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WINTER 2016 - 2017 OUTLOOK

WHAT FACTORS WILL PLAY A ROLE THIS WINTER?

Overview

- What are normal winter season conditions in northern IL and NW IN?
- CPC Winter Outlook
- Weak La Niña in the tropical Pacific may persist through the winter
  - What is ENSO and La Niña?
  - Current and forecast conditions.
  - What has occurred in past similar winters, including local data.
- Other factors to consider
  - Arctic Oscillation and North Atlantic Oscillation.
    - Snow cover advance and extent in Eurasia in October.
  - Pacific Decadal Oscillation
  - Alaska Ridge and Trough Pattern (+/- EPO)
  - Persistent warmth this fall.
- Summary: What we know now and things to consider.
- Conclusion: NWS Chicago Outlook for Winter 2016-17

Normal Winter Season Conditions in N IL & NW IN

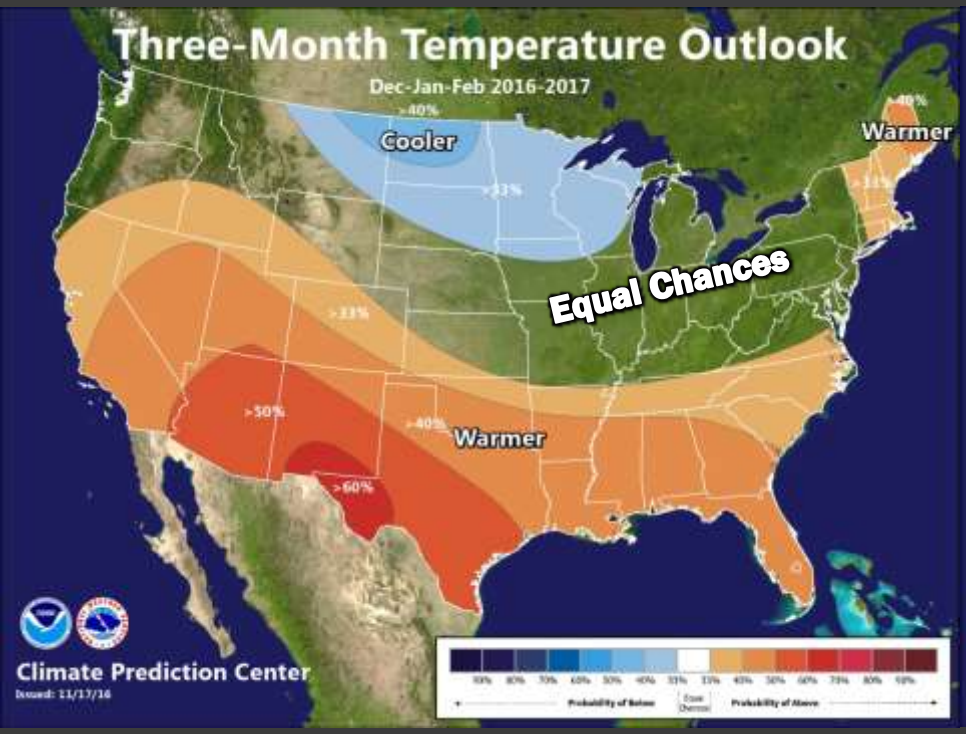
1981-2010 Average Daily High Temperatures		
	Chicago	Rockford
December	34.8°	33.2°
January	31°	29.5°
February	35.3°	34.2°

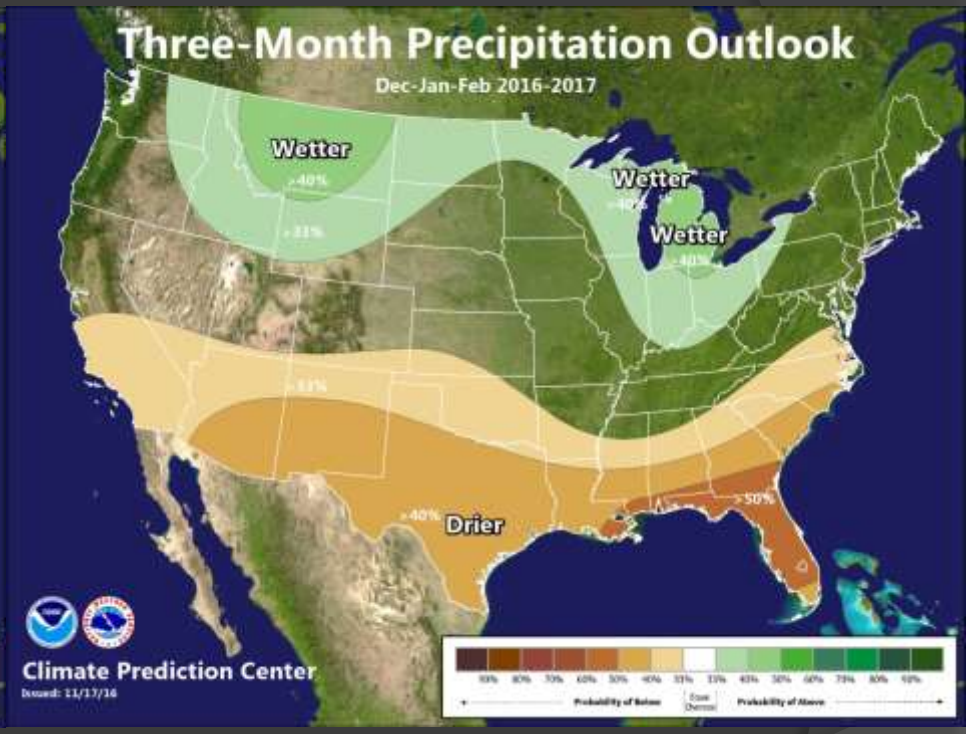
1981-2010 Average Daily Low Temperatures		
	Chicago	Rockford
December	20.7°	17.7°
January	16.5°	13.5°
February	20.1°	17.7°

1981-2010 Average Snowfall		
	Chicago	Rockford
December	8.5"	11.3"
January	10.8"	10.2"
February	9.1"	7.7"
Seasonal (October through May)	36.7"	36.7"

- **Although average seasonal snowfall is nearly 37”, snowfall varies greatly from year-to-year.**
  - **For example, during the 1981-2010 climate normal period seasonal snowfall amounts ranged from 10.4” to 60.3” in Chicago.**
  - **Consider seasonal snow amounts of between *24.7” to 49.4”* to be a typical range of snow amounts in Chicago for any given season (snow amounts fell in this range on 20 of the 30 years between 1981-2010.**
  - **In Rockford this range was between *20.7” to 46.2”*.**

