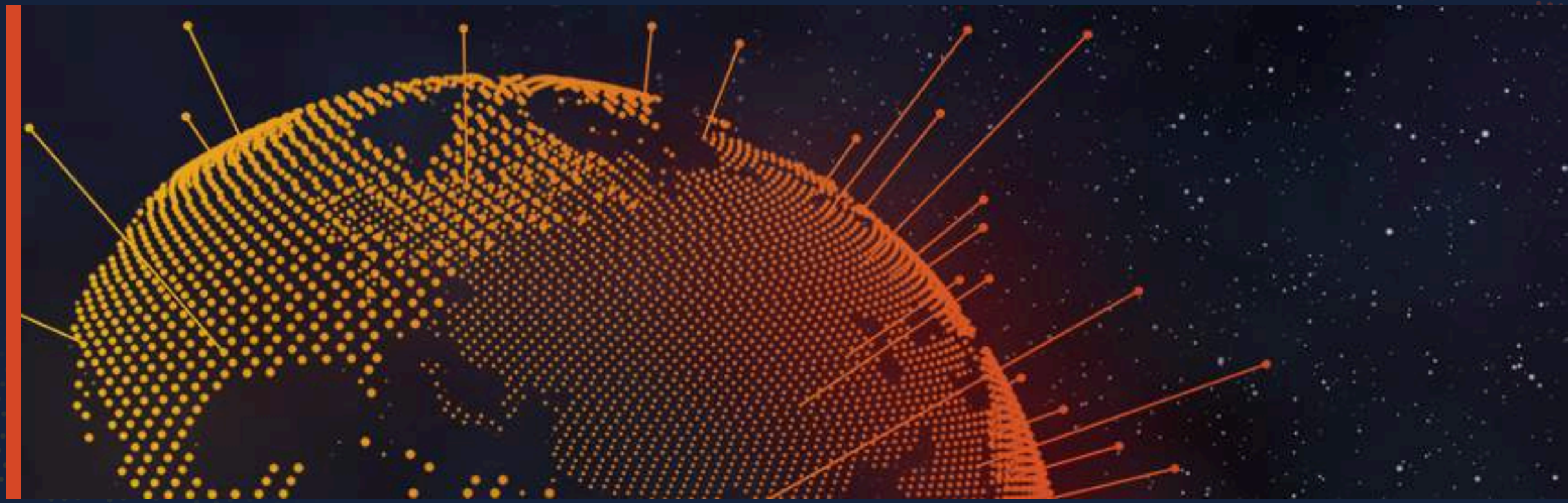
EARTH NETWORKS



WINTER OUTLOOK 2018-2019

PRESENTED BY: SENIOR METEOROLOGIST CHAD MERRILL, NOVEMBER 14, 2018

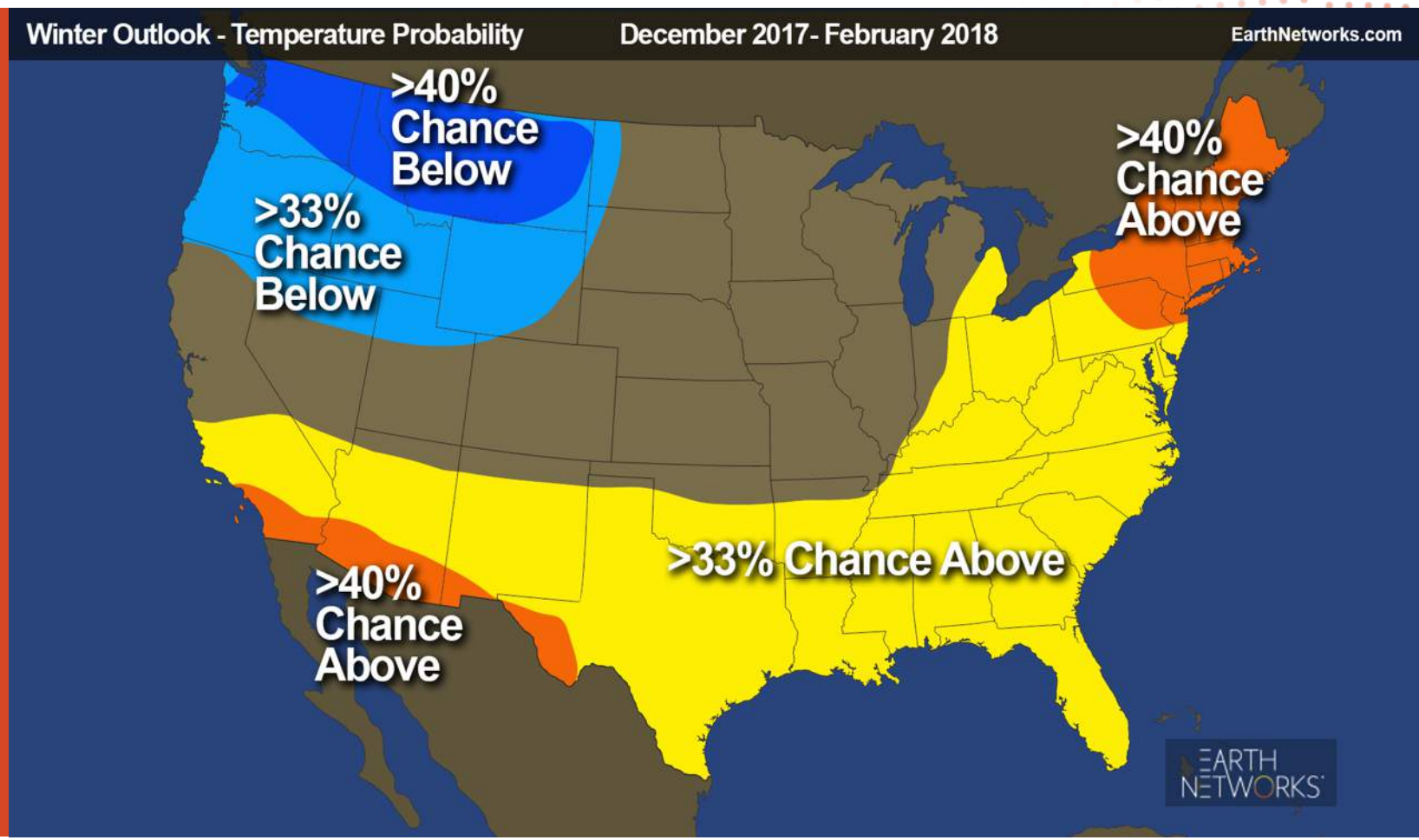
WINTER 2018-2019 OUTLOOK

All references to winter in the following slides refer to the three coldest months of the year

December, **January** and **February**.

EARTH NETWORKS WINTER REVIEW

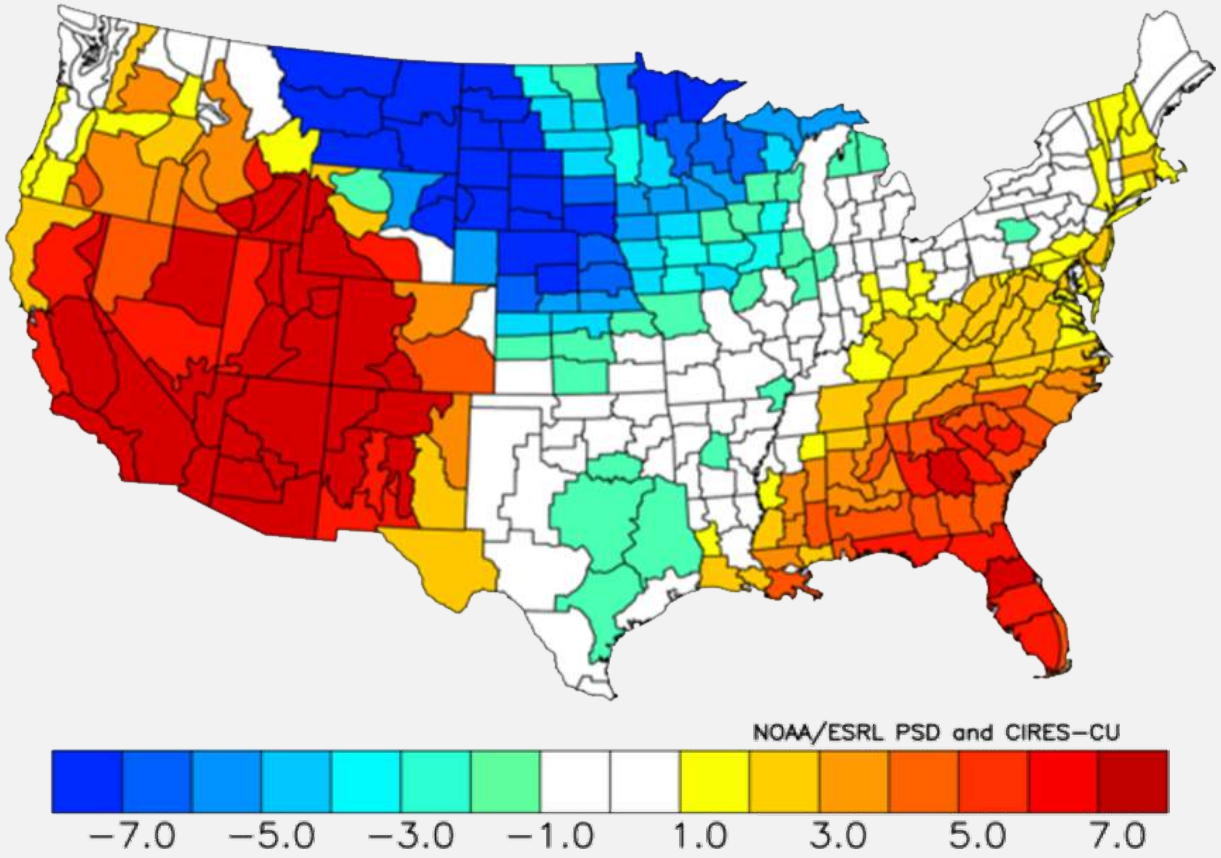
Winter 2017-2018 Temperature Probability Forecast



EARTH NETWORKS WINTER REVIEW

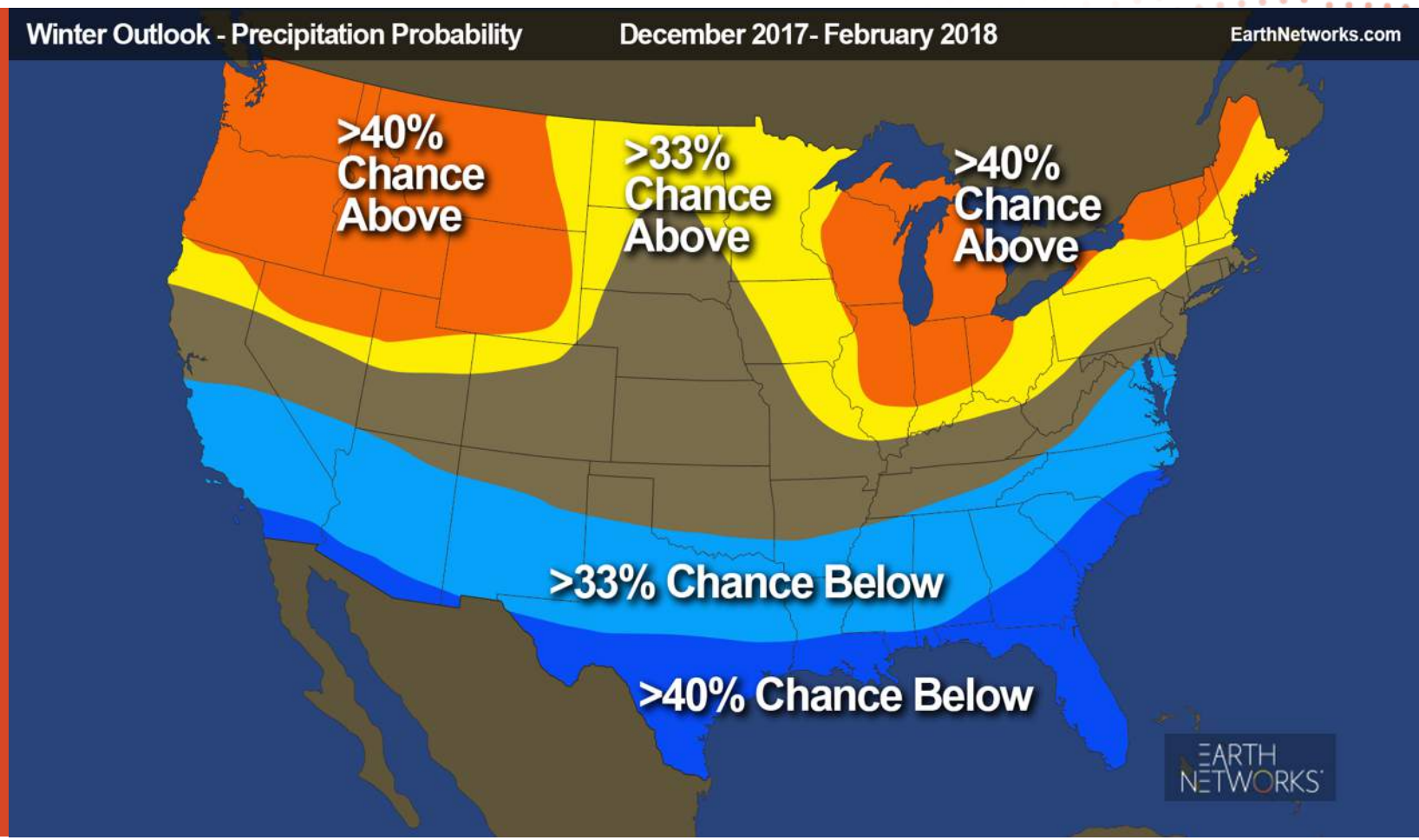
Winter 2017-2018 Temperature Departures

NOAA/NCEI Climate Division Temperature Anomalies (F) Dec to Feb 2017-2018 Versus 1981 – 2010 Long-term Average



