Climate Variability, Climate Change in MO, and an Early Weather Outlook – Summer 2026

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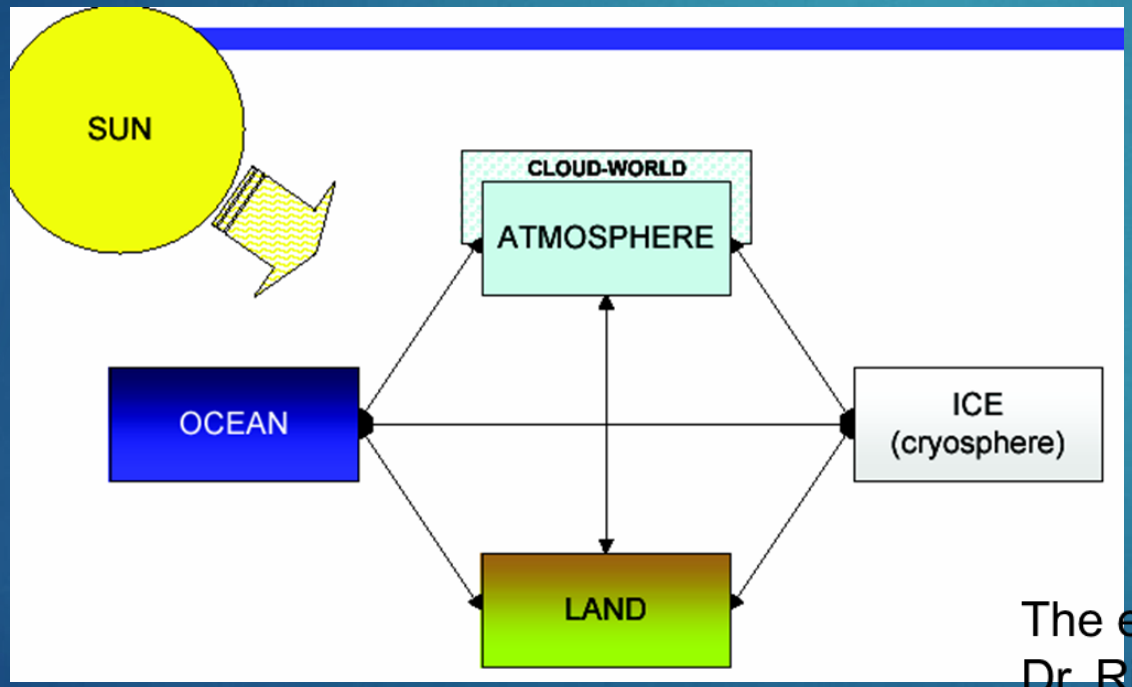
Definitions

- 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:

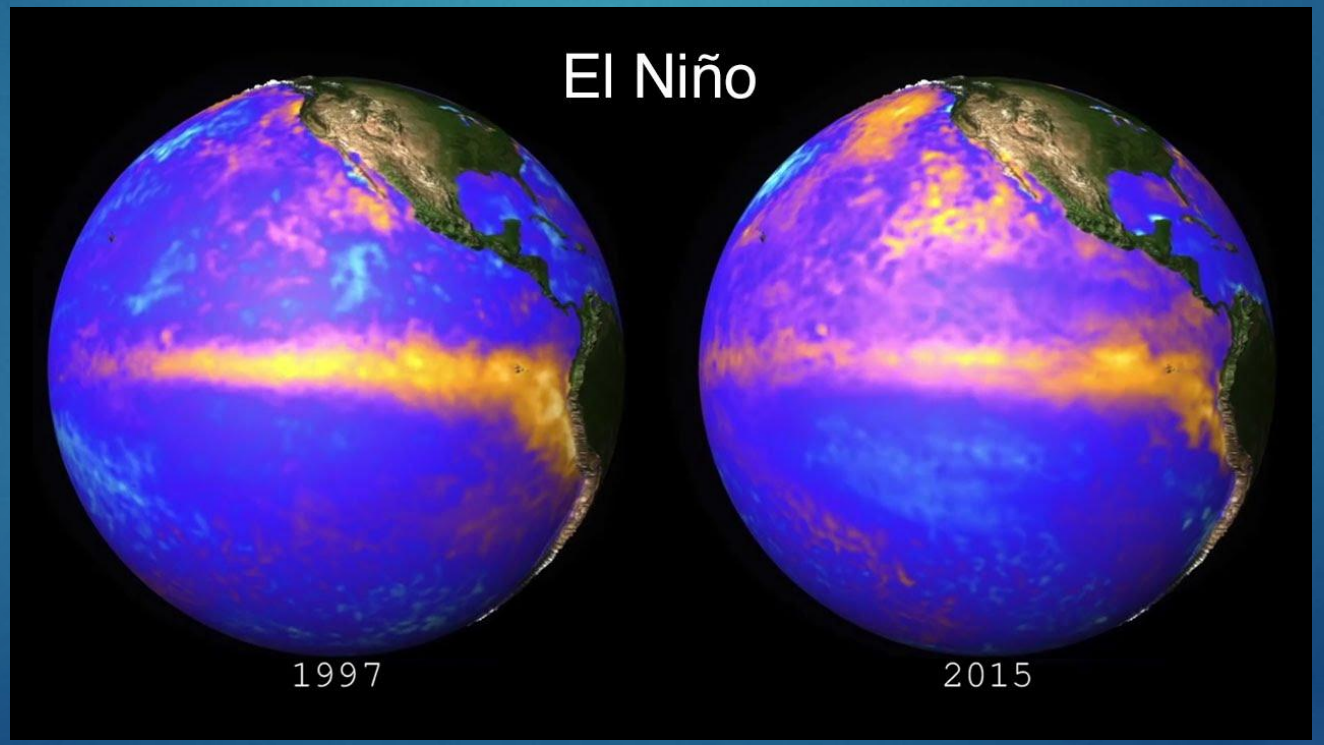
  - Cryosphere (Glaciers, Antarctica)
  - Oceans (and freshwater too)
  - Lithosphere (dirt, continents)
  - Biosphere (life → Plants and Animals)

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

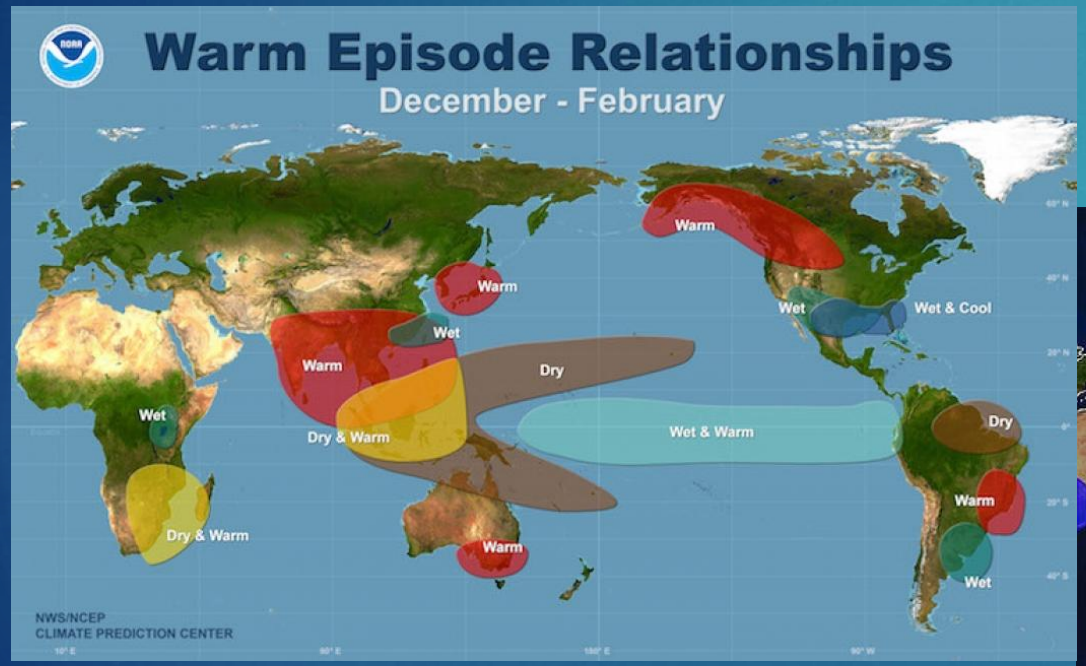
El Niño and Southern Oscillation (ENSO)

