Arctic Oscillation and Polar Vortex Analysis and Forecasts

January 3, 2022

Dr. Judah Cohen from Atmospheric and Environmental Research (AER) embarked on an experimental process of regular research, review, and analysis of the Arctic Oscillation (AO) and Polar Vortex (PV). This analysis is intended to provide researchers and practitioners real-time insights on one of North America's and Europe's leading drivers for extreme and persistent temperature patterns.

During the winter schedule the blog is updated once every week. Snow accumulation forecasts replace precipitation forecasts. Also, there is renewed emphasis on ice and snow boundary conditions and their influence on hemispheric weather. With the start of spring we transition to a spring/summer schedule, which is once every two weeks. Snow accumulation forecasts will be replaced by precipitation forecasts. Also, there will be less emphasis on ice and snow boundary conditions and their influence on hemispheric weather.

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

Summary

The Arctic Oscillation (AO) is currently neutral and is predicted to go briefly positive at the end of the week and then straddle neutral the next two weeks with mixed pressure/geopotential height anomalies across the Arctic with mixed pressure/geopotential height anomalies across the mid-latitudes. The North Atlantic Oscillation (NAO) is currently positive and is predicted to remain neutral to positive as pressure/geopotential height anomalies are predicted to remain mostly negative across Greenland the next two weeks.

- The next two weeks, troughing/negative geopotential height anomalies across Greenland will favor ridging/positive geopotential height anomalies coupled with normal to above normal temperatures across much of Europe including the United Kingdom (UK) with the exception of troughing/negative geopotential height anomalies coupled with normal to below normal temperatures across Scandinavia this week and Southeastern Europe next week.

- The current pattern across Asia this week is troughing/negative geopotential height anomalies across Western and Northeastern Asia with ridging/positive geopotential height anomalies dominating much of Asia. This will favor normal to below normal temperatures across the northern corners of Asia with normal to above normal temperatures widespread across the remainder Asia. However next week the troughing in Northwestern Asia will expand eastward and eventually merge with the Northeastern Asia trough helping to expand below normal temperatures across Northern Asia.
- This week, ridging/positive geopotential height anomalies will be limited to western Alaska and the Southwestern US with troughing/negative geopotential height anomalies widespread across Canada and the Northern and Eastern US. However next week, ridging/positive geopotential height anomalies are predicted to consolidate across western North America with troughing/negative geopotential height anomalies in eastern North America. This pattern favors this week normal to below normal temperatures across Alaska, much of Canada and the Eastern United States (US) with normal to above temperatures for the Western US and Northeastern Canada. However, next week the pattern will transition to normal to above normal temperatures in western North America and normal to below normal temperatures in eastern North America.
- In the *Impacts* section I discuss my expectation of how the weather will evolve over the next several weeks and the potential impact of a stretched polar vortex (PV) on the weather of the Northern Hemisphere (NH).
- section I discuss that I feel that the atmosphere has made a turn but not decisive, towards a weaker polar vortex (PV) in January and how it may impact the remainder of the winter for the Northern Hemisphere (NH).

Plain Language Summary

I feel that the much anticipated (by me at least) stretched polar vortex is finally here and is contributing to the colder and snowier pattern in the Eastern US for early January. Seems to me there are signs of another similar event mid-month so after a brief warm-up I am anticipating a longer lasting cold period in the Eastern US. Mid to late January. If I am wrong, then the likelihood is high for another mild month. These events also tend to favor overall mild weather for Europe with the possible exception of Scandinavia. Longer term still lots of uncertainty.

Impacts

Happy New Year! Hard to focus on the blog with what I consider an impressive snowstorm in the Mid-Atlantic and for many the biggest snowstorm in several years. Also, impressive that for many of these locations it was in the 60's even 70's yesterday! That may be common in Denver at a mile high in elevation but much harder to do at sea level. I am a believer that Mother Nature likes to foreshadow, and this could be coloring the blog today, but I also believe that Mother Nature likes to throw

head fakes as well. Distinguishing between the two can make a big difference. I have certainly been fooled before.

In today's blog I want to focus on the relatively obscure stretched polar vortex (PV) that was the focus of my most recent paper Cohen et al. 2021 and was a follow up to earlier work in Kretschmer et al. 2018. My involvement in both of these papers really had me wondering how come there is so little research on this phenomenon given its impact on North American weather. And I believe that we have only scratched the surface of these events and weather impacts. The only research that I know of that did study this phenomenon in more detail is from the influential Japanese scientist Dr. Kuni Kodera (see for example Kodera et al. 2008) and he only focused on a limited number of case studies and those were associated with sudden stratospheric warmings (SSWs). He did label them "reflective" events, though a very appropriate term, I prefer not to use so as not to confuse with the reflective events discussed by Perlwitz and Harnik 2003. They could be related but in Perlwitz and Harnik's work they discuss a strong PV, positive NAM throughout the atmospheric column and relatively mild temperatures across the mid-latitudes. Kodera discusses how they occur during SSWs, which is the weakest of PV states and result in relatively cold temperatures in the mid-latitudes.

In our recent paper we argued that the stretched PV was contributing to more severe winter weather and was at least partially responsible for the observed cooling trend in central North America in February during the era of Arctic amplification (shown in our Figure S6) but I show here (**Figure i**) from the trend analysis from Brian Brettschneider that I pulled off his twitter feed (@climatologist49). Obviously, this is of vigorous debate, but I think in a time of a strong global warming trend, a notable cooling trend of 30 years is begging for an explanation other than randomness. As I have argued in multiple papers the increasing trend in PV disruptions is a dynamic cooling that is at least partially offsetting the radiative warming trend caused by increasing greenhouse gases from anthropogenic activities.

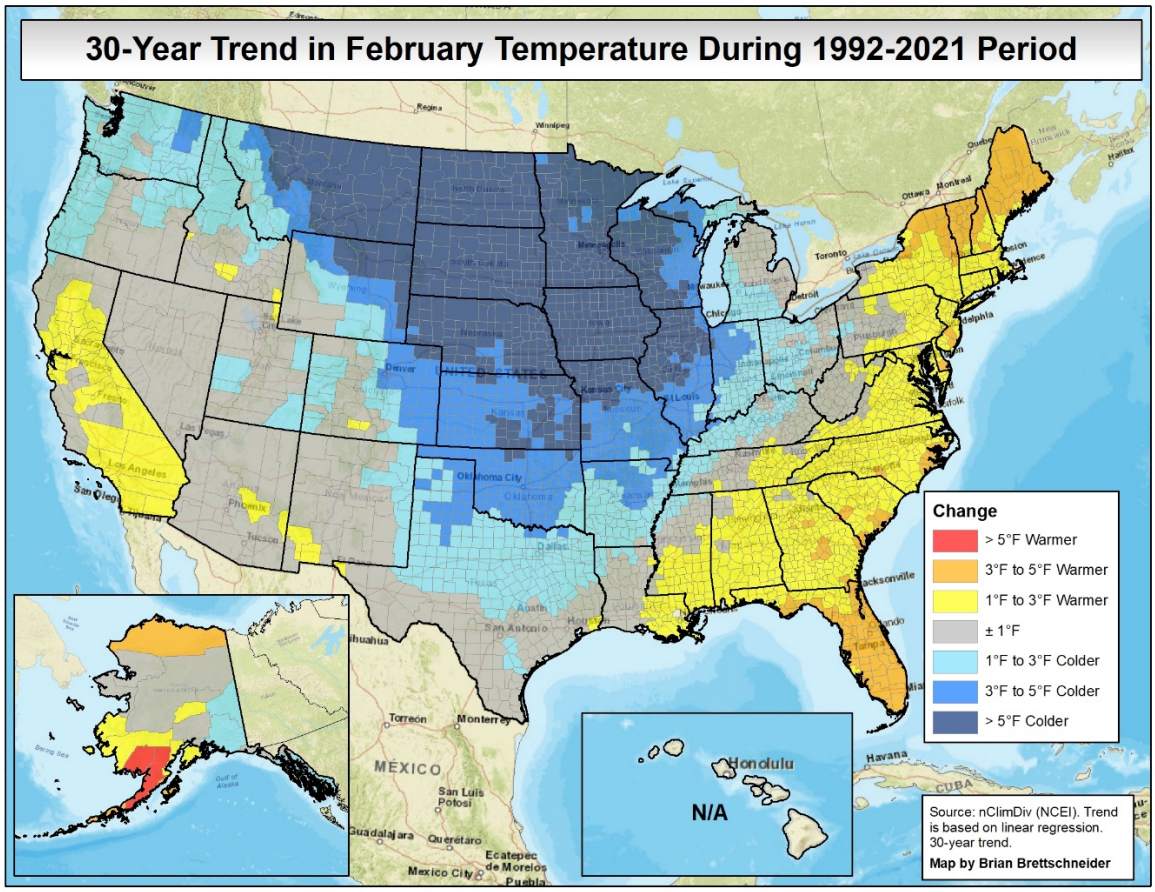


Figure i. Surface temperature February trend analysis (°F; shading) for the US from 1992-2021. Plot is taken from @climatologist49 Twitter feed.

There is still much that I don't understand so I hope that the reader will allow me large breadth for ideas that are not mature or could be mostly wrong. The Eastern US experienced record warm October and December but with below normal temperatures in November (see **Figure ii**). The cold in November may not look terribly impressive but it is impressive relative to the adjacent months. I would explain the difference in that there was stretched PV event in November but none in October and December. And in the late October and November blogs I did point out that I believed that a stretched PV was occurring and even speculated on a very mild December, in anticipation of a strong PV, which is typical following a stretched PV (see the impacts section of the October 25, 2021 blog post). Again, this idea is admittedly overly simplistic, but I do believe that it is hard to get sustained cold in the Eastern US and Europe without a disrupted PV of some sort.

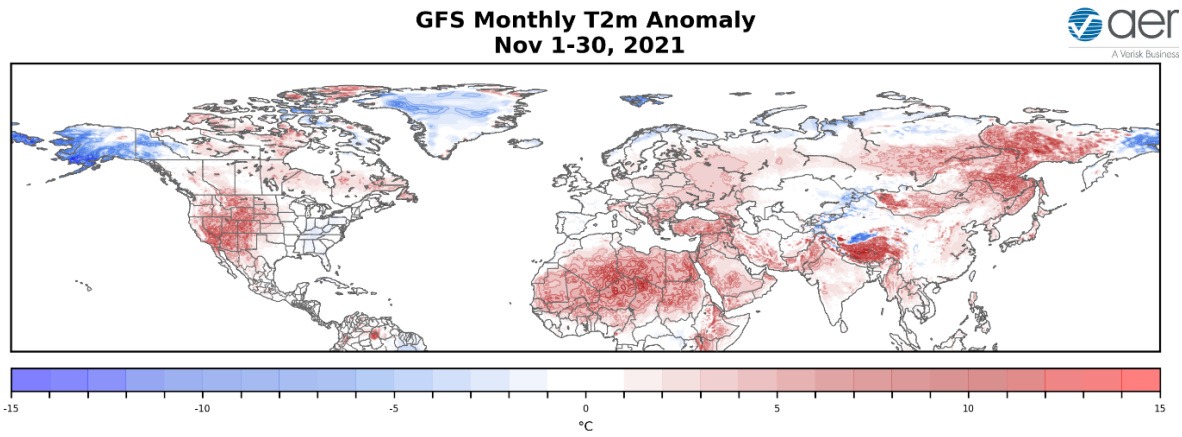


Figure ii. Observed surface temperature anomalies (°F; shading) from 1-30 November 2021. The observations taken from GFS initialization.

