# Meteorological Memories of 2010

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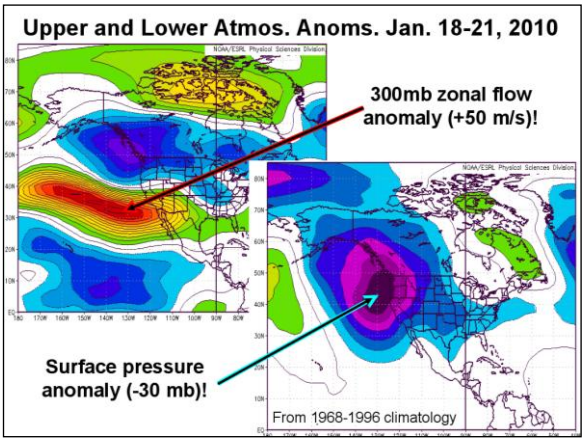
*This article follows very closely the order and information presented by the author on these episodes of interesting and extreme weather over the United States at the 35th National Weather Association Annual Meeting in Tucson, Arizona, October 2010. These personal "Meteorological Memories of 2010" are presented in quasi-chronological order with no attempt to rank the events by their severity or magnitude.*

## Number 1 – Western Wallop, January 20-22, 2010

A series of powerful low-pressure systems slammed the US West Coast during the week of January 20th. As the storms moved across a large area of the west, from Oregon to Arizona, they produced heavy rain, flash flooding, high winds, heavy snow and even tornadoes. By the 22nd, precipitation totals for this series of storms ranged from 4-12 inches from coastal areas, inland across lower elevations of Arizona. As much as 8-16 inches of rain soaked the foothills and mountains with periods of intense rainfall producing flash flooding, mud slides and debris flows in burn areas of California.



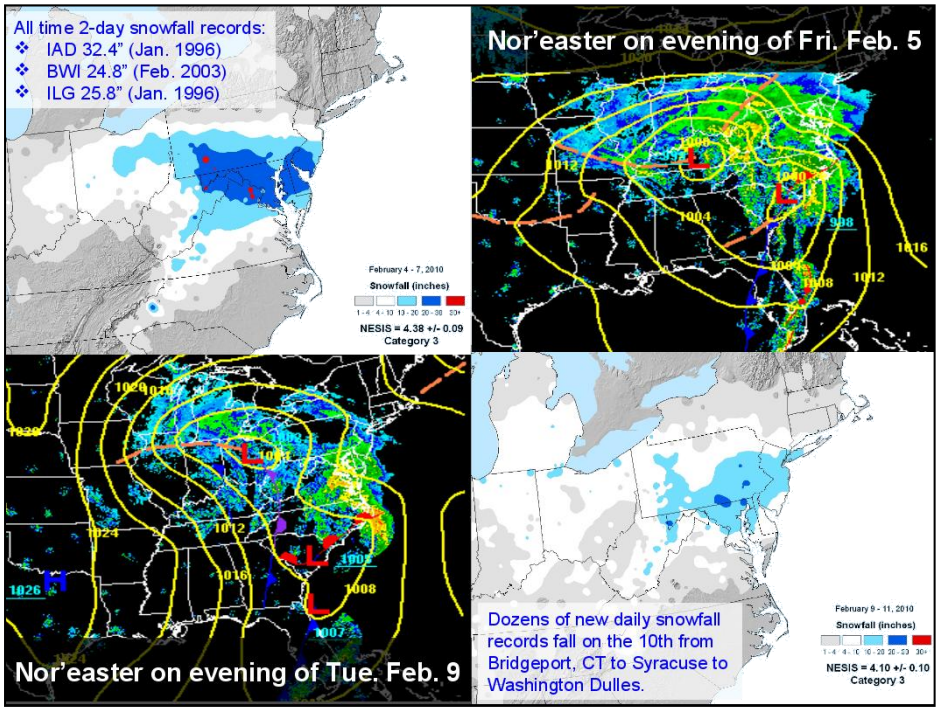

The 300-mb zonal wind anomaly (m/s) for the period January 18-20, 2010 (upper left), and the surface pressure anomaly (mb) for the same time period are shown. These anomalies were computed from the 1968-1996 base climatology available at the ESRL Web site.

From Oregon to Arizona, new all-time record surface low-pressure values were established. Some of these pressure records had first been established in the late 1800s. A tornado watch in Arizona during this event was the first time a tornado watch had been issued in January in Arizona since 1993.

## Number 2 – Double Dumps in Delmarva, February 5-10, 2010

These two major East Coast snowstorms followed the "Snowpocalypse" of December 2009. Back-to-back nor'easters, with less than a 5-day break from the heavy snow, dumped deep, heavy, wet snow across Washington D.C. and surrounding areas in what was described in the media as "Snowmageddon", and then "Snoverkill".

