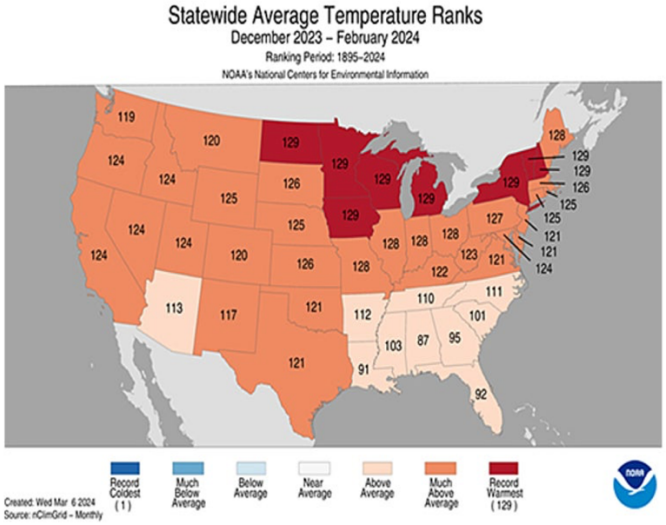
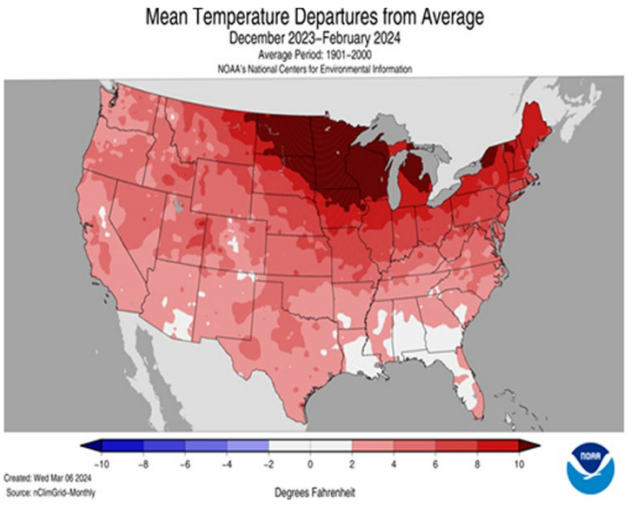
El Nino Winter of 2023-24: Why The Underperformance For Most?

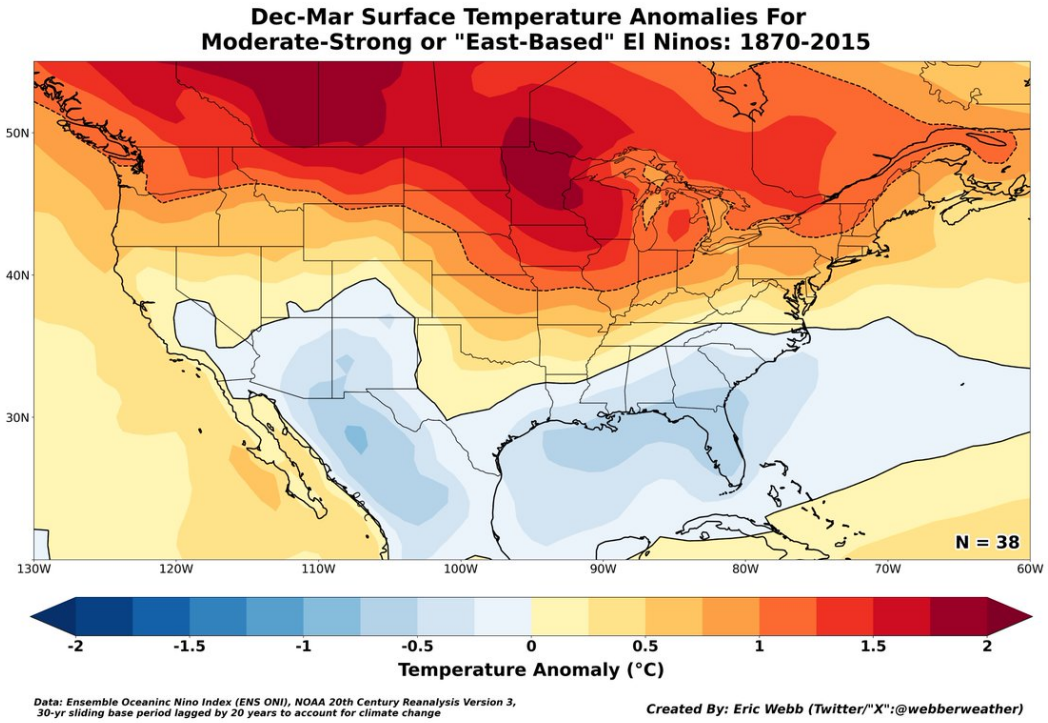
Since we can look back on the winter of 2023-24, statistics can be compared to previous analog years where eastern-based Pacific El Nino's occurred. Every winter, seasonal forecasters and meteorologists try to garner a wealth of data in the form of previous years closest to the current state. That and we all try to gather up complex indices that have produced winter patterns, which are also most like the present year. However, it's difficult to find those "perfect" matches because every year is different in its own way, and we must account for the apparent warmth building across the globe that plays a role as well.

