HOUSTON / GALVESTON NATIONAL WEATHER SERVICE

2009 Remembering IKE

HURRICANE WORKSHOP






Storm Surge

Power Restoration

Hurricane Winds

hurricaneworkshop.com

Welcome

Welcome to the 2009 Houston/Galveston Area Annual Hurricane Workshop. The purpose of our workshop is to increase public awareness of the hurricane hazards for our area and to give citizens useful information on how to prepare for and respond to a land falling hurricane.

The theme for the 2009 Workshop is "Remembering Ike". In 2008 Hurricane Ike made a direct impact on the Houston/Galveston region. A storm surge that has not been seen in this area since Hurricane Carla in 1961 and power outages that impacted over two million people were the result of this large hurricane. The preparations that were made prior to the 2008 hurricane season were extremely valuable but many more lessons were learned from our experience with Hurricane Ike. The workshop will communicate the many lessons learned from Hurricane Ike both good and bad.

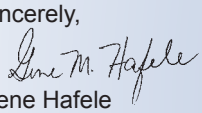
CenterPoint Energy and the City of Houston have created a private/public partnership to assist the Houston/Galveston National Weather Service (NWS) in conducting the annual Houston/Galveston Hurricane Workshop for the last 4 years. In 2008, over 1200 citizens from throughout southeast Texas attended the hurricane workshop and we are expecting over 2000 for this year's workshop. In fact a free lunch is being provided by Walmart for the first 2500 guests.

In 2009 we will continue to expand our effort to make this workshop an event for the family. The kid's area will return for the third straight year and will be larger and more interactive, with Radio Disney making an appearance for the second straight year. The workshop will be more interactive and opportunities to ask questions from the experts will be much easier. All activities will be located in one location making it easier to move from one venue to the next.

Our special guest this year will be Mr. Bill Read, the former Meteorologist-in-Charge of the Houston/Galveston NWS, and now the Director of the National Hurricane Center (NHC). Bill will inform the citizens of southeast Texas on some new products that will be available from the NHC in 2009 as the forecasts continue to become more accurate.

We believe you will find the workshop informative and helpful. Thank you for attending.

Sincerely,



Gene Hafele
Meteorologist in Charge
National Weather Service Houston/Galveston

Acknowledgements

The National Weather Service would like to acknowledge the contributors of several agencies, organizations and individuals that have made the 2009 Hurricane Workshop a great success.

Our thanks goes out to the Hurricane Workshop Team that has been meeting on a monthly basis since late 2008 to put together the pieces needed for a successful workshop. The members of this team represent CenterPoint Energy, City of Houston, Harris County, Interfaith Ministries, Weather Research Center and members of the National Weather Service. Special thanks go out to Jackie Miller of the City of Houston for leading this team.

CenterPoint Energy continues to be the main sponsor of this event and also provides the design for the outside of this booklet. Special thanks also go out to Sparkle Anderson for providing the leadership from CenterPoint Energy.

The City of Houston has once again provided for the use of the George R. Brown Convention Center at no cost to the NWS. This facility offers a great venue for this event that is easily accessible for the entire region.

Finally, thanks go out to several folks at the Houston/Galveston National Weather Service who contributed to the Hurricane booklet on "Remembering Ike". Paul Lewis was in charge of collecting all of the articles and providing the leadership to have the book done in a timely manner. Kim Armstrong once again pulled all of the information together and put the booklet in its final form prior to being sent to the printer.

The booklet and the workshop will help the Houston/Galveston Region get ready for the 2009 Hurricane Season as we "Remember Ike".

Front cover photos credits: Left two - NWS / Center two - CenterPoint / Right two - City of Houston

WFO Houston/Galveston National Weather Service
2009 Hurricane Workshop Booklet *"Ready or Not...Remembering Ike"*

Meteorologist-in-Charge - Gene Hafele
Editors - Paul Lewis and Dan Reilly
Design and Production - Kim Armstrong

Table of Contents

Hurricane Ike Summary.....

By Lance Wood

Track and Intensity

Hurricane Ike was a long lived tropical cyclone that originated from a well defined tropical wave which moved off of the western African coast on August 28, 2008. Bursts of convection associated with a developing area of low pressure occurred along the wave axis for the next several days; however, it was not estimated to be a tropical depression until 1:00 AM CDT on September 1st while 775 miles west of the Cape Verde Islands. The depression continued to organize and quickly strengthened to become Tropical Storm Ike just 6 hours later. Moving west-northwest around the southern periphery of a strong subtropical high, Ike strengthened and became a hurricane early on the afternoon of September 3rd when an eye became apparent on visible and microwave satellite imagery. Ike was now 690 miles east-northeast of the Leeward Islands and was in the process of rapidly intensifying. During this 24-hour rapid intensification period (1:00 AM CDT September 3rd to 1:00 AM CDT September 4th), Ike's intensity increased by 80 mph, reaching a maximum intensity of 145 mph on Thursday, September 4th. This is also the time when Ike reached its northern most point while moving across the Atlantic Ocean. Although the National Hurricane Center's day 5 forecast point had Ike reaching the eastern Gulf of Mexico, an historical analysis of past hurricane tracks from this Atlantic location indicated that it was very unlikely that Ike would reach the Gulf of Mexico from this location (**Figure 1**).

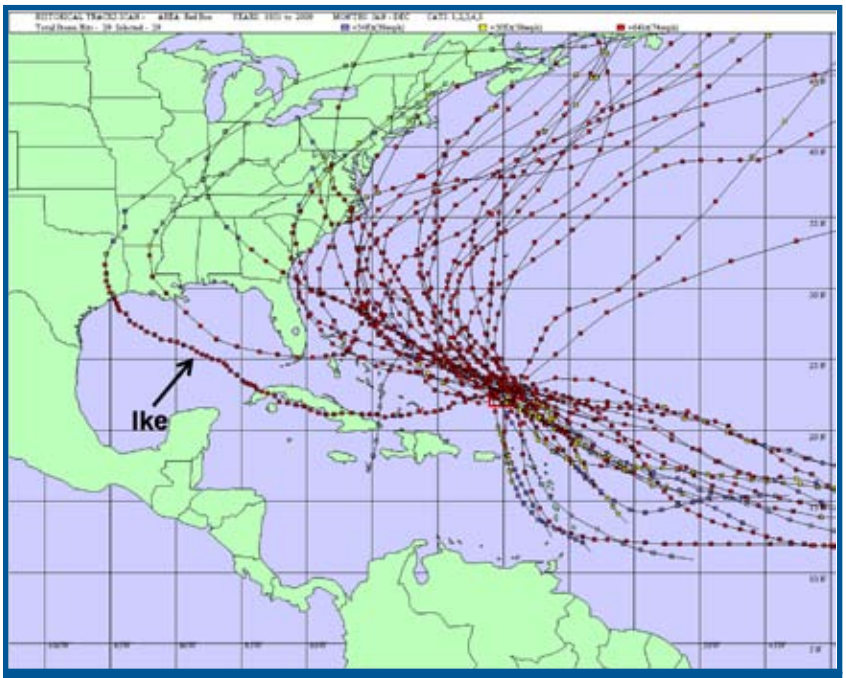


Figure 1. Hurrevac image of historical hurricane tracks since 1851 passing through a 120 Nautical Mile box centered around the position of Ike on September 4, 2008.

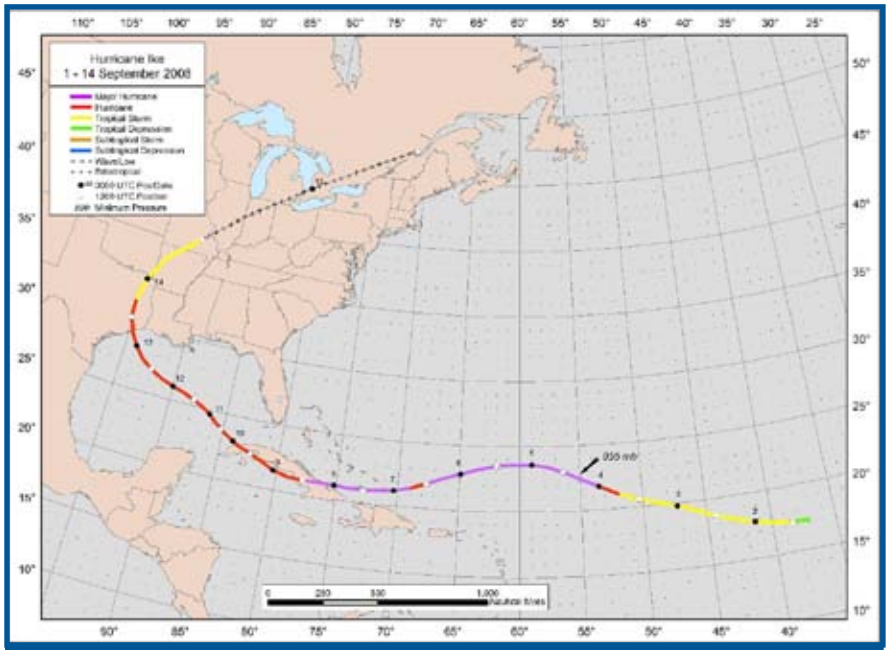


Figure 2. Track of Hurricane Ike

However, a building upper high pressure area to Ike's north induced an uncommon west and then west-southwest motion beginning on September 4th and continuing through the 7th. During this period, the storm impacted the Turks and Caicos Islands and moved across the island of Great Inagua as a Category 3 hurricane on the Saffir-Simpson scale. By late on the 7th (Sunday evening),

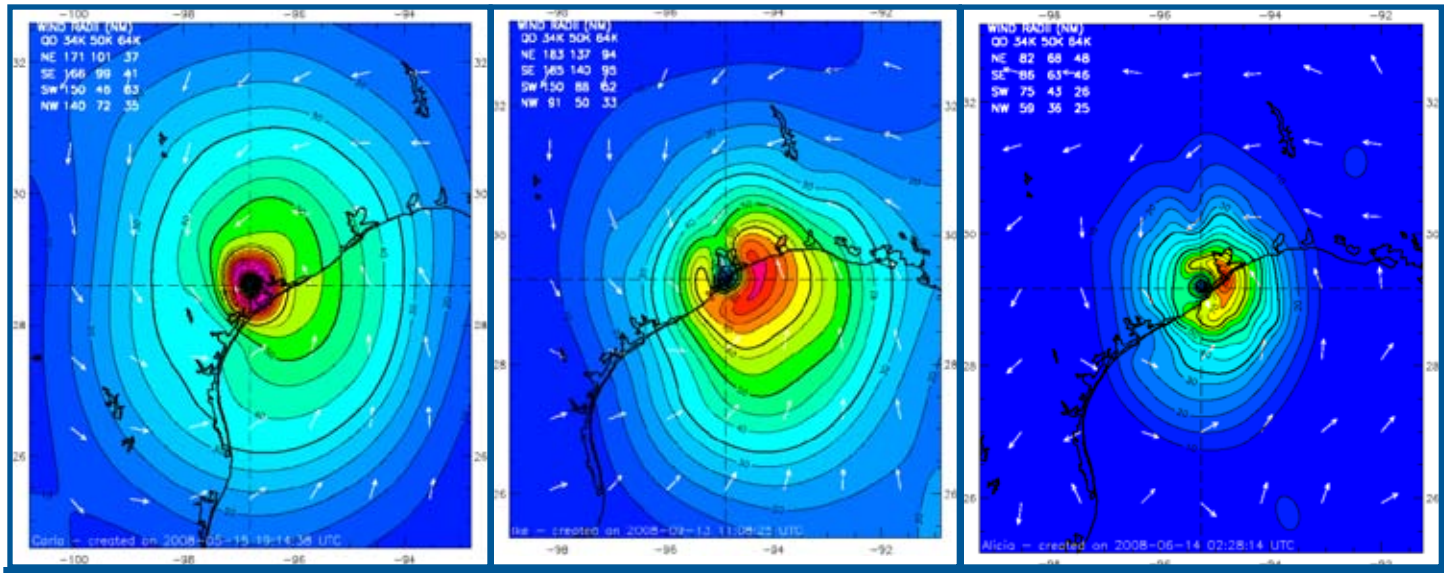


Figure 3. (a) Hurricane Carla (1961) wind field near landfall. (b) Hurricane Ike (2008) wind field near landfall. (c) Hurricane Alicia (1983) wind field near landfall. Wind speed in knots. Images are from the Hurricane Research Division.

Ike made the first of two landfalls along the Cuban coast near Cabo Lucrecia with maximum winds around 130 mph. After moving off and paralleling the Cuban coastline, Ike made a second landfall near the city of San Cristobal. Just prior to crossing the northwest tip of Cuba as a Category 1 hurricane, with winds close to 80 mph, Ike began producing tropical storm force winds across portions of the Florida Keys on Tuesday morning, September 9th. Fortunately for the Keys, it was only a glancing blow, as the hurricane continued to move west-northwest toward the U.S. Gulf coast (**Figure 2**).

Although Ike's interaction with Cuba disrupted the inner core of the hurricane and prevented rapid strengthening over the warm waters of the Gulf of Mexico, Ike did quickly grow in size. The extent of the tropical storm force winds reached 275 miles while hurricane force winds stretched 115 miles across the Gulf. Ike did slowly intensify to a Category 2 hurricane with maximum winds of 100 mph by Wednesday evening, September 10th. On Thursday September 11th, the hurricane reached the western periphery of the subtropical high and began to move due northwest towards the upper Texas coastline. Although Ike's intensity remained in the Category 2 range, the storm continued to grow and became a very large hurricane. By Friday, September 12th, the diameter of tropical storm force winds stretched a total of 425 miles from the northwest to southeast as Ike approached the upper Texas coast. Landfall was at 2:10 AM CDT Saturday, September 13th, near Galveston, Texas, with maximum sustained winds of 110 mph. Once inland, Ike moved north-northwest, just east of Interstate 45, and brought hurricane force winds to the eastern two-thirds of southeast Texas.

Size and Surge Comparison

For residents of southeast Texas, Ike will forever be remembered for its large size and significant storm surge. Although just under the sustained wind speed criteria for a major hurricane (115 MPH or greater), Ike produced the greatest storm surge across the upper southeast Texas coast since Hurricane Carla (a Category 4 storm) made landfall near Port Lavaca in 1961. Interestingly, although considerably weaker than Carla as far as maximum wind speeds are concerned, Ike did have a larger area of hurricane force winds at landfall and a similar tropical storm force wind field (**Figures 3a and 3b**). Therefore, from a total energy standpoint, Ike was very similar to Carla. This explains why the magnitude of the surge events was similar for both storms. Ike's surge was much greater, both in magnitude and areal extent, when compared to the surge produced by Hurricane Alicia (1983) – the last major landfalling hurricane to affect the

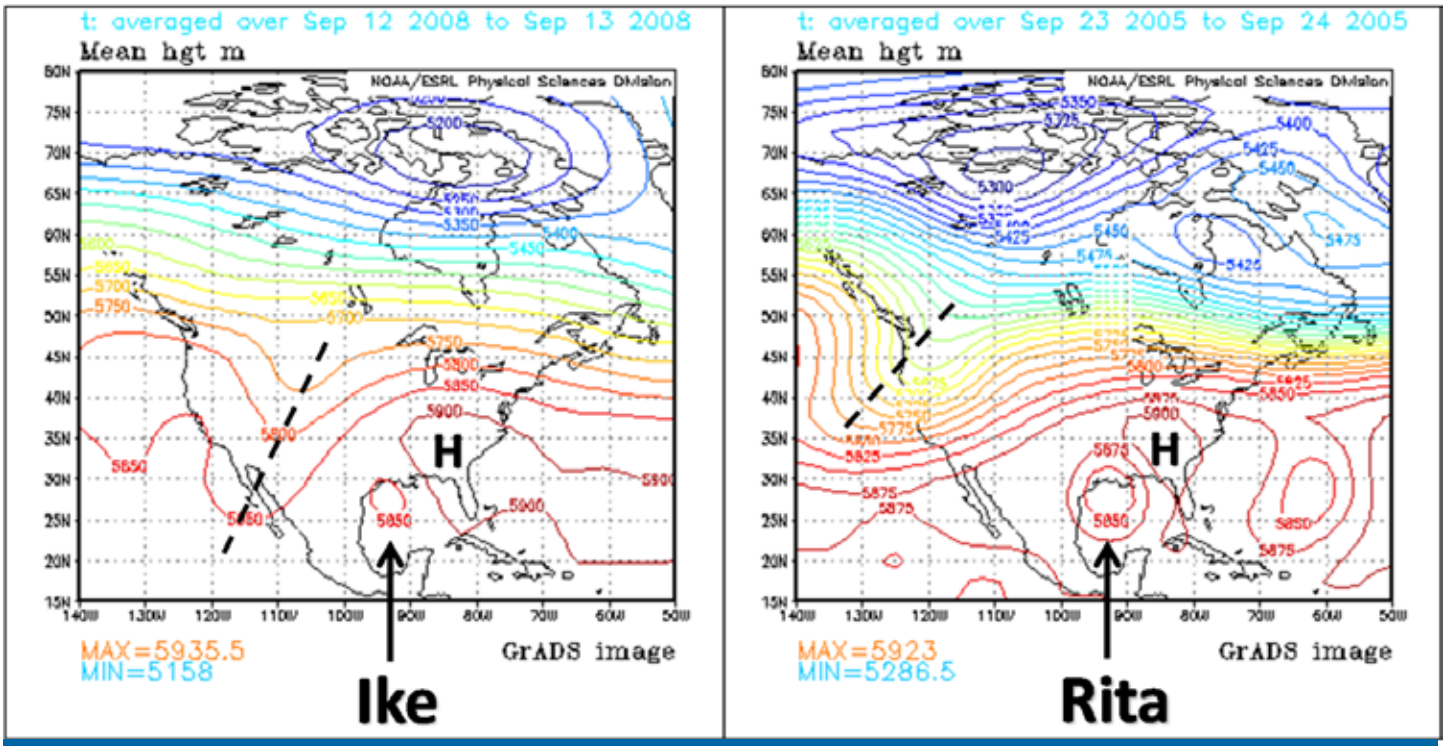


Figure 4. 500 Millibar Geopotential Height averaged over a two day period around the landfall of Hurricanes Ike and Rita. Significant weather features are displayed.

area. This surge difference was largely due to the size difference between the two hurricanes: Ike was significantly larger than Alicia when the size of the hurricane and tropical storm force wind fields are compared (**Figure 3c**).

