

Tropical Cyclone Report
Tropical Storm Barry
2-7 August 2001

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Barry was a strong tropical storm that caused minor damage in the western Florida Panhandle.

a. Synoptic history

Barry formed from a tropical wave that moved westward from the coast of Africa on 24 July. The wave moved westward across the tropical Atlantic with little development until the 28th, when convection started increasing just east of the Lesser Antilles. The system moved into the eastern Caribbean Sea on 29 July accompanied by poorly organized thunderstorms and gusty winds. Convection continued increasing on 30-31 July as the wave moved west-northwestward through the Caribbean. It moved into the southeastern Gulf of Mexico on 1 August, accompanied by widespread heavy rains over southern Florida and western Cuba.

A broad 1014 mb low formed along the wave near Dry Tortugas, Florida late on 1 August. The low moved northwestward and intensified. An Air Force Reserve Hurricane Hunter aircraft reached the center at 1829 UTC 2 August and found that the system had become Tropical Storm Barry. A large area of tropical storm winds existed north and east of the center, primarily due to interaction with a strong surface ridge. Post-analysis suggests that the low had become a tropical depression about 6 h earlier approximately 175 n mi west-northwest of Key West, Florida (Figure 1 and Table 1).

Barry may not have been fully tropical when it formed, because an upper level low was over the surface center. However, southwesterly upper level flow moved the upper low moved northeastward while Barry moved west-northwestward due to the ridge over the United States. This shear, combined with falling external surface pressures as the ridge weakened, caused it to weaken to a depression early on 4 August. Barry then remained in a generally unfavorable environment until early on the 5th. The weakening ridge caused the steering currents to collapse, and Barry slowed to a west-southwestward drift on the 3rd. This was followed by a general northeastward drift on the 4th.

Flow around a mid/upper level low dropping southward into the western Gulf states caused Barry to turn northward and accelerate on 5 August. Concentrated convection formed near the center early that day and this led to another significant burst of intensification. The central pressure fell from 1004 mb to 990 mb in 7 h as the organization of the system improved dramatically in satellite and radar imagery. Although the strengthening was short-lived, it made Barry a 60 kt cyclone. This intensity was maintained through landfall near Santa Rosa Beach, FL at 0500 UTC 6 August. Figure 2 is a reflectivity image from the Eglin Air Force Base (AFB) radar an hour before landfall showing that Barry was forming an eye and had strong convection in the northern eyewall.

The cyclone turned northwestward and weakened rapidly after landfall. It became a tropical depression over southern Alabama later on the 6th and further weakened to a low pressure area near Memphis, TN the next day. The remnant low dissipated over southeastern Missouri on the 8th.

b. Meteorological statistics

Table 1 shows the best track positions and intensities for Barry, with the track plotted in Figure 1. Figures 3 and 4 depict the curves of minimum central sea-level pressure and maximum sustained one-minute average “surface” (10 m above ground level) winds, respectively, as functions of time. These figures also contain the data on which the curves are based: aircraft reconnaissance and dropsonde data from the Air Force Reserve Hurricane Hunters, satellite-based Dvorak technique intensity estimates from the Tropical Analysis and Forecast Branch (TAFB), the Satellite Analysis Branch (SAB) of the National Environmental Satellite Data and Information Service (NESDIS), and the Air Force Weather Agency, and estimates from synoptic data.

The Air Force Reserve Hurricane Hunters made 35 center “fixes” during Barry. The maximum flight level winds reported by the aircraft were 71 kt just after the center made landfall. Additionally, an eyewall dropsonde measured 61 kt surface winds at 1847 UTC on the 5th. The maximum surface winds reported by an official land station were 42 kt with gusts to 69 kt at station C-72 of the Eglin AFB mesonet. Additional selected surface observations from official stations are included in Table 2.

Shortly after landfall, an unofficial observation from Seagrove Beach, FL reported a 3-minute average wind of 82 kt with gusts to 93 kt. This and the 71 kt flight-level wind suggested the possibility that Barry had reached hurricane strength just as it was making landfall. No official observations supported the Seagrove Beach data, so several efforts were made to verify its validity:

First, personnel from the NWS Forecast Office in Mobile, AL investigated the Seagrove Beach report. They indicate that the wind damage in the area was far less than what would be expected for the reported winds. This casts some doubt as to the accuracy of the data.

