A Brief History of Hurricanes

A Brief History of Hurricanes

More than just storms

Muxing Chen

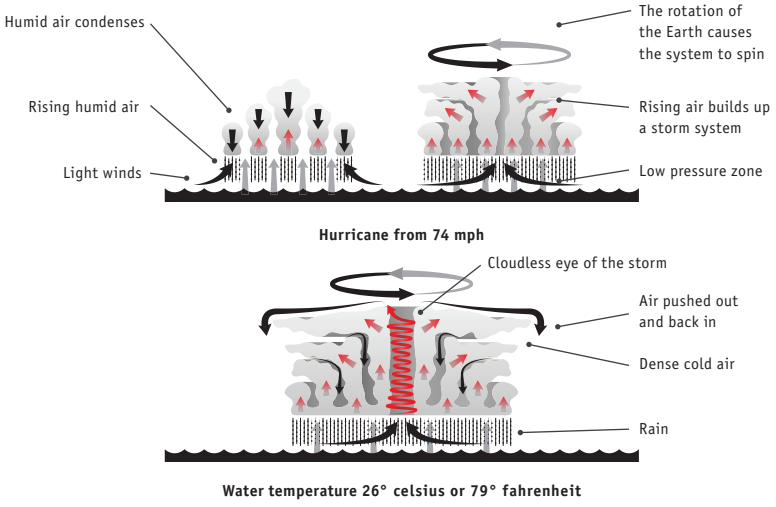
typset in Trade Gothic 8/12, 6/8
ITC Officina Sans 10/12, 6/8

Contents

Hurricane Anatomy

01

Hurricane formation diagram



How do hurricanes form

Hurricanes — or tropical cyclones — form over waters where humidity is high, sea surface temperatures are warm (more than 26 degrees Celsius) and light winds prevail. Those conditions usually occur in the summer and early autumn in the tropical North Atlantic and North Pacific.

These cyclones use “warm, moist air as fuel,” according to NASA. The air moves up and away from the ocean’s surface, causing an area of low air pressure to form. Air from high-pressure areas moves into the low-pressure zone. It warms and rises too. The cycle continues, and as that warm, moist air rises and cools, the water in it forms clouds. The clouds multiply; the wind whips up and grows, continuing to be fed by the ocean’s heat and water. The storm system’s rotation speeds up and forms a calm area of low pressure in the center, known as the eye. The strongest winds occur outside of this in the eye wall.

Category

1	Sustained Winds: **74–95 mph** Storm surge: **4 to 5 feet**	275
2	Sustained Winds: **96–110 mph** Storm surge: **6 to 8 feet**	269
3	Sustained Winds: **111–129 mph** Storm surge: **9 to 12 feet**	165
4	Sustained Winds: **130–156 mph** Storm surge: **13 to18 feet**	151
5	Sustained Winds: **157 mph or higher** Storm surge: **18 feet or higher**	44

Atlantic hurricanes counted by category (1851–2017)