EARTH NETWORKS WINTER REVIEW

Winter 2017-2018 Precipitation Probability Forecast



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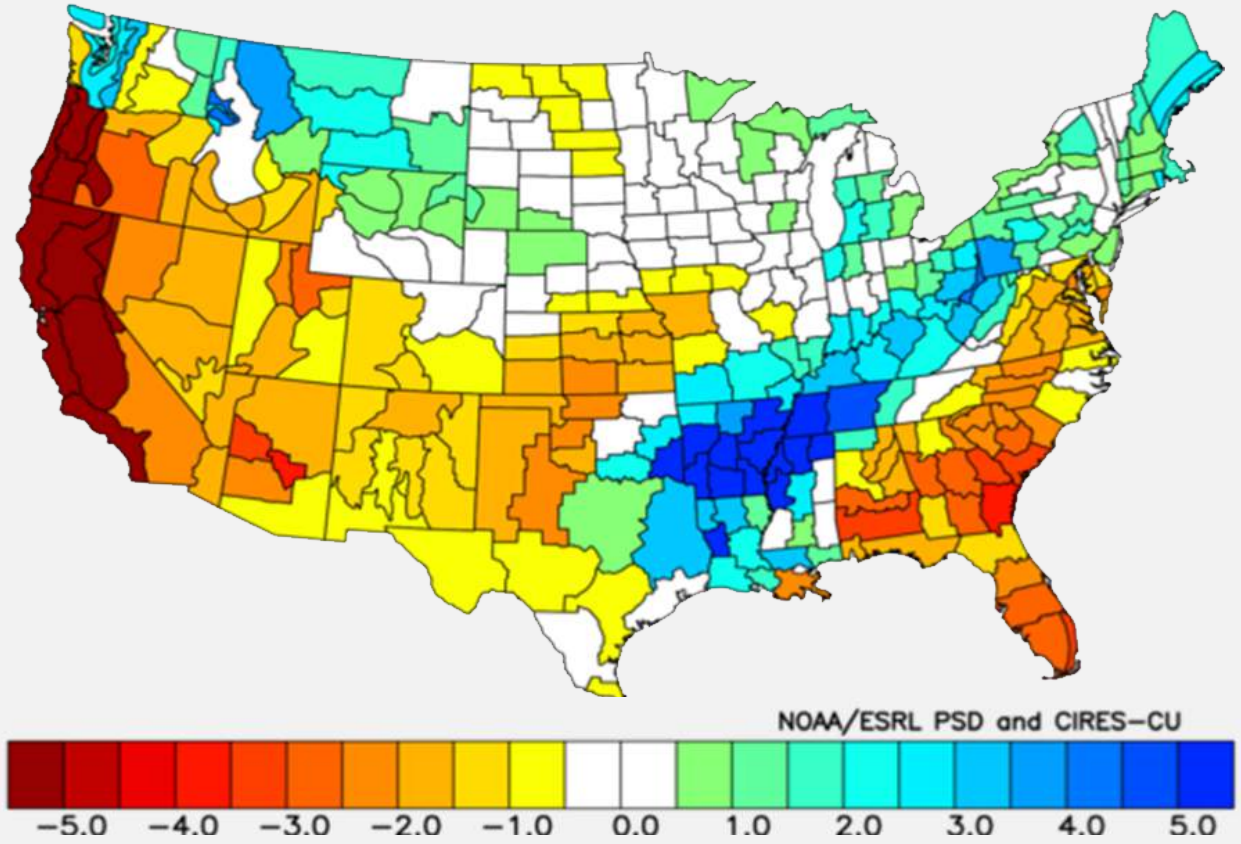
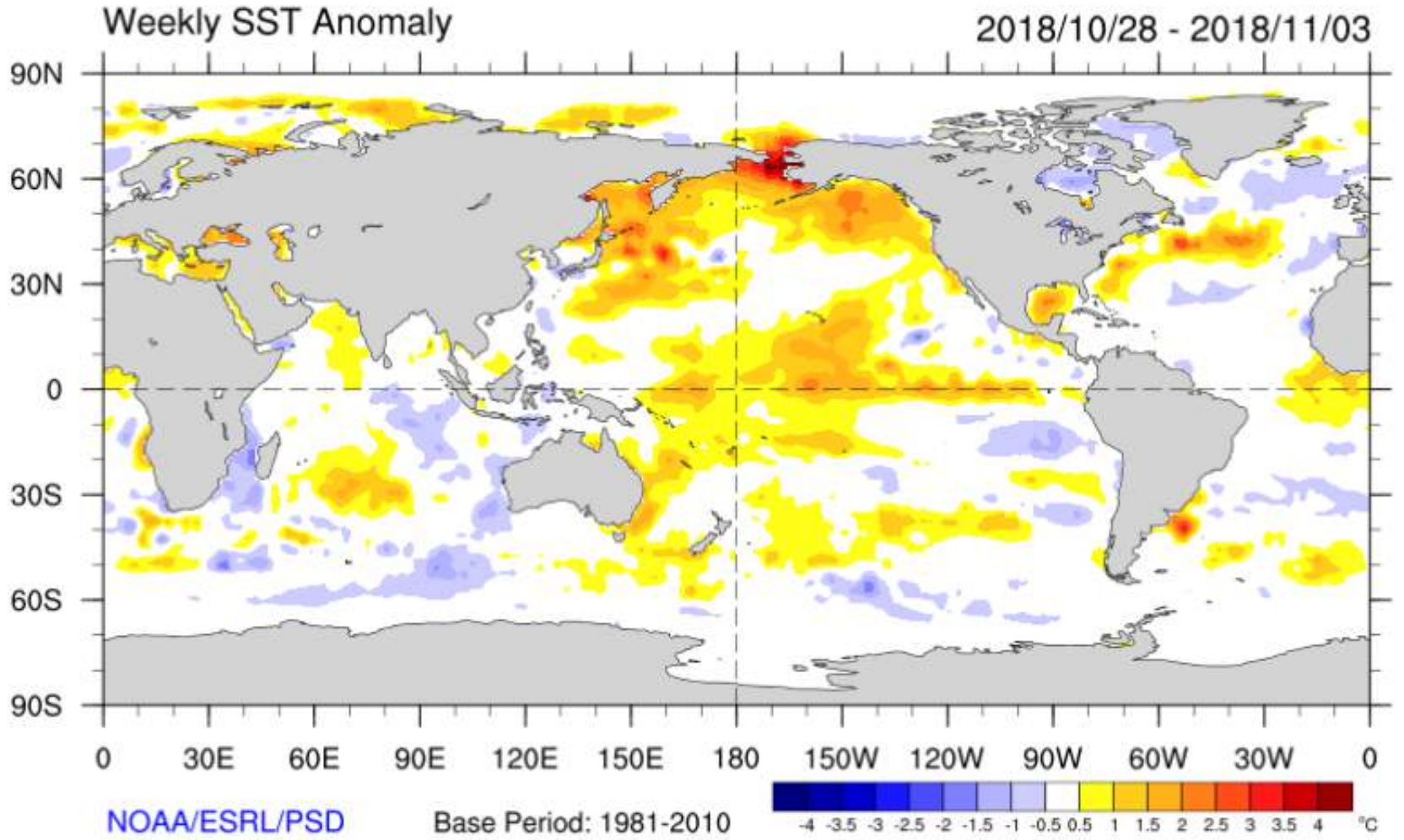


WINTER 2018-2019 INPUTS

THE MAJOR PLAYERS…


Weekly SST Anomaly
2018/10/28 - 2018/11/03
90N
60N
30N
0
30S
60S
90S
0
30E
60E
90E
120E
150E
180
150W
120W
90W
60W
30W
0
NOAA/ESRL/PSD
Base Period: 1981-2010
-4 -3.5 -3 -2.5 -2 -1.5 -1 -0.5 0.5 1 1.5 2 2.5 3 3.5 4
°C

WINTER 2018-2019 INPUTS

MOST SIGNIFICANT FACTORS In The Forecast

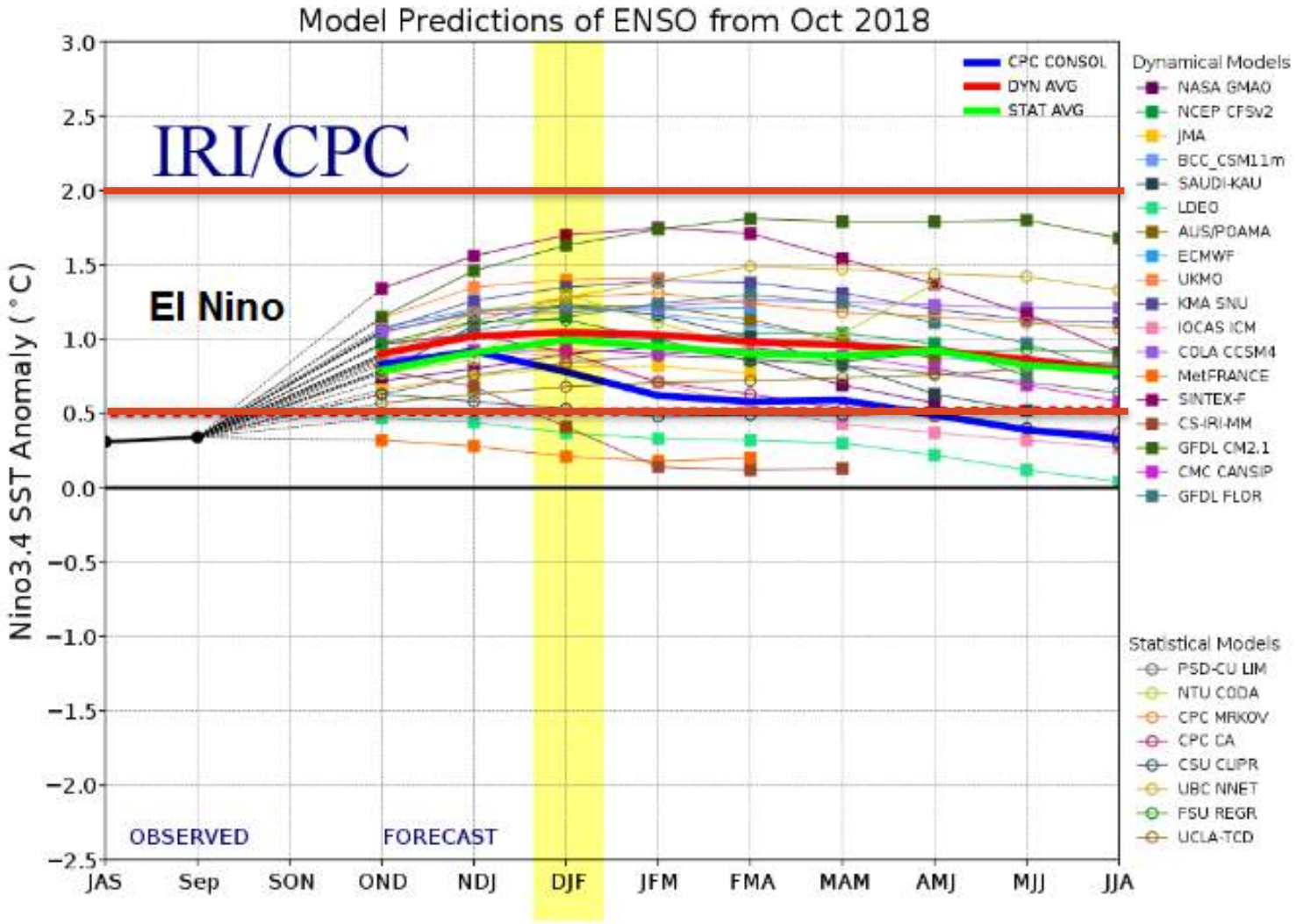
EL NIÑO SOUTHERN OSCILLATION (ENSO)
Equatorial Pacific Sea Surface Temperatures that impact global circulation patterns

CLIMATE/DECADAL TEMPERATURE TRENDS
Are certain parts of the U.S. trending warmer/cooler?

