

A. Introduction

The tropical depression which was to become tropical storm Beryl formed over southeastern Louisiana on the evening of 07 August. After drifting southeastward over the Mississippi Sound during the following twenty-four hours with major portions of the system remaining over land, the depression strengthened to a storm and buffeted the immediate coastal sections and offshore oil rigs with minimal tropical storm-force winds. Beryl made a clock wise loop and headed northwestward by the evening of 08 August, passing over the New Orleans area shortly before daybreak on 09 August. The short-lived tropical storm was downgraded to a depression by that evening, and the remnants became a major rain producer over northeast Texas by 11 August. Figure 1 shows the best track and Table 1 list the best track statistics.

B. Synoptic History

On 01 August a weak surface low pressure center moved off the Mid-Atlantic Coast with a trailing surface trough extending southwestward into the extreme northeast Gulf of Mexico. During the next several days, the northern portion of the trough dissipated. However, the portion that extended over the northeast Gulf persisted and by 03 August it began to drift slowly toward the west. Upper air analysis at 0000 UTC 03 August indicated cyclonic circulation had developed from 850 millibars upward through the 500-millibar level and a 200-millibar cut-off low had formed over eastern Texas. The first sign of a surface circulation (1015-millibar) was observed at 0000 UTC 04 August on the Mississippi Coast. During the next several days, the weak broad circulation remained quasi-stationary over the Mississippi Sound. Meanwhile the middle and upper atmosphere gradually became better organized as the cyclonic circulation increased and aligned in the vertical. At the 200-millibar level the cold low drifted toward the southwest and a 200-millibar anticyclone developed over the budding storm.

By 0000 UTC 07 August the surface low had drifted toward the northwest and was centered over southeastern Louisiana. Visible satellite imagery during the day of 07 August showed a well-organized system. By 0000 UTC 08 August the low center had begun to drift southeastward toward the Gulf waters, and an initial tropical depression advisory was issued by the National Hurricane Center. Based upon ship reports and observations from oil rigs (see Table 5), the depression was upgraded to a tropical storm at 1000 UTC 08 August.

At this time all meteorological variables appeared favorable for development. The upper air pattern provided excellent diffluence, the mid-level cyclonic circulation was well established and the surface circulation had moved back over the warm Gulf waters. However, by 0000 UTC 09 August a digging 200-millibar trough from the northeast destroyed the 200-millibar anticyclone which had recently formed over the storm. A frontal trough approaching from the northwest then caused the storm to begin moving toward the northwest, over land. As a result within the next several hours Beryl ceased to strengthen. Figures 2 and 3 illustrate the change in wind and pressure with time.

The lowest central pressure of 1001 millibars occurred near 0600 UTC on 09 August. Note that maximum observed winds did not occur during the time of lowest pressure. Mesoscale analysis indicates the difference between Beryl's central pressure and the ambient pressure decreased during the time of Beryl's minimum pressure. Perhaps the reason the strongest winds occurred on the day before the lowest central pressure was observed could be attributed to the stronger pressure gradient.

By 0700 UTC Beryl began to weaken and the storm was downgraded to a depression by 2200 UTC while moving on a west northwest track over southeast Louisiana. Weakening continued on 10 August and the surface circulation dissipated on 11 August over eastern Texas.

C. Meteorological/Hydrological Statistics

Tropical storm Beryl produced minimal tropical storm-force winds over the open waters of the Gulf and tropical storm-force gusts over the coastal sections of southeast Louisiana, Mississippi and Alabama. Tables 2 and 5 contain a list of selected observations. A maximum sustained wind of 40 knots at Gulfport was the strongest reported from a land station, while the ship Primula DHOU and the offshore oil rig P21(MP73) each observed a maximum sustained wind of 46 knots.

