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WINTER 2017 - 2018

OUTLOOK

WHAT FACTORS WILL PLAY A ROLE THIS WINTER?

Overview

- **Bottom Line Up Front**
- **What are normal winter season conditions in northern IL and NW IN?**
- **CPC Winter Outlook**
- **Developing La Niña conditions in the tropical Pacific expected to persist through the winter (55%-65% probability)**
 - **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.**
 - **Quasi-Biennial Oscillation (QBO) Phase**
 - **Alaska Ridge and Trough Pattern (+/- EPO)**
 - **Impact of November pattern & temps on winter pattern & temps.**
- **Summary: What we know now and things to consider.**
- **Conclusion: NWS Chicago Outlook for Winter 2017-18**

Bottom Line Up Front

La Niña conditions in place and will continue through the winter.

- Means cooler than normal Sea Surface Temps (SST's) in the eastern and central equatorial Pacific, which can significantly impact jet stream pattern/storm track across North America. This is why we care about it.

What could this mean for us?

- A more active weather pattern across our region, with good potential for above average winter precipitation (rain and/or snow).
 - Difficult to say if this will translate into above average snow, but a more active weather pattern could result in above average snow.
- Periods of both very mild weather and deep cold.
 - Highly variable day-to-day temperatures, with the noteworthy cold and mild periods possible due to a more active weather pattern.
 - This makes it difficult to say if the winter will end up warm, cold or near normal overall.
- Possible cold season severe weather events?
 - Some recent La Niñas have featured cold season severe weather in our area, such as: 1/7/08 EF-3 tornado; 11/22/10 EF-2 tornado; 2/28/17 tornadoes, including Ottawa/Naplate EF-3 tornado

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

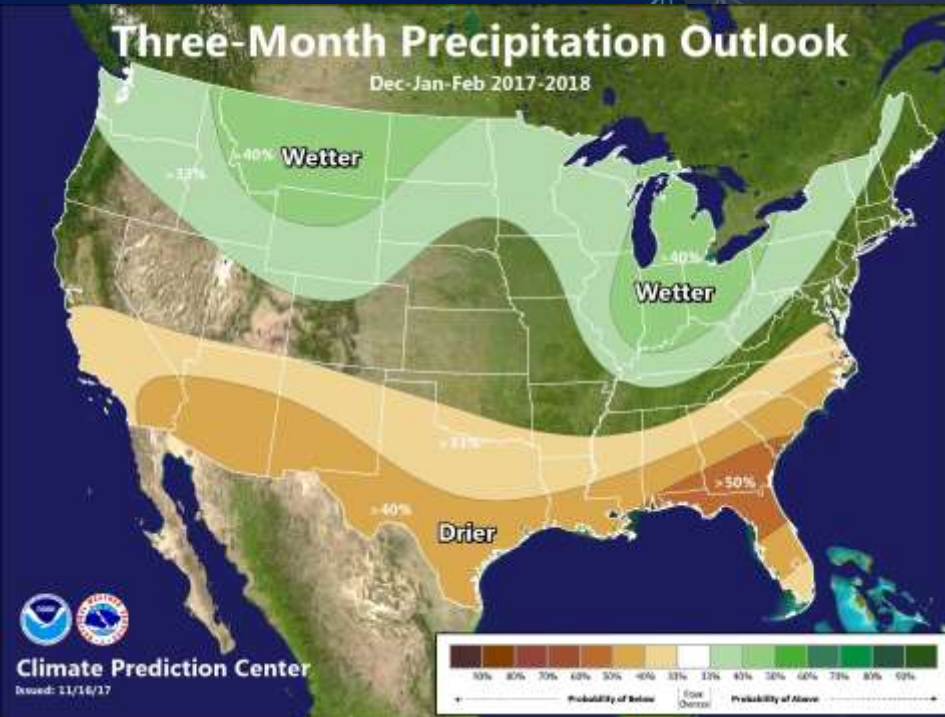
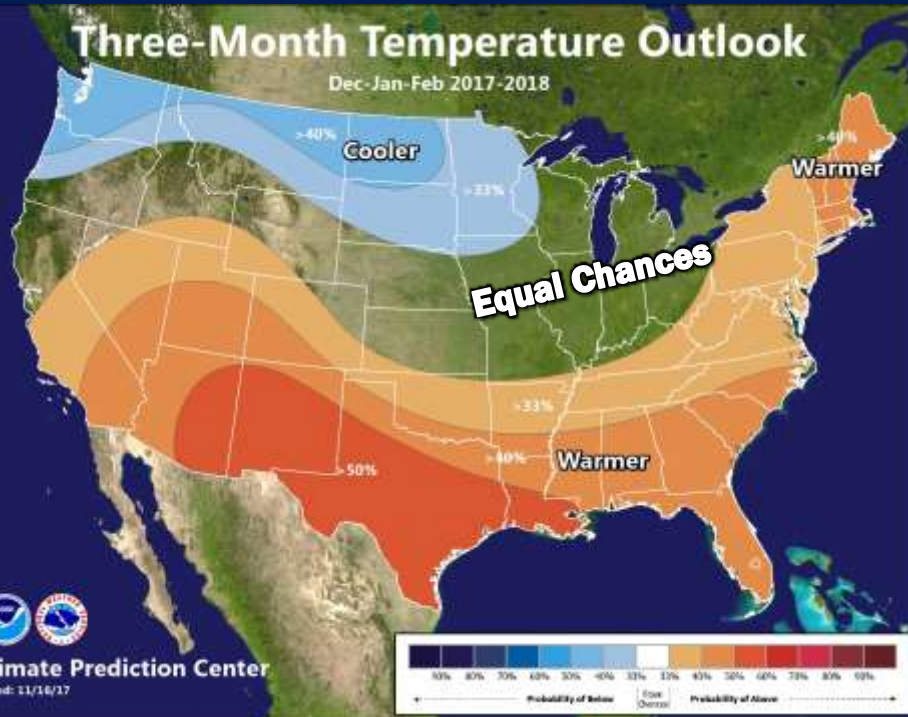
	Chicago	Rockford
December	20.7°	17.7°
January	16.5°	13.5°
February	20.1°	17.7°

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 23.9" to 60.3" in Chicago.
 - Consider seasonal snow amounts of between **28.5" to 48.0"** to be a typical range of snow amounts in Chicago for any given season (snow amounts fell in this range on 15 of the 30 years between 1981-2010).
 - In Rockford this range was between **26.6" to 41.4"**.

Official CPC Winter 2017-18 Outlook



Equal Chances: Equal probabilities of well below normal, near normal or well above normal average temperatures.

- No strong signal for a predominantly colder, near normal or warmer meteorological winter (higher confidence in colder N & W and warmer S & E). Significant temperature variability possible.

Enhanced chance/probability of above normal precipitation (liquid equivalent).

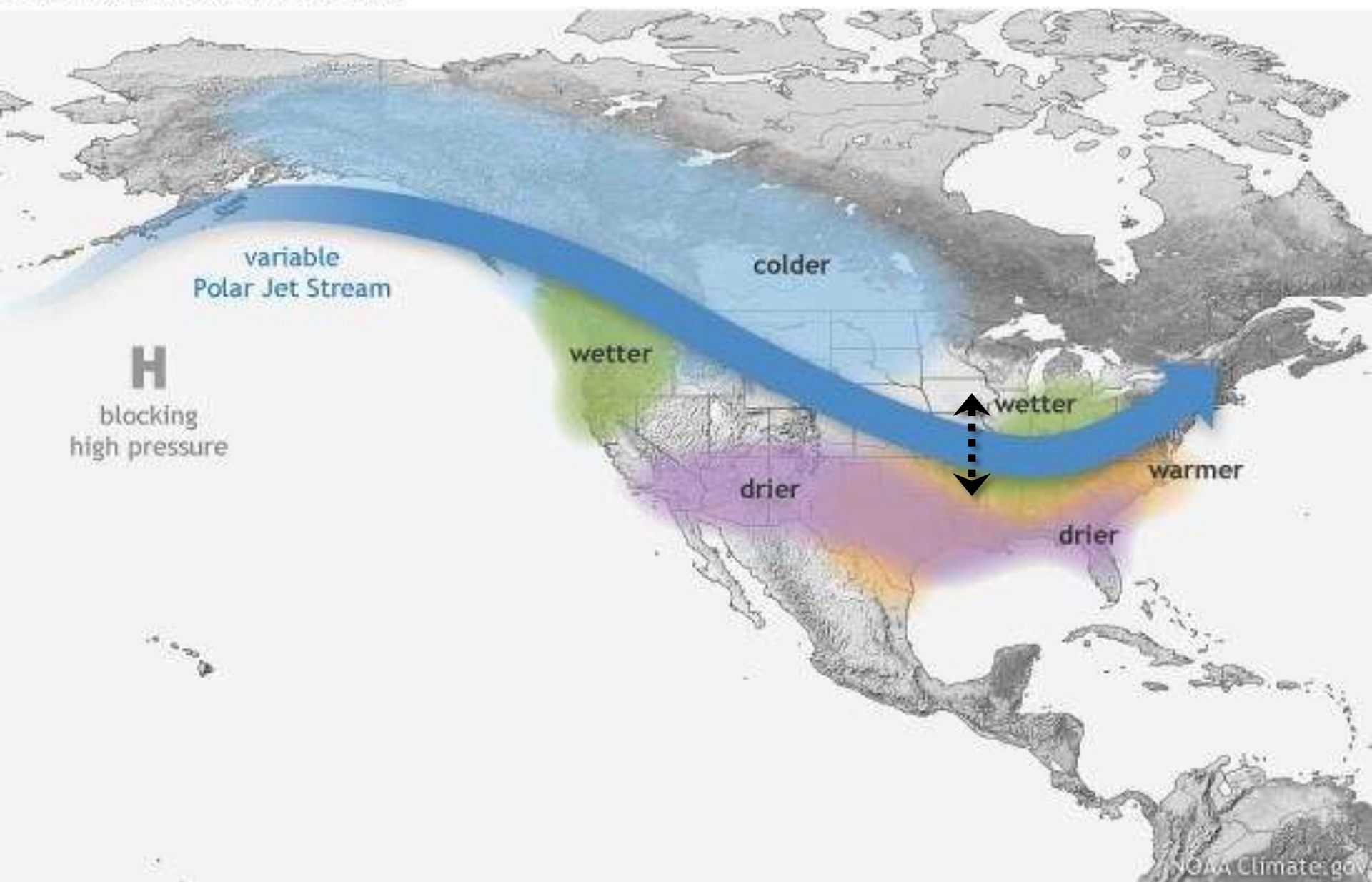
- Not a snowfall forecast.
- Seasonal snowfall amount will depend on the track of individual storm systems and the air mass being sufficiently cold for snow when it does precipitate.

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 $+0.5^{\circ}\text{C}$.
- **La Niña:** characterized by a negative ONI less than or equal to -0.5°C .
- **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 $\pm 0.5^{\circ}\text{C}$ 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 $+0.4^{\circ}\text{C}$
- **Most recent ONI value (July – September 2017): -0.1°C**

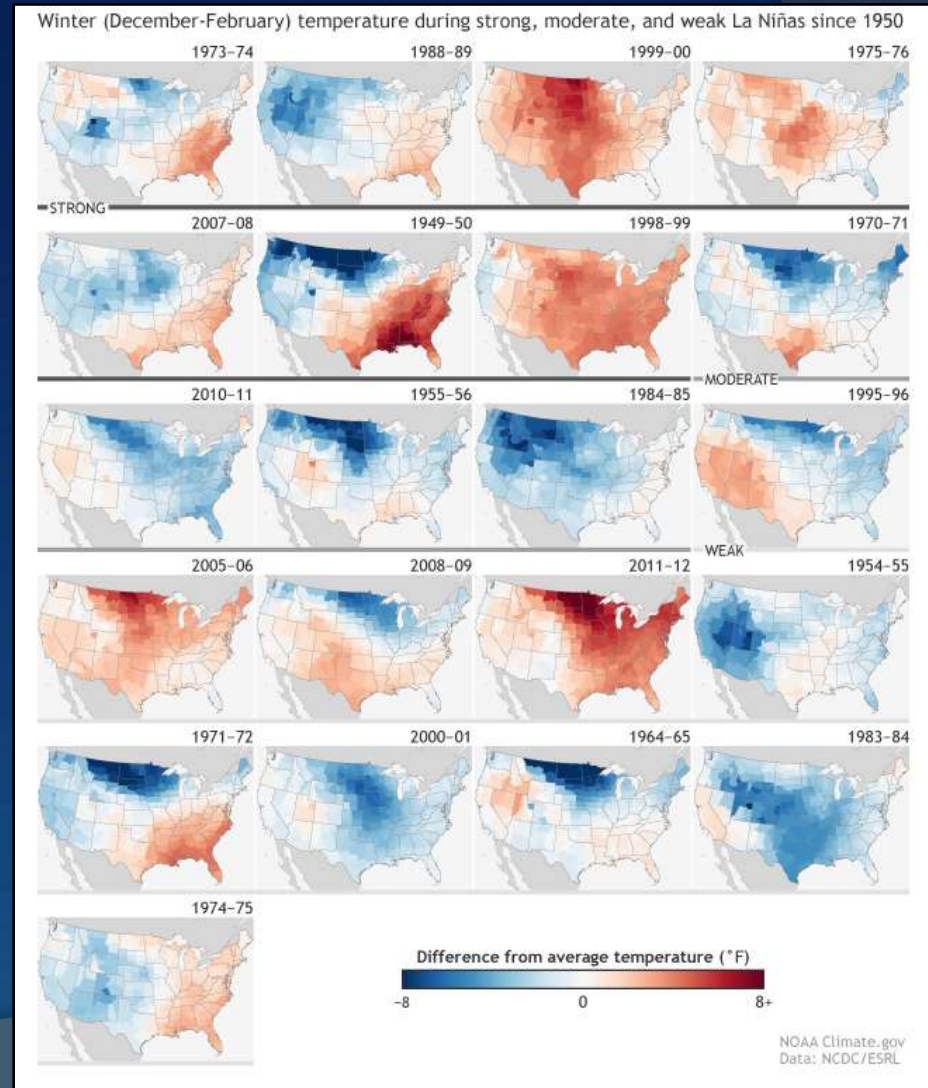
WINTER LA NIÑA PATTERN



Historical La Niña

Winter Temperatures over the CONUS

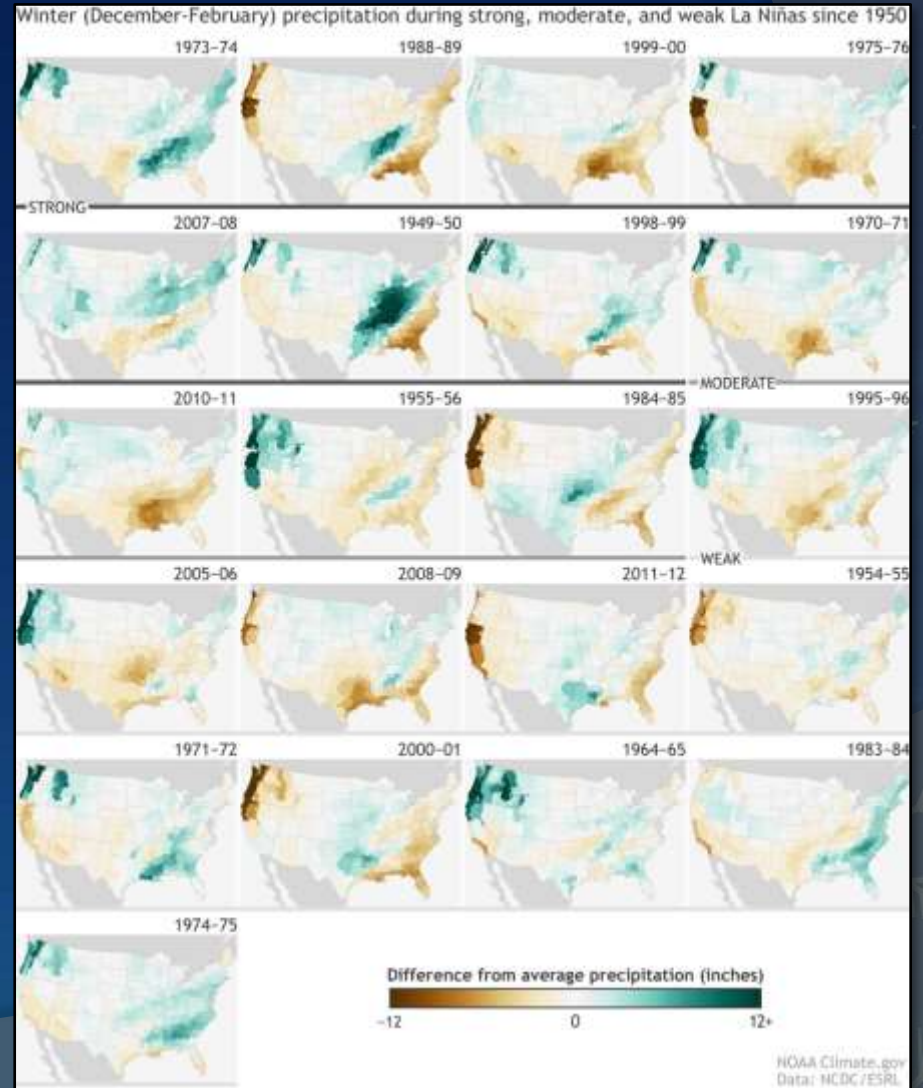
- While stronger events can produce more reliable impacts on the CONUS, it's not always the case.
- Quite a bit of variability between episodes.



