



## North Atlantic Tropical Cyclones, 1989

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**ut of Africa— This season the recent trend for large, Cape Verde type hurricanes continued. One of these, Hurricane Hugo, became the most costly hurricane in history.**

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**W**hile tropical cyclone activity for the Atlantic, Caribbean and Gulf of Mexico was just slightly above normal, the trend for large, strong Cape Verde hurricanes continued. Hurricane Hugo reached category five on the Saffir/Simpson Scale and caused an estimated \$7 billion damage in the U.S. and \$3 billion elsewhere. Gabrielle was another large Cape Verde type that reached category four, but remained at sea.

*Elaine Barto (right) and her daughter Mellisa show a moment of shock as they look at the remains of their home in Folly Beach, SC. The beach front home was destroyed by Hurricane Hugo on the 21st of September when Hugo hit the South Carolina coast. Boston Globe photo by Barry Chin.*

It appears from the relatively small number of ships reporting 50 knots or greater that shipping was able to avoid this season's intense tropical cyclones. Although routinely available satellite imagery is one of the primary observational tools, ship reports retain their significance to tropical weather forecasters, particularly during the initial development phase of cyclones where surface truth is important in documenting the correct intensity.



### Tropical Storm Allison

Tropical Storm Allison developed from the remnants of eastern Pacific Hurricane Cosme and a tropical wave. Based upon observations from offshore oil rigs and coastal surface data, a tropical depression formed on the 24th. It was upgraded to tropical storm status on the 26th based on a wind report of 35 knots with gusts to 45 knots from the *M/T Jacinth*, some 100 nautical miles northeast of the center. Allison moved inland over the mid Texas coast, near the northeast end of Matagorda Bay, with a central pressure of 1002 millibars but continued to strengthen slightly over the next 12 hours as the central pressure dropped to 999 millibars on the 27th.

Torrential rains accompanying Allison fell along the upper Texas coast and over the western two-thirds of



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Louisiana. Nearly 30 inches of rain fell in a 6-day period at a few locations in north-central Louisiana. The death toll in Allison was 11, all attributed to drowning. Estimated damage is near one half billion dollars, due mainly to flooding.

### Tropical Storm Barry

A tropical depression developed on the 9th of July, while located midway between Africa and the Lesser Antilles. The depression tracked northwestward and was upgraded to tropical storm strength on the 11th based on satellite intensity estimates. A 35-knot wind reported later by the *Sirius*, located 15 nautical miles north northeast of the center, confirmed the tropical storm status. Barry weakened to a depression on the 13th.

### Hurricane Chantal

Chantal, the first hurricane of the season, was detected on the 24th of July as a disturbance near Trinidad. Ships and satellites indicated that a tropical depression formed on the 30th. The depression became a tropical storm on the 31st, when an Air Force reconnaissance plane estimated maximum surface winds of 45 knots, while the *Saudi Diriyah* reported a 50-knot wind on the east side of the storm center. Chantal continued strengthening while moving northwest toward the upper Texas coast and was upgraded to a hur-

## Monthly Summary of 1989 Atlantic Tropical Cyclones

	Jun	Jul	Aug	Sep	Oct	Nov	Total
Tropical Depressions	1	0	2	0	1	0	4
Tropical Storms	1	1	0	1	0	1	4
Hurricanes	0	2	3	1	1	0	7
Total	2	3	5	2	2	1	15

(Tropical cyclones are assigned to the month in which they first became a tropical depression)

ricane by the 1st of August. Chantal reached its peak, just prior to the center making landfall at High Island, Texas with top winds of 70 knots.

Thirteen deaths were attributed to Chantal and, just as in Allison, all were the result of drowning. The main effects were flooding, by torrential rains, and beach erosion. Total damage is estimated to be near \$100 million.

