Preliminary Report
Tropical Storm Charley
21-24 August 1998

Edward N. Rappaport
National Hurricane Center
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a. Synoptic History

The origin of Tropical Storm Charley is unclear. It could have been a large swirl of clouds that exited the coast of Africa on 9 August at rather high latitude, mainly to the north of Dakar, Senegal. More definitely, the precursor consisted of a small area of deep convection first noted a few hundred miles to the northeast of the Leeward Islands on the 15th. Intermittent convective activity continued while the system moved just west of north for the following few days. On the 19th, animation of satellite pictures showed a cyclonic rotation of the clouds over the southeastern Gulf of Mexico.

The first formal position estimate from satellite analysts came on the evening of the 19th and Dvorak T-numbers (1.5) were first assigned the next day over the central Gulf. By the morning of the 20th, surface winds had begun to increase, with NOAA's central Gulf buoy 42001 measuring sustained winds as high as 31 kt and gusts to 45 kt at 1700 UTC. These stronger winds were fleeting, however, and an investigation of the system late that day by U.S. Air Force Reserves reconnaissance aircraft did not indicate a closed low-level circulation center.

A center "fix" was made aboard reconnaissance aircraft early in the following flight, near 1300 UTC the next day, and this is the basis for indicating that the system became a tropical depression around 0600 UTC on the 21st (Fig. 1 and Table 1). At that time, the depression was centered about 275 n mi off of the south Texas coast. The tropical cyclone moved toward the west-northwest to northwest at about 10 kt during its three-day lifetime.

Although the center was not well-formed initially, the amount of deep convection steadily increased, particularly over the northern semicircle. That part swept over the oil platforms of the northern Gulf and data from them (e.g., Table 2) suggest that tropical storm status was reached by 1800 UTC on 21 August. Winds of hurricane force were noted in intense convection to the northeast of the center at a flight level of 1500 feet early on the 22nd. Charley was likely then at its peak strength, near 60 kt. The wind speeds measured aboard aircraft were considerably lower thereafter and it is estimated from that data and other observations that surface winds were closer to 40 kt when Charley's center made landfall near Port Aransas about 1000 UTC on the 22nd.

The surface circulation weakened further after landfall and likely dissipated early on the 24th along the Rio Grande near Del Rio, Texas. Although the winds diminished inland, and a closed surface circulation could no longer be identified, a slow-moving circulation aloft persisted in the Del Rio vicinity and generated flooding rains that were most devastating in that area on the 23rd and 24th. By late on the 25th, most of the remnant cloud system had deteriorated and precipitation had diminished.

b. Meteorological Statistics

The "best track" intensity was obtained from the data presented in Figs. 2 and 3. Those figures show Charley's estimated central pressure and maximum one-minute wind speed, respectively, versus time. Position and intensity estimates were obtained from analyses of satellite pictures by NOAA's Synoptic Analysis Branch (SAB) and Tropical Analysis and Forecast Branch (TAFB), and by the Air Force Weather Agency (AFGWC in figures). Analyses also included surface observations, and radar and aircraft data.

Charley's primary legacy will be the rainfall and associated flooding it produced in the Del Rio vicinity. On 23 August, 16.83 inches of rain fell in Del Rio. This easily surpassed the previous daily record of 8.79 inches on 13 June 1935. A nearby site recorded 17.59 inches for the 24 hour period ending in the morning hours of 24 August. Along the coast, maximum rainfall totals were near 5 inches except for an unofficial report of 9 inches near the mouth of the San Bernard River in Brazoria County.

River flooding along the Rio Grande occurred well downstream from Del Rio, in the Laredo area.

Storm tides of 2 to 3.5 feet above normal astronomical levels were reported from the coast.

The ASOS sites at Rockport (RKP) and Galveston (GLS), Texas were the only two surface reporting stations on land to measure sustained tropical storm force winds. They recorded two-minute winds of 36 kt and 34 kt, respectively. A gust to 55 kt was reported from the Pt. O'Connor Coast Guard.

A minimum pressure of 1000 mb is estimated at landfall from the observation of 1000.7 mb at RKP an hour later.

c. Casualty and Damage Statistics

The death toll currently stands at 13 in Texas, with 6 people unaccounted. All were apparently flood victims located well inland. The total consists of four people including two toddlers whose pickup was swept away by rising water in Real County on the 23rd. Seven other people from the truck were rescued. Nine deaths due to drowning occurred in Del Rio (Val Verde County) along the San Felipe Creek during the late night of 23 August. Some in the

latter group could have expired after the system was no longer classified as a tropical cyclone.

