Arctic Oscillation and Polar Vortex Analysis and Forecasts

February 24, 2025

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 positive and is predicted to remain positive this week but then but trend towards neutral later this week and next week as pressure/geopotential height anomalies across the Arctic are currently mostly negative and are predicted to become more mixed 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 remain positive the next two weeks as pressure/geopotential height anomalies are predicted to remain negative across Greenland.
- The next two weeks troughing/negative geopotential height anomalies across Greenland will support ridging/positive geopotential height anomalies across most of Europe with the exception of troughing/negative geopotential height anomalies across the Eastern Mediterranean. This pattern will support mostly normal to above normal temperatures across most of Europe including the United Kingdom (UK) with normal to below normal temperatures mostly limited to Turkey.
- The general pattern across Asia the next two weeks is ridging/positive geopotential height anomalies across Northwestern Asia supporting troughing/negative geopotential height anomalies across Southwestern and Northeastern Asia. This pattern favors widespread normal to above normal temperatures across Northwestern Asia with

normal to below normal temperatures across Southwestern and Northeastern Asia including much of Siberia the next two weeks.

- The general pattern across North America the next two weeks is strengthening ridging/positive geopotential height anomalies across in the Gulf of Alaska and western North American side supporting deepening troughing/negative geopotential height anomalies across Eastern Canada and the United States (US). This week patten will favor widespread normal to above normal temperatures across much of Alaska, Canada and the US with normal to below normal temperatures limited to Arctic coast. However next week normal to below normal temperatures will spread across Eastern Canada and the Eastern US from north to south with normal to above normal temperatures persistent across Alaska, Western Canada and the Western US.
- This winter has been all about the polar vortex (PV) alternating among three different states: strong, a Canadian warming but most of all a stretched PV. We have had stretched PVs in October, November, December, January and February. Looks like at least one more in early March and then could the PV finally be ready for summer vacation?

Plain Language Summary

The imprint of the two stretched polar vortex (PV) events can be easily seen in the February surface temperature anomalies so far (see **Figure**). The cold is widespread in Northeast Asia, Eastern Siberia but especially Western and Central Canada and the Northern US. Some debate among the models about what happens in March but looks to me that one more stretched will occur during the first and second weeks of March that will bring cold weather first to Northeast Asia and then eastern North America. After that a bigger PV disruption is looking increasingly likely.

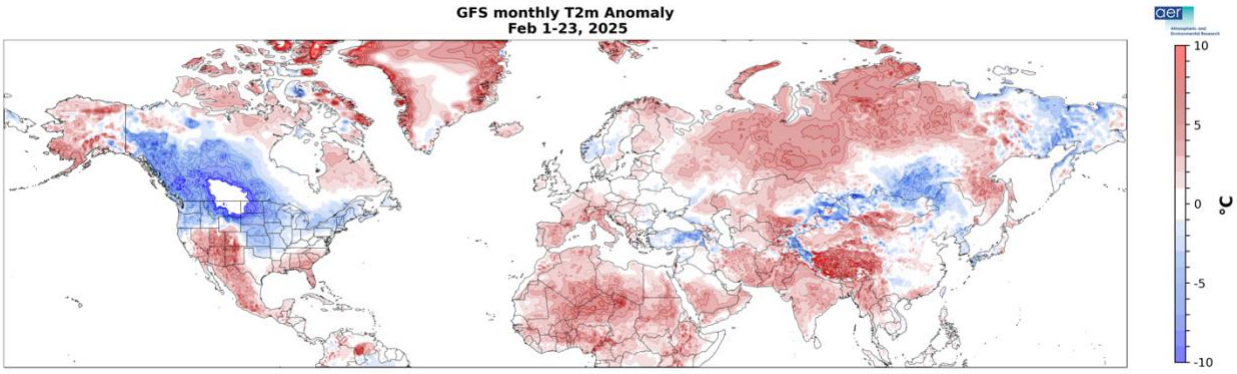

Figure. Estimate of the observed surface temperatures (°C; shading) from 01 to 23 Feb 2025 based on GFS initializations and the GFS forecast from the 24 Feb 2025 run.

Impacts

I did want to address a recent blog from NOAA Climate.gov on the polar vortex (PV). In the blog it is claimed that the widespread cold in North America during the month of February is unlikely to be related to the stratospheric PV. This may be somewhat self-serving since in the previous blog they discussed at the end of January that the predicted strong PV for February will likely favor milder temperatures. This is obviously in direct contrast with just about every blog that I have published so far this winter. I would prefer to just ignore the NOAA blog and I have tried since its inception but I felt this time I need to address what was presented.

As far as I can tell the only support for their argument was that the zonal mean zonal winds were stronger than normal and that the polar cap geopotential height anomalies (PCHs) shows that the stratosphere and troposphere remain mostly uncoupled this winter. Ironically, I believe that I was first present the PCH plot at a NOAA workshop over twenty years ago and has shown up in the blog since its inception. I have also commented often that based on the PCH the troposphere and stratosphere appear to be uncoupled. I introduced the PCH plot because the common metric at the time the NAM or AO, I felt masked the influence of the troposphere on stratosphere-troposphere coupling.

But the PCH and certainly the NAM is only useful for identifying coupling that is wave zero (the complete absence of waves) or zonally symmetric anomalies or when the variability throughout the atmospheric column is annular in shape (think donut and hence the term Northern Annular Mode). Looking at the animations that I have presented all winter certainly in the troposphere but clearly even in stratosphere waves exist in both i.e., zonally asymmetric anomalies), the PV this winter has only briefly appeared as an annulus or wave zero. In fact, the polar vortex has spent most of the winter in a wave-2 configuration seen in my PV animations and in the beautiful animation presented by NOAA. This is typical of stretched PVs as wave-2 in the troposphere forces the wave-2 in the stratosphere. Again, in NOAA's own animation you can see the stretched PV starts with Scandinavian/Ural blocking forcing troughing over East Asia the first week of February and then evolves into Alaskan blocking and North American troughing east of the Rockies the second week of February. You can see that the same wave pattern of Scandinavian/Ural blocking coupled with troughing over East Asia the first week of February and Alaska blocking and North American troughing east of the Rockies the second week of February in the troposphere in my 3 Feb 2025 blog post. Can the waves in the stratosphere and troposphere be more coupled? Does it really matter that a metric that assumes no waves looks uncoupled?

But I will even take it a step farther. The NOAA blog says we only know of the stratosphere and troposphere coupling during SSWs (and when the PV is very strong). The last winter when everyone agrees classical coupling existed between the stratosphere and troposphere coupled is 2017/18 when an SSW occurred on 12 February 2025. In **Figure i**, I include the PCH from that entire winter season. For almost the entire winter the stratosphere and troposphere remain uncoupled with the main exception of two brief periods in late December and early March. The late December coupling was actually a stretched PV as I discussed in my winter recap (lost in

the dark web it seems) and Matthias and Kretschmer (2020). The SSW occurred second week of February yet for almost the entire month based on NOAA's condition for proving coupling the stratosphere and troposphere were uncoupled. Coupling did occur three weeks later in early March.

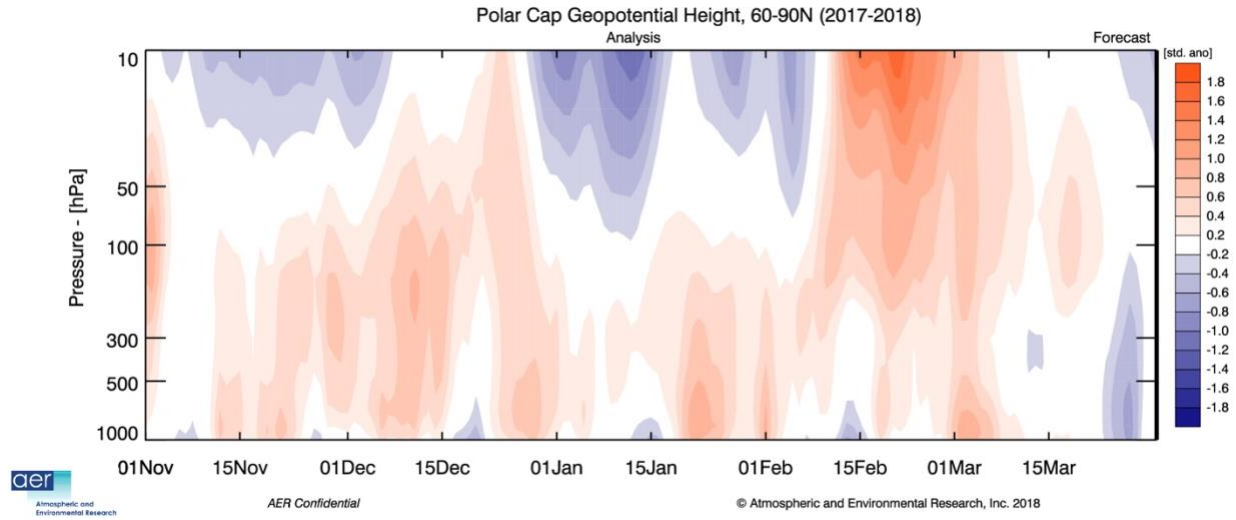

Figure i. Observed daily polar cap height (i.e., area-averaged geopotential heights poleward of 60°N) standardized anomalies from 1 Nov 2017 through 31 Mar 2018.

You may be asking yourself, hmm how does an SSW in the stratosphere that occurs on the 12th of February force Greenland blocking and a negative AO/NAO a full three weeks later. And I agree that is a great question, a question as far as I know has not been satisfactorily answered with various floating hypotheses out there. I have never heard a convincing answer to how exactly does an SSW in the stratosphere force Greenland blocking in the troposphere three weeks later?

To me the best proof of an idea is making a successful forecast with the that idea. Four days before the initial NOAA blog discussing strong PVs and mild weather, in my PV blog I predicted another stretched PV that would bring cold to the Eastern US starting the second week of February. And as I tweeted out that was a full week before any of the weather models predicted the cold. And if you don't believe me look at all the different models, including the GFS and the ECMWF predicting wall to wall warmth for the US in February even when initialized on 1 February 2025. With the blog I really try to put my money where my mouth is and getting a correct forecast three weeks in advance and contradicting all the models is truly not easy and not fully appreciated until you actually try it. And I have correctly predicted cold weather with all ten PV stretches this winter. I guess anyone can be randomly correct once, but ten times?

