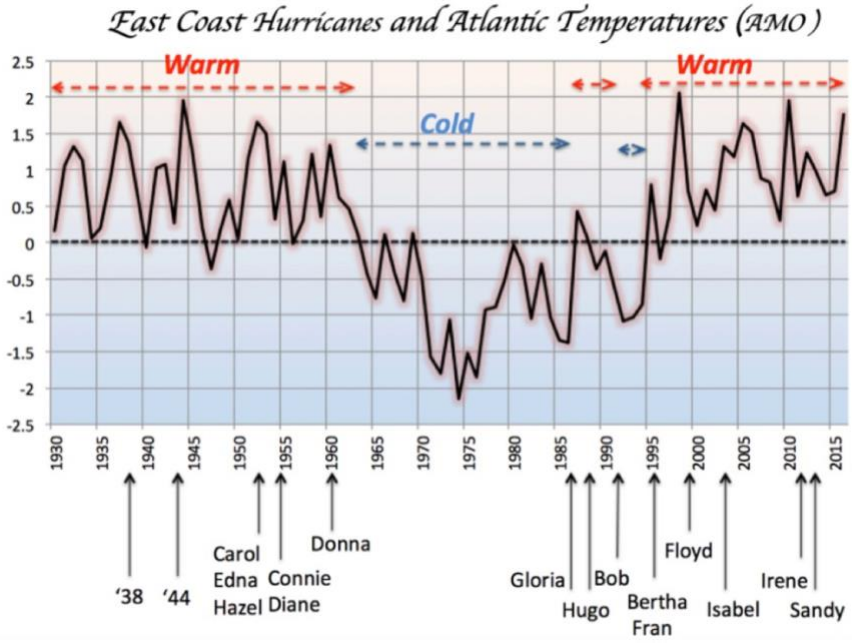
Hurricane Trends and Our Climate

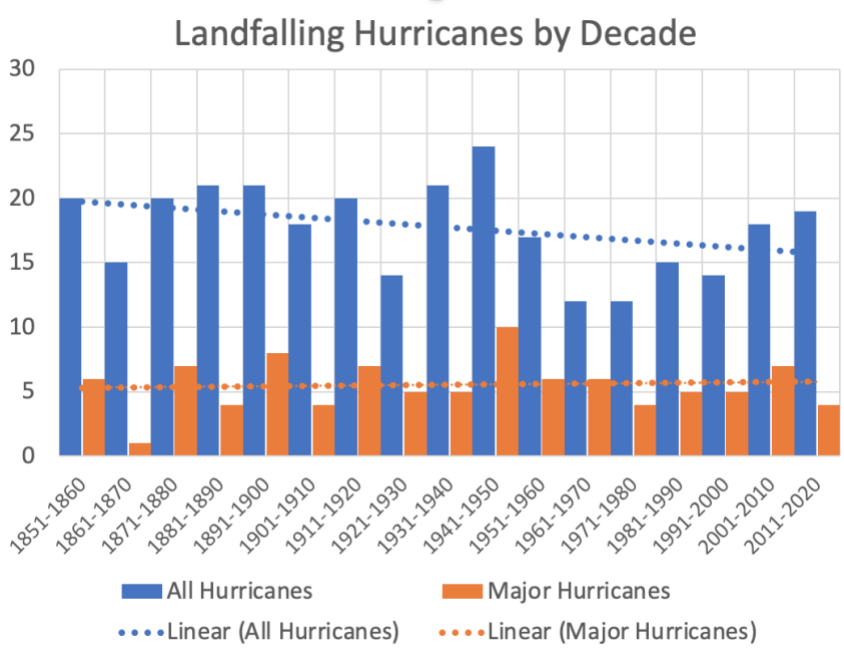
Major storms are nature's way to attempt to reduce temperature imbalances and restore equilibrium. Major winter storms move cold air south and warm air north. Hurricanes transport of excess heat from tropics to higher latitudes. There are more major winter storms when extreme cold comes south and hurricanes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

Hurricanes are giant heat engines – the average storm generates heat energy equivalent to all the electric energy produced in the US in an entire year. *(Chris Landsea NOAA HRL).* See how the hurricane threat diminished during the cold period from the 1960s to 1990s.



