Arctic Oscillation and Polar Vortex Analysis and Forecasts

December 4, 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

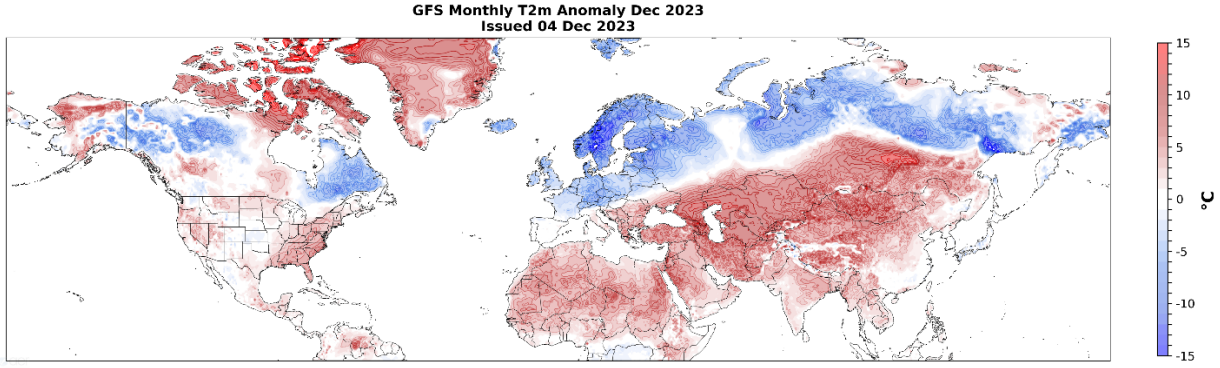
- The Arctic Oscillation (AO) is currently negative and is predicted to trend back to neutral the next two weeks as pressure/geopotential height anomalies across the Arctic are currently mostly positive and are predicted to remain mostly positive to mixed over the next two weeks. The North Atlantic Oscillation (NAO) is currently negative with positive pressure/geopotential height anomalies across Greenland and the NAO is predicted to trend positive the next two weeks as pressure/geopotential height anomalies become increasingly mixed across Greenland.
- This week, ridging/positive geopotential height anomalies in the North Atlantic including Greenland will force troughing/negative geopotential height anomalies across Northern Europe with more ridging/positive geopotential height anomalies across Southern Europe. However, as Greenland blocking wanes ridging will become more widespread

across Europe. This pattern will support normal to below normal temperatures across Northern Europe including the United Kingdom (UK) with normal to above normal temperatures across Southern Europe this week. However next week above normal temperatures will become more widespread while below normal temperatures will become mostly limited to Scandinavia.

- The next two weeks ridging/positive geopotential height anomalies will spread across the Asian Arctic with deepening troughing/negative geopotential height anomalies across mid-latitude Asia. This pattern favors widespread normal to below normal temperatures across Northern Asia with normal to above normal temperatures across Southern Asia this week. However next week the normal to below normal temperatures will wink south across Asia including the populated cities of East Asia with normal to above normal temperatures returning to Northern and Eastern Siberia.
- The general predicted pattern across North America the next two weeks is troughing/negative geopotential height anomalies across Alaska and the Gulf of Alaska forcing ridging/positive geopotential height anomalies across Eastern Canada and much of the United States (US). This pattern favors normal to below normal temperatures across Alaska this week but spreading into Western Canada next week with normal to above normal temperatures across Eastern Canada and much of the US.
- in the Impacts section I discuss my expected evolution of polar vortex (PV) behavior over the coming weeks and the impact on Northern Hemisphere (NH) weather. I also include the AER winter surface temperature anomalies for the NH using ERA5.

Plain Language Summary

High pressure in the North Atlantic and Greenland brought some impressive even record cold and snow to Europe for the beginning of winter (see **Figure below**). But now the cold is sliding east towards Siberia and then East Asia. It is my expectation the cold will make it over the Pole into North America before the month si over but so far the weather models are not in agreement with me.



Observed surface temperatures (°C; shading) from 1 – 4 December 2023 based on GFS initializations.

A larger PV disruption is possible in early January that has the potential to persist the cold across North America but for now the details remain murky.

Impacts

Let me just start off today's discussion by saying that if I had to draw up the tropospheric circulation for early December to setup an interesting winter season, I would barely change it from the current forecasts but more on that below.

I asked and you responded! So, in **Figure I,** I show the AER winter forecast using ERA5 reanalysis instead of NCEP/NCAR. The pattern looks very similar to the forecast posted in last week's blog but I am using a finer color scale so the anomalies are more well defined and more detail is included. But nice to see consistency across reanalysis products, though I do consider the ERA5 to be a much superior product.

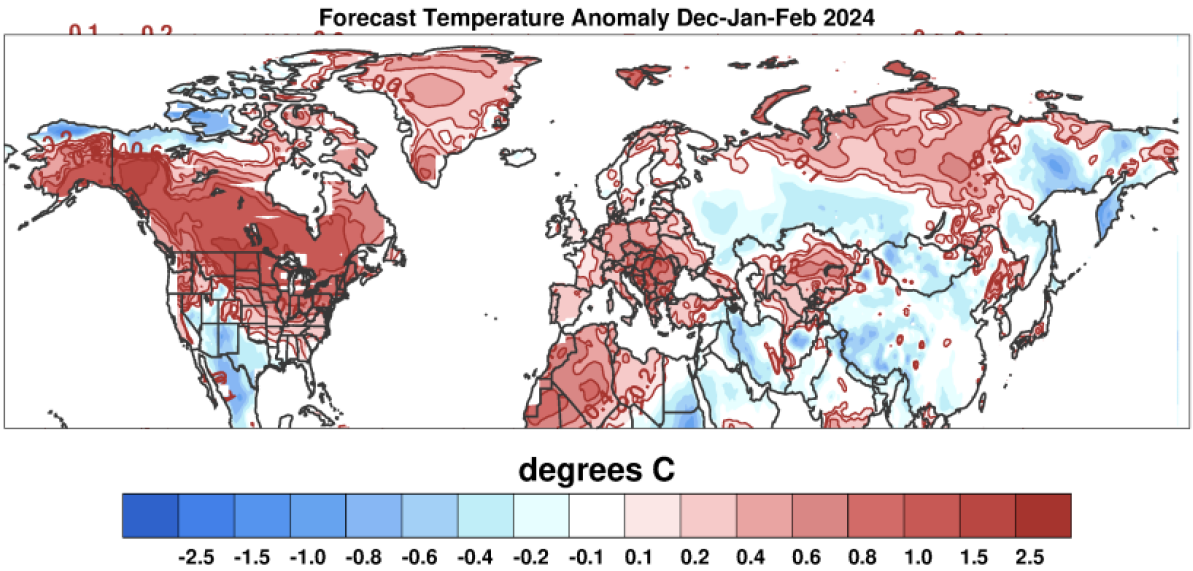


Figure i. The AER winter surface temperature anomaly °C; shading) forecast for December 2023, January and February 2024. Forecast based on ERA5 reanalysis.

I have for much of my career argued that a cold Northern Hemisphere winter has its origins in a cold Siberia in late fall and early winter (the discussion is relative and not absolute cold). The cold predicted in Siberia in the coming two weeks (see **Figure ii**) is impressive and for me that is the single most encouraging signal that we are likely going down a path towards a sudden stratospheric warming (SSW) rather than a strengthening polar vortex (PV).

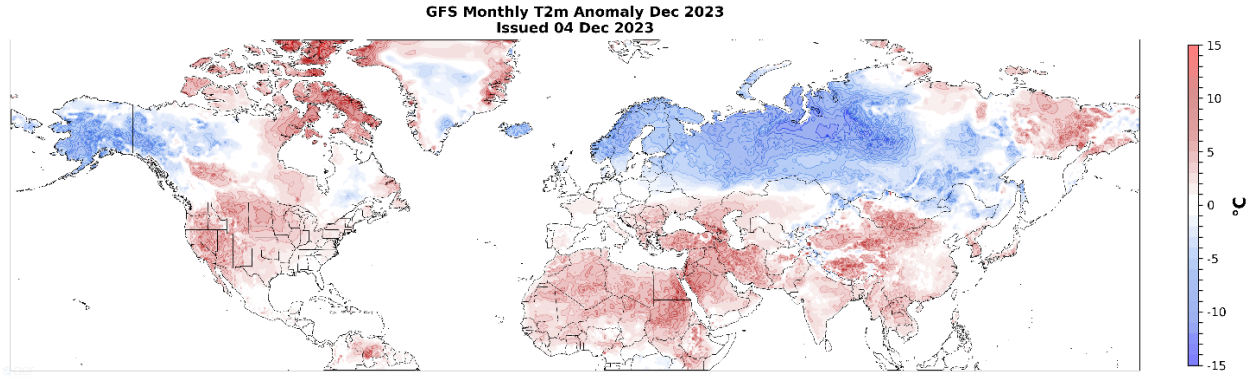


Figure ii. Observed 1 – 4 December 2023 and predicted surface temperature anomalies (°C; shading) from 5 – 19 December 2023. The forecast is from the 00Z 4 December 2023 GFS ensemble.

But equally impressive is the forecast for the sea level pressure (SLP) anomalies for the remainder of December. In **Figure iii**, I show the SLP anomaly forecast from the GFS, alongside a figure that regresses both October snow cover extent (SCE) with November SLP (contours) and December Vertical Wave Activity Flux (WAFz) with November SLP (shading). This figure is from Cohen et al. (2014) and is one the most striking figures that I ever created (with my co-authors of course!) in my opinion.

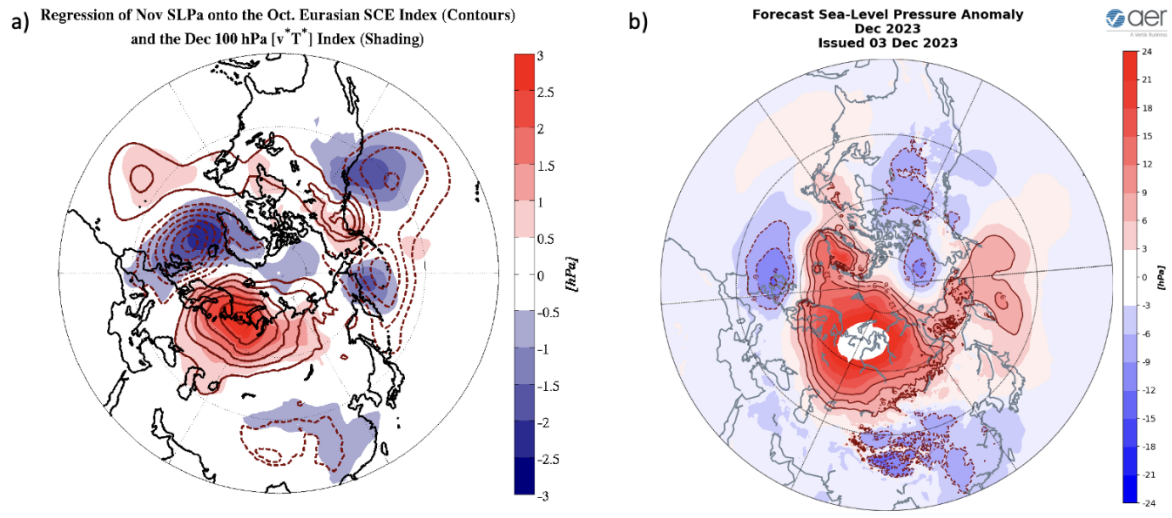


Figure iii. a) Regression of November SLP anomalies (hPa) onto October monthly-mean Eurasian SCE (contouring) and onto December meridional heat flux anomalies at 100 hPa, averaged between 40° and 80°N (shading). b) Predicted sea level pressure anomaly (hPa) from the GFS foreast from the 00z 4 December 2023 GFS ensemble.