Emergency operations personnel in Mexico reported that as of early October the number of fatalities in Ciudad Acuña, Mexico, across the border from Del Rio, was seven. Media reports indicate that three of these victims drowned while trying to cross a flooded gully.

A preliminary estimate of the total loss due to the inland flood is $50 million. Property losses were reported in several counties and consisted of damages to residences, businesses, roads, bridges and agriculture. About 1500 homes, 200 mobile homes, and 300 apartments were damaged or destroyed in Val Verde County, where about $40 million in losses occurred.

Minor beach erosion was reported.

d. Forecast and Warning Critique

Tropical Weather Outlooks and Special Tropical Disturbance Statements issued by the NHC correctly identified the incipient disturbance as a candidate for development once it entered the southeastern Gulf of Mexico.

Charley was a tropical storm for less than a day and this is too short a period to obtain a meaningful quantitative evaluation of forecast accuracy. Qualitatively, NHC forecasts showed the correct motion and intensity trends.

The NHC issued a tropical storm warning from Brownsville to High Island, Texas on its first advisory (as a tropical depression) at 1500 UTC on the 21st, about 19 hours prior to landfall in that area. The warning was extended eastward to Cameron, Louisiana six hours later. When the center of Charley was about to come ashore, the warning was discontinued northeast of Sabine Pass, Texas at 0900 UTC on the 22nd. The remaining warning was discontinued at 1500 UTC 22 August.

Acknowledgements

Some data for this report were furnished by National Weather Service offices in Corpus Christi, Lake Charles, and Austin/San Antonio.

Table 1. Preliminary best track, Tropical Storm Charley, 21-24 August 1998.

Date/Time (UTC)	Latitude (°N)	Longitude (°W)	Pressure (mb)	Wind Speed (kt)	Stage
21/0600	25.3	92.3	1008	25	Tropical Dep.
1200	25.4	93.8	1008	30	" "
1800	26.0	94.5	1008	40	Tropical Storm
22/0000	26.8	95.4	1006	45	" "
0600	27.5	96.5	1002	60	" "
1200	27.9	97.4	1001	35	" "
1800	28.3	98.1	1003	30	Tropical Dep.
23/0000	28.5	98.7	1005	25	" "
0600	28.7	99.3	1006	20	" "
1200	28.8	99.9	1007	20	" "
1800	29.1	100.6	1008	20	" "
24/0000	29.4	101.2	1008	20	Dissipating
0600					Dissipated
22/1000	27.8	97.1	1000	40	Landfall near Port Aransas and Minimum Pressure

Table 2. Tropical Storm Charley selected surface observations, August 1998.

Location	Press. (mb)	Date/ time (UTC)	Sustained wind (kt)[a]	Peak gust (kt)	Date/ time (UTC)[b]	Storm tide (m)[c]	total rain (mm)
Louisiana							
Lake Charles (LCH) ASOS			32	38	21/1918		29.97
Cameron						0.7	
Texas							
Jefferson Cty Arpt ASOS (BPT)			29	37	20/2054		40.60
NWSO Corp. Christi (CRP)	1005.8	22/1059	27	32	22/1040		10.67
NAS Cor. Christi (NGP)			27	36	22/0756		1.78
Rockport (RKP) ASOS	1000.7	22/1059	36	42	22/0806		58.67
Victoria (VCT) ASOS			30	37	22/1122		66.80
Pt. Aransas (incom. record) C-MAN (PTA)			29	36	22/1100		
Aransas Pass				46	22/0800		
Cotulla (COT) ASOS				37	22/2013		
Seadrift				39	22/8-9		
Skidmore				39			
Tynan				35			
Pt. O'Connor Cst Guard				55			
Refugio 3SW							185.4
Woodsboro 10S							127.0
Port O'Connor						0.6-0.9	
Palacios (PSX)				42			
Galveston (GLS) ASOS			34	38	22/0823		
Freeport							132.3
Matagorda							111.8
Pleasure Pier						1.5	
Offshore Oil Rigs							
KS58			35	48	21/1645		
KH08			35		21/1642		
K7R8			40	50	21/1647		

[a] ASOS provides a 2 minute average

[b] Date/time is for sustained wind when both sustained and gust are listed.

[c] Storm tide is water height above NGVD, except for Pleasure Pier where observation is relative to mean low lower water.

