Claim: Global warming is causing more hurricanes and stronger hurricanes

Major storms are nature's way to attempt to reduce temperature imbalances and restore equilibrium. Major winter storms move cold air south and warm air north. Hurricanes transport of excess heat from tropics to higher latitudes. There are more major winter storms when extreme cold comes south and hurricanes in warm years and eras when more heat builds on the tropics.

Hurricane activity varies year-to-year and over longer periods as short-term ocean cycles like ENSO (El Nino or La Nina) and multi-decadal cycles in the Pacific (Pacific Decadal Oscillation or PDO) and Atlantic (Atlantic Multidecadal Oscillaton or AMO) ocean temperature regimes favor changes in activity levels in one or more basins (West Pacific, East/Central Pacific or Atlantic) over others (Gray). Other factors such as oscillating stratosphere tropical winds (QBO), 11 year and longer solar cycles, variations in Saharan or volcanic dust play a role in timing or intensity and/or frequency of tropical activity.

Based on the accepted measure of global hurricane and major hurricane activity, the Accumulated Cyclone Energy (ACE Index), the long-term linear trend in the number and intensity of global hurricane activity has remained flat or even declined in recent decades.

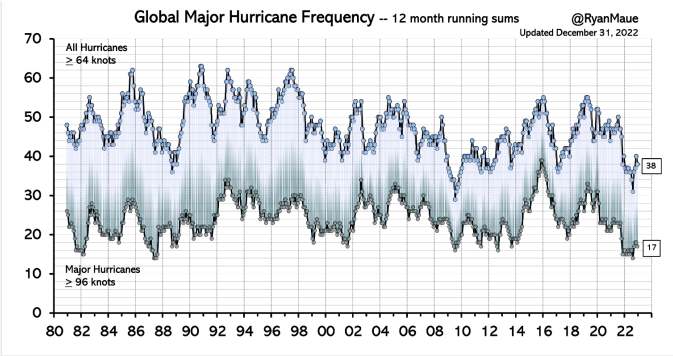
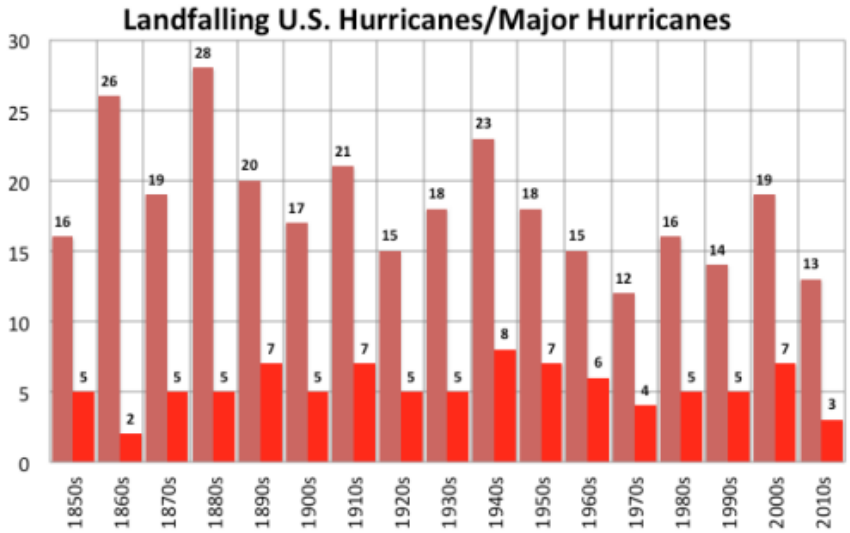


Figure: Global Hurricane Frequency (all & major) -- 12-month running sums. The top time series is the number of global tropical cyclones that reached at least hurricane-force (maximum lifetime wind speed exceeds 64-knots). The bottom time series is the number of global tropical cyclones that reached major hurricane strength (96-knots+). Adapted from Maue (2011) GRL.

https://www.aoml.noaa.gov/hrd/Landsea/science01.pdf

Credible data show this trend pattern is true despite much better open ocean detection than before the 1960s when many short-lived storms at sea would have been missed as there were no satellites, no aircraft reconnaissance, no radar, no buoys and no automated weather stations back then.

Landfall counts are more reliable. This data actually shows that the number of U.S. landfalling hurricanes and major hurricanes has been on the decline since the late 1800s. This past decade was the quietest one for landfalling hurricanes (behind the 1970s) and major hurricanes (behind only the 1860s).



Source: AOML

The impacts on the United States has varied considerably with time, with very active seasons giving way to long lulls during which the public forgets the lessons from past storms and the risks of settling in vulnerable areas. The regions targeted vary too.

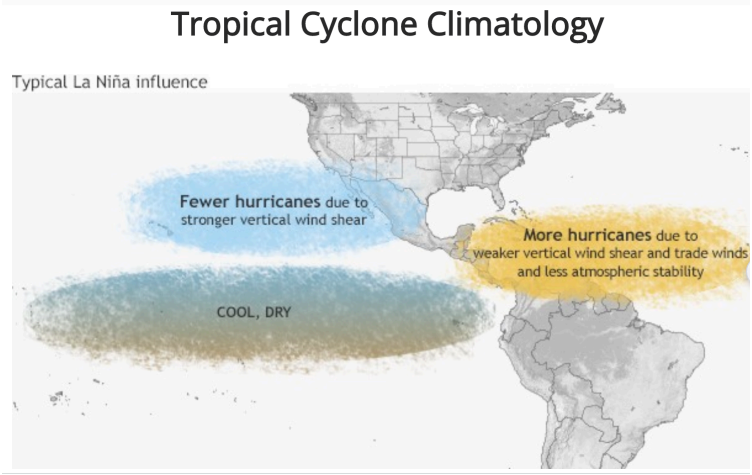
The ACE Metric of Overall Activity by Basin by Year

The accumulated cyclone energy index was originally created by William Gray and his associates at Colorado State University, as the Hurricane Destruction Potential index (HDP). They argued that the destruction of a hurricane's wind and storm surge was better related to the square of the maximum wind speed ($Vmax^2$) than simply to the maximum wind speed. The index was calculated by squaring the estimated maximum sustained wind speed by themselves, for all tropical cyclones with windspeeds of above 65 knots (120 km/hour; 75 mph) every six hours over the entire season.[2][3] This scale was subsequently adjusted by the United States National Oceanic and Atmospheric Administration (NOAA) to include all tropical cyclones, with winds above 65 km/h; 40 mph. NOAA also renamed it the *accumulated cyclone energy index*. (see)

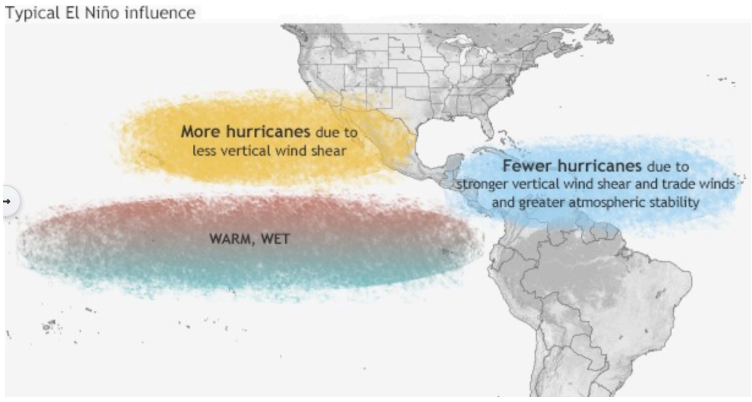
Since the scale was adjusted by NOAA, the storm totals have been used in a number of different ways, by various agencies and researchers, to categorize how active a tropical cyclone season was as well as to identify possible long-term trends in the various hurricane basins of hurricaness and major hurricanes. Within the Atlantic Ocean, the United States National Oceanic and Atmospheric Administration and others use the ACE index of a season to classify the season into one of four categories. These four categories are extremely active (above 159.6), above-normal (above 126.1), near-normal (73-126.1), and below-normal (below 73).

ENSO IMPACTS

Activity tends to be higher in the Atlantic when La Ninas and the negative (cold) PDO are in place. The cold eastern Pacific waters reduce hurricane development there with less heat and stronger vertical wind shear. As a result, in those years, to the east in the Atlantic Main Development region there is reduced vertical shear and increased instability, which increases ability for disturbances to develop into tropical storms and hurricanes.

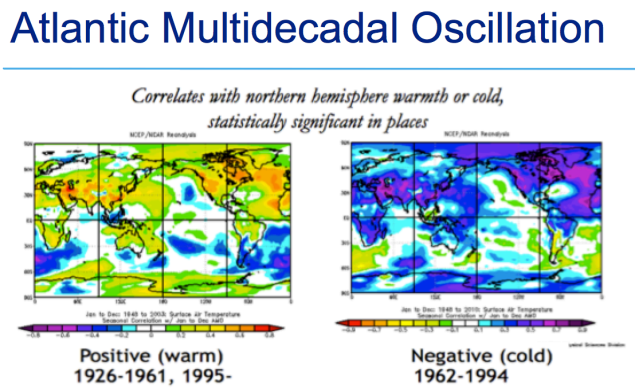


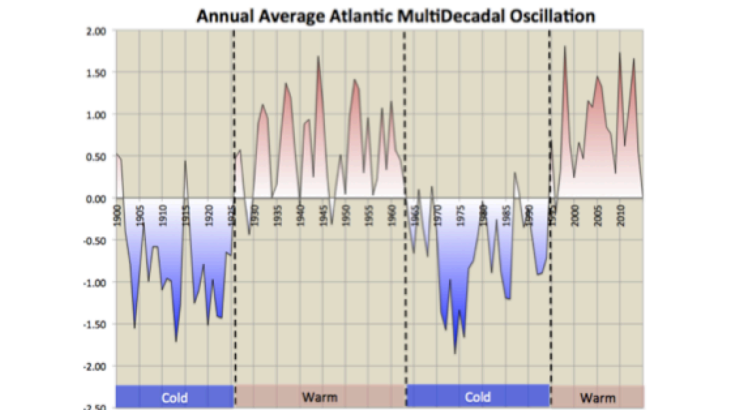
When El Ninos and the warmer Pacific Decadal Oscillation (PDO) are present, more storms develop in the eastern Pacific, hurricanes become more likely there. Downstream, the atmosphere over the tropical North Atlantic and Caribbean are observed to have increased stability and higher tropospheric vertical shear due to increased westerlies in the higher levels in the Atlantic Main Development region. Large vertical wind shear is detrimental to tropical cyclone formation and intensification, which reduces the number of systems that are able to develop. Moderate to strong El Niño events have been observed to reduced the number of Atlantic hurricanes by 44% from non-El Niño years (Gray 1984a). Recent examples 1982 (6 tropical, 2 hurricanes, 1major) and 1992 (7 tropical, 4 hurricanes, 1major) and 1997 (7 tropical, 3 hurricanes, 1major).



