GUY CARPENTER

2014 ATLANTIC HURRICANE SEASON: ONE NEVER TRULY KNOWS

The 2004 hurricane season was a weak El Niño year, which brought five landfalling U.S. hurricanes, four of which affected Florida.

The risk of a landfalling hurricane is a serious threat for *any* tropical season, regardless of seasonal outlooks for the Atlantic Basin at large. In fact, sea-surface temperatures (SSTs) along the U.S. coast and northern Caribbean are trending above average, and tropical cyclone development in these areas close to the mainland is cause for concern. Such development depends on short-term weather patterns at the time of occurrence, not on how many hurricanes are expected in the Atlantic basin at large.

For the North Atlantic Basin, seasonal outlook providers are expecting tropical activity to fall below the long-term average of 1954-2013. Common factors noted by these providers include a probable warm or "El Niño" phase of the El Niño Southern Oscillation and cool SSTs in the Atlantic Main Development Region (MDR) (the area of the tropical Atlantic between Africa and the Gulf of Mexico, specifically 10 degrees north to 20 degrees north longitude and 20 degrees west to 85 degrees west latitude).

Indeed tropical waters of the Central and Eastern Atlantic are cooler than average, but warmer waters in the West Atlantic adjacent to the coast are still cause for a moment of pause.

It is also accepted that El Niño conditions tend to suppress hurricane development in the Atlantic basin, but scientific research reveals that this effect is strongest in the deep tropics. Also, the strength, placement and onset date of the El Niño and its suppressing effects are still subject to some uncertainty. The 2004 hurricane season was a weak El Niño year, which brought five landfalling U.S. hurricanes, four of which affected Florida. The 1965 season was a strong El Niño year, with four hurricanes in the Atlantic Basin, and a single landfalling U.S. Hurricane named Betsy, that rendered severe impacts to the Florida Keys and the Northern Gulf Coast. The 1992 season was a decaying El Niño year, and a quiet season with only four hurricanes in the basin, and a single U.S. landfall — Hurricane Andrew. That storm is among the strongest U.S. landfalling hurricanes on record and brought long-lasting impacts to the insurance industry, not to mention the residents of Homestead, Florida.

It is clear that the proportion between basin activity and hurricane landfalls has been historically very volatile. Basin activity does not consistently relate to landfalls (or their severity) – these are determined by weather patterns at the time of occurrence, not pre-season estimates of hurricane frequency.

We know that unexpected events can and do happen, with examples like Charley (2004), Betsy and Andrew. Warmer waters in the West Atlantic and Caribbean, and the uncertainty of the strength and placement of the oncoming El Niño especially warrant a moment of pause for the 2014 season.

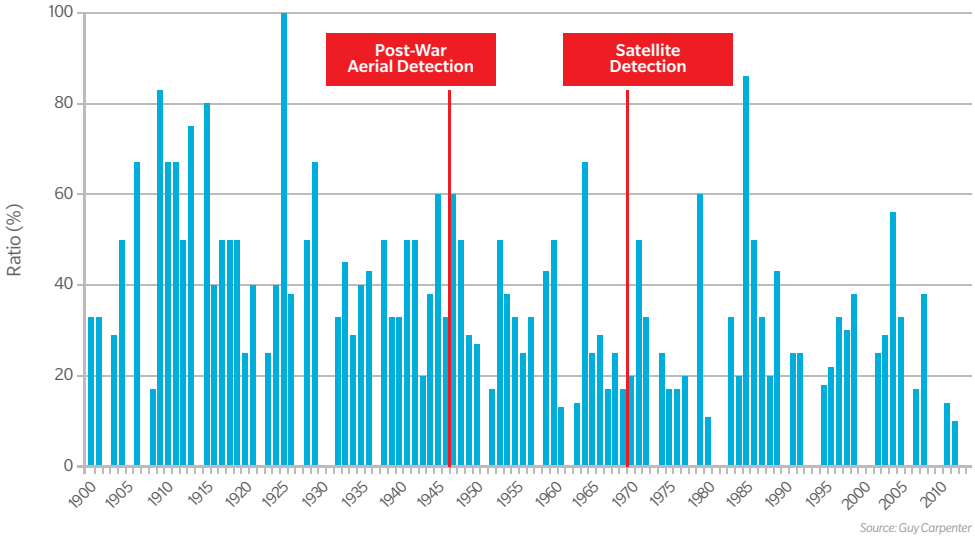
As with any hurricane season, a review of response plans and procedures is essential for property owners and the (re)insurance industry alike.

