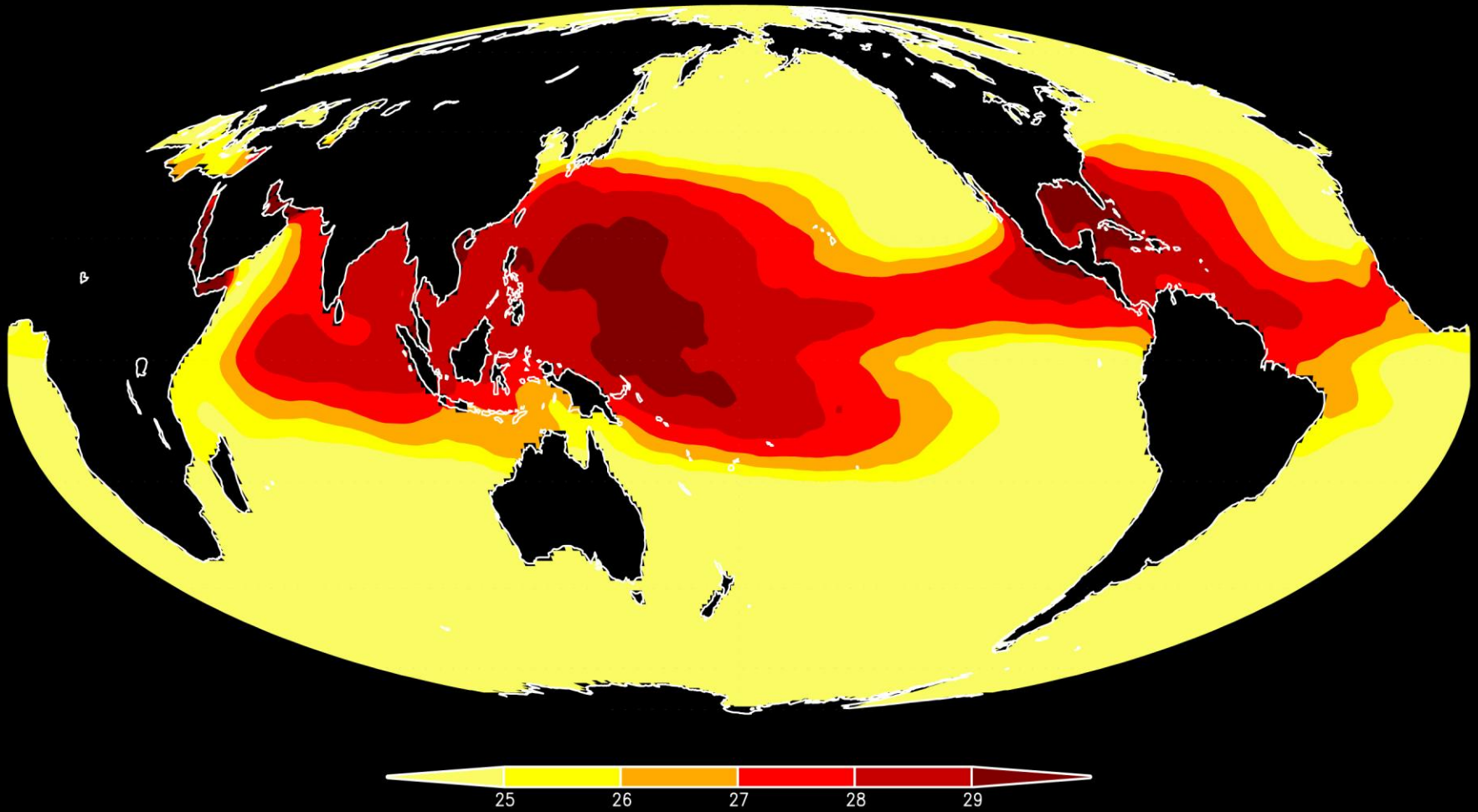


Drought in a Warming Climate

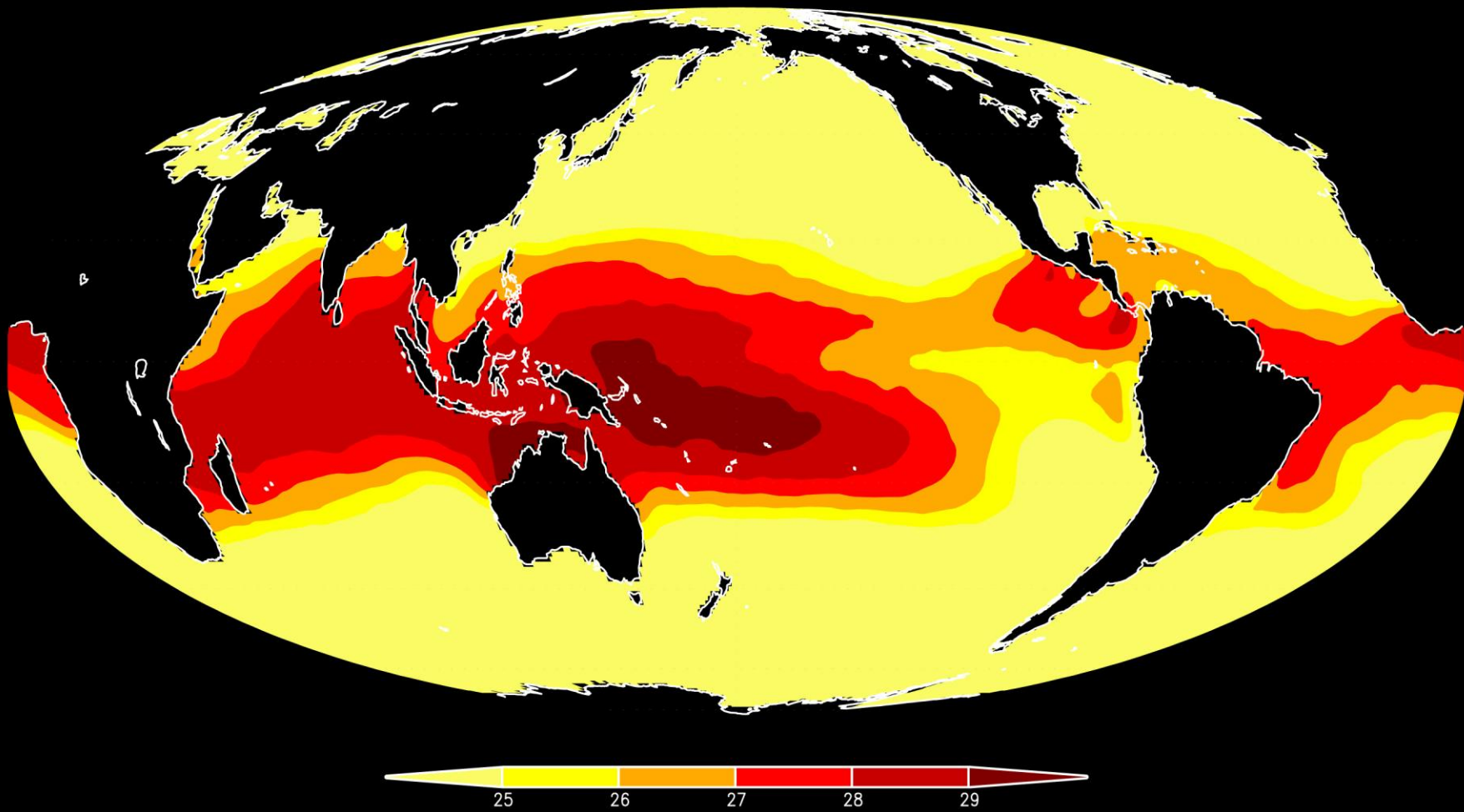
- ° *Ocean trends*
- ° *Rainfall trends*
 - S.W. North America
 - Murray Darling Basin
 - Mediterranean



