

# Arctic Oscillation and Polar Vortex Analysis and Forecasts

November 01, 2021

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 neutral and is predicted to straddle neutral over the next two weeks with mixed pressure/geopotential height anomalies across the Arctic and mixed pressure/geopotential height anomalies across the mid-latitudes. The North Atlantic Oscillation (NAO) is currently negative and is predicted to remain negative as pressure/geopotential height anomalies are predicted to remain mostly positive across Greenland the next two weeks.
- This week Europe will be dominated by ridging/positive geopotential height anomalies coupled with normal to above normal temperatures. However, beginning next week strengthening ridging/positive geopotential height anomalies across Greenland will promote troughing/negative geopotential height anomalies coupled with normal to below temperatures across Western Europe including the United Kingdom (UK) as ridging/positive geopotential height anomalies coupled with normal to above normal temperatures persist across Eastern Europe.
- Much of Asia will be dominated by ridging/positive geopotential height anomalies coupled with normal to above normal temperatures over the next two weeks. However, one exception is troughing/negative geopotential height anomalies coupled with normal to below temperatures that begins over northwest Asia this week that slides eastward into Central Asia and then East Asia and deepens. Deepening troughing in Central and extending into East Asia could have longer term implications for North American weather.
- The pattern across North America this week is troughing/negative geopotential height anomalies coupled with normal to below normal temperatures along the west coast of North

America including Alaska and the Eastern United States (US) with ridging/positive geopotential height anomalies coupled with normal to above temperatures in Eastern Canada. However, next week strengthening ridging/positive geopotential height anomalies coupled with normal to above temperatures in western North America will contribute to deepen troughing/negative geopotential height anomalies coupled with normal to below temperatures in the Eastern US.

- In the *Impacts* section I once again discuss Siberian snow cover extent and the possibility of a stretched stratospheric polar vortex (PV) second week of November and the implication for North American weather.

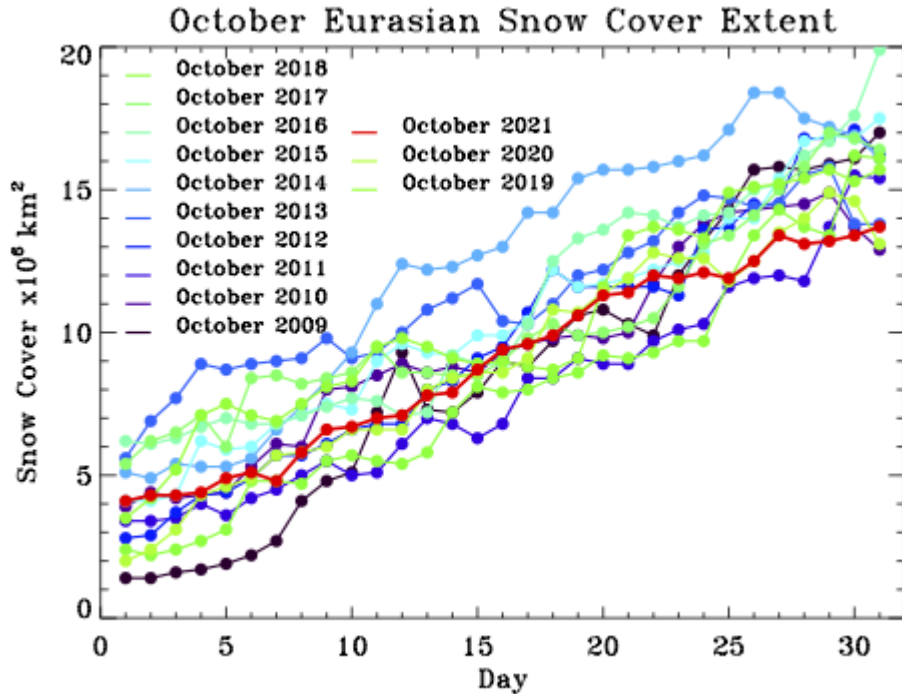
### ***Plain Language Summary***

I use October Eurasian snow cover extent (SCE) as one of our main predictors for winter temperature anomalies across the Northern Hemisphere (NH). Eurasian SCE is likely to be very close to normal for the month of October so not a strong indicator. But even a normal SCZE I would consider a warm bias to the forecast. I will continue to monitor the snow cover extent into November and December for further clues. In contrast, I do believe that Arctic sea ice is favorable for colder weather this winter.

I do believe that troposphere-stratosphere coupling that causes the polar vortex to stretch like a rubber band or taffy is underway. The important weather implications for this coupling is for colder weather first in East Asia and then North America east of the Rockies. However this event looks relatively minor and I don't expect its impacts to last longer than two weeks or beyond mid-November.

### ***Impacts***

With the first day of November, I can now present the complete daily Eurasian snow cover extent (SCE). in **Figure i**, I present my estimate of the observed daily snow cover extent for October 2021 compared with other Octobers dating back to 2009. The more extensive the snow cover the greater probability of an impactful PV disruption during winter and colder weather across the NH with a less extensive snow cover extent favoring a strong PV and milder weather across the NH.



**Figure i.** Observed Eurasian daily snow cover extent in km<sup>2</sup> throughout the month of October from 2009 through 2020. Also shown in red is the snow cover extent 1 – 31 October 2021.

Again as a reminder, the vast majority of those Octobers, the SCE was above normal, so the graph is a bit skewed, but SCE in October 2021 is in the lower end of the pack. Over the past week SCE advanced unusually slowly across Eurasia. The lowest year over the past decade was 2011. I think this October will come in higher than 2011 but probably not much higher. Of all the years on the plot, 2021 is the only October when Eurasian SCE failed to exceed 14 km<sup>2</sup> even for a day. It does seem to me that El Niño is more favorable for the rapid advance in Eurasian snow cover during October and La Niña favors a slower advance; 2021 seems to be consistent with this personal observation.

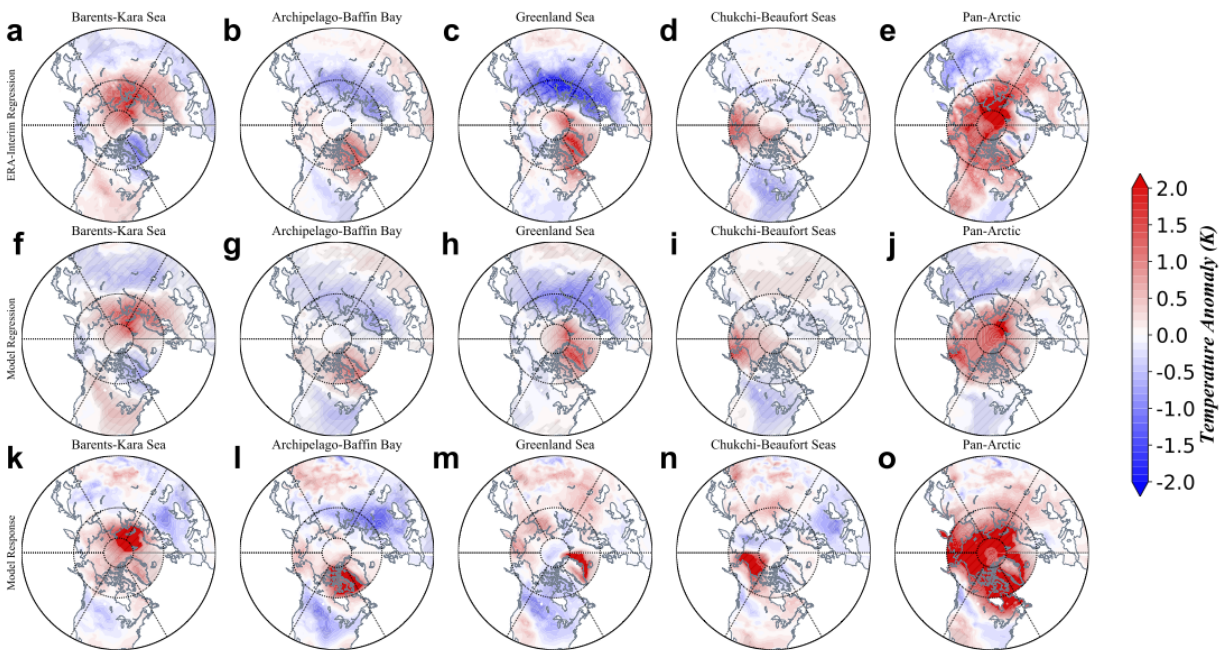
Just to reiterate what I mentioned last week, I will continue to pay attention to SCE even beyond October. It does look a more rapid advance of SCE will take place in the next week or so. Based on recent studies Eurasian SCE in other months besides October can have an impact on NH weather.

I have also computed the snow advance index (SAI; see [Cohen and Jones 2011](#)). It's value in 2021 is -1.4, which is suggestive of a strong PV and milder weather. Though in more recent years, I have thought of it as a better indicator to the timing of a possible PV disruption. A positive value suggests an earlier PV disruption and a negative value suggests a later PV disruption. Based on this thinking don't expect a major disruption of the PV any time soon.

Summarizing what may be surmised from Eurasian SCE and advance this past October – unfortunately not much. October Eurasian SCE will be close to normal so not much of a signal in either direction. Though relative to recent years it is on the very low end so if the SCE is leaning in one direction, I would have to say it is more indicative of a strong PV, a positive AO and milder winter weather across the NH including the Eastern US, Europe and East Asia.