Official CPC Winter 2016-17 Outlook

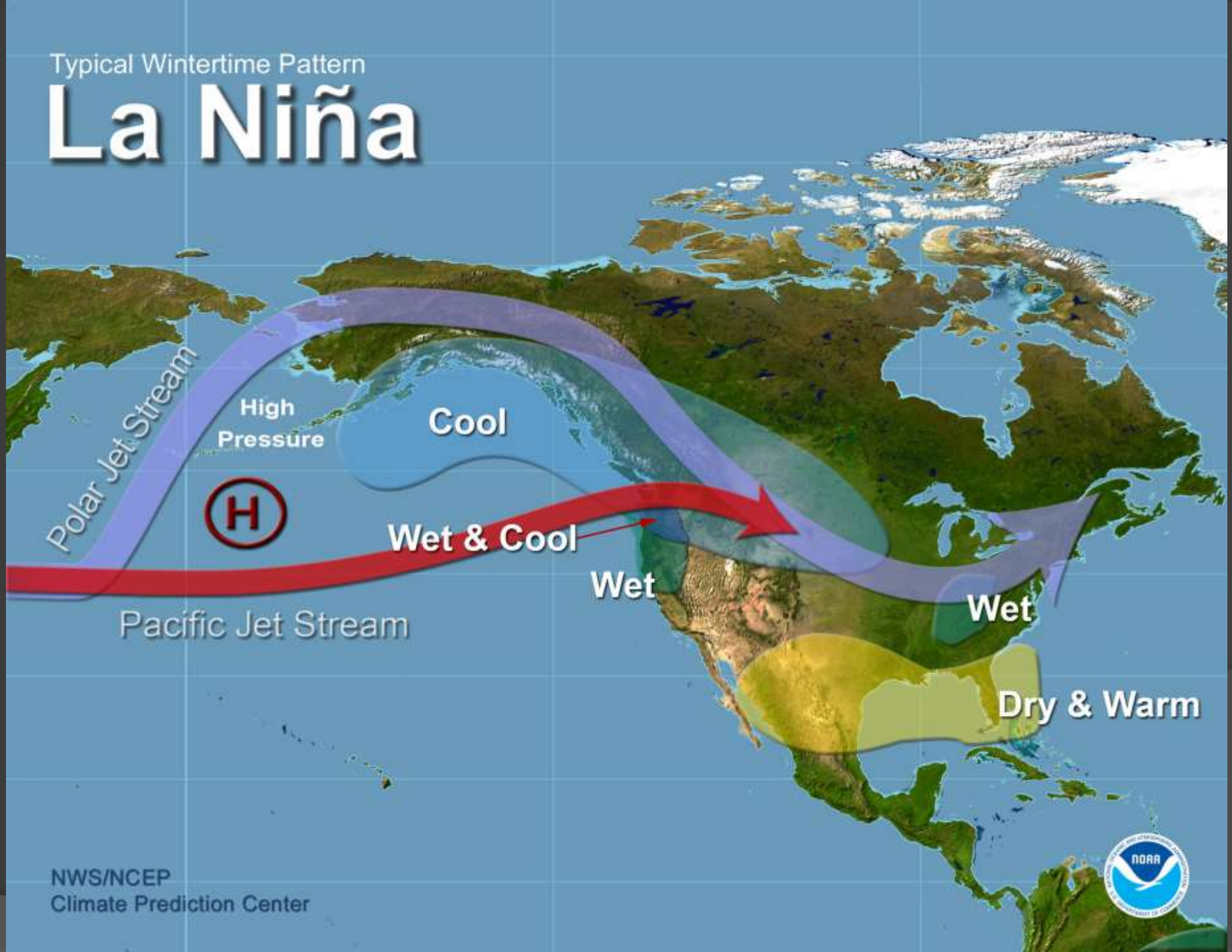




Weak La Niña (cooler than average water temperatures) in the Tropical Pacific Ocean

Operational Definitions for El Niño, La Niña and ENSO Neutral (El Niño Southern Oscillation Neutral)

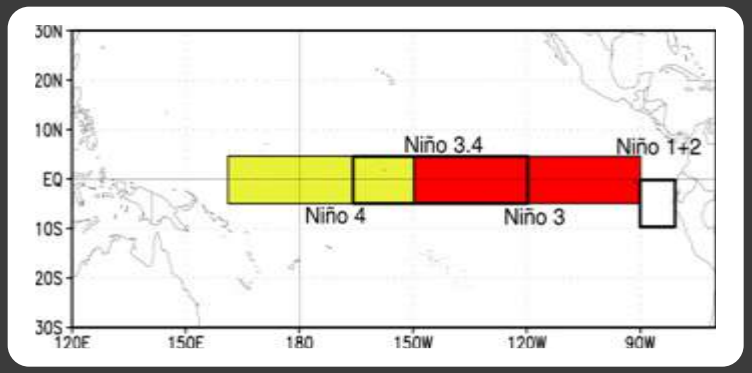
- El Niño: characterized by a positive ONI (SST departures in defined Niño 3.4 region of tropical Pacific) greater than or equal to +0.5ºC.
- La Niña: characterized by a negative ONI less than or equal to -0.5ºC.
- By historical standards, to be classified as a full-fledged El Niño or La Niña episode, these thresholds must be exceeded for a period of at least 5 consecutive overlapping 3-month seasons.
- CPC considers El Niño or La Niña conditions to occur when the monthly Niño 3.4 OISST departures meet or exceed +/- 0.5ºC along with consistent atmospheric features. These anomalies must also be forecasted to persist for 3 consecutive months.
- ENSO Neutral: characterized by an average ONI between -0.4°C and + 0.4°C
- Most recent ONI value (August – October 2016): -0.7°C

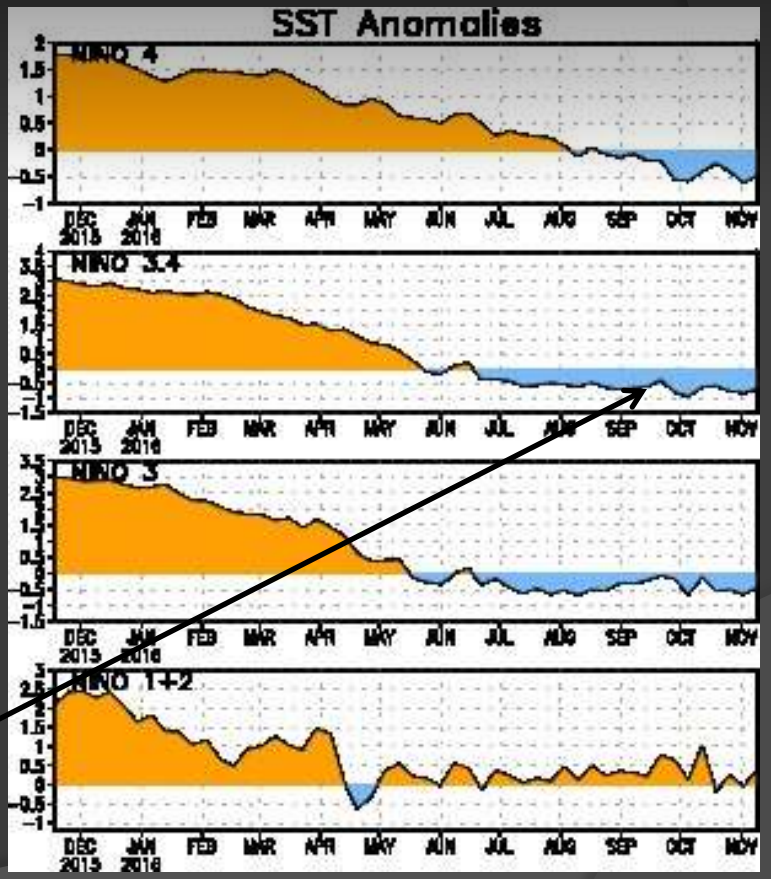

Typical Wintertime Pattern
La Niña
Polar Jet Stream
High Pressure
H
Cool
Wet & Cool
Wet
Wet
Dry & Warm
Pacific Jet Stream
NWS/NCEP
Climate Prediction Center

Niño Region SST Departures (ºC)
Recent Evolution

The latest weekly SST departures are:

Niño 4	-0.5ºC
Niño 3.4	-0.7ºC
Niño 3	-0.4ºC
Niño 1+2	0.4ºC



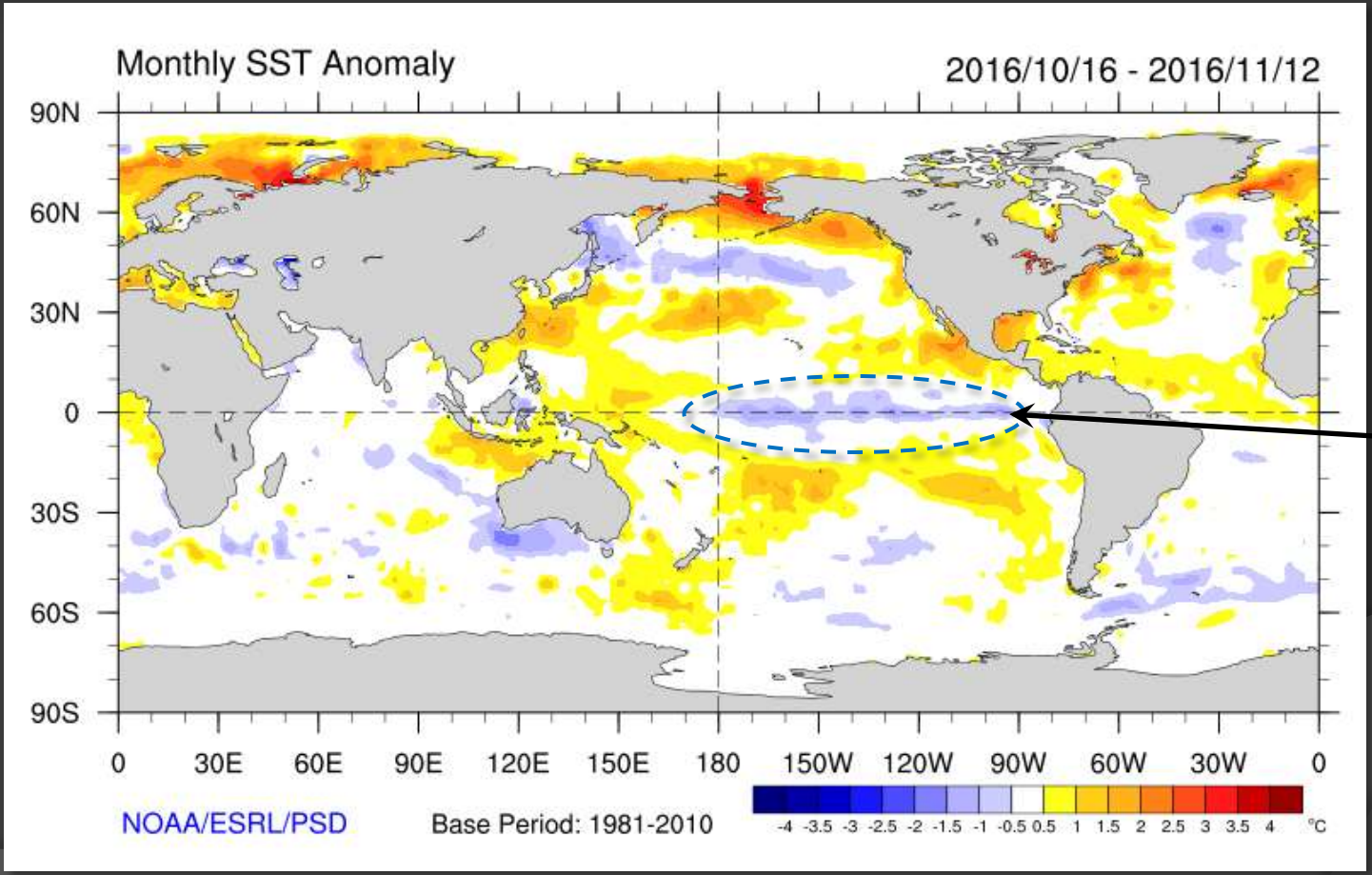


Weak La Niña

ENSO status is determined by SST departures in this region.