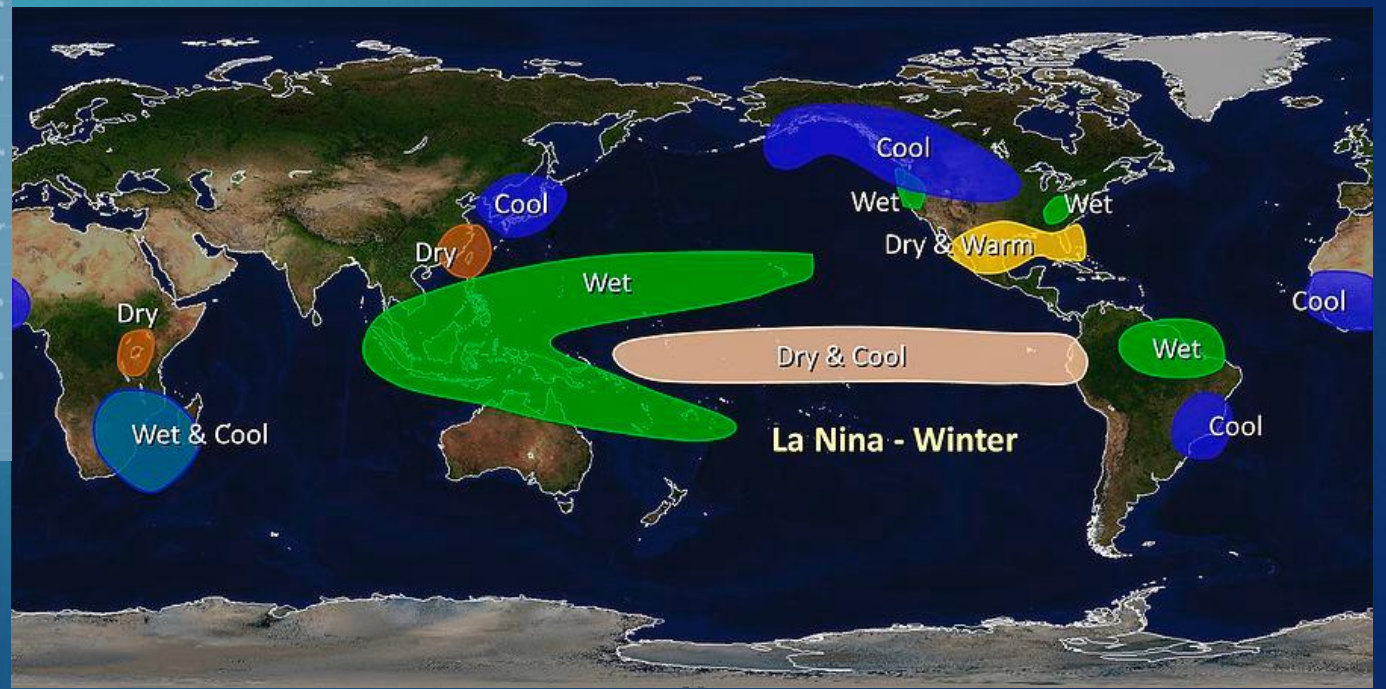
- is a two-to-seven year warming of water in the Eastern Tropical Pacific that impacts weather and climate world-wide.



