

Preliminary Report
Hurricane Bertha
05 - 14 July 1996

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BERTHA WAS AN EARLY-SEASON CAPE VERDE HURRICANE THAT MOVED ACROSS THE ISLANDS OF THE NORTHEASTERN CARIBBEAN SEA AS A CATEGORY 1 HURRICANE ON THE SAFFIR/SIMPSON SCALE AND MADE LANDFALL ON THE NORTH CAROLINA COAST NEAR WILMINGTON AS A CATEGORY 2 HURRICANE. BERTHA'S ONE-MINUTE WINDS REACHED THEIR MAXIMUM VALUE OF 100 KNOTS ON 9 JULY, WHILE LOCATED TO THE NORTH OF PUERTO RICO. THE LAST HURRICANE TO REACH THIS STRENGTH, THIS EARLY IN THE SEASON, WAS ALMA IN 1966 IN THE EASTERN GULF OF MEXICO WITH 110 KNOTS. BERTHA IS RESPONSIBLE FOR AN ESTIMATED 12 DEATHS AND \$250 MILLION IN U.S. DAMAGES.

a. Synoptic History

Bertha originated from a tropical wave which moved from Africa to the Atlantic on 1 July. A weak circulation was first detected on satellite imagery on 3 July, centered about 500 n mi south of the Cape Verde Islands in the far eastern Atlantic Ocean. The track of the circulation center begins on 5 July, when the circulation is believed to have reached the surface and become a tropical depression, in the central tropical Atlantic. This track is displayed in Fig. 1 and listed in Table 1.

Bertha followed a fairly smooth curved path around the western periphery of the Atlantic subtropical high pressure ridge. This ridge changed little during Bertha's existence and a weak mid-level trough persisted in the western North Atlantic. For three days, the depression moved toward the west-northwest at the fast forward speed of 20 to 25 knots and strengthened to a hurricane with 1-min. maximum sustained winds of 75 knots on the 8th as the center moved across the Leeward and Virgin Islands of the northeastern Caribbean. The center moved between Antigua and Barbuda at 0600 UTC on the 8th, across St. Barthelemy, Anguilla, and St Martin, just north of St. Thomas, and over the British Virgin Islands by 1800 UTC.

The track gradually turned northwestward on the 9th and maximum sustained winds reached 100 knots at 0600 UTC. Bertha was centered 120 n mi north of Puerto Rico at this time, but earlier passed within 30 n mi of this island. The strongest winds were located in the northeast quadrant of the hurricane and most of Puerto Rico experienced only tropical storm conditions, except for Culebra, over which hurricane-force winds might have occurred.

Moving northwestward at a slower forward speed of 15 to 20 knots, the center of Bertha moved parallel to the Bahama islands, passing 40 to 60 n mi northeast of the Turks and Caicos islands, San Salvador, Eleuthera and the Abacos. Again, the strongest winds were located to the

northeast of the center, but 65-knot sustained winds might have reached some of the above mentioned islands.

Continuing on its gradual turn, the track became north-northwestward on the 10th and 11th and the center moved parallel to the coast of Florida and Georgia at a distance of 150 to 175 n mi offshore. During this time, the forward speed slowed to about 8 knots. Moving northward and re-accelerating to a forward speed of 15 knots, Bertha made landfall at 2000 UTC on the 12th on the coast of North Carolina, with the center crossing the coast midway between Wrightsville and Topsail Beaches. The hurricane had been gradually weakening since its top speed of 100 knots on the 9th to 70 knots on the 11th. Then, in 12 hours just before landfall, the winds increased to 90 knots, which is the estimated maximum 1-min. wind speed at landfall. Bertha quickly dropped below hurricane strength when it moved inland over eastern North Carolina.

