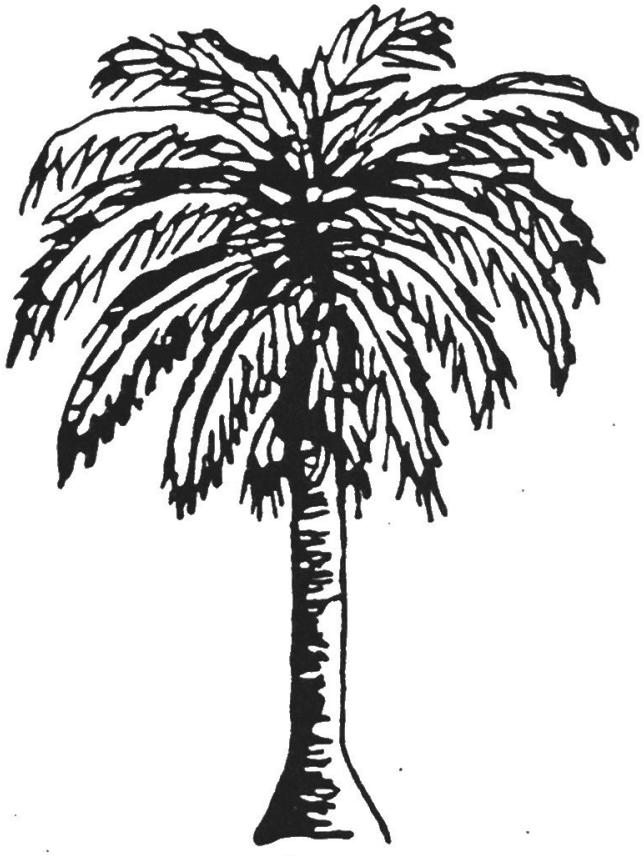
CLIMATE REPORT NO. G27

HURRICANE CHARLEY (1986)



STATE OF SOUTH CAROLINA
WATER RESOURCES COMMISSION
SOUTH CAROLINA STATE CLIMATOLOGY OFFICE

MAY 1987

Charley (1986)

by

John C. Purvis
Wes Tyler
Scott Sidlow

South Carolina State Climatology Office
1201 Main Street, Suite 1100
Capitol Center
Columbia, South Carolina 29201

May 1987

PREFACE

The writers thank Mr. Miles Lawrence for furnishing much of the data for this publication. Mr. Lawrence is a meteorologist on the staff of the National Hurricane Center.

Appreciation is also given to Mr. Yarbrough and staff of the South Carolina Water Resources Commission for preparation of the maps. A very special thanks to Ms. Verger Ashley for typing this publication.

TABLE OF CONTENTS

TABLES AND FIGURES

INTRODUCTION

Hurricane Charley was the only tropical cyclone that affected the South Carolina coast during 1986. Even so, damage was insignificant, being confined to minor beach erosion along the northeast coast.

Charley was the second hurricane of 1986 to make landfall on the continental United States coast. The first, Hurricane Bonnie, moved inland on the upper Texas coast in late June. It was also the second tropical cyclone of the season to require warnings along the North Carolina coast (gale warnings were issued for portions of the North Carolina coast for Tropical Storm Andrew). Hurricane Charley just barely reached hurricane strength, but its track required warnings over a large stretch of the east coast. In addition, during its extratropical phase, it developed rather strong winds over a very large area and moved through the North Atlantic shipping lane all the way to Europe as a significant system.

The rainfall directly produced by Charley remained, for the most part, off the South Carolina shore. However, rainfall associated with the synoptic situation that preceded, accompanied and followed Charley brought welcome relief to the parched South Carolina country-side suffering from one of the worst droughts of the century.

Unfortunately, flash flooding with heavy damage and loss of life occurred at Newberry, Lockhart and near Columbia as a result of these scattered thunderstorms.

SYNOPTIC HISTORY

The system which was to become Hurricane Charley was initially noted as a trough of low pressure which persisted over south Florida and the southeast Gulf of Mexico. Showers and thunderstorms associated with this system first appeared over the Florida peninsula on August 11th. This activity then spread over the extreme east Gulf of Mexico on August 12th. Some surface observations in the region indicated that a very broad and weak low pressure center was forming over the southeast Gulf of Mexico on August 12th. The trough of low pressure then appeared to extend from the southeast Gulf toward the north. This poorly defined and diffuse system appeared to drift to the north on the 12th and 13th where it became a little better organized over the Florida Panhandle. At that stage it merged with a decaying frontal trough over the Florida Panhandle and Georgia. The system continued to become better defined over land and finally moved off the Georgia/South Carolina coast during the morning hours of August 15th.

Satellite pictures and radar observations indicated that a tropical depression had formed off the South Carolina coast by early afternoon on August 15th. A NOAA reconnaissance aircraft then flew into the system by mid afternoon and found that the depression had attained tropical storm strength.

A weak ridge was located to the north of the Tropical Storm Charley from August 15th through August 16th resulting into an initial slow easterly drift, and later into a slow northeast drift as an amplifying upper local trough approached from the west. This trough intensified as it passed over the eastern half of the U.S. resulting in a north to north northeast movement of Charley on August 17th and 19th. A mid level vorticity center then developed in the highly amplified trough over Georgia, south of Charley. The northern portion of the trough flattened out and Charley started to move on a northeast and then east course on August 19th and weakened. At this stage the storm started to merge with the frontal trough and began to accelerate eastward across the Atlantic. The system had been weakening steadily through this period and began to spread out, becoming extratropical. On August 21th, a substantial baroclinic intensification took place which resulted in a very large and relatively strong low pressure system moving all the way to Europe. This system finally dissipated over the North Sea when another center developed to the southeast of the original center and then moved over northern Europe (Figure 1).