2014 SEASONAL OUTLOOKS SUGGEST REDUCED ATLANTIC BASIN ACTIVITY

Development Near United States Still Possible – U.S. Landfalls Uncertain

The proportion of hurricanes counted in the Atlantic Basin and those that made landfall has been very volatile through the years. While there is indeed a weak correlation between hurricane counts in the Atlantic Basin and the number of U.S. landfalls, statistical significance is a subject of some debate in the scientific community (Coughlin et al., 2009; Dailey et al., 2009).

F-1 | U.S. LANDFALL TO BASIN RATIO – DETECTED HURRICANES (1900-2013)



Source: Guy Carpenter

Note declining trend over time with post-war overflight detection (late 1940s) and satellite detection (1970s). Note variability from year to year, and high ratio in 1985.

The year-to-year volatility warrants preparation for any season. The 2010 season saw 19 named storms and 12 hurricanes without a single U.S. landfall. In 1985 there were seven hurricanes in the basin, and six of these made U.S. landfall (some of which were very impactful). We in the industry are also well aware of the 1992 season that produced only four hurricanes, including one historic U.S. landfall (Andrew), not unlike 1965 with Betsy and the severe impacts to southern Louisiana.

Seasonal activity predictions for the basin are valuable, but the impacts of even a single landfall (quiet season or not) can be quite severe. Historical experience warrants proper review and preparation of hurricane plans by all interests from individual homeowners to businesses to the insurance industry at large.

In light of this reality, seasonal outlook providers expect 2014 counts to fall near or slightly below the long-term mean of 1954-2013. The forecasts also fall clearly below the short-term 1995-2013 mean.

Factors of greatest influence include:

1. The expected onset of an El Niño.
2. Cooler than normal temperatures in the Atlantic MDR.

The predictions of seasonal outlook providers, including the Colorado State University team of Professors William M. Gray and Phillip J. Klotzbach, are included in Table 1 below.

Another key theme for seasonal tropical outlooks this year is uncertainty. Seasonal outlook providers such as Gray and Klotzbach emphasize such uncertainty and note factors such as the strength and placement of the expected El Niño for the upcoming summer.

T-1 | SEASONAL OUTLOOKS FOR THE 2014 ATLANTIC HURRICANE SEASON

Source	Named Storms[7]	Hurricanes[8]	Major Hurricanes[9]	A.C.E.[10]
WSI[1] (April 22)	11 (9-11)	5 (4-6)	2 (0-2)	-
TSR[2] (April 7)	12 (8-16)	5 (2-8)	2 (0-4)	75 (18-132)
CSU[3] (June 2)	10 (6.3-13.7)	4 (1.9-6.1)	1 (0-2.6)	65 (17-113)
UK Met[4] (May 16)	10 (7-13)	6 (3-9)	-	84 (47-121)
NOAA[5] (May 22)	8-13	3-6	1-2	37-97
NCSU[11] (April 15)	8-11	4-6	1-3	-
1995-2013 Mean[6]	15.2	7.7	3.5	134.3
1954-2013 Mean[6]	11.3	6.2	2.5	101.1

Values In Parentheses Indicate Uncertainty Range As Provided By The Source.

1 Weather Services Incorporated/The Weather Channel
2 Tropical Storm Risk
3 Colorado State University (Klotzbach, Gray)
4 U.K. Met Office
5 Climate Prediction Center of the National Oceanic and Atmospheric Administration (NOAA)
6 Hurricane Research Division (NOAA)
7 Maximum sustained winds of 39 mph or greater
8 Maximum sustained winds of 74 mph or greater
9 Maximum sustained winds of 111 mph or greater (Category 3, 4 or 5 on the Saffir-Simpson scale)
10 Accumulated Cyclone Energy (or A.C.E.) is defined as the sum of squares of six-hourly maximum sustained wind speeds (in knots) for all tropical storms or hurricanes. Units are $x10^4$ $knots^2$. This index is a proxy for the energy expended by a tropical cyclone.
11 North Carolina State University. (Xie et. al.,2014)

EL NIÑO PHENOMENON

The El Niño phenomenon is signaled by warmer than normal SSTs in the tropical East Pacific. The large-scale circulations associated with El Niño enhance wind shear (changing wind speed with height) in the tropical Atlantic. The enhanced wind shear disrupts tropical cyclone formation, generally associated with fewer tropical cyclones in the Atlantic Basin. The suppressing effects of El Niño are found to be strongest in the deep tropics (Kossin et al., 2010).