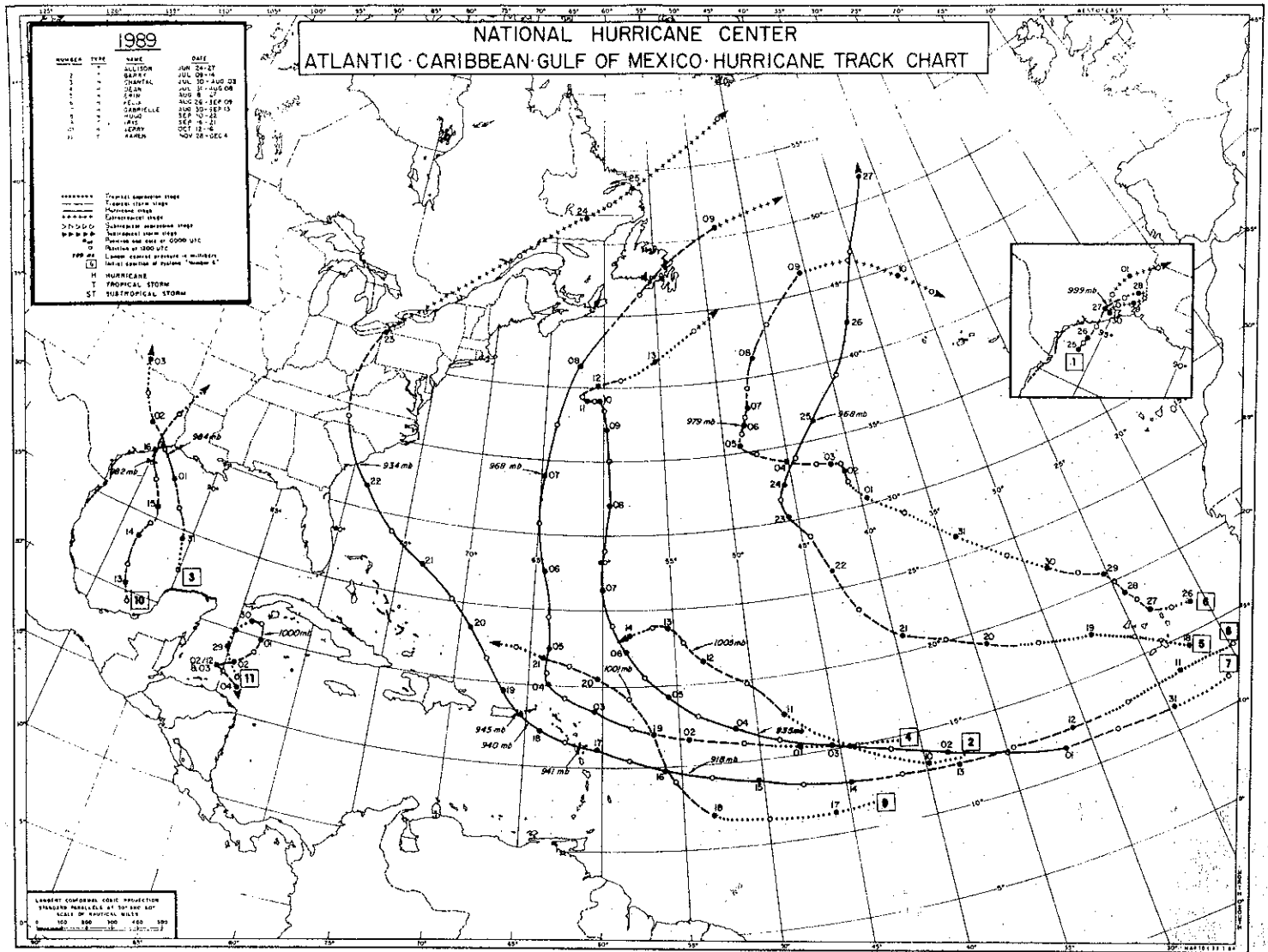
### Hurricane Dean

A tropical depression developed from a westward-moving tropical wave, on the 31st of July, midway between the Cape Verde Islands and the Lesser Antilles. It attained tropical storm strength by the 1st of August and was upgraded to a hurricane on the 2d.