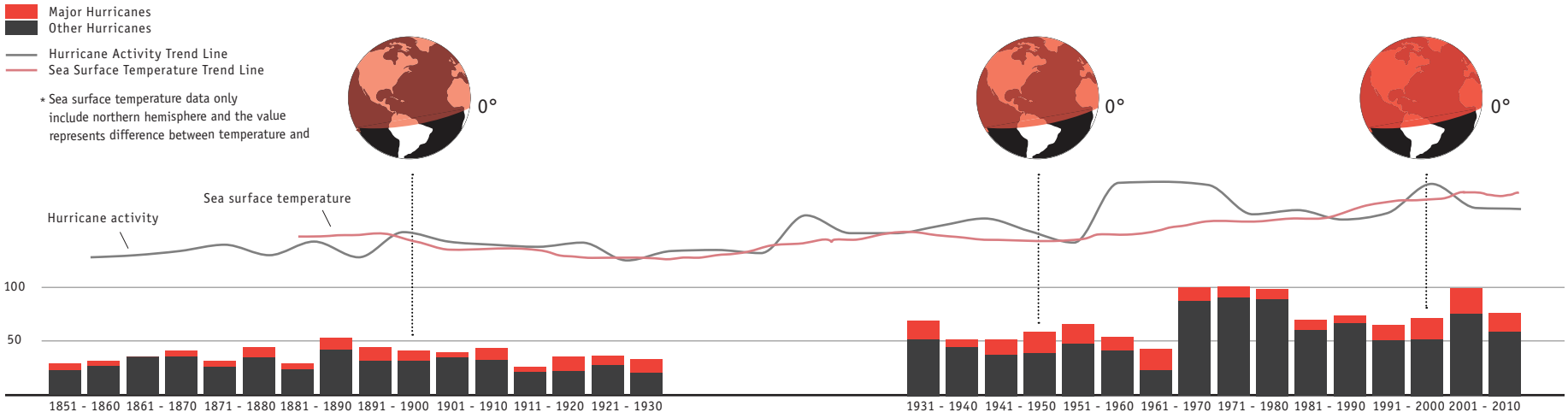
A fun fact about names

The practice of giving storms names became widespread in World War II. Initially, only female names were used, but since 1979, storms have been given both male and female names.

Frequency Over Time

07

Atlantic Storm Activity (1851–2010)
And Sea Surface Temperature* Change (1880–2010)



Data Source: NOAA, National Hurricane Center

Exploring the history of hurricanes, let's first dive into it from a time series's perspective. According to the introduction in chapter 1, we have already known sea surface temperature is one of the most significant factors of forming hurricanes. So, we combine the data of both sea surface temperature and hurricanes and do an insightful comparative analysis.

From the infographic, we are easy to capture a trend that both sea surface temperature and hurricane activities increased drastically since the 1930s. Not only the total quantity of hurricanes rocketed but also the number of major hurricanes, indicating more intense became more frequent. And 1930s, as a "split", is also a milestone timing of the second industrial revolution.

Activity Over Space

03

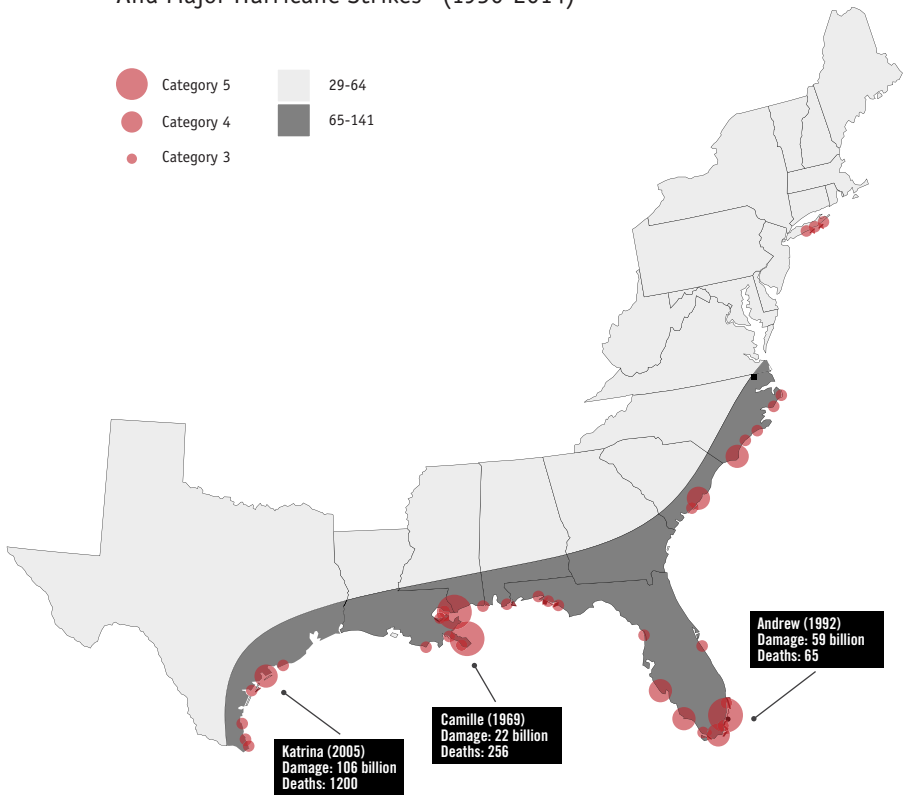
Historical Hurricane Probabilities by States (1878–2017)

