

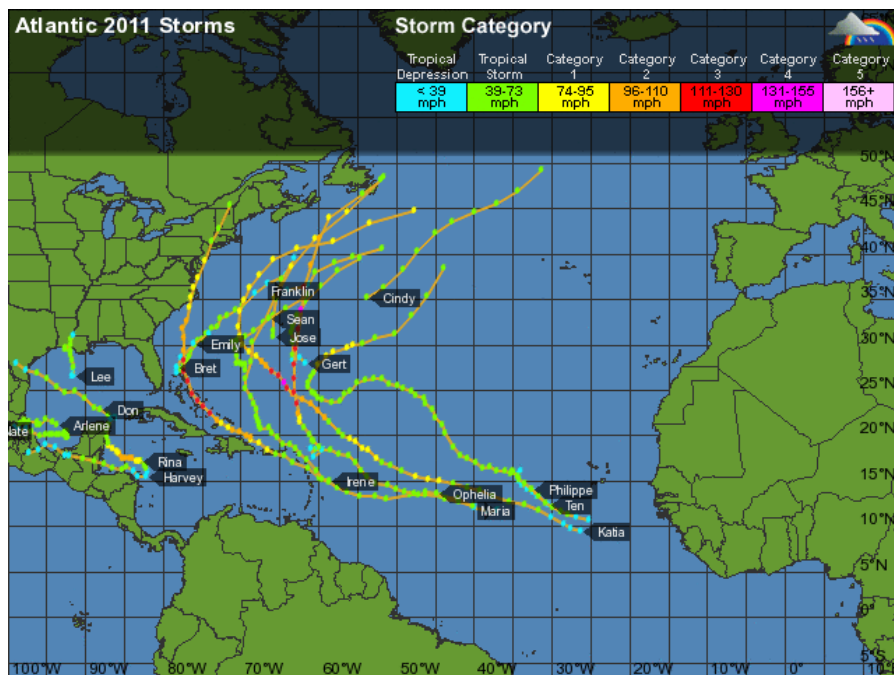
## **SHORELINES – January 2012**

As presented to the *Island Review* magazine

### **The 2011 Hurricane Season - Revisited**

November 30<sup>th</sup> recently passed signifying the last day of the 2011 hurricane season which officially began on June 1<sup>st</sup>. 2011 will forever be remembered locally as the year of *Irene*, which made landfall at Cape Lookout as a Category 1 hurricane at 7:30 am on August 27, 2011. “Baby dune” erosion and considerable losses of sand offshore along Bogue Banks, massive overwash on Core Banks, oceanfront pier damage, soundside flooding and structural damage, and significant debris are probably within everyone’s top 5 *Irene* impacts (and not necessarily in that order). While none of these impacts isolated alone were “the worst ever”, the diverse scope and intensity of damages does indeed make *Irene* a memorable hurricane for Carteret County. *Irene* has been the focus for the past few editions of *Shorelines* and we have dedicated a webpage to the hurricane complete with reports, hundreds of photos, videos, and more – see <http://www.protectthebeach.com/temp/irene.html>. But for this edition of *Shorelines*, we’re going to take a more macroscopic review of the 2011 hurricane season and as we’ll see; Carteret County was an unlucky victim of the old adage, “location, location, location”.

The 2011 hurricane season followed a more recent and odd trend of possessing a very high number of named cyclones, but very few if any U.S. landfalls (Fig. 1). 2011 tied the years of 2010, 1995, and 1887 as the 3<sup>rd</sup> highest number of cyclones (19) ever recorded for a season - only 2005 (28 named cyclones) and 1933 (21 named cyclones) were busier than 2011. However despite the high number of cyclones, only one weak tropical storm made a direct landfall on U.S. soil (tropical storm *Lee* in Louisiana at 60 mph) and of course one hurricane made landfall as well (*Irene* as described above).



**Figure 1** – Graphic prepared by WeatherUnderground depicting all cyclone positions (tracks) and intensities reported for the 2011 hurricane season.

Our lone hurricane strike in 2011 (*Irene*) was the first one in the U.S. since *Ike* landed in Texas in 2008, and was the first hurricane since 2005 to make landfall along the Atlantic seaboard. 2011 also continues a record of six straight years without a **major** hurricane hitting the U.S. (*Wilma* in 2005 was the last one). That's pretty amazing when you think about it - the average annual number of U.S. landfalling hurricanes since 1851 is 1.7. From 1995 to 2009 roughly 30% of all cyclones (tropical storms and hurricanes) that formed struck the U.S. The meteorological factors for this recent phenomenon invoke terms such as North Atlantic Oscillation, *El Niño* Southern Oscillation, the Bermuda High, sea surface temperatures, Sahara Dust; and would take a couple months worth of articles to delve into, so we'll have to punt that discussion for now.

