Preliminary Report
Hurricane Marilyn
12 - 22 September 1995

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Hurricane Marilyn devastated portions of the U.S. Virgin Islands when it hit that area with Category 2 to near Category 3 intensity on the Saffir/Simpson Hurricane Scale (SSHS).

a. Synoptic History

Marilyn originated from a tropical wave that crossed from the west coast of Africa to the eastern tropical Atlantic Ocean on 7-8 September. A large circulation of low- and middle-level clouds accompanied the wave, but little deep convection was generated at that time. The system moved westward at about 17 knots over the following few days, under upper-level easterlies on the south side of a well-defined anticyclone aloft, which also moved westward.

The initial Dvorak technique T-number intensities of 1.0 were assigned late on the 11th by satellite analysts at the National Hurricane Center (NHC) and the NESDIS Synoptic Analysis Branch (SAB). Although the low-level circulation was rather disorganized then, deep convection developed and became concentrated near the analyzed center on the 12th. Based on analysis of satellite pictures, it became the fifteenth 1995 Atlantic tropical depression at 1800 UTC on the 12th (Table 1, Fig. 1). The cyclone strengthened further, becoming Tropical Storm Marilyn six hours later. Marilyn reached hurricane strength 24 hours after that, at 0000 UTC on the 14th, shortly after the U.S. Air Force Reserves (Hurricane Hunters) first identified a closed eyewall during their reconnaissance flight.

Over the following three days, the track gradually became directed toward the west-northwest and then the northwest while the hurricane moved toward a weakness in the subtropical ridge over the central Atlantic Ocean. Marilyn continued to strengthen in an "embedded center" cloud pattern, but at a slower rate during that period. It was a Category 1 hurricane on the 14th when the center passed about 45 n mi to the north of Barbados, then just north of Martinique, over Dominica, to just southwest of Guadeloupe.

Marilyn continued moving northwestward over the northeastern Caribbean Sea. It hit the U.S. Virgin Island during the afternoon and night of the 15th as a strengthening Category 2, nearly Category 3, hurricane. The Hurricane Hunters reported hail, an unusual occurrence for tropical cyclones. They noted an eye of 20 n mi diameter. The strongest part of the hurricane, the eyewall to the east and northeast of the center, passed over St. Thomas. Maximum one-minute surface winds at that time were close to 95 knots.

After passing just offshore from eastern Puerto Rico early on

the 16th, the center of Marilyn was again over the Atlantic Ocean. An upper-level low had developed to the west and this could have enhanced outflow aloft from Marilyn. An eye became distinct on satellite pictures and Marilyn reached its peak intensity, about 949 mb and 100 knots (Category 3) as it began to turn northward on the 17th. Flight-level data showed some evidence of a concentric pair of eyewall wind maxima. Reconnaissance data indicated a marked weakening later that day. The central pressure rose 20 mb in about 10 hours and the peak flight-level winds decreased from 121 to 89 knots. The primary (inner) eyewall disintegrated into a few fragments. The weakening was likely caused by some combination of shearing within the system reported by the flight crew, the impact of nearby waters upwelled not long before by Hurricane Luis that were 1 to 3°C cooler than normal, and the decaying phase of an eyewall cycle.

Marilyn began accelerating toward the north-northeast late on the 18th and its center passed about 150 n mi to the west of Bermuda a day later. It had made a brief resurgence, with an eye reappearing in satellite pictures. However, upper-level westerly winds then began to shear Marilyn and the low-level cloud center became partially exposed. Marilyn ceased generating deep convection late on the 21st and became extratropical on the 22nd. The remnant circulation meandered over the central tropical Atlantic Ocean for another 10 days before becoming absorbed in a frontal system.

b. Meteorological Statistics

The "best track" (i.e., post-operational) intensities were obtained from the data presented in Figs. 2 and 3, and in Table 2. Those figures show Marilyn's estimated central pressure and maximum one-minute wind speed, respectively, versus time. The Hurricane Hunters made numerous flights through Marilyn. Position and intensity estimates from satellite pictures were provided by SAB, the NHC's Tropical Analysis and Forecast Branch (formerly TSAF, as in the figures), and the Air Force Global Weather Central (AFGWC). These data were supplemented by surface observations from some islands and ships and, to the southwest of Bermuda, by data obtained from a network of drifting NOAA buoys deployed ahead of Marilyn by the Hurricane Hunters.

Surface meteorological data during Marilyn's passage over Dominica are not available at the NHC.

Over Martinique and Guadeloupe, the maximum wind speed (presumably, sustained over the WMO-standard of 10-minutes) was 51 knots with gusts between 70 and 75 knots. Guadeloupe had exceptionally heavy rain, with one station, Saint-Claude, recording 20.00 inches in a 12-hour period. The maximum rainfall reported from Martinique was about 9 inches.