Unequivocally, it was certainly one of the warmest winters on record, and technically it was the warmest Dec.-Feb. trimonthly period observed since the late 19th century according to NOAA. Below are two official graphics created by NCEI (National Centers for Environmental Information). On the left reveals statewide temperature rankings, where higher the number correlates to that state's temperature record. Most states have finished much above with 8 states finishing with record warmth. On the right is simply the temperature departure in Fahrenheit. Unsurprisingly, a whole lot of red!

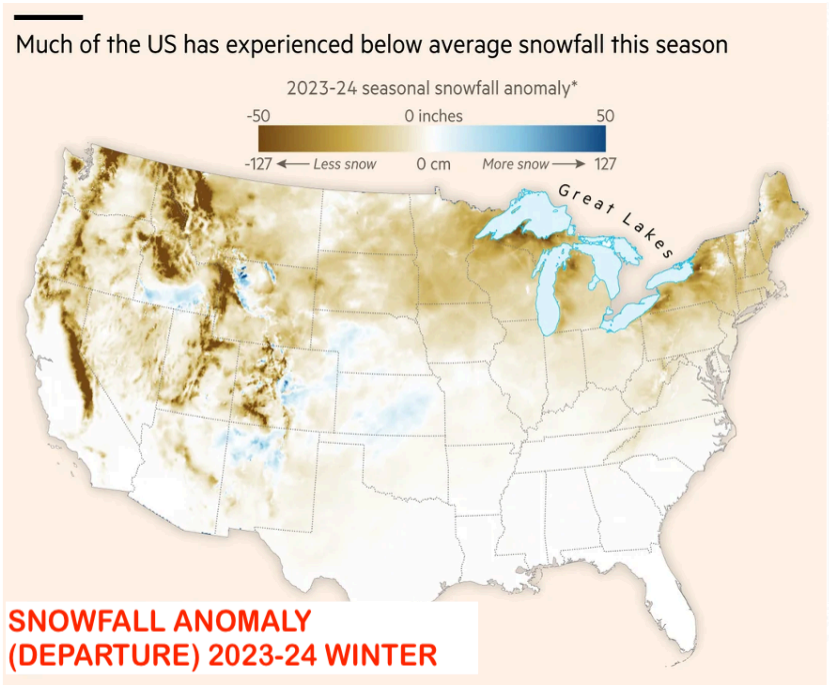


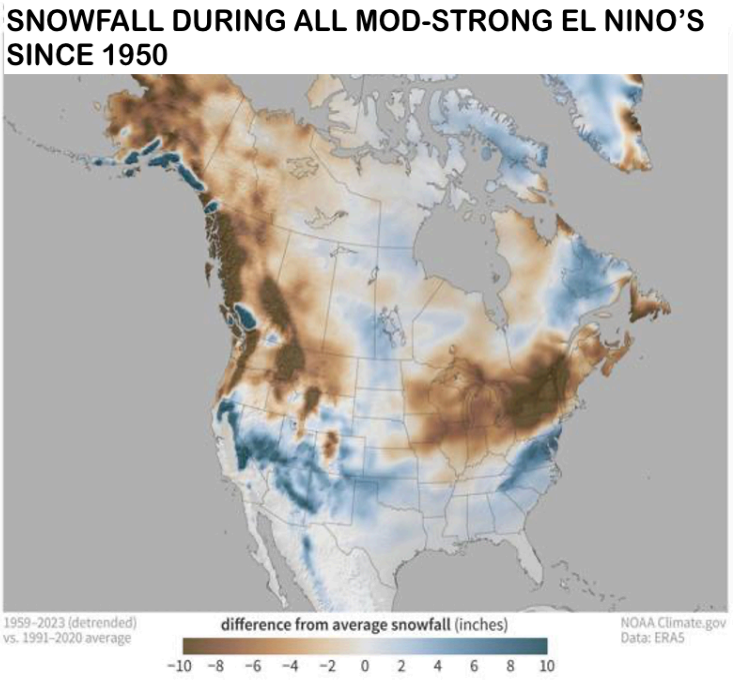


Let's take a step back. In an article published prior to this winter, we discussed the various "flavors" of El Nino's and how the warmest water depending on its position dictates many factors that ultimately influence the placements of the jet streams. Below a composite created from Eric Webb revealed that with relatively strong east-based Nino's we see a lot more warmth. Indeed, that verified this winter season. We also figured that prior to the 23-24 winter that there were going to be more attributes of a central-based Pacific Nino that history has shown that produced more widespread cold and snow. However, that wasn't really the case this winter season.



Once again, in the snowfall department we were lackluster as a whole (adding to the consecutive string of years already of subpar snowfall). Below, thanks to NOAA's great graphics we can see where it was below average and for the most part the northern Plains, Great Lakes, and a good chunk of the Northeast finished well below. Also apparent is the lack of it in the west, and parts of the southern Mid-Atlantic (i.e. Carolinas and Virginia). On the right is snowfall averages for all moderate to strong El Nino's dating back to the 1950's. It's pretty striking how collectively similar the U.S. did with snow relative to the composite on the right as much of it aligns. Places in the Mid-Atlantic and central Plains ended up average or a bit above. Regardless, it's unsurprising that one of the warmest winters on record coincided with a relative snowless (by how widespread it was observed) winter.



