Arctic Oscillation and Polar Vortex Analysis and Forecasts

November 21, 2022

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.

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

Summary

- The Arctic Oscillation (AO) is currently positive and is predicted to trend negative and dipping slightly negative for much of the next two weeks as pressure/geopotential height anomalies across the Arctic are currently mostly negative across the Arctic but are predicted to become increasingly positive in the North Atlantic sector. The North Atlantic Oscillation (NAO) is currently near neutral and is predicted to remain neutral to negative the next two weeks as pressure/geopotential height anomalies are predicted to remain mostly positive across Greenland.
- Over the next two weeks troughing/negative geopotential height anomalies in the eastern North Atlantic will favor ridging/positive geopotential height anomalies centered near Scandinavia and the Barents-Kara Seas. This pattern will generally favor normal to above normal temperatures across much of Europe including the United Kingdom (UK). However, the North Atlantic troughing is predicted to extend far enough east to bring normal to below normal temperatures across Northern Europe including the northern UK this week and then into Southeastern Europe next week.
- Over the next two weeks, predicted Scandinavian/Barents-Kara Seas ridging/positive geopotential height anomalies will force troughing/negative geopotential height anomalies this week across Central Asia and then East Asia next week. This pattern favors normal to below normal temperatures across Northern and Central Asia this week and then Northern and Eastern Asia next week with normal to above normal temperatures across Southern Asia the next two weeks.
- The general pattern this week across North America is ridging/positive geopotential height anomalies across Western North America forcing downstream troughing/negative geopotential height anomalies in eastern North America including the Central and Eastern United States (US). However, next week ridging/positive geopotential height anomalies centered near the Aleutians will force troughing/negative geopotential height anomalies in western North America with ridging/positive geopotential height anomalies in the Eastern US. This pattern favors this week widespread normal to above normal temperatures across Alaska, Western Canada and the Western US with normal to below normal temperatures across Eastern Canada and the Eastern US. However, next week colder temperatures will expand across Alaska, Western Canada and the Western US while milder temperatures will spread east of the Rockies in Canada and the US. However, for the first week of December there seems to be important differences in the ECMWF and GFS forecasts for North America.
- In the near term I still believe there is much uncertainty in the behavior of the polar vortex (PV) and Northern Hemisphere (NH) temperatures in the coming weeks.

- I will continue to discuss October Eurasian snow cover extent and current Arctic sea ice and how they might portend the behavior of the polar vortex (PV) and the Northern Hemisphere (NH) winter.

Plain Language Summary

I will publish the AER winter forecast for the Northern Hemisphere next week. In the meantime, still lots of uncertainty, though it is looking increasingly likely that an elongated or stretched polar vortex that favors colder temperatures east of the Rockies and East Asia (but does not have a strong signal for Europe) will continue in the coming weeks.

Impacts

I plan on posting the AER winter forecast for the Northern Hemisphere (NH) next week. But I will admit upfront that I find the forecast very challenging. My thinking remains unchanged from the past few weeks, and I am wrestling with - which will have the greatest staying power, the strong stratospheric polar vortex (PV) favoring an overall milder winter or high latitude blocking favoring an overall colder coder for the continental NH. I will say that it is my impression the GFS forecast of a strengthening PV in early December is looking shaky at best. As I mentioned in last week's blog, as long as high latitude blocking remains certainly focused near Scandinavia and the Barents-Kara Seas and even if it is more spread out between Greenland to the Barents-Kara Seas, the risk for a stretched PV remains high. This thinking is founded on our analysis of the tropospheric precursors to a stretched PV in Cohen et al. 2021.

However, if the high latitude becomes focused near Greenland that may bring some temporary colder weather to Europe and even the Eastern US but that does not seem favorable to me to weaken the PV especially if low pressure develops near the Urals at the same time. The exception would be if the high latitude blocking quickly slides east towards the Barents-Kara Seas also based on Cohen et al. 2021. This of course assumes that there is also high latitude blocking in the northern North Pacific sector between eastern Siberia and Alaska. This generalized wave-two pattern of high pressure ridging in the North Atlantic sector of the Arctic and the North Pacific sector of the Arctic with low pressure troughing across Asia and North America and into the North Atlantic seems very favorable for PV stretching.

Last winter during the months of January and February it was the case of lather, rinse, repeat with the PV stretching, snapping back to a more circular configuration, and then repeating the whole cycle many times in relatively quick succession. We seem to be in the same sort of lather, rinse, repeat pattern right now but just expecting a repeat of last winter almost never works out. The PV is currently in a stretched configuration that is predicted to last through the end of November, yet the GFS is predicting a tropospheric pattern not consistent with a stretched PV in early December with troughing (see **Figure**

8) and colder temperatures (see **Figure 9**) in western North America and ridging and milder temperatures in eastern North America. In contrast the ECMWF is predicting a tropospheric pattern more consistent with a stretched PV with ridging entered near Alaska and troughing downstream across eastern North America (see **Figure i**). Though from a quick glance at the 12z run of the GFS, it seems to be more consistent with the ECMWF forecast and a stretched PV.

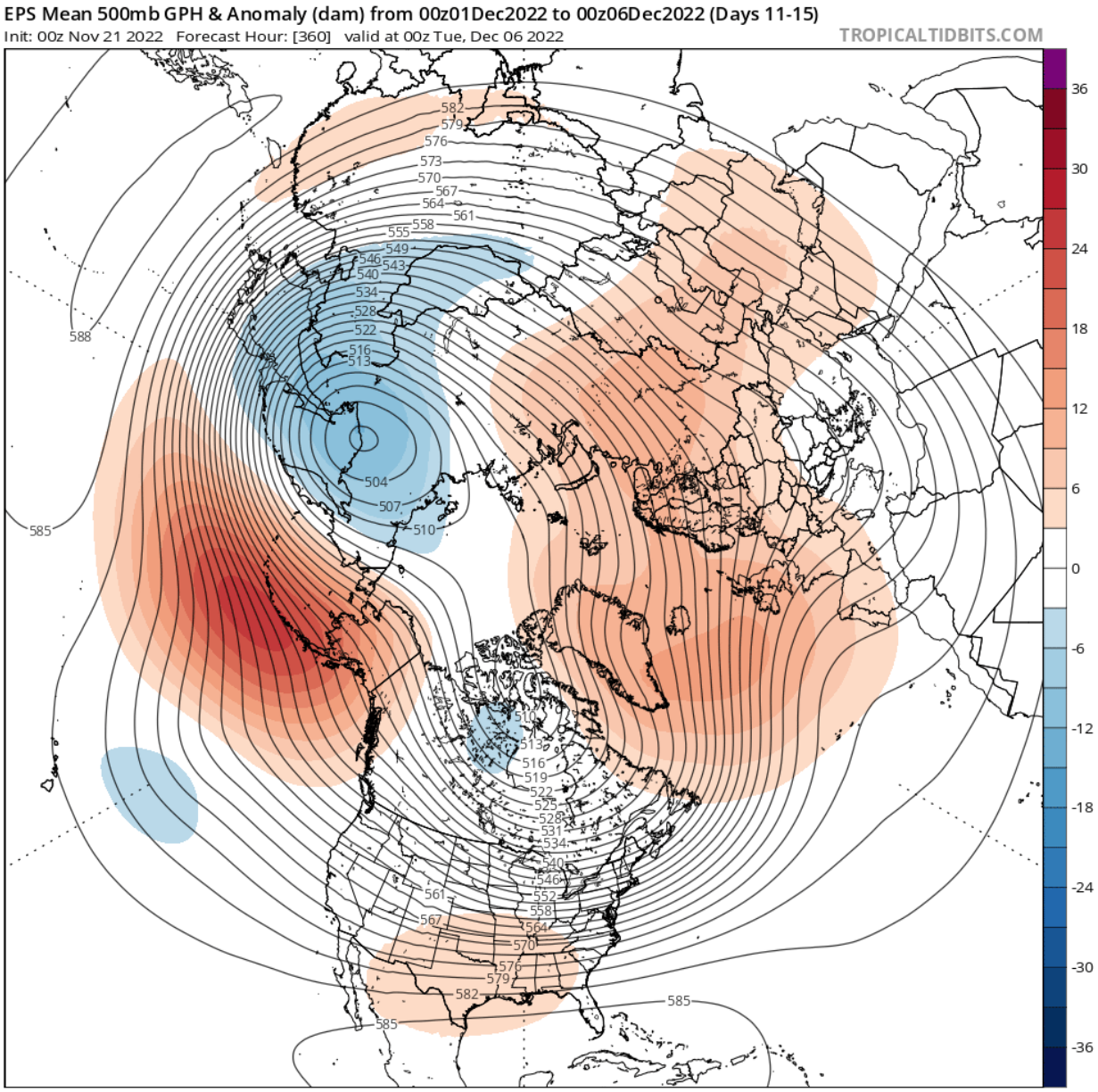

Figure i. Forecasted average 500 mb geopotential heights (dam; contours) and geopotential height anomalies (dam; shading) across the Northern Hemisphere from 1 – 6 December 2022. The forecasts are from the 00z 21 November 2022 EPS ensemble. Plot from https://www.tropicaltidbits.com/analysis/models/.

The models are predicting that the Asian troughing will slide east from a trough axis in Central Asia to a trough axis in East Asia. This realignment of the wave pattern across the Eastern Hemisphere could signal a transition from upwelling tropospheric energy that favors the more minor PV stretching to upwelling tropospheric energy that favors the more substantive sudden stratospheric warming (SSW) type of PV disruption. No evidence of this yet but if the North Atlantic high latitude blocking can persist and the Asian trough moves east (e.g., **Figure 8**) this would affectively lengthen the dominant NH wavelength from wave-2 (favoring PV stretching) to more wave-1 (favoring an SSW), especially if the Alaskan ridging flattens. All speculation on my part to be honest but something that I am monitoring closely. How that all transpires is hard to know but the one thing I would expect is a generally milder pattern in the Eastern US, with the one caveat if Greenland blocking is present as well.

Of course, I am still watching Arctic boundary conditions for clues about high latitude blocking. First, Arctic sea ice, which as expected is below normal (see **Figure ii**) but the regional anomalies have been more extensive in recent years. I believe that the realization of a cold NH winter is most dependent on high latitude blocking in the North Atlantic sector, and that is where I am focused. Sea ice extent is below normal in the Barents-Kara Seas, which I believe favors high latitude blocking in the region but I would be more confident of high latitude blocking persisting in the Scandinavian-Barents-Kara Seas-Urals region if the lack of sea ice was more extensive.