Part of Marilyn's eye passed over St. Croix. However, owing to the northwestward motion of the hurricane, Marilyn's strongest winds were located in the eastern or northeastern eyewall which passed just offshore. The highest one-minute wind speed (estimated

for open exposure at 10 meters elevation) at St. Croix was likely a little less than the 85 knots shown in the best track.

On the other hand, St. Thomas *was* hit by the hurricane's eastern and northeastern eyewall. In addition, the hurricane strengthened as it approached and passed St. Thomas. An uncommissioned FAA Automated Surface Observing System (ASOS) at the St. Thomas King Airport provided the only continuous "official" wind record of the event in the U.S. Virgin Islands. Its maximum two-minute wind was 90 knots at 0352 and again at 0353 UTC on the 16th. (Around then, the peak 10-second winds in the hurricane at the 700 mb flight-level were 105 to 110 knots.) The ASOS measured a gust to 112 knots at 0408 UTC. Based on the ASOS data, the estimated maximum one-minute wind speed (for open exposure at 10 meters elevation) at that time is 95 knots. This is 5 knots higher than was estimated operationally. It is likely that somewhat stronger one-minute winds (perhaps, to Category 3) and gusts above 112 knots occurred on exposed hills. Some unofficial high wind speed observations remain unconfirmed or have been rejected.

The ASOS measured a minimum pressure of 956.7 mb. This occurred at 0422 UTC when the airport was still experiencing 60 knot one-minute winds, apparently on the inside edge of the eyewall. The estimated minimum pressure for Marilyn at that time is 952 mb. This is lower than implied by the data obtained from the Hurricane Hunters. They reported extrapolated and dropsonde pressures of 957 and 960 mb, respectively, at 0305 UTC, and 954 and 958 mb for those techniques at 0600 UTC. This is reminiscent of Hurricane Andrew's landfall over Florida, where the minimum pressure obtained from surface observations was lower than analyzed using aircraft data. The reason for this discrepancy in Marilyn is not obvious.

The storm surge in the U.S. Virgin islands reached 6 to 7 feet, with an isolated storm tide of 11.7 feet reported on St. Croix. Rainfall totals reached about 10 inches in St. Croix and St. Thomas.

An unofficial gust to 109 knots was reported from the island of Culebra.

The center of Marilyn passed far enough to the east of Puerto Rico that hurricane conditions were apparently not experienced on that island. The Naval Base at Roosevelt Roads had maximum one-minute winds of 36 knots with gusts to 50 knots.

Bermuda experienced sustained winds of 39 knots with a gust to 52 knots during the passage of Marilyn's outer circulation.

c. Casualty and Damage Statistics

Marilyn was directly responsible for 8 deaths, 5 in St. Thomas, 1 in St. John, 1 in St. Croix and 1 in Culebra (Puerto Rico). Most drowned and were on boats at docks or offshore.

Marilyn caused severe damage to the U.S. Virgin Islands, in particular to St. Thomas. An estimated 80 percent of the homes and businesses on St. Thomas were destroyed and at least 10,000 people were left homeless. Some of the damage was reportedly attributable to lax construction standards and practices. According to FEMA, 30 percent of the homes on St. John were destroyed and 60 percent were roofless. About 20 to 30 percent of homes in St. Croix received damage. Trees fell and hotel windows broke there. Hillsides were littered with sheets of metal roofing, wooden planks and household debris. On Culebra, 250 homes were destroyed or severely damaged and light planes were overturned.

Large waves crashed over the harbor at Dewey, Culebra, flooding streets. Flash floods occurred over northern and eastern Puerto Rico where the La Plata and Manati rivers overflowed.

The American Insurance Services Group estimated insured losses for the U. S. Virgin Islands and Puerto Rico at $875 million. Because the overall loss is often estimated to be up to about double the insured loss, the total U.S. loss is tentatively estimated at $1.5 billion. The U. S. Virgin Islands Bureau of Economic Research estimated the economic loss at $3 billion. FEMA placed the cost for their programs at $1 billion in the Virgin Islands and $50 million in Puerto Rico. The FEMA totals include losses not traditionally described by the NHC as "damage", such as FEMA's cost to set up field offices, inspector's salaries, disaster unemployment compensation, and crisis counseling.

According to *The New York Times*, the British Virgin Islands were not seriously affected and some (unquantified) damage occurred in Antigua. According to the Antigua Meteorological Service, that island had extensive flooding in low-lying areas, destruction of banana trees and, otherwise, minimal wind damage.

