NOAA Technical Report NWS 35

Pertinent Meteorological Data for Hurricane Allen of 1980

Silver Spring, Md.
September 1983

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Weather Service

NOAA TECHNICAL REPORTS

National Weather Service Series

The National Weather Service (NWS) observes and measures atmospheric phenomena; develops and distributes forecasts of weather conditions and warnings of adverse weather; collects and disseminates weather information to meet the needs of the public and specialized users. The NWS develops the national meteorological service system and improves procedures, techniques, and dissemination for weather and hydrologic measurements, and forecasts.

NWS series of NOAA Technical Reports is a continuation of the former series, ESSA Technical Report Weather Bureau (WB).

Reports listed below are available from the National Technical Information Service, U.S. Department of Commerce, Sills Bldg., 5285 Port Royal Road, Springfield, VA 22161. Prices vary. Order by accession number (given in parentheses).

ESSA Technical Reports

WB 1 Monthly Mean 100-, 50-, 30-, and 10-Millibar Charts January 1964 through December 1965 of the IQSY Period. Staff, Upper Air Branch, National Meteorological Center, February 1967, 7 p, 96 charts. (AD 651 101)

WB 2 Weekly Synoptic Analyses, 5-, 2-, and 0.4-Mb Surfaces for 1964 (based on observations of the Meteorological Rocket Network during the IQSY). Staff, Upper Air Branch, National Meteorological Center, April 1967, 16 p, 160 charts. (AD 652 696)

WB 3 Weekly Synoptic Analyses, 5-, 2-, and 0.4-Mb Surfaces for 1965 (based on observations of the Meteorological Rocket Network during the IQSY). Staff, Upper Air Branch, National Meteorological Center, August 1967, 173 p. (AD 662 053)

WB 4 The March-May 1965 Floods in the Upper Mississippi, Missouri, and Red River of the North Basins. J. L. H. Paulhus and E. R. Nelson, Office of Hydrology, August 1967, 100 p.

WB 5 Climatological Probabilities of Precipitation for the Conterminous United States. Donald L. Jorgensen, Techniques Development Laboratory, December 1967, 60 p.

WB 6 Climatology of Atlantic Tropical Storms and Hurricanes. M. A. Alaka, Techniques Development Laboratory, May 1968, 18 p.

WB 7 Frequency and Areal Distributions of Tropical Storm Rainfall in the United States Coastal Region on the Gulf of Mexico. Hugo V. Goodyear, Office of Hydrology, July 1968, 33 p.

WB 8 Critical Fire Weather Patterns in the Conterminous United States. Mark J. Schroeder, Weather Bureau, January 1969, 31 p.

WB 9 Weekly Synoptic Analyses, 5-, 2-, and 0.4-Mb Surfaces for 1966 (based on meteorological rocketsonde and high-level rawinsonde observations). Staff, Upper Air Branch, National Meteorological Center, January 1969, 169 p.

WB 10 Hemispheric Teleconnections of Mean Circulation Anomalies at 700 Millibars. James F. O'Connor, National Meteorological Center, February 1969, 103 p.

WB 11 Monthly Mean 100-, 50-, 30-, and 10-Millibar Charts and Standard Deviation Maps, 1966-1967. Staff, Upper Air Branch, National Meteorological Center, April 1969, 124 p.

WB 12 Weekly Synoptic Analyses, 5-, 2-, and 0.4-Millibar Surfaces for 1967. Staff, Upper Air Branch, National Meteorological Center, January 1970, 169 p.

NOAA Technical Reports

NWS 13 The March-April 1969 Snowmelt Floods in the Red River of the North, Upper Mississippi, and Missouri Basins. Joseph L. H. Paulhus, Office of Hydrology, October 1970, 92 p. (COM-71-50269)

NWS 14 Weekly Synoptic Analyses, 5-, 2-, and 0.4-Millibar Surfaces for 1968. Staff, Upper Air Branch, National Meteorological Center, May 1971, 169 p. (COM-71-50383)

NWS 15 Some Climatological Characteristics of Hurricanes and Tropical Storms, Gulf and East Coasts of the United States. Francis P. Ho, Richard W. Schwerdt, and Hugo V. Goodyear, May 1975, 87 p. (COM-75-11088)

(Continued on inside back cover)

NOAA Technical Report NWS 35

Pertinent Meteorological Data for Hurricane Allen of 1980

Frances P. Ho and John F. Miller

Silver Spring, Md.
September 1983

U.S. DEPARTMENT OF COMMERCE
Malcolm Baldrige, Secretary

National Oceanic and Atmospheric Administration
John V. Byrne, Administrator

National Weather Service
Richard E. Hallgren, Acting Assistant Administrator

TABLE OF CONTENTS

LIST OF FIGURES

Number		Page

TABLES

PERTINENT METEOROLOGICAL DATA FOR HURRICANE ALLEN OF 1980

Francis P. Ho and John F. Miller
National Weather Service, NOAA
Silver Spring, Maryland

ABSTRACT All available meteorological data for Hurricane Allen, 1980, have been analyzed to provide information as accurate as possible for use in dynamic storm surge models. Detailed analyses are presented of the storm track, forward speed, central pressure, and radius to maximum wind. Particular attention is given to the period surrounding landfall.

1. INTRODUCTION

The purpose of this report is to provide information on a single storm event useful for storm surge modeling. The amount of observed data available from past hurricanes varies greatly and almost all of it requires further analysis and interpretation before it can be of use to storm surge modelers. An effort has been made to gather all the pertinent meteorological information into one report. The amount of data available for any single storm also varies during different portions of the storm's life, from various geographic regions, and from different sections of the hurricane. These data are subject to numerous uncertainties in interpretation. We have attempted to bring this information together to make a comprehensive analysis, to develop an accurate storm track, and to present timely histories of central pressure and radius of maximum winds.

Our intention is to make this report a comprehensive, authoritative source of meteorological information for storm surge modeling. We have tried to provide the quantitative information with as little ambiguity as possible. We have provided the basic data upon which our analysis is based so that the user may judge the degree of uncertainty in our analysis.

This report is the second of a series of reports on pertinent meteorological parameters useful for storm surge modeling. The previous report on Hurricane Carla was published as NOAA Technical Report NWS 32 in August 1982, (Ho and Miller 1982).

2. PREVIOUS REPORTS

The National Hurricane Center (NHC) of the National Weather Service (NWS), National Oceanic and Atmospheric Administration (NOAA), in Miami provided a description of significant features of all Atlantic tropical storms that occurred during 1980, including Hurricane Allen. This information was published in the Monthly Weather Review (Lawrence and Pelissier 1981) and in the National Summary of Climatic Data (NHC 1980). Important features mentioned in regard to Allen were the minimum central pressure of record, the rapid deepening, and the fluctuations in intensity during its life cycle. The appearance of a double eye configuration, inner and outer, was noted from a Brownsville radar picture taken when Allen was 100 nmi off the coast.

Willoughby and Shoreibah (1982) described secondary wind maxima associated with concentric eye walls and the evolution of the hurricane vortex in Allen and a few other hurricanes. They described the sequence of events as reported near Allen's inner core by reconnaissance aircraft on August 5 and 8, 1980. Based on data collected in Allen and other hurricanes, they concluded that an outer maximum is frequently observed to constrict about a pre-existing eye and replace it. They suggest that the concentric eye phenomenon is most frequently observed in intense, highly symmetric systems.

The NHC publication on annual data and verification tabulation for the 1980 Atlantic tropical cyclones (Taylor and staff 1981) also includes a list of Allen's center fix positions obtained by aerial reconnaissance penetrations, satellite images, and land-based radar. The hurricane's central pressure, maximum winds, and other data observed by reconnaissance aircraft are also included in that report.

A smoothed "best" track for Allen has been given in publications previously cited, the Monthly Weather Review and the Climatic Data, National Summary. Cry et al. (1965) combined data from all available sources into a comprehensive report showing the most accurate and consistent locations for all tropical cyclones during their life cycle for the period 1871-1963. Neumann et al. (1981) have extended the period covered and revised earlier tracks where additional data have indicated they were necessary. The objective for these studies was to provide a firm climatological base, treating the tropical cyclone solely on the synoptic scale. Positions were given along the smoothed tracks at daily intervals for the earlier years and at 12-hr intervals subsequent to 1930.

3. SCOPE OF REPORT

Values of meteorological data pertinent for storm surge models are presented in tabular and graphical form in this report. The time period covered in detail starts at 0000 CST on September 9, 1980, and ends at 1200 CST on September 10, 1980. Since we are concerned with storm surge and not with a comprehensive look at the 3-dimensional structure of tropical storms, the data presented are limited to surface observations. Reconnaissance aircraft data and other upper air data are used to determine surface parameters such as track, central pressure, size, winds, etc. A brief history of the storm is provided from its development stage as a tropical depression some 200 nmi east of Barbados until it finally dissipated in northern Mexico on September 11. Detailed analyses were made for the period most important for storm surge generation along the Gulf coast of the United States. For this period, data were analyzed to provide a time history of central pressure, radius of maximum winds, and forward speed. This information is tabulated and presented in table 1 at 3-hr intervals for September 8 and part of September 9 and 10 and at 1-hr intervals for the more crucial time of September 9 and 10.

4. SOURCES OF DATA

The reports discussed in section 2 were used to the maximum extent possible in this investigation. To insure accuracy and completeness of this report and to enable us to provide more detailed information on track position, speed, central pressure, etc., original records were carefully examined. This permitted us to provide the most comprehensive and detailed analysis for this storm of meteorological factors important for storm surge modeling.

Table 1.—Location of storm center, central pressure, and storm size at the surface, hurricane Allen, August 8-10, 1980

Time (CST)	Lat. (°)	Lat. (')	Long. (°)	Long. (')	Central pressure (mb)	Radius of maximum winds (Nautical miles) Primary	(Nautical miles) Secondary	(Statute miles) Primary	(Statute miles) Secondary
August 8, 1980									
0000	22	48	89	12	946	15	65	17	75
0600	23	24	90	30	960	15	65	17	75
1200	23	57	91	48	946	15	65	17	75
1800	24	28	93	00	912	10	65	12	75
August 9, 1980									
0000	25	00	94	15	909	10	64	12	74
0600	25	15	95	21	917	10	61	12	70
1200	25	22	96	08	922	10	55	12	63
1300	25	28	96	15	925	10	53	12	61
1400	25	34	96	17	927	10	52	12	60
1500	25	38	96	22	930	10	51	12	59
1600	25	41	96	28	931	10	49	12	56
1700	25	43	96	34	932	49	10	56	12
1800	25	46	96	39	934	48	10	55	12
1900	25	49	96	44	937	47	10	53	12
2000	25	52	96	48	940	46	10	52	12
2100	25	56	96	54	942	44	10	51	12
2200	26	01	96	59	944	43	10	49	12
2300	26	06	97	06	945	41	10	47	12
August 10, 1980									
0000	26	12	97	11	946	40	10	45	12
0100	26	19	97	14	947	39	10	44	12
0200	26	24	97	18	948	38	–	43	–
0300	26	29	97	22	948	37	–	43	–
0400	26	36	97	31	949	37	–	42	–
0500	26	43	97	40	949	36	–	41	–
0600	26	50	97	49	950	36	–	41	–
1200	27	13	99	00	967	36	–	41	–
1800	27	42	99	48	990	36	–	41	–

The basic information is obtained from the regular reporting network of weather stations operated by National Weather Service (NWS), NOAA. These reports are part of the nation's historic weather records and are maintained at the National Climatic Data Center (NCDC), National Environmental Satellite Data and Information Service (NESDIS) NOAA. Additional data routinely stored in various forms are ship weather observations, radar weather observations, radiosonde records, and weather reconnaissance flight data. Ship weather observations are available on magnetic tape and radarscope photographs are on microfilm.

In addition, the meteorological data collected by research aircraft of NOAA's Research Facilities Center (RFC) were processed as computer printouts of flight data, flight-level wind information, and other meteorological information. These listings are stored on microfilm and magnetic tapes at the Hurriane Research Division of NOAA's Atlantic Oceanographic and Meteorological Laboratory (AMOL) in Miami, Florida. This information was made available to us for this report. A detailed description of the collection of meteorological information by aircraft, including the instrumentation, its calibration, and reliabilities, was first published in the National Hurricane Research Project (NHRP) Report No. 52 (Hawkins et al. 1962). A recent evaluation of in-flight calibration of the NOAA/RFC research aircraft instruments during 1977-78 was published in a NOAA Technical Memorandum ERL RFC-6 (Merceret et al. 1980). These publications provide the most recent discussion of the calibration and instrumentation of the NOAA research aircraft.

In addition to the network of regular reporting stations, observations are taken by many private individuals and corporations for their own use. In some cases, this material is filed with NCDC as part of NOAA's Cooperative Reporting Network.

5. GENERAL METEOROLOGICAL SITUATION

Hurricane Allen originated near Cape Verde Islands, off the west coast of Africa, and developed into the second most severe Atlantic hurricane in modern records. It reached tropical storm strength in the early hours of August 2 1980, and attained hurricane strength in the evening. Its central pressure dropped to 951 mb by the evening of the 3rd as the eye passed just north of Barbados and south of St. Lucia (figure 1). The hurricane continued westward into the Caribbean at about 20 kn and passed south of Puerto Rico during the evening of the 4th. Its central pressure deepened and reached 911 mb, the lowest pressure ever recorded in the eastern Caribbean, on the early morning of the 5th.

The hurricane weakened as it passed the southwest tip of Haiti late on August 5 and moved between Jamaica and Cuba on the 6th. This was the first of three strengthening-weakening cycles that are unprecedented in hurricane records. Allen continued on a west-northwesterly course, passed almost directly over the Cayman Islands, and reintensified rapidly as the circulation moved over the warm waters of the northwestern Caribbean Sea. Arriving at the Yucatan Channel on the 7th, its central pressure deepened to 899 mb, the lowest pressure ever observed in the western Caribbean and the second lowest ever recorded in the Atlantic. The central pressure was only 7 mb higher than the 892 mb recorded in the Labor Day, 1935 storm that struck the Florida Keys.

The hurricane weakened for the second time when it moved over shallow waters off the north coast of Yucatan peninsula. Its central pressure rose very rapidly, reaching 961 mb on the morning of the 8th. As the hurricane continued west-northwestward across the warm open water of the Gulf of Mexico, Allen deepened once again with a minimum pressure of 909 mb observed during the night of the 8th. Figure 2 shows a satellite photograph of Allen during the night of August 8, when it was at its minimum central pressure over the Gulf of Mexico.

As the hurricane approached the Texas coast on the 9th, its intensity weakened and the forward speed decreased. Allen held on to its west-northwesterly course until mid-day and turned northward and then northwestward. After crossing the

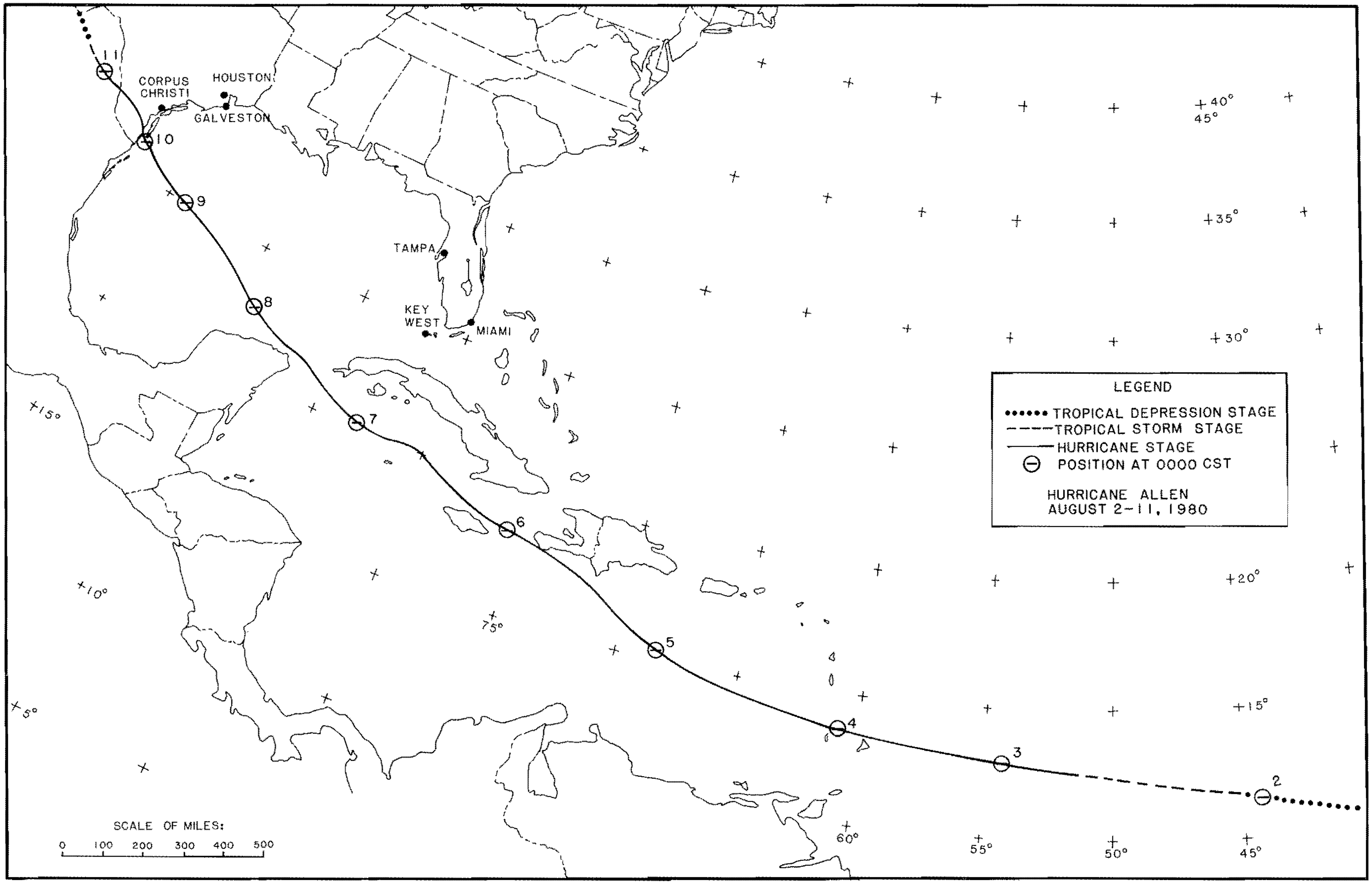

Figure 1.--Hurricane track, August 2-11, 1980, for Hurricane Allen.

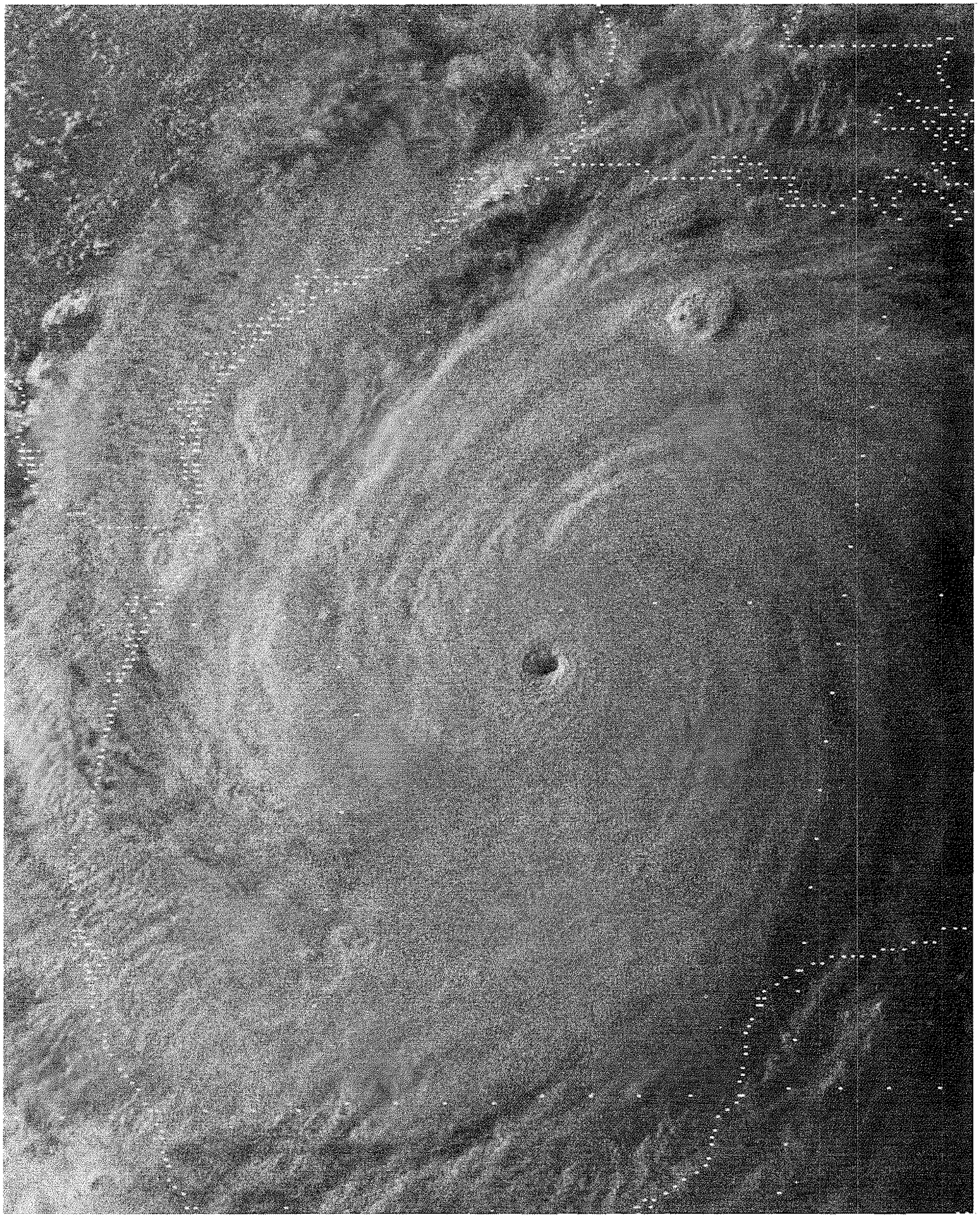

Figure 2.--Satellite photograph for August 8, 1980.

southern end of Padre Island just northeast of Brownsville, Texas, Allen continued on a northwesterly direction. By early morning on the 10th, Allen moved inland at a slightly faster speed and turned gradually towards the west-northwest. In the early afternoon, the hurricane passed just south of Laredo, Texas and moved into Mexico. On August 11, Allen was downgraded to a tropical storm and finally dissipated over the mountainous terrain of northern Mexico.

In addition to the damage from the hurricane winds and storm surge, Hurricane Allen also spawned at least a dozen tornadoes over Texas. Rainfall from Hurricane Allen did not approach the extremes of some other recent storms, such as Agnes in 1972. Still, rainfall amounts up to 20 in. fell across a wide swath over the southern parts of the state.

6. DETAILED METEOROLOGICAL ANALYSIS

A primary focus of this report is to analyze objectively, and in detail, those meteorological factors of hurricanes used in storm surge models. For this purpose, we decided to begin with the raw observational data in order to obtain an unbiased review of all available information. This section describes these analyses. The intent of these analyses is to yield specific values of the hurricane's central pressure, the radius of maximum winds, the direction and speed of its forward motion, and the location of its center at various time intervals. Particular attention was focused on the period just before and after the hurricane made landfall since this is the time interval most critial for storm surge computation. The basic observational data used in these analyses are given in the appendix.

6.1 Storm Track

Generally, the analyses of meteorological data are weighted toward synoptic-scale motion. The hurricane track, thus obtained, is the best estimate of the large-scale storm motion and not a precise location of the eye at discrete time intervals. Therefore, such an analysis of the large-scale motion does not precisely describe the track needed for storm modeling. Track differences of a few miles, insignificant in determining the large-scale motion, can be significant for replicating high water on the open coast and inside bays and estuaries. A surge model requires, among other factors, specific information on the precise landfall point, the time of landfall, and accurate positions at closely spaced intervals in time along the hurricane track for 24-hr prior to and after the hurricane's landfall or along the track while the hurricane is by-passing the coast.

The analysis of this report emphasizes the meteorology in greater detail during August 9-10, when Hurricane Allen was approaching and crossing the Texas coast. The final track determined for Hurricane Allen from 0000 CST August 8 through 0000 CST August 11 is shown in figure 3, with locations of the meteorological stations used in this report. The stations are either National Weather Service offices or military installations, except for Raymondsville and Port Mansfield, and regularly report to the National Weather Service. The positions of the center of the hurricane are shown at 6-hr intervals from 0000 CST August 8 to 11. The central pressure (mb) and the radius of maximum winds (st. mi) are plotted to the left of 12-hr positions.

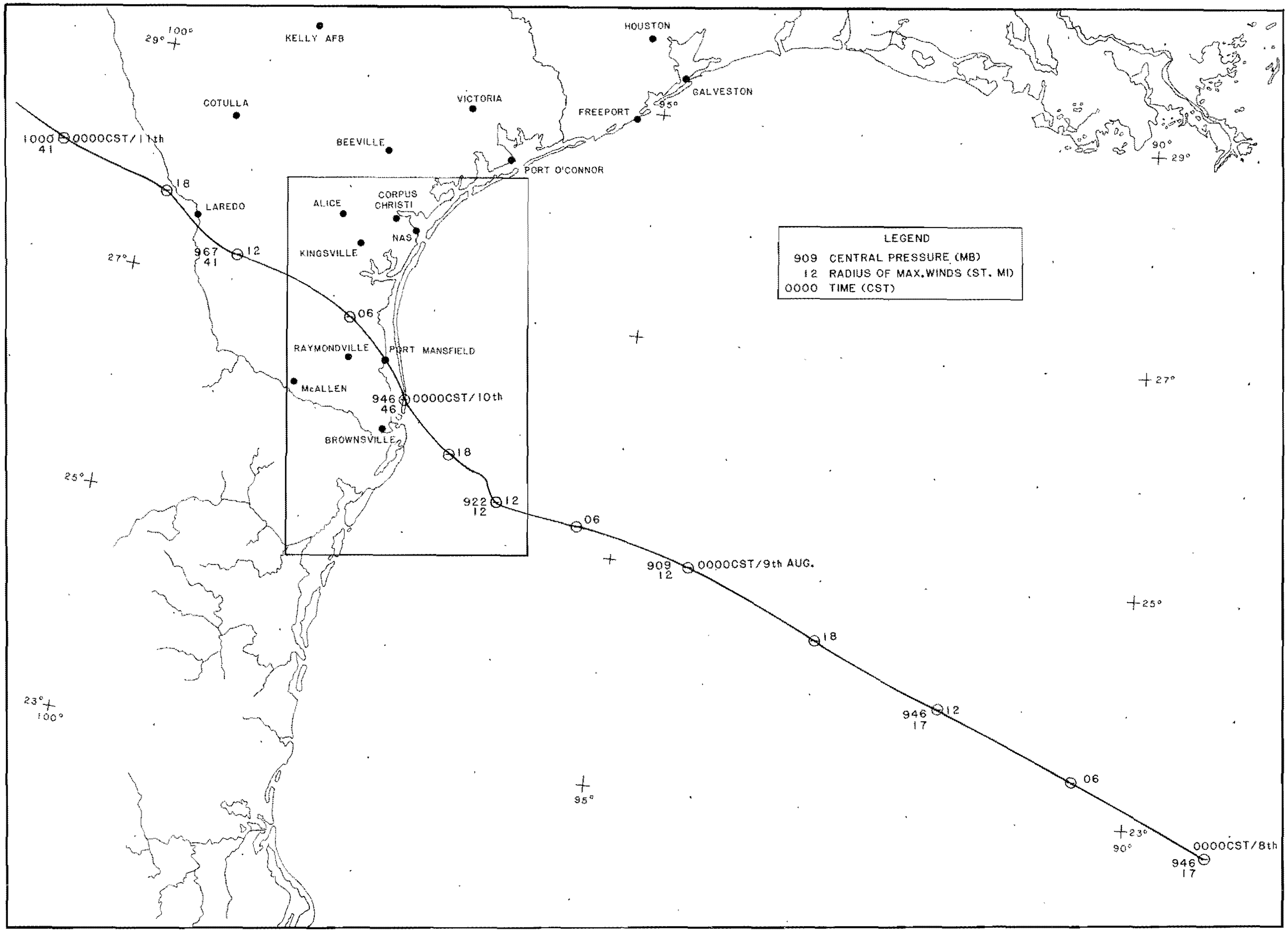

Figure 3.--Hurricane track showing positions every 6 hr from August 8 to 11, with central pressure (mb) and radius of maximum winds (st.mi.) plotted at 12-hr intervals.