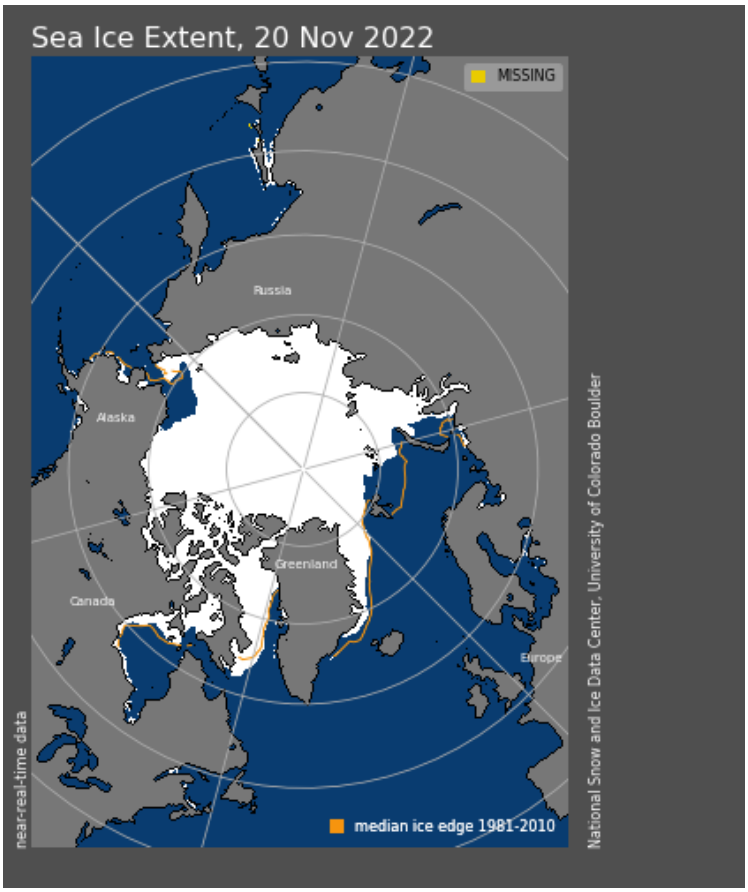

Figure ii. Observed Arctic sea ice extent on 20 November 2022 (white). Orange line shows climatological extent of sea ice based on the years 1981-2010. Image from the National Snow and Ice Data Center (NSIDC).

Snow cover I think is more interesting. Snow cover extent across the NH is fairly impressive, certainly much more so in November than October. NH snow cover extent is near decadal highs (see **Figure iii**). But also looking at NH snow depth anomalies, snow depth in Siberia is almost universally above normal (see **Figure iv**). According to the recent study of Lv et al. (2020) deep snow depth in Siberia is a strong precursor to more active vertical Wave Activity Flux (WAFz). This could be an early sign of a more active period of WAFz that is necessary to disrupt the PV.

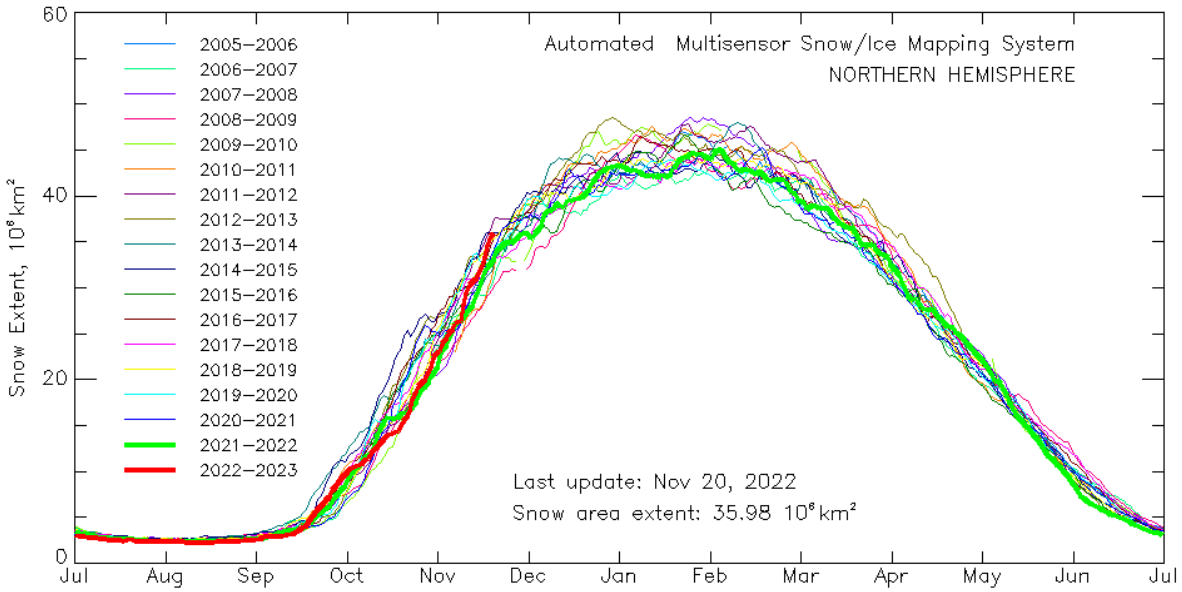

Figure iii. Observed North American snow cover extent through 20 November 2022. Plot from https://www.star.nesdis.noaa.gov/smcd/emb/snow/HTML/snow_extent_monitor.html

If you read my blog, then you know I am a strong believer in predicting weather is "the trend is your friend." For the US east of the Rockies, Decembers are warming, and Februarys are getting colder. For that reason, I rarely anticipate a cold December in the Eastern US but December 2022 could buck the trend. A stretched PV is ongoing and should last until the end of the month. I also believe that another stretched PV is increasingly likely in early December (but still not a given). If we do observe a stretched PV in early December, then we are probably just one more stretched PV that month away from a strong possibility of a cold December in the Eastern US.

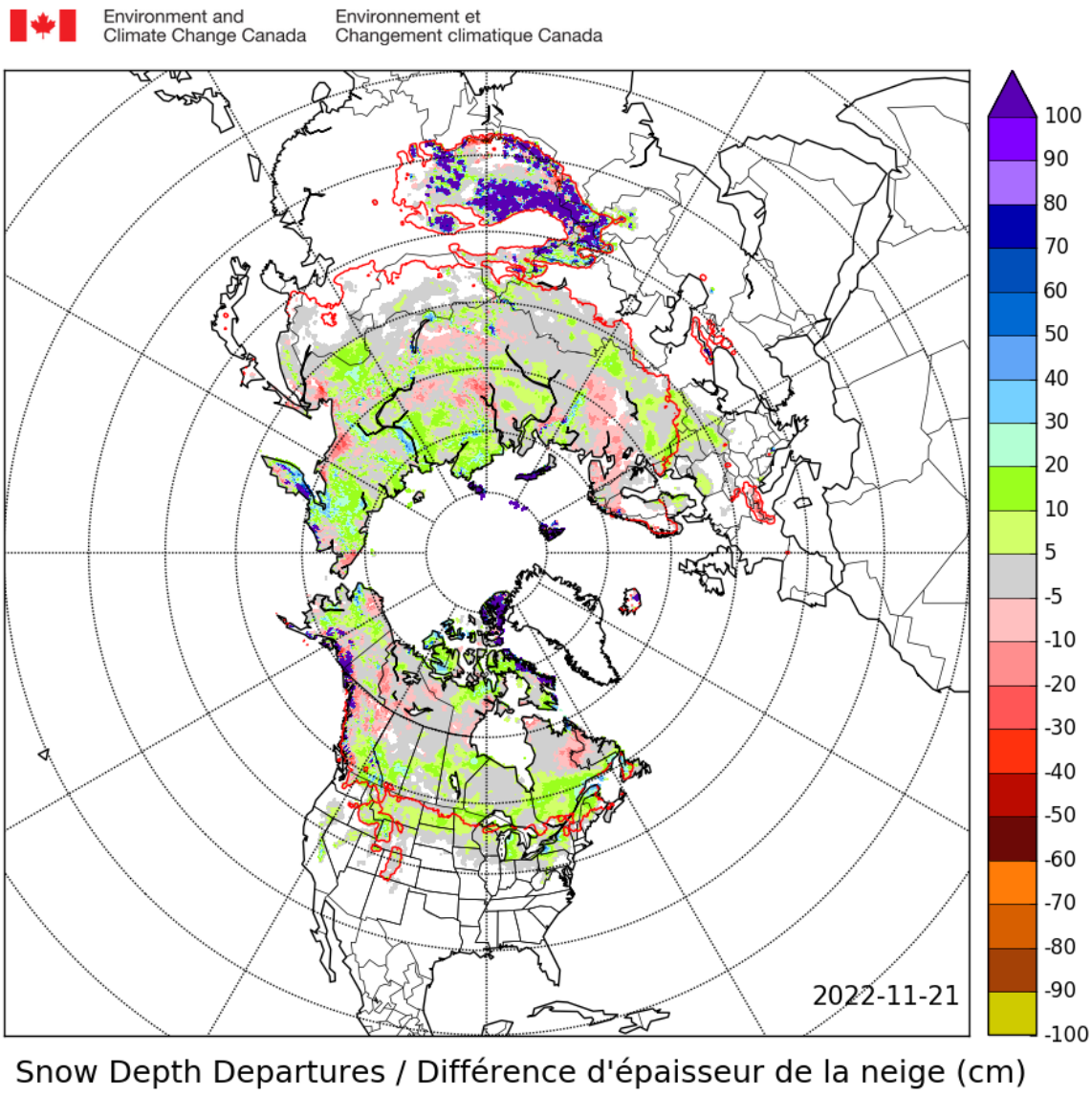

Figure iv. Snow depth anomalies for the Northern Hemisphere from Canadian Cryosphere Watch https://www.ccin.ca/index.php/ccw/snow/current.

It reminds me of what I discussed last year, in my youth the atmospheric feature that I was desiring and hoping for most - was Greenland blocking. But with age and experience I am more interested in seeing Ural blocking especially in the early part of the winter. Blocking in and round the Urals is in my opinion the most important atmospheric feature to disrupt the PV from the relatively minor PV stretching (though tell the residents in Buffalo and Watertown NY, it is only a minor event) to the more major SSW. Greenland blocking is more of an impact player following an SSW. The

longer high latitude blocking can persist in and around the Urals, the higher the probability of a cold winter in East Asia and eastern North America. It is not necessarily favorable for a cold winter in Europe at least initially but if it can eventually result in Greenland blocking, then it could result in a cold winter for Europe as well.

