AN EARLY LOOK AT WINTER 2023-24

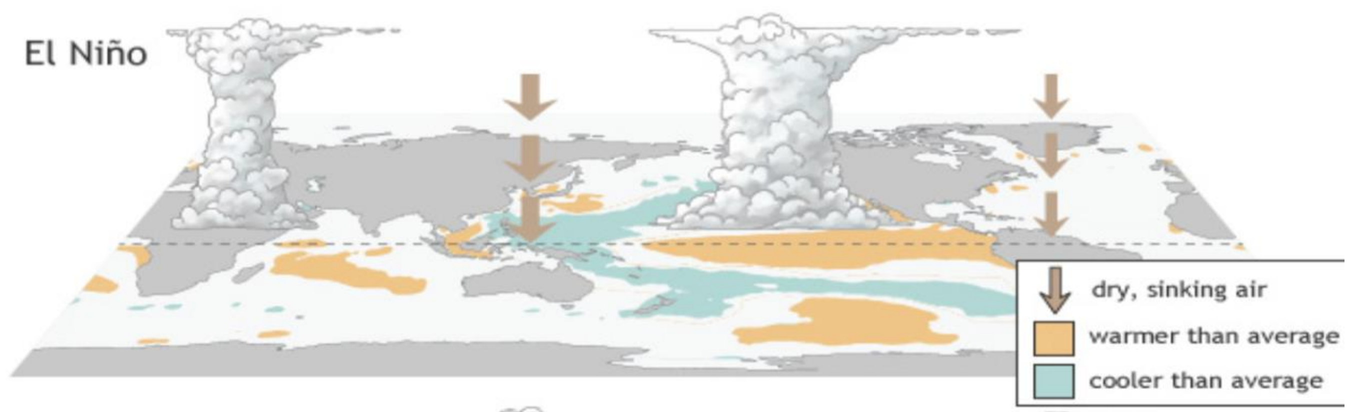
It's just about that time of year again where meteorologists, forecasters, and passionate weather enthusiasts alike begin to gauge a sense of what the upcoming winter may bring. We all try to ascertain atmospheric signals that have a history from past years that produced certain types of patterns across the U.S. It has some merit despite it being early still, though we can look at specific things like El Nino or La Nina, QBO, placement of sea surface temperatures, etc., to help give us a sense of where we're headed as we approach the winter season.

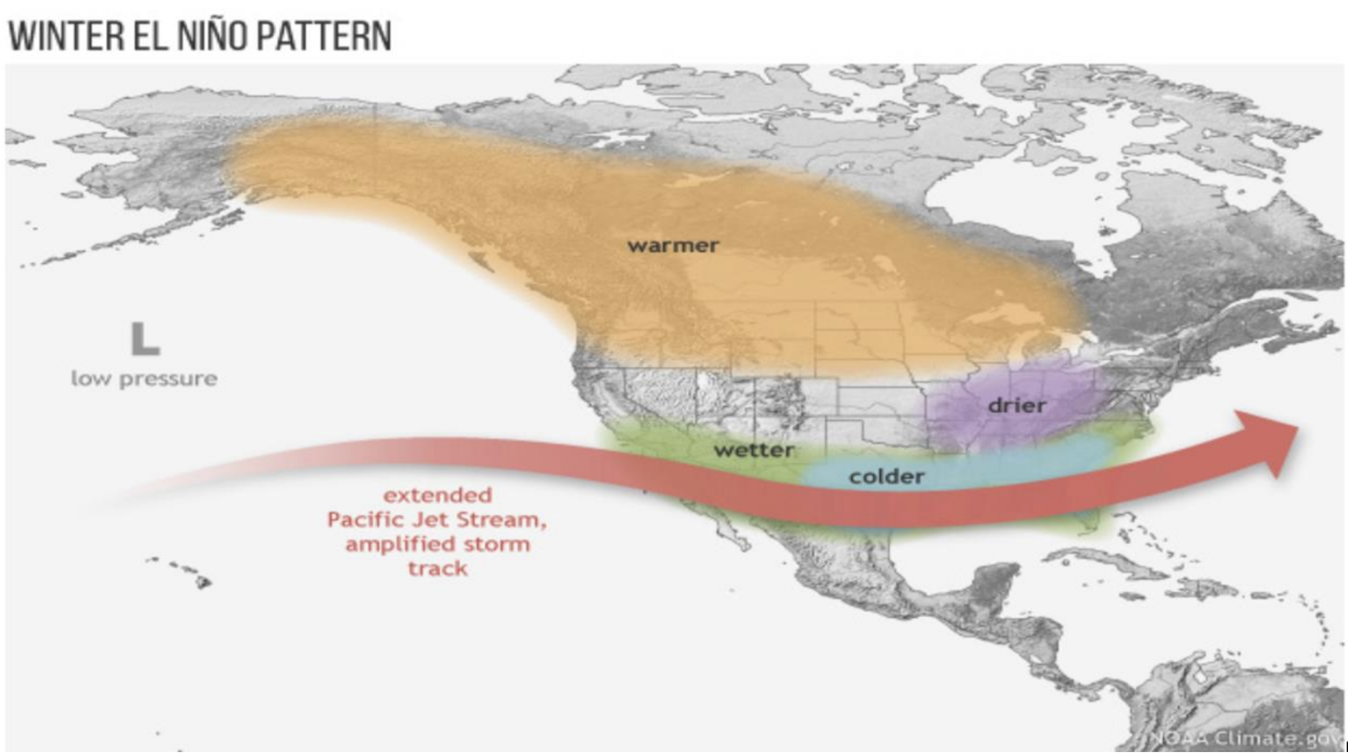
We will begin by quickly covering certain global atmospheric circulations or processes that essentially have winter implications in terms of temperature and precipitation for the U.S. Then we can see how this year compares with previous years by showcasing similar characteristics.