About 12,000 people went to shelters in Puerto Rico. In the U.S. Virgin Islands, 2,243 people were sheltered.

d. Forecast and Warning Critique

Media reports in the U.S. Virgin Islands were critical of the NHC's forecasts and warnings. Some complaints seem almost unavoidable after U.S. landfall events, even when the advisories are exemplary. In Marilyn, there was a perception that the intensity of the hurricane was underestimated. In part, this is due to the public's unfamiliarity with high wind speeds. Regardless of the category of hurricane, they express surprise at the damage and are adamant that winds they experienced were stronger than indicated by the NHC. In contrast, when there is disagreement between the NHC and others in the scientific and engineering communities, analysts within those disciplines suggest that the wind speeds estimated by the NHC are too high (by about 10%).

In the case of Marilyn, the NHC issued:

- A hurricane watch with about 33 hours lead time for St. Croix and 40.5 hours for St. Thomas (Tables 3 and 4).

- A hurricane warning with about 24 hours lead time for St. Croix and 31.5 hours for St. Thomas.

- Track forecasts whose errors were, on average, about two-thirds of the usual magnitude. For the period near the northeastern Caribbean, the forecasts were even better. The 16 track forecasts from 0600 UTC on the 14th through 0000 UTC on the 18th were, on average, in error by about one-third of the usual magnitude (Table 5). In fact, the 36-hour forecast made when the watch was issued (around 1200 UTC on 14th) was off by 46 n mi (about 150 n mi is the long-term average). The 24-hour forecast made when the warning was issued (2100 UTC on 14th) was off by 8 n mi (100 n mi is the long-term average). The corresponding intensity forecasts were about 15 knots too low (equivalent to about 1 category on the SSHS). Those intensity errors are close to normal magnitude.

Beginning at 1500 UTC on the 14th, corresponding to 13.5 hours prior to Marilyn's center passing by St. Thomas, NHC public advisories carried the headline, "Marilyn approaching the U.S. Virgin Islands as a Category 2 hurricane on the Saffir-Simpson Scale." The advisory 6 hours later also noted "...and Marilyn could intensify from a Category 2 to Category 3 hurricane on the Saffir-Simpson Scale tonight or Saturday." The corresponding tropical cyclone discussion stated "The strongest winds are in the N and NE part and could spread over the St. Thomas area."

Watches and warnings were smoothly coordinated with most areas of the Caribbean, the Bahamas, and Bermuda. An exception was the series of issuances by French officials which sometimes differed from the coordinated advice disseminated by neighboring Caribbean islands.

Although Marilyn passed well offshore from the U.S. mainland, some NWS offices along the U.S. east coast issued heavy surf advisories for swells emanating from the hurricane.

Acknowledgments

Some of the data in this report were made available by Rafael Mojica of the NWS San Juan office and by the meteorological services of Martinique, Guadeloupe, Antigua and the Netherlands Antilles.

Table 1. Preliminary best track, Hurricane Marilyn, 12-22 September 1995.

Date/Time (UTC)	Position Lat. (°N)	Lon. (°W)	Pressure (mb)	Wind speed (kt)	Stage
12/1800	11.7	50.9	1006	30	Tropical Depression
13/0000	11.8	52.7	1004	35	Tropical Storm
0600	11.9	54.3	999	45	"
1200	12.1	55.4	995	55	"
1800	12.5	56.5	990	60	"
14/0000	13.0	57.7	988	65	Hurricane
0600	13.5	58.8	987	70	"
1200	14.2	59.8	986	70	"
1800	15.0	60.8	983	70	"
15/0000	15.8	61.7	985	75	"
0600	16.5	62.8	977	80	"
1200	16.8	63.5	974	80	"
1800	17.4	64.2	969	85	"
16/0000	17.9	64.7	962	90	"
0600	18.5	65.2	952	95	"
1200	19.0	65.8	951	95	"
1800	19.7	66.4	950	100	"
17/0000	20.4	67.0	950	100	"
0600	21.2	67.5	953	95	"
1200	22.0	68.2	965	80	"
1800	22.9	68.8	968	80	"
18/0000	24.0	69.1	963	85	"
0600	25.0	69.4	965	85	"
1200	26.1	69.5	966	85	"
1800	27.2	69.3	966	80	"
19/0000	28.4	69.0	969	80	"
0600	29.6	68.6	970	75	"
1200	31.0	68.2	976	75	"
1800	32.6	67.7	974	80	"
20/0000	34.2	66.8	974	80	"
0600	35.8	66.1	976	75	"
1200	37.3	65.2	978	70	"
1800	38.3	64.3	980	70	"
21/0000	39.0	63.3	982	65	"
0600	39.3	61.9	984	65	"
1200	39.4	60.6	987	65	"
1800	39.6	59.3	990	60	Tropical Storm
22/0000	39.8	58.3	992	55	"
0600	39.7	57.6	994	55	Extratropical
1200	39.4	57.1	996	55	"
1800	39.0	56.8	998	55	"
23/0000	38.4	56.7	1000	50	"
0600	37.8	56.7	1001	45	"
1200	37.1	56.7	1002	35	"
1800	36.6	56.8	1003	30	"
24/0000	35.9	57.2	1004	30	"
0600	35.0	58.1	1004	30	"
1200	33.8	57.7	1005	30	"
1800	33.0	57.0	1005	30	"
25/0000	32.6	56.6	1005	30	"
0600	32.0	56.3	1005	30	"
1200	31.1	56.0	1005	30	"
1800	30.9	55.1	1005	30	"
26/0000	31.0	54.7	1006	25	"
0600	31.1	54.2	1006	25	"
1200	31.3	53.8	1007	25	"
1800	31.5	53.4	1008	25	"
27/0000	31.7	53.1	1009	20	"
0600	31.8	52.6	1010	20	"