Wednesday Update

Picking up from the end of the discussion on Monday some interesting developments with both predicted Ural and Greenland blocking high pressure. First the magnitude of the Ural blocking high pressure at the end of November and the beginning of December is very impressive (see **Figure v**). That should excite vertical wave energy from the troposphere into the troposphere and if that were to persist, I would be starting a sudden stratospheric warming (SSW) watch. However, both the GFS and ECMWF models are predicting that the high-pressure blocking will drift westwards towards Greenland with the ECMWF model being more aggressive in that forecast (see **Figure vi**). This has me wondering will the Ural blocking be of sufficient duration to force a mature SSW? I do think that the GFS forecast leaves behind more blocking over towards the Urals that could persist the energy driving necessary for an SSW, but the ECMWF forecast leaves me more uncertain. The model forecast that is more favorable for an eventual SSW and therefore longer-term cold across the NH is the GFS in my opinion.

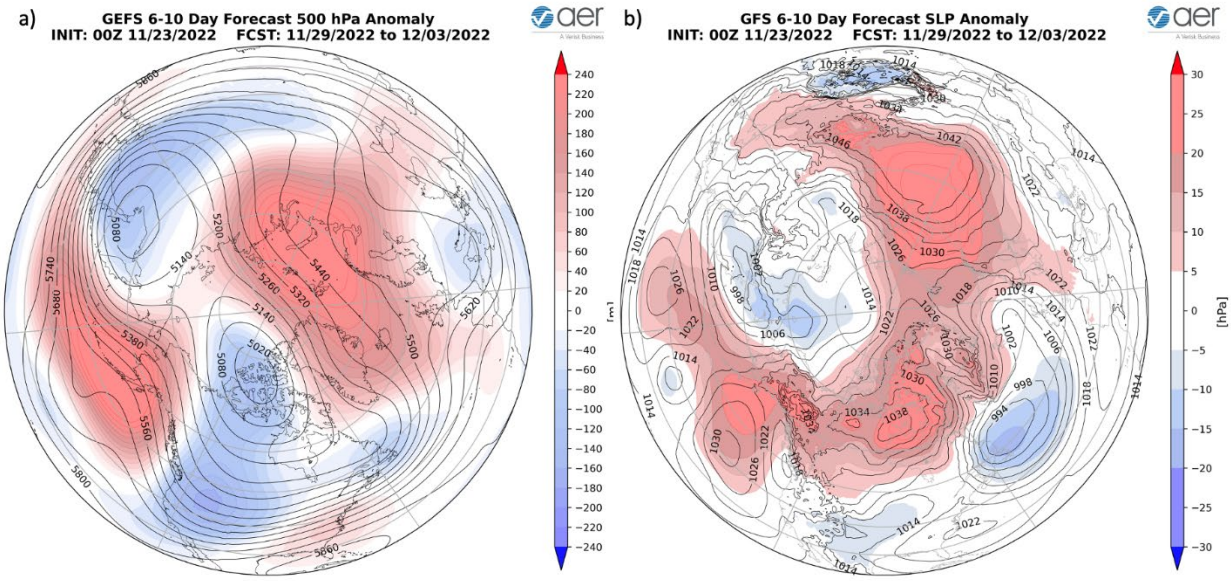

Figure v. Forecasted average (a) 500 mb geopotential heights (dam; contours) and geopotential height anomalies (m; shading) and (b) sea level pressure (hPa; contours) and anomalies (hPa; shading) across the Northern Hemisphere from 29 November – 3 December 2022. The forecasts are from the 00z 23 November 2022 GFS ensemble.

On the other hand, the atmospheric feature most closely related to severe winter weather in Europe is Greenland blocking. So, the ECWMF forecast is more favorable for increasing the risk of short-term severe winter weather especially for Europe and possibly the Eastern US as well. However longer term, if the ECMWF forecast verifies that could decrease the likelihood of severe winter weather longer term. I would also add that it is my impression that models struggle mightily accurately forecasting high latitude blocking beyond a few days; therefore it is really hard to know just yet which model will verify and maybe neither.

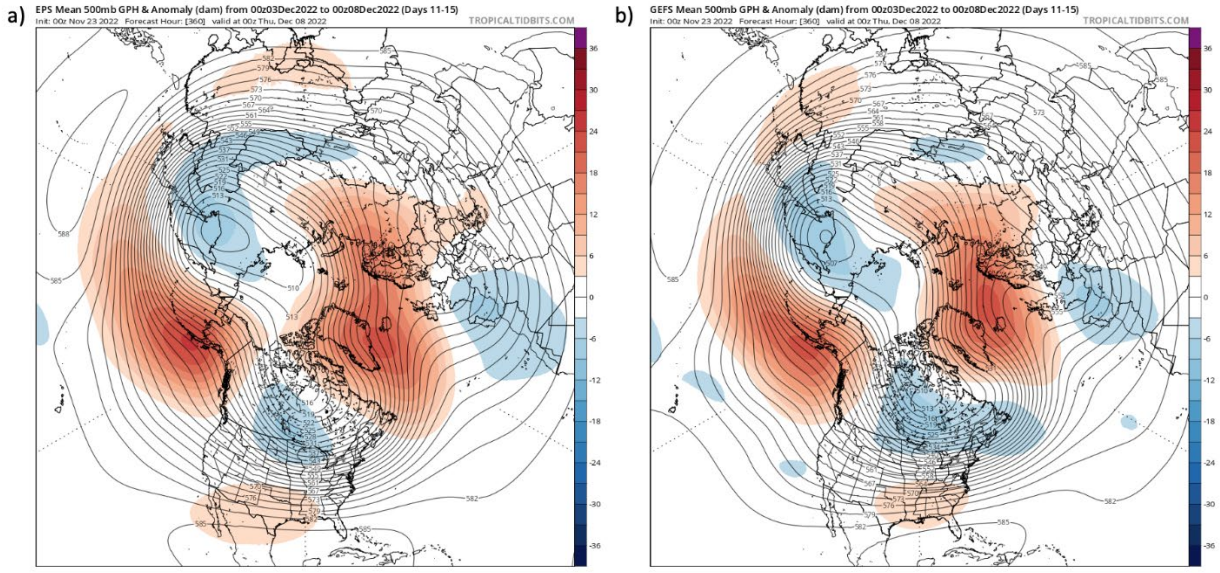

Figure vi. Forecasted average 500 mb geopotential heights (dam; contours) and geopotential height anomalies (dam; shading) across the Northern Hemisphere from 3 – 8 December 2022. The forecasts are from the 00z 23 November 2022 (a) EPS ensemble and (b) GEFS ensemble. Plots from https://www.tropicaltidbits.com/analysis/models/.

I have to say the risk for severe winter weather across the NH for December is much more elevated than I would have anticipated even just a few weeks ago. Asia currently has the highest risk with sea level pressure being predicted to exceed 1060 HPa. There should be some deep cold across Siberia, some of which will likely drain into East Asia. It will be interesting to see if and when the cold hits in the East Asian coast, does it spin up a deep coastal cyclone that could further contribute to weakening the PV. I think the US is also at risk for severe winter weather especially the ECMWF forecast. Last is Western Europe and will likely depend on the development of Greenland blocking in early December but even that is a relatively new development.

I will just end by noting that December is most likely to be the winter month that differs from the other two winter months with January and February more likely to be more similar. So, an important caveat to keep in mind in the coming weeks.

Recent and Very Near Term Conditions

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

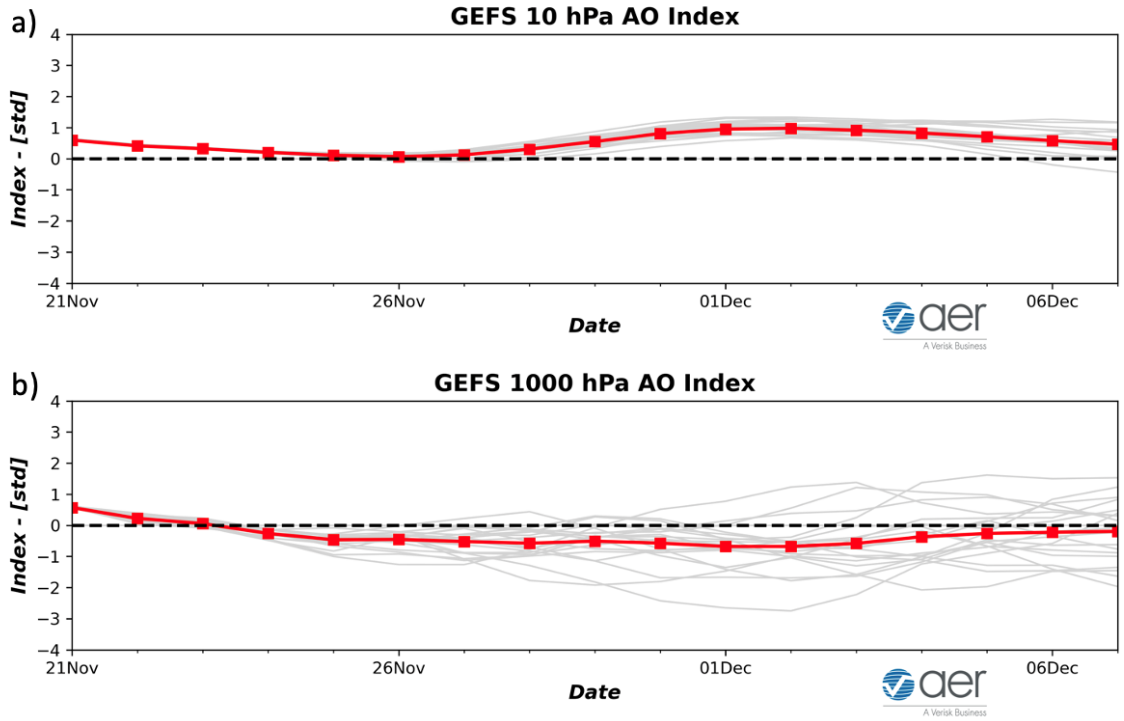

Figure 1. (a) The predicted daily-mean AO at 1000 hPa from the 00Z 21 November 2022 GFS ensemble. (b)The predicted daily-mean near-surface AO from the 00Z 21 November 2022 GFS ensemble. Gray lines indicate the AO index from each individual ensemble member, with the ensemble-mean AO index given by the red line with squares.

Predicted troughing/negative geopotential height anomalies in the eastern North Atlantic will force ridging/positive geopotential height anomalies centered across Northern Scandinavia and the Barents-Kara Seas (**Figure 2).** This will favor normal to above normal temperatures across much of Europe including the Southern UK (**Figure 3**). However, the ridging will be far enough north this period to allow some of the troughing and colder temperatures to undercut the ridge across Northern Europe including the Northern UK (**Figure 3**). Ridging/positive geopotential height anomalies across Northern Scandinavia and the Barents-Kara Seas are predicted to force downstream troughing/negative geopotential height anomalies across Siberia that extend southwestward into Central Asia with ridging/positive geopotential height

anomalies in South and East Asia (**Figure 2**). This pattern favors normal to below normal temperatures across Siberia and Central Asia with normal to above normal temperatures across Southern and Eastern Asia **(Figure 3**).