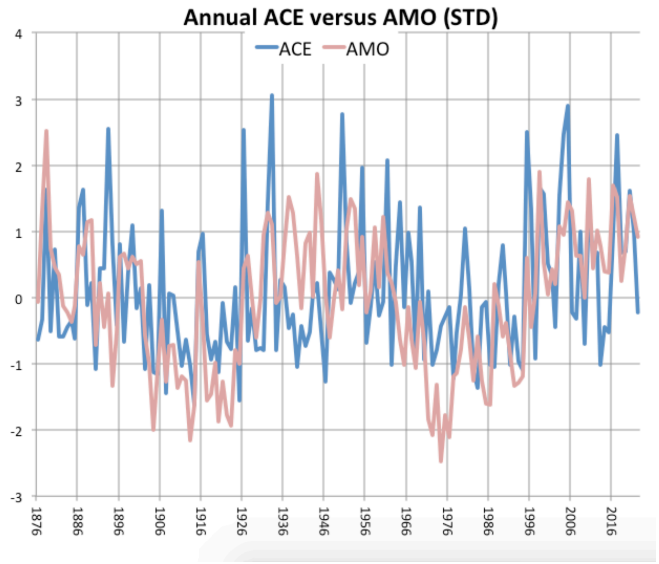
AMO (ATLANTIC MULTIDECADAL OSCILLATION)

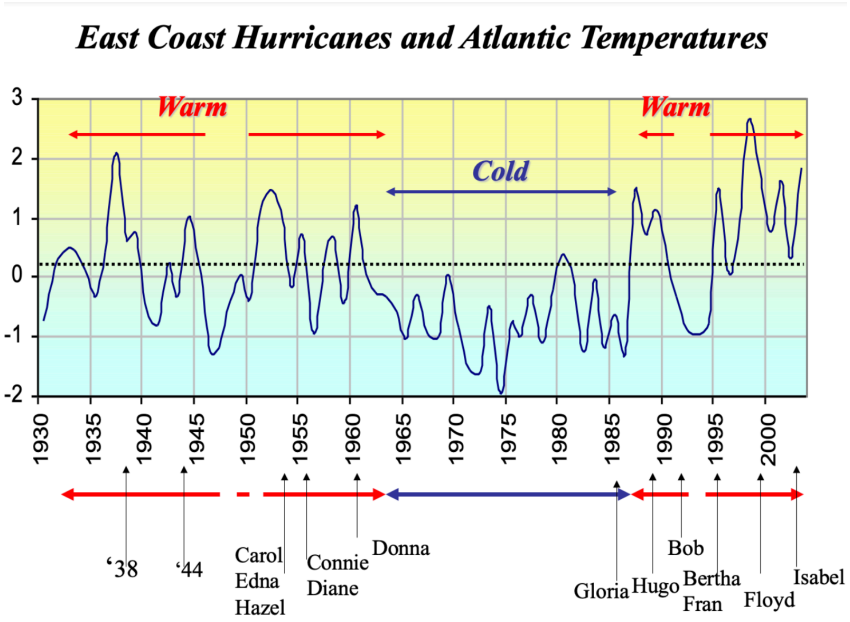
The North Atlantic Basin undergoes multidecadal tendencies for warm and cold water. The maps during the phases with positive and negative Atlantic Mulitidecadal Oscillation below shows how it relates to air (and water) temperatures. It has a very strong influence on tropical activity (Accumulated Cyclone Energy (ACE) in the basin.





See how the ACE Index (and hurricane impacts) increase when the AMO is in the warm cycles and decrease when it is in the cold cycles.
https://www.aoml.noaa.gov/hrd/Landsea/science01.pdf



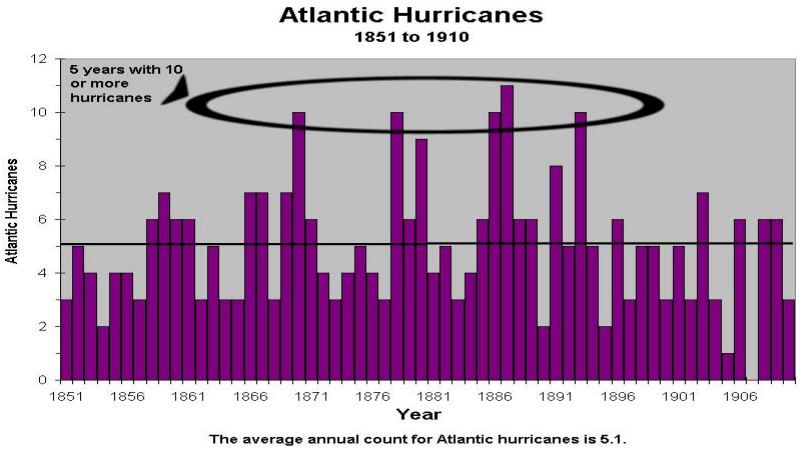


HISTORY OF ATLANTIC BASIN STORMS

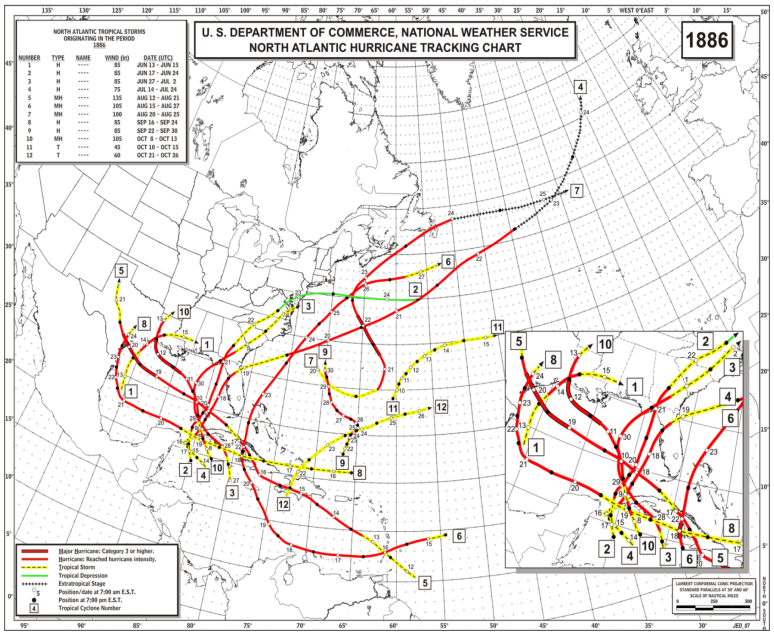
Great Colonial hurricanes in the northeast with storm surges up to 20 feet occurred in 1635 and 1675. A Katrina like storm made landfall in Louisiana in 1722 with major flooding and damage in Louisiana. The Great Chesapeake storm in 1769 like Isabel in 2003 brought major flooding to North Carolina and Virginia.

In the Caribbean, the Great Hurricane of 1780 killed an estimated 27,500 people while ravaging the islands of the eastern Caribbean with winds estimated to top 200 mph. It was one of three hurricanes that year with death tolls greater than 1000.

The period from the 1850s to 1910 was very active in the Gulf area.



1886 had least 10 hurricanes, 7 making landfall (3 in Texas). 4 of the 1886 hurricanes were major hurricanes.



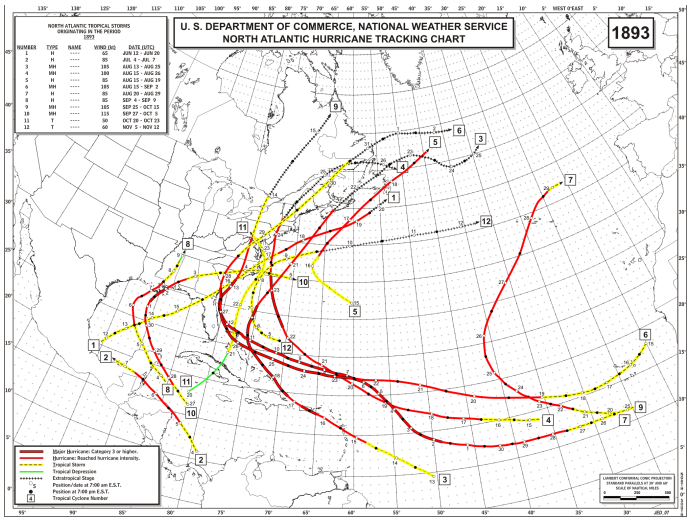
Dr. Neil Frank, longest serving Hurricane Center Director adds:

"Without question the most reliable indicator of a trend in hurricane activity in the Atlantic is to focus on land falling major hurricanes (3-5) in the mainline U.S. I doubt if a major hurricane could have hit the U.S. in the 1800s without being noticed, while a minor hurricane in a remote area could have been undetected so it is important to concentrate on major hurricanes.

