

17C.2 THE REANALYSIS OF ATLANTIC BASIN TROPICAL CYCLONES FROM THE 1920's: A REEXAMINATION OF THREE CATASTROPHIC HURRICANES THAT IMPACTED FLORIDA

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1. INTRODUCTION

The Hurricane Research Division (HRD) of NOAA Atlantic Oceanographic and Meteorological Laboratory is engaged in effort to extend and improve the quality of the National Hurricane Center's (NHC) original North Atlantic best track and intensity database, HURDAT, from 1851 to the present. Employing consistent analysis methods and modern interpretations, the HRD HURDAT reanalysis project is helping to correct several errors and biases, determine better landfall attributes, and provide additional track and intensity data for tropical cyclones (TCs) included in the database (Landsea et al. 2002). Through inspection of historical meteorological records and accounts, previously unknown TCs are also identified and considered as candidate storms to be added to the database. All recommended changes to HURDAT are subsequently submitted to NHC's Best Track Change Committee for approval.

Focusing just on the 1920's, proposed revisions to HURDAT during this decade will be presented along with an updated assessment of the frequency and impact of various-intensity TCs for the individual years. Statistical comparisons of the total amount of TCs, hurricanes, major hurricanes, and landfalling storms will be made between the 1920's and other decades. Additionally, the overall sample will be used to verify multidecadal trends of TC activity during the period. Special attention will be given to the reanalysis of three major hurricanes that made landfall along the west central and southeast coasts of Florida: Tampa Bay in October 1921, Great Miami in September 1926, and Okeechobee in September 1928. In addition to a detailed perspective of the proposed revised track and intensity estimates for these three hurricanes, storm surge measurements will be compared to retrospective SLOSH runs.

2. DATA SOURCES

For the 1920's, the HRD HURDAT reanalysis project primarily utilizes data from Historical Weather Maps series, ships observations included in the Comprehensive Ocean and Atmosphere Data Set (COADS), individual surface station records, archives of ship reports and logs from the NOAA National Climatic Data Center (NCDC), and articles and records published in *Monthly Weather Review*. Supplemental material is extracted from a variety of books, technical memoranda, and journalistic accounts.

3. REANALYSIS EXAMPLE: 1921 TAMPA BAY HURRICANE

3.1 Storm Overview

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The reanalyzed life history of the 1921 Tampa Bay major hurricane is shown in Figure 1. On 20 October 1921, a tropical depression formed in the vicinity of a persistent surface trough in the Southwestern Caribbean. The depression soon intensified into a tropical storm and reached hurricane strength by 00 UTC on the 22nd, as it tracked steadily to the NNW around the western periphery of a large anticyclone. It continued to intensify rapidly and reached major hurricane status by the early morning of the 23rd. Afterwards, it began to recurve to the north, as a ridge present over the Southeast U.S. started to weaken and retreat. By the afternoon, the hurricane attained Category 4 status; the S.S. *Virginia* encountered the eye and reported a minimum pressure of 941 mb in the Yucatan Channel. It remained at Category 4 through the morning of the 25th, as another ship, the S.S. *El Estero*, also passed through the center in the southeastern Gulf of Mexico and reported a minimum pressure of 943 mb. The storm gradually turned towards the NNE and then NE before making landfall at Tarpon Springs, FL, north of Tampa, during the afternoon of the 25th. It had weakened slightly before landfall to a high-end Category 3, as the minimum central pressure measured by Dr. A. P. Albaugh in Tarpon Springs was 952 mb (Bowie 1921). It then crossed central Florida and exited just south of Daytona Beach around 07 UTC on the 26th as a substantially weaker Category 1 storm. Over the next three days it moved to the east and then ESE at a faster speed, remaining at Category 1 status. Finally, the storm accelerated to the ENE on the afternoon of the 29th, weakened to a tropical storm, and was absorbed by a large extratropical system by 12 UTC on the 30th.

Considerable damage from high storm surge, coastal and inland flooding, and winds was prevalent throughout the Tampa Bay region and many areas in central and north central Florida. The Tampa Weather Bureau office reported that the storm tide reached a record 3.2 m (10.5 feet) above mean low water at 19 UTC on the 25th (Bowie 1921). The office also recorded over 216 mm (8.5 inches) of practically continuous rainfall between 09 UTC on the 23rd to 0215 UTC on the 26th. Losses of over \$3 million were estimated from damage to residences, commercial buildings, ships, ports,

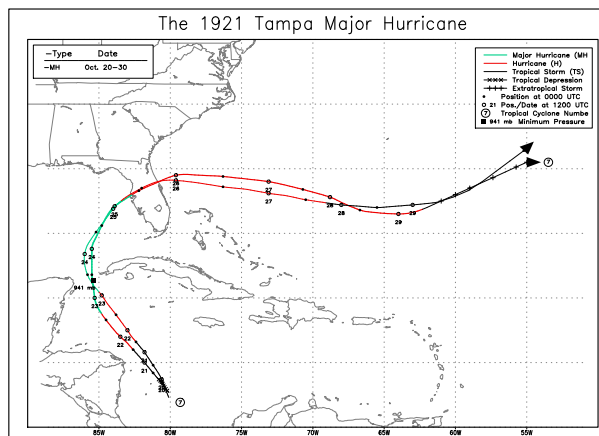


FIG. 1. Original (thin line) and revised (thick line) best track of the October 1921 Tampa Bay hurricane.

marinas, piers, agricultural interests, citrus fruit, and public infrastructure and property. The total number of hurricane-related fatalities was unknown; however, at least eight deaths on the west coast of FL were directly attributed to the storm (Barnes 1998). The damage on the east coast, while significant, was much less substantial compared to the west coast (Bowie 1921).

