

# Arctic Oscillation and Polar Vortex Analysis and Forecasts

March 13, 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.

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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 remain negative to straddle neutral the next two weeks as pressure/geopotential height anomalies across the Arctic are currently mixed and are predicted to remain mostly mixed the next two weeks. The North Atlantic Oscillation (NAO) is currently mixed and is predicted to remain negative to neutral the next two weeks as pressure/geopotential height anomalies are currently mixed and are predicted to remain weakly positive across Greenland the next two weeks.
- The next two weeks predicted ridging/positive geopotential height anomalies centered near Greenland will favor troughing/negative geopotential height anomalies across Northern Europe with ridging/positive geopotential height anomalies across Southern Europe and the Mediterranean. This pattern favors the next two weeks normal to below normal temperatures across Northern Europe including the United Kingdom (UK) with normal to above normal temperatures across Central and Southern Europe.
- The predicted general pattern across Asia the next two weeks is troughing/negative geopotential height anomalies across Northern Asia with ridging/positive geopotential height anomalies centered across Central and Southern Asia. The induced strong zonal or westerly flow the next two weeks favors normal to above normal temperatures across much of Asia this week but then next week normal to below normal temperatures will spread across Siberia.
- The pattern predicted across North America this week is troughing/negative geopotential height anomalies across the Gulf of Alaska, Alaska and Western Canada with ridging/positive geopotential height anomalies across the Northeastern Canada forcing more troughing/negative geopotential height anomalies across the United States (US) with more ridging/positive geopotential height anomalies across the Southeastern US. However, next week the ridging/positive geopotential height anomalies across Northeastern Canada will begin to spread into Alaska with troughing/negative geopotential height anomalies persisting across Southern Canada and the US. This pattern generally favors this week normal to below normal temperatures across Alaska, Western and Central Canada and the US with normal to above normal temperatures across Northern and Eastern Canada and New England. However, next week Alaska will transition to mostly above normal temperatures as well as Northern Canada and New England while below normal temperatures will persist across Central Canada and much of the US.
- It does look like the influence of the large polar vortex (PV) disruption on Northern Hemisphere (NH) surface temperatures will persist a little while longer but will be limited in extent focused in Northern Europe and the US.
- I believe this will be my last post in the winter format and I will be transitioning to the summer format starting in two weeks.

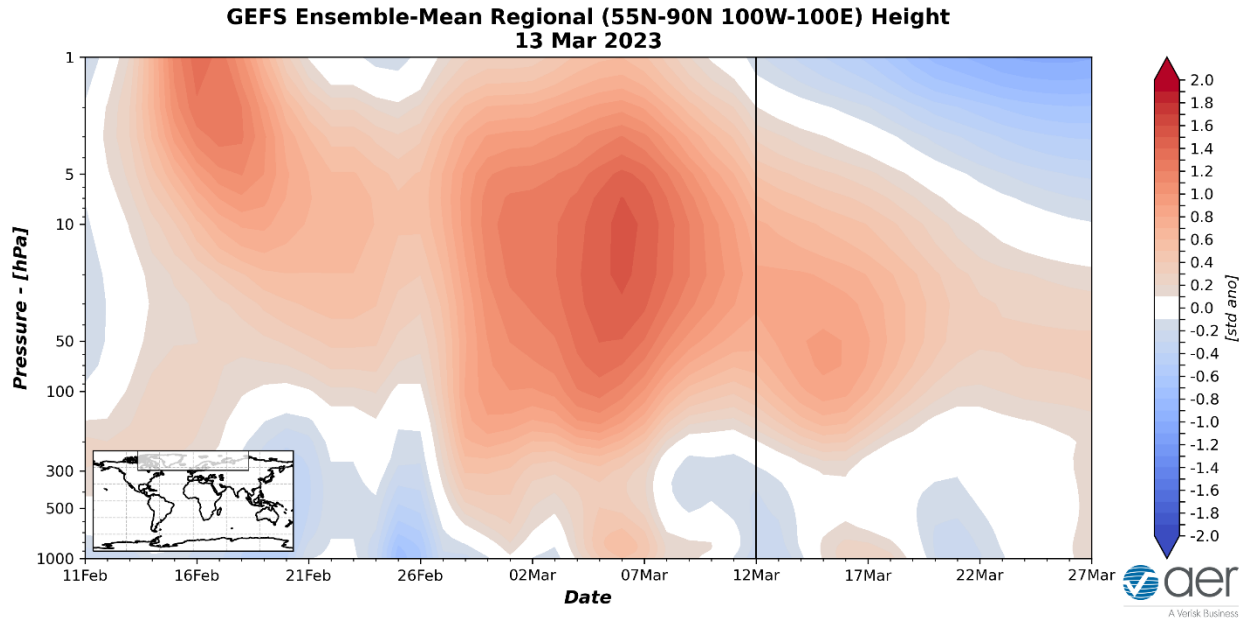
**Plain Language Summary**

The major disruption of the polar vortex (PV) and is referred to as a major sudden stratospheric warming (SSW; see **Figure 13a**) from mid-February is still influencing the weather. Wintry weather has become more widespread across Northern Europe and the Eastern US including snowfalls in the UK and the Northeastern US. Northern Asia has been surprisingly quite mild but colder temperatures are predicted across Siberia for next week (see **Figures 3** and **6**). Further impacts on our weather from the SSW are possible through the end of March.

### **Impacts**

By classical standards the influence from the large stratospheric polar vortex (PV) disruption or major sudden stratospheric warming (SSW) has arrived a little over a week ago at the surface with the warm/positive polar cap geopotential height anomalies (PCHs) “dripping” from the stratosphere to the surface (see **Figure 11**) and with a negative NAO or AO (see last week’s blog). This has resulted in a classic looking response in the tropospheric circulation including ridging/positive geopotential height anomalies across the Arctic but especially Greenland with troughing/negative geopotential height anomalies across Northern Europe, Northern Asia and the US. However, the surface temperature response has been somewhat muted or damped relative to the pressure/geopotential height response especially across Asia. But temperatures have been below normal across Northern Europe with above normal snow cover including the UK. Temperatures are below normal in the Eastern US as well and while snow cover is near normal to slightly above normal in the Eastern US, the largest positive anomalies remain in the Western US. Though the biggest snowstorm of the winter so far is predicted for the Northeastern US tonight and tomorrow.

I have been showing in recent blogs the North Atlantic regional PCHs that has been more emphatically showing stratosphere-troposphere coupling evident with “dripping” that manifests with Greenland blocking/high pressure. As seen in **Figure i**, the first ceiling to floor coupling (or drip of positive PCHs) was in early March and a second is predicted later this week. So even though predicted Greenland blocking/high pressure is fairly weak this week (see **Figure 2**), it is predicted to strengthen next week (see **Figure 5**). So though cold temperatures are mostly limited this week to the US and far Northern Europe (see **Figure 3**), they will expand to include Siberia next week (see **Figure 6**).

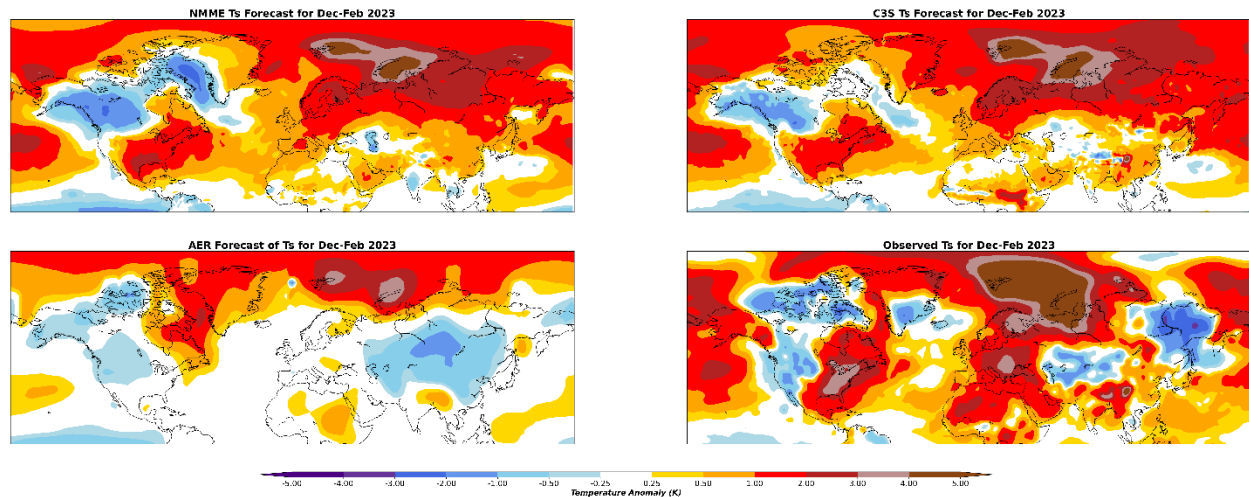


**Figure i.** Observed and predicted daily polar cap height (i.e., area-averaged geopotential heights poleward of 60°N) standardized anomalies limited to the North Atlantic sector (see insert). The forecast is from the 00Z 13 March 2023 GFS ensemble.

Both the pan-Arctic (**Figure 11**) and the North Atlantic regional PCHs suggest yet another “drip” of warm/positive PCHs from the stratosphere to the troposphere the last week of March (see **Figure i**). Such a long-range forecast is questionable but for now I see no reason not to expect some form of Greenland blocking/high pressure to continue for the foreseeable future favoring relatively cold temperatures in the US and Northern Europe and even the continued chance of snow especially at higher elevations.

It does seem to me that through identifying stratosphere-troposphere coupling has been subtle and identifying it has taken some creativity the duration has been comparable to historical averages. I could make the argument that the impacts started as early as the first week of February with the record cold temperatures (and all-time record cold wind chills) in the Northeastern US. And if the forecast in Figure ii is correct the impacts will be on the order of two months and possibly longer. But of course, the impacts of the SSW so late in the season will be very different than had the SSW occurred in January.