But even putting aside the successful forecasts, a physical underpinning has been provided by myself and my co-authors have provided it in our multiple papers. You can follow the energy that couples the troposphere and the stratosphere from inception to completion all on the time scale

of days to week or so with no leaps of faith. This involves both horizontal and vertical wave propagation that is often referred to wave reflection. I prefer to call these events stretched polar vortex events because one visually that is much easier to comprehend or visualize (never seen an animation of wave reflection). But second, wave reflection was first used for a phenomenon that is clearly not this, as I explain and illustrate in our Cohen et al. (2022). The most common "wave reflection" in the literature results in very mild conditions in both Asia and North America clearly not the phenomenon that I have been studying and discussing in the blog.

Our physical explanation for stretched PVs is provided in detail in our multiple papers on the subject in the paper above and in Cohen et al. (2021). The latter has a beautiful schematic that has popped up now in other locations including this NOAA blog post on 7 January 2025 with some appearances that might surprise you. Please read the blog, no skepticism expressed by NOAA the first week of January 2025. I can write more but I think I said enough for now. Obviously, the NOAA blog hit a raw nerve with me.

Excuse the interruption and now back to our regularly scheduled programming:
After three continuous months it does finally appear that the seemingly infinite loop of "lather, rinse repeat," or merry go-round of stretched PV events punctuated by a more circular or strong PV and Canadian warmings is coming to an end. We had two stretched PVs in February that are mostly in the rearview mirror, but not before bringing big snows to Northeast Asia with record snow depths in Japan and record cold temperatures and some snow this past week to the United States (US) and Canada east of the Rockies. We had a total of ten stretched PVs this winter season by my count. This week and into next week we have the second Canadian warming of the winter as seen in the latest PV animation in **Figure ii**. The Canadian warming lasts through 5th of March.

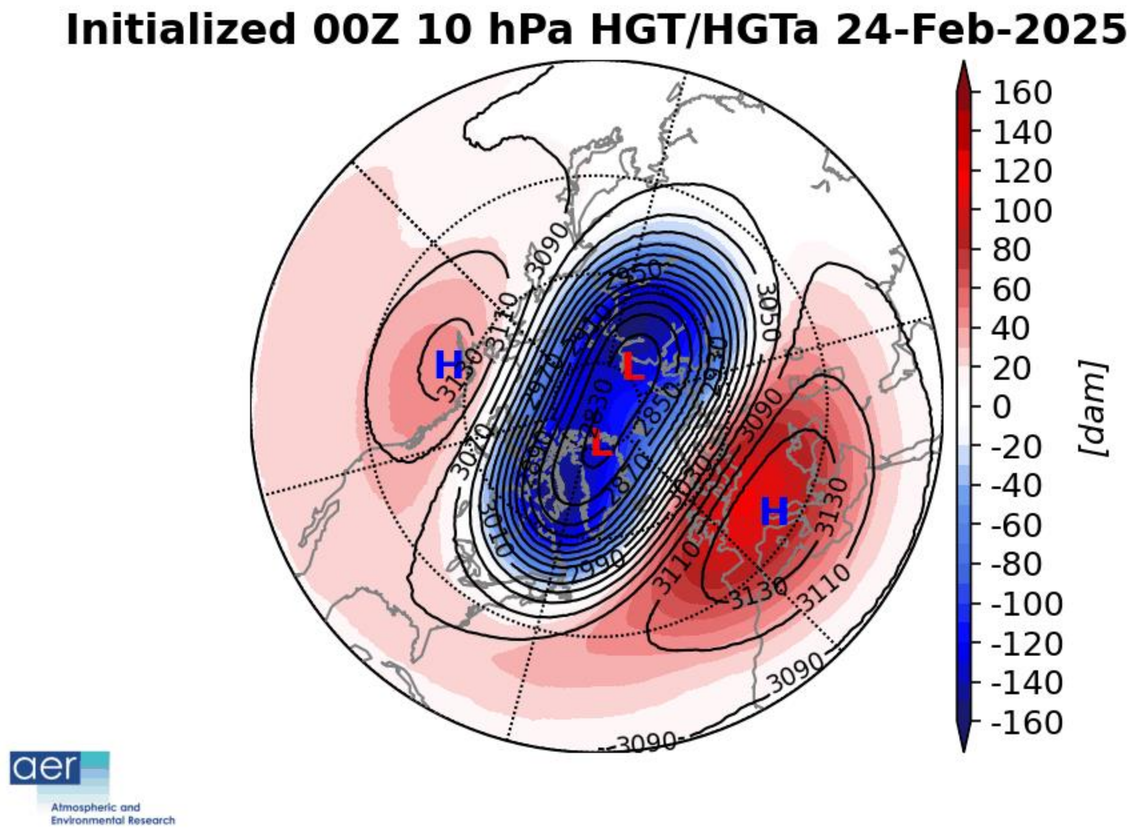

Figure ii. Initialized 10 mb geopotential heights (dam; contours) and temperature anomalies (°C; shading) across the Northern Hemisphere for 24 Feb 2025 and forecasted from 25 February to 11 Mar 2025. The forecasts are from the 00Z 24 Feb 2025 GFS model ensemble.

Once again, I present the wave reflection diagnostics. Wave reflection is the physical underpinning of stretched PV events, and it has seemed to have occurred continuously throughout the month of January and has continued for a good part of February. During wave reflection, wave energy goes up over Asia, bouncing off the stratospheric PV and then downward over North America. The downward wave energy amplifies the ridge-trough wave over North America and determines the strength or amplitude of the North American wave and the axis or position (see **Figure iii**). Next week the GFS predicts more wave reflection (see **Figure iiia**) supportive of at least one more stretched PV event the end of the first week and into the second week of March (see **Figure ii**). This would likely support at least one more cold week for the Eastern US the second week of March (see **Figure 9**). The stretched PV in both the European and Canadian ensembles is fleeting and both models transition to an SSW type event only after a couple of days. For now, I am favoring the GFS ensemble solution (see **Figure 13b**).

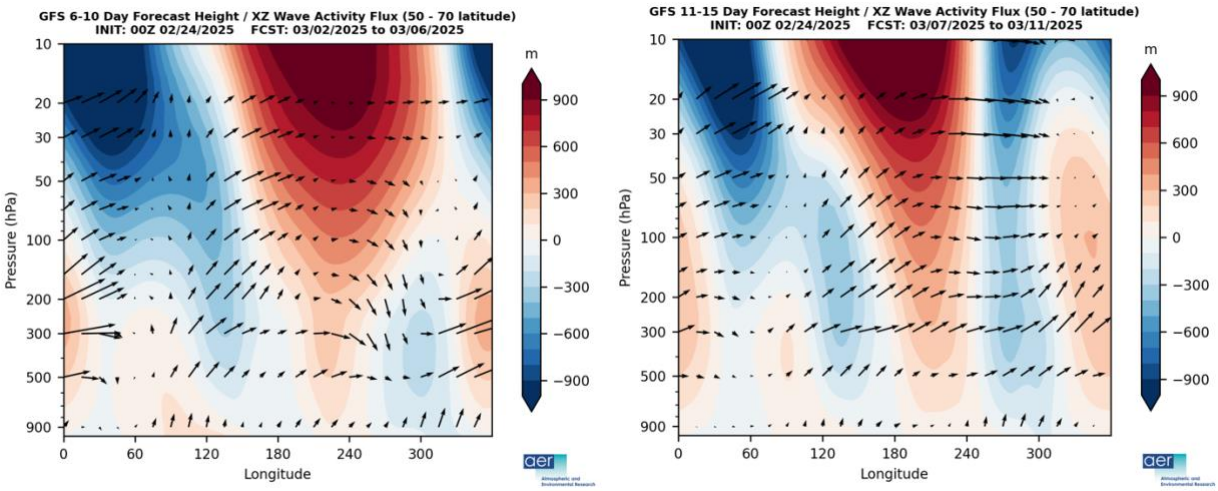

Figure iii. Longitude-height cross section of geopotential eddy height anomalies (shading) and wave activity flux (vectors) a) predicted for 02 Mar through 06 Mar 2025 and b) forecasted for 07 Mar through 11 Mar 2025. The forecasts are from the 00Z 24 February 2025 GFS ensemble.

However, the wave reflection disappears for the second week of March (see **Figure iiib**). The lack of wave reflection is suggestive that the WAFz is being absorbed in the polar stratosphere, resulting in a possible sudden stratospheric warming (SSW). This is showing up in all the models with the possible exception of the GFS ensembles. The GFS operational shown in **Figure ii** is pretty aggressive in going for a full PV split and is likely overdone.

Stretched PVs are related to severe winter weather not only to North America but also East Asia. The upcoming stretched PV is first predicted to stretch or elongate into Asia the first week of March (see **Figure iii**). Ridging over the Urals and then the Laptev Sea/Siberia helps deepen troughing over East Asia next week (see **Figure iv**). The troughing is associated with a cold air outbreak predicted to begin in Siberia and quickly spread southeast into East Asia for the first week of March (see **Figure 6**) but is mostly over by the second week of March (see **Figure 9**). This was anticipated in last week's blog.

Stretched PVs don't have a large impact on Europe. However high latitude blocking that began over the Urals, slid west to Scandinavia and is now over Greenland (see **Figure iv**). The Greenland blocking is quickly waning but will allow cold air to flow from the northeast towards Eastern Europe resulting in a cold week in Eastern Europe while Western Europe is already and remains mild (see **Figure 6**). And as I discussed in the blog rom two weeks ago, milder times were likely for Europe based on the warming in the stratosphere over Europe (see **Figure 13a**) and the absence of Greenland blocking that instead morphs into Scandinavian blocking (see **Figure iv**).