But as I have borrowed the line before in the blog, “man can’t live on bread alone” and neither can the winter forecast. Often in the past it was to advocate using more than El Niño/Southern Oscillation (ENSO) in making winter forecasts but today it is to look beyond snow cover. I do think that Arctic sea ice anomalies so far this fall favor a weaker PV, a more negative AO and colder temperatures across Northern Asia, Europe and the Eastern US. I have been expecting negative sea ice anomalies to become focused in the Barents-Kara Seas, which is certainly the case as seen in **Figure 16**. Below normal sea ice extent in the Barents-Kara Seas are the sea ice anomalies considered the most favorable for disrupting the winter PV and a negative AO and colder temperatures mostly in Central Asia, based on the consensus of studies.

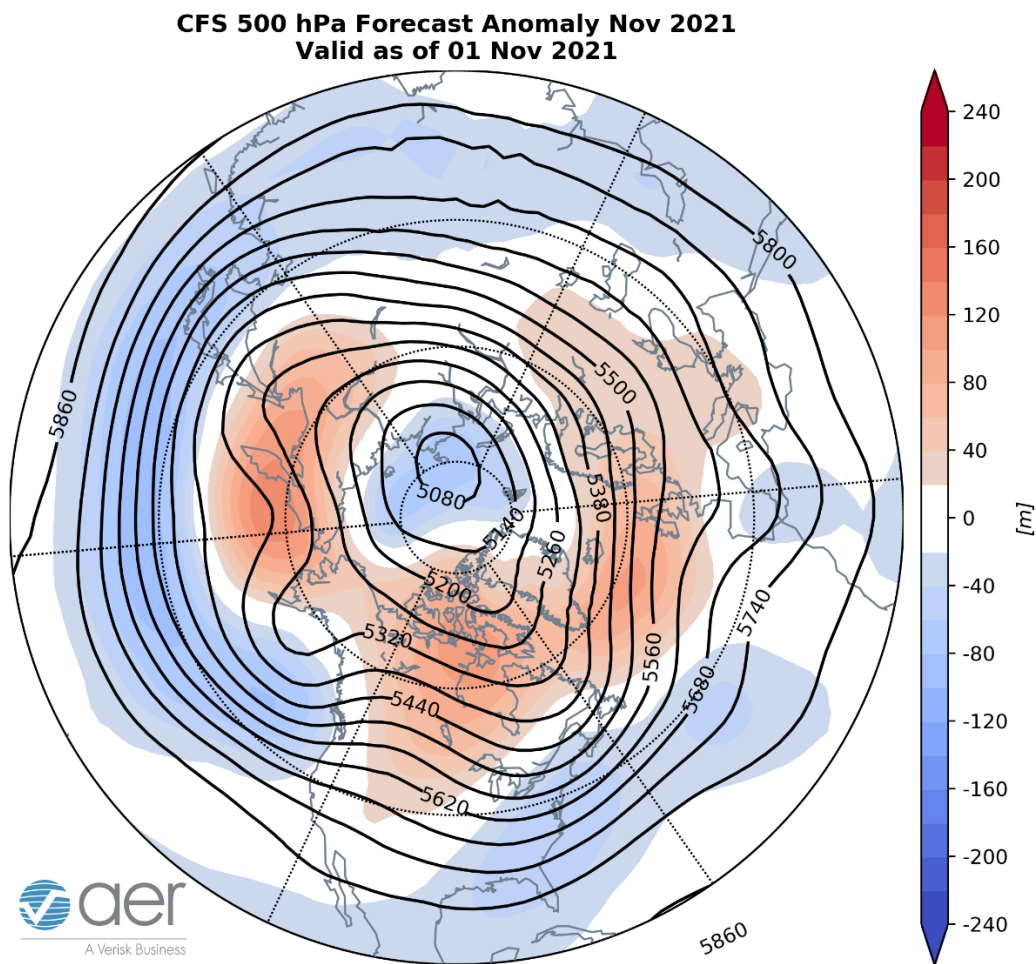
However, another region where large negative anomalies have emerged that I wasn’t expecting is Baffin Bay (**Figure 16**). Clearly what seems now as the permanent ridge/high pressure in Eastern Canada has delayed the fall freeze up in that region. **Figure ii** is from my recent review paper ([Cohen et al. 2020](#)) on Arctic mid-latitude linkages. It shows the inferred and simulated relationship between surface temperatures and sea ice extent anomalies in different regions of the Arctic. Negative sea ice anomalies in Baffin Bay are related to relatively cold temperatures in Northern Europe and the Eastern US. Sea ice anomalies in the Barents-Kara Seas and Baffin Bay have been shown to favor colder region in Asia and Northern Europe/Eastern US respectively.



**Figure ii.** Observed Northern Hemisphere near-surface air temperature anomalies for all days when 850 hPa temperature anomalies were between 0.5 and 3.0 standard deviations above the climatological average for all winters (December, January, February) 1950–2019 in **a)** Barents-Kara Sea, **b)** Canadian Archipelago-Baffin Bay, **c)** Greenland Sea, **d)** Chukchi-Beaufort Seas, and **e)** Pan-Arctic regressed onto NH surface temperatures. Anomalies are calculated relative to climatological averages from 1981 to 2010. **f)-j)** same as for **a)-e)** but for atmospheric output from the ensemble-mean HadGEM2 GCM. October-to-March mean near-surface air temperature responses in HadGEM2 model simulations from [Screen \(2017\)](#) to observed sea-ice loss in the **k)** Barents-Kara Sea, **l)** Canadian Archipelago-Baffin

Bay, **m**) Greenland Sea, **n**) Chukchi-Beaufort Seas, and **o**) Pan-Arctic. Hashing denotes statistically significant response at the 95% confidence level using the Student's t-test.

But regardless of Arctic boundary conditions, there is little chance of a weak PV and widespread cold temperatures without high latitude blocking and amplified large atmospheric waves. Not all negative AOs are created equal and though the GFS forecast is for a negative AO this week and then again in mid-November, it is negative in name only. In **Figure iii**, I present the latest CFS forecast for the 500hPa geopotential height anomaly for November. It reminds me of an annulus with low heights or a donut hole over the Central Arctic with higher heights encircling it across the entire NH centered near 60°N. This looks neither like a cold pattern to me or a pattern conducive to disrupting the PV. We are running our experimental polar vortex model and though it shows some weakening of the PV in early November, it predicts no meaningful weakening of the PV for the entire second half of November.



**Figure iii.** Forecasted average 500 mb geopotential heights (dam; contours) and geopotential height anomalies (m; shading) across the Northern Hemisphere for November 2021. The forecasts are from the 00Z 1 November 2021 CFS.

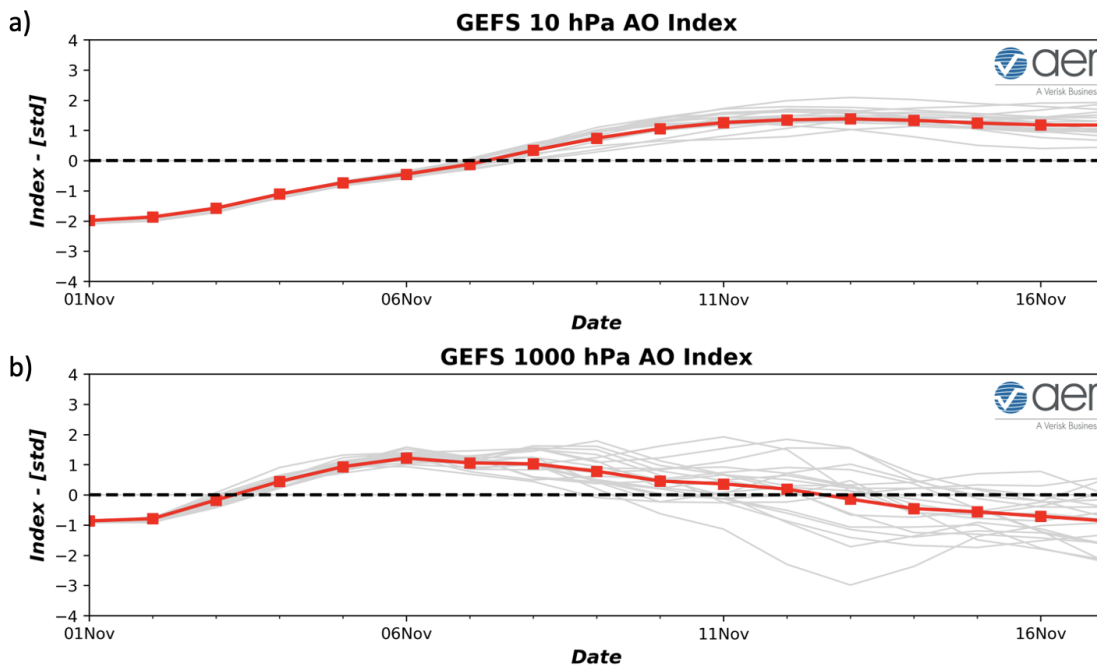
I of course focus on the Arctic but looking at tropical sea surface temperatures (SSTs), a La Niña is looking more and more likely this winter. There is no reason for me to argue with the consensus, La Niña favors colder temperatures across northwestern North America and milder temperatures across

southeastern North America including much of the Eastern US. In addition, the core of the warmest SSTs in the North Pacific has migrated away from the west coast of North America towards the Dateline, and this too could favor troughing and colder temperatures in western North America with milder temperatures in the Eastern US. This is far from settled, however.

