

PRELIMINARY REPORT
Hurricane Hortense
3-16 September 1996

Lixion A. Avila
National Hurricane Center
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Hortense became the second category four hurricane and the fourth category three hurricane on the Saffir-Simpson Hurricane Scale (SSHS) of the season. Hortense was a wet hurricane and most of the damage was caused by its accompanying torrential rains. Hortense crossed the southwestern tip of Puerto Rico and the eastern top of the Dominican Republic as a category one hurricane and the associated floods killed at least 21 people. Hortense moved northward over the western Atlantic and crossed Nova Scotia as a weakening hurricane.

a. Synoptic History

A broad area of low-pressure associated with a tropical wave crossed Dakar, Africa on 30 August. The Dakar vertical-time section during that period showed a well marked cyclonic wind shift below 700 mb and a 55-knot easterly jet at 550 mb. Surface observations indicated that a 1005 mb low associated with the wave moved just south of the Cape Verde Islands on the 31st. Although the system had a well defined low- to middle- level circulation, satellite images indicated that the deep convection was minimal. The low-pressure area continued moving westward and during 3 September, it crossed an array of NOAA drifting buoys. Data from these buoys helped to determine that the system had become a tropical depression at 1200 UTC 3 September (Fig 1).

The depression continued almost due westward around the periphery of a strong high pressure ridge with no significant change in strength. Satellite images suggest that for the next couple of days, deep convection was rather intermittent and not well organized. In fact, on 6 September, the first reconnaissance flight into the system found a broad circulation and only a few squalls. As the depression approached the Lesser Antilles, upper-

level winds became more favorable for strengthening and satellite images showed an increase in deep, organized convection. It is estimated that the depression reached tropical storm status at 0600 UTC 7 September. An early reconnaissance flight on that day reported peak winds of 62 knots at flight level and a minimum pressure of 1001 mb confirming the strengthening of the system.

Hortense moved over Guadeloupe, where the pressure dropped to 998 mb and produced sustained winds of 46 knots with gusts to 70 knots. It also produced torrential rains. The tropical cyclone moved westward into the eastern Caribbean and encountered a fast eastward moving upper-level short wave. This increased the vertical wind shear which temporarily inhibited strengthening. In fact, high resolution visible satellite images clearly showed that the low-level center of the tropical cyclone became exposed during the morning of the 8th. A new burst of deep convection developed over the center later in the afternoon and a gradual intensification began. By then, the short-wave had moved out of the area and the shear had relaxed. Hortense became a hurricane at 0600 UTC 9 September.

After slowing down just to the south southeast of Puerto Rico, Hortense took a jog toward the northwest and the center moved over southwestern Puerto Rico. Fixes from the San Juan WSR-88D radar indicate that the eyewall of Hortense reached the coast near Guanica about 0600 UTC on the 10th and moved over the southwestern tip of the island for about 2 hours.

Hortense moved through the Mona Passage and weakened slightly while the circulation was interacting with land. The center passed very close to Punta Cana, on the eastern tip of Dominican Republic where a calm was felt and the pressure dropped to 988 mb. The hurricane continued on a northwesterly track and the center moved just east of the Turks and Caicos Islands. Hurricane conditions were observed in some of these islands. Thereafter, Hortense briefly reached category four status with a peak intensity of 120 knots and 935 mb minimum pressure at 0000 UTC 13 September.

A developing trough along the eastern United States forced the hurricane to turn northward with an increase in forward speed. A weakened Hurricane Hortense rapidly crossed eastern Nova Scotia on 15 September and became extratropical while moving just south of Newfoundland later on that day.

Hortense's track is shown in Fig. 2. Table 1 is a listing, at

six-hour intervals, of the "best-track" position, estimated minimum central pressure and maximum 1-minute surface wind speed.

b. Meteorological Statistics

The best track pressure and wind curves as a function of time are shown in Fig. 3 and 4 and are based on reconnaissance and surface observations, satellite intensity estimates from the Tropical Analysis and Forecast Branch (TAFB) of the Tropical Prediction Center. It also includes estimates from the Satellite Analysis Branch (SAB) and the Air Force Global Weather Central (AFGWC).

Hortense was a wet hurricane. It produced about 10 inches of rain in Guadeloupe and dumped between 15 and 20 inches of rain over Puerto Rico and the U.S. Virgin Islands with possibly higher amounts in the mountains. Rainfall distribution associated with Hortense is displayed in Fig.5 The Dominican Republic also experienced torrential rains with a maximum of 19.25 inches in the town of San Rafael de Yuma.

There are unconfirmed reports of gusts to 95 knots in the southwestern tip of Puerto Rico about 0800 UTC 10 September. These strong winds may have been a local effect caused by the Venturi effect (acceleration between walls). Residents of the southwestern portion of Puerto Rico reported calm winds and that the "stars were out" as the eye crossed the area. Peak winds of hurricane force were reported over the Dominican Republic, and hurricane force winds were registered in Grand Turk and Nova Scotia. Tables 2 and 3 contain selected surface observations and ships reporting 34-knot winds or higher associated with Hortense.