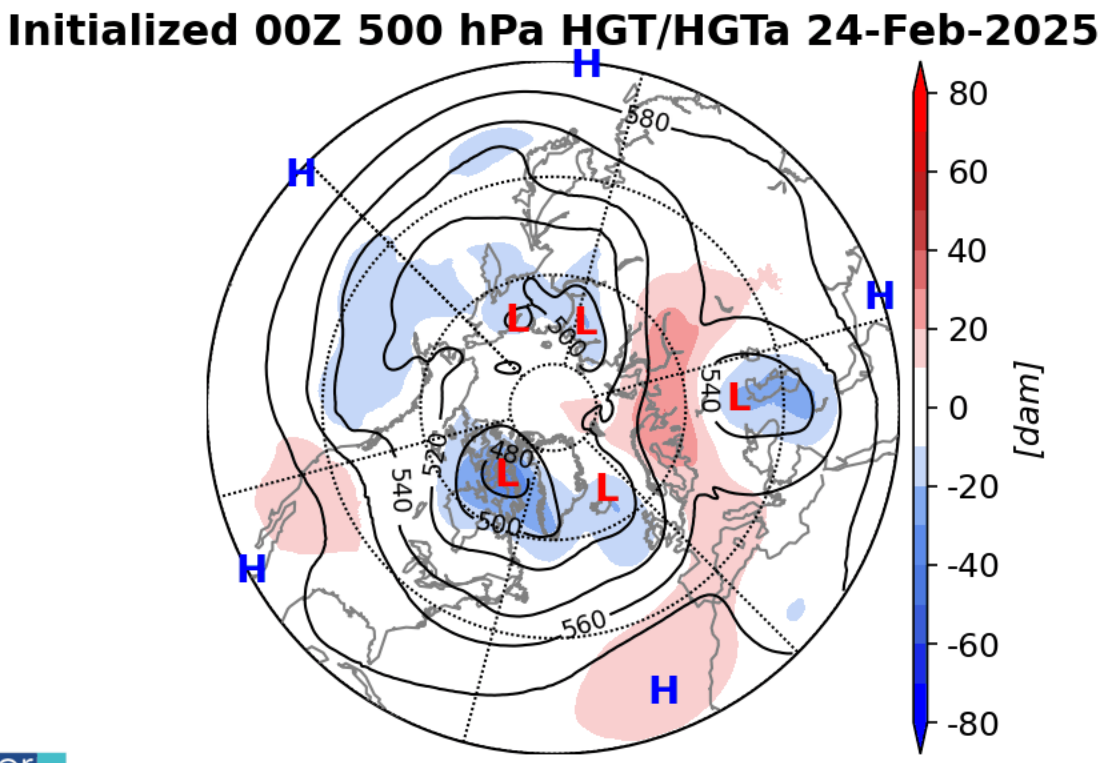

Figure iv. Initialized 500 mb geopotential heights (dam; contours) and decameter anomalies (dam; shading) across the Northern Hemisphere for 24 Feb 2025 and forecasted from 24 Feb to 11 March 2025. The forecasts are from the 00Z 24 Feb 2025 GFS model ensemble.

As I discussed in the blog, the strong warming in the polar stratosphere over Europe (see **Figure ii**) was a likely sign of milder times ahead (see **Figures 3, 6** and **9**). The forecast for Europe over the next two weeks is indeed mild. As I have discussed before a Canadian warming could spawn Greenland blocking. The same can be said for a full-blown SSW. So, a return of Greenland blocking and a colder pattern for Europe is still possible in March but certainly now obvious signs for now.

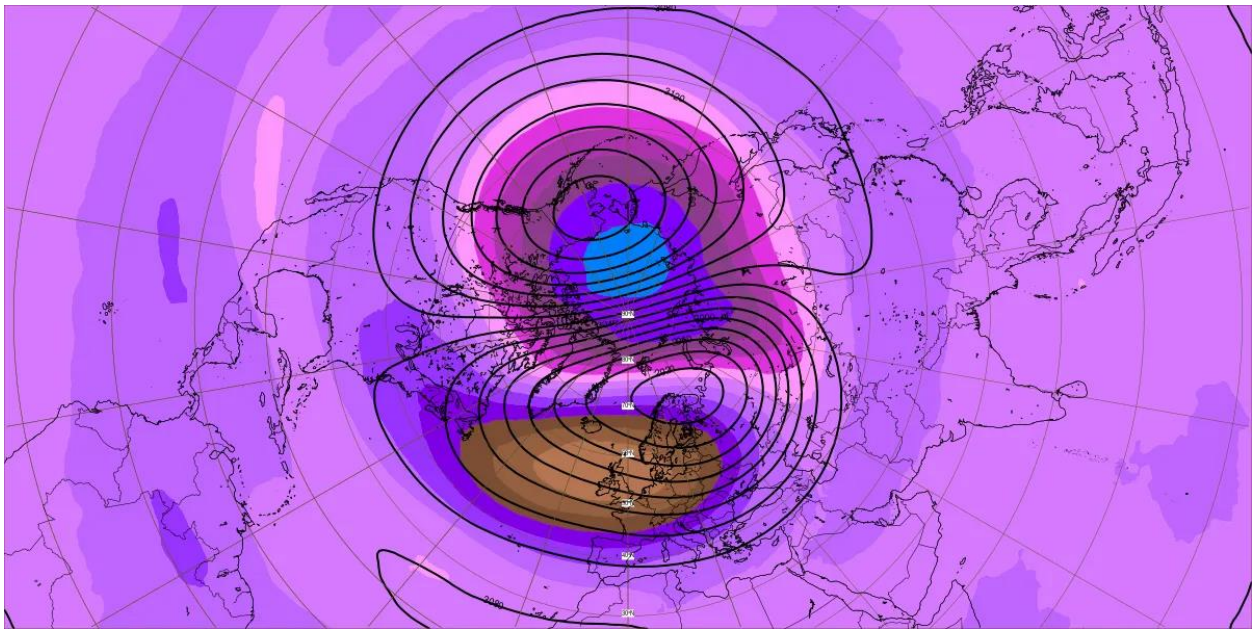

Figure v. Forecasted 10 mb geopotential heights (dam; contours) and temperatures (°C; shading) across the Northern Hemisphere for 10 March 2025. The forecasts are from the 12Z 24 February 2025 ECMWF ensembles. Plot taken from https://charts.ecmwf.int/.

I did take a peek at the 12Z models and the GFS still riding the stretched PV train. For at least one run the ECMWF seems to be back on the stretched PV train (see **Figure v**) and will be interesting to see if it can remain consistent. Yet the models are all pretty mild in the Eastern US the second week of March. It is unusually late to be discussing stretched PVS that don't follow an SSW so the level of difficulty is higher than early in the winter. Still what I say next should not surprise anyone, if the PV model forecasts verify then I would expect temperatures to be colder in the Eastern US than currently predicted by the weather models.

Near-Term

This week

The AO is predicted to be mostly positive this week **(Figure 1**) with mostly negative 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 mostly positive this week as well.

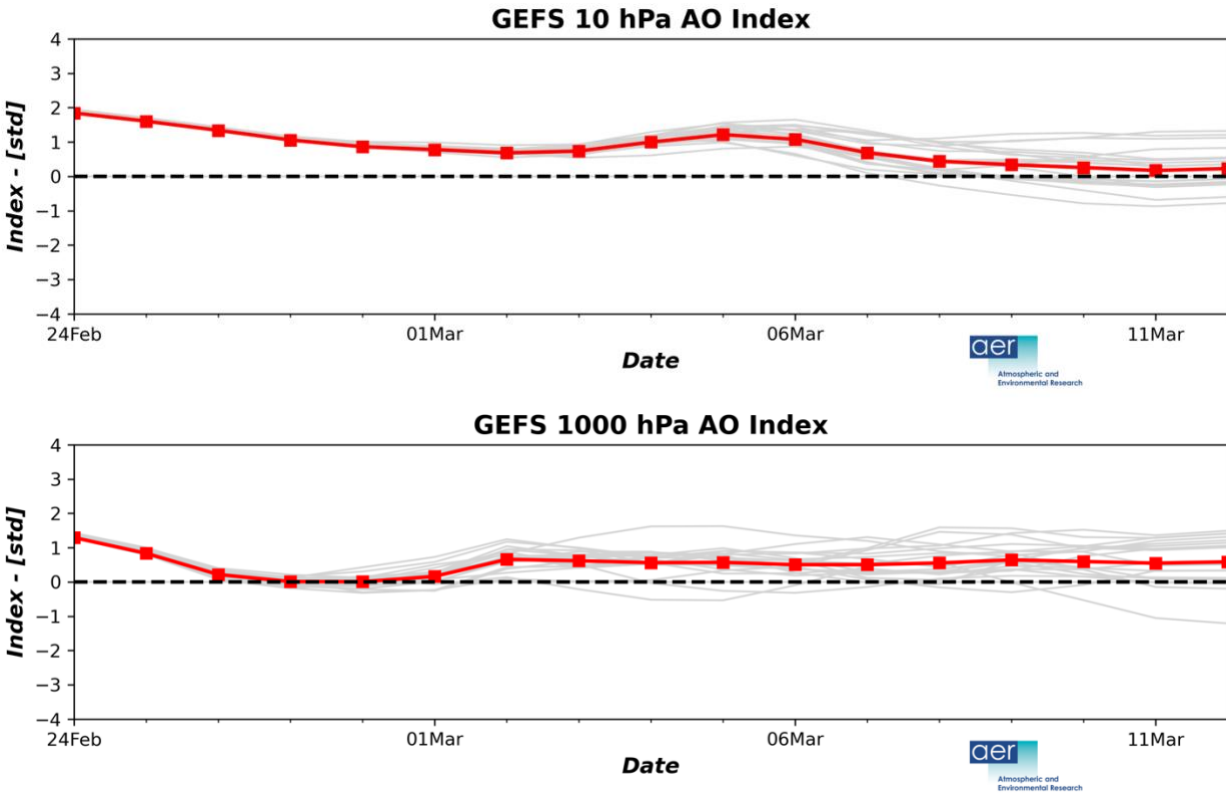

Figure 1. a) The predicted daily-mean AO at 10 hPa from the 00Z 24 February 2025 GFS ensemble. b) The predicted daily-mean AO at 1000 hPa from the 00Z 24 February 2025 GFS ensemble. Gray lines indicate the AO index from each individual ensemble member, with the ensemble mean AO index given by the red line with squares.

This week troughing/negative geopotential height anomalies across Greenland will support ridging/positive geopotential height anomalies across much of Europe with troughing/negative geopotential height anomalies in the Eastern Mediterranean (**Figures 2).** This pattern will favor normal to above normal temperatures across much of Europe including the UK with normal to below normal temperatures across Turkey this period (**Figure 3**). This week ridging/positive geopotential height anomalies across Northwestern Asia will support troughing/negative geopotential height anomalies across Southwestern and Northeastern Asia (**Figure 2**). This pattern favors normal to above normal temperatures widespread across Northwest Asia with normal to below normal temperatures across Southwest and Northeast Asia including Siberia **(Figure 3**).

