

Preliminary Report
Hurricane Gabrielle
30 August - 13 September

a. Synoptic history

Hurricane Gabrielle was a classic Cape-Verde-type tropical cyclone. It developed from an African wave near the Cape Verde Islands, tracked westward across the tropical Atlantic while strengthening to a large category four hurricane on the Saffir/Simpson Hurricane Scale and made the typical parabolic recurvature into the northern North Atlantic. Table 1 contains the six-hourly positions by latitude and longitude, along with the lowest sea-level pressure, maximum winds and tropical cyclone stage. Figure 1 shows the track of Gabrielle, indicating the 0000 UTC and 1200 UTC positions.

The tropical wave which became Gabrielle moved off the coast of Africa on 28 August immediately following the wave which developed into Felix. However the wave associated with Gabrielle was located further to the south than Felix and tracked westward. The wave was well organized with a moderate amount of convection and didn't take long to develop into the tenth tropical depression of the season. Based upon two ship reports at 1200 UTC 30 August (UQYC located near latitude 14.3N, longitude 20.9W with northeast winds of 30 knots in showers and UJTG located near latitude 8.7N, longitude 22.7W with southwest winds of 15 knots), the wave likely became a tropical depression near 1200 UTC on 30 August.

Even though Tropical Depression Ten was located within a thousand miles to the southeast of Tropical Storm Felix, the depression tracked toward the west as high pressure ridging from the northeast built a wedge between the two systems.

A distinct outflow pattern at the 200-millibar level provided ventilation for the budding storm and, based upon satellite imagery from the European Meteosat, the depression was upgraded to Tropical Storm Gabrielle at 0000 UTC 31 August. By 1200 UTC the storm had already become rather large and well developed. A ship of unknown identity located about 180 n mi south of the storm reported 35-knot winds with a pressure of 1008.1 millibars while the upper-air sounding from Sal in the Cape Verde Islands located about 450 n mi to the northeast of Gabrielle's center reported east southeast winds of 50 knots at the 700-millibar level.

Gabrielle tracked toward the west northwest for the next several days and strengthened to a category four hurricane by 3 September. Meanwhile, the ridge of high pressure which had built westward to the north of Gabrielle continued to form a wedge of high pressure between Gabrielle and Felix. By 0000 UTC 4 September a major trough extended from just east of the Canadian Maritimes southwestward to the Georgia-Florida border. By 0600 UTC 5 September a wave developed on the surface trough which created

pressure falls to the northwest of Gabrielle and the hurricane turned to the northwest in response to a change in the steering flow associated with the weakness. Gabrielle passed to the northeast of the northeastern Caribbean islands. During this same period of time Felix, located about a thousand miles to the north northeast of Gabrielle began to strengthen to hurricane force. Felix's strengthening weakened the high pressure between the two hurricanes and Gabrielle turned toward the north.

Gabrielle continued moving toward the north for the next several days in response to a very broad north-south oriented trough which covered most of the western North Atlantic. By 10 September Gabrielle became nearly stationary about 475 n mi east southeast of Cape Cod, Massachusetts. Located in the center of a broad trough with the westerly jet stream well to the north, the weakening hurricane drifted slowly westward and weakened to tropical storm strength on the 10th and to a depression on the 11th.

On 12 September another frontal trough moving off the northeastern U.S. coast turned Gabrielle toward the northeast. By 13 September the depression lost most of its tropical characteristics as it merged with a developing North Atlantic storm off Newfoundland.

b. Meteorological statistics

Based upon satellite imagery, Gabrielle had strengthened to 960 millibars with estimated winds of 102 knots by 1800 UTC 3 September. The first reconnaissance aircraft arrived in the hurricane at 1820 UTC and found a central pressure of 937 millibars by extrapolation from a flight level of 1500 feet. Shortly thereafter, at 2046 UTC, the NOAA reconnaissance aircraft determined the hurricane's minimum pressure to be 935 millibars by extrapolation from the 700-millibar level. Strongest winds measured by the NOAA aircraft at this time were 105 knots. By 0525 UTC on 4 September the central pressure rose to 940 millibars and strongest measured winds remained near 105 knots. The next reconnaissance plane into the hurricane on the afternoon of 4 September measured center pressures of 942 to 944 millibars and strongest 700-millibar flight-level winds of 132 knots. Maximum flight-level winds measured in the hurricane were 139 knots at the 700-millibar level at 2258 UTC 05 September with a central pressure of 943 millibars.