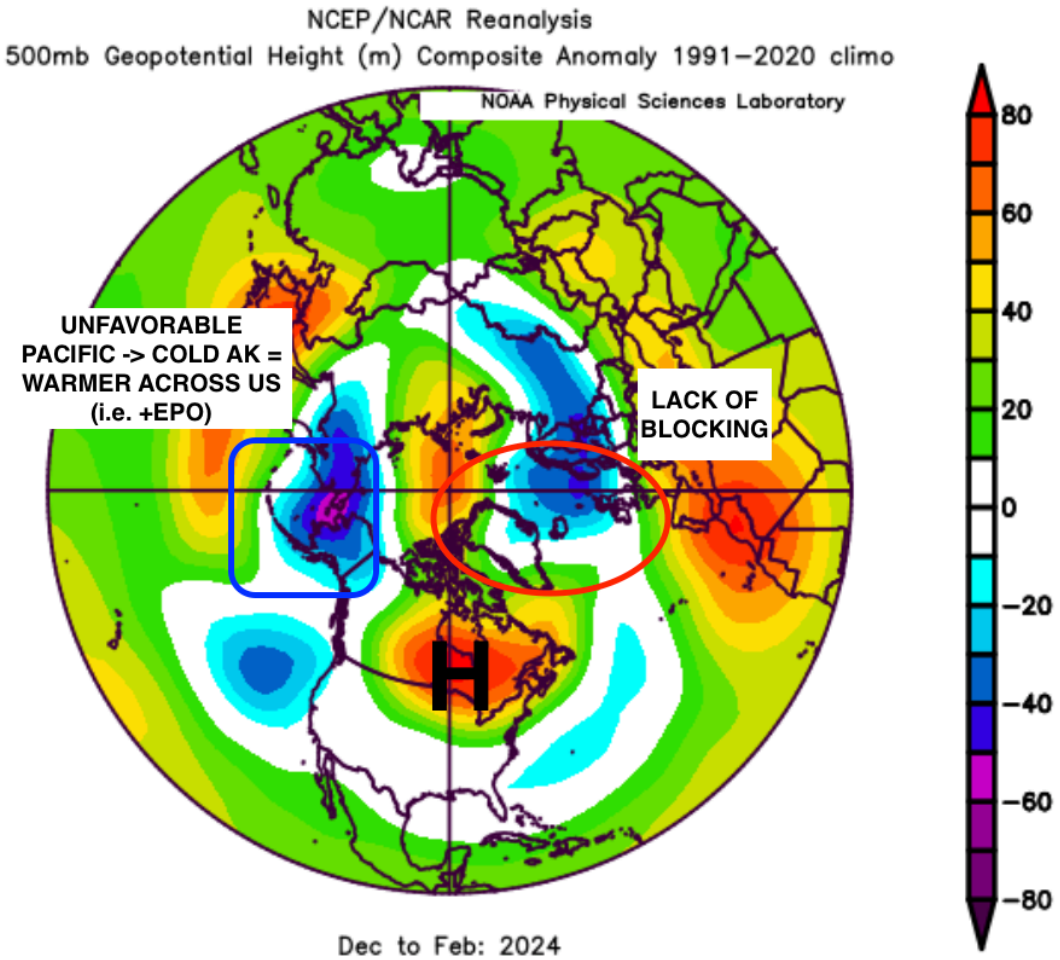


We now will answer the question, "Why"? Analyzing the 500mb height pattern we saw between Dec. and Feb.; several glaring components stand out.

1.) Clear lack of long-standing high latitude blocking. One of the reasons snow enthusiast's cheers for central-based Nino's are because there's a correlation to increased chances of blocking in the form of a -NAO. Blocking allows a greater dislodgement southward of colder air, which for obvious reasons increases chances of more snow. We certainly did see a polar blast in January and a few cold shots, but nothing was able to "hit and hold". High latitude blocking makes "phasing" between