I typically don't post the AER winter temperature forecast to the blog until the very last few days of November. But, if possible, I will post to the blog next week a preliminary forecast based on predictor values from late October.

*1-5 day*

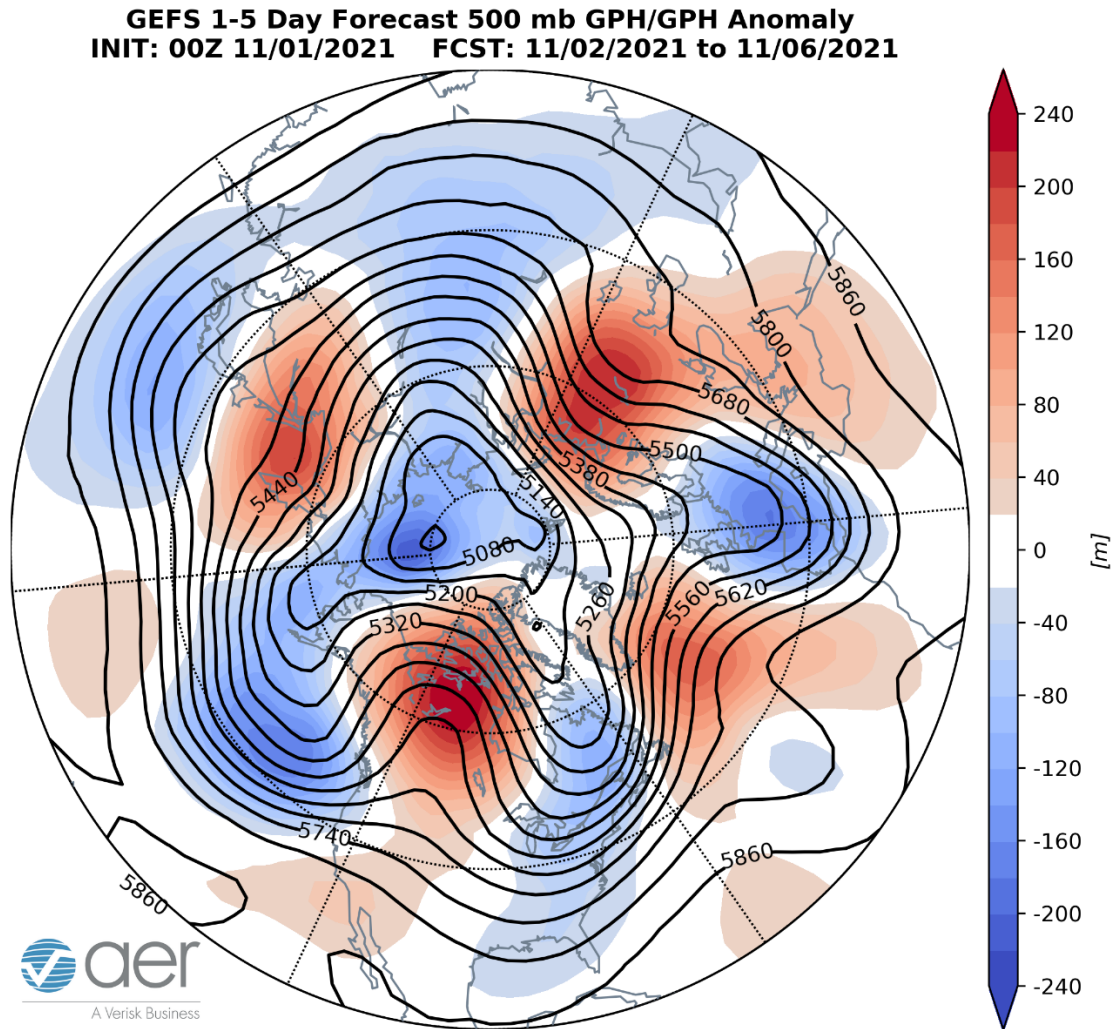
The AO is predicted to be mostly negative this week (**Figure 1**) as geopotential height anomalies are predicted to be mostly negative across the Arctic but positive across Greenland with mixed geopotential height anomalies across the mid-latitudes of the NH (**Figure 2**). And with mostly positive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



**Figure 1. (a)** The predicted daily-mean AO at 1000 hPa from the 00Z 1 November 2021 GFS ensemble. **(b)**The predicted daily-mean near-surface AO from the 00Z 1 November 2021 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 geopotential height anomalies across Greenland will force the return of troughing/negative geopotential height anomalies across Western Europe including the UK with downstream ridging/positive geopotential height anomalies across Eastern Europe this period (**Figures 2**). This will result in normal to above normal temperatures across Western Europe including the UK with normal to below normal temperatures across Eastern Europe (**Figure 3**). The general pattern across Asia this period is ridging/positive geopotential height anomalies centered over Western and Eastern Asia with troughing/negative geopotential height anomalies in Central Asia and Eastern Siberia

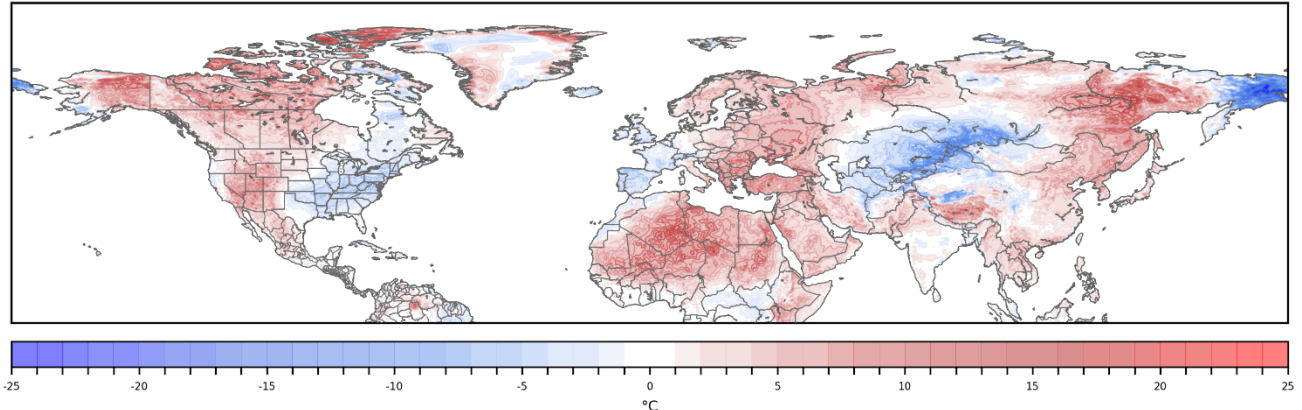
(Figure 2). This pattern favors normal to above normal temperatures in West and East Asia with normal to below normal temperatures in Central Asia and Eastern Siberia (Figure 3).



**Figure 2.** Forecasted average 500 mb geopotential heights (dam; contours) and geopotential height anomalies (m; shading) across the Northern Hemisphere from 2 – 6 November 2021. The forecasts are from the 00z 1 November 2021 GFS ensemble.

The general pattern this week across North America is troughing/negative geopotential height anomalies eastern North America with ridging/positive geopotential height anomalies across western North America (Figure 2). This pattern is predicted to bring normal to below normal temperatures in Eastern Canada and the Eastern US with normal to above normal temperatures across much of Alaska, Western Canada and the Western US (Figure 3).

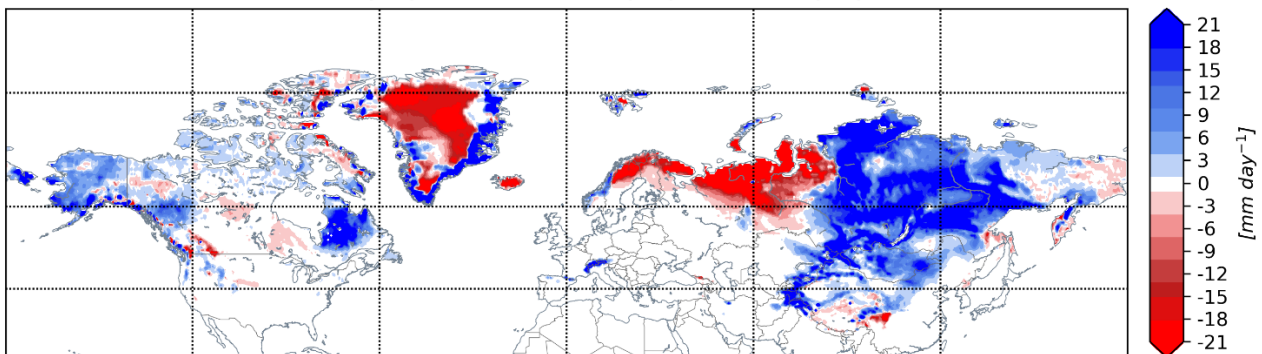
**GFS 1-5 Day Forecast T2m Anomaly**  
**INIT: 00Z 11/01/2021 FCST: 11/02/2021 to 11/06/2021**



**Figure 3.** Forecasted surface temperature anomalies ( $^{\circ}\text{C}$ ; shading) from 2 – 6 November 2021. The forecast is from the 00Z 1 November 2021 GFS ensemble.

Trouging and/or cold temperatures are predicted to support new snowfall across the Alps, Siberia and Central Asia while mild temperatures promote snowmelt in Scandinavia and Northwest Asia (**Figure 4**). Trouging and/or cold temperatures are predicted to support new snowfall across Alaska, Quebec and far Northern and Western Canada (**Figure 4**).