It then moved northeastward along the U.S. east coast, producing 40 to 50 knot sustained winds over land from northern North Carolina to New England and 60 knot winds over nearby Atlantic waters. Bertha was declared extratropical on the 14th when the center moved from the Maine coast to New Brunswick, Canada. The extratropical storm brought 40 to 50 knot winds to the Canadian Maritime Provinces and was tracked to just south of Greenland on the 17th.

b. Meteorological Statistics

Figures 2 and 3, show a plot, versus time, of the various data used to estimate the minimum central sea-level pressure and the maximum 1-min. wind speed, 10 m above ground. Included are data from reconnaissance aircraft and satellite Dvorak-technique wind speed estimates. Table 2 lists selected surface observations of lowest pressure, peak wind, storm surge and rainfall values. Table 3 lists ship reports of 34 knots or greater that were associated with Bertha. The minimum pressure of 960 mb occurred at 0600 UTC on the 9th and is based on a dropsonde measurement. The best track maximum sustained wind speed of 100 knots at the same time is based on a 700-mb flight-level wind speed of 122 knots, measured 19 n mi east-northeast of the center.

Observations are incomplete from the Leeward and Virgin Islands, but because the circular eyewall was 20 - 30 n mi across, it is believed that hurricane conditions with sustained wind speeds to 75 knots could have occurred on Antigua, Barbuda, Nevis, St. Eustatius, St. Bathelmy, Anguilla, St. Martin, and from St. Thomas northward through the U.S. and British Virgin Islands. Experience with Hurricane Marilyn in 1995 suggests that even higher sustained winds can occur over mountainous terrain as is found on many of these islands. Winds of 35 to 40 knots were experienced over portions of Puerto Rico as indicated by the San Juan observations in Table 2.

A reconnaissance aircraft flight level wind speed of 110 knots in the northeast quadrant of the circulation several hours before landfall is the basis for estimating sustained surface winds of 90 knots on the coast at landfall. The lowest sea-level pressure observed at landfall was 977 mb at

Surf City, North Carolina and a value of 974 mb is assumed to be the minimum pressure at landfall.

Storm total rainfall amounts ranged from 5 to 8 inches along a coastal strip from South Carolina to Maine.

Coastal storm surge flood heights, from Florida through New England, ranged from 1 to 4 feet, but values to 5 feet were estimated on the North Carolina coast from Cape Fear to Cape Lookout. A storm surge of 6 feet or a little higher is indicated near Swansboro, where 5 to 6 feet of water was "inside of businesses on the waterfront".(from Newport, North Carolina National Weather Service Forecast Office Preliminary Storm Report).

Seven tornadoes have been confirmed, and these occurred during the passage of an outer rain band. There were five tornadoes in Virginia, one in North Carolina and one in Maryland.

c. Casualty and Damage Statistics

Twelve deaths have been related, in some way, to Hurricane Bertha. One, in Florida, was from an evacuating military jet crashing into a house and three others drowned in rip currents and high surf. One death from an auto accident occurred in North Carolina and another drowned in rip currents. A surfer died in New Jersey. In Puerto Rico, Two died in an automobile accident and another died while surfing. On the French half of St. Martin, one person was electrocuted and one fell off a boat.

The U.S. Virgin Islands, along with North Carolina, has been declared a federal disaster area. Surveys indicate that Bertha damaged almost 2500 homes on St. Thomas and St. John. For many, it was a second hit in the ten months since Hurricane Marilyn devastated the same area.

It is likely that there was beach erosion on the north coast of the Dominican Republic as Bertha passed to the north. The Bahamas were also affected by the weak side of the hurricane, but there are no damage figures available from either of these locations.

The primary effects in North Carolina were to the coastal counties and included storm surge flooding and beach erosion, roof damage, piers washed away, fallen trees, and damage to crops. A survey indicated over 5000 homes damaged, mostly from storm surge. A Federal Emergency Management Agency (FEMA) estimate of the number of persons in South and North Carolina who evacuated is 750,000. Minor wind damage and flooding also spread along the path of the storm all the way to New England.

The American Insurance Association reports an estimate of \$135 million dollars in insured property damage, primarily along coastal North Carolina. A conservative ratio between total damage and insured property damage, compared to past land falling hurricanes, is two to one. Then the total U.S. damage estimate is 2 times \$135 million or \$270 million dollars. No figures

are available from the Caribbean.

d. Forecast and Warning Critique

Bertha moved on a fairly smooth track. The average official track forecast errors for Bertha ranged from 80 n mi at 24 hours (32 cases) to 147 n mi at 48 hours (29 cases) to 224 n mi at 72 hours (27 cases). These errors are 15 per cent, or more, lower than the previous ten-year averages of the official track errors and are from 15 to 40 per cent lower than the CLIPER forecast errors for the same cases.