The Subtropical High and Forecast Track Error

In September 2005, the Houston/Galveston area was largely spared the brunt of Hurricane Rita as the tropical cyclone made landfall along the Texas and Louisiana border. Although the landfall points were

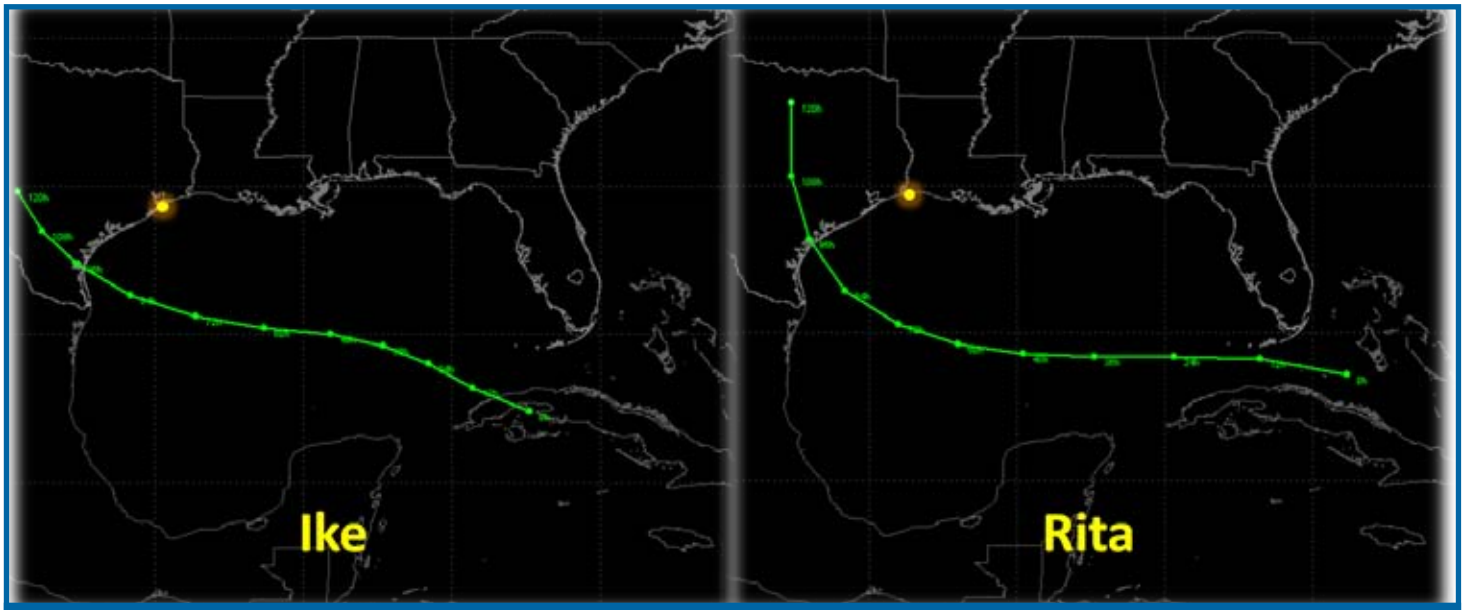


Figure 5. Major model forecast track consensus for Hurricanes Ike and Rita 4 days from landfall. Actual landfall points are shown in yellow.

approximately 50 miles apart, there are some remarkable similarities concerning the mid and upper level steering winds and the model forecast track error associated with Ike and Rita. When examining the ambient synoptic weather pattern for these two September hurricanes, a typical forecast problem that occurs during the transition from summer to fall reared its ugly head. The subtropical high which often dominates the weather pattern over the western Atlantic and southeast U.S. in late August and September began to be affected by the mid-latitude polar jet stream and a low pressure system (a trough) moving from west to east across the country within this jet stream. Transient troughs can cause a breakdown, or erosion, of the climatologically favored southeast U.S./western Atlantic ridge. Numerical model forecast guidance can have significant error when attempting to resolve how a tropical cyclone, the subtropical ridge, and a trough in the polar jet stream will interact (**Figure 4**). The result is often a difficult forecast concerning how a tropical cyclone will move in the western Gulf of Mexico as the edge of the subtropical high is encountered – an approaching trough may or may not induce a more northward component to the tropical cyclone's motion. Just a small error in the strength of the edge of the high and/or the position and strength of the approaching trough can result in a landfall point that is different by more than 100 miles. During the approach of Rita and Ike, a consensus of the most reliable model guidance 3 to 5 days before landfall depicted stronger high pressure to the north of both tropical cyclones and therefore a more westerly tropical cyclone movement than what actually occurred. This resulted in a model consensus forecast track that was significantly left-biased, especially around 4 days before landfall (**Figure 5**). The model track error was so similar in both direction and magnitude that if the Ike consensus model track forecast is adjusted with the appropriate Rita forecast track error, all but one of the adjusted forecasts between day 5 and day 0 (every 12 hours) depict a landfall somewhere along Galveston Island or the Bolivar Peninsula (**Figure 6**).

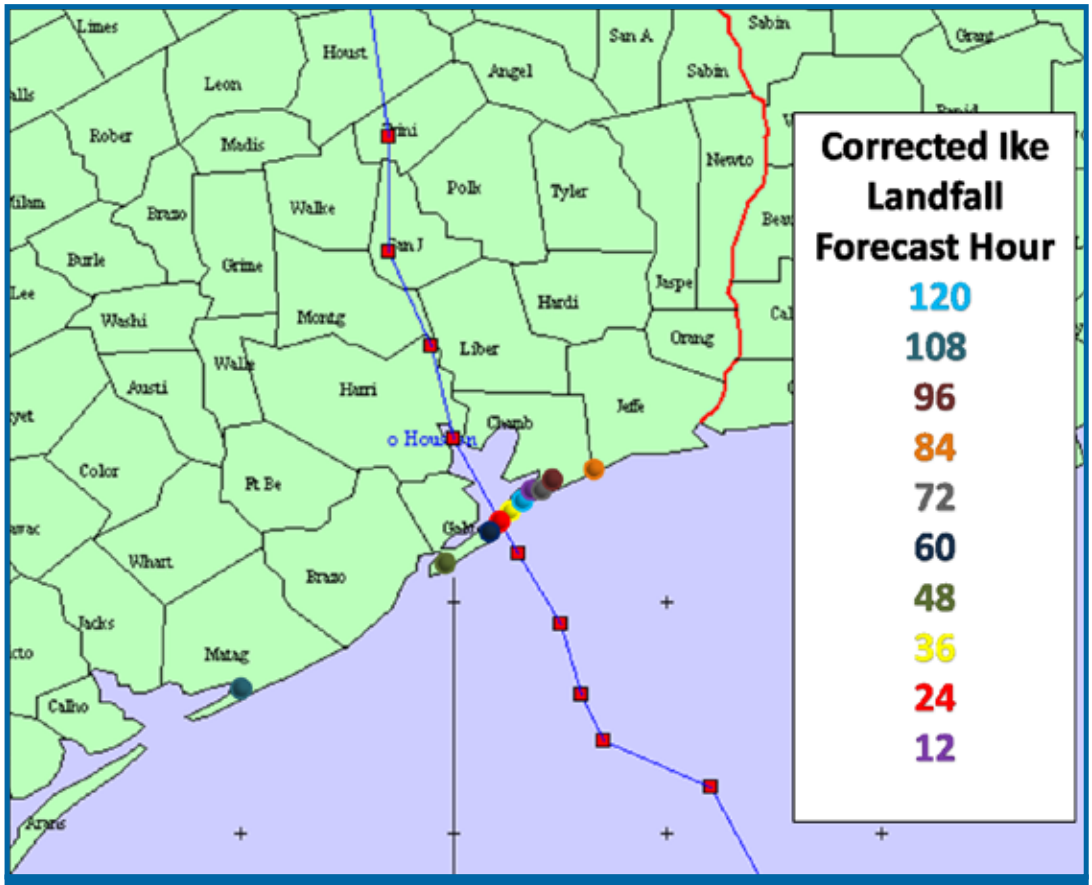


Figure 6. Ike model consensus landfall forecast locations when corrected by the magnitude and direction of the associated Rita model forecast error. All 12 hour forecasts are shown between Day 5 (120 hours) and Day 0 (12 hours).

Hurricane Ike Wind Analysis for Southeast Texas

by Scott Overpeck

Introduction

Hurricane Ike came ashore early Saturday morning on 13 September 2008 as a Category 2 storm on the Saffir-Simpson Scale with maximum sustained winds of 95 knots (110 mph). The maximum sustained winds were determined from dropsondes and flight level winds during reconnaissance flights (Hurricane Hunters) and velocity data from the NWS Houston/Galveston WSR-88D radar. Despite these reliable data, what were the observed winds across southeast Texas as Hurricane Ike moved inland? Were there any tornadoes reported from Hurricane Ike? This discussion investigates wind data from surface observations around the region, wind analysis from the Hurricane Research Division, and wind observations from research groups to better understand the wind field across southeast Texas from Hurricane Ike as well as any tornadoes.

Wind Data from Surface Observations

- Surface Observations

The wind observations came from Automatic Surface Observing Stations (ASOS) sites at airports across southeast Texas as seen in **Table 1**. This should provide a general idea of the strength of the winds across the area, especially for those locations where power outages were not an issue. Only one observing station reported sustained hurricane force winds and hurricane force wind gusts. A manual observation from the air traffic control tower at Hobby Airport in Houston reported winds of 75 mph with gusts of 92 mph. Also note that Bush Intercontinental Airport did not report sustained hurricane force winds despite the eye of the Hurricane Ike passing fairly close to the airport. Ike could have weakened enough not to cause hurricane force winds in that part of the storm as it neared the airport. Other ASOS equipment quit operating as Ike moved inland mainly due to power outages from the strong winds. The observation at Galveston Scholes Field stopped reporting due to the storm surge that moved into the island on Friday. We can only speculate that if other observations did not fail during the hurricane that there would have been more reports of hurricane force winds.

Surface Observation	Minimal Pressure (MB)	Maximum Sustained Wind (MPH)	Peak Wind Gust (MPH)
Bush Intercontinental Airport	961.1	56	82
Brenham Regional Airport	987.5	38	51
Wharton Regional Airport	987.5	39	51
Bay City Municipal Airport	985.8	38	53
College Station/Easterwood Field	985.8	35	50
Conroe/Montgomery County Airport*	962.4	41	60
Houston/D.W. Hooks Airport*	967.5	32	54
Galveston Scholes Field*	1002.3	28	38
Houston/Hobby Airport*	960.0	75	92
Angleton/Brazoria County Airport*	974.6	37	56
Pearland/Clover Field*	982.4	43	64
Palacios Municipal Airport	991.2	35	50
Caldwell Municipal Airport*	991.9	28	37
Sugarland Regional Airport*	991.2	43	54
Huntsville Municipal Airport	968.2	34	58

Table 1. Table of minimal pressure, sustained winds and wind gusts for SE Texas area airports.
*** - Incomplete data due to sensor failure during Hurricane Ike.**

- Wind Observations from Research Organizations

A few hurricane research organizations had set up mobile observing stations across southeast Texas to measure winds from Hurricane Ike. These included the Texas Tech Hurricane Research Team (TTHRT), the Center for Severe Weather Research (who run the Doppler on Wheels), and a few other smaller groups. The Texas Tech HRT placed several anemometers across the area including locations on Galveston Island and through Chambers County. Please see the website **http://www.atmo.ttu.edu/TTUHRT/Ike.htm** for more information. The anemometers were at a height of 2.25 meters instead of 10 meters for official wind observations. This means that the winds speeds observed may be less than winds at the 10 meter height. The wind measurements are also one-minute means with a 3 second gust. Sensor 110A positioned at Fort Travis on Bolivar Peninsula measured maximum sustained winds of 73 mph with a maximum gust of 87 mph. Sensor 104B located in north central Chambers County measured maximum sustained winds of 79 mph with a maximum gust of 96 mph. Just a few miles north of 104B, sensor 216B measured maximum sustained winds of 74 mph with a maximum gust of almost 109 mph. Sensor 216B also measured tropical storm force winds for about 9 hours and hurricane force winds for about 3 to 4 hours. These anemometers were located mainly in the eye of Hurricane Ike or just east of the eye where the strongest winds would be located. Even though these wind observations come from inland locations, the observations still support winds of Category 1 with wind gusts of Category 2 on the Saffir-Simpson Scale.

Wind Analysis - *Ike's Wind Swath*

Wind analyses performed by the Hurricane Research Division (HRD) of Hurricane Ike provide the best way to visualize the wind fields. The wind analyses are computer generated by HRD using observations from many sources that not only include buoy, oil platform, ship and airport observations but also data from reconnaissance flights, some radar data, and satellite data. Please see the website **http://www.aoml.noaa.gov/hrd/Storm_pages/ike2008/wind.html** for more information on how the analyses were made for Ike's wind data. These analyses are useful because they are consistent with the National Hurricane Center's determination of maximum sustained winds using a one minute average.

Based on HRD's wind swath map in **Figure 1**, Hurricane Ike had a large wind field covering a broad area of southeast Texas. Tropical storm force winds extended from Palacios, TX to east of Lake Charles, LA. Tropical storm force winds moved inland as far north as Longview, TX. Hurricane force winds were felt mainly from along the coast from Freeport, TX to Sabine Pass, TX including Beaumont, TX. Hurricane force winds extended inland to include the Houston metro area and as far north as Livingston, TX and almost to Lufkin, TX. While the wind swath map provides a good understanding of how strong the winds were as Ike moved across southeast Texas, it lacks the ability to provide any information about the longevity of the winds.

Even though winds approached 100 mph in some areas as Ike move inland, hurricane force winds persisted for a long time as well. Bush Intercontinental Airport reported tropical storm force winds beginning at midnight on Saturday 13 September and ended when the observation failed at 5:00 AM CDT. These winds most likely persisted longer than 5 hours as the southern eye wall of Ike had yet to pass through the area as seen by radar. According to HRD wind analyses from 0430 UTC 13 September (11:30 PM CDT, 12 September) through 1330 UTC 13 September, it is possible that tropical storm force winds affected most of southeast Texas for as much as 9 hours or longer. Hurricane force winds east of the eye of Ike could have affected portions of east Texas just as long.

Tornadoes

Tornado activity associated with Hurricane Ike was confined to mainly areas east and northeast of southeast Texas over western portions of Louisiana. Outer rain bands that typically spawn tornadoes occurred mostly over western Louisiana which limited tornado activity to these areas. The reflectivity data from the NWS Houston/Galveston radar showed that Hurricane Ike had several small vortices within its eye wall structure. Velocity data and storm relative velocity maps did not indicate any intense areas of rotation within these vortices. It is possible that as Hurricane Ike made landfall that these vortices did produce brief tornadoes that were too small and weak for the radar to detect rotation. The NWS Houston/Galveston did not issue any tornado warnings until

Hurricane Ike Wind Analysis for Southeast Texas continued

4:46 PM CDT 13 September 2008 as a line of storms was moving through Liberty County associated with a front wrapping around Hurricane Ike. There were no tornadoes reported with the storms. This occurred about 12 to 15 hours after Ike made landfall.