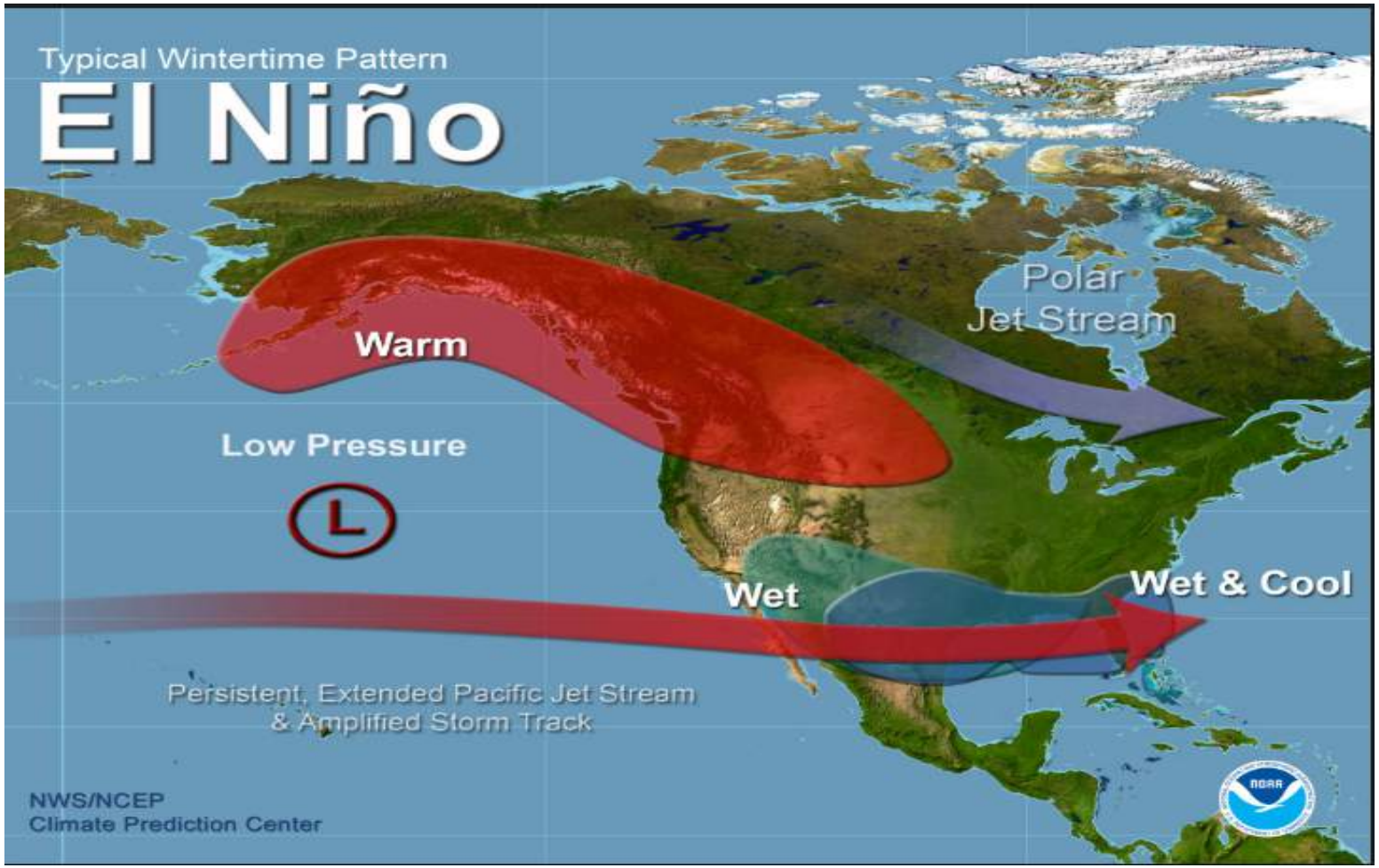
QUASI-BIENNIAL OSCILLATION (QBO)
High-altitude winds near the equator that impact global circulation patterns

SIMILAR YEARS
What happened during previous winters that had similar conditions?

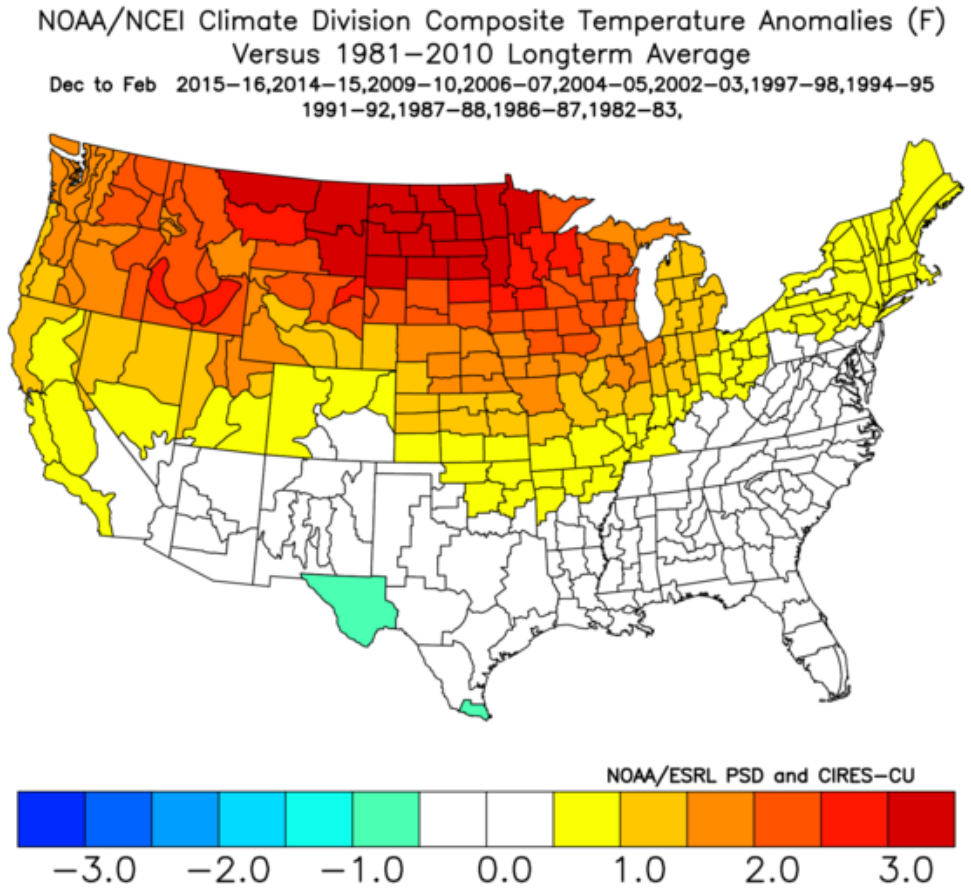
ENSO FORECAST: EL NIÑO HIGHLY LIKELY



TYPICAL U.S. WEATHER PATTERN DURING AN EL NIÑO WINTER

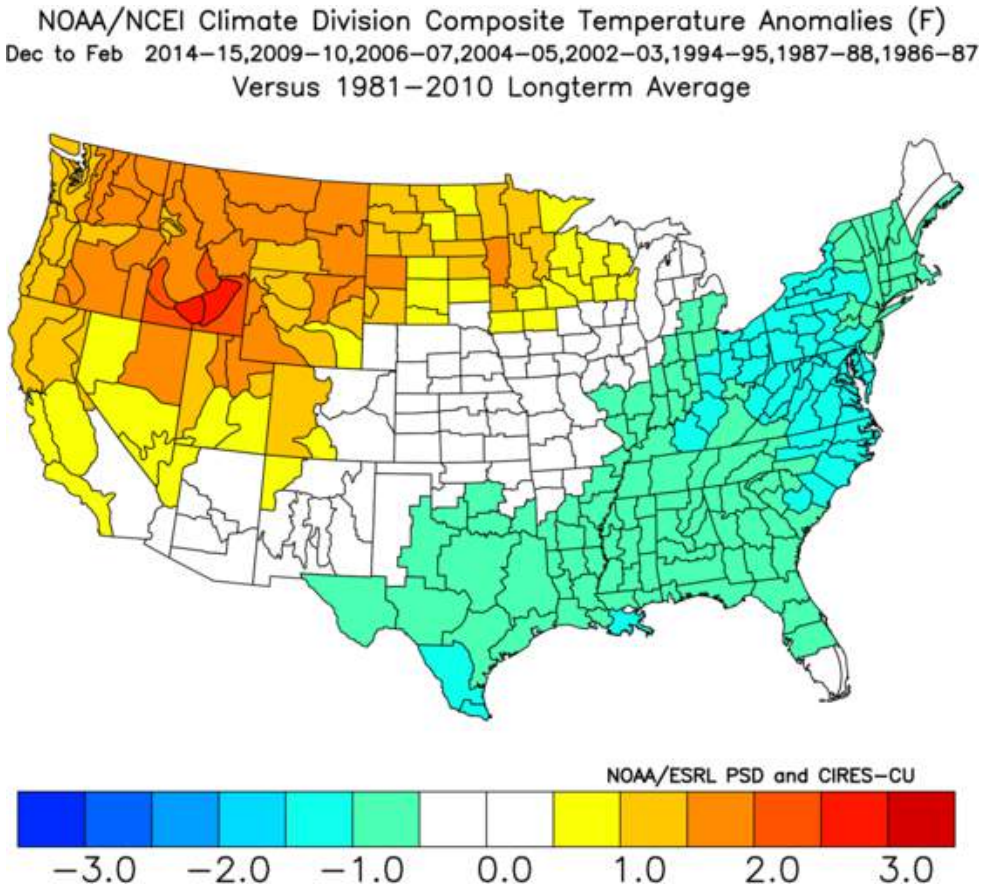


TEMPERATURE TRENDS IN THE 12 MOST RECENT EL NIÑOS



Winter	SST Anomaly
2015-16	2.5
1982-83	2.2
1997-98	2.2
1991-92	1.7
2009-10	1.5
1986-87	1.2
1994-95	1
2002-03	0.9
1987-88	0.8
2006-07	0.7
2004-05	0.6
2014-15	0.6