A new all-time, 2-day snowfall record for the first storm, on 5-6 February, included Dulles Virginia, with over 32 inches. Baltimore, Maryland and Wilmington, Delaware both exceeded 2 feet for new 2-day records. The second storm added to the snow on the ground and by the end of February, new monthly snowfall records were established at New York City's Central Park, Philadelphia, Wilmington, Delaware, Baltimore, Maryland, Pittsburgh, and Dulles,



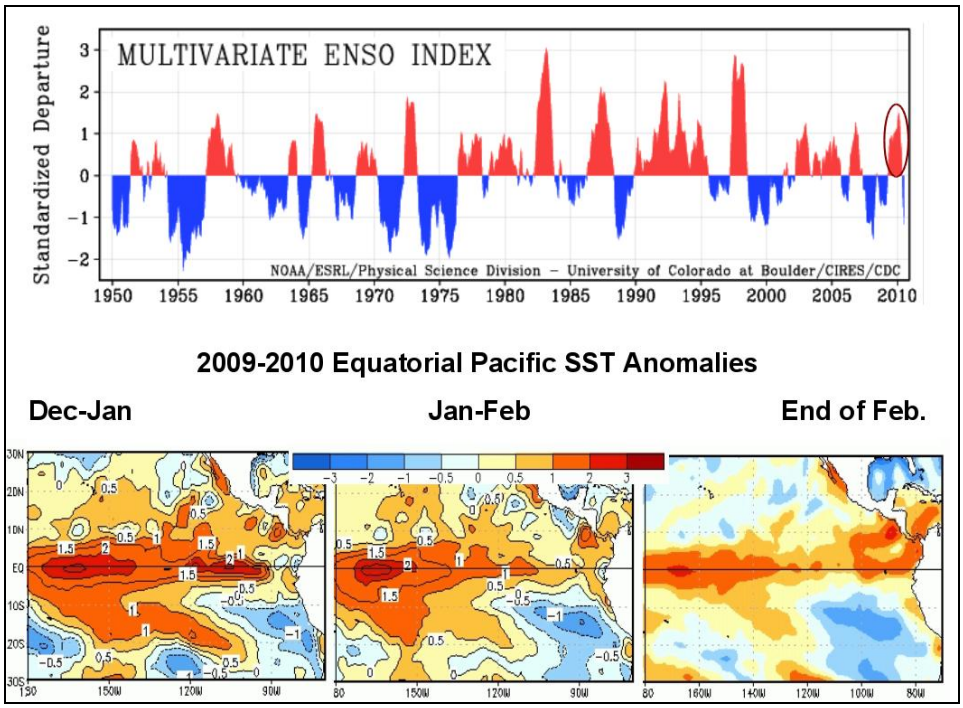

Virginia. With the exception of Central Park, all of these locations also recorded their snowiest winter on record by the close of February 2010. One last record of note: West Virginia drifted way beyond its previous snowiest month state record when just over 158 inches piled up in Bayard. This is over 54 inches more than what was recorded in January 1977, in Terra Alta.

Comparison of the two back-to-back nor'easters is shown in the above figure. Mosaic radar and surface pressure maps for each system are shown in the upper right and lower left. The Northeast Snowfall Impact Scale (NESIS) maps are also shown for each system in the upper left and lower right of the figure. More information about NESIS is at: http://www.ncdc.noaa.gov/snow-and-ice/nesis.php

## Number 3 – El Niño Excitement

The El Niño was a major player in the nation's weather during the winter and into spring before the cool-phase La Niña returned remarkably fast by summer. The warmer ocean water around the equatorial region of the central and eastern Pacific, the hallmark of El Niño, alters the downstream wintertime storm track over the United States. Cool- season, large-scale precipitation and temperature anomalies as a result of El Niño are generally well understood and precipitable. Such was the case through early 2010 with some regional exceptions being seen in the Northeast US, where greater than expected precipitation was observed, and in the Southeast, where drier conditions prevailed, contrary to what composite anomalies of prior El Niño winters would have suggested.

The media tried to tie El Niño to an uptick in tornado activity when an unusually early tornado occurred in far western Oklahoma on March 8. Up until that time, tornado and other severe thunderstorm activity had been running well below the norm, especially compared to recent years. While some research suggests El Niño may suppress cool-season tornadoes in some areas of the country, other areas, such as the Gulf Coast and Florida, have seen increased winter tornado activity during an El Niño. The connections of ENSO phase to tornado numbers are tenuous. It was probably the unusually quiet start to the year, broken suddenly by a close and photogenic encounter with a tornado in Oklahoma that got the media excited and eager to tie that one tornado event to the already newsworthy El Niño. Even if that was a stretch scientifically, it may have sold a few more papers.




