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A TALE OF TWO STORM SURGES: HURRICANE CHARLEY VERSUS HURRICANE IKE

Steven Beckage , Louisiana State University

Storm surge is perhaps the most devastating of the hazards associated with hurricanes. Large waves breaking on the shore cause erosion, property damage, injury and even death. Storm surge is also highly variable, with no two storms having identical surge profiles. Two storms from the past decade serve as case studies in the unpredictability of storm surge. In 2004, Hurricane Charley made landfall on Florida's Gulf coast as a Category 4 storm, with maximum sustained winds of 150 miles per hour. Despite the fierce winds, Charley produced a relatively modest storm surge of 6 to 7 feet, well below what would be expected of a Category 4 storm. Conversely, 2004's Hurricane Ike made landfall in the northwestern Gulf near Galveston, TX. Although Ike's maximum sustained winds were only 110 miles per hour, making it a strong Category 2 storm, a devastating storm surge of 18 feet ravaged the Texas coast.

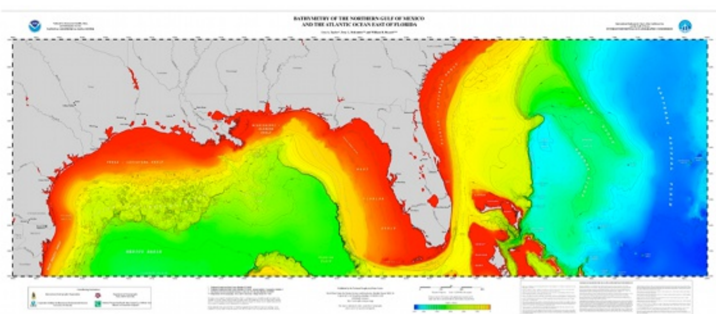

Figure 1: Bathymetric map of the Gulf of Mexico, provided by the NOAA's National Geophysical Data Center. Red areas indicate shallower waters, with green and blue areas representing deeper regions.

Clearly, maximum sustained winds are not the only factor determining storm surge. There are a few dynamic variables that combine to create storm surge. The first factor is bathymetry, or underwater topography. Surge heights tend to be higher on shallow, mildly sloping basins (Chen, 2008.) The bathymetry of the Gulf of Mexico features a relatively mild slope close to shore, with a shallow shelf extending out hundreds of miles in some locations (Figure 1). In general, the bathymetry of the Florida and Texas Gulf coasts are similar, meaning that there had to be other factors responsible for the discrepancies in surge.

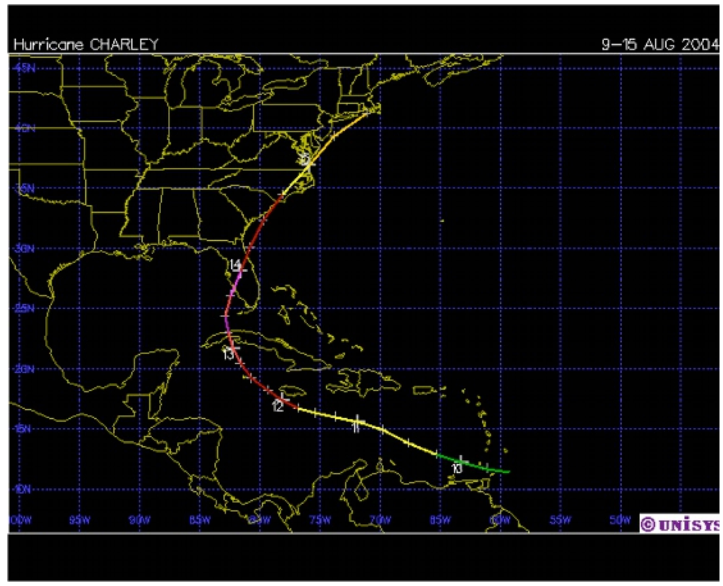

Figure 2: Storm track of Hurricane Charley, provided by the UNISYS Weather Hurricane Archives. Track color corresponds to storm intensity. Hurricane Charley intensified to Category 4 (pink line) very close to landfall.

