Arctic Oscillation and Polar Vortex Analysis and Forecasts

August 4, 2025

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. In late 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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Summary

- The Arctic Oscillation (AO) is currently slightly positive and is predicted to slowly trend negative the next two weeks as pressure/geopotential height anomalies across the Arctic are currently mostly negative and are predicted to remain mostly mixed to positive over the next two weeks. The North Atlantic Oscillation (NAO) is currently strongly positive as negative pressure/geopotential height anomalies dominate across Greenland, and the NAO is predicted to slowly trend negative but remain positive the next two weeks as deep negative pressure/geopotential height anomalies are predicted to slowly weaken across Greenland.
- The next two weeks, troughing/negative geopotential height anomalies across Greenland will support increasing ridging/positive geopotential height anomalies across Europe with the main exception of troughing/negative geopotential height anomalies across Northern Europe this week. This pattern will support widespread normal to above normal temperatures across much of Europe including the UK with the biggest exception of normal to below normal temperatures across Northern and Central Europe this week.
- The general pattern across Asia the next two weeks is ridging/positive geopotential height anomalies centered over the Kara Sea supporting troughing/negative geopotential height anomalies to the couth across Central and East Asia. This pattern favors normal to above normal temperatures across much of Asia but especially Northern Russia with normal to below normal temperatures parts of Central and East Asia, especially this week.

- The general predicted pattern the next two weeks across North America is widespread ridging/positive geopotential height anomalies with troughing/negative geopotential height anomalies across Alaska and Northern Canada and for this week only the Eastern United States (US). This patten will favor widespread normal to above normal temperatures across the US and Southern Canada with normal to below normal temperatures across Alaska and Northern Canada and include the Eastern US this week only.
- I discuss the Northern Hemisphere (NH) summer circulation and temperature forecast in this week's blog.

Plain Language Summary

Widespread warmth dominated the land areas of the Northern Hemisphere (NH) for the first two months of summer especially across Western and Southern Europe and Central Asia (see **Figure**). Warmth has also dominated western and to a lesser extent eastern North America. The biggest exceptions have been relatively cool temperatures in Central Canada, the Central US, Central and Eastern Siberia and India and with close to seasonable temperatures in Northeastern Europe and Western Russia (see **Figure**). Since the last blog the recent record-breaking heatwave in Scandinavia has shifted the seasonal mean from near normal to above normal. Seems like for the most part the trend (over the past few decades) is your friend. I think the seasonal surface temperature anomaly will likely change little from the figure below given the forecasts. Though Western and Central Europe have been relatively cool recently, warm temperatures are predicted to return across most of Europe with the exception of Northeast Europe (see **Figure 9**). And despite that the Eastern US enjoyed a break from the heat so far this week, warm temperatures will return across the Western and Eastern US (see **Figure 6**).

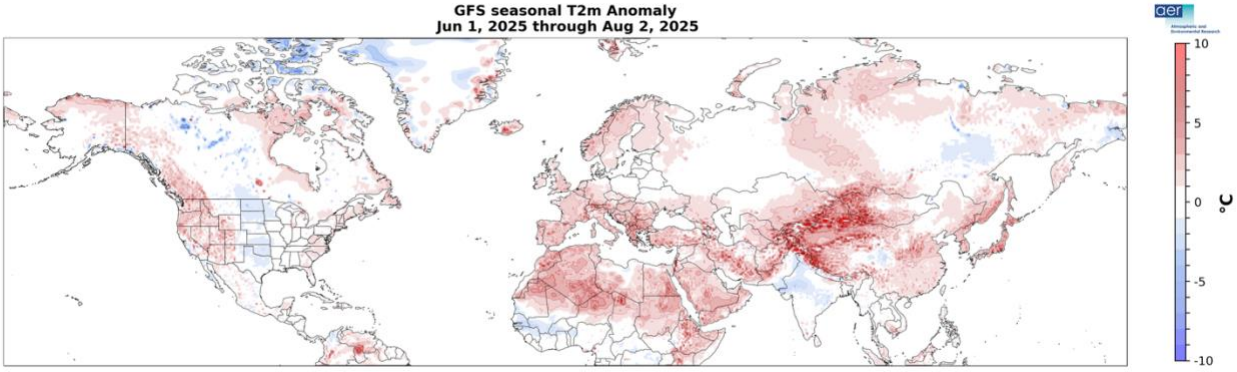

Figure. Estimate of the observed surface temperatures (°C; shading) from 01 Jun to 2 Aug 2025 based on GFS initializations and the GFS forecast from the 3 August 2025 run.

Impacts

My time in Germany is coming to an end, so hoping for a more consistent publication schedule of the blog in the coming weeks. It has been a great trip with many stimulating interactions and planning of future research with colleagues here in Germany. Already looking forward to the next trip.

Maybe this is dangerous territory to venture into but seems to me that the summer weather, at least in terms of surface temperature anomalies, has been fairly well behaved. It is relatively warm where I think it should be expected most, and the exceptions where it is seasonable or even below normal is consistent with recent temperature trends. Europe is warm yet again, though the core of the relative warmth is shifted west compared to recent summers. East Asia is warm, though Siberia doesn't seem to be as warm as some recent summers with some areas even showing up below normal (haven't seen any headlines on Siberian fires). Near normal in Western Russia/the Urals, which again I feel is consistent with recent summers. Finally North America is warm on both coasts and normal to relatively cool down the middle. The seasonable to relatively cool temperatures down the middle of the continent are consistent with the much talked about US "warming hole." And based on the forecasts I think this overall pattern should hold for the entire summer with just some regional changes.

Once again in general, the two-week forecast for the mid-tropospheric circulation is characterized by low pressure centered near the North Pole and high latitude ridging along the periphery of the Arctic (see **Figure i**). This pattern generally favors widespread warmth across both the Eurasian and North American continents (see **Figures 3, 6** and **9**). A pattern that I am fond as referring to as the "ring of fire" summer pattern. As can be seen in the animation of **Figure i**, the biggest heat dome this week will be focused across Hudson Bay. However, with time the dominant high-pressure system will develop over the Kara and Laptev Seas and may even expand to near the North Pole, once again placing a pause on this ring of fire summer pattern.