The November SLP pattern represents both the forced pattern by above normal SCE and the November SLP that forces above normal upward WAFz in December that will weaken the stratospheric PV in January (shading). Let's ignore the months for now, but by comparing the two plots, the predicted SLP pattern is nearly optimal for exciting WAFz and weakening the PV. That uber Ural block is a beast and if verifies will almost certainly rock the PV. The only mismatch is the lack of low pressure in between Eastern Siberia and the Dateline. But I do often refer to the pattern as the tripole pattern and that certainly exists. Another version of the tripole pattern exists in Cohen and Jones (2011) Figure 1. And as I have been saying over multiple blogs in November (the two most recent and even October (on the 23rd and 30th and you can check for yourselves), the most likely time for an SSW is early January. The ECMWF may have waffled but I have not.

But I am getting ahead of myself since we still have a stretched PV in mid-December before any potential SSW at the earliest the very end of December but more likely in early January. Looking at all the weather model forecasts looks like a great example of a stretched PV (for example see **Figure 13b**) but the problem is that the usual cold east of the Rockies in North America is not predicted by the weather models. First the wave diagnostics are suggestive but far from empathic of wave reflection. Second, I know from our analysis of historical stretched PV events, you can get stretched PVs with relatively mild temperatures. However, with that said every event that I have followed in real time has some cold associated with it even if it is of short duration and regionally limited. But as I said in last week's blog a good rule of thumb is that a week after the cold air arrives in Northeast Asia the cold heads southeastward across North America about a week later. I correctly anticipated the slushing of the core of the cold from Europe to Siberia and then eventually Northeast Asia, therefore for now I will stick with the expectation the cold is coming to eastern North America the second half of December. But of course I could be wrong and it happens more often than I would like.

Now to move on from desert to the main course. You know it is serious when I post in the blog the six-step model of how above normal October Siberian snow cover extent can force a PV disruption/sudden stratospheric warming followed by a period of high latitude blocking, a negative AO (though not necessarily) and a period of severe winter weather (potentially weeks in duration) in three preferred regions but rarely simultaneously – East Asia, Europe and the US (typically east of the Rockies) shown in **Figure iv** and is taken from Cohen et al. 2007.

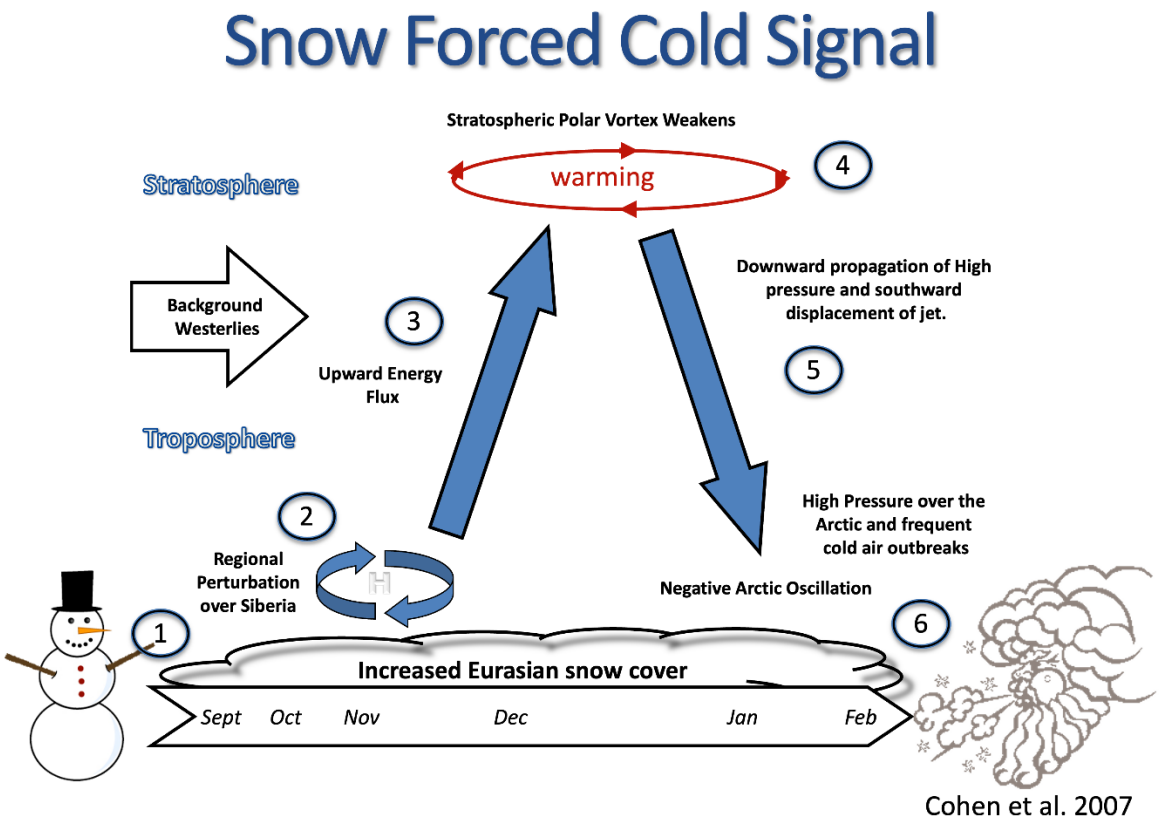


Figure iv. Conceptual model for how fall snow cover modifies winter circulation in both the stratosphere and the troposphere; case for extensive snow cover illustrated: 1. Snow cover increases rapidly in the fall across Siberia, when snow cover is above normal diabatic cooling helps 2. to strengthen the Siberian high and leads to below normal temperatures. 3. Snow forced diabatic cooling in proximity to high topography of Asia increases upward flux of energy in the troposphere, which is absorbed in the stratosphere.4. Strong convergence of wave activity flux (WAF) indicates higher geopotential heights, a weakened polar vortex and warmer temperatures in the stratosphere. 5.Anomalous geopotential heights and winds appear to propagate down from the stratosphere into the troposphere all the way to the surface.6. Dynamic pathway culminates with strong negative phase of the Arctic Oscillation at the surface. The third step is the initiation of positive anomalous Wave Activity Flux in the vertical direction (or z coordinate; WAFz). WAFz is the vertical transfer of energy from waves in the atmosphere and is directly proportional to the poleward transport or advection of heat. Only the largest or Rossby waves (wave numbers 1-2) across the Northern Hemisphere (NH) produce energy strong enough to escape the troposphere into the stratosphere. When the vertical energy is absorbed in the polar stratosphere it leads to warming of the polar stratosphere or a weakening of the stratospheric PV. If it is of sufficient amplitude it will result in the fourth step of the model or in a sudden stratospheric warming (SSW).

Siberian snow cover was slightly above normal, and I did not think initially it necessarily favored triggering the six-step process but snow cover since mid-November advanced more robustly across Eurasia. I think maybe even more importantly, a deficit in snow-depth across Siberia has reversed to a surplus as shown in **Figure v** and compare to **Figure iii** in the blog from 13Nov2023.

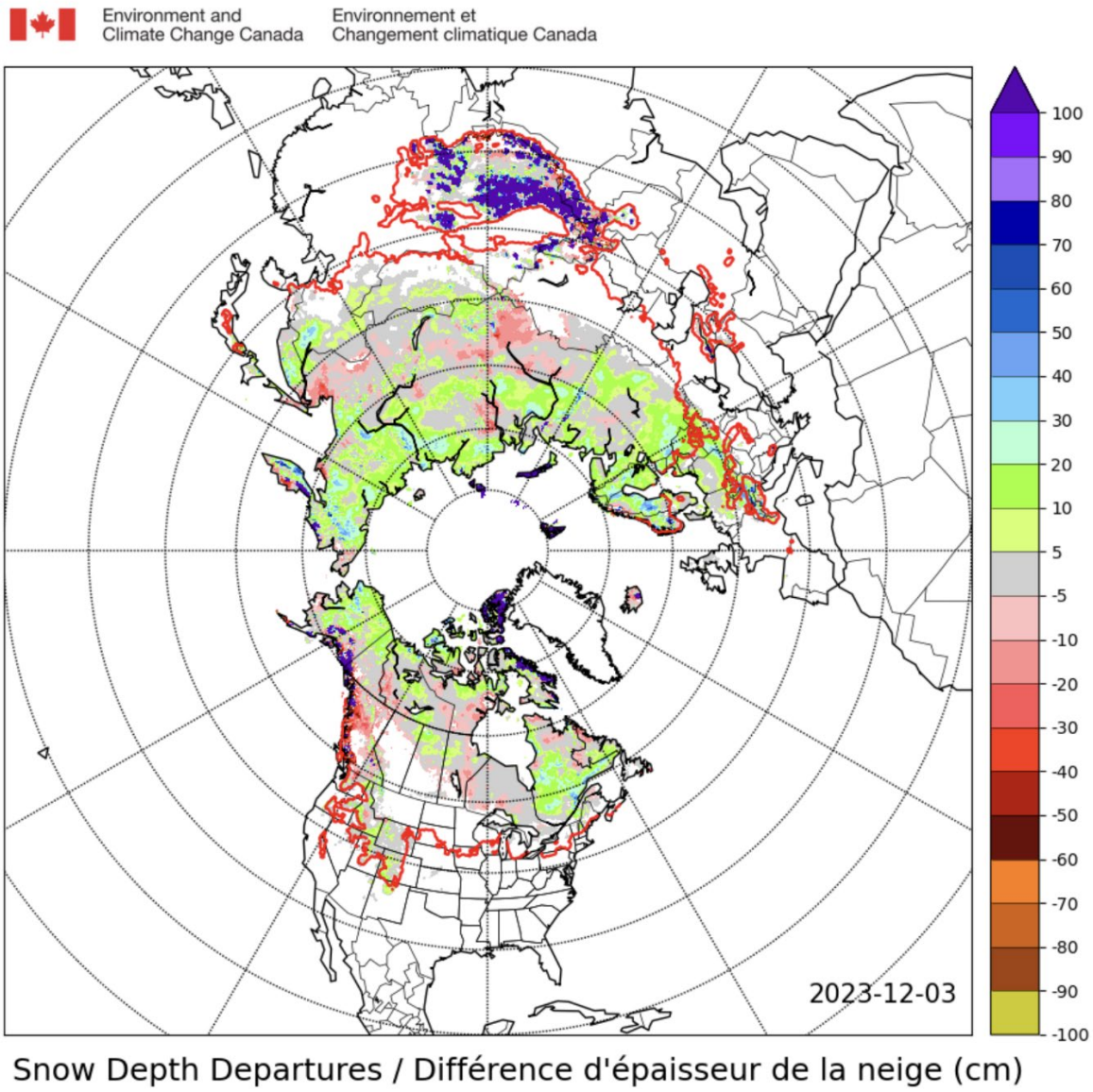


Figure v. Northern Hemisphere snow depth anomalies on 3 December 2023. Plot taken from **https://ccin.ca/index.php/ccw/snow/current/**

I would argue heavy snowfall across Siberia October, but maybe more importantly in November and continuing into December, coupled with low sea ice in the Barents-Kara Seas this entire fall has been favorable for increasing the probability of step two - the northwestward expansion of the Siberian high into the Urals/Scandinavian region that is often referred to as

Ural/Scandinavian blocking. Strong Ural/ Scandinavian blocking is predicted for December as shown above in **Figure iii**, that looks almost textbook.

