

November 11, 2019

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.

With the start of spring we transitioned 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 for the next two weeks.
- The current negative AO is reflective of mostly positive pressure/geopotential height anomalies across the Arctic and mixed pressure/geopotential height anomalies across the mid-latitudes. The North Atlantic Oscillation (NAO) is near neutral with mixed pressure/geopotential height anomalies spread across Greenland and Iceland; and the NAO is predicted to remain near neutral as geopotential height anomalies remain weak across Greenland.
- This week, troughing/negative pressure/geopotential height anomalies over Western Europe are predicted to be sandwiched by ridging/positive geopotential height anomalies in the central North Atlantic and Western Asia. Normal to below

normal temperatures are predicted for Western Europe including the United Kingdom (UK) under northerly flow while normal to above normal temperatures are predicted for Eastern Europe under southerly flow. However, over the next two weeks the ridging in Western Asia will push north into the Barents-Kara Seas allowing cold air in Siberia to flow west underneath the ridge into Northern Europe.

- Currently temperatures are mostly above normal across Western Asia and Southeastern Asia as ridging/positive geopotential height anomalies dominate Western and Southern Asia while temperatures are below normal in Siberia with troughing/negative pressure/geopotential height anomalies dominating the region. However, over the next two weeks, ridging/positive geopotential height anomalies currently centered over the Caspian Sea eventually will drift north into the Barents-Kara Seas allowing troughing/negative geopotential height anomalies with below normal temperatures to stretch across Northern Asia and Northern Europe.
- This week ridging/positive geopotential height anomalies are predicted to dominate western North America with normal to above normal temperatures for Alaska and the West Coasts of Canada and the United States and troughing/negative geopotential height anomalies over eastern North America with normal to below normal temperatures east of the Rockies both in Canada and the US. However, over the next two weeks the pattern is predicted to flip with troughing in western North America with cooler temperatures and ridging in eastern North America temperatures turning milder.
- In the Impacts section I discuss how the atmosphere is predicted to respond to above normal October Eurasian snow cover extent consistent with previous research.

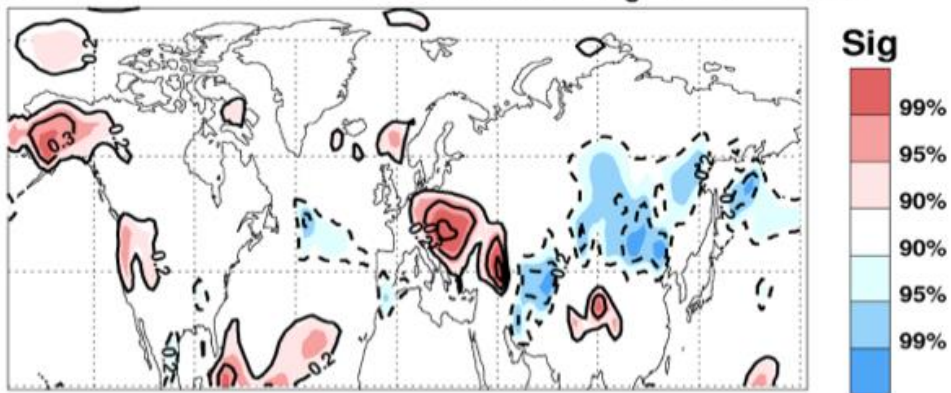
Impacts

Last week I included the graphic of the six-step process of how snow cover advance in October can influence the behavior of the stratospheric polar vortex (PV) in early winter and mid-to late winter weather. This year Eurasian snow cover extent was above normal and therefore I would expect a relatively perturbed or disrupted PV most likely in January followed by a prolonged period where the AO is on average negative and cold temperatures across the mid-latitudes from late January into February. But before then there are two other steps. And of course, as we saw last winter an even highly perturbed PV does not guarantee to be followed by a meaningful period of a negative AO.

The first step following above normal Siberian October snow cover are cold temperatures in Siberia. This is coupled with a northwestward expansion of the Siberian high and ridging/blocking in the mid-troposphere in the Urals/Scandinavian region. I just did a quick correlation of October Siberian with November surface temperatures shown in **Figure i**. Above normal October Siberian snow cover extent is

followed by below normal temperatures in Siberia that extend southwestward towards the Persian Gulf and warm temperatures in the Middle East and Eastern Europe. Temperatures are also above normal in western North America, in particular Alaska. Also included in **Figure i**, is the latest CFS surface temperature forecast for November and the similarity to the temperature response to above normal snow cover is striking. Predicted are below normal temperatures in Siberia that extend southwestward towards the Persian Gulf, relatively warm temperatures in the Middle East and Eastern Europe and warm temperatures in western North America including Alaska.

a) Corr of Eur Oct Snow and Nov T_s 1949-2004



**b) CFS T2m Forecast Anomaly Nov 2019
Valid as of 11 Nov 2019**

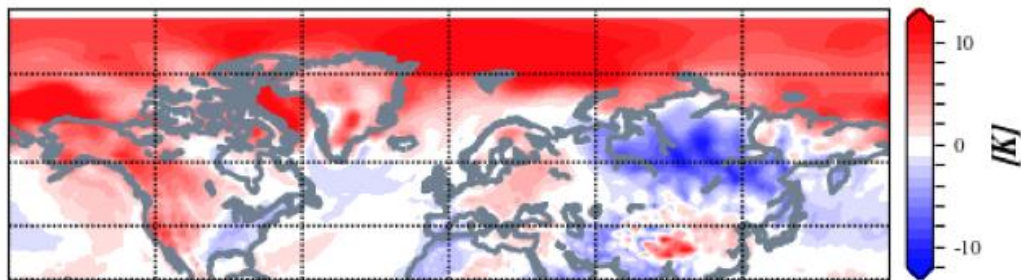


Figure i. **a)** Correlations October Eurasian snow cover extent with Northern Hemisphere surface temperatures 1949 through 2004. **b)** Forecasted average surface temperature anomalies ($^{\circ}\text{C}/^{\circ}\text{K}$; shading) across the Northern Hemisphere for November 2019. The forecasts are from the 11 November 2019 CFS.

As I discussed last week, the response to above normal October Siberian snow cover in pressure/heights is a northwestward expansion of the Siberian high. Last week I showed the analysis for the mid-troposphere but in **Figure ii**, I show the analysis for sea level pressure (a plot that I have shown many times previously in the blog from [Cohen et al. 2014](#)). The northwestward expansion of the Siberian high is coupled with relatively

low pressure in the respective ocean basins, forming a tripole pattern. This pattern is also favorable for exciting vertical energy transfer from the troposphere into the stratosphere. Also included in **Figure ii** is the predicted November SLP from this morning's CFS. Again, the SLP pattern predicted for November is strikingly similar to the pattern shown to be the response to above normal October snow cover. Also included in Figure ii is the average SLP pattern 0-45 days prior to a PV displacement and it is characterized by the northwestward expansion of the Siberian High coupled with deep low pressure in the northern North Pacific as shown in [Cohen and Jones 2011](#). Again, there is a strong similarity between the predicted November average SLP pattern and the pattern most favorable for initiating a PV displacement. Therefore, in my opinion the atmospheric response to above normal October Siberian snow cover has been "textbook," which is also highly favorable to initiating vertical energy transfer from the troposphere to the stratosphere that disrupts the PV. And given the spatial scale of the blocking high pressure across northern Eurasia, it projects more onto wave one that favors a PV displacement over a PV split.

