

February 4, 2019

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
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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](#)). 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.

With transition to a fall/winter schedule, postings are once every week. Precipitation forecasts will be replaced by snow accumulation forecasts along with more 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 slightly negative and is predicted to first trend positive and then negative back to neutral over the next two weeks.
- The current slightly negative AO is reflective of mostly positive pressure/geopotential height anomalies across the North Atlantic side of the Arctic. The North Atlantic Oscillation (NAO) is currently slightly positive with weak pressure/geopotential height anomalies across Greenland but mostly positive pressure/geopotential height anomalies across the mid-latitudes of the North Atlantic and is predicted to slowly trend negative as height anomalies turn mostly positive across Greenland over the next two weeks.
- Ridging/positive geopotential height anomalies centered across western Europe are predicted to yield relatively mild temperatures for much of Europe including the United Kingdom (UK) over the next two weeks. The one exception will be Scandinavia where troughing/negative geopotential height anomalies will bring relatively cold temperatures.
- Troughing/negative geopotential height anomalies and relatively cold temperatures are predicted to persist across Siberia and into Northeast Asia over the next two weeks. Also, ridging/positive geopotential height anomalies are predicted with relatively mild temperatures across Southern Asia including the

Middle East and Southeast Asia. Regional troughing/negative geopotential height anomalies across the northern India subcontinent are predicted to result in normal to below normal temperatures across Northern India and Pakistan.

- The GFS is predicting that over the next two weeks, ridging/positive geopotential height anomalies centered south of the Aleutians are predicted to force downstream troughing/negative geopotential height anomalies and relatively cold temperatures across much of Canada and the Western US with ridging and relatively mild temperatures for the Eastern US. However, the ECMWF model has been predicting a colder solution for the Eastern US and I describe in the Impacts section my reasoning for favoring the ECMWF solution.
- Also, in the *Impacts* section, I try to set the record straight on my thoughts on climate change and severe winter weather.
- A link to our video explaining the link among Arctic amplification, polar vortex (PV) disruptions and severe winter weather across the mid-latitudes including the US Europe and East Asia is now included on our web page.

Impacts

As I have discussed the past two weeks the stratospheric temperature forecast has been suggestive of the focus of the cold temperatures at the surface in Siberia and Western North America. In addition, the fact that warm Arctic temperatures have been concentrated in the Barents-Kara Seas and cold in the rest of the Arctic Ocean also favors cold across Northern Asia but relatively mild temperatures in the Eastern US and Northern Europe (**Figure i**). As I discussed in last week's blog, I find the relatively cold Arctic humbling and I cannot explain it other than to attribute it to natural variability or forcing from outside the Arctic including possibly the tropics.

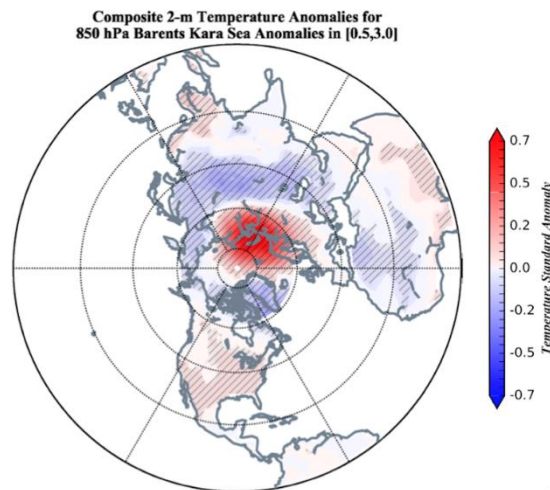


Figure i. Association between surface temperature anomalies across the NH and in the Barents–Kara seas. Climatological averages computed over the period 1981–2010.

Hatching in all figures represents those values found to be statistically significant above 95%.

The GFS model is still predicting that generally this pattern of Arctic temperatures to continue. Therefore, based on the GFS forecast I would argue that even if the impacts from the stratospheric PV disruption continue to descend from the stratosphere to the surface that favor cold in the Eastern US and Europe, the cold can only be transient as warming focused in the Barents Kara Seas favors the most consistent cold across Northern Asia. However, the ECMWF model is predicting colder temperatures in at least the Northeastern US than the GFS with the trough axis across North America further east relative to the GFS.

I favor the ECMWF solution, but I have to admit my reasoning even though is based on ideas that I have discussed before are still fairly speculative so those of a faint of heart might want to skip ahead. As I have discussed previously often the stratospheric polar vortex (PV) center has a reflection in the troposphere. The stratospheric PV is currently centered over Svalbard and is predicted, or a lobe of the PV is predicted, to be centered over or near the Barents-Kara Seas. A polar low in the troposphere would bring colder temperatures to the Barents Kara Seas. An end to the focus of Arctic warming in this region could allow for greater warming elsewhere in the Arctic including near Alaska and possibly over across to Greenland. This would favor an eastward shift of the cold temperatures across North America more consistent with the ECMWF forecast. If I am correct that a tropospheric polar low could set up in the Barents-Kara Seas/Scandinavia region, this does not favor cold but rather mild temperatures for much of Europe.

In addition, now that westerly winds have returned to the polar stratosphere, vertical wave energy can once again propagate from the troposphere to the stratosphere. One such pulse is predicted for next week with predicted warming swinging around East Asia towards Alaska in the stratosphere. This could be a reflective wave pulse, which I have discussed previously that favors cold temperatures in central and eastern North America.

The Madden Julian Oscillation (MJO) forecast could be interpreted as supportive of my ideas as the MJO is currently in phase 7 and after executing a loop de loop is predicted to enter phase 8. These phases are favorable for cold weather in the Eastern US. However, I don't think that the MJO has been a good predictor or indicator of US weather so far this winter. The MJO did a "lather, rinse, repeat" with phases 4, 5 and 6 all of January and yet the temperatures showed extreme variability in the Eastern US during the month.

I do think that as we approach the mid to late winter more persistent patterns grow more likely. I am most confident in persistent cold temperatures in Siberia, followed by eastern North America and lastly across Europe.

Finally, sometimes I feel that Siberian snow cover advance can foreshadow weather during the winter. Snow cover advance was sluggish across Siberia for three quarters and then was rapid for the last quarter of October. Snow cover has been well below normal in the I95 corridor of the Northeastern US. If the focus of the Arctic warmth can move from the eastern (Barents-Kara Seas) to the western Hemisphere (Beaufort-Bering Seas and near Greenland), snowfall could pick up to close out winter. But I have to admit I have thought this for a while and so far, snow has been parsimonious in the I95 corridor.

I did want to use the blog to explain some of my ideas on how Arctic change can lead to extreme winter weather. I feel that there have been certain things said about my ideas that are simply not true and I want to correct the record. I do not claim that climate change will lead to colder absolute winters than fifty, sixty or how many years ago, though a clear cooling trend was observed from circa 1990 to mid 2010's. Instead I claim that winters across the mid-latitude continents are colder than predicted or projected by the models. Observed winters have been consistently colder than the model ensemble-mean and is as cold as the coldest ensemble members or even colder than the coldest ensemble member.

As an example, in [Cohen et al. 2012](#) we compared the annual Northern Hemisphere (NH) land temperature trends (1988-2010) with model simulated or projected temperature trends and that the model trends are comparable to observed trends (**Figure ii**). Yet the same comparison with winter temperatures only, shows that the model and observed temperature trends diverge (**Figure ii**). Observed NH winter temperature trends are nearly flat while modeled winter temperature trends are strongly positive even more than annual temperature trends. Everyone agrees with these facts. The disagreement among scientists is to what do you attribute the observed and model discrepancy or divergence in winter temperature trends. Most dynamicists argue that the difference is attributable to natural variability, the chaotic nature of the system or can be considered random or simply due to chance. Others mostly considered Arctic scientists, including myself, argue that the observed and model difference isn't random but at least in part is due to Arctic change.