Recent research (Irish et al., 2008) indicates that the physical size of the storm influences storm surge. Results indicate that larger storms produce larger surges. This is where our storms in question begin to differ. Charley was a relatively small storm, with a hurricane force wind field of approximately 60 miles in diameter prior to landfall. Ike, on the other hand, was quite large, with a hurricane force wind field more than double Charley's, roughly 130 miles (Overpeck, 2009). Another storm characteristic that defines surge is the duration of maximum winds. Although Charley's maximum sustained winds at landfall were quite strong, these strong winds did not develop until 18 hours before landfall. Prior to that time, Charley was a Category 2 storm with maximum sustained winds of around 105 miles per hour (Figure 2). Ike, on the other hand, was a much longer lived storm, building up water as it tracked across the Gulf (Figure 3). Although Ike's winds made it a Category 2 storm, its long track over the Gulf allowed surge to build unimpeded, well beyond levels normally associated with a Category 2 storm.

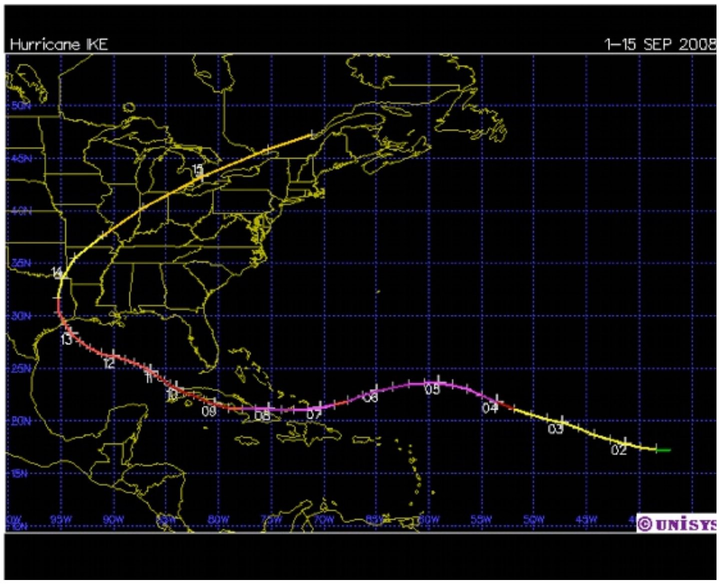

Figure 3: Storm track of Hurricane Ike, provided by the UNISYS Weather Hurricane Archives. Ike was a Category 2 (salmon-colored line) for much of its track across the Gulf of Mexico.

Combining all of these factors provides a better perspective into the surges of these hurricanes. Both storms encountered similar bathymetry in their approach. Until immediately prior to landfall, both storms had roughly the same maximum sustained winds. The main cause for the discrepancies in storm surge in this case appears to lie in the vastly different storm sizes and duration of maximum winds. Ike was an exceptionally large, long lived storm, tracking from the Atlantic across Cuba before traversing the entire Gulf of Mexico. These two factors set up a much larger surge than the wind speed would indicate. Charley was a short-lived storm, and did not develop unusually strong winds until just before landfall. It is likely that the timing of the increase in wind speeds prevented the strong winds from building up storm surge, thus keeping the surge values below what would be expected of a Category 5 storm.

In 2008, NOAA removed storm surge from the Saffir-Simpson scale of hurricane intensity. In light of storms such as Charley and Ike, it is not difficult to see why. Storm surge represents a combination of many dynamic factors, and cannot be correlated strictly with wind speed. Surge must be evaluated on a storm-by-storm basis, and different background characteristics (such as bathymetry) and meteorological scenarios (such as storm size and wind duration) give rise to vastly different surge profiles for each storm.

