



# NOAA *Background*

## NOAA's Top U.S. Weather, Water and Climate Events of the 20<sup>th</sup> Century

The nation's weather, water, and climate scientists of the National Oceanic and Atmospheric Administration (NOAA) had the difficult job of selecting a few of the most notable tornadoes, floods, hurricanes, and climate events that have marked the 20<sup>th</sup> Century in the United States. Factors taken into consideration included an event's magnitude, meteorological uniqueness, as well as its economic impact and death toll. Some of NOAA's best meteorological minds gave a perspective based upon their areas of expertise. The events are found in no particular order and the list is by no means exhaustive.

### A WORD ABOUT NOAA. . .

The National Oceanic and Atmospheric Administration (NOAA) conducts research and gathers data about the global oceans, atmosphere, space, and sun, and applies this knowledge to science and service that touch the lives of all Americans.

NOAA warns of dangerous weather, charts our seas and skies, guides our use and protection of ocean and coastal resources, and conducts research to improve our understanding and stewardship of the environment which sustains us all.

A Commerce Department agency, NOAA provides these services through five major organizations: the National Weather Service, the National Ocean Service, the National Marine Fisheries Service, the National Environmental Satellite, Data and Information Service, and Office of Oceanic and Atmospheric Research; and numerous special program units. In addition, NOAA research and operational activities are supported by the Nation's seventh uniformed service, the NOAA Corps, a commissioned officer corps of men and women who operate NOAA ships and aircraft, and serve in scientific and administrative posts.

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### Galveston Hurricane, 1900

On September 8, 1900, a 20-foot storm surge, associated with one of the most powerful hurricanes of the century, inundated Galveston Island in Texas. More than 8,000 people died, making this the deadliest natural disaster in U.S. history. The Galveston office of the U.S. Weather Bureau later recalled: "Sunday, Sept 9, 1900, revealed one of the most horrible sights that ever a civilized people looked upon. About 3,000 homes, nearly half of the residence portion of Galveston, had been completely swept out of existence, and probably more than 6,000 people had passed from life to death during that dreadful night. The correct number of those who perished will be probably never be known, for many entire families are missing. Where 20,000 people lived on the 8th, not a house remained on the 9th, and who occupied the houses may, in many instances, never be known."

**Technology Sidebar:** In those days, forecasters relied on ship reports, tidal measurements, barometric readings and the color of the sky as warnings of impending tropical storms. It was known that a hurricane was nearby in the Gulf of Mexico, but forecasters lacked the ability to track storms. Today's advancements in technology and science allow NOAA's National Weather Service and National Environmental Satellite, Data, and Information Service to give a forecast for the year's tropical storm activity before the hurricane season starts in June. This year's hurricane season forecast was the agency's most accurate yet.

### Dust Bowl, 1930s

An ecological and human disaster caused by the impact of years of drought on misused farmland

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throughout 100 million acres of the Great Plains. The Dust Bowl, which occurred during the Great Depression, indelibly changed the lives of every Plains resident at the time, and has continued to impact land use practices today. The Dust Bowl is often referred to as "The Black Blizzard" and "Black Roller" due to the reduction of visibility to a few feet in dust storms. The climate event forced the migration of hundreds of thousands of families to other states, looking for a better situation. This was the subject of John Steinbeck's classic tale, *The Grapes of Wrath*.

**Technology Sidebar:** Seventy years later, significant advances have occurred that enable scientists to better understand climate-scale weather events. During the summer of 1999, NOAA and its federal partners unveiled a new tool known as the National Drought Monitor, which not only summarizes the extent and intensity of drought nationwide, but forecasts whether droughts will strengthen or weaken. In cooperation with the Agriculture Department, NOAA posts these weekly assessments on the Internet (<http://www.cpc.ncep.noaa.gov/products/predictions/threats>) to allow agricultural interests to prepare for drought. In addition, NOAA will have the technology to forecast the probability of heat waves two weeks in advance by summer 2000.

