

Climate Variability, Climate Change in MO, and an Early Weather Outlook – Winter 2024- 2025

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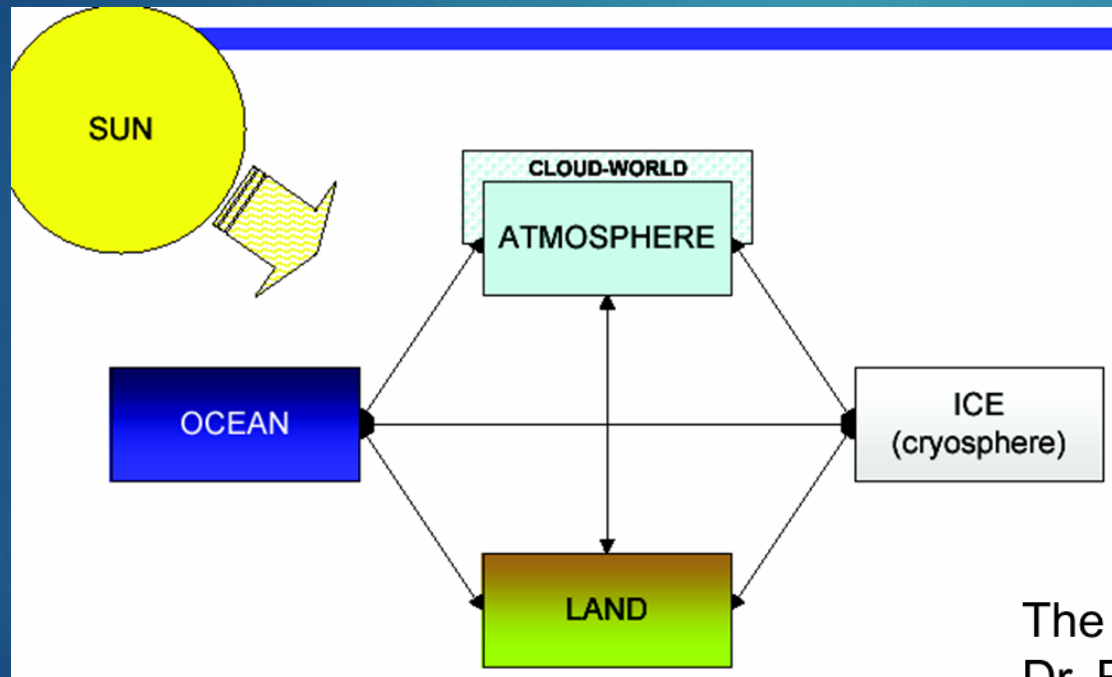
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Definitions

- ▶ **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

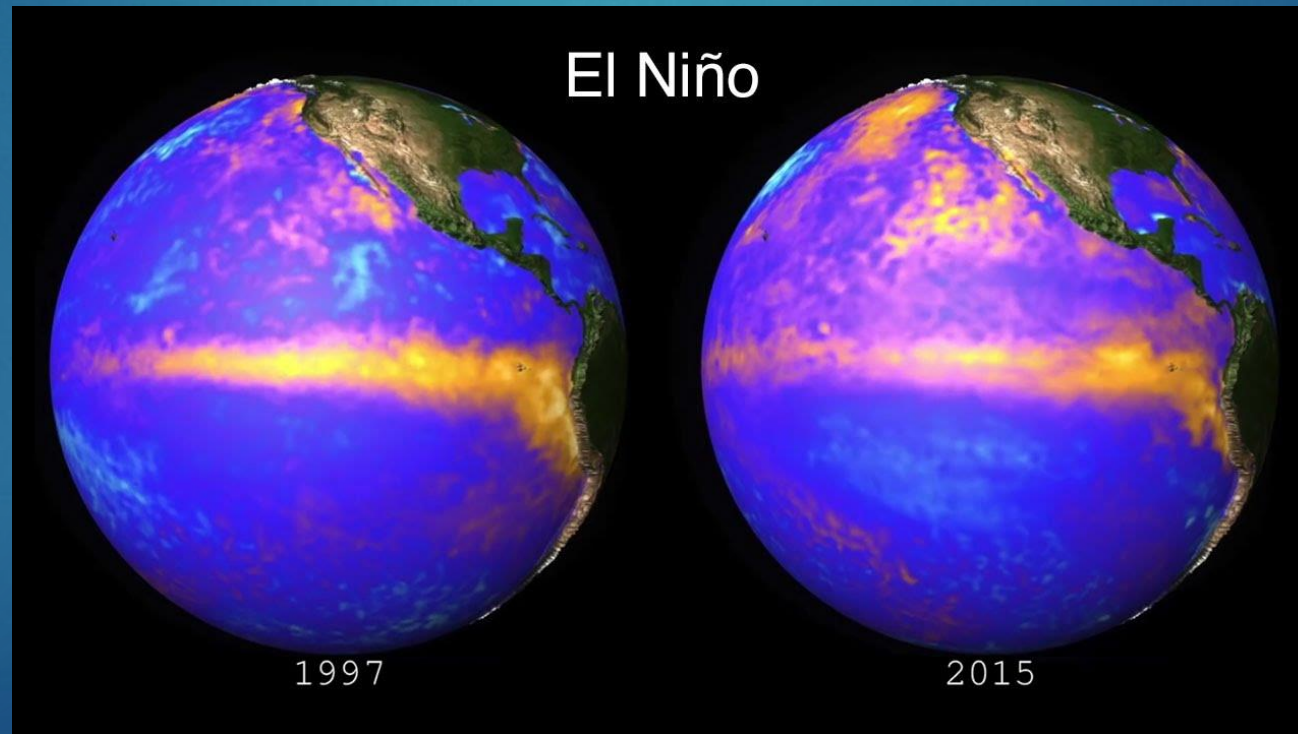
- ▶ The other parts of the climate system are:
 - Cryosphere (Glaciers, Antarctica)
 - Oceans (and freshwater too)
 - Lithosphere (dirt, continents)
 - Biosphere (life → Plants and Animals)