However, there is plenty of terminology associated with the hurricane season that we have already and will continue to use freely. Therefore it will be worth our effort to introduce and demystify some of the basic hurricane vernacular as presented below. This will become important as we review this year's forecasts next.

**Tropical cyclone** - warm-core, atmospheric closed circulation rotating counter-clockwise in the Northern Hemisphere and clockwise in the Southern Hemisphere.

**Tropical storm** – a tropical cyclone with a maximum sustained surface wind speed ranging from 39 mph to 73 mph using the U.S. 1-minute average.

**Hurricane** - a tropical cyclone with a maximum sustained surface wind speed reaching 74 mph or more.

**Saffir Simpson Scale** – a scale including a 1 to 5 rating based upon wind speeds, again utilizing the U.S. 1-minute average. A category 1 hurricane has winds ranging from 74 to 95 miles per hour (mph), category 2 ranges from 96 to 100 mph, category 3 ranges from 111 to 130 mph, category 4 ranges from 131 to 155 mph, and a category 5 hurricane has sustained winds exceeding 155 mph.

**Major Hurricane** – a hurricane reaching category 3 or higher on the Saffir Simpson Scale. Interestingly, category 5 hurricanes very rarely make landfall while maintaining their category 5 intensity - only three have ever made landfall in the U.S. – the Labor Day hurricane (1935), *Camille* (1969), and *Andrew* (1992).

Now to account for some of the weather oddballs, we also need to include;

**Extratropical Storm** - a *cold-core* atmospheric cyclone deriving its energy when cold and warm air masses interact, not as part of the positive feedback loop identified with tropical storms as warm, moist air rises causing continual heat exchange. Unlike tropical storms, extratropical storms can have one or more fronts connected to them, and can occur over land or ocean. Extratropical cyclones can have winds ranging to levels associated with a tropical depression, or as strong as a hurricane and examples include blizzards and nor'easters, which often form in winter and fall months off the mid-Atlantic and drift slowly along the north Atlantic seaboard and eventually east. If it drifts back west towards land, it is called a retrograded nor'easter.

**Subtropical Storm** - occurs if waters under an extratropical cyclone are warm, followed by thunderstorms that gradually build inside the storm. The storm core may subsequently and gradually go from cold to warm, and the storm will be called subtropical.

**Note:** Both subtropical and extratropical cyclones have the highest winds and thunderstorms a good distance away from the center, and may have frontal boundaries associated with the systems. The two (extra- and subtropical) are usually broader systems than a tropical system, but the subtropical system will produce more rain compared to an extratropical one.

## 2011 Forecasts and Season Recap

Hurricane forecasters had a relatively accurate year in 2011. How can we objectively make this assessment? If you're a frequent reader of the *Island Review*, then you will already know my personal preference is to review the predictions generated by groups that make not just their prediction public, but verify their prediction skill in the public arena as well. This really leaves us with; **(1)** the Tropical Meteorology Project at Colorado State University, **(2)** the University College London, U.K. for Tropical Storm Risk, and **(3)** our federal voice for climatology/meteorology matters, the National Oceanic & Atmospheric Administration (NOAA). We then take these groups' last prediction just before or near the start of hurricane season on June 1<sup>st</sup> and compare the predictions to the actual results at the end of the season (November 30<sup>th</sup>).

As the accompanying prediction summary chart indicates (Table 1), the average prediction included 15 total cyclones (the actual was 19), 8 of which were predicted to generate into hurricanes (the actual was 7), with 5 of these becoming major hurricanes (the actual was 3). This means 7 tropical storms were predicted and the actual number was 12.

	NOAA (median)	Colorado State University, U.S.	University College London, U.K.	Average of Predictions	ACTUAL 2011	Average (1950-2000)
<b>Total No. of Named Tropical Cyclones</b>	15	16	14	15	19	10
<b>Tropical Storms</b>	7	8	6	7	12	4
<b>Hurricanes / Major</b>	8/5	9/5	8/4	8/5	7/3	6/2
<b>Accumulated Cyclone Energy (ACE) Index</b>	146	160	124	143	119	96

**Table 1** - Summary comparing publicly available pre-season predictions for the 2011 Hurricane Season with actual results and average activity.