Hortense was upgraded to a category four hurricane of 120 knots based on a report from a hurricane hunter plane of 123 knots at 700 mb in the northeast quadrant at 2130 UTC followed by 128 knots in the southeast quadrant at 2220 UTC. The plane also reported a minimum pressure of 935 mb, a closed eyewall of 11 n mi in diameter and an excellent stadium (outward slope of the convective clouds in the eyewall) effect at 2323 UTC. In addition, satellite objective T-numbers were of the order of 6.5 on the Dvorak scale, corresponding to an intensity 127 knots and a pressure of 935 mb. Visible satellite images revealed a spectacular cloud pattern with a clearly distinct eye during that time.

c. Casualty and Damage Statistics

Hortense devastated portions of Puerto Rico but most of the damage was not done by winds or storm surge. Instead, torrential rains produced flash floods and mud slides which killed at least 18 people. A preliminary report from FEMA indicates that nearly 11,463 homes were severely damaged by Hortense and agricultural losses were of the order of 127 million dollars. In addition, there was significant inland flooding in the low-lying areas as well as serious coastal flooding in Nagabo, Guayanilla and Ponce.

Three people were killed and 21 reported missing in the Dominican Republic and there was significant damage primarily in the northeastern portion of the country. A school and one church were demolished by winds or falling trees, numerous houses were damaged and several electrical poles went down. There was a 9-foot storm surge along the northeast coast. Roads were blocked due to flooding both from the storm surge and from torrential rains. In Samana, 80 percent of the agriculture was damaged.

d. Forecast and Warning Critique

Table 4 summarizes the watches and warnings associated with Hortense. As indicated in Table 4, a hurricane watch and a tropical storm warning were issued for Puerto Rico when Hortense was still in the developing stage over the Leeward Islands. Hortense became sheared and weakened over the eastern Caribbean and the official intensity forecast called for no significant change in strength. Consequently, the hurricane watch for Puerto Rico was discontinued but the tropical storm warning remained in effect. However, it was emphasized in the tropical cyclone discussions issued by the NHC that there was low confidence in the intensity forecast. Hortense reintensified and a hurricane warning was issued for Puerto Rico about 14 hours before landfall.

Hurricane warnings were in place for the entire island because hurricanes can often wobble along the track. These wobbles are in general difficult if not impossible to forecast but are taken into consideration when issuing watches and warnings. Hortense jogged to the north of the main track when it was located just south of Puerto Rico. That wobble or jog brought the center of the hurricane over the extreme southwestern portion of the island.

Figure 6 shows a series of model track forecasts for different periods when Hortense was in the eastern Caribbean. One can notice that most of the model and official forecasts were to the left of the best track. This means that, as expected, neither the models nor the official forecast captured the jog to the north. However, the errors in the forecast, in general, were much smaller than the most recent 10-year average forecast errors. Models and official forecast performance are shown in Table 5.

From the time the tropical cyclone was located over the Lesser Antilles, NHC advisories as well as San Juan Forecast Office statements indicated that 5 to 10 inches of rain, with larger totals over mountains were expected along the path of Hortense. Indeed, most of the damage produced by Hortense was caused by rainfall.

Acknowledgments

Data was primarily provided by NWS forecast office in San Juan Puerto Rico, the Dominican Republic Weather Service and by Environmental Canada.

Figure Captions:

- Fig. 1 1800 UTC 3 September surface map including drifting buoy and ship data.
- Fig. 2. (a) Best track positions for Hurricane Hortense, 3 - 16 September 1996. (b) Best track of Hortense near Puerto Rico showing the northward jog.
- Fig. 3. Best track one-minute surface wind speed curve for Hurricane Hortense.
- Fig. 4. Best track minimum central pressure curve for Hurricane Hortense.
- Fig. 5 Hurricane rainfall totals (inches) over Puerto Rico during 9-10 September 1996.
- Fig. 6 Array of forecast track models while Hortense was over the eastern Caribbean Sea.

Table 1. Preliminary best track, Hurricane Hortense, 3-16 September 1996.

Date/time (UTC)	Position		Pressure	Wind speed(kt)	Stage
	Lat. (°N)	Lon. (°W)			
3/1200	14.9	41.0	1006	25	TD
1800	14.9	42.7	1006	30	"
4/0000	14.8	44.1	1006	30	"
0600	14.7	45.4	1006	30	"
1200	14.6	46.6	1006	30	"
1800	14.7	47.5	1006	30	"
5/0000	14.9	48.4	1006	30	"
0600	14.8	49.5	1006	30	"
1200	14.5	51.1	1006	30	"
1800	14.3	52.6	1006	30	"
6/0000	14.4	53.6	1006	30	"
0600	14.6	54.3	1006	30	"
1200	14.7	55.1	1006	30	"
1800	14.9	55.7	1006	30	"
7/0000	15.2	57.0	1006	30	"
0600	15.4	58.3	1005	35	TS
1200	15.6	59.6	1004	40	"
1800	15.8	60.4	1000	40	"
8/0000	16.1	61.2	996	50	"
0600	16.1	62.0	996	55	"
1200	16.1	62.8	996	60	"
1800	16.1	63.6	991	60	"
9/0000	16.1	64.1	990	60	"
0600	16.1	64.5	987	70	H
1200	16.3	65.0	985	70	"
1800	16.6	65.6	990	70	"
10/0000	17.1	66.1	989	70	"
0600	18.0	66.9	989	70	"
1200	18.3	67.8	989	65	"
1800	18.9	68.4	990	65	"
11/0000	19.5	68.9	982	70	"
0600	20.1	69.5	975	75	"

