

# Impacts of ENSO, AO, and Bermuda High on SC Climate Variability

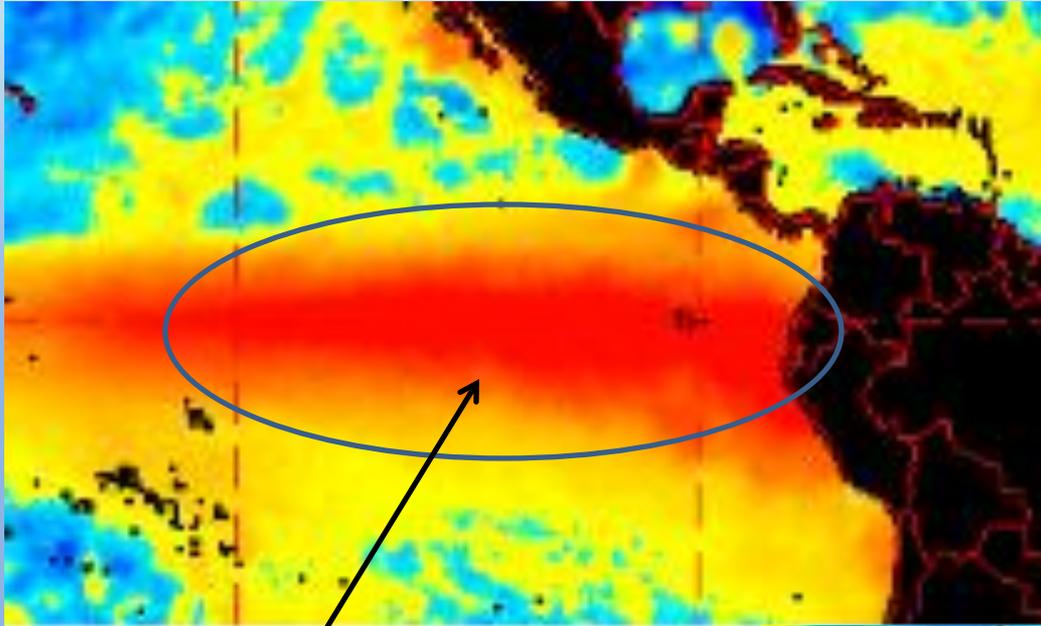
**Ivetta Abramyan and Hope Mizzell**



**Climate Connection Workshop Series  
December 5, 2012**



El Niño (December 1997)

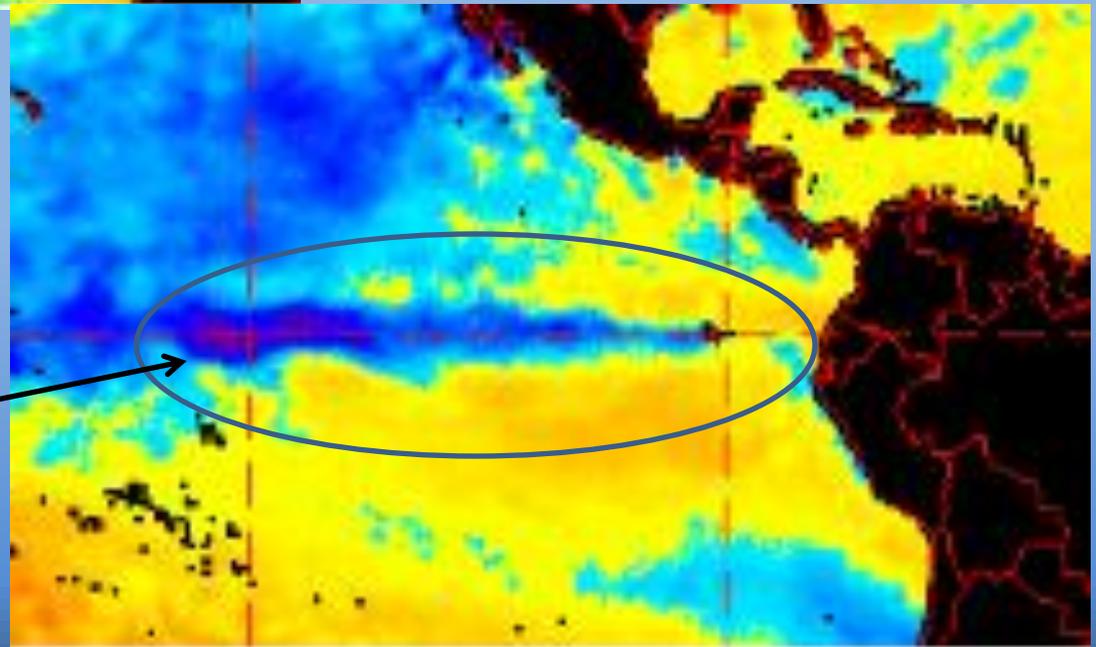


- definition of ENSO
- timescale
- climate connection

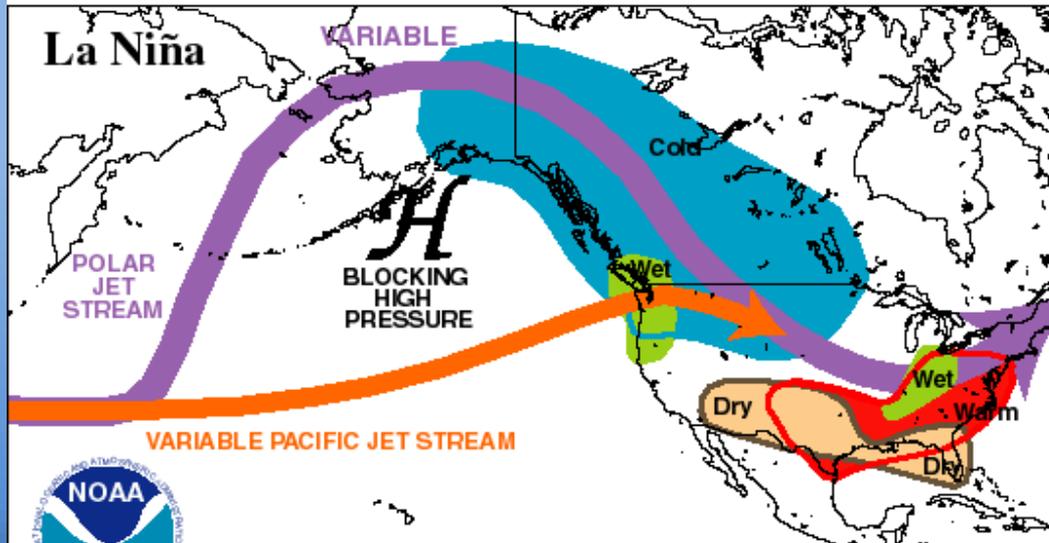
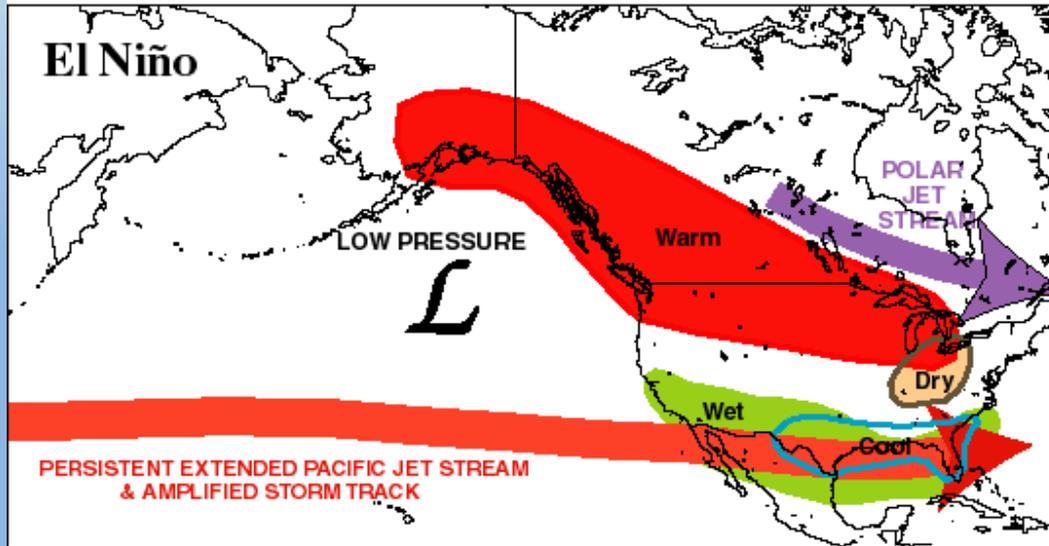
La Niña (December 1998)