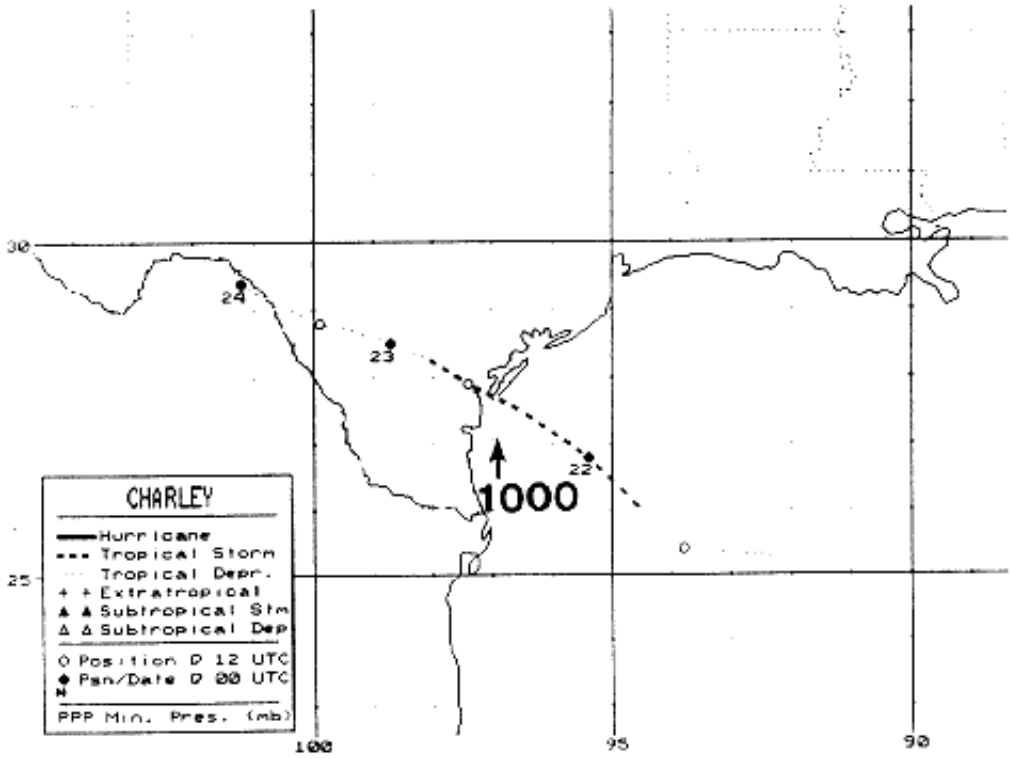

Figure 1. Best track positions for Tropical Storm Charley.

