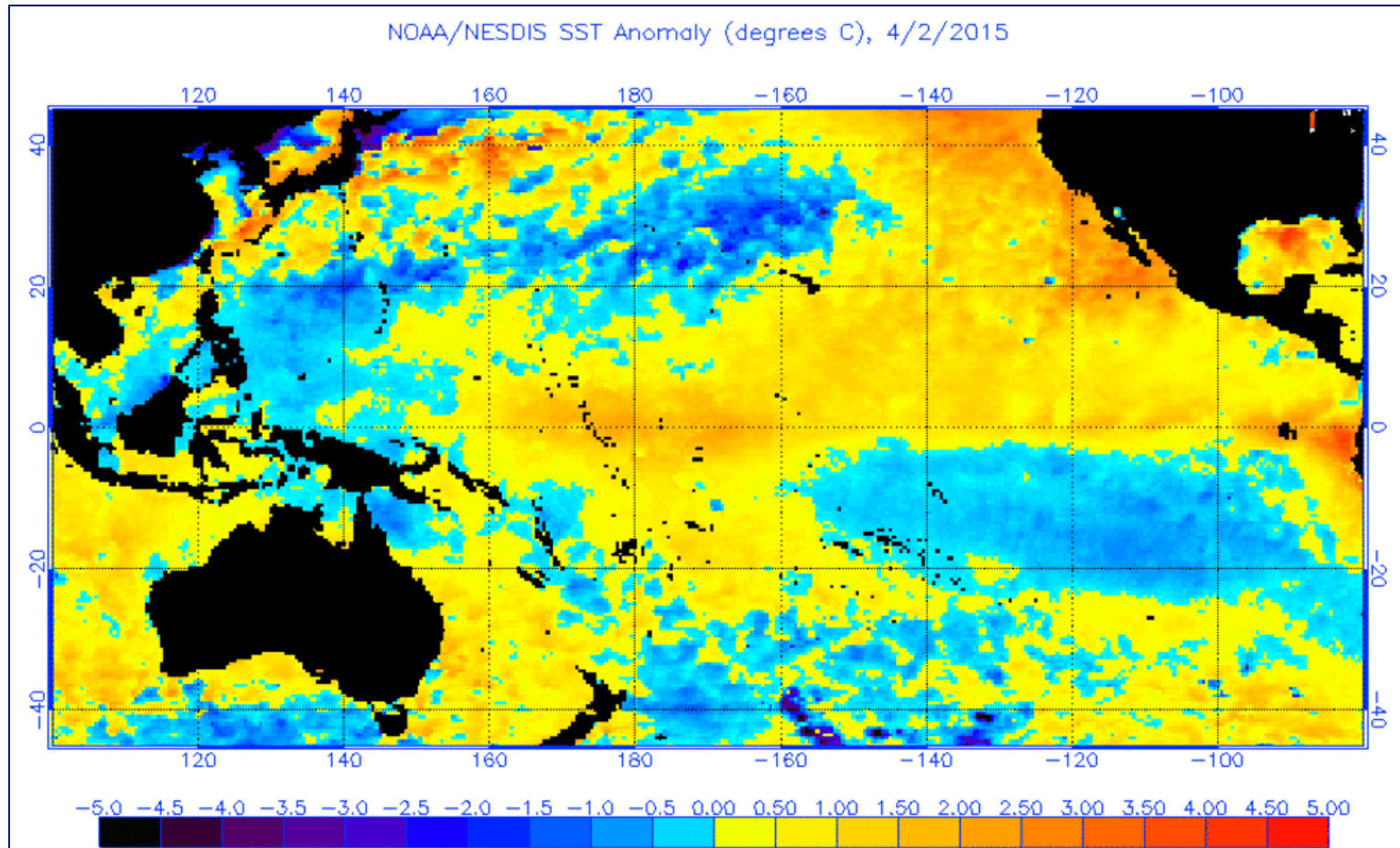


Examining Major El Nino Events: *Impacts on Precipitation and Flood Potential in the Northeast United States*



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david.vallee@noaa.gov <http://weather.gov/nerfc>

Major ENSOs in the Northeast

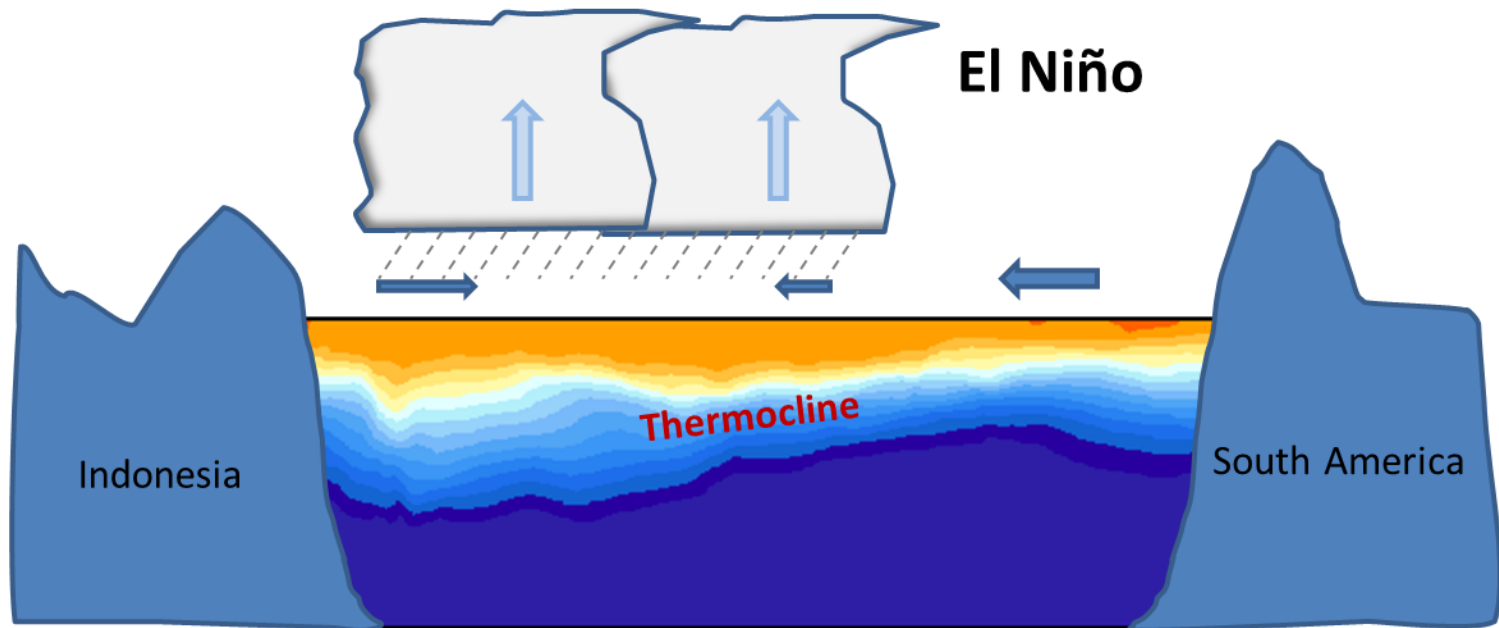
- Overview of “What it is”
- Examining the “many faces” of ENSO
- Variations in Precipitation Departures
- Impacts on Flood Potential

So What Is the El Nino/Southern Oscillation?

- A recurring climate pattern involving changes in the temperature of waters in the central and eastern tropical Pacific Ocean and the patterns of sea level pressure, lower- and upper-level winds, and tropical rainfall across the Pacific basin.
- On periods ranging from about two to seven years, the surface waters across a large swath of the tropical Pacific Ocean warm or cool by anywhere from 1°C to 3°C, compared to normal.
- This irregular oscillation between warm and cool patterns, referred to as the ENSO cycle, directly affects rainfall distribution in the tropics and can have a strong influence on weather across the United States and other parts of the world.
- **El Niño** and **La Niña** are the extreme phases of the ENSO cycle; between these two phases is a third phase called **ENSO-neutral**.

El Niño

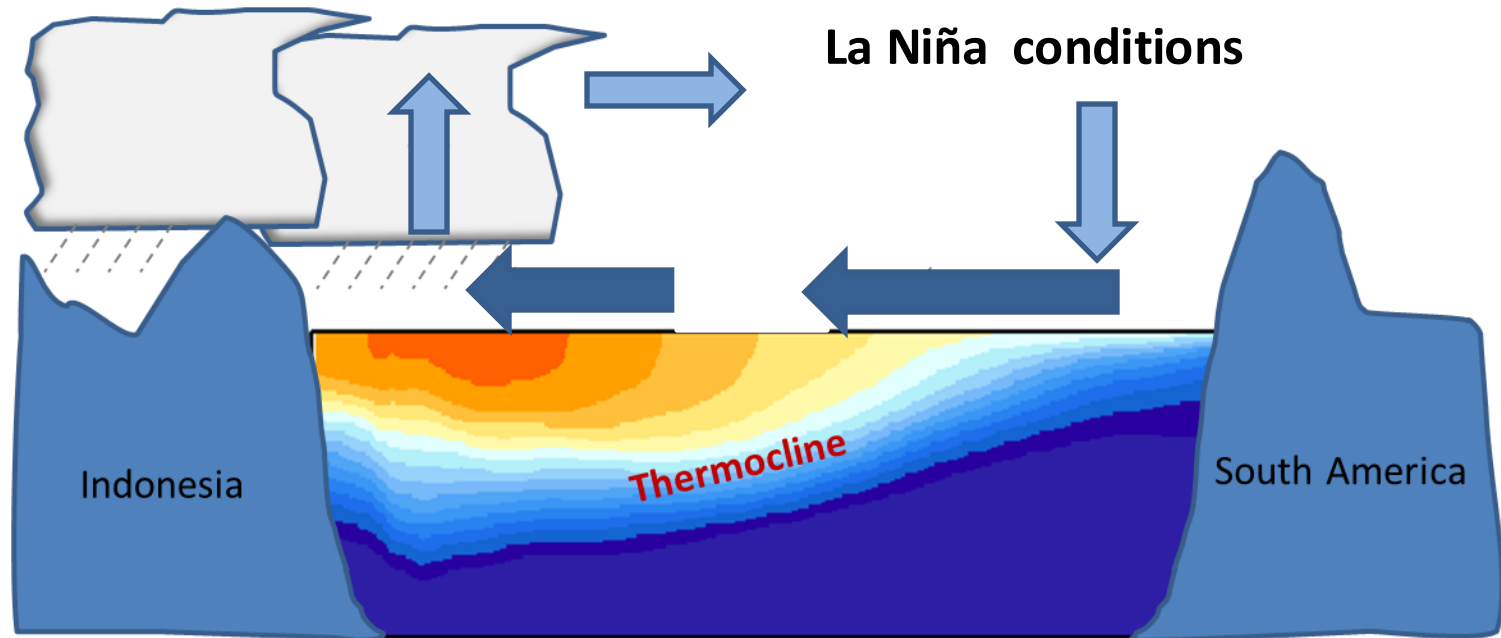
- **El Niño** conditions occur when abnormally warm waters accumulate in tropical latitudes of the central and eastern Pacific Ocean associated with a weakening of the low-level easterly winds. Consequently, tropical rains that usually fall over Indonesia shift eastward.



Courtesy of Vernon Kousky, NOAA/CPC

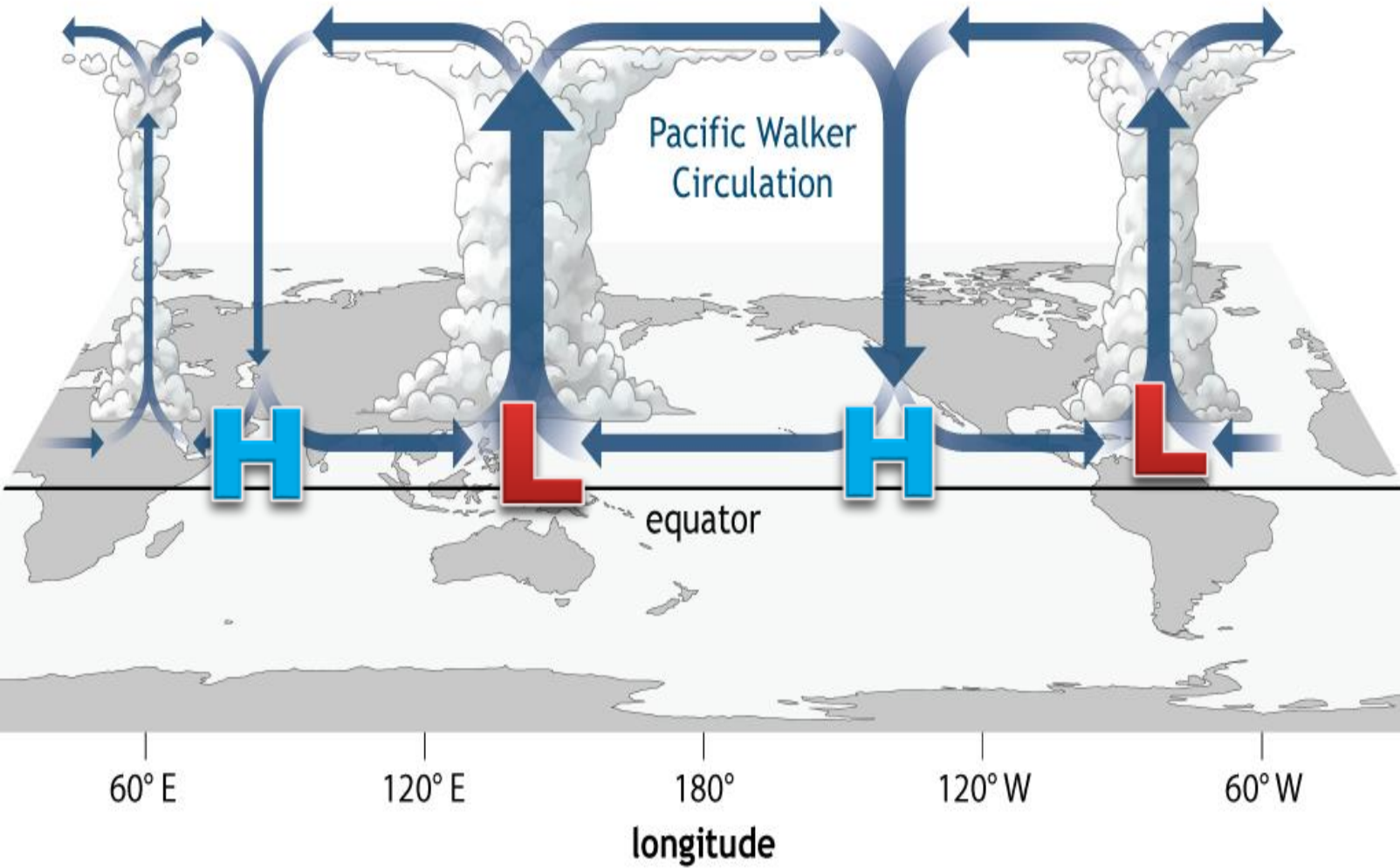
La Niña Conditions

- Trade winds are unusually strong blowing from the east along the equator, pushing warm water farther across the western Pacific Ocean.

