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A TROPICAL CYCLONE DATA TAPE FOR THE NORTH ATLANTIC BASIN, 1886-1983: CONTENTS, LIMITATIONS, AND USES

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CONTENTS

DEFINITIONS

Cyclone: An atmospheric closed-circulation rotating counterclockwise in the Northern Hemisphere.

Extratropical Stage: In tropical meteorology this refers to the transformation of a tropical cyclone from a warm core to a cold core system. This process usually occurrs poleward from the belt of tropical easterlies.

GMT: Greenwich Mean Time. Also referred to as "Z" time or Zulu time. Mean solar time of the meridian at Greenwich, England, used as the basis for standard time throughout most of the world.

Hurricane: A warm-core tropical cyclone in which the maximum sustained surface wind (1-min mean) is $\geq$ 64 kt.

Knot: The unit of speed in the nautical system; 1 n.mi. h^{-1} It is equal to 1.1508 mi h^{-1} or 0.5144 m s^{-1}.

Millibar: A pressure unit of 1000 dyn cm^{-2}, convenient for reporting atmospheric pressures.

Subtropical Cyclones: Nonfrontal, low pressure systems that comprise initially baroclinic circulations developing over subtropical waters. There are two types: (1) A cold low with circulation extending to the surface layer and maximum sustained winds generally occurring at a radius of about 100 mi or more from the pressure center. These cyclones sometimes undergo a metamorphosis and become tropical storms or hurricanes. (2) A mesoscale cyclone originating in or near a frontolyzing zone of horizontal wind shear, with radius of maximum sustained winds generally less than 30 mi. The entire circulation sometimes encompasses an area initially no more than 100 mi in diameter. These marine cyclones may change in structure from cold to warm core. While generally short-lived, they may ultimately evolve into major hurricanes or into extra-tropical cyclones.

Subtropical cyclones are classed according to intensity as follows:

a. Subtropical Depression: A subtropical cyclone in which the maximum sustained surface wind (1-min mean) is $\leq$ 33 kt.
b. Subtropical Storm: A subtropical cyclone in which the maximum sustained surface wind (1-min mean) is $\geq$ 34 kt.

Tropical Cyclone: A nonfrontal low pressure system of synoptic scale developing over tropical or subtropical waters and having definite organized circulation.

Tropical Depression: A tropical cyclone in which the maximum sustained surface wind (1-min mean) is $\leq$ 33 kt.

Tropical Storm: A warm-core tropical cyclone in which the maximum sustained surface wind (1-min mean) ranges from 34 to 63 kt.

A TROPICAL CYCLONE DATA TAPE FOR THE NORTH ATLANTIC BASIN,[1] 1886-1982: CONTENTS, LIMITATIONS, AND USES

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ABSTRACT

The National Hurricane Center maintains a computer file on North Atlantic tropical cyclones. The file contains dates, tracks, wind speeds, and central pressure values (if available) for all tropical cyclones occurring over the 98-year period, 1886 through 1983 and is updated annually. The data organization, format, and limitations are discussed and several uses of the data are demonstrated.

INTRODUCTION

The National Hurricane Center (NHC) is essentially a forecasting, rather than a data collecting, agency of NOAA. However, pursuant to its operational responsibility in the detection, tracking, and forecasting of tropical cyclones, and its additional responsibility in the applied research and public service area, the Center maintains detailed computer files on North Atlantic tropical storms and hurricanes. This report describes the content, format, limitations, and uses of the data, hereafter referred to as the HURDAT (HURricane DATa) data set.

2. BACKGROUND OF DATA SET

The initial requirement for computerized tropical cyclone data at NHC can be traced to a requirement of the NASA Space Program in the mid-1960's. At the request of Space Program officials, Hope and Neumann (1968) of the Spaceflight Meteorology Group, formerly collocated with the National Hurricane Center, studied the climatological impact of tropical cyclones on launches of space vehicles from the Kennedy Space Center. An extension to the authors' studies led to the operational HURRAN (HURRicane ANalog) program (Hope and Neumann, 1970) for the prediction of tropical cyclone motion out through 72 hr.

Originally, Hope and Neumann based their studies on a now obsolete card deck 988 (CD 988) obtained from the National Climatic Center.

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[1] The North Atlantic tropical cyclone basin includes most of the North Atlantic, Gulf of Mexico, Caribbean Sea, and adjacent land areas.

However, the original card deck has been extensively revised by NHC and tailored to its specific needs. Under the sponsorship of the U.S. Navy, the National Climatic Center has also revised card deck 988 and reissued it as card deck 993. The tropical cyclone tracks for the 1886 through 1963 portion of this latter deck correspond to those given by Cry (1965). The tropical cyclone tracks in HURDAT correspond to those given by Neumann, et al. (1981) in a revision to Cry, in which tracks are extended through the 1980 hurricane season. The revision also includes a few changes to some of Cry's original tracks. A copy of this data set may be purchased from NOAA/NESDIS, National Climatic Center, Federal Building, Asheville, NC, 28801. In requesting the tape, specific referrence should be made to the NHC edition.

3. THE HISTORY OF DATA OBSERVATIONS

The four basic pieces of information recorded on the computer file are the tropical cyclone's position (latitude and longitude), maximum sustained wind speed in knots, the central pressure in millibars (if available), and the time and date. The availability and accuracy of these parameters has by no means been constant throughout the years. Figure 1 indicates graphically the technical advances in observing systems that have occurred since the formation of the Hurricane Warning Service in 1871. This figure shows that, until organized reconnaissance began in 1944, the two major sources of information on tropical cyclones were land stations and ships at sea. Undoubtedly, during this early period some storms went undetected. However, ships encountered tropical cyclones more frequently in earlier years because they did not always have the benefit of forecasts. Many times a storm was detected and then "lost" for several days before it was encountered by another ship or observed from a land station. At other times a storm moved over land stations and through the major shipping lanes, thus allowing its track and intensity to be determined with a reasonable degree of accuracy. Therefore, during this early period of data the most useful information is track rather than wind data, although some of the tropical cyclones do have useful maximum wind information. Nevertheless, the user of the wind information is cautioned not to make an overly precise interpretation of this parameter for the entire period of record and especially before 1944. The reader is referred to Neumann, et al. (1981) for a list of additional references on tropical cyclone tracking.

Organized aircraft reconnaissance has allowed continuous monitoring of the storm's track, maximum sustained wind field, and central pressure. This is reflected in the increase of pressure data beginning in 1944. The coastal radar network has improved the track information mainly for landfalling storms.

The largest single advance in the detection and tracking of tropical cyclones has been the introduction of weather satellites with their associated visible and infrared sensors. With the initial position of a tropical cyclone determined from satellite a reconnaissance aircraft is dispatched to measure the more precise wind field, central pressure, and location of the center.