An examination of the data suggests that the strongest winds in Hurricane Gabrielle did not occur simultaneously with the lowest central pressure. The reasoning for this is not fully understood. The NOAA reconnaissance aircraft may not have flown into the areas of maximum winds when the central pressure was 935 millibars, or due to the concentric banding that was occurring during this period the pressure gradient may not have been as strong as the gradient that developed the following day. Since rapid intensification

seemed to occur during the 12 hours prior to the plane's arrival, it is possible that the wind field had not had time to adjust to the rapidly-changing pressure gradient. Figures 2 and 3 show the curves of central surface pressure and maximum one-minute surface wind speed versus time, respectively, along with the satellite and reconnaissance aircraft data upon which these curves are based.

Gabrielle was a very large hurricane. The eye diameter never decreased to less than 20 n mi and the majority of the time while the hurricane was most intense the eye diameter ranged from 40 to 50 n mi. Hurricane-force winds frequently extended outward from the hurricane's center in excess of 100 n mi and 100-knot winds at flight level occasionally extended outward to near 100 n mi. Figure 4 shows both the extent of the winds and the uniformity of hurricane-force winds in all quadrants of the hurricane. Gabrielle's powerful winds covered a very large area of the ocean and generated large ocean swells which pounded the shores of the northeastern Caribbean islands as well as Bermuda and the North American mainland from central Florida to the Canadian Maritimes. Swells ranged from 10 to 15 feet along portions of the U.S. east coast and were as high as 20 to 30 feet along the south coast of Nova Scotia.

c. Casualty and damage statistics

The large swells from Hurricane Gabrielle were responsible for deaths along the mid-Atlantic and New England coasts. Accidents, ranging from people being swept from jetties while watching the large swells to boats capsizing while trying to enter or leave inlets, claimed a total of eight lives. Deaths included two in Massachusetts, four in New York, one in Maine and one in New Jersey.

No estimate of damage from Gabrielle was available at this writing.

d. Critique

Various models did well at different points along the hurricane track. From 31 August through 2 September while Gabrielle was deep in the tropics moving on a westerly course, Cliper did an excellent job. During the first critical time period when Gabrielle made its turn toward the north, BAM was the best model to forecast the turn. However, since BAM and several of the dynamic models had performed so poorly the previous several days, forecasters were reluctant to follow BAM's guidance. Forecasters had to be certain of their forecast since the results of prematurely turning the hurricane northward away from the northeastern Caribbean islands could have been quite disastrous. The QLM was the first model to indicate that the observed decrease in forward speed might occur during 10 September. However, none of the models did well beyond that point in time. The NHC 83

consistently forecast Gabrielle to move toward the northeast and BAM forecast the hurricane to continue northward. The QLM, although having the smallest error during the time the hurricane drifted slowly westward, prematurely forecast Gabrielle to move toward the northeast. To the credit of the forecasters during 10 and 11 September when Gabrielle was drifting toward the west and model guidance varied greatly, the forecasters consistently predicted Gabrielle would move toward the northeast. Forecast errors at this point were a matter of timing, not direction.

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Figure captions

1. Best track positions for Hurricane Gabrielle, 30 August - 13 September 1989.
2. Best track minimum central pressure curve for Hurricane Gabrielle, 30 August - 13 September 1989.
3. Best track maximum sustained wind speed curve for Hurricane Gabrielle, 30 August - 13 September 1989.
4. Flight level winds (700 mbs) from the AF980 aircraft in Hurricane Gabrielle.