TEMPERATURE TRENDS IN THE 8 MOST SIMILAR/RECENT EL NIÑOS



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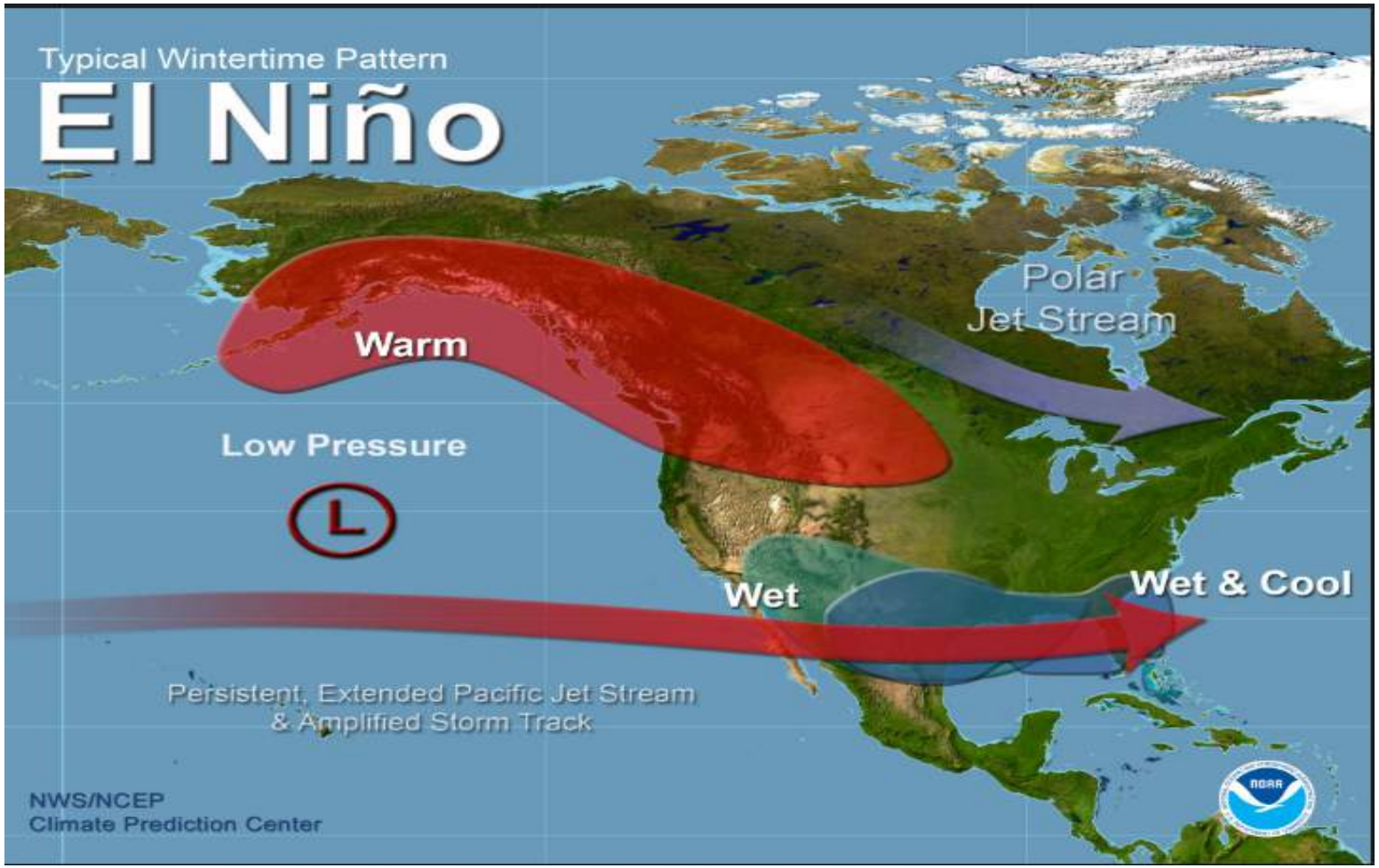
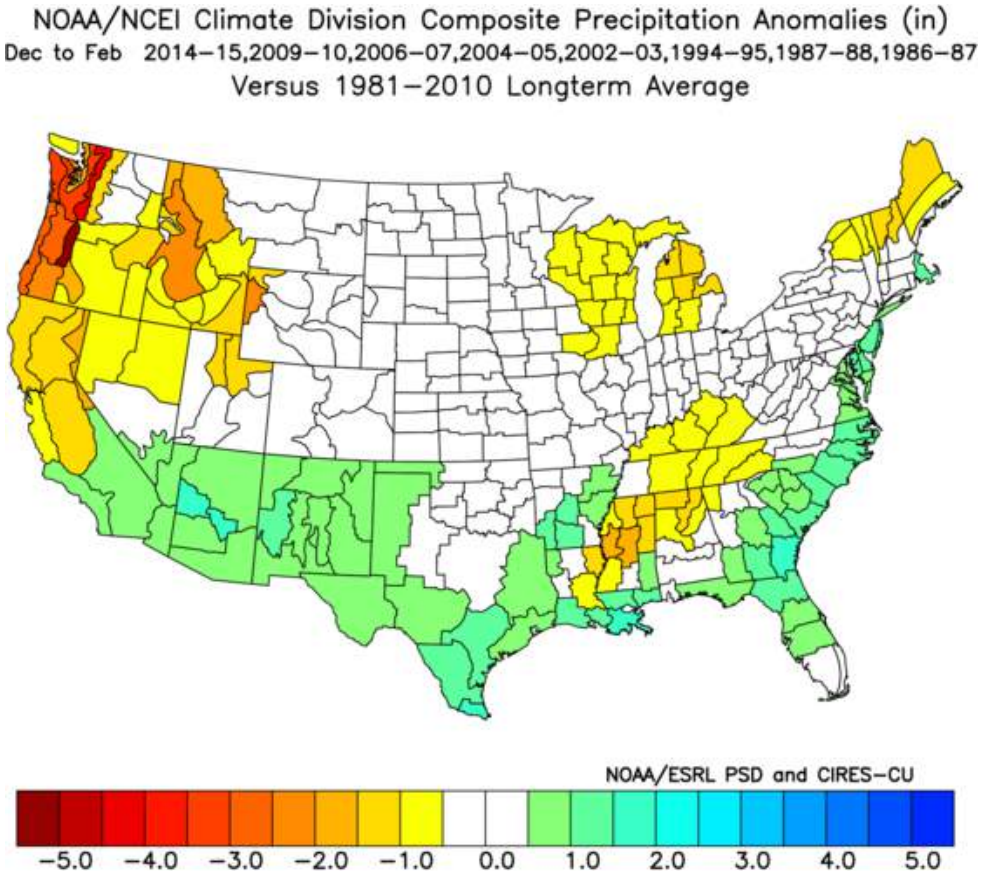


PRECIPITATION TRENDS IN THE 8 MOST SIMILAR/RECENT EL NIÑOS



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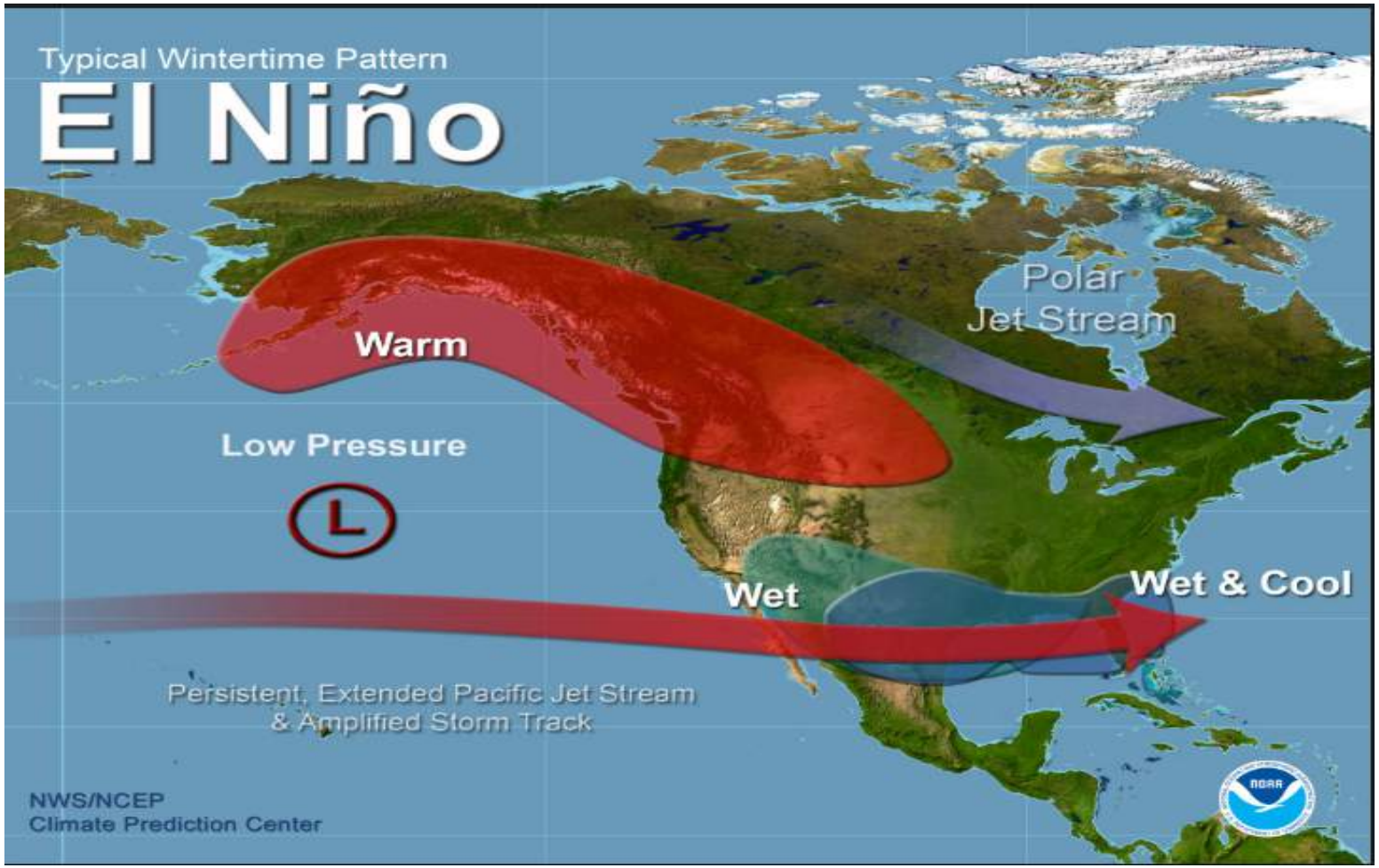
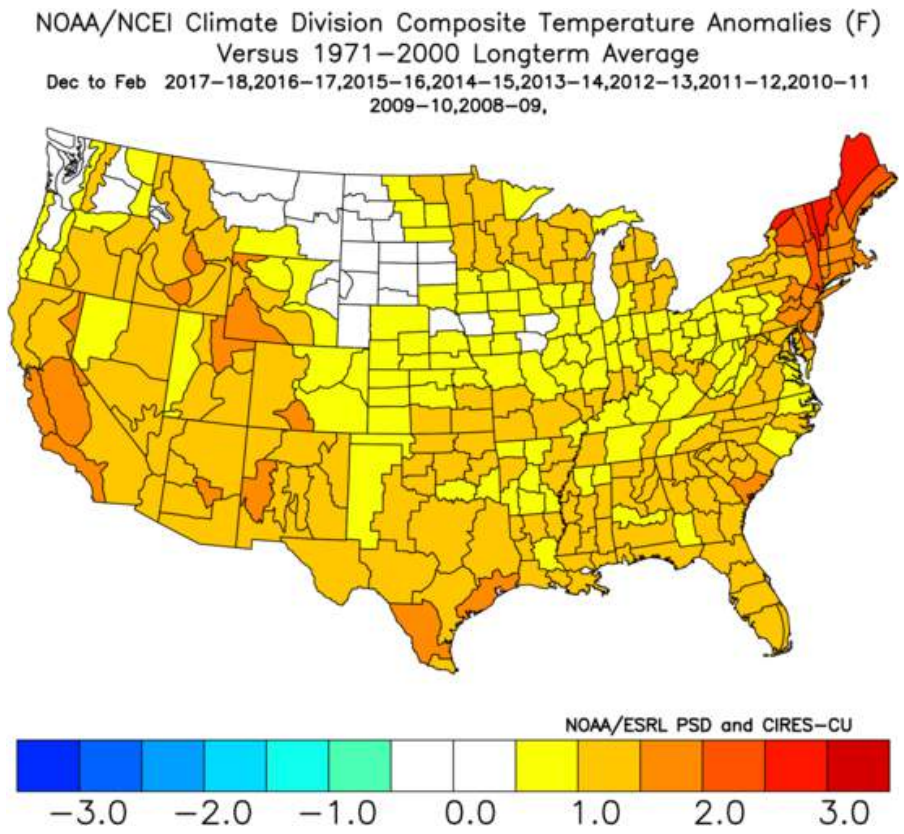
TYPICAL U.S. WEATHER PATTERN DURING EL NIÑO WINTER

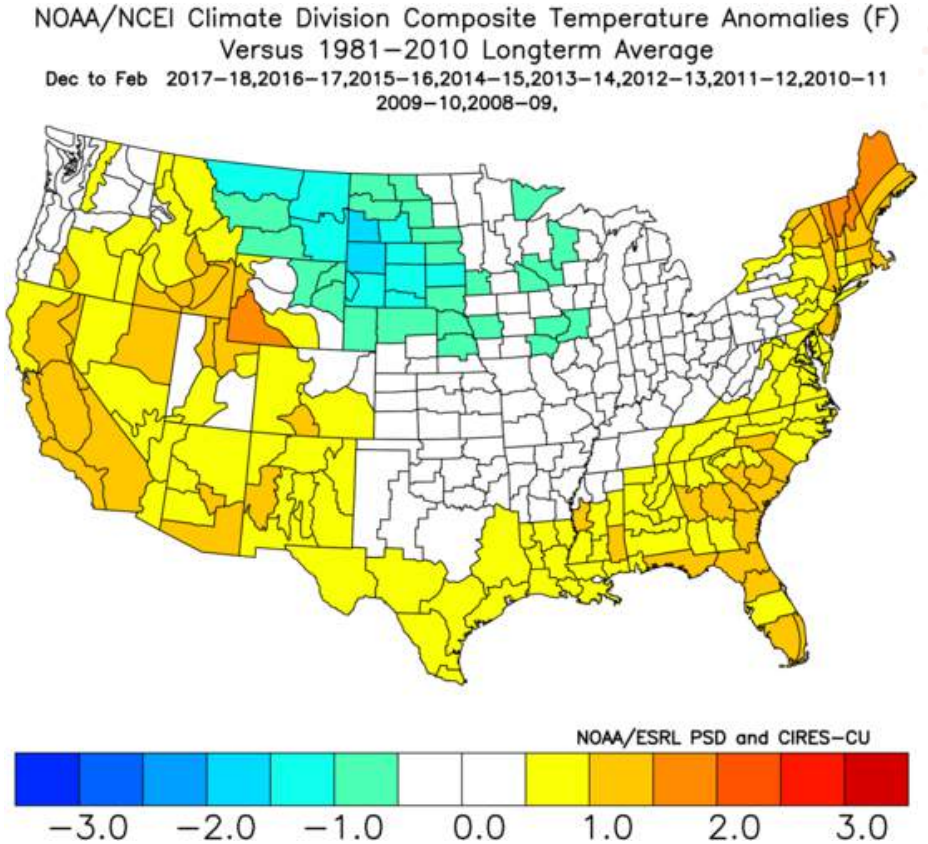


CLIMATE/DECADAL TRENDS

WARMING NOTED IN THE EAST, SOUTHWEST



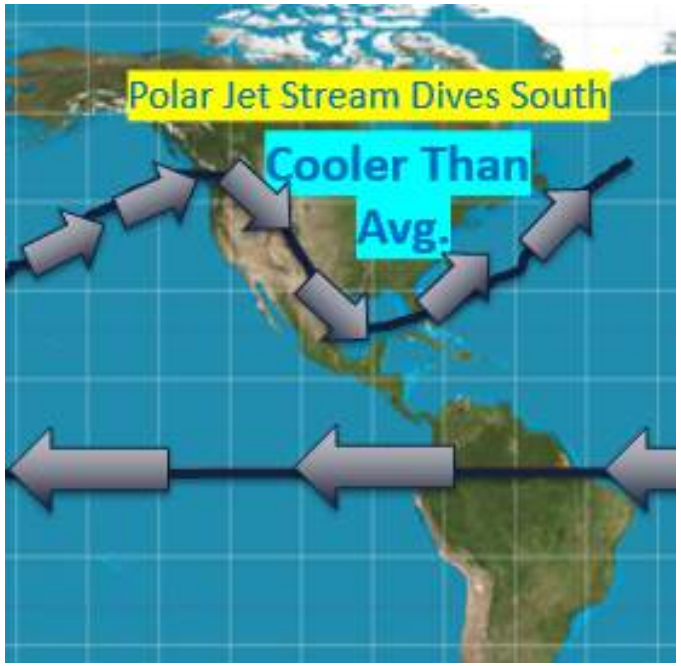
Most recent 10 yrs. (2009 to 2018) warmer than 1971-2000 norms

