

Climate Variability, Climate Change in MO, and an Early Weather Outlook – Winter 2023- 2024

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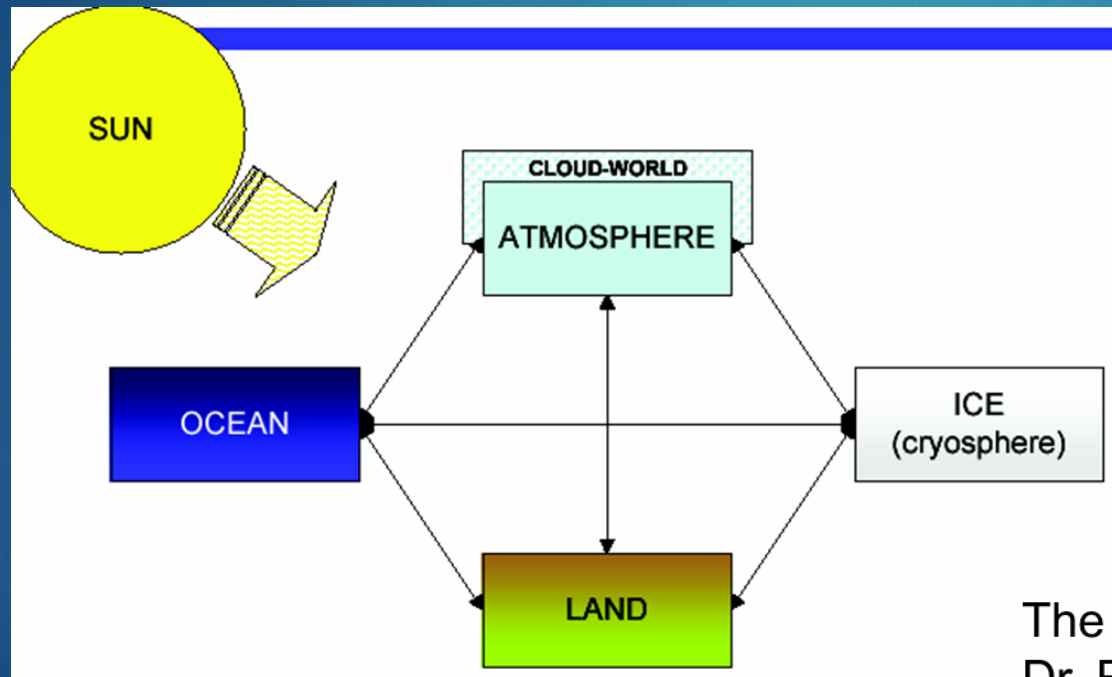
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Definitions

- ▶ **Weather – instantaneous conditions which can be measured using state variables.**
- ▶ **Climate - Is the long-term or time mean state of the earth-atmosphere system and the state variables along with higher order statistics. Also, we must describe extremes and recurrence frequencies**

The Climate System – What is it?

- ▶ The Earth-Atmosphere system is an integrated system of which the atmosphere is only one part!



The earth-atmosphere system, courtesy of Dr. Richard Rood.
(<http://aoss.engin.umich.edu/class/aoss605/lectures/>)

The Climate System

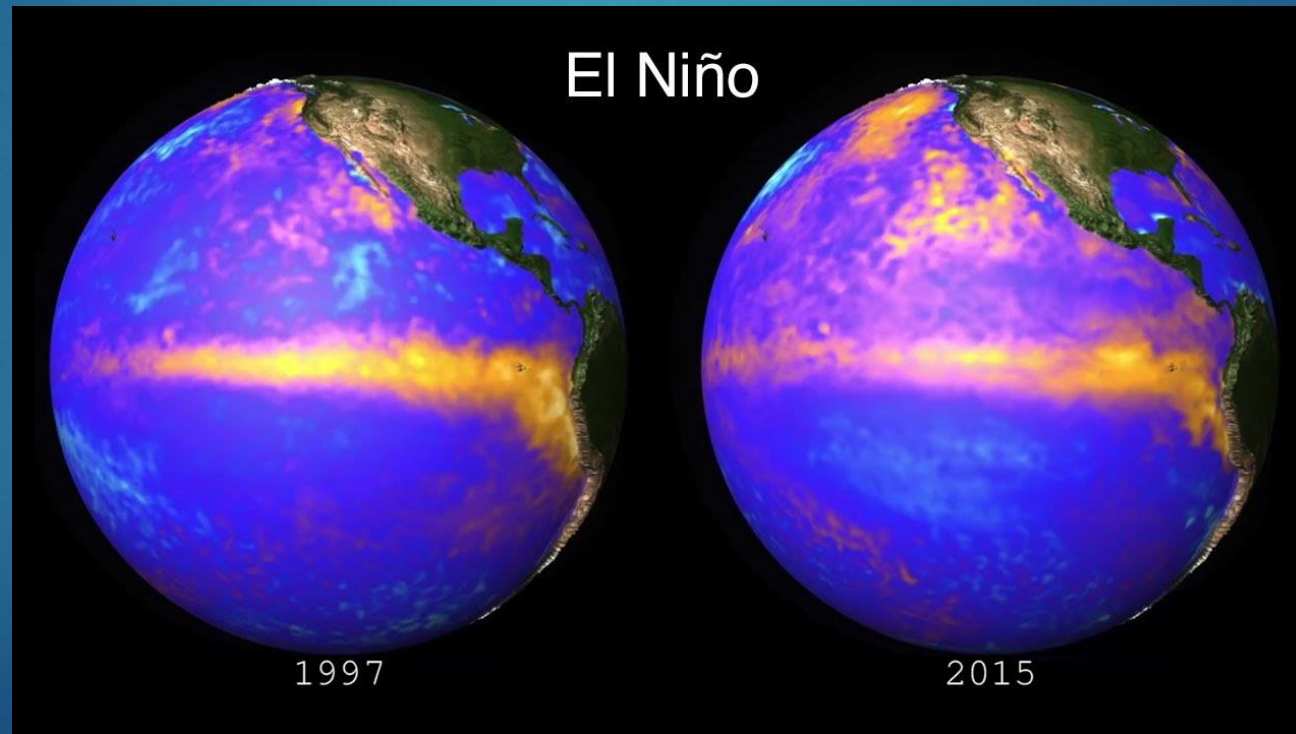
- ▶ The other parts of the climate system are:
 - Cryosphere (Glaciers, Antarctica)
 - Oceans (and freshwater too)
 - Lithosphere (dirt, continents)
 - Biosphere (life → Plants and Animals)

Sub-seasonal and Seasonal Forecasting

- ▶ In this part of the world – there are three basic phenomena which drive sub-seasonal (one to four weeks) and seasonal range forecasting:
- ▶ El Niño and Southern Oscillation
- ▶ Atmospheric Blocking
- ▶ Teleconnections

