Arctic Oscillation and Polar Vortex Analysis and Forecasts

December 30, 2024

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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The AO/PV blog is partially supported by NSF grant AGS: 1657748

Summary

- The Arctic Oscillation (AO) is currently near neutral and is predicted to remain negative the next two weeks as pressure/geopotential height anomalies across the Arctic are currently mixed and are predicted to remain mostly positive over the next two weeks. The North Atlantic Oscillation (NAO) is currently neutral with mixed pressure/geopotential height anomalies across Greenland and the NAO is predicted to remain negative the next two weeks as pressure/geopotential height anomalies are predicted to remain mostly positive across Greenland.
- The next two weeks ridging/positive geopotential height anomalies across Greenland will support deepening troughing/negative geopotential height anomalies across Europe. This pattern will support mostly normal to above normal temperatures across Central and Southern Europe with normal to below normal temperatures across Northern Europe including the United Kingdom (UK) this week. Then next week temperatures will turn mostly normal to below normal across most of Europe including the UK with mild temperatures lingering longest across Southeastern Europe with southwesterly flow.
- The predicted pattern for Asia this week is ridging/positive geopotential height across Western Asia supporting troughing/negative geopotential height anomalies across Eastern Asia. Then next week persistent ridging/positive geopotential height across

Greenland will force troughing/negative geopotential height anomalies will spread across Northern Asia from west to east. This pattern favors widespread normal to above normal temperatures across much of Asia, with regional normal to below normal temperatures across Central and Eastern Siberia this next week. Then next week relatively mild temperatures across Asia with relatively cold temperatures spreading from west to east across Northern Asia.

- The general pattern across North America the next two weeks is ridging/positive geopotential height anomalies centered in Alaska, Western Canada and the Western United States (US) and Northeastern Canada supporting ridging/positive geopotential height anomalies across Eastern Canada and the Eastern US. This pattern favors normal to below normal temperatures across Alaska and Western Canada to flow into the Eastern US with normal to above normal temperatures across Eastern Canada and the Western US. However during the second week of January below normal temperatures will become mostly confined to the Eastern US.
- The battle continues and in the Impacts section I discuss the competing influences of a strong polar vortex (PV) and high latitude blocking on the upcoming weather in the Northern Hemisphere (NH). But the high-latitude blocking come back continues this week and may be getting the upper hand. So far this winter it is all about the PV stretching and then relaxing over and over again in quick succession. There is currently a Canadian Warming as we start the New Year we are back to a stretched PV but what comes next?

Plain Language Summary

We have an upcoming rare occurrence of two overlapping response to two modes of polar vortex (PV) variability impacting different regions of the Northern Hemisphere. First a Canadian warming has spawned a Greenland high pressure that will deliver colder and snowier weather for Europe in early January (**Figures 6** and **7**). Then a stretched PV will spawn Alaskan high pressure that will deliver colder and snowier weather for the Eastern US in early January (**Figures 6** and **7**). What comes next is highly uncertain and I share my latest thoughts but buckle up, it promises to be a wild ride.

Impacts

The polar vortex (PV) continues to transition to different phases or modes at breakneck speed. In January it was stretched polar vortex (PV) events quickly followed by a snap back to a strong PV and then the whole cycle repeating itself. Then the PV added a new trick right at the end of December, a Canadian warming. Then this will transition to yet another stretched PV in early January. The current Canadian warming and the stretched PV can both be seen in the latest PV animation in **Figure i**.

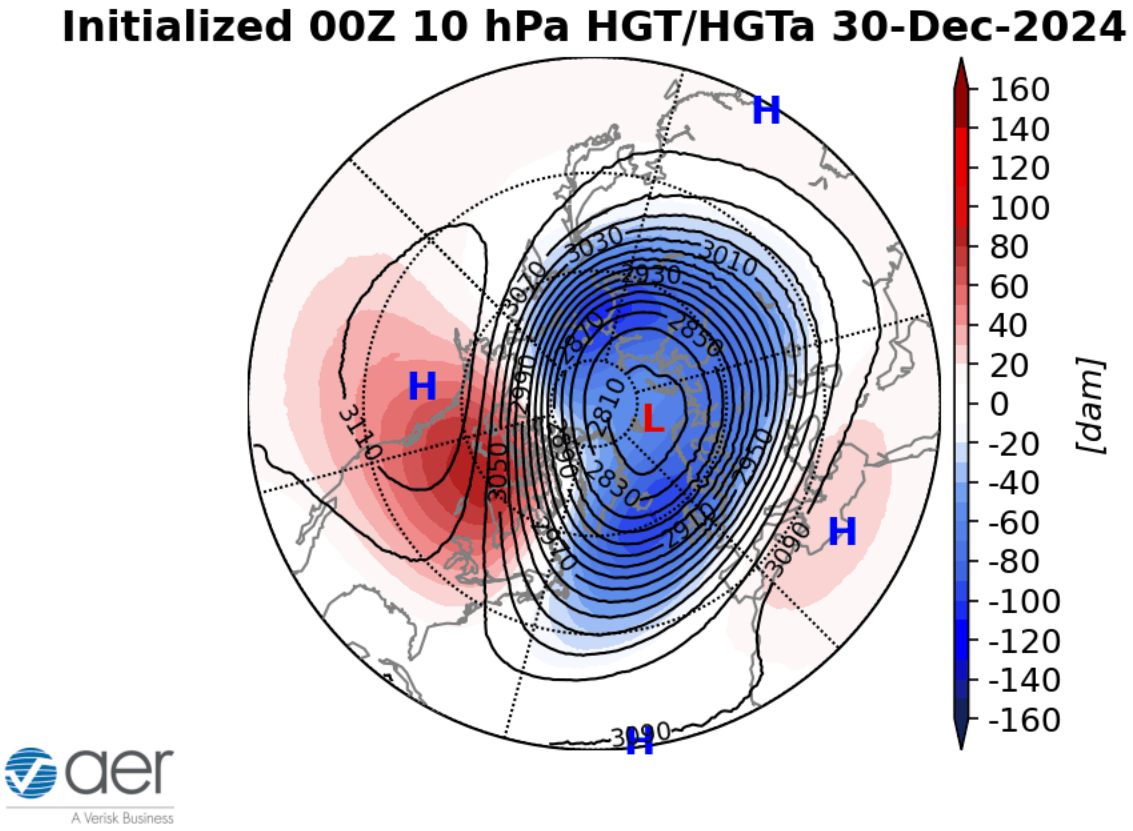

Figure i. Initialized 10 mb geopotential heights (dam; contours) and temperature anomalies (°C; shading) across the Northern Hemisphere for 30 December 2024 and forecasted from 31 December 2024 to 14 January 2025. The forecasts are from the 00Z 30 December 2024 GFS model ensemble.

The upcoming stretched PV will be far the most impressive of the season. With these events I have included energy diagnostics to illustrate wave reflection. 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 ii**). This wave reflection event is quite robust and seems to me one of the best examples that I can recall, and I do think that is contributing to the severity of the cold air outbreak predicted for the Eastern US for the second week of January. This is also likely helping to overcome some shortcomings with this stretched PV (as in producing extreme winter weather) including a lack of antecedent cold air in both Siberia and the North American Arctic, well below normal North American snow cover extent and a PV that is normal to strong. In other stretched PV events that resulted in severe winter weather the PV was weaker than normal, with February 2021, December 2022 and January 2024 as recent examples. But the event hasn't happened yet and I do believe that extreme cold is as hard for the models to predict as Northeast snowstorms.

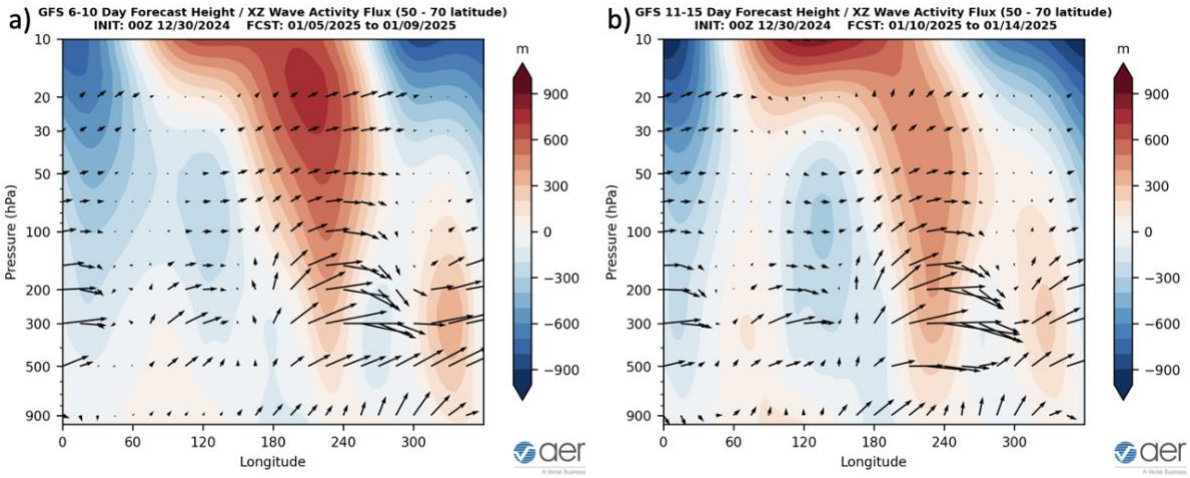

Figure ii. Longitude-height cross section of geopotential eddy height anomalies (shading) and wave activity flux (vectors) forecasted for a) 5 January through 9 January 2025 and b) 10 January through 14 January 2025. The forecasts are from the 00Z 30 December 2024 GFS ensemble.