warm  
SST

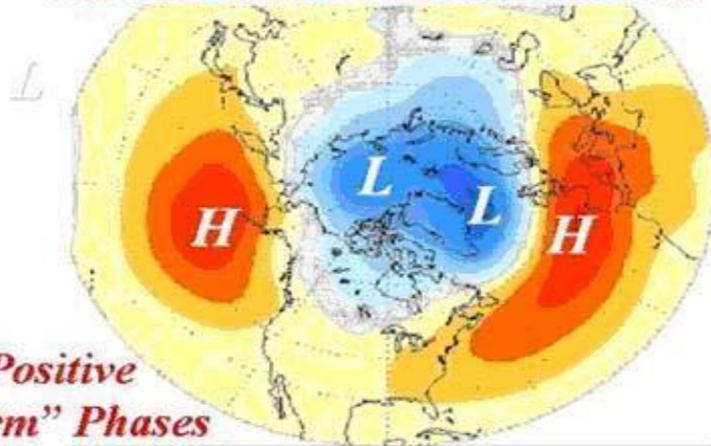
cold  
SST



TYPICAL JANUARY-MARCH WEATHER ANOMALIES  
AND ATMOSPHERIC CIRCULATION  
DURING MODERATE TO STRONG  
EL NIÑO & LA NIÑA



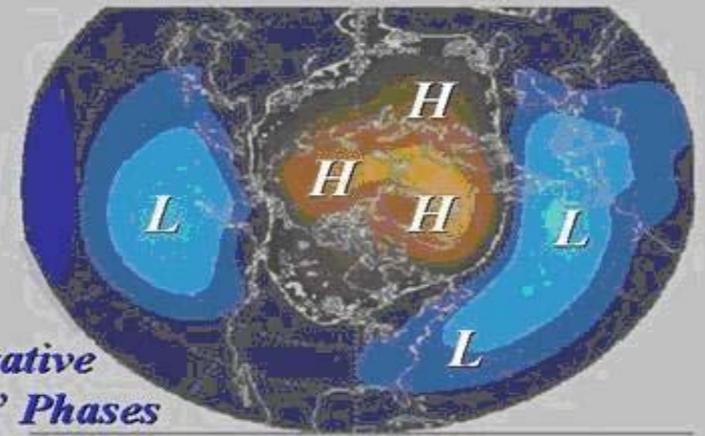
# AO AND NAO OSCILLATIONS



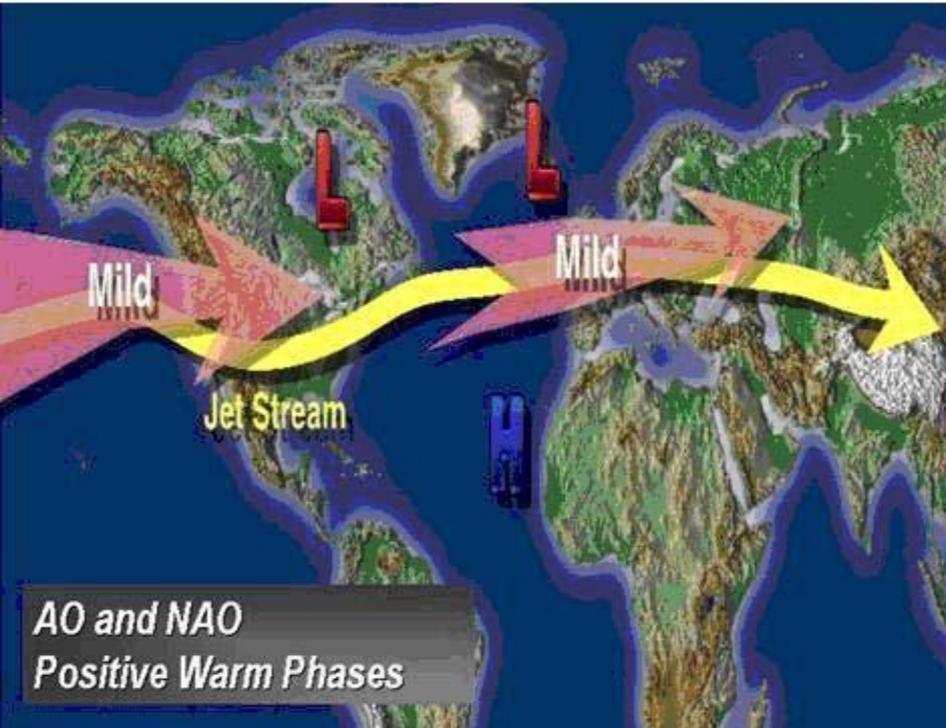
**Positive  
"Warm" Phases**



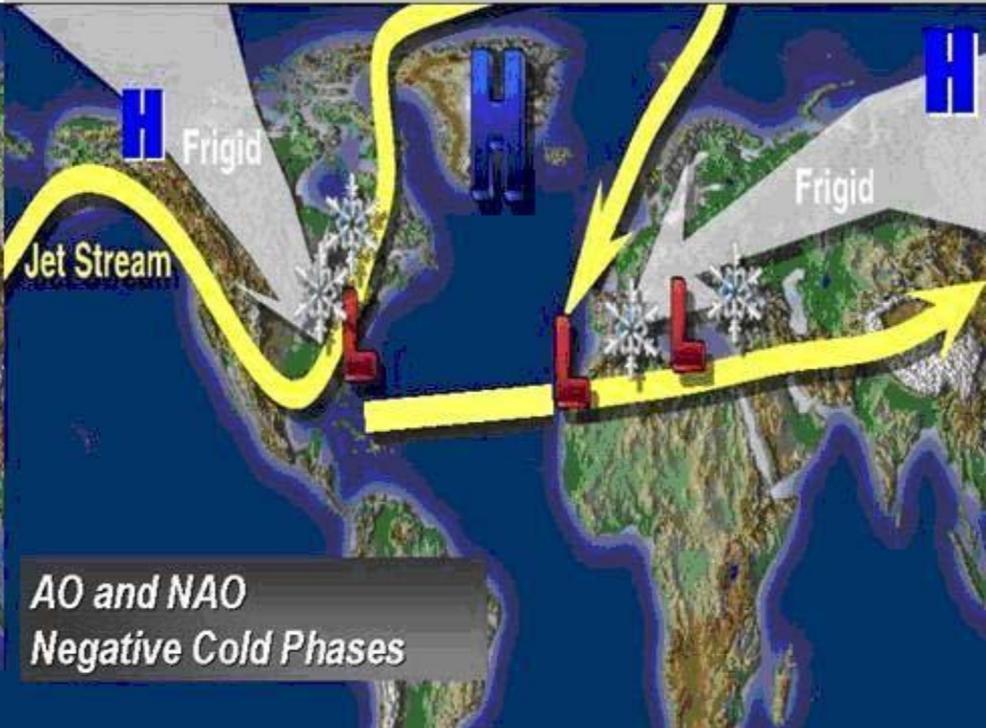
# AO AND NAO OSCILLATIONS



**Negative  
"Cold" Phases**



**AO and NAO  
Positive Warm Phases**



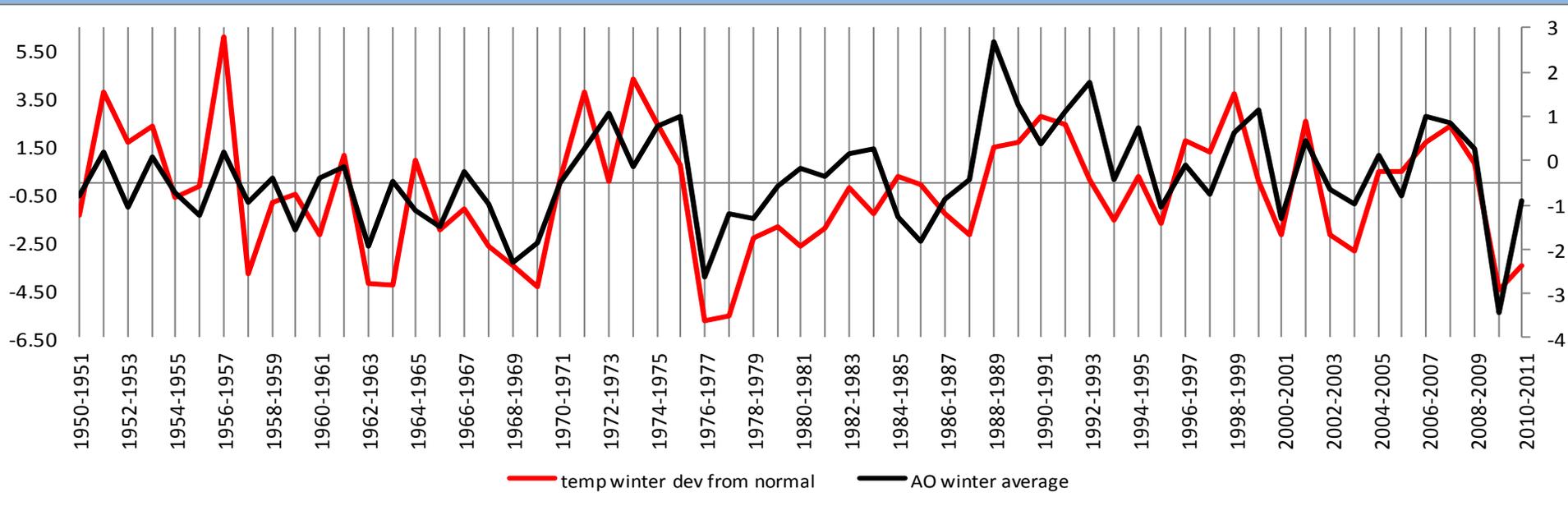
**AO and NAO  
Negative Cold Phases**

