Atmospheric Blocking in 2017: A Cold End to a Warm Year.

Last year, we introduced the topic of atmospheric blocking and the impacts these events can have on local weather and climate. Also, depending on whose data set you reference, 2017 was the second or third warmest year on record as the trend toward a warmer climate continues. In spite of the warm year, the last part of December ended up very cold over the Eastern two-thirds of North America in a manner similar to the more severe winters earlier in this decade (2013-2014, 2014-2015). The same phenomenon that led to these cold winters also created the background for the prolonged California drought from the early-to-mid-2010s.

The phenomenon is a pool of warm oceanic water in the Northeast Pacific known colloquially as "the blob" (e.g. Bond et al. 2015). The pool of warm waters generated persistent high pressure in the atmosphere within this region of the globe, and the high-pressure system (or ridge) acquired the nickname "ridiculously resilient ridge" (e.g. Pinheiro et al. 2018). While scientists do not know why "the blob" exists, we do know that long-term weather and climate are influenced strongly by the conditions of the underlying earth's surface. Since 70% of the earth's surface is water, the condition of the upper ocean has a strong impact on the jet stream. It is this air-sea interaction that allows the phenomenon of El Nino to impact the atmospheric circulation across the globe. In late 2015, "the blob" began to subside, but there are rumors that in late 2017 it is making a comeback.

For the second year in row, we perform an overview the previous year's blocking occurrences using the University of Missouri blocking event archive (http://weather.missouri.edu/gcc). We will examine the blocking year 2017 for the Northern Hemisphere (NH) and Southern Hemisphere (SH) separately, and discuss a few recent trends in blocking activity.

In the NH, the number of blocking events that occur annually has been higher since about 2000 than the previous 30 year period (1970- 1999). During 2017, 40 blocking events occurred over the entire NH, which is the same as in 2016 but a little higher than the mean early 21st century occurrences (37). The persistence of 2017 blocking events was similar to their climatological mean for early 21st century blocks (about 9 – 10 days), but, they have been a little stronger than normal this year, especially in December.

Over the Atlantic Region (80^{o} W – 40^{o} E longitude) in 2017, there were 20 blocking events that occurred and this is almost 30% more than typical for the region. It is known that the occurrence of blocking can be episodic, and 2017 featured two lengthly blocking episodes over Western Europe (France, Germany) and Scandinavia. The first was during a six-week period from mid-March to late April, and the second during September and October, leading to warmer-than-normal conditions for Western Europe (Fig.1a). These periods were also warm over much of the United Kingdom as well (*see Weather – a publication of the Royal Meteorological Society)*, but a cooler downstream over Southwest Russia. Northern Africa also experienced cooler-than-normal conditions. These locations noted above were the locus of blocking activity over the Atlantic during 2017, as 70% of the observed blocking events began in the narrow belt from 20^{o} W to 10^{o}E.

Within the Pacific Region (140^{o} E- 100^{o} W) blocking occurrence was close to the climatological normal during 2017 in their number (13) and duration (9 days). What stands out for this year is that most of these (10) occurred over the Northeast Pacific, and three of those during the last two months of the

year. One particular event (22-27 December) was very strong, and the re-emergence of the "ridiculously resilient ridge" provided the background for the prominence of the late year occurrences in the East Pacific. These conditions led to below normal temperatures over eastern North America and much warmer than normal conditions over western North America and Alaska (Fig 1b) for December. The last ten days of December, however, stand out for their severe cold over virtually all of North America (Fig. 2), and this cold period persisted into early 2018.

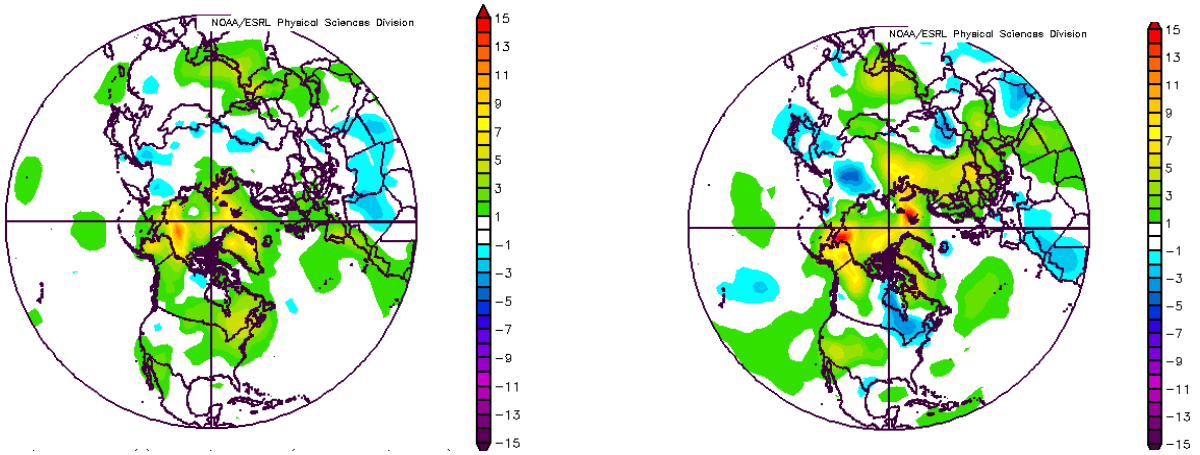

Figure 1. The Northern Hemisphere surface temperature anomaly (°C) for a) October 2017 (left), and b) December 2017 (right).