Historical La Niña

Winter Precipitation over the CONUS

- While stronger events can produce more reliable impacts on the CONUS, it's not always the case.
- Signal for above normal precip in/near our area in many of the cases.



Niño Region SST Departures (°C) Recent Evolution

The latest weekly SST departures as of 11/13:

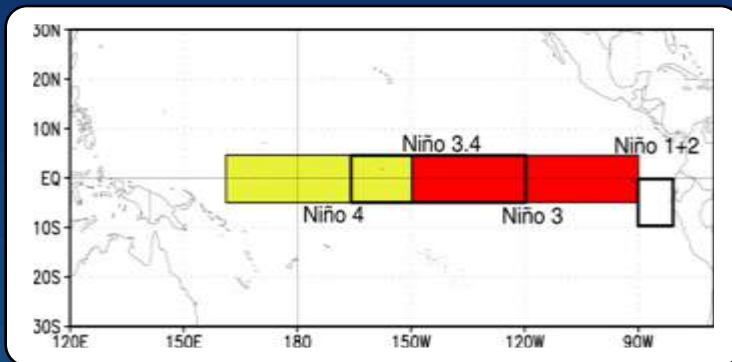
Niño 4 -0.3°C

Niño 3.4 -1.1°C

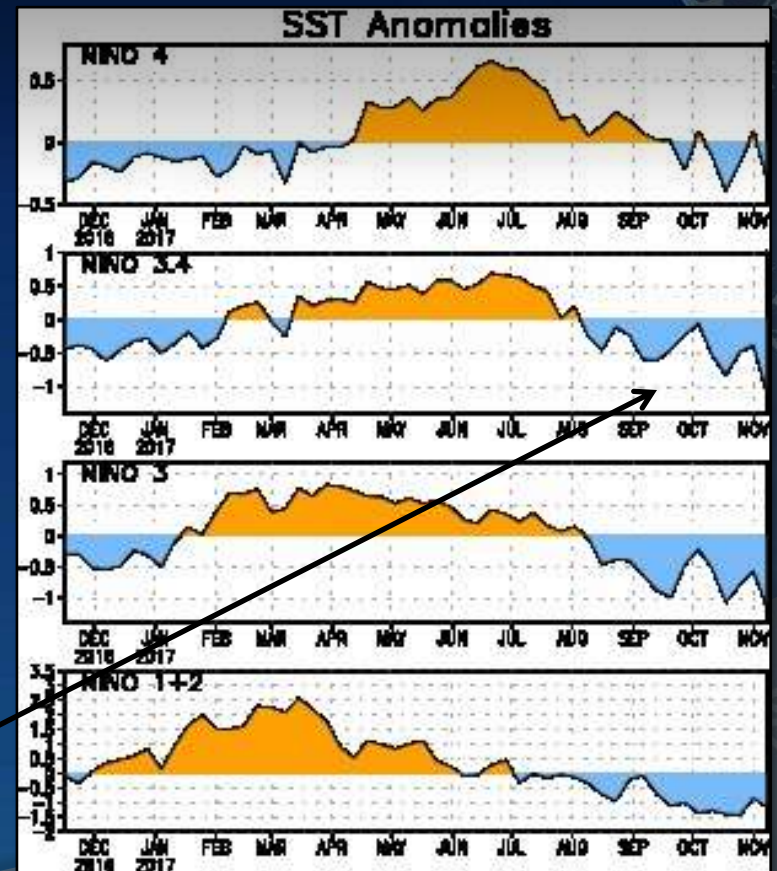
Niño 3 -1.2°C

Niño 1+2 -1.2°C

The latest (Oct. '17) monthly Niño 3.4 index: -0.5°C



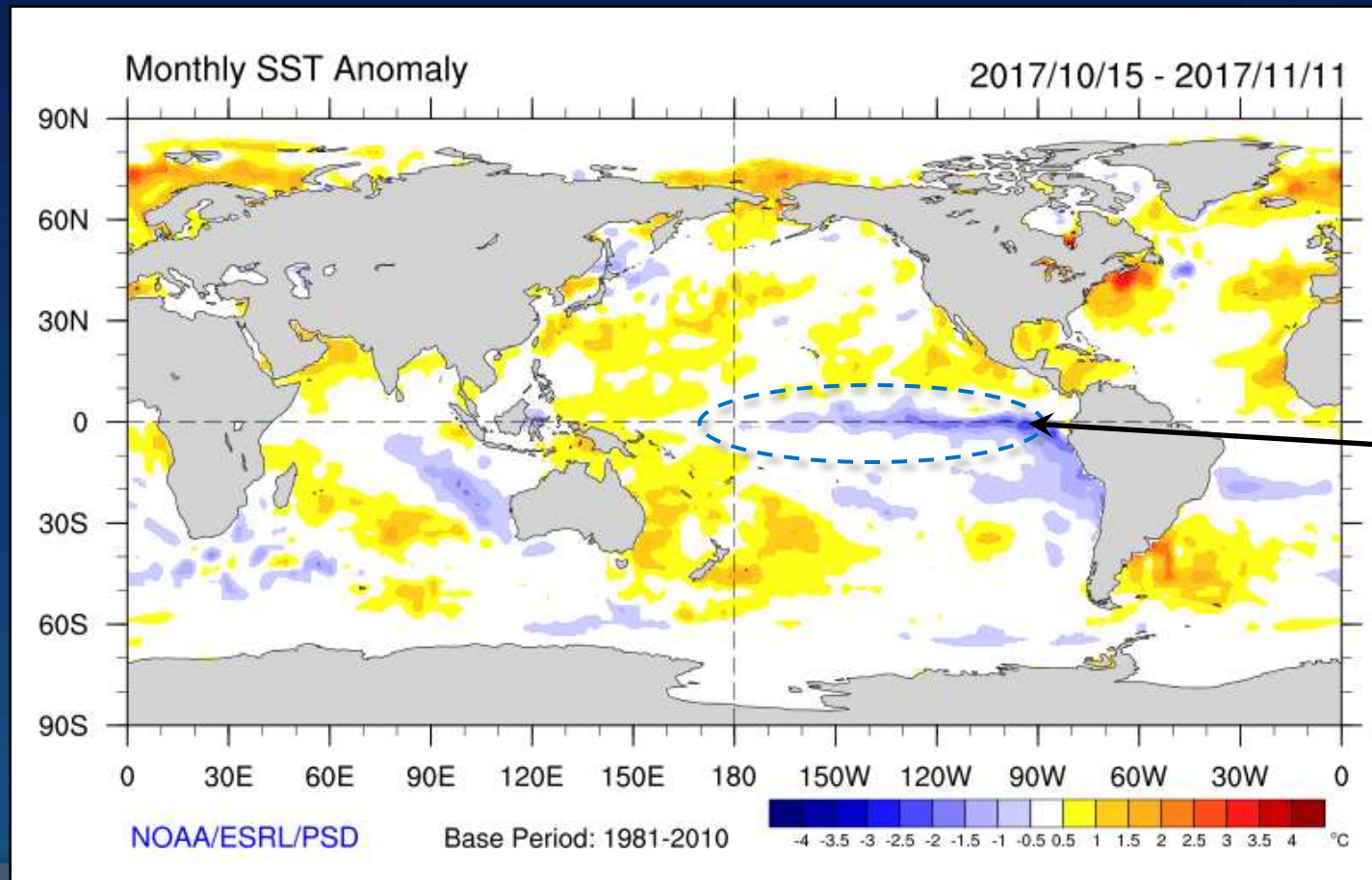
Niño 3.4



ENSO status is determined by SST departures in this region.

Global SST Departures (°C) During the Last Four Weeks

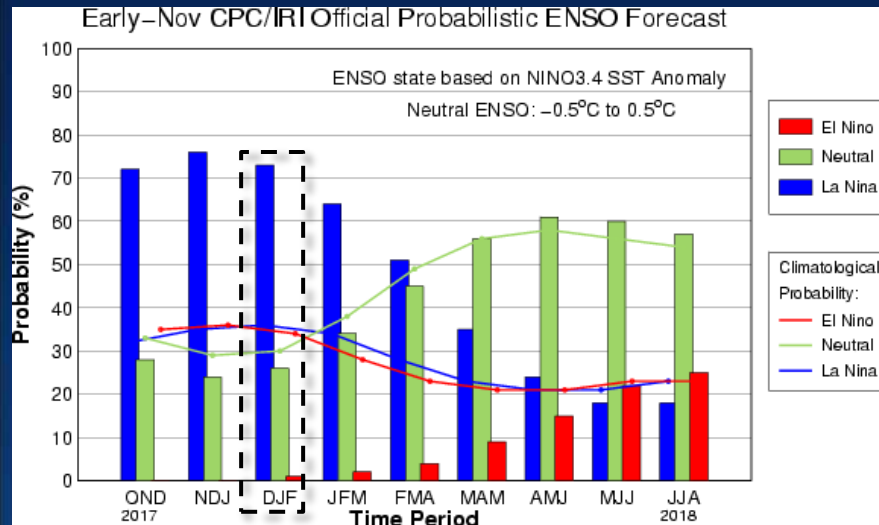
- During the last four weeks, equatorial SSTs were below average in the central and eastern Pacific Ocean.



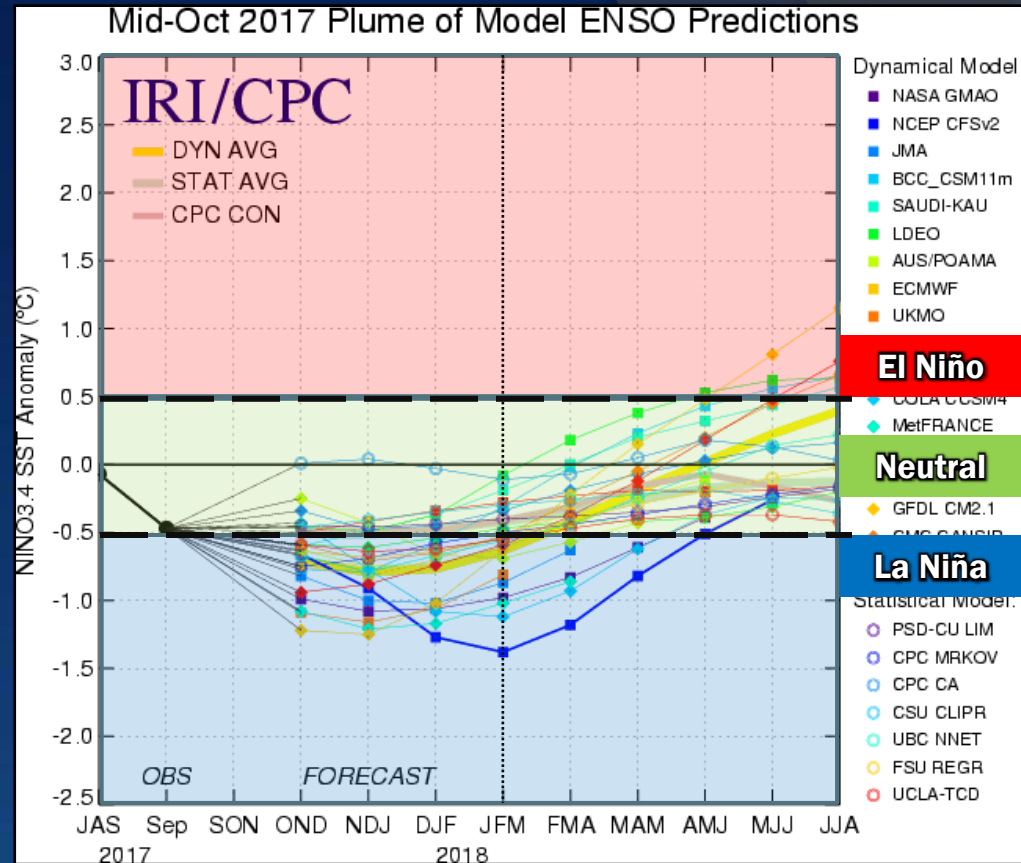
La Niña

La Niña Conditions Expected in the Tropical Pacific

Weak/borderline moderate La Niña conditions are favored through winter 2017-18.



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

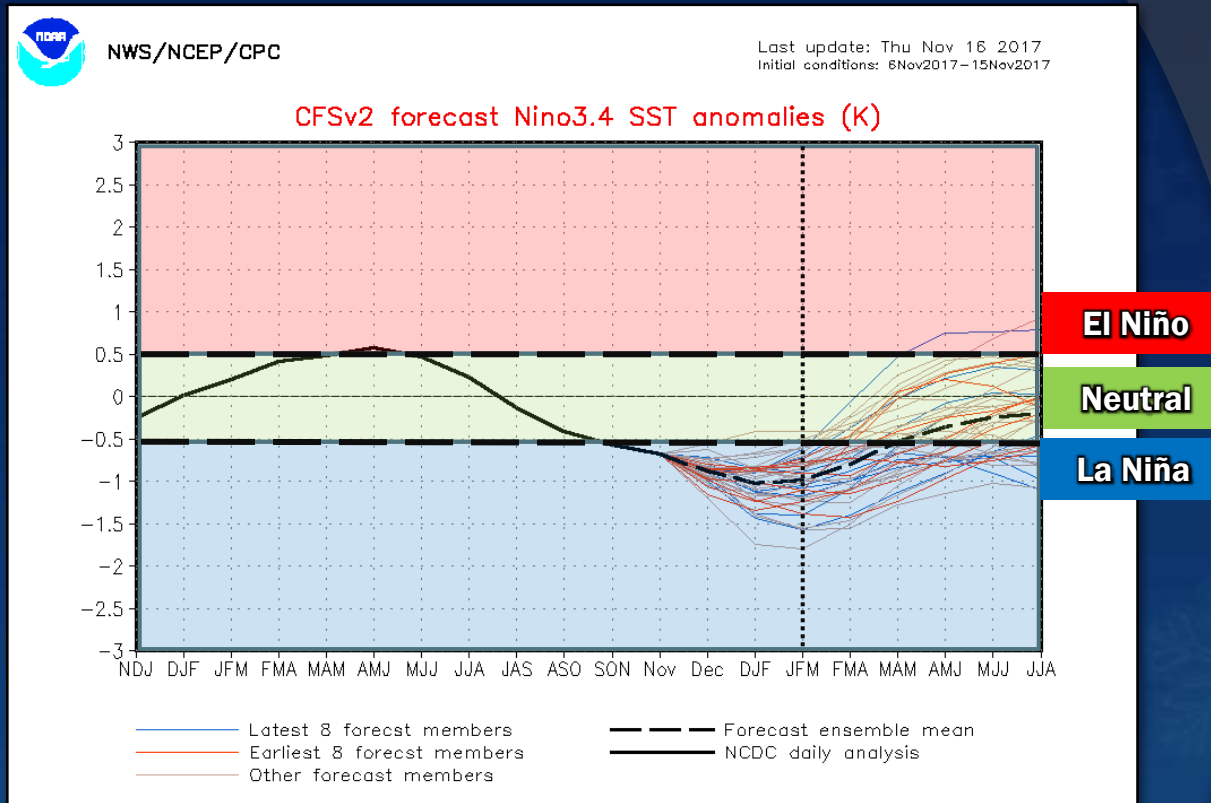
-0.5°C to -0.9°C : Weak
 -1.0°C to -1.4°C : Moderate
 -1.5°C & colder: Strong

ENSO Neutral

-0.1°C to -0.4°C : Cold Neutral
 $+0.1^{\circ}\text{C}$ to $+0.4^{\circ}\text{C}$: Warm Neutral

La Niña Conditions Expected in the Tropical Pacific

CFSv2 Niño 3.4 SST Anomaly Ensemble Forecast



Time periods in figure are for 3-mo. periods.