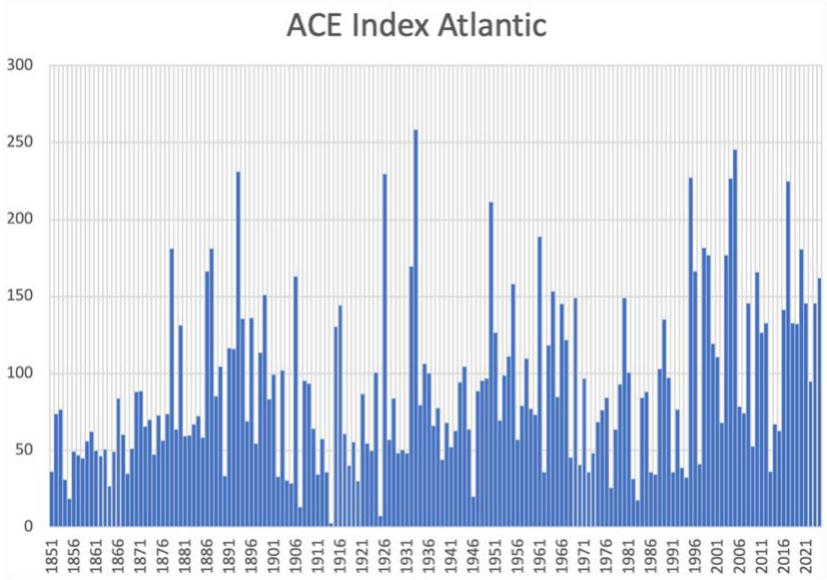
Hurricanes form over warm ocean water (primarily over 80F) during the summer into the fall. The activity varies year-to-year and over longer periods as natural equatorial ocean cycles like ENSO (El Nino or La Nina) and multi-decadal cycles in the northern Pacific (Pacific Decadal Oscillation or PDO) and Atlantic (Atlantic Multidecadal Oscillation or AMO) enhance or limit the ocean warming and affect the potential storm activity levels in one or more basins (West Pacific, East/Central Pacific or Atlantic).

There are more major hurricanes when the heat level in the ocean and the atmosphere in the tropics and subtropics is high. Cold periods are less stormy outside the tropics. See the drop in the 1960s to 1990s colder period.



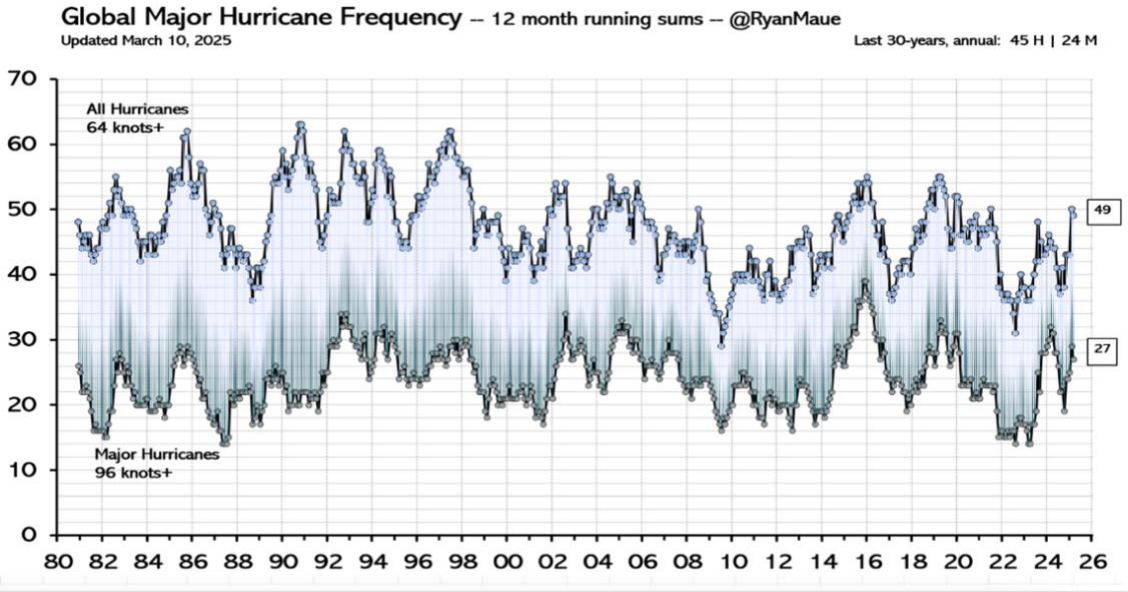
Dr William Gray was a pioneer in hurricane forecasting. Gray and his associates at Colorado State University developed a very useful measure of global hurricane and major hurricane activity, the Accumulated Cyclone Energy (ACE Index). The ACE index takes into account the number, duration, and strength of all tropical storms and hurricanes in each ocean basin during the year.