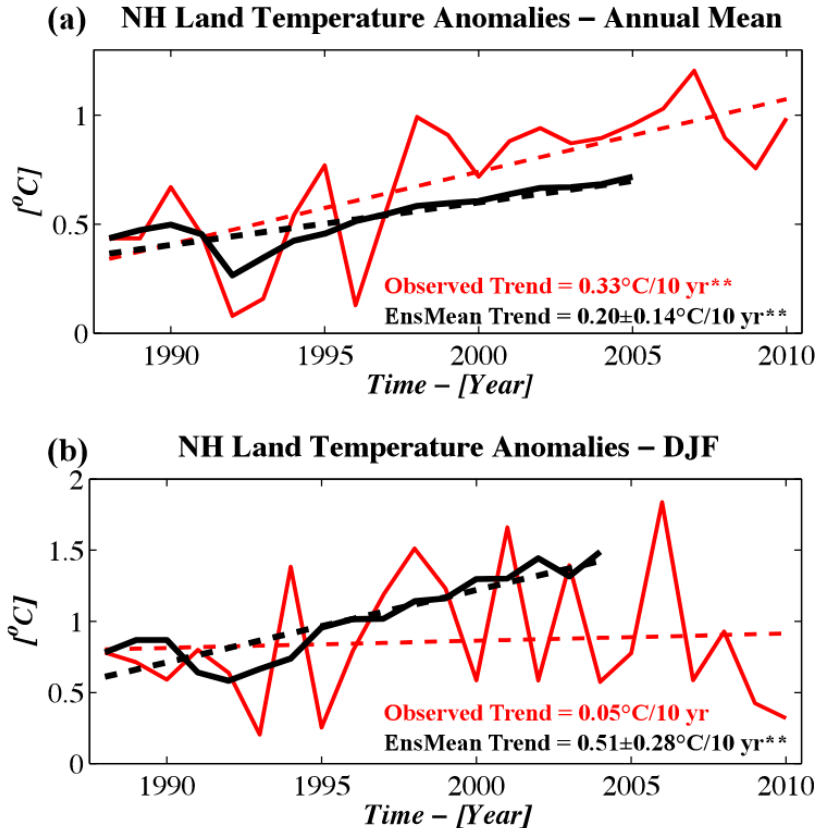


Figure ii. a) The annual-mean area-averaged land temperature anomalies ($^{\circ}\text{C}$; averaged poleward of 20°N) from 1988–2010 from CRUTEM3 (solid red) and the ensemble mean temperature anomaly from the historical scenario of the CMIP5 models (solid black). Also shown is the linear trend for the observations (dashed red) and the CMIP5 ensemble mean (dashed black), including ± 1 standard deviation. A double asterisk (**) indicates trends significant at the $p < 0.01$ level. b) As in (a) but for DJF-averaged observed temperature anomalies (red) and the CMIP5 ensemble mean DJF temperature anomalies (black). In (a) and (b), the plots of model-based anomalies are shifted vertically so that the anomaly in 1988 matches that from the observations.

The theory that has been most popular in the media Among those that argue that Arctic change is forcing more extreme weather in the mid-latitudes is that of [Francis and Vavrus 2012](#). Their argument is that accelerated Arctic warming is leading to a slackened equator to pole temperature differential across the NH. The Jet Stream feeds off of this temperature gradient so therefore the weakened temperature gradient results in a slackening or weakening of the Jet Stream. The slower Jet Stream has further knock on effects of a wavier, more meandering Jet Stream with greater amplitude. A slower, wavier and more amplified Jet Stream produces more extreme weather including more heat and cold waves, flooding and droughts.

I have proposed an alternate theory with different iterations of Arctic sea ice loss and increasing Siberian snow cover leading to more frequent disruptions of the stratospheric PV. In the scientific literature this idea was proposed as early as [Cohen and Barlow 2005](#) (top of page 4511) but possibly best described and illustrated in [Cohen et al. 2014](#) in Box 2. Disappearing Arctic sea ice focused in the Barents-Kara Seas coupled with increasing Siberian snow cover favors an anomalous tropospheric wave across the Eurasian continent with ridging across northwest Eurasia, due to anomalous heating from sea ice loss and troughing across northeast Eurasia, due to anomalous cooling from increased snow cover. This anomalous wave projects onto or amplifies the naturally occurring wave across Eurasia forced by the land ocean contrast and the topography of the Eastern Hemisphere. Amplification of the natural or climatological wave results in greater vertical energy transfer from the troposphere into the polar stratosphere leading to more frequent stratospheric PV disruptions. Stratospheric PV disruptions are often followed by an increase in severe winter weather across the NH mid-latitudes including the Eastern US, Europe and East Asia (**Figure iii**).

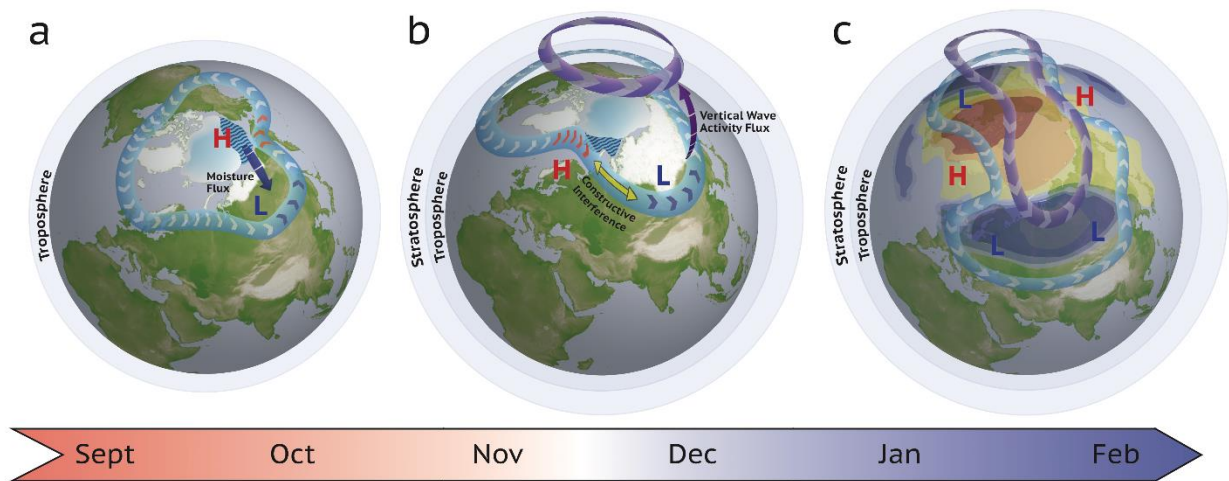


Figure iii. The schematic highlights a proposed way in which Arctic sea ice loss in late summer through early winter may work in concert with extensive Eurasian snow cover in the fall to force the negative phase of the N/AO in winter. Snow is shown in white, sea ice in white tinged with blue, sea ice melt with blue waves, high and low pressure with red “H” and blue “L” respectively, tropospheric jet stream in light blue with arrows and stratospheric jet or polar vortex shown in purple with arrows. On the right globe cold (warm) temperature anomalies associated with the negative phase of the winter N/AO are shown in blue (orange).