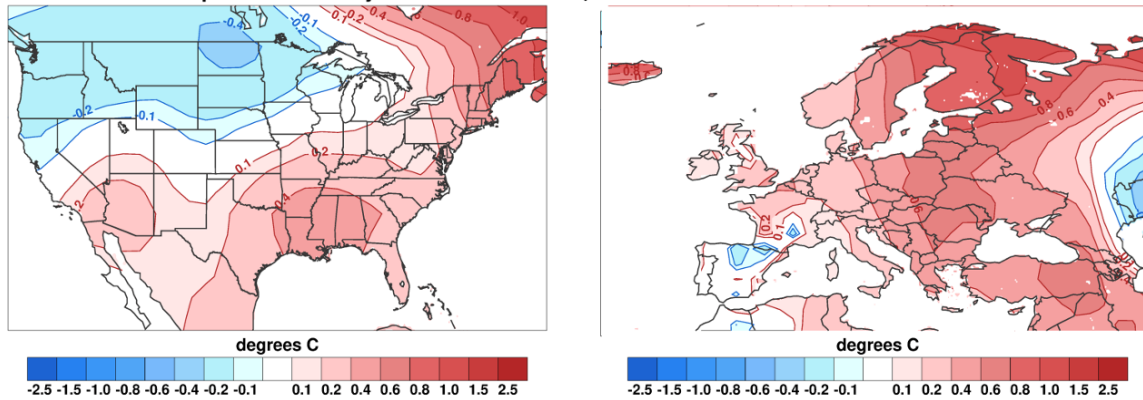
Last week I presented the observed surface temperature anomalies for December 2022 through February 2023 and compare with the three forecasts that I included in the blog of [28 November 2022](#) and the observed anomalies from the NCEP/NCAR reanalysis for comparison. For this week I recreated the same plot with ERA5 reanalysis instead in **Figure ii** with the invaluable help of my colleague Karl Pfeiffer.



**Figure ii.** The NMME winter temperature anomaly forecast for December, January and February 2023 from <https://www.cpc.ncep.noaa.gov/products/NMME/> (top left). The C3S winter temperature anomaly forecast for December, January and February 2023 from <https://www.copernicus.eu/en> (top right). c) The AER winter temperature anomaly forecast for December, January and February 2023 (bottom left). Observed winter temperature anomaly for December, January and February 2023 (bottom right). The observed temperatures are based on the ERA5 reanalysis.

With ERA5 and consistent with what I showed last week using GFS initialized temperatures is a better match for the AER forecast. It was a frustrating winter for me but overall, the forecast performed well and especially when compared to the dynamical models when looking at the temperature anomaly pattern. It was the only forecast to predict a cold Western US and warm Eastern US (for a more detailed US forecast see **Figure iii**). Though like all the forecasts it underpredicted the warmth in the Eastern US. Also, similarly in Eurasia it was the only model to predict a warm Europe but cold Central Asia and Siberia (for a more detailed Europe forecast see **Figure iii**). Again, the warmth in Europe was underpredicted as it was in all the models. The relative cold temperature in Asia is cohesive in the AER winter forecast but splintered into two regions in Asia, which seems to me highly unusual. The AER forecast looked better at the end of January but was degraded by the Asian torch in February. This was almost a black swan event given that Siberia is the region most likely to experience relatively cold temperatures the same month as an SSW; but such is the nature of long-range forecasts, especially those statistical in nature. The forecast is derived from composites or averaging of historical events that smooths out year-to-year variability, but the observations are a data point of one with unique and non-repeatable detail.

a) Forecast Winter Temperature Anomaly Dec-Jan-Feb 2023    b) Forecast Winter Temperature Anomaly Dec-Jan-Feb 2023

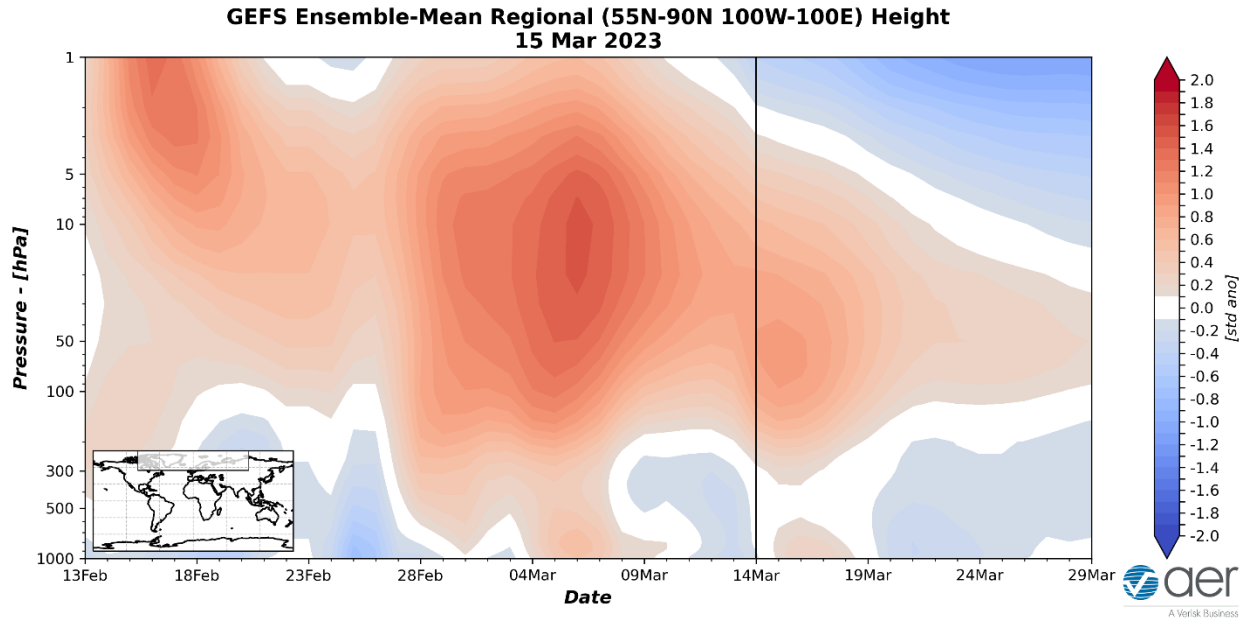


**Figure iii.** Predicted winter surface temperature anomaly ( $^{\circ}\text{C}$ ; shading) for December, January and February 2023 for the a) US and b) Europe from the AER model.

Weather forecasting can be cruel even on the very short term. A winter storm is already underway here in the Boston region and the dynamical weather models vary between 0-24 inches of snowfall for my neighborhood (I guess I can provide a post-mortem in the Wednesday update). So not anticipating months in advance or even understanding why Siberia torched with an SSW, pales in comparison (at least in my opinion). What also frustrated me was that despite the warm forecast for the Eastern US and Europe, why was it so difficult to sustain any cold weather despite repeated PV disruptions. So, while it was disappointing seeing the winter forecast be degraded day by day, hopefully this winter will provide insight into winter weather that was lacking previously. Some disappointment is a worthwhile price for a learned course correction for future forecasts.

### Wednesday Update

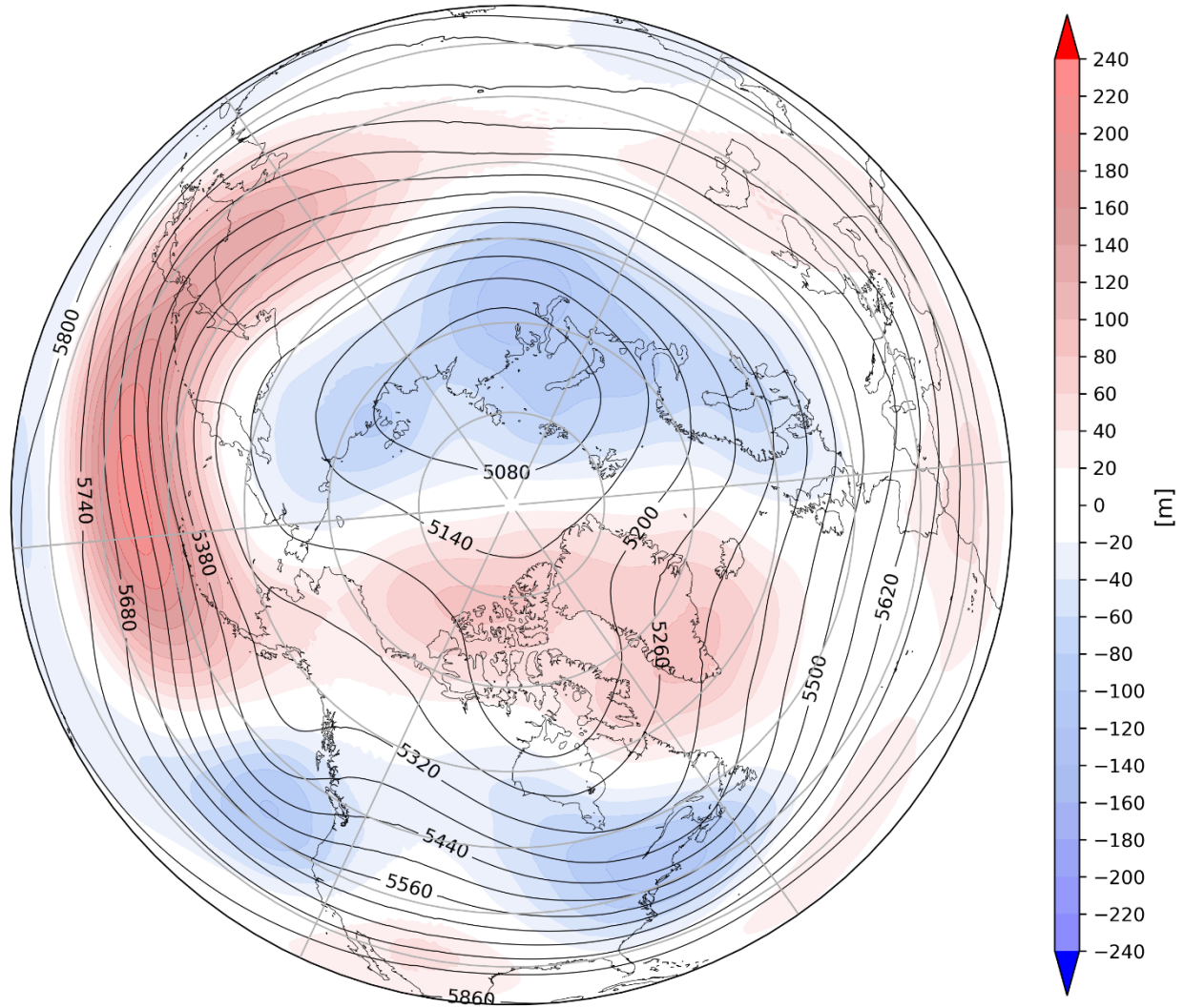
The downward propagation of positive/warm PCHs or “drip” later this week, at least in the North Atlantic sector looks to be on track as seen in today’s North Atlantic regional PCH forecast (see **Figure iv**). Though the subsequent downward propagation or drip at the end of the month has now disappeared, but this forecast tends to be volatile and could change once again.