the polar and subtropical jet streams conducive, which is where we've seen our largest snow events in history. This winter was rather lackluster regarding that dynamic "duo".

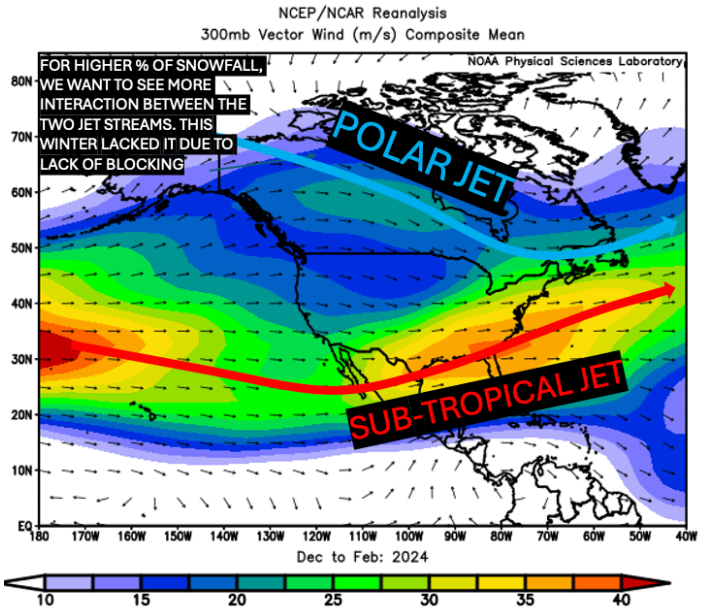
2.) This winter, the greatest averaged positive height anomaly was centered across southern Canada (typically observed during all El Nino's). This resulted in persistent sinking air and warmer surface temperatures, which implied lower snow and ice accumulations in general across that region. The sun's energy can focus into the ground much more and create warmer air that now can "bleed" into systems creating more mixing and more wet than white scenario's.