ENSO Impacts

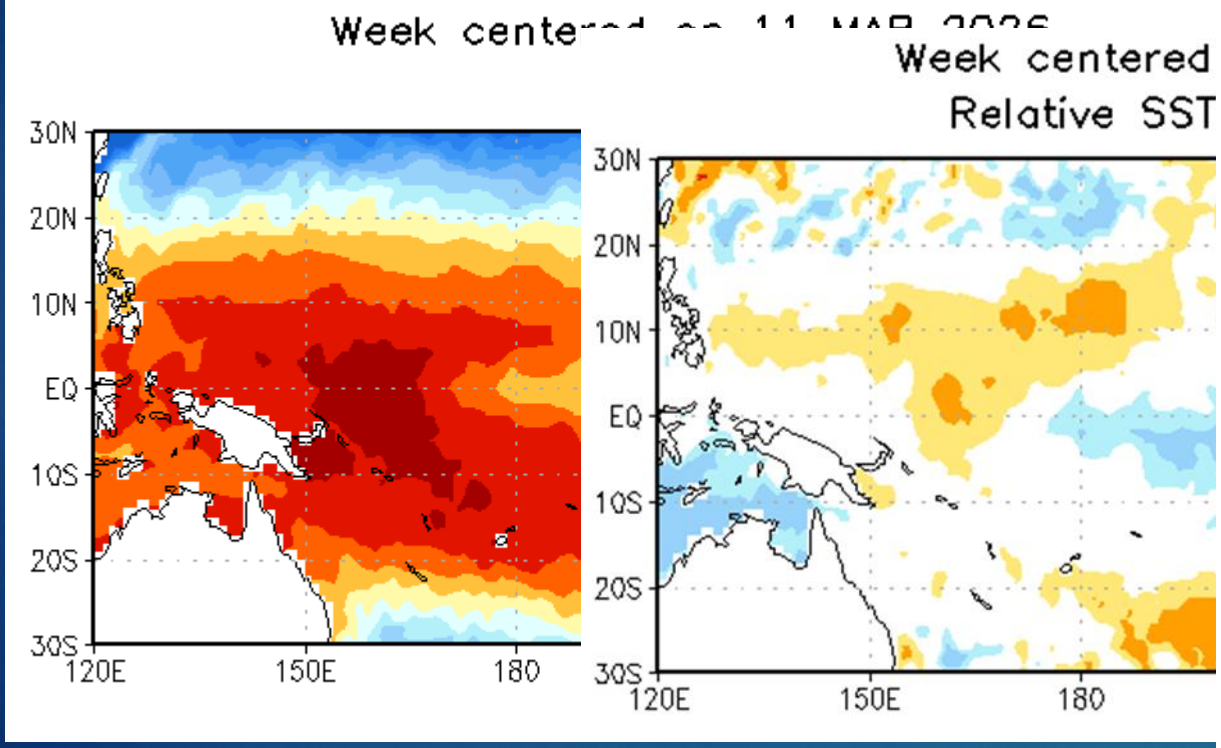
- Influences weather worldwide

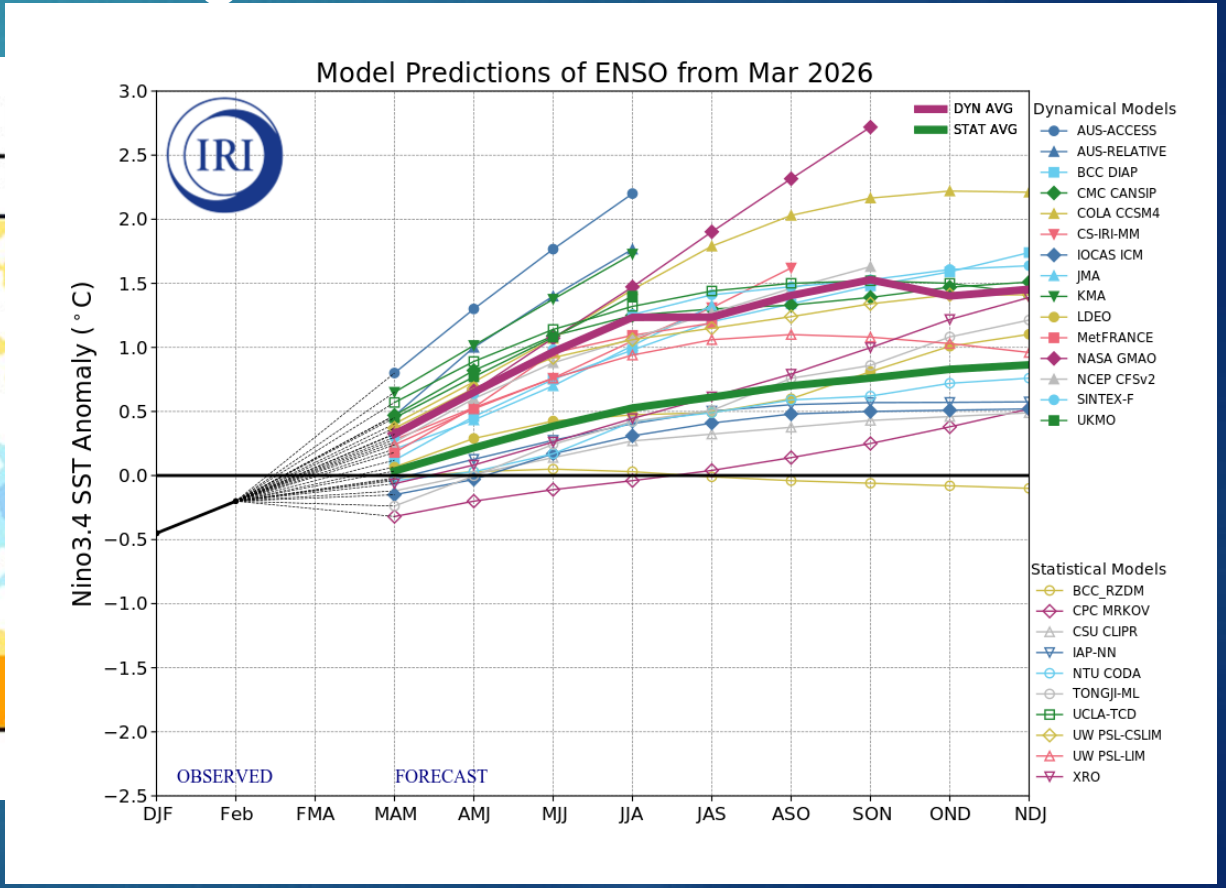




ENSO – Current State – Where are we going?

- March 2026 – El Niño – could be strong?

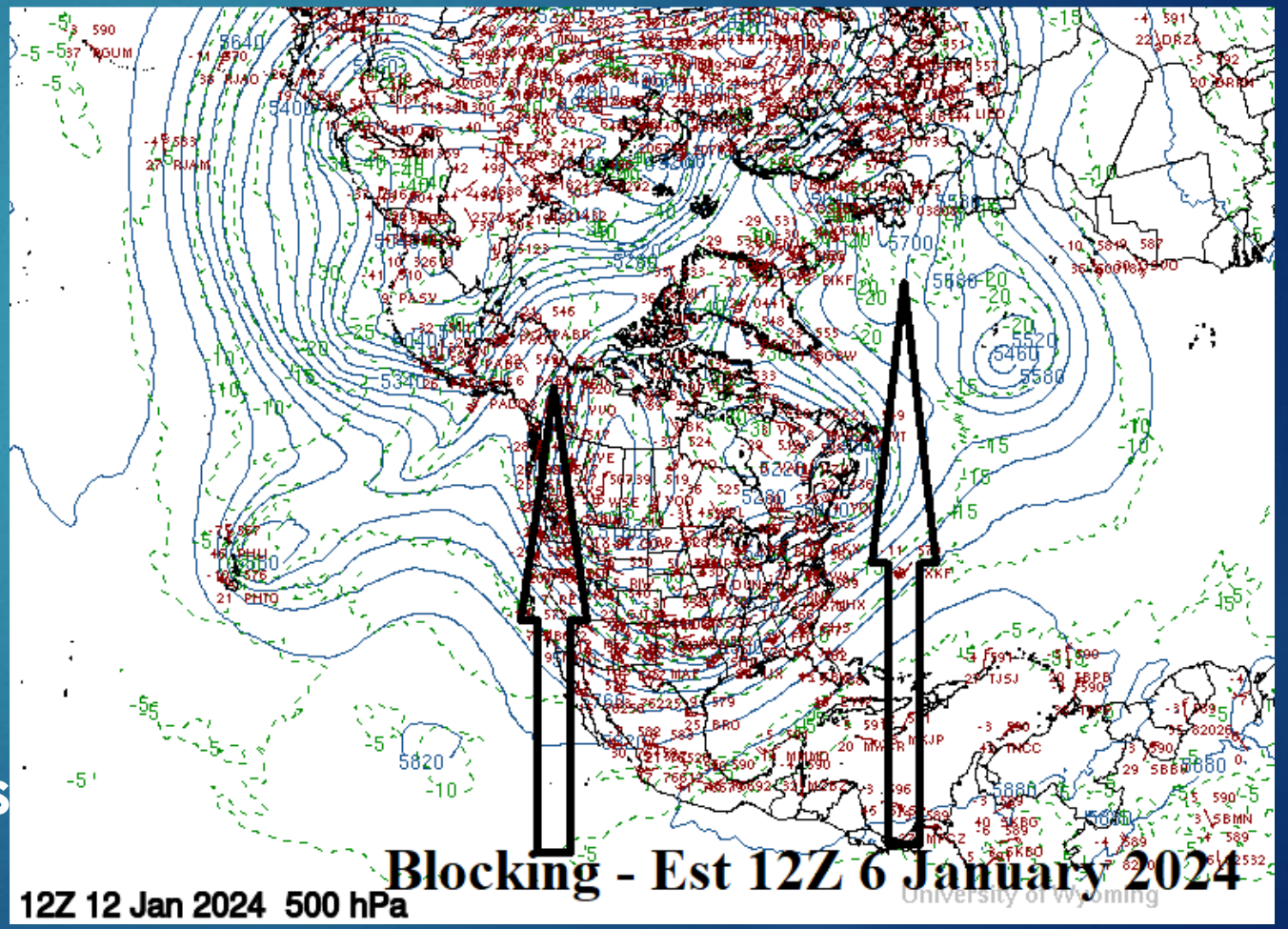




Atmospheric Blocking

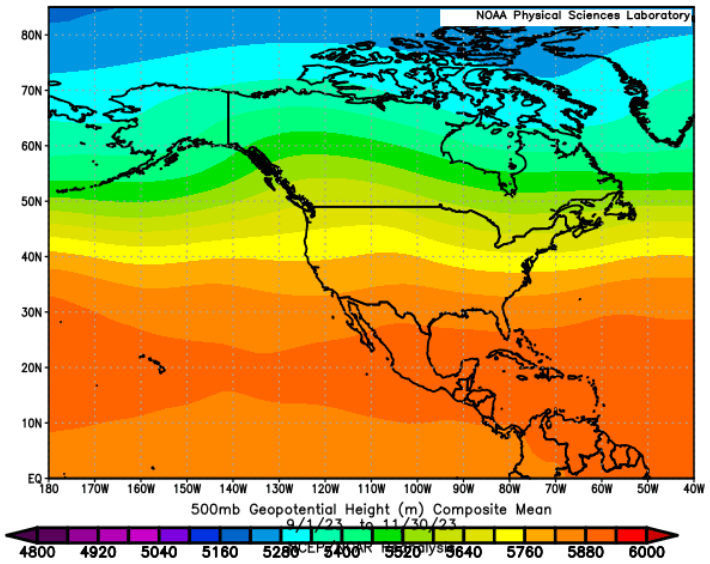
- Atmospheric jet stream

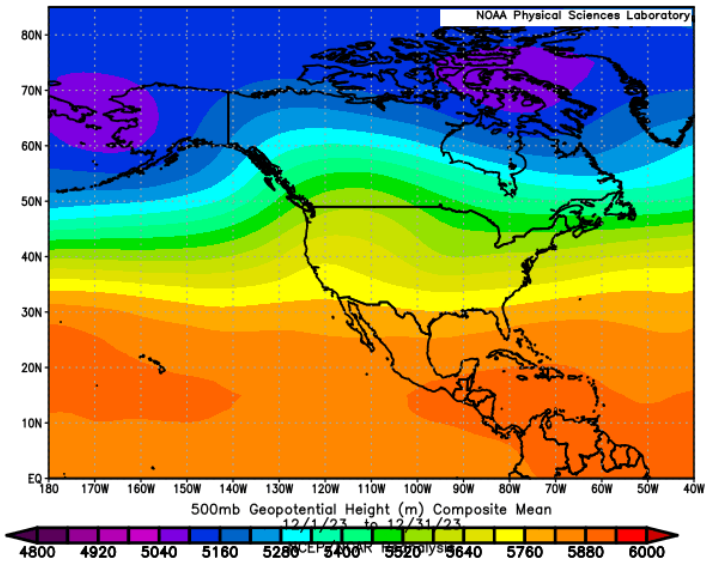
- Blocking - generically – mid-latitude anomalous

