NOAA Technical Memorandum NOS CS 14

VDATUM FOR THE NORTHEAST GULF OF MEXICO FROM MOBILE BAY, ALABAMA, TO CAPE SAN BLAS, FLORIDA: TIDAL DATUM MODELING AND POPULATION OF THE MARINE GRIDS

Silver Spring, Maryland
August 2008

noaa National Oceanic and Atmospheric Administration

U.S. DEPARTMENT OF COMMERCE
National Ocean Service
Coast Survey Development Laboratory

Office of Coast Survey
National Ocean Service
National Oceanic and Atmospheric Administration
U.S. Department of Commerce

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ABSTRACT

To enable conversion between tidal, orthometric, and three-dimensional datums, a vertical datum transformation tool, VDatum, has been designed through a collaboration of NOAA's National Geodetic Survey (NGS), Center for Operational Oceanographic Products and Services (CO-OPS), and the Office of Coast Survey's (OCS) Coast Survey Development Laboratory (CSDL). The datum transformations already available in the VDatum toolbox include the transformation among three-dimensional datums, among orthometric datums, and between the three dimensional datums and orthometric datums. This report chronicles the continuing work to determine the datum transformations among tidal datums and between the tidal datums and the orthometric datums. The focus of this work is on the area from Mobile Bay, Alabama, in the west to Cape San Blas, Florida, in the east. A hydrodynamic model was created to simulate the astronomical tides in this area. The model results were corrected, using a spatial interpolation method, to match the model results to data at NOS tide stations. The final datums were used to populate a VDatum marine grid. The sea surface topography, or the difference between local mean sea level and the North American Vertical Datum of 1988 (NAVD 88) geopotential surface was modeled throughout this region and incorporated in the final VDatum software package.

Key Words: tides, tidal datums, Mobile Bay, Perdido Bay, Pensacola Bay, Choctawatchee Bay, St. Andrew Bay, St. Joseph Bay, Cape San Blas, finite element model, hydrodynamic model, ADCIRC, North American Vertical Datum of 1988, mean sea level, spatial interpolation, coastline, bathymetry.

1. INTRODUCTION

This paper documents the continuing work for the VDatum project in the Gulf of Mexico and estuaries from Mobile Bay, Alabama, in the west to Cape San Blas, Florida, in the east. This VDatum project was conducted as a part of NOAA's Gulf of Mexico Storm Surge Partnership Program, and the model domain and grid will be used for the marine portion of future storm surge modeling work.

The National Ocean Service (NOS) of the National Oceanic and Atmospheric Administration (NOAA) requires tidal datum information such as Mean High Water (MHW) and Mean Lower Low Water (MLLW) to support nautical charting, navigational safety, shoreline photogrammetry, marine boundary determination, and inundation mapping for coastal storms (tsunamis and hurricanes) and sea level rise. In addition, tidal datum information is needed for referencing NOS' older bathymetric data from the Chart Datum of Mean Low Water (MLW) to the current Chart Datum of MLLW. A bathymetric-topographic Digital Elevation Model (DEM) can be created by converting all of the data into one datum using tidal datum and orthometric datum transformations. This DEM can be used for a variety of coastal GIS applications (Parker et al., 2001; Gesch and Wilson, 2001; Tronvig, 2005). Vertical datum transformation information will also be needed for carrying out the kinematic-GPS hydrographic surveying that NOS is planning to implement (Hess et al., 2003).

A software tool under development at NOS called VDatum is designed to transform among approximately 30 vertical reference datums (Milbert, 2002; Parker, 2002). These datums fall into three categories: ellipsoidal, orthometric, and tidal datums. The ellipsoidal datum and orthometric datum fields have already been computed as well as the transformations between these two types of datums on a national-scale grid. The transformations among tidal datums relative to Local Mean Sea Level (LMSL) and the transformation between LMSL and the North American Vertical Datum of 1988 (NAVD 88) are under development.

The two-dimensional barotropic hydrodynamic tide model ADCIRC (Luettich et al., 1992; Luettich and Westerink, 2004) was used to determine the tidal datums in this region of the Gulf of Mexico. An unstructured mesh that closely mimicked the MHW coastline was developed and bathymetry from NOS sounding data was incorporated into the grid. The model was run and the water level was recorded every 6 minutes at every node in the grid. This data was analyzed to compute the datums throughout the domain. The model results were compared to datums at NOS tide stations throughout the region and the error between the model and the data was calculated. The modeled datums were adjusted to match the tide station data by spatially interpolating the error throughout the domain. This error field was subtracted from the modeled datum fields to produce corrected datum fields that match the data at the NOS tide stations. The final corrected datums were used to populate a structured VDatum marine grid that is used in the VDatum software package. Finally, the topography of the sea surface, which relates LMSL to NAVD 88, was developed, based on leveling connections from geodetic benchmarks to tidal benchmarks in the vicinity of each tide station.

2. DATA SOURCES

This VDatum project includes the development of a hydrodynamic storm surge model whose domain and grid cover from region from the Mississippi Delta in the west to Cape San Blas in the east. The VDatum portion is intended to cover a smaller area within this domain, namely the near-shelf coastal waters out to 25 nmi as well as the bays and estuaries of Alabama and west Florida as far east as Cape San Blas. Thus the data acquired must meet both these purposes.

2.1. Coastline Data

The MHW coastline was used as a guideline for creating the unstructured grid used for the tidal datum modeling and to define the extent of the VDatum marine grid. The MHW shoreline derived from Electronic Navigational Charts (ENCs) is the most accurate shoreline available. It is based on nautical charts with scales between 1:10,000 and 1:80,000 with emphasis on the larger scales. Not all of the charts in U.S. waters are available as ENCs, and, therefore, shoreline data was not available for all areas of the domain. Where the ENC data was unavailable, NOAA's Medium Resolution shoreline was used. This shoreline has a nominal mapping scale of 1:70,000. The Medium Resolution shoreline was created by NOAA's Special Projects Office (SPO) in the 1980's, and in most places it differs slightly (around 0.1 nmi) from the ENC shoreline. This is due in part to actual physical changes in the shoreline, but mostly because the newer charts (and therefore newer shoreline) used for the ENCs have revised positions corrected with GPS. The shoreline segments were connected manually to produce one continuous shoreline segment for the land boundary and additional segments for the islands in the region.

2.2. Tide Station Data

The entire model domain extends from southern coastal Louisiana, in the west to Cape San Blas, Florida, in the east. All NOS tide stations between 28.80º N and 30.75º N latitude and between 90.20º W and 85.30º W longitude were selected from the TideSheet1005 (developed in October 2005) version of the Coast Survey Development Laboratory (CSDL) "TideSheet" data file. This data file contains tidal datums and other information as available, such as harmonic constant data ,and geodetic datums, at existing and historic CO-OPS stations. If more than one station occupied the same location, the station with the largest identification number (presumably the most recent or longest-running record) was kept and the other stations were eliminated. A total of 187 stations were found within this boundary. Next, these stations were compared to the grid that was designed for the modeling study (see Section 3). All of the stations that were more than 500 meters away from a grid node were eliminated. After this test, 117 stations remained. Seventeen of these stations were removed for a variety of reasons that are described in Appendix A.

In the end, 100 NOS tide stations were selected for the entire domain. A subset of the 74 stations that fall within the VDatum domain (that extends only from Mobile Bay, Alabama, in the west to Cape San Blas, Florida, in the east) was selected for the final model comparison and correction. The entire set of 100 stations is shown in Figure 1. The 74 stations in the VDatum region are shown in blue and the remainder in red. The locations and names are listed in Table 1.

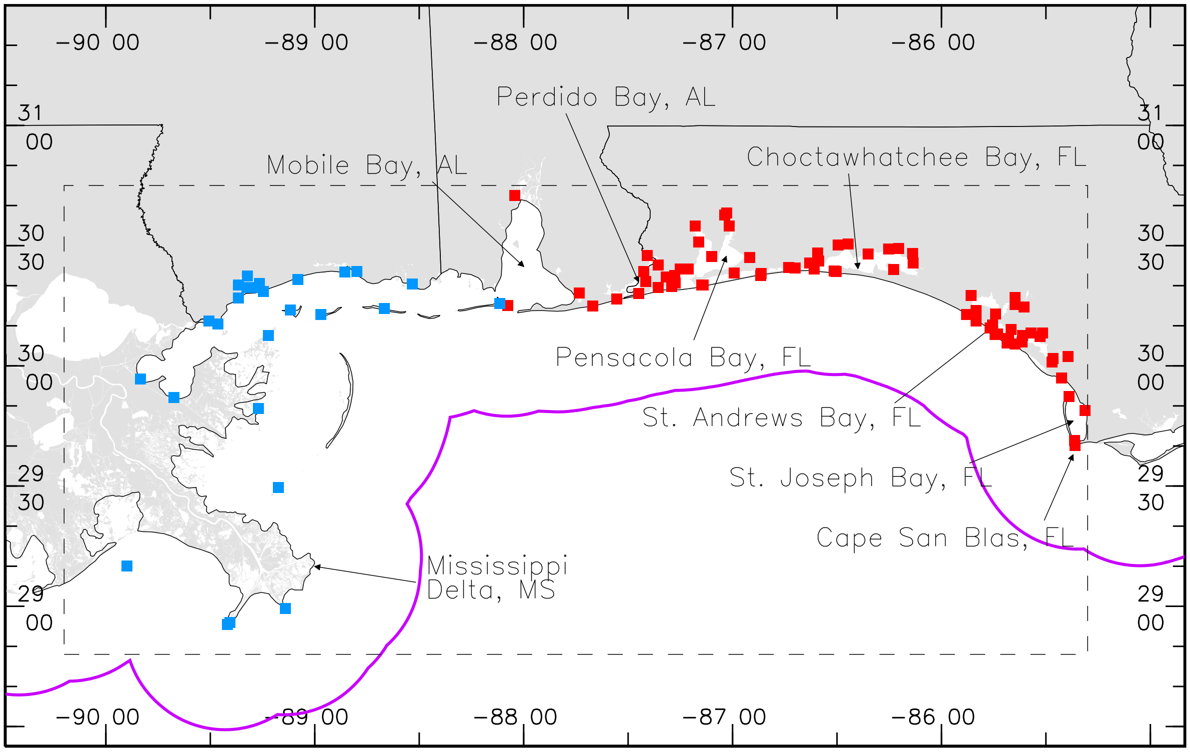


Figure 1. Tide stations in the northeast Gulf of Mexico region used to the hydro-dynamic modeling (red and blue squares) and for VDatum (red squares). The dashed lines represent the limits of the area searched for stations, and the purple line represents the 25 nmi limit.

Table 1. List of the 100 tide stations in the model domain. Stations from the 1983-2001 National Tidal Datum Epoch are marked with an asterisk (*) next to the Station ID.

No.	Station ID		Latitude	Longitude	Station Name
1	8728912	*	29.815001	-85.313332	PORT_ST_JOE_FL
2	8728942	*	29.668301	-85.360001	CAPE_SAN_BLAS
3	8728949	*	29.690001	-85.363297	RICHARDSON_HAMMOCK__ST
4	8728958	*	29.873301	-85.389999	ST._JOSEPH_POINT
5	8728973	*	30.038300	-85.393303	WETAPPO_CREEK__EAST_BAY
6	8728995		29.948299	-85.425003	MEXICO_BEACH
7	8729015	*	30.030001	-85.464996	ALLANTON__EAST_BAY
8	8729017	*	30.016666	-85.470001	FARMDALE_EAST_BAY
9	8729039	*	30.136700	-85.516701	PARKER_BRANCH__LAIRD_BAY
10	8729045	*	30.121666	-85.528336	LAIRD_BAYOU_EAST_BAY_FL
11	8729063	*	30.136700	-85.571701	CALLAWAY_BAYOU__EAST_BAY
12	8729071	*	30.245001	-85.605003	MILL_BAYOU__NORTH_BAY
13	8729084	*	30.126699	-85.611702	PARKER__EAST_BAY
14	8729085	*	30.098301	-85.613297	PEARL_BAYOU__EAST_BAY
15	8729101	*	30.283300	-85.646698	SOUTHPORT__NORTH_BAY
16	8729102	*	30.254999	-85.648300	LYNN_HAVEN__NORTH_BAY
17	8729105	*	30.091700	-85.648300	BEACON_BEACH__ST_ANDREW
18	8729108	*	30.151667	-85.666664	PANAMA_CITY
19	8729117		30.113333	-85.680000	S_OF_DAVIS_POINT
20	8729119	*	30.094999	-85.684998	SHELL_ISLAND
21	8729141	*	30.133301	-85.731697	ST._ANDREWS_STATE_PARK
22	8729149	*	30.129999	-85.743301	ST._ANDREW_STATE_PARK
23	8729152	*	30.170000	-85.754997	ALLIGATOR_BAYOU

Table 1. (Continued).

No.	Station ID		Latitude	Longitude	Station Name
24	8729155	*	30.158300	-85.768303	GRAND_LAGOON__WEST_END
25	8729169	*	30.215000	-85.739998	SHELL_POINT__WEST_BAY
26	8729189		30.186701	-85.833298	PANAMA_CITY_BEACH
27	8729193		30.230000	-85.833336	WEST_BAY
28	8729197	*	30.293301	-85.858299	WEST_BAY_CREEK
29	8729210	*	30.213333	-85.879997	PANAMA_CITY_BEACH
30	8729332	*	30.428301	-86.136703	JOLLY_BAY
31	8729333	*	30.468300	-86.138298	LA_GRANGE_BAYOU
32	8729364	*	30.488300	-86.205002	ALLAQUAY_BAYOU
33	8729376	*	30.400000	-86.228302	SANTA_ROSA_HOGTOWN_BAYOU
34	8729387	*	30.486700	-86.253304	BASIN_BAYOU
35	8729435	*	30.465000	-86.351700	BIG_HAMMOCK_PT
36	8729479		30.506666	-86.446663	ROCKY_BAYOU_FL
37	8729501	*	30.503300	-86.493301	VALPARISO__BOGGY_BAYOU
38	8729505		30.393333	-86.504997	OLD_PASS_LAGOON_FL
39	8729511	*	30.395000	-86.513298	DESTIN__EAST_PASS
40	8729538	*	30.434999	-86.586670	GARNIER_BAYOU
41	8729548	*	30.469999	-86.593300	CAMP_PINCHOT
42	8729554		30.401699	-86.610001	FORT_WALTON_BEACH
43	8729567	*	30.428301	-86.631699	CINCO_BAYOU
44	8729598	*	30.406700	-86.699997	HULBERT_FIELD
45	8729613	*	30.408300	-86.731697	HARRIS__SANTA_ROSA_SND
46	8729678	*	30.376667	-86.864998	NAVARRE_BEACH_FL
47	8729679	*	30.385000	-86.863297	SANTA_ROSA_SOUND
48	8729702		30.450001	-86.918297	EAST_BAY__HOLLEY
49	8729736	*	30.386700	-86.991699	WOODLAWN_BEACH
50	8729747	*	30.581699	-87.014999	SHIELD_POINT__BLACKWATER
51	8729753	*	30.636700	-87.028297	BLACKWATER_RIVER
52	8729757	*	30.626699	-87.036697	MILTON
53	8729791	*	30.455000	-87.099998	HERNANDEZ_POINT_NORTH
54	8729806	*	30.336700	-87.139999	FISHING_BEND__SANTA_ROSA
55	8729808	*	30.336700	-87.146698	LITTLE_SABINE_BAY
56	8729816		30.514999	-87.161697	LORA_POINT__ESCAMBIA_BAY
57	8729824	*	30.581699	-87.180000	FLORIDATOWN__ESCAMBIA_BAY
58	8729840	*	30.403299	-87.211700	PENSACOLA__PENSACOLA_BAY
59	8729849	*	30.401699	-87.251701	BAYOU_CHICO
60	8729868	*	30.344999	-87.273300	PENSACOLA__NAVAL_AIR_STA
61	8729871	*	30.375000	-87.276703	WARRINGTON__BAYOU_GRANDE
62	8729882	*	30.330000	-87.291702	FORT_PICKENS__PENSACOLA
63	8729889	*	30.370001	-87.318298	HEAD_OF_BAYOU_GRANDE
64	8729905	*	30.418301	-87.356697	MILLVIEW__PERDIDO_BAY
65	8729909	*	30.326700	-87.356697	BIG_LAGOON
66	8729938	*	30.350000	-87.415001	TARKLIN_BAY
67	8729943	*	30.458300	-87.408302	HURST_HAMMOCK__PERDIDO
68	8729962	*	30.393299	-87.425003	PERDIDO_BAY
69	8729974	*	30.299999	-87.448303	PERDIDO_KEY__OLD__RIVER
70	8730667	*	30.278299	-87.555000	ALABAMA_POINT__PERDIDO
71	8731269		30.248333	-87.668335	GULF_SHORES_AL
72	8731952	*	30.303301	-87.735001	BON_SECOUR
73	8735180	*	30.250000	-88.074997	DAUPHIN_ISLAND_AL
74	8737048	*	30.708300	-88.043297	MOBILE_STATE_DOCKS
75	8735587		30.258333	-88.113335	NORTH_POINT_DAUPHIN_ISL
76	8741196		30.340000	-88.533302	PASCAGOULA_POINT
77	8742221	*	30.238300	-88.666702	HORN_ISLAND

Table 1. (Continued).

No.	Station ID		Latitude	Longitude	Station Name
78	8743281	*	30.391701	-88.798302	OCEAN_SPRINGS
79	8743735	*	30.389999	-88.856697	BILOXI_(CADET_POINT)
80	8744756	*	30.213301	-88.971703	SHIP_ISLAND
81	8745557	*	30.360001	-89.081703	GULFPORT_HARBOR
82	8745799	*	30.231701	-89.116699	CAT_ISLAND
83	8746819	*	30.309999	-89.245003	PASS_CHRISTIAN_YACHT_CLUB
84	8746943		30.341667	-89.264999	HENDERSON_AVE_BAYOU_PORT
85	8747131	*	30.326700	-89.288300	MALLINI_BAYOU_NORTH
86	8747398	*	30.373301	-89.321701	NORTH_SHORE__BAY_OF_ST.
87	8747437	*	30.325001	-89.324997	BAY_WAVELAND_YC_BAY_ST
88	8747739	*	30.336700	-89.366699	JOURDAN_RIVER_ENTRANCE__
89	8747766	*	30.281666	-89.366669	WAVELAND_MISSISSIPPI_SND
90	8748525		30.173334	-89.463333	LOWER_POINT_CLEAR
91	8748842	*	30.186666	-89.506668	WESTERN_CAMPBELL_OUTSIDE
92	8760551	*	28.990000	-89.139999	SOUTH_PASS_LA
93	8760595	*	29.493299	-89.173302	BRETON_ISLAND
94	8760668	*	30.126667	-89.221664	GRAND_PASS_LA
95	8760742	*	29.823334	-89.269997	COMFORT_ISLAND_LA
96	8760922	*	28.931700	-89.406700	PILOTS_STATION_EAST_SND
97	8760943	*	28.924999	-89.418297	PILOT_STATION__SW_PASS
98	8761305	*	29.868334	-89.673332	SHELL_BEACH_LAKE_BORGNE
99	8761529	*	29.945000	-89.834999	MARTELLO_CASTLE
100	8761623		29.166666	-89.900002	HUMBLE_OIL_PLATFORM

In the following figures the tide stations and their 7-digit NOS identification numbers are shown.

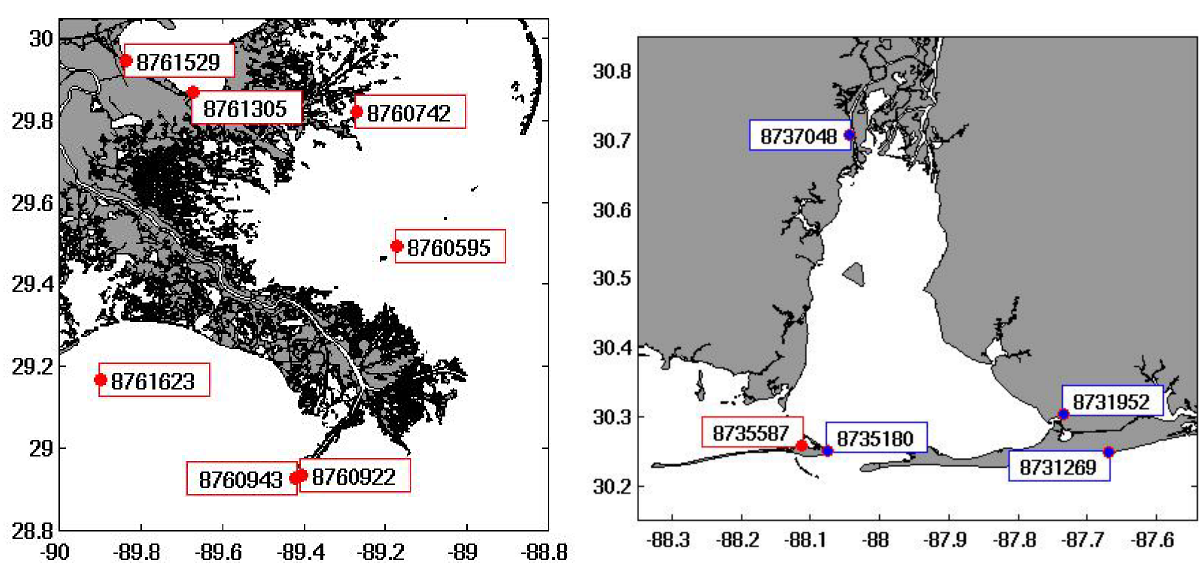


Figure 2. Tide stations on the Mississippi River Delta (left) and in Mobile Bay (right).

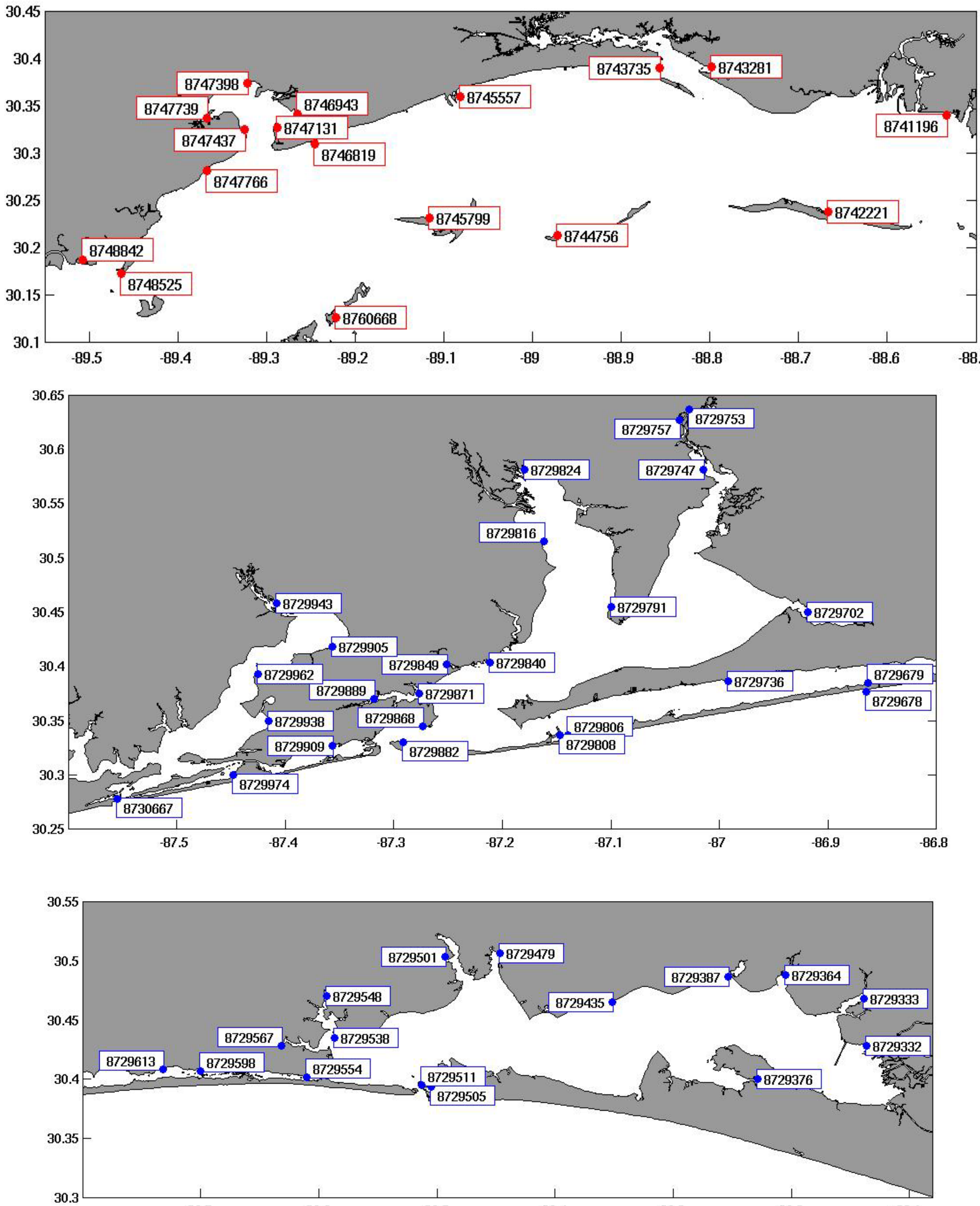


Figure 3. Tide stations in Mississippi (top), Perdido and Pensacola Bays (mid), and Choctawachee Bay (bottom).

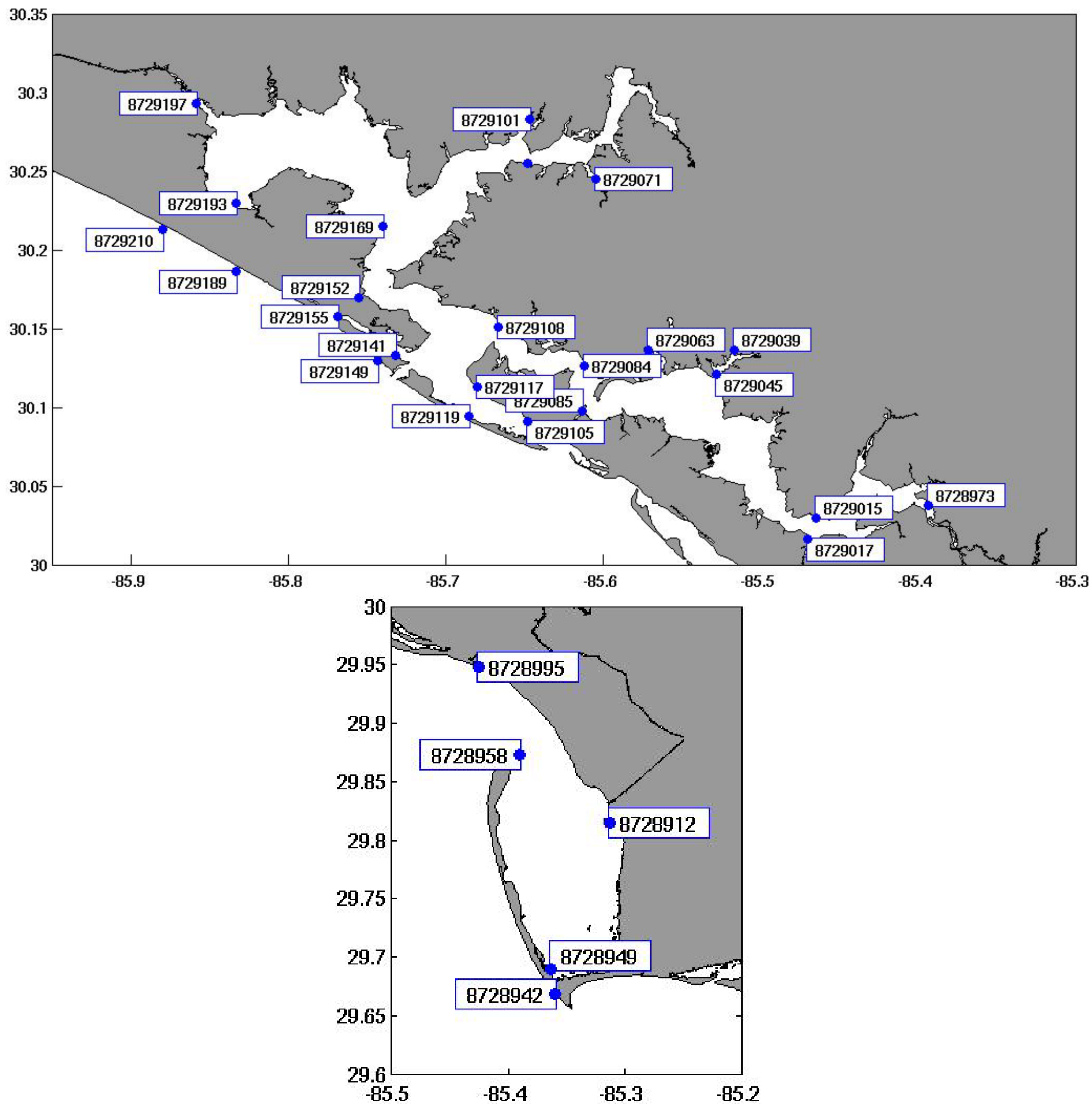


Figure 4. Tide stations in St Andrews Bay (top) and in St Joseph Bay (bottom).

