

# Arctic Oscillation and Polar Vortex Analysis and Forecasts

February 24, 2020

*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) recently 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.

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

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

## **Summary**

- The Arctic Oscillation (AO) is currently positive and is predicted to remain positive the next two weeks.
- The current positive AO is reflective of negative pressure/geopotential height anomalies in the Arctic with mostly positive pressure/geopotential height anomalies across the mid-latitudes. The North Atlantic Oscillation (NAO) is also positive with negative pressure/geopotential height anomalies spread across Greenland and Iceland; and the NAO is predicted to remain positive over the next

two weeks as height anomalies are predicted to remain negative across Greenland.

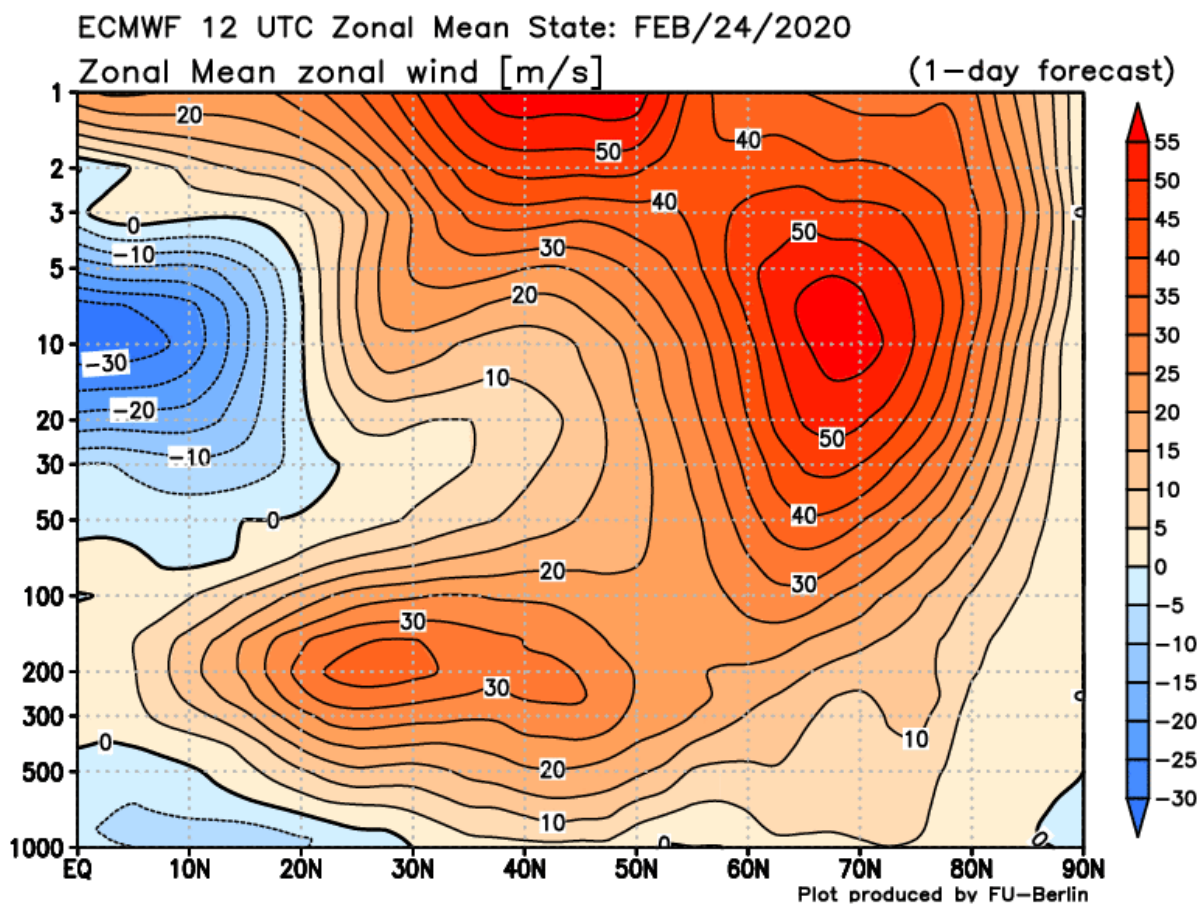
- The general circulation pattern over Europe the next two weeks is troughing/negative geopotential height anomalies across Northern Europe with ridging/positive geopotential height anomalies across Southern Europe forcing a mild, westerly, maritime flow of air across the continent. The high heights and/or westerly flow of maritime air favor above normal temperatures for much of Europe over the next two weeks. One possible exception is across Scandinavia and possibly much of the United Kingdom (UK) as low/negative geopotential height anomalies result in normal to below normal temperatures.
- The predicted general pattern for Asia is an omega block pattern with ridging/positive geopotential height anomalies in Central Asia sandwiched between troughing/negative pressure/geopotential height anomalies on the edges in Northwestern and Northeastern Asia. This pattern favors normal to above normal temperatures across much of Asia except for normal to below normal temperatures in Eastern Siberia with some of that cold air bleeding into Northeastern Asia for the next two weeks. However, by week two troughing and cold temperatures are predicted to become more widespread across Siberia. Also, persistent troughing/negative pressure/geopotential height anomalies across the northern Indian subcontinent will bring normal to below normal temperatures to the region.
- The predicted pattern for North America this week and into next week is ridging/positive geopotential height anomalies in the Gulf of Alaska and/or western North America forcing troughing/negative geopotential height anomalies in the Eastern United States (US) with normal to below normal temperatures. However, in early March the pattern will transition to troughing/negative geopotential height anomalies with normal to below normal temperatures in western North America with ridging/positive geopotential height anomalies and normal to above normal temperatures in the Eastern US. Over the next two weeks, troughing/negative geopotential height anomalies will result in normal to below normal temperatures for Alaska.
- In the Impacts section I discuss the possibility of two polar vortex (PV) reflective events and the strong PV and climate change.

### ***Impacts***

There are finally signs that the vice grip of the strong stratospheric PV has had on the tropospheric circulation and the sensible weather across the Northern Hemisphere (NH) is finally weakening (and for us weather enthusiasts clearly too little too late) but of course this is all relative to near record strong PV and AO. Though there are signs of continued coupling between strong PV and positive AO, the coupling does not seem to be as impressive as the first three weeks of February (see **Figure 11**). Another sign of the weakening strong positive AO is the GFS at least is predicting the most widespread cold temperatures across the NH in quite some time with below normal temperatures

possible for much of Siberia, Canada parts of the US and even Europe, which has had a ridiculously warm winter.

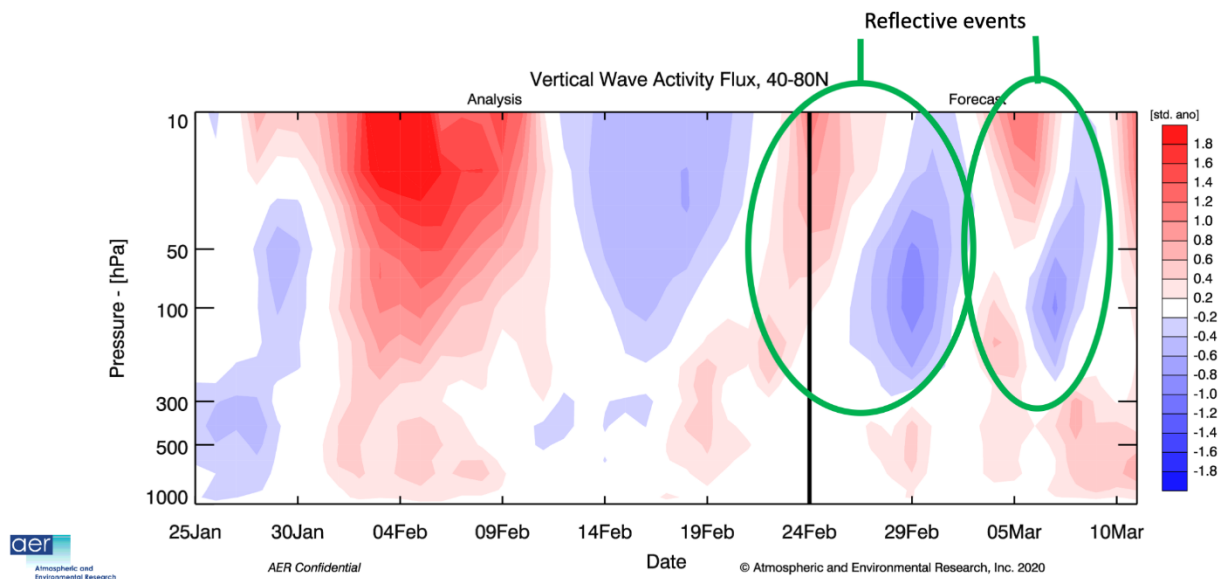
Another possible reason for a weakening of the strong PV and positive AO could be two possible PV reflective events. These events are described in [Kretschmer et al. \(2018\)](#). The background flow needed to support reflective PV events are a negative vertical gradient in the zonal wind in the stratosphere, typically between 10 and 2 hPa. As seen from the ECMWF forecast, the zonal wind does decrease with height in the stratosphere above 10 hPa (see **Figure i**). The negative vertical gradient in the zonal wind in the stratosphere is predicted to persist into the foreseeable future.



**Figure i.** ECMWF predicted zonal mean zonal winds from the equator to the North Pole and from 1000 to 1 hPa for February 24, 2020 (plot taken from <https://www.geo.fu-berlin.de/en/met/ag/strat/produkte/winterdiagnostics/index.html>).