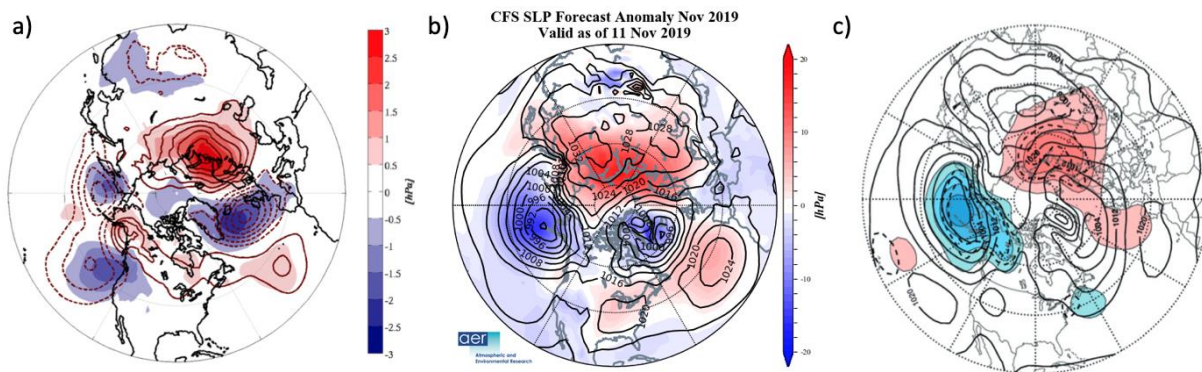


Figure ii. **a)** Regression of November SLP anomalies (hPa) onto October monthly mean, October Eurasian SCE (contouring) and December meridional heat flux anomalies at 100 hPa, averaged between 40-80°N (shading). **b)** Predicted average sea level pressure (hPa; contours) and sea level pressure anomalies (hPa; shading) across the Northern Hemisphere from November 11, 2019 through November 30, 2019. The forecasts are from the 11 November 2019 CFS. **c)** Sea level pressure anomalies (hPa) averaged 45 to zero days prior to polar vortex displacements.

From **Figure 12** below the vertical energy transfer is responding to the atmospheric circulation and is predicted to become more active in the next couple of weeks, which I expect will continue well into December. I do believe that a significant PV disruption is becoming more and more likely but is not guaranteed. As I have discussed over the past year there is vertical energy transfer that can result in a "reflective" PV disruption and alternatively vertical energy transfer that can result in an absorptive PV disruption. A reflective event is characterized by positive vertical energy transfer anomalies or vertical wave activity Flux (WAFz) quickly followed by negative WAFz anomalies. The PV itself is stretched but often not displaced. Also, the cold

temperature response to a reflective event are focused in North America east of the Rockies. If you look at **Figure 12** below you can see a reflective event at the end of October and early November identified by a red blue striation or positive anomalies quickly followed by negative anomalies. I do believe this reflective event is at least partially responsible for the cold air outbreaks of last week and this week.

In contrast during absorptive events the WAFZ is consistently positive until the climax of the PV disruption. Also, the cold temperature response to an absorptive event are focused in Eurasia. Also, I have discussed many times that during positive WAFz leading to an absorptive PV disruption, temperatures tend to be mild in eastern North America but cold in East Asia. Again, in Figure 12 the predicted WAFz anomalies are predicted to be positive only over the next two weeks. Also, the PV is predicted to be displaced towards Eurasia (see below Figure 13). This is looking to me like we are transitioning from a reflective PV disruption in early November to potentially an absorptive PV disruption in late November. The biggest immediate impact on Northern Hemisphere (NH) temperatures would be a shift of cold temperatures from North America to Eurasia. The positive WAFz leading up to an absorptive PV disruption can last up to six weeks. So potentially we are at the beginning of a multi week period of overall mild temperatures in eastern North America.

When I tweeted on Friday about the potential for more cold air for eastern North America based on a minor PV disruption, I had assumed another reflective event. Much of this was based on the time of year. It seems to me that positive WAFz in November most often is associated with reflective events and only later in December and January are the positive WAFz anomalies associated with absorptive events. This was the case the last two years. These events are much easier to diagnose in hindsight, so I am not committing to one type of event or another. As of today, it is starting to look like more of an absorptive event to me but I don't rule out a reflective event just yet. If it is a reflective event, then I do believe it can turn colder in eastern North America. And even if it is an absorptive event, short-lived cold outbreaks are still possible.

Longer term if it is the beginning of absorptive positive WAFz, this could be the initiation of a significant PV disruption. But this takes time and I would guess the earliest would be the second half of December. So far, our speculative polar vortex model does not indicate a significant PV disruption through December 11, but I think over time it will show greater confidence in one based on the predicted NH atmospheric circulation.

Near Term Conditions

1-5 day

The AO is currently slightly negative (**Figure 1**) with mostly positive geopotential height anomalies across the Arctic and mixed geopotential height anomalies across the mid-

latitudes of the NH (**Figure 2**). And with mixed geopotential height anomalies across Greenland (**Figure 2**), the NAO is neutral.

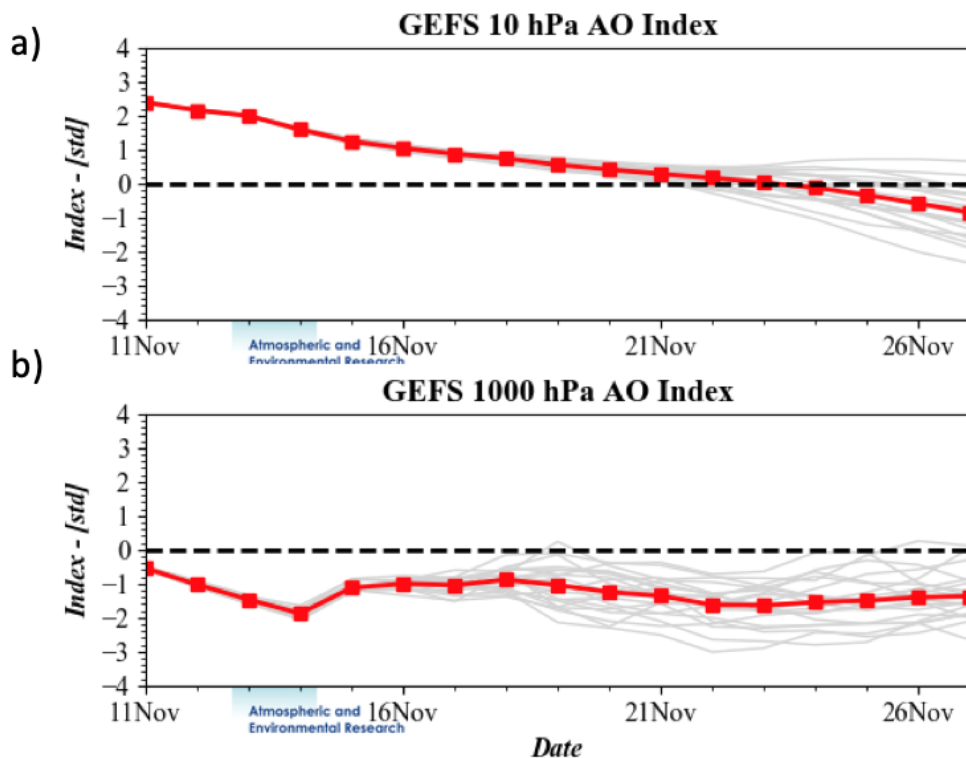


Figure 1. (a) The predicted daily-mean AO at 10 hPa from the 00Z 11 November 2019 GFS ensemble. (b)

The predicted daily-mean near-surface AO from the 00Z 11 November 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.