The third step is the initiation of positive anomalous Wave Activity Flux in the vertical direction (or z coordinate; WAFz). WAFz is the vertical transfer of energy from waves in the atmosphere and is directly proportional to the poleward transport or advection of heat. Only the largest or Rossby waves (wavenumbers 1-2) across the Northern Hemisphere (NH) produce energy strong enough to escape the troposphere into the stratosphere. When the vertical energy is absorbed in the polar stratosphere it leads to warming of the polar stratosphere or a weakening of the stratospheric PV. If it is of sufficient amplitude it will result in the fourth step of the model or in a sudden stratospheric warming (SSW). As seen in **Figure 12**, the WAFz is predicted to remain very active in the coming weeks.

When an SSW occurs, the PV vacates its perch near the North Pole and besides being anomalously warm across much of the polar stratosphere, the vacuum created by the absence of the PV center is filled by relatively high pressure. As an example, I show the latest CFS forecast for the polar vortex in January in **Figure vi**. Meanwhile across the mid-latitudes anomalous low pressure occurs and in the most extreme cases the PV center itself will reach into the mid-latitudes accompanied by relatively cold temperatures. In addition, the belt of strongest zonal (west to east) winds is shifted south or equatorward.

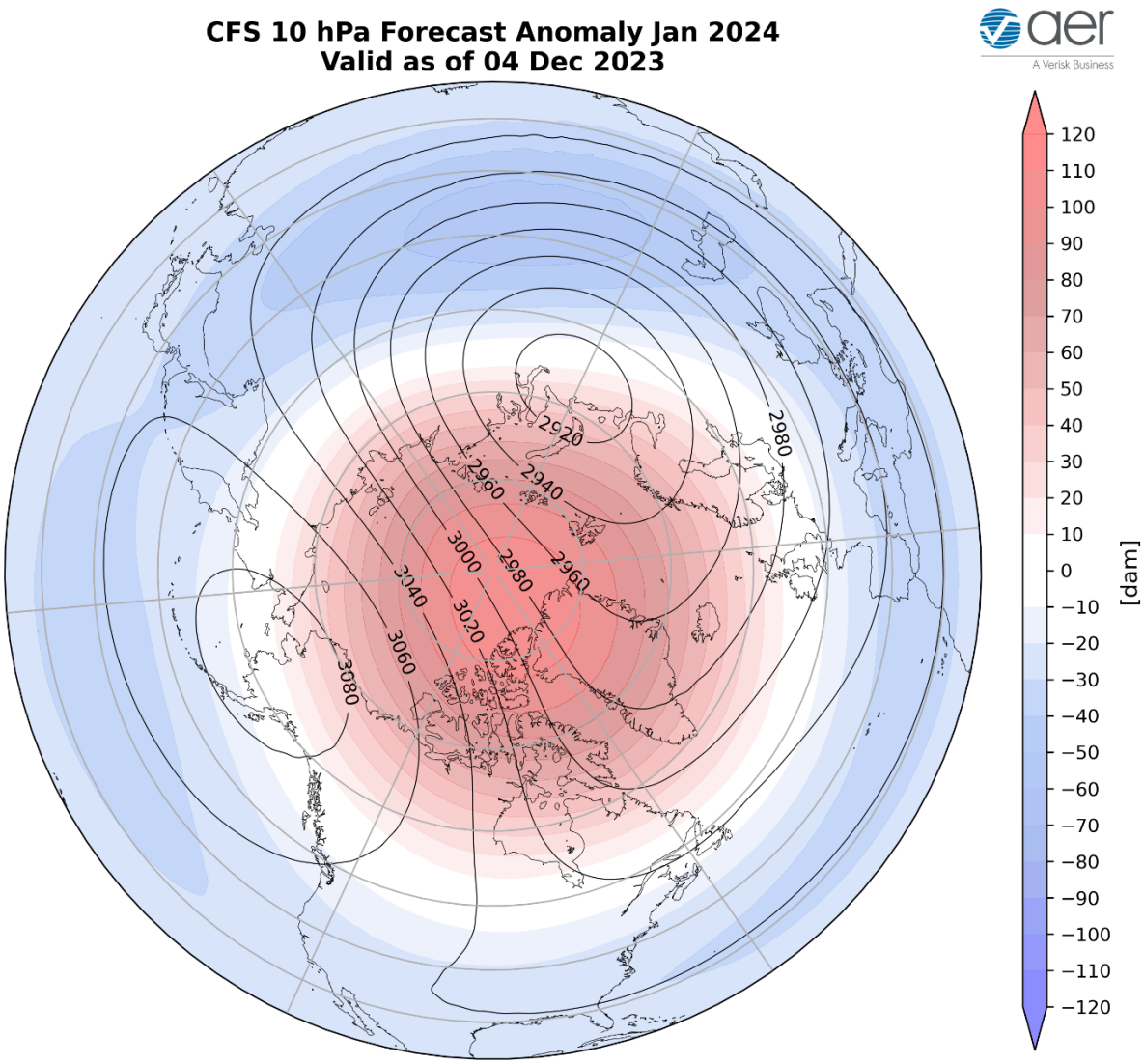


Figure vi. Forecasted average 500 mb geopotential heights (dam; contours) and geopotential height anomalies (m; shading) across the Northern Hemisphere for January 2024. The forecasts are from the 00Z 4 December 2023 CFS.

The fifth step is the downward propagation of the circulation anomalies from the stratosphere to the troposphere and ultimately to the surface. I am of the opinion there is always downward influence from an SSW but at times it needs to be more nuanced.

But based on the average of historical events, the climax or culmination of the whole event is relatively high pressure in the Arctic coupled with anomalous warmth, relative low pressure in the mid-latitudes, especially in the ocean basins and an equatorward shifted Jet Stream. The sixth step are changes in the tropospheric circulation that are consistent with a negative AO/NAO and Greenland blocking. A southward shifted Jet Stream increases the probabilities of both cold air outbreaks and snowstorms across the mid-latitude continents including Europe, East Asia and

the US east of the Rockies. It can be in one or two of those regions but rarely all three. The trouble is it is incredibly challenging anticipating if this will follow any single SSW event.

I remain consistent in thinking the most likely time for an SSW remains early January but this is far from a given. I want to use the analogy of a six-man relay race. For a team to win the race the baton needs to be transferred successfully five times between all of the six runners. If at any handoff the baton is dropped, the race is over for that team. Same with the six steps shown in **Figure iv**. The first handoff from Eurasian snow and Arctic sea ice to Ural blocking is looking very good at the moment. Even the second handoff from Ural blocking to more active WAFz is also looking promising. Less certain is an SSW despite current forecasts from the ECMWF and CFS and all that ensues. I think all of the SSWs since January 2013, with the exception of February 2018 have deviated from the canonical model based on all the historical SSWs in the observational record, with February 2023 possibly being the strangest. Add that on top of a strong El Niño, negative Pacific Decadal Oscillation (PDO), strongly positive Indian Ocean Dipole (IOD), marine and land heat waves (relative to normal) and all that stratospheric water vapor from the Honga Tonga volcano, a long-range weather forecaster has their work cut out for them.

Near-Term

This week

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

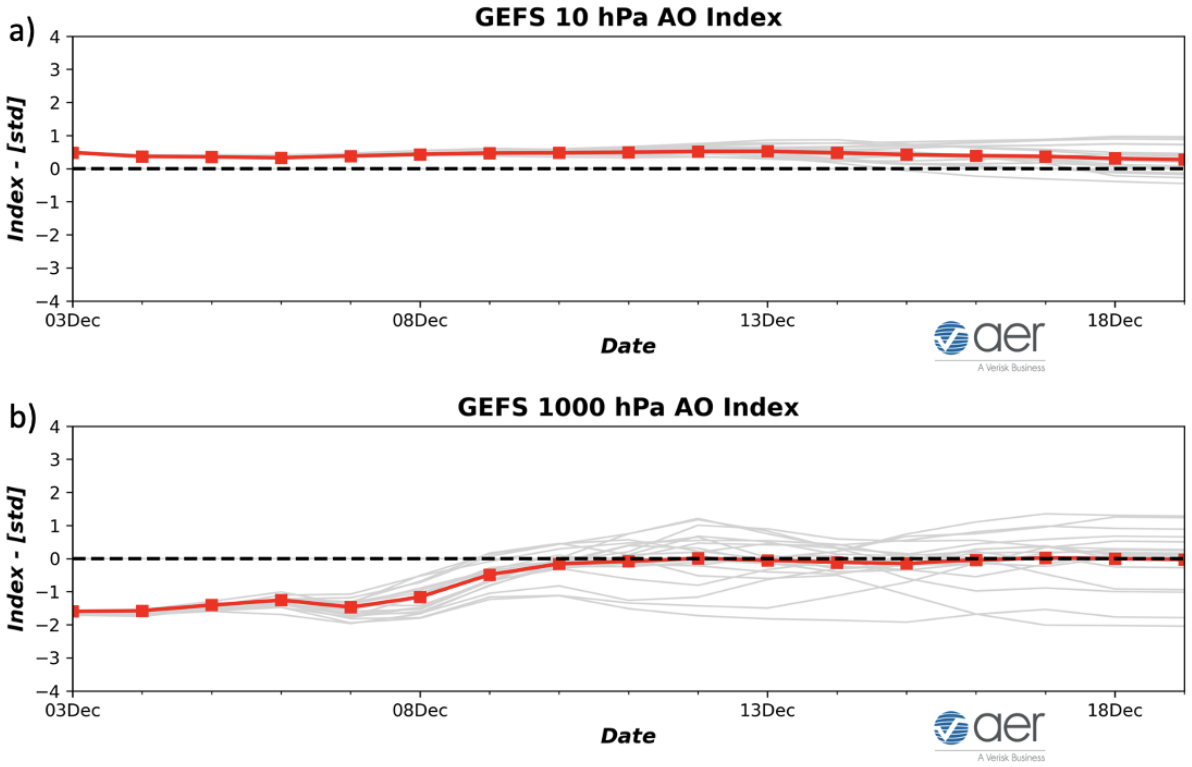


Figure 1. (a) The predicted daily-mean AO at 1000 hPa from the 00Z 4 December 2023 GFS ensemble. (b)The predicted daily-mean near-surface AO from the 00Z 4 December 2023 GFS ensemble. Gray lines indicate the AO index from each individual ensemble member, with the ensemble-mean AO index given by the red line with squares.