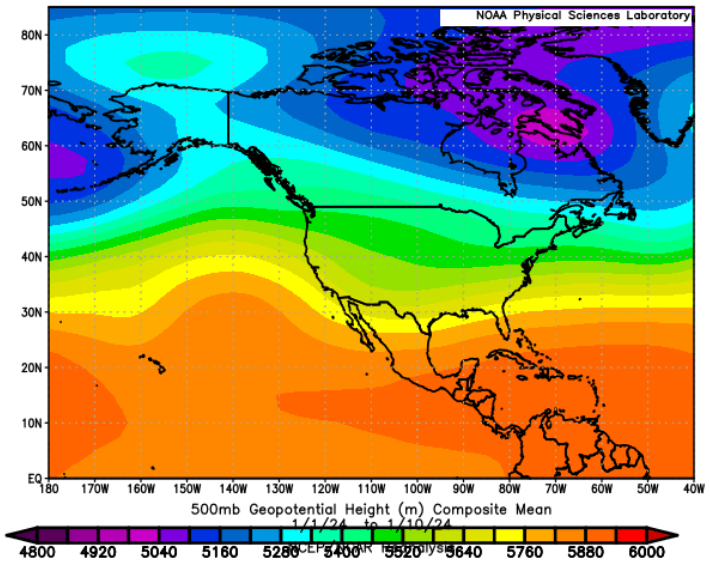


ATMOSPHERIC BLOCKING

- Fall 2023 versus Early Winter 2023 versus Early 2024
- +2.1 (+1.8) F +7.8 (+8.8) F - 4.6 (-5.1) F



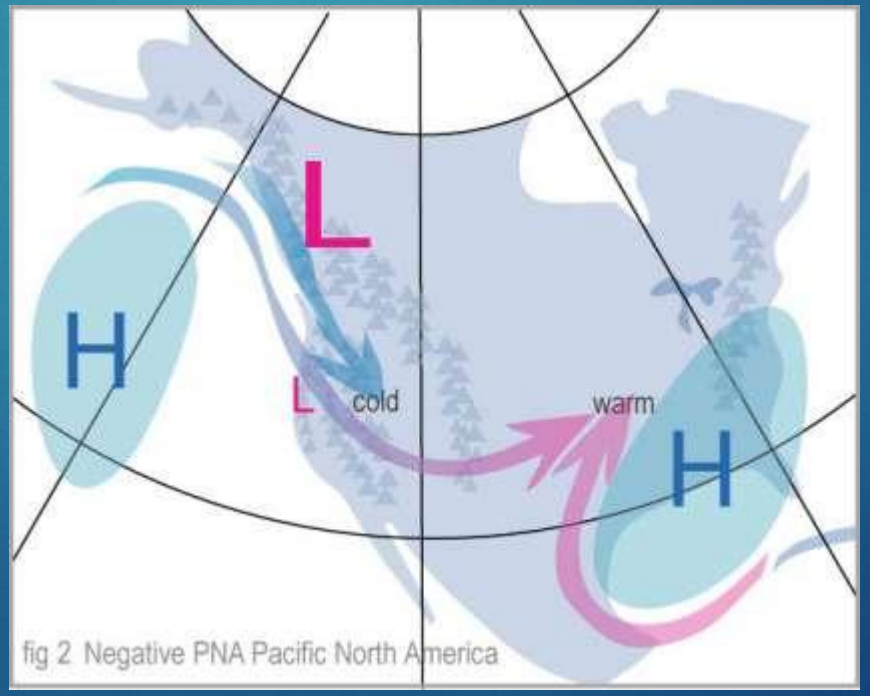


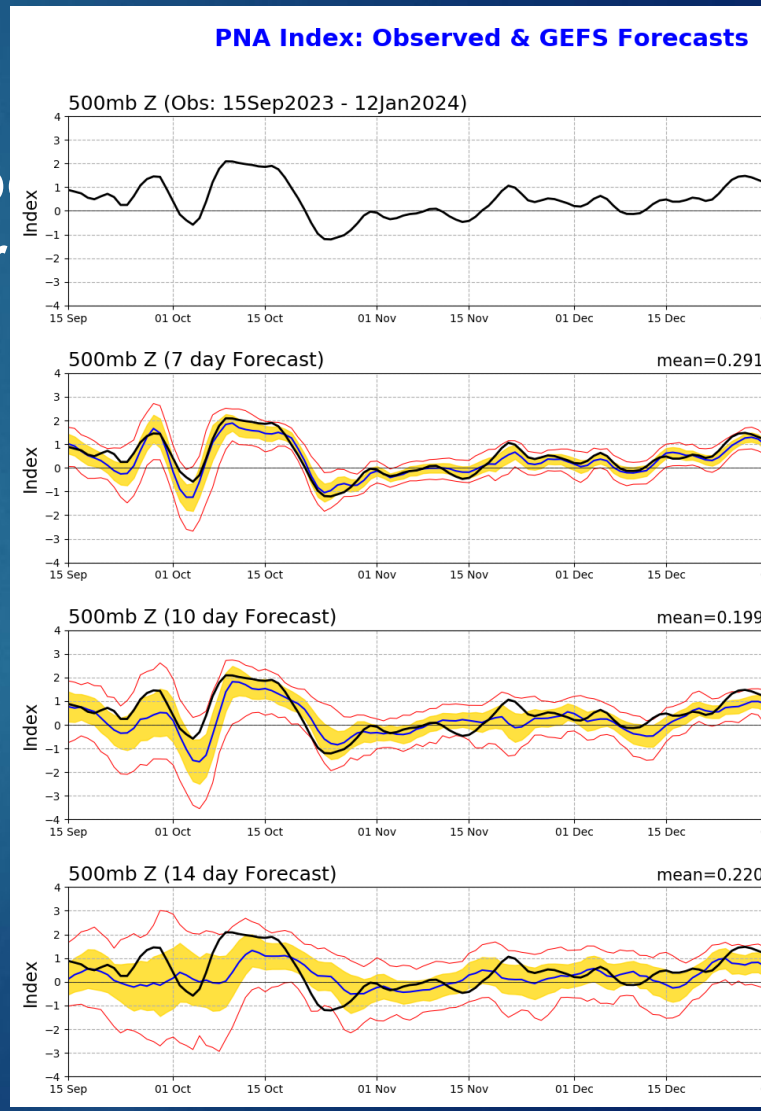


- Temperature versus the 30 year (130 year) average
- Very little blocking until Early 2024

Teleconnections

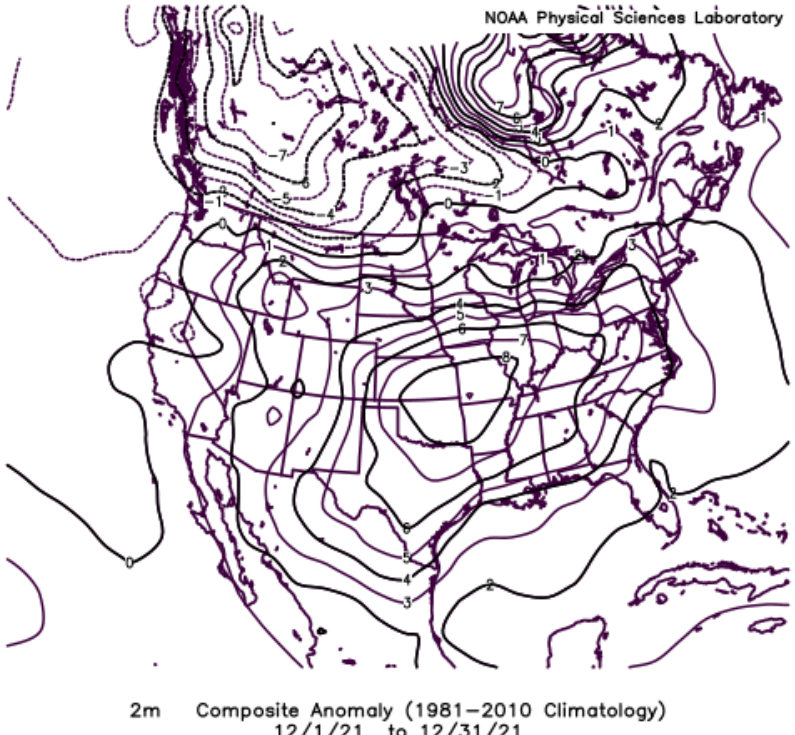
- Teleconnections – are typical jet stream wave p
  that impact certain large-scale areas of the wor
  – 10,000 km, one to two weeks).