This week ridging/positive geopotential height anomalies in the central North Atlantic are forcing downstream troughing/negative geopotential height anomalies across Western Europe with more ridging/positive geopotential height in Western Asia (**Figure 2**). This will result in normal to below temperatures across Western Europe including the UK and Scandinavia under northerly flow and normal to above normal temperatures across Eastern Europe under southwesterly flow (**Figure 3**). This week ridging/positive geopotential height anomalies are predicted to dominate much of Western and Southern Asia with normal to above normal temperatures including the Middle East and Southeast Asia (**Figure 2**). Meanwhile ridging/positive geopotential height anomalies in the Laptev, East Siberian and Chukchi Seas are forcing troughing/negative geopotential height anomalies with normal to below normal temperatures across much of Siberia (**Figure 3**). More regional troughing/negative geopotential height anomalies will

bring normal to below normal temperatures across countries adjacent to the Persian Gulf and Arabian Sea.

GEFS 1-5 Day Forecast 500 mb GPH/GPH Anomaly
INIT: 00Z 11/11/19 FCST: 11/12/19 to 11/16/19

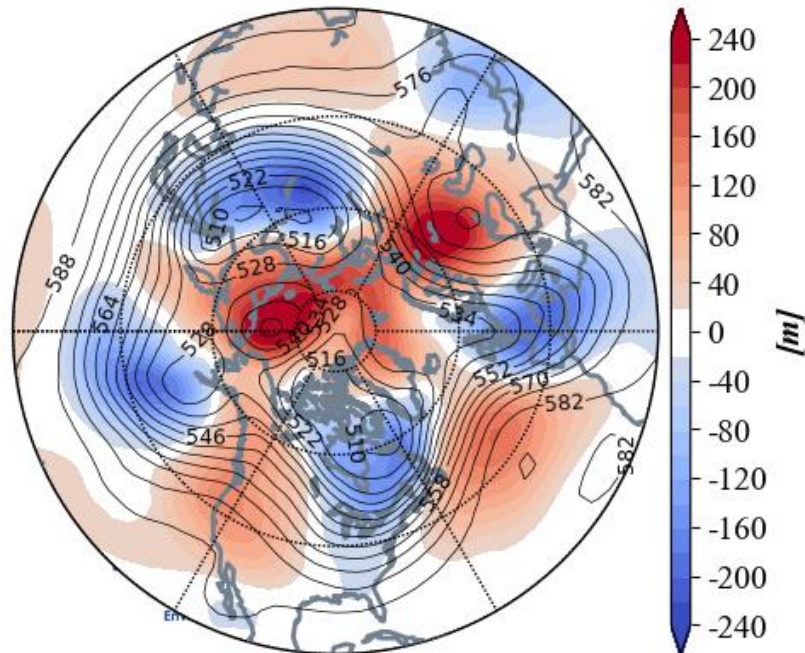


Figure 2. Forecasted average 500 mb geopotential heights (dam; contours) and geopotential height anomalies (m; shading) across the Northern Hemisphere from 12 – 16 November 2019. The forecasts are from the 11 November 00z GFS ensemble.

This week ridging/positive geopotential height anomalies stretching from Alaska to California with normal to above normal temperatures will force downstream troughing/negative geopotential height anomalies with normal to below normal temperatures across Canada and the US east of the Rockies (**Figures 2 and 3**).

GEFS 1-5 Day Forecast T2m Anomaly
INIT: 00Z 11/11/19 FCST: 11/12/19 to 11/16/19

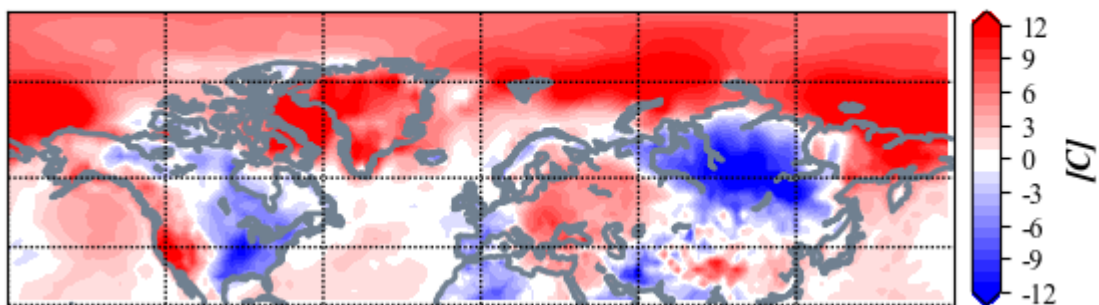


Figure 3. Forecasted surface temperature anomalies ($^{\circ}\text{C}$; shading) from 12 – 16 November 2019. The forecast is from the 00Z 11 November 2019 GFS ensemble.

Trouthing and/or cold temperatures are predicted to bring new snowfall across Siberia, Northwestern Russia, Central Asia, Scandinavia, the Alps and the Pyrenees and surrounding regions (**Figure 4**). However, intrusion of warm air on southerly winds will melt snow in the Baltic States (**Figure 4**). Trouthing and cold temperatures are predicted to bring new snowfall to Alaska, Canada and possibly the Northeastern US (**Figure 4**). Warm temperatures will bring some melting to the Northwestern US and Southwestern Canada (**Figure 4**).

GEFS 1-5 Day Forecast Mean 24-hour Snow Depth Change
INIT: 00Z 11/11/19 FCST: 11/12/19 to 11/16/19

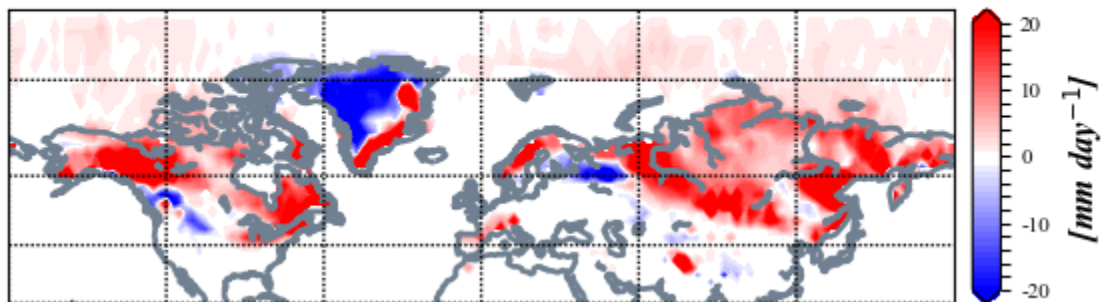


Figure 4. Forecasted snowdepth anomalies (mm/day ; shading) from 12 – 16 November 2019. The forecast is from the 00Z 11 November 2019 GFS ensemble.

Mid-Term

6-10 day

The AO is predicted to remain negative (**Figure 1**) with mostly positive geopotential height anomalies across the Arctic, especially on the Eurasian side and mixed geopotential height anomalies across the mid-latitudes of the NH (**Figure 5**). And with mixed geopotential height anomalies persisting across Greenland (**Figure 2**), the NAO is predicted to remain near neutral.