Table 1. Preliminary best track, Hurricane Gabrielle
30 August - 13 September 1989

Date/Time (UTC)	Position		Pressure (mb)	Wind Speed (kt)	Stage
	Lat (N)	Lon (W)			
30/1200	11.6	21.0	1011	25	Tropical Depression
1800	11.3	23.0	1009	30	" "
31/0000	11.3	24.8	1005	35	Tropical Storm
0600	11.4	26.5	1005	35	" "
1200	11.5	28.3	1000	45	" "
1800	11.5	30.0	994	55	" "
01/0000	11.5	31.7	987	65	Hurricane
0600	11.8	33.4	987	65	"
1200	12.3	35.1	987	65	"
1800	12.8	36.8	987	65	"
02/0000	13.4	38.6	980	75	"
0600	13.9	40.3	977	80	"
1200	14.4	42.0	974	85	"
1800	14.8	43.8	970	90	"
03/0000	15.2	45.5	966	95	"
0600	15.6	47.2	960	100	"
1200	16.1	48.8	948	105	"
1800	16.5	50.3	937	105	"
04/0000	17.0	51.5	937	105	"
0600	17.4	52.7	940	110	"
1200	18.0	53.8	942	115	"
1800	18.6	54.8	942	120	"
05/0000	19.3	55.7	944	125	"
0600	19.9	56.5	941	125	"
1200	20.6	57.2	941	125	"
1800	21.4	57.8	941	125	"
06/0000	22.2	58.3	944	125	"
0600	23.1	58.8	942	120	"
1200	24.0	59.3	944	120	"
1800	25.1	59.8	944	120	"
07/0000	26.4	60.0	943	120	"
0600	27.7	60.0	948	105	"
1200	29.0	59.9	950	95	"
1800	30.5	59.8	951	95	"

Table 2 Ships encountering tropical cyclone winds of 50 kts or more in Hurricane Gabrielle 1989.

VESSEL ID	DATE		TIME UTC	SHIP POSITION		WIND		PRESSURE (mb)
	MO	DAY		Lat. (N)	Lon. (W)	DIR. Deg.	SPEED (kt)	
EOCE	09	07	1200	30.0	57.0	160	55	997.0
UDOB	09	08	0600	34.9	56.2	160	50	993.0
2010	09	08	1200	34.7	62.3	340	55	992.1

Hurricane Gabrielle

- Tropical depression stage
- Tropical storm stage
- Hurricane stage
- +++++ Extratropical stage
- ▽▽▽▽ Subtropical depression stage
- ▽▽▽▽ Subtropical storm stage
- Position and date at 0000 GMT
- Position at 1200 GMT
- 935 mb Lowest central pressure in millibars
- 6 Initial position of system "Number 6"
- H HURRICANE
- T TROPICAL STORM
- ST SUBTROPICAL STORM