**Figure iv.** Observed and predicted daily polar cap height (i.e., area-averaged geopotential heights poleward of 60°N) standardized anomalies limited to the North Atlantic sector (see insert). The forecast is from the 00Z 15 March 2023 GFS ensemble.

Though I am of the opinion that persistence is very important at the end of the seasons and therefore I can see the Greenland blocking persisting beyond this week's "drip" as predicted by the ECWMF and the GFS (see **Figure v**).

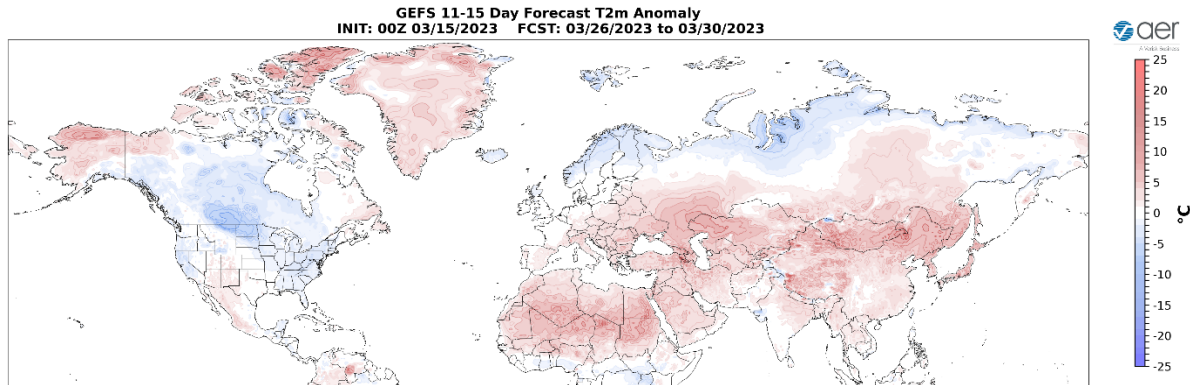
**GEFS 11-15 Day Forecast 500 hPa Anomaly**  
**INIT: 00Z 03/15/2023 FCST: 03/26/2023 to 03/30/2023**



**Figure v.** Forecasted average 500 mb geopotential heights (dam; contours) and geopotential height anomalies (m; shading) across the Northern Hemisphere from 26 – 30 March 2023. The forecasts are from the 00z 15 March 2023 GFS ensemble.

This should support below normal temperatures possibly across Northern Europe but especially across the US east of the Rockies (see **Figure vi**). The cold temperatures in place coupled with deep snow cover across the Northern US and Southern Canada will support a continuation of below normal temperatures.



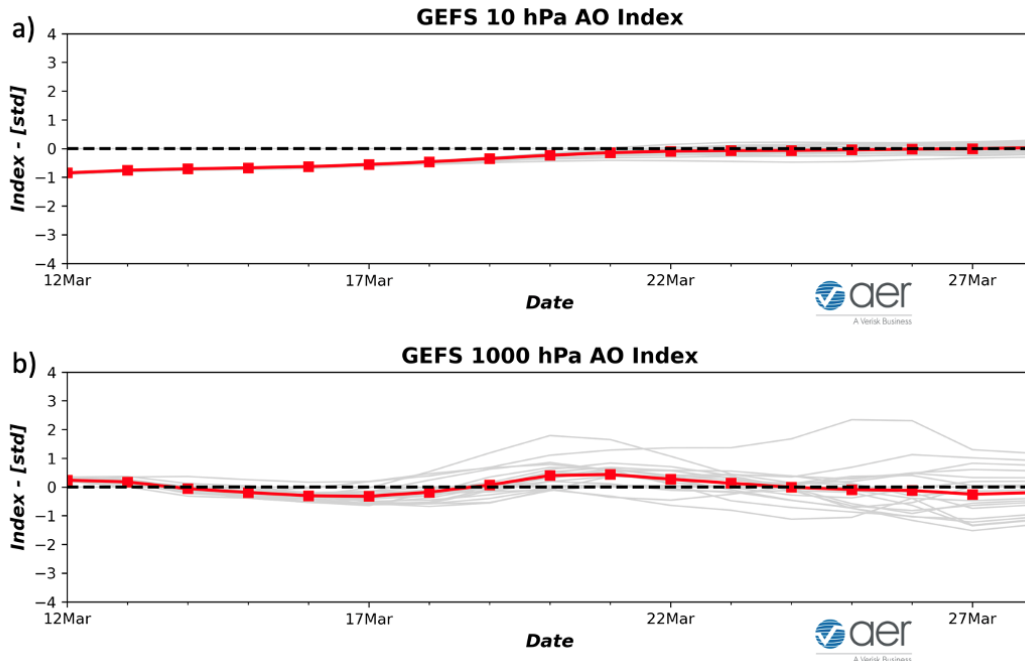


**Figure vi.** Forecasted surface temperature anomalies ( $^{\circ}\text{C}$ ; shading) from 26 – 30 March 2023. The forecast is from the 00Z 15 March 2023 GFS ensemble.

I promised to do a postmortem on the storm from Tuesday and for me it was just another in a string of disappointments this winter and I received only about two inches of slushy snow. But it was white gold in the ski areas of the Northeastern US with many observations in the 3-4 feet (1+ meter) range. This [NWS\\_tweet](#) from the US National Weather Service is from this morning and it is still snowing but it gives an idea of the impressive snowfall in the Northeastern US mountains (or hills when compared to the Rockies and Alps) and totals are approaching four feet in spots.

### ***Recent and Very Near Term Conditions***

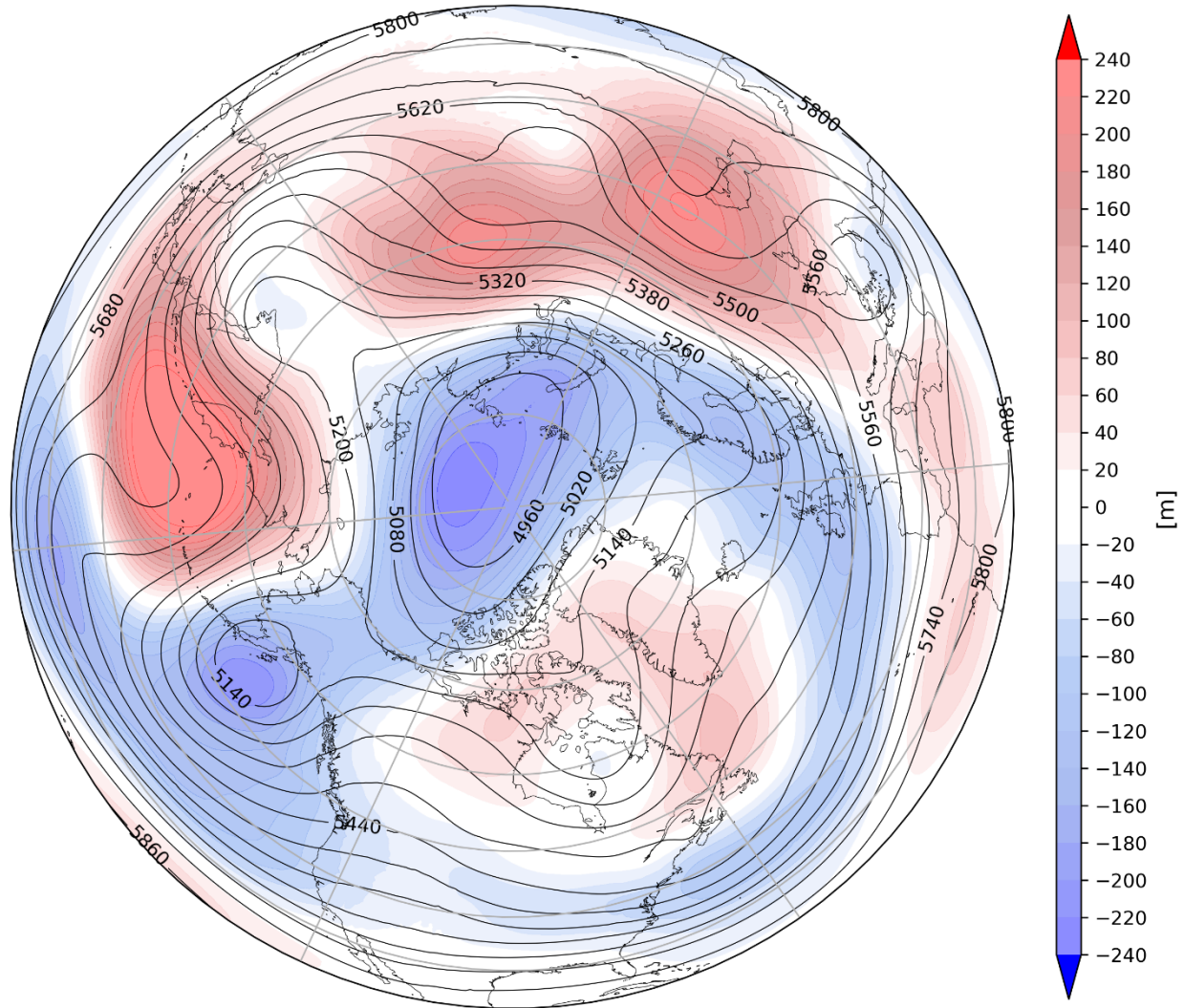
The AO is predicted to straddle neutral this period (**Figure 1**) with mixed geopotential height anomalies across the Arctic with mixed geopotential height anomalies across the mid-latitudes of the NH (**Figure 2**). With positive but weak geopotential height anomalies across Greenland (**Figure 2**), the NAO is predicted to remain negative to near neutral this period as well.



**Figure 1.** (a) The predicted daily-mean AO at 1000 hPa from the 00Z 13 March 2023 GFS ensemble. (b) The predicted daily-mean near-surface AO from the 00Z 13 March 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.