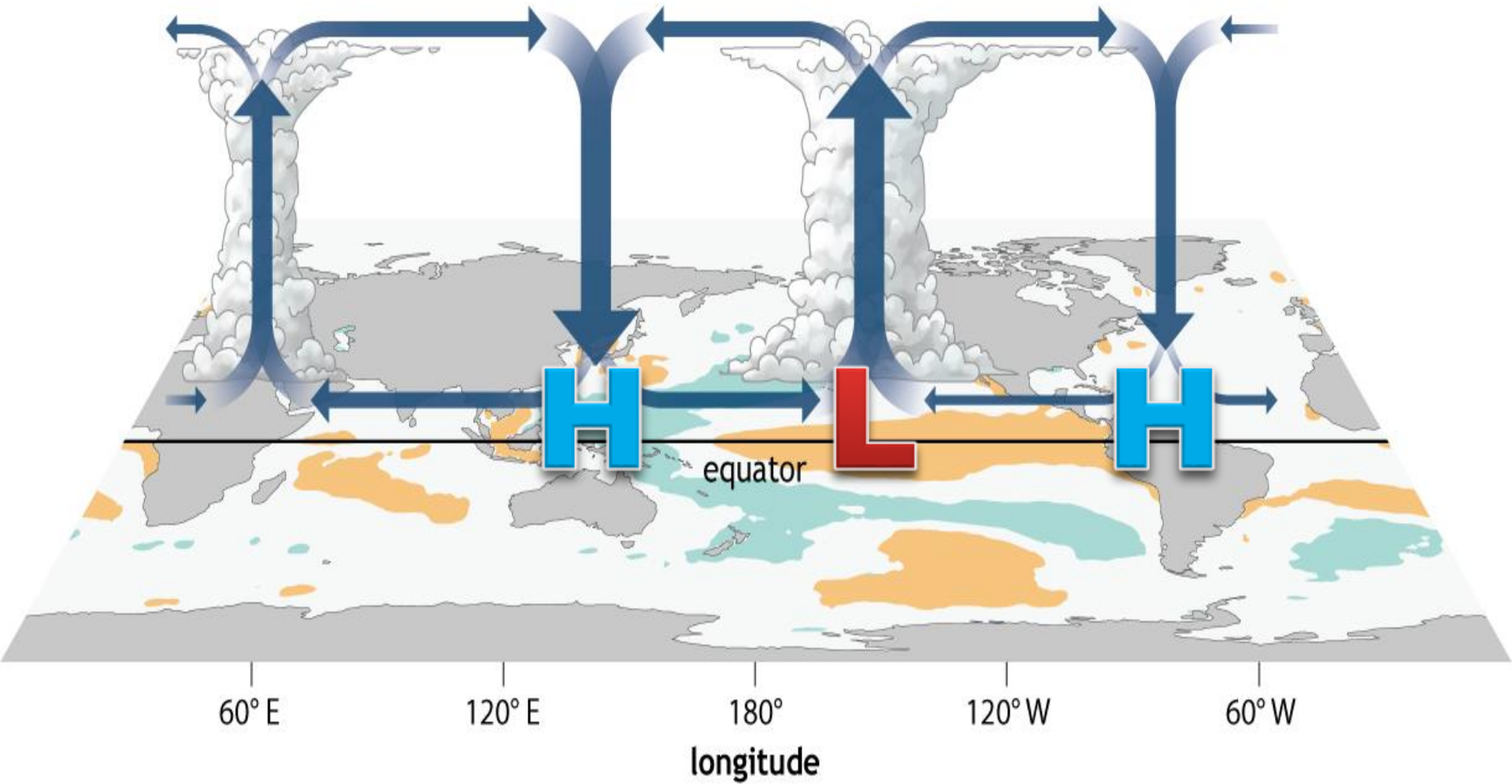


Courtesy of Vernon Kousky, NOAA/CPC

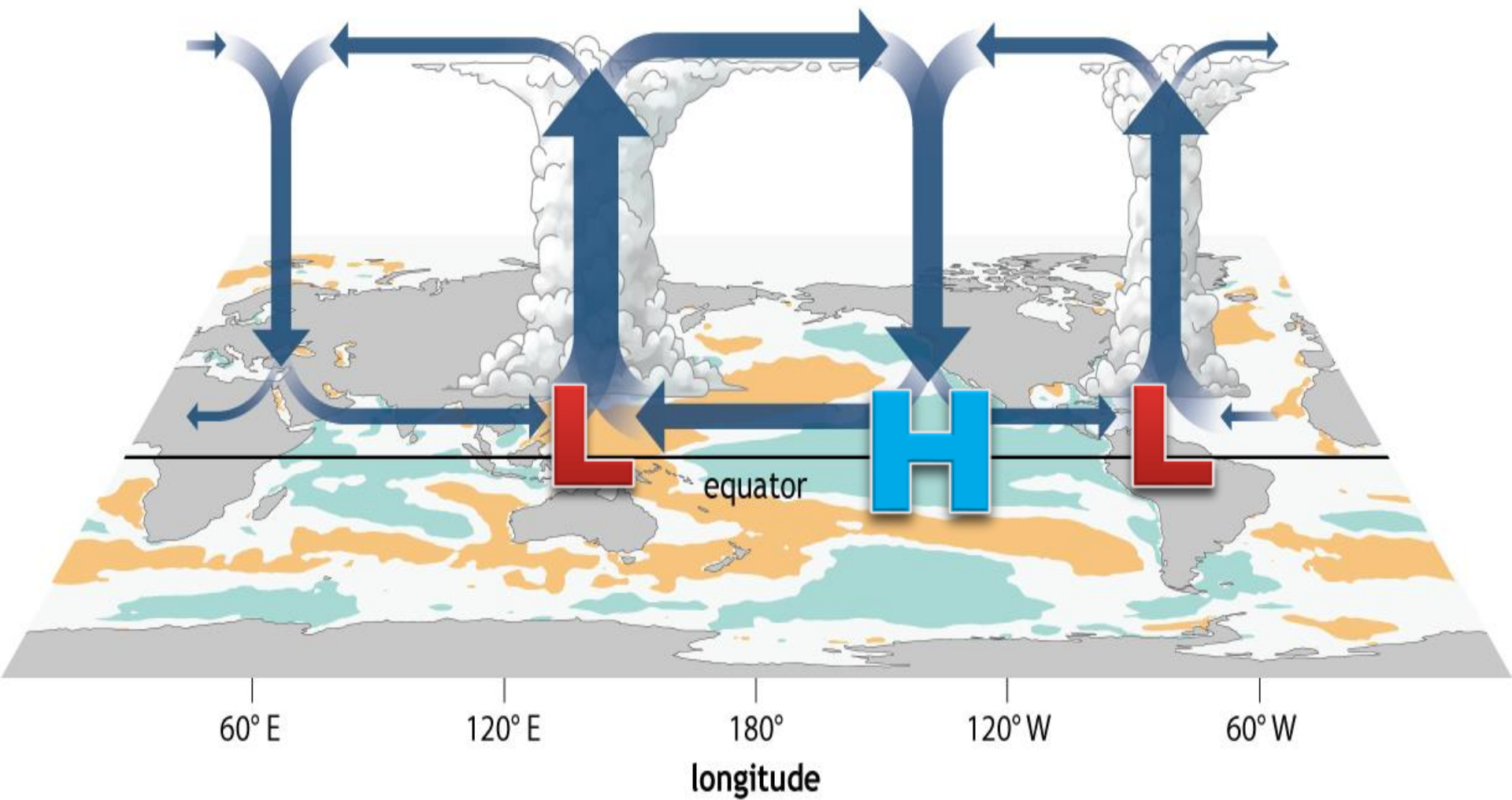
Neutral conditions



El Niño conditions

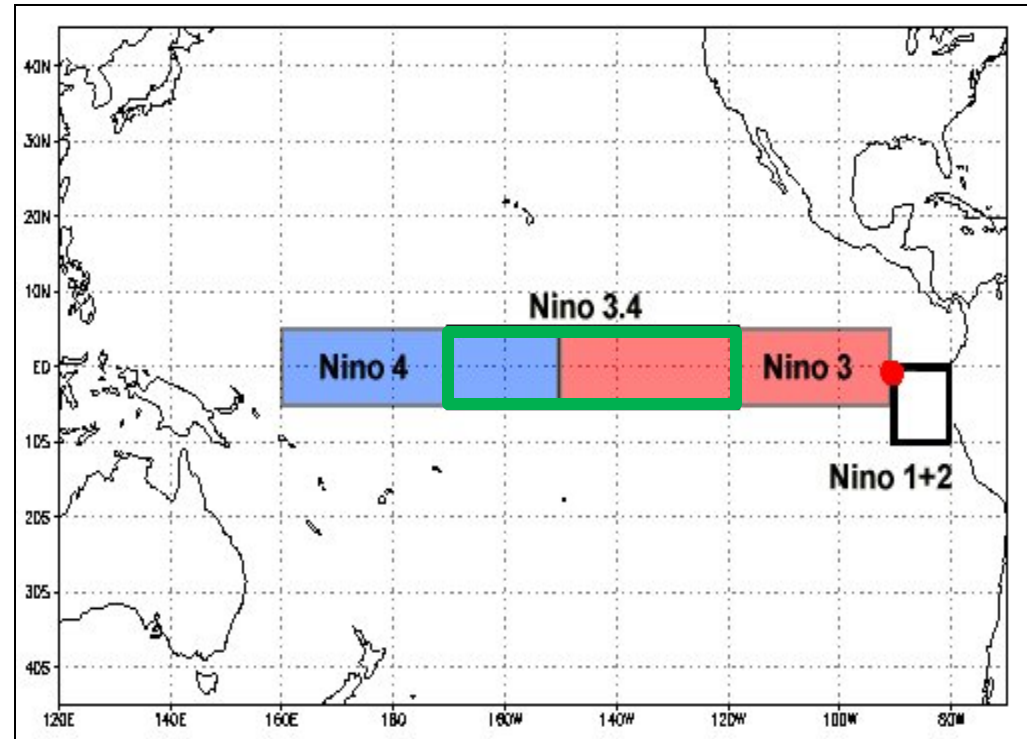


La Niña conditions

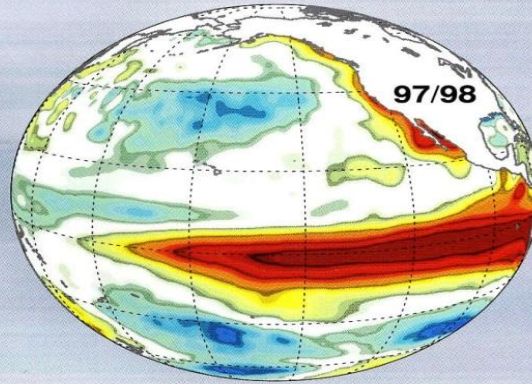
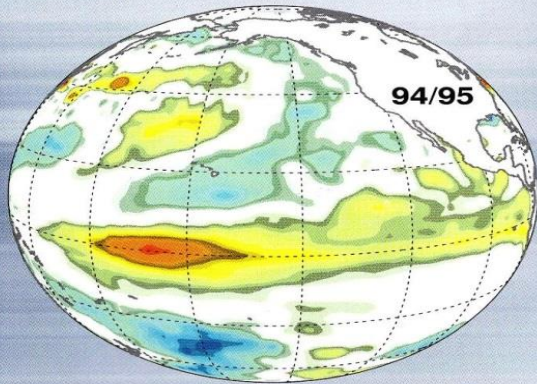
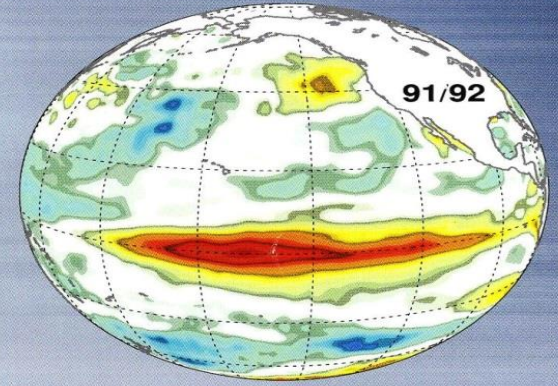
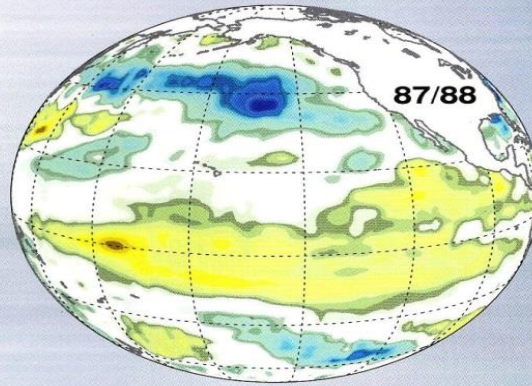
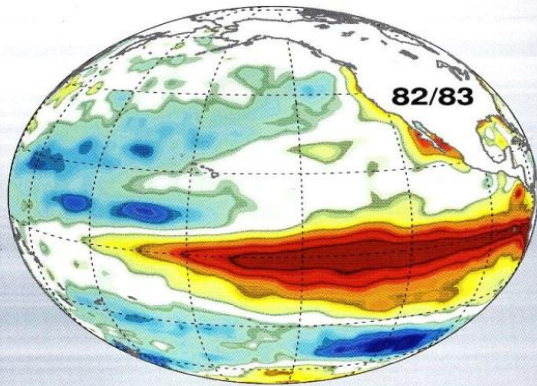


How do we tell what phase ENSO is in?