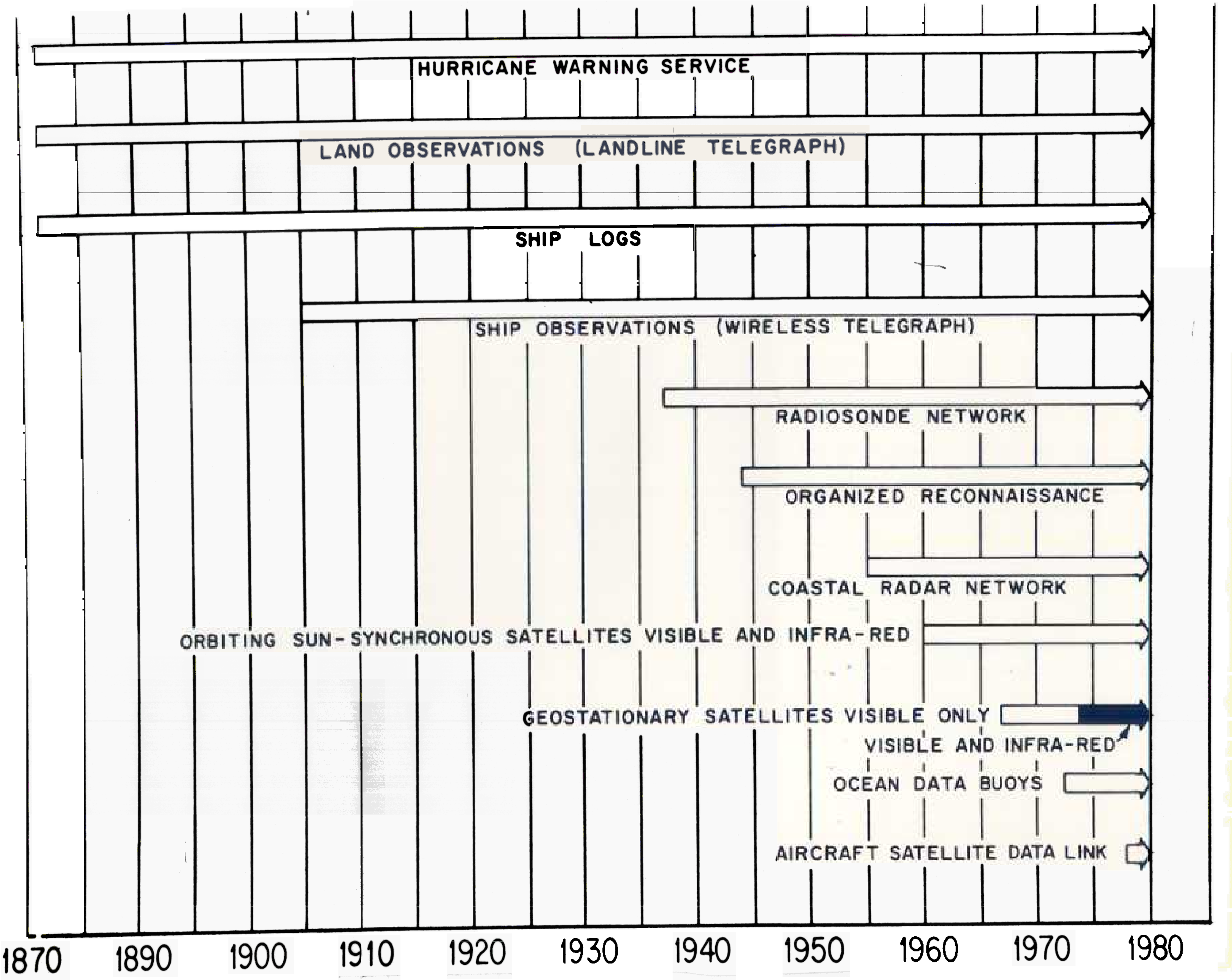
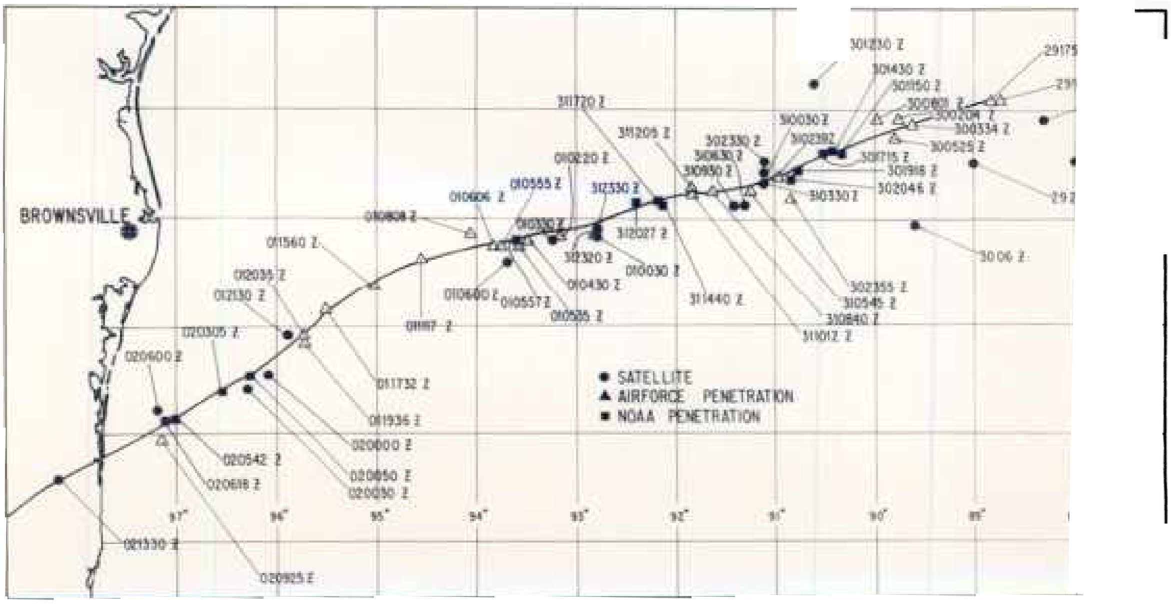


Figure 1. Technical advances in systems for observing tropical cyclones, 1871 through 1980.


BROWNSVILLE
SATELLITE
AIRFORCE PENETRATION
NOAA PENETRATION
97°
96°
95°
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90°
89°
301230 Z
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301150 Z
311720 Z
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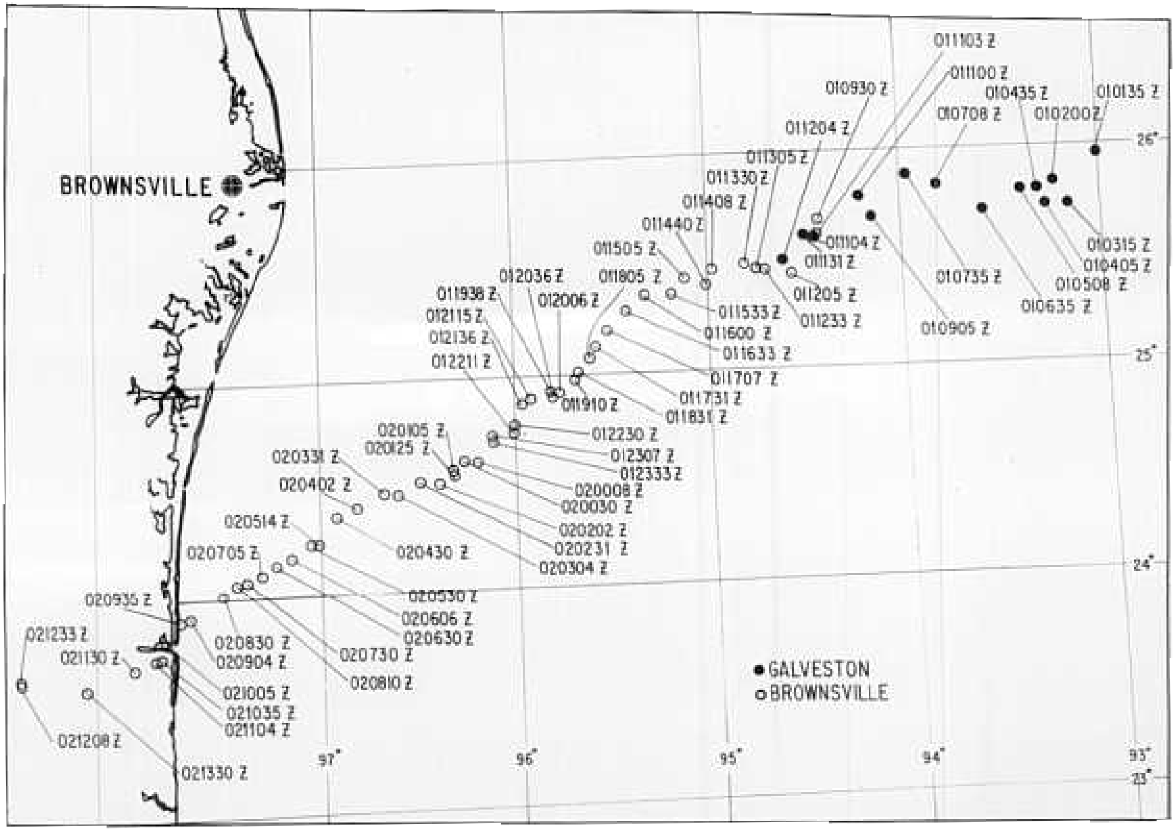


Figure 3. Radar center estimates for tropical cyclone Anita, 1977. The Galveston radar was able to make several estimates before the cyclone passed out of its range and into Brownsville's range. Note the small-scale oscillations in the track and compare this with the best track in Figure 2.