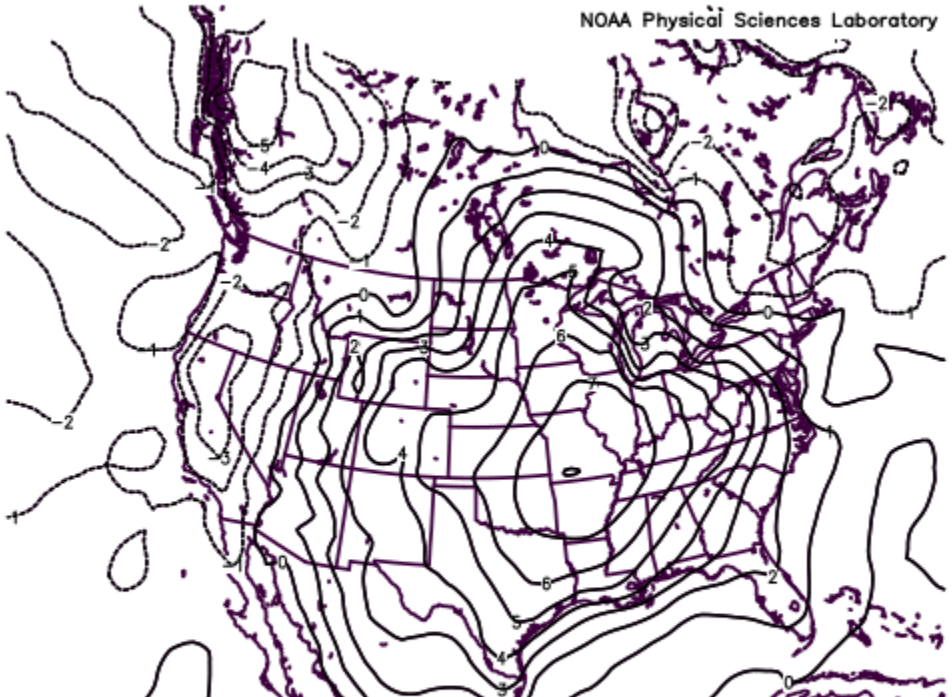




December 2021 versus 1889

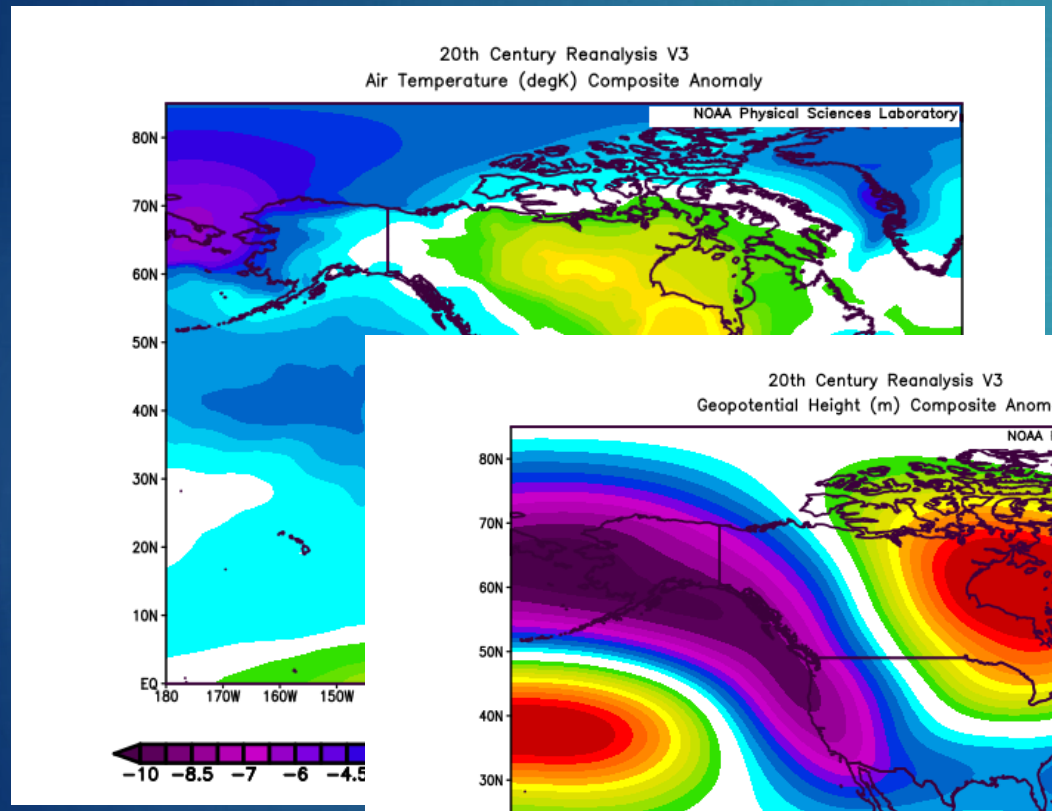
- December 2021 was anomalously warm – but we've seen it before.