According to the NOAA Climate Prediction Center (CPC), El Niño conditions are likely to develop by mid-summer at the latest. Currently, conditions in the tropical Pacific clearly indicate that an El Niño is forming.

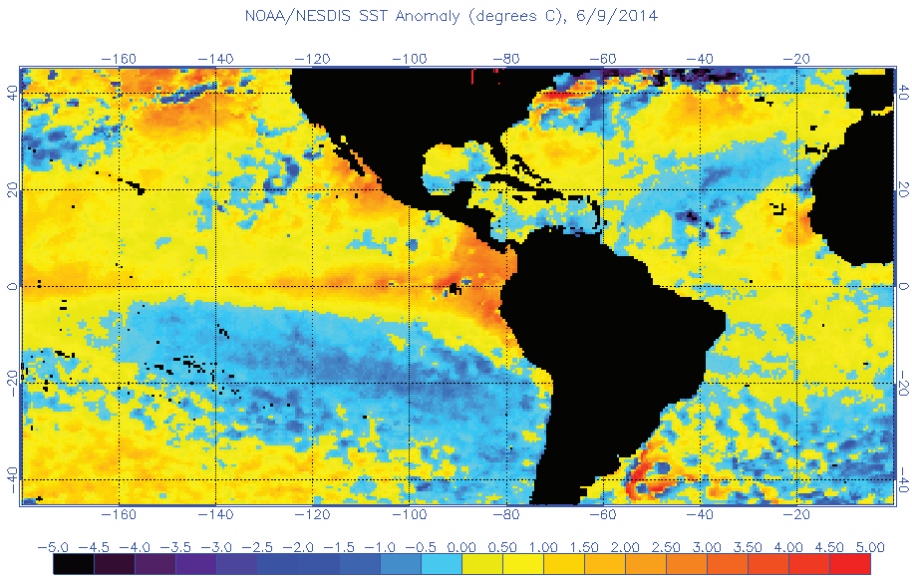
The unresolved questions are how strong this El Niño will be and whether the warmer waters in the tropical Pacific will be in the extreme East Pacific as with a textbook El Niño, or located more towards the Central Pacific. These questions are important because they influence where and how strong the disruptive wind shear will be over the Atlantic. These details could influence basin activity this year, particularly for those storms of the deep tropics and East Atlantic.

The 2004 season was a weak El Niño year with the warm waters located closer to the Central Pacific. The season produced nine hurricanes and five U.S. landfalls, four of which severely affected Florida in a very impactful season. The 1969 season was also a weak El Niño season, producing twelve hurricanes and two landfalls, one of which was Camille – the second strongest landfalling U.S. hurricane in recorded history.

TROPICAL ATLANTIC SSTs

Seasonal outlook providers note the cooler than average SSTs in the tropical Atlantic as one factor for their quiet seasonal predictions. A closer look at SSTs in the Atlantic MDR indeed indicate moderately cool SSTs over a sizeable area.

F-2 | SEA-SURFACE TEMPERATURE ANOMALIES AS OF JUNE 9, 2014



Note the patches below normal in the tropical Atlantic.
Note also the area above normal in the Western Atlantic and northern Caribbean.

Source: National Hurricane Center (NOAA)

However, on closer inspection, above normal SSTs are found in an area adjacent to the U.S. East coast and Florida (Figure 2). The implications are that:

1. Tropical cyclone development may indeed be suppressed in the deep tropics and for African Cape Verde-type storms.
2. Disturbances adjacent to the U.S. mainland and northern Caribbean may find an environment with warmer SSTs and better enabling conditions for development of tropical storms. This applies both to disturbances generated in the area and also for Cape Verde-type disturbances that arrive from their Atlantic transit, even if they have not had a chance to develop.
3. If the El Niño-suppressing effects are weaker and shifted away from the southern United States and northern Caribbean, then a better-enabled environment for storm production is possible.