ENSO – El Nino Southern Oscillation

We're currently in the warm phase of ENSO, meaning we have a legitimate El Nino developing just in time for the winter. What makes this such a significant "driver" in weather patterns is because the placement of warm water along the Equator in the Pacific and elsewhere globally (e.g., Atlantic, Indian Ocean, and Northern Pacific).

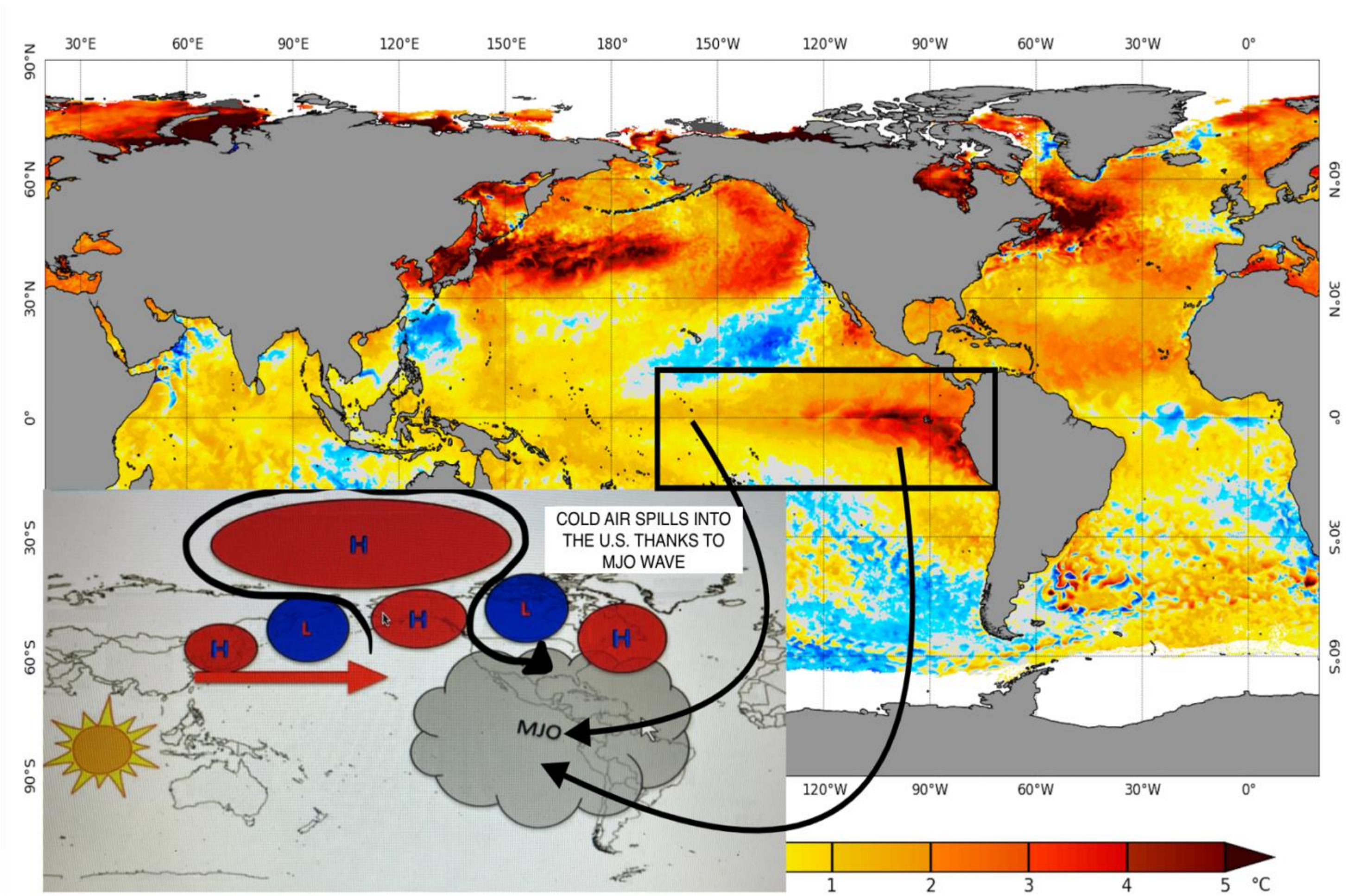
Below, NOAA illustrates how El Nino's impact global weather patterns due to the way the warm and cool waters are displaced, and how this influences the jet streams. We see it's associated with an active sub-tropical jet (brings in a lot of energy and moisture, which is why we've seen some notorious major winter cyclones and nor'easters especially), and an inclination for warmer-than-normal temperatures across Alaska and western Canada. That also implies the positive phase of the PNA (big ridge across Alaska and into West Coast, which suppresses the polar jet stream allowing cold air masses to bleed southward). This is a hallmark of a favorable cold and snowy pattern east of the Appalachians.