Heaviest rainfall from the system occurred over eastern Texas on 11 August as the remnants of Beryl dumped up to twelve and one half inches of rain during the day. Storm totals of over eleven inches were reported at Dauphin Island, Alabama, while close to ten inches fell at Foley, Alabama, and Bay St. Louis, Mississippi. Elsewhere, storm totals of three to five inches were received over the southern portions of Louisiana, Mississippi and Alabama. Table 3 contains miscellaneous rainfall observations from the storm.

Highest tides, in excess of five feet, were observed along the east coast of extreme southeastern Louisiana. Onshore winds pushed tides to more than four feet above normal along the Mississippi Coast, while tides of only one to two feet above normal were observed along the coastal sections of Alabama and the extreme western Florida Panhandle. Table 4 contains maximum tide reports from selected locations along the coast line of the four affected states.

. Casualty and Damage Statistics

The only known death directly caused by the storm occurred in Mobile Bay when a fifteen-year-old boy drowned due to an overturned shrimp boat. The boy's father was rescued by Coast Guard after spending twenty-four hours in the water.

Overall damage from the tropical storm was light. Initial estimates range from two to four million dollars. Most of the damage occurred along the immediate coast and can be attributed to erosion or flood damage due to surge and wave action.

The immediate coastal parishes of southeast Louisiana had some wind damage to trees, minor power outages and some coastal flooding due to the storm surge. There was some voluntary evacuation in St Bernard Parish. There was no significant flooding in Louisiana due to rains. However, the heavy downpours on 11 August over portions of eastern Texas produced some flash flooding.

There was severe beach erosion along portions of the Alabama coast while considerable beach erosion occurred along portions of the Mississippi coast. Dauphin Island, Alabama, had sixty to seventy feet of public beach severely damaged and man-made sand dunes washed away. Damage estimates for the western Florida Panhandle were nil.

E. Forecast and Warning Critique

Initially all models except the QLM forecast the newly-formed depression to move toward the northwest. The 0000 UTC 08 August run of the QLM was the only model to forecast the depression to drift toward the southeast for the first twenty-four hours and then turn back toward the northwest. This forecast motion by the QLM proved to be quite accurate. Based on this guidance, forecasters predicted the depression would remain about stationary for the next twenty-four hours rather than move toward the northwest as the remainder of the guidance models indicated. During later runs of the models, the NHC 83 and the QLM forecast a northwest motion while most other models took the system to the north or northeast.

The SHIFOR intensity forecast scheme did very poorly. It continually forecast the system to near hurricane strength by seventy-two hours. Obviously, the intensification forecast model assumes the system remains over water. Since Beryl had been forecast to be well inland by seventy-two hours the SHIFOR intensity forecast did not apply.

As is always the case when a system develops on the immediate coast, it is difficult to know when to issue the first warnings. With Beryl, tropical storm-force winds had already been observed from oil rigs and ship reports, and tropical storm-force gusts had been reported by coastal stations by the time the National Hurricane Center issued a tropical storm warning. However, once the warnings were issued, they covered the area adequately and never varied. Table 6 contains a summary of all warnings. Forecast rainfall amounts were poorly worded. The term "in excess of 5 inches" used in the advisory should have had an upper limit on the amount of rainfall expected. Tide forecasts were excellent except for the higher tides that occurred along the east coast of extreme southeast Louisiana.

