December 2015

Introduction:

As has already been discussed in great detail, December 2015 went down as the warmest December on record, far exceeding the previous record. Average temperatures at Richmond and Norfolk were more than 10 degrees above the 1981-2010 mean. This brief review will look at teleconnections and patterns to discover why December 2015 was so warm.

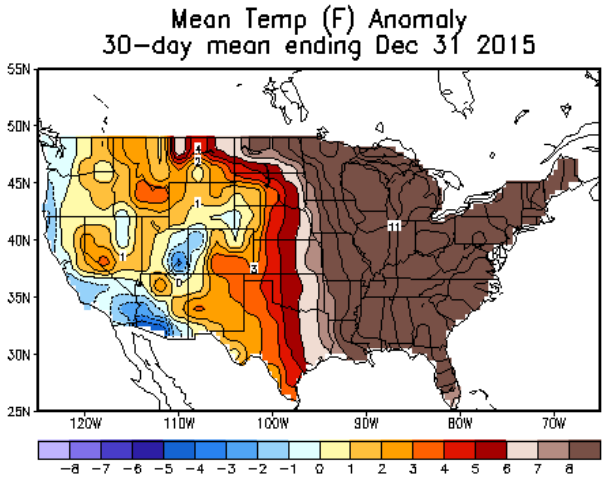

Figure 1 December 2015 Mean Temperature Anomaly (°F)

Teleconnections:

Strong El Nino conditions continued across the tropical Pacific Ocean in December. The ONI for October-November-December matched the previous high of 2.3, which was set in 1997. Sea-surface temperature anomalies in the Nino 3.4 section hovered around +2.5 to +3.0 (Figure 2). As expected with El Nino, the subtropical jet remained active as several storm systems impacted the region through the month. Rainfall amounts for the month were also above normal as there was an increase in flow of marine air into the southern U.S.

In addition to the well-advertised El-Nino conditions, other climate drivers helped impact the nation's weather through December. The first being the Arctic Oscillation (AO). The arctic oscillation is an atmospheric circulation pattern in which the pressure over the polar regions varies in opposition with that over middle latitudes (Figure 3). When the pressure is low in the Arctic and high in the mid-latitudes, the AO is in its positive phase. When the pressure is high in the Arctic and low in the mid-latitudes, the AO is in its negative phase. A strongly negative phase of the Arctic Oscillation brings warm weather to high latitudes, and cold, stormy weather to the more temperate regions where people live. The AO was generally positive in December, rising sharply by mid-December. This trapped the cold arctic air well north of the region.

The North Atlantic Oscillation (NAO) also had a hand in the December pattern. The positive phase of the NAO reflects below-normal heights across the high latitudes of the North Atlantic and above-normal heights and pressure over the central North Atlantic and the eastern United States (Figure 4). The negative phase reflects an opposite pattern of height anomalies over these regions. Both phases of the NAO affect the location and intensity of the jet stream and the resultant storm track. As the index indicates, the NAO stayed in the positive phase through the month. Strong positive phases of the NAO tend to be associated with above-average temperatures in the eastern United States.

In summary, three prominent teleconnection patterns came together in the right phases to result in record warmth across much of the eastern United States, including the Wakefield forecast area. More information on El-Nino and other teleconnection patterns can be found at the Climate Prediction Center. (www.cpc.ncep.noaa.gov)