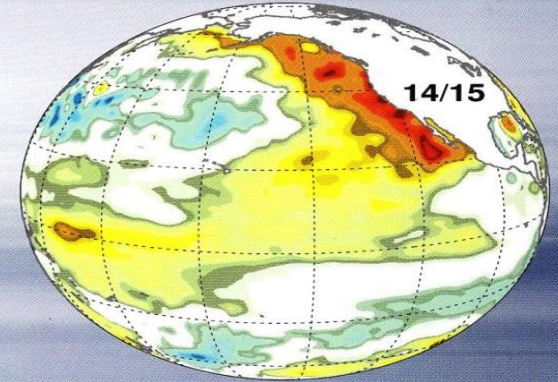
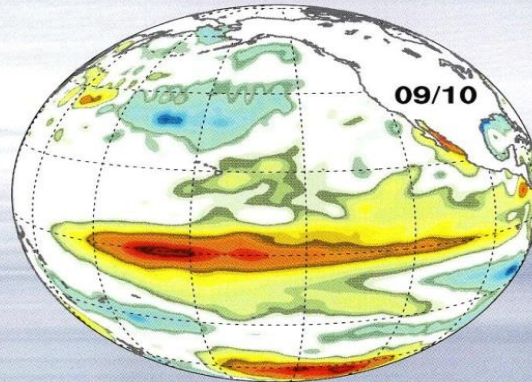
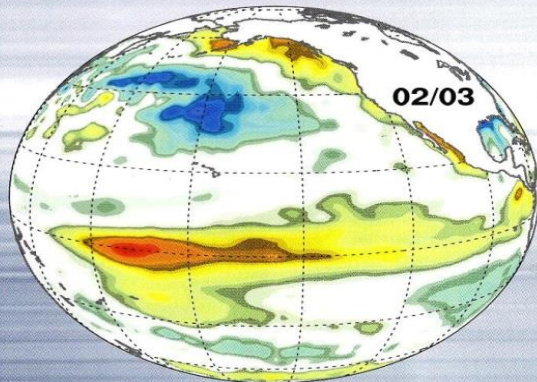
- NOAA's Climate Prediction Center has determined the average monthly sea surface temperature for a particular swath [5°N-5°S, 170°W-120°W] of the tropical Pacific Ocean by averaging measurements collected there over the 30-year period 1981-2010.
- Scientists refer to that swath as the Niño 3.4 region. The observed difference from the average temperature in that region—whether warmer or cooler—is used to indicate the current phase of ENSO.
- Other features that are also monitored include:
 - Upper level winds
 - Outgoing longwave radiation
 - Sea level pressure anomalies across the basin



All ENSO events are not alike

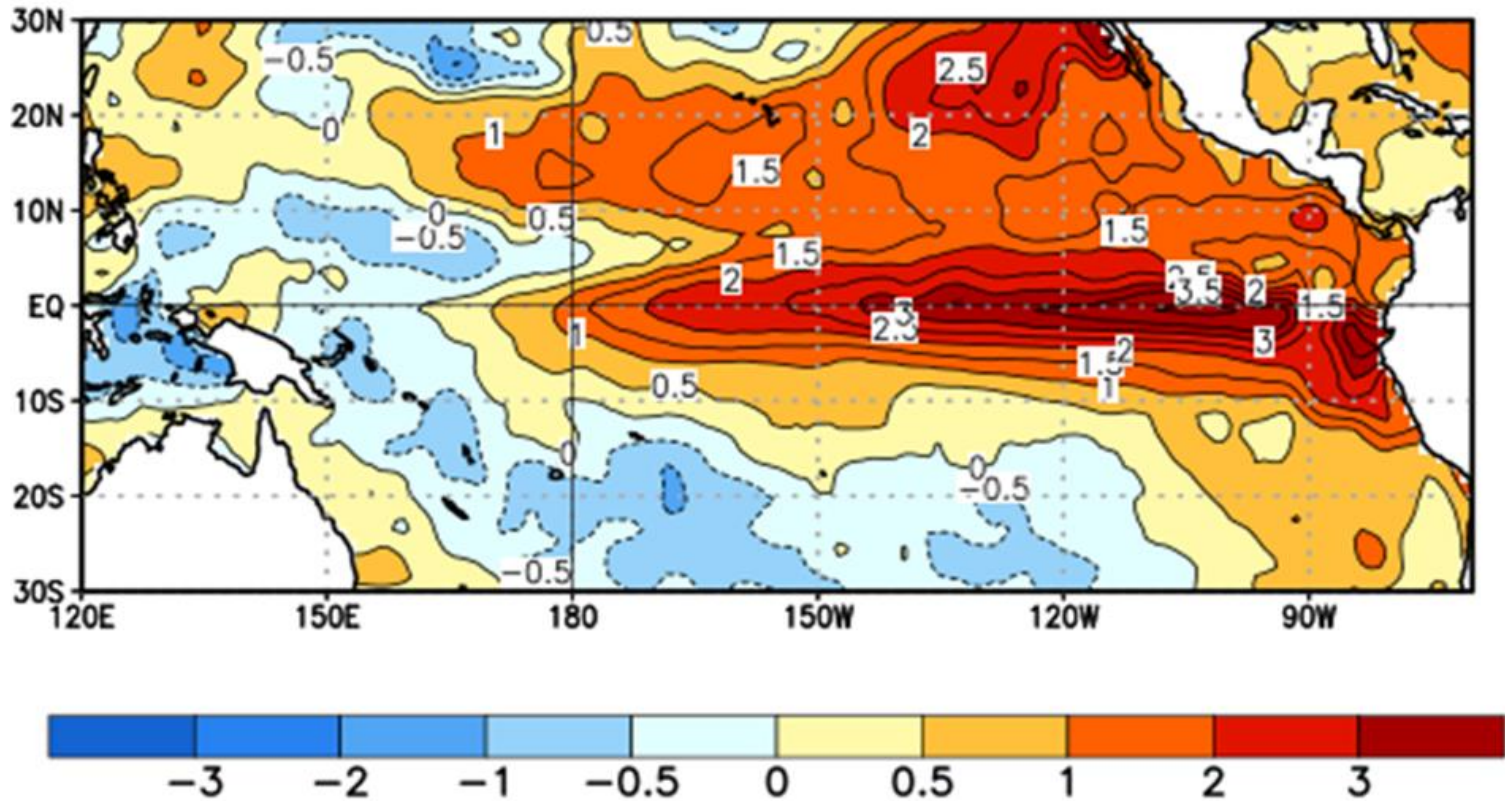


FACES
— of —
ENSO



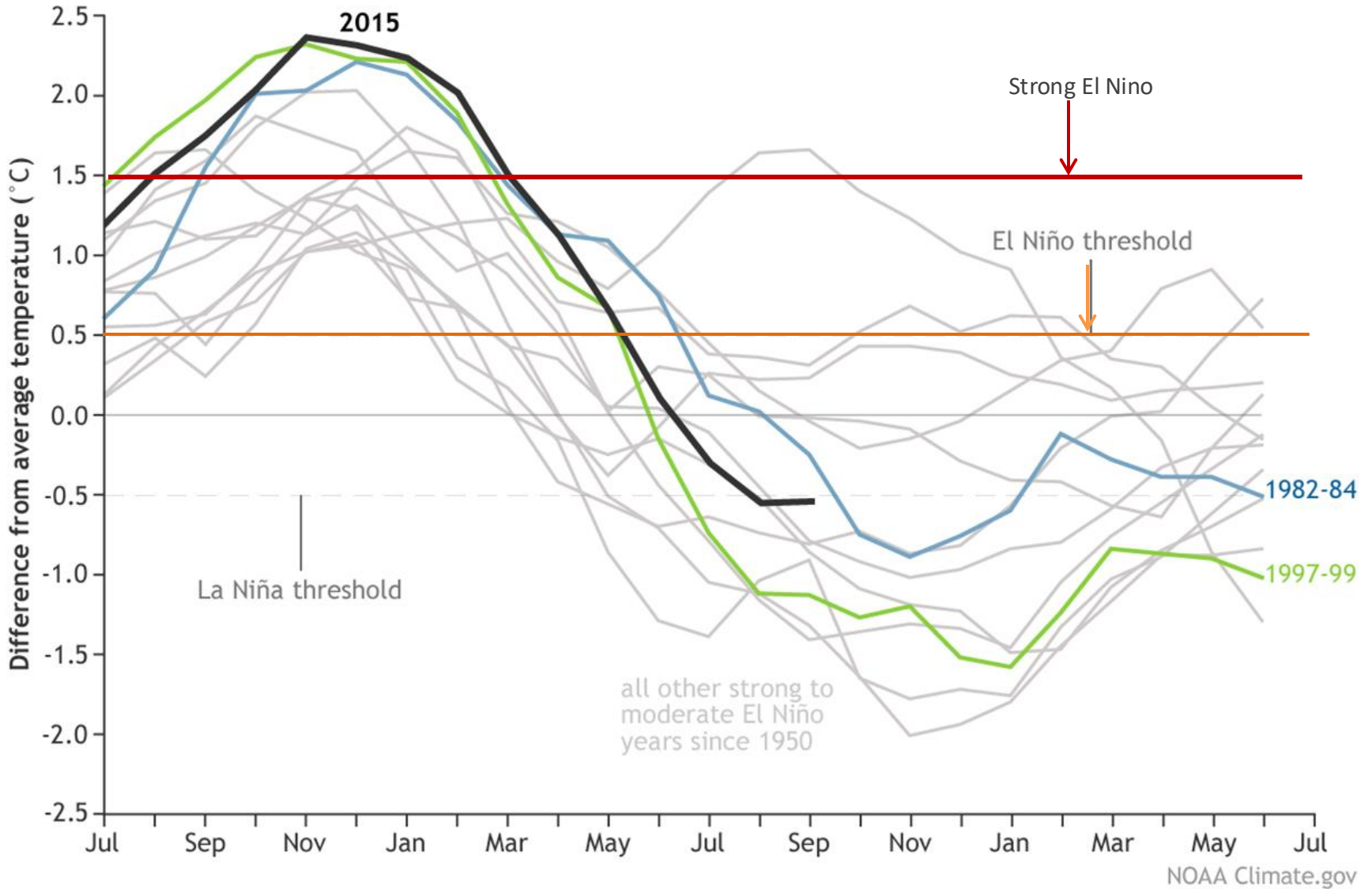
The Face of the 2015-16 El Nino

Average SST Anomalies
13 SEP 2015 – 10 OCT 2015



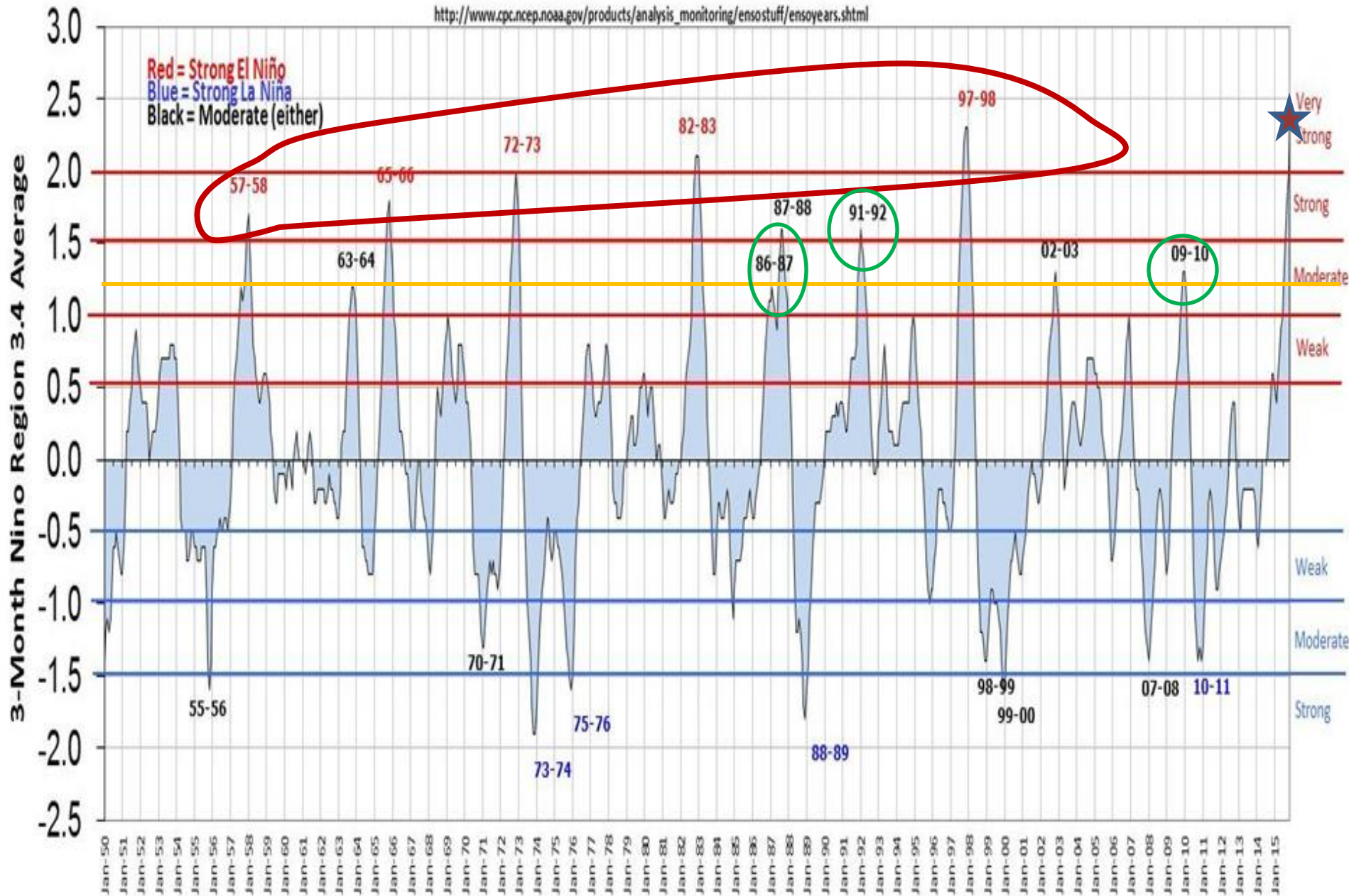
The 2015-16 event was on par with 1997 and 1982

Monthly sea surface temperature Niño 3.4 Index Values



Oceanic Niño Index (ONI)

http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/ensostuff/ensoyears.shtml