### **Super Tornado Outbreak, 1974**

Within a 17-hour period of April 3-4, a strong weather system produced 148 tornadoes from the Great Lakes region southward through the Ohio and Tennessee Valleys into Mississippi and Alabama. The outbreak killed 315 people and injured 6,142. As many as six tornadoes were rated F-5 on the Fujita Scale. At the time, damage estimates surpassed \$600 million.

**Technology Sidebar:** In the early 70's, forecasters used early computer technology to produce basic forecast model to identify weather patterns to predict severe weather. Still satellite images were not clear enough, and radar images only identified rainfall patterns associated with storm systems giving them the inability to predict the formation of a tornado, and usually were unable to issue warnings before a tornado was sighted or touched down. Today, increased understanding by skilled forecasters, and new tools such as the high-resolution Doppler radar, allow detection of tornadic circulations within thunderstorms, and make it possible to issue warnings when tornadoes are in their earliest stages. The high-speed Advanced Weather Interactive Processing System (AWIPS), brings data from Doppler radar, satellites, automated weather observations and computer-gen-

erated numerical weather models into one workstation, enabling NWS meteorologists to issue faster, more accurate forecasts. All 121 U.S. Weather Forecast Offices use AWIPS daily.

### **Hurricane Camille, 1969**

Making landfall at Pass Christian, Miss. with wind gusts estimated to near 200 mph and a storm tide measured at 24.6 feet, Hurricane Camille claimed 256 lives and caused \$1.4 billion in damages (\$6.2 billion in current dollars). Camille was only the second Category 5 hurricane to strike the U.S. It's relatively small size and extreme winds made it an unusually intense storm, leaving a narrow, destructive path. More than 5,000 homes were destroyed and 13,000 others suffered damage. The storm surge was so high that one survivor was washed over Pass Christian without encountering any utility poles, buildings, or trees. The storm had a "double-barrel" effect as it caused record inland flooding after turning northeast through Tennessee, Kentucky, and Virginia before exiting into the Atlantic. The storm dumped a

record 28 inches of rain in central Virginia causing massive flooding and rain-induced landslides. Virginia counted 113 dead from a storm that came not from the Atlantic, but from the west.

**Technology Sidebar:** Camille was the first major land falling hurricane whose approach was followed closely by geostationary satellite images. Later, an operational network of weather satellites provided all NWS forecast offices with crucial data to track tropical storm activity. Since Camille, the NOAA's National Hurricane Center has improved the accuracy of its hurricane track forecasting by one percent each year, allowing forecasters to stretch warning lead time from 18 to 24 hours.

### **The Great Midwest Flood, 1993**

The costliest flood in U.S. history, huge stretches of the Missouri River (from Pipe Stem Reservation, North Dakota to St. Louis) and the Upper Mississippi River (from Minneapolis to St. Louis) overflowed their banks due to heavy rainfall, claimed 48 lives and caused nearly \$18 billion in damage. More than 15 million acres across nine states were inundated, prompting 54,000 people to evacuate. Observations found that 95 points along the two rivers exceeded previous floods of record, many by 6 feet or more. Nearly 500 points along the rivers and tributary systems exceeded flood stage at some time during the event, and although the most intense flooding occurred from June to August, some areas remained above flood stage for five straight months.

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**Technology Sidebar:** Since this catastrophic flood, the NWS has developed a sophisticated, high-technology flood forecasting and water management tool called the Advanced Hydrologic Prediction Service (AHPS). A recent two-year test in the Des Moines, Iowa river basin has proven AHPS to accurately provide flood forecasts hours, days, and even weeks before the waters rise. The agency will soon field AHPS in the upper Midwest and Ohio River basin, and with additional funding, hopes to implement the service nationwide.

### **El Niño Episodes 1982-83 and 1997-98**

In the later part of the 20<sup>th</sup> Century, NOAA scientists learned more about how these climate episodes shape global weather patterns. The latest El Niño has been called the "Event of the Century" for its bold impacts on extreme weather events. One hundred year rainfall records were set in the Southeast, one hundred year warm temperature records were set in the upper Midwest, and a series of strong storms, which included early season tornadoes in Florida, hammered the east coast states during the 1997-98 El Niño episode.