GEFS 6-10 Day Forecast 500 mb GPH/GPH Anomaly
INIT: 00Z 11/11/19 FCST: 11/17/19 to 11/21/19

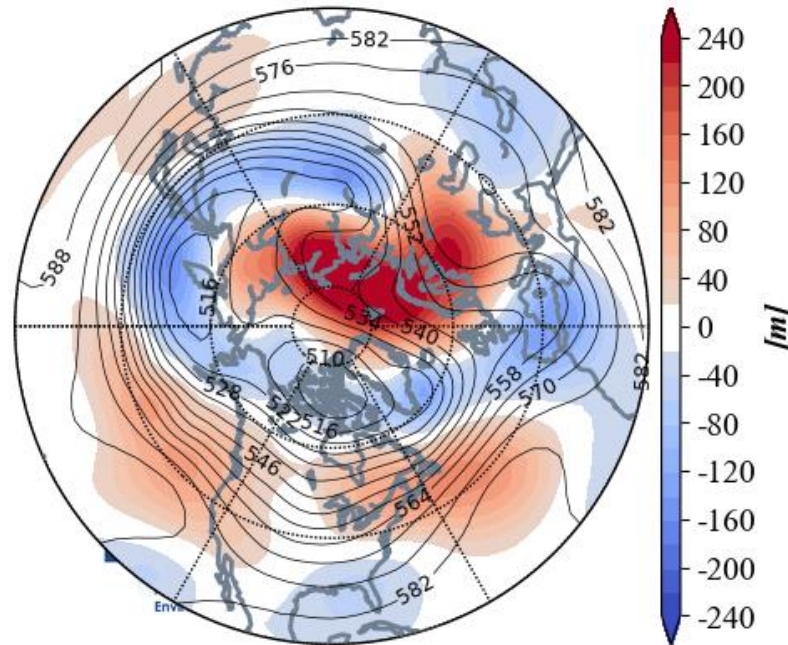


Figure 5. Forecasted average 500 mb geopotential heights (dam; contours) and geopotential height anomalies (m; shading) across the Northern Hemisphere from 17 – 21 November 2019. The forecasts are from the 11 November 00z GFS ensemble.

Nearly stationary ridging/positive geopotential height anomalies in the central North Atlantic are predicted to continue to force downstream troughing/negative geopotential height anomalies across Western Europe with more ridging/positive geopotential height in Western Asia (**Figure 5**). This will result in normal to below temperatures across Western Europe including the UK and Scandinavia under northerly flow and normal to above normal temperatures across Eastern Europe under southwesterly flow (**Figure 6**). Ridging/positive geopotential height anomalies in Western Asia and north of Siberia are predicted to begin merging across northwest Eurasia while forcing downstream troughing/negative geopotential height anomalies across Siberia (**Figure 5**). This is predicted to yield more widespread normal to above normal temperatures for Western Asia, the Middle East and much of Southern and East Asia (**Figure 6**). Deepening troughing will bring normal to below temperatures to Siberia (**Figure 6**). Continued troughing/negative geopotential height anomalies centered over the Persian Gulf (**Figure 5**) will bring normal to below temperatures mostly to Iran (**Figure 6**).

GEFS 6-10 Day Forecast T2m Anomaly
INIT: 00Z 11/11/19 FCST: 11/17/19 to 11/21/19

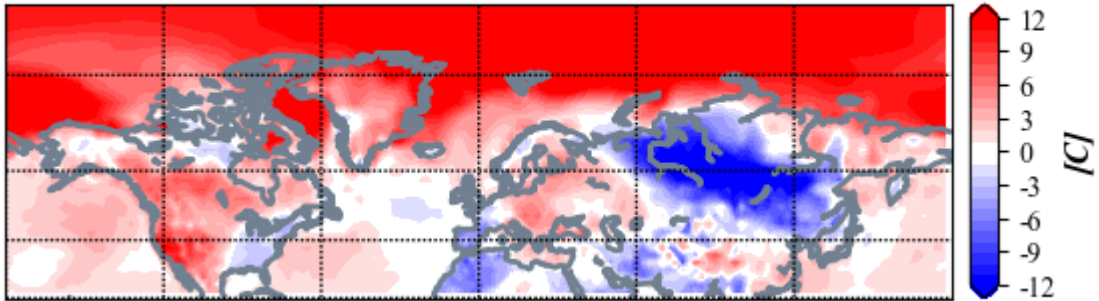


Figure 6. Forecasted surface temperature anomalies ($^{\circ}\text{C}$; shading) from 17 – 21 November 2019. The forecasts are from the 00Z 11 November 2019 GFS ensemble.

The pattern is predicted to transition this period with ongoing ridging/positive geopotential height anomalies along the West Coasts of Canada and the US forcing downstream troughing/negative geopotential height anomalies mostly in the Eastern US with more ridging/positive geopotential height anomalies in Eastern Canada (**Figure 5**). Lower geopotential heights are predicted to reach Alaska from Siberia this period (**Figure 5**). This pattern is predicted to bring normal to above normal temperatures across much of Canada and the Western US with normal to below normal temperatures in Alaska and the US east of the Mississippi River (**Figure 6**).

GEFS 6-10 Day Forecast Mean 24-hour Snow Depth Change
INIT: 00Z 11/11/19 FCST: 11/17/19 to 11/21/19

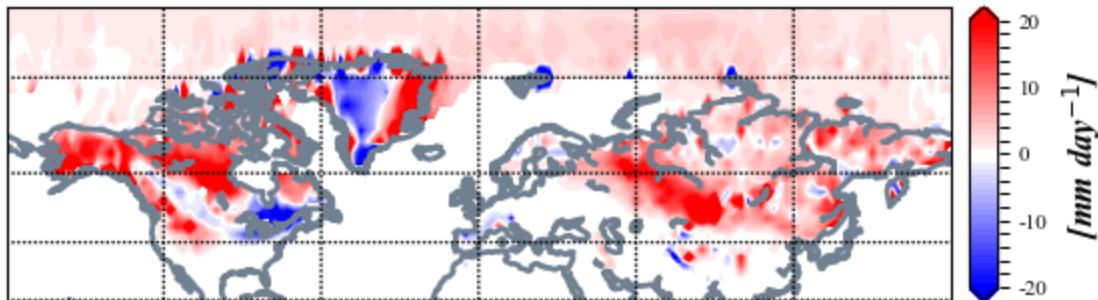


Figure 7. Forecasted snowdepth changes (mm/day ; shading) from 17 – 21 November 2019. The forecasts are from the 00Z 11 November 2019 GFS ensemble.

Troughing and/or cold temperatures will support the potential for new snowfall across much of Siberia, Scandinavia, Northwest Russia, the Tibetan Plateau, Northeast Asia, Alaska, Canada and the Northwestern US (**Figure 7**). Some snowmelt is predicted in parts of Europe, the Northeastern US and Southeastern Canada (**Figure 7**).

11-15 day

With positive geopotential height anomalies predicted for the Arctic especially on the Asian side (**Figure 8**), the AO is predicted to remain negative yet again this period (**Figure 1**). With predicted weak positive pressure/geopotential height anomalies across Greenland (**Figure 8**), the NAO is likely to remain close to neutral this period.

GEFS 11-15 Day Forecast 500 mb GPH/GPH Anomaly
INIT: 00Z 11/11/19 FCST: 11/22/19 to 11/26/19

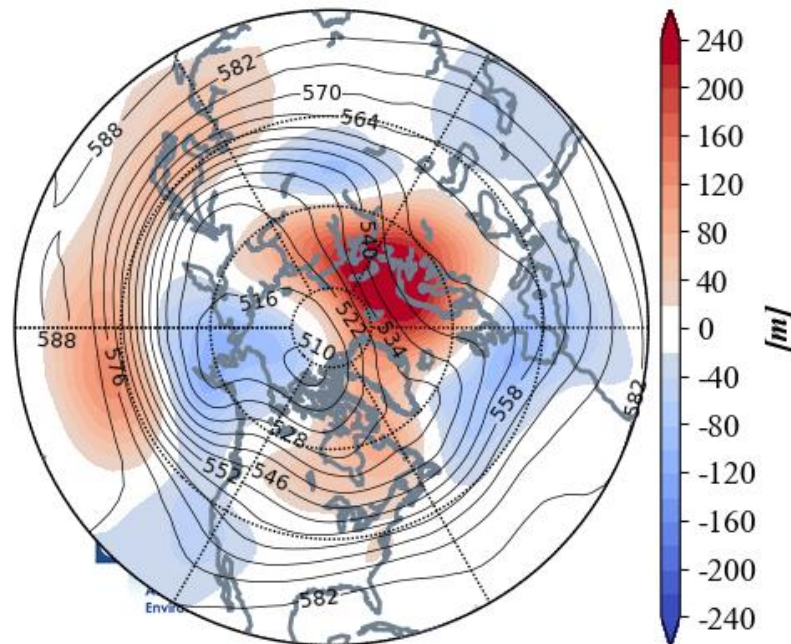


Figure 8. Forecasted average 500 mb geopotential heights (dam; contours) and geopotential height anomalies (m; shading) across the Northern Hemisphere from 22 – 26 November 2019. The forecasts are from the 11 November 00z GFS ensemble.