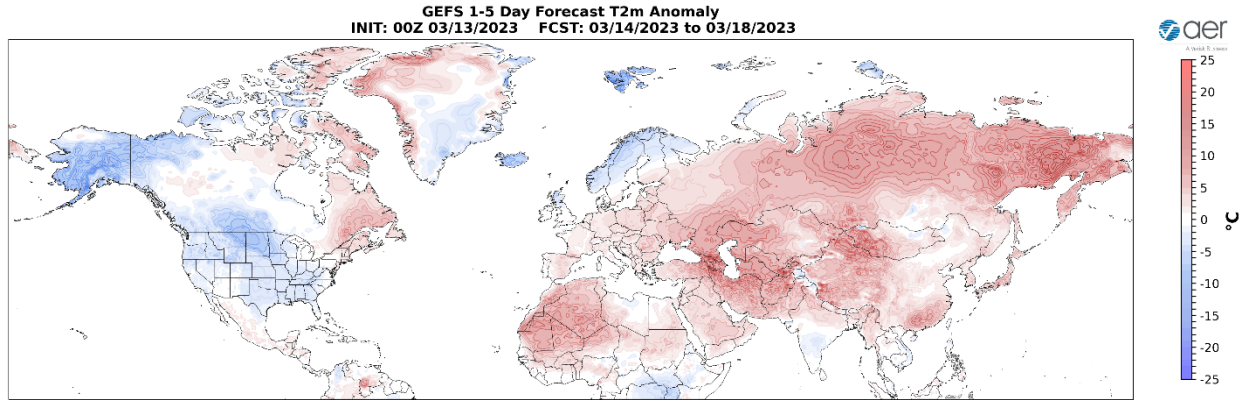
Weak ridging/positive geopotential height anomalies across Greenland will support troughing/negative geopotential height anomalies across Northern Europe with ridging/positive geopotential height anomalies across Southeastern Europe (**Figures 2**). This continues to favor a quasi-negative NAO temperature pattern with normal to below normal temperatures across Scandinavia and the UK with normal to above normal temperatures across Central and Southern Europe (**Figure 3**). Ridging/positive geopotential height anomalies across Greenland will continue to favor troughing/negative geopotential height anomalies across Northern Asia with ridging/positive geopotential height anomalies across Southern Asia but centered in Central Asia this period (**Figure 2**). The resultant strong zonal or westerly flow pattern favors widespread normal to above normal temperatures across all of Asia but focused in Central Asia with the exception of seasonable temperatures in East Asia associated with weak troughing swinging through the region (**Figure 3**).

**GEFS 1-5 Day Forecast 500 hPa Anomaly**  
**INIT: 00Z 03/13/2023 FCST: 03/14/2023 to 03/18/2023**



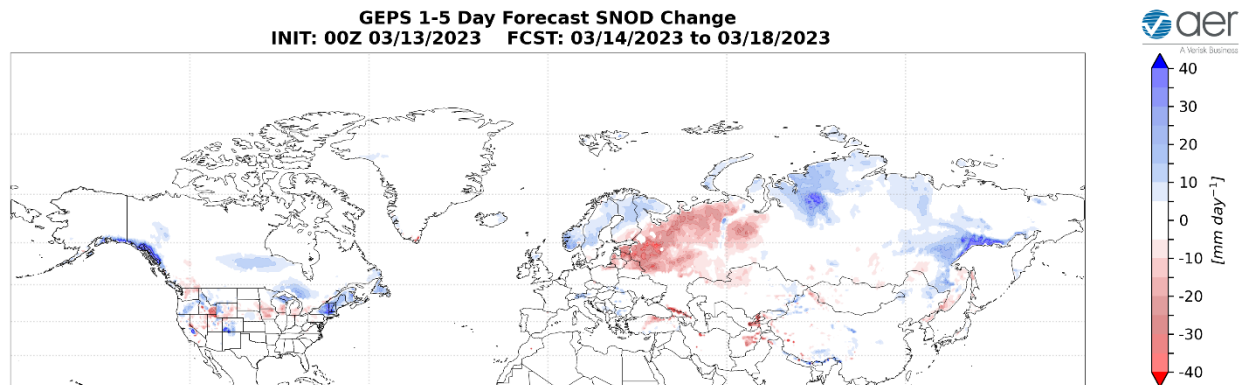
**Figure 2.** Forecasted average 500 mb geopotential heights (dam; contours) and geopotential height anomalies (m; shading) across the Northern Hemisphere from 14 – 18 March 2023. The forecasts are from the 00z 13 March 2023 GFS ensemble.

The pattern this week across North America is troughing/negative geopotential height anomalies previously in the Gulf of Alaska, Alaska and Western Canada with ridging/positive geopotential height anomalies centered in Northern and Eastern Canada forcing more troughing/negative geopotential height anomalies across the US this period (**Figure 2**). This pattern will favor normal to below normal temperatures across Alaska, Western Canada and the US with normal to above normal temperatures across Northern and Eastern Canada and New England (**Figure 3**).



**Figure 3.** Forecasted surface temperature anomalies (°C; shading) from 14 – 18 March 2023. The forecast is from the 00Z 13 March 2023 GFS ensemble.

Trouging and/or cold temperatures will support new snowfall across Scotland, Scandinavia, the Alps, the Tibetan Plateaus and Siberia while mild temperatures will support snowmelt in the Baltics, Northwestern Russia and Central Asia (**Figure 4**). Trouging and/or cold temperatures will support new snowfall across parts Southeastern Alaska, the West Coast and Central Canada, parts of the Western US and New England while mild temperatures will support snowmelt in the Western US, the US Plains and the Great Lakes (**Figure 7**).



**Figure 4.** Forecasted snow depth changes (mm/day; shading) from 14 – 18 March 2023. The forecast is from the 00Z 13 March 2023 GEM (Canadian) ensemble.

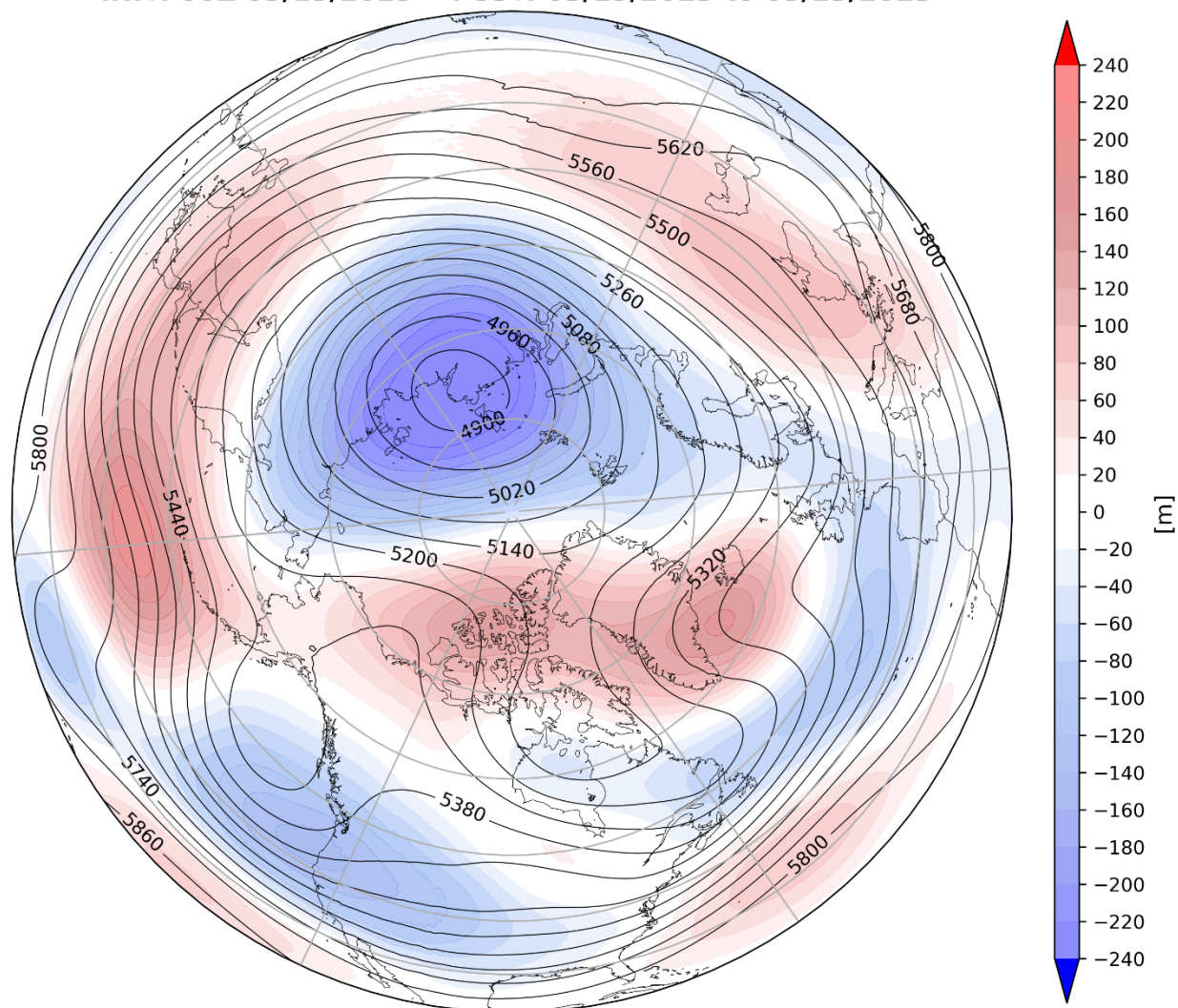
**Near-Term**

1-2 week

With mixed geopotential height anomalies across the Arctic and with mixed geopotential height anomalies across the mid-latitudes this period (**Figure 5**), the AO

should remain near neutral to slightly positive this period (**Figure 1**). With positive but weak pressure/geopotential height anomalies across Greenland (**Figure 5**), the NAO will likely be negative to neutral this period.

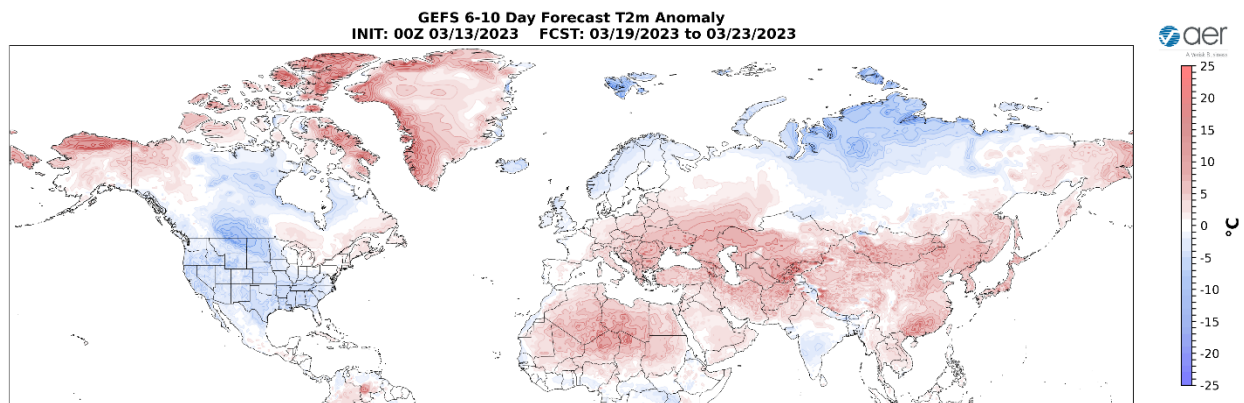
**GEFS 6-10 Day Forecast 500 hPa Anomaly**  
**INIT: 00Z 03/13/2023 FCST: 03/19/2023 to 03/23/2023**



**Figure 5.** Forecasted average 500 mb geopotential heights (dam; contours) and geopotential height anomalies (m; shading) across the Northern Hemisphere from 19 – 23 March 2023. The forecasts are from the 00z 13 March 2023 GFS ensemble.

