

U.S. Weather Highlights of 2010

By Douglas LeComte

The cold air made its way to the Sunshine state, and a damaging freeze affected the Florida Peninsula. The lowest temperatures hit the citrus belt on January 6-7 and 10-12. Minimum readings dipped into the crop-damaging range of 20 to 25°F on January 10-11. Gainesville's low of 17°F on January 11 was its lowest reading since Christmas Eve, 1989, and **West Palm Beach recorded its coldest 12-day period ever from January 2-13, averaging 49.9°F. It was not your typical beach weather.**

Florida's citrus crop escaped devastating damage, but the cold harmed the state's economy by damaging or destroying tropical fish, ornamentals, and nursery crops.

In the West, one of the two epic storms of this year battered the region during January 17-23, bringing heavy rains, floods, landslides, and monster snows to higher elevations. Parts of California and Arizona picked up 10 to 15 inches of precipitation. Indicative of the intensity of the storm, barometers plunged to all-time lows from Oregon to Arizona on January 21. At Los Angeles, California, the minimum pressure of 29.07 inches smashed the old record by 0.18 inches. In Nevada, Reno's pressure of 28.91 inches broke records going back to 1916. Snowfall totals exceeded 100 inches in a few Sierra Nevada locations. In Arizona, Flagstaff noted its second-snowiest six-day period on record (January 18-23), accumulating 54.2 inches. Thirty-five and one-half inches of snow blanketed the town on January 21-23, bringing its snow depth up to 44 inches.

Over the East, the setup for snow began toward the end of January, as the upper-air circulation reverted to the wintry pattern persistent from December into early January, featuring a negative Arctic Oscillation/North Atlantic Oscillation (AO/NAO). The jet stream plunged southward, dumping cold Canadian air into the Plains, while the El Niño-invigorated subtropical jet stream fed an unrelenting train of low pressure systems from California to the East Coast.

The intense coastal low that buried the mid, Atlantic states with two feet of snow on February 5-6 earned the nickname "Snowmageddon" (a.k.a. "Snowpocalypse") for its impact on the millions of residents along the 1-95 corridor from Richmond, Virginia, to Philadelphia, Pennsylvania. **Officially, Washington, D.C. recorded 17.8 inches at the Reagan National Airport, making this the fourth greatest snowstorm on record. But areas of the city north of the airport as well as the close-in suburbs measured close to two feet. Dulles Airport in Virginia set its all-time**

record with 32.4 inches. Isolated spots in Maryland, Virginia, and West Virginia measured up to three feet. Like the December 2009 storm, this one rated a Category 3 ("Major") snowstorm based on NESIS (Northeast Snowfall Impact Scale). The snow crippled transportation, left hundreds of thousands of homes without power, and damaged untold numbers of shrubs and trees due to the heavy weight of the accumulation.

The winter would have been extraordinary even without another flake of snow. But then round three struck. The Nor'easter that blasted the region on February 10-11 was a true blizzard, with powerful winds that caused whiteout conditions. The 10 to 20 inches that smothered the urban areas from Washington, D.C. to Philadelphia, Pennsylvania, added to the deep snowpack already on the ground, resulting in depths (two-three feet plus) rarely if ever seen in this part of the country. Due to the amount of snow deposited on populated areas, this was also rated a Category 3 storm, the third since December. In addition, the new snowfall totals took the winter season numbers over the top, upsetting records established more than a century ago. Over 55 inches fell from December to February in Washington, D.C., while the northern suburbs picked up officially as much as 98 inches, including 55 inches in nine days—numbers that seasoned weather observers thought they would never see in their lifetimes. From Washington, D.C. to Philadelphia, Pennsylvania, and Atlantic City, New Jersey, this was not only the snowiest February on record, but the snowiest month ever. And, despite March being essentially snowless, Richmond, Virginia (28.0 inches); Washington, D.C. (56.1 inches at DCA and 73.2 inches at IAD); Baltimore, Maryland (77.0 inches); Philadelphia, Pennsylvania (78.7 inches); Wilmington, Delaware (72.7 inches); and Atlantic City, New Jersey (58.1 inches) all set records for the snowiest winter since modern recordkeeping began more than 130 years ago.

