

Preliminary Report  
Tropical Storm Arlene  
11-18 June 1999

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7 July 1999

Arlene, the first tropical storm of the 1999 Atlantic hurricane season, spent its life at sea in the central Atlantic. Arlene passed roughly 100 n mi east of Bermuda, but did not bring tropical storm force winds to the islands.

a. Synoptic History

During its initial stages of development Arlene was not a purely tropical system. Although initially cold-core, by the time depression status had been attained on 11 June, the overall structure more-closely resembled a tropical, rather than a subtropical cyclone. At some (unknown) point, the system became warm-core, as revealed by reconnaissance data on the 15<sup>th</sup>.

Arlene's complex development can be traced to a mid- to upper-level cold low that developed near the tail end of a diffuse front in the central Atlantic. Water-vapor imagery first showed the circulation of the upper low a few-hundred miles north of Puerto Rico late on 8 June. Simultaneously, a fairly large-amplitude tropical wave passed through the tail end of the frontal zone southeast of the upper low, and a low-level cloud swirl became visible near 22°N, 61°W, close to the wave axis, and southeast of the upper low. The low-level cloud swirl then moved slowly north-westward over the next two days without development due to westerly shear from the upper low.

Throughout this period, fairly steady convection had been maintained in the diffluence region to the east of the upper low. By 0600 UTC on the 10<sup>th</sup>, the low-level circulation moved underneath the cold low, near 24°N, 63°W. Shortly thereafter, the upper low began to move off to the east into the convective area. As the upper low accelerated northeastward late on the 10<sup>th</sup>, satellite microwave imagery revealed the rapid downward development of a vortex in the convection, which led to the formation of a new low-level center. During the morning of the 11<sup>th</sup>, the convection acquired a well-defined banding pattern, and it is estimated that a tropical depression formed at 1800 UTC on the 11<sup>th</sup>, about 465 n mi southeast of Bermuda. The original low-level cloud swirl continued moving away to the west and gradually dissipated.

The best track locations and intensities for Arlene are given in Table 1, with the track plotted in Figure 1. Almost immediately after reaching depression status, the cyclone slowed and began a northward drift for 24 h. By 1200 UTC on the 12<sup>th</sup>, Dvorak satellite classifications from the Tropical Analysis and Forecast Branch (TAFB) of the Tropical Prediction Center and the NOAA/NESDIS Satellite Analysis Branch (SAB) indicated that tropical storm strength had been attained. Arlene intensified for 12 h until westerly shear began to expose the low-level circulation center. The

maximum intensity was reached at 0000 UTC on the 13<sup>th</sup>, when the winds were estimated to be 50 kt and the minimum central pressure was estimated to be 1006 mb. From the 13<sup>th</sup> to the 15<sup>th</sup>, Arlene moved generally west-northwestward while weakening slightly under the westerly shear.

Steering currents became poorly defined and Arlene moved little on the 15<sup>th</sup>. The best track indicates that Arlene executed a small cyclonic loop, although this apparent motion may have been due a reformation of the center closer to the convection on the east side of the cyclone. A northwesterly motion resumed late on the 15<sup>th</sup>, followed by a gradual turn to the north then northeast over the next three days as Arlene moved around the western edge of the subtropical ridge. Arlene's closest approach to land was at 0600 on the 17<sup>th</sup>, when the cyclone passed about 100 n mi to the east of Bermuda. Convection began to diminish on the 16<sup>th</sup> as the environmental shear changed to northeasterly and Arlene moved over cooler waters. Synoptic-scale upper-level confluence and subsidence in the immediate environment of Arlene also acted to suppress convection. The low-level circulation weakened to depression status at 0000 UTC on the 17<sup>th</sup>, and dissipated ahead of an approaching frontal zone on the 18<sup>th</sup>.

#### b. Meteorological Statistics

Figures 2 and 3 show the best track curves of maximum sustained surface wind (defined as a 1 min average at an elevation of 10 m) and minimum central pressure, respectively, as well as the observations on which the best track estimates are based. There were no direct measurements of surface winds; the best track values are based on interpretation of Dvorak satellite classifications from TAFB, SAB, and the Air Force Weather Agency (indicated by AFGWC in figure legends), as well as reductions of (mostly near 1000 ft) flight-level reconnaissance winds.