While the NWS Houston/Galveston received public reports of brief tornadoes during Ike weeks later, there was no way to confirm these reports. Ike caused extensive wind damage across southeast Texas which would mask any tornado damage. One would not be able to distinguish between hurricane wind damage and tornado damage. In summary, while there may have been brief tornadic circulations, radar data and storm damage could not confirm that Hurricane Ike caused any tornadoes in southeast Texas.

Conclusions

The focus of this discussion was to investigate the intensity of the wind fields as Hurricane Ike moved inland. The NHC with its recon data had maximum sustained winds of 110 mph as Ike made landfall. The HRD wind analysis supports winds of this intensity. Observed maximum sustained winds varied from 75 mph to 90 mph with gusts near 110 mph across southeast Texas, given the HRD wind analysis and wind data from surface observations. The strongest winds were in the northeast quadrant of Hurricane Ike which is very typical for a northward moving hurricane. Wind observations from airports and research groups, and the HRD wind analysis give a good estimate of the longevity of the tropical storm and hurricane force winds. Tropical storm force winds persisted for at least 9 hours for most areas near the center of the hurricane with hurricane force winds lasting 3 to 4 hours. This was mainly due to the fact that Hurricane Ike had a large circulation center and an expansive wind field well east of the storm. More than likely, it was the longevity of the winds that contributed to the extensive damage across southeast Texas, more so than the intensity of the winds. The extensive damage from Ike's winds also masked any tornado damage. It is inconclusive as to whether Ike was responsible for any tornadoes across Southeast Texas.

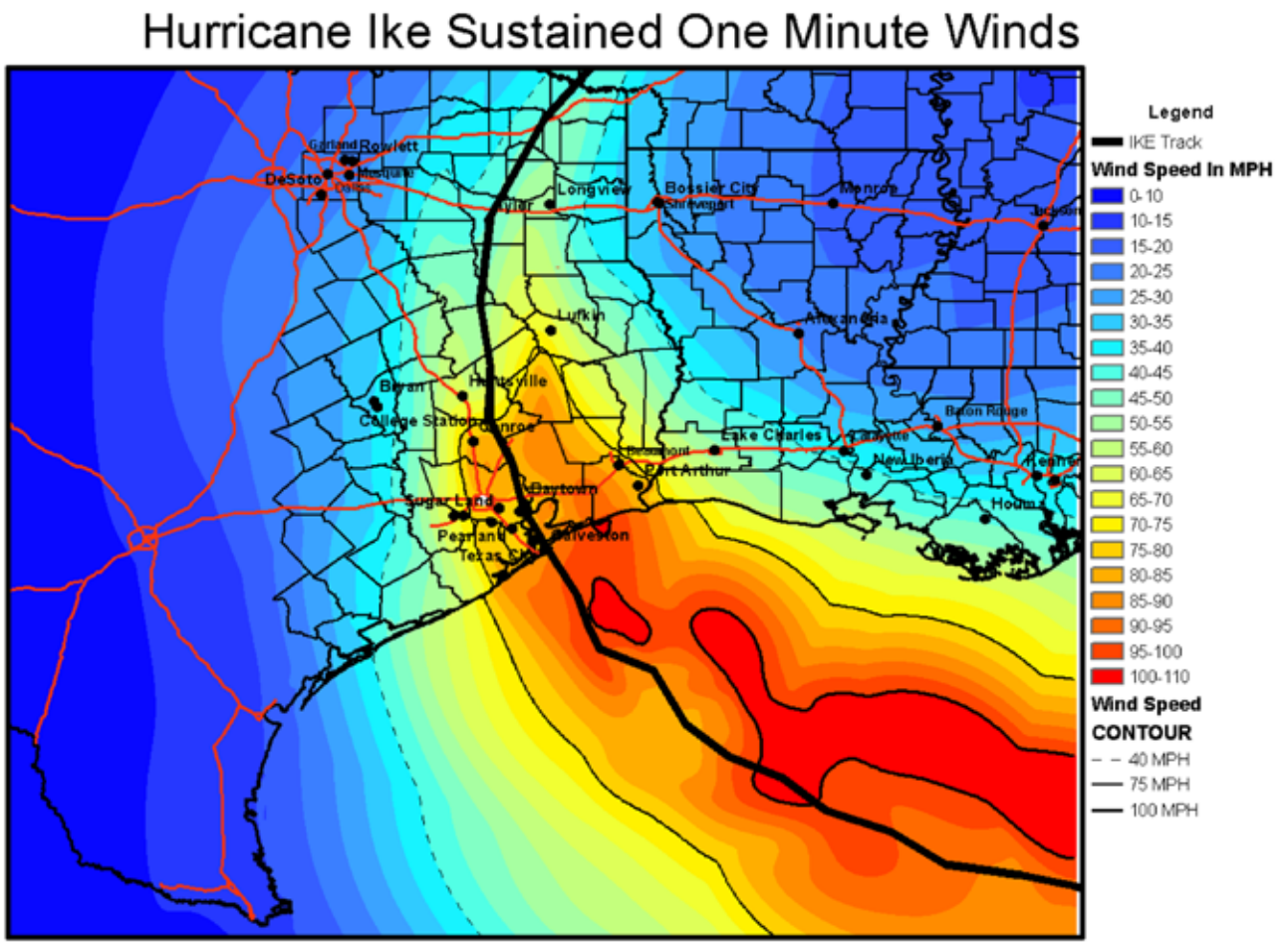


Figure 1. This is an image of the wind swath analysis from the Hurricane Research Division (http://www.aoml.noaa.gov/hrd/Storm_pages/ike2008/wind.html). The image was made by NWS Lake Charles.

Hurricane Ike Storm Surge around Galveston Bay

by Dan Reilly

Hurricanes produce a variety of hazards, including damaging winds, flooding rains and tornadoes. One of the most dangerous hazards to coastal communities is the storm surge. The storm surge with Hurricane Ike caused the majority of the damage and nearly all the fatalities directly related to the storm. Many homes on the Bolivar Peninsula were completely wiped away with only slabs remaining. Much of the debris from the Bolivar ended up in large debris piles 20 miles away in central Chambers County. Most of Galveston Island was inundated by flood waters originating from Galveston Bay. Ike's storm surge led to coastal flooding along much of the Gulf Coast, from Florida to Texas, and especially along Galveston Bay, where the communities of San Leon, Shoreacres, Kemah and Seabrook were hard hit.

Storm surge is defined as the rise in mean water level due to the hurricane. Hurricanes can also produce large waves which occur on top of this elevated water level and can add to its destructive potential. The magnitude of the surge depends on the hurricane's intensity, size, and on the slope of the sea floor, or continental shelf, just offshore. It tends to be the worst near and to the right of the landfall location of the eye. Hurricane Ike was a very large storm with strong winds that extended far from the center. It was Ike's size that contributed to its tremendous surge. Storm surge values were generally 14 to 17 feet across the Bolivar Peninsula and southern Chambers County, with waves on top of the surge adding to the damage potential at the beach front. Surge values were generally in the 10 to 14 foot range across Galveston Island and along the western shore of Galveston Bay. This led to complete inundation of the Bolivar Peninsula, and major coastal flooding over a large portion of the Gulf Coast and along Galveston Bay, with the greatest impact to the right of the landfall position (Figure 1).

Some underestimated the impact of the storm since it was "only a Category 2" hurricane on the Saffir-Simpson Scale. The Saffir-Simpson Scale is primarily a measure of the maximum winds of the hurricane and is not related to the size of the storm, or the areal extent of the high winds. Because of this, a large Category 2 may produce a higher and more extensive surge than a small Category 3 or 4, and one should *not* infer the potential severity of the storm surge from the Saffir-Simpson Scale rating alone. People who live in surge zones should always evacuate when directed to by elected officials, and should not wait too long to leave. This is especially important for those on barrier islands. In the case of Ike, the waters rose well in advance of landfall, and some who had waited to leave became trapped as exit avenues became impassable due to the rising waters. Over a hundred people from the Bolivar Peninsula were airlifted off the island during the day Friday after being trapped by the rising waters. If not for the heroic actions of the Coast Guard and others, the death toll may have been much larger.

Hurricane Ike Inundation Depth

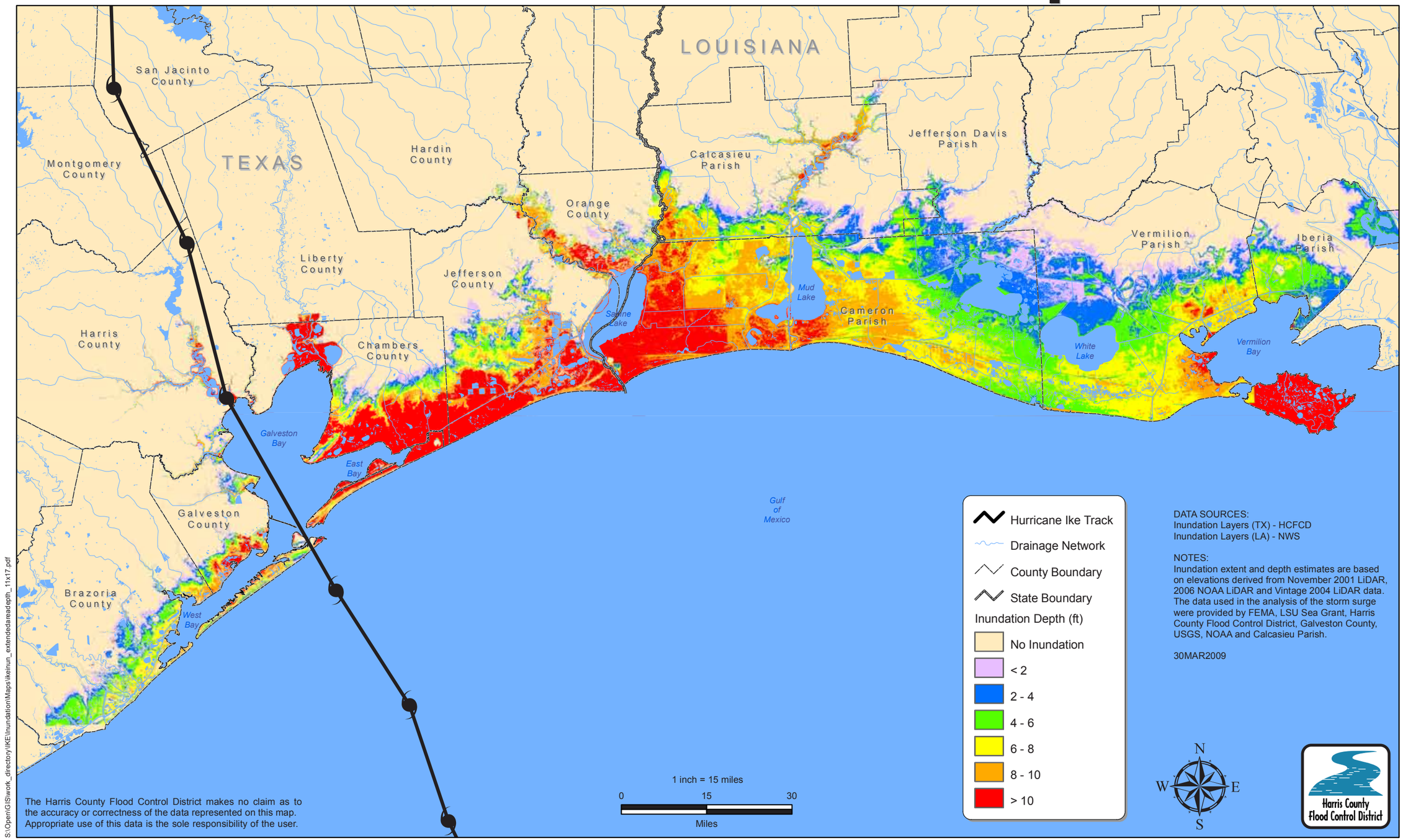


Figure 1. Inundation map from Hurricane Ike showing depth of water above ground level. Track of the center of Hurricane Ike is also indicated (courtesy Harris County Flood Control District)

Hurricane Ike Rainfall in Southeast Texas

by Paul Lewis and Dave Schwertz

Introduction

Hurricane Ike made landfall at Galveston Island, Texas in the early morning hours of September 13, 2008 as a strong Category 2 hurricane and tracked north-northwest along and east of Interstate 45. As Ike trekked inland, two separate heavy rainfall and flooding events occurred across the Houston metropolitan area. The first event happened during the actual landfall of the hurricane as the western and southern eyewall moved inland. Rainfall started around 9:00 PM CDT on September 12th and continued into the early afternoon of the 13th. The second event occurred early on the 14th as a cold front moved across southeast Texas and off the coast. Heavy rainfall developed as the remains of tropical moisture in the wake of Ike focused along the front. Rainfall totals on the 14th equaled or exceeded those associated with Ike and some locations experienced flooding both days.

Rainfall Data

The National Hurricane Center (NHC) estimated that Ike moved northwest between 12 and 18 mph across southeast Texas. The general rainfall estimate rule-of-thumb for a landfalling tropical cyclone is to divide the speed of the storm's movement into 100. When utilizing an average speed of 15 mph for Ike, this calculation gives an estimate of close to 7 inches. Actual rainfall recorded for the hurricane was between 5 and 10 inches across the 9 county area that ranges roughly between Livingston and Navasota south to the coast. Rainfall ahead of the cold front totaled another 5 to 8 inches. Maximum rainfall for both events was near 15 inches across portions of Houston, Liberty, and Montgomery Counties. Isolated observations of around 18 inches were recorded in the uptown area of Houston and along Spring Creek just north of Houston.

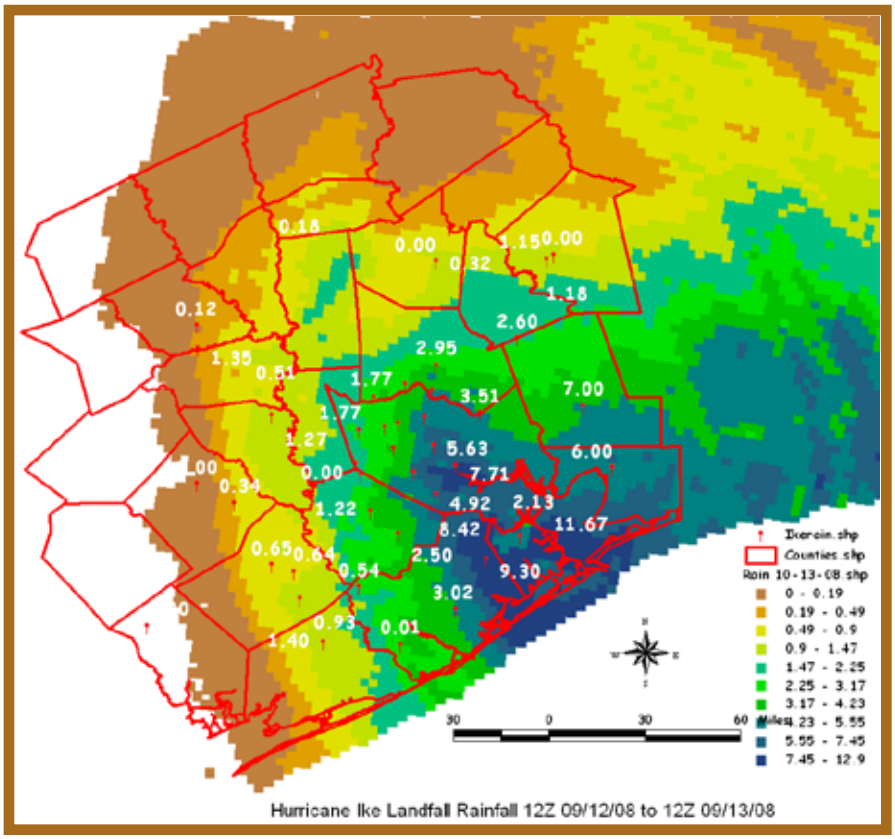


Figure 1 - Hurricane Ike 24-hour WGRFC Corrected Rainfall Ending 7:00 AM CDT September 13, 2008

Moderate to heavy rainfall began as Ike's rain bands moved across the upper Texas coast during the evening hours of the September 12th. These rain bands intensified as the hurricane made landfall at Galveston around 2:10 AM CDT of September 13th. Radar data showed that the heaviest rain fell on the northern and western side of the eye of the storm as it moved northwest up Galveston Bay and into the eastern portions of the Houston Metropolitan area during the pre-dawn hours. The heaviest rainfall area then shifted to the southern half of Ike as the storm's center moved north of Houston. This circumstance caused portions of Harris, Montgomery, and Liberty Counties to experience moderate to heavy rainfall for about a 12-hour period. Another round of heavy rainfall then affected many of the same locations the next day as the front pushed overhead. It is estimated that the rainfall frequency for the landfall event ranged from a 5-year to a 100-year event in most affected areas. The rainfall frequency for the frontal event ranged from a 10-year to a 100-year event, mainly over White Oak and Buffalo Bayous and the San Jacinto River.

