

June 21, 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 neutral and is predicted to trend negative to strongly negative for this time of year over the next week and then reverse and trend positive towards neutral but remain negative over the next two weeks.
- The current neutral AO is reflective of mixed pressure/geopotential height anomalies across the Arctic and mixed pressure/geopotential height anomalies across the mid-latitudes. The North Atlantic Oscillation (NAO) is neutral to slightly negative as weakly positive pressure/geopotential height anomalies are spread across most of Greenland and is predicted to remain mostly negative over the next two weeks.
- Ridging/positive geopotential height anomalies are predicted to dominate Europe much of next week. However, troughing/negative geopotential height anomalies

initially from the east centered over the Barents Kara Seas are predicted to spread across Northern Europe suppressing the ridging to Southern Europe. This pattern favors normal to above temperatures across much of Europe for next week (something that I will get to enjoy in person!) but with temperatures returning to more seasonable levels as heights fall across Northern Europe including the United Kingdom (UK). Across Southern Europe warm temperatures are predicted to persist due to continuous ridging over the next two weeks with the exception of Portugal and Western Spain, which will experience a more relatively cool, maritime flow of air.

- Ridging/positive geopotential height anomalies with relatively warm temperatures are predicted to dominate much of Central Asia with troughing/negative geopotential height anomalies with normal to below normal temperatures in northwestern Asia and far Northeast Asia over the next two weeks.
- Currently troughing/negative geopotential height anomalies with relatively cool temperatures dominate the Northern United States (US) and Southern Canada with ridging/positive geopotential height anomalies and relatively warm temperatures across northern North America and the Southern US. However, the forecast is for above normal geopotential heights and relatively warm temperatures to become more widespread over the next two weeks. One exception is a trough and accompanying cool temperatures that is predicted to remain in the Pacific Northwest through the end of June and then hop over to the Northeastern US in early July.
- In the Impacts section I continue to discuss my thoughts about the long streak of high latitude blocking.

Impacts

Even though two weeks have passed since the previous blog, I don't feel that I have much new and profound to discuss that is different. Now we are in late June and there are still no signs of the positive tropospheric polar cap geopotential heights (PCHs) waning and disappearing. In fact the high latitude blocking predicted for late June is impressive for any time of year but especially for the summer. And with the warm/positive tropospheric PCHs continuing to show strong persistence, it is still not obvious to me what other than synoptic or internal variability can reverse the warm/positive PCHs to cold/negative PCHs. I feel that the probability of a summer characterized by a negative AO and warm tropospheric PCHs has only increased. A negative AO/NAO and Greenland blocking continue to favor seasonable to cool temperatures in the Northeastern US and Western Europe. Western Europe will experience a spike in temperatures next week, but I believe this to be transient. High latitude blocking could also favor troughing and relatively cool temperatures in parts of Northeast Asia.

I think the best two periods for a breakdown in the pattern are early July and early August. But as long as high latitude blocking persists especially near Greenland, the Northeastern US and Western Europe are at risk for below normal temperatures. Also, this could exacerbate melting of land ice on Greenland and sea ice in the Arctic.

Near Term Conditions

1-5 day

The AO is currently neutral and is predicted to trend strongly negative over the next week (**Figure 1**) with mostly positive geopotential height anomalies across the Arctic with mixed geopotential height anomalies across the mid-latitudes of the NH (**Figure 2**). And with positive geopotential height anomalies across Greenland and Iceland (**Figure 2**), the NAO will likely be negative this week as well.