It is important to emphasize that the rainfall in a tropical system is not related to the intensity but depends on the forward speed of motion. In the case of Harvey, the weakening hurricane stalled over southeast Texas for three days.

Finally, as you know the most active hurricane season in the U.S. was 1886 when 7 hurricanes hit the Gulf coast. One of the major hurricanes in Texas destroyed Indianola on the south shore of Matagorda Bay. At one time there were around 20,000 people in the city before a prior major hurricane in 1875 did major damage. The only thing in Indianola today is a cemetery with numerous headstones with dates 1875 or 1886 "

1893 had at least 10 hurricanes. Of those, 5 became major hurricanes. Two of the hurricanes caused over two thousand (2000) deaths in the United States; at the time, the season was the deadliest in U.S. history.

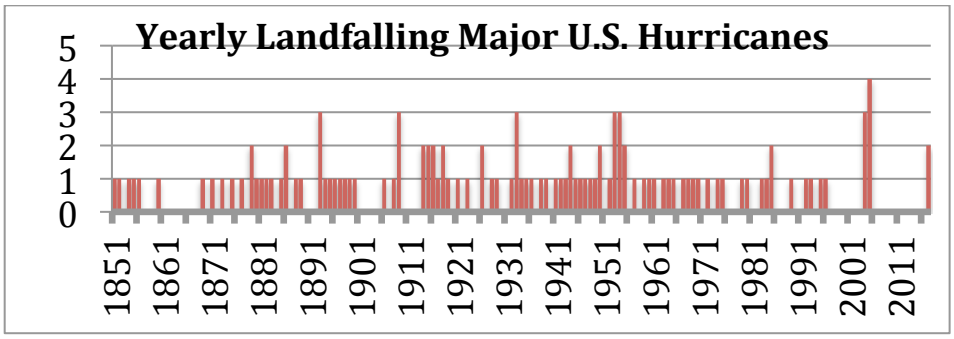


The Galveston Hurricane in 1900 killed at least 8,000 people with some estimates as high as 12,000, making it the deadliest natural disaster in U.S. history.

After decades of no impact storms, there were 8 major devastating storms on the east coast from 1938 to 1960 then a 28-year lull until Hugo began another active era of increased activity.

This century, Isabel in 2003, Charley, Frances, Ivan and Jeanne in 2004 and Dennis, Katrina, Rita and Wilma in 2005 all made landfall on the mainland. 2005 holds the record for 5 category 4 and 4 category 5 impact storms. At the time, some speculated this was the new norm for the Atlantic due to climate change.

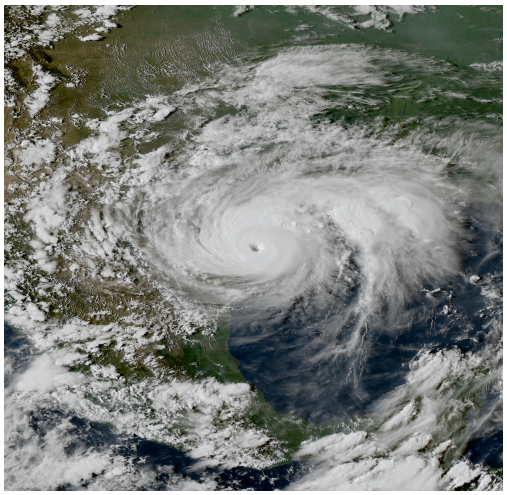
However, after the active 2005 season and before the landfall of two major storms on the U.S. in 2017, the U.S. had gone 4324 days (just short of 12 years) without a major hurricane landfall, exceeding the prior record 8-year lull in the 1860s.



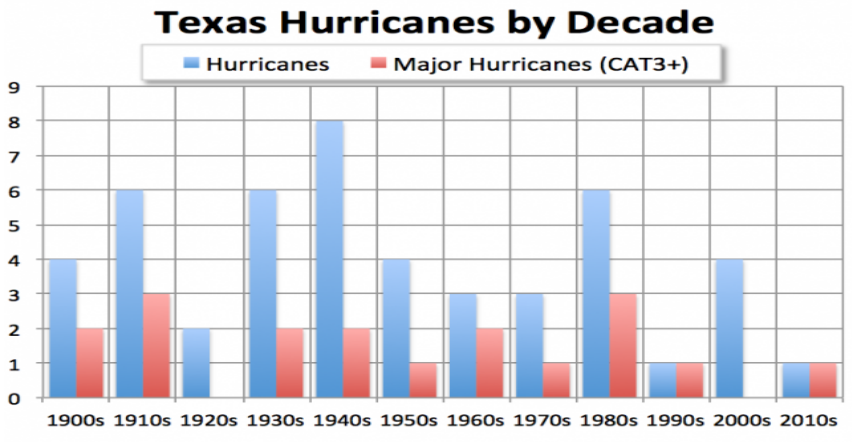
In 2017, Irma was the first landfalling hurricane and major hurricane in Florida since Wilma in 2005. This also was also after a record lull – 4439 days. The previous record lull back to 1851 was 2191 days from 1979 to 1985.

HURRICANE HARVEY

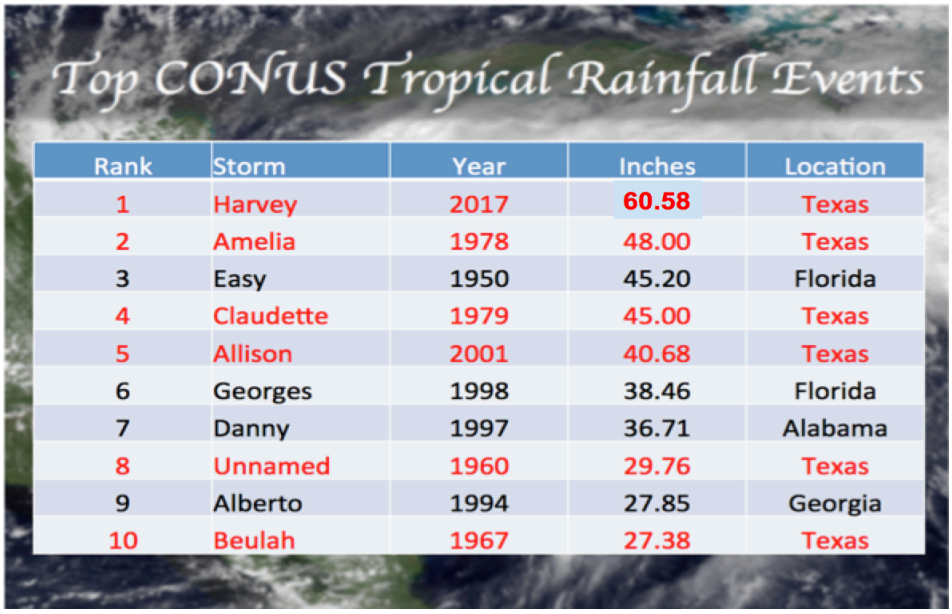
Similarly, Harvey in 2017 was the first hurricane to make landfall in Texas since Ike in 2008 and the first Category 4 hurricane in Texas since Hurricane Carla in 1961.



Harvey was the first hurricane to make landfall in Texas since Ike in 2008 and the first Category 4 hurricane in Texas since Hurricane Carla in 1961. Note that there has been no increase in Texas in either hurricanes or major hurricanes.

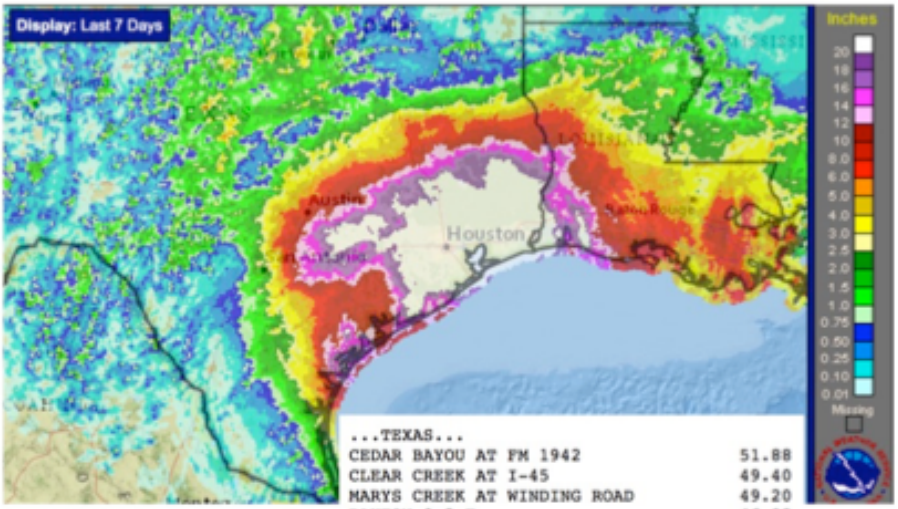


As for the heaviest rain record, Texas is the location where tropical storms often go to die dumping heavy rains for days. Six of the top ten tropical rain events for the mainland U.S. had occurred in Texas as of 2017.