The record warm weather in the Eastern US has at least ended for this week (and I will give my thoughts for how long soon) and again I would attribute this to another stretched PV. I showed this plot last week for the first time and it still needs to be revised/modified. The plot shows the analysis of eddy (difference from the zonal mean) geopotential heights and wave activity flux (WAF) in the zonal and vertical directions (**Figure iii**). This plot looks very similar to a reflected/stretched PV event from discussed in Kodera et al. (2013). Please compare with their Figure 3d from March 5, 2003. Looking at the analyzed geopotential heights at 10 hPa they also resemble what is shown in their Figure 1 from December 2008 (or what is shown in Cohen et al. in Figures 1 and 2 but at 100 hPa) though the polar stratospheric warming is over Europe and not the North Pacific, the significance of which I don't really know. Also looking at the predicted surface temperatures for this week, widespread cold temperatures are predicted for North America and East Asia with strong warming in Eastern Siberia and especially the Chukchi Sea (see **Figure iv**). This resembles the surface temperature anomalies shown in Figure 5 from Kretschmer et al. and Figure 2 from Cohen et al. One difference is the warming in the northern North Pacific does not currently include Alaska but likely will soon. I tweeted this out last week but I include here a schematic from Cohen et al. 2021 (Supplementary Material) with a generalization of stretched PV events in **Figure v**.

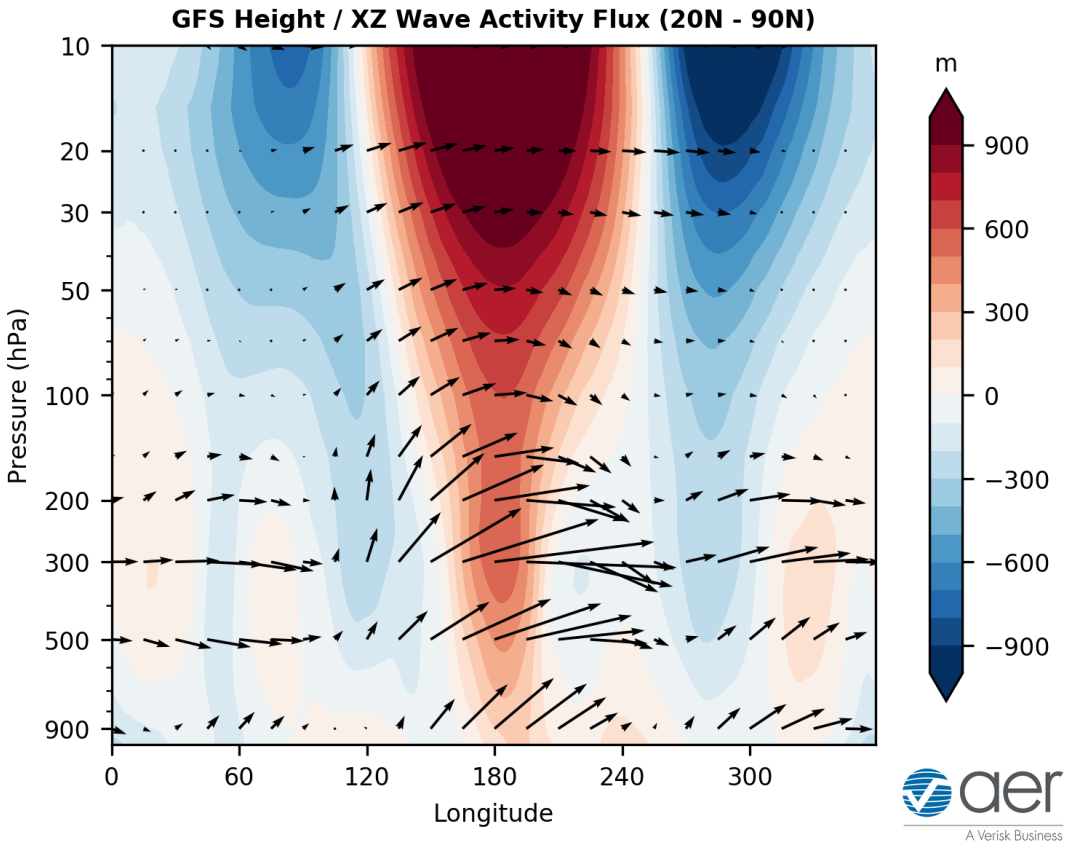


Figure iii. Longitude-height cross section of geopotential eddy height anomalies and wave activity flux vectors in the zonal and vertical directions (averaged between 20-90°N) . Analysis from the 00z 3 January 2022 GFS.

The impacts from stretched PV events are relatively short, certainly compared to an SSW. So maybe a week or two (and based on the models maybe more like a week) of cold and then what. If my forecast back in October worked out so well why not just rinse and repeat? That would mean a quickly strengthening PV and a much milder pattern for much of the remainder of January. The stronger PV (see **Figure 13b**) and the milder temperatures (see **Figure 6**) are looking highly likely. But at least for now my instincts are telling me differently and I will fully admit to be spitballing for the remainder of this section.

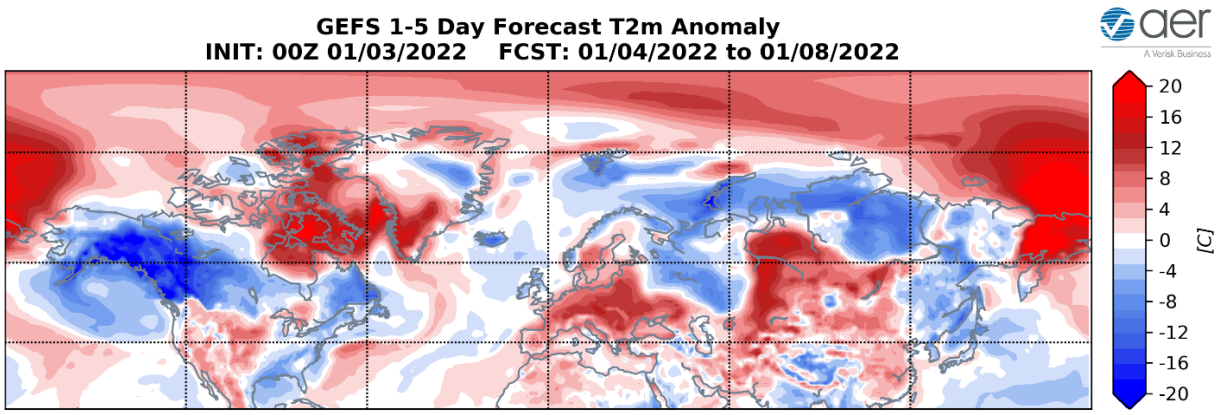
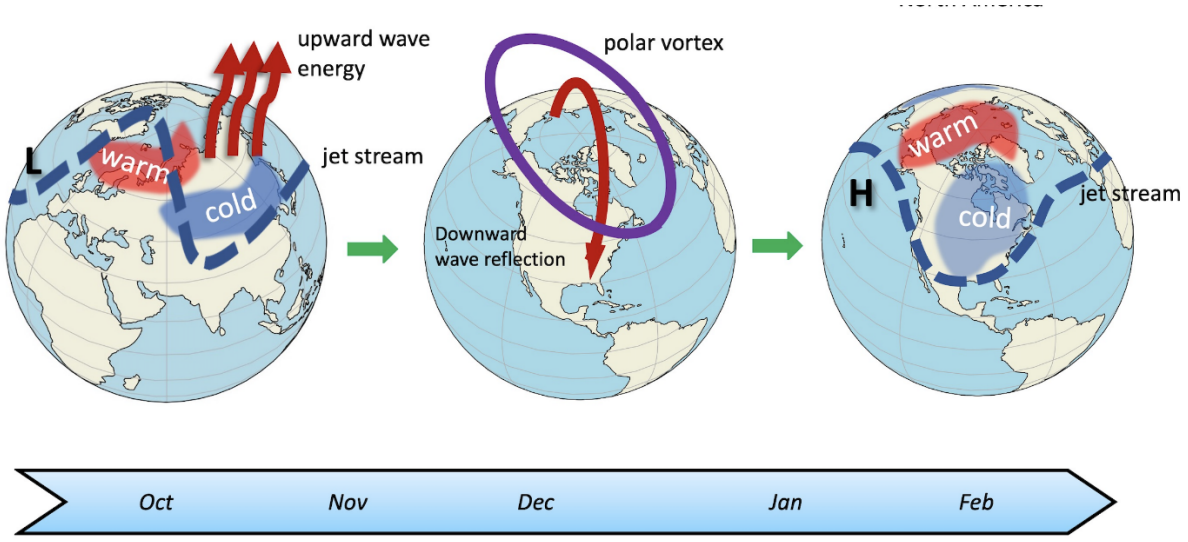


Figure iv. Forecasted surface temperature anomalies (°C; shading) from 4 – 8 January 2022. The forecast is from the 00Z 3 January 2022 GFS ensemble.

First, I don't believe that a tropospheric circulation pattern that can really persist for longer than three to four weeks without being fully coupled to either a strong or weak PV (SSW). We had a western trough/eastern ridge across North America for much or all of December. So pretty much on cue we have quickly transitioned to a quasi-western ridge/eastern trough pattern (not perfect). Now I do think that when the circulation pattern transitions it's not like an on and off light switch but rather it happens in steps. You kind of have a foreshadowing step or phase, then a quick snap back to the previous pattern and finally it settles into the new pattern. That would mean the cold for this week is more of an appetizer then we revert to the old pattern just briefly and then finally Mother Nature serves the main course and the new pattern takes full control. Just as an aside, the potential seems there for a tropospheric polar vortex to swing through eastern North America early next week which could bring extreme cold to parts of Eastern Canada and the Northeastern US. So for some the appetizer could possibly come with a punch. This I believe to be consistent with some stretched PV events and I have a manuscript in preparation on this type of event.



Late fall to early-winter wave amplification over Eurasia leads to mid- to late-winter wave amplification over North America. Wave amplification on both continents favors extreme winter weather.

