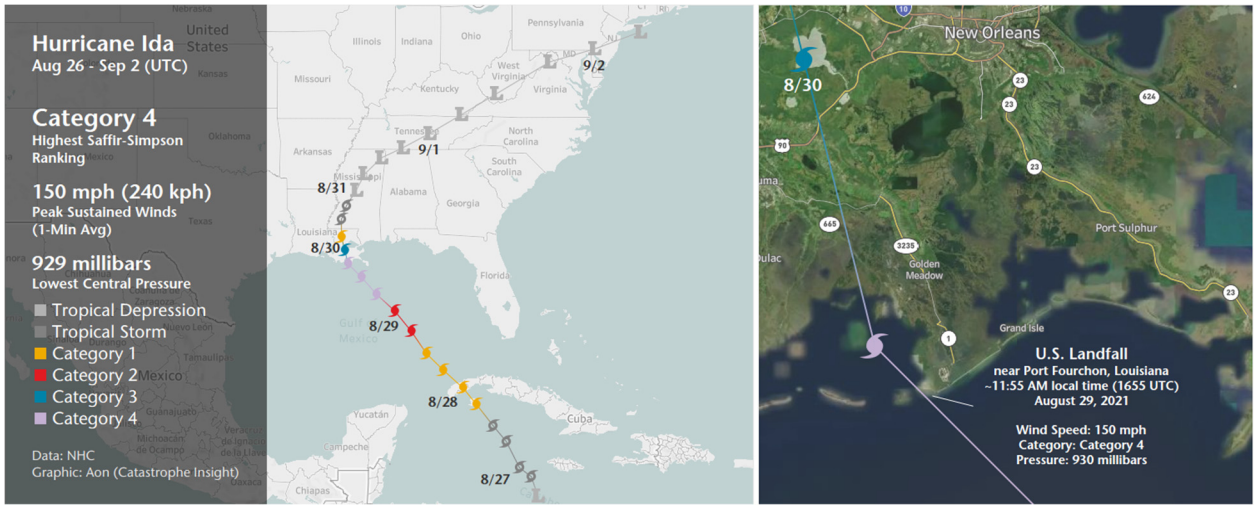
Hurricane Ida makes Category 4 landfall in the U.S.

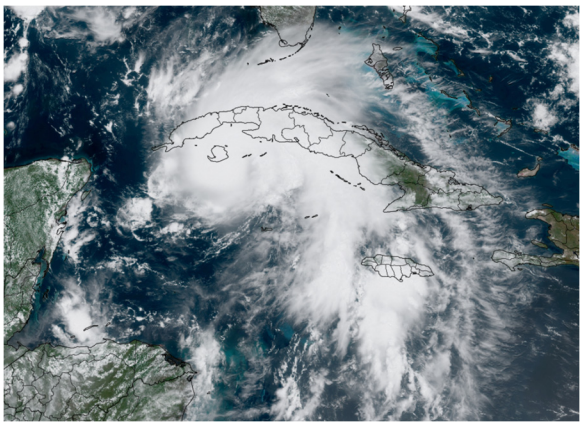
Hurricane Ida made landfall in the United States as a high-end Category 4 storm on August 29. The system had estimated sustained winds of 150 mph (240 kph) when coming ashore near Port Fourchon, Louisiana. Ida tied as the 5th-strongest hurricane to ever strike the U.S. mainland, and Louisiana became the first U.S. state to officially record back-to-back years of 150 mph (240 kph) hurricane landfalls. Extensive and catastrophic damage from high winds, coastal storm surge, and inland flooding was recorded. At least 49 fatalities were confirmed. Ida's remnants later brought catastrophic flooding and severe weather to parts of the Mid-Atlantic and Northeast on September 1. New York City's Central Park set a new one-hour rainfall record of 3.15 inches (80 millimeters). Prior to striking the U.S., Ida made separate landfalls in Cuba as a Category 1 hurricane. Total economic losses from Ida were anticipated to reach well into the tens of billions (USD) in the United States. Most of the wind-related property damage was likely to be insured, though a large portion of damage to infrastructure will not. Despite Louisiana having some of the highest National Flood Insurance Program (NFIP) take-up, there will still be a very sizable portion of storm surge and inland flood losses that will remain uninsured. Further NFIP claims and sewage back-up claims were likely in the Northeast. The total insured loss from Ida was also estimated into the double-digit billions (USD).

Meteorological Recap



The National Hurricane Center (NHC) began monitoring a tropical wave over the eastern Caribbean Sea for potential development on August 23. In subsequent days, the wave gradually organized into a broad area of low pressure by August 26 while evolving northwestward in the southern Caribbean Sea. Increased convective activity coupled with a well-defined circulation on satellite imagery prompted the NHC to officially recognize Tropical Depression Nine at 11:00 AM EDT (15:00 UTC) on August 26. The depression was initially located approximately 115 miles (180 kilometers) south-southwest of Jamaica with maximum sustained winds of 35 mph (55 kph) and tracking northwestward. Despite light to moderate southerly wind shear, the depression was able to steadily strengthen while churning over warm sea surface temperatures in the northwestern Caribbean Sea.

Data from NOAA Hurricane Hunter Aircraft indicated the depression had strengthened into Tropical Storm Ida by 5:20 PM EDT (21:20 UTC) on August 26, with maximum sustained winds reaching 40 mph (65 kph). Ida marked the 9th named storm of the 2021 Atlantic hurricane season. In the early morning hours of August 27, the center of Ida passed through the Grand Cayman Islands, where Tropical Storm Warnings were in effect. Ida continued to be steered northwestward by a western building mid-level ridge anchored off the coast of the Southeastern United States. During this period, continued improvement in structure of the storm was depicted on radar imagery and further aided by increasingly favorable upper-level winds and abundant moisture.



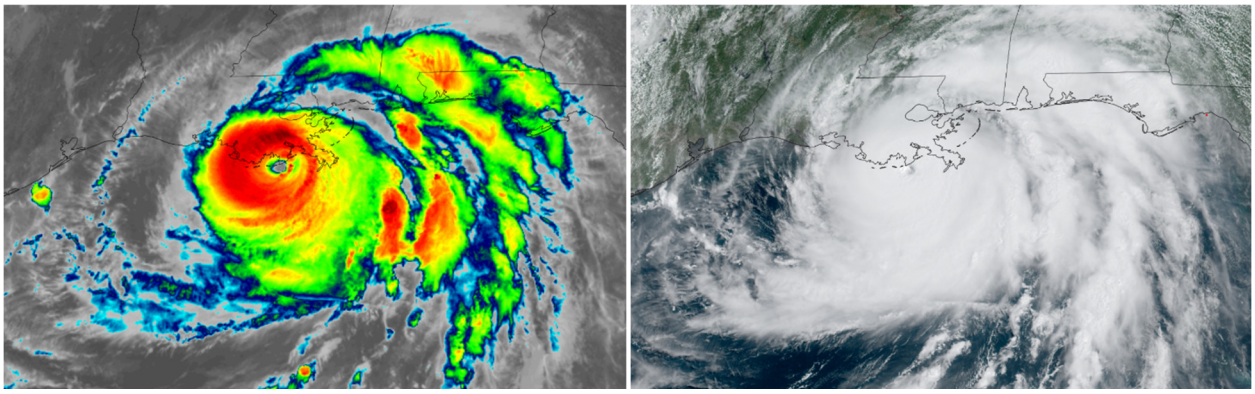
Hurricane Ida over the Isle of Youth on Aug 27
Source: NOAA/RAMMB

Ida obtained hurricane status on August 27, shortly before making landfall along the Cuban Isle of Youth (Isla de la Juventud) at 2:00 PM EDT (18:00 UTC), where a Hurricane Warning was issued. At this time, Hurricane Ida had maximum sustained winds of 75 mph (120 kph) and a minimum central pressure of 987 millibars – equivalent to a Category 1 storm on the Saffir-Simpson Hurricane Wind Scale (SSHWS). Ida became the 4th hurricane of the 2021 Atlantic season. Hurricane Warnings were also posted across the Cuban provinces of Pinar del Rio and Artemisa, as Ida approached western Cuba hours later. At 7:25 PM EDT (23:25 UTC) Ida made landfall in the western Cuban province of Pinar del Rio, east of La Coloma with maximum sustained winds of 80 mph (130 kph).

The inner core of Ida remained relatively intact after emerging into the Gulf of Mexico in the overnight hours of August 27-28, with minor residual effects due to land interactions from Cuba. Once in the Gulf of Mexico, the hurricane resumed a steady strengthening trend in an extremely favorable environment characterized by very warm sea surface temperatures, plentiful moisture, and light vertical wind shear. On August 28, Ida proceeded on a continual northwestern track toward the United States central Gulf Coast. Rapid intensification of Ida was observed in the central Gulf of Mexico, aided by the high oceanic heat content and deep warm waters of the Loop Current eddy. At 1:00 AM CDT (6:00 UTC) on August 29, data from NOAA Hurricane Hunter Aircraft confirmed Ida had strengthened into a major hurricane, with maximum sustained wind speeds of 115 mph (185 kph) – equivalent to a Category 3 storm on the SSHWS. Ida became the 2nd major hurricane of the 2021 Atlantic season, joining Hurricane Grace.

The rapid intensification continued through the early morning hours as Hurricane Ida hastily strengthened into a high-end Category 4 storm with a peak intensity of 150 mph (220 kph) by 6:00 AM CDT (11:00 UTC). This marked a 65 mph (100 kph) increase in sustained wind speeds during a 24-hour period. The NHC defines rapid intensification as an increase in the maximum sustained winds of a tropical cyclone of at least 35 mph in a 24-hour period. In subsequent hours, the minimum central pressure of Ida continued to drop, reaching an impressive 929 millibars. During this period, deep convective wrapped all the way around a clearing, approximately 15-mile-wide, eye feature on satellite and radar imagery.

As an impactful landfall along the southeastern Louisiana coast became imminent, Hurricane Warnings were in effect for Intracoastal City, Louisiana to the Mouth of the Pearl River and included Lake Pontchartrain, Lake Maurepas, and Metropolitan New Orleans. In addition, Storm Surge Warnings were posted from Intracoastal City, Louisiana to the Alabama and Florida border, and included Vermilion Bay, Lake Borgne, Lake Pontchartrain, Lake Maurepas, and Mobile Bay. The National Weather Service (NWS) warned that Hurricane Ida would generate extremely life-threatening storm surge inundation, catastrophic wind damage along the direct path of the cyclones core, and heavy rain which was likely to result in considerable to life-threatening flooding, particularly in regions of Louisiana and Mississippi. Hurricane and Tropical Storm warnings affected 12.5 million people by the morning of August 29, with at least 5 million people under a Storm Surge Warning. Prior to landfall, the NWS in New Orleans issued a rare Extreme Wind Warning indicating widespread destructive wind gusts of 115 to 135 mph (185 to 215 kph) were expected across portions of St. John The Baptist, St. James, St. Charles, Terrebonne, Lafourche, Jefferson, Plaquemines, and Assumption Parishes.