3.2 Proposed Track Changes

Following a thorough evaluation of all available data and records for each day of the storm's existence, recommendations have been made for minor track modifications to the HURDAT database. Figure 1 shows the original and modified tracks. Evidence for these adjustments comes from the Historical Weather Maps (HWM), COADS ship data (COA), individual ship and station archives from NCDC, *Monthly Weather Review* (MWR), Cline (1926), Dunn and Miller (1960), Ho et al. (1987), and Jarrell et al. (1992). Below is an example extracted from a daily assessment:

23 October. HWM indicates a closed low of at most 995 mb at 20°N, 84.5°W. HURDAT listed this as a Category 2 hurricane at 20.2°N, 84.8°W for 12 UTC. The MWR "Summary of the Hurricanes of 1919, 1920, and 1921" shows a center at 20°N, 85.5°W (a.m.). The MWR Tracks of Lows indicates a center at 20°N, 85°W (a.m.) and 21.5°N, 85°W (p.m.). Available observations suggest that the MWR "Summary" position is more accurate than the HURDAT estimate. Ship highlights: Calm and 941 mb at 27.5°N, 85.6°W at ~22 UTC (MWR); 50 kt reported three times (MWR and COA).

3.3 Proposed Intensity Changes

Recommendations have also been made for major intensity alterations to the HURDAT database. Since observations suggest that the cyclone did not obtain tropical storm status until late on the 20th, intensities were slightly reduced accordingly on the 20th and 21st. On the 22nd, Swan Island reported a SW maximum 5 minute wind of 70 kt (1 kt = 0.51 m s⁻¹) at ~22 UTC and 989 mb minimum pressure at ~16 UTC. The 70 kt is reduced to 57 kt after adjustment for instrument high bias and conversion to a peak 1 min wind (Fergusson and Covert 1924 and Powell et al. 1996). A 989 mb peripheral pressure suggests winds of at least 66 kt from the southern pressure-wind relationship. Consequently, 80 kt was retained in HURDAT for 18 UTC on the 22nd. At 22 UTC on the 23rd, the 941 mb pressure measured by the *Virginia* in the eye suggests winds of 118 kt from the southern pressure-wind relationship. Thus 120 kt was selected for the revised HURDAT, an increase of 20 kt. At 03 UTC on the 25th, the 943 mb pressure measured by the *El Estero* in the eye suggests winds of 117 from the Gulf of Mexico pressure-wind relationship. A constant intensity was therefore maintained through 00 UTC on the 25th and then reduced to 115 kt at 06 UTC. Another ship, the *Truxillo*, went through the eye around 1520 UTC on the 25th and measured a pressure of at most 958 mb. However, based upon lower pressure observed later at landfall in Tarpon Springs with a longer calm period, this measurement is probably biased high relative to the central pressure at that time.

At landfall, the central pressure of 952 mb measured in Tarpon Springs between 1940 and 2040 UTC on the 25th suggests winds of 108 kt from the Gulf of Mexico pressure-wind relationship. Ho et al. analyzed a landfall position at 27.9°N, 82.8°W also with a 952 mb central pressure and a radius of maximum winds (RMW) of 33 km. This RMW value is close to average for the nominal latitude and central pressure (Vickery et al. 2000). Thus 110 kt was assigned for the landfall intensity, making it a high-end Category 3 hurricane. This is in agreement with the HURDAT and Jarrell et al. The highest

observed wind at Tampa was 59 kt at 1918 UTC, which converts to 49 kt after adjustment.

Following landfall, the peak observed winds within two hours of the 00 and 06 UTC synoptic times on the 26th were 50 kt and 45 kt from ship observations in the Gulf of Mexico. Meanwhile, the highest land-based winds were 49 kt around 00 UTC at Jacksonville and 37 kt around 06 UTC at Charleston and Savannah. The Kaplan and DeMaria (1995) inland decay algorithm suggested winds of 78 and 70 kt at 00 and 06 UTC, respectively. Consequently, winds in HURDAT were decreased from 85 to 80 kt at 00 UTC and 80 to 70 kt at 06 UTC. The intensity possibly could have been reduced even further; however, there was a dearth of land station observations to use for verification. For the revised HURDAT the hurricane's impact was rated as Category 3 for southwest FL, Category 2 for northwest FL, and category 1 for northeast FL.

Since a 988 mb peripheral pressure observation at 19 UTC on the 26th suggests winds of at least 66 kt from the subtropical pressure-wind relationship, 75 kt was retained in HURDAT for 18 UTC. Available observations on the 27th and early on the 28th suggest that the hurricane did not regain Category 2 intensity. The HURDAT values were hence reduced from 85 kt to 75 kt. Later on the 28th, 979 mb and 984 mb peripheral pressures were measured from ships, suggesting winds of at least 76 and 71 kt, respectively. The HURDAT intensity at 12 UTC was thus increased slightly from 70 to 75 kt. Although HURDAT designated the storm as extratropical by 12 UTC on the 28th, available ship observations indicate that it remained a TC for an additional 36 h. These observations show it weakening to a tropical storm late on the 29th, as it was being absorbed by a larger extratropical low. The storm track was extended an extra six hours on the 30th to accommodate ship data showing that the system was still a separate entity and to provide a more realistic translational velocity at its conclusion.

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