Since the interest in this report is a detailed determination of the path of the hurricane immediately before and after landfall, the area nearest the coast, enclosed in the box on figure 3, is enlarged for greater clarity in figure 4. The hurricane locations at hourly intervals are indicated by open circles. The time at every other hour, together with values for the central pressure (mb) and radius of maximum winds (st. mi), are shown along the track. In addition to regularly reporting weather stations, observations by satellites, personnel of private industries, private individuals, and eyewitnesses were useful aids in determining the storm track.

Any final determination of the track and speed of forward motion of a hurricane, especially over data sparse regions, has inherent uncertainties. The selected track is finalized from a subjective analysis to account for all available information. Figure 5 is an example of the information used in our analysis. Hurricane eye positions based on radar weather observations reported from Brownsville and Corpus Christi, Texas are shown as solid dots. Aircraft reconnaissance penetration fixes are shown by triangles. Locations of the hurricane's center determined from satellite observations are given by diamonds. The selected track, fitted by eye and guided by bias in center location, is presented by the solid curve. Locations at 6-hr intervals, with the time indicated, are shown by open circles.

The data from radar fixes and aircraft penetrations are the primary resource used in determining the track and speed of forward motion of the hurricane over the open ocean. However, information obtained from satellite observation and from all ships operating in the area was considered in determining the final track and speed of motion. The information from each of these sources was carefully evaluated before a final track was selected.

The track position selected (figure 5) deviates from the average radar position line along almost the full length of the track. We chose to follow a more northerly track that relies heavily on aircraft reconnaissance fixes. Radar locations are based upon echo returns from the wall cloud. These have shown some bias in location relative to the pressure and wind center, our primary interest. Pressure, wind, and dropsonde observations obtained by aircraft penetrations are usually more accurate than radar eye fixes in determining the pressure/wind center. Center positions determined by aircraft must, of course, be evaluated in terms of possible navigational instrument error. Holliday (1966) compared reconnaissance aircraft center fixes with the best-fit radar track of the eyes of seven hurricanes obtained by coastal radars. Results of the comparison indicate that the maximum differences vary from 13 to 37 nmi in individual hurricanes.

Aircraft reconnaissance fixes near 0000 CST on the 10th (figure 5) were based on airborne radar observations. These positions seem to be biased in a similar manner as those obtained from land-based radar observations. We decided to ignore these two reconnaissance fixes at the coast and adopted a track crossing the barrier island in a north-northwesterly direction instead of a westerly direction. This is supported by wind observations at Port Mansfield, Texas, and an eyewitness report of calm winds as the eye of the hurricane passed over the station (Hagan 1982).

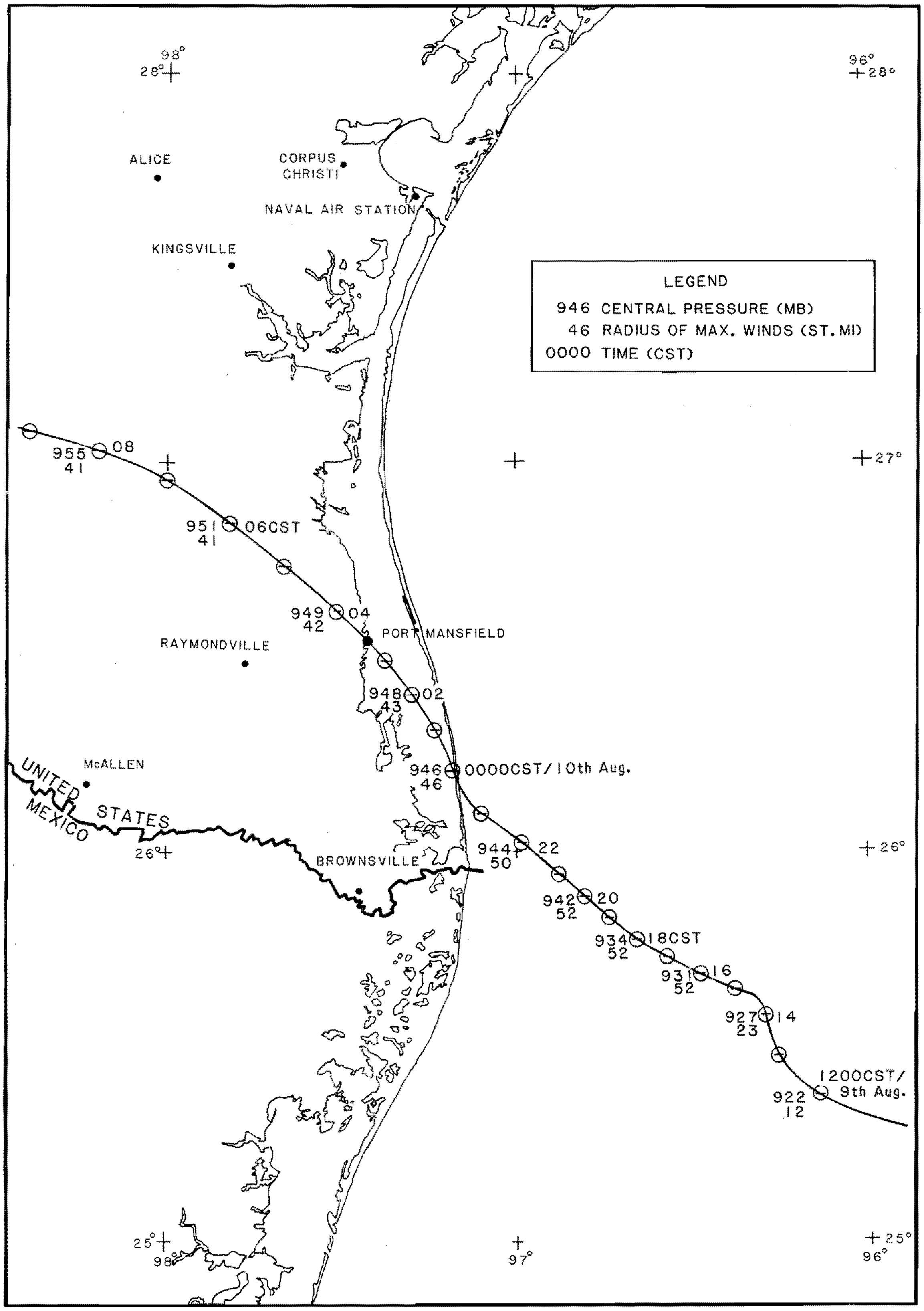

Figure 4.--Hurricane track showing positions at 1-hr intervals from 1200 CST on August 9 through 0900 CST on August 10, 1980, with central pressure (mb) and radius of maximum winds (st. mi.)plotted at 2-hr intervals.

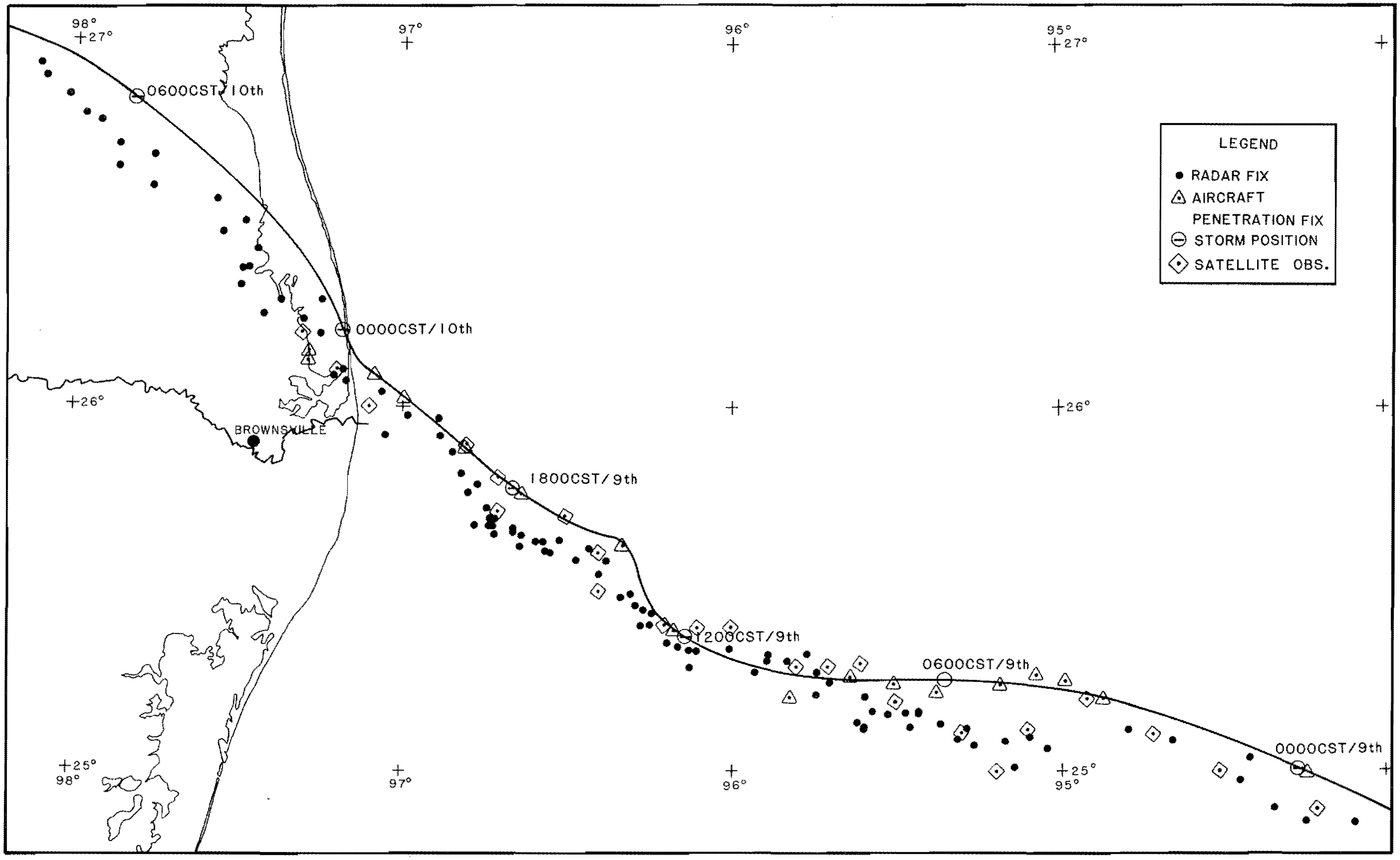

Figure 5.--Hurricane eye center obtained from radar weather observations (.), aircraft reconnaissance penetration fixes (△), and satellite observations (◇) together with positions of hurricane center (⊖) on the selected track.

6.2 Forward Speed

The translation speed of the hurricane is another important ingredient in determination of the surge along the open coast and in bays and estuaries. Hourly positions were the basic building blocks for determining this forward speed of translation. First, speeds between successive hours from initial positions along the best track were determined and plotted on a time scale, and a smooth curve was drawn subjectively to minimize abrupt changes. Second, speeds from three successive hours were averaged and plotted at the mid-hour, and smooth curves drawn from these data were used to adjust the hourly locations. The new locations were examined with regard to the observed data and, if necessary, some further adjustments were made. This process was continued in an iterative fashion until the best combination between smooth forward speeds and observed eye postions was obtained. This process helped to obtain the best possible estimate of forward speed and hourly locations.

Figure 6 shows the forward speed of Allen which was unusually fast after its rapid development east of the Lesser Antilles and westward movement into the Caribbean. Its average speed stayed at about 20 kn until its center reached the north-western Caribbean Sea. The hurricane then decelerated as it moved into the Gulf of Mexico. Its forward motion slowed to a speed of about 15 kn on August 8 and to about 10 kn on the early morning hours of the 9th. There was a further distinct slowing of forward progress in the afternoon of the 9th when Allen was about 50 nmi from the Texas coast. Its center moved at an average speed of about 6 kn for a period of 12 hr (0900-2100 CST) on the 9th and then crossed the barrier inland (092100-100300 CST) at an average speed of 7 kn. After moving inland on the 10th, Allen continued slowly northwestward at about 10 kn into the mountains of northern Mexico.

6.3 Central Pressure

The most important factor in storm surge models is the intensity of the hurricane which is directly related to its central pressure. Figure 7 shows the finalized track of Hurricane Allen as the storm crossed the Texas coast. Also shown are minimum pressures observed at regular reporting stations and minimum pressures obtained during reconnaissance aircraft penetrations. These observations were not all obtained at the same time. Since the storm track did not cross any land station location, none of the values reported at land stations are equal to the minimum central pressure in the storm.

Figure 8 shows our analysis of the pressure information from land stations and aircraft reconnaissance flights that was used to obtain a time history of Allen's minimum pressure. The curve drawn is, in general, a curve fitted to the data by eye. Allen deepened for the third time in its lifespan on the evening of August 8th. A minimum pressure of 909 mb, observed by aircraft reconnaissance at 2358 CST on the 8th, was the lowest reading ever recorded in the western Gulf of Mexico. We considered this pressure to be the lowest that occurred in Hurricane Allen as it approached the coast. The short time interval between central pressures obtained by aircraft, combined with other information, did not indicate any lower pressure at intermediate times. As Allen continued its course west-northwestward, approaching the Texas coast, its intensity weakened. While the hurricane's central pressure rose steadily, the characteristics of its inner core region (as indicated by its eye wall structure and maximum wind distribution) appeared to have undergone dramatic changes. We shall first look into pressure

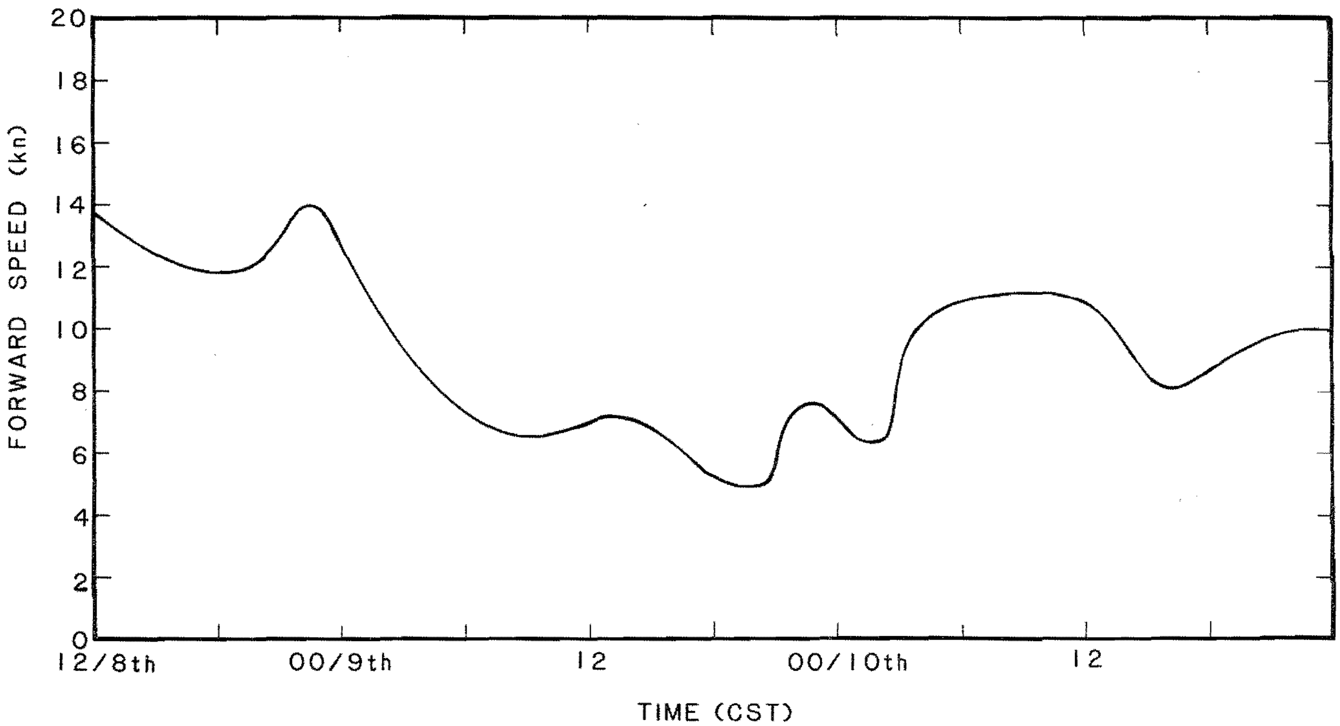

Figure 6.—Variation of forward speed with time, Hurricane Allen, August 8-10, 1980.

changes at individual stations; discussions of other phenomena are presented in subsequent paragraphs.

Sea-level pressure recorded at coastal stations was used to examine the pressure variation during the period when Allen approached the coast and moved inland. Hourly observations of sea-level pressure recorded at Brownsville and Kingsville, Texas were plotted against time and the distances of the hurricane's center from each station at various times as determined from Allen's track (figure 3). By further examining the rate of pressure change at each station and in Allen, we assess the extent to which the pressure variations at individual stations can be related to the movement of the large-scale pressure distribution of the hurricane.

Figure 9 shows a plot of hourly observations of sea-level pressure against time recorded at Brownsville, Texas (dots) with solid lines joining the data points. The distances of the hurricane's center from the station at the time of observation are shown in circled dots and joined by the dashed lines. These curves indicate that the pressure variation at Brownsville appears to be closely related to the distance from the hurricane's center, especially when Allen was within 85 nmi of the station. The rate of pressure drop averaged about 1.7 mb per hour when Allen was within the 85-nmi range. The rate of pressure drop was comparatively small when the hurricane was farther away from the station.

Figure 10 shows similar data from Kingsville, Texas. The curves for Kingsville reveal a rapid pressure fall on the 9th when the center of the hurricane was about 100 nmi from the station. For the 8-hr period starting from 2200 CST, the

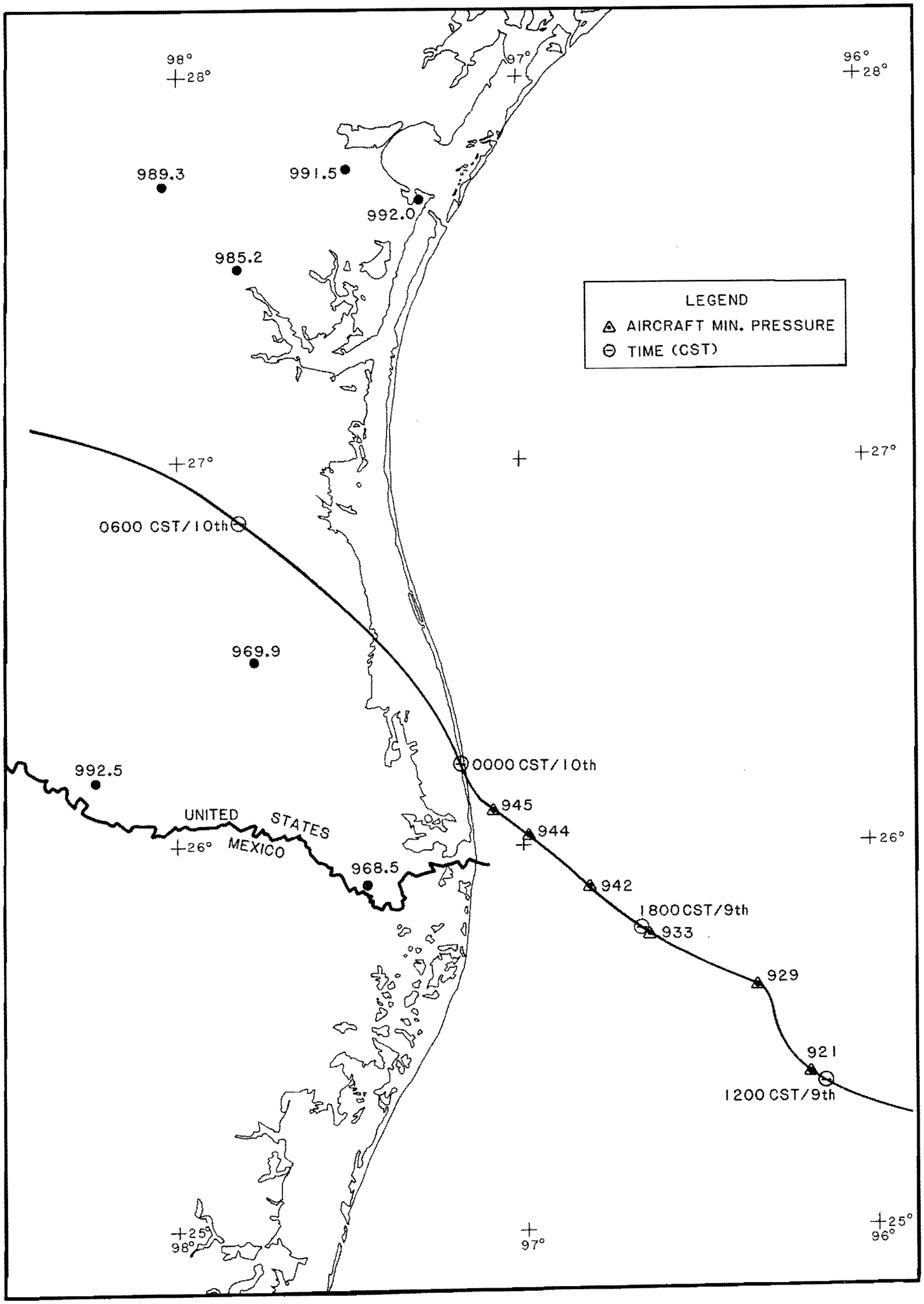

Figure 7.—Minimum pressure recorded at land stations and by aircraft reconnaissance during Hurricane Allen for period 1200-2300 CST on August 9, 1980.

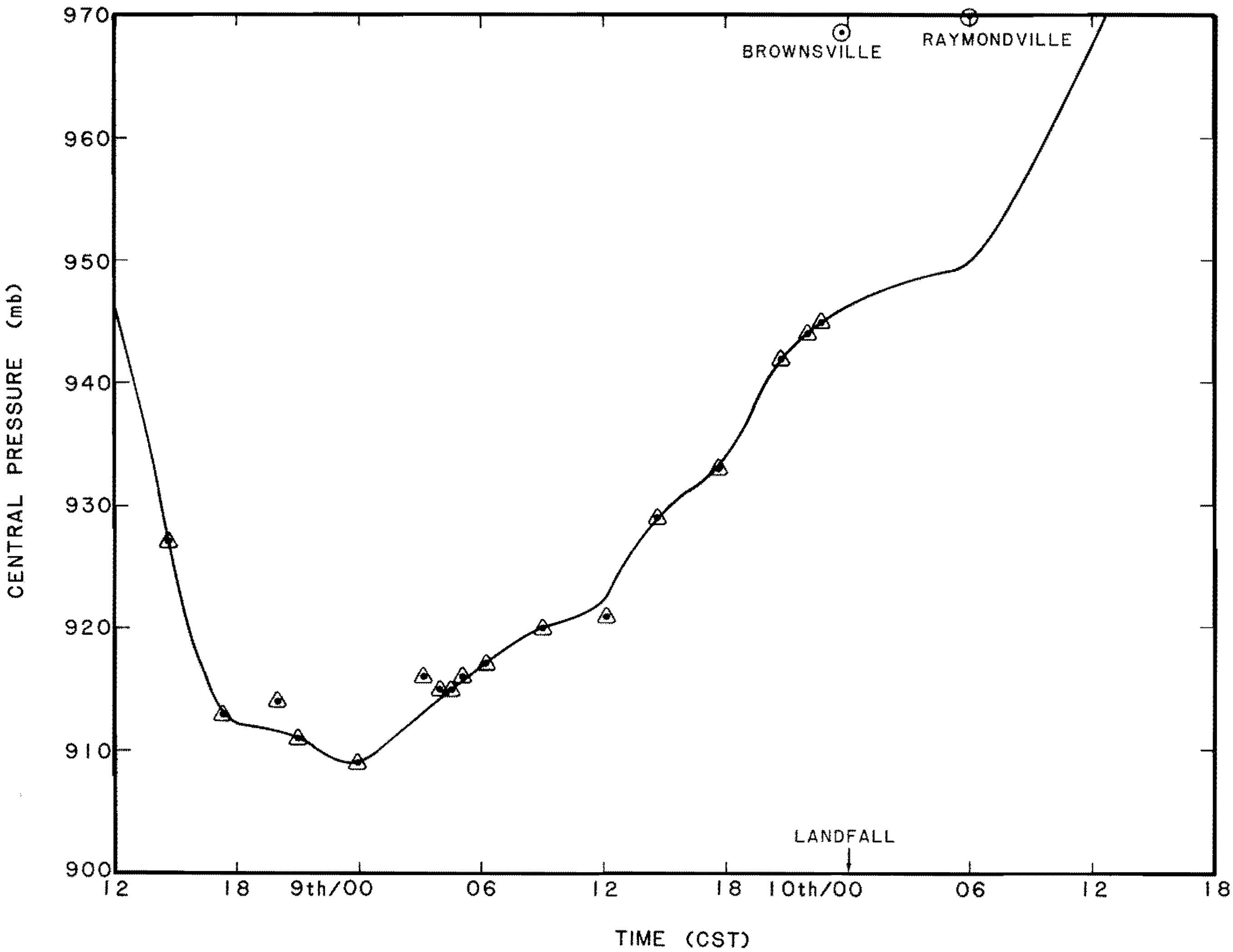

Figure 8.—Variation of central pressure with time, Hurricane Allen, August 8-10, 1980.

average drop in pressure at the station amounts to approximately 1.65 mb per hour which is almost the same as that observed at Brownsville (figure 9). It is of interest to note, as a comparison, the rate of falling central pressure in Allen during one of the rapid deepening stages in its life cycle. Allen's central pressure dropped at an average rate of 4.0 mb per hour over a 12-hr period from 0600 to 1800 CST on August 8 when Allen was located in the western Gulf of Mexico (Lawrence and Pelissier 1981). This change in intensity is another factor (among others) that influences pressure changes at individual stations. The central pressure in Hurricane Allen rose steadily prior to the time of landfall (figure 8). It was 909 mb at midnight on the 8th, 922 mb at noon on the 9th, and reached 946 mb in the next 12 hr when Allen crossed the coast. The weakening of the hurricane, as indicated by increasing central pressure with time, moderated the rate of falling pressure at land stations during the period of Allen's approach.

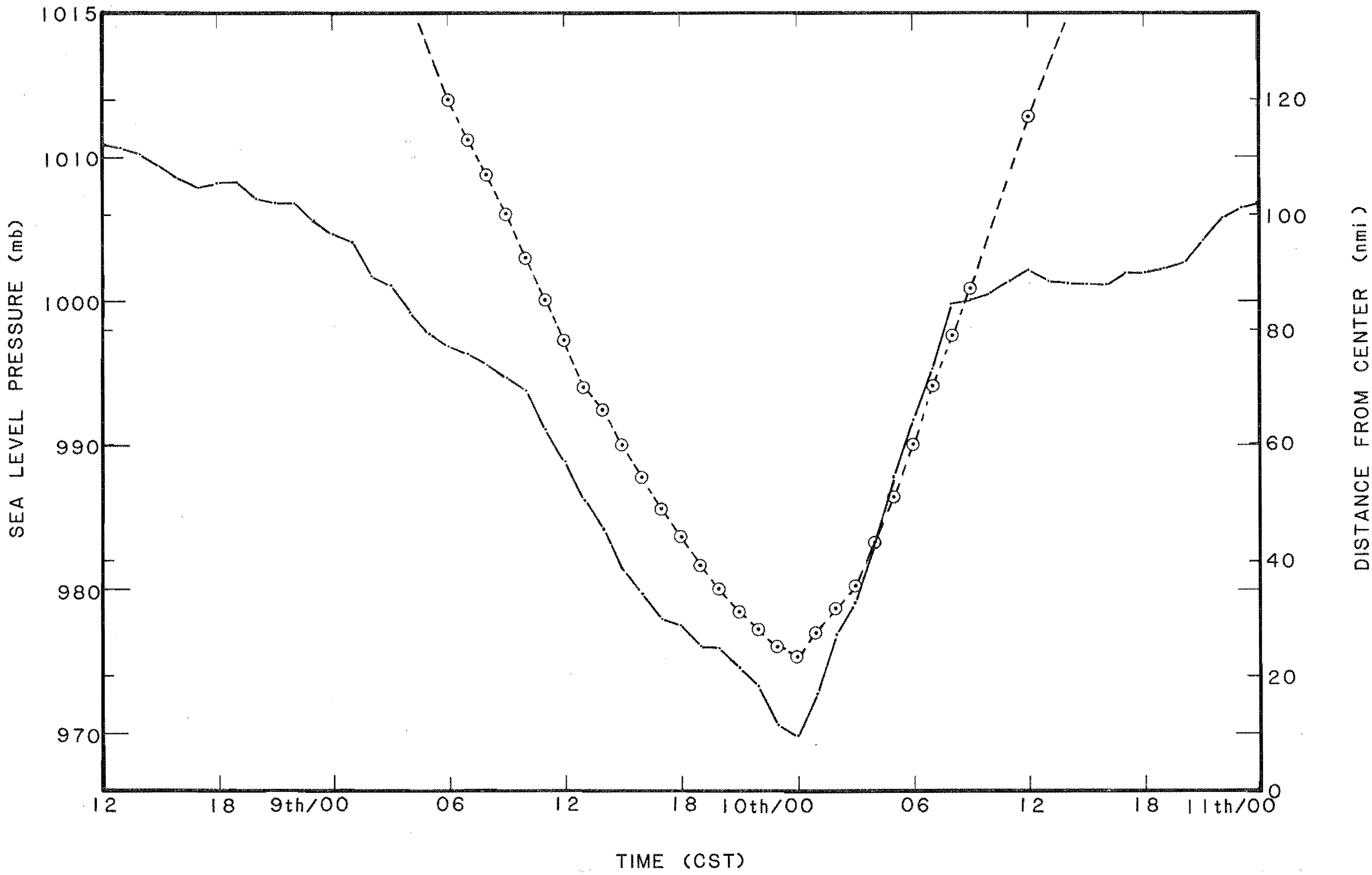

Figure 9.—Hourly observations of sea-level pressure recorded at Brownsville, Texas (.) and distance of Allen's center from station (⊙) for period 1200 CST on August 8 through 2400 CST on August 10.