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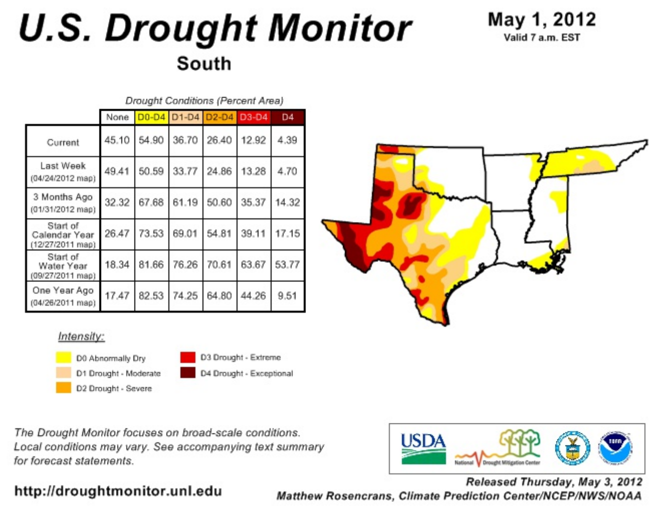
DROUGHT CONDITIONS

Luigi Romolo, Southern Regional Climate Center

Drought conditions in the Southern Region improved for the third consecutive month. Although the total area of the region in drought has increased by approximately one percent, the amount of extreme drought has been decreased by approximately six percent. Much of this improvement occurred in western and southern Texas, which has been under the grip of drought for over a year. Some new drought has popped up in southern Tennessee, where it has been much drier than normal for two consecutive months.



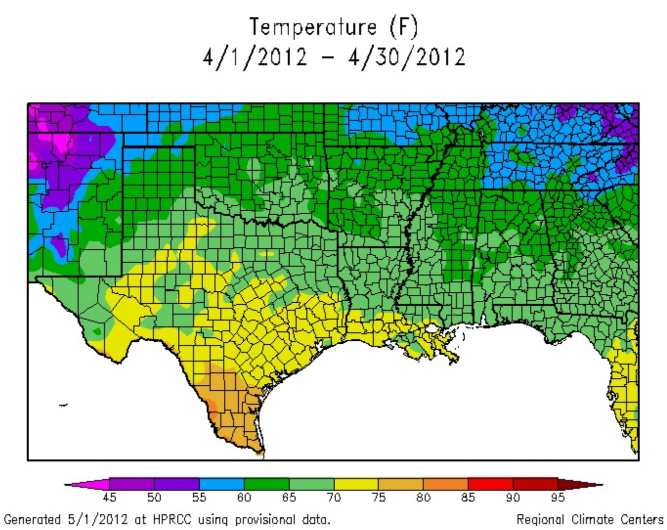
	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	45.10	54.90	36.70	26.40	12.92	4.39
Last Week (04/24/2012 map)	49.41	50.59	33.77	24.86	13.28	4.70
3 Months Ago (01/31/2012 map)	32.32	67.68	61.19	50.60	35.37	14.32
Start of Calendar Year (12/27/2011 map)	26.47	73.53	69.01	54.81	39.11	17.15
Start of Water Year (09/27/2011 map)	18.34	81.66	76.26	70.61	63.67	53.77
One Year Ago (04/26/2011 map)	17.47	82.53	74.25	64.80	44.26	9.51