By the 3d, the hurricane slowed and began to turn toward the north. This brought the eastern eye-wall over Bermuda on the 6th. The highest sustained wind was 70 knots with gusts to 98 knots at the U.S. Naval Annex on the western end of Bermuda.

After Bermuda, Dean accelerated toward the northeast. It passed over Sable Island, Nova Scotia, generating winds of 66 knots with gusts to 77 knots. Dean began to lose tropical characteristics as it moved over southeastern Newfoundland, and became extratropical over the North Atlantic.

There were no reported deaths due to Hurricane Dean. However, 16 people were injured on Bermuda, and damage estimated there was nearly \$9 million.



### Hurricane Erin

This system became a tropical depression near the Cape Verde Islands on August 18th. Steering currents guided it toward the northwest, and it was upgraded to Tropical Storm Erin on the 19th based on satellite imagery. A 65-knot wind reported by the Portuguese ship *Montemuro* resulted in Erin being upgraded to a hurricane on the 22d. Satellite intensity estimates indicated Erin strengthened to a 968-millibar hurricane with peak winds of 90 knots on the 25th. Thereafter Erin accelerated toward the northeast, weakened to a tropical storm on the 27th, and soon became extratropical.

### Hurricane Felix

Felix persevered mostly in the shadow of the much larger and more intense Hurricane Gabrielle to become the longest lasting tropical cyclone of the season.

After emerging from the African coast, on the 25th of August, Felix turned northwestward. From the 26th of August to the 5th of September, Felix strengthened to a storm, weakened to a tropical depression, regained storm status, and finally attained hurricane strength.

Based on satellite imagery, the hurricane's minimum central pressure of 979 millibars with maximum sus-

tained winds of 75 knots occurred from late on the 5th to early on the 6th. Ship reports were rather sparse around Felix with the only significant weather observation from the *OOCL Atlantic*, which observed 40-knot winds with heavy rain just north of the center on the 8th. As Felix came under the influence of the westerlies and moved over the cooler waters, it became extratropical on the 9th. This system became a large non-tropical storm during the next few days and eventually dissipated southeast of the Azores by the 15th. Several ships observed winds near 50 knots around the circulation during the extratropical stage.

## Hurricane Gabrielle

A tropical wave moved off the African coast on the 28th of August. It reached tropical depression strength on the 30th and was upgraded to Tropical Storm Gabrielle on the 31st.

The first reconnaissance aircraft into Gabrielle found a central pressure of 935 millibars on the 3d of September. The hurricane's central pressure remained in the low 940-millibar range for the next 3 days, with the strongest surface winds estimated to be near 125 knots.

After the 4th of September, Gabrielle turned toward the north, passing about 300 nautical miles north-east of the northeastern Caribbean islands. On the 10th Gabrielle became nearly stationary about 475 nautical miles east southeast of Cape Cod, Massachusetts. It drifted slowly westward and dropped to tropical storm strength on the 10th and to a depression by the 12th. The following day it lost most of its tropical characteristics and merged with a developing North Atlantic storm off Newfoundland.

Gabrielle was a very large hurricane. The eye diameter was never less than 20 nautical miles, and, while the hurricane was most intense, this diameter ranged from 40 to 50 nautical

miles. Hurricane-force winds frequently extended in excess of 100 nautical miles from the center. Reports of 50- to 60-knot winds were received from the EOC3 and *Mikhail Stelmakh*, on the 7th and 8th, some 125 to 160 nautical miles from the center.

Gabrielle's powerful winds covered a large area of the Atlantic and generated large ocean swells, which pounded the shores of the northeastern Caribbean islands, Bermuda and the North American mainland from central Florida to the Canadian Maritimes. Swells ranged from 10 to 15 feet along portions of the U.S. East Coast and were as high as 20 to 30 feet along the south coast of Nova Scotia. These swells were responsible for eight deaths along the mid-Atlantic and New England coasts. Accidents ranged from people being swept from jetties while watching the large swells to boats capsizing while trying to enter or leave inlets.