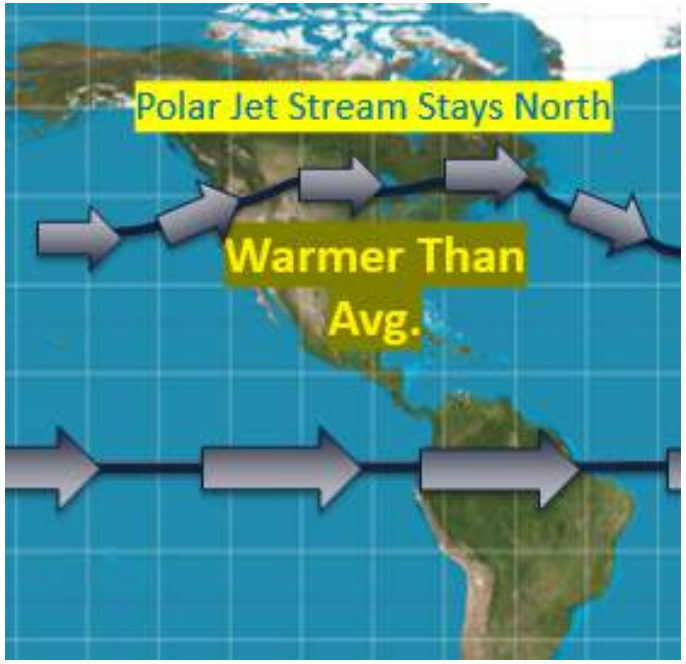


Same years (2009 to 2018) compared to 1981-2010 norms

EARTH NETWORKS

QUASI-BIENNIAL OSCILLATION (QBO):



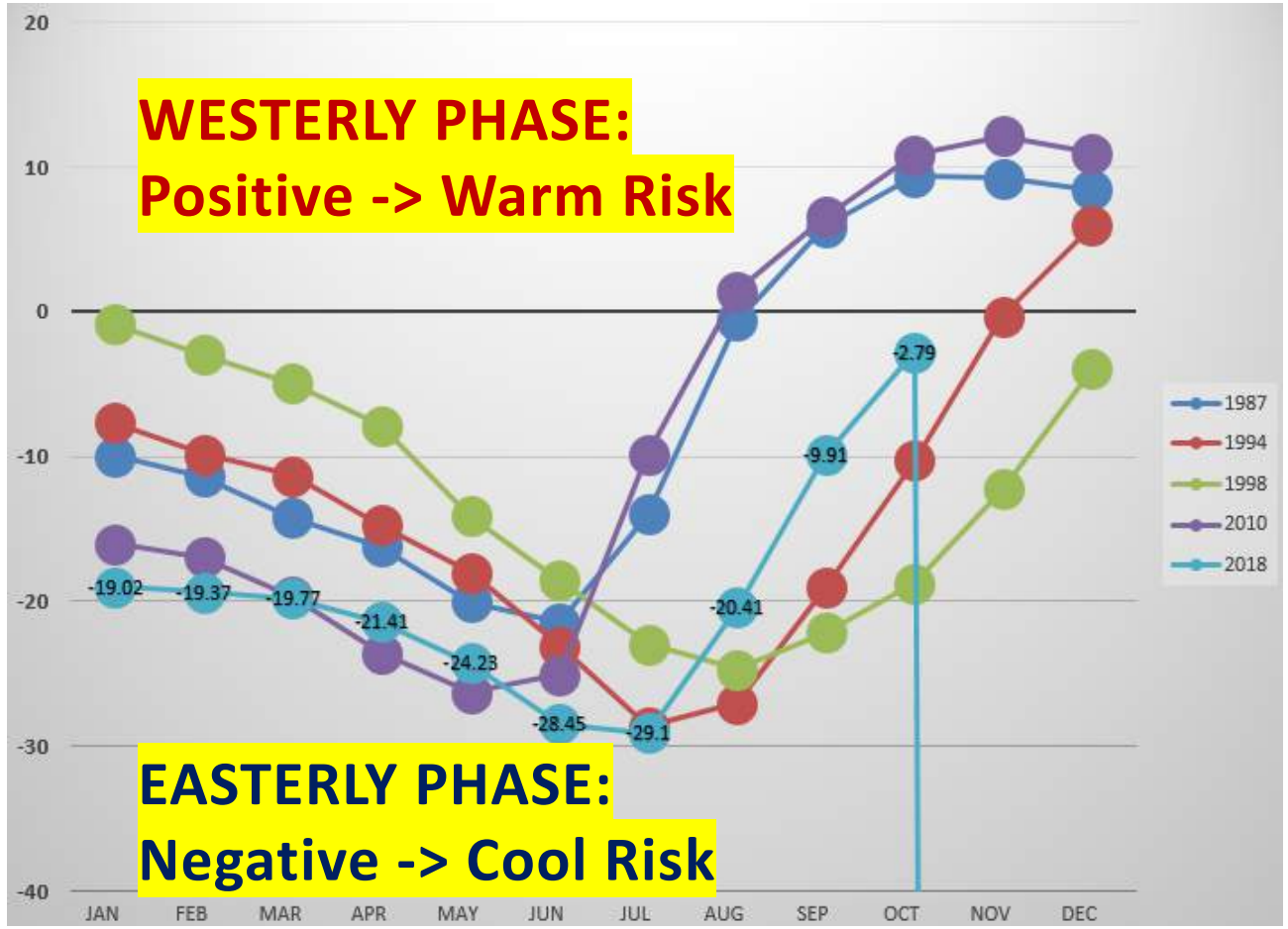


2018: A transition toward a **westerly phase heading into winter?

EASTERLY PHASE:
Weak polar jet, more amplified pattern, cold outbreaks more common

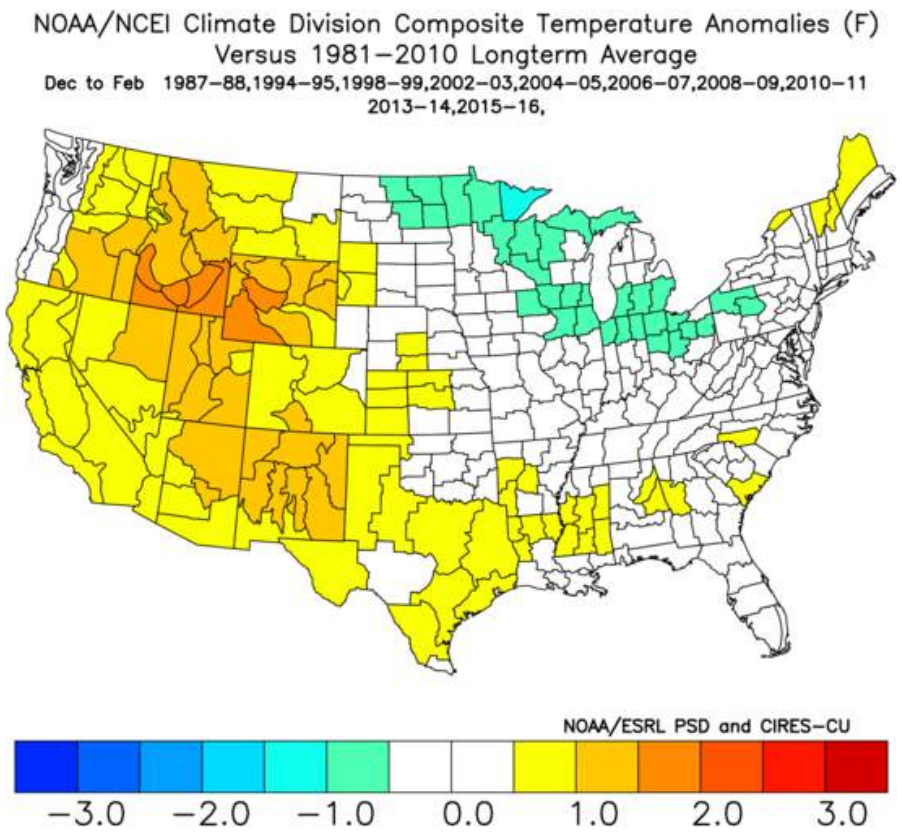
WESTERLY PHASE:
Stronger westerlies/jet stream, less amplified pattern, not as many cold outbreaks

QUASI-BIENNIAL OSCILLATION (QBO):

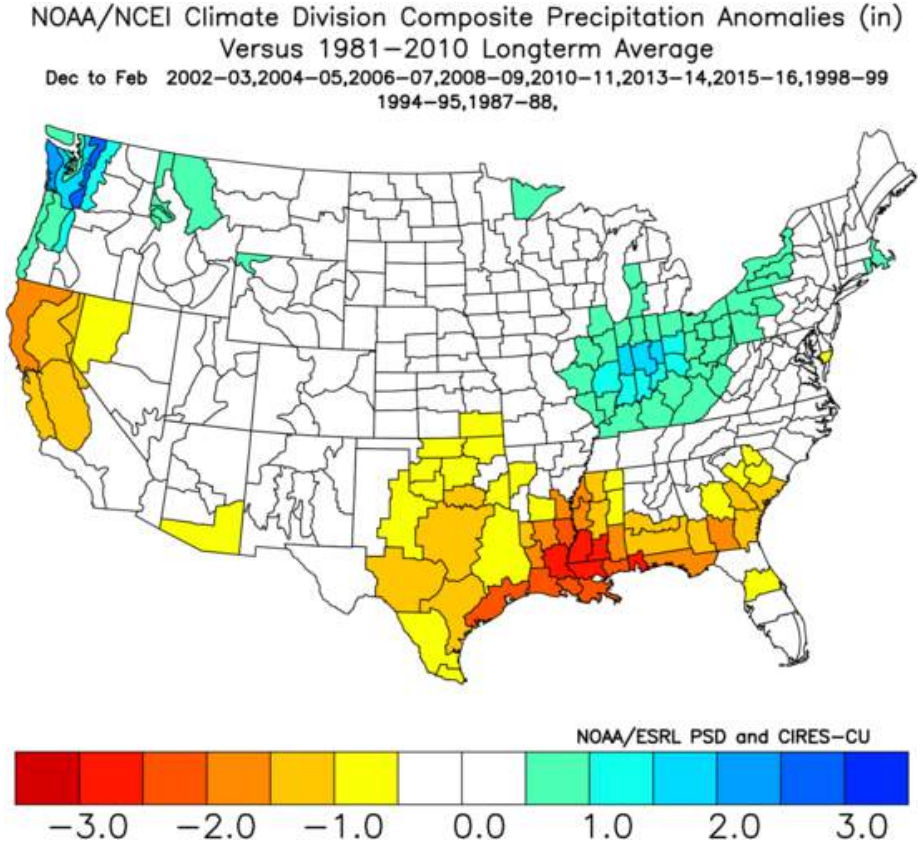


TRANSITIONAL QBO YEARS SINCE 1987 (TRENDING FROM NEGATIVE TO POSITIVE)

WESTERLY PHASE (POSITIVE): WARM RISK WEST



Temperature



Precipitation

NOW FOR THE 2018-2019

WINTER OUTLOOK…

EXPLANATION OF THE FOLLOWING PROBABILITY FORECASTS

Probability of Occurence		
Above	Near	Below
40-50%	33%	26-16%
33-40%	33%	33-26%
Below	Near	Above
33-40%	33%	33-26%
Equal Chances		
33%	33%	33%

