

Eleven storms were identified as having occurred in 1880. Tracks for these storms are presented in Fig. 4.

Storm 1, 1880 (Jun. 21-24).

Quite limited information was found about this storm: 1) From midnight Jun. 21 to the morning of Jun. 24, an ill-defined area of low pressure prevailed in Louisiana and Texas. Its center was probably in the western part of the Gulf of Mexico. The only high wind was E. 29 mph at New Orleans in the afternoon of Jun. 22 (Monthly Weather Review, Jun. 1880). 2) From Galveston News, Jul. 2. The schooner "James Andrew" (from Sabine) encountered a squall on Jun. 21 during which the vessel lost her jib and broke the center board. The squall seemed to extend in a circle of 5 miles and was very severe; vessels a few miles away were entirely out of the winds. The following day (Jun. 22), between Sabine and Calcasieu, the vessel again encountered bad weather. The sea became very jumpy and a blow was imminent when the vessel suddenly entered a field of green turtles, some of them being as large as a round table. The storm that appeared imminent did not come and fair weather and a good sea presented themselves after the vessel passed through the field of turtles (The New York Times, Jul. 7, 1880, p.5, col.6).

The information above was found to be insufficient for the purpose of evaluating the storm track shown in Neumann et al. (1993). Therefore, the author of this study just adopted that track and reproduced it in Fig. 4.

On the basis of items 1) and 2), the storm seems to have been very weak and disorganized. The author of this study is skeptical about the merit this weather system had for his inclusion as one of the storms of 1880; however, as he failed to find any evidence against the existence of this storm as such, he decided to keep it on record.

Storm 2, 1880 (Aug. 4-14).

The following information was found in relation to this storm: 1) Aug. 5. Guadeloupe, E. wind with rain (Monthly Weather Review, Aug. 1880). 2) Aug. 5 and 6. St. Thomas, strong E. and S. wind and rain (Monthly Weather Review, Aug. 1880). 3) Aug. 7 and 8. Same conditions reported for Navassa Island (Monthly Weather Review, Aug. 1880). Author's note: Navassa Island is located between Jamaica and Haiti. Days indicated in items 1) through 3) appear to be off by one day on the basis of the space-time continuity of the storm evolution; the right days are very likely to be Aug. 4 for item 1), Aug. 4 and 5 for item 2) and Aug. 6 and 7 for item 3). 4) On Aug. 6, "a most remarkable fall of the barometer" was reported by Mr. Maxwell Hall, the director of meteorology at Jamaica. Squalls and rains also occurred in that island (Monthly Weather Review, Aug. 1880). 5) Steamer "E.B. Ward". Aug. 9, off Cape San Antonio, lost rudder and had cargo injured; at the same place, the ship "Tula" encountered a severe hurricane in August, probably on

the 9th (Monthly Weather Review, Aug. 1880). 6) On Aug. 10, the bark "Adino" was wrecked on Alacran Reef (Monthly Weather Review, Aug. 1880). Author's note: Alacran Reef is located off the northern coast of the Yucatan peninsula. 7) At Brownsville, the barometer began to fall and at 9:33 P.M. Aug. 12 it read 29.69 inches; then it sunk to 28.32 inches at 11:45 P.M. (a drop of 1.37 inches in 2 hours and 12 minutes). The anemometer was blown down after it registered 48 mph at 10:48 P.M. From 11:45 P.M., calm prevailed from 1 hour and then the barometer started rising and the wind shifted to S. The center apparently passed over Matamoros, a few miles S. of Brownsville, at midnight. Two boats sank in the Rio Grande River and 8 vessels were wrecked at Port Isabel (Monthly Weather Review, Aug. 1880). 9) At Indianola, the wind was N.E. 64 mph; at Galveston, it was N.E. 29 mph (Monthly Weather Review, Aug. 1880). 10) New Orleans. Aug. 21. A special dispatch to The Times from Corpus Christi gives an account of the storm on the Lower Texas coast and in Mexico. It is estimated that 300 houses were wrecked at Matamoros. At Port Isabel and Brazos, the storm was most disastrous. At Brownsville, the streets are full of debris, the houses wrecked and trees and fences blown down. Several vessels were wrecked at Port Isabel and, at Brazos, the wharf was demolished and the railroad was badly damaged (The New York Times, Aug. 22, 1880, p.1, col.6).

Based on the above items, the author of this study proposed a slight northward adjustment along the track shown in Neumann et al. (1993) for the period Aug. 6-10 and a minor adjustment in the 7 A.M. position for Aug. 13. The adjustment for the period Aug. 6-10 was introduced in order to bring the storm a little closer to Jamaica on the basis of the "most remarkable fall of the barometer" reported there (item 4) and also somewhat closer to the western tip of Cuba as suggested by the information contained in item 5). This northward adjustment of the track also involved a slight adjustment of the 7 A.M. Aug. 10 position in order to obtain a better space-time continuity along the track and to satisfy better item 6). The slight adjustment for the 7 A.M. Aug. 13 position was introduced to satisfy the passage of the center over Matamoros around midnight Aug. 12-13 (item 6). The modifications above required new 7 A.M. estimated positions by the author of this study for the following days: Aug. 7, 17.7 degrees N., 80.0 degrees W.; Aug. 8, 19.3 degrees N, 84.0 degrees W.; Aug. 9, 20.7 degrees N., 86.7 degrees W.; Aug. 10, 22.0 degrees N., 89.7 degrees W.; Aug. 13, 26.5 degrees N., 98.5 degrees W. On the basis of these positions and after adopting those in Neumann et al. (1993) for the remaining of the days, he prepared the storm track which is shown in Fig. 4.

The pressure reading of 28.32 inches reported at Brownsville (item 7) not only shows that the storm was a hurricane but that it was an intense one.

#### Storm 3, 1880 (Aug. 15-20).

The following information of interest was found in relation to this storm: 1) Steamship "Nith" (taken from the log by Mr. Maxwell Hall, meteorologist at Jamaica). Aug. 15, S. point of Guadeloupe bearing N. 3 miles. Fresh N.E. wind, gradually increasing with hard

squalls. Aug. 16 started with similar conditions. Wind E. at times backing to N.E., noon Aug. 16 position: lat. 16 04 N., long. 65 55 W.; less wind but sea running high and turbulent. Afterwards, hard gale and heavy squalls which continued with torrents of rain during the early portion of the morning of Aug. 17; the wind moderated towards noon Aug. 17 and veered from N.E. to S.E. to S.; position at noon: lat. 16 10 N., long. 70 26 W.; barometer 29.35 inches. Wind again heavy; it abated somewhat towards sunset but at 9 P.M. it came again with renewed force. Aug. 18 commenced with terrific squalls from E. and S.E., torrents of rain and incessant thunder and lightning; towards noon the storm increased in violence and the vessel headed southward; noon Aug. 18 position: lat. 16 27 N., long. 74 57 W.; barometer reading 29.15 inches. At 4 P.M., the wind veered to S. and moderated (Monthly Weather Review, Aug. 1880). 2) The steamship "Atlas" at Aux Cayes, left port in the afternoon of Aug. 18. While in port the wind set in from N.E. and veered around to E., barometer 29.10 inches. The captain put at sea and allowed the storm to pass (Monthly Weather Review, Aug. 1880). Author's note: The barometer reading of 29.10 inches appears to be too low. 3) Some observations taken at Kingston. Barometer at 7 A.M. Aug. 18, 29.86 inches; at 3 P.M., 29.69 inches; at 9:15 P.M., 28.93 inches (lowest reading); at 11 P.M., 29.40 inches; at 7 A.M. Aug. 19, 29.82 inches. Some winds (although being affected by the mountains): Up to 8 P.M. the wind remained almost calm; 8:15 P.M., N.E. 5 mph; 9:30 P.M., S.E. 15 mph; 9:45 P.M., S. by E. 20 mph; 10 P.M., S. 60 mph; 10:15 P.M., S. 80 mph; 10:30 P.M., S. 60 mph; 10:45 to 11 P.M., S.S.W. 70 mph; 11:15 P.M., S.S.W. 50 mph; 11:30 to midnight (Aug. 18-19), W.S.W. 20 mph (Monthly Weather Review, Aug. 1880). 4) Some other data taken at Jamaica. Steamer "Tropic", at San Antonio harbor, Aug. 18, 6 A.M., wind E. fresh, barometer 30.00 inches; 4 P.M., heavy S.E. gale, barometer 28.60 inches (?); 11 P.M., heavy S. gale, barometer 28.40 inches. At midnight, storm passed S. (?), barometer rising rapidly, heaviest wind was from S. and lasted 1 hour. St. Ann's Bay, 4:45 P.M. Aug. 18, barometer 29.56 inches; 9 P.M., fearful hurricane until near daybreak Aug. 19. A second report from St. Ann's stated that the gale increased in violence until about 12:30 A.M. Aug. 19, when a lull took place; at 1 A.M., the wind veered to W.S.W. and lasted as violent as before until 4 A.M. Chapelton, 6 P.M. Aug. 18, it began blowing from N. and, changing to N.W., continued to 2 A.M. Aug. 19., violent from 9 P.M. to midnight. Port Maria, awful time from 7 P.M. Aug. 18 to 3 A.M. Aug. 19 (Monthly Weather Review, Aug. 1880). Author's note: Barometer readings taken on board the "Tropic" appear to be unreliable. St. Ann's Bay and Port Maria are located on the northern coast of Jamaica; San Antonio harbor seems to refer to Port Antonio on the N.E. coast of the island and Chapelton is located in the interior of Jamaica, about 30 miles to the west of Kingston. 5) Baltimore, Sept. 5. Steamer "American" arrived at this port from Kingston, bringing the papers containing details of the hurricane which swept the island on Aug. 18. The captain of the "American" said that 45 vessels were lying in the port of Kingston when the storm occurred and that two, the "American" and a German bark escaped destruction. The barometer readings at Kingston were as follows: 8:15 P.M., Aug. 18, 29.71 inches; 8:37 P.M., 29.60