## Hurricane Hugo

Hugo, the strongest hurricane of 1989, left a path of death and destruction across the Leeward Islands, the Virgin Islands, Puerto Rico, and South and North Carolina.

Hugo was first detected by

satellite, on the 9th of September, as a cluster of thunderstorms off the coast of Africa. A tropical depression formed southeast of the Cape Verde Islands and moved westward across the tropical Atlantic Ocean at 18 knots. It became a tropical storm on the 13th about 1100 nautical miles east of the Leeward Islands.

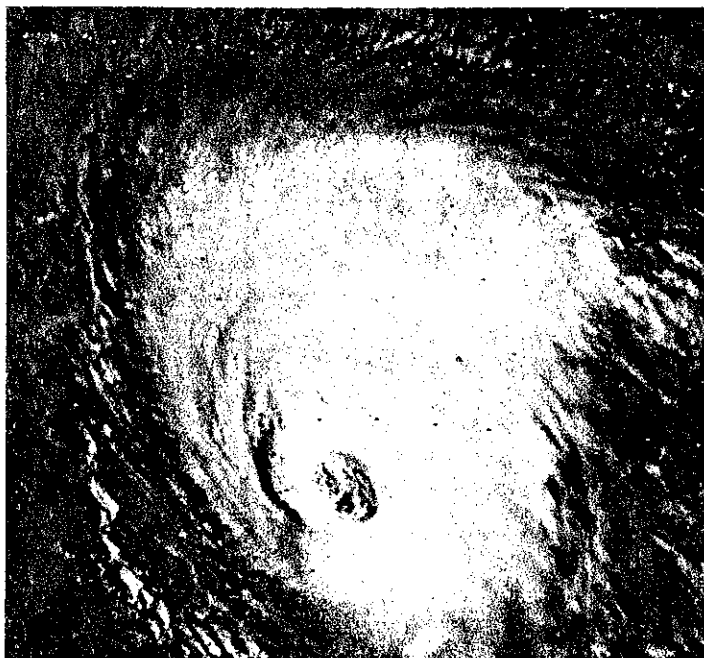
Hugo gradually turned toward the west northwest and slowed. On the 15th, Air Force and NOAA reconnaissance aircraft reached the hurricane several hundred miles east of the Leeward Islands and reported a central pressure of 918 millibars, a wind speed of 165 knots at an altitude of 1500 feet, and an estimated surface wind speed of 140 knots. This was Hugo's maximum intensity and earned the hurricane a category five rating.

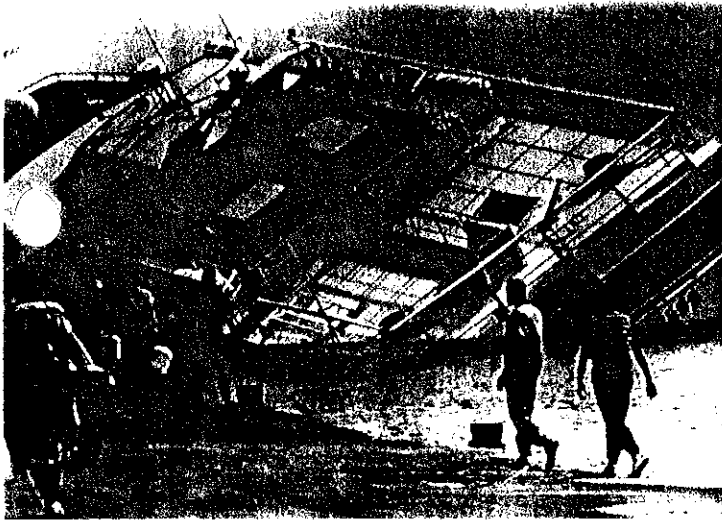
Hugo crossed Guadeloupe on the 17th with a central pressure of 941 millibars and 120-knot winds. The hurricane turned northwestward and hit St. Croix the next day, with maximum surface winds remaining near 120 knots.

