Storm Signals

Houston/Galveston National Weather Service Office

Volume 73 Summer 2006

2006 Hurricane Season Outlook

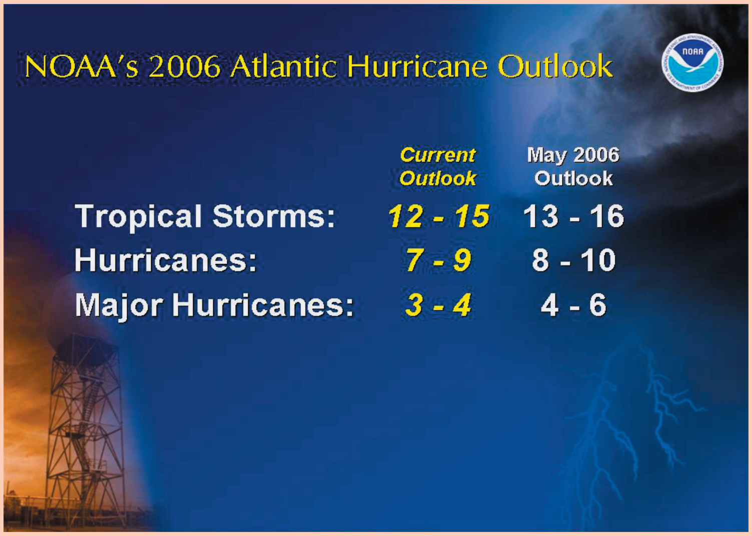


Figure 1: NOAA's 2006 Atlantic Hurricane Outlook (August 2006)

Although it is not expected to be as severe as last year's record-shattering season, NOAA is forecasting a 75 percent chance of an above normal hurricane season in the Atlantic Basin for 2006. NOAA is forecasting 12 to 15 named storms, of which 7 to 9 will become hurricanes, and 3 to 4 of these becoming major hurricanes (Category 3 or higher). A "normal" hurricane season yields 11 named storms, with 6 becoming hurricanes, and 2 becoming major hurricanes.

This forecast is slightly lower than the initial projections that were sent out in late May of this year (see Figure 1). The 2006 season has started off quiet so far, with only three named storms through mid August, and no hurricanes yet. According to Gerry Bell, Ph.D., NOAA's lead seasonal hurricane forecaster, conditions were ripe in 2005 for early season storm development. "La Niña-like convection in the central equatorial Pacific during June and July of 2005 contributed to the development of numerous early-season storms," he said. "Conditions this year reflect a more typical active season, with peak activity expected during August-October."

The vast majority of this year's storms are expected to form over the tropical Atlantic Ocean between now and the end of October, which is typical of above normal seasons. These systems typically track westward toward the Caribbean Sea and the United States. Above normal seasons typically result in 2 to 3 landfalling hurricanes in the United States, and 2 to 3 hurricanes striking the region around the Caribbean Sea. However, NOAA does not make official forecasts for the number of landfalling hurricanes.

In this Issue

Favorable Climatic Conditions for an Above Normal Season

Every Atlantic basin hurricane season since 1995 has seen above normal activity, except for two moderate to strong El Niño years (1997 and 2002).

The regional atmospheric circulation and oceanic conditions that contribute to these long-period fluctuations in hurricane activity are linked to the "tropics-wide multi-decadal signal."

The key aspects of the "multi-decadal signal" across the North Atlantic include the following:

1. Warmer than normal SSTs (Sea Surface Temperatures)
2. Lower surface air pressure
3. Increased moisture
4. Amplified upper level high pressure ridge over the central and eastern subtropical North Atlantic
5. Reduced vertical wind shear in the deep tropics over the central North Atlantic
6. Weaker easterly trade winds in the middle and lower atmosphere favor enhanced development of tropical waves as they move west off the African coast

Some of the other aspects of the multi-decadal signal that were present during 2005's record setting season include the amplified upper level high pressure ridge over the subtropical Atlantic, and exceptionally low surface pressures over the Gulf and Caribbean. Many of these aspects will again be present in the 2006 season and once again lead to an above normal season (Figure 2).

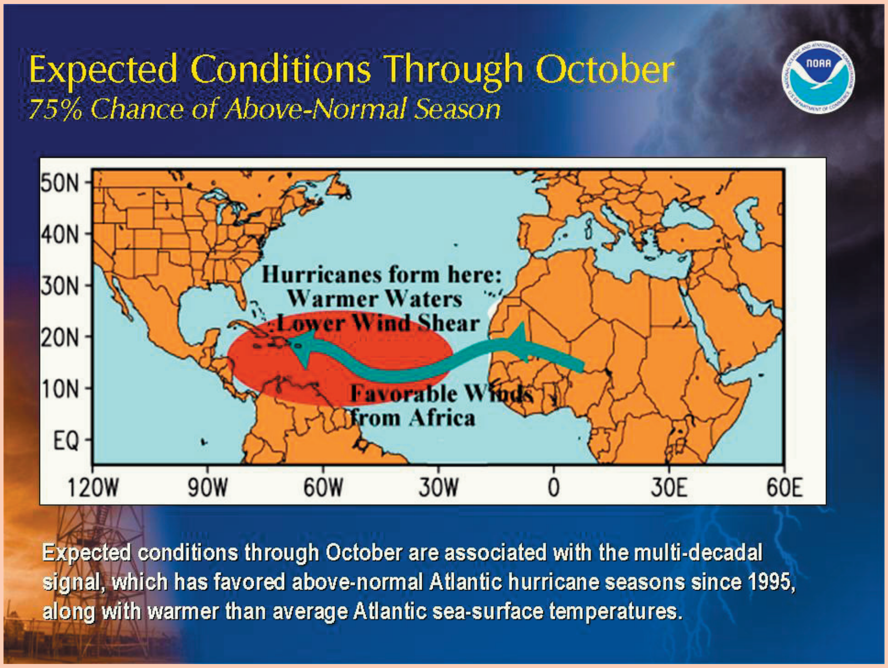


Figure 2: Aspects of the "multi-decadal signal" that will lead to an above normal season in 2006.

The forecast for the 2006 season has been lowered slightly from initial projections because a number of the aspects of the multi-decadal signal are not present or are less pronounced at this point in the season than previously expected. The atmospheric wind and air pressure patterns are not as conducive as expected. The tropical Atlantic SSTs are closer to normal than the values observed either earlier in the season or during the 2005 season. In addition, the very persistent upper level ridge over the eastern U.S. and western Atlantic that led to very active hurricane seasons in the 2003 to 2005 period is no longer present (see Figures 3 and 4). While La Nina conditions were a factor in last year's record setting season, ENSO-neutral conditions are expected for much of this hurricane season. Therefore, ENSO should not have much of an impact.

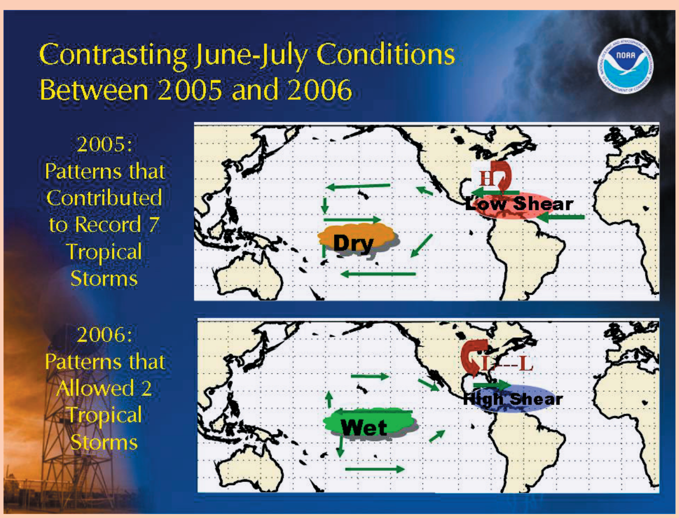


Figure 3: Contrasting Atmospheric conditions in June/July 2005 vs June/July 2006.

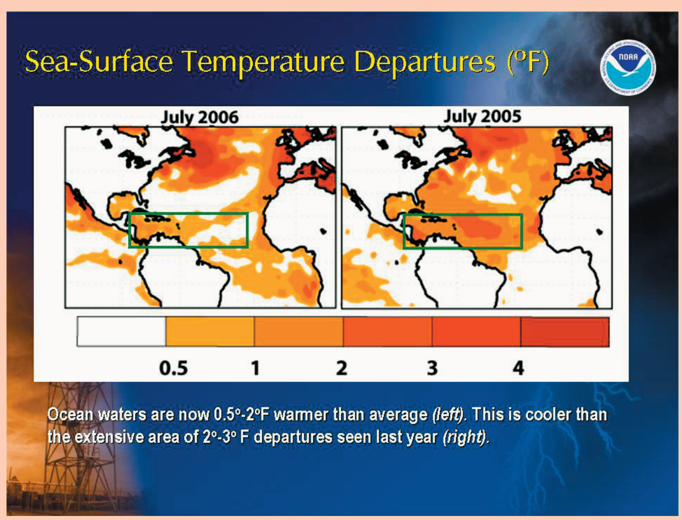


Figure 4: Contrasting SSTS in the Atlantic began in July 2006 vs. July 2005.

Multi-Decadal Fluctuations in Atlantic Hurricane Activity

Atlantic hurricane seasons exhibit prolonged periods lasting decades of generally above-normal or below-normal activity. These fluctuations result almost entirely from an increase or decrease in the number of storms forming in the main development region – the Atlantic Ocean and the Caribbean Sea. Tropical activity in the Gulf of Mexico is less correlated with these fluctuations.

Hurricane seasons in the 1995 to 2005 period have averaged 15 named storms, 8.5 hurricanes, and 4 major hurricanes. Nine of these hurricane seasons have been classified as above normal seasons. In contrast, in the preceding 25 year period from 1971 to 1994, the hurricane seasons averaged just 8.5 named storms, 5 hurricanes, and 1.5 major hurricanes. Only three of these 25 seasons were classified as above normal seasons.

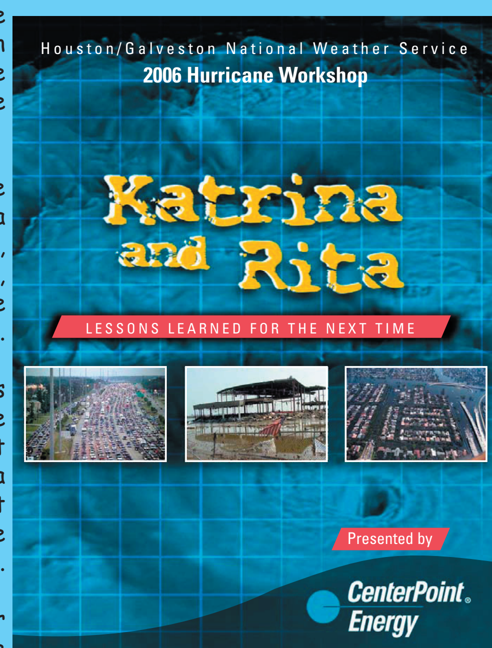
Uncertainties in the Outlook

The primary uncertainty in this year's outlook is related to the strong variability in atmospheric and oceanic conditions in the tropical Atlantic in recent months. Another uncertainty: the high activity of the last three hurricane seasons resulted partly from an amplified upper-level high pressure ridge and lower than normal wind shear over the western North Atlantic and eastern United States. This high pressure ridge has been notably absent so far this season, but it could again develop. If it were to redevelop, the 2006 season could be more severe than currently forecast.

Keep in mind that this is a general seasonal outlook and it is impossible to predict at this point in the season the number of landfalling storms or whether one location is more likely to be impacted by a hurricane than another. In addition, remember that it doesn't take an above normal hurricane season to be a destructive one in the United States. One major hurricane hitting a large metropolitan area will cause far more damage than several hurricanes hitting sparsely populated areas. A good example of this is the 1992 hurricane season – one of the least active on record. However, the 1992 season yielded Hurricane Andrew which stands as the second costliest hurricane in U.S. history. The last major hurricane to strike the Houston/Galveston area – Hurricane Alicia in 1983 – occurred during one of the least active hurricane seasons on record.

Hurricane Workshop 2006

In preparation for the 2006 hurricane season, the Houston/Galveston National Weather Service Office held its annual Hurricane Workshop on Tuesday, May 30th. This year, the Hurricane Workshop moved from the Pasadena Convention Center to the George R. Brown Convention Center in Houston. This change in venue was made possible by the City of Houston who donated space at the George R. Brown Convention Center to hold this very important workshop in hopes of accommodating a large diverse audience. This year's theme was, "Katrina and Rita: Lessons Learned for the Next Time." As always, admission was free and doors were open to the public.



With Katrina fresh on the minds of citizens in Southeast Texas, Hurricane Rita became a serious threat to our area last September. Although Rita eventually made landfall just to our east in the Texas-Louisiana border area, massive evacuations, along with a shortage in gasoline and other supplies, occurred across Southeast Texas. The 2006 Workshop focused on the 2005 Hurricane Season, in particular the impacts of both Katrina and Rita.

