

Evaluation of Storm Tide Measurements at Panama City Beach, FL 1993-2007

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1.0 Introduction

An evaluation of available Gulf of Mexico open coast tide gage data for the Florida Panhandle Region was performed in order to obtain storm tide hydrograph information. The measured hydrograph data was compiled and evaluated to assist in providing documented field data support for computer model-generated storm hydrographs. The primary intent for conducting this work was to provide field data to support model-generated storm tide hydrographs for high-frequency storm events for the Gulf shoreline region extending from Panama City Beach in Bay County through Escambia County.

Specific intent of this work was to provide field data support for high-frequency storm hydrograph shape. The hydrograph shape is identified as the rise and fall of the super-elevated storm tide above the normal predicted astronomical tide over an associated time period interval. Computer model-generated hydrographs for high-frequency storm events, such as those generated by Florida State University-Beaches and Shores Resource Center (FSU-BSRC) (2009), are dependent on a number of specific storm characteristic parameters. These parameters include forward speed, radius to maximum winds, central pressure deficit, landfall location, and landfall direction angle (relative to shoreline angle). Specific description of model-generated storm hydrographs can be found in the study reports by FSU-BSRC.

Storm tide data was extracted from an open coast tide gage at Panama City Beach and plotted to observe specific hydrograph shapes. Three separate groups of storm hydrographs were compiled to assist in identification of characteristic hydrograph shapes for use in providing field support for the computer model-generated hydrographs. Average hydrographs were produced and plotted for each of the 3 storm groups. This report provides documentation of the field data support evaluation work performed.

2.0 Tide Gage Data Measurements

Continuous, real-time water elevation data was obtained in the Gulf of Mexico by the National Ocean Survey (NOS) of the National Oceanographic and Atmospheric Administration (NOAA) at Panama City Beach, Florida, from 1993 through early 2008. The water elevation data was obtained through the NOS installation of a tide gage mounted on the Dan Russell pier in Panama City Beach.

The NOS tide gage station evaluated was Station Number 8729210. This station has provided the only long-term, continuous, open coast tide data for the Florida Panhandle coast. The available verified tide gage data record on-line extends from January 1, 1993 through January 25, 2008. As a result of severe damage to the pier from Hurricane Ivan in September 2005 and subsequent pier re-construction work, the tide gage was disabled and the tide data measurements were discontinued on January 25, 2008.

More information about the tide gage and NOS data collection programs can be found at the following internet address: <http://tidesandcurrents.noaa.gov/>

2.1 Tide Gage Location and Information

A map showing the location of the NOS tide gage 8729210 is shown in Figure 1 below. The gage was mounted on the pier in approximately -15 foot (NAVD) depths (based on June 2005 pre-Ivan survey profiles) and was located approximately 830 feet seaward of the FDEP range monument R-40. Specific geographic coordinates are provided on the NOS website referenced above. The tide gage location was approximately 450 feet seaward of the Gulf shoreline based on the June 2005 pre-Ivan survey profiles obtained during beach restoration project monitoring.



Figure 1. Map depicting location of NOS tide gage on the Florida Panhandle coast

The aerial photo (April 2004; pre-Ivan) shown in Figure 2 depicts the location of the NOS tide gage on the pier and near proximity of the pier and tide gage to FDEP range location at R40. The pier and tide gage are located approximately 150 feet east of R40. A beach and nearshore profile cross-sectional schematic plot showing pre-Ivan conditions at the pier and the approximate location of the tide gage is given in Figure 3.

The verified tide gage data archived on the NOS website provides 6-minute and hourly interval data compilations in mean low low water (MLLW), as well as other vertical datums. A threshold of 3 feet (MLLW) was used to extract storm tide data from the historic data. For tide events exceeding the 3 foot threshold, 72 hr. data blocks of tide data were extracted for further evaluation. The tide data sets, extracted in feet (MLLW),