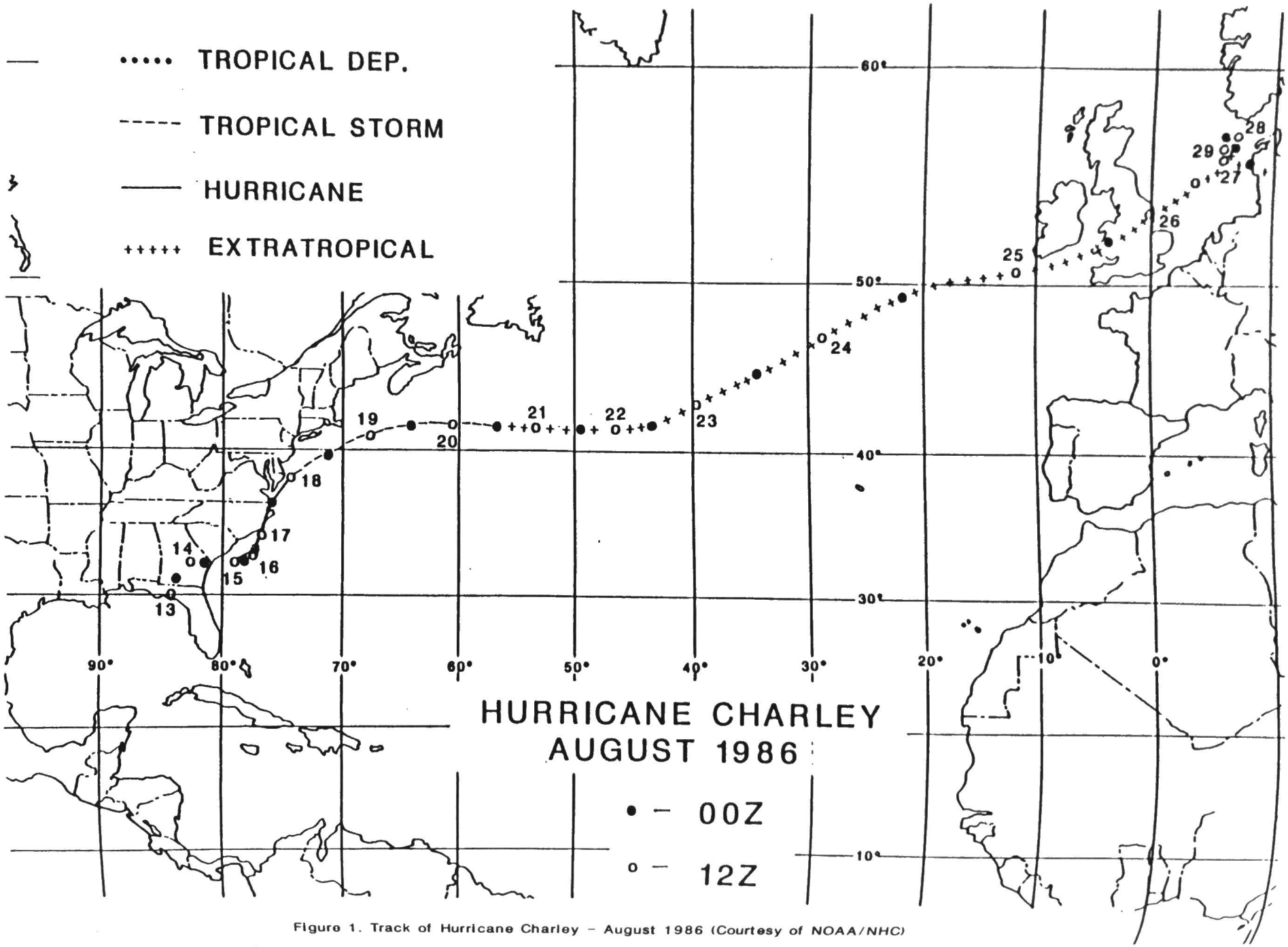


Figure 1. Track of Hurricane Charley – August 1986 (Courtesy of NOAA/NHC)

METEOROLOGICAL AND HYDROLOGICAL STATISTICS

Hurricane Charley barely attained hurricane strength (Table 1) and only remained a hurricane for about 24 hours. The strongest winds measured on board the reconnaissance aircraft were 65 knots with a maximum surface wind estimate of 75 knots (Figure 3). The minimum pressure measured by the reconnaissance aircraft was 989 millibars late on August 17th (Figure 2). Peak winds of 75 mph or more were recorded on the coasts of North Carolina, Virginia, Maryland and Delaware (probably also on Nantucket island where a sustained wind of 60 mph was reported). Sustained winds exceeded 50 mph at several coastal locations (Table 4).

Hurricane Charley was not a heavy rain producer. Some welcome rain, however, was produced by the initial disturbance over the southeast United States where a major drought was taking place. Most of the heavy convective elements remained over the water during its stronger phases. However, storm totals of 2 to 3 inches (Table 4) were produced over portions of Maryland, primarily from thunderstorms which developed ahead of the system.

Storm tides (Table 4) were generally only 2 to 3 feet above normal along the affected coastal areas. However, abnormally high tides were occurring at the time which resulted in some coastal flooding and beach erosion. Tides along the North Carolina, Virginia and Maryland coasts as well as Nantucket Island were generally 4 to 6 feet above mean low water levels.