The ACE Index 1851-2024 for the Atlantic Basin shows major year to year variance with active and quieter years and periods we can tie to natural variations in the ocean and atmosphere.

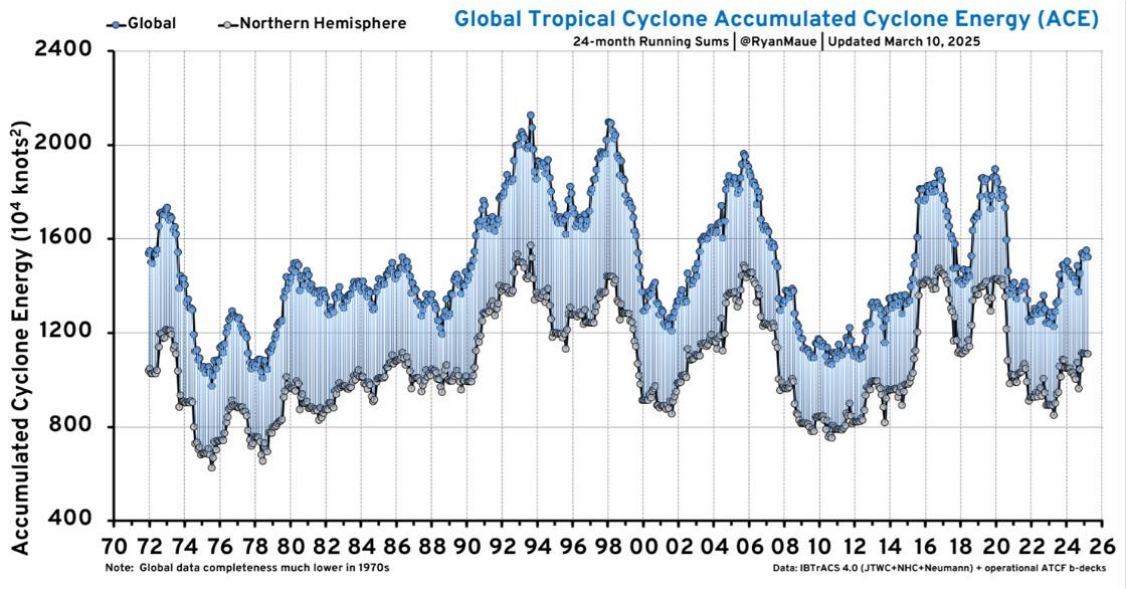


The trends are flat to down despite the active periods.

Dr. Ryan Maue showed the 12 month running sums of global and Northern Hemisphere hurricanes and major hurricanes are flat to down since 1980.



The global and Northern Hemisphere 2 year running sums since 1970 show an active period from the early 1990s to 2006. The trendline since 1990 to present is down.

