

# Arctic Oscillation and Polar Vortex Analysis and Forecasts

February 1, 2021

*Special blog on winter 2018/2019 retrospective can be found here*  
- <http://www.aer.com/winter2019>

*Special blog on winter 2017/2018 retrospective can be found here*  
- <http://www.aer.com/winter2018>

*Special blog on winter 2016/2017 retrospective can be found here*  
- <http://www.aer.com/winter2017>

*Special blog on winter 2015/2016 retrospective can be found here*  
- <http://www.aer.com/winter2016>

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 negative and is predicted to remain negative the next two weeks as pressure/geopotential height anomalies are predicted to remain positive across the North Atlantic side of the Arctic the next two weeks.

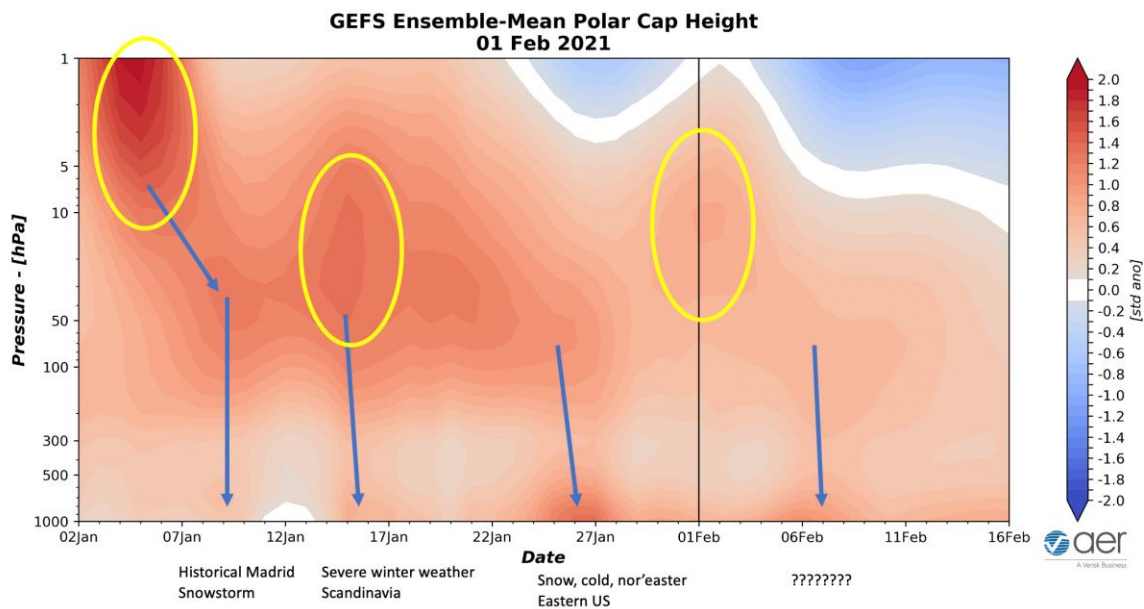
- The current negative AO is reflective of mostly positive pressure/geopotential height anomalies across the Arctic with mixed pressure/geopotential height anomalies across the mid-latitudes. The North Atlantic Oscillation (NAO) is currently neutral with weak pressure/geopotential height anomalies across Greenland and Iceland; and the NAO is predicted to remain neutral to negative as positive pressure/geopotential height anomalies are predicted to strengthen across Greenland the next two weeks.
- Over the next two weeks predicted strengthening ridging/positive geopotential height anomalies across Greenland will favor deepening troughing/negative geopotential height anomalies across Europe. This week because the center of the high pressure remains over Baffin Bay, this will allow a less amplified flow across Europe with a strong westerly component bringing in milder, maritime air across the continent with widespread normal to above normal temperatures for much of Europe including the United Kingdom (UK). The exceptions will be Scotland and Scandinavia which will remain north of the westerly belt of winds and where low heights favor normal to below temperatures. However next week the winds are predicted to turn more northerly allowing cold temperatures to expand across much of Europe.
- Over the next two weeks, persistent ridging/positive geopotential height anomalies in the Central Arctic, and then coupled with ridging across Greenland will anchor troughing/negative geopotential height anomalies across Northern Asia with ridging/positive geopotential height anomalies to the south. This pattern favors normal to below normal temperatures across Northern and parts of Eastern Asia, including much of Siberia, with normal to above normal temperatures across Southern and Western Asia.
- Across North America, ridging/positive geopotential height anomalies in the Gulf of Alaska, in the Central Arctic and then across Greenland will deepen troughing/negative geopotential height anomalies first in western North America but will expand into eastern North America next week. This week, normal to below normal temperatures will build across Alaska and Western Canada with seasonably cold temperatures along the United States (US) East Coast behind today's Nor'easter however over next week normal to below normal temperatures will deepen and become more widespread across Alaska, much of Canada and the Western and Central US with normal to above normal temperatures in Northeastern Canada and the Southeastern US.
- In the Impacts section I discuss how ongoing peculiarities in this winter's polar vortex (PV) disruption (s) and the additional possible influence from the ongoing and complex PV disruption on the weather across the Northern Hemisphere (NH).

### ***Impacts***

I want to warn everyone first that in this blog, I will be winging it and spit balling it. As I have been saying in many previous blogs, I do consider this event unique in the

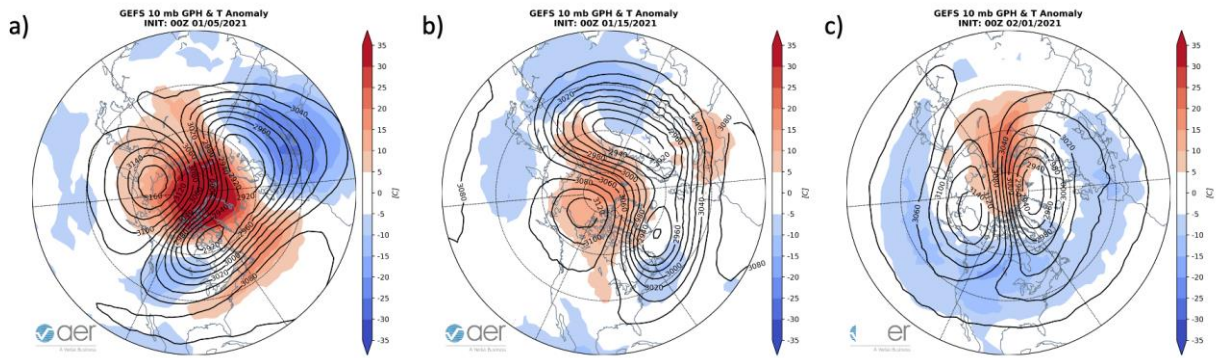
observational record and in my own experience. But hopefully I can draw the right conclusions from past successes but more importantly from past failures.

As I discussed in last week's blog, I don't feel that this now month-long PV disruption should be considered just one long event but is multiple events consisting of two or possibly three separate PV disruptions. I copied **Figure 11** of polar cap geopotential height anomalies (PCHs) below and highlighted in yellow the three different stratospheric PV disruptions in **Figure i**. The first one occurred the end of the first week of January and seems to be focused in the upper stratosphere.



**Figure i.** 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 February 2021 GFS ensemble. Blue arrows show downward propagation of PCHs and yellow ovals show PV disruptions.

In **Figure ii**, I show the 10 hPa geopotential heights similar to **Figure 13** for the day when winds reversed from westerly to easterly at 60°N and 10 hPa (a major mid-winter warming or MMW) for all three disruptions. At the time I thought that it was ambiguous whether the PV disruption will be considered a displacement or a split but at least from **Figure ii** it appears to be a split. With the blue arrows, I highlight downward propagation of maximums in the PCHs, similar to last week. The PV disruption then propagated to the mid-stratosphere early in the second week of January and then quickly to the surface. I also include in **Figure i**, some severe winter weather coincident with the downward propagation of maximum PCHs.



**Figure ii.** (a) Observed 10 mb geopotential heights (dam; contours) and temperature anomalies ( $^{\circ}\text{C}$ ; shading) across the Northern Hemisphere for 5 January 2021. (b) Same as (a) except for 15 January 2021. (c) Same as (a) except for 1 February 2021

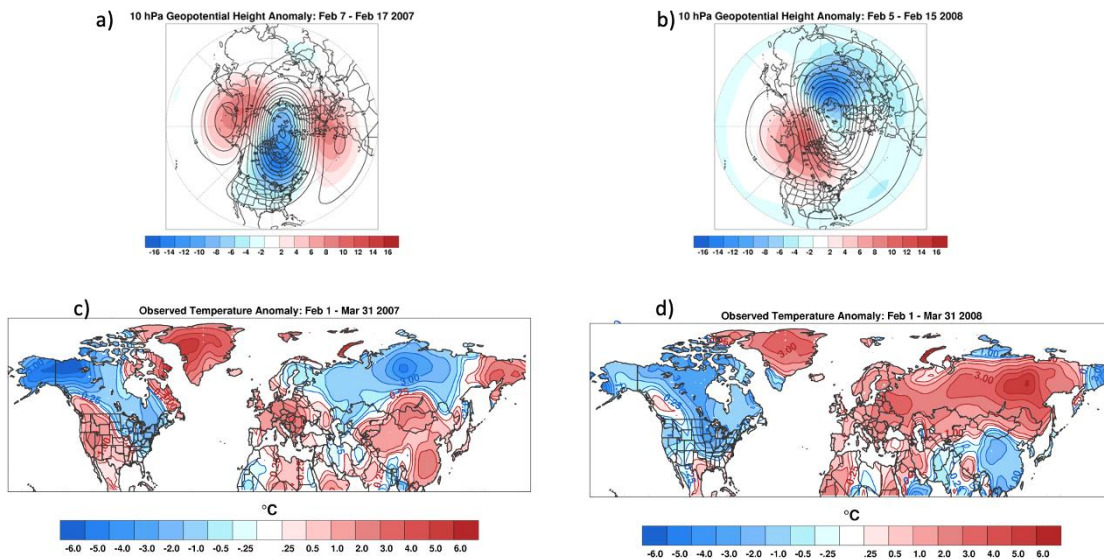
The second disruption of the stratospheric PV occurred right around January 15<sup>th</sup> and this event peaked in the mid-stratosphere. This event resulted in even stronger easterly winds at  $60^{\circ}\text{N}$  and 10 hPa than the first event (was actually a record for the date). From **Figure ii** we can see that this disruption also resulted in a PV split. The maximum PCHs then quickly propagated to the surface and coincided with the historical Madrid snowstorm. But this disruption has a long tail in the lower stratosphere and there was a second propagation to the surface at the end of January that coincided with widespread snow across the US (as I tweeted out North American snow cover extent went from decadal lows to decadal highs in just a matter of days), an Arctic outbreak into the Northeastern US and seems to be wrapping up with today's historical Nor'easter (a strong winter storm in the Northeastern US that often brings heavy snow and is called such because of the accompanying northeast winds).

