
Plotting Early Nineteenth-Century Hurricane Information

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Hurricane climate research for the United States is based largely on records spanning only the last 100 years or so [*Elsner et al.*, 2000; *Landsea et al.*, 1996]. Accounts of hurricanes exist in a variety of documents that include compendiums sorted by region and date, documents with records for individual states, and personal research. Original sources for these works include direct observations, ship records, newspaper accounts, personal letters, and governmental archive reports.

Efforts have been made to collate available document-based evidence of past hurricanes for 1800-1850, a period that represents the years prior to those of the National Oceanic and Atmospheric Administration's "Best-Track" data set [*Jarvinen et al.*, 1984], which begins with the year 1851. The purpose of the collation is to bring together historical archives into a single electronic reference and to add value by plotting the information on maps. The result is a historical hurricane impact tool (HHIT) that can be used for investigations of hurricane climate variability and change. It can also serve as the basis for a re-analysis of early American hurricanes.

Ludlum [1963] is the primary source document for the HHIT. However, we also include data from more recent historical chronologies compiled by *Ho* [1989], *Barnes* [1998, 2001], *Cotterly* [1999], *Henning* [1999], *Roth* [1998, 2000], *Roth and Cobb* [2001], and *Prokop* [2001]. These works contain additional information about some of the storms listed in *Ludlum* [1963], as well as notes on storms not mentioned.

David Ludlum's 1963 monograph, titled *Early American Hurricanes: 1492-1870*, is a compilation of high-quality textual summaries of tropical cyclone activity over the western North Atlantic and Gulf of Mexico [*Sharkov*, 2000]. Major sources include *Garriott* [1900], *Fassig* [1913], *Tannehill* [1956], and *Dunn and Miller* [1960], which are based on the work of *Poey* [1855] and others. The monograph contains local newspaper accounts of shipboard damage reports that were published in newspapers, personal letters, and diaries, as well

as records in archives that provide descriptions of the storms and their dates. Some of the reports include meteorological observations.

The HHIT GIS tool is available through the Hurricane Climate Institute at Florida State University in a CD-ROM version, and as a Web version that is view-only and does not allow for modification (<http://garnet.acns.fsu.edu/~jelsner/HHITProject/hhithome.htm>).

A GIS Tool

Information from *Ludlum* [1963] and others has been used to construct a series of mapped accounts of tropical cyclones using a Geographic Information System (GIS). Data within HHIT are organized chronologically by year. Upon opening the GIS product and selecting the HHIT directory, a listing of years between 1800 and 1850 appears; each year is a separate GIS project file. For each year, the tropical cyclones are organized chronologically by landfall date. Thirty-seven of the 51 years had evidence of at least one tropical cyclone. The HHIT includes evidence from ninety tropical cyclones during the 51-year period. The most active year prior to 1851 was 1837, with ten tropical cyclones, six of which likely made direct landfall along the U.S. coast. The second most active year was 1844, with eight tropical cyclones and four landfalls.

Table 1 provides hurricane count statistics in 50-year periods. Seasonal distributions of tropical cyclone counts are similar among the periods. The coefficient of skewness is negative in all four periods, indicating more landfalls in the latter part of the hurricane season. The mode interval indicates the 10-day bin with the greatest landfall activity in each period; the intervals are the same for each period.

Table 1. Summary Statistics of Seasonal U.S. Hurricane Activity. Counts from 1801-1850 are from the HHIT, and Counts from 1851-2000 are from the NOAA "Best-Track" Dataset.

<i>Period</i>	<i>Number of Hurricanes</i>	<i>Mean Date</i>	<i>Median Date</i>	<i>Skewness</i>	<i>Mode Interval</i>
1801-1850	52	Sept. 4	Sept. 9	-0.767	Sept. 9-18
1851-1900	88	Sept. 6	Sept. 10	-0.798	Sept. 9-18
1901-1950	92	Sept. 2	Sept. 4	-0.221	Sept. 9-18
1951-2000	72	Sept. 1	Sept. 7	-0.432	Sept. 9-18

Callouts. Descriptive information regarding hurricanes and tropical storms is found in callout boxes over base maps of the United States. Most callouts contain information verbatim from the source documents, with some minor paraphrasing to make the descriptions more compact. The boxes are positioned on the map near the geographic location described within, and include a pointer to the location, if known (Figure 1). Instances in which the location is unknown utilize a text box rather than a callout box. Text and callout boxes are scale-dependent: changing the map scale changes the text scale in reciprocity. The layout (the view of each storm prepared for hard copy) includes a storm summary taken directly from the source documents. Statements not garnered from the original source documents are included in separate text boxes.