Trouching/negative geopotential height anomalies accompanied by relatively cold temperatures are predicted to persist across Western Europe including the UK this period (**Figures 8 and 9**). However ridging/positive geopotential height anomalies in Western Asia are predicted to continue to drift north into the Barents-Kara Seas allowing cold temperatures to slide west out of Siberia across all of Northern Europe with milder temperatures across Southern Europe (**Figure 9**). Ridging/positive geopotential height anomalies are predicted to consolidate in the Barents-Kara Seas forcing troughing/negative geopotential height anomalies across much of Siberia and Northwest Asia (**Figure 8**). This pattern favors normal to above normal temperatures across Southern, Western and Southeast Asia including the Middle East and the Indian subcontinent with normal to below normal temperatures widespread across Northern Asia including Northeast Asia and Western Russia but especially Siberia (**Figure 9**).

GEFS 11-15 Day Forecast T2m Anomaly
INIT: 00Z 11/11/19 FCST: 11/22/19 to 11/26/19

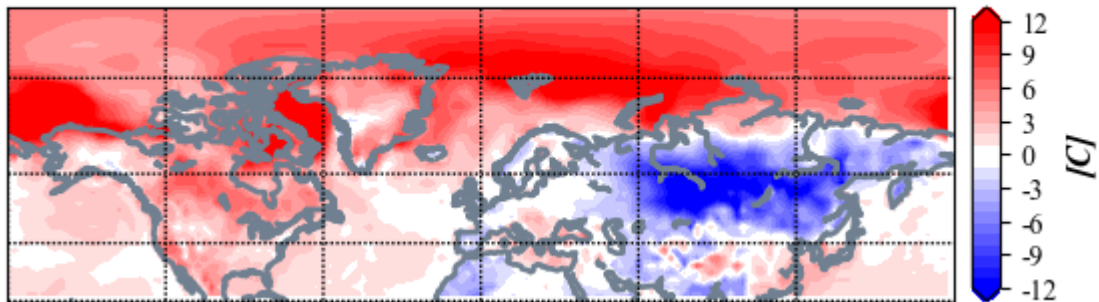


Figure 9. Forecasted surface temperature anomalies (°C; shading) from 22 – 26 November 2019. The forecasts are from the 11 November 00z GFS ensemble.

The overall pattern across North America is predicted to continue to transition with troughing/negative geopotential height anomalies stretching from Alaska into the Gulf of Alaska and along the West Coasts of Canada and the US with downstream ridging/positive geopotential height anomalies in eastern North America (**Figure 8**). This is predicted to favor widespread normal to above normal temperatures across Canada and the US with pockets of normal to below normal temperatures across Alaska, Western Canada and the Western US (**Figure 9**).

GEFS 11-15 Day Forecast Mean 24-hour Snow Depth Change
INIT: 00Z 11/11/19 FCST: 11/22/19 to 11/26/19

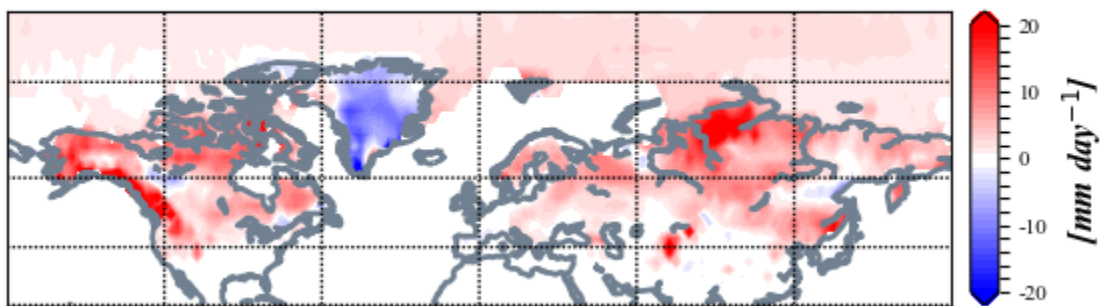


Figure 10. Forecasted snow depth changes (mm/day; shading) from 22 – 26 November 2019. The forecasts are from the 00z 11 November GFS ensemble.

Troughing and/or cold temperatures will support new snowfall across much of Siberia, Western Russia, Northeast Asia, possibly parts of Scandinavia and Eastern Europe, Alaska, much of Canada and even the Northwestern US (**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 the stratosphere and normal to above normal PCHs in the troposphere (**Figure 11**). Currently the lower troposphere PCHs are above normal and are predicted to peak in amplitude later this week, when the AO could possibly turn briefly strongly negative (**Figure 1**).

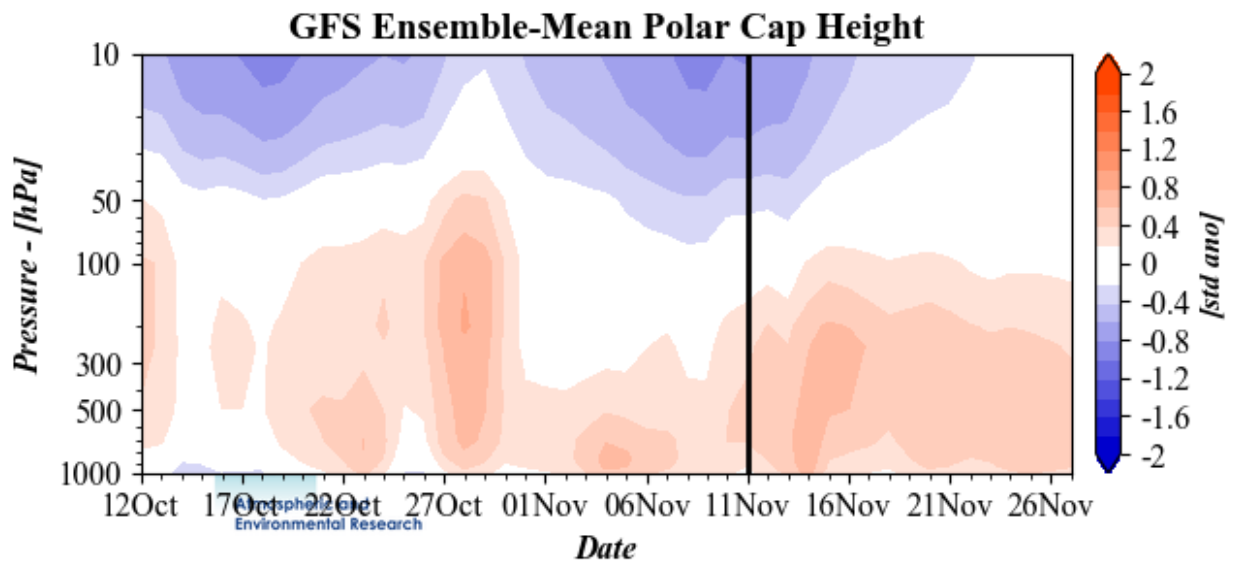


Figure 11. Observed and predicted daily polar cap height (i.e., area-averaged geopotential heights poleward of 60°N) standardized anomalies. The forecasts are from the 00Z 11 November 2019 GFS ensemble.