The long-term time series of the Multivariate ENSO Index is shown at the top of the figure above. The cool-weather season of 2009-2010 over the US is indicated by the red circle. Equatorial Pacific sea-surface temperature anomaly maps for Dec 2009-Jan 2010, Jan-Feb 2010, and the end of Feb 2010, show the decrease with time of the above-normal, sea-surface temperatures associated with the warm phase of ENSO (bottom of figure).

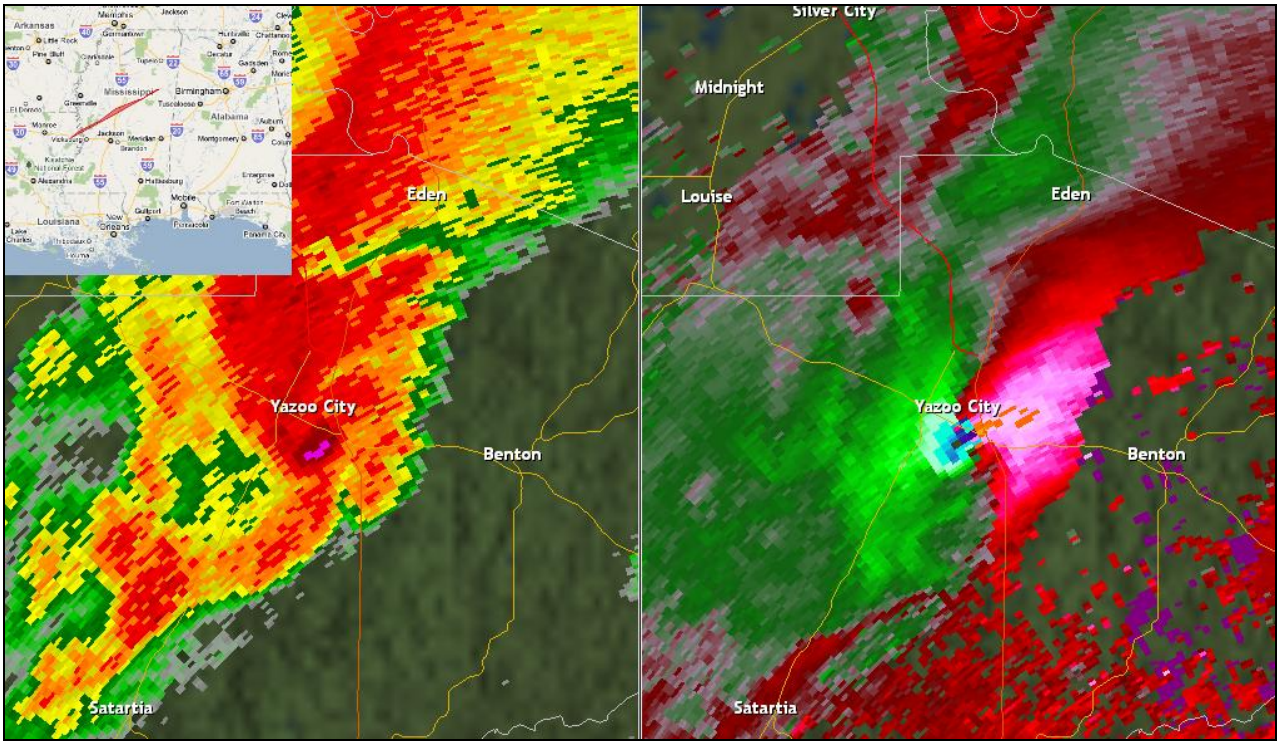
## Number 4 – Southern New England Soaking, March 29-31, 2010

Record rains from a slow-moving and extremely wet nor'easter triggered historic flooding in Rhode Island and southeastern Massachusetts, with several rivers exceeding 100-year flood levels by the start of April. Over 16 inches of rain fell in Providence, Rhode Island during March, the most rain ever in a month. This exceeded the previous record of 15.38 inches, set in October 2005. Over half of this rainfall (10 inches), came in just 2 days.

The widespread flooding closed portions of Interstate 95, near Providence, Rhode Island, washed out roads from Massachusetts to New Hampshire, and prompted Presidential Disaster Declarations in all 3 of these states.