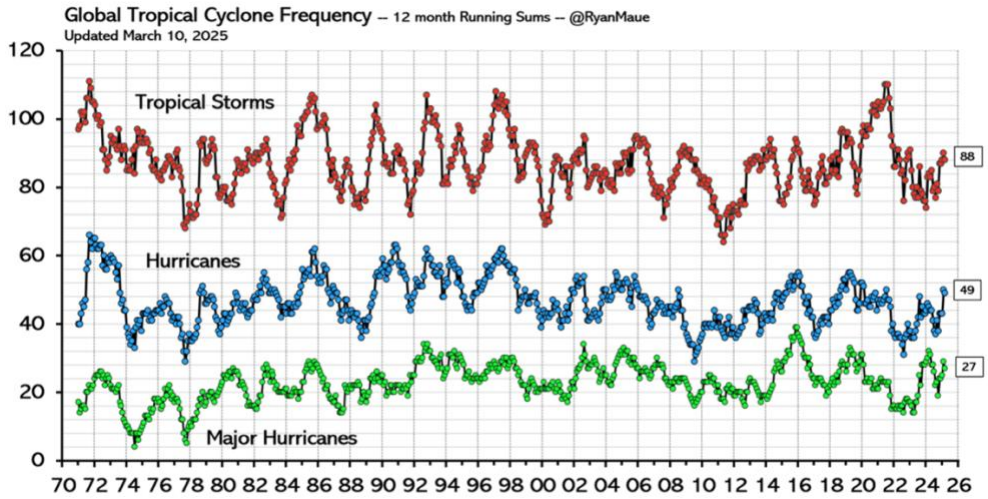


The top seasons in the Atlantic basin vary in time with five 1961 or earlier and five from 1995 to 2017. The colder period from 1962 to 1995 had lower ACE and fewer mainland impact storms.

Top 10 Atlantic hurricane seasons

Season	TS	HU	MH	ACE
1933	20	11	6	258.57
2005	28	15	7	245.3
1893	12	10	5	231.15
1926	11	8	6	229.56
1995	19	11	5	227.10
2004	15	9	6	226.88
2017	17	10	6	224.88
1950	16	11	6	211.28
1961	12	8	5	188.9
1998	14	10	3	181.76

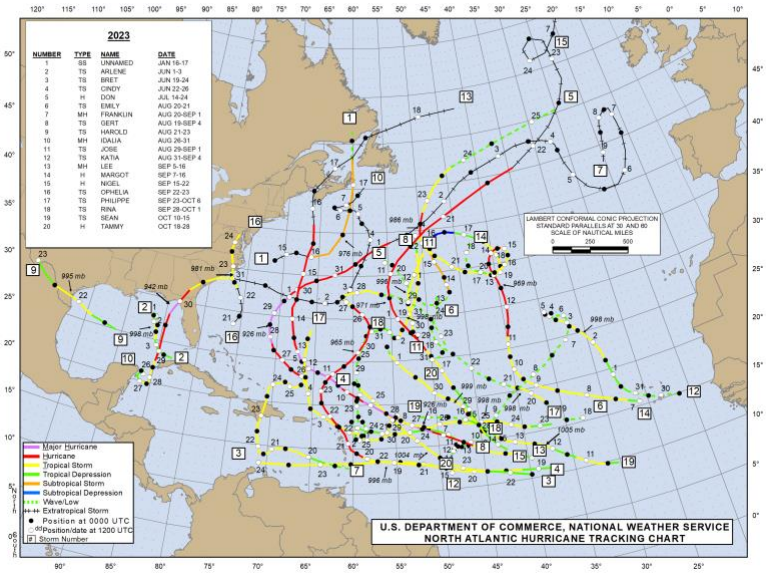
Dr. Ryan Maue showed how the trends for tropical storms, hurricanes and major hurricanes are all flat or even trending down.



The last 2 years showed how different the threat from year to year can change.

HURRICANE SEASON 2023

Notice how many storms clustered over the Atlantic but effect on the land areas was minimal.



The 2023 Atlantic hurricane season was characterized by warm sea surface temperatures in the Atlantic Basin and a strong El Nino. The El Nino limited impacts to the Gulf and mainland of the US as more storms in the eastern Pacific feeding off that warmth disrupted the upper atmosphere in the western Atlantic basin, deflecting most of the Atlantic storms north over the open ocean.

The Atlantic basin saw 20 named storms in 2023, which ranks fourth for the most-named storms in a year since 1950. Seven storms were hurricanes and three intensified to major hurricanes. An average season has 14 named storms, seven hurricanes and three major hurricanes. But most of the storms stayed in the Atlantic.