The negative vertical wind gradient then acts to reflect positive vertical Wave Activity Flux (WAFz) into the stratosphere back into the troposphere. The signature of the WAFz reflection is positive WAFz anomalies quickly followed by negative WAFz

anomalies. This signature shows up twice in the WAFz forecast plots in the GFS ensembles, but I think is clearer in the GFS operational WAFz forecast, which I highlighted with green ovals (**Figure ii**). There are positive WAFz anomalies this week immediately followed by negative WAFz anomalies at the end of the week. Then for the end of next week and into the weekend there is again positive immediately followed by negative WAFz anomalies. The main temperature anomalies associated with reflective events are cold temperatures in central and eastern North America and Siberia/Central Asia. I would argue that the cold temperatures predicted in the Eastern US the end of this week and into next week are related to the first reflective event. Based on the today's forecast plots there is no obvious cold weather in the Central and Eastern US predicted with the second event, however if the second reflective event verifies, I would expect predicted temperatures to trend colder. I would also argue that the reflective events are contributing to the colder forecasts for Siberia.



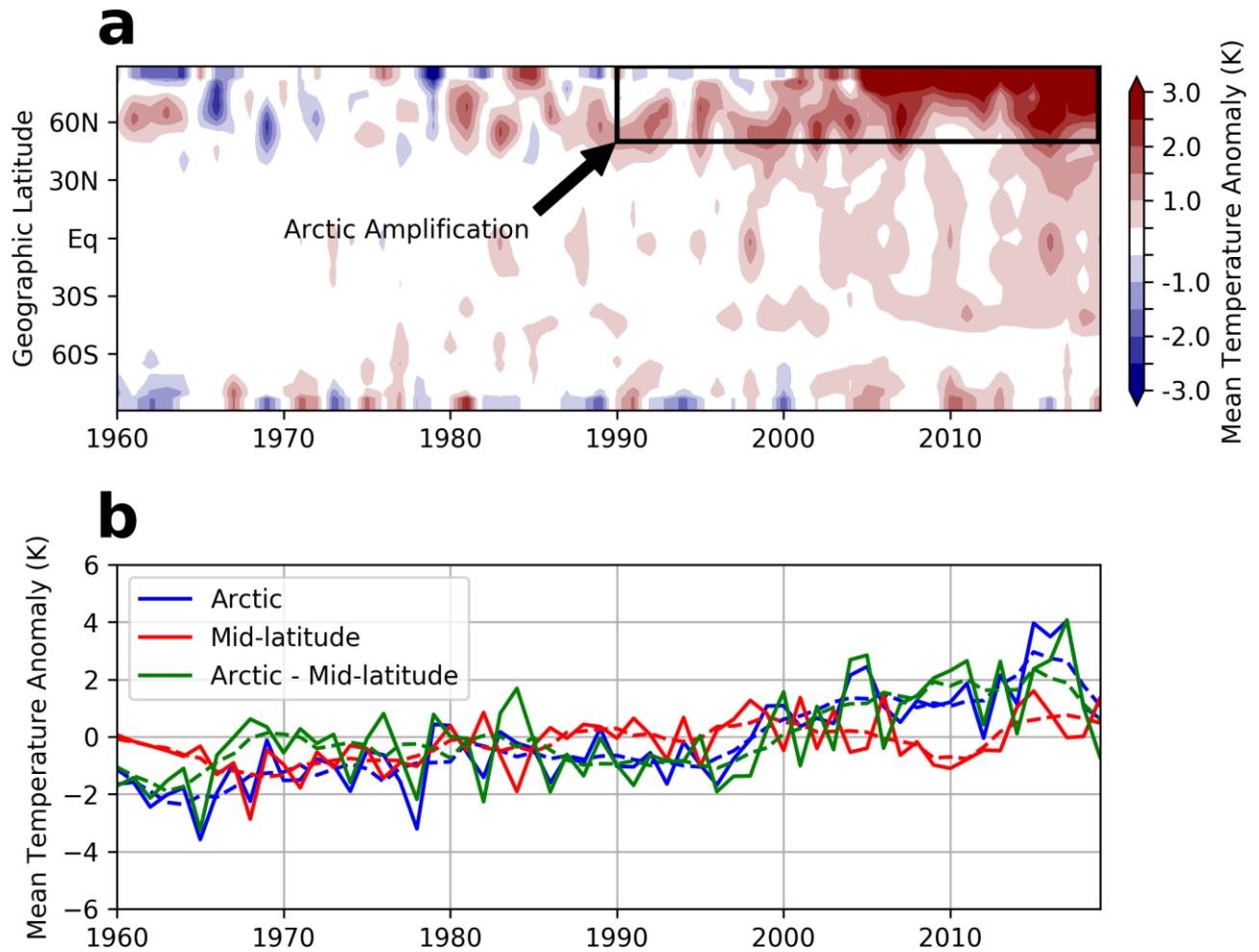
**Figure ii.** Observed and predicted daily vertical component of the wave activity flux (WAFz) standardized anomalies, averaged poleward of 40-80°N. The forecast is from the 00Z 24 February 2020 GFS operational model.

I did also want to briefly discuss a different subject. I have seen in the media this idea that this winter represents what we should expect from climate change in particular the strong PV and positive AO, and this idea is overly simplistic and problematic. This is not a new idea and in fact was very trendy (with many high-profile publications) in the late 1990's and early 2000's, i.e., climate change would contribute to a positive AO and/or strong stratospheric PV. This motivated me to publish my only negative results paper that there is no observational evidence of a linkage between global warming a positive

AO and/or strong PV ([Cohen and Barlow 2005](#)). I am especially proud of that this was as far as I know the first published paper to argue that Arctic amplification (AA or accelerated Arctic warming) could contribute to harsher winter weather across the mid-latitudes. Of course, a few more winters like this one and I won't be so proud anymore.

Returning to this winter and a point that I raised two weeks ago, this winter has demonstrated to me that it is very difficult to have both a strong PV/positive AO and AA. AA exists in all models forced with increasing greenhouse gases and is a consistent result in global climate models going back to at least the 1970's (you can read some of the earlier papers in my recent review article [Cohen et al. 2020](#)). The first supplementary figure from the review paper shows AA. I updated the figure with an estimate from this winter and incredibly enough the value for AA this winter is negative (**Figure iii**)! It is the most negative value since winter 2001/02, when the mid-latitudes were also exceptionally warm. However, in 2001 the Arctic was a considerably colder region and sea ice much more extensive than today (summer 2002 is likely the very beginning of the modern era of low summer Arctic sea ice).

## Winter Mean Surface Temperature Anomalies



**Figure iii. a)** Mean temperature (averaged for December, January, and February), shown as anomaly from 1951–1980 mean temperatures. The area inside the black box shows the amplified warming in the Arctic. **b)** Interannual (solid) and five-year running mean (dashed) of the temperature anomaly time series of December, January and February Arctic (60–90°N; blue), mid-latitude land only (30–60°N; red), and the difference between Arctic and mid-latitude area averaged temperatures (green) for 1960/61 through 2019/20.

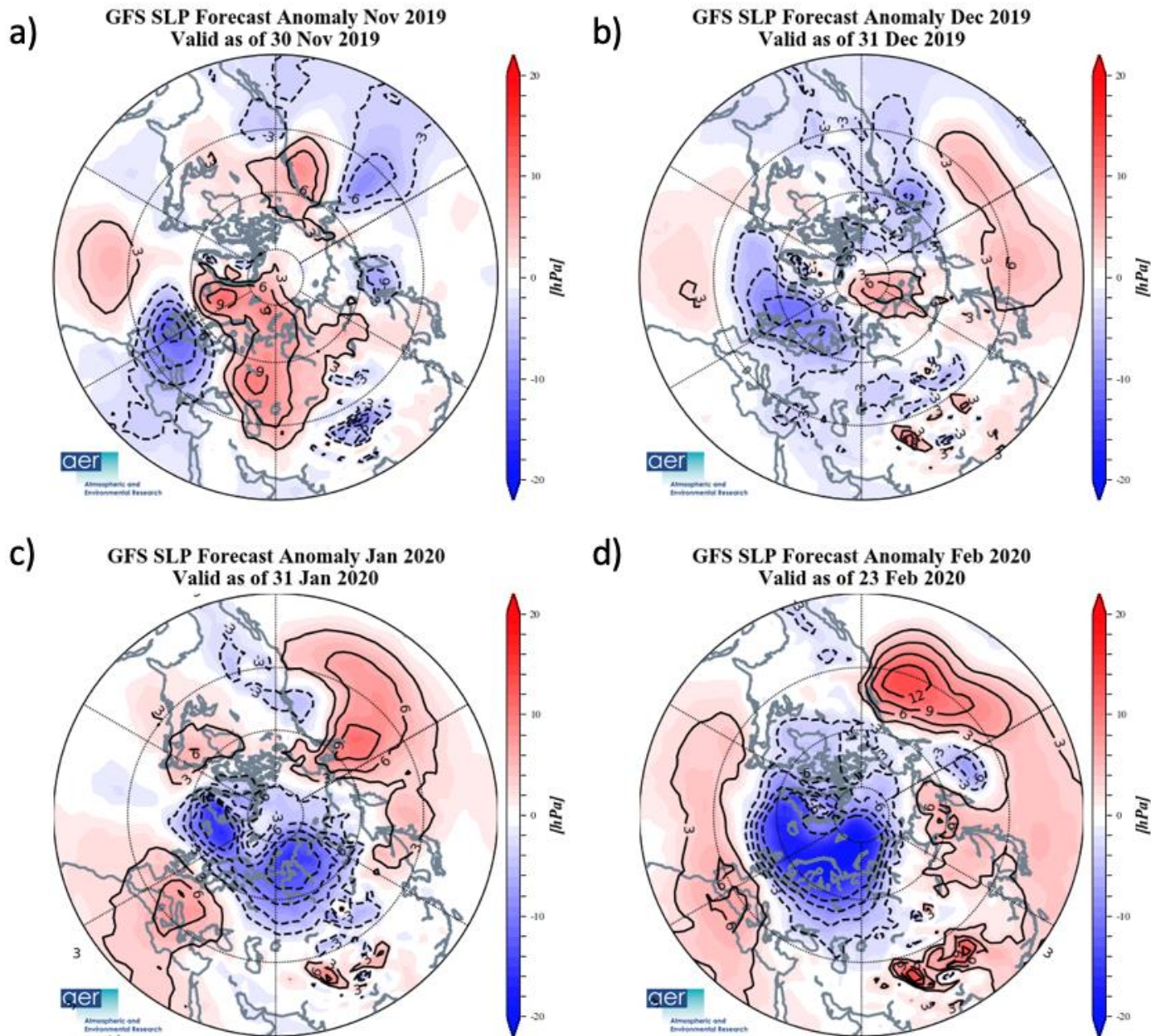
It is plausible that climate change could force a positive AO and/or strong PV but then we are unlikely to also observe AA. I am not willing to argue that AA is an absolute symptom of climate change but if we are to argue that climate change does not include AA then our current thinking of climate change and or modeled projections of climate change are seriously flawed, something that I am not prepared to admit at present.

