

Demystifying Weather Forecasts and Other Meteorological Oddities.

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IOWA DEPARTMENT OF
**AGRICULTURE &
LAND STEWARDSHIP**

Presentation Highlights

- Climatological Trends
- Weather Myths
- Predicting Frost/Freeze
- What Does a 40% Chance of Rain Really Mean
- Seasonal Predictability
- How is an Outlook Created?



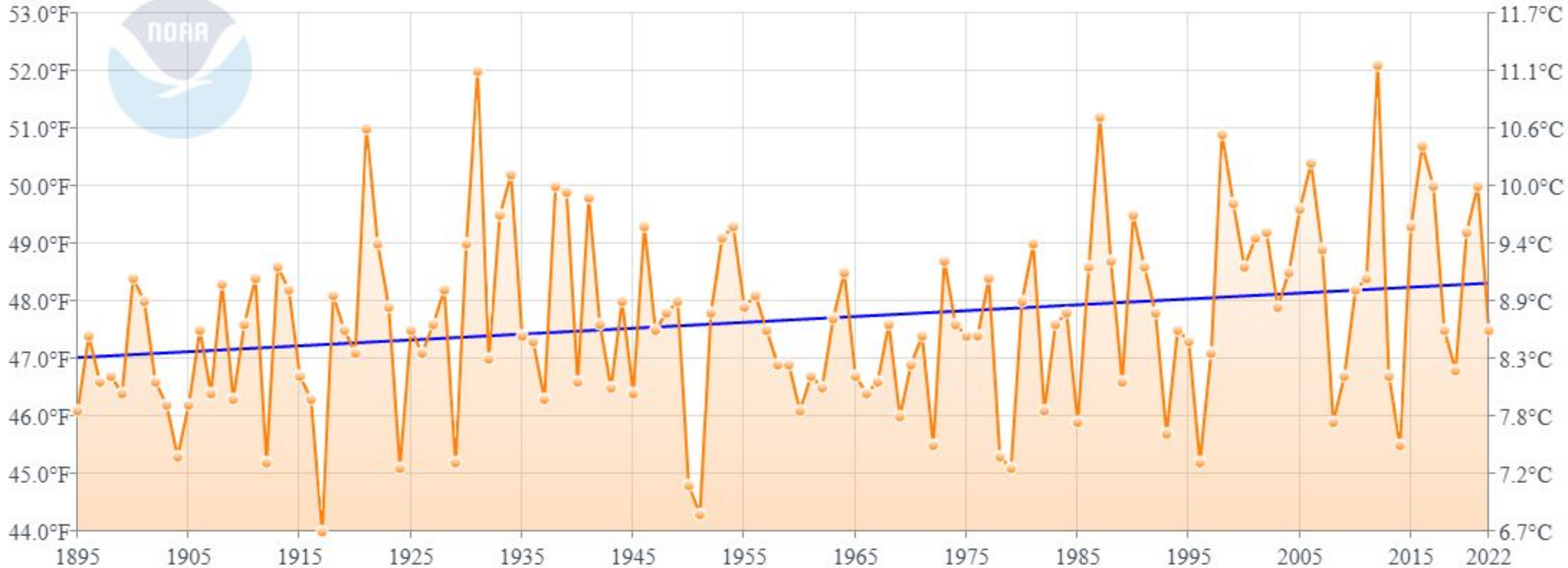
Iowa's Climatological Trends

Iowa Temperature Trend Since 1895

Iowa Average Temperature

January-December

1895-2022 Trend
(+0.1°F/Decade)

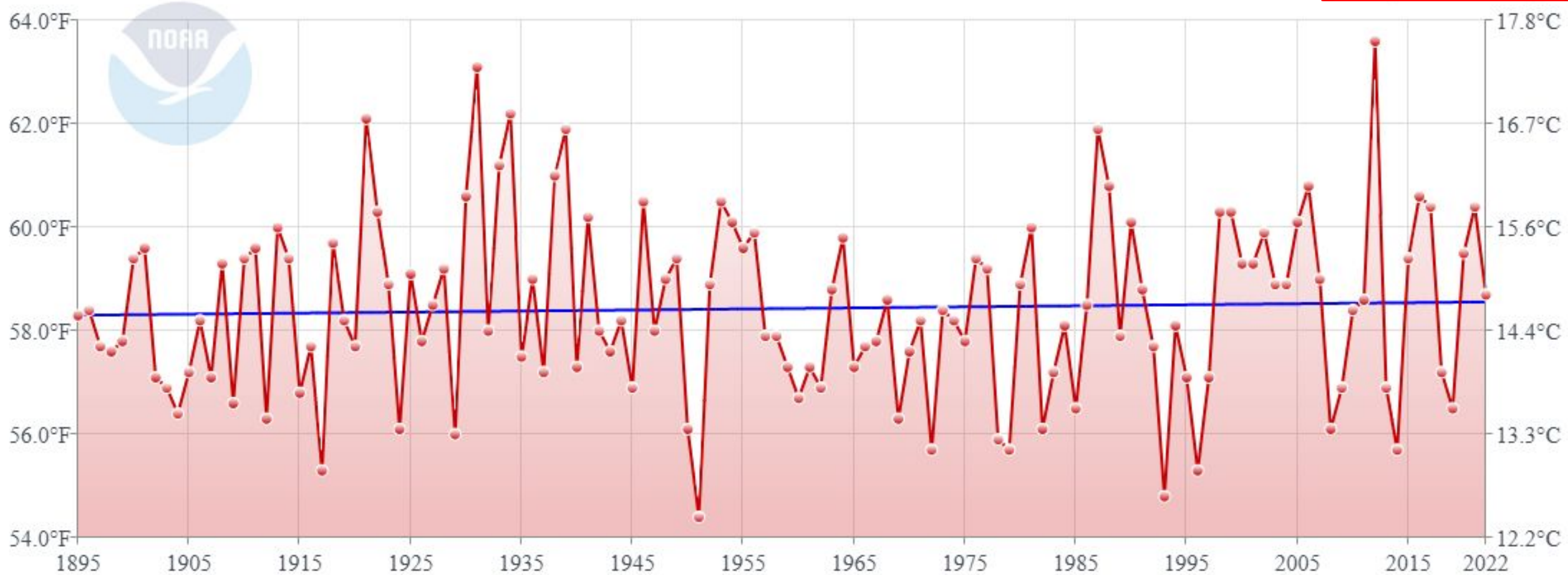


Iowa Max. Temperature Trend Since 1895

Iowa Maximum Temperature

January-December

1895-2022 Trend
(+0.0°F/Decade)

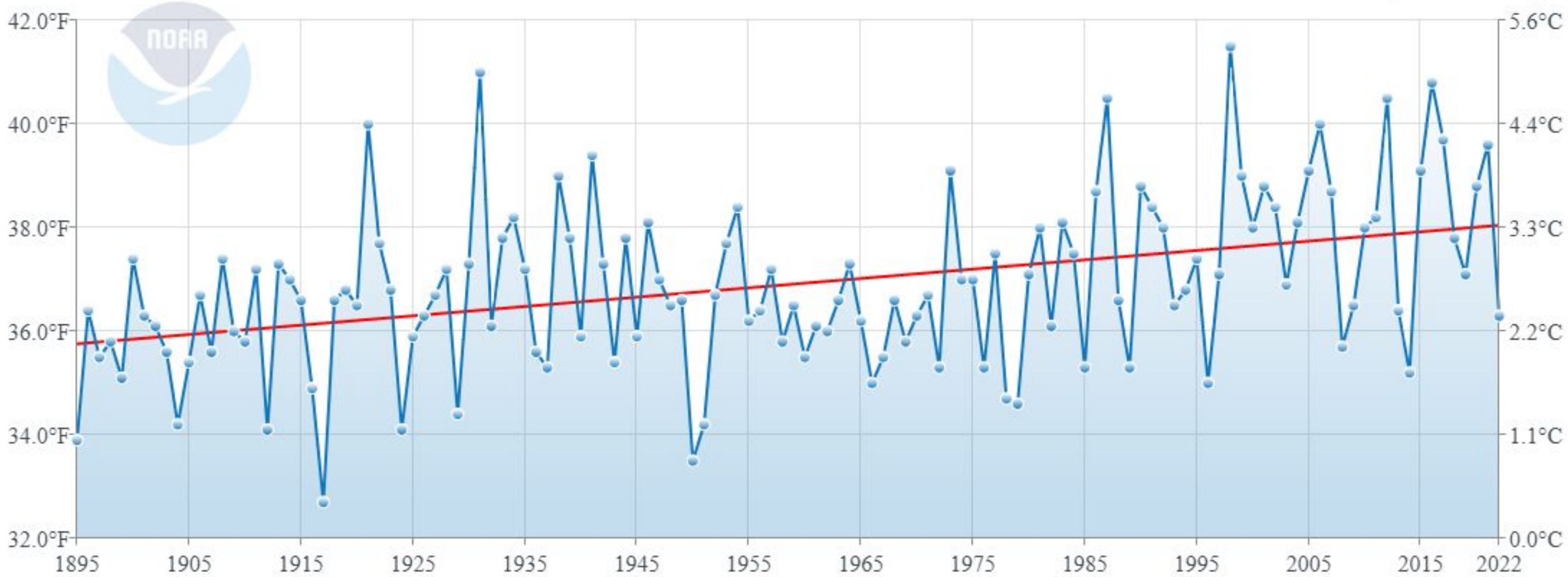


Iowa Min. Temperature Trend Since 1895

Iowa Minimum Temperature

January-December

1895-2022 Trend
(+0.2°F/Decade)



WARMER AIR



MORE EVAPORATION



MORE PRECIPITATION

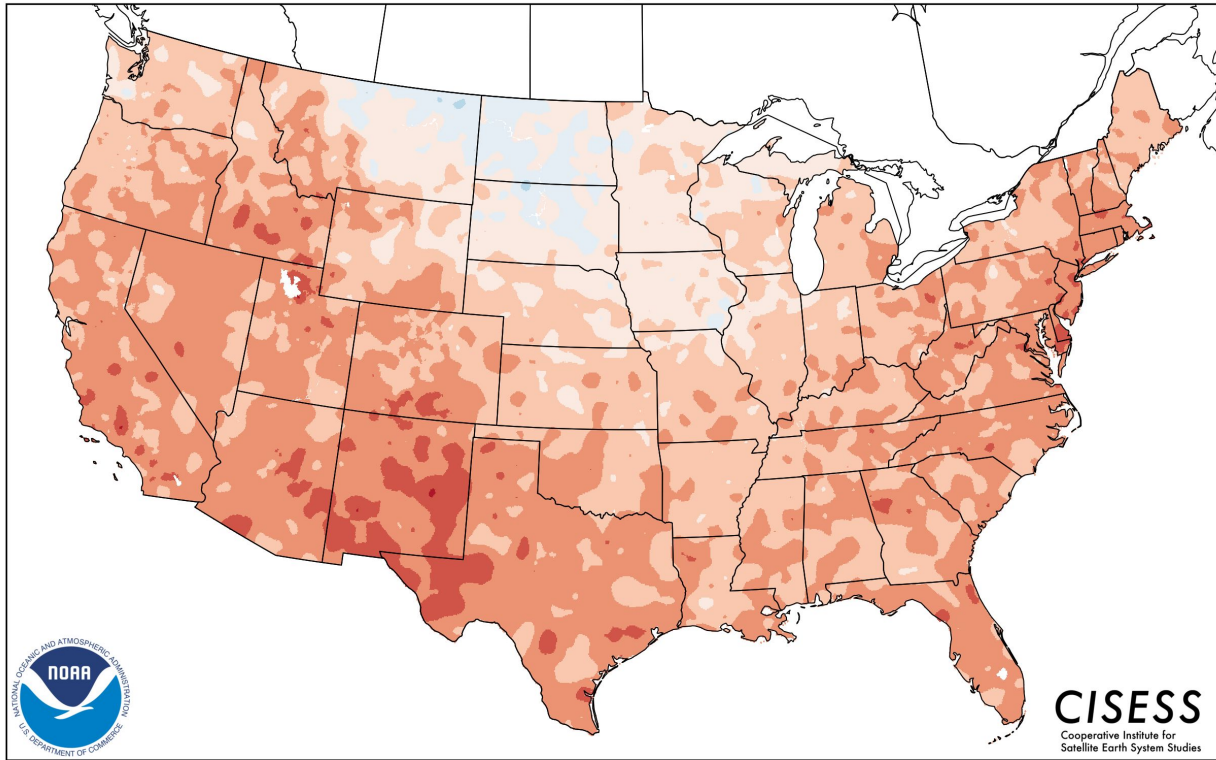
Available
water

**1°F increase =
4% more water vapor**

- Temperature +

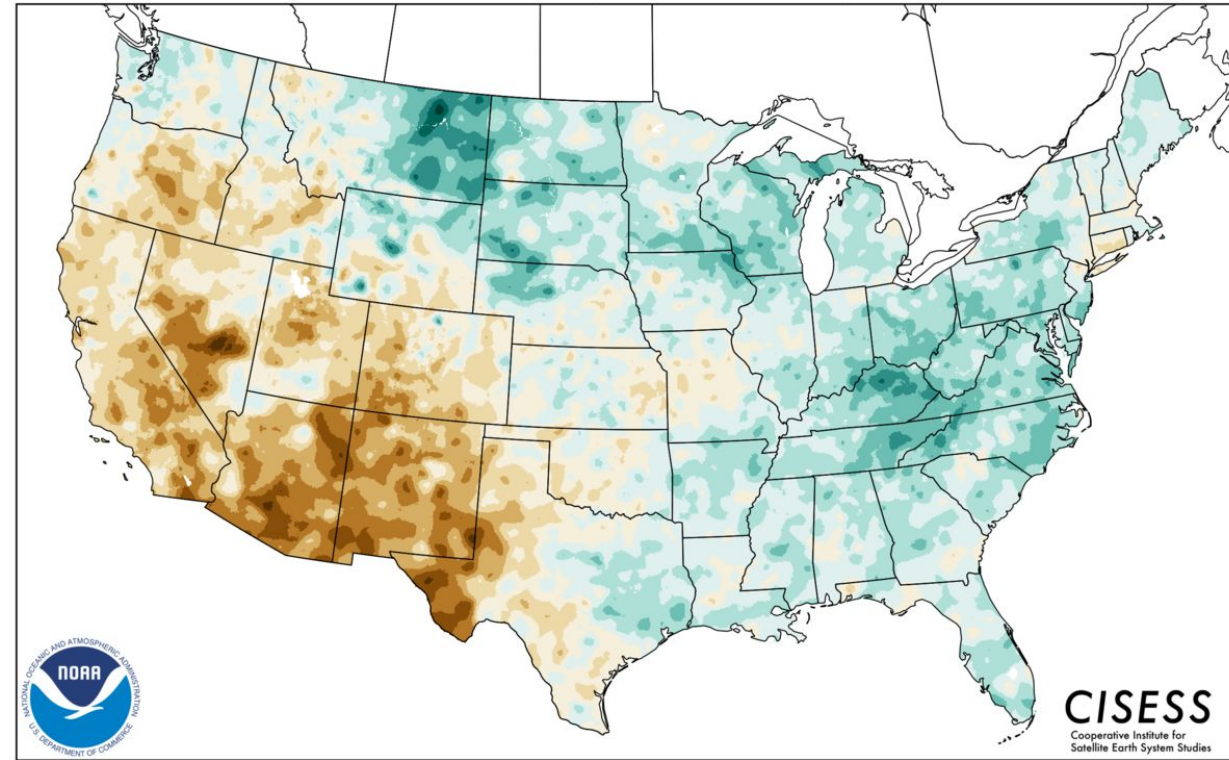
1991-2020 Normals Departure

Annual Mean Temperature Change



-1.0 -0.5 0.0 0.5 1.0
1991-2020 minus 1981-2010 (°F)

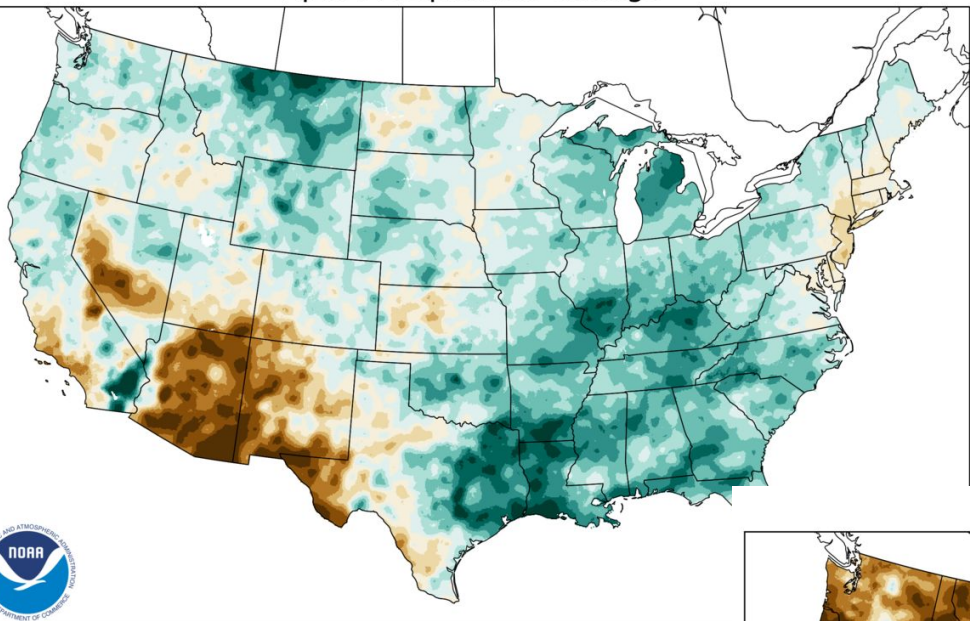
Annual Precipitation Change



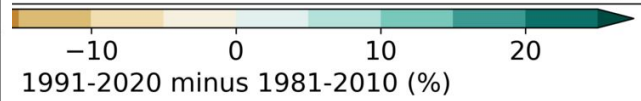
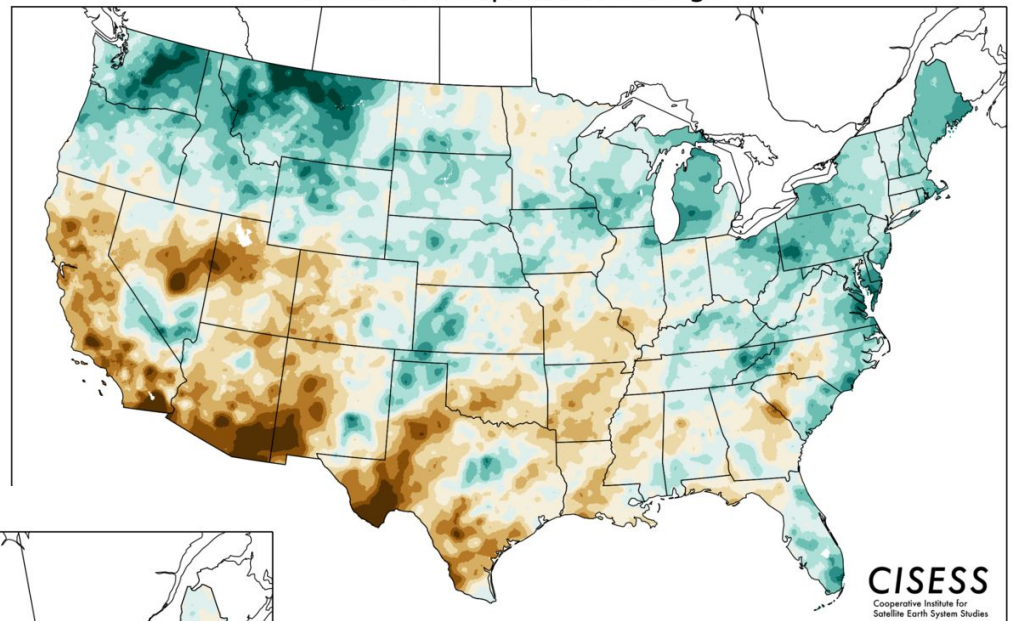
-10 -5 0 5 10
1991-2020 minus 1981-2010 (%)