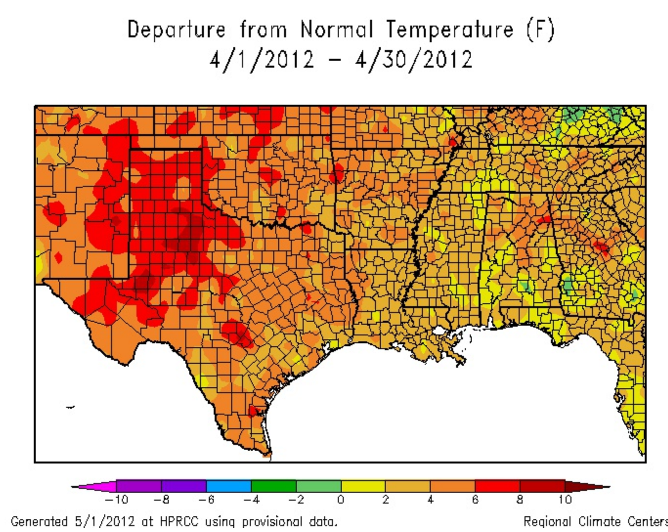
Above: Drought conditions in the Southern Region. Map is valid for April 2012. Image courtesy of the National Drought Mitigation Center.

TEMPERATURE SUMMARY

Luigi Romolo, Southern Regional Climate Center

Like March, April was generally a warmer than normal month for the Southern Region. For the most part, temperatures averaged between 2 and 4 degrees F (1.11 and 2.22 degrees C) above expected values. The highest anomalies occurred in northwestern Texas and western Oklahoma, were many stations experienced average temperatures that ranged from 6 to 8 degrees F (3.33 to 4.44 degrees C) above normal. State average temperature Texas was 70.30 degrees F (21.28 degrees C), which makes it the third warmest April on record (1895-2012). For Oklahoma, it was their twelfth warmest April on record, with a state average temperature of 63.70 degrees F (17.61 degrees C). Arkansas reported its thirteenth warmest April on record (1895-2012) with a state average temperature of 64.10 degrees F (17.83 degrees C). Other state average temperatures include: Louisiana at 69.20 degrees F (20.67 degrees C), Mississippi at 65.40 degrees F (18.56 degrees C) and Tennessee at 60.30 degrees F (15.72 degrees C).



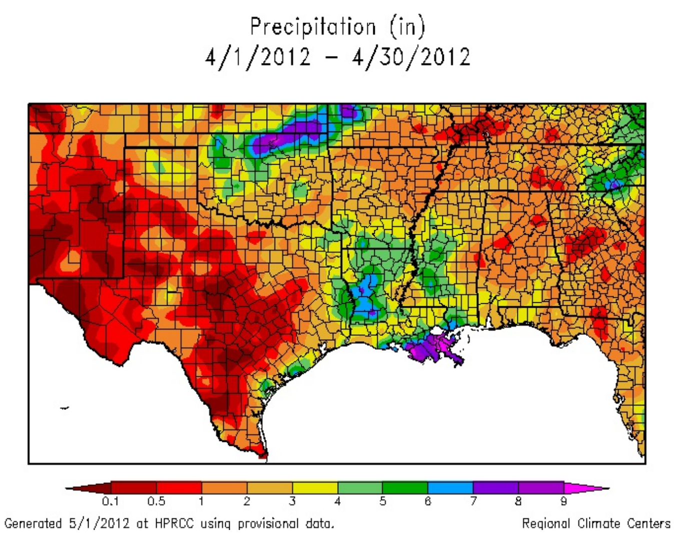


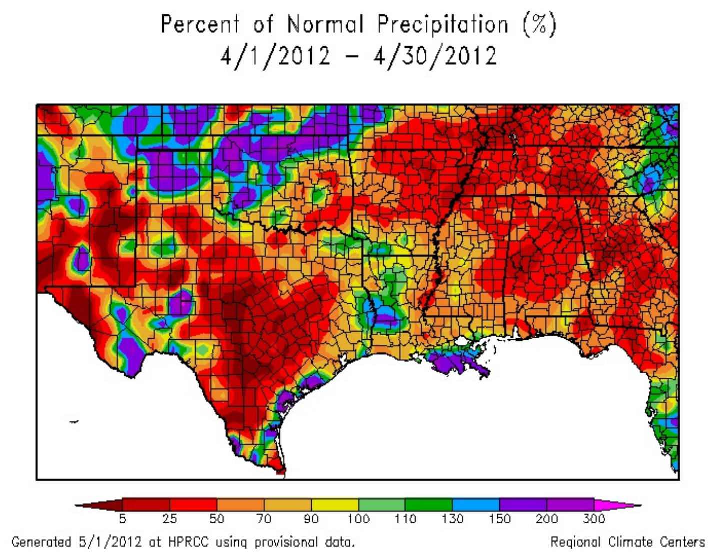
Average temperatures (left) and departures from 1971-2000 normal average temperatures (right) for April 2012, across the South.