1200	20.9	70.1	971	90	"
1800	21.6	70.6	970	95	"
12/0000	22.3	71.1	967	100	"
0600	23.0	71.4	962	105	"
1200	23.9	71.8	959	115	"
1800	24.7	71.8	946	115	"
13/0000 ¹	25.9	71.5	935	120	"
0600	27.2	71.4	942	115	"
1200	29.0	70.9	948	100	"
1800	31.0	70.3	948	100	"
14/0000	33.3	69.5	948	90	"
0600	35.9	68.4	955	90	"
1200	38.5	67.1	960	85	"
1800	42.0	65.2	960	75	"
15/0000	44.3	63.3	970	70	"
0600	45.5	61.5	980	65	"
1200	46.3	59.1	982	60	TS
1800	46.0	55.0	996	40	E
16/0000	46.0	54.0	998	40	E
0600	45.0	50.0	999	35	E
1200					merged with front
10/0600 ²	18.0	66.9	989	70	H
15/0300 ³	44.8	62.5	978	70	H

¹ Minimum Pressure.

² Landfall near Gunica Puerto Rico

³ Landfall Nova Scotia

TD: Tropical Depression

TS: Tropical Storm

H: Hurricane

E: Extratropical

Cape Sable								
St. Paul Island	994.4	15/0742	66	82	15/0742			
Sidney	984.8	15/0900	30	51	15/0448			102.1
Forchu Head			43	52	15/0348			65.4
Hart Island	978.4	15/0545	32	49	15/0145			
Beaver Island	982.8	15/0144	43	55	15/0144			136.6
Halifax Int'l	989.8	15/0200	20	39	15/0200			
Shearwater	985.0	15/0200	29	42	15/0200			99.6
Cape Sable		a		63				
Cape Race, Nfld	994	15/2043	40	49	15/2043			
BOUY								
44144	997.6	15/0000	48					
44144	992.8	15/0300	60					
44144	995.1	15/0600	52					
44144	999.1	15/0900	40					

a: time unknown

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

date/time (UTC)	ship name	latitude °N	longitude °W	wind dir/speed knots	pressure (mb)
7/1800	<i>SVEN OLTMAN</i>	13.0	69.9	110/41	1005.5
9/1200	<i>3FOAS *</i>	18.0	63.5	110/34	1010.0
9/1200	<i>8PNI *</i>	18.1	53.6	130/36	1010.3
9/1800	<i>8PNI *</i>	17.2	64.2	100/41	1007.0
9/1800	<i>SEALAND HAWAII</i>	18.68	66.2	100/39	1008.2
9/1800	<i>ELRI2 *</i>	19.1	64.3	110/58	1006.5
9/2100	<i>3FOAS*</i>	16.1	61.9	100/37	1008.0
9/2100	<i>8PNI*</i>	16.9	64.5	100/45	1006.4
10/0000	<i>8PNI*</i>	16.5	64.7	080/45	1008.0
10/0000	<i>ELRI2 *</i>	18.6	63.7	120/58	1006.5
10/0000	<i>TROPIC SUN</i>	18.6	65.5	090/37	1008.2
10/0600	<i>TROPIC SUN</i>	18.5	64.9	080/35	1009.4
10/0600	<i>SEALAND HAWAII</i>	18.6	66.2	070/56	1005.5
11/0600	<i>CRUSADER</i>	19.9	66.1	100/35	1010.0
11/0600	<i>SS NUEVO SAN JUAN</i>	20.4	66.1	120/50	1011.6
12/1200	<i>COPACABANA</i>	28.4	68.8	110/36	1014.0
12/1200	<i>COPACABANA</i>	27.3	67.5	110/38	1013.0
12/2100	<i>C6QK *</i>	24.4	69.2	140/36	1007.5
13/0000	<i>COPACABANA</i>	26.1	66.2	140/35	1013.0
13/0000	<i>3FKD6*</i>	26.7	68.5	130/37	1009.2
13/0600	<i>COPACABANA</i>	24.9	64.9	120/43	1013.0
14/1200	<i>ATLANTIC HURON</i>	39.3	70.0	330/40	999.5
14/1500	<i>TARANTAU</i>	41.9	82.2	250/45	980.0
14/2100	<i>ZCBF2 *</i>	43.6	63.5	070/41	977.9
15/0000	<i>MV JOSEPH</i>	46.7	59.8	090/38	1010.0
10/0000	<i>ELRI2 *</i>	18.6	63.7	120/58	1006.5

* name unknown

Table 4. Watch and warning summary, Hurricane Hortense, September 1996.