Ida making landfall in Louisiana in infrared (left) and visible (right) satellite imagery on Aug 29
Source: NOAA/RAMMB

Hurricane Ida made landfall along the southeastern coast of Louisiana near Port Fourchon in Lafourche Parish around 11:55 AM CDT (16:55 UTC) on August 29. At landfall, Category 4 Hurricane Ida retained maximum sustained winds of 150 mph (240 kph), and a minimum central pressure of 930 millibars. A ship observation near Port Fourchon measured a 172 mph (277 kph) wind gust shortly after Ida made landfall. Ida became the first major hurricane to impact the United States in 2021. Additionally, Hurricane Ida tied with the Last Island Hurricane of 1856 and Hurricane Laura in 2020 for the strongest sustained winds in a landfalling hurricane on record in the State of Louisiana – records extend back through 1851. Ida made landfall in Louisiana on the 16th anniversary of Hurricane Katrina's landfall.

Shortly after, radar imagery indicated the eye of Ida made a second landfall southwest of Galliano in Lafourche Parish around 2:00 PM CDT (19:00 UTC), with maximum sustained winds estimated at 145 mph (235 kph) while progressing northwestern at 12 mph (19 kph). According to the NHC, near this time a Weatherflow station near Dulac in Terrebonne Parish reported sustained winds of 89 mph (143 kph) and a gust to 138 mph (222 kph). Throughout the day on August 29, Ida remained a powerful hurricane (Category 3 or higher) while retaining a mostly concentric eye with rotating meso-vortices on radar imagery, in part due to heat and energy derived while slowly traversing the Louisiana Bayou.

Ida weakened into a tropical storm by 4:00 AM CDT (9:00 UTC) on August 30 over southwestern Mississippi, as the storm began to accelerate northward around the western periphery of a deep ridge anchored across the Southeastern United States.

As Ida and its remnants progressed northeastward through September 2, significant flooding rains affected portions of the Southeast, Tennessee Valley, and the Mid-Atlantic – where a corridor of Flash Flood Watches were in effect. Unabated rains in these regions were enhanced as the surge of tropical moisture associated with the remnants Ida interacted with a nearly stationary frontal boundary.

On the evening of September 1, a particularly bad situation unfolded as life-threatening flash flooding shifted from the Mid-Atlantic into the Northeast and Southern New England – which included densely populated regions across northern New Jersey and New York City. A corridor of extremely efficient tropical rainfall resulted in numerous Flash Flood Emergencies, while periodic supercells along the boundary spawned damaging tornadoes which created particularly dangerous situations across portions of Maryland, Pennsylvania, and New Jersey. The City of Trenton in New Jersey was affected by both a rare Tornado and Flash Flood Emergency in the span of several hours on September 1.

Data from the NWS indicated a record hourly rainfall of 3.15 inches (80 millimeters) fell in New York City's Central Park on September 1 between 8:51 and 9:51 PM local time, breaking the previous record of 3.05 inches (77 millimeters) set in 1913. In anticipation of torrential rainfall, the NWS declared a rare High RIsk of excessive rainfall on September 1 spanning from southern Pennsylvania through New York City and into Connecticut. Flooding was further enhanced by already saturated soils across portions of the Mid-Atlantic and New England which persisted from heavy rainfall produced by Tropical Storm Henri the previous week.

Summary of Ida's Official Landfalls per NOAA

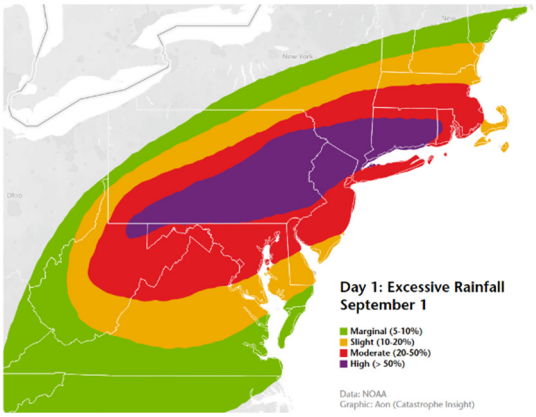
Landfall Time (UTC)	Landfall Time (local)	Location	Wind Speed (mph)	Saffir-Simpson Category Rating	Minimum Central Pressure
Aug. 27: 1700	1:00 PM	Isle of Youth, Cuba	75 mph	Category 1	987 millibars
Aug. 27: 2325	7:25 PM	East of La Coloma, Cuba	80 mph	Category 1	985 millibars
Aug. 29: 1655	11:55 AM	near Port Fourchon, Louisiana (USA)	150 mph	Category 4	930 millibars
Aug. 29: 1900	2:00 PM	near Galliano, Louisiana (USA)	145 mph	Category 4	934 millibars

Commentary: NOAA Forecasts & Ida

It is worth noting the exceptional forecasting success that several branches of NOAA achieved in the various forecasts surrounding Hurricane Ida. This was one of the best forecast events in recent memory.

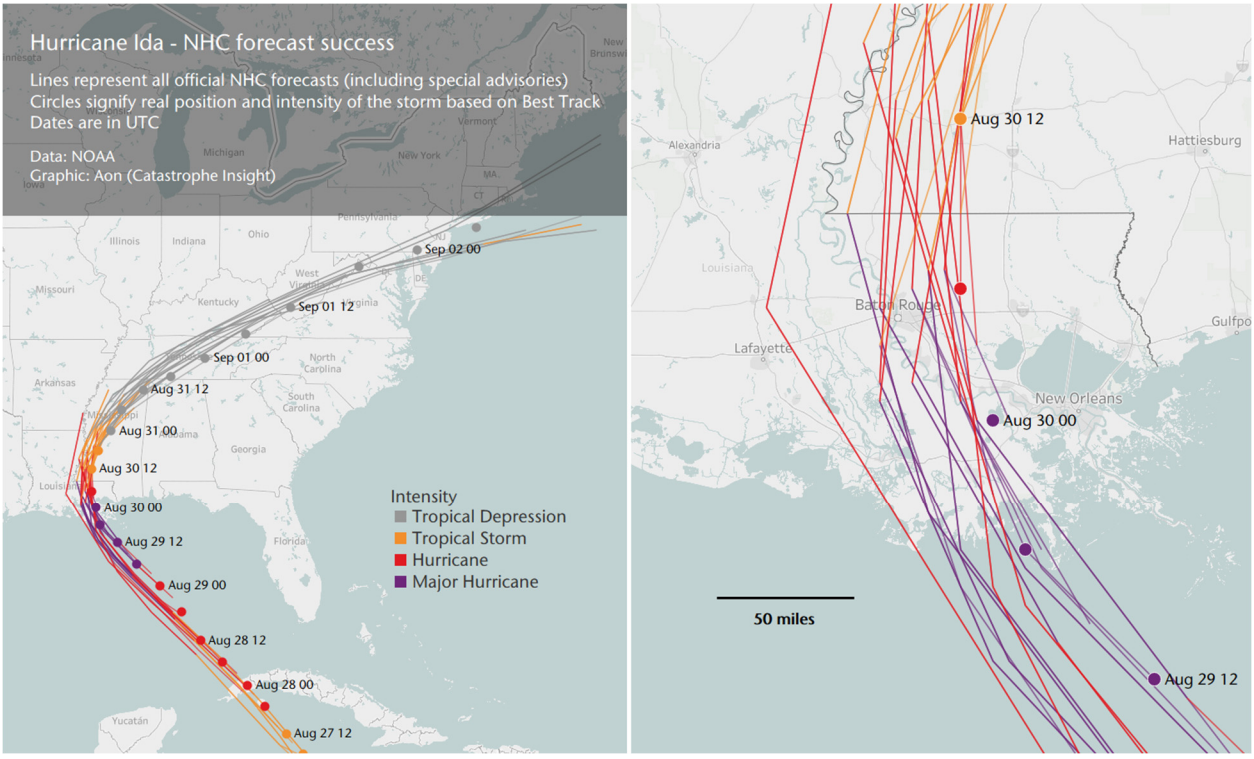
Weather Prediction Center / National Weather Service

The extensive rainfall that led to catastrophic flooding across the Mid-Atlantic and Northeast was forecast well in advance by the Weather Prediction Center (WPC) and the National Weather Service (NWS). Both agencies highlighted that the last several months of above-average rainfall in addition to torrential rains less than 10 days prior from Tropical Storm Henri had left soils highly saturated. The arrival of Ida and its remnants interacted with a complex weather pattern which resulted in a funnel of moisture into the Northeast. Due to this likelihood, the WPC issued a rare High Risk warning for excessive rainfall and extreme flooding.



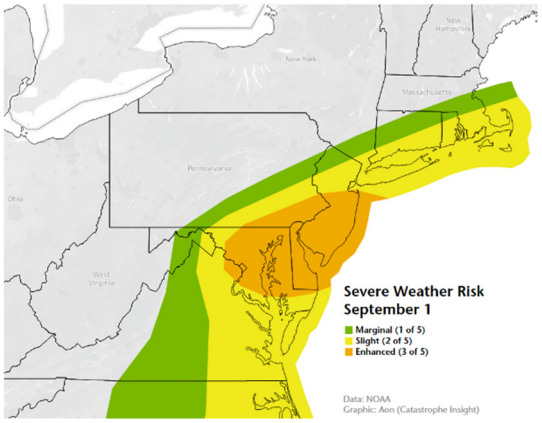
National Hurricane Center

Post landfall forecast analysis revealed a very high accuracy in the National Hurricane Centers (NHC) intensity and track forecasts for Hurricane Ida. As early as August 26, the NHC forecasts called for Ida to rapidly intensify over warm waters of the Gulf of Mexico before threatening the central Gulf Coast as a major hurricane. Confidence in this forecast was steadfast through subsequent advisories, up until the time of landfall in Louisiana on August 29. The consistency in the model forecast – both track and likelihood of intensification – was well verified. This forecast is widely considered one of the most successful NHC forecasts for a major U.S. hurricane landfall in the history of the agency.