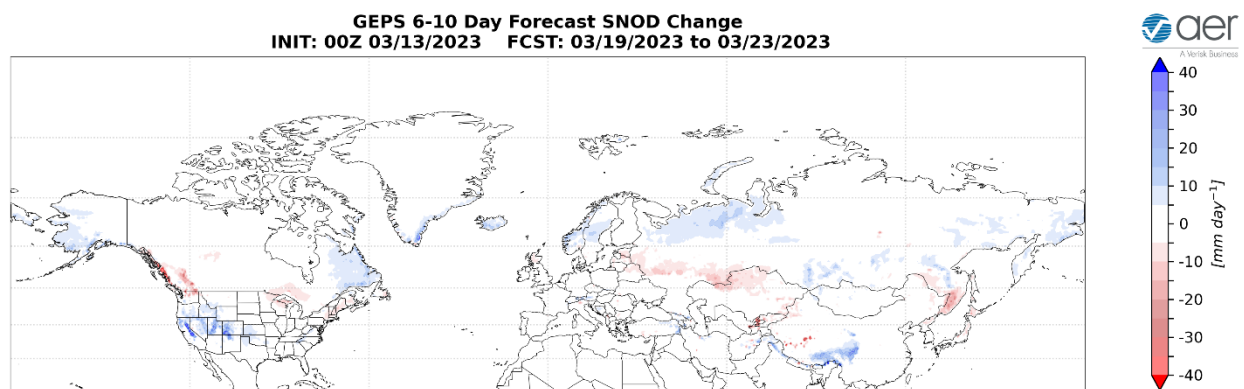
Ridging/positive geopotential height anomalies centered across Greenland albeit weak will continue to support troughing/negative geopotential height anomalies across Northern Europe with ridging/positive geopotential height anomalies across Southeastern Europe this period (**Figure 5**). This pattern should continue to favor normal to below normal temperatures across Northern Europe including the UK with

normal to above normal temperatures across Central and Southern Europe (Figures 6). Troughing/negative geopotential height anomalies is predicted to persist over Northern Asia with widespread ridging/positive geopotential height anomalies spread across Southern Asia this period (Figure 5). The induced zonal flow pattern favors widespread normal to above normal temperatures across Southern and Central Asia and Eastern Siberia with normal to below normal temperatures mostly limited to Western and Central Siberia this period (Figure 6).



**Figure 6.** Forecasted surface temperature anomalies (°C; shading) from 19 – 23 March 2023. The forecast is from the 00Z 13 March 2023 GFS ensemble.

Ridging/positive geopotential height anomalies centered south of the Aleutians will continue to anchor troughing/negative geopotential height anomalies in the Gulf of Alaska, Western Canada and much of the US with more ridging/positive geopotential height anomalies strung across the North American Arctic this period (Figure 5). This pattern favors widespread normal to above normal temperatures across Alaska, Northern, Western and Eastern Canada and New England with normal to above normal temperatures across Central Canada and much of the US (Figure 6).



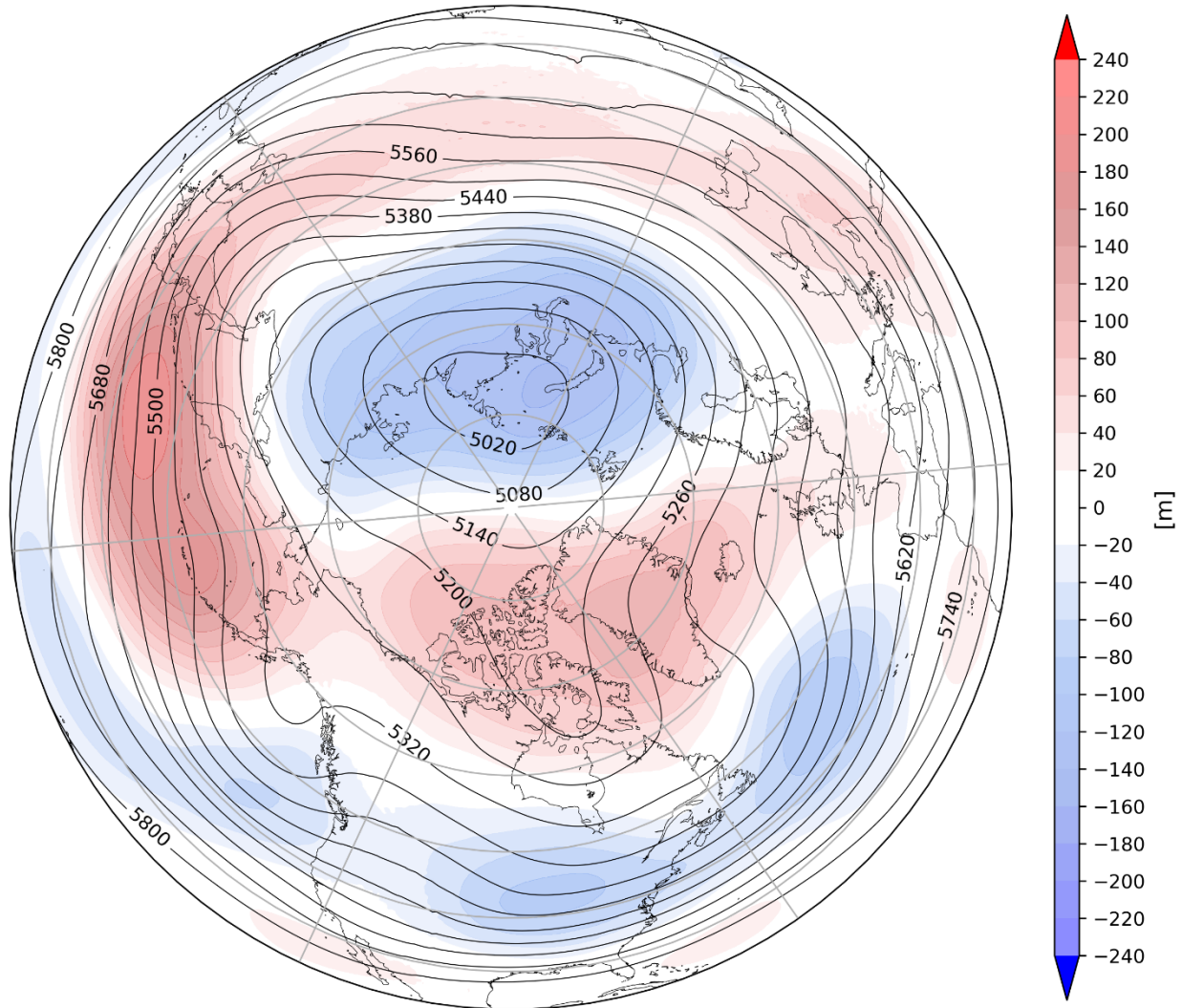
**Figure 7.** Forecasted snow depth changes (mm/day; shading) from 19 – 23 March 2023. The forecast is from the 00Z 6 March 2023 GEM (Canadian) ensemble.

Trouching and/or cold temperatures will support new snowfall across Scandinavia, Northern Siberia and the Tibetan Plateau while mild temperatures will support snowmelt across the Baltic States, Northwestern and Central Asia (**Figure 7**). Trouching and/or cold temperatures will support new snowfall across western Alaska, Eastern Canada and the Western US while mild temperatures will support snowmelt across Western and Southern Canada 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 remain near neutral this period (**Figure 1**). With positive but weak pressure/geopotential height anomalies across Greenland (**Figure 8**), the NAO will likely be negative to neutral this period.

**GEFS 11-15 Day Forecast 500 hPa Anomaly**  
**INIT: 00Z 03/13/2023 FCST: 03/24/2023 to 03/28/2023**

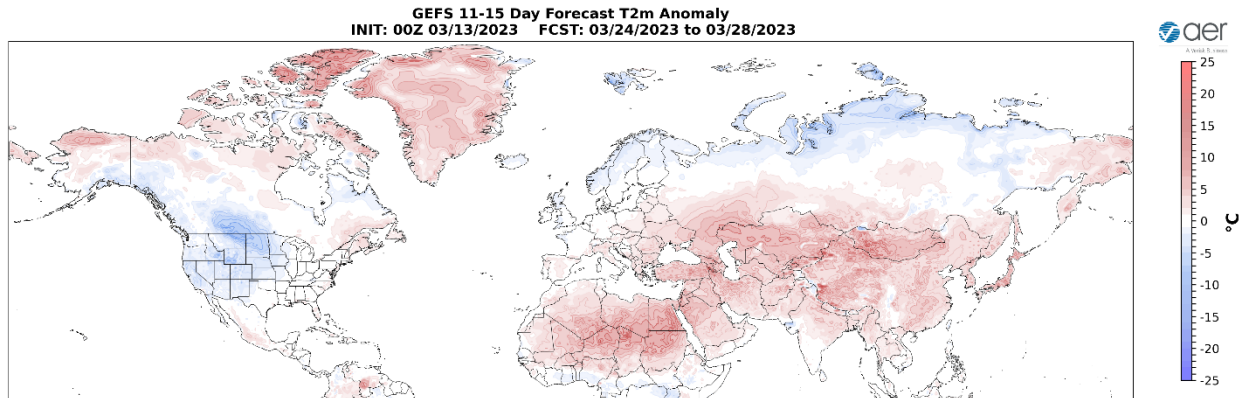


**Figure 8.** Forecasted average 500 mb geopotential heights (dam; contours) and geopotential height anomalies (m; shading) across the Northern Hemisphere from 24 – 28 March 2023. The forecasts are from the 00z 13 March 2023 GFS ensemble.