Of the 74 stations in the VDatum area (which are the first 74 stations listed in Table 1), all have been updated to the 1983-2001 NTDE except for 9 stations, which are referenced to the 1960-1978 NTDE. The 65 stations that were updated to the 1983-2001 NTDE were compared with data at the same location from the 1960-1978 NTDE. The absolute averaged difference in the Diurnal Range of Tide (GT), which is the difference between MHHW and MLLW, between the datums for adjacent NTDEs averaged over all stations is 0.86 cm, which is 3.2% of the total GT. Although several outliers exist, the average difference is low enough that the 9 stations still referenced to the 1960-1978 NTDE were deemed acceptable and used for model validation and correction. In general, differences of the range of tide between NTDE periods should only be expected if the tidal hydrodynamics change significantly over time, such as due to dredging and channel deepening (Zervas, 2003). Table 2 lists the range for each of the 65 stations and the statistics computed at each station.

Table 2. Diurnal tide ranges from the Old (1960-1978) and the New (1983-2001) National Tidal Datum Epochs, and the differences. Percent is 100 times the Difference, divided by the mean of Old and New ranges.

Station	Range (m) 1960-1978 NTDE	Range (m) 1983-2001 NTDE	Ratio (New/Old)	Difference(m) (Old – New)	Percent
8728912	0.509	0.504	0.99	0.005	0.99%
8728942	0.424	0.438	1.03	-0.014	3.33%
8728949	0.530	0.522	0.98	0.008	1.59%
8728958	0.475	0.475	1.00	0.000	0.10%
8728973	0.518	0.504	0.97	0.014	2.77%
8729015	0.471	0.466	0.99	0.005	1.07%
8729017	0.486	0.476	0.98	0.010	2.08%
8729039	0.451	0.438	0.97	0.013	2.95%
8729045	0.456	0.448	0.98	0.008	1.77%
8729063	0.451	0.438	0.97	0.013	2.95%
8729071	0.463	0.456	0.98	0.007	1.59%
8729084	0.439	0.432	0.98	0.007	1.59%
8729085	0.433	0.428	0.99	0.005	1.12%
8729101	0.479	0.472	0.99	0.007	1.38%
8729102	0.457	0.448	0.98	0.009	2.03%
8729105	0.408	0.402	0.98	0.006	1.59%
8729108	0.418	0.409	0.98	0.009	2.08%
8729119	0.402	0.400	0.99	0.002	0.58%
8729141	0.424	0.418	0.99	0.006	1.35%
8729149	0.475	0.466	0.98	0.009	2.02%
8729152	0.421	0.417	0.99	0.004	0.95%
8729155	0.396	0.392	0.99	0.004	1.08%
8729169	0.445	0.418	0.94	0.027	6.26%
8729197	0.460	0.444	0.97	0.016	3.59%
8729210	0.427	0.418	0.98	0.009	2.13%
8729332	0.168	0.170	1.01	-0.002	1.40%
8729333	0.134	0.131	0.98	0.003	2.35%
8729364	0.155	0.153	0.98	0.002	1.59%
8729376	0.134	0.178	1.33	-0.044	28.12%
8729387	0.131	0.123	0.94	0.008	6.35%
8729435	0.137	0.148	1.08	-0.011	7.60%
8729501	0.137	0.151	1.10	-0.014	9.61%
8729511	0.155	0.186	1.20	-0.031	17.90%
8729538	0.128	0.124	0.97	0.004	3.19%
8729548	0.152	0.134	0.88	0.018	12.85%
8729554	0.162	0.156	0.97	0.006	3.49%
8729567	0.140	0.142	1.01	-0.002	1.27%
8729598	0.360	0.356	0.99	0.004	1.02%
8729613	0.381	0.381	1.00	0.000	0.00%
8729678	0.427	0.421	0.99	0.006	1.35%
8729679	0.427	0.422	0.99	0.005	1.11%
8729736	0.421	0.415	0.99	0.006	1.35%
8729747	0.472	0.484	1.02	-0.012	2.42%
8729753	0.494	0.505	1.02	-0.011	2.25%

Table 2. (Continued).

Station	Range (m) 1960-1978 NTDE	Range (m) 1983-2001 NTDE	Ratio (New/Old)	Difference(m) (Old – New)	Percent
8729757	0.491	0.482	0.98	0.009	1.79%
8729791	0.402	0.397	0.99	0.005	1.34%
8729806	0.393	0.391	0.99	0.002	0.56%
8729808	0.396	0.392	0.99	0.004	1.08%
8729824	0.445	0.442	0.99	0.003	0.68%
8729840	0.387	0.383	0.99	0.004	1.06%
8729849	0.381	0.376	0.99	0.005	1.32%
8729868	0.366	0.364	1.00	0.002	0.48%
8729871	0.372	0.368	0.99	0.004	1.04%
8729882	0.357	0.350	0.98	0.007	1.87%
8729889	0.384	0.376	0.98	0.008	2.12%
8729905	0.229	0.229	1.00	0.000	0.17%
8729909	0.311	0.322	1.04	-0.011	3.51%
8729938	0.189	0.193	1.02	-0.004	2.11%
8729943	0.238	0.240	1.01	-0.002	0.94%
8729962	0.219	0.218	0.99	0.001	0.67%
8729974	0.195	0.247	1.27	-0.052	23.49%
8730667	0.265	0.262	0.99	0.003	1.14%
8731952	0.472	0.470	1.00	0.002	0.52%
8735180	0.372	0.367	0.99	0.005	1.31%
8737048	0.500	0.479	0.96	0.021	4.26%

2.3. Bathymetric Data

All of the bathymetric data for this project came from NOS sounding data archives or were digitized directly from the nautical charts. A search of the NOAA National Geodetic Data Center’s (NGDC’s) GEOphysical DAta System (GEODAS) yielded a total of 328 NOS hydrographic surveys conducted within the model domain. Of these surveys, 125 were referenced to MLLW and the other 202 were referenced to MLW. The dates of the MLW surveys range from 1899 to 1989, and the MLLW survey dates range from 1935 to 1994. These data are saved in file pscola_nos_bathy.tar. Additionally, 6,823 sounding depths were digitized from current Electronic Navigation, and these were all referenced to MLLW. These data are saved in file dig_bathy.tar. A sample of the depths from NGDC’s Coastal Relief Model in the coastal region of the study area is shown in Figure 5. Additional information about the source of the bathymetric data is given in Appendix B.

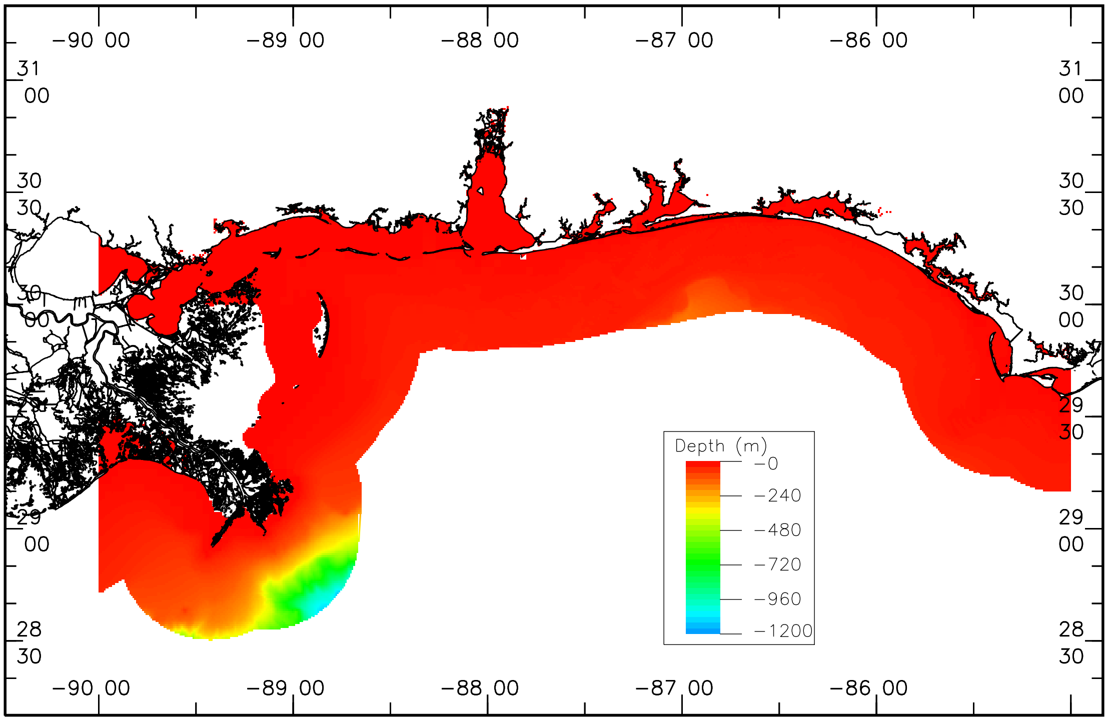


Figure 5. Bathymetry in the coastal region within 25 nmi of the coastline. Data are from NOAA's Coastal Relief Model.

3. TIDAL DATUM MODELING

Throughout the development of the VDatum vertical datum transformation software, several approaches have been used for computing the tidal datum fields that are used to populate the VDatum marine grids. The simplest method is to spatially interpolate the datum values directly from the NOS tide stations. This method works best in an enclosed bay or estuary with a dense network of stations. An example of this method was used in the creation of the first version of the Delaware Bay VDatum application (Hess et al., 2003). The second method that has been employed for the VDatum project is to use data from a pre-existing tidal constituent database. The harmonic constant data is re-constituted into water level time series, which are then analyzed to calculate the tidal datum fields. The datums are adjusted so that the datums match the NOS tide station data at those locations. This method is dependent on the availability of a tidal constituent database in the area of interest. This method was used for the creation of the Strait of Juan de Fuca VDatum application (Spargo et al., 2006). The third method, which was used for this study, is to set up and run a regional hydrodynamic model. This approach is the most complex and time consuming as the modeler needs to create a grid for the domain, populate this grid with bathymetry, set the model parameters, and run the model several times to converge to the best modeled solution. At that point, the error between the model and the station data is spatially interpolated to allow the final datum fields to match the station data at those locations. The advantage of this approach over using tidal databases is the flexibility in grid design over the pre-positioned tidal constituent database grids. Another example of a VDatum application using this approach is in the Central North Carolina area (Hess et al., 2005). Whereas the interpolation of the datums does not address the underlying physical processes, the model will more accurately reflect the hydrodynamics in the region.

3.1. Hydrodynamic Model

The hydrodynamic model used for this study was the two-dimensional, depth-integrated version of the ADvanced CIRCulation (ADCIRC) model (Luettich et al., 1992; Luettich and Westerink, 2004). This is a barotropic finite element model that has been used in previous VDatum areas (Hess et al., 2005; Spargo and Woolard, 2005). The ADCIRC code allows a variety of user-specified input parameters. For these model runs, the full non-linear form of the equations were used, which includes non-linear bottom friction, finite amplitude and convection terms. The model runs began with a smooth hyperbolic tangent time ramp function, which was applied for the first 5 days. The open boundary of the model grid, located in the Gulf of Mexico, was forced with a synthetic tide that was generated using the amplitude and phase of six tidal constituents (K_1, O_1, Q_1, M_2, S_2, and N_2) extracted from an inverse model (Myers and Baptista, 2001; Myers, unpublished document) based on the model grid used to create the EastCoast2001 tidal constituent database (Mukai et al., 2001). The node factors and equilibrium arguments were set to the values from the middle of 1992 (which is in the middle of the 1983-2001 NTDE). A no flow boundary was set for all land segments except at the upstream end of the Perdido River, where, to prevent reflection of the tide back into Perdido Bay, a radiation boundary condition was used Wetting and drying was allowed for this model run. The lateral eddy viscosity coefficient was set to 5 m^2/s, which was the lowest possible number that did not produce numerical instabilities.

The ADCIRC model allows for several different methods of implementing bottom stress. Generally, bottom stress is expressed as $\tau_{bx}=U\tau_*$ and $\tau_{by}=V\tau_*$, where U and V are the velocity terms and τ_* is the bottom friction coefficient. For the linear friction option, $\tau_* = C_f$, where C_f is the user-specified bottom friction coefficient, and that term is constant in time, but may vary in space. For the quadratic friction option, which was used for the model runs discussed in this report, a more complex formula is used for τ_* such that:

$$\tau_* = \frac{C_f (U^2 + V^2)^{1/2}}{H} \qquad (1)$$

where H is the bathymetric depth at the node, and the C_f value was set to a standard value of 0.003.

For each iteration, the model was run for 40 days with a 3 second time step. The small time step was due to the Courant number limitation imposed by the small element sizes. The water surface elevation was recorded at every node in the grid every 6 minutes for the last 33 days of the 40-day model run. This time series data was later used to tabulate the higher-high, lower-high, higher-low, and lower-low waters, from which the datums could be computed.

The ADCIRC model has been parallelized using domain decomposition, a conjugate gradient solver and Message Passing Interface (MPI) based message passing. This parallel version of the code was compiled and run on NOAA's Earth System Research Laboratory (ESRL) EJET computer in Boulder, Colorado. It took approximately 6 wall-clock hours to complete a single 40-day run utilizing 50 processors.

3.2. Model Grid Development

The ADCIRC model takes advantage of unstructured grids, which allow increasing resolution in areas of interest or areas with complex hydrodynamics such as over the shelf break or through inlets. Knowing that the grid developed for this study would become the base grid of the Gulf of Mexico Storm Surge Partnership Project, the domain was expanded beyond the VDatum region (from Mobile Bay, Alabama, to Cape San Blas, Florida) to include Chandeleur Sound, Brenton Sound and the Mississippi Delta region in Louisiana.

Figure 6 gives several views of the unstructured grid. The resolution, which is measured as the average distance between the nodes in an element, ranges from 24 km at the open ocean boundary down to 24 m in sections of the Intracoastal Waterway. Along the coastal areas of Louisiana, the resolution is around 350 m, and the average in the Alabama and Florida regions is 100 m. For model stability, the change in size between elements must be gradual, and great care was taken to ensure a smooth transition between areas of low and high resolution. The grid has 192,889 nodes and 367,019 elements.

3.3. Incorporating Bathymetric Data

3.3.1. General Methods

Two methods were used to interpolate the bathymetric sounding data onto the grid. In most locations, the bathymetric data was added to the grid using a so-called cluster averaging approach. Each node in the grid is surrounded by a cluster of elements that share that node as one of the vertices. (For nodes that are on the edge of the grid, there may be only one or two nodes in this "cluster".) For the cluster averaging method, all of the sounding data points that fall within that cluster of elements are linearly averaged and that average is applied as the bathymetric depth for the node. This method allows the data to be filtered into the grid at the grid scale. In cases where no sounding points fall within the element cluster surrounding a node, the null value of -9999 is assigned as the bathymetric depth for that node.

The second method used was a linear interpolation option available with the Surface-Water Modeling System (SMS) software. The sounding data points are read into SMS and the program triangulates the data points to create a TIN. The surface is assumed to vary linearly across each triangle in the TIN. Since a TIN only covers the convex hull of a scatter point set, extrapolation beyond the convex hull does not occur. The nodes in the grid are assigned values based from the TIN, but any nodes outside the convex hull of the scatter point set are assigned the null value of -9999.

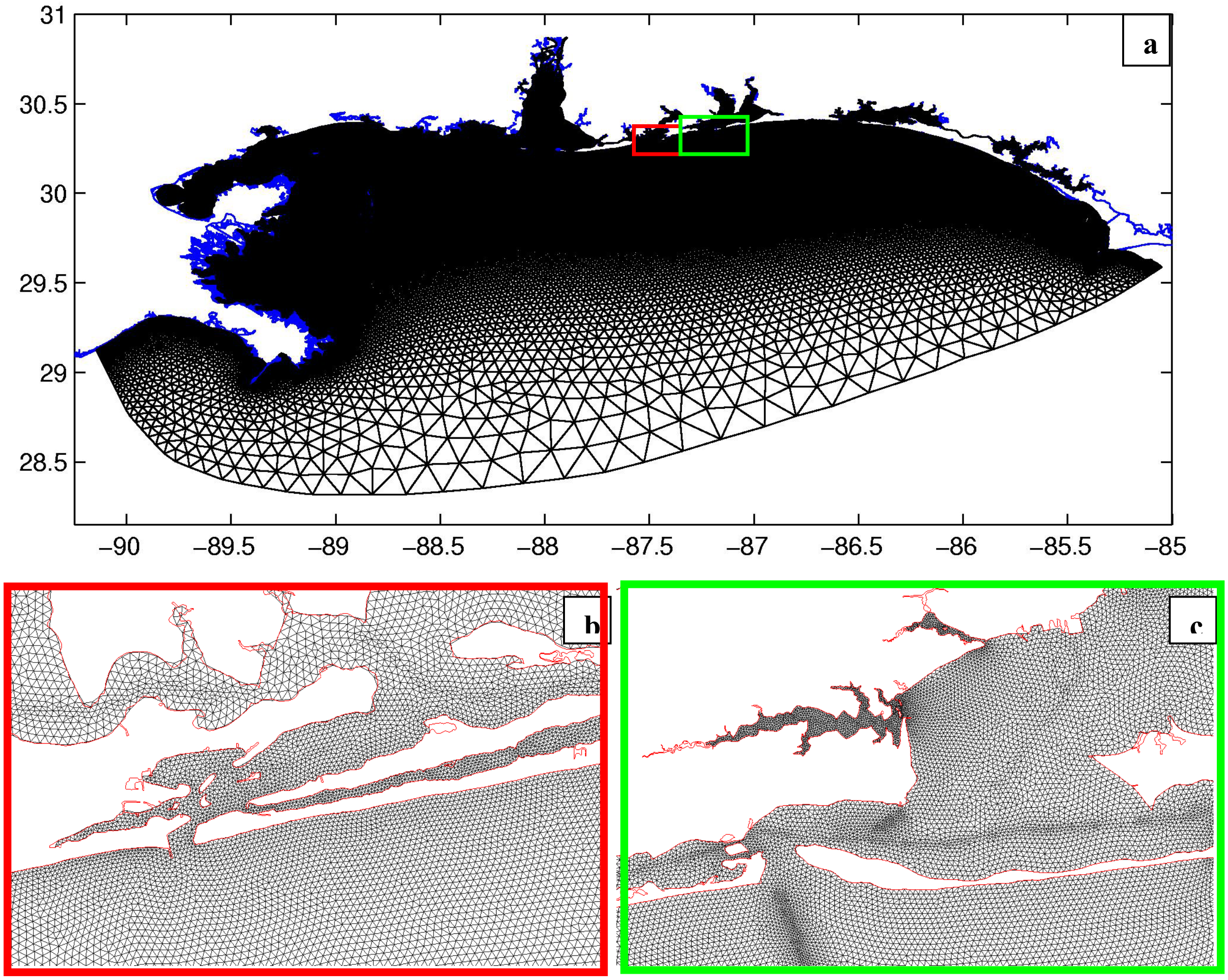


Figure 6. Unstructured grid of (a) the entire modeling region and zoomed views of the entrances to (b) Perdido Bay and (c) Pensacola Bay.

3.3.2. Adding Bathymetric Data

The bathymetry in the final unstructured grid was built up, in a sense, starting with the newest and most reliable data and filling in the gaps with older, less reliable data. Initially, all of nodes in the grid were given bathymetric depths of -9999. The survey data was added one survey at a time by date and datum. First the 126 surveys referenced to MLLW were used in order from newest to oldest. All of the data from the newest MLLW-referenced survey were added to the grid using the cluster averaging approach. In the areas where no data from that survey was found, the nodes retained the -9999 null value. This process continued with the second newest MLLW-referenced survey. In this case, if nodes had a bathymetric value (from the application of the more recent survey data), no changes would be made; only the nodes with -9999 null values could be populated with bathymetry from the second newest MLLW-referenced dataset. This process continued until all of the surveys had been processed, which resulted in a grid file with bathymetric data referenced to MLLW where it was available. The digitized soundings (referenced to MLLW) were added to this grid to expand the coverage of the MLLW data. A visual inspection showed that the recent surveys referenced to MLLW in Mobile Bay were very sparse. Eventually when the older MLW surveys (from the 1960's) were added to the sparse grid with newer surveys (from1987), the resulting bathymetry contours would be very irregular and unrealistic. To avoid this problem, the linear interpolation package available with the SMS software was used in Mobile Bay to spatially interpolate the sparse soundings. Figure 7 shows the soundings interpolated onto the grid using the cluster averaging approach and then with the SMS linear interpolation.

Next, the MLW-referenced survey data were applied to the original blank grid file (where all nodes had bathymetry listed as -9999). The data was again added survey by survey from newest to oldest. In this way, two separate grids were made where all of the data in one was referenced to MLLW and the other referenced to MLW. The data could not be combined until the data was referenced to a common datum.

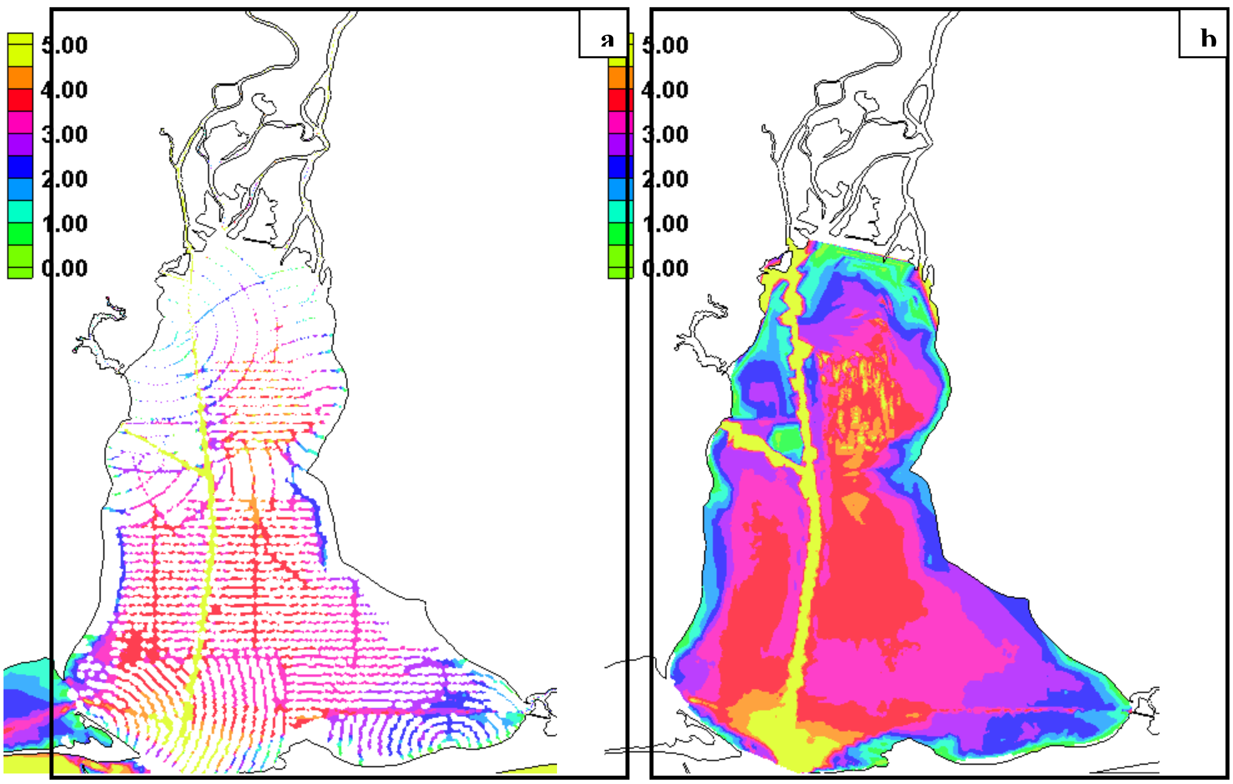


Figure 7. MLLW sounding values interpolated onto the grid by (a) the cluster averaging approach and (b) linear interpolation using the utilities in the Surface Water Modeling System software.

3.3.3. Adjusting Data to a Common Vertical Datum

The adjustment to a common datum is the most complex part of the problem. In fact, this is what the VDatum software is designed to do, but without the completed VDatum package, determining the tidal datum fields becomes an iterative process.

The first step is to make an initial guess at the datum differences. For this modeling study, the initial adjustment was a 2-step process. First the MLW-to-MLLW difference was examined at all 100 NOS tide stations throughout the region. The difference was very small, averaging only about 2 cm. In the ADCIRC model, all depths are positive numbers and heights are negative numbers, so to adjust grid with the bathymetry referenced to MLW to a grid with to MLLW-referenced data, the 2 cm offset was added to every node (except the null value nodes).

At this point, the original MLLW grid and the grid where the MLW bathymetric depths were approximately adjusted to MLLW could be combined. At the nodes where the original MLLW data was available, those depths were used, and the MLW bathymetry adjusted to MLLW was used elsewhere. There were still 6,450 nodes with -9999 null values for the depth. These were filled in by interpolation and extrapolation from the surrounding nodes.

The ADCIRC model zero (MZ) is a geopotential surface. In the open ocean, this is very close to MSL, but in the inlets and estuaries, MZ can differ from MSL. For this initial estimate, the two were assumed to be equal throughout the domain. The difference between MLLW and MSL was calculated to be a spatially varying field. This field was created using the Tidal Constituent And Residual Interpolation (TCARI) program (Hess, 2002) which used the MLLW-MSL difference from all 100 NOS tide stations located throughout the region to solve the Laplace Equation taking landforms into account. The TCARI spatial interpolation program will be discussed in more detail in Section 4, below. TCARI was run on the same unstructured grid designed for the model runs, so a spatially interpolated MLLW-MSL field was generated with an adjustment value at every node in the grid. The grid with bathymetry referenced to MLLW was easily adjusted to an estimated MSL-referenced bathymetry by adding the spatially interpolated adjustment field to the original bathymetric data.

After the initial model run (with the grid depths referenced to MSL based on the estimates discussed above), the 33-day water surface elevation time series was analyzed at each node to calculate the MHHW, MHW, MLW, and MLLW datum fields all relative to MSL. These modeled tidal datum fields were used to apply a spatially changing adjustment for the original bathymetry (instead of a constant value). The grid with the bathymetry referenced to MLW was adjusted directly to MZ (which can now vary from the MSL calculated from the model runs) without an intermediate adjustment to MLLW. The grid with the bathymetry referenced to MLLW was adjusted directly to MZ, as well. At this point, the depths values in the two grids were combined in the manner discussed above, where the depths from the MLLW-to-MZ grid were used first and the MLW-to-MZ grid depths were used second. Again, there were 6,450 nodes with null values that were filled by interpolation and extrapolation from the surrounding nodes depths.

After this initial step, the iterative process continued: after each model run, the original MLW and MLLW grid depths were adjusted to MZ and then combined to create a grid for the next model run.

3.4. Model Results

After each model run, the results were evaluated for accuracy compared to the 74 NOS tide stations in the area. Additionally, the tidal datum fields were examined visually for discontinuities or abnormalities that would indicate instabilities in the model run.

After the initial set of runs, the absolute value of the error for each modeled datum compared to the station data was generally less than 3 cm, but due to the very small tide range, this absolute error translated into a percent error of over 25% in some places. The highest errors were in the Perdido Bay area where the model results showed an over-prediction trend compared to the data. Several attempts to correct this error in this area were made. First, the domain was extended to include the lower end of the Perdido River. The results from this grid showed no marked improvement over the original results. A radiation boundary condition was added to the up-stream end of the river to prevent the tides from being reflected back into the domain. Still, the model results showed an overprediction in the tidal datum values in this region. Upon further examination, most of the tide appeared to be entering the bay not through the inlet at the entrance to Perdido Bay, but through the Intracoastal Waterway (ICW) that connects Perdido Bay to Pensacola Bay. Further refinement was added to this section of the ICW, which allowed a more accurate representation of the bathymetry in this passage. No major changes were yielded from this approach. For experimental purposes, the bathymetry in the channel was artificially truncated to create a shallower entrance to the Perdido Bay. Again, no major changes were observed. At the conclusion of these experiments, several changes were incorporated. The grid used for the final series of runs had the extended section of the Perdido River with the radiation boundary condition and increased resolution in the ICW connecting Pensacola Bay to Perdido Bay with the regular (non-modified) depths in that channel. Instead of dramatically tuning the bathymetry or other model input parameters in this region (which could disrupt the balance in other regions of the model), the final model results were accepted and corrections were made using the TCARI spatial interpolation program to match the model results to the station data located throughout the domain.

As discussed in Section 3.3 above, the first run of the model used a grid with bathymetry depths adjusted to MZ based on an initial estimate of the datum differences and the assumption that MZ and MSL were equal. The results from this model run were used to adjust the original bathymetry set. Another model run was completed where the grid for this run had bathymetry relative to MZ based on the adjustments calculated from the previous run. In total, 5 iterative model runs were completed. Negligible improvements were seen after each run indicating that the model had converged to a stable solution. Table 3 lists the absolute average and percent error for each model run for the MHHW, MHW, MLW and MLLW datums (all relative to Local MSL) averaged over all 74 NOS tide stations in the VDatum region.

