

Tropical Cyclone Report  
Tropical Storm Cristobal  
5-8 August 2002

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Tropical Storm Cristobal was a relatively weak tropical cyclone that meandered in the western Atlantic prior to being absorbed into a frontal zone.

a. Synoptic History

The origin of Cristobal was non-tropical. On 1 August, a surface trough of low pressure extended from the northern Gulf of Mexico across Florida into the western North Atlantic Ocean. This trough moved little over the next few days, spawning Tropical Storm Bertha in the Gulf of Mexico on 4 August, while a second area of low pressure was also developing within the trough near the South Carolina coast. This second low moved slowly eastward and its associated convection gradually became better organized; by 1800 UTC 5 August, when the low was about 150 n mi east-southeast of Charleston, South Carolina, it had acquired sufficient organization to be considered a tropical depression. The “best track” chart of the tropical cyclone’s path is given in Fig. 1, with the wind and pressure histories shown in Figs. 2 and 3, respectively. The best track positions and intensities are listed in Table 1.

The depression moved slowly south-southeastward over the next day and a half. Development was limited by strong northerly wind shear and a relatively dry environment, and most of the system's convection was confined to the southern portion of the circulation. The surface circulation became elongated in the southwesterly flow in advance of a southward-moving cold front. Nevertheless, a reconnaissance aircraft late on 6 August found that the central pressure had fallen and that the depression had strengthened to a tropical storm. On 7 August, Cristobal began a slow eastward motion as it began to feel some influence of a large mid- to upper-level trough moving off the U. S. east coast. The main convective activity shifted from the south to the southeast, and then to the east quadrant of the circulation by early on 8 August. This reorganization of the convection was accompanied by a modest increase in winds, to 45 kt, although there was apparently no concurrent decrease in central pressure.

On 8 August, with additional dry air moving into the circulation and convection becoming intermittent, Cristobal began a sudden acceleration to the east-northeast, with its forward speed increasing from roughly 3 to 20 kt over a 12 h interval. By 1800 UTC, reconnaissance aircraft reported some difficulty in closing a low-level circulation as Cristobal was becoming absorbed into the frontal zone, about 300 n mi southeast of Cape Hatteras, North Carolina. Satellite imagery suggests that the circulation of Cristobal had dissipated within the frontal zone by 0000 UTC 9 August.

b. Meteorological Statistics

Observations in Cristobal (Figs. 2 and 3) include satellite-based Dvorak technique intensity estimates from the Tropical Analysis and Forecast Branch (TAFB), the Satellite Analysis Branch (SAB) and the U. S. Air Force Weather Agency (AFWA), as well as flight-level observations from flights of the 53<sup>rd</sup> Weather Reconnaissance Squadron of the U. S. Air Force Reserve Command.

Ship reports of winds of tropical storm force associated with Cristobal are given in Table 2. A report from ship DGBE of 43 kt at 1800 6 August is not considered accurate (based on a history of anomalously high wind reports) and is not included in the table. There were no land-based observations of tropical storm force winds. Cristobal was operationally upgraded to a tropical storm based on a reconnaissance flight-level wind report of 48 kt from an altitude of 6300 ft at 2249 UTC 6 August. The strongest flight-level winds, 59 kt (from 1500 ft) were reported during Cristobal's rapid acceleration on 8 August, just before the circulation became lost within the frontal zone.

c. Casualty and Damage Statistics

There were no reports of damage or casualties associated with Cristobal.

d. Forecast and Warning Critique

Official track forecasts (OFCL, Fig. 4) for Cristobal were poor, to the point of being not skillful. Average OFCL errors (with the number of cases in parentheses) for Cristobal were 62 (7), 136 (5), 322 (3), and 632 (1) n mi for the 12, 24, 36, and 48 h forecasts, respectively. These errors are significantly larger than the average OFCL errors for the 10-yr period 1992-2001 (Table 3). The poor official forecasts resulted from a reliance on global model guidance, most notably the Aviation (AVNI), which consistently was too early with the eastward acceleration of the tropical cyclone. While the official forecasts and discussions did correctly conclude that the Aviation model was over-forecasting the acceleration (OFCL errors were considerably smaller than those of AVNI), the extent of this error was not appreciated. The medium BAM (BAMM) performed very well with Cristobal, although the reasons for this are not clear. Part of the failure of models such as the Aviation, GFDL, and UKMET can be attributed to failing to predict the initial southward track of Cristobal, which took the cyclone farther from the strong southwesterly flow ahead of the advancing mid- to upper-level trough. During this period Cristobal was experiencing northerly shear, and nearly all the significant convection was south of the circulation center. One can speculate that some of the southward motion was attributable to cyclone-scale non-advective effects that might be poorly represented in the global models.