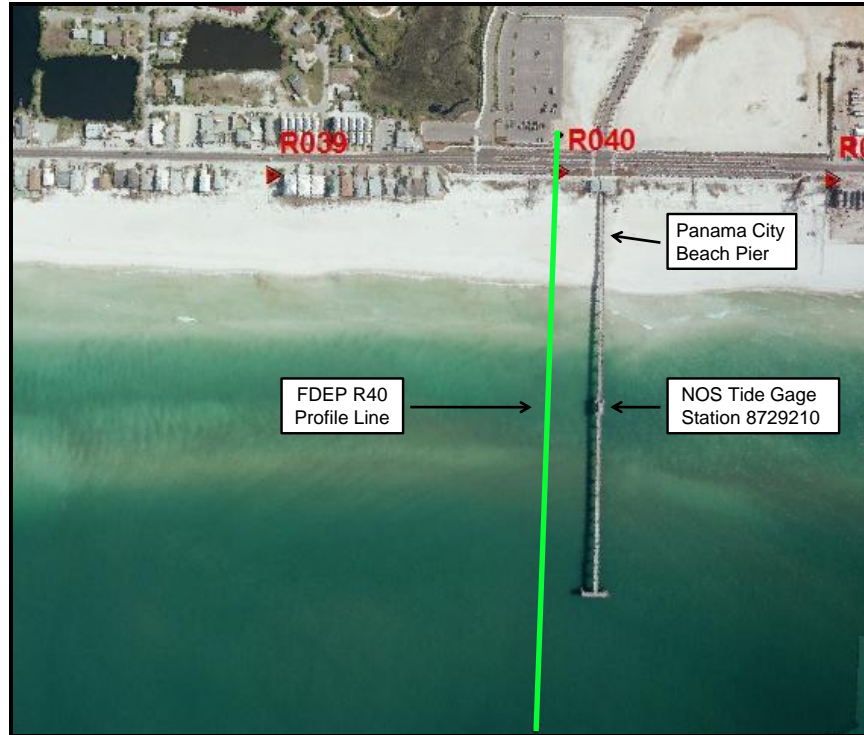


Figure 2. Pre-Ivan aerial photo depicting location of NOS tide gage and R40 profile line

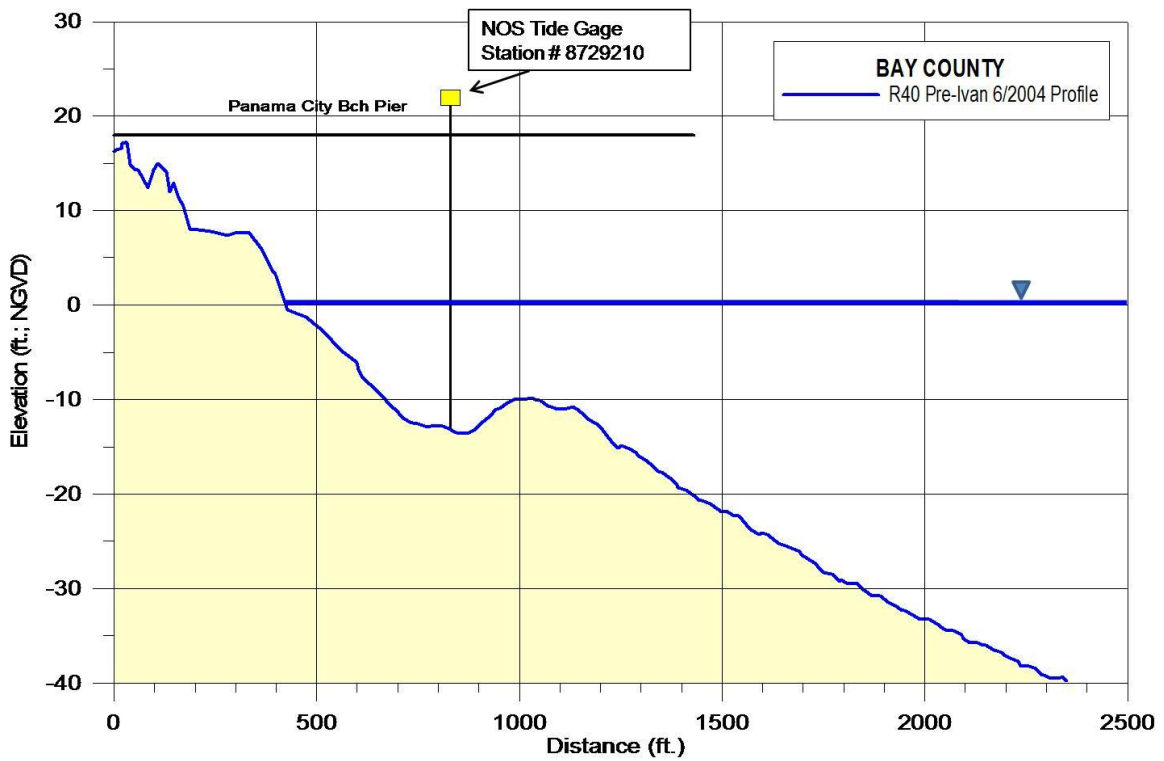


Figure 3. Pre-Ivan (6/2004) survey profile at R40 and approximate tide gage location