There was only a limited amount of *in-situ* aircraft reconnaissance data from the Air Force Reserve Hurricane Hunter Squadron, from 1200 UTC on the 15<sup>th</sup> to 0000 UTC on the 17<sup>th</sup>. The maximum winds from the reconnaissance aircraft were observed from 15/1200-16/0600 UTC, when the surface winds were estimated to be 45 kt (Figure 2). As is typical for storms in the subtropics, central pressures measured by reconnaissance were somewhat higher than satellite-based estimates (Figure 3). Arlene's minimum central pressure is estimated from satellite imagery and ship reports to be 1006 mb at 13/0000 UTC, although the lowest pressure measured by aircraft reconnaissance was 1008 mb at 15/1200 UTC.

There are no known ship or land reports of winds in excess of 34 kt associated with Arlene.

#### c. Casualty and Damage Statistics

There have been no reports of casualties or damage from Arlene.

#### d. Forecast and Warning Critique

Official forecast track errors for Arlene were 30, 55, 89, 101, and 99 n mi, for the 12, 24, 36, 48, and 72 h forecasts, respectively. These errors are 30%-60% lower than the average official Atlantic basin errors for the period 1989-1998. Early forecasts did not capture the sharp turn to west. The recurvature path was fairly well forecast, although there was a slight westward bias (in the direction of Bermuda).

Arlene's intensity was generally overforecast, but with errors comparable to the 1990-1997 period average. Arlene was briefly forecast to become a hurricane. Intensity forecast errors during the second half of Arlene's track were very low.

Tropical storm watches and warnings (Table 2) were issued for Bermuda; however, Arlene passed sufficiently far to the east that no significant weather affected the islands.

Table 1. Best track for Tropical Storm Arlene, 11-18 June 1999.

Date/Time (UTC)	Latitude (°N)	Longitude (°W)	Pressure (mb)	Wind Speed (kt)	Stage
11/1800	27.1	58.1	1010	30	tropical depression
12/0000	27.7	57.4	1010	30	“
12/0600	28.1	57.3	1010	30	“
12/1200	28.3	57.3	1009	35	tropical storm
12/1800	28.5	57.4	1008	45	“
13/0000	28.8	57.5	1006	50	“
13/0600	29.0	57.8	1006	50	“
13/1200	29.1	58.2	1007	50	“
13/1800	29.1	58.7	1007	50	“
14/0000	29.1	59.2	1008	45	“
14/0600	29.2	59.8	1009	40	“
14/1200	29.3	60.4	1009	40	“
14/1800	29.6	60.7	1009	40	“
15/0000	29.8	61.1	1009	40	“
15/0600	29.7	61.5	1009	40	“
15/1200	29.6	61.3	1008	45	“
15/1800	29.9	61.4	1009	45	“
16/0000	30.0	61.7	1009	45	“
16/0600	30.3	62.0	1010	45	“
16/1200	30.8	62.3	1012	40	“
16/1800	31.3	62.5	1012	35	“
17/0000	31.8	62.8	1014	30	tropical depression
17/0600	32.5	63.0	1015	30	“
17/1200	33.4	63.0	1015	30	“
17/1800	34.4	62.3	1015	30	“
18/0000	35.4	61.6	1015	25	“
13/0000	28.8	57.5	1006	50	minimum pressure

Table 2. Watch and warning summary for Tropical Storm Arlene, June 1999.

Date/Time (UTC)	Action	Location
14/1500	tropical storm watch issued	Bermuda
16/0600	tropical storm warning issued	Bermuda
17/0900	tropical storm warning discontinued	Bermuda