River Forecast Center Rainfall Data

The West Gulf River Forecast Center (WGRFC) in Fort Worth made corrections to the KHGX radar precipitation due to the radar bias and that which was recorded by rainfall gages. These graphics with the gage data incorporated are shown in figures 1 through 4.

Figure 1 presents the rainfall associated with landfall of Ike through 7:00 AM CDT September 13, 2008. Rainfall that fell during the next 24-hour period ahead of the cold front is shown in **Figure 2** with the residual rainfall behind the cold front given in **Figure 3**. The total rainfall for the 3-day period is presented in **Figure 4**.

Summary

Although the storm surge and wind from Ike made the greatest impact on the upper Texas coast, rainfall from the storm and a cold front following on its heels adversely affected a 9-county area of southeast Texas. Portions of the Houston metropolitan area received a rainfall frequency that equaled a 100-year event and some bayous, creeks, and rivers experienced both storm surge and rainfall flooding.

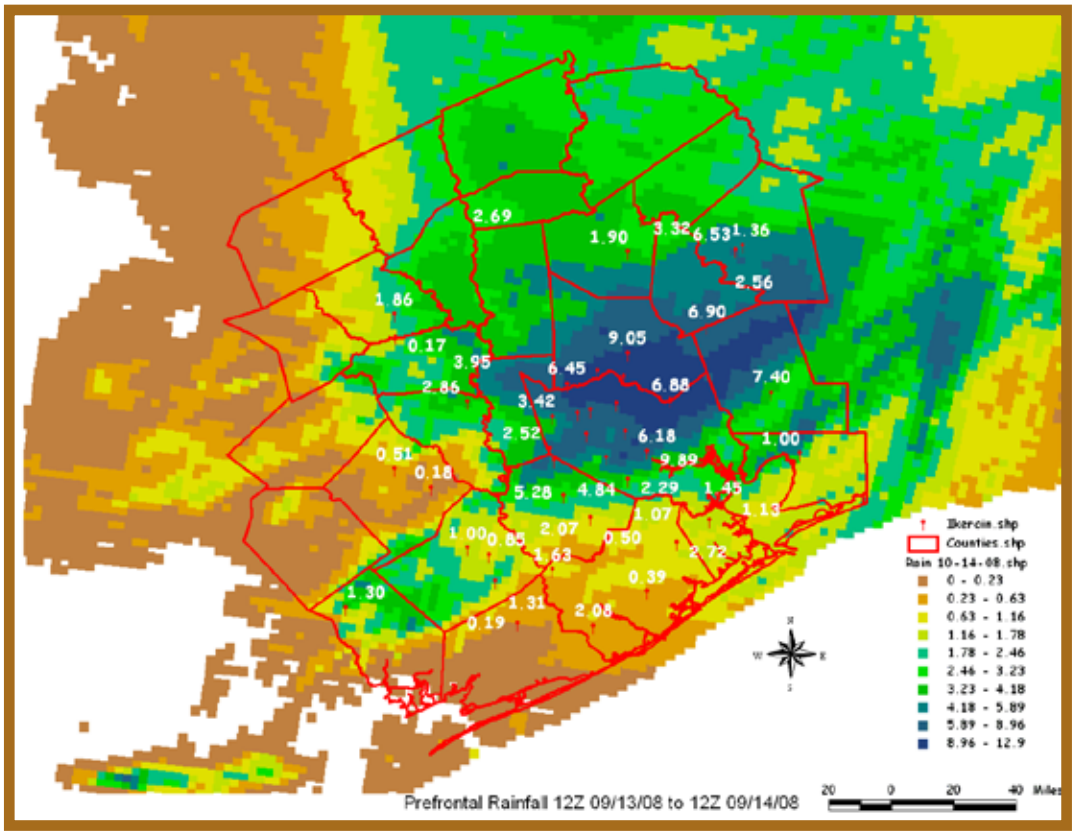


Figure 2 - Prefrontal 24-hour WGRFC Corrected Rainfall Ending 7:00 AM CDT September 14, 2008

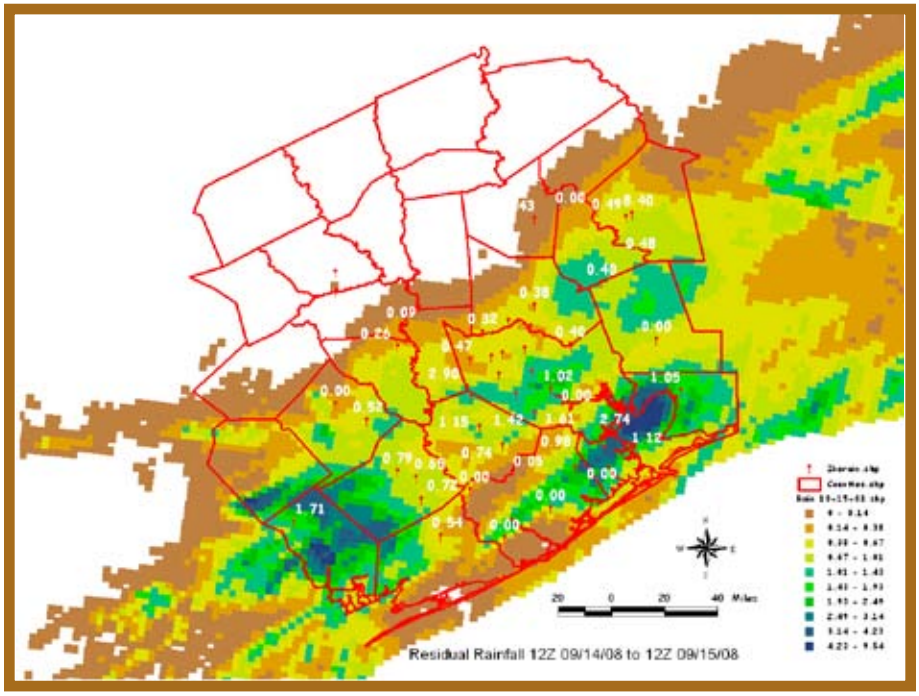


Figure 3 - Post Frontal 24-hour WGRFC Corrected Rainfall Ending 7:00 AM CDT September 15, 2008

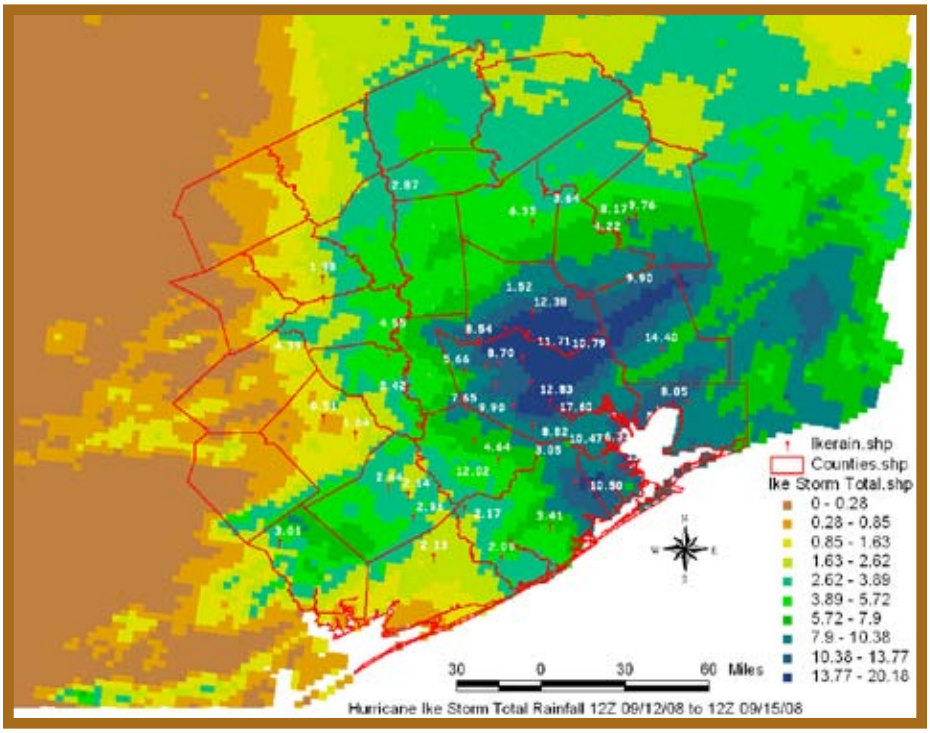


Figure 4 - Hurricane Ike WGRFC Corrected Rainfall 3-Day Total Ending 7:00 AM CDT September 15, 2008

Hurricane Hazards: Inland Flooding

Protecting Yourself and Others from the Dangers of Inland Flooding

There are practical ways which can nearly eliminate the risks of death, injury, and financial loss during an inland flood event. These can be summarized into five practical keys:

1. Protect Your Past – The 15-Minute Rule: A focus on personal records and special items
2. Protect Your Present – Buy Flood Insurance: A focus on replaceable items
3. Protect Your Future – Flood Proof Your Home: A focus on minimizing flooding impacts
4. Protect Your Peace of Mind – Save Your Life: A focus on planning and communication
5. Protect Yourself and Others – Never Drive on Flooded Roads: A focus on "Turn Around, Don't Drown!"

A. Protect Your Past – The 15-Minute Rule

Protecting your past involves taking care of valuables such as pictures, important documents, or collectibles. This can be accomplished by utilizing various sized plastic tubs with locking tops. Regular storage of valuables in these tubs can help greatly reduce the amount of time it takes to move them in the advent of a flood. The 15-minute rule means that it should be possible to secure and move all your valuables within fifteen minutes.

B. Protect Your Present – Buy Flood Insurance

Since a major financial asset for most people is their home, protecting the ability to repair or replace a home is important. Most homeowners' policies do not cover flood damage! Too often, homeowners discover this after they have been flooded. The irony is that the low cost of flood insurance is one of the best deals around.

Most homeowners live outside the 100-year, or one percent flood plain. This means that there is a one percent chance of flooding in any given year, or a 30 percent chance of flooding over a standard 30-year mortgage. Flood insurance is available from the National Flood Insurance Program (NFIP). This program is administered by the federal government, is available through your regular insurance agent or from the NFIP, is very reasonably priced, and it covers flood damage. More than 25 percent of NFIP claims have come from structures outside identified flood plains – meaning those who had coverage got a great bargain. More information can be found on the NFIP website at:
http://www.fema.gov/about/programs/nfip/index.shtm

C. Protect Your Future – Flood Proof Your Home

There are simple, low-cost ways to prevent damage and minimize the disruption of normal activities which flooding usually causes. If water starts to enter your home, shutting off the power at the main circuit breaker will prevent appliances from short circuiting and eliminate the threat of electrocution to those in the home. Outside air conditioning units can be raised on platforms above ground level. Storing rarely used items in the attic, or expensive items on high shelves, will reduce the chance flood waters can cause damage.

D. Protect Your Peace of Mind – Save Your Life

Good decision making is essential in saving your life during a flood event. Gathering information and developing a plan of action in advance of a flood event can help keep you from panicking or withdrawing during an emergency. Good sources of information can be obtained from NOAA Weather Radio, cable and broadcast TV, radio and the Internet. Be sure to have battery powered radios or televisions in the event of a power outage. An action plan can be started by checking a set of detailed maps for your county such as a Key Map. These allow you to plan an evacuation route and alternatives in case your primary route is blocked by flood waters or traffic.

E. Protect Yourself and Others – Never Drive on Flooded Roads

Despite consistent warnings to avoid flooded roads over the past thirty years, most people who lose their lives during a flood are swept away in their vehicles or drown after evacuating a stalled vehicle. During Tropical Storm Allison in 2001, 19 of the 22 deaths and many of the emergency rescues were related to driving or walking through flood waters. To help amplify the flood awareness message, the National Weather Service in cooperation with the Federal Alliance for Safe Homes (FLASH) and others have instituted the "Turn Around Don't Drown!" program. This is similar to the "Stop, Drop, and Roll" fire safety technique that is taught to children.

Driving into flooded roadways puts your life and the lives of others at risk. Consider the impact driving into flood waters has on others, especially rescue workers whose lives are unnecessarily put at risk when trying to rescue stranded motorists. Emergency workers focused on avoidable flood rescue are not available in other needed areas such as medical emergencies or evacuating elderly or handicapped residents. During most flood events you are probably safest staying at your current location unless specifically told to evacuate.

If you encounter flood waters when driving, Turn Around, Don't Drown!

Hurricane Hazards: Storm Surge

Storm surge is defined as the increase in mean water level due to the effect of the low pressure of the hurricane and of the wind pushing the water toward the shore. The advancing surge combines with the normal tides to generate the hurricane storm tide, which can increase the mean water level 20 feet or more (**Figure 1**). Wind driven waves occur on top of the storm tides which add to the destructive potential. This rise in water level can cause severe flooding in coastal areas, particularly when the storm surge coincides with the normal high tides. Because much of the United States' densely populated Atlantic and Gulf Coast coastlines lie less than 20 feet above mean sea level, the potential danger from storm surge and storm tides is tremendous.

The level of surge in a particular area is determined by several factors: the strength of the hurricane, the size of its wind field, and speed and direction of the storm. The shape of the coastline and the slope of the continental shelf also affect the surge height. A shallow slope off the coast (similar to the upper Texas coast) allows a greater surge to inundate coastal communities. A steeper slope (similar to the east coast of south Florida) leads to less surge inundation, although large breaking waves could still present major problems. Storm tides, waves, and currents in confined harbors can severely damage ships, marinas, and pleasure boats.

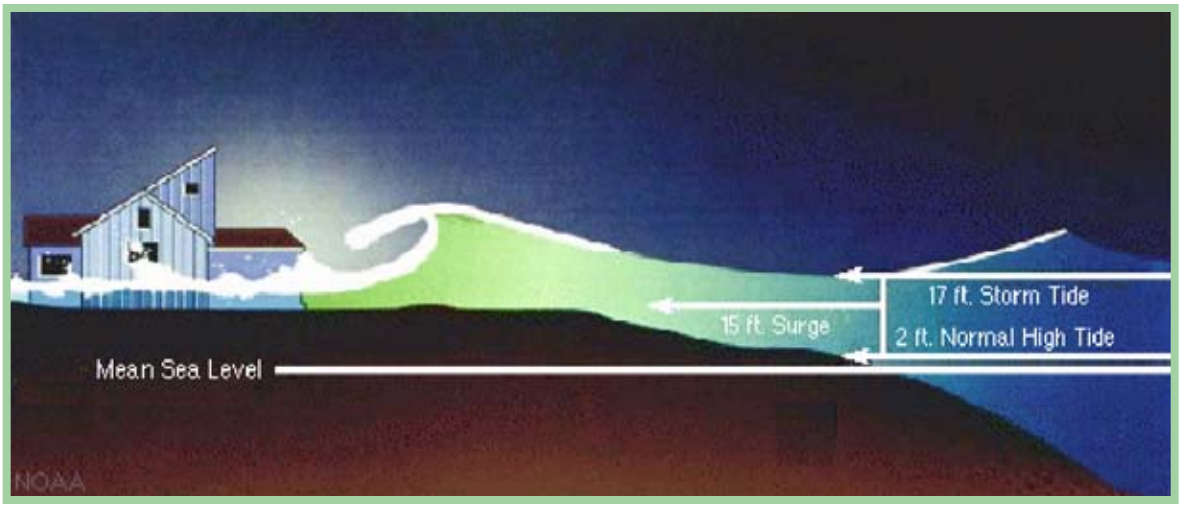


Figure 1

Houston/Galveston Storm Surge Potential…The Houston/Galveston region, from a large intense hurricane, could potentially experience a storm surge of 25 to 30 feet along the Galveston Bay and 18-22 feet along the beach front. When you look at the storm surge heights and the large number of people that would be impacted by the storm surge, there is the potential for a very large loss of life and for tremendous property damage, even greater than that experienced with Hurricane Ike.