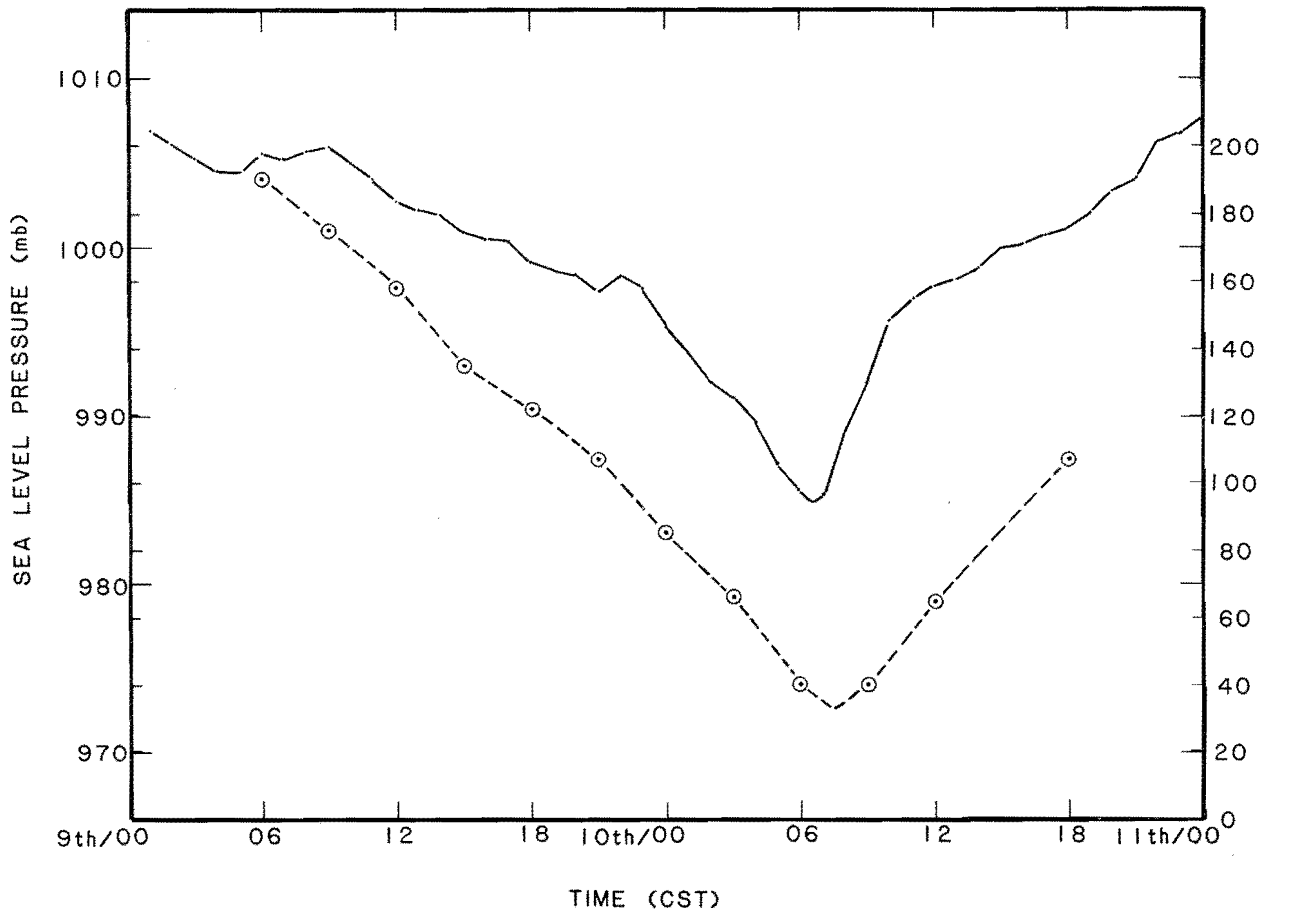

Figure 10.—Same as figure 9, for Kingsville, Texas.

6.4 Wind Analysis

We analyzed the wind field for Allen in two ways. We first examined the wind observations of the regular reporting land stations. Next, we did a streamline analysis of the windfields at the 6-hr intervals for the period from 0600 CST August 8 through 0000 CST August 10. This wind analysis was used to aid in the determination of the radius of maximum wind. It also provided some guidance in determining the best track.

6.4.1 Analysis of Observed Winds at Weather Stations

Supplemental to the minimum pressure reported at stations during hurricane passage, surface winds were reported at several weather stations operated by the National Weather Service, the military services, and other federal agencies such as Coast Guard stations and FAA operated airport facilities. We attempted to relate the variation of surface wind speed to the distance of the storm's center from the station in the same manner described for pressure variation at individual stations. Figure 11 shows a plot of the time variation of hourly wind speed recorded at Brownsville, Texas (solid curve) and the distance of the storm's center from the station (circled dots plotted at hourly intervals). The resultant magnitudes, after the storm's speed of translation was subtracted from the observed wind speed, are also shown in the diagram (dashed line). These give

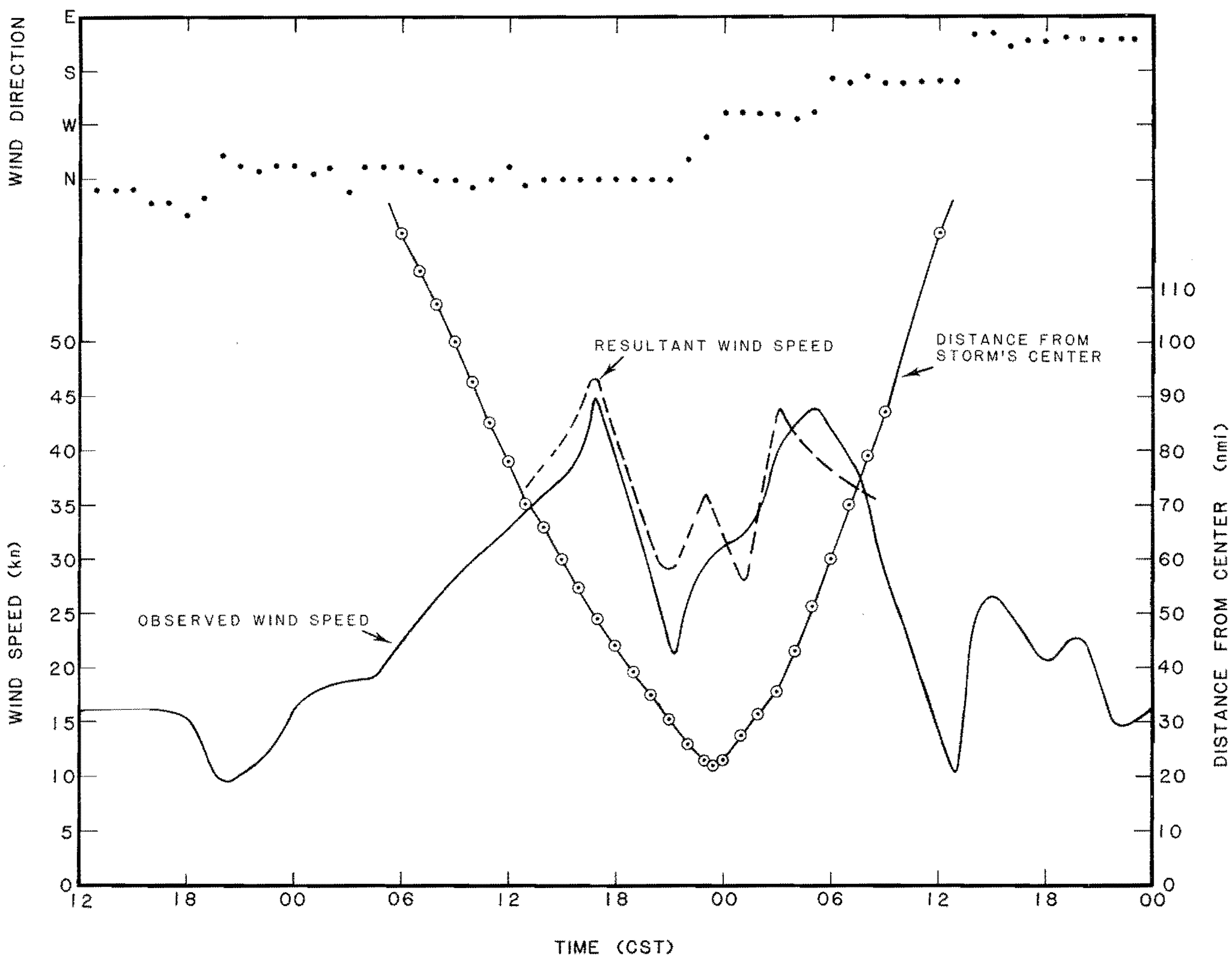

Figure 11.--Hourly observations of wind speed and distance of Allen's center from Brownsville, Texas for period 1200 CST on August 8 through 2400 CST on August 10, 1980.

the wind speeds relative to the storm's center. The observed wind directions at hourly intervals are shown by dots at the top of the diagram. The solid curve reveals that the maximum wind at Brownsville was observed at 1645 CST on the 9th when Allen was about 49 nmi to the east. A second maximum appeared at 0500 CST when the hurricane's center, moving away from the station, was located at a distance of 50 nmi. This second maximum relative to the storm's center actually occurred 2 hr earlier, and the distance from the storm's center was 35 nmi when the speed of its forward motion was subtracted from the observed wind speed (dashed line). In general, there is an inverse correlation of the wind speed and the distance from the storm's center except for winds inside the radius of maximum winds. The dashed line indicates that a small fluctuation of the wind speed occurred inside the region of wind maxima.

A similar plot of hourly winds for Kingsville, Texas (diagram not shown) shows that the time variation of wind speed at Kingsville also was closely correlated with distance from the storm's center. A maximum observed wind of 60 kn occurred when the storm's center was 35 nmi south of the station.

6.4.2 Streamline Analysis of Surface Charts

Since surface data were too limited and scattered to make an analysis of the winds when the hurricane was located some distance off the coast, all reconnaissance aircraft observations within intervals of several hours were combined and plotted on surface charts. In the course of penetrating the center, aerial reconnaissance recorded flight-level winds within a 100-nmi radius of the hurricane's center. No ship report was nearer than 70 nmi to the center. Surface charts at 6-hr intervals were analyzed for the period from 0600 CST (1800 GMT) August 8 through 0000 CST (0600 GMT) August 10 (figures 12a through 12g). Observations at coastal stations and ship observations taken at map time were plotted on the appropriate charts. Flight-level winds and observed minimum pressure reported by reconnaissance aircraft within 6-hr of map time were also plotted.

As a supplemental aid in the streamline analysis, the position of each observation taken in aerial reconnaissance was measured in terms of azimuth angle and radial distance relative to the hurricane's center at the time of observation. Each wind observation was then transposed to the location relative to the hurricane's center. These transposed observations are not shown in the charts. For the purpose of illustration, examples of two transposed wind observations were plotted on figure 12a. Flight-level wind of 170°/80 kn was observed at 081840 GMT when the reconnaissance aircraft was located at 23.7°N, 90.5°W. This information was plotted on the chart for 081800 GMT. We then obtained the location of the hurricane's center at the time of observation (081840 GMT) by interpolation of hourly positions given by the hurricane tracking charts (figures 3 and 4). The next step was to measure the location of the plotted observation relative to the hurricane's center at the time of observation, yielding an azimuth angle of 103° and a radial distance of 72 nmi. Using this relative location, the observation was transposed to a location relative to the hurricane's center and plotted on the chart with the wind direction and speed underlined. The transposed location on the chart is just slightly east of the location shown for the observation. Similarly, the observed wind of 070°/85kn was plotted at the location with azimuth angle of 315° and a radial distance of 61 nmi, relative to the hurricane's center.

Figures 12a through 12g show the stream analysis of winds within the hurricane's circulation at 6-hr intervals from 1200 CST (1800 GMT) on August 8 through 0000 CST (0600 GMT) on August 10. Isotach patterns are shown in dashed lines. The maximum flight-level winds reported near the eye are not shown on the charts to make room for a clear illustration of the isotach pattern near the center. These maximum flight-level winds are shown in figure 13 and listed in table A.3 of the appendix. From 1200 CST August 8 through 0000 CST August 9, the hurricane was in a rapidly deepening stage. The central pressure dropped from 946 mb to 909 mb (figure 8). A maximum flight-level wind of 145 kn was reported at 1719 CST on August 8 at a radial distance of 10 nmi. During the same period, an area of secondary wind maximum appeared on each of the three charts (figures 12a, b, and c) at a radial distance of 60-65 nmi. Winds of 80-85 kn were reported in this area throughout the 12-hr period and remained the same for

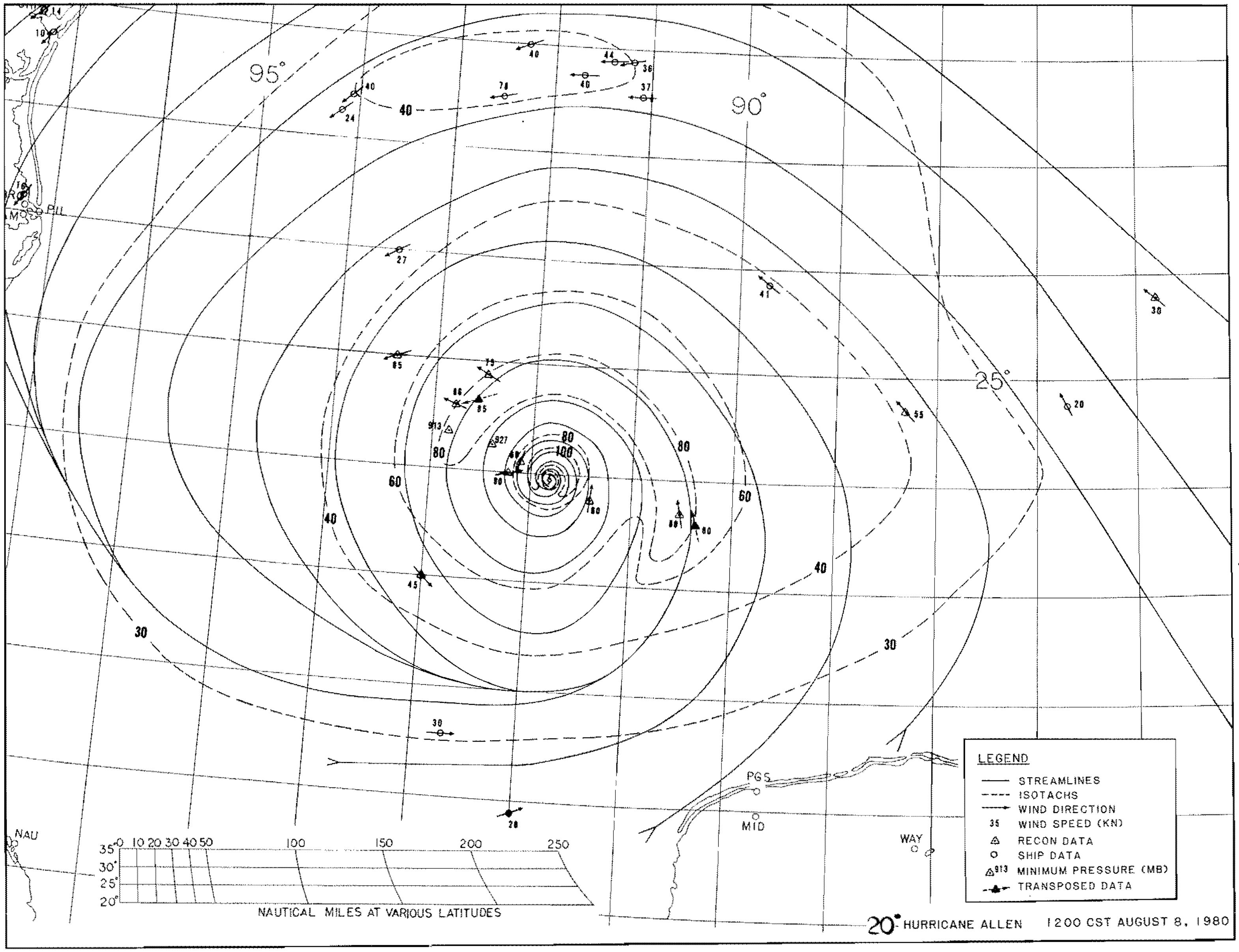

Figure 12a.--Streamline analysis, 1200 CST (1800 GMT), August 8, 1980.

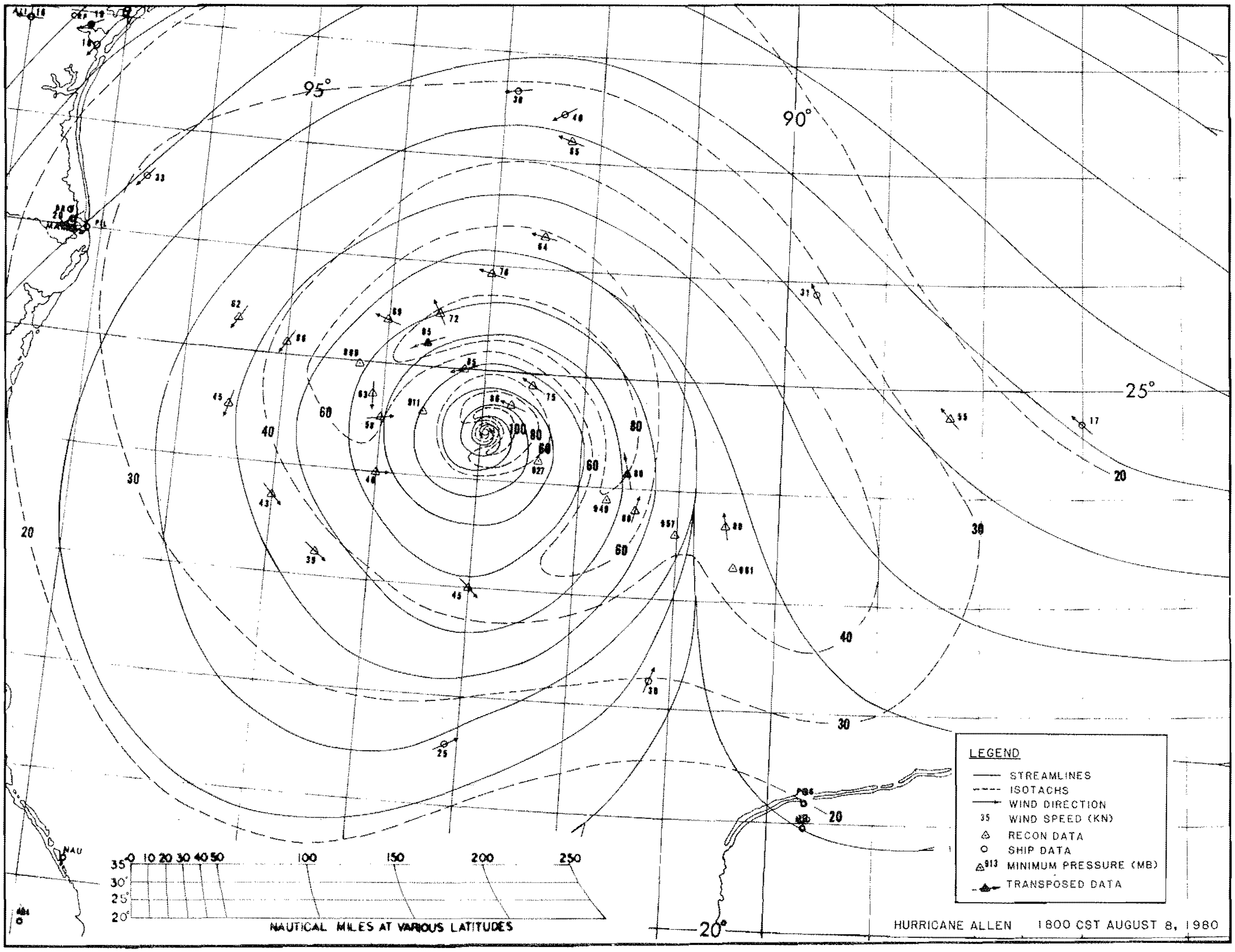

Figure 12b.--Streamline analysis, 1800 CST, August 8, 1980.

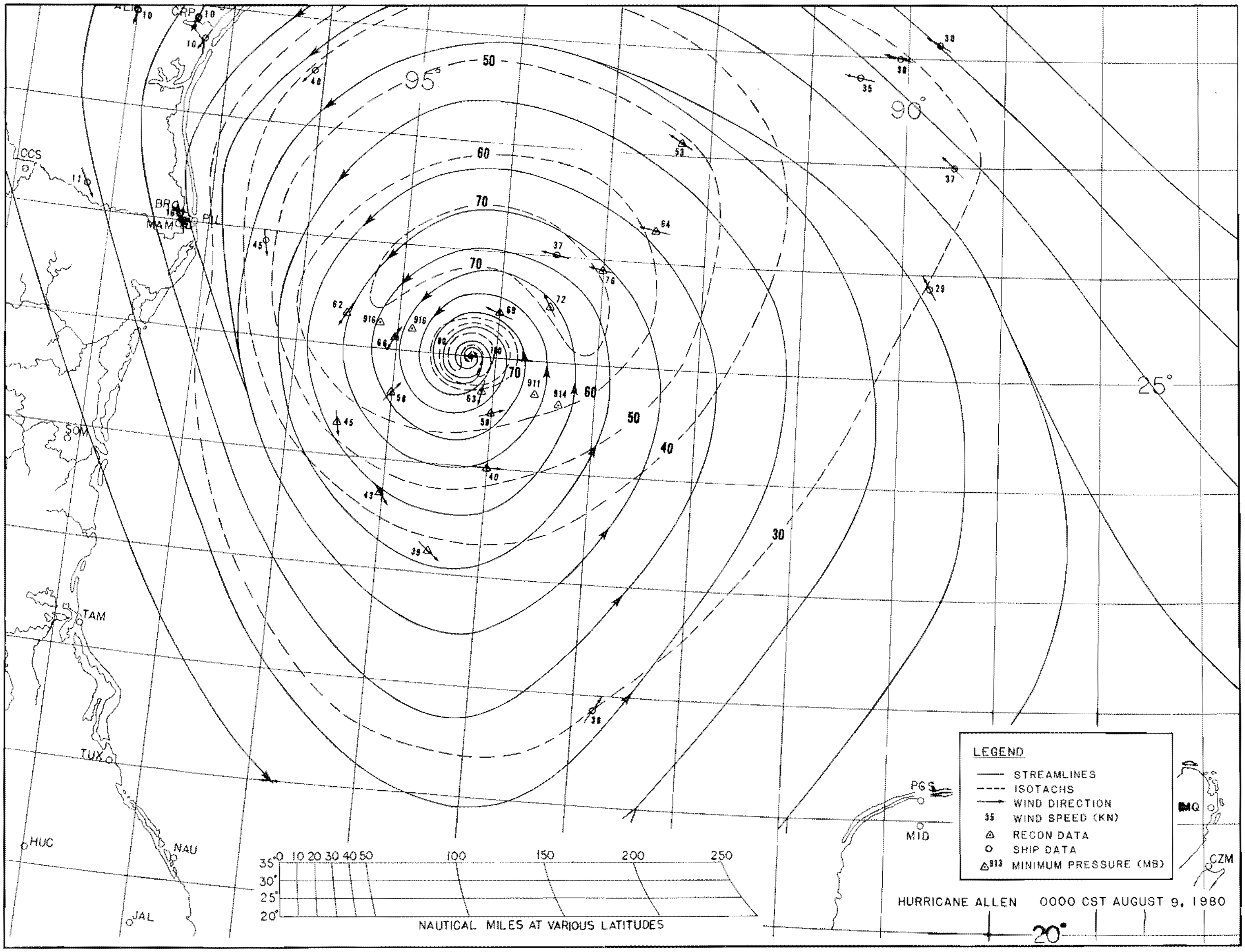

Figure 12c.--Streamline analysis, 0000 CST, August 9, 1980.

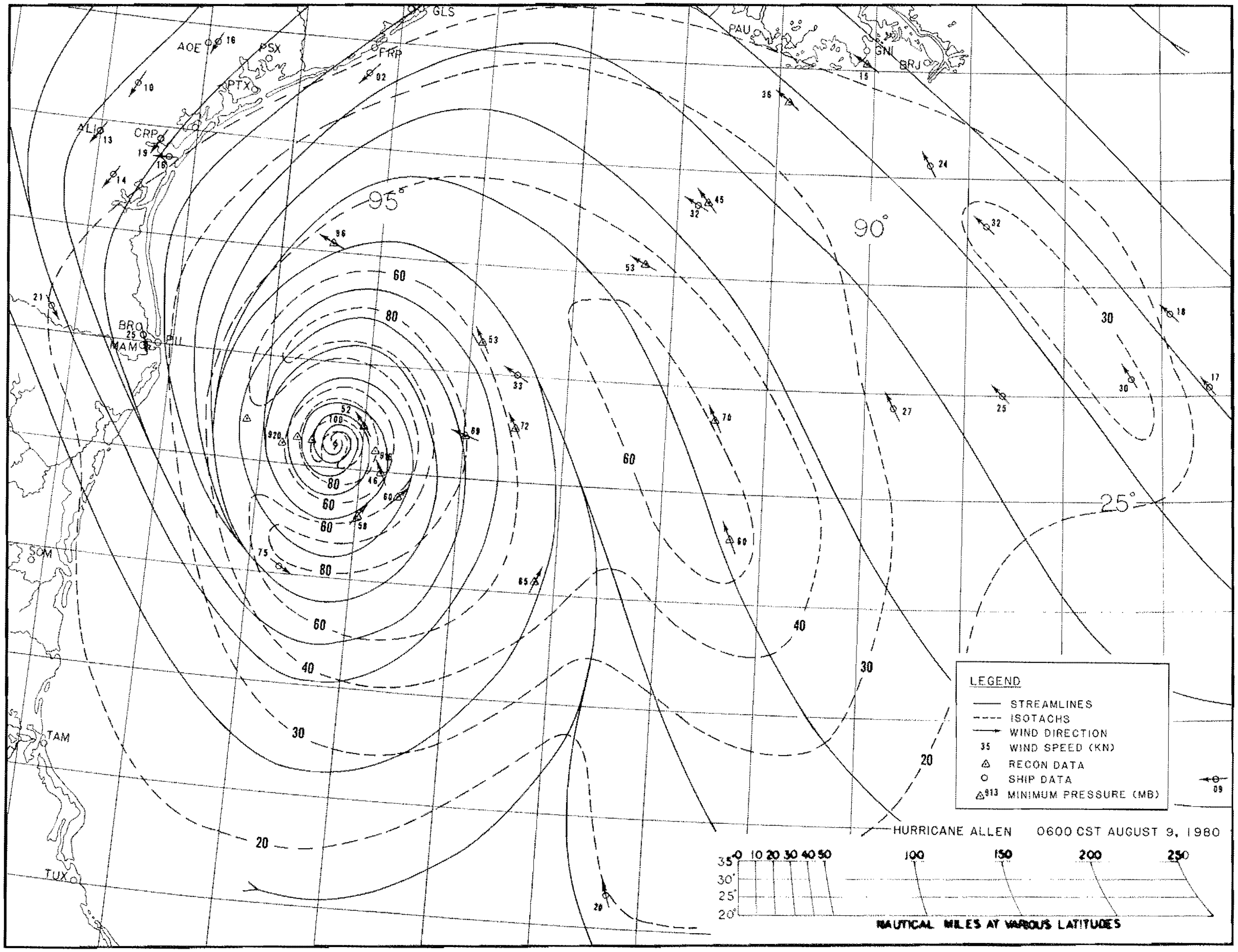

Figure 12d.--Streamline analysis, 6000 CST, August 9, 1980.