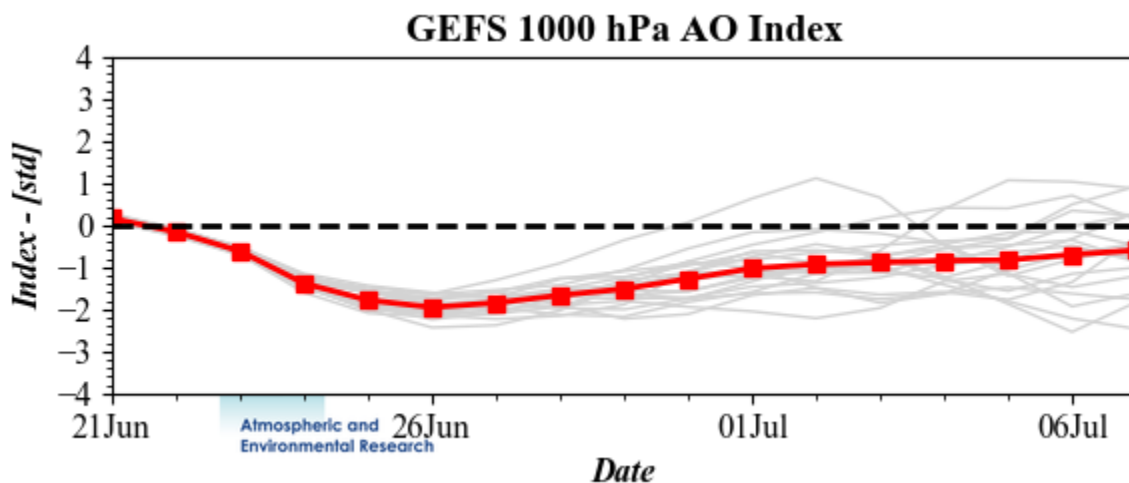


Figure 1. The predicted daily-mean AO at 10 hPa from the 00Z 21 June 2019 GFS ensemble. Gray lines indicate the AO index from each individual ensemble member, with the ensemble-mean AO index given by the red line with squares.

Ridging/positive geopotential height anomalies centered over Central Europe will dominate much of Europe with troughing/negative geopotential height anomalies limited to Northern Scandinavia (**Figure 2**). This pattern is predicted to result in normal to above normal temperatures across much of Europe including the UK except for normal to below temperatures across Northern Scandinavia (**Figure 3**). Mid-tropospheric troughing in the eastern North Atlantic (**Figure 2**) is also predicted to bring cool temperatures to Portugal and Western Spain (**Figure 3**). Much of Asia will be dominated by ridging/positive geopotential height anomalies with the exception of troughing/negative geopotential height anomalies for the Urals and parts of Northeast Asia (**Figure 2**). This is predicted to yield normal to above normal temperatures for

much of Asia including the Middle East and Southeast Asia and normal to below normal temperatures for the Urals and far Northeast Asia (**Figure 3**).

GEFS 1-5 Day Forecast 500 mb GPH/GPH Anomaly
INIT: 00Z 06/21/19 FCST: 06/22/19 to 06/26/19

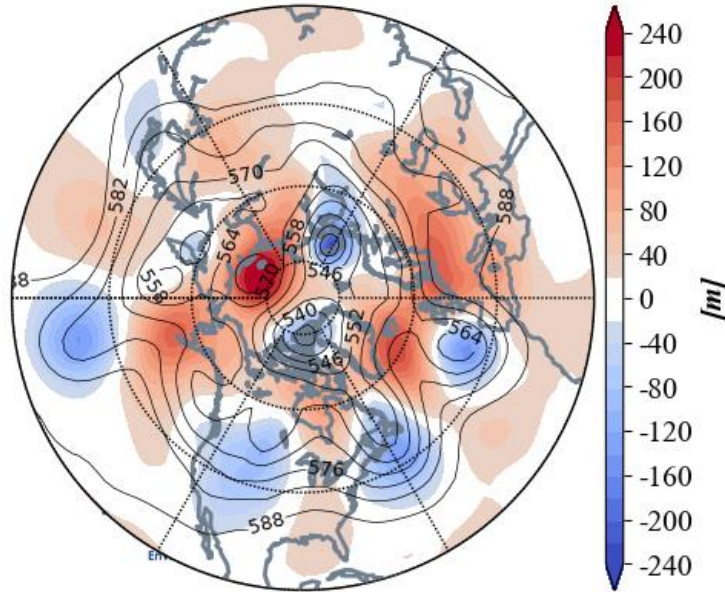


Figure 2. Forecasted average 500 mb geopotential heights (dam; contours) and geopotential height anomalies (m; shading) across the Northern Hemisphere from 22 – 26 June 2019. The forecasts are from the 21 June 00z GFS ensemble.

Ridging/positive geopotential height anomalies across Alaska and the Gulf of Alaska and stretching across Northern Canada are predicted to force troughing/negative geopotential height anomalies downstream across the Western US while ridging/positive geopotential height anomalies across Greenland favor troughing/negative geopotential height anomalies in the Northeastern US (**Figure 2**). This pattern is predicted to bring normal to below normal temperatures in Southwest Canada, the Western US and the Northeastern US with normal to above normal temperatures for Alaska, the Southeastern US and Northern Canada (**Figure 3**).

GEFS 1-5 Day Forecast T2m Anomaly
INIT: 00Z 06/21/19 FCST: 06/22/19 to 06/26/19

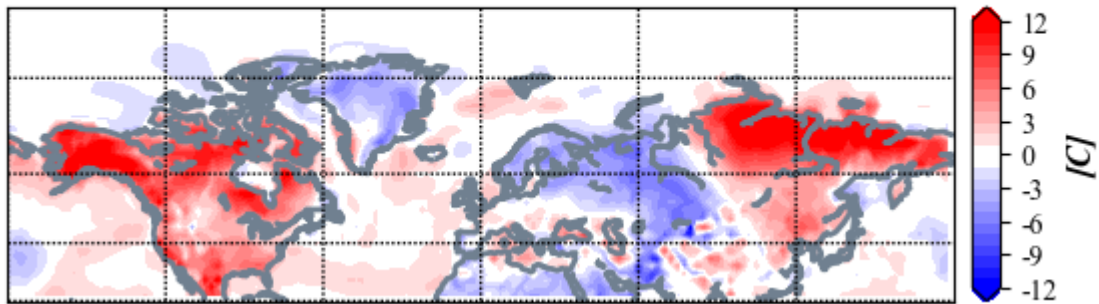


Figure 3. Forecasted surface temperature anomalies ($^{\circ}\text{C}$; shading) from 22 – 26 June 2019. The forecast is from the 00Z 21 June 2019 GFS ensemble.