Figure v. Idealized schematic based stretched polar vortex events. Amplification of the jet stream over Eurasia, triggers increased upward atmospheric wave energy. Under favorable conditions (decreasing zonal winds with height in the stratosphere) this leads to a stretched polar vortex (PV) and wave reflection that is upward over Eurasia and downward over North America. Convergence of downward wave energy in the North American sector leads to a northward shifted jet stream over the Gulf of Alaska and Alaska, a southward shifted jet stream over North America and an increase in extreme winter weather (cold & snow) across eastern North America. All temperature anomalies are relative to their own period.

So, my forecast for the Eastern US would be cold this week, milder next week and then followed by a multi-week period of cold. Again, I think that the colder pattern later this month will likely be associated with a stretched PV. A Ural ridging/East Asia troughing pattern is predicted for next week (see **Figure 5**) it's far from impressive but could be just enough to initiate another stretched PV event mid-month and this is certainly suggested by the model forecasts. For example, I include the latest PV animation in **Figure vi**. Looking at the latest GFS ensembles this time the stretched PV could evolve into a more significant disruption but that is speculative for this speculative paragraph and I see little support for a larger PV disruption right now. Of course, I could be wrong and instead we have a brief period of winter in the Eastern US over the next week or so before we return to our regular scheduled programming of mild and no snow.

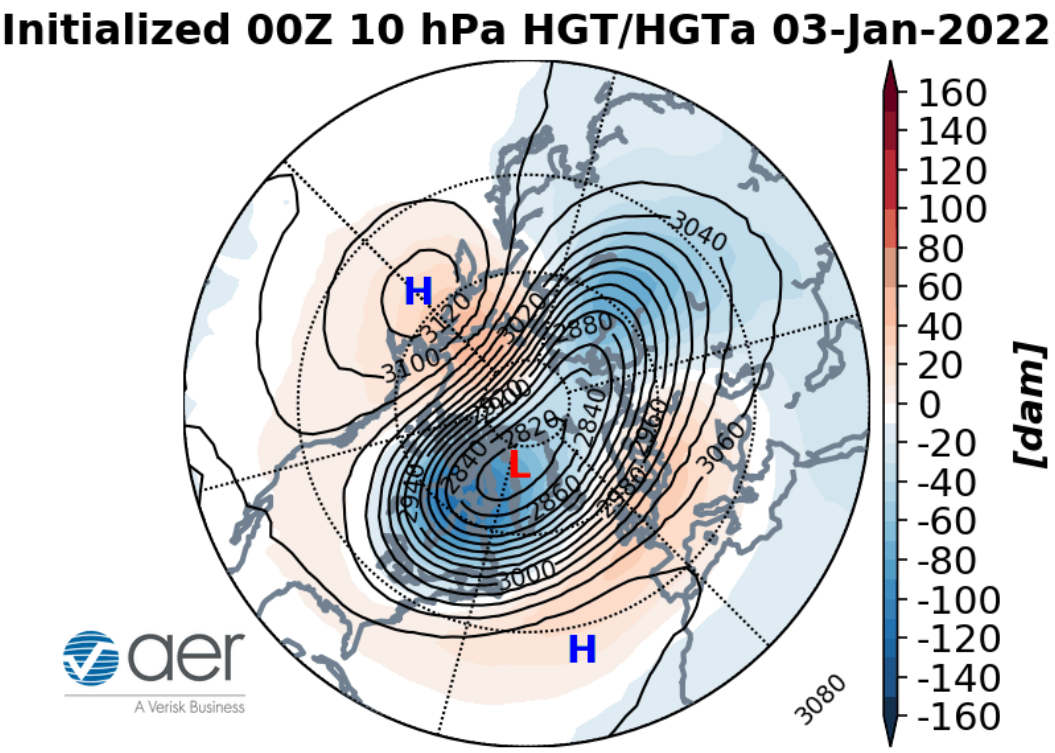


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Figure vi. (a) Initialized 10 mb geopotential heights (dam; contours) and temperature anomalies (°C; shading) across the Northern Hemisphere for 3 January 2022 and forecasted from 4 – 19 January 2022. The forecasts are from the 00Z 3 January 2022 GFS model ensemble.

My apologies for readers in Europe if you feel neglected but stretched PV events bring colder weather to East Asia and eastern north America. I don't think that they have much impact on European temperatures but stretched PVs do tend to fire up the North Atlantic jet which tends to flood Europe with mild, maritime air. I don't see a cold pattern for Europe in the near future. One exception could be Scandinavia where it remains cold. A cold Scandinavia does seem to be a precursor to a stretched PV event (see Figure 2 from Cohen et al.). Longer term the models are suggestive of colder air filtering into Eastern Europe from Western Asia and my attitude right now is wait and see. The models are suggesting a very expansive trough across much of northern Eurasia mid-month and really not sure what to make of it. Almost looks like the tropospheric response to an SSW, the problem is there was no SSW. But obviously still plenty of time to try to figure it all out.

There has been some impressive winter weather in East Asia over the past couple of months and I think the potential for the cold weather to continue, reinforced by stretched PV events and deep and extensive snow cover.

1-5 day

The AO is predicted to be positive this week **(Figure 1**) as geopotential height anomalies are predicted to be mostly negative across the North Atlantic side of the Arctic with mixed geopotential height anomalies across the mid-latitudes of the NH (**Figure 2**). And with mostly negative geopotential height anomalies predicted across Greenland (**Figure 2**), the NAO is predicted to be positive this week as well (**Figure 1**).

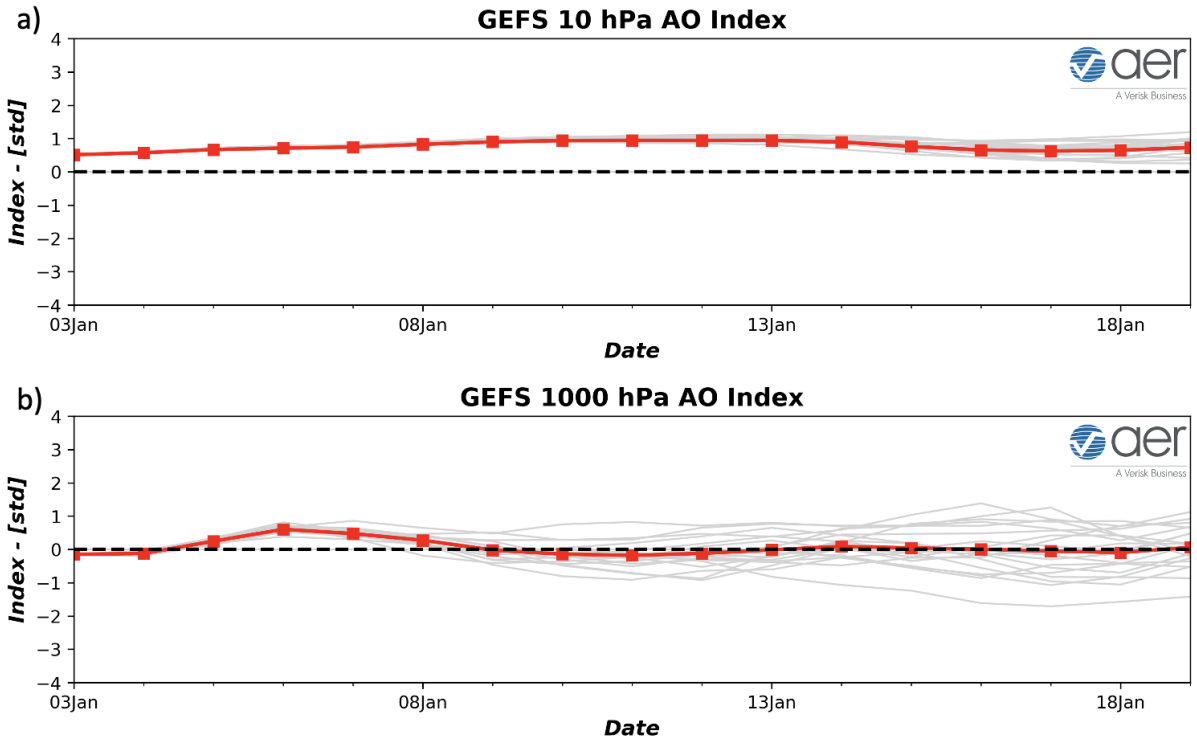

Figure 1. (a) The predicted daily-mean AO at 1000 hPa from the 00Z 3 January 2022 GFS ensemble. (b)The predicted daily-mean near-surface AO from the 00Z 3 January 2022 GFS ensemble. Gray lines indicate the AO index from each individual ensemble member, with the ensemble-mean AO index given by the red line with squares.

This week, troughing/negative geopotential height anomalies will dominate the northern North Atlantic including Northern Europe and the UK with ridging/positive geopotential height across Southern Europe this period (**Figures 2).** The resultant zonal flow will result in normal to above normal temperatures across much of Europe with normal to below normal temperatures across Northern Europe including the UK (**Figure 3**). This week, ridging/positive geopotential height anomalies will dominate much of Asia except

for troughing/negative geopotential height anomalies across Northwestern Asia and Northeastern Asia (**Figure 2**). This pattern favors widespread normal to above normal temperatures across much of Asia with normal to below normal temperatures confined to Northwestern and Northeastern Asia **(Figure 3**).