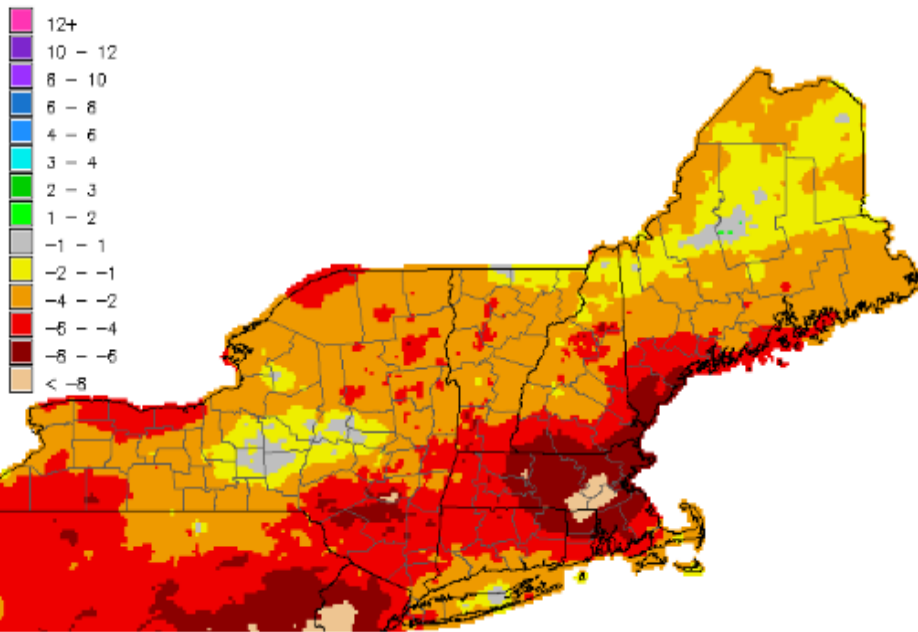


Local Study on Precipitation & Flood Frequency

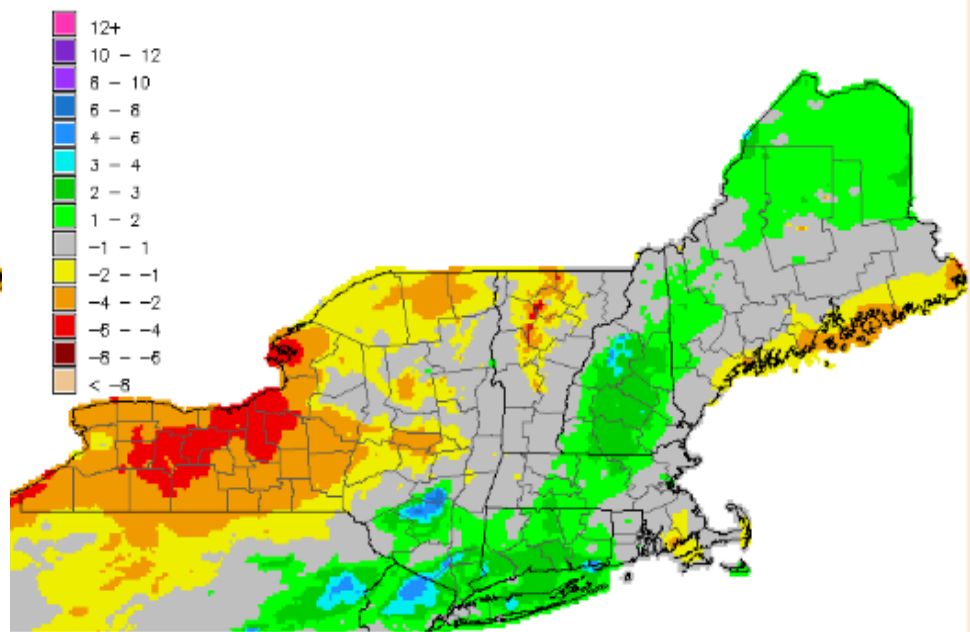
Local research initiative to better define possible sensible impacts on precipitation and flood potential (winter/spring) across the Northeast

- Premise: strongest possible correlations exist with the most significant ENSO events
- Examined the top 5 warmest El Nino events
- Calculated 3 month precipitation departures
- Found several common theme
 - *Dry late summer/fall*
 - *Below normal snowfall southeast New England and at or above normal inland*
 - *Wet late winter/spring*
 - *Increased spring flood potential*
- *One outlier year: **1965** – but the region was in the heart of its record 3 year drought!

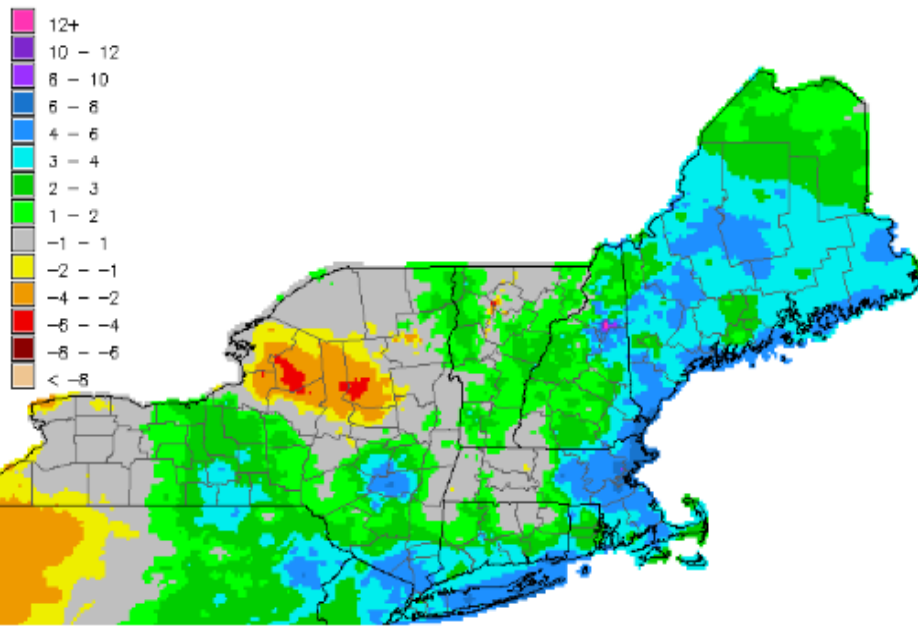
Jul-Aug-Sep 1957 Difference



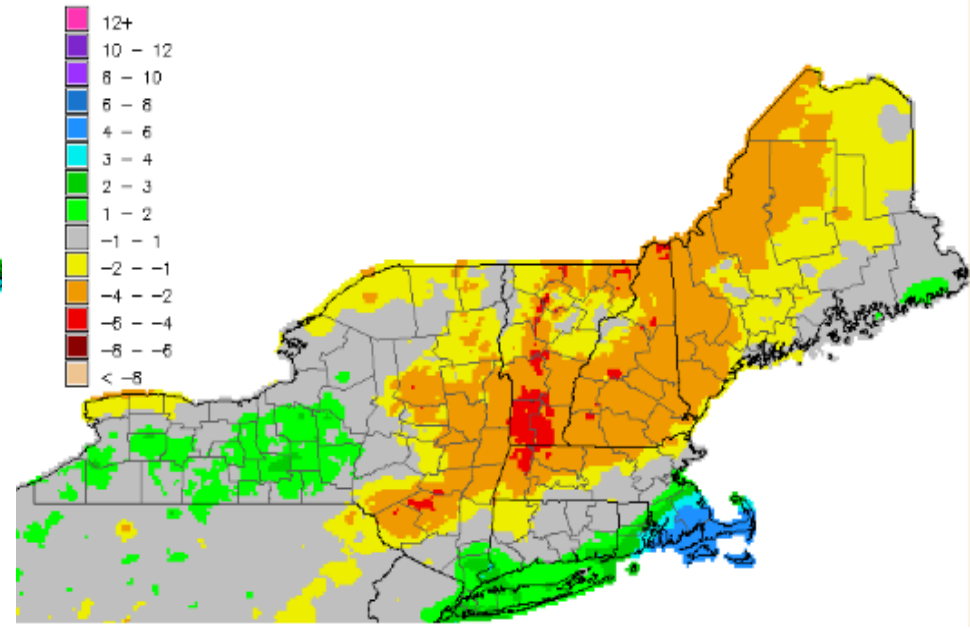
Oct-Nov-Dec 1957 Difference



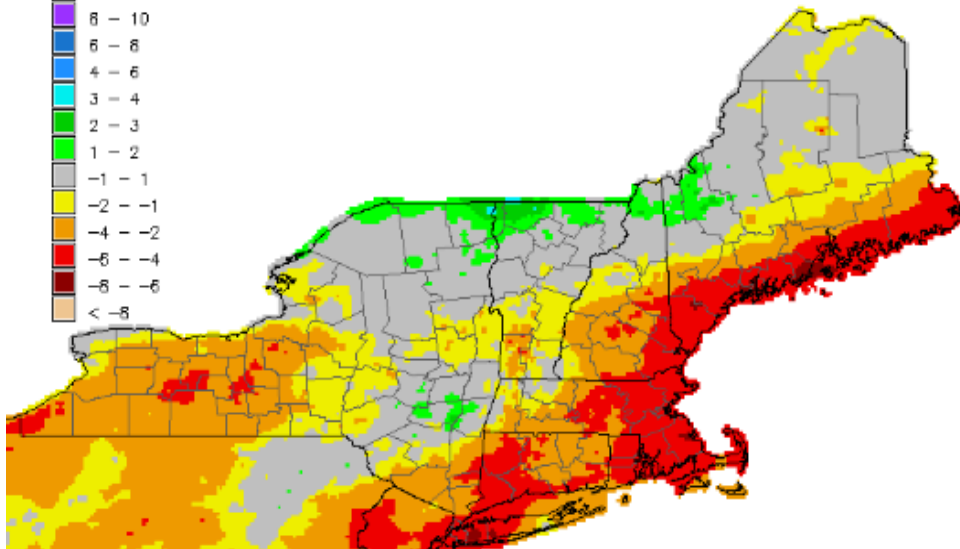
Jan-Feb-Mar 1958 Difference



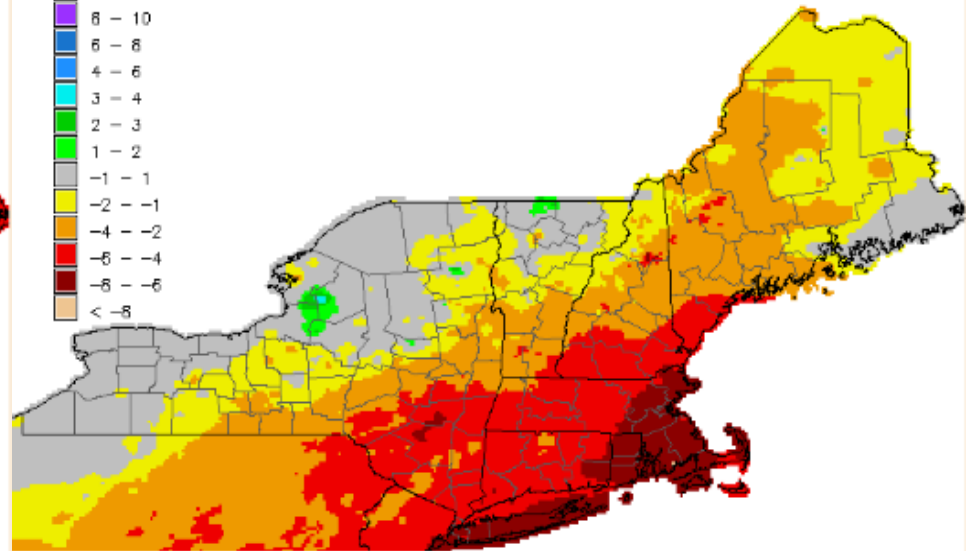
Apr-May-Jun 1958 Difference



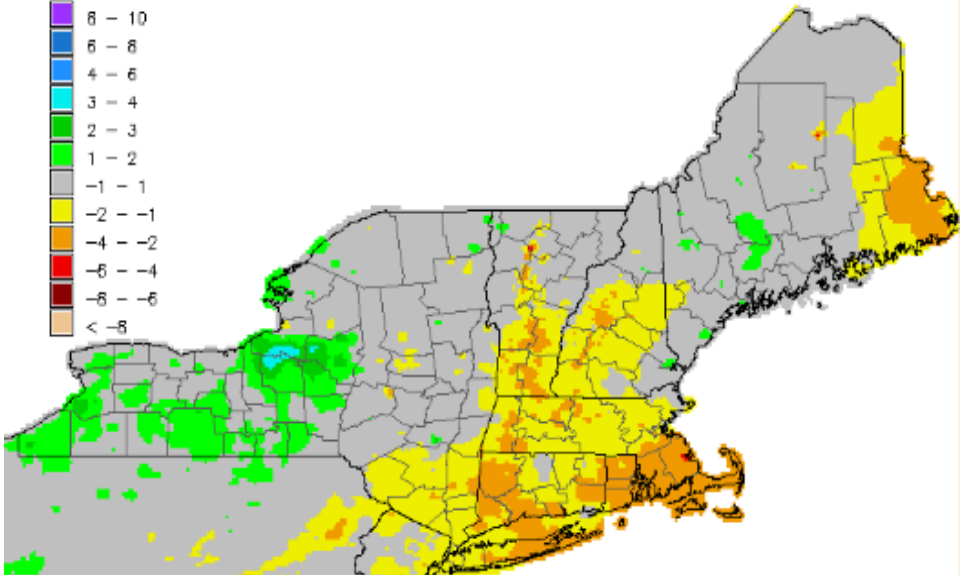
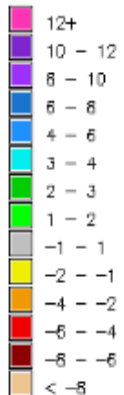
Jul-Aug-Sep 1965 Difference



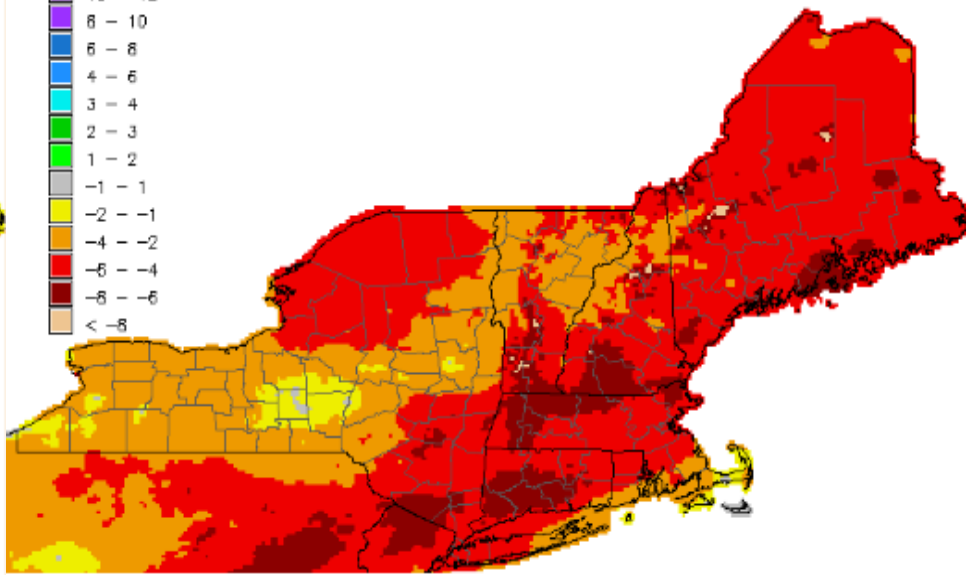
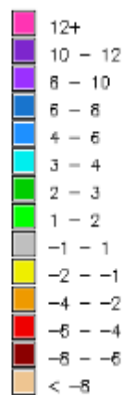
Oct-Nov-Dec 1965 Difference