Aerial photo of Bolivar Peninsula near Rollover Pass taken after Ike.

Surge damage in Bayou Vista, Texas due to Ike

Hurricane Hazards: Storm Surge continued...

The upper Texas gulf coast has a history of storms that have caused significant storm surge. Listed below are a few of the more memorable storms.

Name of the Storm	Height of the Surge	Number of Lives Lost
1900 Storm	15 - 20 feet Galveston Island and Bay	>8000
1915 Storm	11 - 18 feet Galveston Island and Bay	275
Carla 1961	15 - 22 feet Matagorda Bay	46
Alicia 1983	8 - 12 feet Galveston Island and Bay	21
Ike	13 - 18 feet Bolivar Peninsula and East Galveston Bay	20

The worst case scenario for the Houston/Galveston region is for a large category 4 or 5 storm making landfall along the Brazoria County coastline and moving north-northwest, staying west of Galveston Bay and downtown Houston. This would put Galveston Bay, and the highest concentration of population, in the right quadrant of the storm where the highest surge is typically observed. **Figure 2** shows the inundation area and depth from a category 5 storm.

If you live along the upper Texas coast, it is important to know your threat from storm surge for your home and your business. You need to know the elevation of your home and whether you are in an evacuation zone and when you will be asked to evacuate. This information is available from your local emergency manager. A list of emergency managers both for cities and counties is located on pages 38 and 39 in this publication.

Damage from surge Caplen, Texas on the Bolivar Peninsula

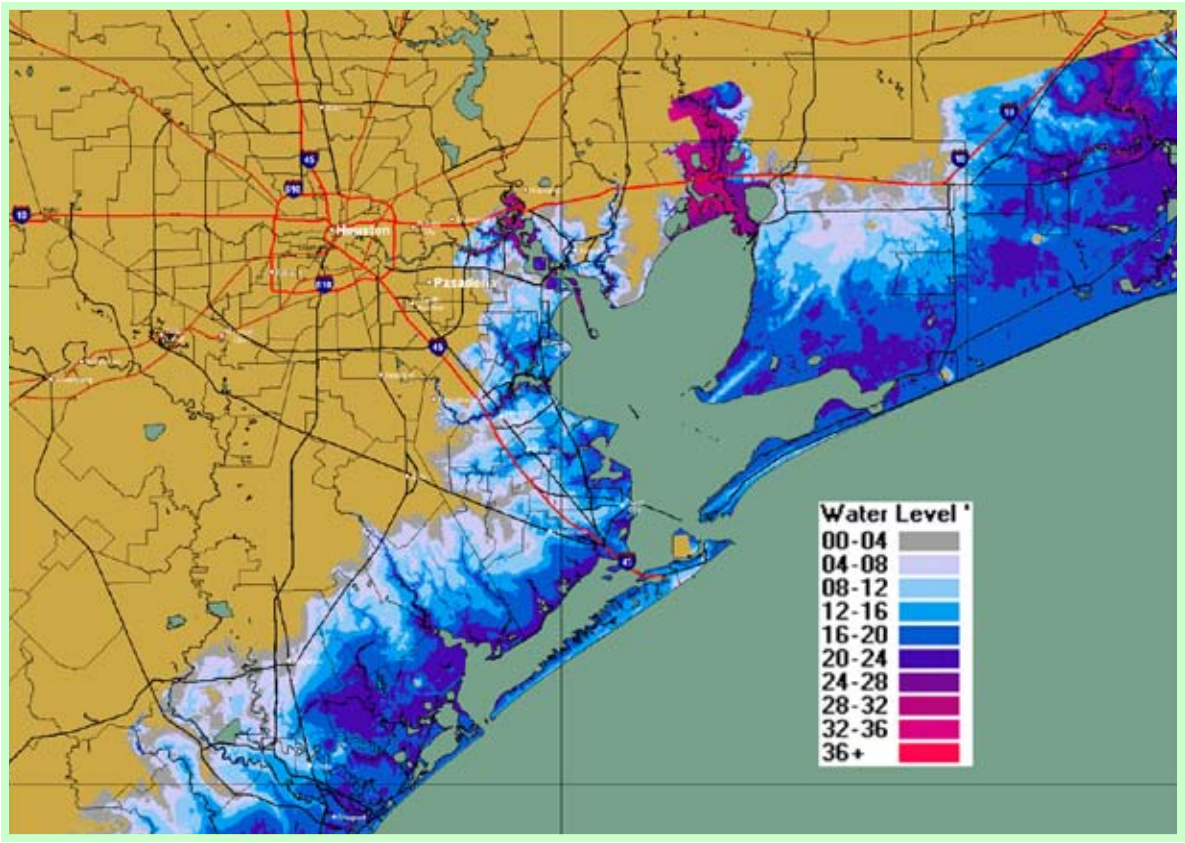


Figure 2 - Land inundation due to a Category 5 hurricane (worst case scenario)

Hurricane Hazards: Hurricane Winds

Hurricane winds are a force to be reckoned with as coastal communities decide on building codes. As winds increase, pressure on objects increases at a disproportionate rate. Pressure against a wall increases with the square of the wind speed. For example, if the wind speed increases by a factor of three, the pressure on a structure increases by a factor of nine. A 25 mph wind generates about 1.6 pounds of pressure per square foot. For example, a four by eight sheet of plywood will be pushed by a weight of 50 pounds. In 75 mph winds, that force increases to 450 pounds. At 125 mph, the pressure force reaches 1250 pounds. For some structures, this force is more than enough to cause failure.

In a hurricane, weaker winds are generally located in the outer rain bands with wind speeds increasing rapidly near the eye. Hurricane winds are most intense around the perimeter of the eye commonly referred to as the eye wall. As a hurricane moves inland, winds begin to rapidly decrease, but can remain above hurricane strength well inland. A general rule of thumb is that wind speeds will decrease 50% within 12 hours of landfall. Thus, the faster the storm motion, the further inland hurricane force winds will be experienced.

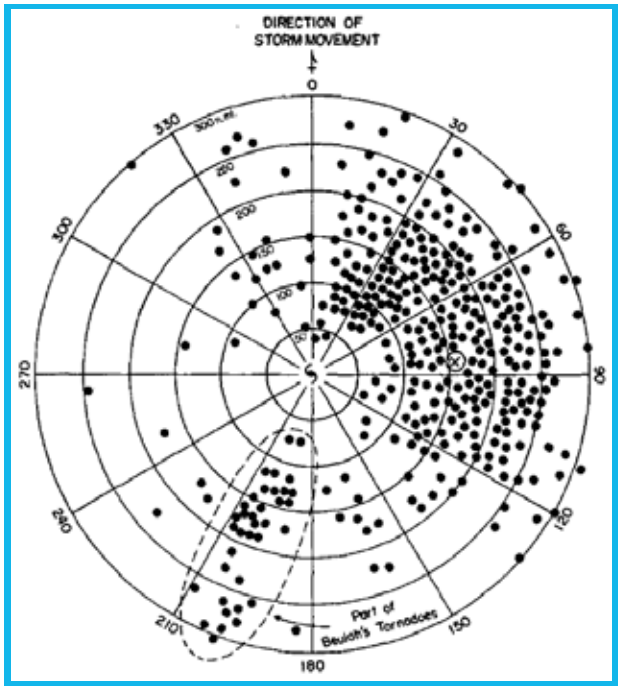
Wind damage patterns are often very different from storm to storm. In 1983, Hurricane Alicia made landfall on the west end of Galveston Island. Before Alicia had weakened below hurricane strength, hurricane force wind gusts extended to Huntsville, more than 100 miles from the coast. In 1989, Hurricane Hugo made landfall near Charleston, South Carolina. This fast moving storm cut a path of destruction from the coast to Charlotte, North Carolina, almost 175 miles from the coast. Hurricane Andrew slammed into south Florida in 1992. The compact, intense storm produced tremendous wind damage over a small but highly populated and developed area. In 2005, southern Louisiana was hammered with a one-two punch as Katrina and Rita produced widespread wind damage from New Orleans to the Sabine River.

Hurricane Hazards: Tornadoes

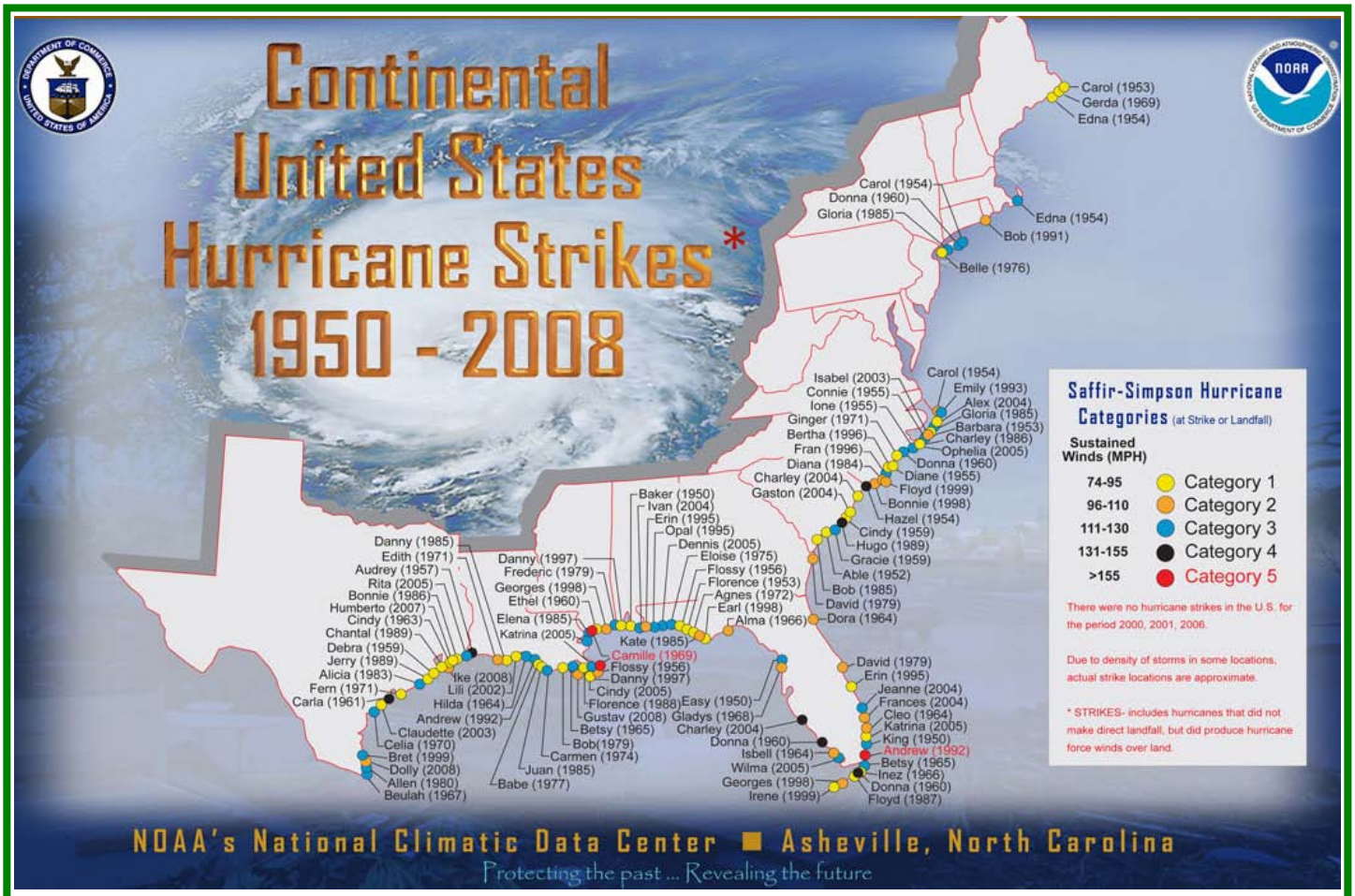
Tornadoes are frequently associated with landfalling hurricanes. Though the numbers of tornadoes vary with each hurricane, most tornadoes are located in the right-front quadrant of the hurricane. Tornadoes have been discovered to exist mainly within the outer rain bands; although, they have also been documented close to the hurricane's eye wall. Tornadoes can affect locations up to 300 miles from the center of the hurricane and can occur days after landfall.

Typically, the more intense a hurricane is, the greater the tornado threat. As a hurricane moves inland, the fast-moving air hits terrain and structures, causing a frictional convergence which enhances lifting. Frictional convergence may be at least a contributing factor to tornado formation in hurricanes. Other factors include low altitude instability and strong wind shear.

The largest known tornadic outbreak from a U.S. land-falling hurricane occurred with Hurricane Ivan in 2004. Over a two day period, Ivan produced 127 tornadoes from Florida up to Pennsylvania! Ivan's total broke the old record held by Hurricane Beulah. In 1967, Beulah spawned 115 tornadoes over South Texas.



A plot of 373 U. S. hurricane tornadoes between 1948 and 1972 with respect to the hurricane center and its direction of motion. The circled "x" located at 80 degrees azimuth and 150 nm from the hurricane center is the centroid point of all the plotted tornadoes. Image obtained from Novlan D. J., and W. M. Gray, 1974: Hurricane-Spawned Tornadoes. Mon. Wea. Rev., 102, 476-488.



Between 1900 and 2007, the upper Texas coast (Brazoria, Chambers, Galveston, Harris, Jefferson and Orange Counties) has received more hurricane strikes than any portion of the coastline. Nineteen hurricane strikes for Galveston County in this one hundred eight year period averages out to one hurricane strike every 5.7 years. Despite this average, there was an eighteen year gap between the last two hurricane strikes (Jerry in 1989 and Humberto in 2007).

Saffir-Simpson Hurricane Wind Scale

All hurricanes are dangerous, but some are more so than others. The combination of storm surge, wind, and other factors determine the hurricane's destructive power. The Saffir-Simpson Hurricane Wind Scale was designed to help determine ***wind*** hazards of an approaching hurricane easier for emergency officials. The scale is assigned five categories with Category 1 attributed to a minimal hurricane and Category 5 to a worst case scenario. Categories 3 to 5 are defined as major hurricanes. The criteria for each category are shown below.

Category	Winds (mph)	Damage	Storm Example Name/Year
1	74-95	**Minimal:** Damage to building structures possible, primarily to unanchored older model mobile homes. Damage to poorly constructed signs, shrubbery, and trees. Loose outdoor items become projectiles. Numerous power outages.	Humberto (TX) 2007
2	96-110	**Widespread from very strong winds**: Some roofing material, door, and window damage to buildings. Considerable damage to trees, vegetation, mobile homes, and piers. A number of high rise building glass windows dislodged to become projectiles. Widespread power outages up to several days.	Ike (TX) 2008
3	111-130	**Extensive from dangerous winds:** Some structural damage to small residences and utility buildings with minor amount of wall failures. Mobile homes destroyed. Many trees uprooted or snapped. Power outages lasting several days or weeks.	Alicia (TX) 1983
4	131-155	**Devastating from extremely dangerous winds:** Some wall failures with complete house roof structure failures. Extensive damage to doors, windows, and trees. Electricity unavailable for weeks.	Carla (TX) 1961
5	>155	**Catastrophic:** Complete roof failure on many residences and industrial buildings. Some complete building failures with small buildings blown over or away. Electricity unabailable for weeks or months.	Andrew (FL) 1992

American Red Cross

ATLANTIC HURRICANE TRACKING CHART

Always remember

If you live along the coast or in a low-lying area, if you live in a mobile home in an area subject to hurricane water or wind, or if authorities tell you to... Go!

Storm Surge

A storm surge is a dome of water often 50 miles wide that comes sweeping across the coastline near the area where the eye of the hurricane makes landfall. The surge, aided by the hammering effect of breaking waves, acts like a giant bulldozer sweeping away everything in its path. Nine out of ten hurricane deaths are caused by storm surge. That's why it's important to leave well before a hurricane may come your way.

Wind Damage

Hurricane winds can cause significant damage to homes and businesses far from the shore. If you live in an area anywhere near the path of a hurricane, you should take steps to protect property from high winds. Bring in anything from outside that may become airborne in high winds, including toys, lawn chairs, trash cans, coconuts, etc. Cover all windows of your home. If shutters are not installed, use 3/4" marine plywood panels. Tape does not work, so it is not recommended. Remain inside until authorities tell you the danger has passed.

Other Hurricane Effects

Hurricanes can produce flooding far inland, especially if the storm "stalls" or produces a lot of rain. Also, tornadoes can form when hurricanes come on shore. Ask your American Red Cross, National Weather Service, or emergency management office what to do in case of a flood or tornado.