were converted to the NGVD-1929 vertical datum consistent with the storm hydrograph work for Walton and Okaloosa counties performed by FSU-BSRC (2009).

2.2 Storm Tide Measurements and Evaluation

The archived verified data records were reviewed for each year that tide data was obtained from the tide gage. The described storm threshold was applied during review of the data and each qualifying occurrence was extracted. For each storm event occurrence, 72 hours (3 days) of data was extracted which extended for a complete day before and after the day which contained peak tide elevation(s).

A total of 14 occurrences/events which met the threshold criterion were extracted during the 15 years of tide gage records. The events were catalogued by date of occurrence. A companion review was performed of storm reports compiled by the National Hurricane Center (NHC) and archived on the NHC website. Named storms/hurricanes affecting the Gulf of Mexico at Panama City Beach which corresponded to the dates of the tide gage events were identified. All except two of the 14 events corresponded with named tropical storms or hurricanes. A list of the event dates, event names, and landfall locations for the 14 events is given in Table 1.

Table 1

Gulf of Mexico Storms/Hurricanes Affecting the Florida Panhandle Coast 1993-2007

1)	07-03-94	TS Alberto	Destin, FL
2)	10-02-94	no-name	-----
3)	08-02-95	Hurricane Erin	Pensacola
4)	10-04-95	Hurricane Opal	Pensacola
5)	09-03-98	Hurricane Earl	Panama City Beach
6)	09-28-98	Hurricane Georges	Biloxi, MS
7)	10-14-01	no-name	-----
8)	10-03-02	Hurricane Lili	LA coast
9)	09-16-04	Hurricane Ivan	Gulf Shores, AL
10)	06-11-05	TS Arlene	(just west of) Pensacola
11)	07-10-05	Hurricane Dennis	SR Is. between Navarre Beach & Gulf Breeze
12)	08-29-05	Hurricane Katrina	Buras, LA
13)	09-24-05	Hurricane Rita	SW tip of LA
14)	06-13-06	TS Alberto	Adams Bch (Big Bend), FL

The 72 hour storm tide records were plotted for each of the 14 events and reviewed. One of the events, a no-name event of October 14, 2001, was discarded from the compiled

storm data upon inspection of the hydrograph as a result of irregularities and anomalies in the hydrograph. After review of the hydrographs for the remaining 13 events, the storm tide hydrographs were organized into three groups for further evaluation. Group 1 consists of storms with tide elevations exceeding 3 feet (NGVD), and includes all 13 events. Group 2 removed some of the lower elevation, marginal events and consists of a total of 6 of the storms. Group 3 includes only the highest 3 storm tide elevation events and consists of Hurricanes Opal, Ivan, and Dennis.

It should be noted that the tide gage location is within the outer margins of the surf zone for many or all of these storm events. As such, effects of set-up (or set-down) are likely included in the measured data. Since the intent of the work described in this report is for evaluation of the hydrograph shapes, as described previously, then the extent of wave-influenced effects are not particularly significant to the results of this work. Some more specific attention to the set-up effects in the measured data can be found in the report by Leadon and Nguyen (2009).

Plots of the hydrographs for all storms included in each of the three storm groups and an average hydrograph for each group are shown in Figures 4, 5, and 6. Peak storm tides for the hydrographs have been lined up for better hydrograph comparison and for computing averages by adjusting the time occurrences for the tide data. An additional hydrograph plot is provided in Figure 7 which shows the average hydrographs for each storm group superimposed for comparison purposes.