SON = September, October and November

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La Niña Categorization

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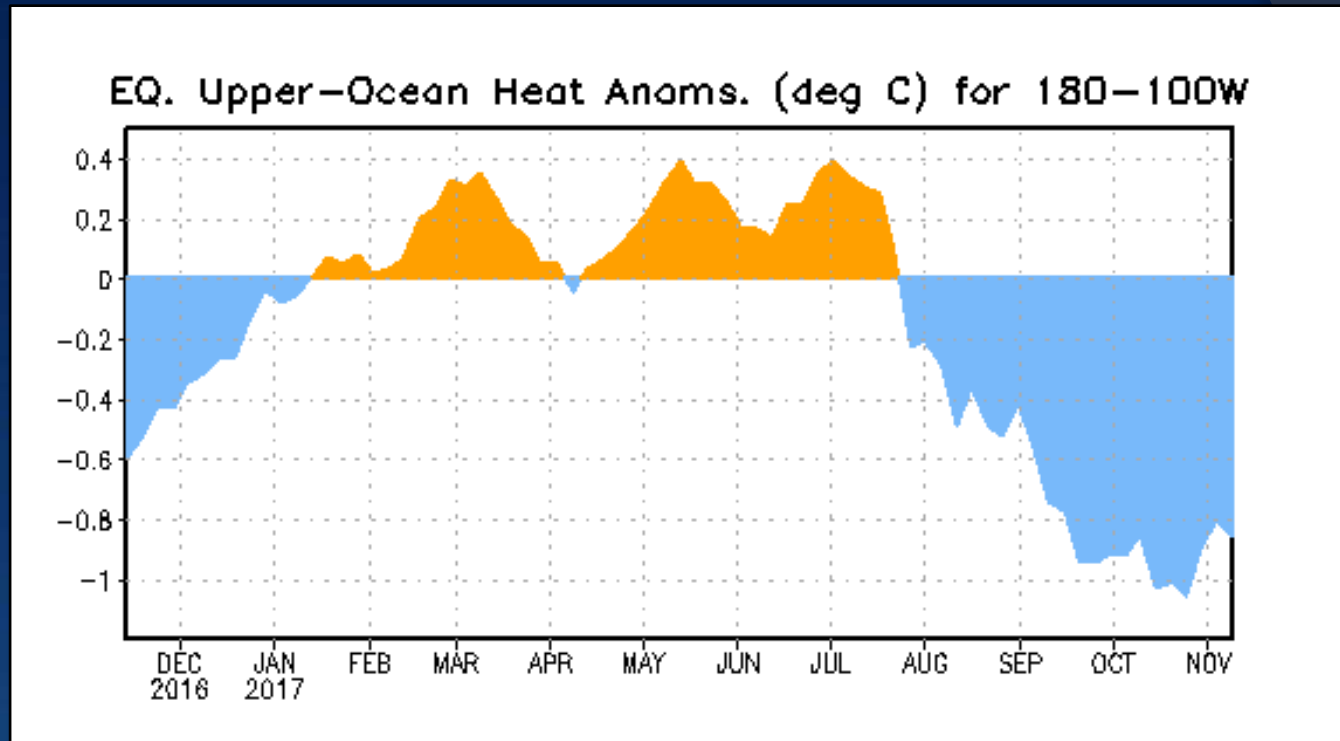
ENSO Neutral

-0.1°C to -0.4°C: Cold Neutral

+0.1°C to +0.4°C: Warm Neutral

La Niña Conditions Expected in the Tropical Pacific

Sub-surface anomalies favor La Niña maintenance at the surface in Niño 3.4 Region

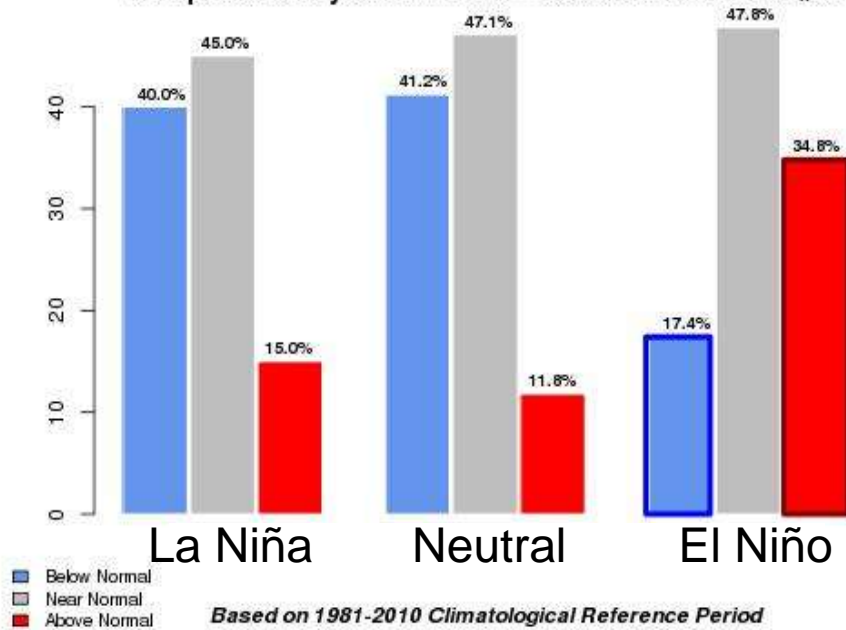


Local Temperatures During La Niña Winters

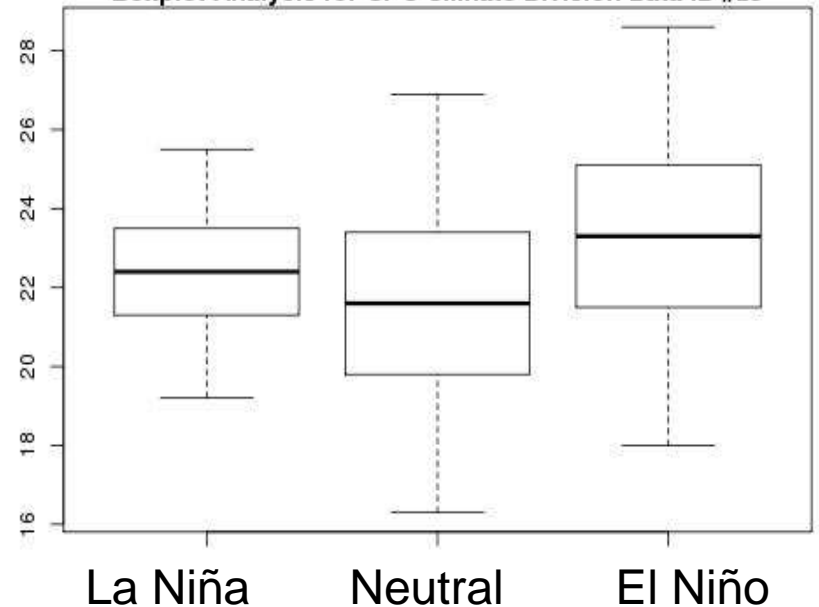
- No statistically significant tendency for temperatures during La Niña winters in northern Illinois and northwest Indiana.
- Box plots do indicate more of tendency for near to slightly below normal temperatures.

Median = 22.7°

December-January-February Average Temperature (Degrees F)
Composite Analysis for CPC Climate Division Data ID #25



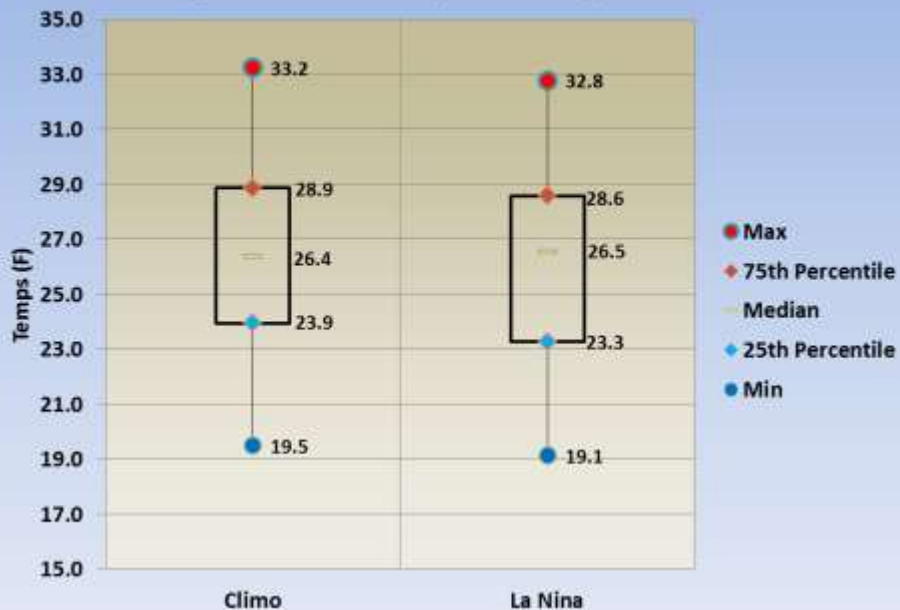
December-January-February Average Temperature (Degrees F)
Boxplot Analysis for CPC Climate Division Data ID #25



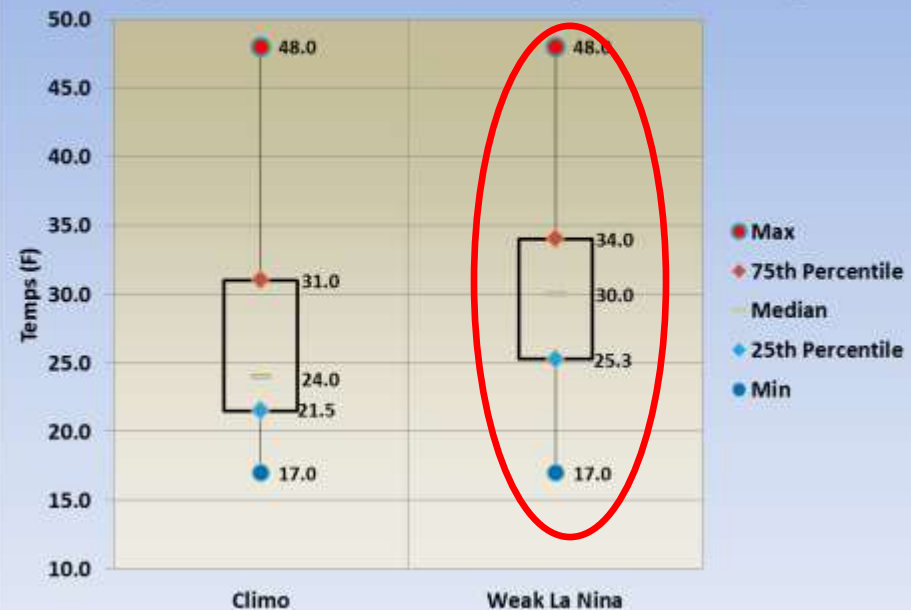
Temperatures During La Niña Winters

- The winter temperature distributions during La Niña events mirrors climatology.
- However, La Niña events can produce highly variable intra-monthly temperatures.
 - Winter season daily temperature change extremes tend to be higher than climatology would suggest.
 - I.E. Large temperature swings and/or periods of both noteworthy warmth and cold

Chicago Winter Temps During La Nina



Highest Winter Season Daily Temp Change

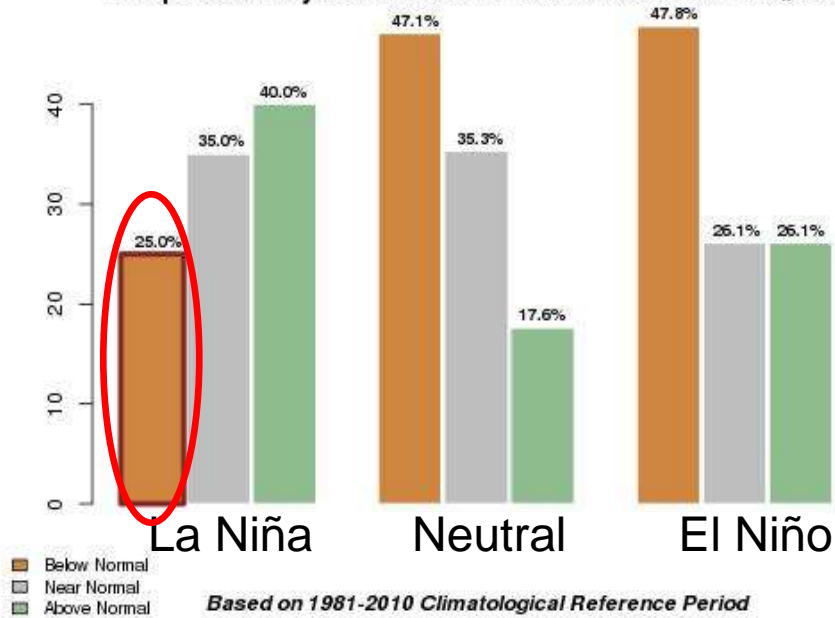


Precipitation During La Niña Winters

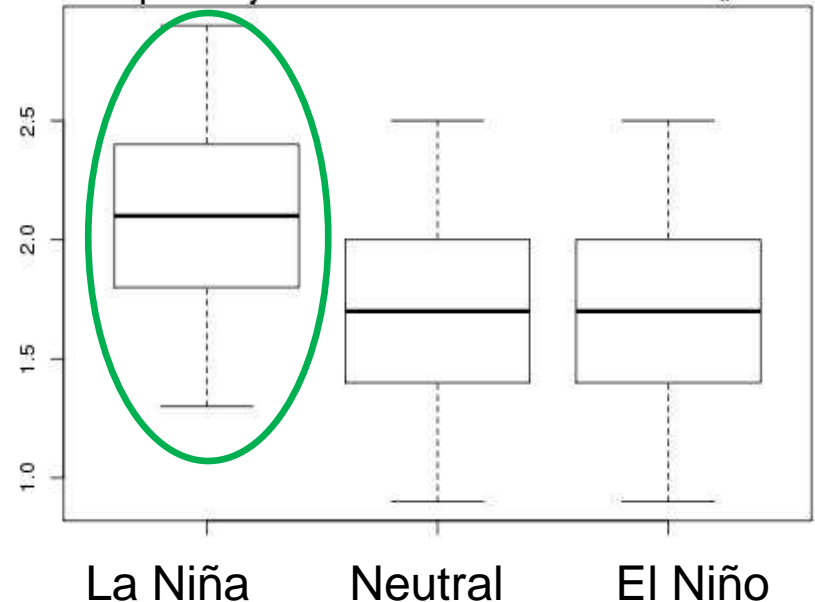
- Boxplots indicate an statistically significant lack of dry winters during La Niña winters.
- There is a strong tendency for La Niña winters to favor above normal precipitation.

