Twelve storms were identified as having occurred in 1878. Tracks for these storms are presented in Fig. 2.

Storm 1, 1878 (Jul. 1-3).

The following information was found in relation to this storm: 1) Jul. 1. Frequent rains, easterly winds and diminishing pressure indicated the advance of the storm. Jul. 2. Barometer, minimum in Punta Rassa, 29.77 inches, in the afternoon. Frequent gales continued in Florida and extended to South Carolina. Jul.3. Easterly gales and rainy weather along the South Atlantic States from Hatteras southward. Maximum wind velocities associated with the storm: Key West, W. 36 mph; Tybee Island, E. 37 mph; Charleston E. 36 mph; Smithville, E. 38 mph; Cape Lookout, S.E. 36 mph (Monthly Weather Review, Jul. 1878). 2) Washington, Jul. 3, 1 A.M. The barometer is lowest east of Florida (The New York Times, Jul. 3, 1878, p.5, col.4). 3) Washington, Jul. 4, 1 A.M. A slight depression moved south of the South Atlantic coast where N.E. winds prevailed (The New York Times, Jul. 4, 1877, p.5, col.6).

It was found that, in general, the content of items 1) through 3) supported the track for this storm which is shown in Neumann et al. (1993). Therefore, the author of this study adopted such a track without any modification and reproduced it in Fig. 2.

Storm 2, 1878 (Aug. 8-18).

The following information was found in connection with this storm: 1) Aug. 8, Point-a-Pitre (Guadeloupe), 2 A.M., barometer 29.77 inches, high winds, squalls and rain. Aug. 10, Point-a Pitre, threatening weather during the last few days, much rain and thunder (Monthly Weather Review, Aug. 1878). 2) Aug. 13, heavy squalls at Santiago de Cuba. Aug 14, thunderstorm with S.E. wind at Havana. Aug. 15, Punta Rassa, S.E. wind 26 mph; two schooners left and were compelled to put back and reported a very severe storm in the Gulf of Mexico (Monthly Weather Review, Aug. 1978). 3) Washington, Aug. 14, 1 A.M. Indications of a hurricane are reported in the Caribbean Sea (The New York Times, Aug. 14, 1877, p.5, col.6). 4) Aug. 17, N.E. wind and rain along the west Gulf coast. Indianola, wind E. 39 mph. Gale continued to Aug. 18. Waters in the bay driving in, overflooding some streets (Monthly Weather Review, Aug. 1878). 5) Map showing the storm near 24.5 degrees N., 86.5 degrees W. in the morning of Aug. 15, near 23.5 degrees N., 92.5 degrees W. in the morning of Aug. 16 and near 23 degrees N., 96.5 degrees W. in the morning of Aug. 17 (Monthly Weather Review, Aug. 1878). 6) Bark "Padang" was wrecked on Key Arenas, a coral reef near Sisal (Mexico). Encountered a violent vein of wind, rain and fog, after 2 days of uncomfortable weather. About 1:30 A.M. Aug. 18, as she was driving ahead through pitch darkness and torrents of rain, she struck the reef. The wind and waves were raging wildly as she grounded (The New York Times, Sept. 10, 1878, p.8, col.2). 7) The German packet "Padang" left Tonila (it should read Tonala), Mexico on Aug. 14 and experienced heavy weather until Aug. 17 when

encountered a fierce hurricane from S.S.W., lasting all night with terrific sea; the ship was wrecked at Arenas Key (22 degrees N., 91.5 degrees W.) on Aug. 18 in the morning (Monthly Weather Review, Sept. 1878). 8) Bark "Unica" left Santecomapa (it should read Santecomapan), on the Veracruz coast, and encountered storm Aug. 16-19; sprung a leak. Was abandoned on Aug. 20 between New Bank (Banco Nuevo) and Triangles (Triangulos), off Yucatan (Monthly Weather Review, Sept. 1878).

In the light of the items above, some modifications along the track shown in Neumann et al. (1993 were proposed by the author of this study. The author decided to star his track after estimating a 7 A.M. Aug.8 position near 14.7 degrees N., 61.5 degrees W. on the basis of data from Point-a-Pitre (Guadeloupe) contained in item 1). He then estimated 7 A.M. positions for the following days: Aug. 9, 14.5 degrees N., 63.3 degrees W.; Aug. 10, 14.3 degrees N., 66.5 degrees W.; Aug. 11, 14.0 degrees N., 71.3 degrees W. For the period Aug. 12-14, the author of this study retained the positions given in Neumann et al. (1993). These positions are as follows: Aug. 12, 15.0 degrees N., 77.5 degrees W.; Aug. 13, 18.0 degrees N., 81.5 degrees W.; Aug. 14, 21.0 degrees N., 85.0 degrees W. As the storm is not mentioned to have affected Cuba in any of the catalogs of Cuban hurricanes (Sarasola, 1928; Martinez-Fortun, 1942), the author of this study believes that the storm did not turn temporarily to the N.N.W. during Aug. 14 as suggested by the track in Neumann et al. (1993). He believes that the storm continued on a northwesterly course through the Yucatan Channel, having affected only the western tip of the island (where just a few people lived) as the center passed some 50 miles to the southwest of Cape San Antonio. Consequently, he adjusted the 7 A.M. Aug. 15 position in Neumann et al. (1993) to 23.0 degrees N., 87.5 degrees W., while still giving room for the two schooners mentioned in item 2) to have reported a very severe storm in the Gulf of Mexico. The author's estimated 7 A.M. Aug. 16 position near 23.0 degrees N., 90.3 degrees W. is basically an interpolation between corresponding positions for Aug. 15 and Aug. 17; it should be mentioned that such a position is about 100 miles closer to the Yucatan peninsula than the 7 A.M. position displayed in Neumann et al. (1993). The author's estimated 7 A.M. Aug. 17 position near 23.0 degrees N., 94.0 degrees W. was based on the information provided by the "Pandag" (items 6 and 7) and to a lesser extent by the "Unica" (item 8); the author believes that such a position is quite reliable. The author's estimated 7 A.M. Aug. 18 position near 22.7 degrees N., 97.5 degrees W. was taken from Neumann et al. (1993). The author's track, after having made the above mentioned modifications along the one shown in Neumann et al. (1993), is displayed in Fig. 2.

There are strong indications that the storm reached hurricane intensity in the Gulf of Mexico (items 2 and 7). It is not clear, however, that the storm had attained hurricane status while moving over most of the Caribbean Sea.

Storm 3, 1878 (Aug. 19-20).

This is a new storm documented by the author of this study.

Strictly speaking, however, the storm is not a new one because it has been covered before in the Monthly Weather Review, Aug. 1878 without indicating any tropical characteristics associated with it.

The following information was used to study the storm: 1) Aug. 19, lat. 35 N. long. 61 W., hurricane (Monthly Weather Review, Sept. 1878). 2) Baltimore, Aug. 26. The steamer "Yorkshire" brought here the crew of bark "Arvid", abandoned at lat. 37 13 N., long. 56 35 W., having lost fore and maintopmast in a squall on Aug. 19 (The New York Times, Aug. 27, 1878, .5, col.3). Author's note: The Monthly Weather Review, Aug. 1878 also indicated that the "Arvid" was struck by the squall on Aug. 19 and added that the vessel was abandoned the next day; an Aug. 19 vessel position at lat. 37 51 N., long. 59 52 W. mentioned in the Monthly Weather Review might have corresponded to the "Arvid". 3) Aug. 19, lat. 41 10 N., long. 66 13 W., strong N.W. wind, heavy rain (Monthly Weather Review, Aug. 1878). 4) Aug. 19, lat. 41 45 N., long. 61 22 W., W. by N. moderate gale (Monthly Weather Review, Aug. 1878). 5) Aug. 19, lat. 42 N, long. 60 W., violent gale from N.W. (Monthly Weather Review, Aug. 1878). 6) Aug 19, near Sable Island, hurricane from S.E. to S.W. lasting 5 hours (Monthly Weather Review, Aug. 1878). 7) Aug. 19, lat. 42 40 N., long. 59 W., hurricane from E.S.E. lasting 5 hours, then setting to a N.W. gale (Monthly Weather Review, Aug. 1878). 8) Aug. 19, lat 40 32 N., long. 57 30 W., A.M., rainy weather wind S.E. increasing; noon, hurricane lasting 3 hours, wind veered to S.W.; 1 P.M., storm at its height, barometer 29.08 inches, tremendous sea; 4 P.M., wind W., blowing a gale until Aug.20 at noon (Monthly Weather Review, Aug. 1878). 9) Aug. 19, lat. 42 45 N. long. 57 W., hurricane from S.S.E. to S.W. lasting 3 hours (Monthly Weather Review, Aug. 1878). 10) Aug. 19, lat. 42 35 N., long. 56 30 W., heavy gale from S.S.E., blowing a hurricane for 1 hour (Monthly Weather Review, Aug. 1878). 11) Aug. 19, lat. 40 N., long. 58 40 W., hurricane from S.E. to N.W. (Monthly Weather Review, Sept. 1878). 12) Aug. 19, lat. 43 20 N., long. 59 40 W., S.W. hurricane (Monthly Weather Review, Sept. 1878). 13) Aug. 19, lat. 45 N., long. 58 W., heavy gale (Monthly Weather Review, Sept. 1878). 14) Bark "Calcutta", Aug. 19, lat. 42 40 N., long. 55 W., heavy squall from S., lasting 4 hours (Monthly Weather Review, Sept. 1878). 15) At 7:35 A.M. Aug. 19: Eastport (Maine), barometer 29.57 inches; Halifax, barometer 29.53 inches (Monthly Weather Review, Aug. 1878). 16) At 4:35 P.M. Aug 19: Halifax, barometer 29.27 inches; Sydney (Cape Breton), barometer 29.18 inches (Monthly Weather Review, Aug. 1878). 17) At 11 P.M. Aug 19: Halifax, barometer 29.20 inches; Sydney, barometer 28.44 inches (Monthly Weather Review, Aug. 1878). 18) 3.29 inches of rain fell at Sydney, wind backing from E. to N.E. to S.W. (Monthly Weather Review, Aug. 1878). 19) At Magdalen Islands, the gale commenced in the morning of Aug. 19 and lasted until Aug. 23; the wind started from S.E. and changed to N.E. with great fury; a number of vessels were damaged or destroyed and crops suffered severely at Etang du Nord (Monthly Weather Review, Aug. 1878). 20) Map showing a track for the storm having been near 47 degrees N., 72 degrees W. (over the St. Lawrence Valley) in the morning of Aug. 18, near 44.5 degrees N., 65 degrees W. (west of Halifax) in the morning of Aug. 19 and near 47.5 degrees N., 58.5 degrees W. (off Newfoundland) in the morning