Near Term Conditions

1-5 day

The AO is slightly negative (**Figure 1**), with mixed geopotential height anomalies across the Arctic but mostly positive on the North Atlantic side (**Figure 2**). Geopotential height anomalies are weak across Iceland and Greenland but positive across the mid-latitudes of the North Atlantic (**Figure 2**) and therefore the NAO is slightly positive.

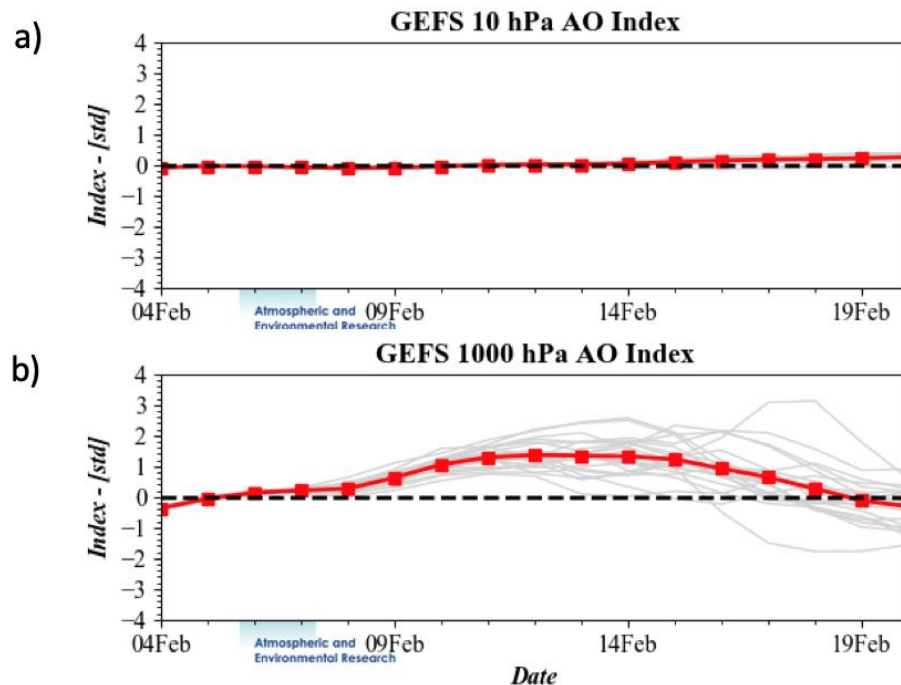


Figure 1. (a) The predicted daily-mean AO at 10 hPa from the 00Z 4 February 2019 GFS ensemble. (b) The predicted daily-mean near-surface AO from the 00Z 28 February 2019 GFS ensemble. Gray lines indicate the AO index from each individual ensemble member, with the ensemble-mean AO index given by the red line with squares.

Currently ridging/positive geopotential height anomalies centered just west of Spain (**Figure 2**) are forcing troughing/negative geopotential height anomalies downstream across Scandinavia and Central Europe with more ridging/positive geopotential height anomalies across Eastern Europe (**Figure 3**). Low heights and mostly northerly flow of air favor normal to below normal temperatures across Western Europe including the UK but especially Scandinavia while high heights and westerly winds favor normal to above normal temperatures for Eastern Europe (**Figure 3**). Ridging/positive geopotential height anomalies in Western Russia are forcing troughing/negative geopotential height anomalies downstream across all of Siberia and into Northeast Asia with ridging/positive geopotential height anomalies widespread across Southern Asia (**Figure 2**). This pattern is predicted to yield widespread normal to below normal temperature for Siberia and Northeast Asia with normal to above normal temperatures across Western Russia and much of Southern Asia including the Middle East and

Southeast Asia (**Figure 3**). However, regional troughing/negative geopotential height anomalies across the northern India subcontinent (**Figure 2**), are predicted to result in normal to below normal temperatures across Northern India and Pakistan (**Figure 3**).

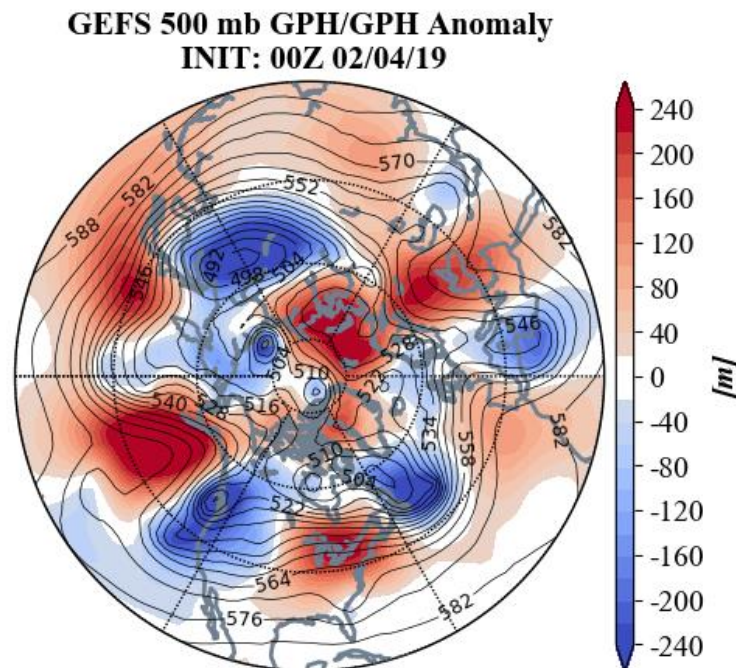


Figure 2. Observed 500 mb geopotential heights (dam; contours) and geopotential height anomalies (m; shading) for 00Z 4 February 2019.

Ridging/positive geopotential height anomalies across Alaska and south of the Aleutians are forcing downstream troughing/negative geopotential height anomalies across the West Coast of North America with more ridging/positive geopotential height anomalies across eastern North America (**Figure 2**). This pattern is predicted to result in normal to below normal temperatures for Western, Central and Northeastern Canada and the Western US with normal to above normal temperatures for Alaska, Southeastern Canada and the Eastern US (**Figure 3**).

GEFS 1-5 Day Forecast T2m Anomaly
INIT: 00Z 02/04/19 FCST: 02/05/19 to 02/09/19

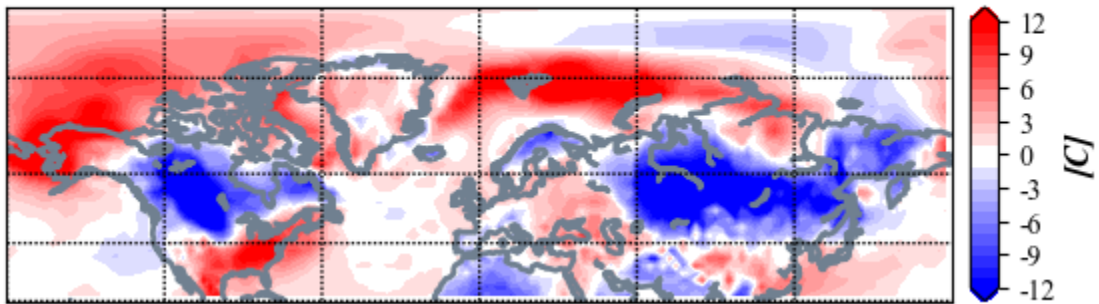


Figure 3. Forecasted surface temperature anomalies ($^{\circ}\text{C}$; shading) from 5– 9 February 2019. The forecast is from the 00Z 4 February 2019 GFS ensemble.

Trouching and/or cold temperatures will bring new snowfall to Western Russia, Central Asia and part of China (**Figure 4**). Across North America, troughing and cold temperatures will bring widespread new snowfall across Southern Canada and the Northwestern US (**Figure 4**). Milder temperatures will result in snowmelt across parts of Europe and the Northeastern US (**Figure 4**).