Median = 1.77"

December-January-February Total Precipitation (inches)
Composite Analysis for NCDC Climate Division Data ID #IL02



December-January-February Total Precipitation (inches)
Boxplot Analysis for NCDC Climate Division Data ID #IL02



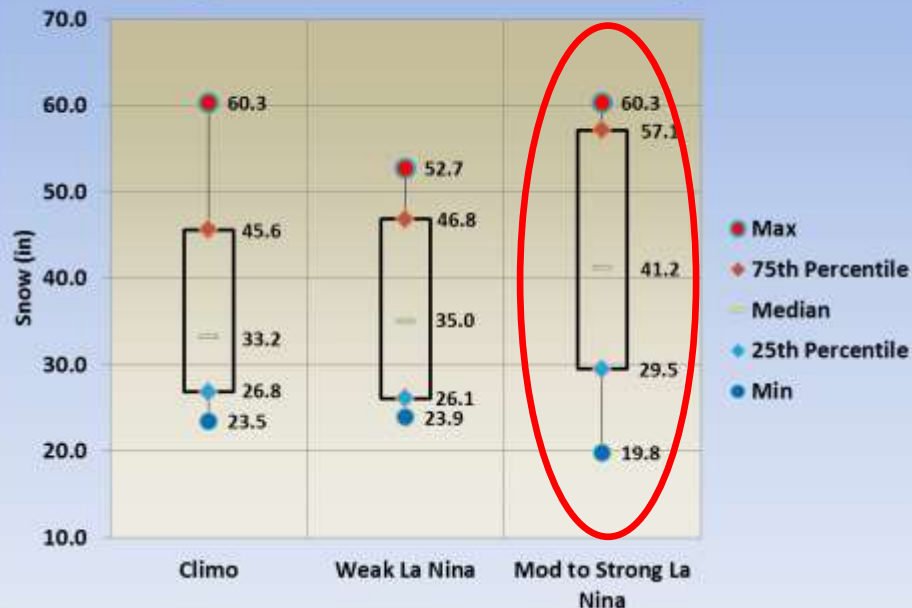
Precip./Snow During La Niña Cold Seasons

Strong tendency for above average cold season precipitation, especially for mod to strong events.

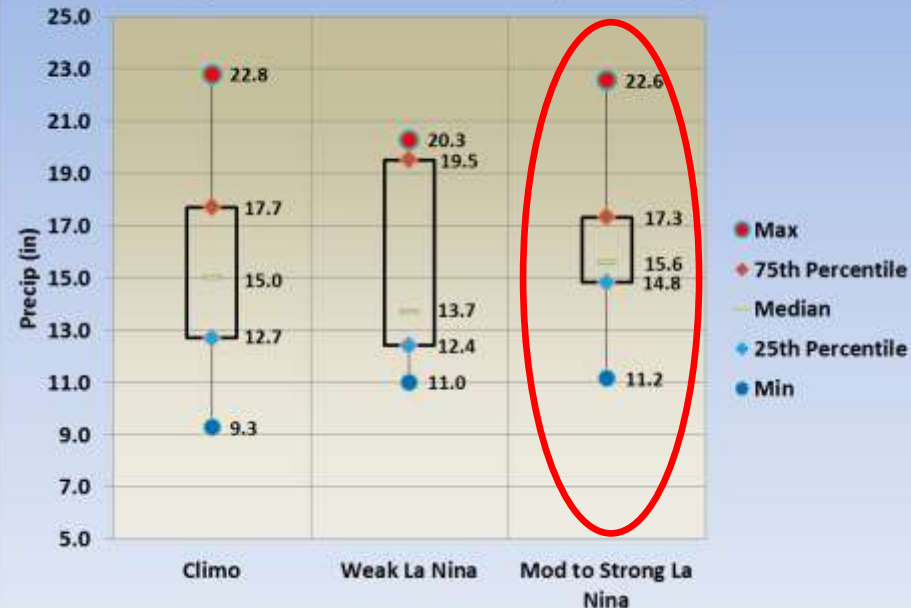
- Very wide range of snowfall amounts, in spite of a very small range in precipitation.
- Snow amounts strongly depend on the placement of active storm track (e.g., to our northwest, more rain, to our southwest more snow).

Bottom Line: While there is a good chance for above average precipitation, this may or may not be the case for snowfall given the wide range shown below.

Chicago Seasonal Snowfall During La Niña



Chicago Cold Season Precip During La Niña

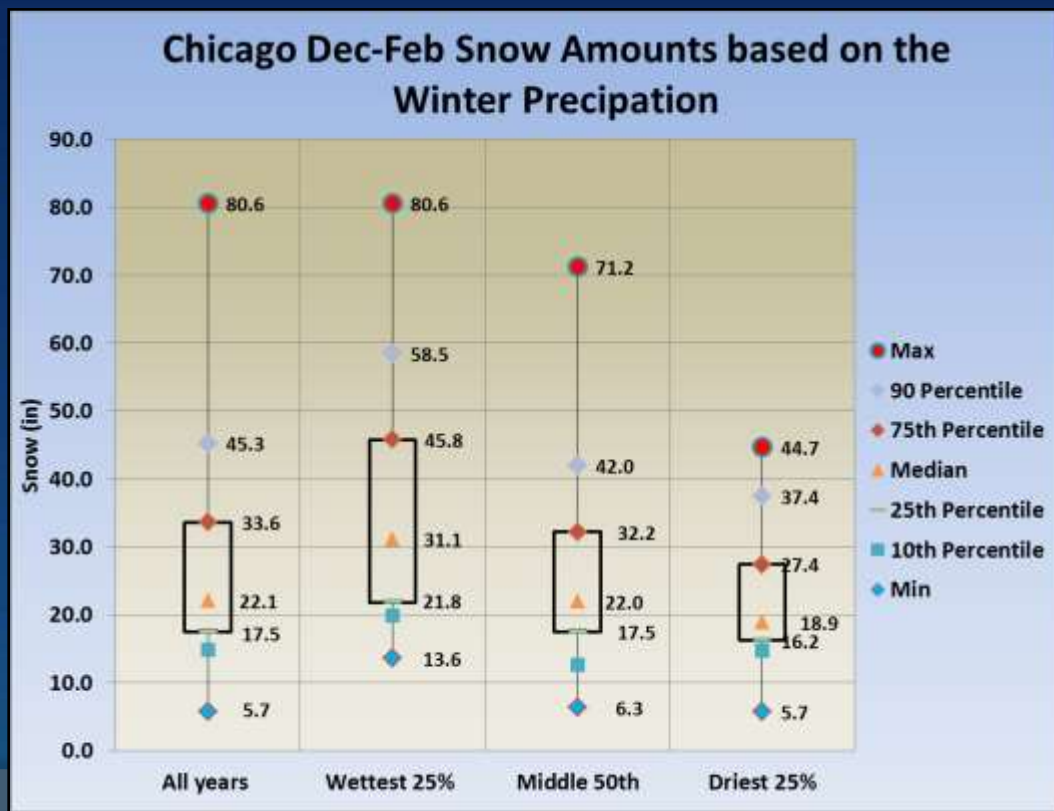


Does Above Average Precip. Support More Snow?

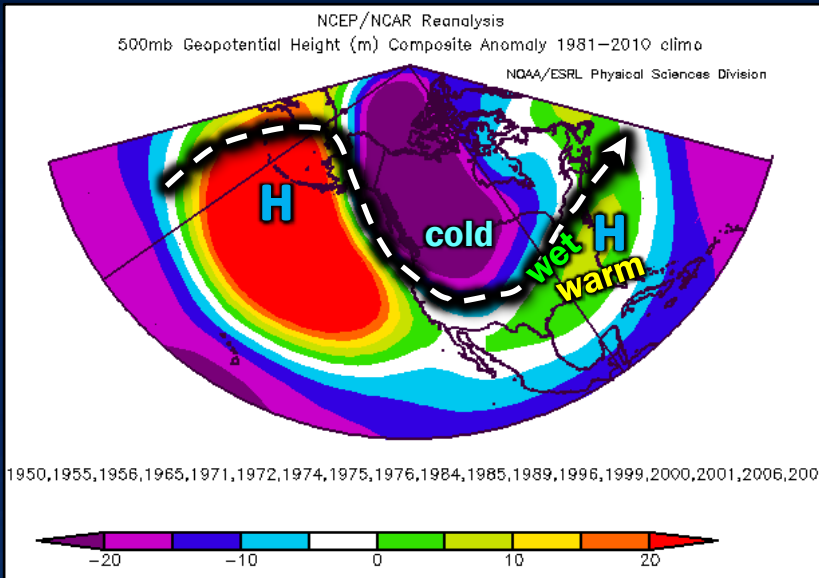
While there are some exceptions due to the possibility of the precip. falling as rain, in general more winter precipitation does favor more snow.

- The wettest 25% of Dec-Feb periods tended to be snowier than normal.
- Similarly, the drier winters tended towards below average snow.

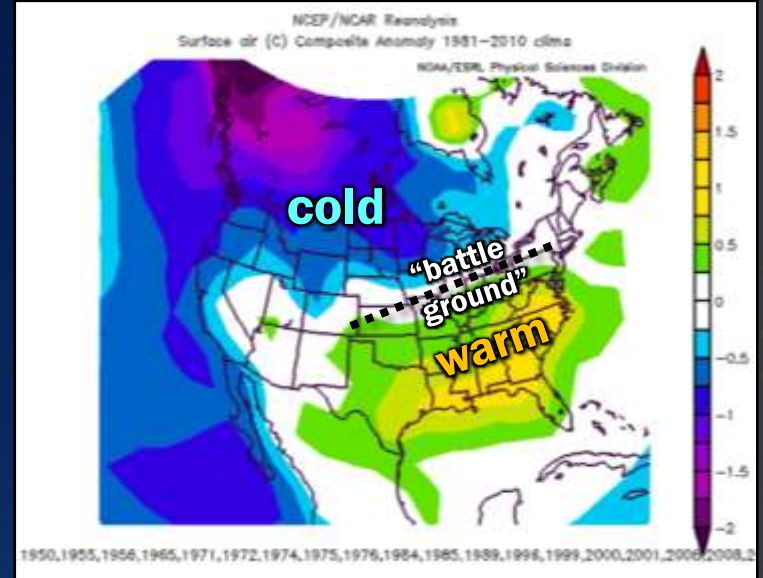
Bottom Line: While an above average precipitation forecast does not always lead to more snow, it certainly increases the odds of having above average snow.



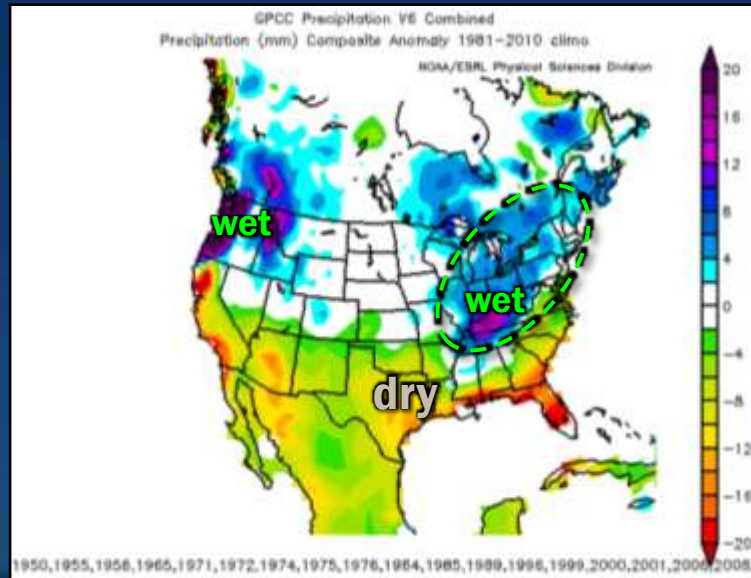
La Niña Winter Composite (since 1949-50)



Upper Level (jet stream) Pattern



Temperature Anomalies



Precipitation Anomalies

The composite supports/explains the local data well.

- Higher confidence in above normal precipitation.
- Lower confidence in temperature regime (cold/near normal/warm) and likelihood of variability.

Recent La Niña Episodes Since 1995-96 (Chicago Data)

Normal winter season temperature is 26.4°

Seasonal snowfall normal is 36.7"

5 Colder than Normal:

1995 - 96 → **well below normal snow (23.9")**

2000 - 01 → above normal snow (39.4")

2007 - 08 → well above normal snow (60.3")

2008 - 09 → well above normal snow (52.7")

2010 - 11 → well above normal snow (57.9")

5 Warmer than Normal

1998 - 99 → **well above normal snow due to Jan. blizzard (50.9")**

1999 - 00 → below normal snow (30.3")

2005 - 06 → well below normal snow (26.0")

2011 - 12 → well below normal snow (19.8")

2016 - 17 → well below normal snow (26.1")

Average of the coldest 5 winters: 23.5°

Average of the warmest 5 winters: 30.5°

Average of the snowiest 5 winters: 52.2"

Average of the least snowy 5 winters: 25.2"



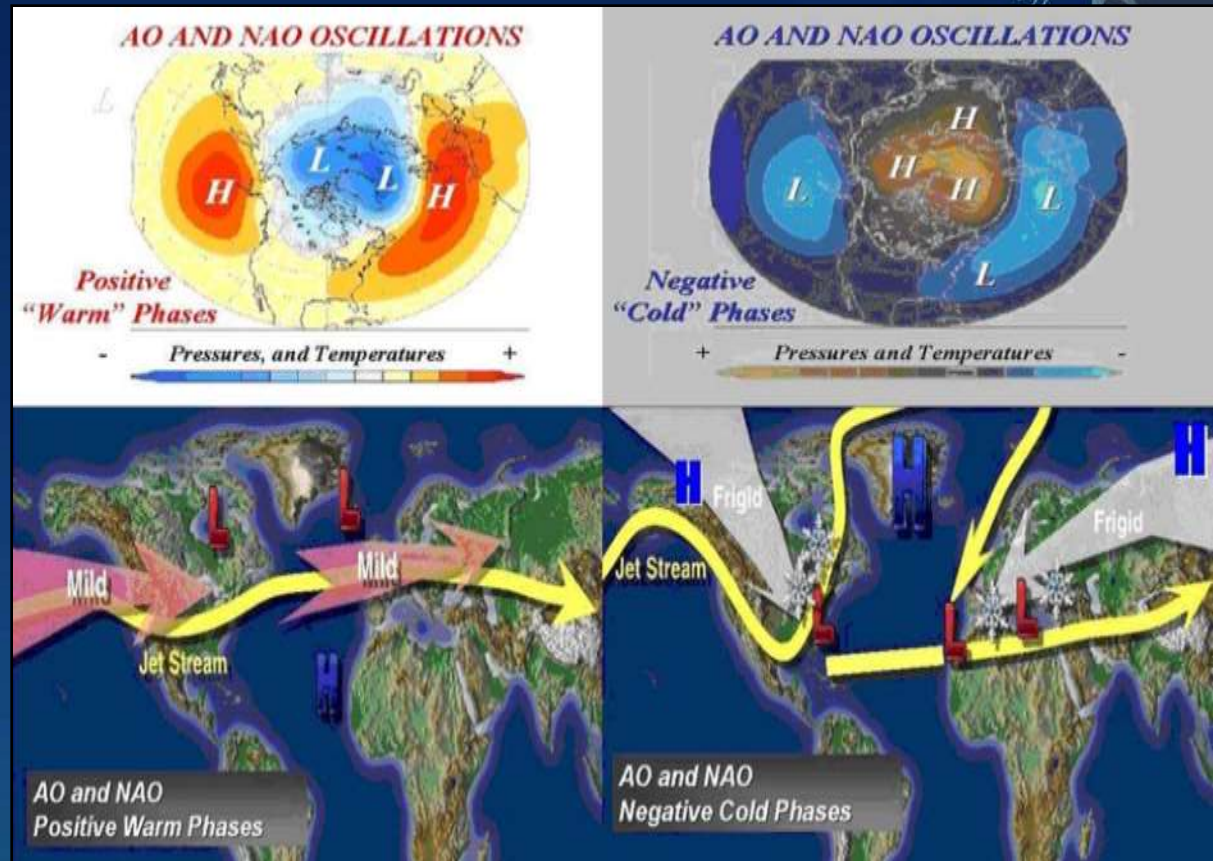
What Are Some Other Factors to Consider?

The Arctic and North Atlantic Oscillations (AO/NAO)

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

- Negative phase can favor more arctic outbreaks with colder than normal conditions and more snowfall across the eastern half of the country.

- Positive phase can favor warmer and drier conditions across the eastern half of the country.