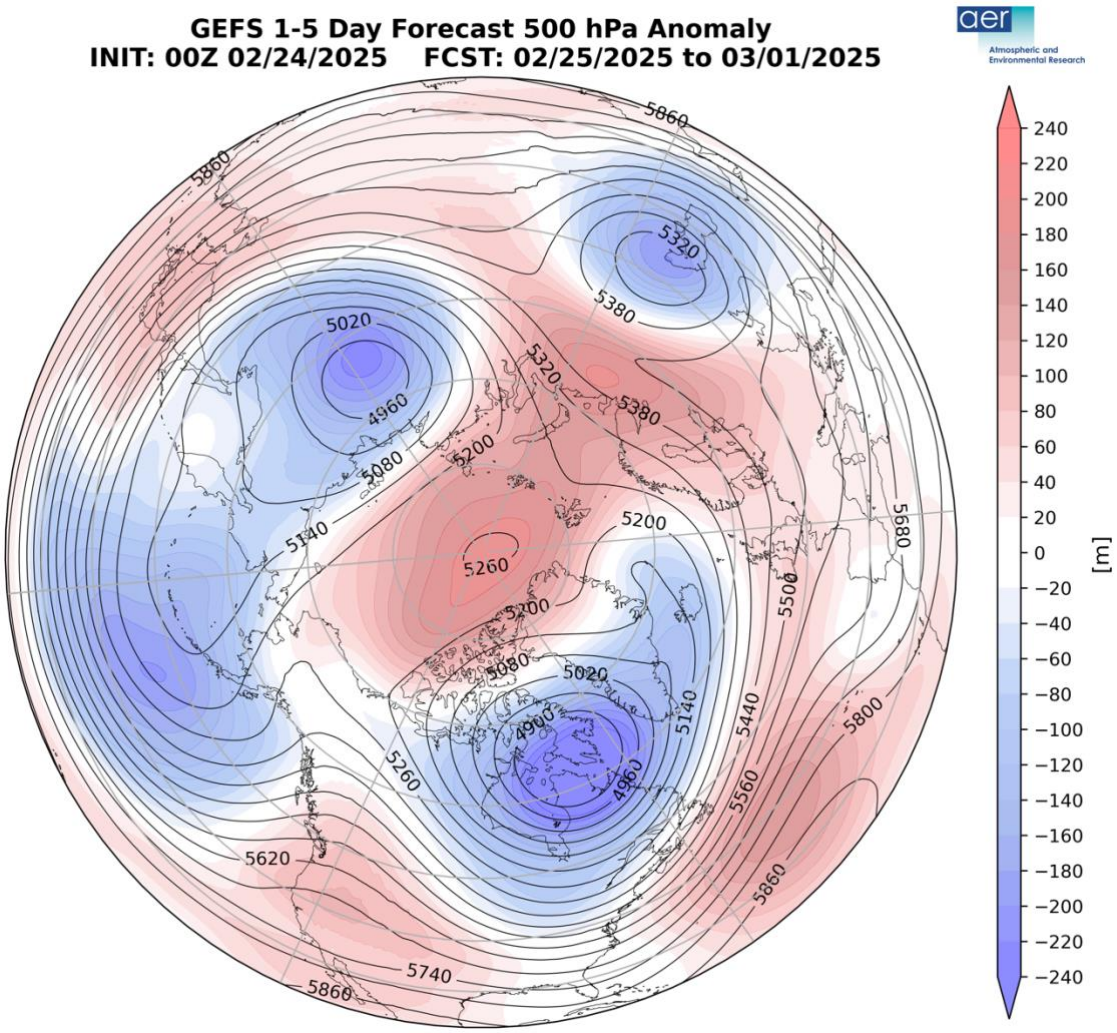

Figure 2. Forecasted average 500 mb geopotential heights (dam; contours) and geopotential height anomalies (m; shading) across the Northern Hemisphere from 25 Feb to 01 Mar 2025. The forecasts are from the 00Z 24 February 2025 GFS ensemble.

This week ridging/positive geopotential height anomalies along the west coast of North America will support troughing/negative geopotential height anomalies across Eastern Canda and the Eastern US. (**Figure 2**). This pattern favors widespread normal to above normal temperatures across Alaska, Canada and the US with normal to below normal temperatures mostly limited to the Arctic coast. (**Figure 3**).

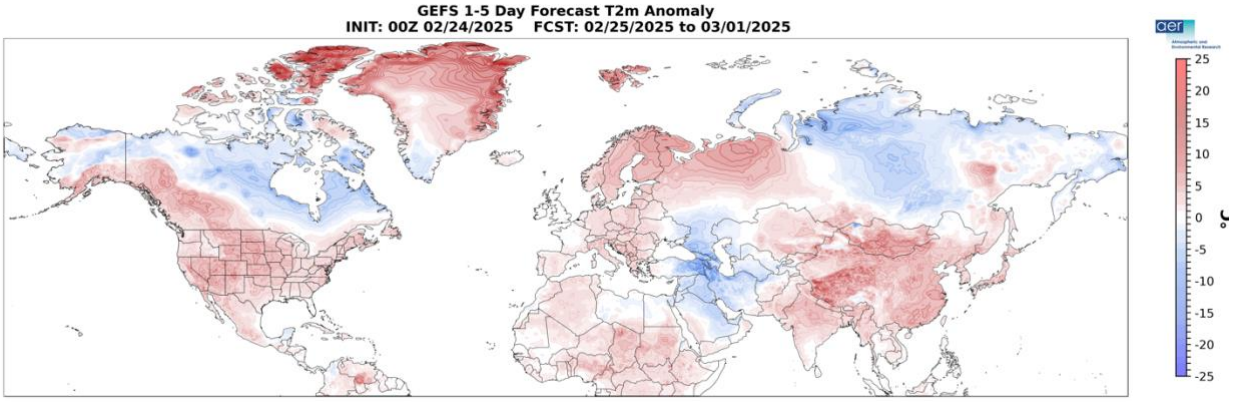

Figure 3. Forecasted surface temperature anomalies (°C; shading) from 25 Feb to 01 Mar 2025. The forecasts are from the 00Z 18 February 2025 GFS ensemble.

Troughing and/or cold temperatures will support new snowfall in the Caucuses, parts of Siberia, Central and Northeast Asia and the Tibetan Plateau while warm temperatures will support snowmelt in Scandinavia, around the Black Sea and Northwest Russia this week (**Figure 4**). Troughing and/or cold temperatures will support new snowfall across the higher elevations of the West Coastal mountains of Canada and Central Canada while warm temperatures will support snowmelt in central Alaska, Western and Southeastern Canada and the Northern US this week (**Figure 4**).

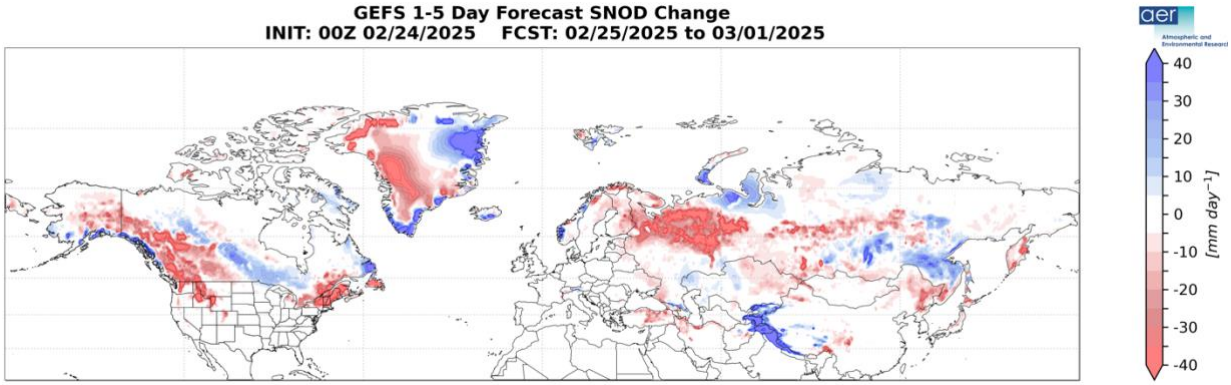

Figure 4. Forecasted snow depth changes (mm/day; shading) from 25 Feb to 01 Mar 2025. The forecasts are from the 00Z 24 February 2025 GFS ensemble.