What looks to be the third and final stratospheric PV is occurring today also peaking in the mid-stratosphere. Once again winds reversed from westerly to easterly at  $60^{\circ}\text{N}$  and 10 hPa, though this is the weakest of the three. From **Figure ii**, in contrast to the two previous PV disruptions this looks to be more of a PV displacement, where the PV center remains whole but bodily is displaced from its favored location near the North Pole. The GFS is predicting another downward propagation to the surface over the weekend and into early next week. Of course, I don't know what severe winter event will coincide with this upcoming downward propagation, but the GFS is showing increased risk of widespread snowfall across Europe and the ECMWF has been toying with a second Nor'easter.

For much of the season and in previous winters I have characterized PV splits as favoring cold in Europe, not so much cold for the Eastern US but an increased risk in heavy snowfalls/Nor'easters and in contrast PV displacements favor cold but less favorable for snow in the Eastern US and often Europe remains mild. Siberia which is

the region with the greatest sensitivity to PV strength, is cold for both splits and displacements.

As I have been arguing for weeks now even if the PV center is displaced towards Eurasia, that the PV disruption does eventually favors cold in the Eastern Canada/US. In addition, I do believe that the latest PV disruption favors cold in Eastern Canada/US with the PV center in the North Atlantic side of the Arctic, high pressure near Alaska. And with counterclockwise flow around low pressure this would create cross polar flow from Siberia to Canada and eventually the US, driving cold south east of the Rockies. In **Figure iii**, I show the two most recent PV displacements from early February 2007 and 2008, that also resemble the current displacement from early February 2021, and the observed NH surface temperature anomalies for February and March 2007 and 2008 respectively. Both winters experienced cold temperatures from Alaska, for much of Canada and the Eastern US while Europe was mild.



**Figure iii.** (a) Observed 10 hPa geopotential heights (dam; contours) and anomalies (m; shading) across the Northern Hemisphere for 7 - 17 February 2007. (b) same (a) except for 5 -15 February 2008. (c) observed surface temperatures 1 February - 31 March 2007 (d) same as (a) except for 1 February - 31 March 2008.

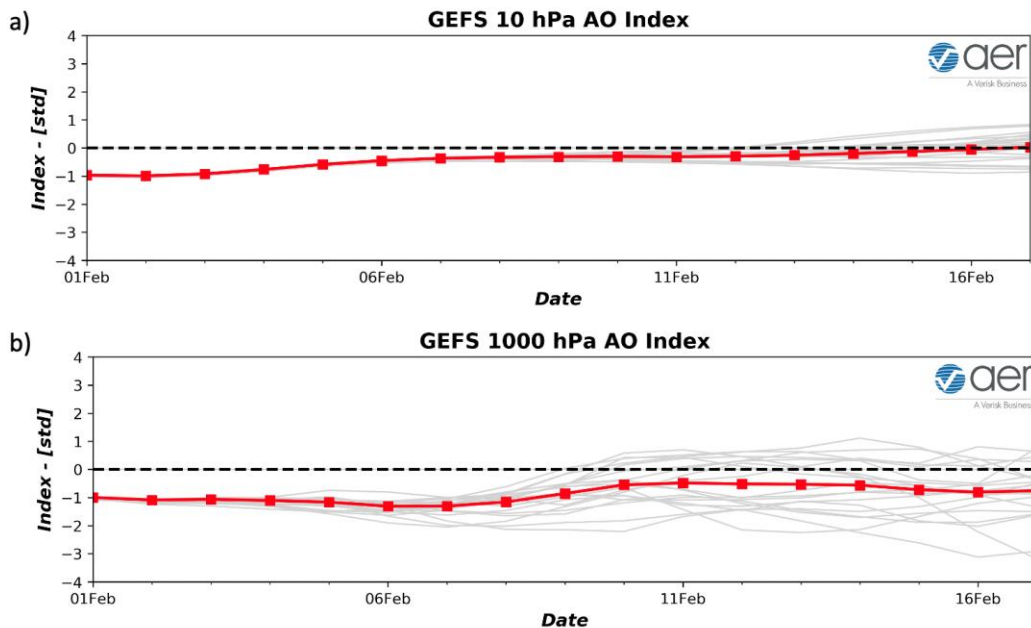
Now here is challenge, I would argue there are at least two maybe three different disruptions. Which one influences our weather, the first, the second, the third or all three, none? I of course don't believe none. For the Eastern US, I believe any of the three events favors colder weather eventually though the displacement might favor a more intense cold. What about Europe? A PV split favors cold but a displacement does not. But even if a PV displacement does not favor cold weather in Europe, this one just might. First, I often discuss the stratospheric PV center has a reflection in the mid-troposphere. The stratospheric PV center is predicted to be located near Scandinavia

and should promote low heights in the region in the troposphere favoring cold. The multiple PV disruptions seem to have also given rise to Greenland blocking/high pressure that shows no signs of abating. High pressure centered on Greenland will force troughing across Europe with cold temperatures.

I guess this post is not as provocative now that the models are showing cold both in the US and Europe. But if I was skeptical of the models when they were predicting mild, that should not change if they are now predicting cold (though it is comforting). It is my experience and there may even be papers on this (so if you know of one please let me know!), the models struggle predicting the impacts of stratosphere-troposphere coupling until the signal reaches the tropopause (generally below 100 hPa). From **Figure i**, we can see that the signal from the latest PV disruption is still in the mid-stratosphere and is not predicted to reach the lower stratosphere/tropopause until the weekend. That is when the model forecasts should become reliable. I did include the CFS forecast from February in the blog (**Figure 14**) because whether I trust it or not, it is consistent with my thinking.

1-5 day

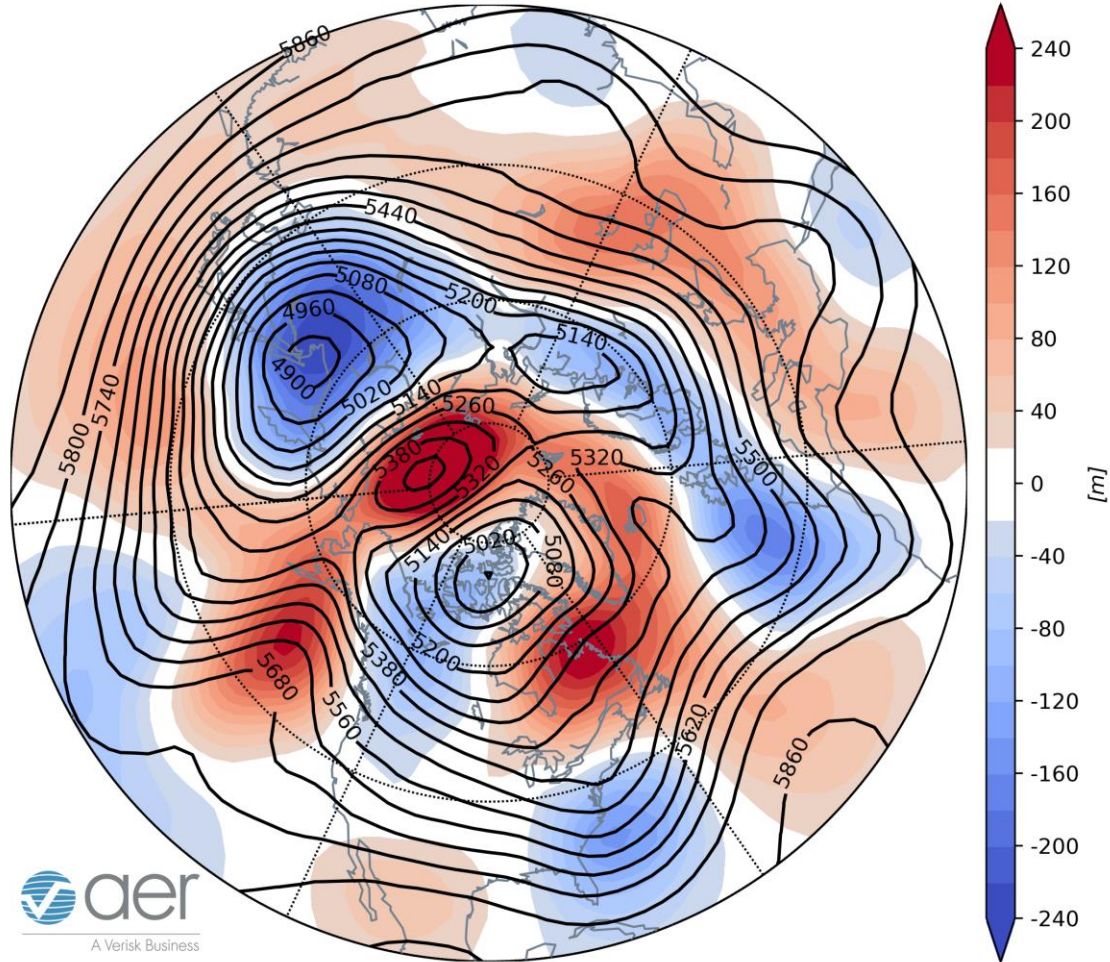
The AO is currently negative (**Figure 1**) with mostly positive pressure/geopotential height anomalies across the Arctic and mixed geopotential height anomalies across the mid-latitudes of the NH (**Figure 2**). And with predicted positive geopotential height anomalies across Greenland (**Figure 2**),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