**GEFS 1-5 Day Forecast SNOD Change**  
**INIT: 00Z 11/01/2021 FCST: 11/02/2021 to 11/06/2021**



**Figure 4.** Forecasted snow depth changes ( $\text{mm}/\text{day}$ ; shading) from 2 – 6 November 2021. The forecast is from the 00Z 1 November 2021 GFS ensemble.

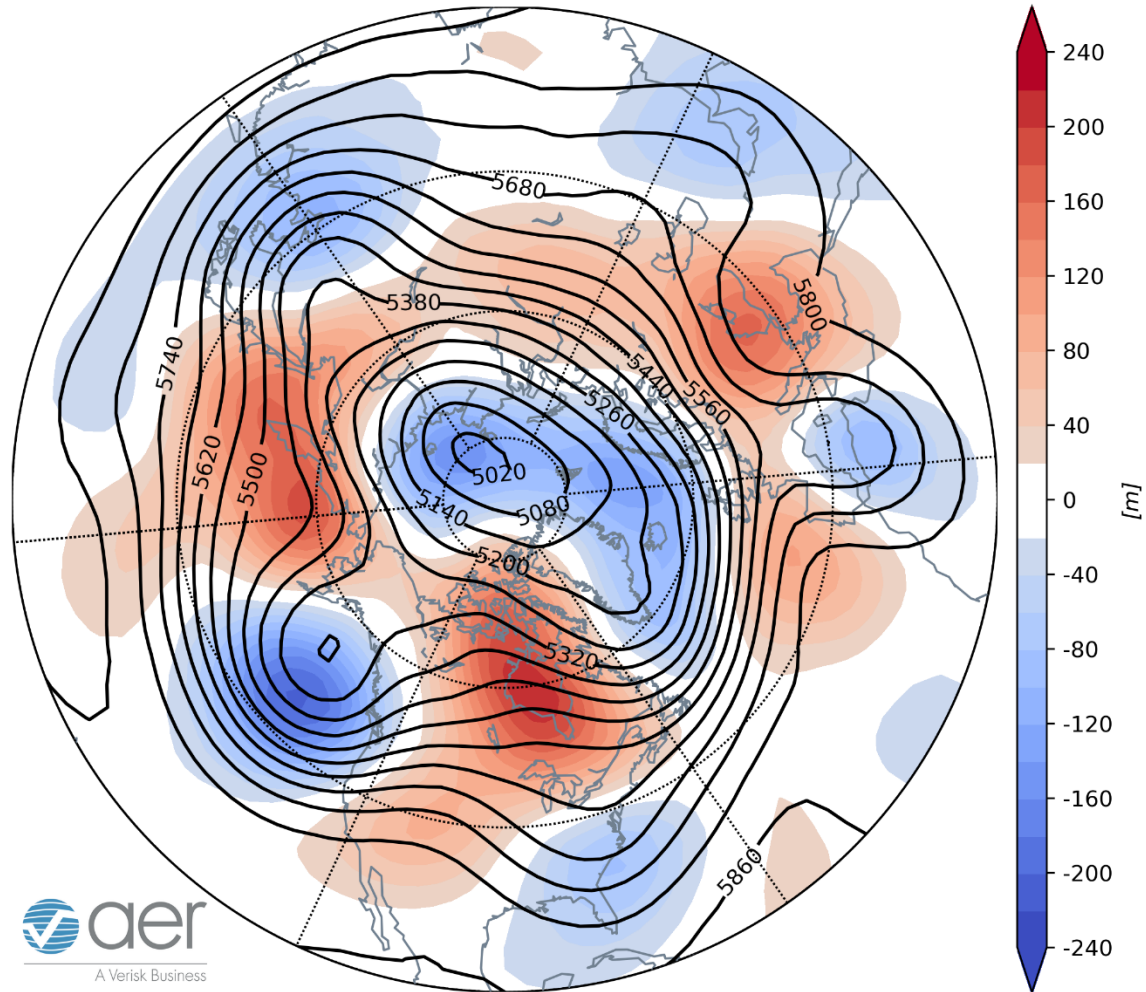
*Mid-Term*

*6-10 day*

The AO is predicted to rise into positive territory this period (**Figure 1**) as geopotential height anomalies remain negative in the Central Arctic and turn negative across Greenland with mixed geopotential height anomalies across the mid-latitudes of the NH (**Figure 5**). And with rising geopotential height anomalies continuing across the North Atlantic side of the Arctic (**Figure 5**), the NAO is predicted to trend positive this period.



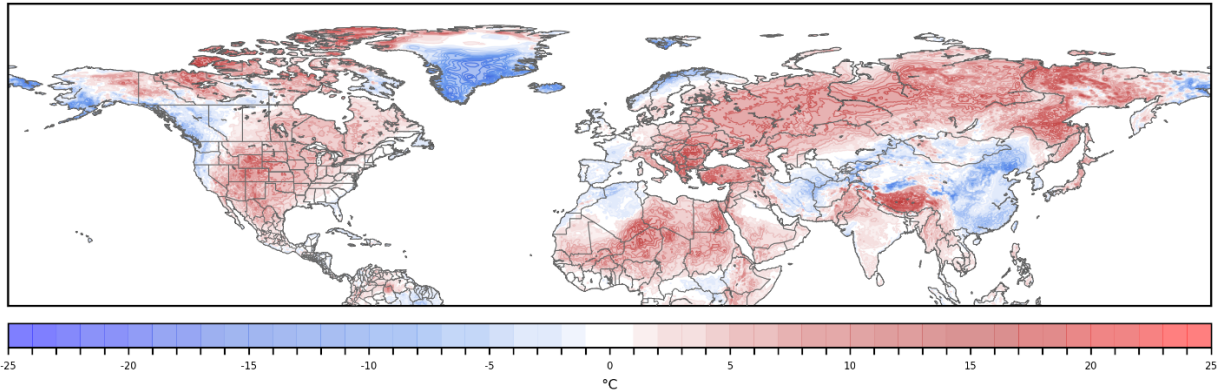
**GEFS 6-10 Day Forecast 500 mb GPH/GPH Anomaly**  
**INIT: 00Z 11/01/2021 FCST: 11/07/2021 to 11/11/2021**



**Figure 5.** Forecasted average 500 mb geopotential heights (dam; contours) and geopotential height anomalies (m; shading) across the Northern Hemisphere from 7 – 11 November 2021. The forecasts are from the 00z 1 November 2021 GFS ensemble.

The return of troughing/negative geopotential height anomalies across Greenland will favor a more zonal pattern across Europe with some residual troughing/negative geopotential height anomalies across the Western Mediterranean with downstream ridging/positive geopotential height anomalies across the Eastern Mediterranean this period (**Figure 5**). This will result in normal to above normal temperatures across much of Europe including the UK except for normal to below normal temperatures across Southwestern Europe and Scandinavia (**Figure 6**). Troughing/negative geopotential height anomalies previously in Central Asia are predicted to swing into East Asia while ridging/positive geopotential height anomalies spread across much of Western and Central Asia this period (**Figure 5**). This pattern favors normal to above normal temperatures widespread across much of Northern and Western Asia with normal to below normal temperatures in Eastern Asia (**Figure 6**).

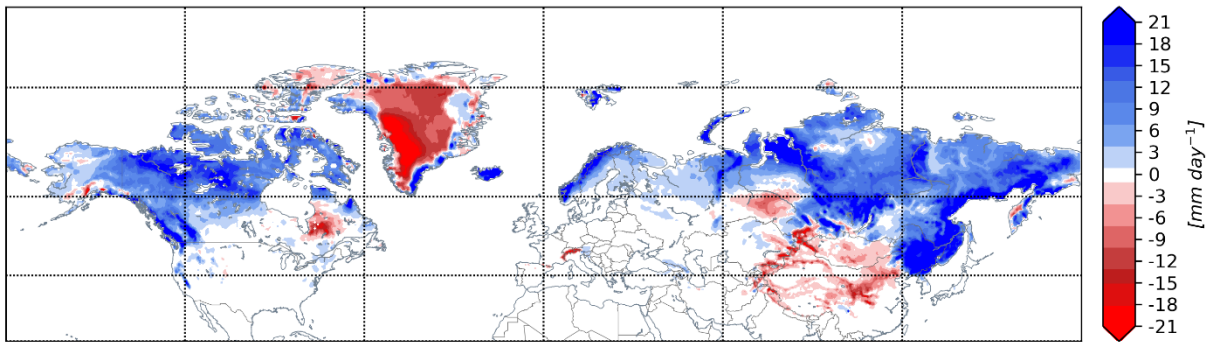
**GFS 6-10 Day Forecast T2m Anomaly**  
**INIT: 00Z 11/01/2021 FCST: 11/07/2021 to 11/11/2021**



**Figure 6.** Forecasted surface temperature anomalies ( $^{\circ}\text{C}$ ; shading) from 7 – 11 November 2021. The forecasts are from the 00Z 1 November 2021 GFS ensemble.

Trouching/negative geopotential height anomalies previously near the Aleutians are predicted to slide into the Gulf of Alaska and along the west coast of North America contributing to building ridging/positive geopotential height anomalies across the US and Eastern Canada with residual troughing/negative geopotential height anomalies in the Southeastern US (**Figure 5**). The widespread ridging is predicted to bring normal to above normal temperatures across much of Canada and the US with normal to below normal temperatures in Western Alaska, the West Coasts of Canada and the US and the Southeastern US (**Figure 6**).