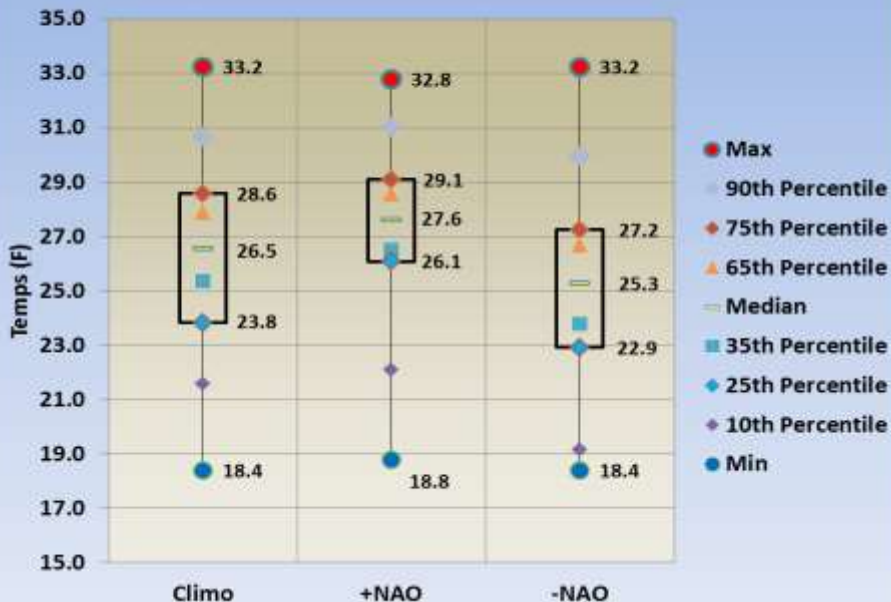
La Niña and the NAO

The predominant phase of the NAO can have an impact on how the La Niña event will impact the winter season across the region.

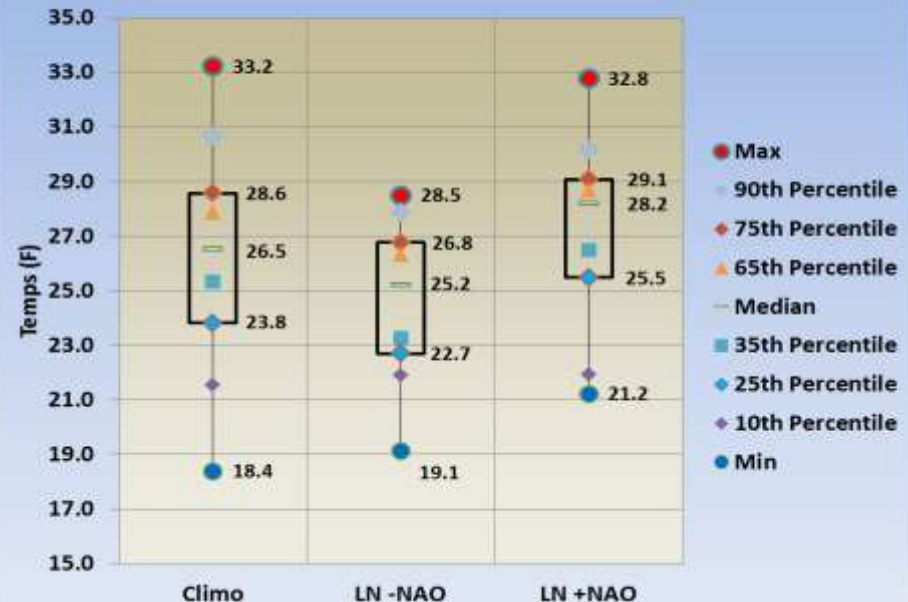
- -NAO could favor a colder than normal winter.
- +NAO could help sway the odds for a mild winter season.

Results similar at Rockford

Chicago Dec-Feb Temps Based on NAO



Chicago Dec-Feb Temps During La Niña



Sample sizes include: 38 +NAO, 28 -NAO, 11 -NAO LN and 15 +NAO LN.

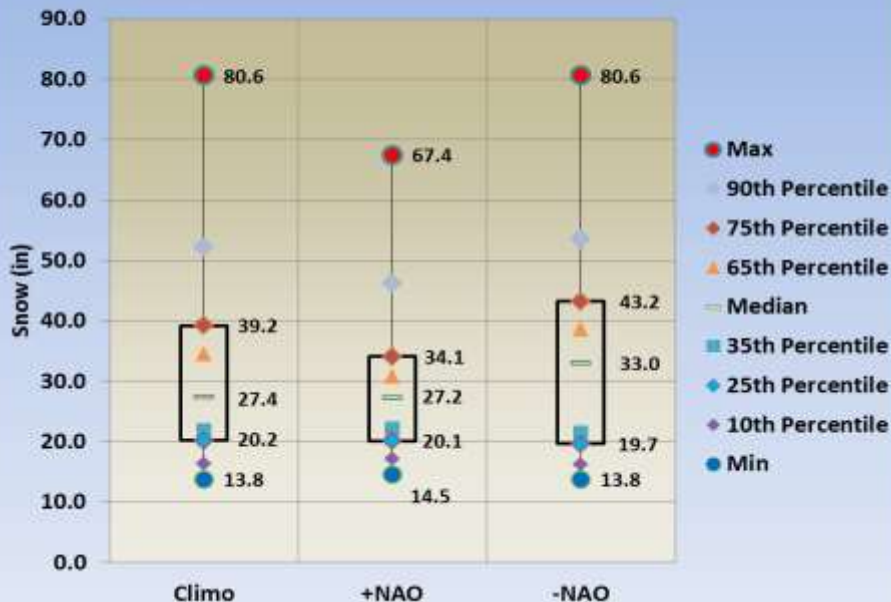
La Niña and the NAO

The phase of the NAO can have an impact on snowfall.

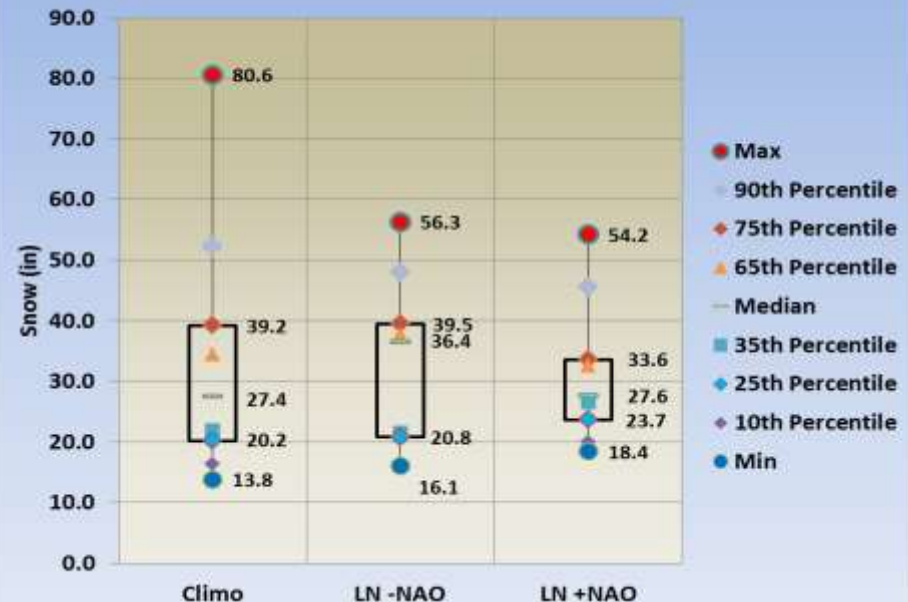
- -NAO can support a snowier than normal winter.
- +NAO may result in less snow due to warm conditions, but not always the case.

Results similar at Rockford

Chicago Dec-Feb Snow Based on NAO



Chicago Dec-Feb Snow During La Niña



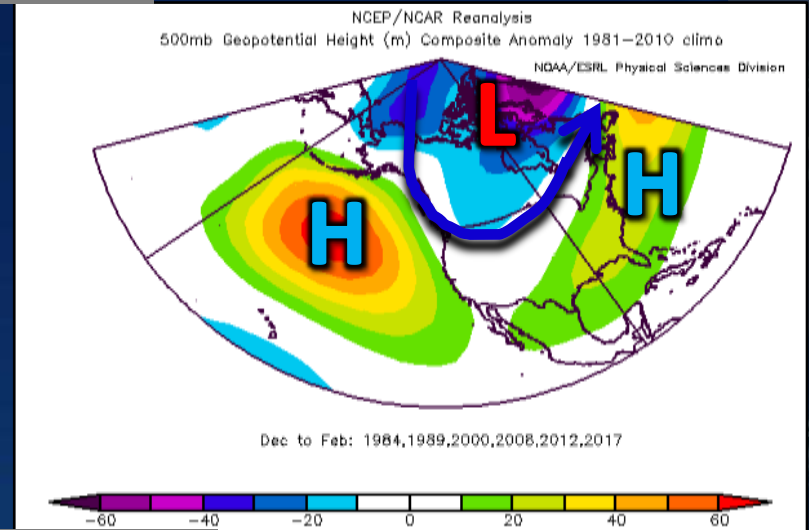
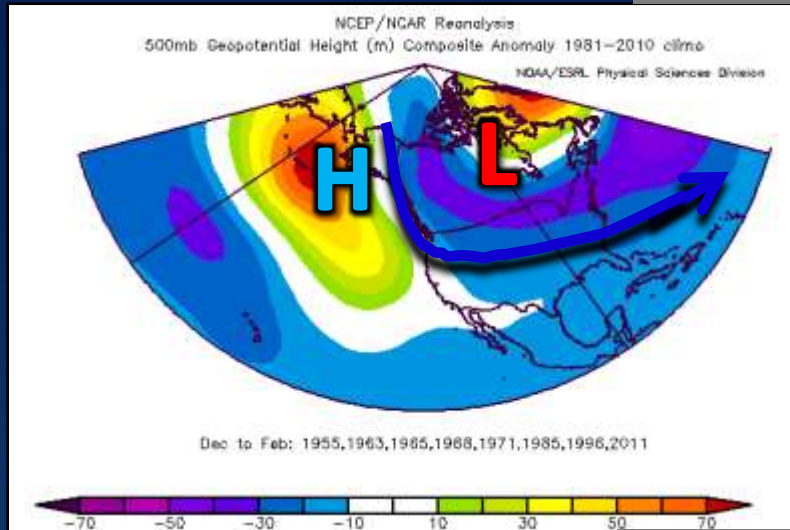
Sample sizes include: 38 +NAO, 28 -NAO, 11 -NAO LN and 15 +NAO LN.

“La Niña and the NAO”

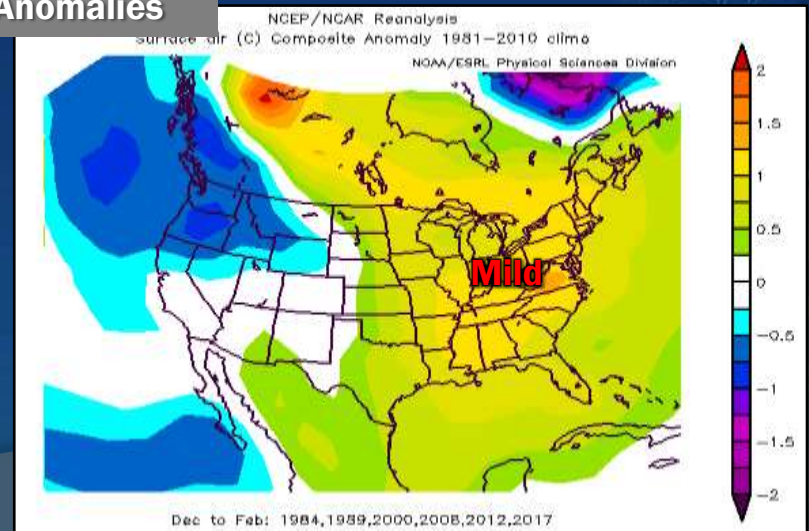
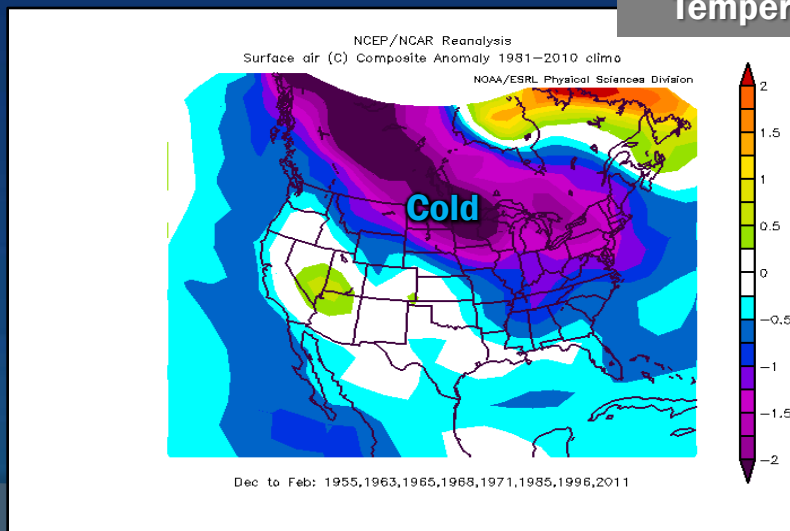
-NAO La Niña

500 Height Anomalies

+NAO La Niña



Temperature Anomalies



The Arctic and North Atlantic Oscillations (AO/NAO)

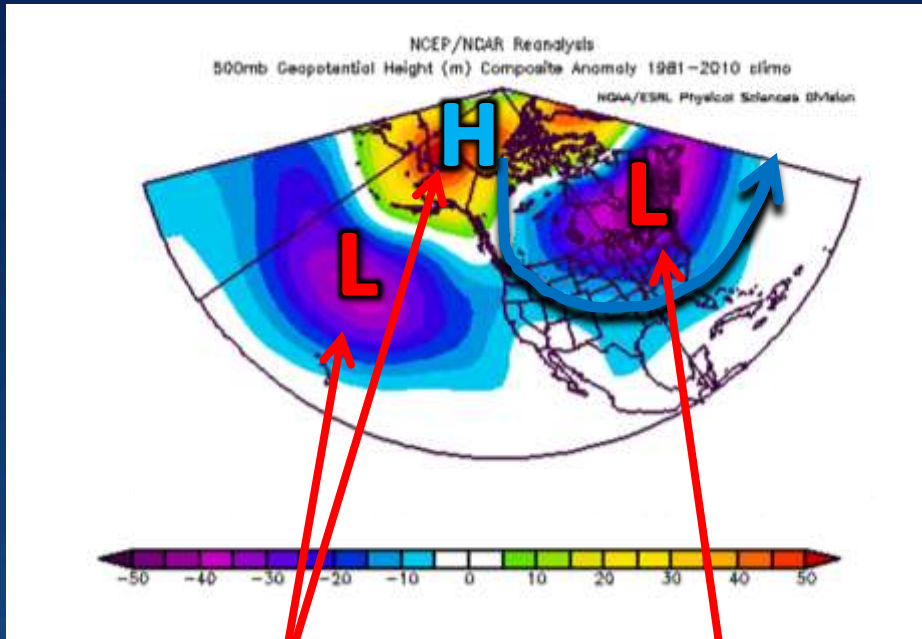
- A predominantly negative (positive) AO/NAO *could* enhance the chances for a lean towards colder (milder) conditions.
 - ***Unpredictable beyond a few weeks, though new research within the past few years is promising in terms of aiding predictability of the predominant seasonal scale AO/NAO pattern.***
 - ***Well above normal Northern Hemisphere high latitude and North American snow cover this November could help favor more pronounced blocking episodes this winter.***

The Arctic and North Atlantic Oscillations (AO/NAO)

- ***Possible* impact of the Quasi-Biennial Oscillation (QBO) on the predominant winter AO/NAO phase**
- The quasi-biennial oscillation (QBO) is a regular variation of the winds that blow high above the equator. Strong winds in the stratosphere travel in a belt around the planet, and every 14 months or so, these winds completely change direction. This means a full cycle takes roughly 28 months to complete.
- The QBO cycle has an easterly (negative) phase and a westerly (positive) phase.
- The stratospheric polar vortex (large area of low pressure across the high latitudes) is weaker in the easterly phase of the QBO than in the westerly phase.
- A strong (weak) stratospheric polar vortex tends to support a +AO/+NAO (-AO/-NAO).
- **The QBO is expected to be easterly (negative) through winter 2017-18, which *may* support longer periods of -AO/-NAO.**