Second, additional analysis was conducted by the Hurricane Research Division using the HWIND system on the aircraft and surface data. The analysis yielded a maximum sustained wind at landfall of 62 kt.

Third, the WSR-88D radar at Eglin Air Force Base indicated hurricane-force winds about 1500 ft above the surface as Barry approached the coast. Unfortunately, the radar failed about an hour before landfall, and it is unknown how these winds evolved as the center reached the coast. The National Hurricane Center (NHC) conducted post-analysis of the radar wind data using some experimental algorithms. This was inconclusive as to whether the hurricane-force winds aloft reached the surface.

Fourth, the NHC sent a request to the public asking for additional observations from the landfall area. Over 30 supplemental reports were received, with the most significant and useful included in Table 3. Several of the wind reports were in the 60-65 kt range with higher gusts, which

supports Barry being right on the threshold of a hurricane. However, the quality of this data is uncertain due to the mostly unknown accuracy and exposure of the instruments.

The lowest aircraft-measured pressure was 990 mb at 1154 UTC 5 August and again at landfall. The lowest pressure from an official station was 994.2 mb from the Eglin AFB mesonet (Table 2). The supplemental data included a 988.5 mb pressure in Freeport, FL (Table 3), which was likely in the eastern side of the eye. While this and a 989.1 mb observation in Destin were slightly lower than the landfall pressure reported by aircraft, the accuracy of these supplemental measurements is unknown. Therefore, the best track landfall pressure will be the 990 mb reported by the aircraft.

Most of the much-appreciated supplemental wind and pressure data are consistent with the wind and pressure values the NHC determined from reconnaissance data. However, due to the uncertainties in the data quality, the data are not quite enough to justify calling Barry a hurricane at landfall.

The core of Barry missed most ships and buoys. The most significant marine observation was from buoy 42039, which reported 39 kt sustained winds with gusts to 54 kt and a 1001.5 mb pressure at 2000 UTC 5 August. An unidentified ship reported 30 kt winds with gusts to 50 kt over the southeastern Gulf from 0200-1000 UTC 2 August. This, combined with data from the Coastal Marine Automated Network Station at the Dry Tortugas, provided evidence that the tropical wave was developing into a tropical cyclone.

Storm surges and tides associated with Barry were 2-3 ft near the landfall area in Bay and Walton counties. Tides of 2-3 ft above normal also occurred along portions of the southeast Louisiana coast in association with the strong winds early in Barry's life.

Storm total rainfalls were generally 5-9 inches over the Florida Panhandle near and east of where the center made landfall with 1-4 inches elsewhere in the affected area from southwestern Georgia to northern Mississippi. The maximum amount from an official station was 8.91 inches at Tallahassee, FL. Supplemental observations included 11.00 inches at WJHG-TV in Panama City, FL and 9.57 inches at Port St. Joe, FL. These rains caused localized flooding. The pre-Barry tropical wave produced 3 to 8 inches of rain over portions of southern Florida with local amounts as high as 13 inches in Martin County. These rains helped relieve long-term drought conditions in south Florida.

One tornado has been confirmed in association with Barry - an F0 near Carrabelle, FL. The pre-Barry wave produced F0 tornadoes near Ft. Pierce and Boynton Beach, FL. All three tornadoes caused minor damage.

c. Casualty and Damage Statistics

Two deaths are directly associated with Barry: one due to a lightning strike in an outer band near Jacksonville, FL and one drowning in a rip current at Sanibel Island, FL. One indirect death occurred in a traffic accident during rains associated with the storm. Additionally, as the pre-Barry

wave moved over Cuba and the Straits of Florida, associated winds and seas capsized a boat with Cuban refugees on board. Press reports indicated that 6 of the 28 passengers drowned.

The American Insurance Services Group estimates insured property damage from Barry to be \$15 million. Applying a 2:1 ratio of total damage to insured damage, the total damage from Barry is estimated to be \$30 million.

d. Forecast and warning critique

Table 4 shows the average errors during the tropical storm stage of Barry for the official NHC track forecast and a selection of objective guidance models. The NHC errors were 31 (8 forecasts), 49 (5 forecasts), 105 (4 forecasts), 156 (5 forecasts), and 244 n mi (3 forecasts) for 12, 24, 36, 48, and 72 h respectively. The average errors were better than the 10-yr (1991-2000) average at 12, 24, and 36 h and worse than both the 10-yr average and Climatology-Persistence (CLIPER) at 48 and 72 hr. Several of the objective guidance models had better average errors than the official forecasts. The most notable was the Aviation model (AVNO), which was the overall best performer on Barry.