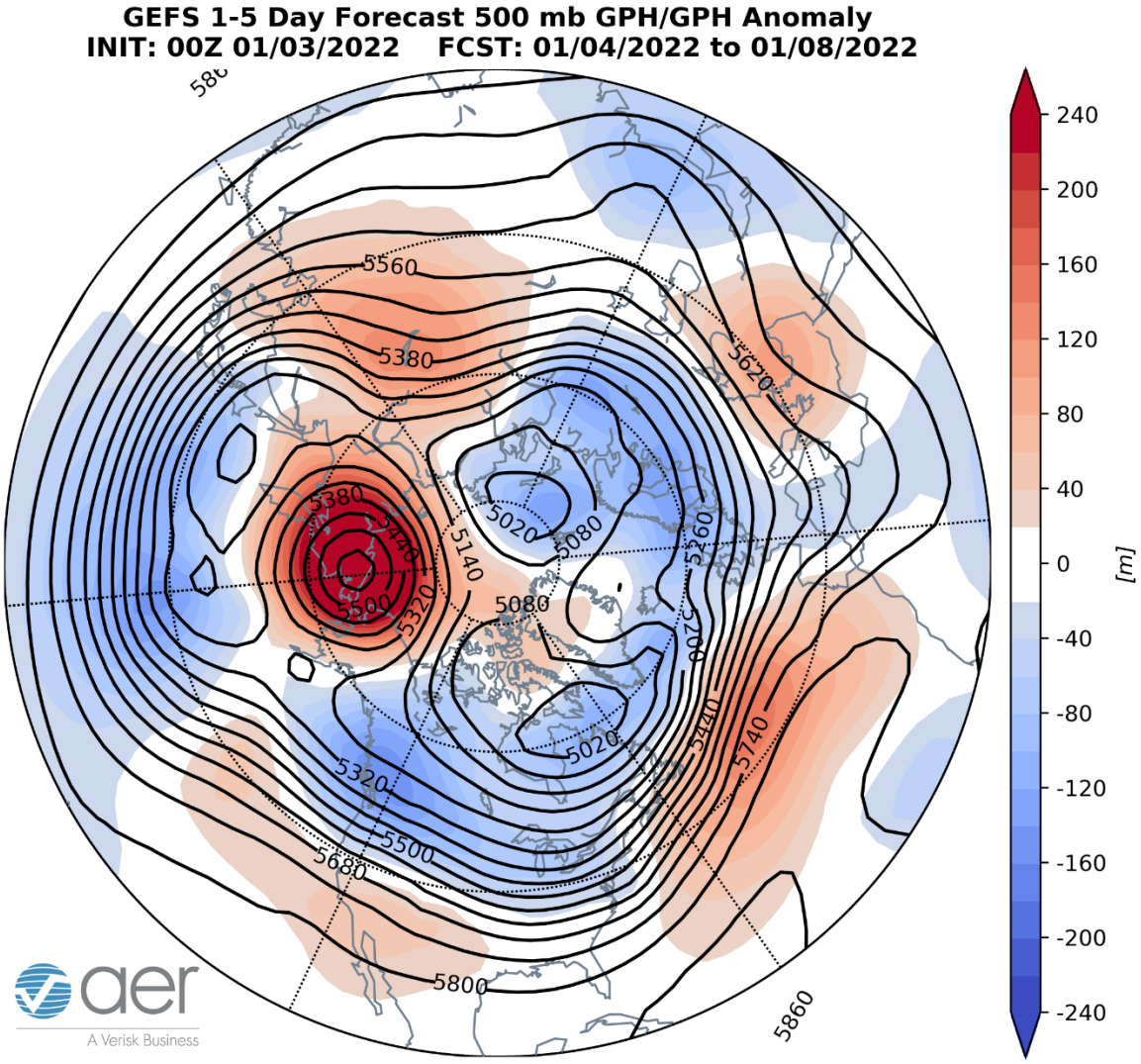

Figure 2. Forecasted average 500 mb geopotential heights (dam; contours) and geopotential height anomalies (m; shading) across the Northern Hemisphere from 4 – 8 January 2022. The forecasts are from the 00z 3 January 2022 GFS ensemble.

Troughing/negative geopotential height anomalies are predicted to be widespread across Canada and the Northern and Eastern US with ridging/positive geopotential height anomalies confined to western Alaska, Northeastern Canada and the Southwestern US this period **(Figure 2).** This will favor normal to below normal temperatures across Alaska, most of Canada and the Northern and Eastern US with

normal to above normal temperatures in Northeastern Canada and the Western US **(Figure 3).**

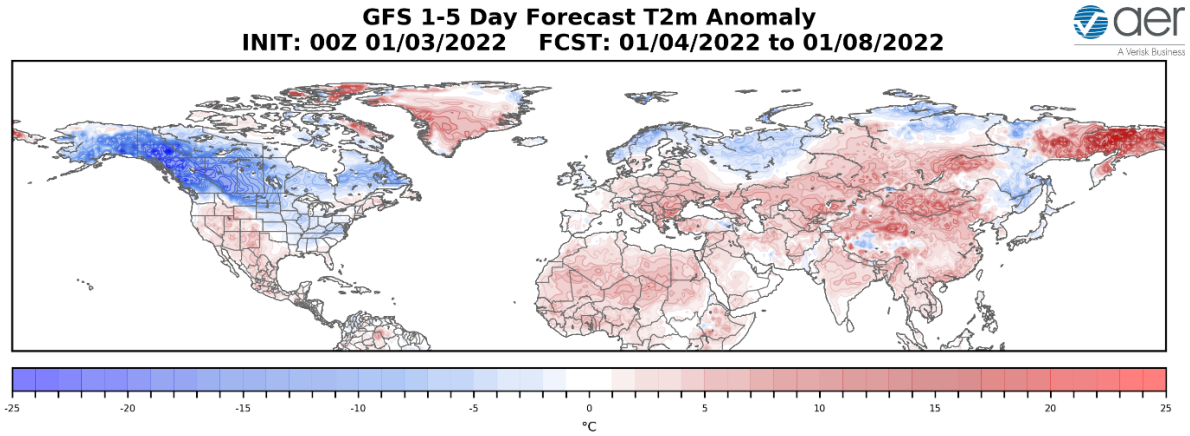

Figure 3. Forecasted surface temperature anomalies (°C; shading) from 4 – 8 January 2022. The forecast is from the 00Z 3 January 2022 GFS ensemble.

Troughing and/or cold temperatures are predicted to support new snowfall across Northern Europe, the Pyrenees, the Alps, Scotland, the Tibetan Plateau and Northern Asia while mild temperatures promote snowmelt in Eastern Europe, Southwestern Asia and Eastern Siberia (**Figure 4**). Troughing and/or cold temperatures are predicted to support new snowfall across Northern and Southern Canada and the Northern US while mild temperatures promote snowmelt in Alaska, the Western US and US Mid-Atlantic (**Figure 4**).

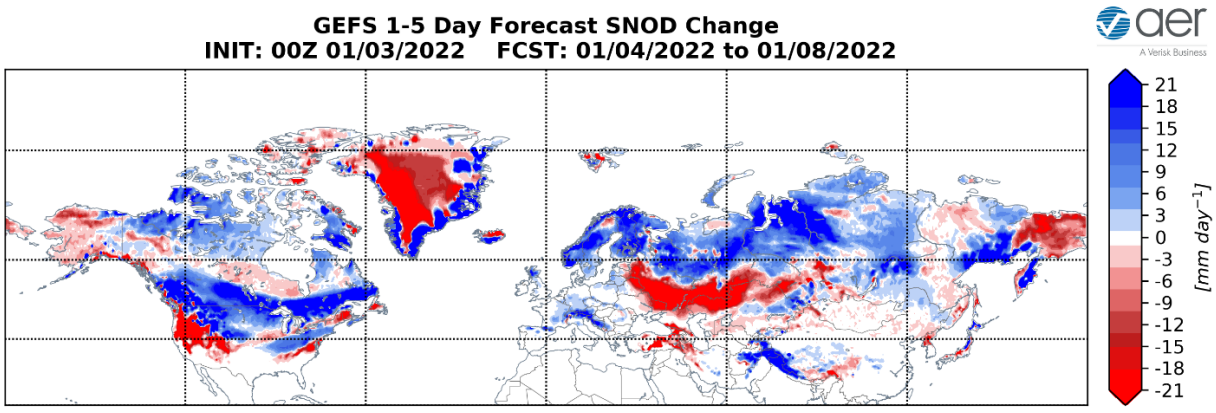

Figure 4. Forecasted snow depth changes (mm/day; shading) from 4 – 8 January 2022. The forecast is from the 00Z 3 January 2022 GFS ensemble.

Mid-Term

6-10 day

The AO is predicted to remain close to neutral this period (**Figure 1**) as geopotential height anomalies remain mixed to mostly negative across the Arctic with mixed geopotential height anomalies across the mid-latitudes of the NH (**Figure 5**). And with mostly negative geopotential height anomalies across Greenland (**Figure 5**), the NAO is predicted to remain neutral to positive this period.

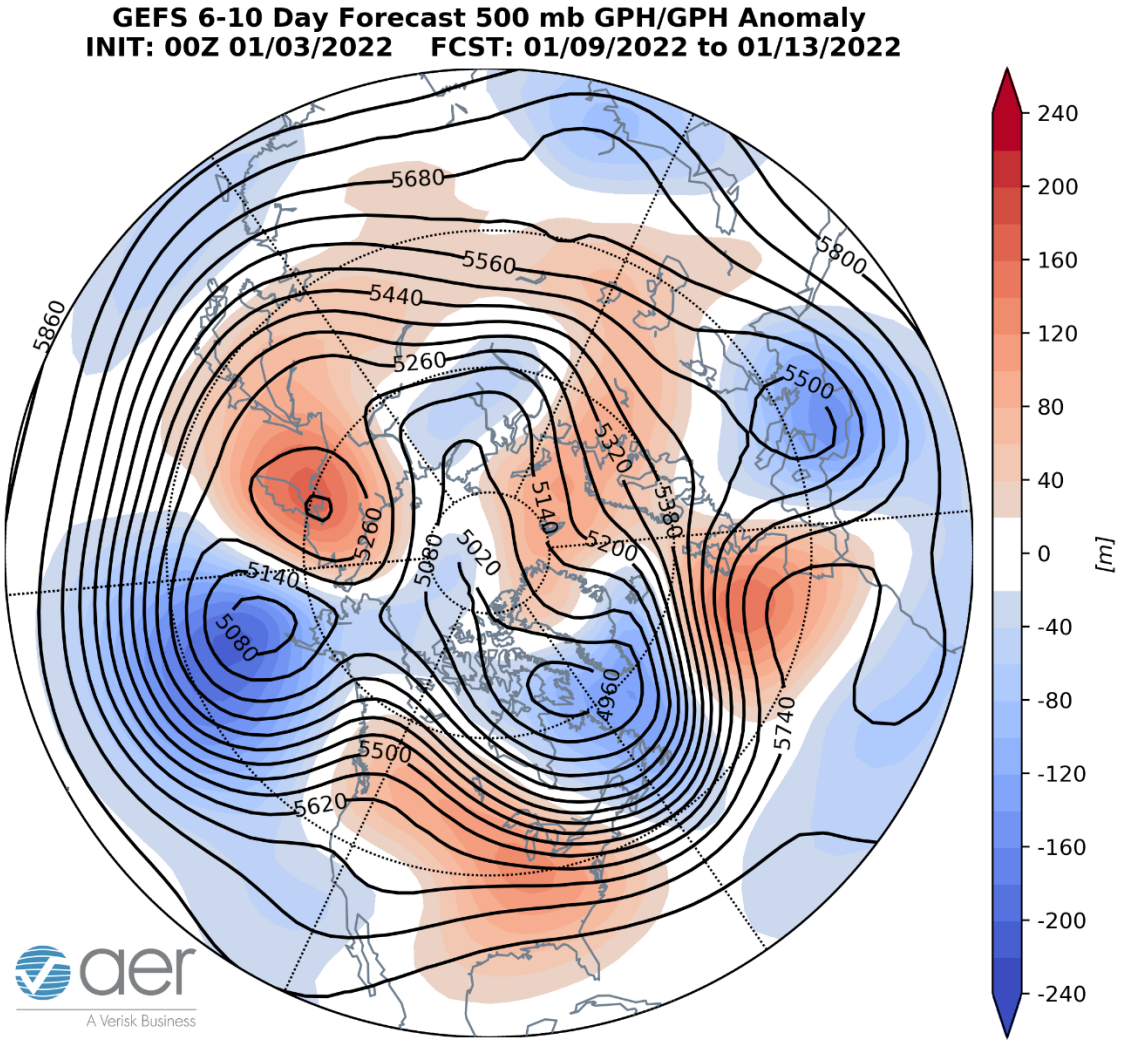

Figure 5. Forecasted average 500 mb geopotential heights (dam; contours) and geopotential height anomalies (m; shading) across the Northern Hemisphere from 9 – 13 January 2022. The forecasts are from the 00z 3 January 2022 GFS ensemble.