Overall, the track model guidance also performed very well. However, the 0000 UTC Aviation Model run on the 9th, when Bertha was located just north of Puerto Rico, (inexplicably?) showed the track recurving significantly further east than the previous run. All of the track guidance models that use the Aviation Model as a background environment also showed a similar track. This resulted in rather large official track forecast errors on the 9th, with a 613 n mi 72-hour error on the 1200 UTC forecast. The Aviation Model and some of the track guidance models recovered to an excellent forecast only 12 hours later. Fortunately, this guidance problem occurred three days prior to landfall in North Carolina and did not have a significant impact on U.S. warnings or on warnings for the Bahamas.

Table 4 lists the various watches and warnings that were issued. Hurricane warnings were issued from Sebastian Inlet, Florida to Chincoteague, Virginia as well as for the Bahamas and for the islands of the northeastern Caribbean Sea from Antigua through Puerto Rico. Tropical storm warnings were issued from Sebastian Inlet to north of Deerfield Beach, Florida and from north of Chincoteague to Watch Hill, Rhode Island. Almost all of the U.S. east coast was involved with some watch or warning and this is the result of the storm track's expected close passage to the southeast U.S. coast. The hurricane watch for the North Carolina landfall area was issued 65 hours before landfall and the hurricane warning was issued 47 hours before landfall. This is far more than the 36- and 24-hour lead times that the National Hurricane Center strives for and is the result of the forward motion decreasing at a faster rate than expected.

Figure Captions:

Fig. 1. Track of Hurricane Bertha, 05-14 July, 1996 (extratropical track 14-17 July).

Fig. 2. Curve of minimum central sea-level pressure versus time.

Fig. 3. Curve of maximum one-minute wins speed versus time.

Table 1. Best track, Hurricane Bertha, 5 - 14 July, 1996 (updated 4 August 1996)

Date/Time (UTC)	Position		Pressure (mb)	Wind Speed (kt)	Stage
	Lat. (°N)	Lon. (°W)			
05/0000	9.8	34.0	1009	30	tropical depression
0600	10.2	36.3	1008	30	"
1200	11.0	39.0	1007	35	tropical storm
1800	12.0	41.2	1006	35	"
06/0000	12.7	43.9	1005	35	"
0600	13.1	46.6	1004	35	"
1200	13.7	48.7	1002	40	"
1800	14.2	51.0	1000	45	"
07/0000	14.9	52.9	999	50	"
0600	15.6	54.8	997	55	"
1200	16.4	56.9	995	60	"
1800	16.5	58.4	992	70	hurricane
08/0000	17.0	60.1	988	75	"
0600	17.5	61.8	985	75	"
1200	18.0	63.5	983	70	"
1800	18.6	64.9	978	75	"
09/0000	19.4	66.1	970	80	"
0600	20.3	67.7	960	100	"
1200	21.4	69.4	965	100	"
1800	22.5	71.1	967	90	"
10/0000	23.6	72.6	969	85	"
0600	24.5	74.0	971	80	"
1200	25.4	75.3	968	80	"
1800	26.4	75.8	966	80	"
11/0000	27.5	76.4	968	75	"
0600	28.3	76.8	972	75	"
1200	29.2	77.5	977	75	"
1800	30.0	78.0	980	70	"
12/0000	30.7	78.3	982	70	"
0600	31.2	78.6	984	70	"
1200	32.2	78.4	975	85	"
1800	33.6	78.1	974	90	"
13/0000	35.0	77.6	993	65	"
0600	36.7	77.0	993	60	tropical storm
1200	38.3	76.1	994	60	"
1800	40.2	74.5	994	60	"
14/0000	42.1	71.9	994	60	"
0600	44.1	69.0	995	55	"
1200	46.0	66.0	995	50	extratropical
1800	47.0	62.0	995	50	"
15/0000	48.0	57.0	995	50	"
0600	49.0	52.0	996	45	"
1200	51.0	47.0	996	40	"
1800	54.0	44.0	996	40	"
16/0000	57.5	42.5	991	40	"
0600	58.5	42.5	988	40	"
1200	59.5	42.0	988	45	"
1800	59.8	41.0	985	45	"
17/0000	60.0	40.0	993	40	"
0600	60.5	39.0	1001	35	"
09/0600	20.3	67.7	960	100	minimum pressure
12/2000	34.3	77.8	974	90	landfall* midway between Wrightsville and Topsail Beaches

*The eyewall also passed over Antigua, Barbuda, St. Barthelemy, Anguilla, St Martin, St Thomas, and the British Virgin Islands and passed close to a number of other islands in the northeastern Caribbean Sea.

