SHORELINES – January 2020

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The 2019 Hurricane Season Review

In what is becoming a recurring theme lately, the 2019 Hurricane Season will likely be remembered by one cyclone alone – last year (2018) it was "*Florence*" and this year (2019) it will most certainly be "*Dorian*". At one time it was an almost 100% fact *Dorian* was going to slam into the Atlantic Coast of Florida as a category 4 or even 5 hurricane; only to change course, stall, and become the strongest hurricane ever to make landfall in the Bahamas. Not done yet, *Dorian* made a pass just offshore the Carolinas having an eerily similar path and forward speed as *Matthew* (2016) as the hurricane swept west to east across Onslow Bay, just missing Bogue Banks, possibly hitting the very tip of Cape Lookout and finally hugging Core Banks and Ocracoke before heading into the North Atlantic and taking one more swipe at the Canadian Provinces. Locally, this motion caused incredible flooding in Core Sound and Pamlico Sounds ultimately flushing water west to east (or from the sound towards the ocean) causing over 50 temporary inlets (or "outlets" as my thesis advisor used to say) along Core Banks/Cape Lookout National Seashore and unprecedented flooding in Ocracoke. Akin to *Matthew* as mentioned above, Carteret County for the most part experienced very little wind or flooding damage from *Dorian*, and no beach erosion either (per our beach survey).

On a more cursory level, forecasters were actually predicting a "near normal" hurricane season for 2019 based predominantly upon the premise that *El Niño* Southern Oscillation (ENSO) warm phase (that's an *El Niño* rather than a *La Niña*) was going to present over the summer months that generally suppress cyclone development, yet on the flip side; both sea surface temperatures were expected to be warmer-than-normal in the Main Development Region (MDR) of the Atlantic (even warmer than last year) and weak tradewinds were also expected in the eastern part of the MDR. Thus these competing interests (*El Niño* vs. warm water and less sheer) resulted in the "near normal" hurricane season prediction for 2019.

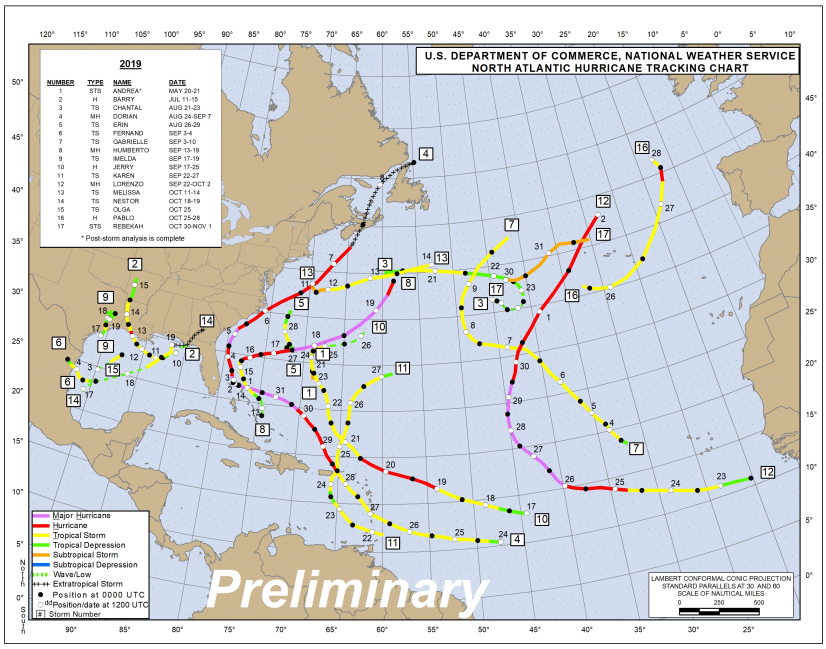

Figure 1 – Graphic prepared by the National Weather Service (NOAA) depicting cyclone tracks and intensities reported for the 2019 hurricane season.

In reality *El Niño* conditions never truly developed and actually dipped into more neutral conditions while shear and warm waters in the tropics ruled the season. The result? No Atlantic cyclones (that's tropical storms and hurricanes) formed between July 12th to August 20th for the first time since 1982. This period of quiescence was followed by a robust several weeks that experienced 10 cyclones which formed between August 21st and September 23rd, tying 1949 and 2010 for the most during this timeframe (Figure 1).