State	Hurricane	Major Hurricane
Texas	**33%**	**12%**
Louisiana	**30%**	**10%**
Mississippi	11%	4%
Alabama	11%	3%
Florida	**51%**	**21%**
Georgia	10%	1%
South Carolina	18%	4%
North Carolina	**29%**	**5%**
Virginia	7%	<1%
Maryland	1%	<1%
Delaware	1%	<1%
New Jersey	2%	<1%
New York	9%	2%
Connecticut	6%	1%
Rhode Island	6%	1%
Massachusetts	6%	<1%
New Hampshire	1%	<1%
Maine	1%	<1%

Source: Landfalling Hurricane Probability Project co-developed by the Tropical Meteorology Project at Colorado State University and the GeoGraphics Laboratory at Bridgewater State University

Exploring the history of hurricanes from a space's perspective, we will find Florida is the most possible state that struck by hurricanes and major hurricanes, which means Florida is exposed to frequent hurricane activity and also the intense and destructive hurricanes as well. Besides, Texas, Louisiana and North Carolina are also suffered from frequent hurricane activity with the probability of around 30%.

Continental United States Storm Activity (1851-2012) And Major Hurricane Strikes* (1950-2014)



Source: NOAA's National Centers for Environmental Information

Note:

1. Due to density of storms in some locations, actual strike locations are approximate.
2. The dots onle include the major hurricane strikes.

* Strikes-include hurricanes that did not make direct landfall but did produce hurricane force winds over land.

Destructions

04

Deadliest Mainland United States Hurricanes (1851–2010)

No.	Year	Storm	Category	Deaths
1	1900	Great Galveston, Texas	4	8,000[a]
2	1928	Lake Okeechobee, Fla.	4	2,500[b]
3	2005	Katrina, La./Miss.	3	1,200
4	1893	Sea Islands, S.C./Ga.	4	1,100–1,400[c]
5	1893	Cheniere Caminada, La.	3	1,000–2,000
6	1881	Ga./S.C.	2	700
7	1957	Audrey, La./Texas	4	416
8	1935	Great Labor Day Hurricane, Fla.	5	408
9	1856	Last Island, La.	4	400
10	1926	Miami Hurricane, Fla./Miss./Ala.	4	372

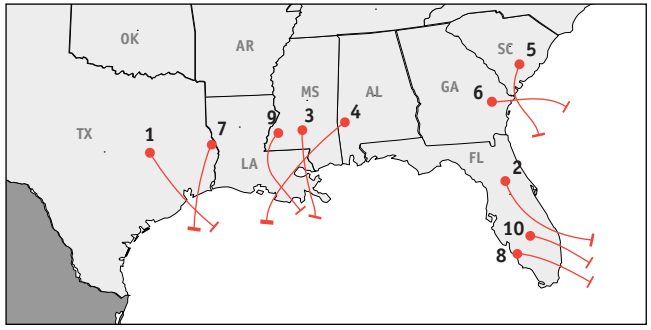
Source: NOAA, U.S. National Weather Service, U.S. National Hurricane Center, EQUECAT

Notes:

a. Could be as high as 12,000

b. Could be as high as 3000

c. Total including offshore losses near 2000



The deadliest hurricane to strike the United States since 1851 was the Galveston, Texas hurricane of Sept. 1900. It stands out from the list, claiming 8,000 lives by most reports, although the true toll may have been as high as 12,000.

