The September Surprise
The Great Hurricane of '38

The year is 1938. Another hot Dust Bowl summer is drawing to a close. The heat has not been as extreme this summer as in some of the prior summers this decade, but it still has been hot, by most all accounts, too hot. The hurricane season is well underway. This one has been uneventful…so far.

A STORM DEVELOPS AT SEA

On Saturday, September 10, a strong tropical wave moves quietly off the coast of Africa and out into the Atlantic where it soon becomes a tropical storm. It is a Cape Verde-type storm, typical of that time of year, in a La Nina summer, long before we knew what that meant. For the next 6 days, it spirals slowly westward and intensifies. On Friday, September 16, the Brazilian vessel S.S. Alegrete reports that the storm, now a hurricane, is currently located off the Leeward Islands in the Atlantic and is still moving to the west.

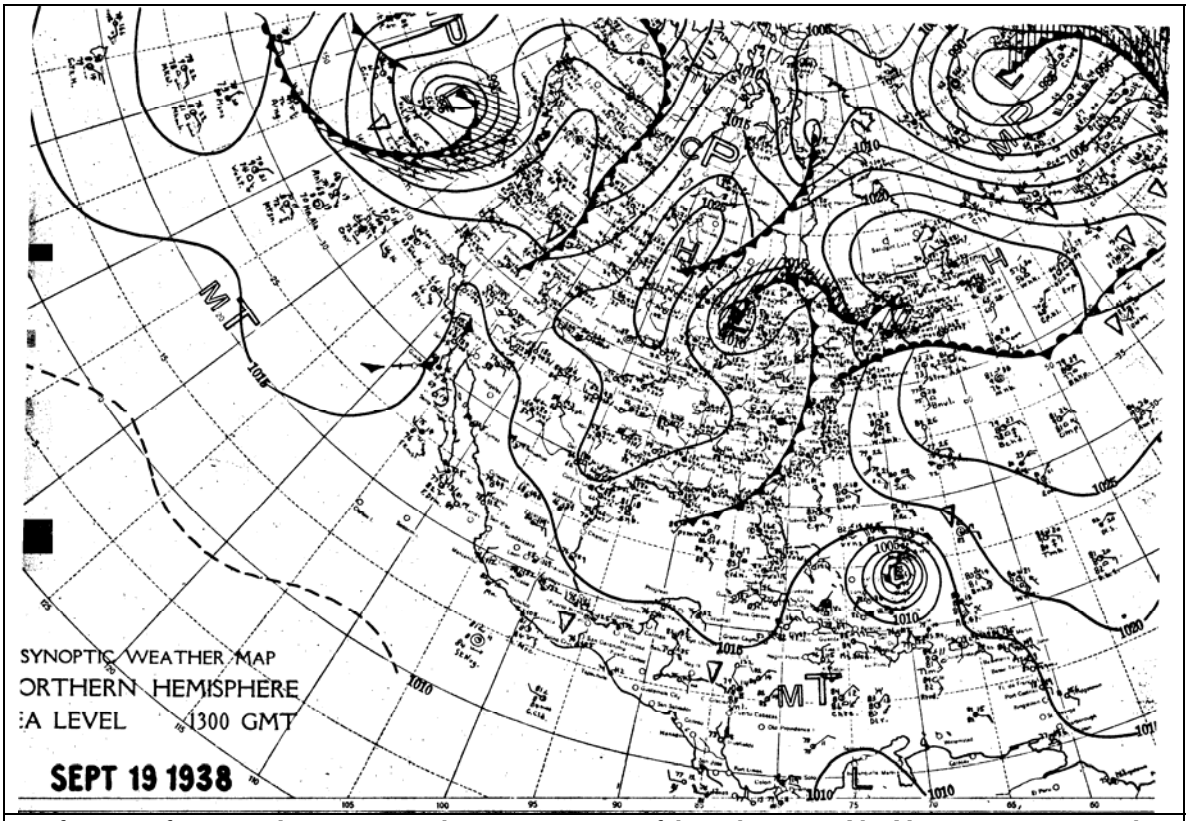
On Sunday, September 18, the storm is situated due north of Puerto Rico and due east of the Bahamas. It is travelling west now at a goodly speed - 15 to 20 mph, on a track towards southern Florida. Gordon Dunn and Grady Norton, U.S. Weather Bureau forecasters in Florida, issue a hurricane warning for Miami for expected landfall on Tuesday, September 20. Miami residents react quickly - stockpiling supplies, boarding windows and securing their boats.