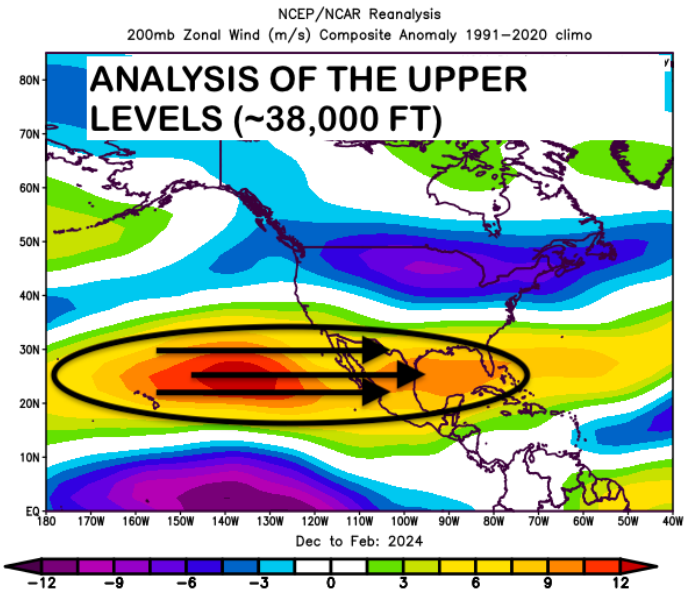
3.) When Alaska remains on the snowy and colder side, that typically means regions in the U.S. lean mild. It also implies that there was a tenacity to have troughiness (cold and active pattern) centered there. In order to have much colder air – and therefore higher chances for snow – we want to instead see a large blocking ridge over Alaska since it "forces" cold high pressure circulations into the lower 48. This winter feature a dearth of that type of pattern.



Further, we can also analyze how the jet streams interacted or in this case the lack thereof. Now since it's averaged, we can't deduce individual days since there were a few cases of interactions, but overall, this can tell the "story". For the most part, the polar jet remained stubbornly northward across Canada (again there's the lack of the -NAO's doings), while the sub-tropical jet was no short of staying active. That of course is not a surprise since one of the main characteristics of stronger Nino's is a very active southern jet!

In fact, us at The Weather Pro's picked out an interesting observation. In the 2nd composite below, this shows zonal winds at the upper level of the troposphere (where we assess upper-level jets). Notice how the deeper reds and oranges are streaming in from the eastern Pacific, which happened to be where the warmest waters were. This analysis of the zonal winds happens to be near max intensity, if not of record potential. Anecdotally, we believe that the "super charged" sub-tropical jet played a role in the overall performance in computer models. This means that while a model was showing a specific favorable track or an agreement, ended up drastically being different leading up to the event and this was the case a few times. While in general there'll always be uncertainty with every possible setup, this hypothesis has merit and could've certainly played a big role in the lack of snow events.





Regardless, the facts have been presented and undeniably it was both a very warm and overall snowless winter in several regions (other than parts of the Mid-Atlantic, Rockies, and Plains). Many of us seasonal forecasters were hoping that by the backend of the winter we'd see more of the "classic" El Nino responses by observing those

impactful large winter cyclones. Once again, it was always about ill-timing and lack of phasing that we needed to clash the cold and moisture together. Certainly, an improvement from last winter's record snowless winter but overall, it fell short of expectations. Going forward, we'll be transitioning into a La Nina most likely by this summer and be firmly in place by this fall. Just to leave the audience with something hopeful to walk away from, here's a composite from NOAA of all La Nina's since 1950 and how winters tend to look regarding snow. Usually, we see better snow prospects across the northern states, but as you very well know by now that there's always surprises and uncertainties in every winter!