Table 3. Absolute average and percent error for each datum for the final series of runs averaged for the 74 NOS tide stations in the VDatum region.

Datum	Initial Run		Run 2		Run 3		Run 4		Run 5	
MHHW-MSL	1.86cm	10.69%	1.88cm	10.64%	1.85cm	10.42%	1.85cm	10.38%	1.86cm	10.44%
MHW-MSL	1.58cm	10.52%	1.58cm	10.42%	1.55cm	10.21%	1.55cm	10.17%	1.55cm	10.23%
MLW-MSL	1.58cm	11.20%	1.58cm	11.05%	1.56cm	10.88%	1.55cm	10.82%	1.56cm	10.87%
MLLW-MSL	2.21cm	12.61%	2.22cm	12.55%	2.19cm	12.34%	2.18cm	12.28%	2.19cm	12.33%
Total Average	1.81cm	11.26%	1.81cm	11.17%	1.79cm	10.96%	1.78cm	10.91%	1.79cm	10.97%

The MHHW-MSL and MLLW-MSL datum results are shown in Figure 8 compared to the observations at the 74 NOS tide stations in the VDatum domain. The 45° line shows a one-to-one correlation. The error bars (dashed lines) are plotted to show a 5-cm difference between the model and the observations. The station name, station identification number, tidal datums at the NOS tide stations, hydrodynamic model results at those locations, difference between the two, and the absolute average percent difference are listed for all 74 stations in Appendix C.

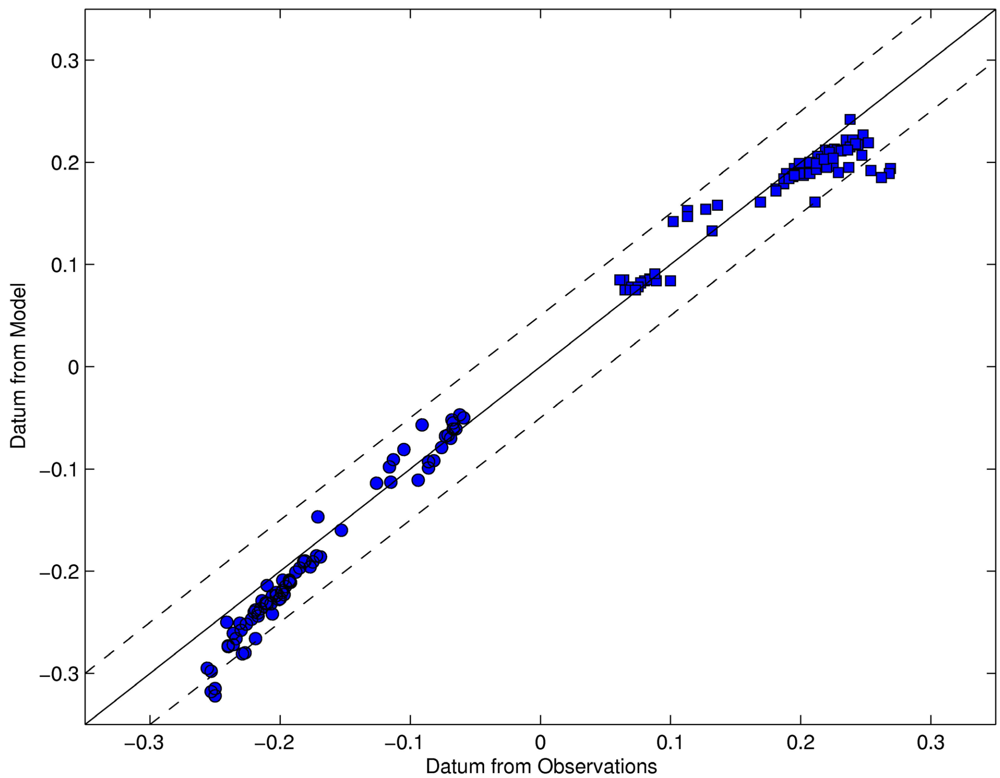


Figure 8. Comparison of the MHHW-MSL (squares) and MLLW-MSL (circles) observations (m) versus the modeled tidal datums with 5-cm error bands.

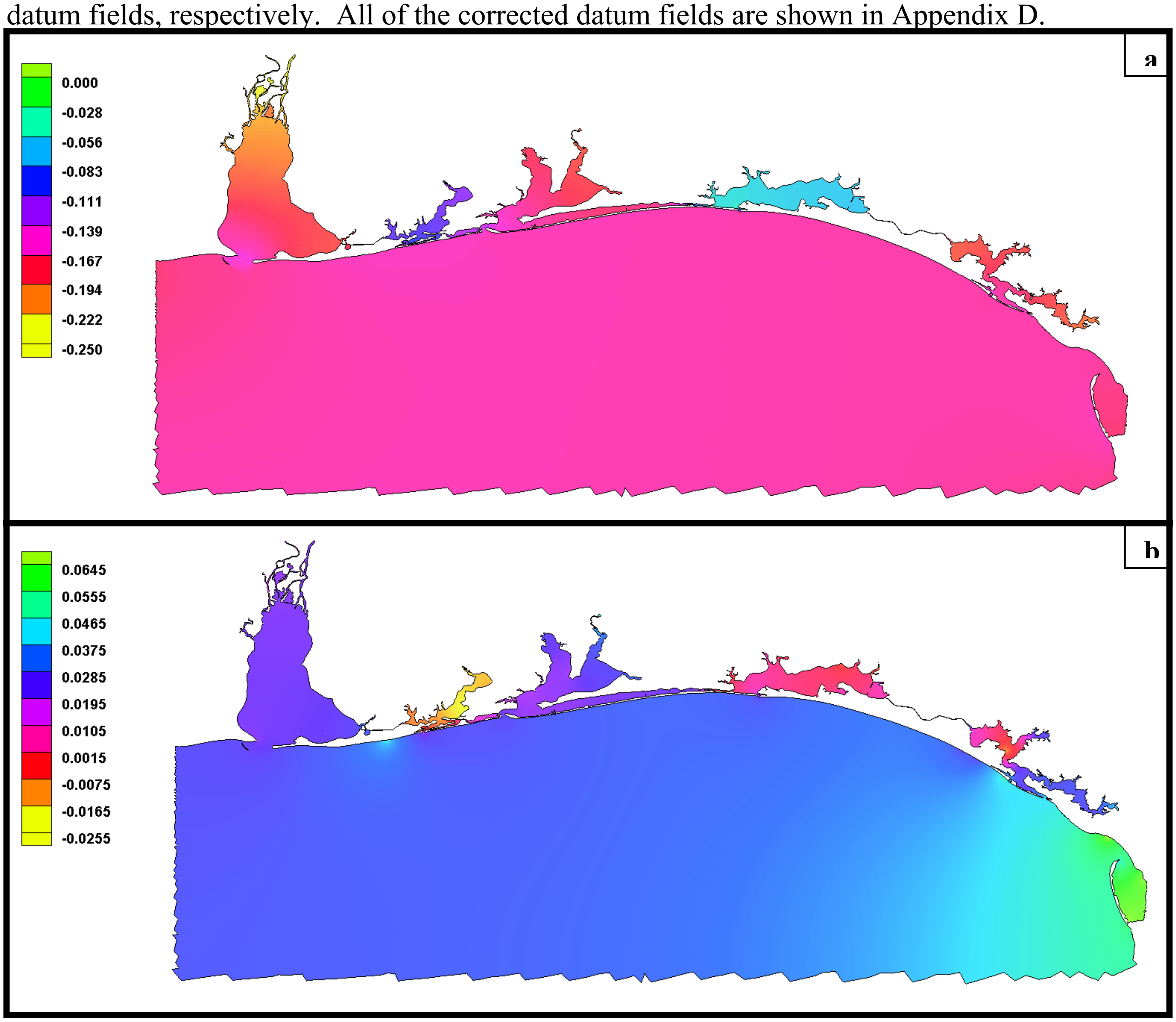
4. INTERPOLATION OF ERRORS

The datum results from the model matched closely with the NOS tide station data in most locations, but did not match exactly at any location. This is expected since the model simulates the astronomical tide only, while the station data includes meteorological effects. The VDatum project is faithful, in a sense, to the data and it is important that the datum fields used with the VDatum software match the published datums at those locations. This match is made possible by spatially interpolating the error between the model and the station data and then applying this error field to the model results.

The Tidal Constituent And Residual Interpolation (TCARI) program, which solves the Laplace Equation taking landforms into account (so that the results bend around islands and peninsulas), was used to spatially interpolate the error. This program has been discussed briefly in previous sections, but more details will be given here. TCARI is available in two versions. The first version solves the equation using the successive over-relaxation finite difference method. This version requires a structured grid. The second version solves the equation using the finite element method. This program requires a triangulated grid. Since the hydrodynamic model grid is triangulated, the finite element version of TCARI was employed so that the same grid could be used. The input into the program was the model error at the locations of the NOS tide stations. The TCARI model was run once for each datum and the results were a new grid file with the spatially interpolated error field listed as the z-value.

The model grid was designed with emphasis on the VDatum region, so the regions with the highest levels of resolution are located in this area. The model error outside that region was not evaluated, and corrections were only made in the VDatum region. To speed up the TCARI program (by eliminating computational points), a subsection of the grid was selected for the interpolation process. The final MLLW-MSL model results on that section of the grid are shown in Figure 9. Also, the TCARI interpolation of the MLLW-MSL error and the corrected model results on the same grid are shown in Figure 9.

After the corrected datum fields were created, the MTL and DTL datum fields were calculated by taking the average of MHW-MSL and MLW-MSL and the average of MHHW-MSL and MLLW-MSL at each node in the smaller model grid (shown in Figure 9) with the corrected datum fields, respectively. All of the corrected datum fields are shown in Appendix D.



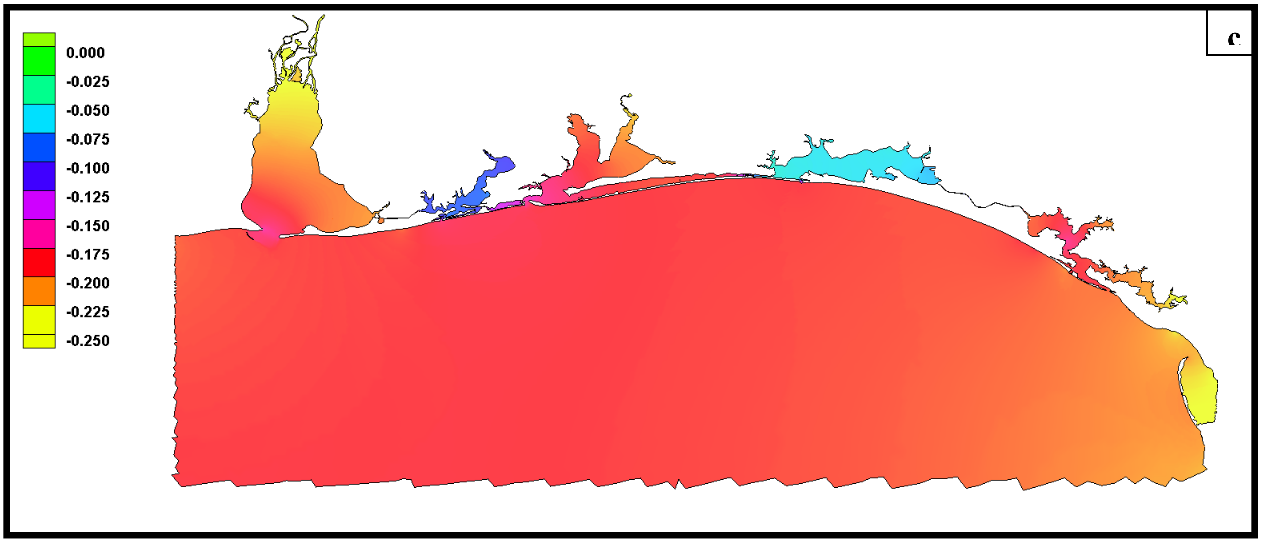


Figure 9. Subsection of the model grid with the (a) modeled MLLW-MSL (m) datum field (m), (b) interpolated MLLW-MSL error field (m), and (c) final corrected MLLW-MSL datum field (m).

5. CREATION OF THE VDATUM MARINE GRID AND POPULATION WITH DATUMS

5.1. Generation of the VDatum Marine Grid

The VDatum software requires a regular grid for the vertical datum transformation calculations. This grid is called the VDatum marine grid and every node in the grid is identified as either a water node or a land node. A computer program (`gridder.f`) is used to create this marine grid, and the program requires both a MHW coastline and a bounding polygon. First, the entire array is developed as a rectangular grid with locations within a latitude and longitude window. Next, individual nodes are designated as either land or water points. Nodes are defined as water if they are (1) completely within the bounding polygon, and are either (2a) not within a land mass or island, or (2b) within a land mass or island but are within one half of a cell size of the coastline. All nodes not meeting these criteria are defined as land. A further description of this process can be found in the paper by Hess and White (2004) describing the creation of the marine grid for Puget Sound grid.

The VDatum area was divided into sub-regions to eliminate a possible problem that can occur when a user tries a datum transformation (for example between MLLW and MSL) at a location in the middle of a barrier island. If there were no land points between the inner sounds and the outer Gulf of Mexico (which could occur if a barrier island were much narrower than the cell dimension), the VDatum program would average the value from the water nodes on the sound side with the value from the water nodes on the Gulf side and the output datum transformation would be too large for the inner sounds and too small for the outer Gulf.

The sub-regions were created as follows. In Alabama and the western Florida panhandle, the separation between the inside sounds and the outside Gulf of Mexico was created by dividing the VDatum area into separate regions. In the eastern Florida panhandle, the separation was created by increased resolution that produced at least one land cell in the middle of every barrier island. Because of the increased resolution, this area was divided into two smaller regions to keep the grid sizes small enough for easy downloads of the VDatum product. In total, five VDatum regions were created and they are shown in Figure 10. Details of the VDatum marine grids created for each of the five regions, including the limits of the grid, the zonal and meridional spacing, the number of nodes in the zonal and meridional directions, and the size of the final "gtx" file (discussed in the next section), are listed in Table 4.

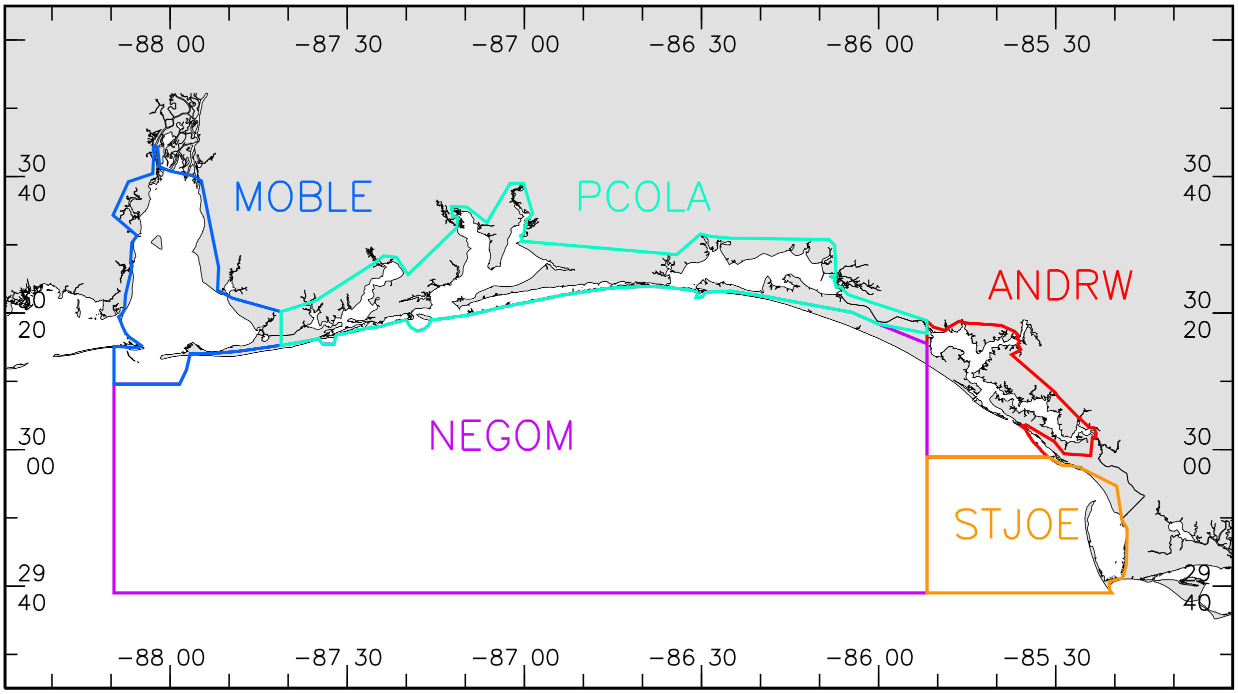


Figure 10. The VDatum bounding polygons for MOBLE, the Mobile Bay region (blue); PCOLA, the Perdido, Pensacola, and Choctawhatchee Bays region (cyan); ANDRW, the St. Andrews Bay region (red), STJOE, the St. Joseph Bay region (orange); and NEGOM, the remaining northeast Gulf of Mexico region (purple).

Table 4. VDatum grid information for the five regions.

VDatum Region	Southwestern Limit	Northeastern Limit	Horiz. Spacing deg (nmi)	Vert. Spacing deg (m)	No. of Horiz. Nodes	No. of Vert. Nodes	Size of one GTX File
MOBLE	-88.1660º, 30.1595º	-87.3277º, 30.7424º	0.0015º (146 m)	0.0010º (111 m)	560	584	3.5Mb
PCOLA	-87.6867º, 30.2580º	-85.86458º, 30.6490º	0.0015º (146 m)	0.0010º (111 m)	1216	392	5.1Mb
NEGOM	-88.1660º, 29.6500º	-85.8635º, 30.3985º	0.0025º (243 m)	0.0020º (222 m)	922	375	3.7Mb
ANDRW	-85.8634º, 29.8918º	-85.38557º, 30.3132	0.0006º	0.0004º (45 m)	797	829	7.0Mb
STJOE	-85.8634º, 29.6500º	-85.3006º, 29.9824º	0.0006º	0.0006º (67 m)	989	555	5.5Mb

5.2. Population of the VDatum Marine Grid with Tidal Datums

The VDatum software program (`vpop.f`) creates "gtx" files for each tidal datum. In the process, the corrected model results are interpolated onto the marine grid by averaging the cluster of elements that surround the marine grid node. This is a better approach than averaging the nearest model grid nodes, especially near the barrier islands and peninsulas that separate the bays of Florida from the Gulf waters in Florida. If the nearest nodes were chosen, it could be a mix of the larger datum values from the Gulf and smaller datum values from the bays; the average would either be too high if the VDatum node were in the bay or too low if the VDatum node were in the Gulf of Mexico. Carefully drawing the bounding polygons along the barrier islands and peninsulas also helps guarantee that the VDatum nodes are populated with datums from only one region.

5.3. Potential Errors in the Marine Gridded Data

Possible errors in the VDatum tidal transformation fields can be traced to three primary sources: errors in the hydrodynamic model results, the interpolation of those errors at the tide stations, and the interpolation of the model results onto the VDatum marine grid.

The error in the hydrodynamic model results has been discussed above in Section 3.4. Again, the absolute average and percent error for the MHHW-MSL, MHW-MSL, MLW-MSL, and MLLW-MSL datums for the final model run compared to the 74 NOS stations in the VDatum area are listed in Table 3 (as Run 5). The error at each of these 74 stations (for that final model run) is listed in Appendix C. The average absolute error between the hydrodynamic model and the observed datums was less than 2 cm.

The second source of errors arises from inaccuracies in the interpolated error field (Section 4). As discussed above, errors in the model results were compensated for by subtracting an interpolated error field that matched the error value at the tide stations and obeys Laplace's equation in the domain. This makes a nearly exact match of VDatum values at the tide station, but the effect on the error throughout the rest of the domain is unknown. It can be noted, though, as shown in Figure 9, the error fields are generally smooth, which is desirable when creating the final, corrected tidal datum fields.

The final source of error arises in the process of interpolating the corrected datums onto the VDatum marine grids (Section 5.2). One source of error is due to the fact that nodes in the triangular grid, which have the corrected values, do not precisely match the actual locations of the tide stations. The second source of error is due to the fact that values at two or more the closest nodes in the triangular grid are averaged to produce the value at the marine grid's node.

Therefore, a check was done to compare the combined datum field results as projected onto the VDatum marine grid with datum information at the NOS tide stations in the region. The root mean squared error (RMSE) and standard deviation were computed for the four at each station. Table 5 lists errors for each VDatum region.

Table 5. Errors for the four tidal datums (m) by VDatum region for the VDatum marine grids.

	Station ID	MHHW	MHW	MLW	MLLW	Station Name
MOBLE						
1	8731952	-0.001	-0.002	0.001	0.001	BON SECOUR
2	8735180	0.000	0.000	-0.002	-0.003	DAUPHIN ISLAND, MOBILE BA
3	8737048	0.001	0.000	0.000	-0.001	MOBILE STATE DOCKS, MOBIL
PCOLA						
1	8729332	0.000	0.000	0.000	0.000	JOLLY BAY, CHOCTAWHATCHEE
2	8729333	0.001	0.001	-0.001	-0.001	LA GRANGE BAYOU
3	8729364	0.000	0.000	0.000	0.000	ALLAQUAY BAYOU
4	8729376	0.000	0.000	0.001	0.001	SANTA ROSA HOGTOWN BAYOU
5	8729381	-0.008	-0.006	0.009	0.009	BASIN CREEK
6	8729387	0.003	0.004	-0.002	-0.002	BASIN BAYOU, CHOCTAWHATCH
7	8729435	0.000	-0.001	0.000	0.000	BIG HAMMOCK PT, CHOCTAWHA
8	8729501	0.000	0.000	0.000	0.000	VALPARISO, BOGGY BAYOU
9	8729511	0.000	-0.002	0.002	0.000	DESTIN, EAST PASS
10	8729538	0.003	0.004	-0.004	-0.003	GARNIER BAYOU, SHALIMAR
11	8729548	0.000	0.000	0.000	0.000	CAMP PINCHOT
12	8729554	0.000	0.000	0.000	0.000	FORT WALTON BEACH, SANTA
13	8729567	0.000	0.000	0.000	0.000	CINCO BAYOU
14	8729598	0.000	0.001	0.000	0.000	HULBERT FIELD
15	8729613	0.010	0.011	0.011	0.009	HARRIS, SANTA ROSA SOUND
16	8729679	0.000	0.000	0.000	0.000	SANTA ROSA SOUND, EAST EN
17	8729702	0.000	0.000	0.000	0.000	EAST BAY, HOLLEY
18	8729736	0.000	-0.001	0.000	0.000	WOODLAWN BEACH
19	8729747	-0.001	-0.001	0.001	0.001	SHIELD POINT, BLACKWATER
20	8729753	-0.001	-0.001	0.002	0.001	BLACKWATER RIVER
21	8729757	0.001	0.001	-0.001	-0.001	MILTON
22	8729791	0.001	0.001	-0.001	0.000	HERNANDEZ POINT NORTH
23	8729793	-0.008	-0.016	0.010	0.015	MULLATTO BAYOU
24	8729806	0.000	0.001	0.000	0.000	FISHING BEND, SANTA ROSA
25	8729808	0.000	0.000	0.000	0.000	LITTLE SABINE BAY
26	8729816	-0.002	-0.002	0.002	0.001	LORA POINT, ESCAMBIA BAY
27	8729824	-0.001	-0.001	-0.001	0.001	FLORIDATOWN, ESCAMBIA BAY
28	8729840	-0.001	0.000	0.000	-0.001	PENSACOLA, PENSACOLA BAY
29	8729849	0.000	0.000	0.000	0.000	BAYOU CHICO
30	8729868	0.000	0.000	0.001	0.001	PENSACOLA, NAVAL AIR STAT
31	8729871	0.001	0.001	-0.002	-0.001	WARRINGTON, BAYOU GRANDE
32	8729882	0.002	0.002	0.000	0.000	FORT PICKENS, PENSACOLA B
33	8729889	0.000	0.000	0.000	0.000	HEAD OF BAYOU GRANDE
34	8729905	-0.013	-0.014	-0.011	-0.014	MILLVIEW, PERDIDO BAY
35	8729909	0.000	0.000	0.000	0.000	BIG LAGOON
36	8729938	0.001	0.001	-0.001	-0.001	TARKLIN BAY
37	8729943	-0.001	0.000	-0.001	0.000	HURST HAMMOCK, PERDIDO RI
38	8729962	0.000	0.000	0.000	0.000	PERDIDO BAY
39	8729974	0.000	0.000	0.000	0.000	PERDIDO KEY, OLD RIVER
40	8730667	0.017	0.017	-0.019	-0.018	ALABAMA POINT, PERDIDO PA

Table 5. (Continued).

	Station ID	MHHW	MHW	MLW	MLLW	Station Name
ANDRW						
1	8728973	0.000	0.000	0.001	0.001	WETAPPO CREEK, EAST BAY
2	8729015	0.000	0.000	-0.001	0.000	ALLANTON, EAST BAY
3	8729017	0.000	0.000	0.000	0.000	FARMDALE, EAST BAY, ST. A
4	8729039	0.000	0.000	0.000	0.000	PARKER BRANCH, LAIRD BAYO
5	8729045	0.000	0.000	0.000	0.000	LAIRD BAYOU, EAST BAY
6	8729063	0.000	0.000	0.000	-0.001	CALLAWAY BAYOU, EAST BAY
7	8729071	0.000	0.000	0.000	0.000	MILL BAYOU, NORTH BAY
8	8729083	0.005	-0.005	0.001	-0.009	DUPONT BRIDGE, EAST BAY
9	8729084	0.000	0.000	0.000	0.001	PARKER, EAST BAY
10	8729085	0.003	0.009	0.000	-0.003	PEARL BAYOU, EAST BAY
11	8729101	0.000	0.000	0.001	0.001	SOUTHPORT, NORTH BAY
12	8729102	0.001	0.001	0.000	0.000	LYNN HAVEN, NORTH BAY
13	8729105	0.001	0.000	0.000	0.000	BEACON BEACH, ST ANDREW B
14	8729107	0.000	0.008	-0.003	-0.012	MASSALINA BAYOU, ST. ANDR
15	8729108	0.001	0.000	0.001	0.000	PANAMA CITY, ST. ANDREW B
16	8729119	0.000	-0.001	0.000	-0.001	SHELL ISLAND, ST. ANDREWS
17	8729136	0.022	0.007	-0.014	-0.010	NEW ENTRANCE CHANNEL, ST.
18	8729141	0.000	0.001	0.000	0.001	ST. ANDREWS STATE PARK, G
19	8729149	-0.001	-0.001	0.003	0.002	ST. ANDREW STATE PARK
20	8729152	0.002	0.002	0.003	0.002	ALLIGATOR BAYOU, PANAMA C
21	8729155	0.001	0.000	0.000	0.000	GRAND LAGOON, WEST END
22	8729169	-0.001	-0.003	-0.003	-0.003	SHELL POINT, WEST BAY
23	8729189	0.000	0.000	0.000	-0.001	PANAMA CITY BEACH
24	8729197	0.000	-0.001	0.001	0.001	WEST BAY CREEK WEST BAY
STJOE						
1	8728912	0.001	0.001	0.000	0.001	PORT ST. JOE
2	8728942	0.000	0.000	0.000	0.001	CAPE SAN BLAS
3	8728949	-0.001	-0.001	0.002	0.001	RICHARDSON HAMMOCK, ST. J
4	8728958	0.023	0.031	0.024	0.019	ST. JOSEPH POINT, ST. JOS
5	8728995	-0.002	-0.003	0.002	0.002	MEXICO BEACH
NEGOM						
1	8729210	0.001	0.002	-0.002	-0.001	PANAMA CITY BEACH, GULF O
2	8729678	0.000	0.000	0.000	0.000	NAVARRE BEACH

6. TOPOGRAPHY OF THE SEA SURFACE

The Topography of the Sea Surface (TSS) is defined as the elevation of the North American Vertical Datum of 1988 (NAVD88) relative to local mean sea level (LMSL). Two methodologies were utilized for computing NAVD88-to-LMSL values and the results were coupled for creation of the final TSS grid by the National Geodetic Survey (NGS). This grid provides compensation for the local variations between a mean sea level surface and the NAVD88 geopotential surface over the Mobile Bay to Cape San Blas Vicinity VDatum region. A positive value specifies that the NAVD88 reference value is further from the center of the Earth than the local mean sea level surface. All data are based on the most recent National Tidal Datum Epoch (1983-2001). The location of tide stations and tidal benchmarks used are illustrated in Figure 11, and a listing of values at each tide station appears in Table 6.