The resultant ridging with the wave reflection (arrows boomeranging off the Alaska ridging shown in orange shading) is around 120ºW and the resultant trough starting to take shape (blue shading where the arrows are pointed downward) is around 80ºW (see **Figure iib**). This is on the eastward envelope of strong wave reflection events and would favor the cold air being focused in the Eastern US rather than the Western or even Central US. The energy diagnostics in **Figure ii** are very volatile and can change from day to day so caution is needed when using them to forecast but this upcoming forecast of wave reflection has been unusually consistent. Stretched PVs are not only associated with extreme cold but also snowstorms and both are risks starting later this week for the next ten days or so in the Eastern US.

Stretched PVs deliver severe winter weather not only to North America but also East Asia. Some events are more severe in East Asia, some events are severe in both East Asis and North America, but this event will clearly be more severe in North America than East Asia. Still there will be a cold air outbreak and additional snowfall in East Asia as well at the end of next week. It will likely add to the already very impressive snow totals in Japan this winter (see tweet from Thierry Goose).

But given the rapidity of PV variability we are seeing the influences on the tropospheric circulation of two PV phases or modes co-existing simultaneously. The current Canadian warming spawned blocking high pressure over Northeastern Canada. Initially the weather models had the resultant high pressure quickly making its way towards Europe. This would have likely resulted in some colder for Europe but of short duration. In a reversal, the models are now predicting that the blocking high pressure will park itself over Greenland for much of the next two weeks (see **Figure iii**). I actually believe that this model forecast reversal is related to the ensuing stretched PV or wave reflection event. For the sake of simplicity, I will not explain my reasoning

as it is a bit technical. The more stationary blocking high over Greenland will likely result in a more significant period of winter weather for Europe including both cold temperatures and snowfall (see **Figures 6** and **7**). Though for now, no sign of the extreme cold that is predicted for the Eastern US.

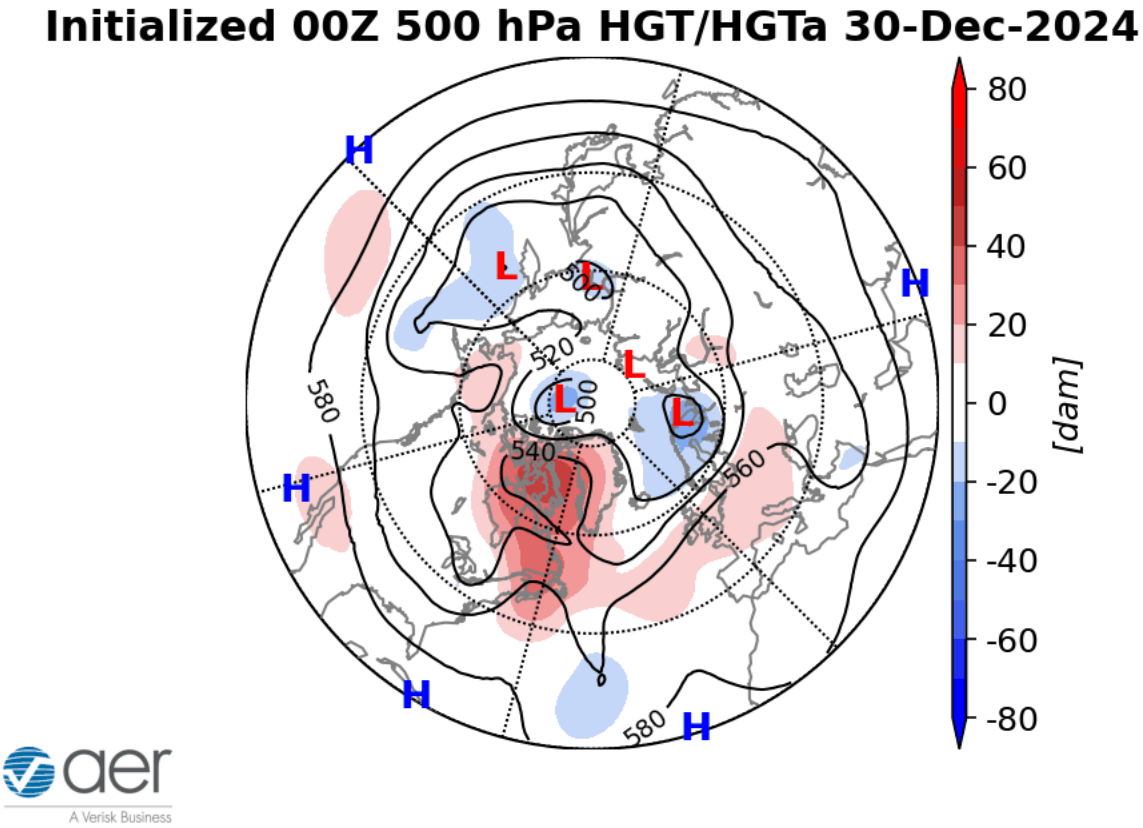

Figure iii. Initialized 500 mb geopotential heights (dam; contours) and decameter anomalies (dam; shading) across the Northern Hemisphere for 30 December 2024 and forecasted from 31 December 2024 to 14 January 2025. The forecasts are from the 00Z 30 December 2024 GFS model ensemble.

The longest lasting Greenland blocks are associated with sudden stratospheric warmings (SSWs). That has not happened so it would be a good guess that the high-pressure block will eventually break away from Greenland once the wave reflection ends.

Whether January becomes a continuation of December or transitions to different PV variability is an open and important question. As far as I can tell the GFS ensembles are predicting incredibly enough another stretched PV that basically looks like one long stretched PV that would keep the Eastern US in the bullseye for severe winter weather. I cannot ever remember such an event happening. Never say never, but often when the models predict a phenomenon or event that is never observed or rarely seen, it is a good rule of thumb to be skeptical.

The Canadian model is predicting another stretched PV that would focus the cold in the Western US. However as long as the Greenland block remains in place, it would likely suppress a ridge popping in the Southeastern US that is very common with these events. Often when the cold becomes focused in the Western US, storms develop lee of the Rockies and cut through the Great Lakes bringing with it very mild weather to the Eastern US. However, if the Greenland block remains in place the storms are shunted to the south and it can remain relatively cold in the Eastern US. One great example of this January 2011. And like in that month, the Canadian is basically predicting a rare coast-to-coast cold in the US mid-January.

I did tweet on Xmas day that our very much flawed PV strength model showing the strength of the PV going over a cliff at the end of the third week of January that would suggest an SSW. Our model is on an island onto itself. I see no credible model output that suggests an SSW anytime in January (ignoring the latest GFS operational model). So, I put out our model forecast mostly as an oddity and will be interesting to see if its forecast has any merit, even partially.

I have been including the European operational PV forecast in the blogs mostly as a contrarian opinion. And the most recent forecast is no exception. The PV at the end of forecast looks fairly contracted, more akin to a strong PV and would suggest to me a fairly mild pattern not only across the US but much of the Northern Hemisphere (NH) (see **Figure iv**). But so far, I don't see agreement from the European ensembles. All weekend the European ensembles were in the Canadian camp of a stretched PV that focuses the cold in the Western US with a clear trend of milder temperatures in the Eastern US. However, to make everything just so much more complicated the most recent run has jumped over to the GFS camp that predicts a stretched PV that that focuses the cold in the Eastern US all the while keeping a troposphere that wants to focus the cold in the Western US.