PRECIPITATION SUMMARY

Luigi Romolo, Southern Regional Climate Center

With only a few exceptions, April was a very dry month for the Southern Region. In southern Louisiana, precipitation totals did dip over twice the monthly normal. Similar values were also observed along the Texas Gulf Coast, northern Texas, and in western and central Oklahoma. Elsewhere, most stations received less than half the expected precipitation for the month. The driest area of the region includes much of central Texas, where many stations reported only five percent of normal precipitation or less. Similar but less extreme dryness was also observed in north eastern Arkansas and throughout much of western and central Tennessee. Tennessee experienced its sixth driest April on record (1895-2012), with a state average precipitation total of only 2.17 inches (55.12 mm). Arkansas reported a state average precipitation total of 2.53 inches (64.26 mm), making it their eleventh driest April on record (1895-2012). For the state of Texas, it was their twenty-first driest April (1895-2012), with a state average precipitation total of 1.39 inches (35.31 mm). Other state precipitation totals include: Louisiana with 4.92 inches (124.97 mm), Mississippi with 3.63 inches (92.20 mm), and Oklahoma with 3.82 inches (97.03 mm).





Total precipitation values (left) and The percent of 1971-2000 normal precipitation totals (right) for April 2012.

A SNEAK PEAK AT THE 2012 HURRICANE SEASON

Barry D. Keim, Louisiana State Climatologist

Phillip Klotzbach and Bill Gray of Colorado State University recently put out their forecast for the 2012 hurricane season. They are predicting 10 named storms, of which 4 will be hurricanes, and of those 4 hurricanes, 2 will be major hurricanes. These values are lower than an average season - with the baseline from 1981-2010 indicating that an average season has 12 named storms, of which 7 are hurricanes, and of those 7 hurricanes, 4 are major hurricanes. As such, this forecast calls for a "below average" hurricane season in the North Atlantic Basin, which of course includes the Caribbean, Gulf of Mexico, and Louisiana. The reasons for this "below average" prediction are twofold. First, the breeding grounds in the tropical Atlantic Ocean currently have sea surface temperatures that are cooler than that of recent years. This is important because cooler sea surfaces have less energy to feed into tropical systems leading to fewer and weaker hurricanes. Secondly, NOAA is predicting that our waning La Nina should fizzle out in coming weeks, and that an El Nino may form before we get to the core of the 2012 hurricane season in August, September, and October. El Nino conditions create an environment that is inhospitable for the development of hurricanes by creating wind shear in the higher levels of the atmosphere. Wind shear prevents hurricanes from having ventilation aloft, which is needed to sustain a hurricane. Therefore, the combination of these two factors led us to this encouraging forecast. Note however, that Hurricane Andrew occurred during the "quiet" hurricane season of 1992, which only had 7 named storms. It was also an El Nino year. That one storm made the 1992 hurricane season a significant one for many inhabitants in south Florida, as well as in Louisiana. While this forecast is encouraging, indeed, it does not mean to let your guard down. Klotzbach and Gray, as well as NOAA, will put out updated seasonal forecasts for the 2012 hurricane season in late May and early June. If you have any comments, complaints, or compliments, feel free to e-mail me at keim@lsu.edu.