The reason why the Great Galveston Hurricane was so destructive is forecast technology was primitive back then without weather satellites. The Weather Bureau, which was only 10 years old, just relied on spotty reports from ships in the Gulf of Mexico. U.S. hurricane science took off since the 1940s, which reflects on the list that most of deadlist hurricanes happened before the 1940s.

Costliest Mainland United States Hurricanes (1851-2010)

Adjusting for inflation, changes in personal wealth and coastal county population to 2010*

No.	Year	Storm	Category	Damage(U.S.)
1	1926	Miami Hurricane, Fla./Miss./Ala.	4	$165 billions
2	2005	Katrina, La./Miss./Ala.	3	113.4
3	1900	Great Galveston, Texas	4	104.3
4	1915	Great Galveston, Texas	4	71.4
5	1992	Andrew, Fla./La.	5	58.6
6	1938	New England Hrricane	3	41.1
7	1944	Southwest Fla.	3	40.6
8	1928	Lake Okeechobee, Fla.	4	35.3
9	2008	Ike, Texas./La.	2	29.5
10	1960	Donna, Fla.	4	28.2

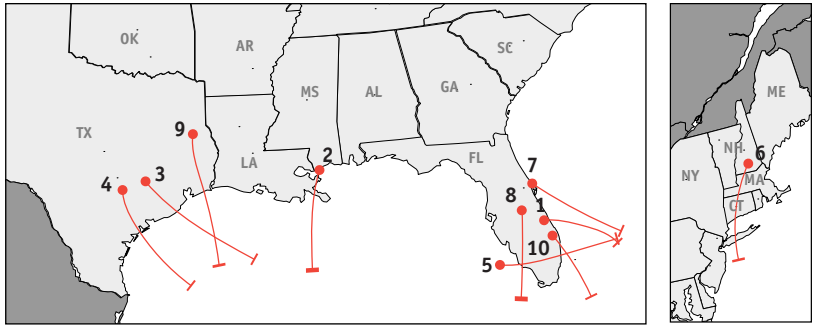
Source: NOAA, U.S. National Weather Service, U.S. National Hurricane Center, EQUECAT

Notes:

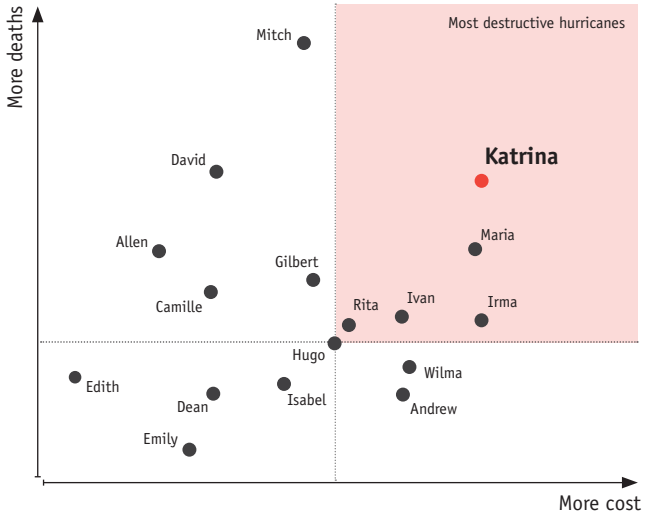
* Normalization reflects inflation, changes in personal wealth and coastal county population to 2005, (Pielke et al. 2007) then including an estimate to 2010 dollars.

The costliest hurricane was the 1926 category 4 storm that hit southeast Florida in 1926. The unnamed storm caused $165 billion in damage (in 2010 dollars).

In the early 1920s, Miami, Florida was the fastest growing city in the United States and began experiencing the Great Depression as a result of the hurricane – 3 years earlier than the rest of the country. Due to the tremendous pace of growth in this vulnerable hurricane area, if a hurricane of parallel force were to strike the same region today, the damage would be catastrophic.