<https://www.ncei.noaa.gov/products/land-based-station/us-climate-normals>

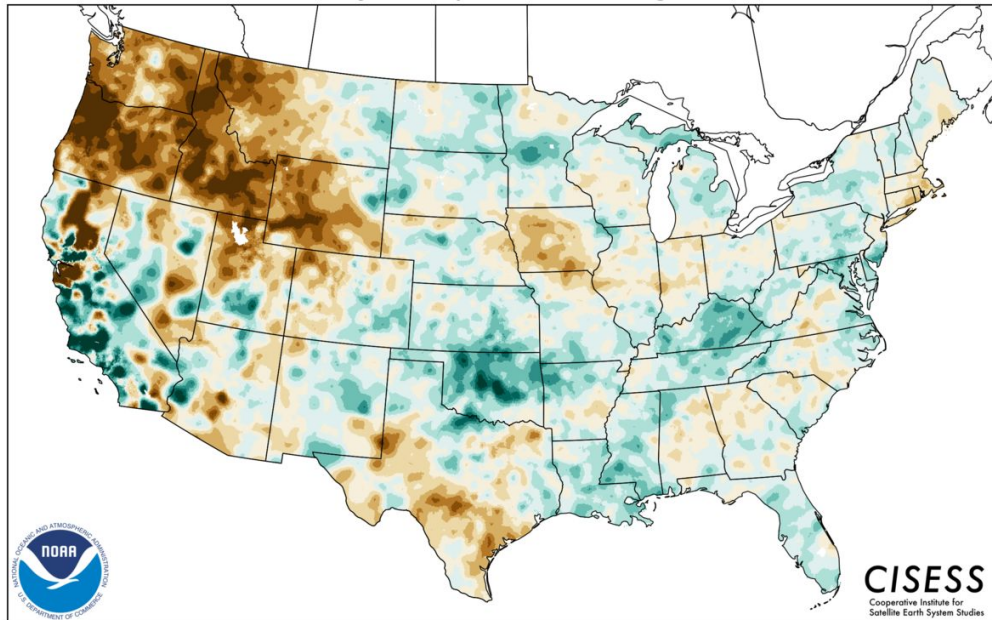
April Precipitation Change



October Precipitation Change



July Precipitation Change

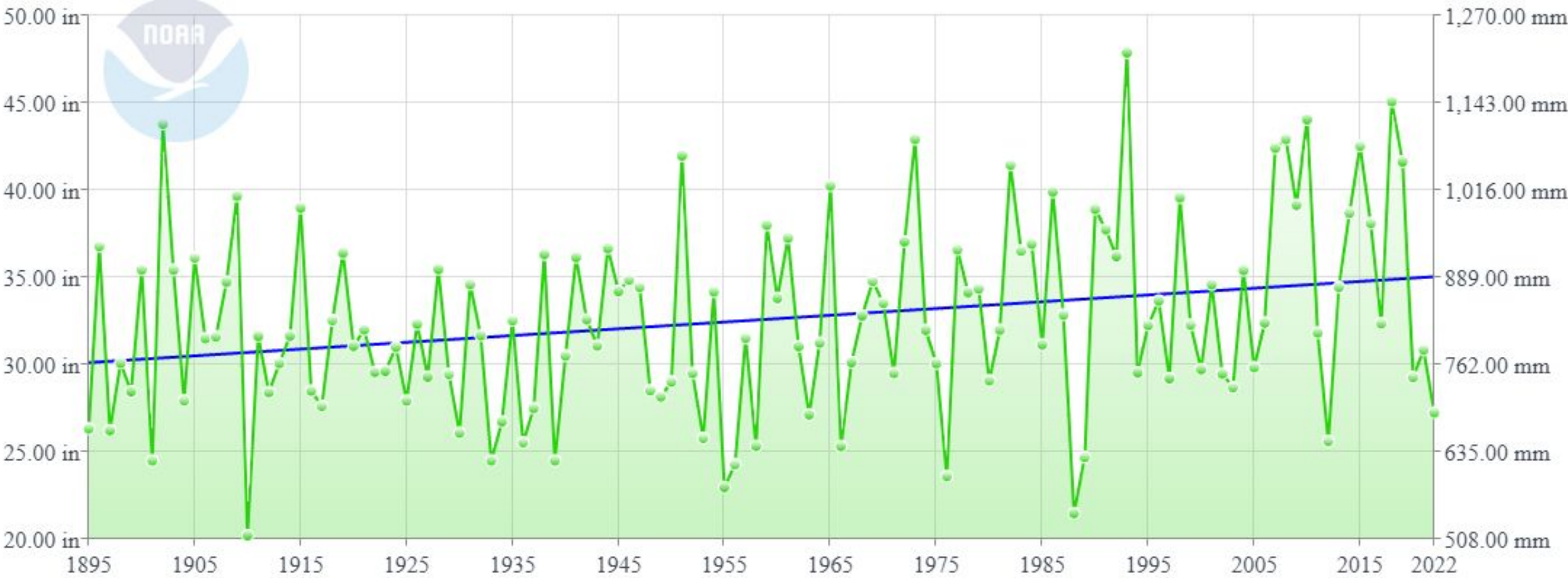


<https://www.ncei.noaa.gov/products/land-based-station/us-climate-normals>

Iowa Precipitation Trend Since 1895

Iowa Precipitation
January-December

1895-2022 Trend
(+0.39 in/Decade)

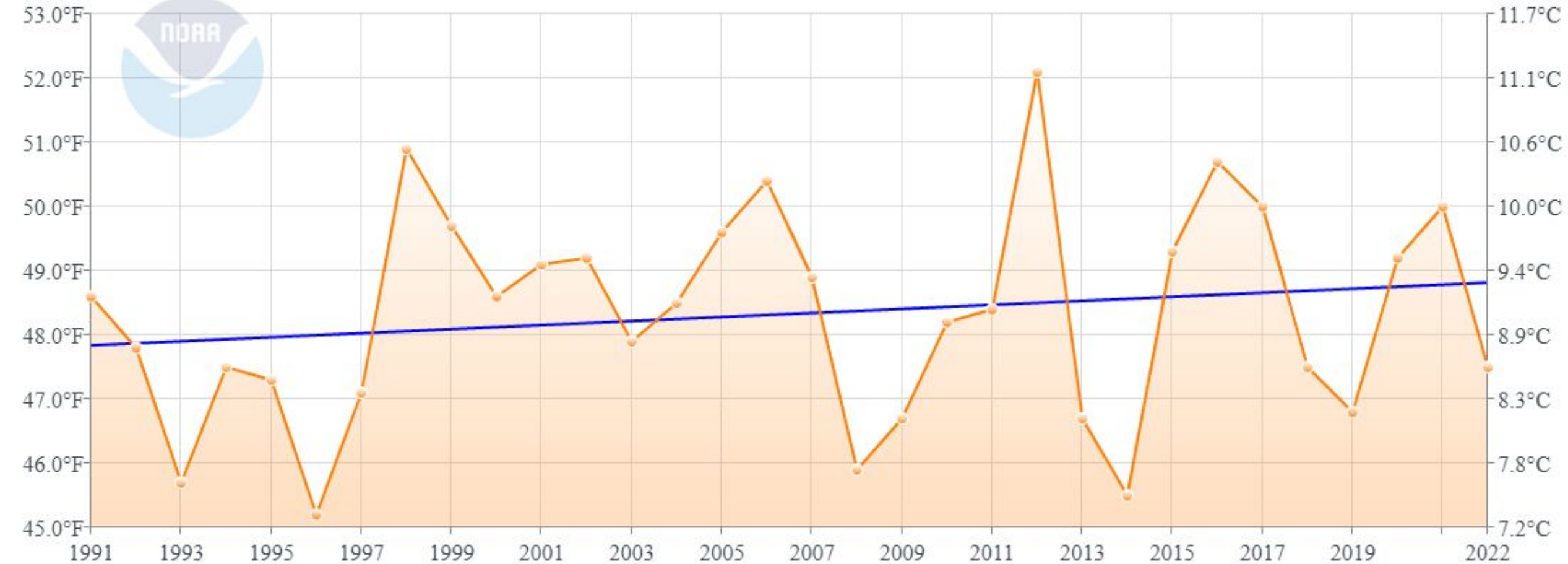


Iowa Temperature Trend Since 1991

Iowa Average Temperature

January-December

1991-2022 Trend
(+0.3°F/Decade)



Iowa Max. Temperature Trend Since 1991

Iowa Average Temperature

January-December

1991-2022 Trend
(+0.3°F/Decade)



Iowa Min. Temperature Trend Since 1991

Iowa Minimum Temperature

January-December

1991-2022 Trend
(+0.2°F/Decade)



Iowa Precipitation Trend Since 1991

Iowa Minimum Temperature

January-December

1991-2022 Trend
(+0.2°F/Decade)



Debunking Weather Myths

- Weather stops at the river.
- Weather stays N/S of the Interstate or travels along it.
- Tornadoes don't go into the city.
- Tornadoes don't happen in hilly terrain.

Scenario: A plan for the week is made on Monday and workers are called off in advance due to high chance of predicted rainfall on Thursday. Thursday dawns sunny and stays that way until 4pm, when thunderstorms crop up. No actual rain falls on the farm, but thunderstorms scour the region all evening.

Observation: A weather forecast viewed on a Friday or Saturday for the following week has 30-40% chance rain/t-storms each day M-F. On the following Monday, forecast will only one or two days with storm chances and the likelihood is distinctly elevated on individual days.

How Are Frost Predictions Made?

The question on the table is “how far out seasonally can frost be predicted?”

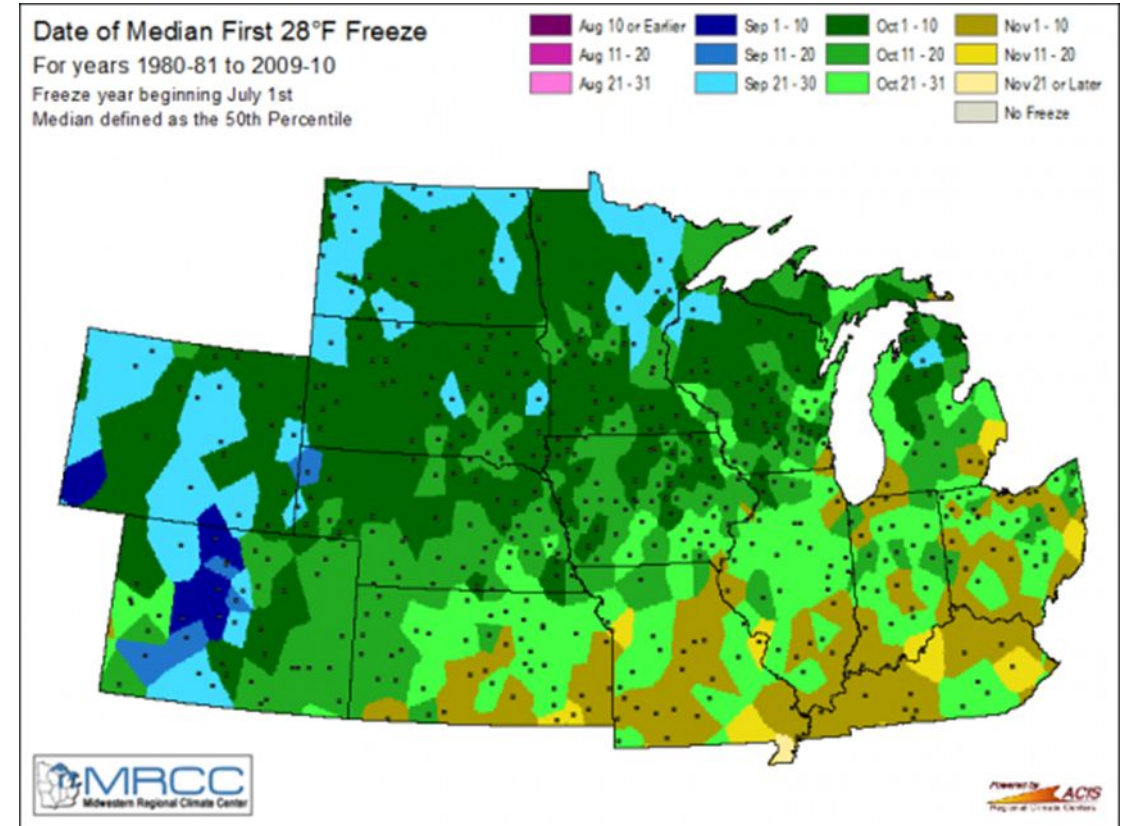
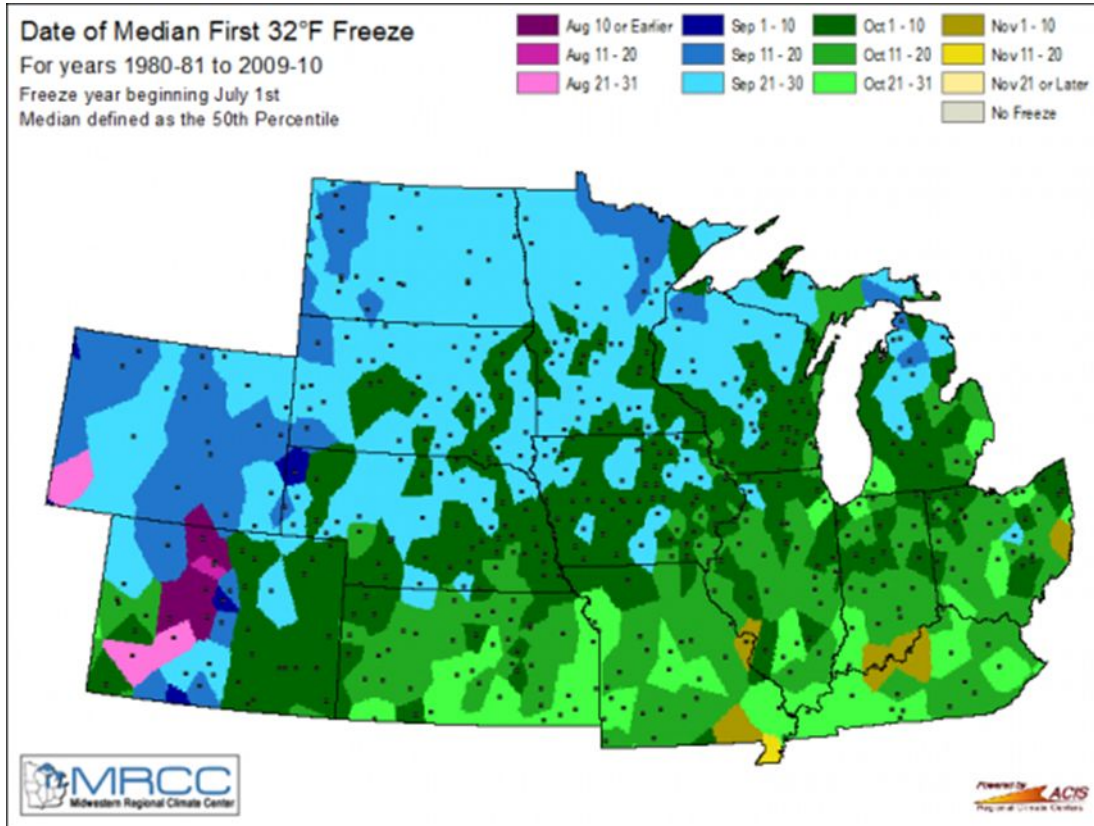
- Typically, the second or third week of September is when we start to get a handle on:
- Short-term (climatological) temperature outlooks (out two weeks), and
- Actual (meteorological) temperature forecasts going out 7-10 days

Fall Frost Potential Scenario

- **Any notion that frost prediction can be done before mid-September is without scientific merit**, especially two seasons out.
- On the technical side, our current seasonal forecast for September-October-November indicates higher probabilities of warmer than average temperatures.
- We are also shifting ENSO neutral conditions to La Nina
- Using Iowa's 30-year climatology, we can get a handle on **average frost (32F; Figure 1)** and **freeze (28F; Figure 2) dates**, which we call the 50th percentile or median date.

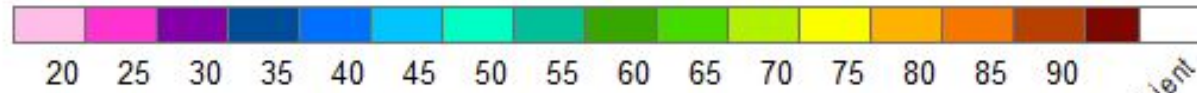
<https://mrcc.purdue.edu/freeze/freezedatetool.html>

Frost/Freeze Climatology



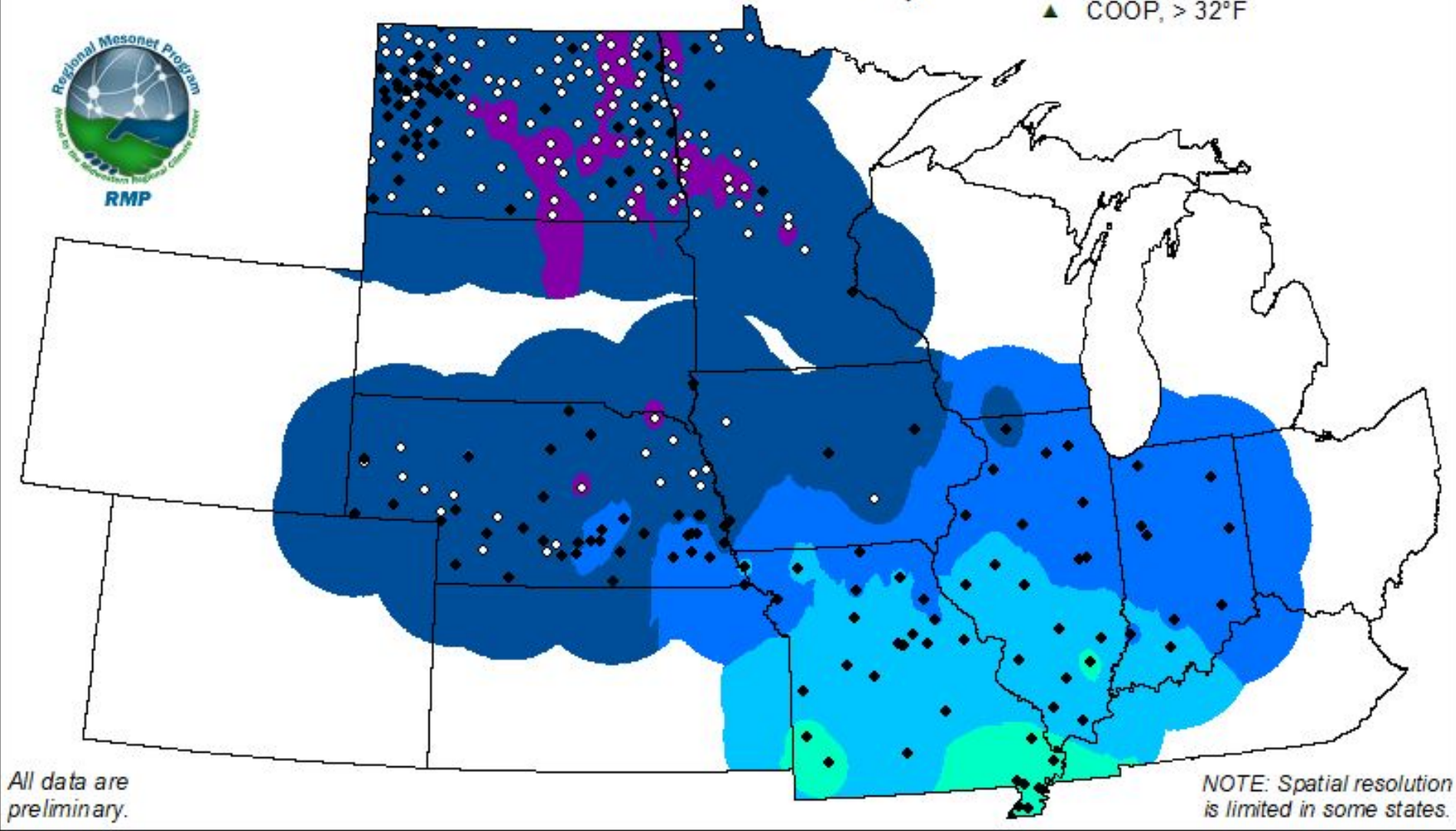
4" Soil Temperature (°F) (Bare)