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

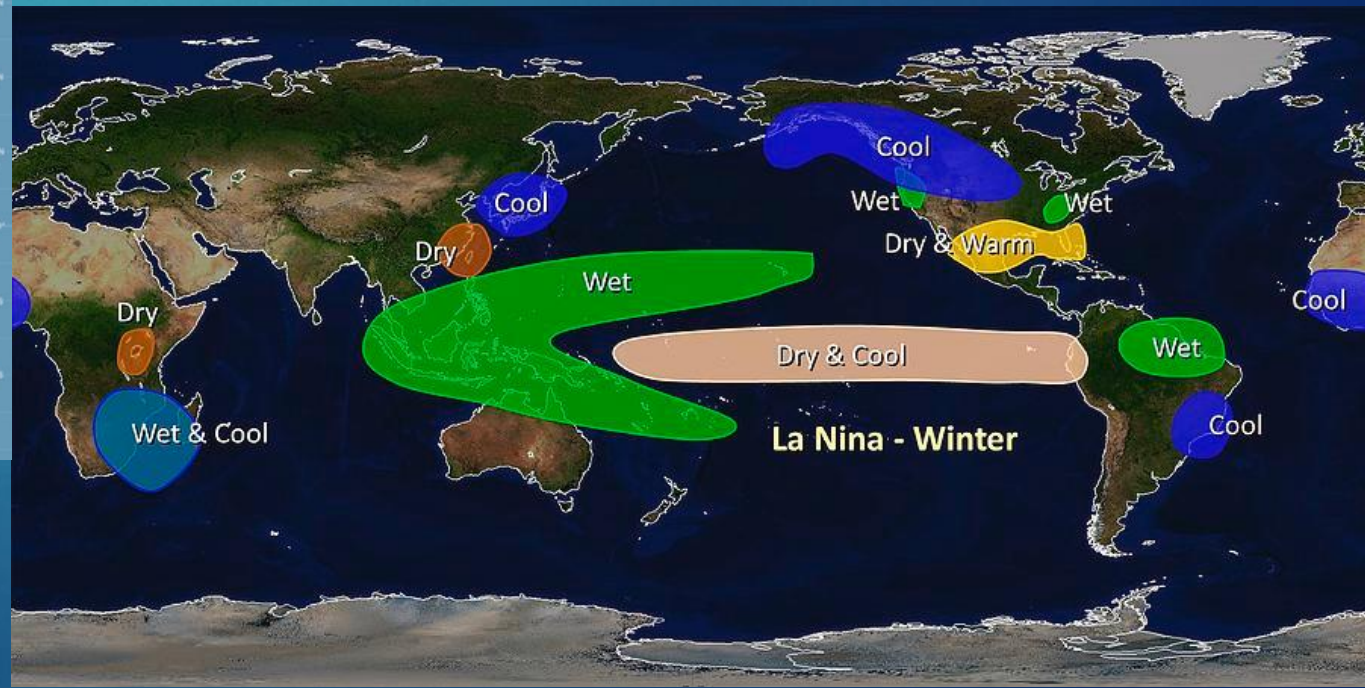
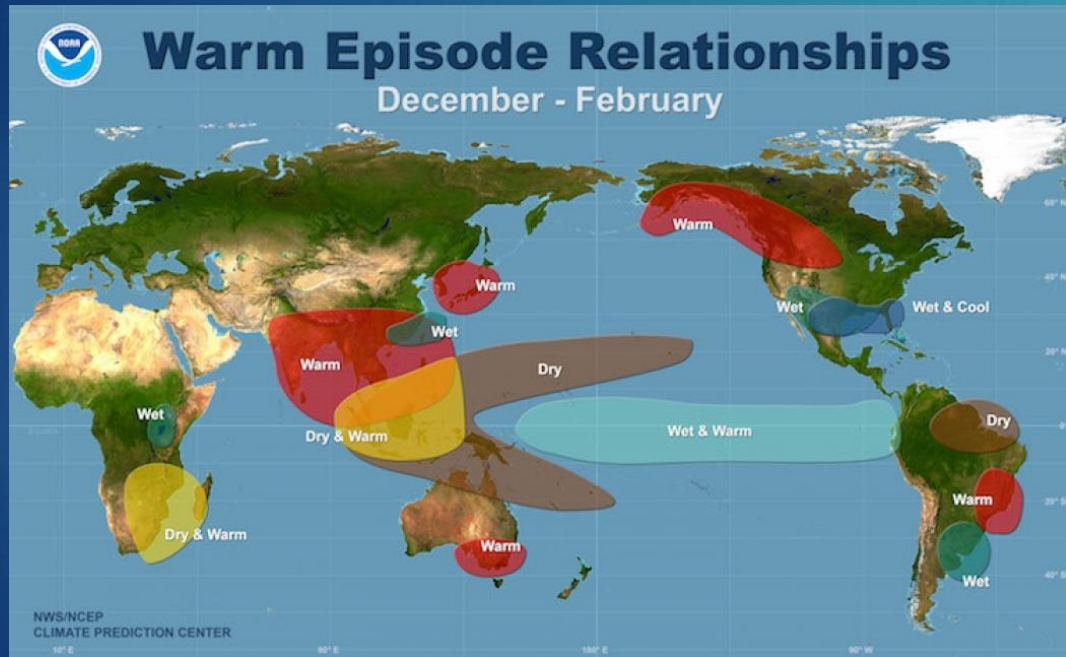
El Niño and Southern Oscillation (ENSO)