This winter does expose how difficult the challenge is to attribute AA to any particular forcing and to attribute mid-latitude severe winter weather to AA. AA was first thought to be a result of disappearing sea ice and snow cover that reflect much greater sunlight than other naturally occurring surfaces. Therefore, the disappearance of ice and snow allows much more sunlight to be absorbed at the surface and the surface heats up much more quickly in the Arctic. The immediate problem with this theory is that AA is greatest in the winter when there is no sunlight and weakest in summer when sunlight is a maximum. One simple answer is that the excess sunlight is absorbed in summer but only returned to the atmosphere in the fall and winter when the air is colder than the surface. But this winter demonstrates that at a minimum it is complicated and possibly AA mostly exists due to advection of heat and moisture from lower latitudes. If advection is greatly responsible for AA, then it stands to reason that advection is also responsible for severe winter weather in the mid-latitudes.

To a certain degree this is true regardless, but I still believe that AA is in part caused by local changes in the Arctic and a warmer Arctic contributes to severe winter weather in the mid-latitudes. And what happened this winter is a “black swan” event. This winter must be an outlier and not symptomatic or emblematic of climate change and accelerated Arctic warming. But if the conditions of this winter repeat more often than not then beliefs that I have held for more than fifteen years will need to be adjusted or reconsidered.

Finally, the question needs to be asked what happened this winter that the PV became so strong and the AO so positive. I do believe that the extreme positive AO was in large part related to the strong PV. But what caused the strong PV? I know the direct answer to this question. The large-scale circulation pattern in the NH was hostile to disrupting the PV for all three winter months of December, January and February. The pattern most favorable for disrupting the PV is ridging/high pressure across Scandinavia and the Urals with troughing/low pressure in East Asia and the northern North Pacific. This pattern existed in November, when we observed the only disruption to the PV this fall and winter, but the opposite pattern has persisted non-stop for three straight months (see **Figure iv**).





**Figure iv.** Sea level pressure anomalies for a) November 2019, b) December 2019, c) January 2020 and d) February 2020.

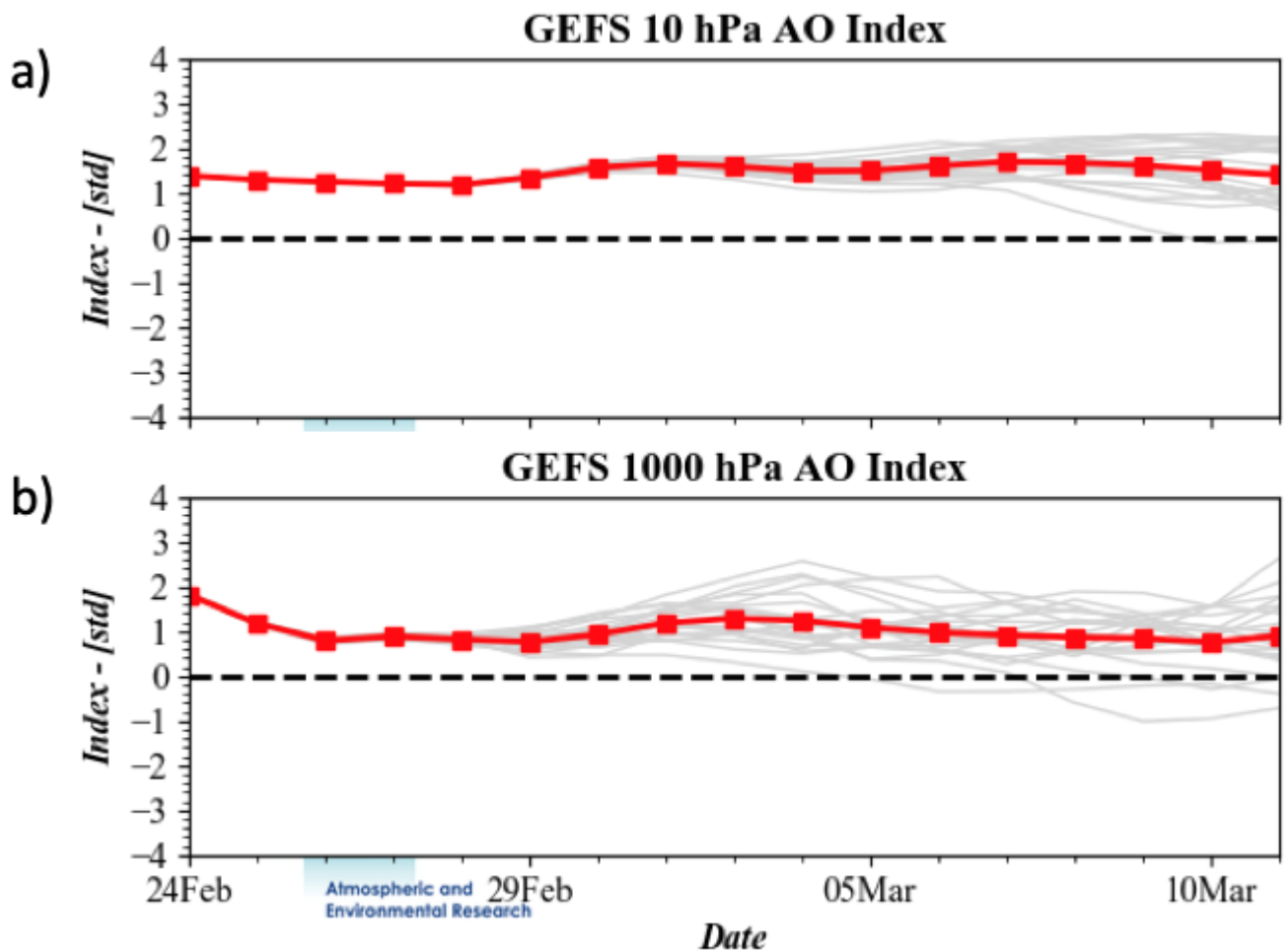
Weather patterns typically change every week or so what caused the same weather pattern to persist for three months? I have no idea and I don't think there are any easy answers. For much of the winter as I have discussed previously, I do believe that Arctic sea anomalies were not favorable for disrupting the PV but I fail to see how that is really the answer. The Madden Julian Oscillation (MJO) did behave strangely this winter but it did vary and the MJO were in the phases considered most favorable for disrupting the



PV ([Garfinkel et al. 2012](#)). People have mentioned the Indian Ocean Dipole (IOD) being in the positive phase but I just checked and the period when the PV was the least susceptible to weakening and the AO was its most positive, the late 1980's early 1990's, the IOD was predominantly negative. So, for now I believe any easy answers will remain elusive.

1-5 day

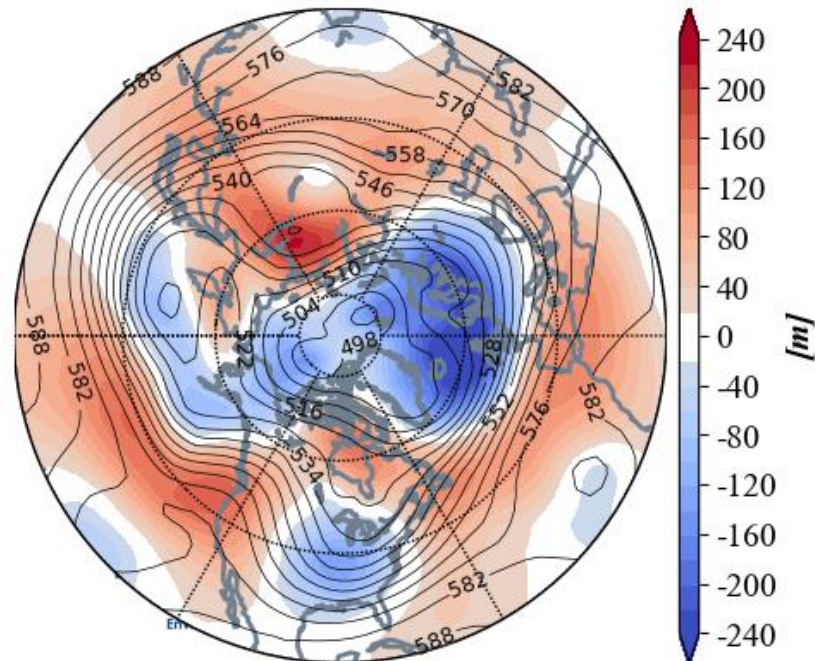
The AO is currently positive (**Figure 1**) with negative geopotential height anomalies across the Arctic and positive geopotential height anomalies across the mid-latitudes of the NH (**Figure 2**). And with negative geopotential height anomalies across Greenland and Iceland (**Figure 2**), the NAO is positive as well.



**Figure 1.** (a) The predicted daily-mean AO at 10 hPa from the 00Z 24 February 2020 GFS ensemble. (b) The predicted daily-mean near-surface AO from the 00Z 24 February 2020 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 troughing/negative geopotential height anomalies across Northern Europe with ridging/positive geopotential height across Southern Europe are predicted to force a westerly flow of maritime, relatively mild air across Europe (**Figure 2**). This will result in normal to above normal temperatures across much of Europe, with the exception of Scandinavia and the UK where low heights will favor normal to below normal temperatures (**Figure 3**). This week, ridging/positive geopotential height anomalies are predicted to dominate much of Asia with just regional troughing/negative geopotential height anomalies confined to Eastern and Southern Siberia and the northern Indian subcontinent (**Figure 2**). This pattern favors normal to above normal temperatures across most of Asia with normal to below normal temperatures confined to Eastern and Southern Siberia and the Tibetan Plateau (**Figure 3**).