GEFS 1-5 Day Forecast Mean 24-hour Snow Depth Change
INIT: 00Z 02/04/19 FCST: 02/05/19 to 02/09/19

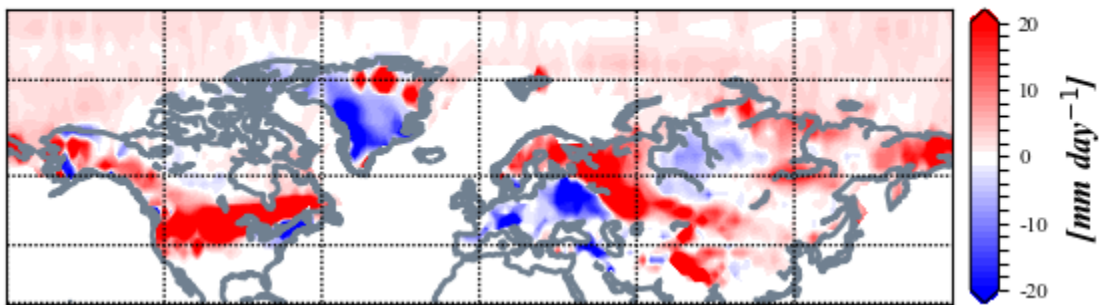


Figure 4. Forecasted snowfall anomalies (mm/day ; shading) from 5 – 9 February 2019. The forecast is from the 00Z 4 February 2019 GFS ensemble.

Mid-Term

6-10 day

The AO is predicted to turn positive next week (**Figure 1**) with mostly negative geopotential height anomalies across the Arctic and positive geopotential height

anomalies across the mid-latitudes of the NH (**Figure 5a**). And with weak geopotential height anomalies across Greenland, the NAO will likely be near neutral next week.

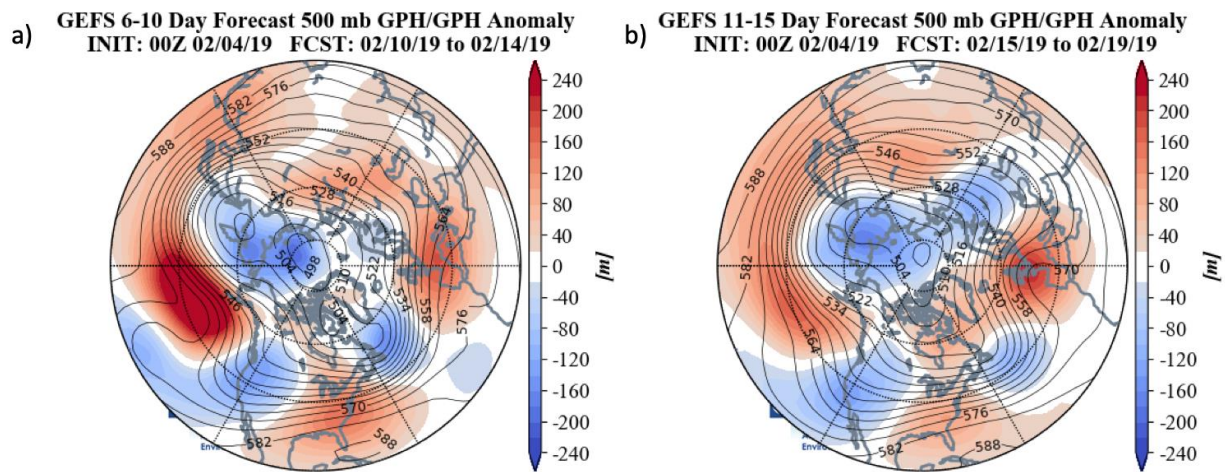


Figure 5. (a) Forecasted average 500 mb geopotential heights (dam; contours) and geopotential height anomalies (m; shading) across the Northern Hemisphere from 10 – 14 February 2019. (b) Same as (a) except averaged from 15 – 19 February 2019. The forecasts are from the 4 February 2019 00z GFS ensemble.

Ridging/positive geopotential height anomalies are predicted to dominate much of Europe with the exception of troughing/negative geopotential height anomalies across Scandinavia this period (**Figure 5a**). Widespread high heights are predicted to result in normal to above normal temperatures widespread across Europe including the UK while low heights will favor normal to below normal temperatures for Scandinavia (**Figure 6**). Ridging/positive geopotential height anomalies in Western Russia are anchoring troughing/negative geopotential height anomalies downstream across Siberia and into Northeast Asia with ridging/positive geopotential height anomalies widespread across Southern Asia (**Figure 5a**). This is predicted to yield normal to below normal temperatures for most of Siberia and into Northeast Asia with normal to above normal temperatures for Western Russia, the Middle East and Southeast Asia (**Figure 6**). Some residual troughing/negative geopotential height anomalies across Northern India (**Figure 5a**) are predicted to yield normal to below normal temperatures for Northern India and possibly into Pakistan (**Figure 6**).

GEFS 6-10 Day Forecast T2m Anomaly
INIT: 00Z 02/04/19 FCST: 02/10/19 to 02/14/19

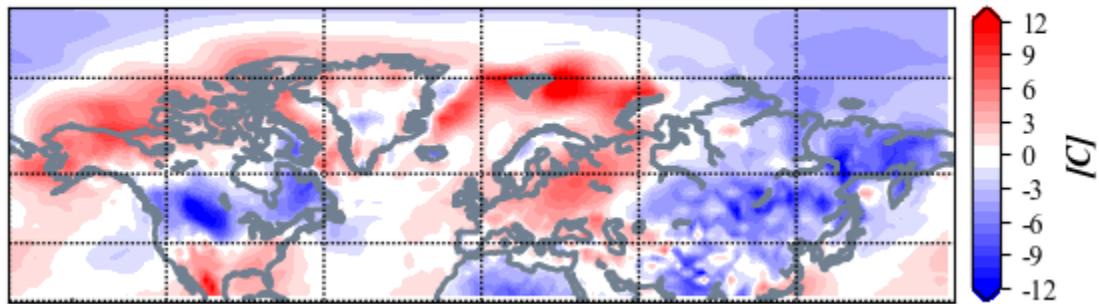


Figure 6. Forecasted surface temperature anomalies ($^{\circ}\text{C}$; shading) from 10 – 14 February 2019. The forecasts are from the 00Z 4 February 2019 GFS ensemble.

Ridging/positive geopotential height anomalies south of the Aleutians are predicted to anchor troughing/negative geopotential height anomalies in Western Canada and the Western US with more ridging/positive geopotential height anomalies in the eastern US (**Figure 5a**). The resultant temperature anomalies across North America are predicted to be normal to below normal temperatures across much of Canada and the Northwestern US with normal to above normal temperatures for Alaska and the Southern and Eastern US (**Figure 6**).

GEFS 6-10 Day Forecast Mean 24-hour Snow Depth Change
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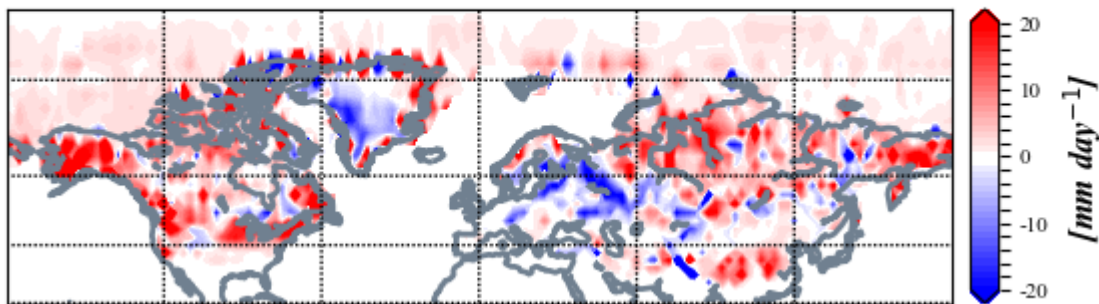


Figure 7. Forecasted snowfall anomalies (mm/day ; shading) from 3 – 7 February 2019. The forecasts are from the 00Z 4 February 2019 GFS ensemble.

