Arctic Oscillation and Polar Vortex Analysis and Forecasts

January 9, 2023

Dear AO/PV blog readers:

We have shifted the public release of the Arctic Oscillation/Polar Vortex blog to Wednesday through the winter season.

For those who would like an early look on Mondays, we will be offering at a nominal price (US $50) a PDF version of the upcoming blog, and we will be rolling out access to the datasets used in the production of this blog. At present we plan to make available in comma-separated values the timeseries of the Polar Cap Height and the timeseries of the Wave Activity Flux (vertical component), though we would appreciate to hear your suggestions for additional data of interest to you all.

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. With the start of 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.

Subscribe to our email list or follow me on Twitter (@judah47) for notification of updates.

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

Summary

- The Arctic Oscillation (AO) is currently slightly negative and is predicted to remain neutral to negative over the next two weeks as pressure/geopotential

height anomalies across the Arctic are currently mixed are predicted to remain mostly mixed. The North Atlantic Oscillation (NAO) is currently positive and is predicted to remain mostly positive the next two weeks as pressure/geopotential height anomalies are predicted to be mostly negative to mixed across Greenland.

- Over the next two weeks ridging/positive geopotential height anomalies centered in the Barents-Kara Seas will favor troughing/negative geopotential height anomalies across Northern Europe but mostly ridging/positive geopotential height anomalies across Southern Europe. The resultant zonal pattern will generally favor normal to above normal temperatures across much of Europe including the United Kingdom (UK) with normal to below normal temperatures limited to northern Scandinavia and mostly week two.
- This week, predicted ridging/positive geopotential height anomalies in the Barents-Kara Seas will force troughing/negative geopotential height anomalies across Western Asia and Siberia with more ridging/positive geopotential height anomalies in East Asia. Then next week ridging will spread across the Urals pushing troughing into East Asia. This pattern favors normal to below normal temperatures across Western Asia and Siberia with normal to above normal temperatures across East Asia this week. Then next week normal to below normal temperatures will continue across Northern Asia and spread into East Asia with normal to above normal temperatures across Southern Asia.
- Over the next two weeks, troughing/negative geopotential height anomalies in the Gulf of Alaska will slowly push into the Western United States (US) forcing ridging/positive geopotential height anomalies across Canada and US east of the Rockies. This pattern favors widespread normal to above normal temperatures Central and Eastern Canada and the Central and Eastern US with normal to below normal temperatures limited to Western Canada and the Western US with mixed in Alaska.
- I discuss what we can expect in the coming weeks with the polar vortex (PV), which is predicted to become increasingly perturbed and hemispheric temperatures. However, my struggles identifying a stretched PV from a larger sudden stratospheric warming (SSW) continue.

Plain Language Summary

One thing seems to be coming clearer, another stretched polar vortex (PV) that favors a cold pattern east of the Rockies in North America is likely to begin this week, but the cold arrives the week of 23 January. Europe is expected to remain mild, and I don't see any substantive change in the foreseeable future. Really cold air has built up in Siberia putting East Asia and eastern North America at risk for more severe cold in my opinion. I am still watching for the possibility of a larger PV disruption that could extend the cold in North America and Asia and/or bring it to Europe.

Impacts

After Wednesday's update feel like I know just enough about the polar vortex (PV) to be dangerous. I think everyone can read in the past few blogs my struggles trying to anticipate whether the PV will stretch or go through a larger disruption generally known as a sudden stratospheric warming (SSW). On Monday I was leaning towards a stretched PV and then on Wednesday an SSW but at least today a stretched PV is looking more certain. But in my defense, I did conclude with these insightful words "Lots going on with the stratospheric polar vortex, a large range of possibilities and lots of uncertainty." That still holds for today.

The energy diagnostics from the GFS that show the Wave Activity Flux (WAF) in the vertical and horizontal directions that I showed last week are noisier than I anticipated, and it seems that every day they show something different. The WAF in the vertical and longitudinal directions still shows wave reflection necessary for a stretched PV but I would not exactly call it textbook. Still based on the ECMWF and Canadian model forecasts predicting increasing ridging in western North America and troughing in eastern North America, and therefore must show a more robust wave reflection than predicted by the GFS. (It seems to me that the 12Z GFS has now come into agreement with the other two weather models.)

What I would say is the biggest difference between this week and last week is increased confidence in a stretched PV and less confidence in an SSW. The biggest reason that I would give, is the change in the model forecasts from last week, where the models are now predicting a shortening of the wavelengths across the NH. I include in **Figure i** the GFS geopotential height 5-day forecast that I posted from last week and a similar forecast from the ECMWF from today. I would argue that the wave pattern from last week projected onto one wavelength across the NH (shown by red oval) maybe two (the second I delineated with a dashed oval). But now this week it looks like three waves will encompass the NH (all three shown with red ovals). Wavelengths one or two are necessary to trigger an SSW, wavelength three or greater aren't of sufficient size to force an SSW. Wave 1 is thought to favor a PV displacement and wav-2 a PV split (see for example Martius et al. 2009). So last week's predicted wave pattern in my opinion favored a PV displacement and maybe to a lesser degree a PV split. However, the new model forecasts maybe favor a PV split but I think they are increasingly favoring a PV stretch as the amplitude is becoming below the threshold to trigger an SSW. Another reason why I believe that the probability of a major SSW is lower because, last week the models were showing ridging centered over the Barents-Kara Seas and the Urals (see **Figure ia**). However, this week the ridging has pushed eastward into the Laptev Sea and I think this eastward movement is less favorable for forcing an SSW. I am curious to see the new ECMWF weeklies and their forecast of a possible SSW late January into early February.

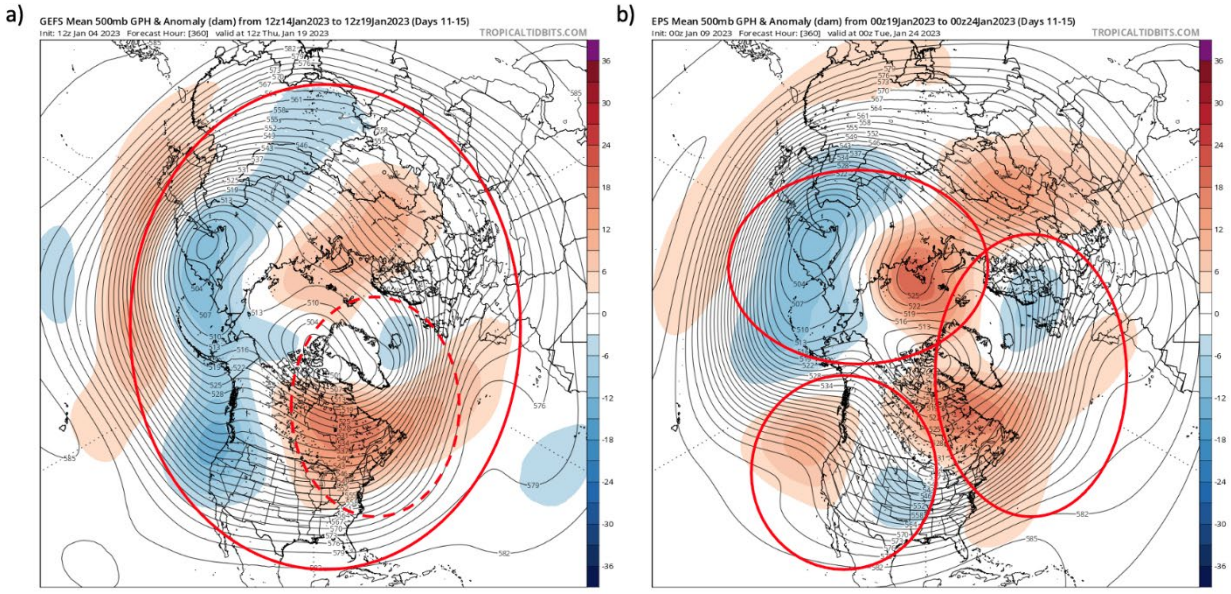

Figure i. a) Forecasted average 500 mb geopotential heights (dam; contours) and geopotential height anomalies (m; shading) across the Northern Hemisphere from 14 – 19 January 2023. The forecasts are from the 12z 4 January 2023 GFS ensemble. b) Forecasted average 500 mb geopotential heights (dam; contours) and geopotential height anomalies (m; shading) across the Northern Hemisphere from 19 – 24 January 2023. The forecasts are from the 0z 9 January 2023 ECMWF ensemble. Graphs taken from https://www.tropicaltidbits.com/analysis/models/.

I believe that a stretched PV, a major SSW (where the zonal-mean zonal wind winds at 60°N and 10 hPa) and a minor SSW (where the winds fail to reverse at 60°N and 10 hPa but there is warming of the polar stratosphere) are all possible in the coming weeks. According to our PV model the most likely time for an SSW is between 27 January and 5 February 2023. After the 5th of February the model says the probability of an SSW quickly decays. As part of our analysis on stretched PVs (follow up to our Cohen et al. 2021 paper), I do believe the PV can go from the current configuration to an SSW or even a stretched PV and then finally an SSW.

I still think a stretched PV is most likely in the next two weeks. I also think a minor SSW is also likely and what is most in doubt would be a major SSW. Over the past two winters, all the stretched PVs have occurred with an overall stronger than normal PV. But stretched PVs can also occur with a weaker than normal PV. It is my impression that the response across eastern North America in general can be more severe and of longer duration when the PV is relatively weak. A good recent example is late December 2017 and early January 2018. To avoid confusion the stretched PV of February 2021 also occurred with a weak PV but that came on the heels of a major SSW. If we do observe a major SSW, I will worry then about whether a stretched PV is looking likely.

Finally, some very cold air has built up again in Siberia. In December this was a precursor to a severe Arctic outbreak in the US. No indications of it int eh models but I do think the risk of severe cold does exist for East Asia and eastern North America.

In conclusion a stretched PV favors cold weather in Asia and eastern North America. The cold is already in place in Asia and is likely to spread across eastern North America the week of January 23rd. Stretched PVs tend not to have a strong influence on European weather or maybe even favor milder weather. We can argue who has made more of a non-winter - Europe or the East Coast of the US, but I think the European "heat-wave" and snow melt across western Eurasia in general was much more anomalous and it is really hard for me to see a recovery from that anomalous warm event with subsequent meaningful winter in Europe with the possible exception of Scandinavia. Of course, you learn in this business "never say never" and I don't want to rule it out, especially if a PV split materializes.

I do think a period of colder weather is coming to the Eastern US late January. The past two winters cold weather associated with stretched PVs have lasted about a week as they have occurred with a relatively strong PV. If the PV can become relatively weak, the cold weather could stretch out for two weeks. If we get a major SSW then cold weather can pretty much last through the end of the winter. I also think starting in February there is less volatility in the temperatures and persistence becomes more important, especially with an established snow cover favoring cold and a lack of one favoring mild. So, as I started still lots of uncertainty.

There is a novel/movie Titled "The Gang that Couldn't Shoot Straight" and I feel that this is the winter that couldn't shoot straight. Given how strong the PV has been there has been surprisingly persistent high latitude blocking this winter. Yet the blocking at first impression looks to be impactful on the weather and gets in position just long enough to tease you about a more established winter pattern before changing just enough to become mostly ineffectual; with the exception of triggering a stretch of the PV and the cadence of once a month.