Ridging/positive geopotential height anomalies across the North Atlantic Arctic including Greenland will support troughing/negative geopotential height anomalies across Northern and Eastern Europe with more ridging/positive geopotential height anomalies across Southwestern Europe this week (**Figures 2).** The pattern favors normal to below normal temperatures across Northern and Eastern Europe including the UK with normal to above normal temperatures across Southern and Western Europe (**Figure 3**). The Asian Arctic is predicted to be dominated by ridging/positive geopotential height anomalies centered near the Barents-Kara Seas forcing troughing/negative geopotential height anomalies across Siberia (**Figure 2**). This pattern favors widespread normal to below normal temperatures across much of Northern Asia with normal to above normal temperatures across Southern Asia **(Figure 3**).

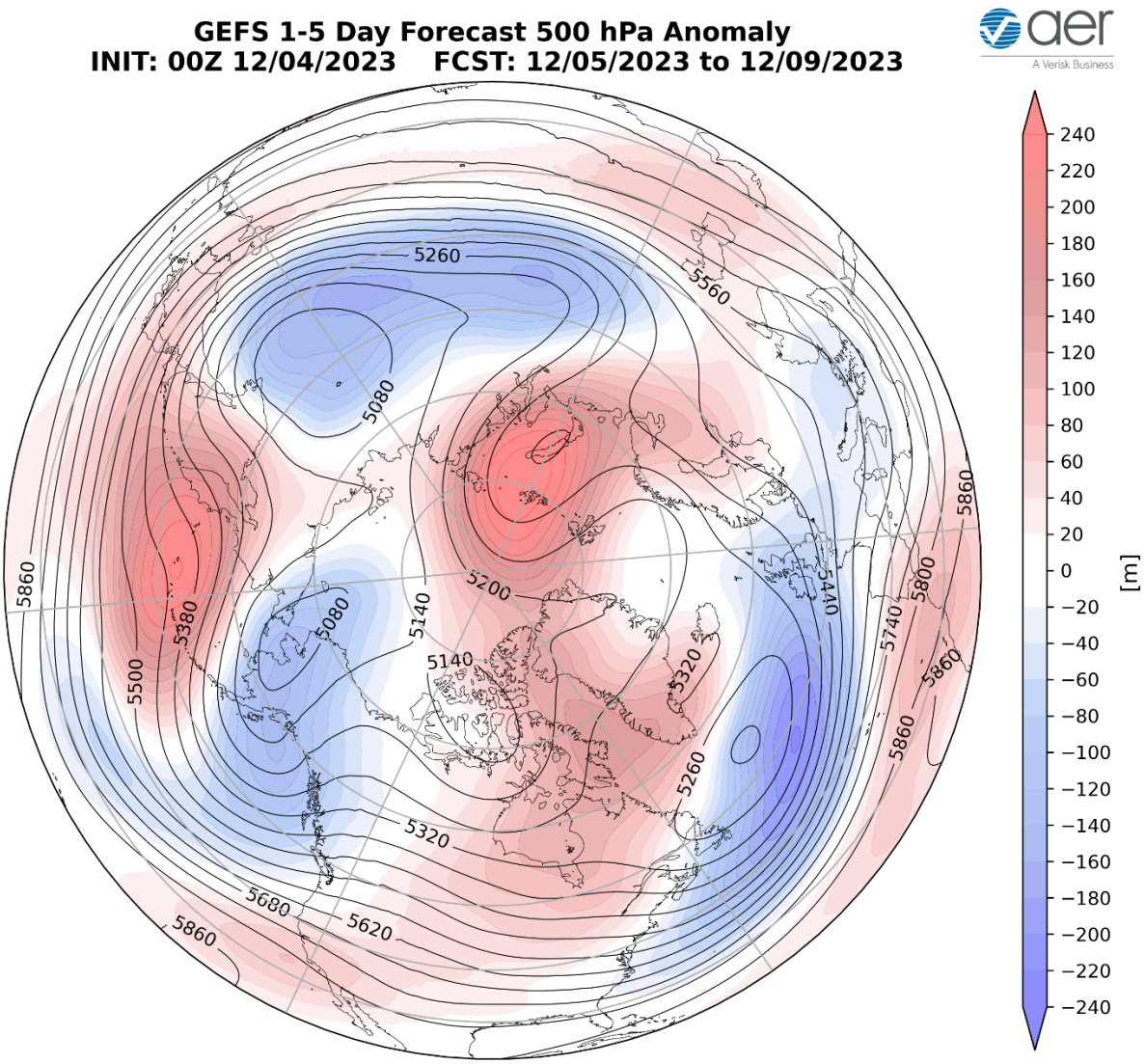


Figure 2. Forecasted average 500 mb geopotential heights (dam; contours) and geopotential height anomalies (m; shading) across the Northern Hemisphere from 28 November – 2 December 2023. The forecasts are from the 00z 4 December 2023 GFS ensemble.

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 Eastern Canada and much of the US **(Figure 2).** This pattern will favor normal to above normal temperatures across Alaska, eastern New England and the Canadian Maritimes with normal to below normal temperatures across much of Canada and much of the US **(Figure 3).**

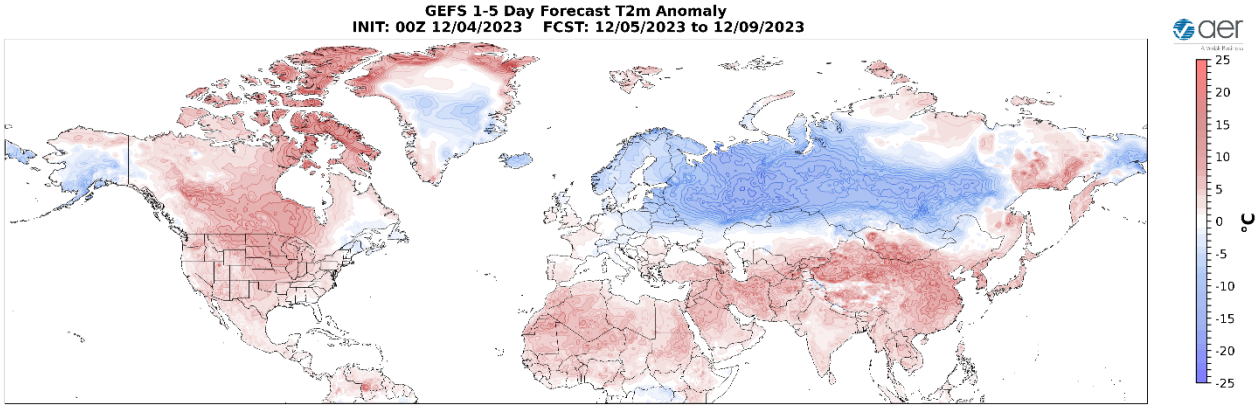


Figure 3. Forecasted surface temperature anomalies (°C; shading) from 28 November – 2 December 2023. The forecast is from the 00Z 4 December 2023 GFS ensemble.

Troughing and/or cold temperatures will support new snowfall across Scandinavia, Ukraine, Siberia and Northeastern China while mild temperatures will support snowmelt across Central Europe, Southern Sweden and Western Russia this week (**Figure 4**). Troughing and/or cold temperatures will support new snowfall across Western and Southeastern Alaska, the West Coast of, Northern and Eastern Canada, and the higher elevations of the Western US while mild temperatures will support snowmelt across southern Ontario and New England this week (**Figure 4**).

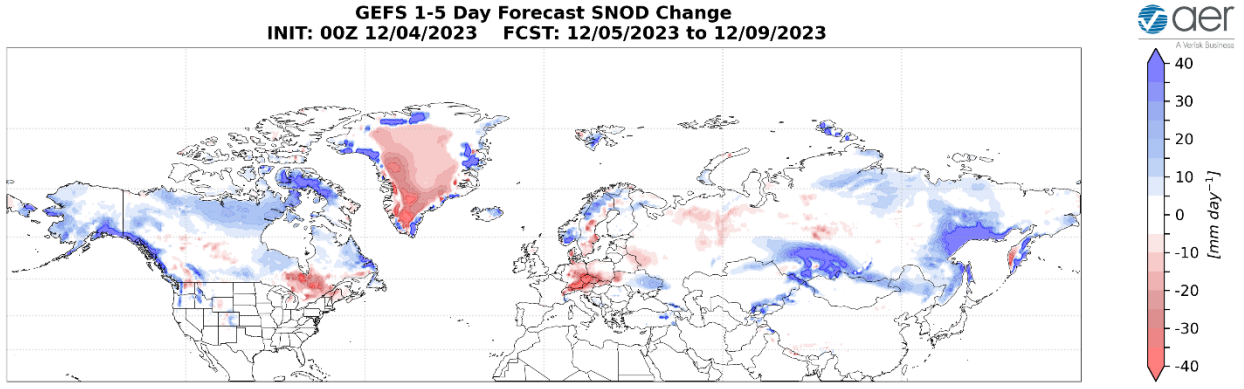


Figure 4. Forecasted snow depth changes (mm/day; shading) from 28 November – 2 December 2023. The forecast is from the 00Z 4 December 2023 GFS ensemble.

Near-Mid Term

Next week

With mixed geopotential height anomalies across the Arctic and with mixed geopotential height anomalies across the mid-latitudes this period (**Figure 5**), the AO should reach neutral this

period (**Figure 1**). With predicted positive but weak pressure/geopotential height anomalies across Greenland (**Figure 5**), the NAO will also reach neutral this period as well.