## Number 5 – Mississippi Monster, April 24, 2010

April can be a dangerous time for severe weather in the south and this event, coming on Saturday, April 24th, will not soon be forgotten. This monster tornado first touched down in extreme eastern Louisiana, then crossed the Mississippi River, and went on a continuous path of destruction for nearly 150 miles, almost crossing the entire state of Mississippi in about 3 hours between noon and 3pm CDT. The tornado claimed 10 lives, injured over 140 people, and caused over $300 million in property damage.




Radar imagery from the Jackson, MS National Weather Service Office showing the tornadic supercell near Yazoo City, Mississippi on April 24th. Inset (upper left) is a map showing the track of the tornado across the state of Mississippi. *Image courtesy: NWS Jackson, MS*.

The storm survey conducted by the Jackson, Mississippi NWS office stated, “The main long-track tornado was strong almost from its initial stage of development in northeast Louisiana. EF2 and EF3 damage was common all along the tornado’s path into central Mississippi with areas of EF4 damage observed in both Yazoo and Holmes counties. After crossing Interstate 55, the tornado weakened with EF1, and occasional EF2, damage being common as the tornado moved across Attala County. The tornado re-intensified as it moved into Choctaw County, with at least high end EF3 damage occurring northwest of the Weir community. The tornado remained strong before rapidly weakening, and then dissipating after moving into Oktibbeha County.”

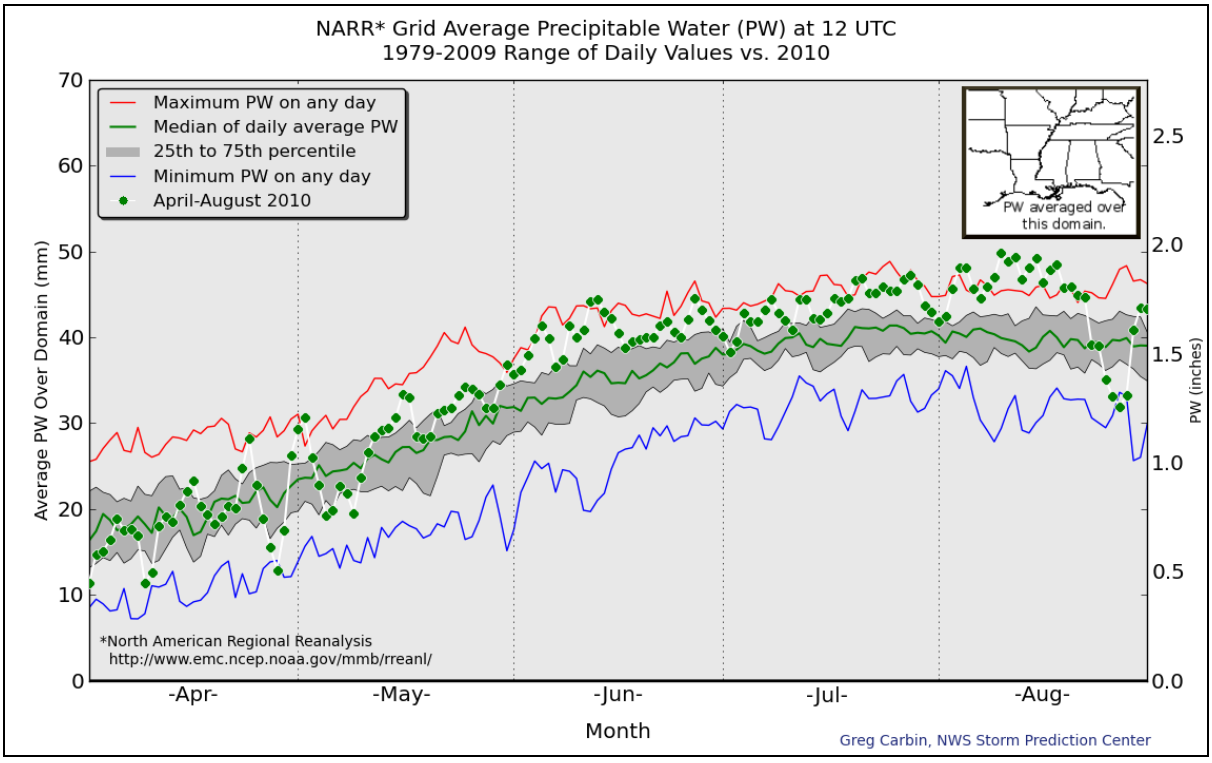
## Number 6 – Mid-South Moisture Madness, May-June 2010

The Nashville, Tennessee area was inundated by the heaviest recorded 1-day and 2-day rainfall in its history in the first days of May. A total of 7.25 inches of rain fell on the city on May 2, breaking the previous record rainfall in any single day. Nashville's third-place, greatest day of rainfall on record had occurred just the previous day, when 6.32" fell! After only 2 days into the month, with nearly 14 inches of rain, May 2010 became Nashville’s wettest May on record. The flooding was like no one had ever seen with new record crests recorded on the Cumberland River. Over 20 people lost their lives and the property damage was well in the hundreds of millions of dollars.