**Figure 1.** (a) The predicted daily-mean AO at 10 hPa from the 00Z 1 February 2021 GFS ensemble. (b) The predicted daily-mean near-surface AO from the 00Z 1 February 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 centered near Greenland are predicted to force downstream troughing/negative geopotential height anomalies across Europe (**Figure 2**). However, with Greenland high pressure/blocking centered in Baffin Bay, this will allow a westerly component to the winds across Europe bringing milder, maritime air. This pattern favors normal to below normal temperatures across Northern Europe including much of the UK as heights remain low but across the remainder of Europe a mild westerly flow will favor normal to above normal temperatures (**Figure 3**). This week, ridging/positive geopotential height anomalies centered over the Central Arctic will help to anchor troughing/negative geopotential height anomalies across much of Siberia and East Asia in the mid-troposphere with ridging/positive geopotential height anomalies across Western Asia (**Figure 2**). This pattern favors normal to below normal temperatures for Northern and Eastern Asia with normal to above normal temperatures for Western and Southern Asia (**Figure 3**).

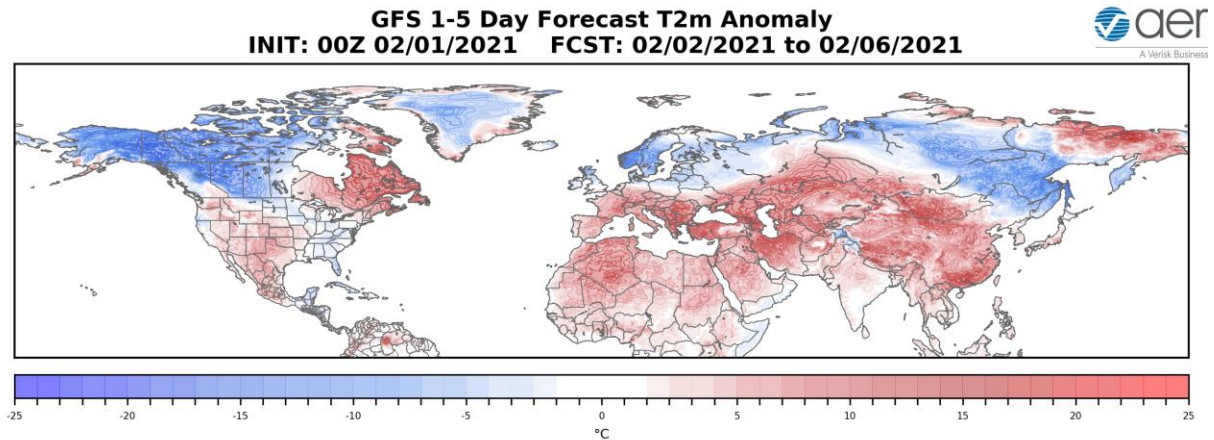
**GEFS 1-5 Day Forecast 500 mb GPH/GPH Anomaly  
INIT: 00Z 02/01/2021 FCST: 02/02/2021 to 02/06/2021**



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

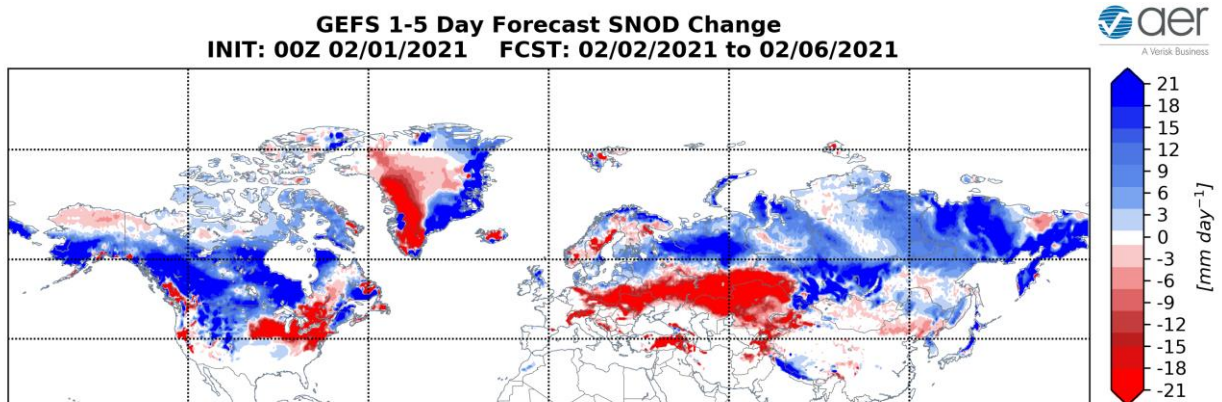
This week ridging/positive geopotential height anomalies across Baffin Bay and the Gulf of Alaska will force troughing/negative geopotential height anomalies across most of Western Canada, the Western US and the Eastern US (**Figure 2**). This pattern is predicted to bring widespread normal to above normal temperatures across Eastern Canada and the Western US with normal to below normal temperatures across Alaska, Western Canada and the Eastern US (**Figure 3**).





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

Trouthing and/or colder temperatures are predicted to support new snowfall across Northeastern Europe, Northern and Eastern Asia while warmer temperatures will cause snow melt in Central Europe and Western Asia (**Figure 4**). Trouthing and/or colder temperatures are predicted to support new snowfall across southern Alaska, Western and Central Canada and Maine while warmer temperatures will cause snow melt in parts of Western Canada, the Western US, the Great Lakes and into the Northeastern US (**Figure 4**).

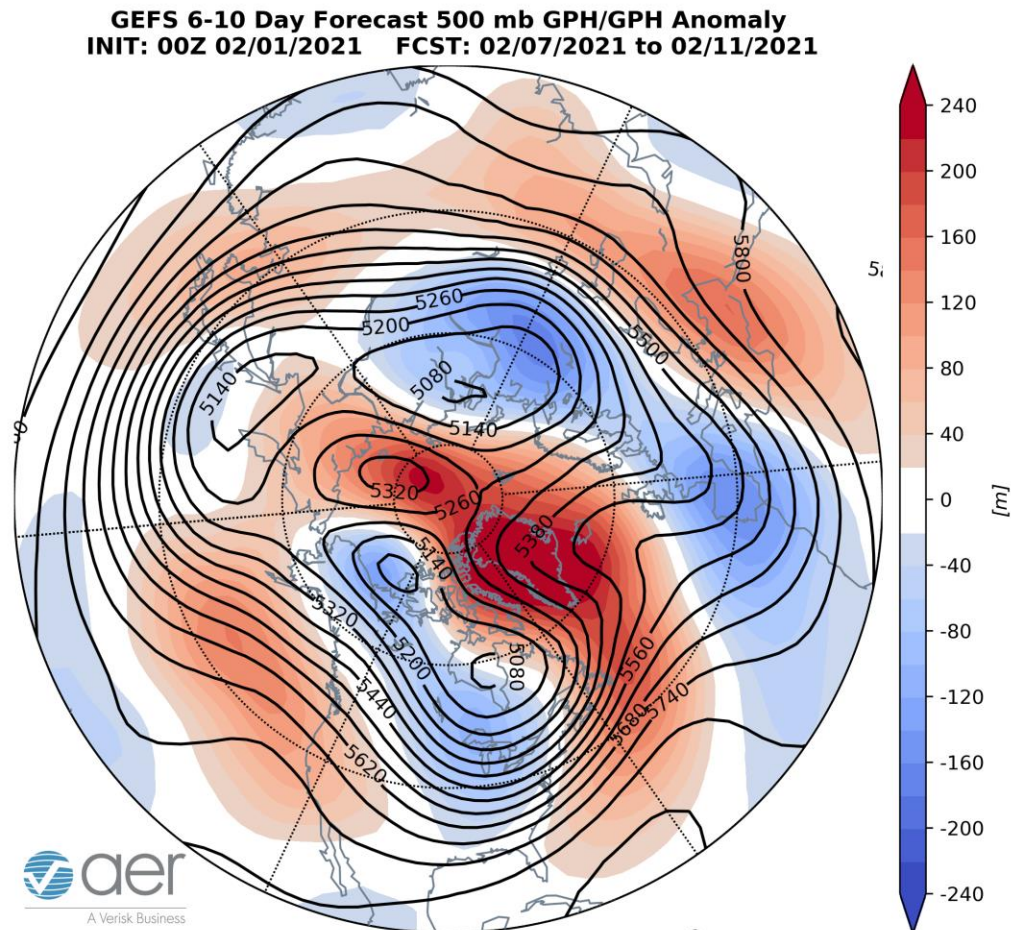


**Figure 4.** Forecasted snow depth changes ( $\text{mm}/\text{day}$ ; shading) from 2 – 6 February 2021. The forecast is from the 00Z 1 February 2021 GFS ensemble.