24-Hour Period Through 2/14/2023



Inefficient Data

- ◇ Mesonets, ≤ 32°F
- ◆ Mesonets, > 32°F
- △ COOP, ≤ 32°F
- ▲ COOP, > 32°F

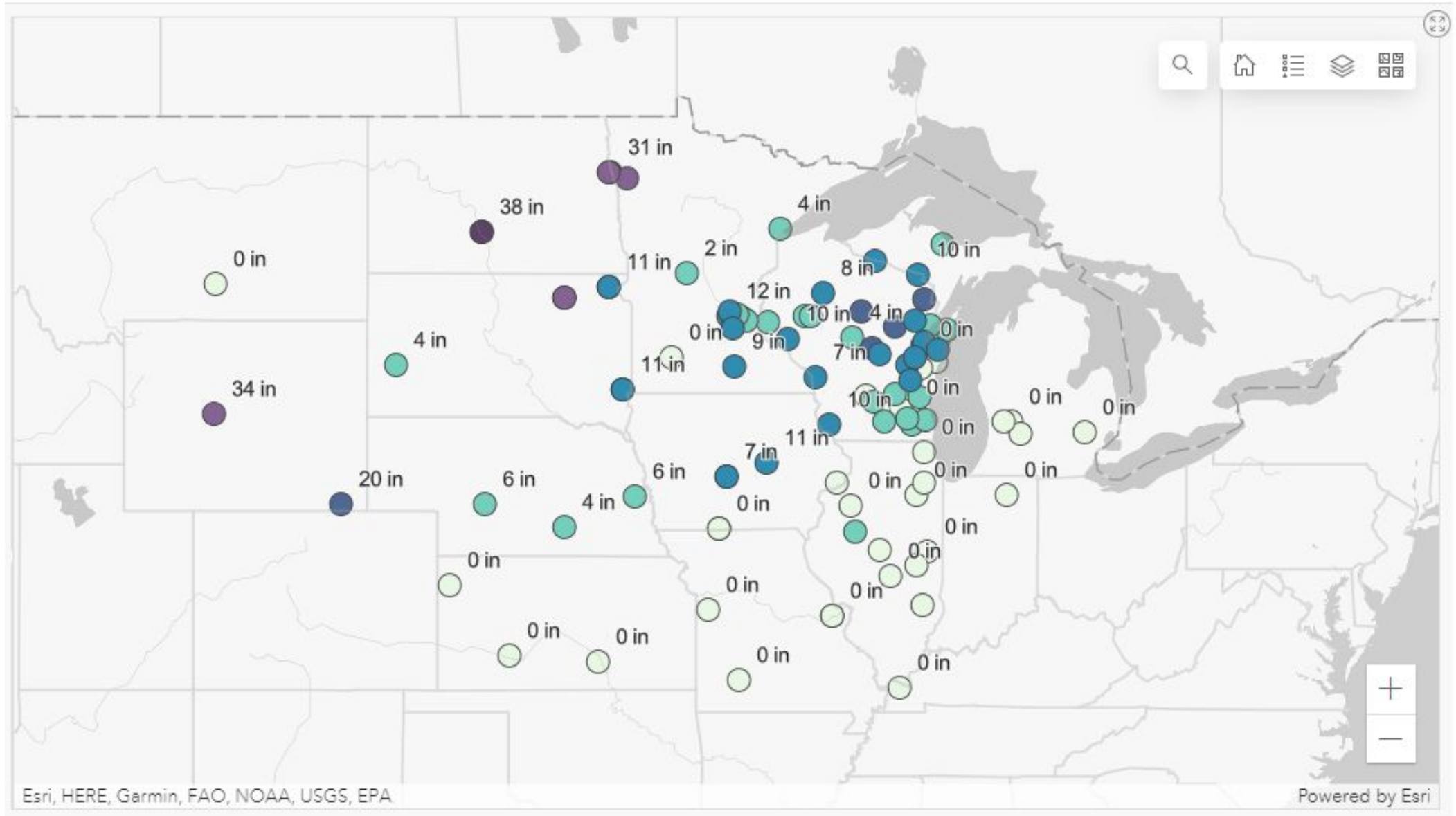


All data are preliminary.

NOTE: Spatial resolution is limited in some states.

Frost Depth (inches)

In regions of the central U.S.



https://www.weather.gov/ncrfc/LMI_FrostDepthMap

Explaining "Probability of Precipitation"

- Forecasts issued by the National Weather Service routinely include a "PoP" (probability of precipitation) statement, which is often expressed as the "chance of rain" or "chance of precipitation".

EXAMPLE

ZONE FORECASTS FOR NORTH AND CENTRAL GEORGIA
NATIONAL WEATHER SERVICE PEACHTREE CITY GA
119 PM EDT THU MAY 8 2008

GAZ021-022-032034-044046-055-057-090815-
CHEROKEE-CLAYTON-COBB-DEKALB-FORSYTH-GWINNETT-HENRY-NORTH FULTON-
ROCKDALE-SOUTH FULTON-
INCLUDING THE CITIES OF...ATLANTA...CONYERS...DECATUR...
EAST POINT...LAWRENCEVILLE...MARIETTA
119 PM EDT THU MAY x 2008

.THIS AFTERNOON...MOSTLY CLOUDY WITH A 40 PERCENT CHANCE OF
SHOWERS AND THUNDERSTORMS. WINDY. HIGHS IN THE LOWER 80S. NEAR
STEADY TEMPERATURE IN THE LOWER 80S. SOUTH WINDS 15 TO 25 MPH.
.TONIGHT...MOSTLY CLOUDY WITH A CHANCE OF SHOWERS AND
THUNDERSTORMS IN THE EVENING...THEN A SLIGHT CHANCE OF SHOWERS
AND THUNDERSTORMS AFTER MIDNIGHT. LOWS IN THE MID 60S. SOUTHWEST
WINDS 5 TO 15 MPH. CHANCE OF RAIN 40 PERCENT.

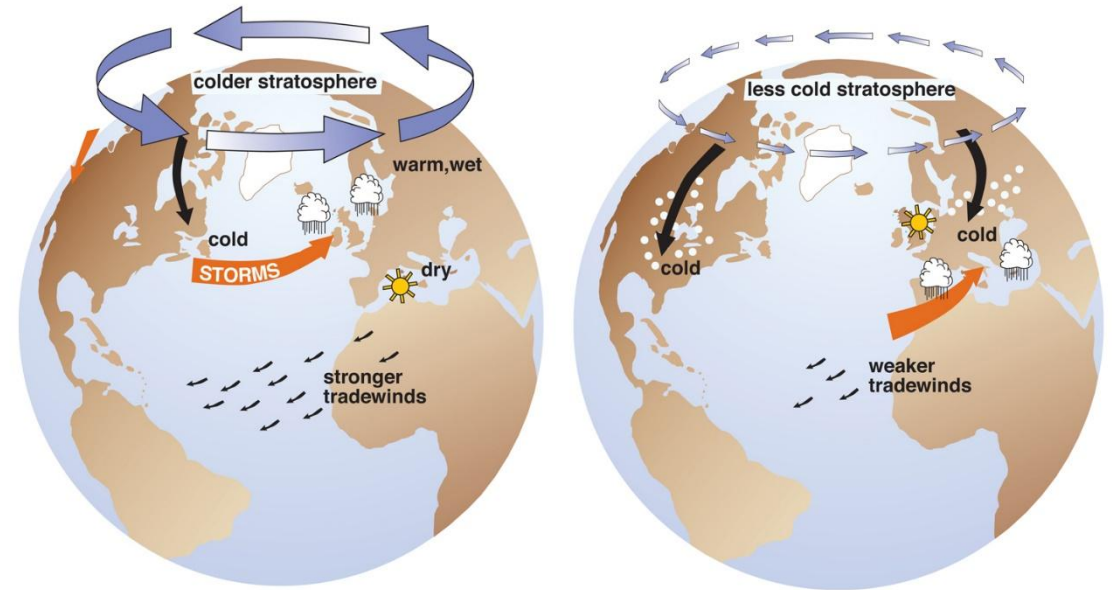
40% of the time .. the day ... the place?

- What does this "40 percent" mean? ...will it rain 40 percent of the time? ...will it rain over 40 percent of the area?
- The "Probability of Precipitation" (PoP) simply describes the probability that the forecast grid/point in question will receive at least 0.01" of rain. So, in this example, there is a 40 percent probability for at least 0.01" of rain at the specific forecast point of interest!

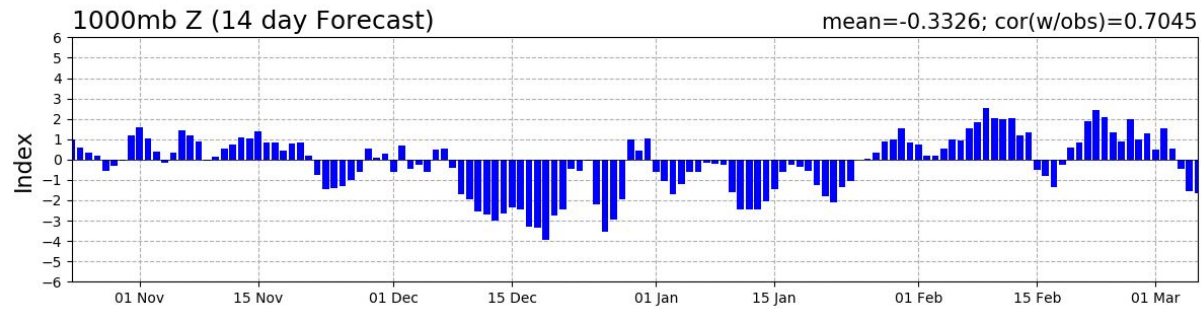
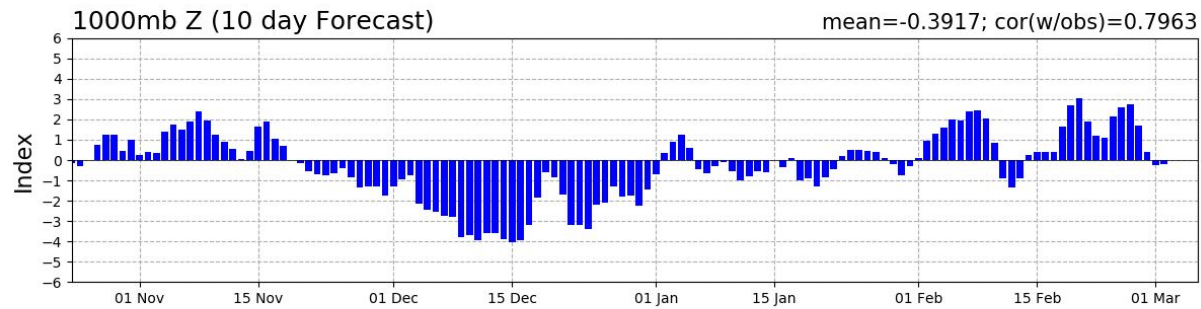
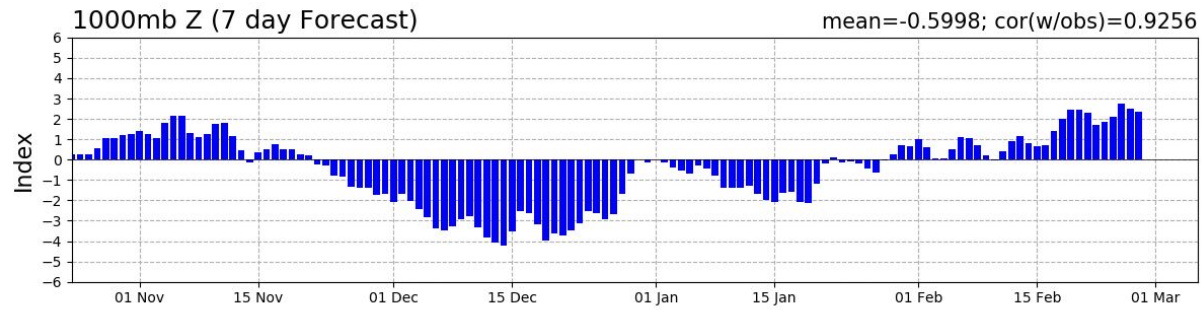
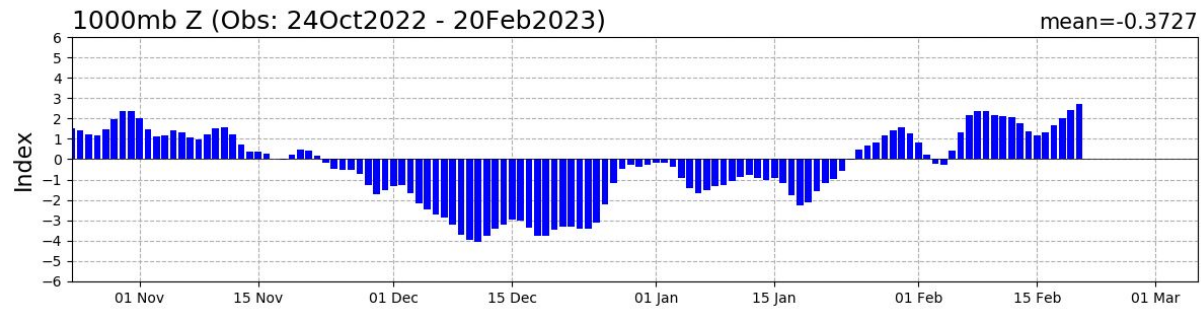
Seasonal Predictability

Arctic Oscillation

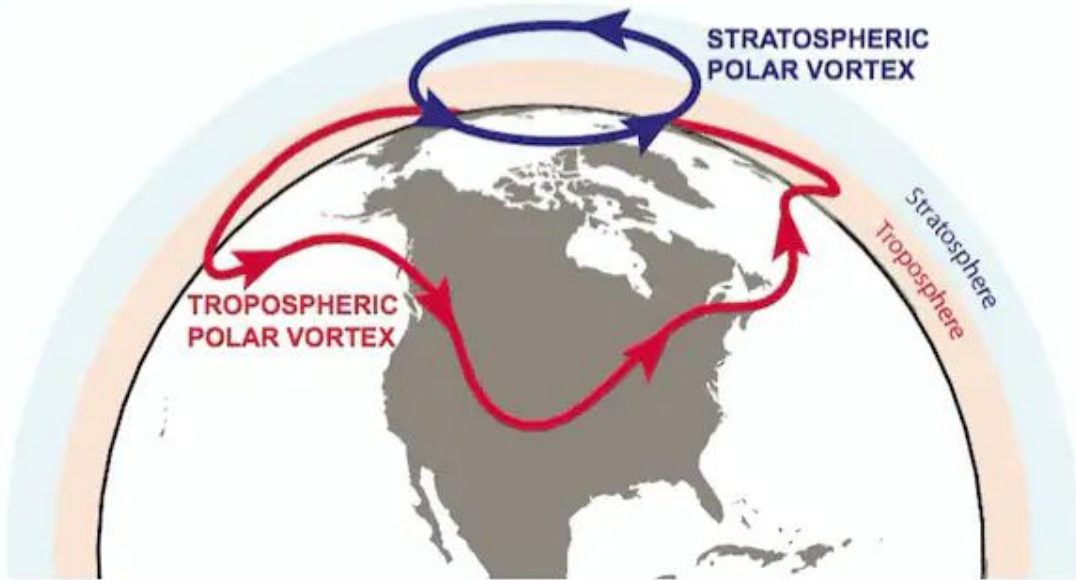
- The Arctic Oscillation (AO) refers to an atmospheric circulation pattern over the mid-to-high latitudes.
- The most obvious reflection of the oscillation's phase is the north-to-south location of the storm-steering, mid-latitude jet stream.



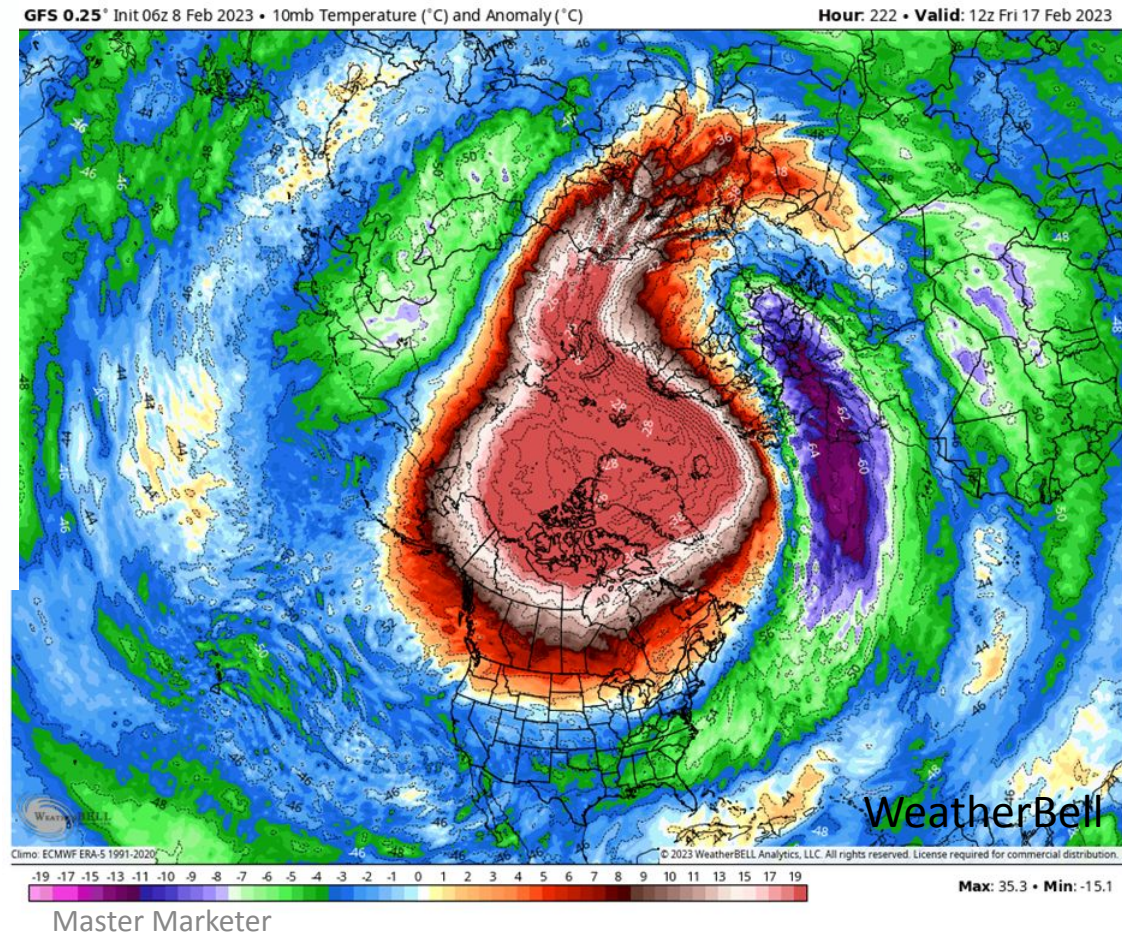
AO Index: Observed & GFS Forecasts



Sudden Stratospheric Warming



(From Waugh et al., American Meteorological Society, 2017)



Climatological Outlooks

Forecast vs. Outlooks
Understanding Probabilities
Various Products

NOAA-NWS Climatological Outlooks

- Based on probabilities: Chances that we are wetter/drier and warmer/colder than average.
- Incorporate various pieces of science
 - Numerical forecast models
 - Oceanic effects (ENSO, MJO, etc.)
 - Recent trends and climatology