1200	32.2	52.1	1011	20	" "
1800	32.6	51.7	1012	20	" "
28/0000	32.9	51.4	1013	20	" "
0600	33.2	51.1	1014	20	" "
1200	33.6	50.9	1014	20	" "
1800	34.0	50.6	1013	20	" "
29/0000	34.3	49.9	1013	20	" "
0600	34.8	49.1	1014	20	" "
1200	35.3	48.2	1014	20	" "
1800	35.3	47.2	1014	20	" "
30/0000	34.9	47.7	1015	20	" "
0600	34.6	48.5	1015	20	" "
1200	34.6	49.3	1016	20	" "
1800	34.7	50.0	1016	20	" "
01/0000	34.8	50.5	1016	20	" "
0600	35.0	51.0	1016	20	" "
1200	35.2	51.5	1016	20	" "
1800	35.3	51.9	1016	20	Merging with front
17/0300	20.7	67.1	949	100	Minimum Pressure

Landfall information:

Jenny Point, Dominica (landfall)

14/2100	15.5	61.3	984	70	Hurricane

Locations receiving a direct hit (site located ≤ 1 Radius of Maximum Wind (RMW) to left or 2 RMW to right of cyclone center) and approximate time of closest approach:

Martinique	14/1800
Guadeloupe (Marie Galant)	14/2300
Guadeloupe (Vieux-Fort and Iles des Saintes)	15/0000
St. Croix	15/2100
St. Thomas, St. John, and Culebra	16/0430