Troughing/negative geopotential height anomalies across Greenland will support ridging/positive geopotential height anomalies across most of Europe including the UK with the exception of troughing/negative geopotential height anomalies centered over

the Adriatic Sea (**Figures 5).** This will result in normal to above normal temperatures across most of Europe including the UK with normal to below normal temperatures limited to Scandinavia and Italy (**Figure 6**). Ridging/positive geopotential height anomalies are predicted to still dominate much of Asia though Northwest Asia troughing/negative geopotential height anomalies are predicted to slide eastward and begin merging with stationary troughing in Northeastern Asia this period (**Figure 5**). This pattern favors normal to above normal temperatures across much of Asia with normal to below normal temperatures limited to parts of Central and Northeastern Asia **(Figure 6**).

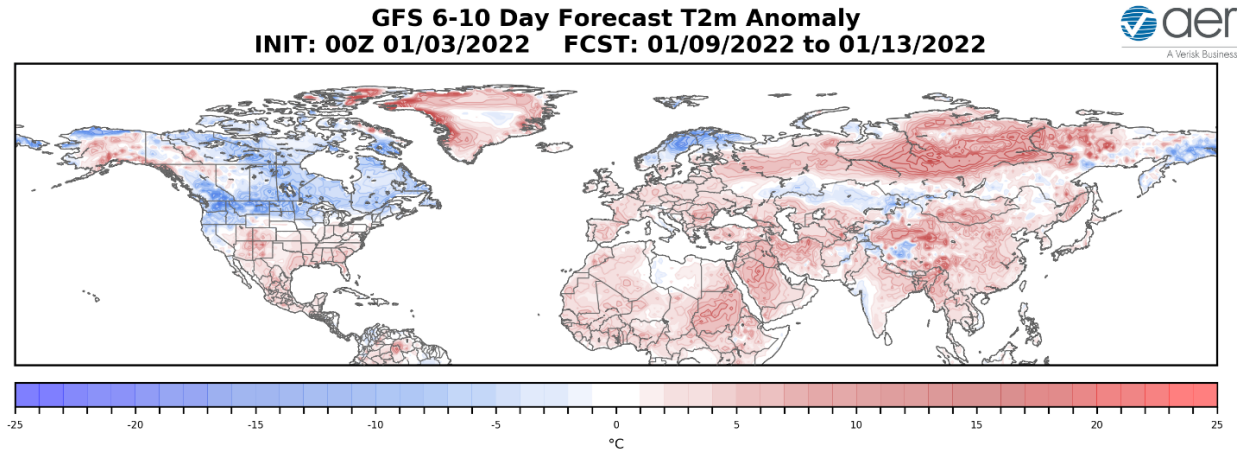

Figure 6. Forecasted surface temperature anomalies (°C; shading) from 9 – 13 January 2022. The forecasts are from the 00Z 3 January 2022 GFS ensemble.

Ridging/positive geopotential height anomalies previously coffined to the Southwestern US will expand across much of the US and Southwestern Canada this period with troughing/negative geopotential height anomalies extending from Alaska southeastward to Eastern Canada and even New England **(Figure 5).** This will favor normal to below normal temperatures across Alaska, much of Canada and the Northern US with normal to above normal temperatures in the Central and Southern US **(Figure 6).**

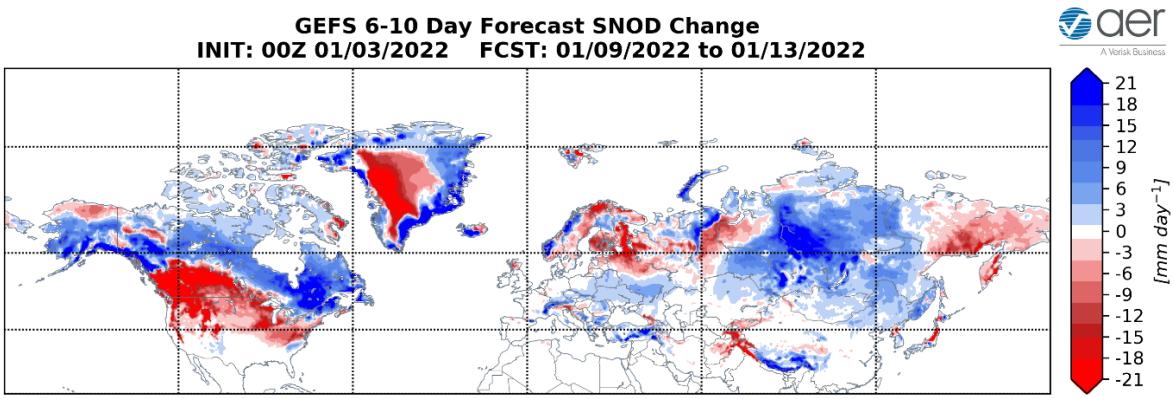

Figure 7. Forecasted snow depth changes (mm/day; shading) from 9 – 13 January 2022. The forecast is from the 00Z 3 January 2022 GFS ensemble.

Troughing and/or cold temperatures are predicted to support new snowfall across the higher elevations of Southern Europe including the Alps, Eastern Turkey, Central Asia including the Tibetan Plateau and East Asia while milder temperatures promote snowmelt across the Baltic States and parts of Japan (**Figure 7**). Troughing and/or cold temperatures are predicted to support new snowfall across Alaska, much of Northern Canada and New England while milder temperatures promote snowmelt across Southwestern Canada, Western US, the US Plains, the Great Lakes and the US Mid-Atlantic (**Figure 7**).

11-15 day

With geopotential height anomalies predicted to remain mixed across the Arctic and mixed geopotential height anomalies across the mid-latitudes of the NH (**Figure 8**), the AO should remain close to neutral this period (**Figure 1**). With predicted mostly negative pressure/geopotential height anomalies across Greenland (**Figure 8**), the NAO is forecasted to remain neutral to positive this period.

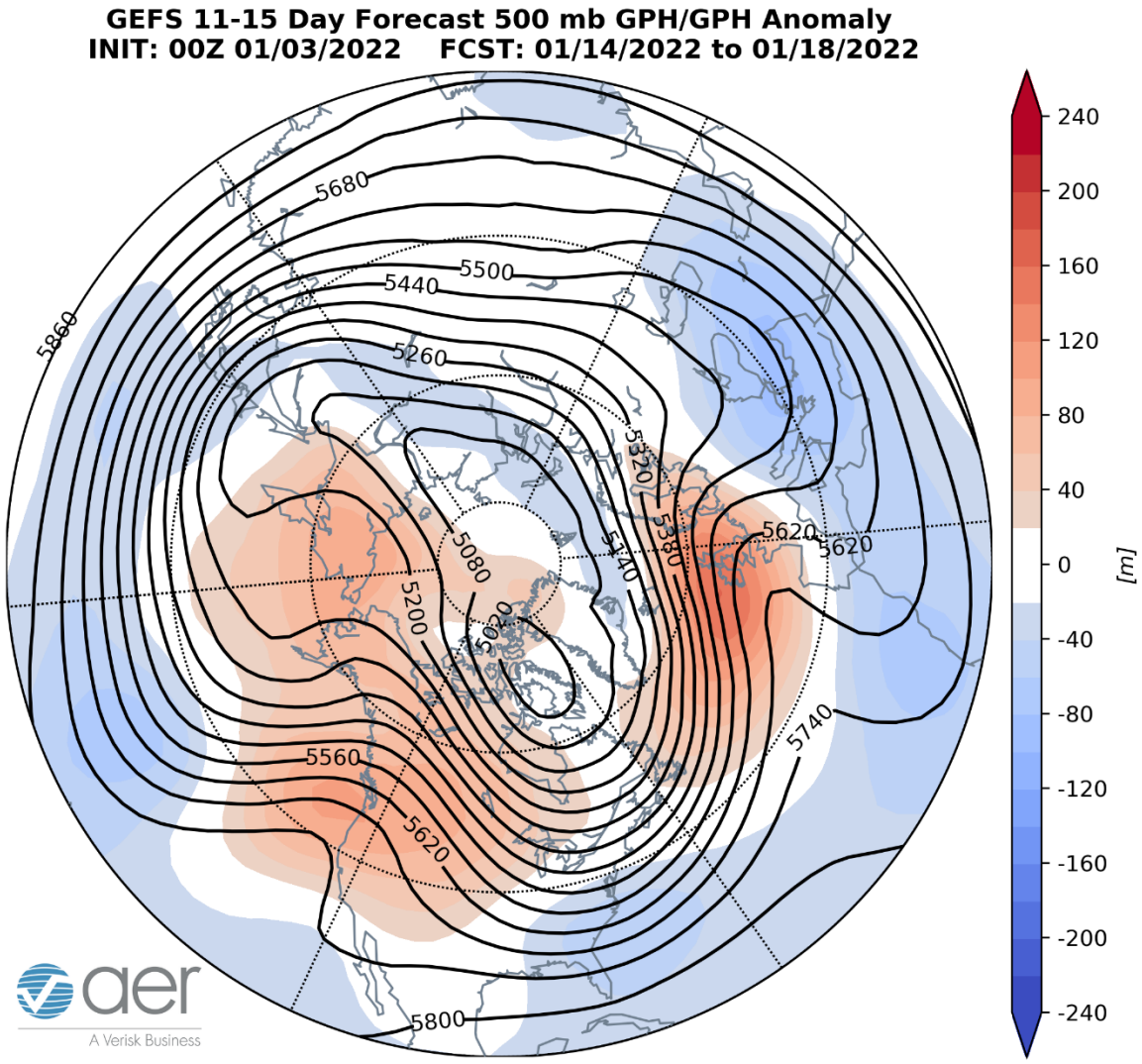

Figure 8. Forecasted average 500 mb geopotential heights (dam; contours) and geopotential height anomalies (m; shading) across the Northern Hemisphere from 14 – 18 January 2022. The forecasts are from the 00z 3 January 2022 GFS ensemble.