Average official intensity errors were 2, 5, 7, and 5 kt for the 12, 24, 36, and 48 h forecasts, respectively. For comparison, the average official intensity errors over the 10-yr period 1992-2001 are 7, 11, 14, and 16 kt, respectively.

Table 1. Best track for Tropical Storm Cristobal, 5-8 August 2002.

Date/Time (UTC)	Latitude (°N)	Longitude (°W)	Pressure (mb)	Wind Speed (kt)	Stage
05 / 1800	32.0	77.2	1008	30	tropical depression
06 / 0000	31.5	77.1	1004	30	"
06 / 0600	31.1	77.0	1004	30	"
06 / 1200	30.7	76.6	1004	30	"
06 / 1800	30.4	76.4	1002	35	tropical storm
07 / 0000	30.1	76.2	999	40	"
07 / 0600	29.7	76.2	999	40	"
07 / 1200	29.4	76.0	999	40	"
07 / 1800	29.7	75.7	1000	40	"
08 / 0000	29.7	75.3	1000	45	"
08 / 0600	29.7	74.9	1000	45	"
08 / 1200	29.9	74.0	1003	45	"
08 / 1800	31.0	72.0	1008	45	"
09 / 0000					absorbed into frontal zone
08 / 0000 - 1800			1000 - 1008	45	maximum wind
07 / 0000 - 1200			999	40	minimum pressure

Table 2. Selected ship reports with winds of at least 34 kt for Tropical Storm Cristobal, 5-8 August 2002.

Date/Time (UTC)	Ship call sign	Latitude (°N)	Longitude (°W)	Wind dir/speed (kt)	Pressure (mb)
7 / 0000	KCKB	28.6	74.4	180/34	1010.1
7 / 0900	WUQL	28.5	74.9	220/34	1006.4
7 / 1200	WUQL	27.7	74.9	240/41	1009.5

Table 3. Preliminary forecast evaluation (heterogeneous sample) for Tropical Storm Cristobal, 5-8 August 2002. Forecast errors for tropical storm and hurricane stages (n mi) are followed by the number of forecasts in parentheses. Errors smaller than the NHC official forecast are shown in bold-face type. Models identified with an asterisk are not available in time to meet forecast deadlines.

Forecast Technique	Forecast Period (h)				
	12	24	36	48	72
CLP5	63 ( 7)	<b>93 ( 5)</b>	<b>164 ( 3)</b>	<b>175 ( 1)</b>	
GFDI	98 ( 7)	249 ( 5)	541 ( 3)	776 ( 1)	
GFDL *	74 ( 7)	193 ( 5)	387 ( 3)	752 ( 1)	
GFNI	<b>44 ( 7)</b>	<b>112 ( 5)</b>	348 ( 3)	<b>382 ( 1)</b>	
LBAR	<b>44 ( 7)</b>	<b>76 ( 5)</b>	<b>206 ( 3)</b>	<b>377 ( 1)</b>	
AVNI	141 ( 6)	311 ( 5)	452 ( 3)	<b>533 ( 1)</b>	
AVNO *	81 ( 7)	250 ( 4)	486 ( 2)		
BAMD	<b>57 ( 7)</b>	<b>87 ( 5)</b>	<b>161 ( 3)</b>	<b>234 ( 1)</b>	
BAMM	<b>40 ( 7)</b>	<b>59 ( 5)</b>	<b>159 ( 3)</b>	<b>164 ( 1)</b>	
BAMS	<b>53 ( 7)</b>	<b>95 ( 5)</b>	<b>188 ( 3)</b>	<b>277 ( 1)</b>	
NGPI	<b>60 ( 7)</b>	145 ( 5)	<b>309 ( 3)</b>	<b>505 ( 1)</b>	
NGPS *	<b>61 ( 7)</b>	<b>117 ( 5)</b>	<b>241 ( 3)</b>	<b>439 ( 1)</b>	
UKMI	<b>47 ( 7)</b>	142 ( 5)	365 ( 3)	635 ( 1)	
UKM *	<b>29 ( 3)</b>	<b>65 ( 2)</b>	<b>316 ( 1)</b>		
A98E	<b>61 ( 7)</b>	<b>81 ( 5)</b>	<b>107 ( 3)</b>	<b>117 ( 1)</b>	
A9UK	<b>58 ( 3)</b>	<b>54 ( 2)</b>	<b>94 ( 1)</b>		
GUNS	67 ( 7)	178 ( 5)	406 ( 3)	633 ( 1)	
GUNA	88 ( 6)	211 ( 5)	416 ( 3)	<b>597 ( 1)</b>	
OFCL	62 ( 7)	136 ( 5)	322 ( 3)	632 ( 1)	
NHC Official (1992-2001 mean)	43 (2199)	81 (1965)	115 (1759)	148 (1580)	222 (1272)