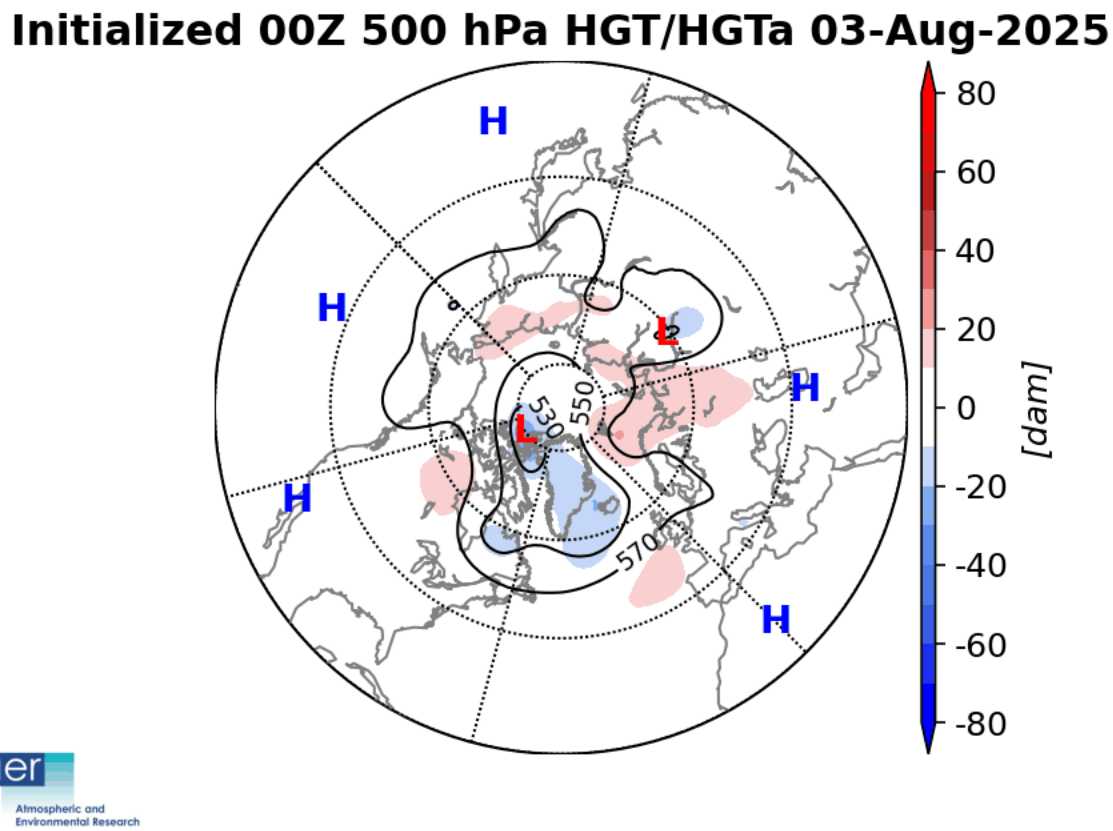

Figure i. Initialized 500 mb geopotential heights (dam; contours) and decameter anomalies (dam; shading) across the Northern Hemisphere for 23 Jun 2025 and forecasted from 3 Aug to 18 Aug 2025. The forecasts are from the 00Z 3 Aug 2025 GFS model ensemble.

Otherwise seems like the overall pattern so far is not a bad indication of what to expect in the coming weeks. Overall Europe looks warm. Impressive even record breaking heat wave in Scandinavia is still ongoing but looks like it is coming to an end. The warm summer in Scandinvaia seems to mark a change from the Honga-Tonga influenced summers of late.

Warm in East Asia looks to continue as well. I have been seeing record heat in Japan, no srurprise with the marine heat wave just offshore (see **Figure 12**). Again the hot summer in East Asia is consistent with recent summers. There could be a break in the heat with the large high pressure over the Kara Sea but not sure how widepsread the cooling from this feature will be.

Warm temperstures are also predicted to continue in the Eastern and Western US and eventually the warm temperatures could overspread much of the US. Still based on the forecasts does look like the Central US will be slow to heat up.

With a nod to the fall and winter, Arctic sea ice is well below normal and on track with 2012 and last summer. I will track it more closely in upcoming blogs, but another near record low sea ice minimum is in the cards. A new record minimum is probably not likely but certainly plausible. But regardless, sea ice is much more below normal on the Eurasian than the North American

side. Therefore, I fully expect come the fall, the largest sea ice anomalies to be found on the Eurasian side of the Arctic especially the Barents-Kara Seas. Don't want to make too much of this in early August but that is probably the most favorable Arctic sea ice anomaly pattern to weaken the winter polar vortex.

Near-Term

This week

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

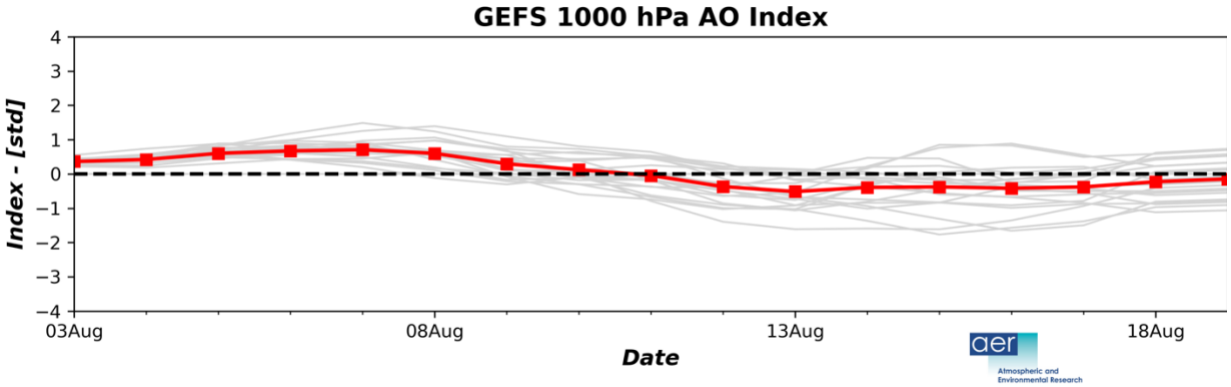

Figure 1. The predicted daily-mean AO at 1000 hPa from the 00Z 3 August 2025 GFS ensemble. Gray lines indicate the AO index from each individual ensemble member, with the ensemble mean AO index given by the red line with squares.

This week predicted troughing/negative geopotential height anomalies across Greenland will support ridging/positive geopotential height anomalies across Western and Southern Europe with troughing/negative geopotential height anomalies across Northern and Eastern Europe (**Figure 2).** This pattern will favor normal to above normal temperatures across Western and Southern Europe with normal to below normal temperatures across Northern and Eastern Europe including the UK this period (**Figure 3**). This week the predicted pattern across Asia is strong ridging/positive geopotential height anomalies centered over the kara Sea supporting troughing/negative geopotential height anomalies across Central and East Asia (**Figure 2**). This pattern favors normal to above normal temperatures across Western and Southern Asia with normal to below normal temperatures across parts of Central and East Asia and Northeastern Siberia with mixed temperatures for Afghanistan, Pakistan and northern India **(Figure 3**).