**GEFS 6-10 Day Forecast SNOD Change**  
**INIT: 00Z 11/01/2021 FCST: 11/07/2021 to 11/11/2021**



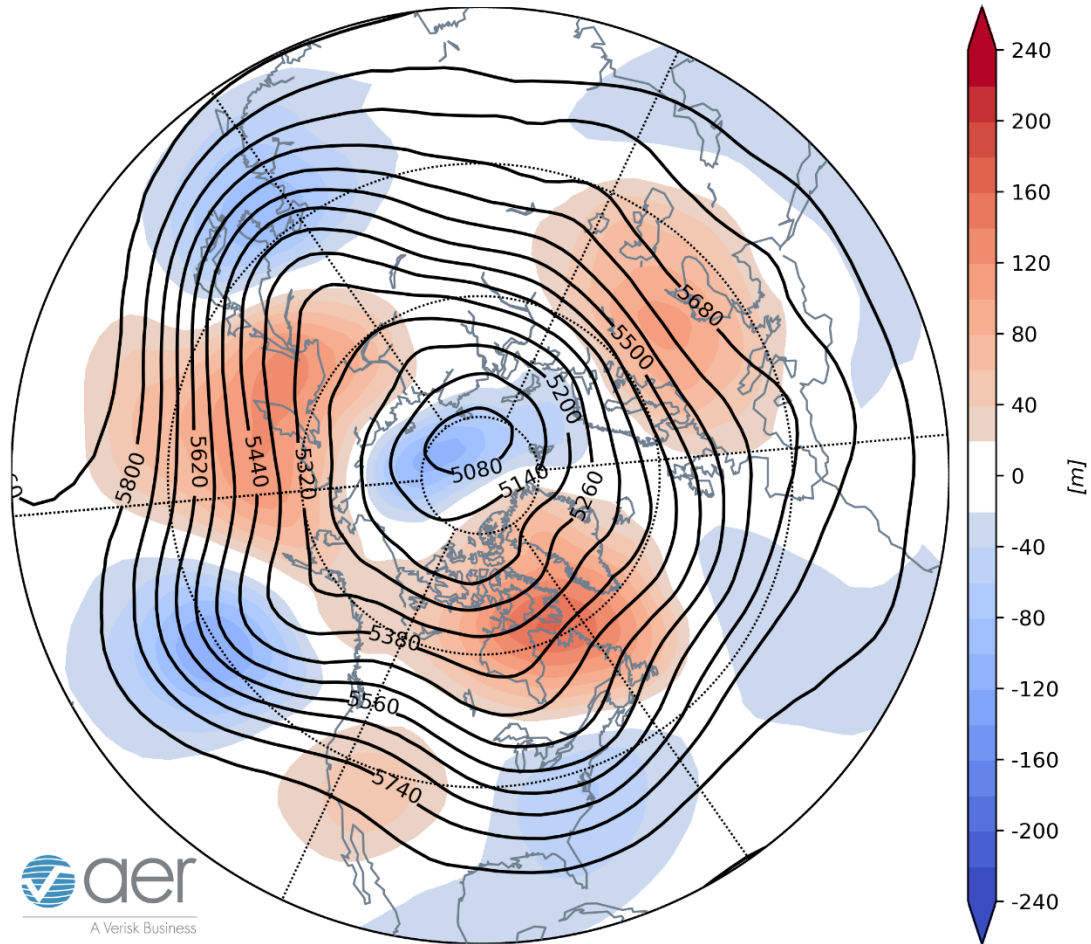
**Figure 7.** Forecasted snow depth changes ( $\text{mm}/\text{day}$ ; shading) from 7 – 11 November 2021. The forecast is from the 00Z 1 November 2021 GFS ensemble.

Trouching and/or cold temperatures are predicted to support new snowfall across Scandinavia. Northern and Eastern Asia while milder temperatures promote snowmelt across Central Asia (**Figure 7**). Trouching and/or cold temperatures are predicted to support new snowfall across Alaska, much of Canada and the US Rockies while milder temperatures promote snowmelt across the Sierra Nevada (**Figure 7**).

*11-15 day*

With negative geopotential height anomalies predicted across the Central Arctic but positive across Greenland with mixed geopotential height anomalies across the mid-latitudes of the NH (**Figure 8**), the AO should remain near neutral before dipping into negative territory this period (**Figure 1**). With predicted weak positive pressure/geopotential height anomalies across Greenland (**Figure 8**), the NAO is forecasted to remain neutral to negative this period.

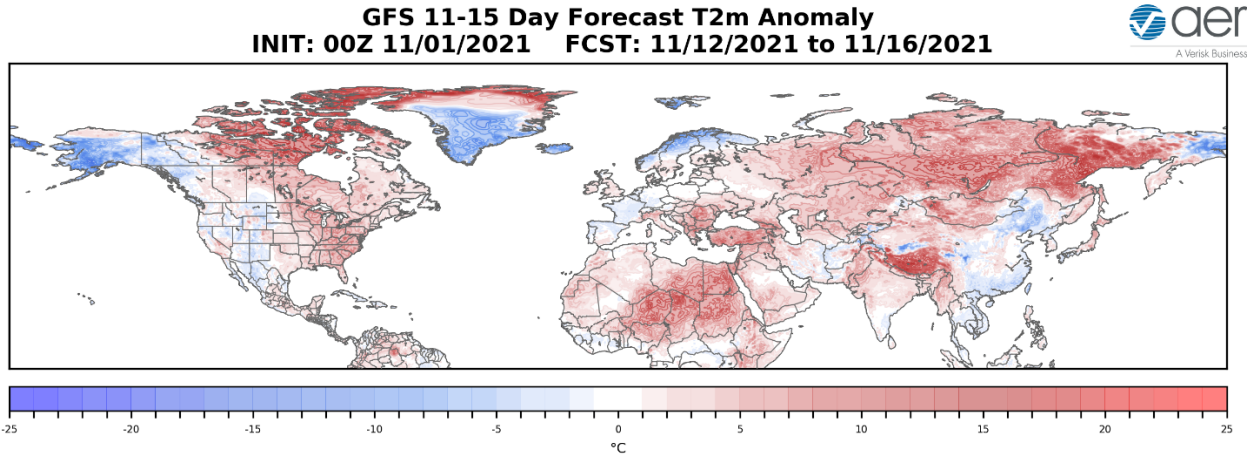
**GEFS 11-15 Day Forecast 500 mb GPH/GPH Anomaly**  
**INIT: 00Z 11/01/2021 FCST: 11/12/2021 to 11/16/2021**



**Figure 8.** Forecasted average 500 mb geopotential heights (dam; contours) and geopotential height anomalies (m; shading) across the Northern Hemisphere from 12 – 16 November 2021. The forecasts are from the 00z 1 November 2021 GFS ensemble.

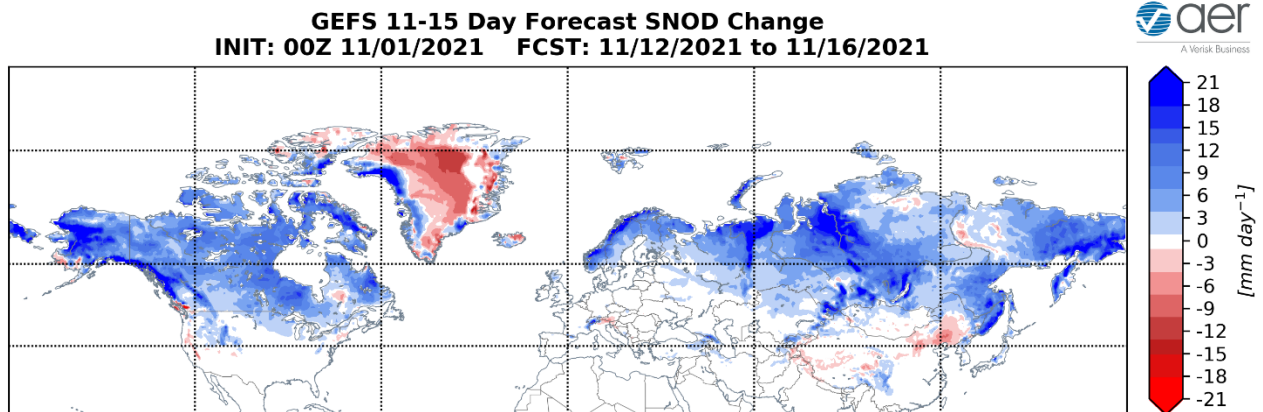
The mostly zonal flow across Europe is predicted to persist with ridging/positive geopotential height anomalies across Eastern Europe with troughing/negative geopotential height anomalies confined to Scandinavia this period (**Figure 8**). This pattern favors widespread normal to above normal temperatures across much of Europe including the Southern UK with normal to below normal temperatures confined to Scandinavia and the Northern UK this period (**Figure 9**). Ridging/positive geopotential height anomalies are predicted across much of Asia with residual troughing/negative geopotential height anomalies in East Asia this period (**Figure 8**). This pattern favors widespread normal

to above normal temperatures across much of Western, Central and Northern Asia with normal to below normal temperatures limited to Eastern China and Southeast Asia this period (**Figure 9**).



**Figure 9.** Forecasted surface temperature anomalies ( $^{\circ}\text{C}$ ; shading) from 12 – 16 November 2021. The forecasts are from the 00z 1 November 2021 GFS ensemble.