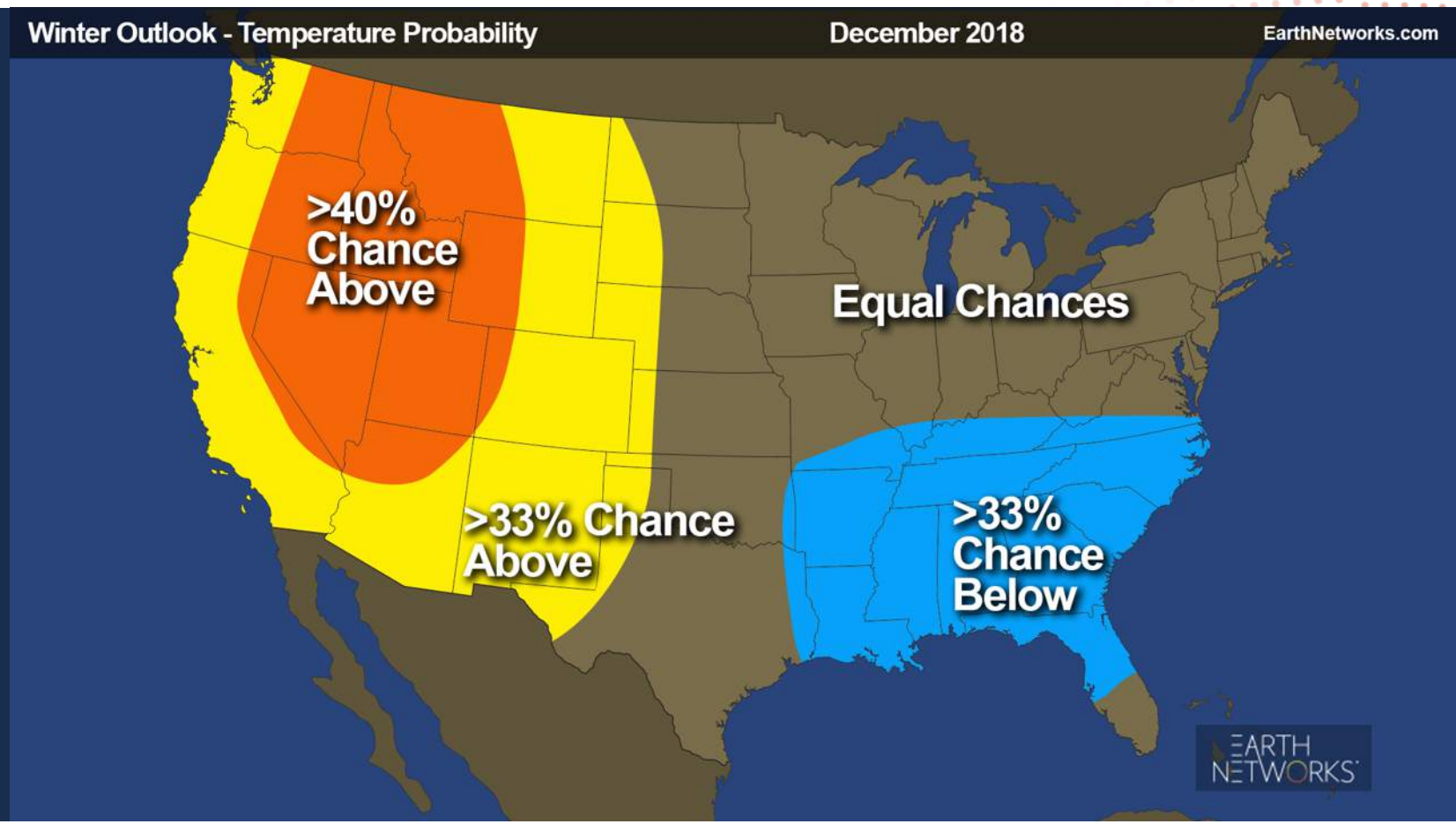
The percentages

DO NOT refer to how much above or below average temperatures or precipitation will be in selected areas.

DECEMBER 2018

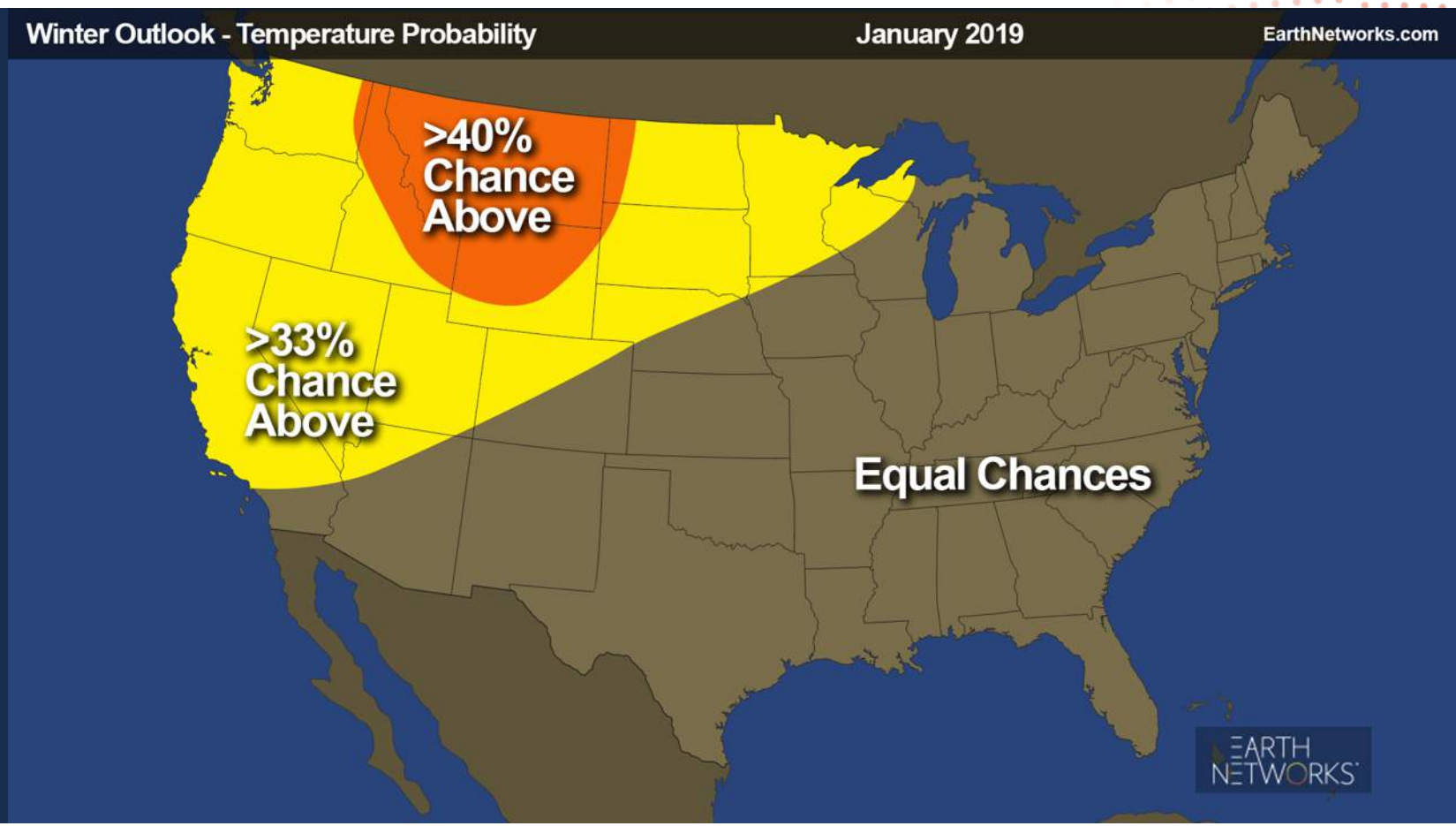
Pattern still amplified

- Warm ridge West
- Cool risk Southeast



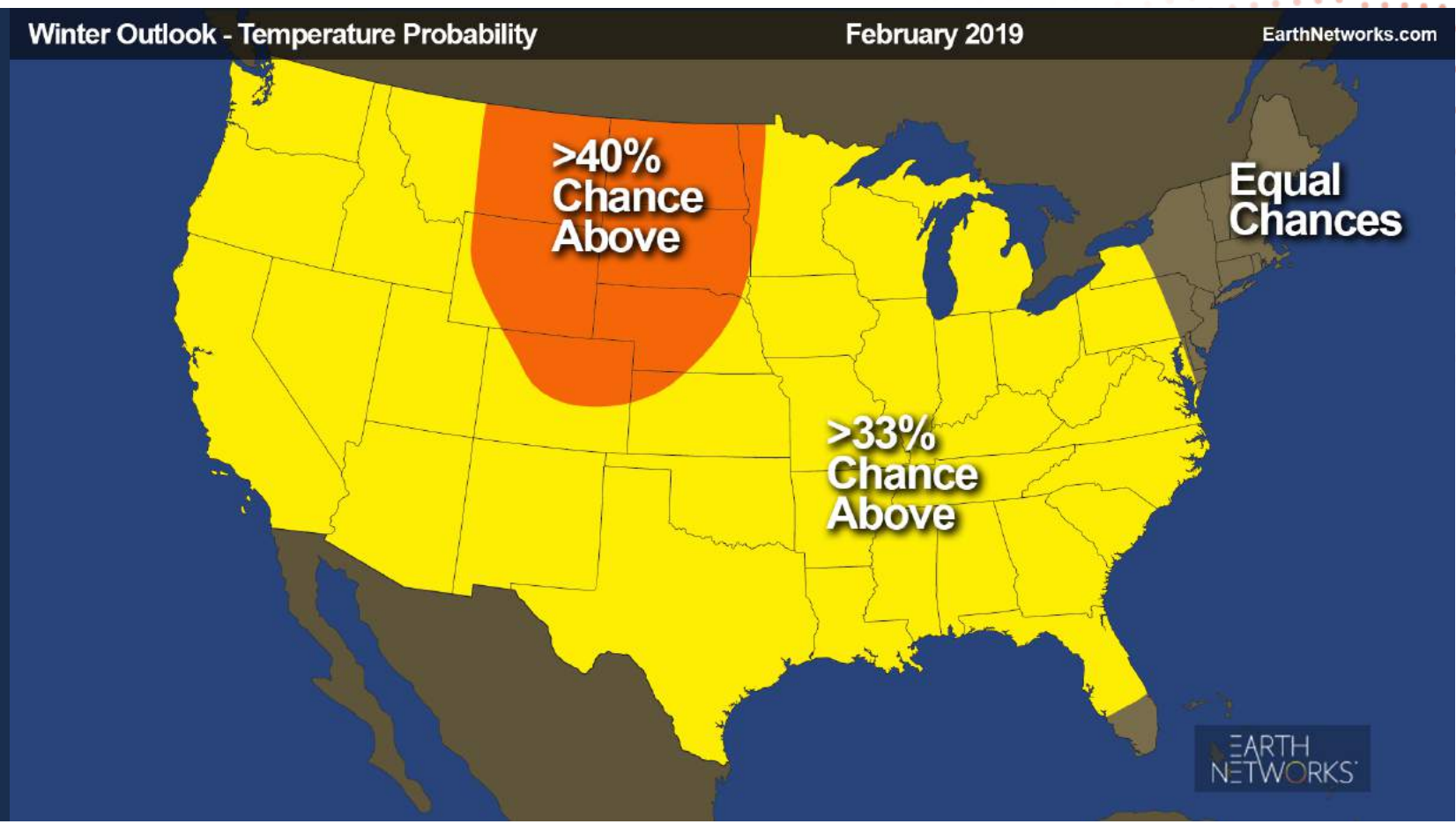
JANUARY 2019

- Jet stream turns less amplified as QBO becomes more positive
- A few cold outbreaks still possible in the East