Table 5 contains reports from ships experiencing gale force or stronger winds in the vicinity of Charley during its tropical storm phase. The track of the storm through the North Atlantic shipping lanes is reflected by the large number of vessels experiencing these stronger winds. Two to three times this number of ships (not listed in Table 5, but some are plotted in Figure 3) experienced gale force or stronger winds during the extratropical phase of Charley as it moved across the Atlantic.

CASUALTY AND DAMAGE STATISTICS

There were five deaths reported as directly associated with Hurricane Charley. Three of those deaths came in the crash of a light aircraft in Chesapeake Bay near Baltimore on Sunday evening, August 17th. This accident occurred in thunderstorms in advance of Charley. One woman drowned when attempting to cross a flooded causeway and drove into a canal near Cape Hatteras, North Carolina. The other reported casualty was in Norfolk, Virginia where a motorist ran into a downed tree.

Damages were reported to be minor in South Carolina, and about $400,000 in the North Carolina area primarily due to tidal flooding and downed trees. Some building damage and aircraft damage was also reported. Damage in the city of Norfolk was estimated to be $310,000, and $80,000 for Virginia Beach. Some of the major damage on Virginia Beach included a motel roof partially blown off and two homes under

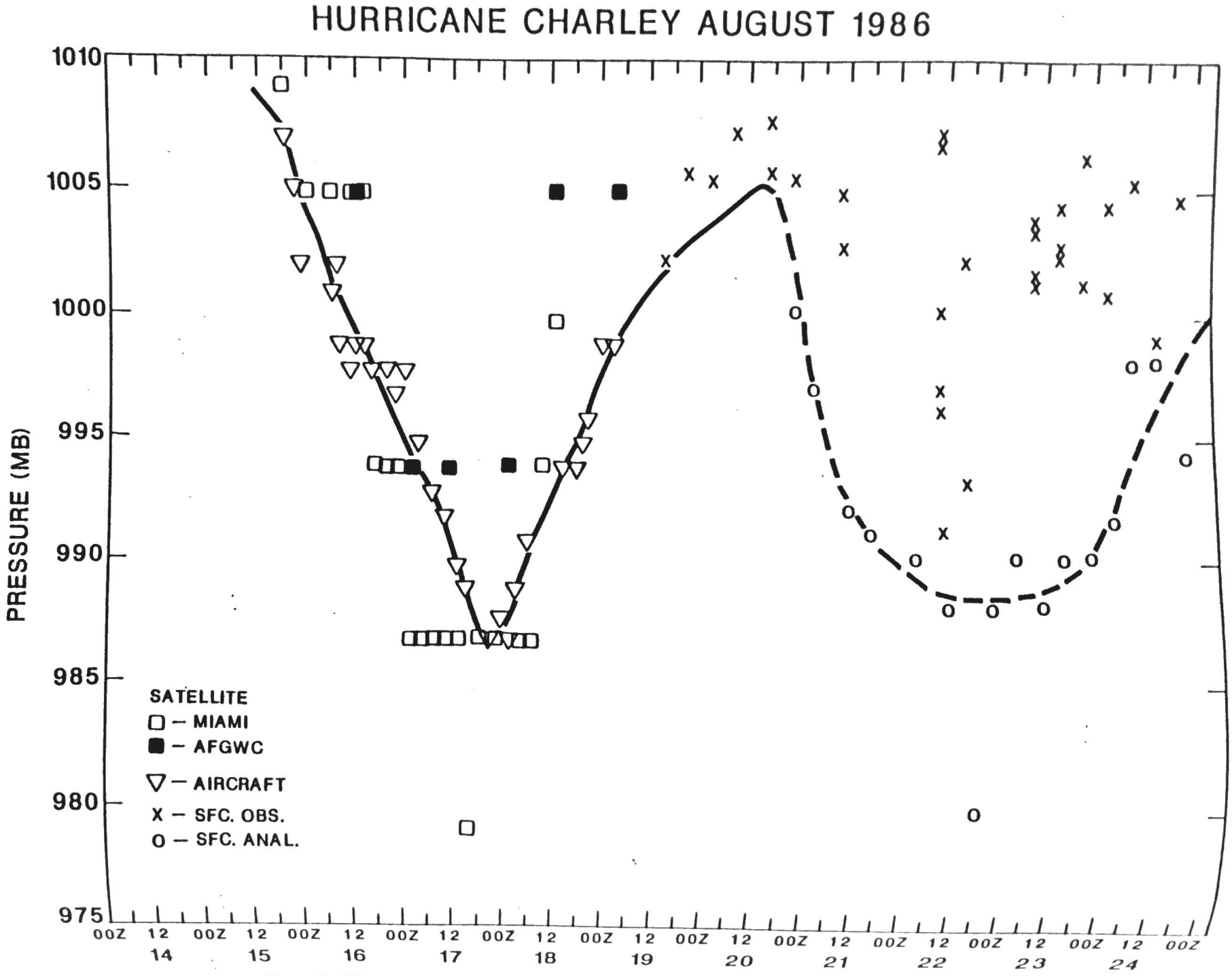


Figure 2. Minimum sea level pressures of Hurricane Charley, August 1986 (Courtesy of NOAA/NHC).