Persistent Greenland troughing/negative geopotential height anomalies are predicted to continue to support ridging/positive geopotential height anomalies across Western and Central Europe including the UK with troughing/negative geopotential height anomalies across Northern and Eastern Europe this period (**Figure 8**). This pattern favors more normal to above normal temperatures across Western and Central Europe including the UK with normal to below normal temperatures across Scandinavia and Eastern Europe this period (**Figures 9**). Troughing/negative geopotential height anomalies previously isolated in Northwestern and Northeastern Asia are predicted to merge across Northern and Eastern Asia with ridging/positive geopotential height anomalies across Central and Southern Asia this period (**Figure 8**). This pattern favors more widespread normal

to below normal temperatures across Northern Asia with normal to above normal temperatures across much of Southern Asia this period (**Figure 9**).

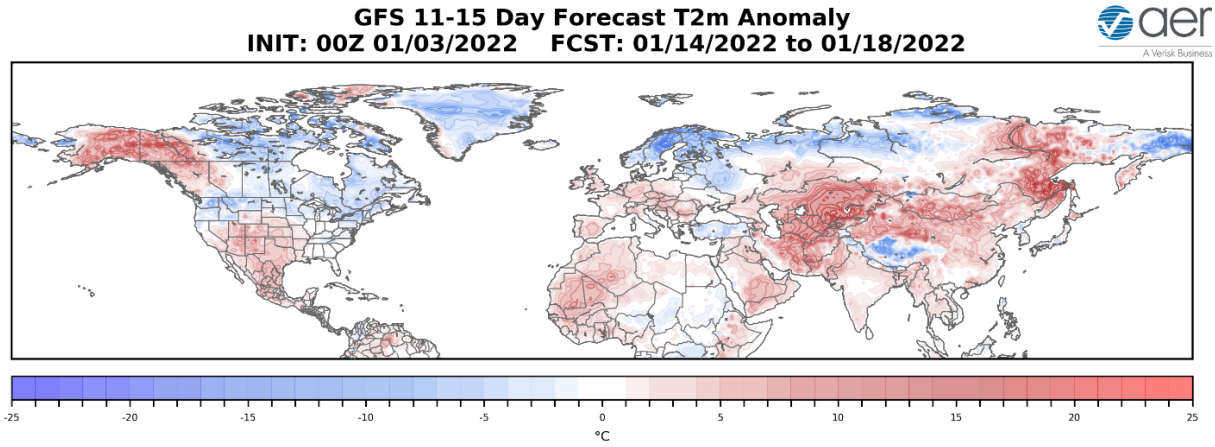

Figure 9. Forecasted surface temperature anomalies (°C; shading) from 14 – 18 January 2022. The forecasts are from the 00z 3 January 2022 GFS ensemble.

Ridging/positive geopotential height anomalies are predicted to consolidate across western North America contributing to deepening troughing/negative geopotential height anomalies in eastern North America this period (**Figure 8**). This pattern favors normal to above normal temperatures across Alaska, Western Canada and the Western US with normal to below normal temperatures in Central and Eastern Canada and the Northern and Eastern US (**Figure 9**).

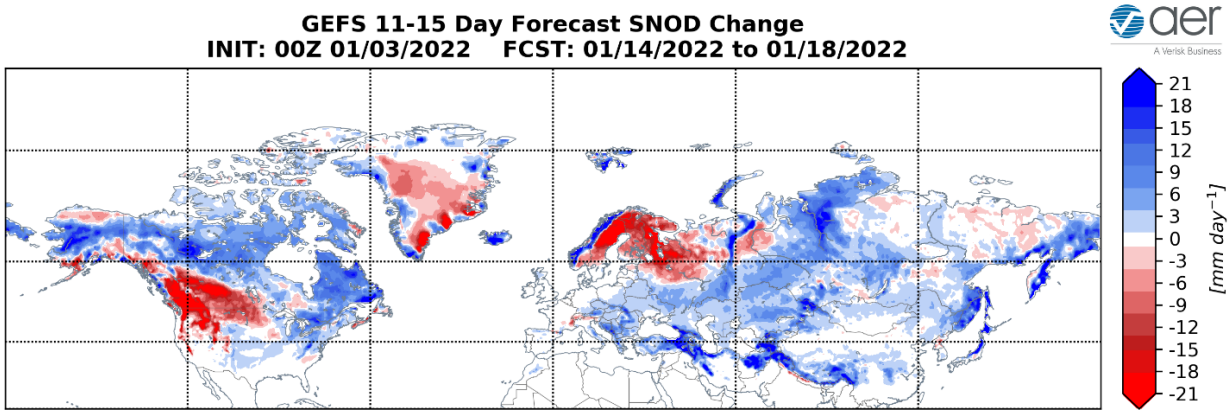

Figure 10. Forecasted snow depth changes (mm/day; shading) from 14 – 18 January 2022. The forecast is from the 00Z 3 January 2022 GFS ensemble.

Troughing and/or cold temperatures are predicted to support possible new snowfall across Southeastern Europe including Turkey and much of Northern Asia and the higher

elevations of Southern Asia while milder temperatures promote snowmelt across the Scandinavia and the Baltic States (**Figure 10**). Troughing and/or cold temperatures are predicted to support possible new snowfall across Alaska, Northern and Eastern Canada and the Northeastern US while milder temperatures promote snowmelt across parts of Southern Alaska, Western Canada and the Western US (**Figure 10**).

Longer Term

30–day

The latest plot of the polar cap geopotential height anomalies (PCHs) currently shows cold/negative PCHs throughout the stratosphere and warm/positive PCHs in the troposphere (**Figure 11**). The negative departures are predicted to deepen in the upper stratosphere next week (**Figure 11**). Currently the stratosphere and troposphere are decoupled and waiting for coupling to resume, though exactly how remains an open question to me.

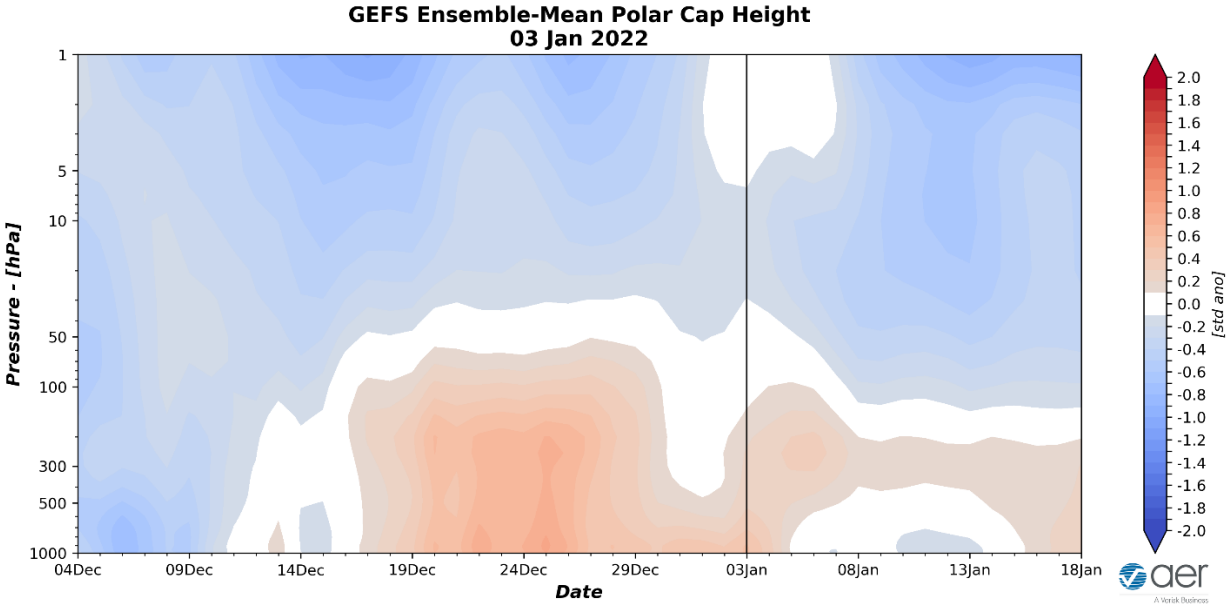

Figure 11. Observed and predicted daily polar cap height (i.e., area-averaged geopotential heights poleward of 60°N) standardized anomalies. The forecast is from the 00Z 3 January 2022 GFS ensemble.

The normal to above normal PCHs predicted this week in the lower troposphere are predicted to briefly turn cold/negative later this week consistent with the predicted positive surface AO later this week (**Figure 1**). The PCH forecast surely looks strange today and suggests a troposphere- (very) low stratosphere-troposphere coupling event that is quite shallow and condensed in time. This could explain the predicted cold-mild-cold forecast for the Eastern US this week over the next two weeks.

The vertical Wave Activity Flux (WAFz) from the troposphere to the stratosphere or poleward heat transport in the stratosphere is currently active (**Figure 12**). The uptick in WAFz is brief and vertical WAF is predicted to below normal for much of the next two weeks (**Figure 12**). However, the positive WAFz anomalies are relatively weak, and the strong polar vortex should remain normal to strong through mid-January as suggested by the near normal to relatively cold stratospheric PCHs. Though the positive vertical WAF quickly followed by negative vertical WAF I believe is a signature of a stretched polar vortex that is ongoing.

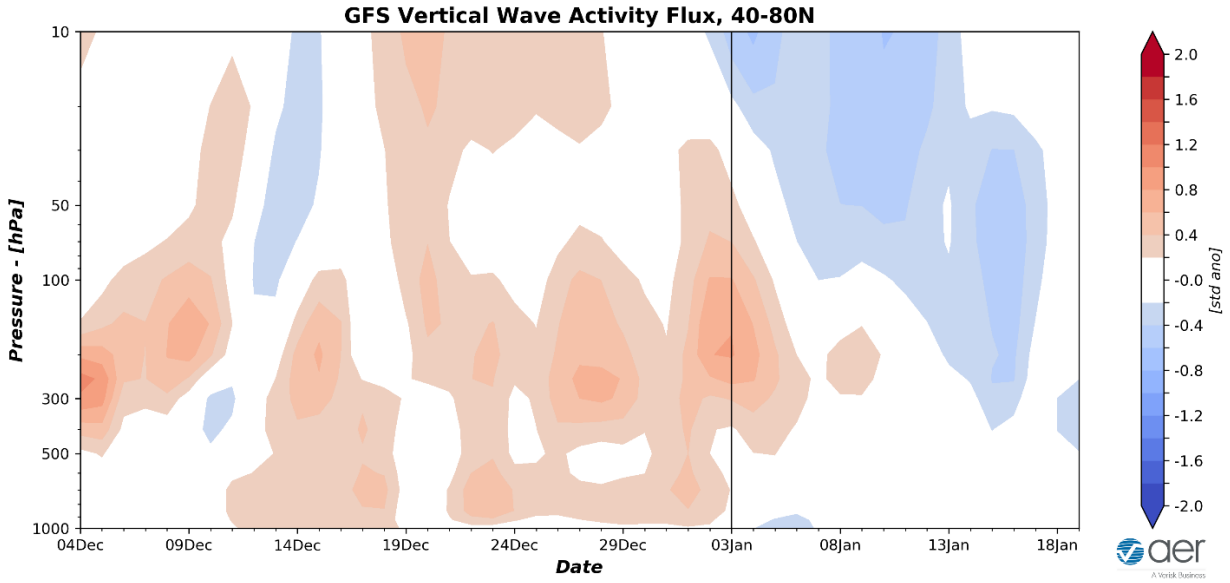

Figure 12. Observed and predicted daily vertical component of the wave activity flux (WAFz) standardized anomalies, averaged poleward of 40-80°N. The forecast is from the 00Z 3 January 2022 GFS ensemble.