This workshop consisted of a main session with several keynote speakers including the mayor of Houston, Bill White and Stacy Stewart, Hurricane Specialist at the National Hurricane Center in Miami. Numerous breakout sessions were also held that touched upon the lessons learned from Katrina and Rita. Other hurricane related topics were also covered such as the latest evacuation plans. Like the past several years, a vendor area was also available for companies involved in hurricane preparedness and hurricane protection.

For the second year in a row, CenterPoint Energy was the presenting sponsor for the workshop. CenterPoint Energy, the company that maintains the electrical lines throughout the Greater Houston area, is very involved in helping the Houston area prepare for and recover from major hurricanes.

We enjoyed seeing you at the 2006 Hurricane Workshop! Have a safe 2006 season.

Area Lake Surges Associated with Hurricane Rita

By Lance Wood and Dave Schwertz

The United States experienced more landfalling major hurricanes (4) during the 2005 hurricane season than in any previously recorded season. One of these hurricanes (Rita) made landfall across a portion of the northwest Gulf coastline which had not experienced a major hurricane in over 40 years. Therefore, it should not be a surprise that inland lake surges associated with Rita were unexpected and caused severe damage to dams at both Lake Livingston and Lake Conroe in southeast Texas. This article details the water surge and release, as well as damage that occurred at Lake Livingston and Lake Conroe in association with Hurricane Rita.

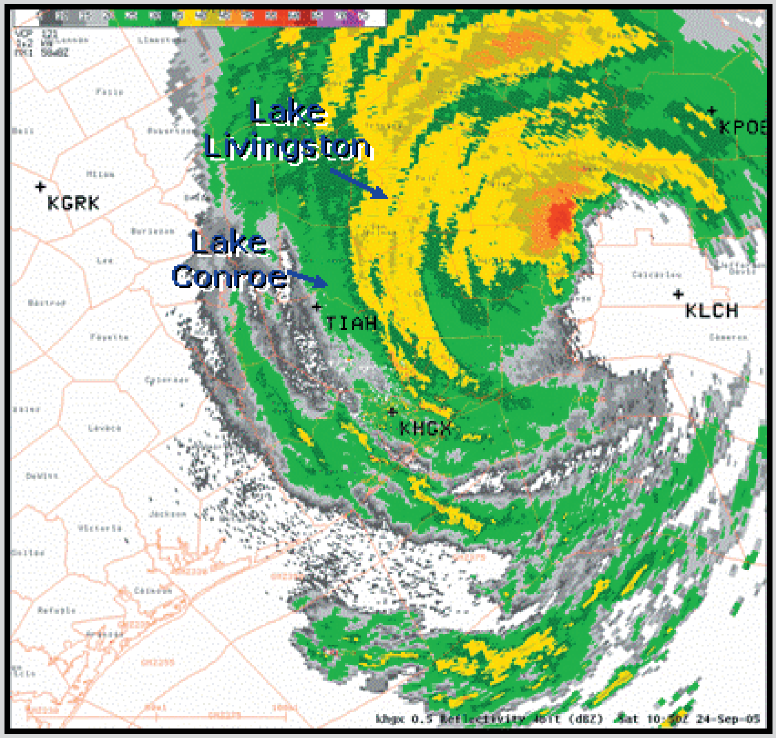


Figure 1. KHGX radar base reflectivity display of Hurricane Rita at 5:50 AM CDT, September 24, 2005.

Rita made landfall during the early morning hours on Saturday, September 24th, 2005. At landfall along the Texas/Louisiana border, Rita was a Category 3 hurricane; the hurricane moved northwest, and passed approximately 70 miles to the east of Lake Livingston and about 90 miles east of Lake Conroe (Figure 1). Because of this close approach from the southeast and east, Lake Livingston was subjected to a prolonged period of 50-70 mph sustained north/northwest winds, with higher gusts. The peak recorded wind gust at the dam was 117 mph at 5:30 A.M. At Lake Conroe, winds were not quite as strong, but were estimated to be sustained around 40 mph for several hours with higher gusts. The northerly wind direction allowed water to surge southward toward the dams as it was aligned along the major axis of the north-south oriented lakes. Although the magnitude of the surge was only around 1.5 feet at the Livingston Dam and less than 1 foot at the Conroe Dam, wave action on top of these surges caused significant erosion of the earthen dams.

The resulting damage/erosion to the Livingston dam was the worst in the history of the structure which was built in 1966. Riprap (36 inch deep stone cover) protecting the dam was washed away by the high water levels and wave action. After most of this riprap was washed away, two fifteen foot caverns developed in the exposed earthen dam (Figure 2). A large portion of the dam ended up severely damaged with a total of 11,000 linear feet affected.

Figure 2. Damage at the Lake Livingston Dam caused by wave action.

During the event, several hours after Rita's landfall, dam operators were fearful that the dam could break due to the significant damage that was occurring. Therefore, water was released at a rate of 80,000 CFS through the flood gates, and an evacuation of communities immediately downstream was ordered. Fortunately, the water releases from the dam quickly abated the failure danger. A timeline graphic depicting the rising and falling water levels at the dam and at Riverside (on the northwest edge of the lake or tail-waters) during the event on September 24th, is shown in Figure 3.

In the wake of Rita, damage assessment and necessary repairs required that the lake be lowered and kept at 4 feet below the normal pool elevation. The repair plans called for some changes to the new protective layer for the earthen dam. For example, a 1 foot deep layer of sand and gravel between the clay dam and riprap was replaced with stones about 8 inches in diameter in an effort to better hold the protective boulders in place. In addition, new material was used to restore the layer of riprap. The 15-foot-deep caverns in the dam's surface near the access road to the dam's low-level outlet were repaired with sandbags and secured with concrete. Only recently has the lake been allowed to begin rising as 9.6 million dollars worth of repairs were completed in the spring. Damage at Lake Livingston was not limited to the dam as any north/northwest facing shore-line was subjected to high water levels and significant wave action. For example, damage occurred at the point in the Indian Hills subdivision (Figure 4) and at Cape Royale.

At the Lake Conroe dam, 1.7 million dollars worth of repairs to about 5, 000 linear feet were necessary as the protective riprap boulders ranging from 4 to 18 inches in diameter were washed away (Figure 5). The dam was held at 3.5 feet below the normal level in the wake of Rita with controlled releases of 2000 CFS necessary for a few days after landfall. Although the dam can now safely handle a normal lake level, a lack of rainfall has resulted in low water levels continuing this summer. As of late June, Lake Conroe remains around 3 feet below normal.

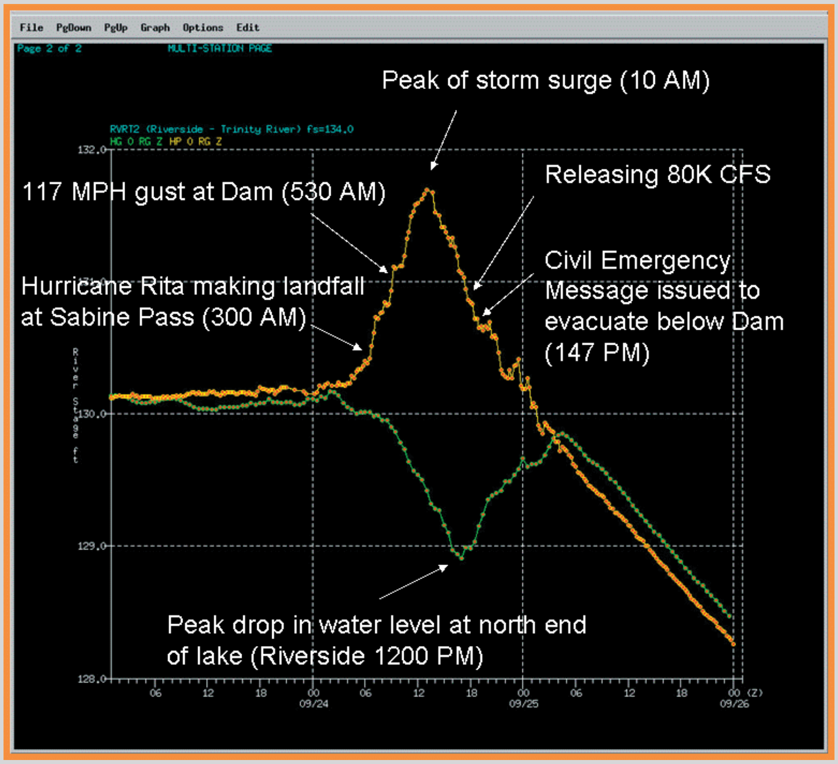


Figure 3. Water levels at the Lake Livingston Dam and at Riverside on September 24, 2005. A timeline of events is also included.

References:

"Dam repairs estimated at 10 million" by Allan Turner / Houston Chronicle, 11/29/2005

"Reservoirs under repair after damage from Rita" by Shannon Tompkins / Houston Chronicle, 3/10/2006

"Putting the lake back in Livingston" by Shannon Tompkins / Houston Chronicle, 5/04/2006

"Lake Conroe dam damaged by high winds and waves" / Montgomery County News, 9/28/2005

Figure 4. Damage to lake front lots at the point of the Indian Hills subdivision.

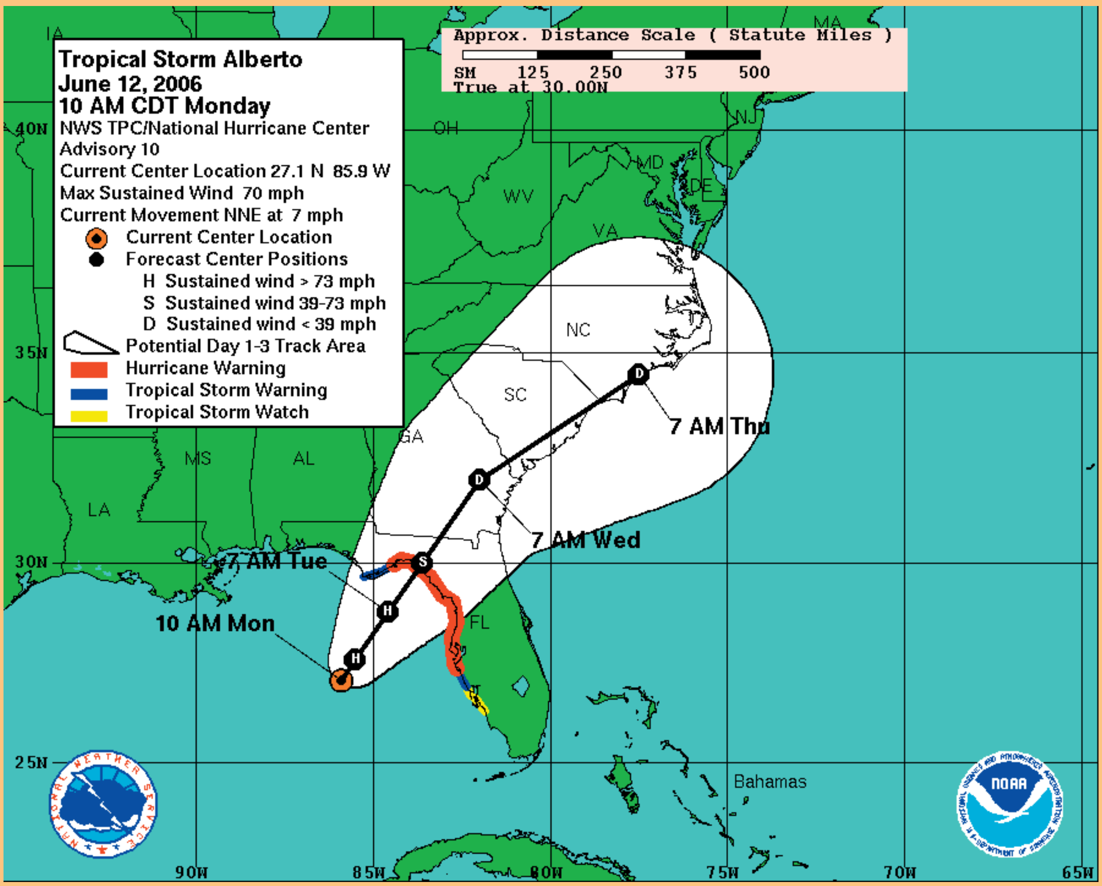
Figure 5. Erosion to the Lake Conroe Dam east of the main gates. Image from Montgomery County News.

WIND SPEED PROBABILITY... A NEW HURRICANE PRODUCT

By Gene Hafele

The National Hurricane Center (NHC) will begin issuing a new product this year called Wind Speed Probability. This new product replaces both the text and graphical hurricane probability product. The previously provided strike probability product (discontinued after 2005) conveyed the chances of a "close" approach of the center of the cyclone. However, these new probability products are about the weather. That is, these cumulative wind speed probabilities provide the chances that wind speeds of at least 74 mph will occur at individual locations. The cumulative probabilities can answer the question, "What are the chances that sustained winds of tropical storm or hurricane force will occur at any specific location?" This can also help one answer the question, "Do I need to take certain actions to prepare?" A companion product, the wind speed probability text product, will also be issued and updated with each advisory package. That product is recommended to more easily assess when winds of each threshold are most likely to start at any specific location, helping to answer the question, "How long do I have to prepare?" Overall, these probabilities provide users with information that can enhance their ability to make preparedness decisions specific to their own situations.