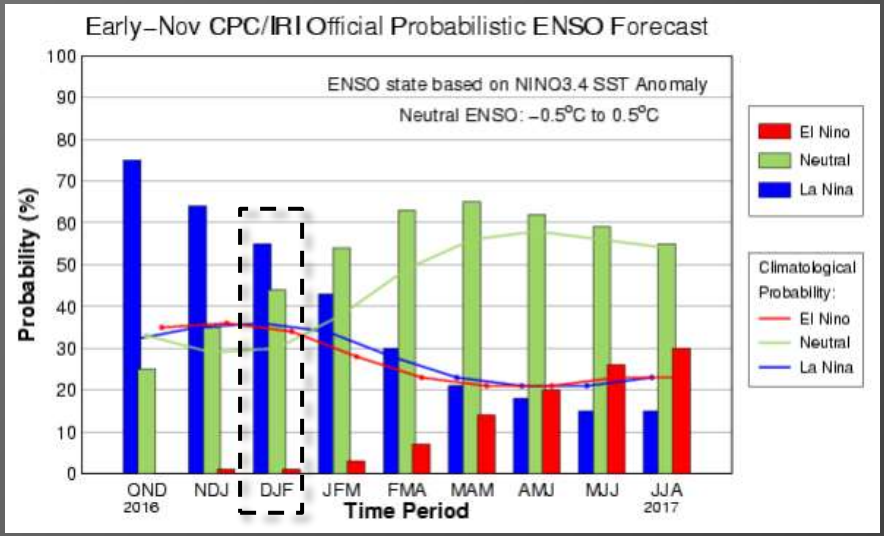
Global SST Departures (ºC) During the Last Four Weeks

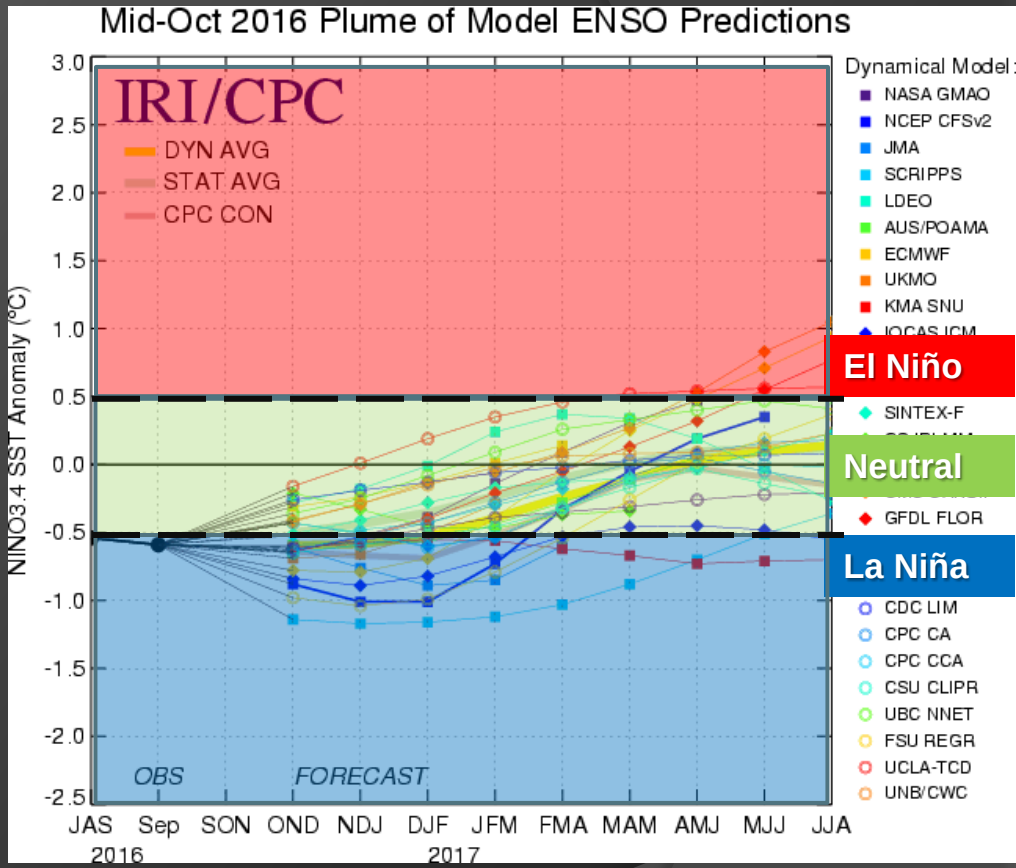
- During the last four weeks, equatorial SSTs were above average near the Maritime Continent and in the Atlantic. Equatorial SSTs were below average across the central and east-central Pacific Ocean.



Weak La Niña Conditions Expected in the Tropical Pacific

Weak La Niña conditions are slightly favored over ENSO Neutral conditions through winter 2016-17.





Time periods in figures are for three month periods.
SON = September, October and November
OND = October, November and December
NDJ = November, December and January
DJF = December, January and February
JFM = January, February and March