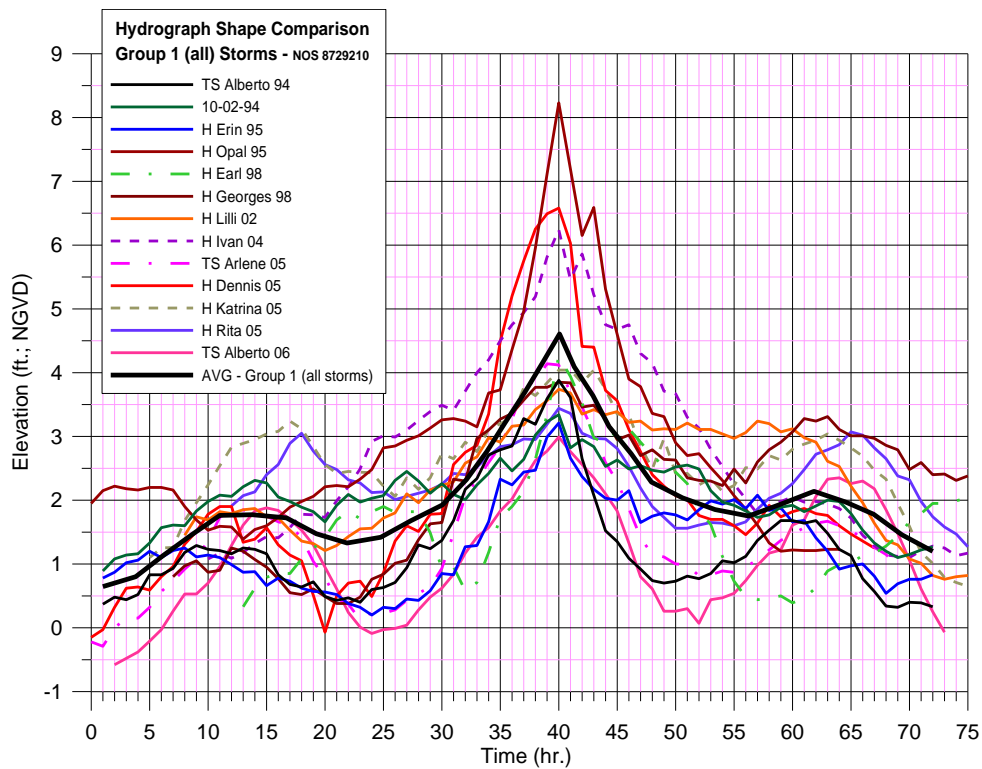


Figure 4. Measured hydrographs for 13 storm events (Group1) at Panama City Beach pier