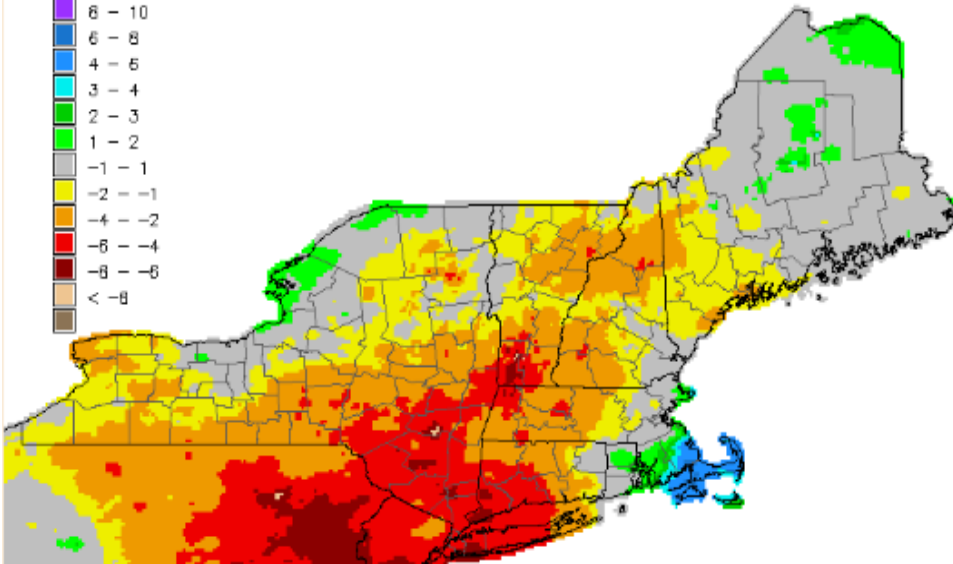
Jan-Feb-Mar 1966 Difference



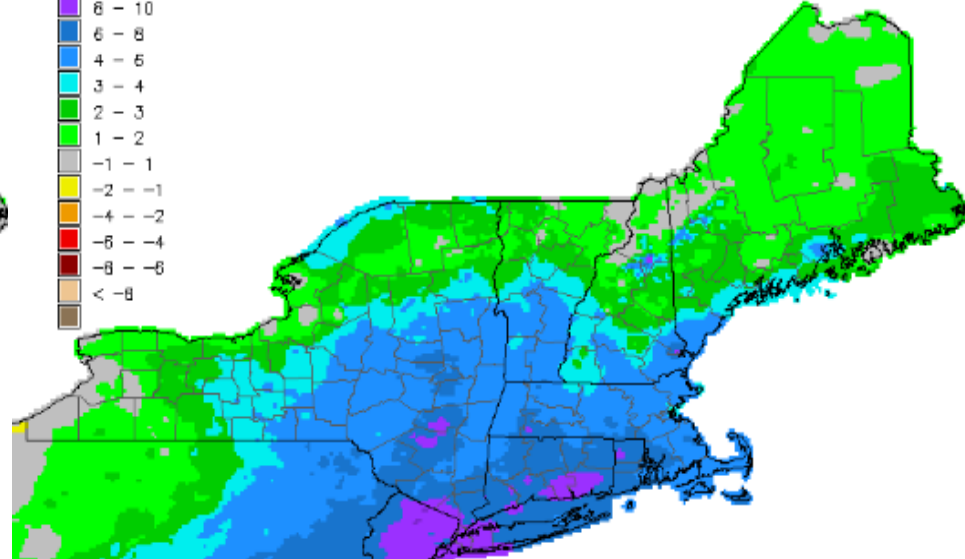
Apr-May-Jun 1966 Difference



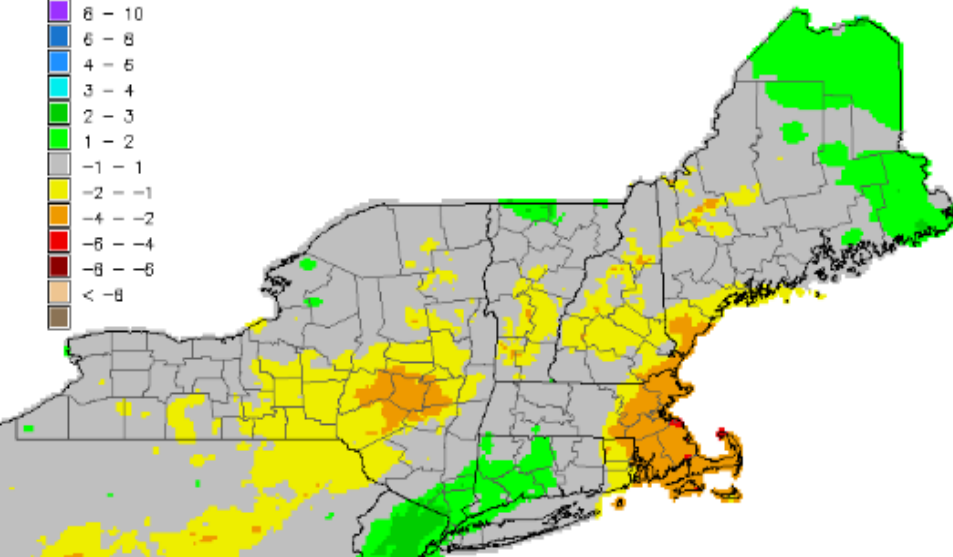
Jul-Aug-Sep 1972 Difference



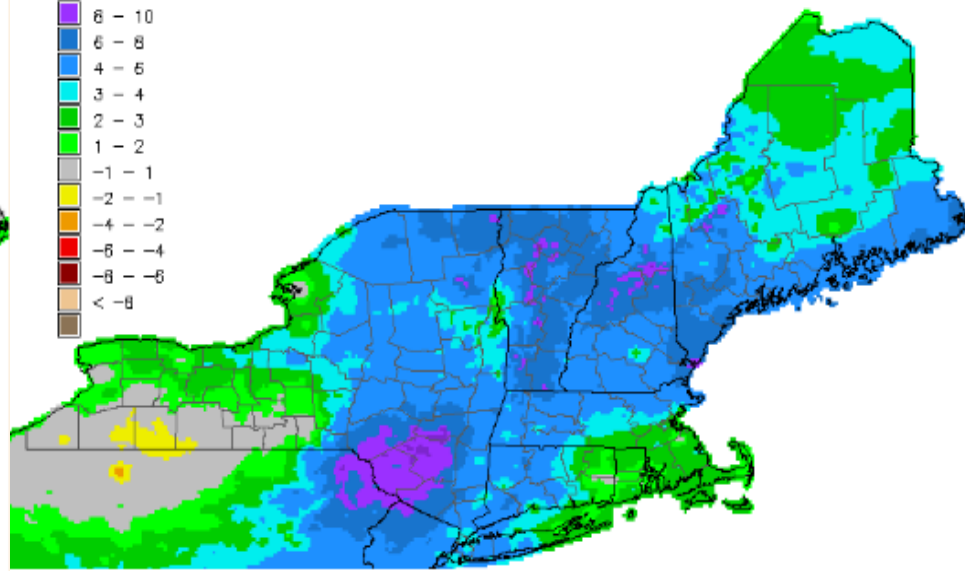
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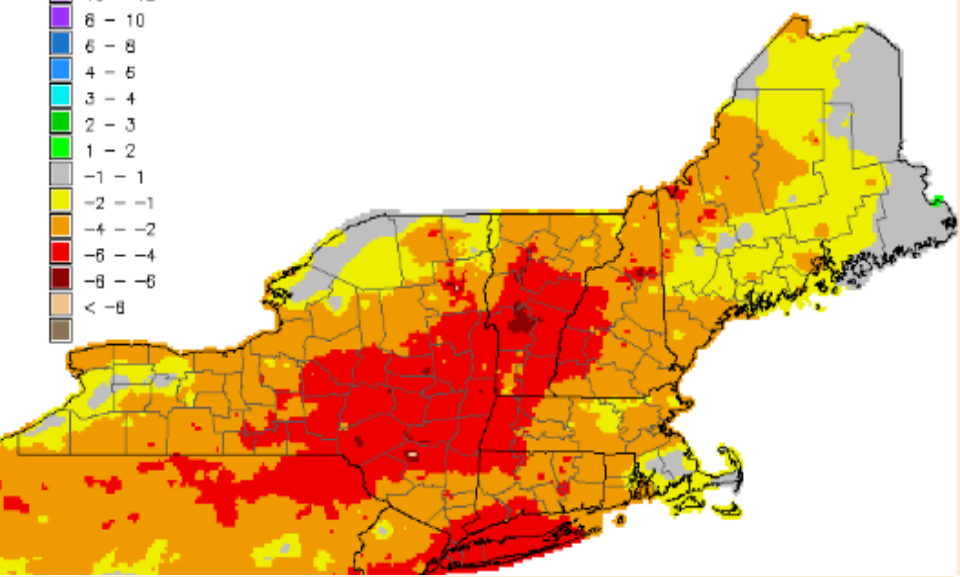
Jan-Feb-Mar 1973 Difference



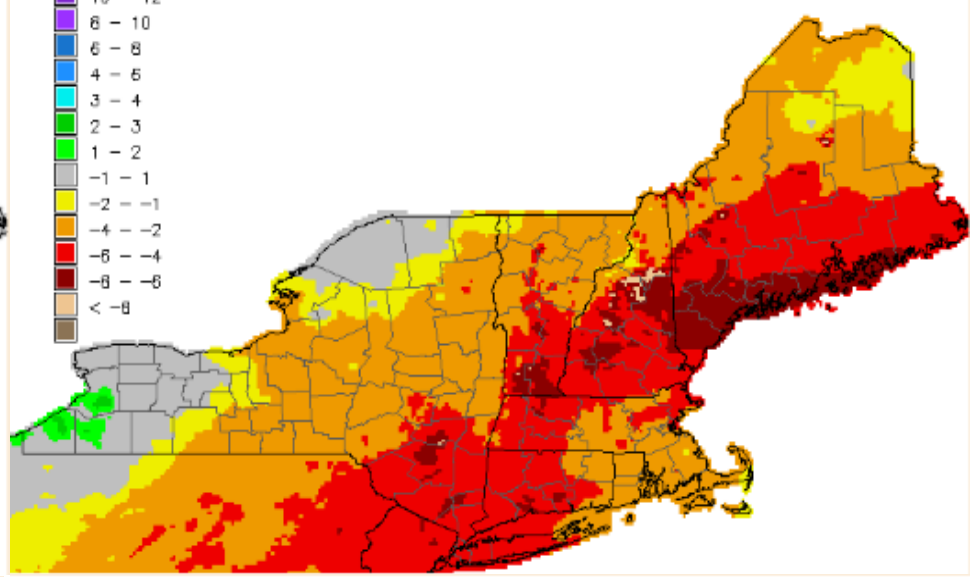
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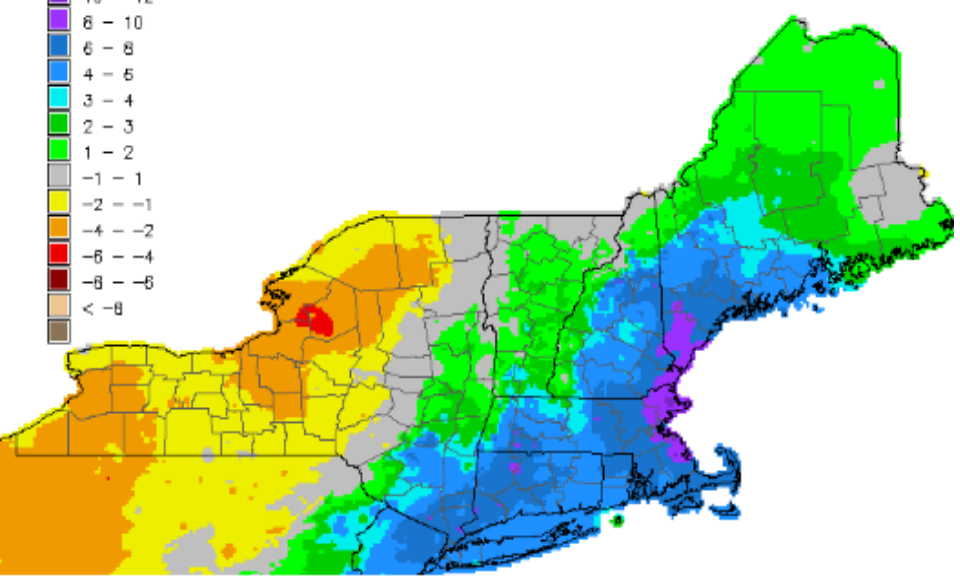
Jul-Aug-Sep 1982 Difference



