Arctic Oscillation and Polar Vortex Analysis and Forecasts

December 26, 2023

Dr. Judah Cohen from Atmospheric and Environmental Research (AER) embarked on an experimental process of regular research, review, and analysis of the Arctic Oscillation (AO) and Polar Vortex (PV). This analysis is intended to provide researchers and practitioners real-time insights on one of North America's and Europe's leading drivers for extreme and persistent temperature patterns.

During the winter schedule the blog is updated once every week. Snow accumulation forecasts replace precipitation forecasts. Also, there is renewed emphasis on ice and snow boundary conditions and their influence on hemispheric weather. In late Spring, we transition to a spring/summer schedule, which is once every two weeks. Snow accumulation forecasts will be replaced by precipitation forecasts. Also, there will be less emphasis on ice and snow boundary conditions and their influence on hemispheric weather

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Summary

- The Arctic Oscillation (AO) is currently neutral and is predicted to be increasingly negative the next two weeks as pressure/geopotential height anomalies across the Arctic are currently mixed and are predicted to become increasingly positive over the next two weeks. The North Atlantic Oscillation (NAO) is currently positive with negative pressure/geopotential height anomalies across Greenland and the NAO is predicted to trend negative the next two weeks as pressure/geopotential height anomalies become increasingly positive across Greenland.
- This week, troughing/negative geopotential height anomalies in the North Atlantic including Greenland will force mostly ridging/positive geopotential height anomalies across Europe with troughing/negative geopotential height anomalies across Northern Europe but especially Scandinavia. This pattern will support widespread normal to above

normal temperatures across Europe including the United Kingdom (UK) with the exception of normal to below normal temperatures across Scandinavia this week but then next week cold temperatures will spread south from Scandinavia including the UK.

- This week the predicted general across Asia is ridging/positive geopotential height anomalies across Western Asia with troughing/negative geopotential height anomalies across Northeast Asia. Then next week the ridging/positive geopotential height anomalies across Western Asia will recede into the Eurasian Arctic allowing troughing/negative geopotential height anomalies to spread across Northern Asia. This pattern favors widespread normal to above normal temperatures across much of Asia with normal to below normal temperatures limited to Northern Siberia and northwest Russia this week. However next week the normal to above normal temperatures will become suppressed south across Asia with normal to below normal temperatures becoming much more widespread across Siberia and Northern Asia.
- The general predicted pattern across North America this week is troughing/negative geopotential height anomalies across Alaska and the Southern United States (US) with ridging/positive geopotential height anomalies across most of Canada. However next week troughing/negative geopotential height anomalies are predicted to persist over the US and deepen over Western Canada. This pattern favors widespread normal to above normal temperatures across North America with the exceptions of normal to below normal temperatures across Alaska and the Southern US the next two weeks and then next week cold temperatures should expand across Western Canada.
- in the Impacts section I discuss the growing likelihood of a large polar vortex (PV) disruption even a possible PV split and the impact on Northern Hemisphere (NH) weather.

Plain Language Summary

Mild weather persists across much of the Hemisphere (NH) continents with just regional exceptions of Alaska, Eastern Siberia and Scandinavia (see **Figure below**). Any anticipated cold across much of the NH is looking to be pushed off into the new Year. A relatively minor perturbation of the polar vortex (PV) where it stretches out like a rubber band to end the month will bring more seasonable temperatures to parts of Canada and the Eastern US (see **Figure 5**).

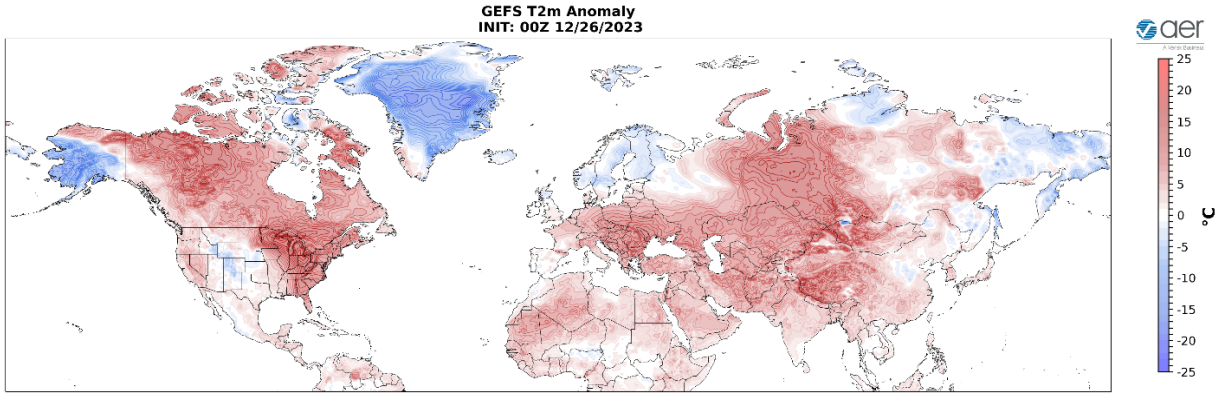

Figure. Observed surface temperature anomalies (°C; shading) for 26 December 2023. The forecast is from the 00Z 16 December 2023 GFS ensemble.

Still a larger PV disruption is more and more likely in early January that has the potential to reverse the overall mild pattern for the NH to a colder one. The regions that should first turn colder in response to the large PV disruption are Northern Europe and Siberia (see **Figure 8**). With time the cold air should spread into the Eastern US as well. Still much uncertainty exists with critical details.

Impacts

There is a saying "If it were easy everyone would be doing it and you wouldn't have an opportunity." So as much as I am tempted to complain about the difficulties of trying to be the polar vortex (PV) whisperer, I guess that is what provides me a platform and why I am writing this blog on my day off.

First if you are keeping score at home the PV has so far this month experienced a Canadian warming, then a PV stretch back to a Canadian warming and that is where we stand currently. In my opinion next comes another PV stretch (all three models agree – GFS, ECMWF and Canadian). I present the Wave Activity Flux (WAF) in the vertical and longitudinal direction in **Figure i**. Again, the characteristic upward and eastward WAF can be seen over the Eurasian sector and then downward and eastward over North America. And unlike the PV stretch in mid-December where the impacts were large in East Asia (record cold and snow) but minimal in eastern North America, this time the impacts look to be a little more significant in eastern North America. Though I do think that the PV stretch was impactful enough to allow a rapid freeze up of Hudson Bay (see **Figure 16**), which I think should not be discounted. I do believe that the unusual open water late into the fall and early winter in Hudson Bay was probably extending or perpetuating ridging and record warm temperatures in eastern North America. The stretched PV in my opinion also contributed to the strong nor'easter that wrought damaging winds and flooding to New England.

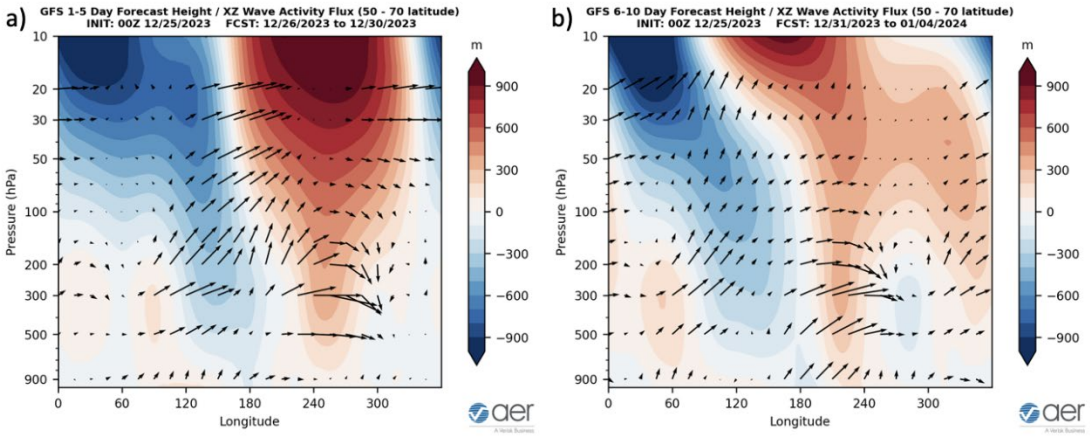

Figure i. Longitude-height cross section of geopotential eddy height anomalies (shading) and wave activity flux (vectors) forecasted for **a)** 26 – 30 December 2023 and **b)** 31 December 2023 – 4 January 2024. The forecasts are from the 00z 25 December 2023 GFS ensemble.

But then comes the $64,000 question: what does the PV do for its tour de force or climax? Looks like a sudden stratospheric warming. But then two more questions is it a major warming (reversal of the zonal mean zonal winds at 60°N and 10hpa) or just a minor warming (spike in temperatures at the North Pole at 10hPa but no zonal wind reversal). And the final question is will it be a displacement (PV center moves south but stays intact) or it splits into two daughter vortices. From what I can tell the Canadian is most aggressive with the PV (full split), split the ECMWF (no split) see is the least aggressive and the GFS is in between (brief split and will not technically qualify.

If you follow from what I wrote last week, one important difference over the course of the week are the model forecasts now persisting longer Ural blocking or high-pressure ridging (see **Figures 2** and **5**). The models struggle predicting this feature and the scenario where the models lose the Ural blocking prematurely is a scenario that I mentioned last week. So at least I think the chances of a major warming are now higher than I thought last week based on the longer persistence of Ural blocking. I think that the probabilities of a major warming are greater than 50% but I have to admit to having a preference bias. All the model forecasts are really close. For example, I include the NASA GEOS forecast in **Figure ii** that predicts that the zonal mean zonal winds at 60°N and 10hpa will just barely cross into negative or easterly territory.