Storm Prediction Center

As is typical in tropical cyclone events – and their remnants – there is always a tornado risk. This is especially true in a storm's outer bands or near the eyewall as fast moving and rotating thunderstorms often result in spin-up tornadoes. The Storm Prediction Center (SPC) issued daily forecasts for heightened tornado risk, including on September 1 as Ida's remnants entered the Northeast. An "Enhanced Risk", a 3 out of 5 on the scale, was identified. As forecast, a series of powerful tornadoes touched down, including in New Jersey and Pennsylvania. In total, at least 16 tornadoes were confirmed during Ida's life cycle.

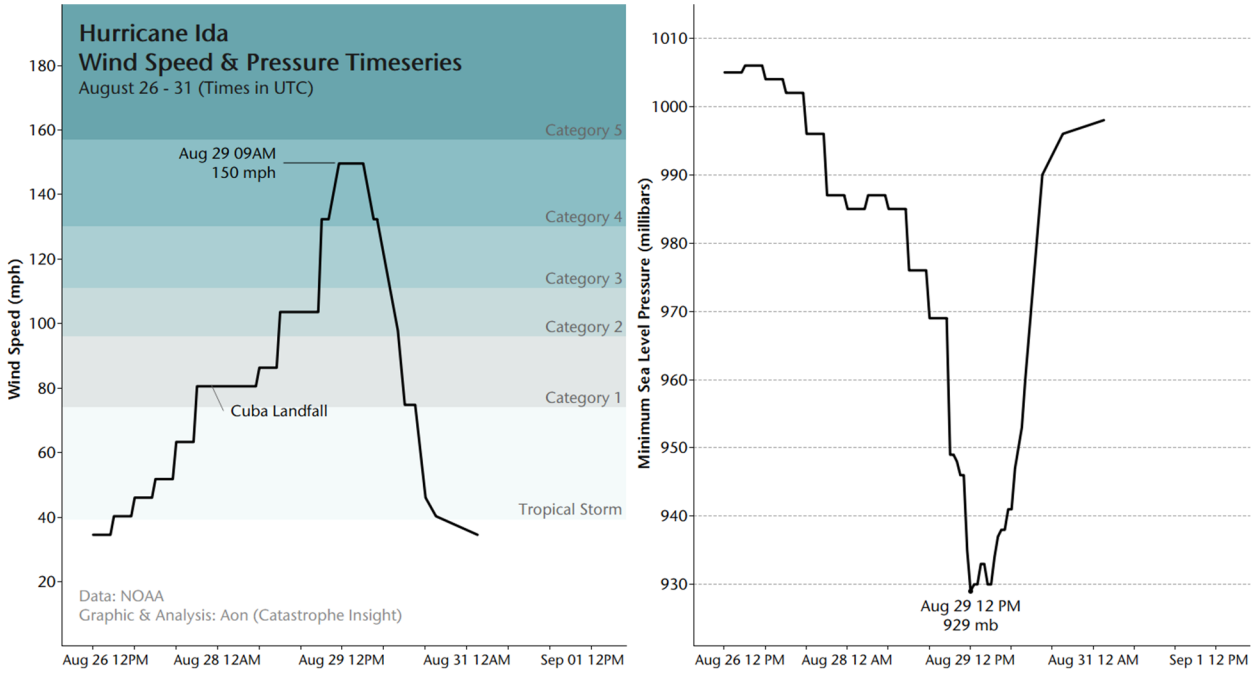


Visualizations: Ida Event Data

Wind Speed & Minimum Sea Level Pressure

Hurricane Ida underwent a period of explosive intensification which saw the storm intensify by 65 mph (100 kph) in a 24-hour period ending on August 29 (12:00 UTC). This also included the minimum central pressure dropping by 46 millibars to 929 millibars during the same timeframe. Ida became the latest storm to undergo rapid intensification up until the point of landfall – like Hurricane Laura in 2020.

The graphic below highlights a timeseries of Ida's wind speed and minimum sea level pressure during the period from August 26-31.



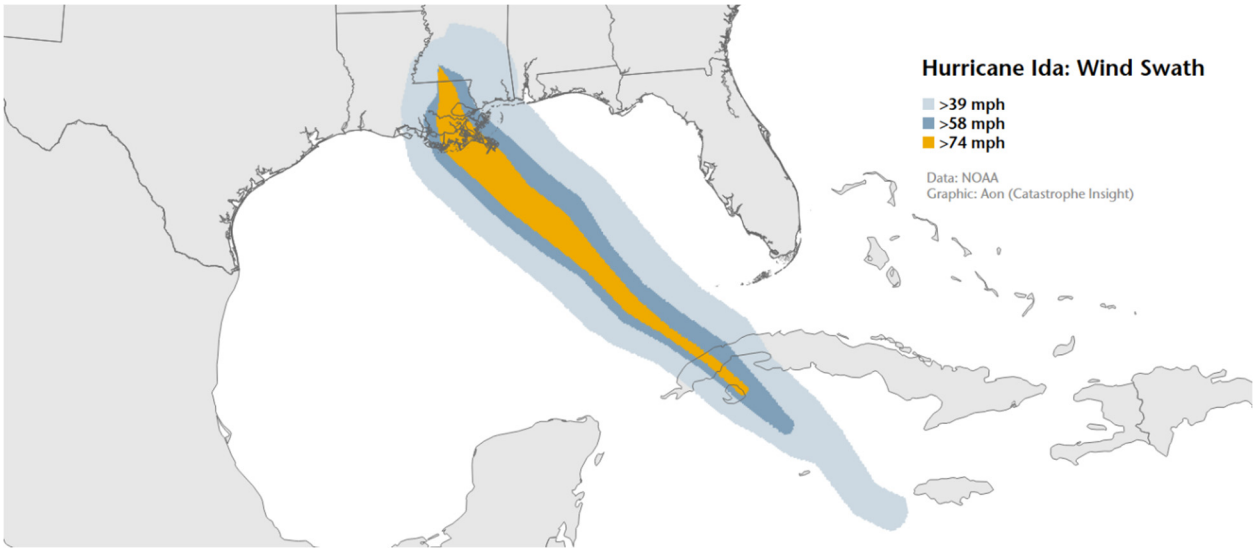
The table below highlights peak wind gusts measured during Ida. The 172 mph (277 kph) gust at on a ship near Port Fourchon, Louisiana is thought to be one of the highest wind gusts ever measured during a tropical cyclone. Please note that many of the stations failed as the peak of Ida passed. The failures included a loss of electricity and physical damage to the station. The data comes via NOAA.

Location	Wind Gust (mph)
Port Fourchon, Louisiana	172
Leeville, Louisiana	153
Dulac, Louisiana	138
Southwest Pass, Louisiana	128
Golden Meadow, Louisiana	125
Galliano, Louisiana	122

Location	Wind Gust (mph)
Pilots Station East, Louisiana	121
Mississippi Canyon, Louisiana	117
West Delta, Louisiana	112
Mandeville, Louisiana	111
North Dulac, Louisiana	110
New Orleans, Louisiana	99

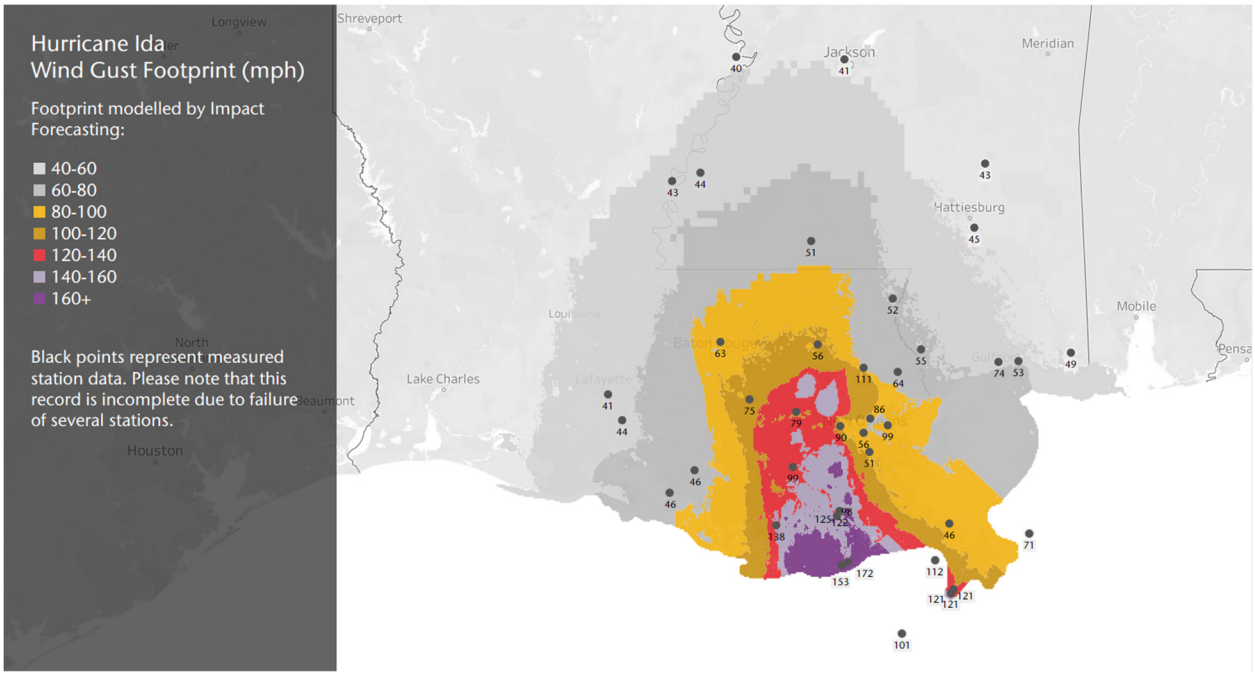
Wind Swath

The graphic below is the official wind swath for Hurricane Ida as provided by NOAA. Note the prolonged period of hurricane-force winds which tracked across Louisiana and into extreme southern Mississippi.



Impact Forecasting: Modeled Wind Gusts

The graphic below comes via Impact Forecasting's U.S. hurricane wind model. This is a footprint of estimated wind gusts while overlaid against official observational wind gusts. Please note that due to many reporting station failures, many areas may have endured higher wind gusts than measured prior to the gauge station being knocked offline or damaged.