More Information

More information about hurricanes, protection from wind damage, floods, and tornadoes is available from your local American Red Cross chapter, National Weather Service Office, or emergency management agency.

0 500 mi
0 500 km

MERCATOR PROJECTION
The scale is accurate along the equator.
Elsewhere on the map, scale increases toward poles.

N

CANADA
NEW BRUNSWICK
NEWFOUNDLAND
NOVA SCOTIA
MAINE
VT.
N.H.
Portland
NEW YORK
MASS.
Boston
CONN.
R.I.
New York
N.J.
PA.
OHIO
MD.
Washington, D.C.
Atlantic City
DEL.
Ocean City
W. VA.
KY.
VIRGINIA
Norfolk
N.C.
Cape Hatteras
S.C.
Wilmington
UNITED STATES
GEORGIA
Charleston
Savannah
BERMUDA
MISS.
ALA.
LA.
TEXAS
Lake Charles
Baton Rouge
Gulf Port
Mobile
Pensacola
New Orleans
Galveston
Tallahassee
Apalachicola
Jacksonville
Daytona Beach
FLA.
Cape Canaveral
Tampa
Palm Beach
Fort Myers
Ft. Lauderdale
Miami
Key West
Corpus Christi
Brownsville
BAHAMAS
Nassau
Havana
TURKS & CAICOS IS.
CUBA
Camagüey
Tampico
MEXICO
Mérida
Campeche
YUCATAN PENNINSULA
Cozumel
Veracruz
CAYMAN IS.
Guantanamo
DOMINICAN REPUBLIC
HAITI
JAMAICA
Port-au-Prince
Kingston
San Juan
Santo Domingo
BRITISH VIRGIN IS.
ANGUILLA
ST. MARTIN
ST.-BARTHÉLEMY
PUERTO RICO (U.S.)
U.S. VIRGIN ISLANDS
ST. KITTS and NEVIS
ANTIGUA
GUADELOUPE
DOMINICA
MARTINIQUE
ST. LUCIA
ST. VINCENT and THE GRENADINES
BARBADOS
GRENADA
TOBAGO
TRINIDAD
Belize City
BELIZE
Puerto Cortés
GUATE-MALA
HONDURAS
Cabo Gracias a Dios
EL SALVADOR
NICARAGUA
San Andres
ARUBA
CURACAO
COSTA RICA
PANAMA
Balboa
COLOMBIA
VENEZUELA
GUYANA

45° 40° 35° 30° 25° 20° 15° 10°
100° 95° 90° 85° 80° 75° 70° 65° 60° 55° 50° 45° 40°

2009 Hurricane Workshop...Remembering Ike

Naming of Hurricanes

The Tropical Prediction Center near Miami, FL keeps a constant watch on oceanic storm-breeding areas for tropical disturbances which may herald the formation of a hurricane. If a disturbance intensifies into a tropical storm (rotary circulation and wind speeds above 38 miles per hour), the Center will give the storm a name. A separate name set is used each year beginning with the first name of the set. The letters Q, U, X, Y and Z are not included because of scarcity of names beginning with those letters.

The name lists have an international flavor because tropical storms and hurricanes affect other nations and are tracked by the public and weather services of countries other than the United States. Names for these lists are agreed upon by nations involved during international meetings of the World Meteorological Organization.

For several hundred years, many hurricanes in the West Indies were named after the particular saint's day on which the hurricane occurred. Ivan R. Tannehill describes in his book "HURRICANES" the major tropical storms of recorded history and mentions many hurricanes named after saints. For example, there was "Hurricane Santa Ana" which struck Puerto Rico with exceptional violence on July 26, 1825, and "San Felipe" (the first) and "San Felipe" (the second) which hit Puerto Rico on September 13th in 1876 and 1928 respectively.

Tannehill also tells of Clement Wragge, an Australian meteorologist, who began giving women's names to tropical storms before the end of the 19th Century.

An early example of the use of a woman's name for a storm was in the novel "STORM" by George R. Stewart, published by Random House in 1941 and since filmed by Walt Disney. During World War II, this practice became widespread in weather map discussions among forecasters, especially Air Force and Navy meteorologists who plotted the movement of storms over the wide expanses of the Pacific Ocean.

In 1953, the United States abandoned a confusing three-year old plan to name storms by phonetic alphabet (Able, Baker, Charlie) when a new, international phonetic alphabet was introduced. That year, this nation's weather service began using female names for storms.

The practice of naming hurricanes solely after women came to an end in 1978 when men's and women's names were included in eastern North Pacific storm lists. In 1979, male and female names were included in lists for the Atlantic, Caribbean, and Gulf of Mexico.

Experience shows that the use of short, distinctive names in written, as well as in spoken communications, is quicker and less subject to error than the older more cumbersome latitude-longitude identification methods. These advantages are especially important in exchanging detailed storm information between hundreds of widely scattered stations, airports, coastal bases and ships at sea.

The use of easily remembered names greatly reduces confusion when two or more tropical cyclones occur at the same time. For example, one hurricane can be moving slowly westward in the Gulf of Mexico, while at exactly the same time another hurricane can be moving rapidly northward along the Atlantic coast. In the past, confusion and false rumors have arisen when storm advisories broadcast from one radio station were mistaken for warnings concerning an entirely different storm located hundreds of miles away.

These lists are recycled every six years (the 2009 list will be reused in 2015). Several names have been changed since the lists were last used. For the 2009 season, Fred, Ida and Joaquin replace Fabian, Isabel and Juan which were retired after the 2003 season.

Names of Atlantic Storms Through 2013

2009	2010	2011	2012	2013
Ana	Alex	Arlene	Alberto	Andrea
Bill	Bonnie	Bret	Beryl	Barry
Claudette	Colin	Cindy	Chris	Chantal
Danny	Danielle	Don	Debby	Dorian
Erika	Earl	Emily	Ernesto	Erin
Fred	Fiona	Franklin	Florence	Fernand
Grace	Gaston	Gert	Gordon	Gabrielle
Henri	Hermine	Harvey	Helene	Humberto
Ida	Igor	Irene	Isaac	Ingrid
Joaquin	Julia	Jose	Joyce	Jerry
Kate	Karl	Katia	Kirk	Karen
Larry	Lisa	Lee	Leslie	Lorenzo
Mindy	Matthew	Maria	Michael	Melissa
Nicholas	Nicole	Nate	Nadine	Nestor
Odette	Otto	Ophelia	Oscar	Olga
Peter	Paula	Philippe	Patty	Pablo
Rose	Richard	Rina	Rafael	Rebekah
Sam	Shary	Sean	Sandy	Sebastien
Teresa	Tomas	Tammy	Tony	Tanya
Victor	Virginie	Vince	Valerie	Van
Wanda	Walter	Whitney	William	Wendy

2008 Hurricane Season Summary

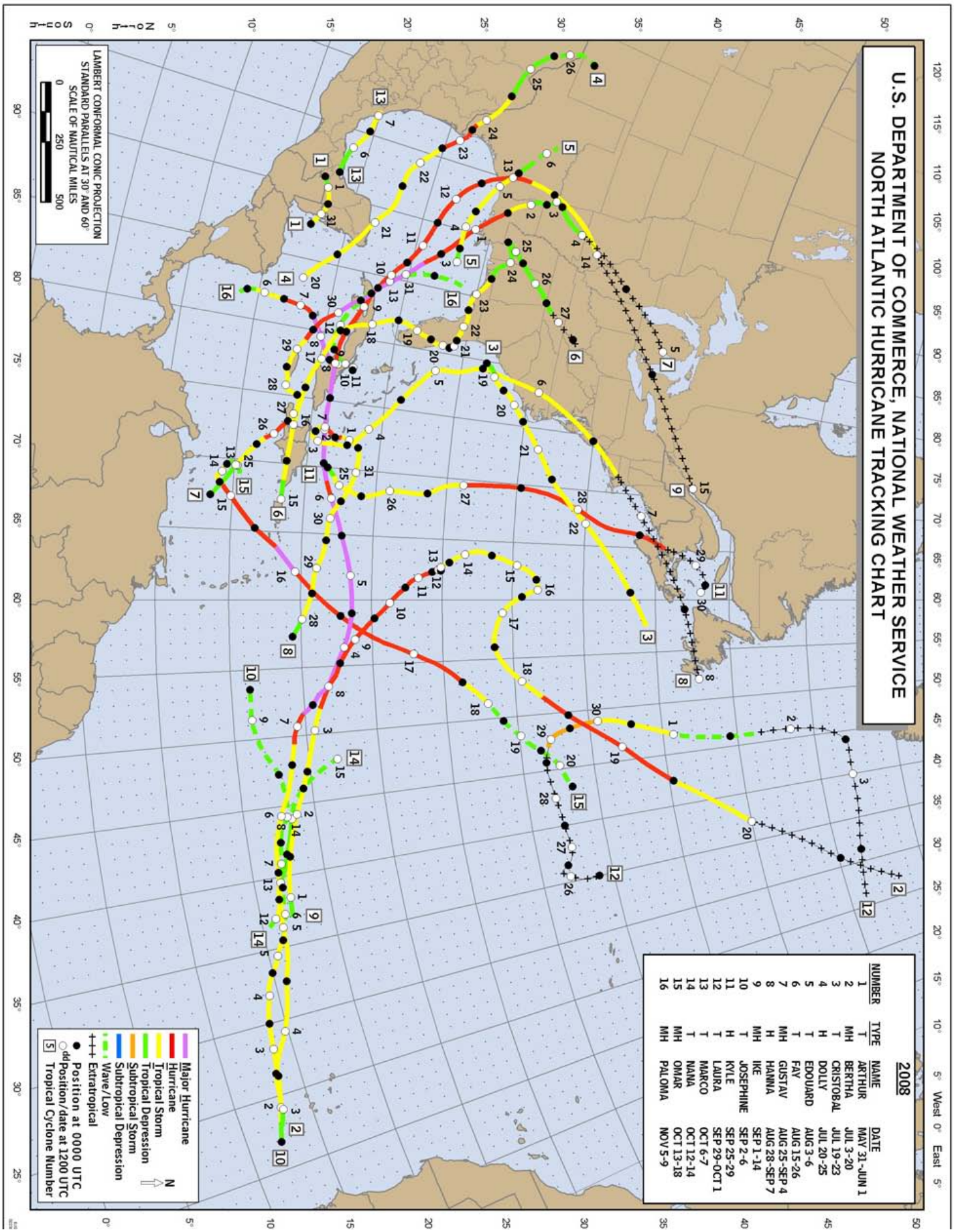
The 2008 Atlantic Hurricane Season saw a total of sixteen named storms, eight of which became hurricanes, with five becoming major hurricanes on the Saffir-Simpson Hurricane Scale. An average season has eleven named storms, six of which become hurricanes, with two becoming major hurricanes. This was the tenth season in the past fourteen years to produce above-normal activity. Since 1944, when aircraft missions began flying into tropical storms and hurricanes, this season tied as the fourth most active in terms of named storms and major hurricanes, and tied as the fifth most active in terms of hurricanes. This season was the first on record to see six consecutive tropical cyclones (Dolly, Edouard, Fay, Gustav, Hanna and Ike) make landfall on the U.S. mainland and a record three major hurricanes (Gustav, Ike and Paloma) to strike Cuba. This also marks the first season on record to have a major hurricane form in five consecutive months (Bertha in July, Gustav in August, Ike in September, Omar in October and Paloma in November). There was over $41 billion in damage during the season, and this places 2008 as the third costliest year behind 2004 and 2005. The season was devastating for Haiti, where over 800 people were killed by four consecutive tropical cyclones (Fay, Gustav, Hanna, and Ike) in August and September. Due to their severity, the names of Gustav, Ike and Paloma have been retired from the official name rotation.

Some season highlights included…

- Bertha was a tropical cyclone for seventeen days (July 3 – 20), making it the longest-lived July storm on record in the Atlantic Basin.
- Fay is the only storm on record to make landfall four times in the state of Florida, and to prompt tropical storm and hurricane watches and warnings for the state's entire coastline.
- Ike, the most destructive storm of the season, devastated portions of Cuba and the upper Texas coast, and will likely become the third costliest natural disaster in United States history behind hurricanes Katrina and Andrew.
- Paloma, reaching Category 4 status with top winds of 145 mph, is the second strongest November hurricane on record behind Lenny in 1999 with top winds of 155 mph.

Name	Class	Dates	Maximum Winds (mph)	Minimum Pressure (mb)	Direct Deaths	U. S. Damage ($million)
Arthur	TS	May 31 – Jun 1	45	1004	5	
Bertha	MH	Jul 3 – 20	125	952	3	
Cristobal	TS	Jul 19 – 23	998	65		
Dolly	H	Jul 20 – 25	100	963	1	1050
Edouard	TS	Aug 3 – 6	65	996	1	minor
Fay	TS	Aug 15 – 26	70	986	13	560
Gustav	MH	Aug 25 – Sep 4	150	941	112	4300
Hanna	H	Aug 28 – Sep 7	85	977	500	160
Ike	MH	Sep 1 – 14	145	935	103	19300
Josephine	TS	Sep 2 – 6	65	994		
Kyle	H	Sep 25 – 29	85	984		
Laura	TS	Sep 29 – Oct 1	60	994		
Marco	TS	Oct 6 – 7	65	998		
Nana	TS	Oct 12 – 14	40	1004		
Omar	MH	Oct 13 – 18	135	958		5
Paloma	MH	Nov 5 – 9	145	940		

a - TS = tropical storm, maximum sustained winds 39-73 mph; H = hurricane, maximum sustained winds 74 mph or greater; MH = major hurricane, category 3 or greater on the Saffir Simpson Hurricane Wind Scale.
b – dates begin at 0000 UTC and include tropical/subtropical depression stage, but exclude extratropical stage.
c - minor damage was reported but the extent of the damage was not quantified.


U.S. DEPARTMENT OF COMMERCE, NATIONAL WEATHER SERVICE
NORTH ATLANTIC HURRICANE TRACKING CHART
2008
NUMBER TYPE NAME DATE
1 T ARTHUR MAY 31-JUN 1
2 MH BERTHA JUL 3-20
3 T CRISTOBAL JUL 19-23
4 H DOLLY JUL 20-25
5 T EDOUARD AUG 3-6
6 T FAY AUG 15-26
7 MH GUSTAV AUG 25-SEP 4
8 H HANNA AUG 28-SEP 7
9 MH IKE SEP 1-14
10 T JOSEPHINE SEP 2-6
11 H KYLE SEP 25-29
12 T LAURA SEP 29-OCT 1
13 T MARCO OCT 6-7
14 T NANA OCT 12-14
15 MH OMAR OCT 13-18
16 MH PALOMA NOV 5-9
LAMBERT CONFORMAL CONIC PROJECTION
STANDARD PARALLELS AT 30° AND 60°
SCALE OF NAUTICAL MILES
0 250 500
Major Hurricane
Hurricane
Tropical Storm
Tropical Depression
Subtropical Storm
Subtropical Depression
Wave/Low
Extratropical
Position at 0000 UTC
dd Position/date at 1200 UTC
5 Tropical Cyclone Number
N

CENTERPOINT ENERGY'S RESPONSE TO HURRICANE IKE

Over the years, CenterPoint Energy crews have restored power to hundreds of thousands of customers across the country who have been left in the dark following natural disasters.

In the aftermath of Hurricane Ike, which left 2.1 million customers without power, the largest outage in CenterPoint Energy's more than 130-year history; the company called on mutual assistance crews.

Twelve thousand line mechanics, tree trimmers and additional personnel from over 70 companies were in Houston to aid in the recovery effort.

More than 30 states (including Texas, Alabama, California, Colorado, Florida, Kentucky, Maryland, Michigan, Missouri, New Jersey, New York, North Carolina, Ohio, Pennsylvania, and Virginia) as well Canada sent workers to help.

When Hurricane Ike hit the gulf coast of Texas on Sept. 13, 2008, its 110-mile-per-hour hurricane-force winds mowed down 50-foot-tall trees and flooded coastal areas engulfing the entire Houston/Galveston service territory. CenterPoint Energy's (CNP) electric delivery system took a direct hit from Ike, resulting in the largest power outage in Texas history. More than 95 percent of CNP's electric delivery customers lost power: 2.15 million at the storm's peak. Across the state, more than 3 million lost power. The impact on Houston – the fourth-largest city in the nation, home to NASA and the Texas Medical Center, the "energy capital of the world" – was huge. Damage estimates have ranged from $6 billion to $18 billion, which could make Ike one of the costliest U.S. storms ever. Most damage affected distribution lines.