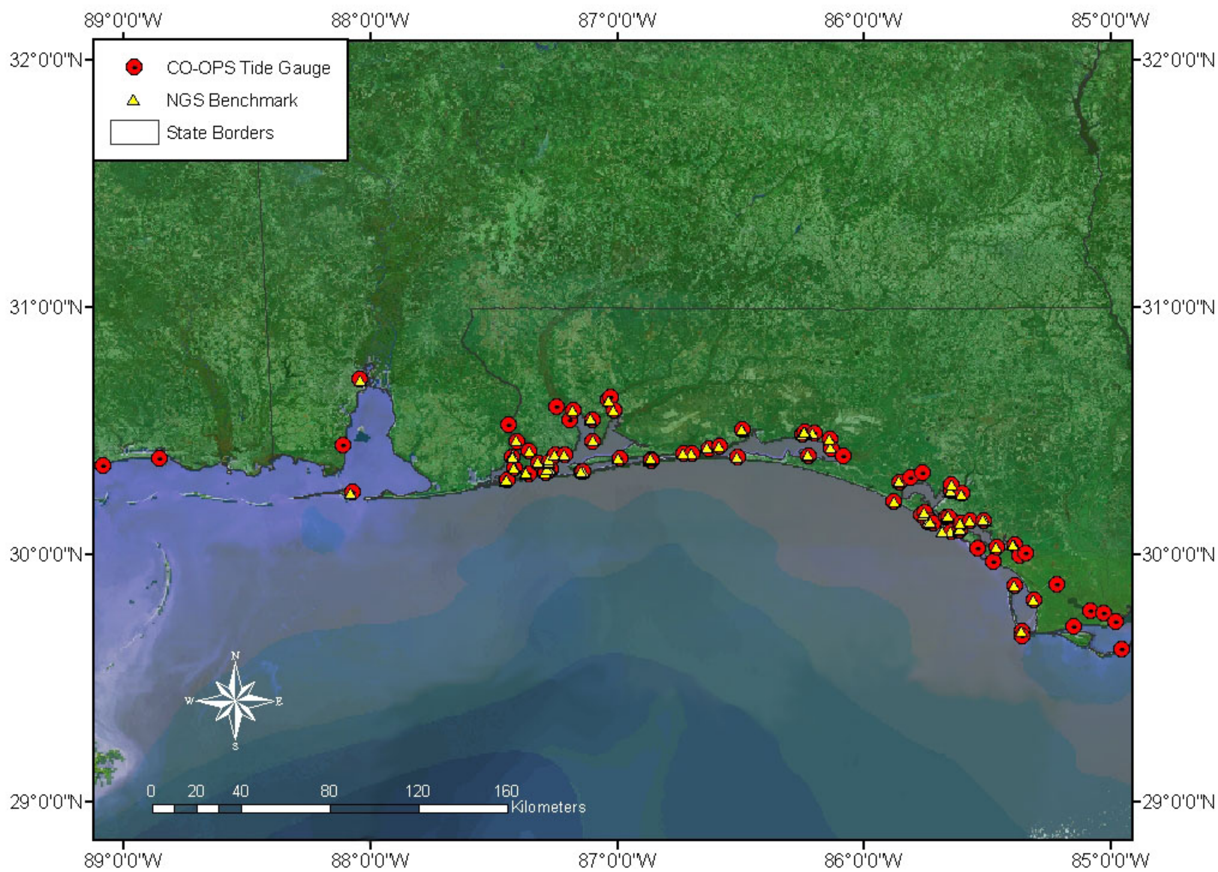


Figure 11. Locations of tide stations and geodetic benchmarks.

Table 6. Tidal and geodetic datums at tide stations in the northeast Gulf of Mexico. Tidal datums are relative to MLLW. Data are from CO-OPS. Station numbers marked with an asterisk have NAVD88 elevations computed from NGS benchmark elevation data, and are not published by CO-OPS in the tide station benchmark sheets.

Station ID		Latitude	Longitude	MLLW	MLW	MSL	MHW	MHHW	NAVD88
8728669		29.613330	-84.958330	0.000	0.159	0.343	0.531	0.600	0.410
8728690		29.726670	-84.981670	0.000	0.122	0.277	0.461	0.492	0.232
8728711		29.763330	-85.033330	0.000	0.094	0.232	0.387	0.412	0.127
8728757		29.770000	-85.085000	0.000	0.117	0.213	0.335	0.369	0.157
8728786		29.706670	-85.153330	0.000	0.126	0.274	0.468	0.509	0.280
8728786		29.706670	-85.153330	0.000	0.126	0.274	0.468	0.509	0.280
8728853		29.880000	-85.223330	0.000	0.031	0.163	0.278	0.296	0.005
8728853		29.880000	-85.223330	0.000	0.031	0.163	0.278	0.296	0.005
8728912		29.815000	-85.313330	0.000	0.062	0.250	0.413	0.504	0.251
8728941		30.003330	-85.348330	0.000	0.061	0.262	0.477	0.516	0.191
8728942		29.668330	-85.360000	0.000	0.029	0.227	0.422	0.438	0.233
8728949		29.690000	-85.363330	0.000	0.046	0.253	0.436	0.522	0.139
8728957		29.996670	-85.370000	0.000	0.046	0.245	0.452	0.482	0.174
8728958		29.873330	-85.390000	0.000	0.027	0.232	0.381	0.474	0.239
8728973		30.038330	-85.393330	0.000	0.004	0.256	0.450	0.504	0.199
8729015		30.030000	-85.465000	0.000	0.033	0.231	0.431	0.466	0.192
8729022		29.970000	-85.480000	0.000	0.044	0.214	0.389	0.431	0.185
8729039		30.136670	-85.516670	0.000	0.025	0.219	0.412	0.438	0.178
8729052		30.025000	-85.541670	0.000	0.044	0.206	0.384	0.420	0.179
8729063		30.136670	-85.571670	0.000	0.018	0.214	0.412	0.438	0.173
8729071		30.245000	-85.605000	0.000	0.032	0.230	0.434	0.456	0.176
8729084		30.126670	-85.611670	0.000	0.021	0.217	0.417	0.432	0.188
8729085		30.098330	-85.613330	0.000	0.021	0.215	0.398	0.428	0.174
8729101		30.283330	-85.646670	0.000	0.032	0.236	0.440	0.472	0.206
8729102		30.255000	-85.648330	0.000	0.032	0.220	0.412	0.448	0.173
8729105		30.091670	-85.648330	0.000	0.017	0.200	0.388	0.402	0.166
8729107		30.151670	-85.660000	0.000	0.008	0.192	0.376	0.400	0.150
8729108		30.151670	-85.666670	0.000	0.014	0.203	0.395	0.409	0.170
8729136	*	30.125000	-85.721670	0.000	0.021	0.193	0.387	0.394	0.167
8729141		30.133330	-85.731670	0.000	0.028	0.206	0.393	0.418	0.182
8729149		30.130000	-85.743330	0.000	0.006	0.229	0.442	0.466	0.186
8729152		30.170000	-85.755000	0.000	0.016	0.210	0.398	0.417	0.159
8729154		30.328330	-85.763330	0.000	0.033	0.205	0.404	0.433	0.156
8729155		30.158330	-85.768330	0.000	0.014	0.197	0.378	0.392	0.159
8729179		30.308330	-85.811670	0.000	0.031	0.220	0.410	0.449	0.160
8729197		30.293330	-85.858330	0.000	0.028	0.222	0.424	0.444	0.168
8729210	*	30.213330	-85.880000	0.000	0.020	0.199	0.392	0.418	0.178
8729329		30.396670	-86.088330	0.000	0.013	0.080	0.149	0.167	-0.021
8729332		30.428330	-86.136670	0.000	0.009	0.086	0.168	0.170	-0.051
8729333		30.468330	-86.138330	0.000	0.004	0.067	0.129	0.131	-0.025
8729364		30.488330	-86.205000	0.000	0.003	0.073	0.146	0.153	-0.032
8729376		30.400000	-86.228330	0.000	0.008	0.094	0.169	0.178	-0.021
8729381		30.496670	-86.240000	0.000	0.003	0.075	0.141	0.150	-0.024
8729387		30.486670	-86.253330	0.000	0.004	0.062	0.114	0.123	-0.048
8729501		30.503330	-86.493330	0.000	0.000	0.076	0.151	0.151	-0.072
8729511		30.395000	-86.513330	0.000	0.003	0.086	0.184	0.186	-0.037

Table 6. (Continued).

Station ID		Latitude	Longitude	MLLW	MLW	MSL	MHW	MHHW	NAVD88
8729538		30.435000	-86.586670	0.000	0.008	0.059	0.119	0.124	-0.060
8729567		30.428330	-86.631670	0.000	0.011	0.069	0.135	0.142	0.051
8729598		30.406670	-86.700000	0.000	0.024	0.175	0.336	0.356	0.079
8729613		30.408330	-86.731670	0.000	0.017	0.201	0.364	0.380	0.097
8729678		30.376670	-86.865000	0.000	0.016	0.201	0.401	0.421	0.144
8729679		30.385000	-86.863330	0.000	0.008	0.206	0.401	0.422	0.118
8729736	*	30.386670	-86.991670	0.000	0.007	0.203	0.401	0.415	0.130
8729747		30.581670	-87.015000	0.000	0.029	0.240	0.453	0.484	0.144
8729753		30.636670	-87.028330	0.000	0.037	0.253	0.467	0.505	0.144
8729757		30.626670	-87.036670	0.000	0.042	0.240	0.444	0.482	0.145
8729791		30.455000	-87.100000	0.000	0.027	0.198	0.380	0.397	0.104
8729793		30.545000	-87.103330	0.000	0.026	0.226	0.442	0.451	0.128
8729806		30.336670	-87.140000	0.000	0.016	0.193	0.370	0.391	0.126
8729808		30.336670	-87.146670	0.000	0.016	0.193	0.376	0.392	0.140
8729824		30.581670	-87.180000	0.000	0.030	0.217	0.423	0.442	0.116
8729831	*	30.545000	-87.195000	0.000	0.022	0.197	0.411	0.421	0.092
8729840		30.403330	-87.211670	0.000	0.008	0.188	0.374	0.383	0.098
8729849		30.401670	-87.251670	0.000	0.014	0.182	0.366	0.376	0.080
8729851		30.598330	-87.246670	0.000	0.024	0.223	0.422	0.445	0.082
8729868		30.345000	-87.273330	0.000	0.011	0.177	0.354	0.364	0.086
8729871		30.375000	-87.276670	0.000	0.016	0.181	0.353	0.368	0.088
8729882		30.330000	-87.291670	0.000	0.008	0.169	0.346	0.350	0.077
8729889		30.370000	-87.318330	0.000	0.007	0.185	0.366	0.376	0.089
8729905		30.418330	-87.356670	0.000	0.004	0.102	0.226	0.229	-0.013
8729909		30.326670	-87.356670	0.000	0.013	0.153	0.313	0.322	0.052
8729938		30.350000	-87.415000	0.000	0.003	0.091	0.191	0.193	-0.011
8729943		30.458330	-87.408330	0.000	0.018	0.113	0.232	0.240	-0.014
8729949		30.523330	-87.443330	0.000	0.016	0.121	0.243	0.253	-0.030
8729962		30.393330	-87.425000	0.000	0.003	0.105	0.214	0.218	-0.012
8729974		30.300000	-87.448330	0.000	0.007	0.115	0.239	0.247	0.008
8735180		30.250000	-88.075000	0.000	0.003	0.172	0.361	0.367	0.070
8735523		30.443330	-88.113330	0.000	0.017	0.217	0.420	0.438	0.084
8737048		30.708330	-88.043330	0.000	0.028	0.241	0.458	0.479	0.062
8743735		30.390000	-88.856670	0.000	0.033	0.270	0.505	0.537	0.115
8745557		30.360000	-89.081670	0.000	0.038	0.269	0.499	0.532	0.130

The two methodologies used for creating the NAVD88-to-MSL values are called the indirect method and the direct method. The indirect method consists of deriving a value calibrated by fitting tide model results to tidal benchmarks leveled in NAVD88. This process used the four tidal datum (MHHW, MHW, MLW, and MLLW) marine grids. At each benchmark location in the NGS database, we have TBM_{navd88}, which is the NAVD88 elevation relative to MLLW, and a set of four TBM_{datum} values, each of which is the Datum elevation relative to MLLW (i.e., Datum – MLLW). Also, from the four tidal datum grids, we have a set of VD_{datum} values, which of which is the difference between the tidal datum and MSL (i.e., Datum – MSL).

For the first step of the indirect method, we compute four residuals. The residual, R, for each datum is defined as:

$$R_{datum} = TBM_{navd88} - TBM_{datum} + VD_{datum} \qquad (2)$$

Note that the VD values are interpolated to the location of the benchmark. The four residuals at the benchmark are averaged to produce the mean, and this mean is an estimate of the quantity MSL – NAVD88. Since the four residuals should be approximately equal, any differences indicate inconsistencies in the VDatum gridded data fields. Due to the large extent of the Mobile Bay to Cape San Blas Vicinity VDatum region, for testing the region was divided into five sub-regions. Note that these sub-regions differ from the tidal sub-regions in that for the TSS, Perdido Bay is combined with Mobile Bay into the first region. The MSL-to-NAVD88 derived estimates can be found in Appendix E.

In the direct method of obtaining NAVD 88-to-LMSL values, the first step includes calculating the orthometric-to-tidal datum relationships at NOAA tide stations where elevation information has been compiled. The tide stations and associated elevation information used in the computation of the TSS are presented in Table 6. Data for the direct method were supplied by CO-OPS and NGS. Next, the mean residuals at all benchmarks are merged with values of the quantity NAVD88 – MSL at CO-OPS' tide stations to produce input data for gridding. Although some of the benchmark data has been used in generating values at the tide stations, if was felt that the benchmark data may provide information at additional locations where tides are no longer measured or where a tide gauge was never installed.

Then, a continuous surface for the five sub-regions representing inverse sea-surface topography was generated as follows. A mesh covering the entire area of benchmarks and tide stations with a spatial resolution similar to that of the tidal marine grids is created. Break lines are inserted to represent the influence of land. A sea surface topography field is generated using the Surfer© software's minimum curvature algorithm to create a surface that honors the data as closely as possible. The maximum allowed departure value used was 0.0001 meters, except for the St. Andrews vicinity TSS grid where a maximum residual of 0.0008 meters was used to allow for convergence. To control the amount of bowing on the interior and at the edges of the grid, an internal and boundary tension of 0.3 was utilized. Once the gridded topography field has been generated, null values are obtained from the marine tidal grids and are inserted to denote the presence of land. The resulting TSS fields are represented in Figures 12 to 16.

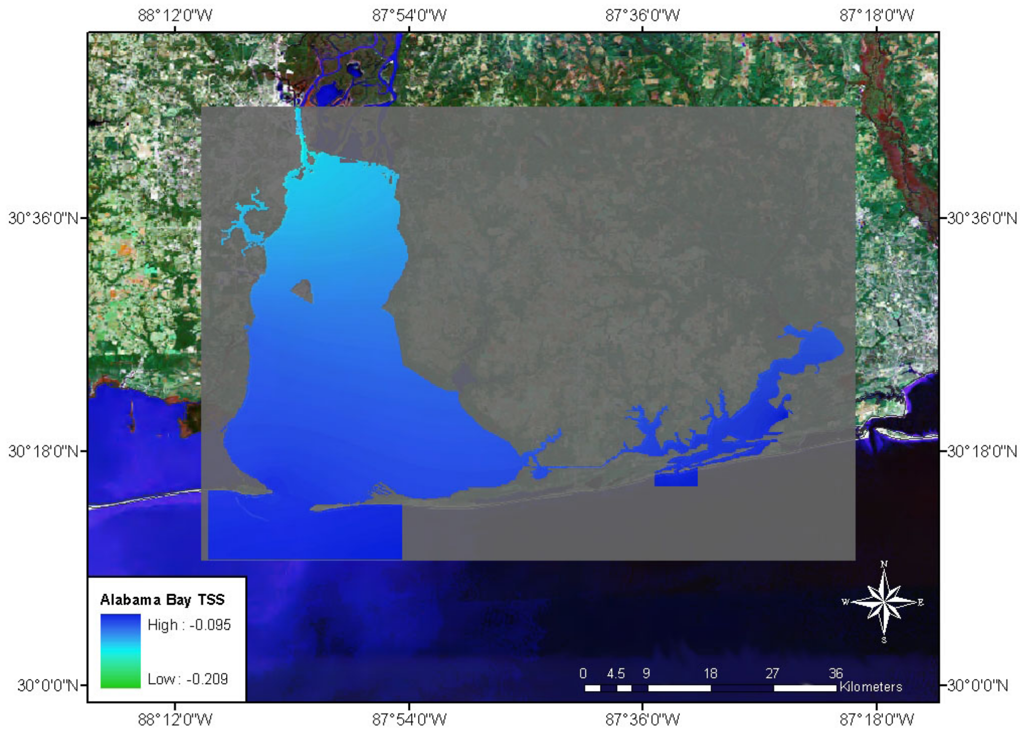


Figure 12. The TSS grid for Mobile and Perdido Bays.

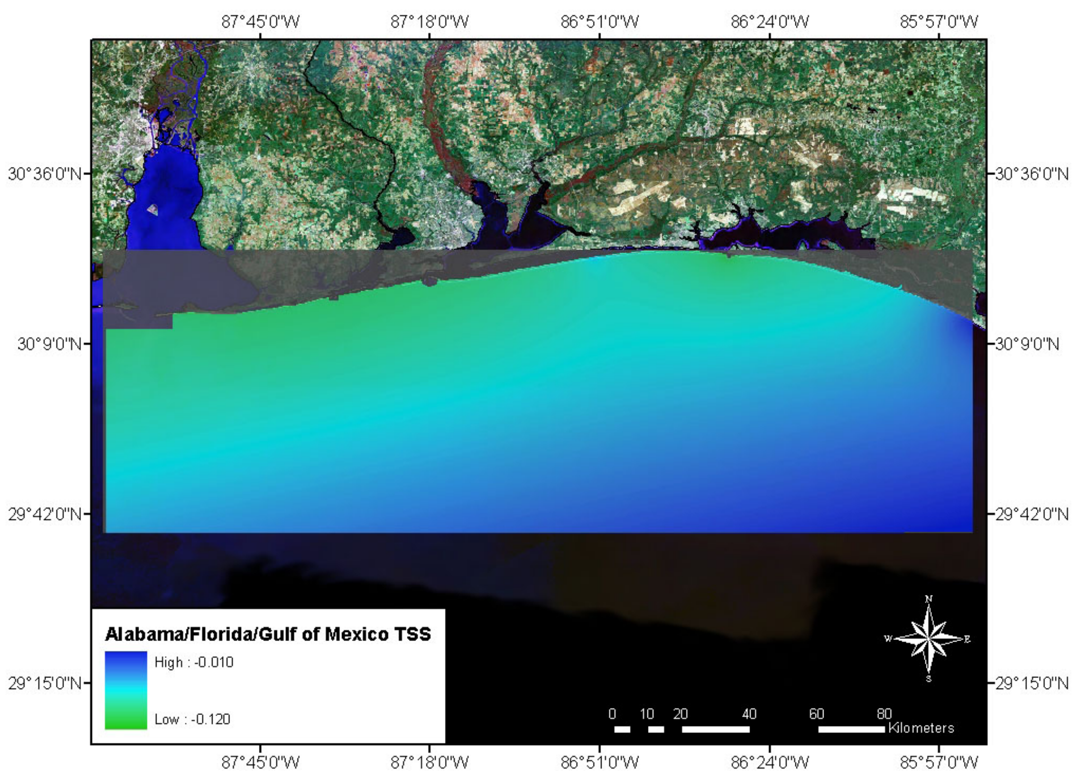


Figure 13. The TSS grid for the Northeast Gulf of Mexico.

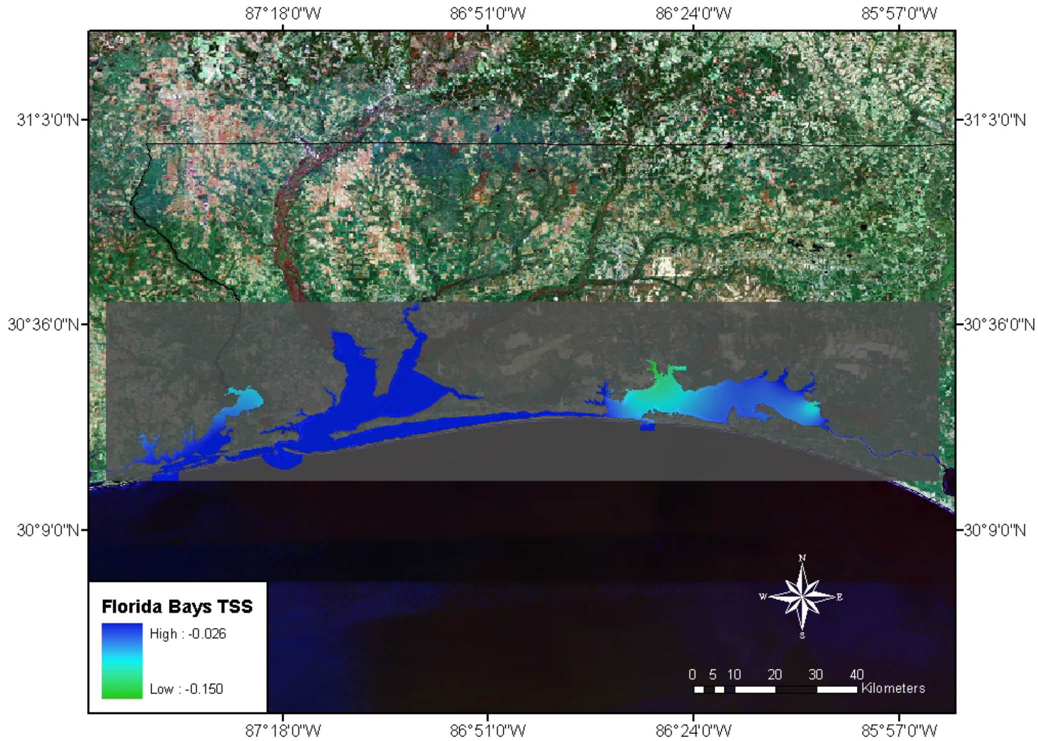


Figure 14. The TSS grid for Perdido, Pensacola, and Choctawhatchee Bays.

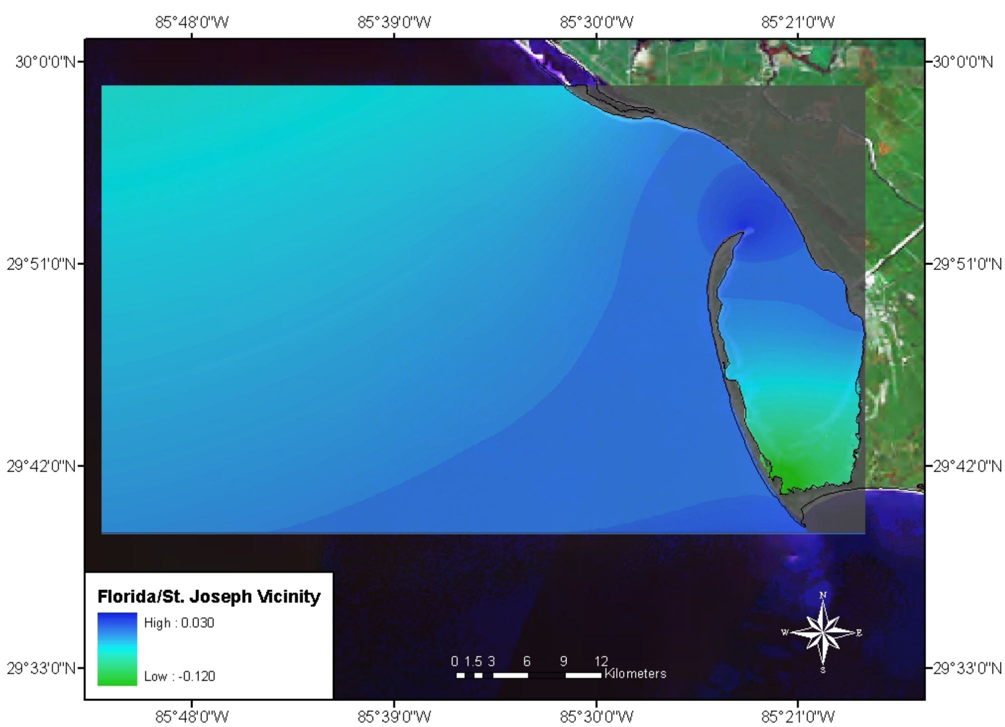


Figure 15. The TSS grid for St. Joseph Bay.

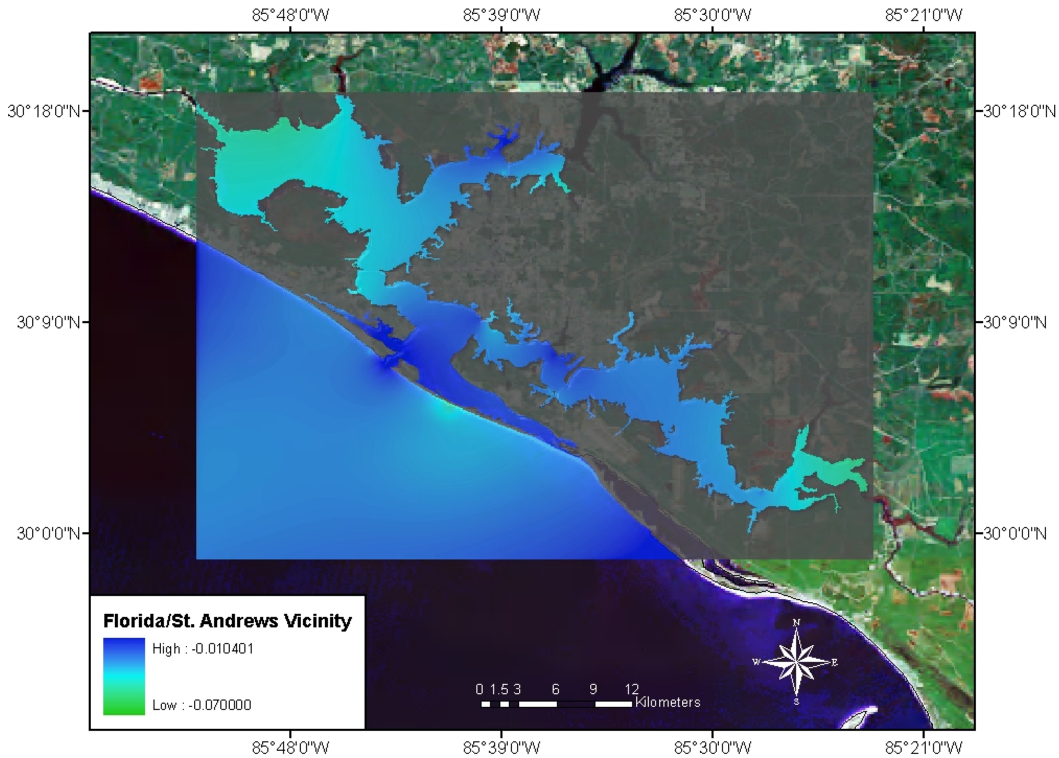


Figure 16. The TSS grid for St. Andrews Bay.

Quality control was facilitated through several different pathways. After the initial TSS was created through interpolation of data compiled through both methodologies, a set of 'Delta' values are computed. Delta represents the difference between the observed tidal datum and the datum as computed by the gridded fields. If S represents the value of the quantity NAVD88 – MSL obtained from the sea surface topography grid, then Delta (D) for each tidal datum is computed as:

$$D_{datum} = TBM_{navd88} - TBM_{datum} + VD_{datum} - S \quad (3)$$

The averaged Deltas tabulated for the Mobile Bay to Cape San Blas TSSs are consistent and small, and are listed in a table for each region (Appendix F). This provides confidence that grids are in agreement. If they are not, the input data and grids are examined, appropriate changes are made, and a new TSS grid is computed from the first step.

In response to the limited amount of data available, the data used to compile the TSS grids for both the direct and indirect methods were utilized in comparing against the TSS grid to generalize accuracies. The mean difference between known NAVD 88-to-MSL values and that calculated for the same point with the individual VDatum region are listed in Appendix G. The differences are summarized in Table 7.

Table 7. Differences between known and computed values to the NAVD88-to-MSL offset.

SUB-REGION	MEAN DIFFERENCE (M)	STD. DEV. (M)
Mobile and Perdido Bays	0.0009	0.0040
NW Gulf of Mexico	-0.0111	0.0188
Perdido, Pensacola, and Choctawatchee Bays	0.0003	0.0039
St. Joseph Bay	-0.0011	0.0036
St. Andrews Bay	0.0002	0.0020

7. QUALITY CONTROL AND TESTING

Before the gtx files can be considered operational, a series of tests was performed on them to assess them for quality, consistency, and accuracy of the data. The files tested consist of six for tidal datum transformation (mhhw.gtx, mhw.gtx, mlw.gtx, mllw.gtx, mlt.gtx, and dtl.gtx) and six for geodetic datum transformation (sst.gtx, ncla.gtx, nclo.gtx, vcn.gtx, g99.gtx, and g03.gtx). For further information on these files and on testing procedures, see NOS (in preparation). Testing began in February 2007, several months after this report's primary author, Emily Spargo, had left government service to work elsewhere. A record of the tests and their outcomes was kept.