The plot of Wave Activity Flux (WAFz) or poleward heat transport shows the relatively quiet recent period coming to an end (**Figure 12**). There is a weak positive pulse of WAFz predicted for the next two weeks. Though there is potential for some of the upcoming pulses to be stronger than predicted.

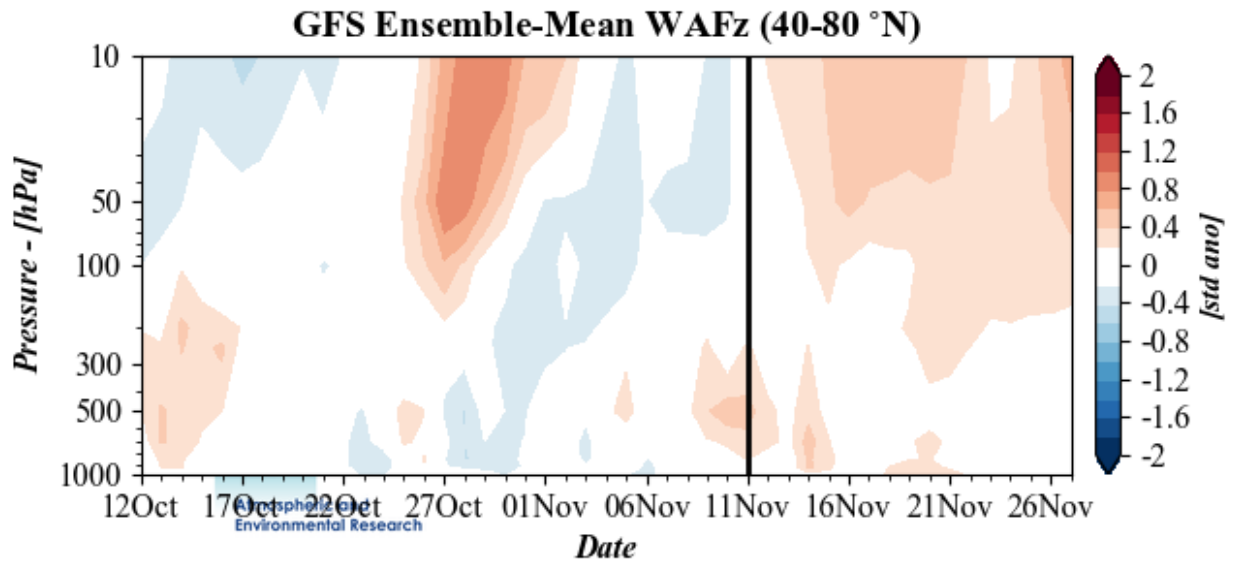


Figure 12. Observed and predicted daily vertical component of the wave activity W_{ux} (WAFz) standardized anomalies, averaged poleward of 40-80°N. The forecast is from the 00Z 11 November 2019 GFS ensemble.

The stratospheric AO is strongly positive (**Figure 1**) reflective of a strong PV. However, in response to the positive WAFz predicted over the next two weeks, the stratospheric AO is predicted to continuously trend negative over the next two weeks and could be in negative territory by the last week of November (**Figure 1**).

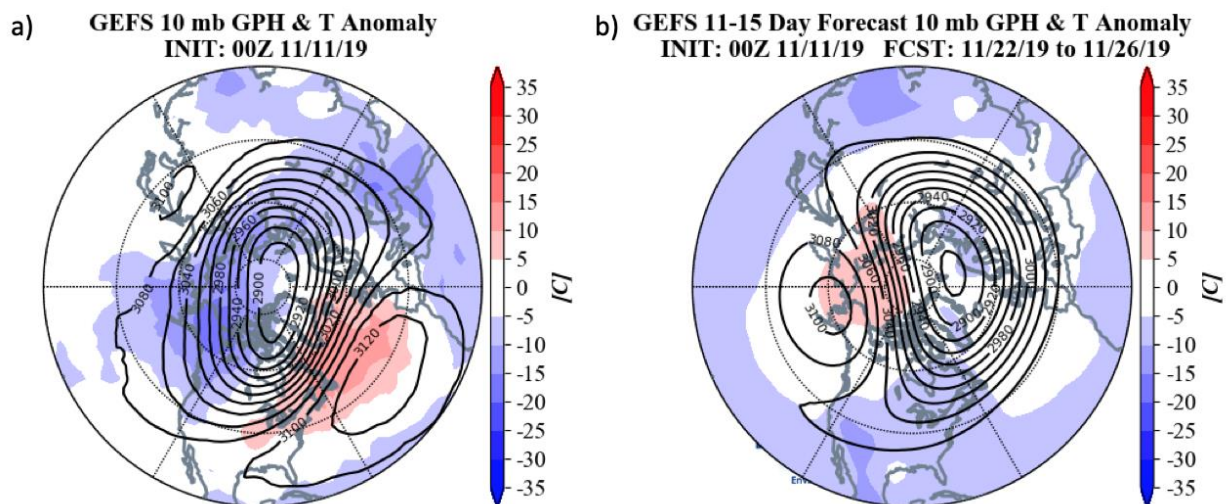


Figure 13. (a) Analyzed 10 mb geopotential heights (dam; contours) and temperature anomalies (°C;

shading) across the Northern Hemisphere for 11 November 2019. (b) Same as (a) except forecasted averaged from 22 – 26 November 2019. The forecasts are from the 00Z 11 November 2019 GFS operational model.

Despite the strong circulation around the PV center and relatively low heights, the PV is not circular in shape but rather elongated (**Figure 13**). The counterclockwise low around the PV center is bringing northerly flow to North America rather than westerly flow more common with a strong PV with a more circular configuration (**Figure 13**). The northerly flow is supportive of cold temperatures in eastern North America.

Currently there is warming and a ridge in the North Atlantic sector of the stratosphere (**Figure 13**). But over time the new WAFz pulses are predicted to cause warming and new ridging centered over the Bering Sea (**Figure 13**). Also, the PV center is predicted to be displaced towards northwest Eurasia with time. The displacement of the stratospheric PV towards Eurasia is usually the first sign of a more significant PV disruption.

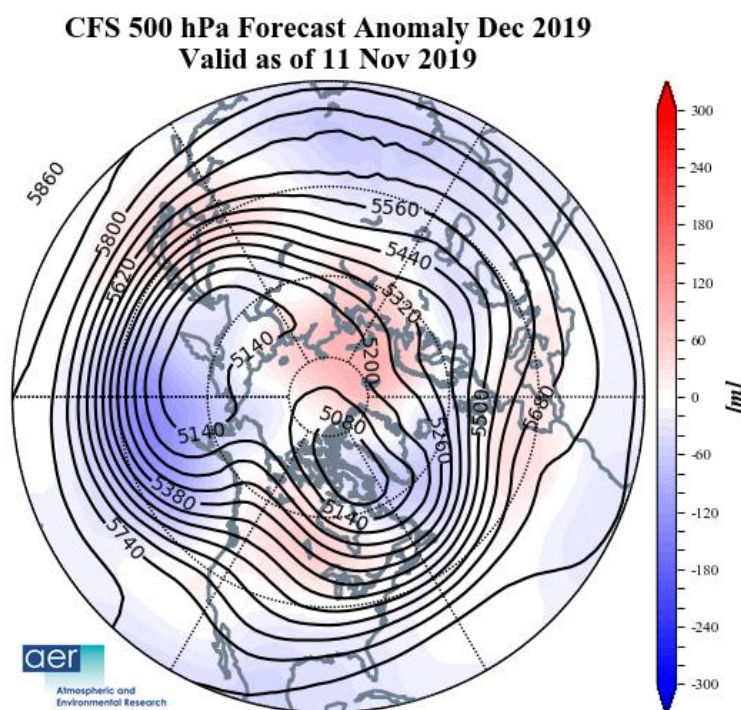


Figure 14. Forecasted average 500 mb geopotential heights (dam; contours) and geopotential height anomalies (m; shading) across the Northern Hemisphere for December 2019. The forecasts are from the 11 November 2019 CFS.