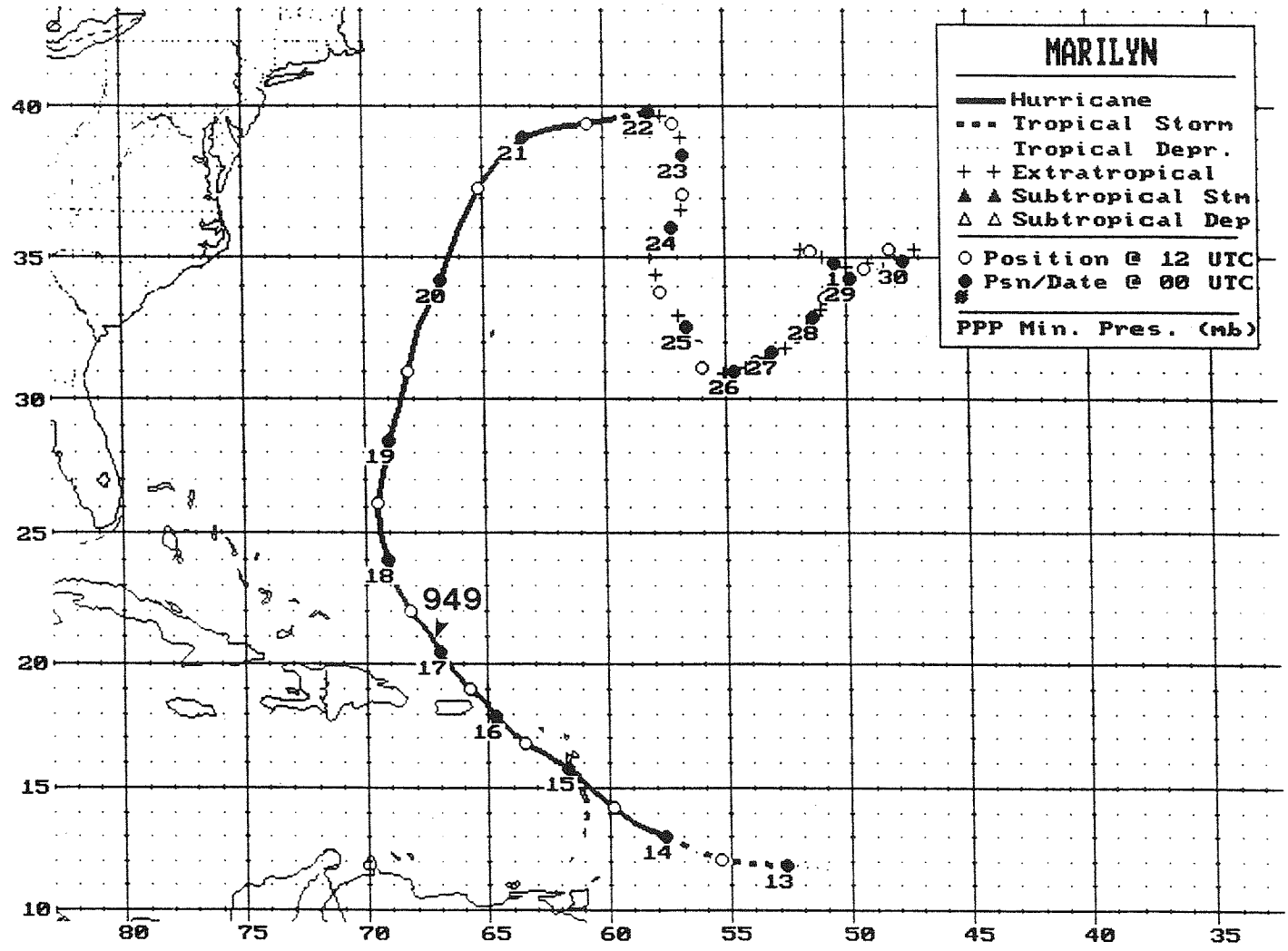

Figure 1. Best track positions for Hurricane Marilyn.

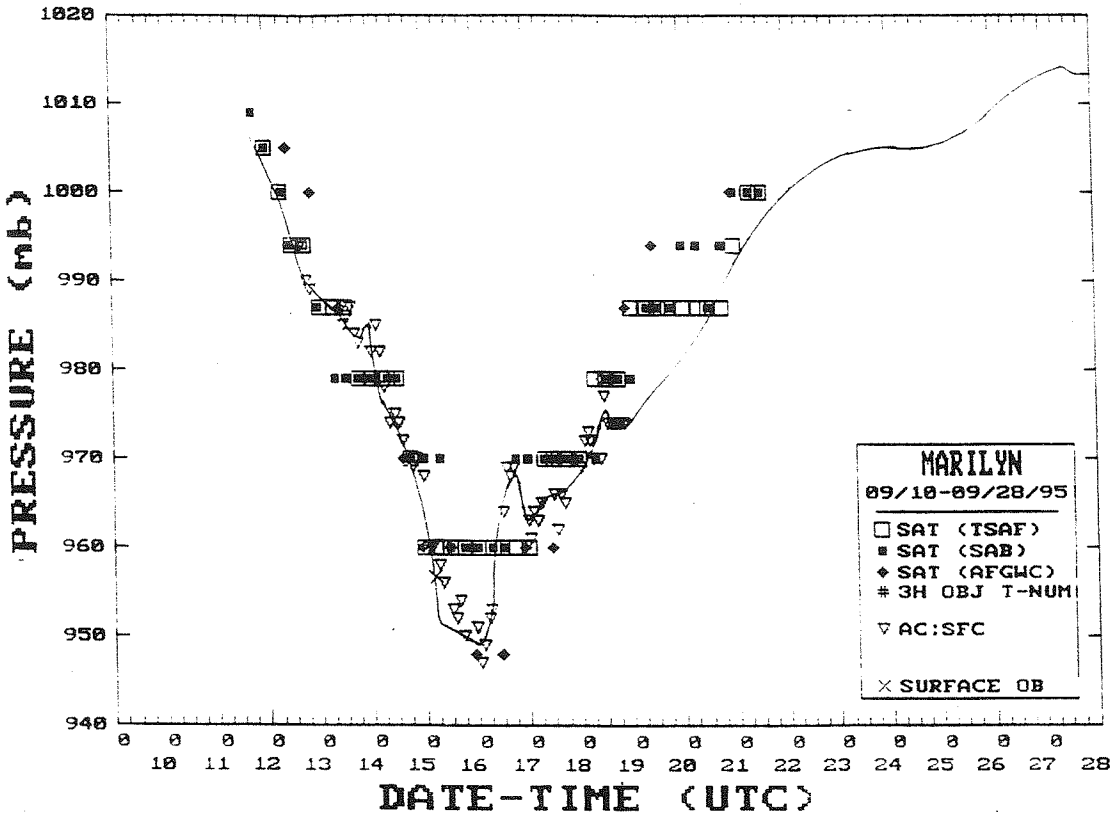

Figure 2. Best track central pressure curve for Hurricane Marilyn, September 1995. X indicates surface analysis or observation.