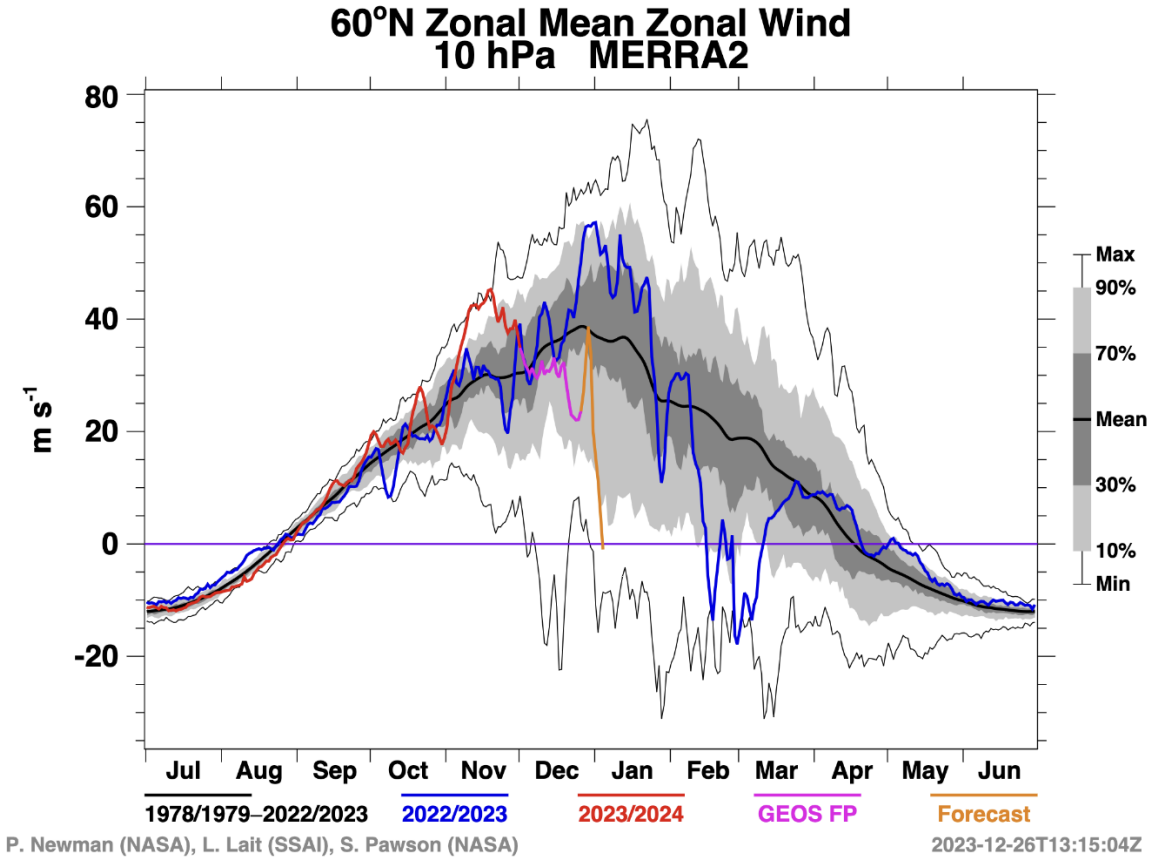

Figure ii. **a)** Observed and predicted daily zonal mean zonal winds at 60°N and 10hpa from the NASA GEOS model. Plot taken from https://acd-ext.gsfc.nasa.gov/Data_services/met/ann_data.html.

And as far as the answer on whether ultimately, we observe a PV displacement or split, I guess that I need to put my money where my mouth is. I have not been shy pointing out the wave-two structure in the mid-troposphere, which I feel favors a PV split and let's not forget a PV stretch, so I think I need to be consistent and hang in there with the PV split eventually emerging once the dust settles. But once again I could be wrong, and the predicted wave-2 is less apparent in the more recent model forecasts.

It's complicated enough trying to figure out what the PV will do over the next few weeks, it is a much more challenging anticipating the impacts to our weather. One rule of thumb is that the impacts from an SSW take about two weeks to influence the weather as seen with the AO/NAO turning negative or warm/positive polar cap geopotential height anomalies (PCHs). However, looking at the latest PCHs forecast (see **Figures 1** and **11**), it appears the impacts will be almost immediately and that could be in part because the PV was perturbed already immediately preceding the SSW. Though it is my opinion there is a nearly immediate impact from all SSWs on our weather, but it may be more nuanced and/or regional.

In fact, if you look at **Figure 11** long enough, you can convince yourself that the predicted warm/positive PCHs in the lower troposphere and negative AO (see **Figure 1**) in early January are a result of downward propagation or influence from the upper stratosphere that was a result of the first Canadian warming, and the timing is consistent with the rule of thumb two week delay. But all of this, I feel complicates what predicting what will be the impacts not just one but multiple PV disruptions. This situation reminds me of the SSW back in 2021 where it also was unusually complicated. Of course, the fact that I know to identify more different behaviors of the PV could add complexity not because the PV is doing anything unusual, just I didn't know to recognize it previously and now I do.

So here are my thoughts on the influence we may see from the different PV disruptions. The stretched PV will bring seasonably colder weather to eastern North America including parts of the US heading into the New Year. Then coincident with the SSW itself colder temperatures are likely to become widespread across Northern Eurasia. Siberia is the region most likely to experience colder temperatures at the time of the SSW and the immediate following weeks. I do think that Northern Europe will also see expanding below normal temperatures related to the proximity of the PV center and because the lowest geopotential heights relative to normal over Northern Europe (see **Figure 13b**). Usually, any cold weather in the Eastern US is delayed by two weeks following an SSW and therefore I would relate any colder weather in the US early next month to the immediately preceding stretched PV and not the SSW. So we could see a milder pattern in the Eastern US after the colder start to the New Year in the Eastern US. Often at the time of the SSW and immediately following it is colder in western North America for reasons that I don't know why. But a lot will likely depend on the evolution of the SSW and if a minor daughter vortex center can form over eastern North America from that lobe of low heights seen over Quebec in **Figure 13b**, that could hasten the return of colder weather.

I am sure that this will be the kiss of death (as you can see the scars of disappointment from the weather, especially Northeast snowstorms, cut very deep) but I thought it would be useful to look at some recent PV splits in **Figure iii** starting in February 2001 around the dates when the SSW achieved major warming status (my apologies for the postage stamp plot and hopefully you can see the individual plots clearly with enlargement). I did not include January 2006 where the split took a while to develop, and the evolution looks quite different. I also included January 2015 that technically did not achieve major warming status, may have actually been an extreme stretched PV event, but does resemble the current event in evolution in the polar stratosphere. But to my eye the event that looks most similar to the current event, at least as predicted by the models, is February 2010 and it has the advantage of being also a moderate to strong El Niño winter.

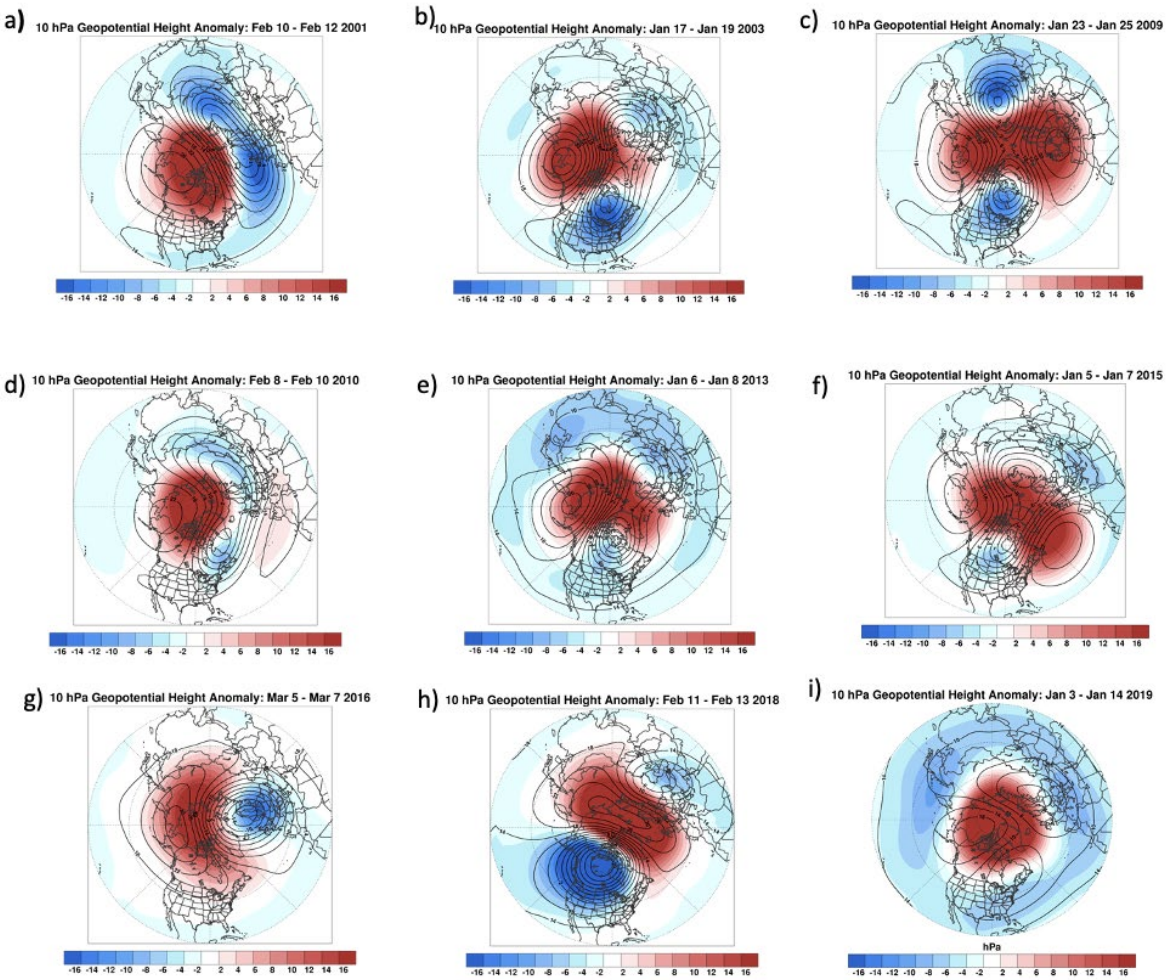

Figure iii. Observed 10hPa geopotential heights (contouring) and anomalies (shading) for a) February 10-12, 2001, b) January 17-19, 2003, c) January 23-25, 2009, d) February 8-10, 2010, e) January 6-8, 2013, f) January 5-7, 2015, g) March 5-7, 2016, h) February 11-13, 2018, and i) January 3-14, 2019.

In **Figure iv**, I show the NH surface temperature anomalies that followed the SSW for multiple weeks or until the end of the winter starting about two weeks after the SSW central date (when major warming status is first observed). There is quite a bit of event-to-event variability but for me there are a few takeaways. First not surprising Siberia has the highest likelihood of experiencing below normal temperatures following the SSW with the exception of 2015, which may not be a good analog anyway. Siberia was also not cold after the SSW in 2016 but that was very late, and I think technically is defined as a Final Warming since the PV never recovered. Eastern North America including the Eastern US also has a high probability of experiencing colder than normal temperatures following the SSW. Northern and Western Europe are also often cold following the SSW. East Asia can be cold as well, but it has been shown that East Asia experience its most intense cold leading up to the SSW and not following the

SSW. Following the SSW in February 2010, possibly the best analog, relative temperatures were cold in Siberia, Europe and the Eastern US. That was one of the most widespread cold events following an SSW in recent memory but probably hard to duplicate given the record warm the fall and the record warm ocean temperatures.