We will use Tropical Storm Alberto that occurred in June 2006 as an example of how this new product can be used. You can access these same products by going to the NHC web page (www.nhc.noaa.gov) and clicking on Advisory Archive on the left column of the web page (www.nhc.noaa.gov/archive/2006/index.shtml). We will look at products from Advisory 10 which is when Alberto was forecast to become a Category 1 hurricane prior to making landfall along the northwest Florida coastline.

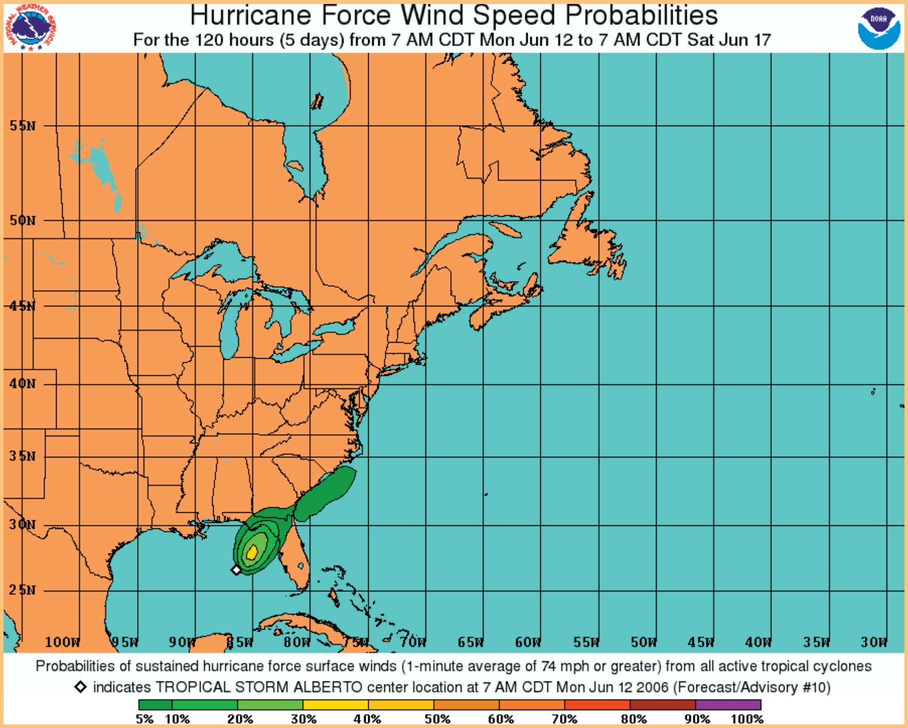


Graphic 1: Watch/Warn 3 day graph for Tropical Storm Alberto Advisory #10.

Graphic 1 is the Watch/Warn 3 day graphic. This graphic is designed to show you where the watches and warnings are currently in place, where the storm is forecast to track in the next 72 hours and the uncertainty in the track of the forecast displayed by the white cone. This graphic does not give you any idea on the uncertainty on the intensity or the uncertainty in the forward speed of the storm. The new wind speed probability product will hopefully provide some information on how strong the winds will be at your location and when those winds will most likely begin.

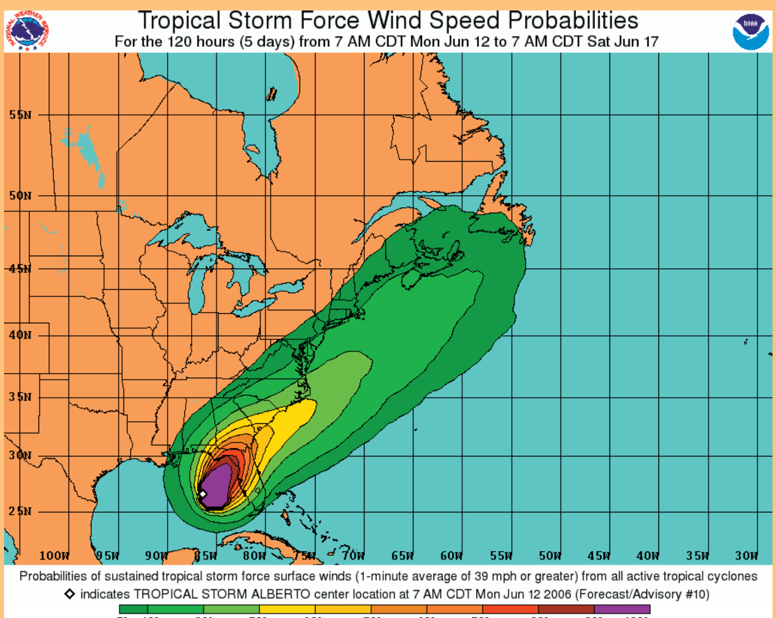
Graphic 2 shows the cumulative probability of hurricane force winds for the next 5 days. The northwest coast of Florida has between a 10 and 20 percent probability of hurricane force winds during the next 5 days. Graphic 3 is a similar graphic but for Tropical Storm Force winds. As you would expect, the probabilities are much higher. The 5-day cumulative probability of Tropical Storm Force winds for northwest Florida is between 80 and 90 percent.

Wind Speed Probability continued...



Graphic 2: Hurricane Force Wind Speed Probabilities for Tropical Storm Alberto Advisory #10

The next question you might have is when is the most likely time that the tropical storm force winds will begin along the northwest coast of Florida. The best product to look at is the Wind Speed Probability text product. In Table 1, I have copied a portion of the product that shows the probabilities for a few cities along the northwest coast of Florida. If you look at Tallahassee, you can see there is a 19 percent chance of 34 knot winds during the first 12 hour period and a 30 percent chance of 34 knot winds during the second 12 hour period. You could then conclude the greatest chance for 34 knot winds would be between 00Z Tue and 12Z Tue. If you now look down at Apalachicola, you can see the greatest probability of 34 knot winds will occur during the first 12 hour period when it shows to have a probability of 44 percent compared to only 22 percent during the second 12 hour period.



Graphic 3: Tropical Storm Force Wind Speed Probabalities for Tropical Storm Alberto Advisory #10.

The last information that can be obtained from the wind speed probability products is the probability the storm will reach certain wind speeds or certain categories. Table 2 shows what this product looked like using the Tropical Storm Alberto case with advisory # 10. This table will give you an idea of the probability a certain storm will reach a certain category at a particular time period. In this particular case, Alberto has a 65 percent chance of becoming a Cat. 1 hurricane during the first 12 hours. The highest probability for Alberto to become a Cat. 2 hurricane would be only 10% in the first 24 hours.

Wind Speed Probabilities For Seclected Locations

Time Periods	From 12Z MON To 00Z TUE	From 00Z TUE To 12Z TUE	From 12Z TUE To 00Z WED	From 00Z WED To 12Z WED	From 12Z WED To 12Z THU	From 12Z THU To 12Z FRI	From 12Z FRI To 12Z SAT
Forecast Hour	(12)	(24)	(36)	(48)	(72)	(96)	(120)
TALLAHASSEE FL	34 19	30(49)	15(64)	2(66)	2(68)	X(68)	X(68)
TALLAHASSEE FL	50 1	14(15)	17(32)	1(35)	1(35)	X(35)	X(35)
TALLAHASSEE FL	64 X	1(1)	7(8)	X(9)	X(9)	X(9)	X(9)
ST MARKS FL	34 29	30(59)	13(72)	3(75)	1(76)	X(76)	X(76)
ST MARKS FL	50 1	22(23)	18(41)	2(43)	1(44)	X(44)	X(44)
ST MARKS FL	64 X	3(3)	9(12)	1(13)	X(13)	X(13)	X(13)
APALACHICOLA	34 44	22(66)	6(72)	1(73)	1(74)	X(74)	X(74)
APALACHICOLA	50 5	27(32)	10(42)	2(44)	X(44)	X(44)	X(13)
APALACHICOLA	64 X	6(6)	6(12)	1(13)	X(13)	X(13)	X(13)

Table 1: Wind Speed Probabilities Table for Tropical Storm Alberto Advisory #10.

It is very possible with some experience with this new product can be used to help with the evacuation decision or the decision to shut down a chemical plant. Most communities have an idea how many hours in advance they must make the evacuation decision to safely evacuate the vulnerable population inland. What we must get a better understanding of is how much risk are you willing to take before pulling the trigger. That risk can be measured in probability, but those probabilities will be small when you are faced with a long lead time.

WIND SPEED FORECAST FOR ALBERTO
EXPRESSED AS PROBABILITY
FROM NHC ADVISORY 10
10:00 AM CDT JUN 12 2006

TIME	WIND SPEED INTERVAL IN MPH							
HOURS	DISSIPATED	TROPICAL DEPRESSION < 39	TROPICAL STORM 39 - 73	HURRICANE >= 74	HURRICANE CAT. 1 74 - 95	HURRICANE CAT. 2 96 - 110	HURRICANE CAT. 3 111 - 130	HURRICANE CAT. 4-5 >= 131
12	<2%	<2%	30%	70%	65%	5%	<2%	<2%
24	<2%	<2%	35%	60%	55%	10%	2%	<2%
36	5%	5%	45%	45%	40%	5%	2%	<2%
48	20%	35%	35%	10%	10%	<2%	<2%	<2%
72	30%	30%	30%	10%	10%	<2%	<2%	<2%

Table 2: Wind Speed Forecast for Tropical Storm Alberto Advisory #10.

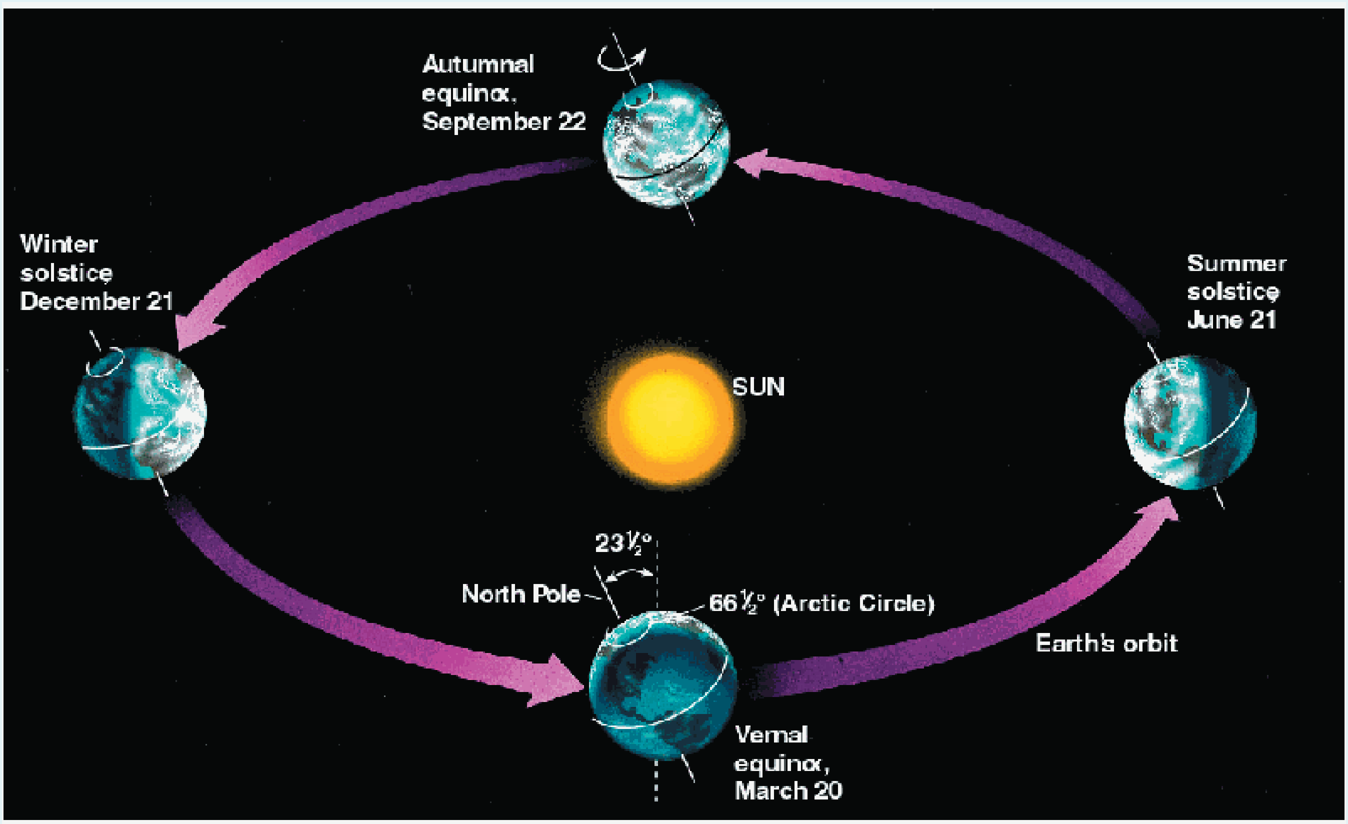
Local Climate Data for the First Half of 2006 and a Brief Overview of Planetary Climatology

By Steve Allen, Science & Operations Officer

1) A brief overview of the complex factors affecting climatology & climatological study

Before launching into a statistical overview of regional climatology in the first half of 2006, it occurred to me that our readers might find it interesting where terms we use like "normal" come from, and what they really mean, and what we know (or think we know) about our climate from an historical perspective. Through the medium of TV, it is usually taken as a point of common knowledge these days that the Earth is a planet in a state of perpetual change. Volcanoes erupt, the Earth's crust slips and slides causing earthquakes and tsunamis, and the seas and tropical cyclones perpetually work to rearrange the coastlines, erasing old barrier islands, while creating new ones, and so on.