The next flood event was a tragic nighttime/early morning flash flood at the Albert Pike National Forest campground, in southwest Arkansas, on June 10. While the rainfall amounts

were not comparable to what happened over Tennessee the prior month, the intense, short duration, rain fell in a small basin with substantial topography. The Little Missouri River went from a trickle to a raging torrent of over 20 feet in about 2 hours before dawn. Tragically, 20 campers were drowned and survivors told of harrowing tales clinging to trees as the flood waters raged through the deep valley and then subsided almost as quickly as they rose.

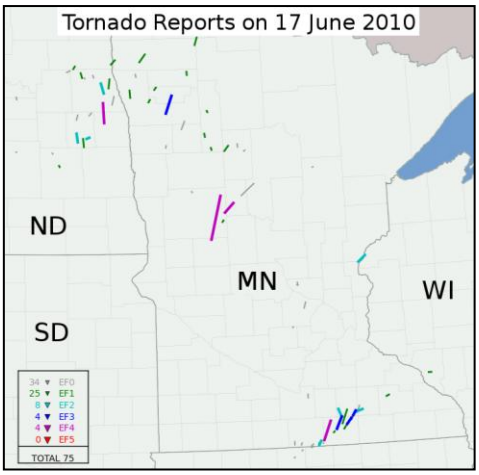
Just four days after the Arkansas flash flood, on June 14, Oklahoma City experienced a deluge of epic proportions as an overnight MCS continued to back-build across the metropolitan area from early morning into the afternoon. The 7.62 inches of rainfall in Oklahoma City on this day established a new daily rainfall record for the city where records go back to 1890. The North Canadian River discharge, below Lake Overholser near Oklahoma City, had not seen anywhere near the level of discharge in 54 years of record keeping. Amazingly, no lives were lost during this unprecedented flash flood event over a major metropolitan area.




Time-series of grid-averaged precipitable water from North American Regional Reanalysis (NARR) data over the domain indicated. Daily median, 1st and 3rd quartiles, and extremes from 1979-2009 are shown. The daily values over the domain for 2010 are indicated by the green dots.

## Number 7 – Multitude of Mid-June Mesocyclones, June 17, 2010

An adjustment has to be made to the list of Meteorological Memories as presented in October at the NWA Annual Meeting. After further review, this event should have been included.




June 17, 2010: A total of at least 75 tornadoes occurred on this day with four EF4-rated tornadoes, three in Minnesota, and one in North Dakota.

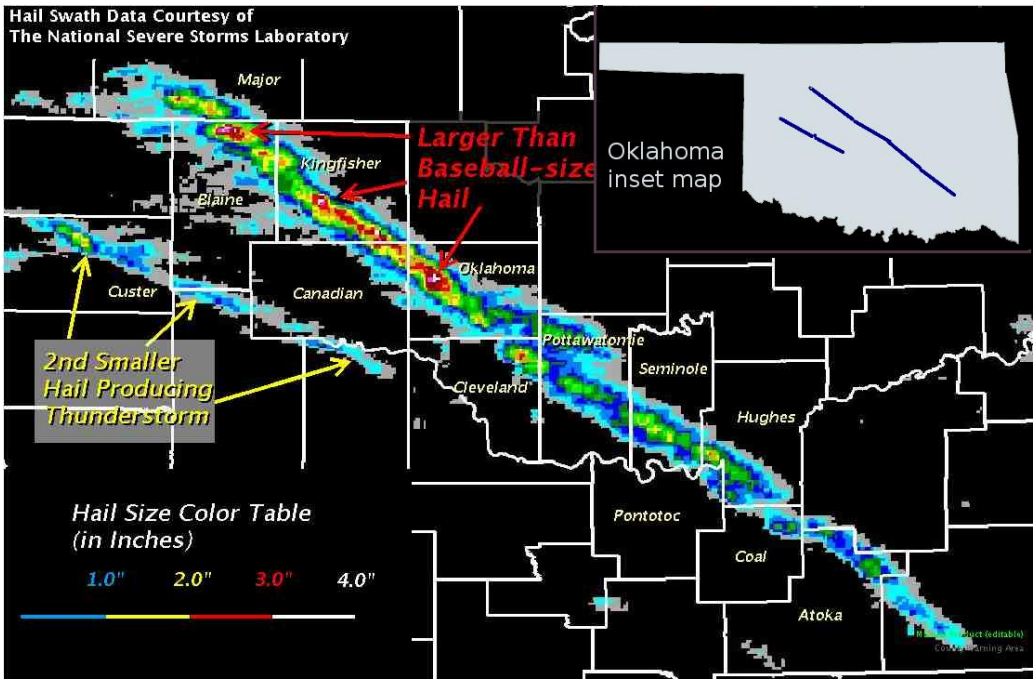
Potent shear and a very warm moist airmass combined with a deep low-pressure system over North Dakota to produce over 70 tornadoes across the eastern Dakotas and Minnesota on this day. The 4 EF4 tornadoes (1 in North Dakota and 3 in Minnesota) combine for the greatest single day total of violent tornadoes since the Super Tuesday Tornado Outbreak of February 2008. The day was the most active tornado day in Minnesota history and the busiest tornado day of 2010 for the nation. This day also helped to propel Minnesota into the number one and dubious position as the most active tornado state for the year, leaving typical number one states like Texas and Kansas, in the dust. Unfortunately, there were 3 direct tornado fatalities, all in Minnesota, numerous injuries, as well as widespread property destruction.