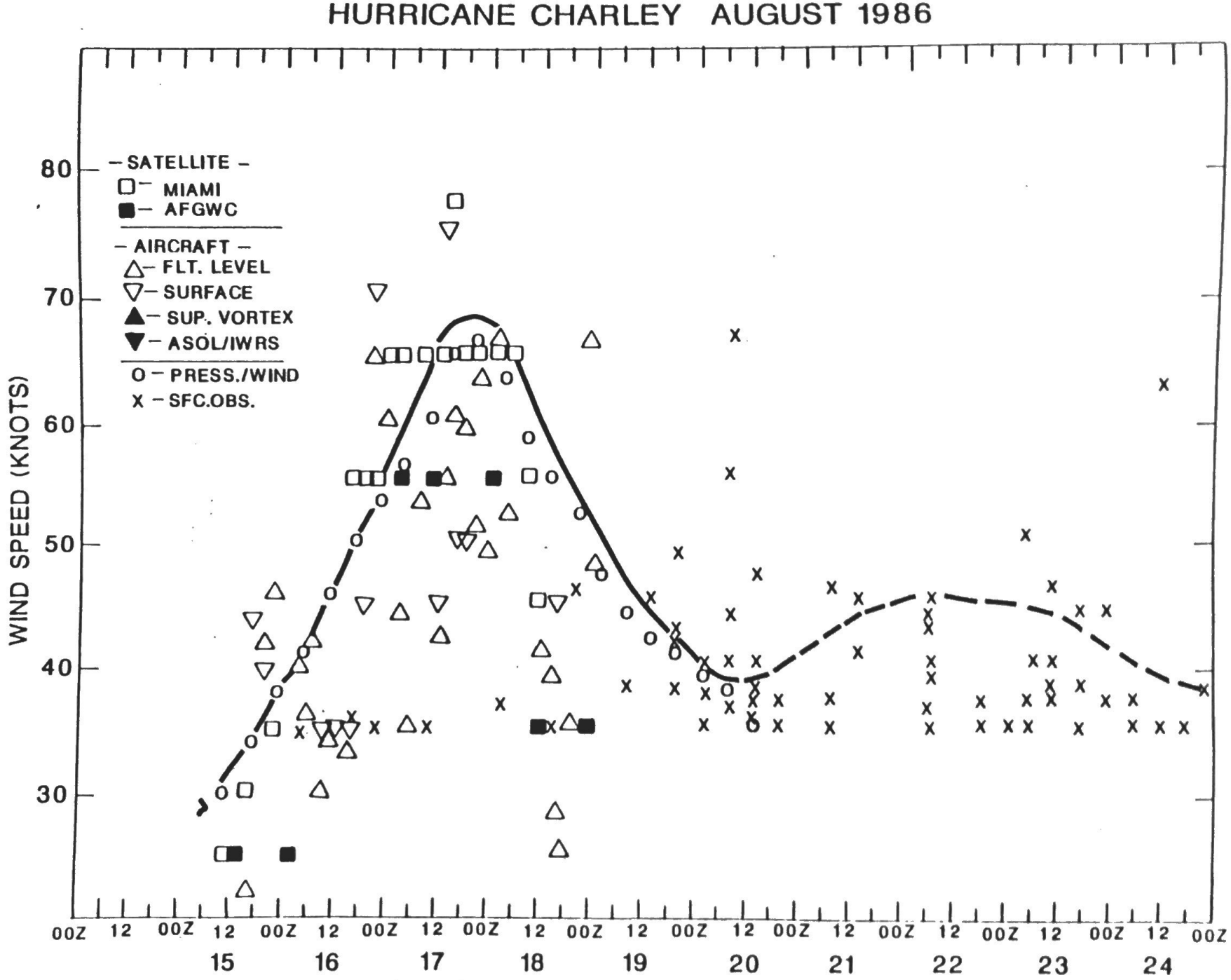


Figure 3. Maximum sustained surface winds for Hurricane Charley – August 1986 (Courtesy of NOAA/NHC)

construction blown down. Other areas in eastern Virginia reported minor damage of trees and signs blown down and a few windows blown out. Total damage for the area was estimated to be about $1 million. Only isolated and minor damage occurred along the Maryland and Delaware coasts (some street flooding in Ocean City). The final area of significant damage occurred on Nantucket Island. There was considerable street flooding due to high tides and rain and several boats were damaged, including one large boat sunk and others beached. Damage in Nantucket Harbor was estimated at $75,000. Damage from heavy rains in advance of Charley over Berkshire County in Massachusetts was estimated at $150,000.

WATCHES AND WARNINGS

Hurricanes moving nearly parallel to the mid Atlantic and New England coasts of the United States often result in rather complicated warning zone definitions. This results from the generally highly populated barrier islands and coastal zones with high degrees of vulnerability, irregular coastlines, numerous large bays and estuaries as well as numerous political and social boundaries, all complicated by the degrees of uncertainty in the forecast strength and track of the hurricane. The complication of the warning process for this type of situation, even for a system barely of hurricane strength, is somewhat illustrated by Table 3. Numerous coastal zones are listed for areas of gale warnings, hurricane watches and hurricane warnings, all progressing north and northeastward as the system moved toward the north and northeast.

Table 2 lists the probabilities of the core of the hurricane passing over various coastal locations for each forecast period. Values exceeding 30 percent within the next 72 hours are noted for the North Carolina coast by 6 P.M. EDT on August 16th and then progressed northward to Virginia and Maryland and Delaware (by interpolation) by noon on August 17th, and New Jersey by 6 P.M. on August 17th. Maximum values then became increasingly smaller in later time periods as the forecast rack turned toward the northeast and east. However, a value exceeding 40 percent is noted for Nantucket, Massachusetts for a forecast issuance time of 6 P.M. on August 18. The storm was forecast to pass to the south but close to that location at that time.

As indicated earlier (Meteorological Data), most of the warned zones experienced gale force winds; and many experienced peak winds of hurricane force. However, the only sustained hurricane force wind at a coastal location was recorded on the Chesapeake Bay bridge (97 mph with a peak wind of 104 mph.)