Floridians take talk of hurricanes seriously. Just three years before in 1935, the strongest hurricane ever to hit the United States inundated the Florida Keys with winds of 200 mph. Miami residents no doubt had read of the many terrifying stories of that storm. One horrific tale told of people caught outside who were sandblasted to death - all that was left were shiny belt buckles and shoes. This 1938 storm, though not quite as strong as the 1935 storm, has now become a category 5 hurricane (the most powerful category on the Saffir-Simpson Scale of hurricane intensity).

MONSTER STORM TURNS TO THE NORTH

On Monday, September 19, the storm takes a sudden turn to the north as so many Cape Verde storms do. Meteorologists know this as recurvature. Forecasters breathe a collective sigh of relief. Every prior storm since 1900 that took this turn in this location continued on a big graceful curve that brought it harmlessly out to sea. Forecasters thought that this storm surely would do the same - the prevailing westerly winds to the north would see to it.

New York City and New England barely take notice. New York had not felt the power of a major hurricane since 1821. Not since 1815 had a storm of this intensity struck New England. Most people have never even heard of the word hurricane or are totally unaware that they can affect non-tropical climes.

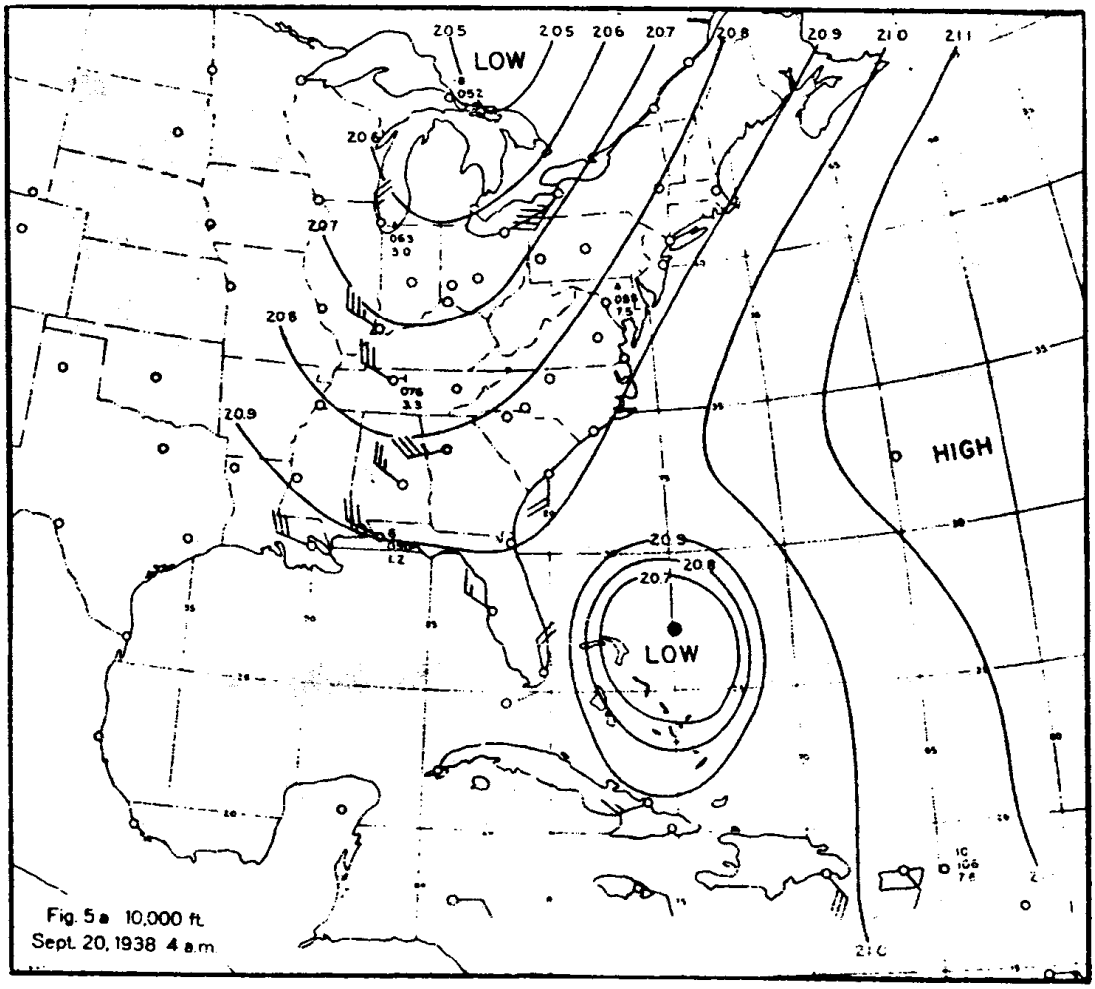


Surface Map for September 19, 1938. The Hurricane east of the Bahamas and had begun recurving north. Rains have been falling across New England as moist tropical air was flowing north around a strong western Atlantic (Bermuda) high pressure system.

The storm moves out of range of observing stations after it passes the Bahamas. It would be more than 20 years until we had "eyes-in-the-sky" - weather satellites to monitor storms in the open sea. This "stealth" storm is out there, but forecasters can only guess where it is now and where it is going.