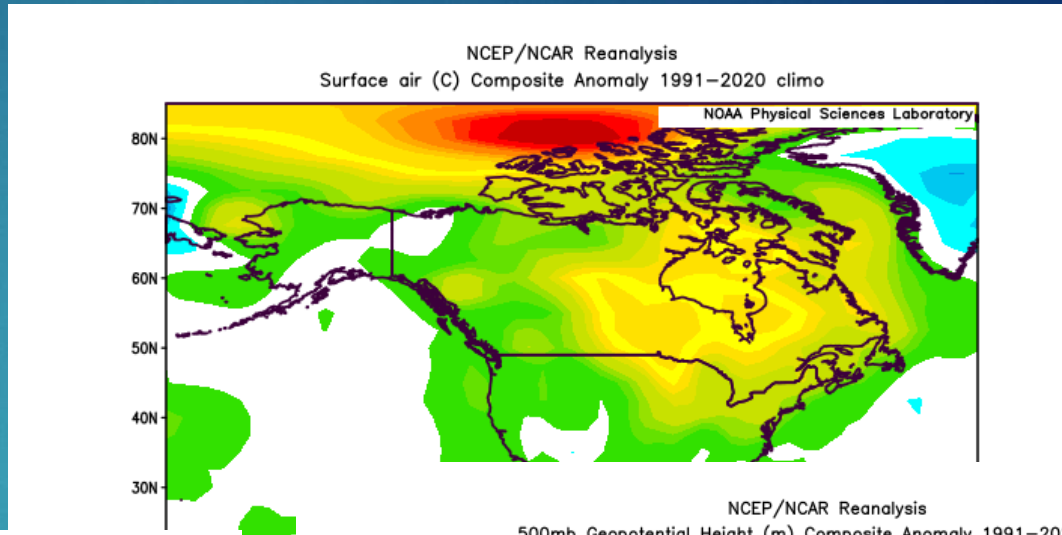


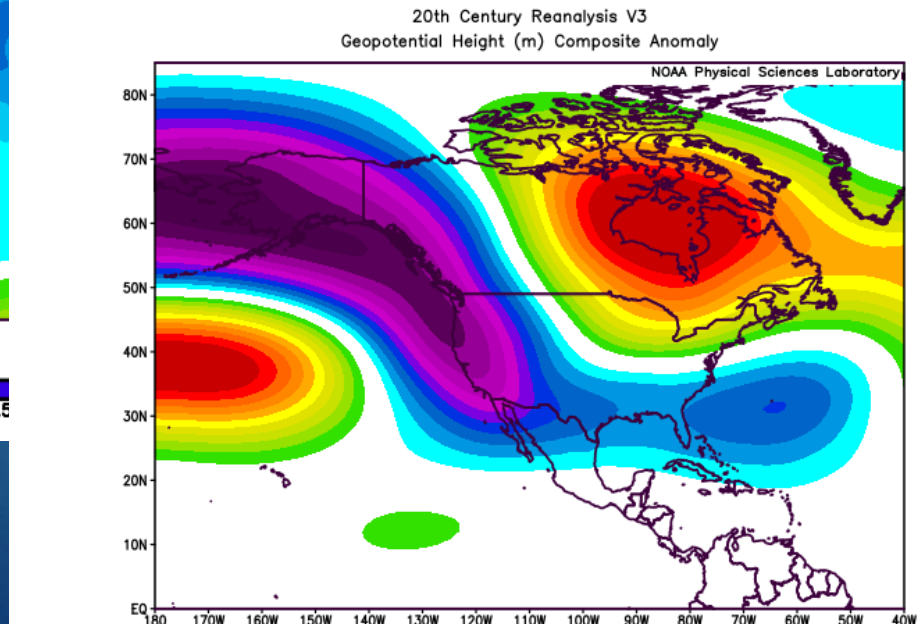


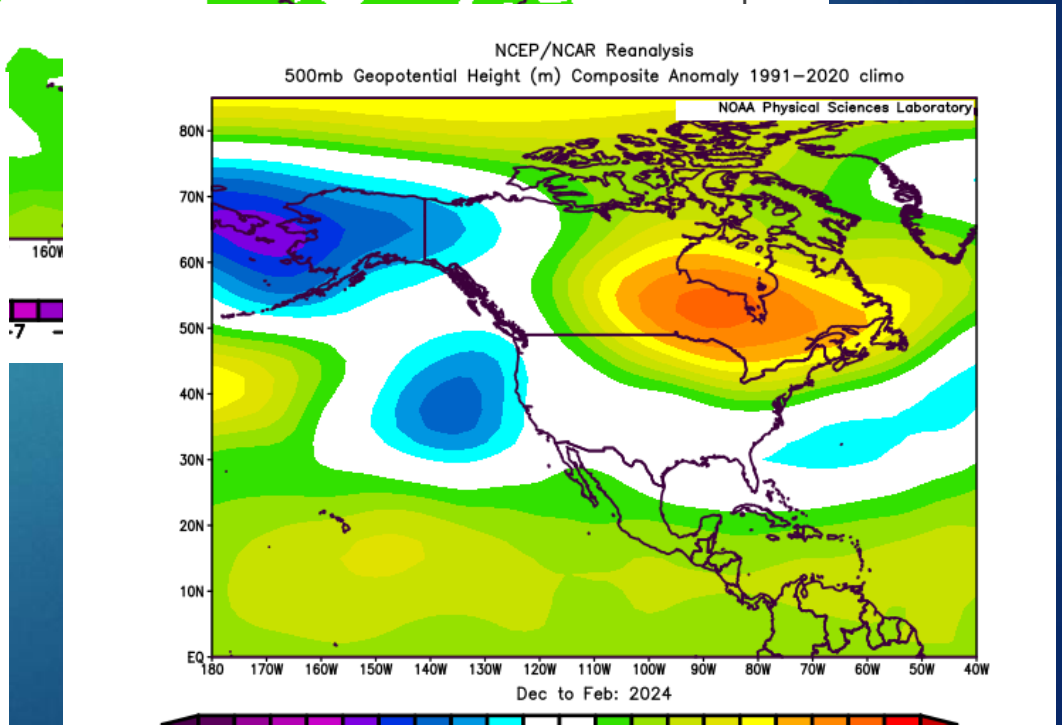
Winter 1877 – 1878 versus 2023 - 2024

- Oh very similar?