inches; 8:34 P.M., 29.53 inches; 8:40 P.M., 29.51 inches; 8:42 P.M., 29.50 inches; 9:30 P.M., 29.33 inches; 11:20 P.M., 29.50 inches. A gentleman occupying No. 1 E. Street stated from personal observation that the damage to the wharves occurred from 10 to 11 P.M. when the wind blew a furious rush from the S.W. (The New York Times, Sept. 6, 1880, p.1, col.3). Author's note: The barometer readings, which most likely were taken on board the "American", seem to be several tenths of an inch too high. 6) Halifax, Aug. 21. A dispatch which was received here yesterday indicated that the brigantine "Caroni" was sunk during a hurricane at Jamaica Thursday, Aug. 19 (The New York Times, Aug. 22, 1880, p.1, col.4). 7) A telegram from Lloyd's agent in Kingston, Jamaica stated that a hurricane has passed over Kingston doing considerable damage and that the "Caroni", the "Everard Delius" and the "American" were damaged (The Times, London, Aug. 23, 1880, p.10, col.4). 8) The Lloyd's agent in Kingston reported that the following vessels also suffered in the Jamaica hurricane: "Ethel Caine", "Akbar" and "Midsummer". Most wharves at Kingston were destroyed and there is immense damage throughout the country (The Times, London, Aug. 25, 1880, p.10, col.1). 9) Advices from Jamaica indicated that Port Antonio was much damaged by the hurricane that passed over the island on "Aug. 31". It is also confirmed that Kingston suffered severely (The Times, London, Sept. 1, 1880, p.5, col.2). Author's note: Aug. 31 is obviously a typographic error; the date should be Aug. 18-19). 10) From The Kingston Standard: During the afternoon of Aug. 18 heavy rain fell but by 8 P.M. the squally weather took the form of a strong gale which lulled somewhat towards 9 P.M. The lull was transient and by 10 P.M. the wind had acquired such force as to gather everyone in the homes in anxious groups. At 11 P.M. the storm raged as an unmistakable hurricane. About 12 midnight the fury abated but it blew a heavy gale until 3 A.M. Aug. 19 (The Times, London, Sept. 13, 1880, p.6, col.6). 11) From a private letter written by a well known minister at Annotto Bay, Jamaica: The awful cyclone of last Wednesday night stripped this house and quite unroofed the cottage so that my wife and I can only get shelter by day or night under the small portion of this roof not carried away. In the afternoon (Aug. 18) the weather increased, especially after 4 o'clock. By 9 P.M. it began to strip roofs and throw down trees, fences, buildings, etc., and by 2 A.M. (Aug. 19) the desolation was complete (The Times, London, Sept. 15, 1880, p.12, col.2). Author's note: Annotto Bay is located on the northern coast of Jamaica. 12) The following observations were received from Father Vines of Havana: Manzanillo, Aug. 18, 9 P.M., barometer 29.95 inches, wind N.E. force 2; Aug. 19, 7 A.M., barometer 29.55 inches, wind N.E. force 3, squally; 8:10 A.M., barometer 29.30 inches, wind E. force 1, ugly; 8:15, barometer 29.30 inches, wind S.E. forces 3 and 4, squally; 9:15 A.M. barometer 29.30 inches, wind S. force 2, squally; noon, barometer 29.70 inches, wind S.W. force 1, cloudy. Santa Cruz del Sur, Aug, 18-19, midnight, barometer 29.92 inches, wind N.E. hard and variable; Aug. 19, 8 A.M., barometer 29.74 inches, wind N., hard; 9 A.M., wind N.N.W. fresh; 10 A.M., wind N.W.; noon, barometer 29.71 inches, after which it rose; nightfall, barometer 29.83 inches, wind W. fresh. Nuevitas, Aug. 19, 11 A.M., barometer 29.40 inches, N.E. hurricane;

noon, barometer 29.50 inches, N.E. hurricane; 4:30 P.M., barometer 29.50 inches, wind S. light, the hurricane having passed northward (Monthly Weather Review, Aug. 1880). Author's note: The fact that the wind did not exceed 18 mph, the top limit of force 4 on the Beaufort scale, at Manzanillo reflected the sheltering effect of the mountains of the Sierra Maestra (eastern Cuba) and the barometer readings taken at Nuevitas appeared to be unreliable. 13) The hurricane crossed Cuba but its effects were not as severely felt over Camaguey and Santiago de Cuba as they had been on the eastern part of Jamaica (Sarasola, 1928). Author's note: Actually taken from the catalog of Cuban hurricanes by M. Gutierrez-Lanza which is included in Sarasola (1928). 14) Barometer at Bermuda fell to 29.85 inches on Aug. 21 (Monthly Weather Review, Aug. 1880). 15) Map showing a parabolic track for the storm starting near 14 degrees N., 62 degrees W., having the vertex near 21 degrees N., 78 degrees W. and ending near 27 degrees N., 74.5 degrees W. (Monthly Weather Review, Aug. 1880).

Based on the information contained in items 4) and 12), the author of this study was able to determine a storm track which is quite accurate and which roughly extended over the 24 hour period from the evening of Aug. 18 to the evening of Aug. 19. This portion of the track was found to be slightly to the east of the one shown in Neumann et al. (1993) for the same period. The new 7 A.M. Aug. 19 position which was estimated by the author of this paper was near 20.3 degrees N., 77.5 degrees W. Some change in the timing along the track in Neumann et al. (1993) for early Aug. 20 was necessary in order to keep space-time continuity with the estimated time (about 4:30 P.M. Aug. 19) the storm center exited Cuba near Nuevitas (item 12). As a result of this change, a new 7 A.M. Aug. 20 position near 24.5 degrees N., long. 76.3 degrees W. was estimated by the author of this study. By using these two positions and keeping unchanged the remaining 7 A.M. positions displayed in Neumann et al. (1993), he constructed the storm track which is shown in Fig. 4. Although there are some indications that the storm existed on Aug. 21, he decided to end his track late on Aug. 20 as he found that information in item 14) was insufficient for estimating a position for 7 A.M. Aug. 21.

The lowest pressure of 28.93 inches reported at Kingston, Jamaica (item 3) fully supports hurricane strength.

It should be mentioned that the recurvature of this storm at about latitude 21 N. in the month of August called Father Vines' attention. He stated that, in his opinion, the unusual feature was related to the existence of another cyclone which was producing a strong cirrus current from the W. at Havana (Vines, 1895). Curiously, there is no evidence of the second storm he mentioned, but there is no doubt that the strong westerlies in which the cirrus clouds were embedded were responsible for the rather sharp turn to the north and northeast which began when the storm was over Jamaica in the evening of Aug. 18. In addition, the westerlies probably caused the continuation of the weakening trend observed as the storm crossed Cuba (item 13) and its possible dissipation late on Aug. 21 or early Aug. 22.

Storm 4, 1880 (Aug. 24- Sept. 2).

The following information was found in connection with this storm: 1) Brig "M.A. Doran". Aug. 25, lat. 25 30 N., no long. given, heavy N.N.E. gale veering to N.W. with barometer rapidly falling from 30.40 to 29.50 inches (Monthly Weather Review, Aug. 1880). 2) Schr. "S.A. Snow" was wrecked about 125 miles of Bermuda in a hurricane on Aug. 26 (Monthly Weather Review, Aug. 1880). 3) Ship "Saint Jose" was dismasted S. of Bermuda on Aug. 26 (Monthly Weather Review, Aug. 1880). 4) Ship "Sunrise". Aug. 26, lat. 26 N., long. 69 W., fell into the S.W quadrant of a violent hurricane moving N.N.W. (Monthly Weather Review, Aug. 1880). Author's note: The hurricane was not moving towards the N.N.W.; it was moving roughly to the W.N.W. 5) Schr. "James H. Hoyt" put in Lewis, De., with the crew of brig "H. Houston" which had left Trinidad (Cuba) on Aug. 3. The brig experienced a violent gale from N.N.E. on Aug. 26 and sprung a leak. The "H. Houston" was abandoned at lat. 36 57 N., long. 74 20 W. and the crew took their boat right before the brig sank on Aug. 29 (The New York Times, Sept. 4, 1880, p.8, col.3). 6) The hurricane was located near lat. 25 50 degrees N., long. 74 10 degrees W. on Aug. 27 when it overtook the steamship "Santiago" at noon; hurricane, wind N.N.W., sea N.E., barometer 29.80 inches; at midnight (Aug. 27-28), wind shifting to very heavy S.W. and high cross seas, barometer 29.40 inches; after which, wind and sea moderated (Monthly Weather Review, Aug. 1880). 7) Key West, Sept. 8. The bark "Antonio Bartet" was towed into this port this afternoon, waterlogged. She was struck by the hurricane 60 miles N. of the Bahamas and entirely dismasted (The New York Times, Sept. 9, 1880, p.1, col.6). 8) Panama, Sept. 8. The steamer "Clyde" (from New York) arrived at Aspinwall in the night of Sept. 2 and reported she encountered a severe gale from S.E. and was compelled to lay to 22 hours (The New York Times, Sept. 17, 1880, p.5, col.4). 9) Steamship "New Orleans". Aug. 28, 8 P.M., 40 miles E.N.E. off Jupiter Inlet; the wind backed from N.N.W. to S.E. showing that the hurricane had passed to the north (Monthly Weather Review, Aug. 1880). The New York Times, Sept. 3, 1880, p.8, col.4 stated that the shifting wind caused a dangerous cross sea which swept over the vessel and that a crew was lost overboard. 10) Steamship "Morgan City". Aug. 28, off the Florida coast, experienced a hurricane from W. backing to S.E. and lasting until Aug. 29; the barometer fell from 30.00 to 28.70 inches (Monthly Weather Review, Aug. 1880). Author's note: The New York Times, Sept. 3, 1880, p.8, col.4, published that the "Morgan City" escaped without injury. 11) Ship "H. Livingston" spoke the schooner "Annabell", 14 miles E. of Cape Romain light on Sept. 2 at 6 P.M. The captain of the "Annabell" said that she was caught on the hurricane of Aug. 28 while sailing from Cape Haytien for Boston (The New York Times, Sept. 6, 1880, p.8, col.3). 12) Bark "Levanter" (from Pensacola in 22 days). Aug. 28, lat. 30 30 N., long. 78 40 W., was caught in a hurricane. The wind first came from N.E. and then veered to S.E., causing an extremely heavy sea. The hurricane lasted 24 hours but the bark did not sustain damage (The New York Times, Sept. 6, 1880, p.8, col.3). 13) The loss of the "City of Wera Cruz" was confirmed by a report of seven survivors. The ship sank at 5:30 A.M. Sunday morning (Aug.