Rank	Storm	Year	Inches	Location
1	Harvey	2017	60.58	Texas
2	Amelia	1978	48.00	Texas
3	Easy	1950	45.20	Florida
4	Claudette	1979	45.00	Texas
5	Allison	2001	40.68	Texas
6	Georges	1998	38.46	Florida
7	Danny	1997	36.71	Alabama
8	Unnamed	1960	29.76	Texas
9	Alberto	1994	27.85	Georgia
10	Beulah	1967	27.38	Texas

Harvey meandered for several days drawing on a steady influx of Gulf moisture. The Houston area had between 30 and 45 inches generally but one gauge in the 154 rain gauge network in Harris County recorded over 50 inches and one to the east over 60 inches, breaking the record of 48 inches in Amelia in 1978.



...TEXAS...

CEDAR BAYOU AT FM 1942	51.88
CLEAR CREEK AT I-45	49.40
MARYS CREEK AT WINDING ROAD	49.20
DAYTON 0.2 E	46.08
HORSEPEN CREEK AT BAY AREA BLVD	45.60
SANTA FE 0.7 S	45.02
BERRY BAYOU AT FOREST OAKS BLVD	44.80
BERRY BAYOU AT NEVADA	44.44
LITTLE VINCE BAYOU AT BURKE RD	43.52
HOUSTON WEATHER FORECAST OFFICE	43.38

Harris County 171 rain gauges
68 deaths

Southeast Texas is subject to extreme flooding even in other seasons.

In December of 1935 a massive flood occurred in the downtown area as the water level height measured at Buffalo Bayou in Houston topped out at 54.4 feet.

The Buffalo Bayou gauge topped out with Harvey at around 39 feet on the 28th.

Cliff Mass of the University of Washington did a careful analysis of the possible impacts of 'global warming 'on Hurricane Harvey.

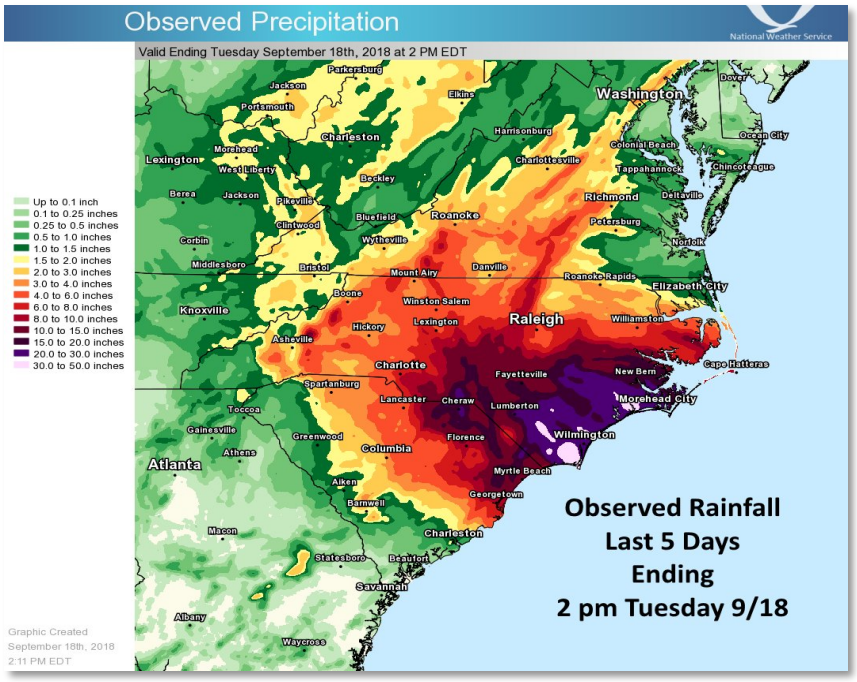
Based on the data, he concluded *"the results are clear: human-induced global warming played an inconsequential role in this disaster….There is no evidence that global warming is influencing Texas coastal precipitation in the long term and little evidence that warmer than normal temperatures had any real impact on the precipitation intensity from this storm…"The bottom line in this analysis is that both observations of the past decades and models looking forward to the future do not suggest that one can explain the heavy rains of Harvey by global warming, and folks that are suggesting it are poorly informing the public and decision makers."*

The heavy rains associated with slow moving Harvey and later in 2018 with Florence led to claims that slow movement was related to climate change.

THE 2018 SEASON

After a slow start, the 2018 season came alive in September, climatologically the busiest month for hurricane activity in the Atlantic. 5 storms were named as more favorable conditions developed. Two became hurricanes, only 1 storm, Florence, became a major storm and had impact.

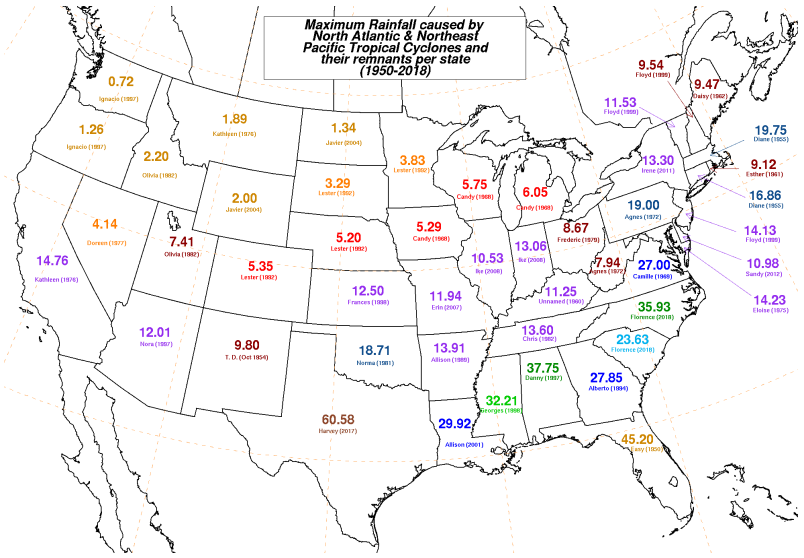
Florence became a major hurricane for almost 4 days before weakening and making landfall in North Carolina as a Category 1 storm. The main impact aside from significant storm surge locally 9 to 11 feet to the east of landfall, was the excessive rains and resulting major flooding.



Several locations topped North Carolina's tropical cyclone rainfall record, including a report of 35.93 inches near Elizabethtown, North Carolina. (See Figure below.) The previous record was 24.06 inches from Hurricane Floyd in 1999.

Florence set a preliminary tropical cyclone rainfall record in South Carolina. Cheraw reported a storm total of 23.68 inches of rain. The previous record was 18.51 inches from Tropical Storm Jerry in 1995.

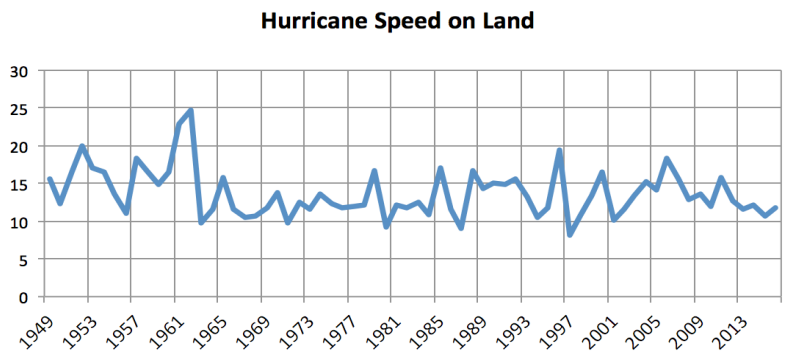
The rains were heavy because like Harvey in 2017, the storm moved inland and stalled as it became surrounded on three sides by high pressure. Moisture kept feeding inland in bands around the weakening low pressure much like what was seen in Texas with Harvey.



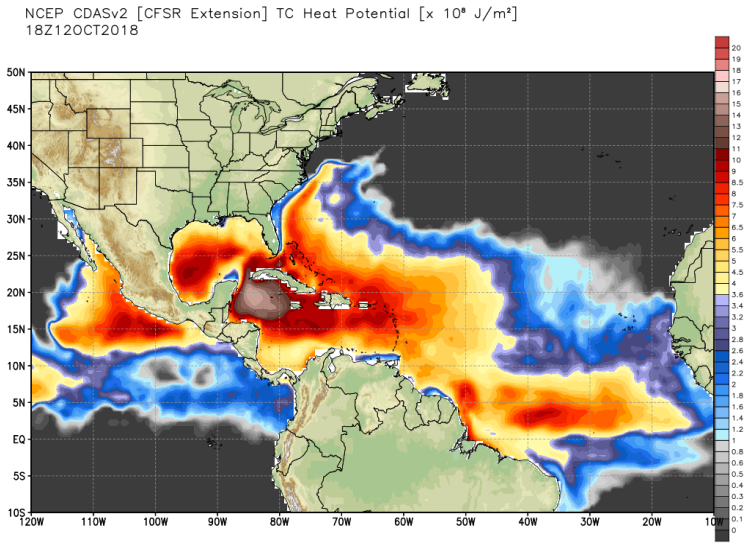
Florence was compared to storms like Hazel in 1954, Hugo in 1989, Floyd in 1999 and Isabel in 2003. These storms brought much stronger winds and storm surge damage but the storms entered the U.S. with a stronger steering flow and the duration of the rains over any one area was measured in hours, not many days.

The claims that storms are moving slower over land due to global warming is not supported by the data. NOAA claimed speed of hurricanes crossing land has slowed by 17% since 1949 resulting in more rainfall.

However NOAA's actual data show no trend since 1963 after a two-year aberration in the early 1960s. A detailed statistical analysis (Roy Spencer, UAH) showed no statistically significant linear trend slope exists over the entire time period when the two early 1960s wild points are accounted for.



In October 2018, Michael developed in the warm Caribbean, where ocean heat content was highest.



