YEAR 1888

Nine storms were found to have occurred in 1888. Tracks for these storms are presented in Fig. 1.

Storm 1, 1888 (Jun. 16-18), H.

The following information was found in relation to this storm: 1) Storm of Jun. 17, 1888. North Texas coast (Tannehill, 1938). 2) Storm of Jun. 17, 1888. Upper Texas coast. Minimal. Center moved S.W. of Galveston (Dunn and Miller, 1960). 3) Washington, Jun. 17. For Alabama, Mississippi, Louisiana and eastern Texas, light and fresh southerly winds. A moderate storm is apparently approaching the coast of Texas (The New York Times, Jun. 17, 1888, p.3, col.4). 4) Galveston. Maximum wind: S.E. 54 mph on Jun. 17; barometer 29.75 inches on Jun. 18 (Monthly Weather Review, Jun. 1888). 5) Corpus Christi. Maximum wind: E. 28 mph on Jun. 16; barometer 29.69 inches on Jun. 17 (Monthly Weather Review, Jun. 1888). 6) Brownsville. Maximum wind: W. 26 mph on Jun. 16; barometer 29.70 inches on Jun. 17 (Monthly Weather Review, Jun. 1888). 7) The storm was first observed at lat. 28 N., long. 95 W. (Mitchell, 1924).

Data contained in the items above were not found to be in contradiction with the storm evolution described in Neumann et al. (1993). Therefore, the track that those authors displayed for the storm was accepted as such and reproduced in Fig. 1.

In spite of that the maximum wind reported at Galveston was only 54 mph (item 4), the category of a hurricane given to the storm in Neumann et al. (1993) was preserved because hurricane winds could have existed between Galveston and the landfall point about 70 miles to the southwest of that city.

Storm 2, 1888 (Jul. 4-6), T. S.

The following information was found in relation to this storm: 1) Storm of Jul. 5, 1888. Galveston (Tannehill, 1938). 2) Storm of Jul. 5, 1888. Upper Texas coast. Minor (Dunn and Miller, 1960). 3) Galveston. Maximum wind: E. 42 mph on Jul. 5; barometer 29.78 inches on Jul. 5 (Monthly Weather Review, Jul. 1888). 4) The storm was first observed at lat. 28 N., long. 95 W. (Mitchell, 1924).

The track shown in Neumann et al. (1993) was not found to contradict the information contained in the above items. Therefore, such a track was accepted by the author of this study who reproduced it in Fig. 1.

Wind information in item 3) was found to support the tropical storm status that Neumann et al. (1993) attributed to this storm.

Storm 3, 1888 (Aug. 14-24), H.

The following information was found about this storm: 1) Storm of Aug. 14-24, 1888. Florida, middle Gulf coast. Wind estimated at 90 mph at New Orleans (Tannehill, 1938). 2) Storm of Aug. 16, 1888. Extreme S. Florida. Minimal. Hurricane winds at Miami. By Aug. 19-20, it had moved to the coastal areas of Louisiana, Mississippi

and Alabama. New Orleans wind: 90 mph (Dunn and Miller, 1960). 3) Nassau, Aug. 20. On Wednesday (Aug. 15), a moderate hurricane passed over the islands of Abaco, Harbor Island and New Providence, doing some damage to fruit orchards, crops, fences, etc. The wind backed from N.E. to S.W. and lasted about 8 hours (The New York Times, Aug. 25, 1888, p.3, col.4). 4) It was a typical cyclone which described very nearly a parabolic path. Its apex was in southern Louisiana. It was first perceived off the southeast coast of Florida on Aug. 16. It moved in a direction 10 degrees N. of W. for 950 miles before changing its course to the N.E. (Monthly Weather Review, Aug. 1888). 5) Maximum winds: Jupiter, S.E. 60 mph on Aug. 16; Titusville, E. 44 mph on Aug. 17 (Monthly Weather Review, Aug. 1888). 6) High N.E. winds prevailed at Sabastien, Fl. in the afternoon and evening of Aug. 16, the wind reaching an estimated velocity of 75 mph at 1:30 P.M. (Monthly Weather Review, Aug. 1888). 7) Winds were very strong on the Gulf coast on Aug. 19 and 20, reaching 60 mph at Pensacola and 55 mph at Mobile on the southeast side of the storm at a distance of 300 miles from the center. The wind was estimated to have blown at a rate of 90 mph at New Orleans from 3:30 to 4 A.M. (no date given but probably on Aug. 19). A barometer reading of 29.35 inches and a W. wind of 44 mph were reported at Vicksburg on Aug. 20. There was a wind velocity of 50 mph at Nashville and Knoxville, and 40 mph at Norfolk, and high winds all along the intermediate coast on Aug. 21 (Monthly Weather Review, Aug. 1888). 8) Baltimore, Aug. 22. The storm which came from the South yesterday swept over Maryland with almost unparalleled velocity (The New York Times, Aug. 23, 1888, p.2, col.4 and 5). 9) Boston, Aug. 22. It will be difficult to estimate the actual damage caused by the disastrous rainfall of last night (The New York Times, Aug. 23, 1888, p.2, col.4 and 5). 10) New Haven, Conn., Aug. 22. The severest storm of the season passed over this city last evening. It rained hard all the afternoon and at 7 P.M. the wind rose and the rain fell in sheets. At 9:15 P.M. the Signal Service officer reported that the wind was blowing at 44 mph (The New York Times, Aug. 23, 1888, p.2, col.4 and 5). 11) In the vicinity of this city (New York), the storm reached the height of severity between 8 and 9 P.M. Tuesday evening (Aug. 21) and by midnight had disappeared in the N.E. (The New York Times, Aug. 23, 1888, p.5, col.3). 12) On Aug. 22 the center was located off the western extremity of Nova Scotia where the minimum pressure of about 29.30 inches was reported. Winds reached 50 mph at Eastport and Block Island on that day and the storm moved over Nova Scotia and Newfoundland during Aug. 22 and 23 (Monthly Weather Review, Aug. 1888). 13) Map showing a track for the storm. Daily positions are: Aug. 16, 25.3 degrees N., 79.3 degrees W.; Aug. 17, 26.7 degrees N., 85.5 degrees W.; Aug. 18, 27.5 degrees N., 90,0 degrees W.; Aug. 19, 28.5 degrees N., 92.5 degrees W.; Aug. 20, 31.7 degrees N., 92.5 degrees W.; Aug. 21, 37.5 degrees N., 85.5 degrees W.; Aug. 22, 43.3 degrees N., 67.3 degrees W.; Aug. 23, 50.3 degrees N., 54.5 degrees W. (Monthly Weather Review, Aug. 1888). 14) Showing a duration of 10 days, the storm was first observed near 23 degrees N. 71 degrees W. on Aug. 14 and last observed near 54 degrees N., 54 degrees W. (Mitchell, 1924).