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



ENSO Impacts

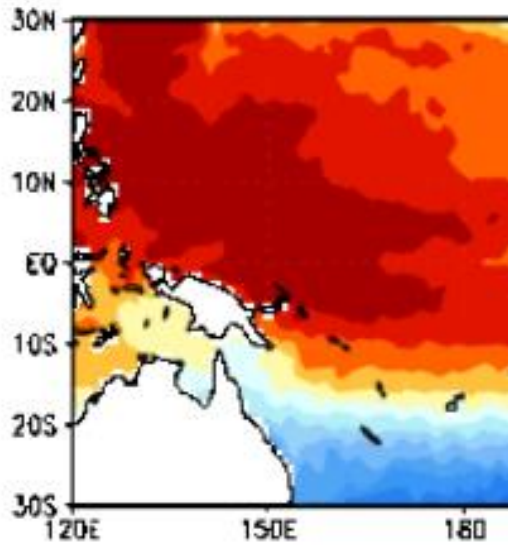
- Influences weather worldwide



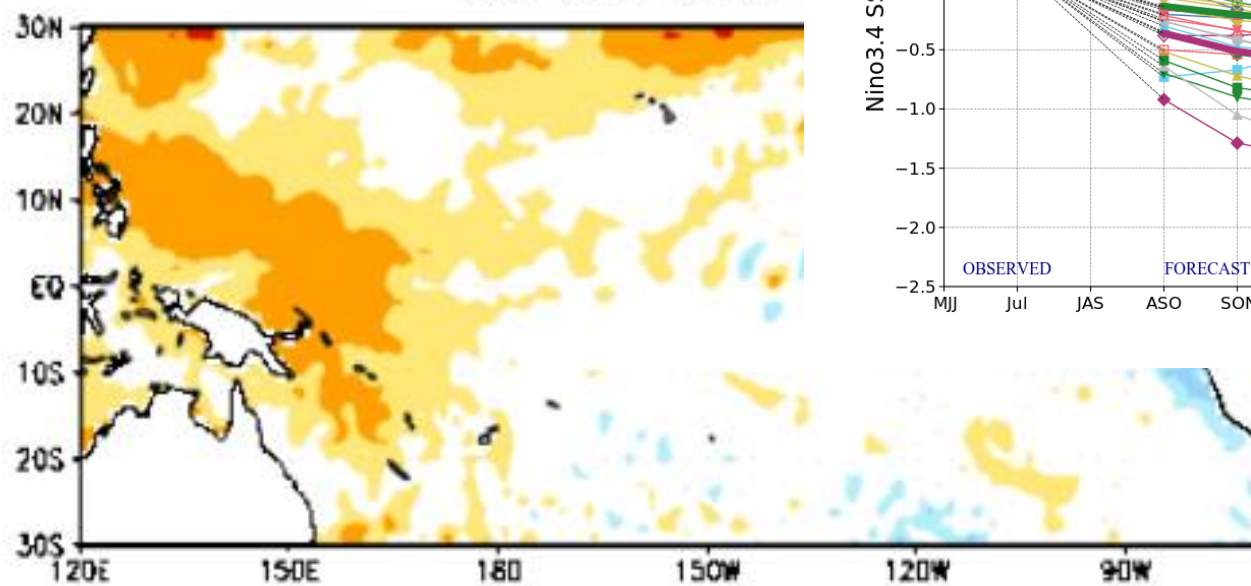
ENSO – Current State – Where are we going?

► August 2024 – Flip-Flop to La Niña?

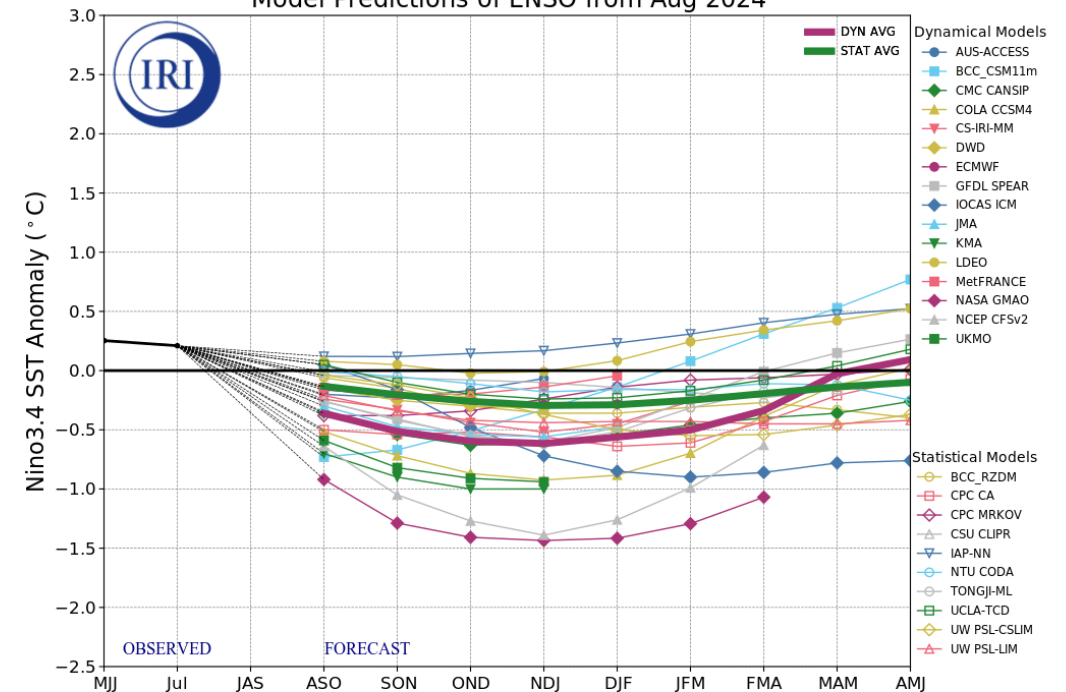
Week centered on 21 AUG 2024
SST (°C)