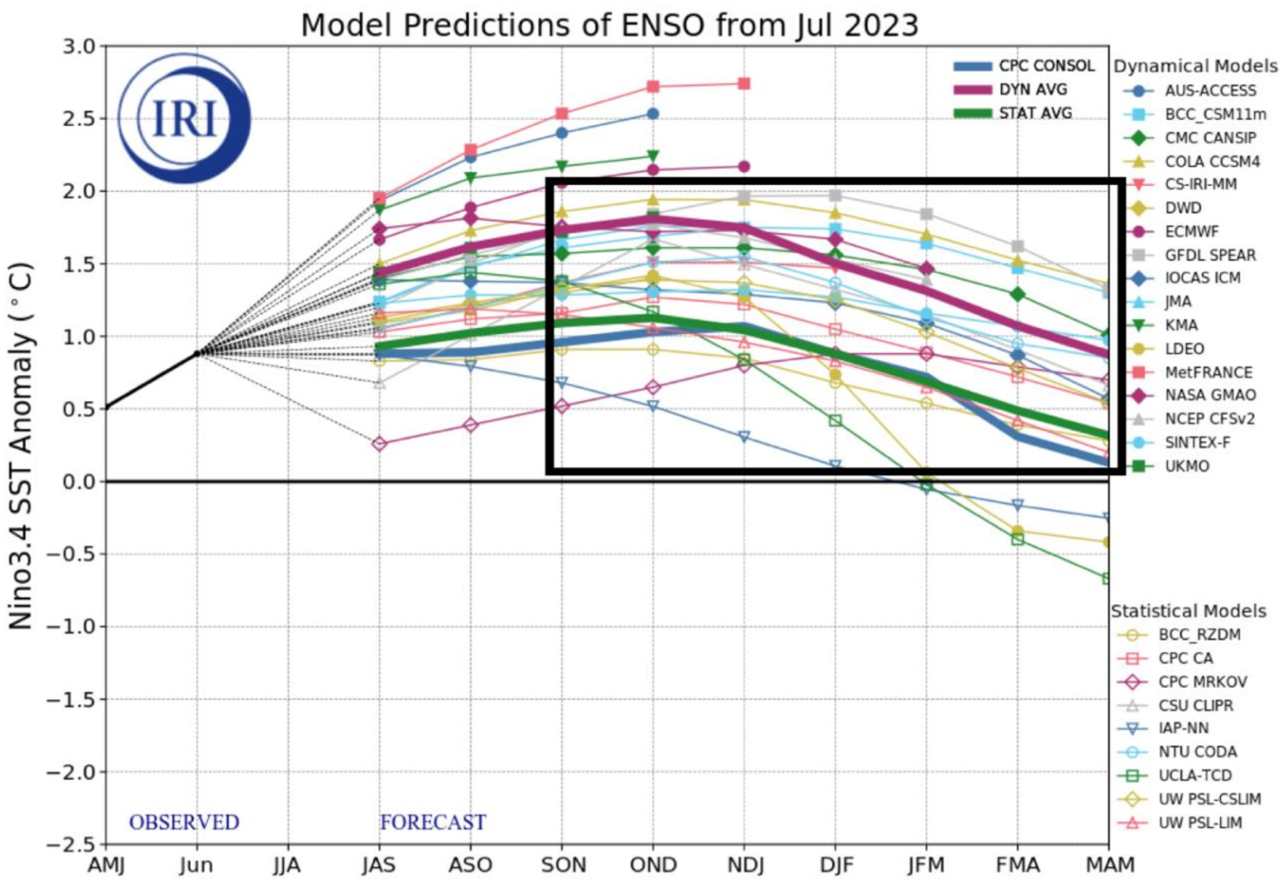


Tropical convection, like the Madden Julian Oscillation (MJO) as a prime example, is modified in certain areas along the Equator which is connected between the tropics and mid-latitudes. If you're unfamiliar with the MJO, it's simply a large cluster of thunderstorms, clouds, and rain that travels along the tropics globally. Its influence directly impacts the jet stream and other atmospheric circulations that have contributed to extreme weather events across the U.S. and is divided into 8 phases stretching from the Indian Ocean to the Pacific. When the MJO shifts into the Pacific during the winter, it sets off a series of large atmospheric processes that ultimately can result in arctic air "bleeding" into the U.S., while "kickstarting" the sub-tropical jet. You can see how we get extreme winter weather events when you have arctic air clashing with juicy warm moisture!

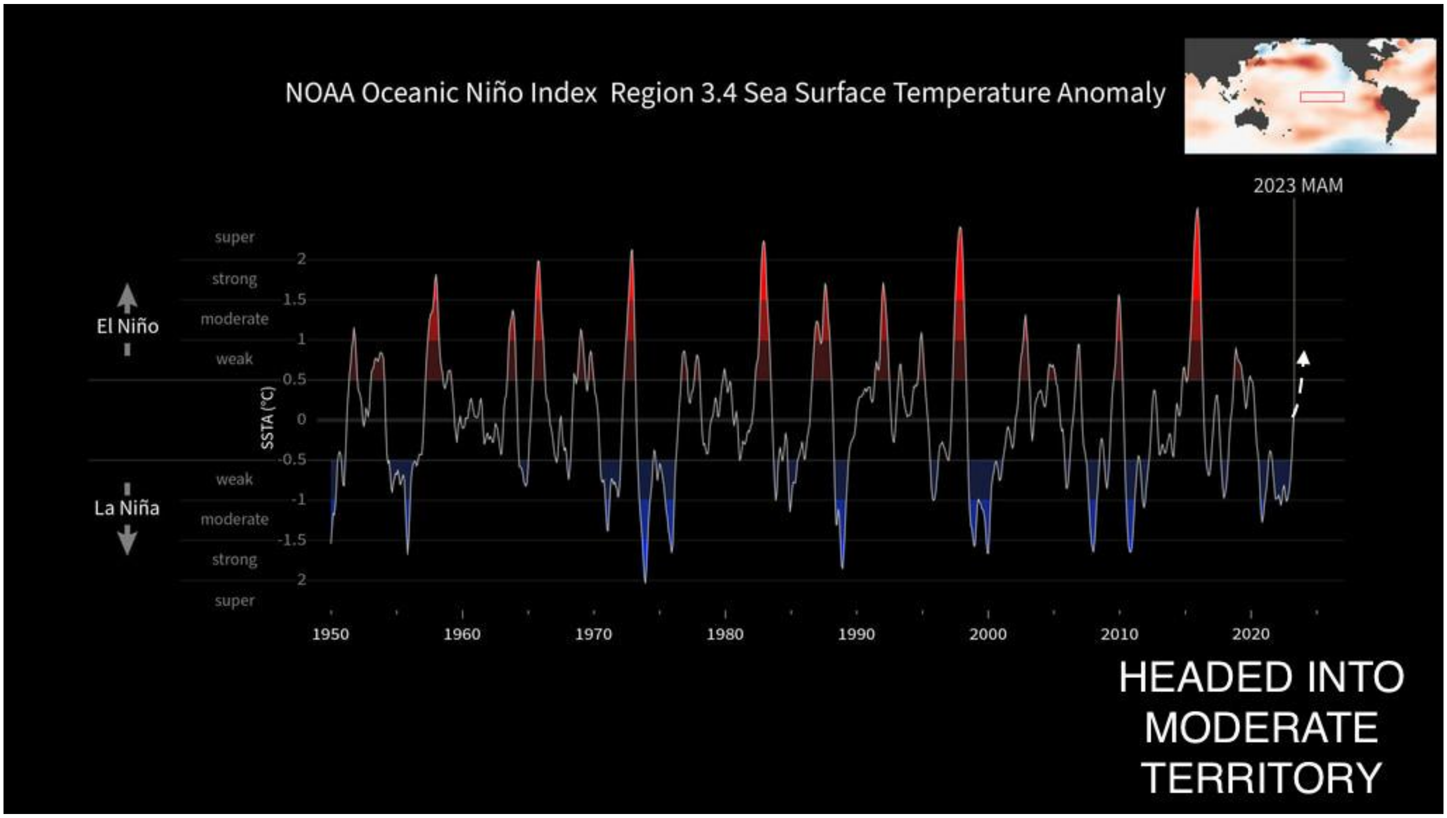
This is illustrated below as a visual reference to help. It's all because of where the warmer water is, and where convection (i.e., thunderstorms) are favored. It's no coincidence that we tend to see the colder and snowier MJO phases east of the Midwest during El Nino's because the warmest water now resides in the central and eastern Pacific.