29) in a hurricane on the Florida coast. There were 79 persons on board, including the crew (The New York Times, Sept. 4, 1880, p.8, col.3). 14) Survivors from the "City of Vera Cruz" stated that the vessel was about 30 miles off the coast Saturday evening (Aug. 28) when the great seas started to pile up over the ship and to fill the hold. The ship must have gone down between Port Orange and Cape Canaveral. By daybreak Aug. 29 it was determined to abandon the ship. The captain and some of the officers went in one of the boats. There was a shock that was felt all over the vessel: the "City of Vera Cruz" had completely broken in two and sank carrying all people on board with her (The New York Times, Sept. 5, 1880, p.1, col.5). 15) Brig "Neva" sailed from Trinidad (Cuba) on Aug. 12 and the vessel was continually on the edge of a hurricane but escaped the full force of the wind and sea (The New York Times, Sept. 4, 1880, p.8, col.4). 16) The "Saratoga" left Havana on Aug. 28, missed the storm but there was still a heavy swell off the Bahamas during the passage (The New York Times, Sept. 3, 1880, p.8, col.4). 17) The "Caribel" coming from Puerto Rico, the "Crescent City" from Aspinwall and the "Colorado" from Galveston and Key West encountered high and confused seas some days after the hurricane passed (The New York Times, Sept. 4, 1880, p.8, col. 3). 18) Savannah, Sept. 7. The schooner "Rosa Esppinger" is a total wreck 16 miles N. of Cape Canaveral, the brig "Long Reach" is stranded at Turtle Mound and two other vessels are stranded N. of New Smyrna Inlet (The New York Times, Sept. 8, 1880, p.2, col.7). 19) During Aug. 29-30, the hurricane passed across Florida. At Cedar Keys the storm was one of the worst ever known. In the morning of Aug. 30, the wind had reached 64 mph from the N.E. when the apparatus became disabled. 6.73 inches fell on Aug. 30 and 31, and the lowest pressure was 29.40 inches at 2 P.M. Aug. 30. At Pensacola, the highest wind: S.W. 32 mph, and the lowest pressure: 29.33 inches, were reported on Aug. 31 (Monthly Weather Review, Aug. 1880). 20) Map showing a track for this storm; the track was started near 27 degrees N., 67 degrees W. on Aug. 26 and ended near the Alabama-Mississippi border in the night of Aug. 31 (Monthly Weather Review, Aug. 1880).

The track shown in Neumann et al. (1993) was found to agree quite reasonably with most of the information contained in the items above, with the exception that the timing along the portion of the track corresponding to Aug. 30 required some adjustment in compliance with the meteorological information for Cedar Keys contained in item 19). In order to fit the timing along the track with the N.E. wind direction reported at Cedar Keys in the morning of Aug. 30 and with the lowest pressure reported to have occurred there at 2 P.M. Aug. 30, the author of this study adjusted the 7 A.M. Aug. 30 position to about 28.7 degrees N., 82.7 degrees W., which is roughly 50 miles to the east-southeast of the corresponding position given in Neumann et al. (1993). The author's track, which is based on the one in Neumann et al. (1993) after having introduced the above mentioned change, is displayed in Fig. 4. Note along this track that the storm slowed down significantly while crossing the Florida peninsula at a forward speed of roughly 5 mph.

The central pressure below 28.70 inches which can be inferred

from item 10) definitively supports hurricane intensity and it should be mentioned that Dunn and Miller (1960) have classified the storm as a major hurricane.

Storm 5, 1880 (Aug. 26- Sept.4).

The following information was found in relation to this storm:

- 1) Brig "Dorothea", Aug. 26-27, lat. 21 N., long. 46 W., experienced a storm. This report is, however, somewhat doubtful (Monthly Weather Review, Sept. 1880). Author's note: No reason was given for the doubtfulness of the report.
- 2) Brig "Lorne". Aug. 29, 8 A.M., E.N.E. breeze; at noon, lat. 32 40 N., long. 62 40 W., hurricane commencing from N.N.E.; 2 P.M., hurricane increasing rapidly with a tremendous sea; at 4 P.M., shifted to N.N.W. Aug. 30, gale moderated (Monthly Weather Review, Sept. 1880).
- 3) Philadelphia, Sept. 5. Steamer "Coronet". Aug. 29, lat. 32 49 N., long. 54 38 W., a hurricane from S.W. to N.W. stove her bulkhead, split the sails, broke the propeller blade, etc. (The New York Times, Sept. 6, 1880, p.8, col.2). Author's note: The longitude is obviously in error, it should read 64 38 W.
- 4) Bermuda observations. Gibb's Hill Light station (246 ft above sea level). Aug. 29, 5 P.M., wind N.N.E., barometer 29.79 inches; 10 P.M., wind N.W. heavy gale; barometer 29.50 inches; midnight Aug. 29-30, N.W. hurricane, barometer 29.24 inches; Aug. 30, 1 A.M., lowest barometer 29.14 inches; 2 A.M., storm fearful; 3 A.M., storm more to W., storm lulled a little; 6 A.M., barometer 29.17 inches; barometer continued to rise through the morning and wind to back to S.W.; noon Aug. 30, barometer 29.55 inches, strong gale (Monthly Weather Review, Sept. 1880).
- 5) Observations from Hamilton, Bermuda. Aug. 29, 6 P.M., barometer 30.00 inches; 10 P.M., N.E. wind, very heavy gusts; 11:30 P.M., barometer 29.45 inches. Aug. 30, 1:30 A.M., barometer 29.28 inches; 2 A.M. to 4 A.M., highest winds; 3 A.M., lowest barometer 29.24 inches; 4 A.M., barometer 29.35 inches, wind veered to S.W. and continued all day from that quarter (Monthly Weather Review, Sept. 1880).
- 6) Bermuda observations. Mont-Hill Lighthouse. Aug. 29, 4 P.M., N.E. wind, fine rain; 8 P.M., gale gradually backing to N.; midnight Aug. 29-30, gale increased to a hurricane; Aug. 30, 1:45 A.M., wind shifted from N. to N.W. in a tremendous squall; 3:30 to 3:45 A.M., wind again shifted from N.W. to S.W.; 4 A.M., wind slightly abating; 4 P.M., bright spots from W., storm breaking (Monthly Weather Review, Sept. 1880).
- 7) A hurricane visited the Bermuda Island with fury which was not equally seen since the hurricane of 1837. All night long on Aug. 29, the wind blew with appalling force and the rain fell in blinding sheets. Capt. Wilson of the steamship "Bermuda" said she was 20 miles N.W. of Bermuda when the falling barometer warned that he could not get out so quickly and ran towards the center of the storm then passing 30 miles to the east. She was exposed to the full fury of the hurricane but received no serious damage (The New York Times, Sept. 8, 1880, p.1, col.7).
- 8) Observations taken on board the steamship "Bermuda". Aug. 29, 8 P.M., barometer falling rapidly, estimated position: 23 miles N.W. by W. of North Rock, Bermuda; 9 P.M., moderate N. gale; midnight Aug. 29-30, violent N. gale; Aug. 30, 4 A.M., barometer 29.82