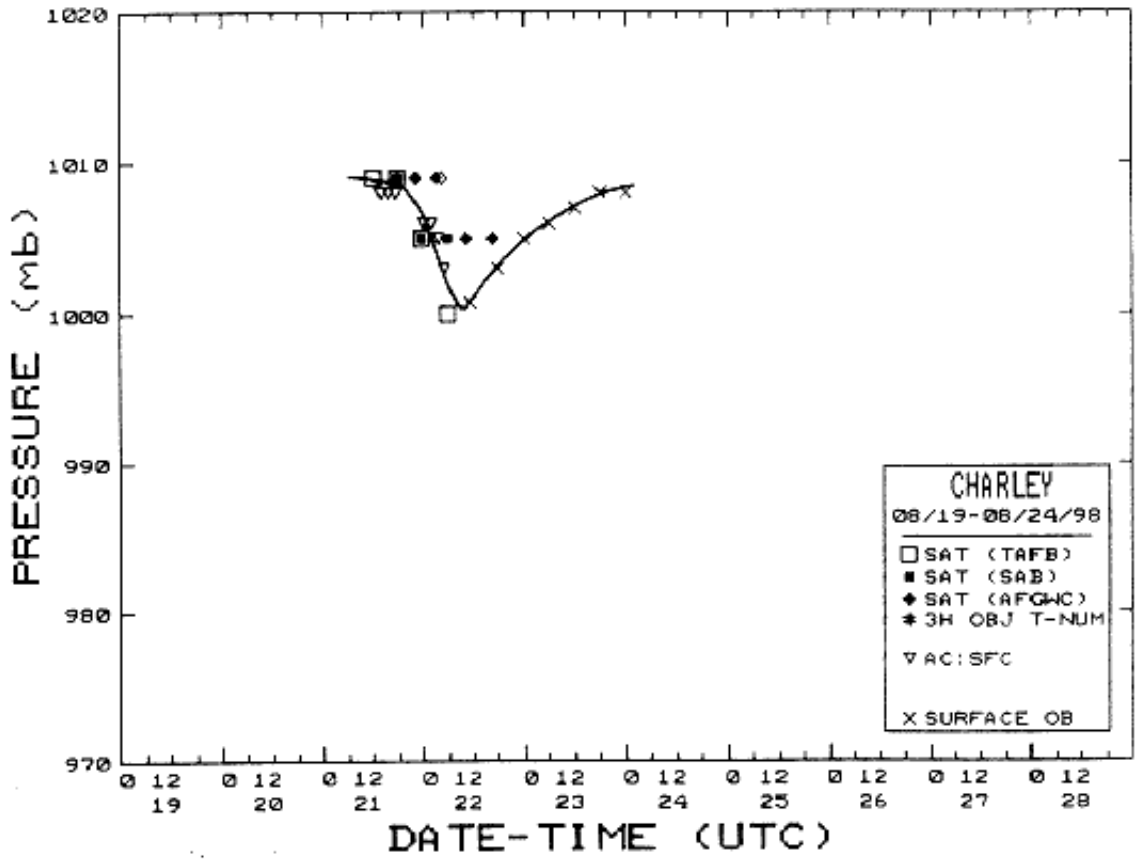

Figure 2. Best track central pressure curve for Tropical Storm Charley, August 1998.

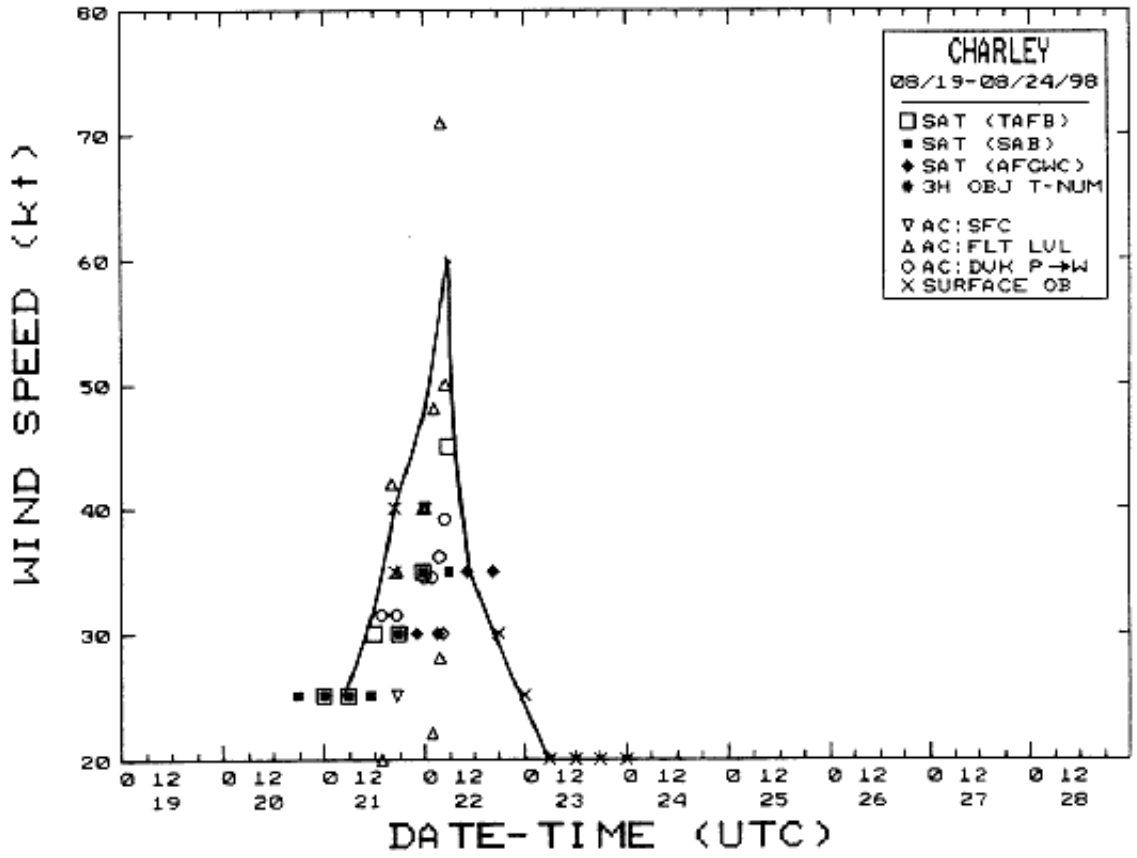

Figure 3. Best track maximum one-minute wind speed curve for Tropical Storm Charley, August 1998.