Troughing and cold air will bring the potential for new snowfall across Scandinavia, Northern and Central Asia (**Figure 7**). Across North America, new snowfall is possible in Alaska, much of Canada and the Northern US (**Figure 7**). Mild temperatures could result in snowmelt in parts of Europe and Western Russia (**Figure 7**).

11-15 day

With mostly positive geopotential height anomalies predicted for the North Atlantic side of the Arctic and negative geopotential height anomalies predicted for the North Pacific side of the Arctic (**Figure 5b**), the AO is likely to be close to neutral this period (**Figure 1**). With weak positive pressure/geopotential height anomalies across Greenland, the NAO is predicted to remain neutral to slightly negative this period as well (**Figure 1**).

Ridging/positive geopotential height anomalies centered across Western Europe (**Figure 5b**) are predicted to result in normal to above normal temperatures for much of Europe including the UK (**Figure 8**). One exception could be northern Scandinavia where troughing/negative geopotential height anomalies and northerly flow (**Figure 5b**) will persist normal to below normal temperatures (**Figure 8**). Western European ridging is predicted to force downstream troughing/negative geopotential height anomalies across Western Europe that extends across Siberia and into Northeast Asia with ridging/positive geopotential height anomalies predicted for Southern Asia (**Figure 5b**). This pattern favors normal to below normal temperatures for much of Northern Asia, but especially Siberia and into Northeast Asia with normal to above normal temperatures for Southern Asia including the Middle East and Southeast Asia (**Figure 8**). Some residual troughing/negative geopotential height anomalies across Northern India (**Figure 5a**) are predicted to yield normal to below normal temperatures for Northern India and Pakistan (**Figure 6**).

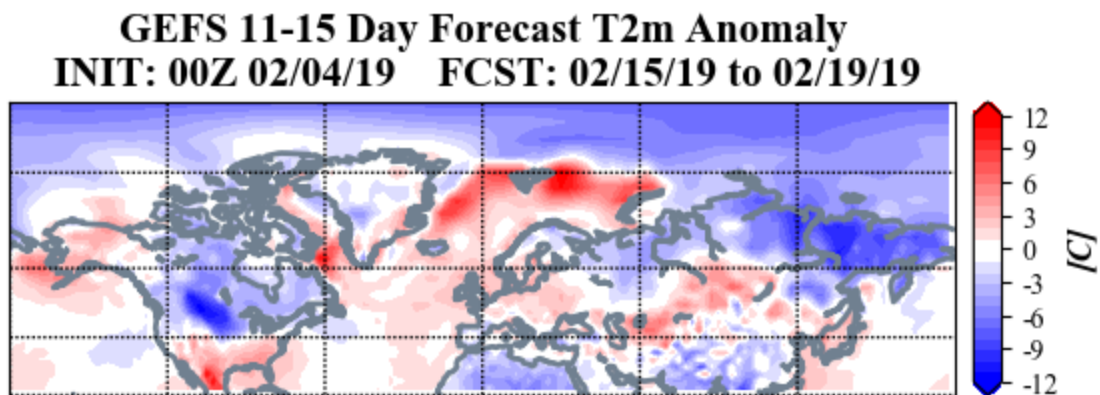


Figure 8. Forecasted surface temperature anomalies ($^{\circ}\text{C}$; shading) from 15 – 19 February 2019. The forecasts are from the 00Z 4 February 2019 GFS ensemble.

Persistent ridging/negative geopotential height anomalies centered south of the Aleutians will continue to support troughing/negative geopotential height anomalies across western North America with ongoing ridging/negative geopotential height anomalies across eastern North America (**Figure 5b**). This will favor normal to below normal temperatures across much of Canada, the US along the Canadian border and

the Western US with normal to above normal temperatures for Alaska and the US east of the Rockies south of 40°N (**Figure 8**).

GEFS 11-15 Day Forecast Mean 24-hour Snow Depth Change
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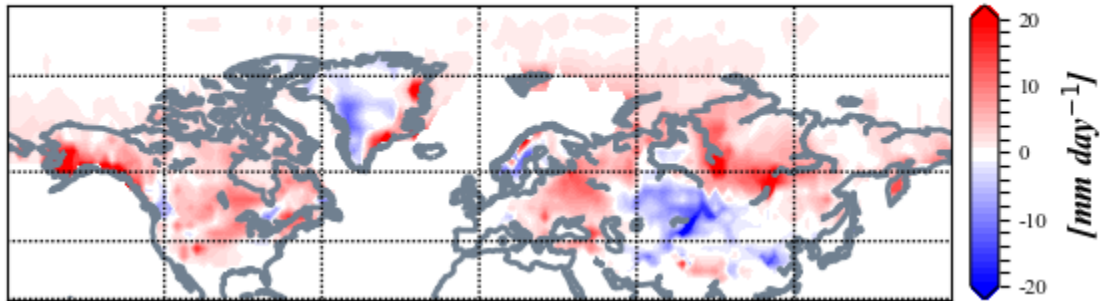


Figure 9. Forecasted snowfall anomalies (mm/day; shading) from 15 – 19 February 2019. The forecasts are from the 00Z 4 February 2019 GFS ensemble.

Once again additional snowfall is possible across much of northern Eurasia including Scandinavia, Eastern Europe, Siberia, Western Asia, Northeastern Asia and even possibly Pakistan and Turkey (**Figure 9**). Cold temperatures across Alaska, Canada and even the Northern US will also support potentially new snowfall (**Figure 9**). Mild temperatures could result in snowmelt across Central Asia (**Figure 9**).

Longer Term

30-day

The latest plot of the polar cap geopotential heights (PCHs) shows in general predicted normal to above normal PCHs in the troposphere and the lower stratosphere with normal to below normal PCHs in the mid stratosphere (**Figure 10**). The above normal PCHs in the troposphere are consistent with a predicted near neutral to negative AO predicted for this week (**Figure 1**). The below normal PCHs in the mid stratosphere are consistent with a return to near neutral stratospheric AO for the next two weeks (**Figure 1**). The positive PCHs in the lower stratosphere and troposphere are related to downward propagation of circulation anomalies related to the sudden stratospheric warming (SSW) and a major mid-winter warming (MMW; where the zonal mean zonal wind reverses from westerly to easterly at 60°N and 10 hPa) earlier this month.