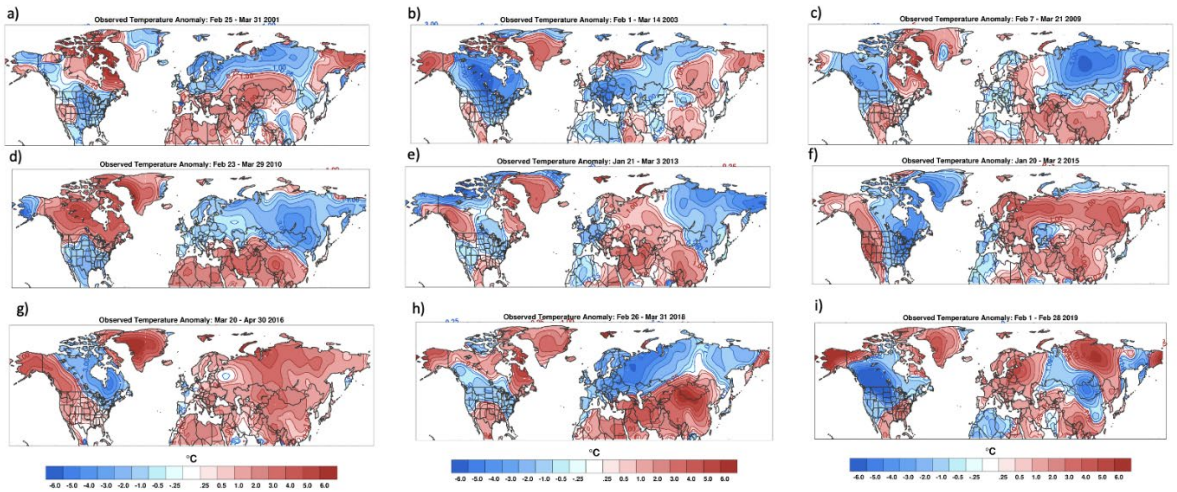

Figure iv. Observed surface temperature anomalies (shading) for a) February 11-24, 2001, b) January 18-31, 2003, c) January 24-February 6, 2009, d) February 9-22, 2010, e) January 7-20, 2013 f) January 6-19, 2015, g) March 6-19, 2016, h) February 12-25, 2018 and i) February 1-28, 2019.

There is also January 2021, which was very complicated and not sure how to categorize it. SSW status was achieved on three separate dates spread out over a month (see **Figure v**). At first it was a displacement in early January, then maybe a PV split in mid-January and then finally a stretched PV in early February.

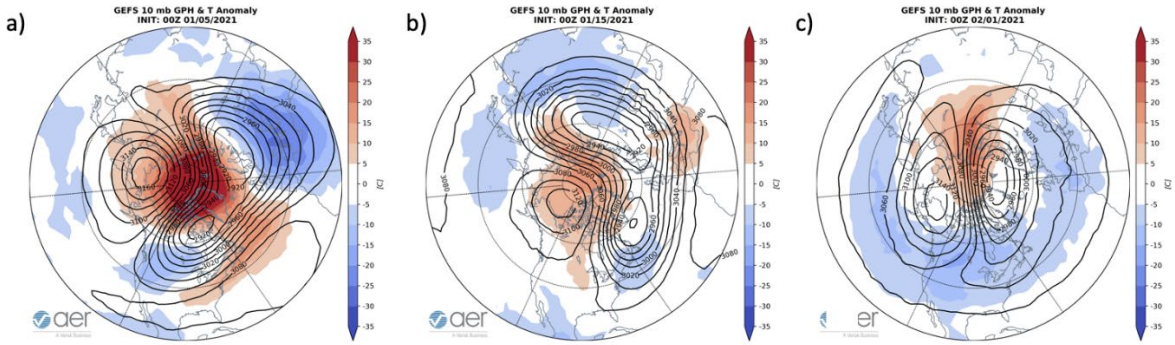

Figure v. Observed 10hPa geopotential heights (contouring) and anomalies (shading) for a) January 5, 2021, b) January 15, 2021, c) February 1, 2021,

For now, I don't see this event as a good analog but for completeness I will show the surface temperature anomalies for the whole winter in **Figure vi** so you can get the idea. The temperature anomalies support that Siberia is the region most sensitive to SSWs. It was cold in the Central and Eastern US but much of that was related to the stretched PV in February and less so to the SSW in January. And Europe was warm that winter.

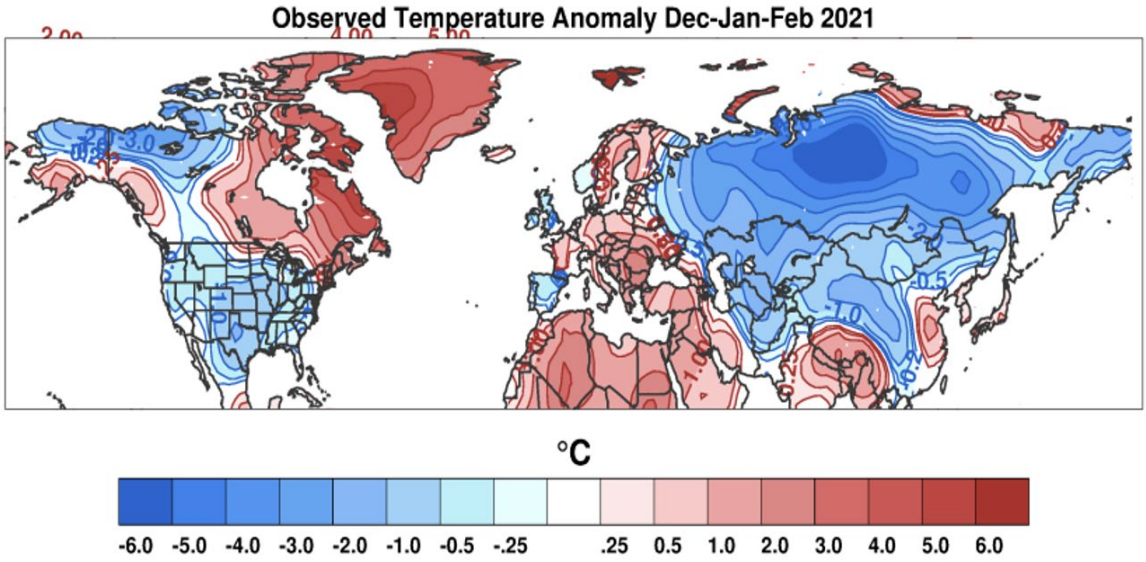

Figure. Observed surface temperature anomalies (°C; shading) for 1 December 2020 – 28 February 2021. The observed temperatures are from the NCEP/NCAR reanalysis.

If my posting the plots for split PVs is successful in stopping the PV split from happening, I will post for PV displacements next. But I will leave you with this final thought, if a major SSW materializes the surface temperature anomalies for December (see **Figure vii**) could be a good predictor for the surface temperature anomalies for the winter as a whole, especially across Eurasia.

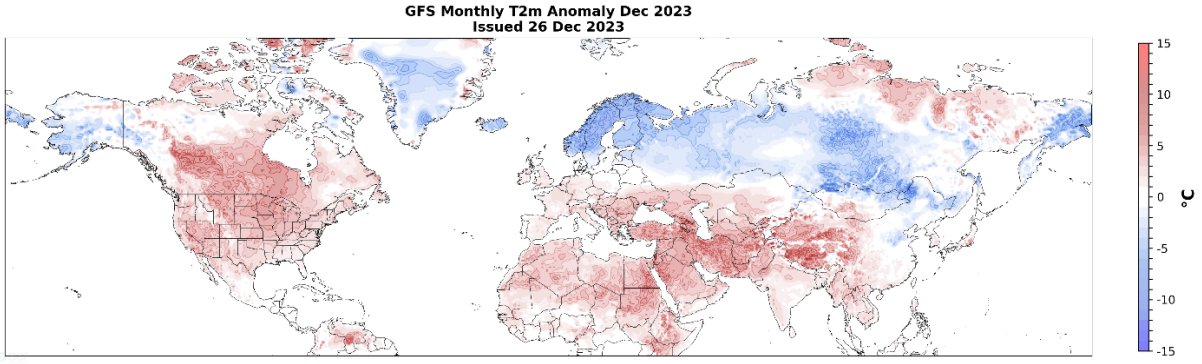

Figure vii. Estimate of the observed surface temperatures (°C; shading) from 1 – 26 December 2023 based on GFS initializations.

Near-Term

This week

The AO is predicted to be neutral this week **(Figure 1)** with mixed geopotential height anomalies across the Arctic and with mixed geopotential height anomalies across the mid-latitudes of the NH (**Figure 2**). With predicted negative geopotential height anomalies across Greenland (**Figure 2**), the NAO is predicted to be positive this period.

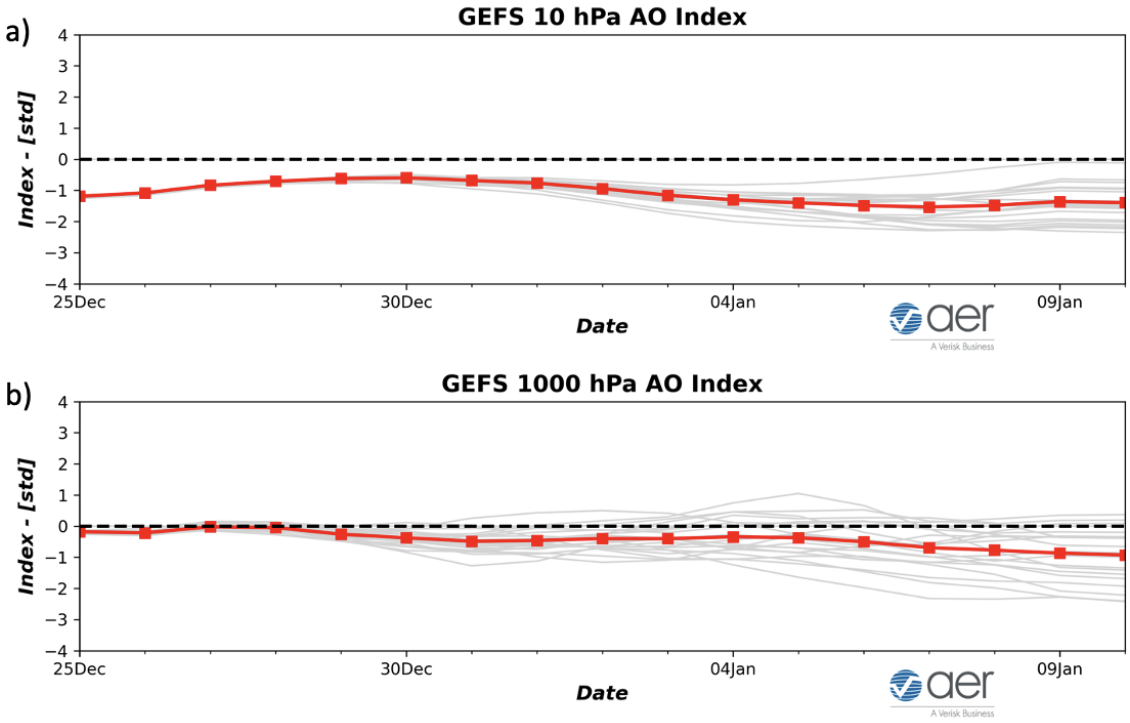

Figure 1. (a) The predicted daily-mean AO at 1000 hPa from the 00Z 26 December 2023 GFS ensemble. (b)The predicted daily-mean near-surface AO from the 00Z 26 December 2023 GFS ensemble. Gray lines indicate the AO index from each individual ensemble member, with the ensemble-mean AO index given by the red line with squares.