Much of Eurasia is predicted to receive below normal precipitation (**Figure 4**). Troughing is predicted to bring above normal rainfall to the Balkans, East Asia and the Eastern US (**Figure 4**).

GEFS 1-5 Day Forecast PCP Anomaly
INIT: 00Z 06/21/19 FCST: 06/22/19 to 06/26/19

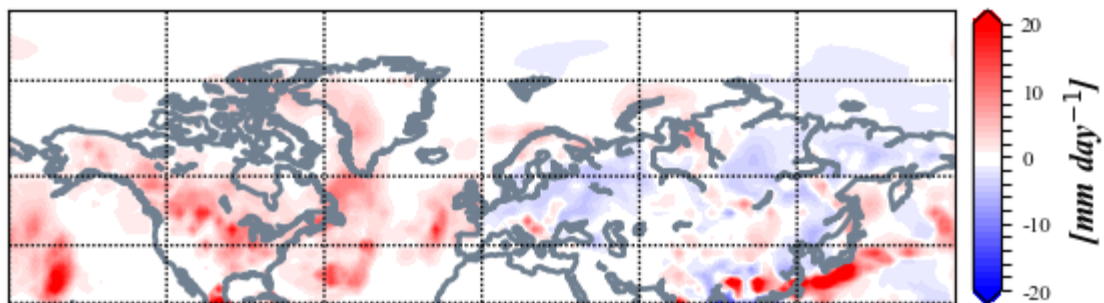


Figure 4. Forecasted rainfall anomalies (mm/day; shading) from 22 – 26 June 2019. The forecast is from the 00Z 21 June 2019 GFS ensemble.

Mid-Term

6-10 day

The AO is predicted to remain negative through the end of next week and into early of the following week (**Figure 1**) as positive geopotential height anomalies remain widespread across the Arctic with mixed geopotential height anomalies across the mid-latitudes of the NH (**Figure 5**). And with persistent positive geopotential height anomalies across Greenland (**Figure 5**), the NAO will likely remain negative as well.

GEFS 6-10 Day Forecast 500 mb GPH/GPH Anomaly
INIT: 00Z 06/21/19 FCST: 06/27/19 to 07/01/19

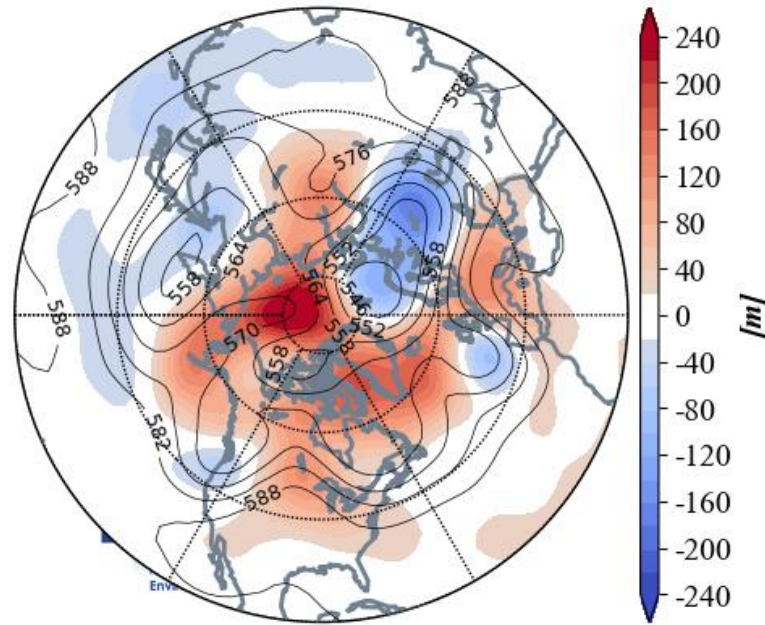


Figure 5. Forecasted average 500 mb geopotential heights (dam; contours) and geopotential height anomalies (m; shading) across the Northern Hemisphere from 27 June – 1 July 2019. The forecasts are from the 21 June 00z GFS ensemble.

