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February 2015: A Month to Remember in New England for Record Cold

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1. Introduction

An extreme cold air outbreak affected all of the Northeast U.S. during February 2015 (NWS ER 2015). In some locations it was the all-time coldest month ever observed. The extreme cold led to ice buildup on waterways and made navigation difficult, slowed commerce, and forced ferry services to be suspended. Boat traffic was restricted as far south as parts of the upper Chesapeake Bay for about a week due to icy conditions, and the start of maple season was delayed by up to three weeks in New England, New York, and Ohio because the extreme cold kept sap from flowing.

The possible causes of the record cold were discussed, and a review of the official forecast from the Climate Prediction Center (CPC), along with the forecasts from two climate models were presented.

2. Data

This study utilized data from the NCEP/NCAR Reanalysis (Kalnay *et al.* 1996) from NOAA's Earth System Research Laboratory. The official forecasts from the CPC were examined as well as the CFSv2 (Saha *et al.* 2014) and NMME (Kirtman *et al.* 2014) forecasts. The ENSO and MJO discussions from the CPC were used as well as the ENSO indices for each region. Prior research that investigated the cold outbreak of January 1977 (Namias 1978), which was the only month in the Northeast U.S. to be more severe than the February 2015 cold outbreak since 1948 was also examined (Walsh *et al.* 2001). Global SST anomalies and Pacific-North America (PNA) and East Pacific (EP-NP) teleconnection patterns were examined.

3. Summary of results

During February 2015 there were persistently low 500 hPa heights across central Siberia, northern Canada, and into the Great Lakes and Northeast U.S. Examining the 500 hPa composite anomalies from

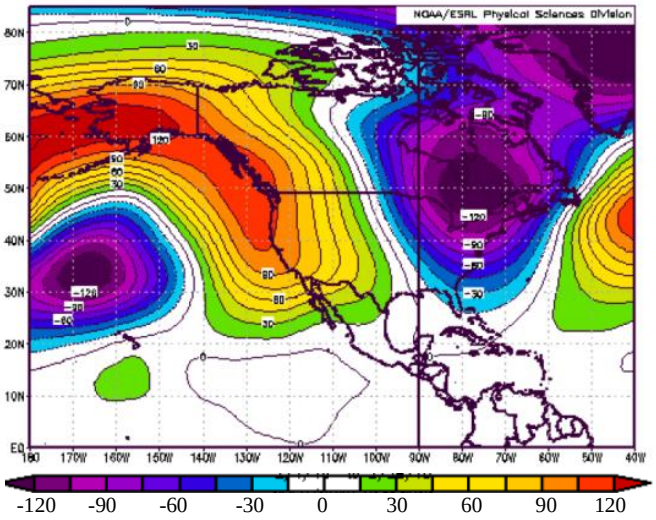

Fig. 1 500 hPa geopotential height composite anomaly (m), from the 1981-2010 climatology, during February 2015. Figure *from NOAA's Earth System Research Laboratory*

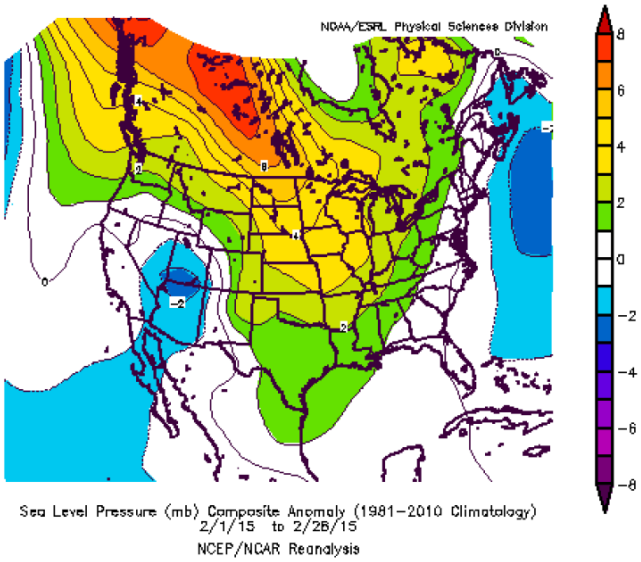

Fig. 2 Sea level pressure composite anomaly (mb), from the 1981-2010 climatology, during February 2015. Figure *from NOAA's Earth System Research Laboratory.*