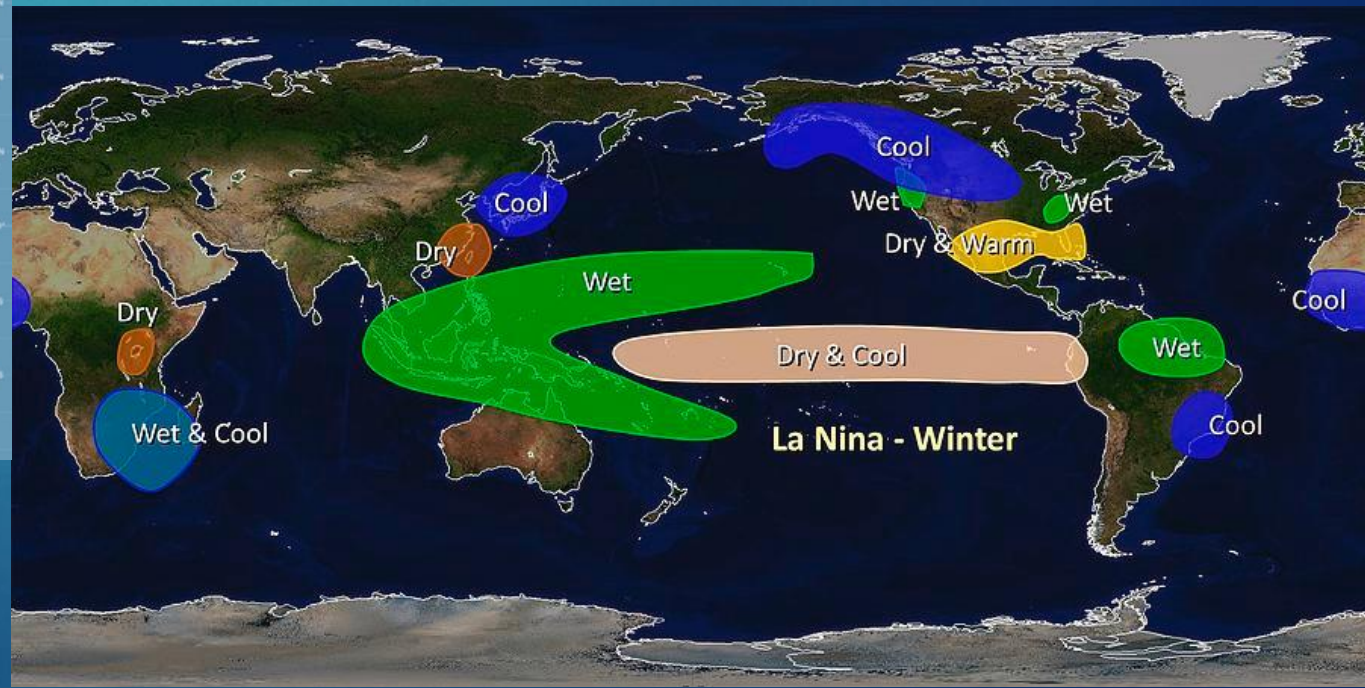
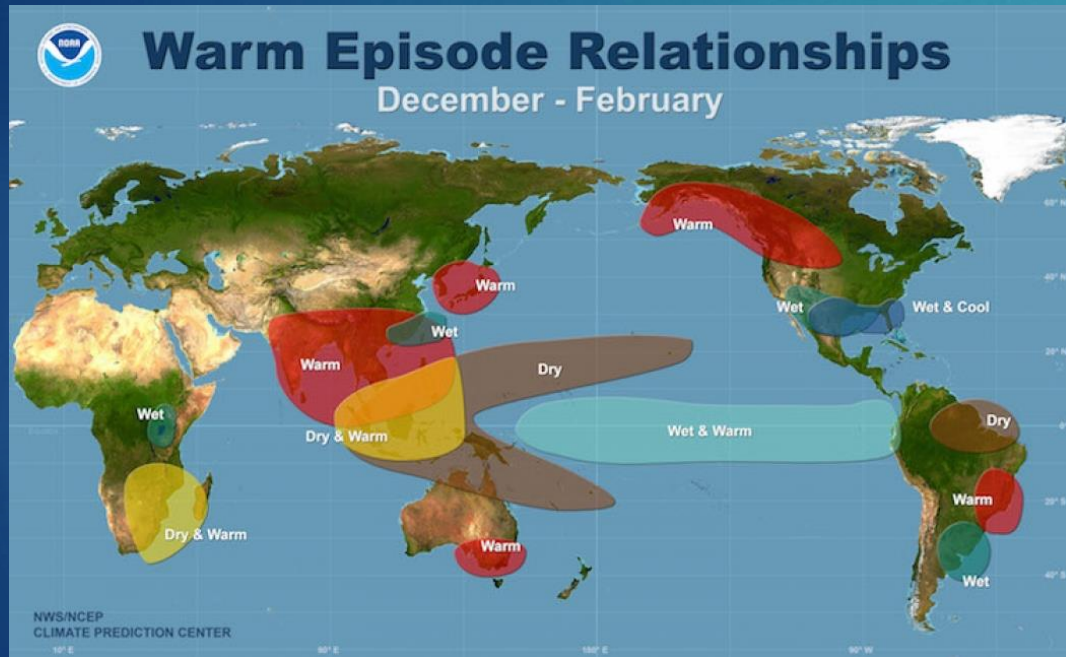
El Niño and Southern Oscillation (ENSO)

- ▶ is a two-to-seven year warming of water in the Eastern Tropical Pacific that impacts weather and climate world-wide.



ENSO Impacts

- Influences weather worldwide



ENSO – Current State – Where are we going?