Ridging/positive geopotential height anomalies are predicted to continue to dominate Europe this period. However, troughing/negative geopotential height anomalies across the Urals will start to expand to the west across Scandinavia and the Baltic States (**Figure 5**). This pattern is predicted to result in normal to above normal temperatures across much of Europe except for normal to below normal temperatures across much of Europe including the UK, with normal to below normal temperatures across Scandinavia and the Baltic States (**Figure 6**). Cool temperatures are possible again across Portugal (**Figure 6**) due to proximity of continuing mid-tropospheric troughing in the eastern North Atlantic (**Figure 5**). Ridging/positive geopotential height anomalies are predicted to dominate Asia with the exception of relatively deep troughing/negative geopotential height anomalies in Western Russia and East Asia (**Figure 5**). This is predicted to yield widespread normal to above normal temperatures for much of Asia including the Middle East and Southeast Asia with normal to below normal temperatures across Western Russia and parts of Northeast Asia (**Figure 6**).

GEFS 6-10 Day Forecast T2m Anomaly
INIT: 00Z 06/21/19 FCST: 06/27/19 to 07/01/19

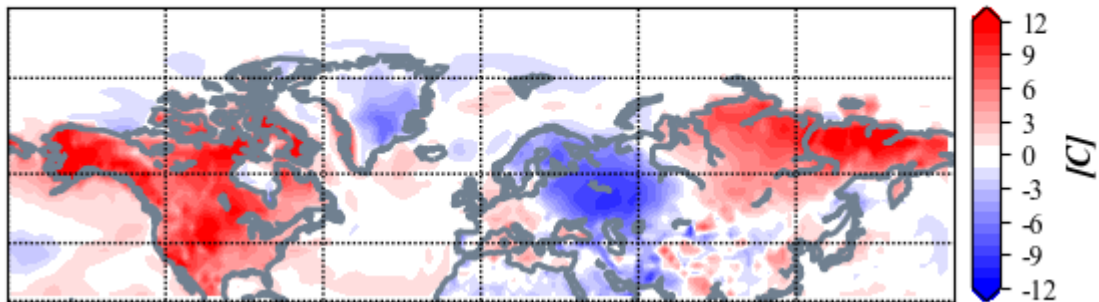


Figure 6. Forecasted surface temperature anomalies ($^{\circ}\text{C}$; shading) from 27 June – 1 July 2019. The forecasts are from the 00Z 21 June 2019 GFS ensemble.

Ridging/positive geopotential height anomalies over Greenland are predicted to favor troughing/negative geopotential height anomalies over the Northeastern US while ridging/positive geopotential height anomalies across Alaska and into the Beaufort Sea are predicted to favor troughing/negative geopotential height anomalies in the Western US this period (**Figure 5**). In between the two troughs along the coasts, strong ridging is predicted in the Central US (**Figure 5**). This pattern is predicted to bring normal to above normal temperatures across Alaska, much of Canada and the Central US with normal to below normal temperatures for the Western US and parts of the Northeastern US (**Figure 6**).

GEFS 6-10 Day Forecast PCP Anomaly
INIT: 00Z 06/21/19 FCST: 06/27/19 to 07/01/19

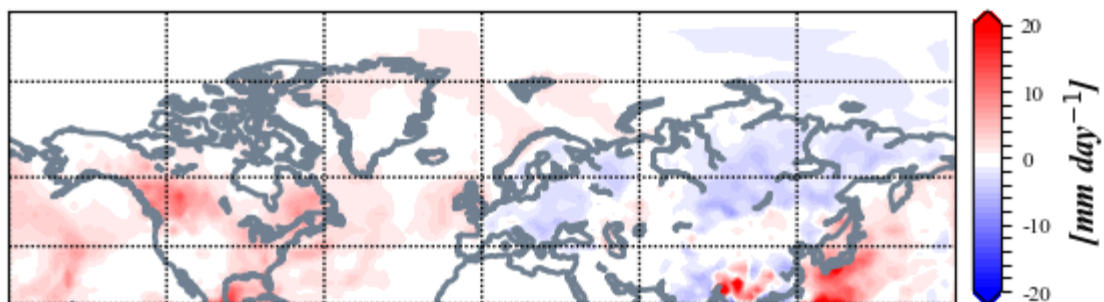


Figure 7. Forecasted rainfall anomalies (mm/day; shading) from 27 June – 1 July 2019. The forecasts are from the 00Z 21 June 2019 GFS ensemble.

Much of Eurasia is predicted to receive below normal precipitation (**Figure 7**). Troughing is predicted to bring above normal rainfall to East Asia, the Pacific Northwest, Southwestern Canada and the Eastern US (**Figure 7**).