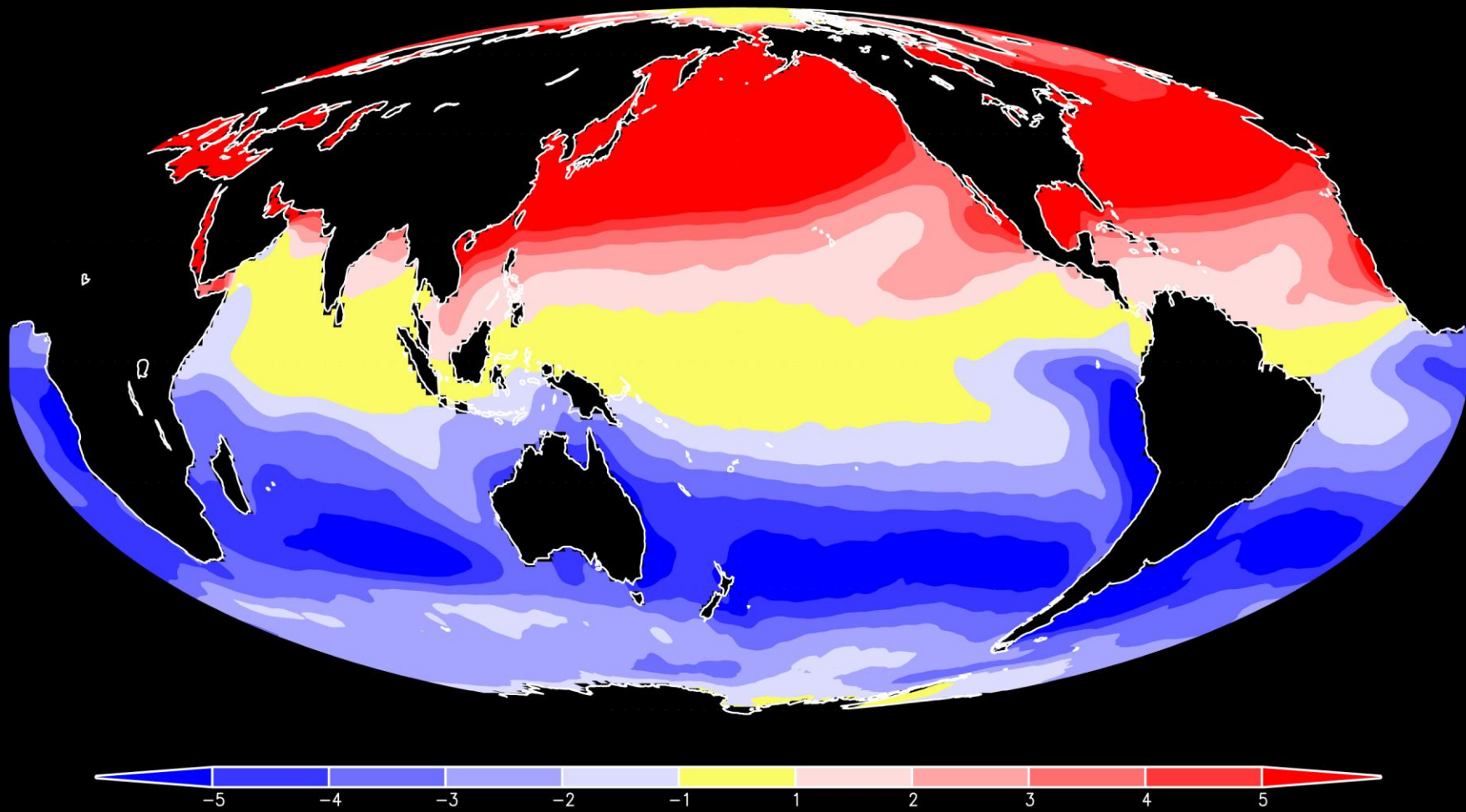
Boreal Summer SSTs



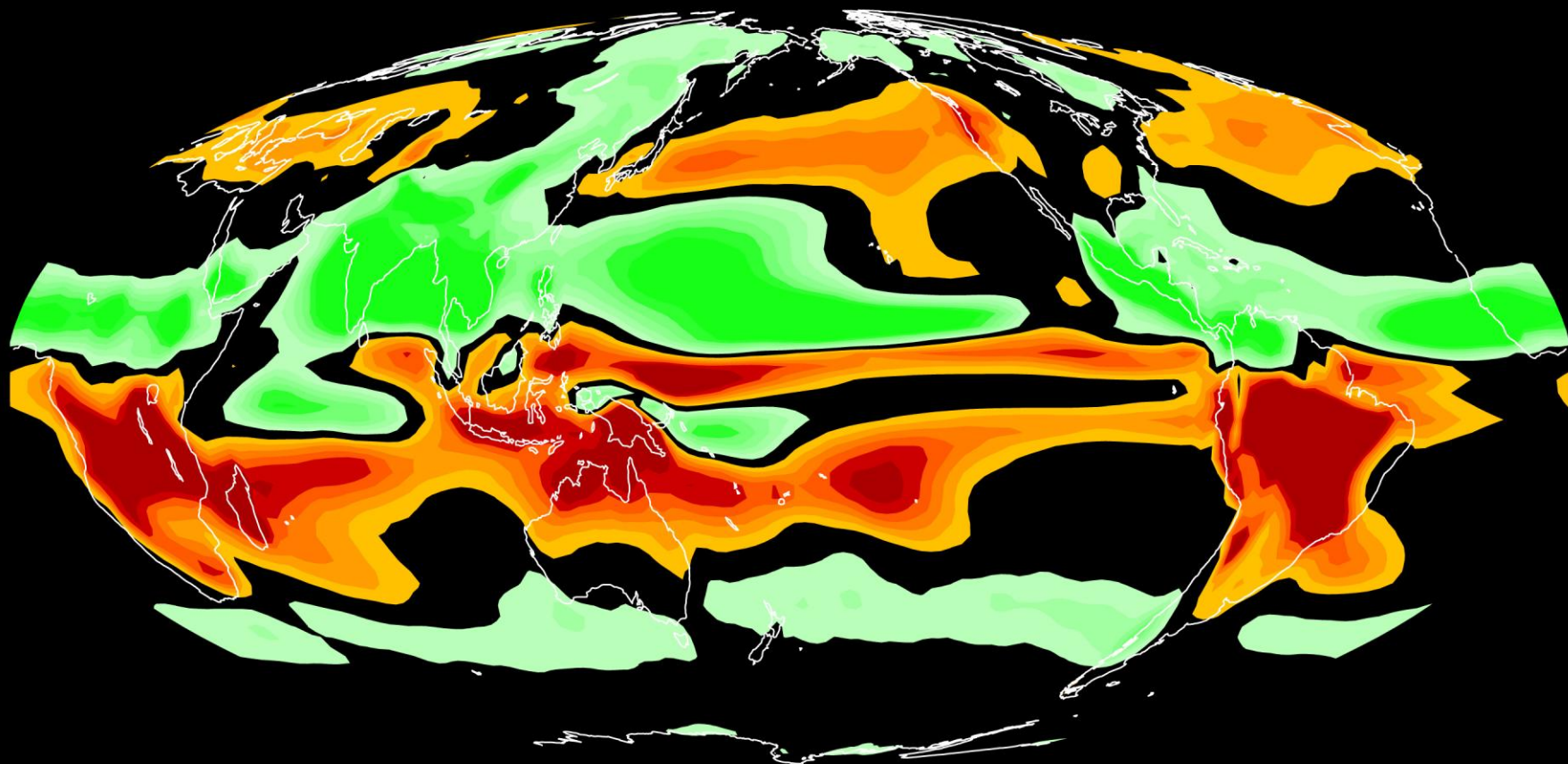
Boreal Winter SSTs



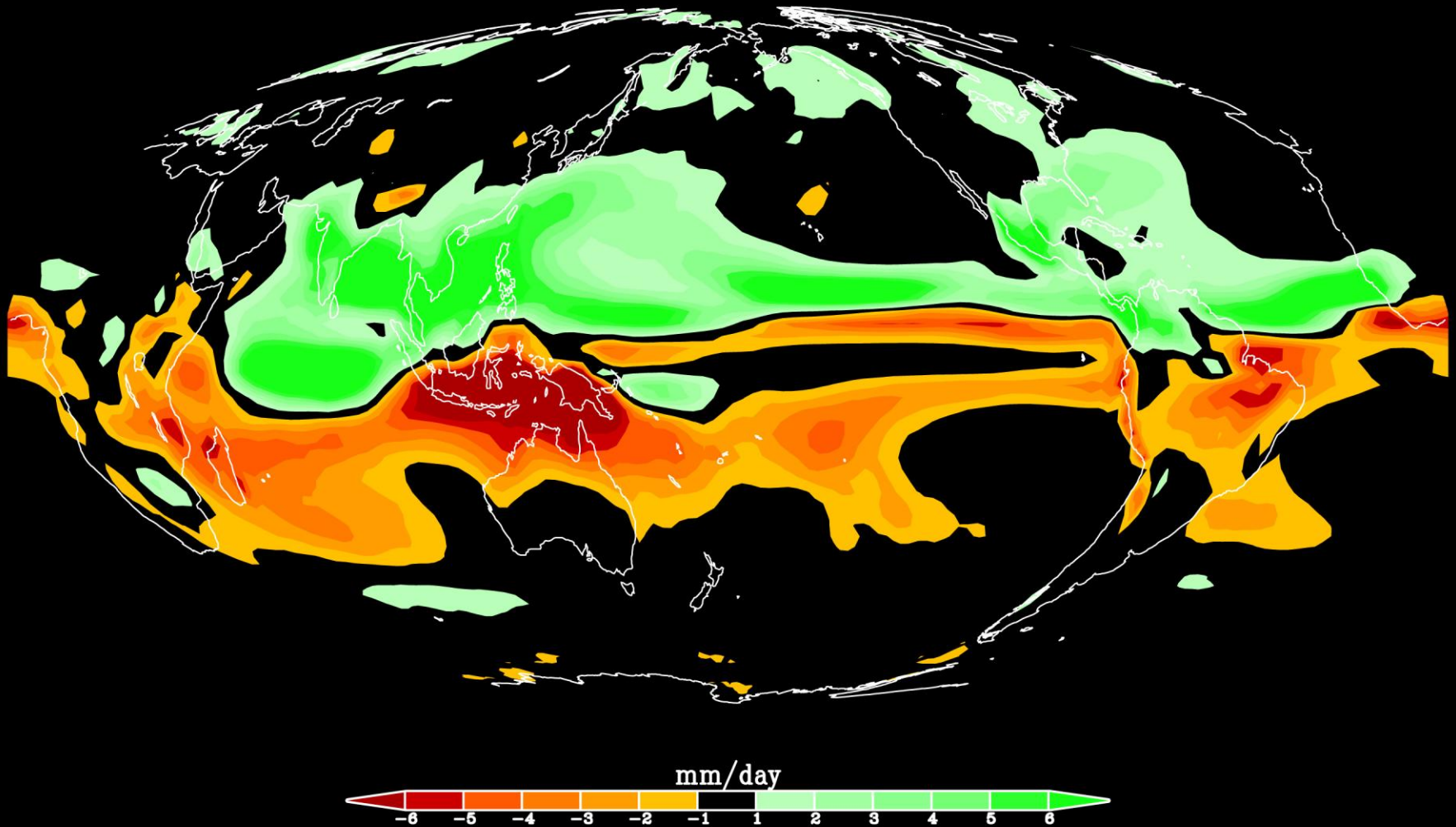
Summer- Winter SSTs



Summer- Winter Pcpn

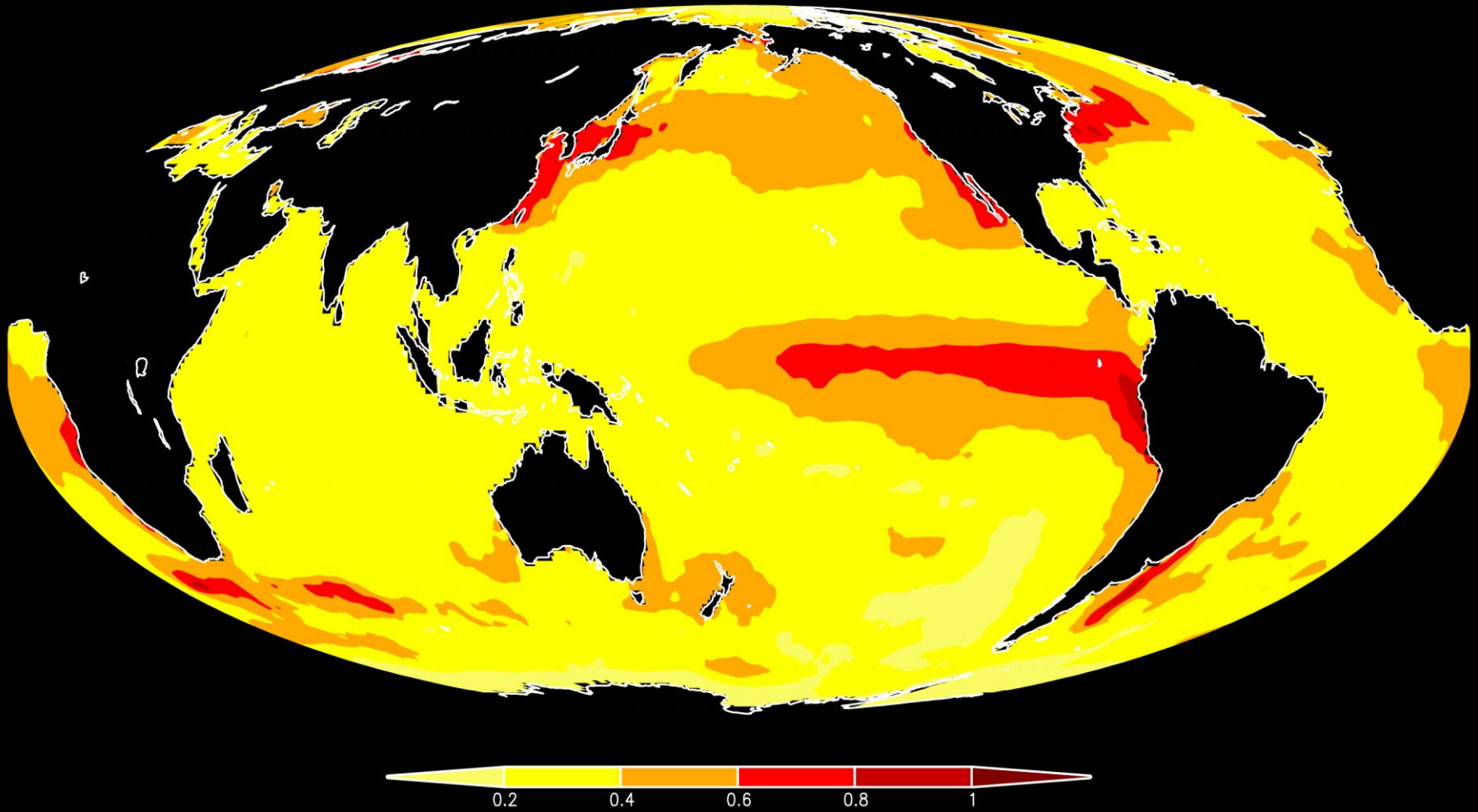


Summer- Winter Pcpn: *Ocean Effect*