Mid-Term

6-10 day

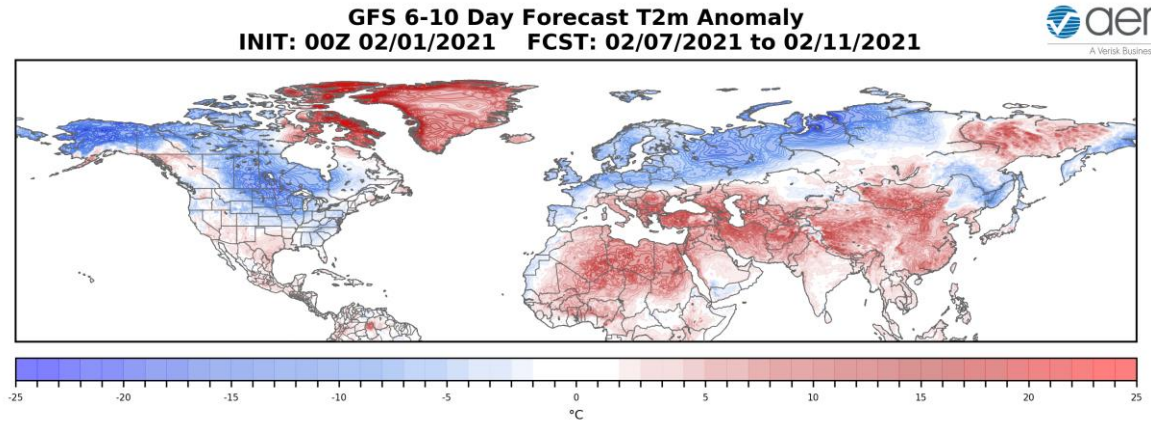
The AO is predicted to remain negative next week (**Figure 1**) as positive geopotential height anomalies strengthen across the North Atlantic side of the Arctic and in the Central Arctic with mixed geopotential height anomalies across the mid-latitudes of the NH (**Figure 5**). And with positive geopotential height anomalies predicted across Greenland (**Figure 5**), the NAO is predicted to also remain negative to neutral.



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

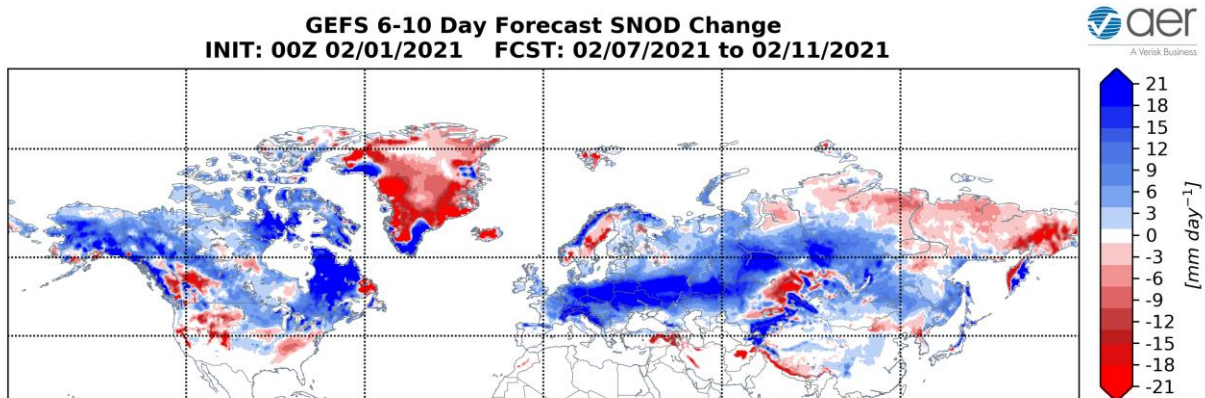
With ridging/positive geopotential height anomalies previously centered across Baffin Bay predicted to become centered over Greenland, troughing/negative geopotential height anomalies will deepen across Europe while the flow will become increasingly northerly this period (**Figures 5**). This will allow normal to below normal temperatures to become more widespread across Northern and Western Europe including the UK with normal to above normal temperatures across Southern and Eastern Europe (**Figure 6**). Persistent ridging/positive geopotential height anomalies in the Central Arctic will anchor troughing/negative geopotential height anomalies in the mid-troposphere across

Siberia and now the Urals with ridging/positive geopotential height anomalies across Southern Asia this period (**Figure 5**). This is predicted to favor widespread normal to below normal temperatures across much of Northern Asia with normal to above normal temperatures in Southern Asia (**Figure 6**).



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

Ridging/positive geopotential height anomalies in the Gulf of Alaska will force troughing/negative geopotential height anomalies from the North Slope of Alaska into the Eastern US with more ridging/positive geopotential height anomalies in the Western US this period (**Figure 5**). This pattern is predicted to bring normal to below normal temperatures across Alaska, much of Canada, the Central US and the US East Coast with normal to above normal temperatures in the Southwestern US and Northeastern Canada (**Figure 6**).

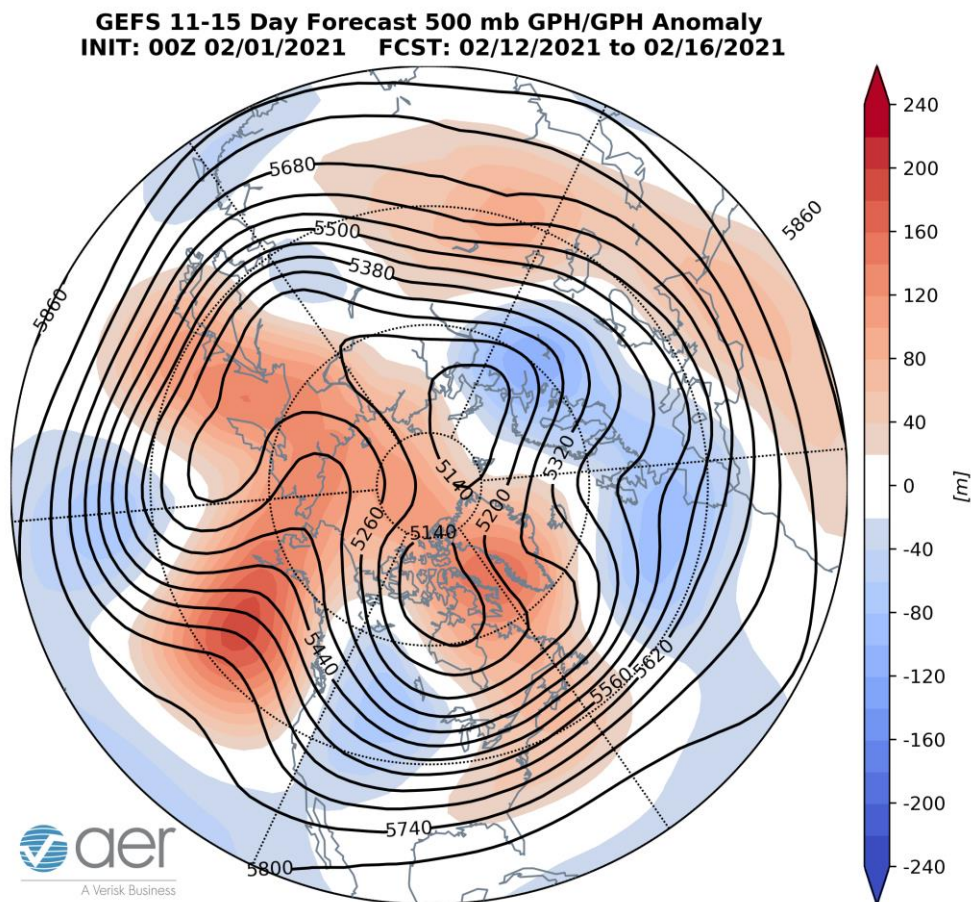


**Figure 7.** Forecasted snow depth changes (mm/day; shading) from 7 – 11 February 2021. The forecasts are from the 00Z 1 February 2021 GFS ensemble.

Trouching and/or colder temperatures are predicted to potentially support new snowfall across parts of the UK, and much of Europe outside of the Mediterranean region, Western, Central and Eastern Asia while warmer temperatures will cause regionalized snow melt in Scandinavia, Central Asia, the Himalayas and Korea (**Figure 7**). Trouching and/or colder temperatures are predicted to support new snowfall across much of Alaska, Canada and the Northern US while warmer temperatures will cause possible snow melt in the Western US and Ohio Valley (**Figure 7**).