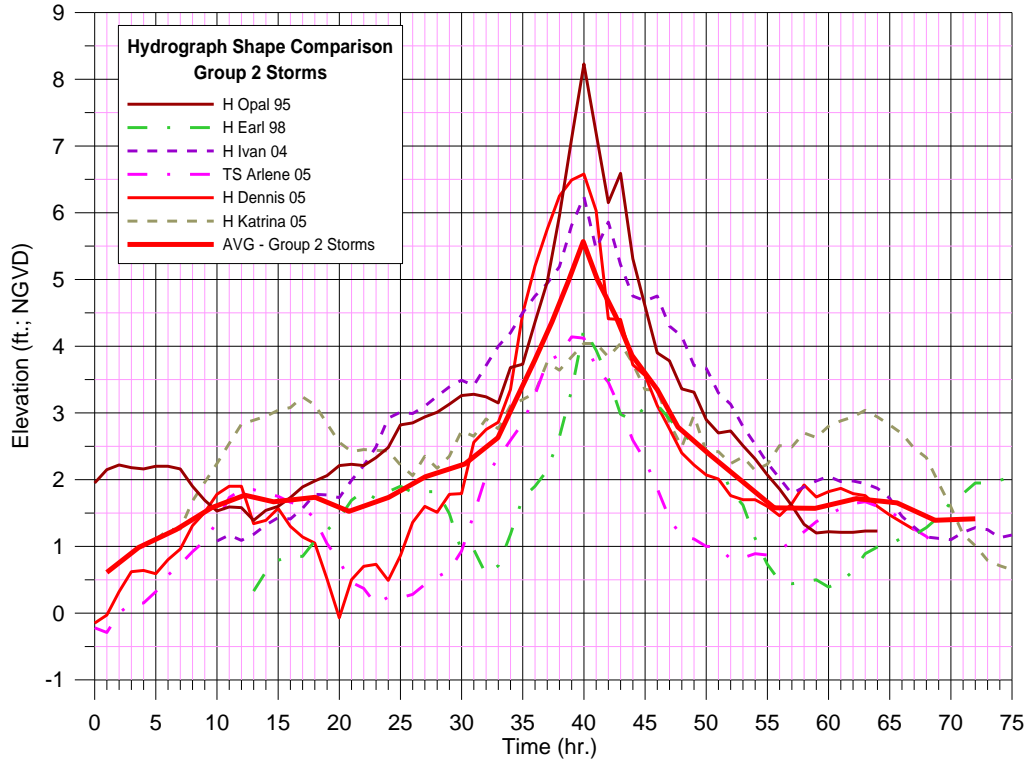


Figure 5. Measured hydrographs for 6 storm events (Group 2) at Panama City Beach pier

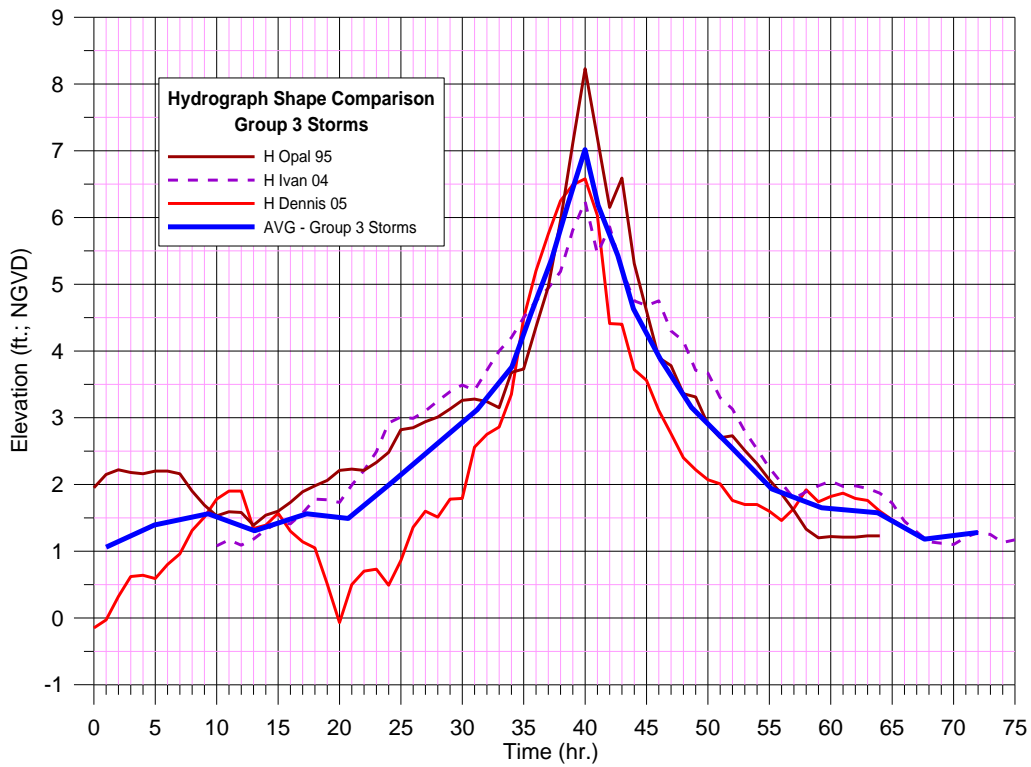


Figure 6. Measured hydrographs for 3 storm events (Group 3) at Panama City Beach pier