Information contained in items 3) and 14) suggests a track

about 75 to 100 miles to the north of the one shown in Neumann et al. (1993) for the two-day period Aug. 14-15. Therefore, a northward adjustment of the track was implemented, resulting in the following 7 A.M. estimates by the author of this study: Aug. 14, near 23.0 degrees N., 71.0 degrees W., based on the first observed position given in item 14); Aug. 15, near 24.3 degrees N., 75.5 degrees W., based on information about the hurricane in the Bahamas given in item 3). These new positions, together with those in Neumann et al. (1993) which, according to information in other items, were found to be to be reasonable, allowed the author to prepared the storm track which is shown in Fig. 1.

The estimated maximum velocity of 90 mph at New Orleans (items 1, 2 and 7) was found to fully support the hurricane status which Neumann et al. (1993) attributed to this storm.

Storm 4, 1888 (Aug. 31- Sept. 7), H.

The following information was found in relation to this storm: 1) Storm of Aug. 31- Sept. 8. Turks Islands, Great Inagua, Cuba, Mexico. Great damage; loss of life at Turks Islands, Great Inagua and in Cuba more than 1000. Whole towns along coast of Cuba swept out of existence by gigantic waves (Tannehill, 1938). 2) This storm was remarkable on account of its exceptional energy and by reason of the abnormal path it pursued after having advanced to the westward to the 80 degrees W. meridian (Monthly Weather Review, Sept. 1888). Author's note: Vines (1895) interpreted this abnormal path as a result of the interaction of this cyclone with a "twin cyclone" which appeared near the Bahamas on Sept.6 and moved later over Florida (Storm 5, 1888). 3) The steamship "Jamaica" experienced a violent hurricane on Aug. 31, 150 miles N.E. of Sombrero Island. Her captain calculated that the vortex had passed 120 miles N. of the Virgin Islands on a N. by W. course, or between W. and W. by N., and estimated its diameter in 500 miles (Monthly Weather Review, Sept. 1888). 4) At noon Sept. 1 (Greenwich time), the center was apparently located N. of the western extremity of Puerto Rico (Monthly Weather Review, Sept. 1888). 5) On Oct. 2, the hurricane devastated Turks Islands where the minimum pressure of 28.95 inches was noted about 5 P.M. (Greenwich time). In the morning the weather was threatening with falling barometer and N.E. wind; subsequent to the passage of the storm the wind shifted to S. and the barometer rose rapidly. Twenty-one persons died. More than 250 houses of peasantry and over 400,000 bushels of salt were entirely destroyed and nearly every house left standing was more or less damaged (Monthly Weather Review, Sept. 1888). 6) By noon Sept. 3 (Greenwich time) the center had moved to the northward of Great Inagua Island, in which locality the barometer fell to 28.70 inches (Monthly Weather Review, Sept. 1888). 7) The steamship "Alps" left Jeremie (Haiti) on Sept. 1. All Sunday Sept. 2 the weather was fine. About midnight Sept. 2-3, near Crooked Island Passage, the sky became dirty and the wind shortly after midnight blew a gale; the barometer, which had been at 29.90 inches, was then falling. Barometer at 7 A.M. Sept. 3: 28.70 inches. At 8 A.M. had risen to 29.10 inches, at 10 A.M. to 29.60 inches and at 11 A.M. to 29.70 inches (The New York Times, Sept. 11, 1888, p.6, col.

6). 8) On Sept. 3, the day began at Santiago de Cuba with N.W. wind which backed to S.W. At 5 P.M. it was blowing fresh from S.S.W. (Monthly Weather Review, Sept. 1888). 9) At Santa Clara (central Cuba) the barometer fell during the afternoon and evening of Sept. 3 to 29.38 inches at 11 P.M. At 5 P.M. heavy rain was falling in the first, and one point of the second quadrant, which changed into a short vigorous rain from N.N.W., with strong squalls from the same direction. The sky then cleared somewhat up to 10 P.M. at which hour the rain squalls came again in greater strength from the same direction as before and, although of short direction, covered the first two quadrants and left the wind at S.S.W. (Monthly Weather Review, Sept. 1888). Author's note: The reading of 29.38 inches appears to be too low. The S.S.W. wind direction is probably in error or a local effect. The Monthly Weather Review, Sept. 1888 attributted the S.S.W. wind at Santa Clara at 10 P.M. Sept. 3 to the influence of a secondary shallow depression which allegedly crossed Jamaica on Sept. 3 and that it was allegedly moving to the W.N.W. at 15 mph, passing off that island at 2 P.M. However, as the distance between Santa Clara and Jamaica exceeds 200 miles, the depression which allegedly left Jamaica at 2 P.M. Sept. 3 and the S.S.W. wind at Santa Clara 8 hours later were probably unrelated. It looks likely that the wind at Santa Clara was either erroneously reported or resulted from local effects. 10) At noon Sept. 4 (Greenwich time) the storm center arrived to the eastward of Sagua where the barometer fell to 28.90 inches at 9:10 A.M. and the wind attained a velocity of 125 mph. During this and early part of the following day the hurricane moved westward over Cuba and passed somewhat to the S. of Havana at about 2 A.M. Sept. 5 (apparently local time) where the mimimum pressure was 29.20 inches and the wind reached a velocity of 90 mph. Advancing in a S. of W. course the center left the western extremity of the island of Cuba during Oct.5. Losses by destruction of property and crops amounted to millions of dollars in Cuba and about 800 lives were lost. The principal buildings of the large cities were demolished and whole towns situated near the seaboard were entirely destroyed by the gigantic waves that swept inland (Monthly Weather Review, Sept. 1888). 11) Sept. 4-5, 1888. Intense hurricane made landfall on the northern coast of Cuba between Caibarien and Sagua la Grande, passed to the S. and near Havana, where the calm corresponding to the vortex was felt, and emerged into the Gulf of Mexico between Mantua and Ensenada de Guadiana (western Cuba), moving towards the third quadrant. It caused great damage at Havana and over the four westernmost provinces. Many lives were lost. This hurricane became famous due to its abnormal track, shifting first to the W. and then towards the third quadrant, taken by surprise people in Cuba who were not expecting it (Sarasola, 1928). Author's note: Actually taken from the catalog of Cuban hurricanes by M. Gutierrez-Lanza, which is included in Sarasola (1928). 12) Terrible hurricane of anomalous track affected the four westernmost provinces (of Cuba). It made landfall between Caibarien and Sagua, passed to the S. of Havana and continued to Veracruz. It reached its height at Caibarien at 5 A.M. Sept. 4; the sea receded from the bay and it was over by midday. Twenty-two houses and several wharves were destroyed, and only one house was standing after the storm. More