Table 1. PRELIMINARY BEST TRACK - HURRICANE CHARLEY - AUGUST 1986.

DATE	TIME (GMT)	POSITION# LATITUDE	LONGITUDE	PRESSURE (MB)	WIND (KT)	STAGE
8/13	1200	30.1	84.0	1009	10	Subtropical Low
"	1800	30.8	84.0	1012	10	" "
8/14	0000	31.4	83.6	1013	10	" "
"	0600	32.0	83.1	1014	10	" "
"	1200	32.5	82.5	1015	10	" "
"	1800	32.4	82.0	1015	10	" "
8/15	0000	32.3	81.2	1013	15	" "
"	0600	32.3	80.0	1013	15	" "
"	1200	32.2	79.0	1009	30	Trop. Depression
"	1800	32.2	78.5	1007	35	Tropical Storm
8/16	0000	32.3	78.1	1004	40	" "
"	0600	32.4	77.9	1002	40	" "
"	1200	32.6	77.6	999	45	" "
8/17	0000	33.2	77.1	995	55	" "
"	0600	33.7	76.9	993	60	" "
"	1200	34.4	76.6	991	65	Hurricane
"	1800	35.4	76.2	988	65	"
8/18	0000	36.5	75.8	987	65	"
"	0600	37.4	75.2	990	65	"
"	1200	38.2	74.1	992	60	Tropical Storm
"	1800	39.0	72.6	994	60	" "
8/19	0000	39.7	70.9	997	55	" "
"	0600	40.4	69.1	999	50	" "
"	1200	40.9	67.5	1000	45	" "
"	1800	41.3	65.8	1002	45	" "
8/20	0000	41.5	64.0	1003	40	" "
"	0600	41.6	62.5	1004	40	" "
"	1200	41.7	60.2	1005	40	" "
"	1800	41.7	58.4	1005	40	" "
8/21	0000	41.6	56.6	1000	40	Extratropical
"	0600	41.5	54.8	997	40	"
"	1200	41.4	53.2	992	40	"
"	1800	41.3	51.2	991	45	"
8/22	0000	41.3	49.4	990	45	"
"	0600	41.3	47.6	989	45	"
"	1200	41.4	46.2	989	45	"
"	1800	41.5	44.8	989	45	"
8/23	0000	41.8	43.2	988	45	"
"	0600	42.3	41.6	989	45	"
"	1200	43.0	39.6	989	45	"
"	1800	43.9	37.2	989	45	"
xxxxxxxxxx	xxxxxxxxxx	xxxxxxxxxx	xxxxxxxxxx	xxxxxxxxxx	xxxxxxxxxx	xxxxxxxxxx
8/17	1400	34.7	76.5	990	65	LANDFALL
8/17	2200	36.2	76.0	987	65	MINIMUM PRESSURE*

minimum pressure extrapolated by U.S. Air Force reconnaissance aircraft

(cont'd)

Table 1 PRELIMINARY BEST TRACK - HURRICANE CHARLEY - AUGUST 198

(page 2 of 2)

DATE	TIME (GMT)	POSITION# LATITUDE	POSITION# LONGITUDE	PRESSURE (MB)	WIND (KT)	STAGE
				990	45	Extratropical
8/24	0000	44.9	34.4	992	40	"
"	0600	46.0	31.6	995	40	"
"	1200	47.0	28.8	997	40	"
"	1800	48.2	26.0	999	40	"
8/25	0000	49.2	21.6	1000	40	"
"	0600	50.0	16.4	994	40	"
"	1200	50.7	11.4	988	50	"
"	1800	51.4	7.2	981	45	"
8/26	0000	52.2	4.4	980	45	"
"	0600	52.9	2.0	982	45	"
"	1200	53.6	0.0	986	45	"
"	1800	54.3	2.0E	984	45	"
8/27	0000	55.0	3.7E	983	45	"
"	0600	55.5	5.0E	985	35	"
"	1200	56.0	5.8E	989	35	"
"	1800	56.3	6.0E	989	35	"
8/28	0000	56.6	6.0E	991	35	"
"	0600	56.8	6.0E	998	30	"
"	1200	57.0	6.0E	999	30	"
"	1800	57.0	5.5E	1002	25	"
8/29	0000	57.0	5.0E	1004	20	"
"	0600	56.8	5.0E	1004	20	"
"	1200	56.5	5.0E	1004	15	"
"	1800	56.2	6.0E	1006	15	"
8/30	0000	56.2	8.0E			
"	0600	Dissipated				

- Latitudes are in degrees and tenths North.
- Longitudes are in degrees and tenths West unless followed by an E which indicates degrees and tenth East.

Table 2. Chances of the center of Charley passing within 65 miles of the listed locations by date and time (EDT) indicated (probabilities in percent).