11-15 day

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

GEFS 11-15 Day Forecast 500 mb GPH/GPH Anomaly
INIT: 00Z 06/21/19 FCST: 07/02/19 to 07/06/19

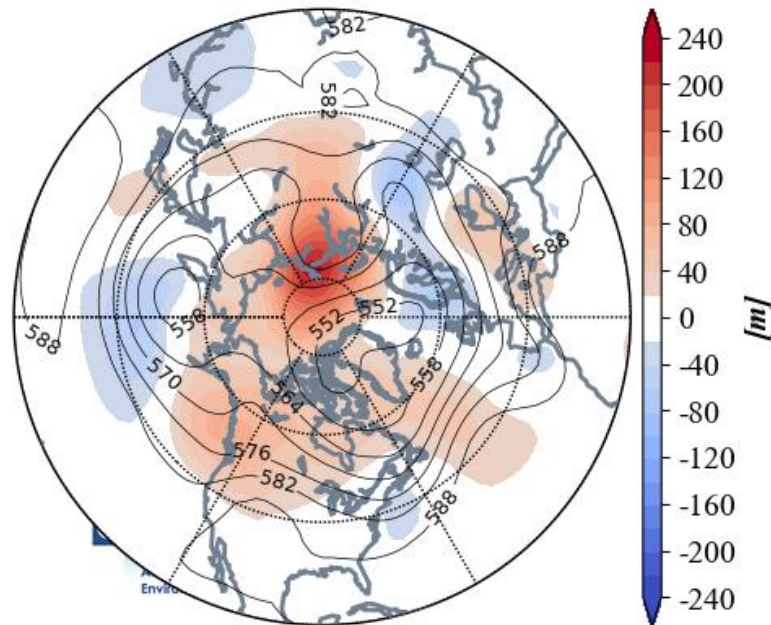


Figure 8. Forecasted average 500 mb geopotential heights (dam; contours) and geopotential height anomalies (m; shading) across the Northern Hemisphere from 2 – 6 July 2019. The forecasts are from the 21 June 00z GFS ensemble.

Trouging/negative geopotential height anomalies previously confined to the Urals is predicted to continue spreading to the west across all of Northern Europe with ridging/positive geopotential height anomalies confined to Southern Europe (**Figure 8**). This pattern is predicted to result in seasonable to below normal temperatures for most of Northern Europe including the UK and normal to above normal temperatures over Southern Europe (**Figure 9**). Persistent troughing in the eastern North Atlantic (**Figure 8**) is predicted to bring seasonable to cool temperatures to Portugal and Western Spain (**Figure 9**). Ridging/positive geopotential height anomalies are predicted to dominate Central Asia this period with troughing/negative geopotential height anomalies in Western Russia, Western Kazakhstan and Northeast Asia (**Figure 8**). This pattern favors normal to above normal temperatures for most of Asia including Southeast Asia and the Middle East with normal to below normal temperatures in Western Russia, Western Kazakhstan and Northeast Asia (**Figure 9**).

GEFS 11-15 Day Forecast T2m Anomaly
INIT: 00Z 06/21/19 FCST: 07/02/19 to 07/06/19

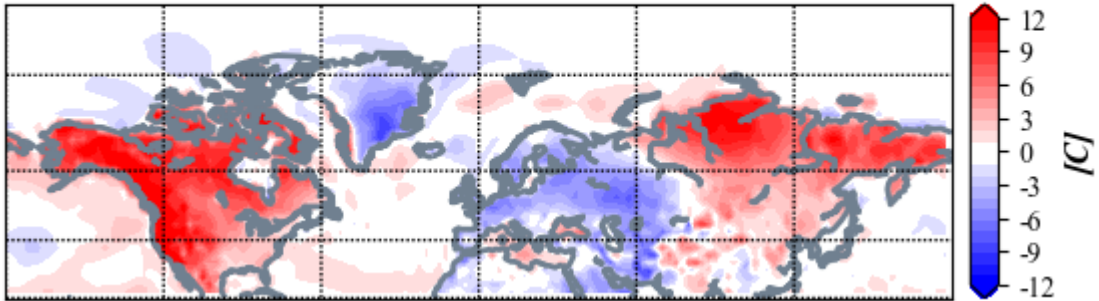


Figure 9. Forecasted surface temperature anomalies ($^{\circ}\text{C}$; shading) from 2 – 6 July 2019. The forecasts are from the 00Z 21 June 2019 GFS ensemble.

Ridging/positive geopotential height anomalies are predicted to dominate much of North America with troughing/negative geopotential height anomalies confined to the Northeastern US (**Figure 8**). This will favor normal to above normal temperatures across Alaska, much of Canada and the Western US with normal to below normal temperatures for the Northeastern US (**Figure 9**).