Analysis of the individual official track forecasts indicates there was a significant westward bias. This resulted from the belief that the strong deep layer ridge over the central United States would hold and move Barry westward, possibly with a landfall in Louisiana. Several later forecasts better anticipated the strength of the Gulf coast trough and correctly forecast landfall in the Florida Panhandle.

The official intensity forecast errors were 7, 11, 9, 13, and 7 kt at 12, 24, 36, 48, and 72 h respectively. These errors are near the 10-yr average at 12 and 24 h and below the 10-yr average at the other times.

Table 5 shows the watches and warnings issued for Barry. Hurricane warnings were issued for portions of the northern Gulf coast in anticipation that Barry's rapid strengthening on the 5th would continue. These were somewhat short-fused with a lead time of about 16 hours. The early erroneous track forecasts led to watches and warnings along portions of the Louisiana and Mississippi coasts that did not verify.

Barry was forecast to become an inland flooding threat after landfall. However, a faster than expected motion and weakening led to inland rainfall totals being less than anticipated.

Acknowledgments:

Much of the data in this report were provided by the local National Weather Service forecast offices in Slidell, LA, Mobile, AL, and Tallahassee, FL. Buoy and C-MAN station data were provided by the National Data Buoy Center. Many of the supplemental observations were forwarded to the NHC by Jason Kelley of TV station WJHG in Panama City, FL. Rich Henning of the Hurricane Hunters and Eglin Air Force Base contributed other supplemental observations as well as the Eglin radar data. Bill Frederick contributed the forecast verification data, and Colin McAdie analyzed the radar data.

Table 1. Best track, Tropical Storm Barry, 2 - 7 August 2001

Date/Time (UTC)	Latitude (°N)	Longitude (°W)	Pressure (mb)	Wind Speed (kt)	Stage
02 / 1200	25.7	84.8	1011	30	tropical depression
02 / 1800	26.2	84.9	1010	45	tropical storm
03 / 0000	26.4	85.6	1007	40	"
03 / 0600	26.6	86.3	1008	35	"
03 / 1200	26.9	87.0	1007	35	"
03 / 1800	26.8	87.2	1007	35	"
04 / 0000	26.7	87.5	1005	30	tropical depression
04 / 0600	26.6	87.8	1005	30	"
04 / 1200	26.9	87.7	1006	30	"
04 / 1800	27.1	87.5	1005	35	tropical storm
05 / 0000	27.3	87.3	1003	35	"
05 / 0600	27.5	86.7	1004	40	"
05 / 1200	28.1	86.4	990	50	"
05 / 1800	28.6	86.4	991	60	"
06 / 0000	29.5	86.3	992	60	"
06 / 0600	30.6	86.4	991	60	"
06 / 1200	31.8	86.9	1007	25	tropical depression
06 / 1800	32.7	87.7	1009	20	"
07 / 0000	33.3	88.5	1012	15	"
07 / 0600	34.0	89.1	1015	15	remnant low
07 / 1200	34.7	89.7	1017	10	"
07 / 1800	35.6	89.8	1018	10	"
08 / 0000	36.6	89.9	1016	10	"
08 / 0600	37.5	90.0	1017	10	"
08 / 1200					dissipated
05 / 1200	28.1	86.4	990	50	minimum pressure
Landfall:					
06 / 0500	30.4	86.3	990	60	Santa Rosa Beach, Florida

Table 2.
Tropical Storm Barry selected surface observations, 2-7 August 2001.