### **Top U.S. Weather Events of the 20th Century**

Galveston Hurricane, 1900  
Dust Bowl, 1930s  
Super Tornado Outbreak, 1974  
Hurricane Camille, 1969  
The Great Midwest Flood, 1993  
El Niño Episodes 1982-83 and 1997-98  
Hurricane Andrew, 1992  
New England Hurricane, 1938  
Superstorm, March 1993  
Tri-State Tornado, 1925  
Oklahoma/Kansas Tornado Outbreak, May 3-4, 1999  
The Great Okeechobee Flood and Hurricane of 1928  
Florida Keys Hurricane, 1935  
New England Blizzard, 1978  
Storm of the Century, 1950

**Technology Sidebar:** The 1997-98 El Niño was a milestone for the NWS' long-range weather and climate forecast abilities. Scientists at NOAA's National Centers for Environmental Prediction saw the recent El Niño coming as early as six months in advance, and began issuing its forecast. That forecast, according to a report published by the American Meteorological Society, prompted California to conduct major mitigation efforts, which helped save the state about \$1 billion in losses.

### **Hurricane Andrew, 1992**

The costliest hurricane in U.S. history, Hurricane Andrew raked across southern Florida and Louisiana, causing 23 deaths and \$25 billion in damages. More than 138,000 homes were destroyed and 86,000 lost their jobs. Some say the storm permanently altered the area's economy and forced the closure of Homestead Air Force Base, which was leveled by wind damage. Had Andrew crossed the Florida coast just 10 miles further to the north, it would have devastated downtown Miami. Andrew serves as the benchmark when discussing potential devastation to populated coastal areas.

**Technology Sidebar:** The NWS provided one of its most accurate hurricane forecasts thanks to computer models that predicted the initial landfall south of Miami and the subsequent landfall near New Orleans three days in advance. Many of the NWS' dedicated cooperative weather observers in South Florida braved Andrew's intense and deadly conditions and continued to send weather information to forecasters right up until the time when their instruments, or homes, were destroyed.

### **New England Hurricane, 1938**

This was one of the most destructive and powerful storms ever to strike southern New England, and was the first tropical storm to hit the heavily populated area of the Northeast in modern times. The storm roared ashore over Long Island, N.Y. at nearly 60 miles per hour, at the time of high tide on September 21<sup>st</sup>. This created a deadly tidal surge, which even submerged downtown Providence, R.I. under 20 feet of water. Hurricane force winds were felt throughout New England, with a gust to 186 miles per hour recorded at the Blue Hill Observatory in Milton, Mass. The Great New England Hurricane of 1938 was responsible for nearly 600 deaths and 1,700 injuries in Southern New England, along with catastrophic property damage estimated at \$400 million.

**Technology Sidebar:** As the storm, later called the "Long Island Express," neared Long Island, and three hours before high tide, residents reported seeing a

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thick bank of fog between 25 and 40 feet above the water. The fog bank turned out to be a massive wall of water, or a storm surge. A storm surge equals the magnified effects of an unusually high tide and forward speed of the storm. The New England Hurricane narrowly missed Manhattan by 55 miles to the east. Forensic hurricanologists agree that New York City would have been devastated had the storm been a few miles more to the west. Today, NWS storm surge experts use high-tech, 3-D models that simulate the impacts of a hurricane's incoming waters and help prepare communities living along the coasts.

### **Superstorm, March 1993**

A gigantic low pressure system screamed up the eastern seaboard, bringing everything from a storm surge to the western coastline of Florida to nearly 60 inches of snow in some parts of the Appalachian. This storm will long be remembered for paralyzing the entire eastern seaboard, at one point shutting down every airport on the Washington/Boston corridor. The superstorm was responsible for 79 direct deaths and more than 600 injuries, along with \$2 billion in damage. It was one of the most well-forecasted storms in history, with timely warnings that limited the death toll of this fierce weather system.