Atlantic Hurricanes Measured by Death and Cost
(1960–2017)



Taking both death toll and economic cost into consideration and just focusing on category 5 hurricanes, Katrina is considered as the most destructive hurricane from 1960 to 2017.

Katrina provided a grim reminder of what can happen in a hurricane landfall. Sociologists estimate, however, that people only remember the worst effects of a hurricane for about seven years (B. Morrow, personal communication). One of the greatest concerns of the National Weather Service's (NWS) hurricane preparedness officials is that people will think that no more large loss of life will occur in a hurricane because of our advanced technology and improved hurricane forecasts. Bill Read, current Director of NHC, as well as former NHC Directors, have repeatedly emphasized the great danger of a catastrophic loss of life in a future hurricane if proper preparedness plans for vulnerable areas are not formulated, maintained and executed.

Insights

05

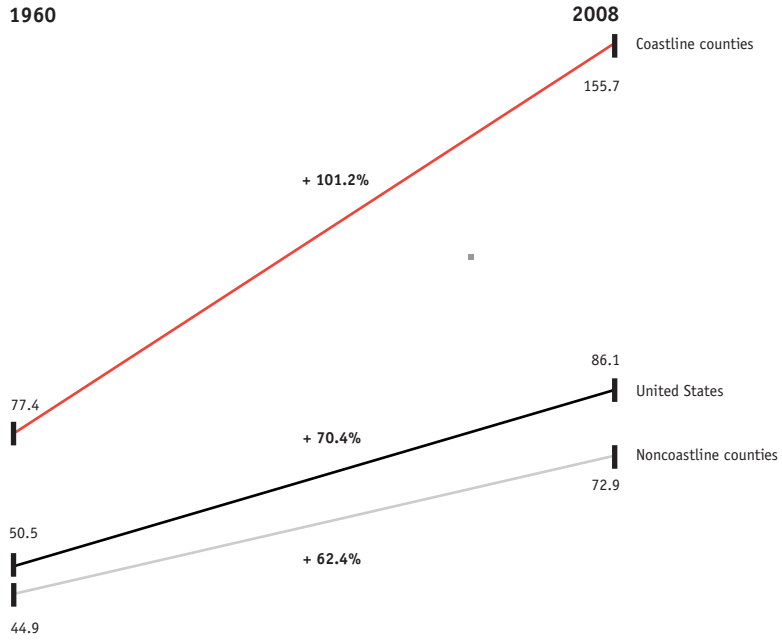
Increasing coastal population is a time bomb

The study by Jarrell et al. (1992) used 1990 census data to show that 85% of U.S. coastal residents from Texas to Maine had never experienced a direct hit by a major hurricane. This risk is higher in 2016 as around 60 million residents lived in the coastal section, increasing from 2000's 52 million. This trend hasn't stopped.

One of the main reasons of hurricanes tend to cost more on average is urbanization. Urbanization brings higher population and denser construction, which make the urbanized coastal areas more vulnerable.

Continued coastal growth and inflation will almost certainly result in every future major landfalling hurricane (and even weaker hurricanes and tropical storms) replacing one of the current costliest hurricanes. For example, all three of the U.S. hurricane landfalls of 2008 made the top 30 list, despite none of them being major hurricanes at landfall. If warnings are heeded and preparedness plans are developed, the death toll can be minimized. However, large property losses are inevitable in the absence of a significant change of attitude, policy, or laws governing building practices (codes and location) near the ocean.