The recent uptick in WAFz has perturbed the stratospheric PV with the PV center displaced towards Greenland with ridging centered on the Dateline and polar stratospheric warming across Europe (**Figure 13**). However, the perturbation is relatively minor, and the PV is relatively strong resulting in a current positive stratospheric AO (**Figure 11**).

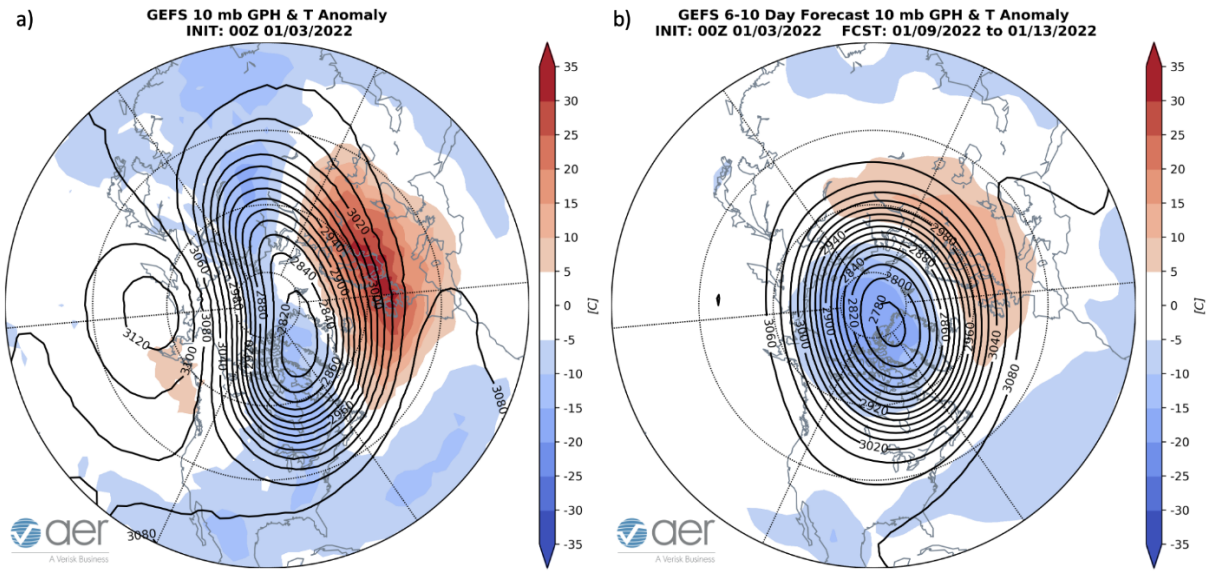

Figure 13. (a) Initialized 10 mb geopotential heights (dam; contours) and temperature anomalies (°C; shading) across the Northern Hemisphere for 3 January 2022. (b) Same as (a) except forecasted averaged from 9 – 13 January 2022. The forecasts are from the 00Z 3 January 2022 GFS model ensemble.

The predicted below normal WAFz is predicted to allow the PV to strengthen and become quite strong with the PV center returning to the North Pole the second week of January (**Figure 13**) with a persistent positive stratospheric AO the next two weeks (**Figure 11**). The strengthening stratospheric PV should coincide with a relatively mild period across the US and Europe next week. However, model forecasts are suggestive of more PV stretching mid-month.

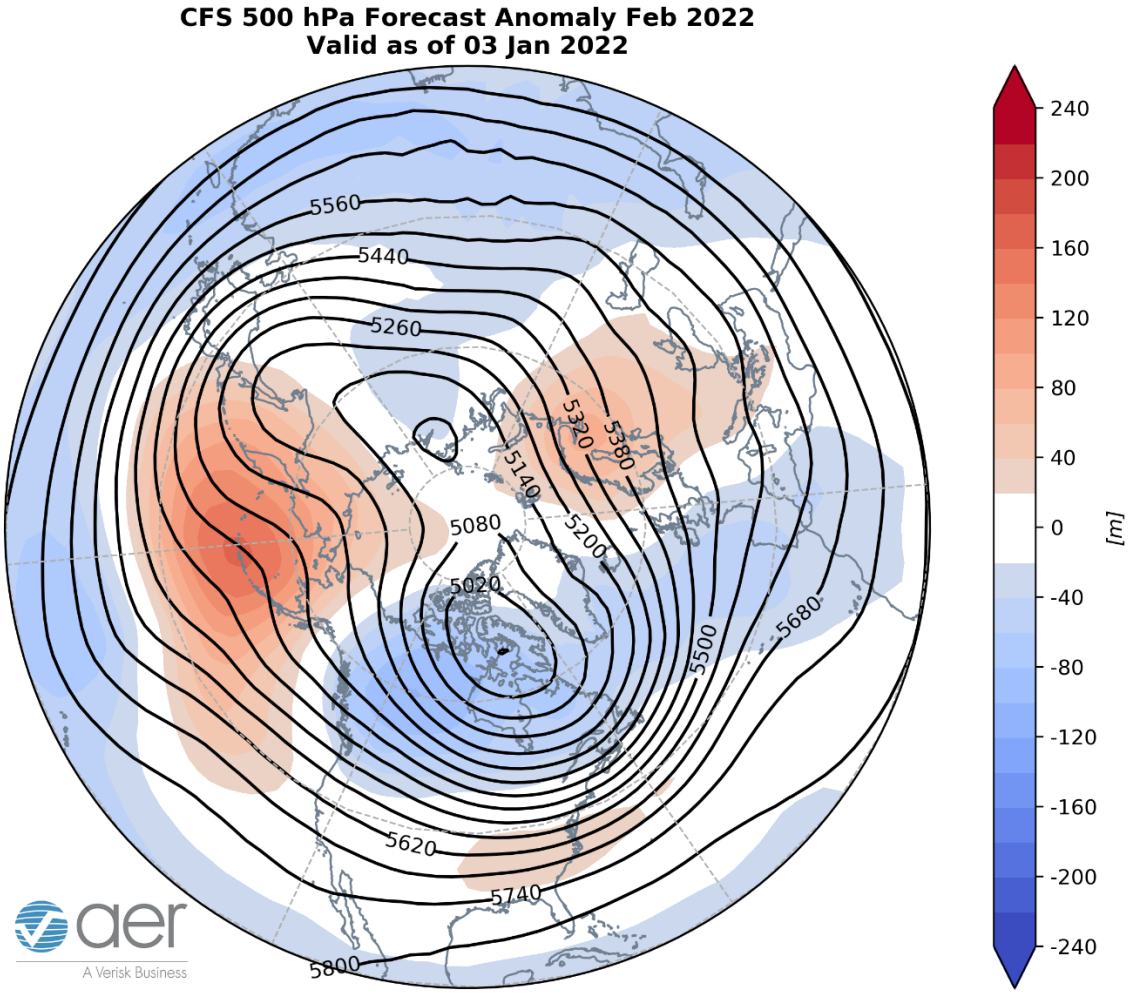

Figure 14. Forecasted average 500 mb geopotential heights (dam; contours) and geopotential height anomalies (m; shading) across the Northern Hemisphere for February 2022. The forecasts are from the 00Z 3 January 2022 CFS.

I include in this week's blog the monthly 500 hPa geopotential heights (**Figure 14**) and surface temperatures for February (**Figure 15**) from the Climate Forecast System (CFS; the plots represent yesterday's four ensemble members). The forecast for the troposphere is ridging centered over Scandinavia/Barents-Kara Seas region, the Dateline and in the Southeastern US with troughing across Western Europe, Western Asia, Northeastern Asia and most of Canada (**Figure 14).** This pattern favors seasonable to relatively warm temperatures widespread across Northern and Eastern Europe, Central Asia, Eastern Siberia and the Western and Southern US with seasonable to relatively cold temperatures across Western Europe, Central and East Asia, Alaska, much of Canada and the Northeastern US (**Figure 15**).The cold in Alaska and Northwestern Canada could be extreme based on the CFS forecast.

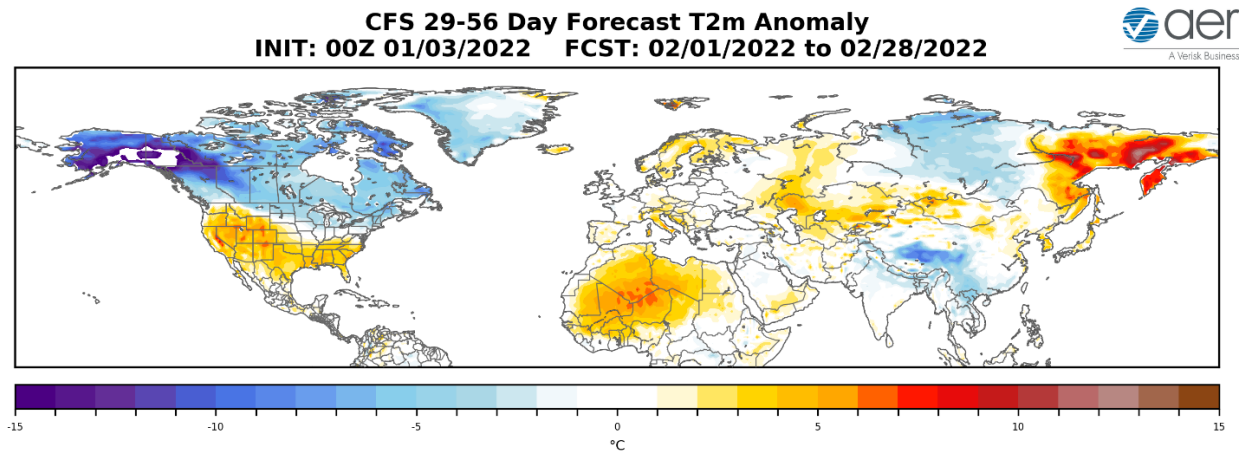

Figure 15. Forecasted average surface temperature anomalies (°C; shading) across the Northern Hemisphere for February 2022. The forecasts are from the 00Z 3 January 2022 CFS.