Date/time (UTC)	Action	Location
7/1500	tropical storm warning issued	Martinique northwestward through the British and U.S. Virgin Islands
7/1500	tropical storm watch issued	Puerto Rico
7/2100	hurricane watch and a tropical storm warning issued	British and U.S. Virgin Islands and Puerto Rico
8/0300	hurricane warning issued	British and U.S. Virgin Islands
8/1500	hurricane warning replaced by tropical storm warning	British and U.S. Virgin Islands
8/1500	hurricane watch discontinued	Puerto Rico
8/1500	tropical storm warning discontinued	From Anguilla southward
8/1800	tropical storm warning discontinued	Northeastern Leeward Islands
9/0000	tropical storm watch issued	Dominican Republic from Cabo Engano to Pedernales of the border of Haiti (south coast)
9/1500	hurricane warning issued	Puerto Rico
9/1500	hurricane watch replaces tropical storm watch	Dominican Republic from Cabo Engano to the border of Haiti.
9/2330	hurricane warning issued	Dominican Republic from Bahia de Calderas to Peninsula de Samana
9/2330	hurricane watch issued	Dominican Republic from west of Bahia de Calderas to Pedernales.
10/0900	hurricane watch issued	Turks and Caicos Islands and southeast Bahama Islands of Mayaguana and Inagua Islands

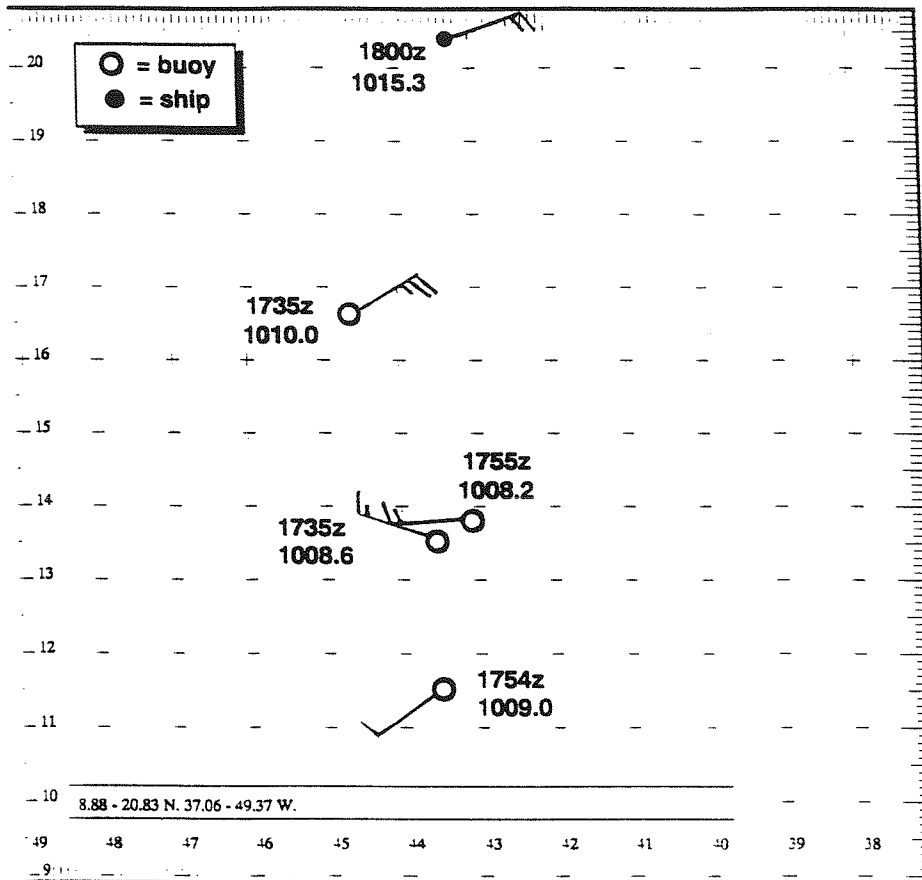
10/1200	hurricane warning extended	Dominican Republic from Peninsula de Samana to Cabrera.
10/1200	hurricane watch discontinued	south coast of Dominican Republic
10/1500	hurricane warning issued	Turks and Caicos, Inagua Islands and Mayaguana
10/1500	tropical storm warning discontinued	U.S. and British Virgin Islands
10/1800	hurricane warning discontinued	Puerto Rico
10/2100	hurricane warning extended	north coast of Dominican Republic
10/2100	hurricane watch issued	central Bahamas
10/2100	tropical storm warning and hurricane watch	north coast of Haiti from St. Nicolas eastward.
11/0000	hurricane watch discontinued	south coast of the Dominican Republic
11/1500	hurricane warning discontinued	Dominican Republic
12/1500	hurricane warnings and watches discontinued	Bahamas

Table 5. Preliminary forecast evaluation Hurricane Hortense. Heterogeneous sample.