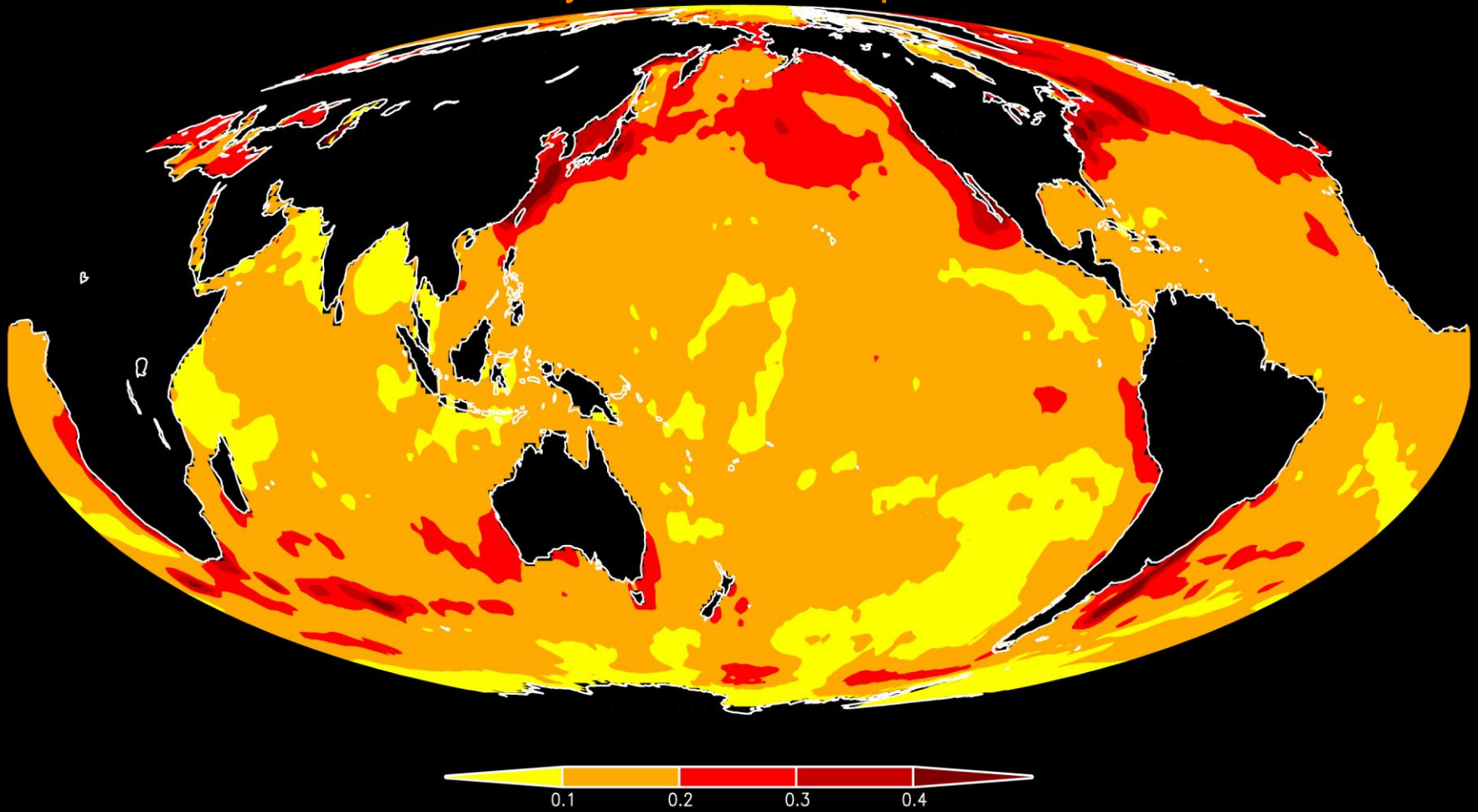
Interannual SST Variability: 1871-2008

Mostly about ENSO



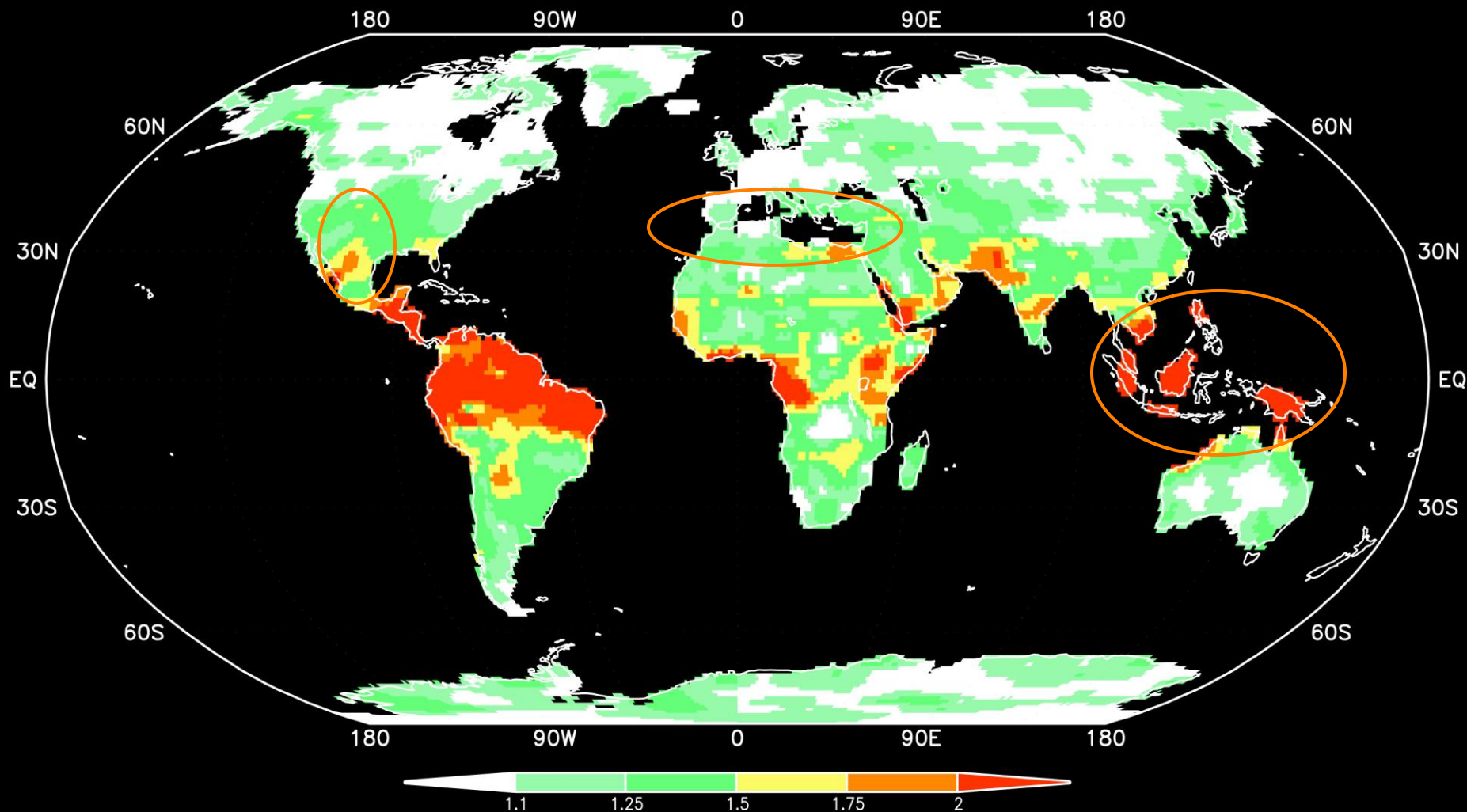
Decadal SST Variability: 1871-2008

Mostly about Extratropical Oceans



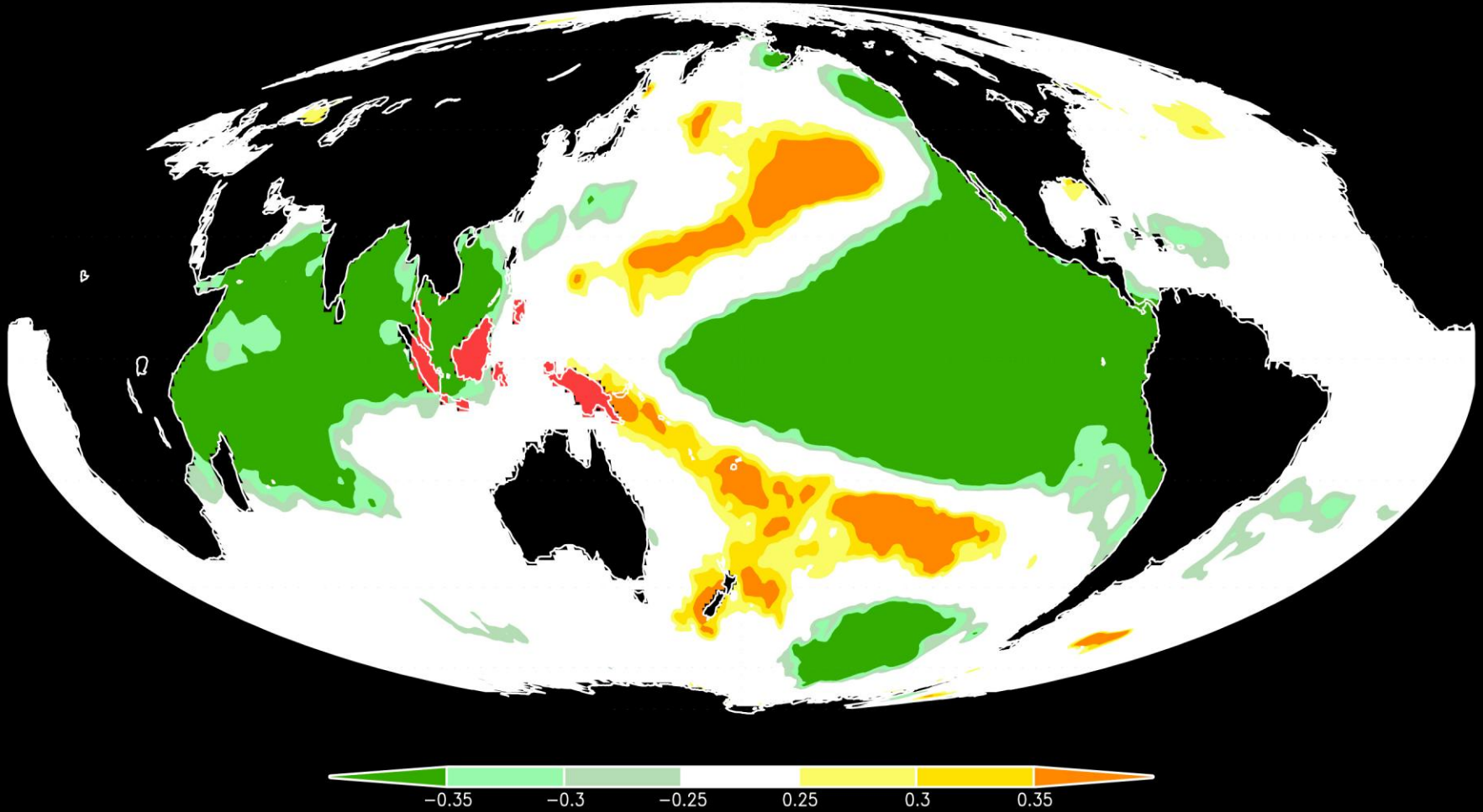
Assessing the Sensitivity of Drought to the Oceans