Location	Pres. (mb)	Date/ Time (UTC)	Sust. Wind (kts) ^a	Peak Gust (kts)	Date/ Time (UTC) ^b	Storm Surge (ft) ^c	Storm Tide (ft) ^d	Total Rain (in)
Alabama								
Dothan	1013.6	06/0736	21	26	06/0940			1.22
Evergreen	1006.1	06/1032	20	28	05/1739			1.23
Fort Rucker								3.50
Maxwell AFB								3.21
Troy								4.05
Florida								
Apalachicola	1011.9	06/0019	27	41	06/0739			6.40
Destin*	999.3	06/0449	31	42	06/0421			
Crestview	996.6	06/0656	31	44	06/0603			2.18
Eglin A-5			28	39	06/0450			
Eglin C-52	994.2	06/0541	27	52	06/0525			
Eglin C-72	995.6	06/0613	42	69	06/0535			
Mary Esther	1005.6	06/0555	24	42	06/0455			0.71
Panama City Bay Cnty. Aprt.	1008.1	06/0141	26	35	06/0440			5.19
Panama City Tyndall AFB	1009.8	06/0255	25	42	05/2350			8.68
Tallahassee	1013.5	06/0701	20	26	06/0222			8.91
Valparaiso	998.6	06/5555	35 ^e	55 ^e	06/0655			3.92
NOAA Buoys and C-MAN Stations								
Buoy 42003	1009.7	04/1000	30 [§]	39	05/1400			
Buoy 42036	1011.6	05/0800	29	37	02/2000			
Buoy 42039	1001.5	05/2000	39	54	05/2000			
Cape San Blas FL (CSBF1)	1009.8	06/0000	35 [§]	44	30/1400			

^a Standard NWS ASOS and C-MAN averaging period is 2 min; buoys are 8 min. Eglin AFB sites are also 2 min averages

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

^e Estimated.

* Incomplete record

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

^d Storm tide is water height above NGVD.

[§] 10 min average

Table 3.
Tropical Storm Barry supplemental unofficial surface observations, 2-7 August 2001.

Location	Pres. (mb)	Date/ Time (UTC)	Sust. Wind (kts)	Peak Gust (kts)	Date/ Time (UTC) ^b	Total Rain (in)
Alabama						
Andalusia						3.12
Floralia						3.48
Red Level	1003.0	06/0930		34	06/0818	3.00
Florida						
Callaway						7.78
Crestview (Davidson HS)	998.3	06/0824		35	06/0724	
DeFuniak Springs	997.9	06/0630				4.60
Destin	989.1		62 ^f	69		
Destin 5-10 E			48	63	06/0440	
Destin AWS	1004.1	06/0435		40	06/0500	
Destin Harbor ^a			65	75	06/0500	
Fort Walton Beach (Choctawhatchee HS)	1002.7			35	06/0613	
Freeport	988.5	06/0440				
Hiland Park	1007.8					5.45
Lynn Haven						7.80
Mary Esther 3 SSW HRT						5.20
Miramar Beach	991.8	06/0503	57	73		
Niceville				57	06/0440	
Panama City Bay HS						6.53
Panama City The Cove						9.56
Panama City WJHG-TV						11.00
Phillips Inlet			64 ^d			4.05
Port St. Joe						9.57
Santa Rosa Beach				70	06/0426	
Seagrove Beach			82 ^c	93	06/0450	
St. Andrews State Park ^a	991.8		63 ^c		06/0310	
St. George Island						4.48
Wasuau 3 E						8.80

^a *Sailboat, likely with non-standard anemometer elevation.*

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

^c *3 minute average.*

^d *1 minute average.*

^f *4 minute average.*

Table 4. Preliminary track forecast evaluation for Tropical Storm Barry - heterogeneous sample. Errors in nautical miles for tropical storm and hurricane stages with number of forecasts in parentheses. Numbers in bold represent forecasts which were better than the official forecast.

Forecast Technique	Period (hours)				
	12	24	36	48	72
CLIP	42 (8)	76 (5)	109 (4)	148 (5)	171 (3)
GFDI	24 (8)	55 (5)	140 (4)	234 (5)	369 (5)
GFDL*	30 (8)	44 (5)	122 (4)	200 (5)	273 (3)
LBAR	40 (8)	84 (5)	168 (4)	194 (5)	293 (3)
VBRI*	45 (8)	118 (5)	162 (4)	161 (5)	149 (3)
VBAR	29 (6)	58 (4)	148 (4)	184 (4)	163 (2)
AVNI	26 (7)	30 (4)	73 (4)	74 (4)	86 (2)
AVNO*	29 (8)	18 (5)	37 (4)	71 (5)	98 (3)
BAMD	31 (8)	63 (5)	134 (4)	170 (5)	255 (3)
BAMM	32 (8)	73 (5)	146 (4)	174 (5)	281 (3)
BAMS	36 (8)	79 (5)	166 (4)	222 (5)	358 (3)
NGPI*	38 (8)	62 (5)	124 (4)	179 (5)	320 (3)
NGPS	36 (3)	63 (1)	117 (1)	179 (2)	356 (1)
UKMI	30 (6)	35 (3)	58 (3)	107 (2)	98 (1)
UKM*	31 (3)	39 (1)	58 (1)	82 (2)	99 (1)
A98E	39 (8)	46 (5)	63 (4)	92 (5)	136 (3)
A9UK	34 (3)	16 (1)	112 (1)	98 (2)	99 (1)
GUNS	24 (6)	34 (3)	95 (3)	183 (2)	221 (1)
GUNA	19 (6)	32 (3)	70 (3)	136 (2)	160 (1)
NHC Official	31 (8)	49 (5)	105 (4)	156 (5)	244 (3)
NHC Official 10-Year Average (1991-2000)	44 (2049)	82 (1835)	118 (1646)	151 (1475)	225 (1187)