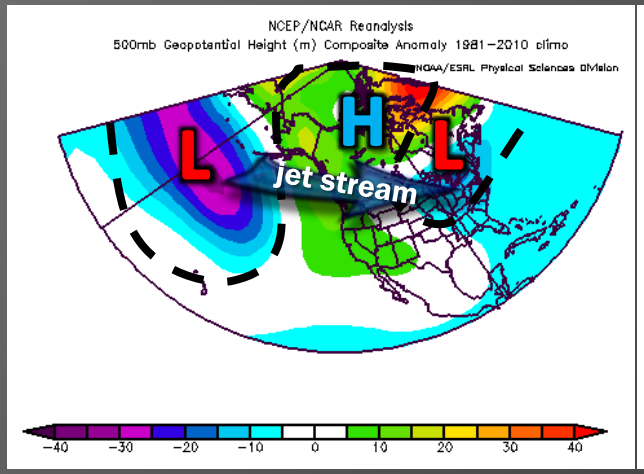
La Niña Categorization

-0.5 °C to -0.9 °C: Weak
-1.0 °C to -1.4 °C: Moderate
-1.5 °C & colder: Strong

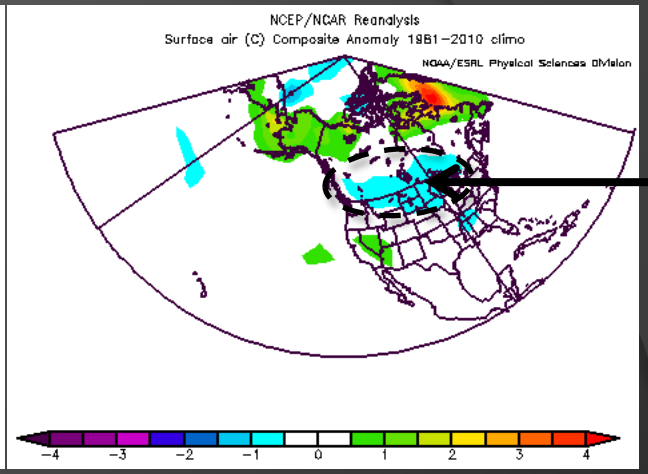
ENSO Neutral

-0.1 °C to -0.4 °C: Cold Neutral
+0.1 °C to +0.4 °C: Warm Neutral

Weak La Niña/ENSO Cold Neutral Composite

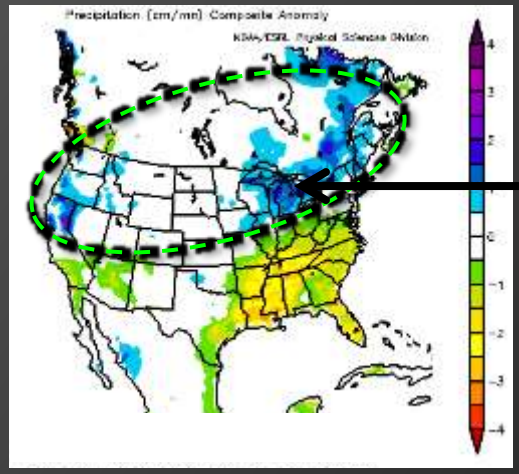


Upper Level Pattern



Cool signal

Temperature Anomalies



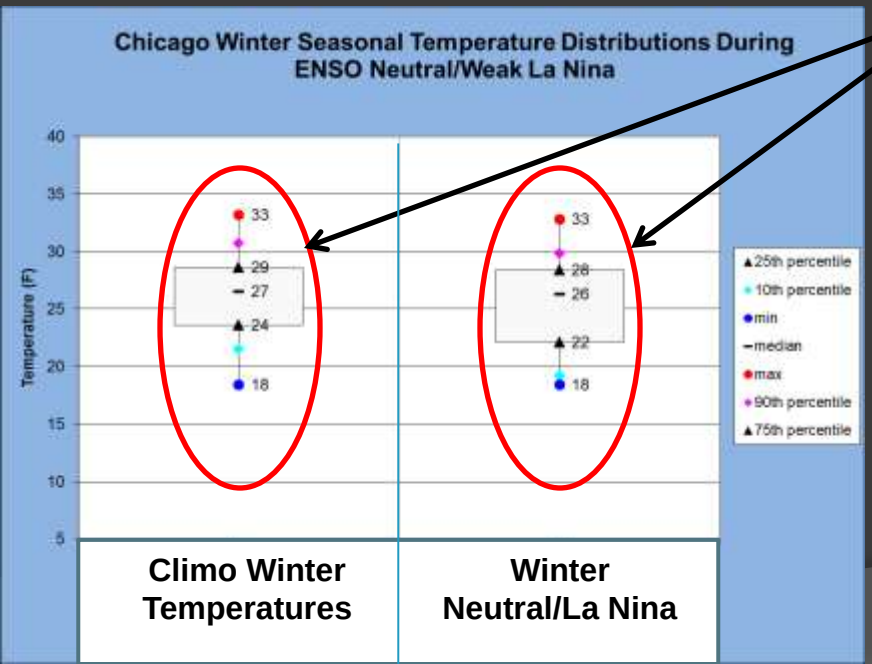
Wet signal

Precipitation Anomalies

- Potential for slightly below average temps over the northern U.S.
- Potential for above average precipitation (liquid equivalent) over the Great Lakes region.

Weak La Niña to ENSO Neutral Local Temperatures

- Average winter monthly temperatures indicate a slight colder than average bias locally during Weak La Niña to ENSO Neutral events.
- In spite of this signal, temperature distributions shown below on the left indicate that any colder signal is not statistically significant.
- Given the weak signal, the current forecast from the Climate prediction center has the area in Equal Chances for above, below or near normal temperatures this winter.



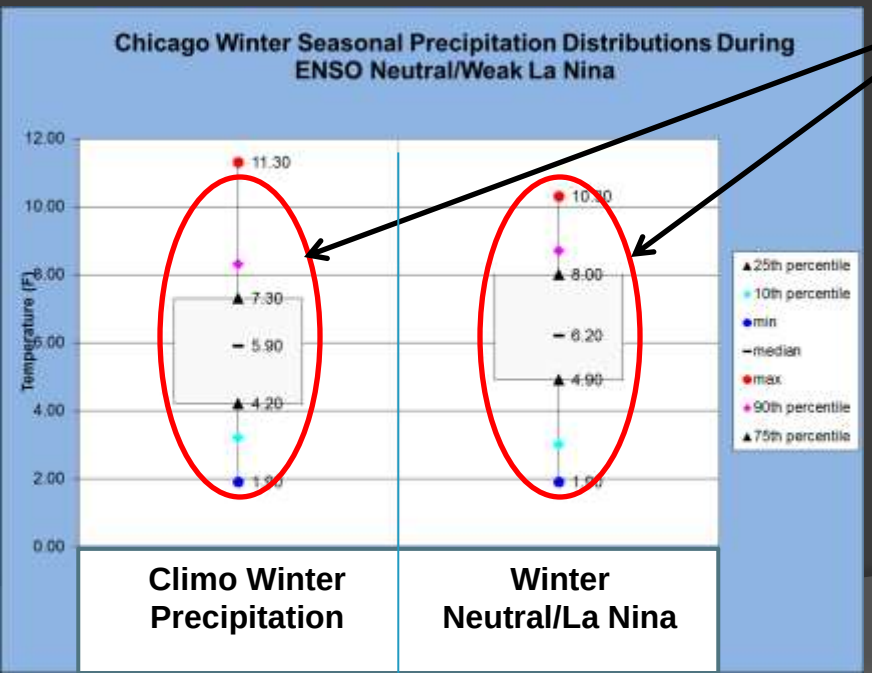
No major difference noted with the temperature distribution during ENSO Neutral/Weak La Niña.

Chicago, IL	1950-2016	25 events
Temperatures	Average	Neutral/La Niña anomaly
December	28.4°F	-1.2°F
January	23.2°F	-0.7°F
February	27.1°F	-0.9°F

Weak La Niña to ENSO Neutral Local Precipitation

- Average winter monthly precipitation (liquid equivalent) tends to be above average locally during ENSO Neutral to weak La Nina events.
  - ➢ This was found to be especially true in January and February, when precipitation amounts averaged 17-19% higher than the 1981-2010 average.

- Precipitation here is a result of both rain and snow events, therefore higher precipitation does not necessarily mean more snow (though a weak signal for higher snow amounts was found).



Tendency for higher winter precipitation.

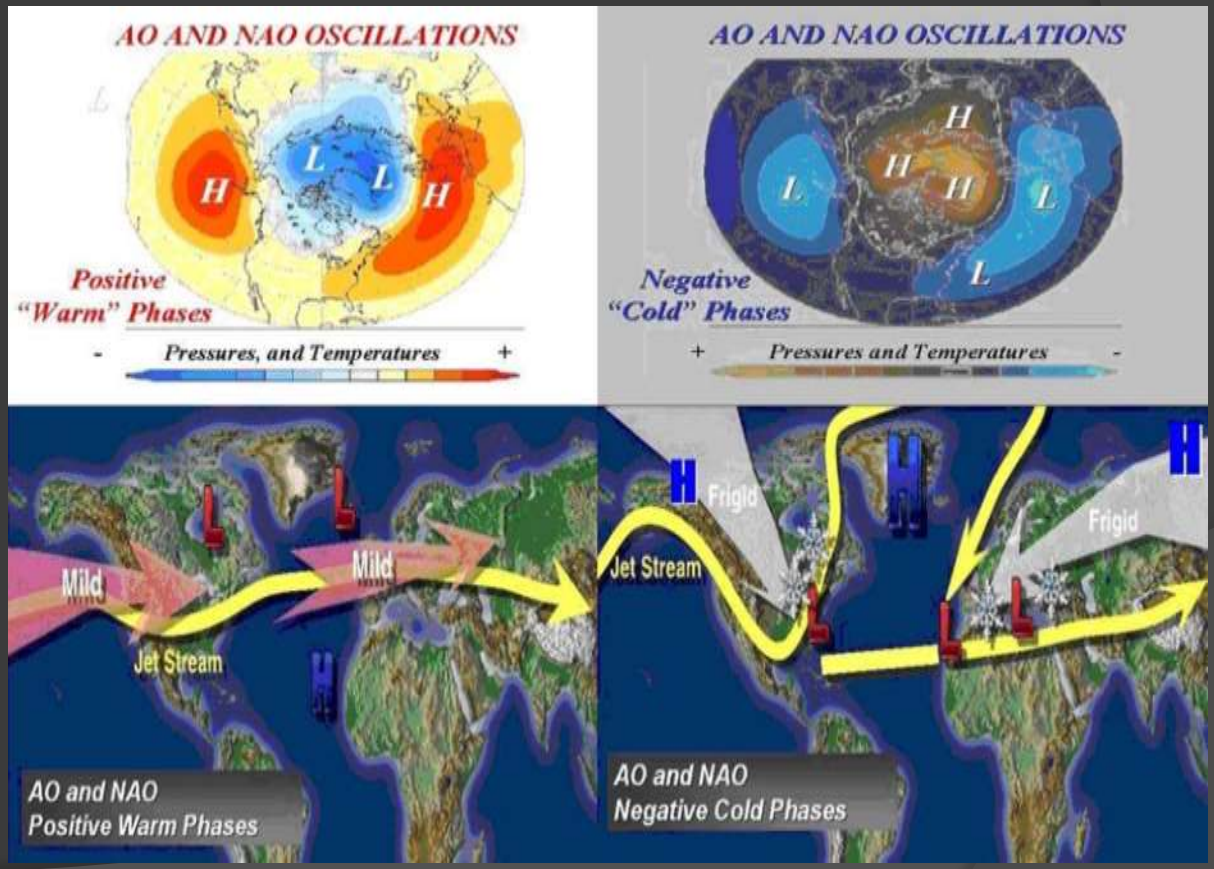
Chicago, IL	1981-2010	25 events
Precipitation	Average	Neutral/La Nina anomaly
December	2.25”	+0.04”
January	1.73”	+0.29”
February	1.79”	+0.35”

What Are Some Other Factors to Consider?