Week centered on 21
SST Anomalies



Model Predictions of ENSO from Aug 2024

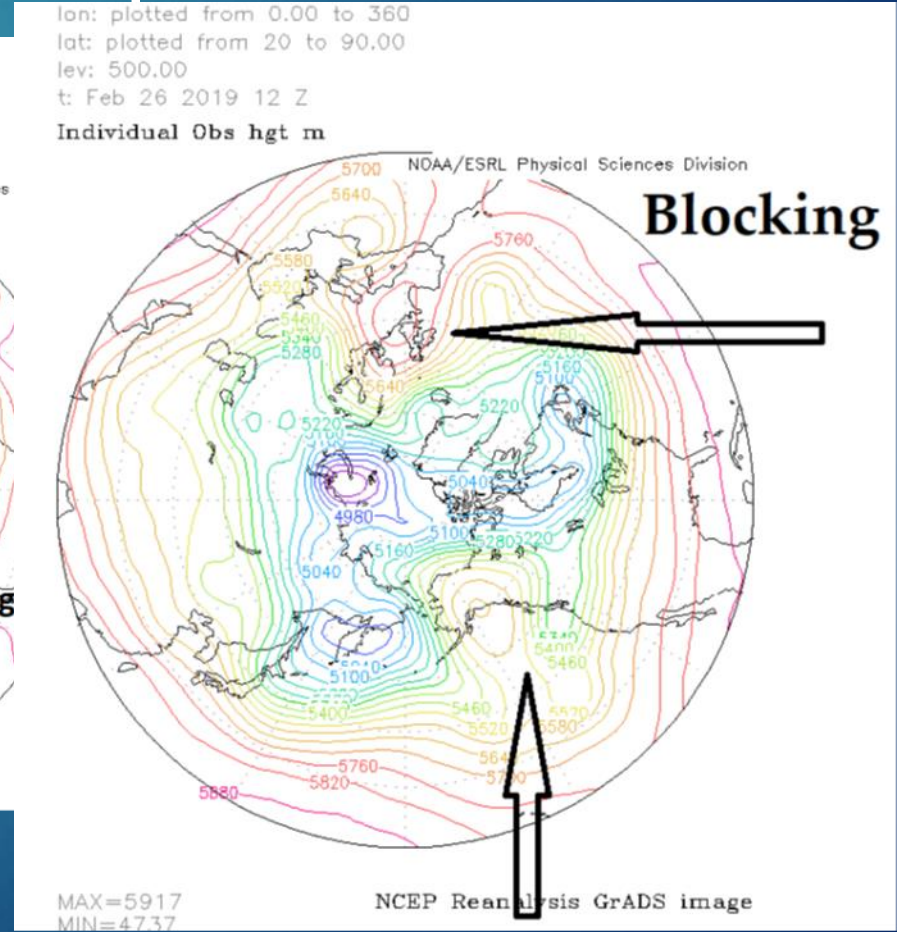
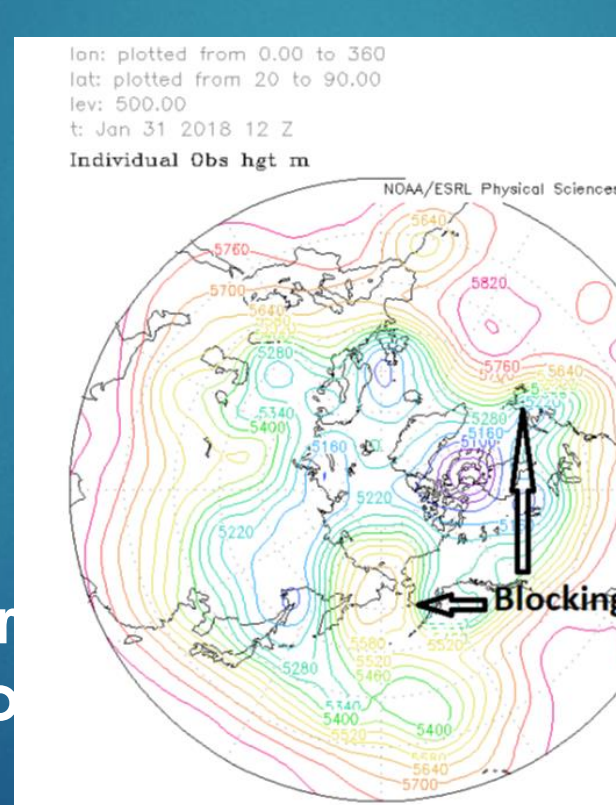


Atmospheric Blocking

- ▶ Atmospheric jet stream behavior is complicated

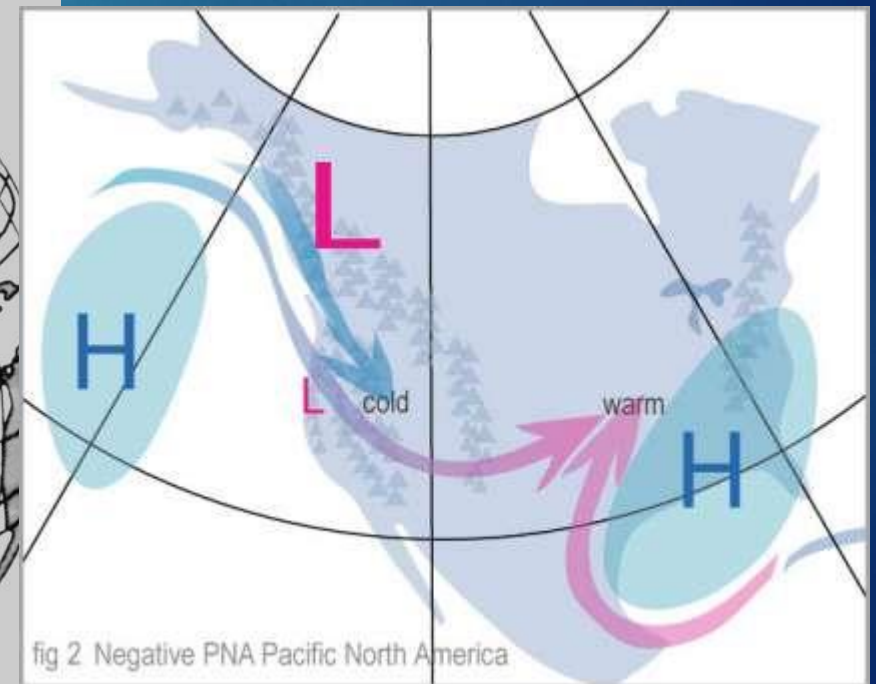
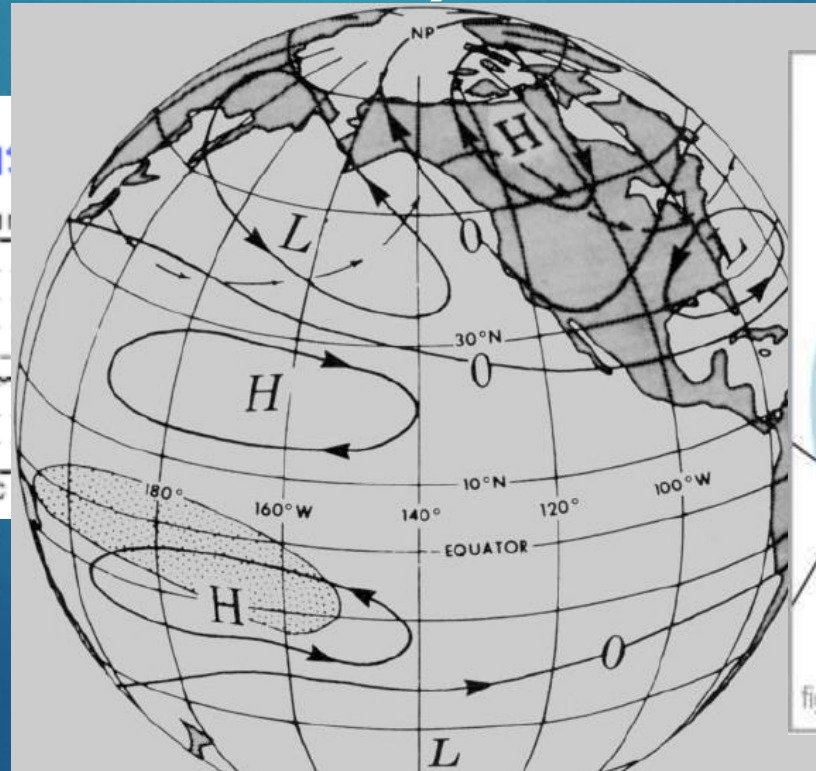
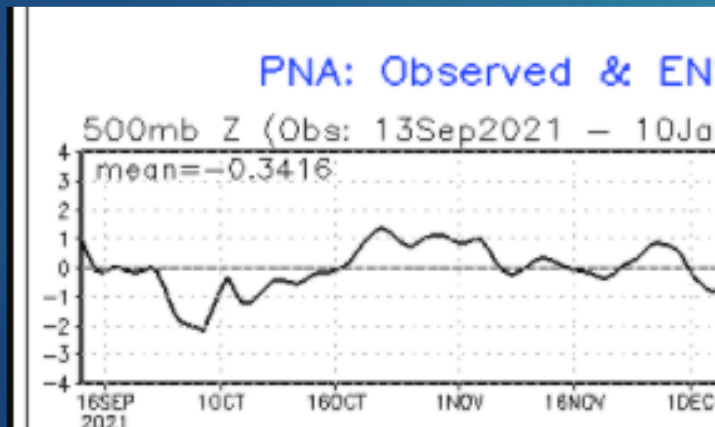