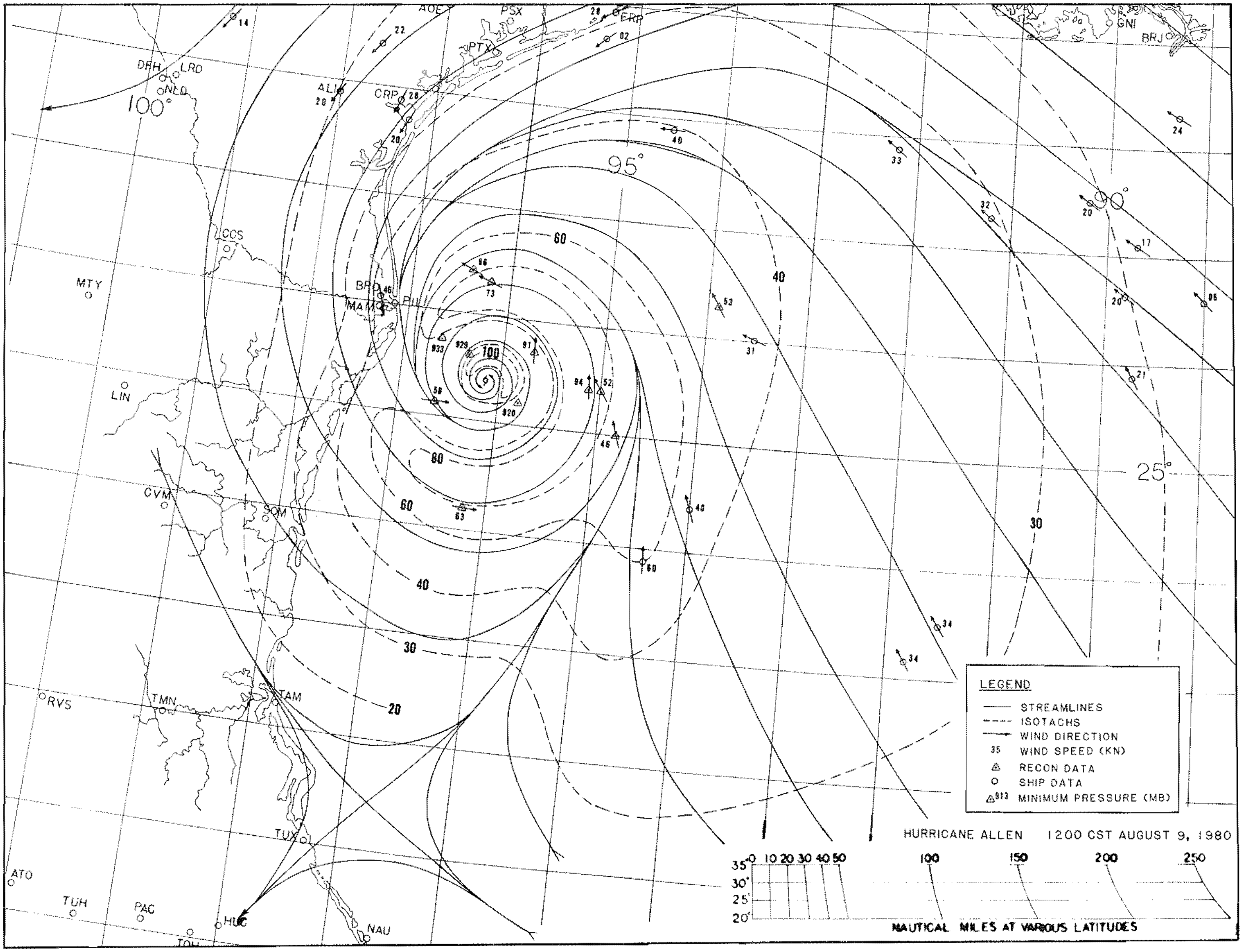

Figure 12e.--Streamline analysis, 1200 CST, August 9, 1980.

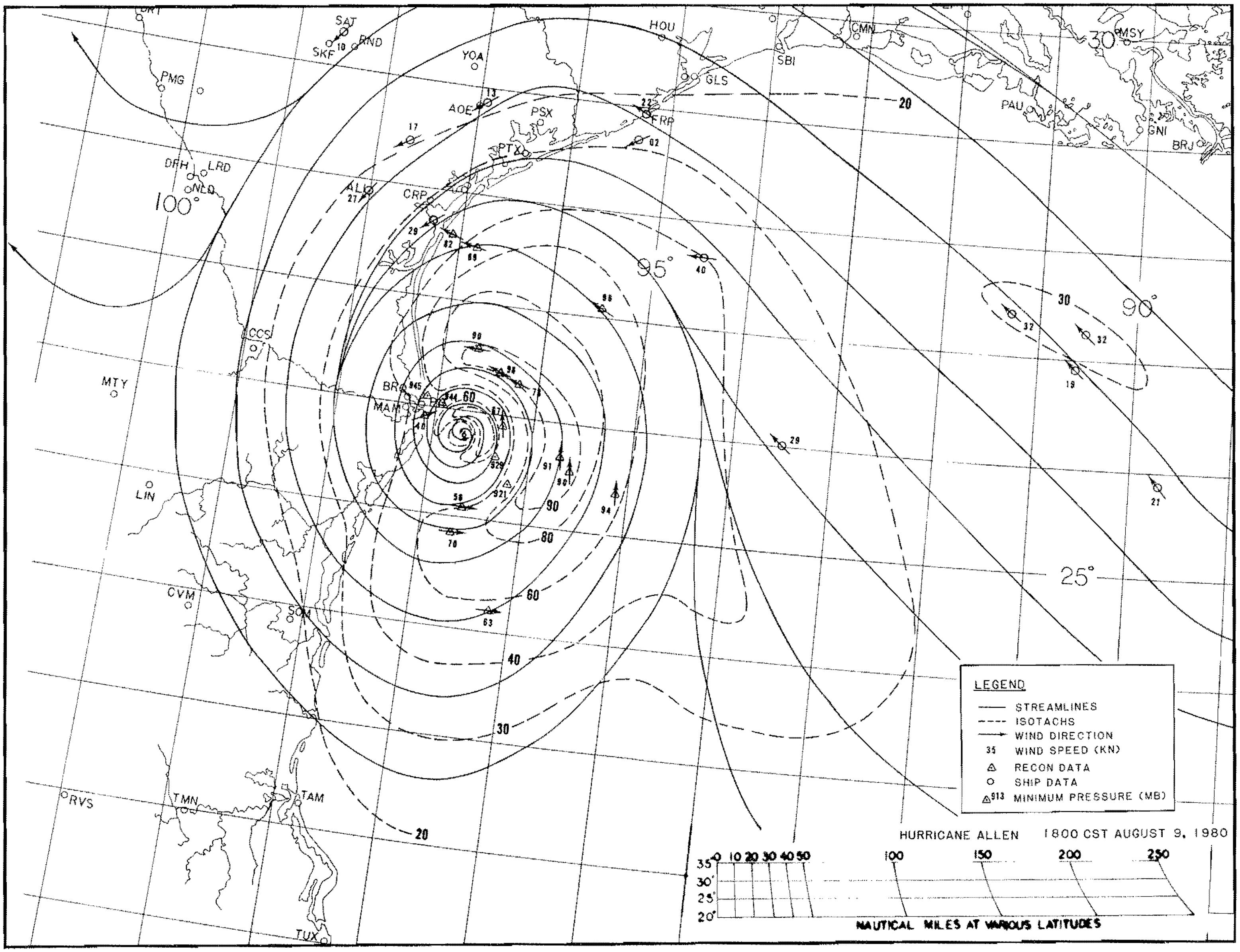

Figure 12f.--Streamline analysis, 1800 CST, August 9, 1980.

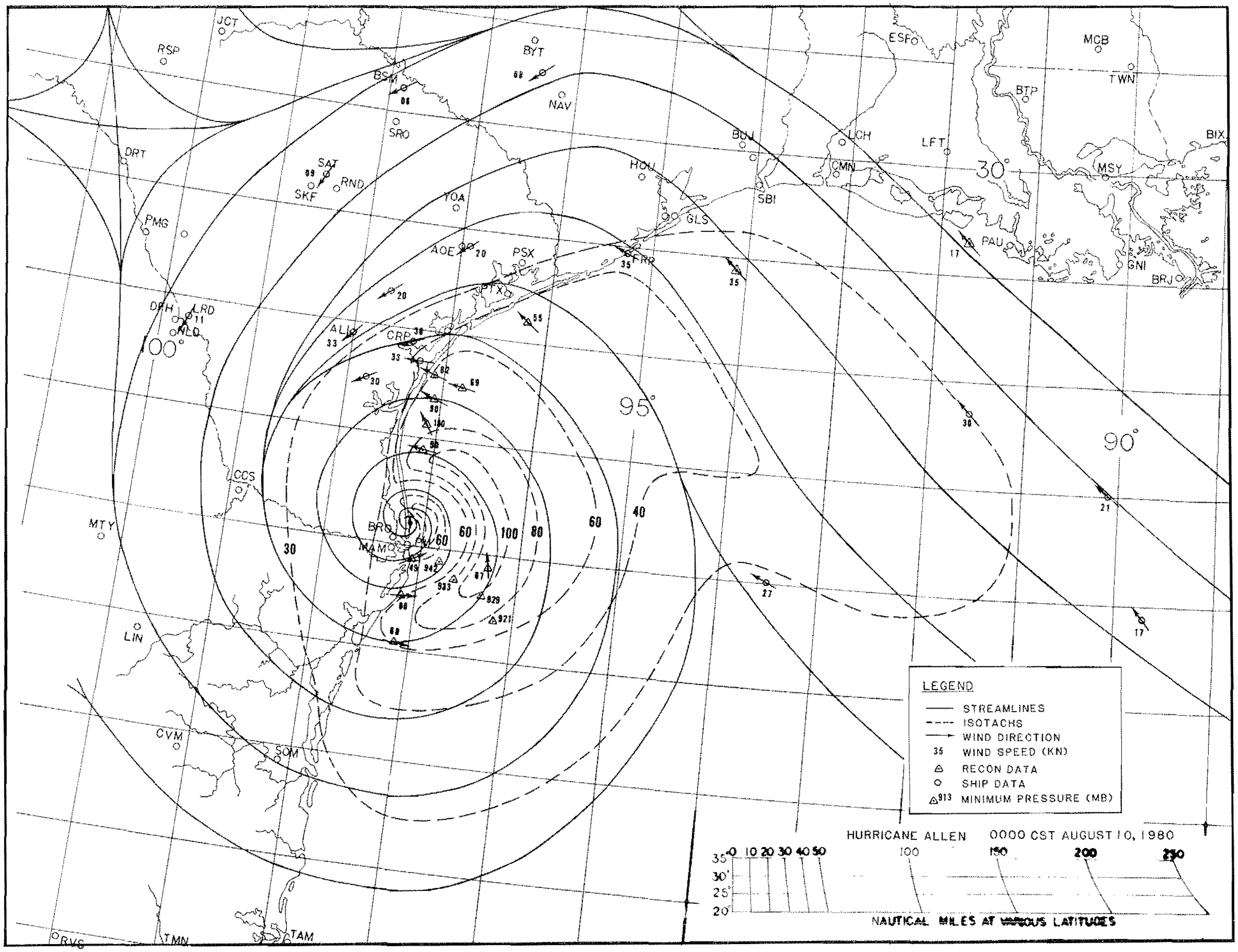

Figure 12g.--Streamline analysis, 0000 CST, August 10, 1980.

the next 12 hrs through 1200 CST August 9. The radial distance of the secondary maximum from the center reduced only slightly during the latter half of the 24-hr period or from 0000 CST to 1200 CST August 9. At 1200 CST August 9, the hurricane was centered about 60 nmi off the Texas coast and wind speeds of about 100 kn were reported at radial distance of 10 nmi, as well as 55-60 nmi from the center. By 1800 CST August 9, the hurricane's center was located at about 23 nmi off the coast, and Brownsville, Texas reported winds of 38 kn from the north after experiencing maximum winds of about 45 kn during the past hour (figure 11). High winds in Allen were then recorded off the Texas coast at a radial distance of about 40 nmi from the center, but a lesser wind speed maximum was still located near the eye at a radial distance of about 10-15 nmi. As the hurricane continued to approach the coast, the observed flight-level winds near the eye decreased to 60-70 kn while the extreme winds at the outer band increased in magnitude and the area migrated inward.

6.5 Radius of Maximum Winds

The size of a hurricane is commonly denoted by the distance between the lowest central pressure and the band of highest winds around the center. The radius to the maximum winds was determined from all the observations available for this storm. Three different types of observations were available. The first measure includes the maximum flight-level winds and estimated surface winds as reported by reconnaissance aircraft. The second is the radar eye diameter, also reported by reconnaissance aircraft as well as by surface observing stations. Some optical reports were used when the reconnaissance aircraft was in the eye of the storm. The third measure, useful only after the hurricane was near shore, estimates the radius from surface wind records at land stations.

Flight-level winds, recorded at one-second (1-s) intervals by the reconnaissance aircraft of the NOAA Research Flight Center were processed, and 10-s running averages of the 1-s intervals are available on magnetic tape. The aircraft location for each observation was translated as a relative position to the storm center. From these records, composite maps of flight-level winds at given intervals were plotted by computer and made available to us by the Hurricane Research Division of NOAA/AMOL. Analysis of these maps yielded another measure of the radius to maximum winds.

Figure 13 is an example of a composite map of flight-level winds for the period of 1330 to 1545 CST on August 9, 1980. The wind data (in m/s) recorded at an altitude of 2368 m were plotted at translated positions relative to the storm center. The highest wind speed of approximately 100 kn along each leg of penetration of the eye was located about 10 nmi from the center. A secondary maximum of about 90 kn can be identified at about 65 nmi from the center. Similar distributions of flight-level winds can be identified in composite maps of other time periods (diagrams not shown). The map series indicates that the secondary (outer) maximum migrated inward as the inner wind maximum weakened. The evolution of this phenomenon can be illustrated by radial wind profiles constructed from flight-level wind data recorded on August 9 and 10. The selected periods covered the time when the hurricane was located about 75 nmi east-southeast of Brownsville, Texas until its center was some 40 nmi inland (6 hr after crossing the coast over the southern tip of Padre Island).

Figure 14 shows flight-level winds recorded at the 700-mb level (minimum height of 2453 m to 2510 m) between 1200 CST and 1500 CST on August 9. The data points

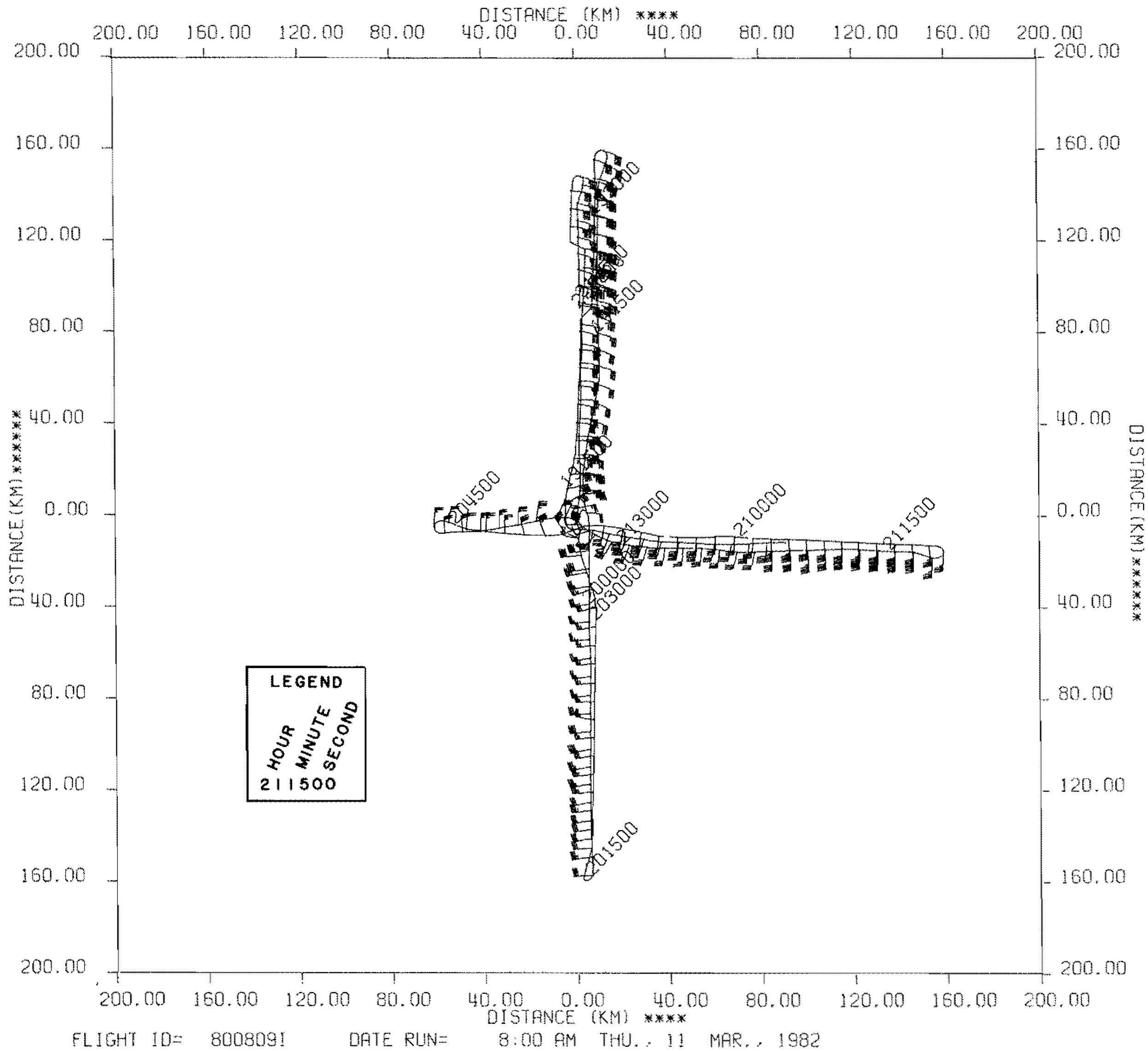

Figure 13.—An example of composite map of flight-level (2500 m) winds for period 1745 to 1900 CST, August 9, 1980. Numerials indicate time of observation in GMT (hours, minutes and seconds). Wind barbs denote speed in m/s.

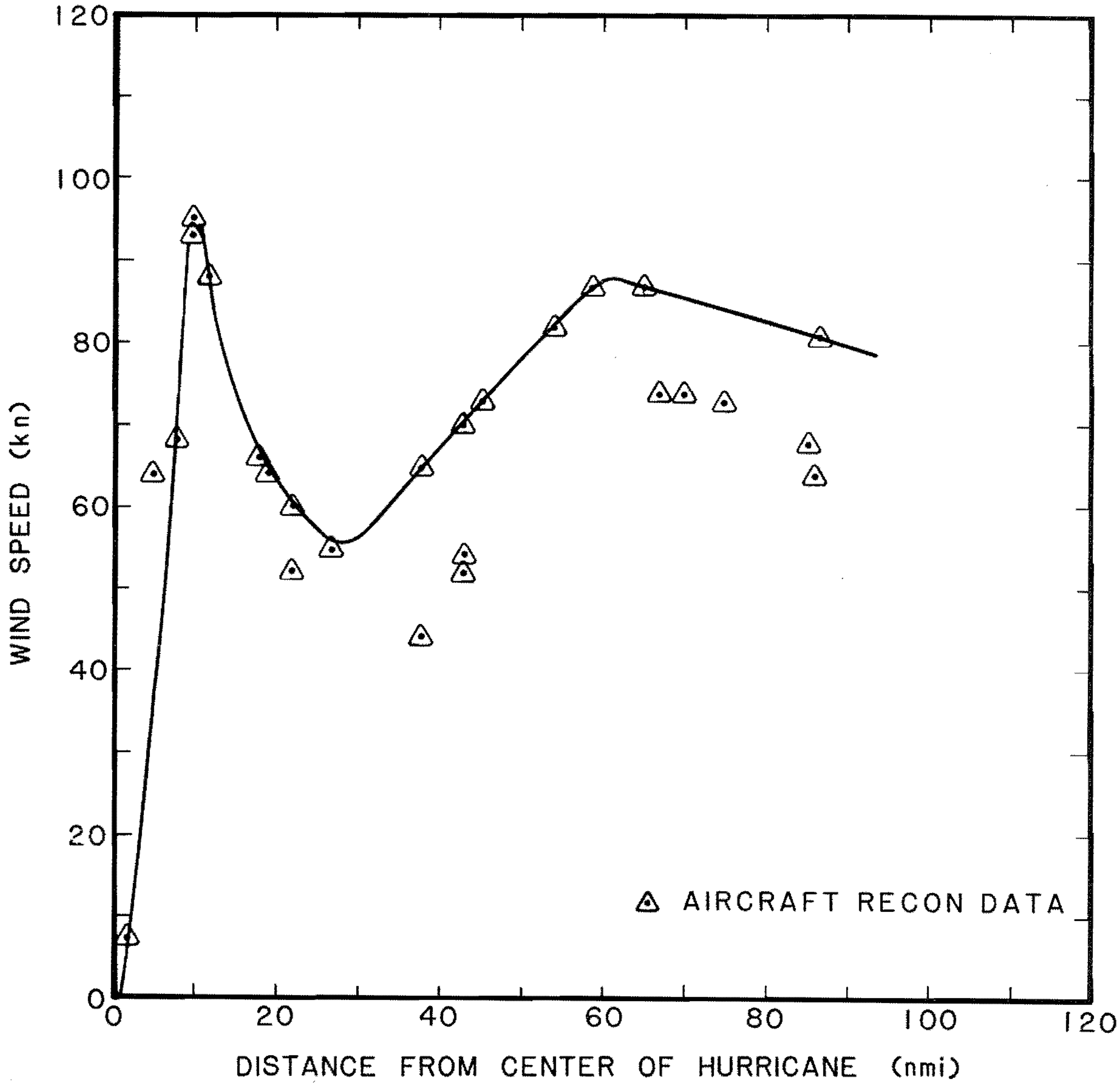

Figure 14.—Radial profile of flight-level (2500 m) winds recorded during period 1200-1500 CST, August 9, 1980. Wind speeds (in knots) are resultant wind speeds with speed of storms's motion subtracted from observed winds.

were plotted against the radial distance from the center of the hurricane at the time of observation. A smooth envelopment curve drawn from the data points reveals that maximum winds of about 90 kn were observed at a distance of 10 nmi from the center with a secondary maxima at about 65 nmi. Similar radial wind profiles at three different levels for the previous day were constructed by Willoughby et al. (1981). However, the wind maxima on the 8th (about 110 kn) were higher than that of the 9th, while the magnitude of the secondary maxima remained about the same.

Figure 15 shows flight-level winds recorded during the period 1500 to 1800 CST on the 9th. Again, the data were plotted against the radial distance from the center of the hurricane. The smooth envelopment curve drawn from these data points indicates that the wind maximum was then about 45 nmi from the center. The inner wind maximum had become the secondary maximum and was still located at

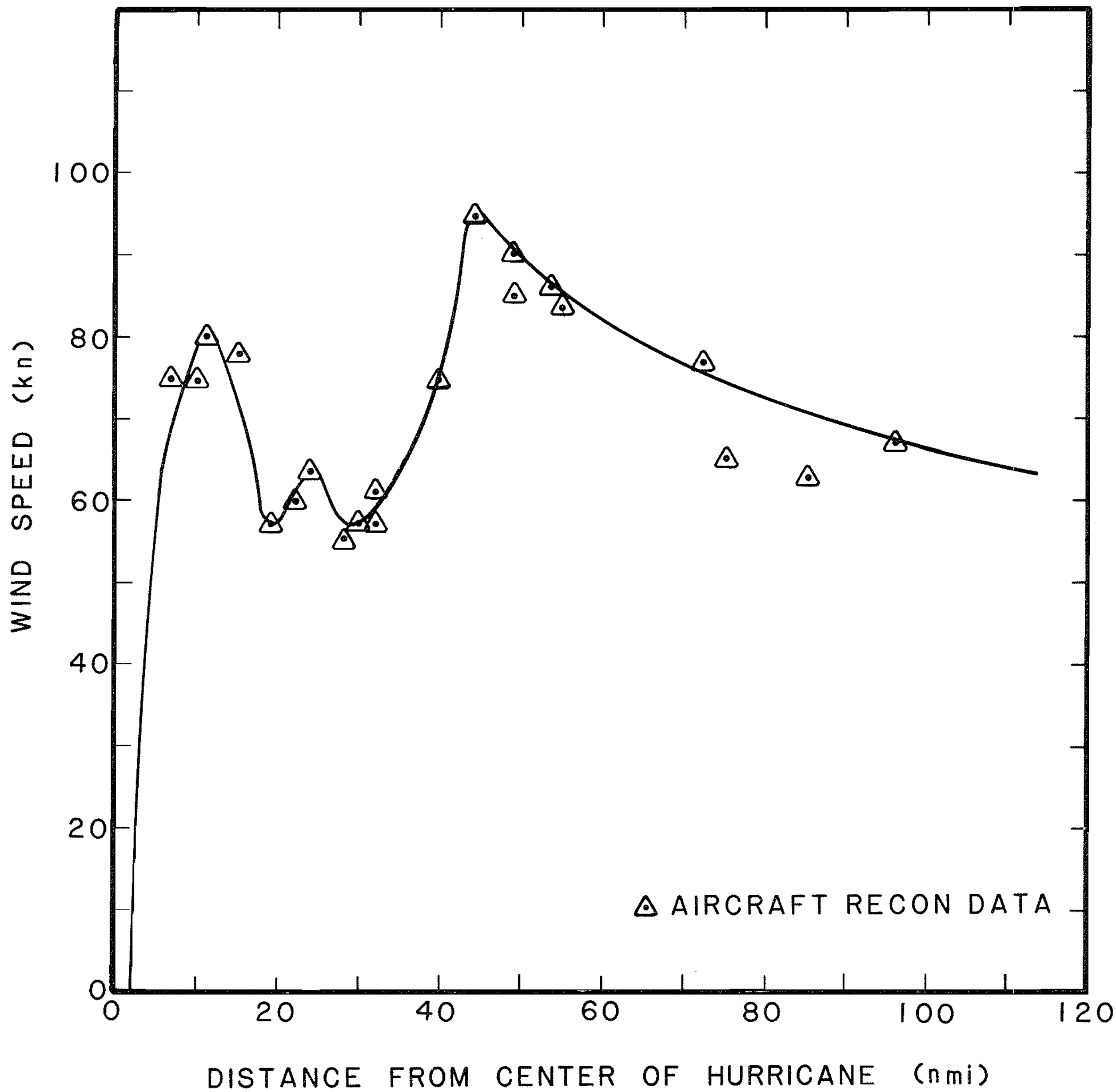

Figure 15.--Radial profile of flight-level (2500 m) winds recorded during period 1500-1800 CST, August 9, 1980. Wind speed (in knots) are resultant winds with speed of storm's motion subtracted from observed winds.

about 10 nmi from the center. A small fluctuation of wind speed appeared 20 to 25 nmi from the center. A similar plot of flight-level winds recorded during the period of 0500 CST through 0800 CST on August 10 is shown on figure 16. There were no observations taken within 45 nmi of the hurricane's center during that time period because the reconnaissance aircraft was flying over water along the coast. We assume that the wind maximum at the flight level remained at a distance of about 45 nmi from the eye.