Drought Variability is Amplified by SST Variability



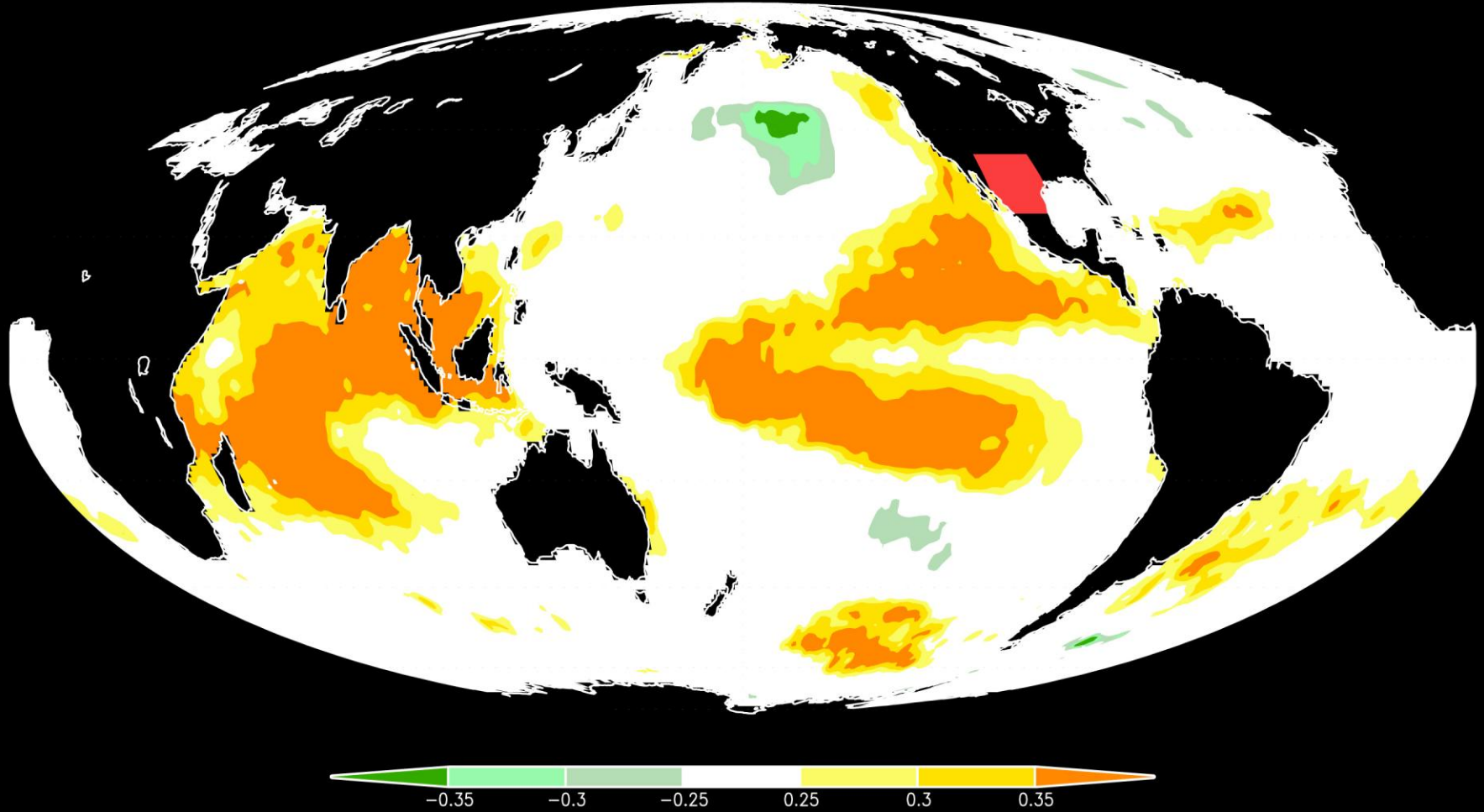
Maritime Continent Drought: *Ocean Link*

El Niño Induces Drought



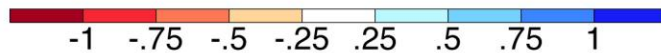
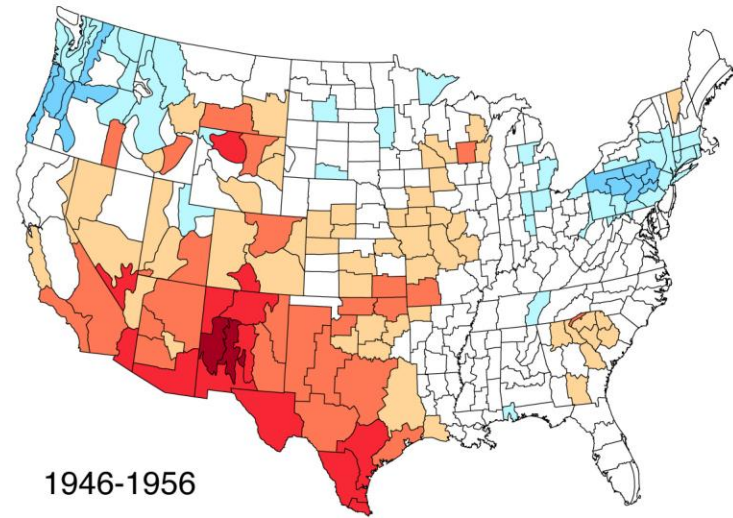
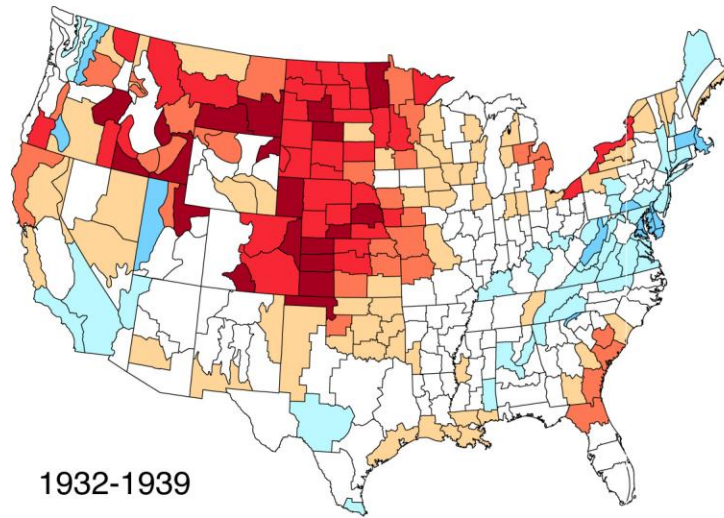
Southern Great Plains Drought: *Ocean Link*

