

Preliminary Report
Hurricane Karl
23 - 28 September 1998

Max Mayfield
National Hurricane Center
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Hurricane Karl was one of four hurricanes in existence over the Atlantic basin at one time. It remained over water without any direct effects to land.

a. Synoptic History

Hurricane Karl developed from a small low of non-tropical origin that was tracked from the coast of the Carolinas beginning on 21 September. Deep convection became better organized as the low moved eastward and the “best track” indicates that a tropical depression formed from the disturbance near 1200 UTC 23 September while centered about 50 n mi west-northwest of Bermuda (Fig. 1 and Table 1). Convective banding increased and the system became Tropical Storm Karl that evening. The tropical cyclone began moving east-southeastward about this time.

Satellite imagery showed the gradual development of a more symmetrical cloud pattern with the center becoming embedded within the coldest convective tops. Karl became a hurricane near 1200 UTC 25 September while centered about 550 n mi east-southeast of Bermuda. At this time, Hurricane Georges was over the Straits of Florida, Hurricane Ivan was over the North Atlantic about 500 n mi west-southwest of the Azores, and Hurricane Jeanne was over the tropical Atlantic about midway between Africa and the Lesser Antilles. Thus, Karl became the fourth hurricane to co-exist over the Atlantic. According to records at the NHC, the last time four hurricanes were in existence in the Atlantic at the same time was on August 22, 1893. Records also note that on September 11, 1961, three hurricanes and possibly a fourth existed.

Karl began to move toward the northeast in response to a large mid- to upper-level trough to the west of the hurricane. A well-defined eye developed and it is estimated that Karl first reached a maximum intensity of 90 knots at 0000 UTC 27 September while centered about 875 n mi east-northeast of Bermuda. The eye remained distinct for at least six hours, after which time the hurricane started to weaken primarily due to increasing upper-level shear.

The hurricane accelerated toward the northeast and weakened to a tropical storm by 0000 UTC 28 September while centered over 23°C water about 175 n mi west-northwest of the westernmost Azores. Karl continued moving over increasingly cooler waters and became extratropical later on the 28th as the circulation center became well removed from any deep convection. The extratropical cyclone was tracked to south of Ireland by late on the 29th.

b. Meteorological Statistics

Figures 2 and 3 show the curves of minimum central pressure and maximum one-minute wind speed, respectively, versus time, along with the observations on which they are based. As usual for a tropical cyclone not threatening land, satellites provided the primary source of observational data. Dvorak technique location and intensity estimates from the satellite data were produced by the Air Force Weather Agency (AFGWC in figures), the NOAA Synoptic Analysis Branch (SAB) and the NOAA Tropical Analysis and Forecast Branch (TAFB). The highest official Dvorak T number was 5.0 (90 knots) from TAFB and SAB near 0000 and 0600 UTC 27 and is the basis for estimating the peak intensity near these times.

c. Casualty and Damage Statistics

There were no reports of casualties or damage from Karl received at the NHC.

d. Forecast and Warning Critique

The NHC average official track forecast errors for Karl (excluding the tropical depression and extratropical stages) were 66 (15 cases), 138 (13 cases), 187 (11 cases), 229 (9 cases) and 472 n mi (5 cases), respectively, for the 12-, 24-, 36-, 48- and 72-hour forecast periods. These were all larger than the 1988-1997 average errors of 47, 88, 127, 166 and 248 n mi for the same time periods. The NHC average official track forecast errors were similar to the averages from the operationally available track prediction models through 48 hours. No meaningful comparisons can be made at 72 hours given the limited number of cases available. The guidance models properly indicated the observed increase in forward speed toward the northeast, but varied considerably on the rate of this acceleration.

The NHC official intensity forecasts showed a distinct negative bias (i.e., intensity was underestimated). The largest intensity forecast error occurred 72 hours prior to

peak intensity and was 45 knots too low. Early official forecasts did not anticipate significant intensification due to a predicted increase in vertical shear.

Watches and warnings were neither issued nor necessary for Karl.

Table 1. Best track, Hurricane Karl, 23 - 28 September, 1998.

Date/Time (UTC)	Position		Pressure (mb)	Wind Speed (kt)	Stage
	Lat. (°N)	Lon. (°W)			
23/1200	33.3	65.4	1003	25	tropical depression
1800	33.2	62.8	1003	30	“
24/0000	33.2	60.7	1003	35	tropical storm
0600	32.9	59.2	1002	35	“
1200	32.5	58.1	1001	40	“
1800	32.0	57.2	1000	45	“
25/0000	31.4	56.2	998	50	“
0600	30.8	55.1	994	55	“
1200	30.4	54.0	987	65	hurricane
1800	30.3	52.9	984	70	“
26/0000	30.5	51.8	981	75	“
0600	31.1	51.0	979	75	“
1200	31.8	49.9	977	75	“
1800	32.6	48.8	973	80	“
27/0000	33.9	47.3	970	90	“
0600	35.5	45.2	970	90	“
1200	37.4	42.5	973	80	“
1800	39.1	39.0	983	70	“
28/0000	40.4	34.7	994	55	tropical storm
0600	41.5	30.0	1001	40	extratropical
1200	42.0	25.0	1002	35	“
1800	43.0	20.0	1000	35	“
29/0000	46.0	16.0	996	35	“
0600	48.0	14.0	994	35	“
1200	49.0	11.0	994	35	“
1800	49.0	8.0	991	35	“
27/0000	33.9	47.3	970	90	minimum pressure
27/0600	35.5	45.2	970	90	minimum pressure