ADVISORY DATE/TIME	15/4PM	16/12AM	16/6AM	16/12PM	16/2PM	17/12AM	17/6AM
PROBABILITY THRU	18/2PM	18/8PM	19/2AM	19/8AM	19/2PM	19/8PM	20/2AM
Miami, FL	5	4	4	3	2	X	X
W. Palm Bch.,	7	6	5	5	2	X	X
Ft. Pierce, FL	9	8	7	7	3	X	X
Cocoa Bch, FL	11	9	8	8	4	2	X
Daytona Bch, FL	13	11	10	10	6	3	X
Jacksonville, FL	14	13	12	11	7	4	X
Savannah, GA	16	16	15	14	10	7	6
Charleston, SC	22	23	23	19	14	10	9
Myrtle Bch, SC	21	29	29	24	24	18	18
Wilmington, NC	18	21	21	21	35	36	53
Morehead City, NC	15	17	18	18	33	47	75
Cape Hatteras, NC	13	14	15	15	22	30	42
Norfolk, VA	9	10	11	11	14	17	22
Ocean City, MD	6	7	8	8	11	13	14
Atlantic City, NJ	4	5	6	6	8	11	9
New York City, NY	3	3	4	4	6	9	6
Montauk Point, NY	2	3	3	3	6	9	4
Providence, RI	2	2	3	3	5	8	3
Nantucket, MA	2	2	3	3	5	8	2
Hyannis, MA	2	2	3	3	5	8	2
Boston, MA	X	X	2	2	4	7	2
Portland, ME	X	X	X	X	3	5	X
Bar Harbor, ME	X	X	X	X	2	4	X
Eastport, ME	X	X	X	X	2	4	X
St. John, NB	X	X	X	X	X	3	X
Moncton, NB	X	X	X	X	X	3	X
Yarmounth, NS	X	X	X	X	2	5	X
Halifax, NS	X	X	X	X	2	4	X
Sable Island, NS	X	X	X	X	X	3	X
Sydney, NS	X	X	X	X	X	2	X
Eddy Point, NS	X	X	X	X	X	2	X
Bermuda	2	2	2	2	3	2	X

X means less than 2 percent.

(cont'd)

Table 2. Chances of the center of Charley passing within 65 miles of the listed locations by date and time (EDT) indicated (probabilities in percent).

ADVISORY DATE/TIME	17/12PM	17/6PM	18/12AM	18/6AM	18/12PM	18/6PM
PROBABILITY THRU	20/8AM	20/2PM	20/8PM	21/2AM	21/8AM	21/2PM
Morehead City, NC	86	62	X	X	X	X
Cape Hatteras, NC	83	97	X	X	X	X
Norfolk, VA	43	73	X	X	X	X
Ocean City, MD	32	51	68	87	75	X
Atlantic City, NJ	22	35	42	49	40	X
New York City, NY	18	25	28	33	23	X
Montauk Point, NY	16	20	24	29	28	24
Providence, RI	15	18	21	24	22	16
Nantucket, MA	14	16	21	23	26	41
Hyannis, MA	14	16	20	22	23	28
Boston, MA	14	16	18	19	17	11
Portland, ME	12	14	14	14	12	16
Bar Harbor, ME	11	12	13	13	11	7
Eastport, ME	10	11	12	12	11	7
St. John, NB	9	11	12	12	10	7
Moncton, NB	8	9	10	10	9	6
Yarmouth, NS	10	12	14	14	14	13
Halifax, NS	8	10	12	12	12	11
Sable Island, NS	6	7	10	10	11	12
Sydney, NS	6	7	10	10	10	7
Eddy Point, NS	7	8	11	11	11	9
Pix Basques, NFLD	5	6	8	8	8	5
Burgeo, NFLD	4	5	8	8	8	8
Ile St. Pierre	4	5	8	8	9	6
Cape Race, NFLD	X	3	7	7	8	6
Hibernia Oilfield	X	X	4	4	5	4

X means less than 2 percent

Table 3. WATCHES AND WARNINGS FOR HURRICANE CHARLEY, AUGUST 1986.

LOCATION	TYPE	EFFECTIVE	DISCONTINUED
Bogue Inlet NC to south of Oregon Inlet NC including Pamlico Sound	GALE WARNINGS TO 55 MPH	8/16/2200Z	UPGRADED 8/17/0100Z
Bogue Inlet to south of Oregon Inlet including Pamlico Sound	HURRICANE WATCH GALE WARNINGS TO 65 MPH	8/179199/Z	UPGRADED 8/17/1000Z
Bogue Inlet to Cape Lookout, NC	HURRICANE WARNING	8/171000Z	8/172000Z
Cape Lookout to south of Oregon Inlet including Pamlico Sound	HURRICANE WARNING	8/171000Z	8/180200Z
West of Bouge Inlet to Topsail Bch., NC	GALE WARNING	8/17/1000Z	8/180200Z
Oregon Inlet, NC to Virginia Bch, VA including Albemarle Sound	GALE WARNING	8/17/1000Z	UPGRADED 8/17/1400Z
Oregon Inlet, NC to Virginia Bch, VA including Albemarle Sound	HURRICANE WARNING	8/17/1400Z	8/180200Z
Virginia Bch, VA to Fenwick Island MD/Del. including S. Chesapeake Bay	HURRICANE WATCH GALE WARNING	8/17/1400Z 8/17/1400Z	UPGRADED 8/172000Z
Cape Lookout, NC to Virginia Bch, VA	HURRICANE WARNING	8/17/2000Z	8/180200Z
Virginia Bch, VA to Cape Charles, VA	HURRICANE WARNING	8/17/2000Z	8/180600Z
Cape Charles, Va to Fenwick Island, MD/DEL including Albemarle and Pamlico Sounds	HURRICANE WARNING	8/172000Z	8/18/1600Z
South Chesapeake Bay	HURRICANE WARNING GALE WARNING	8/17/2000Z 8/18/2000Z	8/18/0600Z 8/18/1600Z
Cape Lookout, NC to Topsail, NC	GALE WARNING	8/17/2000Z	8/18/0200Z
North Chesapeake Bay	GALE WARNING	8/17/2000Z	8/18/1600Z

(cont'd)

Table 3. WATCHES AND WARNINGS FOR HURRICANE CHARLEY, AUGUST 1986.