Even the orbit of the Earth around the sun is not quite circular, but elliptical, with slight eccentricity, currently reaching perihelion (the official name for the Earth's closest point to the sun) around January 4th (91.7 million miles), and reaches its furthest point, aphelion, on about July 4th (94.8 million miles). The reason for the approximations "around January 4th" and "about July 4th" are mainly artifacts of our Gregorian calendar, which adds a day every 4 years (leap year), and of other gravitational tugs of the sun and moon on the Earth. The tilt of Earth's axis for our lifetimes and many lifetimes to come will variously be given as 23.4° or 23.5°, but even this is another item in slow, perpetual change, and probably the most important climatologically, but more on that in a minute. For the time being, just keep in mind that it is the tilt of the planet that causes the seasons, not the Earth's distance from the sun. (The meaning of these angular values, if they are unfamiliar, is that they represent the angular difference between the Earth's axis of rotation and perpendicularity to the plane of our orbit about the sun, which is known as the ecliptic. If there were no tilt at all, and the Earth's axis of rotation was perpendicular to the ecliptic, both hemispheres would receive the same daily duration of energy from the sun, and there would be no seasons at all.) The graphic below (Graph 1) illustrates this relation between the tilt and the seasons:



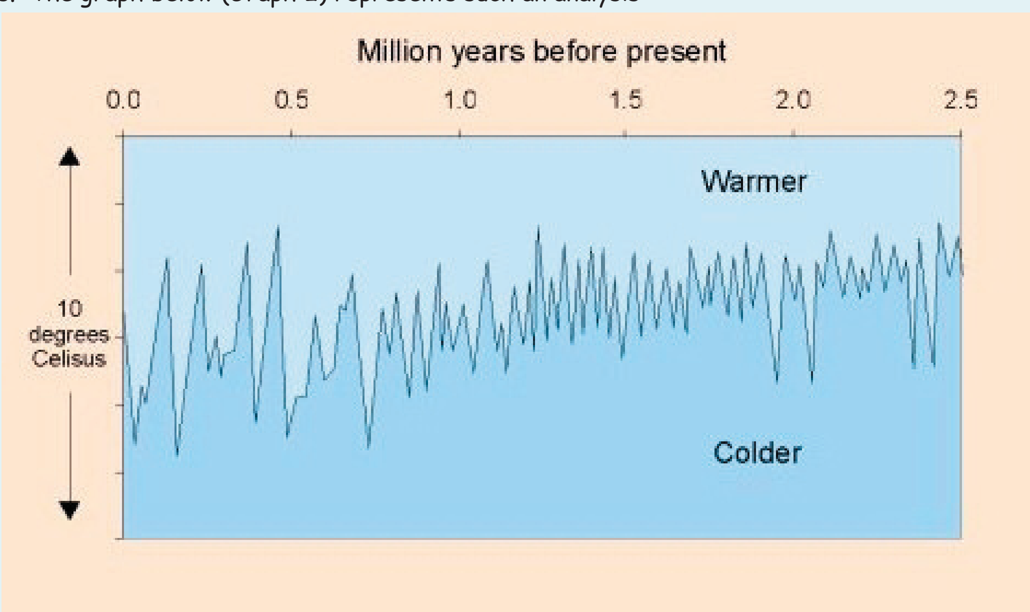
Graph 1: Illustration of the relation between tilt and seasons.

For practical reasons, we measure the year from equinox to equinox (or solstice to solstice), since this is one full cycle of seasons. This is what astronomers call the tropical year, and it is the basis for our current Gregorian calendar. But this cycle, which merely measures when the angular difference of the Earth's axial tilt to the plane of the ecliptic is at the same tilt it was at one set of seasons earlier, actually occurs before the Earth actually reaches the same place in the elliptical orbit that it occupied in the preceding year. This backward motion of where the Earth's axis points in space is known as precession, or more commonly, the precession of the equinoxes. Thus measuring the year by this method, the precession of the equinoxes (the number of years required for the Earth to be exactly in the same place in its orbit with its axis of rotation pointed to exactly the same point in outer space as it did many years before) takes about 26,000 tropical years to make one complete cycle. To give an example of the precessional effect, we currently know the North Star (or pole star) to be Polaris, in the constellation Ursa Minor (little dipper), but at the time the pyramids were built, the north star would have been Thuban in the constellation of Draco (Alpha Draconis). And if you can hang around to 15,000 AD, and you will get to see your compass point to Vega as the North Star, and of course, by 52,000 AD, we will back to having Polaris as the North Star again. But, after reading all that, it will probably disappoint you to know that aside from the tilt of the planet causing the seasons, these facts have little effect on the Earth's climate, for there are other things afoot we have not yet examined.

The first of these is that our convenient option of measuring the year by taking it to be just one complete cycle of the seasons is to a certain extent arbitrary – it makes for a fairly workable calendar. Probably the more important (climatologically) way of measuring the year is known as the anomalistic year, which is the time for the Earth to complete one revolution with respect to its apsides, which are the extreme points of aphelion perihelion, which is to say essentially that the anomalistic year is the time it takes the Earth to make one cycle from perihelion to perihelion (or aphelion to aphelion). In this frame of reference, anomalistic year is about 25 minutes longer than its tropical year, so the solstices and equinoxes precess about 1 day every 58 years, making a full cycle once every 21,000 anomalistic years.

But complicating matters further, our slightly elliptical orbit about the sun also undergoes a cyclical change about every 100,000 years, the time it takes for our orbit to make a small change in its dimension, that is, the distances of the perihelia and aphelia are not fixed, but vary on a cycle of 100,000 years, hence if we were to expect any climatological change in the precession of the equinoxes, the 100,000 year cycle of orbital eccentricity should modulate the anomalistic 21,000 year cycle of the perihelion. But even this change should be quite small, and there is one last player in the game that probably has more effect on Earth's climate than any other.

This other cycle, and probably the most important one in terms of effecting Earth's climate, is a 41,000-year cycle of Earth's obliquity, which is the tilt of the Earth's axis with respect to a direction perpendicular to its orbital plane. This variation is different from precession - the two motions are at right angles to each other - and astronomically is a much smaller effect. The obliquity varies by only a few degrees back and forth, with an extreme range of about 22° at its minimum to a maximum of 24.6° relative to the plane of the ecliptic. The current value of 23.4° is near the middle of the range. However, climatologically, the obliquity variation has the potential to have a fairly direct effect on seasonal extremes. After all, it is the obliquity that causes our seasons in the first place. The Yugoslavian mathematician Milutin Milankovitch was the first to consider that these cycles of tilt, wobble, and orbital eccentricity would lead to periodic ice ages, and analysis of core sampling bears this out as far back as we can go. However, since these anomalies are all time cycles with known periodicities, one can calculate them backwards as far as one wishes. The graph below (Graph 2) represents such an analysis:



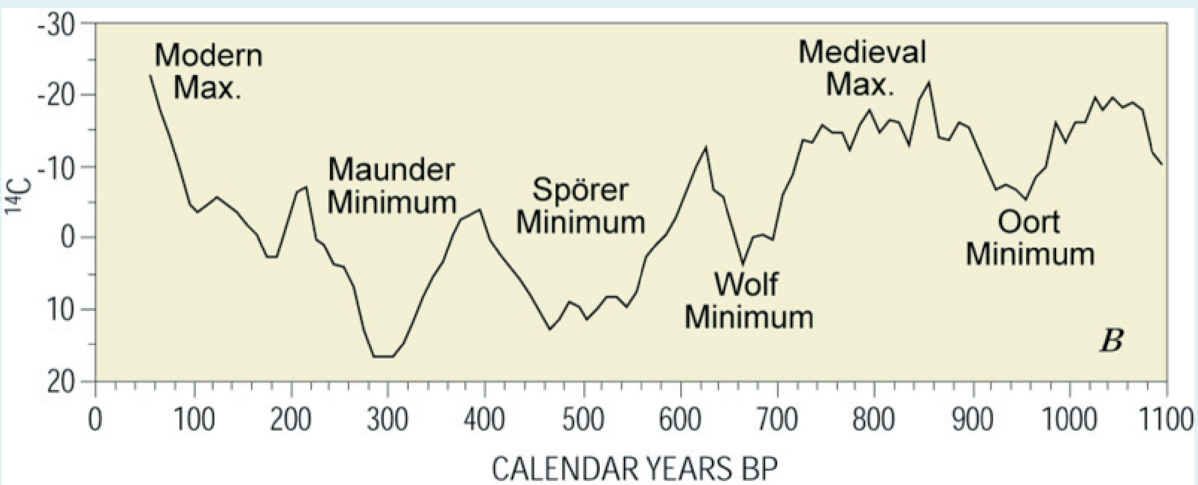
Graph 2: Illustration of temperature variation over a long time period.

And before I cause any further confusion, I suppose I should at least mention that all these variations and arbitrary evaluations do not mean the solstices and equinoxes have a great range of days of occurrence on our calendars (as long as we stick to the Gregorian calendar and the tropical year, they will always range between the 20th and 23rd in March, June, September, and December). It merely means the axis of the planet is changing slightly in direction, and over a longer cycle in obliquity (tilt) as well. And secondly, it is important to note that we are dealing with periods of time that are huge compared to a human lifetime, which at best may go just over a century.

But it is primarily this latter element (the obliquity of the Earth's axis), that can have the greatest impact on our planetary climatology, since it is the tilt of the planet's axis of spin to the ecliptic that causes the seasons, not the distance of the planet from the sun. The side of the planet tilted towards the sun after the summer solstice is the summer hemisphere. In the northern hemisphere, the summer solstice is in June, but on the very same day in the southern hemisphere the same June day is the winter solstice. If the distance of the planet from the sun had anything to do with it – one would expect cooler summers in the northern hemisphere because Earth is as far as it gets from the sun in early July. And I need not mention to anyone living in southeast Texas that it ain't cooler here in July. Nor would I bother to mention to someone in Denver after a September snowstorm there that the planet was just months away from its closest point to the sun. But the tilt is something else: when it is at its maximum of 24.6°, and aphelion in winter hemisphere is at its maximum distance from the sun in the 100,000 year cycle of our orbit's eccentricity, this is highly conducive to lower temperatures – and ice ages. Fortunately for us, the last ice age "ended" (it's really not so precise) about 12,000 years ago, so even for all the hoopla about how much of the rapid global warming we are observing now may be anthropogenic, about one thing there is no doubt: in general the earth has been warming up for about 12,000 years. Whether it has ever warmed up this fast before, we simply don't have the depth of record to know. But for the sake of brevity, the controversial contemporary issue of global warming will not be addressed in this article.

And as a last item of note in Earth's climatology is the role of the sun itself, for even the sun is not constant. It is a huge, ever changing fusion reactor with storms and seasons of its own. Some of these are familiar to us: storms on the sun which eject a solar wind generally referred to as plasma interact with the magnetic field of the earth in brilliant displays of light known as the Aurora Borealis (or Northern Lights), and the strongest of the storms occasionally interfere with satellite communications, and even more rarely, some actually reach the surface, where they can knock out commercial power over broad areas. Such solar storms in recent history caused a power blackout that affected the northeast US and Canada in 1965 that shut-down power over 200,000 square kilometers for 30 million people. This same scenario occurred in 1989, again the result of a solar disturbance.

Additionally, the sun goes through maximums and minimums of sunspot activity (sunspots are caused by huge magnetic storms in the suns "atmosphere"). Such solar storms have a direct effect on the concentration of Carbon 14 in our atmosphere and hence can be mapped back as far as 1100 years or so, as the graph below depicts (Graph 3):



Graph 3: Correlation of Carbon 14 versus Calendar years before present.

(BP in the "Calendar Years BP" here indicates "before present", and the research that developed this historical perspective is based mainly on Carbon 14 concentrations in tree rings and on what sunspot observational data is available, and partly on terrestrial isotopes of Beryllium that are also associated with sun spots and solar activity.)