Michael was a typical end of season storm and had an upper level flow pattern very favorable for intensification and for landfall in the eastern Gulf. This was true despite the fact that many October storms are deflected into the open Atlantic. Michael had a reported pressure of 919 mb on landfall, the 20th lowest pressure for an Atlantic storm and third lowest pressure for a landfalling storm behind the 1935 Labor Day storm and Camille in 1969.

Dorian in 2019 was a CAT 5 storm when it sat for over a day leaving more than 70,000 people homeless on Grand Bahama and the Abaco Islands. It made landfall briefly on the outer bank of Cape Hatteras as a CAT1 hurricane

Strongest Atlantic Storms by Pressure		
Storm	Year	Pressure (mb)
Wilma	**2005**	**882**
Gilbert	1988	888
Labor Day	**1935**	**892**
Rita	2005	895
Allen	1980	899
Camille	1969	900
Katrina	2005	902
Mitch	1998	905
Dean	2007	905
Maria	2017	908
Cuba	1924	910
Ivan	2004	910
Dorian	**2019**	**910**
Janet	1955	914
Irma	**2017**	**914**
Cuba	1932	914
Isabel	2003	915
Opal	1995	916
Hugo	1989	918
Gloria	1985	919
Michael	**2018**	**919**
Hattie	1961	920
Floyd	1999	921
Andrew	**1992**	**922**
Bahamas	1929	924
David	1979	924
Igor	2010	924

Michael whose tight core winds did major damage on a portion of the Florida panhandle had the 20th lowest pressure for an Atlantic storm and was third lowest pressure for a storm making landfall behind the Labor Day Hurricane in 1935 and Hurricane Camille in 1969.

In 2020, Laura, a CAT 4 storm with 938 mb pressure came ashore near where Rita did in 2005 with a similar central pressure. But both were less intense than Katrina that flooded New Orleans in 2005. Claims that Laura was the most intense storm to make landfall in the region were made despite the fact central pressure of 938 mb did not even come close to making the list of the top 27 Atlantic Basin hurricanes.

INCREASING DAMAGE STUDIES

The most recent (2018) U.S. Government analysis of the 36 most costly hurricane disasters in U.S. history, showed that increasing damages are due to increasing population density and infrastructure vulnerability, not due to storm intensity.

Continental United States (CONUS) hurricane-related inflation-adjusted damage has increased significantly since 1900. However, since 1900 neither observed CONUS landfalling hurricane frequency nor intensity shows significant trends, including the devastating 2017 season.

Two large-scale climate modes that have been noted in prior research to significantly impact CONUS landfalling hurricane activity are El Niño–Southern Oscillation on interannual time scales and the Atlantic multidecadal oscillation on multidecadal time scales. La Niña seasons tend to be characterized by more CONUS hurricane landfalls than El Niño seasons, and positive Atlantic multidecadal oscillation phases tend to have more CONUS hurricane landfalls than negative phases.

Growth in coastal population and regional wealth are the overwhelming drivers of observed increases in hurricane-related damage. As the population and wealth of the United States has increased in coastal locations, it has invariably led to the growth in exposure and vulnerability of coastal property along the U.S. Gulf and East Coasts.

Unfortunately, the risks associated with more people and vulnerable exposure came to fruition in Texas and Florida during the 2017 season following the landfalls of Hurricanes Harvey and Irma. Total economic damage from those two storms exceeded $125 billion. Growth in coastal population and exposure is likely to continue in the future, and when hurricane landfalls do occur, this will likely lead to greater damage costs than previously seen. Such a statement is made recognizing that the vast scope of damage from hurricanes often highlights the effectiveness (or lack thereof) of building codes, flood maps, infrastructure, and insurance in at-risk communities.

Chris Landsea (NOAA) in 2011 noted *"instead of a dramatically increasing trend of hurricane damages, destruction from these storms varies on a decade-to-decade timescale with more damages in the early 1900s, low damages during the late 1900s to early 1920s, much higher destruction in late 1920s to the early 1960s, and reduced damages from the late 1960s to early 1990s.*

Certainly, the U.S. hurricane damages from 1996 to 2005 were quite high, but now it is evident that these were quite similar to the decade of 1926 to 1935. So, after straightforward consideration of the non-meteorological factors of inflation, wealth increases, and population change, there remains no indication that there has been a long-term pick up of U.S. hurricane losses that could be related to global warming today. There have been no peer-reviewed studies published anywhere that refute this."

Dr Roy Spencer in his book Inevitable Disaster agrees. After major hurricanes Harvey and Irma made landfall in the United States in 2017, and as Hurricane Florence approaches the Carolinas in 2018, there have been renewed calls to do something about global warming.

The popular perception that landfalling hurricanes in the U.S. are becoming more frequent or more severe, however, is shown to be incorrect.

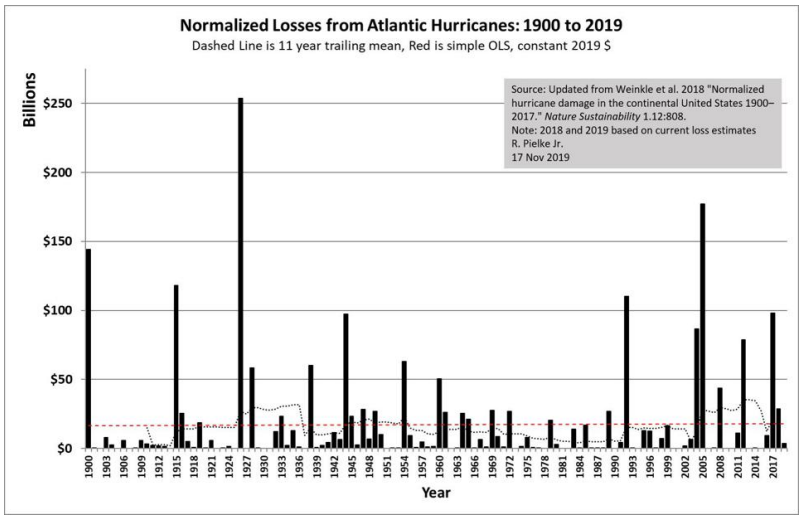
The 30 costliest hurricanes in U.S. history have indeed become more expensive in recent decades, but it is demonstrated that as damages have increased, hurricane intensity has not. The cause of increasing damages is increasing population and infrastructure in hurricane-prone areas. History has demonstrated that major hurricanes, sometimes arriving in pairs, have been part of Atlantic and Gulf coastal life for centuries. Even lake bottom sediments in Texas and Florida reveal more catastrophic hurricane landfalls 1,000 to 2,000 years ago than have happened more recently. Over the last 150 years, the number of major hurricanes hitting Texas has been the same when Gulf of Mexico water temperatures were below normal as when they were above normal.

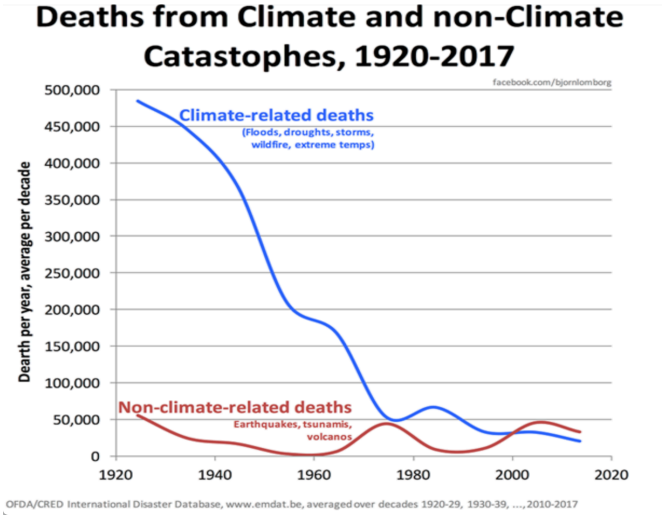
Harvey's record-setting rainfall totals were due to its slow movement, which cannot be traced to global warming (August 2017 was quite cool over most of the U.S.), combined with substantial land subsidence preventing rivers from draining more rapidly to the ocean. Major hurricane strikes in Florida since 1900 have, if anything, become somewhat less frequent and less severe. What has changed in Florida, again, is coastal development. The Miami - Fort Lauderdale metroplex now has a population of over 6 million, whereas a little over 100 years ago it was nearly zero. As a result, our vulnerability to major hurricane strikes has increased dramatically.

Even with no change in hurricane activity, hurricane damages will continue to increase along with wealth and infrastructure in coastal areas. It is only a matter of time before our first trillion-dollar hurricane catastrophe occurs, and it will happen with or without carbon dioxide emissions from fossil fuel use.

One thing to remember about hurricanes is the large variability in their occurrence from year-to-year and decade-to-decade. Not only do hurricanes vary, but so too does the proportion that makes landfall. While storms at sea pose threats to shipping, it is of course those storms that make landfall that pose the greatest threats to life and property.

Indeed, historically, about 60% of all economic damage from disasters worldwide comes from landfalling hurricanes in the United States, and of that damage, more than 80% results from major hurricanes. Improved warnings and preparedness helped save lives despite property damage increases.