The radial profiles of flight-level winds described in preceding paragraphs clearly indicate that the wind maximum near the eye reduced in magnitude, while the outer maximum migrated inward and became the dominant feature in the radial

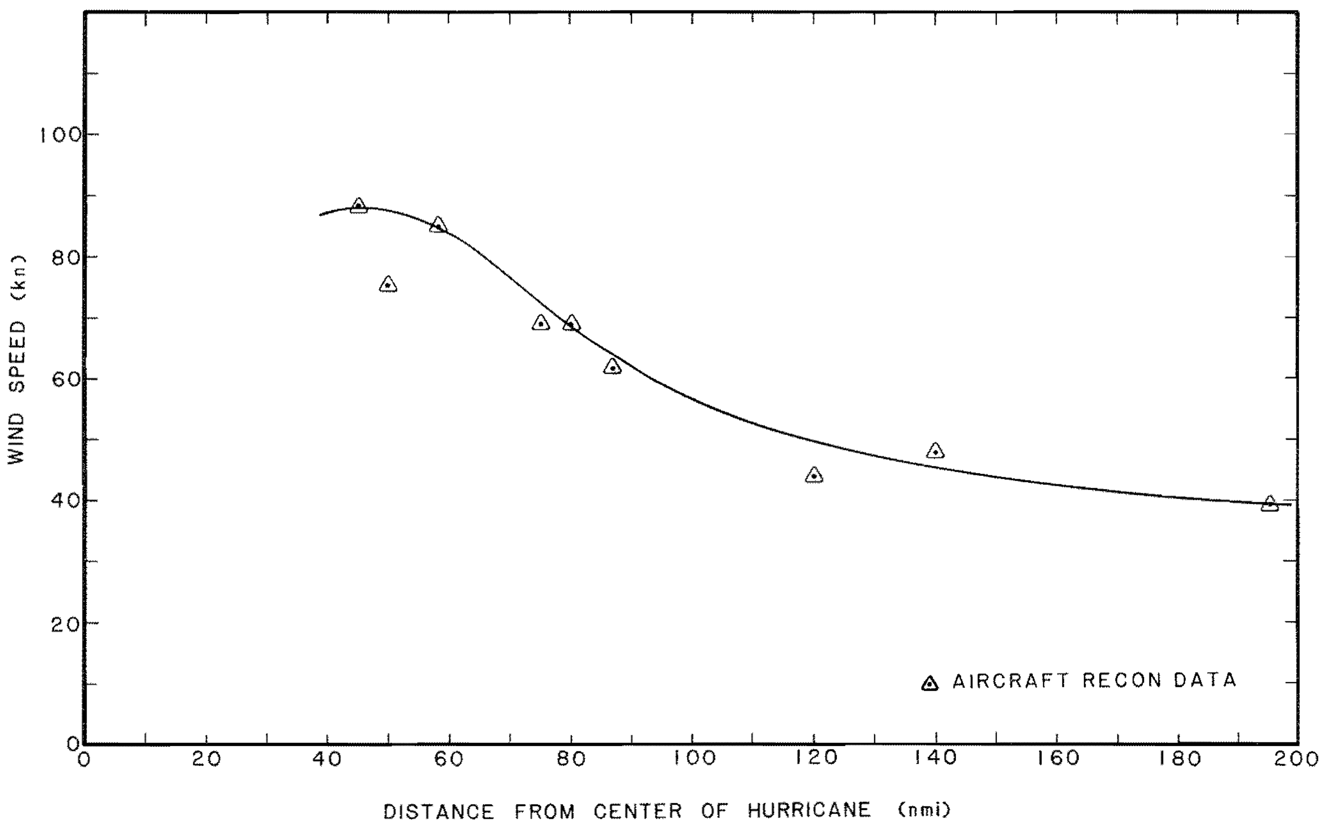

Figure 16.—Radial profile of flight-level (2500 m) winds recorded during period 0500-0800 CST, August 10, 1980. Wind speed (in knots) are resultant wind speeds with speed of storm's motion subtracted from observed winds.

wind profile. The magnitude of the wind maxima at a radial distance of 45 nmi appeared to remain the same at the flight level, as the hurricane moved over land on August 10.

The second measure used in determining the radius of maximum winds is the radar eye diameter. This type of data is obtained from reconnaissance aircraft reports and from land based radar weather observing stations. Figure 17 is a reproduction of a Brownsville, Texas radarscope photograph taken at 0430 CST on August 9, 1980, showing Allen's well-defined concentric eye structure. Similar to other mature hurricanes, the eye of the storm is defined by a ringlike radar echo which is separated from the spiral bands of the storm. Inside this ring, the eye is clear of precipitation echoes. In the case of Allen, this eye structure shown in the radar photograph will be referred to as the "inner eye." There was also a relatively wider ring in the storm interior with little or no radar return. This echo-free area was surrounded by another ring of wall clouds. Thus, the structure of Allen's inner core appeared to have two concentric wall clouds.

The phenomenon of concentric eye structure was first described by Fortner (1958) and observed in Hurricane Donna of 1960 (Jordan and Schatze, 1961) and in Hurricane Carla of 1961 (Jordan 1966). Hoose and Colon (1970) documented a complete concentric eye cycle in Hurricane Beulah of 1967 and related the inner eye deterioration with the shift of maximum wind from the inner eye to the outer eyewall. Similar behavior was described by various authors in Typhoon Gloria of 1974 (Holliday 1977) and in Hurricanes Debbie of 1968 (Gentry 1970;

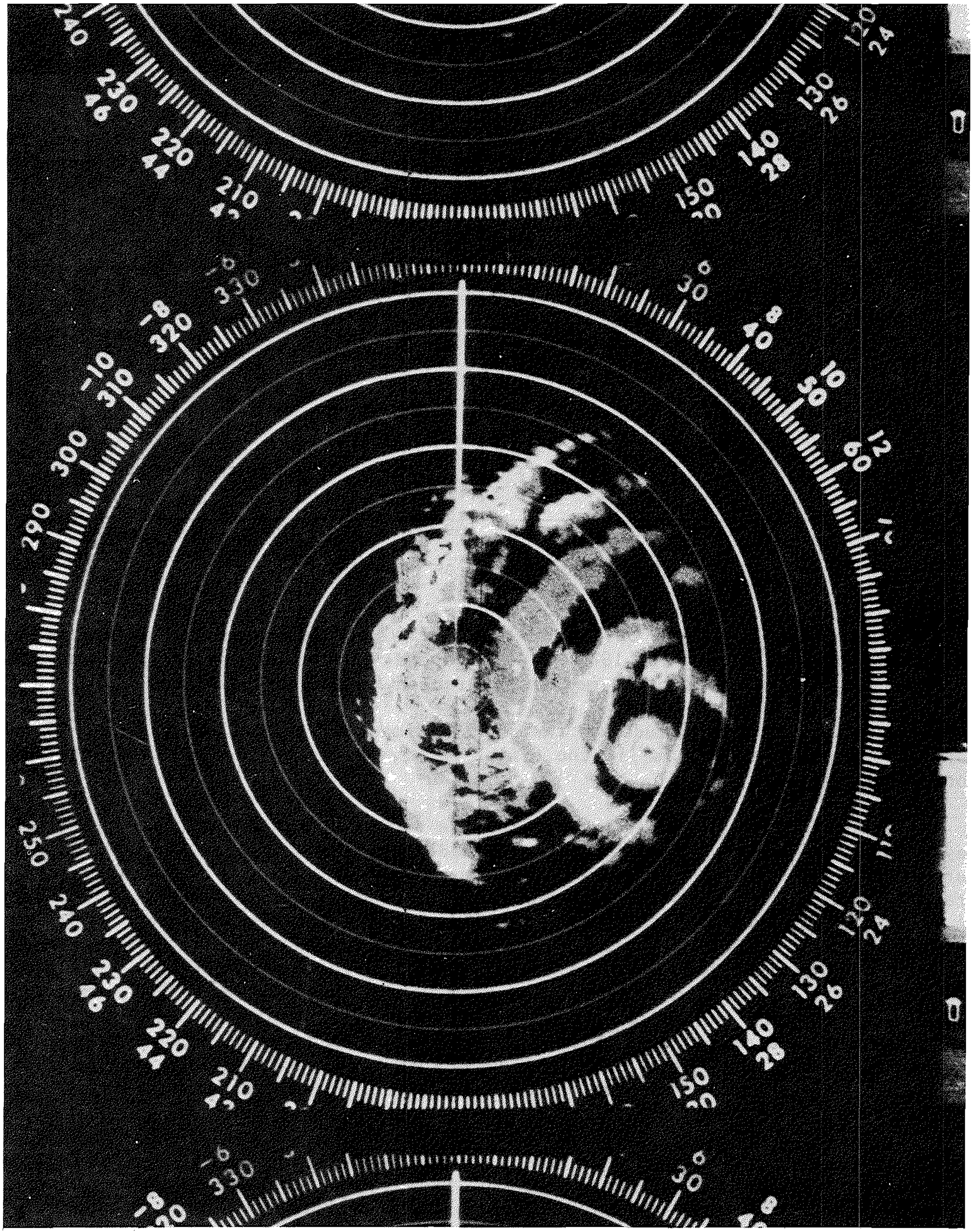

Figure 17.—Brownsville, Texas radarscope photograph taken at 0430 CST August 9, 1980, showing Allen's well-defined concentric eye structure.

Hawkins 1971; Black et al. 1972), Anita of 1977, David of 1979, and Allen of 1980 (Willoughby et al. 1981).

Our main concern in this study is the hurricane characteristics which closely describe surface wind distributions important for storm surge modeling. We looked in great detail at the variation of these parameters during the prescribed period prior to, and after, the hurricane crossed the coast. Land based radar weather observing stations report, among other data information, the diameter of the inner eye as a hurricane approaches the coast. In the case of Allen there was no significant variation with time in the diameter of the inner eye reported during the period of interest on the 9th. We further examined photographs of radar echoes taken at Brownsville, Texas during the period of 0300 CST on the 9th through 0800 CST on the 10th. From these photographs we obtained measurements of radius from the storm's center to the outer perimeter of the inner eye wall and the radius to the rim of the outer echo free area.

Figure 18 shows smooth curves joining these measurements to indicate the variation of the eye structure with time. The data points were read off radar-scope photographs, beginning at 0330 CST and ending at 2300 CST, on the 9th. There was no reading obtained for the lower curve after 2000 CST when the inner eye was completely filled. Radar pictures indicated that the filling process began at about 1430 CST when openings of the inner eye wall appeared to the southwest. These openings, which reflected the dissipation of convective clouds in that quadrant, occurred during the period when flight-level winds recorded by reconnaissance aircraft (1500-1800 CST) were decreasing in magnitude near the inner eye wall (figure 15). The lower curve in figure 18, showing the variation of the radius to the outer perimeter of the inner eye wall, reveals a rapid increase in radius during the 2-hr period of 1230 to 1430 CST on the 9th. This increase in radius indicated an outward expansion of convective precipitation in the inner eye wall prior to the filling of the inner eye. The upper curve in figure 18 shows the variation of radius from Allen's center location to the rim of the outer echo-free area with time. This curve shows a general trend of decreasing radius in the first 12 hr followed by short period oscillations and a rapid decrease in magnitude at around 2100 CST on the 9th. The general trend of decreasing radius occurred in the same time period that the secondary wind maximum migrated inward from 65 nmi of the center. The rapid decrease in radius occurred when Hurricane Allen was about 10 nmi from the coast. Although no specified relation between the radius of the outer echo-free area and the radius to wind maxima is considered in this report, we speculate that they will tend to either increase or decrease together.

The third measure used in determining the radius of maximum winds came from surface winds recorded at land stations. These can be illustrated by radial wind profiles constructed from surface wind records. Figure 19 shows radial wind profiles for the time periods when Allen's center was approaching the coast and when it was moving over land. The wind data plotted on the diagram were resultant wind speeds after the hurricane's speed of translation was subtracted from the observed wind speed. The upper diagram shows a smooth curve fitted by eye to the data observed at Brownsville during the period 0600 through 2100 CST on the 9th and winds recorded at other stations at 01800 CST. This curve indicates that the maximum wind at Brownsville occurred when Allen's center was at a distance of 49 nmi from the station. Since the center bypassed the station at a distance of 21 nmi, there were no observations of surface winds in the hurricane's eye region.

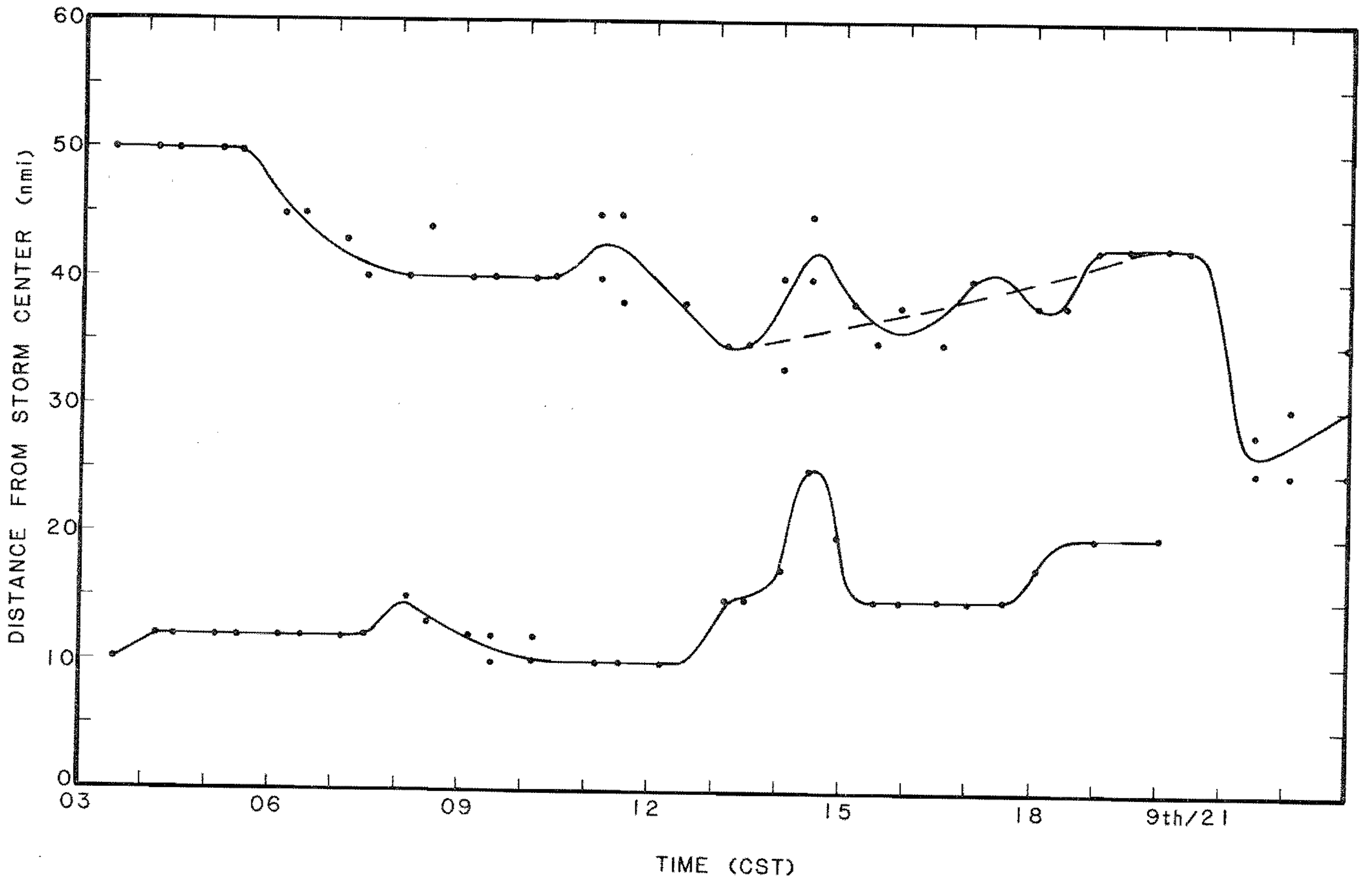

Figure 18.—Eye radii obtained from Brownsville, Texas radarscope for period 0300-2200 CST, August 9, 1980. Upper curve shows radial distance of outer eye from Allen's center. Lower curve shows radial distance of outside parameter of inner eye wall from the center.

The lower curve (figure 19) was fitted by eye to data points based on surface winds recorded at land stations when Allen was moving over land. Observations taken at 2200 and 2300 CST on the 9th at Brownsville when Allen's center was 8 nmi and 4 nmi off the coast, respectively, were included to show the decrease in wind speed from the maximum towards the center. The highest wind speed plotted on this curve was recorded at Kingsville Air Force Base when the center of Hurricane Allen was 35 nmi south of the station. This indicated a decrease in the radius of maximum winds from 49 nmi to 35 nmi as the hurricane approached the coast and moved inland. This observed decrease in radius of maximum winds is supported qualitatively by the eye radius which appeared to have decreased rapidly around 2100 CST on the 9th (figure 18).

Figure 20 provides a curve from which the radius of maximum winds can be determined. It is based on analyses of all available observations previously described. The distances of observed maximum flight-level winds from the hurricane's center reported during aerial reconnaissance are shown by triangles. Radial distances of maximum winds obtained from analyses of flight-level winds are shown by circled dots. These radial distances were read directly from composite charts of flight-level winds (e.g., figure 13), except for those shown in the first 24-hr. The results from the earlier time period

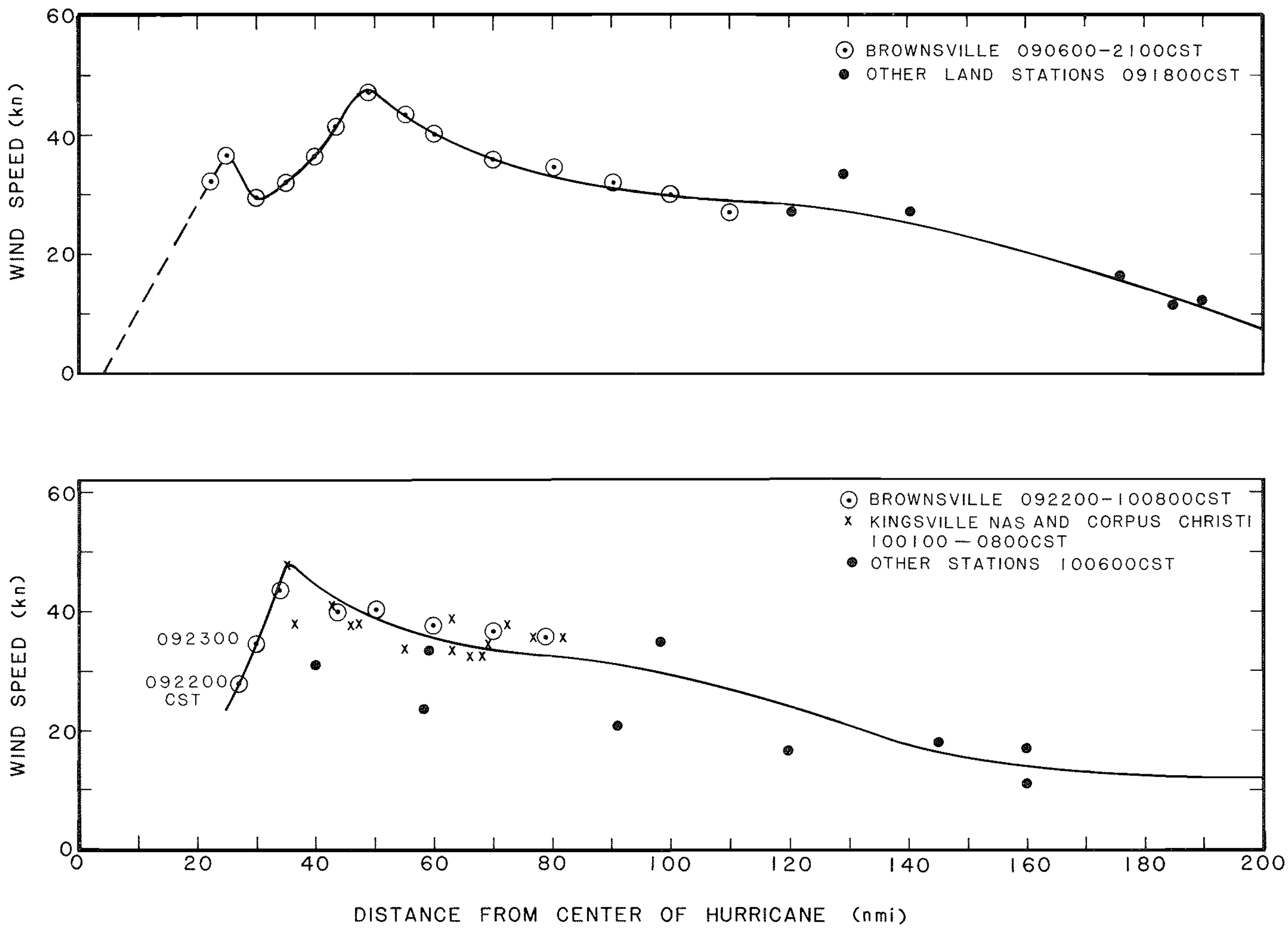

Figure 19.—Radial profiles of surface winds constructed from observations taken at Brownsville, Texas and other stations for periods 0600-2100 CST on August 9 (upper curve) and 092200-100800 CST, August 1980, (lower curve).

were interpolated from analyzed surface charts (figures 12a through g). Radial distances determined from surface winds recorded at land stations are given by inverted triangles. The magnitude of extreme winds recorded at a given time was classified into two categories, a primary and a secondary wind maximum. The occurrences of primary wind maxima are denoted by solid lines while occurrences of secondary wind maxima are indicated by dashed lines. A shift of wind maxima from a radial distance of 10 nmi near the eye to that of about 45 nmi from the center seems to have occurred near 1500 CST on August 9.

Analysis of flight-level wind distributions (e.g., figure 13) and radial profiles of flight-level winds constructed from reconnaissance flight data (figures 14 through 16) reveal that the primary wind maximum near the inner eyewall decreased in magnitude while the secondary maximum migrated inward and became the dominant feature in the radial profiles. The analyzed results of flight-level (2500 m) winds, yielding an estimated radius to wind maximum of 10 nmi during the period of 1800 CST on the 8th through 1200 CST on the 9th, can

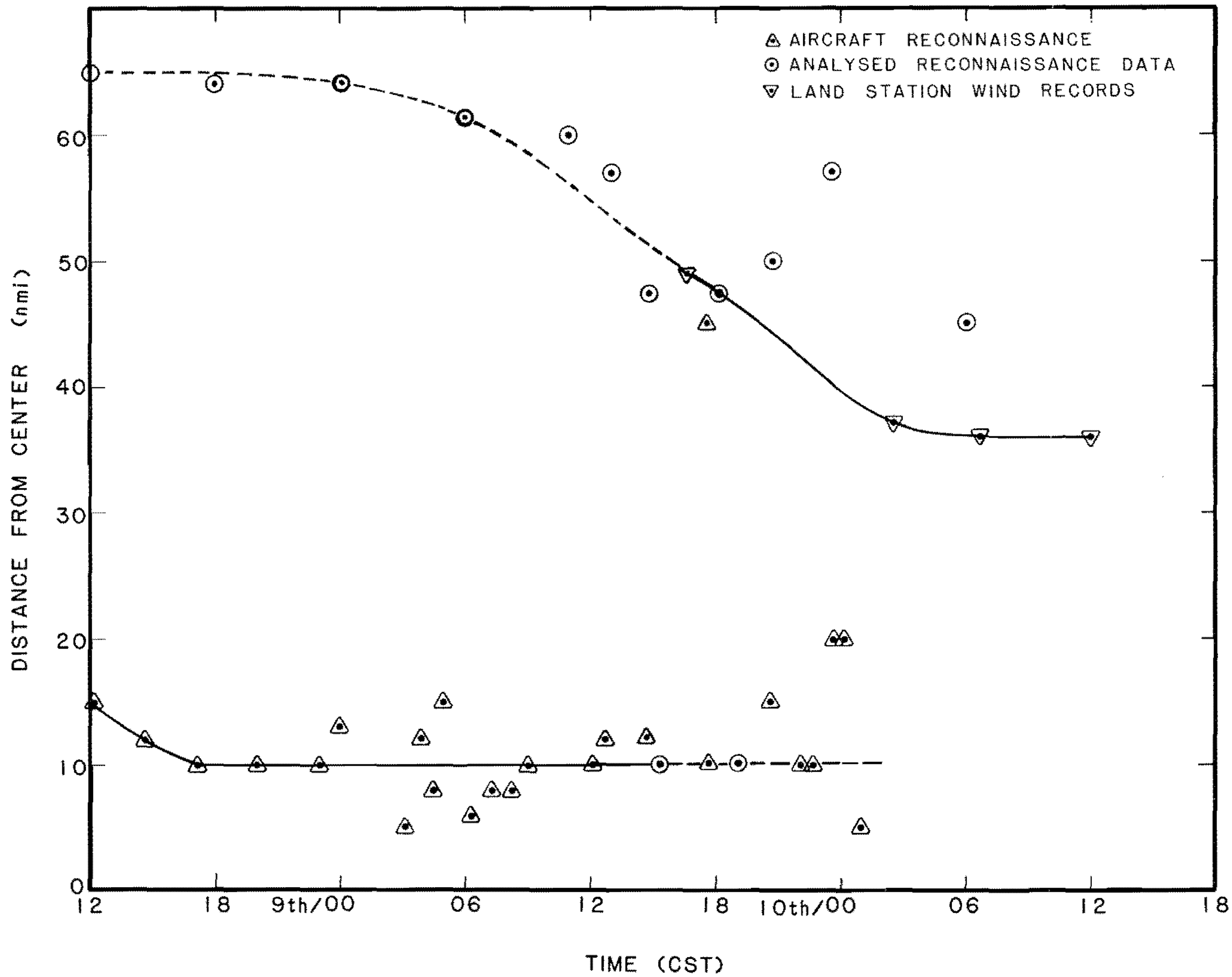

Figure 20.—Variation of radius of primary (solid line) and secondary (dashed line) wind maxima with time, Hurricane Allen, August 8-10, 1980.

be applied to the surface. This was supported by the consistency of observed winds at three different altitudes (850, 600, and 500 mb-levels) recorded within a same time period on the 8th. The vertical structure of wind during that time period had little or no variation with height between flight-levels. (See figure 14 of Willoughby et al. 1982.) The secondary maximum migrated inward as the winds near the inner eyewall decreased in magnitude. By 1500 CST, the existence of a wind maximum at a radial distance of 45 nmi from the hurricane's center can be identified in both flight-level wind analyses and surface wind analyses. For Allen, then, this distance became the radius to the maximum wind, which reached 100-110 kn at flight-levels. After 1500 CST, winds of 70-90 kn at a radial distance of 10-20 nmi were reported by aerial reconnaissance aircraft. The extreme winds were, in fact, secondary wind maxima observed at the flight-level.

Analyses of surface winds recorded at Brownsville, Texas yielded results which agree very well with flight-level winds observed between 1600 CST and 1800 CST. These results indicated that wind maxima occurred at a radial distance of about 45 nmi from the center, implying that maximum winds would begin to strike coastal areas near 1600 CST when the hurricane's center was some 50 nmi off the coast. At Port Mansfield, maximum gusts of 120 kn were recorded at 2240 CST just before the recording instrument became inoperative. This indicated a reduction of the radial distance of maximum winds to about 36 nmi as Allen approached the coast. Surface winds observed at Kingsville, also indicated that the maximum winds remained at the same radial distance of 36 nmi from the center as Allen moved over land.

6.6 Summary and Discussion of Meteorological Analysis

The individual parameters from our analysis of Hurricane Allen are listed in table 1. These are listed for locations of the hurricane center at 3-hr intervals on August 8 and part of August 9 and 10, and at 1-hr intervals between 1200 CST on the 9th and 0600 CST on the 10th. For each location, central pressure and the radius of primary and secondary wind maxima (both in nautical and statute miles) are listed. The table provides, in convenient form, the information that could be obtained from analyses of the basic data described in various sections.

It is of interest to note that there were two areas of wind maxima of approximately equal magnitudes observed during a brief time interval near 1200-1500 CST on the 9th (figure 14). This phenomenon occurred during a transition period when the secondary wind maximum migrated inward and winds near the inner eyewall weakened. During this time period, Allen's central pressure increased from 922 to 930 mb. As the intensity of Allen continued to weaken with its central pressure rising gradually, the wind maximum near the inner eyewall decreased in magnitude. The extreme winds at a greater radial distance then became the dominant feature which influenced the storm surge generation.

7. DISCUSSION

It would be only speculation had we attempted to explain the evolution of wind maxima based on observations of a single hurricane. However, characteristics of the hurricanes previously cited reveal similar evolutions of wind maxima associated with observed phenomena of concentric eye walls. Similar to Allen, Hurricanes Beulah of 1967 and Anita of 1977 are good examples of such evolutions observed in the western Gulf of Mexico. Hurricane Anita deepened on August 31 and September 1 and its central pressure dropped to a minimum of 926 mb during the night of September 1, before striking the Mexican coast about 130 nmi south of Port Isabel, Texas. The concentric eye walls and the associated wind maxima were observed just after the central pressure fell below 940 mb (Willoughby and Shoreibah 1982). Hoose and Colon (1970) observed that concentric eye walls appeared in Hurricane Beulah shortly before the hurricane's central pressure dropped to 940 mb when Beulah was located about 200 nmi south of San Juan, Puerto Rico. They also observed that maximum winds occurred in the precipitation echo-free area outside the inner eye wall. They deduced that the concentric eye configuration would be quite unstable and the inner eye was probably dissipated by the subsiding downdrafts generated by the development of the more stable outer eye system. This concept was confirmed by numerical computations made by Shapiro and Willoughby (1982) using a dynamic model of Eliassen (1951).