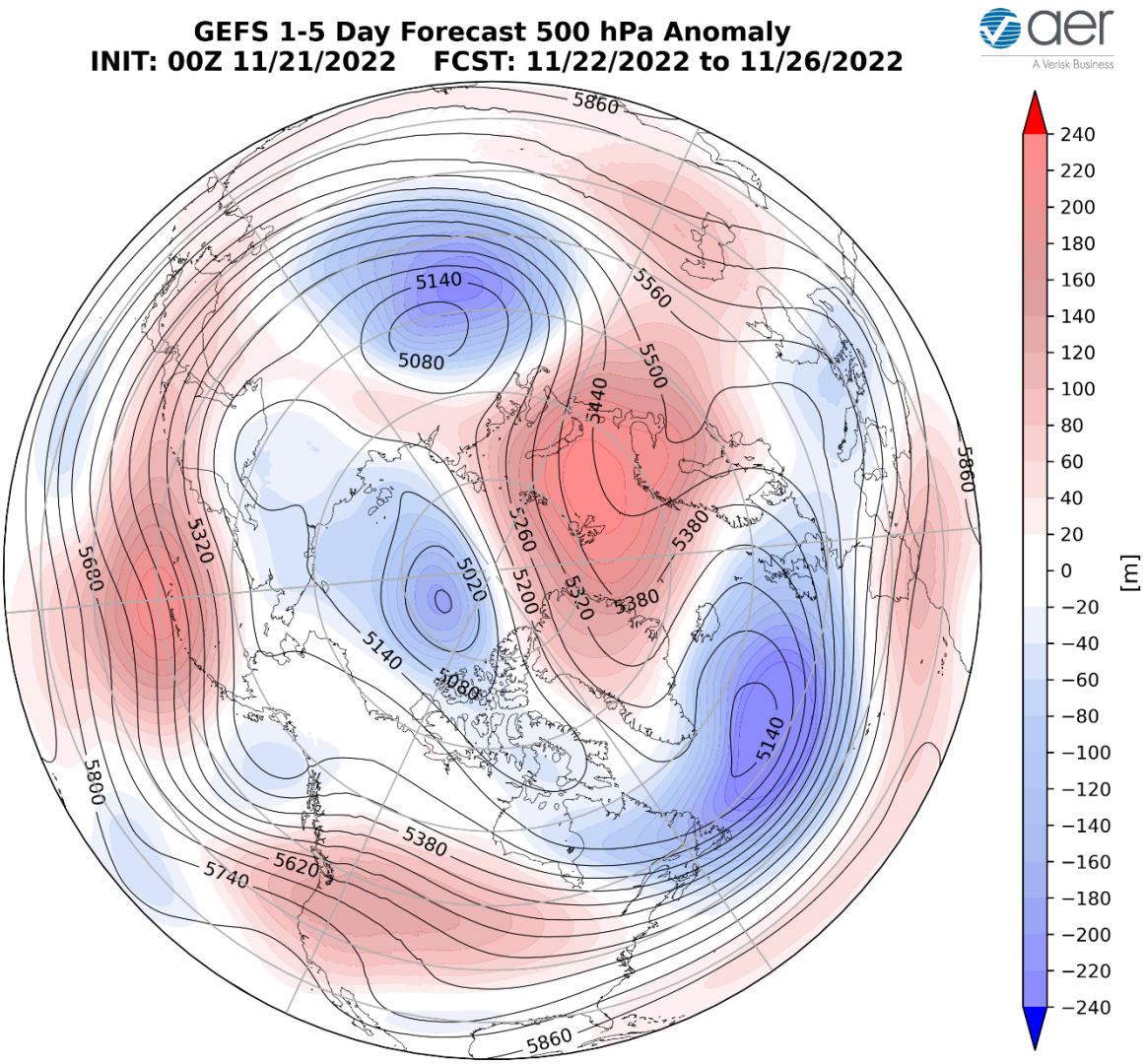

Figure 2. Forecasted average 500 mb geopotential heights (dam; contours) and geopotential height anomalies (m; shading) across the Northern Hemisphere from 22 – 26 November 2022. The forecasts are from the 00z 21 November 2022 GFS ensemble.

Ridging/positive geopotential height anomalies are predicted for Western Canada and the Western US with troughing/negative geopotential height anomalies in Eastern Canada and the Eastern US **(Figure 2).** The pattern will favor normal to above normal temperatures across Alaska, Western Canada and the Western US with normal to below normal temperatures across Eastern Canada and the Eastern US **(Figure 3).**

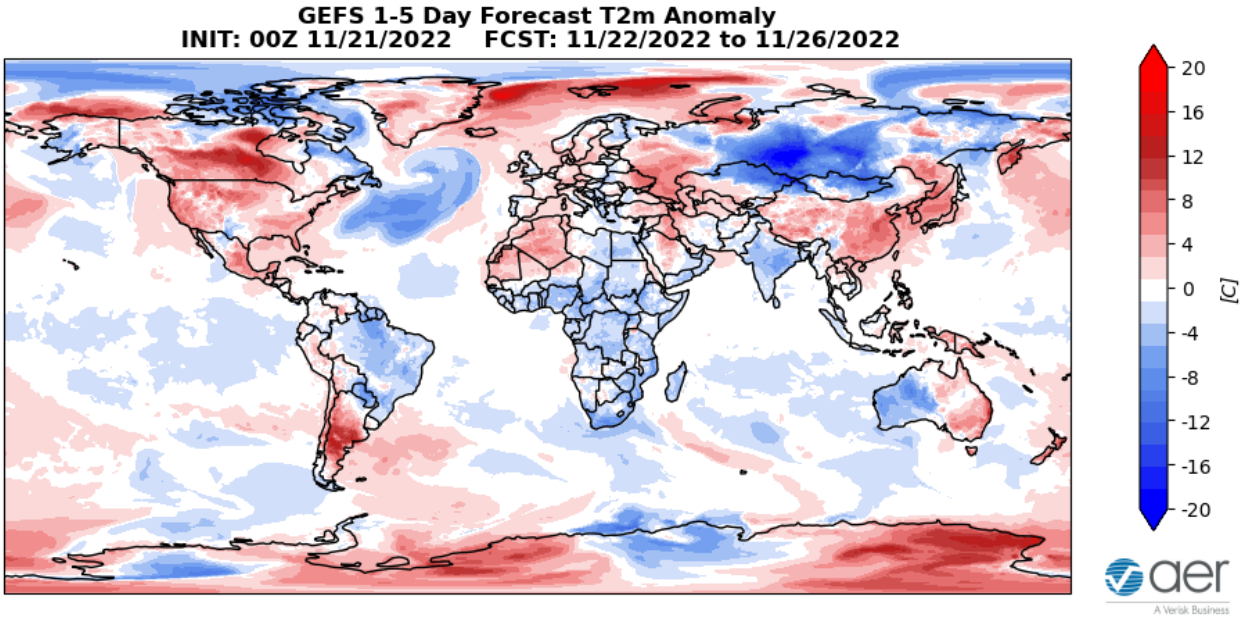

Figure 3. Forecasted surface temperature anomalies (°C; shading) from 22 – 26 November 2022. The forecast is from the 00Z 21 November 2022 GFS ensemble.

Troughing and/or cold temperatures will support new snowfall across Scotland, Norway, the Alps, southern Siberia and Central Asia while mild temperatures will support snowmelt in Eastern Europe (**Figure 4**). Troughing and/or cold temperatures will support new snowfall across Alaska, Northern, Western and Eastern Canada while mild temperatures will support snowmelt across the Northern US (**Figure 4**).

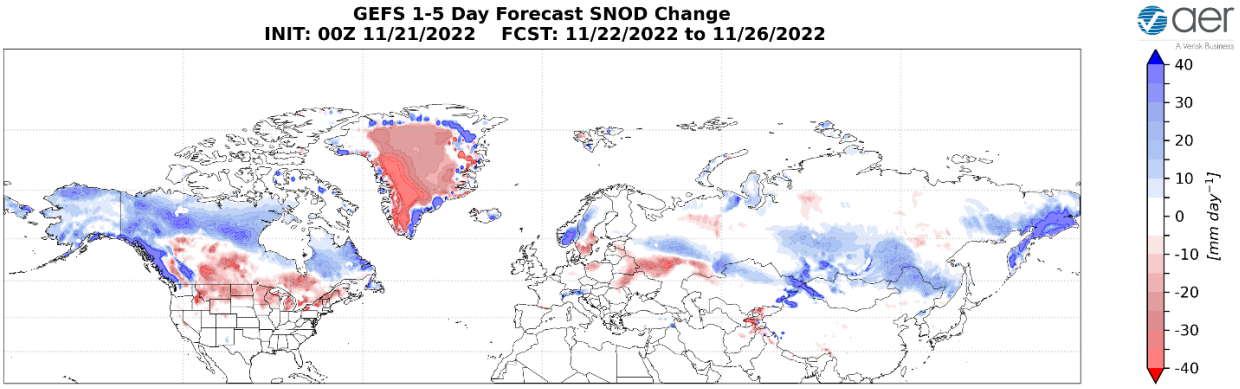

Figure 4. Forecasted snow depth changes (mm/day; shading) from 22 – 26 November 2021. The forecast is from the 00Z 21 November 2021 GFS ensemble.

Near-Term

1-2 week

The AO is predicted to remain slightly negative this period **(Figure 1**) as geopotential height anomalies remain mostly positive across the North Atlantic sector of the Arctic and mixed across the mid-latitudes (**Figure 5**). With mostly positive geopotential height anomalies across Greenland (**Figure 5**), the NAO is predicted to remain slightly negative this period as well.