CNP's transmission and substation structures held up remarkably well, with minor damages repaired quickly. Only 60 (less than 1 percent) of our wooden transmission poles were damaged. Ninety-six percent of CNP's transmission lines were back in service within four days, all of them within a week, with the later restorations concentrated on Galveston Island, which was impacted by both hurricane-force winds and a 12-foot storm surge that flooded four of our substations.

Storm damage to the distribution system was more extensive. Surveying the 5,000 square-mile service territory by air and foot, we discovered 332,045 feet of cable down and 86 percent of almost 1,500 circuits out. CNP replaced about 6,400 wooden distribution poles, less than 1 percent of about 1 million such poles in the system. The small number of poles that required replacement is a testament to the solid performance of our system even in the face of a storm of such magnitude.

Hurricane Ike - a category "tree" storm

We call Hurricane Ike a category "tree" storm because trees caused the majority of the damage. While our ongoing tree trimming program helps prevent limbs from growing into power lines in our easements, it could not keep whole trees from falling into power lines during Ike. With hundreds of poles down, 10 crews with a total of 450 workers took seven days to finish major repairs. Coordinating 14,000 field and support workers at over two dozen sites presented logistical challenges as well. The company used 1.4 million gallons of fuel for 7,000 vehicles and 859,543 meals to fuel 16-hour days followed by 94,155 hotel room nights for those not sleeping on one of 4,000 cots assembled at the same convention center which hosted evacuees from Hurricane Katrina three years before.

With its 300-mile-wide wind field, Hurricane Ike dwarfed its predecessors Rita and Alicia in size and customer power outages. Ike caused 2.15 million customers to lose power compared to the outages that Rita and Alicia caused: 719,000 and 750,000 customers respectively. Nonetheless, CNP and our mutual assistance partners were able to restore power to three times as many customers after Hurricane Ike in 18 days, only two more days than it took to complete restorations after our last direct hit by Hurricane Alicia 25 years ago.

In a way, CenterPoint Energy began preparing for Hurricane Ike a quarter century before its arrival. The company's experience recovering from Hurricane Alicia in 1983 and more recently from the glancing blow of Hurricane Rita in 2005 helped strengthen our storm-recovery culture that has been honed by annual drills and scores of mutual assistance efforts on behalf of other utilities.

We maintain a comprehensive Emergency Operating Plan (EOP) that is updated routinely and coordinated with state and local officials. When the EOP is activated, all employees take on critical emergency response roles and postpone non-essential business tasks. Before the onset of the 2008 hurricane season, we held our annual EOP drill and, with the City of Houston and National Weather Service, sponsored the largest hurricane workshop in the country to help prepare the community for hurricanes such as Ike. When we activated our EOP three days before Ike made landfall, we had already obtained sufficient fuel, lodging and supplies to begin restoration efforts. All personnel assigned to EOP, mutual assistance crews, vendors and distributors were poised and ready for post-storm activities.

Using our online mapping system with an outage tracking application that receives a real-time weather feed every few hours, we prepared probability models to evaluate potential storm impact and system damage. When the storm's path promised a direct hit, we alerted the community with safety information on television, radio and the Web, advising customers to prepare for outages lasting two to three weeks or longer. Hundreds of employees rode out the storm in company command centers, service centers and other facilities. As soon as winds subsided below tropical storm force – nine hours after landfall – crews were dispatched from 12 service centers to assess the damage and begin the largest power restoration effort in Texas history, following a strategy proven in our response to Alicia and Rita. Within a few days, we opened 11 staging sites to support mutual assistance crews that came to aid the restoration.

CenterPoint Energy crews repair pole in South Houston, Texas

Our restoration priorities had been established beforehand. First, we secured downed power lines and restored service to key facilities vital to public safety, health and welfare such as hospitals, wastewater treatment plants and water treatment facilities, including the Trinity River water pumping station: a major source of water for the greater Houston area. The station is located in a neighboring utility's service territory, but as we had first done after Rita, we rerouted power from our electric grid to Entergy's via an intricate switching system without damaging either company's system. Within four days, we had restored 96 percent of our transmission line and substation capabilities, returning service to 832,000 customers – more than all those who had lost power during Alicia or Rita. Second, we repaired major lines and fuses to restore power to the greatest number of customers in the shortest time.

On day five, armies of tree trimmers (ultimately more than 5,000) began to sweep across our service territory, followed by more than 7,000 linemen, who restored power to the one millionth customer on day six and to 1.5 million customers – 75 percent of those who had lost power – within 10 days. Finally, we repaired transformers, which typically serve 10 or fewer customers, and electric drops to individual homes (house-to-house combat, to maintain the military metaphor). By day 16, we had restored power to two million customers. On the 18th day, we concluded emergency operations, having met our initial service restoration projection of two to three weeks. Work continued only on isolated cases requiring repair of customer-owned equipment and to replace temporary fixes with long-term repairs. Nearly as challenging as the restoration effort was the task of communicating with customers and public officials before, during and after the storm.

As with our EOP, our communication plan began well before the storm, with the pre-season hurricane workshop and a year-round Storm Center web page with safety tips and preparation resources. Days before the storm, we purchased radio ads and began communicating with local, state and national media. We tracked Ike's path

Mutual assistance crews in Brazoria County, Texas

on our Web site for days leading up to the storm, with hourly updates right up to and during landfall.

Following the storm and through 18 days of recovery, communications worked in lockstep with operations to deliver the information the public craved almost as much as they did power. Local and national news media inundated the company with requests for interviews and information. We were key participants in frequent press briefings held by Transtar, a consortium of local government agencies responsible for emergency management services, and we held our own press conference to address the restoration. We issued almost two dozen news releases with pre- and post-storm safety tips, FAQs, and restoration expectations and milestones. In an Op-Ed essay for the Houston Chronicle, our president of Regulated Operations, Tom Standish, laid out a vision to build an electric grid of the future to enable us to respond more effectively and hopefully get power restored faster when dealing with the worst of Mother Nature.

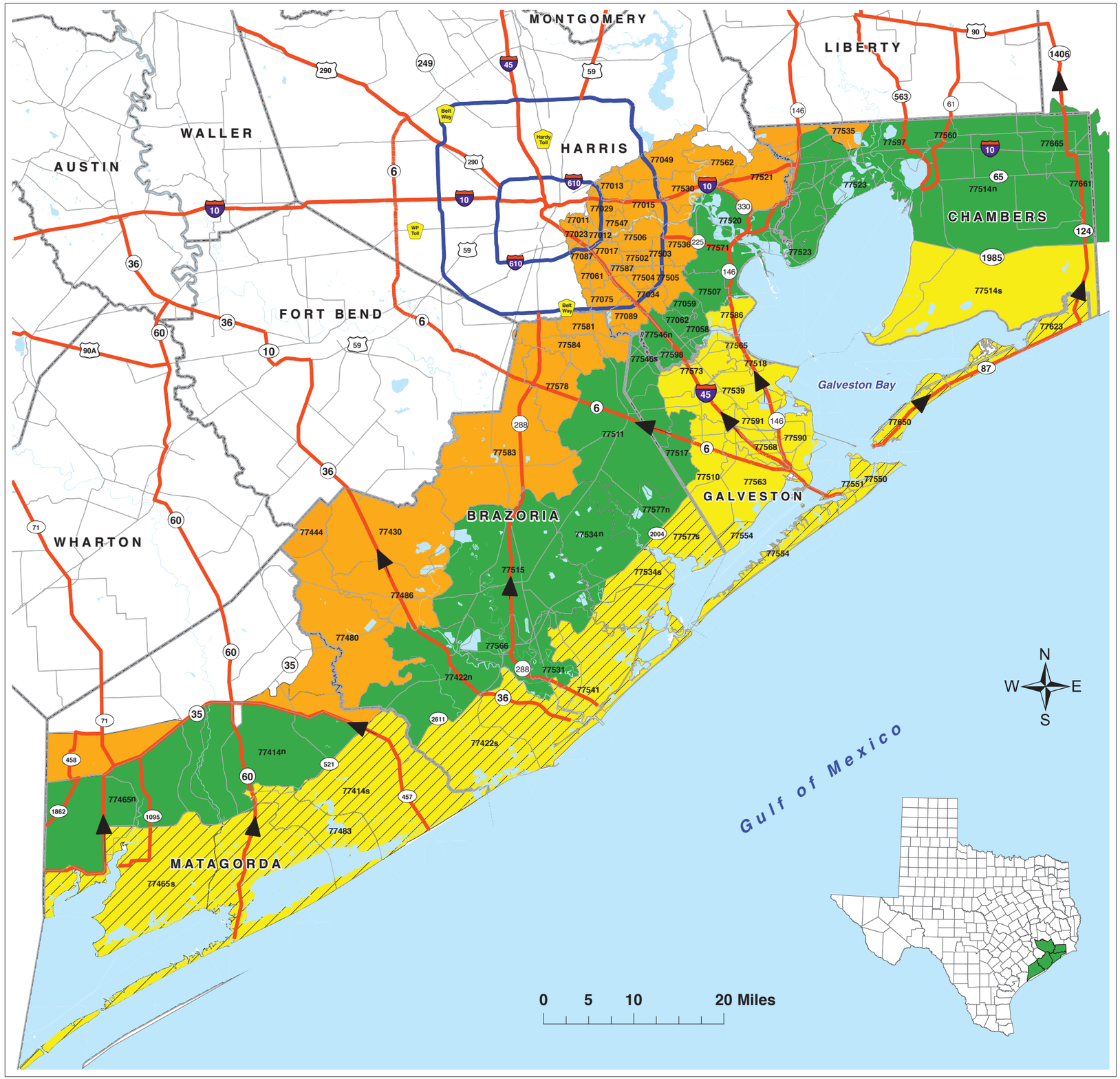
Our Government Relations team provided daily briefings and newsletters to federal, state, county and local officials including congress members and the Public Utility Commission. An executive liaison provided the U.S. Department of Energy with daily updates on restoration objectives and major accomplishments, which made their way to President Bush. Our Call Center staff, along with support from other work groups and third-party vendors, worked around the clock. On the first day, they fielded 90,177 calls, answering 72 percent within 30 seconds. Agents advised customers on safety measures and provided power restoration status and estimates with help from the Interactive Voice Response phone system and Web site. A dedicated Ike channel on the company Web site provided news; recovery resources; restoration forecasts, updates and maps; safety tips and FAQs; information in Spanish; and a photo and video gallery.

As customers without power accessed the Web site through family and friends, public libraries, smart phones and Blackberrys, hits to the Web site surged 2,700 percent. Even more than with Alicia and Rita, our experience with Ike has taught us lessons for future catastrophes. We need to continuously update our priority customer list of hospitals, public health and safety facilities, water pumping stations and citizens dependent on life-supporting equipment. We need to bring in more damage assessors and train all our line mechanics as foreign crew coordinators. We need to help customers have realistic expectations about the time necessary to restore power after a major storm so they can be better prepared for the inconveniences and demands of an extended outage. We also need to develop better methods for tracking restoration progress and communicating that information to customers. Our outage reporting system, designed to facilitate repairs, provided limited customer-centric information.

Nonetheless, our Ike data will enable us to improve our damage prediction models, and while our EOP worked very well under the circumstances, we continue an after action review to be even better prepared next time.

CenterPoint Energy

Always There.®



Brazoria, Chambers, Galveston, Harris and Matagorda Hurricane Evacuation Zip-Zones Coastal, A, B, C

Zip-Zone Coastal				
77414s	77483	77550	77577s	77650
77422s	77534s	77551	77617	
77465s	77541	77554	77623	
Zip-Zone A				
77510	77539	77568	77590	
77514s	77563	77573	77591	
77518	77565	77586		
Zip-Zone B				
77058	77507	77522	77560	77661
77059	77511	77523	77566	77665
77062	77514n	77531	77571	
77414n	77515	77534n	77577n	
77422n	77517	77546n	77597	
77465n	77520	77546s	77598	
Zip-Zone C				
77011	77034	77444	77505	77547
77012	77049	77463	77506	77562
77013	77061	77480	77520	77578
77015	77075	77486	77521	77581
77017	77087	77502	77530	77583
77023	77089	77503	77535	77584
77029	77430	77504	77536	77587

Route Designation

- Evacuation Corridors
- Evacuation Connections
- Other Roads
- County Boundary

Expiration Date December 2009
Map Created by:
Houston-Galveston Area Council

Matagorda Study Area

8 0 8 16 Miles

Saffir-Simpson Scale		Legend
Hurricane Category	Windspeed (MPH)	Primary Evacuation Route Secondary Evacuation Route County Boundary
1	74-95	Risk Area 1
2	96-110	Risk Area 2
3	111-130	Risk Area 3
4	131-155	Risk Area 4
5	>155	Risk Area 5

Risk Area numbers correspond to hurricane categories. For example, in the event of a Category 3 hurricane, Risk Areas 1, 2, 3 would be threatened.

What To Do When A Hurricane Threatens

Find the location of your home on the map and note the risk area where it is located. Plan to evacuate for any hurricane whose category is equal to or greater than the number of your risk area. Thus, those in Risk Area 5 need to evacuate only from a Category 5 hurricane, but those in Risk Area 1 should evacuate from all hurricanes.

If you live near a risk area boundary and are unsure of which risk area you are in, err on the side of caution. Assume that you are in the risk area that will be affected by a lower hurricane category (i.e., a risk area that has a smaller number and is nearer the coast). If you live in a mobile home in any of the five risk areas, plan to evacuate any time a hurricane threatens.

During a hurricane watch, listen to your radio or television constantly. The Emergency Alert stations for your area are KTRH 740 AM and KPRC 950 AM (Matagorda Co.), and KVIC 95.1 FM and KRNX 1340 AM (all other counties). The NOAA Weather Radio Stations are 162.475 megahertz (Port O'Conner), 162.400 (Victoria) and 162.425 (Bay City).

Begin evacuation preparations during the hurricane watch so you will be ready to leave when you receive a hurricane warning. If you will be traveling with young children, older family members, or people with special needs, consider leaving before you receive an official evacuation warning.

When local officials tell you to evacuate, do so immediately. Plan to take the nearest evacuation route (marked by a red line on the map), but be prepared to take an alternate route if your primary evacuation route is congested. Be sure to take plenty of bottled water and snacks with you because the trip may take longer than usual due to congested roads.

Identify a place to stay before you leave. If you plan to stay in a hotel or motel, call ahead to make reservations. If you need to stay in a public shelter, public officials in host cities will let you know where one is located when you arrive. Many hotels and most public shelters do not take pets, so make other arrangements if necessary.

Funded through a grant from the Federal Emergency Management Agency (FEMA)

Lake Sabine Study Area

7 0 7 14 Miles

Saffir-Simpson Scale		Legend
Hurricane Category	Windspeed (MPH)	Evacuation Routes County Boundary
1	74-95	Risk Area 1
2	96-110	Risk Area 2
3	111-130	Risk Area 3
4	131-155	Risk Area 4
5	>155	Risk Area 5

Risk Area numbers correspond to hurricane categories. For example, in the event of a Category 3 hurricane, Risk Areas 1, 2, 3 would be threatened.

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During a hurricane watch, listen to your radio or television constantly. The Emergency Alert stations for your area are KTRH 740 AM and KPRC 950 AM (Chambers Co.) and KLVI 560 AM and KFDM Channel 6 (all other counties). The NOAA Weather Radio Stations are 162.550 megahertz (Galveston), 162.400 (Houston), 162.500 (Lake Livingston), 162.475 (Beaumont) and 162.425 (Burkeville).

Begin evacuation preparations during the hurricane watch so you will be ready to leave when you receive a hurricane warning. If you will be traveling with young children, older family members, or people with special needs, consider leaving before you receive an official evacuation warning.

When local officials tell you to evacuate, do so immediately. Plan to take the nearest evacuation route (marked by a red line on the map), but be prepared to take an alternate route if your primary evacuation route is congested. Be sure to take plenty of bottled water and snacks with you because the trip may take longer than usual due to congested roads.

Identify a place to stay before you leave. If you plan to stay in a hotel or motel, call ahead to make reservations. If you need to stay in a public shelter, public officials in host cities will let you know where one is located when you arrive. Many hotels and most public shelters do not take pets, so make other arrangements if necessary.

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2009 Hurricane Workshop...Remembering Ike

Your Family Hurricane Plan Checklist

STEP I: PREPARING A DISASTER SURVIVAL KIT

The most important thing you and your family can do in preparation for a hurricane is be able to survive on your own after the storm. This means having enough food, water, and other supplies to last at least three days.

You may want to consider storing enough supplies to last up to two weeks. Local officials and relief workers will be on the scene after a disaster, but they can't reach everyone immediately. Basic services such as electricity, gas, water, sewage treatment, and telephones may be cut off for days or weeks.

You should store your kit in a designated place at home and have it ready in case you need to leave your home quickly.