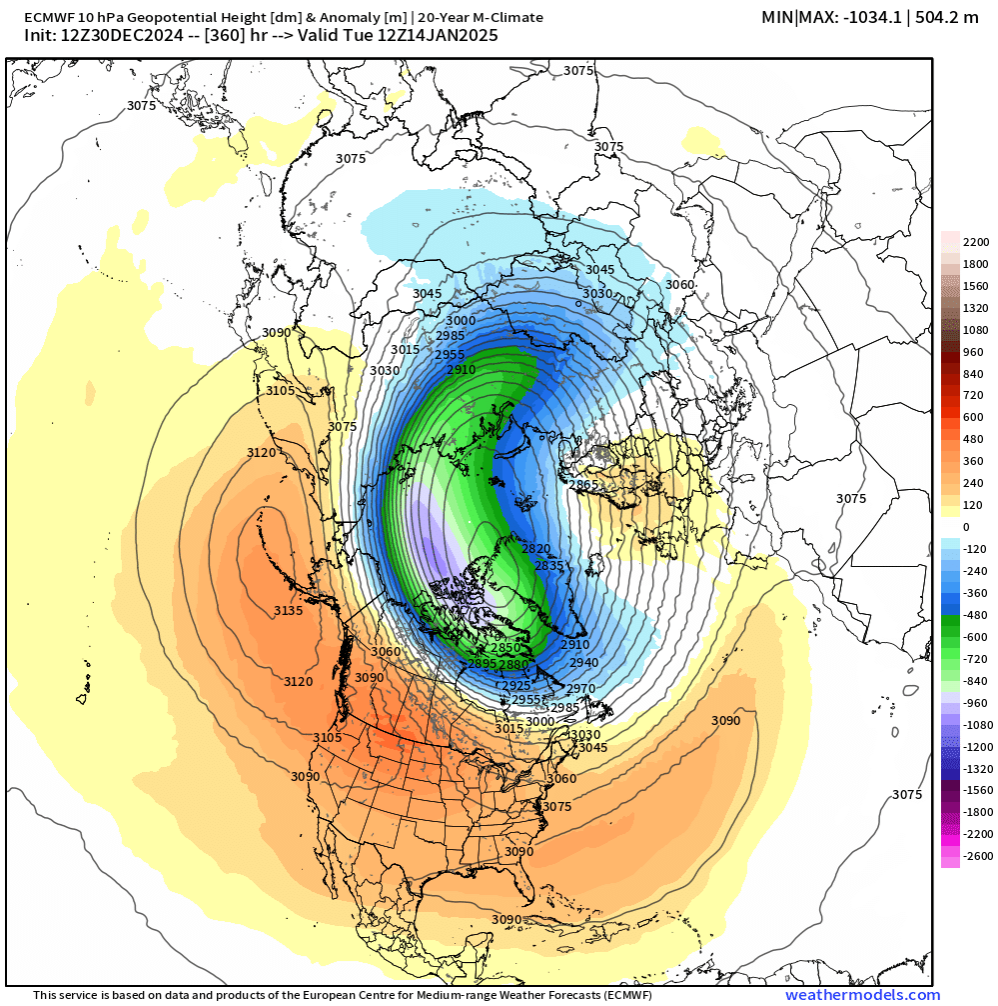

Figure iv. Forecasted 10 mb geopotential heights (dam; contours) and anomalies (meters; shading) across the Northern Hemisphere for 14 January 2025. The forecasts are from the 00Z 30 December 2024 ECMWF operational model. Plot taken from https://weathermodels.com.

I have personally found the forecasting this winter to be very challenging. I have not been alone as the weather models have struggled mightily. I do rely on the weather models doing well with their PV forecasts out to two weeks but this year they have clearly struggled and over the next two weeks the models offer almost every possible solution. From a strong PV to a stretched PV that focuses the cold in the Eastern US and the Western US to even a weak PV on its way to an SSW (though I didn't show it that is what I surmise from the latest GS operational). Another complicating factor is the poor forecast of high latitude blocking. This is a systemic flaw of the models but has important implications for both PV variability and the magnitude and location of severe winter weather.

As much as I would like to sit back and watch the weather like a sports fan and take in the unexpected plot twists and suspense, that is not why I started the blog. If we were playing "Let's Make a Deal" my heart would definitely choose door number two (the Canadian which implies

cold with snow). But my head says door number three (the European troposphere from today but the polar vortex from yesterday).

So here is my educated guess at what is coming next. Our analysis does say that a stretched PV that focuses the cold in the Eastern US is most often followed by a stretched PV that focuses the cold in the Western US. The next chapter of PV variability after the stretched PV that focuses the cold in the Eastern US will be a stretched PV that focuses the cold in the Western US. Wave reflection typically is on the order of days and not weeks, so this should release the blocking high form its tether to Greenland and send it on its way towards Europe. So, during the third week of January this will result in a transition to milder weather in both Europe and the Eastern US with cold weather becoming more entrenched in the Western US. But it also appears Siberia will turn colder at this time, so I don't think winter weather in the Eastern US is done just yet like last winter.

Near-Term

This week

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

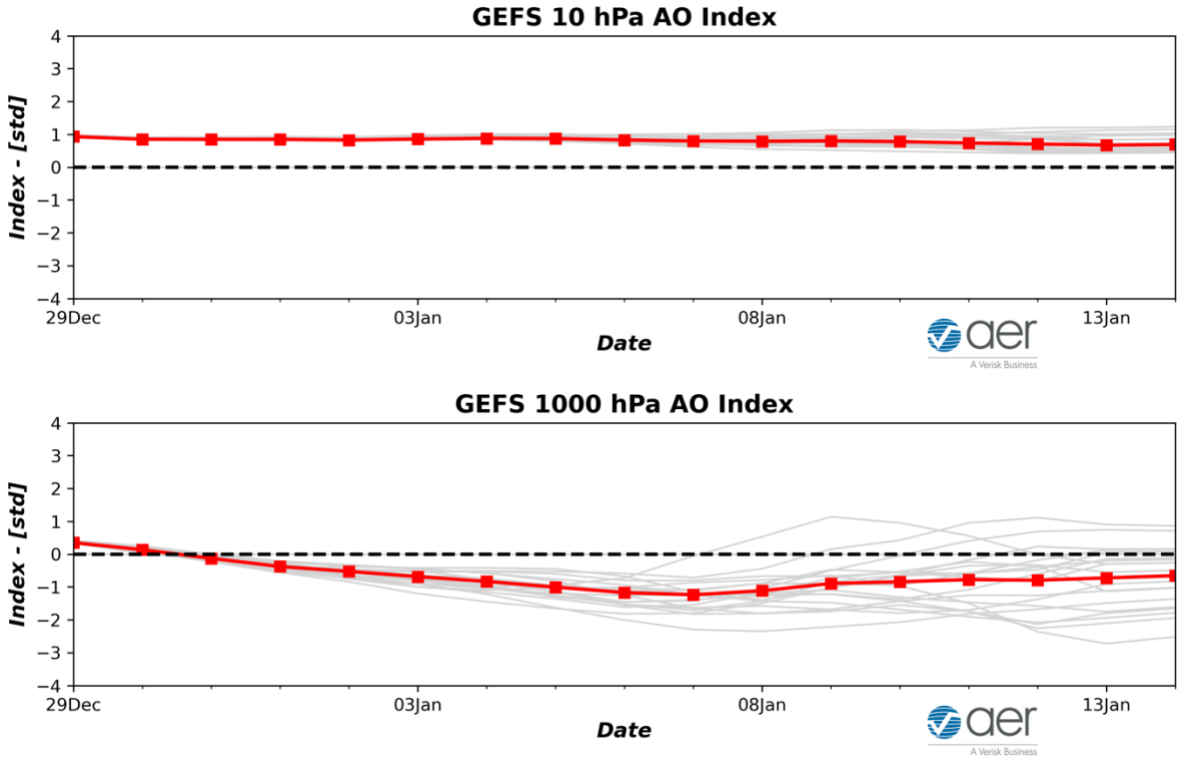

Figure 1. a) The predicted daily-mean AO at 10 hPa from the 00Z 29 December 2024 GFS ensemble. b) The predicted daily-mean AO at 1000 hPa from the 00Z 29 December 2024

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, ridging/positive troughing/negative geopotential height anomalies across Greenland will support troughing/negative geopotential height anomalies across Northern Europe with ridging/positive geopotential height anomalies across Southern Europe (**Figures 2).** This pattern will favor normal to above normal temperatures across Central and Southern Europe with normal to below normal temperatures across Northern Europe including the UK this period (**Figure 3**). This week the predicted pattern across Asia is ridging/positive geopotential height anomalies in Southern Asia and in Western Siberia supporting troughing/negative geopotential height anomalies across Northeastern Asia (**Figure 2**). This pattern favors normal to above normal temperatures widespread across much of Asia with normal to below normal temperatures limited to parts of Central Siberia including Northeast Asia **(Figure 3**).

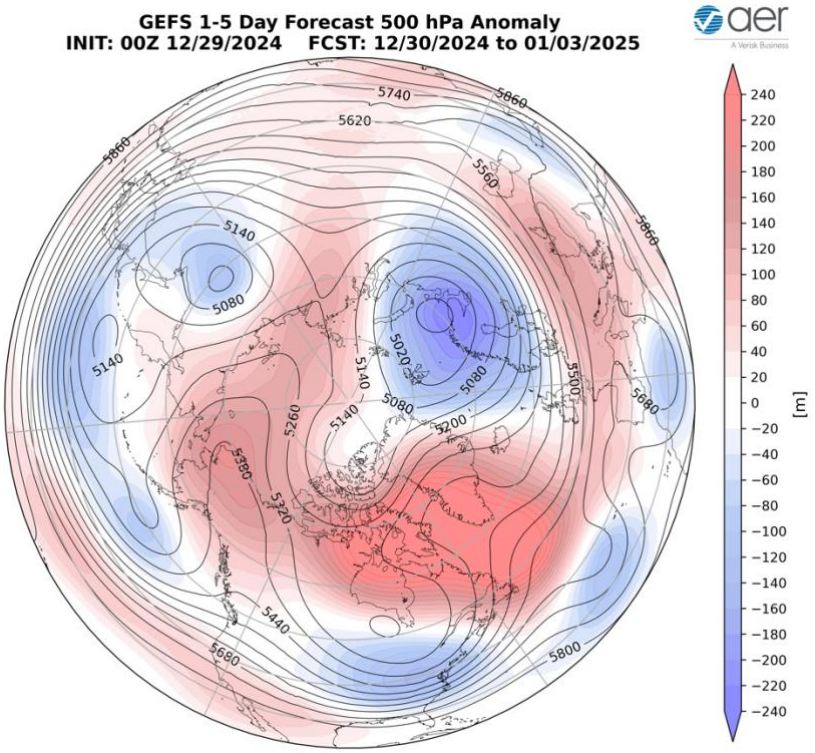

Figure 2. Forecasted average 500 mb geopotential heights (dam; contours) and geopotential height anomalies (m; shading) across the Northern Hemisphere from 30 Dec to 03 Jan 2025. The forecasts are from the 00Z 29 December 2024 GFS ensemble.