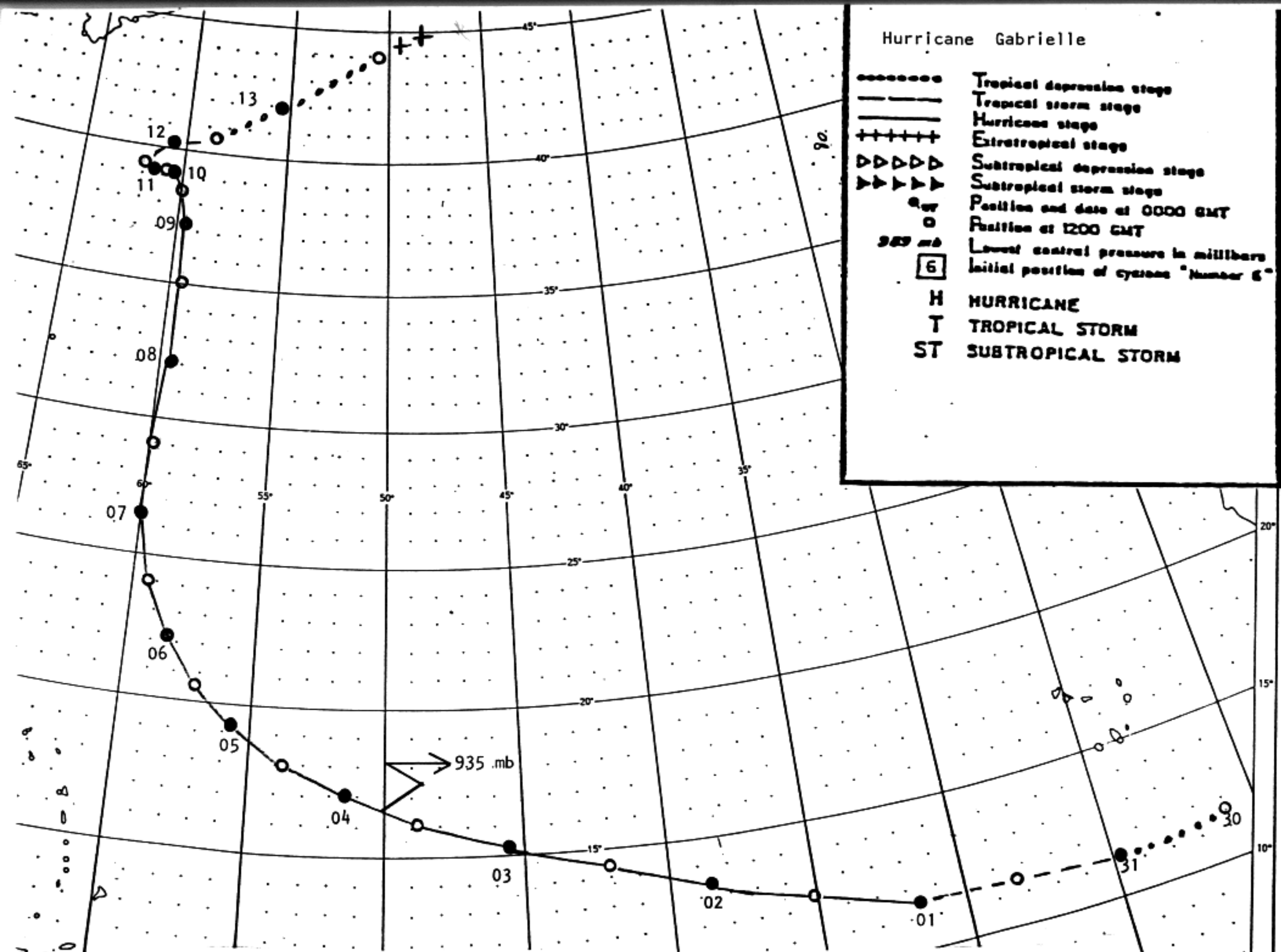
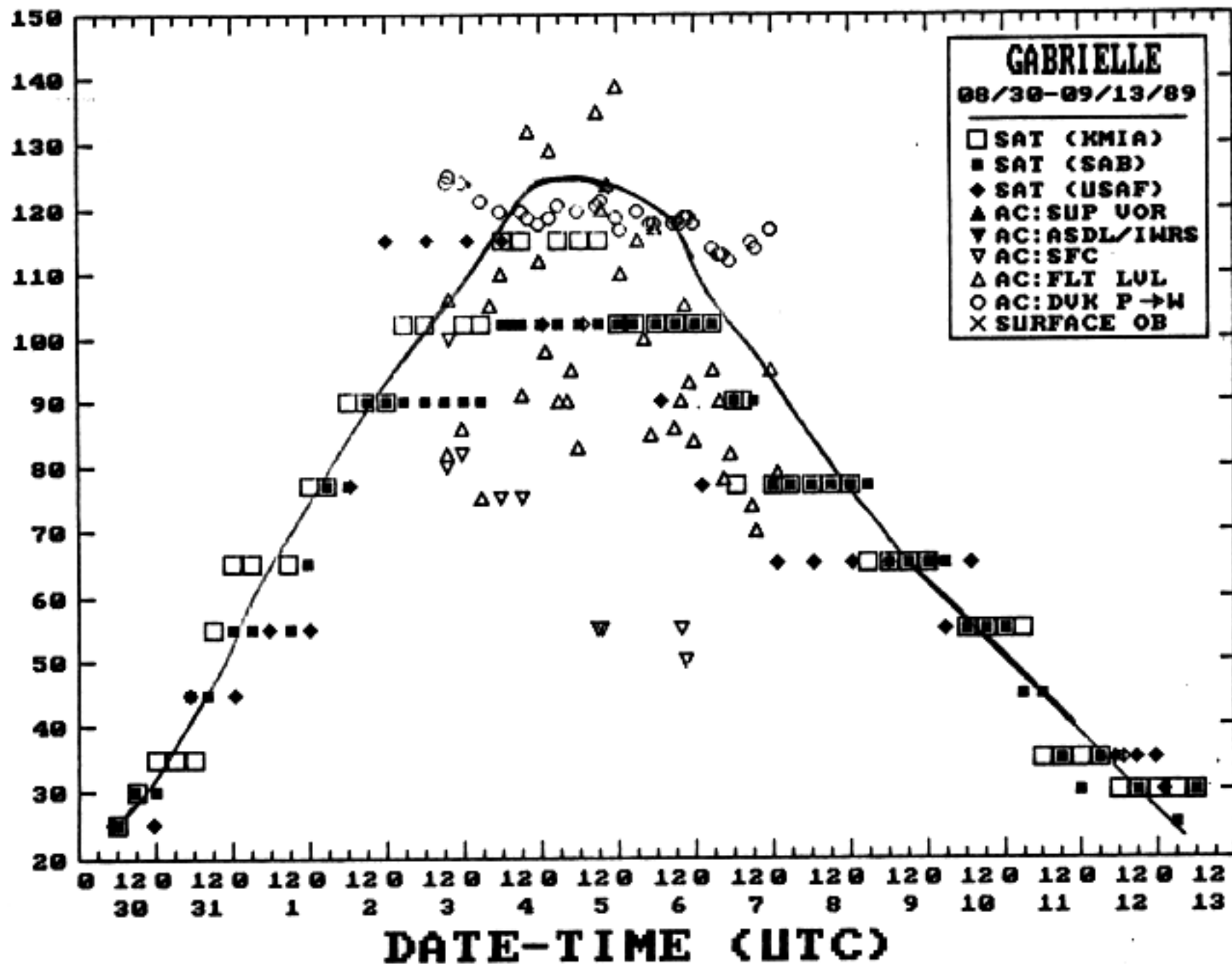