► October 2023 – El Niño “Cometh”

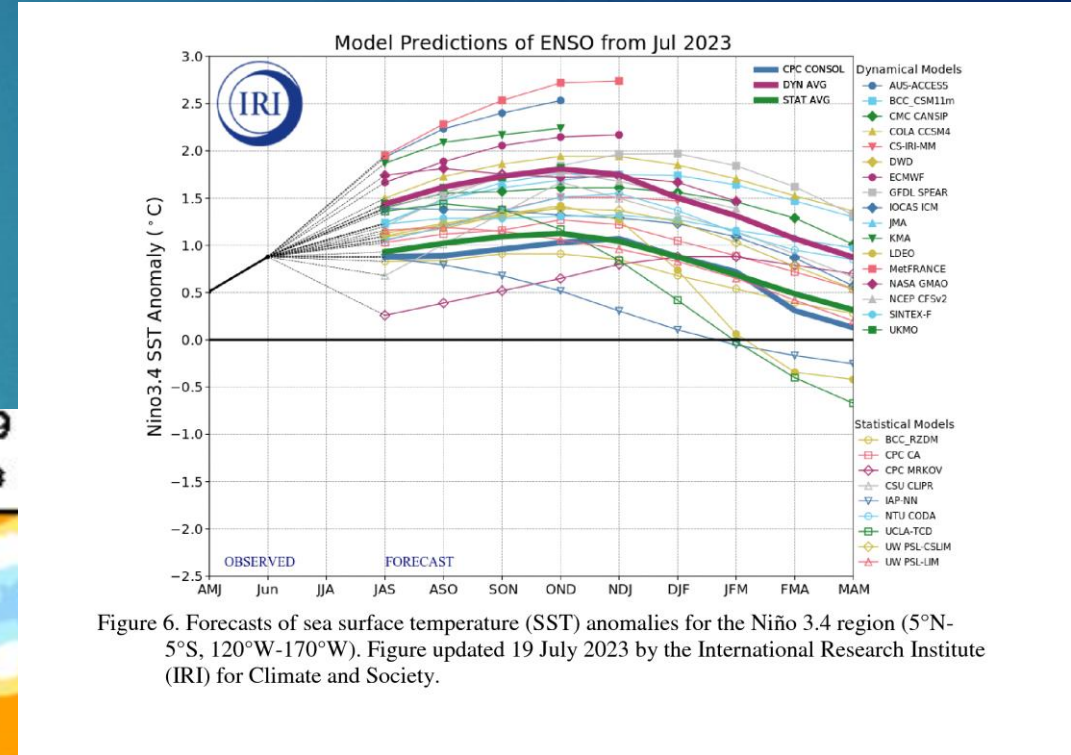
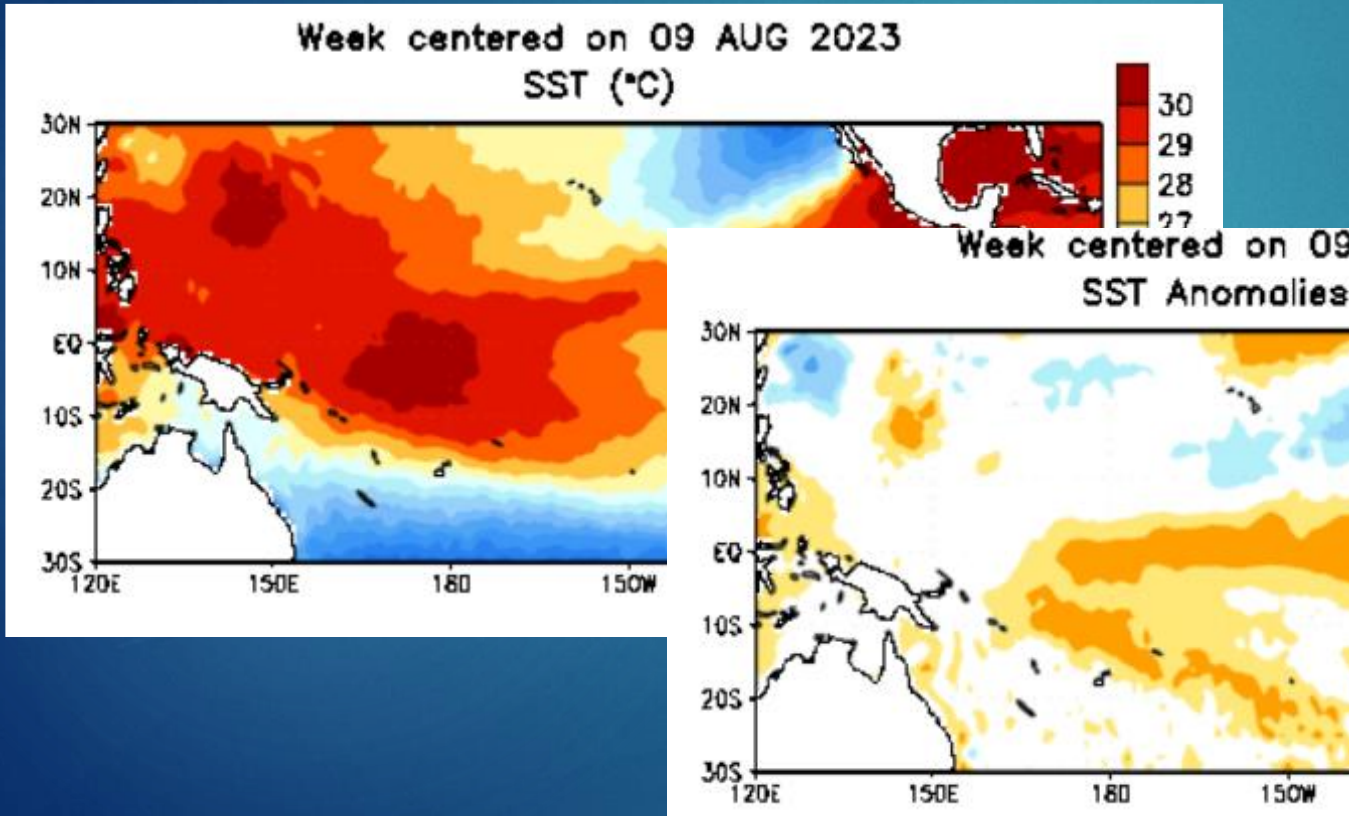