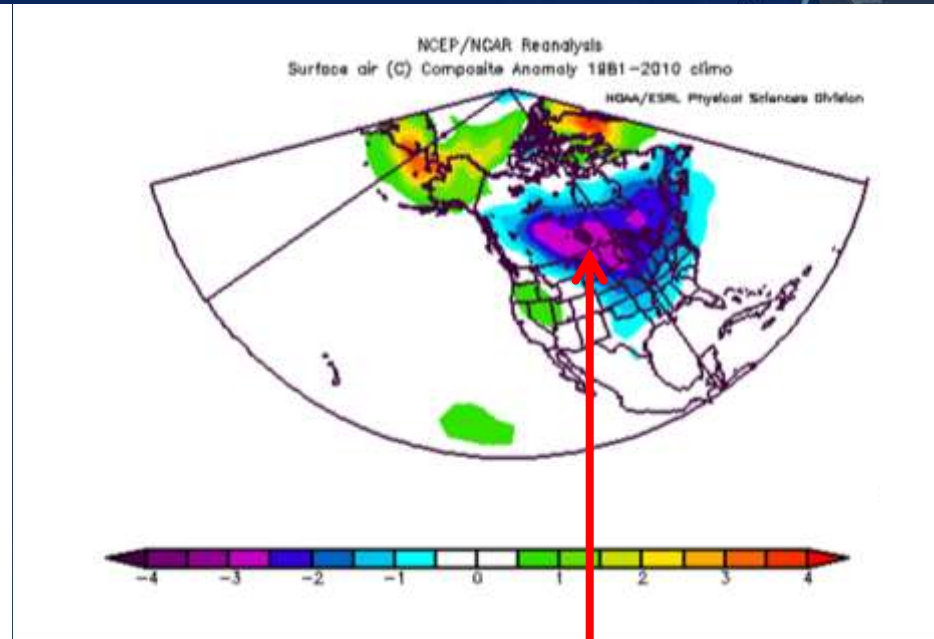
“Alaska Ridge Pattern”(-EPO)

- 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

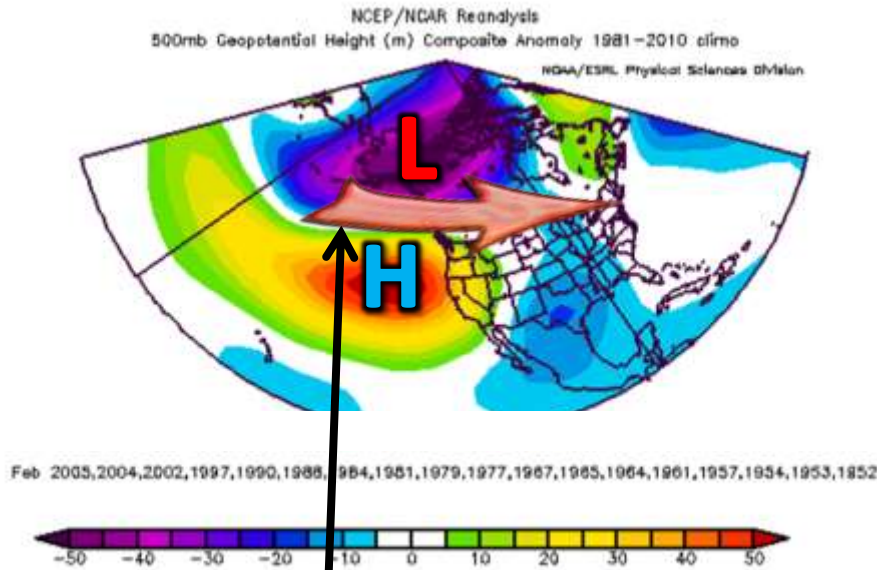


Deep cold

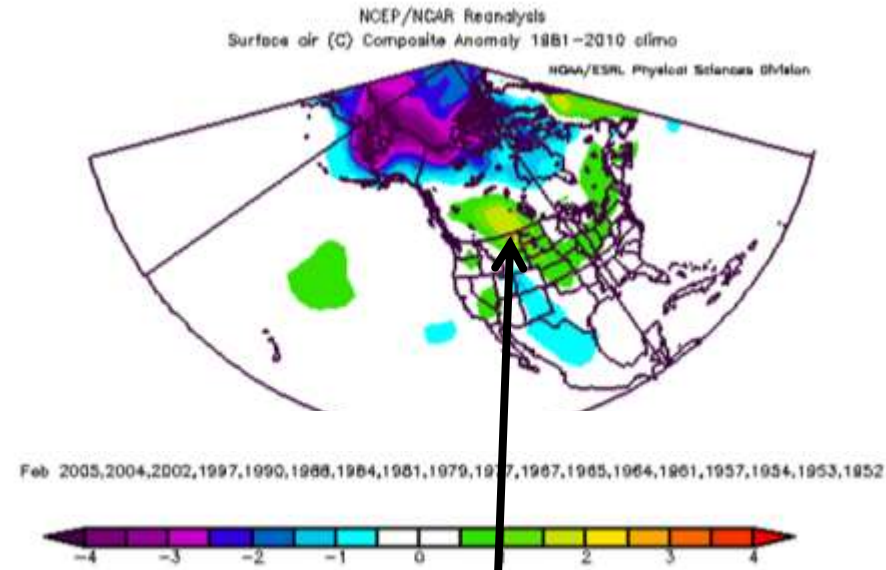
EPO: East Pacific Oscillation

“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

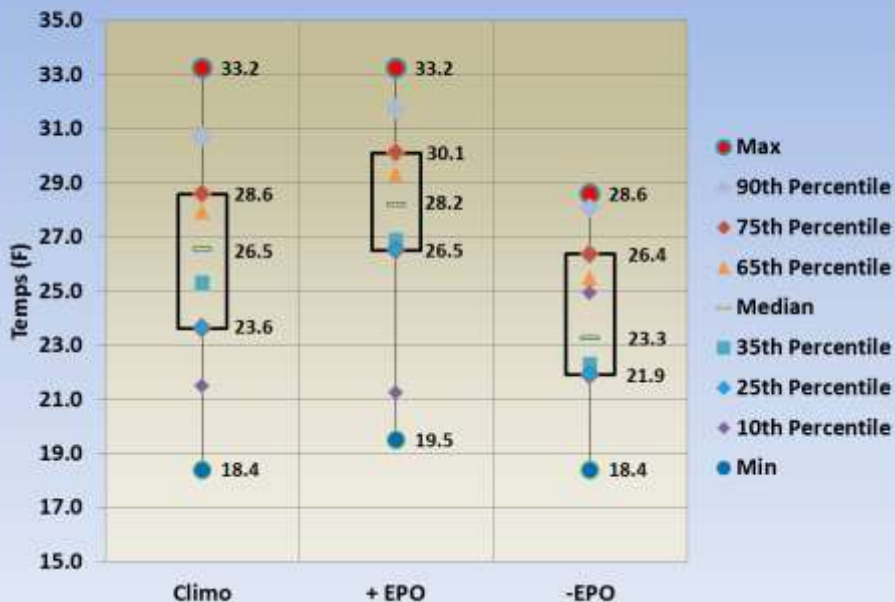
La Niña and the EPO

The predominant phase of the EPO can have a large impact on how the La Niña event will impact the winter season across the region.

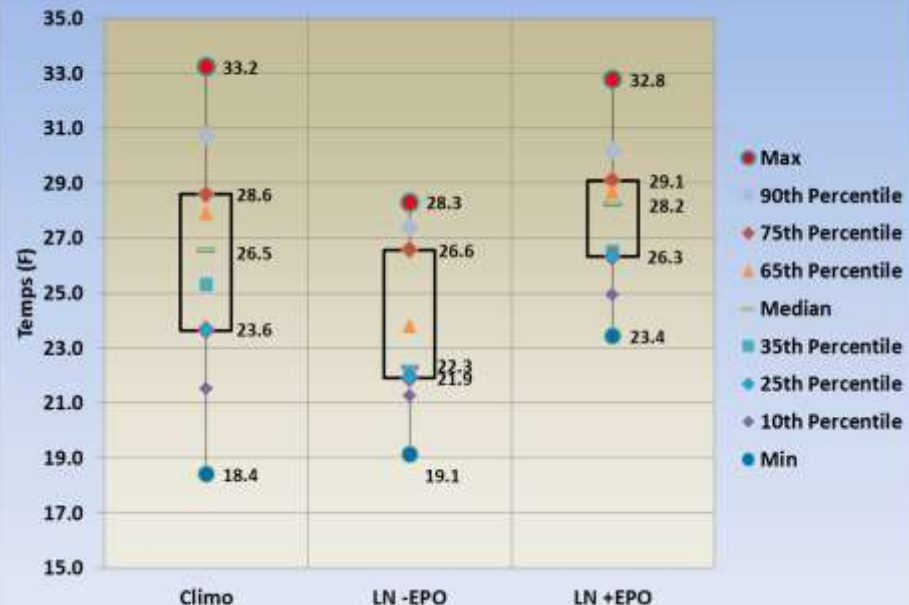
- -EPO (Alaska and North Pacific upper ridging) can result in a colder than normal winter.
- +EPO could help support a milder winter season.

Results similar at Rockford

Chicago Dec-Feb Temps Based on EPO



Chicago Dec-Feb Temps During La Niña

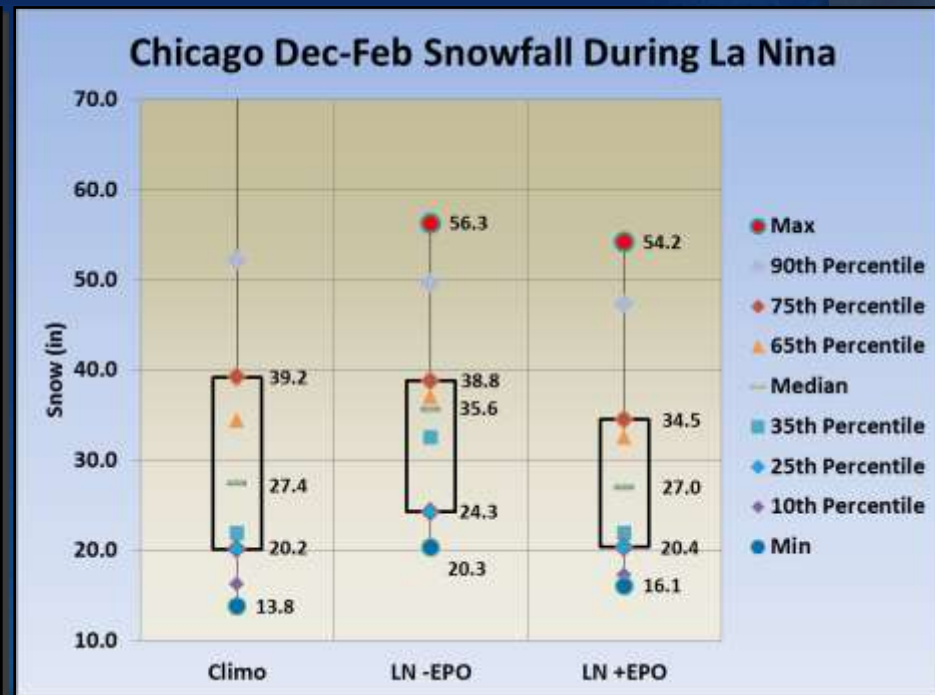
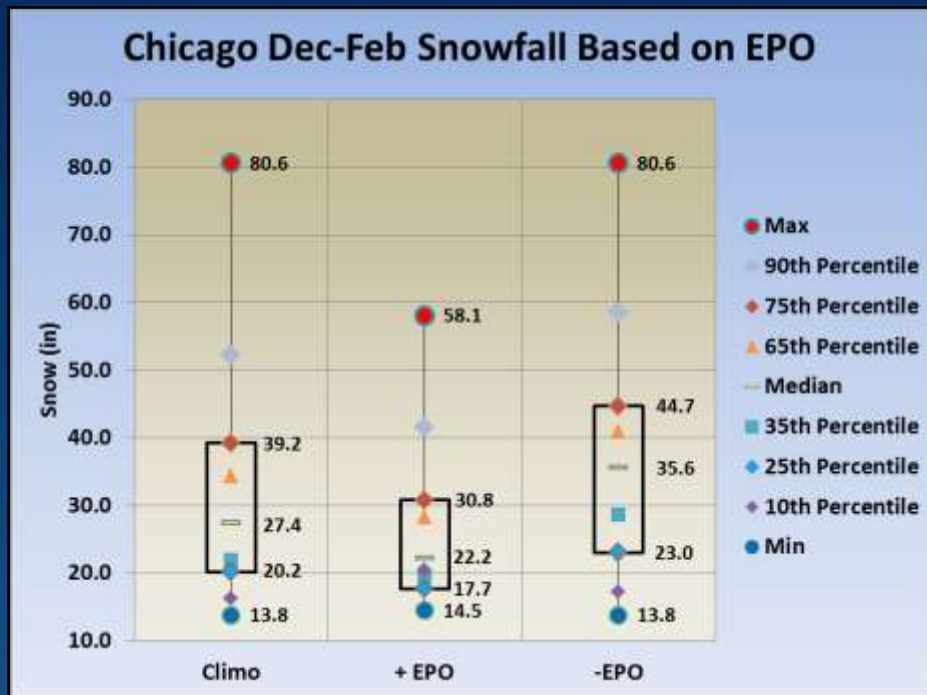


Sample sizes include: 37 +EPO, 29 -EPO, 9 -EPO LN and 15 +EPO LN.

La Niña and the EPO

The predominant phase of the EPO can impact snowfall during La Niña winters across the region.

- -EPO (Alaska and North Pacific upper ridging) can result in above normal snowfall due to colder conditions with an active weather pattern.
- +EPO winter tend to produce below average snow, but during La Niña conditions this is not a guarantee.