I include in this week's blog the monthly 500 hPa geopotential heights (**Figure 14**) and the surface temperatures (**Figure 15**) forecast for December from the Climate Forecast System (CFS; the plots represent yesterday's four ensemble members). The forecast for the troposphere is ridging centered across the Western Europe, the Barents-Kara Seas, East Asia, Alaska and Western Canada with troughs over Greenland and Iceland, Western Asia, Eastern Siberia, the Dateline, and the Central US (**Figure 14**). This pattern favors relatively warm temperatures for much of Europe, Central Asia, most of Canada and the US with seasonable to relatively cold temperatures for Siberia, Northeast Asia, possibly Western Alaska and the Southeastern US (**Figure 15**). The CFS has shown little consistency from run to run.

CFS T2m Forecast Anomaly Dec 2019 Valid as of 11 Nov 2019

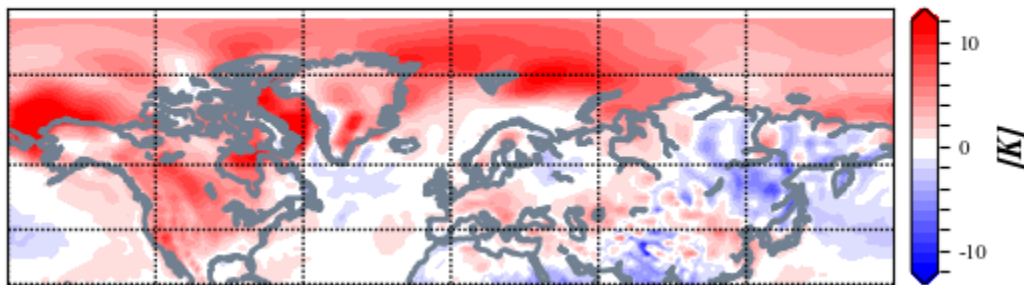


Figure 15. Forecasted average surface temperature anomalies ($^{\circ}\text{C}/\text{K}$; shading) across the Northern Hemisphere for December 2019. The forecasts are from the 11 November 2019 CFS.

Surface Boundary Conditions

Arctic sea ice extent

Arctic sea ice growth rate has accelerated but remains well below normal. Large negative sea ice anomalies exist in three regions: the Chukchi-Beaufort, west of Greenland and Barents-Kara Seas. The anomalies in the North Pacific sector have emerged as the most well below normal (**Figure 16**), however, based on model forecasts sea ice in the Chukchi-Beaufort Seas may grow more quickly in the next two weeks. Below normal sea ice in and around Greenland and the Canadian Archipelagos may favor a negative 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. However so far this fall coupling with the atmosphere has

been stronger in the Chukchi, Beaufort and Bering seas, possibly since the negative anomalies are greater there.

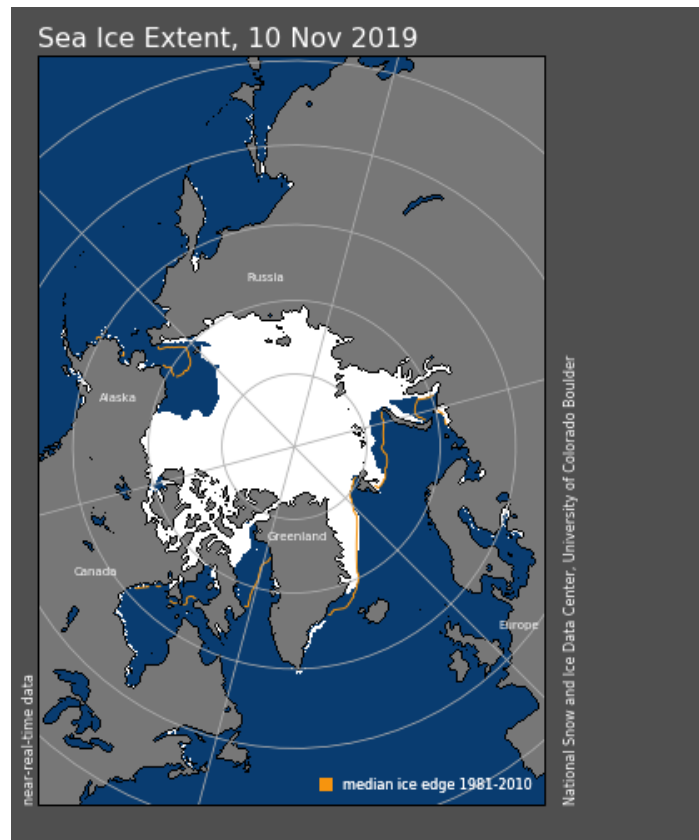


Figure 16. Observed Arctic sea ice extent on 10 November 2019 (white). Orange line shows climatological extent of sea ice based on the years 1981-2010. Image courtesy of National Snow and Ice Data Center (NSIDC). Snow and Ice Data Center (NSIDC).

SSTs/El Niño/Southern Oscillation

Equatorial Pacific sea surface temperatures (SSTs) anomalies have cooled and Neutral El Niño/Southern Oscillation (ENSO) conditions seem most likely (**Figure 17**). Observed SSTs across the NH remain well above normal especially near Alaska and along the north slope of Asia though below normal SSTs exist regionally especially west of South America. Warm SSTs around Alaska may favor mid-tropospheric ridging in the region this upcoming winter.

SST Anomaly - Week Ending 09 Nov 2019

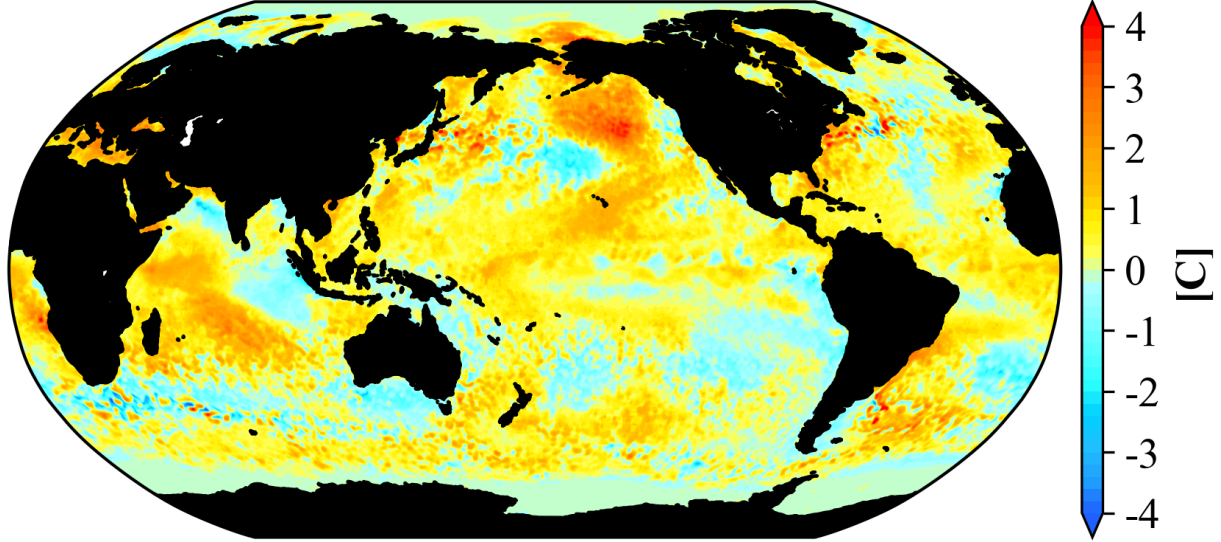


Figure 17. The latest weekly-mean global SST anomalies (ending 9 November 2019).
Data from NOAA OI High-Resolution dataset.