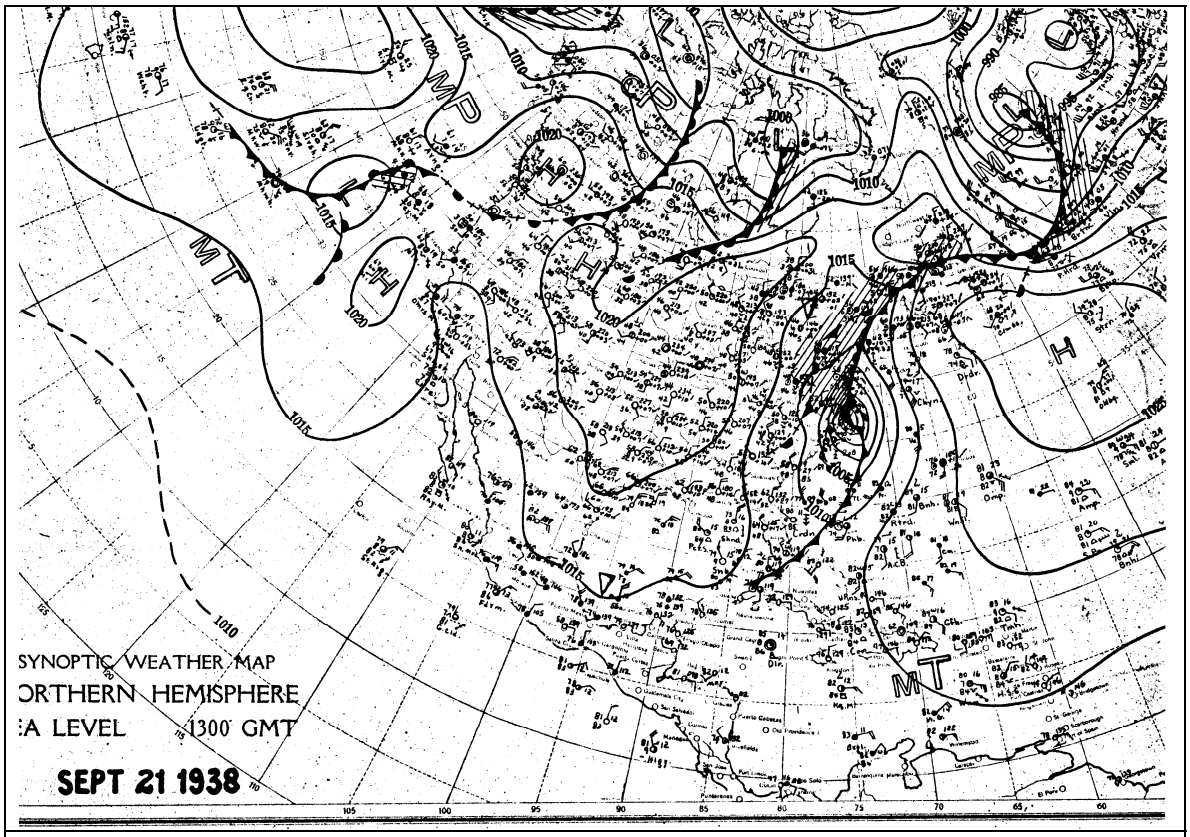
A MISSED FORECAST

As the storm moves away from Florida, the responsibility for monitoring and forecasting the storm passes to the Washington D.C. Weather Bureau office. The forecasters there also believe that the hurricane will be heading out to sea and away from the mainland, all except one junior forecaster that is. Charlie Pierce, 28, filling in during a noon forecast meeting for two senior forecasters who were off duty, argues that a strong Bermuda high, north of its normal position could steer the hurricane towards New England. Unfortunately, the tunnel-vision viewpoint of more senior forecasters prevails and no hurricane warnings are issued.



The 10,000 foot wind pattern at 4 am on September 20th. Note the storm is east of the Bahamas and being caught in a "confluent" flow which will turn the storm north and accelerate it

Even a report of incredibly low pressures (27.85 inches) by the passenger ship Carinthia is inexplicably ignored. At 7 a.m. on Wednesday, September 21, the powerful storm is now east of Cape Hatteras and accelerating north at forward speeds that would soon reach 60 mph or greater.