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1981-2010 climatology (Fig. 1), significant negative anomalies were noted across the greater Northeast U.S. including all of New England. The persistence of the upper air pattern led to well below normal temperatures at the surface, which corresponded well with the upper air anomalies (Nouhan 1999). The sea level pressure composite anomaly (Fig. 2) showed that surface pressures were lower than the climatological mean just off the Northeast U.S. coast. This was due to a series of surface lows that moved toward the Northeast U.S. coast from the west and intensified across the Canadian Maritimes. The persistence of this pattern led to favorable conditions for pulling cold Canadian air into the Northeast U.S. on the back side of the surface lows. Above average sea surface temperatures (SSTs) were observed across the western and central equatorial Pacific as well as along the west coast of North America and across parts of the north Atlantic Basin. The positive SST anomalies along the west coast of North America potentially helped to amplify the mean long wave ridge over the western North America coast, and were likely a significant factor in the long wave pattern at mid and upper latitudes. The positive SST anomalies in the north Atlantic may have been an additional source of latent heat for enhanced east coast cyclogenesis for the New England coast. Additional reinforcing shots of cold air followed the passage of the cyclones and also likely aided in keeping the cold air in place throughout the month. The Madden-Julian Oscillation (MJO) was weak with no coherent MJO pattern observed during the month of February. The fact that the MJO was not coherent and did not disrupt the quasi-stationary position of anomalous convection across the western equatorial Pacific may have been a driver in the persistence of the upper air pattern. It is proposed that the more western displaced Pacific equatorial positive SST anomalies and associated enhanced convection observed during February 2015 and January 1977 potentially resulted in a more regional (rather than basin wide) enhancement of the Hadley Cell circulation over the west central and central tropical north Pacific.

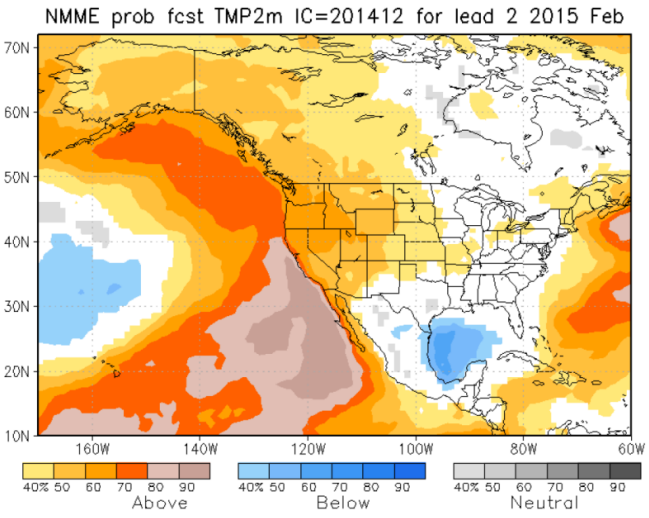

Fig. 3 NMME forecast issued December 9, 2014, valid for February 2015. 2-m temperature tercile probabilities.

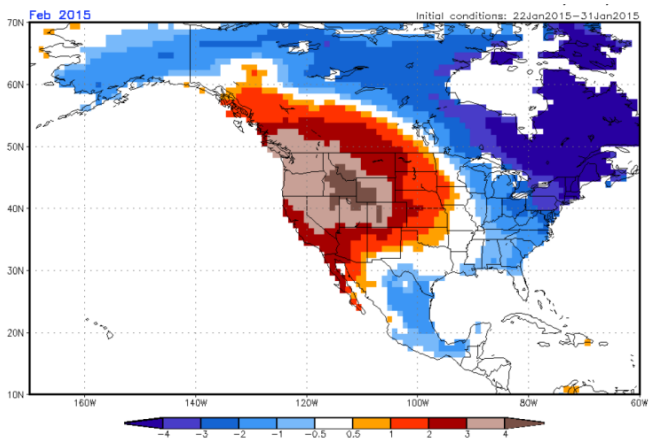

Fig. 4 CFSv2 2-m temperature anomalies (K) forecast for February 2015 based on initial conditions from January 22-31, 2015.