The first test consisted of comparing the bounding polygons to assure that they enclose an area completely within the rectangular area specified by the gtx file header parameters. The program used was the latest version of `test_poly.f`. It was immediately apparent that there were some problems with some of the polygons, which had been altered slightly to accommodate a request from NGS for the use of preliminary data. To resolve the discrepancy, a few rows and/or columns of data were added (by extrapolation) to the gtx files in question. The files includes all six tidal plus sst.gtx for the west Florida bays, St. Andrews Bay, and St. Joseph Bay, and the g99.gtx and g03.gtx files for St. Joseph Bay.

The second test looked for overlap in the set of bounding polygons using the program `test_ovlp.f`. It was quickly determined that a major area of overlap existed between the Alabama bays and the west Florida bays polygons, which both include Perdido Bay, AL. A smaller overlap occurred between the west Florida bays and NE Gulf of Mexico polygons. These overlaps were easily rectified by altering the polygons. In particular, the polygon covering Alabama was reduced so as to exclude Perdido Bay; this bay is now covered in the west Florida bays polygons. Since a large portion of the tidal and TSS gtx files for the Alabama bays covered an area outside of the bounding polygon, these files were truncated. The new polygons were then used in a repeat of the first test; no problems were encountered.

Since there were some changes in the polygons and gtx files, a revised set of sub-region names was adopted. The sub-region covering Alabama is called MOBLE, the west Florida bays is PCOLA, St. Andrews Bay is called ANDRW, St. Joseph Bay is STJOE, and the NE Gulf of Mexico is NEGOM (Figure 10).

For the third test, tidal and TSS datums from the gtx files were compared to those from the CO-OPS data base. Data at tide stations used in the development of the hydrodynamic model (i.e., from the TideSheet data) were compared with the program `test_msf.f`, and the largest difference in tidal datums (2.2 cm) was found at Station 872-9136 in St. Andrews Bay. The largest difference in TSS was 13.0 cm at Ft. Walton Beach (Station 872-9554) in PCOLA. The NAVD88 value was found to be in error and subsequently revised by CO-OPS. NGS then regenerated the TSS files for the five sub-regions; these were retested for polygons (the gridded data for PCOLA, ANDRW, and STJOE were expanded by adding rows and/or columns) and overlap, and they passed. Then, the largest error in TSS was 0.9 cm.

In the fourth test, tidal and TSS datums from the gtx files were compared to those from the most recent (i.e., latest NTDE) CO-OPS spreadsheet data base, and using the program `test_msf.f`. The data were extracted using the program `celect.f` and analyzed using `test_msf4.f,` a version modified to read the output from `celect3.f` as well as in the original (msf) format. The largest tidal datum error was 3.1 cm at 872-8958 in STJOE, and the largest error in TSS was 0.9 cm.

The fifth test compared values at the interfaces of adjacent sub-regions using the program test_cont3.f. A small problem with the TSS values in the PCOLA sub-region was noted. This was solved by extrapolating values along the southern edge of the bounding polygon near the entrance to Pensacola Bay.

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APPENDIX A. UNUSED TIDE STATIONS

One hundred and seventeen tide stations were found in the VDatum region. Twelve of these stations were removed from the list due to incomplete datum information. The other stations were removed because they were within the 500 m tolerance, but located up creeks, rivers, bays and bayous not modeled for this study. Also, the Massalina Bayou station (872-9107) was eliminated not only because it was in a bayou not captured in the model grid, but also because it is close to the Panama City station (872-9108).

Table A.1. Tide station identification number, name, location and reason for removal of the 17 stations eliminated from the final stations list.

	Station ID	Station Name	Latitude	Longitude	Reason for Removal
1	8729002	St. Andrew Sound	-85.480003	29.969999	Off the grid
2	8729107	Massalina Bayou	-85.660004	30.151699	Close to the Panama City station(872-9108) and off the grid
3	8729742	Bay Point	-87.004997	30.571667	Incomplete Data
4	8729793	Mullatto Bayou	-87.103302	30.545000	Off the grid
5	8729887	Fort McRee	-87.311668	30.326666	Incomplete Data
6	8731936	Nelson Landing	-87.736664	30.291666	Incomplete Data
7	8735184	Dauphin Island	-88.080002	30.251667	Incomplete Data
8	8735523	Fowl River	-88.113297	30.443300	Off the grid
9	8747145	Mallini Bayou South	-89.286697	30.311701	Off the grid
10	8760172	Chandeleur Lighthouse	-88.871666	30.048334	Incomplete Data
11	8760579	Port Eads South Pass	-89.160004	29.014999	Incomplete Data
12	8760736	Joesph Bayou	-89.271667	29.058332	Incomplete Data
13	8760841	Jack Bay	-89.345001	29.366667	Incomplete Data
14	8761212	Pelican Island	-89.608330	29.250000	Incomplete Data
15	8761289	Bastian Island	-89.663330	29.286667	Incomplete Data
16	8761557	Bayou Pass	-89.853333	29.309999	Incomplete Data
17	8761687	Barataria Bay	-89.945000	29.275000	Incomplete Data

APPENDIX B. SOURCES OF BATHYMETRIC DATA

All bathymetric data came for NOS sources. The oldest data are from NOS hydrographic surveys from 1899 to 1989, and have depths referenced to MLW. Locations of these survey points (approximately 2.6 million) are shown in Figure B.1. Data from later surveys (1935 to 1994) are referenced to MLLW (the present NOS chart datum), and the locations of these points (approximately 2.0 million) are shown in Figure B.2.

Inspection of Figures B.1 and B.2 show that there are a few gaps in the data, especially in the area centered at 89º 0′ W and 29º 30′ N, just north of the Mississippi River Delta. Bathymetric data for this area, as well as for upper Mobile Bay, waterways connecting Mobile Bay with Perdido Bay and Choctawatchee Bay with St. Andrews Bay, and the barrier island system southeast of the entrance to St. Andrews Bay was obtained from NOS' Electronic Navigation Charts. These charts have depth values (referenced to MLLW) that have been automatically extracted from paper charts. Locations of these points are shown in Figure B.3.

Data from the first two sources is archived in the file pscola_nos_bathy.tar, and data from the third is archived in the file dig_bathy.tar.

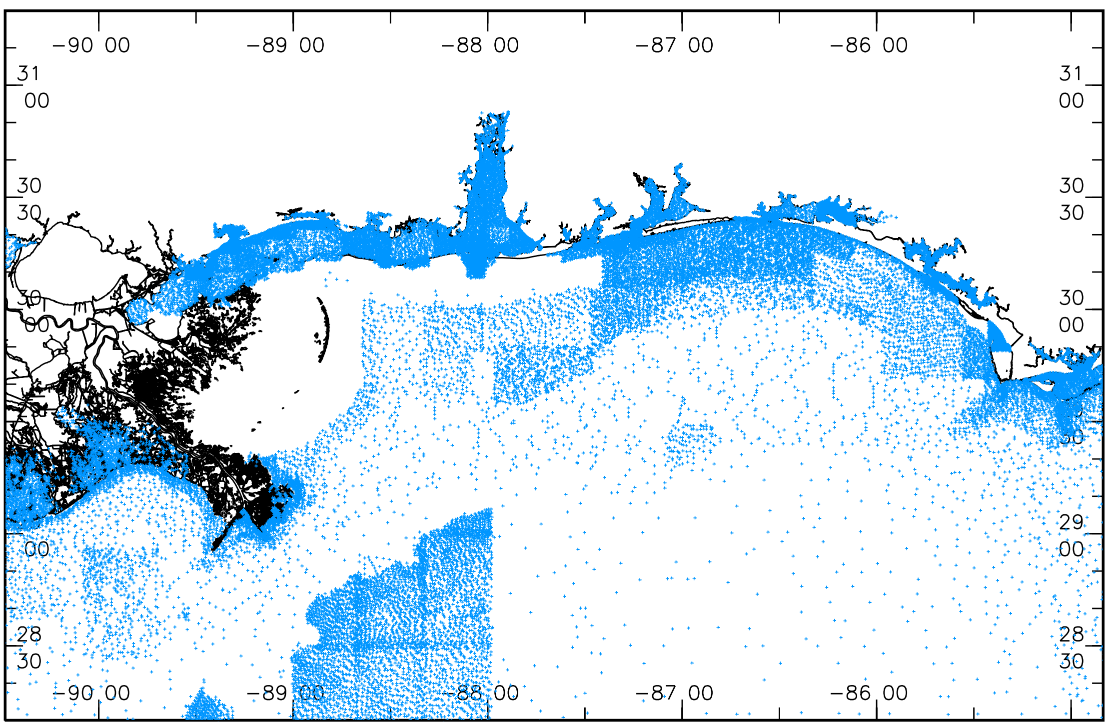


Figure B.1. Location of NOS hydrographic survey data points with depths referenced to MLW. Only every 50th point is shown.

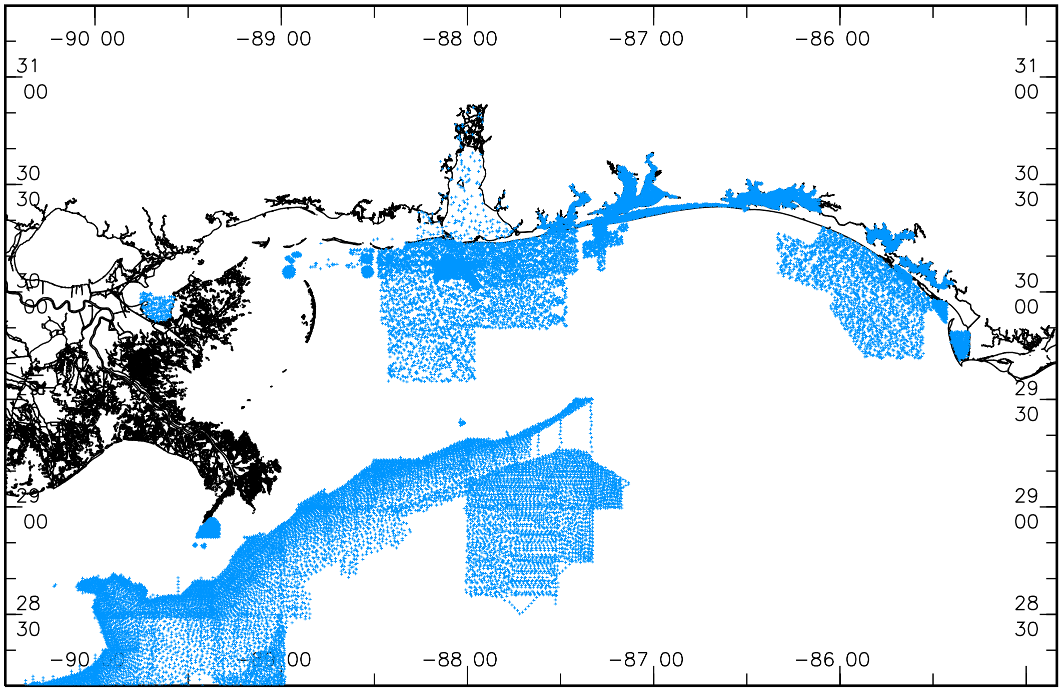


Figure B.2. Location of NOS hydrographic survey data points with depths referenced to MLLW. Only every 50th point is shown.

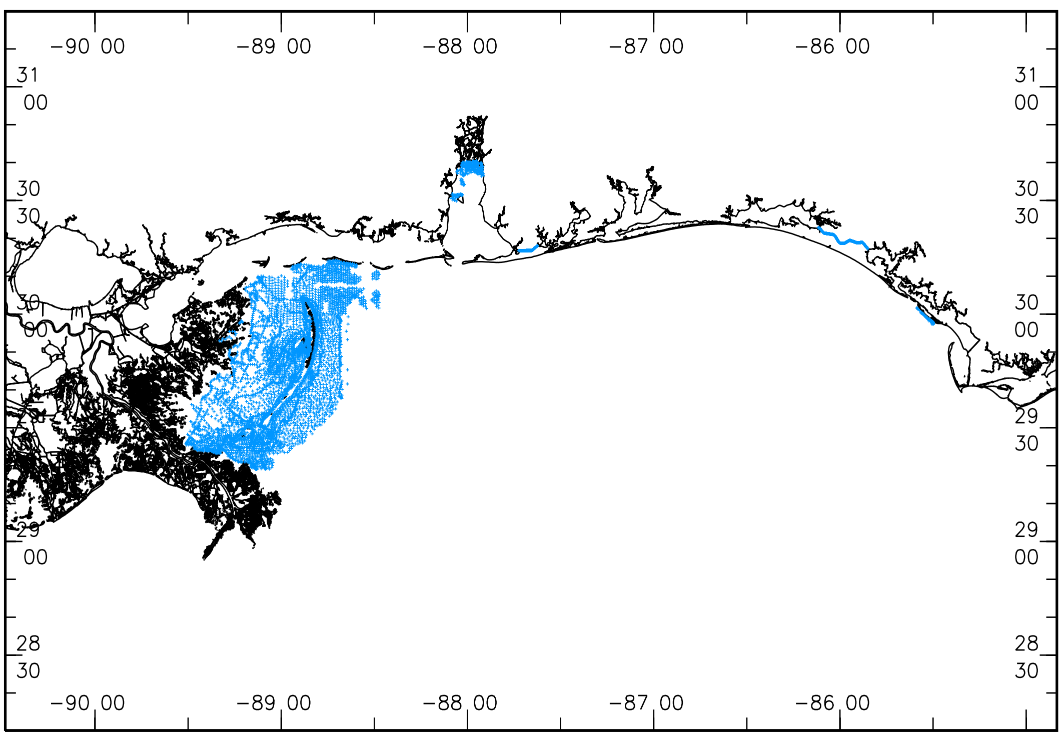


Figure B.3. Location of depth data points from the Electronic Navigation Charts.

APPENDIX C. TIDE STATION DATA AND MODEL RESULTS

Table C.1. Tide station information and model results at those locations.

No.	Station ID	Station Name	Longitude	Latitude	MHHW	MHW	MLW	MLLW	Source
1	8728912	PORT ST JOE	-85.313332	29.815001	25.4	16.3	-18.8	-25.0	data
					19.2	17.5	-17.6	-18.5	model
					-6.2	1.2	1.2	6.5	difference
					24.4%	7.4%	6.4%	26.0%	
2	8728942	CAPE SAN BLAS	-85.360001	29.668301	21.1	19.5	-19.8	-22.7	data
					16.1	16.1	-17.4	-17.4	model
					-5.0	-3.4	2.4	5.3	difference
					23.7%	17.4%	12.1%	23.4%	
3	8728949	RICHARDSON HAMMOCK	-85.363297	29.690001	26.9	18.3	-20.7	-25.3	data
					19.4	17.7	-17.9	-18.8	model
					-7.5	-0.6	2.8	6.5	difference
					27.9%	3.3%	13.5%	25.7%	
4	8728958	ST. JOSEPH POINT	-85.389999	29.873301	26.8	17.7	-17.7	-20.7	data
					18.9	17.7	-17.8	-18.2	model
					-7.9	0.0	-0.1	2.5	difference
					29.5%	0.0%	0.6%	12.1%	
5	8728973	WETAPPO CREEK EAST BAY	-85.393303	30.038300	24.8	19.4	-25.2	-25.6	data
					22.7	18.7	-19.3	-21.7	model
					-2.1	-0.7	5.9	3.9	difference
					8.5%	3.6%	23.4%	15.2%	
6	8728995	MEXICO BEACH	-85.425003	29.948299	26.2	23.1	-21.7	-25.0	data
					18.5	18.0	-17.8	-17.8	model
					-7.7	-5.1	3.9	7.2	difference
					29.4%	22.1%	18.0%	28.8%	
7	8729015	ALLANTON EAST BAY	-85.464996	30.030001	23.5	20.0	-19.8	-23.1	data
					22.2	18.3	-18.7	-21.1	model
					-1.3	-1.7	1.1	2.0	difference
					5.5%	8.5%	5.6%	8.7%	
8	8729017	FARMDALE EAST BAY	-85.470001	30.016666	24.0	20.2	-19.8	-23.6	data
					22.2	18.3	-18.7	-21.1	model
					-1.8	-1.9	1.1	2.5	difference
					7.5%	9.4%	5.6%	10.6%	
9	8729039	PARKER BRANCH LAIRD BAY	-85.516701	30.136700	21.9	19.3	-19.4	-21.9	data
					21.2	17.9	-18.2	-20.0	model
					-0.7	-1.4	1.2	1.9	difference
					3.2%	7.3%	6.2%	8.7%	
10	8729045	LAIRD BAYOU EAST BAY	-85.528336	30.121666	22.2	19.7	-19.3	-22.6	data
					21.2	17.9	-18.1	-20.0	model
					-1.0	-1.8	1.2	2.6	difference
					4.5%	9.1%	6.2%	11.5%	
11	8729063	CALLAWAY BAYOU EAST BAY	-85.571701	30.136700	22.4	19.8	-19.6	-21.4	data
					21.1	17.7	-18.0	-19.9	model
					-1.3	-2.1	1.6	1.5	difference
					5.8%	10.6%	8.2%	7.0%	
12	8729071	MILL BAYOU NORTH BAY	-85.605003	30.245001	22.6	20.4	-19.8	-23.0	data
					21.3	17.9	-18.3	-20.2	model
					-1.3	-2.5	1.5	2.8	difference
					5.8%	12.3%	7.6%	12.2%	
13	8729084	PARKER EAST BAY	-85.611702	30.126699	21.5	20.0	-19.6	-21.7	data
					20.3	18.0	-18.1	-19.0	model
					-1.2	-2.0	1.5	2.7	difference
					5.6%	10.0%	7.7%	12.4%	
14	8729085	PEARL BAYOU EAST BAY	-85.613297	30.098301	21.3	18.3	-19.4	-21.5	data
					20.6	17.8	-17.9	-19.3	model
					-0.7	-0.5	1.5	2.2	difference
					3.3%	2.7%	7.7%	10.2%	
15	8729101	SOUTHPORT NORTH BAY	-85.646698	30.283300	23.6	20.4	-20.4	-23.6	data
					21.2	17.8	-18.1	-20.0	model
					-2.4	-2.6	2.3	3.6	difference
					10.2%	12.8%	11.3%	15.3%	

Table C.1. (Continued).

No.	Station ID	Station Name	Longitude	Latitude	MHHW	MHW	MLW	MLLW	Source
16	8729102	LYNN HAVEN NORTH BAY	-85.648300	30.254999	22.8 21.2 -1.6 7.0%	19.2 17.8 -1.4 7.3%	-18.8 -18.1 0.7 3.7%	-22.0 -20.0 2.0 9.1%	data model difference
17	8729105	BEACON BEACH	-85.648300	30.091700	20.2 18.7 -1.5 7.4%	18.8 17.1 -1.7 9.0%	-18.3 -16.8 1.5 8.2%	-20.0 -17.3 2.7 13.5%	data model difference
18	8729108	PANAMA CITY	-85.666664	30.151667	20.6 19.5 -1.1 5.3%	19.2 17.2 -2.0 10.4%	-18.9 -17.3 1.6 8.5%	-20.3 -18.2 2.1 10.3%	data model difference
19	8729117	S. OF DAVIS PT.	-85.680000	30.113333	20.7 19.0 -1.7 8.2%	17.7 17.4 -0.3 1.7%	-17.4 -17.2 0.2 1.2%	-19.8 -17.7 2.1 10.6%	data model difference
20	8729119	SHELL ISLAND	-85.684998	30.094999	20.7 18.9 -1.8 8.7%	19.6 17.3 -2.3 11.7%	-17.6 -17.1 0.5 2.8%	-19.3 -17.6 1.7 8.8%	data model difference
21	8729141	ST. ANDREWS STATE PARK	-85.731697	30.133301	21.2 19.3 -1.9 9.0%	18.7 17.7 -1.0 5.4%	-17.8 -16.5 1.3 7.3%	-20.6 -17.0 3.6 17.5%	data model difference
22	8729149	ST. ANDREW STATE PARK	-85.743301	30.129999	23.7 19.5 -4.2 17.7%	21.3 17.9 -3.4 16.0%	-22.3 -17.2 5.1 22.9%	-22.9 -17.7 5.2 22.7%	data model difference
23	8729152	ALLIGATOR BAYOU	-85.754997	30.170000	20.7 20.0 -0.7 3.4%	18.8 17.7 -1.1 5.9%	-19.4 -18.0 1.4 7.2%	-21.0 -18.8 2.2 10.5%	data model difference
24	8729155	GRAND LAGOON WEST END	-85.768303	30.158300	19.5 19.4 -0.1 0.5%	18.1 17.8 -0.3 1.7%	-18.3 -16.6 1.7 9.3%	-19.7 -17.1 2.6 13.2%	data model difference
25	8729169	SHELL POINT WEST BAY	-85.739998	30.215000	24.7 20.7 -4.0 16.2%	22.9 17.9 -5.0 21.8%	-13.6 -18.1 -4.5 33.1%	-17.1 -19.5 -2.4 14.0%	data model difference
26	8729189	PANAMA CITY BEACH	-85.833298	30.186701	22.5 19.6 -2.9 12.9%	20.6 17.9 -2.7 13.1%	-18.5 -17.2 1.3 7.0%	-19.6 -17.7 1.9 9.7%	data model difference
27	8729193	WEST BAY	-85.833336	30.230000	23.8 21.5 -2.3 9.7%	17.4 18.1 0.7 4.0%	-17.3 -18.7 -1.4 8.1%	-21.0 -20.6 0.4 1.9%	data model difference
28	8729197	WEST BAY CREEK	-85.858299	30.293301	22.2 21.0 -1.2 5.4%	20.2 17.6 -2.6 12.9%	-19.4 -17.9 1.5 7.7%	-22.2 -19.7 2.5 11.3%	data model difference
29	8729210	PANAMA CITY BEACH	-85.879997	30.213333	21.9 19.6 -2.3 10.5%	19.3 18.0 -1.3 6.7%	-17.9 -17.2 0.7 3.9%	-19.9 -17.7 2.2 11.1%	data model difference
30	8729332	JOLLY BAY	-86.136703	30.428301	8.4 8.6 0.2 2.4%	8.2 8.1 -0.1 1.2%	-7.7 -7.7 0.0 0.0%	-8.6 -7.9 0.7 8.1%	data model difference

Table C.1. (Continued).

No.	Station ID	Station Name	Longitude	Latitude	MHHW	MHW	MLW	MLLW	Source
31	8729333	LA GRANGE BAYOU	-86.138298	30.468300	6.4	6.2	-6.3	-6.7	data
					8.5	8.0	-7.7	-7.9	model
					2.1	1.8	-1.4	-1.2	difference
					32.8%	29.0%	22.2%	17.9%	
32	8729364	ALLAQUAY BAYOU	-86.205002	30.488300	8.0	7.3	-7.0	-7.3	data
					8.4	7.9	-7.6	-7.8	model
					0.4	0.6	-0.6	-0.5	difference
					5.0%	8.2%	8.6%	6.9%	
33	8729376	SANTA ROSA HOGTOWN BAYOU	-86.228302	30.400000	8.4	7.5	-8.6	-9.4	data
					8.5	8.0	-7.5	-7.7	model
					0.1	0.5	1.1	1.7	difference
					1.2%	6.7%	12.8%	18.1%	
34	8729387	BASIN BAYOU	-86.253304	30.486700	6.1	5.2	-5.8	-6.2	data
					8.5	8.0	-7.5	-7.7	model
					2.4	2.8	-1.7	-1.5	difference
					39.3%	53.9%	29.3%	24.2%	
35	8729435	BIG HAMMOCK PT	-86.351700	30.465000	7.7	7.7	-7.0	-7.1	data
					8.2	7.7	-7.3	-7.5	model
					0.5	0.0	-0.3	-0.4	difference
					6.5%	0.0%	4.3%	5.6%	
36	8729479	ROCKY BAYOU	-86.446663	30.506666	7.0	6.4	-6.1	-6.7	data
					7.8	7.5	-7.1	-7.3	model
					0.8	1.1	-1.0	-0.6	difference
					11.4%	17.2%	16.4%	9.0%	
37	8729501	VALPARISO BOGGY BAYOU	-86.493301	30.503300	7.5	7.5	-7.6	-7.6	data
					7.8	7.3	-7.1	-7.3	model
					0.3	-0.2	0.5	0.3	difference
					4.0%	2.7%	6.6%	4.0%	
38	8729505	OLD PASS LAGOON	-86.504997	30.393333	8.9	7.0	-7.0	-8.2	data
					8.4	8.2	-7.0	-7.2	model
					-0.5	1.2	0.0	1.0	difference
					5.6%	17.1%	0.0%	12.2%	
39	8729511	DESTIN EAST PASS	-86.513298	30.395000	10.0	9.8	-8.3	-8.6	data
					8.4	8.2	-7.0	-7.3	model
					-1.6	-1.6	1.3	1.3	difference
					16.0%	16.3%	15.7%	15.1%	
40	8729538	GARNIER BAYOU SHALIMAR	-86.586670	30.434999	6.5	6.0	-5.1	-5.9	data
					7.5	7.2	-6.8	-6.8	model
					1.0	1.2	-1.7	-0.9	difference
					15.4%	20.0%	33.3%	15.3%	
41	8729548	CAMP PINCHOT	-86.593300	30.469999	6.9	6.9	-6.1	-6.5	data
					7.5	7.2	-6.9	-6.9	model
					0.6	0.3	-0.8	-0.4	difference
					8.7%	4.4%	13.1%	6.2%	
42	8729554	FORT WALTON BEACH	-86.610001	30.401699	8.8	8.4	-6.6	-6.8	data
					9.1	8.5	-8.1	-8.4	model
					0.3	0.1	-1.5	-1.6	difference
					3.4%	1.2%	22.7%	23.5%	
43	8729567	CINCO BAYOU	-86.631699	30.428301	7.3	6.6	-5.8	-6.9	data
					7.5	7.2	-6.8	-6.8	model
					0.2	0.6	-1.0	0.1	difference
					2.7%	9.1%	17.2%	1.5%	
44	8729598	HULBERT FIELD	-86.699997	30.406700	18.1	16.1	-15.1	-17.5	data
					17.4	15.3	-14.9	-15.9	model
					-0.7	-0.8	0.2	1.6	difference
					3.9%	5.0%	1.3%	9.1%	
45	8729613	HARRIS SANTA ROSA SOUND	-86.731697	30.408300	18.9	17.4	-17.4	-19.2	data
					18.9	16.2	-15.7	-17.3	model
					0.0	-1.2	1.7	1.9	difference
					0.0%	6.9%	9.8%	9.9%	

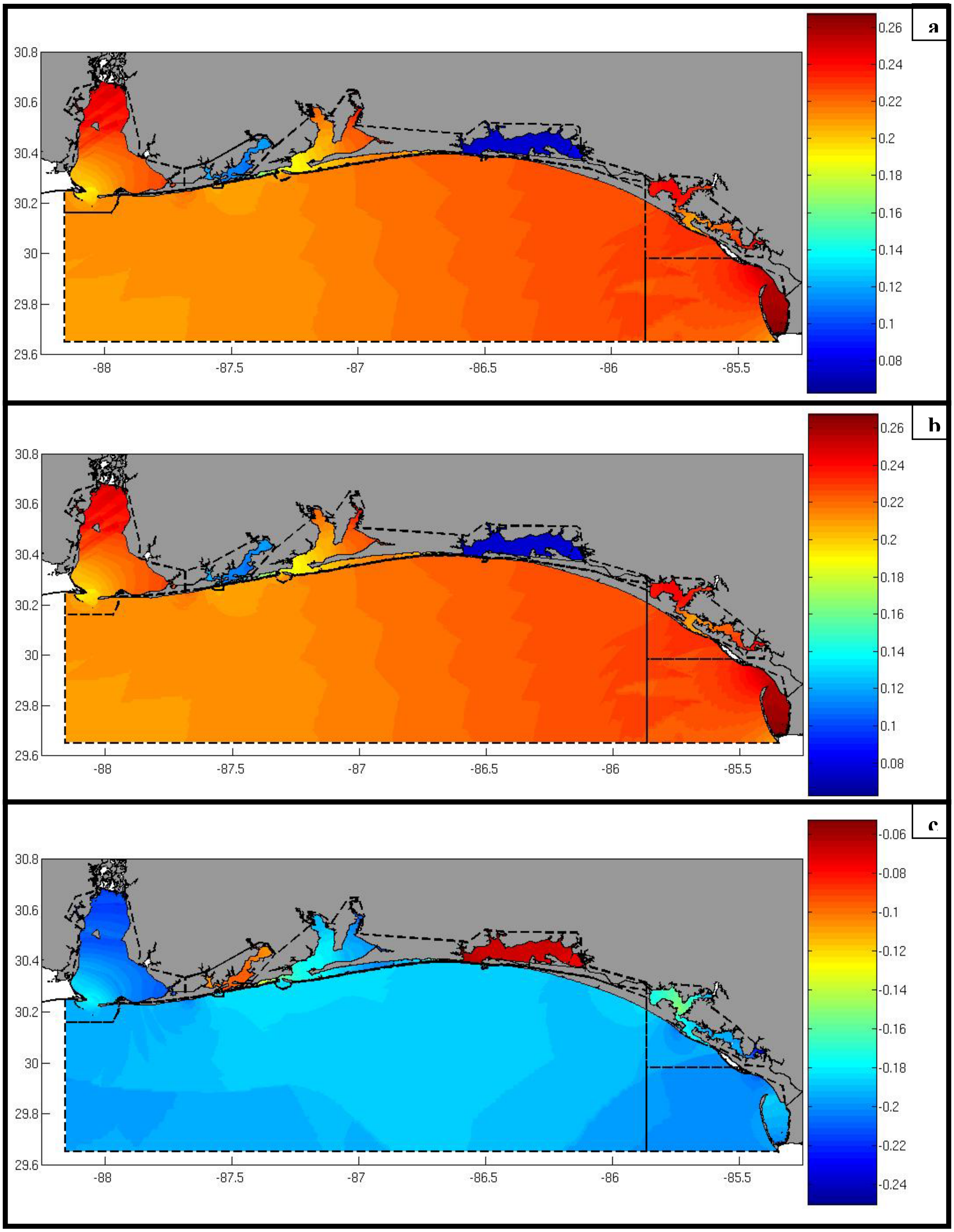
Table C.1. (Continued).