So what does all this confusing astronomical stuff mean? It takes me back where I started: the Earth is in a state of perpetual change for many reasons, and among the elements that are also in perpetual change is our climate. The major point being that the climate has never been in a completely steady state, and it never will be. So strictly speaking, when we use a term like "normal temperature" we are merely addressing a very recent contemporary convention, not something known to have existed as "normal" about the atmosphere for hundreds or thousands of years, say less the age of the atmosphere. And even that latter issue is still open to some debate, though most scientists in fields concerned with atmospheric composition concur that our atmosphere has been in its current chemical compositional state for approximately 2 billion years. And that, mixed in with all the astronomical data above, are some of the things that drive the climate on Earth. And the climate, like so may other things about the planet, goes through regular (but generally very long) periods of change, and in climatology in general, it breaks down into two main categories: glacial periods (ice ages), and warm climates referred to as "interglacials". Within those broad categories, of course, there are a myriad of climatological epochs concerned with different geographical scales or periods of time. But of all the variables on Earth, the climate is the one thing that can change with speeds on the scale of hundreds of years (possibly less) rather than tens of thousands, which is, of course, very much a topic of contemporary debate.

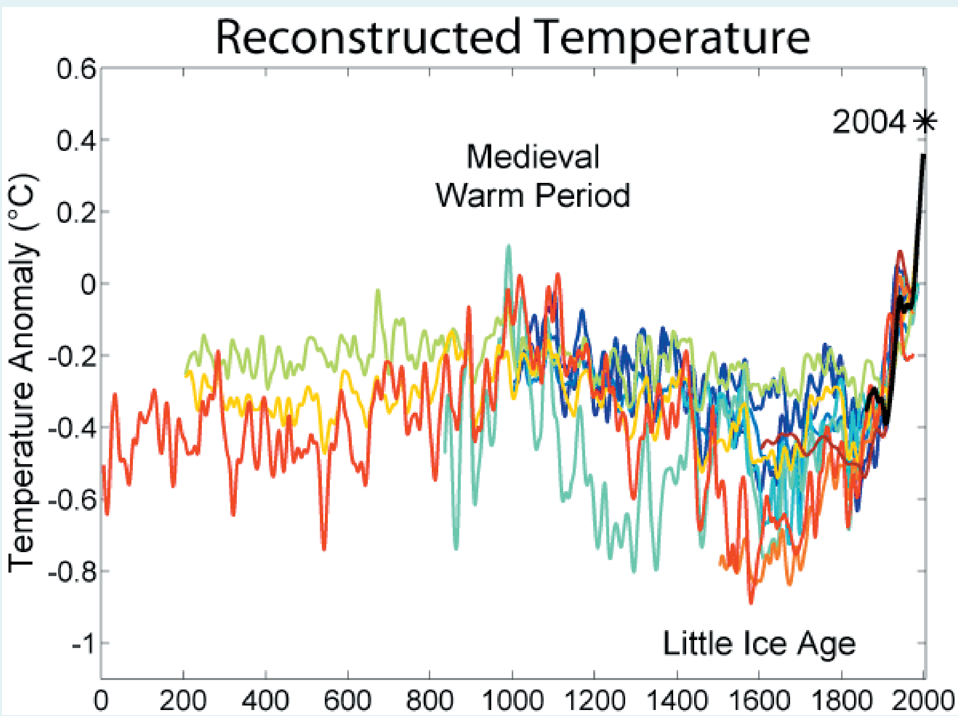
2) Rapid climatological change in the recent past

As an aside, although it is beyond the scope of this article to take on the contemporary controversial topic of global warming, it is worth mentioning that we have, in fairly recent history, seen very rapid climatological change in an event known as The Little Ice Age. Those who have studied this phenomenon cannot agree on its precise beginning (early 13th century, perhaps), but generally agree that it ended in the mid to late 19th century. Some of the high points of the Little Ice Age generally noted are:

* 1250 for when Atlantic pack ice began to grow
* 1300 for when warm summers stopped being dependable in Northern Europe
* 1315 for the rains and Great Famine of 1315-1317
* 1550 for theorized beginning of worldwide glacial expansion
* 1650 for the first climatic minimum

In the particular case of the Little Ice Age, there were many mitigating factors. The sun was at what is now referred to as the Maunder Minimum (see Graph 3), and another especially strong influence late in the period was the enormous eruption in 1815 of the Tambora volcano in Indonesia late in the period, which spewed so much sulfur dioxide into the stratosphere (where it blocked sunlight) that 1816 was known as the year without a summer and 10" snowfalls were reported in Maine in June. But to provide a little local flavor that may be appreciated here in Texas, at the end of this cold period, the temperature fell to a record low of 8°F in Galveston on February 12, 1899, and in the winter of 1899 Galveston Bay froze over for the first time in recorded history (or at least as far back as our recorded history goes…)

And needless to say, if there was a Little Ice Age, it figures that there must have been a warmer period preceding it, and indeed there was, a period known as "The Medieval Warm Period". New methods of analysis of historical climatology, of which I will have more to say in a minute, have been able to reconstruct approximations of temperatures in these eras, which I will include here even at the risk of adding fuel to the ongoing global warming debate: (Here, the temperature "anomaly" indicates departures from statistically determined means from several studies based on isotopic analysis from cores over many locations across the planet. As with most such studies, their greater variability in the earlier years is an artifact of complications in establishing the accuracy of the data.)



Graph 4: Temperature Anomaly over the past 2000 years.

But as you can see, even in the past 2000 years, there has been considerable climatic variability, but what I imagine everyone will notice the most is the upswing since around 1990, when – and this is important to note – the departure from the anomalies established in these studies was zero when the apparent rapid upward trend began to accelerate.

But as an interesting point of fact, the entire evolution of human civilization has occurred mainly during a little patch of warm weather, when seen from the geological time scale. True – humans have been around a lot longer than the last Ice age (which ended roughly 12,000 years ago), so humans have survived ice ages, but apparently none of them were meteorologists who felt it was sufficiently interesting to leave us a note about it.

3) The origins and obstacles in the sciences of meteorology and climatology

Now that I have insinuated we know a great deal about climatology over the past few thousand years or so, I would like to note first of all that that's a very short period when considering an atmosphere 2 billion years old on a planet that is twice as old as that. But to return briefly to the fact the two main types of climatological epochs on Earth are glacial and interglacial, I think it is indeed prudent to keep in mind the point I just mentioned regarding human civilization – the entirety of our recorded history has taken place in what in geological or climatological time scales is merely a short spell of warm weather. But from the beginning of our current fortuitous interglacial era, I will jump forward now to more recent problems in contemporary climatology. As far as can be told, human civilization has only been around (gratuitously) for perhaps 9,000 years. My job as a meteorologist might have been easier then, but I hate to think of the reprisals for a bad forecast. But surely my predecessors were shamans or seers of some sort, but the measuring equipment for the science would be long in coming. In those days (thousands of years ago), the weather was either freezing, cool, warm, or hot. The invention of a device that could measure how high or low the temperature might be with reasonable accuracy would not be arrive until the 17th century. The accolade for the first thermometer goes to the Italian, Santorio Santorio in 1612, but it lacked the accuracy required for practical use for many reasons, and so perhaps that is why we did not see a world wide network of weather observing sites spring up in the 17th century. Nor in the 18th century, for that matter, though by that time (1714) a respectably accurate thermometer based on mercury had been invented by the man whose name is still with us - Gabriel Fahrenheit.

Others would come later, so that by the mid 18th century there were a sufficient number of weather observation sites which could measure wind, temperature, humidity, and pressure to give contemporary meteorology and climatology a very tenuous toe-hold. But it would be towards the end of the 19th century before larger, time coordinated weather observation began to take place.

I must make a short aside here to mention that this was not for lack of interest in weather that weather instruments were slow in coming, because weather played a greater role in international commerce that can be imagined; sinking ships, ruining crops, and interfering with warfare. But real weather observing networks truly did not evolve until the mid 19th century, and it was only at the beginning of the 20th century that the topic of climatology was seriously delineated from dynamic meteorological theory and practical forecasting.

So, for all intents and purposes, the study of climatology is now approximately 106 years old, and despite efforts to emphasize this fact, the public at large still has a tendency to read contemporary climatological information as if it represented the climate of the Earth as it has been for eons. What I wish to emphasize here is that even as meteorologists, we have learned more about the atmosphere and its processes in the last 80 years that in the preceding, 8,000 years. The same goes for climatologists. At best, we have 200 years of solid observational data for a few locations, but necessity turned out (happens a lot) to be the mother of invention, and it was really the advent of human flight that propelled an exponential increase in weather observation sites, and finally, in the 90s, when machines replaced humans as weather observers, the number of observation sites in the data collection network experienced another period of explosive growth. Still, a great deal is now known about prehistoric planetary climatology (and meteorology) that comes from new analytical techniques (analysis of ocean floor and other lithospheric cores, glacial cores, tree-ring analysis, and many other methods) than it does from a database of actual observational data.

So now you know where it comes from: when it comes to meteorology and climatology, despite the incredible growth of knowledge in these fields in the past century, we are still amateurs, having at best, and with the newest analytical methods, only the means to reconstruct the character of the atmosphere (mainly by isotopic analysis of Oxygen trapped in glaciers and ocean sediments) over time perhaps as far back as 700,000 years (in some core analysis), while the history of our subject matter is longer by a factor of millions of years. To put it bluntly, our oldest data available for isotopic analysis (700,000 years old) covers only 0.035% of the time the phenomena we wish to study has been on Earth: 2 billion years. As a species, we got here a little late to get the really big picture.

4) Where today's "normal" temperatures come from

When we speak of normals today, as in monthly summaries below, we are using a convention arrived at by an agreement by the members of the World Meteorological Organization (WMO) to use a temporal depth of 30 years, normalized by a mathematical function known as a cubic spline, and updated every 10 years. To those unfamiliar with mathematics, this means that the high and low temperatures for 30 years would be averaged, and those averages plotted on a graph. The graph would run from January 1 through December 31 and the end result would be a fairly smooth waveform showing that early morning temperatures are cool and afternoons warm. A useful tool of modern algebra known as a cubic spline function can mimic any wave form by producing a 3rd order algebraic equation which is run on the values of the graph, smoothing it just a little more. The results of the cubic spline output become the normals for the 30 year period in question. Every ten years, the process is repeated, dropping the oldest 10 years from the analysis and adding in the latest 10 years. Consequently, a "normal" high temperature for any given day in 2006 represents a smoothed average of the high temperatures for that date from 1971 to 2000. In 2011, the normals will shift to the 30 years from 1981 to 2010, and so on. Additionally, the "official" normals maintained by the National Climatic Data Center in Asheville, N.C. represent temperatures only from the "official" climatic station for a given area. For example, in Houston, that site is IAH. The other weather observing sites in and around the city are not currently taken into consideration. Although plans are in the works to make this process more realistic now that the observation network has more that doubled since this method was first used, this 'one-official-climatic-site-per-city" is still the current method.

And also, since there are so many sites now with less than a 30 year history, climatological normals are being established for them over shorter lengths of time, and the publications of their data indicate the total number of years covered in the record to differentiate them from stations with longer histories.

Even so, as one might imagine, this makes trends (like global warming) very slow – decades – to emerge in normals computed by such a method. To seek trends, one must examine the 30 year means from 40 years ago, to the 30 year means from 30 years ago, and so on, and then analyze these "means of 30 year means " to examine the data for trends, which is one of the many things that climatologists do.

5) Where "normal" precipitation data comes from

Again, this is an area where having only one official climatological observation point is something of a liability. For example, a single heavy rain event on the 19th of June this year produced over 11 inches of rain over parts of southeast Houston, but the "official" climatic data will reflect only the 4.43 inches that fell in the "official" gage at Houston (IAH). In a similar fashion as described above, a slightly different mathematical technique is applied to produce a "normal" precipitation amount for every day of the year, but the average annual rainfall really is an actual average of the last 30 years, and as with the temperature data, it is a "moving" 30 year mean, recalculated every 10 years. Still "normalizing" precipitation is something that most find rather impractical, since it produces a rainfall amount for every day of the year, and as anyone knows, it does not rain in Houston every day of the year, or even on most days of the year, yet climatology reports will show a negative departure from normal for days with no rain.

And now, if I have not spoiled it all for you by describing the science behind climatology and letting you in on the secret that there really is no normal, and the ones we provide, though authenticated by the highest meteorological consortium and authority in the world that this science has (the WMO): we are still only providing a short news report on a deep story, and we've lopped off the first 99+ percent of it because we just don't know what was there. And of what we do know, we only provide a 30 year sample. Maybe 7 or 10 years would be better to determine a concept of "normal" temperatures and pick up more quickly on rapidly changing trends (climatologists argue about such things all the time), but our current "normals" are just something arbitrated by a scientific society, and at the moment, the temporal dimension of "normal" is 30 years. The truth of the matter, as I said before, is that there is nothing on this planet that is normal, so I can only invite you to read into these next pages what you will, because they only tell the story (and only part of it) from 1971 to 2000. The last 5 years don't count yet, and the preceding 2 billion years we don't know enough about to include, so that's thrown out, too. We simply don't know much about what came before, and have set rules that preclude updating the normals (even as a 30 year mean) from year to year rather than decade to decade. So, after just one brief refresher on the astronomical factors that contribute to making our climate variable (and I left out a lot!) I will proceed to the numbers for the first half of 2006.