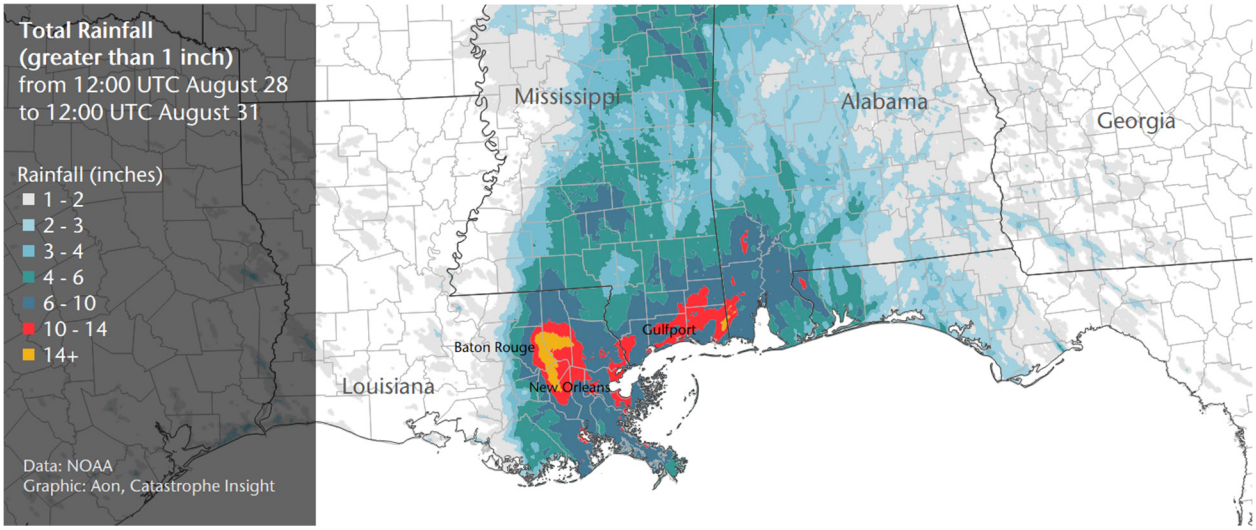


Precipitation

U.S. Southeast

Ida produced a prolonged period of torrential rainfall across portions of southeast Louisiana and coastal Mississippi. Radar estimated rainfall rates in the most affected localities approached and topped 10 to 14 inches (250 to 350 millimeters). Flash Flood Emergencies were issued for portions of St. John the Baptist, St. Charles, and Jefferson Parishes (Louisiana) on August 29. Some cities under the emergency declarations included: Alliance, Laplace, Lafitte, Jean Lafitte, Hammond, Tickfaw, and Ponchatoula. The rainfall-spawned flooding – in addition to river overflows – aided in the flood risk.

The graphic below highlights the total radar-estimated rainfall for Louisiana, Mississippi, Alabama, and Florida from August 28-31. The data comes via NOAA.



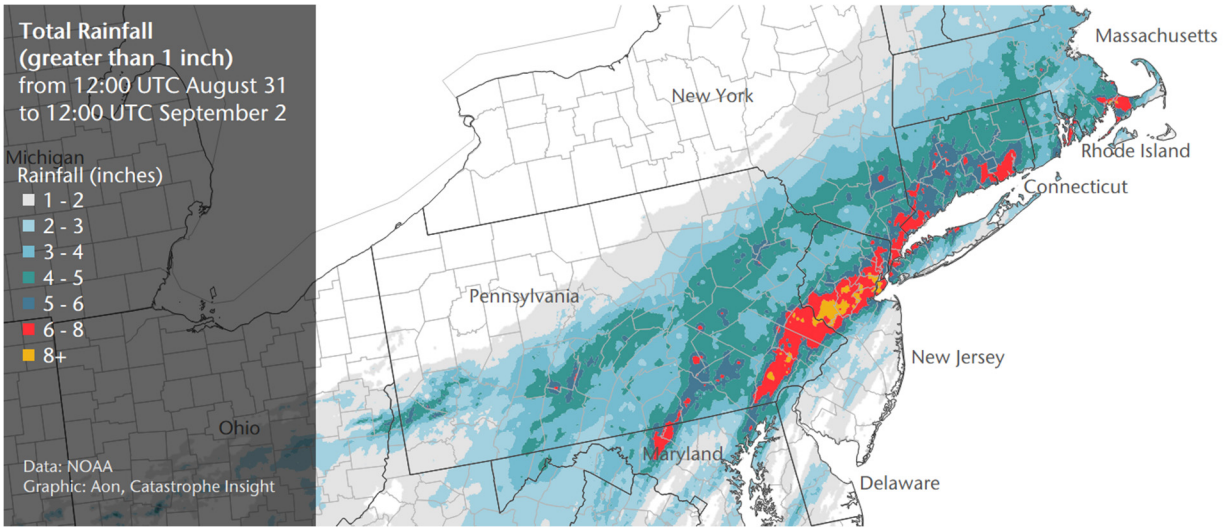
Peak rainfall totals for the Southeast are seen in the table below:

Location	Total Rainfall (in)
Rigolets, LA	15.73
New Orleans, LA	13.73
Bay St. Louis, MS	13.12
Moss Point, MS	12.54
Kiln, MS	12.14
Biloxi, MS	12.08
Napolean, LA	11.27
Wilmer, AL	11.24
Gulfport / Biloxi Intl Airport, MS	10.72
Folsom, LA	10.67

Location	Total Rainfall (in)
Lake Pontchartrain, LA	10.19
Mobile, AL	9.41
Slidell, LA	9.19
Walnut Hill, FL	8.20
Pensacola, FL	8.18
Fairhope, AL	7.30
Hattiesburg, MS	7.03
Pike, MS	7.03
Highlands, NC	5.72
Blue Ridge, GA	4.34

U.S. Northeast

Ida produced exceptional rainfall across the U.S. Mid-Atlantic and Northeast on September 1 as it began to track towards the Atlantic Ocean. With an interaction with a frontal boundary, and further influence from the Atlantic Ocean, this led to an enormous influx of moisture and energy to prompt torrential rainfall across a broad area. Flash Flood Emergencies and Flash Flood Warnings were issued across Pennsylvania, New Jersey, New York, Connecticut, and Massachusetts. The Flash Flood Emergency declaration in New York City metro marked the first time the local National Weather Service (NWS) office had issued such an alert for the city, and it also became the highest population count of people under the flood emergency declaration in the history of NWS.



Peak rainfall totals for the Mid-Atlantic and Northeast are seen in the table below:

Location	Total Rainfall (in)
Ringoes, NJ	9.91
Uri Peckham Farms, RI	9.83
New Bedford, MA	9.50
Coatesville, PA	9.43
Carteret, NJ	9.31
Warren, NJ	8.94
Staten Island, NY	8.92
Newark, NJ	8.44
Passaic, NJ	8.43
Newtown, PA	8.39

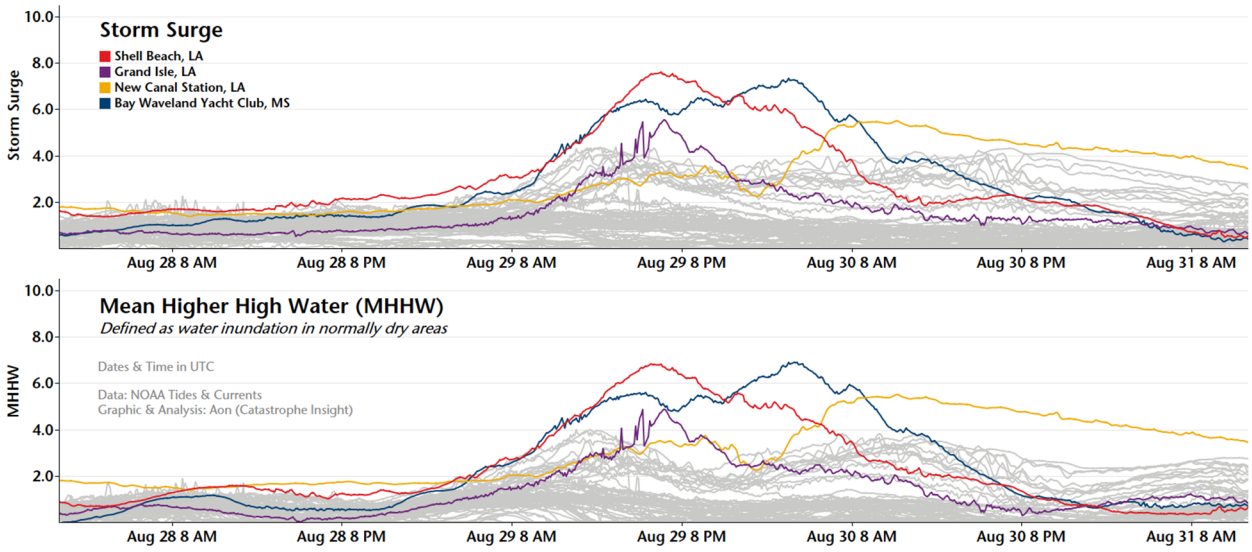
Location	Total Rainfall (in)
Quakertown, PA	8.35
Brooklyn, NY	7.76
Manhattan, NY	7.49
Holliston, MA	7.42
New York (Central Park), NY	7.19
Middletown, CT	6.95
Stamford, CT	6.91
New York (La Guardia), NY	6.89
Harrisburg, PA	6.53
Bristol, RI	6.38

Storm Surge

The graphic below highlights storm surge and Mean Water High Water (MHHW) heights as measured every six minutes by official gauge stations maintained by NOAA's Tides and Currents network. The peak storm surge officially measured was at Shell Beach, Louisiana. Storm surge measures the height of water above the forecast tide. Another way to measure how much coastal flooding actually got onto normally dry land – known as "Inundation" – is officially referred to as Mean Higher High Water (MHHW). The highest such value was in Bay Waveland, Mississippi.

For a full description on the various ways to measure water heights, please see the next page.

Please note that there are only a limited number of storm surge gauges along the U.S. Gulf Coast. Due to this reason, it is highly likely that the peak surge and inundation height values were not captured. A standard practice after a hurricane event is NOAA and its various branches conduct thorough post-event damage surveys. This includes seeking for water marks on damaged structures or trees to identify actual storm surge or inundation heights. Final and official totals will be released by NOAA in the coming months.



Peak storm surge and MHHW heights as measured by NOAA are seen in the two tables below. This data comes via NOAA's Tides and Currents group.