ACKNOWLEDGEMENTS

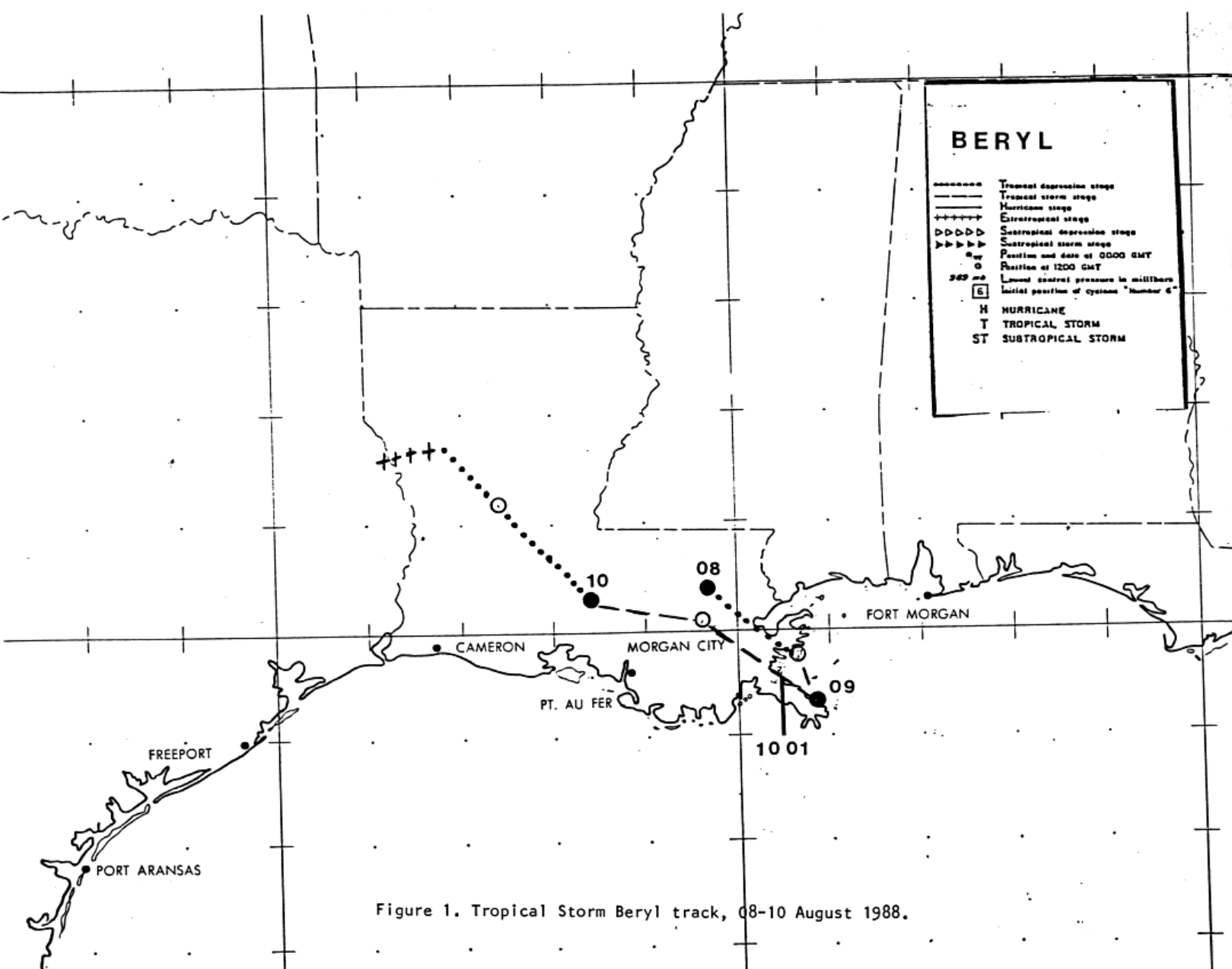
Much of the information contained in this report was obtained from the excellent storm summaries supplied by the National Weather Service offices at New Orleans, Mobile, Pensacola and Kansas City.