Table2. Hurricane Bertha selected surface observations, July 1996 (updated 1 September 1996)

Location	Press. (mb)	Date/time (UTC)	Sustained wind(kt)*	Peak gust	Date/time (UTC) ^b	Storm surge(ft) ^c	Storm tide(ft) ^d	total rain(in.)
Florida								
Jacksonville	1011.9	11/2256	22(2 min)	27	11/1721			trace
Jacksonville Beach							2	
Georgia								
Sea Island							3	
St. Simon							3	
South Carolina								
Charleston international airport	1008.5	12/1155	30 (2-min.)	39	12/0130			1.48
Charleston city office			36	50	12/1130			0.94
Charleston harbor						2.7		
Cheraw								0.38
Cherry Grove pier				68				
Garden City pier				54				
Loris								2.77
Myrtle Beach								2.40
Myrtle Beach, Sands Resort								4.73
Myrtle Beach Springmaid pier						3.3		
Myrtle Beach pavilion				52				
Summerville								1.40
North Carolina								
Beaufort Duke marine lab						2.8		
Beaufort				56	12/2125			
Bath							6	
Bellhaven							7	
Brunswick							5	
Carolina Beach							6	
Cherry Point (NKT)				64	12/2242			
East Wilmington				70				
Elizabeth City (ECG)	998.9	13/1313	39	48	13/0055			
Greenville				76				4.11
Hatteras ferry office				63	13/0100			
Kure Beach			49	80	12/1835			
Lake Waccamaw								2.39
Newport	994.3			78				2.95
New Bern				62	12/2208			4.56 ^e
New River (NCA)				94	12/2021			
Pongo River							4.5	
Seymour Johnson AFB	986.3	12/2355	33	52	12/2155			4.03
Snow Hill								5.44
S. Pamlico River							3	
Southport (Nixon)	978.3	12/1835	55	74	12/1703			
Surf City (Horodner)	977	12/2005						
Swansboro							8	
Williamston								4.10
Wilmington (ILM)	978.7	12/2028	46(2-min)	61	12/1902	1.3		5.66
Wilmington, Fig. Eight Is.				83	12/1725			
Wilmington NC state port				77				
Wilmington port terminal	980.1	12/1850	NOAA ship Whiting, 34.2N 77.96W					
Cape Lookout Buoy				73	12/1837			
Diamond Shoals Buoy				71	13/0200			
FPSN7 (CMAN, 80 ft asl)	977.5	12/1800	77(10 min)	101	12/1610			
Wrightsville Bch. Banks ch.				80				
Virginia								
Cape Charles				61	13/0330			