of Aug. 1878 (Monthly Weather Review, Aug. 1878). 21) Another map showing a track for the storm; some morning positions on the second map were as follows: Aug. 19, 44 degrees N., 65 degrees W.; Aug. 20, 47 degrees N., 59 degrees W.; Aug. 21, 52 degrees N., 56 degrees W. (Government Printing Office, 1881). Author's note: Regarding this item and other items mentioned later in this study, the Government Printing Office is the publisher of the Annual Report of the Chief Signal Officer to the Secretary of War. Maps originally published in the various issues of the Monthly Weather Review were reproduced together in the above mentioned Annual Report).

It was not an easy decision for the author to include this storm among his storms of tropical nature for the year 1878. The decision was made on the basis that, according to the author's track, the storm seems to have come along a south-north course and to have passed over the Gulf Stream (which experience tells is a good source for tropical storm brewing) but, above all, on the basis of the very low pressure of 28.44 inches which was reported as the storm passed near Sydney, Cape Breton (item 17). Such a low pressure value is practically impossible to be found in the North Atlantic by mid August unless it is found to be associated with a hurricane or with a storm of tropical origin in the process of becoming extratropical. Based on information contained in several items, and particularly on the narrative in item 8), the author estimated a 7 A.M. Aug. 19 position near 39.3 degrees N., 60.3 degrees W., which is about 300 miles to the S.E. of the position indicated on the maps referred to in items 20) and 21). While still there might have been a center to the west of Halifax at 7 A.M. Aug. 19 in association with the low pressure area which was near 47 degrees N., 72 degrees W. 24 hours earlier, the author believes that, by and large, the dominant center at that time was the one moving northward roughly along the 60 W. meridian. By late afternoon this latter center had caused a very significant pressure drop in Nova Scotia and Cape Breton (item 16) and it passed near Sydney (Cape Breton) during the night of Aug. 19 as the pressure drop there to 28.44 inches (item 17). In agreement with the wind direction change to the S.W. reported to have occurred at Sydney (item 18), the author of this study extrapolated the track to an estimated 7 A.M. Aug. 20 position near 48.0 degrees N., 59.5 degrees W. The author's track is displayed in Fig. 2. Such a track was terminated on Aug 20 because no independent information was found in order to verify the Aug. 21 morning position mentioned in item 21).

As the storm is referred to as a hurricane in many of the items above and the lowest reported pressure (28.44 inches) fully supports hurricane winds, the author of this study believes that this storm attained hurricane intensity.

No vestige of the storm was found south of the 35 degrees N. parallel and the exact location where it formed remains unknown.

Although the relatively short duration of hurricane winds reported by vessels (items 6 to 10) was due, in part, to the fact that the storm was moving at a rate of 20-25 mph, it also appears to suggest that the hurricane winds were not located at great distances from the center of the storm as typically observed in

extratropical systems. Such a suggestion tends to confirm that the storm had at least some tropical characteristics although it might have not been a typical tropical cyclone either.

Storm 4, 1878 (Aug. 25-30).

This storm is not included in Neumann et al. (1993). Strictly speaking, the storm does not represent a new case discovered by the author of this study because even a track for this storm was found in Government Printing Office (1881). Nonetheless, it will be treated as a new case because its existence and tropical nature have not been widely recognized before.

The following information was found in support for this storm: 1) Aug. 25, lat. 26 N., long. 76 W., severe S.E. to N.W. gale, barometer 29.40 inches (Monthly Weather Review, Sept. 1878). 2) Schr. "Pedrito" (from Gibara, Cuba, to New York). Aug. 26, heavy hurricane from S. to N.W. lasting 12 hours (Monthly Weather Review, Sept. 1878). Author's note: The "Pedrito" reported a position at lat. 28 35 N., long. 71 53 W. on Aug. 28. 3) Schr. "J.B. Atkinson" (from Turks Is. to Philadelphia). Aug. 26, reported a hurricane lasting 8 hours (Monthly Weather Review, Sept. 1878). 4) Aug. 26, lat. 28 40 N., long. 70 30 W., hurricane from S. to S.E. veering to N.E. and N.W. (Monthly Weather Review, Sept. 1878). 5) Aug. 26, lat. 28 N., long. 72 W., severe hurricane from S.W. to N.W. (Monthly Weather Review, Sept. 1878). 6) Aug. 27, lat. 30 09 N., long. 70 30 W., hurricane (Monthly Weather Review, Sept. 1878). 7) Aug. 27, lat. 30 30 N., long. 69 W., hurricane increasing to "cyclone" and continuing to 4 A.M. Aug. 28 (Monthly Weather Review, Sept. 1878). 8) Vineyard Haven, Sept. 12. Brig "Alice", Aug.27, lat. 31 06 N., long. 68 05 W., encountered a hurricane S.W. to N.W.; lay on her beam ends for 4 hours; lost lower topsail, etc. (The New York Times, Sept. 14, 1878, p.5, col.2). 9) Brig "Brittania" (from Barbados to New York). Aug. 27, lat. 30 30 N., long. 69 W., squally, wind S.; 4 P.M., barometer 30.00 inches, squally throughout the night. Aug. 28, 5 A.M., barometer 29.30 inches, wind S.E.; 9 A.M., barometer 29 20 inches, hurricane; noon, barometer 28.70 inches, perfect cyclone; 2 P.M., moderated for a time; about 3 P.M., wind veered to N.E. with increasing violence and fearful sea; 4 P.M., wind N.W., sea more regular, barometer rising rapidly (Monthly Weather Review, Sept. 1878). Author's note: Long. 69 W. appears to be in error, the brig was probably farther east on Aug. 27. 10) Schr. "G.B. Douglas" (from New York to Antigua). Aug. 27, 10 P.M., barometer commencing to fall, wind S.W. backing to N.E. with heavy sea. Aug. 28, 5:30 A.M., lat. 31 50 N., long. 66 35 W., while under bare poles was hove down (Monthly Weather Review, Sept. 28). 11) Bark "Marie B.", 75 miles S.W. of Bermuda, encountered a hurricane on Aug. 27 and 28 (Monthly Weather Review, Sept. 1878). 12) Bark "Hornet", 100 miles W. of Bermuda, had decks swept in gale commencing from S.E. and working around E. to N.W. at 2 A.M. Aug. 28 (Monthly Weather Review, Sept. 1878). 13) Aug. 28, lat. 33 N, long. 65 W., hurricane from S.E. veering around to N.W. (Monthly Weather Review, Sept. 1878). 14) Aug. 28, lat. 33 40 N., long. 64 W., hurricane (Monthly Weather Review, Sept. 1878). 15) Brig "Echo", spoken at lat. 32 N., long. 61 W. on Aug.

31, reported a hurricane on Aug. 28 (Monthly Weather Review, Sept. 1878). 16) The steamer "Canima" arrived from Bermuda and reported that a terrible hurricane swept that island in the morning of Aug. 28. The gale set about midnight Aug. 27 and the hurricane was blowing before morning.It was dark and the inhabitants did not know which way to turn to save their lives. There was serious damage to government and private property but no lives lost. Many vessels were disabled (The New York Times, Sept. 9, 1878, p.8, col.2). 17) Prospect, Bermuda, 9 A.M. Aug. 28, barometer 29.57 inches, wind S.W. force 6, rainfall past 24 hours: 2.43 inches (Monthly Weather Review, Sept. 1878). Author's note: Force 6 on the Beaufort scale corresponds to 19-24 mph (Monthly Weather Review, Sept. 1878). 18) Schr. "Iris", when N.E. of Bermuda on Aug. 28, encountered a hurricane commencing from S.E. and working E. to N.W. (Monthly Weather Review, Sept. 1878). 19) Ship "Norton Stover". Aug. 28, 80 miles N.E. of Bermuda, hurricane (Monthly Weather Review, Sept. 1878). 20) Aug. 29, lat. 32 57 N., long. 60 37 W., severe hurricane (Monthly Weather Review, Sept. 1878). 21) Bark "Joe Rauers", Aug. 29, 150 miles N.E. of Bermuda, 4:45 A.M., barometer 28.80 inches, violent and high sea (Monthly Weather Review, Sept. 1878). 22) Aug. 29, lat. 38 N., long. 55 50 W.; A.M., storm from S.S.E. hauling to S.E. and increasing; P.M., wind W.N.W., heavy rain (Monthly Weather Review, Sept. 1878). 23) Aug. 29, lat. 36 N., long. 55 23 W. Terrific gale S.E. to E. to N.E.; vessel on beam ends for 5 hours (Monthly Weather Review, Sept. 1878). 24) Bark "Ocean Pearl" (from Leghorn to Philadelphia, Sept. 11). Aug. 30, encountered a severe hurricane from W.S.W. veering to S. and E., lasting 14 hours; the vessel had to scud before the gale ; at 4 P.M. was struck by a heavy sea (Monthly Weather Review, Sept. 1878). 25) Map showing a track for this storm. The track was started near 23 degrees N., 84 degrees W. on Aug. 24 and extended to near lat. 45 N., long. 39 W. on Aug. 31. Other daily positions along the track were as follows: Aug. 25, 28 degrees N., 76 degrees W.; Aug. 26, 30 degrees N., 73 degrees W.; Aug. 27, 31 degrees N., 71 degrees W.; Aug. 28, 34 degrees N., 67 degrees W.; Aug. 29, 35 degrees N., 58 degrees W.; Aug. 30, 37 degrees N., 46 degrees W. (Government Printing Office, 1881).