La Niña Induces Drought



Different Patterns of U.S. Drought

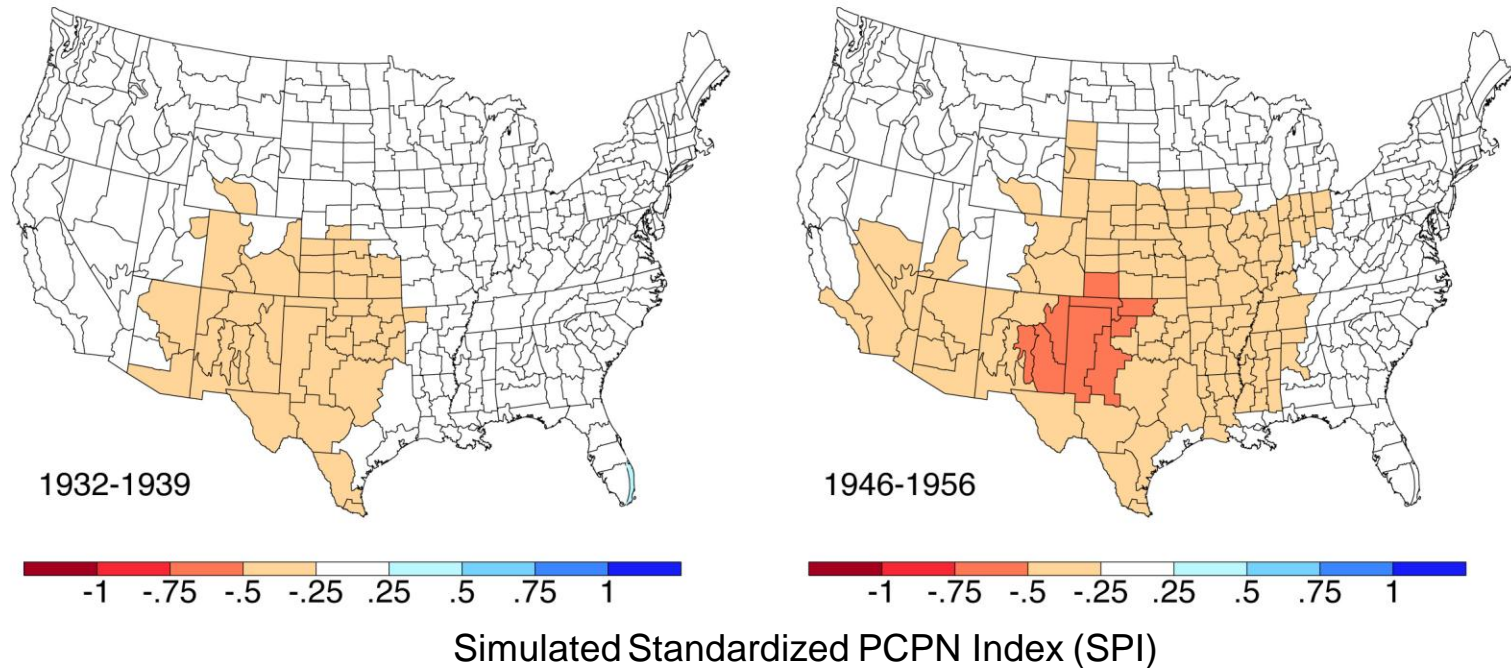
Are They Determined by the Oceans?



Observed Standardized PCPN Index (SPI)

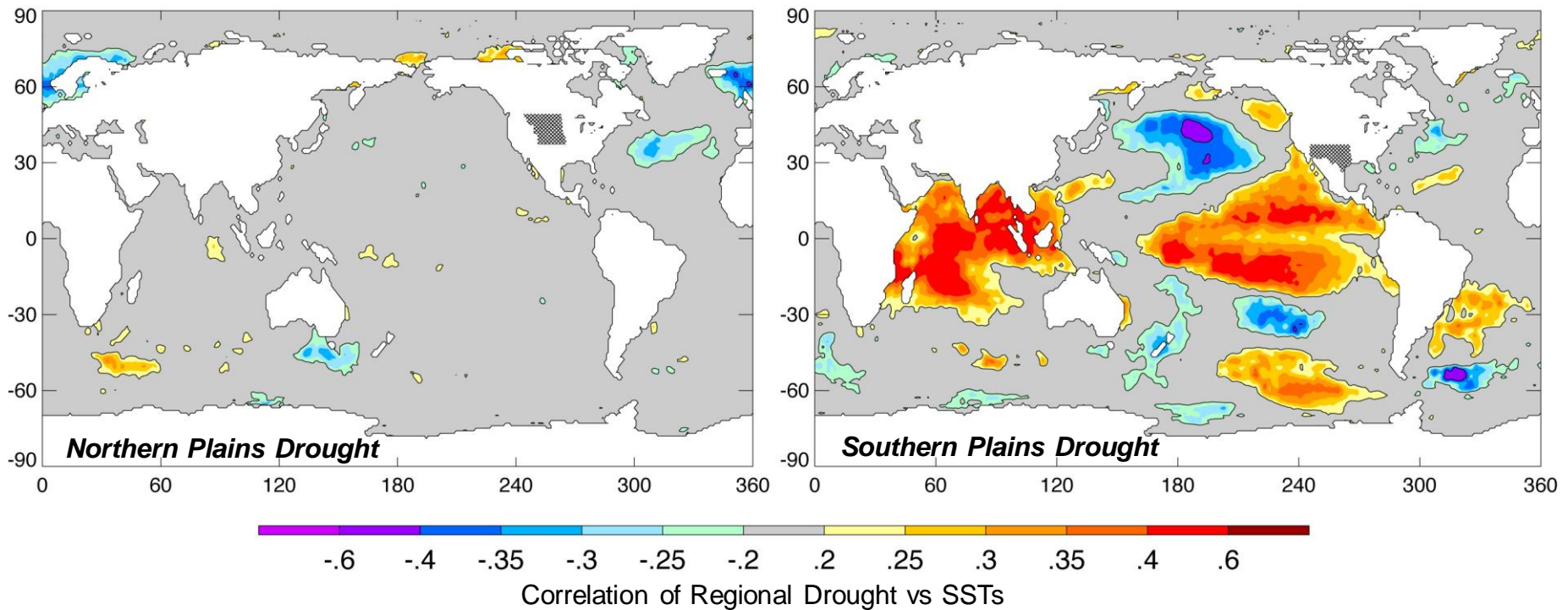
Impact of Oceans on Principal U.S. Droughts

Ocean information does not discriminate '30s from '50s droughts



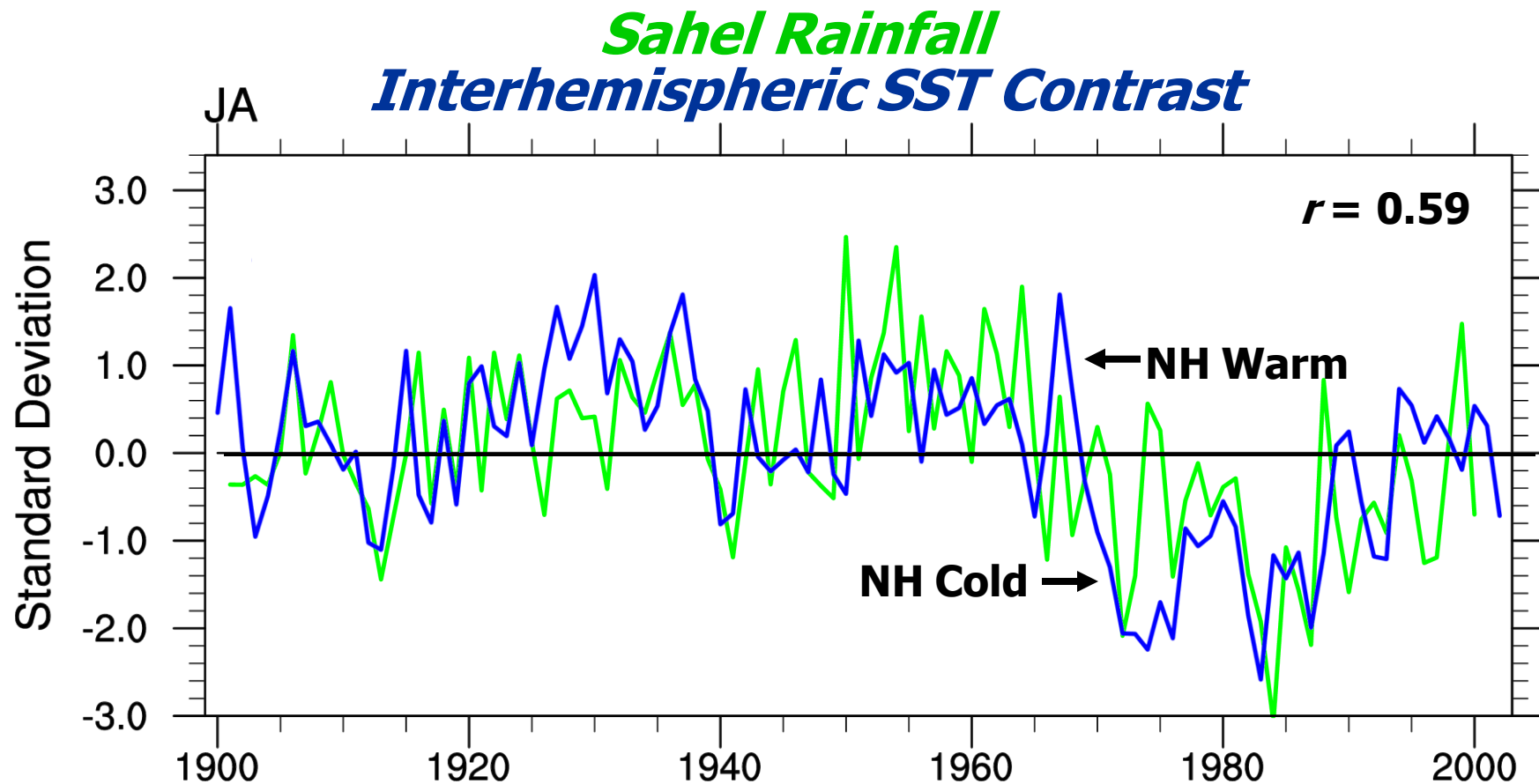
What Ocean Information for Great Plains Drought?