IMPLICATIONS

In light of the expected El Niño and cooler than average SSTs over the Atlantic MDR, some subtle but important factors warrant consideration:

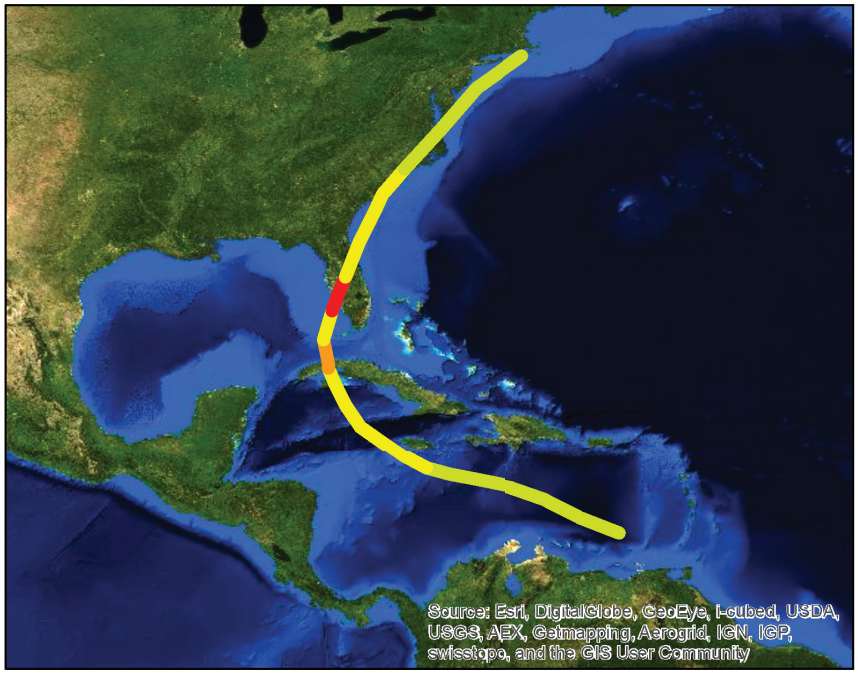
1. The strength and placement of the El Niño remain uncertain and could displace the effects of disruptive wind shear.
2. The suppressive effects of El Niño are found to be strongest over the deep tropics (Kossin et al., 2010) and Cape Verde origin storms and less pronounced for Gulf-origin storms of higher latitude.
3. SSTs are somewhat cooler than normal over the East and Central Atlantic, but not for the waters adjacent to the eastern United States and northern Caribbean.
4. Disturbances originating in the West Atlantic or northern Caribbean may find an enabling environment in which to develop. The same argument applies for Cape Verde-type disturbances arriving in the West Atlantic (even if they had not experienced development during their Atlantic transit).
5. Landfalls are influenced by large-scale weather circulation at the time of occurrence, which by experience we know can be surprising to the world's best forecasters.

HISTORICAL IMPACTS – WHAT WE KNOW CAN HAPPEN

Hurricane Charley (2004)

- Maximum Sustained Winds at Landfall: 145 mph (Category 4 on the Saffir-Simpson scale)
- Storm Surge: six to seven feet observed near Sanibel and Estero Islands, Florida.
- Charley experienced a period of explosive development just prior to its landfall as a Category 4 hurricane.
- An abrupt track change to the southeast caused Charley to make landfall further south than expected, drastically lessening impacts to the Tampa/St. Petersburg, Florida area.
- Charley was a compact but very powerful storm that rendered catastrophic damage in Charlotte County, and especially Punta Gorda, Florida with more moderate damage well inland. Estimated economic losses of USD17.2 billion in 2010 dollars, correcting for wealth and inflation (Blake et al., 2011).
- The 2004 tropical season was a weak El Niño year that produced five U.S. hurricane landfalls, four of which impacted Florida.