Troughing/negative geopotential height anomalies across the North Atlantic Arctic including Greenland will support ridging/positive geopotential height anomalies across much of Europe with the exception of troughing/negative geopotential height anomalies across Northern Europe this week (**Figures 2). The** zonal flow pattern favors widespread normal to above normal temperatures across Europe including the UK with the exception of normal to below normal temperatures across Scandinavia mostly due to low heights (**Figure 3**). Predicted this period are ridging/positive geopotential height anomalies are predicted across Western Asia with troughing/negative geopotential height anomalies across Northeastern Asia this period (**Figure 2**). This pattern favors widespread normal to above normal temperatures across

much of Asia with normal to below normal temperatures mostly limited to Northern Siberia **(Figure 3**).

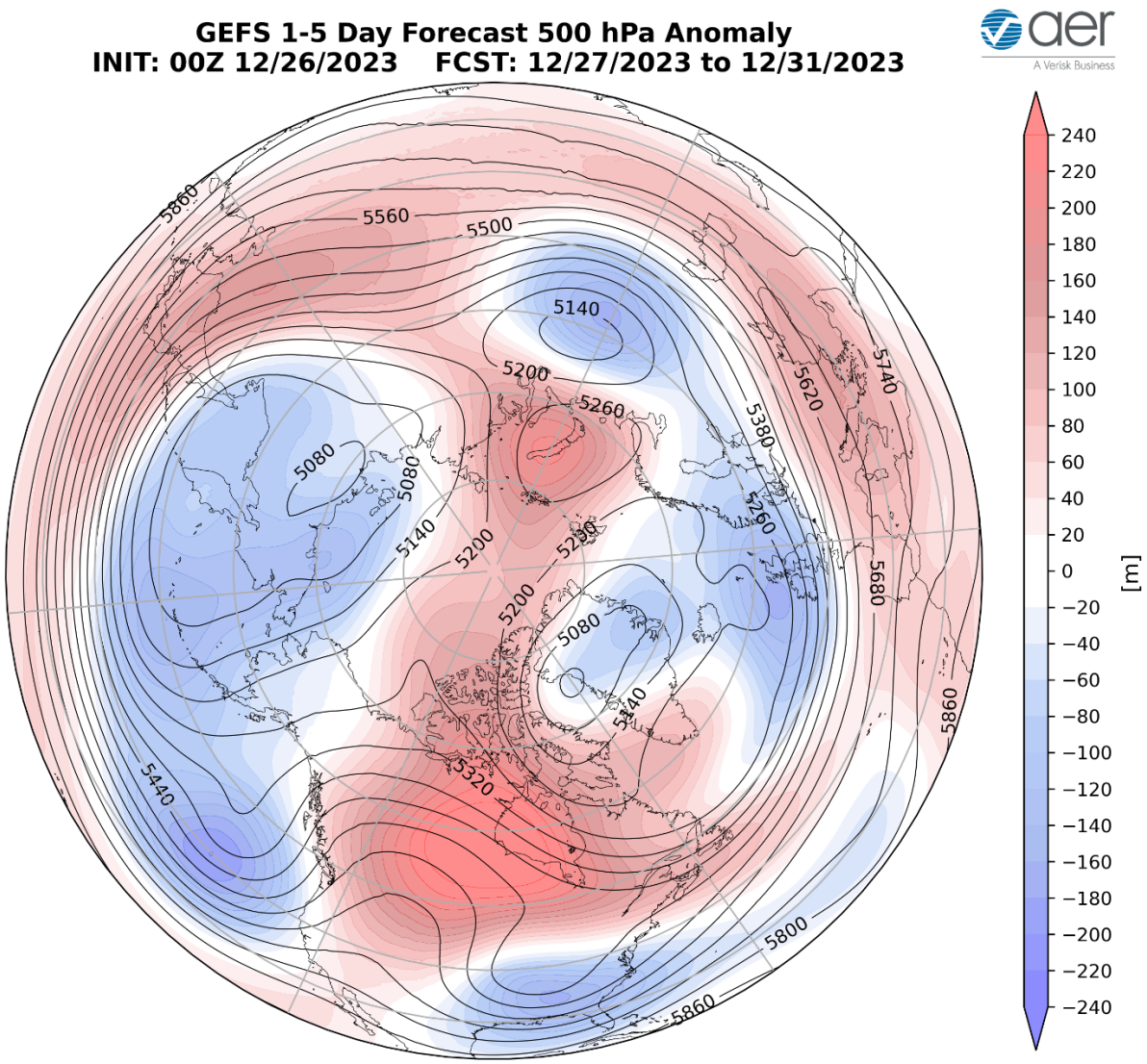

Figure 2. Forecasted average 500 mb geopotential heights (dam; contours) and geopotential height anomalies (m; shading) across the Northern Hemisphere from 27 – 31 December 2023. The forecasts are from the 00z 26 December 2023 GFS ensemble.

The pattern this week across North America is troughing/negative geopotential height anomalies across Alaska and the Gulf of Alaska forcing across ridging/positive geopotential height anomalies across Canada and the Northern US with more troughing in the Southern US **(Figure 2).** This pattern will favor normal to above normal temperatures across much of Canada and the US with normal to below normal temperatures limited to Alaska and the Southcentral US **(Figure 3).**

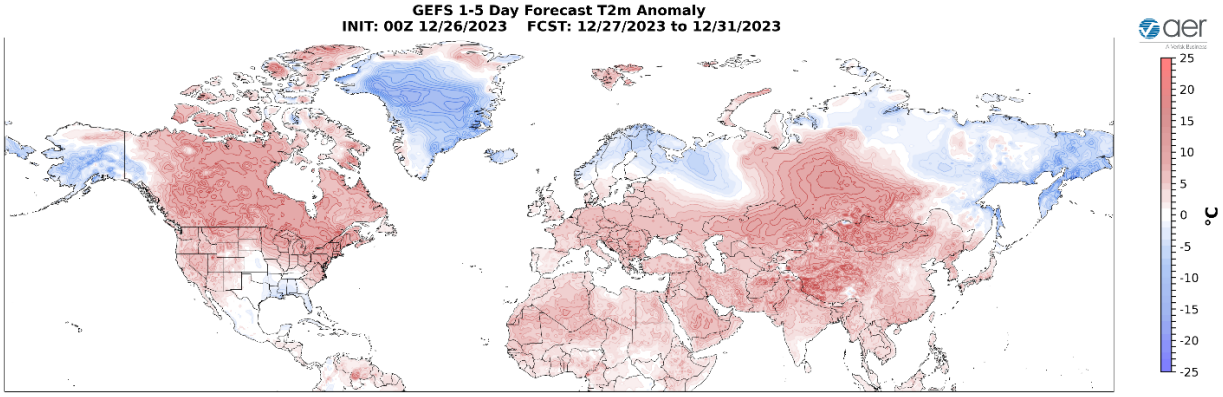

Figure 3. Forecasted surface temperature anomalies (°C; shading) from 27 – 31 December 2023. The forecast is from the 00Z 26 December 2023 GFS ensemble.

Troughing and/or cold temperatures will support new snowfall across Norway, Siberia and Central Asia while mild temperatures will support snowmelt across Sweden, Finland and Western Russia this week (**Figure 4**). Troughing and/or cold temperatures will support new snowfall across Southern Alaska and Northern Canada while mild temperatures will support snowmelt across Southwestern Canada, the US Rockies and the US Plains this week (**Figure 4**).

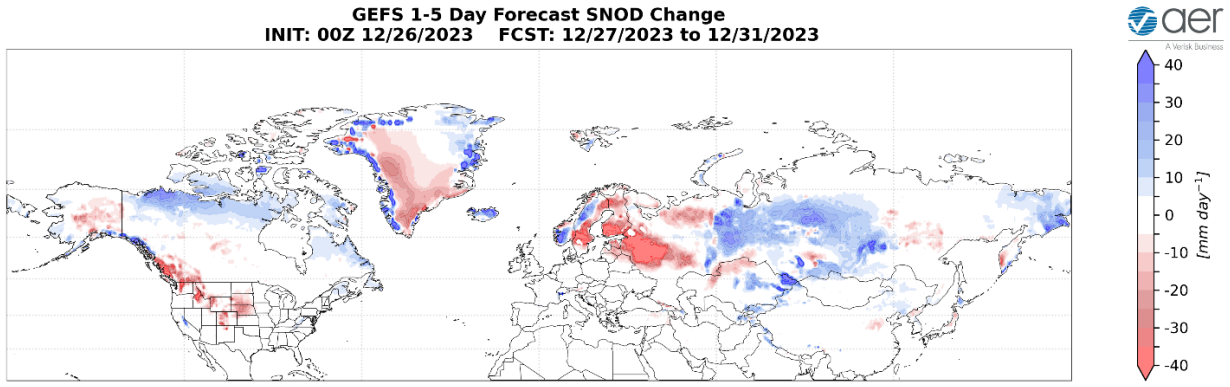

Figure 4. Forecasted snow depth changes (mm/day; shading) from 27 – 31 December 2023. The forecast is from the 00Z 26 December 2023 GFS ensemble.

Near-Mid Term

Next week

With mostly positive geopotential height anomalies across the Arctic and with mixed geopotential height anomalies across the mid-latitudes this period (**Figure 5**), the AO should turn negative this period (**Figure 1**). With predicted mixed pressure/geopotential height anomalies across Greenland (**Figure 5**), the NAO will also land close to neutral this period.