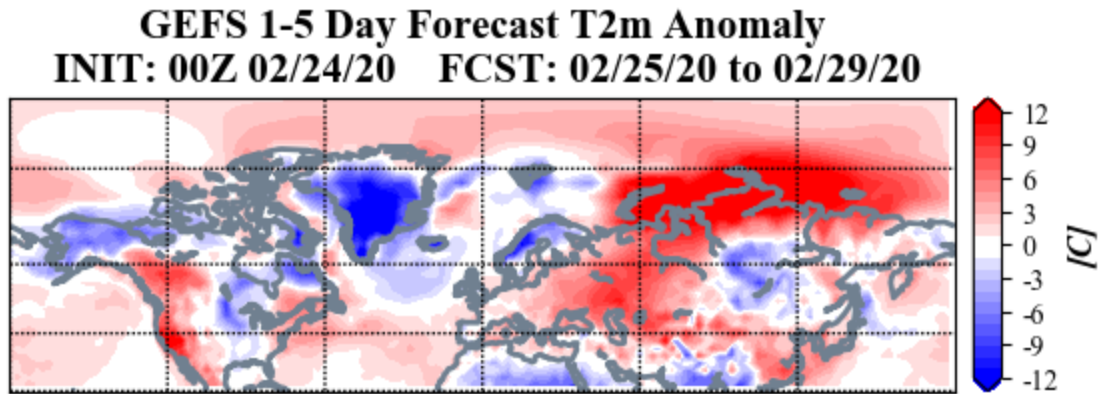
**GEFS 1-5 Day Forecast 500 mb GPH/GPH Anomaly**  
**INIT: 00Z 02/24/20 FCST: 02/25/20 to 02/29/20**



**Figure 2.** Forecasted average 500 mb geopotential heights (dam; contours) and geopotential height anomalies (m; shading) across the Northern Hemisphere from 25 – 29 February 2020. The forecasts are from the 00z 24 February 2020 GFS ensemble.

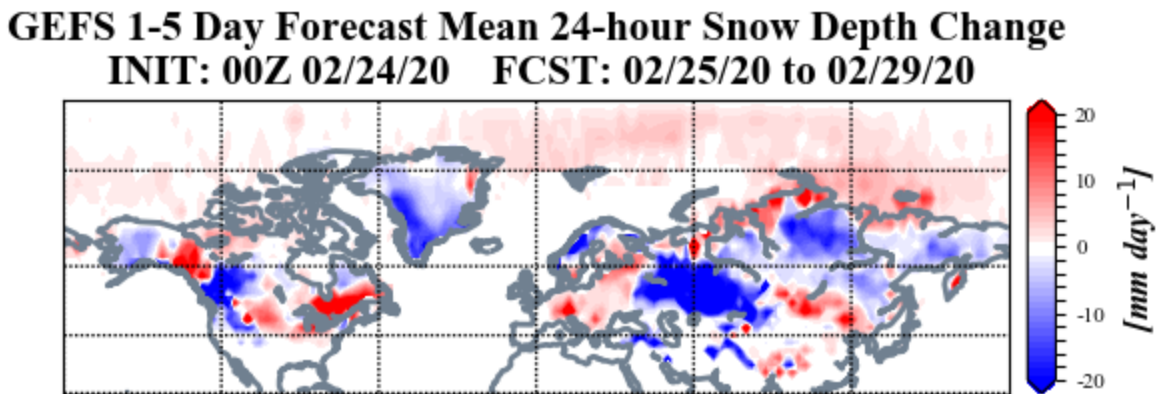
This week, ridging/positive geopotential height anomalies in the Gulf of Alaska and western North America will force downstream troughing/negative geopotential height anomalies across the Central and Eastern US with more ridging in New England and Eastern Canada (**Figure 2**). This is predicted to result in normal to above normal temperatures in Western and Eastern Canada, the Western US and the Northeastern US with normal to below normal temperatures across Central Canada and the Central US (**Figure 3**). Troughing/negative geopotential height anomalies

across Alaska (**Figure 2**) are predicted to result in normal to below normal temperatures for Alaska (**Figure 3**).



**Figure 3.** Forecasted surface temperature anomalies ( $^{\circ}\text{C}$ ; shading) from 25 – 29 February 2020. The forecast is from the 00Z 24 February 2020 GFS ensemble.

Trouching and/or cold temperatures are predicted to bring new snowfall to parts of Siberia, the Tibetan Plateau and possibly Central and Eastern Europe (**Figure 4**). Trouching and/or cold temperatures are predicted to bring new snowfall to Northwestern and Southeastern Canada and possibly the US Central Plains into the Great Lakes (**Figure 4**). Warm temperatures are predicted to result in snowmelt for a large swath of Western Asia, Northern Siberia, Scandinavia, the Middle East, Western Canada and the Pacific Northwest (**Figure 4**).



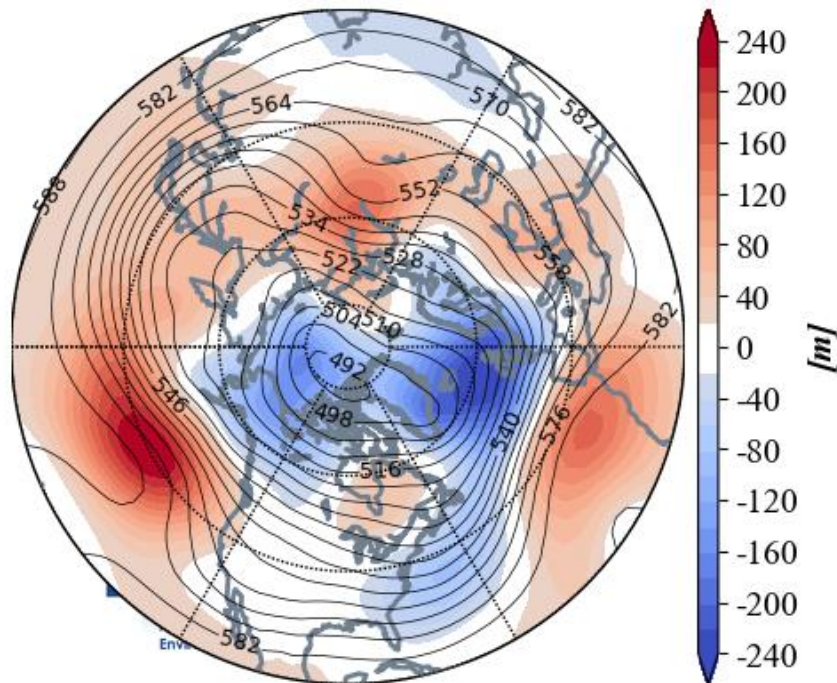
**Figure 4.** Forecasted snowdepth anomalies ( $\text{mm}/\text{day}$ ; shading) from 25 – 29 February 2020. The forecast is from the 00Z 24 February 2020 GFS ensemble.

*Mid-Term*

6-10 day

The AO is predicted to remain positive (**Figure 1**) as negative geopotential height anomalies continue to dominate the Arctic with mostly positive geopotential height anomalies across the mid-latitudes of the NH (**Figure 5**). And with negative geopotential height anomalies predicted across Greenland (**Figure 2**), the NAO is predicted to remain positive as well.

**GEFS 6-10 Day Forecast 500 mb GPH/GPH Anomaly**  
**INIT: 00Z 02/24/20 FCST: 03/01/20 to 03/05/20**

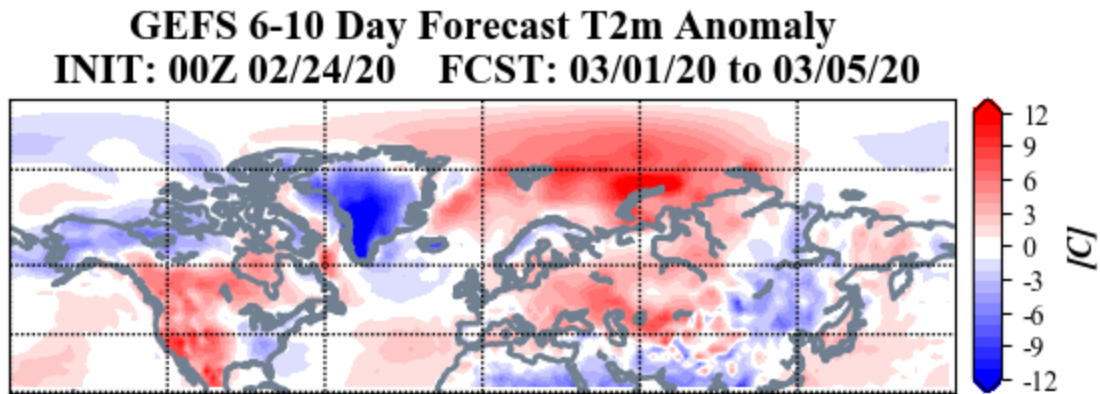


**Figure 5.** Forecasted average 500 mb geopotential heights (dam; contours) and geopotential height anomalies (m; shading) across the Northern Hemisphere from 1 – 5 March 2020. The forecasts are from the 00z 24 February 2020 GFS ensemble.