Table 1. Preliminary Best Track, Tropical Storm Beryl, 07-10 August 1988

<u>DATE</u>	<u>TIME</u> (UTC)	<u>POSITION</u>		<u>PRESSURE</u> (mb)	<u>WIND</u> (kt)	<u>STAGE</u>
		<u>Latitude</u>	<u>Longitude</u>			
8/08	0000	30.4	90.3	1010	25	Trop Dep
	0600	29.7	89.7	1009	30	"
	1200	29.7	89.4	1007	35	Trop Storm
	1800	29.4	89.2	1005	40	"
8/09	0000	29.3	89.1	1002	45	"
	0600	29.6	89.5	1001	45	"
	1200	30.1	90.4	1002	45	"
	1800	30.1	90.9	1005	40	"
8/10	0000	30.3	91.6	1006	30	Trop Dep
	0600	30.7	92.2	1007	30	"
	1200	31.2	92.6	1008	25	"
	1800	31.7	93.2	1011	20	Low Pres Center
8/11	0000	+++++++ Dissipated ++++++				

Lowest Pressure

8/09	0600	29.6	89.5	1001	45	Trop Storm
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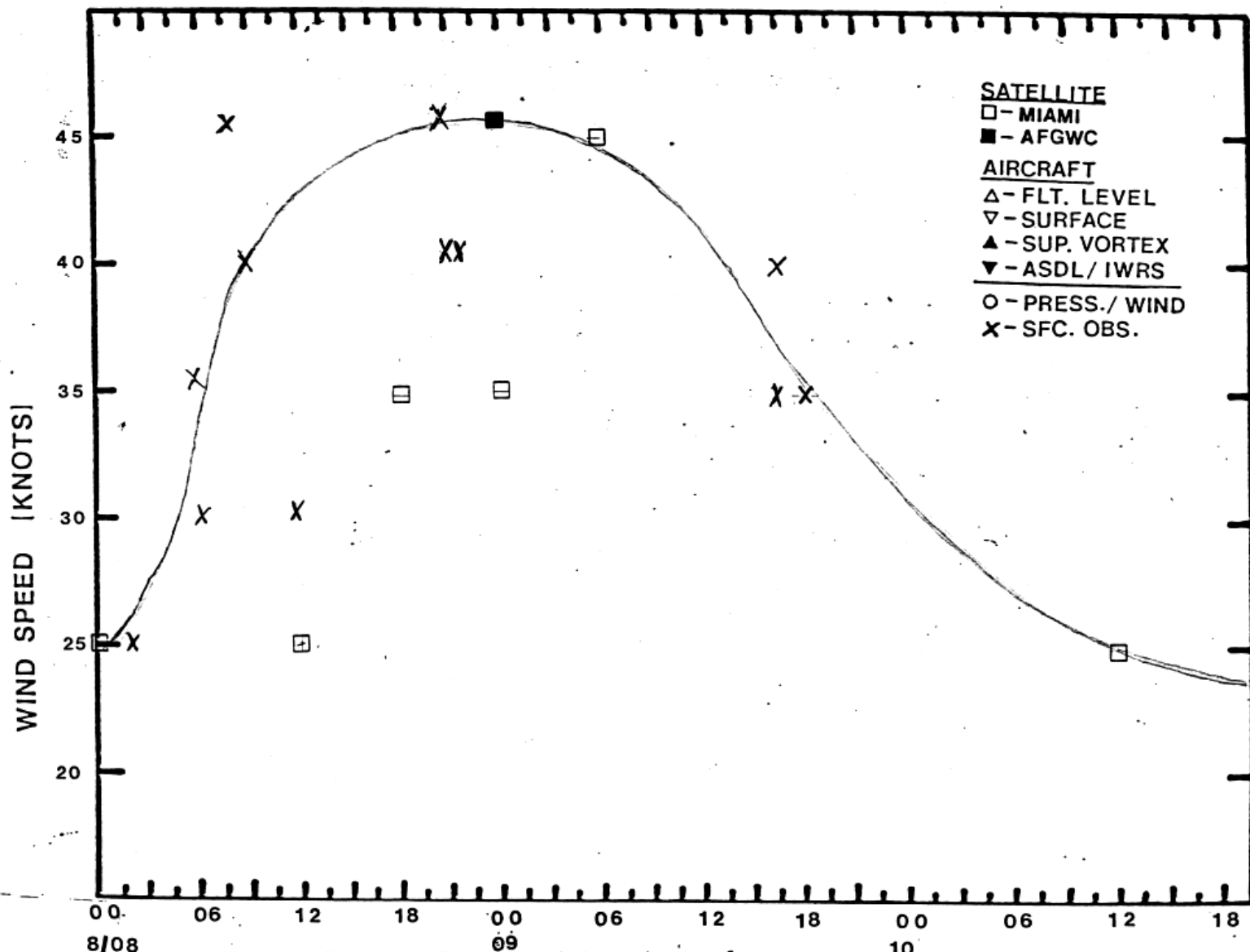