(Errors in n mi for for tropical storm and hurricane stages with number of forecast in parenthesis)

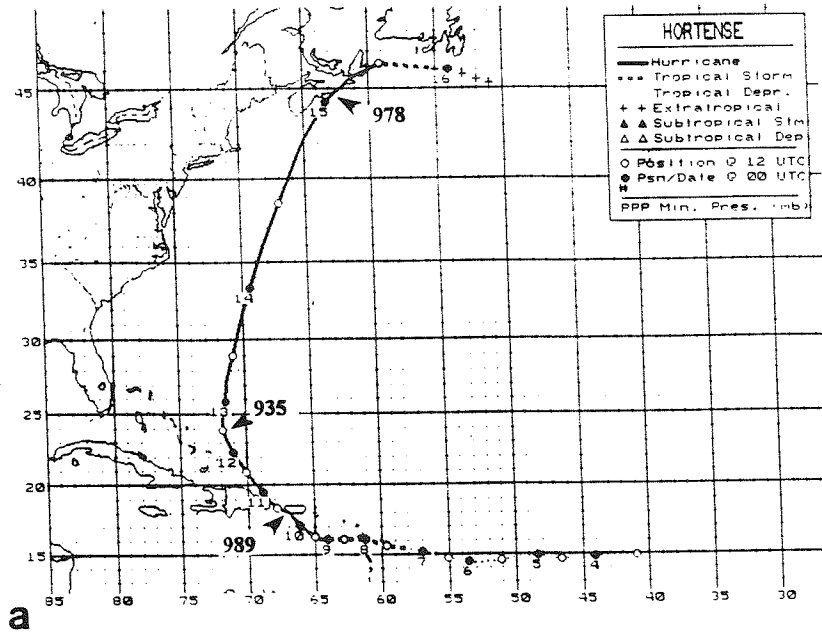
MODEL	Period (hours)				
	12	24	36	48	72
OFCL	48(34)	92(33)	110(31)	140(29)	251(25)
OFCI	47(33)	79(32)	110(31)	152(29)	299(25)
AVNI	51(31)	109(31)	159(30)	176(28)	216(24)
GFDI	46(31)	91(31)	124(30)	156(29)	240(24)
VBRI	37(33)	53(32)	90(31)	126(29)	273(25)
NGPI	53(26)	298(26)	386(26)	193(26)	121(20)
UKMI	60(24)	120(24)	155(23)	188(21)	321(16)
CLIP	61(34)	126(33)	182(31)	233(29)	371(25)
BAMD	37(34)	72(33)	99(31)	140(29)	213(24)
BAMM	51(34)	98(33)	148(31)	182(29)	232(24)
BAMS	66(34)	126(33)	177(31)	211(29)	263(24)

18 UTC 3 Sept. 1996 - NDBC drifting buoy data
NDBC drifting buoys and ships in EARTH-RELATIVE coordinates
NOTE: buoy winds are adjusted to 10 m and 1-min values

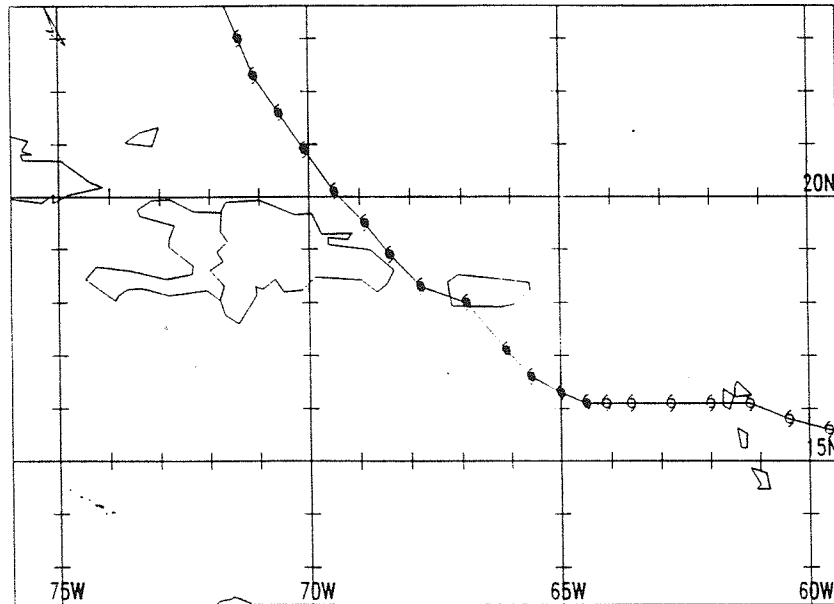


Experimental research product of:
NOAA / AOML / Hurricane Research Division

Fig. 1 1800 UTC 3 September surface map including drifting buoy and ship data.



a



b

Fig. 2. (a) Best track positions for Hurricane Hortense, 3 - 16 September 1996. (b) Best track of Hortense near Puerto Rico showing the northward jog.