Location	Storm Surge (feet)
Shell Beach, Louisiana	7.62
Bay Waveland, Mississippi	7.34
Grand Isle, Louisiana	5.55
New Canal Station, Louisiana	5.51
Pilots Station East, Louisiana	4.37

Location	Inundation (feet)
Bay Waveland, Mississippi	6.91
Shell Beach, Louisiana	6.85
New Canal Station, Louisiana	5.52
Grand Isle, Louisiana	4.89
Pilots Station East, Louisiana	4.01

How to Measure Coastal Water Heights

There are several different parameters used to measure water heights. Each is a different way to measure the typical rise and fall of water values over time and can often be confusing. The graphics below – courtesy of NOAA – are meant to help differentiate these parameters, which include: Mean Lower Low Water (MLLW), Mean Higher High Water (MHHW), and Mean Sea Level. These parameters are used to identify the height of storm surge, storm tide, and inundation.

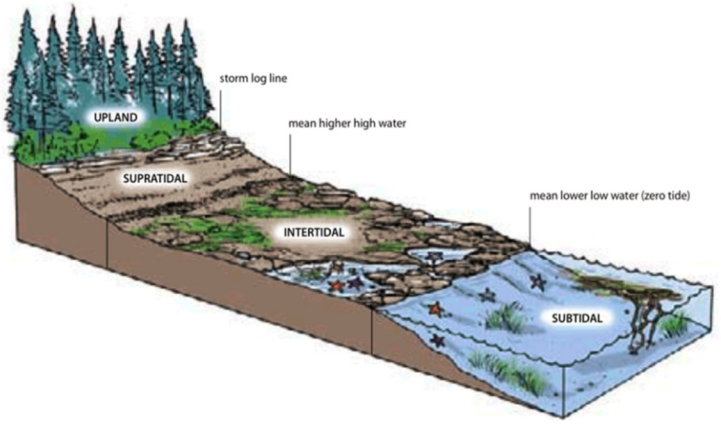
But what do these terms mean? Below is a glossary from NOAA to help explain.

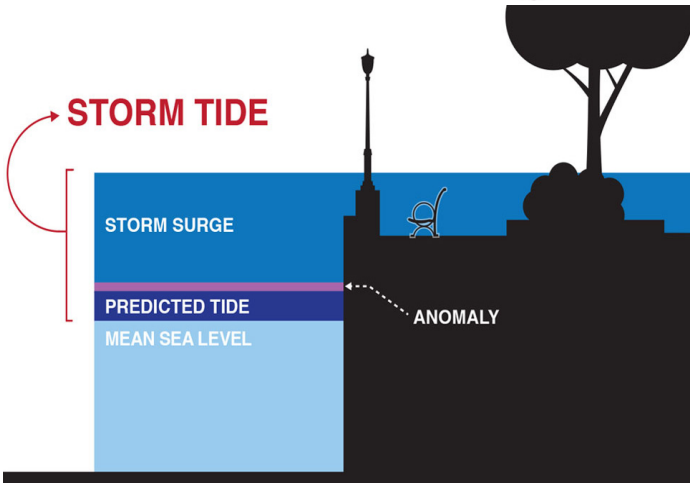
Storm Surge
The abnormal rise in seawater level during a storm, measured as the height of the water above the normal predicted astronomical tide. The surge is caused primarily by a storm's winds pushing water onshore. The amplitude of the storm surge at any given location depends on the orientation of the coast line with the storm track; the intensity, size, and speed of the storm; and the local bathymetry.

Storm Tide
The total observed seawater level during a storm, resulting from the combination of storm surge and the astronomical tide.

Mean Higher High Water
Highest of the two high tides per day (or the one low tide) averaged over a 19-year period. This 19-year period is called the National Tidal Datum Epoch, which currently runs from 1983 through 2001.

Also referred to as "inundation". It measures the height of water in areas normally considered as dry ground.





Source: NOAA

Mean Lower Low Water
Lowest of the two low tides per day (or the one low tide) averaged over a 19-year period. This 19-year period is called the National Tidal Datum Epoch, which currently runs from 1983 through 2001.

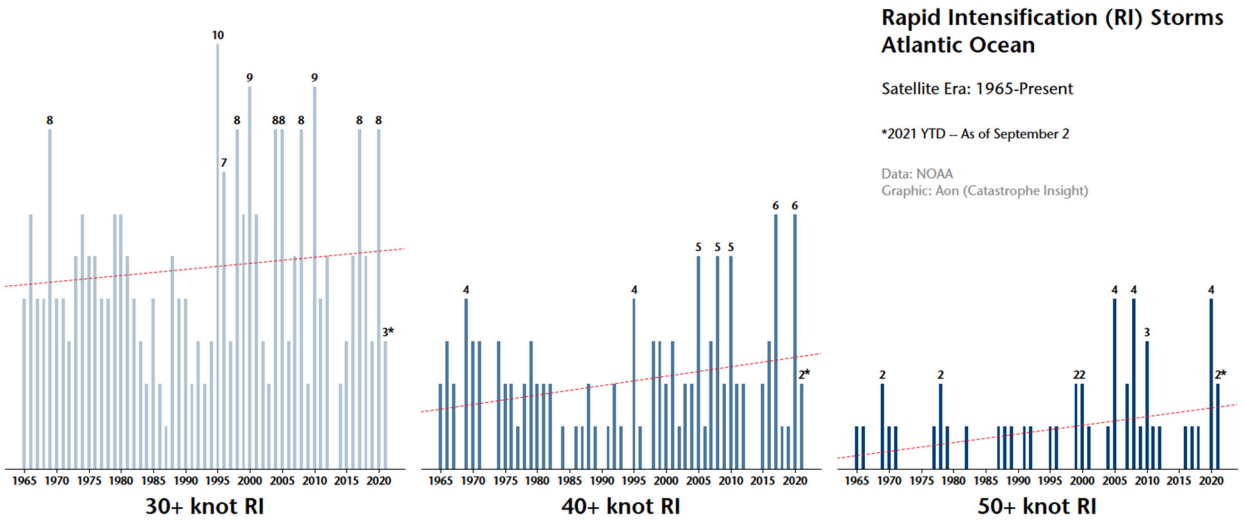
Also referred to as "Zero Tide". NOAA cites that U.S. nautical charts use MLLW to reference charted depths so that ship navigators know what water depths can be counted on for safe passage; even at the lowest levels of the astronomical tide.

Mean Sea Level
Derived mean from 19 years of tidal observations at a tide station. This 19-year period is called the National Tidal Datum Epoch, which currently runs from 1983 through 2001.

Visualizations: Miscellaneous Atlantic Ocean Tropical Cyclone Analysis

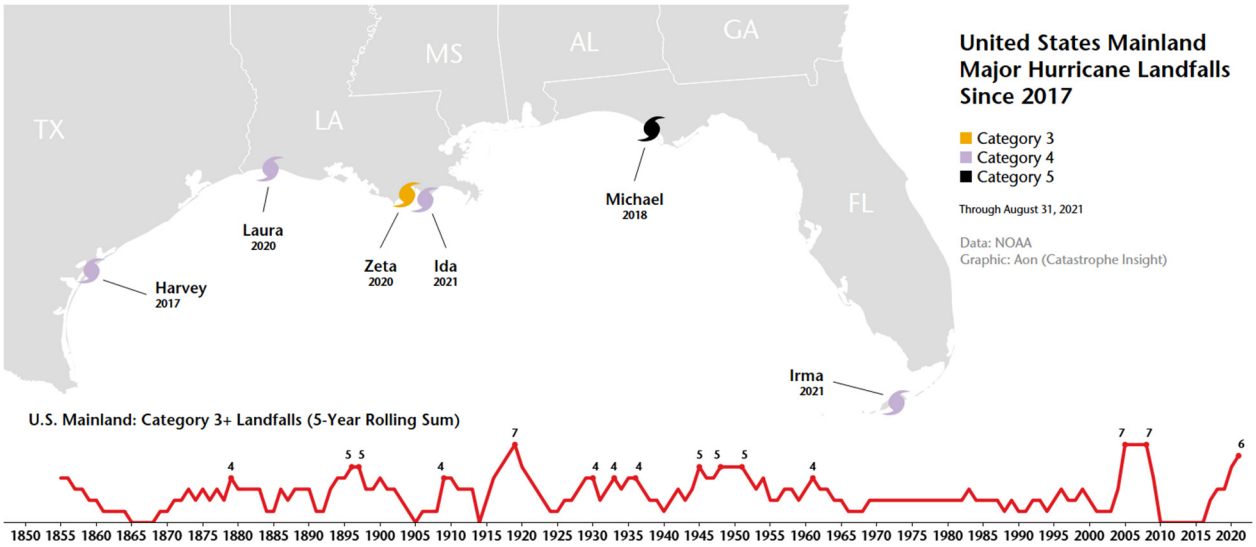
Rapid Intensification

Ida became the latest tropical cyclone in the Atlantic Ocean to undergo rapid intensification (RI). RI is defined as a storm's wind speeds intensifying by at least 35 mph (55 kph) within a 24-hour period. There has been a clear increasing trend in such Atlantic events during the past 55+ years. More recently, explosive RI – defined as a 60 mph (95 kph) or greater wind speed increase within a 24-hour period – has become even more common. This is tied to consistent annual increases in sea surface temperatures.



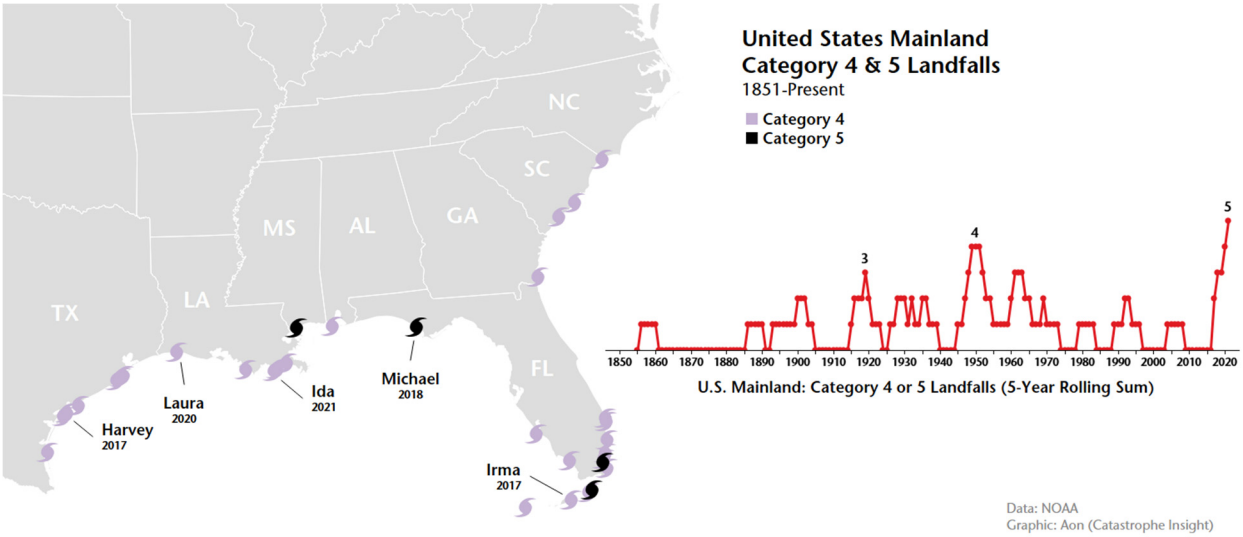
U.S. Major Landfall Trends

Six major hurricanes have struck the U.S. mainland since 2017, making this one of the highest 5-year stretches on record. Only 5-year stretches in the early 2000s and late 1910s had more (7).