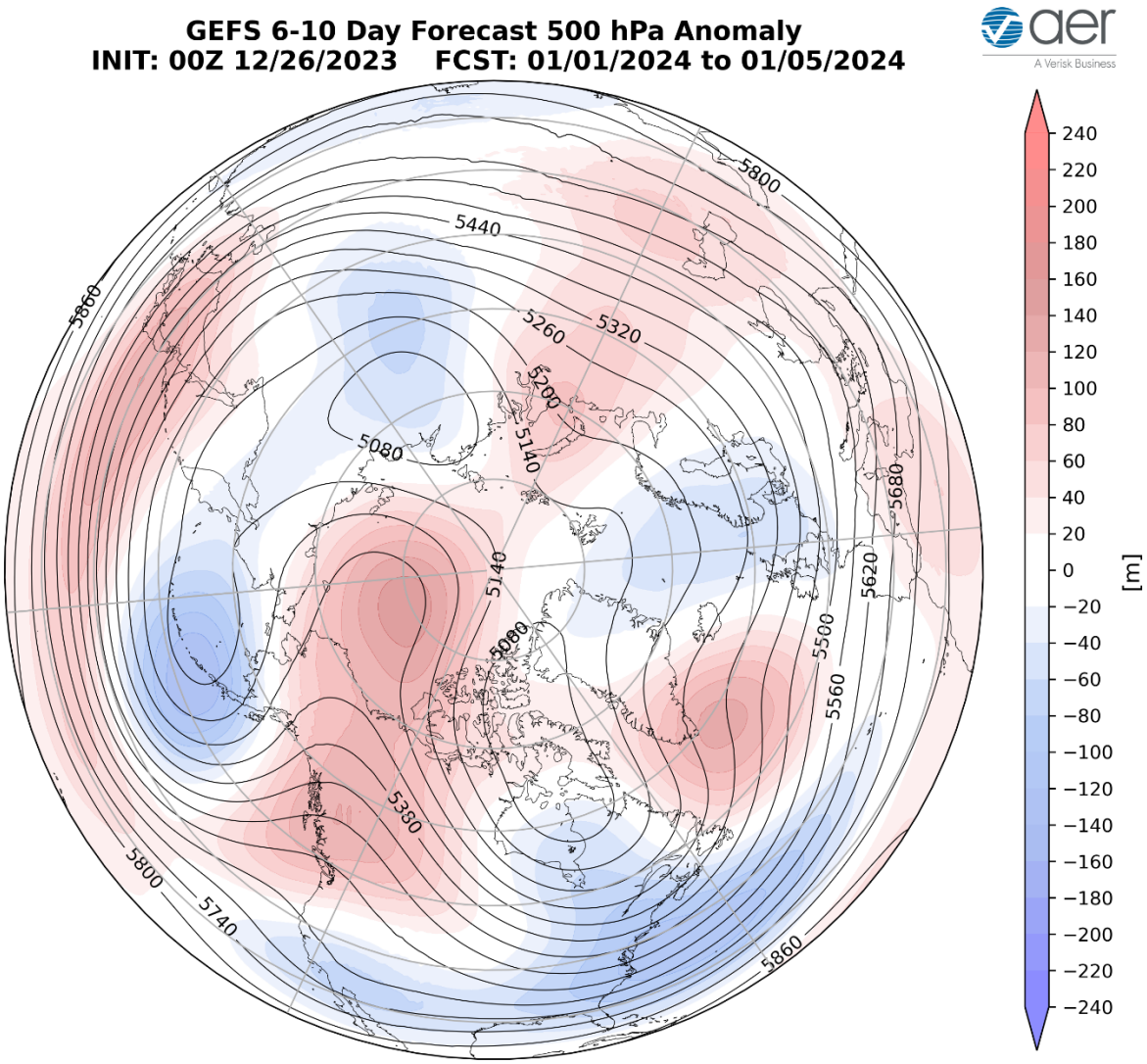

Figure 5. Forecasted average 500 mb geopotential heights (dam; contours) and geopotential height anomalies (m; shading) across the Northern Hemisphere from 1 – 5 January 2023. The forecasts are from the 00z 26 December 2023 GFS ensemble.

Persistent troughing/negative geopotential height anomalies across the North Atlantic including Northern Europe will support ridging/positive geopotential height anomalies across Southern Europe this period (**Figure 5**). The zonal pattern will favor widespread normal to above normal temperatures across Southern and Central Europe with normal to below normal temperatures across Northern Europe including the UK due to low heights (**Figures 6**). Ridging/positive geopotential height anomalies will persist across Western Asia with troughing/negative geopotential height anomalies across Siberia this period (**Figure 5**). This pattern favors widespread normal to above normal temperatures across much of Asia with normal to below normal temperatures across Siberia this period (**Figure 6**).

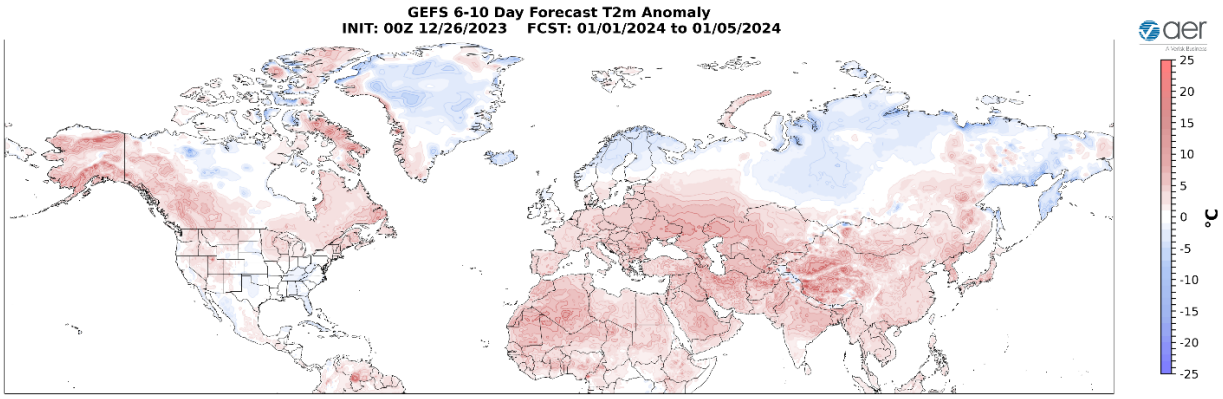

Figure 6. Forecasted surface temperature anomalies (°C; shading) from 1 – 5 January 2023. The forecasts are from the 00z 26 December GFS ensemble.

The predicted general pattern across North America this period is ridging/positive geopotential height anomalies across Alaska and Western Canada forcing troughing/negative geopotential height anomalies across Eastern Canada and much of the US (**Figure 5**). This pattern favors widespread normal to above normal temperatures across Alaska, much of Western and Eastern Canada and the Northern and Western US with normal to below normal temperatures across Central Canada and the Southern US (**Figure 6**).

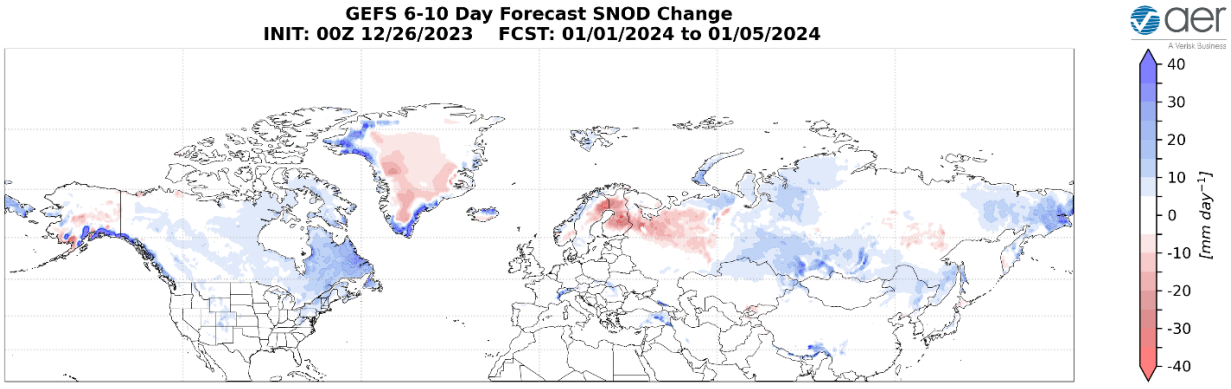

Figure 7. Forecasted snow depth changes (mm/day; shading) from 1 – 5 January 2023. The forecast is from the 00Z 26 December 2023 GFS ensemble.

Troughing and/or cold temperatures will support new snowfall across the Alps, Siberia and Northeastern China while mild temperatures will support snowmelt in Scandinavia, the Tibetan Plateaus and Western Russia this period (**Figure 7**). Troughing and/or cold temperatures will support new snowfall across southern Alaska, the West Coast of Canada, Eastern Canada, the higher elevations of the Western US and New England while mild temperatures will support snowmelt in in Central Alaska this period (**Figure 7**).

Mid Term

Week Two

With increasingly positive geopotential height anomalies across the Arctic and mixed geopotential height anomalies across the mid-latitudes this period (**Figure 8**), the AO should turn more strongly negative this period (**Figure 1**). With predicted positive pressure/geopotential height anomalies across Greenland (**Figure 8**), the NAO should turn negative as well this period.

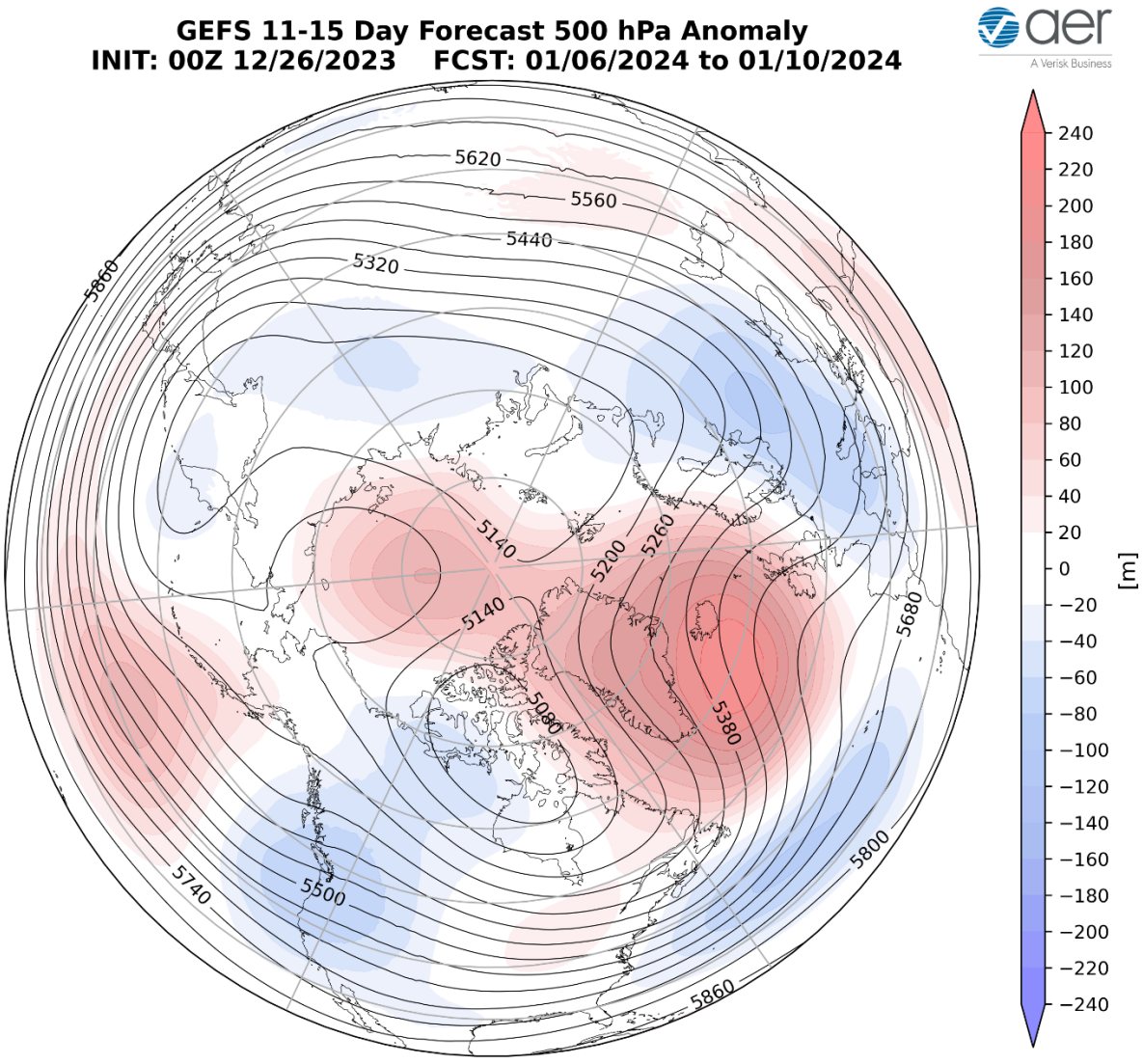

Figure 8. Forecasted average 500 mb geopotential heights (dam; contours) and geopotential height anomalies (m; shading) across the Northern Hemisphere from 6 – 10 January 2024. The forecasts are from the 00z 26 December 2023 GFS ensemble.