- ▶ Blocking - generally associated with mid-latitude and



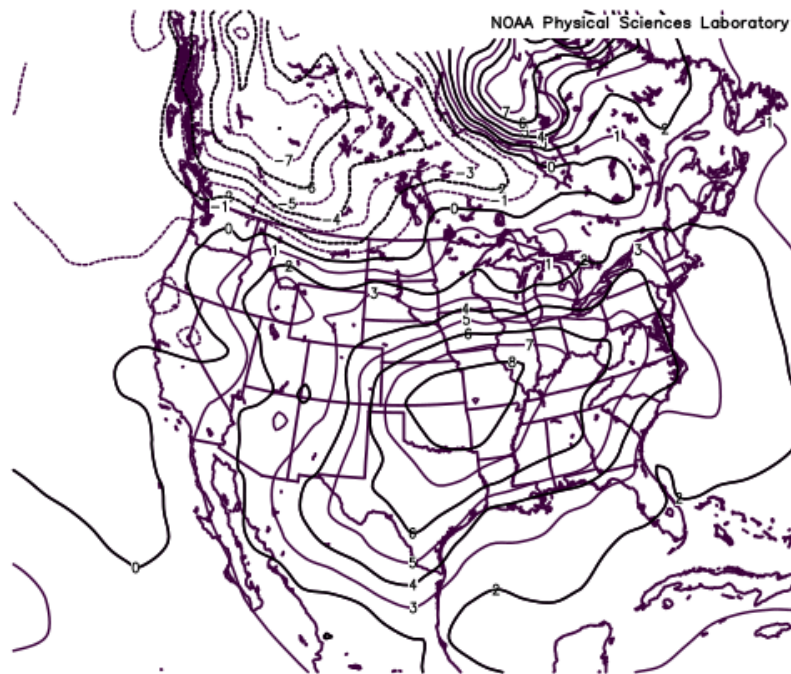
Teleconnections

- ▶ 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).