Wednesday Update

I would say the biggest update from Monday, is that on Monday I described the wave energy propagation that is triggering the stretched PV as less than textbook. The prognostics from the GFS the past two days are certainly looking "textbook" (see Figure ii) That is a very nice reflection predicted, deeper than previous ones so far this winter and reminds me of the ones we analyzed in the late winter of 2013/14 (see Cohen et al. 2022). So at least in the polar stratosphere, I expect this to be a larger event than ones previously this winter and even from last winter, but a big event in the stratosphere is not necessarily a big event in the troposphere and on our weather. That is a lesson I had to learn the hard way. But also I do want to emphasize that these energy prognostics are more volatile than I anticipated and they can look very different day to day and I don't want to over sell their accuracy.

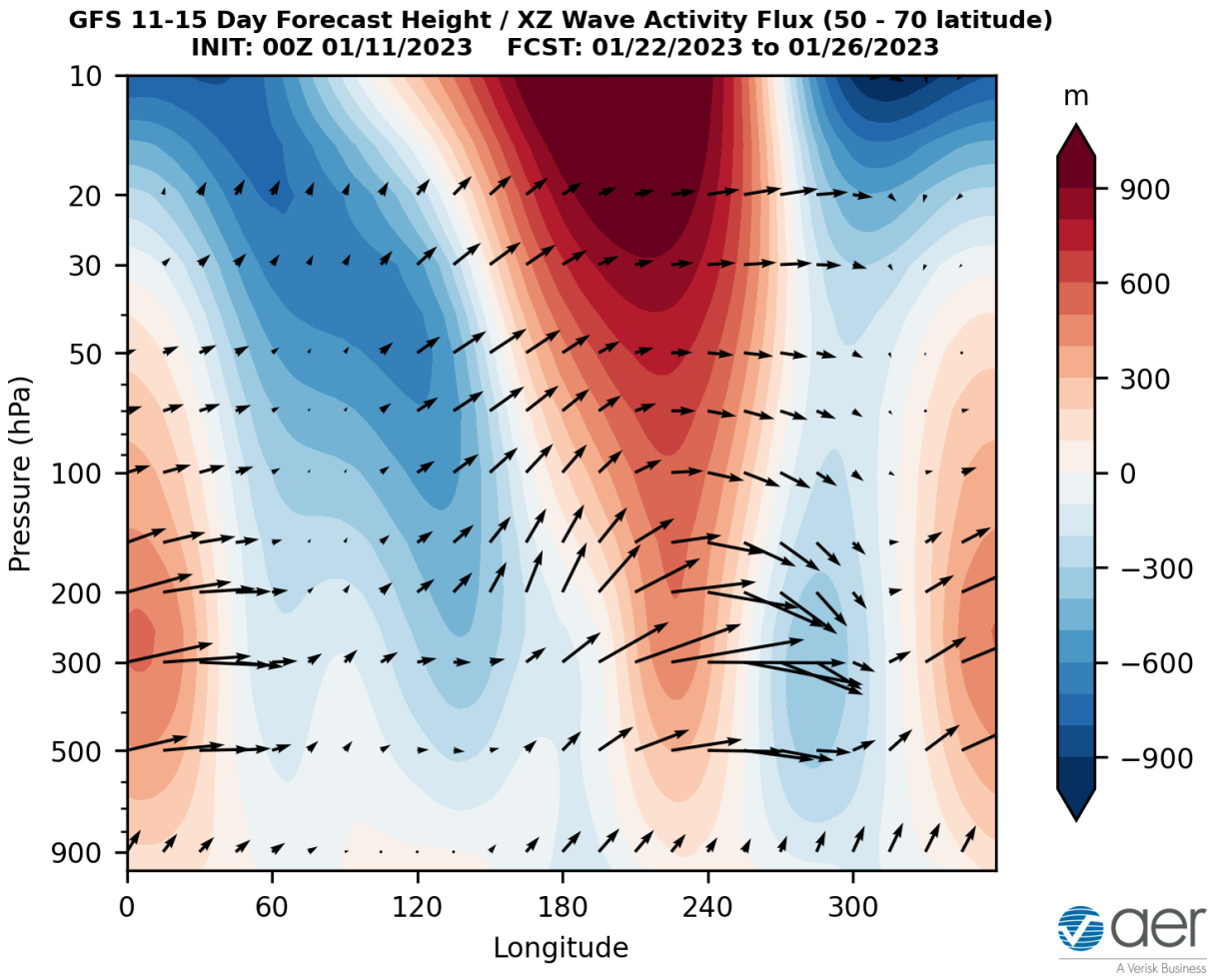

Figure ii. Longitude-height cross section of geopotential eddy height anomalies (shading) and wave activity flux (vectors) forecasted for 22-26 January 2023. The forecasts are from the initialized 0z 11 January 2023 GFS ensemble.

The high latitude blocking may not be ideal, but I think if anything it looks better for influencing the polar vortex. I feel at least a minor sudden stratospheric warming is likely to accompany the predicted stretched PV event at the very end of January and early February. I think the ECMWF has the best handle on predicting the upcoming pattern and I show in **Figure iii** the ensemble forecast for Day 15. I would feel more comfortable showing a forecast a week or so away rather than two weeks, but hard to see if that forecast is correct, we don't get at least a minor SSW, with the core of the anomalous warmth in the polar stratosphere directly aimed at the North Pole.

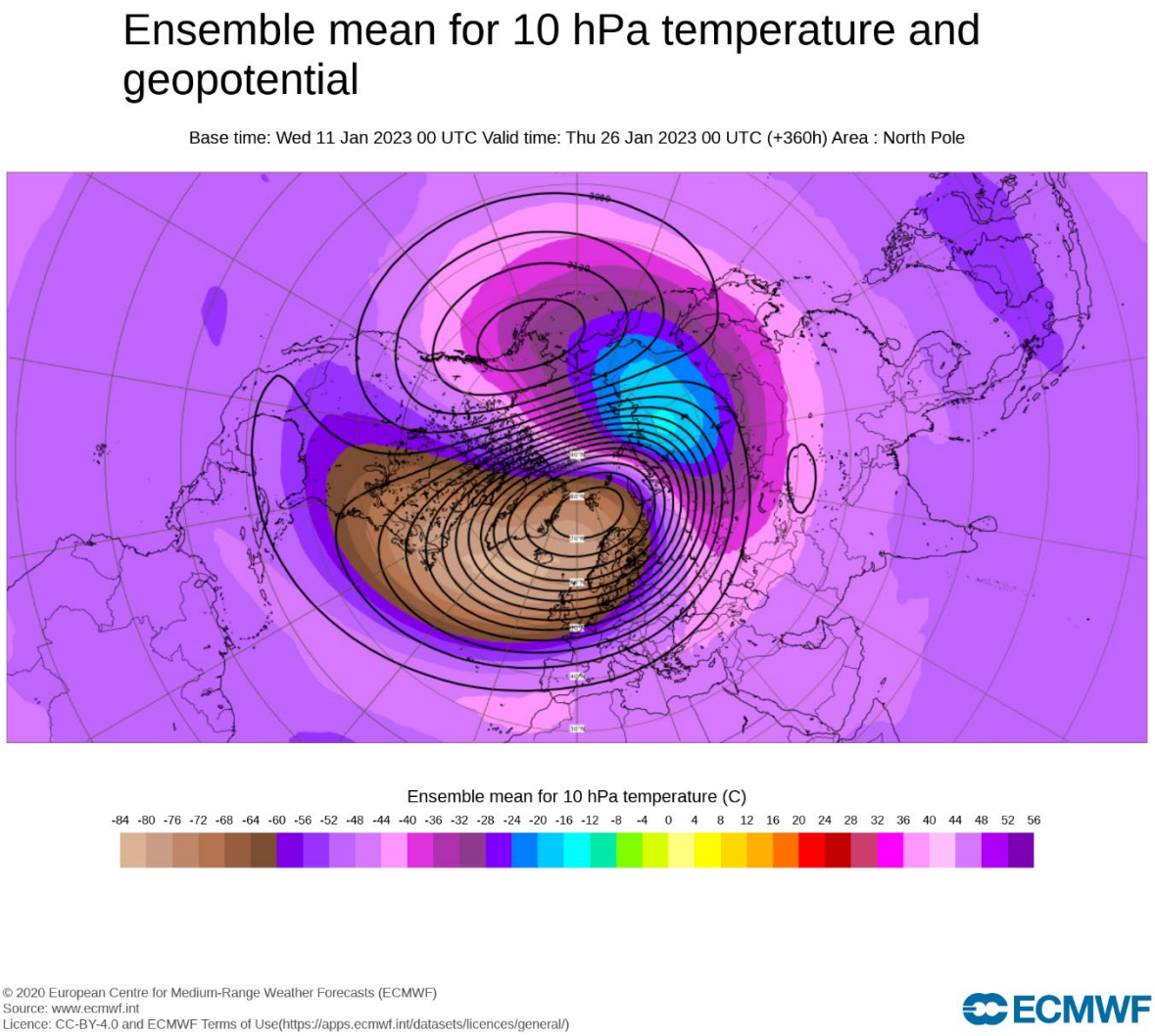

Figure iii. Forecasted 10 mb geopotential heights (dam; contours) and temperature anomalies (°C; shading) across the Northern Hemisphere for 26 January 2023. The forecasts are from the 00Z 11January 2023 ECMWF model ensemble. Graph taken from https://charts.ecmwf.int/

Much more uncertain is whether we get a major SSW but I still think that it is possible and not an insignificant one at that. Like I discussed on Monday the wavelength has shortened across the NH with wave-3 dominating and not waves 1 and 2. But it does look like wave-2 as well with decent Ural blocking and downstream troughing across Siberia extending into the North Pacific (see **Figure iv**). And if anything I think that the ECMWF has held on the Ural blocking more strongly than the GFS and may be the reason that the ECMWF appears more bullish on polar stratospheric warming. I think as long as that pattern can hold, it will exert at least some pressure on the PV that is already clearly weakened or disturbed. If and when a major SSW occurs will likely change the trajectory of the remainder of the winter.