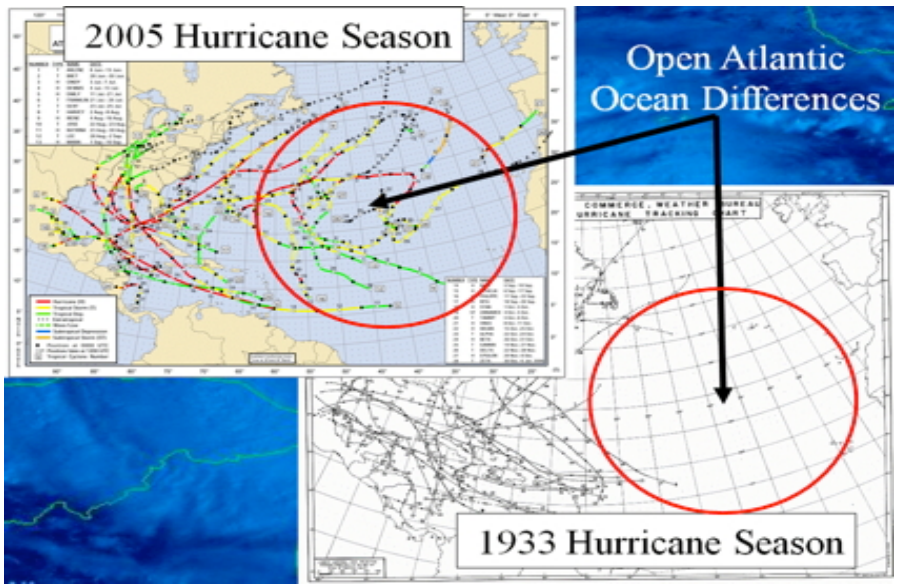
COMPARING HURRICANE COUNTS BEFORE THE SATELLITE ERA

In the years up until the 1960s, the count of Atlantic storms away from land was unreliable as there were no satellites, no aircraft reconnaissance, no radar, no buoys and no automated weather stations.

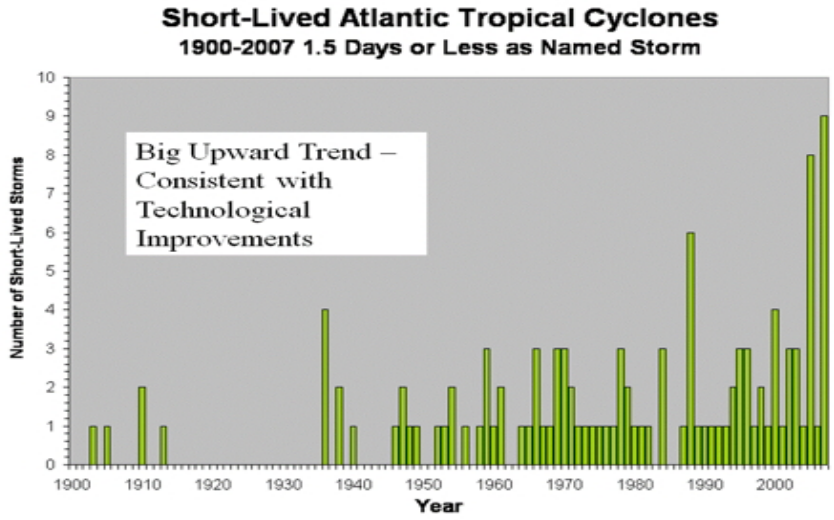
NOAA's Chris Landsea wrote: "*Comparing the two busiest hurricane seasons on record - 2005 and 1933 - the difference across the ocean between those two years is apparent: there were several tropical storms and hurricanes in the eastern half of the North Atlantic in 2005, while in 1933 there were none. So either this huge gap in 1933 actually occurred, or there were tropical storms and hurricanes in the eastern half of the ocean, but they went unobserved.*

If one restricts the counting to those tropical storms and hurricanes that hit land in 2005, 17 of the 28 tropical storms and hurricanes made landfall. But in 1933, 19 of the 21 tropical storms and hurricanes in that season struck a coast.

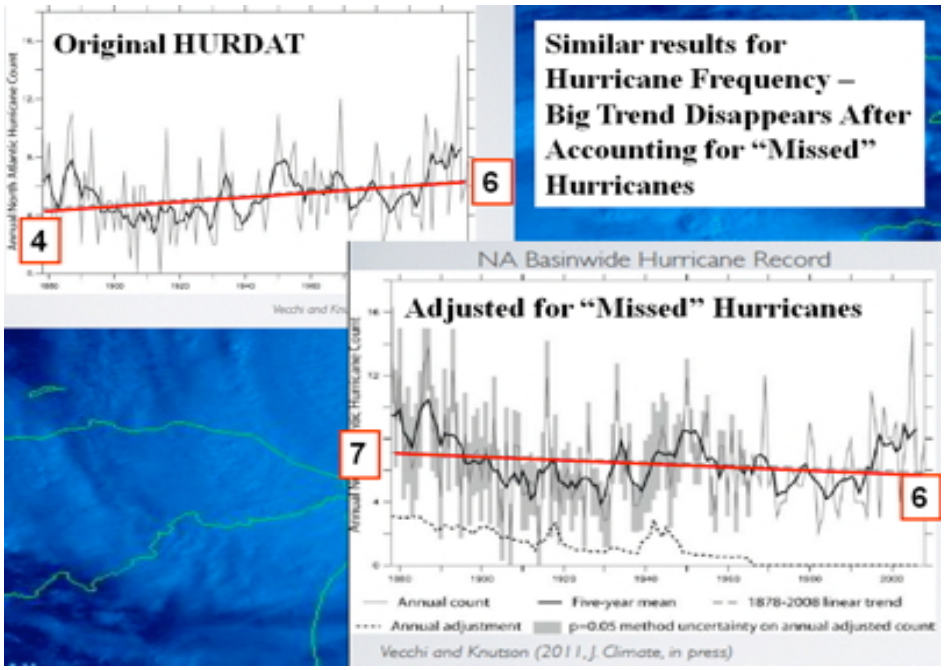
So by a metric of landfalling cyclones, 1933 was busier than 2005 and much of the long-term upward trend is removed".



Landsea reviewed the storms in 2007 and 2008 seasons and was able to identify at least six weak, short-lived tropical storms that would be very unlikely to have been "named" previously.



Landsea also speculated that even major hurricanes over the central or eastern North Atlantic - such as 2009's Hurricane Fred[27] and 2010's Hurricane Julia[28] - very likely would not have been "counted" as a major hurricane in the pre-satellite era of the 1940s to 1960s (and may have been even missed completely, given their locations).



Vecchi etal (2021) found "Historical changes in observing practices limit the utility of century-scale records of Atlantic major hurricane frequency. To evaluate past changes in frequency, we have here developed a homogenization method for Atlantic hurricane and major hurricane frequency over 1851–2019. We find that recorded century-scale increases in Atlantic hurricane and major hurricane frequency, and associated decrease in USA hurricanes strike fraction, are consistent with changes in observing practices and not likely a true climate trend. After homogenization, increases in basin-wide hurricane and major hurricane activity since the 1970s are not part of a century-scale increase, but a recovery from a deep minimum in the 1960s–1980s. We suggest internal (e.g., Atlantic Multidecadal) climate variability and aerosol-induced mid-to-late-20th century major hurricane frequency reductions have probably masked century-scale greenhouse-gas warming contributions to North Atlantic major hurricane frequency."

Weinkle etal (2020) found *"Consistent with observed trends in the frequency and intensity of hurricane landfalls along the continental United States since 1900, the updated normalized loss estimates also show no trend. A more detailed comparison of trends in hurricanes and normalized losses over various periods in the twentieth century to 2017 demonstrates a very high degree of consistency."*

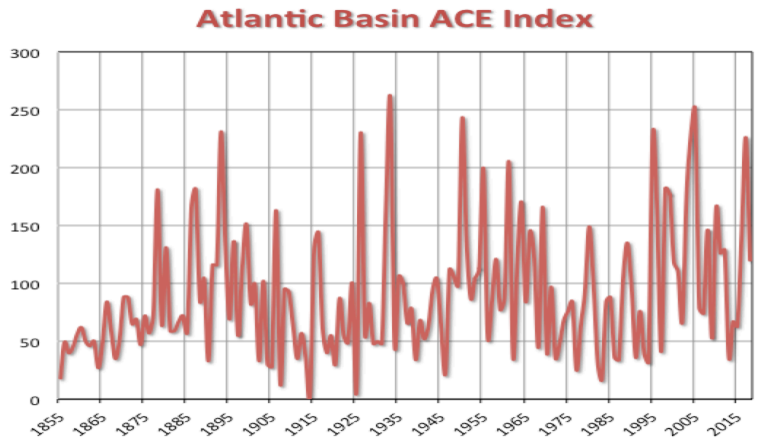
Klotzbach etal (2018) wrote: "*Continental United States (CONUS) hurricane-related inflation-adjusted damage has increased significantly since 1900. However, since 1900 neither observed CONUS landfalling hurricane frequency nor intensity shows significant trends, including the devastating 2017 season.*

Two large-scale climate modes that have been noted in prior research to significantly impact CONUS landfalling hurricane activity are El Niño–Southern Oscillation on interannual time scales and the Atlantic multidecadal oscillation on multidecadal time scales. La Niña seasons tend to be characterized by more CONUS hurricane landfalls than El Niño seasons, and positive Atlantic multidecadal oscillation phases tend to have more CONUS hurricane landfalls than negative phases.

Growth in coastal population and regional wealth are the overwhelming drivers of observed increases in hurricane-related damage. As the population and wealth of the United States has increased in coastal locations, it has invariably led to the growth in exposure and vulnerability of coastal property along the U.S. Gulf and East Coasts. Unfortunately, the risks associated with more people and vulnerable exposure came to fruition in Texas and Florida during the 2017 season following the landfalls of Hurricanes Harvey and Irma. Total economic damage from those two storms exceeded $125 billion. Growth in coastal population and exposure is likely to continue in the future, and when hurricane landfalls do occur, this will likely lead to greater damage costs than previously seen. Such a statement is made recognizing that the vast scope of damage from hurricanes often highlights the effectiveness (or lack thereof) of building codes, flood maps, infrastructure, and insurance in at-risk communities."