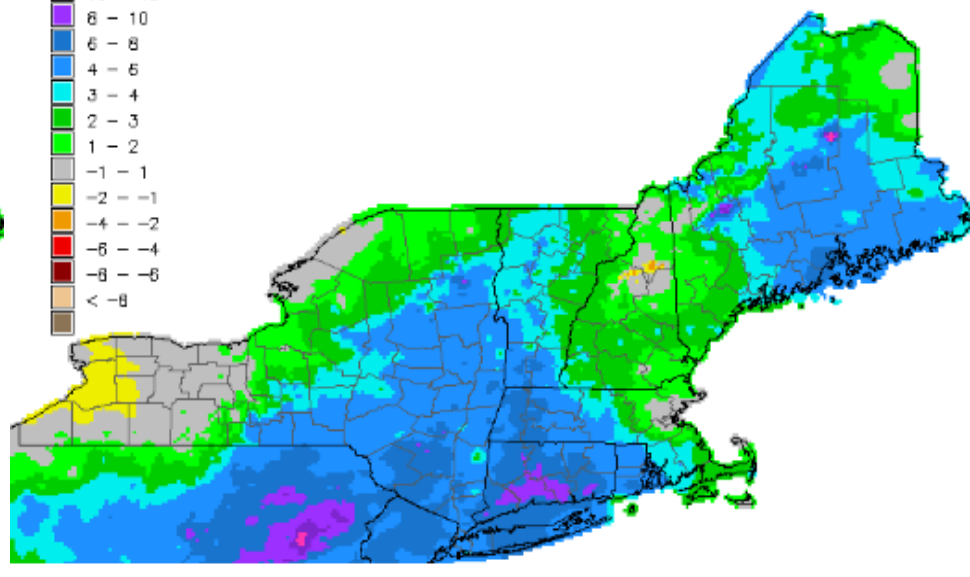
Oct-Nov-Dec 1982 Difference



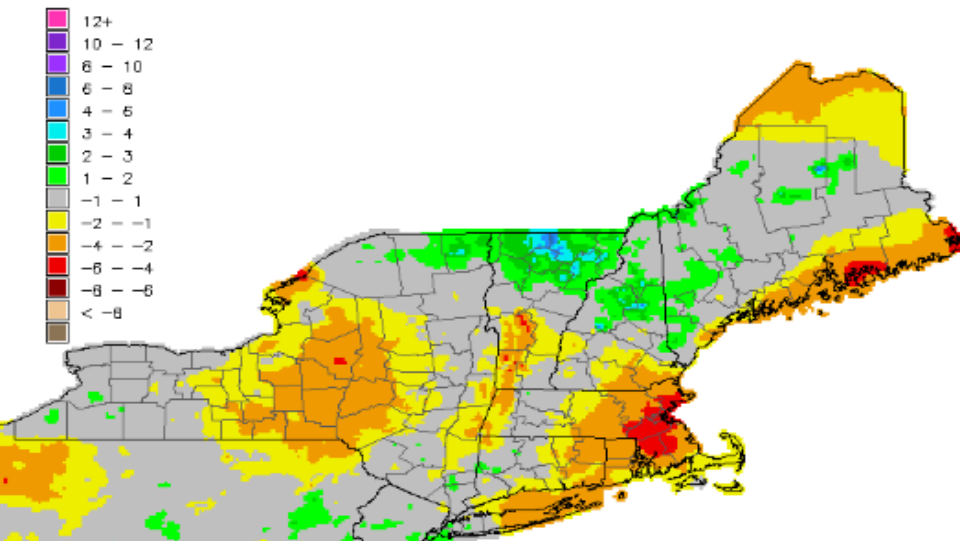
Jan-Feb-Mar 1983 Difference



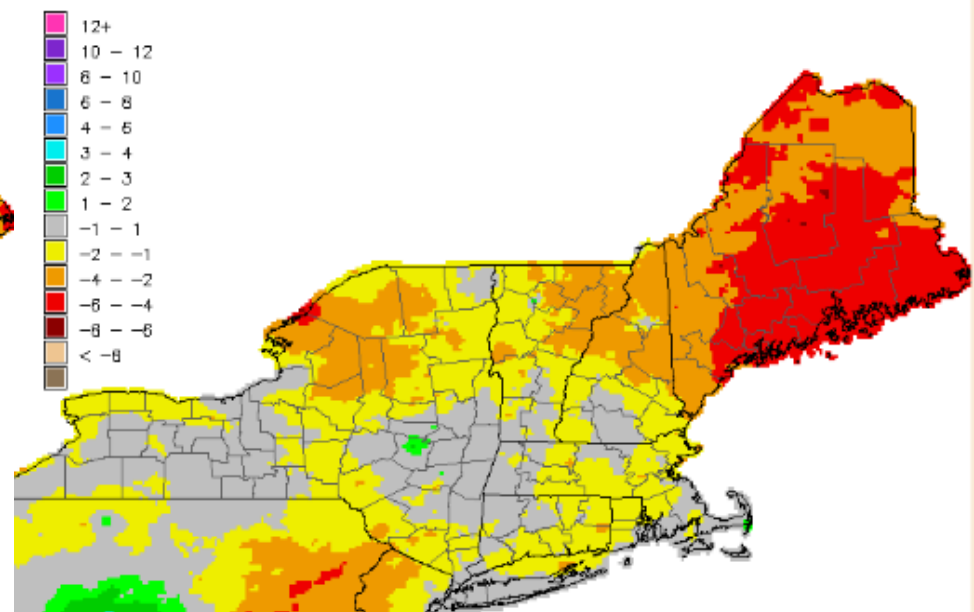
Apr-May-Jun 1983 Difference



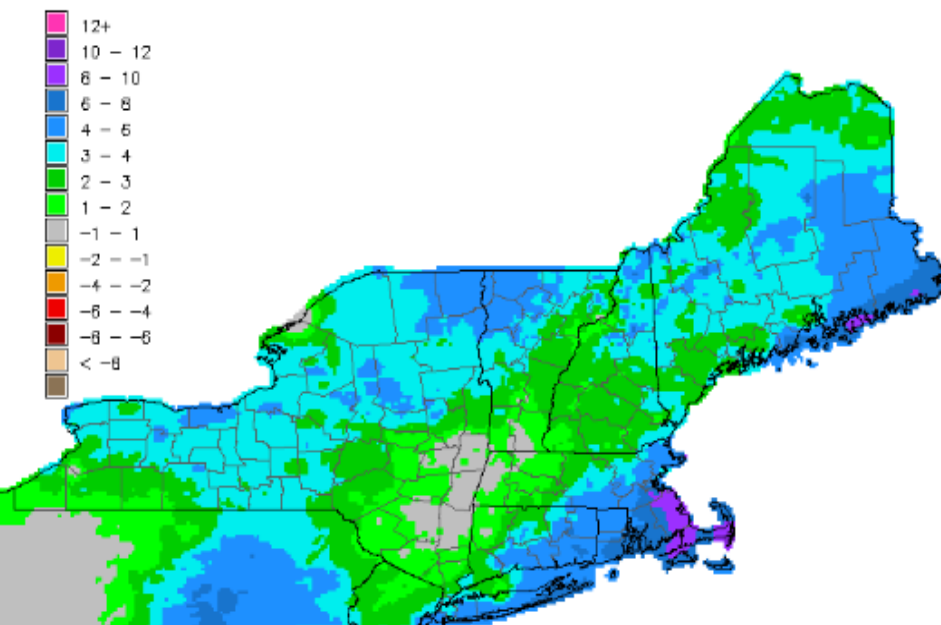
Jul-Aug-Sep 1997 Difference



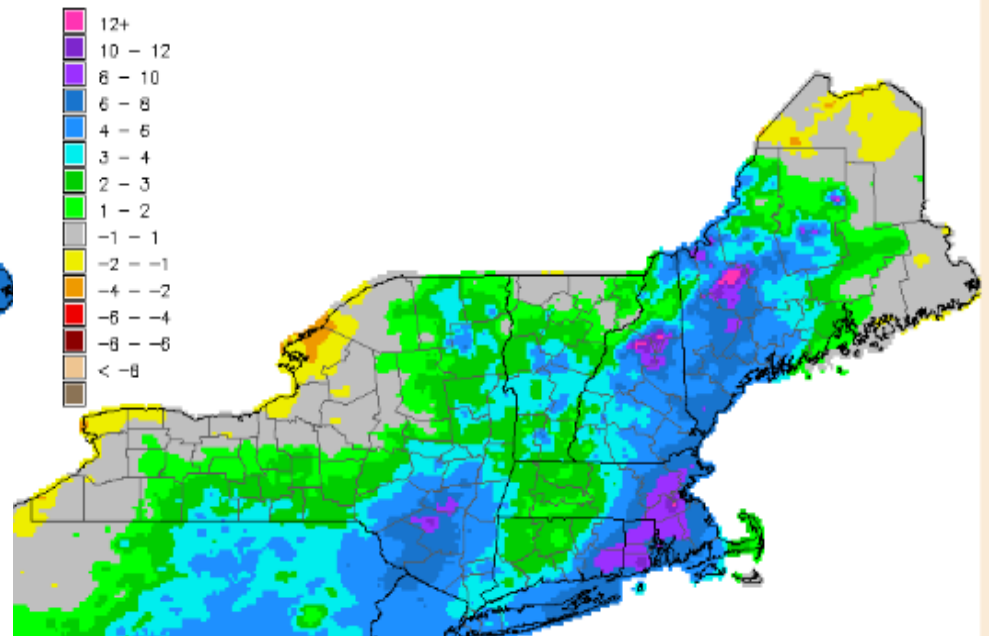
Oct-Nov-Dec 1997 Difference



Jan-Feb-Mar 1998 Difference



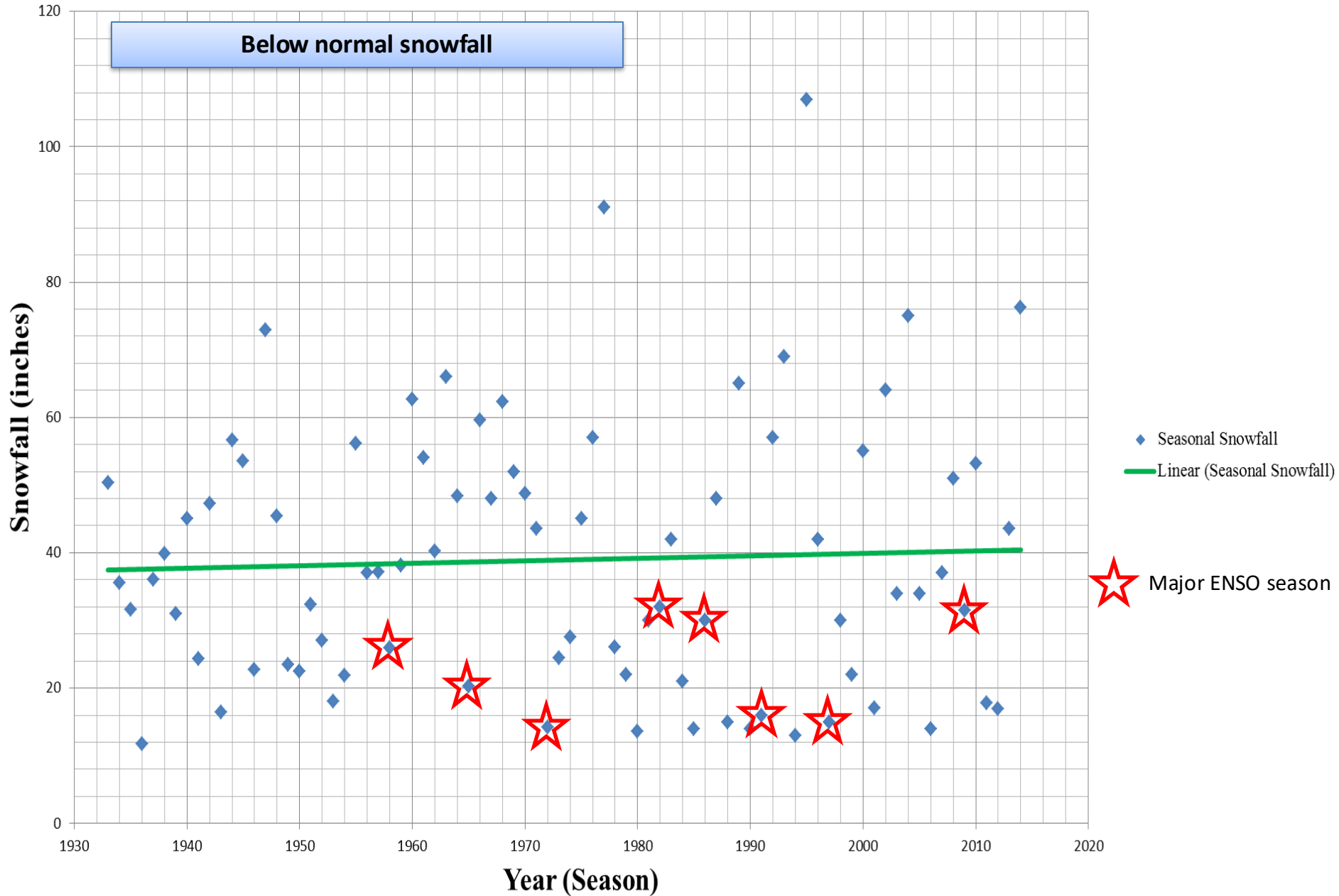
Apr-May-Jun 1998 Difference



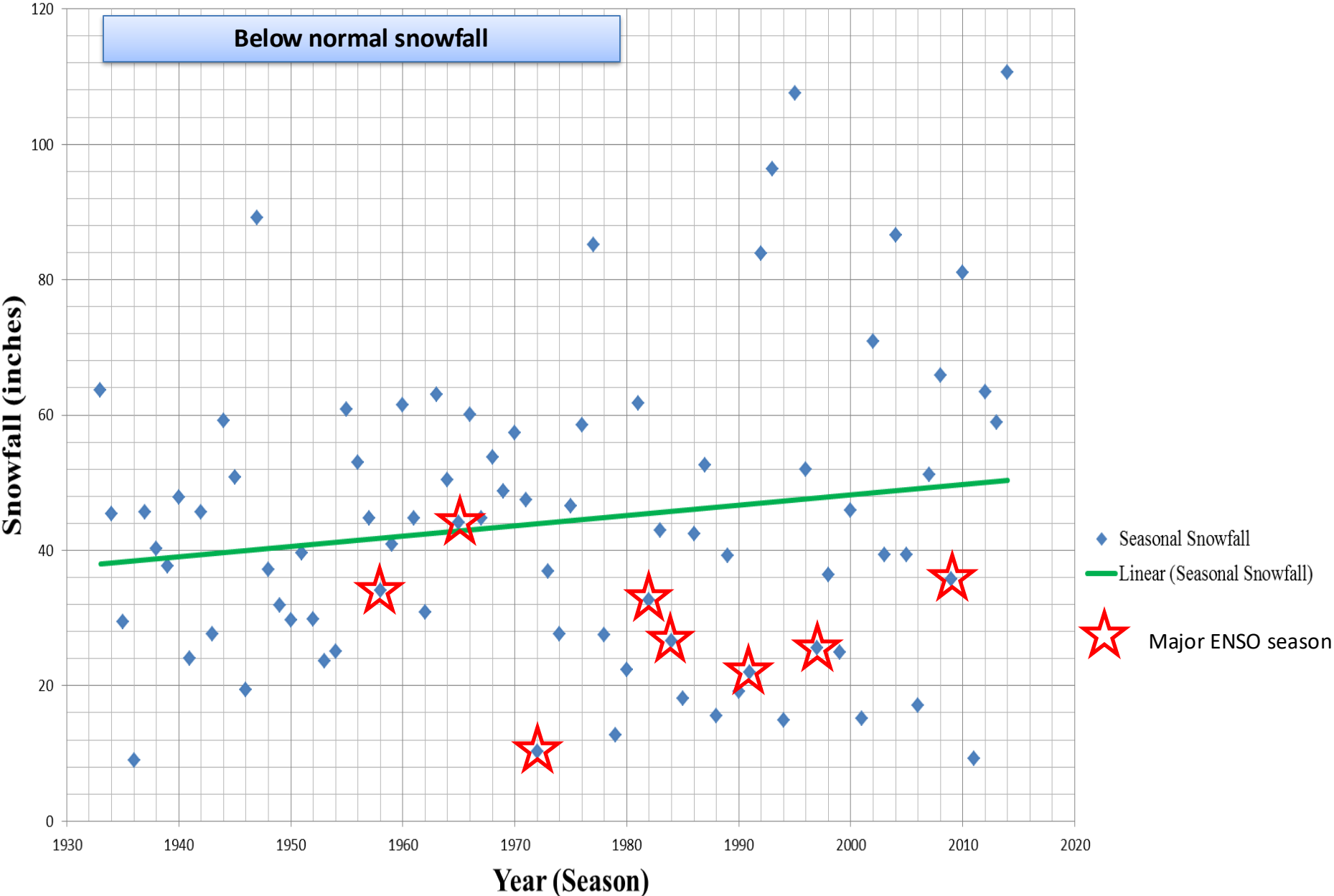
Winter Snowfall

- Providence, RI
 - Boston, MA
- Worcester, MA
- Portland, ME
- Burlington, VT

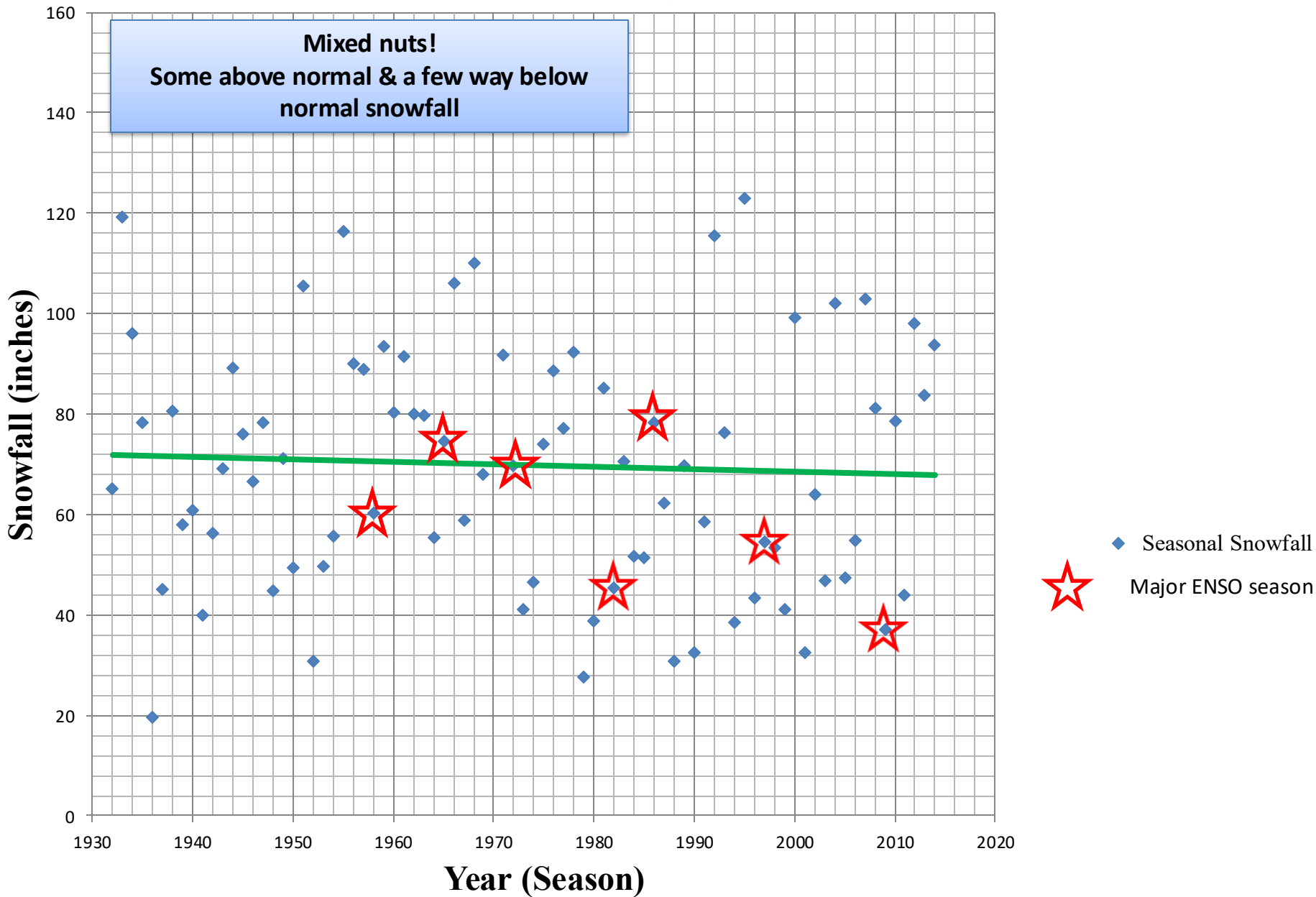
Seasonal Snowfall at Providence RI 1933-34 through 2014-15



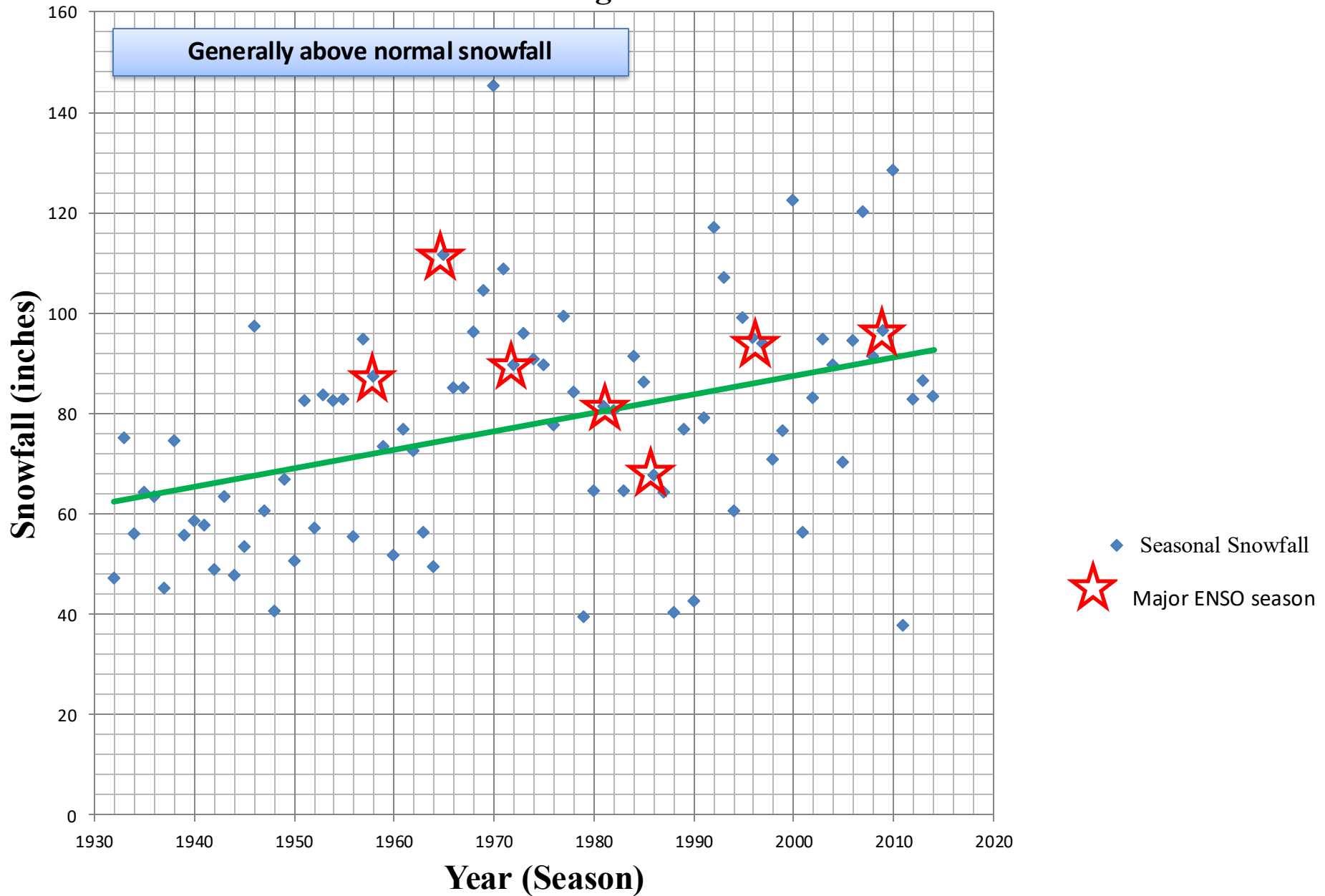
Seasonal Snowfall at Boston Ma 1933-34 through 2014-15



Seasonal Snowfall at Portland Maine 1932-33 through 2014-15



Seasonal Snowfall at Burlington Vermont 1932-33 through 2014-15



Applying local research

Albeit a very small sample size

- Examined the top 5 warmest El Nino events
- Calculated 3 month precipitation totals and departures from normal
- Found several pronounced patterns
 - **Dry late summer/fall**