After having examined very carefully the information contained in the above items, the author of this study decided to start his track for this storm near 26.0 degrees N., 76.3 degrees W. at 7 A.M. Aug. 25 on the basis of information contained in item 1). He discarded the position near 23 degrees N., 84 degrees W. for Aug. 24 mentioned in item 25) because had a storm existed there on the indicated day, it should have been reported as having affected western Cuba and this was not the case in the catalogs of Cuban hurricanes (Sarasola, 1928; Martinez-Fortun, 1942). Other estimated 7 A.M. positions along the author's track are as follows: Aug. 26, 29.0 degrees N., 73.3 degrees W.; Aug. 27, 31.5 degrees N., 69.3 degrees W.; Aug. 28, 33.5 degrees N., 65.3 degrees W; Aug. 29, 35.7 degrees N., 58.7 degrees W.; Aug. 30, 37.3 degrees N., 46.5 degrees W. The author's track was terminated on Aug. 30 on the basis of the information given for that day in item 25) and after verifying that such a position was also along the course the "Ocean Pearl" (which encountered the hurricane on Aug. 30) should have followed while

coming from Leghorn to Philadelphia (item 24). The Aug. 31 position given in item 25) was not used because the author could not get any independent support for the large northward jump in the track which would have been introduced had the Aug. 31 position been accepted.

Barometer readings of 28.70 inches reported by the "Brittania" (item 9) and of 28.80 inches reported by the "Joe Rauers" (item 21) clearly indicate that the storm attained full hurricane status.

Storm 5, 1878 (Sept.1-13).

This is the same storm Neumann et al. (1993) identify as Storm 3, 1878.

Abundant information was found about this storm: 1) At Trinidad, the hurricane was the severest in 40 years, barometer 29.05 inches being the lowest recorded on the island. The hurricane began about 7 P.M. Sept. 1 and continued to 4 P.M. Sept. 2; it then abated for 1 hour, after which the wind returned with great velocity for 15 minutes. During the passage, the wind "veered" from N.W. to S.W. The hurricane was central near Trinidad at midnight Sept. 1-2; 7 inches of rain fell (Monthly Weather Review, Sept. 1878). Author's note: The abatement mentioned to have occurred at 4 P.M. Sept. 2 could not have been related to the center of the storm which is said to have been near Trinidad at midnight Sept. 1-2. The source of the conflicting statement appears to be a narrative by Capt. Francis F. Robbins, a passenger on the steamer "Bahama" (at Trinidad during the hurricane), which is published in The New York Times, Sept. 22, 1878, p.12, col.2. 2) Brig "Typhoon", from Port-of-Spain to Boston, was dismasted on Sept. 2.; no position was given (Monthly Weather Review, Sept. 1878). 3) The steamer "Lotharingia", from La Guayra (Venezuela) to St. Thomas, encountered the hurricane at midnight Sept. 2-3 near lat. 15 N., long. 68 30 W. (Monthly Weather Review, Sept. 1878). Author's note: Long. 68 30 W. appears to be too far west for a La Guayra- St. Thomas sailing. 4) The hurricane was very violent at Santo Domingo and Haiti. At Jacmel, a high sea did great damage to shipping and wharves; at Port-au-Prince, buildings were entirely destroyed; at Aux-Cayes, 434 houses were destroyed (Monthly Weather Review, Sept. 1878). 5) The captain and 3 of the crew of the schooner "Ocean Lilly" were brought to New York from Guantanamo by the bark "Evening Star". The "Ocean Lilly" left Kingston for Turks Is. on Aug. 28. A gale sprung on Sept. 2. On the morning of Sept. 4 it increased to a hurricane and lasted until 8 P.M. when it came calm for 20 minutes and then blew more fiercely than before. The vessel was 12 miles E.S.E. of Caleta Point on the southern coast of Cuba. When the hurricane sprung up again it came from the S.S.W. It continued to blow with hurricane force all night long and at 6 A.M. Sept. 5 land was discovered 6 miles leeward and being W. by S. At 2:30 P.M. she struck a sandy beach (The New York Times, Oct. 23, 1878, p.8, col.4). Author's note: Caleta Point is located about 15 miles to the S.W. of Maisi Point, the easternmost tip of Cuba. 6) Sept. 4, 40 miles S. of Guantanamo, a vessel reported a hurricane. Entering Cuba about midnight Sept.4-5, Father Vines stated that the vortex made landfall near Guantanamo, moving later toward Puerto Principe (city of Camaguey) which was a short distance to the right

of the track; then it moved between Jucaro and Villa Clara (city of Santa Clara), where the calm associated with the vortex was felt; then exited the island of Cuba a short distance to the east of Cardenas (Monthly Weather Review, Sept. 1878). Author's note: Father Benito Vines was the director of the Belen College Observatory at Havana. 7) Signal Service observations from Santiago de Cuba. Sept. 4, 4:35 P.M., rain intermittently falling; hurricane commenced about midnight (Sept. 4-5) from N.W.; 2 A.M. Sept. 5, W.N.W. wind; 3 A.M., S.W. wind; 4 A.M., S. wind. Barometer: 3 A.M., 29.49 inches; 3:20 A.M., 29.49 inches; 3:40 A.M., 29.52 inches; 5 A.M., 29.51 inches. At 7:35 A.M. Sept. 5, barometer 29.70 inches, S.E. wind, light squall (Monthly Weather Review, Sept. 1878). 8) Havana, Sept. 6. There was a hurricane at Santiago de Cuba yesterday, which passed in the northern direction. It entered from the sea with remarkable velocity but moderated as it went out. It is feared much damaged has been done in the oriental and central departments, especially at Colon and Cardenas. The weather was squally at Havana (The New York Times, Sept. 7, 1878, p.1, col.3). 9) Havana, Sept. 7. The weather in Havana is windy and rainy (The New York Times, Sept. 15, 1878, p.6, col.7). 10) Havana, Sept.9. The weather is tempestuous and very rainy. Some 60 plantations are reported to be under water by the inundation of the districts of Cardenas and Colon (The New York Times, Sept. 15, 1878, p.6, col.7). 11) Key West observations. Sept. 6, evening, gales began. Sept. 7, lowest barometer 29.54 inches at 3 P.M., highest wind velocity 59 mph at 6:35 P.M. Sept. 8, barometer steady from 29.61 to 29.64 inches, highest wind 47 mph from W. Sept. 9, highest wind S.W. 48 mph at 10:45 A.M. and at 4:32 P.M., barometer at the end of the day remaining steady at 29.51 or 29.52 inches. Sept. 10, barometer 29.43 inches at 3 A.M. , 29.48 inches at 7 A.M. and 29.44 inches at 4.P.M., rising after that time; highest wind W. 48 mph at 7:05 A.M. and S.W. at 3 P.M. Gale ended in the morning of Sept. 11. Total rainfall was 4.93 inches (Monthly Weather Review, Sept. 1878). 12) Jacksonville observations. Sept. 8, brisk N.E. wind, barometer falling. Sept. 10, barometer continued falling; at midnight (Sept. 10-11), gale at its height, wind N.E. 40 to 48 mph. The gale ceased on Sept. 11, lowest barometer 29.23 inches at 4 P.M., 5 hours after the gale had ended. Total rainfall: 9.78 inches (Monthly Weather Review, Sept. 1878). 13) Washington, Sept. 9, 1 A.M. The barometer is low in the Northwest and E. of Florida (The New York Times, Sept. 9, 1878, p.1, col.4). 14) Washington , Sept. 11, 1878, 1 A.M. A storm of considerable energy is central E. of Florida (The New York Times, Sept. 11, 1878, p.2, col.3). 15) Washington, Sept. 12, 1 A.M. A storm of great energy is central near Jacksonville, Florida (The New York Times, Sept. 12, 1878, p.2, col.3). 16) Havana, Sept. 13. The steamer "Carondelet" arrived yesterday afternoon. She experienced very heavy weather and took off the crew of the American brig "Sally Brown" (from Pensacola for Santos, Brazil) which was abandoned at sea (The New York Times, Sept. 16, 1878, p.1, col.3). 17) Havana, Sept. 13. The steamer "Santiago de Cuba" arrived last night. She experienced a tremendous hurricane off the Florida coast; lay to for 4 days off Cape Canaveral and was obliged to throw her deck-load overboard (The New York Times, Sept. 16, 1878, p.1, col.3). 18) Bark "Rebecca