inches; 6 A.M., perfect hurricane; noon, barometer 29.40 inches, full hurricane; 2 P.M., barometer 29.32 inches, stationary; 4 P.M., barometer 29.34 inches, S.W. wind; 5 P.M., sudden calm; 5:20 P.M., hurricane burst upon the ship with redoubled force from S.S.W.; 8 P.M., barometer 29.10 inches, "ship buried on port side from sheer force of the wind"; midnight Aug. 30-31, lowest barometer reading 28.85 inches; Aug. 31, 4 A.M., barometer rising, wind abating slightly; 6 A.M., barometer 29.00 inches; 8 A.M., barometer 29.18 inches; 10 A.M., barometer 29.40 inches; noon, barometer 29.64 inches, weather moderating; 8 P.M. position: estimated to be 45 miles N.E. of St. David's Head, Bermuda, wind W., sea gone down; Sept. 1, 7 A.M., about 72 miles E. of St. David's Head; 10 A.M., steering W.; noon, lat. 33 11 N., long. 63 23 W. (Monthly Weather Review, Sept. 1880). 9) Observations taken on board the bark "Eliza Barss". Aug. 30, 6 A.M., lat. 34 40 N., long. 66 50 W.; 6 P.M., barometer 29.85 inches, very heavy S.E. swell; 8 P.M., barometer 29.60 inches, wind commencing to back and blow harder, rain squalls; 9 P.M., barometer 29.58 inches, wind N.N.W.; midnight Aug. 30-31, barometer 29.60, wind N.W.; Aug. 31, 6 A.M., barometer 29.70 inches, wind W.N.W., sky very clear to west but hard, ugly-looking clouds to N.E.; noon, Bermuda veering E.S.E. (Monthly Weather Review, Sept. 1880). 10) Boston, Sept. 18. Brig "Alice Tarlton" (from Machias to Cienfuegos) put into this port today and reported that on Sept. 1, in a hurricane, she was thrown on her beam ends for 15 hours (The New York Times, Sept. 19, 1880, p.2, col.3). Author's note: Machias is located on the northeastern coast of Maine and Cienfuegos is located on the southern coast of Cuba. 11) Observations taken on board the brig "Twilight" (from Shelbourne, Nova Scotia, to Trinidad. Aug. 31, noon, lat. 38 26 N., long. 62 05 W., fresh gale from N. veering to S.E., heavy sea from S.S.W.; Sept. 1, E.N.E. increasing wind with a very heavy sea; Sept. 2, N.N.E. hurricane, vessel on beam ends, deck swept; 11 P.M., lat. 35 06 N., long. 60 15 W.; Sept. 3, N.N.E. blowing terrific; 2 A.M., wind moderated; 3 A.M., wind hauled to S.E.; midnight Sept. 3-4, gale abated; Sept. 4, S.W. light breeze, fine weather (Monthly Weather Review, Sept. 1880). Author's note: A similar weather description was published in The New York Times, Oct. 4, 1880, p.1, col. 4; the description added that when the wind hauled to S.E. at 3 A.M. Sept. 3, it blew harder than before and it was not possible to be on the deck without being lashed. 12) Map showing positions for the storm as follows: Aug. 29, 30 degrees N., 61 degrees W.; Aug. 30, 32 degrees N., 63 degrees W.; Aug. 31, 34 degrees N., 62 degrees W.; Sept. 1, 35 degrees N., 60 degrees W.; Sept. 2, 35 degrees N., 58 degrees W.; Sept. 3, 35 degrees N., 56 degrees W.; Sept. 4, 35 degrees N., 54 degrees W. (Monthly Weather Review, Sept. 1880).

Based on a careful analysis of items 1) through 12), the author of this study concluded that such information did not support the track for this storm shown in Neumann et al. (1993). Therefore, he decided to prepare an entirely new track, which brought the storm to a position just to the N.E. of Bermuda based on observations taken at three sites on that island (items 4 through 6) and, to a lesser extent, on information in other items. This position contrasted with the parabolic motion around Bermuda

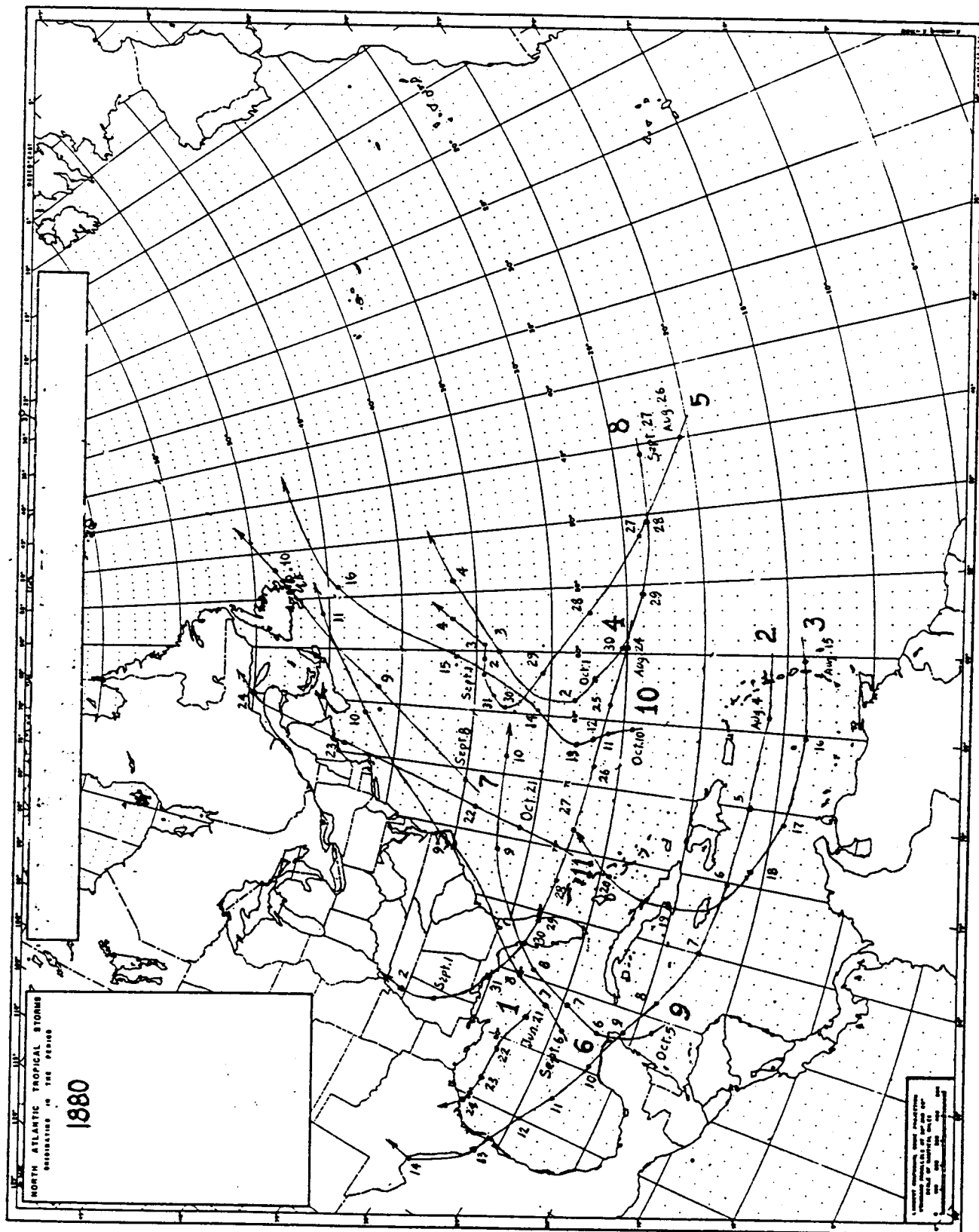


Fig. 4

which is shown in Neumann et al. (1993) and which allegedly brought the center about 200 miles S. of the island, a little over 100 miles W. of the island and about 175 miles N. of the island. The author's track was started near 20.5 degrees N., 45.0 degrees W. which is an estimated position based on information in item 1). Estimated 7 A.M. positions for other days were as follows: Aug. 27, 24.0 degrees N., 51.5 degrees W.; Aug. 28, 27.5 degrees N., 57.0 degrees W.; Aug. 29, 30.5 degrees N., 61.7 degrees W.; Aug. 30, 33.0 degrees N., 64.7 degrees W.; Aug. 31, 33.7 degrees N., 63.7 degrees W.; Sept. 1, 34.5 degrees N., 62.0 degrees W.; Sept. 2, 34.5 degrees N., 60.7 degrees W.; Sept. 3, 34.5 degrees N., 59.5 degrees W.; Sept. 4, 36.7 degrees N., 57.3 degrees W. The drift to the N.E. and E. from Aug. 30 through Sept. 3 was supported, primarily, by information in items 8) and 11) and, to a lesser extent, by information in items 9) and 12). The author's track is displayed in Fig. 4.

The lowest pressure of 28.85 inches reported by the steamship "Bermuda" (item 8) as well as information contained in other items were found to fully support hurricane strength.