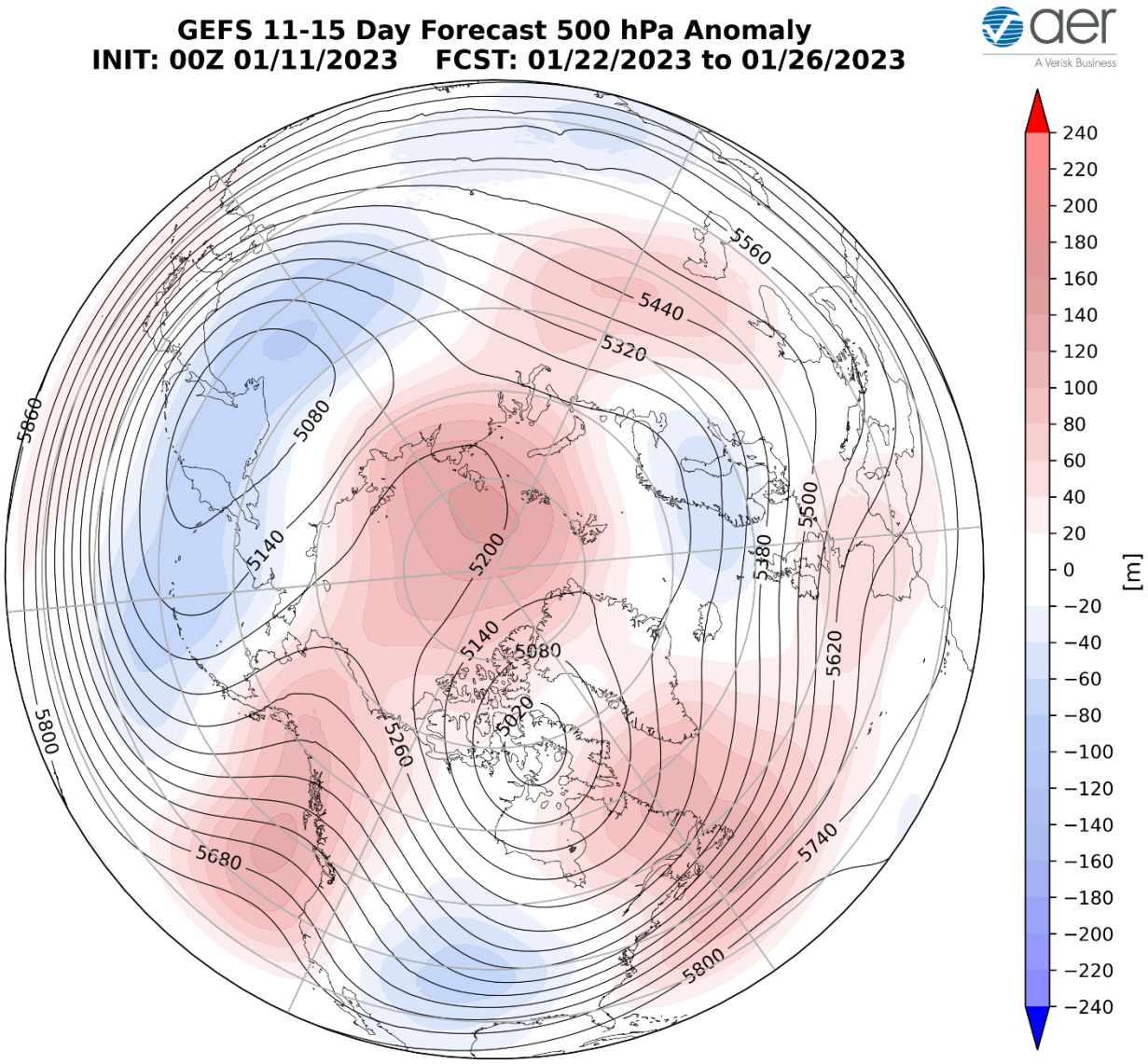

Figure iv. Forecasted average 500 mb geopotential heights (dam; contours) and geopotential height anomalies (m; shading) across the Northern Hemisphere from 22 – 26 January 2023. The forecasts are from the 00z 11 January 2023 GFS ensemble.

Recent and Very Near Term Conditions

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

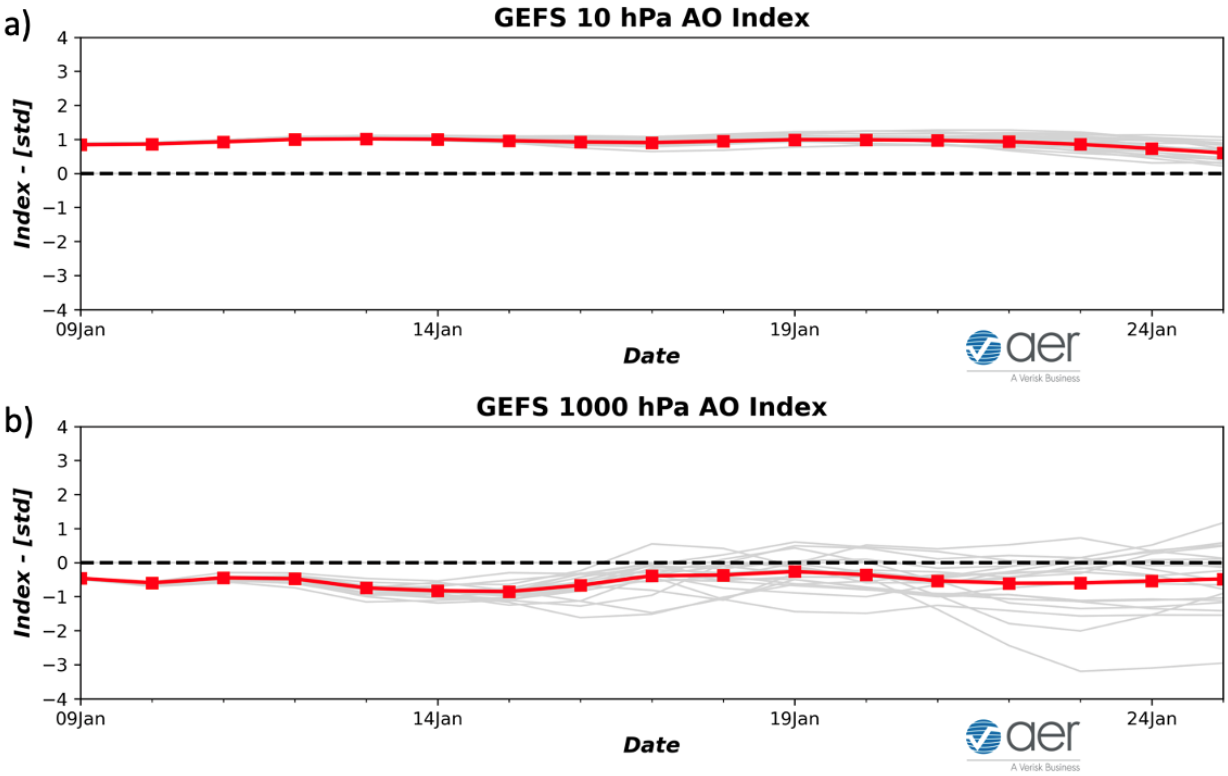

Figure 1. (a) The predicted daily-mean AO at 1000 hPa from the 00Z 9 January 2023 GFS ensemble. (b)The predicted daily-mean near-surface AO from the 00Z 9 January 2023 GFS ensemble. Gray lines indicate the AO index from each individual ensemble member, with the ensemble-mean AO index given by the red line with squares.

Predicted ridging/positive troughing/negative geopotential height anomalies centered in the Barents-Kara Seas will favor ridging/positive geopotential height anomalies across Northern Europe with more ridging/positive geopotential height anomalies across Southern Europe (**Figure 2).** The resultant zonal flow will favor normal to above normal temperatures across much of Europe including the UK except for normal to below normal temperatures across far Eastern Europe (**Figure 3**). Ridging/positive geopotential height anomalies in the Barents-Kara Seas will favor troughing/negative geopotential height anomalies across Western Asia and Siberia with more ridging/positive across Eastern Asia (**Figure 2**). This pattern favors normal to below normal temperatures across Western Asia and Siberia with normal to above normal temperatures across East Asia **(Figure 3**).

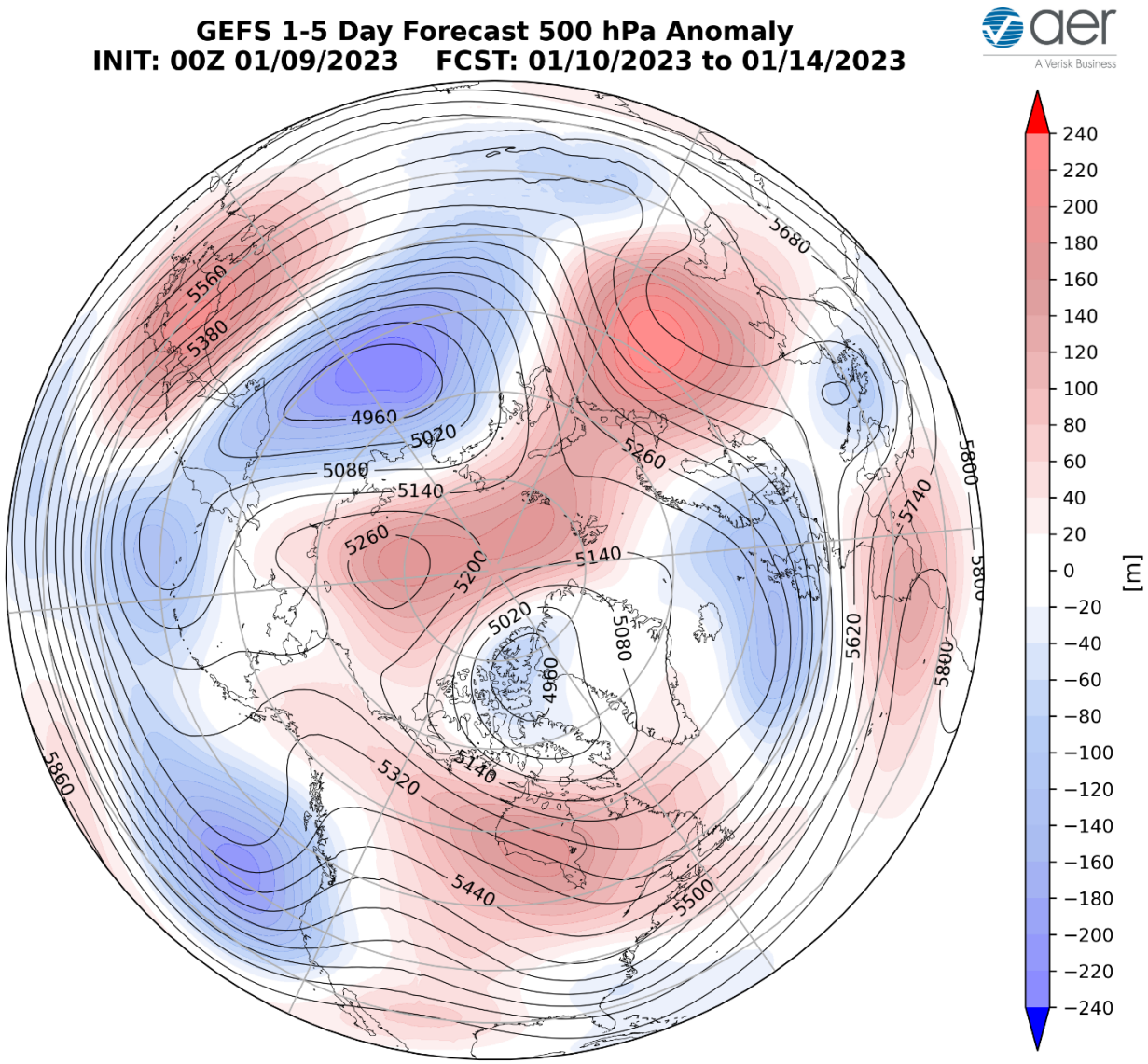

Figure 2. Forecasted average 500 mb geopotential heights (dam; contours) and geopotential height anomalies (m; shading) across the Northern Hemisphere from 10 – 14 January 2023. The forecasts are from the 00z 9 January 2023 GFS ensemble.