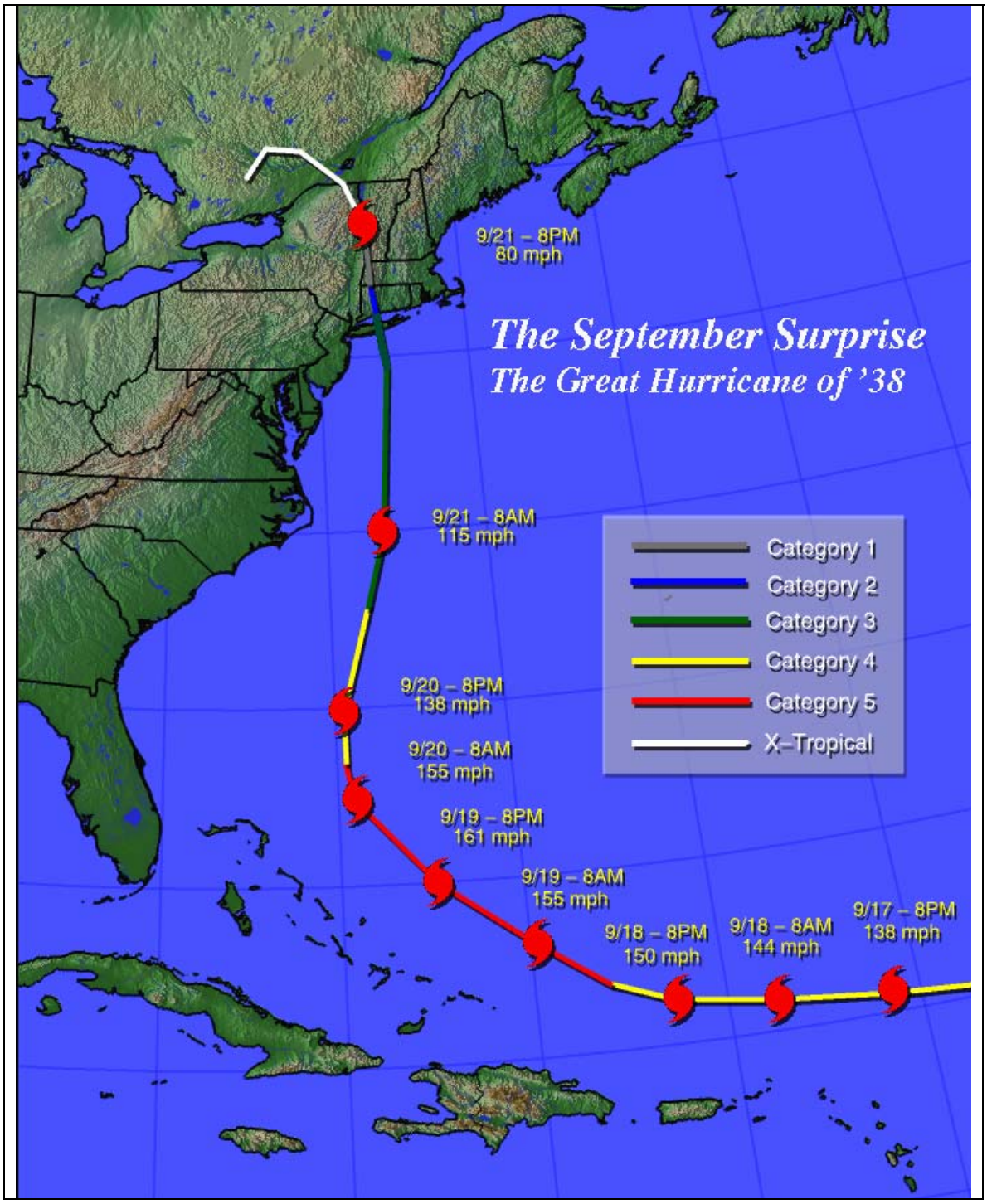


Surface Map for September 21, 1938. The Hurricane is now east of Cape Hatteras and accelerating north. Heavy rains continue across New York and New England as moist tropical air flows over a stalled frontal system. The storm was now accelerating north.

The fury contained within this storm is incredible-- the equivalent of three 10 megaton bombs exploding every hour. Little did residents of New York and New England know, but that fury was soon to be unleashed on them.

CAUGHT BY SURPRISE

As the storm races north and the winds and seas increase and rains begin, forecasters are forced into a reactive mode. At 10:30 a.m. on September 21, "storm warnings" are issued for the offshore waters from Atlantic City to Block Island. It is upgraded to a whole gale warning at 12:30 p.m. as the winds steadily increase. At 2:30 p.m., the 50-mile wide eye of the storm is over Long Island with a central pressure of an unprecedented 27.94 inches. Wind gusts estimated as high as 150 and 200 mph are pounding parts of Long Island and the offshore waters.



As the eye of the storm approaches Long Island, south coast residents watch as a thick bank of "fog" twenty-five to forty feet high rolls in towards the south-facing coast. But what they think is a fog bank is really the storm surge, a virtual mountain of water that is associated with the extremely strong winds and low pressure near the center of the storm. Many die on Long Island as this wall of water smashes ashore. Huge waves, of 30 feet or more atop the storm surge add to the destructive power. The storm tide completely

engulfs Fire Island. The impact of the storm surge is so great, that it actually shows up on the earthquake seismographs at Fordham University in New York City and Sitka, Alaska.

After a quick trip across Long Island, the great Hurricane speeds to New England, again with a killer storm surge. Storm tides of 14 to 18 feet are experienced across most of the Connecticut coast with 18 to 25 foot tides from New London to Cape Cod. In Narragansett Bay, a storm surge of 12 to 15 feet destroys most coastal homes, marinas and yacht clubs.