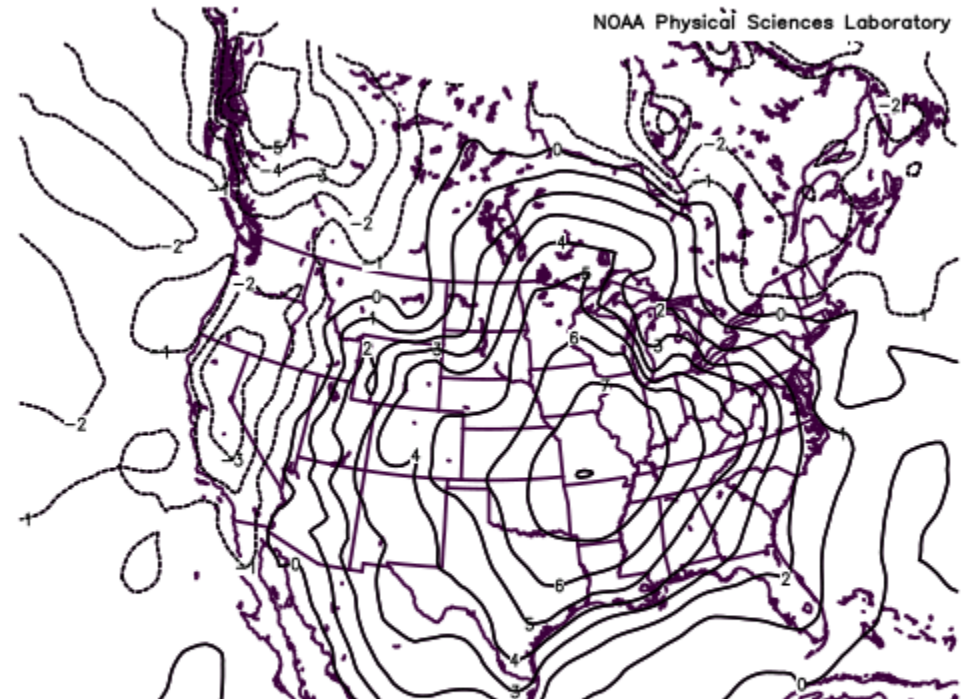


December 2021 versus 1889

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



2m Composite Anomaly (1981–2010 Climatology)
12/1/21 to 12/31/21



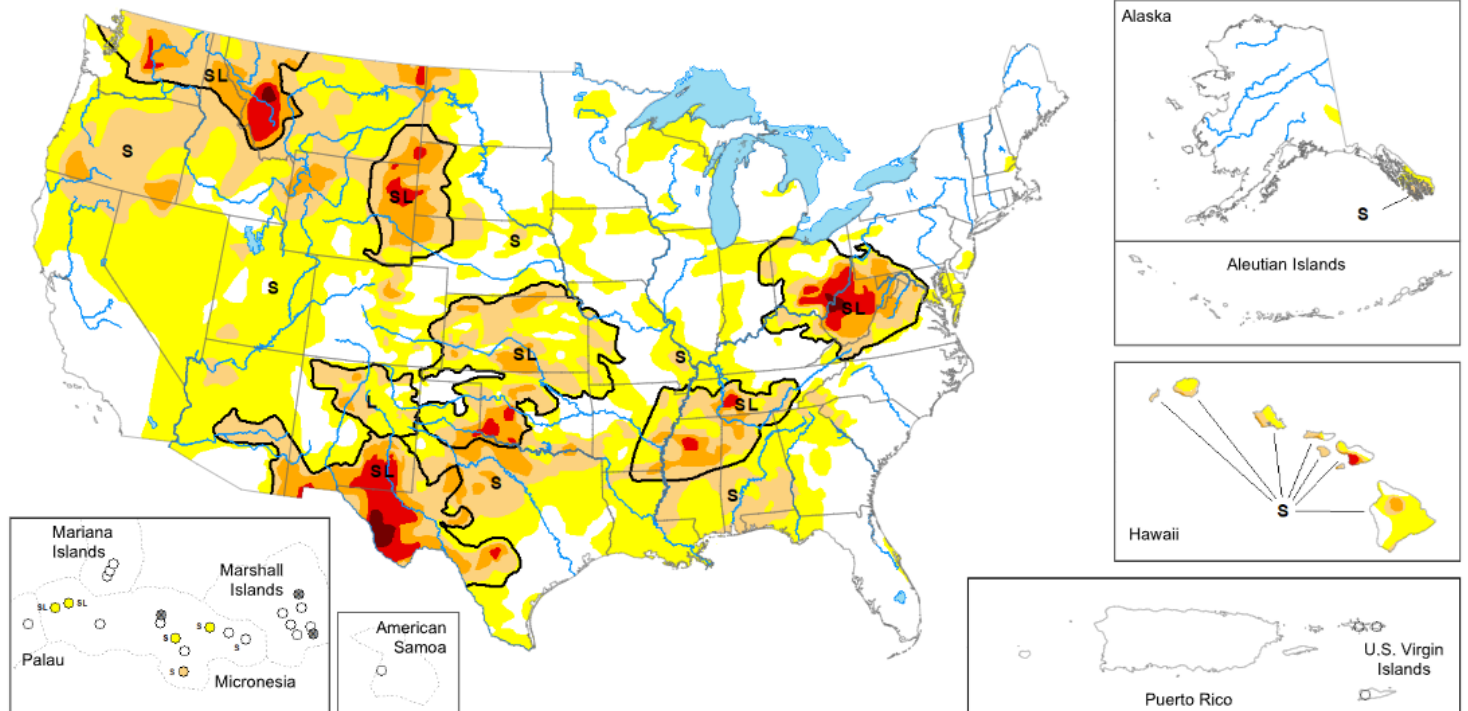
National Drought Monitor

- ▶ Current Drought Conditions – better than last year – worse than the start of August

Map released: August 29, 2024

Data valid: August 27, 2024

View grayscale version of the map



Our Forecast – Winter Recap 2023 - 2024

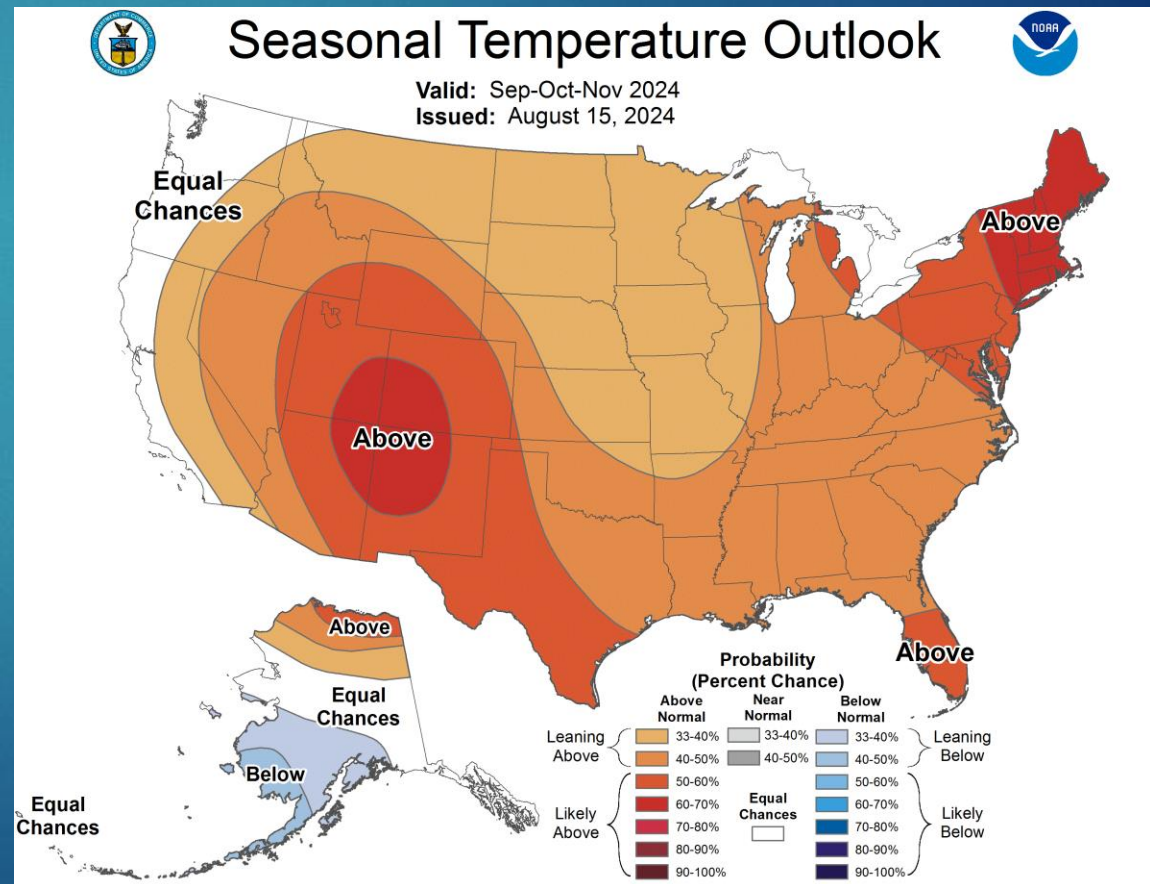
- ▶ We went with a slightly warmer winter than normal. We're looked at the recent "classic" El Ninos of 1997, 2014, 2015, and the El Nino of 2019. Temperature will be about 0.5-1.0 sigma above normal – which is about 1.5-3 F, with more humid conditions. Cool falls before and a warmer spring after are common.
- ▶ 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 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.
- ▶ Precip ended up as +0.11 inches which is near normal, so we escape with 2 points. There was about 10 inches of snow.