* Output from these models was unavailable at time of forecast issuance.

Table 5. Watch and warning summary, Tropical Storm Barry, 2 - 7 August 2001.

Date/time (UTC)	Action	Location
03/1500	Tropical storm watch issued	Southeast Louisiana from Mouth of Pearl River to Morgan City
04/1500	Tropical storm warning issued	Mississippi Delta region of Louisiana from Grand Isle to the Mouth of the Pearl River...including New Orleans and adjacent lakes
04/1500	Tropical storm watch issued	Mouth of the Pearl River eastward to Panama City, Florida and west of Grand Isle to Morgan City, Louisiana
04/2100	Tropical storm warning extended	Grand Isle, Louisiana to Apalachicola, Florida
05/0300	Tropical storm watch discontinued	West of Grand Isle to Morgan City, Louisiana
05/1300	Hurricane warning issued	Pascagoula, Mississippi eastward to the Ochlockonee River, Florida
05/1300	Tropical storm warning extended	Eastward from east of the Ochlockonee River to the Mouth of the Suwanee River, Florida
05/2100	Tropical storm warning discontinued	Grand Isle, Louisiana to the Mouth of the Pearl River including New Orleans
06/0300	Hurricane warning changed to tropical storm warning	West of Pensacola, Florida to just east of Pascagoula, Mississippi
06/0300	All warnings discontinued	Pascagoula, Mississippi westward
06/0700	Hurricane warning downgraded to a tropical storm warning	Apalachicola to Ft. Walton Beach, Florida
06/0700	All warnings discontinued	East of Apalachicola and west of Ft. Walton Beach, Florida
06/1200	Tropical storm warning discontinued	Apalachicola to Ft. Walton Beach, Florida