Figure 2. "Best Track" maximum wind speed curve for Tropical Storm Beryl, 08-10 August 1988.

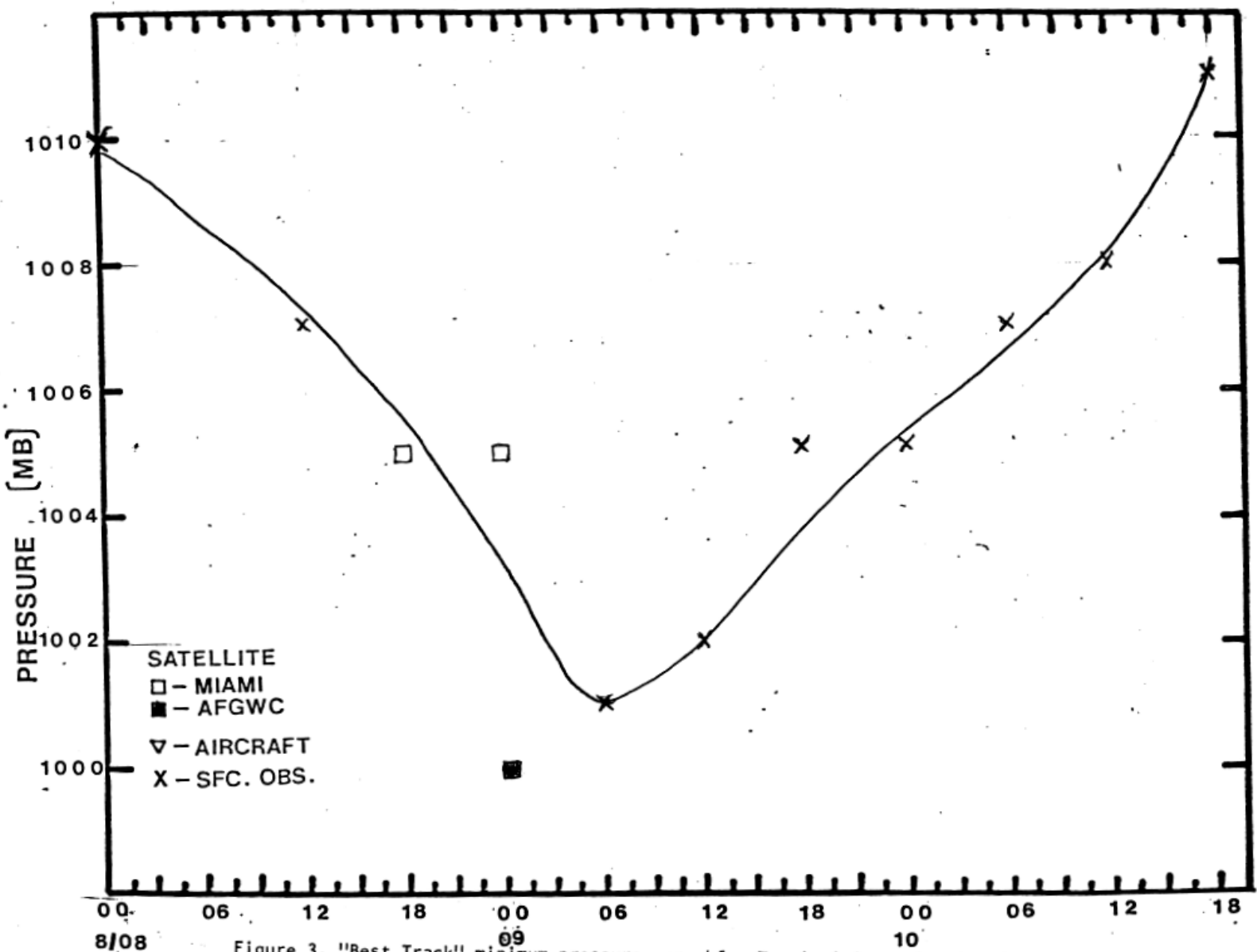


Figure 3. "Best Track" minimum pressure curve for Tropical Storm Beryl, 08-10 August 1988.

Table 2. Selected Meteorological and Hydrological Statistics for Tropical Storm Beryl... August 1988.

<u>LOCATION</u>	<u>STRONGEST WINDS(KT)</u> <u>DATE/TIME</u> <u>SUSTD</u> <u>PEAK</u>	<u>MIN PRESS.</u> <u>DATE/TIME</u>	<u>RAINFALL(IN)</u> <u>DATE</u> <u>24 HRS</u>	<u>STORM</u> <u>TOTAL</u>
<u>Louisiana</u>				
New Orleans(MSY)	09/0100Z 010/22 31	09/1030Z 29.59 (1001.9)	09 0.62	1.54
New Orleans(NEW)	09/0705Z 030/23 35	09/0951Z 29.59 (1001.9)	09 1.61	2.78
New Orleans(NBG)	09/0120Z 340/17 30	09/0955Z 29.60 (1002.2)		
<u>Mississippi</u>				
Keesler (AFB)	08/0559Z SE/24 37	09/0752Z 29.72 (1006.4)		2.69
Gulfport	08/0900Z —/40 45	09/0600Z 29.69 (1005.3)	8/9 5.2-	
<u>Florida</u>				
Pensacola (WSO)	08/1714Z —/18 21	09/0950Z 29.88 (1011.7)	09 0.91	1.26
Pensacola (NAS)	09/1404Z —/20 33	09/0655 29.85 (1010.7)	09 1.79	2.34
<u>Alabama</u>				
Mobile (WSO)	09/0851Z SE/24 34	09/0851Z 29.81 (1009.5)		5.09
Dauphin Island Sea Lab	09/0743Z SE/33 47	09/0550Z 29.77 (1008.1)		11.82