than 40 persons died on the keys which are adjacent to the coast between Caibarien and Sagua. Several houses were demolished at Remedios and 13 at Yaguajay. About 50 tobacco houses were destroyed at Camajuani (Martinez-Fortun, 1942). Author's note: All places mentioned in this item are located on or near the northern coast of central Cuba. 13) At Havana the cyclone commenced late in the afternoon of Sept. 4, it reached maximum intensity at midnight (Sept. 4-5) and lasted until 3 A.M. Sept. 5. At Sagua the cyclone commenced early in the morning of Sept. 4 (Wednesday). At 8 A.M. the hurricane increased in violence which maintained until 3 P.M. The wind kept blowing after that hour with less intensity until late in the night. The vortex of the cyclone entered the island near Sagua, crossing between Havana and Batabano and through Consolacion del Sur, leaving Cuba for Veracruz. A peculiarity of this cyclone was its southward tendency (The New York Times, Sept. 20, 1888, p.8, col.5). Author's note: Batabano is a port on the southern coast of Havana province and Consolacion del Sur is a town located near the center of Pinar del Rio province. 14) Havana, Sept. 6. The cyclone of Tuesday last (Sept. 4) will long be remembered on this island. It was terribly destructive in life and property. The gunboat "Lealtad" foundered at Batabano and nine of her crew were drowned. Advices from Sagua are that 50 persons lost their lives there and that Pueblo Nuevo, a village near Sagua, was literally wiped out (The New York Times, Sept. 7, 1888, p.5, col.6). 15) New Orleans, Sept. 7. A special from Havana says that the hurricane which has just swept over the city surpassed anything experienced in recent years. Immense trees were uprooted and in some instances their huge trunks were carried several blocks by the force of the wind. News from eastern portions and Vuelta Abajo indicate crops sustained great damage (The New York Times, Sept. 8, 1888, p.5, col.3). 16) Havana, Sept. 8. Owing to the interruption of the wires details are still missing of the effect of the hurricane in many parts of the island. Many vessels foundered at Matanzas. At Sagua the gale was so violent that a railroad train was overturned. Two seamen from the Spanish cruiser "Jorge Juan" were drowned in the harbor and a person was crushed to death at Marianao. The wind blew at times 40 meters per second or about 90 mph (The New York Times, Sept. 14, 1888, p.1, col.5). 17) Key West, Sept.4. The effects of the West Indian hurricane that was reported traveling in this direction were felt all day. The wind is N. attaining a velocity of 55 mph and increasing steadily. The barometer has dropped 2 (tenths of an inch) since the morning and is still falling. Frequent rain squalls tonight indicate that the storm is rapidly approaching and storm signals were hoisted late this afternoon. Indications point to the passage of the storm center to the S. and W. of this station (The New York Times, Sept. 5, 1888, p.4, col.7). Author's note: According to the Monthly Weather Review, Sept. 1888, the maximum velocity at Key West was N.E. 54 mph and the minimum pressure was 29.66 inches, both having being recorded on Sept. 4. 18) Key West, Sept. 6. The steamer "State of Texas" encountered the great storm 20 miles W. of Dry Tortugas. Her bulwarks and bulk heads were stove in by the sea and her cabin ruined (The New York Times, Sept. 7, 1888, p.5, col.6). 19) A cyclone of more than ordinary rigor was reported from

Washington yesterday at noon to have entered the eastern Gulf of Mexico and it was central to the S.W. of Key West (The New York Times, Sept. 6, 1888, p.5, col.6). Author's note: It appears that the storm center was still over extreme western Cuba at noon Sept. 5. 20) After leaving Cuba the vortex moved in a nearly W.S.W. direction over or off the coast of Yucatan and reached the Mexican coast between Veracruz and Coatzacoalcos during the night of Sept. 7-8, where it exhibited great strength and occasioned considerable damage to property and shipping (Monthly Weather Review, Sept. 1888). 21) City of Mexico, Sept. 8, via Galveston. Veracruz dispatches state that the cyclone struck there 3 days ago. The wind was from the N. and so continued until this morning, when it veered around to the S.E. It was blowing " by guns" and rain came down in torrents. Three vessels were driven ashore and wrecked. A Mexican bark collided with the Spanish steamer "Bahia de Cadiz" and the crew from the wrecked bark "Agricola" have been saved (The New York Times, Sept. 9, 1888, p.2, col.6). 22) City of Mexico, Sept. 9, via Galveston. Advices from Verecruz state that the fore (it should probably read core) of the cyclone is broken and that the shipping is safe (The New York Times, Sept. 10, 1888, p.4, col.7). 23) Map showing a track for the storm. Daily positions are: Sept. 1, 20.7 degrees N., 67 degrees W.; Sept. 2, 20.7 degrees N., 70.3 degrees W.; Sept. 3, 21 degrees N., 74 degrees W.; Sept. 4, 22 degrees N., 79.3 degrees W.; Sept. 5, 21.3 degrees N., 85 degrees W.; Sept.6, 20.7 degrees N., 87 degrees W.; Sept. 7, 19.5 degrees N., 92 degrees W. (Monthly Weather Review, Sept. 1888). Author's note: Another map showing a track which does not differ very much from the one in the Monthly Weather Review, Sept. 1888 is shown in Tannehill (1938). 24) Lasting 8 days, the hurricane was first observed at 19 degrees N., 60 degrees W. on Aug. 31 and last observed at 18 degrees N., 96 degrees W (Mitchell, 1924).

The information contained in the above items suggested some slight modifications along the track shown in Neumann et al. (1993) for the period Sept. 4-5. The 7 A.M. Sept. 4 position in that publication was displaced a few miles to the northwestward to near 22.7 degrees N., 79.7 degrees W. in order to fit better the information about landfall on the northern coast of Cuba which is given in items 10) through 13). Similarly, the 7 A.M. Sept. 5 position was adjusted to the E.N.E. by about 60 miles to the vicinity of 22.5 degrees N., 83.7 degrees W. in order to fit better a space and time continuity with the fact that the storm was passing to the S. of Havana around or shortly after midnight Sept. 4-5 (items 10 to 13). Other 7 A.M. positions given in Neumann et al. (1993) were found to be supported by the information contained in the items above and, therefore, were kept unchanged by the author in preparing the storm track displayed in Fig. 1.