Population density for Coastline Counties by state, 1960–2008

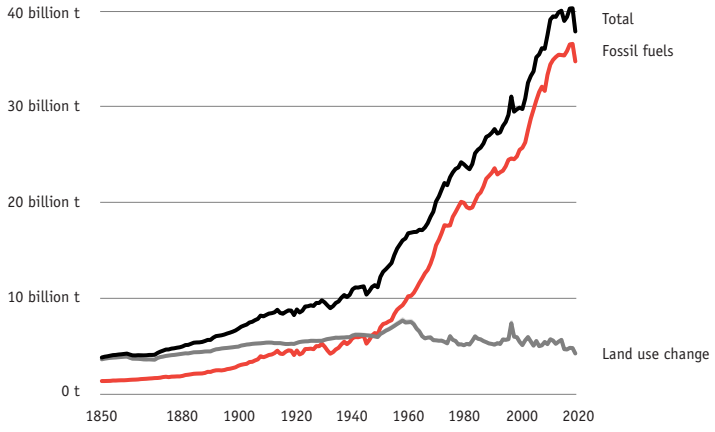


The history of hurricanes is not only the history of hurricanes

The history of hurricanes is also the history of human activities. In Chapter 2, we found that the frequent activities of hurricanes are closely related to sea surface temperature, which is highly correlated with carbon dioxide emissions. The logic behind this is that though the ocean can absorb part of the carbon dioxide, the ability to absorb will decrease after reaching a tipping point, causing more greenhouse gases to stay in the atmosphere. And this is the main factor that leads to global warming, which will increase the ocean temperature.

From the line chart above, we notice a similar trend we saw in the infographic in chapter 2. Carbon dioxide emission from fossil fuel is mainly produced by human activities and have rocketed since the 1930s. So if we put hurricanes activity, sea surface temperature and CO2 emissions together, we will get a bigger picture.

Global CO2 emissions from fossil fuels and land use change



Source: Global Carbon Project. (2021). Supplemental data of Global Carbon Budget 2021 (Version 1.0)

References

06

National Weather Service & National Hurricane Center. (2011, August). THE DEADLIEST, COSTLIEST, AND MOST INTENSE UNITED STATES TROPICAL CYCLONES FROM 1851 TO 2010 (AND OTHER FREQUENTLY REQUESTED

Osterath, B. (2017, September 22). Hurricanes release energy of 10,000 nuclear bombs. Climate Change. https://www.climatechange.ie/hurricanes-release-energy-of-10000-nuclear-bombs/

Terrebonne Parish Office of Homeland Security & Emergency Preparedness. (n.d.). TOHSEP - Severe Weather. Hurricane Preparedness. Retrieved December 14, 2021, from http://tohsep.com/SevereWeather/Hurricanes

National Centers for Environmental Information (NCEI). (2018b, November 5). Continental United States Hurricane Strikes. National Centers for Environmental Information. https://www.ncei.noaa.gov/access/metadata/landing-page/bin/iso?id=gov.noaa.ncdc:C00694

Little, B. (2021, August 25). How the Galveston Hurricane of 1900 Became the Deadliest US Natural Disaster. HISTORY. https://www.history.com/news/how-the-galveston-hurricane-of-1900-became-the-deadliest-u-s-natural-disaster

Hurricanes: Science and Society: 1926- Great Miami Hurricane. (n.d.). Hurricanes: Science and Sociaty. http://www.hurricanescience.org/history/storms/1920s/GreatMiami/

Hallman, C. (2021, April 14). A Study of All Category 5 Hurricanes of the Past 50 Years [Infographic] | TitleMax. TitleMax. https://www.titlemax.com/discovery-center/lifestyle/50-years-category-5-hurricanes/

US Census Bureau. (2021, October 8). 60 Million Live in the Path of Hurricanes. Census.Gov. https://www.census.gov/library/stories/2018/08/coastal-county-popula-

Wilson, S. G., & Fischetti, T. R. (2010, May). Coastline Population Trends in the United States: 1960 to 2008. https://www.census.gov/prod/2010pubs/p25-1139.pdf

Ritchie, H. (2020, May 11). CO2 emissions. Our World in Data. https://ourworldindata.org/co2-emissions

The Ocean's Carbon Balance. (2008, July 1). Earth Observatory. https://earthobservatory.nasa.gov/features/OceanCarbon