Ridging/positive geopotential height anomalies are predicted to stretch across Southern Europe with troughing/negative geopotential height anomalies stretched across Northern and Central Europe this period (**Figures 5**). A westerly flow of maritime air will favor widespread normal to above normal temperatures for much of Europe with the exception of Scandinavia and the UK where low heights will favor normal to below normal temperatures (**Figure 6**). Persistent ridging/positive geopotential height anomalies will dominate Central Asia with troughing/negative geopotential height anomalies across Northwest Asia and Eastern Siberia (**Figure 5**). This is predicted to yield normal to above normal temperatures for most of Asia with normal to below temperatures confined to Eastern Siberia (**Figure 6**). Northerly flow in East Asia (**Figure**



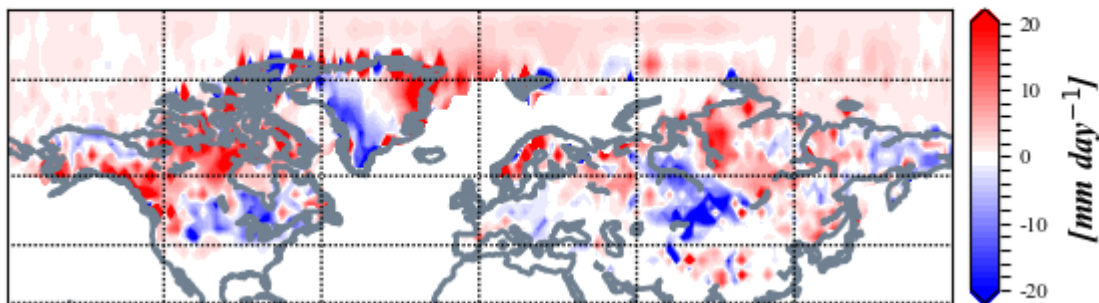
5) will help to filter some of the cold air from Eastern Siberia into Northeast Asia (**Figure 6**). Persistent troughing/negative geopotential height anomalies across the northern Indian subcontinent (**Figure 5**) favors normal to below normal temperatures for the Tibetan Plateau (**Figure 6**).



**Figure 6.** Forecasted surface temperature anomalies ( $^{\circ}\text{C}$ ; shading) from 1 – 5 March 2020. The forecasts are from the 00Z 24 February 2020 GFS ensemble.

Flat ridging/positive geopotential height anomalies in the Gulf of Alaska favor weak troughing/negative geopotential height anomalies mostly confined to Alaska and the Eastern US but with an overall zonal flow across North America (**Figure 5**). This pattern is predicted to bring normal to below normal temperatures across Alaska, Northern Canada and the Eastern US with normal to above normal temperatures across Southern Canada and the Western US (**Figure 6**).

**GEFS 6-10 Day Forecast Mean 24-hour Snow Depth Change**  
**INIT: 00Z 02/24/20 FCST: 03/01/20 to 03/05/20**



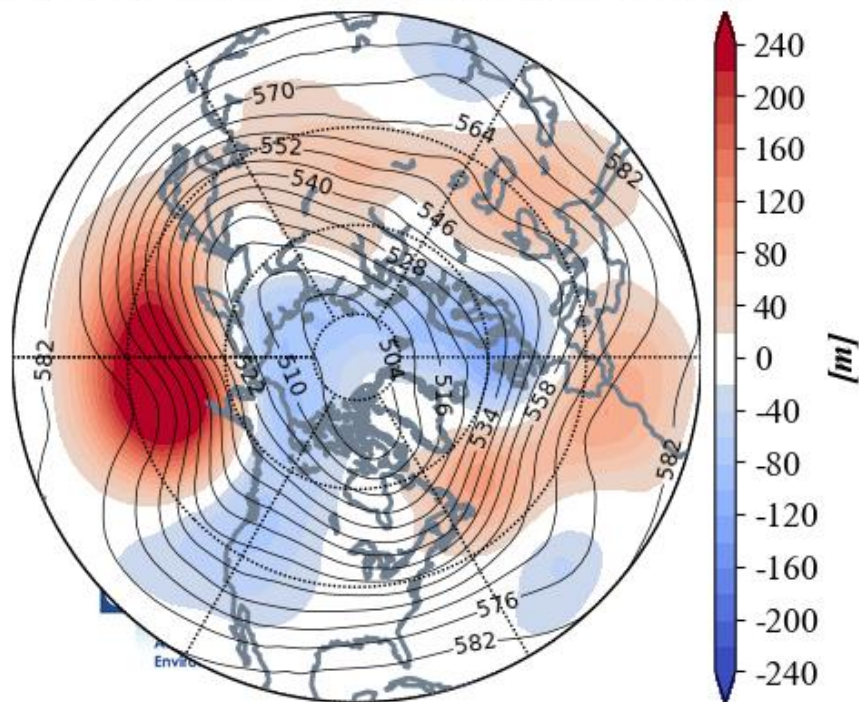
**Figure 7.** Forecasted snowdepth changes ( $\text{mm}/\text{day}$ ; shading) from 1 – 5 March 2020. The forecasts are from the 00Z 24 February 2020 GFS ensemble.

Trouging and/or cold temperatures will support the potential for new snowfall across Northern and Eastern Asia, Northern Europe, the Tibetan Plateau, Alaska, the Canadian West Coast, Northern and Eastern Canada and the Northwestern US (**Figure 7**). Some snowmelt is predicted in Central Asia, Central Canada, the US Plains and Great Lakes (**Figure 7**).

11-15 day

With continued negative geopotential height anomalies predicted for the Arctic and mostly positive geopotential height anomalies across the mid-latitudes of the NH (**Figure 8**), the AO is predicted to remain positive this period (**Figure 1**). With predicted negative pressure/geopotential height anomalies across Greenland (**Figure 8**), the NAO is likely to remain positive as well.

**GEFS 11-15 Day Forecast 500 mb GPH/GPH Anomaly**  
**INIT: 00Z 02/24/20 FCST: 03/06/20 to 03/10/20**

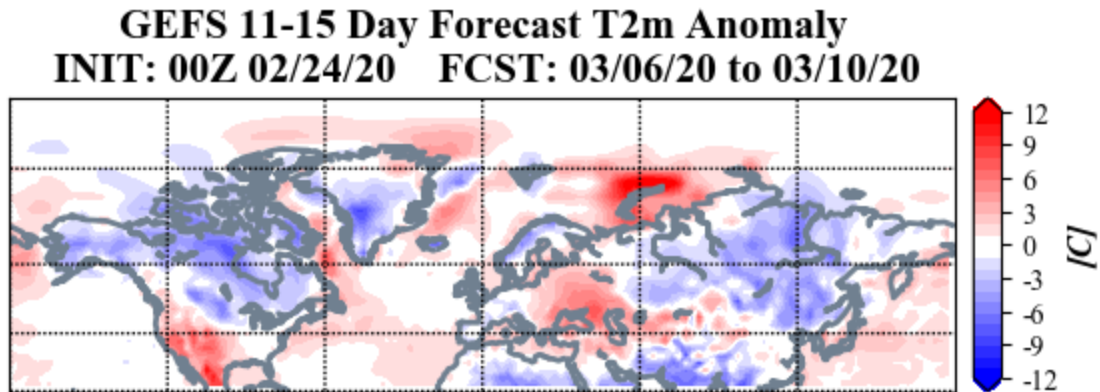


**Figure 8.** Forecasted average 500 mb geopotential heights (dam; contours) and geopotential height anomalies (m; shading) across the Northern Hemisphere from 6 – 10 March 2020. The forecasts are from the 00z 24 February 2020 GFS ensemble.

Ridging/positive geopotential height anomalies will dominate Southeastern and Southwestern Europe with troughing/negative geopotential height anomalies across Northern and Central Europe this period (**Figures 8**). With ridging now confined to the southern corners, near normal temperatures will return to Northern and Central Europe

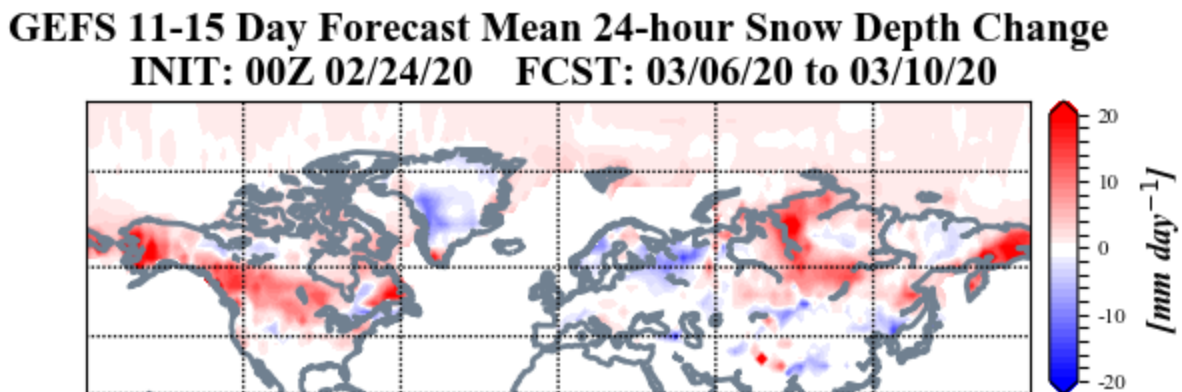


including the UK with normal to above normal temperatures across Southwestern and Eastern Europe (**Figures 9**). Troughing/negative geopotential height anomalies are predicted to dominate Northern and Southern Asia with ridging/positive geopotential height anomalies sandwiched in between (**Figure 8**). This pattern favors normal to above normal temperatures for Western and Central Asia with normal to below normal temperatures for Siberia and the northern Indian subcontinent (**Figure 9**).



**Figure 9.** Forecasted surface temperature anomalies ( $^{\circ}\text{C}$ ; shading) from 6 – 10 March 2020. The forecasts are from the 00z 24 February 2020 GFS ensemble.

Ridging/positive geopotential height anomalies south of the Aleutians are predicted to force troughing/negative geopotential height anomalies across all of western North America with more ridging/positive geopotential height anomalies in Atlantic Canada and New England (**Figure 8**). This pattern is predicted to favor normal to below normal temperatures across Alaska, much of Canada and the Western US with normal to above normal temperatures for Southeastern Canada and the US East Coast (**Figure 9**).