Understanding Probabilistic Outlooks

Precip	Temp	Probability of Occurrence			Most likely category
		Above	Near	Below	
		80.0%-90.0%	16.7%-06.7%	03.3%	"Above"
		70.0%-80.0%	26.7%-16.7%	03.3%	"Above"
		60.0%-70.0%	33.3%-26.7%	06.7%-03.3%	"Above"
		50.0%-60.0%	33.3%	16.7%-06.7%	"Above"
		40.0%-50.0%	33.3%	26.7%-16.7%	"Above"
		33.3%-40.0%	33.3%	33.3%-26.7%	"Above"
		33.3%-30.0%	33.3%-40.0%	33.3%-30.0%	"Near Normal"
		30.0%-25.0%	40.0%-50.0%	30.0%-25.0%	"Near Normal"
		33.3%-26.7%	33.3%	33.3%-40.0%	"Below"
		26.7%-16.7%	33.3%	40.0%-50.0%	"Below"
		16.7%-06.7%	33.3%	50.0%-60.0%	"Below"
		06.7%-03.3%	33.3%-26.7%	60.0%-70.0%	"Below"
		03.3%	26.7%-16.7%	70.0%-80.0%	"Below"
		03.3%	16.7%-06.7%	80.0%-90.0%	"Below"
		33.3%	33.3%	33.3%	"Equal Chances"

https://www.cpc.ncep.noaa.gov/products/predictions/long_range/seasonal_info.php

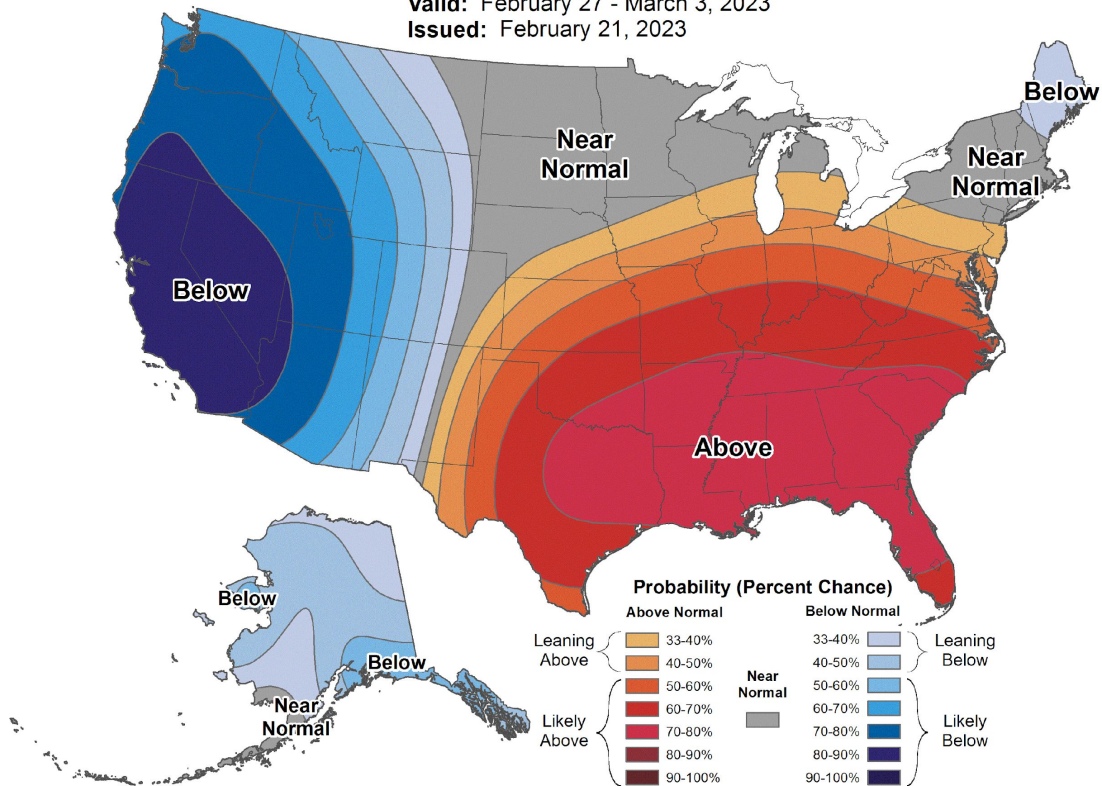
6-10 Day Outlooks



6-10 Day Temperature Outlook



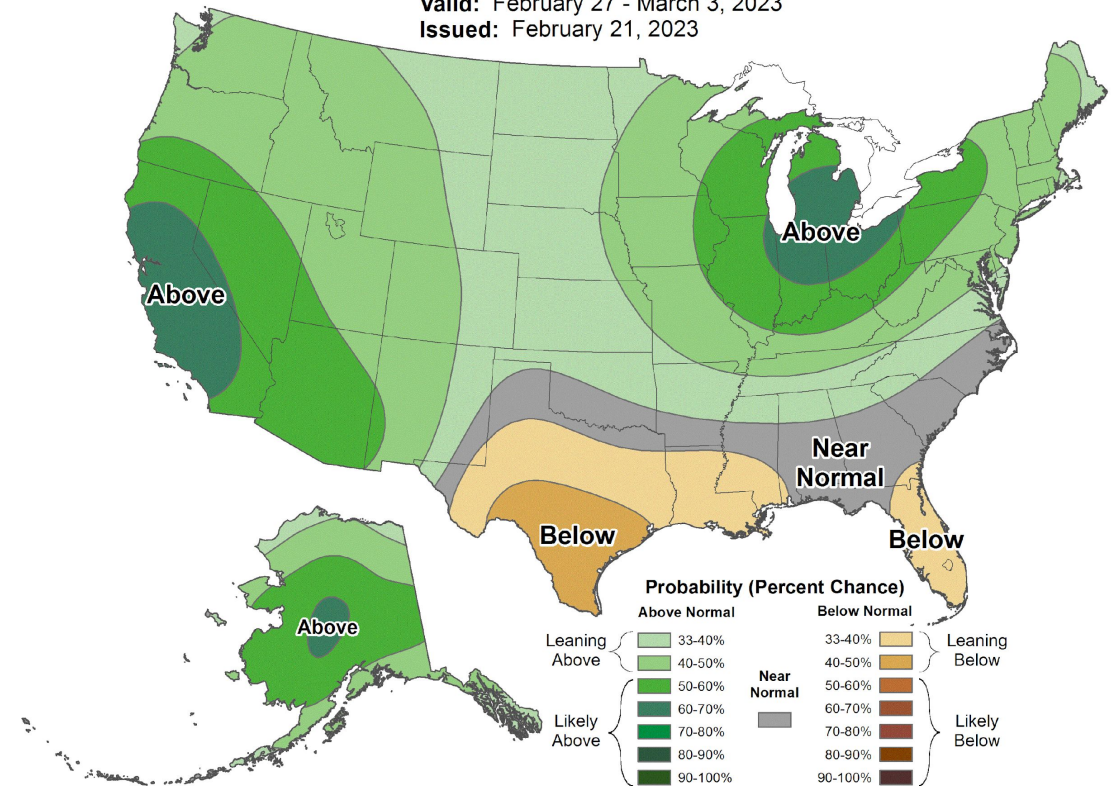
Valid: February 27 - March 3, 2023
 Issued: February 21, 2023



6-10 Day Precipitation Outlook



Valid: February 27 - March 3, 2023
 Issued: February 21, 2023



<http://www.cpc.ncep.noaa.gov/>

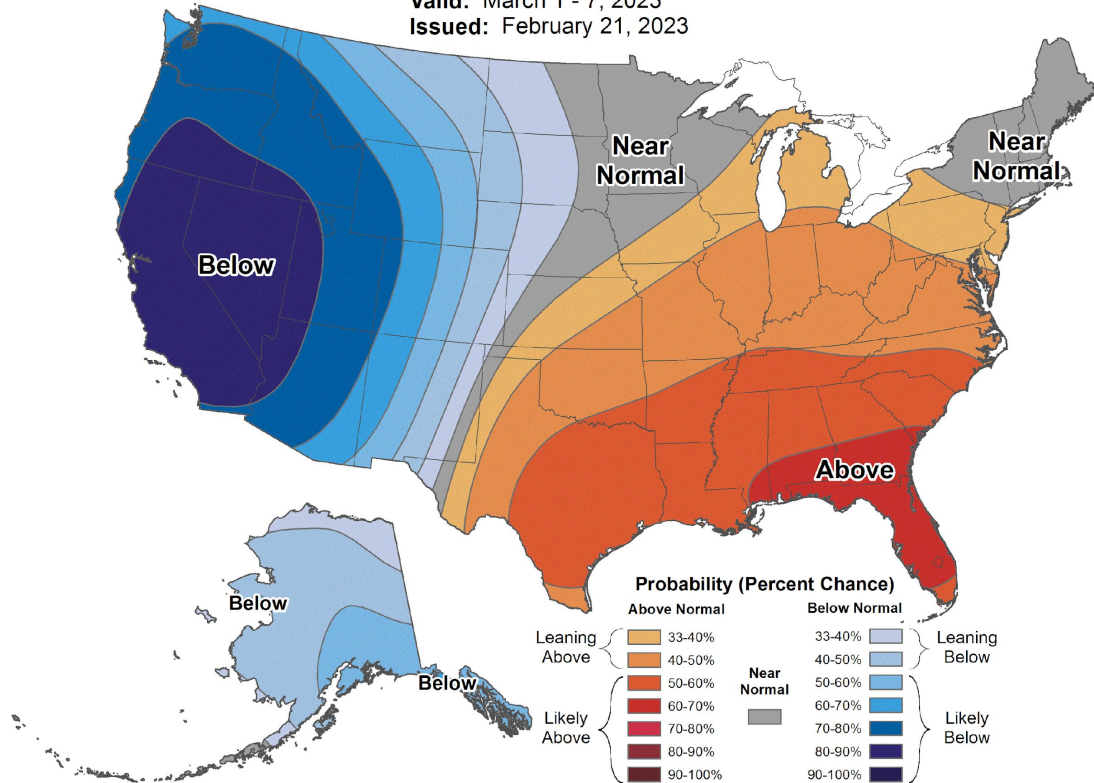
8-14 Day Outlooks



8-14 Day Temperature Outlook



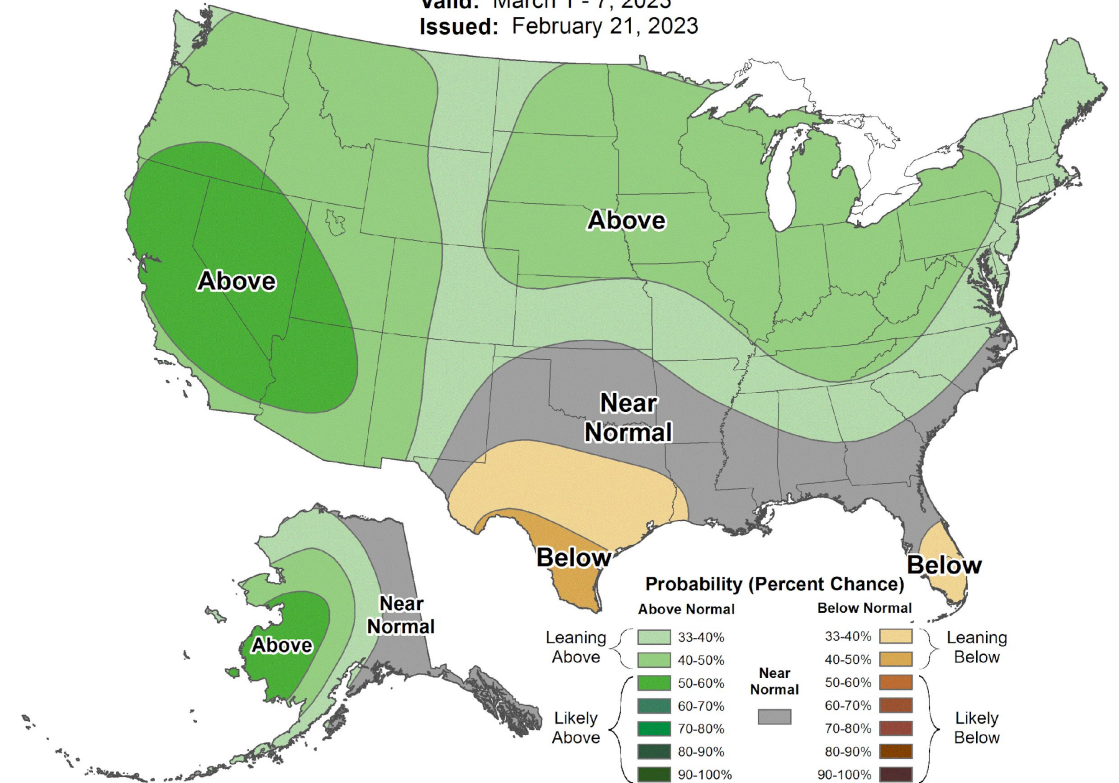
Valid: March 1 - 7, 2023
 Issued: February 21, 2023



8-14 Day Precipitation Outlook

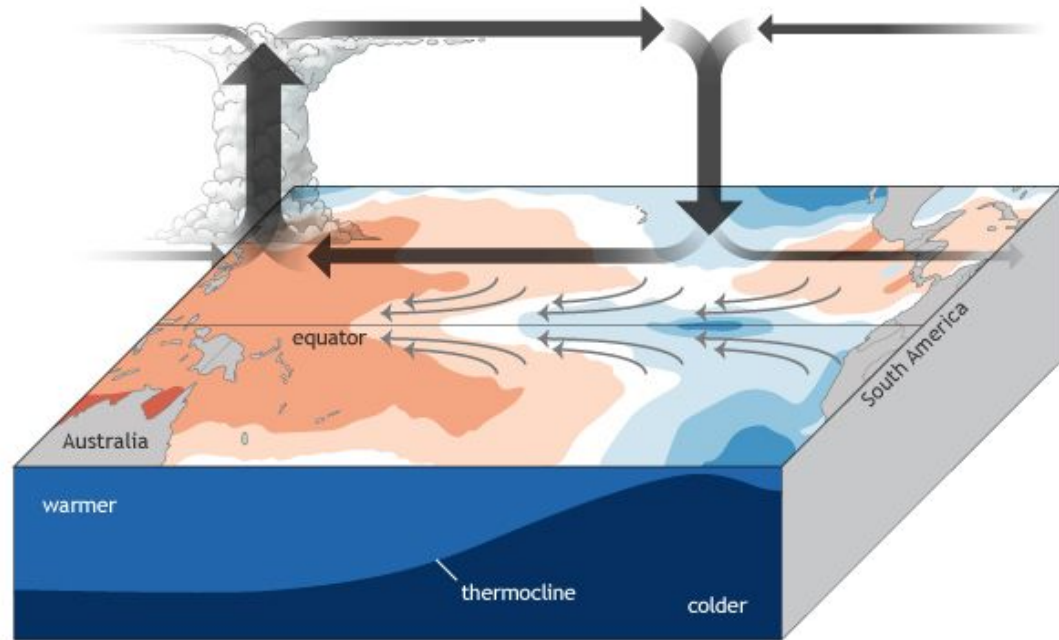


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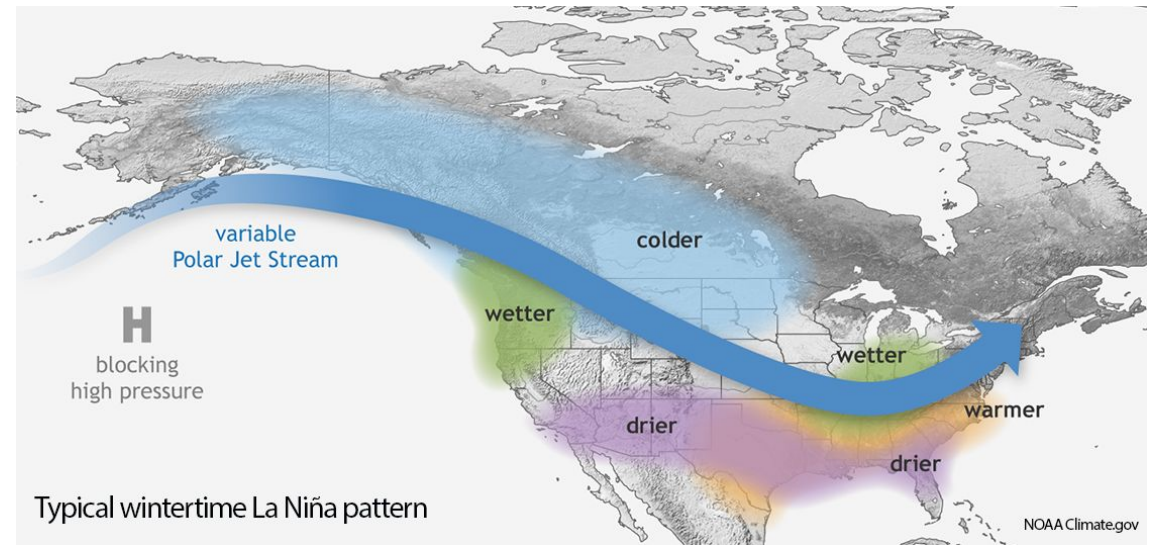


La Niña Winter

Atmosphere-ocean feedbacks during El Niño-Southern Oscillation
La Niña



NOAA Climate.gov

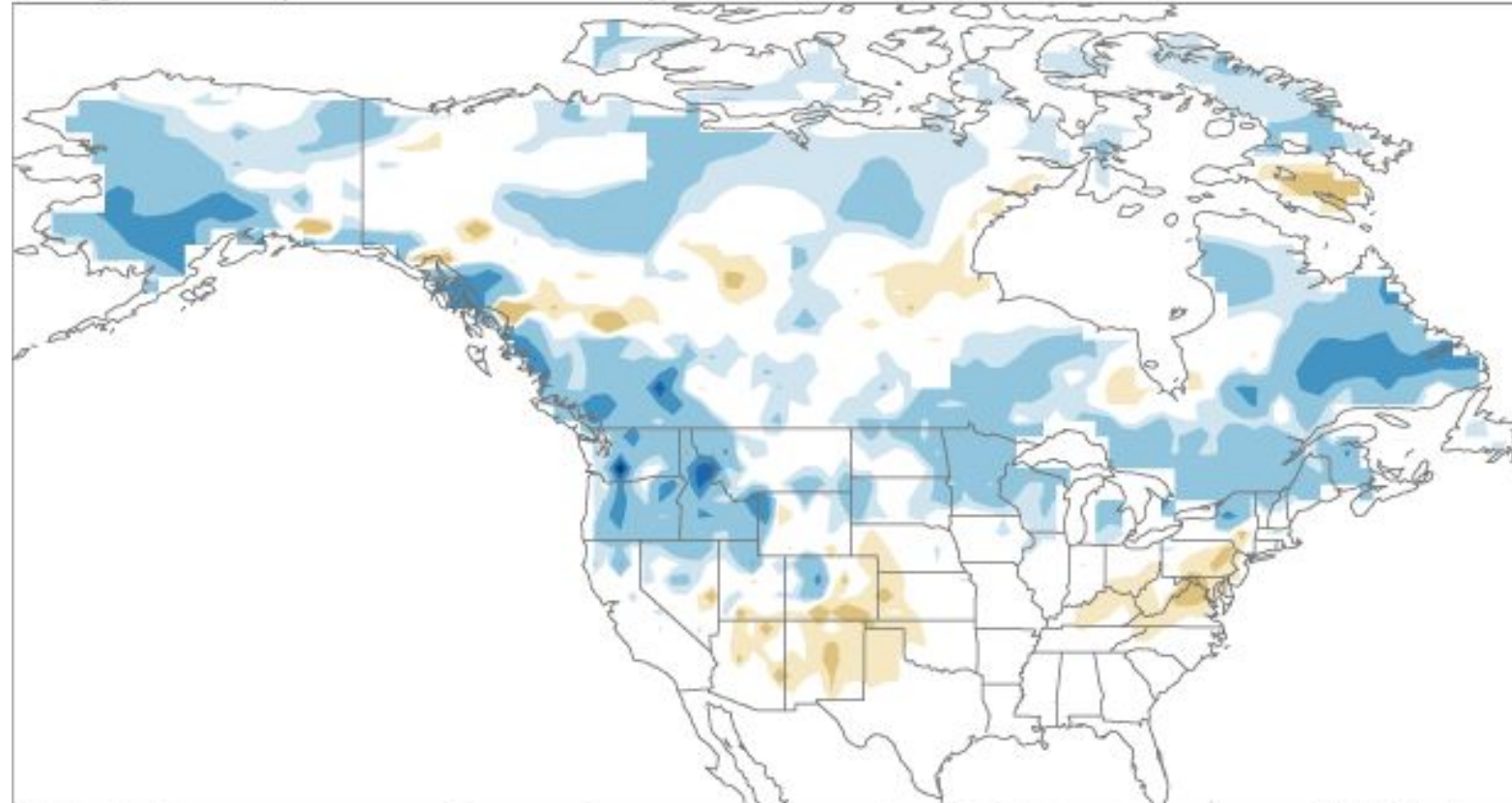


Typical wintertime La Niña pattern

NOAA Climate.gov

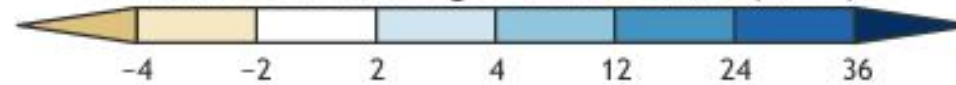
La Niña Snow Potential

Average snowfall patterns for all La Niña years



October-April
1950-51 to 2008-09

Difference from average seasonal snowfall (inches)