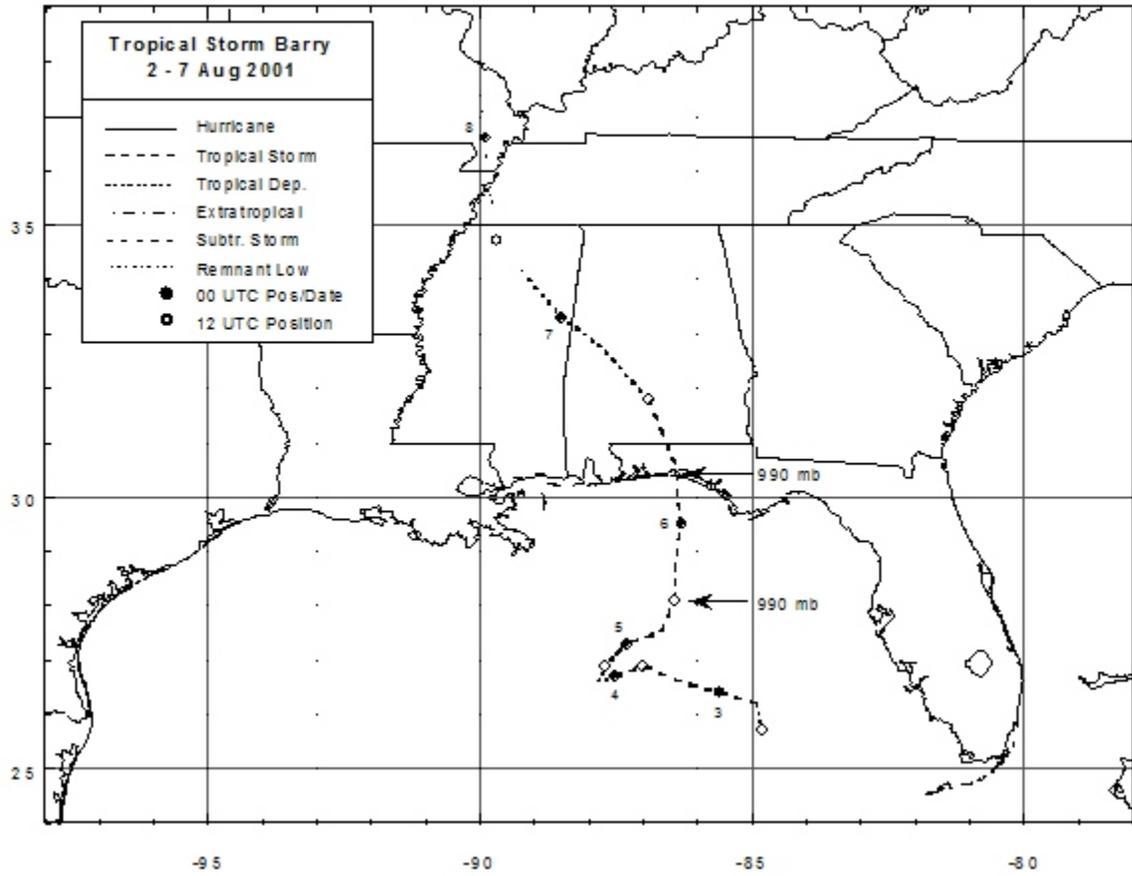


Figure 1. Best track of Tropical Storm Barry, 2-7 August 2001

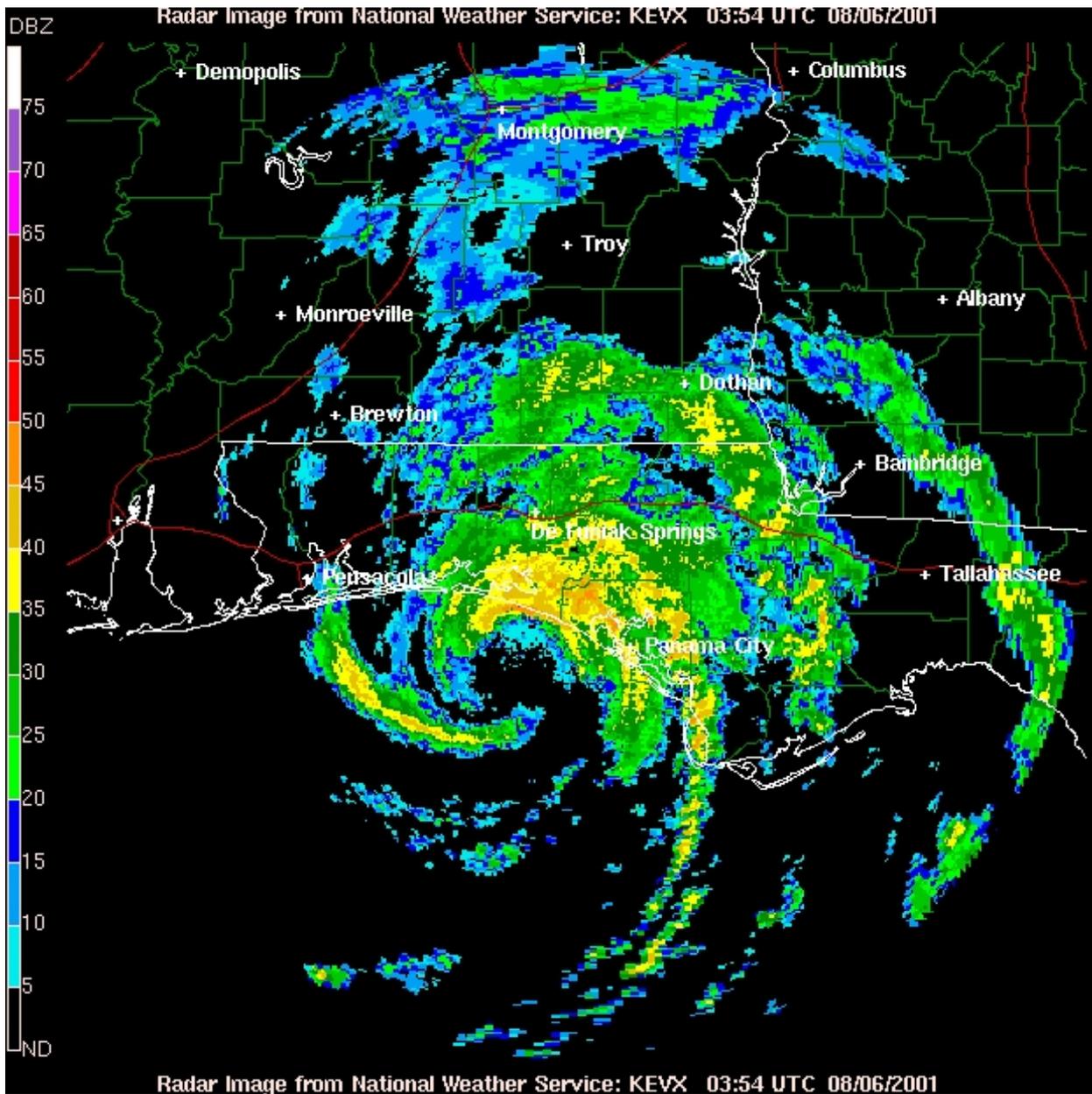


Figure 2. Eglin Air Force Base WSR-88D