GEFS 11-15 Day Forecast PCP Anomaly
INIT: 00Z 06/21/19 FCST: 07/02/19 to 07/06/19

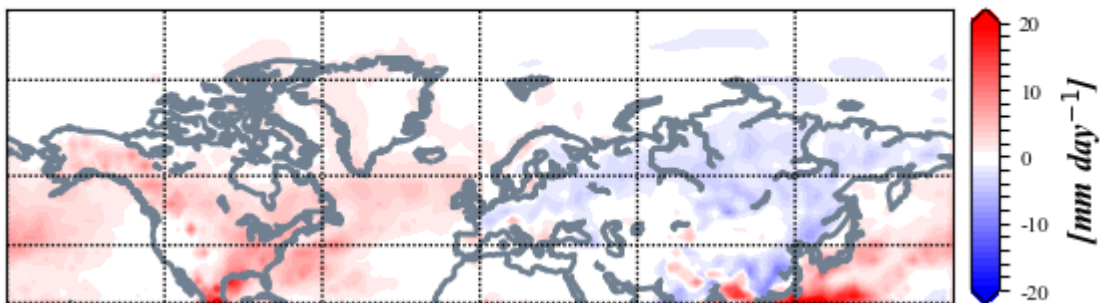


Figure 10. Forecasted rainfall anomalies (mm/day ; shading) from 2 – 6 July 2019. The forecasts are from the 00Z 21 June 2019 GFS ensemble.

Much of Eurasia is predicted to receive below normal precipitation as ridging dominates the continent (**Figure 10**). Troughing is predicted to bring above normal rainfall to Spain, East Asia and the Northeastern US (**Figure 10**).

Longer Term

30-day

The latest plot of the polar cap geopotential heights (PCHs) shows currently normal to below normal PCHs in the stratosphere and above normal PCHs throughout the troposphere (**Figure 11**). In the lowest troposphere PCHs are above normal, consistent with a negative AO (**Figure 1**).

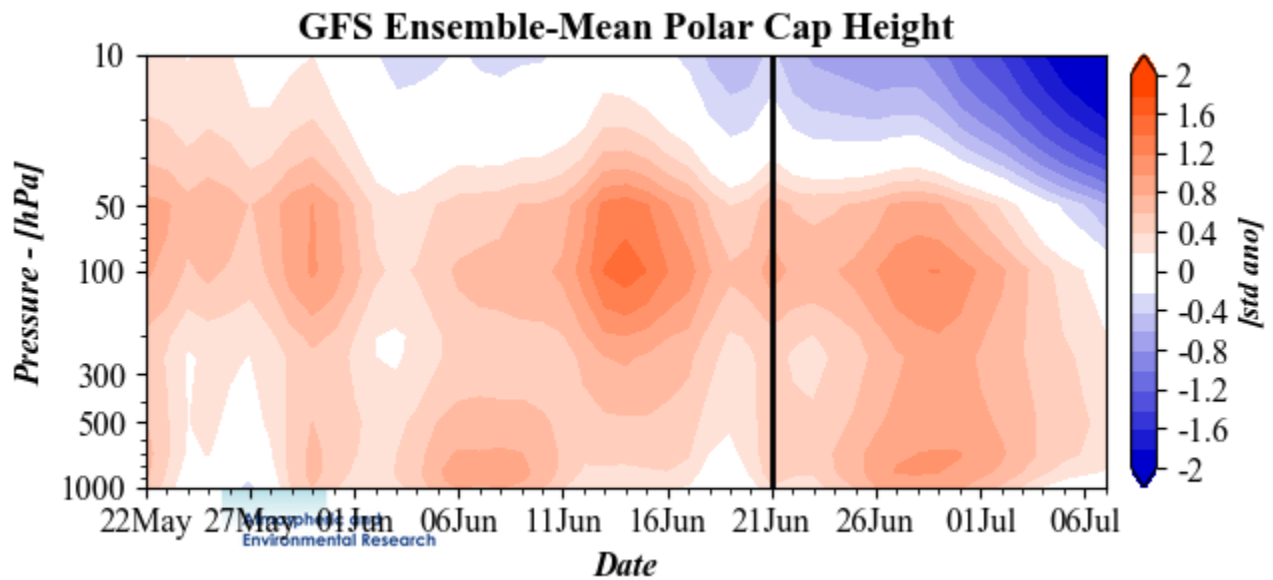


Figure 11. Observed and predicted daily polar cap height (i.e., area-averaged geopotential heights poleward of 60°N) standardized anomalies. The forecasts are from the 00Z 21 June 2019 GFS ensemble.

Positive PCHs in the mid to lower troposphere are predicted to strengthen at the end of June supporting a strongly negative AO the last week of June (**Figure 11**). The persistence of positive PCHs to the lower troposphere suggest an increased probability of high latitude blocking, which could force more troughing in the mid-latitudes. Therefore, I believe that caution is warranted for the GFS forecast of warm temperatures becoming more widespread in early July.