**Technology Sidebar:** At the time of the 1993 Superstorm, the NWS' ability to predict accurate snowfall amounts was 37 percent. In 1997, the accuracy improved to 45 percent. The NWS is striving to reach a goal of 75 percent snowfall accuracy by 2005. While this storm will be long remembered for its heavy snow in the Mid-Atlantic and Northeast, it impacted every state in the south with torrential rains, a deadly coastal surge, tornadoes and hail.

### **Tri-State Tornado, 1925**

The deadliest tornado in U.S. history swept down the Ohio Valley on March 18, cutting a 219-mile long swath in areas of southeast Missouri, southern Illinois and southwest Indiana. At times, some observers said, this mammoth tornado was a huge, black wall of debris, moving at speeds topping 60 mph. This tornado claimed 695 lives and holds the record for the most lives lost in one location – 234 – in Murphysboro, Ill. The tornado also holds the U.S. record for the longest continuous track on the ground, and the longest duration – 3½ hours. It is also the third fastest forward-moving tornado at 62 mph.

**Technology Sidebar:** The Tri-State Tornado occurred more than 20 years before the first official tornado warning issued at Oklahoma's Tinker Air Force in 1948. In 1925, the NWS, then called the U.S. Weather

Bureau, had no ability to provide advance warning of tornadoes. However, the Tri-State Tornado helped to raise awareness among meteorologists about the prevalence of a "tornado season" and paved the way for a formal tornado warning program.

### **Oklahoma/Kansas Tornado Outbreak, May 3-4, 1999**

This was the most expensive tornado outbreak in U.S. history. In less than 48 hours, a total of 74 tornadoes touched down across the two states, with as many as four tornadoes from different storms on the ground at once. An F-5 tornado, the strongest on the Fujita Tornado Scale, tracked for 40 miles, skirting south of Oklahoma City through the communities of Moore and Chickasaw. The tornadoes killed 42 people, injured 800, and caused \$1 billion in damage, including the destruction of portions of Oklahoma City.

**Technology Sidebar:** The event proved the effectiveness of the modernized National Weather Service and its improved tornado warning system where the average lead time was 21 minutes (up from an 11 minute average), with some areas receiving more than 30 minutes notice before being hit. NOAA storm researchers estimate that more than 600 people would have died in the absence of warnings. During this tornado outbreak, a mobile Doppler radar on wheels recorded the strongest winds ever measured on earth – 318 mph.

### **The Great Okeechobee Flood and Hurricane of 1928**

An immense Category 4 Hurricane with 150 mph winds, rain and resulting flooding caused a death toll of 1,836 in Florida, and another 1,575 in the Caribbean. Some estimate the death toll as high as 3,500. The hurricane fell just short of establishing a new record low for barometric pressure at 27.43 inches (a reading of 27.37 inches was measured in 1919). Only the Galveston Hurricane of 1900 (over 6,000 deaths), the Johnstown Flood of 1889 (2,200 deaths) and the two hurricanes of 1893 (2,000 deaths each) are likely to have caused more deaths in the United States.

### **The Storm of the Century, Nov. 1950**

The first storm ever forecasted using NWS numerical model programs, brought heavy snow and hurricane-force winds across 22 states. The storm killed 383 lives and caused \$70 million in damages.

### **Florida Keys Hurricane, 1935**

The 1935 "Labor Day Hurricane," which struck the Florida Keys was the first of only two Category 5 hurricanes to make landfall in the U.S. A relief train was sent from Miami to rescue Keys residents and

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several hundred World War I veterans workings in the area. On its return trip, a storm surge — estimated at 15 to 20 feet — swept all the cars of the train from the tracks, drowning hundreds. All told, more than 400 people died as a result of this hurricane.

### **New England Blizzard, 1978**

A rapidly intensifying low pressure center stalled off the southern New England coast for more than 24 hours. Blizzard conditions and coastal flooding were the big stories in this storm, as hurricane force winds drove an angry sea onshore, causing great damage to coastal property. Snowfall amounts on the order of 30 to 38 inches fell in and around the Boston metropolitan area. The storm paralyzed New England for a week. ☹️

*For more information, contact NOAA National  
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