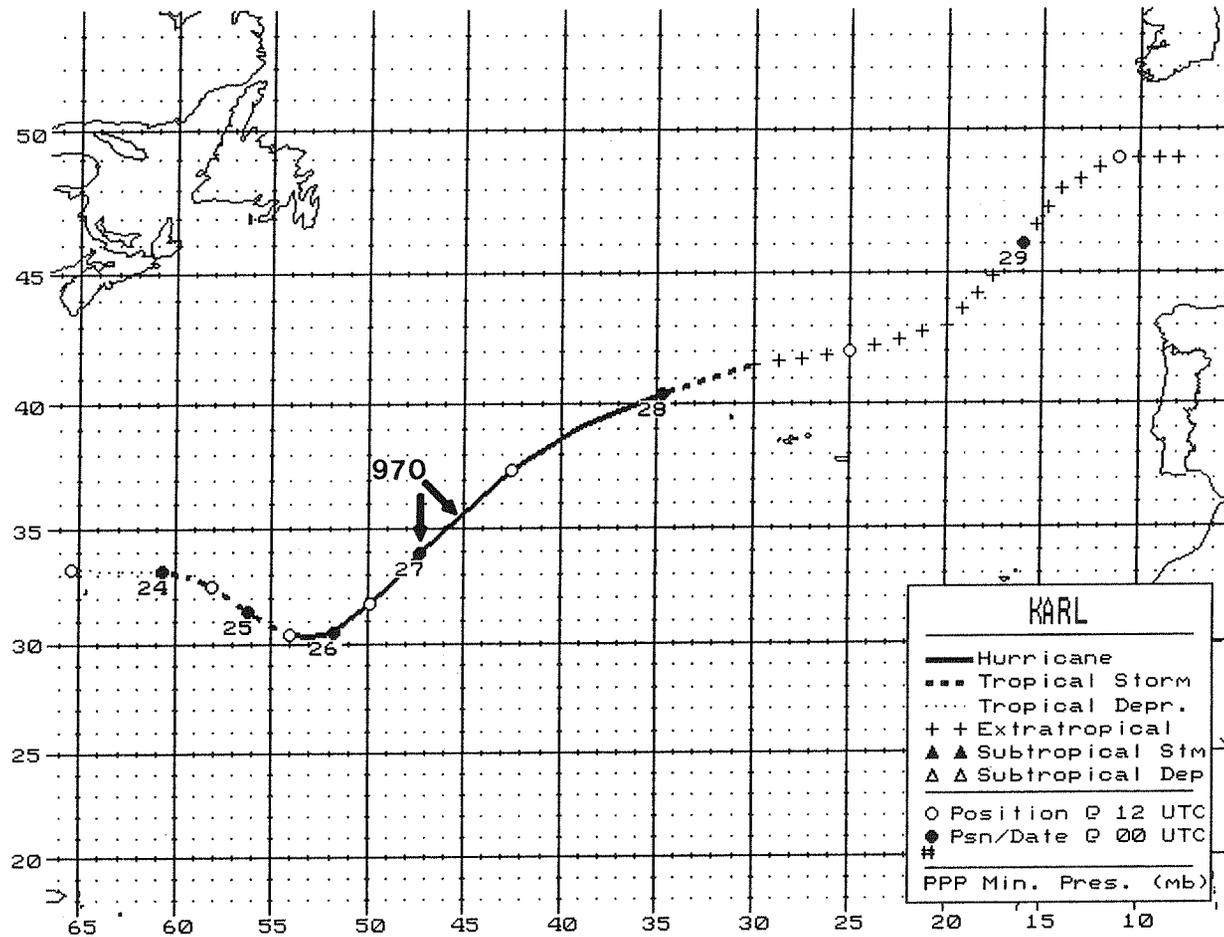


Figure 1. Best track positions for Hurricane Karl, 23 - 28 September 1998.