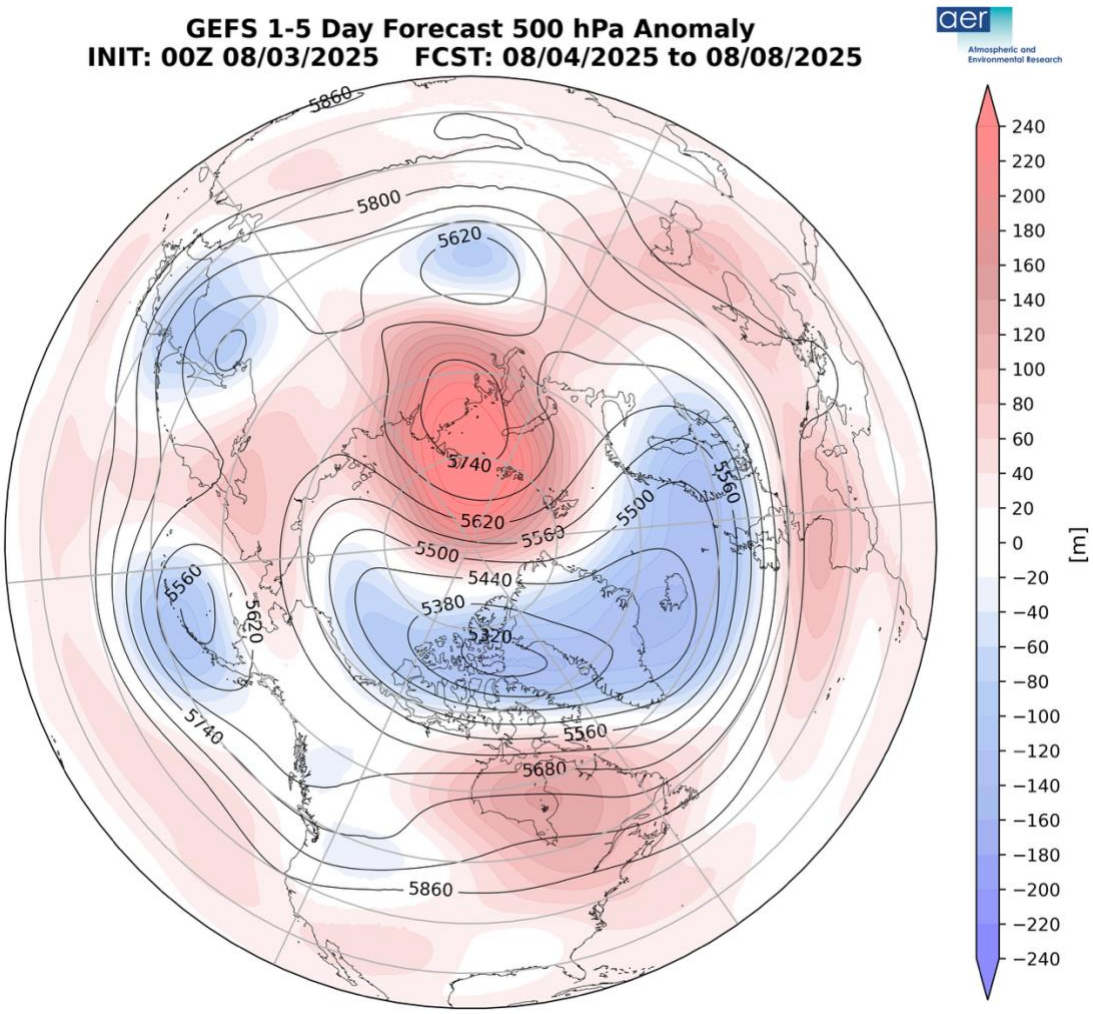

Figure 2. Forecasted average 500 mb geopotential heights (dam; contours) and geopotential height anomalies (m; shading) across the Northern Hemisphere from 4 Aug to 8 Aug 2025. The forecasts are from the 00Z 3 Aug 2025 GFS ensemble.

This week ridging/positive geopotential height anomalies are predicted to be centered over Hudson Bay supporting troughing/negative geopotential height anomalies across the Western and Eastern US with more troughing in Northern Alaska and Canada (**Figure 2**). This pattern favors normal to above normal temperatures across much of Canada and the US Rockies with normal to below normal temperatures in the Western and Eastern US, northern Alaska and Northern Canada. (**Figure 3**).

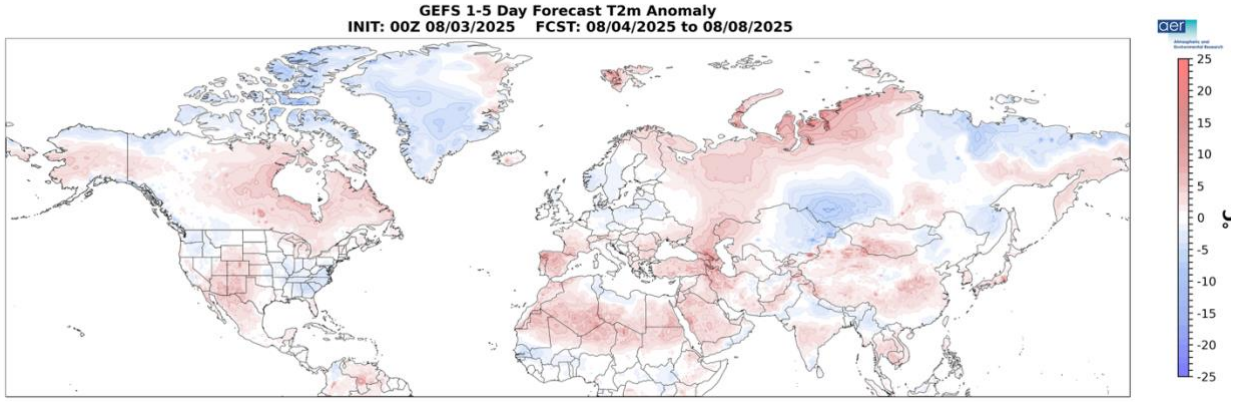

Figure 3. Forecasted surface temperature anomalies (°C; shading) from 4 Aug to 8 Aug 2025. The forecasts are from the 00Z 3 Aug 2025 GFS ensemble.

Troughing will support new rainfall across the Scandinavia into Western Russia, Southern Siberia, parts of Southeast Asia and the Tibetan Plateau with otherwise mostly dry conditions widespread across Europe and Asia, with near normal precipitation across Afghanistan and Pakistan this week (**Figure 4**). Troughing will support new rainfall across parts of Western Canada and the Southeastern US with otherwise mostly dry conditions widespread across Canada and the US this week (**Figure 4**).

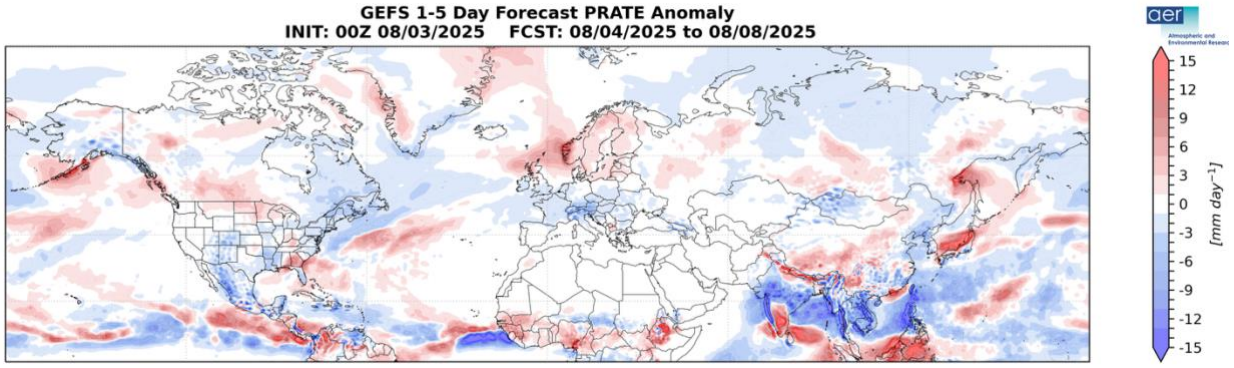

Figure 4. Forecasted rainfall (mm/day; shading) from 4 Aug to 8 Aug 2025. The forecasts are from the 00Z 3 Aug 2025 GFS ensemble.