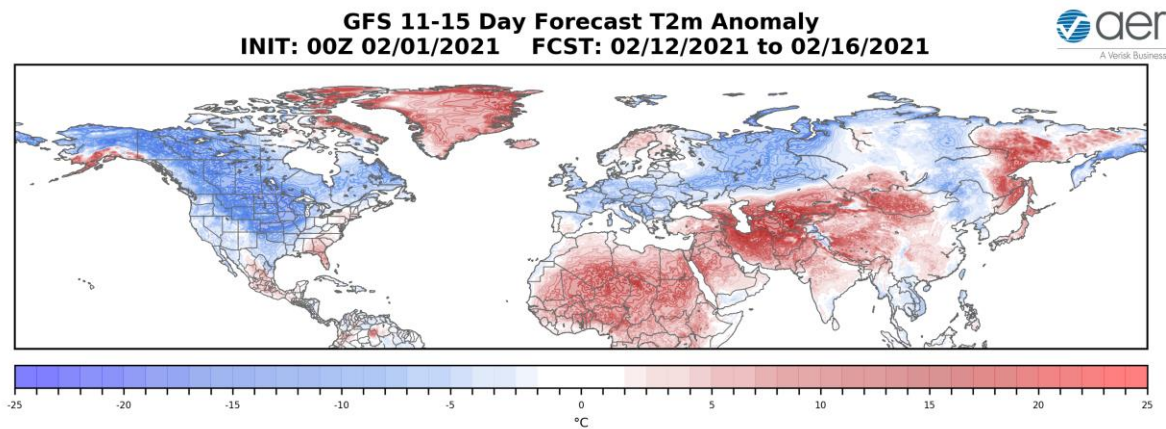
### 11-15 day

As geopotential height anomalies are predicted to remain positive on the North Atlantic side of the Arctic and in the Central Arctic with mixed geopotential height anomalies across the mid-latitudes of the NH (**Figure 8**), the AO should remain negative this period (**Figure 1**). With continued positive pressure/geopotential height anomalies spread across Greenland (**Figure 8**), the NAO is predicted to remain neutral to negative this period as well.



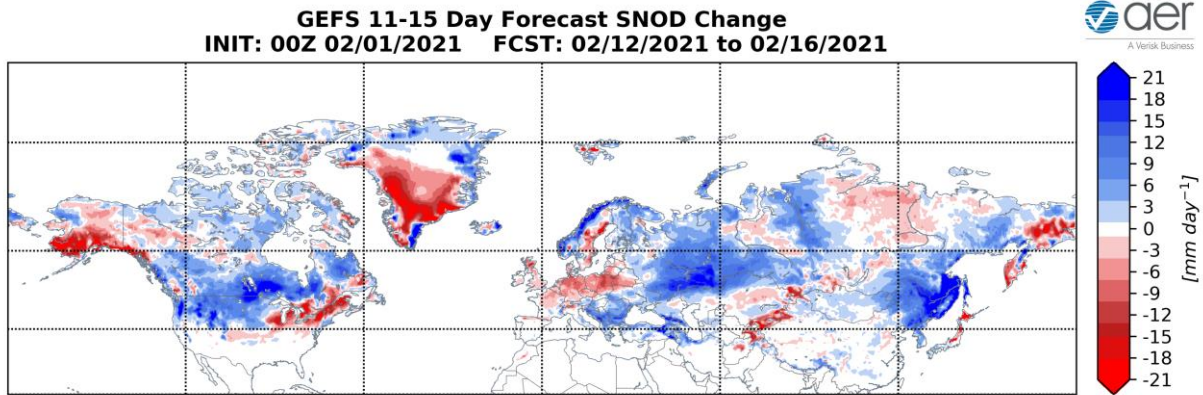
**Figure 8.** Forecasted average 500 mb geopotential heights (dam; contours) and geopotential height anomalies (m; shading) across the Northern Hemisphere from 12 – 16 February 2021. The forecasts are from the 00z 1 February 2021 GFS ensemble.

With persistent ridging/positive geopotential height anomalies over Greenland, this will anchor troughing/negative geopotential height anomalies across Europe this period (**Figures 8**). The forecast remains for widespread normal to below normal temperatures across Europe, with the exceptions of normal to above normal temperatures across Scandinavia, and Portugal this period (**Figures 9**). Ridging/positive geopotential height anomalies across the Arctic and over Eastern Siberia will help persist troughing/negative geopotential height anomalies across Northern and East Asia with ridging/positive geopotential height anomalies across Southern Asia this period (**Figure 8**). This pattern favors normal to below normal temperatures across Northern and Eastern Asia with normal to above normal temperatures across Eastern Siberia, Western and Southern Asia (**Figure 9**).



**Figure 9.** Forecasted surface temperature anomalies (°C; shading) from 12 – 16 February 2021. The forecasts are from the 00z 1 February 2021 GFS ensemble.

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



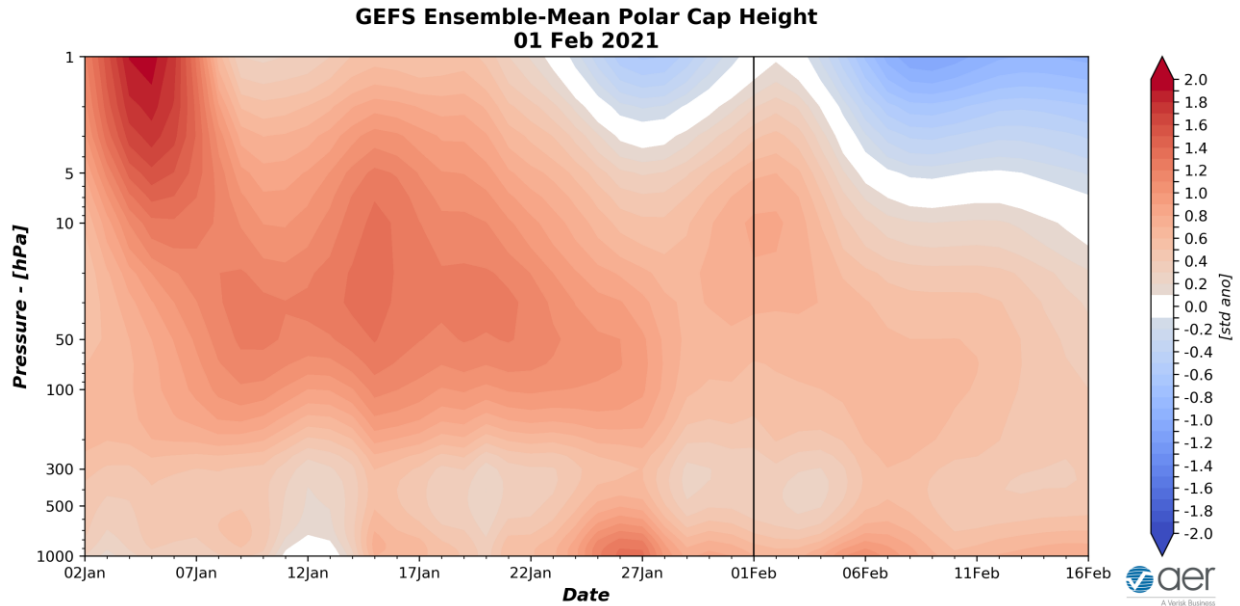
**Figure 10.** Forecasted snow depth changes (mm/day; shading) from 12 – 16 February 2021. The forecasts are from the 00z 1 February 2021 GFS ensemble.

Trouging and/or colder temperatures are predicted to support new snowfall across Southeastern Europe, Western and Eastern Asia, including Korea while warmer temperatures will cause snowmelt in Western Europe, Finland and Eastern Siberia (**Figure 10**). Trouging and/or colder temperatures are predicted to support new snowfall across Alaska, much of Southern Canada and the Northwestern and Northcentral US and while warmer temperatures will result in snowmelt in the Great Lakes, Southeastern Canada and Northeastern US (**Figure 10**). Though based on the temperature forecast this seems overdone.

### *Longer Term*

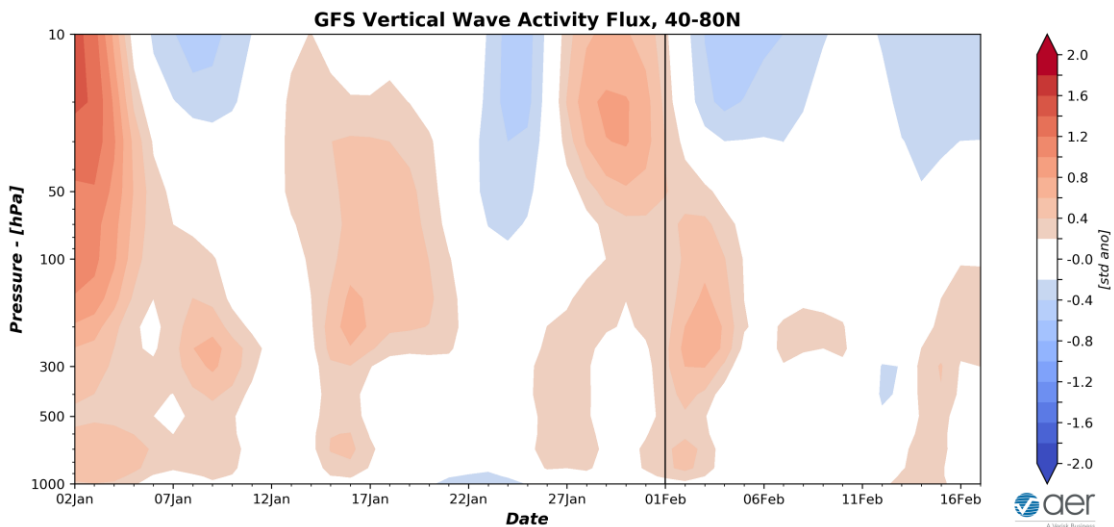
#### *30-day*

The latest plot of the polar cap geopotential height anomalies (PCHs) currently shows warm/positive PCHs throughout the troposphere and stratosphere (**Figure 11**). The warm positive PCHs are predicted to persist for the next two weeks across the mid to low stratosphere and troposphere however in the upper stratosphere PCHs are predicted to turn cold/negative for much of the next two weeks as the PV tries to recover from previous and ongoing PV disruptions.