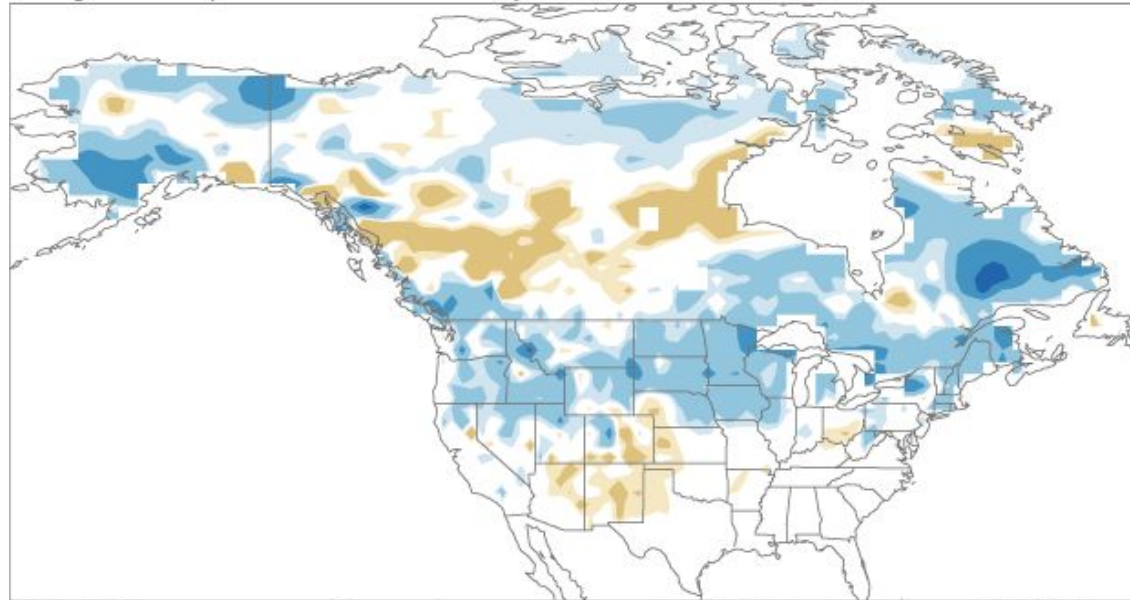


NOAA Climate.gov
Data: Rutgers GSL

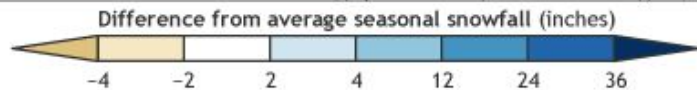
<https://www.climate.gov/news-features/blogs/enso/what-about-snow-during-la-ni%C3%B1a-winters>

La Niña Strength and Impacts on Snow

Average snowfall patterns for weak La Niña years

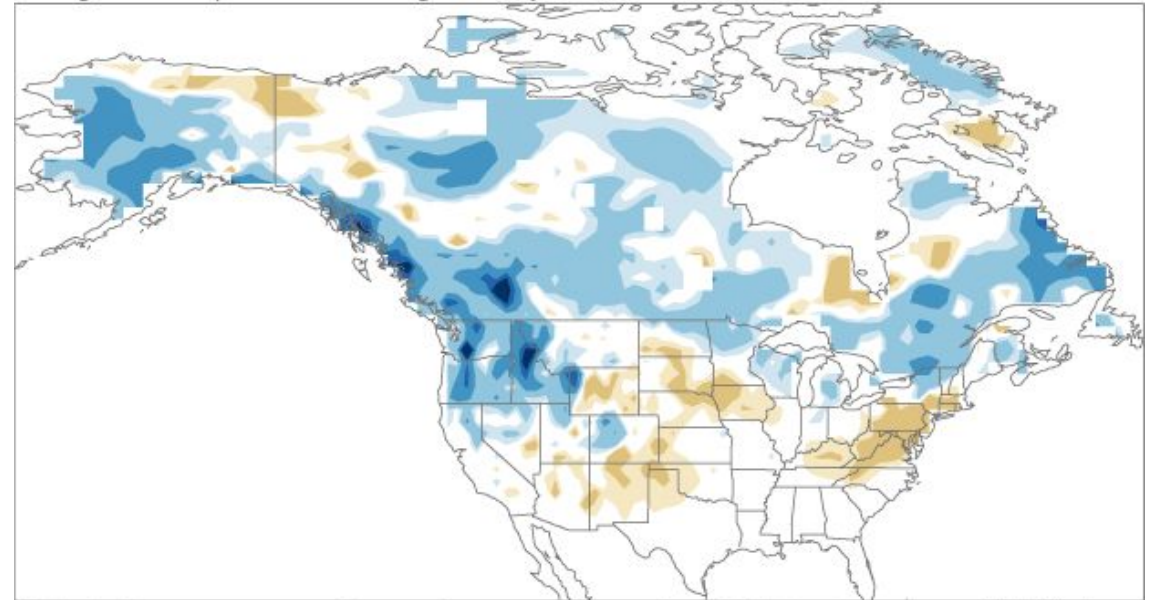


October-April
1950-51 to 2008-09

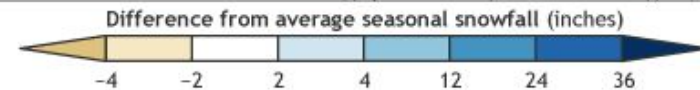


NOAA Climate.gov
Data: Rutgers GSL

Average snowfall patterns for strong La Niña years



October-April
1950-51 to 2008-09



NOAA Climate.gov
Data: Rutgers GSL

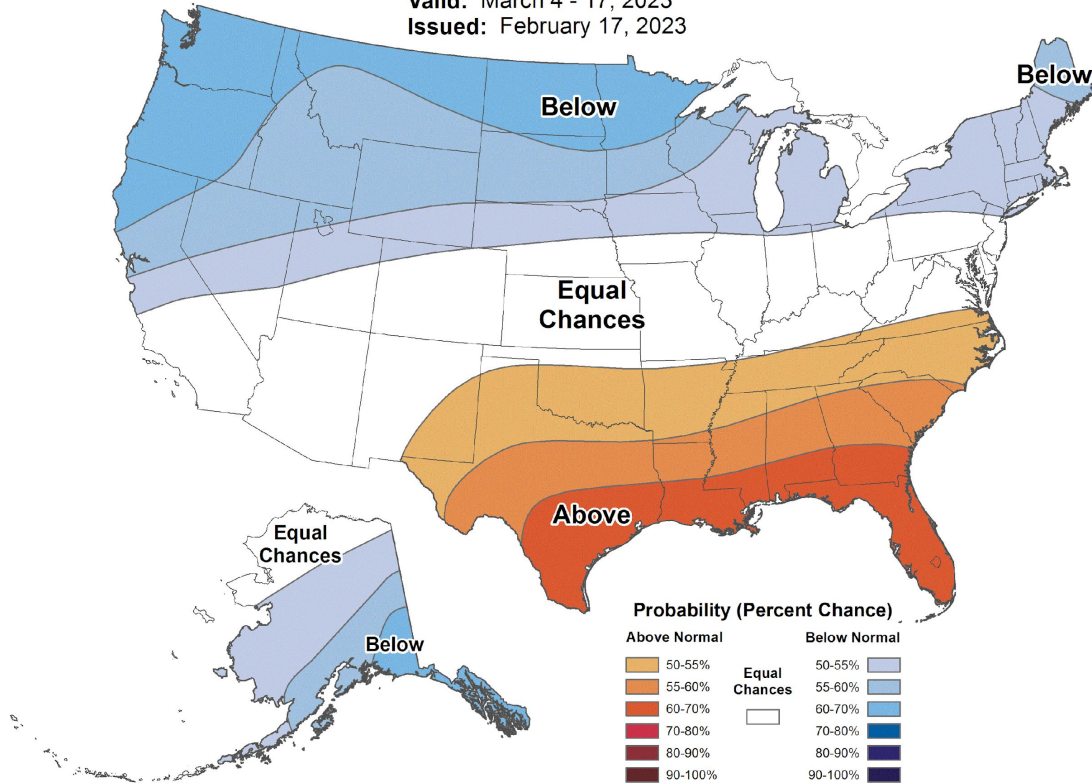
3 – 4 Week Outlook



Weeks 3-4 Temperature Outlook



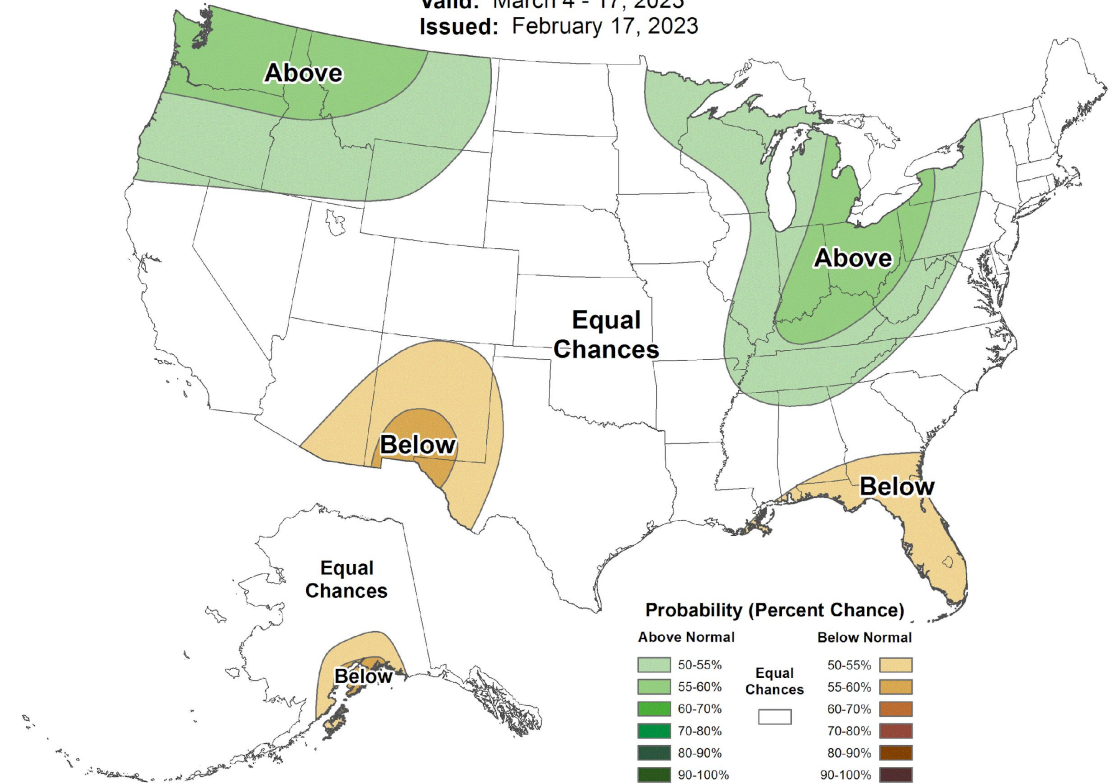
Valid: March 4 - 17, 2023
 Issued: February 17, 2023



Weeks 3-4 Precipitation Outlook



Valid: March 4 - 17, 2023
 Issued: February 17, 2023



<http://www.cpc.ncep.noaa.gov/>

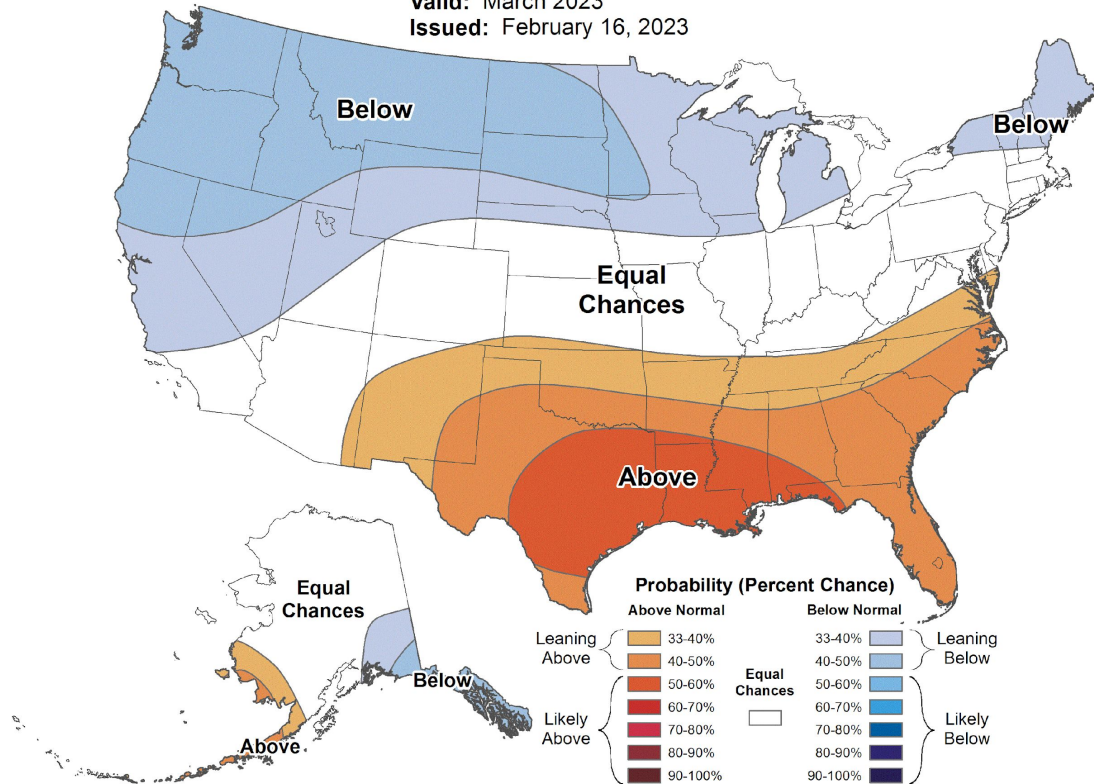
Initial March 2023



Monthly Temperature Outlook



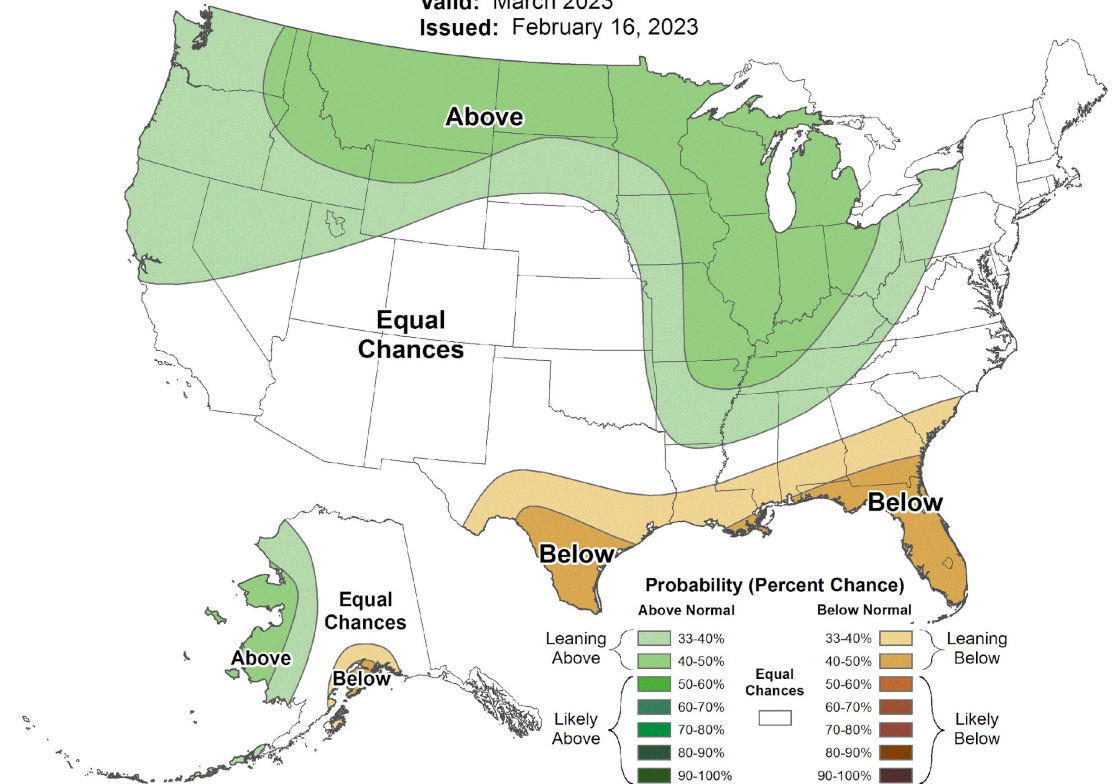
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Issued: February 16, 2023



Monthly Precipitation Outlook



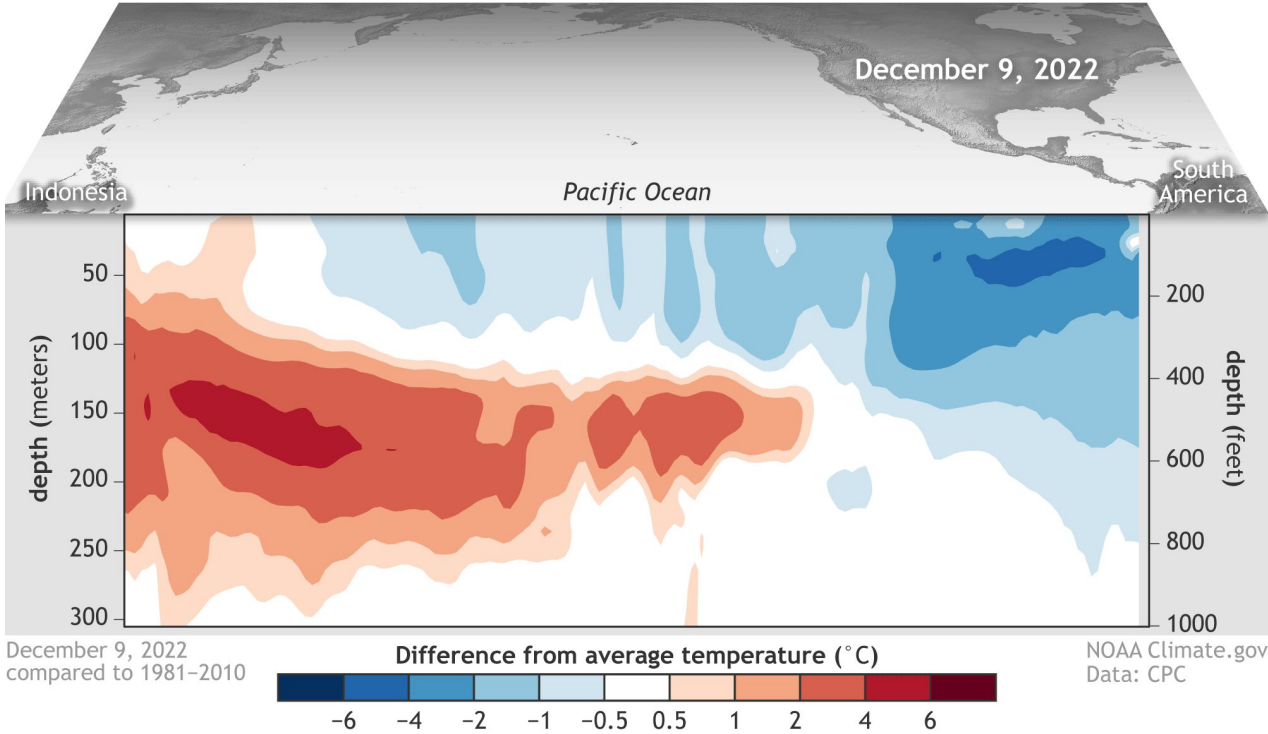
Valid: March 2023
Issued: February 16, 2023



<http://www.cpc.ncep.noaa.gov/>

ENSO Forecast

Below-surface cold pool in eastern Pacific growing smaller



- ENSO Phase Transition Potential
- Seasonal Composites
- Pacific Basin Conditions
- El Niño by Mid-Summer?