Near-Mid Term

Next week

With geopotential height anomalies becoming mostly mixed across the Arctic and with mixed geopotential height anomalies across the mid-latitudes this period (**Figure 5**), the AO will likely remain close to neutral this period (**Figure 1**). With predicted negative pressure/geopotential height anomalies across Greenland (**Figure 5**), the NAO will likely be positive this period.

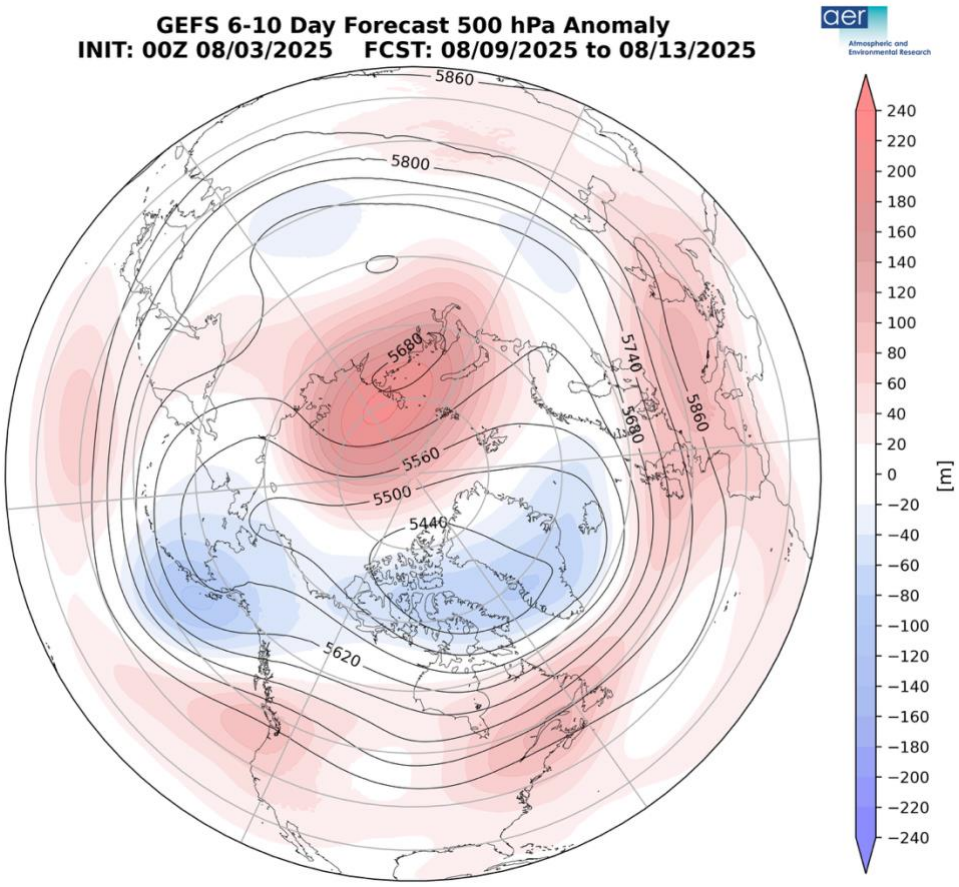

Figure 5. Forecasted average 500 mb geopotential heights (dam; contours) and geopotential height anomalies (m; shading) across the Northern Hemisphere from 9 Aug to 13 Aug 2025. The forecasts are from the 00Z 3 Aug 2025 GFS ensemble.

Persistent troughing/negative geopotential height anomalies across Greenland will continue to support expanding ridging/positive troughing/negative geopotential height anomalies across Europe with just some residual troughing/negative geopotential height anomalies across the northeastern corner of Europe this period (**Figure 5**). This pattern will favor normal to above normal temperatures across most of Europe including the UK with normal to below normal temperatures limited to Northeastern Europe this period (**Figure 6**). Persistent strong ridging/positive geopotential height anomalies will remain centered over the Kara and Laptev Seas will supporting troughing/negative geopotential height anomalies

in Western Russia and East Asia this period (**Figure 5**). This pattern favors widespread normal to above normal temperatures across most of Asia including Afghanistan and Pakistan with normal to below normal temperatures Southwestern Russia and part of East Asia including Eastern Siberia this period (**Figure 6**).

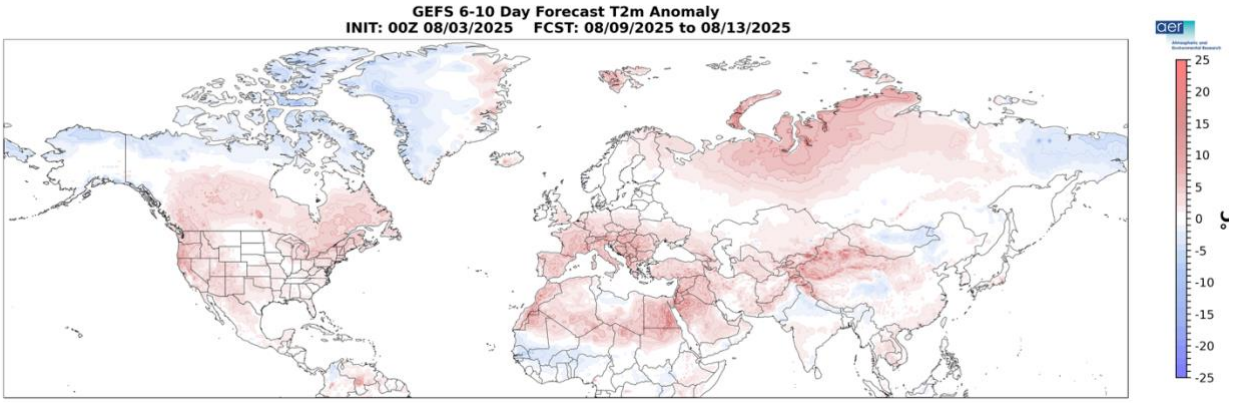

Figure 6. Forecasted surface temperature anomalies (°C; shading) from 9 Aug to 13 Aug 2025. The forecasts are from the 00Z 3 Aug 2025 GFS ensemble.

The predicted pattern across North America is widespread ridging/positive geopotential height anomalies centered over the Eastern and Western US with troughing/negative geopotential height anomalies limited to northern Alaska and Northern Canada this period (**Figure 5**). This pattern will favor widespread normal to above normal temperatures across much of Canada and much of the US with normal to below normal temperatures limited to northern Alaska and Northern Canada and maybe the US Northern Plains (**Figure 6**).