Persistent troughing/negative geopotential height anomalies in the Gulf of Alaska will favor downstream ridging/positive geopotential height anomalies across much of Canada and the US with residual troughing/negative geopotential height anomalies in the Southeastern US this period (**Figure 8**). This pattern favors normal to above normal temperatures widespread across Canada and the US with normal to below normal temperatures limited to Alaska, Northwestern Canada and the Southeastern US (**Figure 9**).



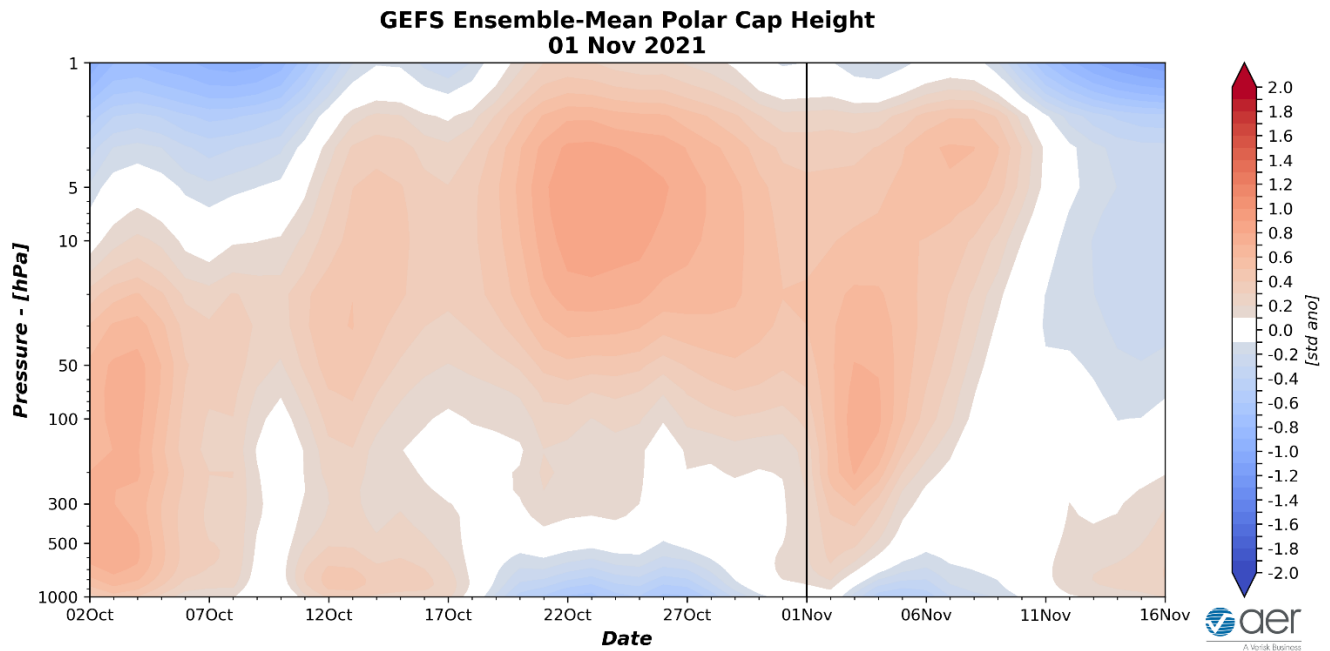
**Figure 10.** Forecasted snow depth changes ( $\text{mm}/\text{day}$ ; shading) from 12 – 16 November 2021. The forecast is from the 00Z 1 November 2021 GFS ensemble.

Troughing and/or cold temperatures are predicted to support possible new snowfall across Scandinavia and Northern Asia (**Figure 10**). Troughing and/or cold temperatures are predicted to support possible new snowfall across Alaska, much of Canada and the US Rockies (**Figure 10**).

*Longer Term*

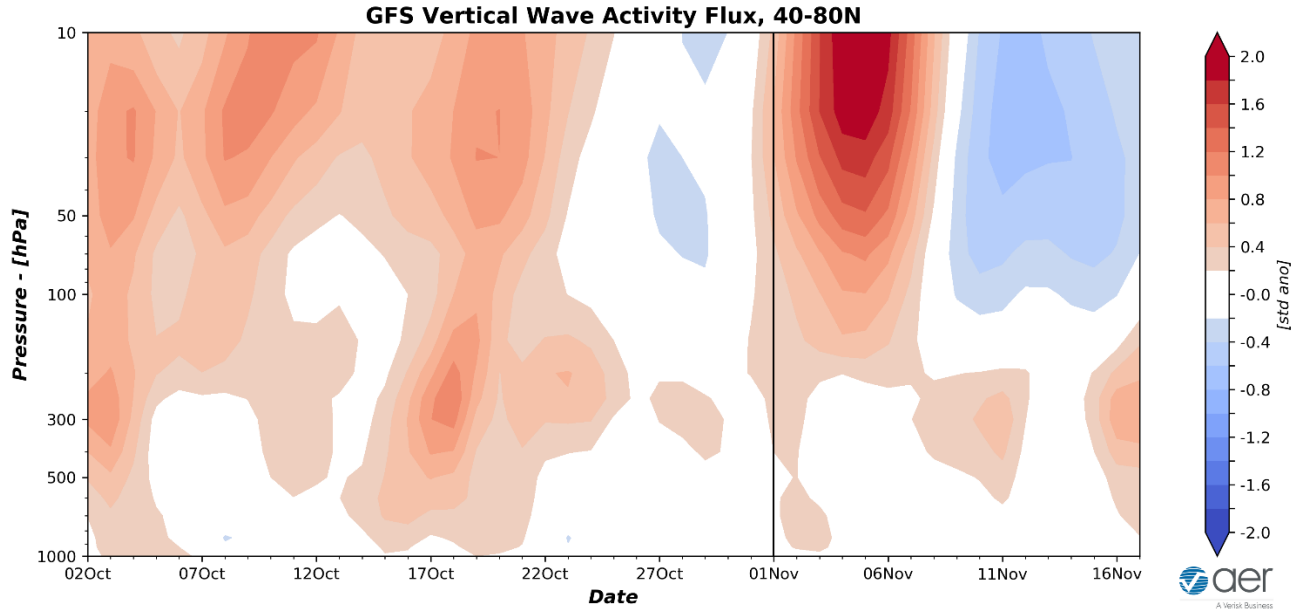
30-day

The latest plot of the polar cap geopotential height anomalies (PCHs) currently shows normal to warm/positive PCHs in the troposphere and stratosphere (**Figure 11**). The PCHs in the lower troposphere are predicted to turn cold/negative this week while warm/positive PCHs in the stratosphere are predicted to turn cold/negative next week (**Figure 11**). Cold/negative PCHs in the lower troposphere next week are predicted to turn warm/positive once again (**Figure 11**). So unusually variable PCHs are predicted for the lower troposphere.



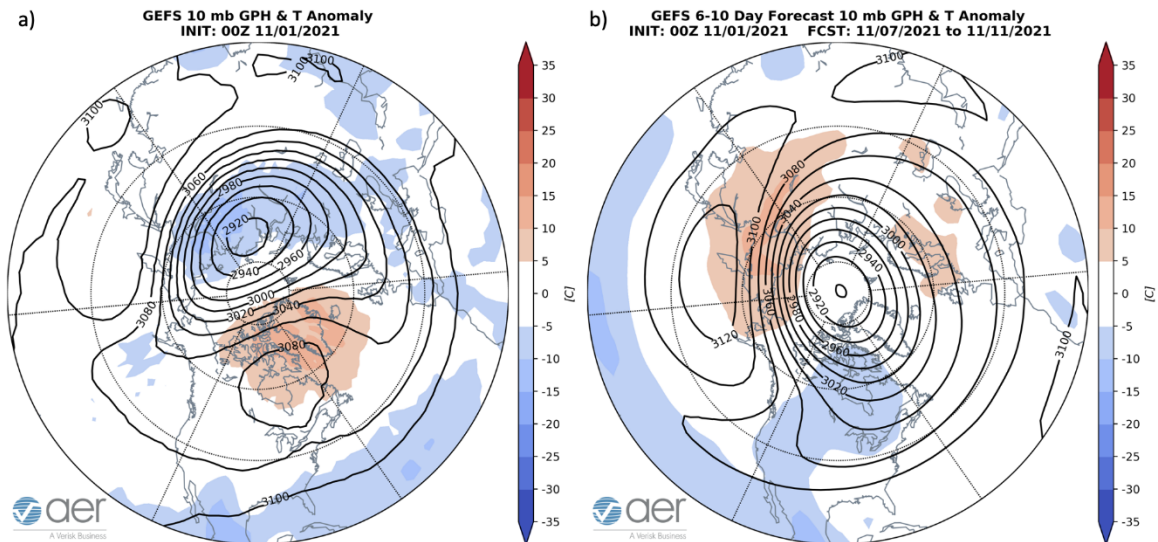
**Figure 11.** Observed and predicted daily polar cap height (i.e., area-averaged geopotential heights poleward of 60°N) standardized anomalies. The forecast is from the 00Z 1 November 2021 GFS ensemble.

The current warm/positive in the lower tropospheric PCHs are consistent with the predicted slightly negative surface AO this week (**Figure 1**). However, as PCHs transition to cold/negative in the lower troposphere this week, the surface AO will climb into positive later this week (**Figure 1**). Then next week as lower tropospheric PCHs transition again to warm/positive, the AO is predicted to reverse to negative once again.