The hurricane status given to this storm in Neumann et al. (1993) was found to be fully justified by the content of the items above. In fact, although the lowest barometer reported in the storm was 28.70 inches (items 6 and 7) and ran short of the 28.50 inches making the threshold to major hurricanes, alleged winds of 125 mph at Sagua (item 10) and the transport of huge trunks from fallen trees for several blocks by the force of the wind (item 15) strongly suggest the possibility of major hurricane intensity.

Storm 5, 1888 (Sept. 6-12), T. S.

The following information was found about this storm: 1) Storm of Sept. 7-17, 1888. Bahamas, off Atlantic coast. Gale on coast (Tannehill, 1938). 2) Storm of Sept. 7-8. Central Florida. Considerable damage at Micco (Dunn and Miller 1960). Author's note: Micco is located on the Florida east coast, just S. of the 28 degrees N. parallel. 3) This was a well defined tropical storm which was first observed near Point Jupiter, Fl. on the afternoon of Sept. 7. It moved slowly northwestward recurving near lat. 30 N. in the vicinity of Cedar Keys, Fl. during the night of Sept. 8, attained by violent winds on the east and west Florida coasts. The wind attained a maximum welocity of 60 mph at Cedar Keys, where the barometer fell to 29.50 inches. The center of the storm moved E. of N. over the South Atlantic States, attended by very heavy rains and dangerous gales along the coast. At noon Sept. 10 it was central near Norfolk, Va., after which it followed the middle Atlantic and New England coasts, causing dangerous gales as far as Boston (Monthly Weather Review, Sept. 1888). 4) Jupiter, lowest barometer 29.60 inches on Sept. 7; maximum wind S. 35 mph on Sept. 8 (Monthly Weather Review, Sept. 1888). 5) Titusville, maximum wind S.E. 48 mph on Sept. 8 (Monthly Weather Review, Sept. 1888). 6) Augusta, Ga., Sept. 10. Heavy rain on Sunday (Sept. 9) along the Savannah Valley caused the river to rise rapidly last night and this morning. Three inches of rain fell from 1 A.M. Sunday to last night (The New York Times, Sept. 11, 1888, p.5, col.4). 7) Norfolk, Va., Sept. 10. A destructive rain and wind storm swept over parts of Nansemond, Isle of Wright and Southampon Counties, destroying crops and blowing down trees and firm buildings (The New York Times, Sept. 11, 1888, p.5, col.4). 8) The storm of yesterday was all that this city (New York) felt of the expected cyclone. Rain commenced to fall at noon and the wind increased from 8 mph in the morning to 17 mph and at 4 P.M. was blowing at 24 mph. The total rainfall up to 8 P.M. last night was 0.36 inches. The area of low barometer was around the city, the reading being here 29.96 inches and still falling at 8 P.M. last night (The New York Times, Sept. 12, 1888, p.5, col.6). 9) Map showing a track for this storm. Daily positions are: Sept. 8, 26.3 degrees N., 82.3 degrees W.; Sept. 9, 30.3 degrees N., 83 degrees W.; Sept. 10, 34.5 degrees N., 79.5 degrees W.; Sept. 11, 37.5 degrees N., 76.5 degrees W.; Sept. 12, 41.5 degrees N., 71 degrees W. (Monthly Weather Review, Sept. 1888). 10) The storm was first observed at lat. 26 N., long. 79.5 W. on Sept. 7 and recurved at lat. 31 N., long. 83 W. (Mitchell, 1924).

Information contained in items 2), 3), 9) and 10) suggested that the 7 A.M. Sept. 8 position which is displayed in Neumann et al. (1993) is a little too far to the west and that the storm center did not emerge over the Gulf waters off the Florida west coast but remained inland and recurved over northern Florida after passing very near to the E. of Cedar Keys. Therefore, the author of this study estimated a new 7 A.M. Sept. 8 position near 28.0 degrees N., 82.0 degrees W., which is about 40 miles to the N.E. of the one given in Neumann et al. (1993). This new position and the remaining unchanged positions in Neumann et al. (1993) for the

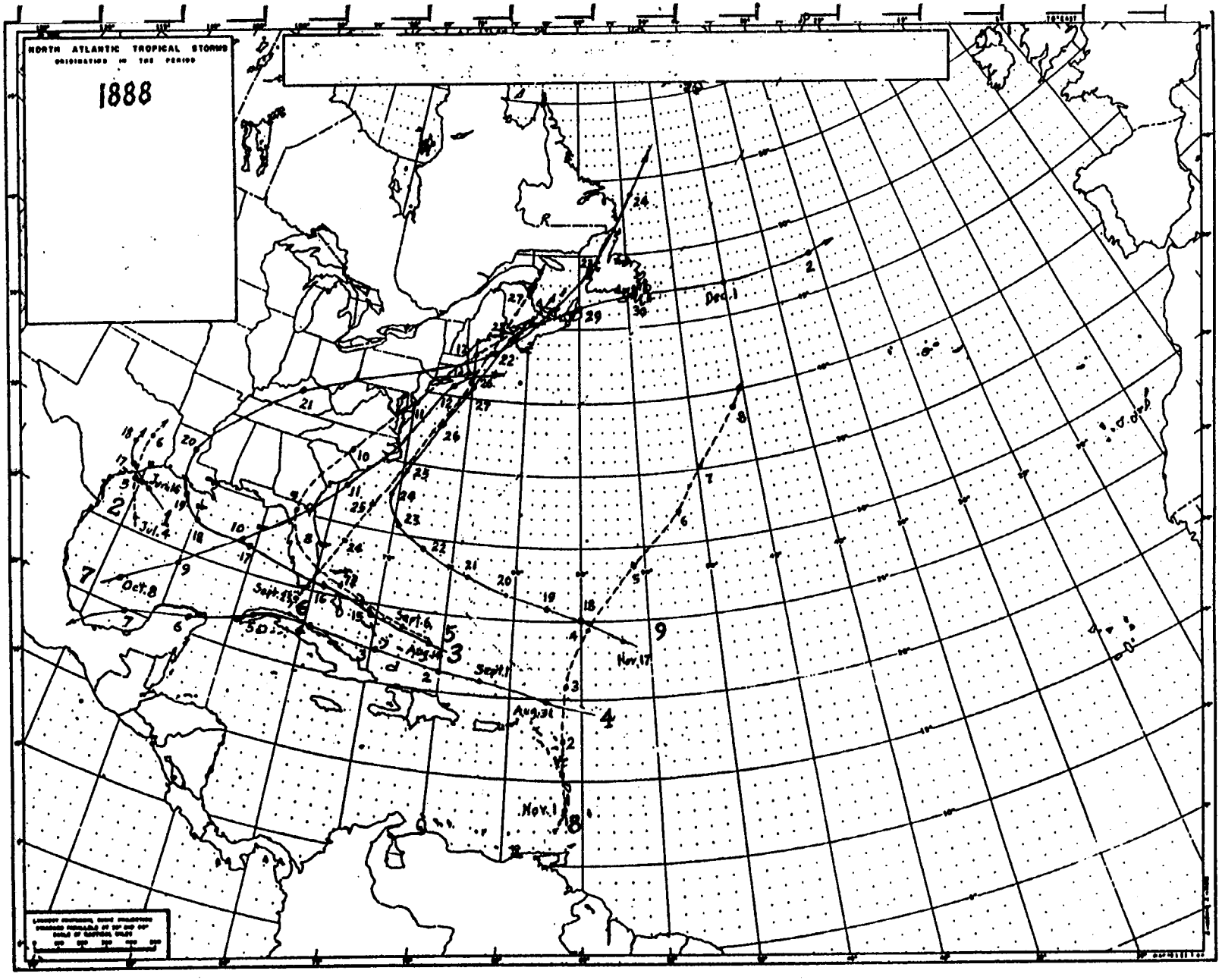
NORTH ATLANTIC TROPICAL STORMS
1888
Jun.16
Jul.4
Oct.8
Sept.13
Sept.6
Aug.31
Sept.1
Aug.31
Nov.17
Nov.1
Dec.1