We examined reconnaissance flight data recorded during a period of five hr when Beulah was about 120 nmi southeast of Brownsville, Texas (figure 21). Our analysis shows that wind maxima appeared at radial distances of 15 and 45 nmi from the hurricane's center near 1430 CST on September 19, after Beulah reached its maximum intensity and the central pressure dropped to 923 mb.

It is gratifying to note that both Beulah and Allen weakened before crossing the southern portion of the Texas coast. In both cases, the maximum winds near the inner eye wall decreased in magnitude while the outer wind maximum contracted in radius. If the hurricanes had deepened and reached their maximum intensity just before making landfall, winds of much higher magnitudes would have occurred at close proximity to the hurricane's center. Under such a configuration of surface winds, surge generation caused by the approaching hurricane would be quite different from that of a weakening hurricane. Table 2 shows the minimum central pressure of some hurricanes and typhoons near the time when concentric eye walls were observed. An examination of the time variation of central pressure in these hurricanes and typhoons reveals that they were in a deepening stage prior to the observed events. The central pressure of all hurricanes and typhoons in this table, except for Debbie of 1969, dropped below 940 mb around the time when concentric eye walls were observed. We speculate that this phenomenon is associated with intense hurricanes in their deepening stage after a threshold intensity (as measured by central pressure of around 940 mb) is reached.

It may be redundant to iterate the importance of wind maxima acting on and influencing the water levels in bays and estuaries when a hurricane crosses the coast and moves over land. However, based on the observations previously discussed, we recommend that further studies are needed to scrutinize wind configurations in intense hurricanes which deepen in the close proximity of the coast. Though this short-lived phenomenon might not change the general characteristics of a mature hurricane, it might well be an important factor to consider in the simulation of surge heights by using historical hurricane parameters as input to surge modeling.

Table 2.—Central pressure of hurricanes and typhoons near the time when concentric eye walls were observed

Storm date	Name	Central pressure (mb)
August 26, 1954	Typhoon Ida	892
March 24, 1956	Typhoon Sarah	940
September 6, 1960	Donna	940
September 9, 1967	Beulah	940
September 19, 1967	Beulah	923
August 20, 1969	Debbie	954
November 5, 1974	Typhoon Gloria	937
September 2, 1977	Anita	930
August 28, 1979	David	938
August 30, 1979	David	930
August 8, 1980	Allen	940

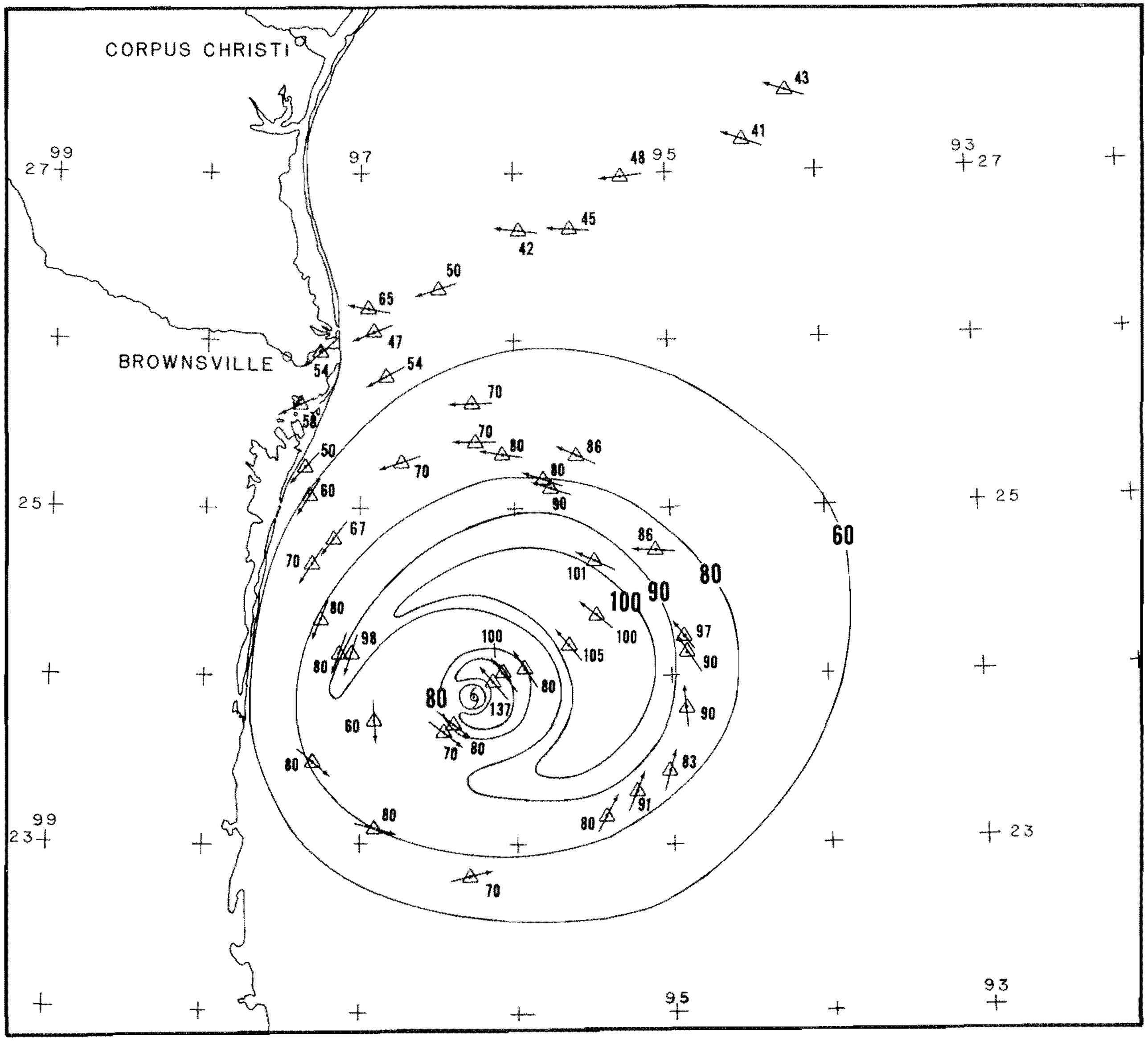

Figure 21.—Composite map of flight-level (990 m) winds observed in Hurricane Beulah during period 1230-1800 CST, September 19, 1967.

ACKNOWLEDGMENTS

The authors wish to thank the staff of the Hurricane Research Division of NOAA's AOML for providing us with data from their files and computer plotted diagrams of flight-level winds from NOAA's research aircraft observations. The research support and technical assistance provided by staff members of Water Management Information Division, NOAA/NWS Office of Hydrology, was most helpful in preparing this report. Dr. Chester P. Jelesnianski of the NOAA/NWS Technical Development Laboratory, and Mr. Miles B. Lawrence of the National Hurricane Center, NOAA/NWS, provided crucial reviews of drafts of this report which were most helpful in improving the quality of the final product.

REFERENCES

Cry, G.W., 1965: Tropical cyclones of the North Atlantic Ocean, 1871-1963. Technical Paper No. 55, Weather Bureau, U. S. Department of Commerce, Washington, D.C.., 148 pp.

Eliassen, A., 1951: Slow thermally or frictionally controlled meridional circulation in a circular vortex. Astrophys. Norv., 5, 19-60.

Fortner, L. E., 1958: Typhoon Sarah, 1956. Bulletin American Meteorological Society, 39, 663-669.

Gentry, R.C., 1970: Hurricane Debbie modification experiments, August 1969. Science, 168, 473-475.

Hagan, Richard, 1982: MIC, Weather Service Office, National Weather Service, NOAA, Brownsville, Texas. Private communication.

Hawkins, H.F., 1971: Comparison of results of the Hurricane Debbie (1969) modification experiments with those from Rosenthal's numerical model simulation experiments. Monthly Weather Review, 99, 427-434.

__________, Christinsen, F.E., Pierce, S.C., and staff, 1962: Inventory use and availability of National Research Project meteorological data gathered by aircraft. National Hurricane Research Project Report No. 52, Weather Bureau, U.S. Department of Commerce, Washington, D.C., 352 pp.

Ho, F.P. and Miller, J.F., 1982: Pertinent meteorological and hurricane tide data for Hurricane Carla. NOAA Technical Report NWS 32, National Weather Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce, Washington, D.C., 111 pp.

Holliday, C.R., 1977: Double intensification of Typhoon Gloria, 1974. Monthly Weather Review, 105, 523-28.

Hoose, H.M., and Colon, J.A., 1970: Some aspects of the radar structure of Hurricane Beulah on September 9, 1967. Monthly Weather Review, 98, 529-533.

Jordan, C.L. and Schatzle, F.J., 1961: The "double eye" of Hurricane Donna. Monthly Weather Review, 89, 354-356.

Lawrence, M.B. and Pelissier, J.M., 1981: Atlantic hurricane season of 1980. Monthly Weather Review, 109, 1567-1582.

Merceret, H.D., DeVino, R., and Lewis, W.M., 1980: In-flight calibration of the NOAA/RFC meteorological research aircraft instruments at the Air Force Eastern Test Range: 1977-1978. NOAA Technical Memorandum ERL-RFC-6, Research Facilities Center, National Oceanic and Atmospheric Administration, U.S. Department of Commerce, Miami, Florida, 20 pp.

National Hurricane Center, NOAA, 1980: Hurricane Allen. Climatological Data, National Summary, July 1980, National Climatic Center, Environmental Data and Information Services, National Oceanic and Atmospheric Administration, U.S. Department of Commerce, Asheville, North Carolina, 76-82.

Neumann, C.J., Cry, G.W., Caso, E.L., and Jarvinen, B.R., 1978: Tropical Cyclone of the North Atlantic Ocean, 1871-1977. National Climatic Center, National Oceanic and Atmospheric Administration, U.S. Department of Commerce, Asheville, North Carolina, 174 pp.

Shapiro, L.J. and Willoughby, H.E., 1982: The response of balanced hurricane to local sources of heat and momentum. Journal of the Atmospheric Sciences, Volume 39, 378-394.

Taylor, G. and staff, 1981: Annual data and verification tabulation, Atlantic tropical cyclones 1980. NOAA Technical Memorandum NWS NHC 15, National Hurricane Center, NWS, National Oceanic and Atmospheric Administration, U.S. Department of Commerce, Miami, Florida, 78 pp.

U.S. Army Corps of Engineers, 1981: Hurricane Allen, 3-10 August 1980, U.S. Army Corps of Engineers, Galveston District, Texas, 62 pp.

Willoughby, H.E., Clos, J.A., and Shoreibah, M.B., 1982: Concentric eye walls, secondary wind maxima, and the evolution of the hurricane vortex, Journal of the Atmospheric Sciences, Volume 39, 395-411.

APPENDIX - METEOROLOGICAL DATA

This appendix gives the basic meteorological data used to develop the analysis presented in this report. The tables list the observations of sea level pressure and wind data at land stations and the hourly reports from ships. They also include positions of the hurricane center as determined from reconnaissance aircraft and land-based radar data.

Table A.1 lists the hourly observations of sea level pressure, wind direction, wind speed, and gustiness obtained at regular reporting stations. These hourly observations are taken from U.S. Weather Bureau Surface Weather Observations forms (WBAN 10) covering the period August 8 through August 10, 1980. The sea level pressure is given in units of millibars (mb). The wind direction is given as the direction from which the wind was blowing to the nearest ten degrees, measured clockwise from north. The reported wind directions were, in most instances, in compass points, i.e., N, NNE, NE, ENE, etc., and converted to degrees from north. The observed wind speed is a 5-min average determined from recorded observations. The gustiness is characterized by sudden, intermittent increases in speed where at least 9 kn were indicated between peaks and valleys with a time interval of less than 20 s. The wind speed is determined to the nearest knot.

The National Weather Service maintains a series of radar observing stations along the U.S. coastline from Brownsville, Texas to Eastport, Maine. These radars are used to track hurricanes for use in the hurricane warning system. Two stations in this network were in a position to track Hurricane Allen as it approached the Texas coastline. These stations are at Brownsville and Corpus Christi, Texas. The radar eye positions reported by these NWS stations, when the center was within range of the land-based radar, are listed in table A.2 by half-hourly intervals.

The complete reconnaissance aircraft reports were considered too voluminous to reproduce entirely in this report. Table A.3 lists those reports that provided the locations of storm center, observed sea level pressure, estimated surface winds, and/or the diameter of the eye. For a few of these reports, the range and maximum winds from the storm center were obtainable. This information is also presented in the remarks column. The reported position of the storm center has the same accuracy as the aircraft position determined by radar and the land navigational systems. With some exceptions, the accuracies of these positions is generally within 1 nmi. The central pressure data is given in millibars and is determined by dropsonde or extrapolation from flight-level data.

To obtain weather reports from oceanic areas, the NWS solicits the cooperation of merchant ships of U.S. and foreign registry and of non-military U.S. Government ships. There are about 200 ships that participate in this program. Observations are visual plus barometric and occasionally cyanometric pressure and are reported by radio at synoptic time when the ship is underway. In addition to the ships in the cooperative programs, all ships are asked to send special radio reports when tropical storms or hurricanes are encountered. Data from ships that report through the regular reporting system, supplemented by data from those ships submitting weather observations after the arrival at their major destination, are listed in table A.4. We have restricted our listing to the location of the reporting ship, sea level pressure, and wind data. The data are grouped by the time of observation from 1800 CST, August 7, through 1200 CST, August 10, 1980. This set of data was useful in the analyses of the pressure field and the wind field of the hurricane, especially when its center was located off the coast. The aneroid barometers on ships in the cooperative observing programs are calibrated by the NWS when a ship is visiting a port in the U.S. where an NWS Port Meteorological Officer is assigned. These calibrations, however, may not be as frequent as desirable.

TABLE A.1
SEA LEVEL PRESSURE AND WIND DATA FROM REGULARLY REPORTING STATIONS

ALICE TX

LATITUDE 27°44'N LONGITUDE 98° 4'W
ELEVATION 201FT

TIME (IN HOURS CST)

DATE AUGUST 8TH, 1980

	1	2	3	4	5	6	7	8	9	10	11	12
PRESSURE(MB)	1013.9	1013.6	1013.6	1013.2	1013.2	1013.5	1013.9	1013.9	1013.9	1013.2	1012.9	1012.4
WIND DIR(DEG)	000	000	000	000	000	360	360	040	050	050	050	090
WIND SPD (KN)	00	00	00	00	00	05	05	10	10	08	14	12
GUST (KN)												

	13	14	15	16	17	18	19	20	21	22	23	24
PRESSURE(MB)	1011.7	1011.0	1010.3	1009.6	1009.6	1009.6	1010.3	1010.3	1010.0	1010.0	1009.6	1009
WIND DIR(DEG)	050	040	100	090	090	090	090	080	060	040	040	010
WIND SPD (KN)	12	15	15	20	14	15	18	14	12	11	12	10
GUST (KN)												

DATE AUGUST 9TH, 1980

	1	2	3	4	5	6	7	8	9	10	11	12
PRESSURE(MB)	1008.6	1007.6	1006.6	1005.9	1005.5	1006.5	1006.9	1008.5	1006.9	1007.6	1006.9	1005.2
WIND DIR(DEG)	020	010	010	010	030	030	040	060	030	070	040	030
WIND SPD (KN)	11	13	15	15	15	13	10	25	15	15	22	20
GUST (KN)												

	13	14	15	16	17	18	19	20	21	22	23	24
PRESSURE(MB)	1004.9	1004.5	1004.9	1003.5	.	.	1001.8	1001.4	1001.0	1000.4	1000.8	999
WIND DIR(DEG)	030		070	040			040	050	040	040	050	050
WIND SPD (KN)	16		28	24			29	30	23	29	24	33
GUST (KN)												

DATE AUGUST 10TH, 1980

	1	2	3	4	5	6	7	8	9	10	11	12
PRESSURE(MB)	998.6	996.5	995.4	994.0	992.6	990.5	990.3	990.6	992.9	995.0	996.8	997.6
WIND DIR(DEG)	060	060	050	060	060	070	110	100	120	120	120	130
WIND SPD (KN)	33	40	35	40	41	40	50	53	50	38	33	33
GUST (KN)												

	13	14	15	16	17	18	19	20	21	22	23	24
PRESSURE(MB)	998.6	998.9	999.2	1000.3	1001.2	1001.2	1001.5	.	1004.6	1006.3	1007.2	1007
WIND DIR(DEG)	130	130	130	130	130	140	130		120	160	130	160
WIND SPD (KN)	30	30	30	28	30	28	16		17	15	12	12
GUST (KN)												

TABLE A.1 -- CONTINUED
SEA LEVEL PRESSURE AND WIND DATA FROM REGULARLY REPORTING STATIONS

AUSTIN TX

LATITUDE 30°17'N LONGITUDE 97°26'W
ELEVATION 597FT

TIME (IN HOURS CST)

	1	2	3	4	5	6	7	8	9	10	11	12
DATE AUGUST 8TH, 1980												
PRESSURE(MB)	1015.2	1014.9	1014.9	1014.9	1014.9	1015.2	1015.6	1015.9	1015.6	1015.2	1014.9	1014.1
WIND DIR(DEG)	000	000	000	000	000	000	000	060	060	060	050	070
WIND SPD (KN)	00	00	00	00	00	00	00	06	04	07	10	05
GUST (KN)												
DATE AUGUST 9TH, 1980												
PRESSURE(MB)	1012.1	1011.4	1011.4	1010.7	1010.7	1010.6	1011.3	1011.6	1011.6	1011.3	1011.3	1011.1
WIND DIR(DEG)	360	010	030	020	030	030	060	040	060	070	080	070
WIND SPD (KN)	04	05	07	06	08	08	09	09	08	12	16	14
GUST (KN)												
DATE AUGUST 10TH, 1980												
PRESSURE(MB)	1008.9	1008.2	1007.9	1007.9	1007.9	1008.5	1008.9	1009.7	1010.0	1010.5	1010.8	1010.1
WIND DIR(DEG)	040	040	060	040	040	040	050	060	060	050	050	060
WIND SPD (KN)	09	07	09	08	10	10	11	12	10	10	10	10
GUST (KN)												

	13	14	15	16	17	18	19	20	21	22	23	24
DATE AUGUST 8TH, 1980												
PRESSURE(MB)	1013.4	1012.4	1011.7	1011.1	1010.4	1010.4	1010.7	1011.4	1012.0	1012.4	1012.1	1012
WIND DIR(DEG)	110	060	110	130	130	130	130	140	130	130	000	020
WIND SPD (KN)	09	09	08	07	10	12	14	07	07	03	00	03
GUST (KN)												
DATE AUGUST 9TH, 1980												
PRESSURE(MB)	1010.7	1009.6	1008.6	1008.6	1008.6	1008.3	1008.3	1008.7	1009.3	1009.3	1009.1	
WIND DIR(DEG)	070	070	060	060	080	090	090	080	090	050	040	
WIND SPD (KN)	12	10	11	12	12	10	09	07	07	06	06	
GUST (KN)												
DATE AUGUST 10TH, 1980												
PRESSURE(MB)		1010.0	1009.0	1008.3	1008.7	1008.3	1008.7	1009.4	1009.7	1010.8	1010.5	1010
WIND DIR(DEG)		090	090	050	040	050	070	080	060	070	050	070
WIND SPD (KN)		12	09	11	10	10	10	06	06	06	05	07
GUST (KN)												

TABLE A.1 -- CONTINUED
SEA LEVEL PRESSURE AND WIND DATA FROM REGULARLY REPORTING STATIONS

BEEVILLE, CHASE FIELD, TX
LATITUDE 28°22'N LONGITUDE 97°40'W
ELEVATION 190FT

TIME (IN HOURS CST)

	1	2	3	4	5	6	7	8	9	10	11	12
DATE AUGUST 8TH, 1980												
PRESSURE(MB)	1014.0	1013.7	1013.6	1013.5	1013.4	1013.6	1014.0	1014.3	1014.0	1013.6	1013.2	^012.4
WIND DIR(DEG)	080	050	040	040	030	360	030	040	040	060	070	040
WIND SPD (KN)	03	03	04	05	06	05	06	06	08	08	07	06
GUST (KN)												
DATE AUGUST 9TH, 1980												
PRESSURE(MB)	1009.5	1008.5	1007.6	1006.7	1006.7	1007.2	1007.0	1008.5	1007.5	1008.1	1009.4	1008.1
WIND DIR(DEG)	040	040	030	030	040	040	050	130	080	120	090	050
WIND SPD (KN)	10	11	10	10	11	10	13	15	06	14	16	22
GUST (KN)												
DATE AUGUST 10TH, 1980												
PRESSURE(MB)	1001.5	1000.4	1000.8	1000.6	999.8	999.3	1000.9	1001.5	1001.7	1002.2	1002.2	1002.4
WIND DIR(DEG)	100	110	110	090	080	090	100	100	100	110	110	130
WIND SPD (KN)	26	16	25	25	34	30	24	18	22	21	24	25
GUST (KN)												

	13	14	15	16	17	18	19	20	21	22	23	24
DATE AUGUST 8TH, 1980												
PRESSURE(MB)	1011.9	1011.3	1010.5	1009.7	1009.6	1010.0	1010.4	1010.4	1010.5	1010.5	1010.4	1010
WIND DIR(DEG)	070	090	080	080	120	100	100	090	060	050	020	030
WIND SPD (KN)	12	10	11	10	11	14	08	10	05	05	06	08
GUST (KN)												
DATE AUGUST 9TH, 1980												
PRESSURE(MB)	1006.5	1006.1	1006.3	1006.2	1005.4	1004.8	1004.3	1004.4	1003.9	1003.1	1002.5	1002
WIND DIR(DEG)	050	070	070	060	070	060	060	060	060	050	060	070
WIND SPD (KN)	14	10	22	19	18	17	16	20	21	21	25	20
GUST (KN)												
DATE AUGUST 10TH, 1980												
PRESSURE(MB)	1002.9	1003.1	1003.4	1002.4	1002.9	1003.2	1003.3	1004.8	1006.5	1007.4	1008.3	1008
WIND DIR(DEG)	120	150	130	150	120	110	110	110	120	120	130	130
WIND SPD (KN)	24	22	19	12	23	24	22	18	12	14	14	14
GUST (KN)												

TABLE A.1 -- CONTINUED
SEA LEVEL PRESSURE AND WIND DATA FROM REGULARLY REPORTING STATIONS

BROWNSVILLE TX

LATITUDE 25°54'N LONGITUDE 97°26'W
ELEVATION 19FT

TIME (IN HOURS CST)

DATE AUGUST 8TH, 1980

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
PRESSURE(MB)	1013.2	1012.9	1012.4	1012.	1011.8	1012.2	1012.1	1012.2	1011.9	1011.6	1011.5	1010.8	1010.6	1010.2	1009.4	1008.5	1007.9	1008.2	1008.2	1007.1	1006.8	1006.8	1005.6	1004
WIND DIR(DEG)	000	330	340	330	320	340	330	360	010	010	030	020	020	020	020	040	040	060	030	320	340	350	340	340
WIND SPD (KN)	00	05	05	06	05	05	06	09	10	15	13	16	17	16	14	16	16	20	12	09	10	11	12	16
GUST (KN)																								

DATE AUGUST 9TH, 1980

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
PRESSURE(MB)	1003.1	1001.7	1001.1	999.2	997.7	996.8	996.3	995.6	994.6	993.8	991.1	988.9	986.2	984.1	981.3	979.7	977.9	977.5	976.1	975.9	974.5	973.3	970.6	969
WIND DIR(DEG)	350	340	020	340	340	340	350	360	360	010	360	350	010	360	360	360	360	360	360	360	360	330	290	250
WIND SPD (KN)	18	19	18	19	19	25	22	24	31	30	38	34	32	36	37	37	42	38	34	38	25	26	30	31
GUST (KN)																								

DATE AUGUST 10TH, 1980

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
PRESSURE(MB)	972.7	976.9	979.1	983.2	987.8	991.7	995.3	999.8	1000.0	1000.5	1001.4	1002.1	1001.3	1001.2	1001.1	1001.1	1001.9	1001.9	1002.2	1002.6	1004.2	1005.8	1006.5	1006
WIND DIR(DEG)	250	250	250	260	250	190	200	190	200	200	200	200	200	120	120	140	130	130	130	130	130	130	130	140
WIND SPD (KN)	33	32	40	40	41	42	40	36	28	25	19	14	10	25	27	25	22	20	22	23	19	14	15	16
GUST (KN)																								

TABLE A.1 -- CONTINUED
SEA LEVEL PRESSURE AND WIND DATA FROM REGULARLY REPORTING STATIONS

COLLEGE STATION TX

LATITUDE 30°35'N LONGITUDE 96°22'W
ELEVATION 314FT

TIME (IN HOURS CST)

DATE AUGUST 8TH, 1980

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
PRESSURE(MB)	1015.6	1015.6	1015.3	1015.6	1015.6	1015.9	1015.9	1016.5	1016.1	1015.4	1015.1	1014.4	1013.4	1013.1	1012.6	1011.6	1011.2	1011.6	1011.9	1012.3	1012.6	1012.9	1012.9	1012
WIND DIR(DEG)	000	000	000	060	060	040	050	050	070	070	110	130	100	100	120	140	130	120	130	150	140	100	070	110
WIND SPD (KN)	00	00	00	04	06	05	08	08	07	08	07	18	12	14	12	12	12	12	10	05	05	05	04	05
GUST (KN)																								

DATE AUGUST 9TH, 1980

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
PRESSURE(MB)	1012.0	1012.0	1011.3	1011.3	1011.0	1011.1	1011.6	1012.6	1012.6	1012.2	1011.8	1011.5	1011.1	1010.5	1009.8	1009.5	1009.8	1009.5	1009.5	1009.5	1010.4	1010.4	1010.4	1010
WIND DIR(DEG)	090	080	070	050	060	050	070	070	090	120	090	120	110	120	100	100	100	090	090	090	090	090	090	070
WIND SPD (KN)	07	06	07	07	08	08	09	10	15	15	15	15	15	15	15	15	15	15	07	06	05	06	10	08
GUST (KN)																								

DATE AUGUST 10TH, 1980

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
PRESSURE(MB)	1010.2	1009.8	1009.5	1009.1	1009.5	1010.2	1010.2	1010.8	1011.1	1011.7	1011.7	1011.1	1011.1	1011.1	1011.1	1010.5	1010.5	1010.2	1010.2	1010.5	1011.6	1011.6	1011.6	1011
WIND DIR(DEG)	090	070	070	070	090	070	060	090	090	120	120	090	120	110	120	090	090	120	130	110	100	120	100	110
WIND SPD (KN)	06	08	10	10	10	08	10	09	12	12	12	11	12	12	15	13	10	12	08	11	05	08	08	08
GUST (KN)																								

TABLE A.1 -- CONTINUED
SEA LEVEL PRESSURE AND WIND DATA FROM REGULARLY REPORTING STATIONS

CORPUS CHRISTI TX

LATITUDE 27°46'N LONGITUDE 97°30'W
ELEVATION 44FT

TIME (IN HOURS CST)

	1	2	3	4	5	6	7	8	9	10	11	12
DATE AUGUST 8TH, 1980												
PRESSURE(MB)	1014.2	1013.9	1013.5	1013.5	1013.5	1013.2	1013.9	1013.9	1013.5	1013.2	1012.9	1012.2
WIND DIR(DEG)	090	080	120	000	360	020	020	360	050	040	040	050
WIND SPD (KN)	07	05	05	00	05	07	09	10	13	12	13	14
GUST (KN)												
DATE AUGUST 9TH, 1980												
PRESSURE(MB)	1007.5	1006.4	1005.4	1005.1	1005.1	1005.4	1006.4	1006.1	1006.4	1005.4	1004.7	1003.7
WIND DIR(DEG)	360	020	030	020	030	040	040	040	050	050	030	020
WIND SPD (KN)	13	14	19	16	17	19	28	22	28	26	25	28
GUST (KN)												
DATE AUGUST 10TH, 1980												
PRESSURE(MB)	995.9	994.9	994.2	993.2	992.6	994.9	996.6	996.3	997.3	999.7	1001.0	1001.4
WIND DIR(DEG)	060	070	080	080	110	110	110	100	110	120	130	140
WIND SPD (KN)	44	44	45	45	48	45	45	45	43	43	30	30
GUST (KN)												