# Arctic Oscillation (AO)

In South Carolina, the AO has a strong winter temperature signal predominantly yielding **colder** temperatures in the negative phase and **warmer** temperatures in the positive phase.

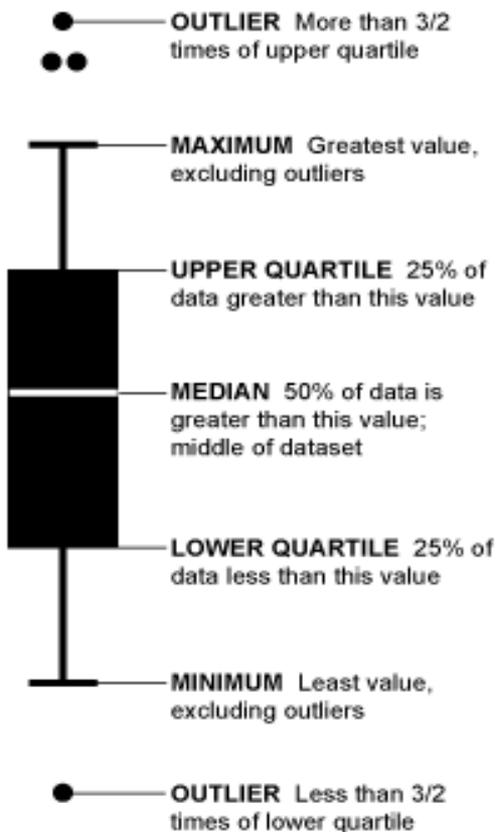
Unlike ENSO, which affects precipitation as well, the AO's precipitation signal is not significant.

## SC Statewide Winter Temperature vs. AO

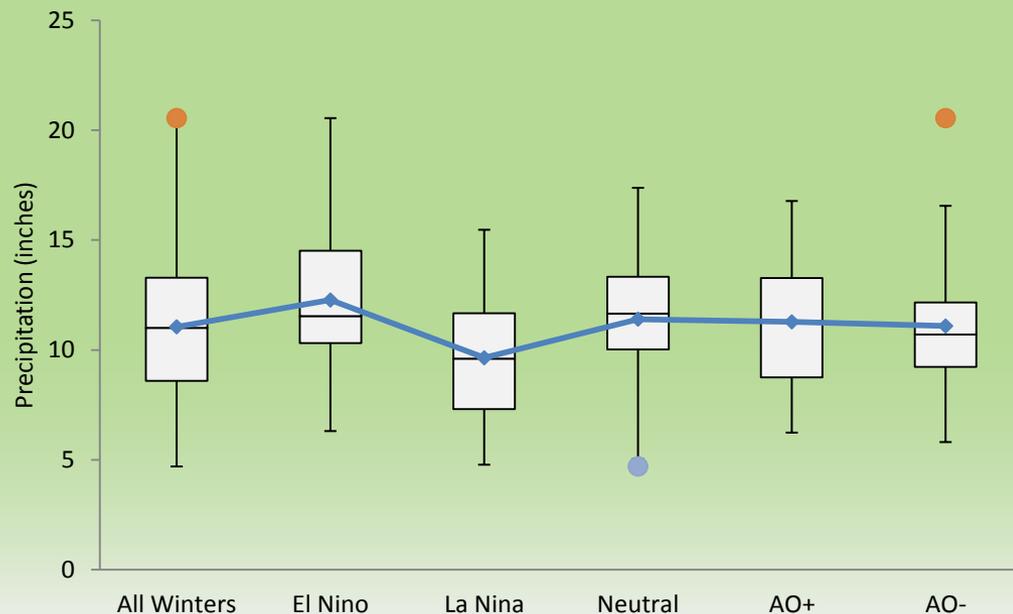


SC La Niña winters are warmer and drier than El Niño winters.

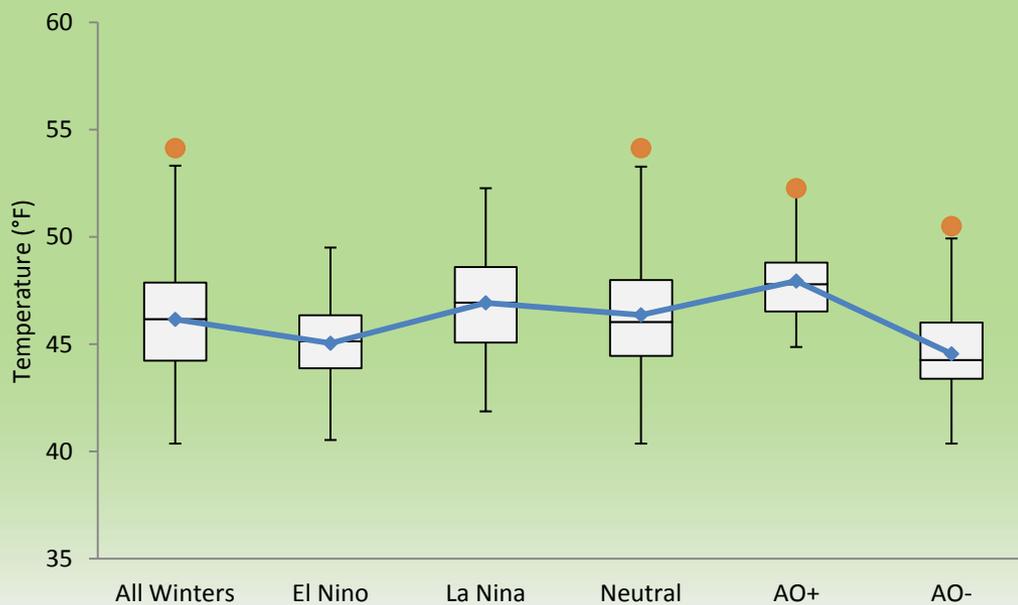
Winter temperatures were lower during the negative AO phase, but the AO phase did not seem to have an effect on winter precipitation.