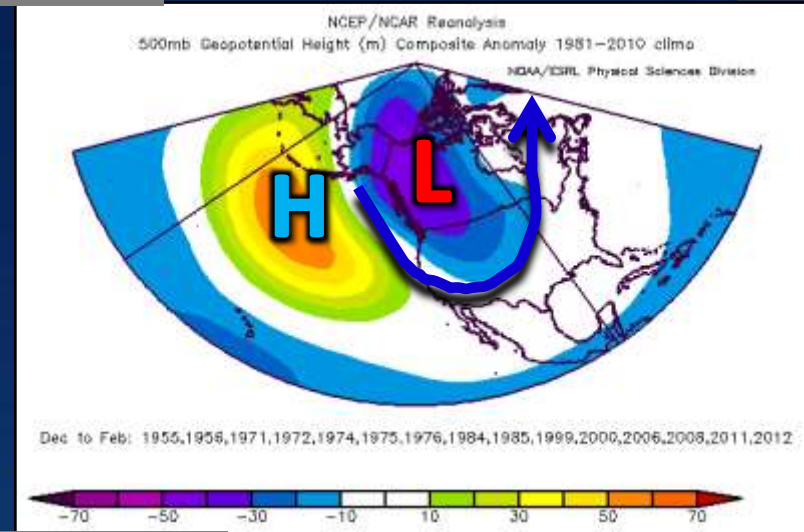
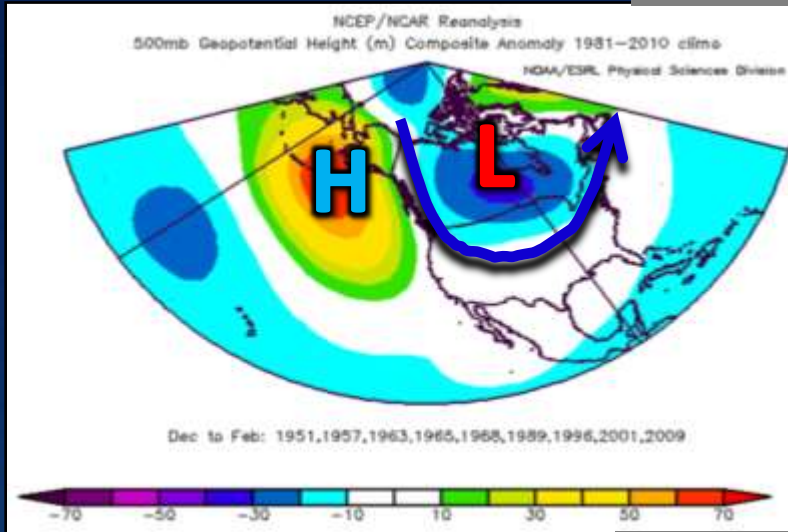
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La Niña and the EPO

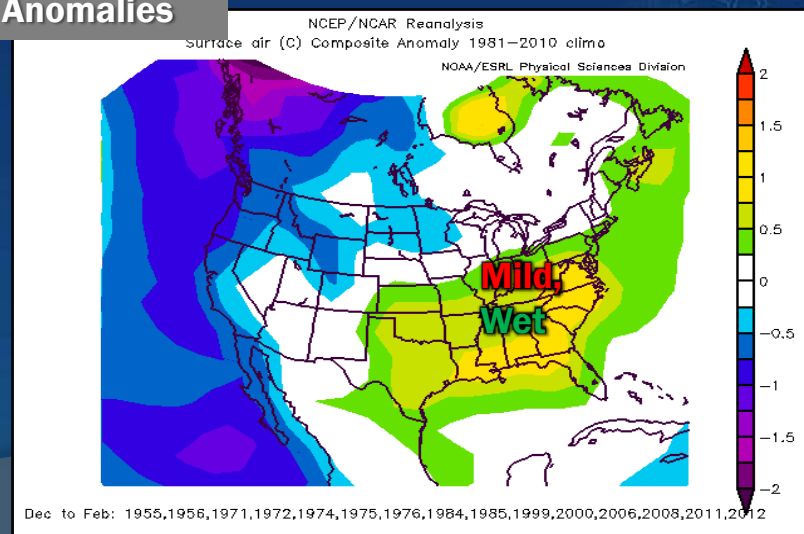
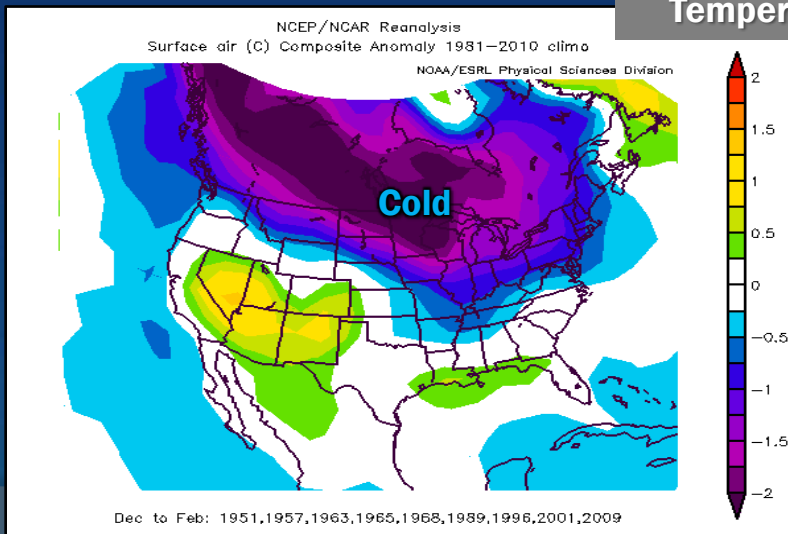
-EPO La Niña

500 Height Anomalies

+EPO La Niña



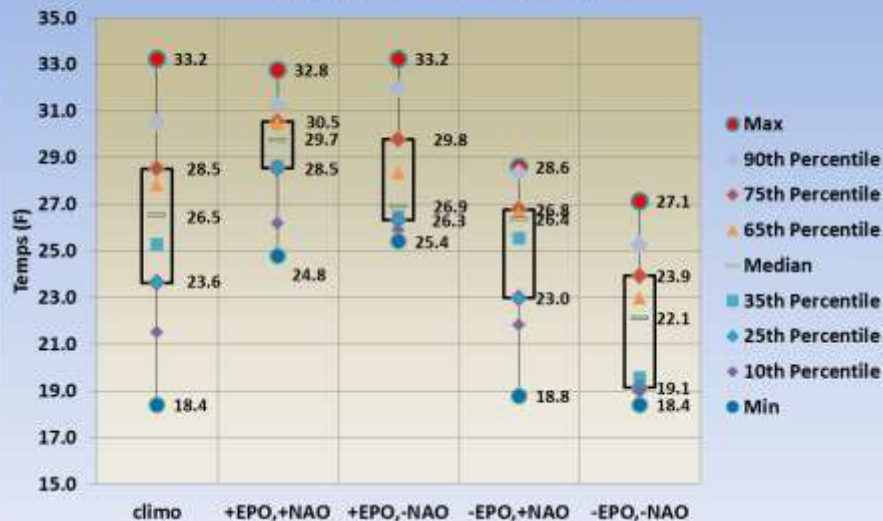
Temperature Anomalies



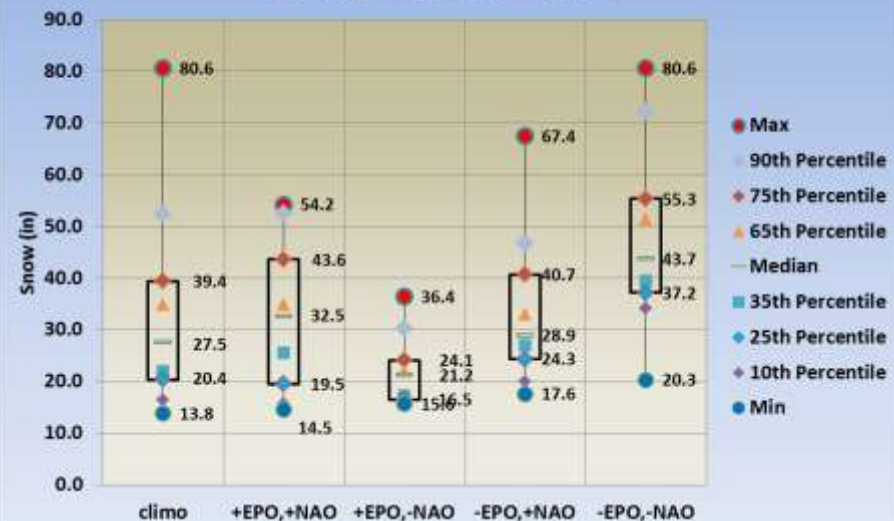
“Constructive” and Destructive phases of the EPO and NAO

- When both are in favorable phases for cold (warm), our winter season is almost always cold (warm).
 - The +EPO and +NAO together almost exclusively produce warm winters across our area, but snow amounts can be mixed (2012, 2000, 1999, 1992 and 1983 fell into this category).
 - Negative phases favor cold and snowy winters (e.g., 2010, 2011, and the late 70s).
- Opposing phases can work against each other.
 - +EPO and -NAO tend to result in warmer and less snowy winters in Chicago.

Chicago Dec-Feb Temps

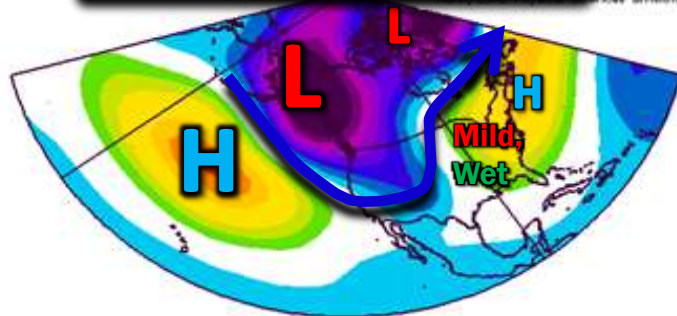


Chicago Dec-Feb Snow



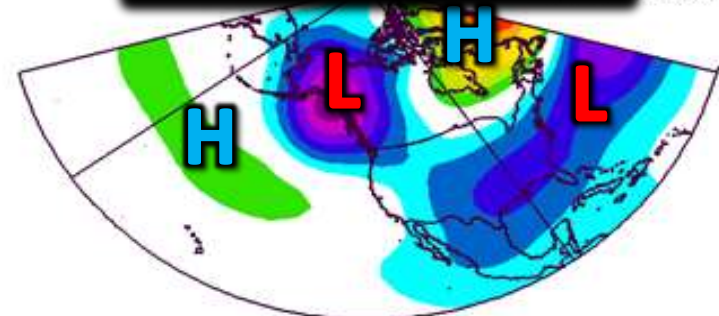
EPO and NAO

+EPO +NAO



Dec to Feb: 1952, 1974, 1975, 1983, 1992, 1999, 2000, 2008, 2012

+EPO -NAO



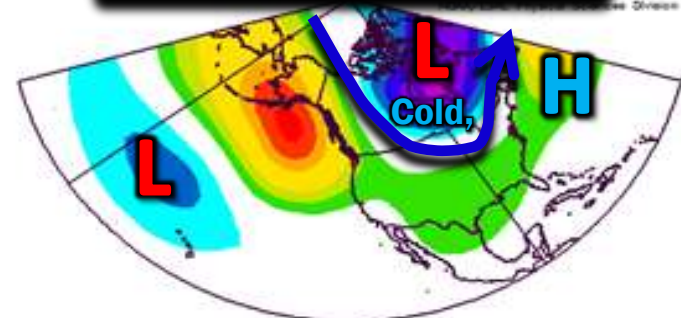
Dec to Feb: 1953, 1955, 1958, 1964, 1965, 1971, 1998

-EPO -NAO



Dec to Feb: 1959, 1963, 1968, 1970, 1977, 1978, 1979, 1985, 2010, 2011

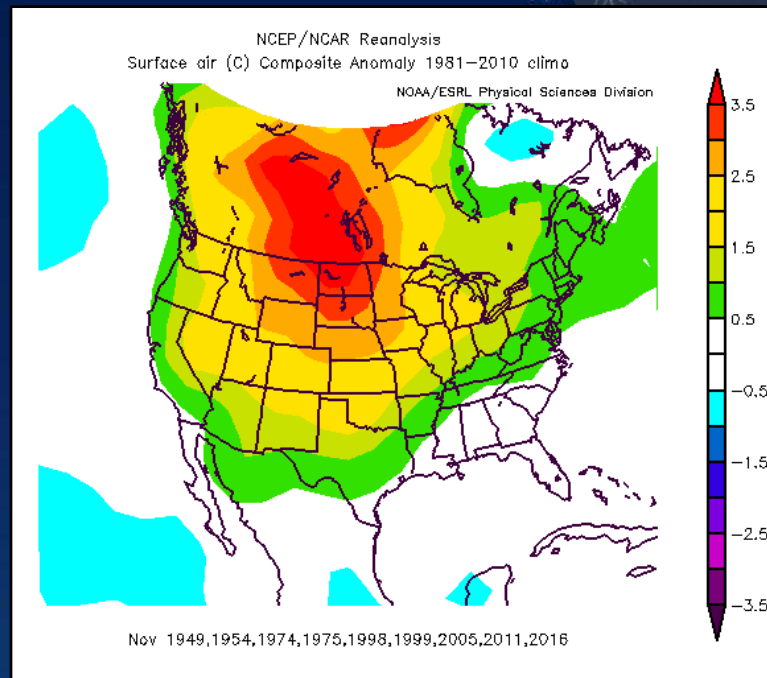
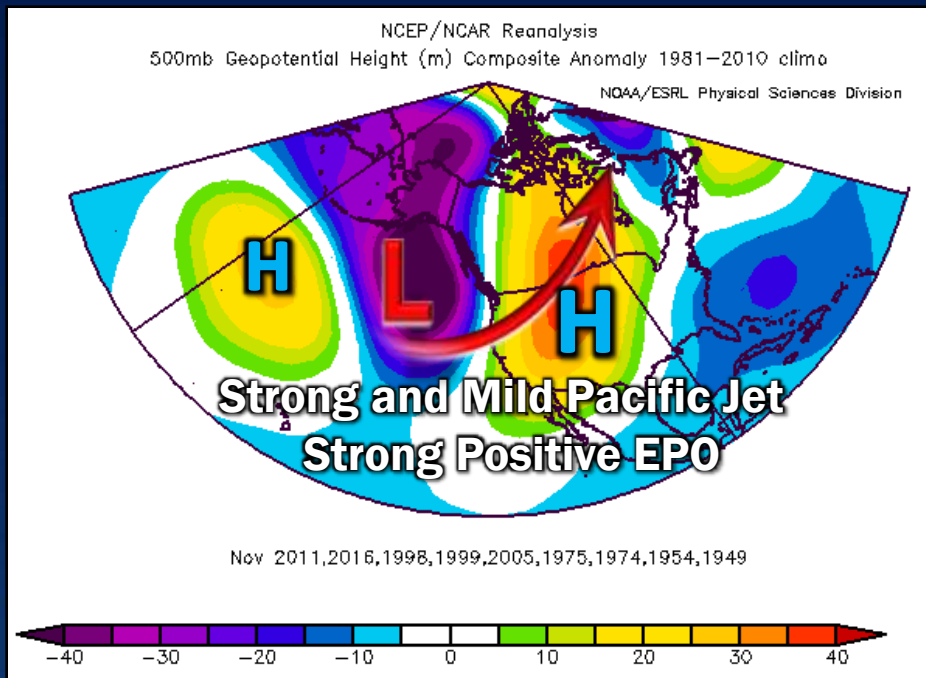
-EPO +NAO



Dec to Feb: 1957, 1961, 1989, 1991, 1993, 1994, 2005, 2014, 2015

Can November Help Tell Us How the Winter May Play Out?

- **The warmest La Niña winters showed a tendency for warmer than normal Novembers.**



Distribution of Nov. Anomalies

**5 months of +4.0° or warmer
(1975, 1998, 1999, 2011, 2016)**

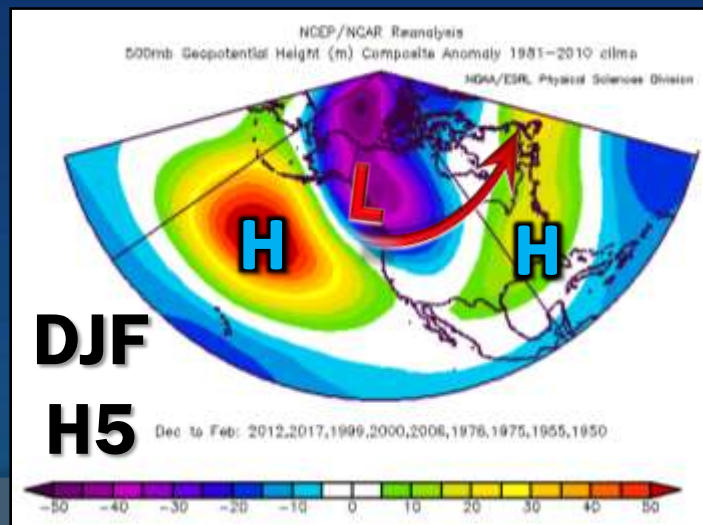
+2.2° (1954)

+1.7° (2005)

+0.6° (1974)