On February 11-12, a storm spread snow across the Deep South, dumping 12.5 inches on Dallas- Fort Worth, Texas, establishing a 24-hour record. Every southern including Florida, witnessed snowfall with this weather system. Satellite images depicted at least some snow on the ground in all of the lower 48 states on February 12.

In late February, it was New England and New York's turn, as two back-to-back Nor'easters that struck the region on February 23-28.

Top 10 U.S. Weather Events 2010

1. Snowmageddon. The "Snowmageddon" of February 5-6 that dumped 2 feet of snow from Washington DC to Philadelphia, followed by the blizzard 5 days later, broke monthly and seasonal snowfall records, going back more than 130 years.

2. Heat, waves in June, July, and August combined to make this the hottest summer (June-August) in at least 116 years from Mississippi to Rhode Island. It was the hottest summer on record in Washington, Baltimore, and New York City.

3. Nashville Flood- Torrential rains brought unprecedented flooding to Tennessee and Kentucky in early May, with 12 to 19 inches of rain. This causing catastrophic river flooding in the Nashville area Flood costs exceeded \$2 billion in Greater Nashville, with over 1,000 structures damaged.

4. Late February Nor' Easter- Back-o-back Nor' Easters on February 23-28 dumped 20 inches or more of snow from New York City into New England, with over 40 inches at some locations. This was the third major Northeast snow storm of the year, and the fourth this winter.

5. December Pacific Storm- A series of Pacific storms slammed into the Pacific Coast on December 17-23, creating epic run and snowfall accumulations One to 2 feet of rain brought flooding, mudslides, road closures, and evacuations to lowland areas of southern California, while 4-13 feet snow buried western mountains.

6. October Midwest Extra-tropical Storm- One of the strongest low pressure systems in the history of the Central U.S. tracked across the Upper Midwest on October 26 and 27, bringing heavy snow, damaging winds, severe thunderstorms and tornadoes to much of the Midwest. The minimum pressure, of 955.2 mb (28.21 inches) was the lowest ever recorded in the Central U.S.

7. April Tornado Outbreak- During a major severe weather outbreak across the South on April 22-25, 142 tornadoes raked the region, including 77 on April 24 alone. Ten died from the long-track tornado that swept across Mississippi on April 24.

8 May Tornado Outbreak- On May 10, Oklahoma experienced its largest tornado outbreak since 1999, with 55 tornadoes, two of which were rated EF4. The tornadoes, which caused severe damage in the southern suburbs of Oklahoma City and near Norman, took 3 lives, injured 81 people, and caused \$2 billion in insured losses.

9. December Nor'easter- The Nor'easter on December 26-27 dumped 10-20 inches of snow from North Carolina to New England, stranding thousands of holiday air travelers. This was the fourth major snowstorm to affect the region this year.

10. January Pacific Storm- A series of Pacific storms hammered the West on January 17-23. A foot of rain flooded low-lying areas in California, up to 100 inches of snow buried the Sierra Nevada, 54 inches of snow blanketed Flagstaff, Arizona, and locations from Oregon to New Mexico recorded their lowest sea level pressure in history.

Snowfall in New York City's Central Park reached 20.9 inches, and the city's February total of 36.9 inches set an all-time monthly record. Snowfall totals exceeded 30 inches north of New York City with this storm, including 38 inches near Monticello, New York. Hunter Mountain in the Catskills unofficially accumulated four feet of snow from February 25-28.

Outstanding snow totals during February 23-27 included 43 inches in Randolph, New Hampshire; 52 inches in Woodford, Vermont; and 53 inches in Potter Hollow, New York.