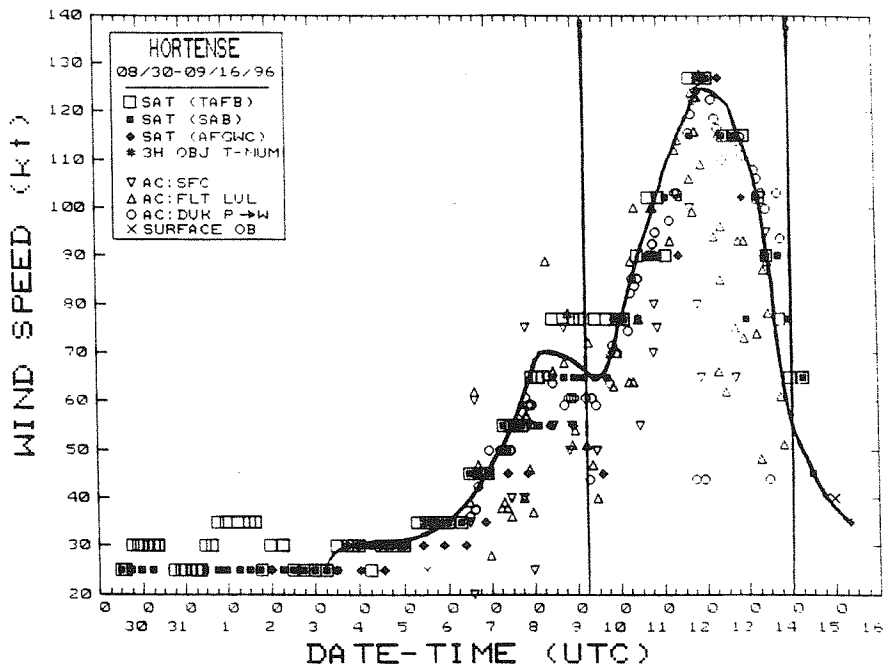


Fig. 3. Best track one-minute surface wind speed curve for Hurricane Hortense.

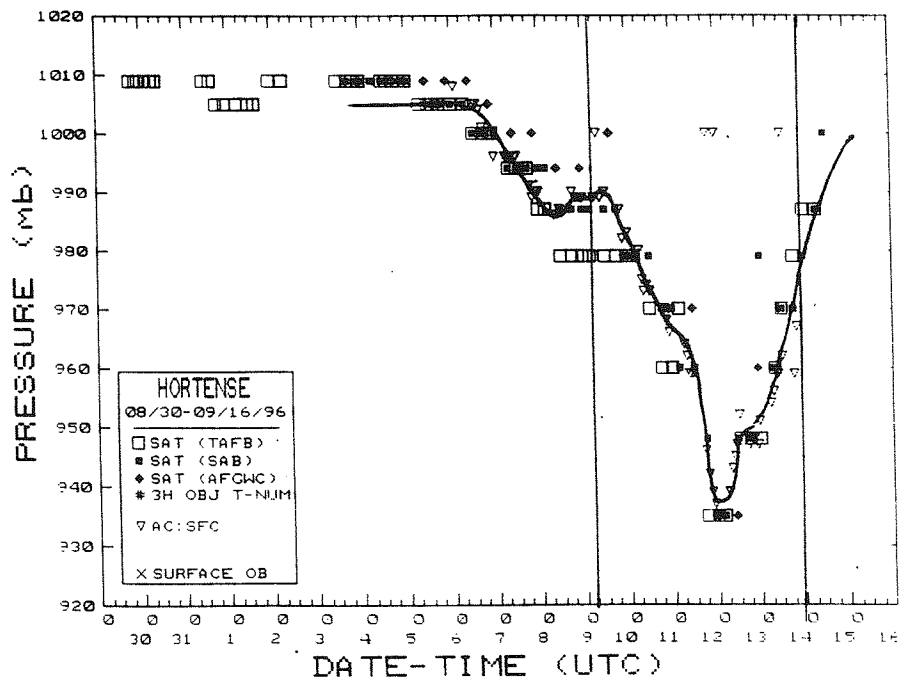


Fig. 4. Best track minimum central pressure curve for Hurricane Hortense.