Caruana". Sept. 9, lat. 25 N., in the Straits of Florida, took a hurricane from S.W. to S. to E. lasting 3 days up to lat. 32 30 N. (Monthly Weather Review, Sept. 1878). 19) Bark "Rebecca Caruana" arrived from Matanzas on Sept. 20. Encountered a hurricane while passing through the Straits of Florida on Sept. 9. The hurricane lasted for 3 days and the vessel was frequently blown to 2 or 3 miles from shore. She almost buried herself in the water, keeping her deck constantly filled and frequently deluging the cabin. On Sept. 11, the last day of the hurricane, the starboard pumps gave out (The New York Times, Sept. 22, 1878, p.2, col.2). 20) Boston, Sept. 26. The bark "New England" arrived from Pensacola and reported that on Sept.8 encountered a heavy gale in the Straits of Florida which increased to a hurricane. On Sept. 11, she experienced a hurricane from the S. which continued for 2 days (The New York Times, Sept. 27, 1878, p.5, col.5). 21) Boston, Sept. 26. Schr. "Bennington" (from New Orleans to Rouen) put in here and reported had encountered in the Gulf (Stream) a severe hurricane from S.W. to E.S.E. which lasted from Sept.8 to Sept. 13 (The New York Times, Sept. 27, 1878, p.5, col.5). 22) Bark "L.T. Stocker" was blown to sea from Key West on Sept. 7 and put into Savannah on Sept. 14 (Monthly Weather Review, Sept. 1878). 23) Brig "Sabre", from Tampico to Le Havre, went ashore 60 miles S. of Cape Canaveral in a hurricane (Monthly Weather Review, Sept. 1878). 24) Sept. 8, off Ridding Rocks, Bahama Banks, hurricane (Monthly Weather Review, Sept. 1878). 25) Tybee, Is. Ga., highest wind E. 52 mph on Sept. 11, lowest barometer 29.33 inches at 7:45 A.M. Sept. 12, total rainfall was 5.61 inches (Monthly Weather Review, Sept. 1878). 26) Savannah, Ga., highest wind E. 42 mph on Sept. 11, lowest barometer 29.35 inches on Sept 12, total rainfall was 4.64 inches (Monthly Weather Review, Sept. 1878). 27) Highest winds: Charleston, E. 44 mph on Sept. 11 and S.E. on Sept. 12; Wilmington, N.C., S.E. 30 mph; Smithville, S.E. 48 mph on Sept. 12; Sloop Point, 65 mph (estimated); Cape Lookout, S.E. 75 mph; Cape Hatteras, N.E. 50 mph (Monthly Weather Review, Sept. 1878). 28) Sept. 11, 120 miles S. of Cape Hatteras, hurricane (Monthly Weather Review, Sept. 1878). 29) Havana,Sept. 13. The steamer "City of New York" arrived on Friday afternoon (Sept. 13) and reported having experienced the hurricane between Cape Hatteras and Charleston, lasting 40 hours (The New York Times, Sept. 16, 1878, p.1, col.3). 30) The steamer "City of Houston" arrived from Galveston yesterday. Had heavy weather until passing Hatteras. She was several times near the edge of a hurricane which appeared to be traveling ahead of her (The New York Times, Sept. 16, p.8, col.3 and 4). 31) Washington, Sept. 13, 1 A.M. A storm central last night near Jacksonville has moved in a northerly track and the lowest pressure is now in West Virginia. A severe gale prevails on the Carolina coast. A very severe gale is anticipated for the Middle Atlantic coast, probably extending to the New England coast (The New York Times, Sept. 13, 1878, p.5, col.5). 32) Cleveland, Sept. 13. One of the most terrific storms of wind and rain ever experienced in this vicinity prevailed here all last night (The New York Times, Sept. 14, 1878, p.1, col.5 and 6). 33) Wheeling, West Virginia, Sept. 13. The rain was continuous all day yesterday and last night fell in torrents. The river rose 12 ft in the latter part of the night (The New York Times, Sept. 14,

1878, p.1, col.5 and 6). 34) Richmond, Va., Sept. 13. A heavy gale prevailed here last night but did no serious damage to the city (The New York Times, Sept. 14, 1878, p.1, col.5 and 6). 35) Pittsburg, Penn., Sept. 13. The severe equinoctial storm reached its full fury last night when rain fell in torrents and was accompanied by a tremendous gale of wind (The New York Times, Sept. 14, 1878, p.1, col.5 and 6). 36) On Sept. 13 at 7:35 A.M. the center of the storm was near Buffalo (Monthly Weather Review, Sept. 1878). 37) Highest winds: Cape May, S.E. 46 mph on Sept. 13; Barnegat, S.E. 44 mph on Sept. 13; New York and Sandy Hook, S.E. 40 mph on Sept. 13 (Monthly Weather Review, Sept. 1878). 38) Newburg, N.Y., Sept. 13. A severe storm of wind and rain passed over the Hudson Valley this afternoon and evening (The New York Times, Sept. 14, 1878, p.1, col.5 and 6). 39) Heavy gale at Coney Island. The wind was high during the night (Sept. 12-13) and towards 8 A.M. (Sept. 13) it blew a perfect gale. The wind was from the S.E. and partially meeting the incoming tide, the high of the surf was increased running as high as 15 ft (The New York Times, Sept. 14, 1878, p.1, col.5 and 6). 40) Inquire at the Signal Service station at New York revealed the fact that the storm was the most severe one in the last six months. The barometer began to fall at 9 P.M. Thursday and it continued to fall until 5 P.M. yesterday (Sept. 13) when it stood at 29.68 inches. The wind reached its maximum velocity of 40 mph at 10 A.M. yesterday and by 7:30 P.M. it had decreased to 20 mph (The New York Times, Sept. 14, 1878, p.2, col.4). 41) Washington, Sept. 14, 1 A.M. The storm has moved rapidly in a northerly track and is now beyond the limits of our map (The New York Times, Sept. 14, 1878, p.2, col.4). 42) Map showing a track for the storm to have passed near Santiago de Cuba in the night of Sept. 4, along the Florida peninsula from the night of Sept. 7 to the morning of Sept. 11 and ended over Canada in the afternoon of Sept. 13 (Monthly Weather Review, Sept. 1878).

Based upon a careful analysis of the information contained in the above items, the author of this study proposed some modifications along the storm track which is displayed in Neumann et al. (1993) as for Storm 3, 1878. Based on information in item 1), the track was slightly adjusted to the south on Sept. 1 and early Sept. 2, bringing the center closer to Trinidad because the barometer reading of 29.05 inches (presumably at Port-of-Spain) with the wind shift from N.W. to S.W. requires the center to have passed quite close to the north of that place near midnight Sept. 1-2. This adjustment also required a slight modification of the timing along the track for Sept. 2 to Sept. 3, while still satisfying item 3). The 7 A.M. Sept. 4 position near Port-au-Prince, Haiti, given in Neumann et al. (1993) was kept unchanged, but a slight southward adjustment was made along the track over the period Sept. 5-7 in order to satisfy the information in items 6) and 7), which requires the center to have passed just south of the city of Camaguey, right over the city of Santa Clara and to have emerged from the northern Cuban coast into the Florida Straits just east of Cardenas. A major modification along the track was introduced over the period Sept. 8-10. This modification was based on information contained in item 11). The modification proposed to keep the storm stationary near 26.0 degrees N., 81.0 degrees W.

over the above mentioned period after having taken into account that the pressure fell at Key West over that period instead of having risen as it would have happened had the storm continued a slow northward movement over the period. In fact, the barometer reading of 29.43 inches at Key West at 3 A.M. Sept. 10 was roughly 2 tenths of an inch lower than the practically stationary pressure between 29.61 and 29.64 inches reported to have occurred on Sept. 8. Although the author decided to keep the storm stationary at 26.0 degrees N, 81.0 degrees W. from 7 A.M. Sept. 8 to 7 A.M. Sept. 10, he acknowledges that erratic motions or even a trajectory in the form of a small loop most likely occurred over such a period. No changes were introduced along the track shown in Neumann et al. (1993) for the period Sept. 11-13 (Storm 3, 1878 in their publication).

The track which was prepared by the author of this study is shown in Fig. 2. Estimated 7 A.M. positions along this track are as follows: Sept. 1, 9.0 degrees N., 57.0 degrees W.; Sept. 2, 12.3 degrees N., 63.3 degrees W.; Sept. 3, 16.0 degrees N., 69.3 degrees W.; Sept. 4, 19.0 degrees N., 73.0 degrees W.; Sept.5, 20.5 degrees N., 76.7 degrees W.; Sept.6, 21.7 degrees N, 78.7 degrees W.; Sept. 7, 23.0 degrees N., 80.7 degrees W.; Sept. 8-10, 26.0 degrees N., 81.0 degrees W.; Sept. 11, 29.7 degrees N., 80.7 degrees W.; Sept. 12, 32.5 degrees N., 80.5 degrees W.; Sept. 13, 41.5 degrees N., 79.0 degrees W.