Near-Mid Term

Next week

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

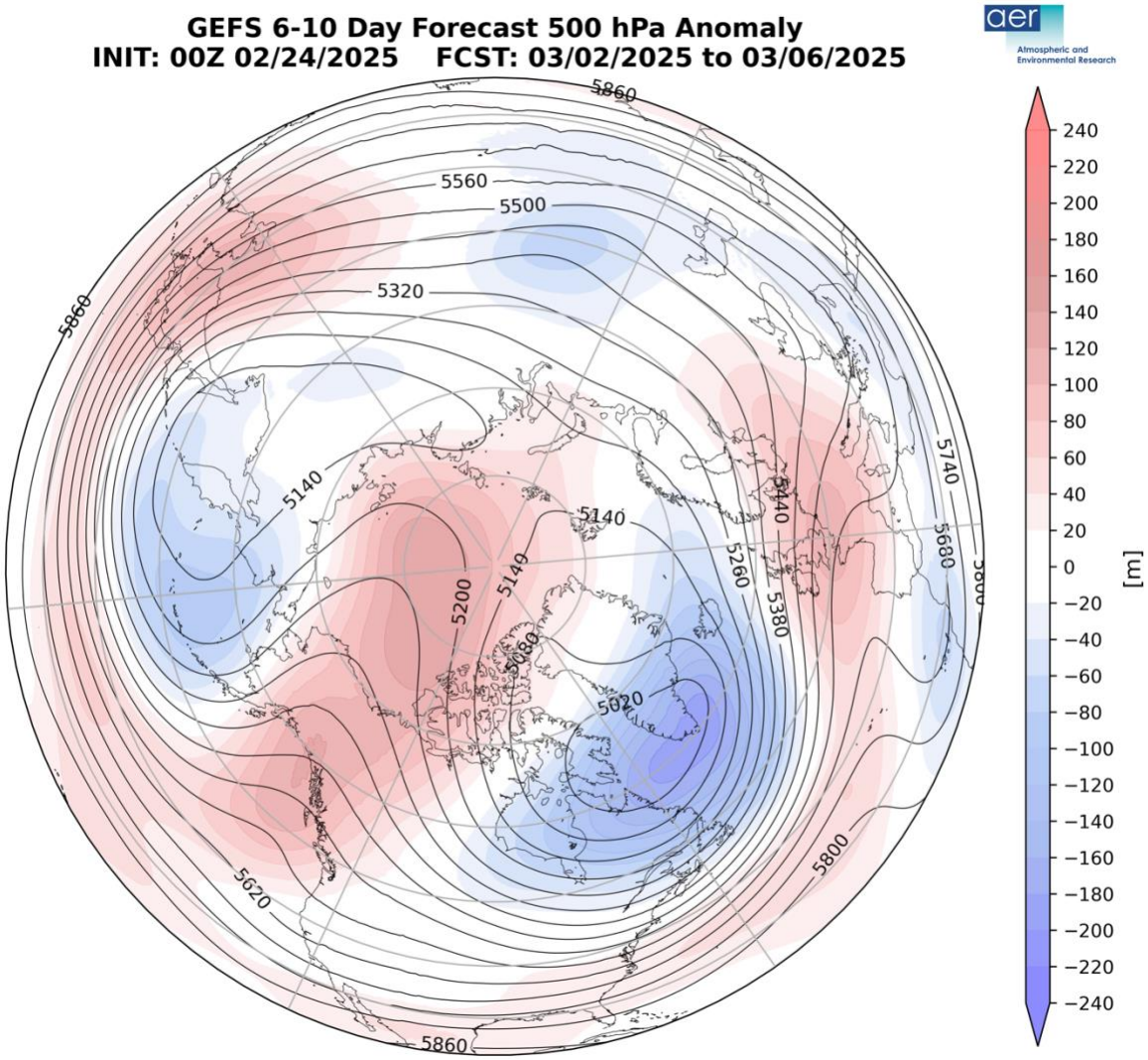

Figure 5. Forecasted average 500 mb geopotential heights (dam; contours) and geopotential height anomalies (m; shading) across the Northern Hemisphere from 02 Mar to 06 Mar 2025. The forecasts are from the 00Z 24 February 2025 GFS ensemble.

Persistent troughing/negative geopotential height anomalies across Greenland will support widespread ridging/positive geopotential height anomalies across Europe with residual troughing/negative geopotential height anomalies across the Eastern Mediterranean this

period (**Figure 5**). This pattern favors widespread normal to above normal temperatures across much of Europe including the UK with normal to below normal temperatures mostly limited to Turkey this period (**Figure 6**). Ridging/positive geopotential height anomalies across Europe and the Central Arctic are predicted to support troughing/negative geopotential height anomalies across Northern Asia with more ridging/positive geopotential height anomalies mostly across Southeast Asia (**Figure 5**). This pattern favors normal to above normal temperatures across Northwestern and Southeastern Asia with normal to below normal temperatures across Southeastern and Northeastern Asia including much of Siberia this period (**Figure 6**).

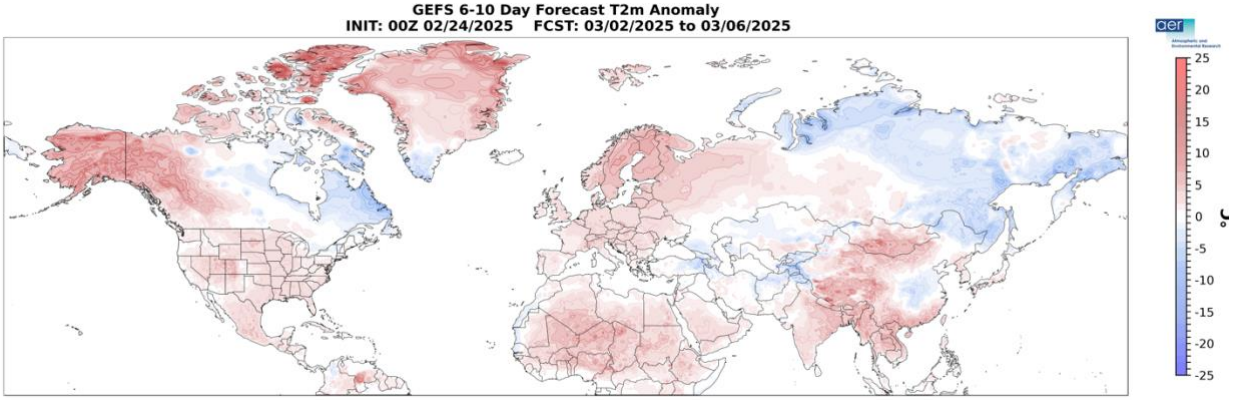

Figure 6. Forecasted surface temperature anomalies (°C; shading) from 02 Mar to 06 Mar 2025. The forecasts are from the 00Z 24 February 2025 GFS ensemble.

Ridging/positive geopotential height anomalies predicted centered in the Gulf of Alaska and Alaska and extending into Western Canada and the Western US will support troughing/negative geopotential height anomalies across Eastern Canada and the Eastern US this period (**Figure 5**). This pattern will favor normal to above normal temperatures widespread across Alaska, Western Canada and much of the US with normal to below normal temperatures limited across Eastern Canada and the Northeastern US (**Figure 6**).

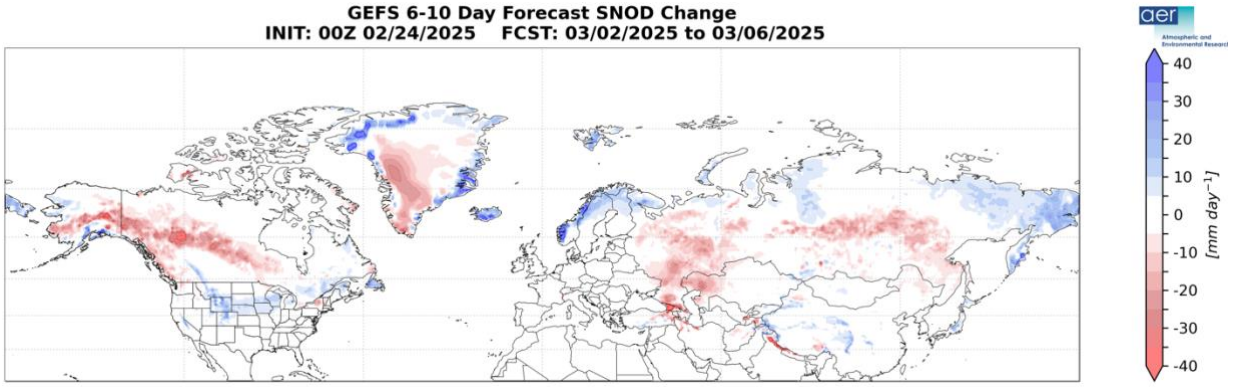

Figure 7. Forecasted snow depth changes (mm/day; shading) from 02 Mar to 06 Mar 2025. The forecasts are from the 00Z 24 February 2025 GFS ensemble.

Troughing and/or cold temperatures will support new snowfall across Scandinavia, Northeastern Asia and the Tibetan Plateau while warm temperatures will support snowmelt in parts of Scandinavia, Western Russia, the Caucuses, Siberia and Northeast Asia this period (**Figure 7**). Troughing and/or cold temperatures will support new snowfall across California, the US Plains into the Great Lakes and Southeastern Canada, while warm temperatures will support snowmelt in southern Alaska, Western and Central Canada and Northwestern US this period (**Figure 7**).

Mid Term

Week Two

With predicted persistent mostly mixed geopotential height anomalies across the Arctic and mixed geopotential height anomalies across the mid-latitudes this period (**Figure 8**), the AO will likely remain close to neutral this period (**Figure 1**). With predicted persistent negative pressure/geopotential height anomalies across Greenland (**Figure 8**), the NAO will likely be neutral to positive this period.

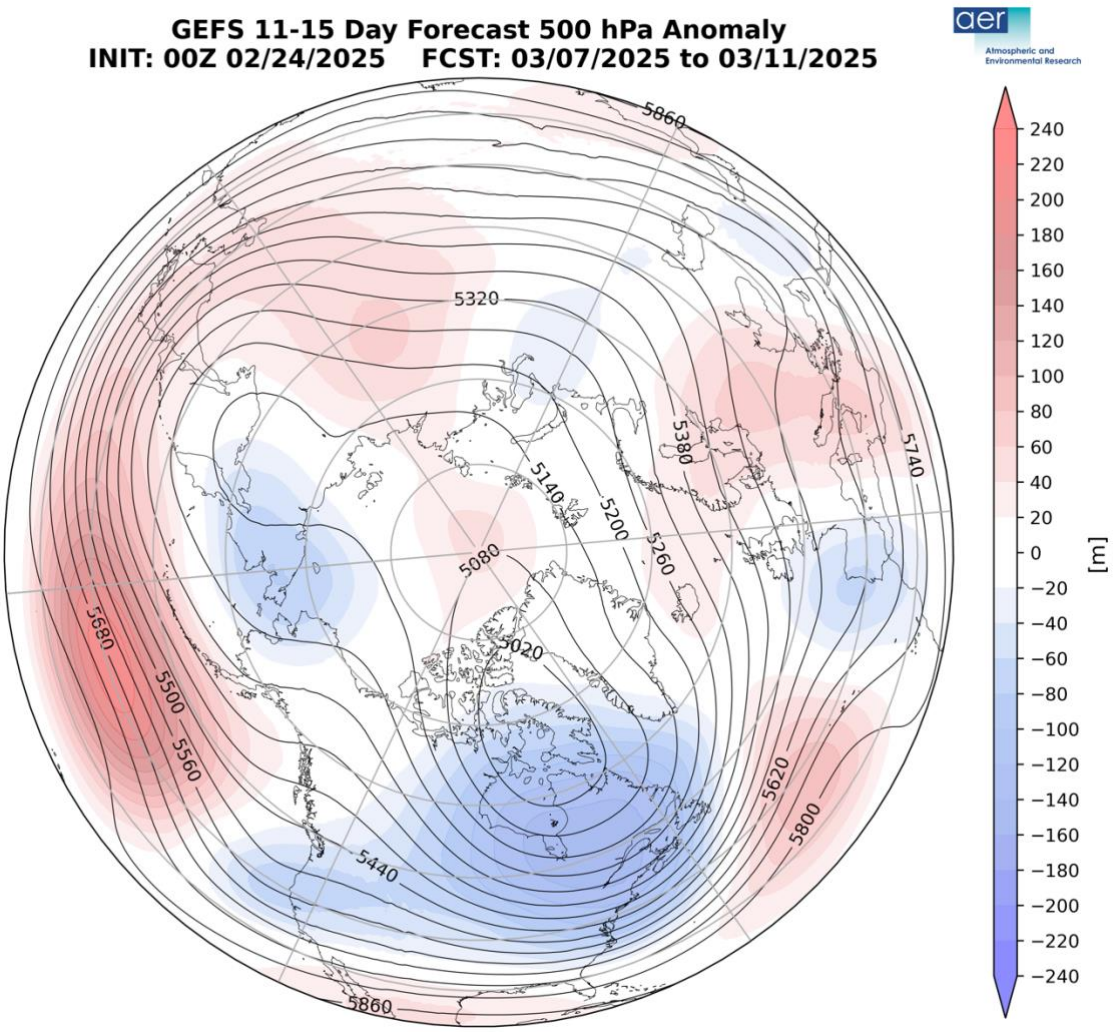

Figure 8. Forecasted average 500 mb geopotential heights (dam; contours) and geopotential height anomalies (m; shading) across the Northern Hemisphere from 07 Feb to 11 Mar 2025. The forecasts are from the 00Z 24 Feb 2025 GFS ensemble.