	13	14	15	16	17	18	19	20	21	22	23	24
DATE AUGUST 8TH, 1980												
PRESSURE(MB)	1011.5	1011.2	1010.8	1010.2	1010.2	1010.2	1010.2	1009.8	1009.5	1009.8	1009.1	1008
WIND DIR(DEG)	060	090	080	080	070	070	060	040	050	050	020	020
WIND SPD (KN)	18	20	18	17	16	19	14	13	12	14	09	10
GUST (KN)												
DATE AUGUST 9TH, 1980												
PRESSURE(MB)	1002.7	1004.1	1002.0	1002.0	1001.7	1000.7	1000.0	1000.0	998.6	1000.0	998.6	997
WIND DIR(DEG)	030	060	040	030	040	040	020	040	040	040	050	070
WIND SPD (KN)	28	30	28	25	32	33	32	36	35	30	32	38
GUST (KN)												
DATE AUGUST 10TH, 1980												
PRESSURE(MB)	1002.0	1000.0	1002.7	1002.0	1001.7	1002.7	1004.1	1004.7	1006.1	1007.8	1008.5	1008
WIND DIR(DEG)	140	120	120	150	140	130	130	120	120	120	120	120
WIND SPD (KN)	29	26	22	12	30	28	28	25	22	18	17	20
GUST (KN)												

TABLE A.1 -- CONTINUED
SEA LEVEL PRESSURE AND WIND DATA FROM REGULARLY REPORTING STATIONS

CORPUS CHRISTI, NAS, TX
LATITUDE 27°42'N LONGITUDE 97°17'W
ELEVATION 1FT

TIME (IN HOURS CST)

DATE AUGUST 8TH, 1980

	1	2	3	4	5	6	7	8	9	10	11	12
PRESSURE(MB)	1014.5	1014.3	1014.0	1013.9	1013.8	1013.9	1014.0	1014.3	1014.2	1013.8	1013.8	1013.4
WIND DIR(DEG)	090	080	080	080	050	030	010	010	030	040	050	040
WIND SPD (KN)	05	03	03	02	02	02	03	08	06	10	10	10
GUST (KN)												

	13	14	15	16	17	18	19	20	21	22	23	24
PRESSURE(MB)	1013.0	1012.5	1012.0	1011.3	1011.0	1010.8	1010.9	1010.2	1010.1	1010.1	1009.4	1008
WIND DIR(DEG)	060	060	060	070	050	050	050	050	030	050	050	030
WIND SPD (KN)	12	13	10	14	14	12	12	14	12	12	13	10
GUST (KN)												

DATE AUGUST 9TH, 1980

	1	2	3	4	5	6	7	8	9	10	11	12
PRESSURE(MB)	1007.6	1006.9	1006.1	1005.4	1006.3	1006.2	1005.7	1005.4	1005.6	1005.1	1004.2	1003.8
WIND DIR(DEG)	030	020	030	020	040	990	030	030	050	030	030	030
WIND SPD (KN)	10	11	10	14	13	16	14	18	20	17	17	20
GUST (KN)					25	28	25	27	30	30	27	31

	13	14	15	16	17	18	19	20	21	22	23	24
PRESSURE(MB)	1003.8	1002.8	1001.8	1001.2	1001.1	999.9	1000.6	999.3	999.4	999.8	999.3	998
WIND DIR(DEG)	070	020	050	060	060	050	090	060	070	090	090	090
WIND SPD (KN)	26	26	24	28	30	27	28	25	26	36	30	33
GUST (KN)	38	38	34	42	42	42	38	44	44		43	47

DATE AUGUST 10TH, 1980

	1	2	3	4	5	6	7	8	9	10	11	12
PRESSURE(MB)	996.7	996.1	995.7	995.0	994.3	995.2	997.2	998.4	999.6	1002.3	1001.9	1002.8
WIND DIR(DEG)	080	080	090	100	110	110	120	110	110	030	130	140
WIND SPD (KN)	33	37	34	30	34	35	31	30	30	30	26	25
GUST (KN)	50	51	48	49	46	60	47	47	42	42	34	34

	13	14	15	16	17	18	19	20	21	22	23	24
PRESSURE(MB)	1003.7	1003.8	1003.8	1002.7	1002.6	1004.1	1004.9	1006.0	1007.2	1008.6	1009.3	1009
WIND DIR(DEG)	140	130	120	120	120	130	140	130	140	140	140	140
WIND SPD (KN)	24	24	20	26	28	24	20	20	18	14	16	14
GUST (KN)				42	41							

TABLE A.1 -- CONTINUED
SEA LEVEL PRESSURE AND WIND DATA FROM REGULARLY REPORTING STATIONS

COTULLA TX

LATITUDE 28°27'N LONGITUDE 99°13'W
ELEVATION 459FT

TIME (IN HOURS CST)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
DATE AUGUST 8TH, 1980																								
PRESSURE(MB)	.	.	.	.	1014.4	1014.4	1014.8	1015.1	1014.8	1014.4	1014.4	1013.6	1012.5	1012.2	1011.0	1010.3	1010.0	1010.0	1010.0	1010.4	1010.7	.	.	
WIND DIR(DEG)					010	030	050	060	030	100	080	130	100	080	110	120	100	070	050	100	110			
WIND SPD (KN)					03	04	04	05	05	08	09	05	09	10	08	06	05	15	04	05	07			
GUST (KN)																								
DATE AUGUST 9TH, 1980																								
PRESSURE(MB)	.	.	.	.	1009.0	1009.0	1010.1	1010.1	1010.4	1010.1	1009.8	1009.8	1010.1	1010.1	1008.4	1007.1	1007.1	1007.9	1007.0	1007.3	1007.3	.	.	
WIND DIR(DEG)					360	350	360	360	010	030	030	040	100	110	090	060	050	080	010	040	360			
WIND SPD (KN)					07	12	06	10	12	13	15	14	15	17	11	11	14	09	06	04	05			
GUST (KN)																								
DATE AUGUST 10TH, 1980																								
PRESSURE(MB)	.	.	.	.	1001.6	1002.0	1001.6	1001.3	1001.0	1000.6	1000.0	999.0	999.0	998.2	998.2	997.6	997.6	1008.0	1008.6	1000.0	1001.0	.	.	
WIND DIR(DEG)					010	050	070	040	020	020	030	050	060	070	080	070	090	090	090	100	100			
WIND SPD (KN)					15	15	17	16	20	20	18	24	25	24	16	24	27	24	17	17	18			
GUST (KN)																								

DATA ENTERED ONLY FOR THOSE TIMES THAT WERE AVAILABLE

TABLE 4.1 -- CONTINUED
SEA LEVEL PRESSURE AND WIND DATA FROM REGULARLY REPORTING STATIONS

DALLAS LOVE FIELD TX

LATITUDE 32°51'N LONGITUDE 96°51'W
ELEVATION 440FT

TIME (IN HOURS CST)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
DATE AUGUST 8TH, 1980																								
WIND DIR(DEG)	170	170	170	190	200	190	200	200	180	160	160	130	200	130	100	140	190	120	140	140	130	120	120	100
WIND SPD (KN)	06	07	08	04	03	03	04	06	06	13	09	08	08	14	12	14	11	10	15	10	07	05	07	05
GUST (KN)																								
DATE AUGUST 9TH, 1980																								
WIND DIR(DEG)	100	120	120	140	150	000	120	140	140	130	140	110	120	130	140	110	140	130	150	150	130	130	130	130
WIND SPD (KN)	05	04	06	07	06	00	06	07	09	10	12	12	13	14	08	15	15	12	12	12	08	07	06	05
GUST (KN)																								
DATE AUGUST 10TH, 1980																								
WIND DIR(DEG)	160	170	150	170	150	160	090	160	120	150	150	130	120	130	150	170	170	150	160	150	180	190	210	200
WIND SPD (KN)	06	10	07	07	08	07	04	10	12	13	11	12	11	10	10	13	10	15	10	08	08	07	04	04
GUST (KN)																								

DATA ENTERED ONLY FOR THOSE TIMES THAT WERE AVAILABLE

TABLE A.1 -- CONTINUED
SEA LEVEL PRESSURE AND WIND DATA FROM REGULARLY REPORTING STATIONS

FORT WORTH TX FAA

LATITUDE 32°49'N LONGITUDE 97°21'W
ELEVATION 670FT

TIME (IN HOURS CST)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
DATE AUGUST 8TH, 1980																								
WIND DIR(DEG)	160	170	170	180	160	190	000	190	140	230	170	170	160	080	140	140	090	140	110	130	130	140	150	130
WIND SPD (KN)	10	10	06	05	06	03	00	09	06	05	12	14	10	08	12	16	12	13	12	08	06	07	05	06
GUST (KN)																								
DATE AUGUST 9TH, 1980																								
WIND DIR(DEG)	090	080	160	110	110	080	110	130	160	080	120	120	120	100	100	090	120	120	140	130	130	140	140	150
WIND SPD (KN)	04	03	05	02	04	04	04	05	10	06	11	11	11	10	11	12	11	08	14	12	11	09	08	09
GUST (KN)																								
DATE AUGUST 10TH, 1980																								
WIND DIR(DEG)	190	180	190	170	150	140	080	110	150	150	130	140	140	100	150	170	160	160	160	150	160	170	180	000
WIND SPD (KN)	06	05	10	07	06	05	06	08	10	12	12	14	13	15	11	15	14	15	12	07	10	05	04	00
GUST (KN)																								

DATA ENTERED ONLY FOR THOSE TIMES THAT WERE AVAILABLE

TABLE A.1 -- CONTINUED
SEA LEVEL PRESSURE AND WIND DATA FROM REGULARLY REPORTING STATIONS

GALVESTON TX

LATITUDE 29°18'N LONGITUDE 94°48'W
ELEVATION 7FT

TIME (IN HOURS CST)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
DATE AUGUST 8TH, 1980																								
WIND DIR(DEG)					040	040	040	030	040	050	070	050	060	060	050	070	080	090	060	060	060			
WIND SPD (KN)					11	09	09	08	11	11	16	17	13	14	20	12	12	13	10	12	15			
GUST (KN)																								
DATE AUGUST 9TH, 1980																								
WIND DIR(DEG)					070	080	070	080	080	080	080	080	090	090	090	090								
WIND SPD (KN)					18	21	17	22	24	21	23	22	21	23	22	21								
GUST (KN)																								
DATE AUGUST 10TH, 1980																								
WIND DIR(DEG)					110	120	120	120	110	120	110	120	120	110	110	110	120	110	110	110	110			
WIND SPD (KN)					22	20	18	21	18	1[illegible]	21	16	18	16	13	15	15	15	14	18	14			
GUST (KN)																								

DATA ENTERED ONLY FOR THOSE TIMES THAT WERE AVAILABLE

TABLE A.1 -- CONTINUED
SEA LEVEL PRESSURE AND WIND DATA FROM REGULARLY REPORTING STATIONS

KINGSVILLE, NAS, TX

LATITUDE 27°30'N LONGITUDE 97°49'W
ELEVATION 5FT

TIME (IN HOURS CST)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
DATE AUGUST 8TH, 1980																								
WIND DIR(DEG)																								
WIND SPD (KN)																								
GUST (KN)																								
DATE AUGUST 9TH, 1980																								
PRESSURE(MB)	1006.9	1006.1	1005.3	1004.5	1004.5	1005.5	1005.3	1005.7	1005.9	1005.0	1004.0	1002.7	1002.2	1001.9	1000.9	1000.5	1000.4	999.1	998.6	998.4	997.3	998.3	997.6	995
WIND DIR(DEG)	350	360	010	010	010	030	020	030	030	020	020	020	020	020	030	030	020	030	020	030	020	040	060	060
WIND SPD (KN)	12	12	12	16	14	14	10	20	20	24	24	24	19	25	22	25	25	26	33	26	24	24	30	30
GUST (KN)																			43	42	44	43	41	49
DATE AUGUST 10TH, 1980																								
PRESSURE(MB)	993.9	992.0	991.1	989.6	987.1	985.4	985.2	989.0	991.9	995.6	996.9	997.7	998.1	998.7	999.9	1000.2	1000.7	1001.1	1002.0	1003.3	1004.0	1006.3	1006.7	1007
WIND DIR(DEG)	070	070	070	080	080	090	120	130	150	150	150	150	140	120	150	130	170	170	140	140	130	160	120	220
WIND SPD (KN)	36	39	36	40	44	38	60	50	44	35	29	25	25	25	23	17	11	15	20	22	20	15	12	10
GUST (KN)	53	49	49	57	57	62	70	66	61	46	37													

TABLE A.1 -- CONTINUED
SEA LEVEL PRESSURE AND WIND DATA FROM REGULARLY REPORTING STATIONS

LAUGHLIN AFB, TX

LATITUDE 29°22'N LONGITUDE 100°47'W
ELEVATION 1082FT

TIME (IN HOURS CST)

DATE AUGUST 8TH, 1980

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
PRESSURE(MB)	1014.9	1014.7	1014.5	1014.5	1014.5	1014.7	1015.1	1015.5	1014.9	1014.9	1014.5	1013.9	1012.9	1012.2	1011.2	1010.5	1010.2	1009.8	1009.7	1010.3	1010.7	1011.0	1010.9	1012
WIND DIR(DEG)	120	120	120	120	110	100	100	120	120	110	120	140	120	000	150	130	120	100	110	120	120	080	110	100
WIND SPD (KN)	08	06	04	04	03	03	05	04	06	04	04	06	04	00	05	08	07	11	05	06	04	02	03	04
GUST (KN)																								

DATE AUGUST 9TH, 1980

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
PRESSURE(MB)	1012.2	1011.8	1011.8	1011.6	1011.0	1010.8	1011.6	1012.2	1012.4	1012.4	1011.8	1010.9	1009.9	1009.0	1008.0	1007.3	1007.5	1007.7	1008.0	1008.0	1008.8	1009.4	1009.5	1009
WIND DIR(DEG)	110	090	080	070	000	300	000	020	010	090	040	070	050	080	080	100	080	120	100	120	110	110	110	000
WIND SPD (KN)	06	02	03	02	00	02	00	02	02	06	06	05	10	07	10	08	14	16	10	07	02	04	05	00
GUST (KN)																								

DATE AUGUST 10TH, 1980

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
PRESSURE(MB)	1008.8	1008.2	1008.3	1007.9	1007.5	1007.2	1008.0	1008.4	1009.7	1010.2	1009.8	1009.3	1008.2	1007.7	1007.1	1006.4	1006.2	1006.2	1006.0	1005.4	1005.2	1005.2	1005.2	1005
WIND DIR(DEG)	000	290	330	010	010	010	010	020	060	030	010	010	010	010	360	010	010	010	010	360	020	030	040	040
WIND SPD (KN)	00	04	03	06	05	07	08	10	06	06	10	11	08	10	12	14	14	15	12	12	18	22	20	20
GUST (KN)																								

TABLE A.1 -- CONTINUED
SEA LEVEL PRESSURE AND WIND DATA FROM REGULARLY REPORTING STATIONS

LUFKIN TX

LATITUDE 31°14'N LONGITUDE 94°45'W
ELEVATION 281FT

TIME (IN HOURS CST)

DATE AUGUST 8TH, 1980

TIME (IN HOURS CST)	PRESSURE(MB)	WIND DIR(DEG)	WIND SPD (KN)	GUST (KN)
1	1016.1	000	00	
2	1016.1	000	00	
3	1016.1	000	00	
4	.			
5	1015.8	000	00	
6	1016.4	000	00	
7	1016.4	050	06	
8	1016.7	040	06	
9	1016.7	050	10	
10	1016.4	060	08	
11	1016.1	050	12	
12	1015.4	040	12	
13	1014.7	080	10	
14	1014.0	070	14	
15	1013.0	070	12	
16	1012.7	100	15	
17	1012.4	090	12	
18	1012.4	100	10	
19	1012.7	100	08	
20	1013.0	120	06	
21	1013.3	090	05	
22	1013.6	120	05	
23	1013.6	080	05	
24	1013	110	05	

DATE AUGUST 9TH, 1980

TIME (IN HOURS CST)	PRESSURE(MB)	WIND DIR(DEG)	WIND SPD (KN)	GUST (KN)
1	1013.0	090	04	
2	1013.0	080	05	
3	1012.7	090	04	
4	1012.7	060	05	
5	1012.7	080	06	
6	1013.0	080	06	
7	1013.0	080	09	
8	1013.7	070	08	
9	1014.0	090	10	
10	1014.0	090	10	
11	1013.0	080	10	
12	1012.3	090	10	
13	1012.3	090	08	
14	1011.6	090	10	
15	1010.9	080	12	
16	1010.3	090	12	
17	1010.3	130	10	
18	1010.3	130	12	
19	1010.6	130	07	
20	1010.9	120	08	
21	1011.9	120	10	
22	1011.6	090	07	
23	1011.3	090	05	
24	1011	120	06	

DATE AUGUST 10TH, 1980

TIME (IN HOURS CST)	PRESSURE(MB)	WIND DIR(DEG)	WIND SPD (KN)	GUST (KN)
1	1011.7	130	06	
2	1011.3	100	06	
3	1011.0	090	06	
4	1011.0	090	06	
5	1011.0	090	06	
6	1011.7	080	04	
7	1012.1	080	08	
8	1012.3	090	12	
9	1012.6	120	10	
10	1012.9	100	12	
11	1012.9	170	12	
12	1012.2	140	07	
13	1012.2	120	08	
14	1011.5	190	10	
15	1011.2	170	0A	
16	1011.2	170	10	
17	1010.9	120	10	
18	1010.9	110	07	
19	1010.9	100	06	
20	1011.2	090	05	
21	1012.1	120	05	
22	1012.4	120	05	
23	1012.4	150	05	
24	1012	120	04	

TABLE A.1 -- CONTINUED
SEA LEVEL PRESSURE AND WIND DATA FROM REGULARLY REPORTING STATIONS

MCALLEN TX

LATITUDE 26°11'N LONGITUDE 98°14'W
ELEVATION 122FT

TIME (IN HOURS CST)

	1	2	3	4	5	6	7	8	9	10	11	12
DATE AUGUST 8TH, 1980												
PRESSURE(MB)	1013.8	1012.8	1012.8	1012.5	1012.5	1012.5	1012.8	1013.1	1012.8	1012.5	1012.1	1011.4
WIND DIR(DEG)	000	300	000	000	360	330	340	010	350	020	360	340
WIND SPD (KN)	00	05	00	00	05	04	06	05	00	07	08	09
GUST (KN)												
DATE AUGUST 9TH, 1980												
PRESSURE(MB)	1006.4	1005.4	1004.0	1003.4	1004.0	1003.0	.	.	.	.	.	.
WIND DIR(DEG)	340	340	330	350	030	330						
WIND SPD (KN)	13	15	13	15	18	15						
GUST (KN)												
DATE AUGUST 10TH, 1980												
PRESSURE(MB)	.	.	.	.	.	.	.	.	995.2	995.6	997.3	998.3
WIND DIR(DEG)									200	200	180	190
WIND SPD (KN)									20	20	20	14
GUST (KN)												

	13	14	15	16	17	18	19	20	21	22	23	24
DATE AUGUST 8TH, 1980												
PRESSURE(MB)	1010.8	1010.1	1009.8	1008.7	1008.7	1008.7	1009.4	1009.0	1008.7	1008.7	1008.4	1007
WIND DIR(DEG)	010	030	020	050	030	020	040	040	020	360	350	330
WIND SPD (KN)	10	14	13	09	11	15	15	07	08	10	12	11
GUST (KN)												
DATE AUGUST 9TH, 1980												
PRESSURE(MB)	.	.	.	.	.	.	.	.	.	.	.	.
WIND DIR(DEG)												
WIND SPD (KN)												
GUST (KN)												
DATE AUGUST 10TH, 1980												
PRESSURE(MB)	999.3	999.7	999.7	1000.0	999.7	1000.7	1002.1	1003.4	1005.7	1005.7	1006.0	1006
WIND DIR(DEG)	180	180	180	180	150	150	150	190	210	180	160	170
WIND SPD (KN)	15	15	15	20	21	20	16	05	12	12	06	05
GUST (KN)												

DATA ENTERED ONLY FOR THOSE TIMES THAT WERE AVAILABLE

TABLE A.1 -- CONTINUED
SEA LEVEL PRESSURE AND WIND DATA FROM REGULARLY REPORTING STATIONS

MIDLAND TX

LATITUDE 31°57'N LONGITUDE 102°11'W
ELEVATION 2857FT

TIME (IN HOURS CST)

DATE AUGUST 8TH, 1980

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
PRESSURE(MB)	1012.7	1012.7	1012.6	1012.6	1013.1	1013.2	1013.6	1013.7	1014.0	1013.6	1013.6	1012.9	1012.1	1011.5	1010.4	1009.8	1009.5	1009.2	1009.1	1010.0	1010.4	1010.7	1011.6	1011
WIND DIR(DEG)	160	160	160	150	140	160	140	160	160	170	130	140	130	140	160	150	150	140	140	130	150	120	110	110
WIND SPD (KN)	07	06	10	10	10	07	08	11	10	11	12	11	14	15	13	14	15	14	13	12	11	07	06	06
GUST (KN)																								

DATE AUGUST 9TH, 1980

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
PRESSURE(MB)	1011.6	1011.2	1011.0	1011.1	1011.2	1011.4	1011.8	1011.6	1012.1	1012.1	1011.7	1011.2	1010.3	1009.5	1008.6	1007.6	1007.4	1007.5	1007.5	1007.7	1008.2	1008.9	1009.1	1009
WIND DIR(DEG)	130	130	130	130	000	000	000	170	160	160	160	140	150	150	120	120	110	140	130	120	110	110	120	130
WIND SPD (KN)	06	05	06	03	00	00	00	08	10	10	13	13	10	17	16	14	14	13	13	13	13	10	12	11
GUST (KN)																								

DATE AUGUST 10TH, 1980

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
PRESSURE(MB)	1009.1	1008.8	1008.7	1008.5	1008.7	1008.7	1009.7	1010.3	1010.6	1010.6	1010.5	1010.1	1009.6	1009.1	1008.7	1008.3	1008.2	1008.5	1008.6	1009.2	1009.8	1009.9	1010.7	1011
WIND DIR(DEG)	140	150	000	140	000	000	000	140	130	120	130	130	100	110	120	130	130	140	120	120	130	110	100	100
WIND SPD (KN)	07	06	00	06	00	00	00	07	11	12	14	12	15	14	17	14	19	18	20	16	15	20	14	12
GUST (KN)																								

TABLE A.1 -- CONTINUED
SEA LEVEL PRESSURE AND WIND DATA FROM REGULARLY REPORTING STATIONS

PORT ARTHUR,WSO,TX

LATITUDE 29°57'N LONGITUDE 94° 1'W
ELEVATION 16FT

TIME (IN HOURS CST)

DATE AUGUST 8TH, 1980

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
PRESSURE(MB)	1015.2	1014.8	1014.4	1014.5	1014.6	1014.8	1015.1	1015.3	1015.6	1015.3	1015.3	1014.6	1014.2	1013.5	1013.0	1012.5	1012.1	1012.2	1012.4	1012.1	1012.6	1012.6	1012.2	1012
WIND DIR(DEG)	040	020	030	040	360	020	050	050	080	080	090	090	060	050	090	080	080	060	060	080	080	070	070	060
WIND SPD (KN)	06	06	07	06	06	06	09	11	15	16	16	16	15	20	17	17	16	15	13	13	14	13	15	15
GUST (KN)																								

DATE AUGUST 9TH, 1980

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
PRESSURE(MB)	1011.2	1010.8	1010.8	1010.[illegible]	1011.0	1011.0	1011.2	1012.2	1012.2	1012.3	1012.3	1011.9	1011.4	1011.3	1010.6	1010.4	1010.2	1010.0	1010.4	1010.8	1010.8	1010.8	1011.1	1010
WIND DIR(DEG)	060	060	070	070	060	070	070	080	070	100	110	110	090	120	120	120	100	100	090	110	090	090	110	100
WIND SPD (KN)	15	15	16	16	16	15	18	18	18	20	20	23	23	22	22	22	20	13	14	17	16	14	10	14
GUST (KN)																								

DATE AUGUST 10TH, 1980

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
PRESSURE(MB)	1010.3	1009.8	1009.6	1009.6	1009.9	1010.3	1010.6	1011.4	1012.1	1012.5	1012.8	1012.5	1012.1	1011.8	1011.6	1011.3	1011.2	1011.3	1011.0	1011.3	1012.0			
WIND DIR(DEG)	100	090	090	090	090	090	090	100	130	100	130	120	120	120	120	110	120	130	110	120	120	120	110	110
WIND SPD (KN)	11	10	10	10	12	10	10	11	12	14	17	15	15	15	17	14	13	12	12	10	08	08	08	10
GUST (KN)																								

TABLE A.1 -- CONTINUED
SEA LEVEL PRESSURE AND WIND DATA FROM REGULARLY REPORTING STATIONS

SAN ANTONIO TX

LATITUDE 29°32'N LONGITUDE 98°28'W
ELEVATION 794FT

TIME (IN HOURS CST)

DATE AUGUST 8TH, 1980

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
PRESSURE(MB)	1015.3	1015.3	1015.0	1015.1	1015.1	1015.1	1015.4	1015.6	1015.6	1015.0	1015.0	1013.9	1013.2	1012.6	1011.8	1011.1	1010.8	1010.5	1010.5	1011.4	1011.7	1012.2	1012.1	1012
WIND DIR(DEG)	100	000	000	320	320	000	350	030	090	050	120	070	050	060	070	060	090	090	120	110	100	100	350	340
WIND SPD (KN)	03	00	00	03	04	00	03	05	08	09	10	08	09	10	14	11	14	10	10	15	10	07	04	04
GUST (KN)																								

DATE AUGUST 9TH, 1980

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
PRESSURE(MB)	1011.7	1011.4	1010.7	1010.3	1009.7	1009.7	1010.7	1010.7	1010.7	1010.6	1010.7	1010.5	1009.7	1009.1	100A.5	1008.4	1008.0	1007.6	1007.6	1008.0	1008.7	1008.7	1008.4	1008
WIND DIR(DEG)	330	340	360	020	010	030	040	020	060	070	050	050	040	050	070	360	010	050	060	050	050	040	030	030
WIND SPD (KN)	05	05	06	08	08	09	10	11	13	15	12	14	13	14	17	05	08	10	10	08	08	06	11	09
GUST (KN)																								

DATE AUGUST 10TH, 1980

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
PRESSURE(MB)	1007.3	1007.0	1006.3	1006.[illegible]	1006.3	1006.3	1006.6	1006.7	1007.5	1008.1	1007.8	1007.0	1006.7	1005.6	1004.4	1005.0	1005.9	1005.6	1006.3	1007.0	1008.0	1008.5	1008.5	1009
WIND DIR(DEG)	030	050	040	040	050	040	030	030	030	050	040	030	050	030	050	070	080	070	050	070	060	070	070	090
WIND SPD (KN)	13	12	12	12	14	14	12	14	17	20	18	17	20	24	22	30	21	20	21	20	17	17	20	14
GUST (KN)																								

TABLE A.1 -- CONTINUED
SEA LEVEL PRESSURE AND WIND DATA FROM REGULARLY REPORTING STATIONS

SAN ANTONIO,KELLY AFB, TX
LATITUDE 29°23'N LONGITUDE 98°35'W
ELEVATION 690FT

TIME (IN HOURS CST)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
DATE AUGUST 8TH, 1980																								
PRESSURE(MB)	1015.5	1015.2	1015.0	1015.3	1015.1	1015.3	1015.3	1015.5	1015.6	1015.0	1014.6	1014.0	1013.2	1012.4	1011.7	1010.9	1010.6	1010.4	1010.4	1011.0	1011.7	1012.1	1012.3	1012
WIND DIR(DEG)	120	000	000	000	000	030	020	050	040	100	100	090	100	090	130	090	090	110	100	120	130	090	100	060
WIND SPD (KN)	04	00	00	00	00	02	04	03	06	05	03	05	05	06	08	10	10	10	11	11	10	08	04	02
GUST (KN)																								
DATE AUGUST 9TH, 1980																								
PRESSURE(MB)	1011.9	1011.4	1011.0	1010.5	1009.6	1009.9	1010.9	1010.9	1010.8	1010.5	1010.5	1010.4	1009.5	1008.8	1008.2	1008.4	1008.4	1007.6	1007.9	1007.8	1008.6	1008.4	1008.2	1008
WIND DIR(DEG)	000	020	010	030	030	030	060	040	050	070	040	060	060	040	070	050	040	100	100	070	060	060	050	040
WIND SPD (KN)	00	02	02	06	06	10	12	12	10	12	10	14	18	12	06	04	04	04	04	04	10	12	06	12
GUST (KN)																								
DATE AUGUST 10TH, 1980																								
PRESSURE(MB)	1007.2	1006.6	1006.2	1006.1	1006.1	1006.2	1006.4	1006.2	1006.8	1007.3	1007.0	1006.4	1005.6	1004.7	1003.2	1003.8	1005.5	1005.3	1005.3	1005.6	1006.7	1007.6	1007.8	1009
WIND DIR(DEG)	040	050	050	060	050	050	040	040	030	070	060	040	040	040	070	080	090	090	080	100	080	080	080	090
WIND SPD (KN)	15	16	15	16	16	16	16	16	18	10	18	20	18	20	24	20	20	10	10	18	18	20	20	15
GUST (KN)																								