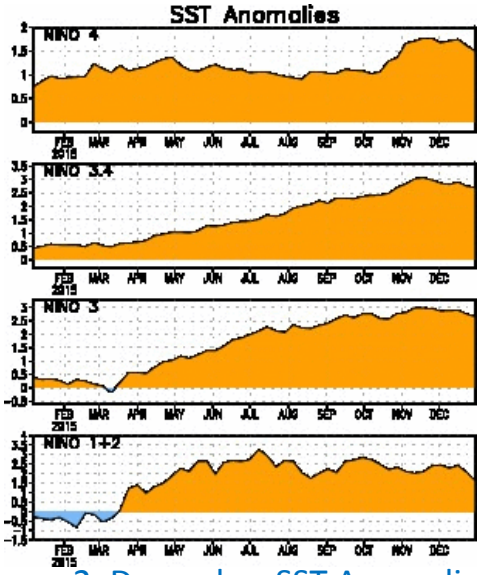

Figure 2: December SST Anomalies

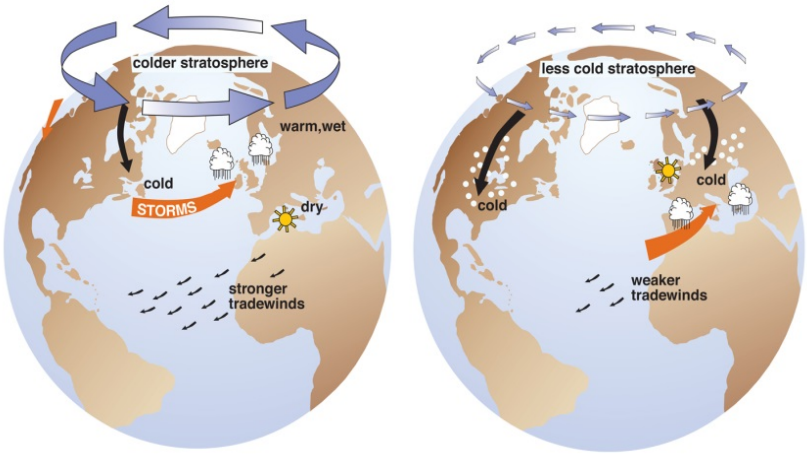

Figure 3: Arctic Oscillation Pattern

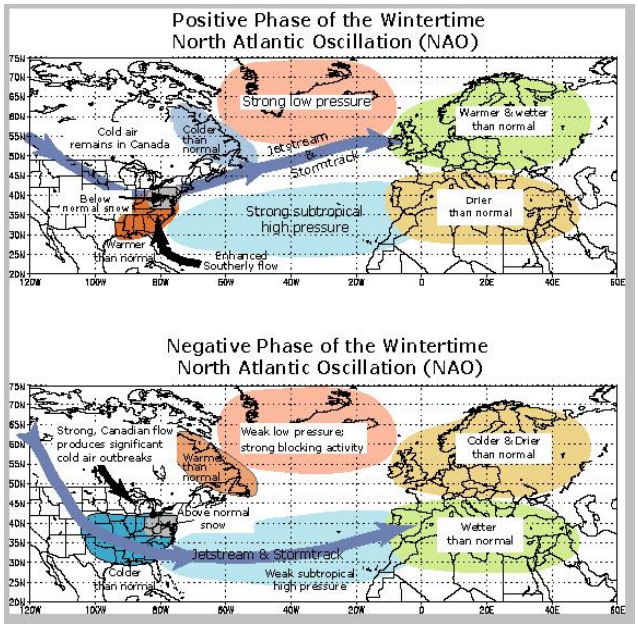

Figure 4: North Atlantic Oscillation Pattern

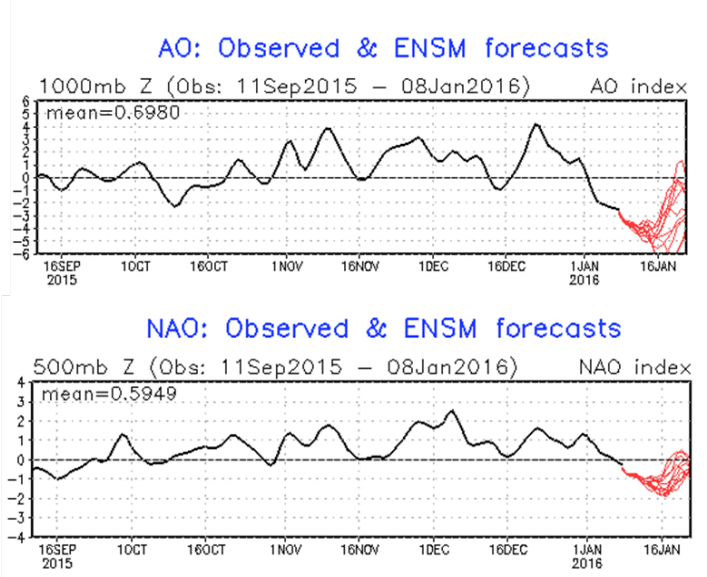

Figure 5: AO and NAO Observations

Synoptic Pattern:

While the teleconnection patterns tell us about the synoptic patterns, we'll still take a look at the anomalies over the continental United States. Starting at the top of the atmospheric funnel, the Northern Hemispheric 250mb zonal winds indicate strong positive wind anomalies over the Gulf of Alaska into northern California (Figure 6). Another area of strong positive wind anomalies is visible over eastern Canada. Closer to home, strong negative height anomalies are visible over the southeast U.S. Weak upper level winds over the western Atlantic was a sign of anomalous heights in the mid-levels. This can be seen in the 500mb height mean (Figure 7). A persistent ridge of high pressure remained anchored over the western Atlantic throughout much of the month. This resulted in extended periods of southwesterly flow aloft and positive height anomalies across the east. This can be seen in the 500mb height anomalies (Figure 8). The highest anomalies were observed over New England, with low height anomalies visible over the west. This is a sign of a +AO. This pattern is also reflected at 850mb. Temperatures were anomalously warm at 850mb, with composite anomalies greater than 8°C over much of the northeast, including Virginia (Figure 9). The warm 850mb temperatures translated to warm temperatures in the low levels.

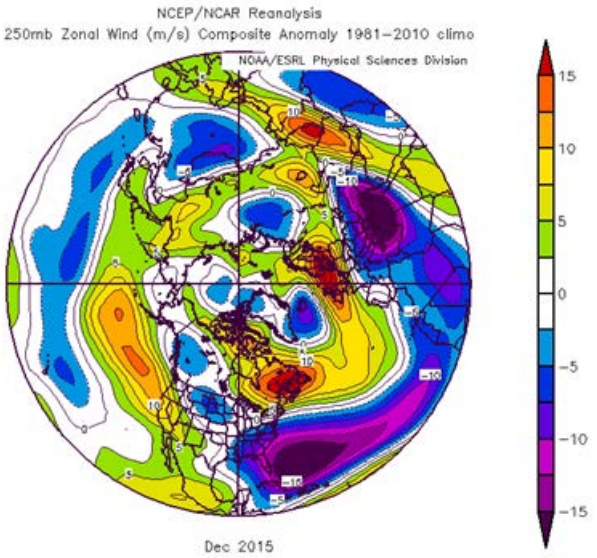

Figure 6: December 250mb Zonal Wind Anomaly

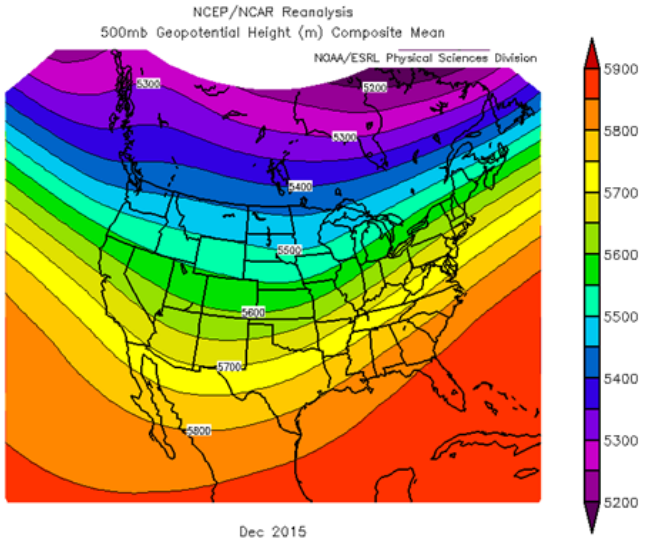

Figure 7: December 500mb Height Mean