CFS 500 hPa Forecast Anomaly Jul 2019
Valid as of 21 Jun 2019

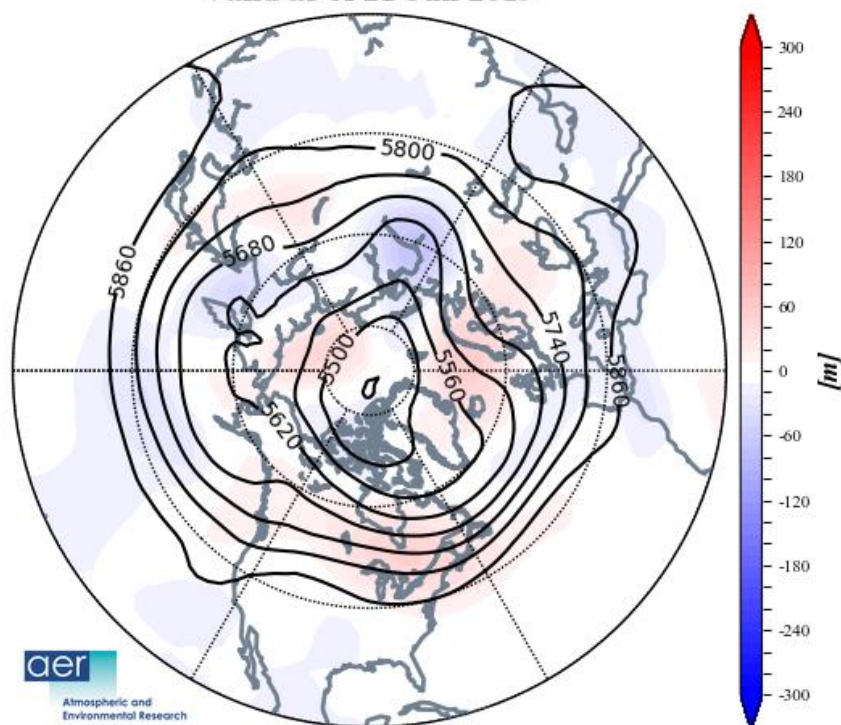


Figure 12. Forecasted average 500 mb geopotential heights (dam; contours) and geopotential height anomalies (m; shading) across the Northern Hemisphere for July 2019. The forecasts are from the 21 June 2019 CFS.

I include in this week's blog the monthly 500 hPa geopotential heights (**Figure 12**) and the surface temperatures (**Figure 13**) forecast for July from the Climate Forecast System (CFS; the plots represent yesterday's four ensemble members). The forecast for the troposphere is ridging centered across Northern Europe, Northeast Asia, the Gulf of Alaska, Eastern Canada and Greenland with troughs in Western Europe, Western Russia, Southeast Asia and the US West Coast (**Figure 12**). This pattern favors relatively cool temperatures for Western Europe, Western and Southeast Asia and possibly the Northeastern US with relatively warm temperatures for Northern Europe, Northeast Asia and much of North America (**Figure 13**).

CFS T2m Forecast Anomaly Jul 2019 Valid as of 21 Jun 2019

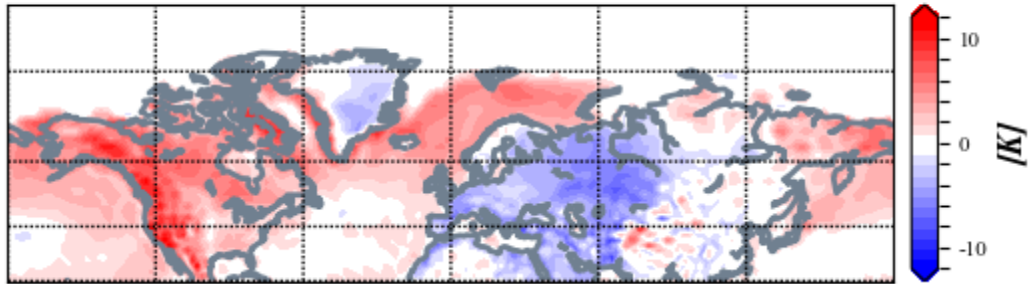


Figure 13. Forecasted average surface temperature anomalies ($^{\circ}\text{C}$; shading) across the Northern Hemisphere for July 2019. The forecasts are from the 21 June 2019 CFS.

Surface Boundary Conditions

SSTs/El Niño/Southern Oscillation

Equatorial Pacific sea surface temperatures (SSTs) anomalies remain warm and weak El Niño conditions are expected for this summer (**Figure 14**). Observed SSTs across the NH remain well above normal though below normal SSTs exist regionally.