First, small-scale oscillatory (trochoidal) motions which are transitory in nature and not representative of the more conservative motion of the entire storm envelope must be considered. Smoothing is necessary to remove these small-scale motions, which are on the order of 5 to 20 n.mi. about some mean path. Radar documentation of these eye oscillations on tropical cyclone Carla, 1971, is presented in Figure 4. Recent evidence of similar motion based on satellite imagery of tropical cyclone Belle, 1976, is provided by Lawrence and Mayfield (1977). Therefore, final tracks should be considered as the best estimate of the larger scale storm motion, rather than precise locations of the eye.

Second, for a number of reasons, the pattern of wind, rainfall, and storm surge are typically higher in the right semicircle of a storm (looking towards the direction of motion) where the rotational and translational forces work in the same direction. Again, final tracks must take into account these asymmetries.

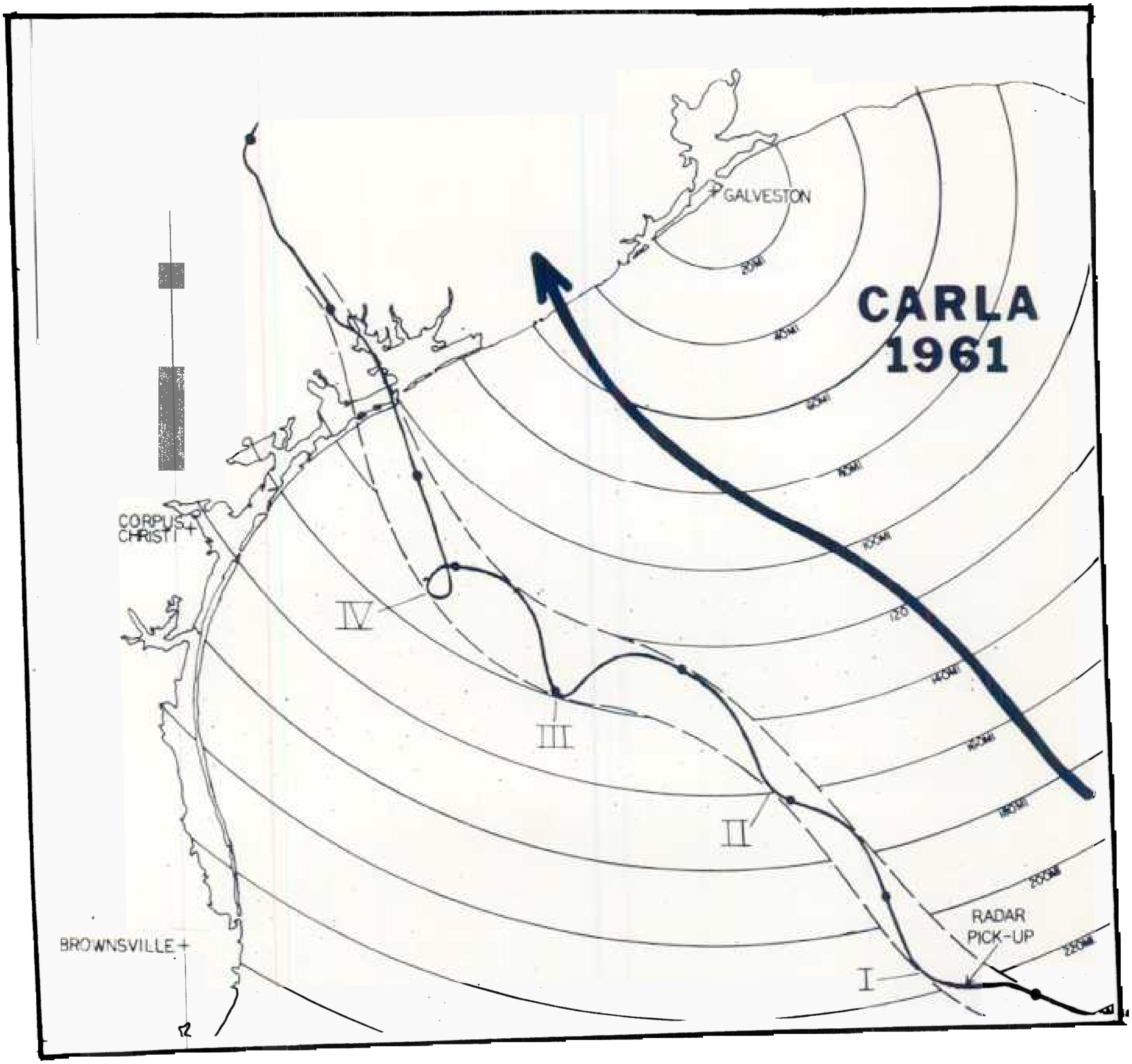


Figure 4. Portion of hurricane Carla track over Gulf of Mexico showing four smoothed trochoidal oscillations of storm center. Track is based on "fixes" from three coastal radars. Heavy track, offset to northeast, shows portion of smoothed "best track". Range markers are at 20-n.mi. intervals. (Figure adapted from Weatherwise, October, 1961.)

When an analyst has finished constructing a best track, storm positions at 6-hourly intervals are noted. The times for the four positions per day are (0000, 0600, 1200, and 1800) Greenwich Mean Time (GMT). These are the positions that are stored on the HURDAT tape. Each position is given by latitude and longitude to the nearest tenth of 1 degree.

Before 1931, only 1200 GMT positions were recorded on the original card deck 988 (see page 1). The three intermediate positions were interpolated from the 1200 GMT positions. From 1931 through 1956, although four positions per day were determined by the forecaster, only the 0000 and 1200 GMT positions were recorded. Here it was necessary to interpolate for the 0600 and 1800 GMT positions. A nonlinear interpolation scheme was used to obtain these intermediate positions. The polynomial interpolation described by Akima (1970) gave highly satisfactory results. However, each track interpolation was carefully checked to insure that important features, such as loops in the track, were retained.

Beginning in 1956, storm positions were recorded four times per day for verification of official forecasts which are also issued four times per day. The need for these positions increased during the 1960's with the coming of the computer age; they are required for many purposes, such as computer plotting of the tracks, implementation of the operational models, verification of the forecasts from the operational models, and verification of the official forecasts.

5. WIND SPEEDS

Each of the four daily storm positions has a corresponding wind speed. These wind values are specified in knots and rounded to the nearest 5-kt value, i.e., 68 kt becomes 70 kt while 67 kt becomes 65 kt. The wind values are estimated or measured averages over a 1-min period. Therefore, these values are not the peak winds or gusts. For further information on the relationship of gusts to average winds, the reader is referred to Dunn and Miller (1964), pp. 61-67; Padya (1975); and Atkinson and Holliday (1977).

To understand the limitations of the wind speed values, it is instructive to explore the various means by which the different observing platforms have actually measured the wind. First, for land stations, several types of wind recording devices have been used over the period of record. For example, in the 1890's, triple register instruments were introduced. The wind speed was one of the parameters measured and recorded by a counter device utilizing a 3-cup anemometer. In the 1950's, the present day recording device used by the National Weather Service was introduced. Known as the F-420 system, it measures wind speed and direction and also records wind gusts. Several other types of anemometers have been used in the recording of the maximum wind speed. These include 4-cup and 22-cup anemometers, it is felt that larger errors are introduced by the location and height of a particular anemometer.

The locations and heights of anemometers have varied at National Weather Service stations as the stations have been moved. The exposure of the anemometer to buildings can be very significant. For example, during the most destructive storm in the history of Miami, Florida, in 1926, the official recording anemometer was between several large buildings. It was estimated by the meteorologist in charge that the wind values recorded were approximately one-half of the actual value.

It should be noted that the chance of a tropical cyclone passing directly over a fully instrumented facility is remote. On many occasions, even when a storm passes over a populated area, the maximum wind must be inferred from indirect evidence, such as peripheral wind measurements or damage profiles.

Estimations of the wind over the ocean by ships are determined by the state of the sea and given in the Beaufort scale. Over the past 30 years some ships have been instrumented with anemometers. However, because the ship is a moving platform (in three directions), corrections are necessary to determine a wind value. The state-of-the-sea determination is a one-step observation and is thus favored by mariners. A study by Shinners (1963) found that anemometer-measured winds versus state-of-the-sea-determined winds were (1) lower up to about 20 kt, (2) approximately the same from 20 to 30 kt, and (3) greater above 30 kt. In other words, state-of-the-sea-determined winds are underestimates of the actual wind at higher speeds. The magnitudes of these underestimates are approximately 6 kt for the range 36 to 45 kt, 13 kt for the range 46 to 55 kt, and 15 kt for the range 56 to 65 kt. However, both types of wind values are received in ship reports today.