 - **Milder than normal winter with below normal snowfall southeast New England and at or above normal away from the coast**
- *Wet late winter/spring with an above to much above normal flood threat ??????*

Flood Potential

“Super-ENSO events ≥ 1.7 ”

Basin	Flood Potential (all categories)	Most active flood season of major ENSOs
Great Lakes	Above	72-73
Hudson-Mohawk	Above	97-98
Champlain	Much above	97-98
Connecticut	Above	97-98
Southern New England	Much above	82-83 and 97-98
Merrimack	Above – lower Neutral – upper	97-98 72-73
Maine	West – Much Above East - Above	97-98 82-83

- **Notable events in the 1.5-1.7 range include 1986-87 and 2009-10**
- **Both 86-87 and 09-10 ENSO were “Modoki Events” – central Pacific-based**



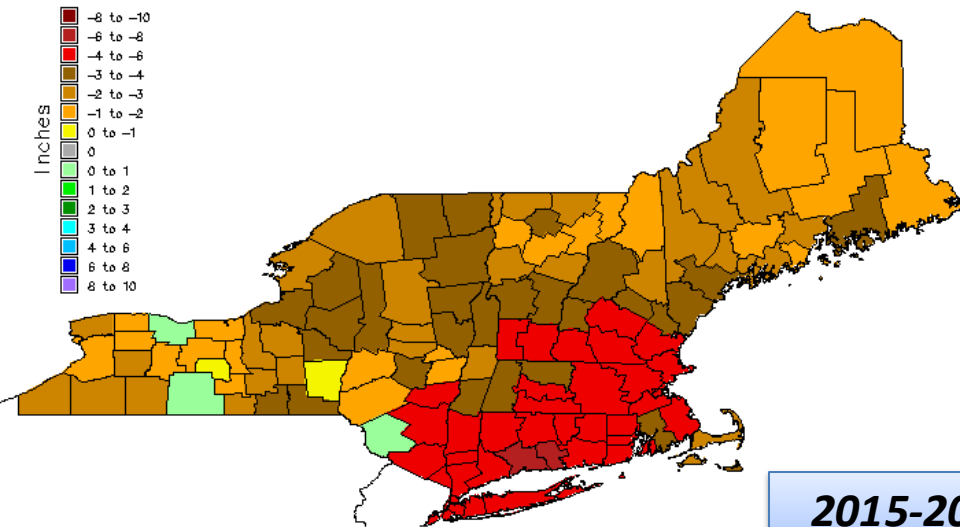
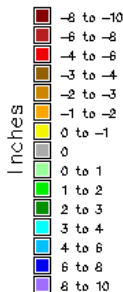
County Precipitation Departure

July-Sept Precip Departures

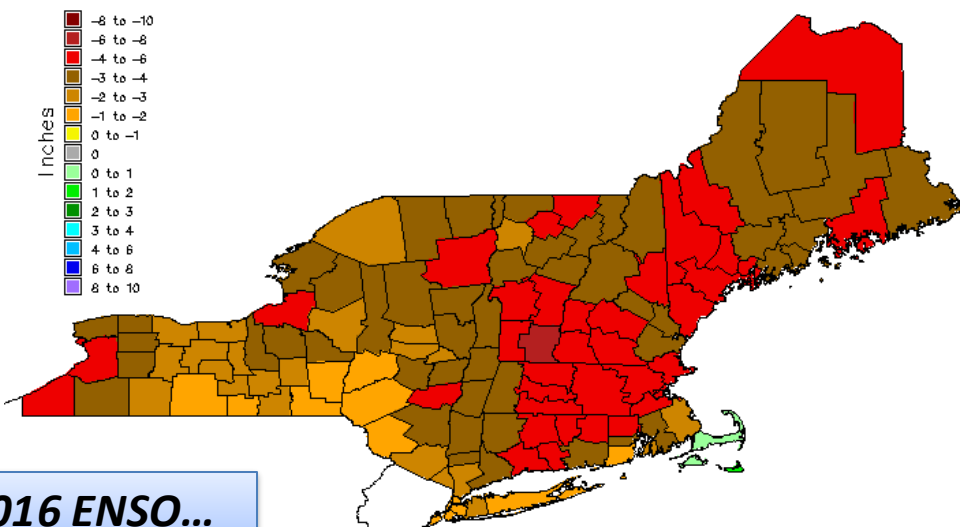
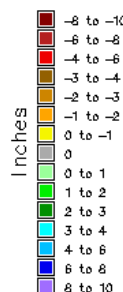


County Precipitation Departure

October-December Precipitation Departures



Source: NOAA Northeast River Forecast Center, Taunton, MA



Source: NOAA Northeast River Forecast Center, Taunton, MA

2015-2016 ENSO...