#### Storm 6, 1880 (Sept. 6-11).

The following information was found in relation to this storm:

- 1) Steamship "Hutchison", from Galveston. On Sept. 5, fierce squalls travelled over the Gulf of Mexico and the vessel was caught in some of them; at 8 P.M. sea became very rough and choppy. At 6 A.M. Sept. 6, the storm grew furious and continued all day and night until the following afternoon when it began to abate. The vessel was clear of the Gulf and was sailing up the Gulf Stream. On Sept. 8, the weather again became stormy (The New York Times, Sept. 12, 1880, p.5, col.2).
- 2) Pensacola, morning of Sept. 8, barometer 29.84 inches. Cedar Keys, afternoon of Sept. 8, wind S.W. 30 mph. The low pressure moved N.E. and was central off the South Carolina coast at midnight Sept. 8-9; barometer at Charleston 0.24 inches below normal (Monthly Weather Review, Sept. 1880).
- 3) Morning of Sept. 9, Cape Lookout, wind S. 44 mph; Cape Henry, wind E. 50 mph (Monthly Weather Review, Sept. 1880).
- 4) Steamer "Arrow". Sept. 9, lat. 34 40, long. 74 W.; 2 A.M. barometer 29.40 inches, wind S.; 3 A.M., barometer falling fast, wind "veering" to S.E. with violent squalls and confused seas; 4 A.M., barometer 29.15 inches, wind "veering" rapidly to E., N.E., N. and N.W.; 6 A.M., barometer rising; 8 A.M., barometer rising steadily, wind W.N.W., confused seas (Monthly Weather Review, Oct. 1880). Author's note: Provided that times are correct, the author believes that the true position of the ship during the height of the storm was off the North Carolina coast to the S.W. of Cape Lookout.
- 5) Some maximum winds: Cape Henry, N.E. 50 mph; Cape Lookout, S. 44 mph; Kittyhawk, N.E. 44 mph; Cape Hatteras S.E. 48 mph (Monthly Weather Review, Sept. 1880).
- 6) The storm was one of unusual severity, especially at Cape Henry where considerable damage was done and along the New England coast where numerous wrecks and disasters were reported (Monthly Weather Review, Sept. 1880).
- 7) Steamship "De Ruyter". Sept. 4-7, while on the Banks of Newfoundland, heavy fog prevailed. On Sept. 7 the weather was rainy and drizzle continued until last Thursday

afternoon (Sept.9). At 10 P.M., rain fell and the storm steadily increased in violence and at midnight (Sept. 9-10) the gale was terrific and huge waves which rolled up from the S.W. tossed the ship in the roughest manner; the gale and seas began to go down shortly after daybreak Friday, Sept. 10 (The New York Times, Sept. 12, 1880, p.8, col.2). 8) Bark "Agantyr" arrived from Cork and reported having experienced a violent gale when off George's Shoals. Wind came first from S.S.E. and then shifted to N.W. The gale lasted 12 hours and the sea was very high (The New York Times, Sept. 16, 1880, p.8, col.2). Author's note: As no day was given, it is not certain that this item corresponds to this storm; it could correspond to another storm which passed near the same area about 24 hours earlier. 9) Provincetown, Ma., Sept. 11. A heavy N.E gale prevailed here Thursday night (Sept. 9) and vessels report a very heavy sea outside (The New York Times, Sept. 12, 1880, p.2, col.5). 10) Gloucester, Ma., Sept. 9. The steamer "Hercules" and a large fleet of coasting vessels, mostly from the eastward, put into this harbor today to escape the storm (The New York Times, Sept. 10, 1880, p.2, col.2). 11) Some maximum winds: Delaware Breakwater, N.E. 46 mph; Atlantic City, N.E. 40 mph; Sandy Hook, N.E. 38 mph; Wood's Hole, N.W. 44 mph; Portland, N. 28 mph; Eastport, N.E. 30 mph (Monthly Weather Review, Sept. 1880). 12) The ship "Franconia" left Portland, Me., in the evening of Sept. 9. At 8 A.M. Sept. 10, between Thatcher's Island and Cape Cod, a tremendous sea broke over the vessel, which was obliged to put into Provincetown, Ma. (The New York Times, Sept. 12, 1880, p.5, col.2). 13) Brig "T.H.A. Pitts". Sept. 9, lat. 42 05 N., long. 64 30 W., 6 P.M. wind refreshing, thick rain; midnight (Sept. 9-10), N.E. gale, barometer 30.00 inches, wind increasing rapidly and hauling to S.; 3 A.M., perfect hurricane, barometer 29.50 inches; 5 A.M., barometer 29.40 inches, wind S.S.W. ; 10 A.M., wind moderating and hauling to W. (Monthly Weather Review, Oct. 1880). 14) Ship "Odin" (from Dunkirk). Sept. 10, lat. 42 N., long. 63 W., encountered a violent gale from S.S.W. veering around to N.W. and continuing for 4 hours (The New York Times, Sept. 20, 1880, p.8, col.2). 15) In the afternoon of Sept. 11, the storm was to the east of Cape Breton Island (Monthly Weather Review, Sept. 1880). 16) Map showing a track for this storm starting on the Georgia coast on Sept. 8 and extending to the English Channel (Europe) on Sept. 15 (Monthly Weather Review, Oct. 1880).

After a careful analysis of the information contained in items 1) through 16), the author of this study decided to discard a portion of the storm track shown in Neumann et al. (1993) and to introduce some slight modifications along the remaining of it. The author's track was started near 24.5 degrees N., 88.0 degrees W. at 7 A.M. Sept. 6 on the basis of information in item 1). Author's estimated positions for 7 A.M. Sept. 7 and 7 A.M. Sept. 8 were primarily based on information in items 1) and 2), respectively. These positions were near 26.0 degrees N., 86.7 degrees W. for Sept. 7 and near 28.3 degrees N., 85.0 degrees W. for Sept. 8. The 7 A.M. Sept. 9 estimated position was near 35.5 degrees N., 76.5 degrees W. and was based on information in items 3) through 5). For late Sept. 9 and for the period Sept. 10-11, the author's track was found to differ only slightly from the one in Neumann et al.

(1993), the difference consisting, primarily, in the timing along the track. The 7 A.M. Sept. 10 estimated position near 42.3 degrees N., 66.0 degrees W., which was based on information in item 9) and items 12) through 14), was about 250 miles to the E.N.E. of the corresponding position along the track in Neumann et al. (1993). Similarly, the author's estimated position for 7 A.M. Sept. 11, which was near 45.3 degrees N., 56.7 degrees W., was found to be roughly 175 miles to the E.N.E. of their corresponding position. The author's track is displayed in Fig. 4. Note in the figure that the storm seemed to have accelerated quite significantly over the period Sept. 6-9. However, the very rapid motion from 7 A.M. Sept. 8 to 7 A.M. Sept. 9 might reflect some reformation process of the storm off the Carolina coast because indications were that the center which had moved over the Gulf was over northern Florida, just N. of Cedar Keys, by late afternoon Oct. 8 (item 2).

Information contained in several items, particularly in items 4) and 6), was found to fully support hurricane intensity.

#### Storm 7, 1880 (Sept. 8-10).

This is a storm which is not included in Neumann et al. (1993) and that the author of this paper has recently uncovered since even a track for it had been presented in the Monthly Weather Review, Oct. 1880. The author of this paper confirmed the existence of this storm on the basis of the following information: 1) Sept. 8, barks "New Light" and "Eastern Star" had hurricane winds from S.W. near lat. 33 N., long. 73 W. (Monthly Weather Review, Oct. 1880). 2) Bark "Daniel Draper". Left New Orleans on Aug. 23. Sept. 8, 4:30 A.M., wind increased, barometer 29.95 inches; 7 A.M., barometer 29.50 inches, blowing a hurricane; position: lat. 35 45 N., long. 70 W.; 10 A.M., barometer 29.00 inches, gale at its height; afternoon, weather started to moderate; at 6 P.M., barometer 29.80 inches; Sept. 9, fresh N. breeze; Sept. 10-13, fine weather and barometer about 30.00 inches; Sept. 14, 4:30 A.M., made Bermuda Light (New York Times, Oct. 4, 1880, p.1, col.4). 3) The "City of Brussels", coming from England, reported that about midnight Sept. 8 she encountered a cyclone about 400 miles from Sandy Hook. Capt. Walkins consulted the barometer about 10 minutes before the appearance of the hurricane and found that the mercury had fallen "several inches" and was still falling rapidly. For several hours, the storm raged with great violence (The New York Times, Sept. 11, 1880, p.8, col.2). Author's note: "Several inches" should read several tenths of an inch; in addition, "midnight Sept. 8" refers to midnight Sept. 8-9. 4) Ship "Cleveland" (from London). Sept. 9, lat. 40 15 N., long. 64 50 W., was caught in a hurricane which continued for 6 hours with great fury. The wind came first from S.E. and then shifted to W. (The New York Times, Sept. 20, 1880, p.8, col.2). 5) Bark "Agantyr" arrived from Cork and reported having experienced a violent gale off George's Shoals. Wind came first from S.S.E. and then shifted to N.W. The gale lasted 12 hours and the sea was very high (The New York Times, Sept. 16, 1880, p.8, col.2). Author's note: As no day was given, it is not certain that this item corresponds to this storm; it could correspond to another storm which passed near the same area 24 hours later. 6) Steamship

"Britannic". Sept. 9, lat. 44 N., long. 58 W., 9 A.M., barometer 30.24 inches, wind S.S.E. force 4; noon, barometer 30.00 inches, strong breeze, heavy rains; 2 P.M., wind hauling to S.W. and increasing to a violent gale, barometer 29.85 inches; 4 P.M., similar weather; 6 P.M., barometer 29.95 inches, moderating (Monthly Weather Review, Oct. 1880). Author's note: The barometer readings above appear to be too high. 7) Low pressures were reported at St. John, Newfoundland, in the morning of Sept. 10 and strong weather from S.W. prevailed at lat. 48 degrees N., long. 45 degrees W. during the day of Sept. 10 (Monthly Weather Review, Oct. 1880). 8) Map showing a track for this storm starting near 35 degrees N., 70 degrees W. on Sept. 8 and displaying positions near 42 degrees N., 62 degrees W. and near 44 degrees N., 53 degrees W. for Sept. 9 and Sept. 10, respectively (Monthly Weather Review, Oct. 1880).