Table 3. MISCELLANEOUS RAINFALL OBSERVATIONS (INCHES) FROM TROPICAL STORM BERYL

<u>LOCATION</u>	<u>DATE/24 HOUR AMOUNT</u>	<u>STORM TOTAL</u>
Abbeville, LA	11 4.10	
Hana, LA	10/11 4.15	
St.Martinville, LA		3.98
Reserve, LA		5.19
Thibadaux, LA		2.99
Bogalusa, LA		3.29
Mt. Enterprise, TX	11 12.50	
Clayton, TX	11 11.15	
Cushing, TX	11 8.00	
Reklaw, TX	11 6.73	
Carthage, TX	11 5.73	
Bay St. Louis, MS		10.00
Gulf Shores, LA		4.5-
Point Clear, AL		8.34
Stapleton, AL		3.92
Fairhope, AL	09 4.5-	6.75
Silverhill, AL	09 3.39	4.69
Foley, AL	09 6.3-	10.27
Bay Minette, AL	09 2.98	4.19

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Table 4. MISCELLANEOUS MAXIMUM TIDE REPORTS FROM TROPICAL STORM BERYL

<u>LOCATION</u>	<u>TIDES (FEET)</u>	<u>LOCATION</u>	<u>TIDES (FEET)</u>
Bayou			
Bienvenue, LA	5.5 abv norm	Biloxi, MS	3.3 abv norm
Paris Road, LA	5.0 abv norm	Pass Christian, MS	4.1 abv norm
Rigolets, LA	3.0 abv norm	Gulfport, MS	4.7 abv norm
Mandeville, LA	3.0 abv norm	Pensacola, FL	.5 to 1 abv norm
Mobile, AL	1.9 abv norm		

Table 5. Selected ship and oil rig reports from Tropical Storm Beryl. Wind direction is in degrees, speed in knots and pressure in millibars.