LOCATION	TYPE	EFFECTIVE	DISCONTINUED
Fenwick Island to Manasquan, NJ including Delaware Bay	HURRICANE WATCH GALE WARNING	8/17/2200Z 8/17/2200Z	UPGRADED 8/18/0200Z
Manasquan, NJ to Sandy Hook, NJ	HURRICANE WATCH GALE WARNING	8/17/2200Z 8/17/2200Z	UPGRADED 8/18/0200Z
Sandy Hook, NJ to Chatham, MA	HURRICANE WATCH GALE WARNING	8/17/2200Z 8/17/2200Z	8/18/1600Z
Fenwick Island to Sandy Hook, NJ including Delaware Bay	HURRICANE WARNING	8/18/0200Z	8/18/1600Z
Cape Henlopen, DE to Watch Hill, RI including mouth of Delaware Bay	GALE WARNING TO 55 MPH	8/18/1600Z	8/18/2200Z
Watch Hill, RI to Chatham, MA	GALE WARNING TO 55 MPH TO 45 MPH	 8/18/1600Z 8/18/2200Z	 8/18/2200Z 8/19/0100Z
Coastal waters from Chatham, MA to Martha's Vineyard, MA	GALE WARNING	8/19/1000Z	8/191600Z

Table 4. Selected Meteorological and Hydrological Statistics for Hurricane Charley August 1986.

LOCATION	STRONGEST WIND (MPH) DATE/TIME	SUSTD	PEAK	MIN PRESS. DATE/TIME	RAINFALL (IN) DATE	24 HR	STORM TOTAL
North Carolina							
Wilmington	17/1904Z	-	29	17/0905Z 29.65	17	0.39	0.48
Jacksonville	17/1656Z	21	29	17/1056Z 29.62	17	0.77	0.85
New Bern	17/1450Z	17	25	17/1450Z 29.61	18	1.45	1.71
Cherry Point	17/1230Z	30	39	17/1355Z 29.49	18	0.87	1.60
Cape Lookout	17/1100Z	47	58	-	-	-	-
Atlantic Beach	17/1130Z	35	58	-	-	-	-
Buxton	17/1630Z	49	65	17/1605Z 29.51	17	2.73	?
Frisco Camp	17/1725Z	55	80	17/1700Z 29.51	-	-	-
Dare Co. Swanquarter	17/1930Z	58	78	17/1850Z 29.31	-	-	-
Duck Coe Pier	17/2000Z	56	77	-	-	-	-
Virginia							
Norfolk Airpt.	18/0050Z	40	63	18/0100Z 29.50	18	1.08	?
S. Chesapeake Bay Bridge	17/2300Z	97	17/2224Z 104	-	-	-	-
Cape Henry	17/2300Z	54	82	-	-	-	-
Coal Piers	17/2300Z	-	81				
West Norfolk							
Maryland							
Baltimore	17/1858Z	-	28	18/0930Z 29.79	18	0.29	0.29
Salisbury	18/0700Z	-	48	18/1000Z 29.54	18	1.70	1.70
Ocean City	18/1030Z	50	78	-	17/18	-	2.70
Assateague Seashore	18/1000Z	-	73	-	17/18	-	3.25

(cont'd)

Table 4. Selected Meteorological and Hydrological Statistics for Hurricane Charley August 1986.

LOCATION	STRONGEST DATE/TIME	WIND SUSTD	(MPH) PEAK	MIN PRESS. DATE/TIME	RAINFALL (IN) DATE	24 HR	STORM TOTAL
Delaware							
Wilmington	181157Z	21	29	18/1000Z 29.72	18	-	0.02
Rehoboth Bch.	18/1100Z	52	75	18/1000Z 29.54	-	-	-
Massachusetts							
Nantucket Is.	19/0530Z	60	-	19/0530Z 29.70	19		3.20
Chatham	19/0313Z	37	48	19/0600Z 29.53	19	2.68	?
New York							
New York City	18	-	35	18/2000Z 29.85	18	-	0.36
JFK Airport	18	-	35	18/2000Z 29.83	18		

XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

MISCELLANEOUS RAINFALL STORM TOTALS

LOCATION	TOTAL (INCHES)	LOCATION	TOTAL (INCHES)
Patuxent NAS, MD	2.13	Prince Frederick, MD	1.56
Hollywood, MD	4.24	Bryantown, MD	3.57
Churchton, MD	3.85	Mount Victoria, MD	2.75
Snow Hill, MD	2.35	S.W. Baltimore, MD	2.60
Lewes, DE	0.47	Georgetown, DE	0.15
Laguardia Apt. NY	0.82	Islip, NY	0.52

XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

MISCELLANEOUS MAXIMUM TIDE REPORTS FOR HURRICANE CHARLEY

LOCATION	TIDES (FEET)	LOCATION	TIDES (FEET)
S. Pamlico Sound	2 to 3 abv norm	Buxton, NC	4.63 abv MLW
Duck Coe Pier, NC	5.78 abv MLW	South Island	
Sewells Pt., VA	5.4 abv MLW	Chesapeake Bay	5.4 abv MLW
Ocean City, MD	4.6 abv MLW	Long Island, NY	1 to 2 abv norm
Nantucket, MA	3.5 to 4 abv norm		

Table 5. Ship reports in vicinity of Charley (during tropical stages)
(Wind direction in degrees, speed in knots, pressure in millibars.)