Likewise, although aircraft reconnaissance measures the flight-level winds anywhere from 500 to 10000 ft, the surface winds are a subjective estimate based upon observation of the sea state and/or tables relating flight-level winds to surface winds.(Black and Adams, 1983)

Finally, wind speed values were computed on occasions from pressure values using the formula (Kraft, 1961):

$$V_{max} = 14*(1013-P_{center})^{1/2}$$

where:

V_{max} = maximum sustained wind
and
P_{center} = pressure at center in millibars

Since the advent of weather satellites, techniques have been developed by Dvorak (1973 and 1975) and Hebert and Poteat (1975) to determine wind speed from the shape of a tropical and subtropical cyclone's cloud field, respectively. This estimation, along with those received from aircraft reconnaissance, forms the main nucleus of information to determine the final wind field. Figure 5 contains final surface wind and pressure profiles for tropical cyclone Anita, 1977. Also shown are the original surface wind and pressure information which was used to determine the profiles. Time increases to the right. The wind speed is specified in knots and pressure in millibars. The scatter and discrepancies in the various wind reports is quite evident. Here, again, as in the best track determination, the analyst subjectively determines the profiles. It is extremely important for the analyst to understand the weaknesses and strengths of the various measuring platforms.

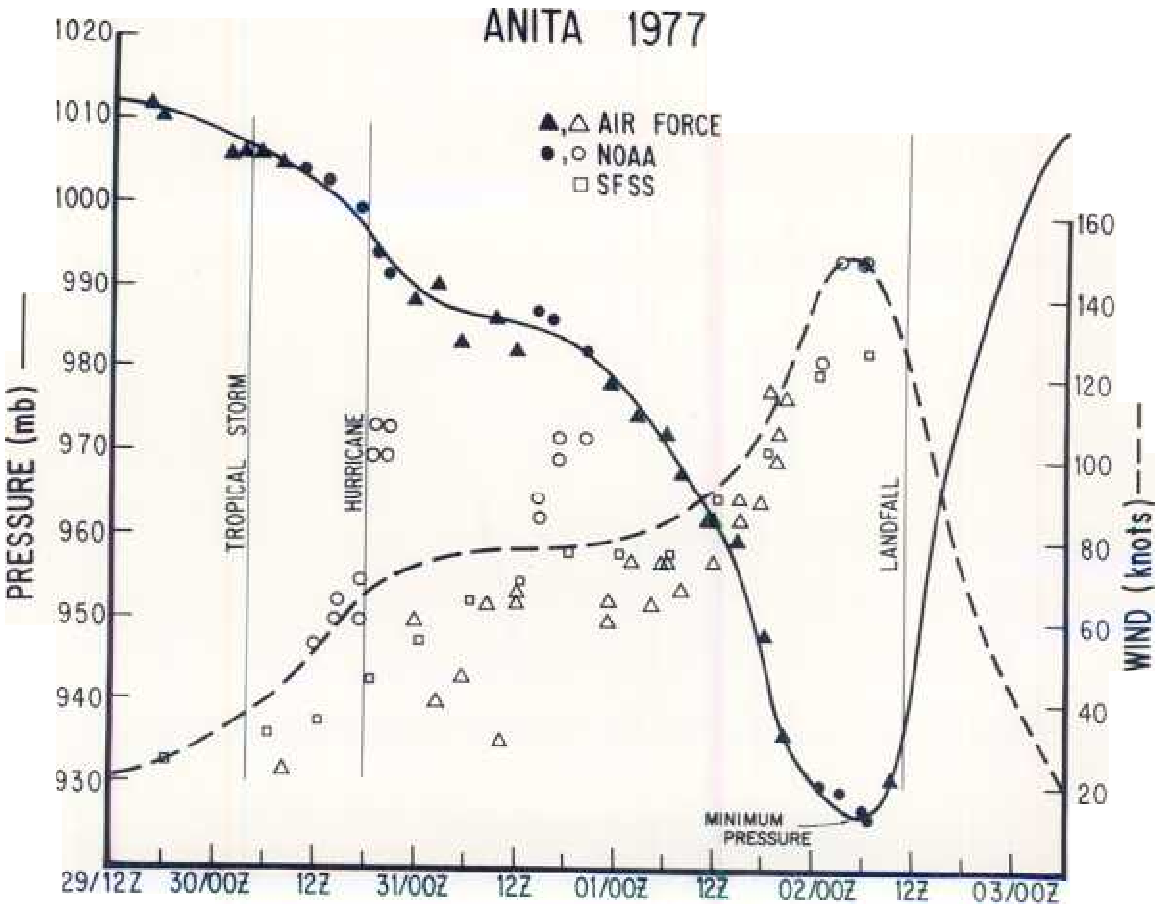


Figure 5. Final wind (dashed line) and pressure (solid line) profiles with actual data for tropical cyclone Anita, 1977.

6. PRESSURES

The tropical cyclone's central pressure on HURDAT is specified in millibars. Only reported central pressures within +2 hr of one of the four reporting times are included in the data. As discussed earlier, the frequency of pressure values decreases as one goes back in the period of record. Thus, unlike wind speeds, central pressures are often missing.

Pressures at populated centers affected by a storm may be well documented, even though the eye of the storm passed a good distance away. Those pressures are not part of this data set. It should be emphasized that all pressures on HURDAT are observed and that no pressures were determined from the winds.

Figure 5 shows a pressure profile and actual pressure data used to determine this profile. Since the satellite intensity classification determines the maximum sustained winds only, no pressure values are given. It is clearly evident from the raw pressure data that the central pressure is a much more conservative property of the tropical cyclone than the wind field.

7. DATA FORMATS

The master deck that was used to generate the computer file consisted of three types of cards: Title, Data, and Classification. Each storm has one title card containing all required information to identify it. The first item on the card is the sequence number. The month, day, and year follow in that order. This is the first day on record for the storm. The next three numbers refer to the number of days the storm was in existence (M), the storm number for that year, and the cumulative storm number (SNBR), where the first storm in 1886 is 1 and the last storm in 1983 is 815. The next variable is the storm name. Before the naming of tropical storms in 1950, a "not named" message fills the space on the cards. The next item on the card is a storm crossing index (XING). The final item on the card is the Saffir/Simpson Hurricane Scale (SSS). In the present version this number should be ignored before 1899. To relate hurricane intensity to damage potential, the National Hurricane Center has adopted the Saffir/Simpson Hurricane Scale. This descriptive scale, over a range of categories 1 through 5, is shown in Table 4. Saffir/Simpson scale numbers are given only for hurricanes that crossed the continental United States. In a few instances, a Saffir/Simpson number of zero appears. This indicates that the storm, although classified as a hurricane over coastal waters, weakened to below hurricane strength before crossing the immediate coast line. On the title card, column 80 is used to denote the last storm of the year if punched with an L.

The single Title card is followed by two or more Data cards, one for each GMT day of the storm's existence. Each contains four sets of numbers where each set contains the storm type, the storm position (latitude in degrees north and longitude in degrees west), wind speed, and the central pressure. The sets correspond to the times 0000, 0600, 1200, and 1800 GMT. The storm types are *-Tropical Storm or Hurricane, D-Tropical Disturbance, S-Subtropical Storm, W-Tropical Wave, and E-Extratropical Storm.

The Classification card's purpose is to classify the maximum status attained during a storm's life. The index can take on one of three values: Tropical Storm (TS), Hurricane (HR), or Subtropical Storm (SS).

Tables 1 through 3 indicate the exact location of each parameter on the three types of cards. Copies of the computer cards for Anita, 1977, and an unnamed tropical storm, 1937, are shown in Figure 6. Note the difference in the amount of central pressure data.

The record size on the magnetic tape is 80 bytes, (i.e., each record is a card image.) This allows the user to read the tape as if it were a card deck. The user may then want to store certain information in larger records which will reduce input/output time. A fortran program to read and write the HURDAT tape, with formatted input and output statements, is given in Appendix I. The necessary physical parameters for reading the tape (i.e., density, parity, etc.) will be supplied by the National Climatic Center along with the tape.