TOGA-TAO/ENSO Prediction for Southern Plains Drought



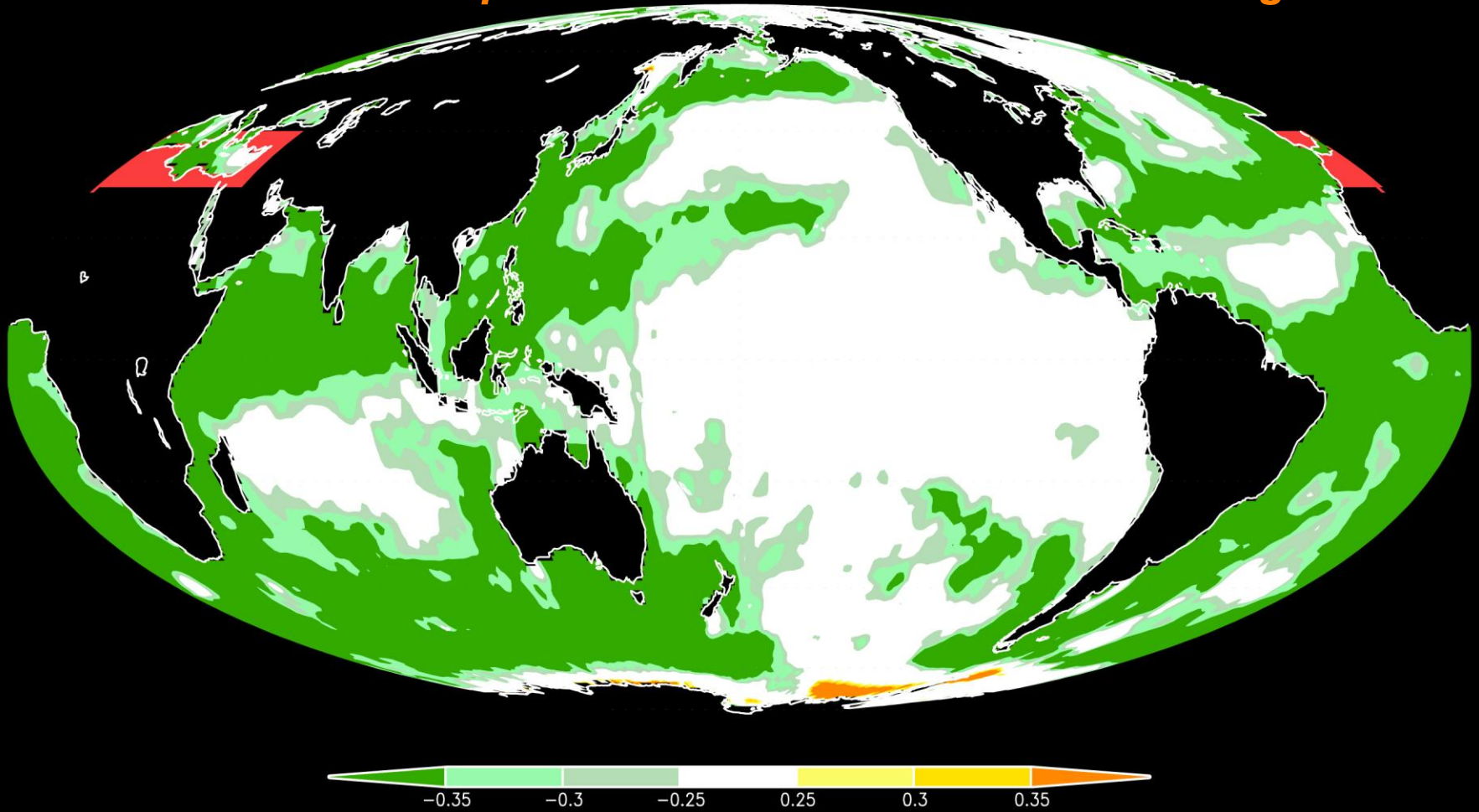
What Ocean Information for Sahel Drought?

Sahel drought sensitive to global SST conditions

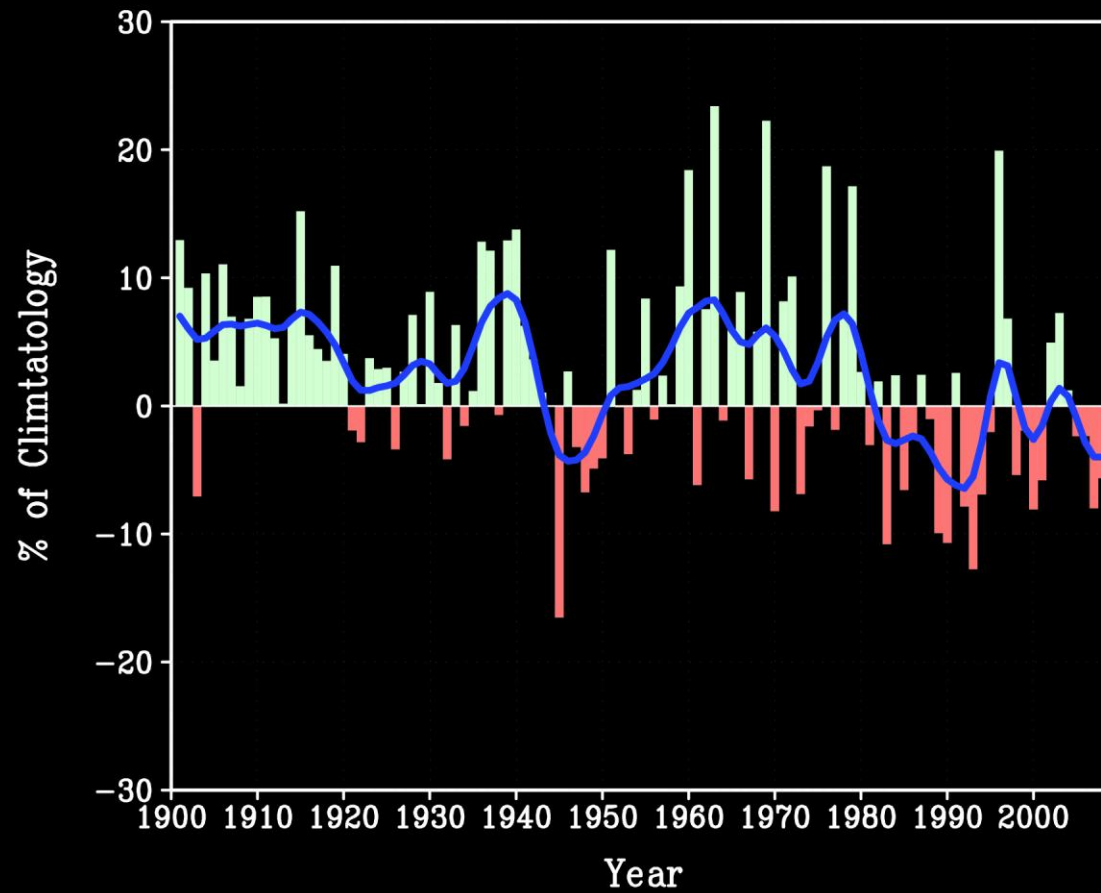


Mediterranean Drought: Ocean Link

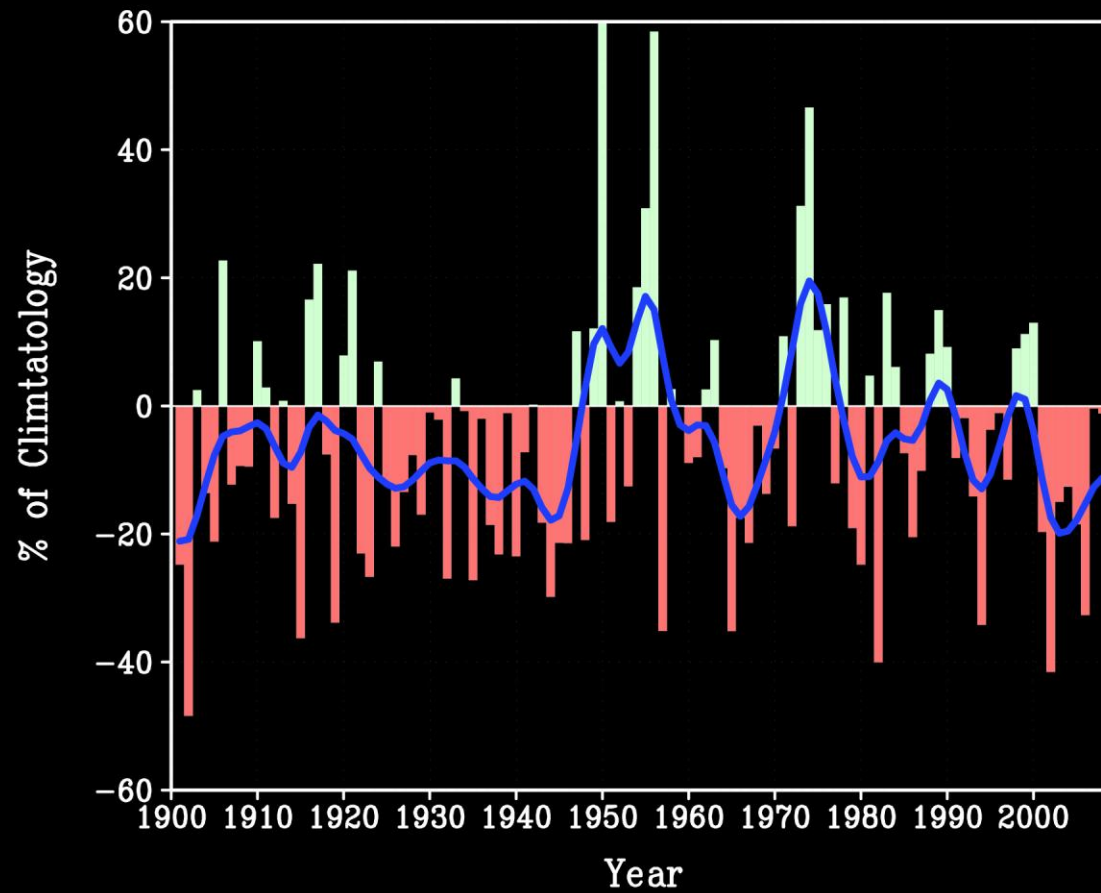
Warm “warmpool” Related to Mediterranean Drought