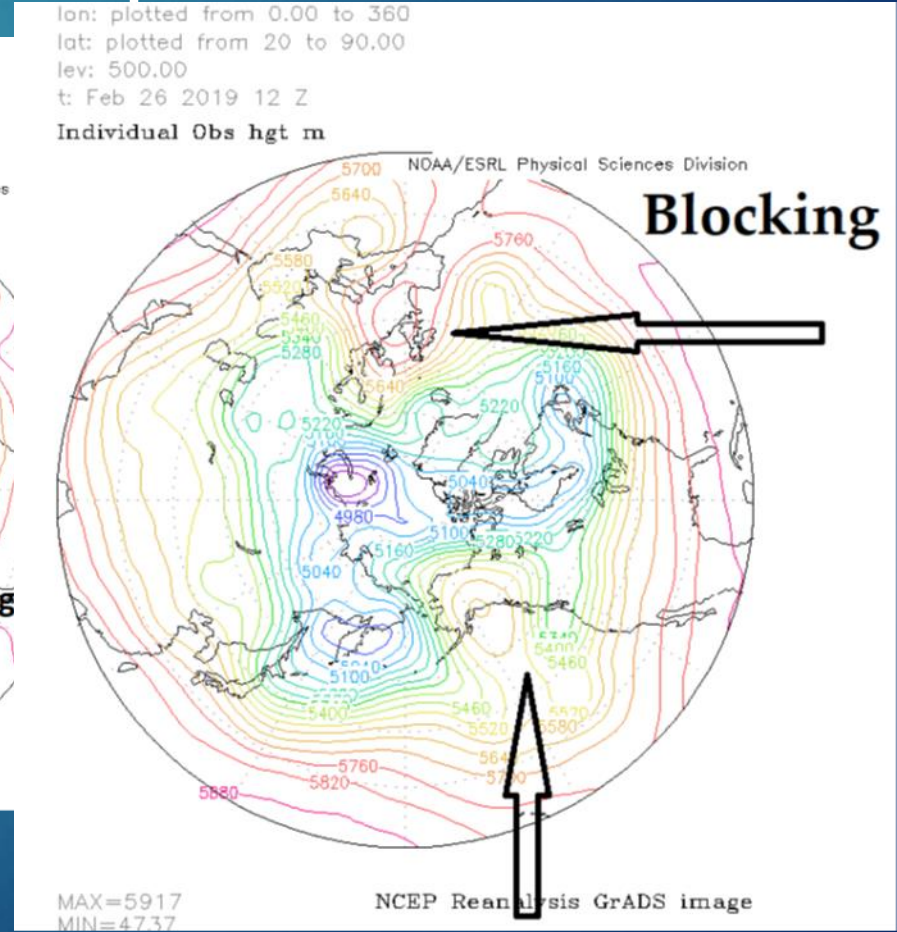
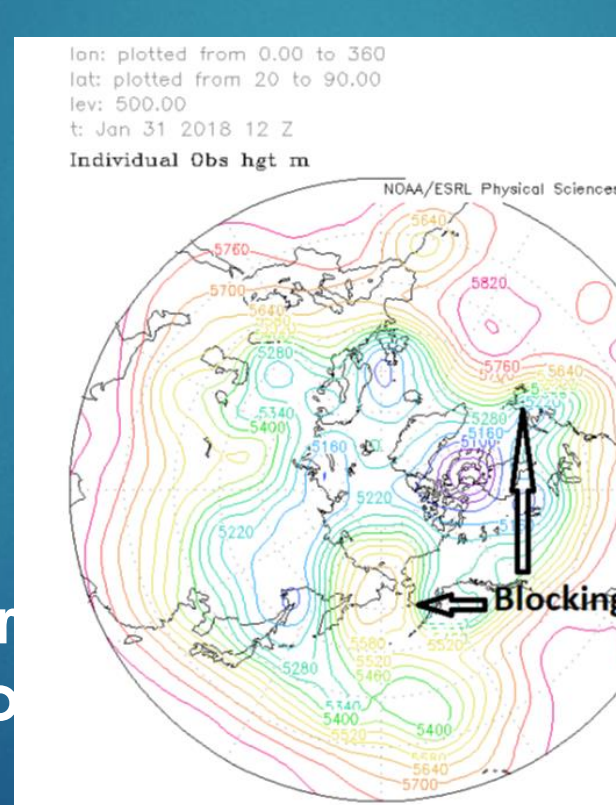
Figure 6. Forecasts of sea surface temperature (SST) anomalies for the Niño 3.4 region (5°N-5°S, 120°W-170°W). Figure updated 19 July 2023 by the International Research Institute (IRI) for Climate and Society.

Atmospheric Blocking

- ▶ Atmospheric jet stream behavior is complicated

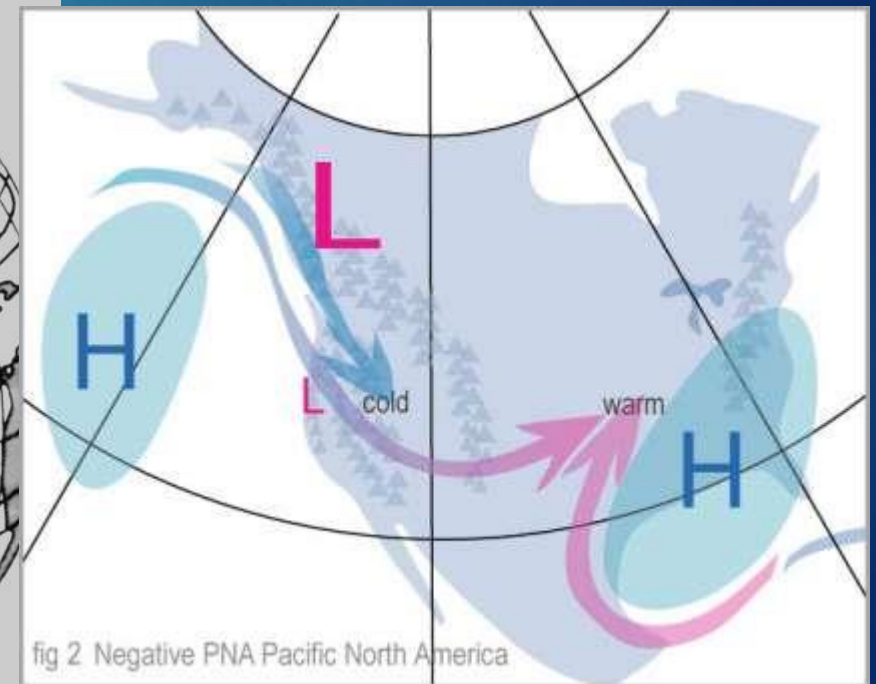
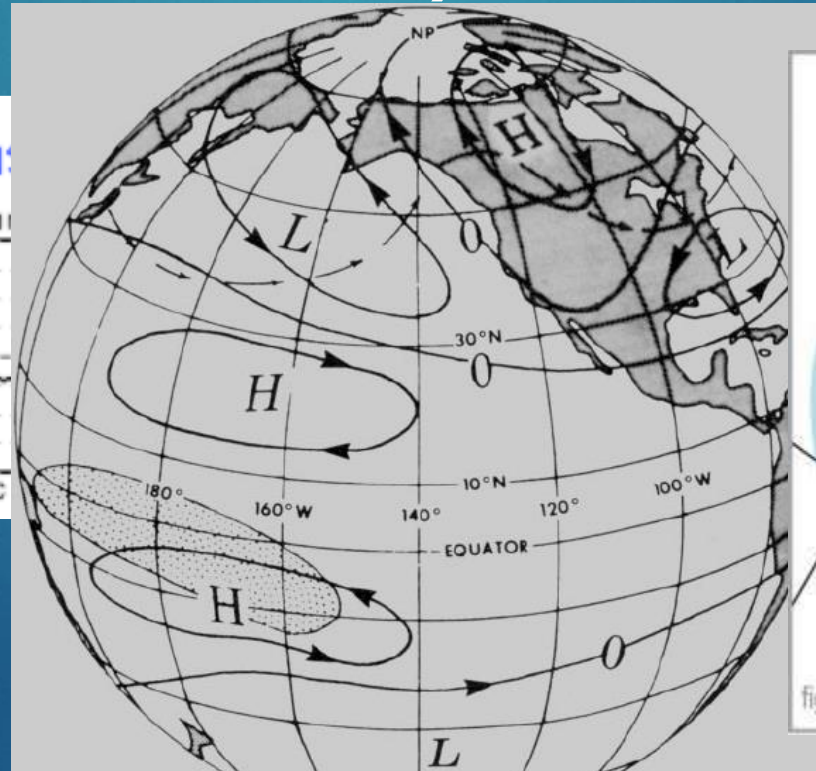
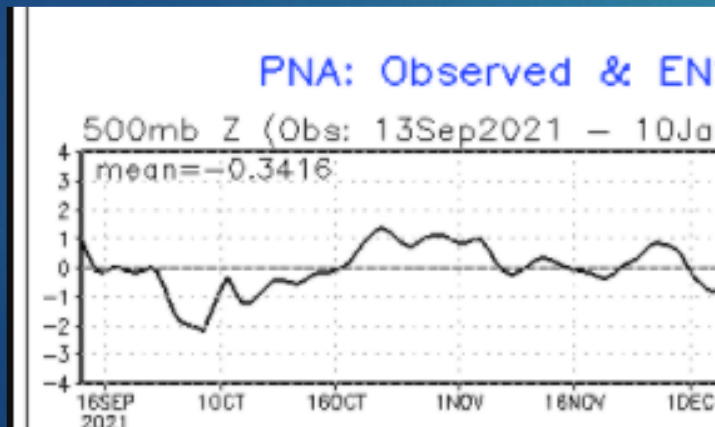