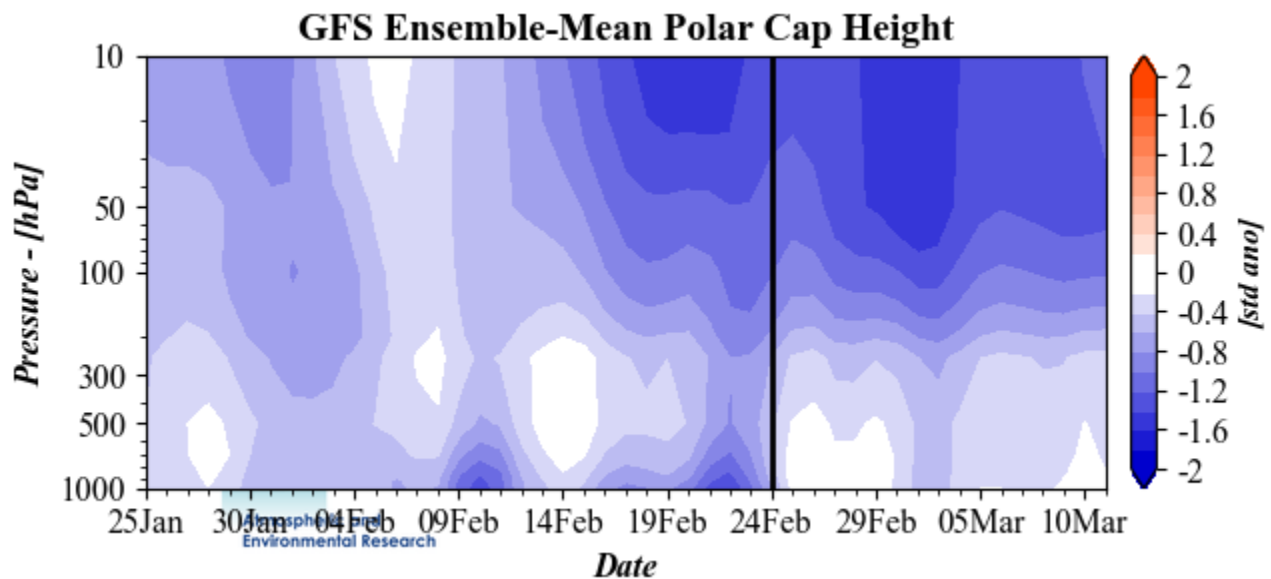
**Figure 10.** Forecasted snow depth changes ( $\text{mm}/\text{day}$ ; shading) from 6 – 10 March 2020. The forecasts are from the 00z 24 February 2020 GFS ensemble.

No strong signals are evident but troughing and/or cold temperatures could support new snowfall across parts of Northern Asia, Scandinavia and Southeastern Europe (**Figure 10**). New snowfall is possible across Alaska, much of Canada and possibly the Northeastern US (**Figure 10**). Some snowmelt is possible in Western and Central Asia and Eastern Canada (**Figure 10**).

### Longer Term

#### 30-day

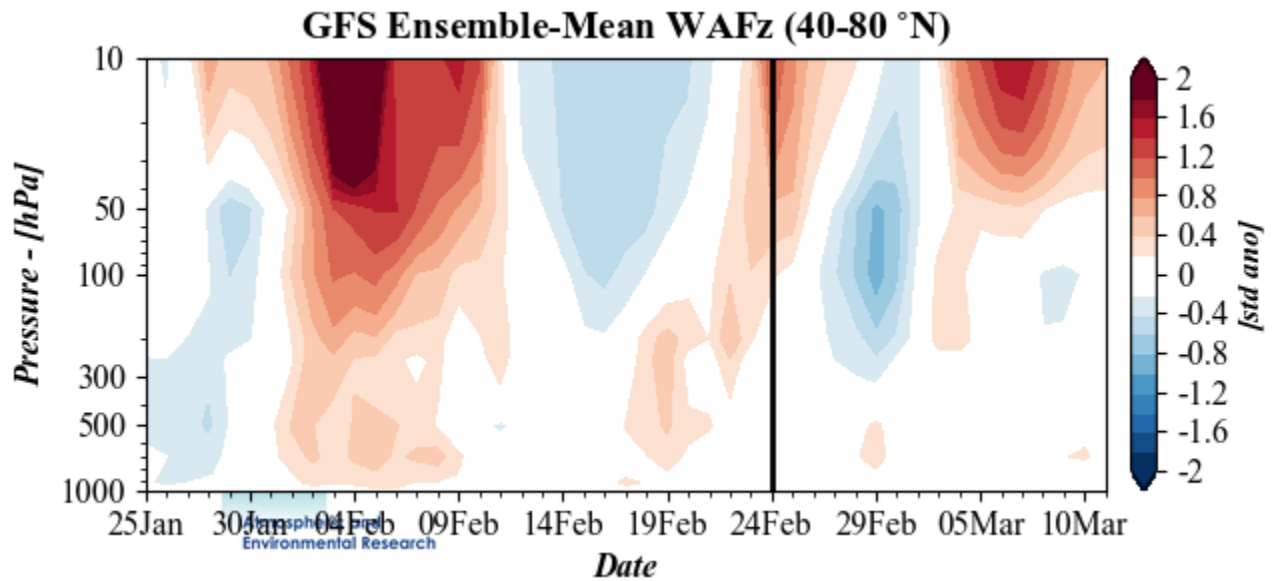
The latest plot of the polar cap geopotential height anomalies (PCHs) currently shows normal to below normal PCHs in both the troposphere and stratosphere (**Figure 11**). The cold PCHs in the middle stratosphere are related to a normal to strong PV since December that coupled to the troposphere for much of January, early February and is predicted to persist for the foreseeable future (**Figure 11**). The predicted cold tropospheric PCHs are consistent with a predicted positive surface AO (**Figure 1**). Though the predicted downward propagation of cold PCHs from the strong stratospheric PV to the surface is not as impressive as it was earlier in the month.



**Figure 11.** Observed and predicted daily polar cap height (i.e., area-averaged geopotential heights poleward of 60°N) standardized anomalies. The forecasts are from the 00Z 24 February 2020 GFS ensemble.

The plot of vertical Wave Activity Flux (WAFz) or poleward heat transport forecast shows two relatively modest pulses of positive anomalies over the next two weeks (**Figure 12**). The first WAFz pulse for this week is quickly followed by negative WAFz anomalies for the end of the week (**Figure 12**). Positive WAFz quickly followed by

negative WAFz is a signature of reflective PV events that stretch the PV and favor cold temperatures in eastern North America. I do believe this event is contributing to the predicted cold temperatures in the Central and Eastern US this week into next. There are suggestions of a second reflective PV event the second week of March with again positive WAFz anomalies followed quickly by negative WAFz anomalies, though the negative anomalies are quite weak.



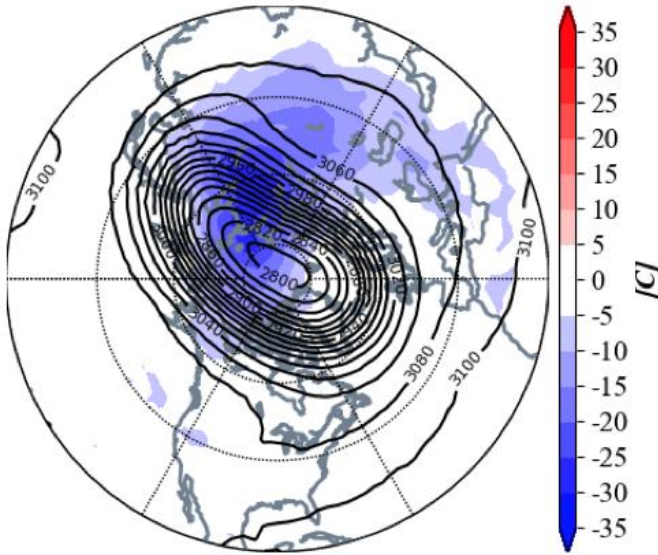
**Figure 12.** Observed and predicted daily vertical component of the wave activity flux (WAFz) standardized anomalies, averaged poleward of 40-80°N. The forecast is from the 00Z 24 February 2020 GFS ensemble.

The stratospheric AO is currently positive (**Figure 1**) consistent with a relatively normal to strong PV (**Figure 1**). The GFS predicts some relatively minor disrupting of the PV over the next two weeks with changes in shape and orientation of the PV but little change is predicted in the overall positive AO over the next two weeks.