5) A brief review of the astronomical variables affecting the Earth and its climate

- Our planet orbits a variable star that does not provide the heat energy that drives all life on Earth in equal amounts at all times.
- Our orbit about this sun in not only elliptical but eccentric, so that the apside distances of the perihelion and aphelion are not always at exactly the same distance from the sun. This eccentricity has a periodicity of about 100,000 years, so you have to live a long time to see the whole show.
- The Earth is not truly round, but an oblate spheroid, and the gravitational tugging of the sun and moon always try to bring the equatorial oblation more or less into the plane of the ecliptic which causes the tilt, or obliquity, of the planet to range from 22° to 24.6° with a periodicity of 41,000 years.
- Then there is the means we use to measure the year itself (the tropical year, a full set of seasons), which means that each New Year's Eve (or any date you wish to use), we are actually a little further back along the eccentric ellipse along which we travel than we were the year before, and, using the tropical year, we go through this cycle every 26,000 years.

And at that, you should feel lucky that I resisted the temptation to dig into the terrestrial effects on our climate, but I could not go there without getting fully engaged in the current global warming controversy. You might have perhaps found that more interesting, but this article would have gone to 50 pages to cover all the bases there. And now, here are the numbers you've been waiting for…

6) Climate statistics for the first half of 2006

January: Warmer & drier than normal

The first month of 2006 was considerably warmer than normal. Temperatures during the month ranged from 5 degrees above normal near the coast to 7 degrees above normal inland. It was the eighth warmest January in recorded history for College Station (57.3 degrees) and Galveston (60.6 degrees) and the tenth warmest January on record for Houston (58.9 degrees). In addition to the warmer temperatures, January was also below normal for rainfall. Rainfall totals averaged about 1 to 3 inches below normal, which made January the 5th month of below normal rainfall in the last 12 months. Galveston recorded its seventh driest January in recorded history.

Significant weather events:

Golf ball sized hail fell over parts of Matagorda and Trinity counties on the 21st, otherwise January was a mild month as severe weather goes. Fronts moving through the region warranted wind advisories (sustained winds of 25 mph or higher) on the 13th and 17th. As is typical for the month, there were several episodes of dense fog, and the lack of rainfall, warm temperatures and breezy conditions elevated the threat of fire danger for rapidly spreading grass fires.

February: Nearly normal but for lower rainfall, especially along the coast.

With the exception of Palacios, average temperatures in February were all within the 30-year normal range, a fairly significant drop from the January averages with average temperatures 2.5 to 3.5 degrees cooler. A cold front followed by cold temperatures (by Houston standards) left a record minimum high temperature at IAH on the 18th.

Of greater significance was the lack of rainfall in the region with only the northwest part of the area receiving near or above average rainfall. On the other end of the spectrum, the two month total of 1.24 inches at Galveston made 2006 the second driest January/February experienced since records have been kept there. Most of the rest of the region also had rainfall deficits over an inch, which kept fire danger high across most of the region.

March: Warmer than normal temperatures; coastal drought continued

Rainfall in March was generally below normal over most of southeast Texas. There were pockets of heavier rainfall that occurred late in the month over about the northwest 1/3 of the area, but the coast remained essentially dry. Temperatures averaged 2 to 4 degrees above normal area wide, with Galveston topping the list with its seventh warmest March in recorded history. And too, the scant rainfall in Galveston in prior months made 2006 the driest first quarter in the existing record.

Significant weather events:

Brief heavy downpours caused minor urban flooding in isolated areas, and thunderstorms on March 28th produced short episodes of penny sized hail.

April: Warmer than normal trend continues; coastal drought continues

April brought the largest departures from normal in 2006, with averages running 4.5 to 5.5 degrees above normal. Rainfall was again below normal with coastal areas suffering the greatest rainfall deficits, although a heavy rain event late in the month helped bring April rainfall totals closer to normal. As for the coast, although Galveston received over an inch of rain in April, 2006 continues to maintain its standing as the second driest third of a year in Galveston in the city's history.

Significant weather events:

On the 20th, penny sized hail fell near Brenham and Independence, and strong winds brought down power lines near Bryan and damaged a barn near Kurten. A thunderstorm outbreak on April 28th produced several tornadoes and wind damage was widespread from Washington County to Liberty County. An F2 tornado ripped through Coldspring around 7 am and damaged several homes and injured four persons. An F1 tornado damaged several homes and mobile homes near Liberty, and downed power lines in southern Liberty County. Rainfall averaged 1 to 2 inches across the region with the heaviest rainfall totals generally north of 1-10.

May: Temperatures closer to normal, more cloudiness, sporadic rainfall

May began on a wet note with rain falling on three of the first seven days of the month. A cold front on the 14th brought more rain to the region and much drier conditions mid-month in the wake of the front. But the real fireworks began over Memorial Day weekend with periods of heavy rain developing, with very high totals in a few areas. Bouts of heavy rain persisted through the end of the month.

Significant weather events:

Hazardous spring weather occurred on the 4th, 6th, 10th, and 14th of May. Hail exceeding two inches in diameter pummeled parts of the Champions Forest subdivision near Tomball on the 4th. A tornado watch was in effect on the 6th as an early morning storm system moved across Southeast Texas. Another cluster of thunderstorms raced across Southeast Texas on the 10th. These storms produced more large hail across parts of Polk, Fort Bend and Jackson counties. A brief tornado touched down in Fort Bend County near Needville along FM 360. On the 14th, more thunderstorms produced damage across parts of the area generally south of I-10. Winds toppled trees near Aldine in Harris County, and golf ball sized hail covered the ground near Boling-Iago. Hail and high winds affected Brazoria County toppling trees, power lines, and billboards from Alvin to Angleton.

Heavy rain at the end of the month produced flooding across parts of Harris, Galveston, Chambers, Liberty, Brazoria, Jackson and Wharton counties. Record rainfall (4.33 inches) fell at Houston's Intercontinental Airport on the 29th, with other parts of the county received 6 to 10 inches of rain. Parts of Liberty and Chambers County received over 15 inches of rain during the early morning hours of the 29th. Additional rain on the morning of the 31st snarled traffic in Harris County with 3 to 5 inch rainfall totals.

June: Wetter than normal, but temperatures near normal

June 2006 was wetter than normal due to a slow moving upper level low that meandered across East Texas from the 17th through the 21st, destabilizing the atmosphere. At the same time, abundant moisture was being transported into the area from the Gulf of Mexico on a light southeasterly flow. The increase in cloudiness due to the rains, rain cooling of the atmosphere, and the solar heating lost in the process of evaporating standing water (on sunny days) combined to keep temperatures near normal.

Significant weather events:

The combination of meteorological ingredients mentioned above led to numerous showers and thunderstorms, some of which formed trains or static clusters which produced tremendous rainfall over some spots in the region. Most of these very heavy rain events were over the extreme east and southeast portions of Southeast Texas. Parts of Liberty, Harris, Chambers, Galveston, Matagorda, and Brazoria counties received between 10 and 15 inches of rain in less than 24 hours. Heavy rain across the city of Houston produced widespread flooding on the morning of June 19th, flooding over 3000 homes.

In addition to the flooding issues caused by heavy rain, severe weather erupted on the 13th when strong thunderstorm wind gusts, mainly microbursts, damaged several homes near Crosby. One of the microbursts produced strong winds near I-45 and FM 646 in northern Galveston County which toppled an 18-wheeler truck onto a sedan. Both vehicles had stopped due to the torrential rains, and fortunately there were no serious injuries. Winds from this same system of storms blew down numerous fences in League City, and toppled trees and power lines in Fort Bend County near Sienna Plantation.

Another episode of severe weather occurred on the 25th with wind damage reported in Coldspring in San Jacinto County and near Pecan Grove in Fort Bend County.

For more detail on monthly climatology in our local area, see the Climate section of our web site at http://www.srh.noaa.gov/hgx/. The highly detailed monthly reports you will find there are written by our Climate Focal Point, Senior Forecaster Charles Roeseler, from which the foregoing information was redacted. For questions or comments on this article, contact our webmaster or email me directly at Steve.Allen@noaa.gov.

For readers unfamiliar with the identifiers of observing sites used in this article, or the reason for this particular suite of sites, it is that they are all the ASOS and AWOS (most reliable) automated weather observing sites in our 23 county warning and forecast area. Here is an index of their full names and locations:

For non-local readers, point your browser to http://maps.google.com and type in the city and state to find any of these locations.

ICAO ID	Airport or Facility Name	Resident City or Closest City	County
CLL	Easterwood Airport	College Station	Brazos
CXO	Lone Star Executive Airport	Conroe	Montgomery
DWH	David Wayne Hooks Memorial Airport	Tomball	Harris
GLS	Scholes International Airport	Galveston	Galveston
HGX	Houston/Galveston National Weather Service Office	League City	Galveston
HOU	William P Hobby Airport	Houston (south side)	Harris
IAH	George Bush (Sr.) Intercontinental/Houston Airport	Houston (north side)	Harris
LBX	Brazoria County Airport	Angleton	Brazoria
LVJ	Pearland Regional Airport (aka Clover Field Airport)	Pearland	Brazoria
PSX	Palacios Municipal Airport	Palacios	Matagorda
SGR	Sugar Land Regional Airport	Sugar Land	Fort Bend
UTS	Huntsville Municipal Airport	Huntsville	Walker

January Temperature and Precipitation Statistics						
Site	Average High	Average Low	Average Daily Temp	Temp Departure from normal	Rainfall	Rainfall Departure from normal
IAH	70.2	47.6	58.9	7.1	2.50	-1.18
GLS	67.7	53.5	60.6	4.8	0.57	-3.51
CLL	69.8	44.7	57.3	7.1	2.63	-0.69
HOU	70.8	49.8	59.9	6.0	1.92	-2.33
PSX	70.1	49.8	59.9	7.0	1.38	-1.80
CXO	69.8	41.2	55.5	NA	3.36	NA
UTS	68.8	45.5	57.1	NA	3.5	NA
LBX	71.1	45.7	58.4	NA	2.48	NA
LVJ	70.5	48.0	59.3	NA	2.11	NA
SGR	70.3	45.5	57.9	NA	2.64	NA
DWH	70.6	46.0	58.3	NA	2.33	NA
HGX	69.6	47.4	58.5	NA	1.92	NA

January Record Events									
Type	High Temperature			Low Temperature			Rainfall		
Site	Old Record	New Record	Tied or New?	Old Record	New Record	Tied or New?	Old Record	New Record	Tied or New?
IAH	80 in 1934	81 on 1/1/6	New						
IAH							1.01" in 1980	1.02" on 1/22/6	New
CLL	81 in 1952	81 on 1/1/6	Tied						
CLL							1.64" in 1980	1.66" on 1/22/6	New
GLS	73 in 1965	78 on 1/2/6	New						
GLS	74 in 1957	75 on 1/4/6	New						

February Temperature and Precipitation Statistics						
Site	Average High	Average Low	Average Daily Temp	Temp Departure from normal	Rainfall	Rainfall Departure from normal
IAH	66.6	44.4	55.5	0.1	1.46	-1.52
GLS	65.4	51.0	58.2	0.2	0.67	-1.94
CLL	64.0	42.2	53.1	-1.4	3.70	1.32
HOU	67.2	46.9	57.1	-0.6	1.62	-1.39
CXO	65.3	39.5	52.4	-1.1	3.21	-0.24
UTS	63.9	41.9	52.9	0.0	3.29	-0.15
DWH	67.2	43.1	55.2	0.3	2.39	-1.22
SGR	67.1	44.2	55.6	-0.4	1.68	-1.38
LVJ	67.2	46.4	56.8	0.7	1.84	-1.40
HGX	66.2	45.5	55.9	-0.1	1.68	-1.59
LBX	68.2	45.2	56.7	0.3	1.06	-2.38
PSX	68.8	49.0	58.9	3.1	0.64	-1.81

February Record Events									
Type	High Temperature			Record Low Maximum			Rainfall		
Site	Old Record	New Record	Tied or New?	Old Record	New Record	Tied or New?	Old Record	New Record	Tied or New?
GLS	79 in 1996	79 on 2/2/6	Tied						
GLS	75 in 1996	75 on 2/22/6	Tied						
IAH	81 in 1982	81 on 2/16/6	Tied	46 in 1958	38 on 2/19/6	New			
CLL							1.23" in 1941	2.11" on 2/1/6	New