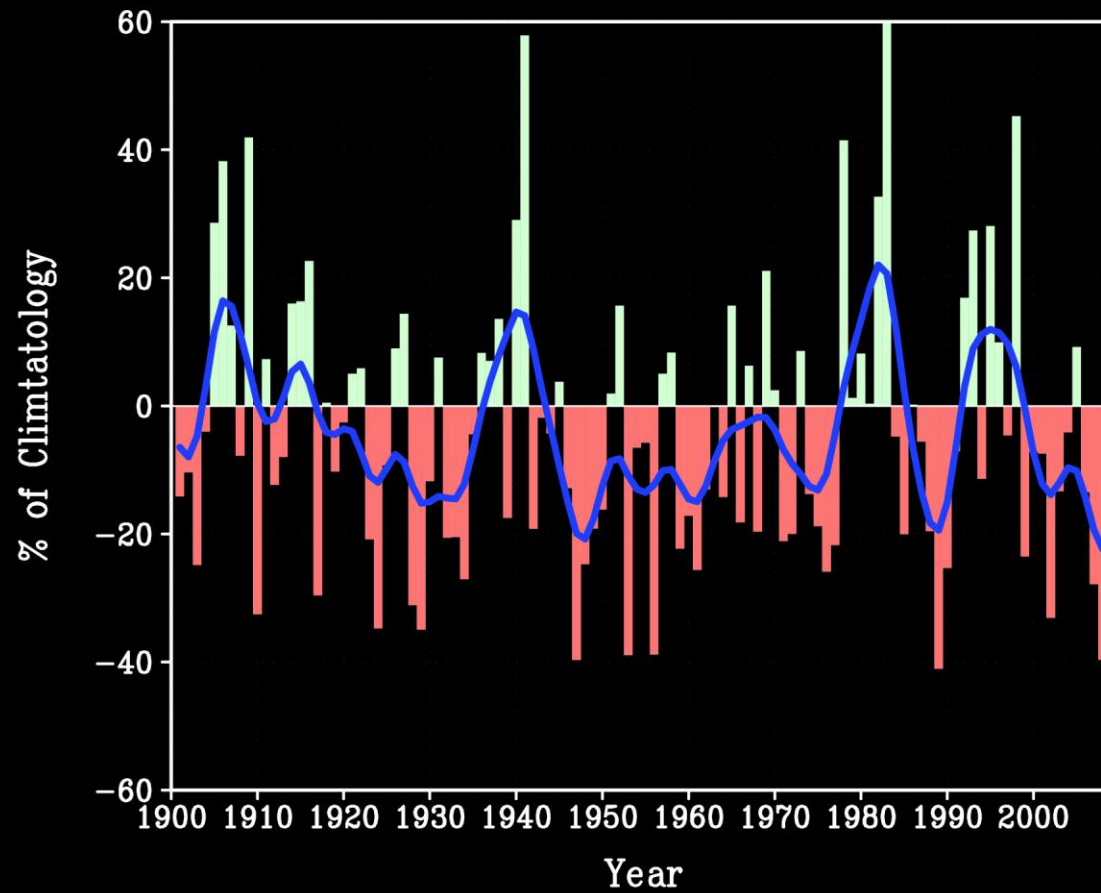
Mediterranean Annual Pcpn: 1901-2008



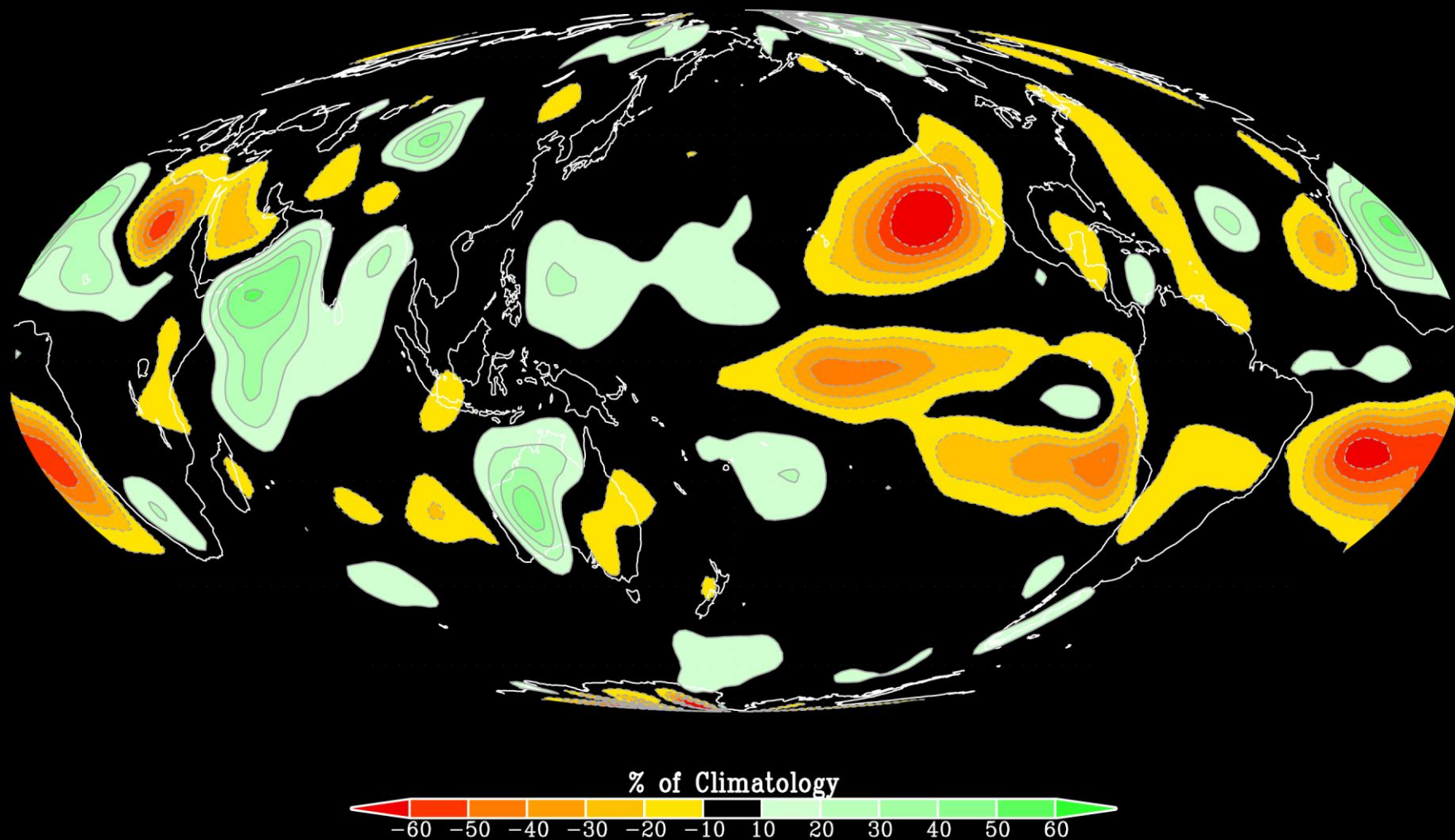
Murray Darling Annual Pcpn: 1901-2008



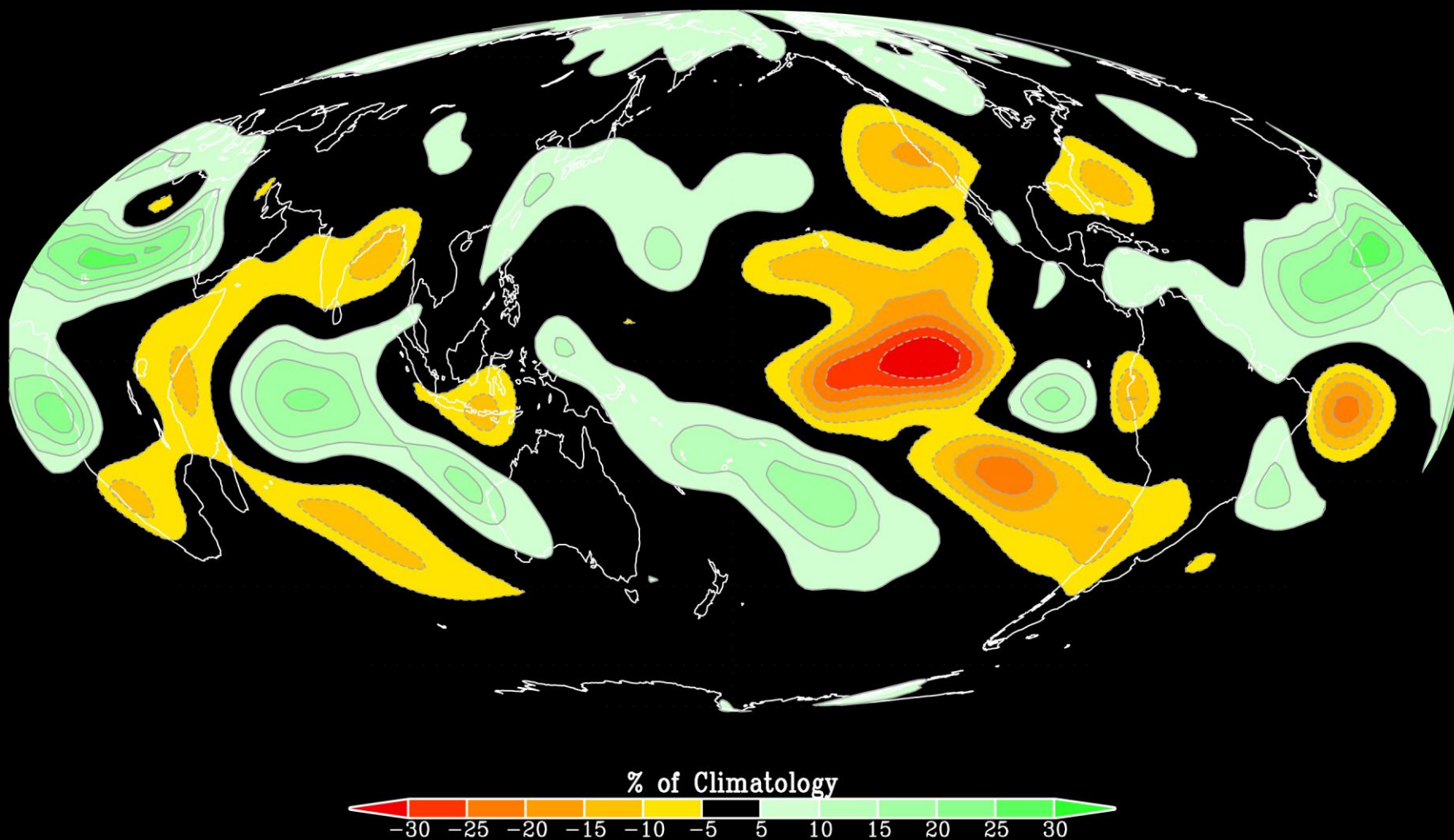
Southwest U.S. Annual Pcpn: 1901-2008



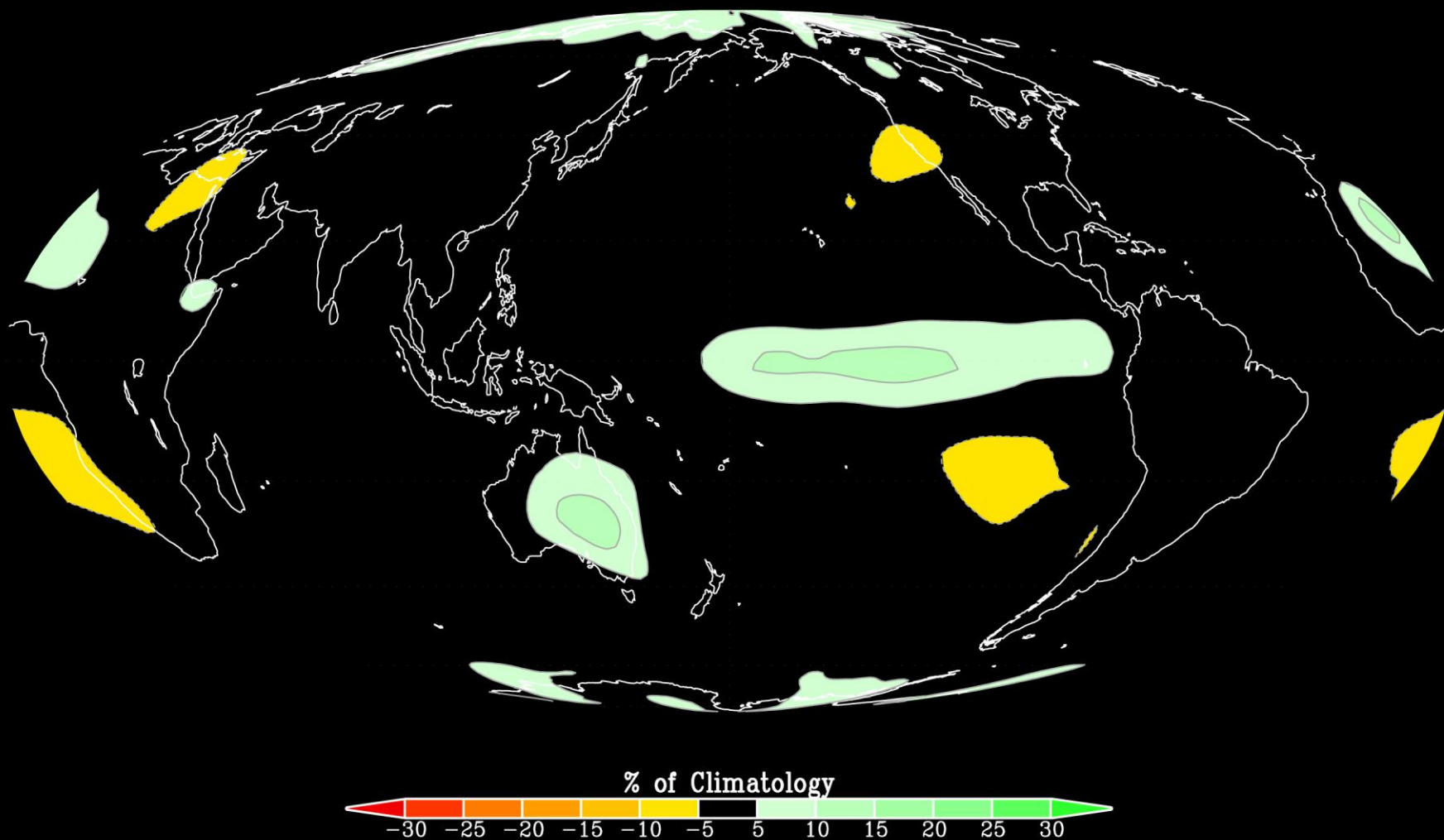
Pcpn Change 1977-2006: *Observed*



Pcpn Change 1977-2006: *Ocean-Forced*

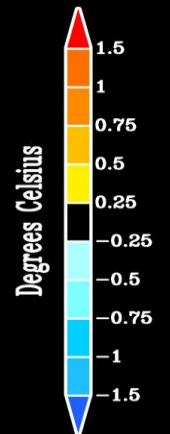
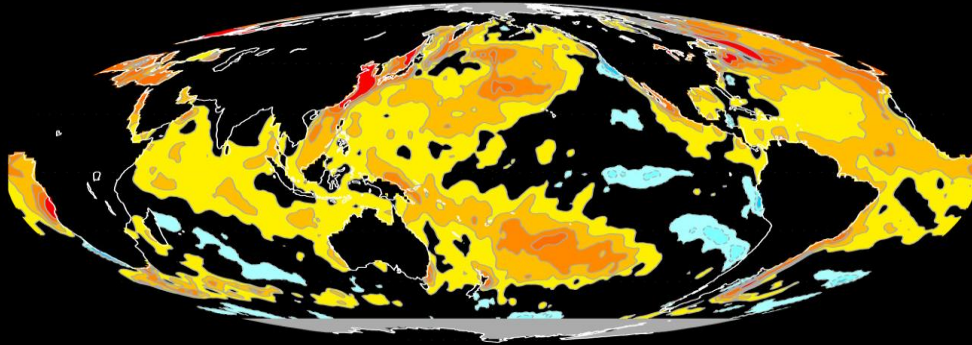


Pcpn Change 1977-2006: *GHG-Forced*



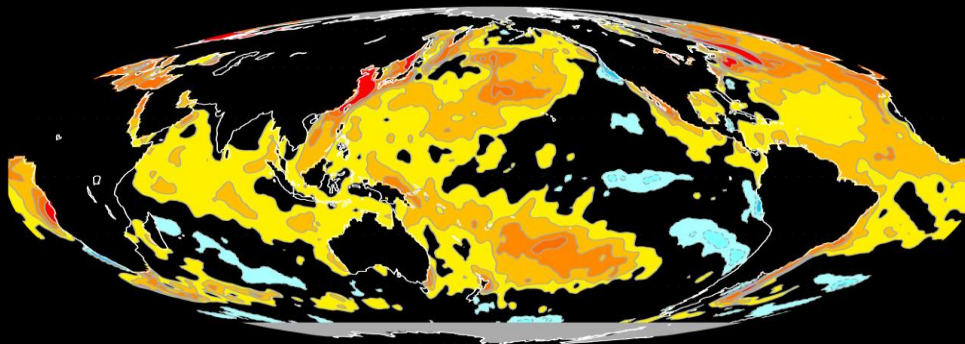
Annual Sea Surface Temperature Trend 1977-2006

OBS

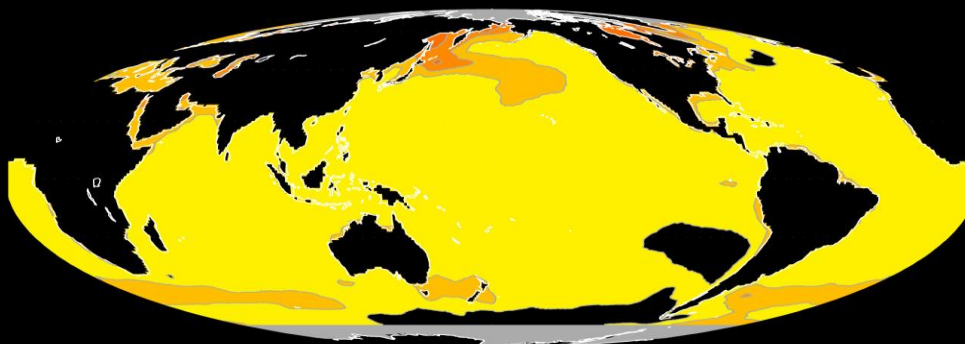


Annual Sea Surface Temperature Trend 1977-2006