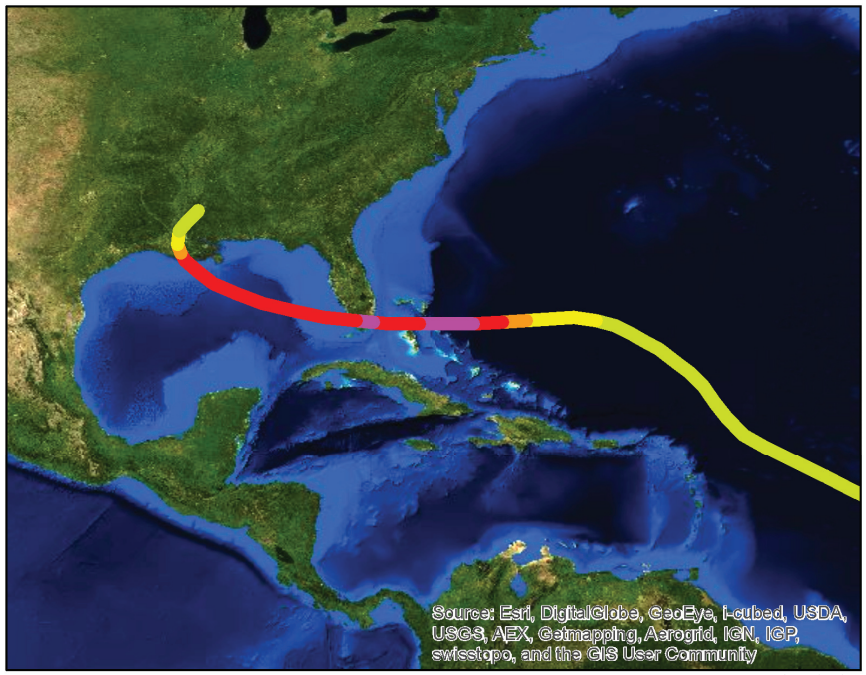
F-3 | HURRICANE CHARLEY (2004)



Hurricane Andrew (1992)

- Andrew originated from a tropical wave and experienced disruptive wind shear until arriving in the West Atlantic.
- Once in the West Atlantic, Andrew first reached hurricane status on the morning of August 22 and then developed explosively into a Category 5 hurricane.
- Maximum Sustained Winds at U.S. Landfall: 165 mph.
- Second landfall in coastal Louisiana with maximum sustained winds of 115 mph, a Category 3 hurricane.
- Storm Surge: Estimated near 17 feet near Burger King International headquarters on Biscayne Bay, Florida.
- Severe to complete damage across Dade County, Florida and complete devastation in the Bahamas.
- Estimated economic losses of USD58.5 billion in 2010 dollars, correcting for wealth and inflation (Blake et al., 2011).
- This was a very quiet season under a decaying El Niño year, with only four hurricanes in the Atlantic basin, one of which made U.S. landfall.

F-4 | HURRICANE ANDREW (1992)



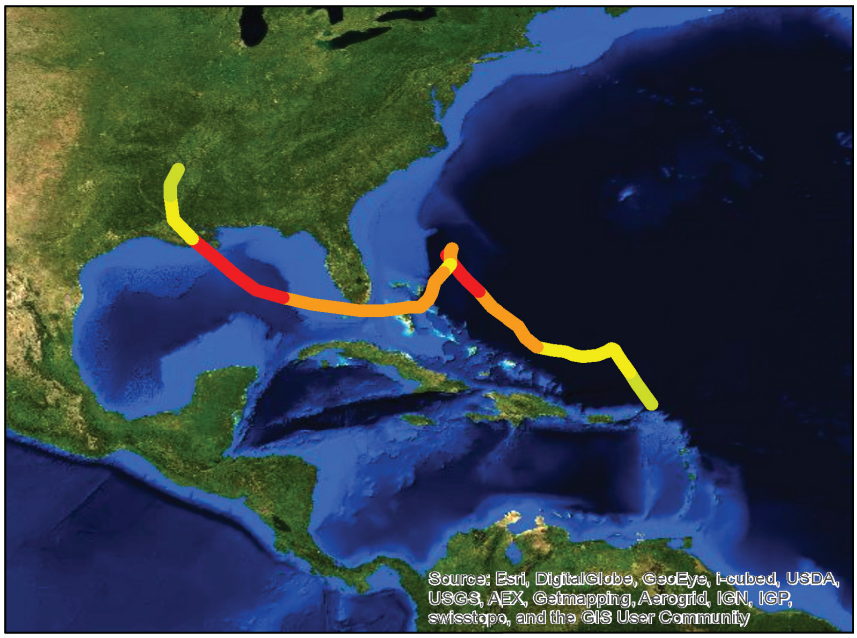
Source: Guy Carpenter using the HURDAT2 database (NOAA/HRD)