This week ridging/positive geopotential height anomalies across Alaska, Western and Northeastern Canada and the Western US will support troughing/negative geopotential height anomalies across Central and Eastern Canada and the Eastern US. (**Figure 2**). This pattern will favor normal to below normal temperatures flowing out of Alaska and Western and Central Canada, and into the US Northern Plains and eventually the Southeastern US with normal to

above normal temperatures across Eastern Canada, the Western and Northeastern US (**Figure 3**).

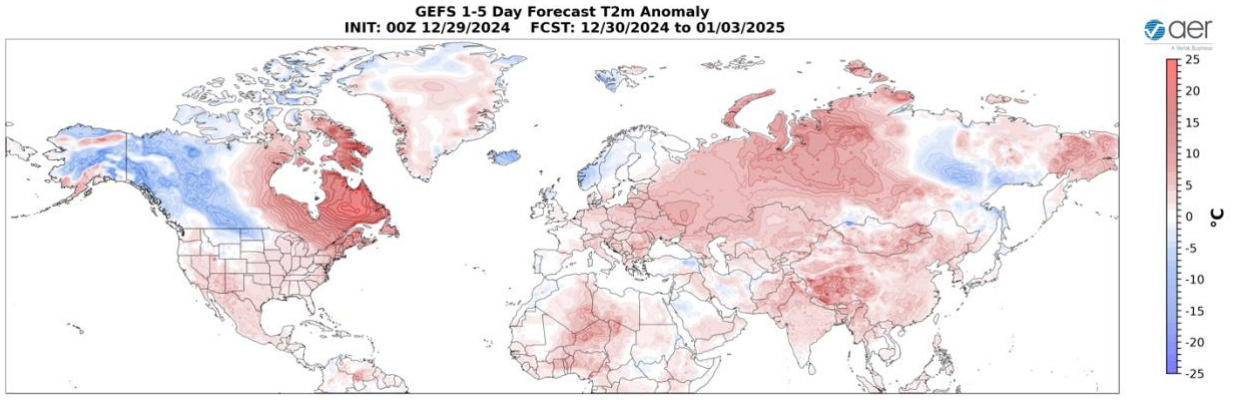

Figure 3. Forecasted surface temperature anomalies (°C; shading) from 30 Dec to 03 Jan 2025. The forecast is from the 00Z 29 December 2024 GFS ensemble.

Troughing and/or cold temperatures will support new snowfall in Scotland, Scandinavia, the Balkans, the Baltic region, Northwestern Russia, Eastern Siberia and the Tibetan Plateau while warm temperatures will support snowmelt in Southwestern Russia this week (**Figure 4**). Troughing and/or cold temperatures will support new snowfall across Northern and Eastern Canada, the higher elevations of the Canadian West Coast, the Northwestern US and New England while warm temperatures will support snowmelt in Alaska and the Canadian Maritimes this week (**Figure 4**).

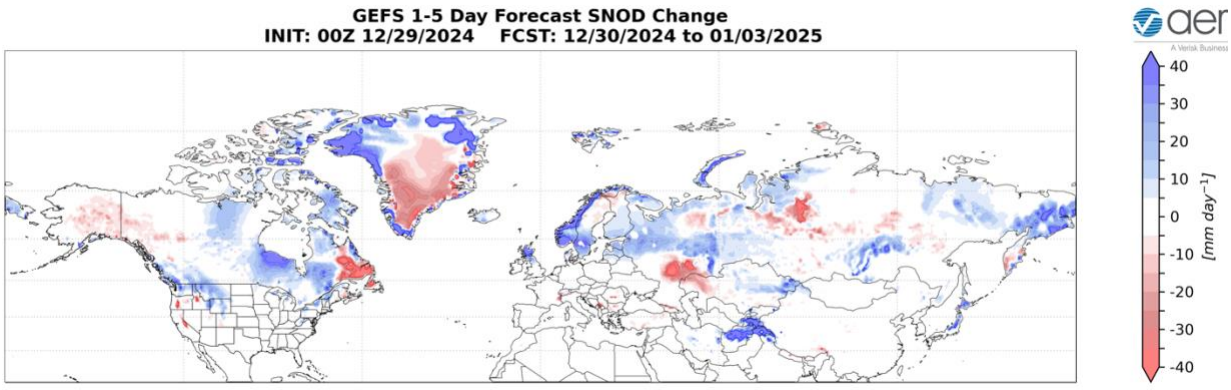

Figure 4. Forecasted snow depth changes (mm/day; shading) from 30 Dec 2024 to 03 Jan 2025. The forecast is from the 00Z 29 December 2024 GFS ensemble.

Near-Mid Term

Next week

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

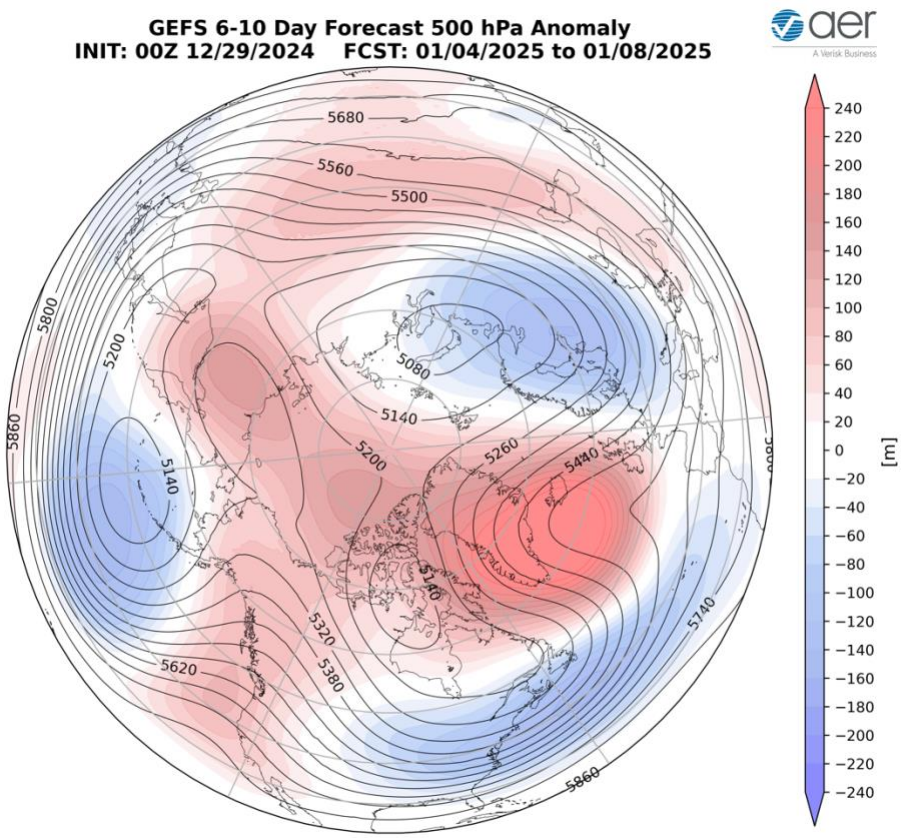

Figure 5. Forecasted average 500 mb geopotential heights (dam; contours) and geopotential height anomalies (m; shading) across the Northern Hemisphere from 04 Jan to 08 Jan 2025. The forecasts are from the 00Z 29 December 2024 GFS ensemble.

Predicted persistent ridging/positive geopotential height anomalies across Greenland will support deepening troughing/negative geopotential height anomalies across much of Europe with ridging/positive geopotential height anomalies across the Eastern Mediterranean this period (**Figure 5**). This pattern favors normal to below normal temperatures across Northern and Central Europe including the UK with normal to above normal temperatures across Southern Europe this period (**Figure 6**). The predicted pattern across Asia is troughing/negative from Northern Europe pushing into Northwestern Asia with ridging/positive geopotential height anomalies across Central and Eastern Siberia anchoring troughing/negative geopotential height anomalies across Northeast Asia (**Figure 5**). This pattern favors widespread normal to above normal temperatures across Asia with

normal to below normal temperatures limited to Northwest Russia and parts of Northeastern Asia (**Figure 6**).