- ▶ Blocking - generally occurs in mid-latitude and



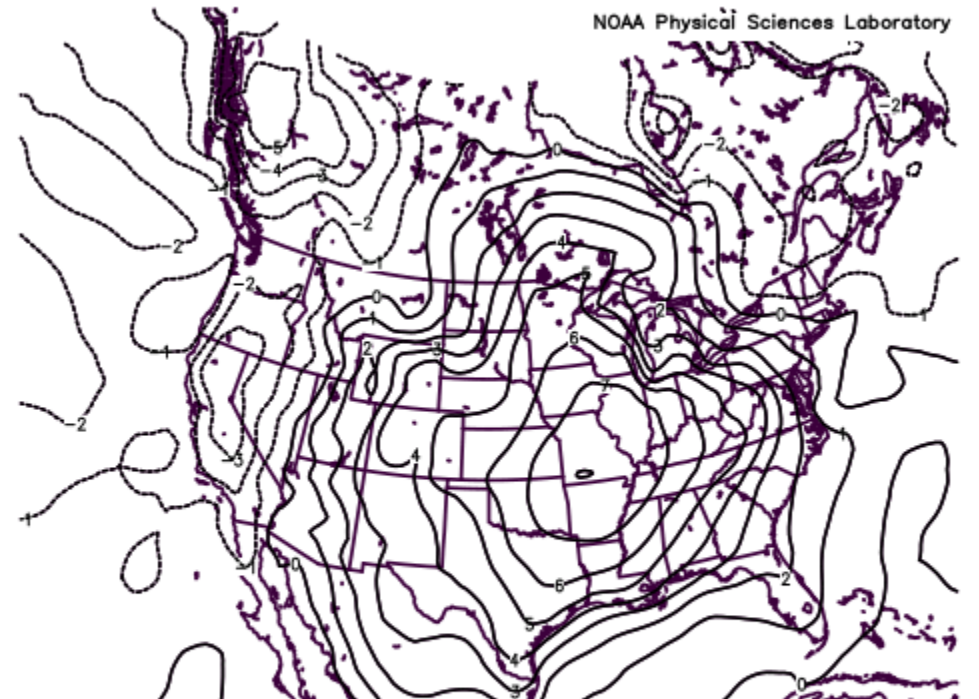
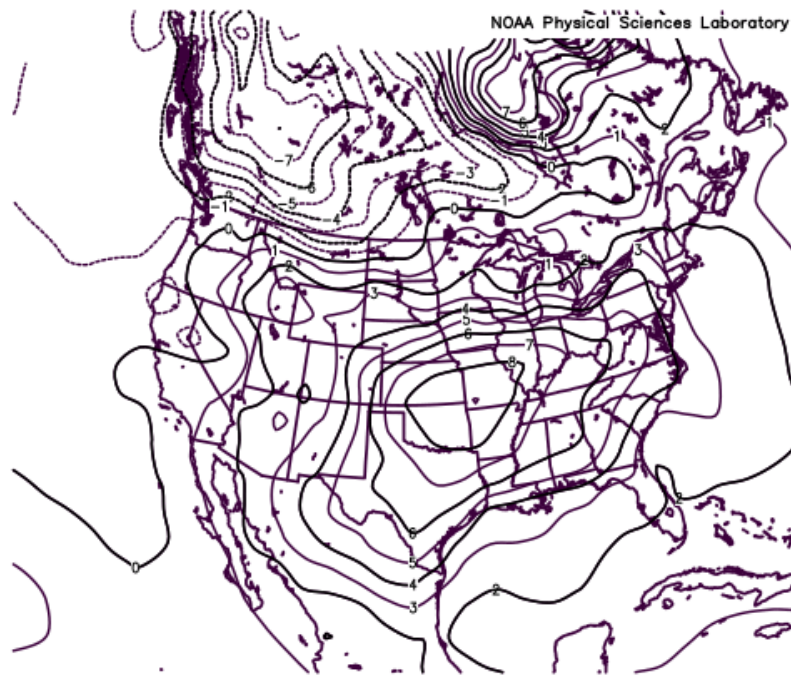
Teleconnections

- ▶ Teleconnections – are typical jet stream wave patterns that impact certain large-scale areas of the world (6,000 – 10,000 km, one to two weeks).