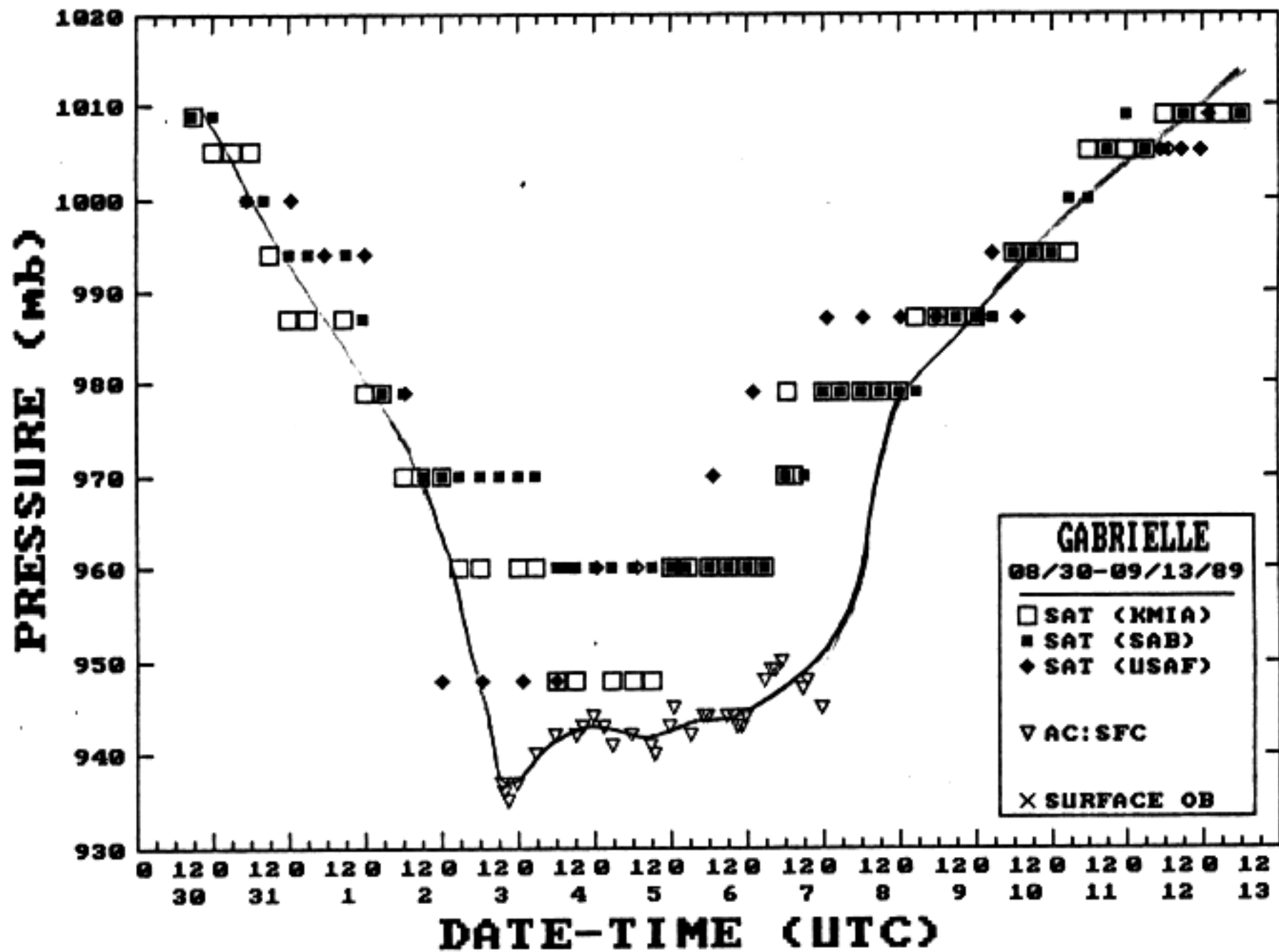