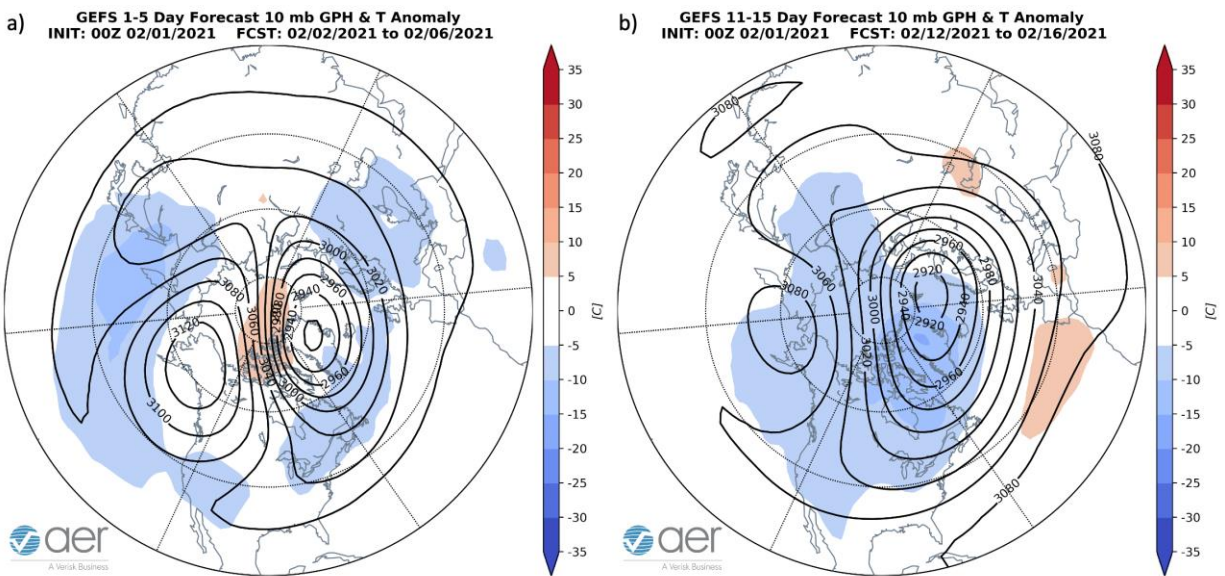
**Figure 11.** Observed and predicted daily polar cap height (i.e., area-averaged geopotential heights poleward of 60°N) standardized anomalies. The forecast is from the 00Z 1 February 2021 GFS ensemble.

Normal to warm/positive PCHs in the lower troposphere are consistent with the predicted negative surface AO the next two weeks (**Figure 1**). Warm/positive PCHs in the mid-stratosphere are consistent with the negative to neutral stratospheric AO (at 10 hPa) the next two weeks (**Figure 1**).



**Figure 12.** Observed and predicted daily vertical component of the wave activity flux (WAFz) standardized anomalies, averaged poleward of 40-80°N. The forecast is from the 00Z 1 February 2021 GFS ensemble.

The plot of the Wave Activity Flux (WAFz and is proportional to poleward heat transport) forecast is showing currently one last pulse of active WAFz in the stratosphere and troposphere this week (**Figure 12**). Though a major mid-winter warming (MMW where the zonal winds reverse from westerly to easterly at 60°N and 10 hPa) has already occurred in early January, this new pulse of WAFz is predicted to force another MMW which will delay its recovery. The stratospheric community will consider this just one long event, but I do think that they should be considered at least two separate events.

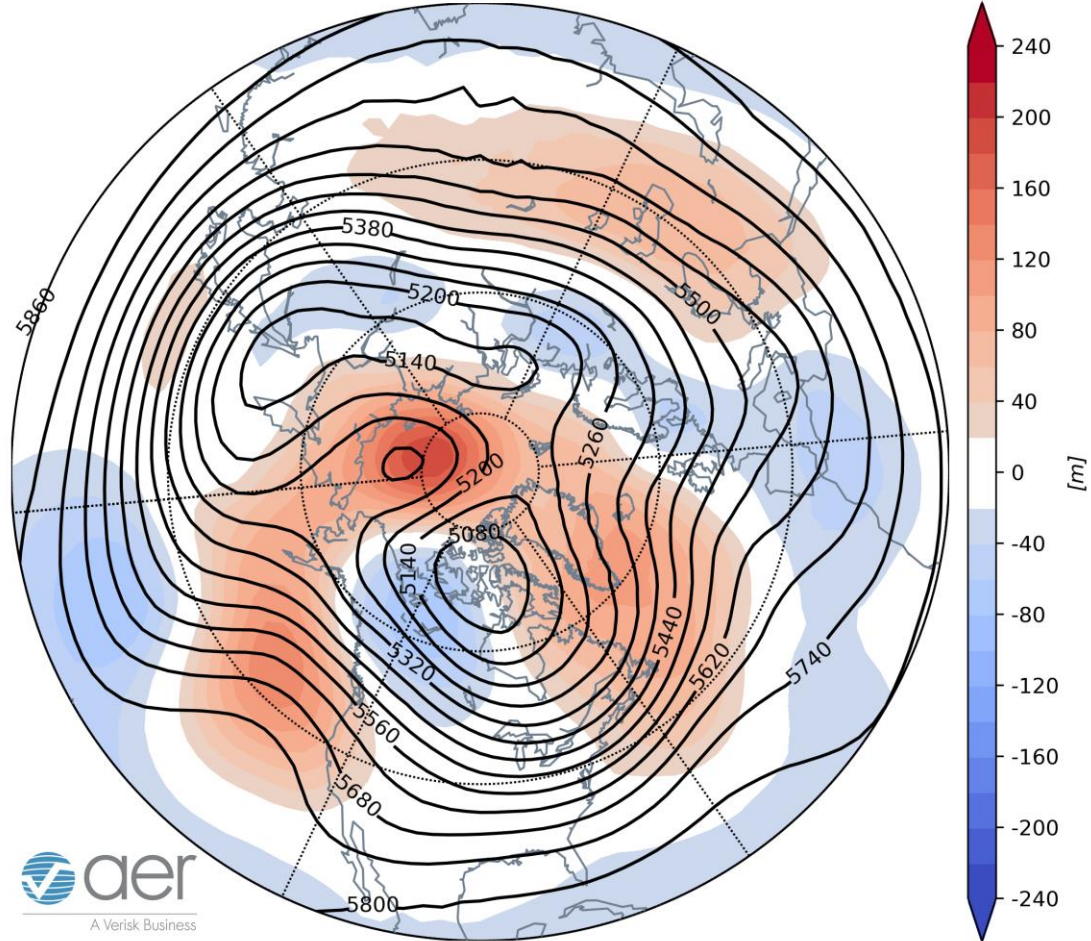


**Figure 13.** (a) Forecasted 10 mb geopotential heights (dam; contours) and temperature anomalies (°C; shading) across the Northern Hemisphere for 2 – 6 February 2021. (b) Same as (a) except forecasted averaged from 12 – 16 February 2021. The forecasts are from the 00Z 1 February 2021 GFS model ensemble.

The PV is currently split with the major daughter vortex over Greenland and the minor daughter vortex over the North Pacific (**Figure 13**). The minor daughter vortex is predicted to quickly move westward to try to merge with the major daughter vortex over Siberia (**Figure 13**). The increased WAFz activity this week is predicted to result in yet more warming of the polar stratosphere, though more minor than last month (**Figure 13**). The increased WAFz activity this week will also change the PV's orientation from east to west across Northern Eurasia to one north south across the North Atlantic side of the Arctic from the Urals/Scandinavia to Eastern Canada while high pressure strengthens near Alaska (**Figure 13**). There are lobes of low pressure one over Siberia from the remnants of the daughter vortex and another over the Western US. There could be reflections of these lobes in the mid-troposphere. I believe that this orientation of the PV favors cold temperatures in Central and Eastern North America.