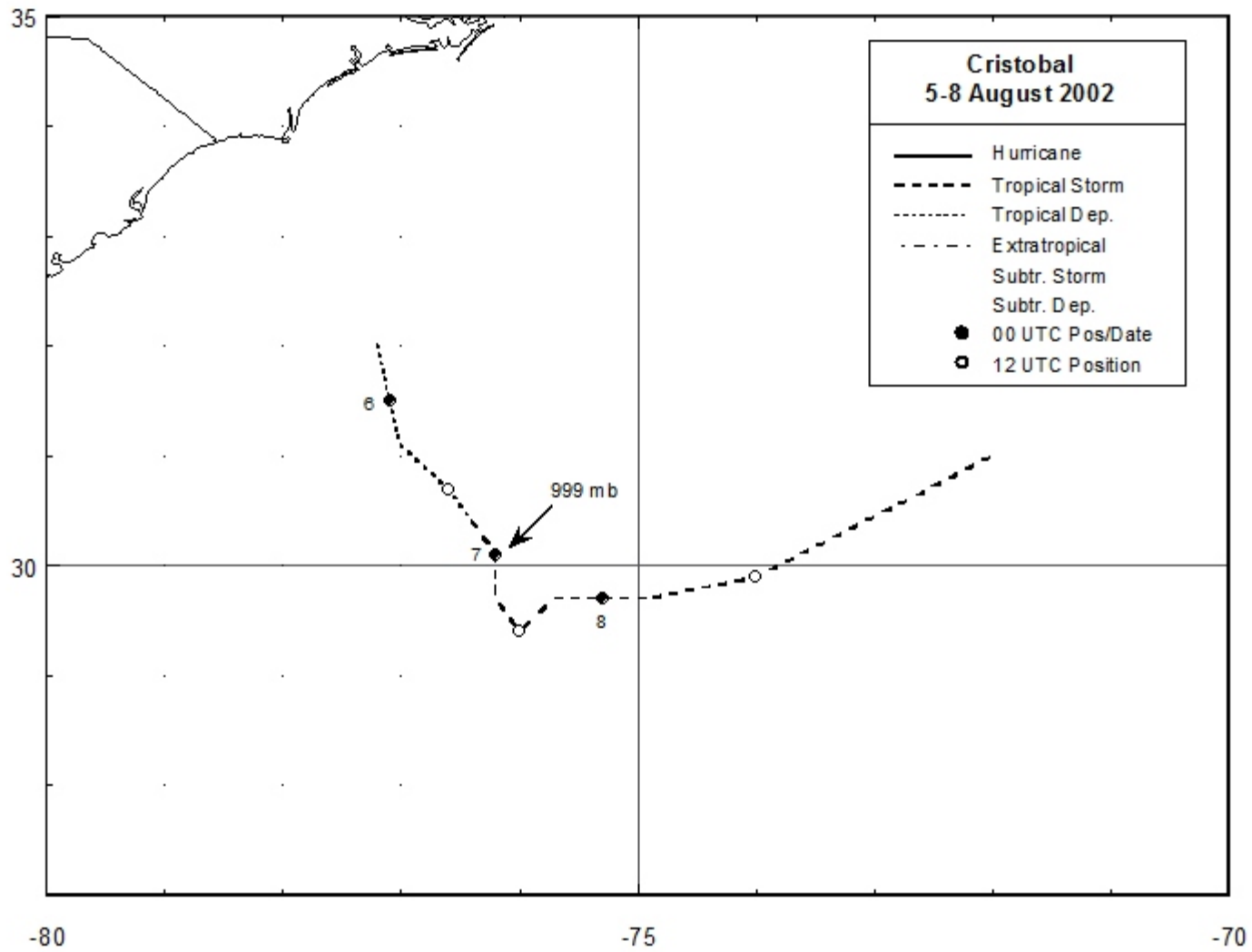


Figure 1. Best track positions for Tropical Storm Cristobal, 5-8 August 2002.