Official NOAA CPC ENSO Probabilities (issued Feb. 2023)

based on $-0.5^{\circ}/+0.5^{\circ}\text{C}$ thresholds in ERSSTv5 Niño-3.4 index

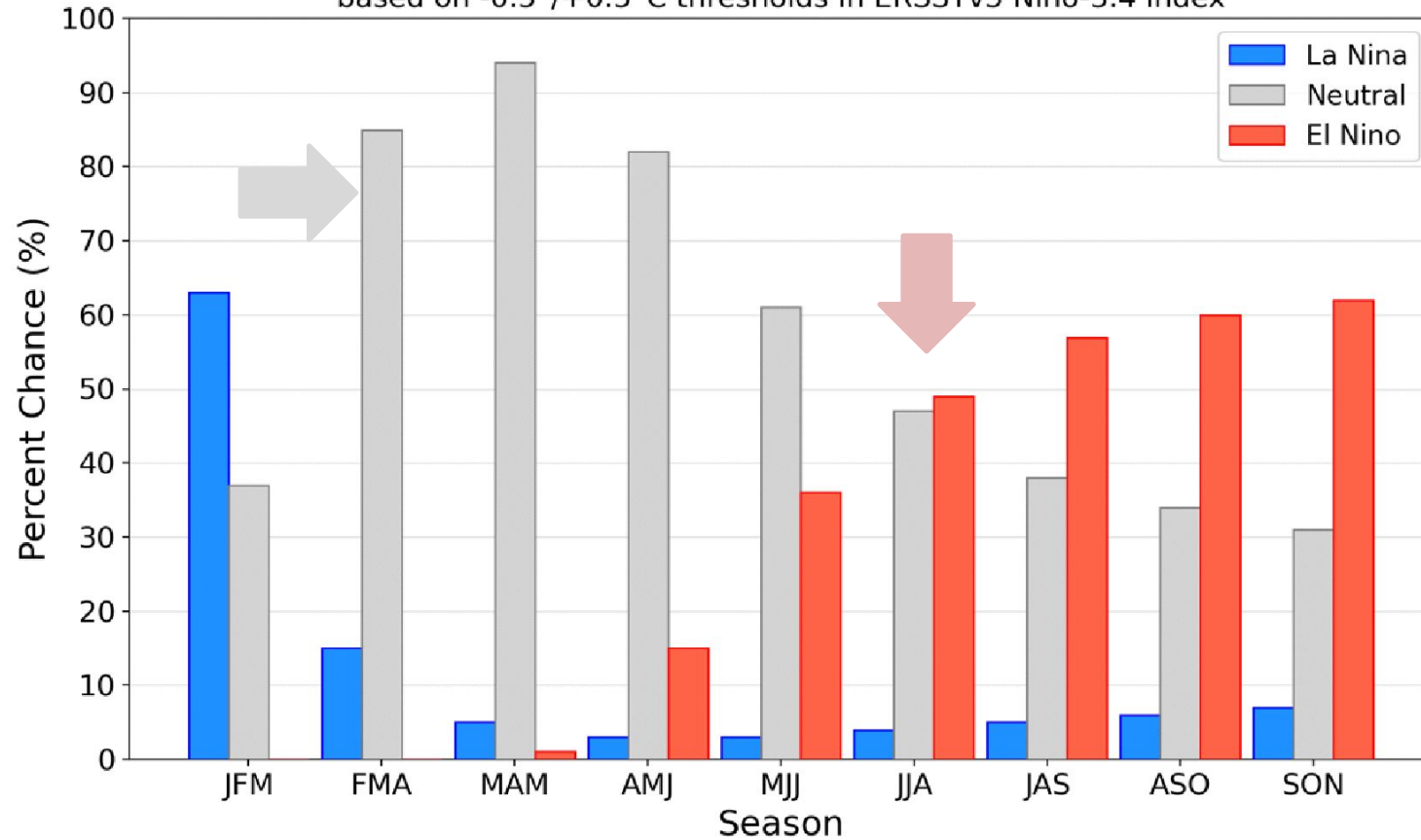


Figure 7. Official ENSO probabilities for the Niño 3.4 sea surface temperature index (5°N - 5°S , 120°W - 170°W). Figure updated 9 February 2023.

https://www.cpc.ncep.noaa.gov/products/analysis_monitoring/enso_advisory/figure07.gif

FMA LA NINA TEMPERATURE ANOMALIES (C)
AND FREQUENCY OF OCCURRENCE (%)

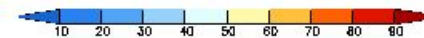
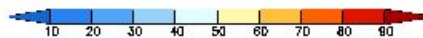
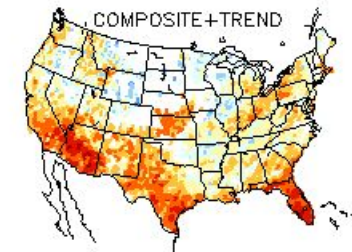
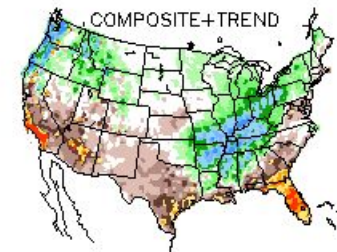
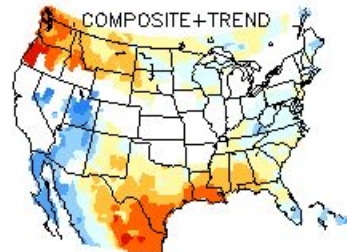
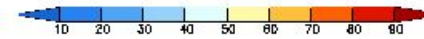
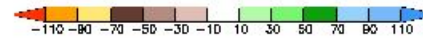
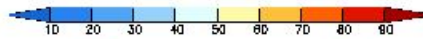
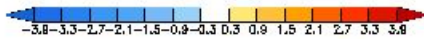
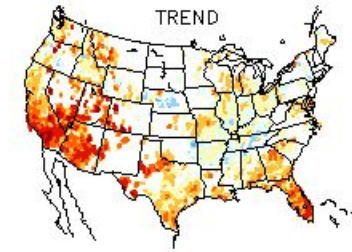
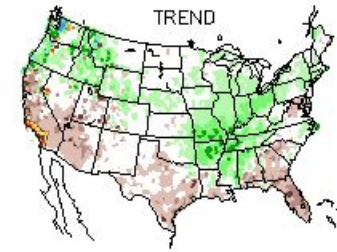
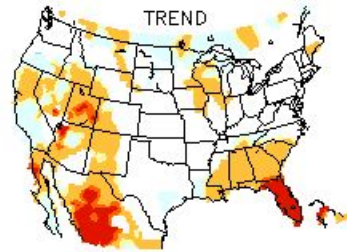
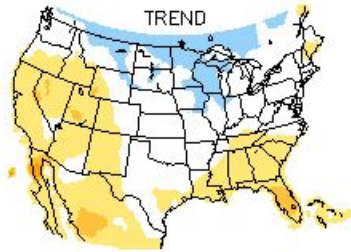
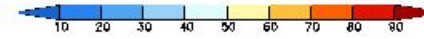
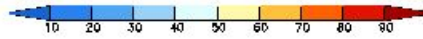
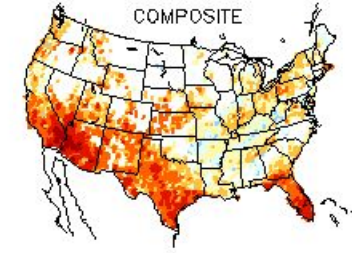
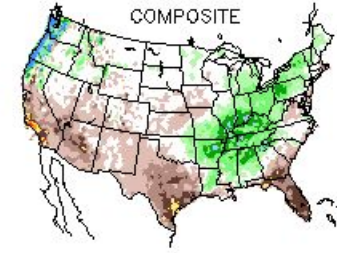
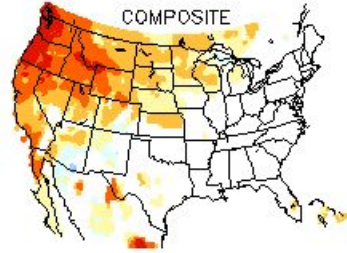
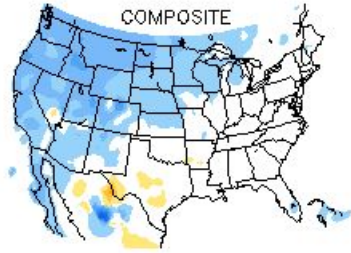
FMA LA NINA PRECIPITATION ANOMALIES (MM)
AND FREQUENCY OF OCCURRENCE (%)

ANOMALIES

FREQUENCY

ANOMALIES

FREQUENCY



(19 CASES: 1950 1955 1956 1971 1974 1975 1976 1985 1989 1996 1999 2000 2006 2008 2009
2011 2012 2018 2021)

(19 CASES: 1950 1955 1956 1971 1974 1975 1976 1985 1989 1996 1999 2000 2006 2008 2009
2011 2012 2018 2021)

https://www.cpc.ncep.noaa.gov/products/precip/CWlink/ENSO/composites/EC_ENP_index.shtml

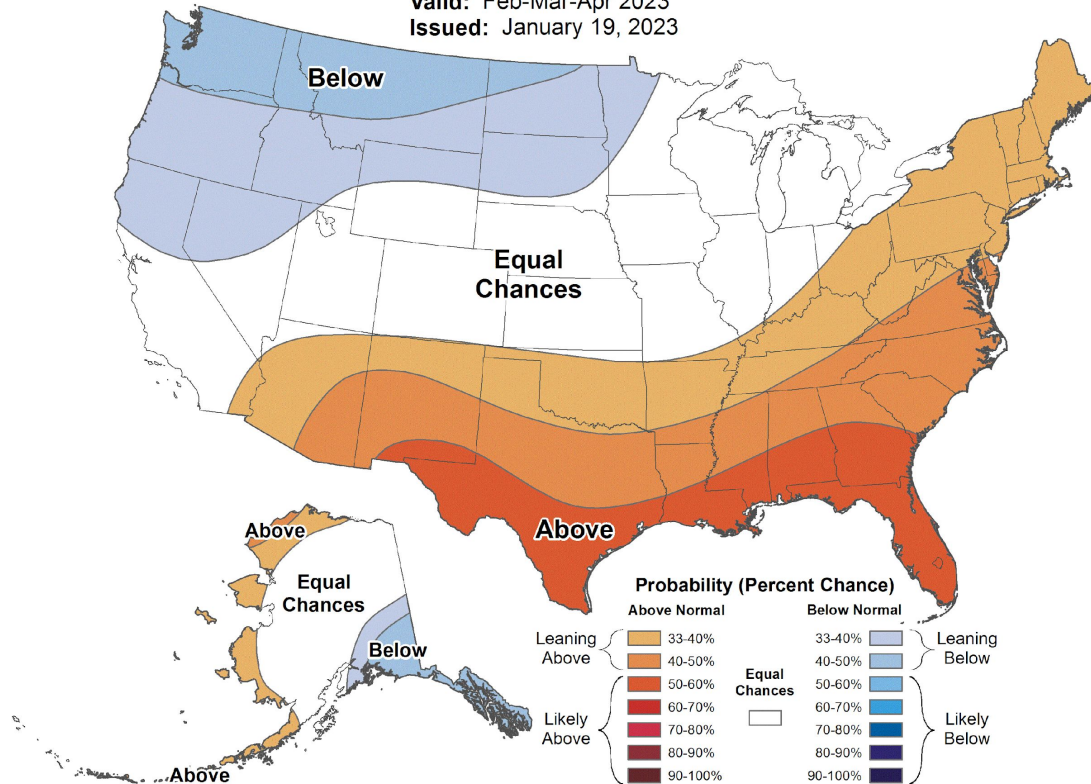
February-March-April 2023



Seasonal Temperature Outlook



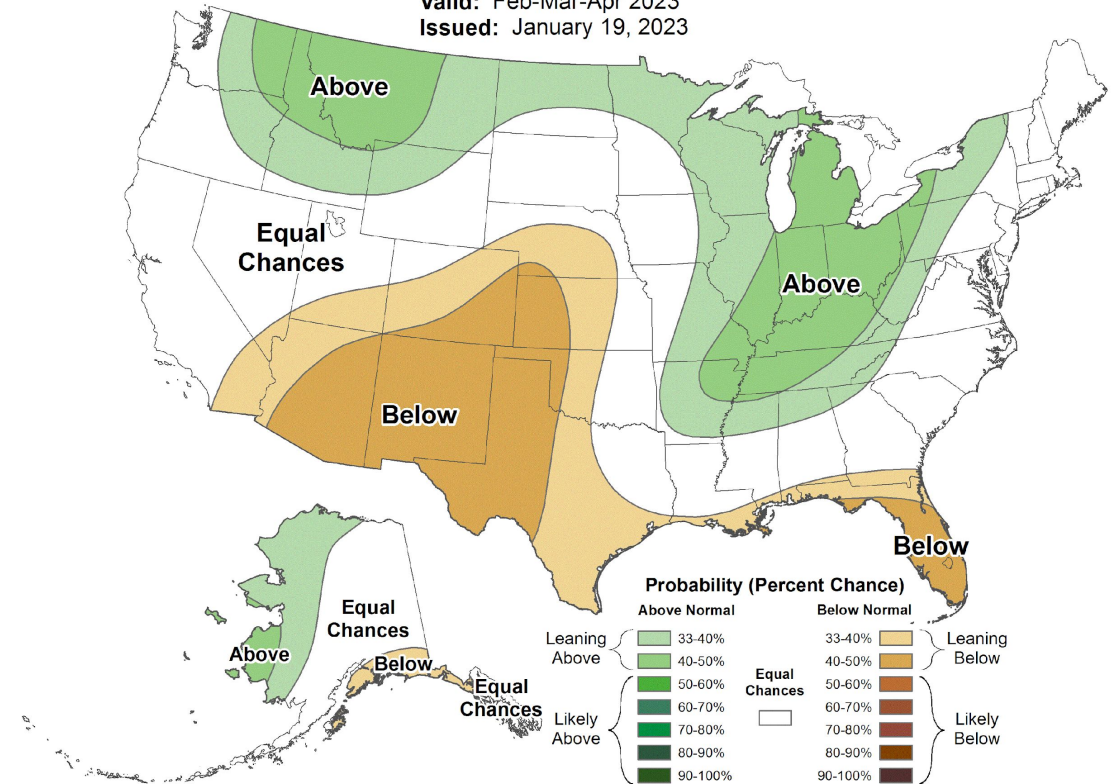
Valid: Feb-Mar-Apr 2023
 Issued: January 19, 2023



Seasonal Precipitation Outlook



Valid: Feb-Mar-Apr 2023
 Issued: January 19, 2023



<http://www.cpc.ncep.noaa.gov/>

Current Pacific Ocean Conditions

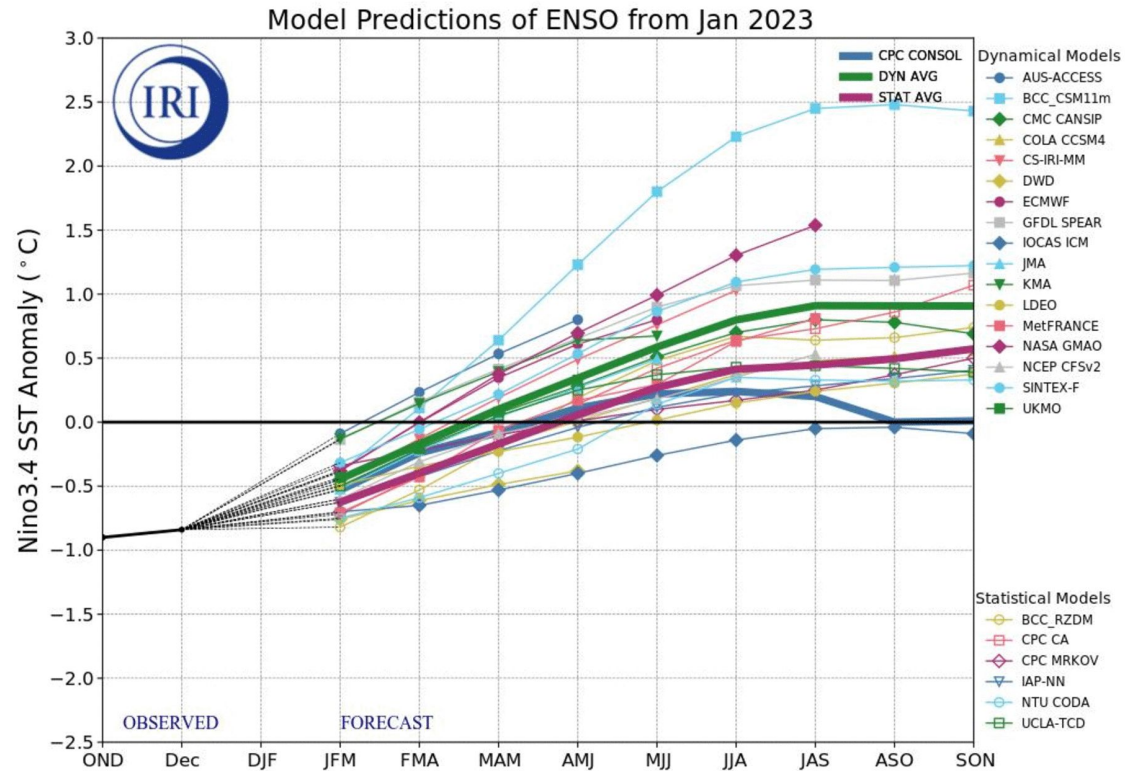


Figure 6. Forecasts of sea surface temperature (SST) anomalies for the Niño 3.4 region (5°N-5°S, 120°W-170°W). Figure updated 19 January 2023 by the International Research Institute (IRI) for Climate and Society.

SST Anomalies (°C)

01 FEB 2023

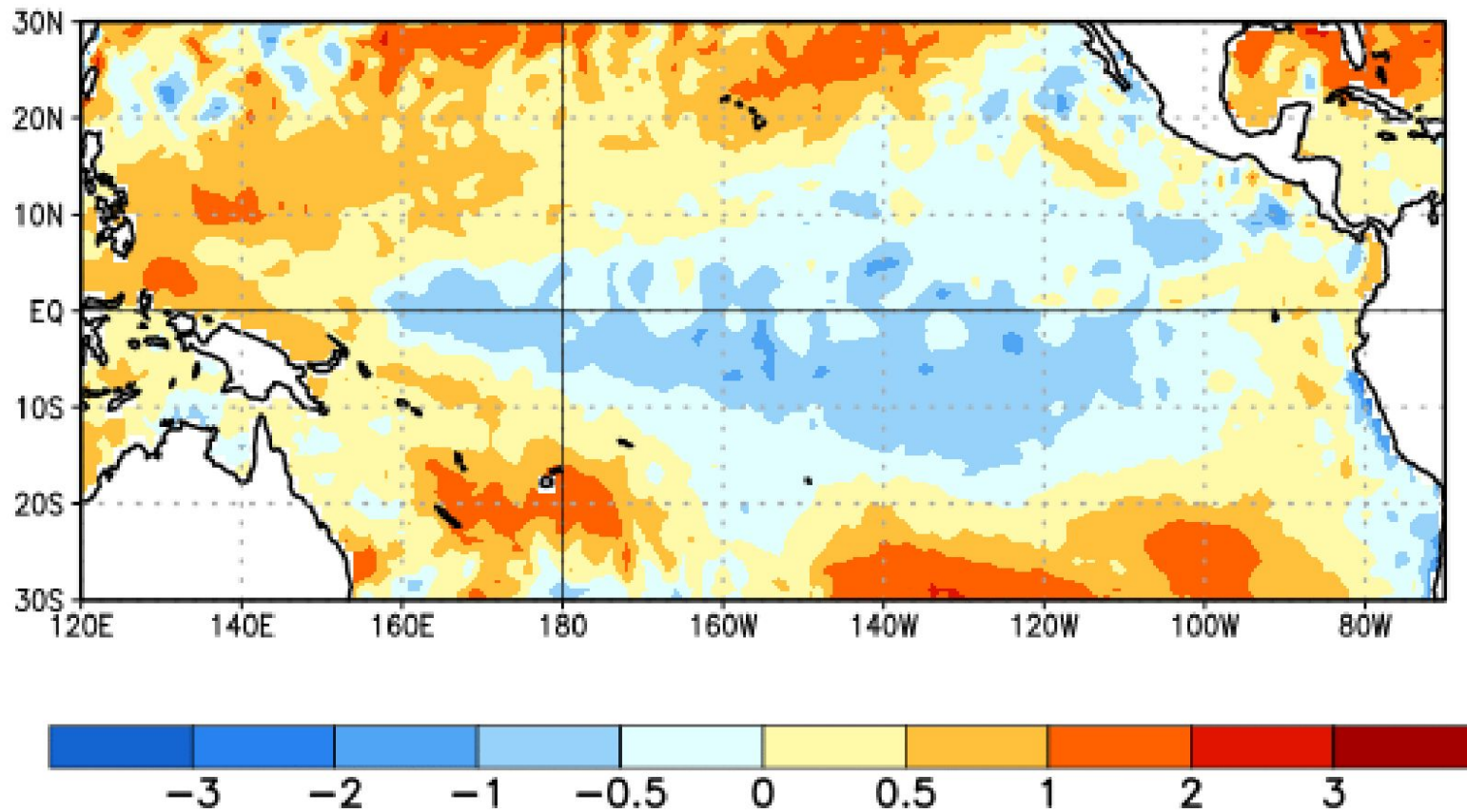


Figure 1. Average sea surface temperature (SST) anomalies (°C) for the week centered on 1 February 2023. Anomalies are computed with respect to the 1991-2020 base period weekly means.