The front page headlines of the morning newspaper in Providence, Rhode Island on September, 21, 1938, the day of the storm, were all focused on the situation in eastern Europe and the German threat. There was no mention of a storm. The city is first alerted at 3:40 p.m. that the storm is coming. Just over an hour later, the storm was devastating the city. Providence reports 100 mph sustained winds with gusts to 125 mph. But the real killer is the water. Downtown Providence is submerged under a storm tide of nearly 20 feet. The storm tide carries boats and houses into the capital, flooding downtown buildings, where workers are just preparing to leave for the day. Having no idea what a storm surge is, many workers do not evacuate and are trapped and drown where they work.

Hurricane winds prevail all across Long Island and southern New England. The strongest official winds are measured at Blue Hill Observatory with 121mph winds and a maximum gust of 186 mph.

The fast moving storm continues to accelerate. Already by 8 p.m. on September 21, the center of the storm is over Vermont and by 2 a.m. over Montreal. The storm in many cases moved faster than the news about it spread. Millions are caught by total surprise all the way from Long Island to Southern Canada.

WIDESPREAD DEVASTATION

Officially 564 deaths were attributed to the hurricane, but many believe the death toll may have been closer to 700. Another 1,700 were injured. The great Hurricane of '38 remains the fourth deadliest hurricane in U.S. History.

A total of 16,740 structures were destroyed and many more damaged. 16,000 families were displaced or left homeless. The toll for the mariners could only be described as catastrophic. Over 2,600 boats were lost or destroyed beyond repair and another 3,300 damaged.

The landscape was instantly and permanently altered. Debris was everywhere. An estimated 2 billion trees were downed along with 20,000 miles of electric power and telephone lines. The wind-driven rains carried dissolved ocean salt, which damaged vegetation 50 to 100 miles inland. There were reports of a sea-salt residue on windows in Montpelier, Vermont.

And then there was the water, tons of it. During the rainfall that preceded and accompanied the hurricane, an average of 11 inches of rain fell over a 10,000 square mile area. Four days of rain culminating in the hurricane downpours left 10 to 17 inches in the Connecticut River Valley, resulting in some of the worst flooding ever recorded there. The wave of flooding inflicted major damage from New York and Connecticut to Massachusetts and Vermont.

In 1990 dollars, the Great Hurricane of '38 left in its wake approximately $3.6 billion damage throughout New York and New England. Christopher Landsea, a meteorologist at the Hurricane Research Division and Roger Pielke Jr., at the National Center of Atmospheric Research looked at the most destructive hurricanes and estimated the cost if they were to hit today. The Hurricane of '38, they found would be the sixth costliest of all-time. In 1998 dollars, their study estimates that a repeat of the '38 storm would produce $18 billion in damages today.

THE WORST POSSIBLE SCENARIO

There were numerous factors conspiring to make this storm so devastating.

The hurricane's forward speed accelerated to 60 to 70 miles an hour as it moved north of Cape Hatteras. This fast speed minimized the time the storm was over cold water. Hurricanes thrive over waters that are 80°F or warmer, and they weaken over colder water. The warm Gulf Stream current bends northeast off of Cape Hatteras. Water temperatures to the north of the Cape drop below the critical 80°F. The fast moving storm of '38 spent only 6 to 8 hours over the colder water after it left the Gulf Stream, and therefore did not have time to weaken. Other hurricanes that have hit New England the last few decades - all moving much slower - weakened more and as a result were barely classified as hurricanes when they came ashore.

In fast moving storms, the momentum of forward movement makes the net effect of the wind in the storm's right front quadrant much greater. You can virtually add the forward speed of motion of the storm to the storm produced winds in that quadrant. In the case of the Hurricane of '38, the storm tracked into central Long Island and then across western New England putting eastern Long Island and much of southeastern New England in the worst possible location for wind damage.

The storm struck at or near the time of high tide and close to the autumnal equinox and new moon, both of which factors produce higher than normal tides even in the absence of a storm.