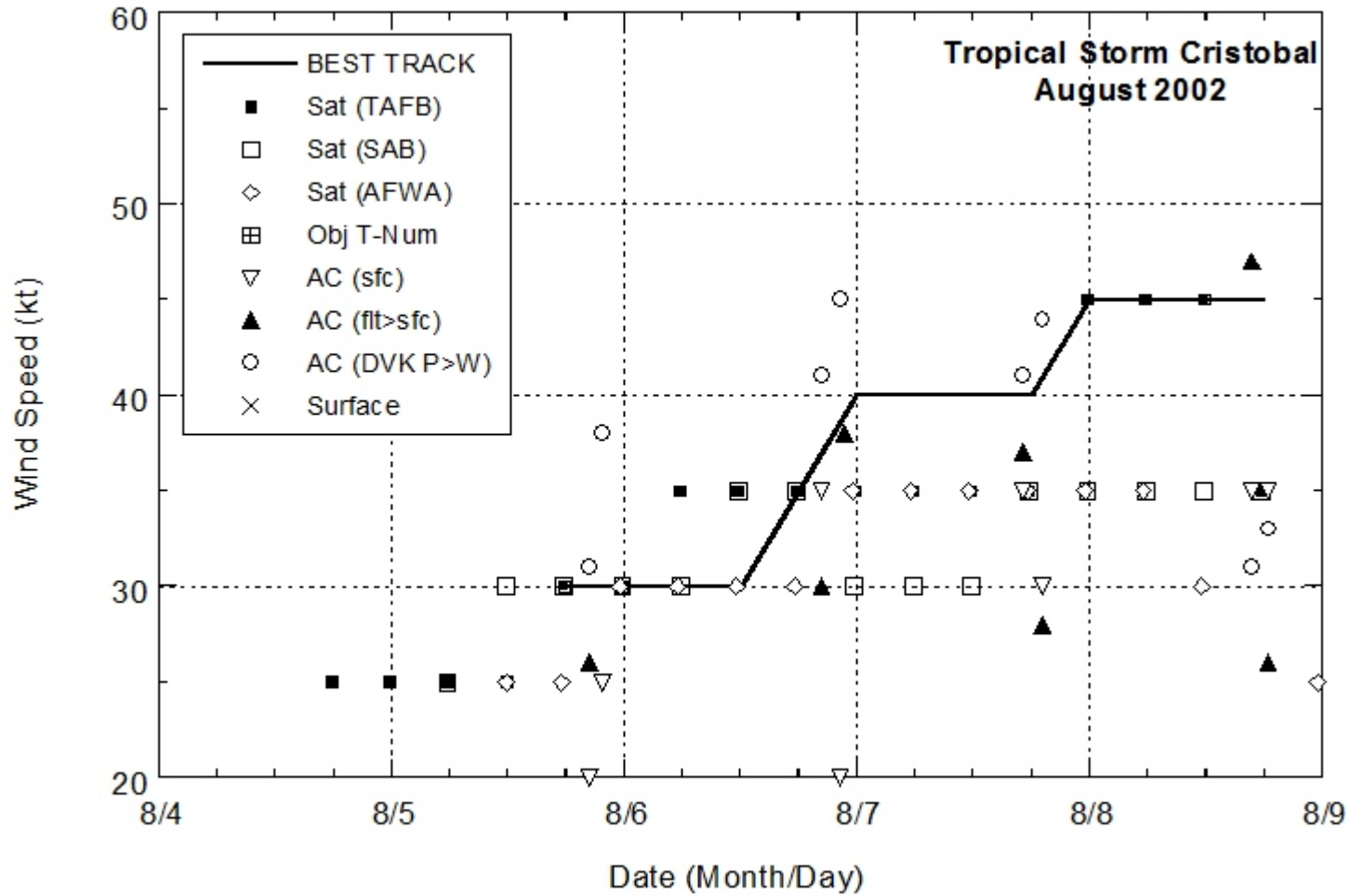


Figure 2. Selected wind observations and best track maximum sustained surface wind speed curve for Tropical Storm Cristobal, 5-8 August 2002. Aircraft observations have been adjusted for elevation using 90%, 80%, and 80% reduction factors for observations from 700 mb, 850 mb, and 1500 ft, respectively.