The Arctic and North Atlantic Oscillations (AO/NAO)

- Consists of the positive and the negative phases shown in the image below.

- Negative phase favors more arctic outbreaks with colder than normal conditions and more snowfall across the eastern half of the country.
- Positive phase favors warmer and drier conditions across the eastern half of the country.



The Arctic and North Atlantic Oscillations (AO/NAO)
Local Data

Chicago, IL	*35 events*	*27 events*
Temperature anomalies	*+AO/NAO*	*-AO/NAO*
December	+1.7°F	-2.7°F
January	+1.7°F	-2.3°F
February	+0.6°F	-0.5°F
Chicago, IL	***35 events***	***27 events***
Snowfall anomalies	*+AO/NAO*	*-AO/NAO*
December	-1.5”	+2.9”
January	-1.5”	+1.8”
February	-0.3”	-0.6”
Winter	-3.4”	+2.6”

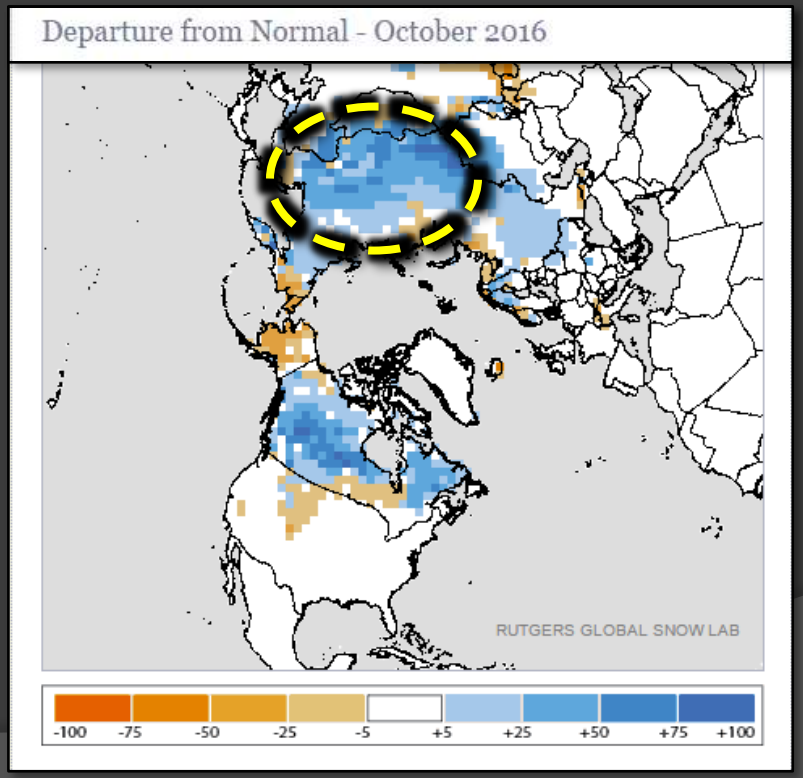
The Arctic and North Atlantic Oscillations (AO/NAO)

- A predominantly negative (positive) AO/NAO *could* enhance the chances for a lean towards colder (milder) conditions.

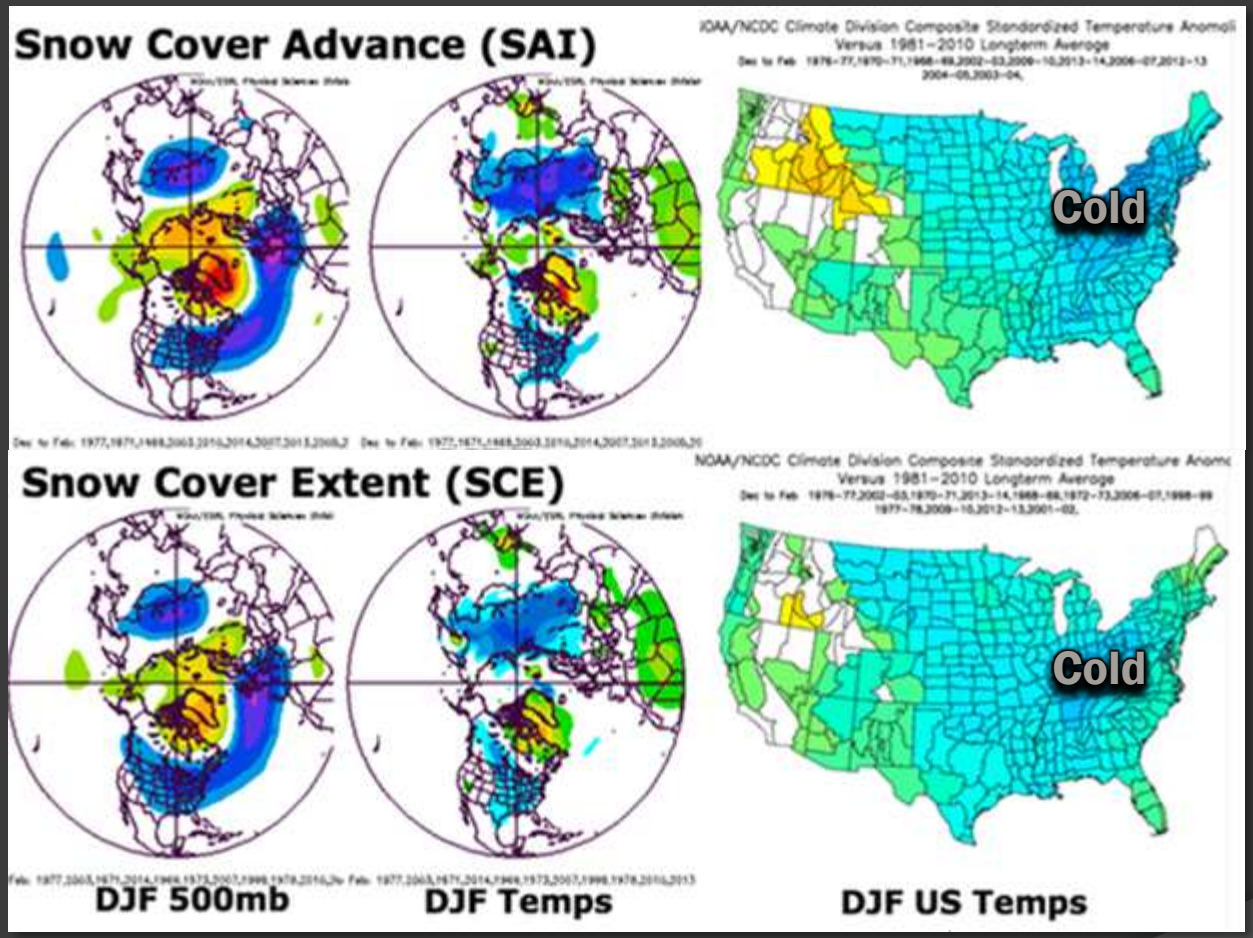
  → ***Somewhat unpredictable beyond a few weeks, though new research within the past few years is promising in terms of predictability of the predominant seasonal scale AO/NAO pattern.***

Rapid October Buildup of Snow Cover Across Eurasia

- Some research suggests that there is a strong correlation between rapid snow advancement and overall extent across Siberia and Eurasia during October and winter temperatures over the Eastern CONUS.
- The research suggests this can favor a predominantly –AO during the following winter season.
- October snow built up very rapidly across Siberia, which *could* drive a –AO this winter. *Snow cover extent across Eurasia in October 2016 was the 3rd highest in the period of record after 1976-77 and 2014-15 (both were cold winters across the eastern CONUS).*
- Therefore, AO *could* average negative this winter.