No.	Station ID	Station Name	Longitude	Latitude	MHHW	MHW	MLW	MLLW	Source
46	8729678	NAVARRE BEACH	-86.864998	30.376667	22.0 19.5 -2.5 11.4%	20.0 17.9 -2.1 10.5%	-18.5 -16.9 1.6 8.7%	-20.1 -17.4 2.7 13.4%	data model difference
47	8729679	SANTA ROSA SOUND	-86.863297	30.385000	21.6 20.3 -1.3 6.0%	19.5 17.5 -2.0 10.3%	-19.8 -17.0 2.8 14.1%	-20.6 -18.8 1.8 8.7%	data model difference
48	8729702	EAST BAY HOLLEY	-86.918297	30.450001	23.1 21.1 -2.0 8.7%	20.7 18.7 -2.0 9.7%	-20.9 -18.6 2.3 11.0%	-22.6 -20.0 2.6 11.5%	data model difference
49	8729736	WOODLAWN BEACH	-86.991699	30.386700	21.2 19.9 -1.3 6.1%	19.8 17.6 -2.2 11.1%	-19.6 -17.2 2.4 12.2%	-20.3 -18.5 1.8 8.9%	data model difference
50	8729747	SHIELD POINT	-87.014999	30.581699	24.4 21.7 -2.7 11.1%	21.3 18.4 -2.9 13.6%	-21.1 -19.1 2.0 9.5%	-24.0 -20.6 3.4 14.2%	data model difference
51	8729753	BLACKWATER RIVER	-87.028297	30.636700	25.2 21.9 -3.3 13.1%	21.4 18.6 -2.8 13.1%	-21.6 -19.4 2.2 10.2%	-25.3 -20.8 4.5 17.8%	data model difference
52	8729757	MILTON	-87.036697	30.626699	24.2 21.8 -2.4 9.9%	20.4 18.6 -1.8 8.8%	-19.8 -19.3 0.5 2.5%	-24.0 -20.7 3.3 13.8%	data model difference
53	8729791	HERNANDEZ POINT NORTH	-87.099998	30.455000	19.9 19.9 0.0 0.0%	18.2 18.2 0.0 0.0%	-17.1 -17.7 -0.6 3.5%	-19.8 -18.7 1.1 5.6%	data model difference
54	8729806	FISHING BEND	-87.139999	30.336700	19.8 19.0 -0.8 4.0%	17.7 17.3 -0.4 2.3%	-17.7 -16.8 0.9 5.1%	-19.3 -17.7 1.6 8.3%	data model difference
55	8729808	LITTLE SABINE BAY	-87.146698	30.336700	19.9 18.9 -1.0 5.0%	18.3 17.9 -0.4 2.2%	-17.7 -17.0 0.7 4.0%	-19.3 -17.5 1.8 9.3%	data model difference
56	8729816	LORA POINT ESCAMBIA BAY	-87.161697	30.514999	21.8 20.3 -1.5 6.9%	20.0 18.6 -1.4 7.0%	-19.5 -18.1 1.4 7.2%	-21.1 -19.1 2.0 9.5%	data model difference
57	8729824	FLORIDATOWN	-87.180000	30.581699	22.5 20.4 -2.1 9.3%	20.6 18.7 -1.9 9.2%	-18.7 -18.3 0.4 2.1%	-21.7 -19.3 2.4 11.1%	data model difference
58	8729840	PENSACOLA	-87.211700	30.403299	19.5 18.8 -0.7 3.6%	18.6 17.7 -0.9 4.8%	-18.0 -17.0 1.0 5.6%	-18.8 -17.5 1.3 6.9%	data model difference
59	8729849	BAYOU CHICO	-87.251701	30.401699	19.4 18.6 -0.8 4.1%	18.4 17.5 -0.9 4.9%	-16.8 -16.8 0.0 0.0%	-18.2 -17.3 0.9 5.0%	data model difference
60	8729868	PENSACOLA NAVAL AIR STA	-87.273300	30.344999	18.7 17.9 -0.8 4.3%	17.7 16.9 -0.8 4.5%	-16.6 -15.3 1.3 7.8%	-17.7 -15.8 1.9 10.7%	data model difference

Table C.1. (Continued).

No.	Station ID	Station Name	Longitude	Latitude	MHHW	MHW	MLW	MLLW	Source
61	8729871	WARRINGTON BAYOU GRANDE	-87.276703	30.375000	18.7	17.2	-16.5	-18.1	data
					18.4	17.3	-16.7	-17.2	model
					-0.3	0.1	-0.2	0.9	difference
					1.6%	0.6%	1.2%	5.0%	
62	8729882	FORT PICKENS	-87.291702	30.330000	18.1	17.7	-16.1	-16.9	data
					17.2	17.2	-15.2	-15.2	model
					-0.9	-0.5	0.9	1.7	difference
					5.0%	2.8%	5.6%	10.1%	
63	8729889	HEAD OF BAYOU GRANDE	-87.318298	30.370001	19.1	18.1	-17.8	-18.5	data
					18.4	17.4	-16.8	-17.3	model
					-0.7	-0.7	1.0	1.2	difference
					3.7%	3.9%	5.6%	6.5%	
64	8729905	MILLVIEW PERDIDO BAY	-87.356697	30.418301	11.3	11.0	-11.0	-11.6	data
					15.3	14.0	-13.1	-13.4	model
					4.0	3.0	-2.1	-1.8	difference
					35.4%	27.3%	19.1%	15.5%	
65	8729909	BIG LAGOON	-87.356697	30.326700	16.9	16.0	-14.0	-15.3	data
					16.1	15.6	-14.6	-14.6	model
					-0.8	-0.4	-0.6	0.7	difference
					4.7%	2.5%	4.3%	4.6%	
66	8729938	TARKLIN BAY	-87.415001	30.350000	10.2	10.0	-8.8	-9.1	data
					14.2	13.4	-12.5	-12.5	model
					4.0	3.4	-3.7	-3.4	difference
					39.2%	34.0%	42.1%	37.4%	
67	8729943	HURST HAMMOCK	-87.408302	30.458300	12.7	11.9	-9.5	-11.3	data
					15.4	14.1	-13.2	-13.5	model
					2.7	2.2	-3.7	-2.2	difference
					21.3%	18.5%	39.0%	19.5%	
68	8729962	PERDIDO BAY	-87.425003	30.393299	11.3	10.9	-10.2	-10.5	data
					14.7	13.8	-12.9	-12.9	model
					3.4	2.9	-2.7	-2.4	difference
					30.1%	26.6%	26.5%	22.9%	
69	8729974	PERDIDO KEY OLD RIVER	-87.448303	30.299999	13.2	12.4	-10.8	-11.5	data
					13.3	12.4	-11.7	-11.7	model
					0.1	0.0	-0.9	-0.2	difference
					0.8%	0.0%	8.3%	1.7%	
70	8730667	ALABAMA POINT	-87.555000	30.278299	13.6	12.4	-11.9	-12.6	data
					15.8	14.9	-13.8	-13.8	model
					2.2	2.5	-1.9	-1.2	difference
					16.2%	20.2%	16.0%	9.5%	
71	8731269	GULF SHORES	-87.668335	30.248333	22.9	21.7	-21.6	-21.9	data
					19.0	17.4	-16.7	-17.2	model
					-3.9	-4.3	4.9	4.7	difference
					17.0%	19.8%	22.7%	21.5%	
72	8731952	BON SECOUR	-87.735001	30.303301	23.6	22.5	-22.1	-23.4	data
					21.2	19.4	-19.2	-20.2	model
					-2.4	-3.1	2.9	3.2	difference
					10.2%	13.8%	13.1%	13.7%	
73	8735180	DAUPHIN ISLAND	-88.074997	30.250000	19.5	18.9	-16.9	-17.2	data
					18.7	18.7	-15.9	-15.9	model
					-0.8	-0.2	1.0	1.3	difference
					4.1%	1.1%	5.9%	7.6%	
74	8737048	MOBILE STATE DOCKS	-88.043297	30.708300	23.8	21.7	-21.3	-24.1	data
					24.2	20.1	-20.3	-23.2	model
					0.4	-1.6	1.0	0.9	difference
					1.7%	7.4%	4.7%	3.7%	

APENDIX D. FINAL TIDAL DATUM FIELDS IN THE VDATUM REGION



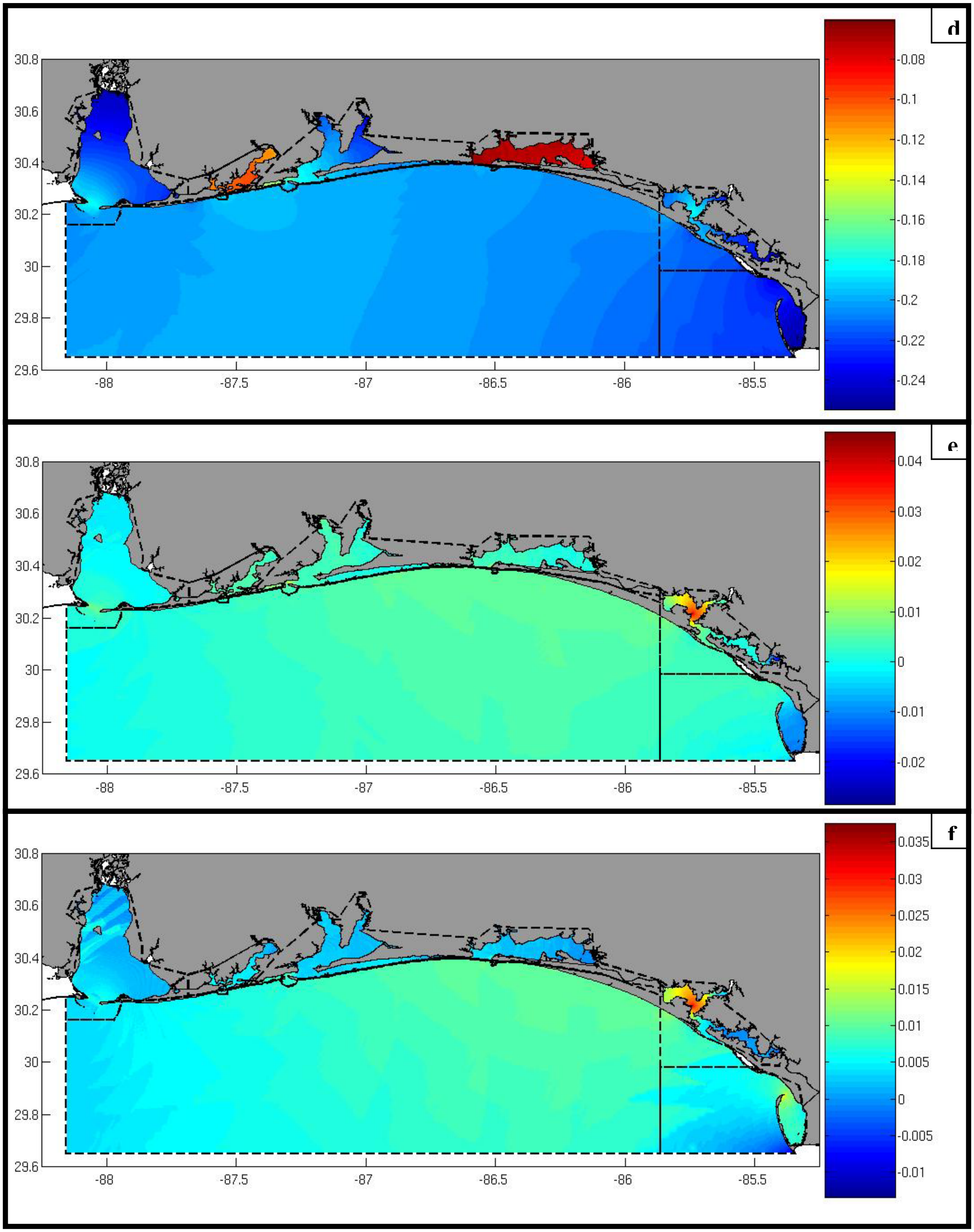


Figure D.1. Final corrected model datum fields on a smaller regional grid for the (a) MHHW, (b) MHW, (c) MLW, (d) MLLW, (e) MTL, and (f) DTL tidal datums.

APPENDIX E. ESTIMATES OF NAVD88 AT BENCHMARKS

Estimated values of NAVD 88 at locations of benchmarks in the NGS database in the five sub-regions (see Figures 12 to 16).

Table E.1. Estimated values of NAVD 88 at benchmark locations in Mobile and Perdido Bays.

Bench-mark	Latitude	Longitude	From MLLW (m)	From MLW (m)	From MHW (m)	From MHHW (m)	Average (m)	Std. Dev. (m)
BH1754	30.24888	-88.07666	-0.1041	-0.1040	-0.1118	-0.1126	-0.1081	0.0047
BH1752	30.24916	-88.07666	-0.1041	-0.1040	-0.1118	-0.1126	-0.1081	0.0047
BH1755	30.24916	-88.07583	-0.1069	-0.1068	-0.1145	-0.1153	-0.1108	0.0047
BH1756	30.24944	-88.07555	-0.1039	-0.1037	-0.1116	-0.1124	-0.1079	0.0048
BG3643	30.29777	-87.44916	-0.1050	-0.1040	-0.1069	-0.1079	-0.1059	0.0018
BG3644	30.29861	-87.44777	-0.1083	-0.1073	-0.1093	-0.1103	-0.1088	0.0013
BG3645	30.29944	-87.44722	-0.1025	-0.1015	-0.1030	-0.1040	-0.1028	0.0010
BG3646	30.29944	-87.44722	-0.1085	-0.1075	-0.1090	-0.1100	-0.1088	0.0010
BG3634	30.34916	-87.41388	-0.1042	-0.1041	-0.1032	-0.1010	-0.1031	0.0015
BG3635	30.34916	-87.41444	-0.1041	-0.1040	-0.1032	-0.1011	-0.1031	0.0014
BG3636	30.34916	-87.41500	-0.0833	-0.0832	-0.0821	-0.0799	-0.0821	0.0016
BG3410	30.39500	-87.42361	-0.1143	-0.1139	-0.1123	-0.1149	-0.1139	0.0011
BG3409	30.39555	-87.42250	-0.1234	-0.1229	-0.1210	-0.1239	-0.1228	0.0013
BG3647	30.40055	-87.42333	-0.1199	-0.1153	-0.1169	-0.1161	-0.1170	0.0020
BG3615	30.41805	-87.35527	-0.1275	-0.1239	-0.1275	-0.1271	-0.1265	0.0017
BG3616	30.41861	-87.35361	-0.1271	-0.1231	-0.1272	-0.1259	-0.1258	0.0019
BG4595	30.45972	-87.40944	-0.1282	-0.1290	-0.1285	-0.1290	-0.1287	0.0004
BG4596	30.45972	-87.40888	-0.1251	-0.1256	-0.1254	-0.1263	-0.1256	0.0005
BG4597	30.45972	-87.40805	-0.1251	-0.1256	-0.1253	-0.1265	-0.1256	0.0006
BG4594	30.46055	-87.40972	-0.1252	-0.1262	-0.1256	-0.1259	-0.1257	0.0004
BG4593	30.46111	-87.40972	-0.1282	-0.1292	-0.1287	-0.1290	-0.1288	0.0004
BH1484	30.70388	-88.04111	-0.2073	-0.2068	-0.2074	-0.2099	-0.2078	0.0014

Table E.2. Estimated values of NAVD 88 at benchmark locations in the NE Gulf of Mexico.

Bench-mark	Latitude	Longitude	From MLLW (m)	From MLW (m)	From MHW (m)	From MHHW (m)	Average (m)	Std. Dev. (m)
AA9918	30.21555	-85.87638	-0.0232	-0.0251	-0.0208	-0.0204	-0.0224	0.0022
BG4570	30.33194	-87.14027	-0.0530	-0.0549	-0.0338	-0.0314	-0.0433	0.0124
BG4571	30.33388	-87.13972	-0.0740	-0.0759	-0.0488	-0.0494	-0.0620	0.0149
BG4572	30.33388	-87.13972	-0.0740	-0.0759	-0.0488	-0.0494	-0.0620	0.0149
BG4573	30.33388	-87.13888	-0.0740	-0.0759	-0.0488	-0.0494	-0.0620	0.0149
BG4574	30.33388	-87.13666	-0.0711	-0.0729	-0.0458	-0.0464	-0.0590	0.0150
BG4574	30.33388	-87.13666	-0.0591	-0.0609	-0.0398	-0.0374	-0.0493	0.0124
BG3467	30.37916	-86.86444	-0.0579	-0.0572	-0.0594	-0.0582	-0.0582	0.0009
BG3683	30.37916	-86.86611	-0.0579	-0.0571	-0.0593	-0.0581	-0.0581	0.0009
BG3466	30.37916	-86.86555	-0.0579	-0.0571	-0.0593	-0.0581	-0.0581	0.0009
BG3465	30.37944	-86.86583	-0.0549	-0.0541	-0.0563	-0.0551	-0.0551	0.0009
BG3464	30.38083	-86.86500	-0.0579	-0.0572	-0.0594	-0.0582	-0.0582	0.0009
BG3464	30.38083	-86.86500	-0.0849	-0.0782	-0.0864	-0.0852	-0.0837	0.0037
BG3463	30.38138	-86.86166	-0.0578	-0.0573	-0.0595	-0.0583	-0.0582	0.0010

Table E.3. Estimated values of NAVD 88 at benchmark locations in Perdido, Pensacola, and Choctawatchee Bays.

Bench-mark	Latitude	Longitude	From MLLW (m)	From MLW (m)	From MHW (m)	From MHHW (m)	Average (m)	Std. Dev. (m)
BG3643	30.29777	-87.44916	-0.1048	-0.1038	-0.1072	-0.1082	-0.1060	0.0020
BG3644	30.29861	-87.44777	-0.1084	-0.1074	-0.1091	-0.1101	-0.1087	0.0011
BG3645	30.29944	-87.44722	-0.1026	-0.1016	-0.1027	-0.1037	-0.1027	0.0008
BG3646	30.29944	-87.44722	-0.1086	-0.1076	-0.1087	-0.1097	-0.1087	0.0008
BG3626	30.32638	-87.36888	-0.1018	-0.1014	-0.1017	-0.1024	-0.1018	0.0004
BG3625	30.32666	-87.36888	-0.1017	-0.1013	-0.1016	-0.1024	-0.1017	0.0005
BG3624	30.32694	-87.36888	-0.1016	-0.1012	-0.1016	-0.1024	-0.1017	0.0005
BG3622	30.32750	-87.36638	-0.1012	-0.1008	-0.1020	-0.1023	-0.1016	0.0007
BG3623	30.32750	-87.36777	-0.1014	-0.1010	-0.1018	-0.1024	-0.1017	0.0006
BG1836	30.32888	-87.28805	-0.0943	-0.0917	-0.0939	-0.0855	-0.0913	0.0041
BG1832	30.33000	-87.29222	-0.0923	-0.0934	-0.0920	-0.0923	-0.0925	0.0006
BG3613	30.33000	-87.29250	-0.0923	-0.0934	-0.0920	-0.0923	-0.0925	0.0006
BG4569	30.33416	-87.14083	-0.0531	-0.0524	-0.0568	-0.0548	-0.0543	0.0019
BG4576	30.33444	-87.13416	-0.0654	-0.0655	-0.0608	-0.0634	-0.0638	0.0022
BG4568	30.33472	-87.14305	-0.0650	-0.0642	-0.0597	-0.0633	-0.0630	0.0023
BG4568	30.33472	-87.14305	-0.0500	-0.0492	-0.0507	-0.0513	-0.0503	0.0009
BG4575	30.33472	-87.13361	-0.0684	-0.0685	-0.0638	-0.0664	-0.0668	0.0022
BG4567	30.33611	-87.14444	-0.0500	-0.0494	-0.0514	-0.0514	-0.0505	0.0010
BG4566	30.33638	-87.14361	-0.0501	-0.0496	-0.0539	-0.0517	-0.0513	0.0019
BG1815	30.34472	-87.26888	-0.0892	-0.0895	-0.0889	-0.0870	-0.0886	0.0011
BG1814	30.34527	-87.27027	-0.0887	-0.0892	-0.0890	-0.0872	-0.0885	0.0009
BG1809	30.34638	-87.27944	-0.0888	-0.0888	-0.0944	-0.0918	-0.0909	0.0027
BG3633	30.34888	-87.41277	-0.1046	-0.1044	-0.1029	-0.1007	-0.1032	0.0018
BG3634	30.34916	-87.41388	-0.1038	-0.1036	-0.1035	-0.1014	-0.1031	0.0011
BG3635	30.34916	-87.41444	-0.1037	-0.1036	-0.1036	-0.1015	-0.1031	0.0011
BG3636	30.34916	-87.41500	-0.0825	-0.0824	-0.0827	-0.0806	-0.0821	0.0010
BG1823	30.36916	-87.27666	-0.0981	-0.0989	-0.0940	-0.0952	-0.0965	0.0023
BG3667	30.36944	-87.27666	-0.0950	-0.0959	-0.0910	-0.0923	-0.0935	0.0023
BG4544	30.37083	-87.32027	-0.0969	-0.0957	-0.0972	-0.0961	-0.0965	0.0007
BG4543	30.37166	-87.32083	-0.0969	-0.0957	-0.0972	-0.0961	-0.0965	0.0007
BG3666	30.37361	-87.27500	-0.0947	-0.0953	-0.0915	-0.0925	-0.0935	0.0018
BG3665	30.38194	-87.27694	-0.0995	-0.1024	-0.0908	-0.0944	-0.0968	0.0052
BG1692	30.38222	-87.27805	-0.0970	-0.0973	-0.0953	-0.0961	-0.0964	0.0009
BG3685	30.38638	-86.86222	-0.0579	-0.0632	-0.0637	-0.0622	-0.0617	0.0027
BG3685	30.38638	-86.86222	-0.0819	-0.0812	-0.0877	-0.0862	-0.0842	0.0032
BG1892	30.38666	-86.99222	-0.0720	-0.0705	-0.0738	-0.0723	-0.0721	0.0014
BG3686	30.38777	-86.86277	-0.0594	-0.0648	-0.0622	-0.0606	-0.0618	0.0024
BG3686	30.38777	-86.86277	-0.0834	-0.0828	-0.0862	-0.0846	-0.0843	0.0015
BG3410	30.39500	-87.42361	-0.1144	-0.1139	-0.1122	-0.1149	-0.1139	0.0012
BG3422	30.39527	-86.51388	-0.1227	-0.1207	-0.1239	-0.1235	-0.1227	0.0014
BG3659	30.39527	-86.51388	-0.1257	-0.1237	-0.1269	-0.1265	-0.1257	0.0014
BG3660	30.39527	-86.51388	-0.1197	-0.1177	-0.1209	-0.1205	-0.1197	0.0014
BG3580	30.39861	-86.22861	-0.1141	-0.1153	-0.1141	-0.1143	-0.1145	0.0006
BG3581	30.39944	-86.22861	-0.1200	-0.1212	-0.1201	-0.1203	-0.1204	0.0005
BG3582	30.40055	-86.22861	-0.1199	-0.1211	-0.1202	-0.1204	-0.1204	0.0005
BG3583	30.40055	-86.22861	-0.1199	-0.1211	-0.1202	-0.1204	-0.1204	0.0005
BG3653	30.40111	-87.25194	-0.1003	-0.1015	-0.1001	-0.0990	-0.1002	0.0010
BG3670	30.40361	-87.21333	-0.1098	-0.1090	-0.1105	-0.1106	-0.1100	0.0007
BG3590	30.40833	-86.73305	-0.0984	-0.0981	-0.0949	-0.0977	-0.0973	0.0016
BG3586	30.40916	-86.70027	-0.0972	-0.0979	-0.0920	-0.0952	-0.0956	0.0026
BG3589	30.40916	-86.73222	-0.0979	-0.0974	-0.0951	-0.0979	-0.0971	0.0013

Table E.3. (Continued).

Bench-mark	Latitude	Longitude	From MLLW (m)	From MLW (m)	From MHW (m)	From MHHW (m)	Average (m)	Std. Dev. (m)
BG3588	30.40972	-86.73250	-0.0979	-0.0974	-0.0951	-0.0978	-0.0971	0.0013
BG3615	30.41805	-87.35527	-0.1276	-0.1241	-0.1276	-0.1272	-0.1266	0.0017
BG3616	30.41861	-87.35361	-0.1272	-0.1233	-0.1273	-0.1261	-0.1260	0.0019
BG2209	30.42972	-86.13583	-0.1254	-0.1257	-0.1266	-0.1274	-0.1263	0.0009
BG4613	30.43000	-86.13611	-0.1254	-0.1257	-0.1266	-0.1274	-0.1263	0.0009
BG4621	30.43055	-86.63333	-0.0568	-0.0580	-0.0560	-0.0581	-0.0572	0.0010
BG2205	30.43083	-86.13555	-0.1314	-0.1317	-0.1325	-0.1334	-0.1323	0.0009
BG4620	30.43138	-86.63333	-0.0385	-0.0400	-0.0380	-0.0402	-0.0392	0.0011
BG4615	30.43194	-86.13500	-0.1255	-0.1257	-0.1265	-0.1274	-0.1263	0.0009
BG3403	30.43527	-86.58416	-0.1219	-0.1255	-0.1101	-0.1121	-0.1174	0.0075
BG3402	30.43694	-86.58444	-0.1187	-0.1206	-0.1145	-0.1161	-0.1175	0.0027
BG4595	30.45972	-87.40944	-0.1281	-0.1287	-0.1285	-0.1294	-0.1287	0.0006
BG4596	30.45972	-87.40888	-0.1251	-0.1256	-0.1254	-0.1265	-0.1257	0.0006
BG4597	30.45972	-87.40805	-0.1251	-0.1256	-0.1254	-0.1265	-0.1257	0.0006
BG3680	30.46027	-87.09583	-0.0972	-0.1010	-0.0900	-0.0878	-0.0940	0.0062
BG3681	30.46055	-87.09666	-0.1003	-0.1042	-0.0929	-0.0907	-0.0970	0.0063
BG4594	30.46055	-87.40972	-0.1252	-0.1259	-0.1255	-0.1262	-0.1257	0.0005
BG4593	30.46111	-87.40972	-0.1282	-0.1292	-0.1287	-0.1290	-0.1288	0.0004
BG3662	30.46527	-86.13972	-0.0925	-0.0913	-0.0884	-0.0889	-0.0903	0.0020
BG3663	30.46583	-86.13888	-0.0924	-0.0912	-0.0886	-0.0891	-0.0903	0.0018
BG2194	30.48500	-86.24444	-0.1185	-0.1175	-0.1050	-0.1068	-0.1120	0.0070
BG0214	30.48694	-86.25222	-0.1044	-0.1034	-0.0966	-0.0976	-0.1005	0.0040
BG2181	30.48694	-86.25194	-0.1166	-0.1156	-0.1085	-0.1094	-0.1125	0.0041
BG3584	30.48694	-86.25083	-0.1051	-0.1041	-0.0956	-0.0967	-0.1004	0.0049
BG2179	30.48750	-86.25194	-0.1195	-0.1185	-0.1115	-0.1125	-0.1155	0.0041
BG4608	30.48888	-86.20583	-0.1000	-0.0999	-0.1003	-0.0994	-0.0999	0.0004
BG4607	30.48972	-86.20555	-0.1030	-0.1029	-0.1033	-0.1024	-0.1029	0.0004
BG4606	30.49055	-86.20555	-0.1070	-0.1069	-0.1073	-0.1064	-0.1069	0.0004
BG4600	30.49583	-86.23861	-0.0905	-0.0895	-0.1041	-0.1058	-0.0975	0.0087
BG4598	30.49638	-86.23805	-0.0905	-0.0895	-0.1041	-0.1058	-0.0975	0.0087
BG4599	30.49638	-86.23861	-0.0905	-0.0895	-0.1041	-0.1058	-0.0975	0.0087
BG4601	30.49638	-86.23972	-0.0905	-0.0895	-0.1041	-0.1058	-0.0975	0.0087
BG4602	30.49666	-86.24000	-0.0875	-0.0865	-0.1010	-0.1028	-0.0945	0.0087
BG1509	30.50138	-86.49083	-0.1450	-0.1439	-0.1481	-0.1469	-0.1460	0.0019
BG4635	30.50361	-86.49388	-0.1488	-0.1486	-0.1502	-0.1500	-0.1494	0.0008
BG4634	30.50416	-86.49277	-0.1487	-0.1483	-0.1504	-0.1500	-0.1494	0.0010
BG4535	30.54583	-87.10388	-0.0802	-0.0862	-0.1114	-0.1025	-0.0951	0.0144
BG4536	30.54583	-87.10444	-0.0832	-0.0892	-0.1144	-0.1055	-0.0981	0.0144
BG4537	30.54583	-87.10583	-0.0832	-0.0892	-0.1144	-0.1055	-0.0981	0.0144
BG4538	30.54944	-87.10583	-0.0862	-0.0922	-0.1174	-0.1085	-0.1011	0.0144
BG4539	30.54972	-87.10611	-0.0832	-0.0892	-0.1144	-0.1055	-0.0981	0.0144
BG3605	30.58055	-87.18000	-0.1030	-0.1050	-0.1063	-0.1056	-0.1050	0.0014
BG3606	30.58055	-87.17972	-0.1030	-0.1050	-0.1064	-0.1057	-0.1050	0.0015
BG4533	30.58055	-87.01500	-0.0948	-0.0965	-0.1002	-0.0999	-0.0979	0.0026
BG4534	30.58083	-87.01444	-0.0948	-0.0965	-0.1002	-0.0999	-0.0978	0.0027
BG3607	30.58138	-87.17944	-0.1031	-0.1049	-0.1063	-0.1055	-0.1049	0.0014
BG3608	30.58138	-87.17972	-0.1002	-0.1018	-0.1031	-0.1023	-0.1019	0.0013
BG3609	30.58250	-87.17888	-0.1000	-0.1020	-0.1033	-0.1026	-0.1020	0.0015
BG0231	30.62138	-87.03277	-0.0974	-0.1011	-0.0960	-0.0964	-0.0977	0.0023
BG0232	30.62277	-87.03555	-0.1004	-0.1032	-0.0996	-0.0995	-0.1007	0.0017

Table E.4. Estimated values of NAVD 88 at benchmark locations in St. Andrews Bay.