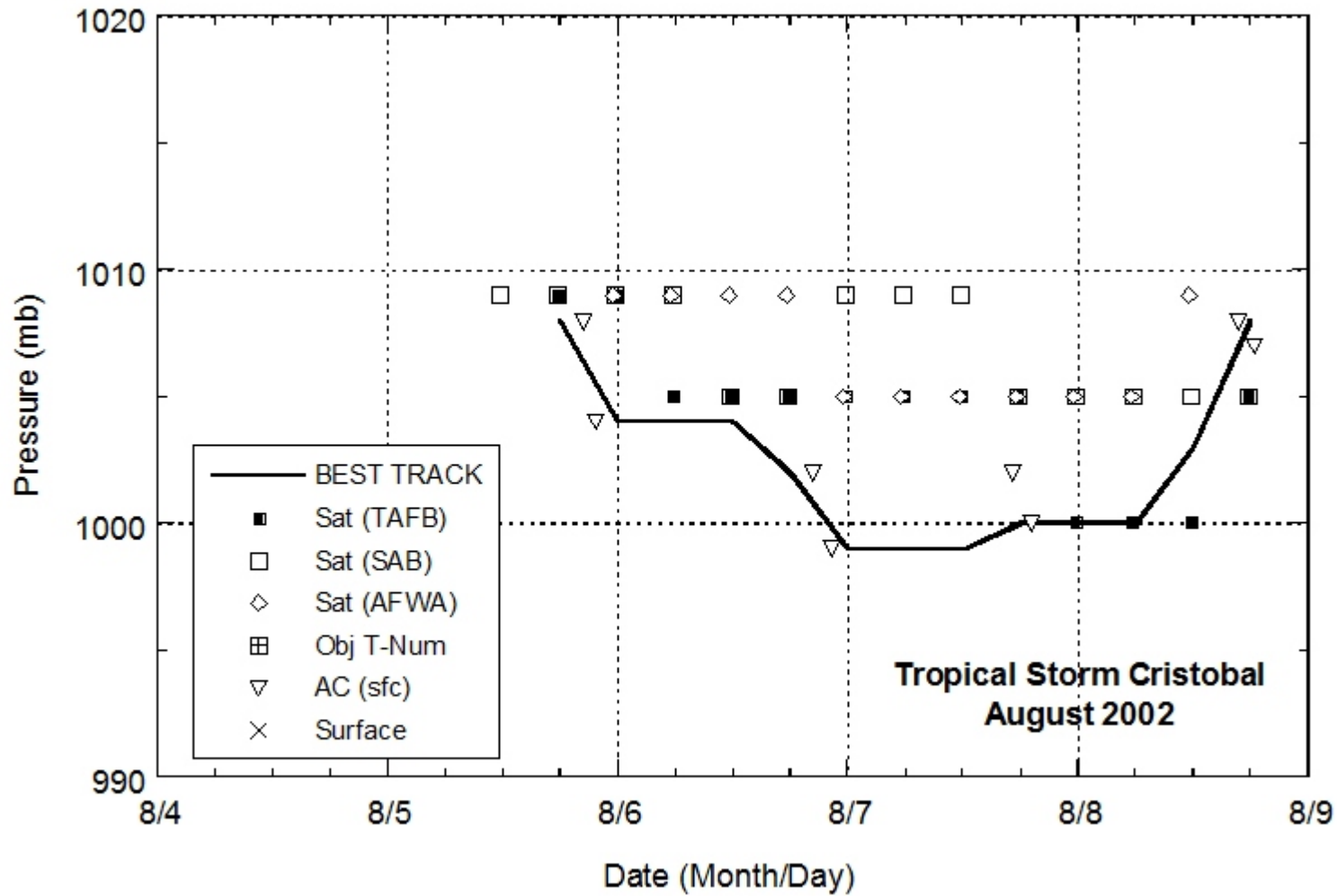


Figure 3. Selected pressure observations and best track minimum central pressure curve for Tropical Storm Cristobal, 5-8 August 2002.