The storm was out over open water and in a location where, in the days without satellite, radar or weather buoys, there were no observations for many hours. Forecasters did not know exactly where the storm was until the direct effects began to be felt as it approached Long Island. As a result, millions of people had no warning of the pending disaster.

Both forecasters and the public were inexperienced with landfalling storms in the Northeast. It had been many decades since one affected that region. Most believed the region was safe from hurricanes.

Three days of heavy rains preceded landfall, which saturated soils and caused rivers to rise to bankfull levels even before the hurricane's rains arrived. This helped make flooding from the storm more immediate and serious. This one-two punch is not uncommon when hurricanes and tropical systems make landfall along the East Coast. This is because in situations where a tropical system recurves to the north as it approaches the coast from the Atlantic, a trough is usually in place aloft in the eastern United States. This trough produces the southerly steering winds that turn the storm to the north. Ahead of the storm, this same southerly flow brings moist tropical air to the north, which can enhance rainfall along any frontal system in that region. That was clearly the case in the 3 days before the Hurricane actually mad landfall.

COULD IT HAPPEN AGAIN?

It is not a matter of could a similar hurricane happen again, but really a matter of when it will happen again.

It appears unlikely that we could see another total surprise. Certainly, with the help of satellite and radar, we should never lose sight of a storm out at sea again.

Also, today we have computer models that predict where the storms are likely to go. Yes, the computer models still have large errors, especially in uncertain steering situations. (Remember the January 2000 blizzard surprise in the Mid-Atlantic region!) But in a situation like the 1938 hurricane, when a strong upper trough and a displaced Bermuda high in the Atlantic combined to channel the storm rapidly north, one would think today's models would be more consistent and the uncertainty less.

But then again, a fast moving storm means less warning. It took just 8 hours for the storm to travel from off of Cape Hatteras to New England. It may take more than 24 hours to evacuate places like Cape Cod, the islands and parts of Long Island. Bridges and ferries may close down before the worst of the storm arrives, stranding many thousands on congested and flooded roadways.

New York City according to the U.S. Army Corps of Engineers (1990 study) is the third most vulnerable city for a hurricane disaster. According to the SLOSH (Sea, Land and Overland Surge from Hurricanes) program used by forecasters, a category 4 hurricane would put New York's JFK airport under 20 feet of water. Storm surges as high as 29 feet would occur with landfall over Long Island.

Water would rush through the Holland and Brooklyn Battery Tunnels and into the city's subways system likely resulting in a heavy loss of life. In a category 3 storm, Montauk Highway and much of the north and south forks would be under water.

Today, thanks to the intense media and television coverage, everyone knows the potential impact hurricanes can have. We have all seen the death and destruction they leave in their wake in places like Florida and the Carolinas.

Yet a very large percentage of people who live in populated areas of the Northeast (more than three-quarters in a recent study) have never experienced a major hurricane. Tens of millions of people who have been through a tropical system have experienced weak, tropical storms or minimal hurricanes, and not a major category 3 or 4 system. Many mistakenly believe that the worst these storms can do there is to produce minor inconveniences, a few downed tree limbs or trees, and temporary power outages.

In reality strong hurricanes threaten to bring a wall of water two stories high, winds on a large-scale the equivalent of an F2 or even F3 tornado, and a normal season's rainfall in a day.

The stark television images burned into our minds of the more recent devastation with Hurricanes Katrina, Rita, Wilma and Ivan should be constant reminders of what strong hurricanes can do.

Everyone who lives, works or vacations in vulnerable regions should recognize the danger, carefully monitor advisories when storms develop, and know what to do when watches and warnings are issued. We may not be able to significantly reduce the damage such a monster storm would inflict, but hopefully we could reduce the death toll when another storm like that in 1938, inevitably happens again.

Important to Note: This year is likely to be a La Nina summer in a warm Atlantic AMO era not unlike the one that brought the great '38 hurricane to the New York and New England.