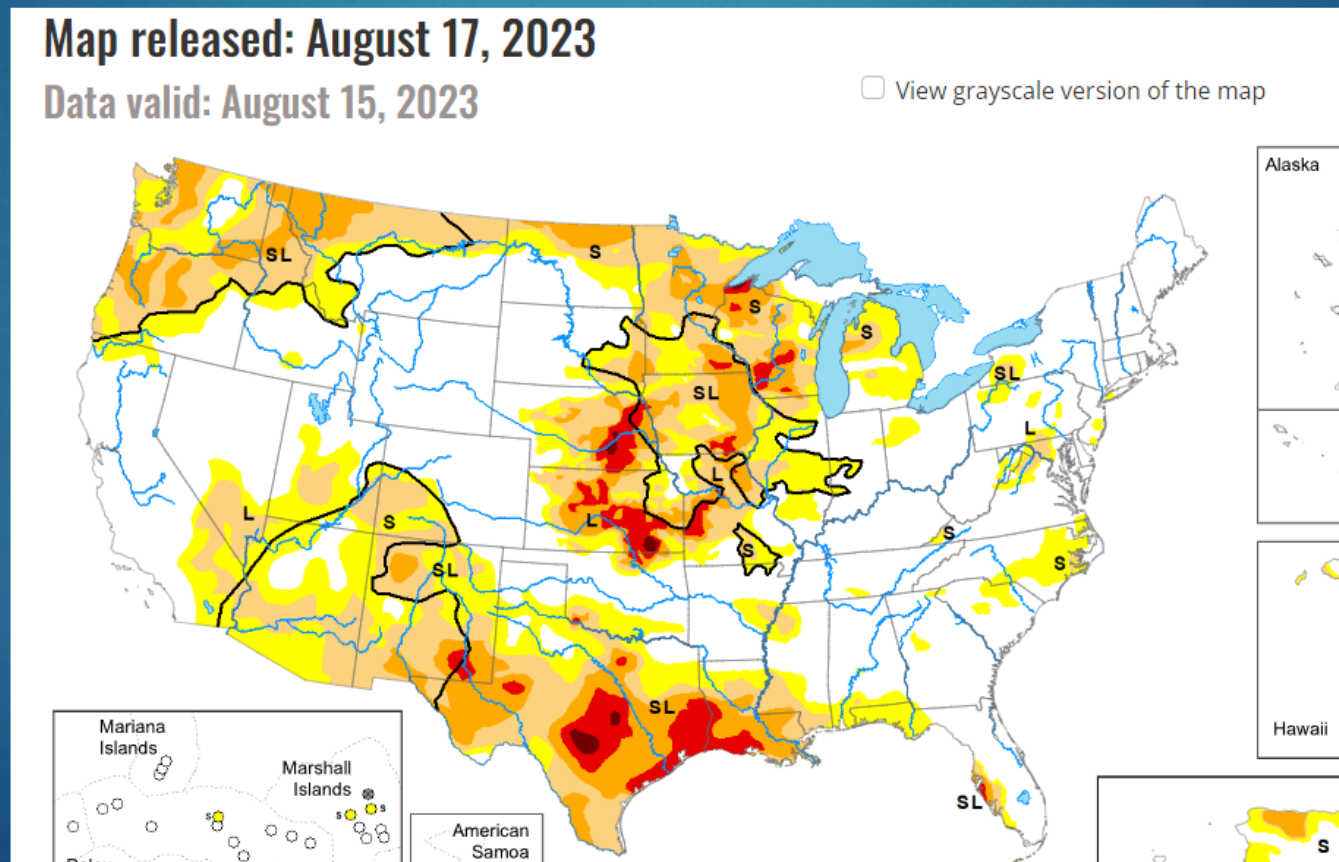
December 2021 versus 1889

- ▶ December 2021 was anomalously warm – but we've seen it before.



National Drought Monitor

► Current Drought Conditions – short-term no improvement



Our Forecast – Winter 2022 - 2023

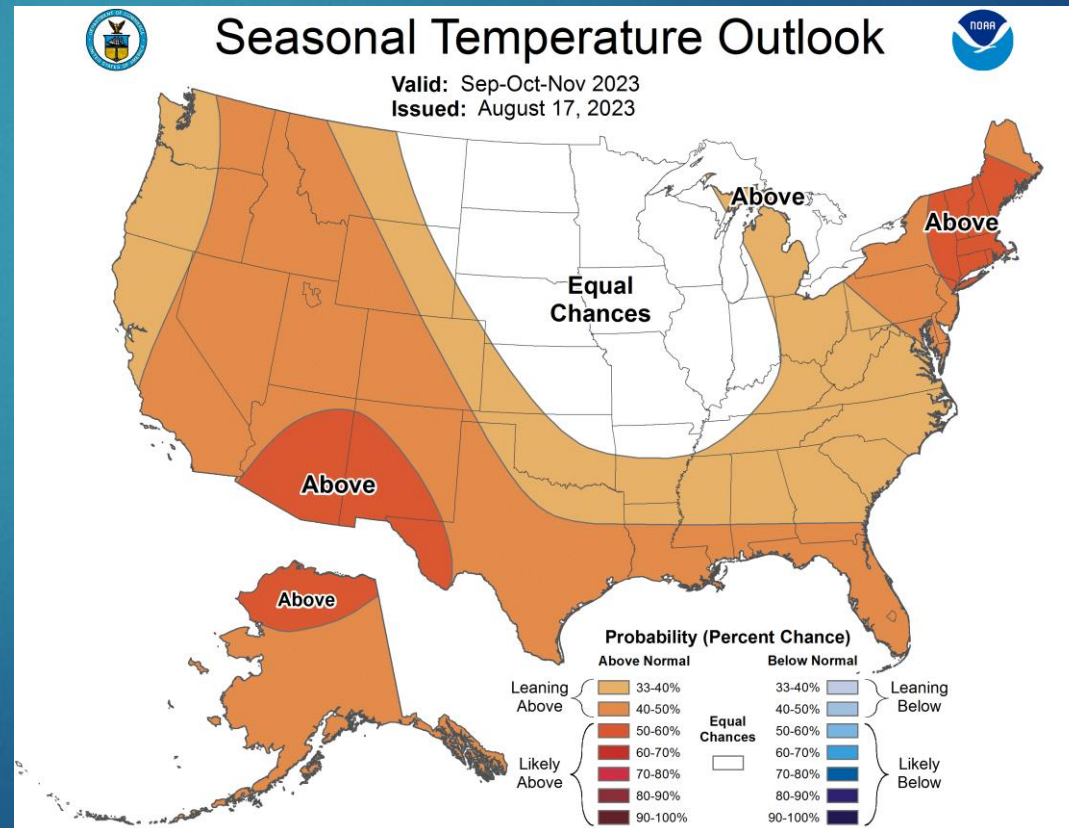
- ▶ We're going to go with a repeat of 2021-2022, toward the warm side into the December period, then cooler and snowy on the back end. Temperature will be about 0.5-1.0 sigma above normal – which is about 1.5-3 F, with more humid conditions.
- ▶ Temps ended up 5.1 F above normal or about 1.5 sigma above normal. We'll award a point.
- ▶ We're going to lean toward precipitation being around normal following last year. This is the closest analogue. We'll also forecast snow to be around 15 inches this winter.
- ▶ Precip ended up as -0.73 inches which is just under 0.5 sigma below normal, so we escape with 2 points. But, there was very little snow.