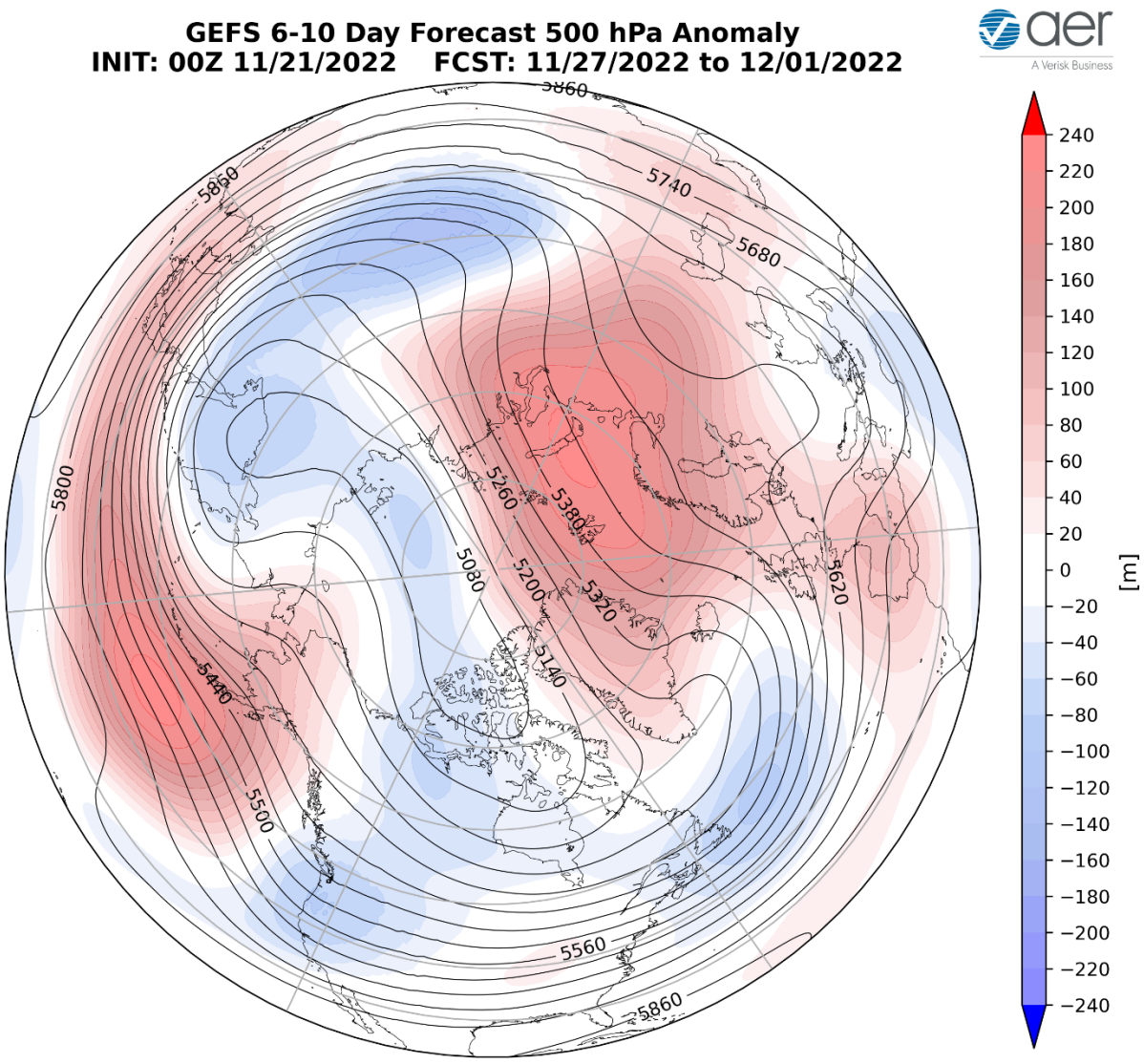

Figure 5. Forecasted average 500 mb geopotential heights (dam; contours) and geopotential height anomalies (m; shading) across the Northern Hemisphere from 27 November – 1 December 2022. The forecasts are from the 00z 21 November 2022 GFS ensemble.

Predicted persistent troughing/negative geopotential height anomalies in the eastern North Atlantic will continue to support ridging/positive geopotential height anomalies persisting across Europe centered near Scandinavia and the Barents-Kara Seas with the

exception of troughing/negative geopotential height anomalies in Southeastern Europe (**Figures 5).** The pattern is predicted to result in widespread normal to above normal temperatures across Europe including the UK with normal to below normal temperatures limited to Southeastern Europe (**Figure 6**). Persistent Northern European ridging/positive geopotential height anomalies are predicted to anchor downstream troughing/negative geopotential height anomalies across Siberia that now extends eastward into Northeast Asia with ridging/positive geopotential height anomalies in Western and Southern Asia this period (**Figure 5**). 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 6**).

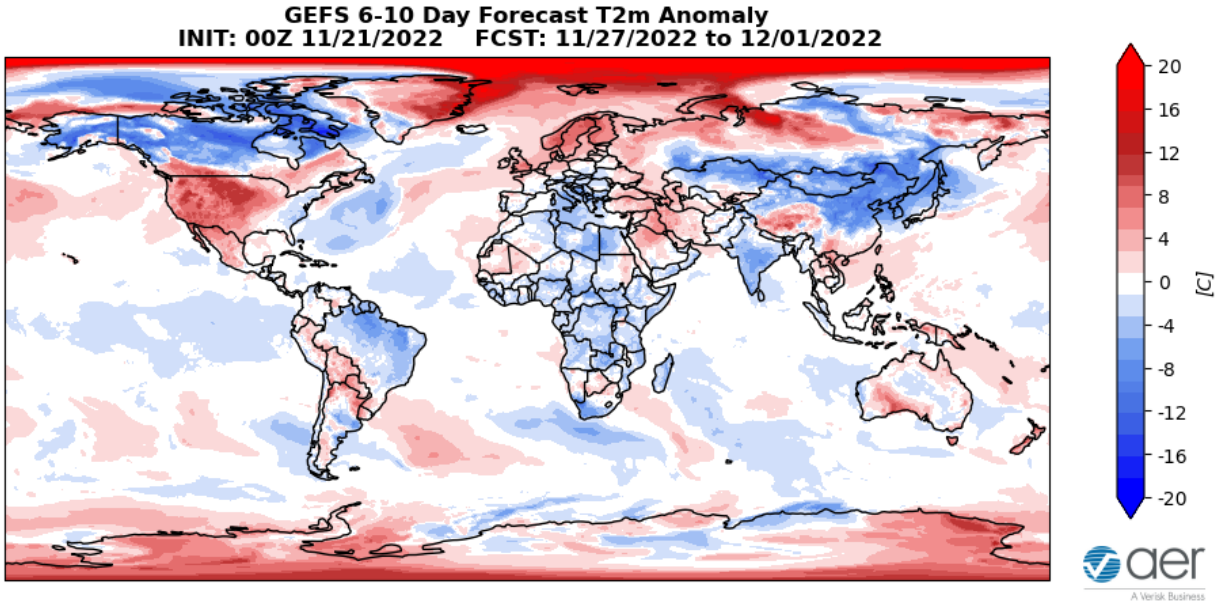

Figure 6. Forecasted surface temperature anomalies (°C; shading) from 27 November – 1 December 2022. The forecast is from the 00Z 21 November 2022 GFS ensemble.

Predicted ridging/positive geopotential height anomalies slowly sliding east across the Aleutians will force troughing/negative geopotential height anomalies across western North America with weak ridging/positive geopotential height anomalies developing across the Eastern US this period **(Figure 5).** This pattern will favor normal to below normal temperatures across Alaska, Western and Central Canada and the Western US with normal to above normal temperatures across Eastern Canada and the Eastern US **(Figure 6).**

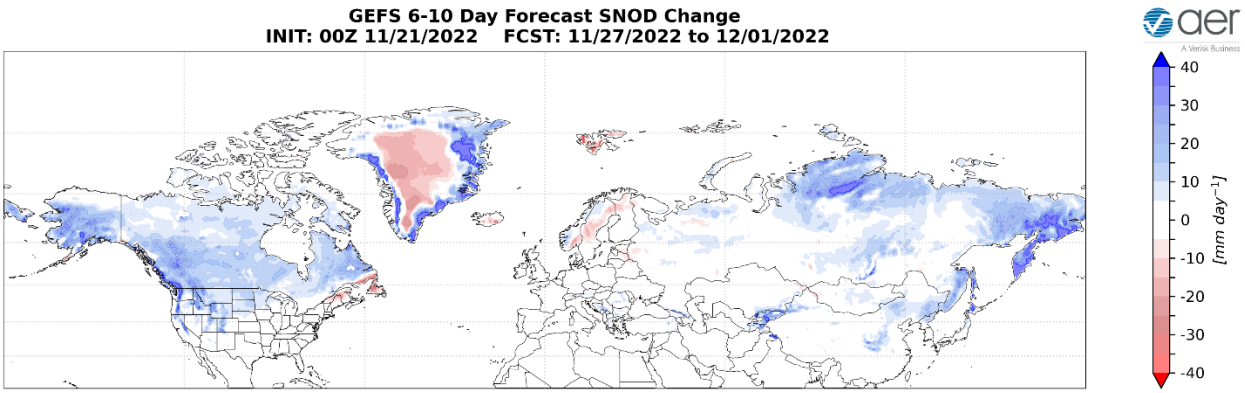

Figure 7. Forecasted snow depth changes (mm/day; shading) from 27 November – 1 December 2022. The forecast is from the 00Z 21 November 2022 GFS ensemble.

Troughing and/or cold temperatures will support new snowfall across Northern and Eastern Asia while mild temperatures will support snowmelt in Scandinavia (**Figure 7**). Troughing and/or cold temperatures will support new snowfall across Alaska, Canada and the Western US while mild temperatures will support snowmelt in New England and Southeastern Canada (**Figure 7**).

3-4 week

Positive geopotential height anomalies are predicted to dominate the North Atlantic sector of the Arctic with mixed across the mid-latitudes this period (**Figure 8**), therefore the AO should remain negative this period (**Figure 1**). With positive pressure/geopotential height anomalies across Greenland (**Figure 8**), the NAO could also remain negative this period.