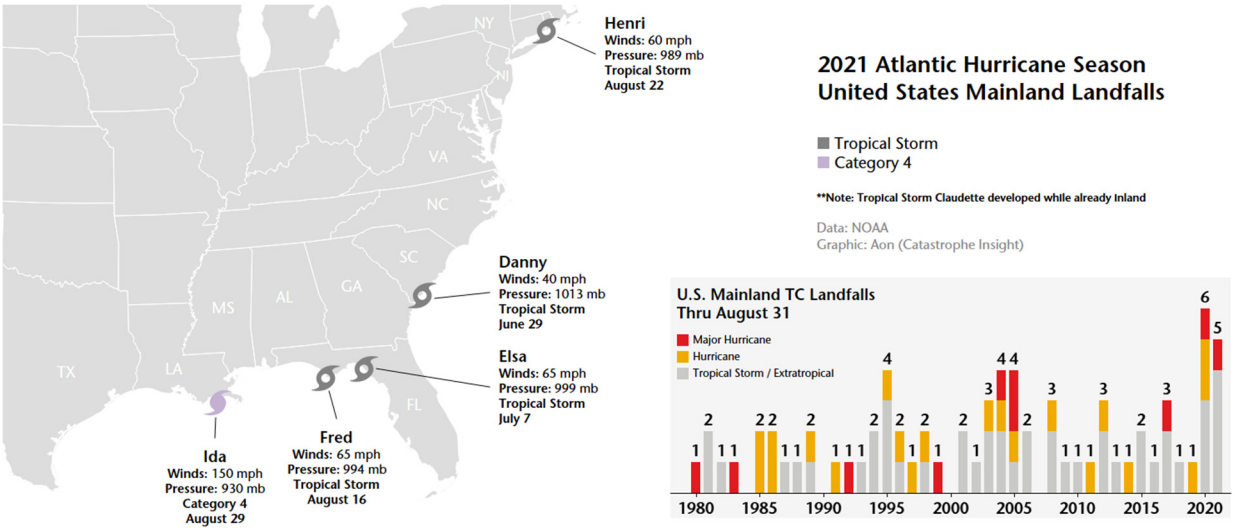
U.S. Mainland: Category 4 or 5 Landfalls

After a 26-year stretch where the United States only recorded one Category 4 or 5 landfall (1993-2016: Charley in 2004), the country has had five such landfalls since 2017. When conducting a 5-year rolling sum analysis since 1851, the current 2017-2021 period represents the most Category 4 or 5 landfalls on the U.S. mainland on record.



U.S. Landfalls: 2021 YTD

Ida marked the fifth landfall, thus far, in the United States during the 2021 Atlantic Hurricane Season. In the last 40+ years, this is the second highest number of named storm landfalls since 2020 (6). Please note that Tropical Storm Claudette developed while already inland. The National Hurricane Center does not currently count such an occurrence as a landfall.



U.S. Mainland: Strongest Landfalls (Sustained Winds)

Hurricane Ida tied as the strongest landfall in the official record in Louisiana in terms of sustained wind speeds. The storm tied Hurricane Laura (2020) and the 1856 Hurricane with 150 mph (240 kph) winds. Louisiana also became the first state to on record to endure back-to-back years with a hurricane landfall of winds in excess of 150 mph (240 kph).

Strongest Louisiana Landfalls (Wind)

Storm	Season Storm #	Winds (mph)	Cat.	MSLP
Ida (2021)	**9**	**150**	**4**	**930**
Laura (2020)	12	150	4	938
Unnamed (1856)	1	150	4	934
Betsy (1965)	3	130	4	946
Unnamed (1893)	10	130	4	948
Katrina (2005)	12	125	3	920
Audrey (1957)	2	125	3	946
Unnamed (1915)	6	125	3	944
Unnamed (1879)	4	125	3	945
Unnamed (1860)	1	125	3	945
Unnamed (1855)	5	125	3	945

Strongest Mainland U.S. Landfalls (Wind)

Storm	Season Storm #	Landfall State	Winds (mph)	Cat.	MSLP
Unnamed (1935)	3	Florida	185	5	892
Camille (1969)	9	Mississippi	175	5	900
Andrew (1992)	4	Florida	165	5	922
Michael (2018)	14	Florida	160	5	919
Ida (2021)	**9**	**Louisiana**	**150**	**4**	**930**
Laura (2020)	12	Louisiana	150	4	938
Charley (2004)	3	Florida	150	4	941
Unnamed (1932)	2	Texas	150	4	935
Unnamed (1919)	2	Florida	150	4	927
Unnamed (1886)	5	Texas	150	4	925
Unnamed (1856)	1	Louisiana	150	4	934

U.S. Mainland: Strongest Landfalls (Minimum Sea Level Pressure)

Hurricane Ida became the second strongest storm on record to strike Louisiana in terms of minimum sea level pressure. Its 930 millibar pressure was second only to Hurricane Katrina (2005) – 920 millibars. In terms of the United States mainland, Ida ranked as the 9th lowest pressure.

Strongest Louisiana Landfalls (Pressure)

Storm	Season Storm #	Winds (mph)	Cat.	MSLP
Katrina (2005)	12	125	3	920
Ida (2021)	**9**	**150**	**4**	**930**
Unnamed (1856)	1	150	4	934
Rita (2005)	18	115	3	937
Laura (2020)	13	150	4	939
Unnamed (1915)	6	125	3	944
Unnamed (1855)	5	125	3	945
Unnamed (1860)	1	125	3	945
Unnamed (1879)	4	125	3	945
Audrey (1957)	2	125	3	946
Betsy (1965)	3	130	4	946
Unnamed (1893)	10	130	4	948

Strongest Mainland U.S. Landfalls (Pressure)

Storm	Season Storm #	Landfall State	Winds (mph)	Cat.	MSLP
Unnamed (1935)	3	Florida	185	5	892
Camille (1969)	9	Mississippi	175	5	900
Michael (2018)	14	Florida	160	5	919
Katrina (2005)	12	Louisiana	125	3	920
Andrew (1992)	4	Florida	165	5	922
Unnamed (1886)	5	Texas	150	4	925
Unnamed (1919)	2	Florida	150	4	927
Unnamed (1928)	4	Florida	145	4	929
Unnamed (1926)	7	Florida	145	4	930
Donna (1960)	5	Florida	145	4	930
Ida (2021)	**9**	**Louisiana**	**150**	**4**	**930**
Carla (1961)	3	Texas	145	4	931

Event Details

Cuba

Hurricane Ida resulted in extensive agricultural losses, fallen trees and communication lines, and damage to property and structures across the **Isle of Youth** (Isla de la Juventud) and the **Pinar del Rio** Province of Cuba on August 28. In total, the Electricity Union reported that 600,000 customers were without power as the hurricane passed. In Pinar del Rio, the most notable impacts were reported in the municipalities of La Palma, Consolación del Sur, and Los Palacios. Authorities confirmed that 10,742 people were evacuated due to the cyclone, of which at least 1,147 people relocated to evacuation centers. Local authorities provided a preliminary summary of damage in both affected provinces as of August 30. In Pinar del Rio, at least 506 homes were damaged, of which 41 collapsed completely. Additionally, nearly 1,800 hectares of agricultural land was affected, mainly tobacco crops. The Isle of Youth reported 140 structures damaged, of which 12 collapsed.

United States

Hurricane Ida's wind, storm surge, and heavy rainfall brought widespread and catastrophic impacts to portions of the central Gulf Coast between August 28-30, including southeastern Louisiana and coastal Mississippi. By the morning of August 30, at least 1.2 million customers across Louisiana and Mississippi were without power – including 14 counties and parishes with at least 80 percent of customers affected by outages. In many instances, power outages were anticipated to persist for days to weeks.

By September 1, torrential rainfall resulted in catastrophic and record-breaking inland flooding and flash-flooding across the Mid-Atlantic and Northeast, accompanied by instances of severe weather and localized damaging tornadoes.

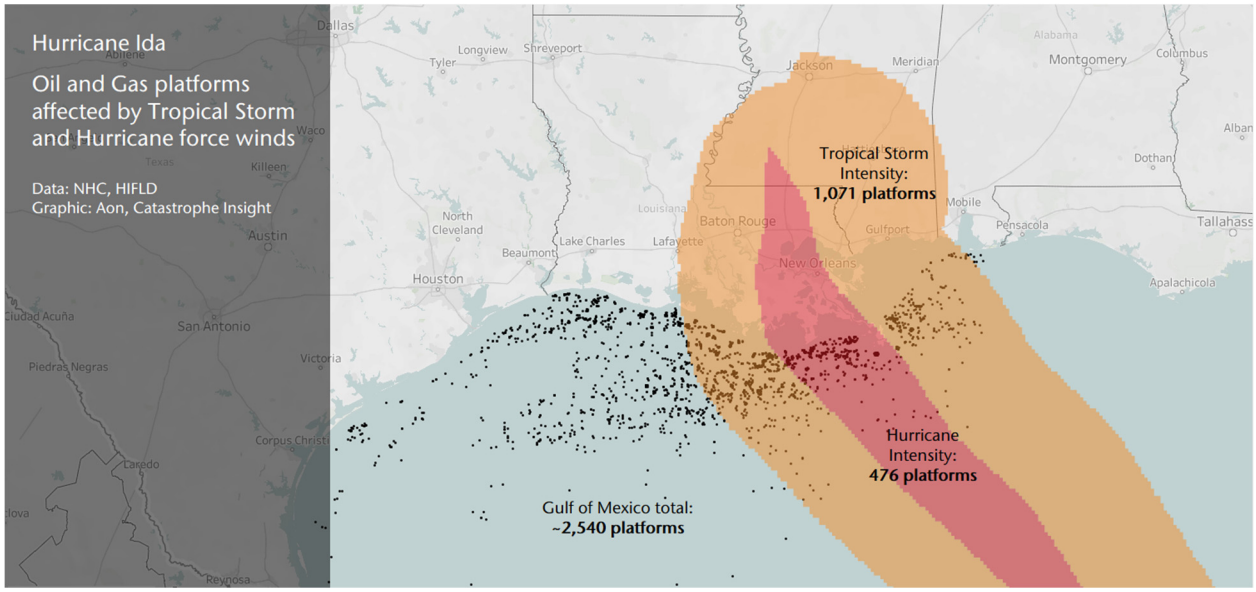
Louisiana

In Louisiana, the Governor declared a State of Emergency on August 26 in anticipation of the impacts from Hurricane Ida, while a federal emergency declaration was approved the following day. As the hurricane approached, a mandatory evacuation order was given for residents of Metropolitan New Orleans who resided outside flood protection areas, in addition to people in all or portions of Assumption, Terrebonne, Lafourche, Plaquemines, and St. Charles Parishes.