Our Forecast – Summer 2023

- ▶ We can also look to Summer 2008, 2011, and 2018 recently.
- ▶ Of these five summers two were dry and two wet, one near normal. Three were cooler than normal while two were warmer than normal.
- ▶ We think temperature will be near normal to maybe a bit above normal (~ 1.0 F), while precipitation will also be close to normal to above normal (up to +2.0 inches).
- ▶ **As of 31 August, we're running 77.5 F or + 1.5 F. Summer precipitation running 15.94 inches (+3.05 inches). Based on the current forecast summer will be a 3 point "win"!**

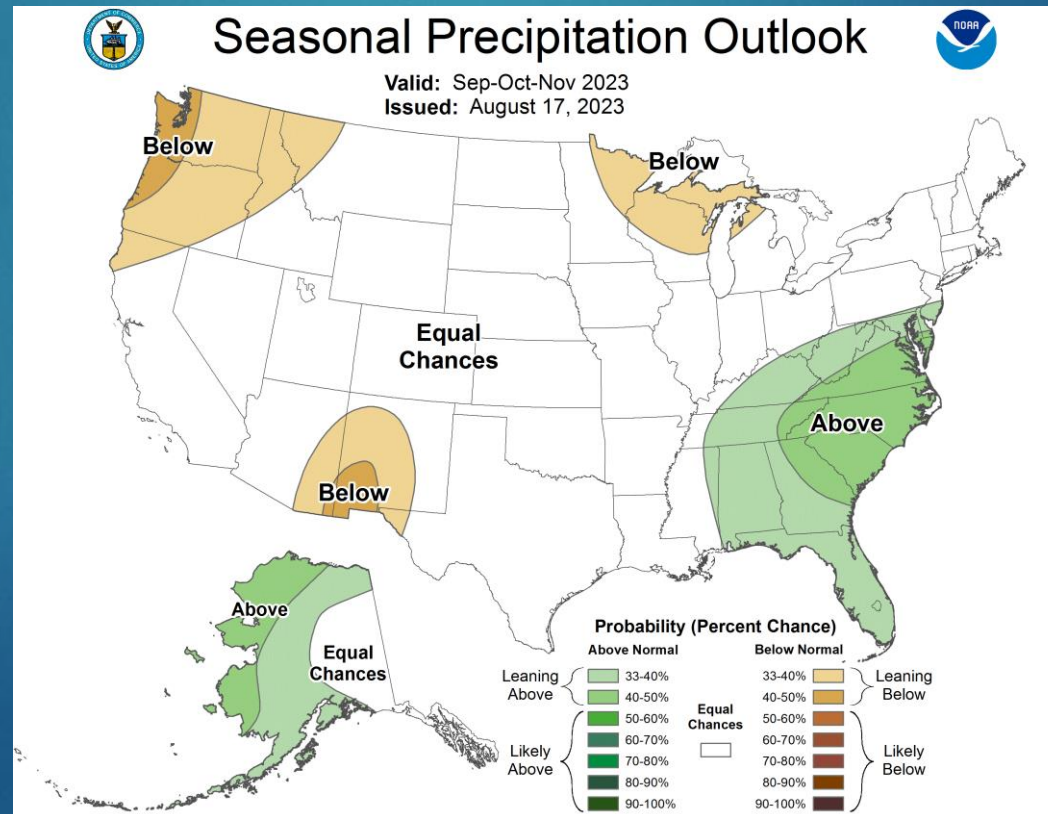
Fall 2023 – CPC outlooks

- ▶ Temperature – projections are for above average temperature across the western and northeastern USA (we're well on the way)!



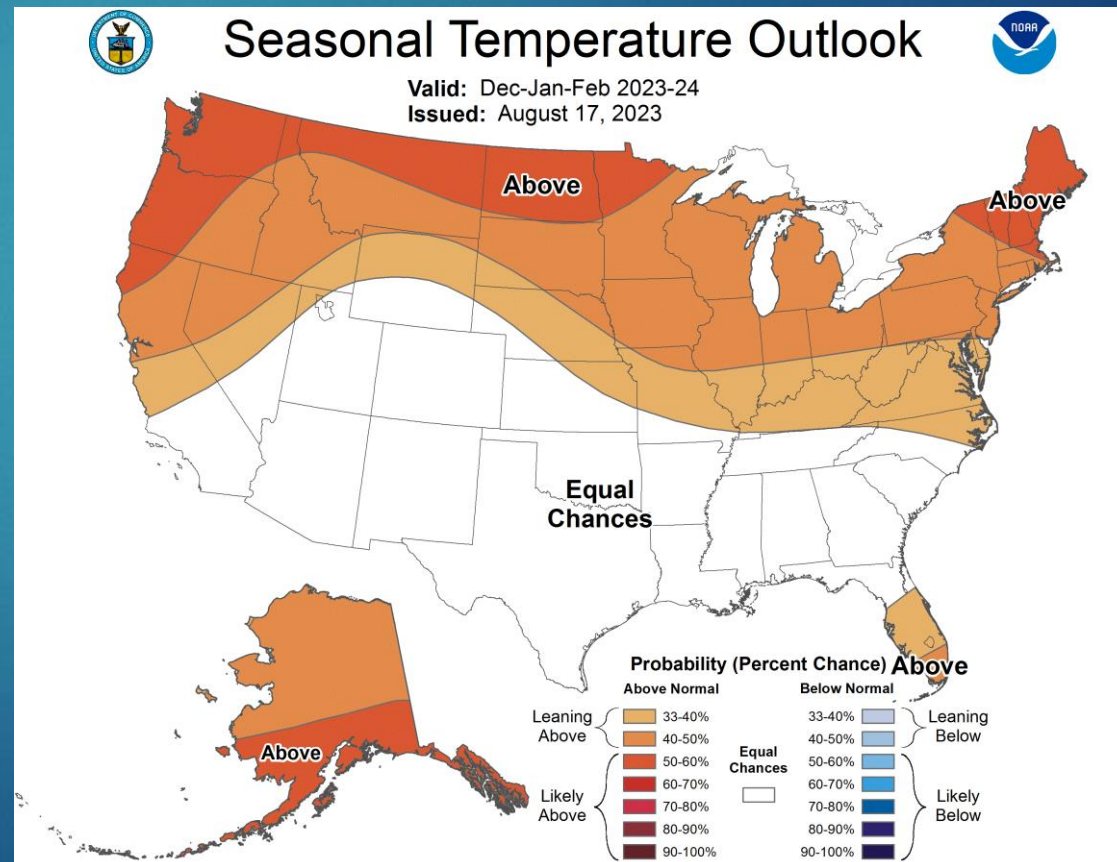
Fall 2023 – CPC Outlooks

- Precipitation – look for drought to continue improvement? (so far so good...)