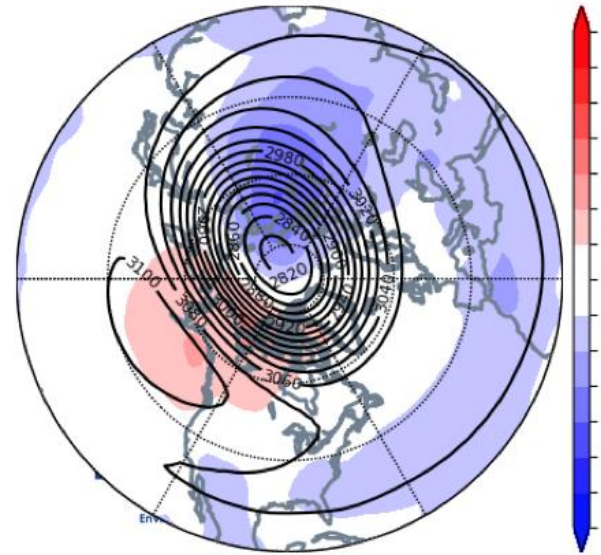
Currently the stratospheric PV is centered near the North Pole (**Figure 13**) with the largest negative temperature departures in the polar stratosphere located over northern Eurasia (**Figure 13**). The PV is no longer circular in shape but instead elongated along an axis from Eastern Siberia to Greenland. I would argue this is related to an ongoing PV reflective event.

a)

GEFS 10 mb GPH & T Anomaly  
INIT: 00Z 02/24/20



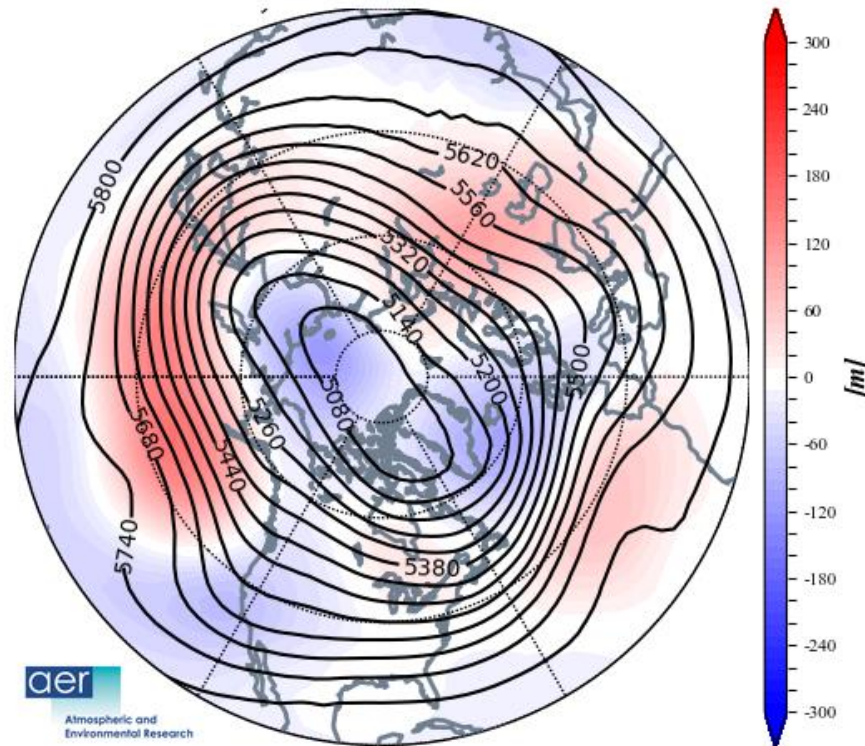
b) GEFS 11-15 Day Forecast 10 mb GPH & T Anom  
INIT: 00Z 02/24/20 FCST: 03/06/20 to 03/10/20



**Figure 13.** (a) Analyzed 10 mb geopotential heights (dam; contours) and temperature anomalies ( $^{\circ}\text{C}$ ; shading) across the Northern Hemisphere at 00Z 24 February 2020. (b) Same as (a) except forecasted averaged from 6 – 10 March 2020. The forecasts are from the 00Z 24 February 2020 GFS operational model.

Over the next two weeks, the PV center is predicted to remain centered near the North Pole but then is predicted to wobble (**Figure 13**). New ridging and warming is predicted across Alaska and Canada probably related to the weak, positive WAFz pulse in early March (**Figure 13**). The PV also is once again elongated along an axis from Eastern Siberia to Eastern Canada. This appears to me as a second PV reflective event.

**CFS 500 hPa Forecast Anomaly Mar 2020  
Valid as of 24 Feb 2020**

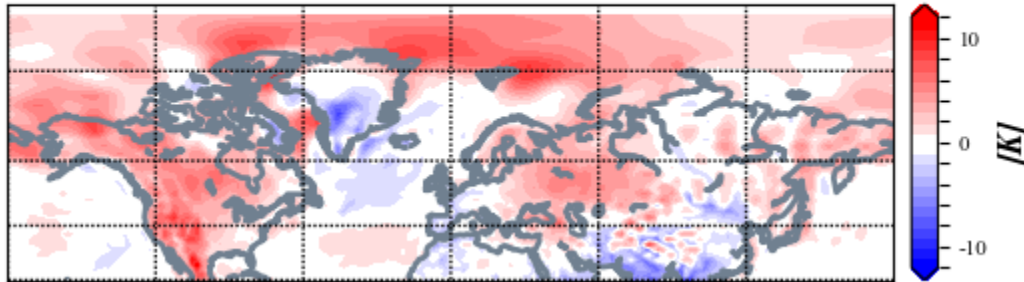


**Figure 14.** Forecasted average 500 mb geopotential heights (dam; contours) and geopotential height anomalies (m; shading) across the Northern Hemisphere for March 2020. The forecasts are from the 00Z 24 February 2020 CFS.

I include in this week's blog the monthly 500 hPa geopotential heights (**Figure 14**) and the surface temperatures (**Figure 15**) forecast for March from the Climate Forecast System (CFS; the plots represent yesterday's four ensemble members). The forecast for the troposphere is ridging across Western Asia, the northern North Pacific and Eastern Canada with troughing in Europe into the Eastern Mediterranean. Eastern Siberia, East Asia and western North America (**Figure 14**). This pattern favors relatively mild temperatures for Western Asia and much of North America with seasonable to relatively cold temperatures for Europe, East Asia and Eastern Canada (**Figure 15**). The CFS forecast has been showing little consistency and I have low confidence in the forecast.



**CFS T2m Forecast Anomaly Mar 2020  
Valid as of 24 Feb 2020**



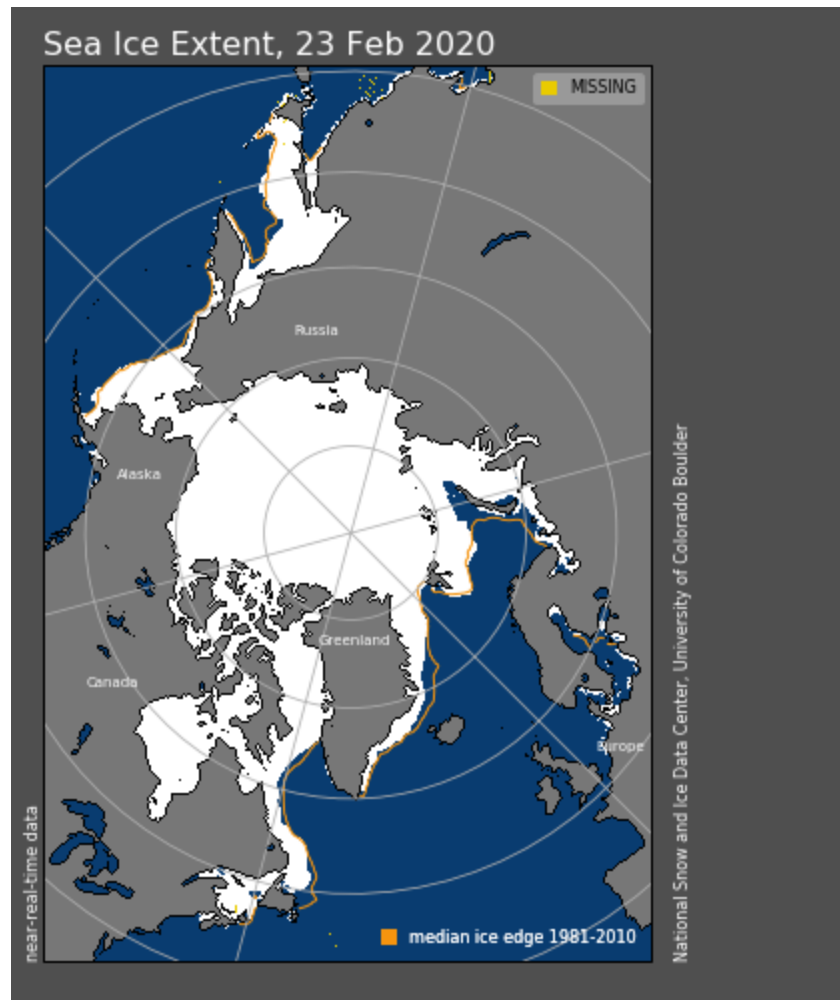
**Figure 15.** Forecasted average surface temperature anomalies ( $^{\circ}\text{C}$ ; shading) across the Northern Hemisphere for March 2020. The forecasts are from the 00Z 24 February 2020 CFS.

*Surface Boundary Conditions*

*Arctic sea ice extent*

The positive AO has been conducive to sea ice growth for much of the winter but the recent strong storms in the North Atlantic have caused sea ice to recede in the Barents-Kara Seas. Even with sea ice pulling back, Arctic sea ice extent remains higher than recent winters. The predicted positive AO remains favorable for further sea ice growth. Overall sea ice extent is near normal throughout the Arctic and negative anomalies exist mostly in seas outside of the Arctic. Recent research has shown that 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. In contrast low sea ice in the Chukchi and Bering seas could favor a strong PV.



