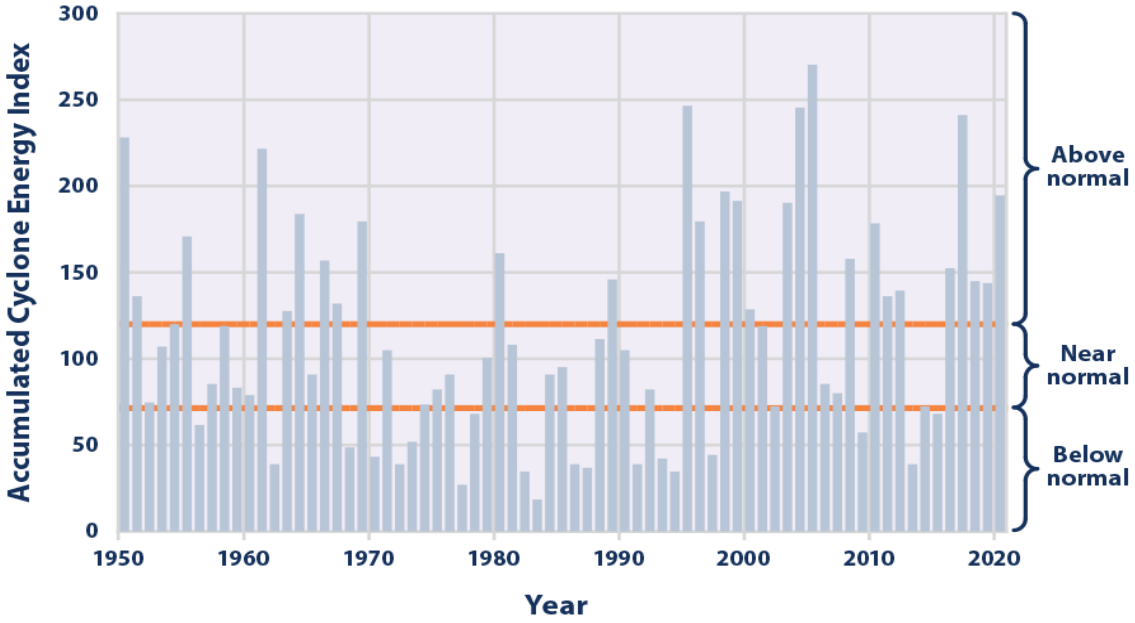
Handout 2.2c Storm Flooding and Wind Damage

As of August 2022, a total of 303 Atlantic tropical cyclones have produced hurricane-force winds in every state along the Atlantic Ocean and Gulf of Mexico (as well as Pennsylvania), with Florida having had more hurricanes affecting it than any other state.[1]

The figure below shows total annual Accumulated Cyclone Energy (ACE) Index values, which North Atlantic Tropical Cyclone Activity According to the Accumulated Cyclone Energy Index, 1950–2020.