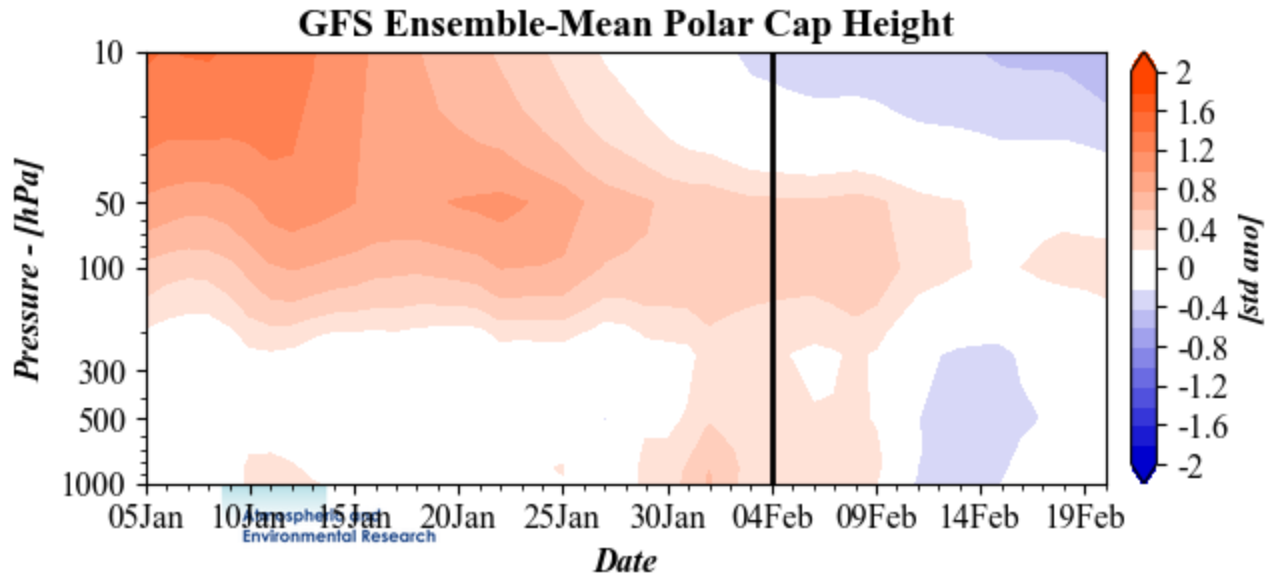


Figure 10. Observed and predicted daily polar cap height (i.e., area-averaged geopotential heights poleward of 60°N) standardized anomalies. The forecasts are from the 00Z 4 February 2019 GFS ensemble.

The GFS predicts that the tropospheric PCHs will turn cold next week consistent with the positive AO forecast. The GFS forecast also gives the impression that the downward propagation of positive PCHs from the stratosphere to the troposphere will essentially end the second week of February. As I have mentioned previously, the impact of the SSW on the weather can be from four to eight weeks. The GFS forecast is on the short end of the range and certainly plausible, but I do think that the influence of the SSW may last longer than suggested by the GFS.

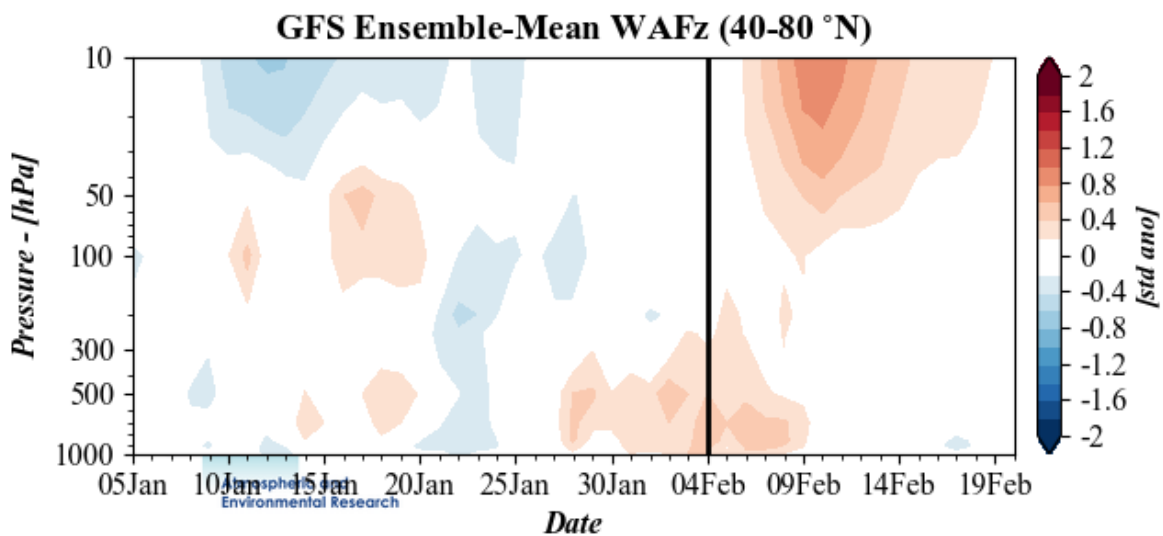


Figure 11. Observed and predicted daily vertical component of the wave activity flux (WAFz) standardized anomalies, averaged poleward of 40-80°N. The forecast is from the 00Z 4 February 2019 GFS ensemble.

Now that the winds have returned to westerly in the mid stratosphere the plot of Wave Activity Flux (WAFz) or poleward heat transport shows more active WAFz (**Figure 11**). Though for now no new substantial disruption of the stratospheric PV is predicted a warming is predicted to swing around from East Asia towards Alaska and could have important implications for the weather in the Eastern US. Such relatively minor polar stratospheric warmings tend to favor cold in Central and Eastern North America.

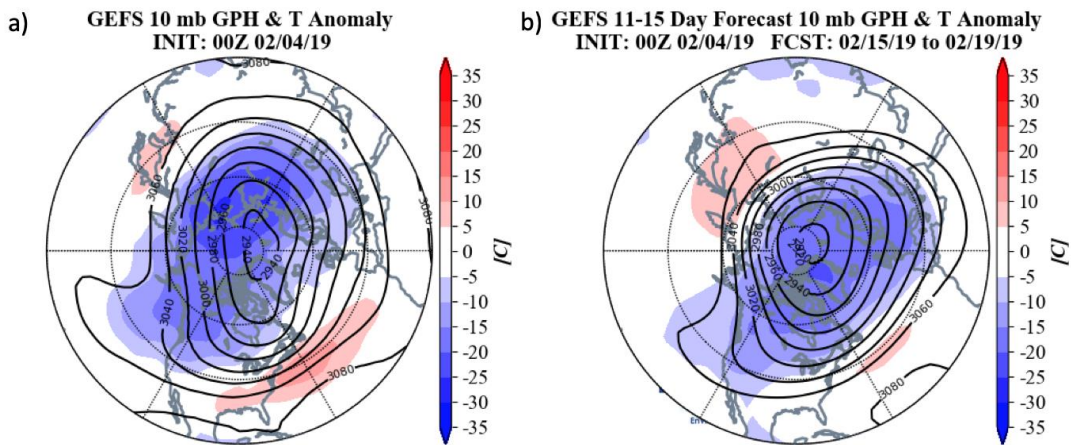


Figure 12. (a) Analyzed 10 mb geopotential heights (dam; contours) and temperature anomalies (°C; shading) across the Northern Hemisphere for 4 February 2019. (b) Same as (a) except forecasted averaged from 15 – 19 February 2019. The forecasts are from the 00Z 4 February 2019 GFS operational model.

The stratospheric PV continues to recover, and the two daughter vortices have merged with the PV centered over Svalbard (**Figure 12**). As I discussed in the last two weeks of the blog the cold temperatures in the stratosphere are focused in Siberia and western North America and could be a sign where the coldest temperatures at the surface may be focused as well during the month of February. However, as I discuss in the Impacts section the GFS may be persisting the cold in Western North America too long.