Basic Disaster Supplies Kit:

(Keep items in airtight plastic bags and put your entire disaster supplies kit in one or two easy to carry containers)

- ☐ Water: three day supply - one gallon per person, per day (see below for further details)
- ☐ Food: three day supply - non-perishable (see below for further details)
- ☐ Portable, battery-powered radio or television and extra batteries
- ☐ Flashlight and extra batteries
- ☐ First aid kit and manual
- ☐ Sanitation and hygiene items (moist towelettes and toilet paper)
- ☐ Matches and waterproof container
- ☐ Extra clothing
- ☐ Kitchen accessories and cooking utensils, including a can opener
- ☐ Photocopies of credit cards and other identification cards
- ☐ Photocopies of important papers and phone numbers
- ☐ Cash
- ☐ Prescriptions
- ☐ Other medical needs items: eye glasses, contacts, hearing aid batteries
- ☐ Items for infants: formula, diapers, bottles, pacifiers

It's important to maintain your disaster supplies kit on a regular basis so that it is safe to use when needed. Change stored food and water supplies every six months. Canned foods should be kept in a dry place and boxed food should be stored in tightly closed plastic or metal containers to extend their shelf life. Replace food with fresh supplies when they go bad.

Water:

You should store at least one gallon of water per person per day. More water may be required for children, nursing mothers, ill people, and in cases of a medical emergency.

The safest and most reliable water supply would be made up of commercially bottled water. The water should be kept in its original container and not opened until it is used. Observe the expiration date.

If you choose to bottle your own water, it is recommended that you use food-grade water storage containers from surplus or camping supply stores. If not, you can use two-liter plastic soft drink bottles. Avoid using any containers that have had juice or milk in them: they can foster bacteria growth. Also avoid using cardboard or glass containers.

Before storing water, thoroughly wash the containers with dishwashing soap and water. Sanitize the bottles by adding one teaspoon of non-scented liquid household chlorine bleach to a quart of water. Swish around the solution so it touches every surface of the bottle. Thoroughly rinse out the sanitizing solution with clean water.

Fill the bottles with tap water and close the bottles with the original cap. Store the bottles in a cool dark place. Replace the tap water every six months.

Food:

Food should be non-perishable. Avoid foods that will make you thirsty. Choose salt-free crackers, whole grain cereals, and canned foods with high liquid content.

Stock canned foods, dry mixes, and other staples that do not require refrigeration, cooking, water, or special preparation. Include a manual can opener. Remember special dietary needs.

Your Family Hurricane Plan Checklist continued

STEP II: PREPARATIONS AT THE START OF HURRICANE SEASON

- ☐ Know whether or not your family lives in a designated evacuation zone (see the maps in this book). If you do live in an evacuation zone, plan ahead of time where you will go and where you will stay.
- ☐ Know your children's school emergency plan. Ask how the school will communicate with families during a crisis.
- ☐ Find out your workplace evacuation and emergency plan.
- ☐ Learn how to shut off utilities (such as water and electricity) in your home.

Preparations around your property:

- ☐ Permanent storm shutters offer the best protection for windows. A second option is to board up windows with 5/8-inch marine plywood.
- ☐ Roof clips or straps (fastening roof to frame structure) can help reduce roof damage.
- ☐ Trim trees and shrubbery around the home.
- ☐ Clear clogged rain gutters.
- ☐ Determine how and where to secure your boat.
- ☐ Find a central room on the lowest floor of your home away from windows to serve as a shelter during the storm.

Inventory/Records:

- ☐ Make copies of important documents: Insurance policies (Property, Life, Health, etc.), credit cards, identification cards, property deeds. Keep copies in your disaster supplies kit.
- ☐ Make inventory of personal property for insurance purposes.
- ☐ Make video of your personal property – furniture, pictures, appliances, clothes, tools, etc.
- ☐ Consider storing important documents in a safety deposit box away from your home.
- ☐ Have an emergency fund (savings account) that could be tapped into in a crisis.
- ☐ Keep a small amount of cash in a safe place that can be quickly accessed during evacuation.

Plan for Those with Special Needs:

If you or someone close to you has special needs, you may have to take additional steps for protection in an emergency. The following special needs should be considered: the hearing or mobility impaired, the critically ill, the single working parent, non-English speaking persons, people without vehicles, and people with special dietary needs.

A special needs person should register with the office of emergency management for assistance so that required help can be provided in a time of crisis. Create a network of contacts to aid the person in an emergency. Be sure each knows how to operate necessary equipment. Keep specialized items available, including extra batteries, oxygen, medication, and any other items that might be needed. Make provisions for medications that require refrigeration. In an apartment or high-rise building, ask management to make arrangements to help the person leave the building.

Sheltering Pets:

Plan ahead on where you will board your pets during a hurricane. Some emergency shelters do allow pets now, but only certain shelters. Check ahead with a local emergency management office or animal shelter on which shelters, motels or hotels will allow pets, and where boarding facilities are located. Be prepared to make sure your animal is properly identified and to take veterinary records with you to prove vaccinations are current if you are asked to evacuate.

Sheltering Larger Animals (such as horses or cattle):

Ensure all animals have some form of identification. Make available vehicles and trailers for transporting each type of animal. Be prepared to evacuate the animals if necessary. Ensure that destinations have food, water, veterinary care, and handling equipment.

STEP III: WHEN A HURRICANE THREATENS

- ☐ Frequently monitor radio, TV, NOAA Weather Radio, Internet or hurricane hotline telephone numbers for official bulletins of the storm's progress.
- ☐ Fuel and service family vehicles.
- ☐ Inspect and secure mobile home tie downs.

Your Family Hurricane Plan Checklist continued

- ☐ Prepare to cover all window and door openings with shutters or plywood.
- ☐ Check prescription medicines — obtain at least a ten day to two week supply.
- ☐ Store and secure outdoor lawn furniture and other loose, lightweight objects, such as garbage cans, garden tools, potted plants, etc.
- ☐ Stock up on extra batteries for radios, flashlights, and lanterns and check for ample first aid supplies.
- ☐ Get an extra supply of cash to last two weeks. Banks may be closed and ATM machines may not work after the storm.
- ☐ Make sure you have a full disaster supplies kit (see list in Step I).

Plan to evacuate if you...

- ☐ Live in a designated evacuation zone (see maps in this book). If so, you may be directed by local authorities to evacuate. Be sure to follow their instructions.
- ☐ Live in a mobile home or temporary structure. Do not stay in a mobile home under any circumstances.
- ☐ Live on the coastline or on an offshore island, or live near a river or in a flood plain.
- ☐ Live in a high-rise building. Hurricane winds are stronger at higher elevations.

If you are evacuating:

- ☐ Disconnect utilities (including phone and electricity) as a precaution to prevent further damage.
  Electricity: remember to shut off individual circuits before shutting off the main circuit breaker.
  Gas: turn off gas at each appliance but do not turn off main gas line to the house.
- ☐ Leave early and if possible, during daylight hours.
- ☐ Notify neighbors and family members outside of the warned area of your evacuation plans.
- ☐ Stay with friends or relatives or at a low-rise inland hotel or motel outside of flood zones. Leave early to avoid heavy traffic, roads blocked by early flood waters, and bridges made impassable due to high winds.
- ☐ Hurricane shelters will be available for people who have no other place to go. Shelters may be crowded and uncomfortable, with no privacy and no electricity. Do not leave your home for a shelter until government officials announce that a particular shelter is open.

What to bring to a shelter:

- ☐ First-aid kit, medicines, baby food and diapers, cards, games, books, toiletries, battery-powered radio, flashlights, extra batteries, blankets or sleeping bags, identification, valuable papers (insurance) and cash.
- ☐ Pets: remember that only certain emergency shelters will allow pets. Keep veterinary records with you to prove vaccinations are current.

If you are staying in a home:

(Reminder! Only stay in a home if you have not been told to leave. If you ARE told to leave, DO SO IMMEDIATELY.)

- ☐ Make sure all windows and doorways are covered by hurricane-proof shutters or 5/8-inch plywood.
- ☐ Turn refrigerator to maximum cold and open only when necessary.
- ☐ Turn off utilities if told to do so by authorities. Turn off propane tanks. Unplug small appliances.
- ☐ Stay inside your home at all times and away from windows and doors.
- ☐ If you lose power, use flashlights rather than candles or open flames to move around in the darkness.

Your Family Hurricane Plan Checklist continued

If winds become strong:

- ☐ Take refuge in an interior room, closet, or hallway on the lowest floor away from doors or windows. Take a battery-powered radio, a NOAA Weather Radio and a flashlight with you.
- ☐ Lie on the floor under a table or another sturdy object.
- ☐ Close all interior doors. Secure and brace external doors. Keep curtains and blinds closed.
- ☐ If you are in a multiple-story building and away from the water, go to the first or second floors and take refuge in the halls or other interior rooms away from windows. Interior stairwells and the areas around elevator shafts are generally the strongest part of a building.

NOTE: Be alert for tornadoes which often are spawned by hurricanes. Also, if the "EYE" of the hurricane should pass over your area,
be aware that the improved weather conditions are only temporary and that the storm conditions will return with winds coming
from the opposite direction sometimes in a period of just a few minutes.

STEP IV: AFTER THE STORM

- ☐ Stay in your protected area until announcements are made on the radio or TV that the dangerous winds have passed. Stay off the streets unless absolutely necessary.
- ☐ If you have evacuated, do not return home until officials announce your area is ready. Remember, proof of residency may be required in order to re-enter the evacuation areas.
- ☐ Be aware of the surroundings when returning as extreme damage could render a familiar landscape unrecognizable.
- ☐ If your home or building has structural damage, do not enter until it is checked by officials. Do not enter your home if you smell gas, floodwaters remain around the building, or if authorities have declared it unsafe. In a damaged home, have the electrical system checked out by an electrician before turning it back on. If water pipes are damaged, turn off the main water valve. Check with authorities before using any water as it may have become contaminated during the storm.
- ☐ Beware of outdoor hazards such as downed power lines and any water they may be lying in, poisonous snakes driven from their dens by high water, weakened bridges, washed out roads, weakened limbs on trees and/or damaged overhanging structures.
- ☐ Do not use the telephone unless absolutely necessary. The system is usually jammed with calls during and after a hurricane.
- ☐ Guard against spoiled food. Use dry or canned food. Do not drink or prepare food with tap water until you are certain it is not contaminated with flood waters. Throw out any food, water, or supplies that have been contaminated or come in contact with flood waters.
- ☐ When cutting up fallen trees, use caution, especially if you use a chain saw. Serious injuries can occur when these powerful machines snap back or when the chain breaks.
- ☐ Call your insurance agent. Take video or still pictures of damaged property. Keep records of your repair and clean up costs.

Coping with post-disaster stress:

- ☐ Maintain a normal family and daily routine, limiting responsibilities on yourself and your family.
- ☐ Seek help from professional counselors for yourself and your family if needed. Talk to someone about your feelings even though it may be difficult. Make sure to get help for your children as well.
- ☐ Use existing support groups of family, friends, and religious institutions.
- ☐ Take steps to promote physical and emotional well-being such as healthy eating, rest, relaxation, and meditation.

NOTE: These lists are not intended to be all-inclusive. You must decide what supplies are best suited for you and your family's survival. These lists contain only suggestions for your consideration.

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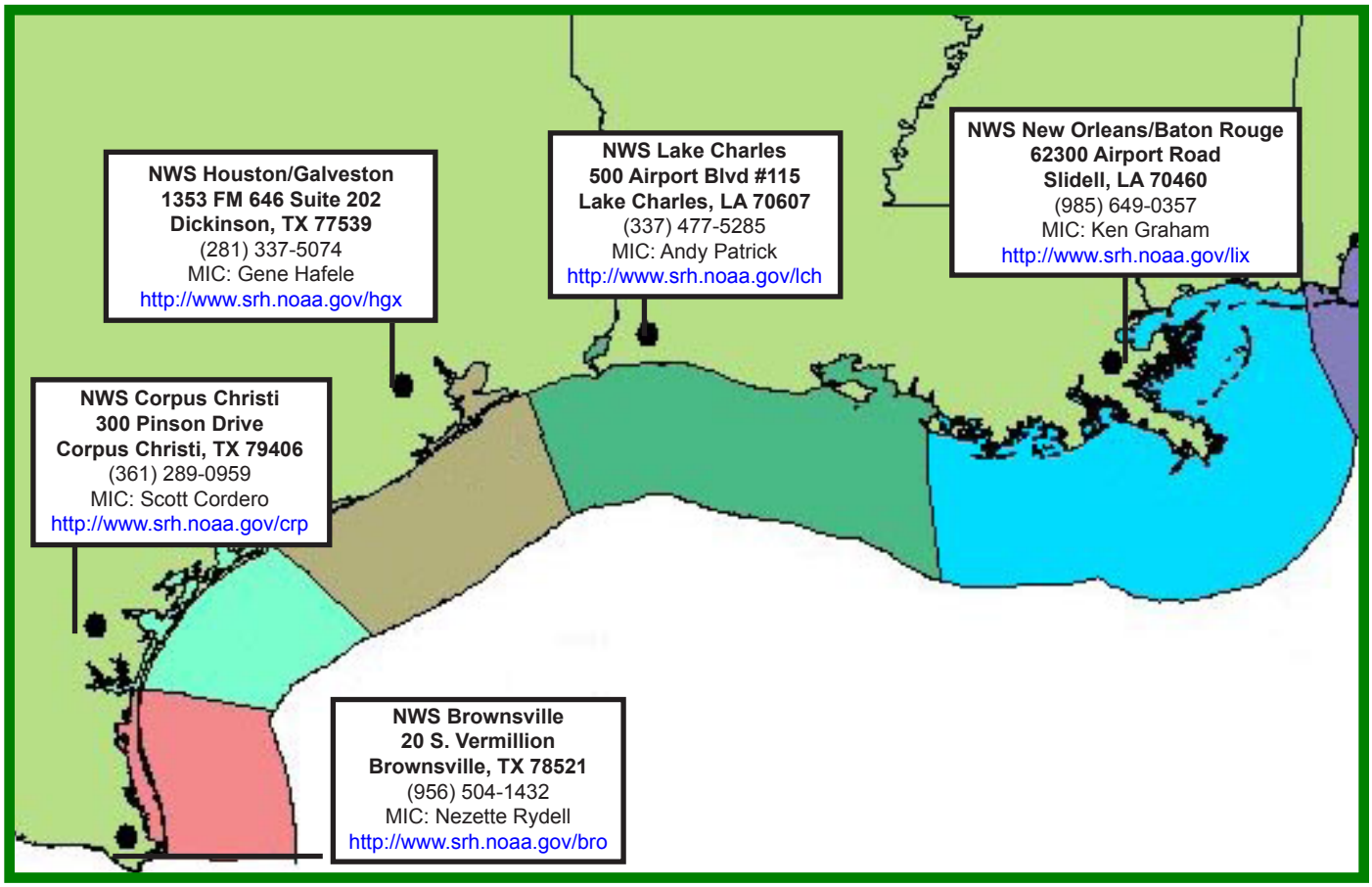
Regional National Weather Service Offices



Hurricane Preparedness and Weather Sites on the Internet

National Hurricane Center
http://www.nhc.noaa.gov

NWS Southern Region Headquarters
http://www.srh.noaa.gov

Storm Prediction Center
http://www.spc.noaa.gov

Historical Hurricane Tracks
http://maps.csc.noaa.gov/hurricanes/index.jsp

EMWIN Houston
http://houston.emwin.org

Klotzbach and Gray Hurricane Forecasts
http://hurricane.atmos.colostate.edu/forecasts

Federal Emergency Management Agency
http://www.fema.gov/hazard/hurricane

Harris County Homeland Security and Emergency Management
http://www.hcoem.org

City of Houston Office of Emergency Management
http://www.houstonoem.net

Galveston County Office of Emergency Management
http://www.gcoem.org

American Red Cross
http://www.redcross.org

Hurricane Ike
http://www.srh.noaa.gov/hgx/projects/ike08.htm

HOUSTON / GALVESTON NATIONAL WEATHER SERVICE

2009 Remembering IKE HURRICANE WORKSHOP

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Statement issued by the Houston/Galveston National Weather Service
at 11:39 a.m. Thursday, prior to Hurricane Ike landfall:

"PERSONS NOT HEEDING EVACUATION ORDERS IN SINGLE FAMILY ONE OR TWO STORY HOMES WILL FACE CERTAIN DEATH."

Contributors:

- Harris County
- Interfaith Ministries for Greater Houston
- The John C. Freeman Weather Museum
- Wal-Mart

hurricaneworkshop.com