With an abundance of dynamical and statistical model forecast predictions below, a clear consensus points to the El Nino growing into a moderate to strong one as we enter the fall and winter seasons.

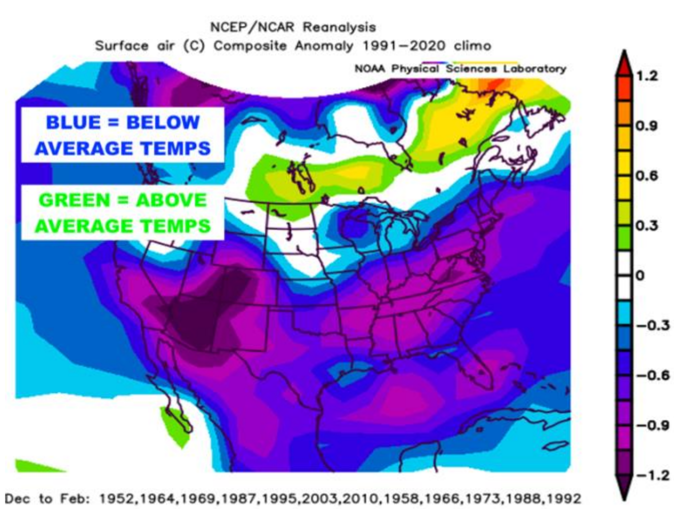


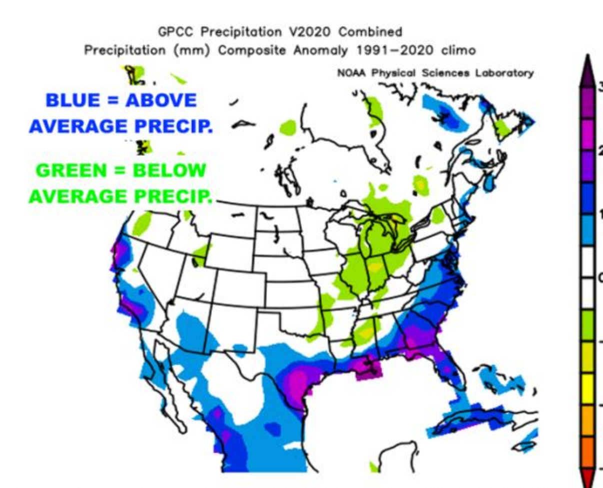
We'll see how moderate to strong El Nino years influenced weather patterns across the lower 48 below to garner a sense of where we're headed. In short, the "flavor" of ENSO is characterized by a rolling three-month value (i.e., JFM, MAM, etc.) in the NINO region 3.4. ENSO is broken up into several domains to help measure the total strength of how warm (or cool) the water is along the Equator in the eastern-central Pacific. NOAA displays a nice graphic to show the region 3.4 highlighted in the red box in the top right corner below. This shows the strength of all El Nino and La Nina events since 1950. We're on our way into moderate territory, and indications are we trend closer into the "strong" category by the Fall, or Winter. We took all El Nino years that reached at least "moderate" and blended it with all "strong".



The results reveal widespread cooler temperatures across the U.S. on the left with precipitation on the right. Notice that the standout for above average precipitation extends from California (makes sense given the extended sub-tropical jet), along the Gulf, and especially up the Eastern Seaboard.