Persistent troughing/negative geopotential height anomalies across Greenland are predicted to support ridging/positive geopotential height anomalies across most of Europe with lingering troughing/negative geopotential height anomalies across the Middle East (**Figure 8**). This pattern should favor normal to above normal temperatures across much of Europe including the UK with normal to below normal temperatures limited to eastern Turkey this period (**Figures 9**). The persistent ridging/positive geopotential height anomalies across Europe are predicted to support troughing/negative geopotential height anomalies across Northwest Asia while ridging/positive geopotential height anomalies across Central Asia will support troughing/negative geopotential height anomalies across Eastern Siberia and Northeastern Asia this period (**Figure 8**). The predicted pattern favors widespread normal to above normal temperatures across most of Asia and the Indian subcontinent with normal to below normal temperatures mostly limited to parts of Southwestern Asia, Eastern Siberia and parts of Northeastern Asia this period (**Figure 9**).

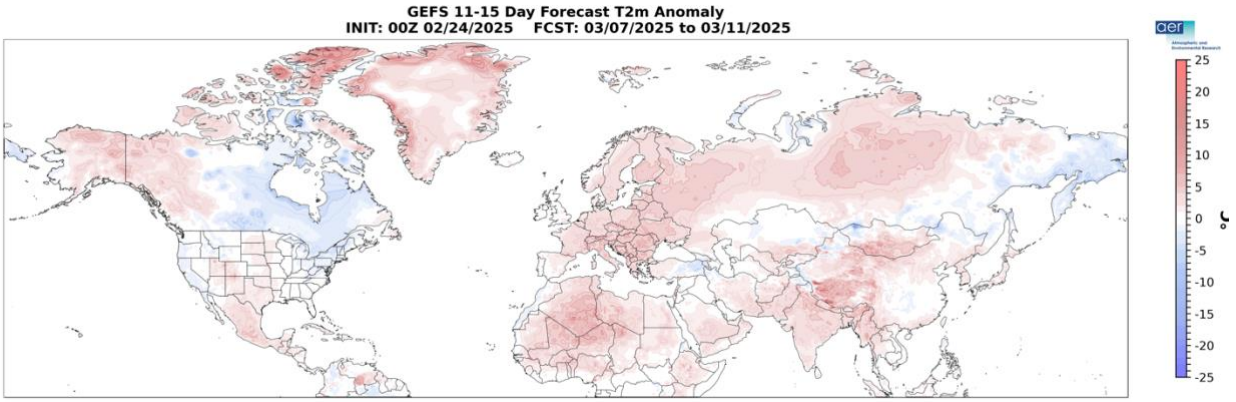

Figure 9. Forecasted surface temperature anomalies (°C; shading) from 07 Mar to 11 Mar 2025. The forecasts are from the 00Z 24 Feb 2025 GFS ensemble.

Persistent ridging/positive geopotential height anomalies in the Gulf of Alaska, Alaska and Western Canada will support troughing/negative geopotential height anomalies across Eastern Canada and the Western and Eastern US this period (**Figure 8**). This pattern continues to support normal to above normal temperatures across Alaska, Western Canada and across the Central US with normal to below normal temperatures across the Western US, Eastern Canada and the Eastern US this period (**Figure 9**).

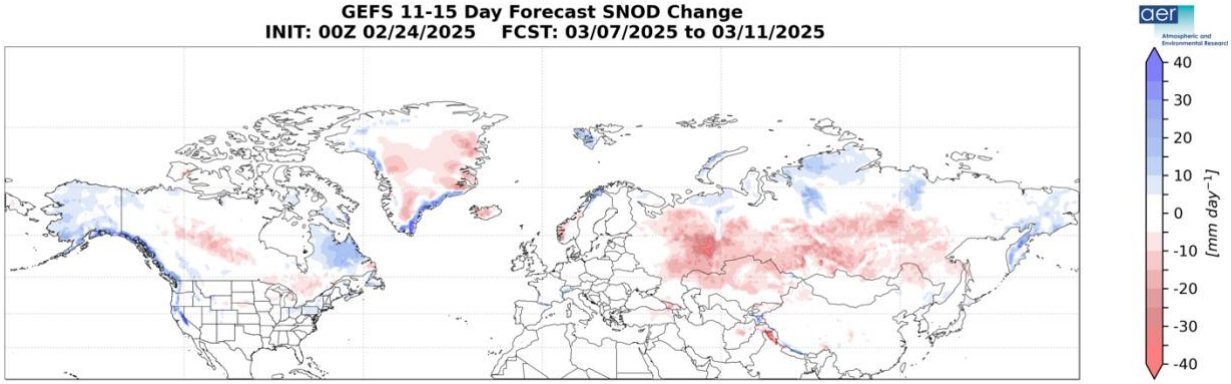

Figure 10. Forecasted snow depth changes (mm/day; shading) from 07 Mar to 11 Mar 2025. The forecasts are from the 00Z 24 February 2025 GFS ensemble.

Troughing and/or cold temperatures will support new snowfall across Norway, the Alps and Northern Siberia while warm temperatures will support snowmelt in the Caucuses, Western Russia, Southern Siberia and the Tibetan Plateau this period (**Figure 10**). Troughing and/or cold temperatures will support new snowfall across western Alaska the Rockies of Canada and the US, the West Coast mountains of the US and Quebec while warm temperatures will support snowmelt in Central and Southeastern Canada and the US 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 troposphere and in the stratosphere (**Figure 11**). The cold/negative PCHs in the stratosphere are predicted to descend into the lower stratosphere next week. The cold/negative PCHs in the troposphere are predicted to flip to warm/positive PCHs next week and possibly persist for the following week. The cold/negative PCHs in the stratosphere representing a strong PV are finally predicted to transition to warm/positive PCHs next week (**Figure 11**) and may be a sign of a sudden stratospheric warming (SSW) or even a Final warming.

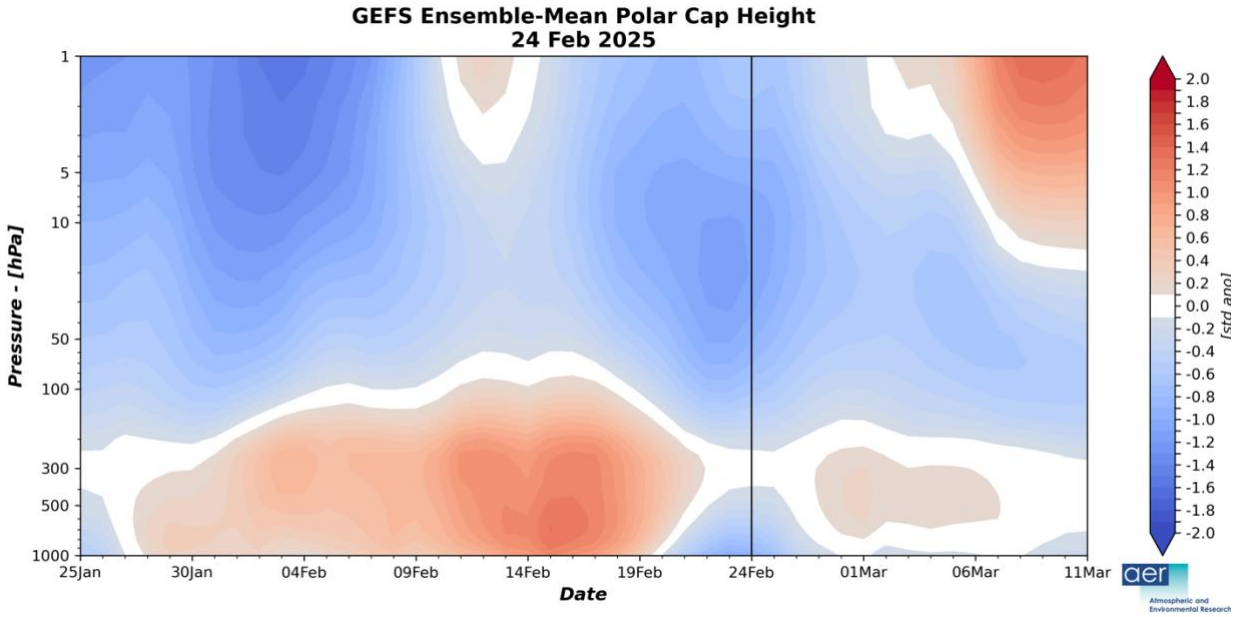

Figure 11. Observed and predicted daily polar cap height (i.e., area-averaged geopotential heights poleward of 60°N) standardized anomalies. The forecast is from the 00Z 24 Feb 2025 GFS ensemble.

The predicted cold/negative PCHs in the lower troposphere this week (**Figure 11**) are consistent with the predicted positive surface AO this week (**Figure 1**). Then as the cold/negative PCHs in the troposphere to trend positive through early march, the surface AO is predicted turn neutral and could even dip into negative territory.