Surface Boundary Conditions

Arctic Sea ice

Arctic sea ice is growing but remains below normal mostly in Baffin Bay. Overall sea ice is relatively extensive compared to recent winters. In the Barents-Kara Seas extent is close to normal. Below normal sea ice in the Barents-Kara seas favors cold temperatures in Central and East Asia, while below normal sea ice in Baffin Bay favors cold temperatures in the Eastern and Northern Europe however this topic remains controversial. Recent research has shown that the regional anomalies that are most highly correlated with the strength of the stratospheric PV are across the Barents-Kara seas region where low Arctic sea ice favors a weaker winter PV. Low sea ice in the Chukchi, Beaufort and Bering seas may favor colder temperatures across North America but has not been shown to weaken the PV.

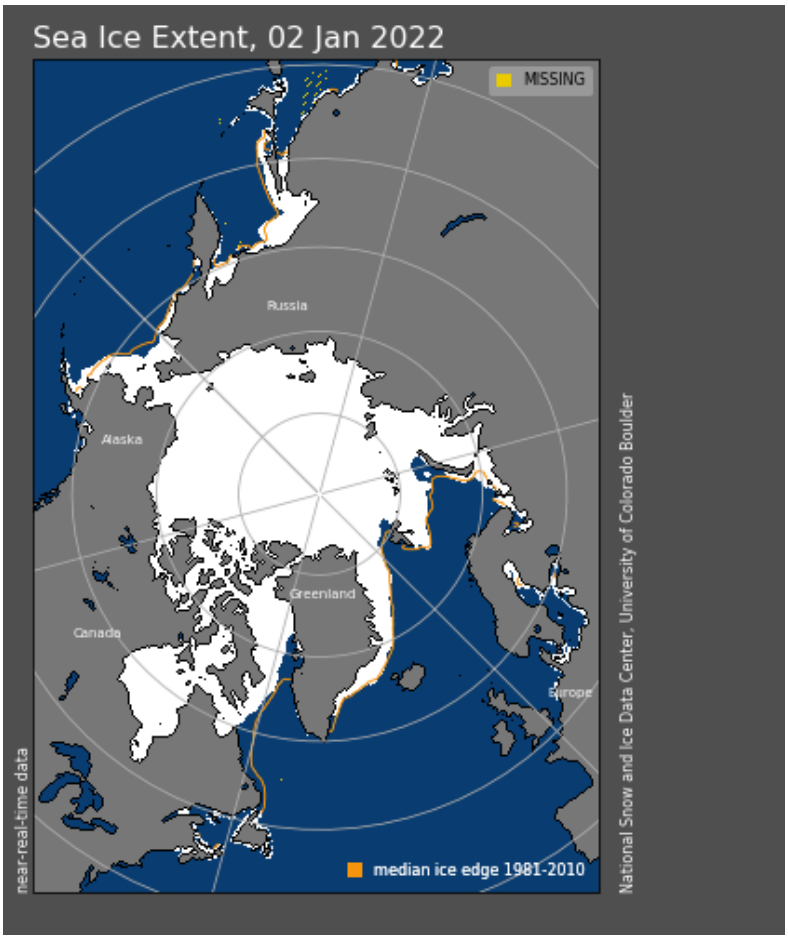

Figure 16. Observed Arctic sea ice extent on 2 January 2022 (white). Orange line shows climatological extent of sea ice based on the years 1981-2010. Image from the National Snow and Ice Data Center (NSIDC).

SSTs/El Niño/Southern Oscillation

Equatorial Pacific sea surface temperatures (SSTs) anomalies are below normal and we continue to observe weak to possibly moderate La Niña conditions (**Figure 17**) and La Niña conditions are expected through the winter. Observed SSTs across the NH remain well above normal especially in the central North Pacific (west of recent years), the western North Pacific and offshore of eastern North America though below normal SSTs exist regionally especially in the North Pacific. Not my expertise but the SST pattern in the North Pacific are strongly resembling a negative Pacific Decadal Oscillation (PDO) pattern that favors colder temperatures across northwestern North America and milder temperatures across southeastern North America.

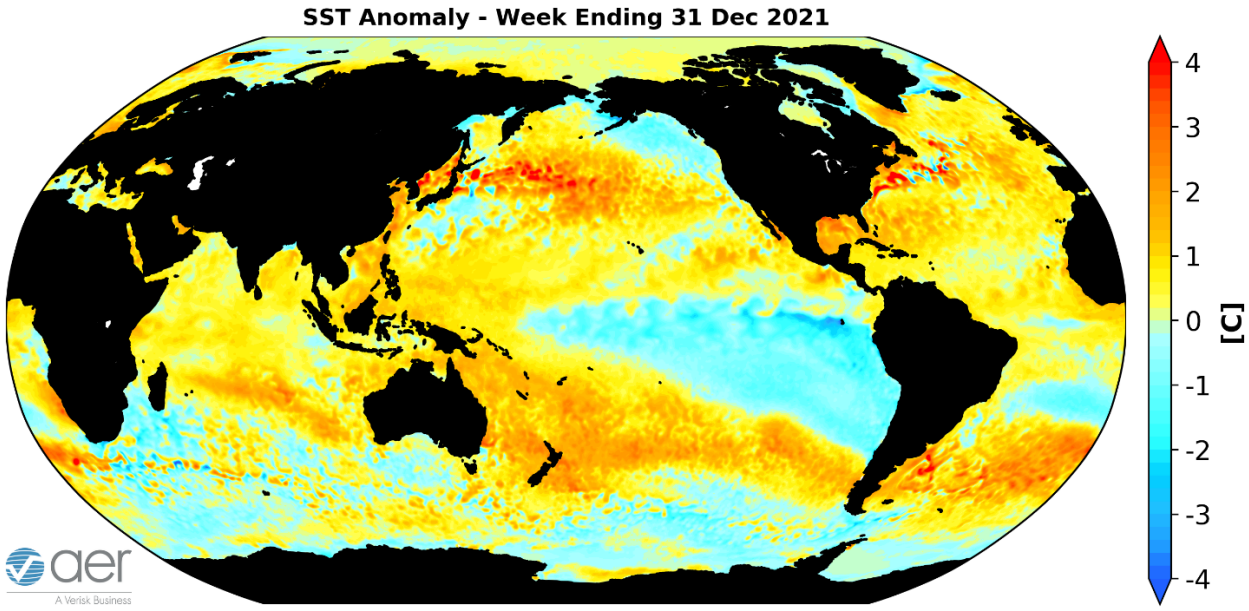

Figure 17. The latest weekly-mean global SST anomalies (ending 31 December 2021). Data from NOAA OI High-Resolution dataset.

Currently the Madden Julian Oscillation (MJO) is barely in phase eight (**Figure 18**). The forecasts are for the MJO to linger mostly in phase seven through mid-January. MJO phase seven favors high latitude blocking including Alaska. Initially phase seven favors troughing and cold temperatures in the Western US and ridging and mild temperatures in the Eastern US but then reverses. To be honest not sure what to make of the MJO forcing this week and next week and admittedly this is outside of my expertise.

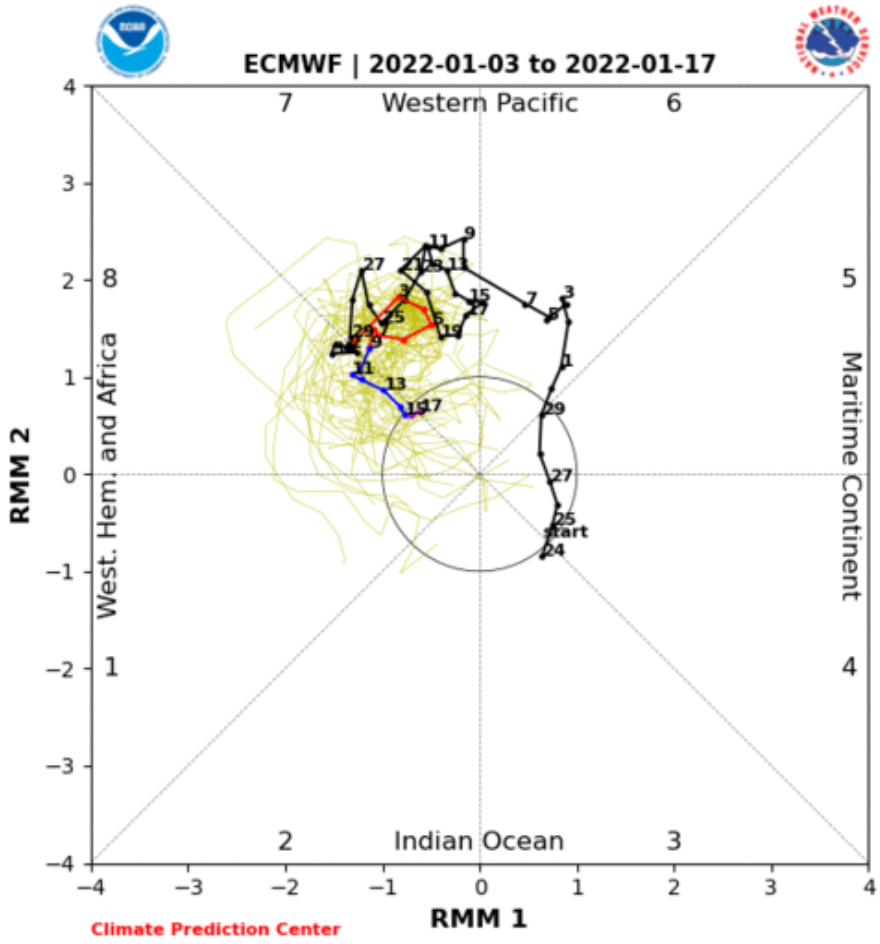

Figure 18. Past and forecast values of the MJO index. Forecast values from the 00Z 3 January ECMWF model. Yellow lines indicate individual ensemble-member forecasts, with the green line showing the ensemble-mean. A measure of the model "spread" is denoted by the gray shading. Sector numbers indicate 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

Get Detailed Seasonal Weather Intelligence with sCast

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

Dr. Cohen's detailed monthly seasonal forecast, sCast, is also available for purchase. sCast provides a monthly 30-60-90-180-day outlook into temperature and

precipitation, solar flux and wind anomalies across the globe, and regional population weighted cooling and heating degree forecasts for the US.

Our sCast principal engineer, Karl Pfeiffer, can help you use sCast and other AER seasonal forecast products to deliver important, long-lead time weather intelligence to your business. Please reach out to Karl today!