As can be quickly gleaned from this prediction chart, all the key elements for the 2011 hurricane season were higher than the 1950-2000 average. Even more technically speaking, we had an "above normal" hurricane season, which is actually determined by looking at term we haven't discussed yet - the *Accumulated Cyclone Energy Index* (ACE Index). The ACE Index is simply a measurement taking a storm's wind speed strength for each 6-hour period of its existence into account. The larger the ACE Index value, the more active the season. The ACE Index is actually one of the more revealing parameters we can use and serves as a better barometer of whether or not a hurricane season is truly "active" or not. This past decade has some great examples to support this assertion.

For instance as mentioned earlier in this article, 2011 and 2010 are tied with 1995 and 1887 for the third-most named cyclones in one year at nineteen. However only seven of these cyclones developed into hurricanes in 2011, compared to twelve in 2010. Accordingly the ACE Index for 2011 and 2010 was 119 and 163, respectively, because again the mathematical formula takes each cyclone's wind speed and duration into account. The average ACE Index is 96. In 2009, the ACE Index was a dramatically low of 51 – only 14 hurricane seasons had a lower ACE Index than that value. There were 12 cyclones in 2009 – most were relatively weak with the exception of three hurricanes, of which, two became major.

On the flip side, 2005 had an ACE Index of 248 – the highest on record and was punctuated by more tropical storms, total hurricanes, and category 5 hurricanes than in any season previously recorded; and included *Ophelia* for North Carolina and the infamous major hurricanes of *Katrina*, *Wilma*, and *Rita* in the Gulf of Mexico. Table 2 includes the ACE Index for the past nine years and a few notes justifying the value.

YEAR	ACE Index	Notes
2011	119	Tied with 2010, 1995, and 1887 for the 3rd-most most cyclones for a season at 19, but fewer of the cyclones developed into hurricanes (7 hurricanes in 2011 compared to 12 in 2010), yielding a lower ACE value. <i>Irene</i> was the first U.S landfalling hurricane since <i>Ike</i> in 2008.
2010	163	Tied for 3rd-most most cyclones for a season at 19, and tied for 2nd-most hurricanes for a season at 12. <i>Igor</i> had an ACE Index of 42 alone - highest since <i>Ivan</i> (2004).
2009	51	<i>El Niño</i> year - 15th lowest ACE Index since 1950, 12 cyclones (most were short-lived), 3 hurricanes.
2008	145	<i>Ike</i> and <i>Gustav</i> were two major hurricanes that impacted Tx. and La., <i>Bertha</i> was an extremely long-lived cyclone, and collectively accounted for 60% of the total ACE Index for 2008.
2007	72	Five more tropical cyclones than average, but most were very short-lived or rather weak, with the exception of two category 5 hurricanes that impacted Central America ( <i>Dean</i> and <i>Felix</i> ).
2006	79	Ten cyclones total (lowest number since the 1997 season)
2005	248	Highest ACE Index on record and included the most cyclones (28), hurricanes (15), and category 5 hurricanes (4) in a single season, and the most intense hurricane on record ( <i>Wilma</i> ).
2004	225	4th highest ACE Index value on record, hurricane <i>Ivan</i> alone had an ACE Index of 70, 2004 had six major hurricanes.
2003	175	Hurricane <i>Isabel</i> will long be remembered in Carteret County for Down East flooding, and for the island breach near Hatteras Village in Dare County. <i>Isabel's</i> ACE Index alone was 63, one of the highest recorded for an individual cyclone.

**Table 2** – ACE Index summary chart (2003 – 2011).

In closing, the ACE Index is also used to determine whether a hurricane season is termed as “below normal” (<68), “near normal” (68 – 106), “above normal” (106 – 168) or even “hyperactive” (>168). Hence why **above normal** is used here as an objective term to characterize the 2011 hurricane season – again, the ACE Index for 2011 was 119 (average is 96).

Unfortunately and bringing things back home, it only takes one cyclone to make or break a hurricane season, with 1992 being a perfect example – 7 named cyclones, 4 of which were hurricanes, with one of those classified as major, and an ACE index value of 75. Sounds like a very quiet year, except the one major hurricane was *Andrew*, which struck Florida and was the costliest natural disaster in U.S. history until *Katrina* in 2005. 2011 had only one landfalling hurricane and the first such strike along the Atlantic seaboard since 2005. Of course that hurricane was *Irene* and will be remembered for a long time in Carteret County, and underscores the need to be prepared for each and every hurricane season regardless if it is an active season or not.