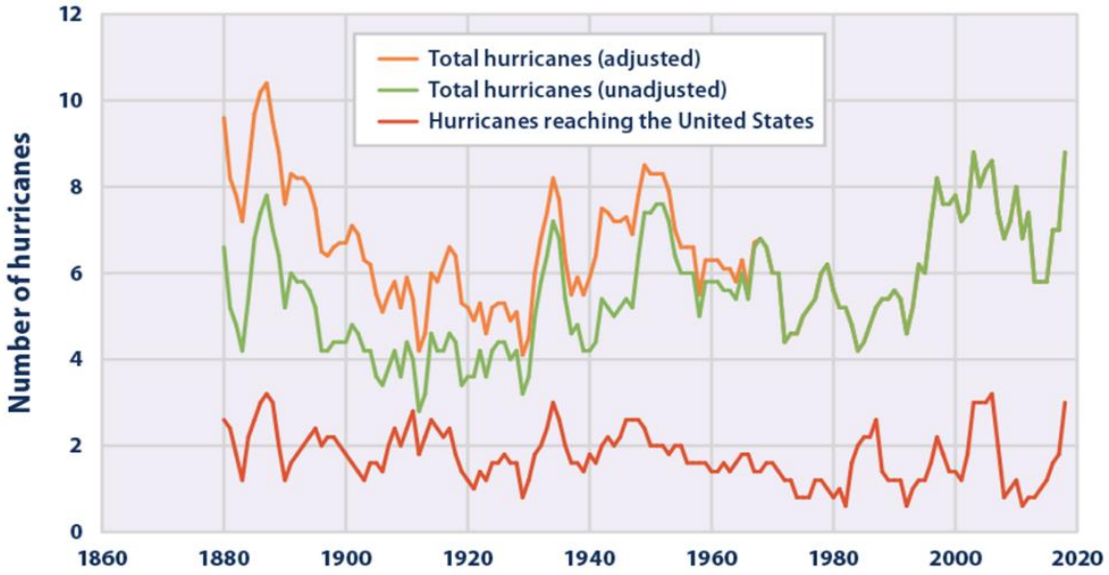


North Atlantic Tropical Cyclone Activity According to the Accumulated Cyclone Energy Index, 1950–2020

This figure shows total annual Accumulated Cyclone Energy (ACE) Index values, which account for cyclone strength, duration, and frequency, from 1950 through 2020. The National Oceanic and Atmospheric Administration has defined "near normal," "above normal," and "below normal" ranges based on the distribution of ACE Index values over the 30 years from 1981 to 2010.

Data source: NOAA, 2021[6]
Web update: April 2021

The tropical cyclone activity indicator examines the frequency, intensity, and duration of hurricanes and other tropical storms in the Atlantic Ocean, Caribbean, and Gulf of Mexico