Fig. 1.

period Sept. 6-12 were used in preparing the track for Storm 5, 1888 shown in Fig. 1.

As no evidence of hurricane winds was found, the tropical storm status that Neumann et al. (1993) attributed to Storm 5, 1888 is believed to be correct.

Storm 6, 1888 (Sept. 23-27), T. S.

The following information was found about this storm: 1) Storm of Sept. 23-27, 1888. Florida Straits, Atlantic. 2) Marine reports indicate that this storm originated east of and near the Florida coast on Sept.24. It moved rapidly northward, passing from the latitude of northern Florida to southern New England in 24 hours. Reports received from Hatteras. N.C., indicate that the center passed to the east of, and near, that station on the afternoon of Sept. 25, while on the morning of Sept. 26 the center had reached the vicinity of Nantucket, where dangerous gales were reported, the wind reaching a velocity of 60 mph from the N.E. at Block Island and 50 mph from the S.E. at Nantucket. On the southern New England coast the barometer fell 0.78 inches in 12 hours and reached a minimum of 29.08 inches at Nantucket on the morning of Sept. 26. By 8 P.M. Sept. 26, the center had reached the vicinity of Eastport, Me. and the wind attained a maximum velocity of 60 mph at both Boston and Eastport during the day. This storm moved at an unusually rapid rate and it probably passed beyond the stations N.E. of New England during Sept. 27 (Monthly Weather Review, Sept. 1888). Author's note: According to the information given in this item, the storm took more than 24 hours (probably between 36 and 48 hours) to move from the latitude of northern Florida to southern New England. Therefore, the 24 hours mentioned in the item for such occurrence is an underestimate. 3) Providence, R.I., Sept. 26. The rain began at midnight accompanied by the wind, which increased in velocity every hour, culminating between 8 and 9 A.M. (The New York Times, Sept. 27, 1888, p.1, col.7). 4) Nantucket Beach, Sept. 26. The N.E. gale which began early this morning and has continued since is the severest for years (The New York Times, Sept. 27, 1888, p.1, col.7). 5) Boston, Sept. 26. The storm which began shortly after midnight and continued until noon was the most intense in several years with the exception of a very short gale a few weeks ago. The wind, coming from N. here and N.E. further up the coast, registered 60 mph (The New York Times, Sept. 27, 1888, p.1, col.7). Gloucester, Ma., Sept. 26. A N.E. rain storm with great energy commenced early this morning and is raging with unabated fury (The New York Times, Sept. 27, 1888, p.1, col.7). 7) Map showing a track for the storm. Daily positions are: Sept. 25, 28.7 degrees N., 78 degrees W.; Sept. 26, 40.7 degrees W., 67 degrees W.; Sept. 27, 49.5 degrees N., 63.7 degrees W. (Monthly Weather Review, Sept. 1888). 8) The storm lasted for 4 days. It was first observed at lat. 24 N., long. 81 W. on Sept. 23 and last observed at. lat. 48 N., long. 65 W. (Mitchell, 1924).

The track for this storm which is displayed in Neumann et al. (1993) was found to be supported, in general, by the information contained in the items above. Consequently, the author of this study accepted such a track without any modification and reproduced

it in Fig. 1.

As maximum wind velocities of 60 mph were reported at Block Island, Boston and Eastport (item 2), the tropical storm status which Neumann et al. (1993) attributed to Storm 6, 1888 was found to be adequate. It should be mentioned, however, that the lowest pressure of 29.08 inches reported at Nantucket supported hurricane intensity, but no evidence of such intensity was found in the wind reports. This is why the tropical storm status was retained.

Storm 7, 1888 (Oct. 8-12), H.

The following information was found in relation to this storm: 1) Storm of Oct. 8-12, 1888. Bay of Campeche, Atlantic (Tannehill, 1938). 2) Storm of Oct. 10-11. Minimal. N. of Cedar Keys, Carolinas. Inland N. of Charleston (Dunn and Miller, 1960). 3) Cedar Keys, Fl., Oct. 10. On this day a storm of marked energy was central over the eastern part of the Gulf of Mexico. At 9:30 P.M. the wind veered from E. to S. and the barometer stood at 29.22 inches (lowest during the storm). At this hour the water was at low water mark, and by 10 P.M. had risen over 9 feet, covering the streets in the lower part of the town and floating off three large rafts of logs. Many people fled from their houses and were obliged to wade waist deep in water. No lives were lost, although a number of narrow escapes were reported. Total damage in the vicinity was estimated at five thousand dollars (Monthly Weather Review, Oct. 1888). 4) Lowest barometer readings reported in relation to this storm: Titusville, 29.65 inches on Oct. 10; Jacksonville, 29.64 inches on Oct. 10; Savannah, 29.50 inches on Oct. 11; Charleston 29.37 inches on Oct. 11; Wilmington, 29.45 inches on Oct. 11; Hatteras, 29.65 inches on Oct. 11 (Monthly Weather Review, Oct. 1888). 5) Maximum wind velocities reported in relation to this storm: Titusville, S. 28 mph on Oct. 10; Cedar Keys, S. 75 mph on Oct. 10; Jacksonville, N. 38 mph on Oct. 11; Savannah, N.E. 50 mph on Oct. 11; Charleston, N.E. 48 mph. on Oct. 11; Wilmington, N.E. 60 mph on Oct. 11; Block Island, E. 52 mph on Oct. 12; New London, N.E. 36 mph on Oct. 12 (Monthly Weather Review, Oct. 1888). 6) Savannah. Ga., Oct. 14. The steamship "Nachoochee" arrived here today with the crew of the schooner "Nava May", abandoned off Cape Henry Friday morning, waterlogged, while on voyage from Pamlico Sound to Philadelphia. At 8 A.M. Thursday morning (Oct. 11) she encountered a gale in which she labored until 3 A.M. next morning (The New York Times, Oct. 15, 1888, p.5, col.3). 7) This depression is a continuation of the low pressure area which moved northeastward along the Atlantic coast of the United States, attended during Oct. 11 and 12 by destructive hurricanes over the adjacent ocean. On Oct. 14 the storm was central in about lat. 40 N., long. 67 30 W. from which position it moved E. to the 60 degrees W. meridian on Oct. 15. By noon Oct. 16 (Greenwich time) the center had moved E.N.E. over the Banks of Newfoundland and during the next 3 days advanced slowly N. of E. and disappeared E. of the 20 degrees W. meridian after Oct. 19. This depression possessed moderate energy during its passage over the ocean (Monthly Weather Review, Oct. 1888). Author's note: The space-time continuity of this depression with the storm moving along the