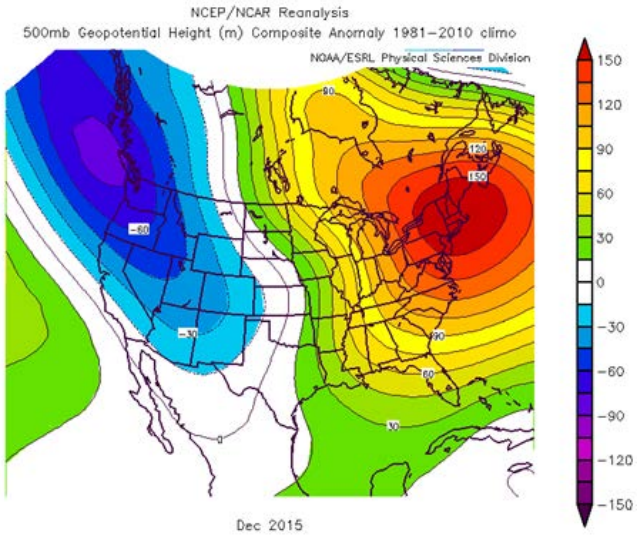

Figure 8: December 500mb Height Anomaly

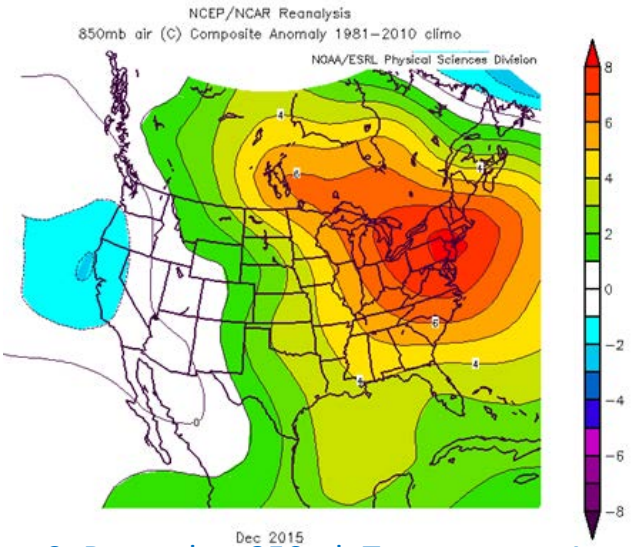

Figure 9: December 850mb Temperature Anomaly

Surface Pattern:

Impressive height anomalies over the western Atlantic translated to mean sea level pressure anomalies in the same locations (Figure 10). Strong positive anomalies were observed over the western Atlantic with strong negative anomalies over the western and central U.S. As observed aloft, high pressure was nearly a permanent fixture over the western Atlantic through the month. This can be seen in the MSLP composite mean (Figure 11). The result was several days of warm, return flow. The strongest meridional wind anomalies were observed just off the Mid-Atlantic Coast (Figure 12). The average wind direction for the month was 204°, or out of the southwest. Southwest winds also resulted in anomalous moisture during December. Surface relative humidity anomalies were high over the southeast U.S. into the Mid-Atlantic States (Figure 13). High RH can also be seen in the daily average dewpoint (Figure 14). The climo average dewpoint for the month of December at Richmond is 31°F. The average dewpoint for December 2015 was 45°F, which represents a departure of +1 standard deviation. The Richmond average daily dewpoint reached as high as 66°F on Christmas Eve and Christmas Day, or roughly +3.5 standard deviation. These were the mornings that set all-time record high minimums at Richmond.