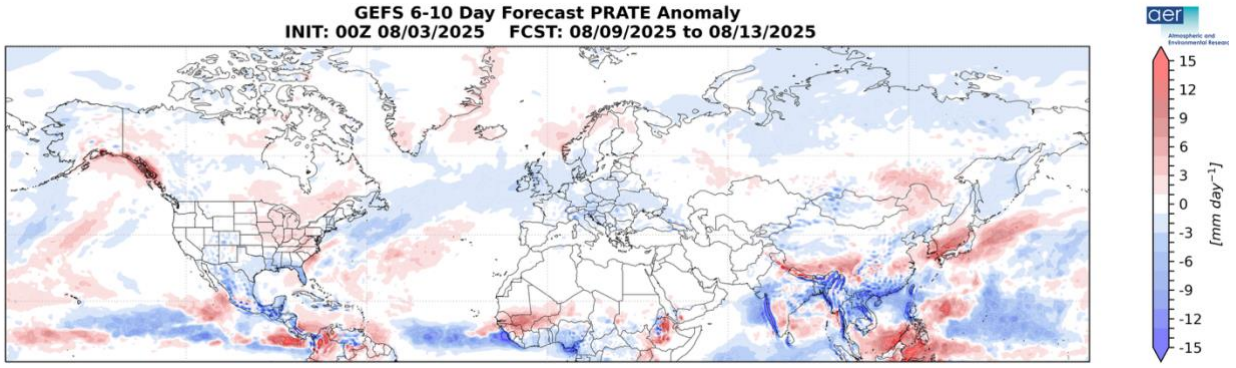

Figure 7. Forecasted precipitation rate (mm/day; shading) from 9 Aug to 13 Aug 2025. The forecasts are from the 00Z 3 Aug 2025 GFS ensemble.

Troughing will support new rainfall across northern Scandinavia, Southern Siberia, parts of Northeastern Asia, parts of Southeast Asia and the Tibetan Plateau including northern Pakistan with otherwise mostly dry conditions widespread across Europe and Asia and near normal across Afghanistan and Pakistan this period (**Figure 7**). Troughing will support new rainfall across southern Alaska, Western and Southeastern Canada and the Northeastern US with

otherwise mostly dry conditions widespread across Canada and the Western US this period (**Figure 7**).

Mid Term

Week Two

With predicted persistent mostly mixed to positive geopotential height anomalies across the Arctic and mixed geopotential height anomalies across the mid-latitudes this period (**Figure 8**), the AO will likely remain neutral to slightly negative this period (**Figure 1**). With predicted weak but mostly negative pressure/geopotential height anomalies across Greenland (**Figure 8**), the NAO will likely be positive this period.

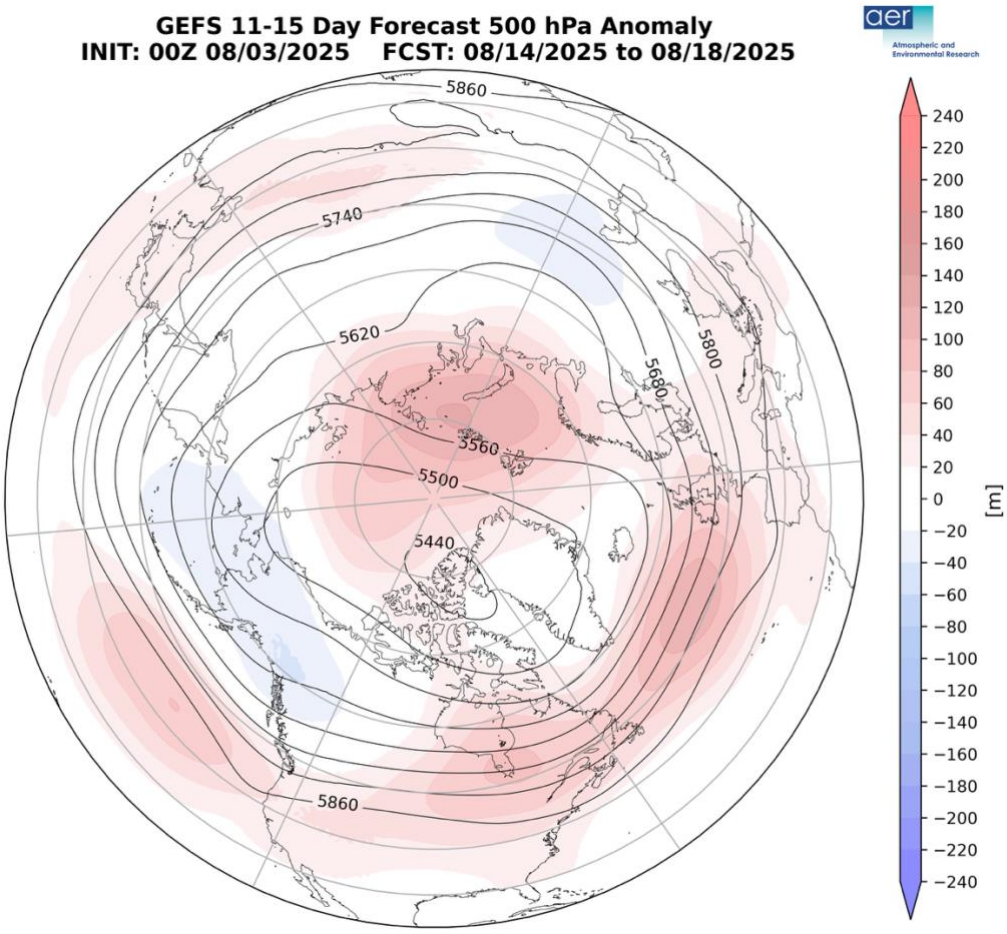

Figure 8. Forecasted average 500 mb geopotential heights (dam; contours) and geopotential height anomalies (m; shading) across the Northern Hemisphere from 14 Aug to 18 Aug 2025. The forecasts are from the 00Z 3 Aug 2025 GFS ensemble.

Persistent troughing/negative geopotential height anomalies across Greenland will support widespread ridging/positive geopotential height anomalies across Europe this period (**Figure 8**).

This zonal pattern should favor normal to above normal temperatures across much of Europe including the UK this period (**Figures 9**). Persistent ridging/positive geopotential height anomalies are predicted to persist centered in the Kara and Laptev Seas will support weak troughing/negative geopotential height anomalies centered on the Urals and Eastern Siberia with ridging/positive geopotential height anomalies across Central, Eastern and Southern Asia this period (**Figure 8**). The predicted pattern favors limited normal to below normal temperatures across Western Russia, western Kazakhstan, Eastern Siberia and northern India with normal to above normal temperatures across Central, Southern and Eastern Asia including Pakistan and Afghanistan with this period (**Figure 9**).