<u>DATE/TIME</u> <u>(UTC)</u>	<u>REPORTING</u> <u>PLATFORM*</u>	<u>POSITION</u>		<u>WIND</u> <u>DIR/SPEED+GUSTS</u>	<u>PRESSURE</u>
		<u>LATITUDE</u>	<u>LONGITUDE</u>		
08/0600	SHIP WIDO	30.0	88.5	160/36	1014.3
08/0700	RIG P21(MP73)	29.3	88.9	—/46	
08/0900	RIG SS158C	28.7	91.0	WNW/34 +41	1010.9
08/1440	RIG S58	28.2	91.8	280/40 +52 TRW	
08/1800	RIG P26(GI94)	28.5	90.1	310/34	1008
08/1800	RIG P26(GC18)	27.9	91.0	275/34	1007
08/1800	SHIP DHOU	30.1	88.7	100/46	1009.5
08/2211	RIG P26(MP73)	29.3	88.9	—/35	
09/0000	SECDO	28.7	90.1	010/35 +42	1003.4
09/0600	SHIP DHOU	29.3	87.7	140/37	1009.0
10/0300	RIG P30(WC533)	28.3	93.0	310/36	

* Anemometer heights vary on different oil rigs.

Table 6. Summary of Tropical Storm Beryl Warnings.

<u>DATE/TIME</u> <u>(UTC)</u>	<u>ACTION</u>	<u>LOCATION</u>
08/1000	Tropical Storm Warning issued	From the mouth of the Mississippi River to Pensacola, Florida.
08/1600	Tropical Storm Warnings extended	Westward to Morgan City. T.S. Warnings in effect from Morgan City, La to Pensacola Fl.
09/2200	Discontinued all Warnings	

Table 7. Chance of the center of Beryl passing within 65 miles of the listed location by date and time (CDT) indicated. Probabilities in percent. X means probabilities of less than 2 percent.

<u>Advisory Date/Time</u> <u>Probability Thru</u>	<u>08/11AM</u> <u>11/7AM</u>	<u>08/5PM</u> <u>11/1PM</u>	<u>08/11PM</u> <u>11/7PM</u>	<u>09/5AM</u> <u>12/1AM</u>
Marathon, FL.	02	02	X	X
Key West, FL.	02	02	X	X
Marco Island, FL.	03	05	02	X
Ft. Myers, FL.	04	07	02	X
Venice, FL.	05	10	03	X
Tampa, FL.	06	14	04	X
Cedar Key, FL.	07	18	06	X
St. Marks, FL.	10	16	09	X
Apalachicola, FL.	12	20	11	X
Panama City, FL.	13	20	13	X
Pensacola, FL.	17	25	19	13
Mobile, AL.	20	34	29	18
Gulfport, MS.	46	57	58	59
Buras, MS.	97	88	81	96
New Orleans, MS.	85	35	44	93
New Iberia, LA.	17	12	18	38
Port Arthur, TX.	12	05	13	18
Galveston, TX.	11	03	12	15
Freeport, TX.	10	03	11	14
Port O Connor, TX.	09	02	10	12
Corpus Christi, TX.	08	X	08	09
Brownsville, TX.	07	X	08	08
GULF 29N 85W	12	22	10	06
GULF 29N 87W	21	30	20	11
GULF 28N 89W	44	29	26	17
GULF 28N 91W	23	14	21	22
GULF 28N 93W	15	04	15	18
GULF 28N 95W	11	02	12	14
GULF 27N 96W	10	X	10	11
GULF 25N 96W	08	X	08	08