HISTORICAL IMPACTS – WHAT WE KNOW CAN HAPPEN - *continued*

Hurricane Betsy (1965)

- Betsy made landfall on Key Largo, Florida, with estimated winds of 125 mph (Category 3 hurricane) before entering the Gulf of Mexico.
- Betsy made a second landfall near Grand Isle, Louisiana, with estimated winds of 155 mph (Category 4 hurricane).
- Storm surge of eight feet at Big Pine Key, Florida, also with severe beach erosion along the Southwest Florida coast.
- Storm surge of about 16 feet near Grand Isle, Louisiana.
- Estimated economic losses of USD18.7 billion in 2010 dollars, correcting for wealth and inflation (Blake et al., 2011).
- This was a very quiet season under a strong El Niño year, with only four hurricanes in the Atlantic basin, one of which made U.S. landfall.

F-5 | HURRICANE BETSY (1965)



Source: Guy Carpenter using the HURDAT2 database (NOAA/HRD)

WHAT ARE WE PREPARING FOR ANYWAY?

Any hurricane can produce wind, surge and inland flood impacts. The severity and scope of impacts is not always consistent with ratings on the Saffir-Simpson scale, particularly for surge as we have seen with Katrina (2005) and Sandy (2012).

- **Wind:** For a typical wood frame structure, damage usually starts from the top of the structure and most often with the roof (trees notwithstanding). These effects can become noticeable with sustained wind speeds as low as 40 mph. For more severe wind events, wind damage will affect the walls, and in extreme cases such as Andrew or Charley, many structures will be barely recognizable following the event. Downed trees and powerlines are commonly found with any tropical cyclone.
- **Storm surge:** This weather event is related to many factors including wind speed over water, the area of water affected by wind, bathymetry and coastline shape. Elevated waters will ruin the interior of any coastal property. Water velocity and particularly wave activity will cause severe to complete structural damage since water weighs about one ton per cubic yard. Water damage usually begins at the bottom of a structure and becomes more severe with increasing water levels and wave height. With excessive water velocity or wave activity, the foundation itself can be dislodged resulting in structural failure. In extreme cases the property can be scoured from the foundation such as in the Mississippi Gulf coast area from Katrina. Our most recent reminder of U.S. surge impacts is from Sandy. While Sandy was a post-tropical cyclone at landfall, the size of the wind field and angle of landfall near Brigantine, New Jersey, drove a historic surge event for the area extending as far north as Massachusetts. The severity of surge impacts was equivalent to a typical Category 3 hurricane, yet the wind speeds alone did not suggest the potential for such damage.
- **Freshwater flooding:** This type of flood is affected by factors such as excessive rainfall, the capacity of local storm water management infrastructure and local geography. The freshwater impacts of Hurricanes Irene (2011) and Fay (2008) were quite severe in the New England and North Florida areas, respectively. Floodwaters can ruin any structure they affect and can even cause structural damage if water velocity is sufficient. Water damage starts at the bottom of the structure and increases in severity as waters rise.

Preparation for each of these impacts and the resulting disruption to infrastructure should be an ongoing and essential process for homeowners, businesses, government agencies including NOAA and the Federal Emergency Management Administration and, of course, the (re)insurance industry. The landfall of one or two hurricanes cannot be ruled out for any season.

CLOSURE

Hurricane activity is projected by seasonal outlook providers to be near or below average for the 2014 season, but these providers all stress the uncertainty of their estimates. Cool SSTs and a probable El Niño would indicate reduced activity. However, the strength and placement of the El Niño in the Pacific Ocean will determine how strong the suppressing effects in the Atlantic will be, and these suppressing effects are shown to be strongest in the deep tropics. Warm SSTs in the West Atlantic and northern Caribbean warrant some caution against development off the U.S. coast. Regardless of basin activity, proper preparation for at least two landfalling hurricanes is a necessity as history has shown more than once.

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