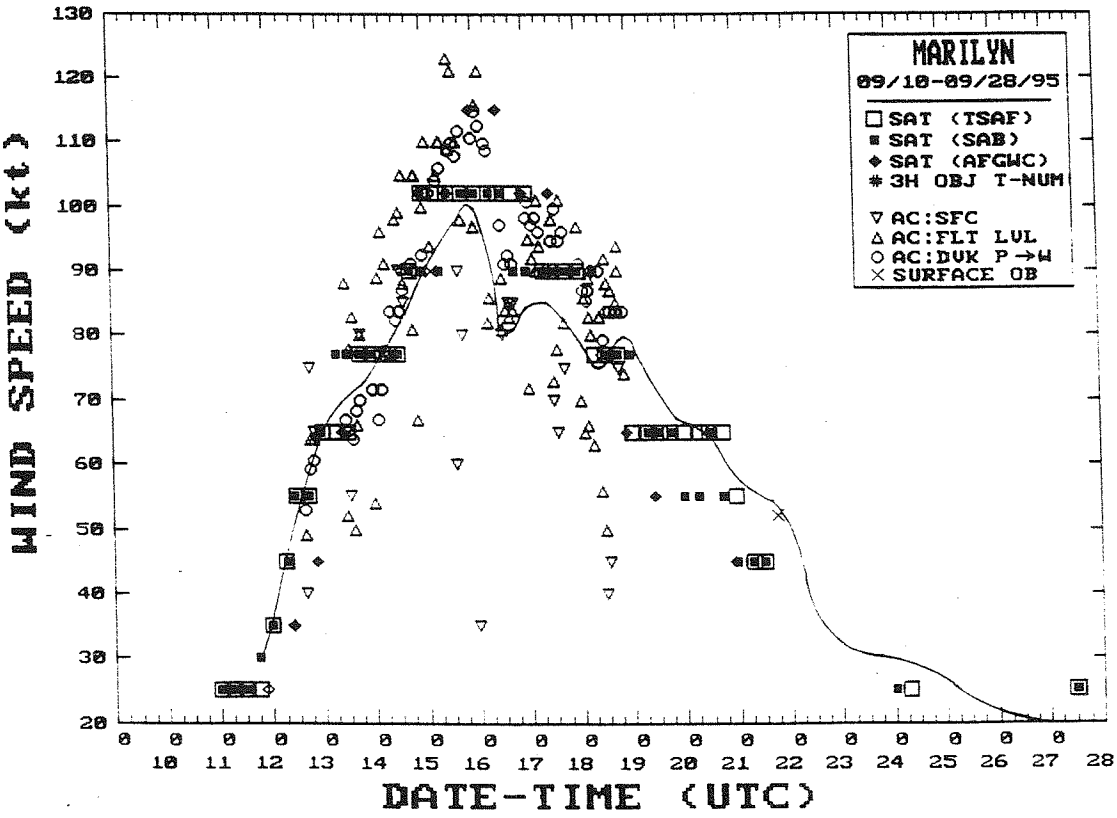

Figure 3. Best track maximum one-minute wind speed curve for Hurricane Marilyn, September 1995. Not all aircraft observations are samples of the maximum wind speed. X indicates surface analysis or observation.

Table 2

Hurricane Marilyn selected surface observations, September 1995

Location	Minimum sea-level pressure		Maximum surface wind speed (kt)			Storm surge[b] (ft)	Storm tide[b] (ft)	Rain (storm total) (in)
	Pressure (mb)	Date/time (UTC)	sustained wind	Peak gust	Date/time (UTC)[a]			
Dominica								
Not Available								
Martinique								
Trinite (Caravelle)			51[e]	74	14/1300			
F. St Denis M. (des Cadets)				60	14/1000			
Ducos (la Manzo)				54	14/1330			
Vauclin (Chateaupaille)				51	14/1400			
Fort de France (Desaix)				51	14/1500			
Macouba (Hab. Bijou)				43	14/1430			
Lamentin (Aeroport)				36	14/1510			
St Joseph (Riv. Lezarde)				35	14/1230			
Morne Rouge (Champflore)								9.06
Ajoupa Bouillon (Aileron2)								8.94
Saint Pierre (Plateau Sable)								6.40
Gros Morne (Pa lourde)								6.24
Precheur (Moliere)								6.10
Riviere Pilote (La Mauny)								6.01
Ducos (Bois neuf)								6.00
Guadeloupe								
Marie-Galante			51[e]	73				
Raizet			41[e]	60				
Desirade			39[e]	53				
Moule			31[e]	53				
Saint-Claude								20.00[h]
Guillard-Basse-Terre								19.09[h]
Gaba								17.63[h]
Saint-Barthelemy			40[e]	51				
St. Maarten			37[e]	53	15/1600-1700			3.35