Snowfall in New Hampshire's White Mountains piled up to 55 inches (Hermit Lake, 4,000 feet elevation).

Mount Washington in New Hampshire experienced 14 consecutive hours with 100-mph wind gusts. As the storm moved onshore across southern New England on February 25-26, the pressures dropped, as low as 28.68 inches (971 mb) in Milton, Massachusetts.

The late February storm also earned the rank of Category 3 based on the NESIS scale, and ranked 15th of all such storms in the past 55 years.

Nationally, meteorological winter (December- February) ranked as the coldest since 1984-1985.

Stormy Spring

Storms kept on targeting the Northeast in March, although without the deep snows.

After three significant low pressure systems drenched the region, Massachusetts, Rhode Island, and New Jersey all measured their wettest March in 116 years.

Of the storms striking the Northeast in March, the huge Nor'easter that hammered the region on March 12-14 was the fiercest.

Heavy rain and snow melt triggered flooding from southern New Hampshire to northern Virginia, and numerous rivers ran over their banks.

But the wind damage might be the most memorable feature, especially in the New York City area.

JFK airport recorded a 75-mph gust on March 13, and the tree damage in southern parts of New York State and Connecticut was reminiscent of a hurricane.

Broken trees and 50-plus mph winds extended all the way to Massachusetts. The snapped trees and power lines left over 1 million homes and businesses without power.

Another rainstorm on March 29-30 pushed numerous rivers over their banks in Rhode Island and Massachusetts, resulting in historical flooding across Rhode Island.

Residents in East Providence clamored aboard boats to evacuate their homes. Storm total rainfall reached 9.97 inches in Washington County, Rhode Island.

The monthly total of 16.34 inches set an all-time monthly record in Providence, Rhode Island, and Boston, Massachusetts, with 14.87 inches, had its soggiest month in 55 years.

April often sees an uptick in severe weather and this held true in 2010.

The biggest and deadliest outbreak of the year tore across the South on April 22-25, when 142 tornadoes raked the region. Forty twisters stuck on April 22 and 77 on April 24. The latter day's storms concentrated in Mississippi, Alabama, Tennessee, and Kentucky. A long-lived twister left a trail of destruction extending over 149 miles from Louisiana through Mississippi, resulting in 10 deaths and 75 injuries. This EF4 storm, which grew to a width of 1.75 miles, sported the fourth longest track in Mississippi history. This storm destroyed part of Yazoo City,

Mississippi. The Swiss Reinsurance Company estimated insured damages with this outbreak at \$1.58 billion. Following an abnormally cold winter for most of the nation, temperatures flipped to the warm side over areas east of the Continental Divide beginning with spring. Already in early April, a heat wave spread across the Mid-west and Northeast. The record heat that affected the region on April 6-7 included 93°F at the Washington-Dulles Airport on April 6, the earliest 90-degree reading of record, On April 7, Newark, New Jersey, shattered its daily record by seven degrees when the maximum temperature rose to 92°F The Northeast ended up with its second warmest April in 116 years.

But winter would not fade away that easily, and April snows struck the mountains in the Northeast and the West. In New Hampshire, Mount Washington reported 21.5 inches of snow on April 27-28 and wind gusts to 80 mph. In Utah, Alta picked up 47 inches of snow on April 5-6.

At the start of May, a strong upper-level trough moved into the Plains, triggering numerous severe thunderstorms and torrents of rain in the Tennessee River Valley. May 1-3 totals exceeded six inches across Kentucky and Tennessee, with over 10 inches in central and western Tennessee. The 13.57 inches that inundated Nashville on May 1-2 shattered rainfall records and brought on a 1-in-1000-year flood. By May 3, swollen rivers had escaped their banks in eight states from Arkansas to Ohio. Officials evacuated downtown Nashville, Tennessee, as the Cumberland River overflowed, flooding such landmarks as the Grand Ole Opry House. The river crested at 11.86 feet above flood stage on May 3, the highest level since 1937. In all, flooding killed 26 people in Kentucky and Tennessee, including 11 in greater Nashville, where property damage exceeded \$2 billion. At least 11,000 structures were damaged.