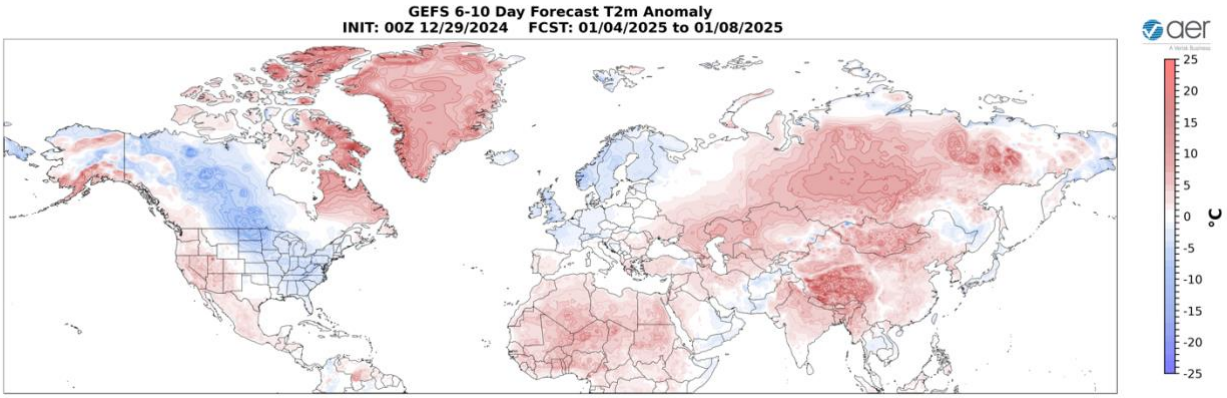

Figure 6. Forecasted surface temperature anomalies (°C; shading) from 04 Jan to 08 Jan 2025. The forecast is from the 00Z 29 December 2024 GFS ensemble.

The amplified pattern is predicted to continue across North America with ridging/positive geopotential height anomalies predicted across Alaska, Western and Northeastern Canada and the Western US with troughing/negative geopotential height anomalies across Central Canada and the Eastern US this period (**Figure 5**). This pattern will favor widespread normal to below normal temperatures across Western and Central Canada and the Central and Eastern US with normal to above normal temperatures across Alaska, Northeastern Canada and the Western US (**Figure 6**).

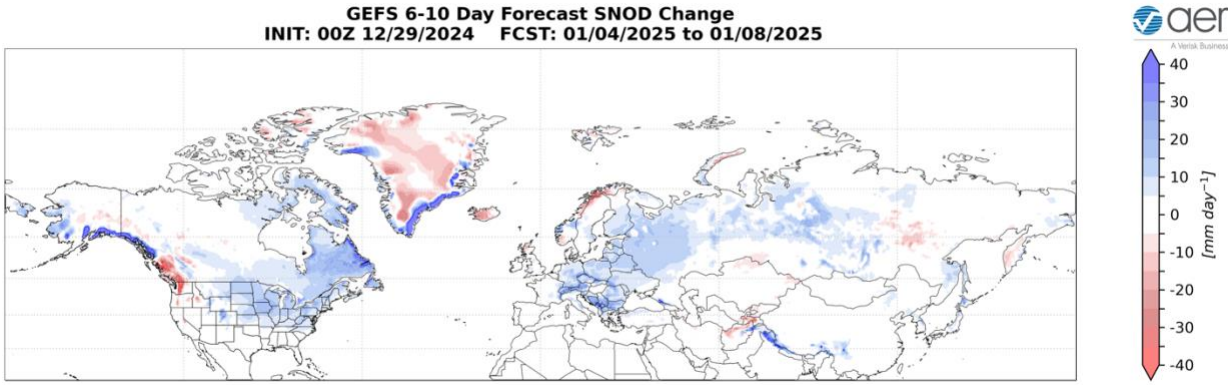

Figure 7. Forecasted snow depth changes (mm/day; shading) from 04 Jan to 08 Jan 2025. The forecast is from the 00Z 29 December 2024 GFS ensemble.

Troughing and/or cold temperatures will support new snowfall across Central and Eastern Europe, Western Russia, Tibetan Plateau and Western Siberia while warm temperatures will support snowmelt in parts of Central Asia this period (**Figure 7**). Troughing and/or cold temperatures will support new snowfall across southern Alaska, the West Coast mountains of Canada, Southern and Eastern Canada, the US Northern and Central Plains and the Northeastern US while warm temperatures will support snowmelt in Southwestern Canada and the Northwestern US this period (**Figure 7**).

Mid Term

Week Two

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

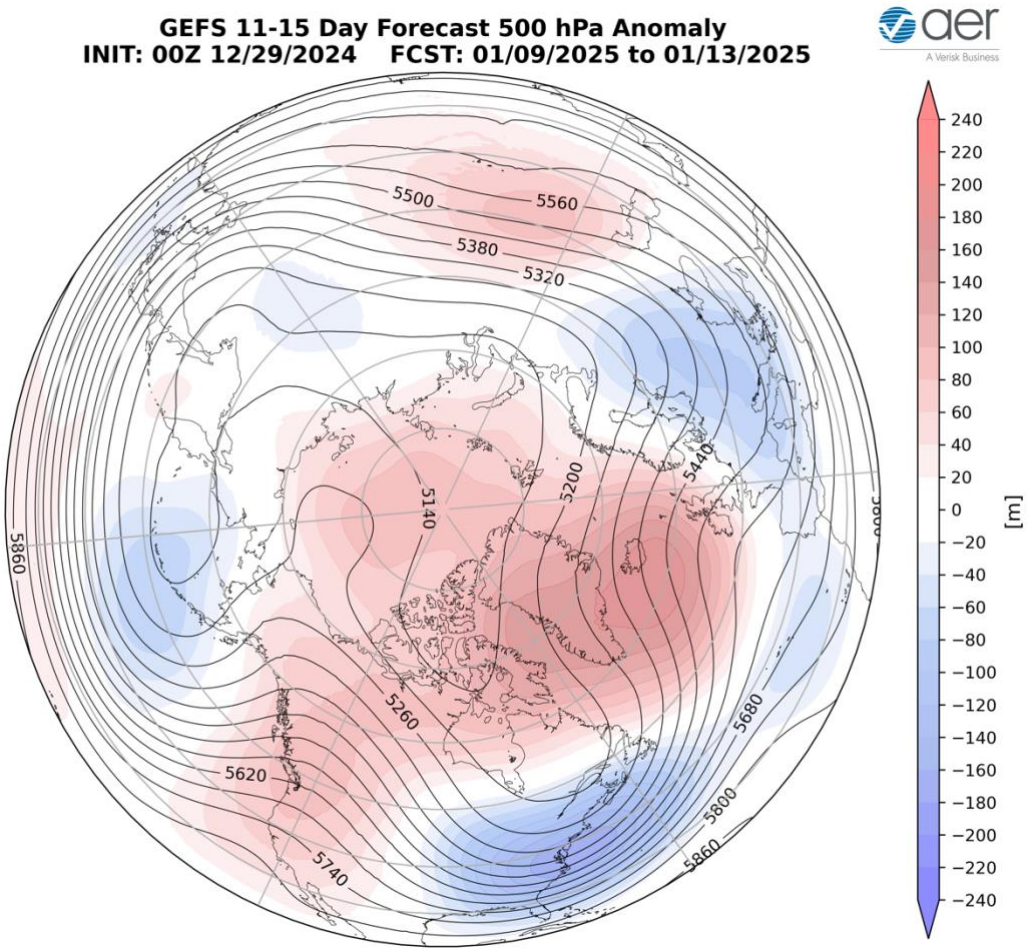

Figure 8. Forecasted average 500 mb geopotential heights (dam; contours) and geopotential height anomalies (m; shading) across the Northern Hemisphere from 09 Jan to 13 Jan 2025. The forecasts are from the 00Z 30 December 2024 GFS ensemble.

Persistent ridging/positive geopotential height anomalies across Greenland is predicted to support troughing/negative geopotential height anomalies across much of Europe with ridging/positive geopotential height anomalies from Greenland approaching the British Isles (**Figure 8**). This pattern should favor widespread normal to below normal temperatures across

much of Europe with normal to above normal temperatures limited to along the Mediterranean Sea this period (**Figures 9**). The persistent ridging/positive geopotential height anomalies across Greenland is predicted force expanding troughing/negative geopotential height anomalies across Northern Asia ridging/positive geopotential height anomalies across Southern Asia centered on Central Asia this period (**Figure 8**). The predicted pattern favors widespread normal to above normal temperatures across much of Asia with normal to below normal temperatures expanding across Northern Asia this period (**Figure 9**).

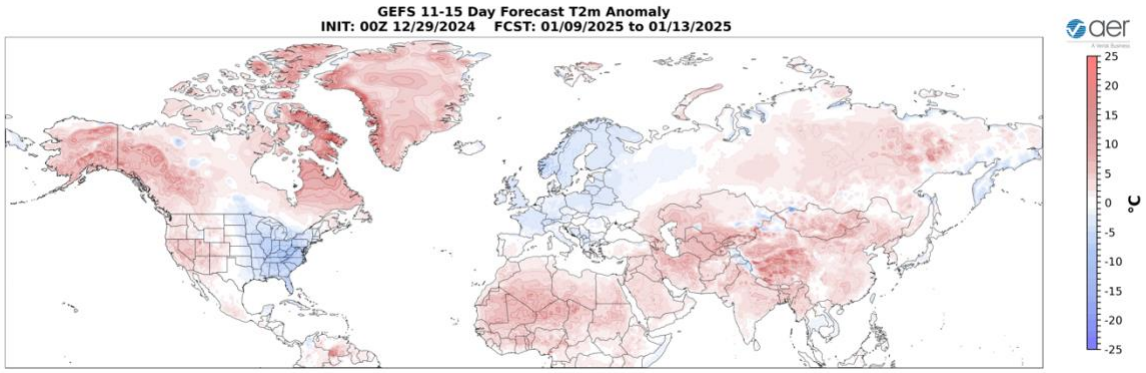

Figure 9. Forecasted surface temperature anomalies (°C; shading) from 09 Jan to 13 Jan 2025. The forecast is from the 00Z 29 December 2024 GFS ensemble.