ACE DATA ALSO BELIES THE CLAIM

The Accumulated Cyclone Energy (ACE) Index takes into account the number, duration and strength of all tropical storms in the year. It will be shown below that the pattern reflected in this data can be demonstrated to result from Natural Factors. The annualized Accumulated Cyclone Energy Index for the Atlantic shows a cyclical pattern behavior with spikes in 1893, 1926, 1933 and 1950 then again in 1995, 2004, 2005 and 2017. Note again this data likely underestimates the early decades.



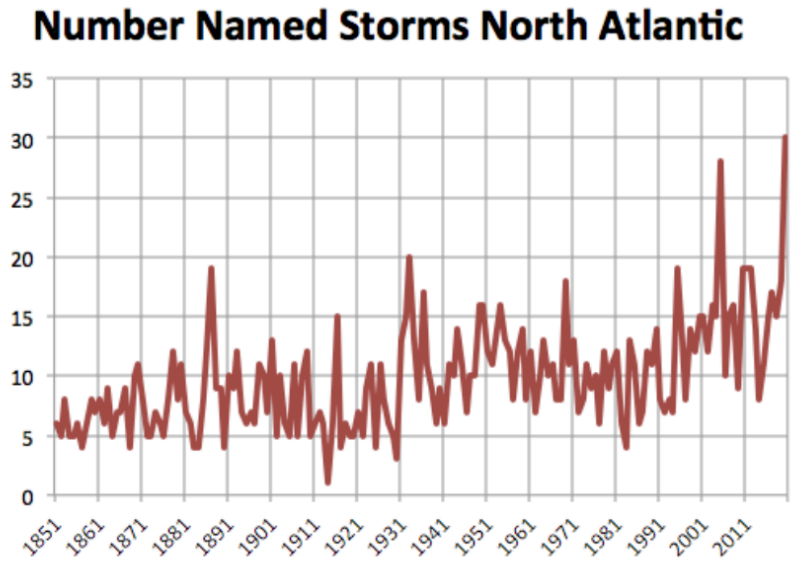
(UCO Tropical Meteorology Project)

2017 ranked 7th.

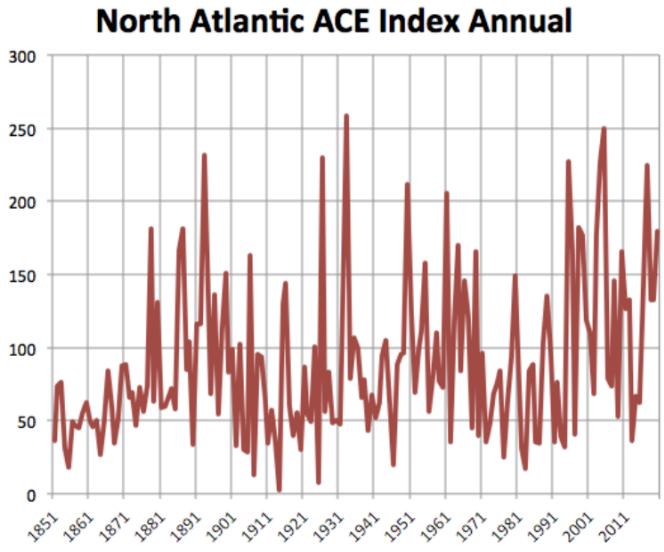
Rank	Season	ACE
1	1933	259
2	2005	250
3	1893	231
4	1926	230
5	1995	228
6	2004	227
7	2017	226
8	1950	211
9	1961	205
10	1998	182

THE ODD DIVERGENCE GROWS IN 2020

2020 had been a hyperactive season with a warm Atlantic and a developing La Nina in the Pacific that limits shear in the Atlantic, allowing more waves to develop. 30 named storms were tallied for the Atlantic.



But most remained weak or short lived and the cyclone energy is only slightly above the long-term average. See where the ACE ended.



Landfalls in the Gulf and Atlantic coast included 4 major storms.

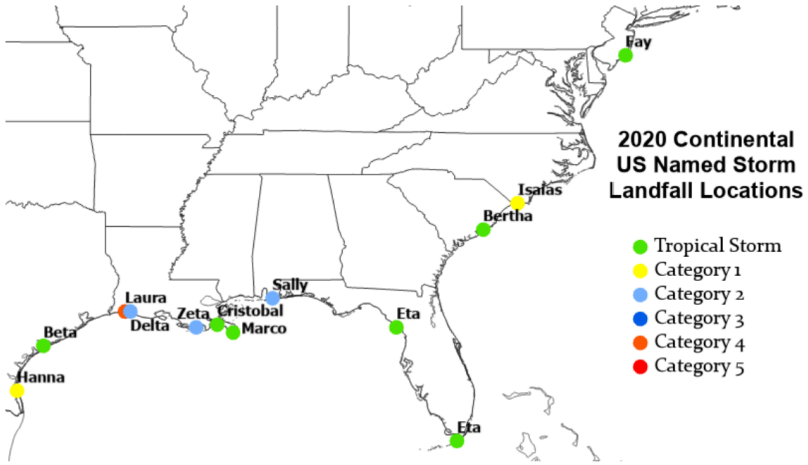
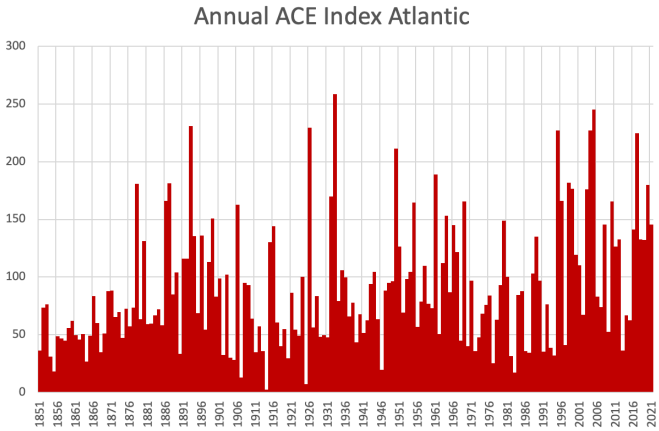


Figure 3: Location of the named storms making landfall in the continental US during the 2020 Atlantic hurricane season. Eta made two separate landfalls in Florida.

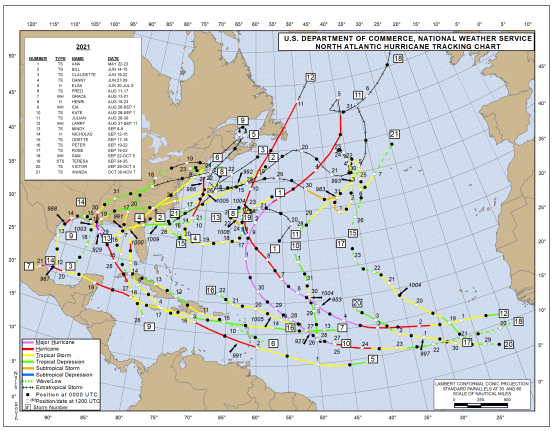
Globally the ACE was only 78% of normal as both the eastern and western Pacific Basins were much quieter than normal. The trend in the western Pacific was down since 1951 in 2020.

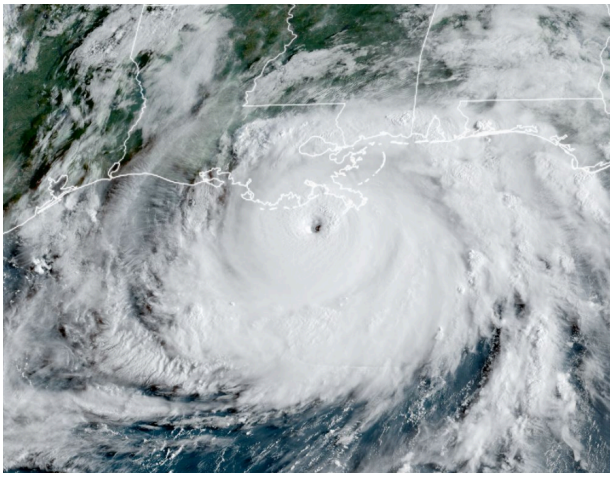
Hurricane Season 2021

The Atlantic in 2021 was similar – ACE of 146.9 (89.5% of normal).



As of the end of August, the tracks of 21 storms, 4 major are shown below. Ida was the big one.





Ida produced major hurricane conditions near the landfall area in southeastern Louisiana. However, there are no reliable wind reports from the coastal area where the eyewall came ashore. The highest reported sustained wind close to the landfall area was 101 kt at 1630 UTC 29 August from a United States Geological Survey (USGS) station located 11 n mi north-northeast of Grand Isle, Louisiana

Hurricane Season 2022

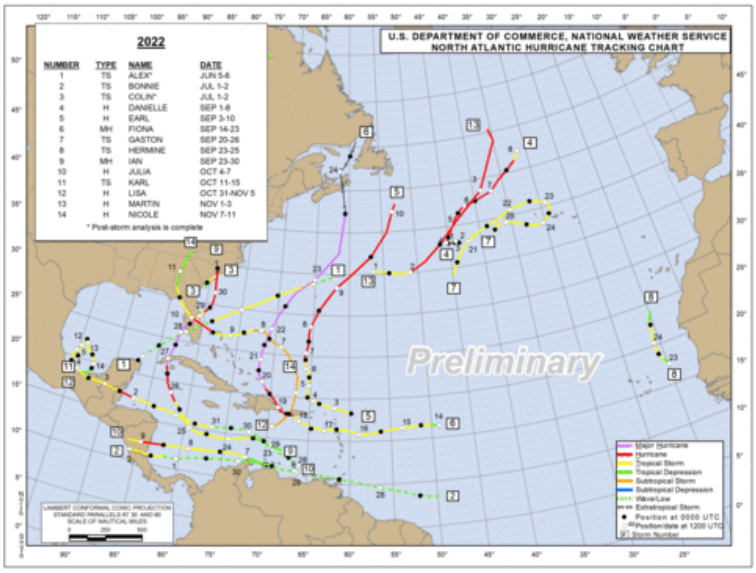
All regions on the Northern Hemisphere had well below normal activity as the two year La Nina and low solar activity led to low latitude cooling. The ACE for all regions was below 100% average. The Atlantic ACE was 95.1 (77.6% of normal). Three storms were notable in the Atlantic, Fiona made landfall in Puerto Rico, the Dominican Republic, and the Turks and Caicos Islands as a hurricane, and affected Atlantic Canada as a powerful post-tropical cyclone.

