SHORELINES – July 2018

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2018 Hurricane Season Preview – Uncertainty Rules the Day

The 2018 hurricane season started its rite of passage on June 1st (well not really – thanks *Alberto*) and will conclude six months later on November 30th. This year's forecast is quite complex and uncertain for reasons we will discuss later, but in the interim; it's important to review the common terminology we will be exposed to. For instance, Subtropical Storm *Alberto* formed in the Gulf of Mexico just before the official start of the hurricane season in late May and the remnants of this cyclone caused severe flooding in the western part of the State. So what's the difference between a tropical storm and subtropical storm? Or a hurricane and a major hurricane? The following vocabulary list should help in our understanding.

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 done so in the U.S. – the Labor Day hurricane (1935), *Camille* (1969), and *Andrew* (1992).

Now to account for some of the other "tropical" oddities, 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.

Post-tropical Cyclone – a hybrid term describing a cyclone no longer possessing the characteristics to be considered a tropical cyclone, and are further divided into either "extratropical" (see above) or "remnant lows".

What to Expect for 2018

The Barcelona Supercomputing Center in cooperation with Colorado State University developed a website summarizing roughly eighteen Atlantic hurricane season forecasts for 2018. WOW – where should we start?

If you're a frequent reader of the *Island Review*, then you will already know our preference is to review the predictions produced by groups that make not just their forecasts 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 subsequently take these groups' last prediction before or near when the hurricane season starts and begin to "torture the statistics until they confess" as one my favorite professors used to say. As the accompanying prediction summary table indicates, we could expect 15 named cyclones, 6 of which will generate into hurricanes, with 2 of these becoming a major hurricane (on average).

	NOAA (median) 5/24/18	Colorado State University, US 5/31/18	University College London, UK 5/30/18	Average of Predictions	Historical Average (1981-2010)
Total No. of Named Tropical Cyclones	13	14	19	15	12
Tropical Storms	6	8	13	9	6
Hurricanes / Major	7/3	6/2	6/2	6/2	6/3
Accumulated Cyclone Energy (ACE) Index	94	88	66	83	104

Table 1 - Summary comparing publicly available pre-season predictions for the 2018 Hurricane Season with average activity.

However as evidenced from the summary table, there is a big spread in the numbers among the forecast groups – most notably when it comes to a 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 a hurricane season is truly "active" or not. This past decade has some fantastic examples to support this claim.

For instance 2012, 2011, and 2010 were tied with 1995 and 1887 for the third-most named cyclones in one year at nineteen. However the ACE Index Values were different. Why? In 2012 we had ***10*** of the nineteen cyclones develop into hurricanes (ACE = 128), while only ***7*** of the nineteen cyclones developed into hurricanes in 2011 (ACE = 119). 2010 had the highest ACE value of these past consecutive three years (ACE = 163) with ***12*** of the nineteen cyclones developing into hurricanes, including the particularly intense and long-lasting hurricane *Igor* that had an ACE value/contribution of 42 in itself. This all makes

sense because again the mathematical formula takes each cyclone's wind speed and duration into account.

To put the ACE Index in even a better context, the highest value ever recorded was in 2005 – a hurricane season 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. The ACE Index was 248 (that's not a typo) compared to the historical 1981-2010 average of 104. Last year (2017), the ACE Index was 223 – the 7th highest ACE Index on record and was punctuated with hurricanes *Irma*, *Jose'*, and *Maria*. Table 2 includes the ACE Index for the past fifteen years with a few interesting notes justifying each value.