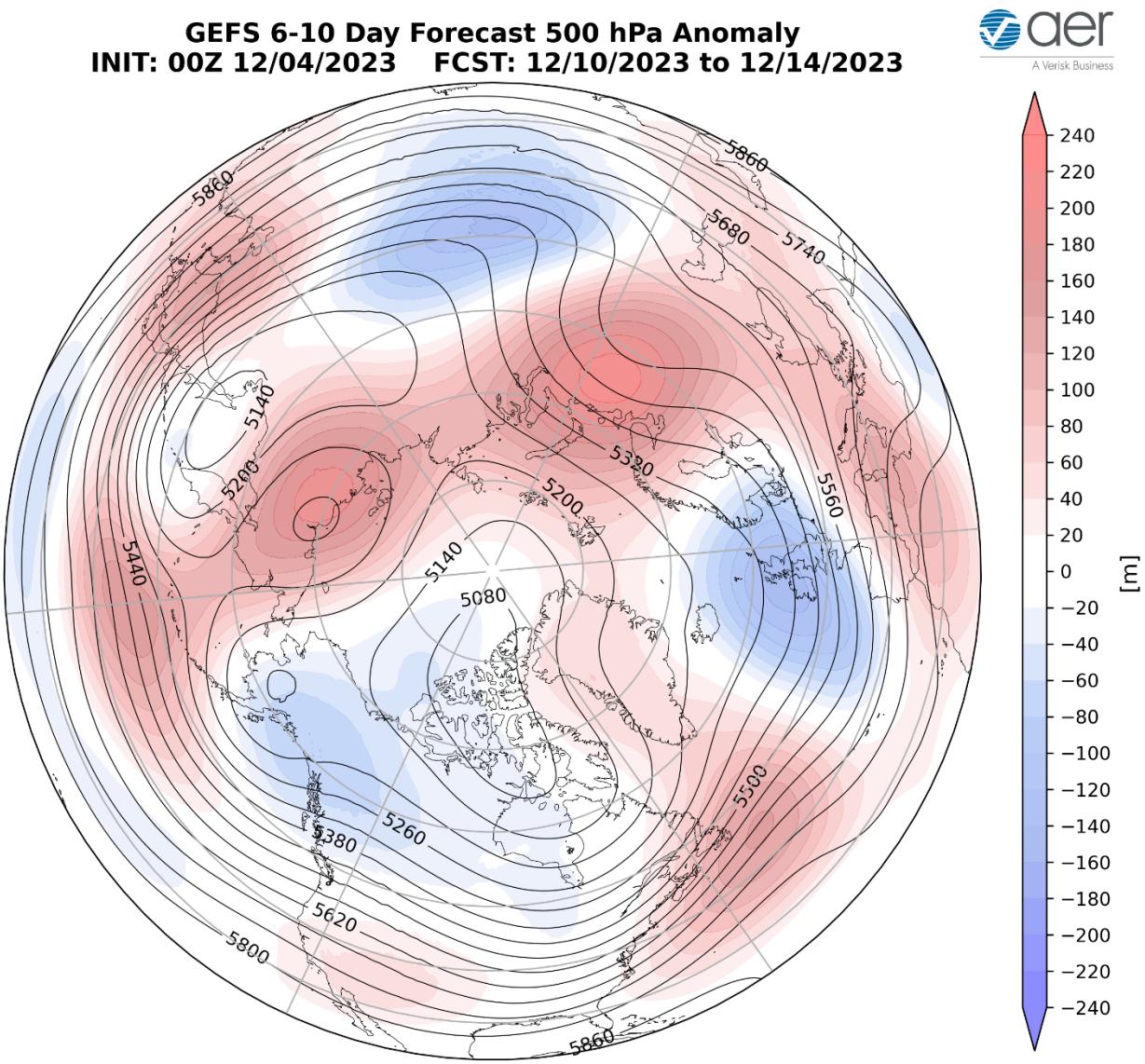


Figure 5. Forecasted average 500 mb geopotential heights (dam; contours) and geopotential height anomalies (m; shading) across the Northern Hemisphere from 3 – 7 December 2023. The forecasts are from the 00z 4 December 2023 GFS ensemble.

Persistent albeit weakening ridging/positive geopotential height anomalies across the North Atlantic and Greenland will support troughing/negative geopotential height anomalies across Northern Europe with ridging/positive geopotential height anomalies across Southern Europe this period (**Figure 5**). The pattern will favor normal to below normal temperatures across Northern and Eastern Europe **with** normal to above normal temperatures across Southern and Western Europe including the UK (**Figures 6**). Ridging/positive geopotential height

anomalies consolidating across the Asian Arctic will force troughing/negative geopotential height anomalies to become widespread across the mid-latitudes of Asia with more ridging/positive geopotential height anomalies stretched across Southeastern Asia this period (**Figure 5**). This pattern favors widespread normal to below normal temperatures across much of Northern and Central Asia with normal to above normal temperatures across Southern Asia and Eastern Siberia this period (**Figure 6**).

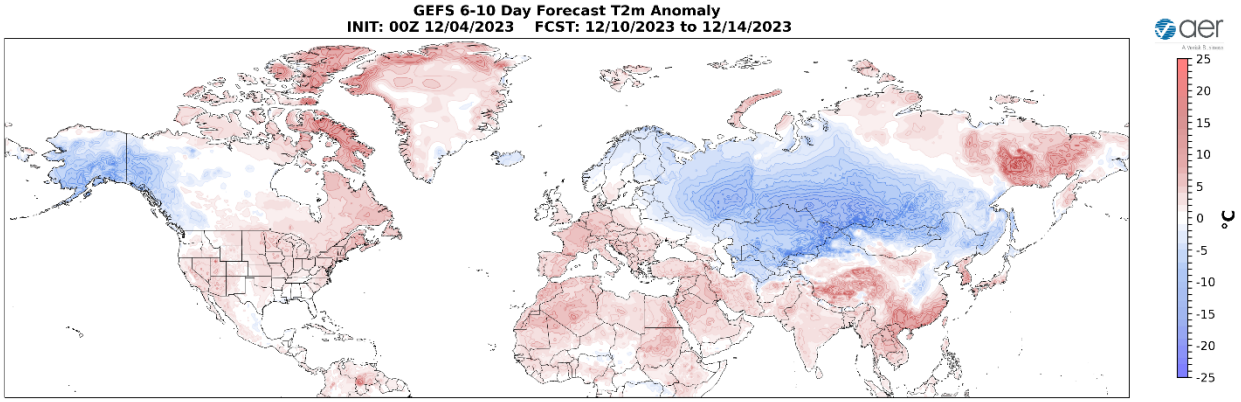


Figure 6. Forecasted surface temperature anomalies (°C; shading) from 3 – 7 December 2023. The forecasts are from the 00z 4 December GFS ensemble.

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

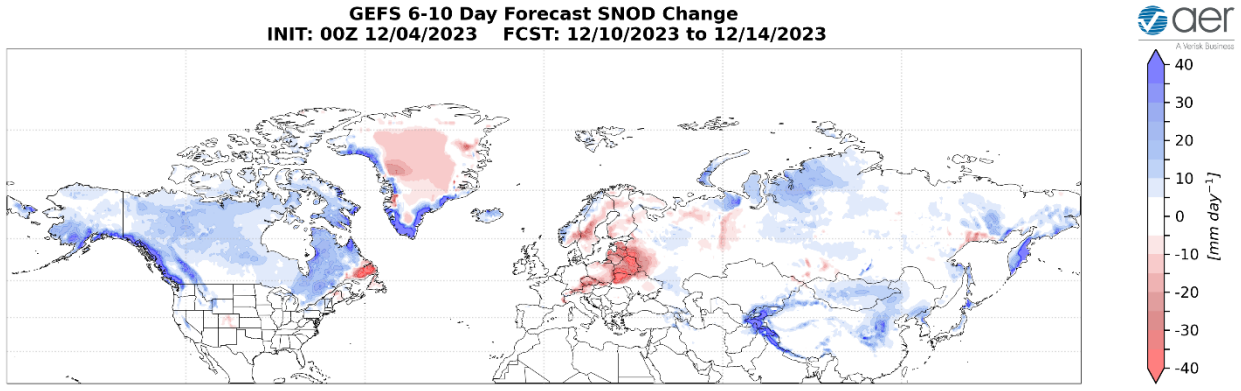


Figure 7. Forecasted snow depth changes (mm/day; shading) from 3 – 7 December 2023. The forecast is from the 00Z 4 December 2023 GFS ensemble.

Troughing and/or cold temperatures will support new snowfall across Norway, Northern Asia including much of Siberia and Central Asia while mild temperatures will support snowmelt in Scandinavia, Eastern Europe and the Alps this period (**Figure 7**). Troughing and/or cold temperatures will support new snowfall across Alaska, much of Canada and New England while mild temperatures will support snowmelt in the higher elevations of the Western US and the Canadian Maritimes this period (**Figure 7**).

Mid Term

Week Two

With predicted mixed geopotential height anomalies across the Arctic and mixed geopotential height anomalies across the mid-latitudes this period (**Figure 8**), the AO should remain neutral this period (**Figure 1**). With predicted weak and mixed pressure/geopotential height anomalies across Greenland (**Figure 8**), the NAO will also likely be near neutral this period as well.

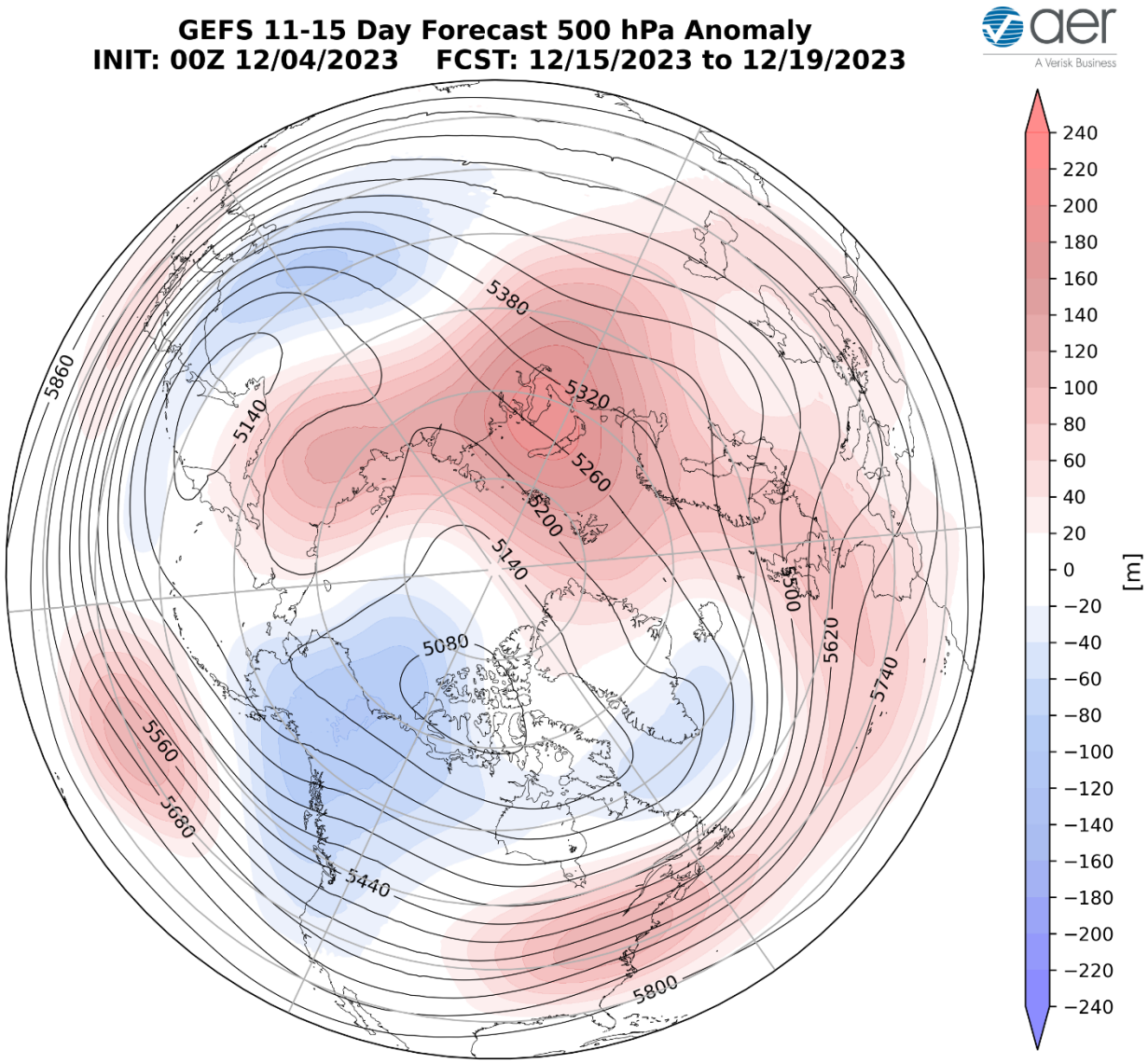


Figure 8. Forecasted average 500 mb geopotential heights (dam; contours) and geopotential height anomalies (m; shading) across the Northern Hemisphere from 8 – 12 December 2023. The forecasts are from the 00z 4 December 2023 GFS ensemble.