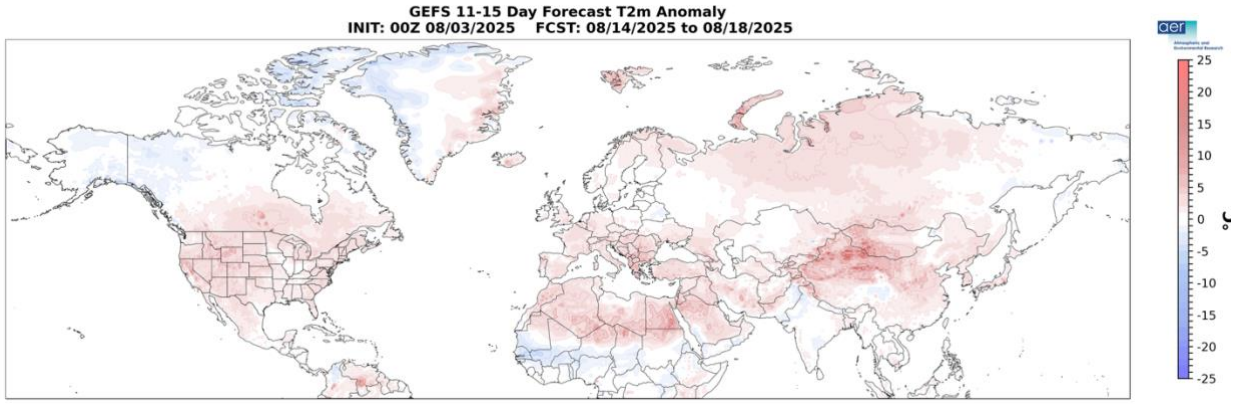

Figure 9. Forecasted surface temperature anomalies (°C; shading) from 14 Aug to 18 Aug 2025. The forecasts are from the 00Z 3 Aug 2025 GFS ensemble.

Ridging/positive geopotential height anomalies, centered over James Bay, are predicted to dominate much of North America with troughing/negative geopotential height anomalies across Alaska this period (**Figure 8**). This pattern supports widespread normal to above normal temperatures across Eastern Canada and the US with normal to below normal temperatures across Alaska and Western Canada this period (**Figure 9**).

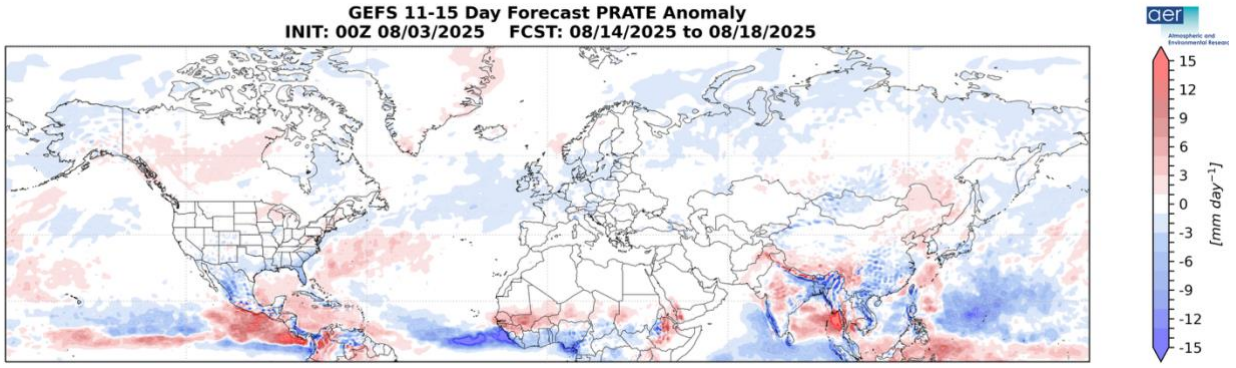

Figure 10. Forecasted precipitation rate (mm/day; shading) from 14 Aug to 18 Aug 2025. The forecasts are from the 00Z 3 Aug 2025 GFS ensemble.

Troughing will support new rainfall across Southeastern Siberia, parts of Northeast Asia, Northern India, Pakistan and the Tibetan Plateau with otherwise mostly dry conditions widespread across Europe and Asia and near normal precipitation in Afghanistan this period (**Figure 10**). Troughing will support new rainfall across Northern Canada and parts of the US Upper Midwest with otherwise mostly dry conditions widespread across Canada and the US this period (**Figure 10**).

Longer Term

30–day

The latest plot of the polar cap geopotential height anomalies (PCHs) currently shows cold/negative PCHs in the upper stratosphere with warm/positive PCHs in the lower stratosphere and upper troposphere and near normal PCHs in the lower troposphere (**Figure 11**). The cold/negative PCHs are predicted to persist in the stratosphere over the next two weeks with warm/positive PCHs weakening in the lower stratosphere and upper troposphere but also descending to the surface in mid-August.

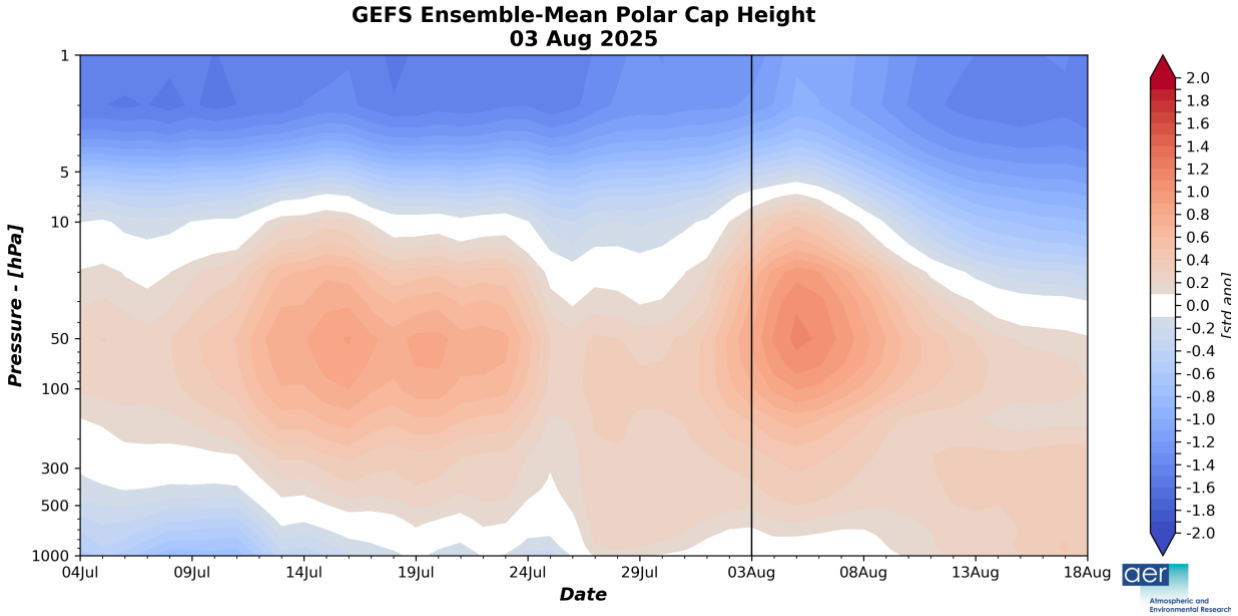

Figure 11. Observed and predicted daily polar cap height (i.e., area-averaged geopotential heights poleward of 60°N) standardized anomalies. The forecast is from the 00Z 3 Aug 2025 GFS ensemble.

The predicted near normal PCHs in the lower troposphere this week (**Figure 11**) are consistent with the predicted neutral to positive surface AO this week (**Figure 1**). Then heading towards mid-month, the predicted increasing warm/positive PCHs in the lower troposphere (**Figure 11**) should start to bias the surface AO negative (**Figure 1**).