Table 1. Title Card - Format and Contents

Computer Card Columns	Contents
1 - 5	Card sequence number
7 - 8	Month
10 - 11	Day (first day of storm on record)
13 - 16	Year
20 - 21	Value of M (M=number of days storm existed)
23 - 24	Storm number for that year
31 - 34	Cumulative storm number
36 - 47	Storm name
53	Crossing (1=hit U.S. coastline, 0=did not)
59	Saffir/Simpson Hurricane Scale number
80	Last storm of year if L

Table 2. Storm Data Card - Format and Contents
Latitudes and longitudes are rounded to the nearest tenth.
Wind speed is rounded to the nearest 5 kt.
Pressure is rounded to the nearest millibar.

Computer Card Columns	Contents
1 - 5	Card sequence number
7 - 8	Month
10 - 11	Day
12	Storm type at 0000Z
13 - 15	Latitude at 0000Z
16 - 19	Longitude at 0000Z
21 - 23	Wind speed at 0000Z
25 - 28	Central pressure at 0000Z
29	Storm type at 0600Z
30 - 32	Latitude at 0600Z
33 - 36	Longitude at 0600Z
38 - 40	Wind speed at 0600Z
42 - 45	Central pressure at 0600Z
46	Storm type at 1200Z
47 - 49	Latitude at 1200Z
50 - 53	Longitude at 1200Z
55 - 57	Wind speed at 1200Z
59 - 62	Central pressure at 1200Z
63	Storm type at 1800Z
64 - 66	Latitude at 1800Z
67 - 70	Longitude at 1800Z
72 - 74	Wind speed at 1800Z
76 - 79	Central pressure at 1800Z

Table 3. Classification Card - Format and Contents

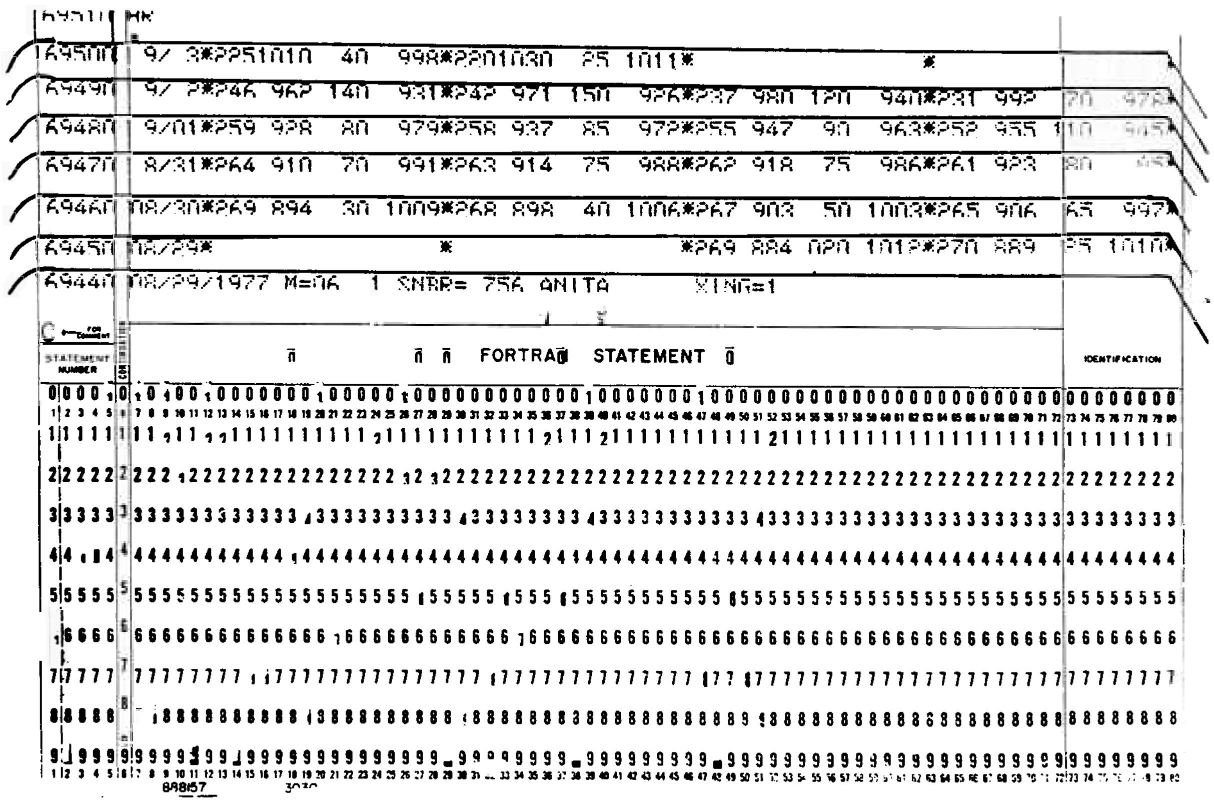
Computer Card Column	Contents
1 - 5	Card sequence number
7 - 8	Maximum status of storm during its life

Table 4. Saffir/Simpson Hurricane Scale

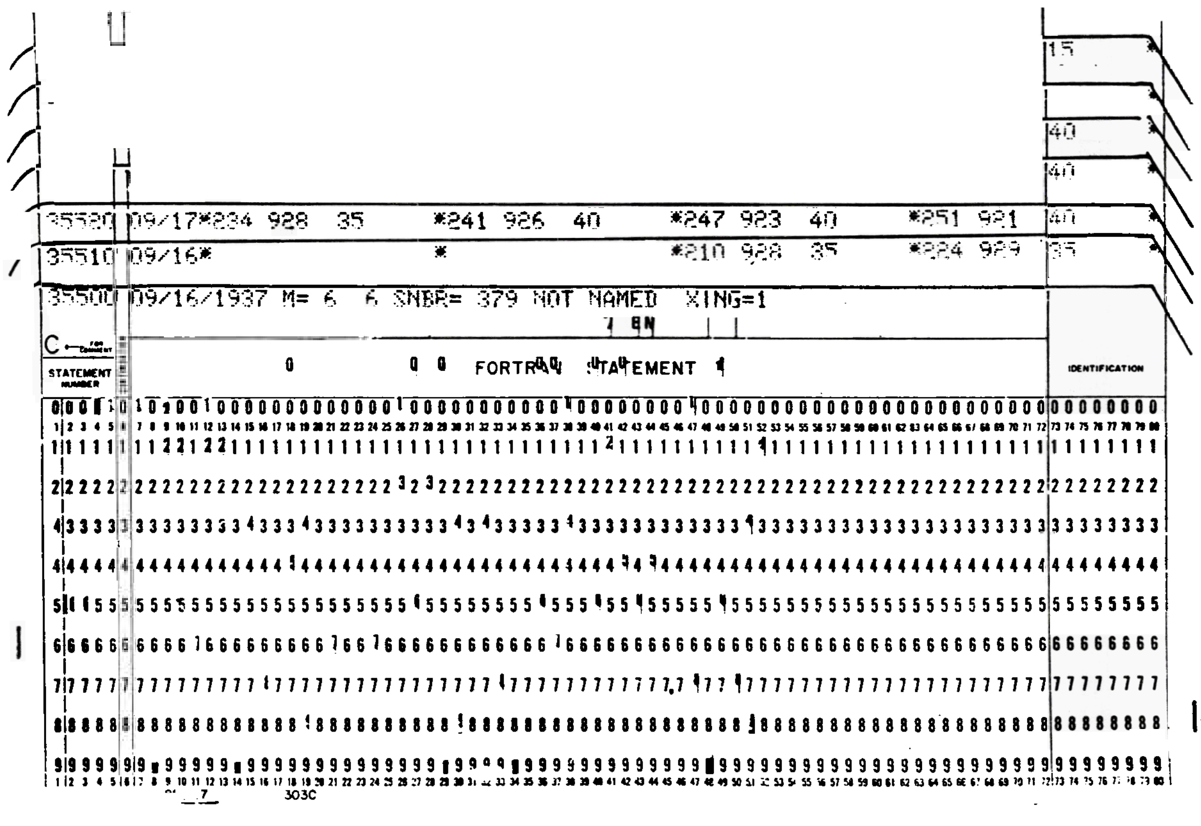
Category Number	Definition
1	Winds of 74 to 95 miles per hour. Damage primarily to shrubbery, trees, foliage, and unanchored mobile homes. No real damage to other structures. Some damage to poorly constructed signs. And/or: storm surge 4 to 5 feet above normal. Low-lying coastal roads inundated, minor pier damage, some small craft in exposed anchorage torn from moorings.
2	Winds of 96 to 110 miles per hour. Considerable damage to shubbery and tree foliage; some trees blown down. Major damage to exposed mobile homes. Extensive damage to poorly constructed signs. Some damage to roofing materials of buildings; some window and door damage. No major damage to buildings. And/or: storm surge 6 to 8 feet above normal. Coastal roads and low-lying escape routes inland cut by rising water 2 to 4 hours before arrival of hurricane center. Considerable damage to piers. Marinas flooded. Small craft in unprotected anchorage torn from moorings. Evacuation of some shoreline residences and low-lying island areas required.
3	Winds of 111 to 130 miles per hour. Foliage torn from trees; large trees blown down. Practically all poorly constructed signs blown down. Some damage to roofing materials of buildings; some window and door damage. Some structural damage to small buildings. Mobile homes destroyed. And/or: storm surge 9 to 12 feet above normal. Serious flooding at coast and many smaller structures near coast destroyed; larger structures near coast damaged by battering waves and floating debris. Low-lying escape routes inland cut by rising water 3 to 5 hours before hurricane center arrives. Flat terrain 5 feet or less above sea level flooded inland 8 miles or more. Evacuation of low-lying residences within several blocks of shoreline possibly required.