SST Anomalies

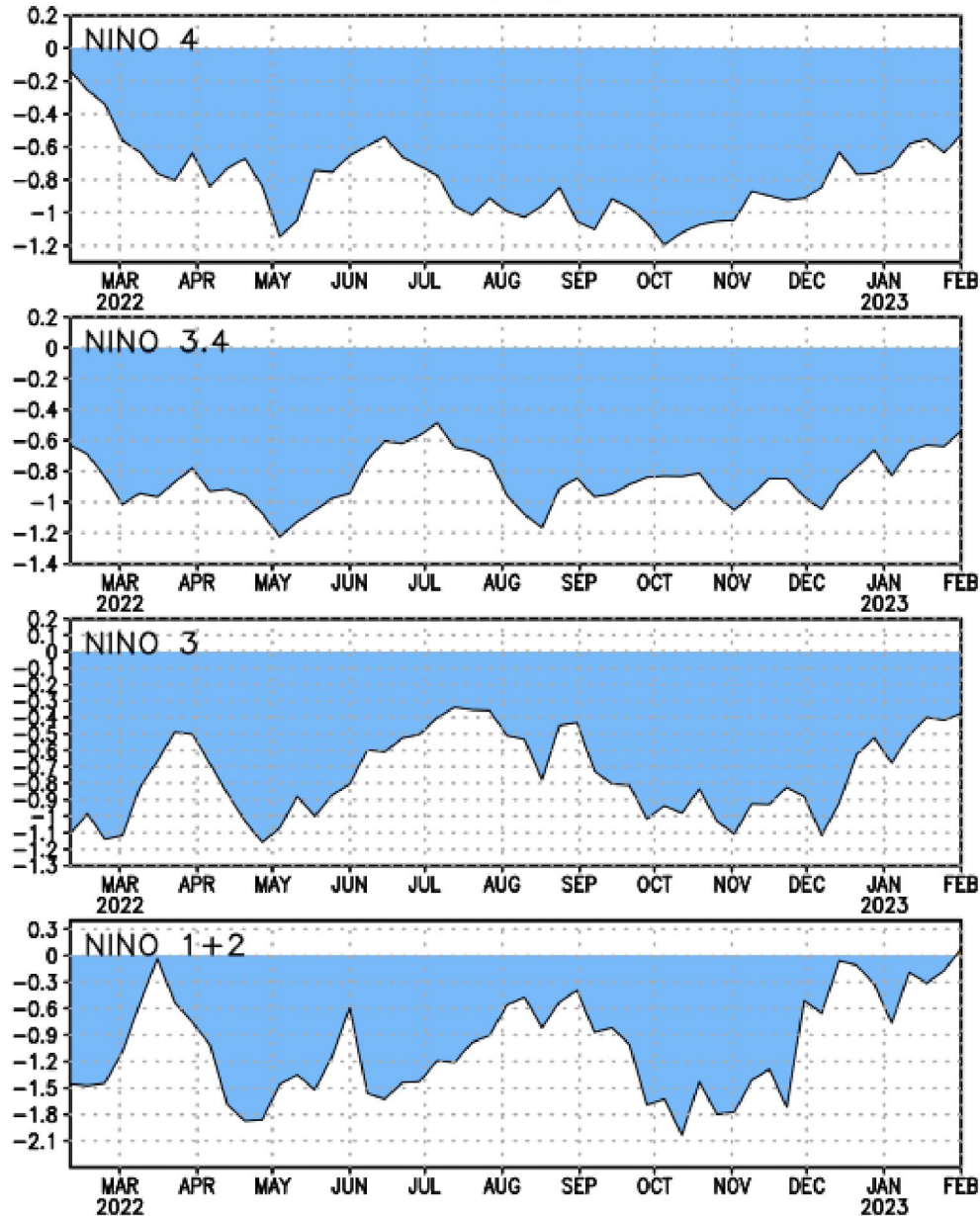
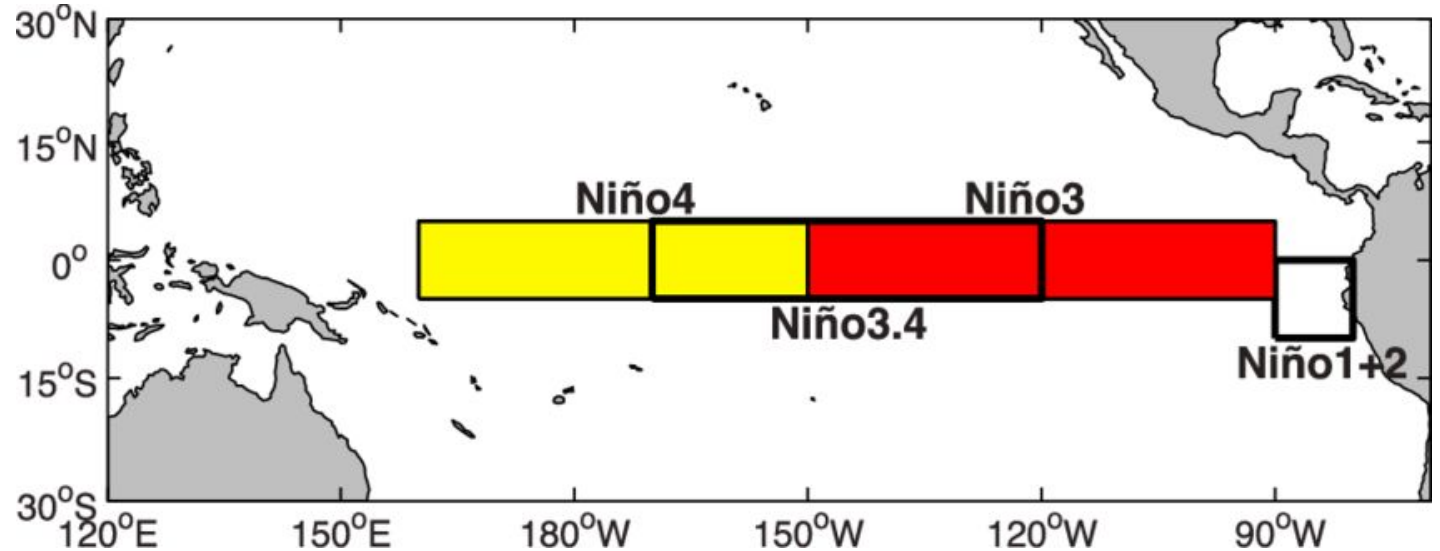


Figure 2. Time series of area-averaged sea surface temperature (SST) anomalies ($^{\circ}\text{C}$) in the Niño regions [Niño-1+2 (0° - 10°S , 90°W - 80°W), Niño-3 (5°N - 5°S , 150°W - 90°W), Niño-3.4 (5°N - 5°S , 170°W - 120°W), Niño-4 (5°N - 5°S , 150°W - 160°E)]. SST anomalies are departures from the 1991-2020 base period weekly means.



OLR Anomalies 08 JAN 2023 to 02 FEB 2023

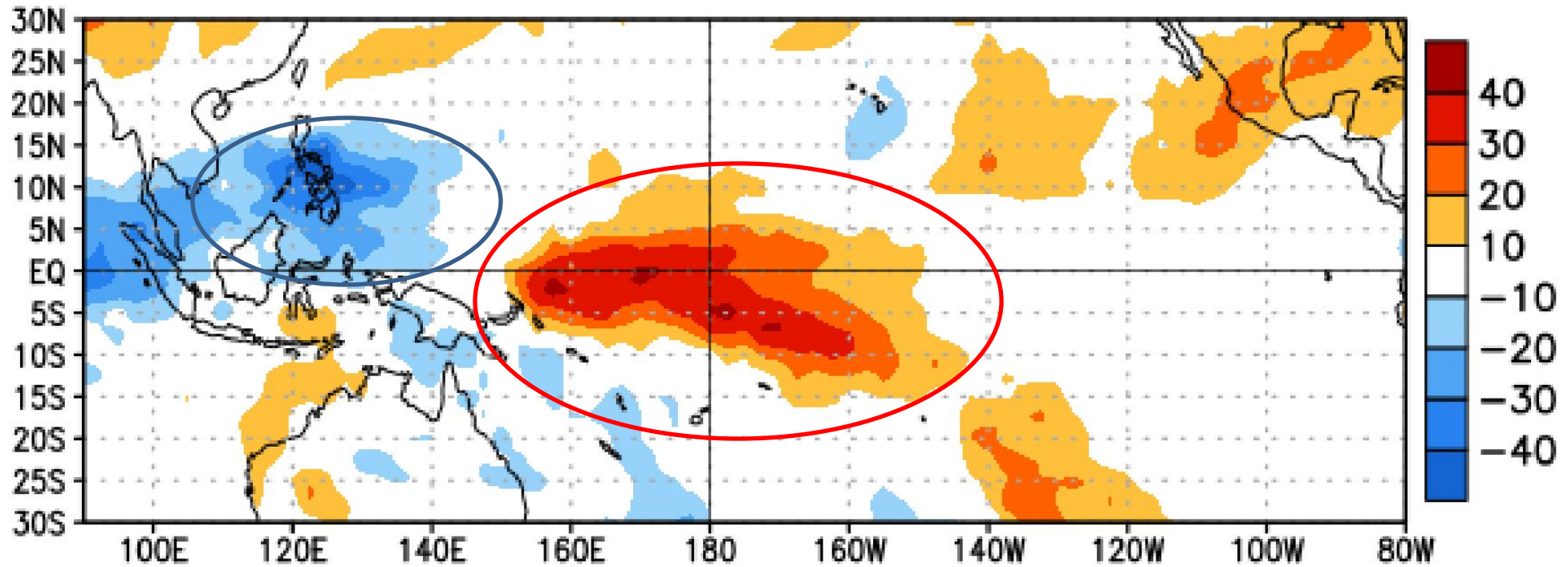
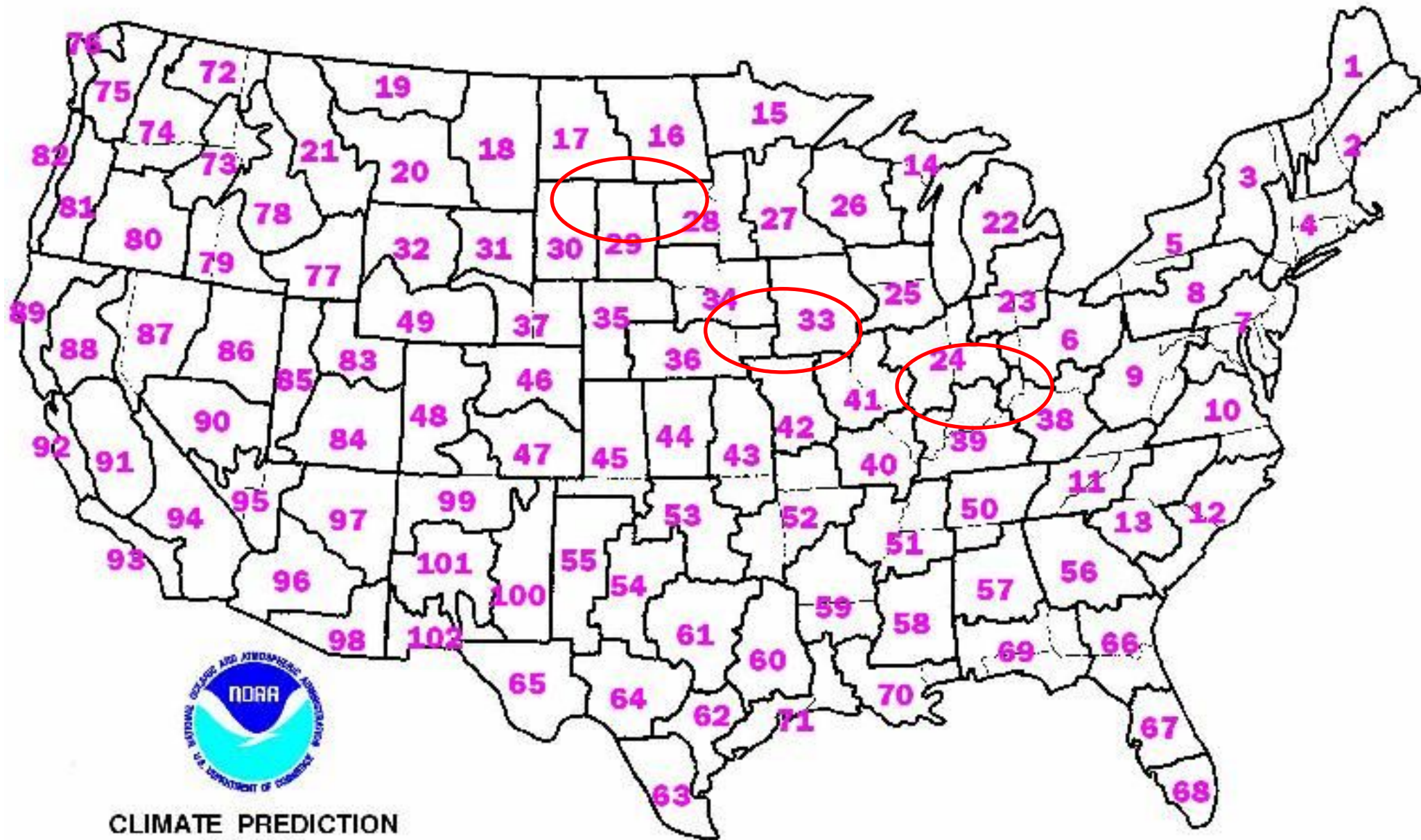


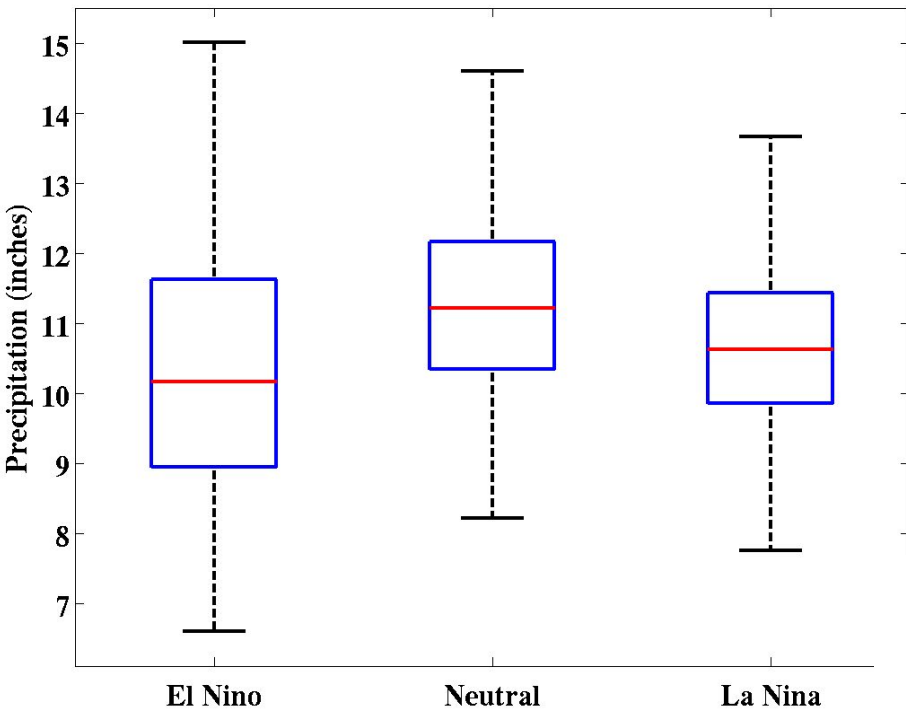
Figure 5. Average outgoing longwave radiation (OLR) anomalies (W/m^2) for the period 8 January – 2 February 2023. OLR anomalies are computed as departures from the 1991-2020 base period pentad means.



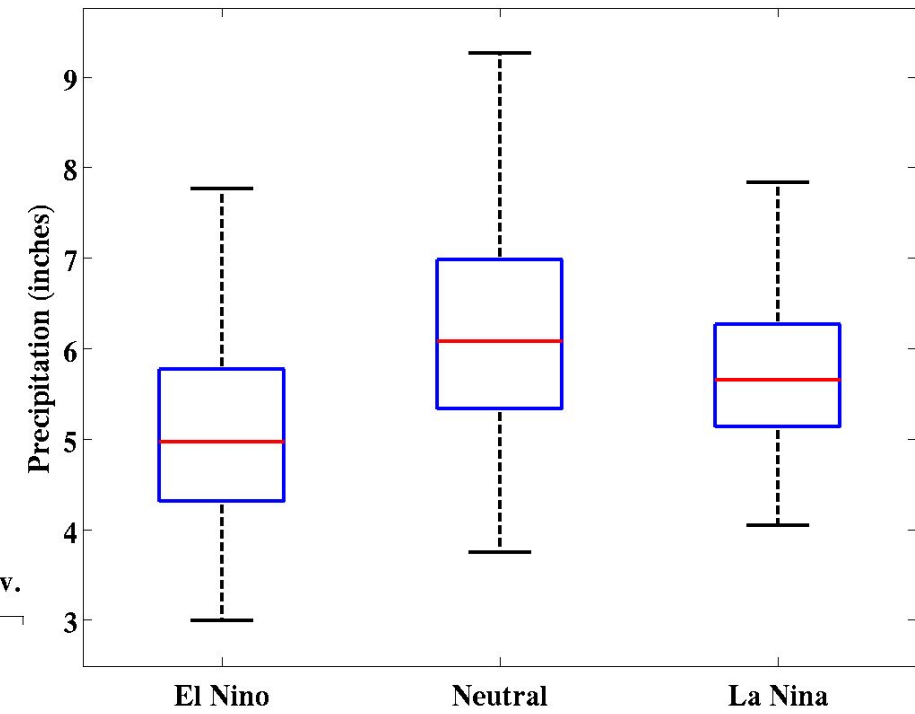
CLIMATE PREDICTION CENTER

https://www.cpc.ncep.noaa.gov/products/precip/CWlink/ENSO/box_whiskers/index.php

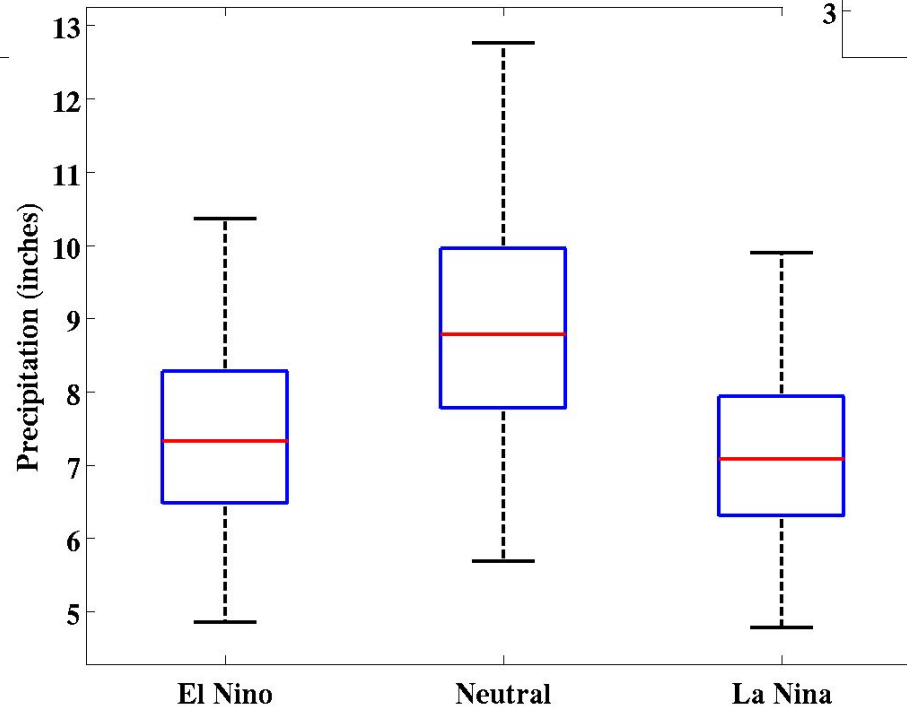
MAM Precipitation Distribution for Climate Div. #024



MAM Precipitation Distribution for Climate Div. #029

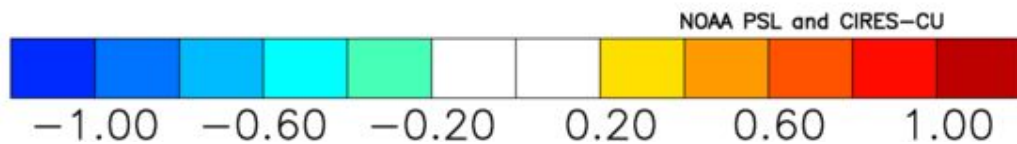
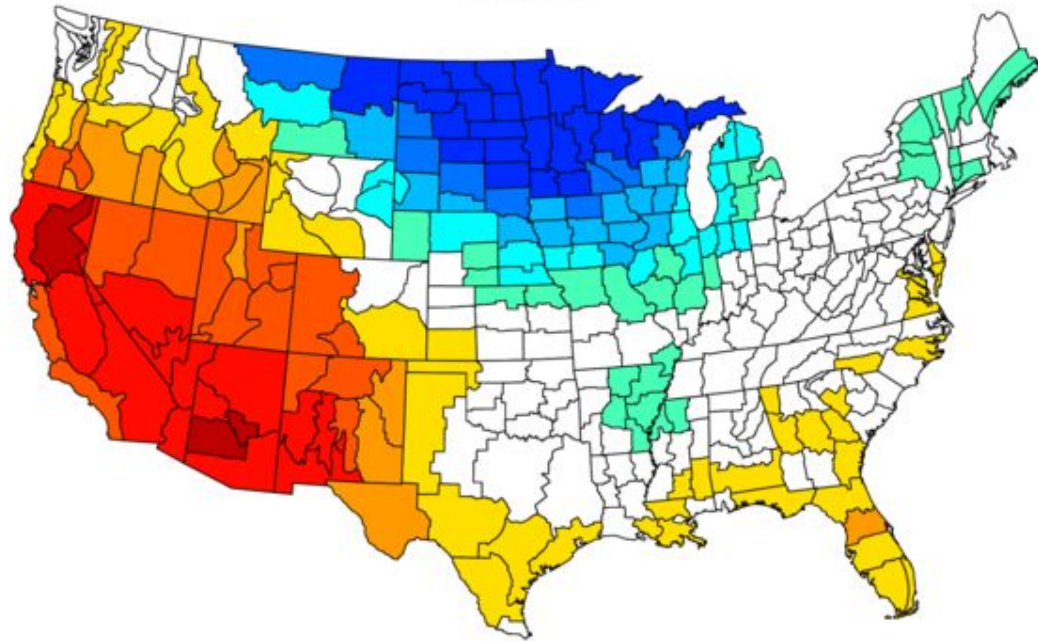


MAM Precipitation Distribution for Climate Div.