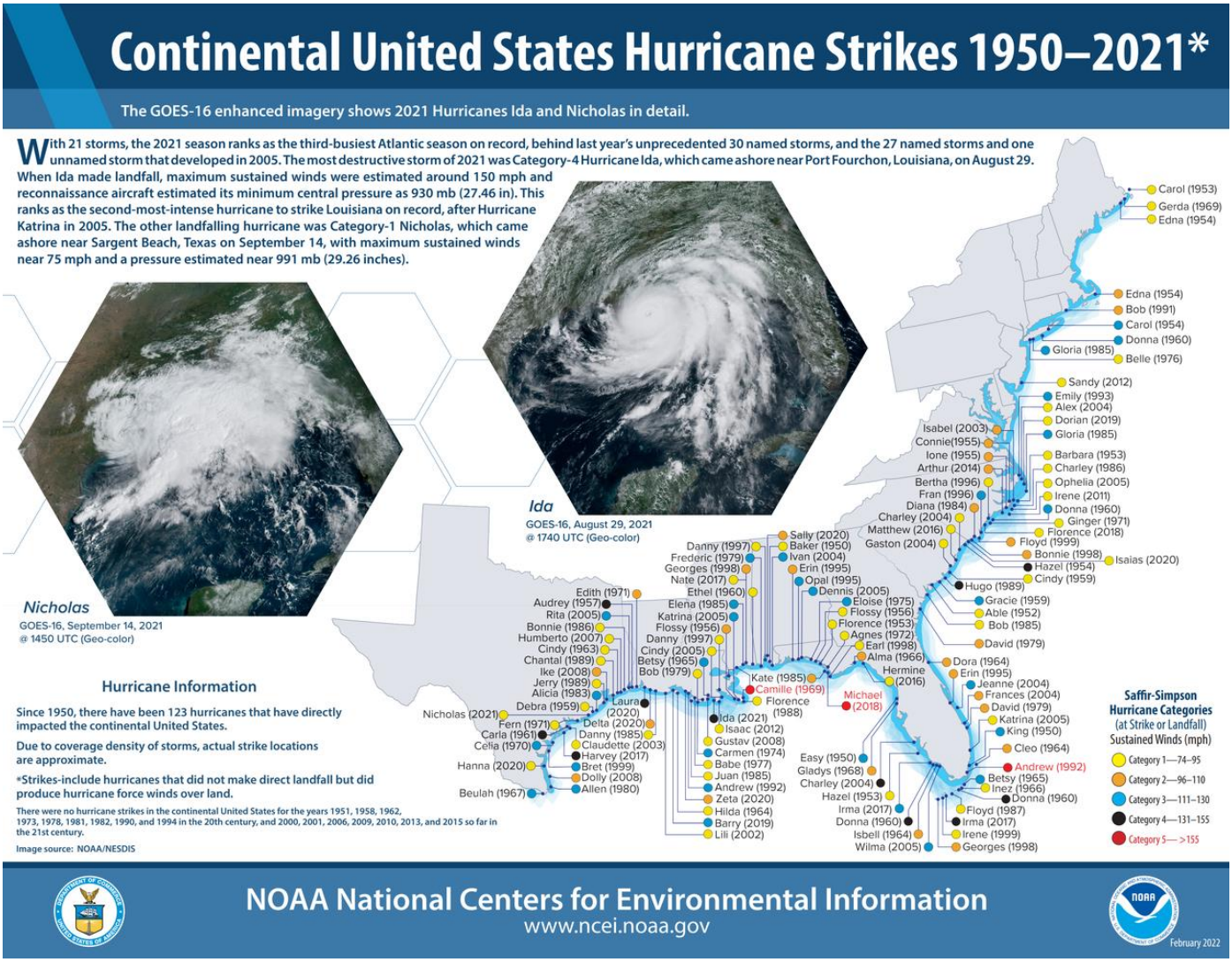


Number of Hurricanes in the North Atlantic, 1878–2020

This graph shows the number of hurricanes that formed in the North Atlantic Ocean each year from 1878 to 2020, along with the number that made landfall in the United States. The orange curve shows how the total count in the green curve can be adjusted to attempt to account for the lack of aircraft and satellite observations in early years. All three curves have been smoothed using a five-year average, plotted at the middle year. The most recent average (2016–2020) is plotted at 2018.

Data source: NOAA, 2021[4]; Vecchi and Knutson, 2011[5]
Web update: April 2021

The list of United States hurricanes The list below is taken from the list compiled on Wikipedia (List of United States hurricanes - Wikipedia) for Virginia. It includes all tropical cyclones officially recorded to have produced sustained winds of greater than 74 mph (119 km/h) in the United States, which is the minimum threshold for hurricane intensity. The Wikipedia list, is sorted by U.S. state and begins in 1851 with the start of the official Atlantic hurricane database (HURDAT), as provided by the National Oceanic and Atmospheric Administration's Hurricane Research Division. Since 1851, a total of 303 North Atlantic hurricanes produced hurricane-force winds in 19 states along the Atlantic coast. Some of these storms may not have made a direct landfall (i.e. remained just offshore) while producing hurricane-force winds on land; some of them may have weakened to a tropical storm or became extratropical before landfall but produced hurricane conditions on land while still a hurricane and some of them made landfall in an adjacent state but produced hurricane conditions over multiple states. This list does not include storms that only produced tropical storm conditions on land in the United States.



Source: National Centers for Environmental Information – Poster Public Domain

As of August 2022, a total of 303 Atlantic tropical cyclones have produced hurricane-force winds in every state along the Atlantic Ocean and Gulf of Mexico (as well as Pennsylvania), with Florida having had more hurricanes affecting it than any other state.[1]

The earliest time in the year for a hurricane (and a major hurricane) to strike the nation was June 9, which was set by Alma in 1966. The earliest major hurricane (category 3 or greater) to make an actual landfall in the nation occurred in 1957, when Hurricane Audrey made landfall at category 3 intensity on June 27. The latest in the year for a hurricane to strike the nation was on November 24 with Hurricane Iwa in Hawaii; for the Atlantic basin the latest was on November 22, which was set by Hurricane Kate in 1985. The latest in the year for a major hurricane to strike the nation was from Hurricane Zeta, which moved ashore on October 28.[2]

The 1990s were the most active decade for the United States, with a total of 31 hurricanes affecting the nation. By contrast, the least active decade was the 1860s and 1970s, each with a total of only 15 hurricanes affecting the United States. A total of 33 seasons on record passed

without an Atlantic hurricane affecting the country — the most recent of which was the 2015 season. Seven Atlantic hurricanes affected the country in the 1886 season, which was the year with the most United States hurricanes.[1]