Accelerating, the eye moved over the island of Vieques, Puerto Rico and then over the extreme eastern tip of mainland Puerto Rico on the 18th. Maximum winds were estimated at 110 knots. The lowest recorded surface pressure on the island was 946.1 millibars at Roosevelt Roads.

Hugo then took aim on the South Carolina coast. It made its final landfall on the 22d at Sullivan's Island, near Charleston. Based on a reconnaissance aircraft measurement of 934 millibars and 140-knot winds at an altitude of 12,000 feet just before landfall, the surface wind at landfall was estimated to be 120 knots. A report of 76 knots with a gust to 94 knots was received from downtown Charleston. However, the strongest winds probably occurred 20 nautical miles or so to the northeast of Charleston, near Bulls Bay. The strongest sustained surface wind measured was 104 knots from the ship *Snow Goose*, anchored in the Sampit River, a few nautical miles west of Georgetown, South Carolina. This

To the right is a GOES Visible image of Hurricane Gabrielle at 1231 UTC on the 6th of September 1989, over the open Atlantic.





Wide World

A large passenger craft is beached at Pointe-a-Pitre, Guadeloupe (left) on the 18th during Hugo. At far right, Hugo leaves little untouched on the barrier island of Isle of Palms, South Carolina after it passed on the 22d.

above the predicted tide as far north as Hatteras, North Carolina.

Rainfall totals ranged from a trace at Jacksonville, Florida, to 6.10 inches at Savannah, Georgia, to a maximum of 8.10 inches at Mt. Pleasant, South Carolina (near Charleston), to 2.30 inches at Myrtle Beach, South Carolina, and 0.58 inches at Hatteras, North Carolina. A 150-nautical-mile-wide swath of 3 to 8 inches of rain spread inland across South Carolina and continued over western North Carolina, with a maximum of 6.91 inches reported at Boone. Rainfall totals were in the 2- to 4-inch range across western Virginia, West Virginia, western Pennsylvania, eastern Ohio, and western New York.

The total number of deaths associated with Hugo is estimated at 49, 21 on the U.S. mainland. The \$10-billion damage estimate makes Hugo the most costly hurricane in history.

### Tropical Storm Iris

The tropical wave that spawned Iris was immediately behind the wave that spawned Hugo. Although the system remained in the unfavorable environment of Hugo's wake, a tropical depression formed on the 16th of September and reached tropical storm strength, 390 miles east of Barbados on the 18th. Iris turned northwestward and reached its maximum strength of 1001 millibars, with estimated 60-knot surface winds, on the 19th. Thereafter, increased outflow from the powerful and strengthening Hugo resulted in Iris' weakening, with satellite images eventually showing the low-level center exposed from the deep convection.

### Hurricane Jerry

Jerry originated from a tropical wave that moved across the tropical Atlantic and Caribbean Sea. There were no additional signs of organization before it developed into a tropical depression on the 12th of October as it moved into the Bay of Campeche.

measurement was taken from a three-cup Tradewind anemometer located on the ship's mast at an elevation of 61 feet.

Moving inland and weakening, the center passed between Columbia and Shaw Air Force Base prior to sunrise on the 22d. The air base reported a sustained wind of 58 knots with a gust to 95 knots. By sunrise Hugo was a tropical storm and had passed just west of Charlotte, North Carolina, with winds of 60 knots and gusts to 86 knots.

Moving northward across extreme western Virginia, West Virginia, and eastern Ohio, Hugo became extratropical near Erie, Pennsylvania, on the 23d. During the next 2 days it moved across eastern Canada and into the far northern Atlantic Ocean.