SST Anomaly - Week Ending 19 Jun 2019

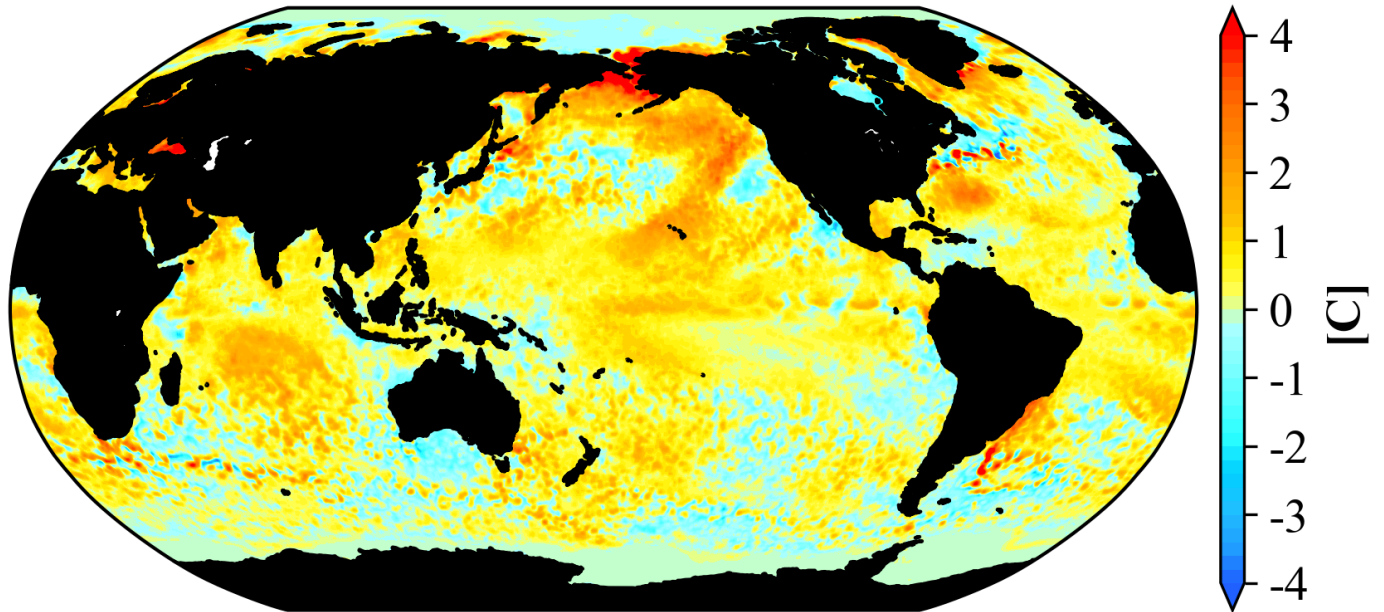


Figure 14. The latest weekly-mean global SST anomalies (ending 19 June 2019). Data from NOAA OI High-Resolution dataset.

Currently no phase of the Madden Julian Oscillation (MJO) is favored (**Figure 13**). And the forecasts are for no phase of the MJO to be favored over the next two weeks. Therefore little influence from the MJO is expected over the next two weeks.

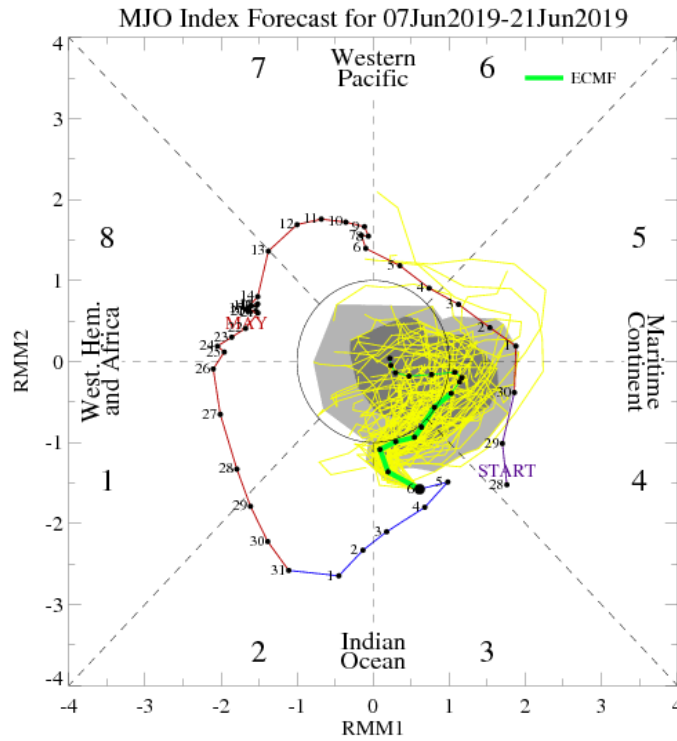


Figure 13. Past and forecast values of the MJO index. Forecast values from the 00Z 7 June 2019 ECMWF model. Yellow lines indicate individual ensemble-member forecasts, with the green line showing the ensemble-mean. A measure of the model “spread” is denoted by the gray shading. Sector numbers indicate 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>