Name	Saffir–Simpson Category	Date of closest approach	Year
Unnamed	Category 1 hurricane	September 17	1876
Unnamed	Category 1 hurricane	October 23	1878
Unnamed	Category 2 hurricane	August 18	1879
Unnamed	Category 1 hurricane [notes 1]	October 13	1893
Unnamed	Category 1 hurricane	September 29	1894
Unnamed	Category 1 hurricane [notes 1]	September 30	1896
Unnamed	Category 1 hurricane [notes 2]	September 16	1933
Unnamed	Category 1 hurricane	September 18	1936
Unnamed	Category 2 hurricane [notes 2]	September 14	1944
Connie	Category 1 hurricane	August 12	1955
Donna	Category 1 hurricane [notes 2]	September 12	1960
Isabel	Category 1 hurricane	September 19	2003

Tropical Cyclones to affect Virginia 1851-2021 Source: Chronological List of All Hurricanes which Affected the Continental United States: 1851–2012[1]

For additional background on tropical cyclones to affect Virginia go to: Virginia Hurricane History (noaa.gov)

The Saffir–Simpson hurricane wind scale (SSHWS) classifies hurricanes—which in the Western Hemisphere are tropical cyclones that exceed the intensities of tropical depressions and tropical storms—into five categories distinguished by the intensities of their sustained winds. This measuring system was formerly known as the Saffir–Simpson hurricane scale, or SSHS.

The Cost of storms systems in the United States

NOAH's National Center for Environmental Information (NCEI) is the Nation's scorekeeper in terms of addressing severe weather and climate events in their historical perspective. As part of its responsibilities of monitoring and assessing the climate, they track and evaluate climate events in the United States that have great economic and societal impacts. The NCEI maintains a consistent record of weather and climate disasters with costs equaling or exceeding $1 billion in damages (adjusting for inflation).

During 2021, there were 20 separate billion-dollar weather and climate disaster events across the United States. The total cost from these events of 2021 was $145.0 billion and is the third most costly year on record, behind 2017 and 2005. The total costs for the last five years ($764.9 billion) is more than one-third of the disaster cost total of the last 42-years (1980-2021), which exceeds $2.195 trillion (inflation-adjusted to 2021 dollars). This reflects a 5-year cost average of nearly $152.9 billion/year—a new record—as shown in the chart below by the black line.

2021 also follows the year 2020 that set the new annual record of 22 events. 2021 is the seventh consecutive year (2015-2021) in which 10 or more billion-dollar weather and climate disaster events have impacted the United States. Over the last 42 years (1980-2021), the years with 10 or more separate billion-dollar disaster events include 1998, 2008, 2011-2013, and 2015-2021.

The average cost per event by disaster types are the following:

1. Tropical cyclones have the highest average cost per event of $20.3 billion.
2. Drought/heat waves have an average cost of $10.0 billion per event.
3. Wildfires have an average cost of $6.2 billion per event.
4. Flooding events have an average cost of $4.7 billion per event.
5. Winter storms have an average cost of $4.1 billion per event.
6. Freezes have an average cost of $3.7 billion per event.
7. Severe storms have an average cost of $2.3 billion per event, but are the most frequent disaster type.

The information and graph below is taken from the NCEI summary statistics page (Summary Stats | Billion-Dollar Weather and Climate Disasters | National Centers for Environmental Information (NCEI) (noaa.gov)). You can use this page to determine the cost of severe storms in any time period covered by NOAA and other national agency sources. For example the cost of all disasters form 2000 until October 11, 2022 is **$1,788.3** billion dollars.