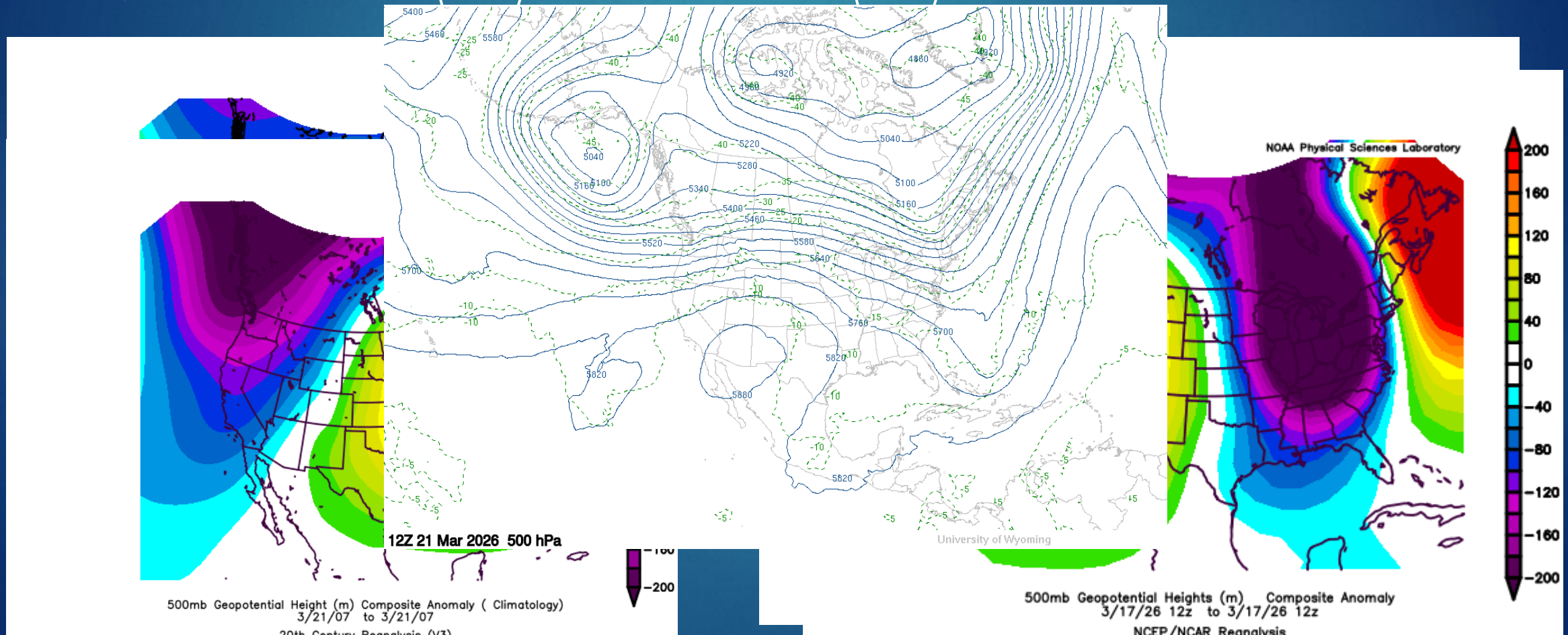






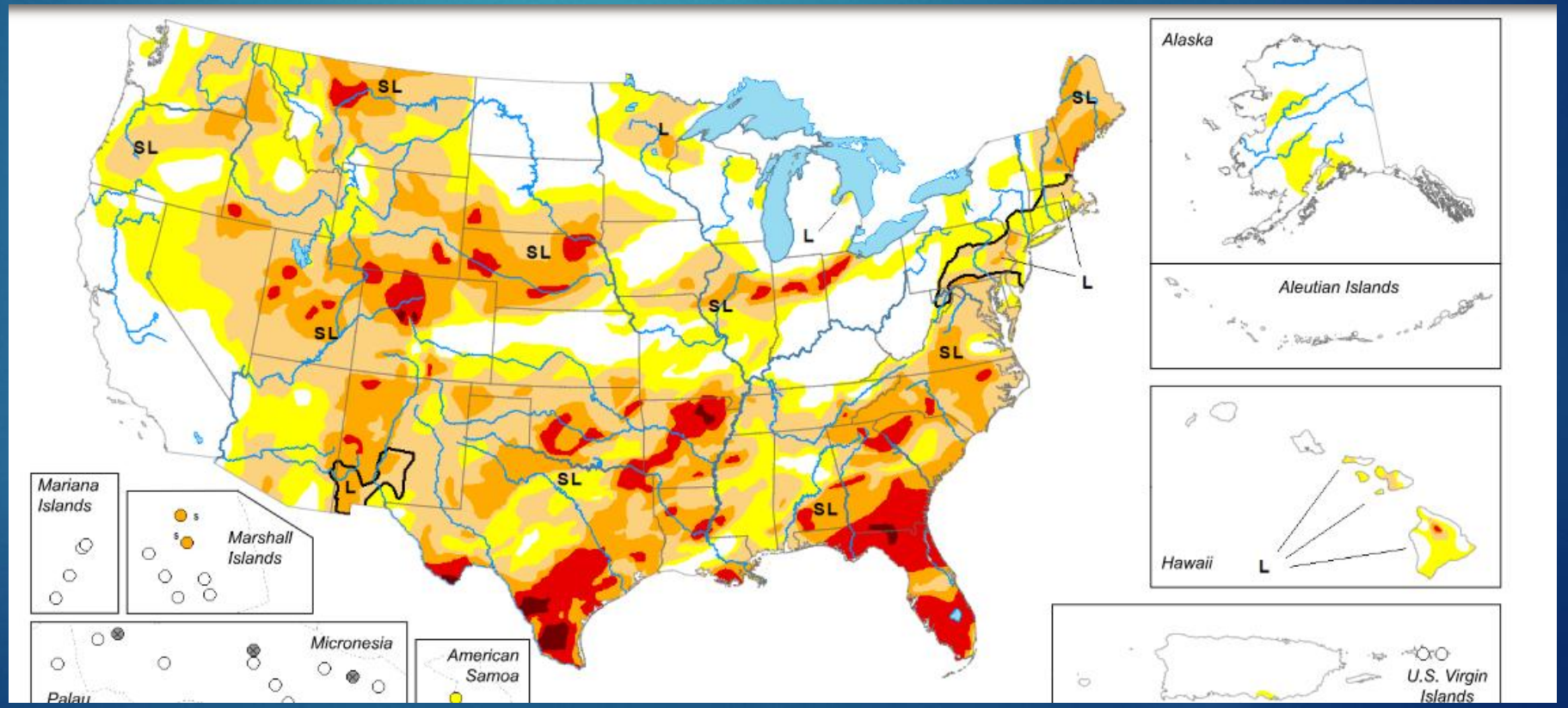
March 1907 and 2026 Hot Hot Hot

- 21 March 1907 (92 F) 21 March 2026 (91 F)



National Drought Monitor

- Current Drought Conditions as of March 17th – Early March saw improvement – but with heat we are giving it back



Our Forecast – Winter 2025 - 2026

- We forecasted a winter very close to normal based on the recent "classic" La Ninas of 2007, 2010, 2017, 2020, and 2021. And last year! This seems to be a strong indicator. Temperature to be within 0.5 sigma of normal which is -1.6 to +1.6F.
- The actual temperature was +2.0 F on the strength of a very warm February. December and January were very close to normal. So, we can only get one point of two.
- We leaned toward precipitation being below normal mimicking the previous year. We also forecast snowfall at 15 – 20 inches. We received 11.9 inches.
- The actual was a bone-dry 2.70 inches as all three months we received less than 1 inch. This leaves us about one to two standard deviations below normal. Similar to last year. Let's call it a win at two points. We got 3 of 4 for the winter!

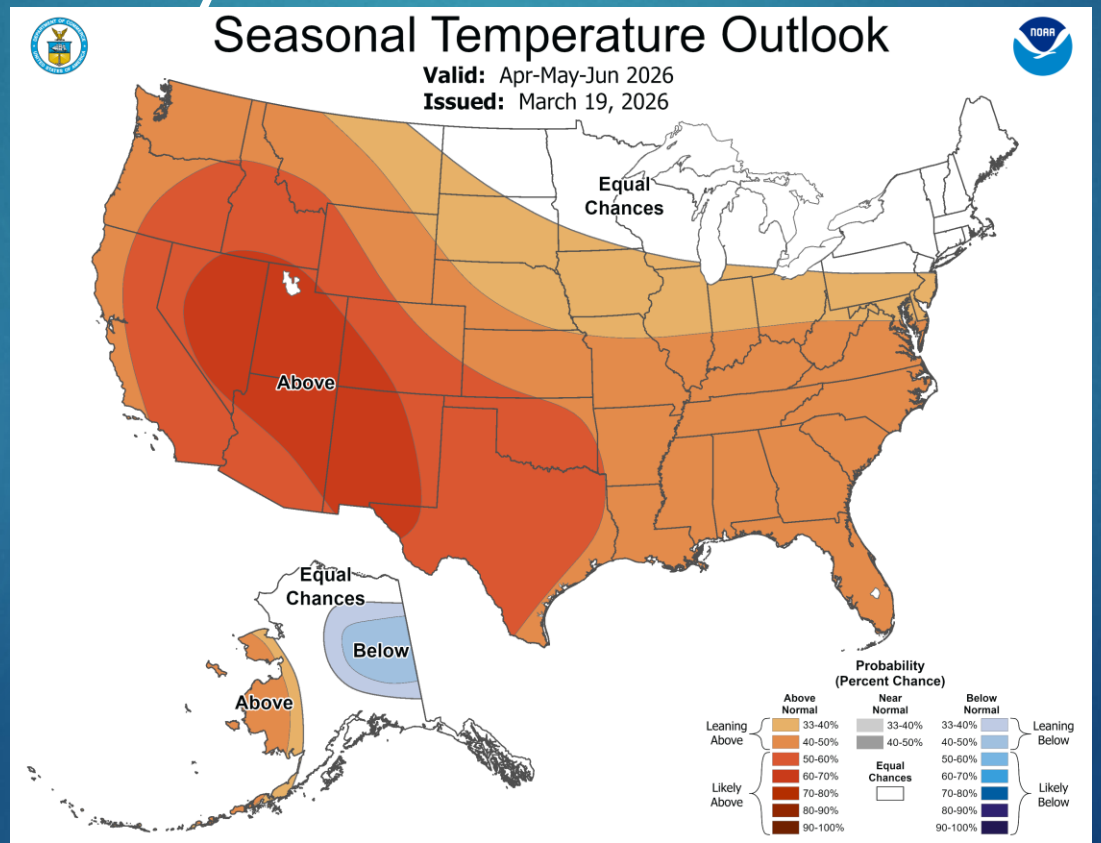
Our Forecast – Winter 2025 - 2026

- Reasoning: “Persistence” is the name of the game.

- Weak La Niña in 2024 – 2025 never really made it to La Nina. This may be the same again. The dynamic and statistic models track similarly this year and make it weak. We need to see if we’ll make it to La Nina this year. We forecasted the winter will mimic 2024 – 2025 and late 2021 and 2022 showed similar conditions. Remember Winter 2021 was the Great Polar Vortex of February. Last year was brutally cold in late February as well. But, the cold January was also an issue. This year we have strong cold weather in Early December 2025 and late January 2026, but the period from 15 Dec – 15 Jan was warm, as was February. The wild card in all of this was blocking. Blocking was there for the cold periods, but somewhat absent during the warm ones.