March Temperature and Precipitation Statistics

Site	Average High	Average Low	Average Daily Temp	Temp Departure from normal	Rainfall	Rainfall Departure from normal
IAH	70.2	47.6	58.9	7.1	2.50	-1.18
GLS	67.7	53.5	60.6	4.8	0.57	-3.51
CLL	69.8	44.7	57.3	7.1	2.63	-0.69
HOU	70.8	49.8	59.9	6.0	1.92	-2.33
PSX	70.1	49.8	59.9	7.0	1.38	-1.80
CXO	69.8	41.2	55.5	NA	3.36	NA
UTS	68.8	45.5	57.1	NA	3.50	NA
LBX	71.1	45.7	58.4	NA	2.48	NA
LVJ	70.5	48.0	59.3	NA	2.11	NA
SGR	70.3	45.5	57.9	NA	2.64	NA
DWH	70.6	46.0	58.3	NA	2.33	NA
HGX	69.6	47.4	58.5	NA	1.92	NA

March Record Events

Type	High Temperature			Low Temperature		
Site	Old Record	New Record	Tied or New?	Old Record	New Record	Tied or New?
GLS	80 in 1984	84 on 3/9/6	New			
GLS	76 in 1951	78 on 3/11/6	New			
GLS	79 in 1961	81 on 3/13/6	New			
GLS	78 in 1907	80 on 3/20/6	New			
IAH				46 in 1958	36 on 3/25/6	New
CLL				31 in 1952	31 on 3/23/6	Tied
CLL						
IAH	59 in 1952	54 on 3/23/6	Tied			

April Temperature and Precipitation Statistics

Site	Average High	Average Low	Average Daily Temp	Temp Departure from normal	Rainfall	Rainfall Departure from normal
IAH	83.8	63.5	73.6	5.1	2.93	-0.67
GLS	80.0	69.0	74.5	4.5	1.34	-1.22
CLL	83.4	62.7	73.1	5.2	2.45	-0.75
HOU	82.6	64.5	73.6	3.6	2.23	-1.23
CXO	84.0	60.2	72.1	4.8	2.84	-1.00
UTS	83.4	61.9	72.6	5.4	2.75	-0.75
DWH	84.7	63.5	74.1	4.2	3.06	0.14
SGR	84.0	62.7	73.3	2.8	2.37	-0.27
LVJ	82.5	64.6	73.6	4.2	1.50	-1.27
HGX	81.0	63.5	72.2	4.4	2.34	-1.65
LBX	81.8	62.9	72.4	2.6	1.00	-2.77
PSX	82.6	67.9	75.2	6.7	2.32	-0.48

April Record Events

Type	High Temperature			Record High Minimum			Rainfall		
Site	Old Record	New Record	Tied or New?	Old Record	New Record	Tied or New?	Old Record	New Record	Tied or New?
GLS	78 in 1978	80 on 4/5/6	New	70 in 1956	71 on 4/1/6	New			
GLS	82 in 2000	83 on 4/20/6	New	71 in 1929	71 on 4/1/6	Tied			
GLS	84 in 1883	85 on 4/22/6	New	76 in 1967	76 on 4/25/6	Tied			
GLS	84 in 2002	84 on 4/29/6	Tied						
IAH	87 in 1980	87 on 4/3/6	Tied	69 in 1956	72 on 4/1/6	New			
IAH	92 in 1987	92 on 4/17/6	Tied						
IAH	88 in 1999	88 on 4/22/6	Tied						
IAH	90 in 1987	90 on 4/25/6	Tied						
CLL	91 in 1925	93 on 4/17/6	New	68 in 1935	71 on 4/1/6	New	1.40" in 1941	1.65" on 3/20/6	New
CLL	93 in 1996	94 on 4/18/6	New						

May Temperature and Precipitation Statistics

Site	Average High	Average Low	Average Daily Temp	Temp Departure from normal	Rainfall	Rainfall Departure from normal
IAH	86.6	66.8	76.7	0.9	8.78	3.63
GLS	84.1	73.0	78.5	1.6	3.24	-0.46
CLL	87.0	66.5	76.7	1.4	2.65	-2.40
HOU	86.1	67.7	76.9	-0.1	6.02	0.91
CXO	86.7	63.0	74.8	0.2	4.95	-0.67
UTS	86.7	65.8	76.3	1.9	4.56	-0.52
DWH	87.0	66.4	76.7	0.6	9.12	6.36
SGR	86.9	65.8	76.3	-0.9	2.56	-1.06
LVJ	86.5	68.2	77.4	1.3	6.59	2.84
HGX	84.5	66.4	75.4	0.0	10.15	5.57
LBX	86.0	66.2	76.1	-0.2	3.41	-1.35
PSX	86.0	71.5	78.8	3.1	4.61	0.06

May Record Events

Type	High Temperature			Record Low Maximum			Rainfall		
Site	Old Record	New Record	Tied or New?	Old Record	New Record	Tied or New?	Old Record	New Record	Tied or New?
GLS	86 in 2003	86 on 5/17/6	Tied	76 in 2003	76 on 5/3/6	Tied			
CLL	94 in 2003	94 on 5/19/6	Tied						
CLL	94 in 2005	94 on 5/25/6	Tied						
IAH							1.01" in 2001	1.28" on 5/6/6	New
IAH							0.54" in 1975	0.76" on 5/14/6	New
IAH							3.56" in 2005	4.33" on 5/29/6	New

June Temperature and Precipitation Statistics

Site	Average High	Average Low	Average Daily Temp	Temp Departure from normal	Rainfall	Rainfall Departure from normal
IAH	86.6	66.8	76.7	0.9	8.78	3.63
GLS	84.1	73.0	78.5	1.6	3.24	-0.46
CLL	87.0	66.5	76.7	1.4	2.65	-2.40
HOU	86.1	67.7	76.9	-0.1	6.02	0.91
CXO	86.7	63.0	74.8	0.2	4.95	-0.67
UTS	86.7	65.8	76.3	1.9	4.56	-0.52
DWH	87.0	66.4	76.7	0.6	9.12	6.36
SGR	86.9	65.8	76.3	-0.9	2.56	-1.06
LVJ	86.5	68.2	77.4	1.3	6.59	2.84
HGX	84.5	66.4	75.4	0.0	10.15	5.57
LBX	86.0	66.2	76.1	-0.2	3.41	-1.35
PSX	86.0	71.5	78.8	3.1	4.61	0.06

June Record Events

Type	High Temperature						Rainfall		
Site	Old Record	New Record	Tied or New?				Old Record	New Record	Tied or New?
GLS	94 in 1929	94 on 6/9/6	Tied						
IAH	99 in 1998	100 on 6/13/6	New				1.42" in 1963	1.43" on 6/17/6	New
IAH							2.24" in 1961	4.43" on 6/19/6	New

New Aviation Terminal Aerodrome Forecast (TAF) Services

By Robert Van Hoven

Currently, the National Weather Service Forecast Office in Houston/Galveston (HGX) provides TAF services for Houston/George Bush Intercontinental Airport (KIAH), Houston/William P. Hobby Airport (KHOU), College Station/Easterwood Field (KCLL), Galveston/Scholes International (KGLS), and Brazoria County Airport (KLBX). However, beginning August 29, 2006 at 7 AM CDT or 1200 Coordinated Universal Time (UTC), HGX will issue TAFs for 3 additional airports in Southeast Texas. The airports are: Sugarland Regional Airport (KSGR) at Sugarland, Lone Star Executive Airport at Conroe (CXO), and Huntsville Municipal Airport (KUTS) at Huntsville. Both routine and updated TAFs will be issued 24 hours a day, 7 days a week. KSGR, KCXO, KUTS and the Federal Aviation Administration Flight Service Station at Conroe have requested TAF services for these airport sites in light of increasing general aviation traffic. Instead of using or relying on TAFs issued for the closest airport, KSGR, KCXO and KUTS will receive TAFs specifically tailored for their sites. Needless to say, safety will be enhanced for general aviation pilots landing or and taking off from these airports.

The American Meteorological Society Houston Chapter A year in Review: 2005 - 2006

By Patrick Blood

This past season proved to be a very interesting, and eclectic, year for the American Meteorological Society's Houston Chapter. Our goal for this past year was to go beyond the bounds of the science of meteorology, explore other local disciplines that pertain to the earth sciences….goal achieved!

The 2005-2006 season started out on an unusual, but very poignant, note! Our first meeting of the season was cancelled due to Hurricane Rita's forecasted arrival and subsequent mass evacuation. The theme? None other than the National Weather Service's Lance Wood discussing his Hurricane Decision Tree! Of course, Mr. Wood eventually had a second chance to display his decision-related flow chart the following month, but only after our unwelcome visitor, Rita, had exited stage right! We closed the year out with a turn in another direction by inviting Texas A&M oceanographer, Dr. Bob Stewart, to give us a lecture on the globe's ocean-atmosphere interaction. Mind the order of the Global System mentioned in the previous sentence. Dr. Stewart's approach was from that of an oceanographer: The ocean drives the atmosphere and not the other way around! A different, albeit refreshing, point-of-view taken by all of us weather enthusiasts who tend to only see things from the atmospheric perspective.

The New Year ushered in new ideas leading to fresh themes. We kicked off 2006 with a visit to the Houston Museum of Natural Science to personally meet and greet Dr. Chris Rapley from Britain's Antarctic Survey and to attend his Lecture Series forum. Dr. Rapley is becoming well known within the school-of-global-warming thought and its possible effect upon our polar regions. It was our pleasure to listen to Dr. Rapley's personal experiences from Antarctica and to learn more from his expertise about this relatively-unknown continent's general climate & ice/glacier changes over the recent years. Our next meeting epitomized that element of variation this year's chapter sought to attain; the Subsidence Issue in the greater Houston-Galveston area. The idea that our region is literally "sinking" was presented to us by Mr. Ron Neighbors of the Houston Subsidence Group. This geology-based talk was an excellent change-of-pace. We entered into the spring equinox by being involved with a local weather companies' opening of Houston's first solely weather-dedicated museum. Weather Research invited us to participate in their grand opening and tour festivities. Of course, we graciously accepted their invitation to be a part of this Houston Weather History milestone.

We closed out the season with our sixth meeting centered about the Houston/Galveston's Hurricane Workshop's theme of **Katrina and Rita: Lessons Learned for the Next Time**. Our guest speaker was Mr. Stacy Stewart from Miami's Tropical Prediction Center. The main theme from his talk was simple and needed to be heard as we headed into this hurricane season; There is no reason at this time to believe that this season will be any different than in recent years in terms of heightened hurricane frequency!

On that note, we adjourned with hopes that our city and surrounding areas remain out of harm's way. In other words, we are planning on not having our 2006-7's first meeting cancelled this coming fall due to a threatening tropical cyclone!

Heat Waves

Know What These Terms Mean...

* Heat wave: Prolonged period of excessive heat and humidity. The National Weather Service steps up its procedures to alert the public during these periods of excessive heat and humidity.
* Heat index: A number in degrees Fahrenheit (F) that tells how hot it really feels when relative humidity is added to the actual air temperature. Exposure to full sunshine can increase the heat index by 15 degrees F.
* Heat cramps: Heat cramps are muscular pains and spasms due to heavy exertion. Although heat cramps are the least severe, they are an early signal that the body is having trouble with the heat.
* Heat exhaustion: Heat exhaustion typically occurs when people exercise heavily or work in a hot, humid place where body fluids are lost through heavy sweating. Blood flow to the skin increases, causing blood flow to decrease to the vital organs. This results in a form of mild shock. If not treated, the victim may suffer heat stroke.
* Heat stroke: Heat stroke is life-threatening. The victim's temperature control system, which produces sweating to cool the body, stops working. The body temperature can rise so high that brain damage and death may result if the body is not cooled quickly.
* Sunstroke: Another term for heat stroke.

If a Heat Wave Is Predicted or Happening...

* Slow down. Avoid strenuous activity. If you must do strenuous activity, do it during the coolest part of the day, which is usually in the morning between 4:00 a.m. and 7:00 a.m.
* Stay indoors as much as possible. If air conditioning is not available, stay on the lowest floor, out of the sunshine. Try to go to a public building with air conditioning each day for several hours. Remember, electric fans do not cool the air, but they do help sweat evaporate, which cools your body.
* Wear lightweight, light-colored clothing. Light colors will reflect away some of the sun's energy.
* Drink plenty of water regularly and often. Your body needs water to keep cool.
* Drink plenty of fluids even if you do not feel thirsty.
* Water is the safest liquid to drink during heat emergencies. Avoid drinks with alcohol or caffeine in them. They can make you feel good briefly, but make the heat's effects on your body worse. This is especially true about beer, which dehydrates the body.
* Eat small meals and eat more often. Avoid foods that are high in protein, which increase metabolic heat.
* Avoid using salt tablets unless directed to do so by a physician.

Signals of Heat Emergencies...

* Heat exhaustion: Cool, moist, pale, or flushed skin; heavy sweating; headache; nausea or vomiting; dizziness; and exhaustion. Body temperature will be near normal.
* Heat stroke: Hot, red skin; changes in consciousness; rapid, weak pulse; and rapid, shallow breathing. Body temperature can be very high-- as high as 105 degrees F. If the person was sweating from heavy work or exercise, skin may be wet; otherwise, it will feel dry.