This storm attained hurricane intensity and indications are that its strength reached a peak in the Caribbean islands of Trinidad (item 1) and Hispaniola (item 4).

Storm 6, 1878 (Sept. 12-18).

This is the same storm Neumann et al. (1993) displayed as Storm 4, 1878.

The following information was found about this storm: 1) Sept. 12, lat. 14 43 N., 58 55 W., heavy hurricane from N.W. "veering" to S.W. (Monthly Weather Review, Sept. 1878). Author's note: The longitude appears to be erroneous; it would look reasonable if it were long. 48 55 W. in lieu of long. 58 55 W. 2) Sept. 13, lat. 19 20 N., long. 54 40 W., heavy gale (Monthly Weather Review, Sept. 1878). 3) Brig "Mary Knowlton" (from Pernambuco, Brazil, Aug. 24 to New York, Oct. 7). Sept.13, heavy S.E. gale lasting until Sept. 16 when took hurricane from N.N.W. with heavy sea, lasting until Sept. 18 (Monthly Weather Review, Sept. 1878). 4) Sept. 15, lat. 19 43 N., long. 63 09 W., fresh gale N.E. to N.W., barometer 29.87 inches (Monthly Weather Review, Sept. 1878). 5) Brig "Adelaide". Sept. 15, lat. 18 57 N., long. 58 56 W., lost sails, etc. in a hurricane (Monthly Weather Review, Sept. 1878). 6) Sept. 15, lat. 19 N., long. 56 20 W., S.E. gale (Monthly Weather Review, Sept. 1878). 7) Sept. 16, lat. 18 23 N., long. 64 36 W., N. and N.W. strong breeze, barometer 30.00 inches (Monthly Weather Review, Sept. 1878). 8) Sept. 16, lat. 21 19 N., long. 58 30 W., severe hurricane lasting through Sept. 17 (Monthly Weather Review, Sept. 1878). 9) Brig "Bogota". Sept. 16, lat. 18 to 21 17 N. to 23 28 N., long. 57 14 W. to 59 05 W.; hurricane on Sept. 17 (Monthly Weather Review, Sept. 1878). 10) Brig "Bergliot" encountered a hurricane on Sept. 17 and

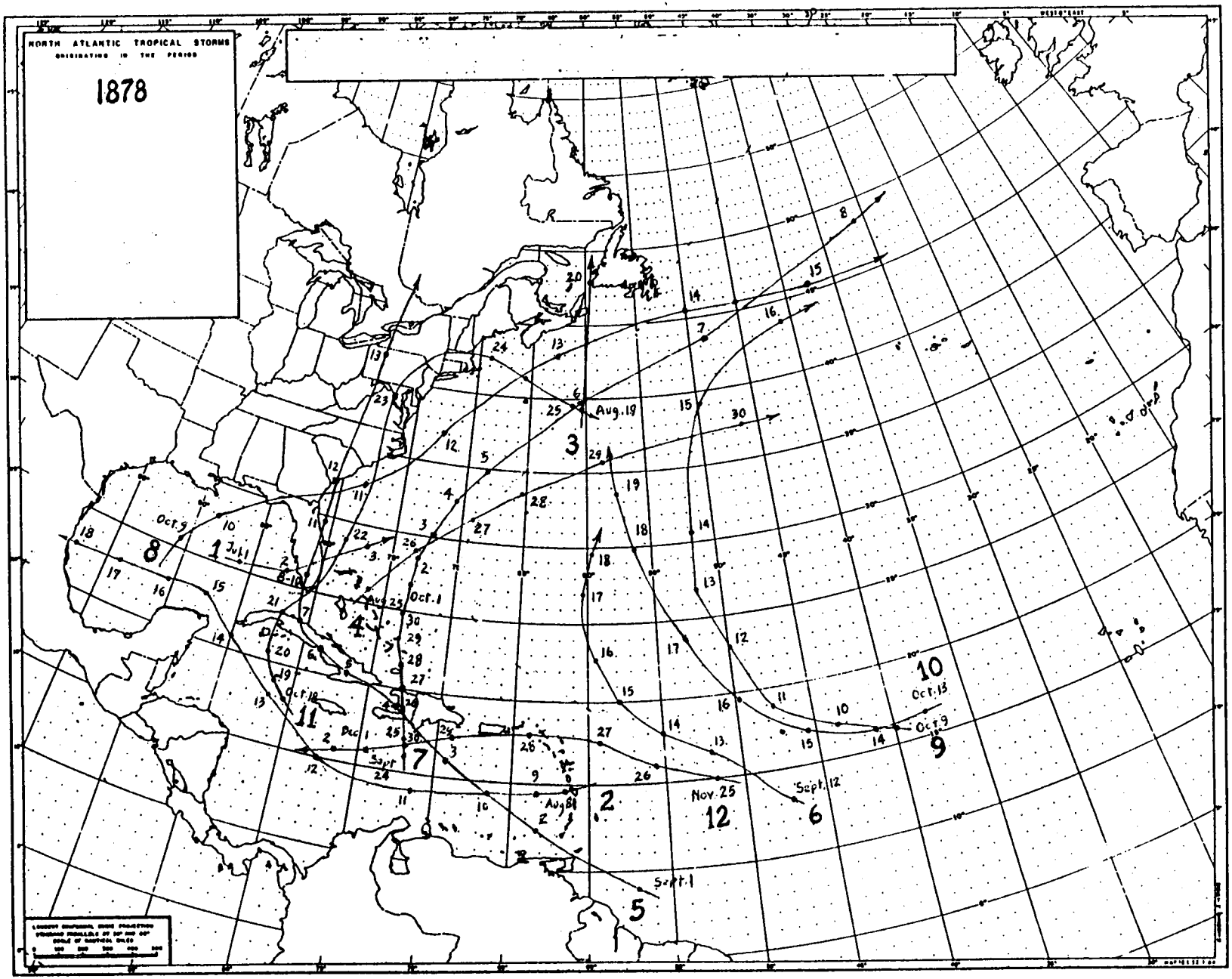
NORTH ATLANTIC TROPICAL STORMS
1878
Aug. 19
Oct. 9
July 1
Aug. 25
Oct. 1
Oct. 10
Dec. 1
Sept. 24
Aug. 31
Sept. 1
Nov. 25
Sept. 12
Oct. 13
Oct. 9

Fig. 2

was abandoned in lat. 26 N., long. 58 27 W. on Sept. 20 (Monthly Weather Review, Sept. 1878). 11) Sept. 17, lat. 26 18 N., long. 58 40 W., hurricane from S.W. (Monthly Weather Review, Sept. 1878).

In general, the above information was found to support the track shown in Neumann et al. (1993) as for Storm 4, 1878. Therefore, the author of this study adopted such a track and reproduced it in Fig. 2.

It should be mentioned that the author of this study made an attempt to extend the track in Fig 2 beyond Sept. 18 by using information that the bark "Emma" was wrecked off the east bar of Sable Island during a strong breeze on Sept. 22 and that gales were reported by vessels off Sable Island on Sept. 22, and near lat. 42 N., long. 57 W. and near lat. 47 N., long 52 W. on Sept. 23 (Monthly Weather Review, Sept. 1878) However, he discarded the idea of extending the track because he found that there was too much uncertainty in such an operation.

Indications are that this storm reached hurricane intensity.

Storm 7, 1878 (Sept. 24- Oct. 8).

This is the same storm Neumann et al. (1993) identify as Storm 5, 1878.

The following information was found in relation to this storm: 1) Bark "Princess Alexandra" was lost at Jacmel, Haiti, in a hurricane on Sept. 25 (The New York Times, Oct. 12, 1878, p.4, col.6). 2) Brig "William Phipps", which arrived in New York from Aux Cayes yesterday, was struck by a hurricane and thrown on her beam ends. Her masts were cut away to light her and was obliged to put into Montego for repairs. She obtained ropes and fresh supplies at Key West (The New York Times, Oct. 20, 1878, p.12, col.1). Author's note: There is a possibility that this event might have been associated with the Sept. 4 hurricane in Haiti and not with the hurricane of late September. 3) Another hurricane visited the S. coast of Haiti during which an American brigantine was wrecked at Tiburon and all hands loss (Monthly Weather Review, Oct. 1878). 4) There were gales on the Florida Straits on Oct. 2-5 and N.E. gales along the North Carolina coast on Oct. 3-4. This was probably the same storm which crossed Haiti on Sept. 25-26. Some wind velocities: Cape Lookout, 48 mph; Cape Hatteras, 40 mph; Kittyhawk, 44 mph (Monthly Weather Review, Oct. 1878). Author's note: These gales were probably related to a strong pressure gradient due to the combination of the storm and high pressure over eastern U.S. 5) The steamship "Regulator" brought the captain and crew of the schooner "Ben Borland" (Charleston, Sept. 21 for Baltimore). The schooner took squally weather on Sept. 28 and 29, the gale increased in fury and the vessel developed a leak (The New York Times, Oct. 12, 1878, p.4, col.6). 6) Bark "S.R. Lyman" brought the captain and crew of the schooner "Freddie C. Elbert" (from St. John, N.B. Sept. 22 for St. Thomas). On Sept. 29, the schooner took a hurricane at lat. 32 N., long. 67 W. and sprung a leak. A tremendous sea was on and the waves flooded the decks constantly. In the morning of Oct 1, it was still blowing a hurricane and the sailors became completely exhausted. The storm moderated somewhat on Oct. 3, but it blew again a hurricane on Oct.4. In the afternoon