Based on information in items 1) and 2) the author of this study estimated a 7 A.M. Sept. 8 position near 35.0 degrees N., 71.0 degrees W. His estimated position for 7 A.M. Sept. 9 was near 41.5 degrees N., 63.5 degrees W. and was based on information in items 3), 4) and 6). The author's 7 A.M. Sept. 10 estimated position was near 48.5 degrees N., 52.0 degrees W. and was based on item 7). For Sept. 8 and Sept. 9, author's estimated positions do not differ much from the positions shown in item 8); however, the author's estimated position for Sept. 10 was found to differ by roughly 275 miles from the corresponding position in item 8). The author's track is shown in Fig. 4.

The barometer reading of 29.00 inches reported by the "Daniel Draper" (item 2) and the content of several other items fully support that the storm attained hurricane intensity.

#### Storm 8, 1880 (Sept. 27- Oct. 4).

This is the same storm which Neumann et al. (1993) identify as Storm 7, 1880.

The following information was found in connection with this storm: 1) Havana, Oct. 23. Schr. "Abe", from New York for Para, Brazil, was disabled in a cyclone on Sept. 27 and 28. The crew was picked up by the brig "Santona", from Antwerp to Havana (The New York Times, Oct. 24, 1880, p.5, col. 5). 2) The crew of the schooner "Jacob E. Ridgeway" was brought from Havana by the "Newport". That crew had been picked up by the "Santona" and brought to Cuba. The "Ridgeway" was sailing from New York, Sept. 8 to Para (Brazil) when eastward of the Bahamas the weather became very threatening and the wind increased in violence at a rapid rate until the schooner was caught in the middle of a cyclone. A tremendous sea was running and the vessel sprung a leak. During Sept. 28, the leak gained rapidly and the heavy sea swept over the dismasted hull. On Sep. 29 the storm had passed but the sea was still confused (The New York Times, Oct. 28, 1880, p.2, col.4). Author's note: The crew the "Santona" picked up seemed to belong to the "Jacob E. Ridgeway" and not to the "Abe" as stated in item 1). 3) New Orleans, Oct. 9. Steamship "William Dickinson", from Genoa, reported that on Oct. 1, in lat. 27 N., long. 63 20 W., encountered a hurricane from S.E., that the vessel was repeatedly thrown on her

beam ends and sustained damage and that for 2 hours the sea was blown flat, the spray resembling a dense fog (The New York Times, Oct. 10, 1880, p.5, col.6). 4) Bark "Carlotta" (from Colombo, Sri Lanka). Oct. 1, 300 miles S. of Bermuda. During the afternoon, the barometer went down fast and by late evening the vessel was thrown on her beam ends. Shortly after midnight (Oct. 1-2), the weather became calm for about 20 minutes. The calm was followed by the return of the hurricane which blew as before. At 8 A.M. (Oct. 2) the hurricane was at its height but it moderated during the morning (The New York Times, Oct 23, 1880, p.3, col.4). 5) Bark "Golden Fleece" (from Barbados for Sydney, Cape Breton). Moderate weather until the evening of Oct. 1, when it began to blow heavily. Noon position Oct. 2, lat. 28 30 N., long. 68 30 W. At 8 A.M. Oct. 2, barometer as low as it can fall in the captain's barometer. The hurricane had spent its force. Then followed calm for about half an hour; wind suddenly shifted to S.W. and blew as violently as before. (The New York Times, Oct. 26, 1880, p.8, col.2). Author's note: Longitude 68 30 W. seems to be somewhat west of the expected route for a Barbados-Sydney voyage. 6) Some marine reports for Oct. 1: lat. 25 N., long. 63 W., hurricane; lat. 26 N., long. 64 W., hurricane E. to S.W., lasting 12 hours; lat. 27 N., long. 63 W., hurricane from S.W.; lat. 27 N., long. 63 W., hurricane lasting 2 hours; lat. 27 N., long. 64 W., hurricane from E.N.E. to E.; lat. 28 N., long. 64 W., hurricane (Monthly Weather Review, Nov. 1880). 7) Boston, Oct. 17. Bark "T.K. Weldon". Oct. 2, lat. 32 N., long. 64 W., hurricane from S.E. to W.N.W. with heavy sea running, lasting 4 hours (The New York Times, Oct. 18, 1880, p.5, col.5). 8) Bark "Kalliope" (from Iquique, South America). On Oct. 2 a very heavy gale was experienced. The bark was obliged to scud before the wind for several hours (The New York Times, Oct. 23, 1880, p.3, col.4). 9) Some marine reports for Oct. 2: lat. 27 N., long. 64 W., hurricane E.N.E., E., calm, S.W., center at 1:40 A.M., barometer 27.40 inches; lat. 27 N., long. 66 W., hurricane N.N.E. to S.W., lasting several hours; lat. 28 N., long. 68 W.; hurricane S.W. to W., center at 8 A.M., barometer 27.40 inches; lat. 29 N., long. 63 W., hurricane; lat. 30 N., long. 64 W., hurricane S.S.E. to N.E., lasting 14 hours; lat. 32 N., long. 64 W., hurricane S.E. to W.N.W., lasting 4 hours; lat. 32 N., long. 64 W., hurricane N.E. to S.E., lasting 7 hours (Monthly Weather Review, Nov. 1880). 10) Bark "C.L. Tyler". Oct. 3, lat. 35 30 N., long. 55 45 W., had a hurricane; wind shifted from S.E. to N.W. and caused a terrific sea (The New York Times, Oct. 6, 1880, p.2, col.1). Some marine reports for Oct. 3: lat. 34 N., long. 57 W., hurricane; lat. 35 N., long. 50 W., S.E. to N.E. hurricane; lat. 35 N., long. 56 W., S.E. to N.W. hurricane, lasting 12 hours; lat. 35 N., long. 57 W., N.E. hurricane; lat. 35 N., long. 59 W., hurricane; lat. 36 N., long. 55 W., hurricane lasting 10 hours; lat. 36 N., long. 58 W., E. to N. hurricane, lasting 5 hours; lat. 37 N., long. 56 W., S.E. to W.N.W. hurricane, lasting 3 hours; lat. 37 N., long. 56 W., N.N.E. hurricane; lat. 37 N., long. 58 W., S.E. to N.W. hurricane; lat. 38 N., long. 54 W., hurricane S.E. to N.E. and N.N.W. (Monthly Weather Review, Nov. 1880). 12) Some marine reports for Oct. 4: lat. 37 N., long. 55 W., S.S.E. to N.E. hurricane, lasting 5 hours; lat. 38 N., long 54 W., E.S.E. to E.N.E. hurricane (Monthly Weather Review,

Nov. 1880). 13) Map showing a track for this storm. Positions along the track are: Sept. 27, 16 degrees N., 46 degrees W.; Sept. 28, 17 degrees W., 51 degrees W.; Sept. 29, 19 degrees N., 55 degrees W.; Sept. 30, 21 degrees N., 59 degrees W., ; Oct. 1, 24 degrees N., 63 degrees W.; Oct. 2, 28 degrees N., 64 degrees W.; Oct. 3, 33 degrees N., 59 degrees W. (Monthly Weather Review, Nov. 1880).

Although the track in item 13) was found to be, on the average, about 300 miles to the south of the track shown in Neumann et al. (1993) for the period Sept. 27- Oct. 1 (Storm 7, 1880 in their publication), the author of this study did not propose a change along the latter track because the information in items 1) and 2) was inadequate to provide any additional clue on this matter and, furthermore, the track in Neumann et al. (1993) was closer to the route the "Santona" should have followed on her trip from Antwerp to Havana during which the vessel picked up the crew of the schooner "Jacob E. Ridgeway". However, the author of this study did propose some modifications along the track displayed in Neumann et al. (1993) for the period Oct. 2-4. Primarily on the basis of information in item 9), he estimated a 7 A.M. Oct. 2 position near 28.3 degrees N, 63.7 degrees W.; he specifically used a marine report at lat. 27 N., long. 64 W. which stated that the vessel went through the center of the storm at 1:40 A.M. Oct. 2 (a second report of a ship passing through the center at 8 A.M. Oct. 2 was discarded because the longitude given was obviously too far west). The author believes that these two vessels were the "Carlotta" (item 4) and the "Golden Fleece" (item 5), respectively. The author's 7 A.M. Oct. 3 estimated position, which was near 33.5 degrees N., 60.0 degrees W., was based on the facts that all ship reports for that day were east of the 60 degrees W. meridian and that only some of the ships northward and eastward from a point at lat. 35 N., long. 58 W. reported winds exhibiting a northerly component or a wind shift to a northwesterly direction (items 10 and 11). The author's 7 A.M. Oct. 4 estimated position near 36.5 degrees N., 54.0 degrees W. was primarily based on information in item 12). It should be noted that the author's 7 A.M. estimated positions for Oct. 2 and Oct. 3 did not differ much from the respective positions in item 13). The author's track in Fig. 4 is a combination of the track he adopted from Neumann et al. (1993) for the period Sept. 27- Oct. 1 (Storm 7, 1880 in their publication) and the continuation of that track resulting from joining his 7 A.M. estimated positions for the period Oct. 2-4 by a smooth curve.

The central pressure of 27.40 inches reported by vessels on Oct. 2 (item 9) clearly shows that this storm was a very intense hurricane.