Ridging/positive geopotential height anomalies are predicted to persist across Alaska, Western and Northeastern Canada supporting troughing/negative geopotential height anomalies across Eastern Canada and the Eastern US this period (**Figure 8**). Above normal temperatures will continue to expand across Alaska much of Canda and the Western US with normal to above normal temperatures persisting across far Southeastern Canada and the Eastern US this period (**Figure 9**).

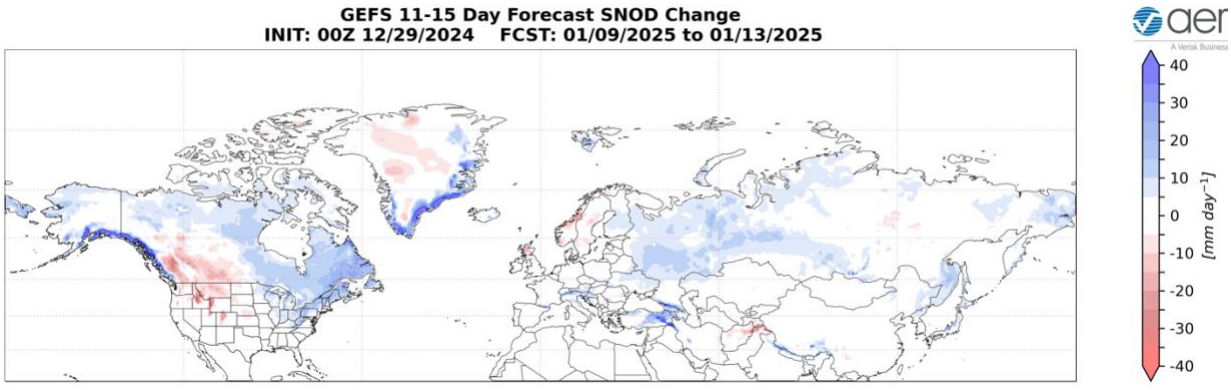

Figure 10. Forecasted snow depth changes (mm/day; shading) from 09 Jan to 13 Jan 2025. The forecast is from the 00Z 29 December 2024 GFS ensemble.

Troughing and/or cold temperatures will support new snowfall across Scandinavia, the Alps, the Baltic region, Turkey Western Russia and Northeastern Asia while warm temperatures will

support snowmelt in Scotland and Norway this period (**Figure 10**). Troughing and/or cold temperatures will support new snowfall across the West Coast mountains of Canada, Northern and Eastern Canada and the Northeastern US while warm temperatures will support snowmelt in Southwestern Canada and the Northwestern US this period (**Figure 10**).

Longer Term

30–day

The latest plot of the polar cap geopotential height anomalies (PCHs) currently shows normal to warm/positive PCHs in the troposphere with cold/negative PCHs in the stratosphere and troposphere (**Figure 11**). The cold/negative PCHs from the stratosphere are predicted to persist the next two weeks while the warm/positive PCHs in the troposphere are predicted to strengthen. The contrast between cold/negative PCHs in the stratosphere and warm/positive PCHs in the troposphere continues for yet another two weeks (**Figure 11**). For now, this suggests that the stratosphere and troposphere are mostly uncoupled but does look like the high latitude blocking has made a remarkable recovery leading ad will likely peak next week. It is also contributing to an is increasingly weak PV.

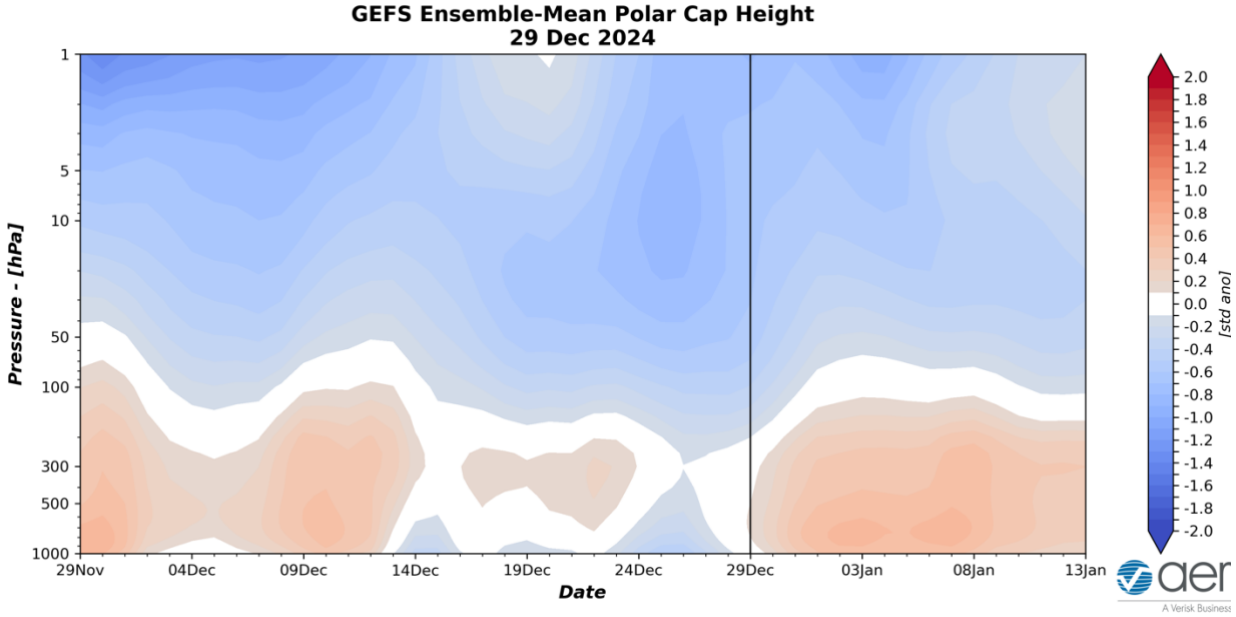

Figure 11. Observed and predicted daily polar cap height (i.e., area-averaged geopotential heights poleward of 60°N) standardized anomalies. The forecast is from the 00Z 29 December 2024 GFS ensemble.

The predicted warm/positive PCHs in the lower troposphere the next two weeks (**Figure 11**) are consistent with the predicted negative surface AO this week and next week (**Figure 1**). Still waiting to see if the warm/positive PCHs in the troposphere could force a larger polar vortex disruption. Still, lots of questions.

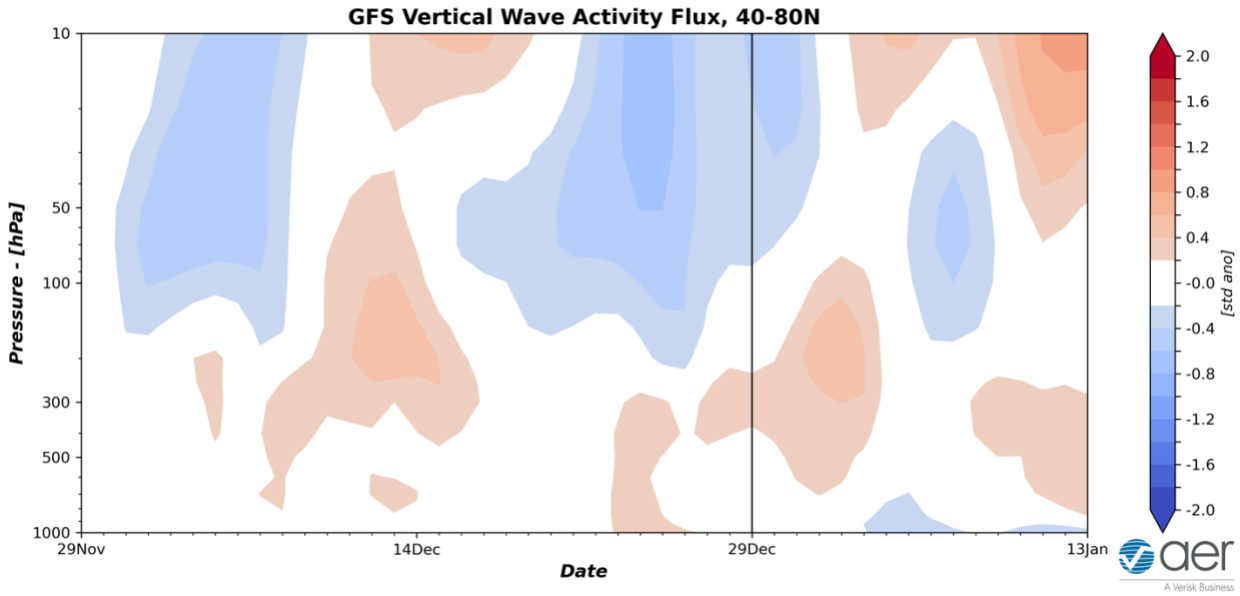

Figure 12. Observed and predicted daily vertical component of the wave activity flux (WAFz) standardized anomalies, averaged poleward of 40-80°N. The forecast is from the 00Z 29 December 2024 GFS ensemble.