ALL MODERATE TO STRONG EL NINO YEARS DEC-FEB: SURFACE TEMPERATURES (L) AND PRECIPITATION (R)





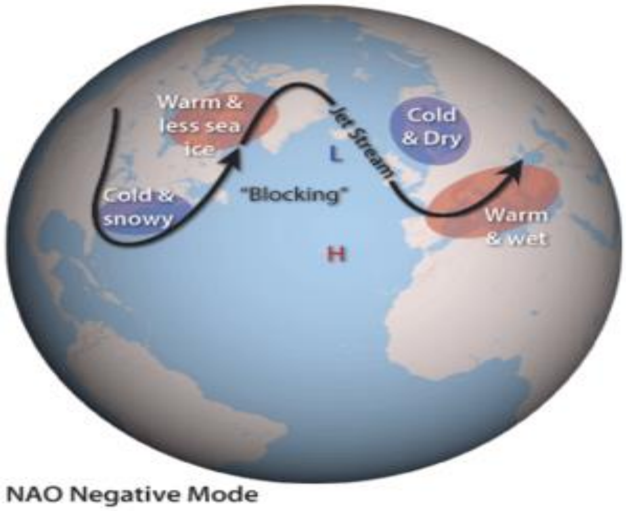
QBO – Quasi Biennial Oscillation

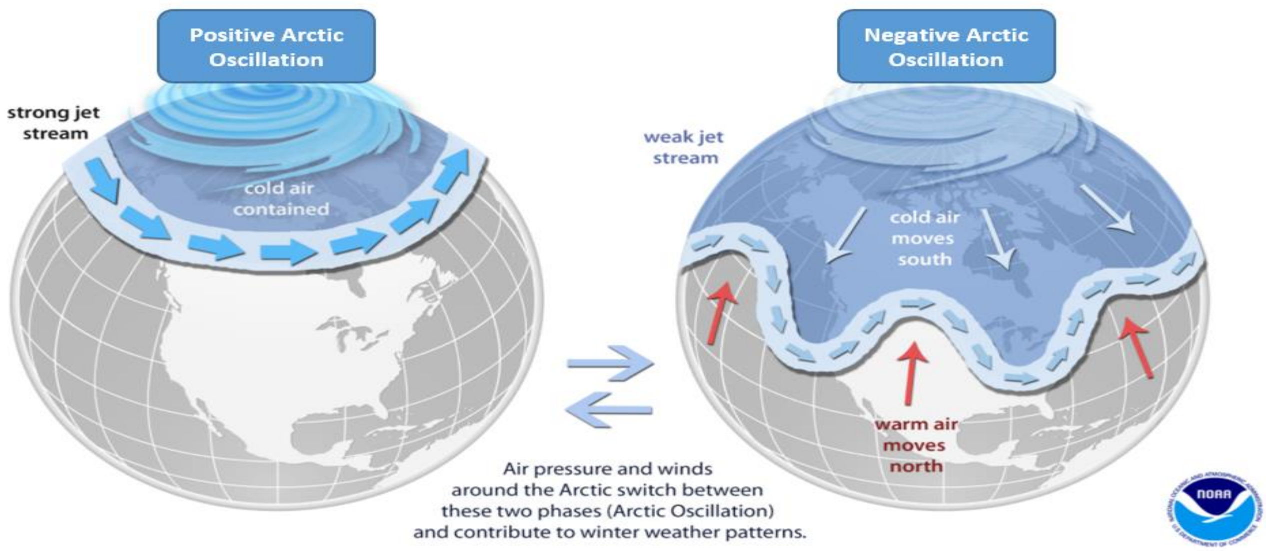
The term may look complex and technical, but it's simpler than you think. The QBO is just a band of zonal winds in the stratosphere that are known to vary between westerly (positive) and easterly (negative) phases over the course of 12 – 24 months. These winds then descend into the troposphere (where our weather transpires) and impacts the polar vortex.

A negative phase (easterly winds) has shown to promote a weaker stratospheric polar vortex. This implies that it's much more susceptible to being disturbed, thereby resulting in a very good chance of high latitude blocking episodes. We know that as the NAO and AO teleconnections. A weaker polar vortex means a higher likelihood of the negative phases of the NAO and AO, which is favorable for cold and snowy patterns in the East. We can also see this through the different phases of each teleconnection below.

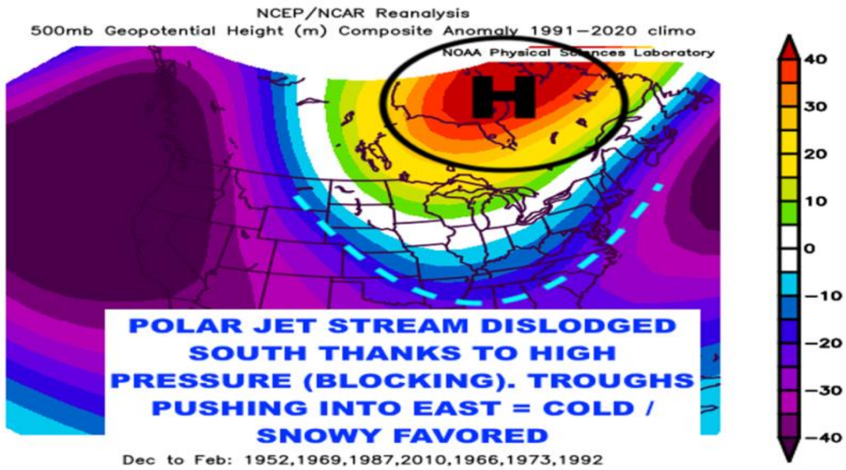
A negative North Atlantic Oscillation (NAO) is associated with a dislodgement of colder air east of the Rockies as high latitude blocking (a ridge – high pressure) forces the polar jet stream southward. This is why we've seen some of the biggest nor'easters and winter events for the Mid-Atlantic and Northeast because of the cold, and because of potential "phasing" with energy coming from the fueled sub-tropical jet stream.

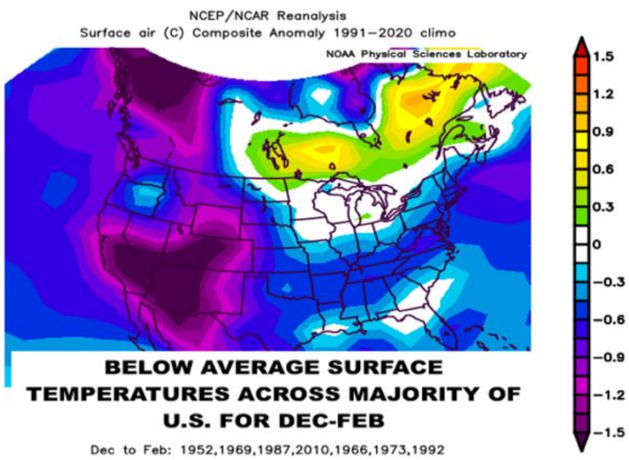
A positive phase leads to the opposite and is unfavorable for cold and snow. Similarly, the Artic Oscillation acts just like the NAO. The negative phase implies cold air to sink southward into the mid-latitudes, whereas the positive phase is associated with cold air retreating toward the North Pole.