Storm 9, 1880 (Oct. 5-10).

This is the same storm which Neumann et al. (1993) identify as Storm 8. 1880.

The following information was found in relation to this storm: 1) Oct. 3-9, 1880. This hurricane went around the western portion of Cuba, keeping a good distance from the island. It caused moderate winds on the coasts and very intense and prolonged



torrential rains which produced some damage (Sarasola, 1928). Author's note: Actually taken from the catalog of Cuban hurricanes by M. Gutierrez-Lanza which is included in Sarasola (1928). 2) Remarks by Mr. Chas. Hasselbrink, of Havana. "On the 5th, the barometer commenced to fall, probably by the cyclone recurving at that time, and having on the 6th, entered the second branch of its parabolic course, and coming nearer us, on that day fell more under its influence"; "7th, sign of cyclone perhaps more accentuated" (Monthly Weather Review, Oct. 1880). 3) Marine reports from the Gulf of Mexico indicated that it passed from the northern portion of Yucatan across the Gulf as a severe storm (Monthly Weather Review, Oct. 1880). 4) The wind increased along the Florida coast during the night of Oct. 8 (it should read Oct. 7-8). By afternoon Oct. 8, the center was between Cedar Keys and Jacksonville and the gale had increased along the coast (Monthly Weather Review, Oct. 1880). 5) The following was received at the Signal Service Office at New York last night: The storm central in the Gulf this morning is now central near Jacksonville and will probably be felt along the Atlantic coast. Violent N.W. gales are reported between Cape Hatteras and Jacksonville (The New York Times, Oct. 9, 1880, p.2, col.3). Author's note: "N.W. gales" is probably in error; N.E. gales make much better sense. 6) The wind reached 52 mph at Savannah, 40 mph at Smithville, 37 mph at Charleston, 32 mph at Kittyhawk and 39 mph at Cape Henry (Monthly Weather Review, Oct. 1880). 7) Bark "Lisboa", from Santa Anna, Tabasco (Mexico), was caught in a hurricane when off Charleston; wind blew S.S.E. to N.N.E. with terrific force for 6 hours (The New York Times, Oct. 19, 1880, p.8, col.1 and 2). 8) Some marine reports for Oct. 8: lat. 30 N., long. 80 W., S.E. gale; lat. 29 N., long. 79 W., S.S.E. hurricane; lat. 33 N., long. 75 W., E.N.E. hurricane; lat. 32 N., long. 74 W., E. gale (Monthly Weather Review, Nov. 1880) 9) Bark "Florence I. Genovar" (coming to New York from Matanzas). Oct. 8, lat. 33 30 N., long. 74 W., N.E. hurricane lasted 24 hours; the bark hove to in the meantime (The New York Times, Oct. 22, 1880, p.10, col.1 and 2). 10) Bark "Elvina" (coming to New York from Mexico). Oct. 8, off Charleston, had a hurricane; wind came from S.E. and shifted to N.E.; it blew with violence for 6 hours (The New York Times, Oct. 22, 1880, p.10, col.1 and 2). 11) Some marine reports for Oct. 9: lat. 33 N., long. 76 W. S.E. to N. hurricane, cyclone lasted 9 hours; lat. 36 N., long. 74 W., E. gale (Monthly Weather Review, Nov. 1880). 12) Bark "Belle Wooster" (coming to New York from Santa Anna, Mexico). N.E. winds and high seas since passing the Florida Straits; a cyclone of 5 hour duration was met at lat. 33 N., long. 76 10 W. on Oct. 9 (The New York Times, Oct. 20, 1880, p.2, col.5). 13) Marine report for Oct. 10: lat. 34 N., long. 67 W., E. hurricane (Monthly Weather Review, Nov. 1880). 14) Bermuda Gazette, Oct. 12. "Oct 10, Sunday a cyclone evidently passed S.W. of us"... "and on Monday, another cyclone passed E. of Bermuda" (Monthly Weather Review, Nov. 1880). 15) Barometer at Gibb's Hill Lighthouse, Bermuda, morning of Oct. 11, 29.70 inches; wind N.E. and very unsettled weather. The 29.70 inches reading was the lowest pressure at that place (Monthly Weather Review, Nov. 1880). 16) Some marine reports for Oct. 11: lat. 29 N., long. 69 W., N.E. gale lasting 24 hours; lat. 33 N., long. 66 W., furious

N.E. gale; lat. 26 N., long. 66 W., S.W. to N. gale; lat. 33 N., long. 63 W., hurricane from 10 A.M. to 12th; lat. 32 N, long. 52 W. (?), E.S.E. gale, calm, N. hurricane (Monthly Weather Review, Nov. 1880). Author's note: Long. 52 W. is obviously wrong. 17) Map for this storm showing an afternoon Oct. 8 position near 30 degrees N., 82 degrees W., a night Oct. 8 position near 31 degrees N., 78 degrees W. and a morning Oct. 9 position near 32 degrees N., 73 degrees W. (Monthly Weather Review, Oct. 1880). 18) A second map showing storm positions as follows: Oct. 8, 27 degrees N., 83 degrees W; Oct. 9, 31 degrees N., 76 degrees W.; Oct. 10, 30 degrees N., 69 degrees W.; Oct. 11, 29 degrees N., 65 degrees W. (Monthly Weather Review, Nov. 1880).

Based on the information contained in the items above, the author of this study proposed some modifications along the track shown in Neumann et al. (1993) as for Storm 8, 1880. The author's track was started on Oct. 5 on the basis of information in items 1) and 2). The author's 7 A.M. Oct. 5 estimated position was near 19.0 degrees N, 86.0 degrees W. No positions were estimated prior to Oct. 5 in spite that item 1) suggests that the storm existed as early as Oct. 3. The author's 7 A.M. Oct. 6 estimated position was near 22.3 degrees N., 87.3 degrees W. and took into account that the storm moved around the western part of Cuba keeping a good distance from it (item 1) and that marine reports allowed to trace the storm from the northern Yucatan peninsula across the Gulf of Mexico (item 3). The author of this study accepted the 7 A.M. positions in Neumann et al. (1993) for Oct. 7 and for Oct. 8. These positions were near 24.7 degrees N., 86.0 degrees W. and near 27.5 degrees N., 84.5 degrees W., respectively, and were supported by the content of items 3) through 5). The author's 7 A.M. Oct. 9 estimated position was near 32.0 degrees N., 76.0 degrees W. and was based on the content of several items, items 11) and 12) in particular. Finally, the author of this study used information in item 13) to estimate a 7 A.M. Oct. 10 position near 32.5 degrees N., 68.5 degrees W. The author decided to terminate his track for this storm on Oct. 10 because he found it difficult to support the existence of a closed circulation center in the vicinity of Bermuda on Oct. 11 on the basis of information in items 15) and 16). The only center of circulation which could be definitively documented on Oct. 11 was located near 26.0 degrees N., 66.0 degrees W. or roughly 400 miles to the S. of Bermuda and corresponded to a different tropical cyclone. However, the meteorological conditions reported at Gibb's Hill Lighthouse, Bermuda (item 15) and by some ships in the vicinity of that island on Oct. 11 (item 16) could still be related to the remnants of the storm. The author's track is displayed in Fig. 4.

Indications are that the storm might have attained hurricane status both over the Gulf of Mexico and off the U.S. east coast.

Storm 10, 1880 (Oct. 10-16).

The author of this study has recently documented this storm which is not included in Neumann et al. (1993). However, strictly speaking, the existence of this storm is not entirely new since there was a track for it and supporting material was published in

the Monthly Weather Review, Nov. 1880).