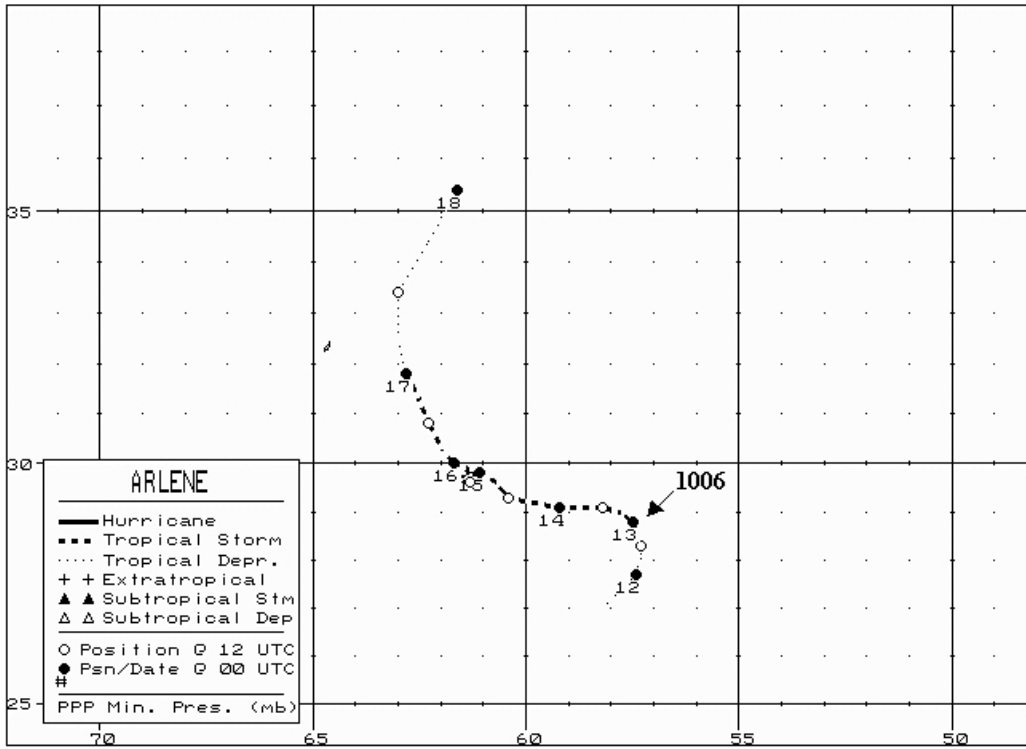


Figure 1. Best track positions for Tropical Storm Arlene, 11-18 June 1999.