Troughing/negative geopotential height anomalies predicted to be centered in the Gulf of Alaska will force ridging/positive geopotential height anomalies across eastern North America **(Figure 2).** The pattern will favor normal to above normal temperatures across much of North America except for normal to below normal temperatures for parts of Alaska, across the West Coast of Canada and the Western US **(Figure 3).**

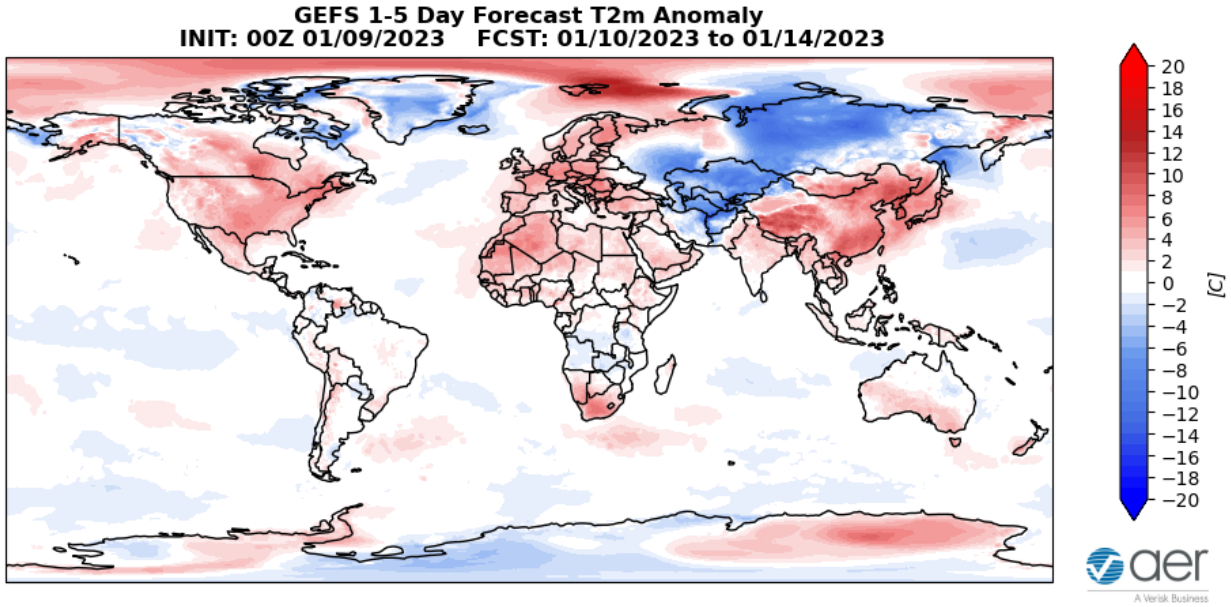

Figure 3. Forecasted surface temperature anomalies (°C; shading) from 10 – 14 January 2023. The forecast is from the 00Z 9 January 2023 GFS ensemble.

Troughing and/or cold temperatures will support new snowfall across parts of Scandinavia, Western and Central Asia while mild temperatures will support snowmelt across parts of Scandinavia, the Baltics and Western Asia (**Figure 4**). Troughing and/or cold temperatures will support new snowfall across western Alaska, Northern Canada and New England while mild temperatures will support snowmelt across Southern Alaska, Southern and Western Canada, the Western US and the Upper Midwest (**Figure 4**). I am seeing on Twitter forecasts of 150 inches of snow in the Sierra Nevada so not sure why that isn't showing up on our snowfall maps.

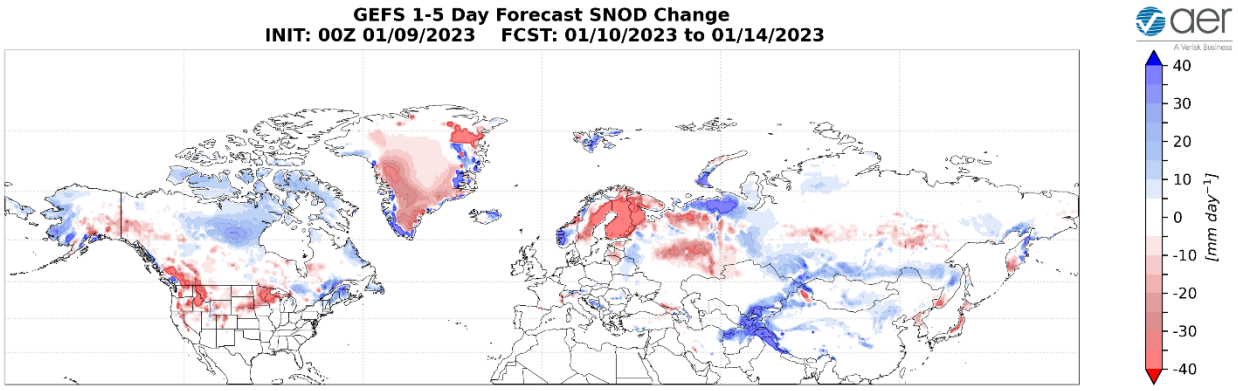

Figure 4. Forecasted snow depth changes (mm/day; shading) from 10 – 14 January 2023. The forecast is from the 00Z 9 January 2023 GFS ensemble.

Near-Term

1-2 week

The AO is predicted to remain neutral to negative this period **(Figure 1**) as geopotential height anomalies continue mixed across the Arctic and mixed across the mid-latitudes (**Figure 5**). With mostly troughing albeit weak geopotential height anomalies across Greenland (**Figure 5**), the NAO is predicted to remain positive this period.

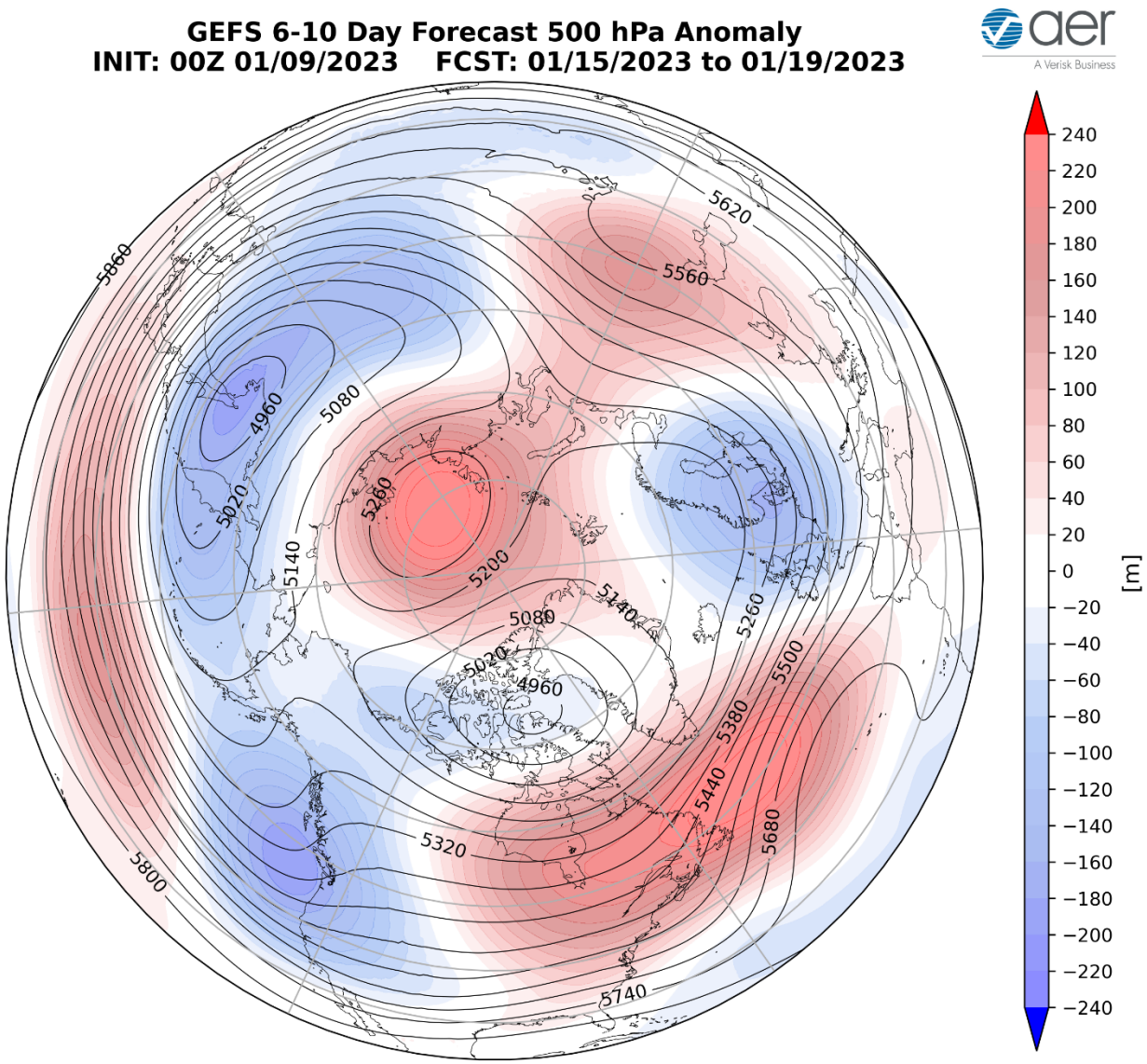

Figure 5. Forecasted average 500 mb geopotential heights (dam; contours) and geopotential height anomalies (m; shading) across the Northern Hemisphere from 15 – 19 January 2023. The forecasts are from the 00z 9 January 2023 GFS ensemble.

Ridging/positive geopotential height anomalies across the Laptev Sea and in the western North Atlantic will continue to favor troughing/negative geopotential height

anomalies across North Europe with ridging/positive geopotential height anomalies across Southern Europe (**Figures 5).** This pattern favors normal to above normal temperatures across much of Europe including the Southern UK with the exception normal to below normal temperatures across Scotland and northern Scandinavia (**Figure 6**). Persistent ridging/positive geopotential height anomalies now centered in the Laptev Sea are predicted to anchor troughing/negative geopotential height anomalies across Siberia and Central Asia with more ridging/positive geopotential height anomalies across Western Asia this period (**Figure 5**). This pattern favors normal to below normal temperatures across much of Siberia and Central Asia with normal to above normal temperatures across Western and Southern Asia **(Figure 6**).