SC Statewide Winter **Precipitation** vs. ENSO and AO



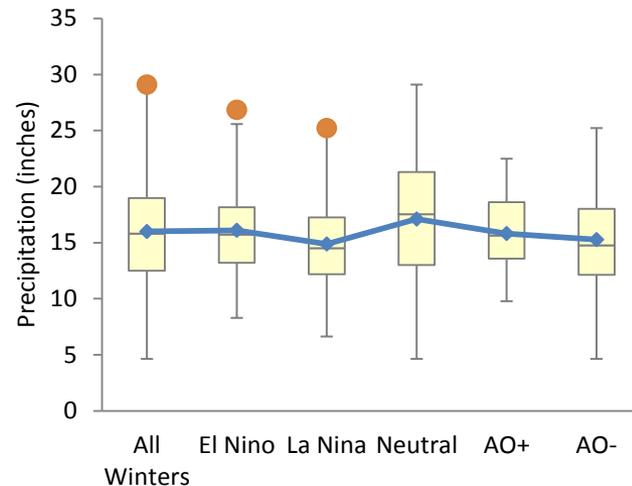
SC Statewide Winter **Temperature** vs. ENSO and AO



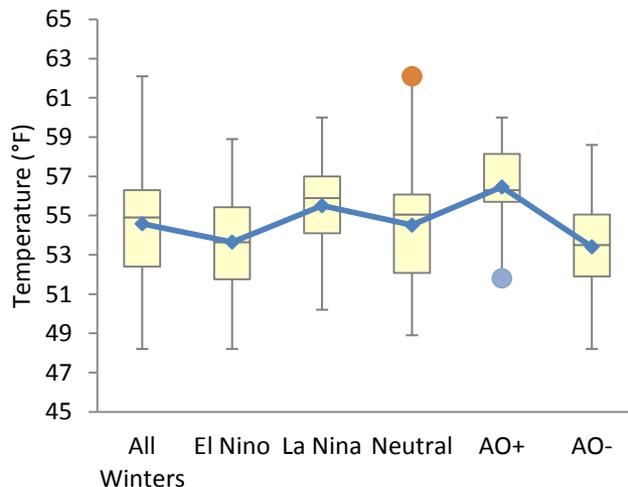


# Walhalla, SC: 1896-2012 (winter)

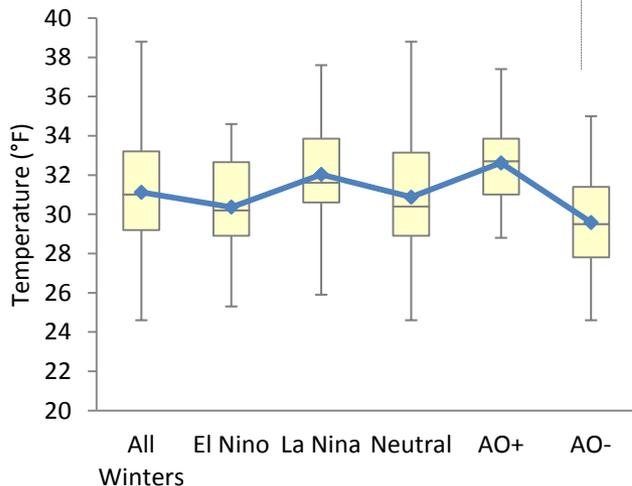
## Total Winter Precip vs. ENSO and AO



## Avg Winter Max Temp vs. ENSO and AO



## Avg Winter Min Temp vs. ENSO and AO



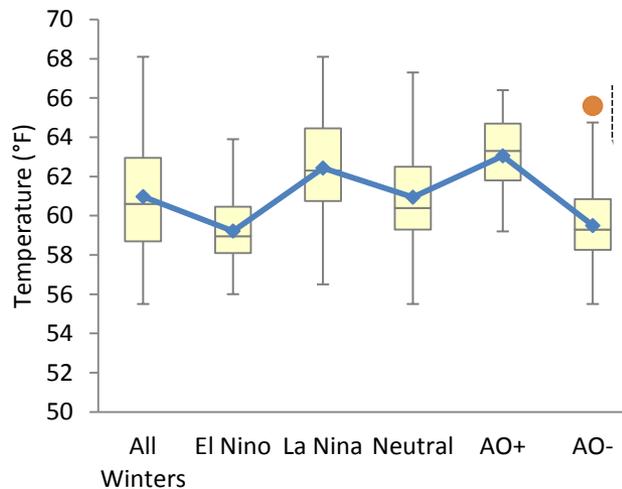
The min and max temp for Walhalla both reflect what we would expect to see for winter, with warmer temperatures associated with La Niña and a positive AO phase.

The variations in precipitation are not as pronounced for Walhalla, with only a slight decrease in La Niña winters.

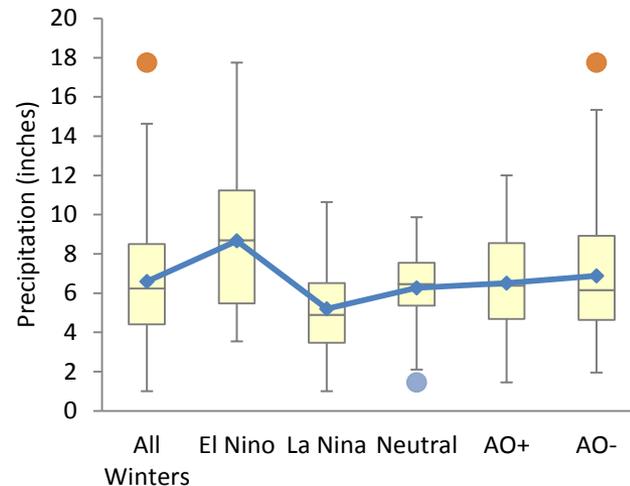


# Charleston, SC: 1938-2012 (winter)

### Avg Winter Max Temp vs. ENSO and AO



### Total Winter Precip vs. ENSO and AO

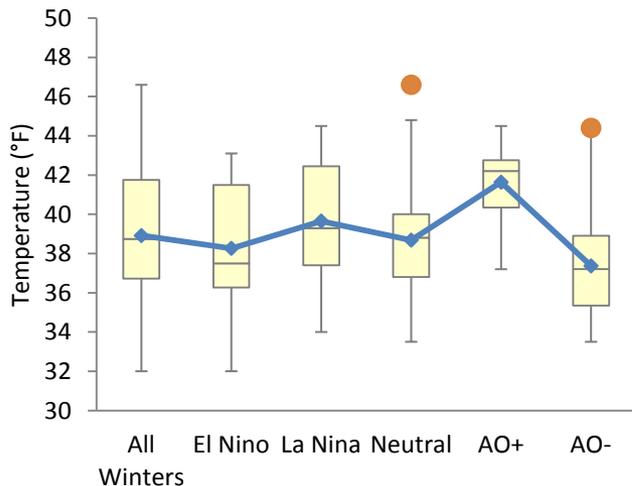


The max temp for Charleston shows a larger difference between El Niño and La Niña winters than the min temp.

There is an even greater difference between the AO positive and AO negative winter temperature signal for Charleston, with colder max and min temperatures in the negative AO phase.

The variations in Charleston precipitation between La Niña and El Niño are more pronounced than in Walhalla, with a substantial decrease in La Niña winters.