The author of this study found the following information in support for this storm: 1) Bark "America" (from Antigua). Oct. 10, lat. 23 58 N., long. 65 40 W., ran into a revolving hurricane. On Oct. 13, another gale was experienced (The New York Times, Oct. 27, 1880, p.8, col.4). 2) Ship "Sea Witch" arrived from Manila yesterday and on Oct. 11, at lat. 26 N., long. 66 W., was caught in a cyclone. The wind worked around from S.W. to N., then back again to S.W. and finally returned to N. The storm continued for 4 days. and was pronounced by Capt. Drew one of the most trying he had ever experienced (The New York Times, Oct. 25, 1880, p.2, col.7). 3) Ship "Crisbrooke Castle", from Calcutta, brought the crew of bark "Witch" abandoned on Oct. 17. The captain of the "Witch" gave a position at lat. 30 06 N., long. 66 50 W. on Oct. 10. On Oct. 11, a gale from S.S.W. set in, continuing to the following morning and then shifting to E.N.E., increasing in violence to a hurricane. The vessel was thrown on her beam ends and her mainmast and foremast were carried away. One of the pumps was broken and the bark was abandoned on Oct. 17 with 3 feet of water in her hold (The New York Times, Oct. 26, 1880, p.2, col.3). 4) Some marine reports for Oct. 11: lat. 29 N., long. 69 W., N.E. gale lasting 24 hours; lat. 33 N. long. 66 W., N.E. furious gale; lat. 26 N., long. 66 W., S.W. to N. gale; lat. 33 N., long. 63 W., hurricane from 10 A.M. to 12th; lat. 32 N., long. 52 W., E.S.E gale, calm, N. hurricane (Monthly Weather Review, Nov. 1880). Author's note: Long. 52 W. is obviously wrong. 5) Bark "America" Oct. 12, lat. 27 N., long. 66 W., revolving gale from W. at 9 A.M.; wind S.E., barometer 29.10 inches. Oct. 13, 3 P.M., lat. 29 N., long. 67 W., wind shifted to N.N.E., blowing heavily and barometer 29.05 inches, and at 6 P.M., 29.20 inches (Monthly Weather Review, Nov. 1880). 6) Some observations for Oct. 12: Grand Turk, barometer 29.70 inches; St. Thomas, barometer 29.82 inches, heavy rain from 2 to 3 P.M.; Bermuda (Gibb's Hill Lighthouse), barometer 29.77 inches (Monthly Weather Review, Nov. 1880). 7) Bark "Pepita". Oct. 12, lat. 26 N., long. 66 W., W. gale set in, barometer falling slowly to 29.10 inches. Oct. 13, noon, lat. 28 N., long. 67 W., wind hauled to S. with increasing gale; 4 P.M., barometer 28.65 inches; 5 P.M., N.E. steady gale; 6 P.M., hurricane, vessel hove under bare poles; 8 P.M., wind shifted back to E.; 9 P.M., barometer rising; 10 P.M., heavy seas sweeping decks; midnight Oct. 13-14, gale moderated (Monthly Weather Review, Nov. 1880). 8) Ship "Pheneas Pendleton" (from Manila) reported a terrific hurricane at lat. 28 30 N., long. 60 W. on Oct. 13. A fearful sea was running and swept over the decks (The New York Times, Oct. 27, 1880, p.8, col.4). Author's note: Long. 60 W. is too far east; the true longitude should have been about 66 W. 9) Steamer "Nasmyth". Oct. 12, lat. 25 N., long. 59 W., barometer 30.20 inches. Oct. 13, noon, lat. 27 N., long. 62 W., rain squalls, "the clouds having great way on them from the S.S.W., with low, rugged clouds near the horizon", barometer falling from 30.00 inches at noon to 29.00 inches at midnight. Oct. 14, 3:30 A.M., wind shifted to S.E. in a very heavy squall lasting 20 minutes, then backed to S.S.W. again; 5:30 A.M., lowest barometer 28.90 inches; 5:30 A.M., quite a lull for 20 minutes, the wind then came out of N.W. with great strength and high cross sea which continued

throughout the day, with rising barometer (Monthly Weather Review, Nov. 1880). Author's note: A report published in The New York Times, Oct. 20, 1880, p.2, col.5, indicated that the gale encountered by the "Nasmyth", coming to New York from Rio de Janeiro, began on Oct. 13 and continued for 30 hours; wind from S.E. and then blowing around the compass. The sea was very high and confused and frequently washed over the decks. 10) Bermuda Gazette, Oct. 19. The steady barometer and lull of Oct. 13 was the precursor of another storm for the night (Oct. 13-14) "the wind increased and the barometer fell". Noon, Oct. 14, Gibb's Hill Lighthouse, barometer had fallen to 29.79 inches with N. gales and squalls. Oct. 15, weather at Bermuda moderated (Monthly Weather Review, Nov. 1880). 11) Bark "Annie J. Marshall". Oct. 15, lat. 45 N., long. 50 W., a hurricane set in and continued for 16 hours; wind changed from S.S.E. to N.W., causing a terrific sea (The New York Times, Nov. 2, 1880, p.3, col.7). Author's note: The storm is likely to have started late on Oct. 15 and lasted for most of Oct. 16. 12) Bark "Minnie Carmichael". Oct. 16, when on the Newfoundland Banks, had a hurricane for 8 hours; the wind came first from S.E. and blew with fearful violence (The New York Times, Nov. 2, 1880, p.3, col.7). 13) Halifax, Oct. 16. A dispatch from North Sydney, Cape Breton, indicated that a report was just received that the schooner "Annie Linwood" capsized off Cape Smoky in a terrible squall last evening and all hands were drowned. High winds prevailed at North Sydney from last evening until noon today (The New York Times, Oct. 17, 1880, p.1, col.6). 14) Steamship "Compton" (from Gibraltar). Oct. 17, at night, from 8 to 12, it blew a hurricane almost around the compass and caused a heavy sea. The "Compton" reached Sydney, Cape Breton on Oct. 19 (The New York Times, Oct. 27, 1880, p.8, col.4). Author's note: The day seems to be in error; it was probably Oct. 16. 15) Map showing a track for the storm starting near 26 degrees N., 68 degrees W. on Oct. 12 and ending near 26 degrees N., 64 degrees W. on Oct. 14 (Monthly Weather Review, Nov. 1880). Author's note: This was found to be a wrong track.

After a careful analysis of the above items, the author of this study produced the track for this storm which is shown in Fig. 4. 7 A.M. positions along the track were estimated to be as follows: Oct. 10, near 24.5 degrees N., 65.5 degrees W., on the basis of item 1); Oct. 11, near 26.0 degrees N., 66.0 degrees W., mostly on the basis of item 2); Oct. 12, near 27.0 degrees N., 66.5 degrees W., primarily on the basis of item 5); Oct. 13, near 28.0 degrees N., 67.0 degrees W., chiefly based on items 5) and 7); Oct. 14, near 30.7 degrees N., 64.7 degrees W., on the basis of items 9) and 10); Oct. 15, near 36.3 degrees N., 60.5 degrees W.; Oct. 16, near 44.3 degrees N., 54.0 degrees W., on the basis of items 11) through 13).

The lowest barometer of 28.65 inches reported by the "Pepita" (item 7) allowed one to state that this storm was at least a moderate hurricane.

Storm 11, 1880 (Oct. 21-24).

This storm corresponds to Storm 9, 1880 in Neumann et al. (1993).

The following information was found in connection with this storm: 1) The storm was probably central near 30 degrees N. and 4 degrees E. of Washington (73 degrees W.) at midnight Oct. 21-22: Cape Hatteras, wind E. 43 mph; Cape Lookout, wind E. 40 mph. During the night (early morning of Oct. 22, the pressure decreased on the coast and wind increased to N.E. 41 mph at Cape Henry and N. 42 mph at Cape Lookout. The barometer fell rapidly on the Middle Atlantic coast being 29.69 inches at Delaware Breakwater at 3 P.M. Aug. 22. The wind shifted to N.W. at Cape Hatteras indicating that the storm was not far to the east of the coast (Monthly Weather Review, Oct. 1880). 2) Brig "Annie Ingram" met a violent S.E. gale off Montauk on Oct. 22. A portion of the deck-load was washed overboard by the heavy seas (The New York Times, Oct. 28, 1880, p.2, col.4). 3) Sunset, Aug. 22: Sandy Hook, gale from E.N.E., raining hard and foggy; City Island, gale from E., heavy rain (The New York Times, Oct. 23, 1880, p.10, col.7). 4) Temperatures at Hudnut's pharmacy in New York, Oct. 22: average, 56 degrees Fahrenheit; maximum, 60 degrees Fahrenheit at 9 A.M.; minimum, 53 degrees Fahrenheit at midnight Oct. 22-23 (The New York Times, Oct. 23, 1880, p.5, col.4). 5) The storm reached the coast near Portland, Me., in the morning of Oct.23, minimum barometer 29.26 inches. Maximum wind velocity at Eastport, Me., was E. 53 mph. After leaving Maine, the storm turned northward and was near Father Point, in the Lower St. Lawrence Valley at midnight Oct. 23-24 (Monthly Weather Review, Oct. 1880). 6) Steamship "Compton". The sailing Sydney (Cape Breton)- New York was stormy as in the morning of Oct. 23 when off George's Bank, a hurricane was encountered (The New York Times, Oct. 27, 1880, p.8, col.4). 7) The steamer "Illyrian" brought the crew of ship "Isaac Webb", which was abandoned at sea at lat. 42 30 N., long. 58 40 W. at midnight Oct. 24-25. During a S.E. gale, the ship went on her beam ends and at 2 P.M. Oct. 24 the foremast broke off. The crew saw the "Illyrian" at 1:30 A.M. Monday Oct. 25 (The New York Times, Oct. 28, 1880, p.2, col.6). 8) The strong westerlies which prevailed yesterday must have driven a number of sailing boats off the coast (The New York Times, Oct. 24, 1880, p.5, col.6). 9) Toronto, Oct. 24. Dispatches received here tonight from various places in Ontario reported very heavy weather with snow last night and this morning. Snowfall from 5 to 25 inches was measured (The New York Times, Oct. 25, 1880, p.5, col.3). 10) Map starting a track for the storm near 31 degrees N., 73 degrees W. at 11 P.M. Oct. 21 and ending it near 51 degrees N., 65 degrees W. at 7 A.M. Oct. 24 (Monthly Weather Review, Oct. 1880).

The author of this study found that the storm track shown in Neumann et al. (1993) was quite reasonable in the light of the information contained in the items above. However, he strongly suspected that their 7 A.M. Oct. 21 position was in error on the basis of information in items 1) and 10) but, as he could not find any additional information to clarify that point, he decided to accept the track in Neumann et al. (1993) without introducing any modification. Such a track is reproduced in Fig. 4.

There is no evidence that this storm had attained hurricane intensity in spite of a barometer reading as low as 29.26 inches reported at Portland, Me. (item 5). However, there is evidence that

the storm had lost practically all tropical characteristics by the time it approached New England: the low temperatures at New York shown in item 4) were an indication of a very cool environment. In addition, the heavy snowfall over northeastern Canada (item 9) fully supported extratropical characteristics late on Oct. 23 and on Oct. 24.