2019 "Preseason" Forecasts Undershot the Mark - Again

There are a spate of hurricane predictions available each year but we usually focus on those that make not just their prediction public, but verify their prediction skill in the public arena as well. This short list therefore includes; **(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 1st and compare the predictions to the actual results at the end of the season (November 30th).

The forecasters were off the mark this year when reviewing their estimations for tropical cyclone activity. As the accompanying prediction summary chart indicates (Table 1), the average prediction included 13 total cyclones (the actual was 18), 6 of which were predicted to generate into hurricanes (the actual was 6 – nice job), with 2 of these becoming major hurricanes (the actual was 3). This means 7 tropical storms were predicted and the actual number was 12. Granted, 7 out of the 12 tropical storms in 2019 lasted 24 hours or less – that's the most on record for one hurricane season.

	NOAA (median) 5/23/19	Colorado State University, US 6/4/19	University College London, UK 5/30/19	Average of Forecasts	ACTUAL 2019	Historical Average (1981-2010)
Total No. of Named Tropical Cyclones	12	14	12	13	18	12
Tropical Storms	6	8	6	7	12	6
Hurricanes / Major	6/3	6/2	6/2	6/2	6/3	6/3
Accumulated Cyclone Energy (ACE) Index	94	100	88	94	130	104

Table 1 - Summary comparing publicly available pre-season predictions for the 2019 Hurricane Season with actual results and average activity.

However, the most glaring discrepancy between the pre-season forecasts and actual activity is for perhaps the most important metric provided in Table 1 - 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 indicator of whether or not a hurricane season is truly "active" or not. The longer duration and/or more intense each cyclone (tropical storm or hurricane); the more contribution to the ACE Index Value – and *vice versa*. The average forecasted ACE Index for 2019 was 94 - the actual was 130, which is also well above the historical 1981-2010 average of 104.

The ACE Index Value for 2019 was significantly more than forecasted across the board, and can also be utilized to determine that we had an "above normal" season. "Below normal" is <68, "near normal" is 68 to 106, "above normal" ranges from 106 to 168, and "hyperactive" is >168). Below (Table 2) is a summary of the past 17 years with respect to the ACE Index – again, it's a great barometer (no pun intended) of tropical cyclone activity. This is the third consecutive year the forecasters were well off the mark of the final ACE index value – last year (2018) the average prediction was 83 and the actual was 129 while in 2017, the average prediction was 100 and the actual was an eye-popping 223!

YEAR	ACE Index	Notes
2019	**130**	10 named cyclones formed between Aug. 21 – Sept. 23, tying 1949 and 2010 for the most during this timeframe. Conversely, 7 cyclones lasted 24 hours or less as a named storm – the most on record. Hurricane *Dorian* had 48 ACE points alone and may have just crossed Cape Lookout.
2018	**129**	Above normal season including the land-falling hurricanes of *Florence* and *Michael* that severely impacted the Carolinas and panhandle area of Florida, respectively. Hurricanes *Florence* , *Leslie* , and *Michael* contributed 74 ACE points collectively (57% of annual total).
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 land-falling 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 – 2019).

As implied earlier, the perceived activity level for a Hurricane season is sometimes all about location, location, location as evidenced when considering the past two years (2017 and 2018). For instance, because of the impacts of *Florence* to our area, 2018 will always be considered as a bad year – maybe the worst in history. But 2017 from a more basin-wide perspective was easily worse - the 2017 ACE Index Value was the 7th highest value ever recorded for a season and was bolstered by the month of September, which had the highest ACE Index Value contribution ever for a single month – 175. That's higher than the entire ACE Index Value recorded for the 2018 or even 2019 season alone! Yet despite all the records that fell in 2017 and the devastation in the Gulf of Mexico and the Caribbean; the Mid-Atlantic and Northeast States look back at 2017 as a benign year.

Thus it only takes one cyclone to make or break a hurricane season, with 1992 perhaps being the best 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. Also, the National Hurricane Center (NHC) track forecasts during the 2019 Atlantic hurricane season were generally accurate (again *Dorian* was kind of a miss), but meteorologists are still wrestling with intensity forecasts and especially the hurricanes that undergo rapid intensification, so again and as always - be prepared and be safe.

Credits:
Colorado State University Tropical Meteorology Project