A few days later, on May 10, Oklahoma experienced its largest tornado outbreak since May 3, 1999. Fifty-five twisters tore through the state, including two rated EF4. The EF4 storms took three lives and injured 81 people. Ironically, both EF4 tornadoes struck Norman, Oklahoma, home of the Storm Prediction Center and the National Severe Storms Laboratory. Fourteen additional tornadoes hit Oklahoma during May 11-13. The May 10 disaster racked up insured property losses of \$2 billion.

Later in the month, winter made another appearance in the West, with cold and snow crossing the region during May 19-25. On May 25, Salt Lake City measured its latest snow ever. The cool, snowy spring in the West provided ski areas with an extended season. Snowbird in Utah, for example, kept its lifts running into the second weekend of June.

Severe weather, heavy downpours, and flooding were a common occurrence from June to September in the Plains states and western Corn Belt this year due to the "ring of fire" effect on the western flank of persisting high pressure over the Southeast.

Deadly flash flooding hit the Plains states and the Mississippi Valley during the first half of June, Highlighted by the tragic flooding that struck an

Arkansas campground in the early morning hours of June 11- Six to eight inches of rain caused the Little Missouri River to rise nearly 20 feet in our hours, taking sleeping campers by surprise in Langley, Arkansas. Twenty people lost their lives. The upper-level disturbance that triggered these downpours also brought over 10 inches of rain northeast of San Antonio, Texas, on June 9, resulting in widespread flooding and a number of rooftop rescues.

During June 14, training thunderstorms associated with a nearly-stationary cold front and an intense low-level jet brought torrential rains to the Oklahoma City, Oklahoma, area. Six to nine inches of rain in little more than three hours caused flash floods, resulting in more than three dozen water rescues. The North Canadian River at Oklahoma City rose from eight feet to over 21 feet almost instantly during the morning of June 14, Oklahoma City's wettest day on record (7.62 inches).

The wet and stormy pattern extended into the Upper Midwest this season. Minnesota experienced a record amount of severe weather this year, thanks largely to a major tornado outbreak on June 17. Forty-eight twisters struck the state in a single day, resulting in three deaths and 45 injuries. Twenty-three additional tornadoes hit the state on June 21-26, contributing to an annual total of 104, easily setting a state record and exceeding Oklahoma's 100 tornadoes.

Severe thunderstorms struck Chicago, Illinois, the next day, damaging skyscrapers.

June rainfall was more than twice normal across the Midwest as well as the Northwest. Michigan recorded its wettest June and Iowa (10.06 inches) notched its wettest June since 1947. By late June, one of the three worst floods on record was ongoing along the Missouri River in Nebraska. **Wisconsin would go on to establish its wettest June-August in at least 116 years.** Wetness even extended into September, when heavy rains on already-wet ground triggered widespread flooding in Wisconsin and southern Minnesota.

Unprecedented Heat

High pressure over the Southeast in June blocked cool Canadian air from penetrating the region, resulting in a record hot month for dozens of cities and towns across the South and East. Both Philadelphia, Pennsylvania, and Washington, D.C. recorded their hottest Junes, with the thermometer in Philadelphia averaging 5.9°F above normal for the month. Miami, Florida notched not just its hottest June, but its hottest month on record, temperatures averaged 3.2°F above the norm. Richmond, Virginia, set record for the most days in June reaching 102 degrees F (June 24, 27, and 28).

The serious heat actually got underway over the Southwest early in the month. In New Mexico, Santa Fe hit 100°F on June 5, its first time this high-elevation city (6,300 feet) had ever reported triple-digit heat. Las Vegas, Nevada, saw its earliest 110-degree reading on record on June 6.