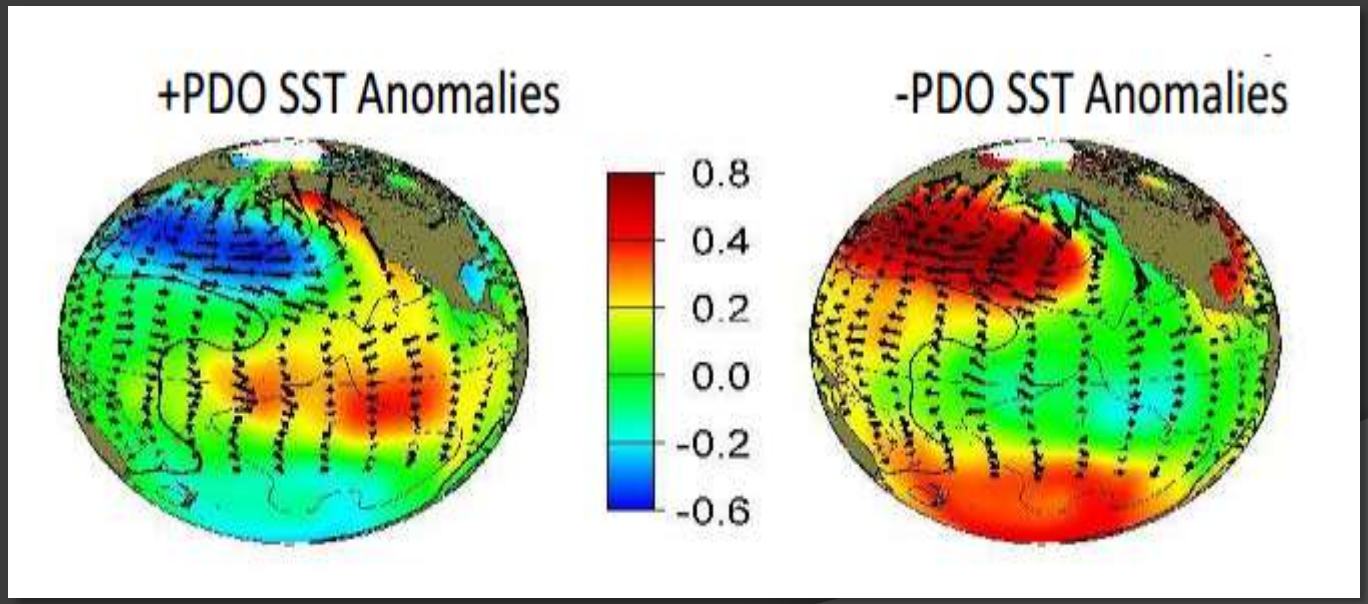
Winters With High Eurasian Snow Cover Advance and Extent



- Higher upper level atmospheric pressure over the polar region during the –AO/NAO displaces the upper level jet stream farther south over the country.
  - Favors colder than average conditions, especially across much of the eastern half of the CONUS.

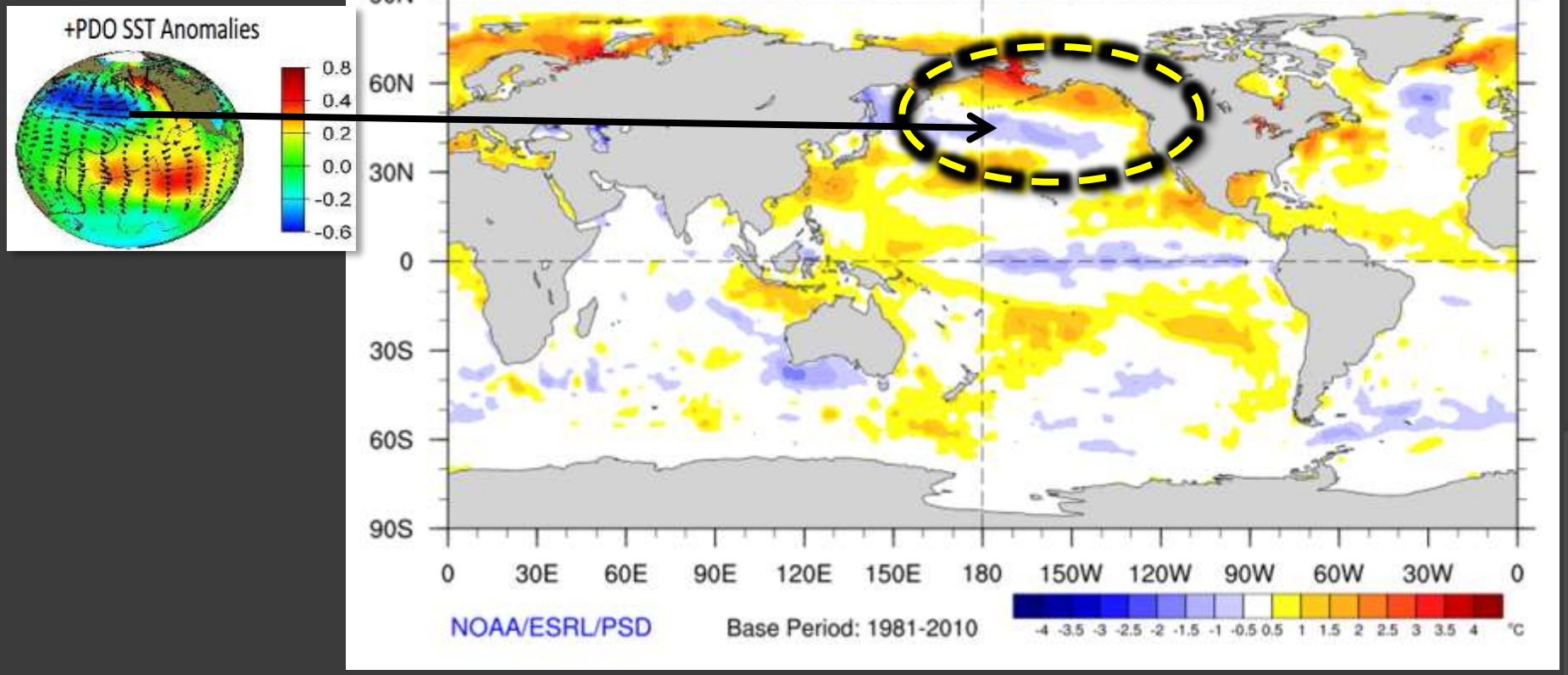
Pacific Decadal Oscillation

- **PDO is the Pacific Decadal Oscillation**
  - A pattern of SST anomalies in the central and northern Pacific
  - Has a positive (warm) and negative (cool) phase
  - Tends to have an impact on the upper level pattern across North America in the winter
  - Usually has a pattern of predominant phases that lasts 20-30 years but does have year to year variability



Pacific Decadal Oscillation

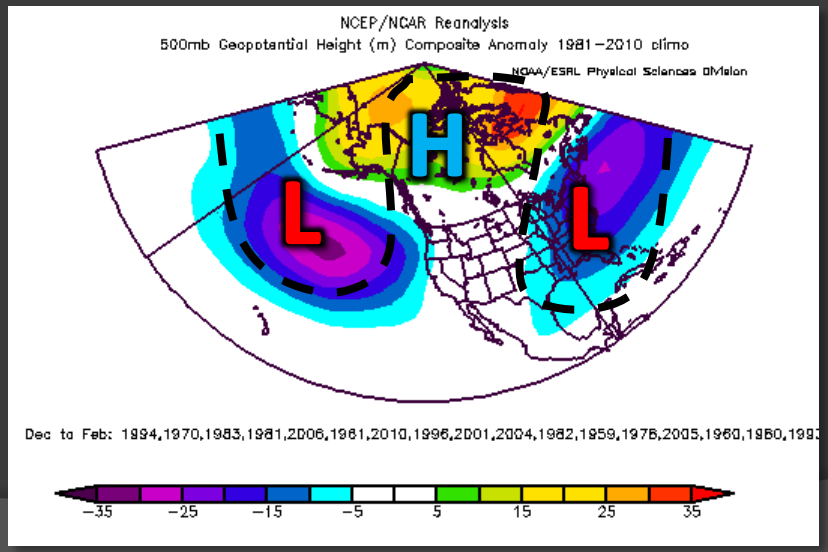
- **Current conditions: SST pattern in central and northern Pacific more closely resembles +PDO.**



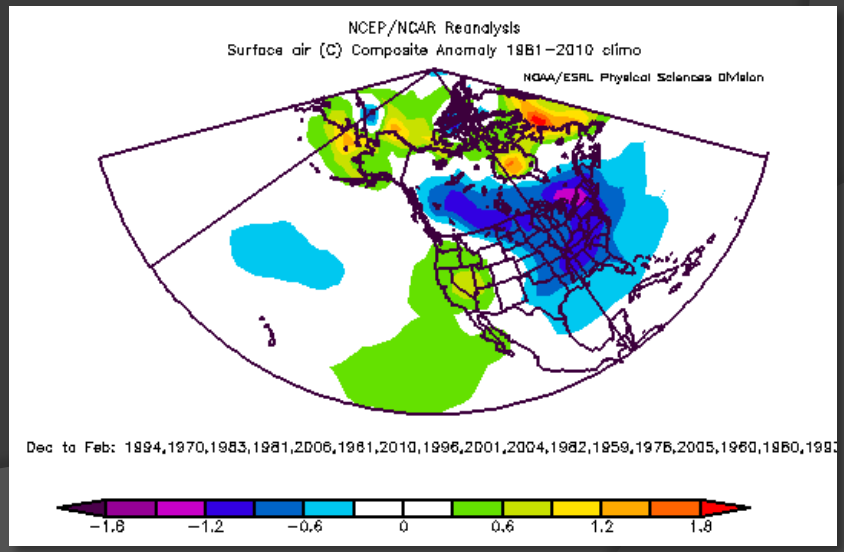
Pacific Decadal Oscillation

- **The PDO has been predominantly positive since 2014.**
  - **PDO was predominantly strongly positive from Fall 2014 through July 2016**
  - **It has since weakened → October value was +0.56**
- **Based off current weakly positive PDO, it's possible that the PDO could average weakly positive (0.25 to 1) in December-February 2016-17.**
- **If a weakly +PDO occurs, past similar episodes have tended to support a buckled jet stream and colder winter season conditions across the eastern half of the CONUS, with a signal for a –AO/-NAO (high pressure/warm colors over Arctic region on upper level pattern plot).**