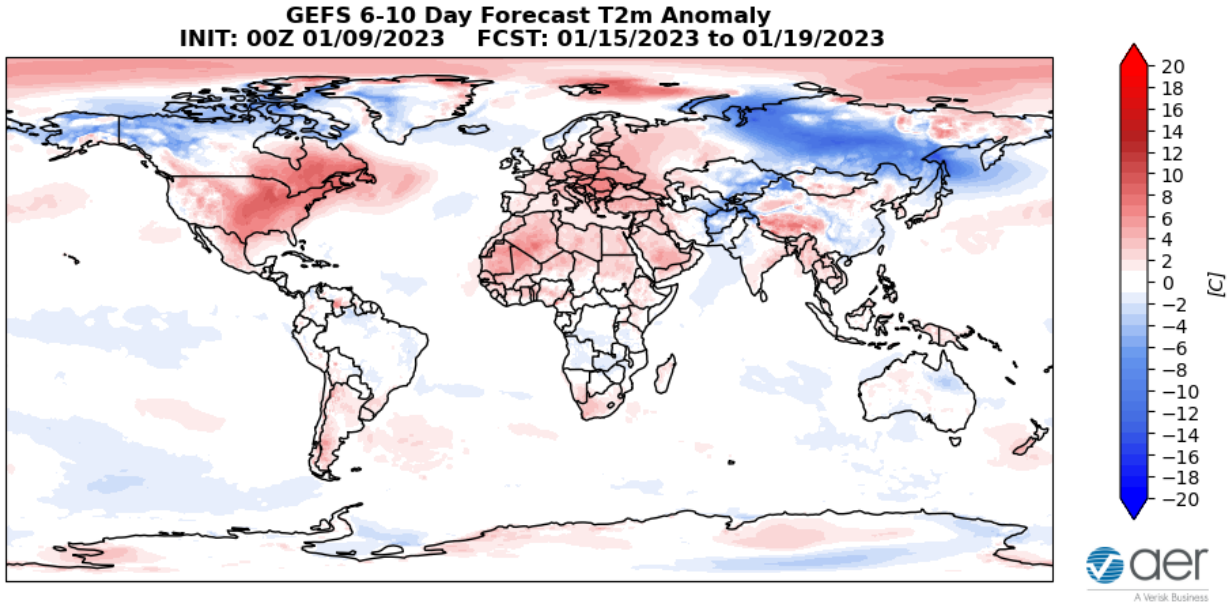

Figure 6. Forecasted surface temperature anomalies (°C; shading) from 15 – 19 Janaury 2023. The forecast is from the 00Z 2 January 2023 GFS ensemble.

Persistent troughing/negative geopotential height anomalies centered in the Gulf of Alaska will anchor ridging/positive geopotential height anomalies across eastern North America this period **(Figure 5).** This pattern will favor widespread normal to above normal temperatures across eastern North America with normal to below normal temperatures across Alaska, the Northern and Western Canada and parts of the Western US **(Figure 6).**

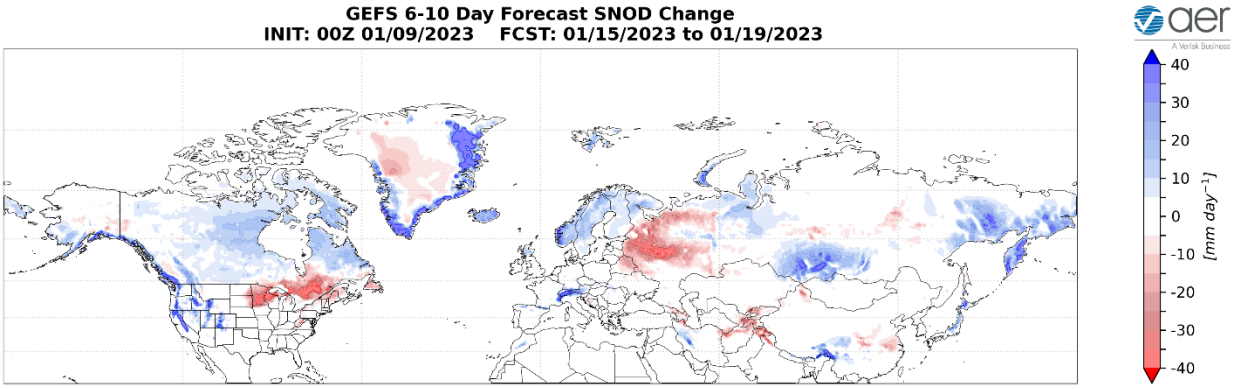

Figure 7. Forecasted snow depth changes (mm/day; shading) from 15 – 19 Janaury 2023. The forecast is from the 00Z 9 January 2023 GFS ensemble.

Troughing and/or cold temperatures will support new snowfall across Scandinavia, the Alps, Northern and Central Asia while mild temperatures will support snowmelt in the Baltics and Northwestern Asia (**Figure 7**). Troughing and/or cold temperatures will support new snowfall across Central and Eastern Canada and higher elevations of the Western US while mild temperatures will support snowmelt in Southeastern Canada, the Upper Midwest and New England (**Figure 7**).

3-4 week

With continued mixed geopotential height anomalies across the Arctic and with mixed geopotential height anomalies across the mid-latitudes this period (**Figure 8**), the AO should continue to remain neutral to negative this period (**Figure 1**). With weak and mixed pressure/geopotential height anomalies across Greenland (**Figure 8**), the NAO will trend to neutral this period.

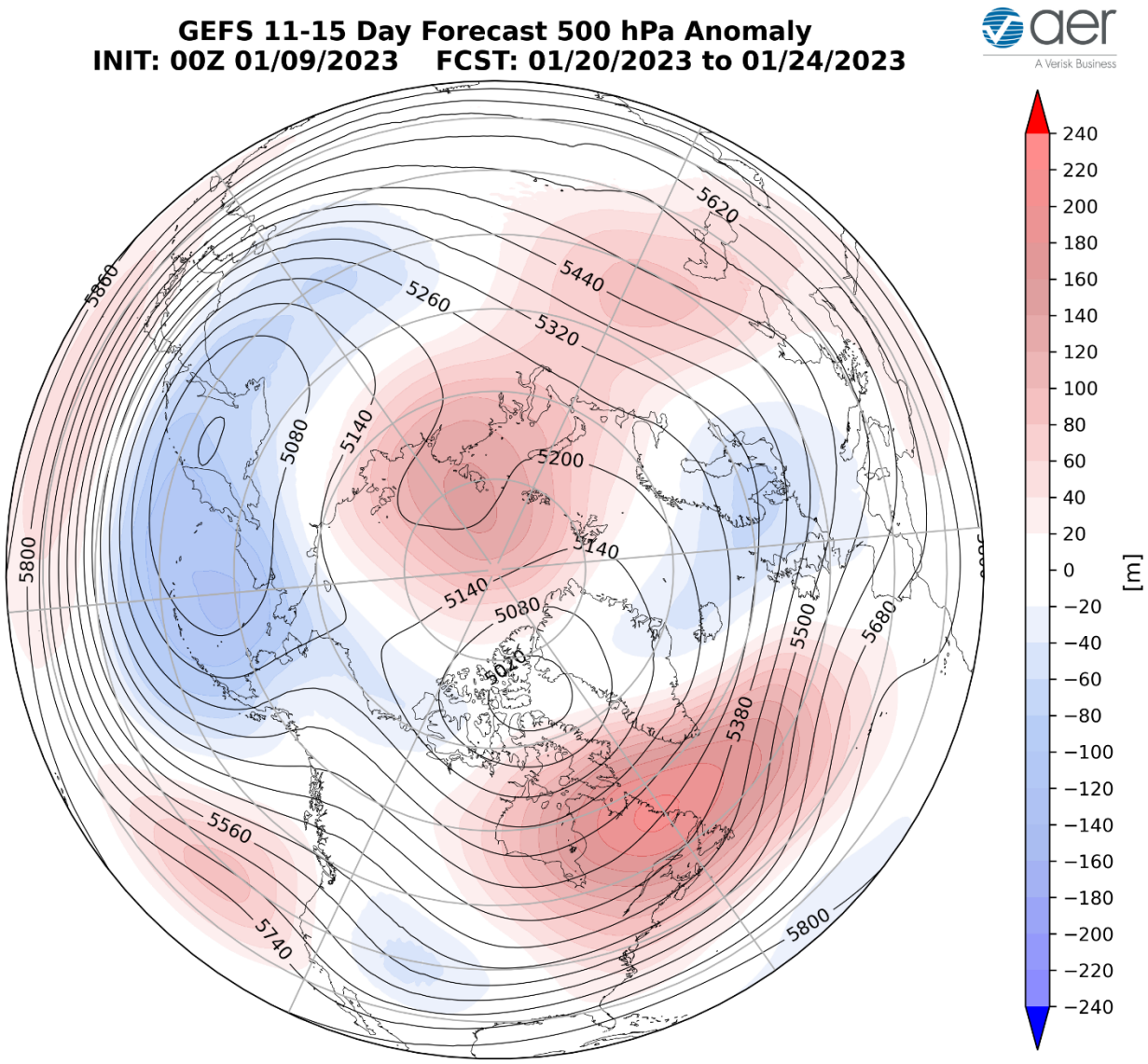

Figure 8. Forecasted average 500 mb geopotential heights (dam; contours) and geopotential height anomalies (m; shading) across the Northern Hemisphere from 20 – 24 January 2023. The forecasts are from the 00z 9 January 2023 GFS ensemble.

Persistent ridging/positive geopotential height anomalies predicted in the Laptev Sea that extends southward across the Urals coupled and in the western North Atlantic will continue to support troughing/negative geopotential height anomalies across Northern Europe with more ridging/positive geopotential height anomalies across Southern Europe this period (**Figure 8**). This pattern favors normal to above normal temperatures across Southern and Central Europe with normal to below normal temperatures across Northern Europe including the UK (**Figures 9**). Predicted persistent ridging/positive geopotential height anomalies in the Laptev Sea and the Urals will help to anchor troughing/negative geopotential height anomalies across Siberia and East Asia (**Figure 8**). This pattern favors widespread normal to below

normal temperatures across Northern and Eastern Asia with normal to above normal temperatures across Western and Southern Asia (**Figure 9**).

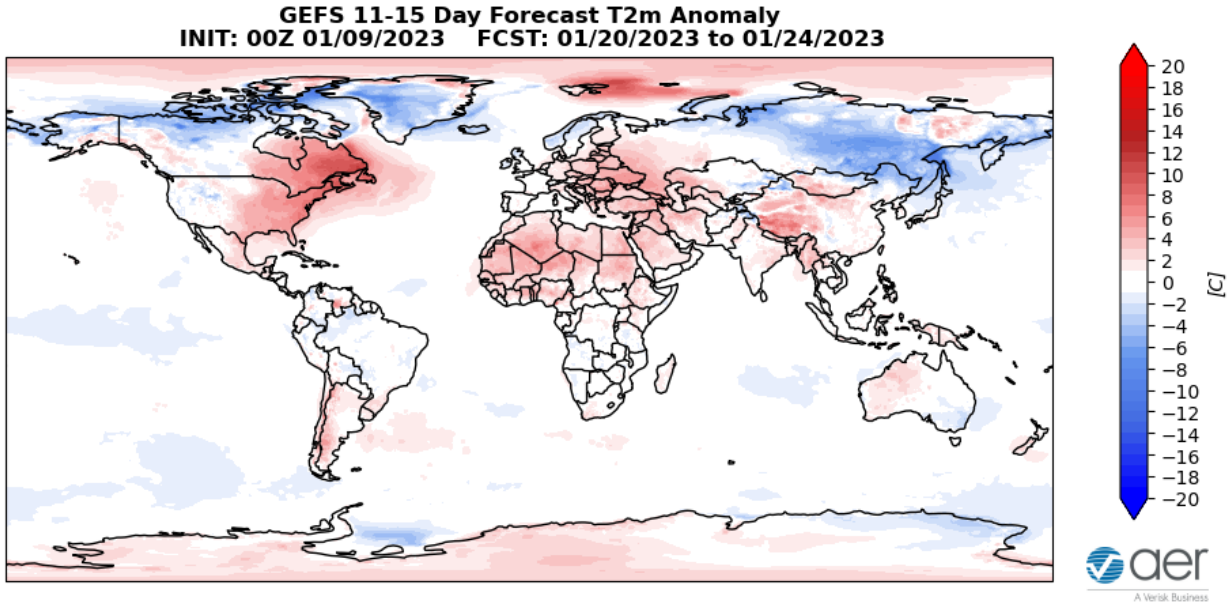

Figure 9. Forecasted surface temperature anomalies (°C; shading) from 20 – 24 January 2023. The forecast is from the 00Z 9 January 2023 GFS ensemble.