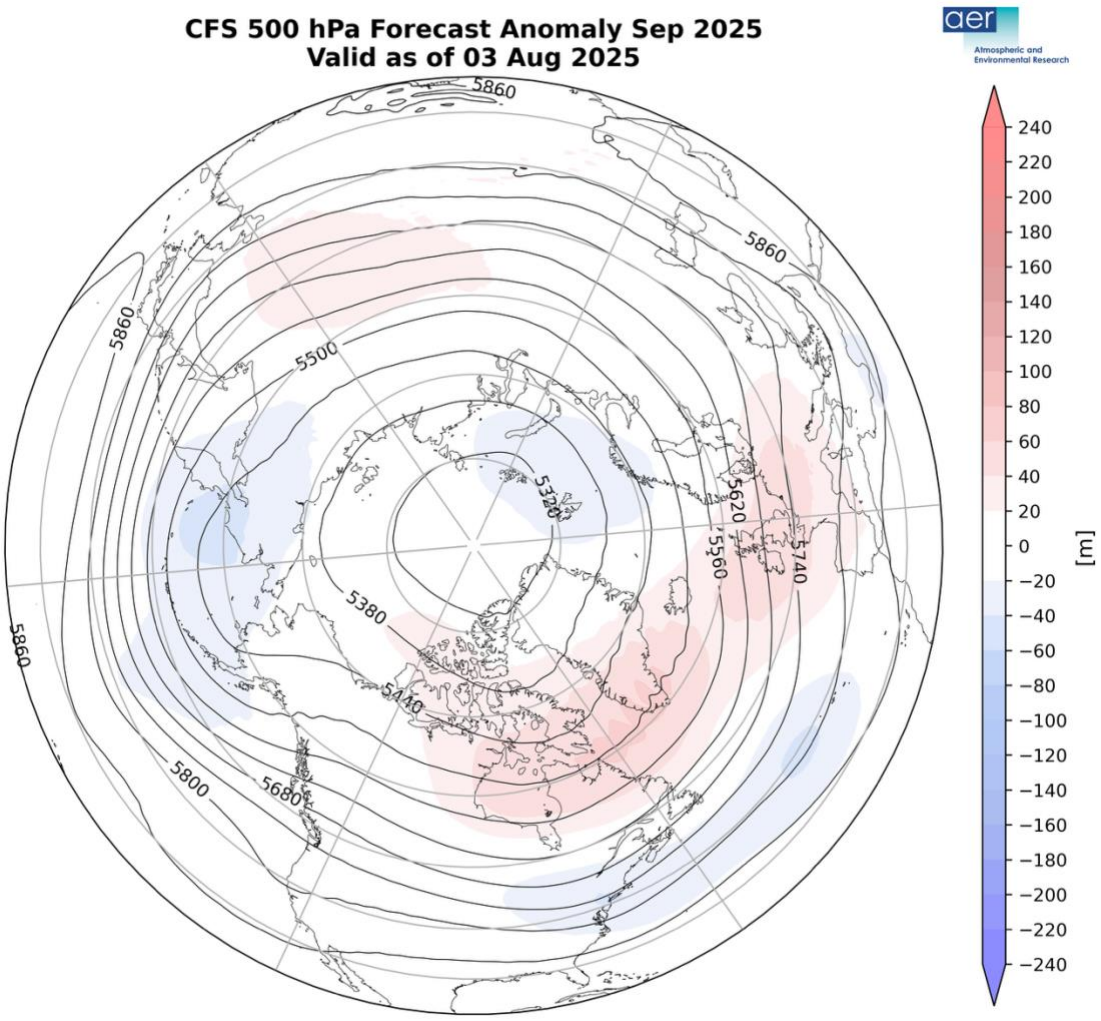

Figure 12. Forecasted average 500 mb geopotential heights (dam; contours) and geopotential height anomalies (m; shading) across the Northern Hemisphere for September 2025. The forecasts are from the 00Z 3 Aug 2025 CFS.

I include in this week's blog the monthly 500 hPa geopotential heights (**Figure 12**) and surface temperatures for September (**Figure 13**) from the Climate Forecast System (CFS; the plots represent yesterday's four ensemble members). The forecast for the troposphere is ridging centered over Western Europe, Eastern Asia and Baffin Bay, with troughing across the Eastern Mediterranean, from Eastern Siberia across the Dateline and into Alaska and the Eastern US (**Figure 12**). This pattern favors seasonable to relatively warm temperatures across Western and Central Europe, much of Asia, including Central Asia and the Tibetan Plateau, Pakistan, Afghanistan, much of Canada and the Western US with seasonable to relatively cool temperatures across Eastern Europe, the Eastern Mediterranean, Western Russia, Kazakhstan, Eastern Siberia, Eastern Siberia, Alaska and the Eastern US (**Figure 13**).

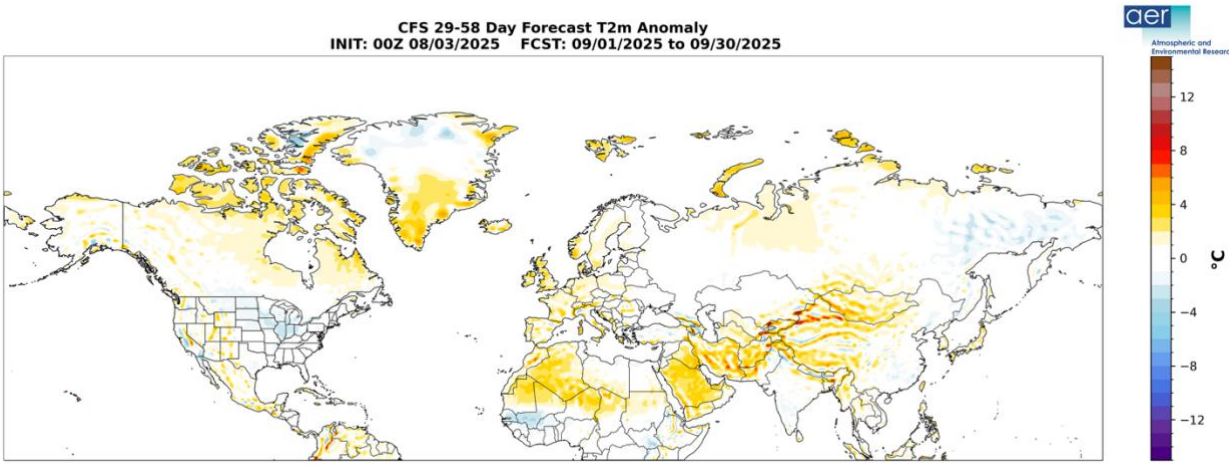

Figure 13. Forecasted average surface temperature anomalies (°C; shading) across the Northern Hemisphere for September 2025. The forecasts are from the CFS 00Z 3 Aug 2025.