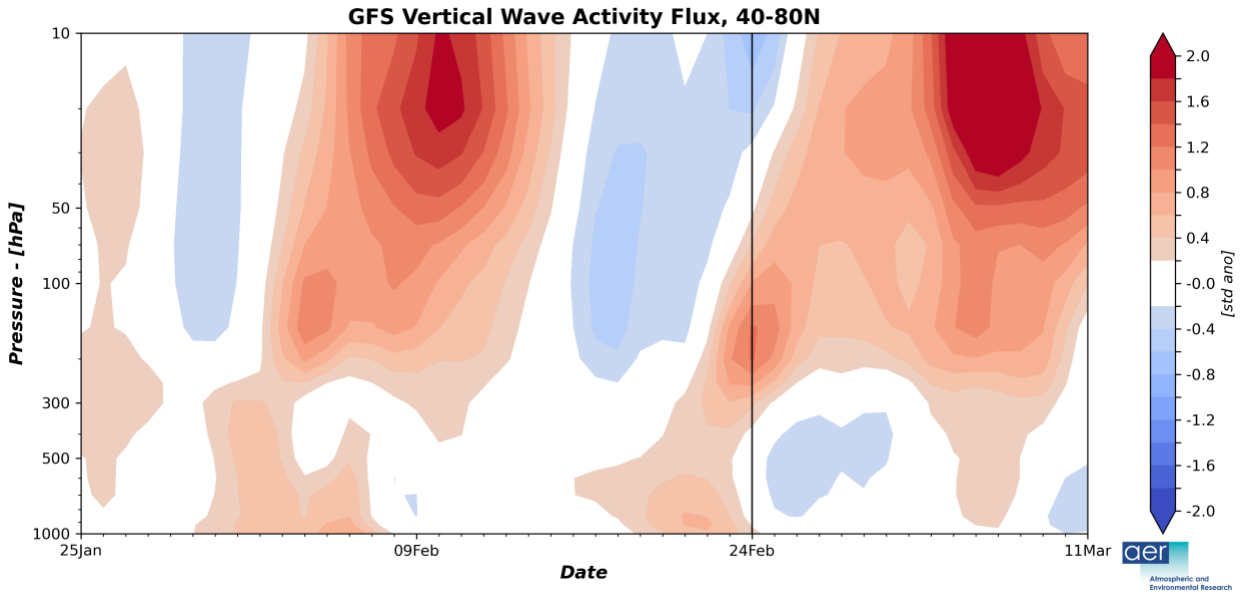

Figure 12. Observed and predicted daily vertical component of the wave activity flux (WAFz) standardized anomalies, averaged poleward of 40-80°N. The forecast is from the 00Z 24 Feb 2025 GFS ensemble.

Vertical Wave Activity Flux (WAFz) from the troposphere to the stratosphere or poleward heat transport in the stratosphere has been relatively quiet this entire season (**Figure 12**). However, the strongest pulse of WAFz of the season ended two weeks ago and a possibly even bigger pulse is predicted starting next week (**Figure 12**). This larger pulse is followed by negative WAFz anomalies next week in the upper troposphere and may be characteristic of shallow wave reflection. Predicted WAFz in the GFS is large enough to trigger an SSW in two weeks' time but I am thinking that it is likely overdone for now.

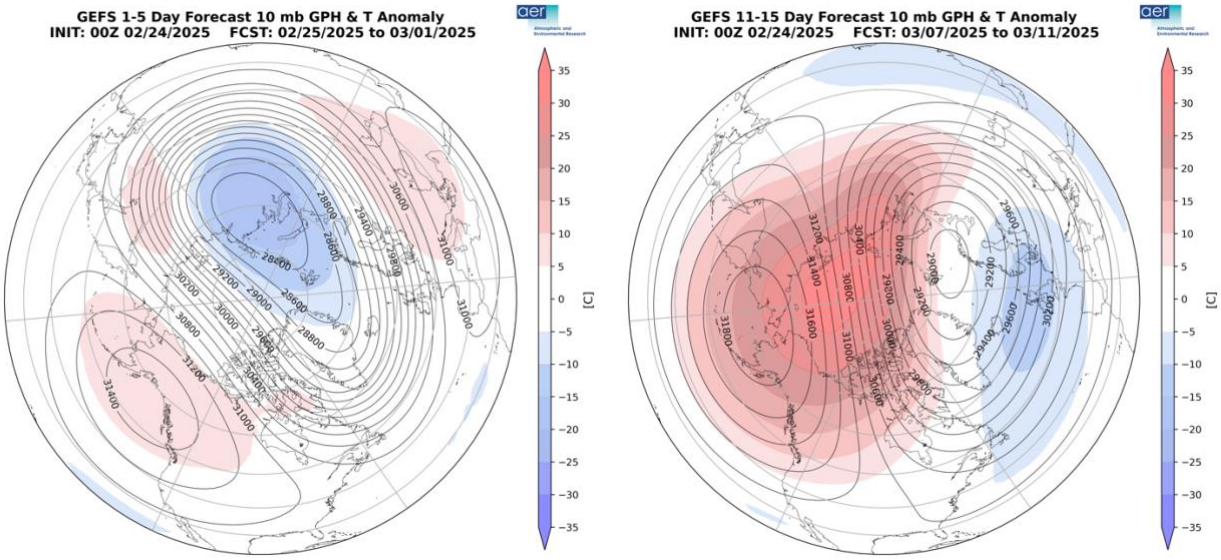

Figure 13. (a) Forecasted 10 mb geopotential heights (dam; contours) and temperature anomalies (°C; shading) across the Northern Hemisphere for 25 Feb to 01 Mar 2025. (b)

Same as (a) except forecasted averaged from 07 Mar to 11 Mar 2025. The forecasts are from the 00Z 24 Feb 2025 GFS model ensemble.

This week the polar vortex (PV) is centered is centered over the Laptev Sea stretched out or elongated in shape with relatively coldest temperatures across Northwest Asia in the polar stratosphere with high-pressure ridging near Alaska but extending into Canada and the relatively warmest temperatures across Alaska and Northern Canada (**Figure 13a**). This is consistent with a developing Canadian warming that favors overall mild temperatures across North America including the US. Then at the end of the first week of March and into the second week of March, the PV is predicted to be centered over the Barents-Kara Seas with ridging centered over the Dateline in the polar stratosphere. The relatively coldest temperatures of the polar stratosphere are predicted across Europe and the warmest temperatures across Siberia, the Central Arctic and into Canada in the stratosphere (**Figure 13b**). This is consistent with yet another stretched PV that favors cold in the Eastern US, the eleventh since late November and early December. The GFS is the most aggressive model in predicting a stretched PV with the European quickly transitioning to an SSW. The stratospheric AO in **Figure 1** this week continues to show that despite the repeated stretched PVs and even the Canadian warmings, overall, the PV remains relatively strong. However it does look like the stratospheric AO wil finally weaken at least to neutral and possibly negative.

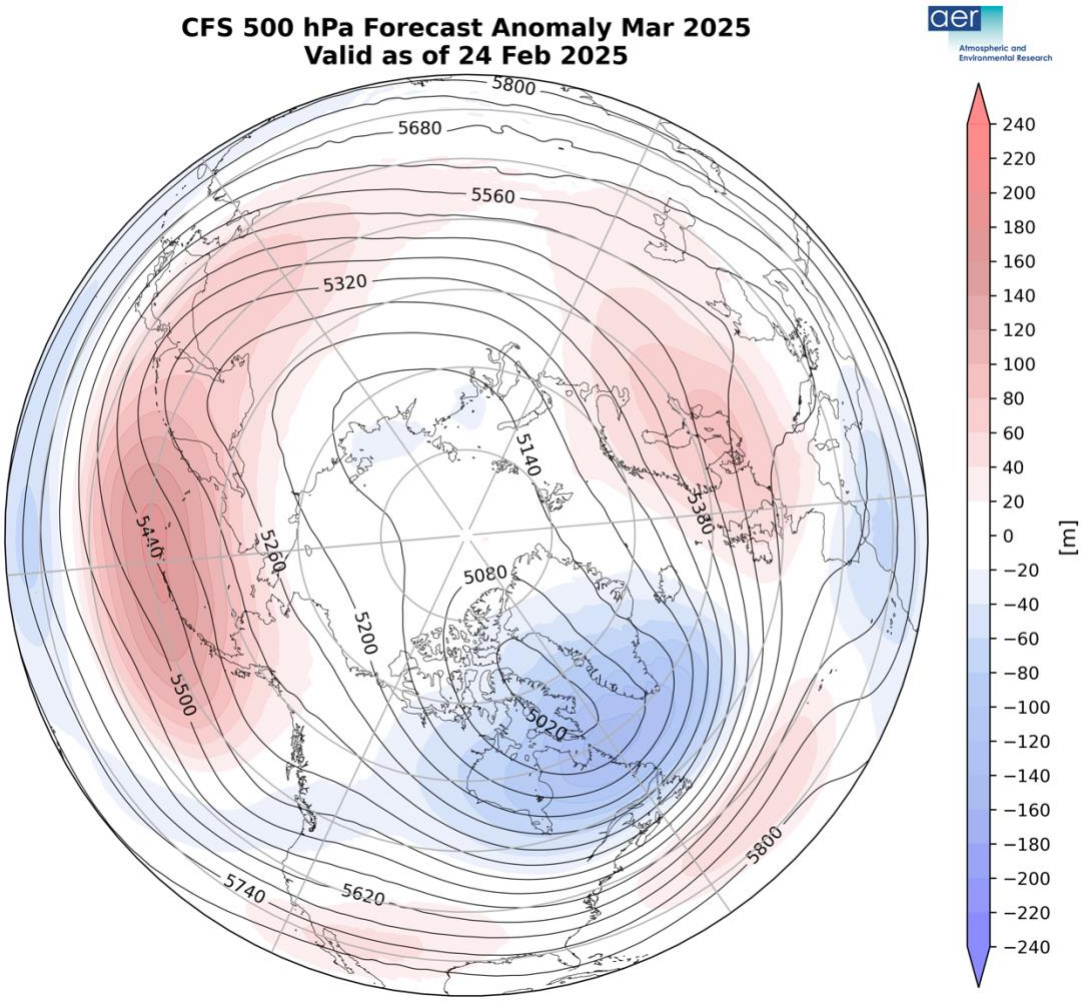

Figure 14. Forecasted average 500 mb geopotential heights (dam; contours) and geopotential height anomalies (m; shading) across the Northern Hemisphere for March 2025. The forecasts are from the 00Z 24 Feb 2025 CFS.