By mid-June, a heat wave had taken firm hold of the Southeast, with Atlanta, Georgia, reading at least 92°F on every day but one from June 12 - 29. By the end of June triple digit heat extends to the mid-Atlantic.

Additional heat waves in July and August made this a summer for the record books, as this was the hottest meteorological summer (June-August in 116 years) for 12 southern and eastern states from Mississippi to Rhode Island. Nationwide, this was the fifth-hottest and the ninth-wettest summer record. It was the hottest summer in Washington D.C.; Baltimore, Maryland; New York City, New York.

The stifling heat wave that gripped the East during July 4-8 was among the worst in decade. On July 6, temperatures rose to 100°F from Virginia to New Hampshire. Washington, DC reported 102 °F, while Hartford, Connecticut's 102-degree reading tied its all-time high.

Delaware, Wilmington's maximum of 103 degrees F made this its hottest day since July 1, 1936. New York City's similar reading made this its hottest day since August 9, 2001. July 7 saw the triple-digit heat expand from Georgia to Connecticut. Hartford, Connecticut, recorded consecutive 100-degree days for the first time since 1991. Newark, New Jersey, reported four consecutive days of triple-digit heat (July 4-7 equaling a record set in 1953 and 1993).

Where to go for relief? The West Coast escape the heat into August thanks to cool, onshore flow. San Diego, California, failed to reach 65°F on July 8. The last time thermometers could not manage to achieve 65 on a July day was in 1912.

But it was more of the same in August, as virtually the entire country east of the Continental Divide experienced above-normal temperatures, with some areas averaging as much as 5°F above normal. Alexandria, Louisiana, saw 105°F on August 2, its hottest day in nearly 10 years. St. Louis, Missouri, exceeded 100°F (102 on August 3) for the first time in three years. Even Alaska got into the act, with Fairbanks reporting a sweltering (for them) 91°F on August 15, its highest temperature so late in the summer.

Tropical Mayhem

The Atlantic Basin was very active in 2010, with 19 named storms, although no hurricanes struck the United States. A few storms, however, brought heavy rains or dangerous surf to the U.S.

Hurricane Alex brought 8.49 inches of rain to Alice, Texas, from June 29-July 2. Tropical Depression 2 made landfall a few days later on July 8 near South Padre Island, Texas, bringing more heavy rains to Texas. Meanwhile, Tropical Storm Bonnie made landfall about 20 miles south of Miami, Florida, on July 23, dumping heavy rain but causing little damage. In mid-August, a tropical depression dropped 10 inches of rain on Louisiana. Hurricane Earl dealt Cape Hatteras, North Carolina, and New England a glancing blow on September 3-4 and set off dangerous surf up and down the East Coast. The remains of Tropical Storm Hermine brought flooding rains to Texas and Oklahoma on September 7-9.

In late September, a slow-moving cold front, an upper level and surface low, and the remains of Tropical Storm Nicole interacted to produce flooding rains from the Carolinas to New England. Satellite imagery depicted an "atmospheric river" of water vapor stretching from the Caribbean to the Canadian Maritimes on September 30. The first phase of the deluge focused on the Southeast, starting on September 26 (4.20 inches Macon, Georgia) and continuing the next day (10.33 inches in Wilmington, North Carolina). As the remains of Nicole tracked toward North Carolina on September 30, tropical downpours spread into the Northeast, On September 30, Baltimore, Maryland, reported its second wettest day on record, with 6.02 inches of rain. Two-day totals on October 1 reached 7.58 inches in Wilmington, Delaware, and exceeded five inches northward into western Massachusetts. Event totals exceeded 16 inches in eastern North Carolina, and over a foot of rain fell northward into the Chesapeake Bay region. Although widespread flooding occurred, drought conditions preceding the deluge mitigated the impacts.