Upper Level Pattern
PDO +0.25 > +1 in Dec - Feb

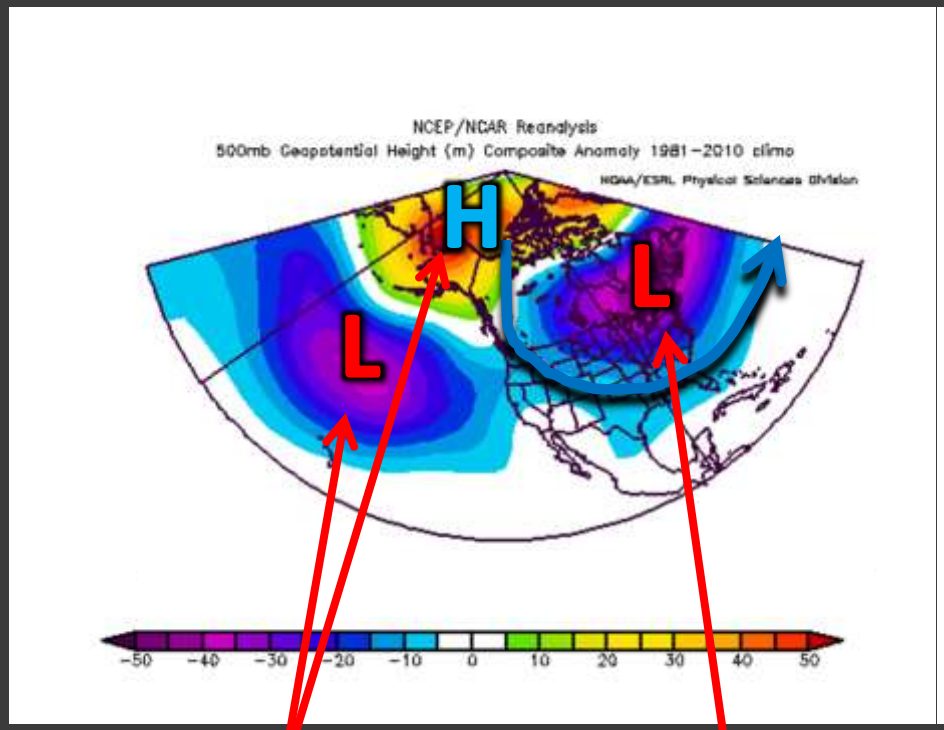


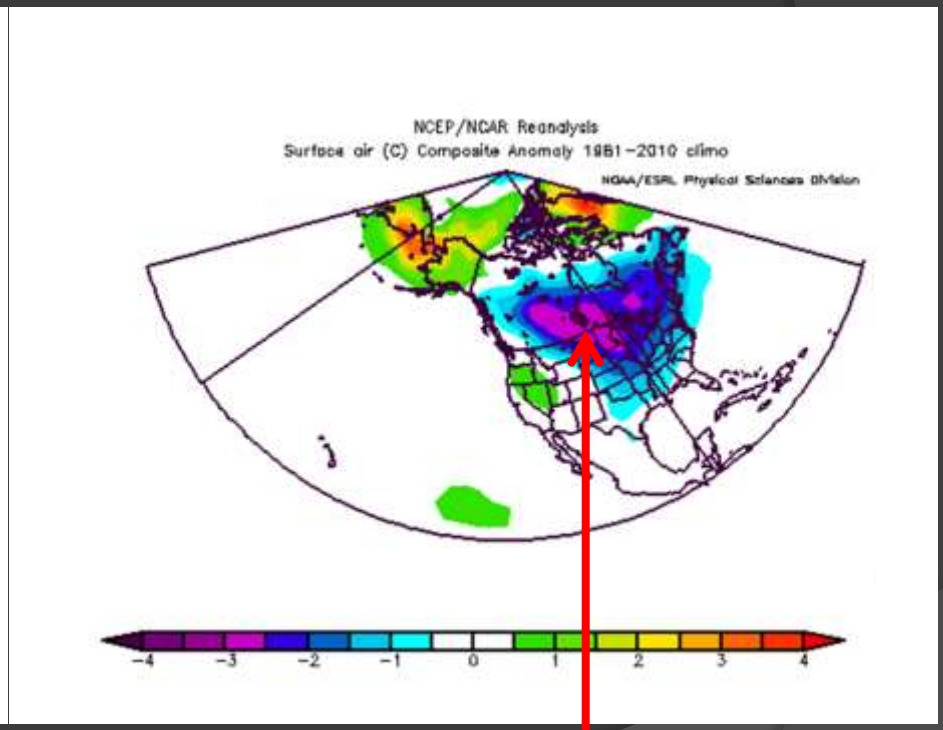
Temperature Anomalies
PDO +0.25 > +1 in Dec - Feb



“Alaska Ridge Pattern”(-EPO)

- The jet stream pattern becomes buckled in this phase, with a deep trough and colder than normal conditions over the central and eastern CONUS.