With ridging/positive geopotential height anomalies in the North Atlantic sector of the Arctic consolidating in the Barents-Kara Seas should allow ridging/positive geopotential height anomalies to spread across much of Europe this period (**Figure 8**). This pattern should favor normal to above normal temperatures across most of Europe including the UK with normal to below normal temperatures limited to Scandinavia this period (**Figures 9**). Ridging/positive geopotential height anomalies are predicted to continue to dominate the Asian Arctic with troughing/negative geopotential height anomalies across Northeastern Asia this period (**Figure 8**). The predicted pattern favors widespread normal

to below normal temperatures across Northern and Eastern Asia with normal to above normal temperatures widespread across Southern Asia and Northern Siberia this period (**Figure 9**).

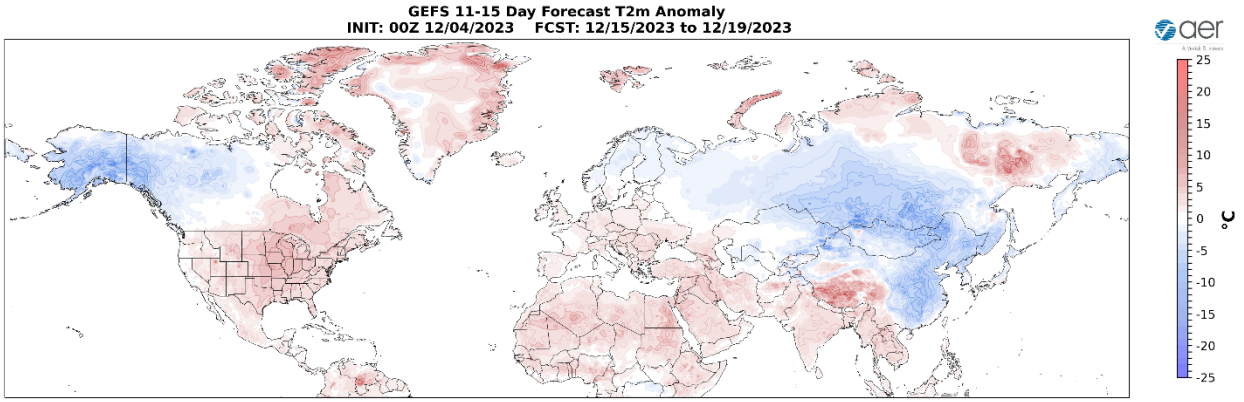


Figure 9. Forecasted surface temperature anomalies (°C; shading) from 8 – 12 December 2023. The forecasts are from the 00z 4 December 2023 GFS ensemble.

Persistent troughing/negative geopotential height anomalies across Alaska and the Gulf of Alaska and now Western Canada will continue to force ridging/positive geopotential height anomalies across eastern North America this period (**Figure 8**). This pattern favors widespread normal to above normal temperatures across Eastern Canada and much of the US with normal to below normal temperatures across Alaska and Western Canada (**Figure 9**).

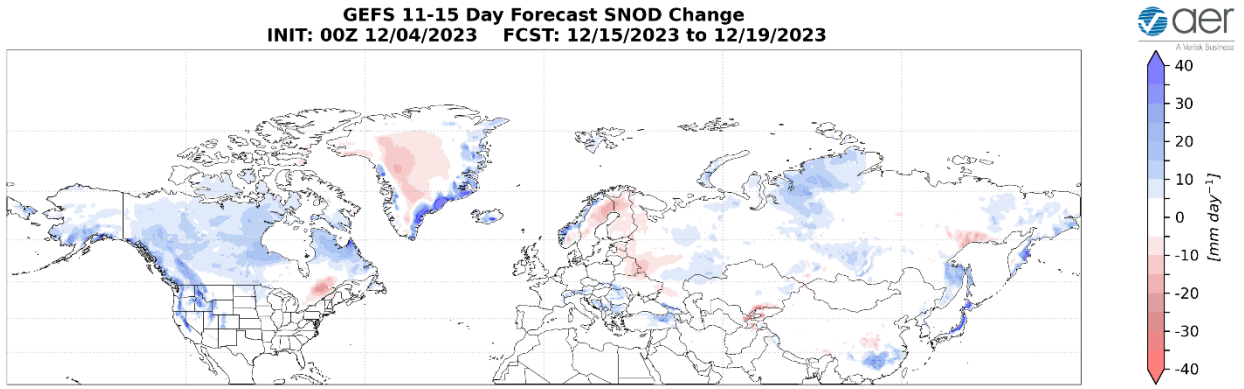


Figure 10. Forecasted snow depth changes (mm/day; shading) from 8 – 12 December 2023. The forecast is from the 00Z 4 December 2023 GFS ensemble.

Troughing and/or cold temperatures will support new snowfall across Norway, Southeastern Europe, Siberia and East Asia while mild temperatures will support snowmelt in Sweden, Finland and the Baltics this period (**Figure 10**). Troughing and/or cold temperatures will support new

snowfall across southern Alaska, much of Canada and the higher elevations of the Western US. Mild temperatures will support snowmelt in southern Quebec 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 mid to lower stratosphere with warm/positive PCHs in the upper stratosphere (related to a Canadian warming) and the troposphere (**Figure 11**). However, next week PCHs are predicted to become more mixed in the stratosphere (**Figure 11**).

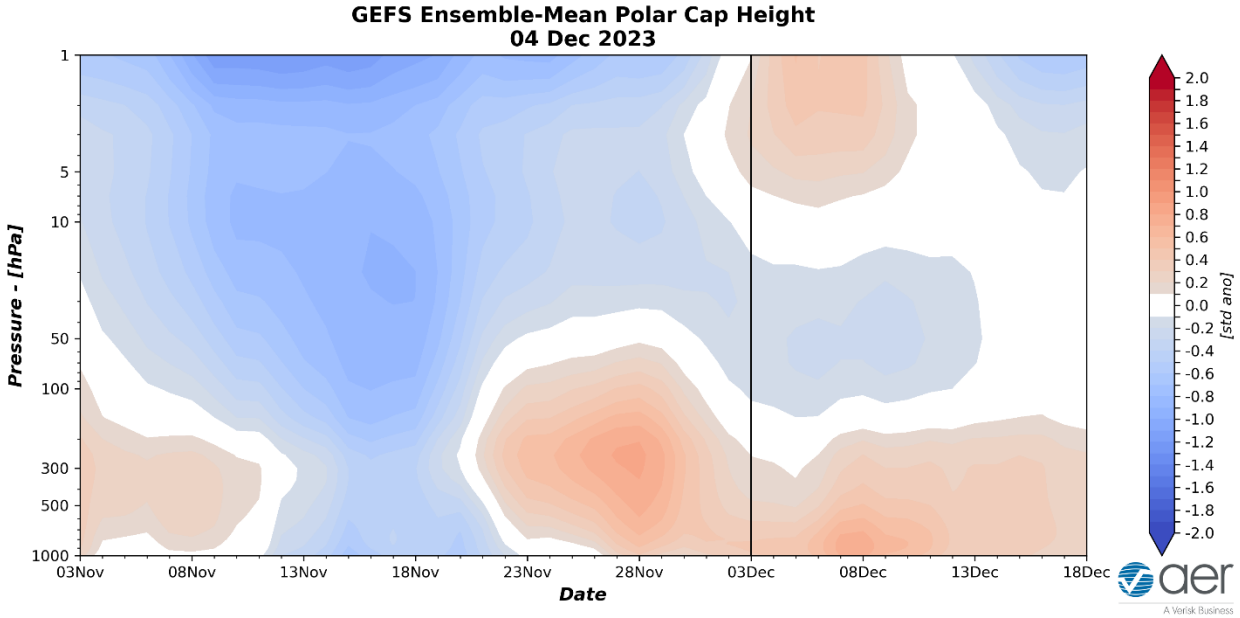


Figure 11. Observed and predicted daily polar cap height (i.e., area-averaged geopotential heights poleward of 60°N) standardized anomalies. The forecast is from the 00Z 4 December2023 GFS ensemble.

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

Also shown in **Figure 1** is the stratospheric AO. The stratospheric AO is currently near neutral and is predicted to remain near neutral for the next two weeks. This is consistent with mixed

stratospheric PCHs. The forecast of mixed PCHs likely signals a higher period of uncertainty for the second half of December.

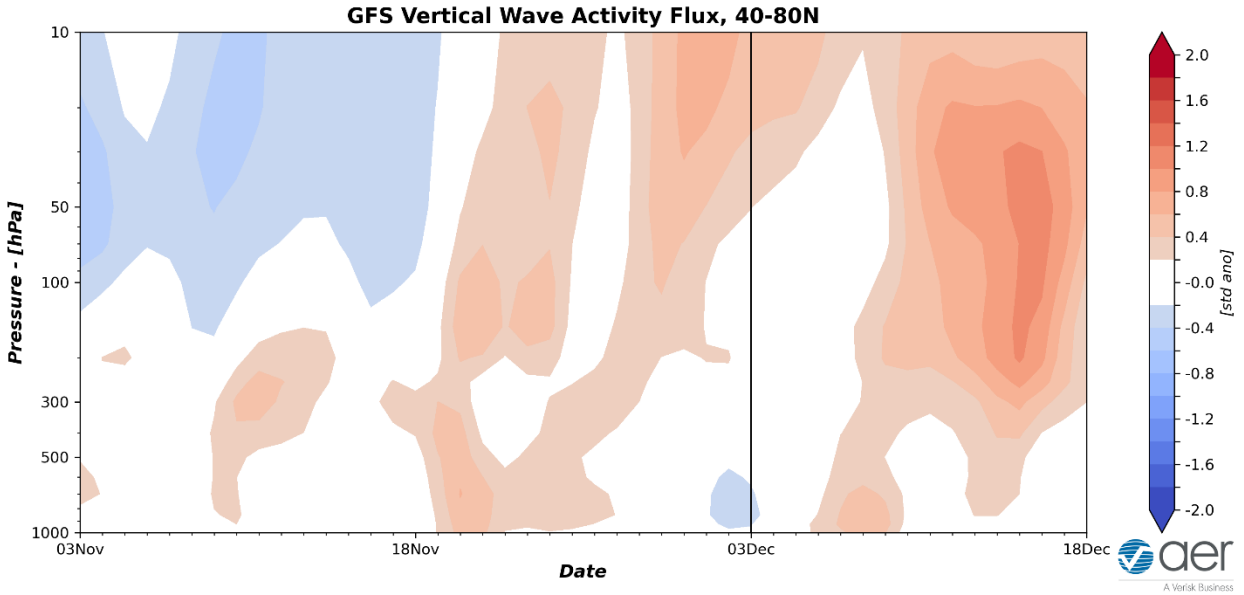


Figure 12. Observed and predicted daily vertical component of the wave activity flux (WAFz) standardized anomalies, averaged poleward of 40-80°N. The forecast is from the 00Z 4 December2023 GFS ensemble.