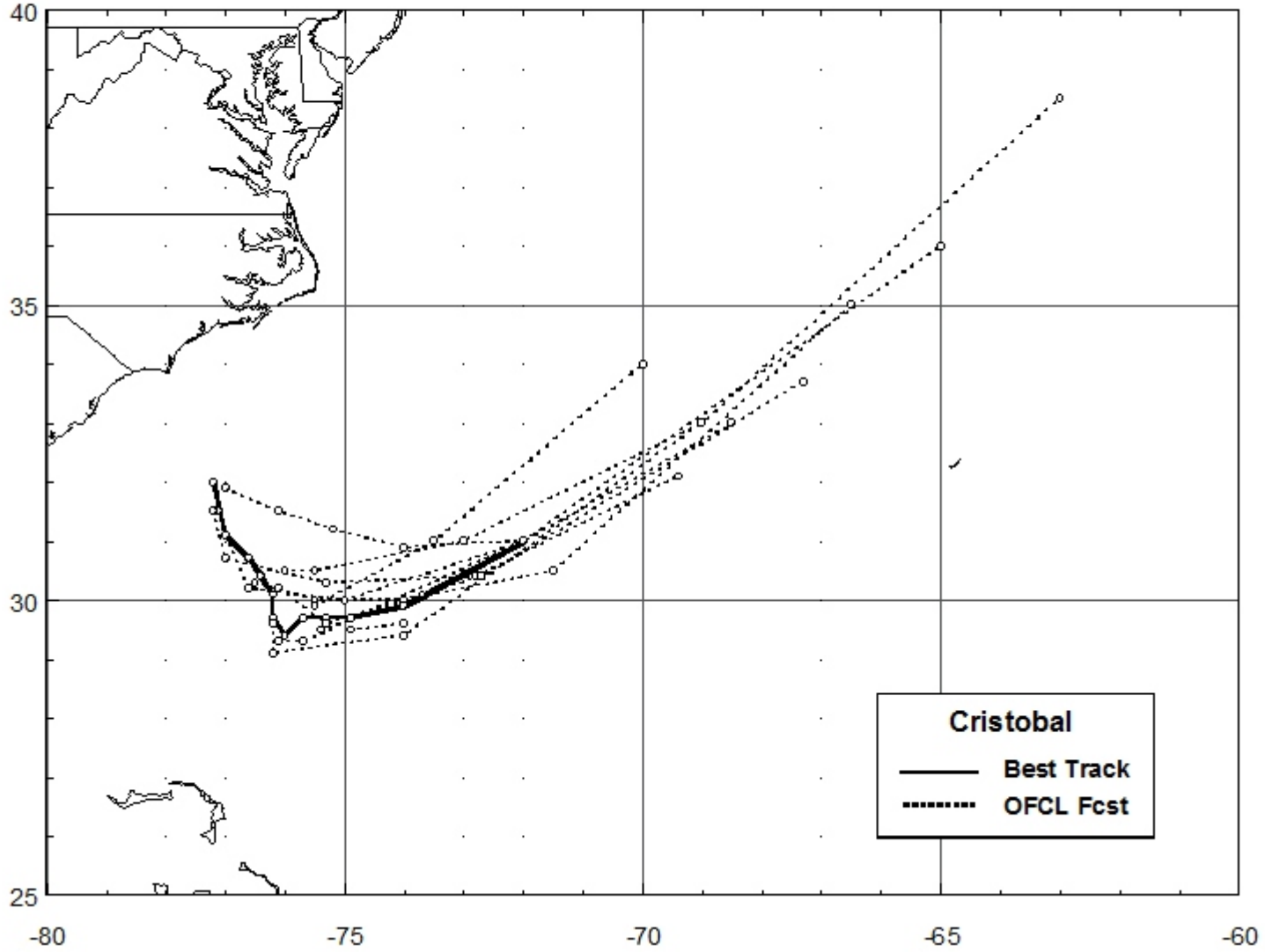


Figure 4. Official track forecasts (dashed lines, with 0, 12, 24, 36, 48, and 72 h positions indicated) for Tropical Storm Cristobal, 5-8 August 2022 (including depression stage, but excluding forecasts verifying after Cristobal was absorbed). The best track is given by the thick solid line with positions given at 6 h intervals.