Strong Blocking

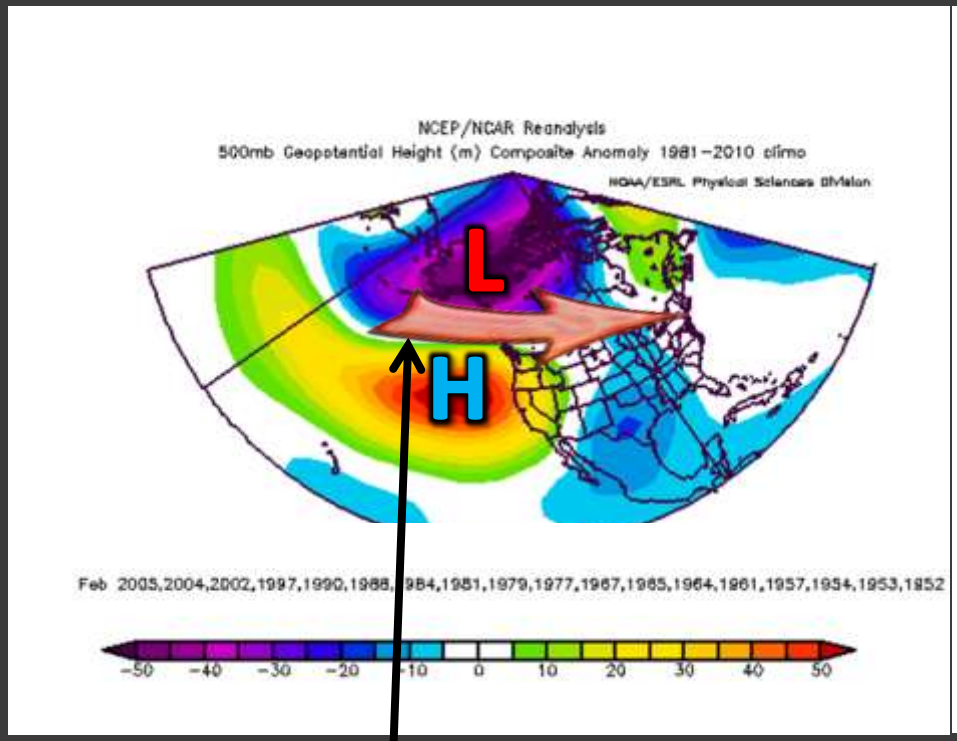
-NAO/AO signal

Deep cold

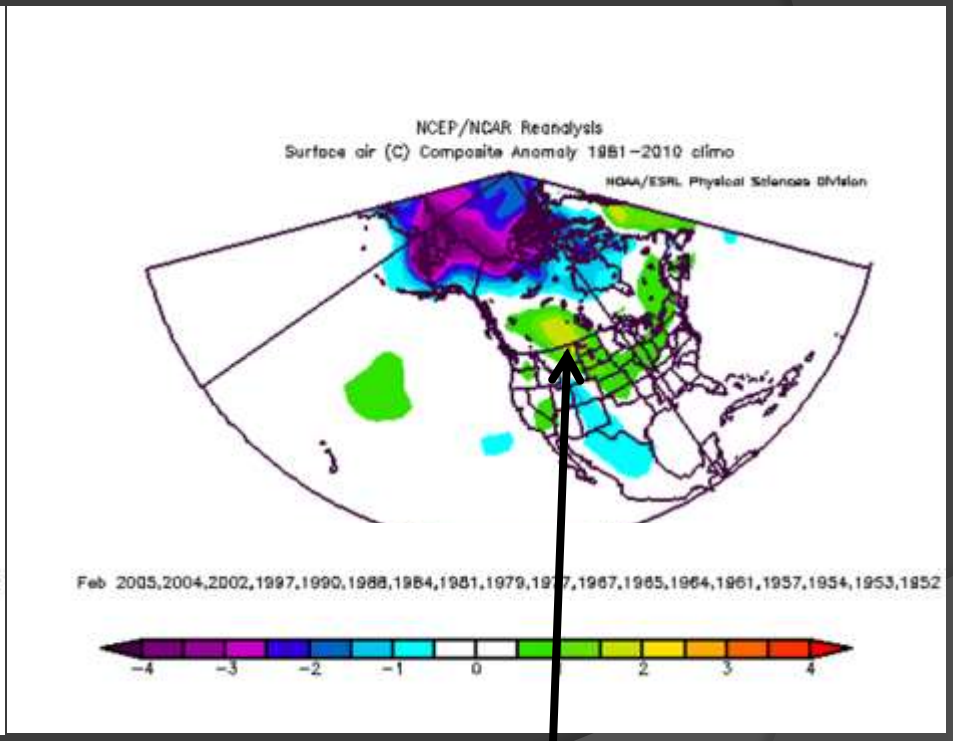
EPO: East Pacific Oscillation

“Alaska Trough Pattern”(+EPO)

- The jet stream becomes strong over the eastern Pacific, which allows mild Pacific origin air masses to dominate over the CONUS, with the deep cold remaining well north.



Strong and Mild Pacific Jet



Near to above normal temperatures

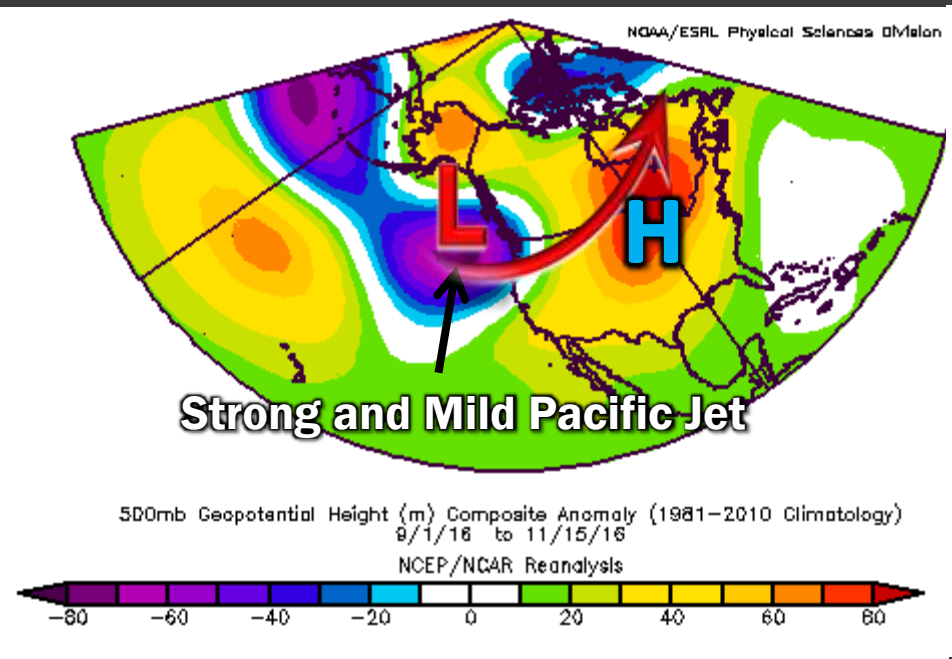
EPO: Local Data

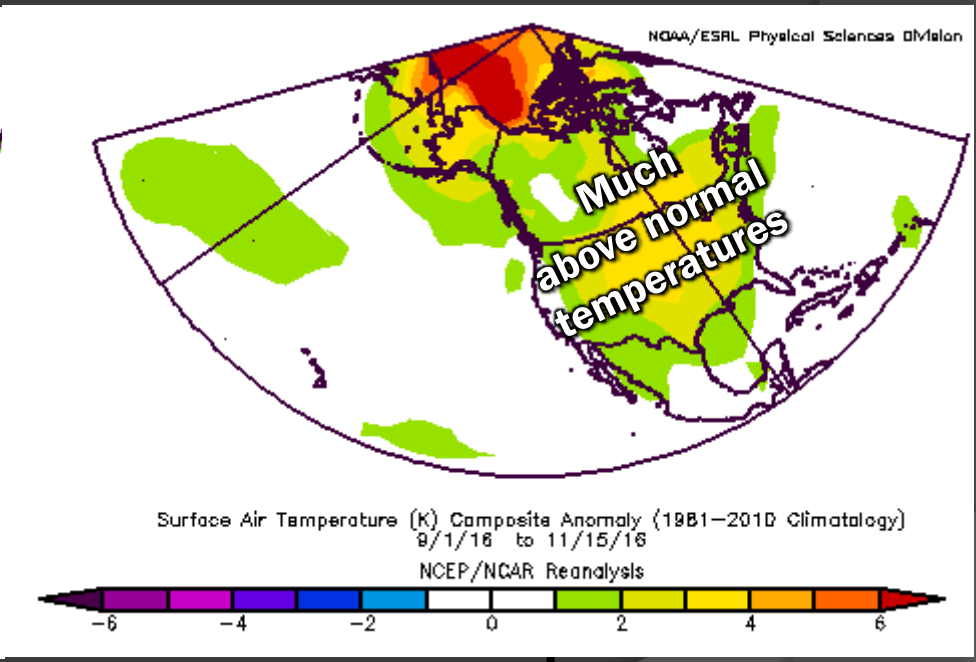
Chicago, IL	1950-2016	(- EPO)	(+EPO)
Temperatures and anomalies	Average	"Alaska Ridge"	"Alaska Trough"
December	28.4°F	-4.9°F	+2.3°F
January	23.2°F	-2.9°F	+2.8°F
February	27.1°F	-2.5°F	+1.4 °F

Chicago, IL	1950-2016	(+ EPO)	(-EPO)
Snowfall and anomalies	Average	"Alaska Trough"	"Alaska Ridge"
December	9.8"	-4.5"	+1.8"
January	11.8"	-1.0"	+2.7"
February	9.8"	+0.7"	+1.7"
Winter Season	31.2"	-3.5"	+7.2"

Near Record Warm Fall 2016

- Persistent deep upper level low pressure off the Pacific Northwest Coast has resulted in a strong and mild Pacific jet stream continuously flooding the US and much of Canada with warm air masses.
- As of mid November, this fall has been among the warmest on record. The cold air in the Northern Hemisphere has been directed into Eurasia.





- There are no signs yet of this overall pattern breaking down. If it does not significantly shift, the outcome this winter could be warmer than normal, regardless of AO/NAO phase etc.

Summary

Based on what we know now:

- Weak La Niña to cold neutral ENSO conditions expected through the winter.
- No strong local temperature signal during these events, though some tendency to trend colder than normal.
- There is a signal for near to above normal precipitation this winter, which could translate to above normal snowfall if temperatures end up cold enough.

Things to watch/keep in mind:

- Arctic Oscillation (AO) and North Atlantic Oscillation (NAO).
  → Snowfall built up very rapidly across Eurasia in October (research has shown a correlation for cold eastern CONUS winters –AO). This could mean a –AO/NAO this winter, which would support colder conditions.

- The pool of warm SST's in the Northeast Pacific (+PDO → -EPO/Alaska Ridge Pattern).
  → Currently in weakly positive phase. Positive PDO winters have shown a tendency for colder conditions in the eastern half of the U.S. due to the tendency for more Northeast Pacific/western North America ridging (-EPO/Alaska Ridge pattern) and hence an increasingly buckled jet stream pattern over eastern North America.

- It's been an exceptionally warm fall. If the large scale weather pattern fails to shift in the coming months, warmer conditions would be favored this winter, and potentially less snowy as well.

Conclusion

NWS Chicago Outlook for Winter 2016-17
Northern/Central IL and Northwest Indiana

Overall, there are some signs pointing to an increased potential for a near normal to slightly colder than average winter and near to above average precipitation. However, this is highly dependent on the current large scale pattern shifting into a more favorable pattern for colder conditions.

- **Temperatures: Near normal to slightly below normal**
  - **Confidence: low**
- **Precipitation: Near to above normal**
  - **Confidence: medium**
- **Snowfall: Near to above normal**
  - **Confidence: low-medium**

Thanks for Reading!

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