Our Forecast – Summer 2024 Recap

- ▶ Reasoning:
- ▶ We saw El Nino fade slowly. We called it, we moved into Neutral Conditions and didn't see a flip back to La Nina. This means the neutral years were good analogs. The best models project us to move out of El Nino conditions into cold neutral or La Nina.
- ▶ So we're going to say that summer will be in the range of normal (within one half sigma of normal or +/- 1.2 F and the summer will be a bit drier than normal (0 – 5 inches below normal)).
- ▶ Outcome: As of 8/29/2024 the temperatures were above normal on the strength of June by +0.5 F but we were at 18.99 inches of rain on the strength of a very wet early July. It's tempting to give ourselves 1/2 credit but we'll bite the bullet and say we missed the precip this year.

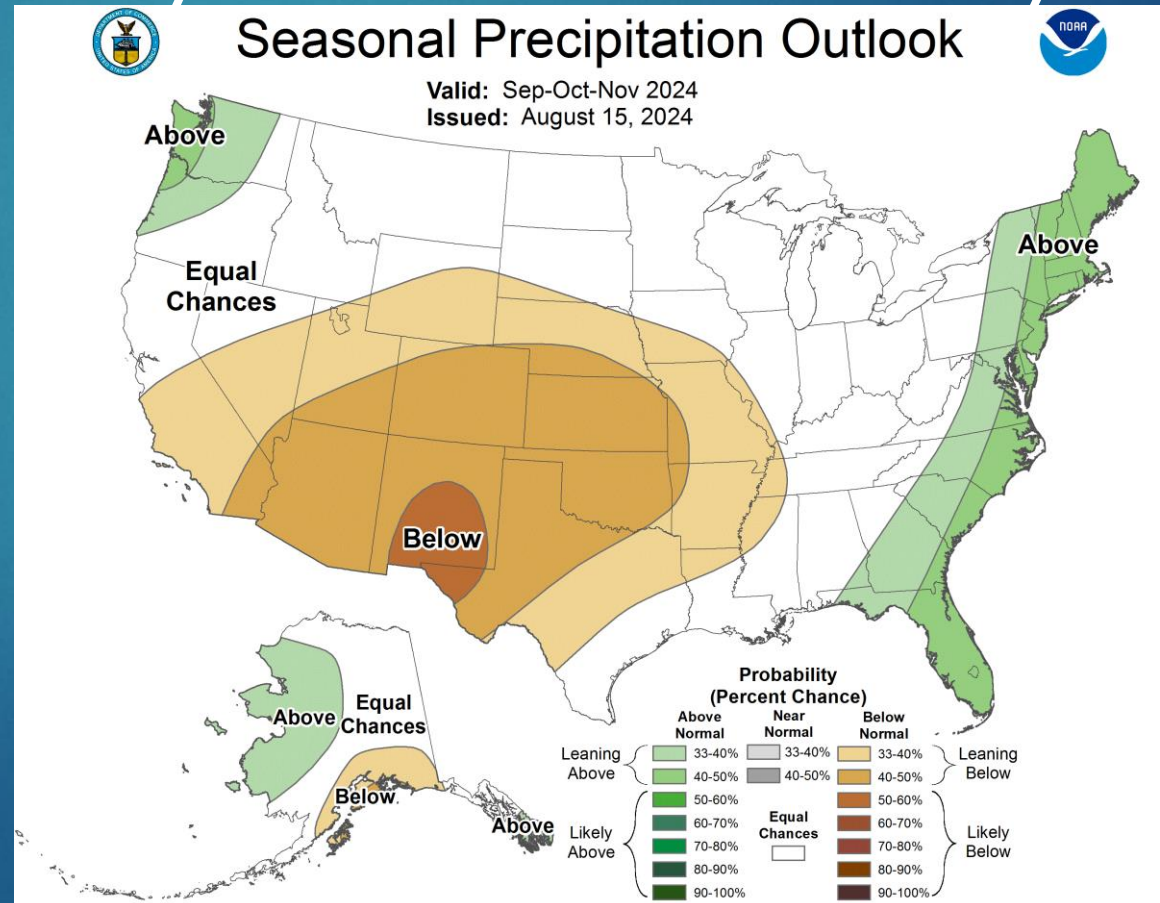
Fall 2024 – CPC outlooks

- ▶ Temperature – projections are for above average temperature across most of the USA with the least confidence in the Midwest.