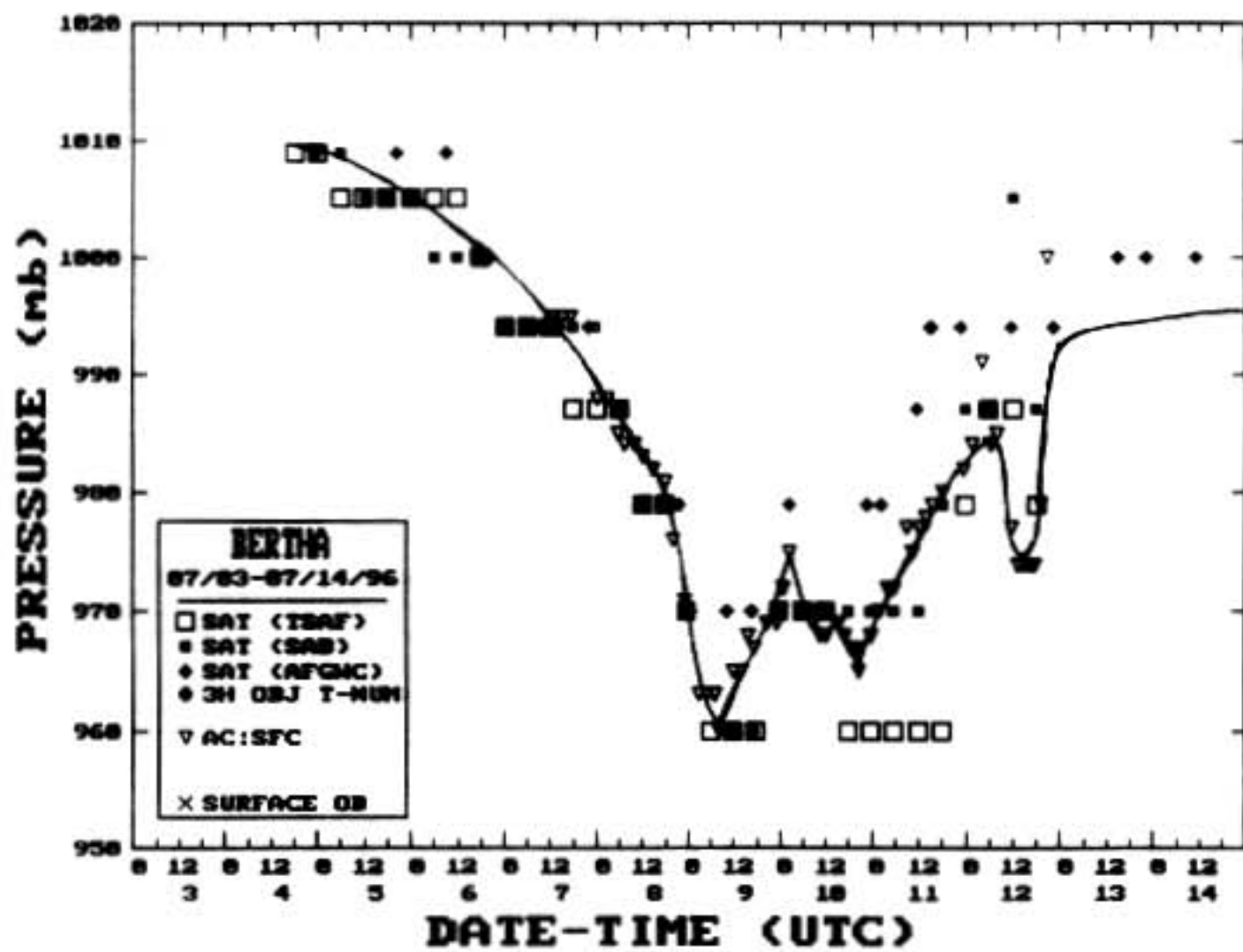


Fig. 2. Curve of minimum central sea-level pressure versus time.