Predicted troughing/negative geopotential height anomalies previously in the Gulf of Alaska will push further east into the Western US and continue to favor ridging/positive geopotential height anomalies across eastern North America this period (**Figure 8**). This pattern favors widespread normal to below normal temperatures across Alaska, Northern and Western Canada and the Western US with normal to above normal temperatures across Eastern Canada and the Eastern US (**Figure 9**). The GFS seems to be alone in holding on to strong ridging in eastern North America and I do think that during this period colder temperatures could begin to filter into eastern North America.

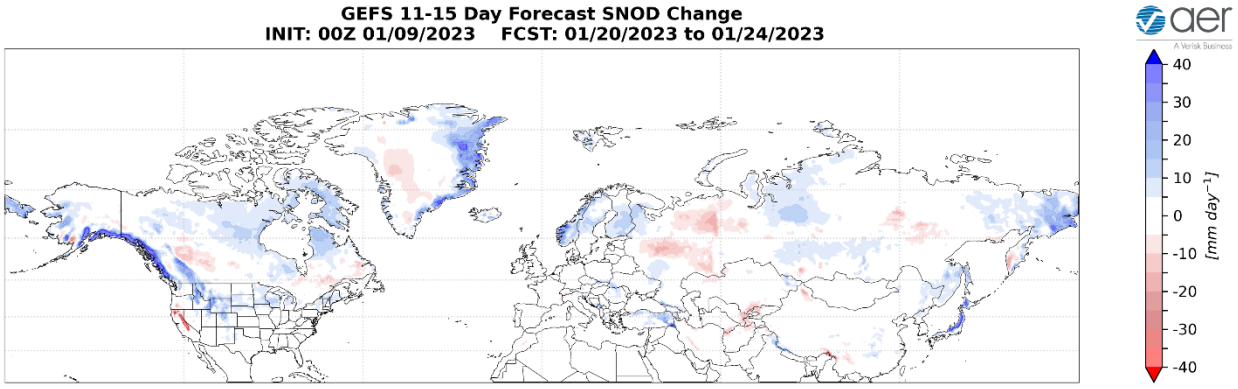

Figure 10. Forecasted snow depth changes (mm/day; shading) from 20 – 24 January 2023. The forecast is from the 00Z 9 January 2023 GFS ensemble.

Troughing and/or cold temperatures will support new snowfall across Scandinavia, Southeastern Europe including Turkey, Northern and Eastern Asia while mild temperatures will support snowmelt in Western Asia (**Figure 10**). Troughing and/or cold temperatures will support new snowfall across western Southern Alaska, Northern Canada and the Northwestern US while mild temperatures will support snowmelt in Southwestern Canada and the Sierras (**Figure 10**).

Longer Term

30–day

The latest plot of the polar cap geopotential height anomalies (PCHs) currently shows cold/negative PCHs throughout the stratosphere with warm/positive PCHs in the troposphere (**Figure 11**). However, the cold/negative PCHs in the stratosphere are predicted to weaken and warm/positive PCHs are predicted to strengthen in the low and mid-troposphere starting this week into next (**Figure 11**).

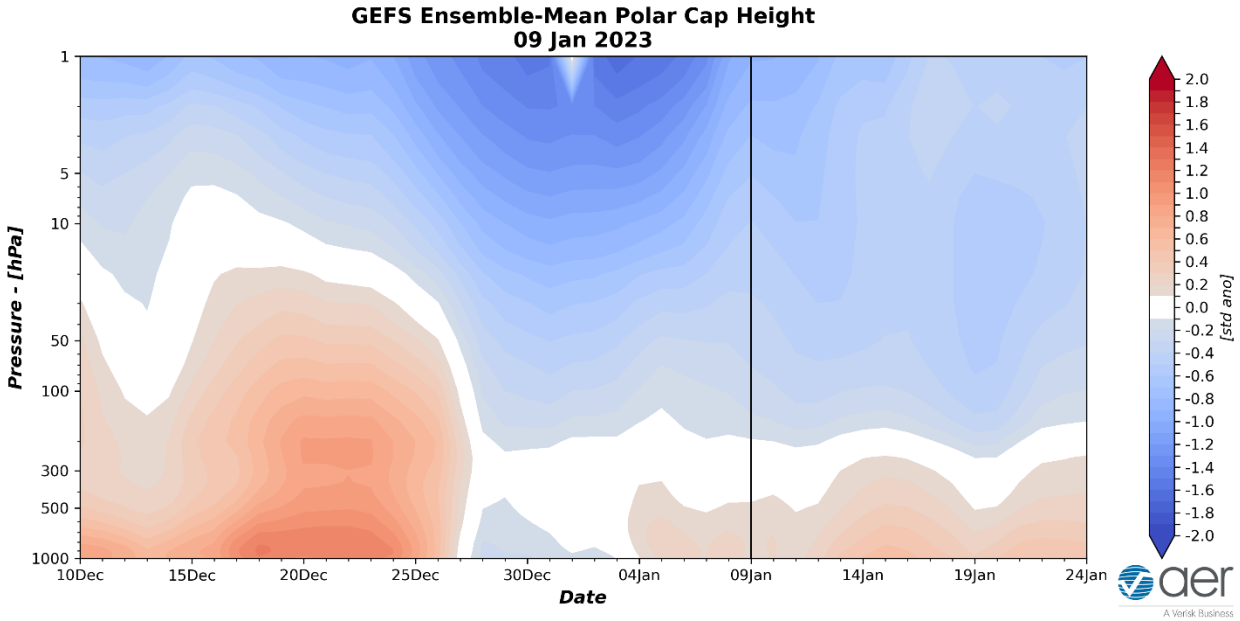

Figure 11. Observed and predicted daily polar cap height (i.e., area-averaged geopotential heights poleward of 60°N) standardized anomalies. The forecast is from the 00Z 9 January 2023 GFS ensemble.

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

1). However next week when the warm/positive PCHs in the lower troposphere are predicted to strengthen (**Figure 11**), the AO could become more negative (**Figure 1**).

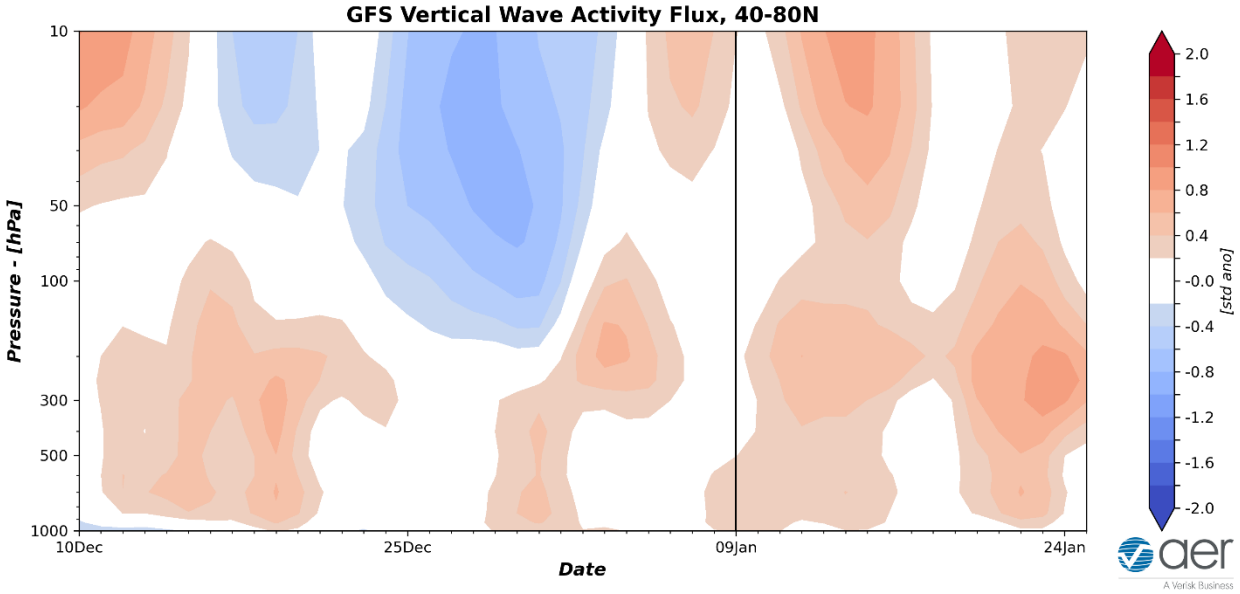

Figure 12. Observed and predicted daily vertical component of the wave activity flux (WAFz) standardized anomalies, averaged poleward of 40-80°N. The forecast is from the 00Z 9 January 2023 GFS ensemble.

Vertical Wave Activity Flux (WAFz) from the troposphere to the stratosphere or poleward heat transport in the stratosphere became more active this past week (**Figure 12**) which has resulted in warming of the very cold/negative stratospheric PCHs from record and near record cold to just weakly cold (**Figure 11**). The GFS is predicting the WAFz will become more active in the next two weeks (**Figure 12**), resulting in continued overall warming of the stratospheric PCHs through late January but for now nothing dramatic (**Figure 11**).

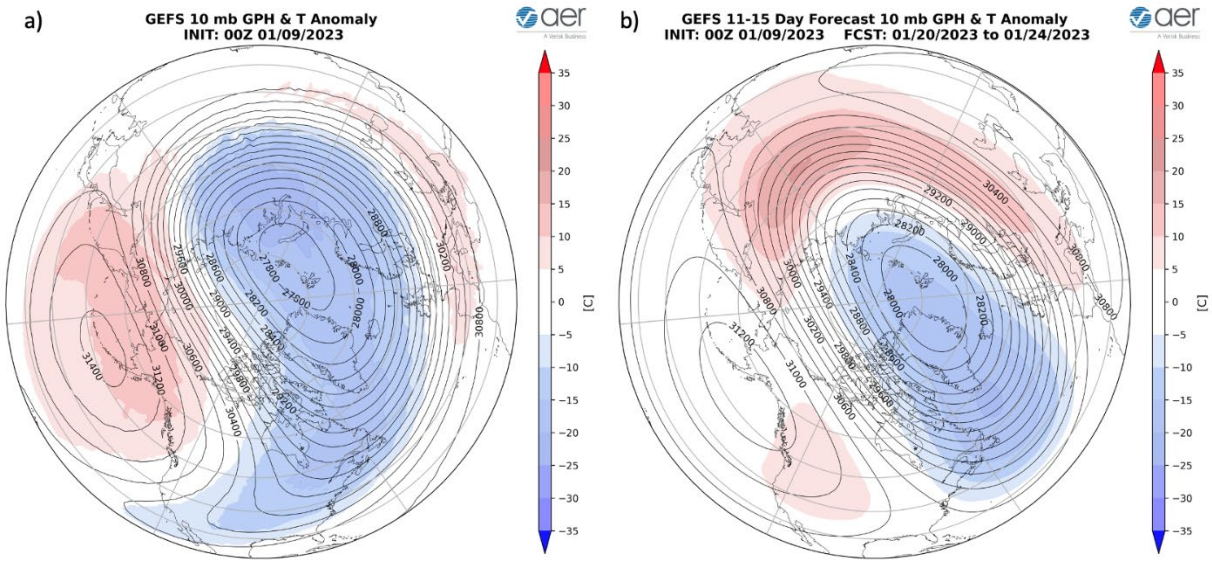

Figure 13. (a) Initialized 10 mb geopotential heights (dam; contours) and temperature anomalies (°C; shading) across the Northern Hemisphere for 9 January 2023. (b) Same as (a) except forecasted averaged from 20 – 24 January 2023. The forecasts are from the 00Z 9 January 2023 GFS model ensemble.