The NMME did not have a signal pointing toward an unusually cold February, and in fact the lead 2 outlook in December indicated an increased likelihood of above normal temperatures (Fig. 3). The CFSv2, which is one of the component members of the NMME, did have an increasing cold signal during the month of January (Fig. 4). The official forecast from the CPC issued on 15 January 2015 had no skill compared to a random forecast; however, the CPC forecast issued on 31 January 2015 (Fig. 5), accurately forecasted an increased likelihood of below normal temperatures in February. The climate models gave little lead time for such a significant event, and were unable to provide any guidance to the forecaster as to whether the anomalies would be record breaking. There are still a significant amount of unknowns that affect monthly climate forecasts and more work is needed to better predict these events.

4. Discussion

February 2015 was one of the coldest Februaries on record across the Northeast U.S., and in some locations the all-time coldest month on record. An upper air analysis showed that there was a very persistent pattern during the month with a strong ridge along the west coast of North America, and a strong downstream trough that extended from the Canadian Archipelago into the Northeast U.S. The pattern retrograded during the month, but only very slowly. This kept a fresh supply of cold arctic air across the Northeast U.S. all month. The lack of a well defined MJO, enhanced convection across the tropical west Pacific, and positive SST anomalies along the west coast of North America may have all played a role in the persistence of the upper air pattern. Surface cyclogenesis along and off the Northeast U.S. coast also likely played a role in keeping the cold air in place across the region.

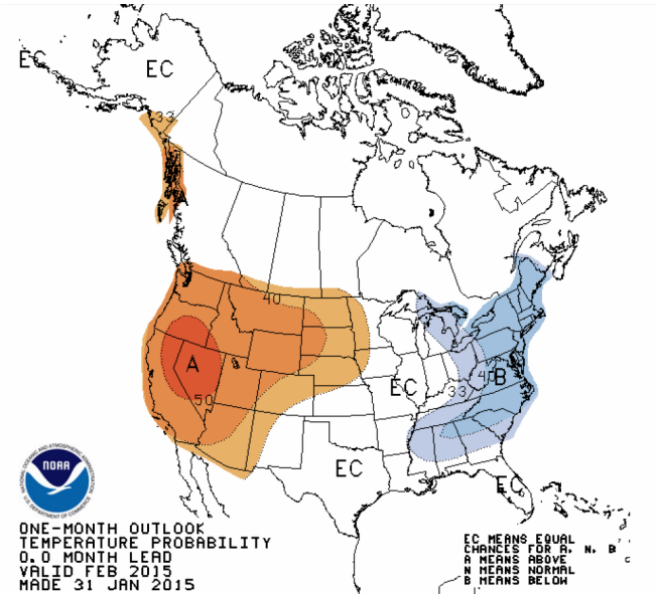

Fig. 5 The final official National Weather Service's Climate Prediction Center temperature forecast for February 2015 from the CPC that was issued January 31, 2015.

Prior extreme cold months did not have a similar distribution to February 2015 in the 500 hPa geopotential height composite anomalies across North America (Konrad 1989). There is therefore not one common composite anomaly pattern in the 500 hPa geopotential heights that forecasters can look for when attempting to determine whether a month has the potential for being record cold, but rather different distributions in the 500 hPa geopotential heights may lead to such extreme outcomes. The mean 500 hPa patterns did, however, show a mean trough in all cases across the Northeast U.S. Further evaluation of the composite anomalies associated with extreme cold months would be a worthy endeavor. Rapid surface cyclogenesis along and off the Northeast U.S. coast does appear to play an important role in reinforcing the cold air.

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