Vertical Wave Activity Flux (WAFz) from the troposphere to the stratosphere or poleward heat transport in the stratosphere has become more active since mid-November (**Figure 12**). This has resulted in a Canadian warming (**Figure 12**) and the return of the stratospheric AO to neutral (**Figure 1**). Over the next two weeks the WAFz is predicted to remain active (**Figure 12**), which should result in the short term a stretched PV in mid-December.

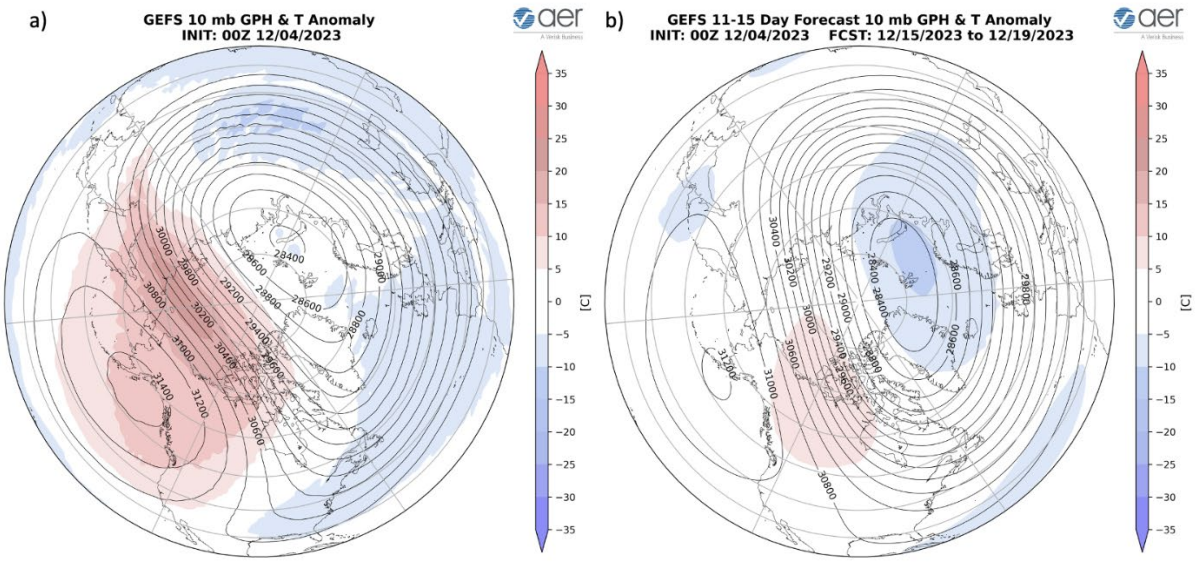


Figure 13. (a) Initialized 10 mb geopotential heights (dam; contours) and temperature anomalies (°C; shading) across the Northern Hemisphere for 4 December 2023 . (b) Same as (a) except forecasted averaged from 8 – 12 December 2023. The forecasts are from the 00Z 4 December 2023 GFS model ensemble.

Currently the polar vortex (PV) is elongated in shape with the PV center shifted south of the North Pole in the direction of the Barents-Kara Seas (**Figure 13a**). This elongated PV configuration is predicted to orient along an axis from Siberia to Greenland. Across North America a ridge is centered near Alaska with the strongest warming aimed at Northern Canada. This is characteristic of a Canadian warming that favors warm temperatures across North America but cold temperatures across northern Eurasia. In mid-December the PV center remains between the Barents-Kara Seas and Greenland with an elongated shape but now oriented from Siberia towards Western Canada characteristic of a stretched PV (**Figure 13b**). Induced northerly flow across Canada should result in colder temperatures spreading southeastward east of the Rockies but is so far not predicted by the weather models.

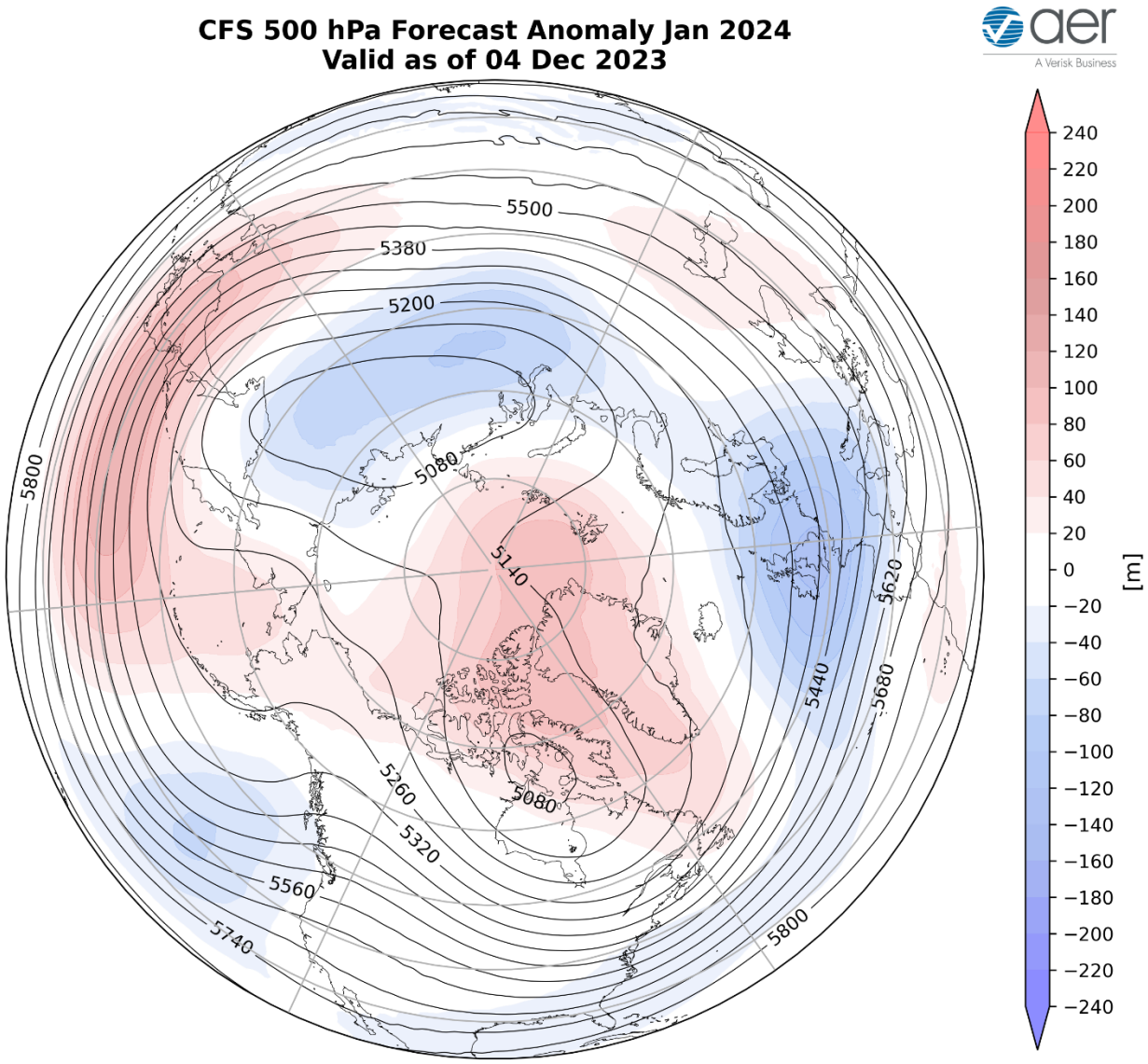


Figure 14. Forecasted average 500 mb geopotential heights (dam; contours) and geopotential height anomalies (m; shading) across the Northern Hemisphere for January 2024. The forecasts are from the 00Z 4 December 2023 CFS.

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 from Greenland across to the Barents-Kara Seas Eastern Siberia, Alaska, Western Canada and the Western US with troughing in Western Europe, Siberia, Northeast Asia, the Gulf of Alaska and eastern North America (**Figure 14).** This pattern favors seasonable to relatively warm temperatures across Southern Europe, Southern Asia, Eastern Siberia, Alaska, Western Canada and the Western

US with seasonable to relatively cold temperatures across Northern Europe, Northern Asia including Siberia, Northeast Asia, Eastern Canada and the Eastern US (**Figure 15**).

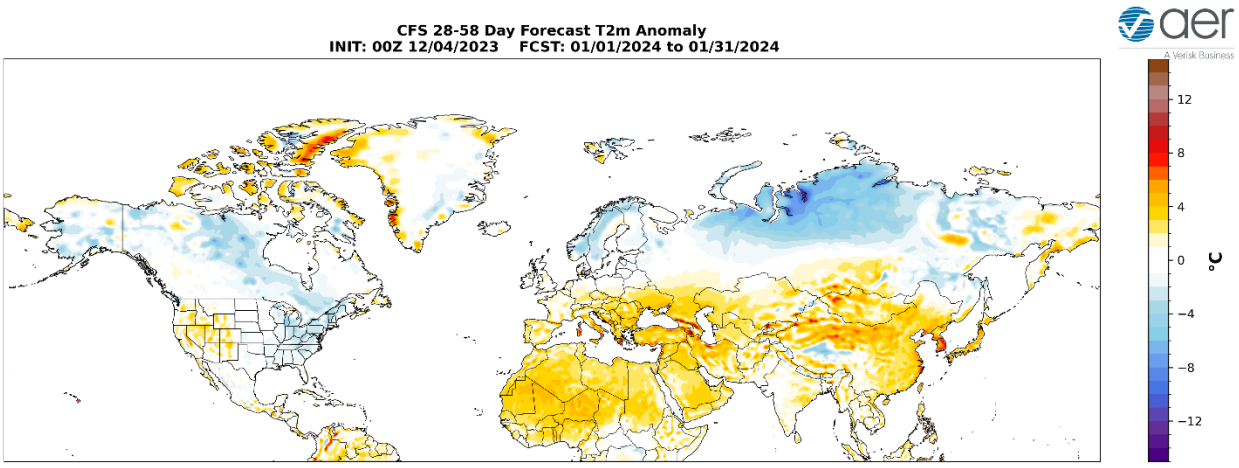


Figure 15. Forecasted average surface temperature anomalies (°C; shading) across the Northern Hemisphere for January 2024. The forecasts are from the 00Z 4 December 2023 CFS.

Boundary Forcings

Arctic sea ice extent

Arctic sea ice extent continues to grow but did go sideways this week. I continue to expect that the negative sea ice anomalies will become more focused in the North Atlantic sector, though so far this has not happened. Blocking in the Barents-Kara sea region is critical from keeping a runaway PV that will squash any widespread and meaningful cold in Northern Eurasia and eastern North America for weeks and possibly even months to come.