Aerial damage surveys conducted by the United States Coast Guard (USCG)
Source: USGS Heartland

In the wake of the storm, more than 1 million power outages were reported by the morning of August 30 in Louisiana alone. Catastrophic transmission damage related to a massive Entergy tower collapse near the Mississippi River in Jefferson Parish resulted in power loss to virtually all Metropolitan New Orleans in the evening of August 29. Entergy officials reported at least 2,000 miles (3,220 kilometers) of power transmission lines were out of service across the region. At the peak, federal officials indicated 441,000 customers lacked water service across 17 parishes, while at least 319,000 people were under boil-water advisories. Ida temporarily shut down a majority of critical oil production and refining operations in the Gulf of Mexico, accounting for approximately 15 percent of the country's total. The situation was further compounded by additional mainland oil production shutdowns, particularly near Baton Rouge and New Orleans.

The graphic below highlights the Ida's wind swath overlaid with the known platforms in the Gulf of Mexico.



According to the Flood Protection Authority, there were no reported levee breaches within the New Orleans Hurricane and Storm Damage Risk Reduction System (HSDRRS) – which consists of 350 miles (563 kilometers) of levees and floodwalls in portions of Orleans, Jefferson, St. Bernard, St. Charles, and Plaquemines Parishes

Ida generated extreme storm surge topping 7.0 feet (2.1 meters) along coastal regions of the state, while hurricane force wind gusts continued inland hours after landfall. Given a lack of available gauge stations, it was anticipated that once NOAA conducts a manual survey in the coming weeks and months that maximum surge heights will be much higher.

Storm total precipitation values across a large region of southeastern Louisiana reached 10 to 14 inches (250 to 350 millimeters), with locally higher amounts. Catastrophic and widespread damage resulted across many communities in Louisiana – particularly New Orleans, Golden Meadow, Houma, Galliano, LaPlace, Lafitte, and Grand Isle among others. Furthermore, disaster planning and evacuations were complicated by a recent surge of COVID-19 cases in the most affected regions.

In **Plaquemines Parish**, significant inundation was observed in the Community of Braithwaite, as water overtopped a levee along the Mississippi River – which was not part of the system that protects greater New Orleans. Hundreds of homes in Braithwaite were affected to varying degrees. In Belle Chase, data from the United State Geological Survey (USGS) indicated that storm surge and strong winds generated by Ida caused the flow of Mississippi River near to temporarily reverse on August 29.

Storm surge and flooding in Grand Isle from Hurricane Ida
Source: Congressman Garret Graves (LA06)

In **Jefferson Parish,** aerial images showed extraordinary damages to homes and structures across the barrier island of Grand Isle, which was among the hardest hit by the hurricane. According to parish officials, nearly 100 percent of structures on the island were damaged to varying degrees, of which at least 40 percent were destroyed or uninhabitable. Sand, debris, and mud from multiple levee failures on the Gulf side damaged and blocked roadways. Elsewhere, exceptional flooding in the towns of Lafitte and Jean Lafitte, enhanced by water overflowing a levee, forced numerous residents to evacuate to attics or roofs while waiting for emergency rescue. According to the Lafitte Mayor, at least 100 people were rescued from floodwaters by August 30. Many roadways and homes throughout the towns were damaged or destroyed, including a local school. At the peak, water levels reportedly topped 10 to 12 feet (3.0 to 3.7 meters). Rescue efforts were complicated in nearby Barataria as the bridge leading to the community was destroyed.

In **Orleans Parish**, all flights at New Orleans International Airport were cancelled for multiple days beginning on August 29. In the wake of the storm, 911 services were unavailable due to issues at a central routing facility. Across New Orleans, floodwaters, debris, and downed utility lines blocked local streets. Notable damages were observed in the French Quarter which included torn roofs and partially collapsed buildings. In East New Orleans, toppled trees and broken water pipes left residents without access to water services.

Damage in New Orleans French Quarter
Source: New Orleans Fire Dept.

Wind damage to homes and timber in Golden Meadow, LA
Source: NOAA

In **Lafourche Parish**, powerful storm surge and hurricane force winds damaged or destroyed multiple homes and structures near Galliano and Golden Meadow, reportedly removing several from their foundation. Additional impacts included overturned and swept away vehicles, and downed trees and power lines. At least one death due to flooding was confirmed. The Lady of the Sea General Hospital in Galliano suffered damages which included a significant amount of roofing torn off. Further south, extensive damage was incurred in Port Fourchon, which acts as a critical hub for servicing oil rigs and supplies across the Gulf of Mexico and the United States.

In **St. John the Baptist Parish**, a particularly bad situation unfolded in LaPlace as incessant rainfall and encroaching floodwater from Lake Pontchartrain resulted in devastating flash-flooding which trapped residents and destroyed multiple homes. Parish officials rescued at least 800 people from the floodwaters.

In **Terrebonne Parish**, dangerous winds left catastrophic impacts near Houma, which took a nearly direct hit from Ida as the eyewall passed just east of the city. Roofing damage was noted at the Terrebonne General Medical Center, while numerous nearby homes and business were damaged or destroyed.

In **St. Bernard Parish,** a maximum storm surge of 7.62 feet (2.3 meters) was recorded at Shell Beach as Ida approached on August 29. Parish officials reported at least twenty-two barges broke loose from their mooring and were drifting in the Mississippi River. In **St. Charles Parish**, Entergy Energy declared an ‘Unusual Event’ on August 29 after power issues affected the Waterford 3 Nuclear Generating Station in Killona. In **Ascension Parish**, at least one death due to a fallen tree was reported. In **St. Tammany Parish**, the parish president reported numerous roadways were blocked and homes were damaged by falling trees.

Jean LaFitte: Before (left) and After (right). A levee breech and overtop led to substantial flooding.
Source: NOAA

Mississippi

The Governor of Mississippi declared a State of Emergency on August 28 in anticipation of Hurricane Ida. The storm left 113,000 customers, predominantly in southern portions of the state without electricity. Significant flooding was reported in coastal regions near Gulfport, Biloxi, and Bay St. Louis. In **George County**, two deaths were confirmed after several vehicles crashed into hole created by the partial collapse of a washed-out highway near Lucedale. Ten other people were injured in the incident.

A preliminary damage assessment provided by the Mississippi Emergency Management Agency (MEMA) indicated **164 homes were impacted, of which six were destroyed and 42 had major damages.** Additionally, **the hurricane affected at least 184 roads and 53 bridges.**

Alabama

In **Jefferson County**, two electrical workers were killed while repairing damage incurred on the power grid on August 31. As of this writing, at least four tornadoes spawned by Ida were surveyed across the state on August 30, and two additional on August 31. An EF-1 tornado which touched down in **Mobile County** on August 30 resulted in roofing damages to several structures and businesses, while uprooting trees along its path.

Mid-Atlantic

In **Virginia**, a State of Emergency was Declared by the Governor on August 31 in order to assist with flooding response and recovery efforts. In **Buchanan County,** at least 20 homes in Hurley, near Knox Creek, were destroyed by flash-flooding on August 31. County officials reported 60 people were evacuated, while one fatality was confirmed.

Flooding in Hurley, Virginia
Source: Roanoke Fire-EMS

In **Maryland**, a confirmed tornado in **Anne Arundel County** resulted in substantial property and tree damage between Edgewater and the state capital of Annapolis on September 1. Damages included at least one school. In **Fredrick County**, multiple swift water rescues were carried out. In **Montgomery County**, at least 150 people were evacuated from flooded apartment buildings. One death in the state due to flooding was reported.

Northeast

Exceptional and historic rainfall led to catastrophic and deadly flash flooding across several states in the Northeast on September 1. **New York**, **New Jersey**, **Pennsylvania**, **Connecticut**, **Rhode Island**, and **Massachusetts** all recorded rainfall that exceeded a 1-in-200-year return period at several different time scales (5-minute, 1-hour, 2-hour, 3-hour, 6-hour, 12-hour, and 24-hour). This means that there was a less than 0.5 percent chance of such an intense rainfall event happening in any given year. The flooding was extensive and deadly, with at least 41 fatalities reported – a majority of which occurred in New York City and New Jersey. The torrential rainfall was accompanied by periods of severe convective storms, where at least seven tornado touchdowns were confirmed as of this writing. In the wake of the deluge, at least 200,000 customers across the region were left without power.

In **New York**, Governor Kathy Hochul declared a state of emergency after intense flooding inundated many areas in metropolitan **New York City**, Long Island, and across the Hudson in New Jersey. The National Weather Service (NWS) issued its first-ever Flash Flood Emergency for the city of New York. Heavy rainfall flooded subway lines and streets in Manhattan, Brooklyn, Queens and New Jersey. The rainfall in Central Park was at least a 1-in-500-year rainfall event (0.2 percent chance of occurrence in any given year), according to NOAA rainfall frequency data, with 5.2 inches (132 millimeters) falling in only three hours. The park recorded 7.13 inches (181 millimeters) of rain on September 1, making it one of the five wettest days in its recorded history. Weather records have been kept in Central Park since 1869.

Flooding streets in NYC on September 1
Source: Chief Juanita Holmes, NYPD

The incessant rainfall resulted in a citywide travel advisory across New York City, while most subway services were suspended. In **Queens**, the partial collapse of two buildings was reported, as multiple businesses, homes, apartments, and vehicles were indurated with floodwater.

At least one person died after a tornado struck in Mullica Hill southern **New Jersey**, damaging at least nine homes along Josephine and Marvin Lanes. According to the NWS, the tornado caused damage consistent with at least an EF-3 rating. An additional EF-1 tornado was confirmed in **Burlington County** before dissipating in Bucks County, Pennsylvania. Storms caused multiple road closures across New Jersey and railway transit was suspended. On September 1, the city of Newark recorded its wettest day in recorded history 8.41 inches (214 millimeters) of rainfall. The old record was set in 1977, 6.73 inches (171 millimeters).