CFS 500 hPa Forecast Anomaly Mar 2019
Valid as of 04 Feb 2019

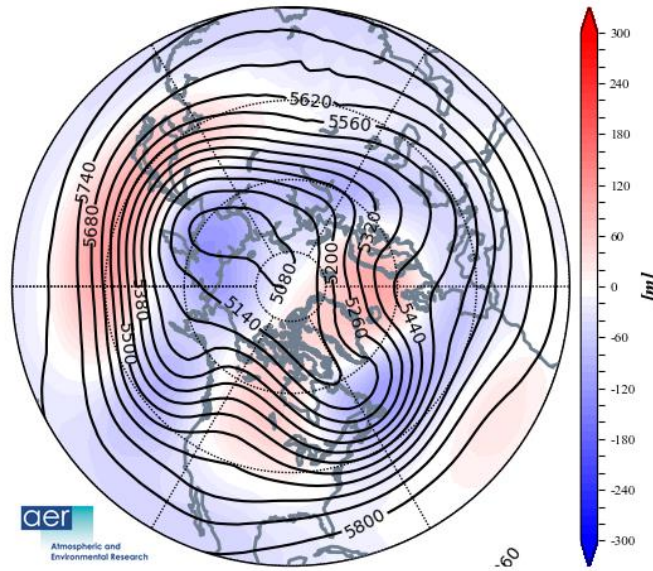


Figure 13. Forecasted average 500 mb geopotential heights (dam; contours) and geopotential height anomalies (m; shading) across the Northern Hemisphere for March 2019. The forecasts are from the 4 February 2019 CFS.

I include in this week's blog the monthly 500 hPa geopotential heights (**Figure 13**) and the surface temperatures (**Figure 14**) forecast for March from the Climate Forecast System (CFS; the plots represent yesterday's four ensemble members). The forecast for the troposphere is ridging centered in Central Canada, from Greenland over to Scandinavia with troughs across Alaska, eastern North America, Europe and Siberia (**Figure 13**). This pattern favors cold temperatures for much of Europe, Northern Asia especially Siberia, Northeast Asia, Eastern Canada and the Eastern US with relatively mild temperatures for the Middle East, Southeast Asia and much of western North America (**Figure 14**). This forecast may be too cold for Eurasia and too warm for North America.

CFS T2m Forecast Anomaly Mar 2019
Valid as of 04 Feb 2019

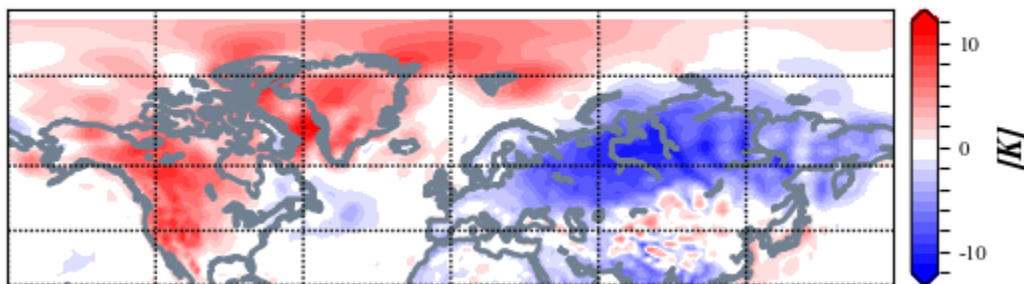


Figure 14. Forecasted average surface temperature anomalies (°C; shading) across the Northern Hemisphere for March 2019. The forecasts are from the 4 February 2019 CFS.

Surface Boundary Conditions

Arctic Sea Ice

Arctic sea ice growth rate continues at a slow rate and remains well below normal but higher than recent years. It appears to me that the overwhelming negative departures in the Barents-Kara Seas (**Figure 13**) is no longer apparent. I would argue that the greatest negative anomalies so far this winter in the Barents-Kara Seas has favored this region for ridging/blocking during the winter months. Some research shows low sea ice in the Sea of Okhotsk favors a positive AO/NAO. Normal to above normal sea ice in and around Greenland and the Canadian Archipelagos may favor a positive winter NAO. Based on recent research low sea ice anomalies in the Chukchi and Bering seas favors cold temperatures in central and eastern North America while low sea ice in the Barents-Kara seas favor cold temperatures in Central and East Asia, however this topic remains controversial. 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.

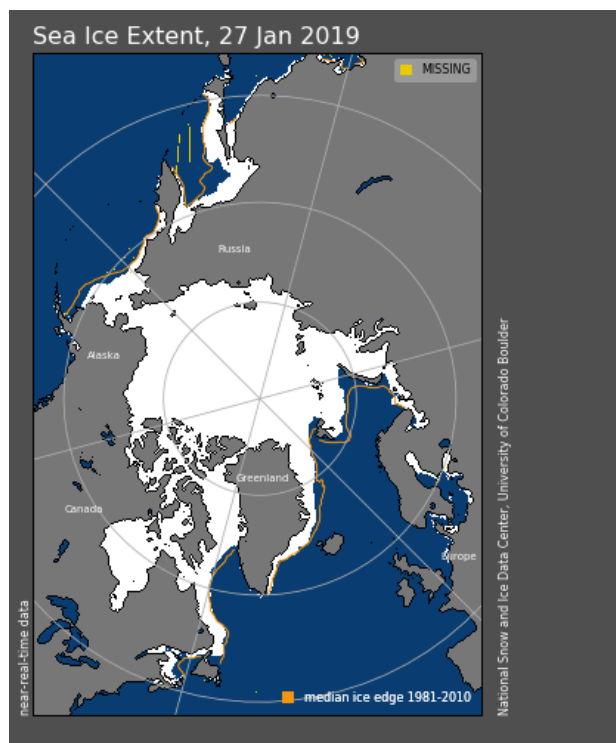


Figure 15. Observed Arctic sea ice extent on 3 February 2019 (white). Orange line shows climatological extent of sea ice based on the years 1981-2010. Image courtesy of National Snow and Ice Data Center (NSIDC). Snow and Ice Data Center (NSIDC).

SSTs/El Niño/Southern Oscillation

Equatorial Pacific sea surface temperatures (SSTs) anomalies remain warm but no longer support El Niño conditions (**Figure 13**). Observed SSTs across the NH remain well above normal though below normal SSTs exist regionally. Cold SSTs south of Iceland and in the subtropics of the North Atlantic with above normal SSTs in the mid-latitudes are thought to favor a positive winter NAO.

SST Anomaly - Week Ending 03 Feb 2019

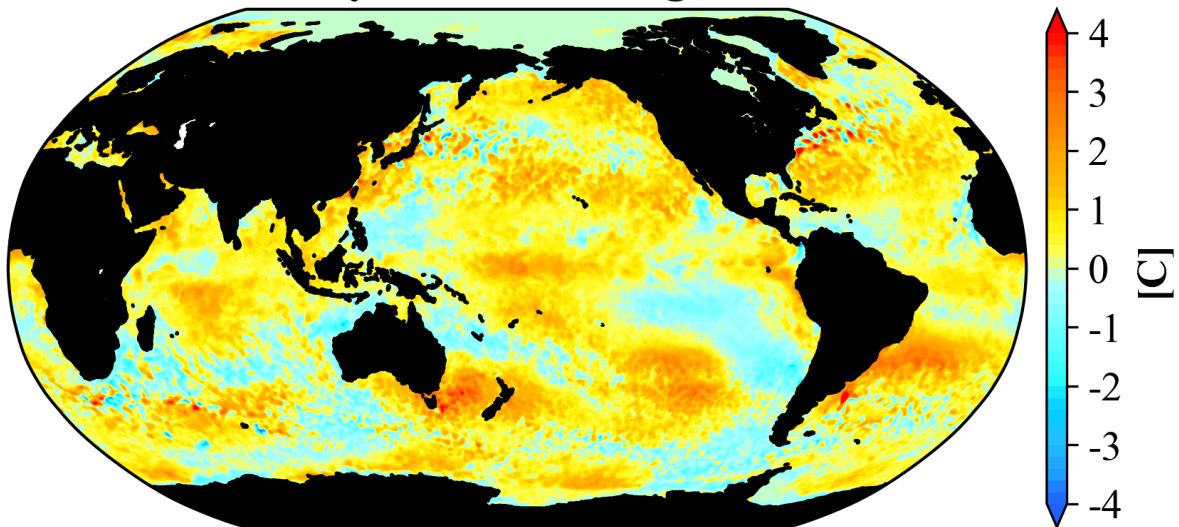


Figure 16. The latest weekly-mean global SST anomalies (ending 27 January 2019). Data from NOAA OI High-Resolution dataset. (Updated from https://www.ospo.noaa.gov/Products/ocean/sst/anomaly/anim_full.html due to US Government shutdown).