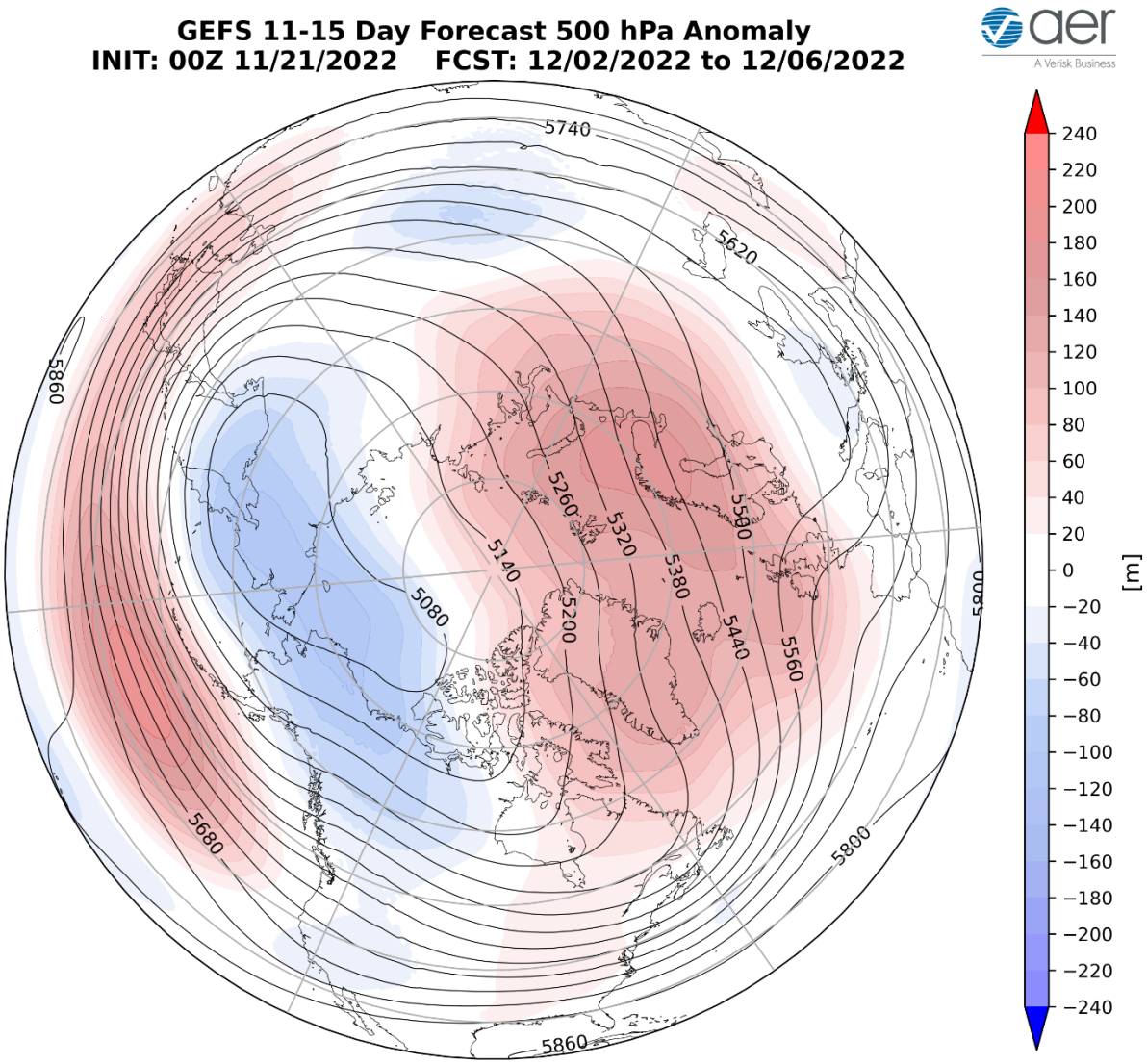

Figure 8. Forecasted average 500 mb geopotential heights (dam; contours) and geopotential height anomalies (m; shading) across the Northern Hemisphere from 2 – 6 December 2022. The forecasts are from the 00z 21 November 2022 GFS ensemble.

Ridging/positive geopotential height anomalies are predicted to extend from Greenland to the Barents Kara Seas and include Northern Europe favoring troughing/negative geopotential height anomalies across Southern Europe this period (**Figure 8**). This pattern favors normal to above normal temperatures across Northern Europe including the UK with normal to below normal temperatures across Southern Europe (**Figures 9**). Persistent ridging/positive geopotential height anomalies centered near Scandinavia and the Barents-Kara Seas to help anchor troughing/negative geopotential height anomalies across Siberia and East Asia with ridging/positive geopotential height anomalies persisting in Western and Southern Asia (**Figure 8**). This pattern favors widespread normal to below normal temperatures across much of Northern and

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

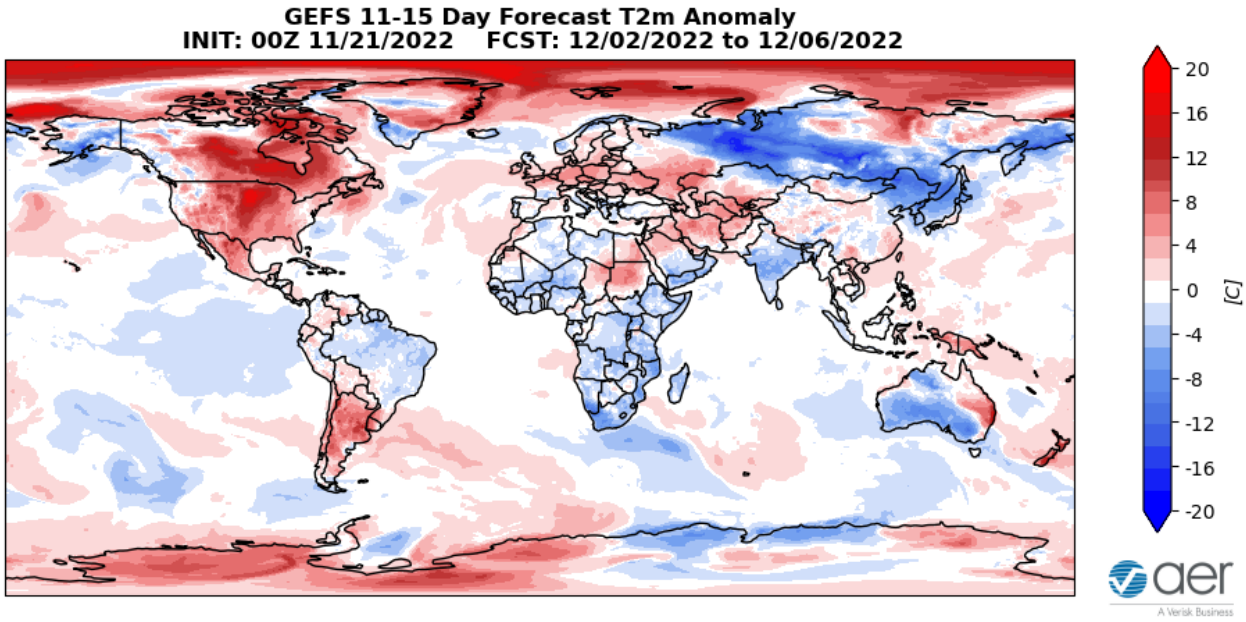

Figure 9. Forecasted surface temperature anomalies (°C; shading) from 2 – 6 December 2022. The forecast is from the 00Z 21 November 2022 GFS ensemble.

The GFS is predicting that persistent ridging/positive geopotential height anomalies previously near the Aleutians will force troughing/negative geopotential height anomalies to persist across Alaska, Western Canada and the Western US with ridging/positive geopotential height anomalies along the east coast of North America this period (**Figure 8**). This pattern favors widespread normal to below normal temperatures across Alaska, Western Canada, the Western US with normal to above normal temperatures across much of Eastern Canada and the Eastern US (**Figure 9**). However, the ECMWF model predicts that the ridging and the troughing will be further east more consistent with the tropospheric response following a stretched PV.

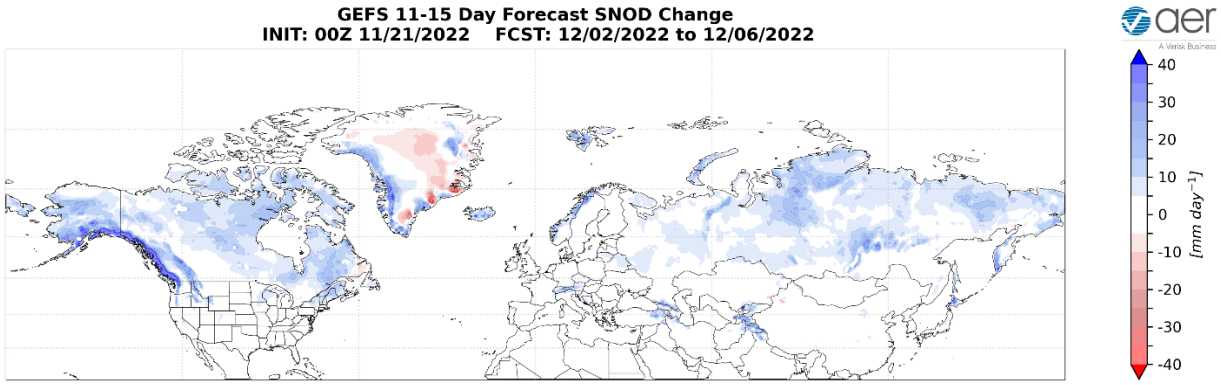

Figure 10. Forecasted snow depth changes (mm/day; shading) from 2 – 6 December 2022. The forecast is from the 00Z 21 November 2021 GFS ensemble.

Troughing and/or cold temperatures will support new snowfall across Scotland, Norway, Northern and Eastern Asia and the Tibetan Plateau (**Figure 10**). Troughing and/or cold temperatures will support new snowfall across Alaska, Canada, the higher elevations of the Western US and Northeastern US (**Figure 10**).

Longer Term

30–day

The latest plot of the polar cap geopotential height anomalies (PCHs) currently shows cold/negative PCHs in the upper to mid stratosphere with warm/positive PCHs in the lower stratosphere and normal in the troposphere (**Figure 11**). However, the cold/negative PCHs currently observed in the stratosphere are predicted to descend into the lower stratosphere in early December while PCHs turn warm/positive in the troposphere (**Figure 11**).

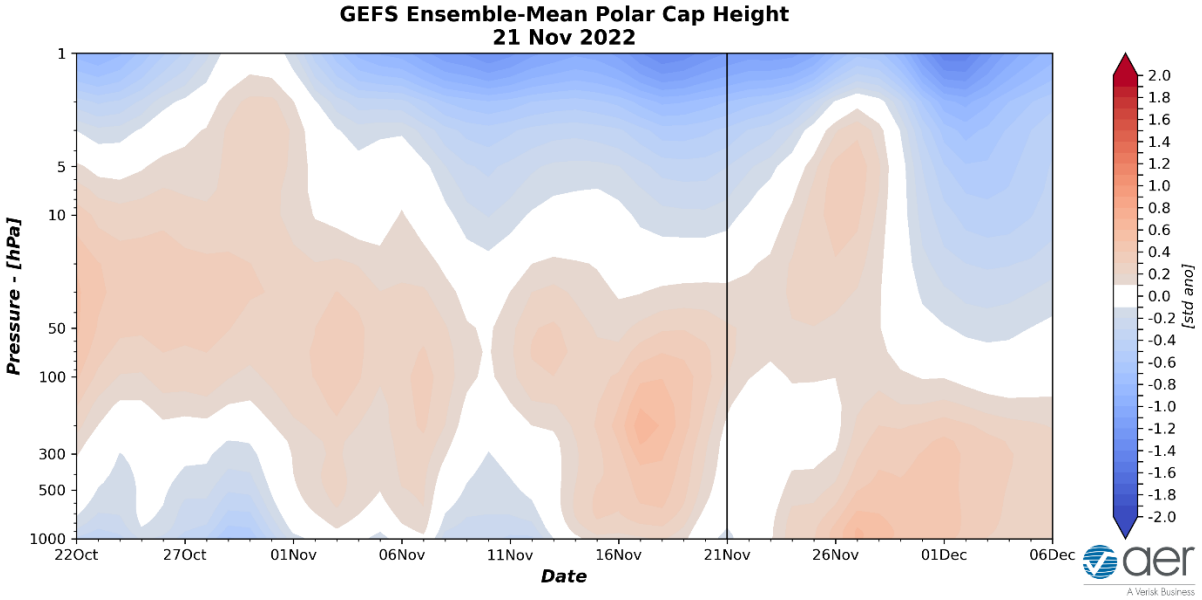

Figure 11. Observed and predicted daily polar cap height (i.e., area-averaged geopotential heights poleward of 60°N) standardized anomalies. The forecast is from the 00Z 21 November 2022 GFS ensemble.