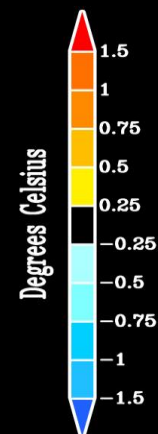
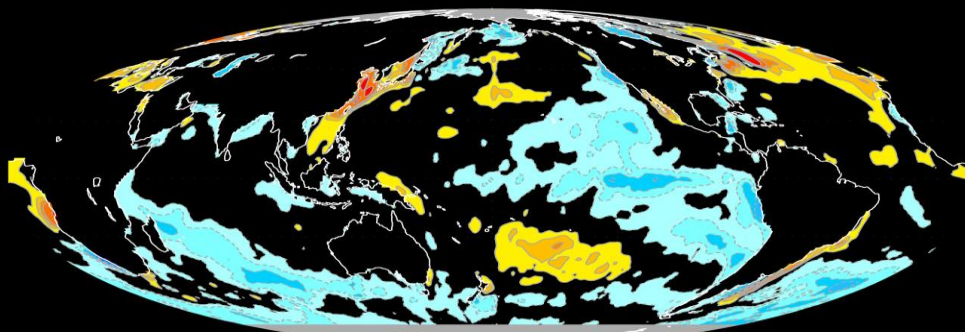
OBS



CMIP



OBS-CMIP

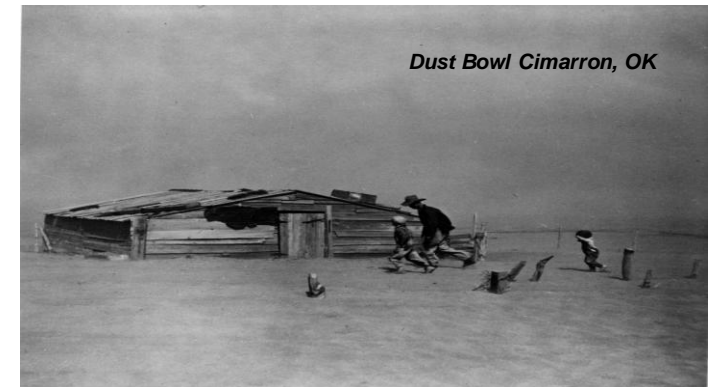


Annually Recurring Dry and Wet Seasons are
Locked to the Ocean's Response to the Sun.
***Paleo-Ocean Data Would Advance Knowledge
Of Wet and Dry Epochs in Earth's History***



SST Variability Enhances Drought Variability
Over all Continents.

***New Ocean Information
(beyond TOGA/TAO) is Needed to Advance
Drought Early Warning.***



Oceans are Key Factors
in the Attribution of Regional Drought
& Trends.

***Climate-Quality Ocean Obs
are Critical for Distinguishing Natural
From Human-induced Ocean Conditions.***





Thank You