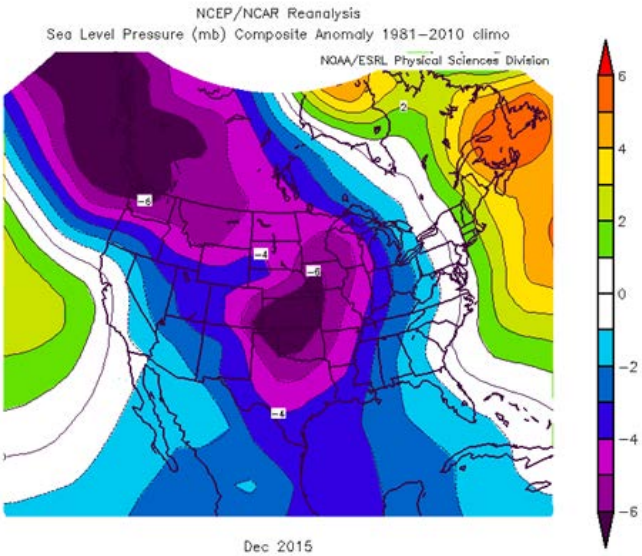

Figure 10: December MSLP Anomaly

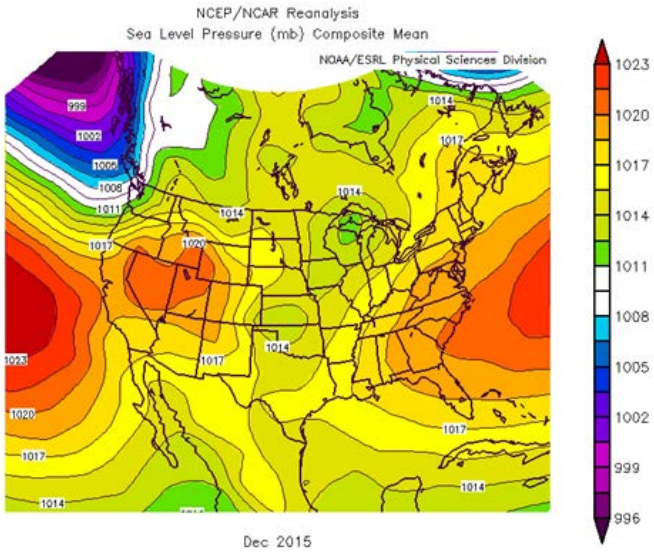

Figure 11: December MSLP Mean

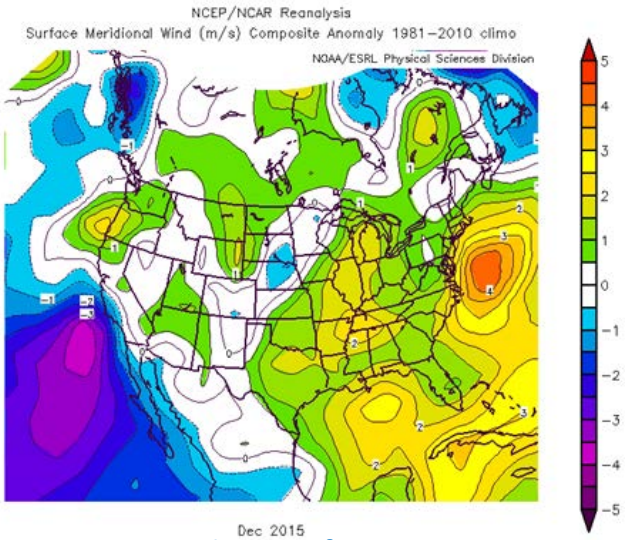

Figure 12: December Surface V-Comp Anomaly

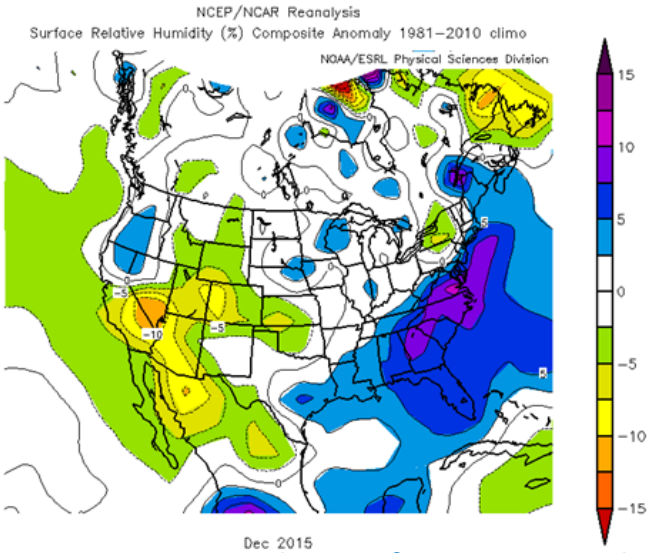

Figure 13: December Surface RH Anomaly

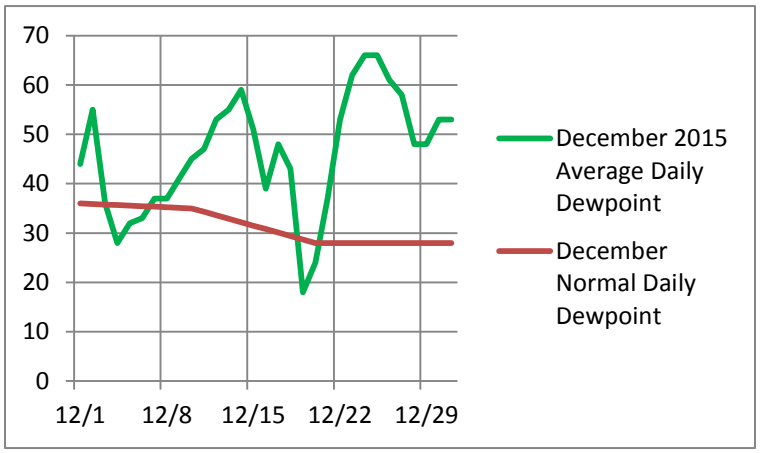

Figure 14: December 2015 Daily Average Dewpoint

Climate Prediction Center Outlook:

Factoring in El-Nino and recent trends, the Climate Prediction Center's December outlook (issued mid-November) predicted increased probabilities for above normal temperatures and above normal precipitation. The outlook also accounted for additional teleconnections, but these forecasts only go out a few weeks and are highly variable. The positive AO of late December would not have been realized until early to mid-December.