1991-2020 Climatological Activity Through December 24 in Parentheses

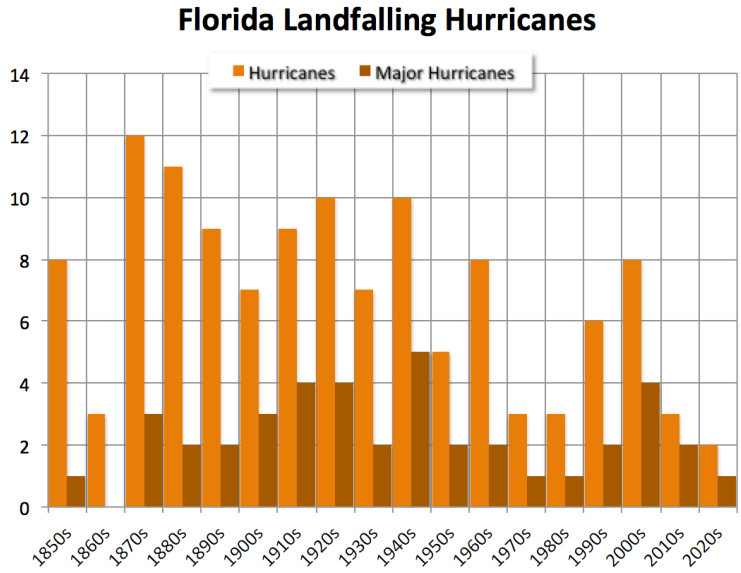
Basin	Named Storms	Named Storm Days	Hurricanes	Hurricane Days	Major Hurricanes	Major Hurricane Days	Accumulated Cyclone Energy
North Atlantic	14 (14.3)	56.25 (69.3)	8 (7.2)	21.25 (27.0)	2 (3.2)	5.75 (7.4)	95.1 (122.5)
Northeast Pacific (East of 180°)	17 (16.6)	76.50 (72.8)	10 (8.8)	26.75 (28.4)	4 (4.6)	4.50 (9.5)	116.5 (132.7)
Northwest Pacific (West of 180°)	22 (25.2)	82.50 (132.2)	12 (15.8)	34.50 (64.3)	5 (9.2)	12.00 (24.9)	163.2 (298.2)
North Indian	7 (5.3)	12.50 (16.5)	1 (2.1)	1.25 (4.3)	0 (1.0)	0.00 (1.5)	10.5 (23.9)
Northern Hemisphere	60 (61.4)	227.75 (290.8)	31 (33.9)	83.75 (124.0)	11 (18.0)	22.25 (43.3)	385.3 (577.3)

Ian made two landfalls as a major hurricane, one in western Cuba and one along the southwest coast of Florida, and another landfall as a hurricane in South Carolina. Hurricane Ian caused at least 137 fatalities including 5 people in Cuba, 126 in Florida, 5 in North Carolina and 1 in Virginia. Ian caused catastrophic damage with losses estimated to be in excess of $67 billion. Damage was mostly from flooding, with the cities of Fort Myers Beach and Naples particularly impacted. Millions were left without power in the storm's wake, and numerous inhabitants were forced to take refuge on their roofs. Sanibel Island and Pine Island were hard hit by storm surge, which caused severe flooding and damaged both the Sanibel Causeway and the bridge to Pine Island.

On November 5, an area of low pressure producing disorganized showers and thunderstorms developed just north of Puerto Rico, it was classified as Subtropical Storm Nicole at 09:00 UTC on November 7. The following morning, Nicole had transitioned into a tropical cyclone. On November 9, Nicole made landfall at Marsh Harbour, Great Abaco Island, Bahamas, with sustained winds of 70 mph. Several hours later, the storm strengthened into a Category 1 hurricane while simultaneously making landfall on Grand Bahama with sustained winds of 75 mph. On November 10, Nicole made land fall on North Hutchinson Island, near Vero Beach, Florida, with 75 mph sustained winds. Nicole then weakened to a tropical storm inland, as it moved across Central Florida. Later that day, its center briefly emerged over the Gulf of Mexico, north of Tampa, before moving onshore again northwest of Cedar Key in Florida's Big Bend region Inland, the storm weakened to a depression, as it moved into southwestern Georgia.

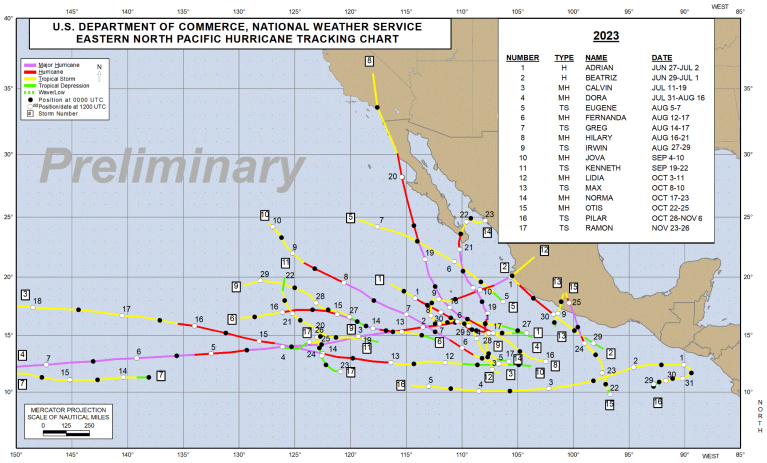


Florida had the two landfalling storms . Still the long-term trend is down.



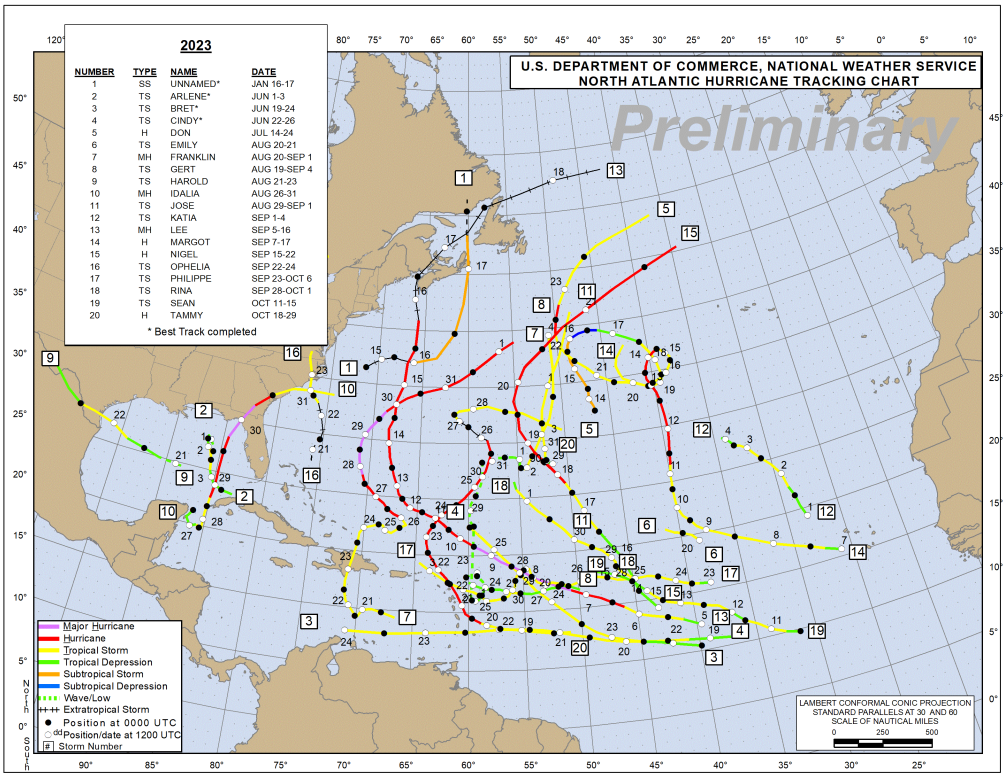
Hurricane Season 2023

With La Nina rapidly giving way to El Nino, hurricanes increased in the eastern Pacific. 20 storms developed in the eastern Pacific, 7 reached Tropical Storm and 10 Hurricane status. Hurricane Hilary in August was most impactful with powerful winds and floding rains and damaging mudslides on Baja California and then southern and central California and southwest. Hilary's highest rain total was in Upper Mission Creek in San Bernardino County, where 13 inches of rainfall was recorded.



El Ninos with active hurricane seasons in the eastern Pacific as we have shown often results in Atlantic storms that often to recurve and not impact the mainland. One lone system Idalia made landfall on the eastern Panhandle of Florida.

Major hurricane became extratropical and brushed far eastern Maine and the Maritimes as an unnamed winter storm had done in January.



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