Currently phase seven of the Madden Julian Oscillation (MJO) is favored (**Figure 14**). However the MJO is expected to transition to phase six and then back to phase 7 then 8. Phases 7 and 8 eventually favor troughing over eastern North America with cold temperatures and ridging over western North America with mild temperatures.

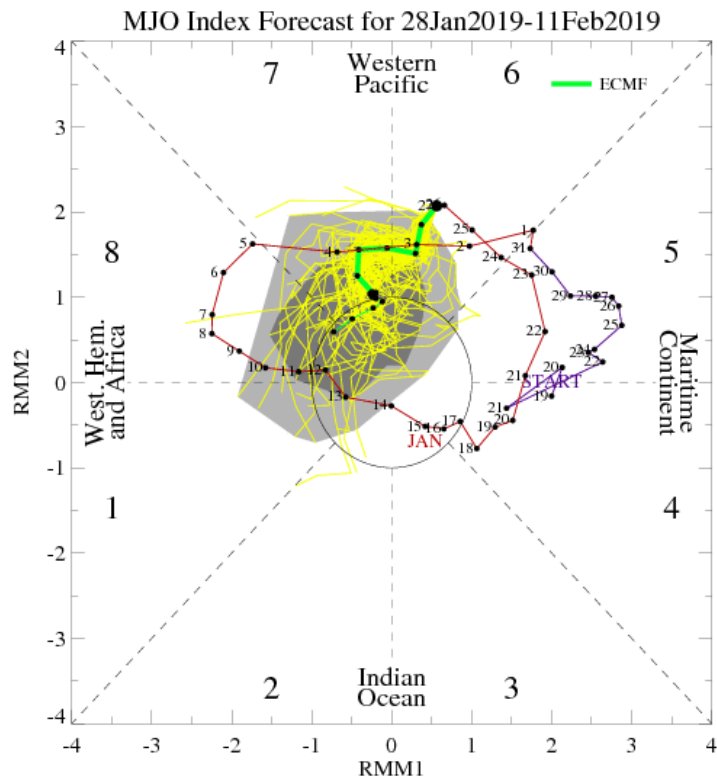


Figure 17. Past and forecast values of the MJO index. Forecast values from the 00Z 4 February 2019 ECMWF model. Yellow lines indicate individual ensemble-member forecasts, with the green line showing the ensemble-mean. A measure of the model “spread” is denoted by the gray shading. Sector numbers indicate 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 advance continues its recent stall across Eurasia but remains near decadal means. Snow cover advance could advance is unlikely in the next couple of weeks as Europe turns milder. Above normal snow cover extent this past 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.

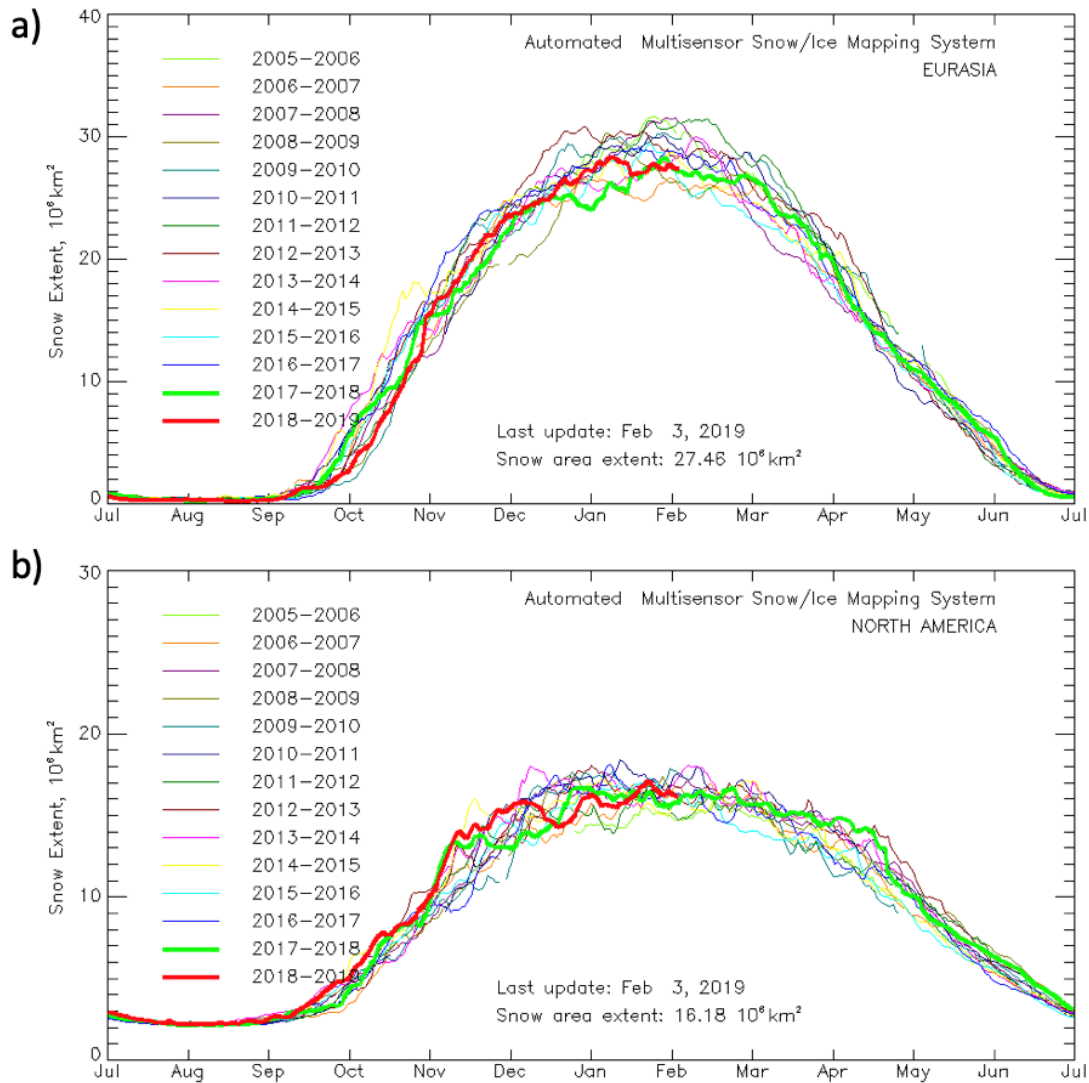


Figure 18. Observed Eurasian (top) and North American (bottom) snow cover extent through 3 February 2019. Image source:

https://www.star.nesdis.noaa.gov/smcd/emb/snow/HTML/snow_extent_plots.html

North American snow cover has remained steady near decadal means. Snow cover could advance further as cold air becomes more widespread across the continent.