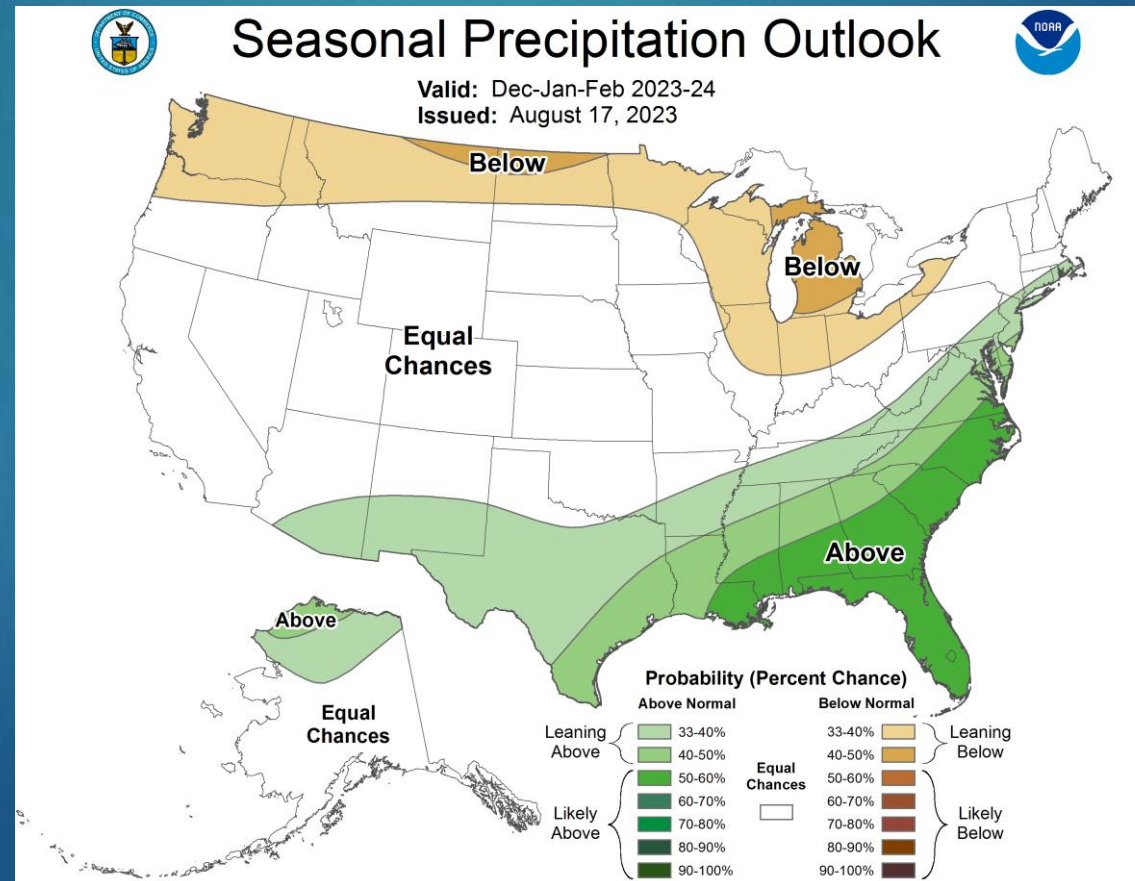
CPC Winter Outlook – 2023 - 2024

► Temperature – “Classic” El Niño.



CPC Winter Outlook 2023 - 2024

- Precipitation – again consistent with El Niño?



Winter 2023 - 2024 Outlook

- ▶ CPC forecast is for a close to normal conditions for the fall, but “flipping to warm for the winter. Very typical of the muted annual cycle of the classic El Nino. Moisture, we’re looking at drought improvement and depending on the width of the storm track, southern and central MO could be wet. Also, recent El Ninos tend to give us an early snow and a late snow and not much between.
- ▶ La Nina conditions were in place this time last year.

Our Forecast – Winter 2023 - 2024

- ▶ We're going to go with a slightly warmer winter than normal. We're looking at the recent "classic" El Ninos of 1997, 2014, 2015, and the El Nino of 2019. Temperature will be about 0.5-1.0 sigma above normal – which is about 1.5-3 F, with more humid conditions. Cool falls before and a warmer spring after are common.
- ▶ We're going to lean toward precipitation being above normal which tends to associate with ENSO classic. We'll also forecast snow to be around 10 – 15 inches this winter. Snow will come early and leave late.

Our Forecast – Winter 2022 - 2023

- ▶ Reasoning:
- ▶ We think that with similar conditions in place to last year, that is a good start. Also, La Nina conditions have persisted since Fall 2020. Three straight La Nina years is very unusual. The best models project us to stay in La Nina conditions. As we go into mid-August, there is some evidence those up and down temperature swings that dominated last winter wish to continue this year.

Community Collaborative Rain, Hail, and Snow Network

- ▶ Please consider joining CoCoRaHS. This data is used by agencies to decide crop loss information. It's worth it to you to join Missouri CoCoRaHS. (State Climatologist Patrick Guinan). MO has been a CoCoRaHS state since 2006.

- ▶ <http://cocorahs.org>

- ▶ Email: lupoa@missouri.edu



Missouri Climate Center

- ▶ Missouri Climate Center
- ▶ <http://climate.missouri.edu>

Climate Change

- **U.S Global Change Research Program:** <http://www.globalchange.gov/>
- **2018 National Climate Assessment:** <https://nca2018.globalchange.gov/>
- **2014 National Climate Assessment:** <http://nca2014.globalchange.gov/>
- **National Oceanic and Atmospheric Administration (NOAA):**
<http://www.noaa.gov/climate>
- **NOAA Climate Portal:** <https://www.climate.gov>
- **NOAA U.S. Climate Resilience Toolkit:** <https://toolkit.climate.gov>
- **Midwestern Regional Climate Center's Climate Trends Tool:**
http://mrcc.isws.illinois.edu/mw_climate/climateTrends.jsp
- **USDA Midwest Regional Climate Hub:** <https://www.climatehubs.oce.usda.gov/hubs/midwest>
- **National Centers for Environmental Information State Climate Summaries:** <https://statesummaries.ncics.org>
- **NASA Global Climate Change:** <http://climate.nasa.gov/>
- **US EPA Climate Change:** https://19january2017snapshot.epa.gov/climate-impacts/climate-change-impacts-state_.html
- **Real Climate:** <http://www.realclimate.org/>
- **Climate Science Centers:** <http://www.doi.gov/csc/index.cfm>