## Number 8 – Oklahoma in Overdrive (Much of the Year!)

Where do we start to list the significant weather events of 2010 in Oklahoma? Actually, we already hit on the flash flood event of June 14. However, there was so much more in 2010. After the region was hit with the Christmas Blizzard in late 2009, a late January ice storm dealt a crippling blow to parts of southwest Oklahoma. And, then came spring…

May 10 saw a classic Southern Plains tornado outbreak when almost every thunderstorm to form on that day attained significant rotation and many produced fast-moving tornadoes. One of those tornadoes took form right near the National Weather Center in Norman, Oklahoma, where the NOAA/NWS/NCEP Storm Prediction Center is located. This tornado went on to produce significant destruction and a fatality, and was later rated EF4. The other tornado rated EF4 was also a killer tornado (2 deaths). It tracked from Moore to Choctaw. Nearly 100 injuries occurred on this day and, given the speed at which the tornadoes were moving (over 50 mph in most cases), it is notable that many more citizens did not perish.

Then, on May 16, a lone supercell initiated over Major County, Oklahoma. The cell tracked to the southeast through the late afternoon and produced giant hail and damaging winds on its trek to the Red River in southeast Oklahoma. The north Oklahoma City area was hit hard by this hailstorm with baseball-size hail producing widespread automobile and building damage. Keep in mind, less than a month later the same area experienced nearly 8 inches of rain in less than 8 hours (see event number 6, above).




Large hail swaths indicated by MESH (Maximum Estimated Size Hail) radar product across Oklahoma on May 16, 2010. *Image courtesy: NWS Norman,OK*.

Oklahoma certainly lived up to its billing as a severe weather Mecca in 2010. It was a most memorable year!