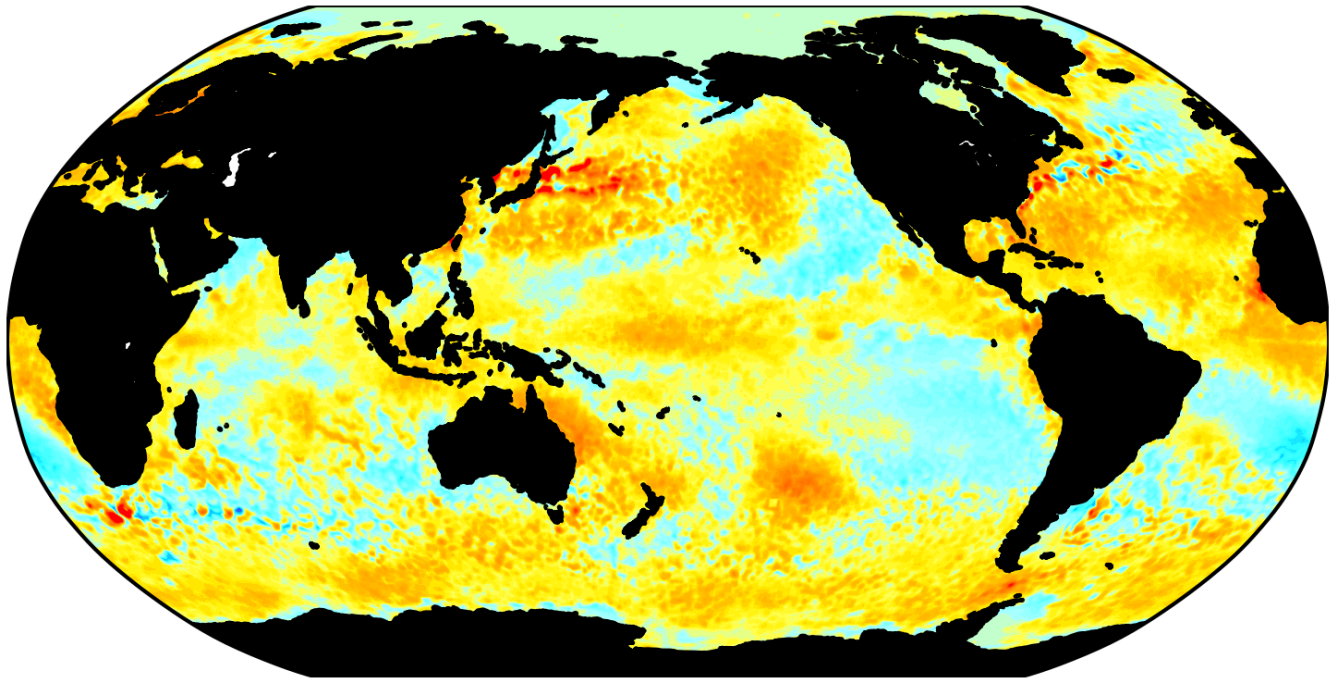


**Figure 16.** a) Observed Arctic sea ice extent on 23 February 2020 (white). Orange line shows climatological extent of sea ice based on the years 1981-2010.

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

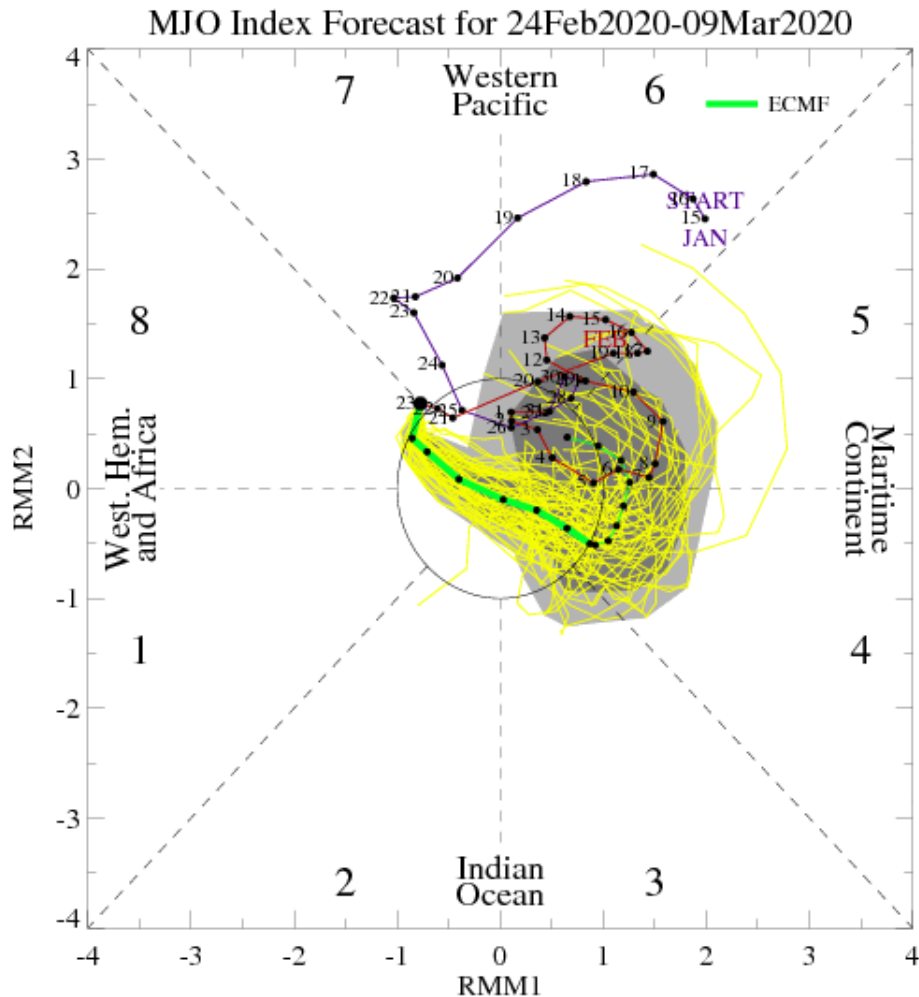
Equatorial Pacific sea surface temperatures (SSTs) anomalies have warmed slightly but neutral El Niño/Southern Oscillation (ENSO) conditions seem most likely this winter (**Figure 17**). Observed SSTs across the NH remain well above normal especially near Alaska and in the Gulf of Alaska and the western North Pacific though below normal SSTs exist regionally especially west of South America. Warm SSTs in the Gulf of Alaska may favor mid-tropospheric ridging in the region this winter.

## SST Anomaly - Week Ending 23 Feb 2020



**Figure 17.** The latest weekly-mean global SST anomalies (ending 16 February 2020 ).  
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 where no phase is favored. Overall it seems that the MJO is not contributing strongly to the predicted pattern across North America.

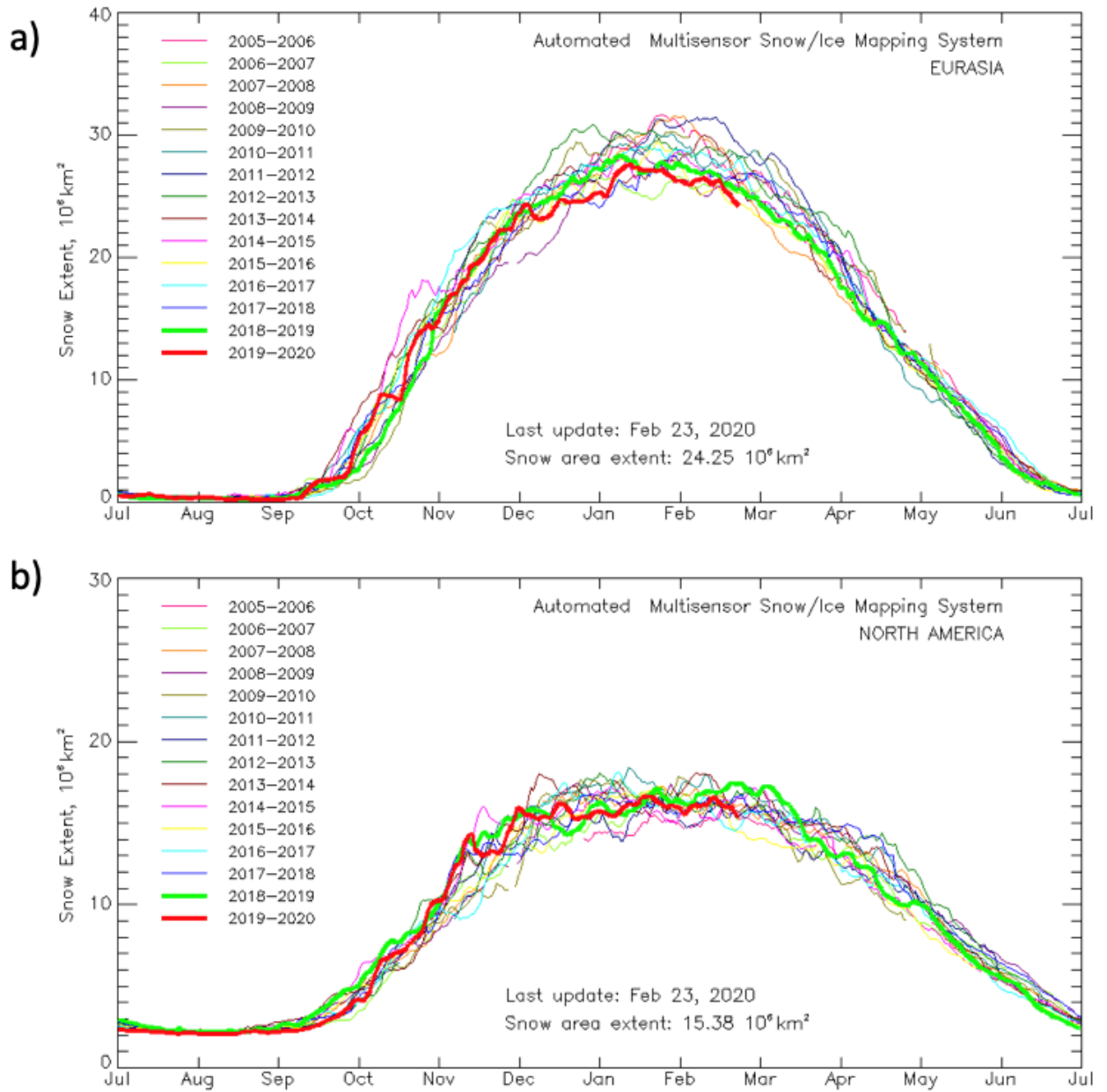


**Figure 18.** Past and forecast values of the MJO index. Forecast values from the 00Z 24 February 2020 ECMWF model. Yellow lines indicate individual ensemble-member forecasts, with the green line showing the ensemble-mean. A measure of the model “spread” is denoted by the gray shading. Sector numbers 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 declined across Eurasia and is near decadal lows. With a predicted positive AO, I don't expect the snow cover to advance much in the coming week. Relative low snow cover extent favors above normal temperatures.



**Figure 19.** Observed Eurasian (top) and North American (bottom) snow cover extent through 23 February 2020. 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 declined slightly but remains near decadal means. Snow is predicted to remain fairly steady in the coming week. If the melting accelerates this could contribute to a warm spring.