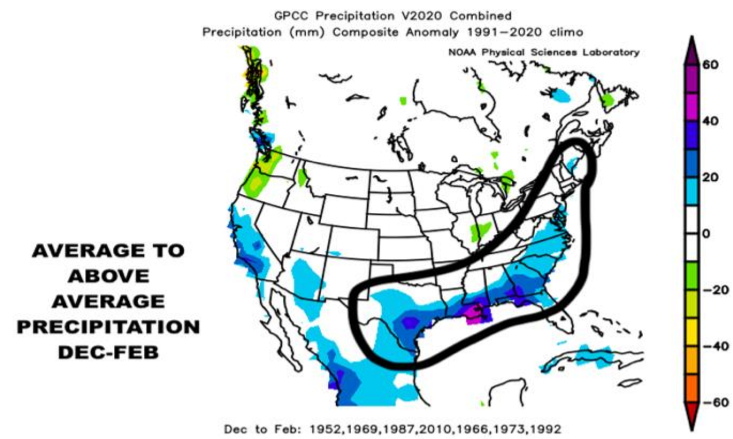




Now we can see how this all ties together with the QBO and the stratospheric polar vortex! The easterly phase, which we're now embarking in and will become established for winter supports both cold and snow, especially along the East Coast. Years that were in a moderate to strong El Nino phase with a negative QBO are shown below that reveal temperature, precipitation, and the general mid-level patterns from a sample of years.



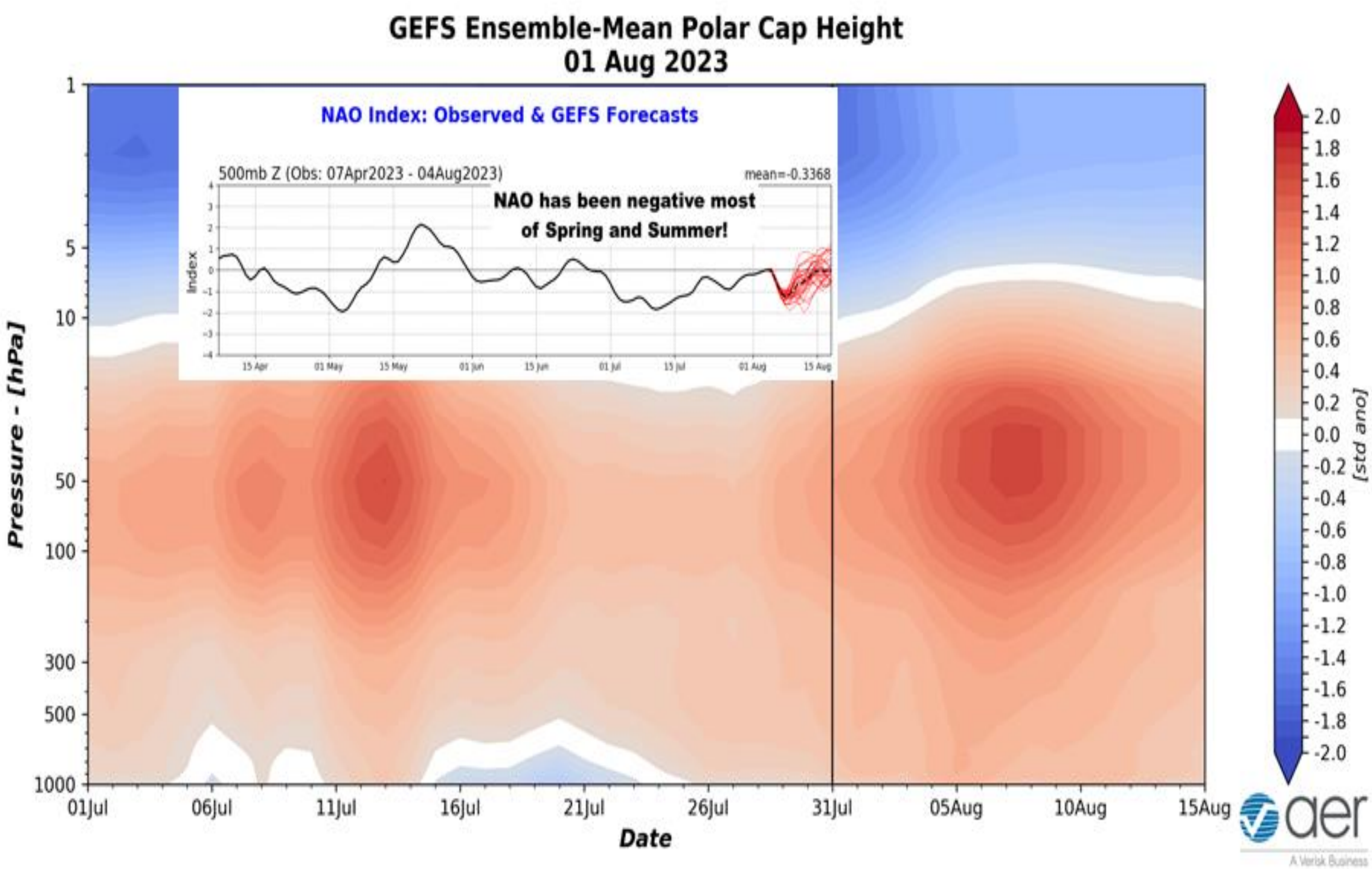




Spring – Summer Polar Blocking

For as complicated the atmosphere is, it also can be predictable at times since one phenomenon is likely to be repeated in the future. Though still in its infancy, research has shown that blocking patterns in the summer have occurred in the following winter.