CLIMATE PERSPECTIVE

State	Temperature	Rank	Precipitation	Rank
Arkansas	64.1	13th Warmest	2.53	11th Driest
Louisiana	69.2	20th Warmest	4.92	50th Wettest
Mississippi	65.4	28th Warmest	3.63	39th Driest
Oklahoma	63.7	12th Warmest	3.82	42nd Wettest
Tennessee	60.3	26th Warmest	2.17	6th Driest
Texas	70.3	3rd Warmest	1.39	21st Driest

State temperature and precipitation values and rankings for April 2012. Ranks are based on the National Climatic Data Center's Statewide, Regional and National Dataset over the period 1895-2011.

STATION SUMMARIES ACROSS THE SOUTH

Station Name	Temperatures (degrees F)								Precipitation (inches)		
	Averages				Extremes				Totals		
	Max	Min	Mean	Depart	High	Date	Low	Date	Obs	Depart	%Norm
El Dorado, AR	77.4	53.7	65.6	1.9	85.0	4/1	41.0	4/24	4.37	-0.18	96
Little Rock, AR	77.3	55.9	66.6	5.2	86.0	4/27+	45.0	4/24	2.84	-2.63	52
Baton Rouge, LA	81.9	58.5	70.2	3.6	89.0	4/30	44.0	4/24	3.27	-2.29	59
New Orleans, LA	82.0	63.8	72.9	4.7	88.0	4/30	53.0	4/24	7.44	2.42	148
Shreveport, LA	80.1	58.6	69.3	4.1	86.0	4/26+	48.0	4/24	3.40	-1.02	77
Greenwood, MS	76.7	53.3	65.0	1.3	87.0	4/30	40.0	4/22	4.22	-1.44	75
Jackson, MS	78.5	55.0	66.7	3.3	87.0	4/30	40.0	4/24	4.57	-1.41	76
Tupelo, MS	76.4	53.0	64.7	3.8	88.0	4/30	36.0	4/12	1.75	-3.19	35
Oklahoma City, OK	75.1	55.5	65.3	5.6	89.0	4/27	44.0	4/23+	5.92	2.92	197
Ponca City, OK	75.6	52.6	64.1	5.2	91.0	4/1	36.0	4/23+	11.54	8.03	329
Tulsa, OK	75.7	55.6	65.6	4.8	90.0	4/1	40.0	4/21	3.62	-0.33	92
Knoxville, TN	73.0	49.9	61.4	3.6	86.0	4/30	33.0	4/12	3.64	-0.35	91
Memphis, TN	76.5	55.5	66.0	3.9	86.0	4/30+	43.0	4/22+	1.04	-4.75	18
Nashville, TN	74.1	49.9	62.0	3.5	87.0	4/2	33.0	4/12	2.86	-1.07	73
Amarillo, TX	78.2	47.6	62.9	6.7	99.0	4/25	35.0	4/4	1.99	0.66	150
El Paso, TX	84.5	55.4	69.9	5.3	96.0	4/24	41.0	4/16+	0.09	-0.14	39
Dallas, TX	80.4	60.2	70.3	5.3	89.0	4/27+	46.0	4/21	4.24	1.04	132
Houston, TX	83.2	64.0	73.6	5.1	88.0	4/25	52.0	4/24+	3.28	-0.32	91
San Antonio, TX	85.2	62.5	73.8	5.2	95.0	4/26	50.0	4/21	0.04	-2.56	2

Summary of temperature and precipitation information from around the region for April 2012. Data provided by the Applied Climate Information System. On this chart, "depart" is the average's departure from the normal average, and "% norm" is the percentage of rainfall received compared with normal amounts of rainfall. Plus signs in the dates column denote that the extremes were reached on multiple days. Blue-shaded boxes represent cooler than normal temperatures; red-shaded boxes denote warmer than normal temperatures; tan shades represent drier than normal conditions; and green shades denote wetter than normal conditions.

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