## Number 9 – A Searing Summer

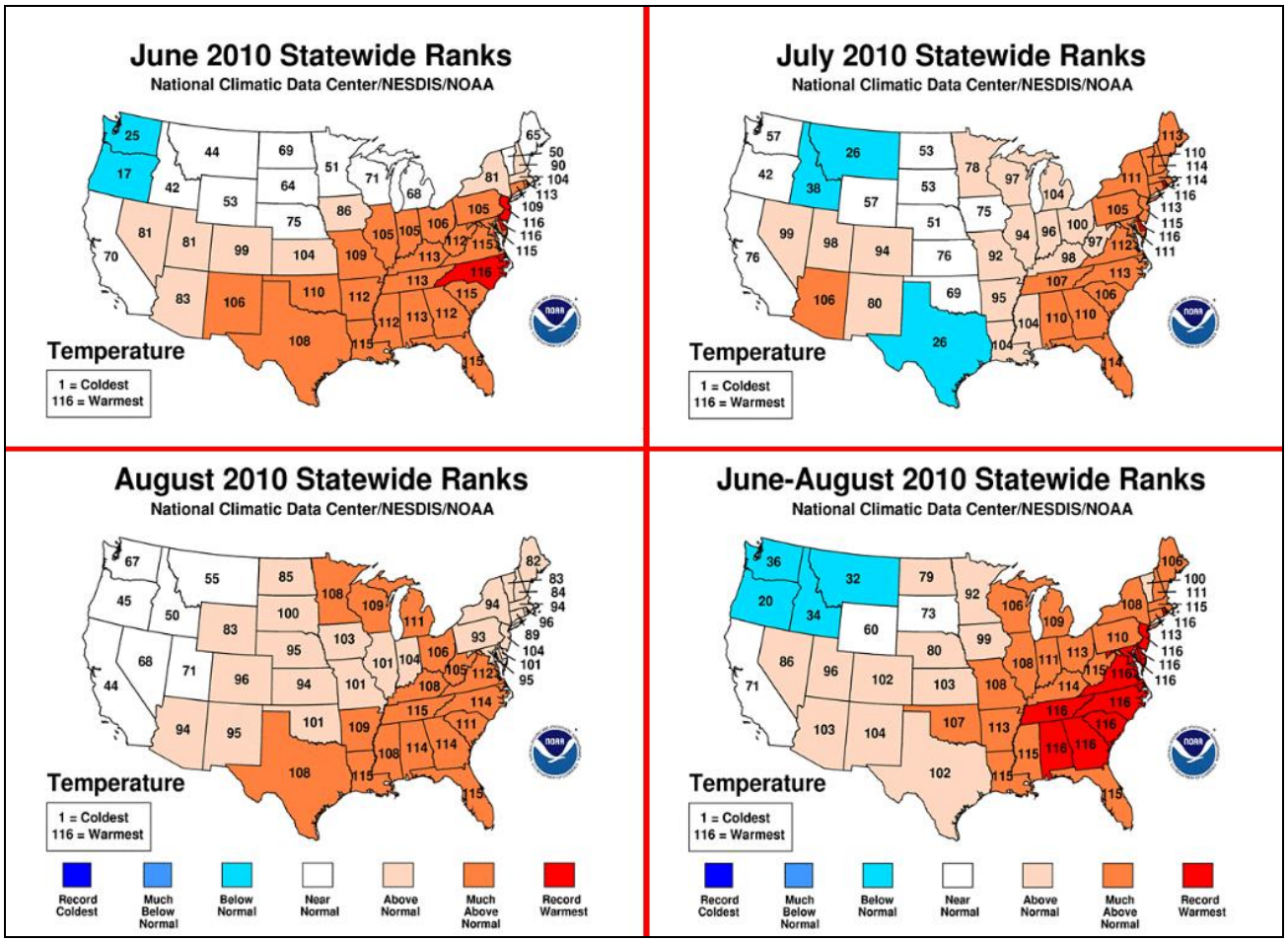
The contiguous United States had the fourth-warmest summer (June-August) on record. The 500-mb heights were much higher than average over much of the nation and the center of the large and semi-permanent sub-tropical high remained across the Deep South and Southeast for most of the summer.

During June there were 808 new daily maximum temperature records established according to the National Climatic Data Center. New all-time June maximums were established in Lajitas, Texas (115F), as well as Orlando and Venice, Florida (both 100F). It was the warmest June on record in Atlantic City, Philadelphia, Jackson and London, Kentucky, Miami and Key West, Florida. For the country as a whole, it was the eighth warmest June in 116 years of record keeping.

On average, July was 17th warmest July since records began in the late 1800s. There were 842 new daily maximum temperature records set in July with all-time maximum temperatures for the month being recorded in Hartford (102F), Philadelphia (104F), Norfolk and Richmond (105F), Edisto, South Carolina, (102F), Tallahassee (103F), Escalante, Utah (104F), and Durango, CO (98F). It was the warmest July on record in Atlantic City, Baltimore, and Las Vegas.

August was an oven with nearly 1400 new daily maximum temperature records set. All-time maximum temperatures for August were tied at all of the following locations: Boothville, Louisiana (97F), Yazoo City, Mississippi (108F), Key West (95F), and Fort Worth (110F).

For New York's Central Park; Philadelphia, Pennsylvania; Trenton, New Jersey; Wilmington, Delaware and Asheville, North Carolina it was the warmest summer since record keeping began nearly 120 years ago. (Contrast this with the enormous record-breaking snow totals seen at some of these locations only 6 months earlier!)