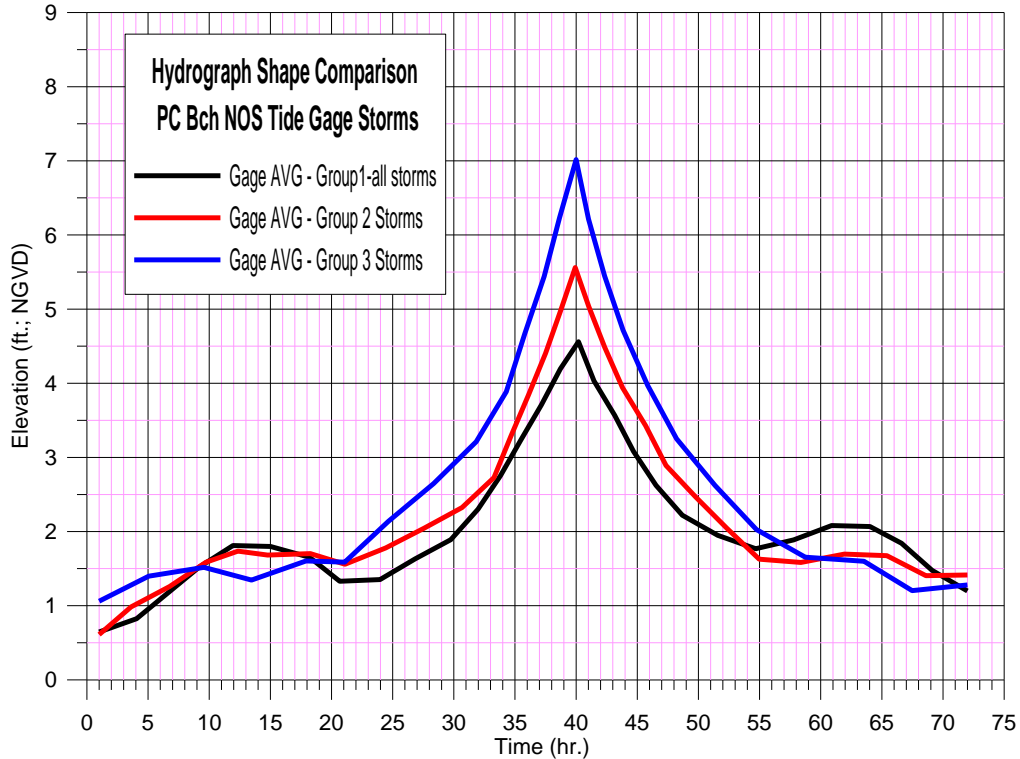


Figure 7. Average measured hydrographs for the 3 storm event groups

3.0 Conclusions and Recommendations

Tide gage records from NOS tide gage #8729210 were evaluated in order to provide field data support for characteristic shape of storm tide hydrographs, particularly for high-frequency storms (for example, 15-25 yr. return period). Storm tide hydrograph data from the available tide gage records may provide basis for selection of computer model-generated high-frequency storm tide hydrographs.

Available long-term open coast tide gage data was obtained by NOAA/NOS at the Panama City Beach's Dan Russell pier from January 1993 through January 2008. A total of 13 storm tide hydrographs were evaluated from the tide gage data records. Three groups of hydrographs were evaluated, including one group with all 13 storms, a second group with the 6 highest storm hydrographs, and a third group with the highest 3 storm tide hydrographs. Average hydrographs were calculated and plotted for the three groups for evaluation and comparison purposes.

Review of the average hydrographs compiled in Figure 7 may be useful in selecting a characteristic hydrograph shape for model-generated hydrographs for high-frequency storms. The average hydrographs for the three storm groups shown in the figures above are based on measured storm tides recorded in nearshore water depths (approximately -15 feet NGVD) and do not represent maximum storm tides. However, the average hydrographs provide a good basis for selecting characteristic hydrograph shapes for high-

frequency storms. It is recommended that the measured storm tide hydrographs be considered in high-frequency storm tide hydrograph development.

4.0 References

- 1) Florida State University-Beaches and Shores Resource Center, “Inclusion of Tropical Storms for the Combined Total Storm Tide Frequency Re-Study for Walton County, Florida (revised May 2009) ”, May 2009.
- 2) Florida State University-Beaches and Shores Resource Center, “Inclusion of Tropical Storms for the Combined Total Storm Tide Frequency Re-Study for Okaloosa County, Florida (revised May 2009) ”, May 2009.
- 3) Leadon, M.E., Nguyen, N. T., “SBEACH Erosion Modeling Analysis for Walton County and Okaloosa County, Florida”, Florida State University-Beaches and Shores Resource Center, May 2009.
- 4) U.S.-NOAA, National Ocean Service, Tides Online, <http://tidesonline.noaa.gov/>
- 5) U.S.- NOAA, National Hurricane Center, <http://www.nhc.noaa.gov/>