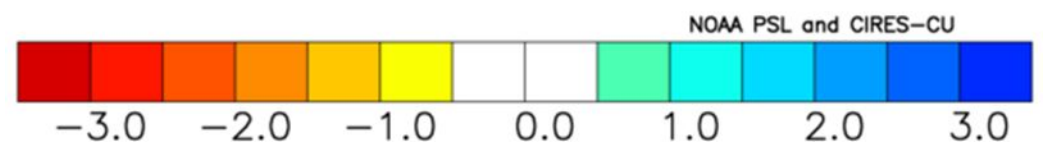
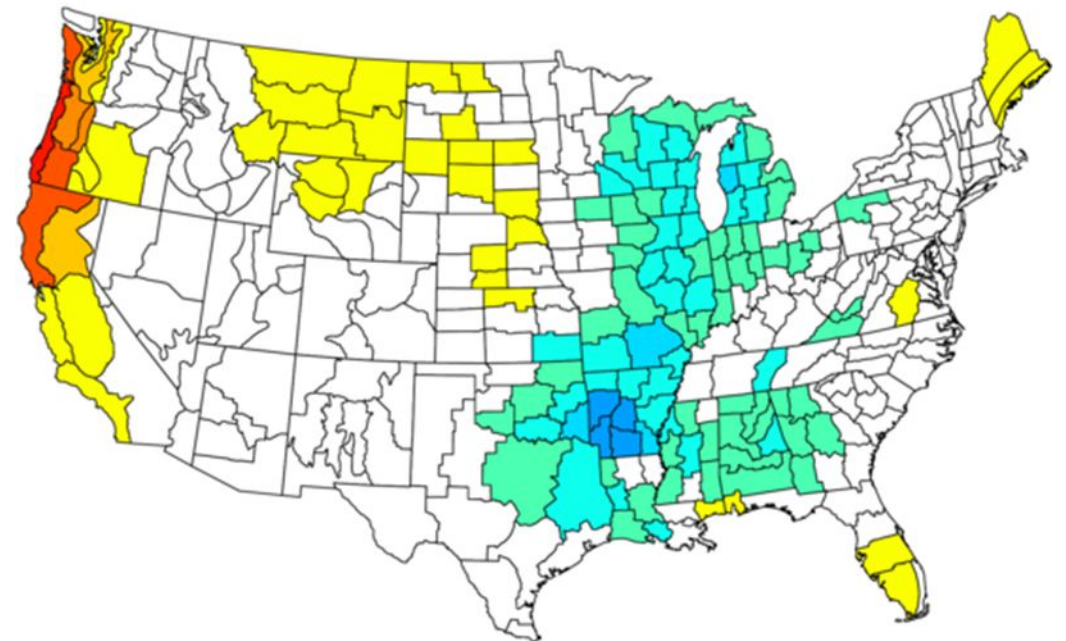


ENSO-Neutral Spring Analogs

NOAA/NCEI Climate Division Composite Temperature Anomalies (F)
Versus 1991–2020 Longterm Average
Mar to May 2001,2002,2004,2006,2009,2013,2014,2015,2017,2018
2019,2020



NOAA/NCEI Climate Division Composite Precipitation Anomalies (in)
Versus 1991–2020 Longterm Average
Mar to May 2001,2002,2004,2006,2009,2013,2014,2015,2017,2018
2019,2020



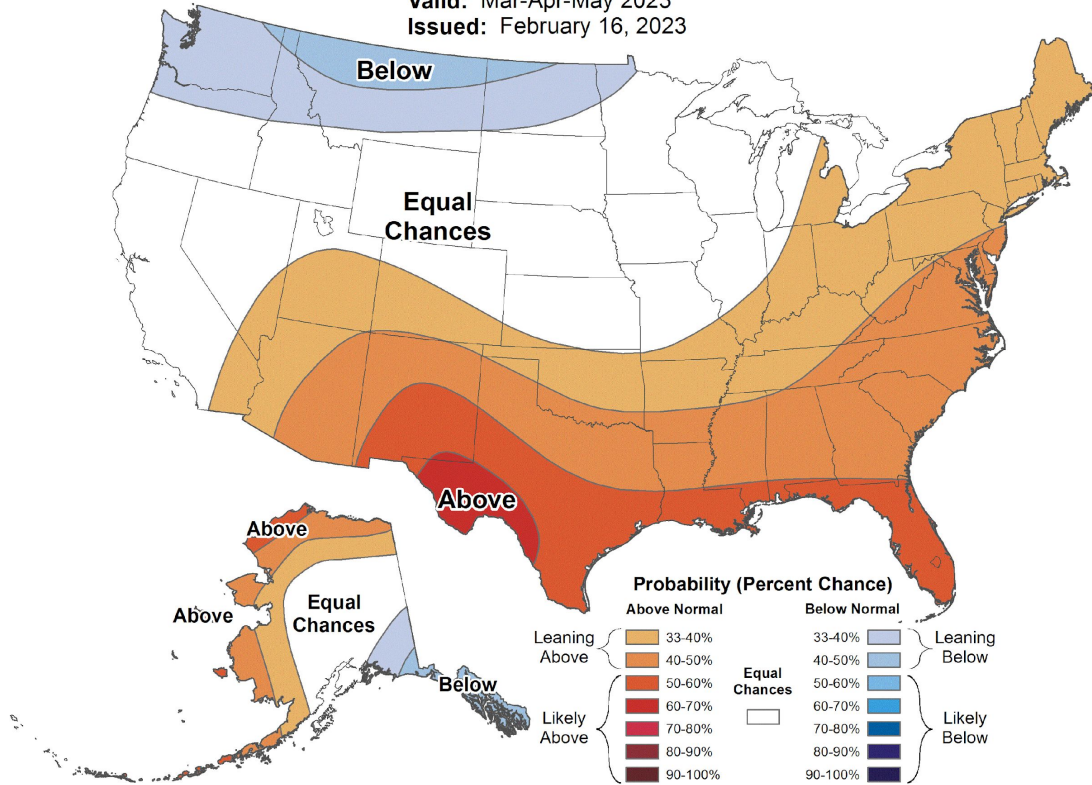
March-April-May 2023



Seasonal Temperature Outlook



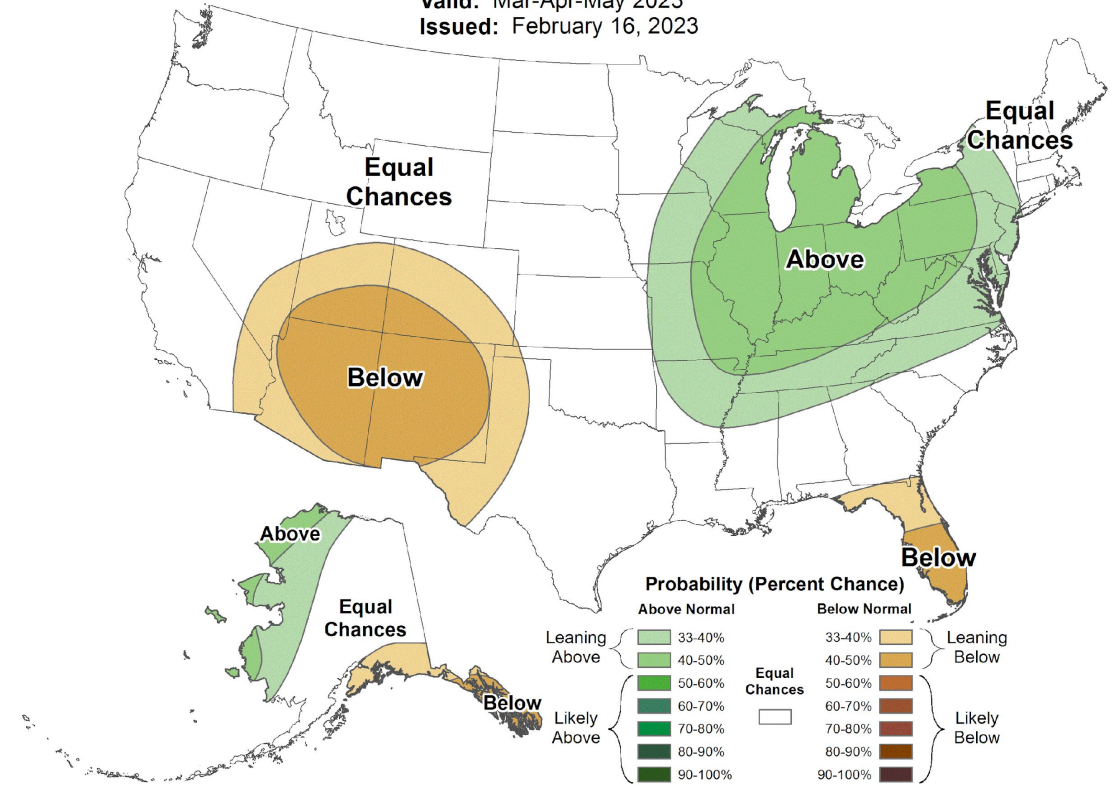
Valid: Mar-Apr-May 2023
Issued: February 16, 2023



Seasonal Precipitation Outlook



Valid: Mar-Apr-May 2023
Issued: February 16, 2023



<http://www.cpc.ncep.noaa.gov/>

JJA EL NINO TEMPERATURE ANOMALIES (C)
AND FREQUENCY OF OCCURRENCE (%)

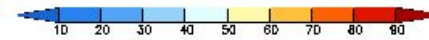
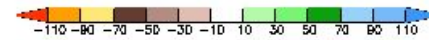
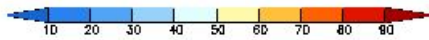
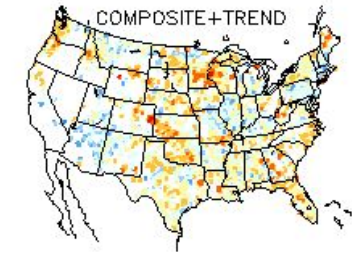
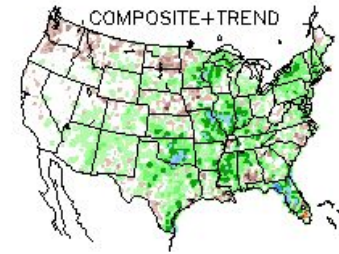
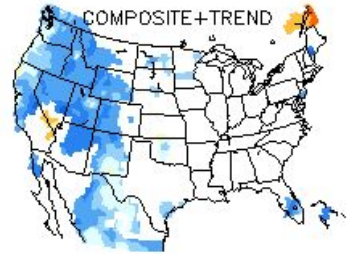
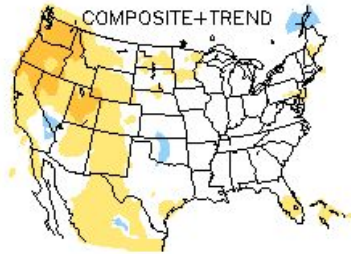
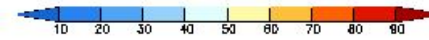
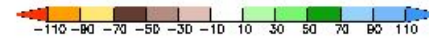
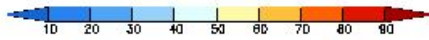
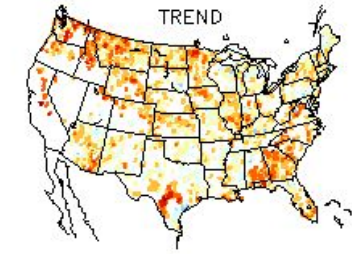
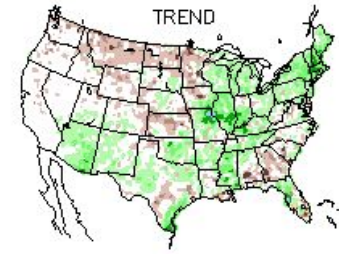
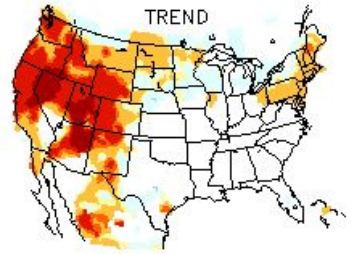
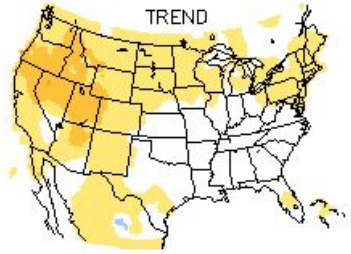
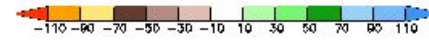
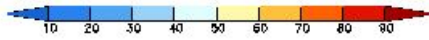
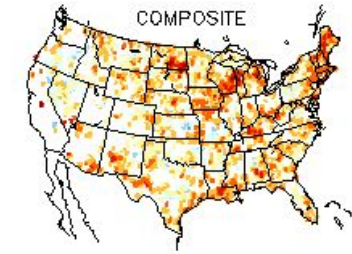
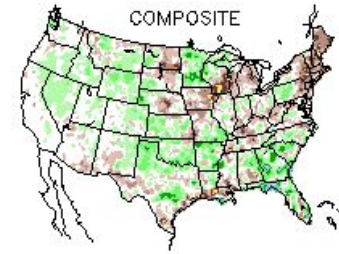
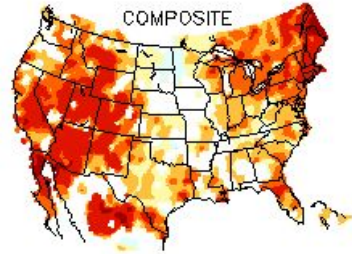
JJA EL NINO PRECIPITATION ANOMALIES (MM)
AND FREQUENCY OF OCCURRENCE (%)

ANOMALIES

FREQUENCY

ANOMALIES

FREQUENCY



(15 CASES: 1951 1953 1957 1958 1963 1965 1968 1972 1982 1987 1991 1997 2002 2004 2015)

(15 CASES: 1951 1953 1957 1958 1963 1965 1968 1972 1982 1987 1991 1997 2002 2004 2015)

https://www.cpc.ncep.noaa.gov/products/precip/CWlink/ENSO/composites/EC_ENP_index.shtml

ASO EL NINO TEMPERATURE ANOMALIES (C)
AND FREQUENCY OF OCCURRENCE (%)

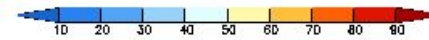
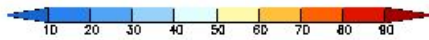
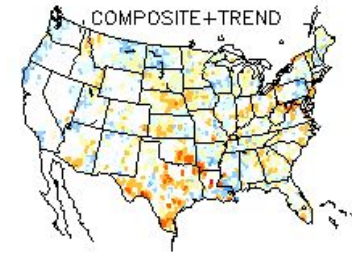
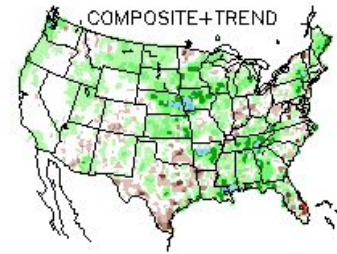
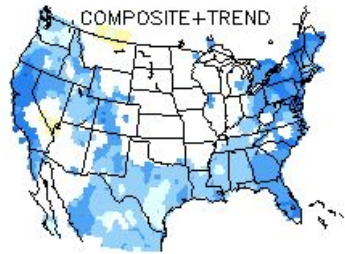
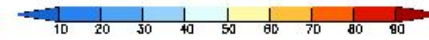
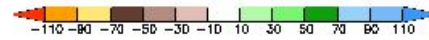
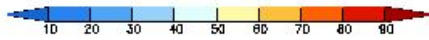
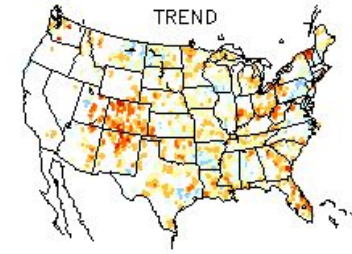
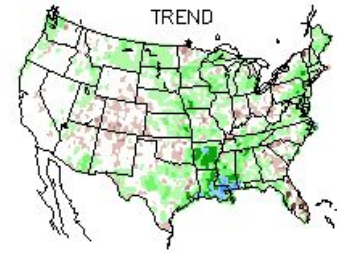
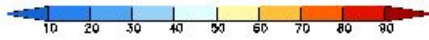
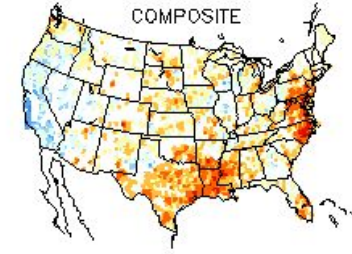
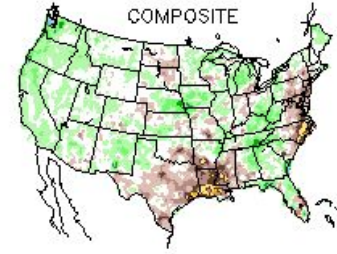
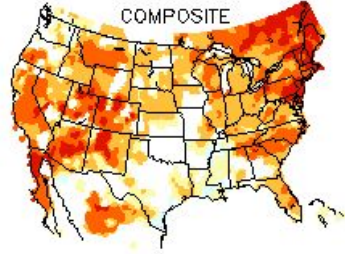
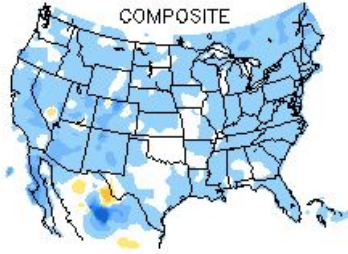
ASO EL NINO PRECIPITATION ANOMALIES (MM)
AND FREQUENCY OF OCCURRENCE (%)

ANOMALIES

FREQUENCY

ANOMALIES

FREQUENCY



(21 CASES: 1951 1953 1957 1963 1965 1969 1972 1976 1977 1982 1986 1987 1991 1994 1997
2002 2004 2006 2009 2015 2018)

(21 CASES: 1951 1953 1957 1963 1965 1969 1972 1976 1977 1982 1986 1987 1991 1994 1997
2002 2004 2006 2009 2015 2018)

https://www.cpc.ncep.noaa.gov/products/precip/CWlink/ENSO/composites/EC_ENP_index.shtml



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**AGRICULTURE &
LAND STEWARDSHIP**

Thank you!

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<https://iowaagriculture.gov/climatology-bureau>