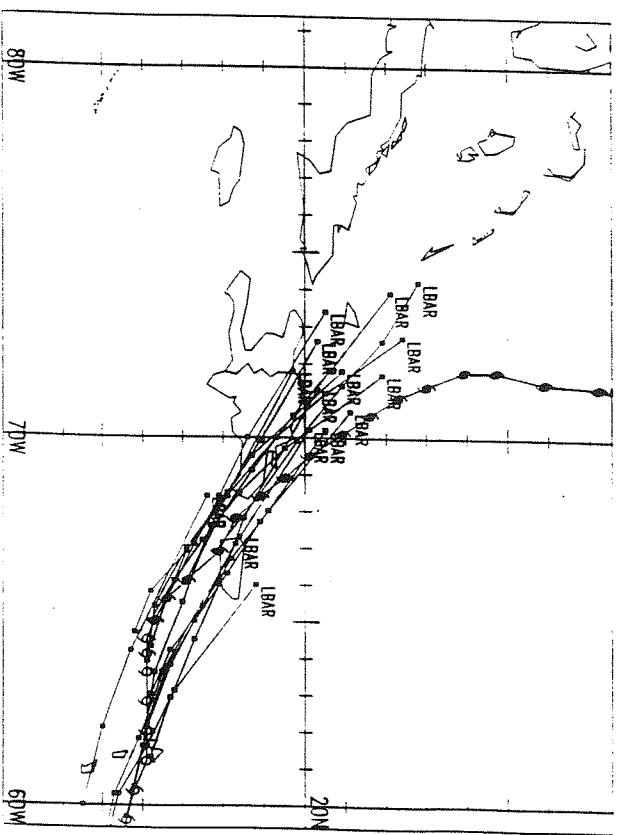
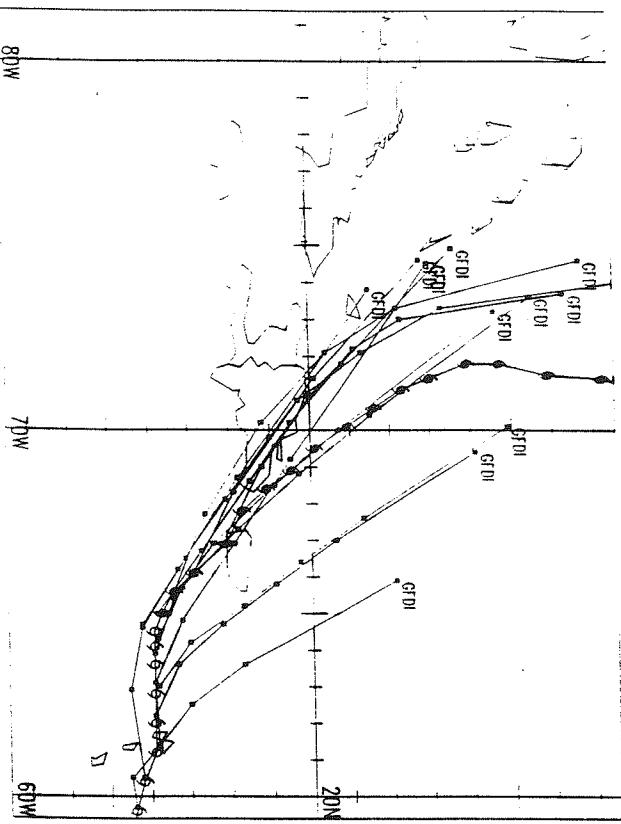
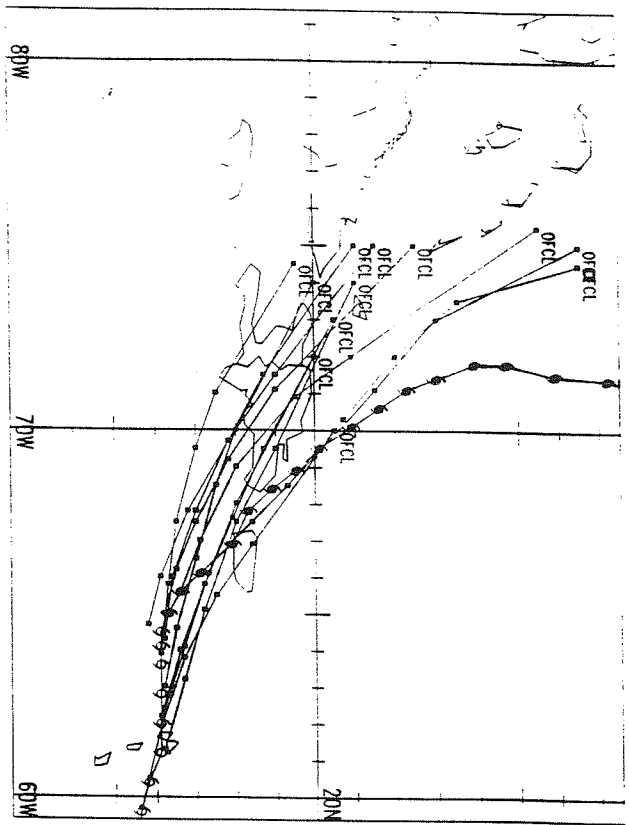


Fig. 6 Array of forecast track models while Hortense was over the eastern Caribbean Sea.