Since the Spring season, we've seen polar blocking prevail across the high latitudes and still going strong. We've not seen something like this in a long time, and its persistence is remarkable. The graphic below, from AER.com (Judah Cohen), shows a height-pressure relationship. Vertical axis is pressure (in millibars) and time is on the bottom. When we say height, we mean the temperature of a layer, so the red colors correspond to higher pressure and therefore warmer temperatures with blue being the opposite (low pressure, cooler temperatures). Going back to the discussion on the NAO, AO, and high latitude blocking; this shows that blocking (high pressure) has dominated not only the troposphere, but into the stratosphere.



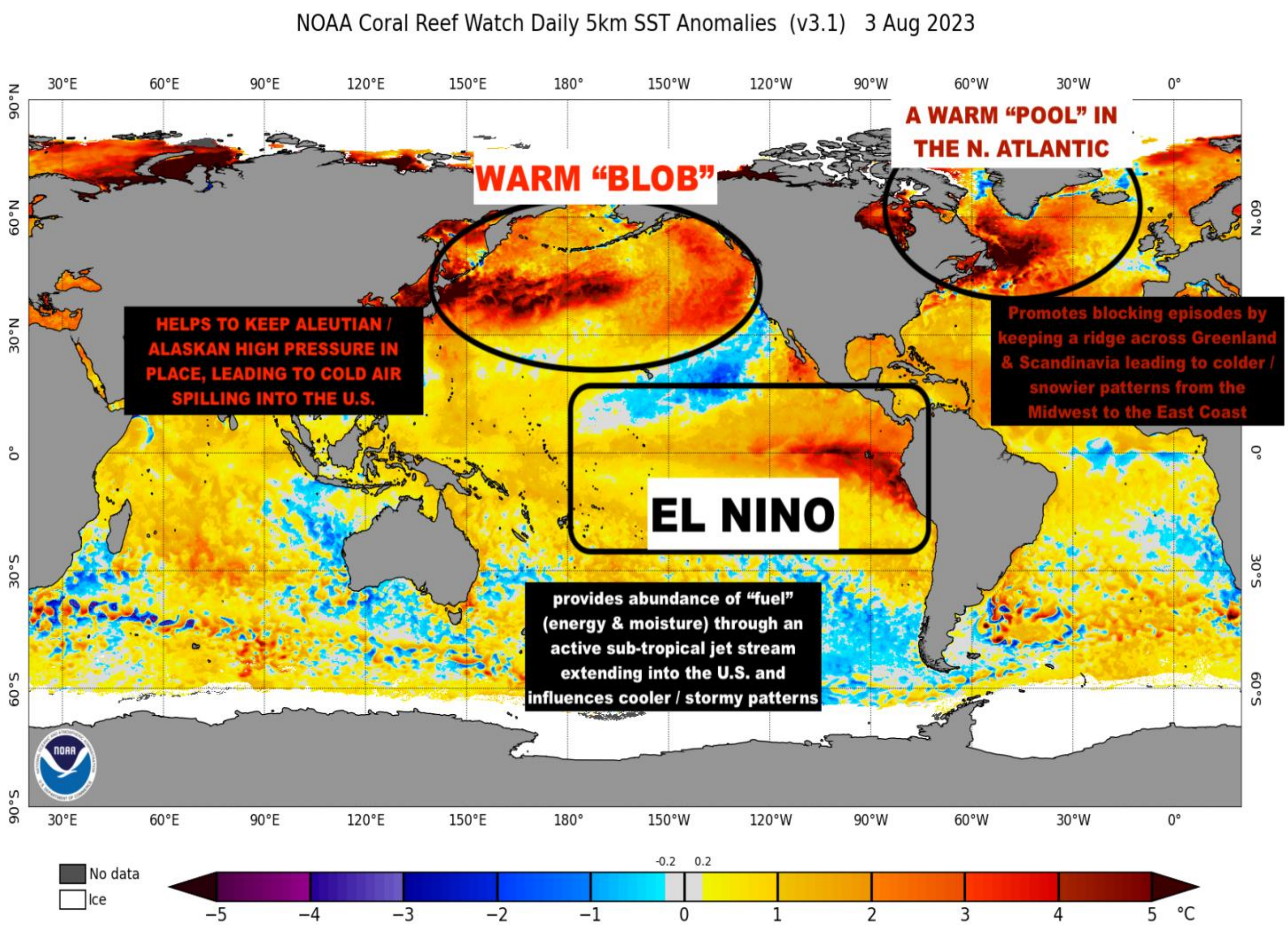
We say this is “coupled”, meaning its connected between the two layers of the atmosphere. Stronger the connection means a more robust response at the surface. Have you noticed that the Northeast for instance, has been somewhat cooler since the start of summer and quite active as well from the Midwest to the Northeast? This is because of the southern dip in the jet stream, and what has caused this is the negative phase of the NAO. All of this is why the NAO has varied in the negative phase since Spring, because of the blocking.

There is a good chance we see this return in the winter, especially when we add in the easterly QBO phase and help from tropical convection since the latter has shown to cause blocking episodes as well. We know high latitude blocking has brought significant winter weather events and arctic snaps, so you tie that in with a maturing El Nino and you can begin to “feel” those winter tingly senses if you’re a big winter fan!

CURRENT "SNAPSHOT" OF 2023

Let's tie everything all together now and take a step back to see what we have going for us at this early stage. We've outlined below, three main areas that play big roles in terms of temperature and precipitation for the U.S. in indirect and direct ways.