that day, they were sighted by the "S.R. Lyman" near lat. 31 03 N., long. 71 W. (The New York Times, Oct. 18, 1878, p.3, col.3). 7) The schooner "Hattie Card", from Cape Haytien, hove to for 7 days in a gale which began on Oct. 1 (The New York Times, Oct. 18, 1878, p.3, col.3). 8) The schooner "Henry Trial" was sailing from Baltimore to St. Thomas and was struck by a hurricane at 2 P.M. Oct 4. The vessel was tripped by the sea and thrown on her beam ends. The schooner lay even with the water and the crew ran to the cabin and lashed themselves there. When the weather moderated on Oct. 7, the pumps were useless (The New York Times, Oct. 18, 1878, p.3, col.3). 9) Bark "Alma" left Baltimore for Queenstown on Sept. 27. On Oct. 4, she took a hurricane which lasted 16 hours (The New York Times, Oct. 18, 1878, p.3, col.3). 10) Brig "Genoa", which arrived from Trieste, encountered squalls on Oct.5 and a hurricane next day (The New York Times, Oct. 18, 1878, p.3, col.3). 11) Ship "Doris" has returned (to New York) after having left for Bremen on Sept. 27. On Oct. 6 at 6 P.M. had a hurricane during which she was thrown on her beam ends, the sea breaking over all directions (The New York Times, Oct. 20, 1878, p.5, col.7). 12) Ship "Hanna", from Dunkirk, lost foretopmast, foretop gallant mast and jibboom and a number of sails were split in a hurricane on Oct. 6 (The New York Times, Oct. 22, 1878, p.6, col.3). 13) Ship "Quebec", which arrived from Liverpool yesterday, met a cyclone on Oct. 7 at lat. 48 02 N., long. 35 W. The wind came from the S.E., then veering around to W. and N., the barometer went down as low as 28.20 inches (The New York Times, Oct. 29, 1878, p.8, col.3). 14) Oct. 7, lat. 38 02 N., long. 35 W., terrible cyclone from S.E. by W. to N. , barometer 28.02 inches. Oct. 8, 4 A.M., sea terribly confused; 6 A.M., terrific hurricane; 10 A.M., moderating (Monthly Weather Review, Oct. 1878). Author's note: Lat. 38 02 N. is very likely in error; lat. 48 02 N. looks more reasonable and if this were the case the vessel should have been the ship "Quebec" in item 13) and either one of the two reported pressures (28.20 inches in item 13 and 28.02 inches in item 14) should be in error. 15) Oct. 7, lat. 49 57 N., long. 33 41 W., noon, barometer 29.80 inches, S.E. wind force 3; 10 P.M., barometer 28.65 inches, E. wind force 10, fierce gale, terrible squalls; midnight Oct. 7-8, barometer 28.72 inches, E.N.E. wind force 11; 4 A.M. (Oct. 8), barometer 29.25 inches, wind N.E. force 10 (Monthly Weather Review, Oct. 1878). Author's note: Force 3 on the Beaufort scale is equivalent to 8-12 mph, force 10 is equivalent to 55 to 63 mph and force 11 is equivalent to 64 to 73 mph. 16) Oct. 7, lat. 44 N., long. 46 W., cyclone from S.E. to N.W. lasting 9 hours, barometer at noon 27.70 inches (Monthly Weather Review, Oct. 1878). 17) Oct. 7, lat. 44 20 N., long. 48 W., very heavy gale, barometer 28.20 inches (Monthly Weather Review, Oct. 1878). 18) Oct. 7, lat. 41 30 N., long. 56 W., hurricane from E.S.E. to S.S.E., lasting 16 hours (Monthly Weather Review, Oct. 1878). Author's note: The day appears to be in error; it should have been Oct. 6.

Information in items 1) through 12) was found to support, in general, the track shown in Neumann et al. (1993) as for Storm 5, 1878. Therefore, the author of this study adopted such a track. However, based on information contained in items 13) through 17), he was able to document that the storm existed on Oct.7 and 8 and,

therefore, to extend its track over these two days. The author estimated a 7 A.M. position near 43.5 degrees N., 48.5 degrees W. based on items 16) and 17) and a 7 A.M. Oct. 8 position near 48.5 degrees N., 31 degrees W. based on item 15) in particular. The track which was prepared by the author of this paper is shown in Fig. 2.

Based on the content of the items above, this storm undoubtedly attained hurricane intensity. A barometer reading as low as 27.70 inches (item 16) indicates that it was an intense hurricane even at high latitudes.

Storm 8, 1878 (Oct.9-15).

This is the same storm which Neumann et al. (1993) identify as Storm 6, 1878.

The following information was found in connection with this storm: 1) The storm probably developed in the Gulf and passed eastward over N. Florida on Oct. 10. At midnight Oct. 11-12, the storm was central off Cape Hatteras (Monthly Weather Review, Oct. 1878). 2) Brig "Florence May". Oct. 11, E.N.E. breeze increasing to a gale; at midnight wind hauled to N.W. by N. and blew a hurricane (Monthly Weather Review, Oct. 1878). 3) Schr. "Sea Nymph" encountered a hurricane on Oct. 11 and was abandoned on Oct. 13 (Monthly Weather Review, Oct. 1878). 4) Schr. "Victor " arrived from Port Maria (Jamaica) yesterday. Lost her mainmast in a hurricane 80 miles S.E. of Hatteras on Oct. 11. A gale set in and lasted 12 hours and, after a calm of only 20 minutes, it suddenly increased to a hurricane which lasted 12 hours during which the vessel went to her beam ends several times (The New York Times, Oct. 22, 1878, p.8, col.3). Author's note: A similar account is given in the Monthly Weather Review, Oct. 1878. 5) Some highest winds: Cape Lookout, N.E. 72 mph; Cape Hatteras, N.E. 52 mph; Cape Henry, N.E. 46 mph (Monthly Weather Review, Oct. 1878). 6) Schr. "Yellow Pine" (coming from Cedar Keys to New York) met a hurricane from E.N.E. at lat. 34 50 N, long. 71 40 W. The wind suddenly changed to N.W. and the deck-load was washed overboard. She was compelled to scud for 12 hours (The New York Times, Oct. 22, 1878, p.8, col.3). Author's note: The Monthly Weather Review, Oct. 1878 gives a similar account. In addition, the wind direction from E.N.E. seems to be in error. 7) A dispatch from Boston. Capt. Anderson of the schooner "Moss Glen" reported that his vessel was lost when, about 45 miles S.E. of Cape Cod, she was overtaken by the gale of Oct. 12 (The New York Times, Oct. 22, 1878, p.1, col.6). 8) During Oct. 12 the storm continued to move towards the N.E. off the coast and by midnight Oct. 12-13 it was probably centered between Cape Cod and Nova Scotia. Maximum winds were: Lewis, 40 mph; Cape May, 48 mph; Atlantic City, 38 mph; Sandy Hook, E. 40 mph on Oct. 11 and N. on Oct. 12; New York, N.W. 32 mph; New Haven, N.E. 28 mph; New London, 26 mph; Newport, 48 mph; Wood's Hole, 32 mph; Boston, 36 mph. Lowest barometer at Wood's Hole: 29.48 inches at 11 P.M. (Monthly Weather Review, Oct. 1878). 9) Oct. 12, lat. 40 39 N., long. 69 21 W., S.S.E. to N.W. heavy gale and high cross sea (Monthly Weather Review, Oct. 1878). 10) Oct. 12, lat. 40 20 N., long. 69 30 W., at midnight wind S.E. moderate,

shifting suddenly to N. and N.N.W. , barometer falling from 30.00 to 29.00 inches, wind increasing to hurricane with terrific sea and continuing to 3 P.M. Oct. 13 (Monthly Weather Review, Oct. 1878). 10) Oct. 12, lat. 38 45 N., long. 71 30 W., severe hurricane lasting 12 hours (Monthly Weather Review, Oct. 1878). 12) Washington, Oct. 13, 1 A.M. The storm that was on Friday night near Cape Hatteras is now near Cape Cod (The New York Times, Oct. 13, 1878, p.7, col.2). 13) Oct. 13, heavy northerly gales and terrific seas were reported off the Nova Scotia coast and, by a study of the shipping notes, the track may be followed still farther eastward (Monthly Weather Review, Oct. 1878). 14) Bark "Stanley" left New York for Great Yarmouth (England) on Sept. 26. She met a severe gale a few days afterwards and sprung a leak. After the gale subsided, the vessel did not leak much until Oct. 15 when, at lat. 47 N., long. 38 W. was caught in an E.N.E. hurricane (The New York Times, Oct. 30, 1878, p.2, col.2).

It was found that, in general, items 1) through 13) support the track for this storm shown in Neumann et al. (1993) as for Storm 6, 1878. Therefore, the author of this study adopted such a track without modifying it. However, he found it possible to extend that track for two additional days on the basis of information contained in item 13) and especially in item 14). Based on item 14), the author of this study estimated a 7 A.M. Oct. 15 position near 45.5 degrees N., 37.5 degrees W. and, by using interpolation along a smooth curve joining the 7 A.M. Oct. 13 position about 42.9 degrees N., 62.6 degrees W. with the above mentioned position, he obtained his estimated 7 A.M. Oct. 14 position near 45.5 degrees N., 50.0 degrees W. The author's track is displayed in Fig. 2.

Based on the information contained in several of the items above, the author of this study believes that the storm reached hurricane intensity.