I include in this week's blog the monthly 500 hPa geopotential heights (**Figure 14**) and surface temperatures for March (**Figure 15**) from the Climate Forecast System (CFS; the plots represent yesterday's four ensemble members). The forecast for the troposphere is ridging centered across Northern Europe, centered near the Dateline and the Southwestern US with troughing across the Western Mediterranean, Northern and Eastern Asia, Alaska, Eastern Canada, the Northwestern and Northeastern US (**Figure 14**). This pattern favors seasonable to relatively warm temperatures across Europe, much of Asia, including Siberia and much of the US with seasonable to relatively cold temperatures across Southwestern Europe, the Middle East, parts of Southern Siberia and Northeast Asia, Canada and the Northwestern and Northeastern US (**Figure 15**).

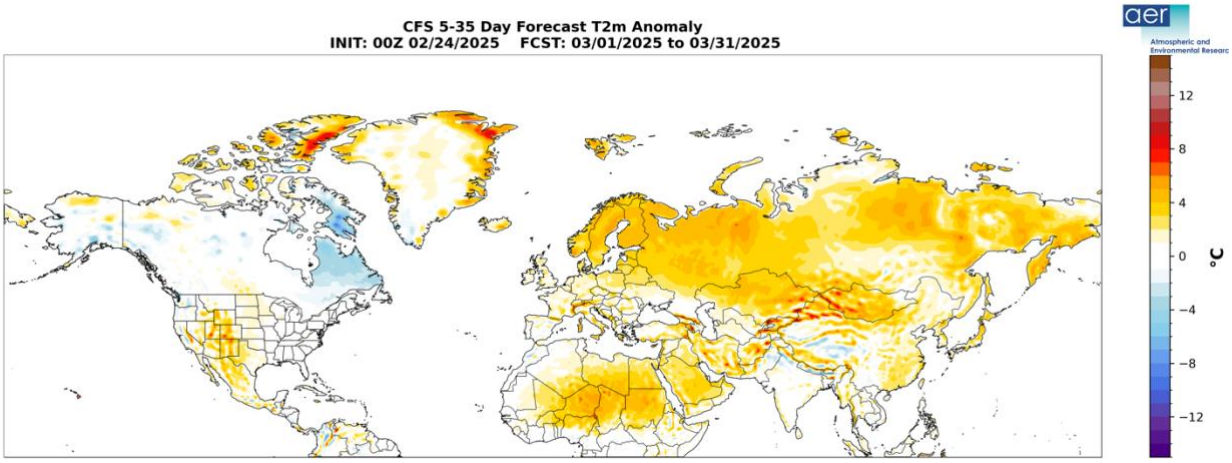

Figure 15. Forecasted average surface temperature anomalies (°C; shading) across the Northern Hemisphere for March 2025. The forecasts are from the CFS 00Z 24 Feb 2025.

Boundary Forcings

Arctic Sea Ice

Sea ice growth continues relatively slowly with negative anomalies in the Barents-Kara Seas, the Sea of Okhotsk, the Bering Sea and the Labrador Sea (see **Figure 16**). The lack of sea ice in the that favors a weak PV, more high latitude blocking and colder temperatures across the interior of the NH continents. The influence of sea ice on remote weather is likely waning and we will soon hit the march sea ice extent maximum for the year.

Figure 16. Observed Arctic sea ice extent on 23 Feb 2025 (white). Orange line shows climatological extent of sea ice based on the years 1981-2010. Image from the National Snow and Ice Data Center (NSIDC). URL: https://nsidc.org/sea-ice-today

SSTs/El Niño/Southern Oscillation

Equatorial Pacific sea surface temperatures (SSTs) anomalies are below normal, between the Dateline and the South America coast, indicating that a La Niña event has emerged but is focused more near the Dateline rather than close to the South American coast (**Figure 17**) and weak La Niña conditions are expected through the end of winter. Observed SSTs across the NH remain well above normal especially in the central North Pacific centered on the Dateline and the western North Pacific, much of the North Atlantic and offshore of the Canadian Maritimes though below normal SSTs exist regionally especially in the South Pacific. I have wondered if the warmer SSTs this year relative to recent years along the west coast of North America is favoring the cold air further to the east this winter compared to the past decade and this was certainly true in January and now also February.

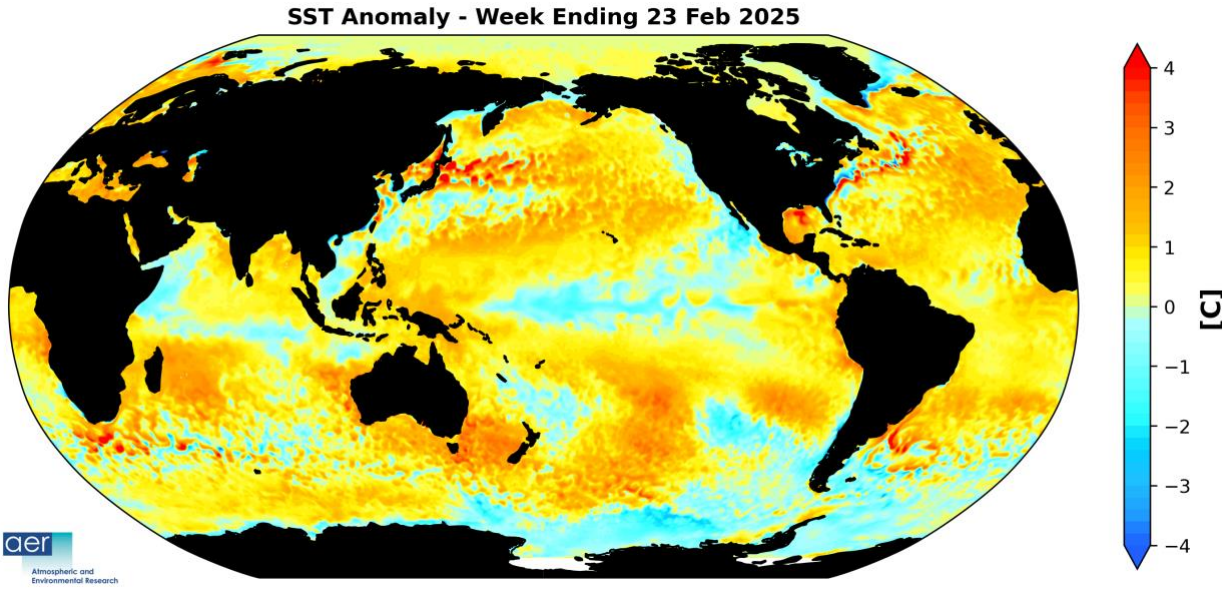

Figure 17. The latest daily-mean global SST anomalies (ending 23 Feb 2025). Data from NOAA OI High-Resolution dataset.

Madden Julian Oscillation

Currently the Madden Julian Oscillation (MJO) is in phase one (**Figure 18**). The forecasts are for the MJO to just hang out in phase one and then weaken to where no phase is favored. Phases one favors Western US ridging and Eastern US troughing initially but then transitions to troughing in the Western US. Therefore, it seems that the MJO may be having some influence on North American weather for next week. But admittedly this is outside of my expertise.

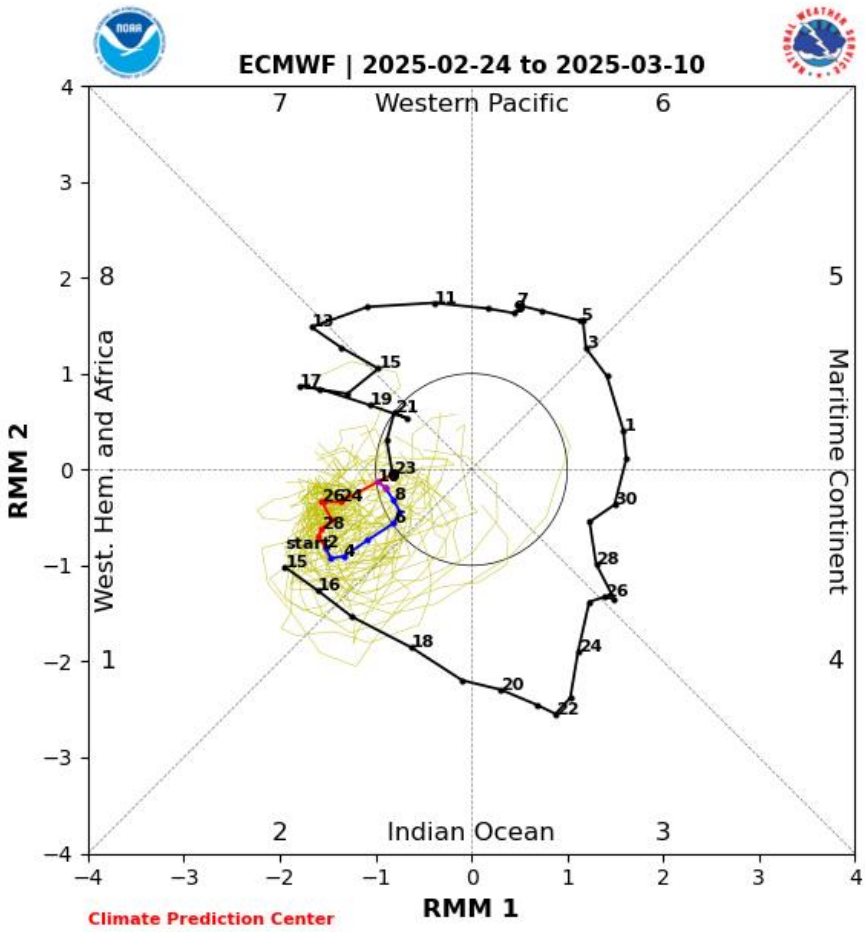

Figure 18. Past and forecast values of the MJO index. Forecast values from the 00Z 24 Feb 2025 ECMWF model. Yellow lines indicate individual ensemble-member forecasts, with the green line showing the ensemble-mean. A measure of the model 'spread' is denoted by the gray shading. Sector numbers indicate 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/ecmf.shtml

Atmospheric and Environmental Research

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

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