YEAR	ACE Index	Notes
2017	**223**	7th highest ACE index on record punctuated by September, which had the highest ACE contribution ever for a single month (175). Hurricanes Irma , Jose' , and Maria contributed more than 40 ACE a piece – first time three tropical cyclones each produced >40 in a single season.
2016	134	Uncommonly prolonged (January 12 to November 25) yet very little activity in the climatological peak of the season as October had a higher ACE Index input (69) than August and September combined. Matthew alone had an ACE Index of 49.
2015	62	Somewhat surprising near average numbers of tropical storms and hurricanes despite the 2015-16 moderate to strong El Niño event. ACE Index higher than forecasted yet still "below normal" and skewed by Joaquin which had an ACE Index of 27 alone.
2014	66	Fewest amount of total cyclones (8) since 1997 (7). Hurricanes Edouard and Gonzalo accounted for over 60% of the ACE Index. Hurricane Arthur crossed Shackleford Banks.
2013	33	6th lowest ACE Index since 1950; 13 cyclones with 2 that developed into hurricanes - fewest number of hurricanes since 1982.
2012	128	Third consecutive year with 19 cyclones that ties record for 3rd-most most cyclones ever for a season (2011, 2010, 1995, and 1887 all had 19 cyclones). Eight cyclones formed in August alone, which tied 2004 for the most to form in that particular month, and only 7 seasons had more hurricanes than 2012 (10).
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. Irene was the first U.S landfalling hurricane since Ike 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. Igor had an ACE Index of 42 alone - highest since Ivan (2004).
2009	51	El Niño year - 15th lowest ACE Index since 1950, 12 cyclones (most short-lived), 3 hurricanes.
2008	145	Ike and Gustav were two major hurricanes that impacted Tx. and La., Bertha 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 (Dean and Felix).
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 (Wilma).
2004	225	4th highest ACE Index value on record, hurricane Ivan alone had an ACE Index of 70, 2004 had six major hurricanes.
2003	175	Hurricane Isabel will long be remembered in Carteret County for Down East flooding, and for the island breach near Hatteras Village in Dare County. Isabel's ACE Index alone was 63, one of the highest recorded for an individual cyclone.

Table 2 – ACE Index summary chart (2003 – 2017).

To these ends, the ACE Index range forecasted for 2018 (Table 1) is anywhere from 66 to 94, and the 94 value is the median prediction for NOAA; not the upper end which could be as high as ~130. Traditionally ACE Index values can be scaled to describe cyclone activity as follows; "below normal" (<68), "near normal" (68 – 106), "above normal" (106 –

168), and even "hyperactive" (>168). Thus in theory, the three major forecast groups in conglomerate are stating we could anywhere from a below, to near normal, to an above normal hurricane season. That's a big range.

The uncertainty is stemming from two major factors;

(1) El Niño Southern Oscillation (ENSO) - Predictions for the development of *El Niño* conditions in the summer, which would subdue tropical cyclone development, are still somewhat speculative. As a quick reminder if you will; *El Niño* is actually a component of *El Niño* Southern Oscillation (ENSO) occurring in the Pacific Ocean basin. ENSO "warm phase" or *El Niño* conditions generally produces atmospheric conditions suppressing the formation of tropical cyclones in the Atlantic as mentioned immediately above. Conversely the "cool phase" of ENSO, or *La Niña* tends to produce atmospheric conditions more favorable for tropical cyclone development. And lastly as you might expect, "ENSO Neutral" conditions are somewhere in between.

(2) Tropical Atlantic Sea Surface Temperatures - The waters of the tropical Atlantic Ocean have anomalously cooled over the past two months (think warm waters as "fuel" for tropical cyclone activity and vice-versa).

Thus if *El Niño* conditions never materialize and the tropical Atlantic warms – especially in August and September, then hurricane activity could be near the upper ends of the predicted ranges; while alternatively, the combination of *El Niño* conditions and a cooler tropical Atlantic waters would favor activity near the lower ranges. There's simply not a bunch of agreement right now on which of these scenarios will rule the day.

Location, Location, Location...

Despite all these great statistics regarding the ACE Index, the number of cyclones, etc.; the perceived activity level for a hurricane season is sometimes all about location, location, location. This can be a cause for complacency and a reason to not be as prepared as we should. Last year was a perfect example. September 2017 had the highest ACE Index Value contribution ever for a single month = 175. That's higher than any of the ACE Index Values recorded for an entire *season* since 2005. Also, hurricanes *Irma*, *Jose'*, and *Maria* contributed more than 40 points to the ACE Index Value a piece – that's the first time on record that three tropical cyclones each produced >40 ACE Index points in a single season. Despite all the records that fell for hurricane activity, the Mid-Atlantic and Northeast States will probably look back at 2017 as a benign year while the Gulf and Caribbean will have completely different thoughts on the matter. As suggested before, it only takes one cyclone to make or break a hurricane season, with 1992 being another perfect example – just 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. So again and as always - be prepared and be safe.