Table 4. Saffir/Simpson Hurricane Scale continued

Category Number	Definition
4	Winds of 131 to 155 miles per hour. Shrubs and trees blown down; all signs down. Extensive damage to roofing materials, windows and doors. Complete failure of roofs on many small residences. Complete destruction of mobile homes. And/or: storm surge 13 to 18 feet above normal. Flat terrain 10 feet or less above sea level flooded as far as 6 miles. Major damage to lower floors of structures near shore due to flooding and battering waves and floating debris. Low-lying escape routes inland cut by rising water 3 to 5 hours before hurricane center arrives. Major erosion of beaches. Massive evacuation of all residences within 500 yards of shore possibly required, and of single-story residences on low ground within 2 miles of shore.
5	Winds greater than 155 miles per hour. Shrubs and trees blown down; considered damage to roofs of buildings; all signs down. Very severe and extensive damage to windows and doors. Complete failure of roofs on many residences and industrial buildings. Extensive shattering of glass in windows and doors. Some complete building failures. Small buildings overturned or blown away. Complete destruction of mobile homes. And/or: storm surge greater than 18 feet above normal. Major damage to lower floors of all structures less than 15 feet above sea level within 500 yards of shore. Low-lying escape routes inland cut by rising water 3 to 5 hours before hurricane center arrives. Massive evacuation of residential areas on low ground within 5 to 10 miles of shore possibly required.



a.



b.

Figure 6. Copies of computer cards giving the information for tropical cyclone Anita, 1977 (a.) and an unnamed tropical cyclone, 1937 (b.).

8. USES OF THE DATA

This section highlights some of the uses of the HURDAT tape at the National Hurricane Center. The thousands of requests received over the years indicate a much broader usage of the data than presented here.

The most requested products are the tracks. Figure 7 shows the tracks for all tropical cyclones beginning September 1 through 5, 1886 through 1977.

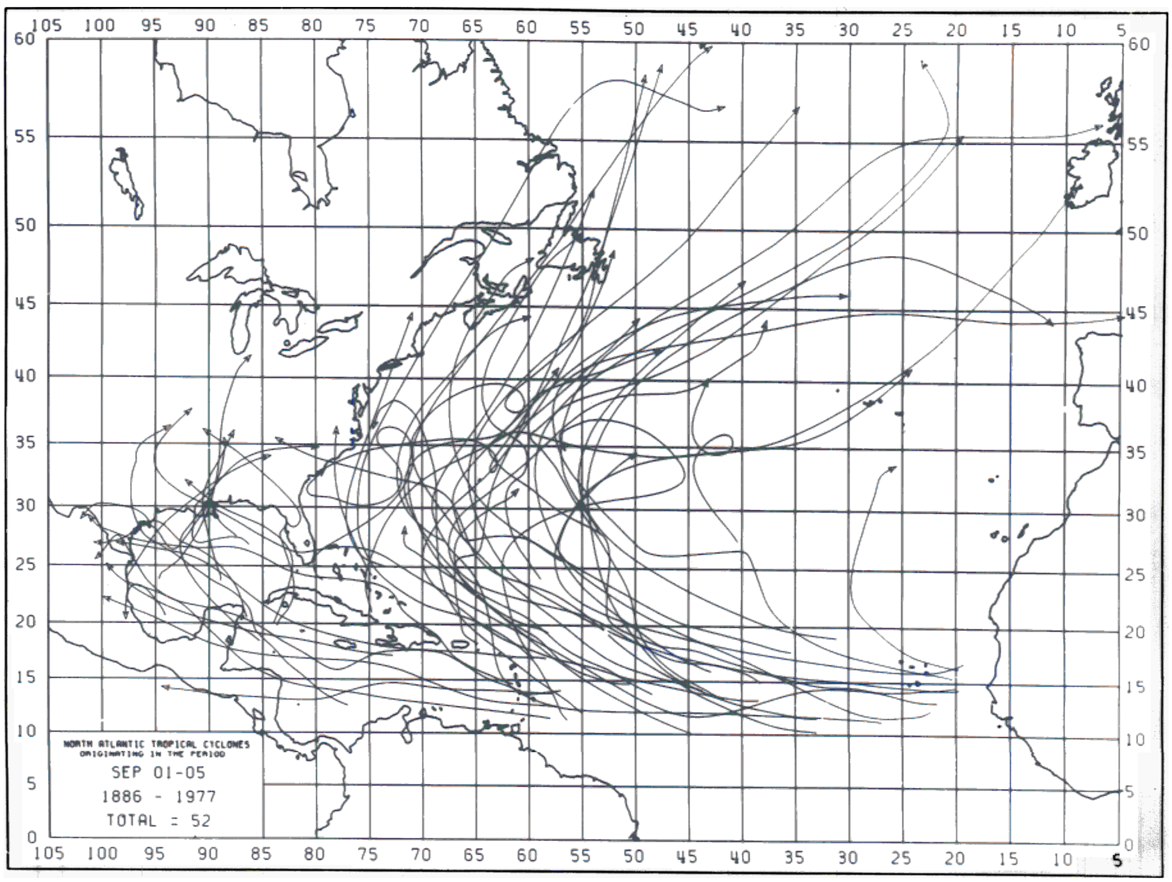


Figure 7. Tracks of tropical cyclones originating September 1 through 5, 1886 through 1977.

There are frequent requests for all tropical cyclones passing within a given distance from a particular location. Figure 8 shows all tracks of tropical cyclones of hurricane intensity when they were within 50 n.mi. of Miami, Florida, for 1886 through 1983. Table 5 is a copy of the printout giving additional information, such as the point and time of closet approach of the tropical cyclone to Miami and the maximum wind within the 50 n.mi. circle. A legend is included to explain each value in the table.