Currently the Madden Julian Oscillation (MJO) is in phase 7 (**Figure 18**). The forecasts are for the MJO to slowly transition through phases 7-8 and 1 over the next two weeks. Some MJO influence is possible across North American weather in the forecast period as these phases favor high latitude blocking and troughing in the US transitioning to ridging in the Eastern US and troughing in the Western US.

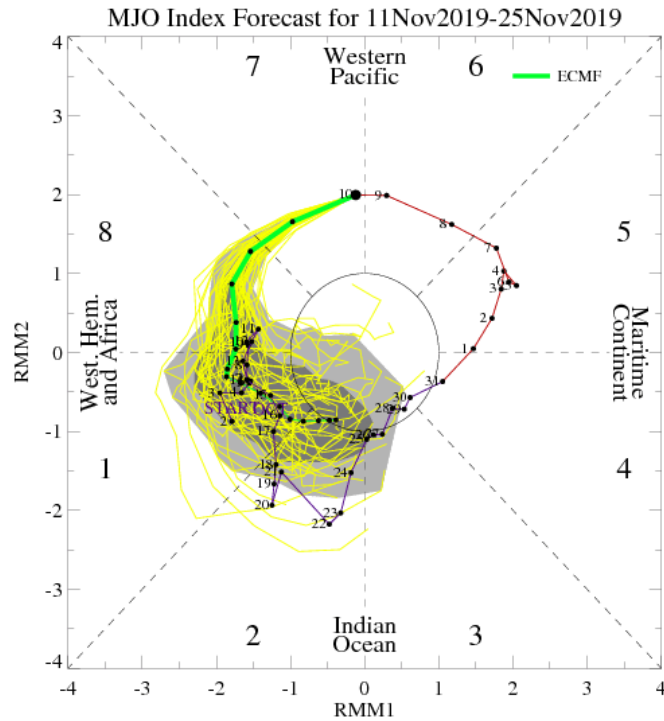


Figure 18. Past and forecast values of the MJO index. Forecast values from the 00Z 11 November 2019 ECMWF model. Yellow lines indicate individual ensemble-member forecasts, with the green line showing the ensemble-mean. A measure of the model “spread” is denoted by the gray shading. Sector numbers indicate 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 climb across Eurasia and is currently near decadal averages. Snow cover will likely continue to advance especially across East Asia next week as troughing and cold temperatures spread across the region. 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.

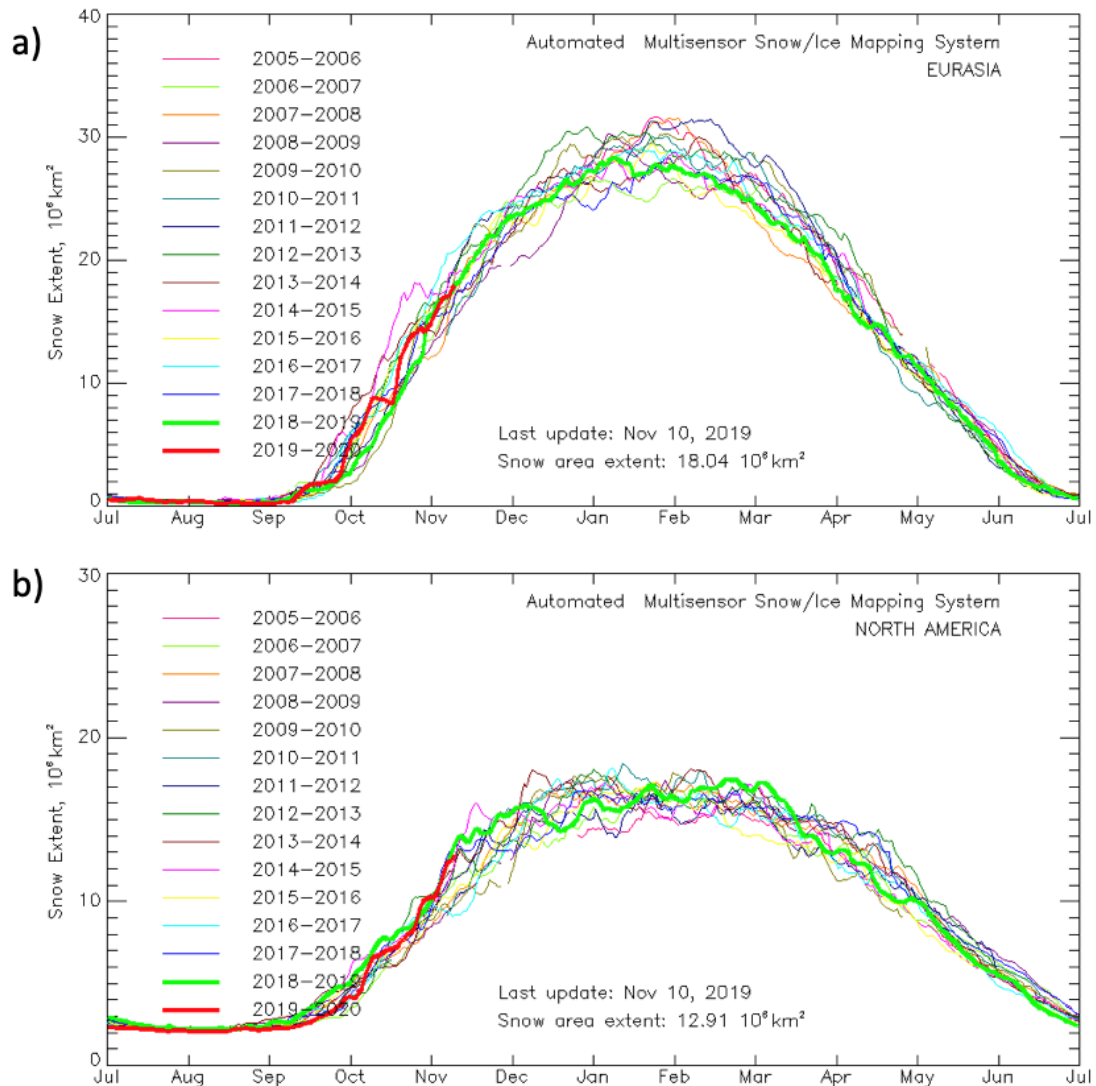


Figure 19. Observed Eurasian (top) and North American (bottom) snow cover extent through 3 November 2019. Image source: https://www.star.nesdis.noaa.gov/smcd/emb/snow/HTML/snow_extent_plots.html

North American snow cover is also steadily advancing to near decadal highs and is comparable to last year at this time. The early advance of snow cover across Canada this fall, has likely contributed to an early start of cold temperatures across the Western US and now Eastern US. However snow cover advance could slow with predicted milder temperatures beginning next week.