Ridging/positive geopotential height anomalies centered across Greenland albeit weak will continue to support troughing/negative geopotential height anomalies across Northern Europe with ridging/positive geopotential height anomalies across far Western and Southeastern Europe this period (**Figure 8**). This pattern should continue to favor normal to below normal temperatures across Northern Europe including the UK with normal to above normal temperatures across Southern Europe (**Figures 9**). Troughing/negative geopotential height anomalies is predicted to persist over Northern Asia with widespread ridging/positive geopotential height anomalies spread across Southern Asia this period (**Figure 8**). The induced zonal flow pattern

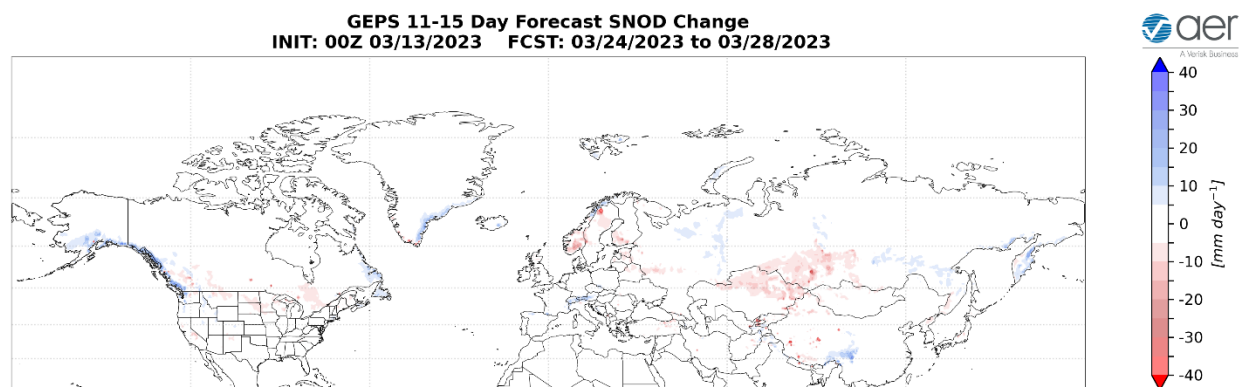


favors widespread normal to above normal temperatures across Southern and Central Asia and Eastern Siberia with normal to below normal temperatures mostly limited to far Northern Asia this period (**Figure 9**).



**Figure 9.** Forecasted surface temperature anomalies (°C; shading) from 24 – 28 March 2023. The forecast is from the 00Z 13 March 2023 GFS ensemble.

Persistent ridging/positive geopotential height anomalies centered south of the Aleutians will continue to anchor troughing/negative geopotential height anomalies in the Gulf of Alaska, Western Canada and much of the US with persistent ridging/positive geopotential height anomalies widespread across the North American Arctic this period (**Figure 8**). This pattern favors widespread normal to above normal temperatures across Alaska, Northern and Eastern Canada and New England with normal to above normal temperatures across Western and Southcentral Canada and much of the US (**Figure 9**).



**Figure 10.** Forecasted snow depth changes (mm/day; shading) from 24 – 28 March 2023. The forecast is from the 00Z 13 March 2023 GEM (Canadian) ensemble.

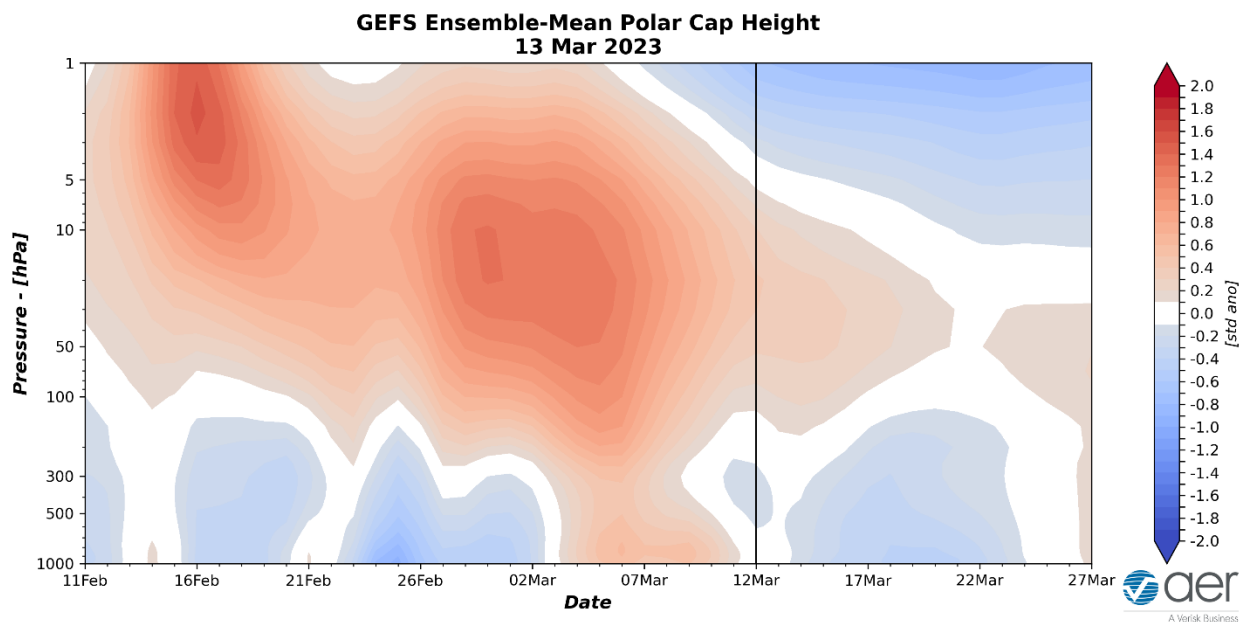
Troughing and/or cold temperatures will support new snowfall across parts of Siberia and the Tibetan Plateau while mild temperatures will support snowmelt across

Scandinavia and Central Asia (**Figure 10**). Troughing and/or cold temperatures will support new snowfall across southern Alaska, Western Canada and the Canadian Maritimes while mild temperatures will support snowmelt across Southern Canada and the Northern US (**Figure 10**).

### Longer Term

#### 30-day

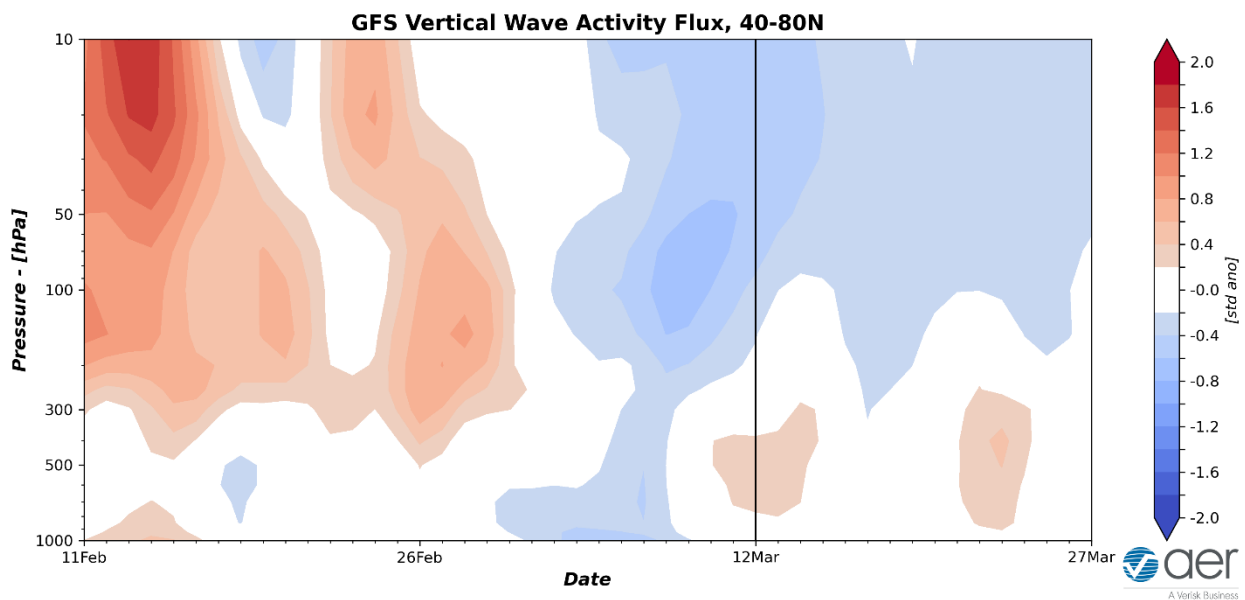
The latest plot of the polar cap geopotential height anomalies (PCHs) currently shows normal to cold/negative PCHs in the upper stratosphere and the mid to lower troposphere with warm/positive PCHs in the lower stratosphere and upper troposphere (**Figure 11**). The warm/positive PCHs in the lower stratosphere are predicted to possibly propagate downward to the surface the last week of March (**Figure 11**). This would be another “drip” of warm/positive PCHs from the stratosphere into the troposphere commonly observed following the major sudden stratospheric warming (SSW) back in mid-February (see **Figure 11**). As long as warm/positive PCHs persist in the lower stratosphere more “drips” into the troposphere are possible.



**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 13 March 2023 GFS ensemble.

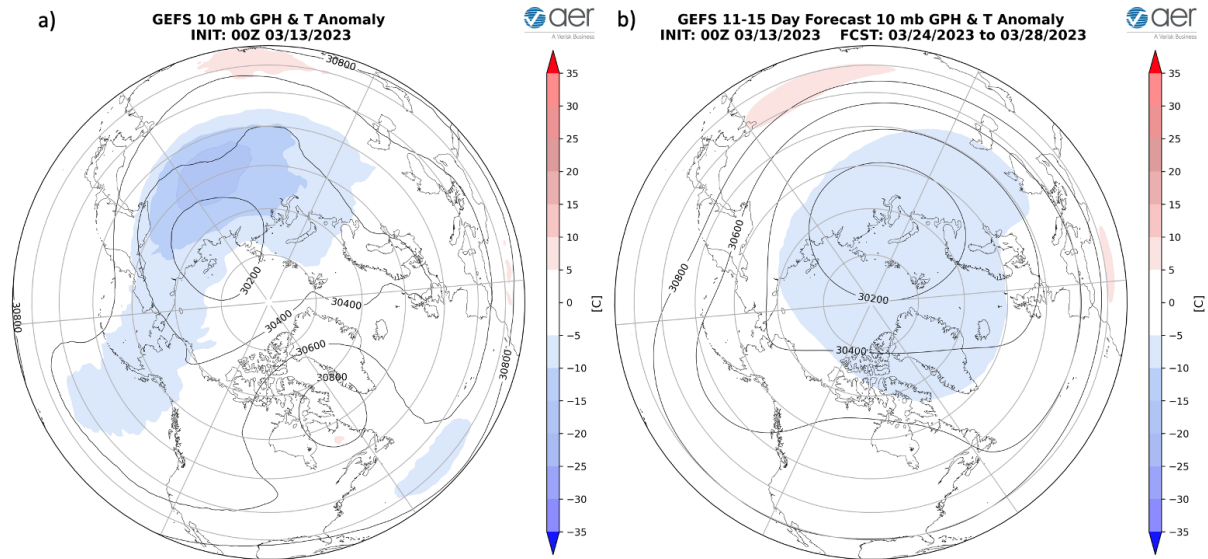
The neutral to cold/negative PCHs in the lower troposphere this week (**Figure 11**) are consistent with the predicted near neutral surface AO (**Figure 1**). However, the AO is

predicted to become more positive next week (**Figure 1**) coinciding when the cold/negative PCHs in the troposphere are predicted to strengthen (**Figure 11**).