Boundary Forcings

SSTs/El Niño/Southern Oscillation

Equatorial Pacific sea surface temperatures (SSTs) anomalies are now slightly below normal, east of the Dateline (**Figure 14**) consistent with neutral conditions but suggestive that La Niña could return once again this winter. Warming of SSTs along the equator near South America are suggestive of an emerging El Niño but for now is not predicted. Instead, current forecasts show large spread and plenty of uncertainty and mostly favor a continuation of neutral conditions. Observed SSTs across the NH remain well above normal especially in the central North Pacific centered on the Dateline and the western North Pacific and much of the North Atlantic with the exception near the Canadian Maritimes and the Northeastern US and extending south of Iceland, though below normal SSTs exist regionally especially in the South Pacific.

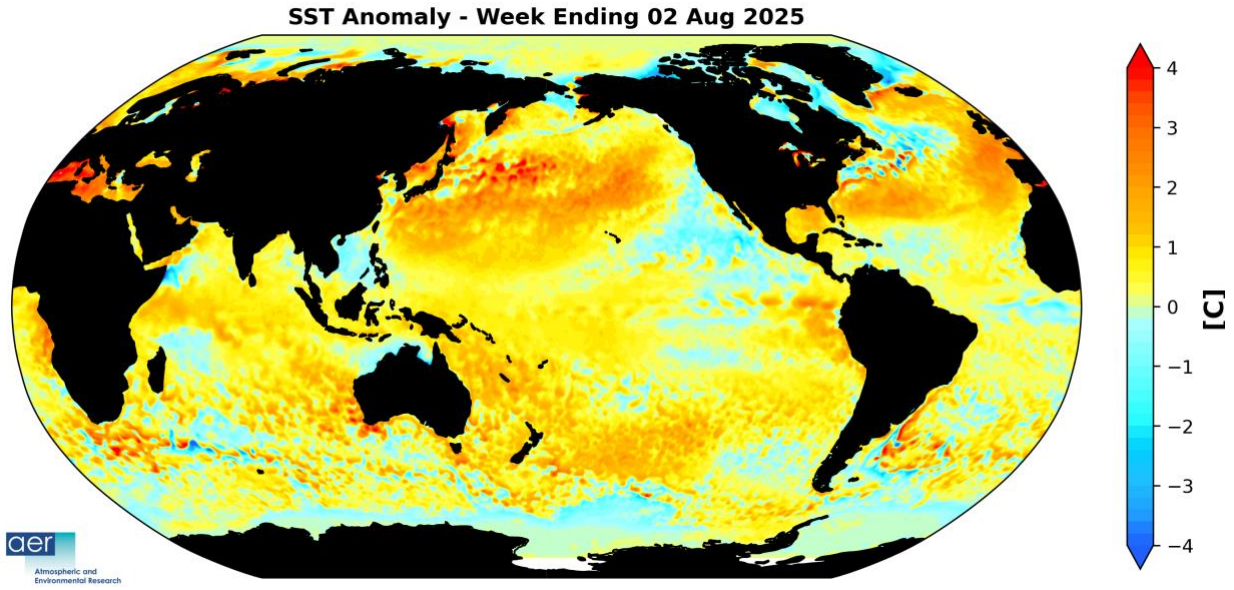

Figure 14. The latest daily-mean global SST anomalies (ending 2 Aug 2025). Data from NOAA OI High-Resolution dataset.

Madden Julian Oscillation

Currently the Madden Julian Oscillation (MJO) is in phase one and is predicted to weaken to where no phase is favored (**Figure 15**). Phase one favors ridging on both coasts of North America with troughing in Western Canada, therefore, it seems to me that the MJO is having some influence on North American weather for the next two weeks. But admittedly this is outside of my expertise.

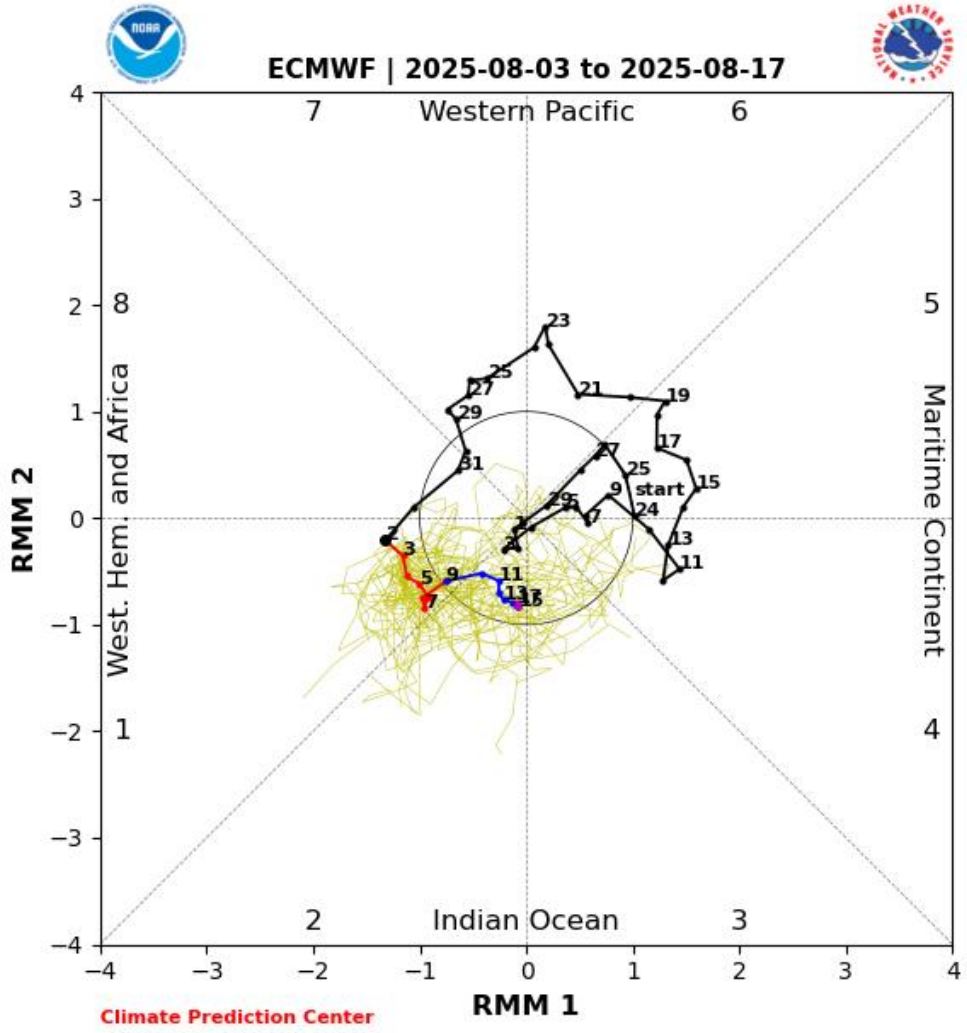

Figure 15. Past and forecast values of the MJO index. Forecast values from the 00Z 3 Aug 2025 ECMWF model. Yellow lines indicate individual ensemble-member forecasts, with the green line showing the ensemble-mean. A measure of the model 'spread' is denoted by the gray shading. Sector numbers indicate the phase of the MJO, with geographical labels indicating where anomalous convection occurs during that phase. Image source https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/CLIVAR/ecmf.shtml

Atmospheric and Environmental Research

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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. 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.

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