The normal PCHs in the lower troposphere (**Figure 11**) are consistent with the predicted neutral to slightly negative surface AO predicted for this week (**Figure 1**). However later this week and next week when the warm/positive PCHs in the lower troposphere are predicted to strengthen (**Figure 11**), the surface AO is predicted to turn negative (**Figure**

1). The warm/positive tropospheric PCHs in mid-November followed by warm/positive stratospheric PCHs in late December and finally a return of warm/positive tropospheric PCHs in early December is consistent with a troposphere-stratosphere-troposphere coupling event that is condensed in time and shallow associated with PV stretching events rather than a sudden stratospheric warming.

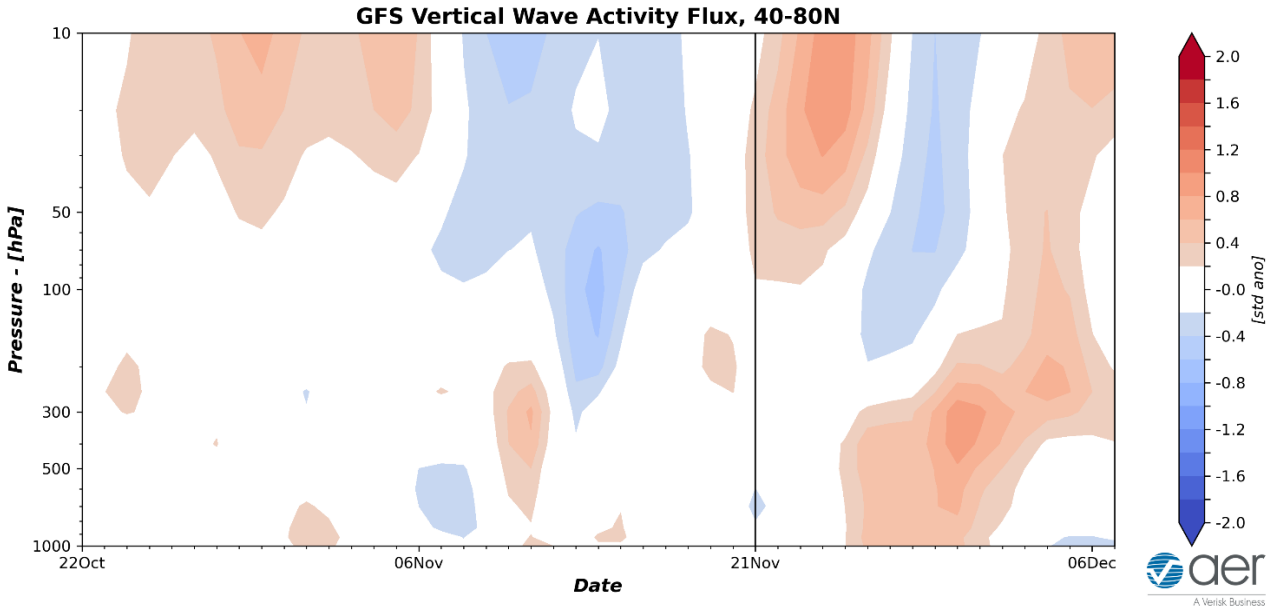

Figure 12. Observed and predicted daily vertical component of the wave activity flux (WAFz) standardized anomalies, averaged poleward of 40-80°N. The forecast is from the 00Z 21 November 2022 GFS ensemble.

The near normal vertical Wave Activity Flux (WAFz) from the troposphere to the stratosphere or poleward heat transport in the stratosphere the past two weeks has allowed the mid to upper stratospheric PCHs to cool (**Figure 12**). The GFS is predicting a brief more active period of WAFZ, resulting in stratospheric PCHs to warm before cooling again (**Figure 12**).

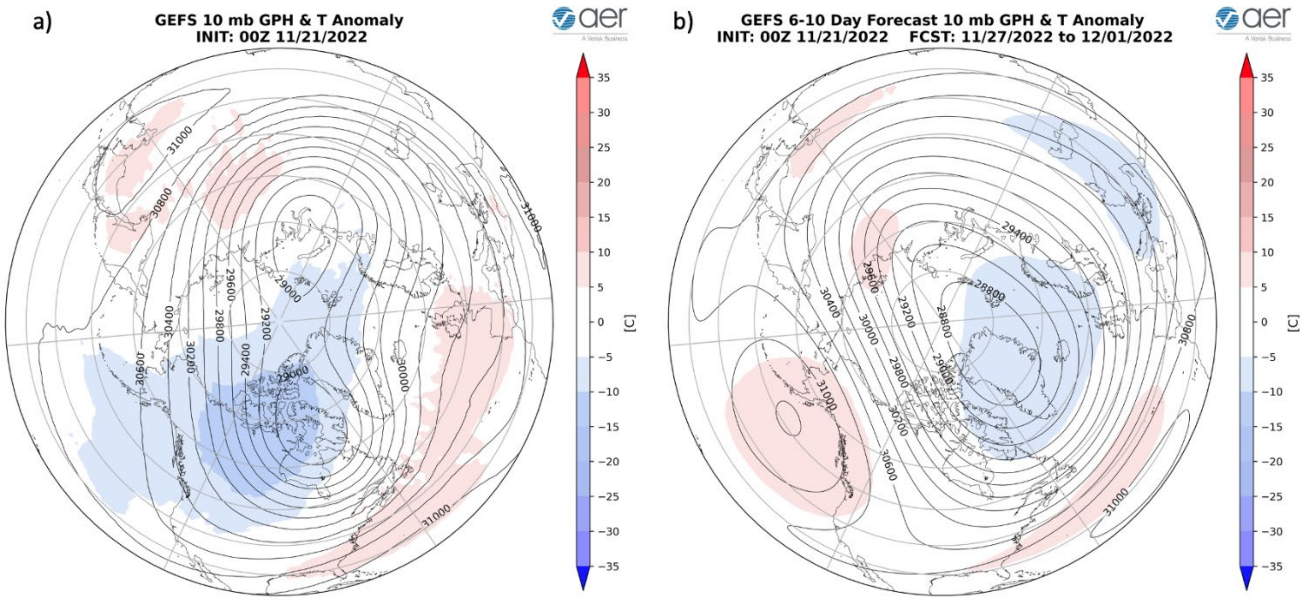

Figure 13. (a) Initialized 10 mb geopotential heights (dam; contours) and temperature anomalies (°C; shading) across the Northern Hemisphere for 21 November 2022. (b) Same as (a) except forecasted averaged from 27 November – 1 December 2022. The forecasts are from the 00Z 21 November 2020 GFS model ensemble.

Still the near normal WAFz has caused a minor perturbation of the stratospheric PV with two PV centers with one center near the Laptev Sea and a second PV center over Hudson Bay **(Figure 13**). Though this resembles a PV split of sorts, I think that it is better to think of it more as an extreme PV stretching event. Enough WAFz is predicted this week to maintain an elongated configuration of the PV (**Figure 13**) through the end of November extending from Siberia to Hudson Bay. The ECMWF model tropospheric forecast for early December is consistent with a stretched PV but the GFS forecast is not. However, the PV is predicted to be normal to stronger than normal over the next two weeks despite the elongated configuration (**Figure 13**). Therefore, the stratospheric AO is predicted to remain neutral to positive over the next two weeks **(Figure 1**).