Predicted ridging/positive geopotential height anomalies should force deepening troughing/negative geopotential height anomalies across Europe this period (**Figure 8**). This pattern should favor normal to below normal temperatures across most of Northern and Central Europe including the UK with normal to above normal temperatures across Southern Europe this period (**Figures 9**). With ridging/positive geopotential height anomalies continuing to consolidate across the Arctic will help deepen troughing/negative geopotential height anomalies across Northern and Eastern Asia this period (**Figure 8**). The predicted pattern favors widespread normal to above normal temperatures widespread across Southern and Central Asia with normal to below normal temperatures across Northern and Eastern Asia this period (**Figure 9**).

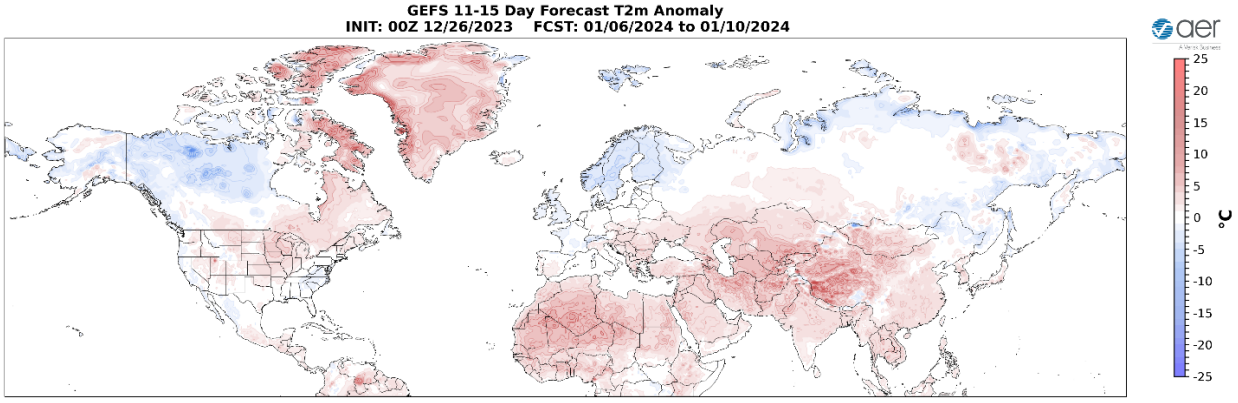

Figure 9. Forecasted surface temperature anomalies (°C; shading) from 6 – 10 January 2024. The forecasts are from the 00z 26 December 2023 GFS ensemble.

Strengthening ridging/positive geopotential height anomalies near the Aleutians will force troughing/negative geopotential height anomalies in the Gulf of Alaska and western North America with more ridging/positive geopotential height anomalies across Eastern Canada and the Eastern US with deepening troughing/negative geopotential height anomalies in the Eastern US this period (**Figure 8**). This pattern favors normal to below normal temperatures across Alaska, Western and Central Canada and the Western and Southern US with normal to above normal temperatures across Eastern Canada and the Central and Northern US (**Figure 9**).

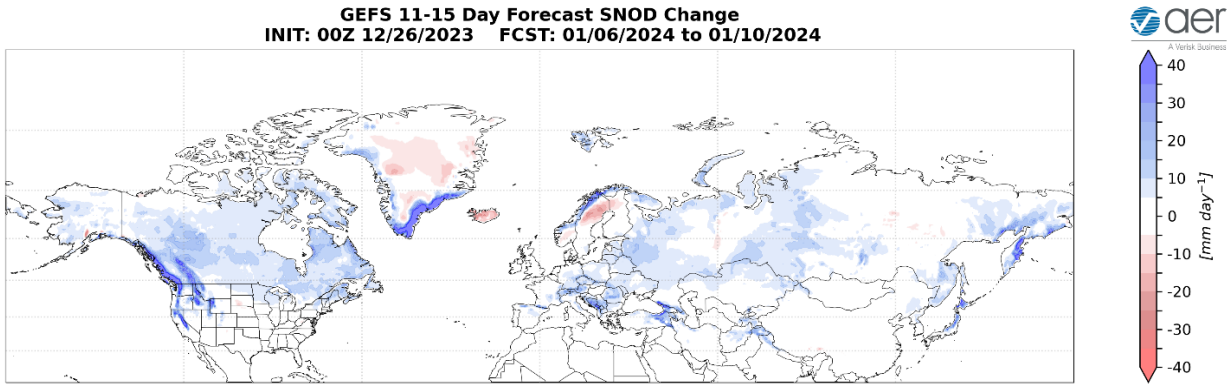

Figure 10. Forecasted snow depth changes (mm/day; shading) from 6 – 10January 2024. The forecast is from the 00Z 26 December 2023 GFS ensemble.

Troughing and/or cold temperatures will support new snowfall across Norway, the Alps, Eastern Europe, Western Asia, Siberia and Northeast Asia while mild temperatures will support snowmelt in Sweden this period (**Figure 10**). Troughing and/or cold temperatures will support new snowfall across western Alaska much of Canada and the higher elevations of the Western US and New England. Mild temperatures will support snowmelt in US Central Plains this period (**Figure 10**).

Longer Term

30–day

The latest plot of the polar cap geopotential height anomalies (PCHs) currently shows cold/negative PCHs in the upper stratosphere with warm/positive PCHs in the mid to lower stratosphere and the troposphere (**Figure 11**). However, next week PCHs in the stratosphere are predicted to become increasingly warm/positive associated with a sudden stratospheric warming. Warm/positive PCHs will continue in the troposphere (**Figure 11**).

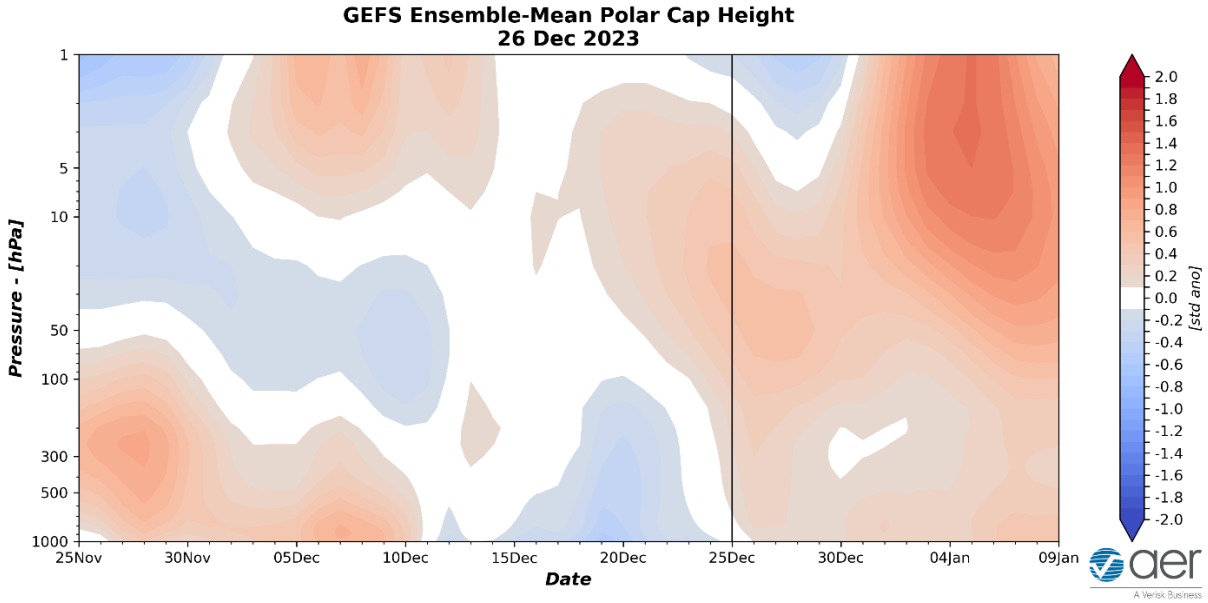

Figure 11. Observed and predicted daily polar cap height (i.e., area-averaged geopotential heights poleward of 60°N) standardized anomalies. The forecast is from the 00Z 26 December2023 GFS ensemble.

The predicted neutral to warm/positive PCHs in the lower troposphere for the next two weeks (**Figure 11**) are consistent with the predicted neutral to negative surface AO the next two weeks (**Figure 1**).

Also shown in **Figure 1** is the stratospheric AO. The stratospheric AO is currently negative and is predicted to dip further negative the next two weeks. This is consistent with increasingly warm/positive stratospheric PCHs. The forecast of warming PCHs likely signals an increasing likelihood of a sudden stratospheric warming in late December and in early January.