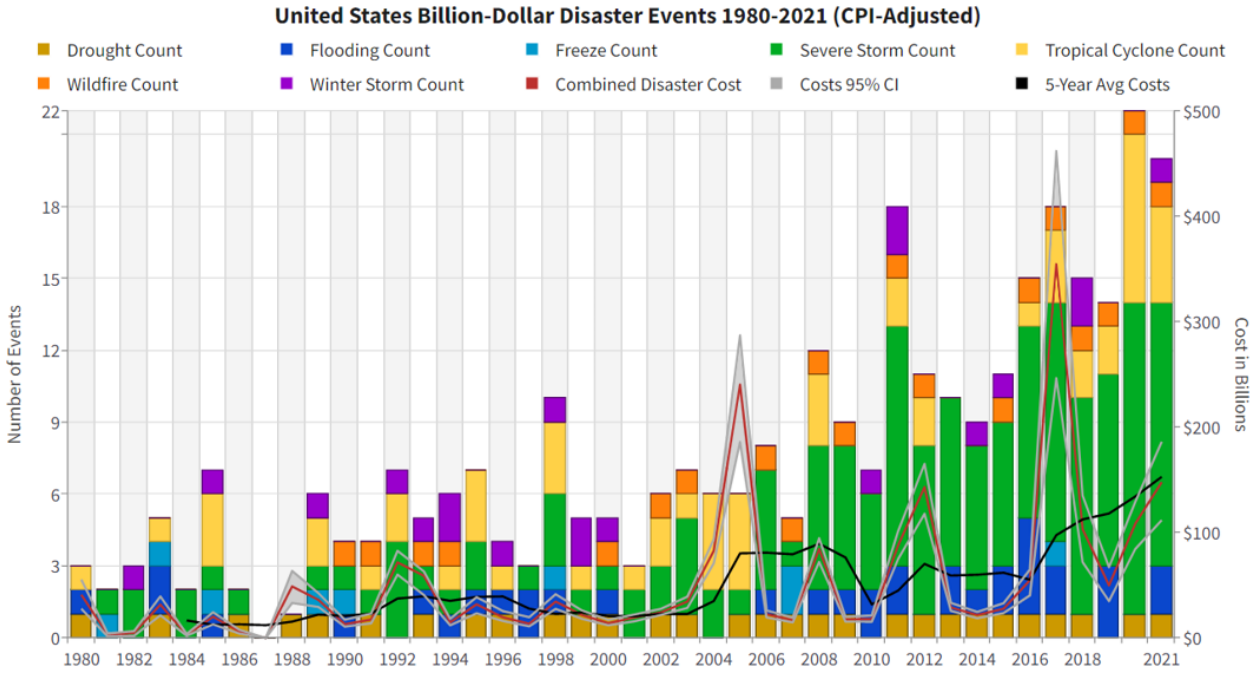
State: United States | Begin Year: 1980 | End Year: 2022 | Update

CPI-Adjusted | Unadjusted

Billion-dollar events to affect the United States from 1980 to 2022 (CPI-Adjusted)*

Disaster Type	Events	Events/ Year	Percent Frequency	Total Costs	Percent of Total Costs	Cost/ Event	Cost/ Year	Deaths	Deaths/ Year
Drought	30	0.7	8.9%	$309.4B CI	13.5%	$10.3B	$7.2B	4,256†	99†
Flooding	37	0.9	10.9%	$174.9B CI	7.6%	$4.7B	$4.1B	676	16
Freeze	9	0.2	2.7%	$34.4B CI	1.5%	$3.8B	$0.8B	162	4
Severe Storm	162	3.8	47.9%	$374.1B CI	16.3%	$2.3B	$8.7B	1,982	46
Tropical Cyclone	59	1.4	17.5%	$1,194.4B‡ CI	52.0%‡	$21.0B‡	$27.8B‡	6,864	160
Wildfire	21	0.5	6.2%	$126.9B‡ CI	5.5%‡	$6.3B‡	$3.0B‡	435	10
Winter Storm	20	0.5	5.9%	$83.4B CI	3.6%	$4.2B	$1.9B	1,314	31
All Disasters	**338**	**7.9**	**100.0%**	**$2,297.5B‡ CI**	**100.0%‡**	**$6.9B‡**	**$53.4B‡**	**15,689**	**365**

†*Deaths associated with drought are the result of heat waves. (Not all droughts are accompanied by extreme heat waves.)*
Flooding events (river basin or urban flooding from excessive rainfall) are separate from inland flood damage caused by tropical cyclone events.
The confidence interval (CI) probabilities (75%, 90% and 95%) represent the uncertainty associated with the disaster cost estimates. Monte Carlo simulations were used to produce upper and lower bounds at these confidence levels (Smith and Matthews, 2015).



For more information on the distribution of damage from these billion-dollar disaster events, see the NCEI summary statistics.

NCEI currently monitors and assesses the costs and impacts of:

- Hurricanes
- Drought and Heat Waves
- Inland floods
- Severe local storms
- Wildfires
- Crop freeze events
- Winter storms and Cold Waves

Source: NOAA National Centers for Environmental Information (NCEI) U.S. Billion-Dollar Weather and Climate Disasters (2022). https://www.ncei.noaa.gov/access/billions/, DOI: 10.25921/stkw-7w73