### Avg Winter Min Temp vs. ENSO and AO



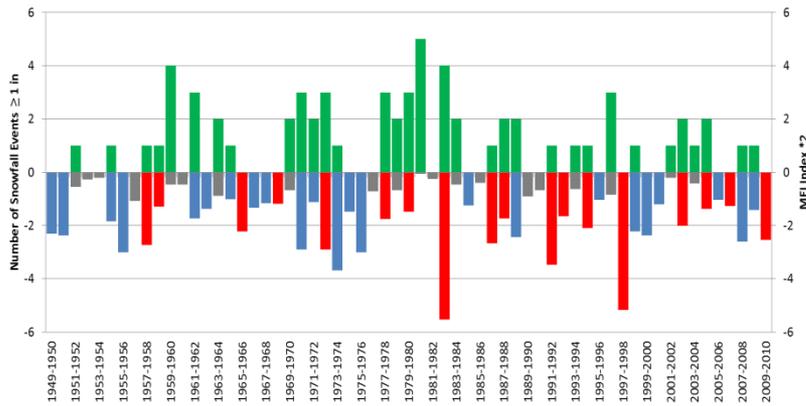


# Snowfall in the Upstate



Image Source: [weather.com](http://weather.com)

Walhalla, SC  
Snowfall Events  $\geq 1.00$  inch Vs. ENSO phase

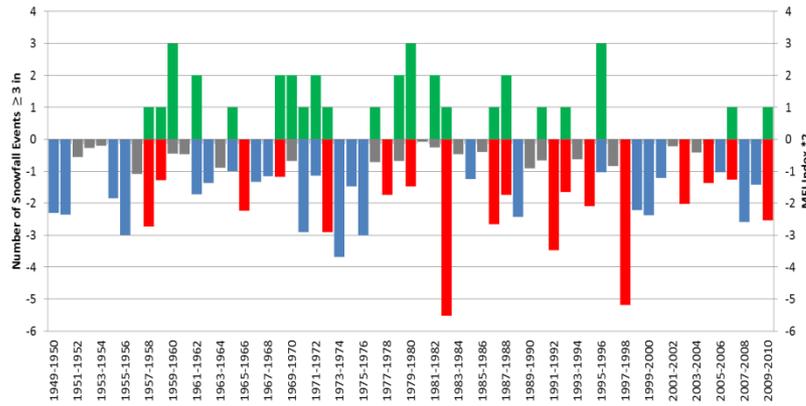


## Walhalla, SC – Snowfall Events vs. ENSO phase

El Nino – 12/33 – 36%  
La Nina – 10/33 – 30%  
Neutral – 11/33 – 33%

Events  $\geq 1$  inch are dispersed almost equally with about  $\frac{1}{3}$  of the events occurring in each phase.

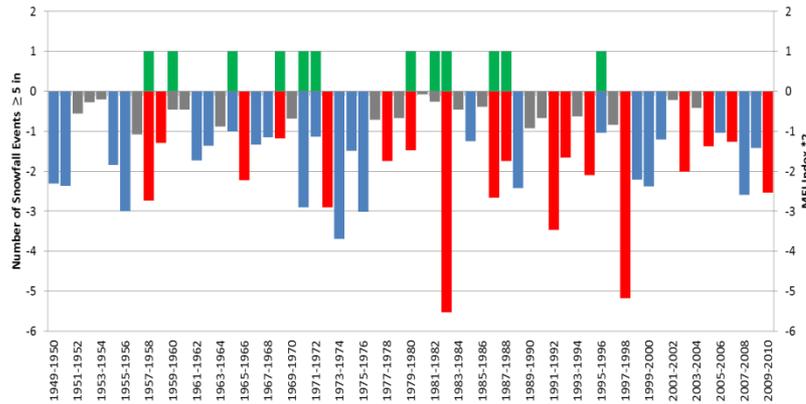
Walhalla, SC  
Snowfall Events  $\geq 3.00$  inch Vs. ENSO phase



El Nino – 11/22 – 50%  
La Nina – 5/22 – 23%  
Neutral – 6/22 – 27%

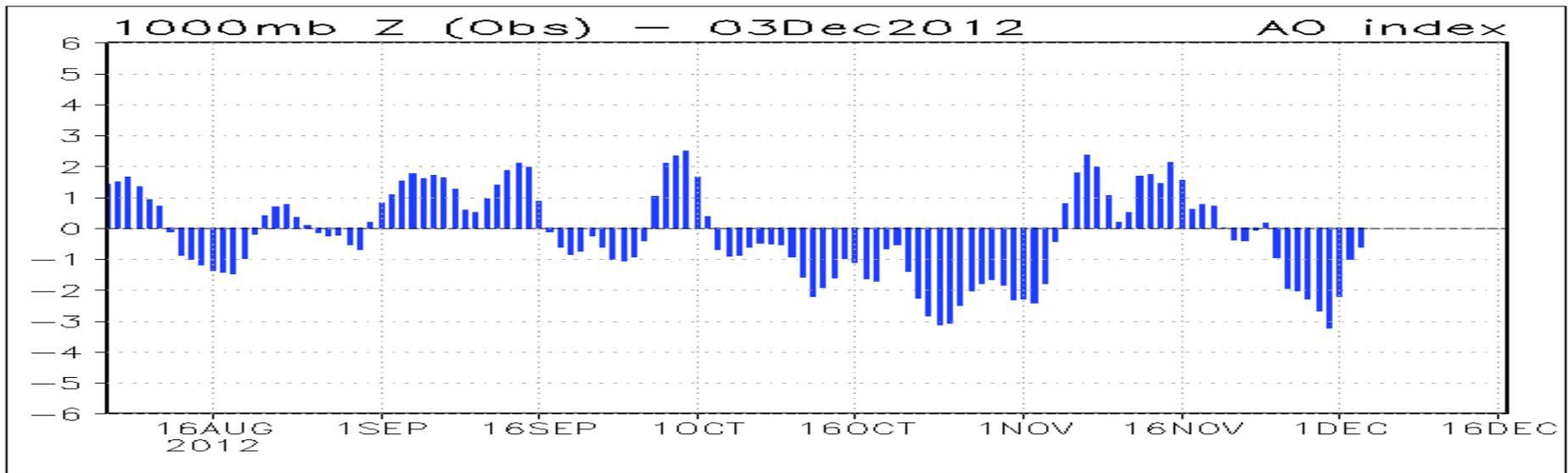
Events  $\geq 3$  inches occur in the El Niño phase 50% of the time and in the La Niña phase 23% of the time.

Walhalla, SC  
Snowfall Events  $\geq 5.00$  inch Vs. ENSO phase

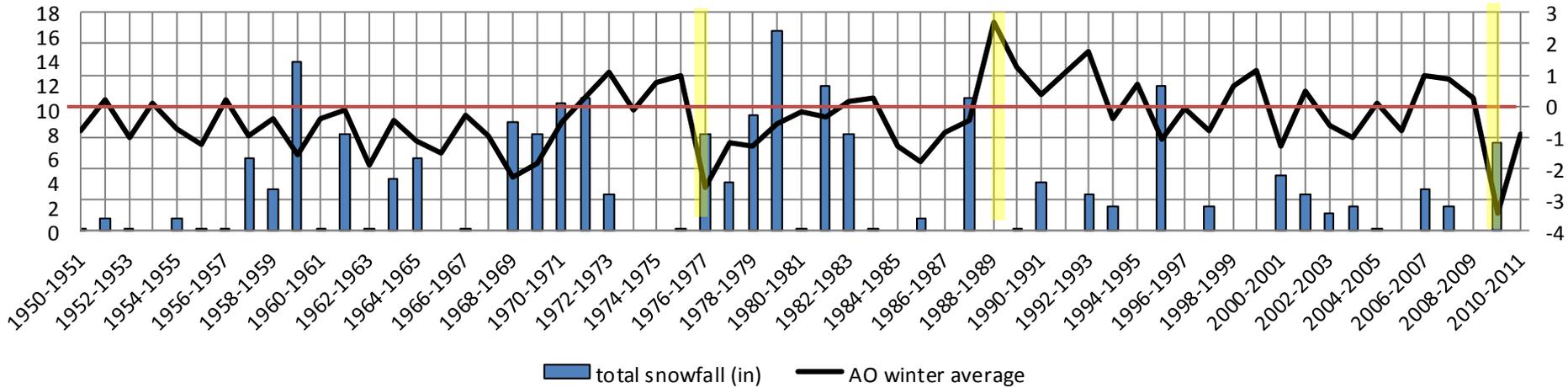


El Nino – 6/12 – 50%  
La Nina – 4/12 – 33%  
Neutral – 2/12 – 17%

Events  $\geq 5$  inches occur in the El Niño phase 50% of the time and in the La Niña phase 33% of the time.