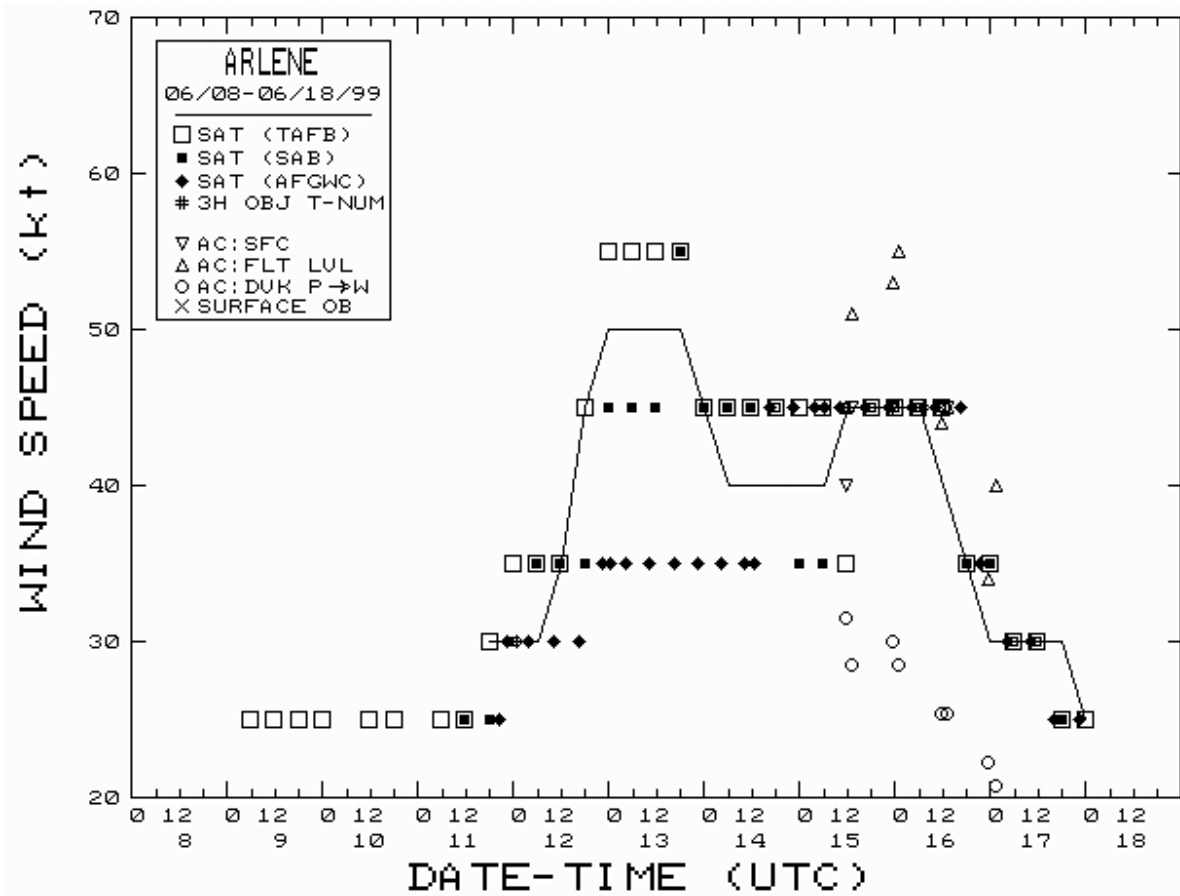


Figure 2. Best track maximum sustained wind speed curve for Tropical Storm Arlene.

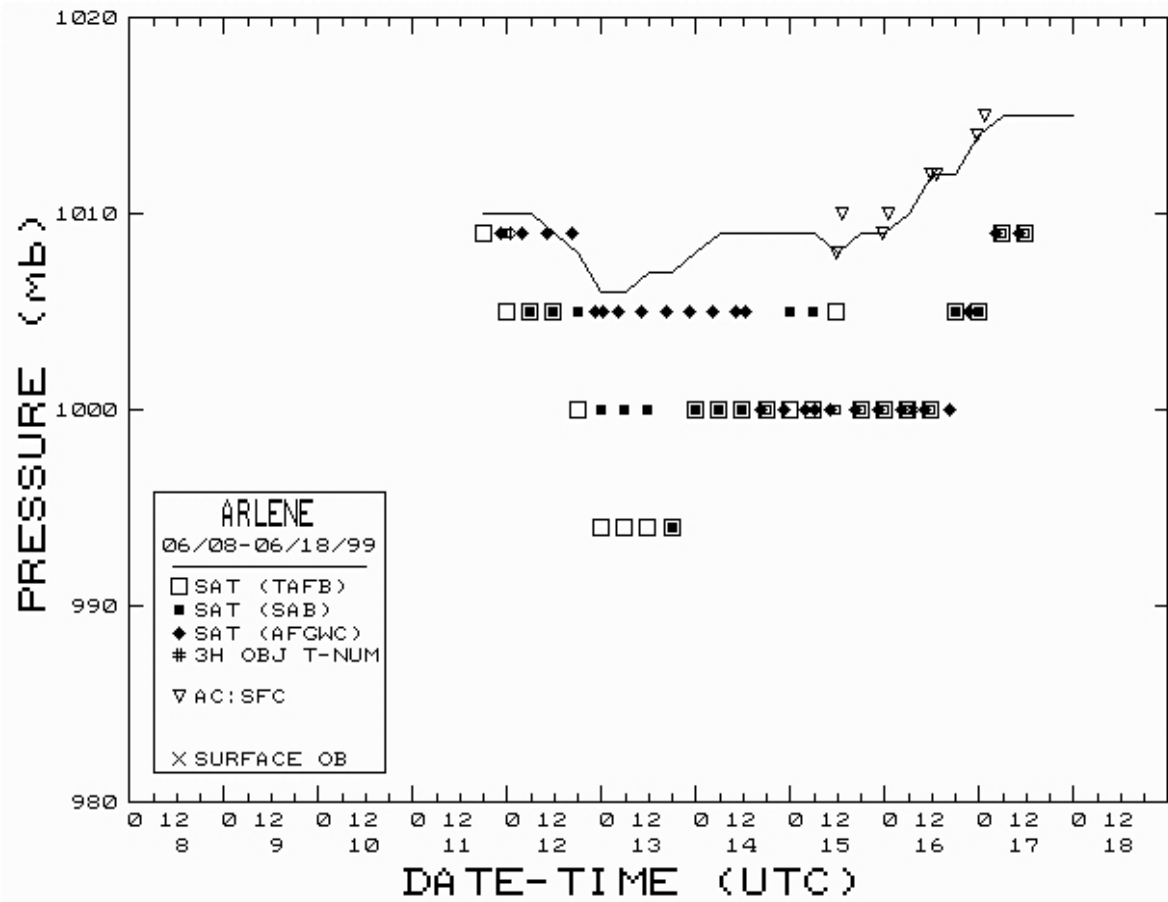


Figure 3. Best track minimum central pressure curve for Tropical Storm Arlene.