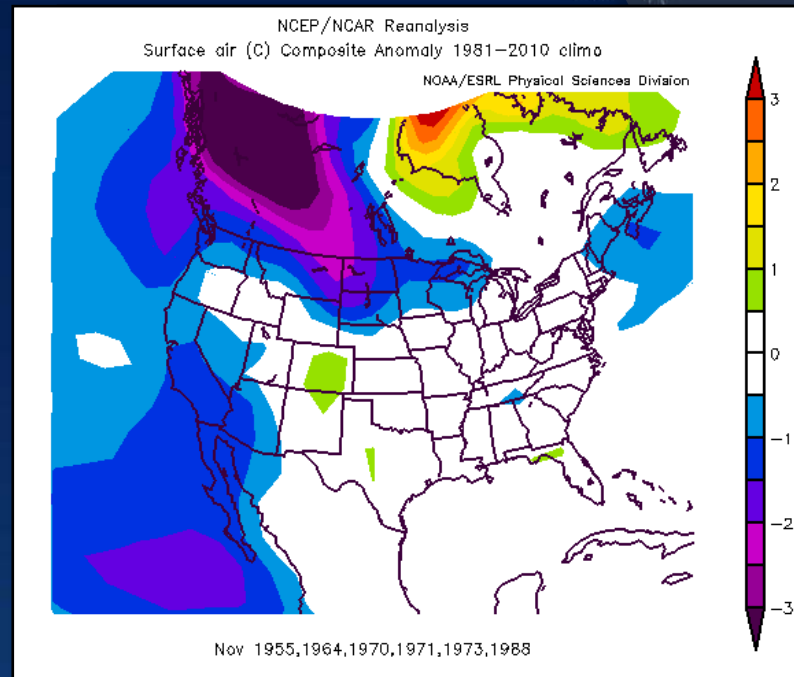
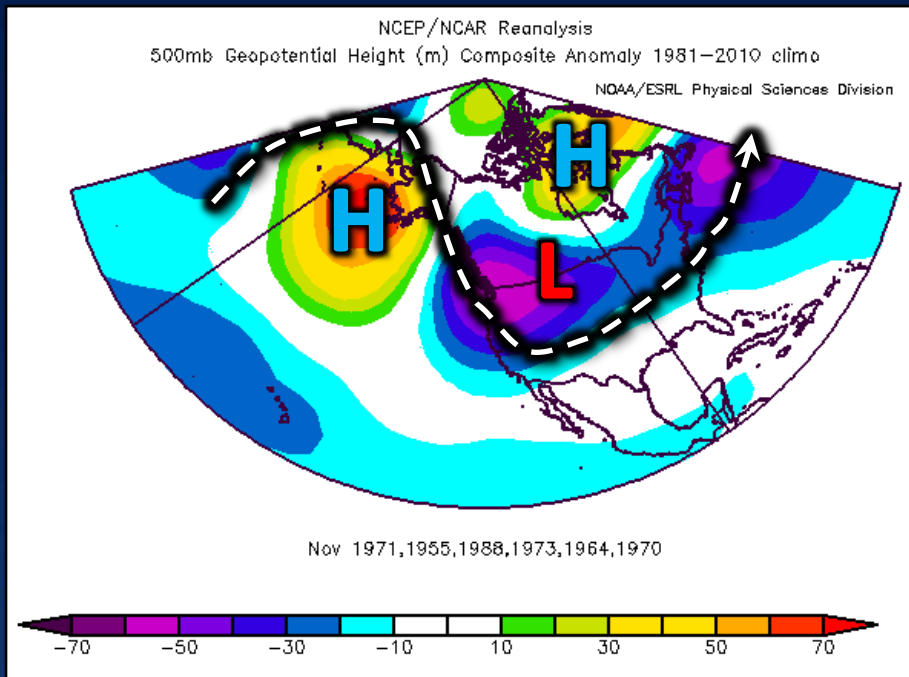
-0.2° (1949)

Chicago Data



Can November Help Tell Us How the Winter May Play Out?

- **The near normal La Niña winters showed a tendency for mixed Novembers (no strong signal).**



Distribution of Nov. Anomalies

1955: -4.3°

1964: +3.4°

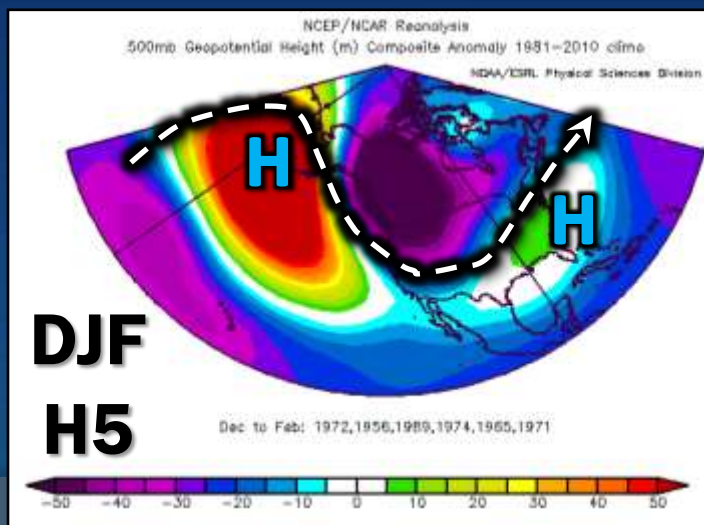
1970: +0.4°

1971: +1.7°

1973: +1.6°

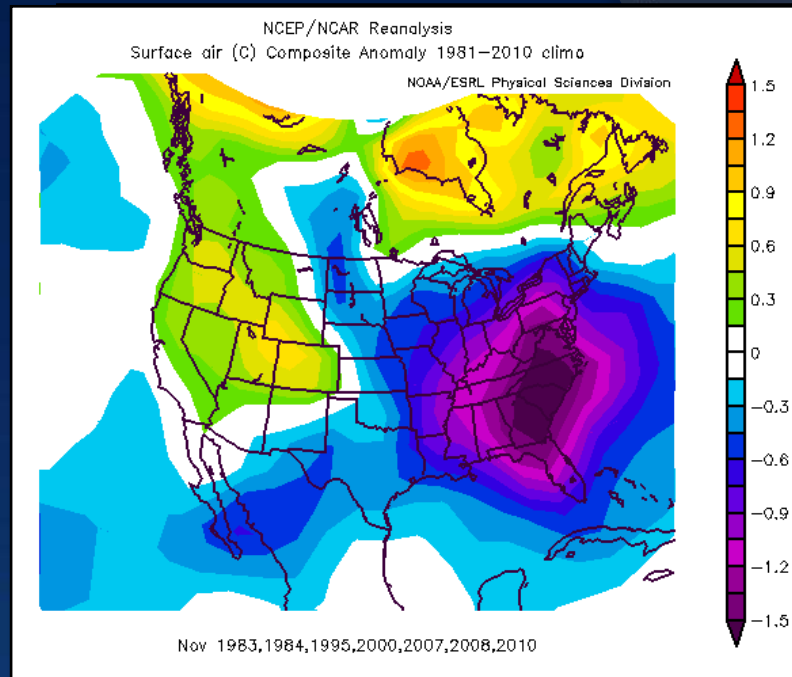
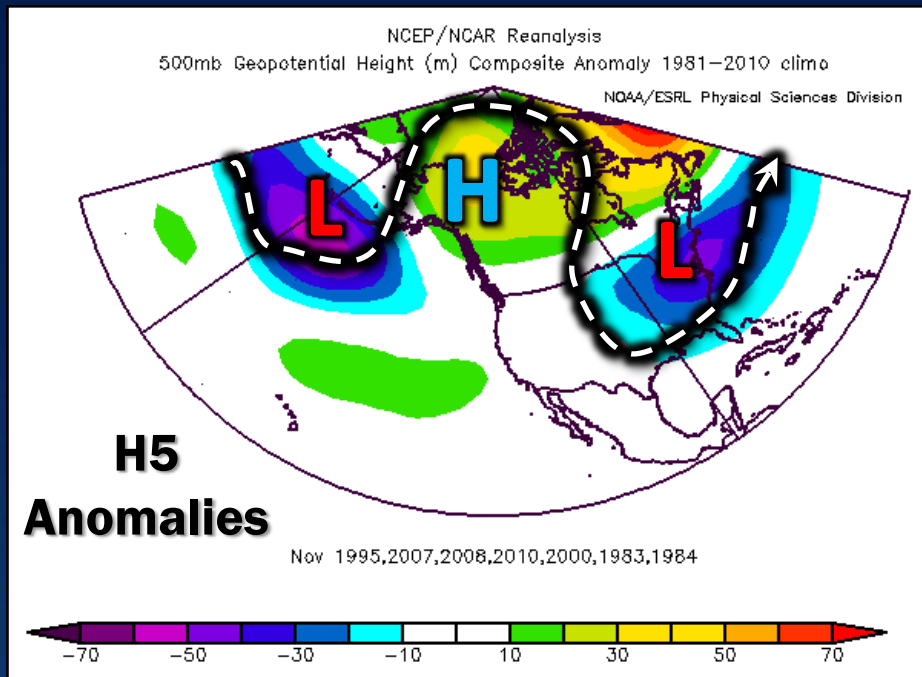
1988: +1.4°

Chicago Data



Can November Help Tell Us How the Winter May Play Out?

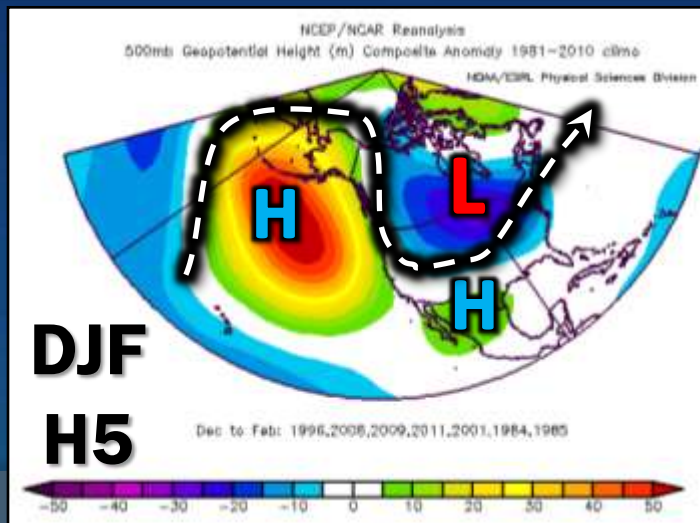
- **The coldest La Niña winters showed a tendency for colder than normal Novembers.**



Distribution of Nov. Anomalies

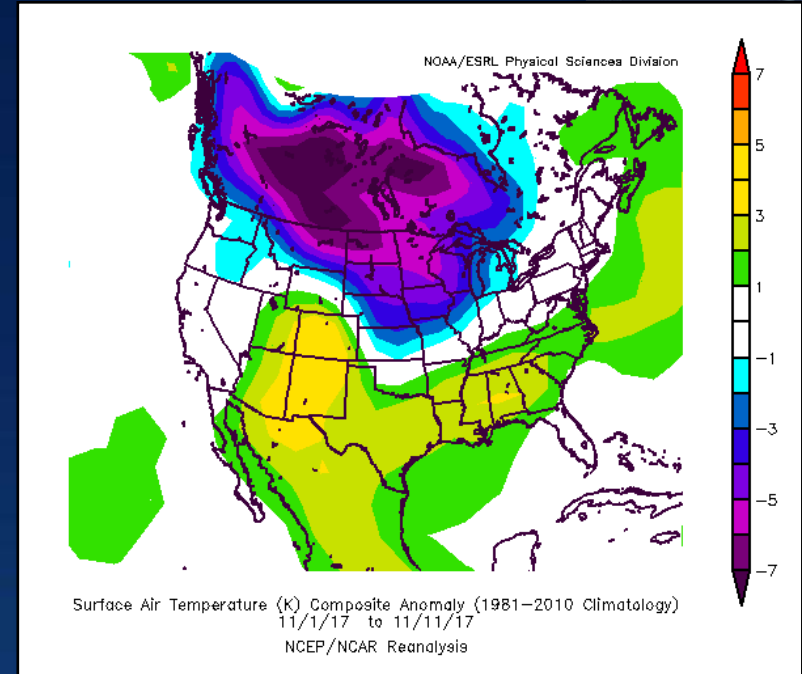
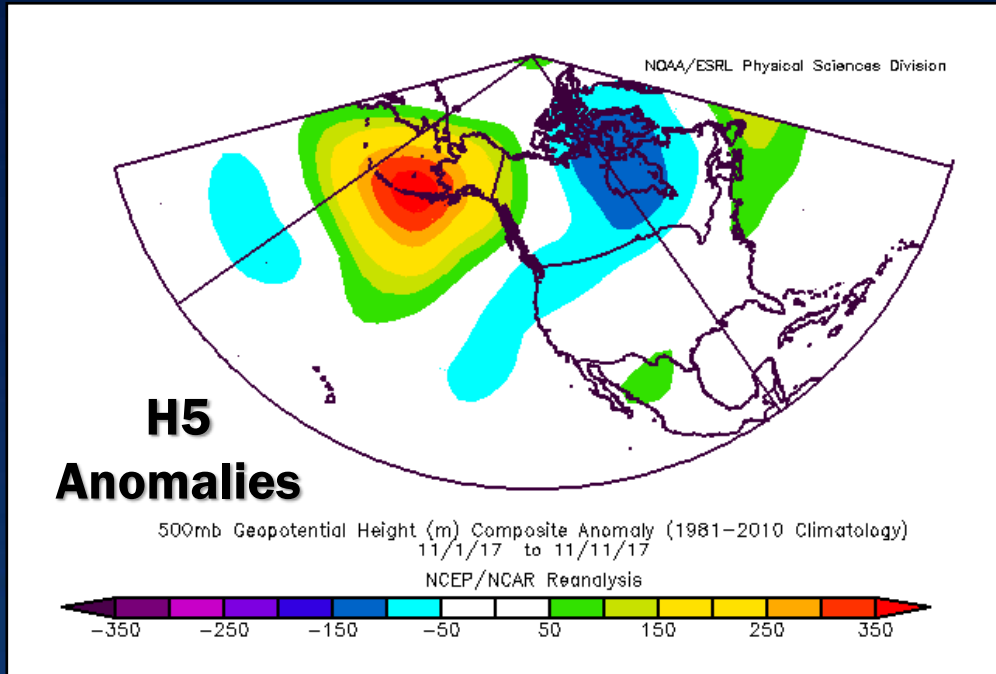
- 1983: +0.8°
- 1984: -2.2°
- 1995: -7.3°
- 2000: -3.3°
- 2007: -0.9°
- 2008: -1.0°
- 2010: +1.2°

Chicago Data



Can November Help Tell Us How the Winter May Play Out?

- **This November has been significantly colder than normal so far.**



Average Monthly Temperature Departure From Normal Through November 14th

Chicago: -5.7°

Rockford: -7.0°

Outlook through Late November:

- Mixed signals on the ensembles re. specifics, but extreme warmth that would substantially cut into negative temperature departure appears unlikely.
- Mean 500 mb anomaly for month is likely to maintain strong NE Pac ridging signal.

Summary

Based on what we know now:

- **La Niña conditions are favored to persist through the winter.**
- **Lower confidence in predominant temperature regime vs. normal**
 - **No strong local temperature signal during these events.**
 - **The past 10 events produced an equal number of warm and cold winters.**
 - **Temperatures may vary significantly between noteworthy cold and mild periods, with periods of both fairly likely along with large day-to-day temperature swings.**
- **Higher confidence in above normal precipitation (liquid equivalent)**
 - **Based off past events and seasonal climate models, a good signal for above normal winter precip. exists, which may or may not translate to above normal snowfall.**
 - **Ultimately depends on favored storm track of individual storm systems and the availability of sufficiently cold air masses for snow.**
 - **Signal/higher confidence for above normal precip. increases chances for above normal snowfall in terms of odds/probabilities.**
 - **Below normal snowfall still a possibility if storm track and temperature patterns are more often unfavorable.**

Summary

Things to watch/keep in mind:

- **Arctic Oscillation (AO) and North Atlantic Oscillation (NAO) and the Eastern Pacific Oscillation (EPO).**
 - **The predominant phases of these likely to play large roles in whether this winter will end up on the cold or the mild side.**
 - **Easterly (negative) QBO *may* be more conducive to getting a -NAO/-AO**
- **The predominant mid-upper level pattern over the northeast Pacific and North America and temperature regime during November could provide a sign of the predominant winter pattern and temperature regime.**
 - **A very warm November and associated pattern could be a prelude to a winter pattern that favors above to well above normal temperatures.**
 - **Conversely, a near to below normal November and associated pattern could be a prelude to a winter pattern that favors near normal to below/well below normal temperatures.**
 - **This November's pattern has been one supportive of well below normal temps.**

Conclusion

NWS Chicago Outlook for Winter 2017-18 ***Northern/Central IL and Northwest Indiana***

Overall, there are signs pointing to an increased potential for above normal precipitation. However, temperatures could end up quiet variable between cold and mild conditions during the winter.

- **Temperatures: Highly variable, near to below normal on average**
 - Confidence: low-medium in predominant regime
 - November pattern *may* be helping increase confidence toward colder
- **Precipitation: Above normal**
 - Confidence: medium-high
- **Snowfall: Near to above normal**
 - Confidence: low-medium

Thanks for Reading!

**Have any questions?
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