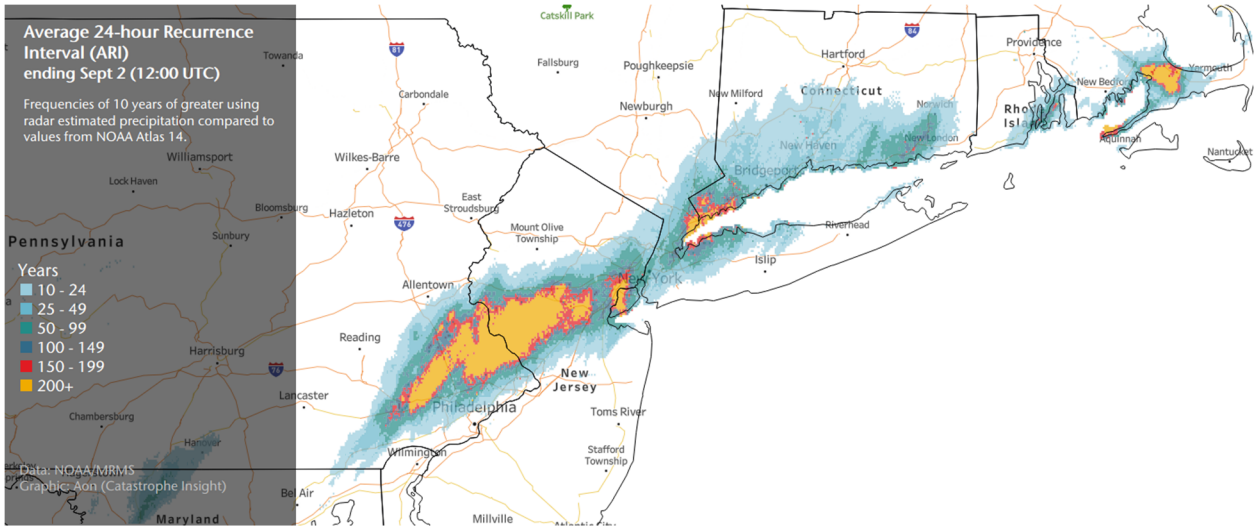
A State of Emergency was declared in New Jersey due to the historic flooding and damaging tornadoes. At Newark Liberty Airport, significant flooding was observed inside a terminal and baggage room, while at least 370 flights were canceled on September 2.

Water rescue in Washington County, PA
Source: Cherry City Fire

In **Pennsylvania**, a Flash Flooding Emergency was issued for communities below the Wilmore Dam in Cambria County on September 1 as incessant rainfall caused water levels behind to dam to exceed capacity. According to county emergency officials, the initial evacuation order included no fewer than 3,000 people. Across the state, the Pennsylvania Department of Transportation (PennDOT) indicated 50 roads were closed due to flooding by the afternoon of September 1.

In **Washington County,** boats were required to rescue at least 40 students and a driver after a school bus became trapped in rising floodwater. In **Montgomery County**, at least 352 water rescues were executed between September 1-2. The NWS reported EF-2 tornado damaged was surveyed from Fort Washington and Upper Dublin Township to Horsham Township. The tornado had estimated peak winds speeds 130 mph (210 kph). As of this writing, three deaths were reported in the county. The Schuylkill River at Norristown crested at a record level of 26.85 feet (8.2 meters) on September 2. Several people were forced to evacuate to rooftops to avoid rapidly rising water levels. The Perkiomen Creek at Graterford also crested at a record height. An EF-1 tornado was confirmed in **Bucks County**, near Buckingham Township.

The graphic below highlights the annual exceedance probability (AEP), or the annual likelihood of such a volume of rainfall occurring. A significant swath of eastern Pennsylvania, central New Jersey, southern New York, southwest Connecticut, southeast Rhode Island, and southeast Massachusetts recorded 24-hour rainfall rates exceeding a 1-in-200-year return period. This equals a 0.5 percent chance of such rainfall occurring in a specific area in any given year. This amplified the rate of flash flooding and fast river rises across the Northeast on September 1 into the morning hours of September 2.



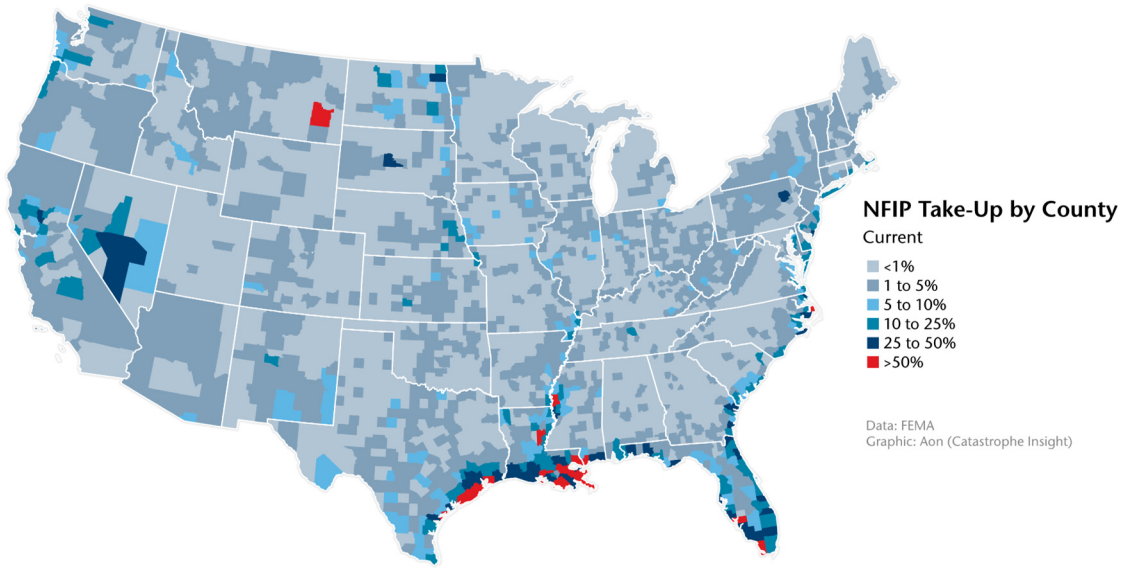
Financial Loss

The financial impact from Hurricane Ida is going to be significant. The initial swath of extensive wind, storm surge, and inland flood-related damage across Louisiana was already estimated to have caused economic damage and direct losses well into the double-digit billions (USD) even prior to its remnants moving further inland across the Southeast and Tennessee Valley. The catastrophic flood-related damage in the Mid-Atlantic and Northeast is additionally poised to result in an additional double-digit billion economic damage toll. The enormous scale of damage along Ida's path will result in a lengthy period of damage assessment and quantifying the direct fiscal cost to residential and commercial property, vehicles, the energy sector, infrastructure (transportation and electrical), agriculture, and direct net-loss business interruption. Ida is anticipated to become one of the costliest U.S. mainland tropical cyclones on record – based on nominal (actual) and inflation-adjusted values.

The impact to the insurance industry is also expected to be high. Wind-related residential, commercial and auto damage across Louisiana and parts of Mississippi and Alabama were anticipated to primarily be covered by standard insurance policies. The same is true with the severe convective storm damage in the Northeast, including the series of tornadoes which struck New Jersey and Pennsylvania.

However, a sizeable portion of the eventual economic damage cost is not likely to be covered by insurance. This includes most coastal and inland flood damage, such as damage to infrastructure (roads, bridges, electrical grid, etc) or properties without an active National Flood Insurance Program (NFIP) policy. Damage photos across New York and New Jersey noted a high volume of property flooding due to either drainage back-ups or sewage back-ups. How specific language is written in contractual policies and how individual damage cases are assessed will be key to how much of the flood damage to homes, condos, and businesses is covered by insurance. Flooded vehicles are typically covered in a standard auto policy. Coastal areas in New York, New Jersey, and Connecticut have a relatively high percentage of NFIP take-up, which could lead to elevated program claims payouts in the Northeast.

The expectation is that the insurance impact – including losses from private and public entities – will be a significant double-digit billion (USD) total. It will take many months or longer for the financial view of this event to fully develop. Loss estimates will be subject to several revisions as more data is obtained.



Costliest U.S. Mainland Tropical Cyclones

The table below highlights the Top 10 costliest United States mainland hurricane landfalls on record on an economic and insured loss basis. The values take the actual incurred damage and use a simple inflation-adjustment using the U.S. Consumer Price Index to index to today's dollars.

Costliest U.S. Mainland Hurricanes (Economic)

Storm Name (Year)	Economic Loss (2021 USD)	Insured Loss (2021 USD)
Katrina (2005)	**170 billion**	88 billion
Harvey (2017)	**136 billion**	33 billion
Sandy (2012)	**79 billion**	35 billion
Andrew (1992)	**51 billion**	30 billion
Irma (2017)	**44 billion**	27 billion
Ike (2008)	**37 billion**	22 billion
Ivan (2004)	**29 billion**	12 billion
Michael (2018)	**27 billion**	14 billion
Wilma (2005)	**26 billion**	14 billion
Florence (2018)	**25 billion**	6 billion

Costliest U.S. Mainland U.S. Hurricanes (Insured)

Storm Name (Year)	Economic Loss (2021 USD)	Insured Loss (2021 USD)
Katrina (2005)	170 billion	**88 billion**
Sandy (2012)	79 billion	**35 billion**
Harvey (2017)	136 billion	**33 billion**
Andrew (1992)	51 billion	**30 billion**
Irma (2017)	44 billion	**27 billion**
Ike (2008)	37 billion	**22 billion**
Wilma (2005)	26 billion	**14 billion**
Michael (2018)	27 billion	**14 billion**
Ivan (2004)	29 billion	**12 billion**
Rita (2005)	25 billion	**12 billion**

About the Data

The data in the above tables include **actual** direct damage or net loss business interruption costs at the time of occurrence (nominal). A simple inflation adjustment using the U.S. Consumer Price Index has been used to determine the losses in today's dollars.

Other historical loss analysis may use a "normalization" technique in an attempt to estimate the cost if the event occurred today. This **hypothetical** analysis is useful to see what losses would be in a current environment with changes in exposure, building construction improvements, infrastructure development, changes in population, and cost of living. Such an analysis would add many historical early 20th Century storms near the top of the list.

About Aon

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