Atlantic coast on Oct. 11-12 looks highly suspicious because it would imply an abrupt deceleration and change to the E. of the storm course off New England on Oct. 12 and 13 to match the position at lat. 40 N., long. 67 30 W. given for Oct. 14. Some eastward deviation occurred but, as no evidence of drastic deceleration was found, the author of this study believes that the depression mentioned in this item was an extratropical low pressure area which was unrelated to the Atlantic coastal storm. 8) Map showing a track for this storm. Daily positions are: Oct. 10, 27.2 degress N., 85.8 degrees W.; Oct. 11, 33.3 degrees N., 79 degrees W.; Oct. 12, 39.7 degrees N., 73.7 degrees W.; Oct. 13, 42.5 degrees N., 70.2 degrees W. (Monthly Weather Review, Oct. 1888). Author's note: Starting from the Oct. 13 position, an abrupt change to the S.E. in the storm motion would have to be introduced along the track to conform with the Oct. 14 position given for the depression in item 7). Such a change appears to be quite questionable to have occurred in reality, bringing this perception additional support to the idea that the Atlantic coastal storm and the depression in item 7) were separate meteorological events. 9) The storm lasted for 4 days. It was first observed in lat. 21 N., long. 94 W. on Oct. 8 and last observed at lat. 41 N., long. 72 W (Mitchell, 1924).

Most information contained in the above items was found to support the track for Storm 7, 1888 which is shown in Neumann et al. (1993). Therefore, such a track was reproduced by the author of this study in Fig. 1. Because of the uncertainties mentioned in the author's notes corresponding to items 7) and 8) and after having also taken into account the content of item 9), no attempt was made to extend the track in Neumann et al. beyond Oct. 12.

The hurricane status that Neumann et al. (1993) attributed to this storm was found to be supported by the 75 mph wind (item 5) and by the 9 ft. tide and the barometer reading of 29.22 inches (item 3), which were reported to have occurred at Cedar Keys.

Storm 8, 1888 (Nov. 1-8), T. S.

The following information was found about this storm: 1) Storm of Nov. 1-8, 1888. St. Vincent, Antigua, Atlantic (Tannehill, 1938). 2) This system is first charted N.E. of the Windward Islands under the date of Nov. 5 and is thence traced northeastward to about lat. 35 N., long. 45 W. by noon Nov. 8 (Greenwich time), after which its course cannot be determined with reports at hand. The storm possessed great energy and its advance was attended by violent gales (Monthly Weather Review, Nov. 1888). 3) The steamer "Exeter City" arrived from Swansea in 16 days. On Nov. 8, in lat. 49 05 N., long. 44 W., a tremendous storm came in from the N.N.W. The sea swept over the vessel, smashing 3 life boats and her port jolly boat and carrying away the lookout bridge. For 2 hours the wind blew a hurricane and the vessel hove to for 26 hours (The New York Times, Nov. 18, 1888, p.10, col.7). Author's note: The ship's position given in this item is about 600 miles to the N. of the 7 A.M. Nov. 8 position given for Storm 8, 1888 in Neumann et al. (1993). This fact suggests that either the ship encountered an extratropical storm which was not related to the system of tropical

origin or a northward extension of the track shown in Neumann et al. (1993). Because the "tremendous storm came from N.N.W.", the first option seems to have occurred and the system of tropical origin should have been absorbed by the extratropical one. 4) Map showing a track for this storm. Daily positions are: Nov. 5, 27 degrees N., 58.5 degrees W.; Nov. 6, 29 degrees N., 55.7 degrees W.; Nov. 7, 32.7 degrees N., 52.5 degrees W.; Nov. 8, 34.8 degrees N., 46 degrees W. (Monthly Weather Review, Nov. 1888). 5) This storm lasted for 7 days. It was first observed at lat. 13 N., long, 61 W., it recurved at lat. 17 N, long. 61 W. and it was last observed at lat. 39 N. long. 46 W. (Mitchell, 1924).

Information contained in the above items was found to support, in general, the track for this storm shown in Neumann et al. (1993). Therefore, such a track is reproduced in Fig. 1. The possibility of a northward extension of the track which is stated in the author's note corresponding to item 3) was not implemented because of the reasons discussed above.

As a result of the discussion in the author's note pertaining to item 3), the author of this study decided to discard the hurricane winds mentioned in that item as having been directly linked to Storm 8, 1888 and to keep the tropical storm status attributed to the storm in Neumann et al. (1993).

Storm 9, 1888 (Nov. 17- Dec. 2), H.