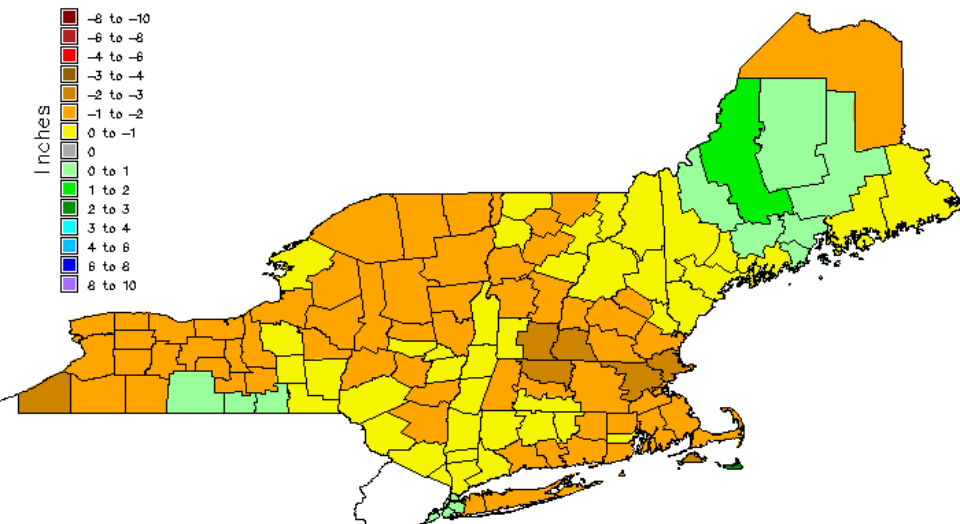
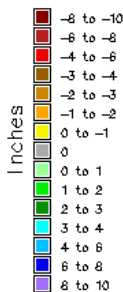
County Precipitation Departure

January through early March 2016

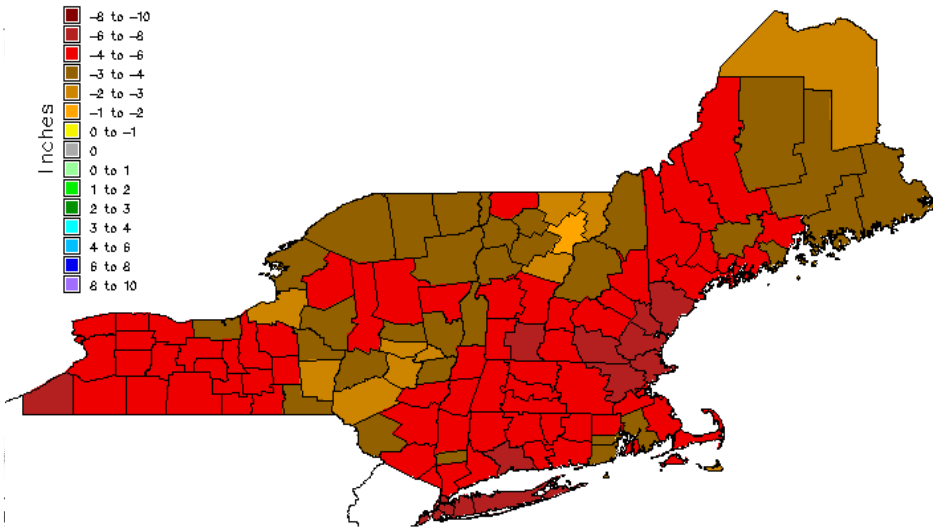
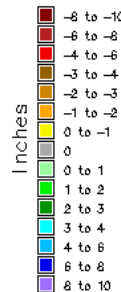


County Precipitation Departure

April - June 2016



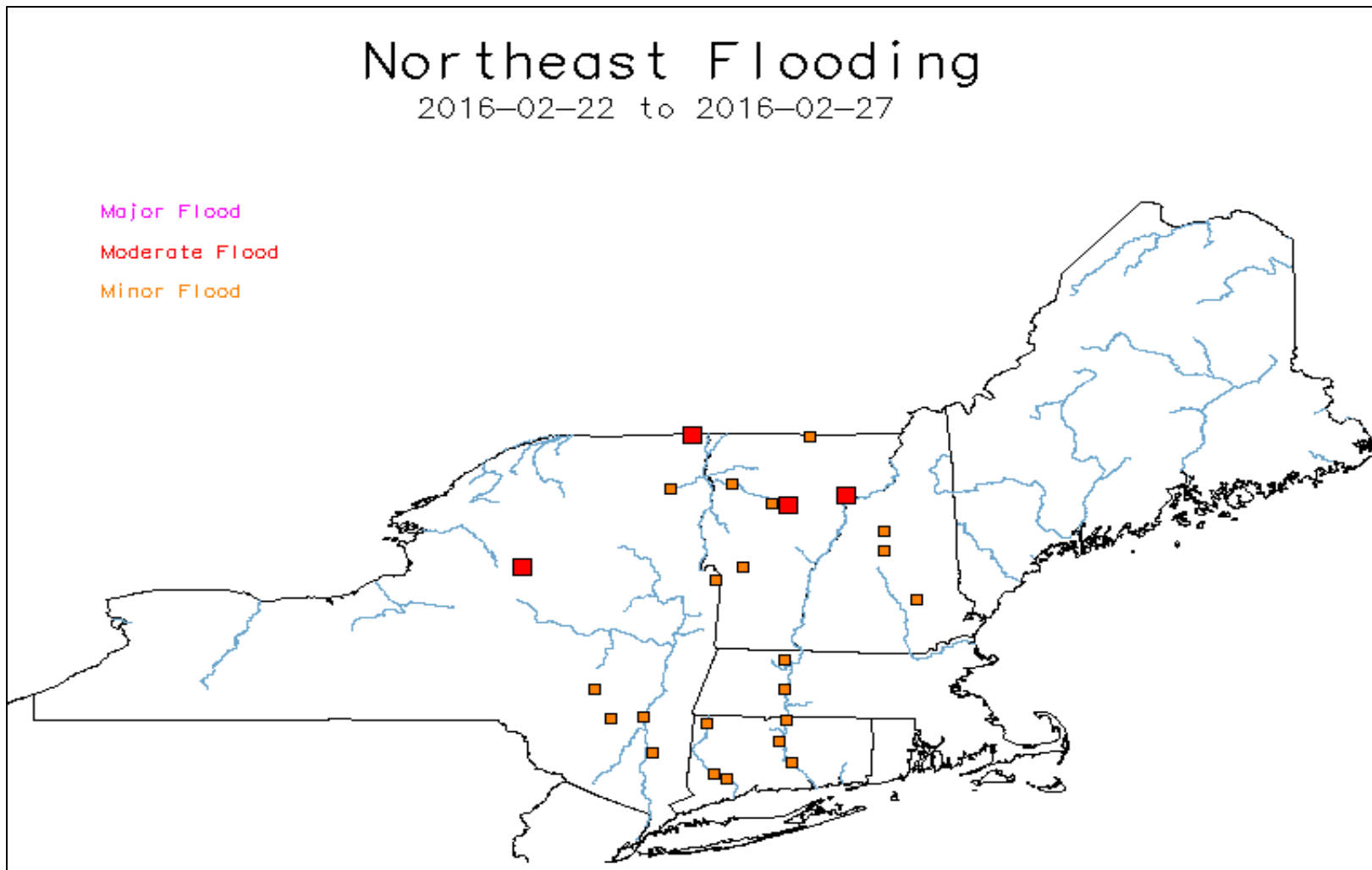
Source: NOAA Northeast River Forecast Center, Taunton, MA



Source: NOAA Northeast River Forecast Center, Taunton, MA

Just one significant flood episode...

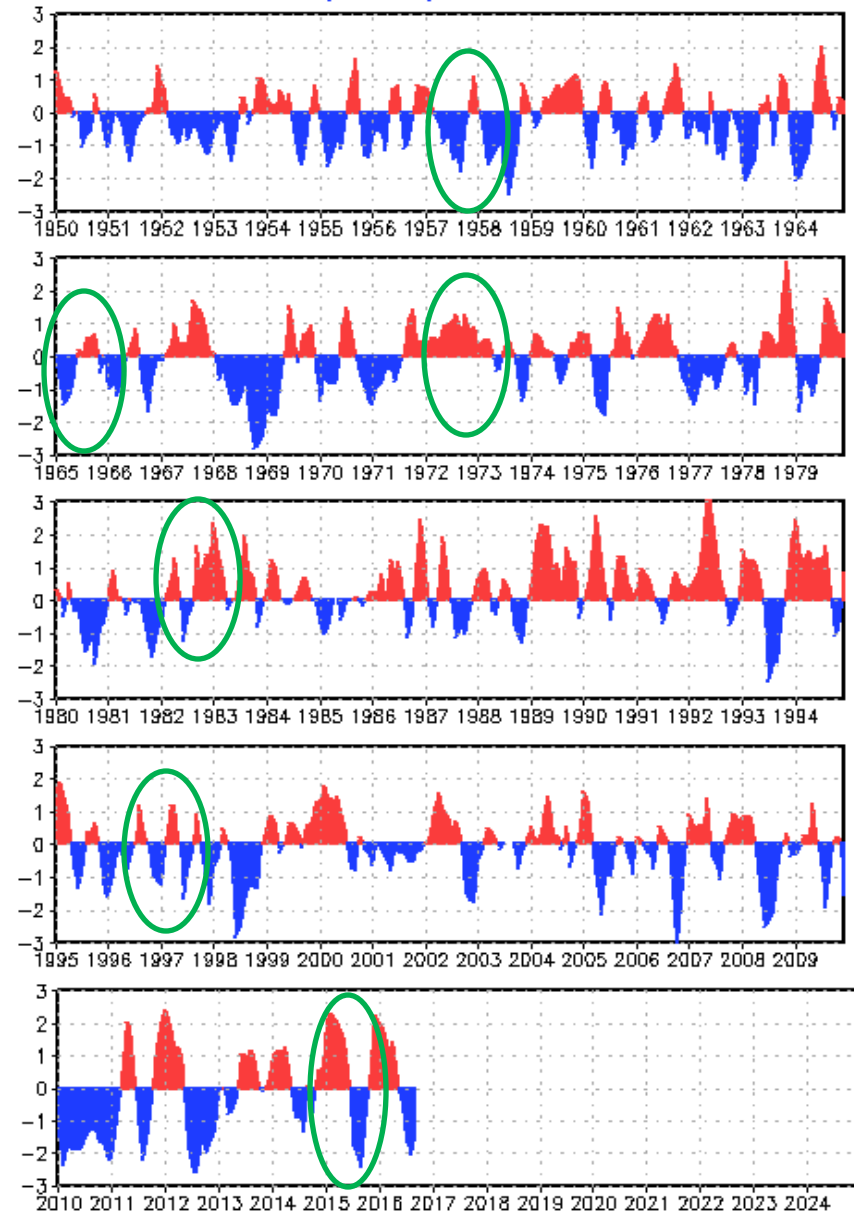
and that occurred in February



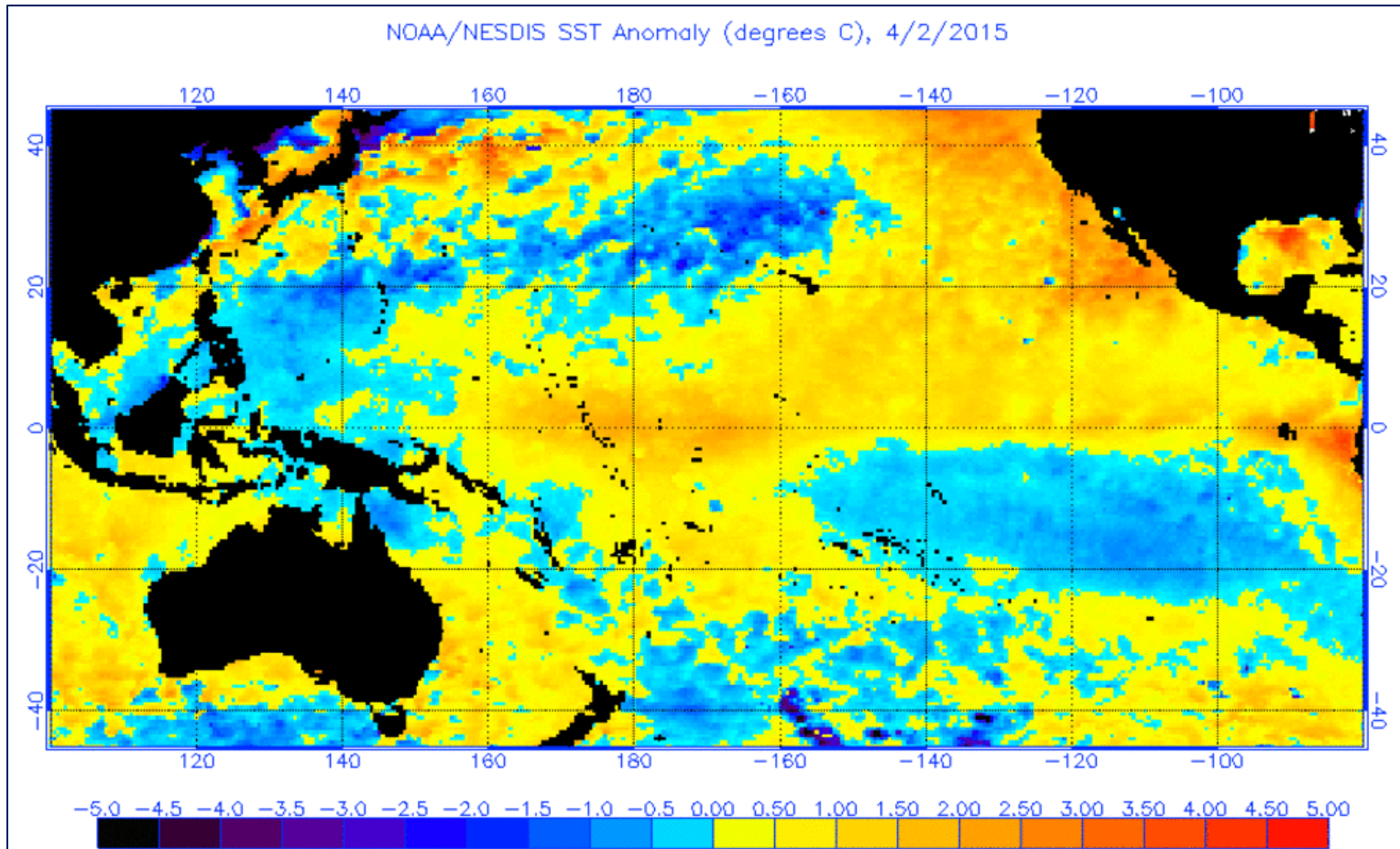
Summary

- ENSO is just one of several major forcing mechanisms that can drive the weather patterns in the Northeast
 - NAO, PNA, EPO, AO etc.
 - But they are all devilishly interconnected
- Sample size of 5 is very small
- Some basic themes played out:
 - **Dry summer/fall heading into ENSO**
 - **Lack luster snowfall in parts of the region**
- Some basic themes did not play out:
 - *Absence of significant rainfall in the spring*
 - *Absence of late winter/spring river flooding*

North Atlantic Oscillation Phase
Standardized 3–Month Running Mean NAO Index
Through September 2016



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