reflectivity image of Barry at 0354 UTC 6 August 2001.

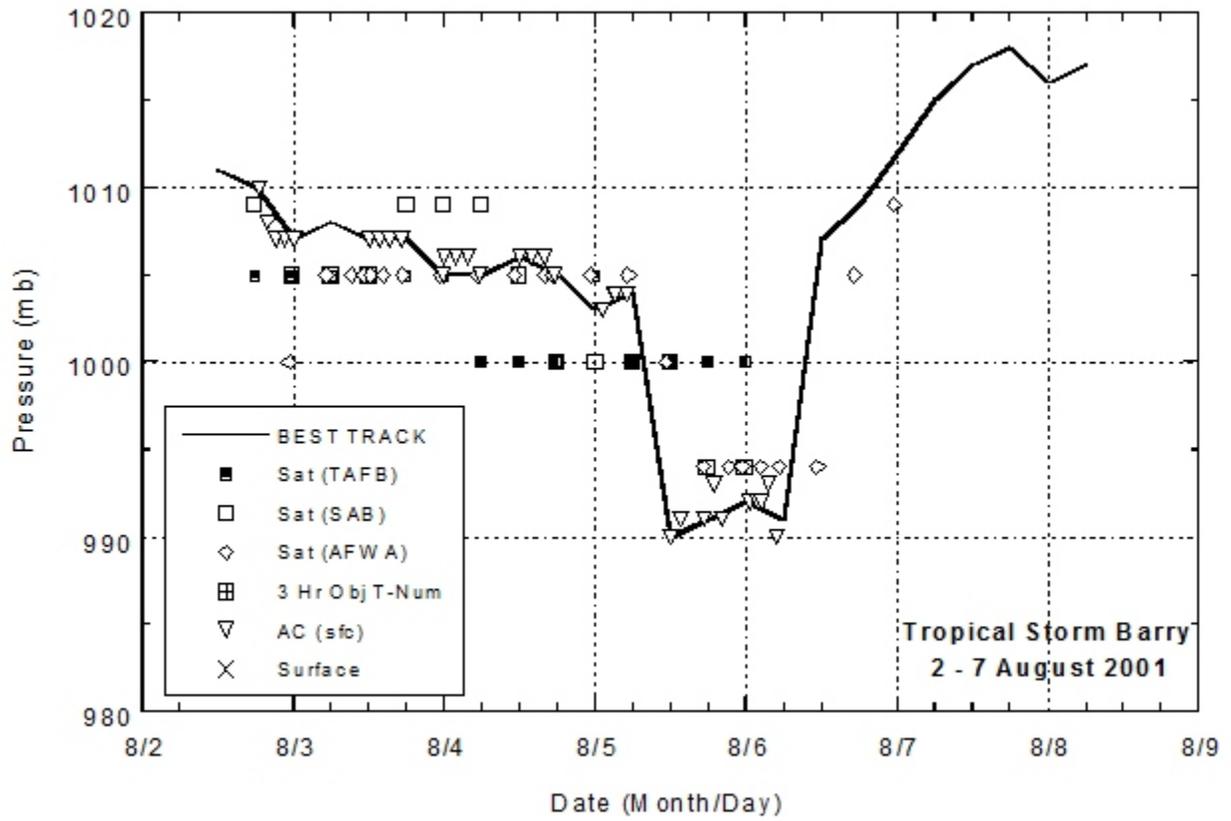


Figure 3. Best track minimum central pressure curve for Tropical Storm Barry, 2 - 7 August 2001.