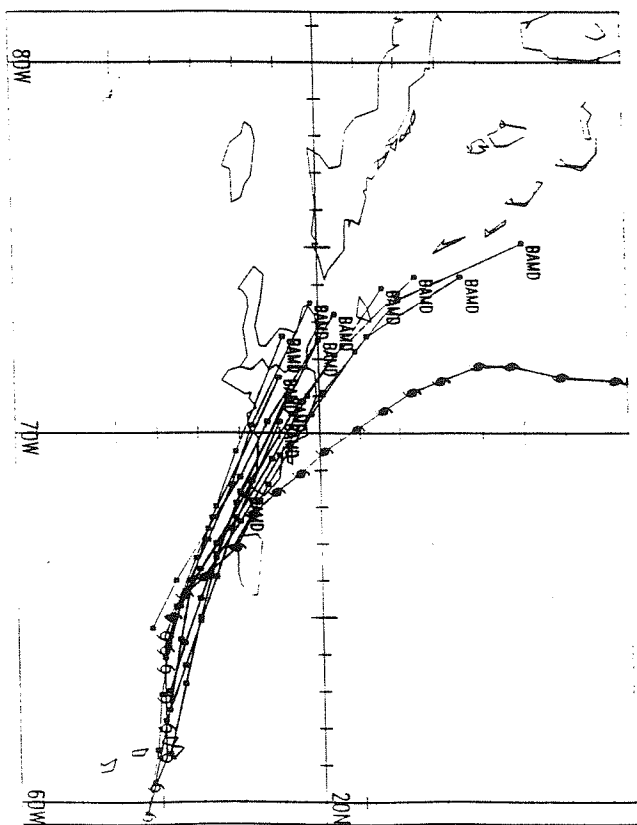
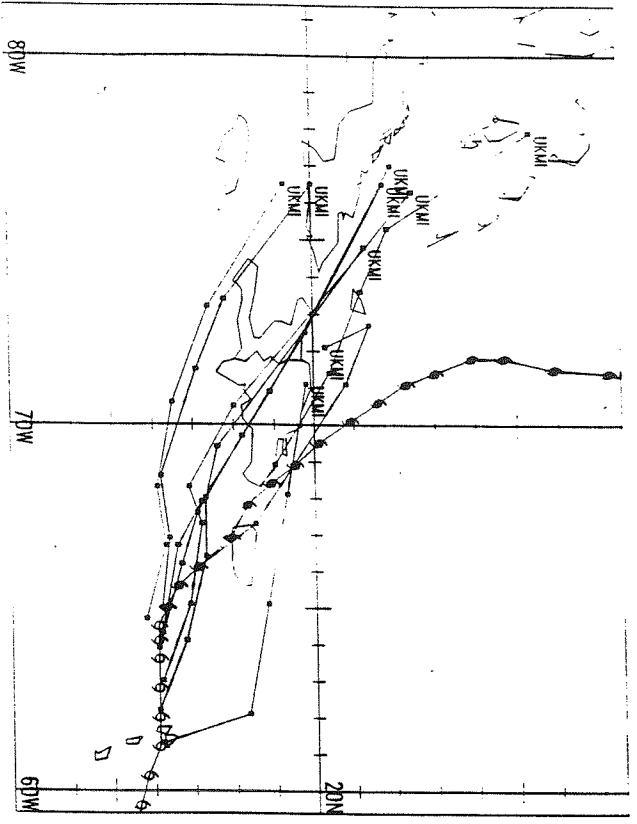
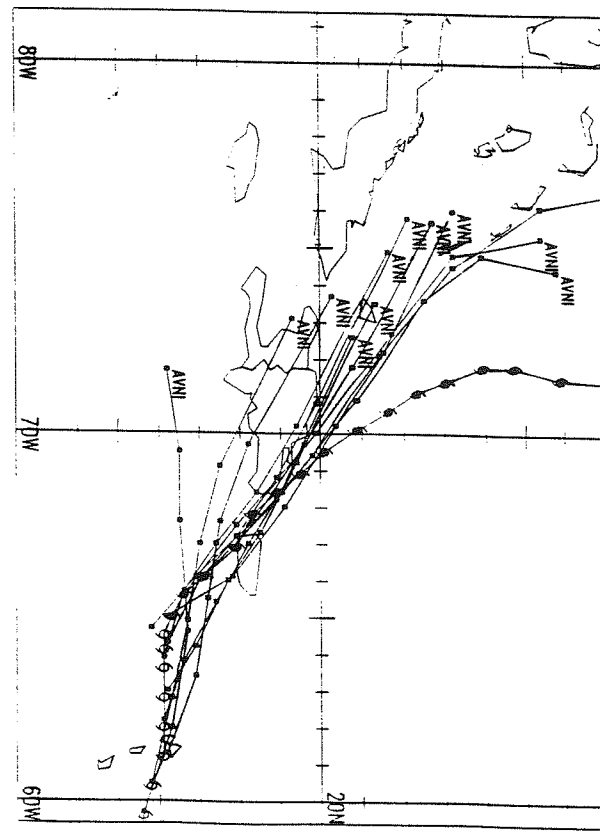
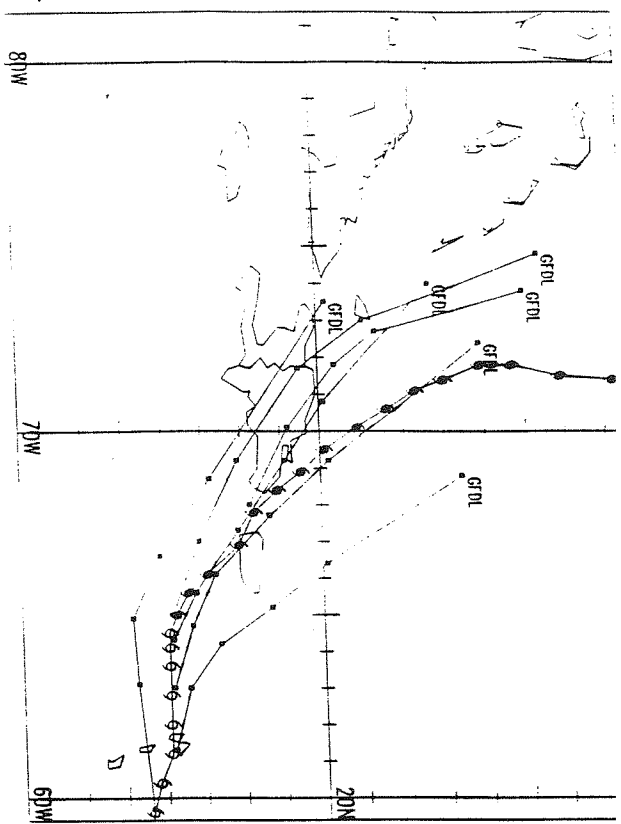


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