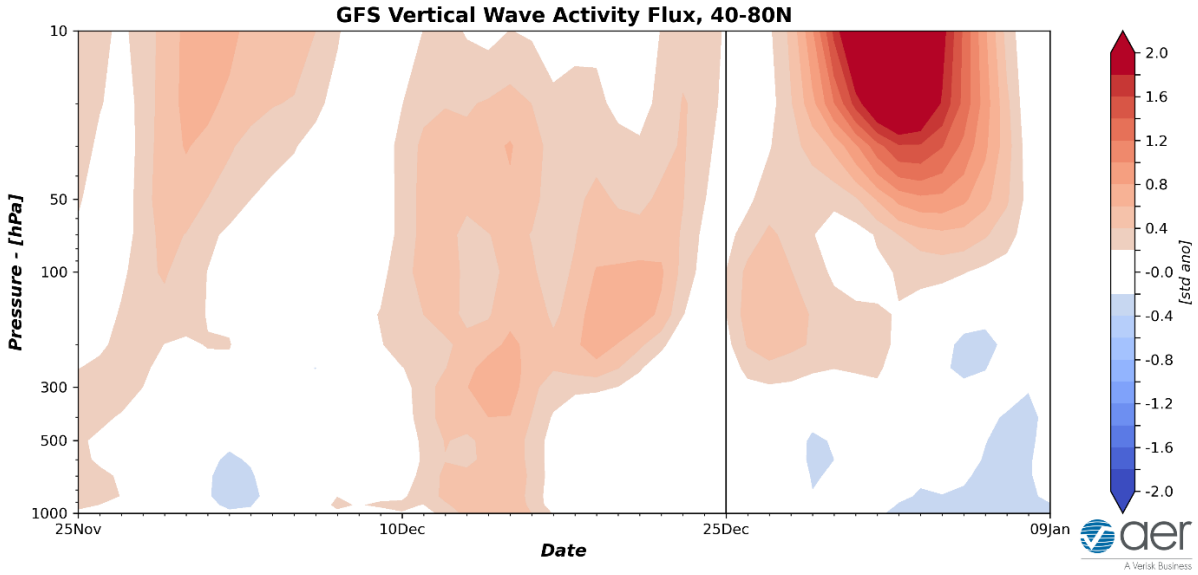

Figure 12. Observed and predicted daily vertical component of the wave activity flux (WAFz) standardized anomalies, averaged poleward of 40-80°N. The forecast is from the 00Z 26 December2023 GFS ensemble.

Vertical Wave Activity Flux (WAFz) from the troposphere to the stratosphere or poleward heat transport in the stratosphere has been active since mid-November (**Figure 12**). This has resulted in the in multiple but brief minor PV disruptions (**Figure 12**) and the return of the stratospheric AO to neutral and now negative (**Figure 1**). Over the next two weeks the WAFz is predicted to become even more active (**Figure 12**), which should result in a sudden stratospheric warming even possibly a major warming.

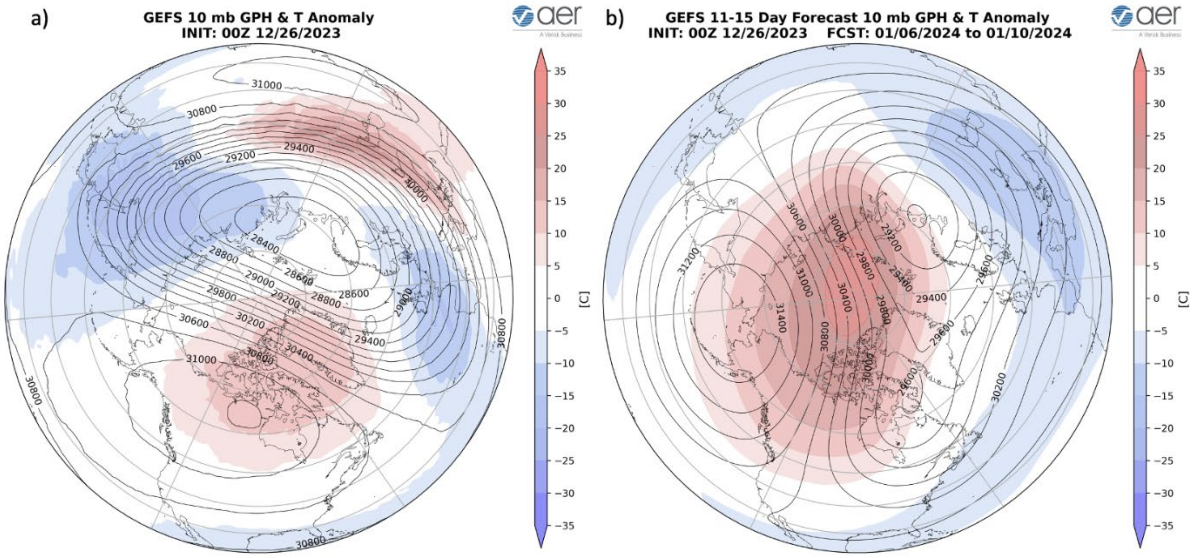

Figure 13. (a) Initialized 10 mb geopotential heights (dam; contours) and temperature anomalies (°C; shading) across the Northern Hemisphere for 26 December 2023 . (b) Same as (a) except forecasted averaged from 6 – 10 January 2024. The forecasts are from the 00Z 26 December 2023 GFS model ensemble.

Currently the polar vortex (PV) is elongated in shape with the PV center shifted south of the North Pole over the Barents Kara Seas (**Figure 13a**). This elongated PV configuration is predicted oriented along an axis from Siberia to Scandinavia. Across North America, a ridge is centered across Northern Canada with the strongest warming centered in the Canadian Maritimes. This PV configuration is consistent with a Canadian warming that favors colder temperatures across northern Eurasia with mild temperatures across North America. Then next week the PV center slides towards Northwest Russia with an elongated shape but now oriented from Western Russia towards Quebec coupled with warming more widespread in the polar stratosphere more characteristic of a sudden stratospheric warming (**Figure 13b**). It is possible that a second minor vortex forms over Canada that would result in a split PV.

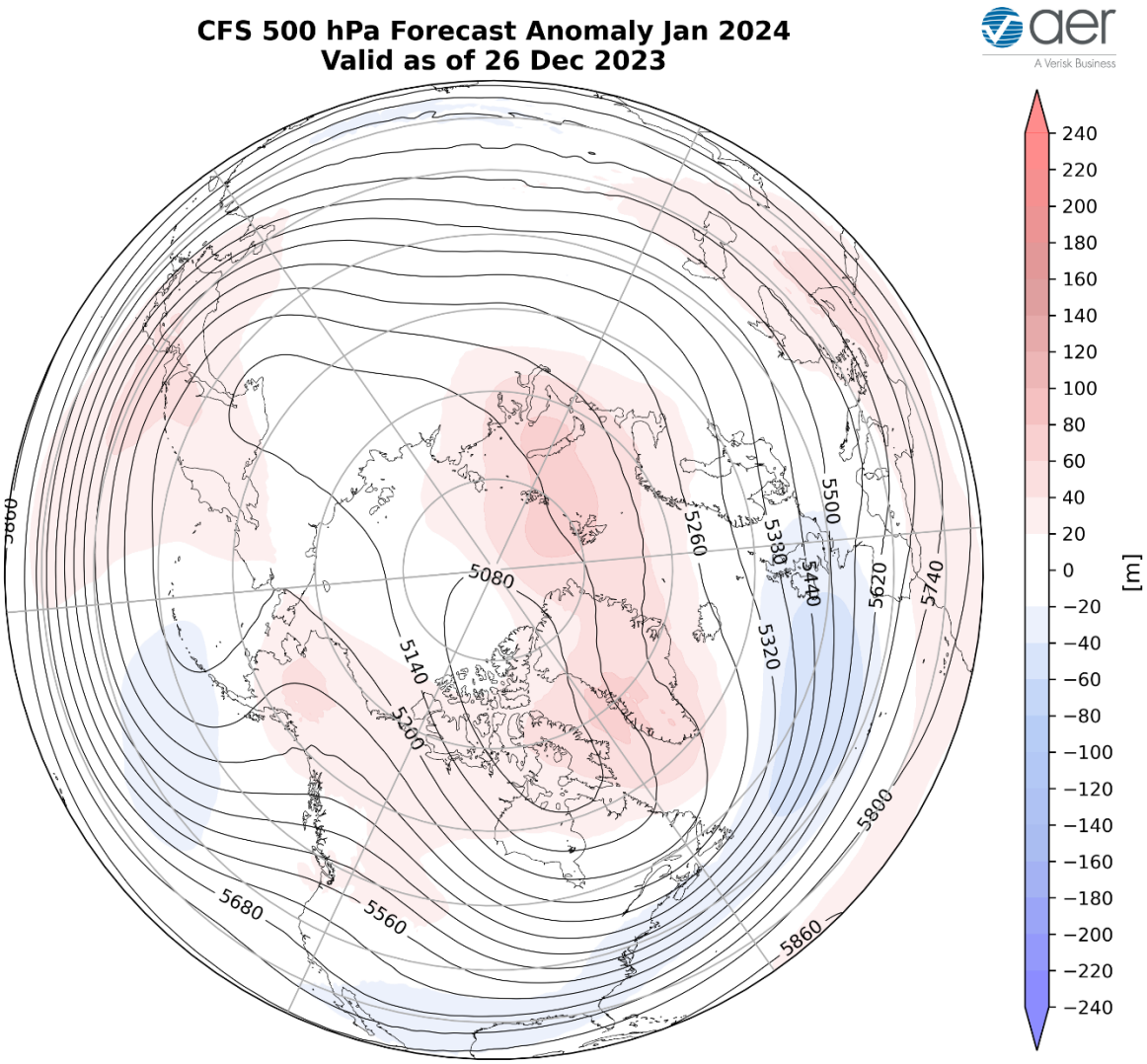

Figure 14. Forecasted average 500 mb geopotential heights (dam; contours) and geopotential height anomalies (m; shading) across the Northern Hemisphere for January 2024. The forecasts are from the 00Z 26 December 2023 CFS.

I include in this week's blog the monthly 500 hPa geopotential heights (**Figure 14**) and surface temperatures for January (**Figure 15**) from the Climate Forecast System (CFS; the plots represent yesterday's four ensemble members). The forecast for the troposphere is ridging stretching from Greenland to the Barents-Kara Seas, Eastern Siberia, Alaska and Western Canada with troughing in the mid-latitudes of the North Atlantic, Eastern Europe, the Urals, Siberia, Northeast Asia, the Aleutians and eastern North America (**Figure 14).** This pattern is consistent with a negative AO that often follows an SSW. This pattern favors seasonable to relatively warm temperatures across Southern Europe, Southern and Central Asia, Eastern Siberia, Alaska, Western Canada and the Western US with seasonable to relatively cold temperatures across Northern Europe, Siberia, Northeast Asia, Eastern Canada and the Eastern US (**Figure 15**)**.**

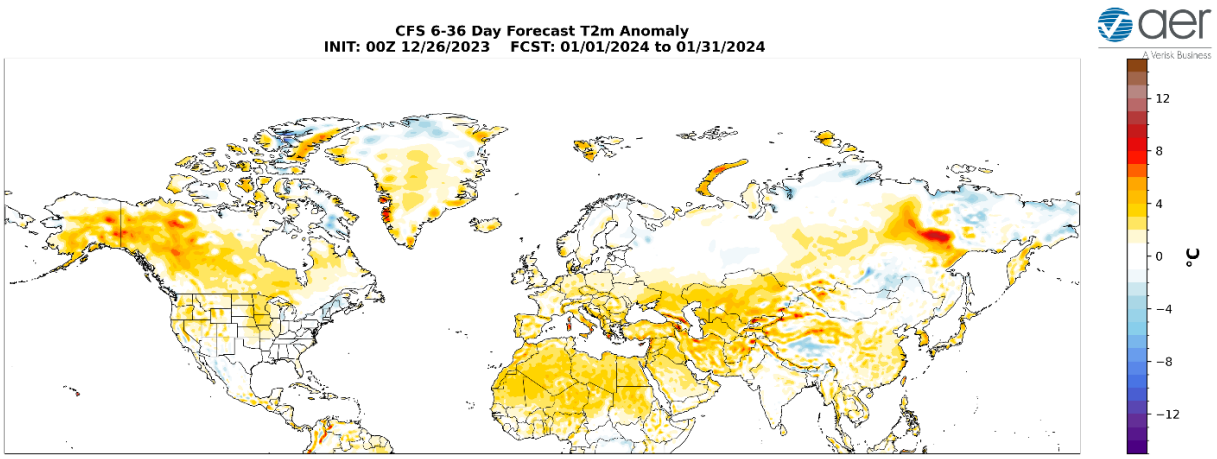

Figure 15. Forecasted average surface temperature anomalies (°C; shading) across the Northern Hemisphere for January 2024. The forecasts are from the 00Z 26 December 2023 CFS.