Abundant information was found about this storm: 1) Storm of Nov. 17- Dec. 2, 1888. Atlantic. Recurved near North Carolina coast. Hurricane winds at sea (Tannehill, 1938). 2) Marine data for Nov. 17: Steamship "Ascania"; storm from Nov. 16 to 18; wind shifted from N.E. to S.S.E., highest force 11 to 12; lowest barometer 29.81 inches at 4 P.M. Nov. 17 in lat. 25 01 N., long. 57 46 W. (Monthly Weather Review, Nov. 1888). 3) Marine data for Nov. 20: Steamship "Auskaro"; gale during Nov. 19-20; wind shifted from E.N.E. to N.N.E and N., highest force 8; lowest barometer 29.56 inches at 3:30 A.M. Nov. 20 in lat. 26 45 N., long. 66 07 W. Steamship "Mozart"; storm from Nov. 17 to 25; wind shifted from N.N.W. to N.E., highest force 10 to 11; lowest barometer 29.75 inches at noon Nov. 20 in lat. 28 28 N., long. 67 08 W. (Monthly Weather Review, Nov. 1888). 4) Marine data for Nov. 21 and 22: Steamship "City of Augusta"; strong gale from N.E. to N.; lowest barometer 29.97 inches at 5 A.M. Nov. 20 in lat. 36 20 N., long. 75 W. Steamship "Tropic"; N.N.W. gale of hurricane force on Nov. 22; lowest barometer 29.94 inches at noon in lat. 26 06 N., long. 80 07 W. (Monthly Weather Review, Nov. 1888). Author's note: The time of lowest barometer given by the "City of Augusta" seems doubtful. 5) Marine data for Nov. 23: Steamship "Fort William"; whole N. to N.W. gale on Nov. 23; lowest barometer 29.71 inches at noon in lat. 27 20 N., long. 79 25 W. Steamship "Fanita"; N. gale of hurricane force; lowest barometer 29.55 inches at 7:50 P.M. off Frying Pan Shoals. Steamship "Colon"; violent gale attaining force 11 on Nov. 23; lowest barometer 29.40 inches at 6 A.M. in lat. 30 06 N., long. 74 10 W. (Monthly Weather Review, Nov. 1888). Author's note: In addition, The New York Times, Dec. 10, 1888, p.8, col.1, published that the bark "Frateill" met a heavy gale from N.E. on Nov. 23

which increased to a hurricane and blew furiously for 4 days and that the bark "Hitar" met with much the same weather. 6) Marine data for Nov. 24: Bark "Monsita"; gale attaining force 11, at noon Nov. 24 in lat. 32 14 N., long. 75 29 W.; direction of wind at maximum velocity, W.S.W. Steamship "Manhattan"; gale attaining force 9 on Nov. 24; wind shifted from N.E. to N.; lowest barometer 29.94 inches at noon in lat. 29 45 N., long. 80 22 W. The gale commenced the day after leaving New York, Nov. 22, and lasted until noon Nov. 25 (Monthly Weather Review, Nov. 1888). 7) Marine data for Nov. 25: Steamship "City of San Antonio"; W.N.W.gale force 10; lowest barometer 29.06 inches at 5 P.M. in lat. 36 46 N., long. 73 54 W. Schooner "Morancy"; N.W. storme force 11; lowest barometer 29.01 inches in lat. 37 27 N., long. 73 29 W. Steamship "Wyanoke"; N.N.E. storm on Nov. 25, lowest barometer 28.96 inches at 4 P.M. off Hog Island, Va. Steamship "Chattahooche"; N. storm; lowest barometer 29.11 inches at 4 A.M., 25 miles E.N.E. from Cape Henry (Monthly Weather Review, Nov. 1888). Author's note: In addition, The New York Times, Dec. 10, 1888, p.8, col.1, indicated that the steamer "Longhirst" met a tremendous hurricane on Nov. 25. 8) Marine data for Nov. 26: Steamship "Effective", noon, in lat. 38 35 N., long. 71 49 W.; 1 A.M., wind N.E. barometer 28.80 inches, strong gale and increasing high sea; 5 A.M., very heavy gale, ship headed bow to sea; noon, wind E., hard gale, barometer 28.60 inches; 5 P.M., wind N.N.E., hard revolving gale, barometer 28.20 inches; midnight, wind W., barometer 28.20 inches (doubtful). Steamship "Gracian"; N.W. hurricane; lowest barometer 28.74 inches at 9 A.M. in lat. 38 10 N., long. 72 45 W. Pilot boat "J.F. Loubat"; strong gale from Nov. 23 to 26; lowest barometer 28.80 inches at 10 A.M. Nov. 26 in lat. 38 N., long. 73 50 W. Steamship "Richmond"; N.W. gale on Nov. 26; lowest barometer 28.93 inches, 100 miles off Cape Henry. "Light Vessel No. 45", in lat. 37 57 N., long. 75 05 W; N.N.W. to N.W. hurricane; lowest barometer 29.42 inches at 5 P.M. (Monthly Weather Review, Nov. 1888). 9) Marine data for Nov. 27: Steamship "Werra"; gale veering from E.S.E. to S.; lowest barometer 29.27 inches at 5 P.M. in lat. 40 33 N., long. 71 40 W. (Monthly Weather Review, Nov. 1888). Author's note: The location and/or the time of lowest barometer looked suspicious. 10) Lowest pressure at some locations: Hatteras, 29.58 inches on Nov. 26; New London, 29.26 inches on Nov. 25; New Haven, 29.30 inches on Nov. 25; Block Island, 29.24 inches on Nov. 26; Woods Hole, 29.31 inches on Nov. 26; Nantucket, 29.31 inches on Nov. 26 (Monthly Weather Review, Nov. 1888). 11) Maximum wind velocity at some locations (Hatteras, N. 66 mph on Nov. 25; New London, N.E. 36 mph on Nov. 25; New Haven, N.E. 51 mph on Nov. 25; Block Island, N.E. 84 mph on Nov. 26 (Monthly Weather Review, Nov. 1888). 12) Some selected meteorological information of interest: Atlantic City, N.J., barometer fell to 28.96 inches at 2 P.M. Nov. 26 and high tide caused much damage. New Haven, Conn., snow began at 8:40 A.M. Nov. 25, changed to sleet at 4:10 P.M. Nov. 25 and changed to rain during the following night. Block Island, R.I., the maximum velocity of 84 mph occurred at 3:25 A.M. Nov. 26 and the barometer reached a minimum of 28.91 inches around noon Nov. 27. Eastport, Me., the gale was accompanied by snow, sleet and heavy rain, much damage was done to fences and buildings. Boston, Ma., the barometer