Hurricane Idalia was the only U.S. landfalling hurricane in 2023. It made landfall as a category-3 hurricane on Aug. 30 near Keaton Beach, Florida, causing storm surge inundation of 7 to 12 feet and widespread rainfall flooding in Florida and throughout the southeast.

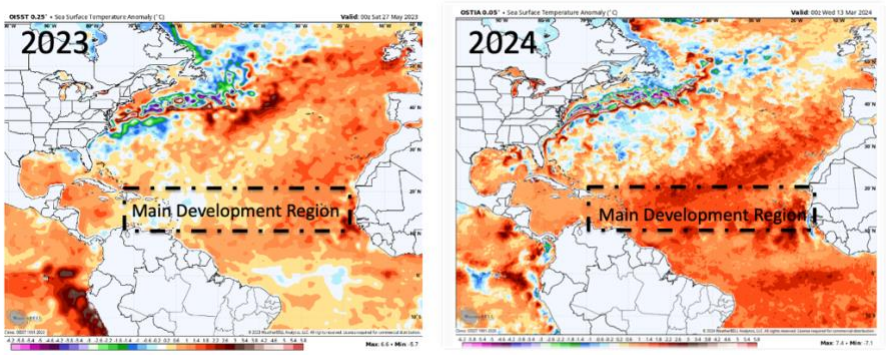
“The Atlantic basin produced the most named storms of any El Nino influenced year in the modern record,” said Matthew Rosencrans, lead hurricane forecaster at NOAA’s Climate Prediction Center - a division of NOAA’s National Weather Service. “The record-warm ocean temperatures in the Atlantic provided a strong counterbalance to the traditional El Nino impacts.” The transport of heat north over the ocean spared the impact on people and property for the mainland Gulf and Atlantic states.

The global scale heat transport was also achieved by a very active eastern Pacific basin, where given the El Nino, the eastern Pacific hurricane season given the El Nino was well above normal with 17 named storms, of which 10 were hurricanes and eight of those major hurricanes. From Aug. 16 to 21, Tropical Storm Hilary brought widespread heavy rainfall and flooding to Southern California, with some areas receiving up to 600% of their normal August rainfall. Hilary resulted in the first ever Tropical Storm Watches and Warnings for the Southern California coastline by NOAA's National Hurricane Center. Hurricane Otis made landfall near Acapulco, Mexico, on Oct. 25 as a category-5 hurricane with sustained winds of 165 mph.

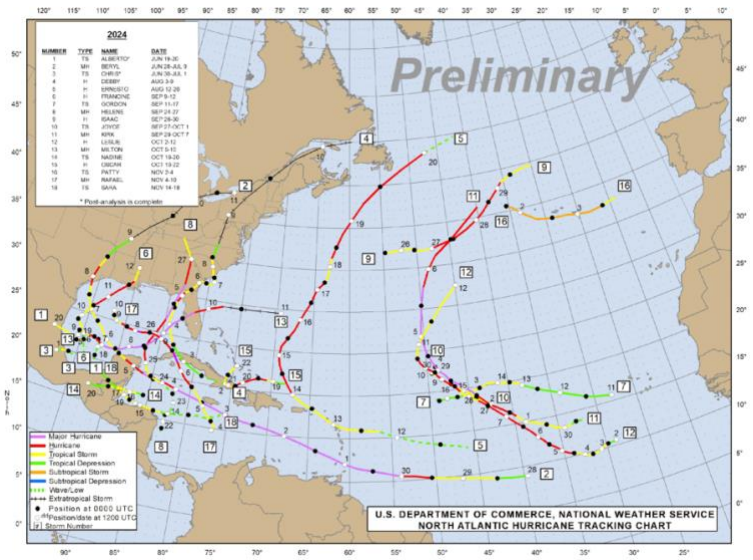
HURRICANE SEASON 2024

The 2024 Atlantic hurricane season had above-average activity, with a record-breaking ramp up following a rare peak-season lull. Global factors caused all other global tropical regions to have below normal hurricanes while the Atlantic temperatures in the classic subtropical development region was well above normal with two major impact storms.

Notice how much warmer the Main Development Region was than 2023.