Table 2 continued

Location		Minimum sea-level pressure		Maximum surface wind speed (kt)			Storm surge[b] (ft)	Storm tide[b] (ft)	Rain (storm total) (in)
		Pressure (mb)	Date/time (UTC)	sustained wind	Peak gust	Date/time (UTC)[a]			
PJJU	35.4°N 69.0°W	1009.0		50		20/0600			
C6QK	32.0°N 57.7°W	1020.2		41		20/1200			
unknown	35.2°N 62.3°W	1012.7		39		20/1800			
HZZF	40.1°N 66.1°W	1013.8		50		20/1800			
unknown	36.4°N 64.6°W	1012.0		34		21/0600			
HZZF	38.8°N 66.0°W	1014.5		51		21/0600			
VRUB4	37.5°N 59.7°W	1006.1		42		21/0900			
VRUB4	37.2°N 59.8°W	1005.8		42		21/1200			
LACG4	37.2°N 61.3°W	1006.6		42		21/1200			
C6JQ9	38.6°N 58.9°W	1001.6		45		21/1200			
unknown	38.9°N 58.9°W	1000.2		52		21/1200			
VRUB4	36.9°N 60.1°W	1007.9		47		21/1500			
VRUB4	36.7°N 60.4°W	-----.-		45		21/1800			
LACG4	37.0°N 62.2°W	1008.8		44		21/1800			
unknown	38.5°N 59.1°W	996.3		41		21/1800			
HZZF	38.7°N 63.4°W	1014.0		50		21/1800			
VRUB4	36.5°N 60.8°W	1008.6		45		21/2100			
VRUB4	36.3°N 61.3°W	1010.9		45		22/0000			
C6JQ9	38.2°N 60.0°W	1003.3		40		22/0000			
unknown	38.3°N 60.1°W	1003.9		45		22/0000			
C6JQ9	37.9°N 61.5°W	1008.9		37		22/0600			
unknown	38.2°N 61.4°W	1007.9		34		22/0600			
HZZF	38.5°N 59.2°W	1011.0		52		22/1800			

[a] Time of 1-minute wind speed unless only gust is given.
[b] Storm surge is water height above normal tide level. Storm tide is water height relative to National Geodetic Vertical Datum (NGVD) which is defined as mean sea level in 1929.
[c] Two-minute averaged wind.
[d] One-minute averaged winds.
[e] Unknown averaging period.
[f] A more extreme value could have occurred.
[g] WMO standard 10-min wind
[h] 12-hour total

Table 2 continued

Location	Minimum sea-level pressure: Pressure (mb)	Minimum sea-level pressure: Date/time (UTC)	Maximum surface wind speed (kt): sustained wind	Maximum surface wind speed (kt): Peak gust	Maximum surface wind speed (kt): Date/time (UTC)[a]	Storm surge[b] (ft)	Storm tide[b] (ft)	Rain (storm total) (in)
U.S. Virgin Islands								
St. Croix						6.0[f]		
unofficial: sailboat **Puffin** at Green Cay Marina				85				
Annaly								11.67
Granard								5.25
St. Thomas						6.6		
noncommissioned ASOS instrument	956.7	16/0422	90[c]	112	16/0352, 0353			
Red Hook Bay								9.96
Puerto Rico								
TJSJ Luis Munoz International Airport	1001.1	16/0952	23[d]	39	16/0951			2.52
TJSJ NWS non-commissioned ASOS instrument	1001.3	16/0856	32[c]	40	16/0900			
TJNR Roosevelt Roads Naval Base	996.5	16/0600	36[d]	50	16/0055			2.45
Naguabo								5.60
Luquillo Pico Del Este								5.50
Culebra (unofficial)	996.5	16/0600		109	16/0600			
Antigua			30[e]	40				
Bermuda			39[g]	52	19/2000			
Ship reports[e]								
XX11 17.8°N 62.0°W	1011.7		42		15/0000			
unknown 17.9°N 61.0°W	1012.3		55		15/0600			
unknown 16.9°N 62.4°W	1011.5		50		15/1800			
DQEU 18.9°N 63.8°W	1009.5		35		16/0000			
WYBI 20.5°N 64.4°W	1010.5		38		16/1200			
WYBI 20.4°N 64.5°W	1009.0		42		16/1800			
KIRF 20.8°N 68.7°W	1008.0		37		17/1800			
KIRF 21.8°N 69.1°W	1007.2		35		18/0000			
WFQB 25.5°N 67.2°W	1008.5		35		18/0000			
PJJU 34.9°N 67.6°W	997.0		55		20/0000			