In the NH, it was the Continental Region blocking events that occurred less frequently (7) than for a typical year (10). But, their location of occurrence was not unusual for 2017. These seven blocking events occurred sporadically over the Asian Continent and none occurred over North America in 2017. The occurrence of blocking over North America is comparatively rare.

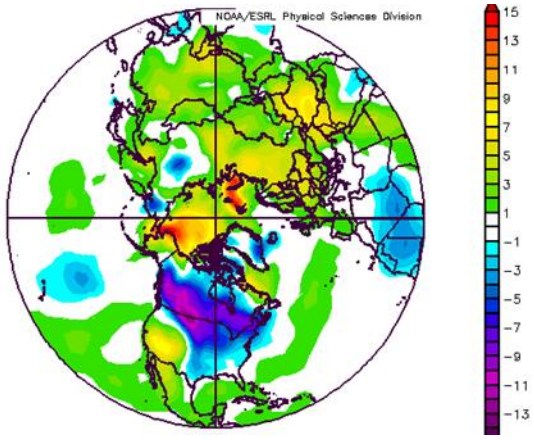

Figure 2. As in Fig 1, except for 21 – 31 December 2017.

For the SH, there were 21 events during 2017 and this is about a 30% greater frequency of occurrence over the annual climatological value (16). Weidenmann et al. (2002) demonstrated that most

blocking events occur in the South Pacific and during the months of May and June. For 2017, 16 blocking events occurred over the South Pacific, but only four occurred during the late fall (May June). Typically, the period from October to December is very quiet in the SH with respect to blocking activity. However, for this year, five events were identified during those months and most of these occurred over the Southwest Pacific and New Zealand contributing to the very warm late spring and early summer. Two very persistent events (17.5 days and 14 days respectively) occurred in the period from late November to early January and led to a balmy December down under (Fig. 3a). Most of the 2017 SH blocking events were very short in duration (five to seven days), and overall these events were a little weaker than normal.

Additionally, two short-lived events were associated with unusual ridging in the southeast Pacific during September and October 2017. This ridging led to a cooler than normal spring season for Chile and Argentina (Fig. 3b). The events of mid-September and October were also weaker than typical events for their region and season of occurrence.

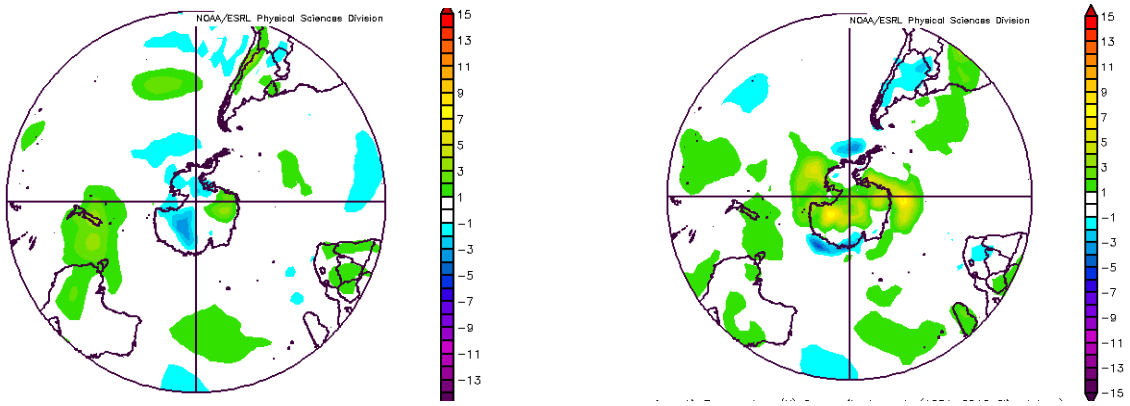

Figure 3: The Southern Hemisphere surface temperature anomaly (°C) for a) December 2017 (left), and b) October 2017 (right).

In summary, during 2017 there were 14% more blocking events globally (61) than in 2016 (53) and this difference was accounted for entirely by an increase in SH blocking occurrences. Unlike last year, when blocking events in both hemispheres made it onto the list of the top 20 strongest or persistent blocking events on record, no events were characterized as such in 2017. Also, the character of blocking events in 2017 were very consistent with those which have occurred since 2000. In the NH for 2017, blocking events were slightly stronger than normal, while SH blocking events were a little weaker than normal. Finally, blocking episodes were at least partly responsible for anomalous warm temperature conditions over Western Europe, North America, and New Zealand during 2017.

References:

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