The more active WAFz has shifted the still strong stratospheric PV center over towards Svalbard and has caused it to stretch or elongate **(Figure 13**). Coupled with the elongated PV is ridging and warming centered near the Dateline in the polar stratosphere (**Figure 13**). The above normal WAFz predicted for the next two weeks will continue to perturb the PV, with the PV shape remaining oblong with additional warming/ridging to remain anchored near Alaska (**Figure 13**). These are all signs of a stretched PV that favor cold in eastern North America. Despite any disruptions of the PV, the stratospheric AO is predicted to remain positive over the next two weeks **(Figure 1**).

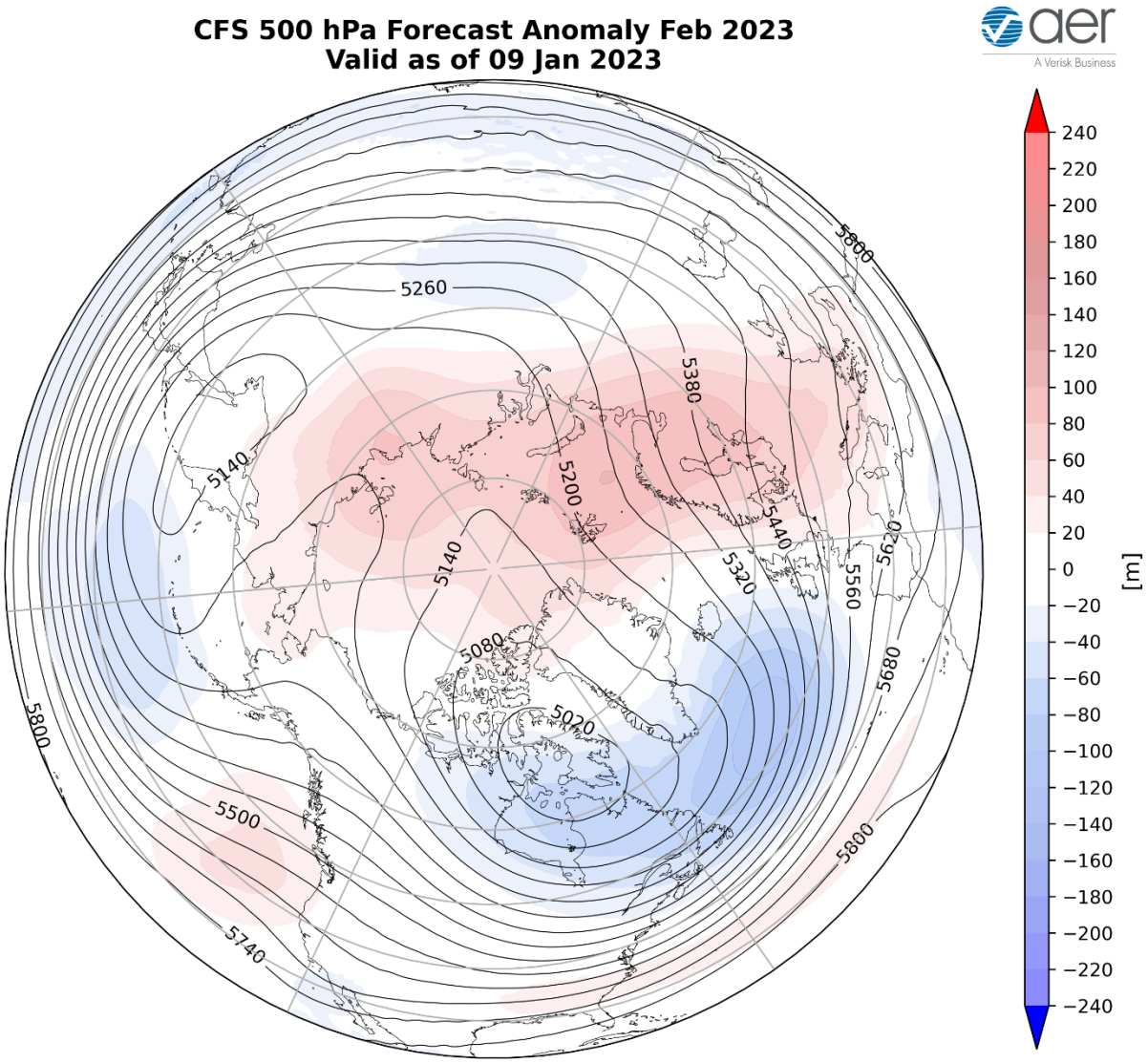

Figure 14. Forecasted average 500 mb geopotential heights (dam; contours) and geopotential height anomalies (m; shading) across the Northern Hemisphere for February 2023. The forecasts are from the 00Z 9 January 2023 CFS.

I include in this week's blog the monthly 500 hPa geopotential heights (**Figure 14**) and surface temperatures for February (**Figure 15**) from the Climate Forecast System (CFS; the plots represent yesterday's four ensemble members). The forecast for the troposphere is ridging extending across Europe and stretching into the Laptev Sea and the Gulf of Alaska with troughing stretching from Baffin Bay across Greenland to Iceland, Siberia, East Asia and eastern North America (**Figure 14).** This pattern favors seasonable to relatively warm temperatures across Europe, Eastern Siberia, Southeastern Asia, Western Canada and the Western US with seasonable to relatively cold temperatures across Siberia, Northern and East Asia, Western Alaska, Eastern Canada and the Eastern US (**Figure**

15).

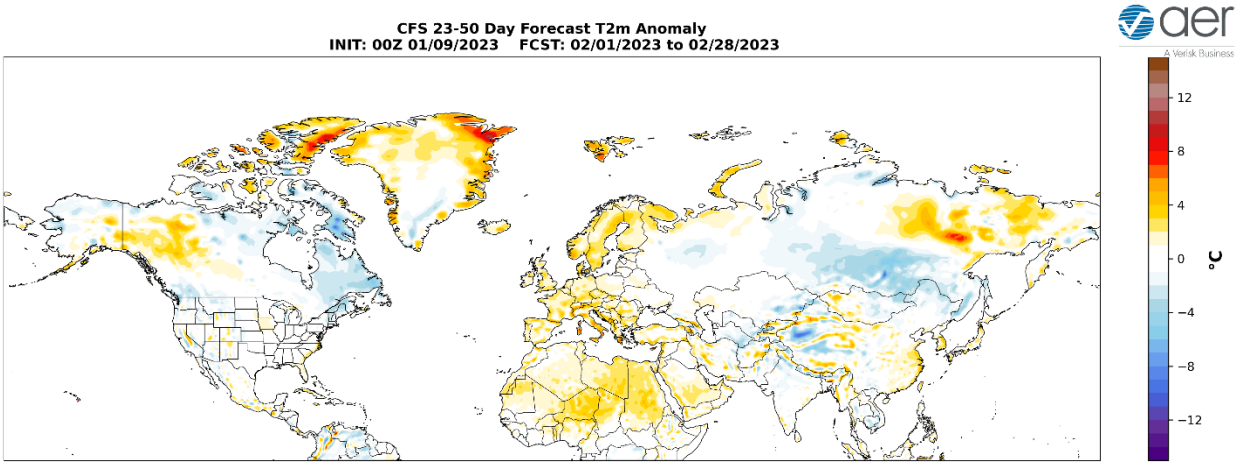

Figure 15. Forecasted average surface temperature anomalies (°C; shading) across the Northern Hemisphere for February 2023. The forecasts are from the 00Z 9 January 2023 CFS.

Boundary Forcings

Arctic Sea Ice

Arctic sea ice, which as expected is below normal (see **Figure 16**) but the regional anomalies have been more extensive in recent years. The greatest concentration of below normal remains in the Barents-Kara Seas, which I believe favors high latitude blocking. So it could be Arctic sea ice is increasingly favoring high latitude blocking in the Barents-Kara Seas region and PV disruptions.

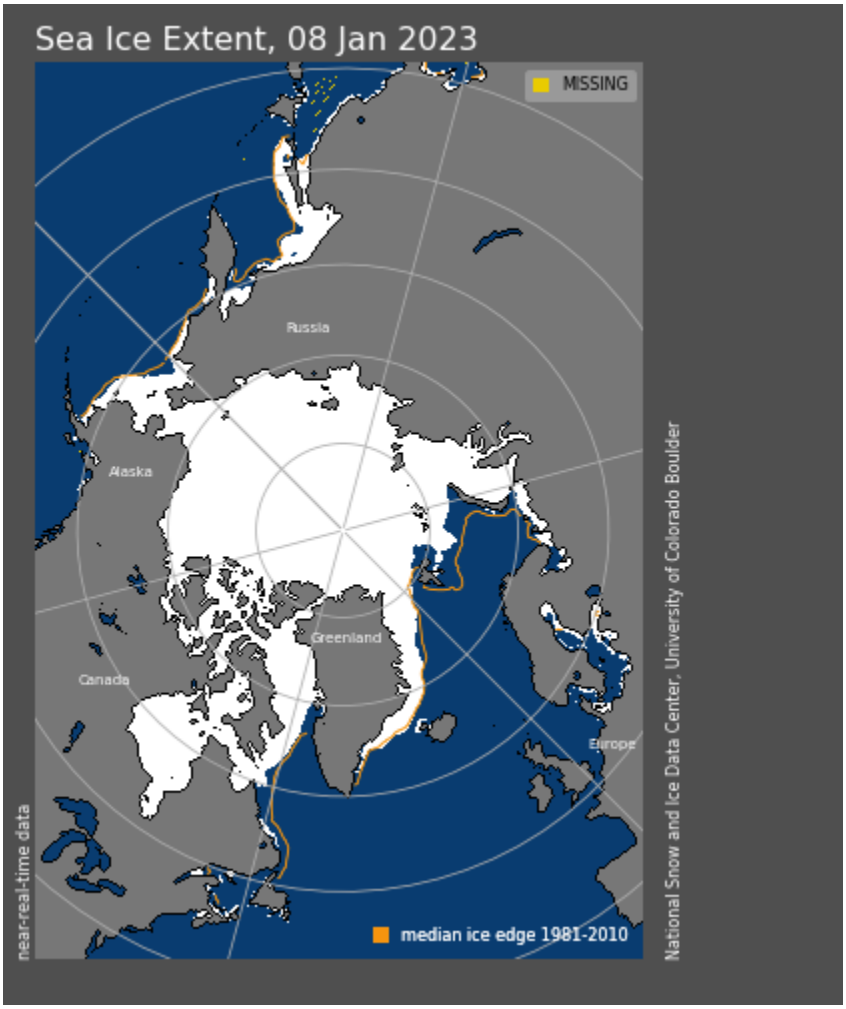

Figure 16. Observed Arctic sea ice extent on 8 January 2023 (white). Orange line shows climatological extent of sea ice based on the years 1981-2010. Image from the National Snow and Ice Data Center (NSIDC).