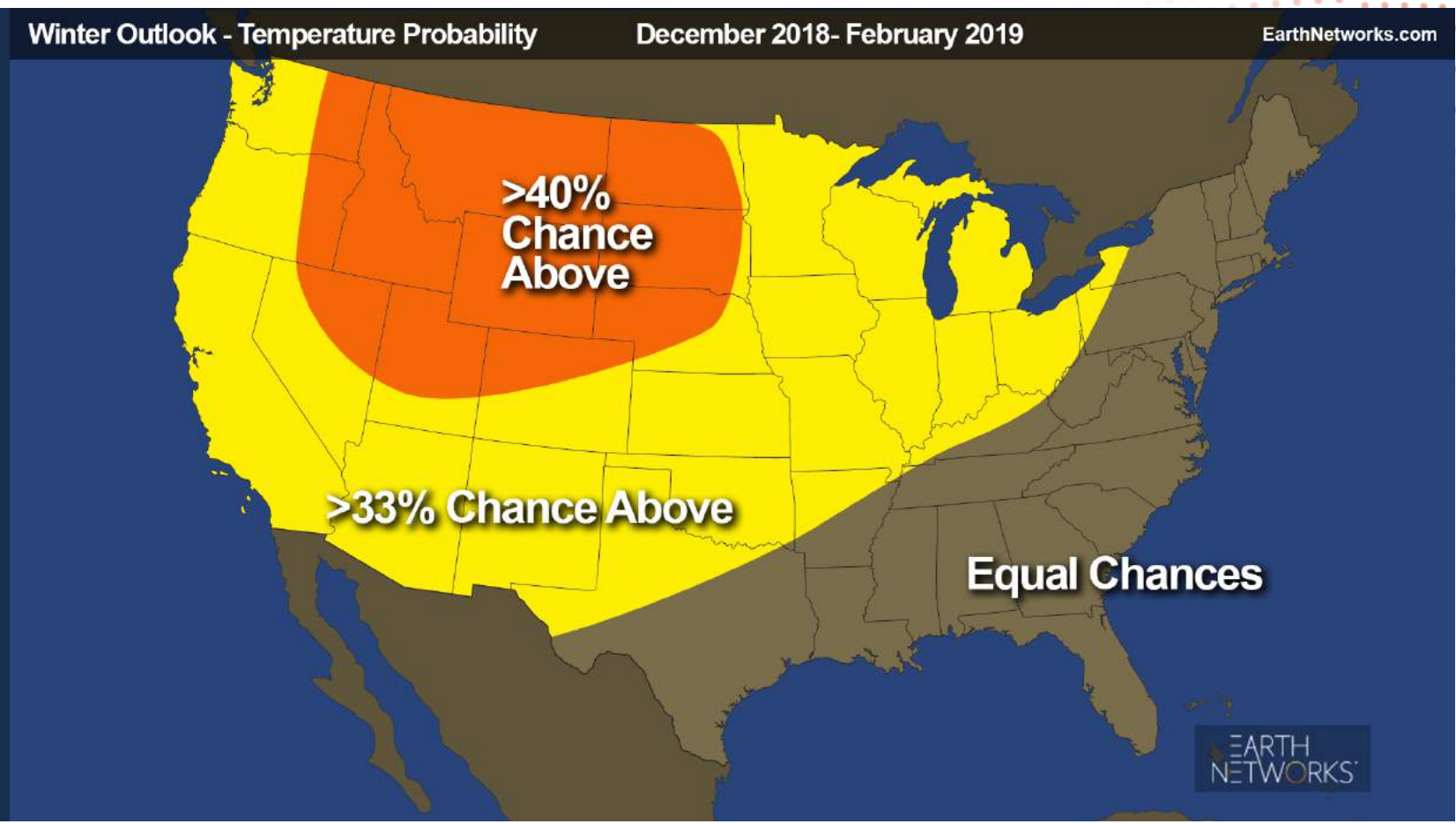
FEBRUARY 2019

- Polar air increasingly confined to north of the U.S. border.



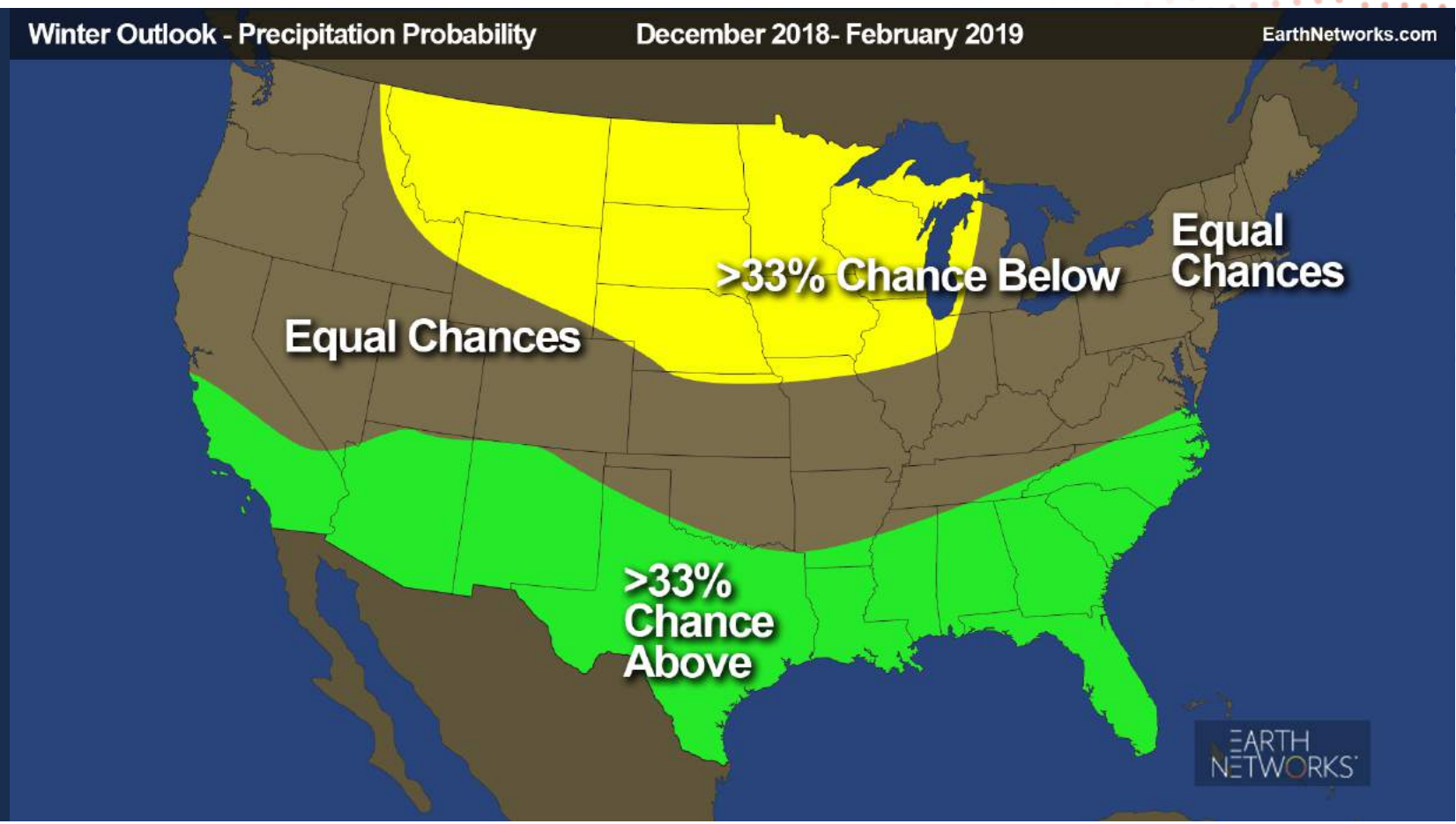
DECEMBER – FEBRUARY 2019

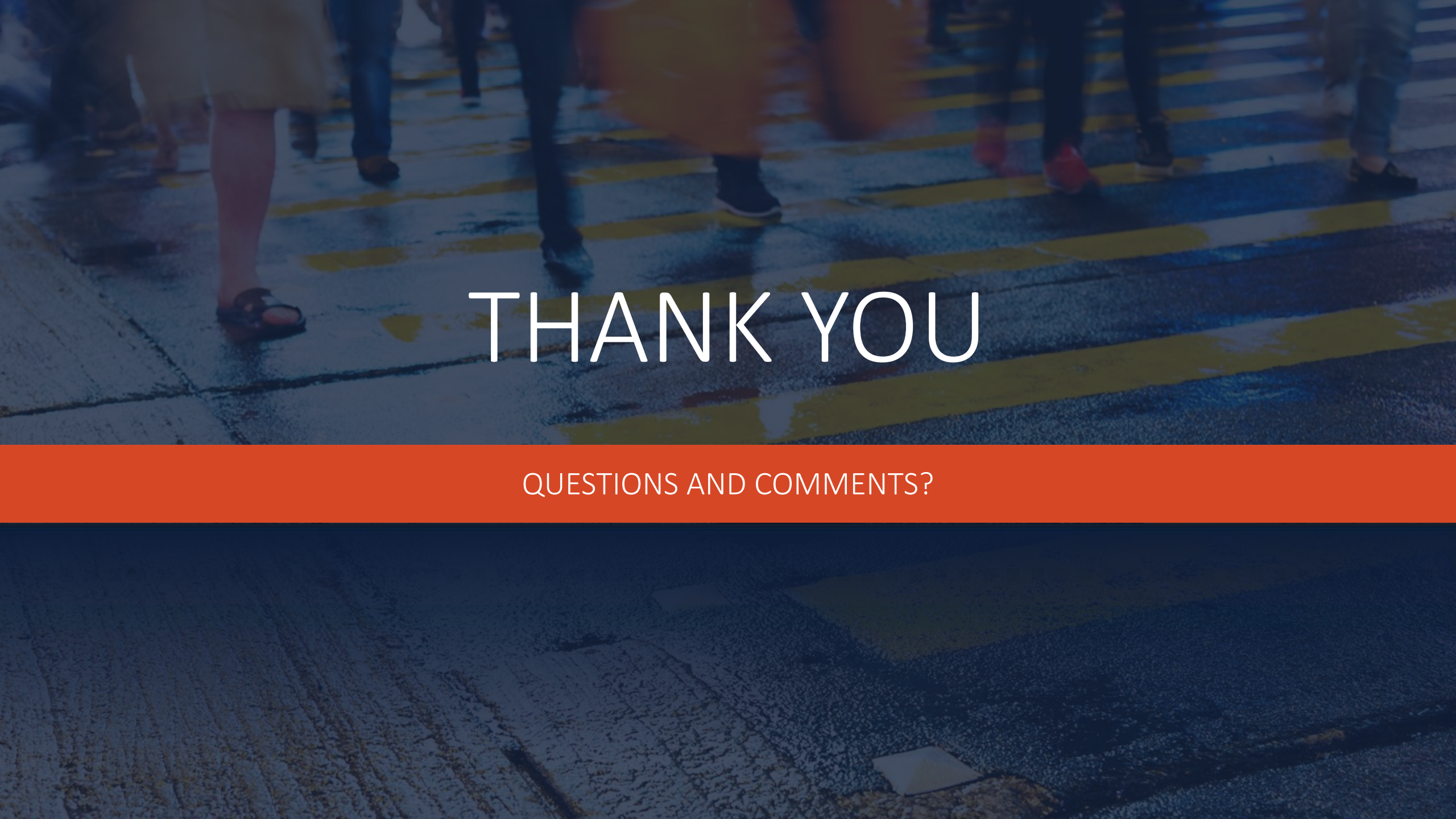
- Northern Rockies have best chance to be warmer than average
- Mixed signals in the East



DECEMBER – FEBRUARY 2019

- Active southern jet stream associated with El Niño
- Dry risk in the northern Plains to Upper Midwest



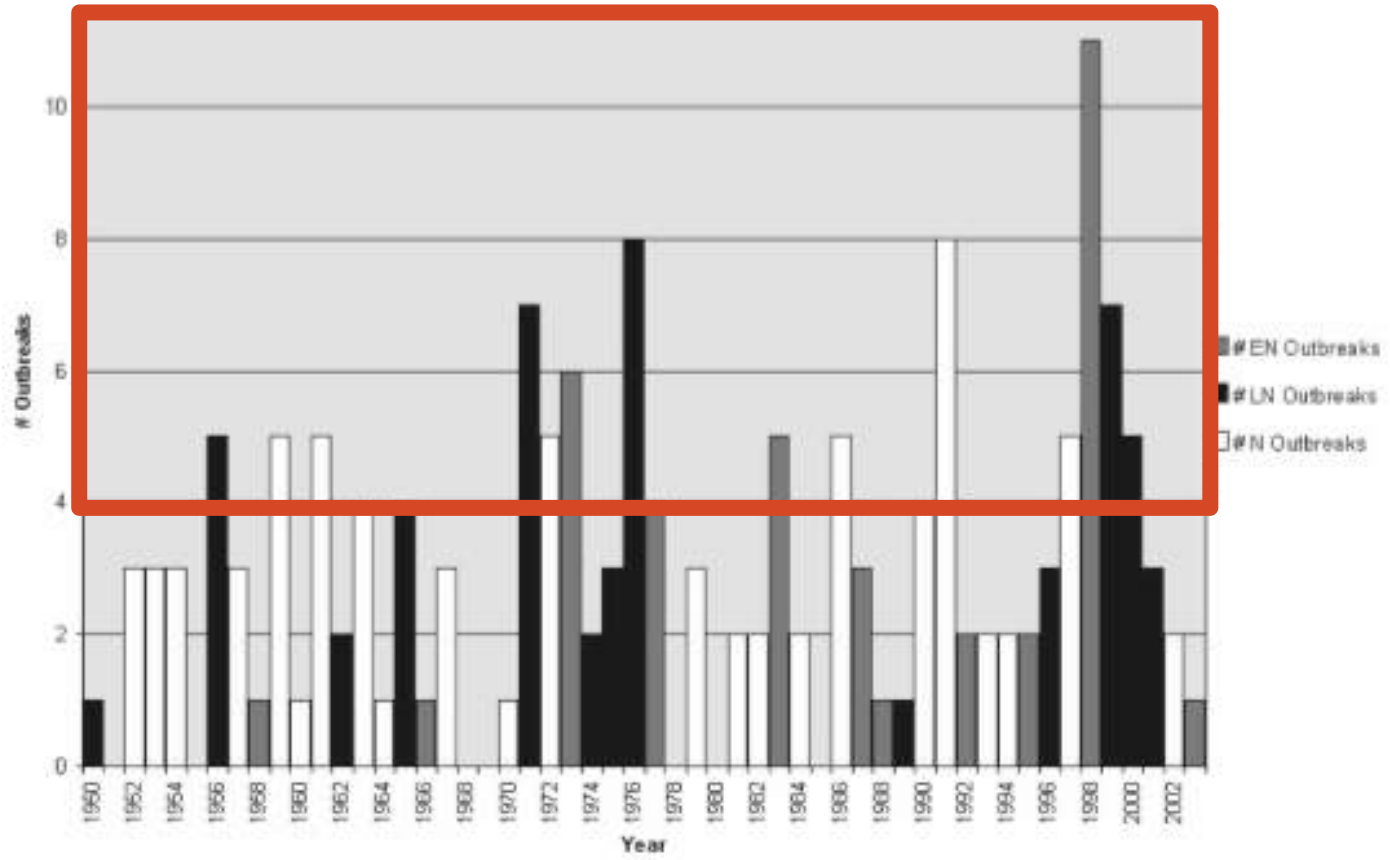


THANK YOU

QUESTIONS AND COMMENTS?