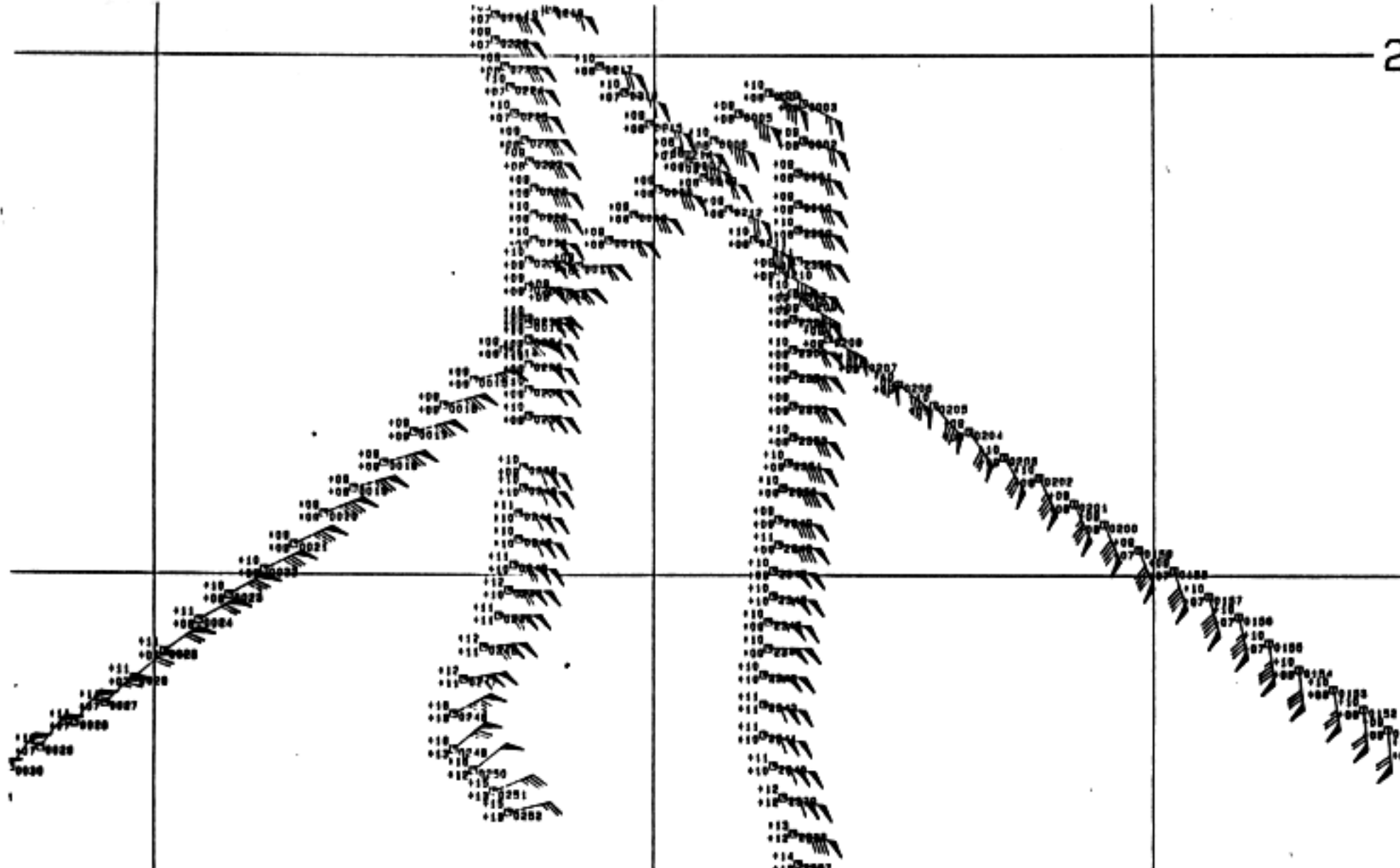
Fig. 1. Best track positions for Hurricane Gabrielle, 30 August - 13 September 1989.