**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 13 March 2023 GFS ensemble.

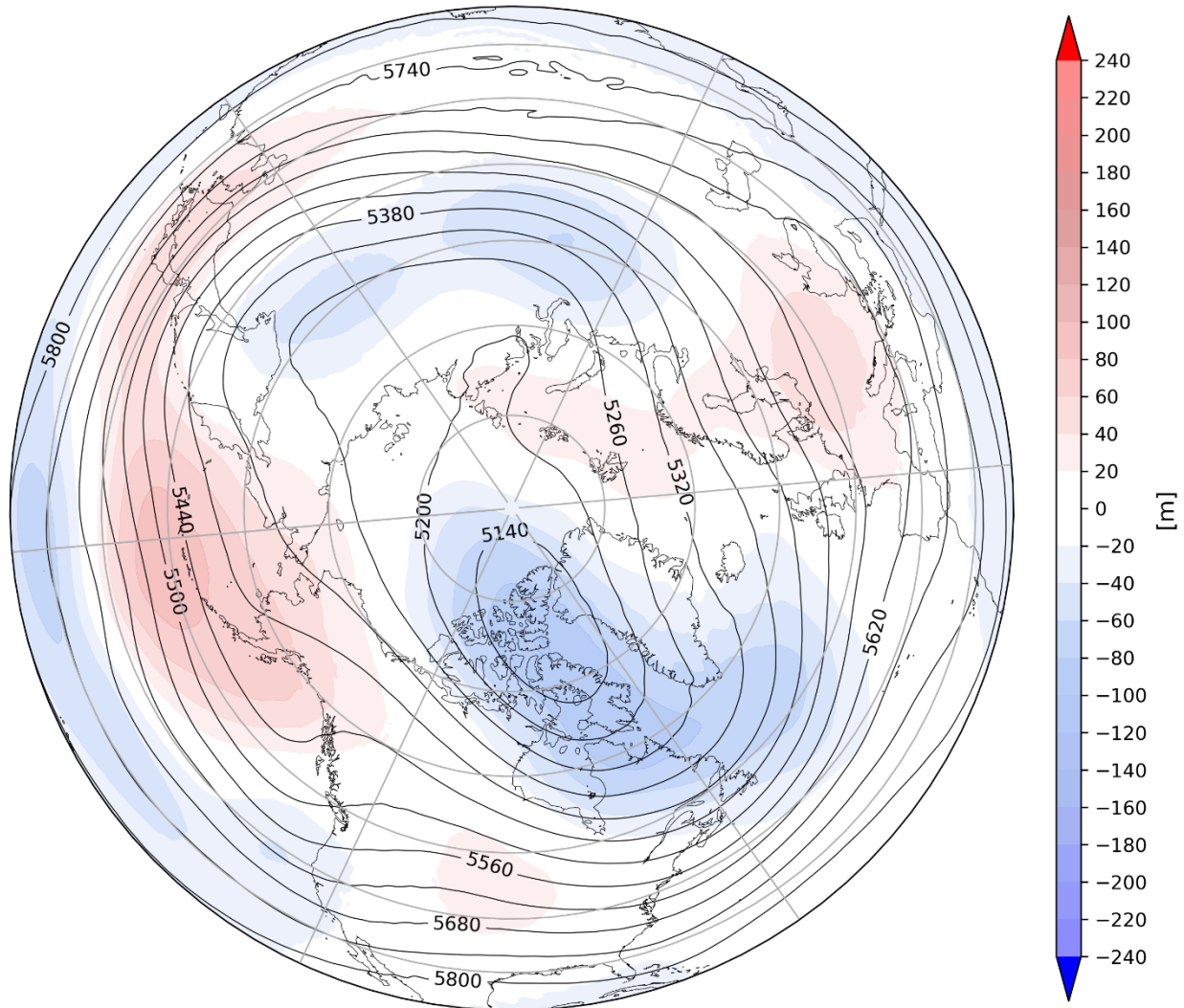
The Vertical Wave Activity Flux (WAFz) from the troposphere to the stratosphere or poleward heat transport in the stratosphere has been below normal WAFz this past week and is predicted to remain weak for the next two weeks (**Figure 12**). Below normal WAFz will allow the highly disrupted stratospheric PV to strengthen represented by predicted cold/negative mid to upper-stratospheric PCHs for next two weeks (**Figure 12**).



**Figure 13.** (a) Initialized 10 mb geopotential heights (dam; contours) and temperature anomalies ( $^{\circ}\text{C}$ ; shading) across the Northern Hemisphere for 13 March 2023. (b) Same as (a) except forecasted averaged from 24 – 28 March 2023. The forecasts are from the 00Z 13 March 2023 GFS model ensemble.

The previously active WAFz has weakened the stratospheric PV with a diffuse PV center over Siberia (**Figure 13a**) with the relatively coldest temperature anomalies across Northern Asia and the North Pacific sector. Meanwhile ridging is spread across Greenland and Northeastern Canada and centered in Baffin Bay in the polar stratosphere (see **Figure 13a**). The less active WAFz predicted the next two weeks will allow the PV to strengthen, with the PV center sliding north to a position over the Laptev Sea coupled with relative cold temperatures over the Arctic (see **Figure 13b**). Meanwhile ridging and warming will all but disappear (see **Figure 13b**). With the ongoing relatively weak PV, the stratospheric AO is predicted to remain negative to neutral the next two weeks (**Figure 13**).

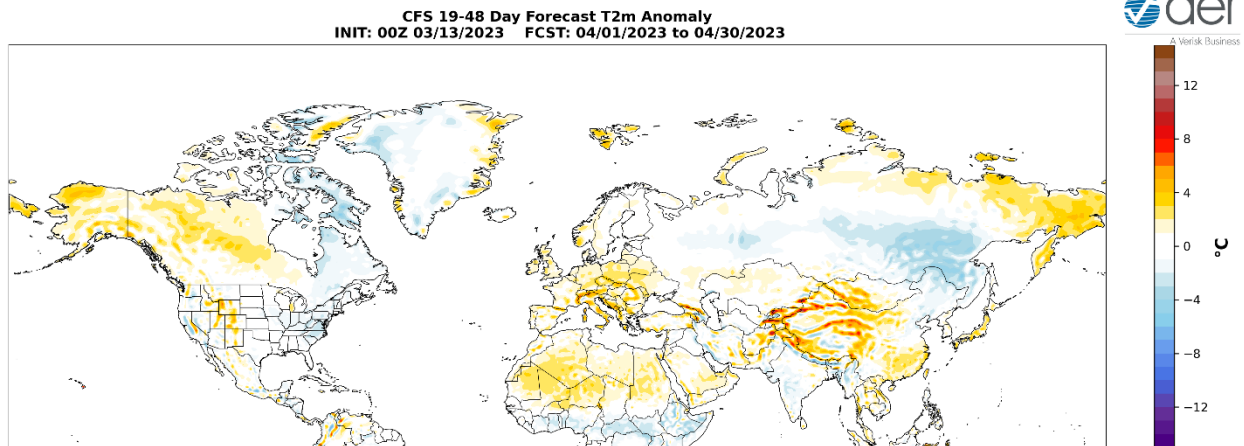
**CFS 500 hPa Forecast Anomaly Apr 2023  
Valid as of 13 Mar 2023**



**Figure 14.** Forecasted average 500 mb geopotential heights (dam; contours) and geopotential height anomalies (m; shading) across the Northern Hemisphere for April 2023. The forecasts are from the 00Z 13 March 2023 CFS.

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

15).

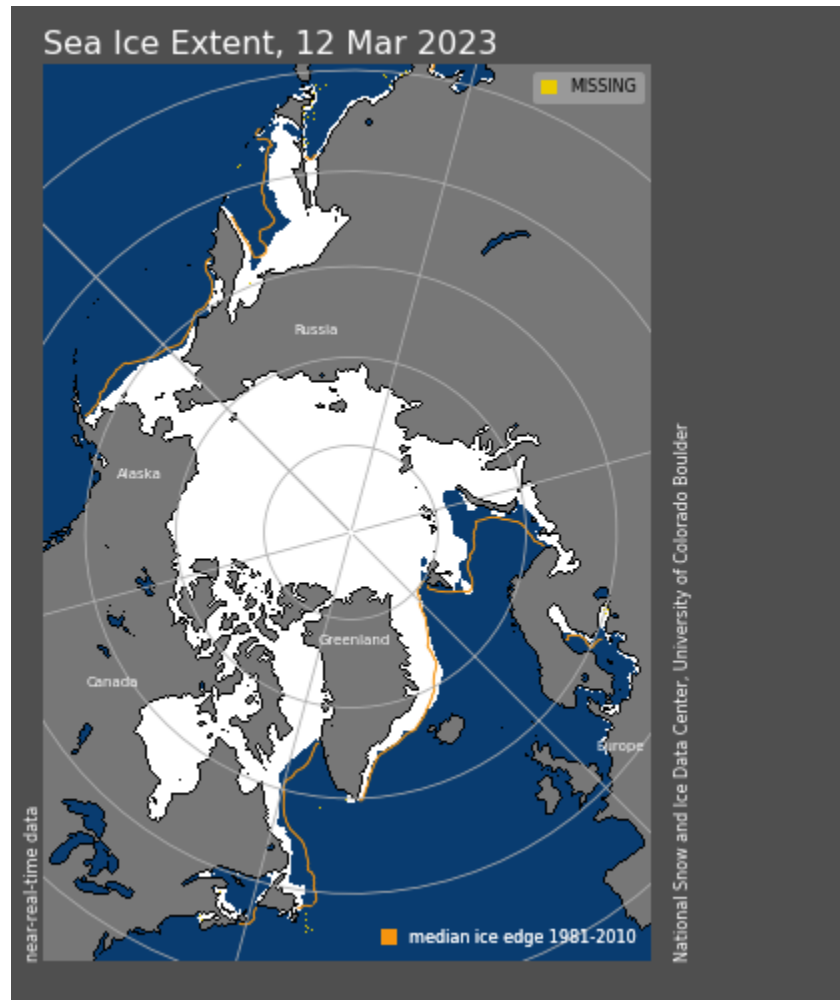


**Figure 15.** Forecasted average surface temperature anomalies ( $^{\circ}\text{C}$ ; shading) across the Northern Hemisphere for April 2023. The forecasts are from the 00Z 13 March 2023 CFS.