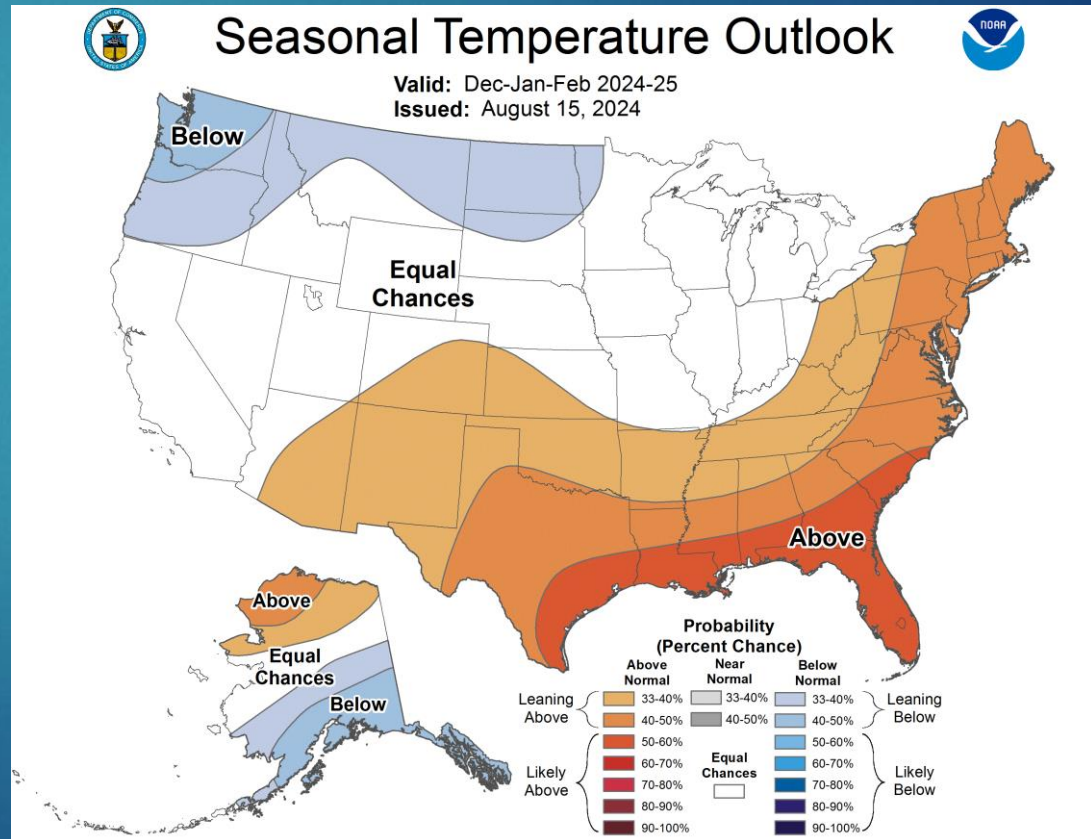
Fall 2024 – CPC Outlooks

- Precipitation – look for dry conditions to worsen mildly.



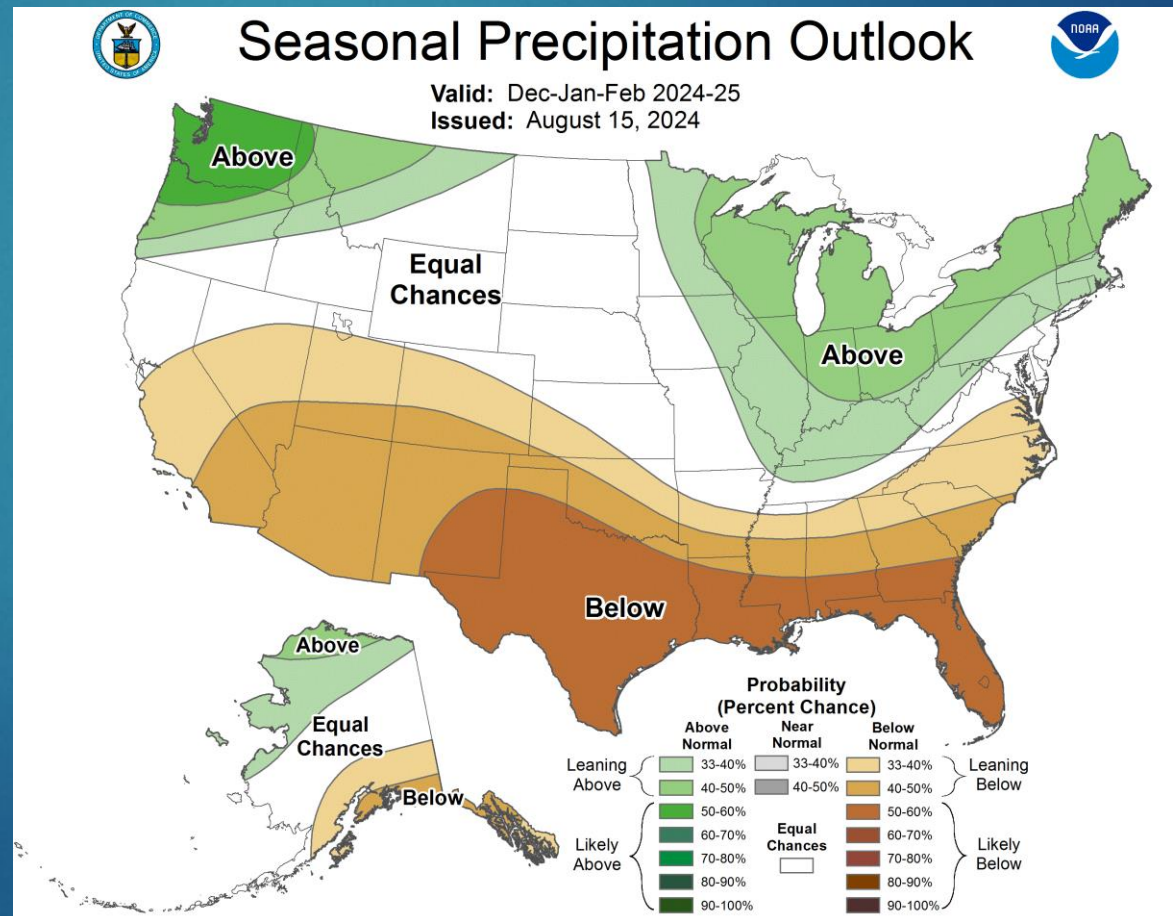
CPC Winter Outlook – 2024 - 2025

► Temperature – “Classic” La Niña.



CPC Winter Outlook 2024 - 2025

- Precipitation – again consistent with La Niña?



Winter 2024 - 2025 Outlook

- ▶ CPC forecast is for warm conditions for the fall, but “trending” toward cooler by winter, especially the later winter. Moisture, we’re looking at some improvement on dry conditions. The last few weeks have seen us “flip” from zonal to strong meridional flow with a high amplitude ridge / trough over North America. We’ve also seen some unusual summer blocking in our neighborhood. Also, recent La Ninas tend to give us more snow on the back half of winter.
- ▶ El Nino conditions were in place this time last year.

Our Forecast – Winter 2024 - 2025

- ▶ We're going to go with a cooler winter than normal. We're looking at the recent "classic" La Ninas of 2007, 2010, 2017, 2020, and 2021. Temperature will be within 0.5 sigma of normal which is -1.5 to +1.5F, I like the lower end of the range.
- ▶ We're going to lean toward precipitation being above normal which tends to associate with recent La Ninas. We'll also forecast snow to be around 15 – 20 inches this winter a little more than the last few years, but not horrible. We forecast a few moderate snowfall, probably not one big one.

Our Forecast – Winter 2024 - 2025

- ▶ Reasoning:
- ▶ La Nina is coming in slowly. The dynamic models think it emerges but is weak. The statistical models keep us in Neutral conditions. This after we were El Nino last year. I see fall starting warm and dry but trending toward a cooler second half of winter with a little more precipitation. Early 2021 and 2022 showed similar conditions. Remember Early 2021 was the Great Polar Vortex of February. I don't see this happening, but the last two years, the second half of winter has been warm. The last few weeks have seen the emergence of strongly meridional patterns. I think this continues. I see a winter with alternating warm and cool conditions as we'll be on the "node" of the waves. The wild card in all of this is blocking. We've seen some this summer. If blocking happens frequently in the east Pacific / West North America, those periods will be cooler.

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 Zach Leasor). 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>