### Walhalla, SC - Snowfall Total with AO index



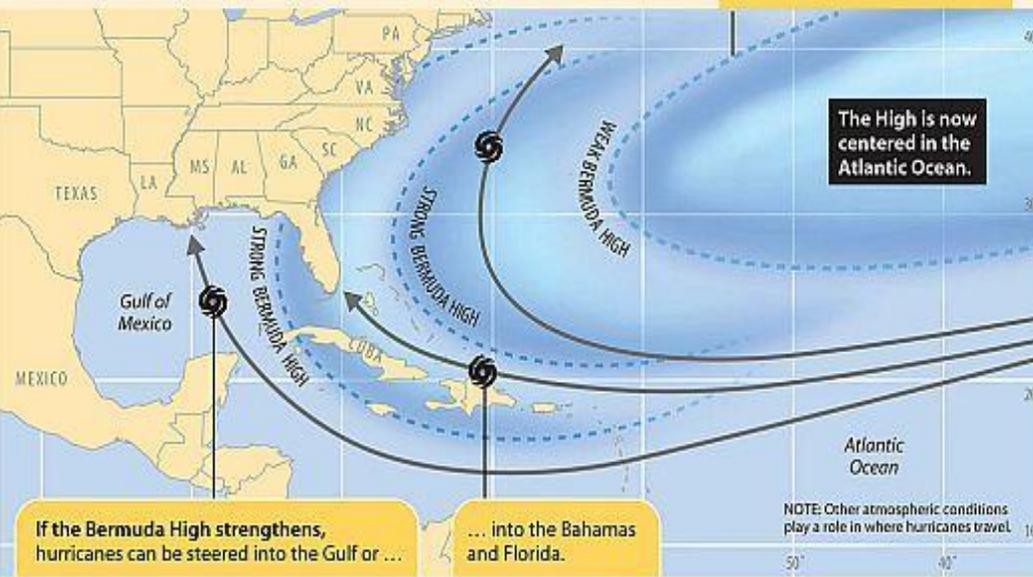
# Bermuda High Pressure



## The Bermuda High: Navigator of hurricanes

The location and strength of the Bermuda High, a ridge of high pressure, is a major factor in determining whether South Florida is besieged with hurricanes.

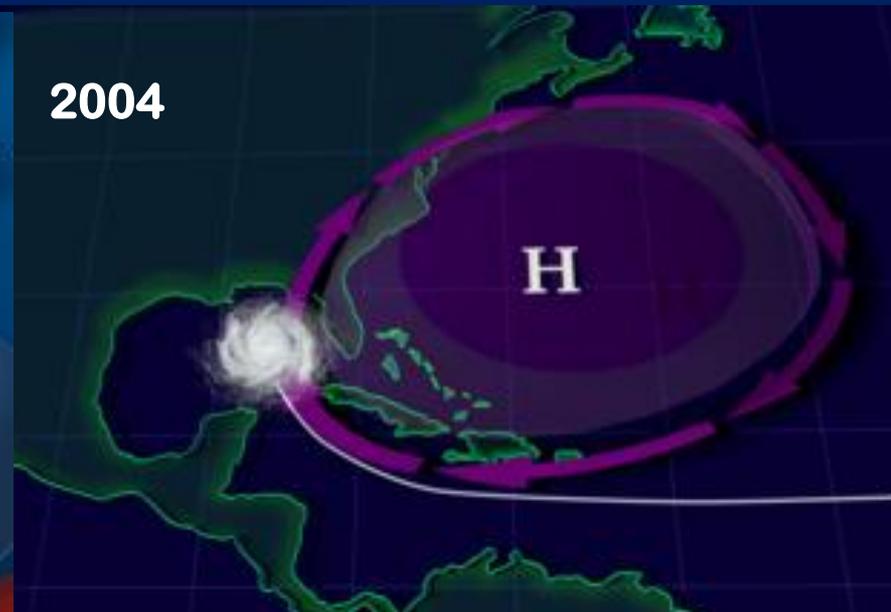
A weak Bermuda High allows hurricanes to move north along the East Coast and out to sea.



If the Bermuda High strengthens, hurricanes can be steered into the Gulf or ...

... into the Bahamas and Florida.

2004



2006

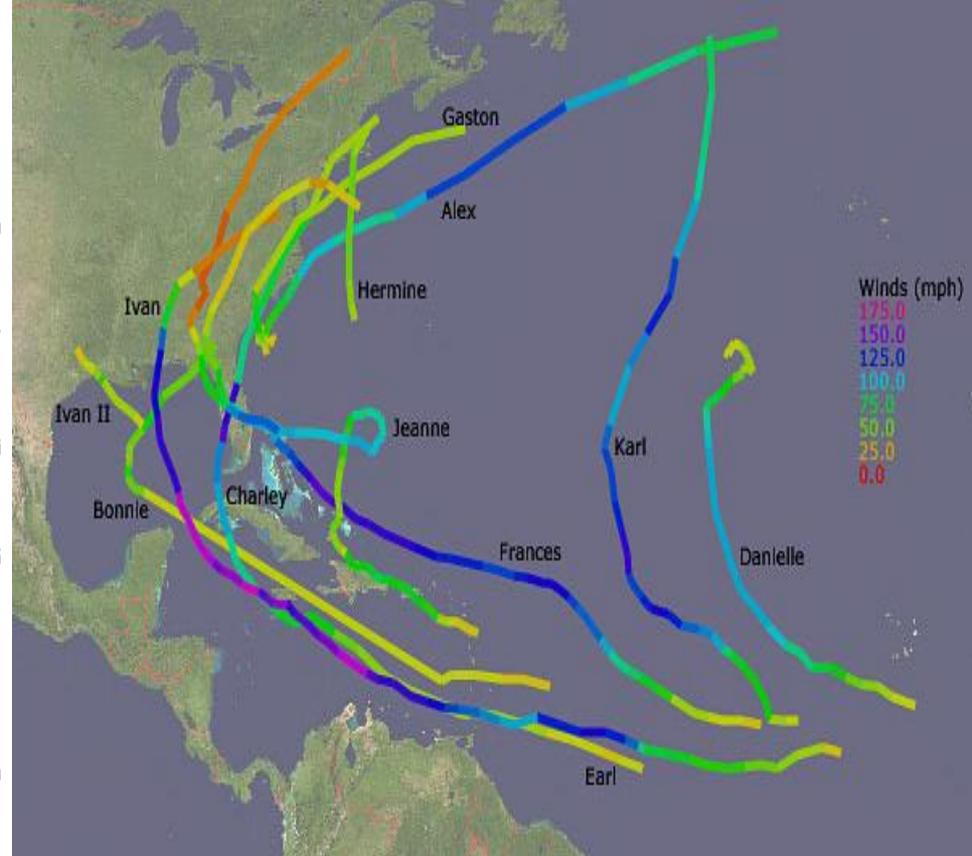
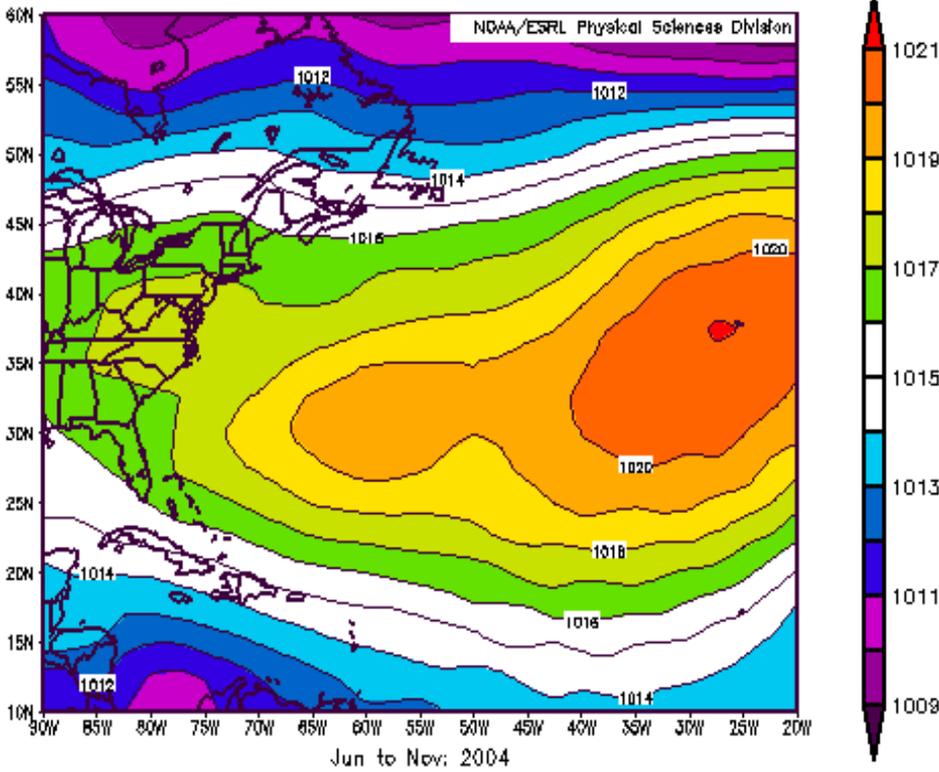