**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 1 November 2021 GFS ensemble.

The current warm PCHs in the stratosphere are a result of strong vertical Wave Activity Flux (WAFz) from the troposphere to the stratosphere or poleward heat transport in the stratosphere that has been observed for much of October (**Figure 12**). One more big WAFz pulse is predicted for this week before WAFz anomalies turn negative next week (**Figure 12**).

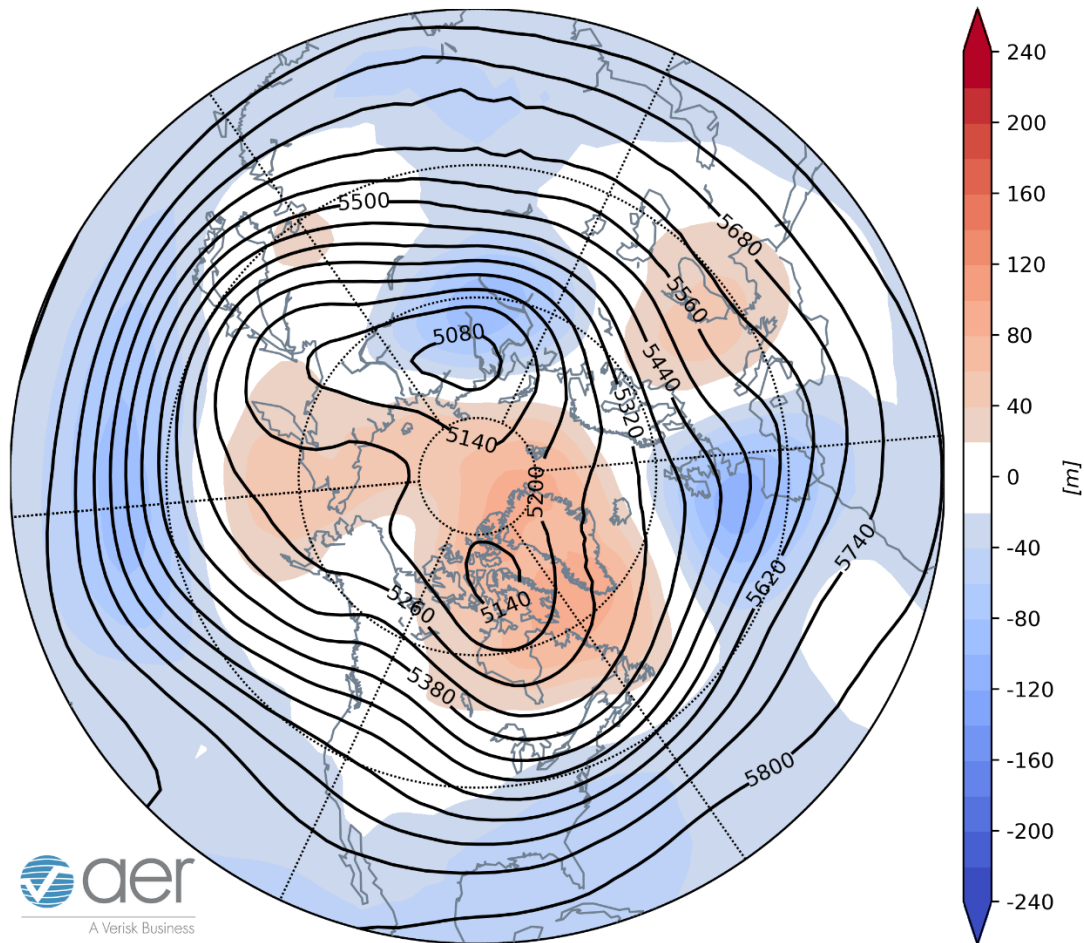


**Figure 13.** (a) Initialized 10 mb geopotential heights (dam; contours) and temperature anomalies (°C; shading) across the Northern Hemisphere for 1 November 2021. (b) Same as (a) except forecasted averaged from 7 – 11 November 2021. The forecasts are from the 00Z 1 November 2021 GFS model ensemble.

The positive WAFz this month perturbed the stratospheric PV, with the PV currently displaced towards northwestern Siberia and with weak warming over Greenland in the polar stratosphere (**Figure 13**). The perturbed PV is resulting in a strongly negative stratospheric AO (**Figure 11**). The positive WAFz predicted for this week will lead to new warming coming out of East Asia directed towards Alaska with ridging centered near the Dateline in the polar stratosphere though the PV is predicted to recover and return to being centered near the North Pole (**Figure 13**) with a return to a positive stratospheric AO next week (**Figure 11**).

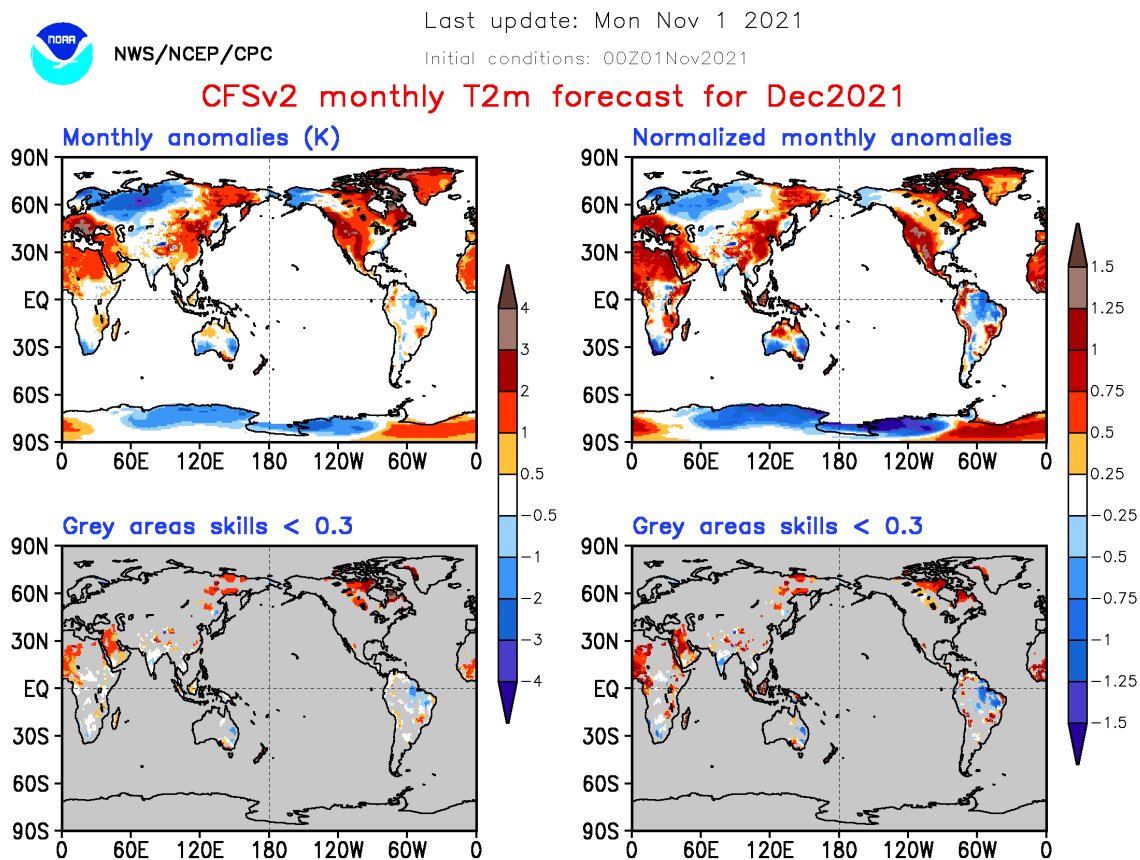
It does appear to me that the ridging in the polar stratosphere centered near the Dateline and warming stretching from East Asia towards Alaska with below normal geopotential heights over Eastern Canada (**Figure 13**) is suggestive of a stretched polar vortex event. A stretched polar vortex is associated with cold temperatures first in Central and East Asia and then across Canada and the US east of the Rockies. This is looking like a minor event but seems to be providing a stretch of some below normal temperatures in the Eastern US, something that has been very unusual this fall so far. There has yet to be a freeze in my area and just one frost. This is highly unusually and is consistent with the greater New England region. Following stretched polar vortex events, the PV can recover quickly and this is something to watch.

**CFS 500 hPa Forecast Anomaly Dec 2021  
Valid as of 01 Nov 2021**



**Figure 14.** Forecasted average 500 mb geopotential heights (dam; contours) and geopotential height anomalies (m; shading) across the Northern Hemisphere for December 2021. The forecasts are from the 00Z 1 November 2021 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 over much of the Arctic including Greenland, Eastern Europe Eastern Siberia over to the Dateline with troughing in Western Europe, Central Asia, Japan, Alaska and eastern North America (**Figure 14**). This pattern favors seasonable to relatively warm temperatures widespread across Southern Europe, East Asia, Western Canada and the Western US with seasonable to relatively cold across Northern Europe, Northern Asia, Alaska and the Eastern US (**Figure 15**). Please note that our plot did not generate so I used a plot from NOAA CPC.