Vertical Wave Activity Flux (WAFz) from the troposphere to the stratosphere or poleward heat transport in the stratosphere has been relatively quiet this season (**Figure 12**). However, the alternating positive (red) and negative (blue) WAFz anomalies is characteristic of wave reflection associated with stretched PVs (**Figure 12**). What is unusual is the rapidity of the changes. The alternating anomalies of WAFz are predicted to continue the first half of January, signaling yet at least one more stretched PV.

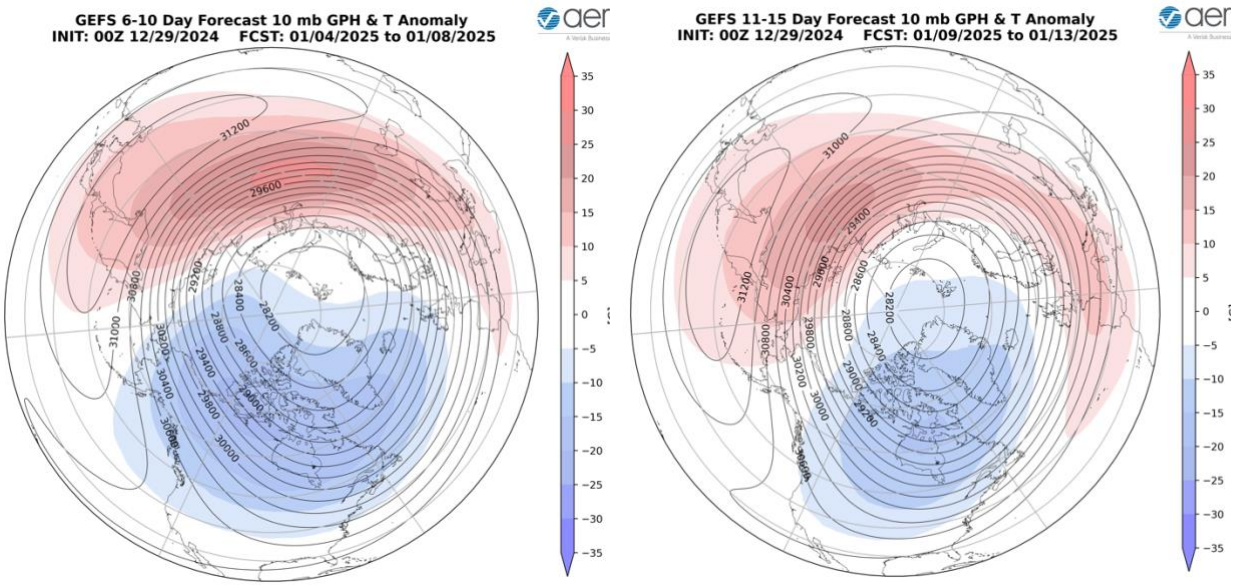

Figure 13. (a) Forecasted 10 mb geopotential heights (dam; contours) and temperature anomalies (°C; shading) across the Northern Hemisphere for 04 Jan to 08 Jan 2025. (b) Same as (a) except forecasted averaged from 09 Jan to 13 Jan 2025. The forecasts are from the 00Z 29 December 2024 GFS model ensemble.

Next week the polar vortex (PV) is predicted to become more elongated in shape as the PV comes out of the Canadian warming at the end of December. The greatest polar stratospheric warming is predicted over Asia pushing the PV center over the Barents Kara Seas (**Figure 13a**). Then, PV center is predicted to move closer to North Pole and become more elongated in shape with relatively coldest temperatures across Canada in the polar stratosphere (**Figure 13b**). This is consistent with a mature stretched PV (for those keeping score at home, the fifth of the season). The stratospheric AO in **Figure 1** this week continues to show that despite the repeated stretched PVs and even the Canadian warming, overall the PV remains strong, and any cold air outbreaks should remain brief with each individual stretched PV event. However, this is by far the strongest stretched PV of the winter and will result in the biggest severe winter weather outbreak in the US.

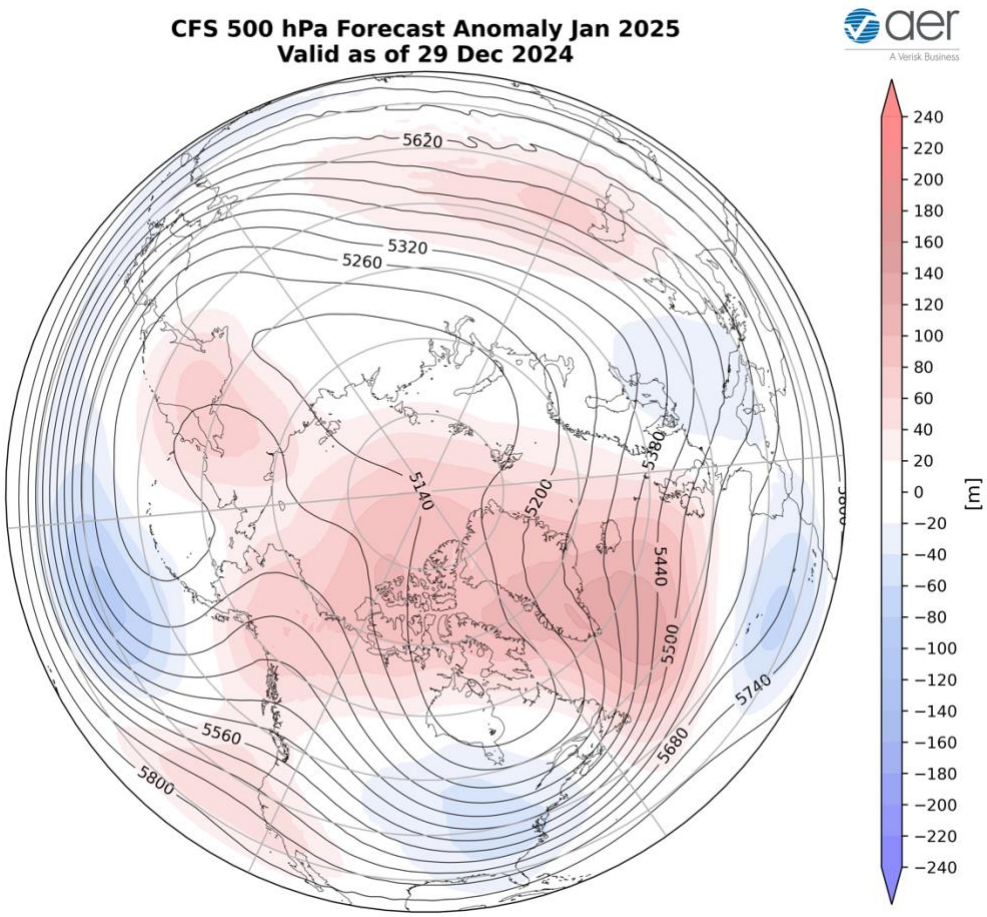

Figure 14. Forecasted average 500 mb geopotential heights (dam; contours) and geopotential height anomalies (m; shading) across the Northern Hemisphere for January 2025. The forecasts are from the 00Z 29 December 2024 CFS.

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 across the Arctic stretching from the Gulf of Alaska, Alaska, across the Canadian archipelagos, Greenland and the North Atlantic near Iceland, Central Asia, Eastern Siberia and the Western US with troughing across Europe and the Mediterranean, Northern and East Asia extending to south of the Aleutians, Central and Eastern Canada and the Eastern US (**Figure 14**). This pattern favors seasonable to relatively warm temperatures across Central and Southern Asia, Alaska, Western and Northeastern Canada and the Western US with seasonable to relatively cold temperatures across Europe, Western, Northern and East Asia, including much of Siberia, Central Canada and the Eastern US (**Figure 15**).

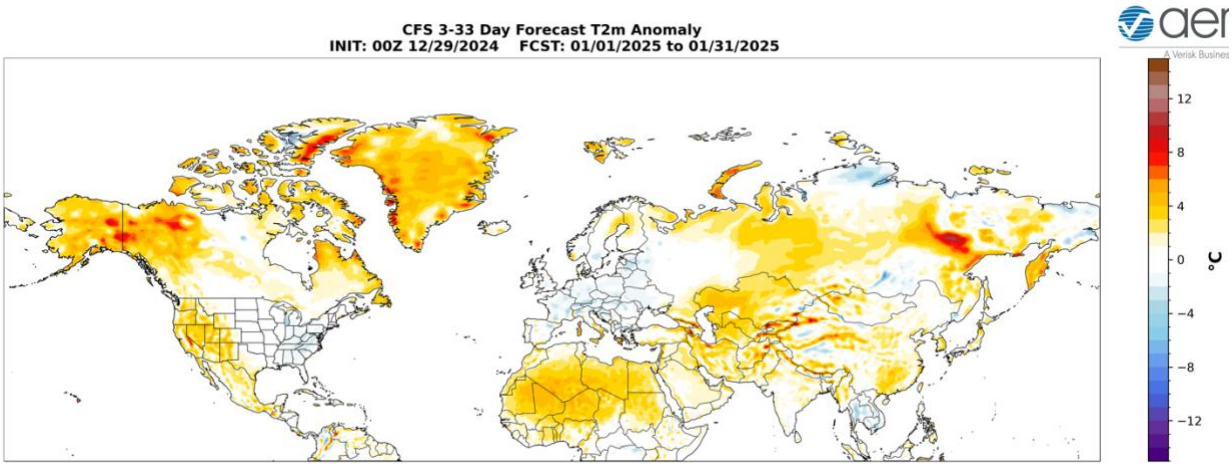

Figure 15. Forecasted average surface temperature anomalies (°C; shading) across the Northern Hemisphere for January 2025. The forecasts are from the 00Z 29 December 2024.