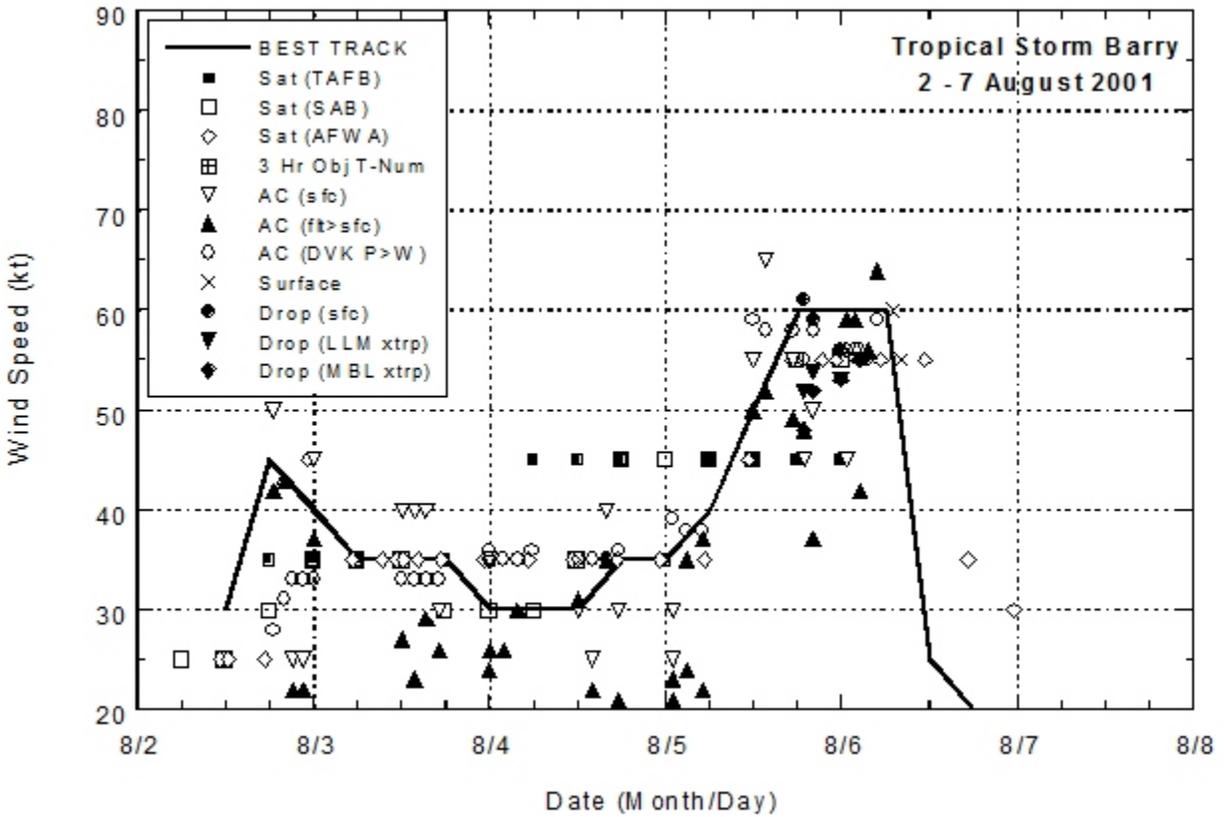


Figure 4. Best track maximum sustained surface wind speed curve for Tropical Storm Barry, 2-7 Aug. 2001, and the observations on which the best track curve is based. Aircraft observations have been adjusted for elevation using 90%, 80%, and 80% reduction factors for observations from 700 mb, 850 mb, and 1500 ft, respectively. Dropwindsonde observations include actual 10 m winds (sfc), as well as surface estimates derived from the mean wind over the lowest 150 m of the wind sounding (LLM), and from the sounding boundary layer mean (MBL).