Table 3

Tropical Cyclone watch and warning summary, Hurricane Marilyn

Date/Time (UTC) / Action	Location
12/2200 Tropical Storm Warning issued	Barbados
Tropical Storm Watch issued	St. Vincent, Grenadines, St. Lucia, Grenada
13/0300 Tropical Storm Watch issued	Tobago and Trinidad
13/0900 Tropical Storm Warning issued	St. Lucia, St. Vincent, Grenadines, Grenada, Tobago
13/2100 Hurricane Warning issued	Barbados, St. Vincent, Grenadines, St. Lucia
Hurricane Watch issued	Dominica
14/0300 Hurricane Warning issued	Dominica
Tropical Storm Watch discontinued	Trinidad
14/ N/A Hurricane Watch issued	Martinique
14/1200 Hurricane Warning extended	Grenadines through St. Martin, except Guadeloupe, St. Barthelemy and French portion of St. Martin
Hurricane Watch issued	British and U.S. Virgin Islands
Hurricane Warning discontinued	Barbados
Tropical Storm Warning discontinued	Grenada and Tobago
14/ N/A Tropical Storm Warning issued	Guadeloupe
14/1500 Hurricane Watch issued	Puerto Rico
Hurricane Warning discontinued	Grenadines
14/1700 Hurricane Watch issued	Guadeloupe, St. Barthelemy, and French portion of St. Martin
14/2100 Hurricane Warning issued	Puerto Rico, U.S. and British Virgin Islands, and Guadeloupe
Hurricane Warning discontinued	St. Vincent and St. Lucia
14/???? Hurricane Warning discontinued	Martinique
15/0300 Hurricane Warning discontinued	Dominica
15/1000 Tropical Storm Warning replacing Hurricane Watch	St. Barthelemy and French portion of St. Martin
15/1200 Hurricane Warning discontinued	Guadeloupe, Antigua, Barbuda, and Montserrat
15/1500 Hurricane Watch issued	Dominican Republic from Cabrera to Cabo Engano
Hurricane Warnings discontinued	Guadeloupe, Nevis, and St. Kitts
15/2200 Tropical Storm Warning discontinued	St. Barthelemy and French portion of St. Martin
16/0000 Hurricane Warning discontinued	St. Martin and Anguilla southward
16/1500 Tropical Storm Warning replacing Hurricane Warning	Puerto Rico and U.S. and British Virgin Islands
16/2100 All Hurricane and Tropical Storm Warnings and Watches discontinued	
16-17/ N/A Hurricane Watch issued	Turks and Caicos and Mayaguana, Acklins, Crooked Islands of the southeastern Bahamas
17/2100 All Hurricane Watches discontinued	
18/1500 Tropical Storm Watch issued	Bermuda
18/2100 Tropical Storm Warning issued	Bermuda
19--20/ N/A Tropical Storm Warning discontinued	Bermuda

Table 4

Watch and warning lead times for U.S. sites during Hurricane Marilyn

Lead time refers to time lapsed from issuance to closest approach of center.

Location	Type	Lead Time (hours)
St. Croix	Hurricane Watch	33
	Hurricane Warning	24
St. Thomas, St. John, and Culebra	Hurricane Watch	40.5
	Hurricane Warning	31.5

Table 5

PRELIMINARY FORECAST EVALUATION HURRICANE MARILYN
HETEROGENEOUS SAMPLE

(Errors in nautical miles for tropical storm and hurricane stages with number of forecasts in parenthesis)

Forecast Technique	Period (hours)									
	12		24		36		48		72	
GFDI	38	(37)	71	(37)	91	(35)	112	(33)	189	(29)
GFDL*	39	(19)	64	(19)	91	(19)	102	(18)	155	(16)
VBAR*	40	(37)	75	(37)	107	(36)	151	(35)	210	(31)
AVNI	40	(38)	86	(38)	141	(36)	158	(32)	306	(28)
BAMD	48	(39)	91	(39)	144	(37)	205	(35)	335	(31)
BAMM	47	(39)	87	(39)	126	(37)	168	(35)	268	(31)
BAMS	52	(38)	95	(38)	130	(36)	161	(35)	261	(31)
A90E	47	(39)	94	(39)	143	(37)	200	(35)	284	(31)
CLIP	49	(39)	105	(39)	167	(37)	218	(35)	323	(31)
NHC Official	38	(39)	71	(39)	102	(37)	142	(35)	222	(31)
NHC Official (near northeastern Caribbean from 14/0600 UTC-18/0000 UTC)	21	(16)	36	(16)	48	(16)	65	(16)	93	(16)
NHC Official (1985-94 10-yr average)	50		98				194		296	

* GFDL output not available until after forecast issued. VBAR output sometimes not available until after forecast issued.