Boundary Forcings

Arctic Sea Ice

Sea ice growth continues relatively slowly with a larger negative anomaly in the North Atlantic sector compared to the North Pacific sector though reduced from during the fall (see **Figure 15**). This is important because it is the lack of sea ice in the Barents-Kara Seas that favors a weak PV and colder temperatures across the interior of the NH continents. The other region where sea ice is below normal is Hudson Bay. I do wonder if low sea ice extent in Hudson Bay is contributing to the atmospheric ridging and very mild temperatures over eastern North America.

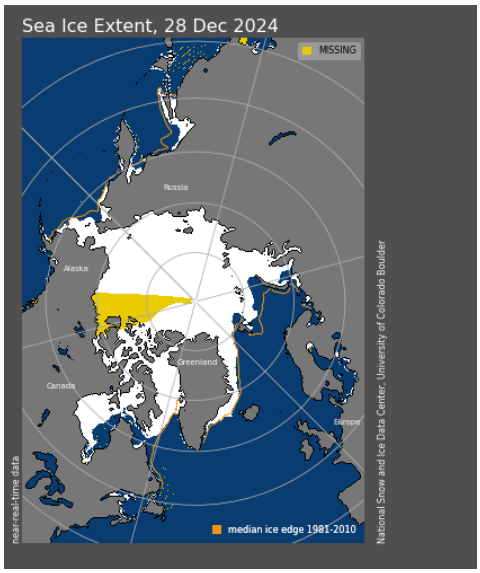

Figure 15. Observed Arctic sea ice extent on 28 December 2024 (white). Orange line shows climatological extent of sea ice based on the years 1981-2010. Image from the National Snow and Ice Data Center (NSIDC). URL: https://nsidc.org/sea-ice-today.

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 is emerging (**Figure 17**) and weak La Niña conditions are expected through the 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 do wonder 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.

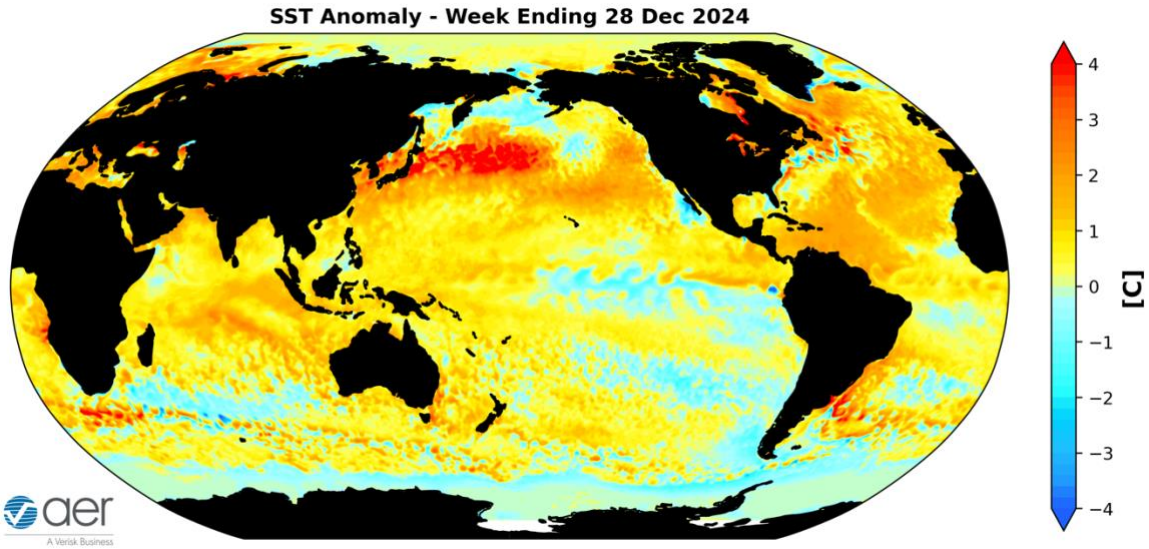

Figure 16. The latest daily-mean global SST anomalies (ending 28 Dec 2024). Data from NOAA OI High-Resolution dataset. Source https://psl.noaa.gov/map/clim/sst.shtml

Madden Julian Oscillation

Currently the Madden Julian Oscillation (MJO) is currently in in phase seven (**Figure 17**). The forecasts are for the MJO to slowly make its way into phase eight and then weaken where no phase is favored and then briefly re-emerge in phase one. Phases eight and one favor ridging the Western US and troughing in the Eastern US. Therefore, it seems that the MJO may be having some influence on North American weather the next couple of weeks. But admittedly this is outside of my expertise.

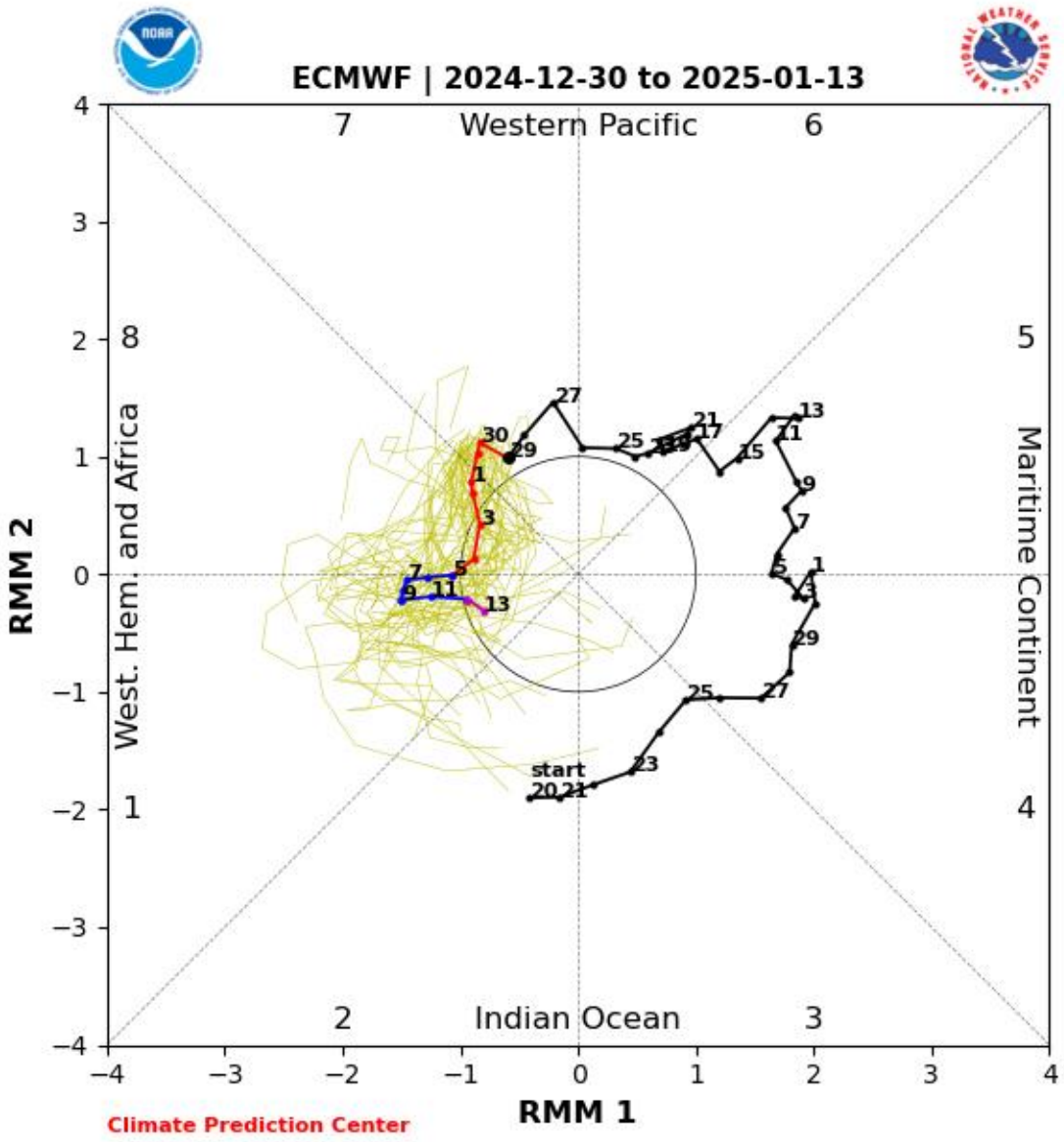

Figure 17. Past and forecast values of the MJO index. Forecast values from the 00Z 30 December 2024 ECMWF model. Yellow lines indicate individual ensemble-member forecasts, with the green line showing the ensemble-mean. A measure of the model 'spread' is denoted by the gray shading. Sector numbers indicate 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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