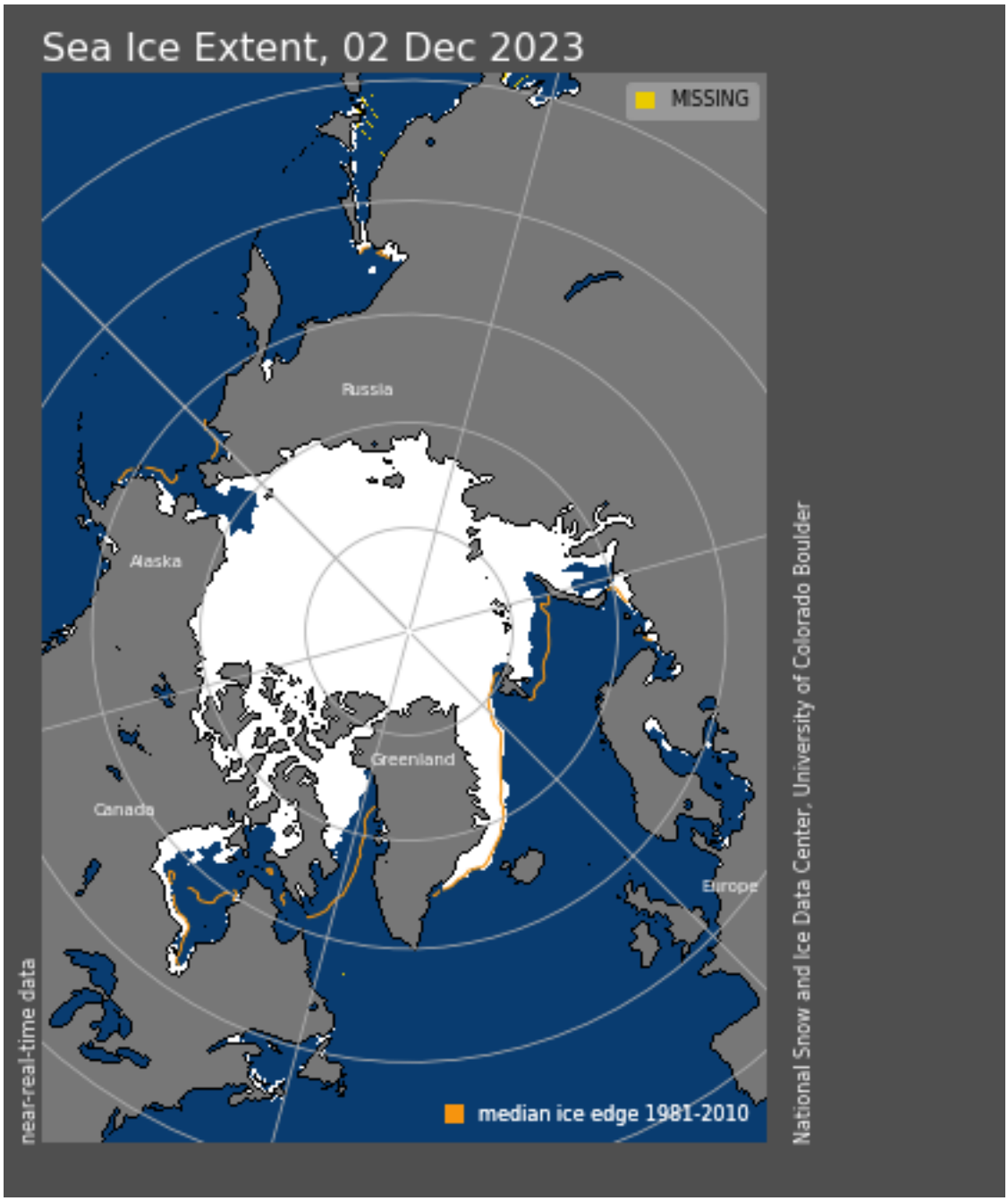


Figure 16. Observed Arctic sea ice extent on 02 December 2023 (white). Orange line shows climatological extent of sea ice based on the years 1981-2010. Image courtesy of National Snow and Ice Data Center (NSIDC). Snow and Ice Data Center (NSIDC).

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.

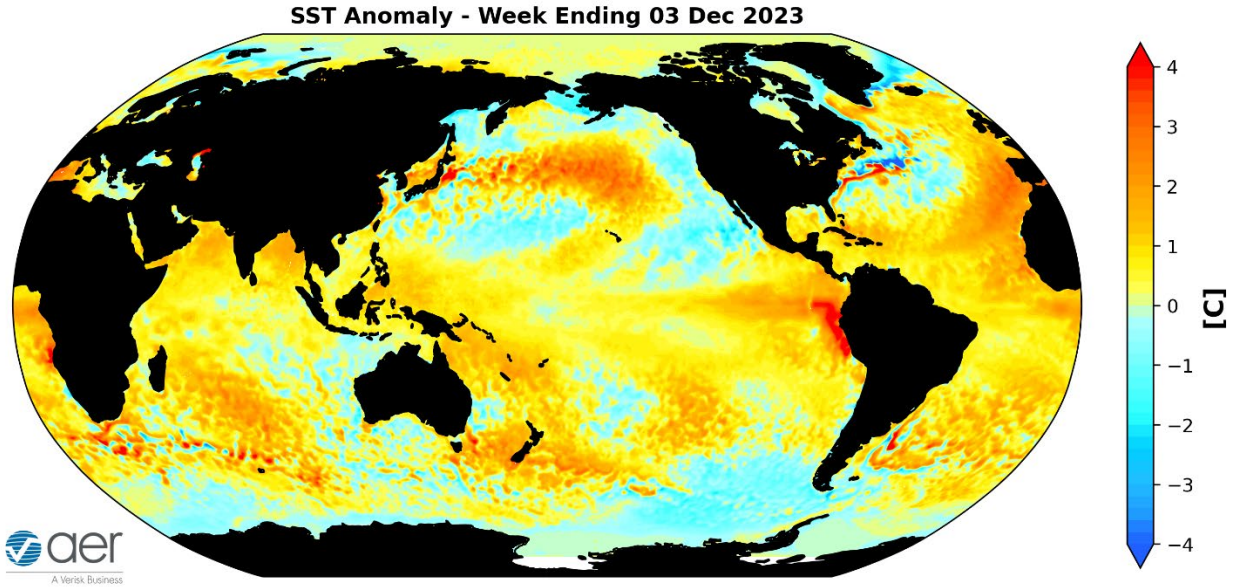


Figure 17. The latest weekly-mean global SST anomalies (ending 03 December 2023). Data from NOAA OI High-Resolution dataset.

Madden Julian Oscillation

Currently the Madden Julian Oscillation (MJO) is in phase two (**Figure 1**). The forecasts are for the MJO to immediately weaken where no phase is favored. Phase two favors troughing along the west coast of North America and ridging in eastern North America. Therefore it seems that the MJO could be having some limited influence on North American weather next week. But admittedly this is outside of my expertise.

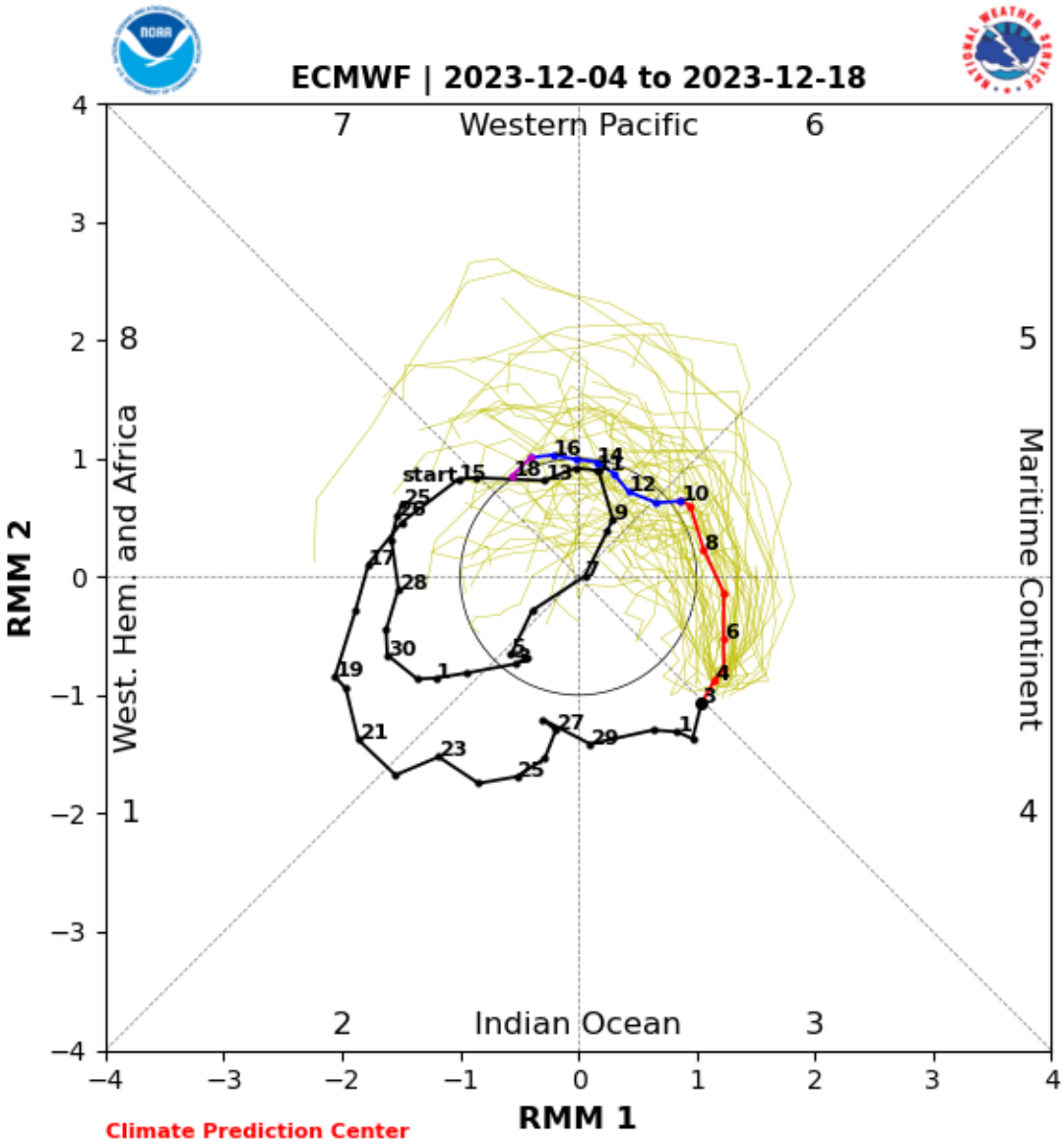


Figure 18. Past and forecast values of the MJO index. Forecast values from the 00Z 04 December 2023 ECMWF model. Yellow lines indicate individual ensemble-member forecasts, with the green line showing the ensemble-mean. A measure of the model "spread" is denoted by the gray shading. Sector numbers indicate 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

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!