Treatment of Heat Emergencies...

* Heat cramps: Get the person to a cooler place and have him or her rest in a comfortable position. Lightly stretch the affected muscle and replenish fluids. Give a half glass of cool water every 15 minutes. Do not give liquids with alcohol or caffeine in them, as they can make conditions worse.
* Heat exhaustion: Get the person out of the heat and into a cooler place. Remove or loosen tight clothing and apply cool, wet cloths, such as towels or sheets. If the person is conscious, give cool water to drink. Make sure the person drinks slowly. Give a half glass of cool water every 15 minutes. Do not give liquids that contain alcohol or caffeine. Let the victim rest in a comfortable position, and watch carefully for changes in his or her condition.
* Heat stroke: Heat stroke is a life-threatening situation. Help is needed fast. Call 9-1-1 or your local emergency number. Move the person to a cooler place. Quickly cool the body. Immerse victim in a cool bath, or wrap wet sheets around the body and fan it. Watch for signals of breathing problems. Keep the person lying down and continue to cool the body any way you can. If the victim refuses water or is vomiting or there are changes in the level of consciousness, do not give anything to eat or drink.

Heat Index °F (°C)

Relative Humidity (%)

Temperature	40	45	50	55	60	65	70	75	80	85	90	95	100
110 (47)	136 (58)												
108 (43)	130 (54)	137 (58)											
106 (41)	124 (51)	130 (54)	137 (58)										
104 (40)	119 (48)	124 (51)	131 (55)	137 (58)									
102 (39)	114 (46)	119 (48)	124 (51)	130 (54)	137 (58)								
100 (38)	109 (43)	114 (46)	118 (48)	124 (51)	129 (54)	136 (58)							
98 (37)	105 (41)	109 (43)	113 (45)	117 (47)	123 (51)	128 (53)	134 (57)						
96 (36)	101 (38)	104 (40)	108 (42)	112 (44)	116 (47)	121 (49)	126 (52)	132 (56)					
94 (34)	97 (36)	100 (38)	103 (39)	106 (41)	110 (43)	114 (46)	119 (48)	124 (51)	129 (54)	135 (57)			
92 (33)	94 (34)	96 (36)	99 (37)	101 (38)	105 (41)	108 (42)	112 (44)	116 (47)	121 (49)	126 (52)	131 (55)		
90 (32)	91 (33)	93 (34)	95 (35)	97 (36)	100 (38)	103 (39)	106 (41)	109 (43)	113 (45)	117 (47)	122 (50)	127 (53)	132 (56)
88 (31)	88 (31)	89 (32)	91 (33)	93 (34)	95 (35)	98 (37)	100 (38)	103 (39)	106 (41)	110 (43)	113 (45)	117 (47)	121 (49)
86 (30)	85 (29)	87 (31)	88 (31)	89 (32)	91 (33)	93 (34)	95 (35)	97 (36)	100 (38)	102 (39)	105 (41)	108 (42)	112 (44)
84 (29)	83 (28)	84 (29)	85 (29)	86 (30)	88 (31)	89 (32)	90 (32)	92 (33)	94 (34)	96 (36)	98 (37)	100 (38)	103 (39)
82 (28)	81 (27)	82 (28)	83 (28)	84 (29)	84 (29)	85 (29)	86 (30)	88 (31)	89 (32)	90 (32)	91 (33)	93 (34)	95 (35)
80 (27)	80 (27)	80 (27)	81 (27)	81 (27)	82 (28)	82 (28)	83 (28)	84 (29)	84 (29)	85 (29)	86 (30)	86 (30)	87 (31)

Category	Heat Index	Possible heat disorders for people in high risk groups
Extreme Danger	130°F or higher (54°C or higher)	Heat stroke or sunstroke likely.
Danger	105 - 129°F (41 - 54°C)	Sunstroke, muscle cramps, and/or heat exhaustion likely. Heatstroke possible with prolonged exposure and/or physical activity.
Extreme Caution	90 - 105°F (32 - 41°C)	Sunstroke, muscle cramps, and/or heat exhaustion possible with prolonged exposure and/or physical activity.
Caution	80 - 90°F (27 - 32°C)	Fatigue possible with prolonged exposure and/or physical activity.

Precautions To Take Against Excessive Heat

Increase your intake of non-alcoholic, non-carbonated, caffeine free beverages such as water and juice.
Wear clothing that is light in color and loose fitting.
Avoid the outdoors during extreme heat. Stay out of the sun.
Stay in an air-conditioned environment if possible. Shopping malls offer relief if your home is not air-conditioned.
Check on the elderly. They are especially susceptible to heat related illness.
Eliminate strenuous activity such as running, biking and lawn care work when it heats up.

Heat Related Illnesses And Their Symptoms

SUNBURN - Redness and pain in the skin. In severe cases there is also swelling, blisters, fever, and headaches.
HEAT CRAMPS - Heavy sweating and painful spasms usually in the leg or abdomen muscles.
HEAT EXHAUSTION - The person becomes weak and is sweating heavily. The skin is cold, pale and clammy. Fainting and vomiting accompanies heat exhaustion.
HEATSTROKE/SUNSTROKE - High body temperature (106 degrees or higher) along with hot dry skin and a rapid and strong pulse. Unconsciousness is possible.

Weather Safety: Hurricanes

Safety and Preparedness Fact Sheet

Before the Hurricane Season

- Determine safe evacuation routes inland.
- Learn location of official shelters.
- Make emergency plans for pets.
- Check emergency equipment, such as flashlights, generators and battery-powered NOAA Weather Radio All Hazards and cell phones.
- Buy food that will keep and store drinking water.
- Buy plywood or other material to protect your home.
- Clear loose and clogged rain gutters and downspouts.
- Trim trees and shrubbery.
- Decide where to move your boat in an emergency.
- Review your insurance policy.

TERMS TO KNOW

Hurricane Watch: Hurricane conditions are *possible* in the specified area of the watch, usually within 36 hours.

Hurricane Warning: Hurricane conditions are *expected* in the specified area of the warning, usually within 24 hours.

Tropical Storm Watches and Warnings: Take these alerts seriously. Although Tropical Storms have lower wind speeds than hurricanes, they often bring life-threatening flooding and dangerous winds. Take precautions!

During the Storm

When in a Watch area...

- Listen frequently to radio, TV or NOAA Weather Radio All Hazards for bulletins of a storm's progress.
- Fuel and service your vehicles.
- Inspect and secure mobile home tie-downs.
- Board up windows in case the storm moves quickly and you have to evacuate.
- Stock up on batteries, food that will keep, first aid supplies, drinking water and medications.
- Store lawn furniture and other loose, light-weight objects, such as garbage cans and garden tools.
- Have cash on hand in case power goes out and ATMs don't work.

Plan to evacuate if you...

- Live in a mobile or manufactured home. They are unsafe in high winds no matter how well fastened to the ground.
- Live on the coastline, an offshore island or near a river or flood plain. In addition to wind, flooding from storm surge waves is a major killer.
- Live in a high-rise. Hurricane winds can knock out electricity to elevators, break windows and more.

When in a Warning area...

- Closely monitor radio, TV or NOAA Weather Radio All Hazards for official bulletins.
- Close storm shutters.
- Follow instructions issued by local officials. **Leave immediately if ordered!**
- If evacuating, leave as soon as possible. Stay with friends or relatives, at a low-rise inland motel or at a designated public shelter outside the flood zone.
- DO NOT stay in a mobile or manufactured home.
- Notify neighbors and a family member outside of the warned area of your evacuation plans.
- Take pets with you if possible, but remember, most public shelters do not allow pets other than those used by the handicapped. Identify pet-friendly motels along your evacuation route.

If Staying in a Home...

- Turn refrigerator to maximum cold and keep closed.
- Turn off utilities if told to do so by authorities.
- Turn off propane tanks.
- Unplug small appliances.
- Fill bathtub and large containers with water in case tap water is unavailable. Use water in bathtubs for cleaning and flushing only. Do NOT drink it.

If Winds Become Strong...

- Stay away from windows and doors, even if they are covered. Take refuge in a small interior room, closet or hallway.

Weather Safety: Hurricanes

- Close all interior doors. Secure and brace external doors.
- If you are in a two story house, go to an interior 1st floor room.
- If you are in a multi-story building and away from water, go to the 1st or 2nd floor and stay in the halls or other interior rooms away from windows.
- Lie on the floor under a table or other sturdy object.

Be Alert For...

- Tornadoes: They are often spawned by hurricanes.
- The calm "eye" of the storm. It may seem like the storm is over but after the eye passes, the winds will change direction and quickly return to hurricane force.
- Storm surge flooding. These high waves can be more deadly than hurricane winds. Leave the coast and stay away from low lying areas, creeks, streams and other inland waterways.

After the Storm

- Keep listening to radio, TV or NOAA Weather Radio.
- Wait until an area is declared safe before entering.
- Watch for closed roads. If you come upon a barricade or a flooded road, **Turn Around Don't Drown!™**
- Avoid weakened bridges and washed out roads.
- Stay on firm ground. Moving water only 6 inches deep can sweep you off your feet. Standing water may be electrically charged from power lines.

FEMA

American Red Cross

What to Bring to the Shelter

- First aid kit
- Medicine, prescriptions
- Baby food and diapers
- Games, books, music players with headphones
- Toiletries
- Battery-powered radio and cell phone
- Flashlights
- Extra batteries
- A blanket or sleeping bag for each person
- Identification
- Copies of key papers such as insurance policies
- Cash, credit card

REMINDER: If you are told to leave, do so immediately!

- Once home, check gas, water and electrical lines and appliances for damage.
- Use a flashlight to inspect for damage. Never use candles and other open flames indoors.
- Do not drink or prepare food with tap water until officials say it is safe.
- If using a generator, avoid electrocution by following manufacturers instructions and standard electric code.

NWS hurricane links, forecasts, assessments:
http://www.weather.gov/os/hurricane
NOAA Weather Radio All Hazards:
http://www.weather.gov/nwr
National Hurricane Center:
http://www.nhc.noaa.gov
Central Pacific Hurricane Center:
http://weather.gov/cphc
NOAA Hurricane Website
http://hurricanes.noaa.gov/
American Red Cross:
http://www.redcross.org
Federal Emergency Management Agency:
http://www.fema.gov

Staff Spotlight: Paul Lewis

Name: Paul Lewis
Position: Forecaster
Favorite Movie: "The Wizard of Oz"

Personal Information
Hometown: Reidsville, NC
Status: Married, 1 kid, 2 stepkids
Siblings: Oldest of 6 children -- 3 brothers and 2 sisters

NWS Background

1984-1986	National Climatic Data Center; Asheville, NC; Radar and Satellite Data Quality Control
1989-1995	NWSO Lansing, MI; Meteorological Intern
1995-present	NWSFO Houston/Galveston (HGX), TX; Journeyman Forecaster

Favorite Song Growing Up: "The Lion Sleeps Tonight" by the Nylons
Dream Vacation Spot: The Appalachian Mountains in North Carolina

Career Highlights / Achievements / Duties / Other Tidbits

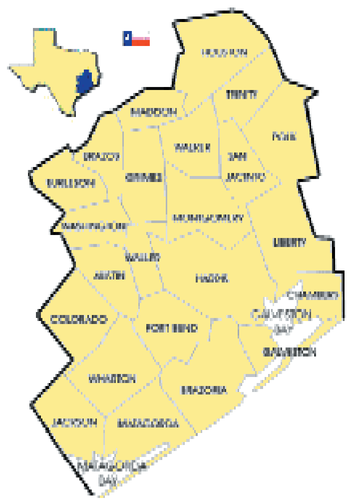
- Duties: public forecasts, aviation forecasts, marine forecasts, severe weather operations, fire weather forecasts
- Focal Point duty at HGX: hurricane
- Wrote and produced the 15 minutes videos that opened our annual Houston/Galveston Hurricane Workshops from 2000 to 2005; favorite was the one on Inland Flooding with Tropical Storm Allison in 2002
- Worked with NC State University research teams while at NCDC to determine the cause of high altitude tree deaths in western NC in the mid 1980s; results indicated that it was a combination of acid rain, drought, disease, and insects

Most Admired Person? Abraham Lincoln
Fold, Roll or Ball Socks? Fold then ball

What got you interested in weather?
Growing up on a farm you were very aware of the weather being outdoors almost all the time.

Most memorable weather event(s)?
1. Hurricane David (1979) – My college roommate and I looked all over town for an umbrella and could not find one.
2. The Christmas Eve Snowstorm (2004) – First snow while here in Texas.
3. Hurricane Rita (2005) – Our first real/big hurricane event for the office.

What is your favorite college memory other than NC State beating UH in the NCAA basketball finals in 1984 (held in Albuquerque)?
A tornado outbreak occurred just west of Raleigh on March 28, 1984, the night before an important government class debate.



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