Bench-mark	Latitude	Longitude	From MLLW (m)	From MLW (m)	From MHW (m)	From MHHW (m)	Average (m)	Std. Dev. (m)
BE1732	30.03083	-85.46472	-0.0517	-0.053	-0.0501	-0.0506	-0.0514	0.0013
BE1733	30.03083	-85.46444	-0.0399	-0.0413	-0.0381	-0.0385	-0.0394	0.0014
BE3817	30.03944	-85.39388	-0.0570	-0.0543	-0.0584	-0.0574	-0.0568	0.0018
BE3815	30.03972	-85.39305	-0.0570	-0.0541	-0.0584	-0.0574	-0.0567	0.0018
BE3816	30.03972	-85.39388	-0.0567	-0.0533	-0.0582	-0.0575	-0.0564	0.0022
BE3018	30.09222	-85.64750	-0.0345	-0.0356	-0.0336	-0.0336	-0.0343	0.0009
BE3019	30.09222	-85.64805	-0.0346	-0.0357	-0.0337	-0.0340	-0.0345	0.0009
BE3020	30.09222	-85.64805	-0.0346	-0.0357	-0.0337	-0.0340	-0.0345	0.0009
BE1354	30.09277	-85.68500	-0.0633	-0.0638	-0.0648	-0.0610	-0.0632	0.0016
BE3011	30.09750	-85.61250	-0.0415	-0.0409	-0.0400	-0.0399	-0.0406	0.0008
BE3012	30.09861	-85.61250	-0.0471	-0.0442	-0.0347	-0.0396	-0.0414	0.0054
BE3013	30.09916	-85.61305	-0.0445	-0.0439	-0.0428	-0.0428	-0.0435	0.0009
BE3015	30.10166	-85.61111	-0.0433	-0.0404	-0.0316	-0.0367	-0.0380	0.0051
AI3216	30.12388	-85.73333	-0.0306	-0.0339	-0.0214	-0.0058	-0.0229	0.0126
AI3217	30.12388	-85.73472	-0.0493	-0.0569	-0.0122	0.0069	-0.0279	0.0303
AI3215	30.12500	-85.73055	-0.0293	-0.033	-0.0172	-0.0012	-0.0202	0.0143
AI3218	30.12500	-85.73166	-0.0306	-0.0339	-0.0214	-0.0058	-0.0229	0.0126
BE2976	30.12583	-85.61000	-0.0300	-0.0308	-0.0326	-0.0323	-0.0314	0.0012
BE2990	30.13027	-85.74305	-0.0437	-0.0423	-0.0473	-0.0471	-0.0451	0.0025
BE2991	30.13027	-85.74305	-0.0287	-0.0273	-0.0323	-0.0321	-0.0301	0.0025
BE2988	30.13194	-85.73055	-0.0225	-0.025	-0.0235	-0.0264	-0.0243	0.0017
BE1720	30.13333	-85.50638	-0.0414	-0.0381	-0.0366	-0.0389	-0.0388	0.002
BE2956	30.13638	-85.57111	-0.0413	-0.0396	-0.0396	-0.0413	-0.0405	0.001
BE2957	30.13638	-85.57027	-0.0416	-0.0395	-0.0397	-0.0414	-0.0405	0.0011
BE2958	30.13638	-85.57027	-0.0416	-0.0395	-0.0397	-0.0414	-0.0405	0.0011
BE2959	30.13638	-85.57027	-0.0416	-0.0395	-0.0397	-0.0414	-0.0405	0.0011
BE1719	30.13805	-85.51611	-0.0422	-0.0410	-0.0409	-0.0429	-0.0418	0.0010
BE0760	30.14750	-85.65888	-0.0556	-0.0474	-0.0335	-0.0407	-0.0443	0.0094
BE0758	30.15138	-85.66000	-0.0518	-0.0444	-0.0307	-0.0387	-0.0414	0.0089
BE3029	30.15194	-85.66444	-0.0324	-0.0313	-0.0329	-0.0296	-0.0315	0.0015
BE3030	30.15194	-85.66444	-0.0384	-0.0373	-0.0389	-0.0356	-0.0375	0.0015
BE0757	30.15333	-85.65972	-0.0548	-0.0473	-0.0337	-0.0417	-0.0444	0.0089
BE2994	30.15888	-85.76166	-0.0407	-0.0391	-0.0368	-0.0357	-0.0381	0.0023
AI3221	30.17000	-85.75555	-0.0464	-0.0447	-0.0475	-0.0475	-0.0465	0.0013
AI3222	30.17000	-85.75638	-0.0469	-0.0454	-0.0479	-0.0479	-0.0470	0.0012
BE2969	30.24472	-85.60583	-0.0464	-0.0444	-0.0464	-0.0477	-0.0462	0.0014
BE2970	30.24472	-85.60583	-0.0554	-0.0534	-0.0554	-0.0567	-0.0552	0.0014
BE2971	30.24472	-85.60583	-0.0524	-0.0504	-0.0524	-0.0537	-0.0522	0.0014
BE2972	30.24472	-85.60583	-0.0554	-0.0534	-0.0554	-0.0567	-0.0552	0.0014
BE1713	30.25277	-85.64805	-0.0426	-0.0407	-0.0399	-0.0419	-0.0413	0.0012
BE0655	30.25444	-85.64805	-0.0427	-0.0410	-0.0402	-0.0421	-0.0415	0.0012
BE0657	30.25444	-85.64972	-0.0455	-0.0432	-0.0432	-0.0449	-0.0442	0.0012
BE0656	30.25472	-85.64944	-0.0426	-0.0403	-0.0404	-0.0420	-0.0413	0.0012
BE0658	30.25500	-85.65000	-0.0423	-0.0400	-0.0396	-0.0417	-0.0409	0.0013
BE2963	30.27944	-85.64555	-0.0219	-0.0195	-0.0297	-0.0303	-0.0253	0.0055
BE2965	30.27944	-85.64555	-0.0249	-0.0225	-0.0327	-0.0333	-0.0283	0.0055
BE2964	30.27944	-85.64555	-0.0219	-0.0195	-0.0297	-0.0303	-0.0253	0.0055
BE2961	30.28277	-85.64583	-0.0298	-0.0277	-0.0316	-0.0324	-0.0304	0.0021
BE2962	30.28277	-85.64583	-0.0268	-0.0247	-0.0286	-0.0294	-0.0274	0.0021
BE1323	30.29305	-85.85833	-0.0523	-0.0508	-0.0549	-0.0548	-0.0532	0.0020
BE1324	30.29333	-85.85833	-0.0588	-0.0575	-0.0606	-0.0609	-0.0594	0.0016

Table E.4. (Continued).

Bench-mark	Latitude	Longitude	From MLLW (m)	From MLW (m)	From MHW (m)	From MHHW (m)	Average (m)	Std. Dev. (m)
BE1325	30.29361	-85.85833	-0.0532	-0.0521	-0.0543	-0.0550	-0.0537	0.0013
BE1322	30.29388	-85.85833	-0.0523	-0.0511	-0.0549	-0.0556	-0.0535	0.0021
BE0633	30.29500	-85.85694	-0.0509	-0.0492	-0.0558	-0.0548	-0.0527	0.0031

Table E.5. Estimated values of NAVD 88 at benchmark locations in St. Joseph Bay.

Bench-mark	Latitude	Longitude	From MLLW (m)	From MLW (m)	From MHW (m)	From MHHW (m)	Average (m)	Std. Dev. (m)
AS0930	29.68944	-85.36277	-0.1120	-0.1112	-0.1140	-0.1131	-0.1126	0.0012
AS0304	29.81722	-85.31222	0.0050	0.0033	0.0079	0.0053	0.0053	0.0019
AS0956	29.87250	-85.39194	0.0227	0.0285	0.0371	0.0271	0.0289	0.0060
AS0955	29.87305	-85.39138	0.0236	0.0274	0.0402	0.0258	0.0293	0.0075
AS0953	29.87416	-85.39055	0.0182	0.0214	0.0474	0.0212	0.0270	0.0137
AS0954	29.87416	-85.39138	0.0113	0.0140	0.0559	0.0153	0.0241	0.0212

APPENDIX F. COMPUTED DELTA VALUES FOR EACH DATUM

Delta represents the difference between the observed tidal datum and the datum as computed by the gridded fields. Differences are computed at each NOS benchmark, denoted by the PID.

Table F.1. Difference (i.e., Delta) values for the Mobile and Perdido Bays sub-region.

PID	Latitude (deg)	Longitude (deg)	MHHW Deltas (m)	MHW Deltas (m)	MLW Deltas (m)	MLLW Deltas (m)	Avg. (m)	Std. Dev. (m)
BH1754	30.24888	-88.07666	0.0048	0.0049	-0.0028	-0.0036	0.0008	0.0047
BH1752	30.24916	-88.07666	0.0049	0.0049	-0.0028	-0.0036	0.0009	0.0047
BH1755	30.24916	-88.07583	0.0008	0.0009	-0.0068	-0.0076	-0.0032	0.0047
BH1756	30.24944	-88.07555	0.0037	0.0039	-0.0040	-0.0048	-0.0003	0.0047
BG3643	30.29777	-87.44916	0.0013	0.0023	-0.0007	-0.0017	0.0003	0.0018
BG3644	30.29861	-87.44777	-0.0027	-0.0017	-0.0038	-0.0047	-0.0032	0.0013
BG3645	30.29944	-87.44722	0.0003	0.0013	-0.0002	-0.0012	0.0001	0.0010
BG3646	30.29944	-87.44722	-0.0057	-0.0047	-0.0062	-0.0072	-0.0059	0.0010
BG3634	30.34916	-87.41388	-0.0080	-0.0079	-0.0070	-0.0049	-0.0070	0.0014
BG3635	30.34916	-87.41444	-0.0080	-0.0079	-0.0070	-0.0049	-0.0070	0.0014
BG3636	30.34916	-87.41500	0.0129	0.0130	0.0141	0.0163	0.0141	0.0016
BG3410	30.39500	-87.42361	0.0008	0.0013	0.0028	0.0003	0.0013	0.0011
BG3409	30.39555	-87.42250	-0.0067	-0.0061	-0.0042	-0.0071	-0.0060	0.0013
BG3647	30.40055	-87.42333	-0.0018	0.0028	0.0012	0.0020	0.0011	0.0020
BG3615	30.41805	-87.35527	-0.0067	-0.0031	-0.0067	-0.0063	-0.0057	0.0017
BG3616	30.41861	-87.35361	-0.0026	0.0015	-0.0026	-0.0013	-0.0013	0.0019
BG4595	30.45972	-87.40944	-0.0007	-0.0015	-0.0011	-0.0016	-0.0012	0.0004
BG4596	30.45972	-87.40888	0.0009	0.0004	0.0007	-0.0003	0.0004	0.0005
BG4597	30.45972	-87.40805	0.0005	0.0000	0.0003	-0.0009	0.0000	0.0006
BG4594	30.46055	-87.40972	0.0006	-0.0004	0.0002	-0.0001	0.0001	0.0004
BG4593	30.46111	-87.40972	-0.0004	-0.0014	-0.0008	-0.0011	-0.0009	0.0004
BH1484	30.70388	-88.04111	-0.0021	-0.0016	-0.0022	-0.0047	-0.0026	0.0014

Table F.2. Difference (i.e., Delta) values for the NE Gulf of Mexico sub-region.

PID	Latitude (deg)	Longitude (deg)	MHHW Deltas (m)	MHW Deltas (m)	MLW Deltas (m)	MLLW Deltas (m)	Avg. (m)	Std. Dev. (m)
AA9918	30.21555	-85.87638	-0.0009	-0.0029	0.0014	0.0018	-0.0002	0.0022
BG4570	30.33194	-87.14027	0.0356	0.0337	0.0548	0.0572	0.0453	0.0124
BG4571	30.33388	-87.13972	0.0146	0.0127	0.0398	0.0392	0.0266	0.0149
BG4572	30.33388	-87.13972	0.0146	0.0127	0.0398	0.0392	0.0266	0.0149
BG4573	30.33388	-87.13888	0.0146	0.0127	0.0398	0.0392	0.0266	0.0149
BG4574	30.33388	-87.13666	0.0175	0.0157	0.0428	0.0422	0.0296	0.0150
BG4574	30.33388	-87.13666	0.0295	0.0277	0.0488	0.0512	0.0393	0.0124
BG3467	30.37916	-86.86444	0.0006	0.0013	-0.0009	0.0003	0.0003	0.0009
BG3683	30.37916	-86.86611	0.0021	0.0029	0.0007	0.0019	0.0019	0.0009
BG3466	30.37916	-86.86555	0.0011	0.0019	-0.0003	0.0009	0.0009	0.0009
BG3465	30.37944	-86.86583	0.0041	0.0048	0.0027	0.0038	0.0038	0.0009
BG3464	30.38083	-86.86500	0.0004	0.0011	-0.0012	0.0000	0.0001	0.0010
BG3464	30.38083	-86.86500	-0.0266	-0.0199	-0.0282	-0.0270	-0.0254	0.0037
BG3463	30.38138	-86.86166	0.0010	0.0016	-0.0007	0.0006	0.0006	0.0010

Table F.3. Difference (i.e., Delta) values for the Perdido, Pensacola, and Chocktawatchee Bay sub-region.

PID	Latitude (deg)	Longitude (deg)	MHHW Deltas (m)	MHW Deltas (m)	MLW Deltas (m)	MLLW Deltas (m)	Avg. (m)	Std. Dev. (m)
BG3643	30.29777	-87.44916	0.0012	0.0022	-0.0012	-0.0022	0.0000	0.0020
BG3644	30.29861	-87.44777	0.0004	0.0014	-0.0003	-0.0013	0.0001	0.0011
BG3645	30.29944	-87.44722	0.0053	0.0063	0.0052	0.0043	0.0053	0.0008
BG3646	30.29944	-87.44722	-0.0007	0.0003	-0.0008	-0.0017	-0.0007	0.0008
BG3626	30.32638	-87.36888	-0.0001	0.0003	0.0001	-0.0007	-0.0001	0.0004
BG3625	30.32666	-87.36888	0.0001	0.0005	0.0001	-0.0007	0.0000	0.0005
BG3624	30.32694	-87.36888	0.0001	0.0005	0.0001	-0.0007	0.0000	0.0005
BG3622	30.32750	-87.36638	0.0004	0.0008	-0.0003	-0.0007	0.0000	0.0007
BG3623	30.32750	-87.36777	0.0003	0.0007	-0.0001	-0.0007	0.0000	0.0006
BG1836	30.32888	-87.28805	-0.0030	-0.0004	-0.0026	0.0058	0.0000	0.0041
BG1832	30.33000	-87.29222	0.0000	-0.0011	0.0003	0.0000	-0.0002	0.0006
BG3613	30.33000	-87.29250	0.0000	-0.0011	0.0003	0.0000	-0.0002	0.0006
BG4569	30.33416	-87.14083	0.0055	0.0062	0.0019	0.0038	0.0044	0.0019
BG4576	30.33444	-87.13416	0.0014	0.0013	0.0060	0.0034	0.0030	0.0022
BG4568	30.33472	-87.14305	-0.0083	-0.0075	-0.0030	-0.0066	-0.0064	0.0023
BG4568	30.33472	-87.14305	0.0067	0.0075	0.0060	0.0054	0.0064	0.0009
BG4575	30.33472	-87.13361	-0.0016	-0.0017	0.0030	0.0004	0.0000	0.0022
BG4567	30.33611	-87.14444	0.0015	0.0022	0.0001	0.0001	0.0010	0.0011
BG4566	30.33638	-87.14361	0.0017	0.0022	-0.0021	0.0001	0.0005	0.0019
BG1815	30.34472	-87.26888	-0.0006	-0.0009	-0.0003	0.0016	-0.0001	0.0011
BG1814	30.34527	-87.27027	0.0001	-0.0003	-0.0001	0.0016	0.0003	0.0009
BG1809	30.34638	-87.27944	0.0022	0.0022	-0.0035	-0.0009	0.0000	0.0028
BG3633	30.34888	-87.41277	-0.0069	-0.0067	-0.0052	-0.0030	-0.0055	0.0018
BG3634	30.34916	-87.41388	-0.0147	-0.0146	-0.0144	-0.0123	-0.0140	0.0011
BG3635	30.34916	-87.41444	-0.0171	-0.0170	-0.0170	-0.0149	-0.0165	0.0011
BG3636	30.34916	-87.41500	0.0007	0.0008	0.0005	0.0026	0.0012	0.0010
BG1823	30.36916	-87.27666	-0.0034	-0.0042	0.0007	-0.0006	-0.0019	0.0023
BG3667	30.36944	-87.27666	-0.0003	-0.0012	0.0037	0.0024	0.0011	0.0023
BG4544	30.37083	-87.32027	-0.0005	0.0007	-0.0007	0.0003	-0.0001	0.0007
BG4543	30.37166	-87.32083	-0.0004	0.0008	-0.0007	0.0004	0.0000	0.0007
BG3666	30.37361	-87.27500	-0.0010	-0.0016	0.0022	0.0011	0.0002	0.0018
BG3665	30.38194	-87.27694	-0.0033	-0.0062	0.0054	0.0018	-0.0006	0.0052
BG1692	30.38222	-87.27805	-0.0006	-0.0009	0.0011	0.0003	0.0000	0.0009
BG3685	30.38638	-86.86222	0.0173	0.0120	0.0115	0.0130	0.0135	0.0026
BG3685	30.38638	-86.86222	-0.0067	-0.0060	-0.0125	-0.0110	-0.0091	0.0032
BG1892	30.38666	-86.99222	0.0006	0.0021	-0.0013	0.0003	0.0004	0.0014
BG3686	30.38777	-86.86277	0.0137	0.0083	0.0109	0.0125	0.0114	0.0023
BG3686	30.38777	-86.86277	-0.0103	-0.0097	-0.0131	-0.0115	-0.0112	0.0015
BG3410	30.39500	-87.42361	-0.0002	0.0003	0.0020	-0.0007	0.0003	0.0012
BG3422	30.39527	-86.51388	0.0002	0.0022	-0.0010	-0.0006	0.0002	0.0014
BG3659	30.39527	-86.51388	-0.0028	-0.0008	-0.0040	-0.0036	-0.0028	0.0014
BG3660	30.39527	-86.51388	0.0032	0.0052	0.0020	0.0024	0.0032	0.0014
BG3580	30.39861	-86.22861	0.0033	0.0021	0.0033	0.0031	0.0030	0.0006
BG3581	30.39944	-86.22861	-0.0036	-0.0048	-0.0037	-0.0039	-0.0040	0.0005
BG3582	30.40055	-86.22861	-0.0045	-0.0057	-0.0048	-0.0050	-0.0050	0.0005
BG3583	30.40055	-86.22861	-0.0045	-0.0057	-0.0048	-0.0050	-0.0050	0.0005
BG3653	30.40111	-87.25194	0.0002	-0.0010	0.0004	0.0015	0.0003	0.0010
BG3670	30.40361	-87.21333	-0.0026	-0.0018	-0.0034	-0.0034	-0.0028	0.0008
BG3590	30.40833	-86.73305	-0.0013	-0.0010	0.0021	-0.0007	-0.0002	0.0016
BG3586	30.40916	-86.70027	-0.0014	-0.0021	0.0038	0.0006	0.0002	0.0026
BG3589	30.40916	-86.73222	0.0002	0.0007	0.0030	0.0002	0.0010	0.0013

Table F.3. (Continued).

PID	Latitude (deg)	Longitude (deg)	MHHW Deltas (m)	MHW Deltas (m)	MLW Deltas (m)	MLLW Deltas (m)	Avg. (m)	Std. Dev. (m)
BG3588	30.40972	-86.73250	0.0007	0.0011	0.0034	0.0007	0.0015	0.0013
BG3615	30.41805	-87.35527	-0.0081	-0.0046	-0.0081	-0.0077	-0.0071	0.0017
BG3616	30.41861	-87.35361	-0.0013	0.0026	-0.0014	-0.0002	-0.0001	0.0019
BG2209	30.42972	-86.13583	0.0019	0.0016	0.0007	-0.0001	0.0010	0.0009
BG4613	30.43000	-86.13611	0.0015	0.0012	0.0003	-0.0005	0.0006	0.0009
BG4621	30.43055	-86.63333	-0.0165	-0.0177	-0.0157	-0.0178	-0.0169	0.0010
BG2205	30.43083	-86.13555	-0.0042	-0.0045	-0.0053	-0.0062	-0.0051	0.0009
BG4620	30.43138	-86.63333	0.0065	0.0050	0.0070	0.0048	0.0058	0.0011
BG4615	30.43194	-86.13500	0.0028	0.0026	0.0018	0.0009	0.0020	0.0009
BG3403	30.43527	-86.58416	-0.0045	-0.0081	0.0073	0.0053	0.0000	0.0075
BG3402	30.43694	-86.58444	-0.0011	-0.0030	0.0030	0.0015	0.0001	0.0027
BG4595	30.45972	-87.40944	-0.0009	-0.0015	-0.0012	-0.0022	-0.0015	0.0006
BG4596	30.45972	-87.40888	0.0020	0.0015	0.0017	0.0006	0.0014	0.0006
BG4597	30.45972	-87.40805	0.0017	0.0012	0.0014	0.0003	0.0012	0.0006
BG3680	30.46027	-87.09583	-0.0008	-0.0045	0.0065	0.0087	0.0025	0.0062
BG3681	30.46055	-87.09666	-0.0037	-0.0076	0.0037	0.0059	-0.0004	0.0063
BG4594	30.46055	-87.40972	0.0022	0.0015	0.0019	0.0012	0.0017	0.0004
BG4593	30.46111	-87.40972	-0.0006	-0.0016	-0.0011	-0.0014	-0.0012	0.0004
BG3662	30.46527	-86.13972	-0.0022	-0.0010	0.0019	0.0014	0.0000	0.0020
BG3663	30.46583	-86.13888	-0.0020	-0.0008	0.0018	0.0013	0.0001	0.0018
BG2194	30.48500	-86.24444	-0.0079	-0.0069	0.0056	0.0038	-0.0014	0.0070
BG0214	30.48694	-86.25222	0.0012	0.0022	0.0090	0.0080	0.0051	0.0040
BG2181	30.48694	-86.25194	-0.0107	-0.0097	-0.0026	-0.0036	-0.0067	0.0041
BG3584	30.48694	-86.25083	0.0019	0.0029	0.0114	0.0103	0.0066	0.0049
BG2179	30.48750	-86.25194	-0.0136	-0.0126	-0.0057	-0.0066	-0.0096	0.0041
BG4608	30.48888	-86.20583	0.0011	0.0012	0.0008	0.0017	0.0012	0.0004
BG4607	30.48972	-86.20555	0.0006	0.0007	0.0003	0.0012	0.0007	0.0004
BG4606	30.49055	-86.20555	-0.0017	-0.0016	-0.0020	-0.0011	-0.0016	0.0004
BG4600	30.49583	-86.23861	0.0072	0.0082	-0.0064	-0.0081	0.0002	0.0087
BG4598	30.49638	-86.23805	0.0068	0.0078	-0.0068	-0.0085	-0.0002	0.0087
BG4599	30.49638	-86.23861	0.0068	0.0078	-0.0068	-0.0085	-0.0002	0.0087
BG4601	30.49638	-86.23972	0.0068	0.0078	-0.0068	-0.0085	-0.0002	0.0087
BG4602	30.49666	-86.24000	0.0096	0.0106	-0.0040	-0.0057	0.0026	0.0087
BG1509	30.50138	-86.49083	0.0012	0.0023	-0.0020	-0.0007	0.0002	0.0019
BG4635	30.50361	-86.49388	0.0002	0.0005	-0.0012	-0.0010	-0.0004	0.0008
BG4634	30.50416	-86.49277	0.0007	0.0011	-0.0010	-0.0006	0.0001	0.0010
BG4535	30.54583	-87.10388	0.0162	0.0102	-0.0150	-0.0061	0.0013	0.0144
BG4536	30.54583	-87.10444	0.0147	0.0087	-0.0165	-0.0076	-0.0002	0.0144
BG4537	30.54583	-87.10583	0.0149	0.0089	-0.0163	-0.0074	0.0000	0.0144
BG4538	30.54944	-87.10583	0.0143	0.0083	-0.0169	-0.0080	-0.0006	0.0144
BG4539	30.54972	-87.10611	0.0173	0.0113	-0.0139	-0.0050	0.0024	0.0144
BG3605	30.58055	-87.18000	0.0015	-0.0005	-0.0018	-0.0011	-0.0005	0.0014
BG3606	30.58055	-87.17972	0.0016	-0.0005	-0.0019	-0.0011	-0.0005	0.0015
BG4533	30.58055	-87.01500	0.0031	0.0014	-0.0023	-0.0020	0.0000	0.0026
BG4534	30.58083	-87.01444	0.0031	0.0014	-0.0024	-0.0021	0.0000	0.0027
BG3607	30.58138	-87.17944	-0.0001	-0.0020	-0.0033	-0.0025	-0.0020	0.0014
BG3608	30.58138	-87.17972	0.0028	0.0012	-0.0001	0.0007	0.0012	0.0012
BG3609	30.58250	-87.17888	0.0013	-0.0008	-0.0021	-0.0014	-0.0007	0.0015
BG0231	30.62138	-87.03277	0.0005	-0.0032	0.0018	0.0015	0.0002	0.0023
BG0232	30.62277	-87.03555	0.0002	-0.0026	0.0010	0.0011	-0.0001	0.0017

Table F.4. Difference (i.e., Delta) values for the St. Joseph Bay sub-region.

PID	Latitude (deg)	Longitude (deg)	MHHW Deltas (m)	MHW Deltas (m)	MLW Deltas (m)	MLLW Deltas (m)	Avg. (m)	Std. Dev. (m)
AS0930	29.68944	-85.3628	-0.0011	-0.0003	-0.0030	-0.0021	-0.0016	0.0012
AS0304	29.81722	-85.3122	0.0050	0.0033	0.0079	0.0053	0.0054	0.0019
AS0956	29.8725	-85.3919	-0.0024	0.0034	0.0119	0.0019	0.0037	0.0060
AS0955	29.87305	-85.3914	-0.0027	0.0012	0.0139	-0.0004	0.0030	0.0074
AS0953	29.87416	-85.3906	-0.0020	0.0012	0.0273	0.0011	0.0069	0.0137
AS0954	29.87416	-85.3914	-0.0166	-0.0139	0.0280	-0.0126	-0.0038	0.0212

Table F.5. Difference (i.e., Delta) values for the St. Andrews Bay sub-region.