Arctic sea ice extent

Arctic sea ice extent continued growing more normally this week. I continue to expect that the negative sea ice anomalies will become more focused in the North Atlantic sector, which is currently the case. Blocking in the Barents-Kara sea region is critical ffor weakening the PV that favorable for widespread and meaningful cold in Northern Eurasia and eastern North America, which can persist for weeks. Outside the Arctic the sea ice is below normal in Hudson Bay and could be contributing to above normal temperatures in Eastern Canada. But the ice has finally made good progress the past two weeks and Hudosn Bay is close to being frozen over. Arctic sea ice extent is higher than many recent years and is comparable to 2021 on this date.

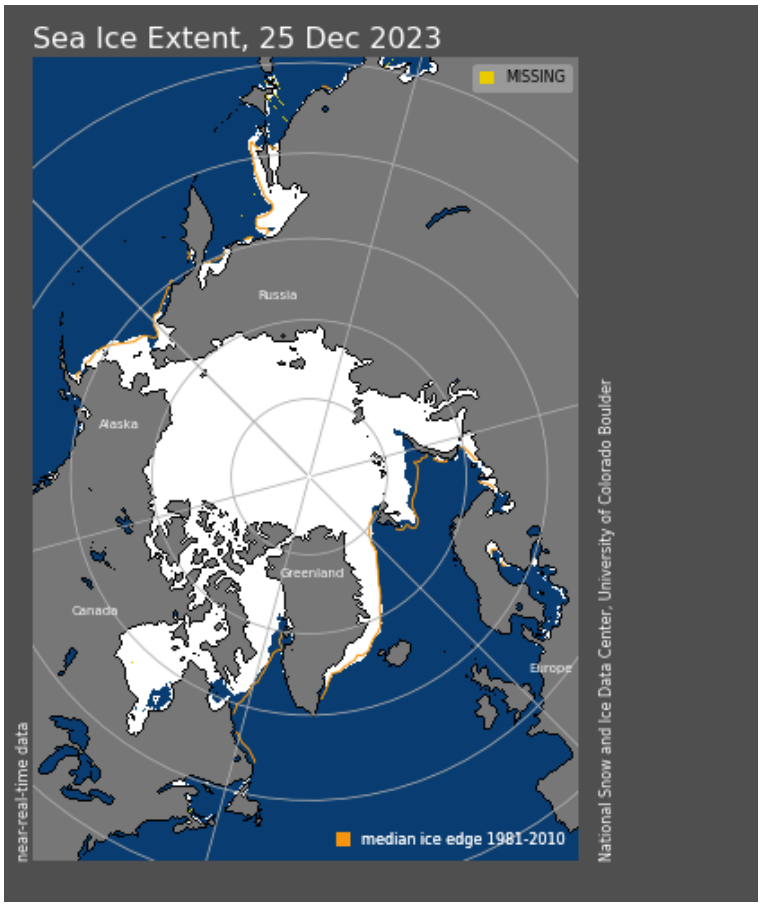

Figure 16. Observed Arctic sea ice extent on 25 December 2023 (white). Orange line shows climatological extent of sea ice based on the years 1981-2010. Image courtesy of National Snow and Ice Data Center (NSIDC). Snow and Ice Data Center (NSIDC).

SSTs/El Niño/Southern Oscillation

Equatorial Pacific sea surface temperatures (SSTs) anomalies are well above normal, especially along the South America coast, indicating that anEl Niño is pertty much a sure thing (**Figure 17)** and El Niño conditions are expected through the winter. Observed SSTs across the NH remain well above normal especially in the central North Pacific (west of recent years), the western North Pacific, the eastern North Atlantic and offshore of eastern North America though below normal SSTs exist regionally especially in the South and North Pacific and the North Atlantic.

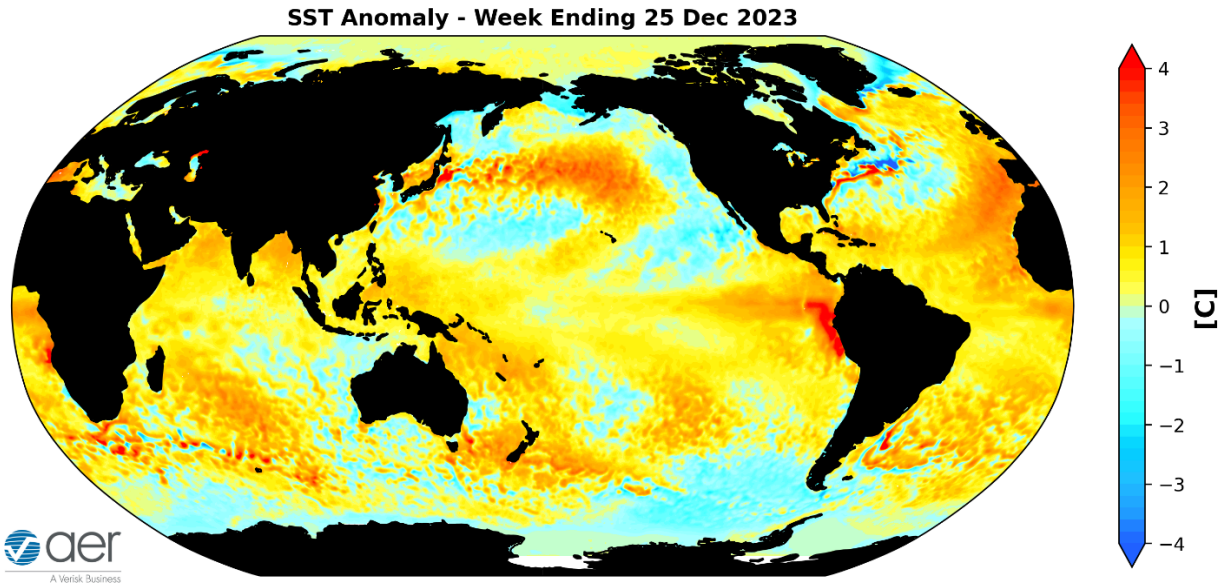

Figure 17. The latest weekly-mean global SST anomalies (ending 26 December 2023). Data from NOAA OI High-Resolution dataset.

Madden Julian Oscillation

Currently the Madden Julian Oscillation (MJO) is in phase one (**Figure 1**). The forecasts are for the MJO to move into phase 2 and then weaken where no phase is favored. Phases one and two favor troughing near Alaska and eventually troughing in the Western US. Therefore it seems that the MJO could be having some influence on North American weather the next two weeks. But admittedly this is outside of my expertise.

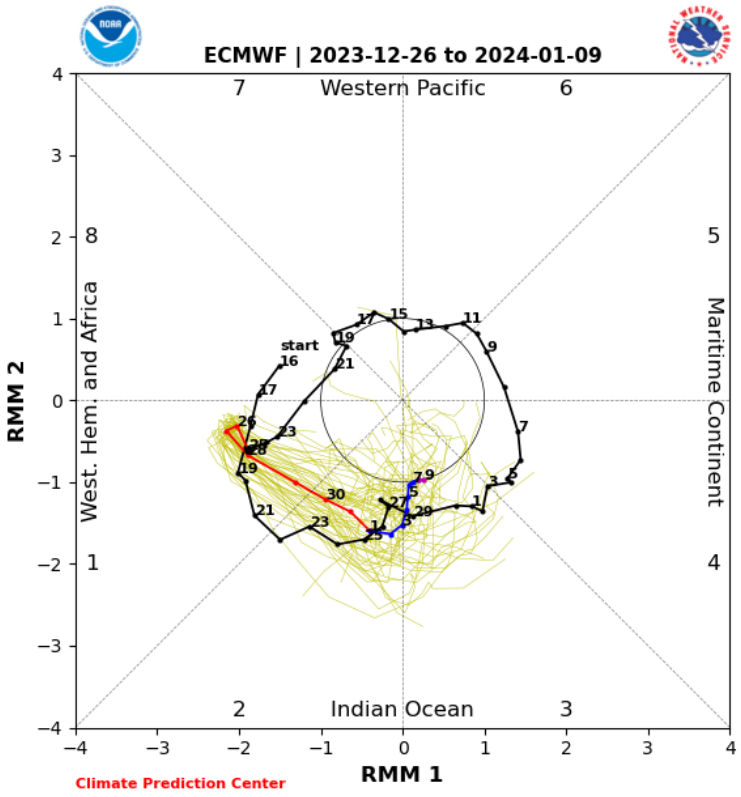

Figure 18. Past and forecast values of the MJO index. Forecast values from the 00Z 26 December 2023 ECMWF model. Yellow lines indicate individual ensemble-member forecasts, with the green line showing the ensemble-mean. A measure of the model "spread" is denoted by the gray shading. Sector numbers indicate the phase of the MJO, with geographical labels indicating where anomalous convection occurs during that phase. Image source: https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/CLIVAR/clivar_wh.shtml

Get Detailed Seasonal Weather Intelligence with sCast

We appreciate your taking the time to read the public Arctic Oscillation blog from Dr. Judah Cohen and the AER Seasonal Forecasting team.

Dr. Cohen's detailed monthly seasonal forecast, sCast, is also available for purchase. sCast provides a monthly 30-60-90-180-day outlook into temperature and precipitation, solar flux and wind anomalies across the globe, and regional population weighted cooling and heating degree forecasts for the US.

Our sCast principal engineer, Karl Pfeiffer, can help you use sCast and other AER seasonal forecast products to deliver important, long-lead time weather intelligence to your business. Please reach out to Karl today!