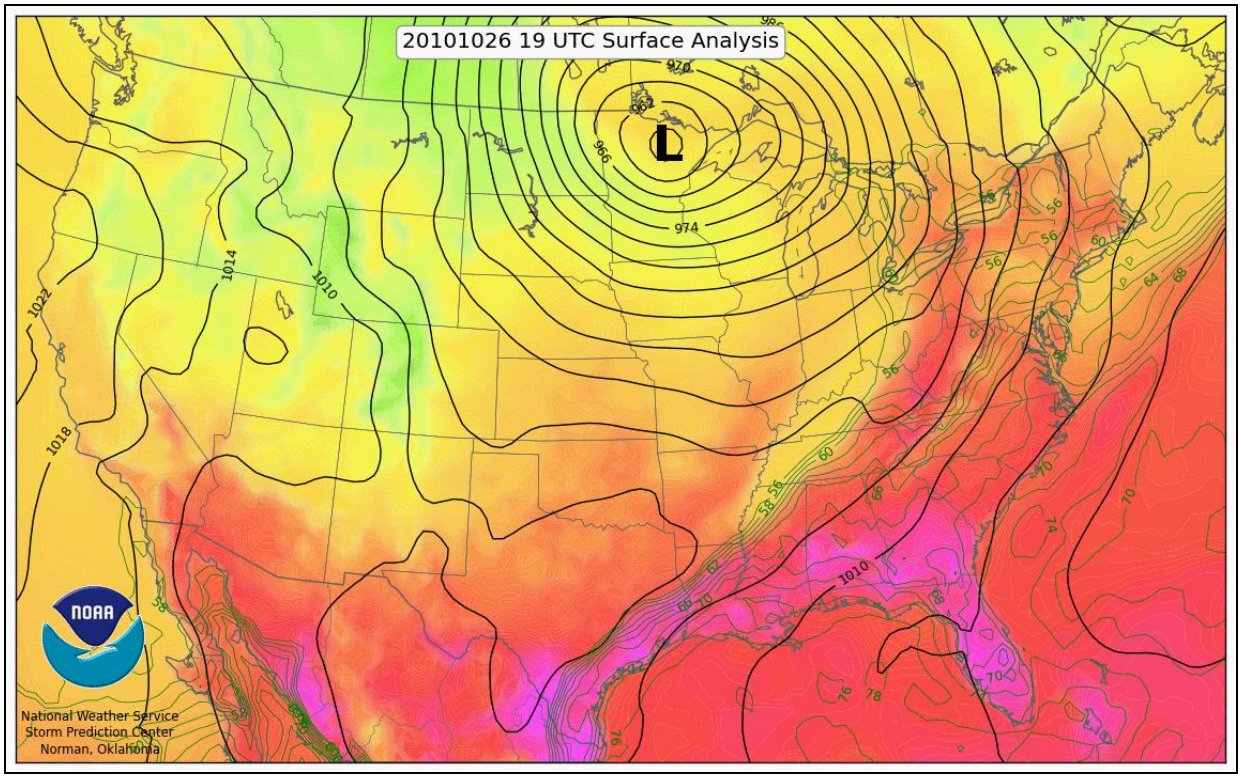



Four-panel display of the monthly and seasonal state ranks for the summer months and summer of 2010. Upper-left: June state rankings, upper-right: July state rankings, lower-left: August state rankings. Lower-right: summer season (JJA) state rankings. *Maps are courtesy of National Climatic Data Center (NCDC).*

**Number 10 – A Minimum of Millibars in Minnesota, October 26-27, 2010**

In late October, a pronounced mid-latitude cyclone spun up to portentous proportions resulting in ear-popping surface low pressure values rarely seen across the interior United States. This storm must be included in the list of memories for its unusual nature and widespread observed impacts.

The 955.2 mb surface pressure (adjusted to sea level) recorded in Bigfork, Minnesota on October 26 established a new record surface low pressure value for an extratropical cyclone occurring away from the coastal regions of the United States. There have been other inland storms (bombs) with pressure values bottoming out close to this value, but not many.




Map depicts sea-level pressure analysis in millibars, surface temperature (color-fill), and dewpoint (green contours, (F)) for 1900 UTC (2 pm CDT) 26 October 2010. Record surface low pressure values associated with an intense extratropical cyclone were established across portions of Minnesota around the time of this analysis.

With the exception of the Ohio Blizzard of 1978, storms of similar magnitude in this part of the country seem to have a proclivity for developing in November. Here is a list of substantial cyclones of the past:

- Great Ohio Blizzard of January 26, 1978 (958 mb)
- Armistice Day Storm November 11, 1940 (967 mb)
- November 10, 1998 storm (963 mb)
- White Hurricane of November 7-9, 1913 (968 mb)
- Edmund Fitzgerald Storm of November 10, 1975 (980 mb)

Widespread wind/tree damage and power outages from winds of 60-70 mph occurred across a large swath of the Upper Midwest with this latest system. Over 500 severe thunderstorm reports arrived at the Storm Prediction Center during this event.

**2010 Honorable Mention**

A New U.S. Record Hailstone in Vivian, South Dakota on July 23, 2010

The Arizona Severe Weather Outbreak of October 6, 2010 (during the 35th NWA meeting)

The Busy but Unusual Hurricane Season of 2010, Many Storms, No U.S. Landfalls

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*This list of 2010 weather events is based entirely on the interests and recollections of the author. The list does not represent any official ranking on the part of NOAA, the National Weather Service, the National Centers for Environmental Prediction, or the Storm Prediction Center. Author contact: Gregory.Carbin@noaa.gov*