TABLE A.1 -- CONTINUED
SEA LEVEL PRESSURE AND WIND DATA FROM REGULARLY REPORTING STATIONS

VICTORIA TX

LATITUDE 28°51'N LONGITUDE 96°55'W
ELEVATION 104FT

TIME (IN HOURS CST)

DATE AUGUST 8TH, 1980

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
PRESSURE(MB)	1014.9	1014.5	1014.2	1014.2	1014.5	1014.7	1014.9	1015.2	1014.9	1014.3	1014.2	1013.3	1012.8	1012.5	1011.5	1011.1	1011.3	1011.3	1011.8	1011.3	1010.8	1011.5	1011.1	1010
WIND DIR(DEG)	040	010	020	020	020	030	020	030	040	050	050	080	090	080	090	080	100	080	090	080	060	070	050	060
WIND SPD (KN)	06	04	05	06	05	08	08	09	12	13	12	13	16	20	18	15	16	18	15	10	06	12	11	13
GUST (KN)																								

DATE AUGUST 9TH, 1980

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
PRESSURE(MB)	1009.8	1009.1	1008.2	1008.1	1008.1	1008.1	1008.4	1008.6	1008.4	1008.4	1009.1	1008.7	1007.7	1007.2	1007.1	1007.7	1007.4	1006.7	1006.7	1007.1	1006.9	1006.4	1006.1	1005
WIND DIR(DEG)	060	040	040	040	040	040	040	050	060	060	060	060	070	070	070	140	070	060	060	080	070	040	070	050
WIND SPD (KN)	14	14	15	15	15	16	16	19	20	21	18	24	19	20	22	15	18	13	12	18	15	14	20	20
GUST (KN)																								

DATE AUGUST 10TH, 1980

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
PRESSURE(MB)	1005.4	1005.0	1004.7	1004.7	1004.3	1005.0	1006.1	1006.4	1006.7	1006.7	1007.1	1006.7	1006.7	1007.2	1007.1	1007.1	1007.1	1007.1	1008.1	1008.4	1009.3	1009.8	1010.1	1010
WIND DIR(DEG)	070	060	070	080	060	030	120	110	090	100	090	100	090	100	090	100	110	090	110	090	110	110	110	140
WIND SPD (KN)	20	19	19	22	18	16	22	20	16	20	24	22	26	22	20	18	19	18	12	12	11	12	12	12
GUST (KN)																								

TABLE A.1 -- CONTINUED
SEA LEVEL PRESSURE AND WIND DATA FROM REGULARLY REPORTING STATIONS

WACO TX

LATITUDE 31°37'N LONGITUDE 97°13'W
ELEVATION 500FT

TIME (IN HOURS CST)

DATE AUGUST 8TH, 1980

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
PRESSURE(MB)	1015.7	1015.7	1015.4	1015.7	1015.7	1015.9	1016.2	1016.5	1016.5	1015.8	1015.5	1014.8	1013.9	1013.6	1012.7	1011.7	1011.5	1011.2	1011.5	1012.1	1012.5	1012.8	1012.8	1012
WIND DIR(DEG)	140	160	220	000	000	360	020	060	050	070	080	130	110	140	140	140	140	140	140	120	110	100	140	000
WIND SPD (KN)	06	08	04	00	00	04	03	03	03	04	09	10	10	13	12	06	12	10	09	05	05	05	07	00
GUST (KN)																								

DATE AUGUST 9TH, 1980

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
PRESSURE(MB)	1012.4	1012.4	1012.4	1012.4	1012.4	1012.4	1013.0	1013.8	1013.3	1013.3	1013.3	1012.0	1011.5	1010.9	1010.2	1009.8	1009.8	1009.5	1009.5	1009.8	1011.0	1011.0	1010.6	1011
WIND DIR(DEG)	180	000	000	000	340	010	080	120	110	110	130	060	110	110	100	110	120	120	110	160	160	150	140	120
WIND SPD (KN)	05	00	00	00	04	05	04	11	09	12	10	11	13	06	13	14	10	10	08	14	09	08	04	04
GUST (KN)																								

DATE AUGUST 10TH, 1980

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
PRESSURE(MB)	1010.6	1010.1	1010.1	1010.1	1010.1	1010.5	1011.2	1011.5	1011.9	1012.1	1012.5	1012.1	1011.5	1010.8	1010.8	1010.8	1010.8	1010.5	1010.5	1010.5	1010.8	1011.5	1011.5	1011
WIND DIR(DEG)	140	130	100	090	050	090	080	120	140	130	150	160	140	150	170	170	150	150	130	120	130	120	130	130
WIND SPD (KN)	08	08	06	05	04	05	05	11	12	12	13	13	09	10	14	12	11	08	09	09	06	05	04	03
GUST (KN)																								

TABLE A.2 -- RADAR EYE POSITION REPORTED BY NWS STATIONS

TIME (CST)	BROWNSVILLE LAT	LONG	TIME (CST)	CORPUS CHRISTI LAT	LONG
AUGUST 8TH, 1980					
2010	24 35	93 20	2000		
2105	24 40	93 31	2100		
2130	24 36	93 41	2130		
2203	24 38	93 50	2200		
2234	24 4[illegible]	93 55	2230		
2310	24 47	93 59	2300		
2330	24 51	94 06	2330		
AUGUST 9TH					
5	24 52	94 14	5		
35	24 53	94 19	30		
103	24 58	94 26	100		
135	25 0	94 34	130		
206	25 04	94 38	200		
235	25 07	94 46	230		
305	25 00	95 06	300		
330	25 04	95 02	330		
410	25 06	95 06	400		
430	25 05	95 10	430		
510	25 06	95 16	500		
530	25 08	95 17	530	25 05	95 18
610	25 03	95 22	600	25 10	95 25
630	25 08	95 28	633	25 10	95 28
710	25 10	95 31	703	25 07	95 35
730	25 11	95 34	734	25 07	95 35
810	25 13	95 37	800	25 08	95 35
830	25 14	95 42	832	25 12	95 44
910	25 16	95 44	900		
930	25 18	95 49	934	25 19	95 54
1010	25 18	95 53	1001	25 16	95 55
1030	25 20	96 00	1030	25 19	95 46
1100			1102	25 20	96 05
1130	25 17	96 07	1135	25 21	96 06
1210	25 22	96 10	1202	25 23	96 11
1235	25 23	96 12	1235	25 23	96 11
1310	25 26	96 14	1303	25 27	96 15
1330	25 27	96 16	1334	25 28	96 17
1402	25 28	96 18	1405	25 27	96 17
1430	25 31	96 20	1435	25 29	96 19
1500	25 34	96 22	1503	25 32	96 26
1531	25 34	96 28	1530	25 37	96 26
1556	25 37	96 31	1608	25 36	96 32
1634	25 38	96 34	1635	25 38	96 34
1703	25 39	96 40	1704	25 38	96 35
1733	25 38	96 40	1735	25 37	96 38
1803	25 40	96 43	1802	25 37	96 38
1830	25 40	96 43	1830	25 39	96 43
1900	25 41	96 43	1906	25 41	96 43
1930	25 43	96 44	1935	25 40	96 45
2006	25 46	96 46	2002	25 41	96 43
2030	25 48	96 46	2035	25 47	96 46
2101	25 52	96 50	2100	25 47	96 46
2133	25 58	96 53	2135	25 55	96 52
2203	25 59	96 59	2200	25 58	96 58
2232	26 02	97 04	2235	25 55	97 02
2303	26 04	97 10	2300	26 03	97 08
2332	26 06	97 11	2335	26 05	97 12
AUGUST 10TH					
3	26 12	97 15	0	26 05	97 12
30			35	26 16	97 15
103	26 14	97 18	56	26 16	97 15
132	26 17	97 22	135	26 15	97 25
202	26 22	97 28	159	26 20	97 29
230	26 27	97 32	235	26 22	97 29

TABLE A.3 -- PERTINENT DATA EXTRACTED FROM RECONNAISANCE FLIGHT REPORTS

DATE/TIME (CST)		STORM CENTER LAT	STORM CENTER LONG	SEA LEVEL PRESSURE (MB)	FLT.LVL WIND (KN)	EYE DIAMETER (N.MI)	REMARKS
7	1920	22 15	88 15		105	10	WIND 160/64KN 30N.MI FROM CENTER
7	2045	22 15	88 27	937	73	10	
7	2310	22 31	88 55	945	67	10	WALL CLOUD 15N.MI THICK
8	112	22 48	89 18	946	82		
8	309	23 06	89 48	950	111	10	
8	431	23 12	90 06	950	82		
8	544	23 18	90 24	961	80	10X30	
8	849	23 36	91 00	959	71	20	
8	1125	23 54	91 42	949	110	18	
8	1436	24 15	92 23	927	120		
8	1719	24 21	92 50	913	145	10	
8	2000	24 37	93 20	914	107	12	
8	2100	24 42	93 35	911		12	
8	2300	24 54	94 00		96		
8	2358	24 59	94 14	909	103	7	
9	306	25 12	94 51	916	93	10X8	
9	351	25 15	94 59		104		
9	427	25 18	95 00	915	103		
9	510	25 14	95 11	916	92	10X7	
9	616	25 13	95 22		92		
9	714	25 14	95 30		98		
9	811	25 16	95 38		91		
9	901	25 12	95 49	920	93	12X9	CLOUDS FILL THE EYE
9	1210	25 23	96 10		100	8	
9	1436	25 37	96 19	929	95	10	MAX WIND 80KN 2ND MAX 60 NMI FROM CENTER
9	1744	25 45	96 38	933	93	7	MAX WIND 95KN 10NMI FROM CENTER
9	2039	25 53	96 48	942	80	20X12	
9	2202	26 01	96 59	944	78		HURRICANE WINDS EXTEND 150NMI OUT NORTH
9	2236	26 05	97 05	945	60	10	
9	2332	26 04	97 12**		70	10	EYE OVER LAND
10	2	26 07	97 17**		60		EYE OVER LAND
10	40	26 09	97 17**		80		CLOUDS FILLING EYE

** STORM CENTER FIXED BY RADAR

TABLE A.4
SEA LEVEL PRESSURE AND WIND DATA FROM SHIP REPORTS

1800CST 7TH AUGUST

LAT	LONG	WIND DIR	WIND SPD	PRESSURE (MB)
20 0	85 12	190	25	1006.1
28 42	95 18	050	02	1014.8
28 36	93 36	100	11	1015.2
28 18	90 42	090	20	1013.8
26 54	90 12	050	18	1012.5
26 0	93 30	070	17	1013.5
24 24	95 18	050	20	1011.9
23 42	90 12	040	30	1005.2
26 48	88 42	070	34	1011.2
25 54	89 42	070	27	1010.2
24 42	86 30	080	34	1006.4

2100CST 7TH AUGUST

LAT	LONG	WIND DIR	WIND SPD	PRESSURE (MB)
25 48	85 18	090	36	1011.4
25 54	89 42	070	29	1009.6
26 0	93 30	070	19	1013.3
23 24	90 42	020	25	1003.8
26 42	87 54	070	34	1011.2
28 42	95 18	050	02	1014.9
27 18	91 6	050	24	1013.0

0000CST 8TH AUGUST

LAT	LONG	WIND DIR	WIND SPD	PRESSURE (MB)
26 0	93 30	080	19	1012.4
23 0	91 24	360	30	1000.8
29 12	88 0	080	16	1015.1
25 54	89 42	080	33	1007.1
24 48	85 54	120	36	1010.2
26 24	96 12	080	17	1013.9
28 42	95 18	070	02	1014.2
28 0	92 42	100	13	1013.9

0300CST 8TH AUGUST

LAT	LONG	WIND DIR	WIND SPD	PRESSURE (MB)
25 54	89 42	100	35	1004.0
26 0	93 30	070	21	1010.3
22 42	91 48	330	28	0997.1
26 54	95 36	060	14	1011.9
27 24	92 6	110	40	1009.8
28 42	95 18	060	02	1013.1

0600CST 8TH AUGUST

LAT	LONG	WIND DIR	WIND SPD	PRESSURE (MB)
26 0	93 30	060	19	1010.1
23 12	92 54	060	25	1011.9

TABLE A.4 -- CONTINUED
SEA LEVEL PRESSURE AND WIND DATA FROM SHIP REPORTS

0600CST 8TH AUGUST

LAT	LONG	WIND DIR	SPD	PRESSURE (MB)
22 12	90 54	300	34	0996.3
22 0	94 6	300	40	1005.1
20 36	93 18	300	15	1006.5
27 48	86 36	110	22	1013.0
25 54	89 42	110	37	1003.2
24 30	85 30	130	34	1010.7
23 6	86 0	140	25	1009.5
27 12	94 54	060	22	1011.9
26 30	85 30	110	25	1016.9
28 42	95 18	050	02	1013.3
27 24	92 0	080	27	1009.4
28 30	94 24	060	14	1013.5
27 54	91 48	090	20	1012.2

0900CST 8TH AUGUST

LAT	LONG	WIND DIR	SPD	PRESSURE (MB)
25 54	89 42	120	37	1004.3
26 0	93 30	050	29	1009.8
27 24	94 12	030	31	1010.5
28 42	95 18	010	02	1013.9

1200CST 8TH AUGUST

LAT	LONG	WIND DIR	SPD	PRESSURE (MB)
26 0	93 30	060	27	1008.9
21 36	92 42	270	30	0999.8
20 54	92 0	290	20	1005.0
25 54	89 42	130	41	1004.9
24 48	86 42	150	20	1013.2
25 30	85 30	120	32	1014.9
25 48	89 54	090	20	1019.0
26 48	86 48	120	19	1015.3
28 42	95 18	030	02	1013.2
27 24	94 6	050	40	1008.7
27 18	94 12	050	24	1008.5
27 30	92 30	080	78	1005.8
28 0	92 18	070	40	1032.0
27 54	91 24	090	44	1010.9
27 54	91 12	080	36	1011.8
27 48	91 42	090	40	1009.1
27 36	91 6	090	37	1009.5

1500CST 8TH AUGUST

LAT	LONG	WIND DIR	SPD	PRESSURE (MB)
27 36	91 12	080	36	1011.0
27 30	93 30	070	35	1007.9
27 30	92 30	360	74	1007.1
28 42	95 18	030	02	1011.4
25 54	89 42	140	35	1005.2

TABLE A.4 -- CONTINUED
SEA LEVEL PRESSURE AND WIND DATA FROM SHIP REPORTS

LAT	LONG	WIND DIR	SPD	PRESSURE (MB)
1500CST 8TH AUGUST				
25 48	86 6	110	18	1013.0
26 0	93 30	070	31	1007.1
21 30	92 54	270	36	0999.9
22 0	93 12	270	30	0999.7
1800CST 8TH AUGUST				
22 18	91 12	200	30	1004.0
21 36	93 6	240	25	1010.2
29 24	87 24	110	09	1011.4
28 54	87 18	120	15	1014.0
25 54	89 42	150	31	1006.4
22 24	85 24	090	05	1011.0
24 42	87 0	130	17	1010.0
26 36	86 6	100	15	1014.6
26 36	96 36	040	33	1007.5
26 0	93 30	070	31	1005.7
28 42	95 18	050	02	1010.7
27 30	92 24	060	40	1006.4
27 42	92 54	080	30	1005.1
28 6	91 12			.
22 6	85 12	130	21	1012.5
2100CST 8TH AUGUST				
26 0	93 30	090	33	1005.9
25 54	89 42	150	31	1007.8
21 48	92 54	240	23	1002.2
25 54	96 24	350	45	1003.0
27 30	96 6	040	40	1005.8
27 36	91 42	080	40	1008.5
27 48	90 30	100	35	1012.0
28 42	95 18	040	02	1010.0
0000CST 9TH AUGUST				
25 30	85 48	110	16	1016.3
26 0	93 30	100	37	1005.0
21 54	92 48	210	30	1002.0
27 0	89 30	130	37	1010.7
25 54	89 42	150	29	1008.8
28 42	95 18	040	02	1008.4
28 0	90 6	100	30	1011.4

TABLE A.4 -- CONTINUED
SEA LEVEL PRESSURE AND WIND DATA FROM SHIP REPORTS

0300CST 9TH AUGUST

LAT	LONG	WIND DIR	SPD	PRESSURE (MB)
25 54	89 42	160	29	1008.2
26 0	93 30	100	35	1004.2
21 54	92 30	170	30	1003.0
28 6	89 42	120	30	1011.2
28 42	95 18	040	02	1006.8
27 42	92 12	110	35	0998.6

0600CST 9TH AUGUST

LAT	LONG	WIND DIR	SPD	PRESSURE (MB)
27 36	88 48	120	32	1011.0
28 6	89 24	150	24	1012.4
22 18	92 18	160	20	1004.4
25 30	90 6	140	25	1011.0
24 6	95 42	300	75	0998.2
26 0	93 30	110	33	1005.0
25 54	89 42	150	27	1009.4
26 36	88 30	140	20	1011.5
26 48	86 54	120	18	1012.5
26 12	87 18	150	30	1015.0
26 6	86 30	140	17	1011.7
26 0	88 36	140	25	1010.1
26 0	85 48	110	15	1012.5
22 30	86 30	090	09	1008.4
22 12	85 24	000	00	1012.0
27 42	91 48	120	32	1007.8
28 42	95 18	040	02	1006.0
27 30	90 6	120	27	1011.2
21 48	85 12	130	08	1011.6
20 12	86 6	140	18	1009.4

0900CST 9TH AUGUST

LAT	LONG	WIND DIR	SPD	PRESSURE (MB)
25 54	89 42	170	23	1011.8
26 48	89 12	110	16	1013.0
27 0	89 48	140	21	1014.2
26 0	93 30	120	33	1007.2
28 18	89 18	120	24	1014.5
27 30	91 30	120	32	1010.2
28 42	95 18	050	02	1006.8

1200CST 9TH AUGUST

LAT	LONG	WIND DIR	SPD	PRESSURE (MB)
26 0	93 30	110	31	1007.5
25 54	89 42	150	21	1011.7
27 6	89 42	120	17	1013.5
26 36	89 48	120	20	1011.9
26 36	89 0	130	06	1015.8
29 12	87 18	110	13	1020.0

TABLE A.4 -- CONTINUED
SEA LEVEL PRESSURE AND WIND DATA FROM SHIP REPORTS

1200CST 9TH AUGUST

LAT	LONG	WIND DIR	SPD	PRESSURE (MB)
23 12	91 48	150	34	1006.4
23 42	87 24	140	04	1010.1
25 6	87 54	130	14	1012.2
28 42	95 18	060	02	1007.0
27 30	90 12	120	20	1014.0
27 18	91 12	130	32	1010.6
27 54	94 30	090	40	1003.0
27 54	92 12	130	33	1002.0

1500CST 9TH AUGUST

LAT	LONG	WIND DIR	SPD	PRESSURE (MB)
25 54	89 42	150	19	1010.4
26 0	93 30	110	31	1007.3
24 24	94 0	160	40	0998.5
23 30	91 30	150	34	1006.1
27 12	89 54	120	24	1011.5
27 54	94 36	110	40	1002.4
28 42	95 18	050	02	1006.3

1800CST 9TH AUGUST

LAT	LONG	WIND DIR	SPD	PRESSURE (MB)
26 0	93 30	120	29	1007.1
27 18	90 30	130	32	1012.4
26 54	90 36	130	19	1011.9
25 54	89 42	140	21	1009.3
27 6	88 12	090	05	1011.0
27 54	86 18	110	13	1014.0
23 42	91 18	120	27	1005.8
24 36	88 30	090	08	1007.3
23 54	86 18	120	15	1009.8
24 24	86 36	100	15	1012.5
24 18	86 6			.
28 42	95 18	060	02	1006.1
27 24	91 18	120	32	1008.2
27 42	94 30	090	40	1002.0

2100CST 9TH AUGUST

LAT	LONG	WIND DIR	SPD	PRESSURE (MB)
25 54	89 42	140	19	1010.7
26 0	93 30	120	31	1007.7
27 12	90 48	140	29	1010.0
27 0	91 12	120	18	1010.8
24 12	91 6	110	31	1006.9
28 42	95 18	070	02	1006.8

TABLE A.4 -- CONTINUED
SEA LEVEL PRESSURE AND WIND DATA FROM SHIP REPORTS

LAT	LONG	WIND DIR	SPD	PRESSURE (MB)

0000CST 10TH AUGUST

LAT	LONG	WIND DIR	SPD	PRESSURE (MB)
27 0	90 6	120	21	1010.1
26 0	93 30	110	27	1008.5
25 54	89 42	140	17	1010.6
22 54	86 6	080	17	1011.5
25 30	88 42	130	18	1010.6
28 42	95 18	070	02	1006.5
27 42	91 36	130	30	1012.9

0300CST 10TH AUGUST

LAT	LONG	WIND DIR	SPD	PRESSURE (MB)
26 0	93 30	120	29	1007.4
25 54	89 42	150	17	1009.8
28 42	95 18	080	02	1006.0

0600CST 10TH AUGUST

LAT	LONG	WIND DIR	SPD	PRESSURE (MB)
25 54	89 42	150	17	1010.4
26 42	85 12	110	39	1011.9
26 36	88 42			
26 0	93 30	120	25	1008.0
26 36	94 30	150	25	1004.4
24 36	85 30	140	13	1011.3
25 6	87 12	130	18	1012.0
25 6	86 30	140	12	1012.0
24 18	87 24	130	10	1011.1
22 54	86 18	110	20	1010.2
28 42	95 18	080	02	1006.8
27 24	93 24	120	25	1008.1
28 0	92 42	130	37	1011.5
22 0	85 36	140	14	1009.4
21 54	85 36	120	09	1009.5

0900CST 10TH AUGUST

LAT	LONG	WIND DIR	SPD	PRESSURE (MB)
25 54	89 42	150	17	1011.3
26 18	87 48	130	17	1012.1
26 0	93 30	130	25	1010.0
26 30	94 36	120	25	1005.1
28 42	95 18	090	02	1008.5

1200CST 10TH AUGUST

LAT	LONG	WIND DIR	SPD	PRESSURE (MB)
26 0	93 30	130	19	1010.5
26 48	93 0	150	27	1011.0
26 30	95 0	120	20	1005.8
25 54	89 42	140	14	1011.9

TABLE A.4 -- CONTINUED

SEA LEVEL PRESSURE AND WIND DATA FROM SHIP REPORTS

LAT	LONG	WIND DIR	SPD	PRESSURE (MB)
1200CST 10TH AUGUST				
24 24	85 30	100	10	1012.0
23 18	86 18	110	10	1012.1
28 42	95 18	090	02	1009.1
28 42	93 42	150	30	1013.3
27 30	92 6	120	16	1008.2
27 36	90 36	140	16	1013.2
21 42	85 30	110	15	1010.0
1500CST 10TH AUGUST				
25 54	89 42	120	12	1010.6
26 0	93 30	130	19	1010.1
26 54	94 42	100	24	1007.1
28 42	95 18	100	02	1009.2

(Continued from inside front cover)

NWS 16 Storm Tide Frequencies on the South Carolina Coast. Vance A. Myers, June 1975, 79 p. (COM-75-11335)

NWS 17 Estimation of Hurricane Storm Surge in Apalachicola Bay, Florida. James E. Overland, June 1975. 66 p. (COM-75-11332)

NWS 18 Joint Probability Method of Tide Frequency Analysis Applied to Apalachicola Bay and St. George Sound, Florida. Francis P. Ho and Vance A. Myers, November 1975, 43 p. (PB-251123)

NWS 19 A Point Energy and Mass Balance Model of a Snow Cover. Eric A. Anderson, February 1976, 150 p. (PB-254653)

NWS 20 Precipitable Water Over the United States, Volume 1: Monthly Means. George A. Lott, November 1976, 173 p. (PB-264219)

NWS 20 Precipitable Water Over the United States, Volume II: Semimonthly Maxima. Francis P. Ho and John T. Riedel, July 1979, 359 p. (PB-300870)

NWS 21 Interduration Precipitation Relations for Storms - Southeast States. Ralph H. Frederick, March 1979, 66 p. (PB-297192)

NWS 22 The Nested Grid Model. Norman A. Phillips, April 1979, 89 p. (PB-299046)

NWS 23 Meteorological Criteria for Standard Project Hurricane and Probable Maximum Hurricane and Probable Maximum Hurricane Windfields, Gulf and East Coasts of the United States. Richard W. Schwerdt, Francis P. Ho, and Roger R. Watkins, September 1979, 348 p. (PB-80 117997)

NWS 24 A Methodology for Point-to-Area Rainfall Frequency Ratios. Vance A. Myers and Raymond M. Zehr, February 1980, 180 p. (PB80 180102)

NWS 25 Comparison of Generalized Estimates of Probable Maximum Precipitation With Greatest Observed Rainfalls. John T. Riedel and Louis C. Schreiner, March 1980, 75 p. (PB80 191463)

NWS 26 Frequency and Motion of Atlantic Tropical Cyclones. Charles J. Neumann and Michael J. Pryslak, March 1981, 64 p. (PB81 247256)

NWS 27 Interduration Precipitation Relations for Storms--Western United States. Ralph H. Frederick, John F. Miller, Francis P. Richards, and Richard W. Schwerdt, September 1981, 158 p. (PB82 230517)

NWS 28 GEM: A Statistical Weather Forecasting Procedure. Robert G. Miller, November 1981, 103 p.

NWS 29 Analyses of Elements of the Marine Environment for the Atlantic Remote Sensing Land Ocean Experiment (ARSLOE)--An Atlas for October 22 Through October 27, 1980. Lawrence D. Burroughs, May 1982, 116 p. (PB82 251281)

NWS 30 The NMC Spectral Model. Joseph G. Sela, May 1982, 38 p. (PB83 115113)

NWS 31 A Monthly Averaged Climatology of Sea Surface Temperature. Richard W. Reynolds, June 1982, 37 p. (PB83 115469)

NWS 32 Pertinent Meteorological and Hurricane Tide Data for Hurricane Carla. Francis P. Ho and John F. Miller, August 1982, 111 p. (PB83 118240)

NWS 33 Evaporation Atlas for the Contiguous 48 United States. Richard K. Farnsworth, Edwin S. Thompson, and Eugene L. Peck, June 1982, 26 p.

NWS 34 Mean Monthly, Seasonal, and Annual Pan Evaporation for the United States. Richard K. Farnsworth and Edwin S. Thompson, December 1982, 85 p. (PB83 161729)

NOAA SCIENTIFIC AND TECHNICAL PUBLICATIONS

The National Oceanic and Atmospheric Administration was established as part of the Department of Commerce on October 3, 1970. The mission responsibilities of NOAA are to assess the socioeconomic impact of natural and technological changes in the environment and to monitor and predict the state of the solid Earth, the oceans and their living resources, the atmosphere, and the space environment of the Earth.

The major components of NOAA regularly produce various types of scientific and technical information in the following kinds of publications:

PROFESSIONAL PAPERS—Important definitive research results, major techniques, and special investigations.

CONTRACT AND GRANT REPORTS—Reports prepared by contractors or grantees under NOAA sponsorship.

ATLAS—Presentation of analyzed data generally in the form of maps showing distribution of rainfall, chemical and physical conditions of oceans and atmosphere, distribution of fishes and marine mammals, ionospheric conditions, etc.

TECHNICAL SERVICE PUBLICATIONS—Reports containing data, observations, instructions, etc. A partial listing includes data serials; prediction and outlook periodicals; technical manuals, training papers, planning reports, and information serials; and miscellaneous technical publications.

TECHNICAL REPORTS—Journal quality with extensive details, mathematical developments, or data listings.

TECHNICAL MEMORANDUMS—Reports of preliminary, partial, or negative research or technology results, interim instructions, and the like.

Information on availability of NOAA publications can be obtained from:

PUBLICATION SERVICES BRANCH (E/AI13)
NATIONAL ENVIRONMENTAL SATELLITE, DATA, AND INFORMATION SERVICE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

Washington, DC 20235

NOAA--S/T 83-109