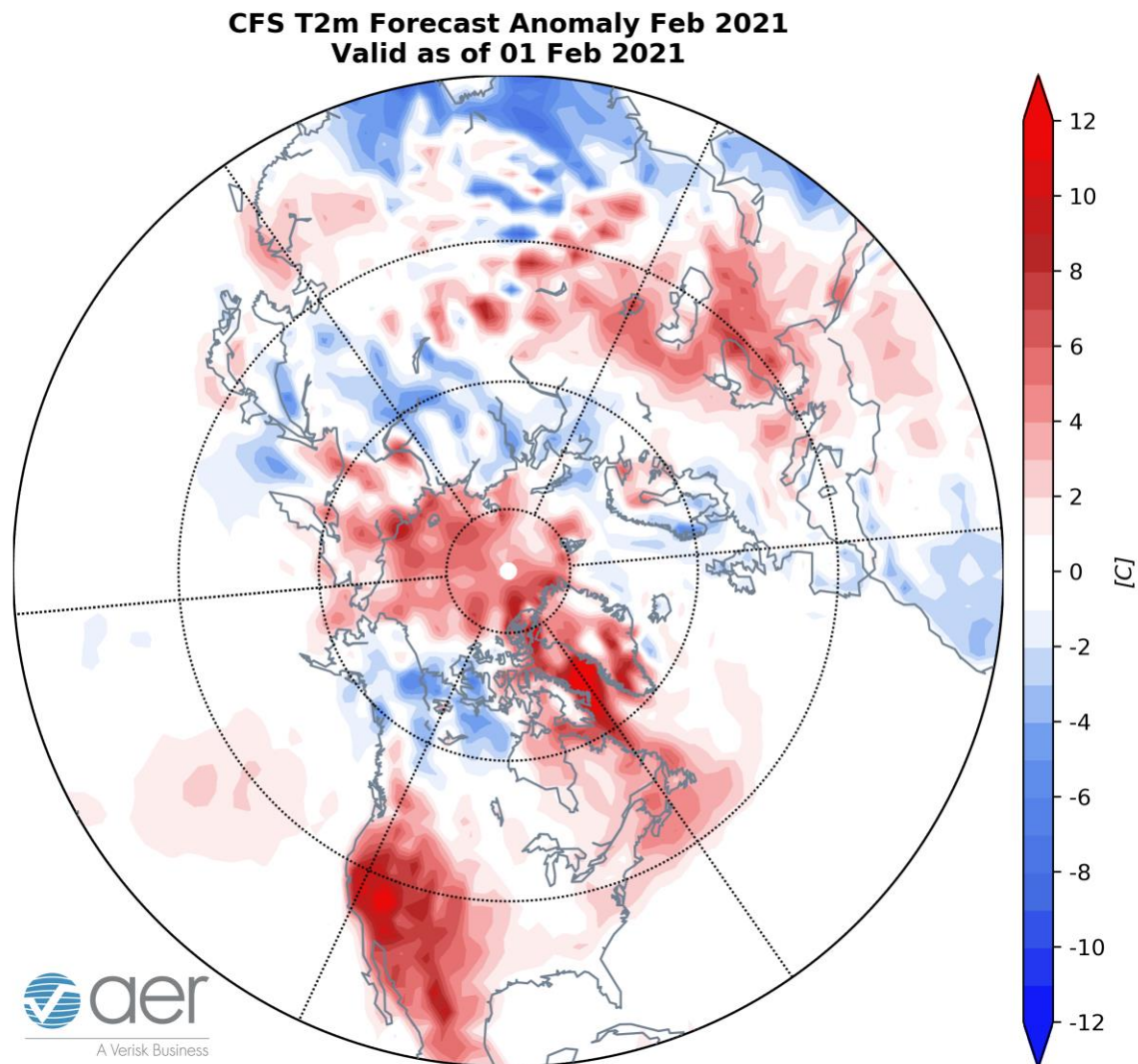
**CFS 500 hPa Forecast Anomaly Feb 2021  
Valid as of 01 Feb 2021**



**Figure 14.** Forecasted average 500 mb geopotential heights (dam; contours) and geopotential height anomalies (m; shading) across the Northern Hemisphere for February 2021. The forecasts are from the 00Z 1 February 2021 CFS.

I made an exception this week and I included in this week's blog the monthly 500 hPa geopotential heights (**Figure 14**) and the surface temperatures (**Figure 15**) forecast for February (the current month and not March the next month) from the Climate Forecast System (CFS; the plots represent yesterday's four ensemble members). The forecast for the troposphere is ridging across Greenland and Iceland, the Central Arctic, the Gulf of Alaska and Southern Asia with troughing in Northern Eurasia including much of Europe and much of North America (**Figure 14**). This pattern favors relatively cold temperatures for Northern and Western Europe, Northern and Eastern Asia, Eastern Canada and the Eastern US with seasonable to relatively warm temperatures for Southern Europe, Central and Southern Asia, Alaska, Western Canada (**Figure 15**). I included the CFS for February because there is much uncertainty about the February forecast but the CFS forecast shows Greenland blocking and cold in Europe and eastern

North America, which is consistent with the period when the PV recovers following a disruption, and it matches my own thinking.



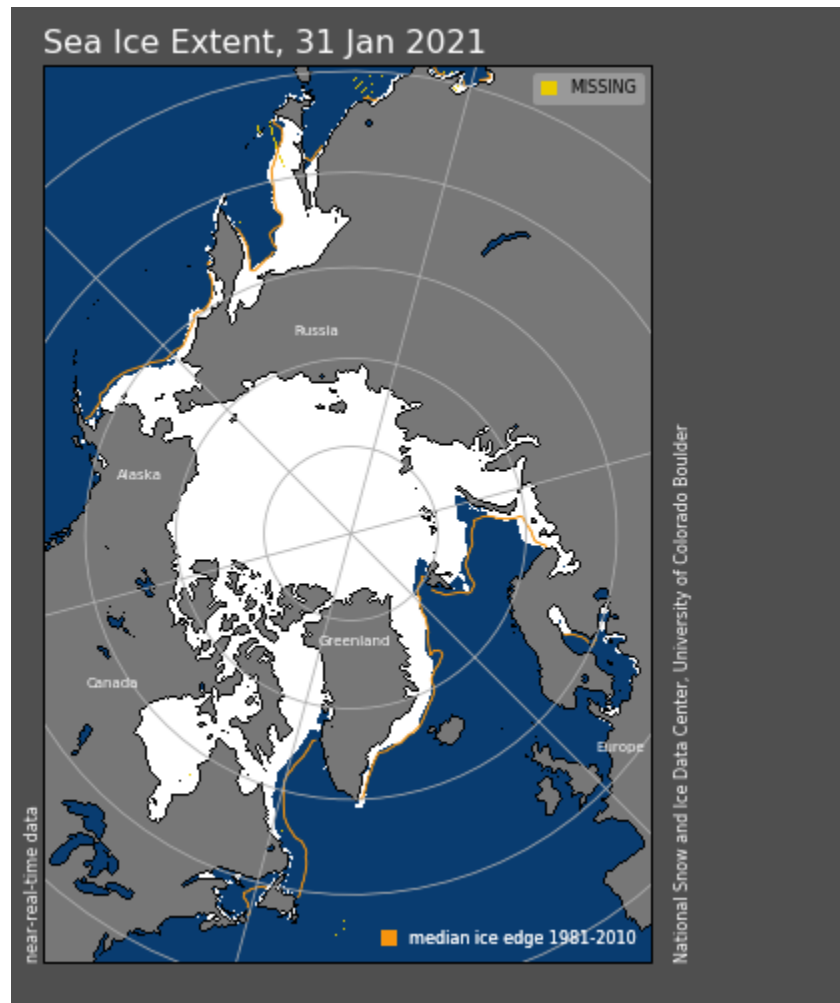
**Figure 15.** Forecasted average surface temperature anomalies ( $^{\circ}\text{C}$ ; shading) across the Northern Hemisphere for February 2021. The forecasts are from the 00Z 1 February 2021 CFS.

### *Surface Boundary Conditions*

#### *Arctic sea ice extent*

Arctic sea ice continues to grow but currently remains below normal. Negative sea ice anomalies exist in the Bering Sea, now in Baffin Bay and in the Barents-Kara Seas (**Figure 16**). A cold winter in Siberia has resulted in above normal sea ice in the Sea of

Okhotsk. Below normal sea ice in the Barents-Kara seas favor Ural blocking and cold temperatures in Central and East Asia, 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 and Bering seas may favor colder temperatures across North America but have not been shown to weaken the PV. Sea ice should continue to grow in this region based on the forecast.



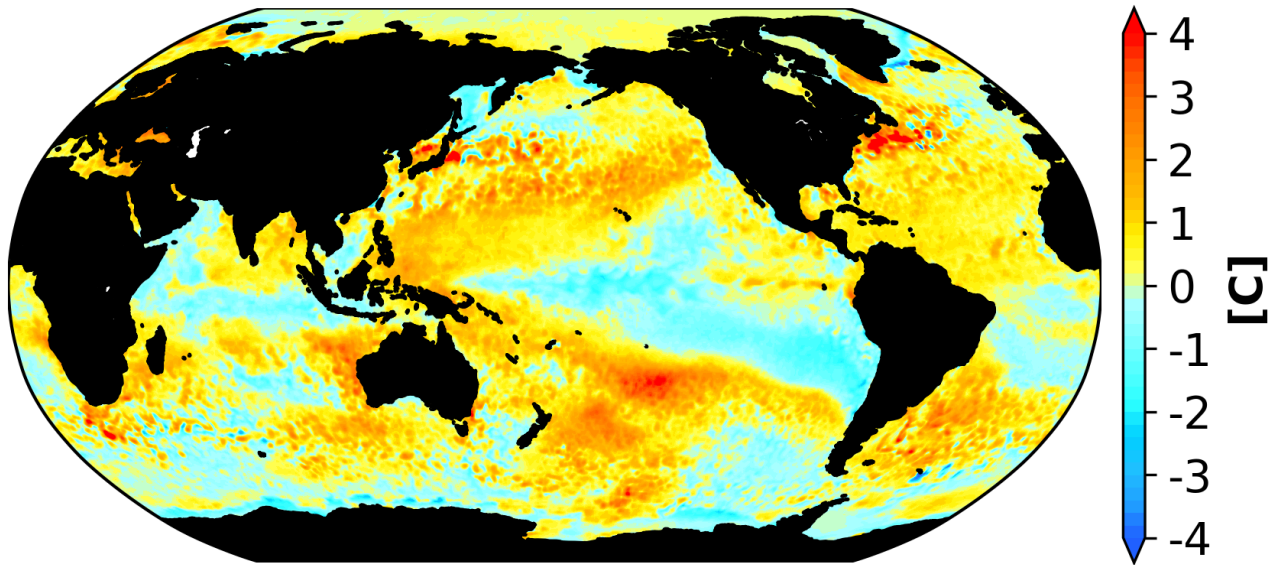
**Figure 16.** Observed Arctic sea ice extent on 31 January 2021 (white). Orange line shows climatological extent of sea ice based on the years 1981-2010. Image courtesy of National Snow and Ice Data Center (NSIDC).