Storm tides along the South Carolina coast ranged from 8 to 10 feet in the Charleston-Folly Beach area to near 20 feet in the south end of Bulls Bay and down to 7 feet at Winyah Bay. The storm surge was reported at 4 feet

### 1989 Atlantic Hurricane Season Statistics

no.	name	class <sup>1</sup>	dates <sup>2</sup>	maximum sustained wind (knots)	lowest press. (mb)	U.S. damage (\$millions)	deaths
1	Allison	T	24-27 Jun	45	999	500	11
2	Barry	T	9-14 Jul	45	1005		
3	Chantal	H	30 Jul-3 Aug	70	984	100	13
4	Dean	H	31 Jul-8 Aug	90	968		
5	Erin	H	18-27 Aug	90	968		
6	Felix	H	26 Aug-9 Sep	75	979		
7	Gabrielle	H	30 Aug-13 Sep	125	935		8
8	Hugo	H	10-22 Sep	140	918	7000	49
9	Iris	T	16-21 Sep	60	1001		
10	Jerry	H	12-16 Oct	75	982	70	3
11	Karen	T	28 Nov-4 Dec	50	1000		

1 T: tropical storm, wind speed 34-63 kt.  
H: hurricane, wind speed 64 kt or higher.

2 Dates begin at 0000 UTC and include tropical depression stage.



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The depression attained tropical storm strength on the 13th. After some hesitation, shearing and a temporary turn to the northeast, Jerry turned toward the north northwest on the 15th and strengthened to a hurricane.

Jerry made landfall on Galveston Island, near Jamaica Beach, on the 16th. No hurricane had ever made landfall on the upper Texas coast so late in the season. Once inland, Jerry moved over eastern Texas, weakened rapidly, and was absorbed by a frontal trough late on the 16th.

Maximum sustained surface winds of 65 knots with gusts to 87 knots were measured at Scholes Field on Galveston Island as the eyewall passed over the airport. The observation site lost power near this time, and the observer-estimated maximum sustained winds reached 70 knots with gusts of 90 to 100 knots. An extrapolated minimum pressure of 982 millibars was reported by a NOAA aircraft and by an Air Force plane just prior to landfall.

Three people were reported

killed, all by drowning. Damage estimates for the hurricane are near 70 million dollars.

### Tropical Storm Karen

Satellite imagery indicated, and aircraft reconnaissance confirmed, a tropical depression formed in the northwest Caribbean on the 28th of November. It was upgraded to Tropical Storm Karen near the Isle of Youth, Cuba, early on the 30th. Karen became the eighth named tropical cyclone to form in November during the past 10 years. This is double the long-term average.

A minimum central pressure of 1000 millibars, with strongest winds of 50 knots, was reached later on the 30th. Karen was a wet storm that dropped 10 to 15 inches of rain over portions of western Cuba.

A strong high pressure system over the Gulf of Mexico forced Karen to move to the south and southwest from late on the 30th to the 3d of December. The last advisory of the 1989 Atlantic hurricane season was issued on the 4th of December after an Air Force plane was unable to locate a circulation center.

**Tropical Cyclone Winds**  
(ship encounters of 50 knots or more)

Tropical Cyclone	Vessel Name	Date Mo/Da	Time UTC	Ship Position Lat N, Lon W	Wind		Pressure (mb)
					Dir/Speed (kn)		
Chantal	<i>Saudi Diriyah</i>	7/31	1200	26.1 89.2	130/50	1009.3	
Erin	<i>Montemuro</i>	8/22	1200	28.5 45.0	270/65	1000.3	
	<i>Merida</i>	8/24	1200	32.1 43.5	200/55	1011.5	
	<i>Maris Gorthon</i>	8/26	1800	49.0 32.0	160/50	1003.5	
Gabrielle	<i>EOC3</i>	9/07	1200	29.9 57.4	150/57	997.0	
	<i>Mikhail Stelmakh</i>	9/08	0600	34.6 56.8	160/50	993.0	
	<i>Yan Kalnberzine</i>	9/12	1200	36.7 58.3	210/50	1018.0	
	<i>Trudy</i>	9/13	1200	44.5 56.3	330/52	1014.6	