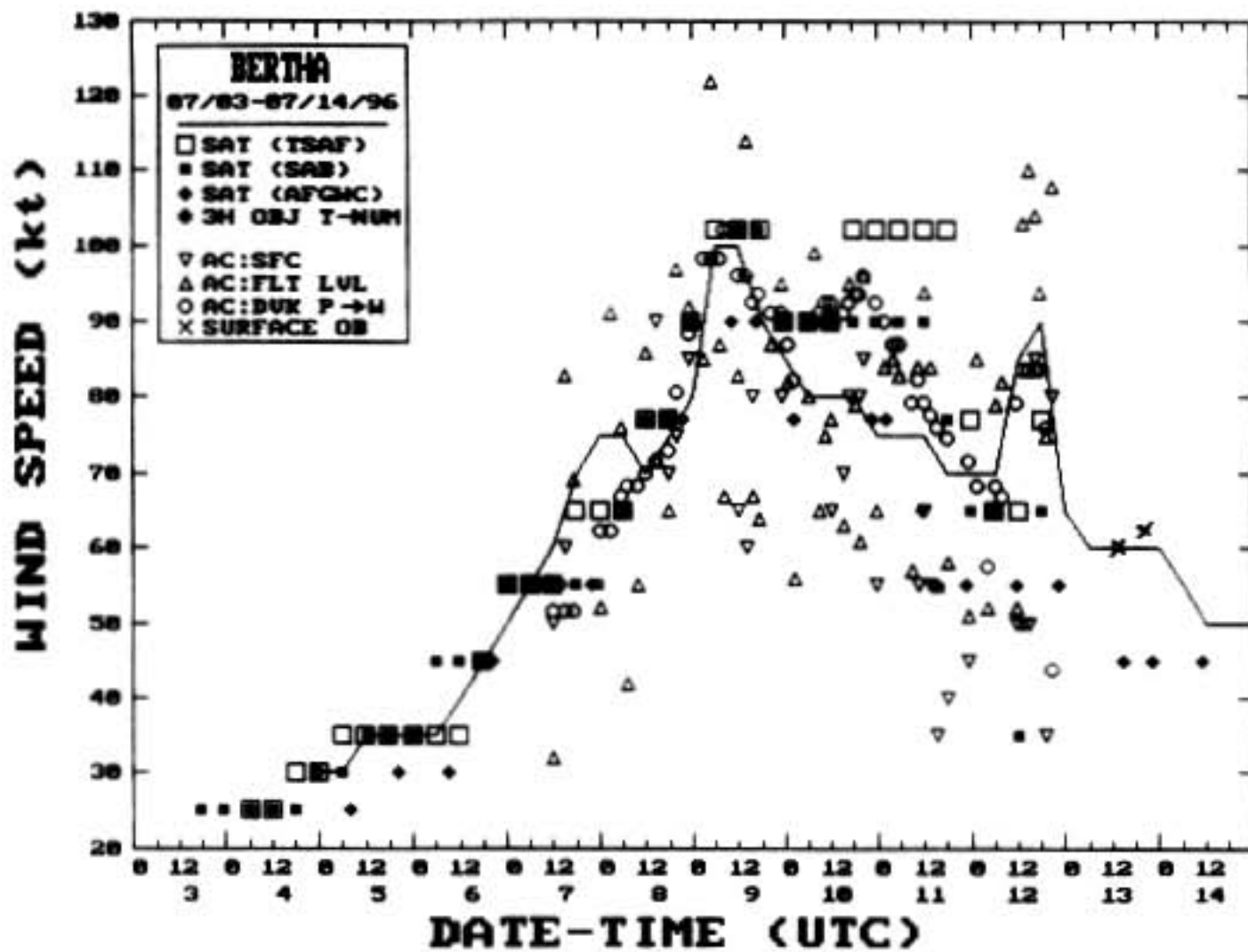


Fig. 3. Curve of maximum one-minute wind speed versus time.

Table2(continued). Hurricane Bertha selected surface observations, July 1996.

Location	Press. (mb)	Date/time (UTC)	Sustained wind(kt) ^a	Peak gust	Date/time (UTC) ^b	Storm surge(ft) ^c	Storm tide(ft) ^d	total rain(in.)
Rhode Island								
Fox Point hurricane barrier						2.1		
Sachuest Point(Middletown)			54	64	14/0010 ^e	hand-held anemometer		
Providence	995.9	13/2336						5.41
Massachusetts								
Goshen								5.70
Billerica								7.20
Boston	996.3	14/0056						
New Bedford			45	76	13/2030	1.7		
Taunton ASOS	995.6	14/0041						
Puerto Rico								
Rio Icacos(Naguabo)								8.17
Roosevelt Roads	992.0	08/1930	38	52	08/1525			1.60
San Juan airport	996.8	08/2056	42(2 min)	52	08/2110			1.56
U.S. Virgin Islands								
Mt Zion(St Thomas)								3.28
St Croix Hess Oil			41		08/1918			

^a Averaging period is 1 min. unless otherwise indicated.

^b Date/time is for sustained wind when both sustained and gust are given.

^c Storm surge is water height above normal astronomical tide level.

^d Storm tide is water height above National Geodetic Vertical Datum.

^e Top of rain gage blew off and "a lot of rain was sucked out".