On the West Coast, where relatively cool conditions had prevailed for most of summer, a brief period of offshore, compressing (and depressing!) desert air reached the coast of southern California on September 27. Long Beach set an all-time high of 111 F that day, and downtown Los Angeles bested its all-time maximum with an amazing 113°F.

Later in October, a storm of virtually unprecedented intensity swept across the Upper Midwest as a Pacific jet roared eastward, an upper-level low deepened, and moist southerly flow streamed northward.

The National Weather Service Forecast Office in Green Bay, Wisconsin, summed it up nicely: "One of the strongest storms in the history of the central U.S. affected the region on October 26-27, 2010, producing wind gusts over 50 mph across much of the Midwest, severe thunderstorms and tornadoes from southeast Wisconsin and northeast Illinois to northern Alabama, and a blizzard over northern Minnesota and North Dakota." There were nearly 100 tornadoes across the Midwest, South, and East on October 24-27, and snowfall reached a foot in north-central Minnesota. **Weather maps on October 26 showed an immense low pressure system centered over northern Minnesota, with a trailing cold front extending to the Gulf Coast. The lowest reported barometric pressure of 28.21 inches (955.2 mb) out of Bigfork, Minnesota, set a record not only for Minnesota, but also for the entire central United States.** Such pressures are characteristic of those found in Category 3 hurricanes.

Déjà Vu All Over Again

Just after mid-November, the Northern Hemisphere circulation pattern reverted to a negative AO/NAO state similar to the pattern that dominated the 2009-2010 winters. This typically translates to a cold and stormy weather regime, and that's what Mother Nature handed us for the second consecutive winter.

A major low pressure system brought blizzard conditions to Minnesota and Iowa on December 10-11 as well as heavy rains to the East Coast. **The 17.1 inches of snow that blanketed Minneapolis-St. Paul made this its largest December snowstorm on record. The blizzard will be remembered for partially collapsing inflatable roof of the Metrodome stadium December 12, forcing the next Vikings game move to Detroit.**

The weather gods seemed to be playing a game of one-upmanship, as the series of Pacific that smashed into the West Coast on December 17-23 in some ways even

outdid in ferocity January storm that battered the same region the same dates 11 months earlier.

As in January, a series of moisture-laden Pacific storms came ashore on the California coast, bringing copious rain and snow to West. A foot of rain and more brought floor mudslides, road closures, and evacuations to land California, while stunning amounts of snow buried mountains in the Rockies and California. Over eight inches of rain fell in parts of Angeles, while over a foot fell in San Bernardino. A Santa Barbara location measured an incredible 18.60 inches. Crestline, in the San Bernardino Mountains reported 26.16 inches. Mammoth Mountain measured 108 to 162 inches of snow as well as 165-mph winds. Estimated snow totals in the southern Sierra Nevada ranged at 17 feet. Over six feet of snow covered slopes Nevada, Colorado, and Utah.

In the Midwest, South, and East Coast, a major winter storm messed up Christmas travel for thousands of families, as heavy snow fell from the Midwest to the East Coast. The Nor'easter that tracked from the Virginia coast to the New England coast on December 26-27 dumped 20 inches of snow from North Carolina New England. This was the fourth Category ("Major") Northeastern snowstorm of and the fifth in 13 months—an unprecedented occurrence during at least the past 60 years.

Monthly temperatures averaged far below normal from the Ohio Valley into the South. Thanks in part to early and mid-month freezes, Florida measured its coldest December on record as did Georgia. Temperatures dipping into 20s wiped out a large part of the vegetable near Lake Okechobee in Florida. Two distant cities from Wilmington, North Carolina, to West, Florida, reported record-low December average temperatures.

Not surprisingly, the eventful year closed with a bang, as a tornado outbreak on December 31 claimed five lives in Missouri and four in Arkansas.

Pages 13-20 Weatherwise May / June Volume 64/ number 3

Contributing Editor DOUGLAS LECOMTE is a retired meteorologist formerly with NOAA's Climate Prediction Center in Camp Springs, Maryland