1.) El Nino
2.) The Northern Pacific warm "blob"
3.) The anomalously warm northern Atlantic



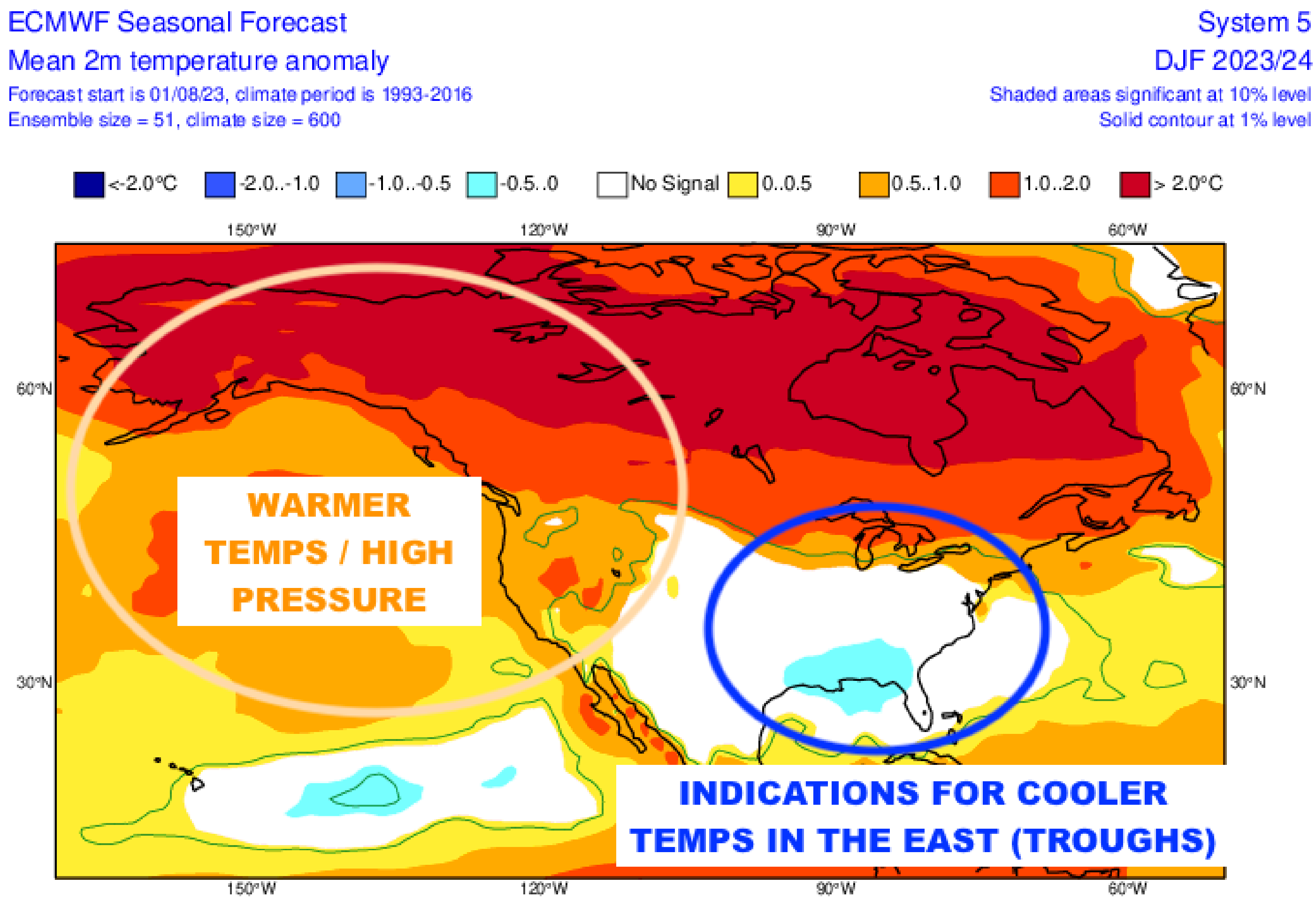
The El Nino has been discussed in depth above, and why it tends to favor the colder and snowier risks across the U.S., especially east of the Midwest. We tend to see "phasing" of both the polar and sub-tropical jet streams during El Nino's with some classic blizzards during past El Nino years. That warm "blob" (a marine heatwave to be more technical) has a correlation to cause high pressure above. Go back to the El Nino graphic from

NOAA where it shows a large orange contour from Alaska to the Great Lakes. That is the big ridge (e.g., +PNA) we want to see expand the West Coast for snowy and colder risks in the East. We're already off to a great start given how warm the Northern Pacific is.

Then there is the warm "boiling" water across the entire Northern Atlantic. Like the Pacific "blob", these warm waters help to keep high pressure as well in the vicinity of Greenland. We know that area to be associated with the NAO. A big area of high pressure there can lead to the negative phase of the NAO, and by now we know what happens when the NAO is negative.

A Computer Model's Forecast: ECMWF

Lastly, we've entered the time of year where it's acceptable to glance at climate and seasonal model predictions for the upcoming cooler seasons. One of the more reliable computer models (statistically proven), the ECMWF (European model), produces long range seasonal forecasts. It just recently produced a new three-month average forecast for the December-January-February timeframe. Unsurprisingly, it reveals a near classic El Nino "look" with below average temperatures in the East, with above average out across the West and across Canada. Obviously, there are always going to be uncertainties in every forecast, and sudden changes since the atmosphere is a chaotic "system"; however, the important point to take away from this is that we're headed in the direction that history has shown to be quite intriguing for the winters with El Nino's.



So, where we stand from this moment in time has a lot going for it, and the signals now are quite encouraging if you're in it for the snow and cold, or just the snow as we all love! Of course, things can change, but the "foundation" is important to build upon and gives us a sense of where we're headed as we enter the fall. Follow us along the way so you can see where we're headed as we inch closer to the winter season!