Table 3. Ship reports of 34 knots or higher wind speed, associated with Hurricane Bertha, July 1996.

date/time (UTC)	ship name	latitude (°N)	longitude (°W)	wind dir/ speed(knots)	pressure (mb)
07/1200	FORT ROYAL	17.1	53.8	110/39	1014.2
08/1800	MAYAGUEZ	21.6	64.3	130/35	1013.0
09/0000	SEALAND CONSUMER	21.6	64.7	080/036	1009.1
09/0300	MAYAGUEZ	20.0	64.6	100/38	1007.0
09/0300	SEALAND CONSUMER	21.0	65.0	100/48	1008.9
09/0600	MAYAGUEZ	16.9	65.1	130/40	1007.5
09/0600	SEALAND CONSUMER	20.6	65.1	130/48	1006.9
09/0900	SEALAND CONSUMER	20.4	65.3	130/42	1009.0
09/1800	SEALAND CRUSADER	23.0	67.9	100/43	1012.0
09/1800	CALAPATRIA	24.3	67.0	110/34	1013.2
11/1800	SEALAND HAWAII	28.5	78.8	270/35	1006.0
11/1800	C6YC	29.6	73.5	150/040	1020.5
11/1800	NOBLE STAR	30.8	79.9	050/40	1010.0
11/1800	AALSMEERGRACHT	31.6	80.4	040/43	1010.0
11/1800	DSR EUROPE	32.4	72.6	140/35	1022.5
11/2100	C6YC	28.9	74.3	140/42	1018.8
12/0000	C6YC	28.3	74.8	140/38	1017.5
12/0000	NOBLE STAR	30.8	80.1	030/38	1004.7
12/0000	AALSMEERGRACHT	31.0	80.9	020/47	1010.0
12/0600	DSR EUROPE	30.7	74.7	140/58	1019.0
12/0600	AALSMEERGRACHT	31.1	80.6	360/66	1005.0
12/0600	SEALAND ATLANTIC	31.3	76.5	130/45	1008.0
12/0900	SEALAND ATLANTIC	30.8	76.4	150/55	1007.3
12/1200	BELGRAND	28.6	79.7	270/34	1015.5
12/1200	SEALAND ATLANTIC	30.4	76.4	150/43	1008.8
12/1200	ELSD9	30.9	75.4	150/37	1016.0
12/1200	SHIP	34.9	71.1	180/52	
12/1500	DSR EUROPE	30.0	77.3	180/39	1015.0

Table 3(continued). Ship reports of 34 knots or higher wind speed, associated with Hurricane Bertha, July 1996.

date/time (UTC)	ship name	latitude (°N)	longitude (°W)	wind dir/ speed(knots)	pressure (mb)
12/1800	DSR EUROPE	30.1	78.1	210/47	1015.5
12/1800	FENELLA	30.5	74.8	170/35	1013.0
12/1800	ELSD9	30.7	76.3	150/37	1017.5
12/1800	SHIP	32.7	73.6	160/40	1016.8
12/1800	ESSO CORAL GABLES	33.8	73.9	140/34	1017.8
13/0000	EXPORT PATRIOT	32.7	75.2	180/35	1022.2
13/0000	ESSO CORAL GABLES	33.6	75.1	170/38	1012.2
13/0600	KAIJIN	32.2	73.7	180/37	1017.0
13/0600	ESSO CORAL GABLES	33.3	76.0	200/38	1013.3
13/1200	ZIM CANADA	39.3	73.9	140/60	1006.0
13/1200	BREMEN EXPRESS	37.9	73.2	150/40	1008.1
13/1500	3FEB5	36.5	69.9	180/40	1019.6
13/1500	BREMEN EXPRESS	37.6	73.9	210/44	1006.5
13/1500	ZIM CANADA	38.7	74.1	160/60	1000.0
13/1800	3FEB5	36.0	70.0	170/37	1017.9
13/1800	BREMEN EXPRESS	37.3	74.8	210/62	1009.6
13/1800	ZIM CANADA	38.1	74.3	210/40	1005.0
13/1800	SONG OF AMERICA	40.6	72.4	170/40	1004.0
13/2100	PHAROS	39.5	69.0	170/37	1012.6
14/0000	PHAROS	39.6	69.5	210/47	1009.8
14/0000	NJPJ	41.9	70.3	180/35	1006.1
14/0600	PHAROS	39.7	70.4	240/35	1013.3
14/0900	A.S.L. SANDERLING	45.0	60.4	170/35	1011.4
14/1200	TRITONHIGHWAY	37.4	66.5	230/39	1022.0
14/1200	ALFRED NEEDLER	43.3	62.6	230/50	1007.0
14/1200	KASUGA 1	43.9	61.3	180/48	1007.8
14/1200	A.S.L. SANDERLING	45.2	59.4	170/35	

Table 4. Watch and warning summary, Hurricane Bertha, July 1996.