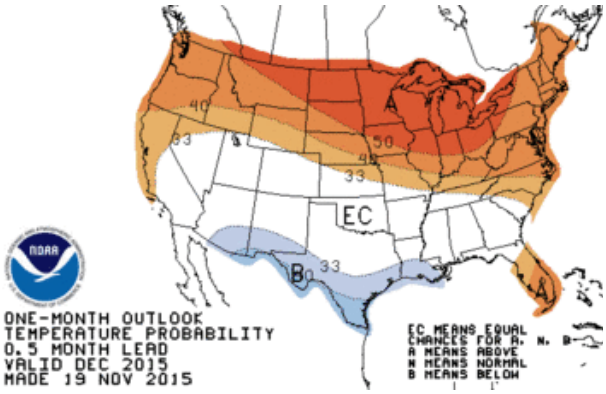

Figure 15: CPC December Temp Outlook

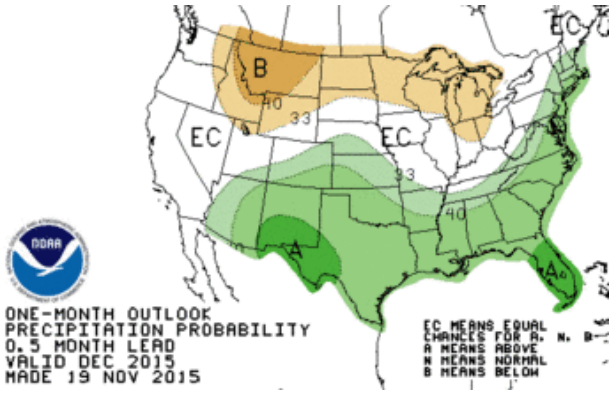

Figure 16: CPC December Precip Outlook

Conclusion:

Favorable teleconnection and synoptic patterns came into play during the month to result in the record warmth over much of the eastern half of the country. These patterns trapped cold, arctic air over the pole region and prevented the air from penetrating the eastern U.S. Warm and moist return flow over the Southeast and Mid-Atlantic States also helped keep temperatures and moisture high. The end result was the warmest December on record, with many climate sites breaking the old average temperature record by nearly 5 degrees.

For more information on the records set, please refer to the Public Information Statement (link: http://www.weather.gov/akq/December2015RecordWarmWeather).