WINTER TORNADO OUTBREAKS DURING ENSO PHASES

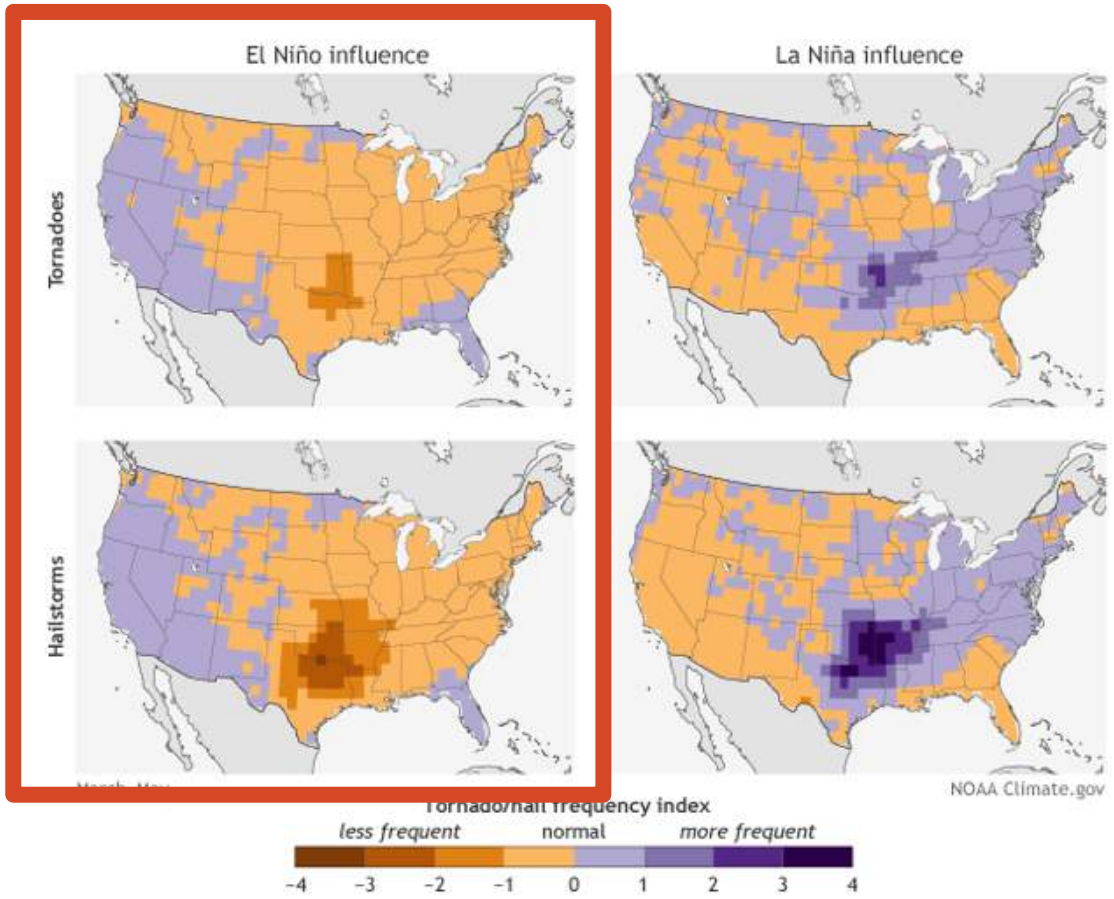
4 or more winter tornado outbreaks more common in Neutral to La Nina winters



- From 1992-2003, more outbreaks occurred during La Niña Winters
- Even tornado outbreak distribution indicated since 1970
- The most frequent tornado outbreak occurred in the 1997-1998 El Niño

Source: https://www.spc.noaa.gov/publications/cook/enso-mwr.pdf

SPRING TORNADO OUTBREAKS DURING ENSO PHASES



March-May values of a blend of tornado and hail reports with a tornado environment index (TEI) and a hail environment index (HEI) for El Nino and La Nina years. Maps by climate.gov; data from the authors.

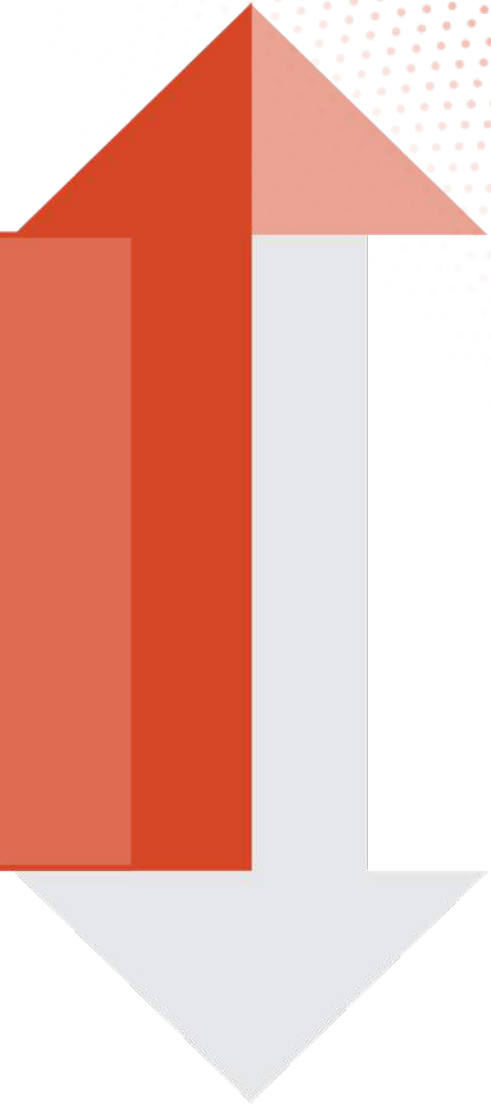
- A stronger signal for fewer severe thunderstorms producing tornados and hail in an El Niño spring compared to a La Niña spring (March-May).

Source: https://www.spc.noaa.gov/publications/cook/enso-mwr.pdf

WINTER 2018–2019 UPSIDE RISK FACTORS

UP

- **Enhanced risk factor for above average temperature in the northern Rockies and northern Plains.**
- **Enhanced risk factor for above average precipitation in the U.S. southern tier.**



EARTH NETWORKS

WINTER 2018–2019 DOWNSIDE RISK FACTORS

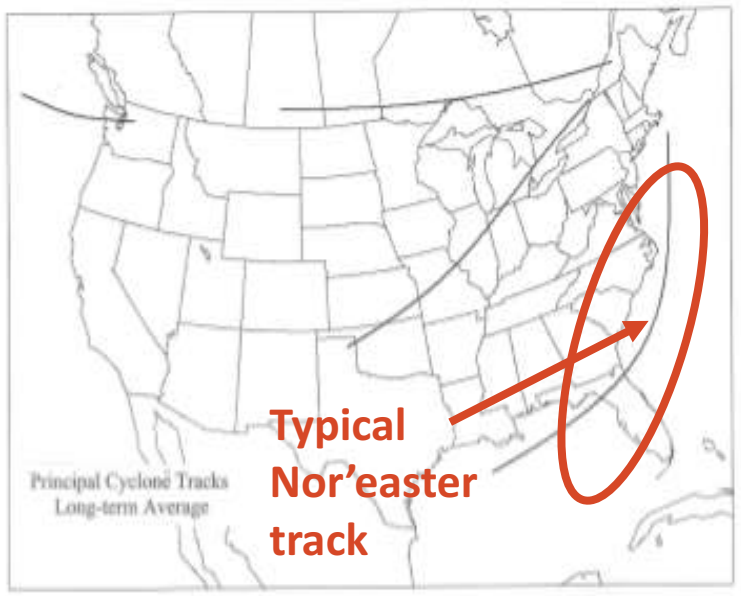
- **More frequent cold outbreaks in the Eastern U.S., leading to a risk for colder than average temperatures.**
- **Active southern jet stream coupled with cold Eastern U.S. outbreaks and warm western Atlantic SST anomalies that could lead to above average precipitation along the East Coast.**

DOWN

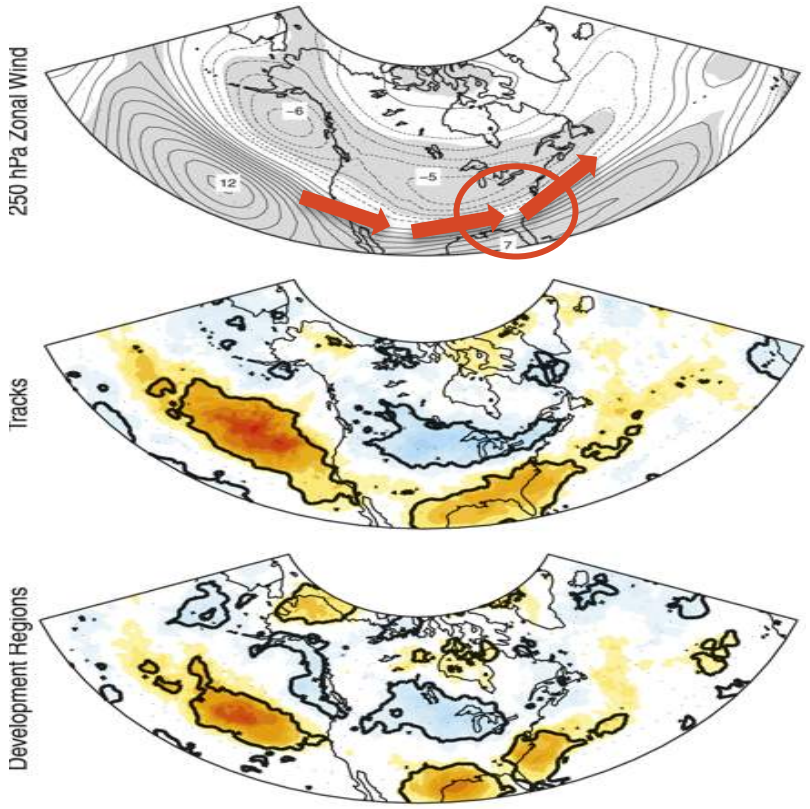
EARTH NETWORKS

EL NIÑO NOR'EASTER POTENTIAL

TYPICAL WINTER STORM TRACKS



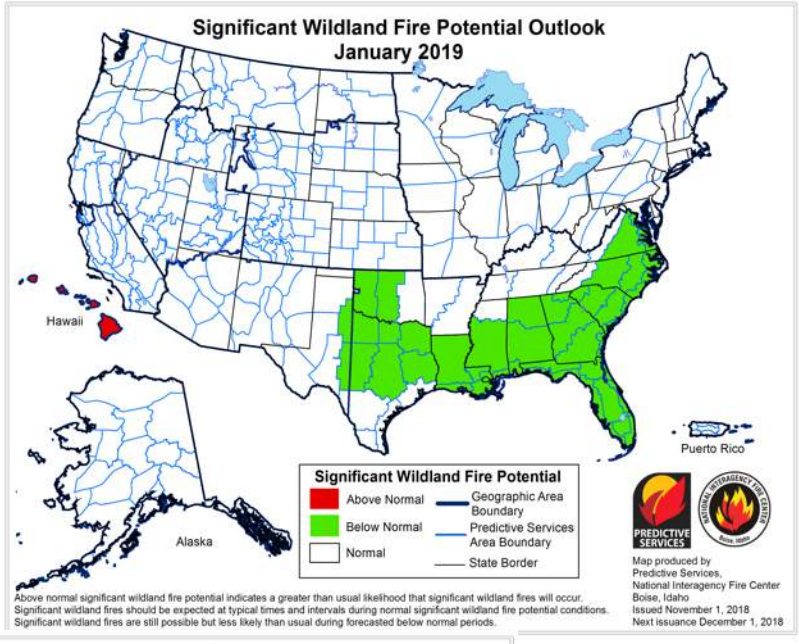
TYPICAL EL NIÑO WINTER STORM TRACK



- Three main winter storm tracks in the Winter.
- El Niño winters tend to produce a better likelihood of Nor'easters.

Source: United States Naval Academy & Lamont-Doherty Earth Observatory

WINTER WILDFIRE POTENTIAL



- Enhanced Wildfire Risk in southern California early this winter, then diminishing.
- Below normal chance of wildfires from the S. Plains to Southeast.

Source: NOAA