Date/time (UTC)	Action	Location
06/1500	hurricane watch	Antigua, Barbuda, Nevis, Montserrat, St Kitts, Anguilla, Saba, St Eustatius, Dominica, and Dutch St Maarten
06/2100	hurricane watch	Guadeloupe, St Barthelemy, French St Martin, U.S. and British Virgin Islands
07/0300	hurricane warning	Dominica northward to Anguilla and St Maarten
07/1200	hurricane watch	Puerto Rico
07/1500	hurricane warning	U.S. and British Virgin Islands and Puerto Rico
08/0000	tropical storm watch	Dominican Republic from Isla Saona to Cabo Frances Viejo
08/0300	hurricane watch	Dominican Republic from Isla Saona to Cabo Frances Viejo
08/0900	hurricane watch	Turks and Caicos Islands
08/1200	hurricane warning	Dominican Republic from Cabo Caucedo to Monte Cristo, southeastern Bahamas
08/1500	hurricane warning discontinued	Dominica
08/1800	hurricane watch	Haiti from St Nicolas to border of Dominican Republic
08/1800	hurricane warning discontinued	Leeward Islands south and east of St Eustatius
08/2100	hurricane warning	Turks and Caicos Islands and southeastern Bahamas
08/2100	hurricane warning discontinued	Leeward Islands
08/2100	hurricane watch	central Bahamas
09/0100	hurricane warning discontinued	U.S. and British Virgin Islands
09/0300	hurricane warning discontinued	Puerto Rico
09/0300	tropical storm warning	Haiti from St Nicolas to border of Dominican Republic
09/0900	hurricane warning	central Bahamas
09/0900	hurricane watch	northwestern Bahamas
09/1500	watches and warnings discontinued	Dominican Republic and Haiti
09/2100	hurricane warning	northwestern Bahamas
10/0300	tropical storm warning	north of Deerfield Beach, FL to Brunswick, GA
10/0300	hurricane watch	north of Brunswick to NC/VA border including Pamlico and Albemarle Sounds

Table 4(cont.). Watch and warning summary, Hurricane Bertha, July 1996.

Date/time (UTC)	Action	Location
10/0900	hurricane warning discontinued	Turks and Caicos Islands and southeastern Bahamas
10/1500	hurricane warning	Sebastian Inlet, FL to Cape Romain, SC
10/1800	hurricane warning discontinued	central Bahamas
10/2100	hurricane warning	Cape Romain to NC/VA border including Pamlico and Albemarle Sounds
10/2100	tropical storm warning discontinued	south of Sebastian Inlet, FL
11/0300	hurricane watch	NC/VA border to Chincoteague VA including southern Chesapeake Bay
11/0600	hurricane warning discontinued	northwestern Bahamas
11/0900	hurricane warning discontinued	south of Brunswick, GA
12/0900	hurricane warning discontinued	Savannah, Ga southward
12/1500	tropical storm warning	NC/VA border to Chincoteague, VA including southern Chesapeake Bay
12/1900	hurricane warning discontinued	Cape Romain, SC southward
12/2100	hurricane warning	NC/VA border to Chincoteague, VA including the Hampton Roads area
12/2100	tropical storm warning	north of Chincoteague, VA to Watch Hill, RI including the lower Delaware Bay
12/2100	tropical storm watch	east of Watch Hill to the Merrimack River, MA
13/0300	hurricane warning discontinued	south of Topsail Beach, NC
13/0300	hurricane watch discontinued	lower Chesapeake Bay
13/0300	tropical storm warning	all of Chesapeake Bay and the lower tidal Potomac River and all of Delaware Bay
13/0700	hurricane warning to tropical storm warning	Topsail Beach, NC to Chincoteague, VA including Albemarle and Pamlico Sounds
13/0900	hurricane warning discontinued	NC/VA border southward
13/1200	tropical storm warning discontinued	south of Fenwick Island, DE
13/1500	tropical storm warning discontinued	south of Brigatine, NJ and Delaware Bay
13/2100	tropical storm warning discontinued	south of Fire Island, NY
14/0000	tropical storm warning discontinued	south of Watch Hill, RI
14/0300	tropical storm warning discontinued	remainder of U.S east coast