Storm 9, 1878 (Oct. 9-16).

This is the same storm Neumann et al. (1993) refer to as Storm 7, 1878.

The following information was found about this storm: 1) Baltimore, Nov. 6. Steamer "Copernicus", Oct. 27, 2 P.M. lat. 20 N., long. 60 W., spoke bark "Strasburg" (from New York to Port Natal, Brazil) which had been dismasted in a hurricane in the night of Oct. 14 and was proceeding to St. Thomas in jury-masts (The New York Times, Nov. 6, 1878, p.3, col.3). Author's note: Although most likely the bark encountered this storm, it is still possible that the bark had encountered a second storm that was following the steps of this one; both storms were roughly along the expected New-York- Port Natal route on Oct. 14. 2) On Oct. 7, the bark "Svea" (from New York bound to Cette, France) took the crew of the brig "Comrade" which was abandoned at lat. 37 10 N., long. 63 W. after having met a hurricane the previous day. On the "Svea" the shipwrecked men were kindly cared for. But on Oct. 14 they met another hurricane from the S.E. which threw the bark on her beam ends and caused the shifting of the cargo. Half an hour after, every spar had been carried away except the mainmast, but the bark then righted and at noon the gale moderated. The wreck was clear

away, jurymast rigged and the bark was kept off for Bermuda (The New York Times, Nov. 5, 1878, p.2, col.7). 3) New Bedford, Nov. 13. The ship "Eliza Adams" reported that on Oct. 17, at lat. 36 05 N., long. 47 45 W., spoke the bark "Sea Fox" which reported that on the morning of Oct. 15 she experienced a hurricane which lasted 12 hours. She had all her sails furled but the foretop mast staysail, and blew them away. About 8 hours after leaving the "Sea Fox", the "Eliza Adams" sighted the brigantine "Luisita" in a sinking condition and took her crew on board. On Oct. 15, in a hurricane, the "Luisita" had lost sails and was stripped by a heavy sea (The New York Times (The New York Times, Nov. 14, 1878, p.2, col.4). 4) Map showing the track for this storm. Positions along the track are as follows: Oct. 13, 25 degrees N., 50 degrees W.; Oct. 14, 31 degrees N., 52 degrees W.; Oct. 15, 39 degrees N., 49 degrees W.; Oct. 16, 48 degrees N., 35 degrees W. (Government Printing Office, 1881).

Information in items 1) through 3) served to verify the existence of the storm but was of little use in studying its track because the positions the vessels encountered the storm were not given.

It should be pointed out that the track mentioned in item 4) was started four days later than the one in Neumann et al (1993), which was started near 16 degrees N., 40 degrees W. on Oct. 9. The positions for Oct. 14 and Oct. 15 do not differ greatly from one track to another, but differences of about 150 and 350 miles are noted for the Oct. 13 and the Oct. 16 positions, respectively.

The author of this study decided to adopt the track for this storm shown in Neumann et al. (1993) as for Storm 7, 1878 and to reproduce such a track in Fig. 2. Note in this figure that this storm was located about 650 miles to the southwest of Storm 8, 1878 on Oct. 15.

Indications are that the storm attained hurricane intensity (items 1 through 3).

Storm 10, 1878 (Oct. 13-19).

This storm corresponds to Storm 8, 1878 in Neumann et al. (1993).

The following information was found in connection with this storm: 1) The first mate of the schooner "George T. Thatcher" (from Boston for the West coast of Africa) reported that on Oct. 18 at lat. 32 N., long. 53 W. encountered a hurricane from the N.E. accompanied by a fearful sea which stove a hole in the bow. While repairing it, another sea carried away the rudder, tearing a large hole in the stern and washing the captain and one man overboard. All hands were got ready at the pumps when suddenly a dead calm was fell for about 10 minutes, barometer down to 28.07 inches, and then blew with increased violence. At 5 P.M. the mizzen-mast went overboard and the vessel was boarded by a sea; at 11 P.M. the fore and main-mast went over and the crew had barely time to launch a boat and to save nothing but the charts and compass and a little bread but no water and, hoisting a blanket for a sail, they directed their course towards the West Indies and were picked up by the bark "Terzo" at lat. 27 30 N., long. 57 40 W. on Oct. 23 (The

9, 1878.

The following information was found in relation to this storm: 1) Storm first detected near 17 degrees N., 81 degrees W., recurving near 21 degrees N., 81 degrees W. and was last reported south of Newfoundland (Garriott (1900). 2) Oct. 19, Kingston reported 1.40 inches of rainfall at 4:35 P.M.; Havana and Key West reported N.E. wind, cloudy and rain (Monthly Weather Review, Oct. 1878). 3) The barometer was falling at Havana at 4:35 P.M. Oct. 20 (Monthly Weather Review, Oct. 1878). 4) Dispatches from Havana reported a hurricane there in the night of Oct. 21, with heavy rains, during which much damage was done to buildings and 3 schooners sunk (Monthly Weather Review, Oct. 1878). Author's note: It should read during the night of Oct. 20-21. 5) Based on the appearance of high clouds in the form of a cirrus focus as seen from the Belen College Observatory, Father Vines stated that he first noticed this cyclone to the S.E. of Havana on Oct. 17; he also stated that the vortex passed a few miles E. of the observatory, between Havana and Matanzas, in the night of Oct. 20-21 (Vines, 1895). 6) Oct. 21, cyclone, primarily at Havana; abundant rains over most of the island of Cuba (Martinez-Fortun, 1942). 7) Oct. 20-22. A moderate cyclone crossed Cuba between Havana and Matanzas; hurricane winds and torrential rains were felt as far east as Cienfuegos. There was considerable damage and loss of life (Sarasola, 1928). Author's note: Actually taken from the catalog of Cuban hurricanes by M. Gutierrez-Lanza which is included in Sarasola (1928). 8) At Key West, Oct. 21, wind backed from N.E. 46 mph at 7:35 A.M. to 44 mph at 2 P.M. and to N.W. 27 mph at 10:41 P.M. Lowest barometer was 29.53 inches at 2 P.M. and 4:16 P.M.; maximum wind was 54 mph in the morning (Monthly Weather Review, Oct. 1878). 9) Havana, 4:35 P.M. Oct. 21, barometer 29.67 inches, wind N.W. 24 mph, light rain (Monthly Weather Review, Oct. 1878). 10) High N.E. and N. winds at Punta Rassa (Monthly Weather Review, Oct. 1878). 11) Washington, Oct. 22, 1 A.M. A storm of great energy, not reported from the West Indian stations, is now E. of Florida (The New York Times, Oct. 22, 1878, p.2, col.6). 12) Steamer "Nueva Barcelona" lost rudder in a gale 8 miles S. of St. Augustine Lighthouse and a severe gale from E.N.E. backing to N. was reported off St. John's bar during Oct. 21 and 22, although at Jacksonville the wind did not exceed 17 mph (Monthly Weather Review, Oct. 1878). 13) Steamer "Juniata" (at Wilmington Oct. 22) reported a terrific N.E. gale and chopped sea between Charleston and Tybee during the night of Oct. 21 (Monthly Weather Review, Oct. 1878. 14) During Oct. 22 the vortex probably moved northward and at 11 P.M. was situated between Wilmington, N.C. and Cape Lookout. At Wilmington, the gale commenced from E. at 3 P.M. Oct. 22; at 10:20 P.M., wind suddenly shifted from N.E. to N.W. ; at 10:40 P.M., wind velocity was 36 mph from N.W.; at 11:56 P.M., lowest barometer 29.12 inches; rainfall was 2.92 inches. At Cape Lookout, 11:02 P.M. Oct. 22, barometer 29.05 inches, wind S.E. 68 mph; maximum velocity 100 mph; rainfall 4.06 inches (Monthly Weather Review, Oct. 1878). 15) Portsmouth, N.C., 11:04 P.M. Oct. 22, wind S.E. 82 mph; rainfall 3.48 inches (Monthly Weather Review, Oct. 1878). 16) At Kittyhawk, the storm began at 6:30 P.M. Oct. 22 and reached the registered maximum velocity of 88 mph at 2 A.M. Oct. 23 when the