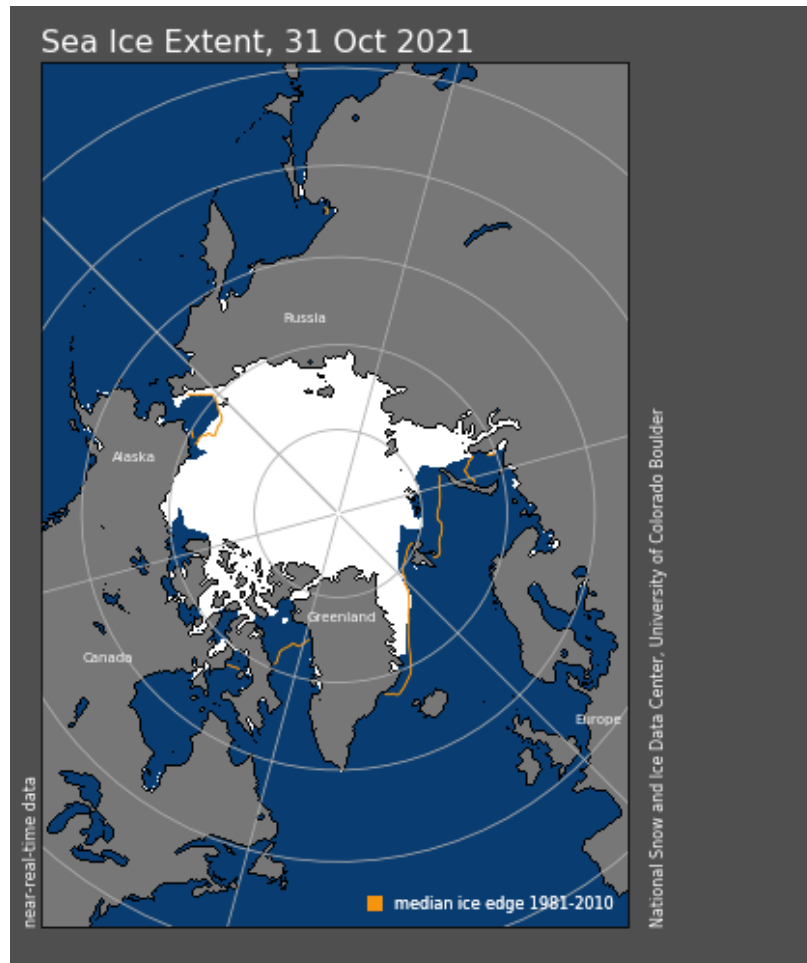
**Figure 15.** Forecasted average surface temperature anomalies ( $^{\circ}\text{C}$ ; shading) across the Northern Hemisphere for December 2021. The forecasts are from the 00Z 1 November 2021 CFS. Plot taken from <https://www.cpc.ncep.noaa.gov/products/people/mchen/CFSv2FCST/monthly/>

*Surface Boundary Conditions*

Arctic Sea ice



Arctic sea ice is growing but remains well below normal east of Greenland but especially in Baffin Bay and in the Barents-Kara Seas. Sea ice is close to normal in the Canadian Archipelagos and in the Chukchi Sea. Below normal sea ice in the Barents-Kara seas favors cold temperatures in Central and East Asia, while below normal sea ice in Baffin Bay favors cold temperatures in the Eastern Europe and Northern Europe however this topic remains controversial. Recent research has shown that the regional anomalies that are most highly correlated with the strength of the stratospheric PV are across the Barents-Kara seas region where low Arctic sea ice favors a weaker winter PV. Low sea ice in the Chukchi, Beaufort and Bering seas may favor colder temperatures across North America but has not been shown to weaken the PV.

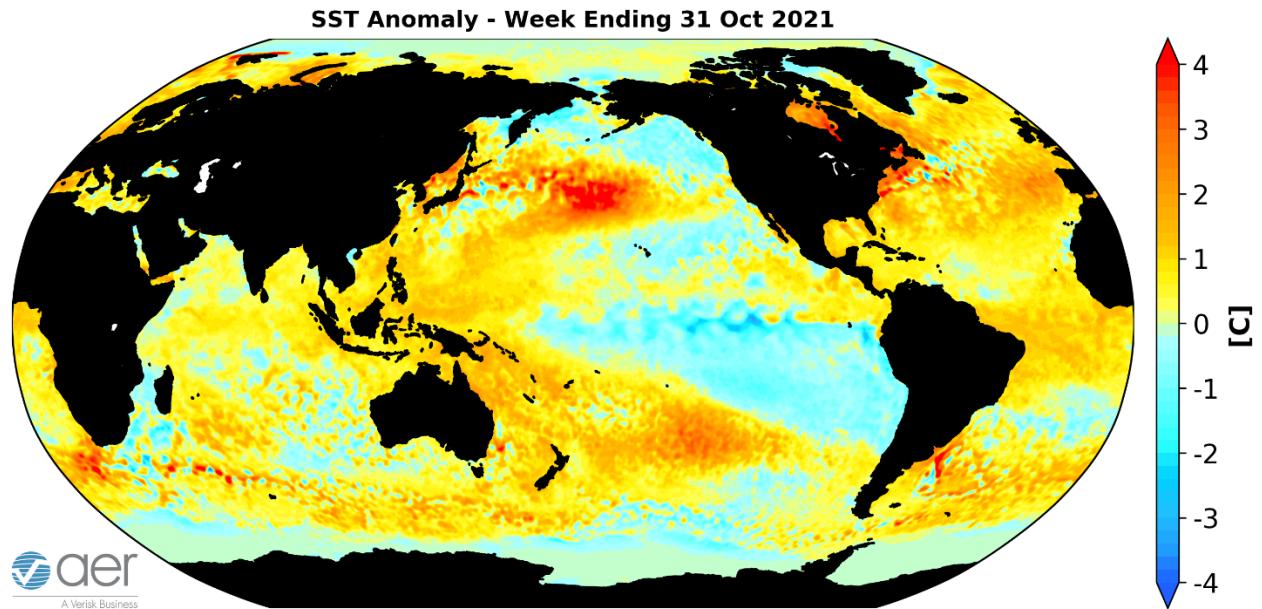


**Figure 16.** Observed Arctic sea ice extent on 31 October 2021 (white). Orange line shows climatological extent of sea ice based on the years 1981-2010. Image courtesy of National Snow and Ice Data Center (NSIDC). Snow and Ice Data Center (NSIDC).

### *SSTs/El Niño/Southern Oscillation*

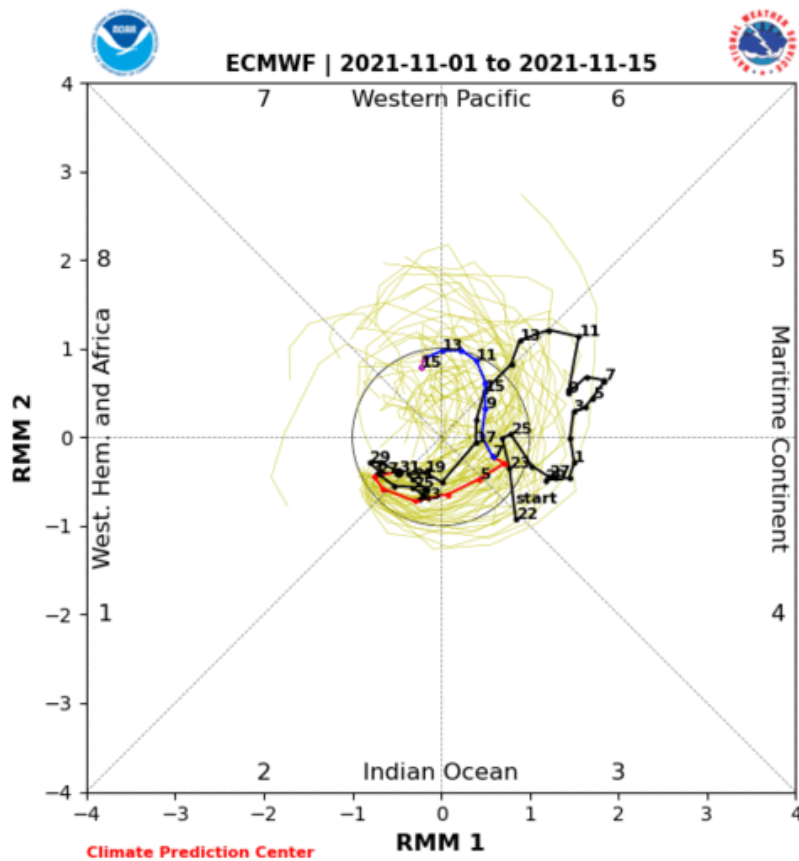
Equatorial Pacific sea surface temperatures (SSTs) anomalies are below normal and we continue to observe neutral to weak La Niña conditions (**Figure 17**) and La Niña conditions are expected through the fall. Observed SSTs across the NH remain well above normal especially in the Baltic Sea, central 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 Southern Hemisphere. Not my expertise but the SST pattern in the North Pacific is starting to resemble a negative Pacific Decadal Oscillation (PDO) pattern that favors colder temperatures across northwestern North America and milder temperatures across southeastern North America.



**Figure 17.** The latest weekly-mean global SST anomalies (ending 31 October 2021). Data from NOAA OI High-Resolution dataset.

Currently no phase of the Madden Julian Oscillation (MJO) is favored (**Figure 18**). The forecasts are for the MJO to remain weak where no phase is favored for the next two weeks. Therefore it seems unlikely that the MJO is contributing significantly to the predicted weather pattern across North America over the next two weeks but admittedly this is outside of my expertise.



**Figure 18.** Past and forecast values of the MJO index. Forecast values from the 00Z 1 November 2021 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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