fell slowly during Nov. 25, reading 29.88 inches at 8 P.M., on Nov. 26 the barometer fell slowly to 29.45 inches at 8 P.M. (Monthly Weather Review, Nov. 1888). Author's note: The selected information above was extracted from detailed weather narratives for various places along the U.S. east coast. In addition, The New York Times, Nov. 26, 1888, p.1, col.1 to 4, published that in some sections of Boston the snow drifted badly. The value and time of occurrence of the minimum pressure at Block Island were found to differ from the ones given in item 10). 13) The intensity of the storm was apparently increased by the advance of an area of decidedly high pressure over the Saint Lawrence Valley. This area of high pressure was moving slightly to the S. of E. in rear of an extended area of low pressure in the North Atlantic. The barometer continued to rise in the lower Saint Lawrence Valley until the afternoon of Nov. 25, reaching 30.80 inches when the storm was central east of Norfolk, Va. The center of the area of high pressure passed to the N.E. of the storm center, causing an unusual gradient in the northern quadrants of the storm, which resulted in destructive gales; these gales continued until the center of disturbance reached the land when, as it is usually the case, the intensity of the storm diminished (Monthly Weather Review, Nov. 1888). 14) The "Seminole", from Charleston, reported that the Frying Pan Lightship was not in her position. The "Louisiana", from New Orleans, felt the gale off Hatteras and was obliged to heave for 30 hours, and the "Andirondack", from Glasgow, had a very stormy passage (The New York Times, Nov. 29, 1888, p.8, col. 1). 15) At Portland, Me., the thermometer was at 26 degrees Fahrenheit. Other temperatures in degrees Fahrenheit were: Atlanta, Ga., 34; Charleston, S.C., 42; Jacksonville, Fl., 46 (The New York Times, Nov. 26, 1888, p.1, col.1 to 4). 16) Map showing a track for the storm. Daily positions are: Nov. 17, 22 degrees N., 57 degrees W.; Nov. 18, 22.7 degrees N., 62.5 degrees W.; Nov. 19, 23 degrees N., 66 degrees W.; Nov. 20, 22.8 degrees N., 70.7 degrees W.; Nov. 21, 23 degrees N., 73.5 degrees W.; Nov. 22, 23.8 degrees N., 78.2 degrees W.; Nov. 23, 26 degrees N., 77 degrees W; Nov. 24, 28.5 degrees N.; 76 degrees W.; Nov. 25, 33.5 degrees N., 74.2 degres W.; Nov. 26, 37.2 degreees N., 71.3 degrees W.; Nov. 27, 40.6 degrees N., 70.4 degrees W.; Nov. 28, 44.2 degrees N., 68.2 degrees W. (Monthly Weather Review, Nov. 1888). Author's note: For the period Nov. 17-24, this track was found to be roughly 200 miles to the S. and S.W. of the one in Neumann et al. (1993). 17) The storm lasted for 15 days. It was first observed at lat. 24 N., long. 57 W. on Nov. 17, it recurved at lat. 31 N., long. 75 W. and it was last observed at lat. 49 N., long. 36 W. (Mitchell, 1924),

A careful analysis of the marine data contained in items 2) through 8) suggested the introduction of some modifications along the storm track shown in Neumann et al. (1993) for Nov. 17 and for the period Nov. 20-26. The new 7 A.M. Nov. 17 position as estimated by the author of this study near 23.7 degrees N., 57.0 degrees W., was based on information in item 2) by allowing the center of the storm to have passed to the S. and then to the W. of the "Ascania", accounting for a change in wind from N.E. to S.S.E. and not bringing the center practically over the vessel in the evening of Nov. 17 as suggested by the track in Neumann et al. (1993). The

author's 7 A.M. Nov. 20 position was near 26.7 degrees N., 65.7 degrees W. and was primarily based on the information given by the "Auskaro" (item 3), this position is slightly to the N.N.E. of the one indicated in Neumann et al. (1993). The author's 7 A.M. positions for Nov. 21 and 22 were near 27.7 degrees N., 68.7 degrees W. and near 29.3 degrees N., 72.3 degrees W, respectively, and were based on space-time continuity along a smooth track; these positions were about 70 and 100 miles of the correspoding ones in Neumann et al. (1993). The author's 7 A.M. Nov. 23 position was near 30.5 degrees N., 74.7 degrees W. and was based on information given by the "Colon" (item 5), this position is about 90 miles to the N. of the one given in Neumann et al. (1993). The author's 7 A.M. Nov. 24 position was near 32.7 degrees N., 75.7 degrees W. and was based on information given by the "Monsita" (item 6), this position is about 110 miles to the N.N.W. of the corresponding one in Neumann et al. (1993). The author's 7 A.M. Nov. 25 position was near 34.5 degrees N., 74.7 degrees W. and was based, in general, on the analysis of all marine data for Nov. 25 (item 7) and, more specifically, on space-time continuity as applied backwards from positions for the latter part of the day which were inferred from information furnished by the "City of San Antonio", the "Morancy" and the "Wyanoke"; the author's 7 A.M. Nov. 25 position is about 100 miles to the N. of the corresponding one in Neumann et al. (1993). The author's 7 A.M. Nov. 26 position was near 38.0 degrees N., 72.3 degrees W. and was primarily based on the information given by the "Effective" and the Gracian" (item 8), this position is about 60 miles to the N. of the corresponding one in Neumann et al. (1993). Positions in Neumann et al. (1993) for the periods Nov. 18-19 and Nov. 27- Dec. 2 were kept unchanged and, together with the new 7 A.M. positions which were estimated by the author of this study, were used in preparing the track for Storm 9, 1888 which is displayed in Fig. 1.

The hurricane status which Neumann et al. (1993) attributed to this storm was supported by the content of several items, in particular by the wind of 84 mph reported at Block Island (item 11) and by surface pressures as low as 28.20 inches reported by one vessel, the "Effective", in item 8).

Although it is possible that the storm might have retained a warm core structure to quite high latitudes, indications are that it was embedded in a quite typical winter environment as it moved off the U.S. east coast. Snow and sleet conditions and cold temperatures reported in items 12) and 15) fully support the latter statement.

Special statement.

Two possible additional cases were found for this year. In both cases, the information which was available to the author of this study was insufficient to fully verify their existence and/or to determine a reliable evolution for them. The cases were as follows:

A) Case of Aug. 13, 1888.

The following information pertains to this possible case: 1) Brig "Acadia", from Barbados and Antigua, was struck by a cyclone

or whirlwind on Aug. 13 in lat. 36 N., long. 70 W. The force of the wind was so great as to completely master the brig taking her aback and whirling her around stern to the sea. At the same time she was struck by a huge wave (The New York Times, Aug. 18, 1888, p.8, col.4).

It is not clear if the weather encountered by the "Acadia" was associated with a cyclone of tropical nature or with a disturbance of other kind, like a tornado or waterspout. This is why the author decided to keep this as a possible case.

B) Case of Sept. 12-13, 1888.

The following information was found in relation to this possible case: 1) The steamer "La Bourgogne" wrestled with a storm for 36 hours. The storm was encountered Wednesday morning (Sept. 12) in lat. 40 N., long. 48 W. The barometer fell rapidly and in the afternnon there was a tremendous sea on. At night, the storm increased in intensity and drove the vessel from her course. At midnight (Sept. 12-13) a huge wave dashed over the steamer and tore away the center of the bridge. A few hours later another wave carried off the rest of the structure (The New York Times, Sept. 17, 1888, p.1, col.2).

This event could have been either independent of or related to Storm 5, 1888, which track was ended near lat. 47.5 N., long. 62.5 W. late on Sept. 12. Because of this uncertainty, the author of this study decided to keep this as a possible case.