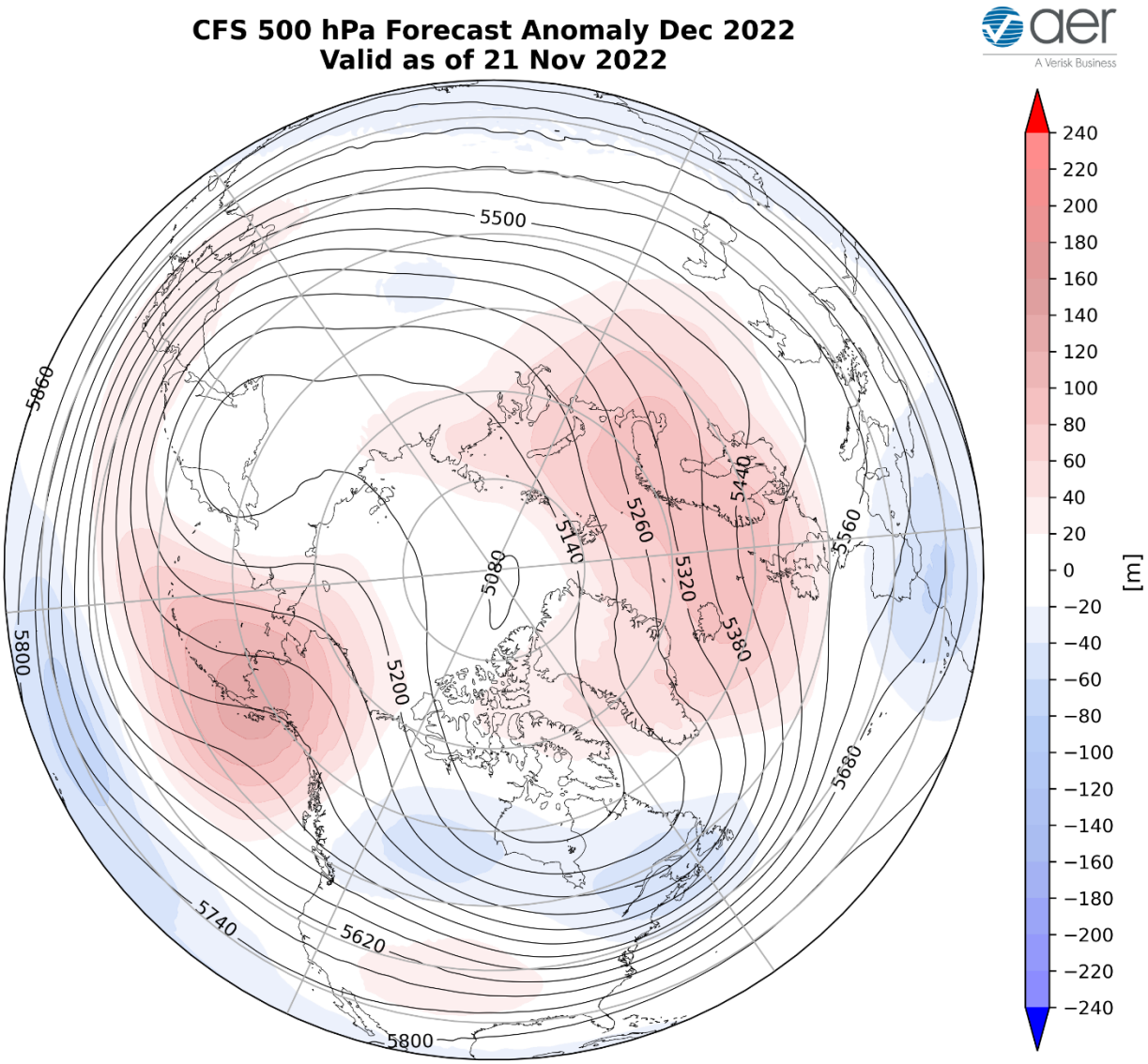

Figure 14. Forecasted average 500 mb geopotential heights (dam; contours) and geopotential height anomalies (m; shading) across the Northern Hemisphere for December 2022. The forecasts are from the 00Z 21 November 2022 CFS.

I include in this week's blog the monthly 500 hPa geopotential heights (**Figure 14**) and surface temperatures for December (**Figure 15**) from the Climate Forecast System (CFS; the plots represent yesterday's four ensemble members). The forecast for the troposphere is ridging stretching from Greenland to Iceland, across Scandinavia and into the Barents-Kara Seas, the Aleutians, Alaska, the Western US and Baffin Bay with troughing across the western Mediterranean, Siberia, East Asia, Central and Eastern Canada and the Northeastern US **(Figure 14**). This pattern favors seasonable to relatively warm temperatures across Northern Europe, Western Asia, Eastern Siberia, Southern Asia, Alaska, Northern Canada and the Western US with seasonable to

relatively cold temperatures across Southern Europe, Northern and Eastern Asia, Central and Southern Canada and the Eastern US (**Figure 15**).

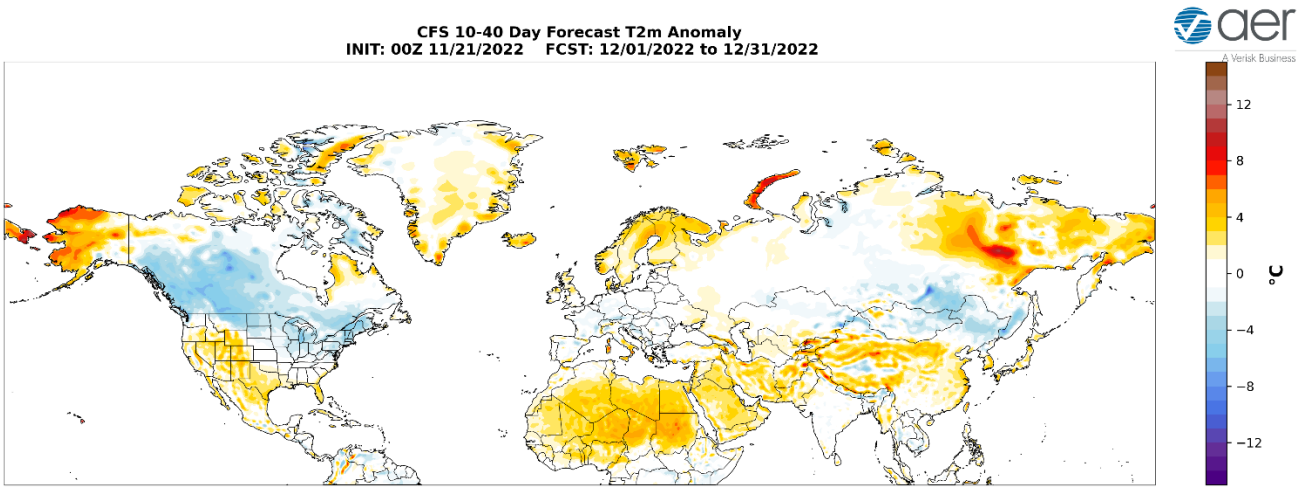

Figure 15. Forecasted average surface temperature anomalies (°C; shading) across the Northern Hemisphere for December 2022. The forecasts are from the 00Z 21 November 2022 CFS.

Boundary Forcings

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 16)** and La Niña conditions are expected through the fall. 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.

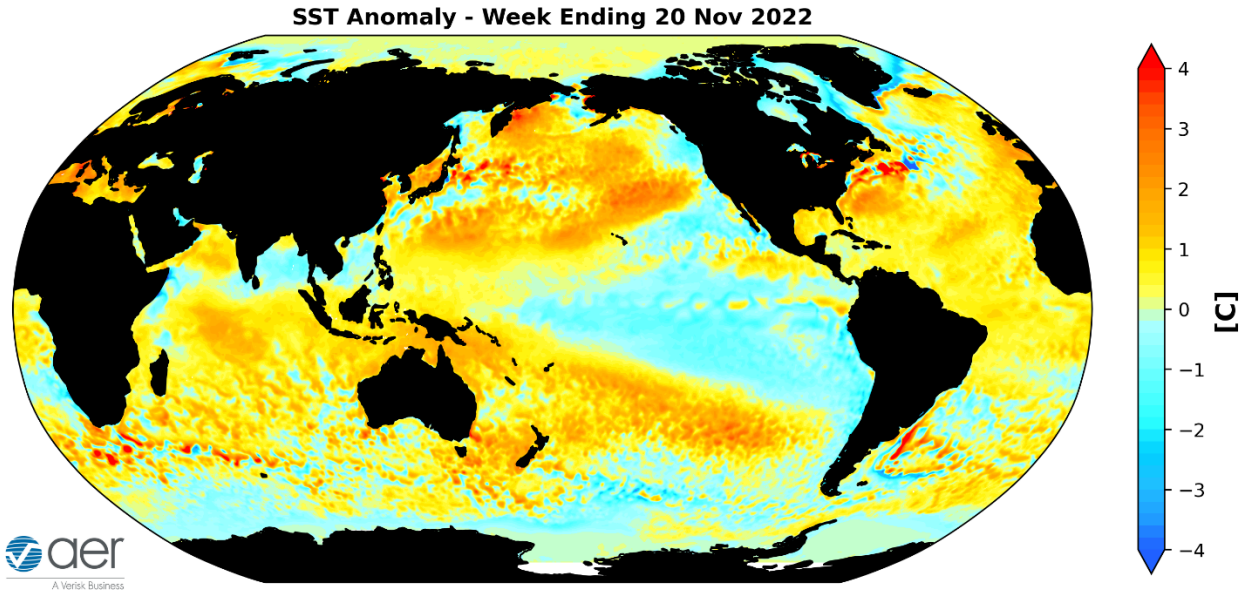

Figure 16. The latest weekly-mean global SST anomalies (ending 20 November 2022). Data from NOAA OI High-Resolution dataset.

Madden Julian Oscillation

Currently the Madden Julian Oscillation (MJO) is in phase six (**Figure 17**). The forecasts are for the MJO to quickly move into phase seven and then weaken to where no phase is favored. MJO phase six favors ridging in the Western US with troughing in the Eastern US while MJO phase seven favors a deep Aleutian low with ridging across Canada and troughing across the US. The MJO could be having an influence on the weather across

North America over the next two weeks. But admittedly this is outside of my expertise.

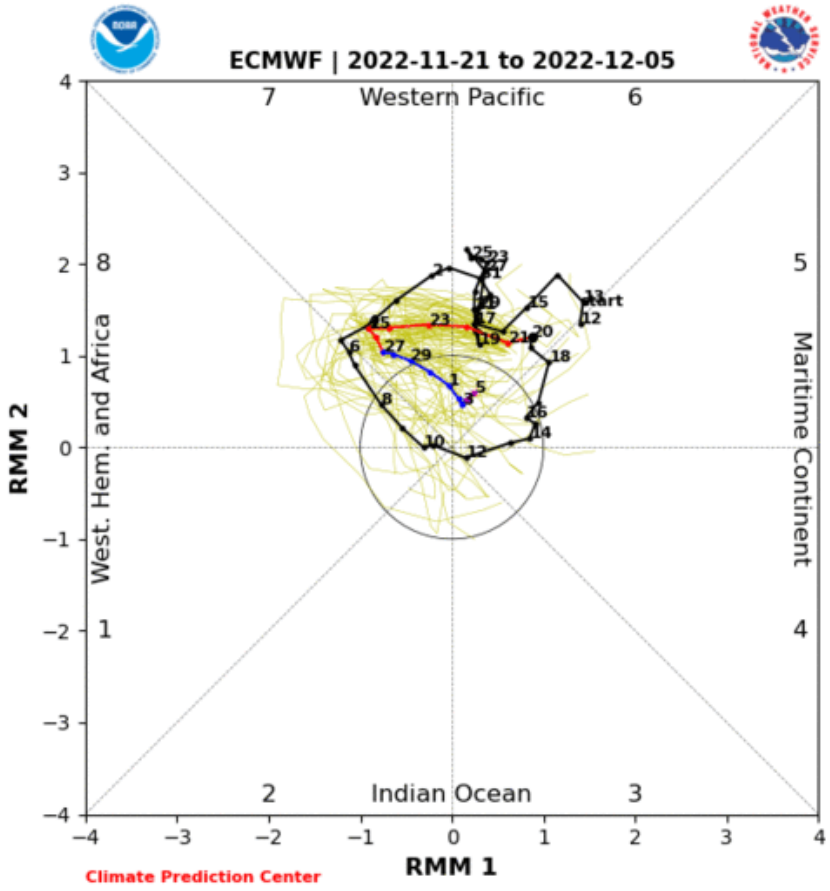

Figure 17. Past and forecast values of the MJO index. Forecast values from the 00Z 21 November 2022 ECMWF model. Yellow lines indicate individual ensemble-member forecasts, with the green line showing the ensemble-mean. A measure of the model "spread" is denoted by the gray shading. Sector numbers indicate 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

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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.

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

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