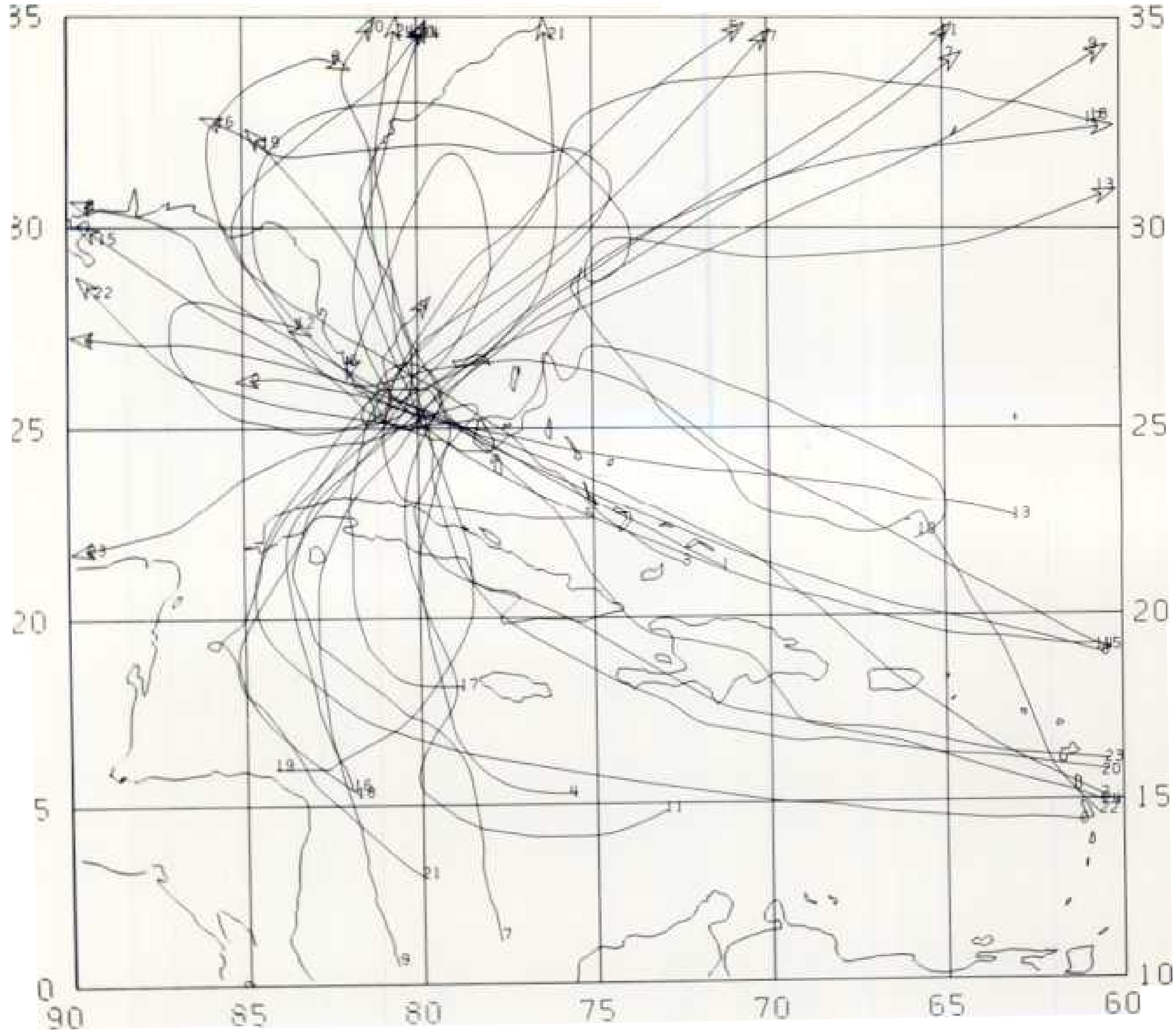


Figure 8. Tracks of all tropical cyclones of hurricane intensity passing within 50 n.mi. of Miami, Florida. The 50 n.mi. circle is also plotted. The numbers at the beginning and end of each track refer to column 1 of Table 4.

Standard statistical graphs showing frequency for various periods are often produced. Figure 9 gives an example of the annual tropical cyclone frequency, 1886 through 1982.

One of the many objective models in current operational usage at NHC is an analog model as described by Hope and Neumann (1970). This model scans the HURDAT tape and selects tropical cyclones that have characteristics similar to the current tropical cyclone in progress. These analog tropical cyclones are composited and a forecast track is generated. Figure 10 shows an example of an analog forecast for tropical cyclone Anita, 1977. Also included in the plot are the 50% probability elipses at the forecast intervals of 12, 24, and 36 hr.

Table 5 Computer Printout of All Hurricanes That Passed Within 50 n.mi. of Miami, Florida 1886 through 1983

MAP INDEX (1)	STARTING DATE (2)	LENGTH (DAYS) (3)	SEASONAL INDEX (4)	STORM'S NAME (5)	CLOSEST POINT OF APPROACH (CPA) (6)	(7)	DATE AT CPA (8)	TIME AT CPA (9)	DISTANCE TO CPA (10)	WIND (11)	REF # (12)
1	8/14/1888	11	3	NOT NAMED	25.6N	80.4W	8/16	1700Z	12.NM	94KT	30
2	8/18/1891	8	3	NOT NAMED	25.4N	80.3W	8/24	1600Z	22.NM	75KT	49
3	9/ 9/1903	8	3	NOT NAMED	26.2N	79.9W	9/11	2200Z	31.NM	83KT	141
4	10/12/1904	10	3	NOT NAMED	26.0N	80.3W	10/17	1600Z	12.NM	65KT	150
5	6/14/1906	10	2	NOT NAMED	25.9N	80.8W	6/17	0800Z	28.NM	70KT	159
6	10/11/1906	12	8	NOT NAMED	25.8N	80.3W	10/18	0900Z	2.NM	106KT	165
7	10/ 6/1909	8	9	NOT NAMED	25.4N	80.0W	10/11	2000Z	29.NM	84KT	189
8	9/11/1926	12	6	NOT NAMED	25.6N	80.3W	9/18	1200Z	12.NM	119KT	276
9	10/14/1926	11	10	NOT NAMED	25.4N	79.9W	10/21	0500Z	33.NM	95KT	280
10	9/22/1929	13	2	NOT NAMED	25.1N	80.6W	9/28	1700Z	47.NM	86KT	296
11	9/23/1935	13	4	NOT NAMED	25.3N	79.5W	9/29	0100Z	50.NM	100KT	355
12	10/30/1935	10	6	NOT NAMED	25.8N	80.3W	11/ 4	1800Z	2.NM	65KT	357
13	10/ 3/1941	12	5	NOT NAMED	25.5N	80.5W	10/ 6	1100Z	23.NM	105KT	408
14	9/12/1945	9	9	NOT NAMED	25.6N	80.4W	9/15	2300Z	17.NM	119KT	449
15	9/ 4/1947	13	4	NOT NAMED	26.3N	80.4W	9/17	1800Z	31.NM	133KT	461
16	10/ 9/1947	8	3	NOT NAMED	25.9N	80.5W	10/12	0700Z	13.NM	75KT	465
17	9/18/1948	8	7	NOT NAMED	26.1N	80.8W	9/22	0500Z	33.NM	97KT	473
18	10/ 3/1948	14	8	NOT NAMED	25.7N	80.1W	10/ 6	0000Z	11.NM	96KT	474
19	10/13/1950	7	11	KING	25.8N	80.2W	10/18	0600Z	4.NM	93KT	499
20	8/20/1964	17	5	CLEO	25.9N	80.0W	8/27	0900Z	13.NM	90KT	629
21	10/ 8/1964	10	11	ISBELL	26.2N	80.8W	10/14	2300Z	38.NM	110KT	635
22	8/27/1965	18	3	BETSY	25.1N	80.3W	9/ 8	1000Z	44.NM	110KT	639
23	9/21/1966	2	9	INEZ	25.2N	80.0W	10/ 4	1400Z	40.NM	75KT	651
24	8/25/1979	15	4	DAVID	26.1N	79.5W	9/ 3	1100Z	45.NM	85KT	777

NOTES.
(1) INDEX NUMBER CORRESPONDS TO INDICIES GIVEN ON MAP AT BEGINNING AND END OF STORM TRACK.
(2) INITIAL DETECTION DATE OF THIS TROPICAL CYCLONE.
(3) RECORDED DURATION OF STORM IN CALENDAR DAYS.
(4) STORM NUMBER FOR GIVEN YEAR CORRESPONDING TO THOSE GIVEN IN REFERENCE (1).
(5) STORMS WERE NOT FORMALLY NAMED PRIOR TO 1950.
(6) - (10) THESE COLUMNS GIVE LOCATION AND TIME OF CLOSEST APPROACH AND DISTANCE OF STORM CENTER TO SITE.
(11) MAXIMUM SUSTAINED WIND SPEED NEAR STORM CENTER WHILE STORM CENTER IS WITHIN SPECIFIED DISTANCE FROM SITE. THIS IS NOT NECESSARILY THE WIND RECORDED AT GIVEN SITE. SEE REFERENCE (2).
(12) CUMULATIVE STORM INDEX NUMBER BEGINNING WITH STORM 1 IN 1886.