DATE/TIME	SHIP	LAT.	LON.	WIND DIR./SPD.	PRESS (mb)
16/1200Z	WFZC	33.7	76.6	140/35	1009.7
16/1800Z	WLCG	33.3	74.5	180/36	1013.8
17/0000Z	VCWZ	33.9	76.9	110/35	-
17/1200Z	CBFA6	33.9	74.1	160/35	1010.8
18/0600Z	GHZK	37.0	76.1	330/37	1000.0
18/1800Z	9VPU	40.5	72.0	070/35	1009.0
19/0000Z	WSNH	38.9	70.2	200/46	1000.8
19/1200Z	?	38.2	68.4	250/38	1006.8
"	HOQH	38.7	66.2	240/44	-
19/1800Z	PFER	39.3	63.8	230/45	1006.0
20/0000Z	PFER	39.3	64.0	260/42	1007.1
"	D5ZA	39.9	61.2	210/43	1008.0
"	?	40.6	60.8	200/38	1005.7
"	KMHF	43.8	60.1	100/49	1007.8
20/0600Z	KMHF	43.9	60.1	060/40	1005.7
"	LFMO	43.8	60.7	060/38	1005.0
"	CG3V	45.3	59.8	070/35	1013.2
20/1200Z	D5XA	39.8	63.3	320/44	1015.0
"	"	40.5	63.0	330/38	1010.9
"	9VBS	42.4	63.1	360/37	1013.5
"	KMHF	43.8	60.1	040/66	1008.8
"	LFMO	43.8	60.7	060/40	1009.3
"	VSG8	44.2	58.4	050/55	1007.2
"	GCXD	45.6	57.9	090/37	1014.2
20/1800Z	ELEA7	39.3	54.8	240/35	1005.5
"	ELDZ7	40.6	52.4	150/38	1009.5
"	VRKB	41.1	60.3	340/38	1008.0
"	KMHF	43.8	60.1	030/47	1014.1
"	CGBV	45.6	57.8	060/40	1015.4
"	GCXD	46.0	53.7	080/37	1015.3

APPENDIX

SAFFIR/SIMPSON HURRICANE SCALE

Category 1: Winds 74 to 95 miles per hour. Damage primarily to shrubbery, tree foliage, and unanchored mobile homes; no real damage to other structures. Some damage to poorly constructed signs. Minor pier damage; some small craft in exposed anchorages torn from moorings. Storm surges 4 to 5 feet above normal tide heights; low-lying coastal roads inundated.

Category 2: Winds 96 to 110 miles per hour. Considerable damage to shrubbery and tree foliage, some trees blown down. Major damage to exposed mobile homes; no major damage to buildings; some damage to roofing materials of buildings; some window and door damage. Extensive damage to poorly constructed signs. Considerable damage to piers, marinas flooded. Small craft in protected anchorages may be torn from moorings. Storm surges 6 to 8 feet above normal tide heights. Coastal roads and low-lying evacuation routes inland cut by rising water 2 to 4 hours before expected landfall.

Category 3: Winds 111 to 130 miles per hour. Foliage torn from trees, large trees blown down. Mobile homes destroyed, some structural damage to small buildings; some damage to roofing materials of buildings; some window and door damage. Practically all poorly constructed signs blown down. Storm surge 9 to 12 feet above normal tide heights. Low-lying evacuation routes inland cut by rising water 3 to 5 hours before expected landfall. Serious coastal flooding; many smaller structures near the coast destroyed, larger ones damaged by battering waves and floating debris. Inland flooding of areas $\leq$5 feet elevation; evacuation of low-lying near shore areas necessary.

Category 4: Winds 131 to 155 miles per hour. Shrubs and trees blown down; all signs down. Complete destruction of mobile homes. Extensive damage to roofing materials, windows and doors. Complete failure of roofs on small buildings. Major damage to lower floors of near-shore structures due to flooding and battering by waves and floating debris. Storm surges 13 to 18 feet above normal tide heights. Low-lying evacuation routes inland cut by rising water 3 to 5 hours before expected landfall. Extensive inland flooding of areas $\leq$10 feet elevation. Major erosion of beaches. Evacuation of all residences near shore and one-story residences in areas $\leq$10 feet elevation required.

Category 5: Winds greater than 155 miles per hour. Shrubs and trees blown down; all signs down. Extensive shattering of glass in windows and doors; complete failure of roofs on many residences and industrial buildings. Complete destruction of mobile homes; small buildings overturned or blown down; some complete failures of other structures. Low-lying evacuation routes inland cut by floodwaters 3 to 5 hours before landfall. Storm surge greater than 18 feet above normal tide heights. Some islands completely swept by storm surge. Major damage to lower floors of all structures ≥15 feet above sea level within half-mile of shore. Evacuation of all residences in low-lying areas within 5-10 miles of shore possibly required.

SAFFIR/SIMPSON HURRICANE SCALE
WITH
CENTRAL BAROMETRIC PRESSURE RANGES

CATEGORY	CENTRAL PRESSURE (Millibars	Inches)	WINDS (mph)	SURGE (feet)	DAMAGE
1	>980	>29.94	74-95	4-5	Minimal
2	965-979	28.50-28.91	96-110	6-8	Moderate
3	945-964	27.91-28.47	111-130	9-12	Extensive
4	920-944	27.17-27.88	131-155	13-18	Extreme
5	<920	<27.17	155+	<18	Catastrophic

REFERENCES

Lawrence, Miles, B., 1986, Preliminary Report: National Hurricane Center, National Weather Service, Coral Gables, Florida 33146, 20 p.

Palmer, Bernard, 1986, unpublished material on Hurricane Bob: National Weather Service Forecast Office, West Columbia, South Carolina 29169, 1 p.

National Oceanic and Atmospheric Administration, 1986, Storm Data Volume 28, Number 7: National Climatic Data Center, Asheville, North Carolina.

National Oceanic and Atmospheric Administration, S.C. Climatological Data for August 1986, National Climatic Data Center, Asheville, North Carolina