### **Boundary Forcings**

#### *Arctic Sea Ice*

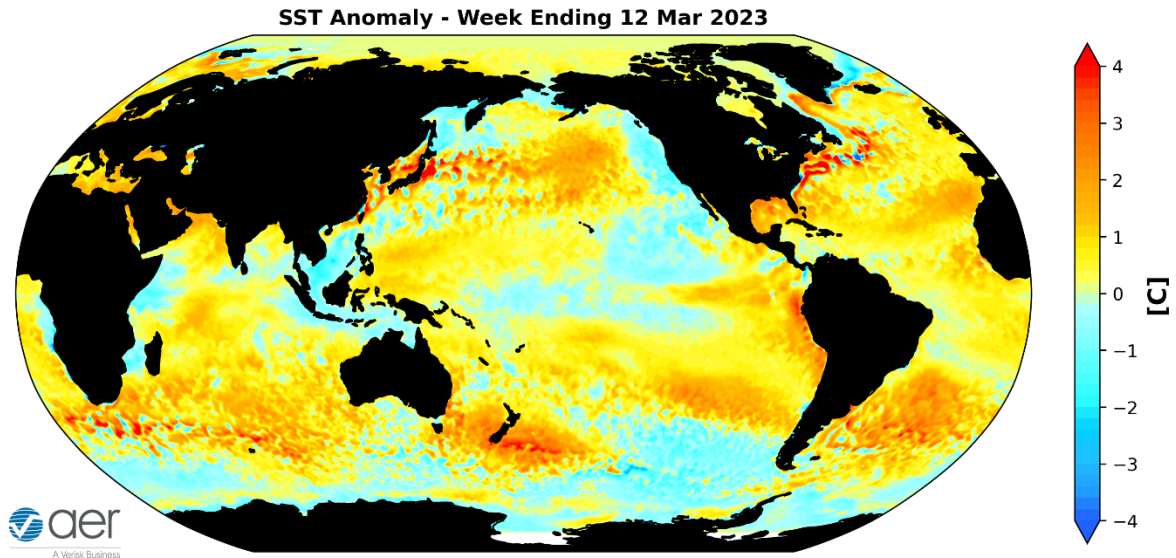
Arctic sea ice, which as expected is below normal (see **Figure 16**) but the regional anomalies have been more extensive than in recent years. The greatest concentration of below normal remains in the Barents-Kara Seas, which I believe favors high latitude blocking. So it could be Arctic sea ice is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



**Figure 16.** Observed Arctic sea ice extent on 12 March 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 slightly below normal and we continue to observe neutral conditions (**Figure 17**) and neutral 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.

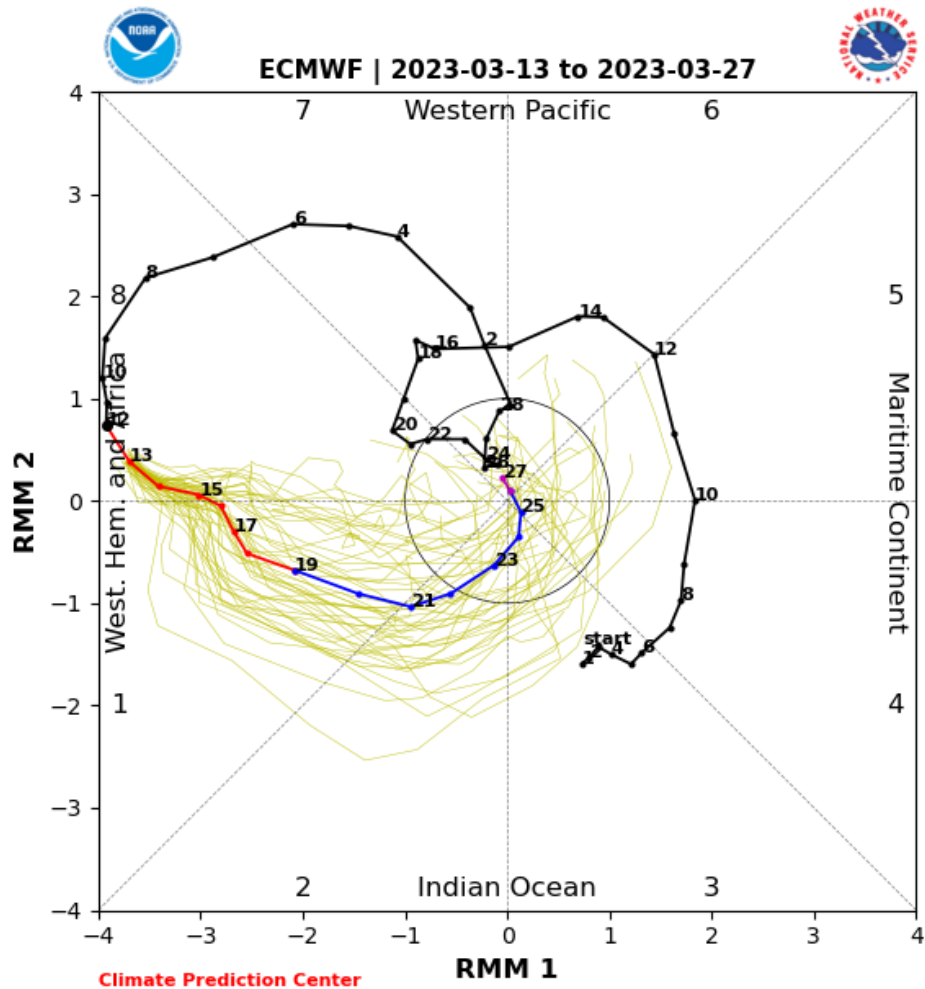


**Figure 17.** The latest weekly-mean global SST anomalies (ending 12 March 2023). Data from NOAA OI High-Resolution dataset.

### *Madden Julian Oscillation*

Currently the Madden Julian Oscillation (MJO) is in phase eight (**Figure 18**). The forecasts are for the MJO to transition into phase 1. Phases 8 and 1 favor high latitude blocking with troughing over the US. Seems that the MJO is having some influence on the weather across North America in the short term but there are also large-scale atmospheric features such as ridging near the Aleutians that is not consistent with MJO phases 8 and 1. But admittedly this is outside of my expertise.





**Figure 18.** Past and forecast values of the MJO index. Forecast values from the 00Z 13 March 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:

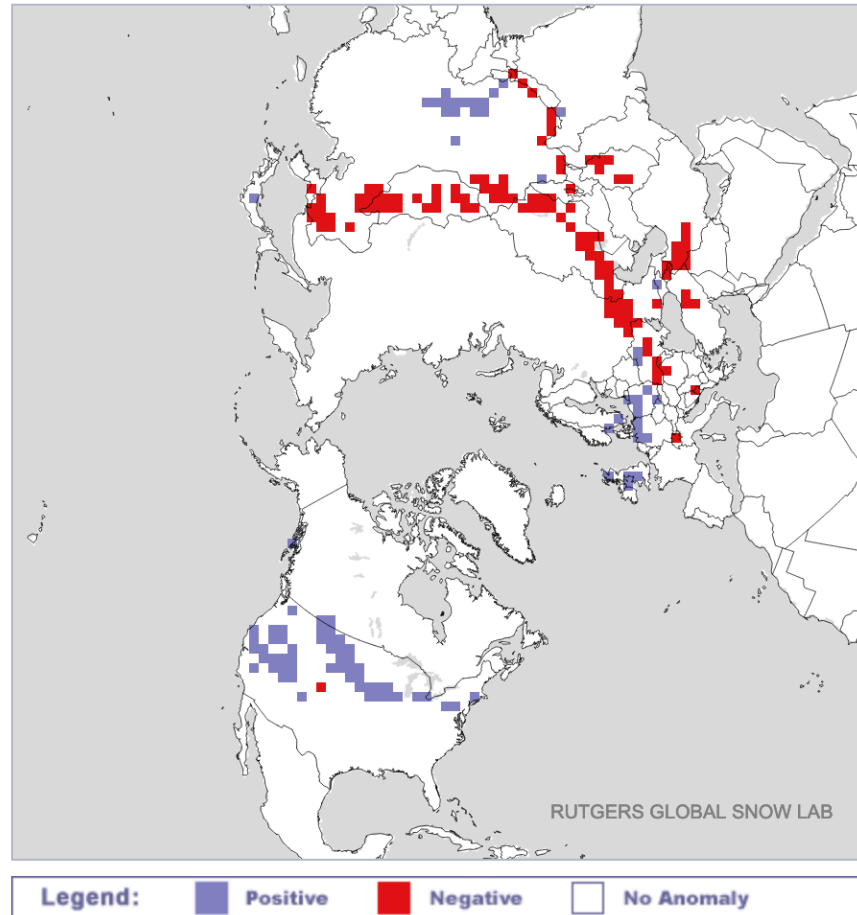
[https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/CLIVAR/clivar\\_wh.shtml](https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/CLIVAR/clivar_wh.shtml)

### Snow Cover

Snow cover extent (SCE) anomalies across the NH has decreased slightly this past week mostly across Eurasia with above normal snow cover focused in China, Northern Europe and the Western US. Meanwhile Eurasian snow cover is now below normal (see **Figure 19**). Snow cover is below normal in Eastern Europe and much of

Asia. Snow cover is above normal in North America. I expect snow cover to decrease in the coming weeks, but more slowly across the US with predicted colder weather.

### Daily SCE Departure - March 12, 2023 (Day 71)



**Figure 19.** Observed North Hemisphere snow cover anomalies on 12 March 2023. Plot from <http://climate.rutgers.edu/snowcover/index.php>

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

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