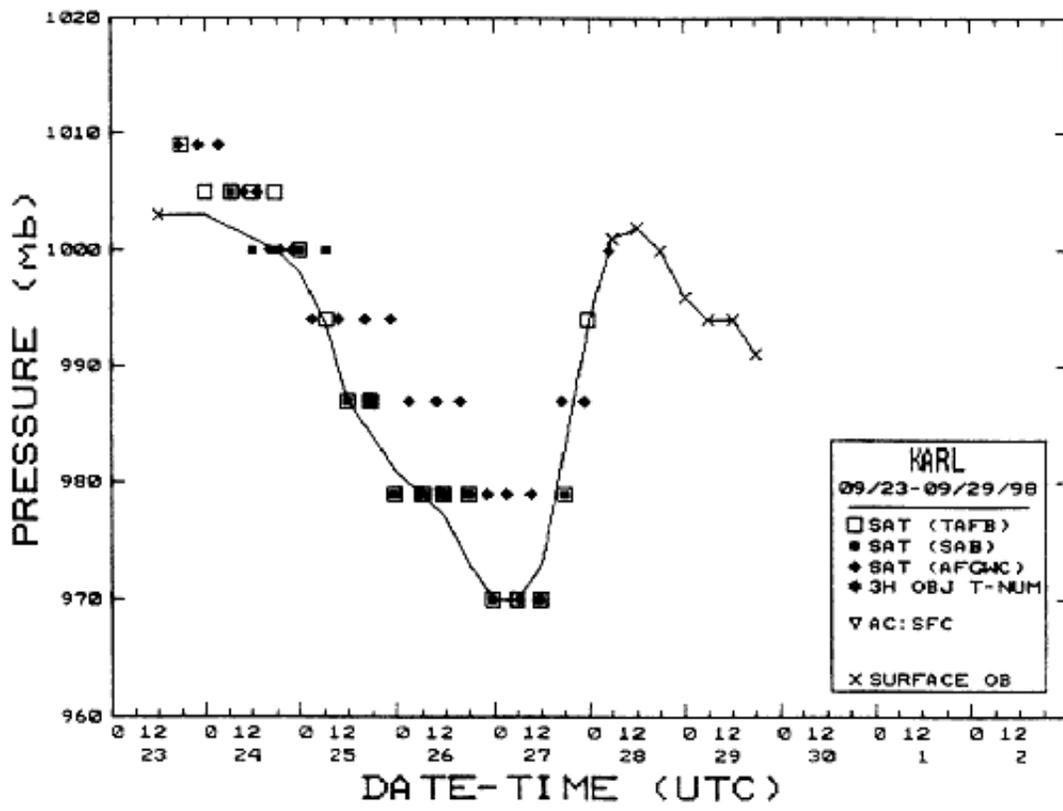


Figure 2. Best track minimum central pressure curve for Hurricane Karl.

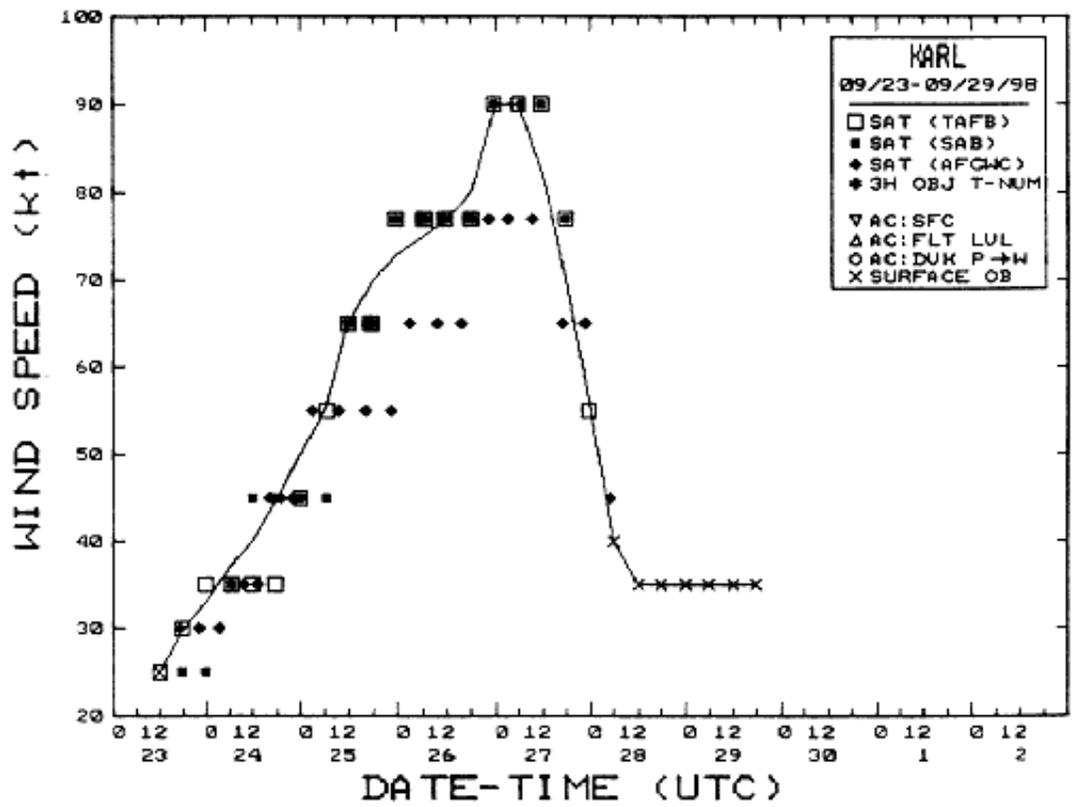


Figure 3. Best track maximum sustained wind speed curve for Hurricane Karl.