anemometer was blown away; lowest barometer 29.06 inches (Monthly Weather Review, Oct. 1878). 17) At Cape Henry and Norfolk, maximum wind velocities were 84 and 44 mph, respectively, and the wind changed from S.E. to S.W; at Lynchburg, the wind backed from N.E. to N.W. (Monthly Weather Review, Oct. 1878). 18) Washington, Oct. 23, 1 A.M. The storm last night east of Florida has moved with great energy in a northerly path and is now central near Cape Hatteras (The New York Times, Oct. 23, 1878, p.5, col.5). 19) The vortex passed almost directly over Washington at 4:40 A.M. Oct. 23, the anemoscope was swung from E. to S., and back again, twice around the compass to W., setting down to N.E. where it remained with little or no wind until 7 A.M., then N.W. winds began abruptly; lowest barometer 28.80 inches at 7:15 A.M. (Monthly Weather Review, Oct. 1878). 20) At Annapolis, barometer 28.82 inches at 7:30 A.M. Oct 23. At 5:45 A.M., the wind shifted from N.E. to S.E. and blew with great violence; wind S.W., moderating, at 7:30 A.M. (Monthly Weather Review, Oct. 1878). 21) Baltimore, maximum wind S.E. 45 mph at 5 A.M. Oct. 23; lowest barometer 28.83 inches at 7:37 A.M. (Monthly Weather Review, Oct. 1878). 22) At Philadelphia, lowest barometer 29.18 inches at 7:30 A.M. Oct. 23; highest wind velocity S.E. 72 mph at 7:40 A.M. (Monthly Weather Review, Oct. 1878). 23) At Cape May, maximum velocity E. 84 mph at 5:45 A.M.; at Barnegat, S.E. 72 mph; at Atlantic City, E. 56 mph (Monthly Weather Review, Oct. 1878). 24) The center passed into the State of New York around noon Oct. 23 and thence over New England during the latter part of that day and morning of Oct. 24. New York, wind 50 mph at 7 A.M. and for several hours. New Haven, highest wind E. 40 mph at 11 A.M.; New London, maximum velocity E. 60 mph; Newport, highest wind S.E. 36 mph; Boston, highest wind S.E. 40 mph; Portland, wind S.E. 70 mph at 9 P.M. Oct. 23 before the anemometer was blown away. At the summit of Mt. Washington, highest wind S.E. 120 mph at 4:57 Oct. 23 (Monthly Weather Review, Oct. 1878). 25) At Philadelphia and other areas in Pennsylvania the storm attained great violence. Hundreds of buildings were blown down or unroofed, 8 persons were killed and 75 wounded (The New York Times, Oct. 24, 1878, p.1, col.7). 26) The storm reached New York from the S. at 5 A.M. yesterday morning. At 5 A.M. the wind was blowing 25 to 28 mph and at 8 A.M. reached 50 mph. It varied from 45 to 50 mph from 8 to midday and decreased to less than 25 mph in the afternoon. At 11 P.M. Oct. 22 the barometer stood at 29.93 inches. At 7 A.M. Oct. 23, it read 29.55 inches and continued down to 29.37 inches at midday. It was 29.53 inches at 8 P.M. (The New York Times, Oct. 24, 1878, p.2, col.2). 27) Albany, N.Y., Oct. 23. A gale of wind passed over the city about noon today doing considerable damage (The New York Times, Oct. 24, 1878, p.2, col.2). 28) Hartford, Conn., Oct. 23. As the morning freight train from New Haven to this city was passing Berlin, a gale of wind swept across the track and a load of lumber on a platform car was blown off, carrying with it a brakeman, who was badly injured (The New York Times, Oct. 24, 1878, p.2, col.2). 29) Bark "Gladiolus", which had left this port for Europe on Oct. 21, met with a severe gale Friday night (Oct. 25) during which her cargo shifted somewhat and the pumps came chocked; the captain decided to put back (The New York Times, Oct. 31, 1878, p.2, col.5). 30) Map showing a storm

track indicating a position just S.W. of Cienfuegos in the morning of Oct. 21, to have been near Wilmington in the night of Oct. 22-23, near Washington, D.C. in the morning of Oct. 23, over southernmost Vermont in the night of Oct. 23-24, near 42.5 degrees N., 68.5 degrees W. in the morning of Oct.24 and then continuing towards the E.S.E. (Monthly Weather Review, Oct. 1878).

In the light of information contained in the above items, the author of this study proposed some modifications along the track for this storm which is shown in Neumann et. al. (1993) as for Storm 9, 1878. Their starting location near 18.0 degrees N., 80.5 degrees W. for 7 A.M. Oct. 18 was accepted, although it is very likely that the storm had formed on Oct. 17 or earlier in accordance with item 5). The author's track for the period Oct. 19-21 is significantly to the west of the corresponding one in Neumann et al. (1993). For said period, the author estimated the following 7 A.M positions: Oct. 19, 19.0 degrees N., 81.3 degrees W.; Oct. 20, 20.5 degrees N., 82.3 degrees W.; Oct. 21, 23.3 degrees N., 82.0 degrees W. These positions are in good agreement with information in items 4) through 7) which clearly states that the storm vortex crossed Cuba between Havana and Matanzas in the night of Oct. 20-21 and not over Las Villas province on Oct. 21 as shown in Neumann et at. (1993). The author of this study kept unchanged the 7 A.M. positions given in Neumann et al. (1993) for the period Oct. 22-25; however, he adjusted the track slightly to the south over the 24-hr period from 7 A.M. Oct. 23 to 7 A.M. Oct. 24 in order to fit better the information in items 24) through 28) and, at the same time, to smooth to some extent the sharp curvature shown by the track in Neumann et al. (1993) during the above mentioned 24-hr period. The author's track is displayed in Fig. 2.

Dunn and Miller (1960) have classified this storm as a major hurricane. Only the non-representative maximum wind of 120 mph reported at the summit of Mt. Washington (item 24), which is roughly 6300 ft above sea level, would support major hurricane status. The lowest pressure of 28.80 inches reported at Washington, D.C. (item 19) and the maximum wind speed of 100 mph reported at Cape Lookout, at an altitude between 100 and 1000 times closer to sea level than the summit of Mt. Washington, failed to provide a confirmation that the storm had attained major hurricane intensity.

Storm 12, 1878 (Nov. 25- Dec. 2).

This is the same storm Neumann et al. (1993) identify as Storm 10, 1878.

The following information was found in relation to this storm: 1) The storm formed near 13 degrees N., 51 degrees W., did not recurve and dissipated over the Caribbean Sea (Garriott, 1900). 2) Nov. 24 and 28, violent hurricane reported S. of St. Thomas. At midnight Dec. 1 the schooner "Thos Pickering" was reported driven ashore by a hurricane 35 miles N.N.E. of Saona Island, near Santo Domingo. Dec. 1 and 2, heavy E. and S.E. squalls at Navassa Island. At Colon, a severe "norther" commenced on Dec. 4 and lasted until Dec. 10, accompanied by heavy rains and sea (Monthly Weather Review, Dec. 1878). Author's note: The hurricane seems to have been S. of St. Thomas on Nov. 28 and not on Nov. 24. Navassa is a tiny

island located between Jamaica and Haiti. Colon is located on the northern coast of Panama. 3) Map showing a track for the storm. Morning positions shown on that map are: Nov. 25, 16 degrees N., 53 degrees W.; Nov. 26, 17 degrees N., 55 degrees W.; Nov. 27, 18 degrees N., 58 degrees W.; Nov. 28, 19 degrees N., 64 degrees W.; Nov. 29, 18 degrees N., 68 degrees W.; Nov. 30, 17 degrees N., 72 degrees W. (Monthly Weather Review, Jul. 1879). 4) Nov. 24-28, 1878, storm E. of Puerto Rico (Tannehill, 1938). 5) Gaceta Oficial de Puerto Rico, Dec. 10. San Juan, 10 A.M. Nov. 28, wind N.W. about 20 mph; lowest barometer 29.61 inches at 4 P.M. (Salivia, 1972). 6) Boletin Mercantil de Puerto Rico, Dec. 1. Dispatch from the Captain of the Port of Aguadilla, Nov. 29. There has been a "temporal" since late yesterday; there are 5 vessels in port under the captain's protection. Dispatch from Humacao. From 5 A.M. Thursday (Nov. 28) to this time, there have been here wind gusts from the S. with high seas. The sloop "Perseverancia" was wrecked on the beach (Salivia, 1972). Author's note: Aguadilla is located over the northwestern coast of Puerto Rico and Humacao near the southeastern tip of that island. 7) The storm passed close to the southern coast of Puerto Rico and was felt at some towns from E., S. and W. The storm was called "San Rufo" (Salivia, 1972). 8) Nov. 28, Storm of "San Rufo" at the Dominican Republic (Garcia-Bonnelly, 1958). Author's note: The storm should have also affected the island of Hispaniola on Nov. 29-30. 9) The "Moselle" arrived at Plymouth from the West Indies. No Panama papers were brought by this ship as, owing to unseasonably severe weather the railways were inundated; consequently, passengers who intended coming to England by this ship were prevented by this circumstance (The Times, London, Dec. 30, 1878, p.4, col.4).

Based on the information contained in the above items, the author of this study proposed some modifications along the track shown in Neumann et al. (1993) as for Storm 10, 1878. As suggested by the information contained in items 5) through 7), the track was slightly adjusted to the north, making the center to have skirted the southern coast of Puerto Rico during Nov. 28. Some northward adjustment was also made along the track for the period Nov. 29-30 on the basis that the storm was felt on the island of Hispaniola (item 8), and the track was extended to Dec. 1 and 2 in order to satisfy the weather information which was available from Navassa Island (item 2). The storm was dissipated on Dec. 2 in order to allow for a northerly flow of air to have set in over the entire western Caribbean Sea, and to have caused the "norther" with heavy rains which started to blow at Colon, Panama, on Dec. 4 (item 2) and which was responsible for the flooding conditions described in item 9).

In accordance with the discussion above, the author of this paper accepted the 7 A.M. positions shown in Neumann et al. (1993) for the period Nov. 25-28, but estimated new 7 A.M. positions for the period Nov. 29- Dec. 2. These positions were as follows: Nov. 29, 17.5 degrees N., 69.5 degrees W.; Nov.30, 16.7 degrees N., 72.0 degrees W.; Dec. 1, 16.0 degrees N., 74.5 degrees W.; Dec. 2, 15.7 degrees N., 76.5 degrees W. The author's track is displayed in Fig. 2.

In spite that a hurricane is mentioned to have been located S.

of St. Thomas (item 2), the author of this study is skeptical in regard that the storm had indeed attained hurricane intensity.