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

Equatorial Pacific sea surface temperatures (SSTs) anomalies remain negative and we continue to observe moderate to weak La Niña conditions (**Figure 17**) and La Niña is expected to persist and remain moderate to weak through the winter. Observed SSTs

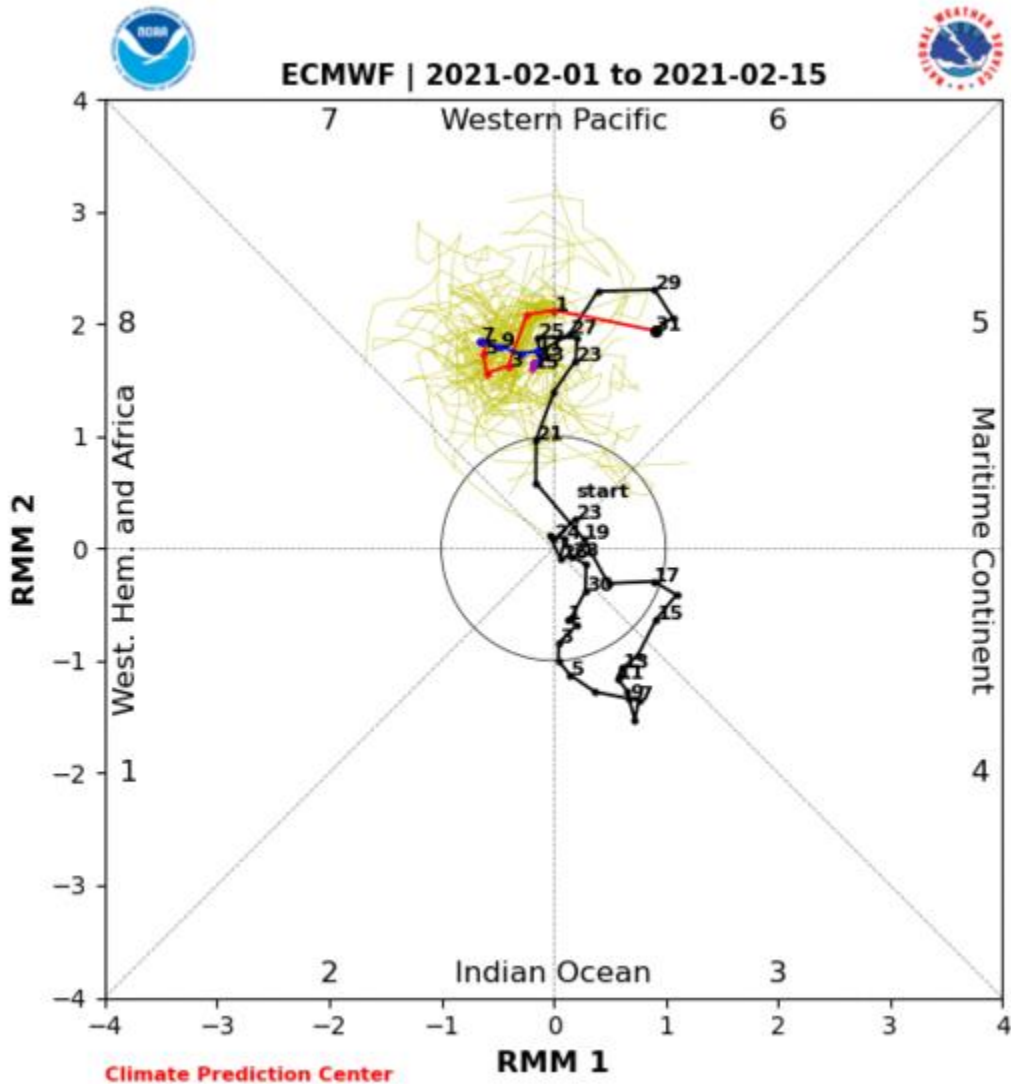
across the NH remain well above normal especially near Alaska and in the Gulf of Alaska, the western North Pacific and offshore of eastern North America though below normal SSTs exist regionally especially in the Southern Hemisphere and south of Iceland. Warm SSTs in the Gulf of Alaska may favor mid-tropospheric ridging in the region.

### SST Anomaly - Week Ending 31 Jan 2021



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

Currently the Madden Julian Oscillation (MJO) is in phase six (**Figure 18**). The forecasts are for the MJO to remain in phase six and then move into phase seven. Phases six and seven favor ridging in eastern North America but eventually favors blocking across Northern Canada and troughing in the Eastern US. The MJO could eventually contribute to a colder pattern across eastern North America but admittedly this is outside of my expertise.



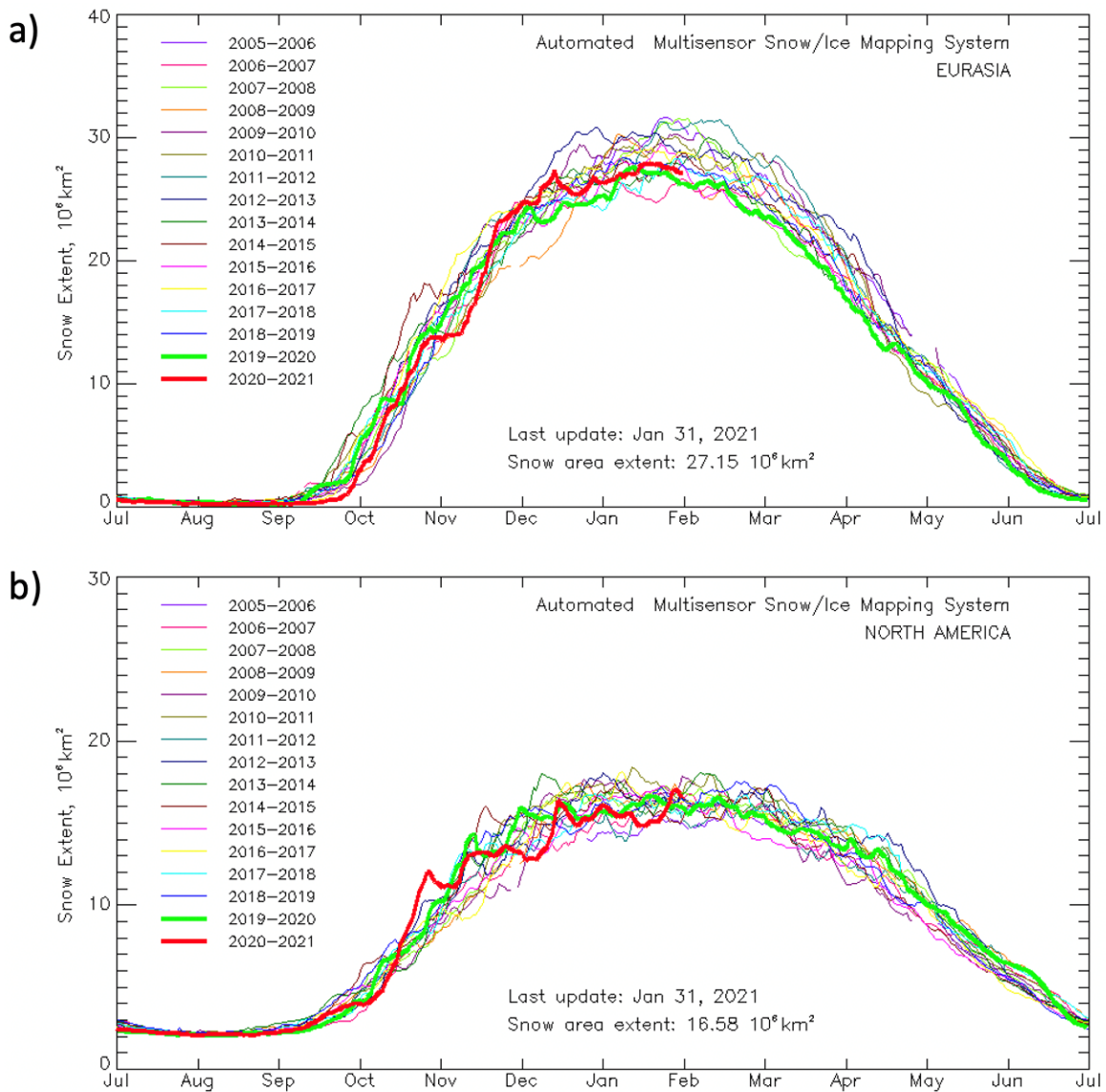
**Figure 18.** Past and forecast values of the MJO index. Forecast values from the 00Z 1 February 2021 ECMWF model. Yellow lines indicate individual ensemble-member forecasts, with the green line showing the ensemble-mean. A measure of the model “spread” is denoted by the gray shading. Sector numbers 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>

### Northern Hemisphere Snow Cover

Snow cover extent remained steady over the past week across Eurasia and is near decadal means. Snow cover advance will likely continue to increase especially across Europe next week. Above normal snow cover extent in October, favors a strengthened Siberian high, cold temperatures across northern Eurasia and a weakened polar

vortex/negative AO this upcoming winter followed by cold temperatures across the continents of the NH.



**Figure 19.** Observed Eurasian (top) and North American (bottom) snow cover extent through 31 January 2021. Image source: [https://www.star.nesdis.noaa.gov/smcd/emb/snow/HTML/snow\\_extent\\_plots.html](https://www.star.nesdis.noaa.gov/smcd/emb/snow/HTML/snow_extent_plots.html)

North American snow cover advanced strongly over the past week and is near decadal highs. And snow cover could advance further over the next two weeks. The advance of snow cover could be setting the stage for colder temperatures across North America.