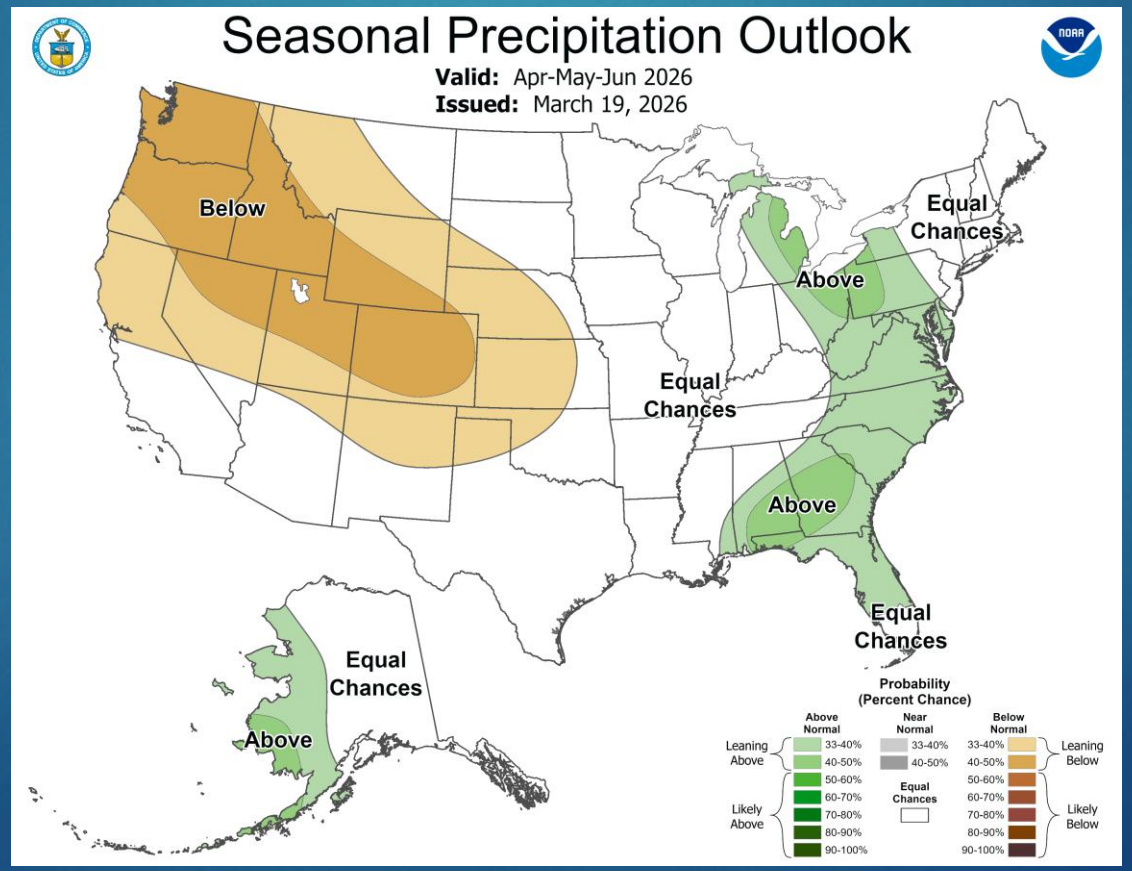
Spring 2026 – CPC outlooks

- Temperature – projections are for near normal temperature across the northern and northeastern USA – temperatures are expected to be very hot in the southwest.



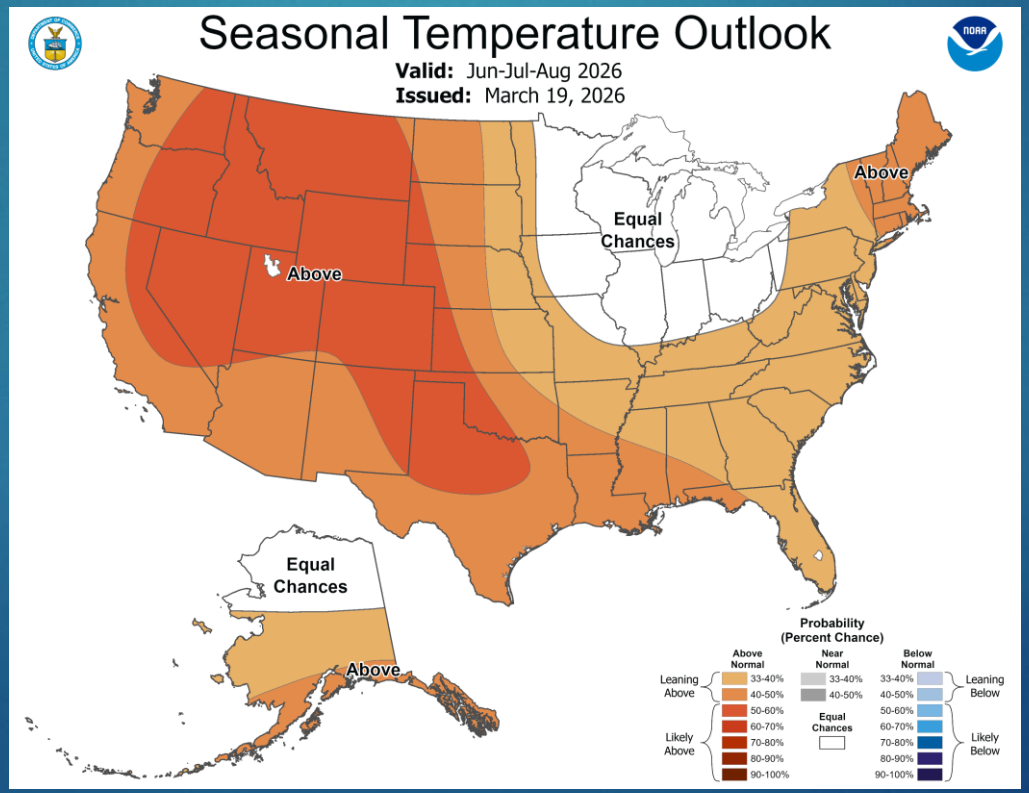
Spring 2026 – CPC Outlooks

- **Precipitation – look for drought to improve?**



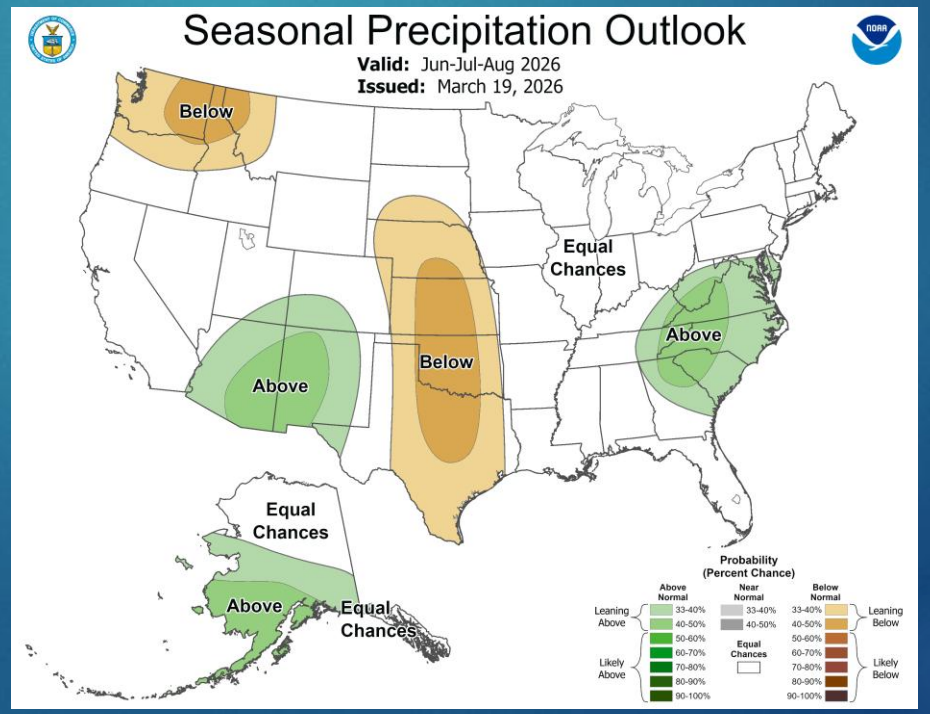
CPC Summer Outlook – 2026

- **Temperature – the seventh straight year the forecast has look like this. We're not even trying……..**



CPC Summer Outlook 2026

- Precipitation – we are looking for dry conditions in the southern plains. This is as animated a summer forecast I've seen in a few years. Looking for above normal precipitation in the Carolinas and southwest USA (wet monsoon season).



Our Forecast – Summer 2025

- Reasoning:

- We thought that the current weak La Niña (cold neutral) will fade somewhat but slowly. We ended up moving toward Neutral Conditions and even back to La Niña.

- So we forecast that summer would be on the warm side of normal (one half to one sigma of normal or +1.2 – 2.4 F and the will be within the range of normal (+/- 2.5 inches above normal). We nailed precipitation, though June and July were wet and the skies shut off in August. Temperatures were only a hair above normal. So with precipitation we got two points and one for temperature – so three of four!

Summer 2026 Outlook

- CPC forecast is for a warm spring across the south and west coast and equal chances for the north and northeast. They are going for continued drought in the southern plains states but wet in the southwest and Carolinas. But, we're in a La Niña or at least cold neutral. The projection is going toward El Niño and a fairly strong one. Some good analog years could be 2008, 2011, 2018 which transitioned out of La nina for the first and last one.

- Weak La Niña conditions were in place this time last year.

Our Forecast – Summer 2026

- Reasoning:

- We think we'll head toward El Niño and that La Niña will fade. This means the La Niña transitioning toward El Nino years are good analogs. That would be 2008, 2018, and 2023. Two of them experienced normal temperatures and wet (2008 and 2023), one was hot and dry (2018). There is also the issue of the dry conditions and the fact that March 2026 is somewhat similar to March 2012.

- So we're going to say that summer will be on the warm side of normal (up to one half sigma from normal or 0.0 to +1.2 F and the summer will be within the range of normal (around +/- 2.5 inches from normal).

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 Zachary Leasor). MO has been a CoCoRaHS state since 2006.

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Missouri Climate Center

- Missouri Climate Center
- http://climate.missouri.edu/change.php

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
- **Landscape Conservation Cooperatives:** http://www.fws.gov/landscape-conservation/lcc.html