# Welcome to Florida

We are here



NCEP/NCAR Reanalysis  
Sea Level Pressure (mb) Composite Mean



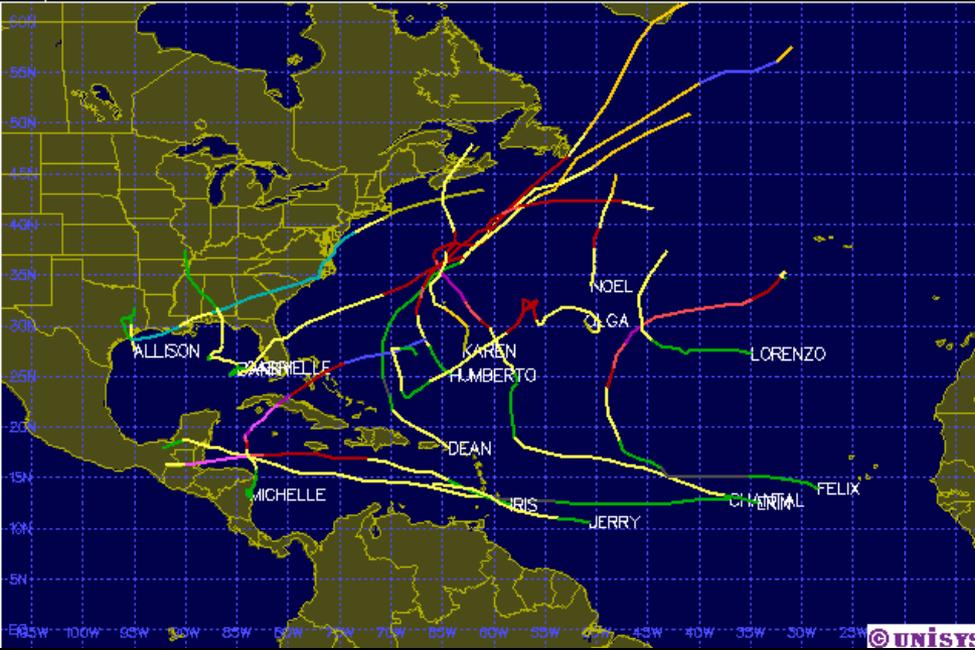
In 2004:

The Bermuda High extended further west and south, shifting the storm track accordingly

**It was the first time four hurricanes have hit one state in one season since four hurricanes hit the Texas coast in the 1886 season**