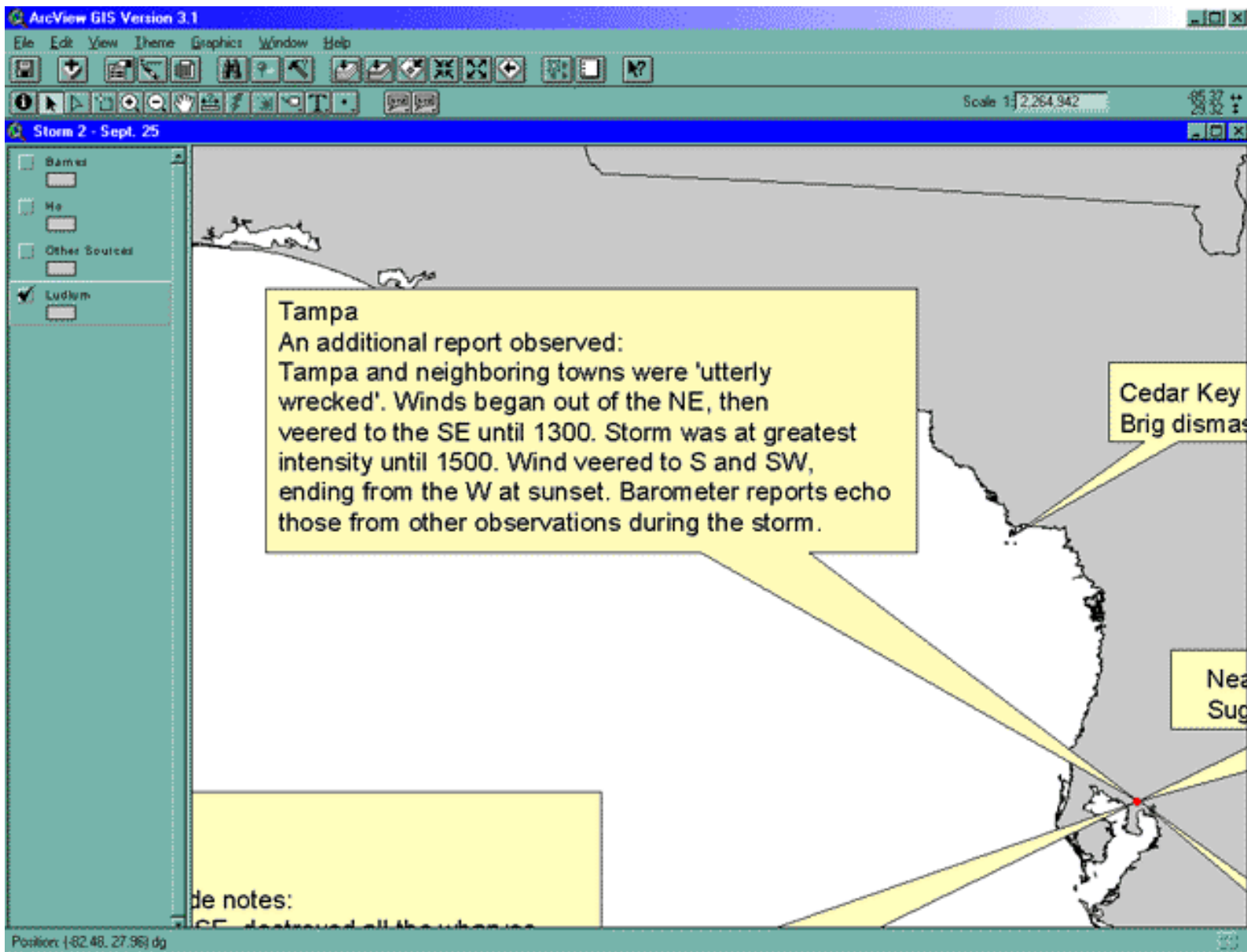


Fig. 1. An example of a callout in the HHIT from a portion of a GIS view for the September 1848 Tampa Bay hurricane (ArcView project version).

User's manual. The original version of the HHIT uses Environmental Systems Research Institute's (ESRI) ArcView GIS software (version 3.1). Therefore, any user of the original project must have ArcView 3.1 or later version installed on a PC to access. The project shapefiles (the files used by the GIS to display the hurricane information) must be installed to the user's hard disk. Once a GIS project is selected, the project opens and displays the various menu icons available to the user. The two most commonly used menu icons are the "Views" and the "Layouts." The "Views" are the core of each project and contain the descriptive information relating to the storm. The "Views" also contain the estimated track of the storm. They are chronologically organized by date of influence on the United States. The "Layouts" are designed as hardcopy layout tools, and are where a user will find finished descriptive maps, track maps, intensity estimations, and additional storm descriptions.

Within the "Views" are callout descriptions for each storm. Upon opening a "View," the user sees a map display containing descriptive information for each storm and a selection of "Themes" from which to choose.

Source documents are treated as separate "Themes" for each storm. The "Views" involving tracks have one "Theme" titled "Track." Toggling the checkbox for this "Theme" will alternately display and hide from view the track of the storm. Where no track is specified, "Track Unspecified" will appear in the "View." Estimated storm intensities at landfall are also included, but are present only in the "Layout" for each storm.

The digital nature of the HHIT allows for editing and modification. For example, new documentary accounts of a particular storm can be added in the tool by adding a new "Theme." Entirely new storms can be added by creating a new "View." Additional years can be added by creating new projects with separate views for each storm.

Map interpretation. Extreme caution must be exercised when interpreting information from these maps. Although storm track and intensity estimates are included for some storms, the potential for large errors in track location and storm intensity is high. A preponderance of evidence can lead to a more definitive estimation of track and/or intensity for some well-documented cases. For most storms, however, track and intensity estimates can be considered baseline approximations. While confidence bounds are not depicted for the tracks themselves, the intensity estimations provided in the current version of HHIT should be considered accurate to within ± 2 Saffir-Simpson categories, based on the minimum damage reports to imply hurricane strength. The track and intensity estimations provide a starting point for further assessments. Three types of tracks are given in the HHIT. Those that are taken directly from *Ho* [1989] are colored blue, those taken directly from *Tannehill* [1956] are colored green, and those that are based on our analysis are colored red. Where estimates are possible, tracks are modified from solid to dotted lines to indicate weakening to tropical storm strength.

The data contained within the HHIT are useful, but need to be treated with caution due to the uncertainty present in documentary evidence. *Elsner and Bossak* [2001] and *Elsner and Jagger* [2004] demonstrate how to combine earlier records of lesser accuracy with later records of greater accuracy in making hurricane climate forecasts, which are important for insurance and reinsurance contracts [*Michaels et al.*, 1997].

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