PID	Latitude (deg)	Longitude (deg)	MHHW Deltas (m)	MHW Deltas (m)	MLW Deltas (m)	MLLW Deltas (m)	Avg. (m)	Std. Dev. (m)
BE1732	30.03083	-85.46472	-0.0075	-0.0088	-0.0059	-0.0063	-0.0071	0.0013
BE1733	30.03083	-85.46444	-0.0001	-0.0015	0.0016	0.0012	0.0003	0.0014
BE3817	30.03944	-85.39388	-0.0003	0.0024	-0.0017	-0.0007	-0.0001	0.0018
BE3815	30.03972	-85.39305	-0.0003	0.0025	-0.0017	-0.0007	0.0000	0.0018
BE3816	30.03972	-85.39388	-0.0002	0.0032	-0.0017	-0.0010	0.0001	0.0022
BE3018	30.09222	-85.64750	-0.0002	-0.0013	0.0007	0.0007	0.0000	0.0009
BE3019	30.09222	-85.64805	-0.0002	-0.0012	0.0008	0.0005	0.0000	0.0009
BE3020	30.09222	-85.64805	-0.0002	-0.0012	0.0008	0.0005	0.0000	0.0009
BE1354	30.09277	-85.68500	-0.0026	-0.0031	-0.0041	-0.0003	-0.0025	0.0016
BE3011	30.09750	-85.61250	-0.0009	-0.0003	0.0006	0.0007	0.0000	0.0008
BE3012	30.09861	-85.61250	-0.0060	-0.0031	0.0064	0.0015	-0.0003	0.0054
BE3013	30.09916	-85.61305	-0.0011	-0.0005	0.0007	0.0006	-0.0001	0.0009
BE3015	30.10166	-85.61111	-0.0051	-0.0023	0.0066	0.0014	0.0001	0.0051
AI3216	30.12388	-85.73333	-0.0077	-0.0110	0.0015	0.0171	0.0000	0.0126
AI3217	30.12388	-85.73472	-0.0223	-0.0299	0.0149	0.0340	-0.0008	0.0304
AI3215	30.12500	-85.73055	-0.0091	-0.0127	0.0030	0.0190	0.0001	0.0143
AI3218	30.12500	-85.73166	-0.0076	-0.0109	0.0016	0.0172	0.0001	0.0126
BE2976	30.12583	-85.61000	0.0014	0.0006	-0.0012	-0.0009	0.0000	0.0012
BE2990	30.13027	-85.74305	-0.0050	-0.0036	-0.0085	-0.0084	-0.0064	0.0025
BE2991	30.13027	-85.74305	0.0100	0.0114	0.0065	0.0066	0.0086	0.0025
BE2988	30.13194	-85.73055	0.0018	-0.0007	0.0008	-0.0021	-0.0001	0.0017
BE1720	30.13333	-85.50638	-0.0026	0.0007	0.0022	-0.0001	0.0001	0.0020
BE2956	30.13638	-85.57111	-0.0007	0.0010	0.0010	-0.0008	0.0001	0.0010
BE2957	30.13638	-85.57027	-0.0010	0.0010	0.0008	-0.0009	0.0000	0.0011
BE2958	30.13638	-85.57027	-0.0010	0.0010	0.0008	-0.0009	0.0000	0.0011
BE2959	30.13638	-85.57027	-0.0010	0.0010	0.0008	-0.0009	0.0000	0.0011
BE1719	30.13805	-85.51611	-0.0005	0.0007	0.0008	-0.0012	-0.0001	0.0010
BE0760	30.14750	-85.65888	-0.0114	-0.0032	0.0107	0.0035	-0.0001	0.0094
BE0758	30.15138	-85.66000	-0.0104	-0.0030	0.0107	0.0027	0.0000	0.0089
BE3029	30.15194	-85.66444	0.0019	0.0030	0.0014	0.0047	0.0028	0.0015
BE3030	30.15194	-85.66444	-0.0041	-0.0030	-0.0046	-0.0013	-0.0032	0.0015
BE0757	30.15333	-85.65972	-0.0106	-0.0031	0.0105	0.0025	-0.0002	0.0089
BE2994	30.15888	-85.76166	-0.0026	-0.0010	0.0013	0.0024	0.0000	0.0023
AI3221	30.17000	-85.75555	0.0001	0.0018	-0.0010	-0.0010	0.0000	0.0013
AI3222	30.17000	-85.75638	0.0000	0.0015	-0.0011	-0.0011	-0.0002	0.0012
BE2969	30.24472	-85.60583	0.0067	0.0087	0.0067	0.0054	0.0069	0.0014
BE2970	30.24472	-85.60583	-0.0023	-0.0003	-0.0023	-0.0036	-0.0021	0.0014
BE2971	30.24472	-85.60583	0.0007	0.0027	0.0007	-0.0006	0.0009	0.0014
BE2972	30.24472	-85.60583	-0.0023	-0.0003	-0.0023	-0.0036	-0.0021	0.0014
BE1713	30.25277	-85.64805	-0.0014	0.0005	0.0013	-0.0007	-0.0001	0.0012

Table F.5 (Continued).

PID	Latitude (deg)	Longitude (deg)	MHHW Deltas (m)	MHW Deltas (m)	MLW Deltas (m)	MLLW Deltas (m)	Avg. (m)	Std. Dev. (m)
BE0655	30.25444	-85.64805	-0.0011	0.0006	0.0014	-0.0005	0.0001	0.0011
BE0657	30.25444	-85.64972	-0.0042	-0.0019	-0.0019	-0.0036	-0.0029	0.0012
BE0656	30.25472	-85.64944	-0.0011	0.0012	0.0011	-0.0006	0.0001	0.0012
BE0658	30.25500	-85.65000	-0.0013	0.0010	0.0014	-0.0007	0.0001	0.0013
BE2963	30.27944	-85.64555	0.0045	0.0069	-0.0034	-0.0040	0.0010	0.0055
BE2965	30.27944	-85.64555	0.0015	0.0039	-0.0064	-0.0070	-0.0020	0.0055
BE2964	30.27944	-85.64555	0.0045	0.0069	-0.0034	-0.0040	0.0010	0.0055
BE2961	30.28277	-85.64583	-0.0005	0.0016	-0.0023	-0.0031	-0.0011	0.0021
BE2962	30.28277	-85.64583	0.0025	0.0046	0.0007	-0.0001	0.0019	0.0021
BE1323	30.29305	-85.85833	0.0019	0.0034	-0.0007	-0.0006	0.0010	0.0020
BE1324	30.29333	-85.85833	-0.0042	-0.0030	-0.0060	-0.0063	-0.0049	0.0016
BE1325	30.29361	-85.85833	0.0011	0.0022	-0.0001	-0.0007	0.0006	0.0013
BE1322	30.29388	-85.85833	0.0011	0.0023	-0.0014	-0.0022	-0.0001	0.0021
BE0633	30.29500	-85.85694	0.0018	0.0035	-0.0031	-0.0021	0.0000	0.0031

APPENDIX G. COMPARISON OF OBSERVED AND COMPUTED NAVD88 VALUES

The following tables contain the comparison of the values of observed NAVD88-to-MSl offset at both NOS benchmarks (referenced by NGS PID) and tide stations (referenced by CO-OPS 7-digit Station ID, or SID) and the offsets computed at the same location using the VDatum TSS fields. The difference is the computed minus the observed.

Table G.1. Comparison of observed and computed values of NAVD88-to-MSL and their differences for the Alabama Bays sub-region.

PID or SID	Latitude (deg)	Longitude (deg)	Observed (m)	TSS Derived Value (m)	Difference (m)
BH1754	30.24888	-88.07666	-0.1081	-0.1090	-0.0009
BH1752	30.24916	-88.07666	-0.1081	-0.1090	-0.0009
BH1755	30.24916	-88.07583	-0.1108	-0.1077	0.0031
BH1756	30.24944	-88.07555	-0.1079	-0.1076	0.0003
BG3643	30.29777	-87.44916	-0.1059	-0.1062	-0.0003
BG3644	30.29861	-87.44777	-0.1088	-0.1056	0.0032
BG3645	30.29944	-87.44722	-0.1028	-0.1028	0.0000
BG3646	30.29944	-87.44722	-0.1088	-0.1028	0.0060
BG3634	30.34916	-87.41388	-0.1031	-0.0961	0.0070
BG3635	30.34916	-87.41444	-0.1031	-0.0961	0.0070
BG3636	30.34916	-87.41500	-0.0821	-0.0962	-0.0141
BG3410	30.39500	-87.42361	-0.1139	-0.1152	-0.0013
BG3409	30.39555	-87.42250	-0.1228	-0.1168	0.0060
BG3647	30.40055	-87.42333	-0.1170	-0.1181	-0.0011
BG3615	30.41805	-87.35527	-0.1265	-0.1208	0.0057
BG3616	30.41861	-87.35361	-0.1258	-0.1246	0.0012
BG4595	30.45972	-87.40944	-0.1287	-0.1275	0.0012
BG4596	30.45972	-87.40888	-0.1256	-0.1260	-0.0004
BG4597	30.45972	-87.40805	-0.1256	-0.1256	0.0000
BG4594	30.46055	-87.40972	-0.1257	-0.1258	-0.0001
BG4593	30.46111	-87.40972	-0.1288	-0.1278	0.0010
BH1484	30.70388	-88.04111	-0.2078	-0.2052	0.0026
BH1484	30.70388	-88.04111	-0.2078	-0.2052	0.0026
BH1484	30.70388	-88.04111	-0.2078	-0.2052	0.0026
8735180	30.25000	-88.07500	-0.1020	-0.1044	-0.0024
8737048	30.70833	-88.04333	-0.1790	-0.1800	-0.0010
8729974	30.30000	-87.44833	-0.1070	-0.1048	0.0022
8729962	30.39333	-87.42500	-0.1170	-0.1170	0.0000
8729943	30.45833	-87.40833	-0.1270	-0.1270	0.0000
8729938	30.35000	-87.41500	-0.1020	-0.0988	0.0032
8729905	30.41833	-87.35667	-0.1150	-0.1199	-0.0049

Table G.2. Comparison of observed and computed values of NAVD88-to-MSL and their differences for the Northeast Gulf of Mexico sub-region.

PID or SID	Latitude (deg)	Longitude (deg)	Observed (m)	TSS Derived Value (m)	Difference (m)
AA9918	30.21555	-85.87638	-0.0224	-0.0222	0.0002
BG4570	30.33194	-87.14027	-0.0433	-0.0886	-0.0453
BG4571	30.33388	-87.13972	-0.0620	-0.0886	-0.0266
BG4572	30.33388	-87.13972	-0.0620	-0.0886	-0.0266
BG4573	30.33388	-87.13888	-0.0620	-0.0886	-0.0266
BG4574	30.33388	-87.13666	-0.0590	-0.0886	-0.0296
BG4574	30.33388	-87.13666	-0.0493	-0.0886	-0.0393
BG3467	30.37916	-86.86444	-0.0582	-0.0585	-0.0003
BG3683	30.37916	-86.86611	-0.0581	-0.0600	-0.0019
BG3466	30.37916	-86.86555	-0.0581	-0.0590	-0.0009
BG3465	30.37944	-86.86583	-0.0551	-0.0590	-0.0039
BG3464	30.38083	-86.86500	-0.0582	-0.0582	0.0000
BG3464	30.38083	-86.86500	-0.0837	-0.0582	0.0255
BG3463	30.38138	-86.86166	-0.0582	-0.0588	-0.0006
8729678	30.37667	-86.86500	-0.0570	-0.0579	-0.0009
8729210	30.21333	-85.88000	-0.0210	-0.0212	-0.0002

Table G.3. Comparison of observed and computed values of NAVD88-to-MSL and their differences for the Perdido, Pensacola, and Chocktawatchee Bays sub-region.

PID or SID	Latitude (deg)	Longitude (deg)	Observed (m)	TSS Derived Value (m)	Difference (m)
BG3643	30.29777	-87.44916	-0.1060	-0.1060	0.0000
BG3644	30.29861	-87.44777	-0.1087	-0.1088	-0.0001
BG3645	30.29944	-87.44722	-0.1027	-0.1080	-0.0053
BG3646	30.29944	-87.44722	-0.1087	-0.1080	0.0007
BG3626	30.32638	-87.36888	-0.1018	-0.1017	0.0001
BG3625	30.32666	-87.36888	-0.1017	-0.1017	0.0000
BG3624	30.32694	-87.36888	-0.1017	-0.1017	0.0000
BG3622	30.32750	-87.36638	-0.1016	-0.1016	0.0000
BG3623	30.32750	-87.36777	-0.1017	-0.1017	0.0000
BG1836	30.32888	-87.28805	-0.0913	-0.0913	0.0000
BG1832	30.33000	-87.29222	-0.0925	-0.0923	0.0002
BG3613	30.33000	-87.29250	-0.0925	-0.0923	0.0002
BG4569	30.33416	-87.14083	-0.0543	-0.0586	-0.0043
BG4576	30.33444	-87.13416	-0.0638	-0.0668	-0.0030
BG4568	30.33472	-87.14305	-0.0630	-0.0567	0.0063
BG4568	30.33472	-87.14305	-0.0503	-0.0567	-0.0064
BG4575	30.33472	-87.13361	-0.0668	-0.0668	0.0000
BG4567	30.33611	-87.14444	-0.0505	-0.0515	-0.0010
BG4566	30.33638	-87.14361	-0.0513	-0.0518	-0.0005
BG1815	30.34472	-87.26888	-0.0886	-0.0886	0.0000
BG1814	30.34527	-87.27027	-0.0885	-0.0889	-0.0004
BG1809	30.34638	-87.27944	-0.0909	-0.0909	0.0000
BG3633	30.34888	-87.41277	-0.1032	-0.0977	0.0055
BG3634	30.34916	-87.41388	-0.1031	-0.0891	0.0140
BG3635	30.34916	-87.41444	-0.1031	-0.0866	0.0165
BG3636	30.34916	-87.41500	-0.0821	-0.0832	-0.0011
BG1823	30.36916	-87.27666	-0.0965	-0.0947	0.0018

Table G.3 (Continued).

PID or SID	Latitude (deg)	Longitude (deg)	Observed (m)	TSS Derived Value (m)	Difference (m)
BG3667	30.36944	-87.27666	-0.0935	-0.0947	-0.0012
BG4544	30.37083	-87.32027	-0.0965	-0.0964	0.0001
BG4543	30.37166	-87.32083	-0.0965	-0.0965	0.0000
BG3666	30.37361	-87.27500	-0.0935	-0.0937	-0.0002
BG3665	30.38194	-87.27694	-0.0968	-0.0962	0.0006
BG1692	30.38222	-87.27805	-0.0964	-0.0964	0.0000
BG3685	30.38638	-86.86222	-0.0617	-0.0752	-0.0135
BG3685	30.38638	-86.86222	-0.0842	-0.0752	0.0090
BG1892	30.38666	-86.99222	-0.0721	-0.0726	-0.0005
BG3686	30.38777	-86.86277	-0.0618	-0.0731	-0.0113
BG3686	30.38777	-86.86277	-0.0843	-0.0731	0.0112
BG3410	30.39500	-87.42361	-0.1139	-0.1142	-0.0003
BG3422	30.39527	-86.51388	-0.1227	-0.1229	-0.0002
BG3659	30.39527	-86.51388	-0.1257	-0.1229	0.0028
BG3660	30.39527	-86.51388	-0.1197	-0.1229	-0.0032
BG3580	30.39861	-86.22861	-0.1145	-0.1174	-0.0029
BG3581	30.39944	-86.22861	-0.1204	-0.1164	0.0040
BG3582	30.40055	-86.22861	-0.1204	-0.1154	0.0050
BG3583	30.40055	-86.22861	-0.1204	-0.1154	0.0050
BG3653	30.40111	-87.25194	-0.1002	-0.1005	-0.0003
BG3670	30.40361	-87.21333	-0.1100	-0.1072	0.0028
BG3590	30.40833	-86.73305	-0.0973	-0.0971	0.0002
BG3586	30.40916	-86.70027	-0.0956	-0.0958	-0.0002
BG3589	30.40916	-86.73222	-0.0971	-0.0981	-0.0010
BG3588	30.40972	-86.73250	-0.0971	-0.0985	-0.0014
BG3615	30.41805	-87.35527	-0.1266	-0.1195	0.0071
BG3616	30.41861	-87.35361	-0.1260	-0.1259	0.0001
BG2209	30.42972	-86.13583	-0.1263	-0.1273	-0.0010
BG4613	30.43000	-86.13611	-0.1263	-0.1269	-0.0006
BG4621	30.43055	-86.63333	-0.0572	-0.0403	0.0169
BG2205	30.43083	-86.13555	-0.1323	-0.1272	0.0051
BG4620	30.43138	-86.63333	-0.0392	-0.0450	-0.0058
BG4615	30.43194	-86.13500	-0.1263	-0.1283	-0.0020
BG3403	30.43527	-86.58416	-0.1174	-0.1174	0.0000
BG3402	30.43694	-86.58444	-0.1175	-0.1176	-0.0001
BG4595	30.45972	-87.40944	-0.1287	-0.1272	0.0015
BG4596	30.45972	-87.40888	-0.1257	-0.1271	-0.0014
BG4597	30.45972	-87.40805	-0.1257	-0.1268	-0.0011
BG3680	30.46027	-87.09583	-0.0940	-0.0964	-0.0024
BG3681	30.46055	-87.09666	-0.0970	-0.0966	0.0004
BG4594	30.46055	-87.40972	-0.1257	-0.1274	-0.0017
BG4593	30.46111	-87.40972	-0.1288	-0.1276	0.0012
BG3662	30.46527	-86.13972	-0.0903	-0.0903	0.0000
BG3663	30.46583	-86.13888	-0.0903	-0.0904	-0.0001
BG2194	30.48500	-86.24444	-0.1120	-0.1106	0.0014
BG0214	30.48694	-86.25222	-0.1005	-0.1056	-0.0051
BG2181	30.48694	-86.25194	-0.1125	-0.1058	0.0067
BG3584	30.48694	-86.25083	-0.1004	-0.1070	-0.0066
BG2179	30.48750	-86.25194	-0.1155	-0.1059	0.0096
BG4608	30.48888	-86.20583	-0.0999	-0.1011	-0.0012
BG4607	30.48972	-86.20555	-0.1029	-0.1036	-0.0007
BG4606	30.49055	-86.20555	-0.1069	-0.1053	0.0016
BG4600	30.49583	-86.23861	-0.0975	-0.0977	-0.0002
BG4598	30.49638	-86.23805	-0.0975	-0.0973	0.0002

Table G.3. (Continued).

PID or SID	Latitude (deg)	Longitude (deg)	Observed (m)	TSS Derived Value (m)	Difference (m)
BG4599	30.49638	-86.23861	-0.0975	-0.0973	0.0002
BG4601	30.49638	-86.23972	-0.0975	-0.0973	0.0002
BG4602	30.49666	-86.24000	-0.0945	-0.0971	-0.0026
BG1509	30.50138	-86.49083	-0.1460	-0.1462	-0.0002
BG4635	30.50361	-86.49388	-0.1494	-0.1490	0.0004
BG4634	30.50416	-86.49277	-0.1494	-0.1494	0.0000
BG4535	30.54583	-87.10388	-0.0951	-0.0964	-0.0013
BG4536	30.54583	-87.10444	-0.0981	-0.0979	0.0002
BG4537	30.54583	-87.10583	-0.0981	-0.0981	0.0000
BG4538	30.54944	-87.10583	-0.1011	-0.1005	0.0006
BG4539	30.54972	-87.10611	-0.0981	-0.1005	-0.0024
BG3605	30.58055	-87.18000	-0.1050	-0.1045	0.0005
BG3606	30.58055	-87.17972	-0.1050	-0.1046	0.0004
BG4533	30.58055	-87.01500	-0.0979	-0.0979	0.0000
BG4534	30.58083	-87.01444	-0.0978	-0.0979	-0.0001
BG3607	30.58138	-87.17944	-0.1049	-0.1030	0.0019
BG3608	30.58138	-87.17972	-0.1019	-0.1030	-0.0011
BG3609	30.58250	-87.17888	-0.1020	-0.1013	0.0007
BG0231	30.62138	-87.03277	-0.0977	-0.0979	-0.0002
BG0232	30.62277	-87.03555	-0.1007	-0.1006	0.0001
8729974	30.30000	-87.44833	-0.1070	-0.1070	0.0000
8729962	30.39333	-87.42500	-0.1170	-0.1160	0.0010
8729943	30.45833	-87.40833	-0.1270	-0.1269	0.0001
8729938	30.35000	-87.41500	-0.1020	-0.1021	-0.0001
8729909	30.32667	-87.35667	-0.1010	-0.1010	0.0000
8729905	30.41833	-87.35667	-0.1150	-0.1160	-0.0010
8729889	30.37000	-87.31833	-0.0960	-0.0961	-0.0001
8729882	30.33000	-87.29167	-0.0920	-0.0923	-0.0003
8729871	30.37500	-87.27667	-0.0930	-0.0931	-0.0001
8729868	30.34500	-87.27333	-0.0910	-0.0910	0.0000
8729849	30.40167	-87.25167	-0.1020	-0.1014	0.0006
8729840	30.40333	-87.21167	-0.0900	-0.0963	-0.0063
8729824	30.58167	-87.18000	-0.1010	-0.1022	-0.0012
8729808	30.33667	-87.14667	-0.0530	-0.0530	0.0000
8729806	30.33667	-87.14000	-0.0670	-0.0665	0.0005
8729793	30.54500	-87.10333	-0.0980	-0.0962	0.0018
8729791	30.45500	-87.10000	-0.0940	-0.0940	0.0000
8729757	30.62667	-87.03667	-0.0950	-0.0965	-0.0015
8729753	30.63667	-87.02833	-0.1090	-0.1087	0.0003
8729747	30.58167	-87.01500	-0.0960	-0.0965	-0.0005
8729736	30.38667	-86.99167	-0.0730	-0.0726	0.0004
8729679	30.38500	-86.86333	-0.0880	-0.0876	0.0004
8729613	30.40833	-86.73167	-0.1040	-0.1014	0.0026
8729598	30.40667	-86.70000	-0.0960	-0.0960	0.0000
8729567	30.42833	-86.63167	-0.0180	-0.0279	-0.0099
8729538	30.43500	-86.58667	-0.1190	-0.1188	0.0002
8729511	30.39500	-86.51333	-0.1230	-0.1228	0.0002
8729501	30.50333	-86.49333	-0.1480	-0.1486	-0.0006
8729387	30.48667	-86.25333	-0.1100	-0.1057	0.0043
8729381	30.49667	-86.24000	-0.0990	-0.0971	0.0019
8729376	30.40000	-86.22833	-0.1150	-0.1155	-0.0005
8729364	30.48833	-86.20500	-0.1050	-0.1039	0.0011
8729333	30.46833	-86.13833	-0.0920	-0.0921	-0.0001
8729332	30.42833	-86.13667	-0.1370	-0.1340	0.0030

Table G.4. Comparison of observed and computed values of NAVD88-to-MSL and their differences for the St. Joseph Bay sub-region.

PID or SID	Latitude (deg)	Longitude (deg)	Observed (m)	TSS Derived Value (m)	Difference (m)
AS0930	29.68944	-85.36277	-0.1126	-0.1109	0.0017
AS0304	29.81722	-85.31222	0.0053	0.0000	-0.0053
AS0956	29.87250	-85.39194	0.0289	0.0251	-0.0038
AS0955	29.87305	-85.39138	0.0293	0.0262	-0.0031
AS0953	29.87416	-85.39055	0.0270	0.0201	-0.0069
AS0954	29.87416	-85.39138	0.0241	0.0279	0.0038
8728958	29.87333	-85.39000	0.0070	0.0094	0.0024
8728949	29.69000	-85.36333	-0.1140	-0.1126	0.0014
8728942	29.66833	-85.36000	0.0060	0.0061	0.0001
8728912	29.81500	-85.31333	0.0010	0.0000	-0.0010

Table G.5. Comparison of observed and computed values of NAVD88-to-MSL and their differences for the St. Andrews Bay sub-region.

PID or SID	Latitude (deg)	Longitude (deg)	Observed (m)	TSS Derived Value (m)	Difference (m)
BE1732	30.03083	-85.46472	-0.0514	-0.0442	0.0072
BE1733	30.03083	-85.46444	-0.0394	-0.0397	-0.0003
BE3817	30.03944	-85.39388	-0.0568	-0.0567	0.0001
BE3815	30.03972	-85.39305	-0.0567	-0.0567	0.0000
BE3816	30.03972	-85.39388	-0.0564	-0.0565	-0.0001
BE3018	30.09222	-85.64750	-0.0343	-0.0343	0.0000
BE3019	30.09222	-85.64805	-0.0345	-0.0345	0.0000
BE3020	30.09222	-85.64805	-0.0345	-0.0345	0.0000
BE1354	30.09277	-85.68500	-0.0632	-0.0607	0.0025
BE3011	30.09750	-85.61250	-0.0406	-0.0406	0.0000
BE3012	30.09861	-85.61250	-0.0414	-0.0411	0.0003
BE3013	30.09916	-85.61305	-0.0435	-0.0434	0.0001
BE3015	30.10166	-85.61111	-0.0380	-0.0382	-0.0002
AI3216	30.12388	-85.73333	-0.0229	-0.0229	0.0000
AI3217	30.12388	-85.73472	-0.0279	-0.0271	0.0008
AI3215	30.12500	-85.73055	-0.0202	-0.0202	0.0000
AI3218	30.12500	-85.73166	-0.0229	-0.0230	-0.0001
BE2976	30.12583	-85.61000	-0.0314	-0.0314	0.0000
BE2990	30.13027	-85.74305	-0.0451	-0.0388	0.0063
BE2991	30.13027	-85.74305	-0.0301	-0.0388	-0.0087
BE2988	30.13194	-85.73055	-0.0243	-0.0243	0.0000
BE1720	30.13333	-85.50638	-0.0388	-0.0388	0.0000
BE2956	30.13638	-85.57111	-0.0405	-0.0406	-0.0001
BE2957	30.13638	-85.57027	-0.0405	-0.0405	0.0000
BE2958	30.13638	-85.57027	-0.0405	-0.0405	0.0000
BE2959	30.13638	-85.57027	-0.0405	-0.0405	0.0000
BE1719	30.13805	-85.51611	-0.0418	-0.0417	0.0001
BE0760	30.14750	-85.65888	-0.0443	-0.0442	0.0001
BE0758	30.15138	-85.66000	-0.0414	-0.0414	0.0000
BE3029	30.15194	-85.66444	-0.0315	-0.0343	-0.0028
BE3030	30.15194	-85.66444	-0.0375	-0.0343	0.0032
BE0757	30.15333	-85.65972	-0.0444	-0.0442	0.0002

Table G.5. (Continued).

PID or SID	Latitude (deg)	Longitude (deg)	Observed (m)	TSS Derived Value (m)	Difference (m)
BE2994	30.15888	-85.76166	-0.0381	-0.0381	0.0000
AI3221	30.17000	-85.75555	-0.0465	-0.0465	0.0000
AI3222	30.17000	-85.75638	-0.0470	-0.0468	0.0002
BE2969	30.24472	-85.60583	-0.0462	-0.0531	-0.0069
BE2970	30.24472	-85.60583	-0.0552	-0.0531	0.0021
BE2971	30.24472	-85.60583	-0.0522	-0.0531	-0.0009
BE2972	30.24472	-85.60583	-0.0552	-0.0531	0.0021
BE1713	30.25277	-85.64805	-0.0413	-0.0412	0.0001
BE0655	30.25444	-85.64805	-0.0415	-0.0416	-0.0001
BE0657	30.25444	-85.64972	-0.0442	-0.0413	0.0029
BE0656	30.25472	-85.64944	-0.0413	-0.0415	-0.0002
BE0658	30.25500	-85.65000	-0.0409	-0.0410	-0.0001
BE2963	30.27944	-85.64555	-0.0253	-0.0263	-0.0010
BE2965	30.27944	-85.64555	-0.0283	-0.0263	0.0020
BE2964	30.27944	-85.64555	-0.0253	-0.0263	-0.0010
BE2961	30.28277	-85.64583	-0.0304	-0.0293	0.0011
BE2962	30.28277	-85.64583	-0.0274	-0.0293	-0.0019
BE1323	30.29305	-85.85833	-0.0532	-0.0542	-0.0010
BE1324	30.29333	-85.85833	-0.0594	-0.0546	0.0048
BE1325	30.29361	-85.85833	-0.0537	-0.0543	-0.0006
BE1322	30.29388	-85.85833	-0.0535	-0.0535	0.0000
BE0633	30.29500	-85.85694	-0.0527	-0.0527	0.0000
8729197	30.29333	-85.85833	-0.0540	-0.0546	-0.0006
8729155	30.15833	-85.76833	-0.0380	-0.0380	0.0000
8729152	30.17000	-85.75500	-0.0510	-0.0495	0.0015
8729149	30.13000	-85.74333	-0.0430	-0.0415	0.0015
8729141	30.13333	-85.73167	-0.0240	-0.0241	-0.0001
8729136	30.12500	-85.72167	-0.0260	-0.0260	0.0000
8729108	30.15167	-85.66667	-0.0330	-0.0331	-0.0001
8729107	30.15167	-85.66000	-0.0420	-0.0418	0.0002
8729105	30.09167	-85.64833	-0.0340	-0.0341	-0.0001
8729102	30.25500	-85.64833	-0.0470	-0.0456	0.0014
8729101	30.28333	-85.64667	-0.0300	-0.0299	0.0001
8729085	30.09833	-85.61333	-0.0410	-0.0414	-0.0004
8729084	30.12667	-85.61167	-0.0290	-0.0290	0.0000
8729071	30.24500	-85.60500	-0.0540	-0.0537	0.0003
8729063	30.13667	-85.57167	-0.0410	-0.0410	0.0000
8729039	30.13667	-85.51667	-0.0410	-0.0410	0.0000
8729015	30.03000	-85.46500	-0.0390	-0.0384	0.0006
8728973	30.03833	-85.39333	-0.0570	-0.0570	0.0000