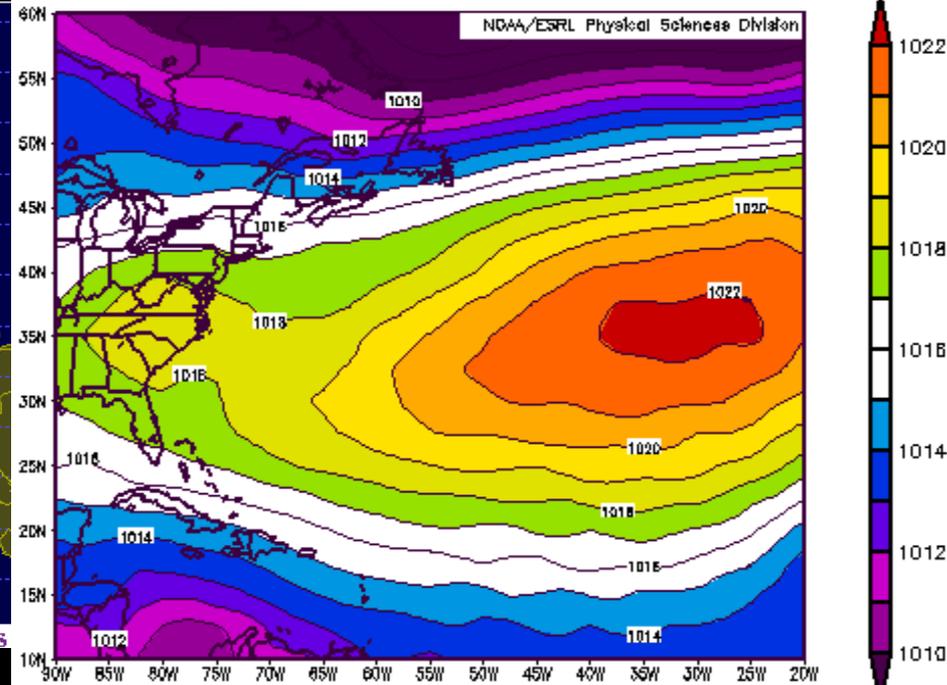
Tropical Storm Tracks

Year 2001



© unisys

NCEP/NCAR Reanalysis  
Sea Level Pressure (mb) Composites Mean

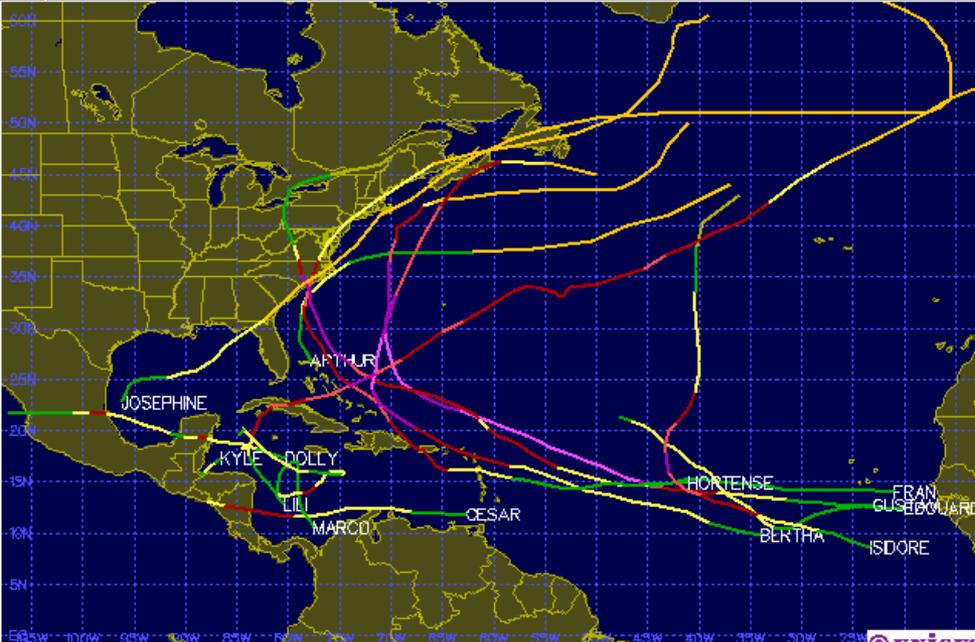


Jun to Nov: 2001

Sea Level Pressure (mb) Composites Mean

Tropical Storm Tracks

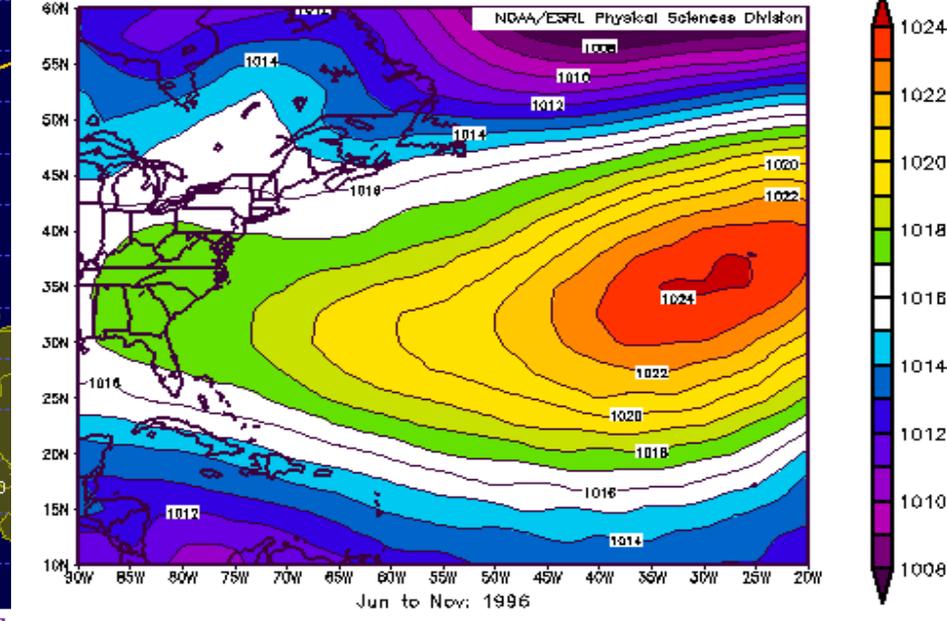
Year 1996



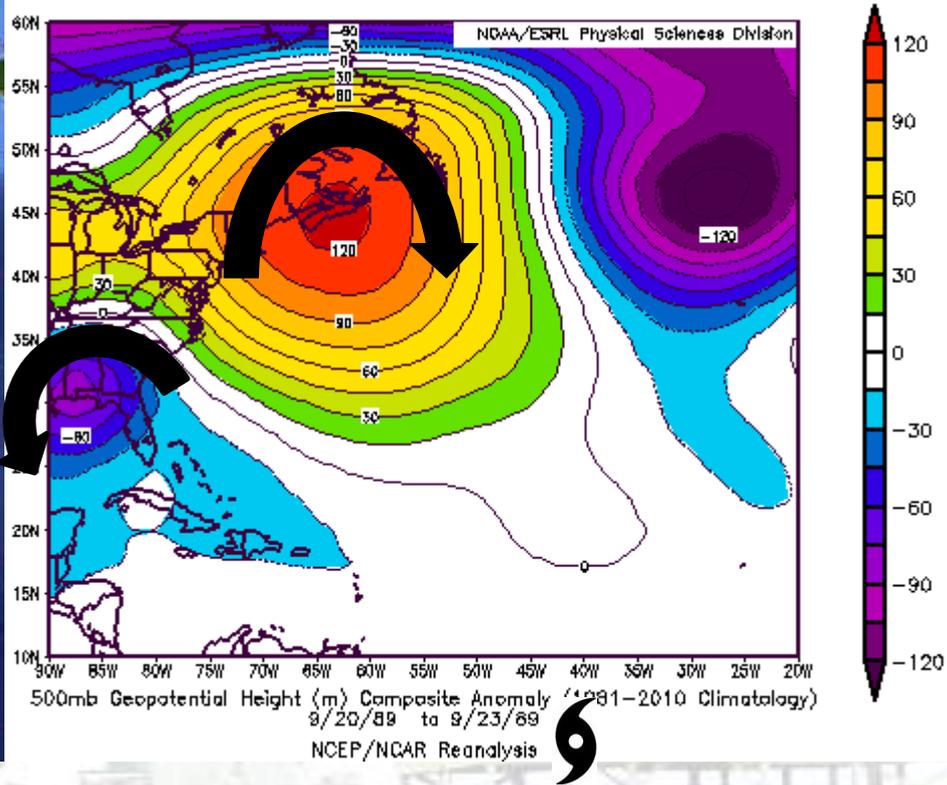
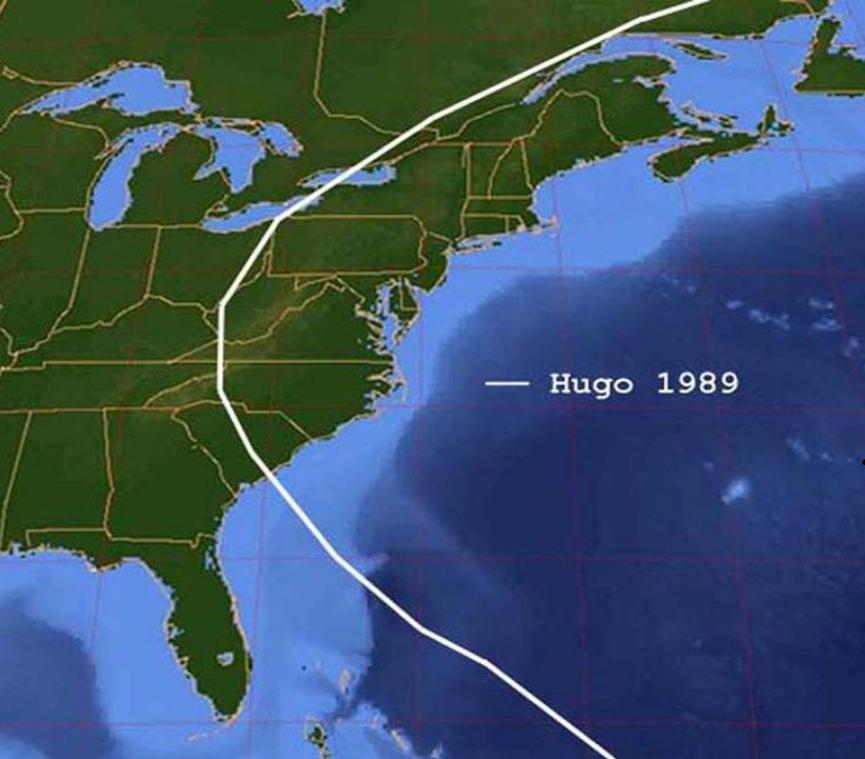
© unisys

Jun to Nov: 2001

Sea Level Pressure (mb) Composites Mean



Jun to Nov: 1996



# BERMUDA HIGH & Drought

- Summer droughts in the Southeast may be associated with a weakening of the Bermuda high (Anchukaitis *et al.* 2006).

reduced central pressure  weaker circulation  less moisture advection into southeast

- Anomalous westward expansion of the Bermuda High into the interior southeastern U.S. has been associated with dry regimes from 1925-55 and 1985-present. (Stahle & Cleaveland 1992).
- It seems logical that a relationship exists between variations in the Bermuda High and variations in Atlantic and/or Pacific Ocean conditions. However, in the absence of confirmed relationships between the Bermuda High and other known climatic controls in the region, long-term forecasting of drought remains difficult in the southeastern U.S.

# Thank You



"CURTIS, I WANT YOU TO FIND A WAY TO BLAME ALL THIS ON EL NINO."



<http://www.dnr.sc.gov/climate/sco>

NCEP/NCAR Reanalysis  
Sea Level Pressure (mb) Composite Anomaly 1981-2010 climo