SSTs/El Niño/Southern Oscillation

Equatorial Pacific sea surface temperatures (SSTs) anomalies are below normal and we continue to observe weak La Niña conditions (**Figure 17)** and La Niña conditions are expected through the spring. Observed SSTs across the NH remain well above normal especially in the central North Pacific (west of recent years), the western North Pacific and offshore of eastern North America though below normal SSTs exist regionally

especially in the South Pacific.

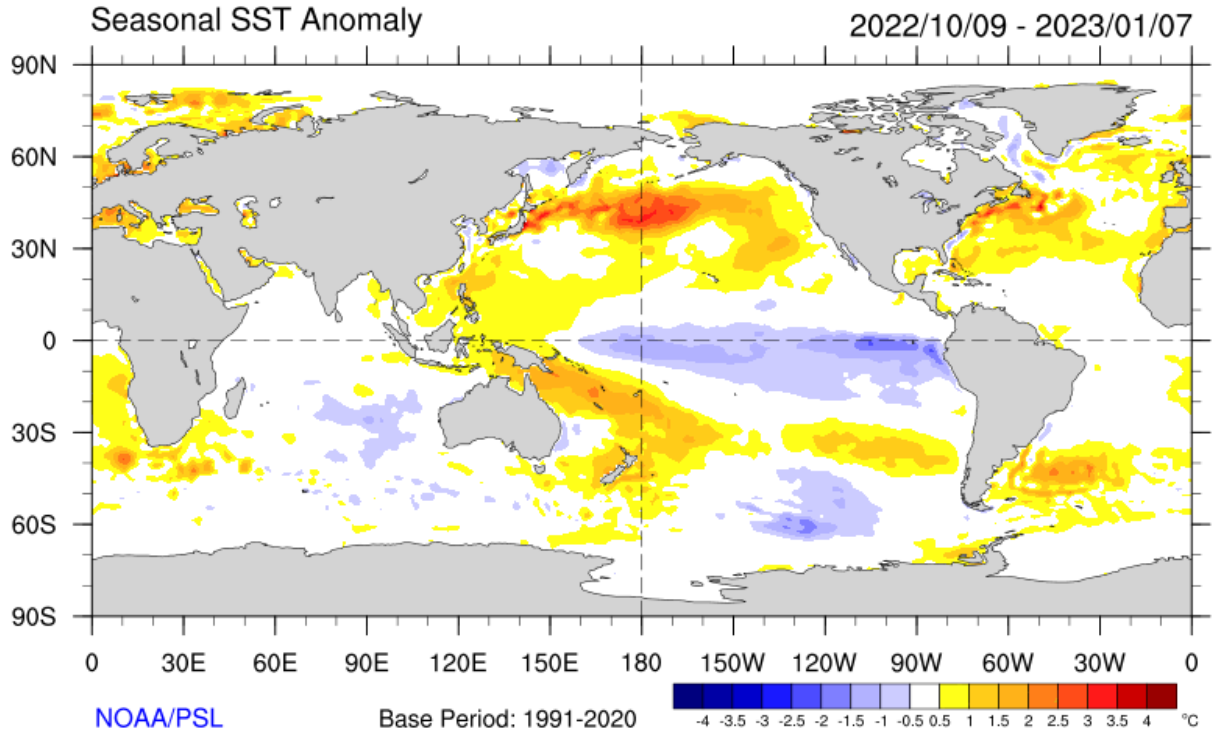

Figure 17. The latest weekly-mean global SST anomalies (ending 7 January 2023). Graph from https://psl.noaa.gov/map/.

Madden Julian Oscillation

Currently the Madden Julian Oscillation (MJO) is in phase seven (**Figure 18**). The forecasts are for the MJO to transitions to phase eight next week and then weaken to where no phase is favored. Phase seven favors first troughing over the Western US with ridging across eastern North America and then phase eight favors ridging over the Western US with increasing troughing in the Eastern US. Seems that the MJO could be having an influence on the weather across North America in the short term. But admittedly this is outside of my expertise.

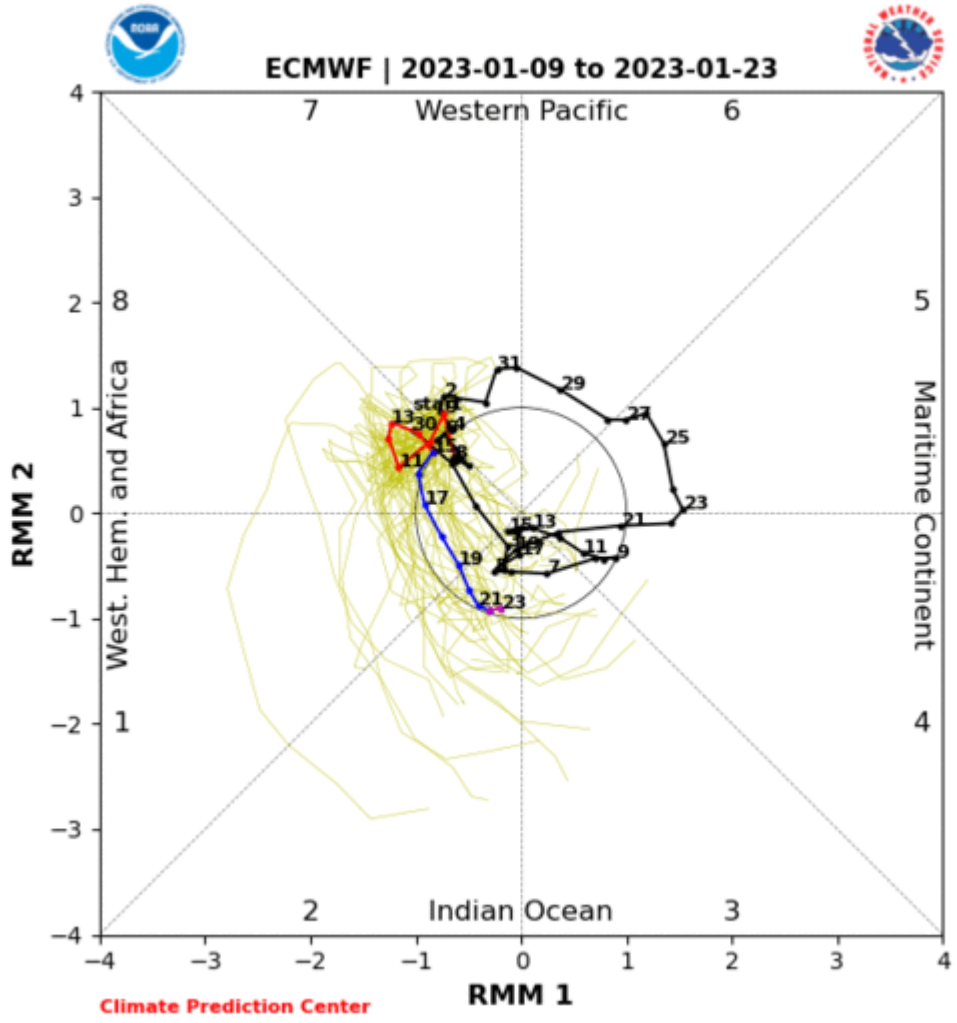

Figure 18. Past and forecast values of the MJO index. Forecast values from the 00Z 2 January 2023 ECMWF model. Yellow lines indicate individual ensemble-member forecasts, with the green line showing the ensemble-mean. A measure of the model "spread" is denoted by the gray shading. Sector numbers indicate the phase of the MJO, with geographical labels indicating where anomalous convection occurs during that phase. Image source: http://www.atmos.albany.edu/facstaff/roundy/waves/phasediags.html

Snow Cover

Snow cover extent (SCE) across the NH has continued to decline this past week due to mild temperatures in both North America and Eurasia (see **Figure 19**). Snow cover has declined both across North American and Eurasia this week and therefore SCE is at decadal lows. With the predicted widepsread cold across Eurasia, I expect snow cover

to advance more rapidly across Eurasia than North America next week but then could reverse in late January.

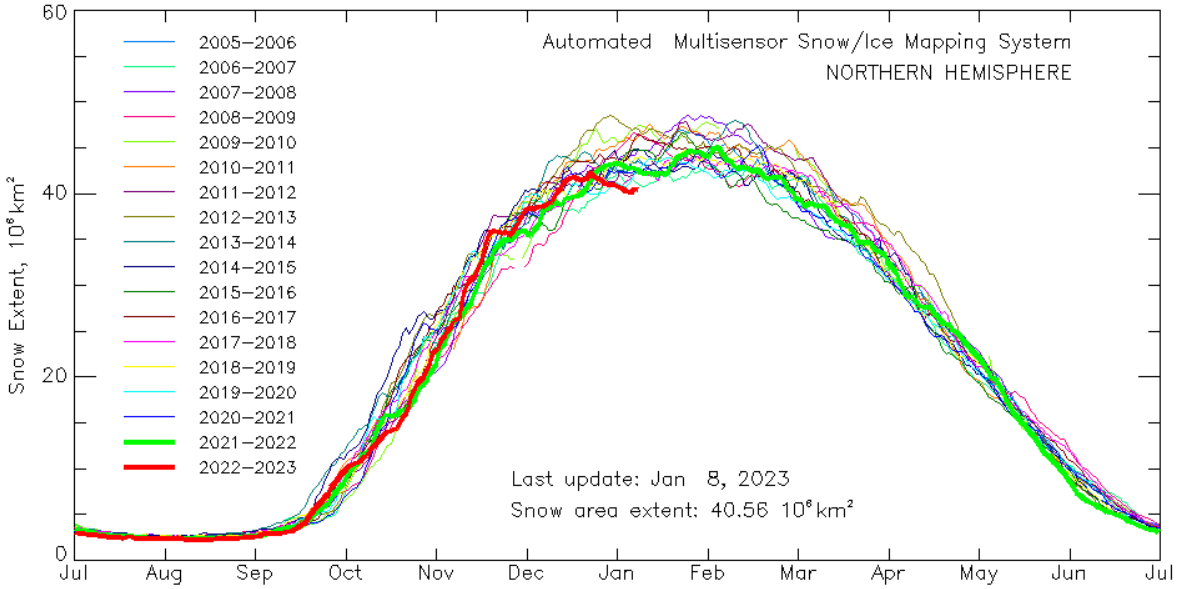

Figure 19. Observed North American snow cover extent through 8 January 2023. Plot from https://www.star.nesdis.noaa.gov/smcd/emb/snow/HTML/snow_extent_monitor.html