Eighteen tropical depressions formed, and all of them were named storms. Eleven storms became hurricanes, of which five strengthened into major hurricanes (Category 3 or higher on the Saffir-Simpson Hurricane Wind Scale). Of those storms, five made landfall in the continental U.S., with two making landfall as major hurricanes.



Though the 2024 Atlantic hurricane season officially began on June 1, due to a large stationary heat dome over Central America and Mexico, it had its slowest start since 2014. The season's first named storm, Tropical Storm Alberto, formed in the western Gulf of Mexico on June 19, making landfall on the northeastern coast of Mexico the following day. Next came Hurricane Beryl, the earliest Atlantic basin Category-5 hurricane on record in a season and the strongest June and July hurricane on record in the basin.

Beryl affected parts of the Caribbean, the Yucatán Peninsula, and the Gulf Coast of the United States, causing moderate storm surge flooding across parts of Texas and Louisiana after making landfall near Matagorda, Texas, as a Category-1 storm. After Beryl dissipated on July 11, the Atlantic basin would fall under a period of inactivity due to the Saharan air layer, which suppresses tropical activity.

Despite the unseasonably warm ocean temperatures in the North Atlantic and the climatological Main Development region, the equatorial Atlantic cooled rapidly into an "Atlantic Niña" due to upwelling caused by shifts in the trade winds and the Atlantic zonal mode.

After nearly three weeks of inactivity, the longest in over fifty years at that point in the season, Hurricane Francine formed on Sept. 9, making landfall in Louisiana as a Category 2 system on Sept. 11. Four systems developed during the final week of September, starting with Hurricane Helene on September 24.

Hurricane Helene made landfall as a Category-4 storm on the Florida Gulf Coast on Sept. 26. The storm caused catastrophic flooding across the southern Appalachians, widespread wind damage from the Gulf Coast to the North Carolina mountains and storm surge flooding along portions of western Florida.

Helene was the strongest hurricane on record to strike the Big Bend region of Florida, the deadliest Atlantic hurricane since Maria in 2017 and the deadliest hurricane to affect the continental United States since Hurricane Katrina in 2005, with more than 150 direct fatalities, the majority of which occurred in North Carolina and South Carolina. Hurricane Helene marked the first time ever that NHC forecasted a system to become a major hurricane before it became a tropical depression or tropical storm.

Early October saw the formations of Hurricanes Leslie and Milton, which, along with Kirk, marked the first time on record that there were three simultaneously active hurricanes in the Atlantic basin after September.

Hurricane Milton notably underwent explosive rapid intensification within the Gulf of Mexico to become the second Category 5 hurricane of the season, making 2024 the first Atlantic hurricane season since 2019 to feature multiple Category 5 hurricanes. Milton made landfall on the west coast of Florida on Oct. 9, less than two weeks after Hurricane Helene devastated the state's Big Bend region, resulting in a tornado outbreak that produced 19 tornadoes, and caused torrential rainfall and localized flooding with total rainfall amounts of 10 to 15 inches (and higher). Milton became the first Atlantic hurricane since Hurricane Wilma (2005) to reach a pressure below 900 mb (26.58 inHg) and the second-most intense tropical cyclone ever recorded over the Gulf of Mexico, behind only after Hurricane Rita. Milton was the thirteenth named storm, ninth hurricane, fourth major hurricane, and second Category 5 hurricane of the 2024 Atlantic hurricane season and the strongest tropical cyclone worldwide in 2024.

References:

Changes in Atlantic major hurricane frequency since the late-19th century, Gabriel A. Vecchi, Christopher Landsea, Wei Zhang, Gabriele Villarini , Thomas Knutson , Nature Communications volume 12, Article number: 4054 (2021)

Continental U.S. Hurricane Landfall Frequency and Associated Damage Philip J. Klotzbach, Steven G. Bowen, Roger Pielke Jr. and Michael Bell Bulletin of the American Meteorological Society, Vol. 99, No. 7 (July 2018), pp. 1359- 1376 (19 pages)

Normalized hurricane damage in the continental United States 1900–2017. Weinkle, J., Landsea, C., Collins, D. et al. Normalized hurricane damage in the continental United States 1900–2017. Nat Sustain 1, 808–813 (2018). https://doi.org/10.1038/s41893-018-0165-2