WIND SPEED (kt)

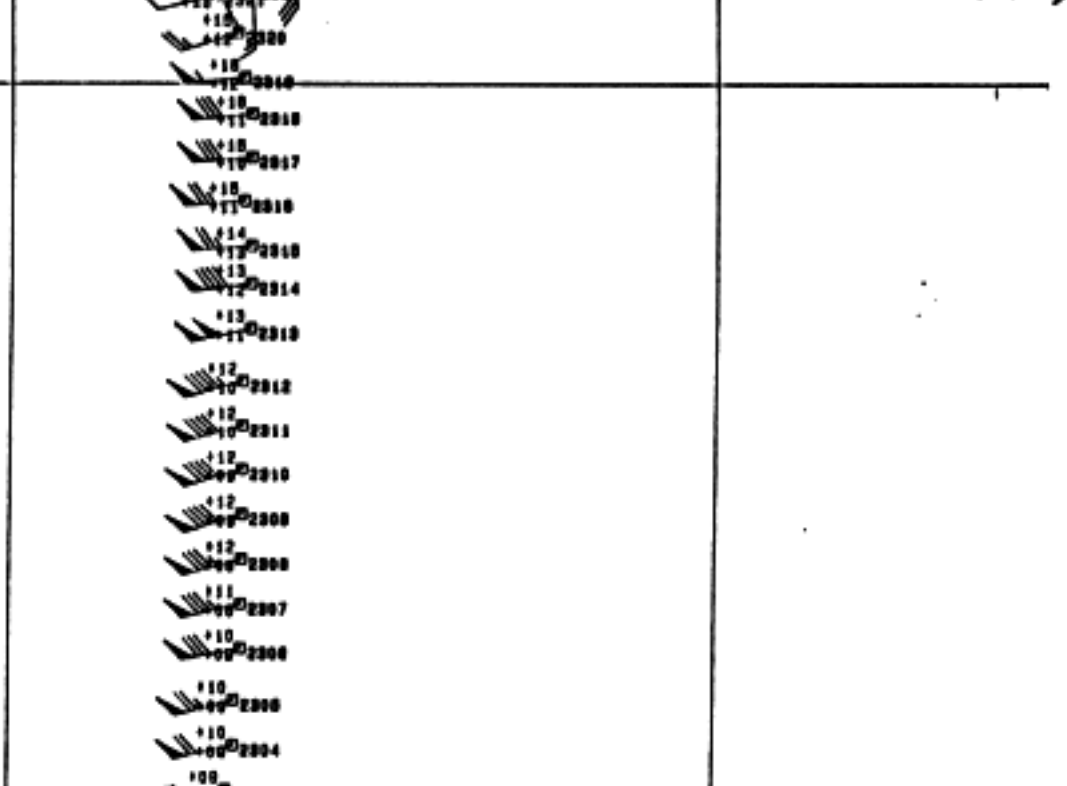




20N



19N



18N

SEP 04, 1989
 AF980 0410 GABRIELLE
 SCALE IS 1: 1000000
 OBSERVATION PERIOD :
 2241Z - 0309Z

57W

56W

55W