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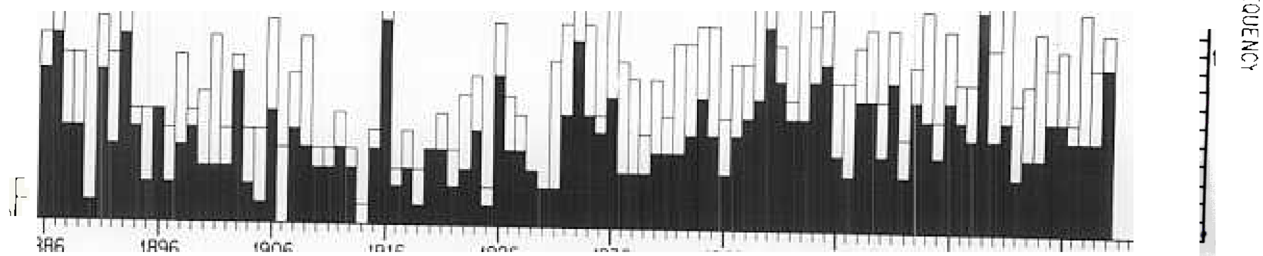
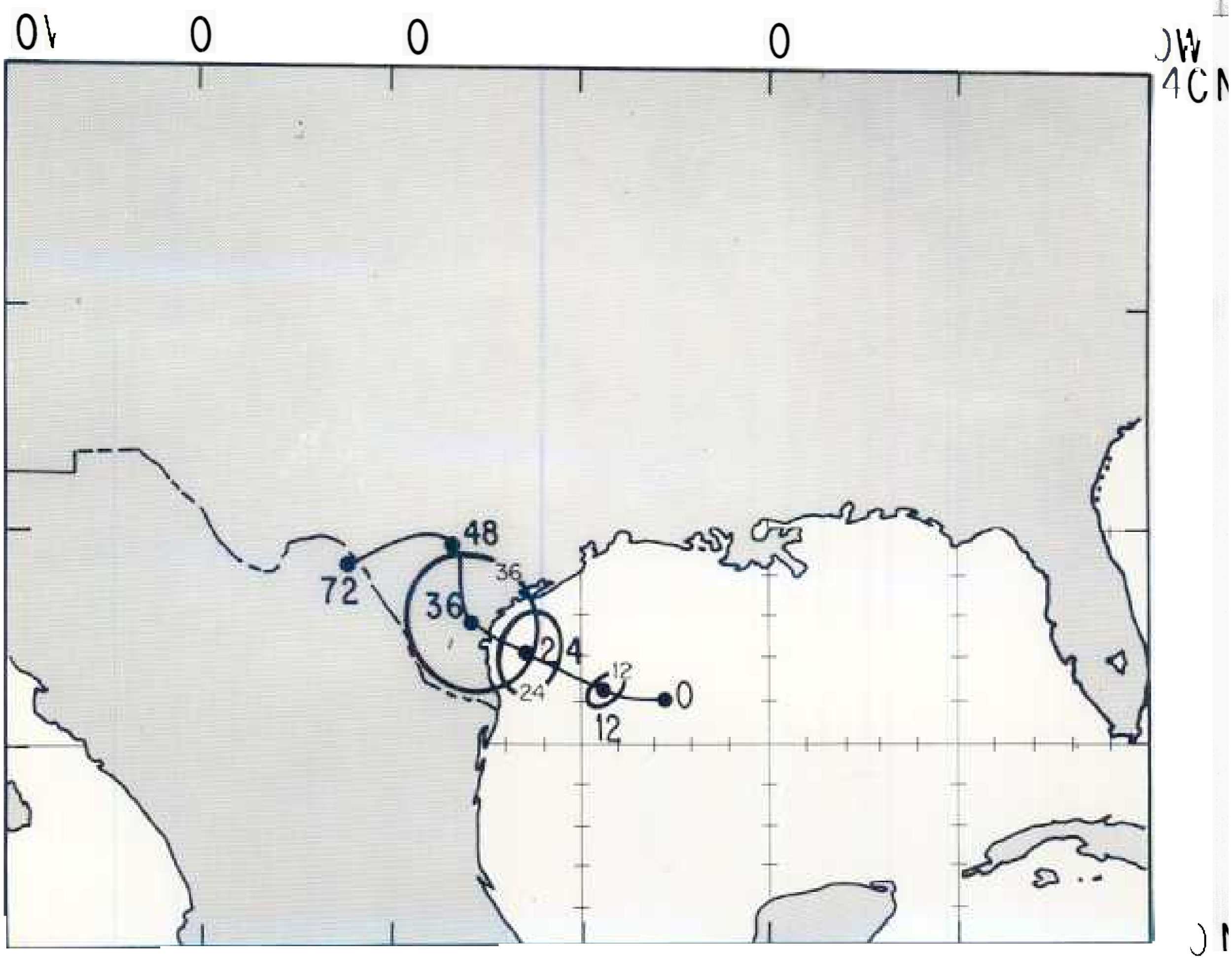
(1) JARVINEN, B. R., AND E. L. CASO, 'A TROPICAL CYCLONE DATA TAPE FOR THE NORTH ATLANTIC BASIN, 1886-1977: CONTENTS, LIMITATIONS, AND USES', NOAA TECHNICAL MEMORANDUM NWS NHC 6, JUNE 1978.
(2) NEUMANN, C. J., G. W. CRY, E. L. CASO AND B. R. JARVINEN, 'TROPICAL CYCLONES OF THE NORTH ATLANTIC OCEAN, 1871-1980', NOAA, NATIONAL CLIMATIC CENTER, ASHEVILLE, N. C., JULY 1981, PP. 174.

CONSULT REFERENCES 1 AND 2 FOR DATA LIMITATIONS.


1896
1906
FREQUENCY


48
72
36
24
12
0

These are determined from the scatter of the analog composites at the respective forecast interval. Other forecast models use the climatological information as one of many pieces of information to determine a forecast track.

Uses of the data also include intensity forecasts from regression analyses of the wind data and determination of pressure wind relationships.

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APPENDIX I A SAMPLE PROGRAM TO READ AND WRITE HURDAT

```
      DIMENSION IDATE(50,5),ALAT(50,4),ALON(50,4),IPED(50,4),IPRE(50,4)
      DIMENSION IA(19),IB(58),ICE(50,4)
      WRITE(6,1)
    1 FORMAT(1H1)
      DO 50 I=1,1000
C     EACH PASS THROUGH DO LOOP 50 READS ONE STORM
      READ(19,2,END=99) (IA(J),J=1,19),M,(IB(J),J=1,58),LSTORM
C     19=HURDAT TAPE.  READ TITLE CARD.  OBTAIN M WHICH GIVES THE
C     NUMBER OF GMT DAYS THAT THE STORM WAS IN EXISTENCE.
    2 FORMAT(19A1,I2,58A1,1X,A1)
      DO 7 II=1,M
C     DO LOOP 7 READS M DATA CARDS AND STORES VALUES IN ARRAYS.
      READ(19,5) (IDATE(II,J),J=1,5),((ICE(II,J),ALAT(II,J),ALON(II,J),
     1IPED(II,J),IPRE(II,J)),J=1,4)
    5 FORMAT(6X,5A1,4(A1,F3.1,F4.1,1X,I3,1X,I4))
    7 CONTINUE
      READ(19,8) IQ
C     READ IDENTIFICATION CARD
    8 FORMAT(6X,A2)
C
C     DATA FOR ONE STORM READ INTO STORAGE.  THE FOLLOWING STATEMENTS
C     WRITE THIS DATA OUT.
C
      WRITE(6,11)
      WRITE(6,12) (IA(J),J=7,19),M,(IB(J),J=1,59)
      DO 9 J=1,M
      WRITE(6,13) (IDATE(J,K),K=1,5),((ICE(J,K),ALAT(J,K),ALON(J,K),
     1IPED(J,K),IPRE(J,K)),K=1,4)
    9 CONTINUE
   11 FORMAT(1H0,/,/,/,2X,40H----------------------------------------)
   12 FORMAT(1H0,10x,13A1,I2,59A1,/,/,20X,5H0000Z,17X,5H0600Z,17x,
     15H1200Z,17X,5H1800Z,/,/,
     27X,4HDATE,2X,4(3HLAT,3X,3HLON,2X,3HVEL,1X,4HPRES,3X))
   13 FORMAT(1H ,5X,5A1,1X,4(A1,F4.1,1X,F5.1,1X,I3,1X,I4,2X))
   50 CONTINUE
   99 CONTINUE
      STOP
      END
```