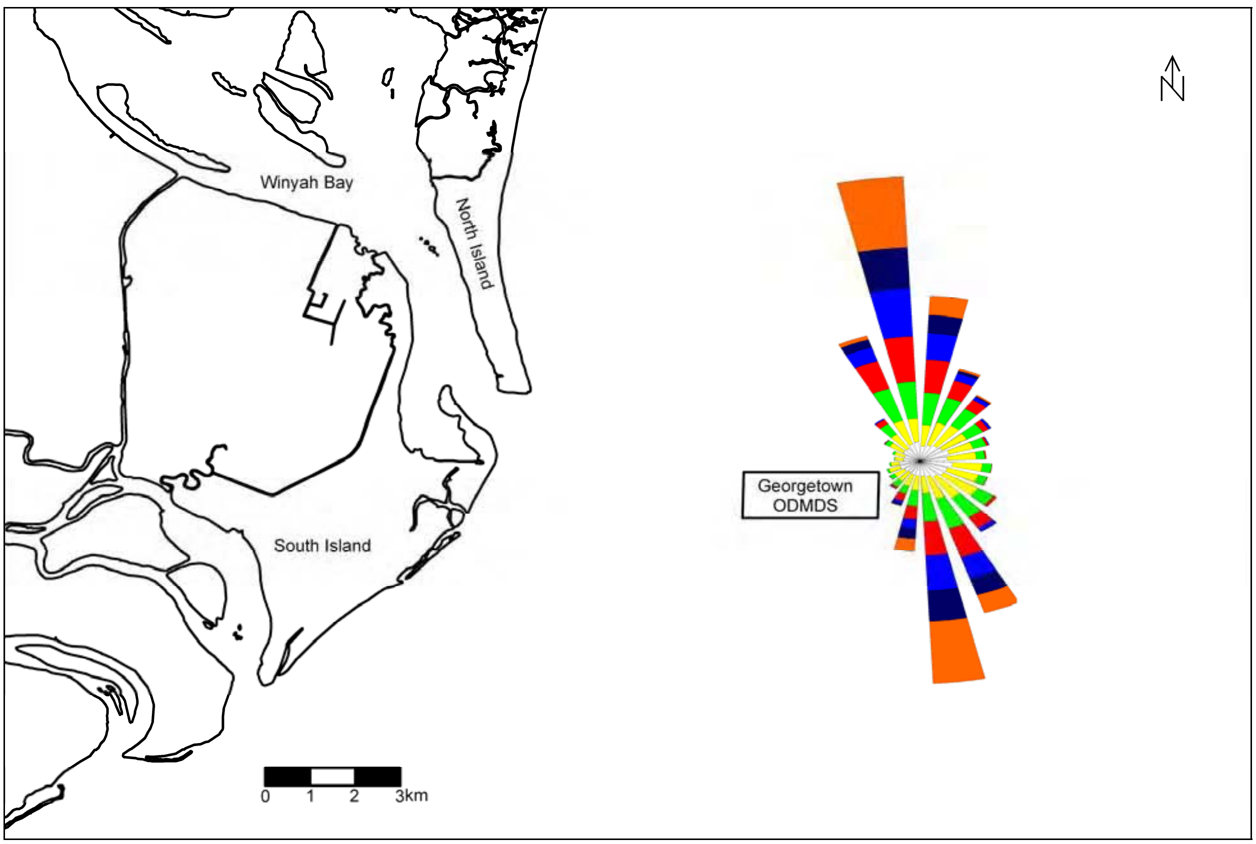
Ocean Current and Wave Measurements at the Georgetown Ocean Dredged Material Disposal Sites

October 2007 through September 2008



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Ocean Current and Wave Measurements at the Georgetown Ocean Dredged Material Disposal Sites

October 2007 through September 2008

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Science and Ecosystem Support Division

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U.S. Environmental Protection Agency Region 4
Atlanta, Georgia

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Table of Contents

Tables

Appendices

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Ocean Current and Wave Measurements at the Georgetown Ocean Dredged Material Disposal Site

1.0 INTRODUCTION

It is the responsibility of the U.S. Environmental Protection Agency (EPA) and the U.S. Army Corps of Engineers (USACE) under the Marine Protection, Research, and Sanctuaries Act (MPRSA) of 1972 to manage and monitor each of the Ocean Dredged Material Disposal Sites (ODMDSs) designated by the EPA pursuant to Section 102 of MPRSA. Additionally, the Memorandum of Understanding (MOU) between EPA Region 4 and the USACE South Atlantic Division specifies that it is in the best interest of the EPA and the USACE to act in partnership concerning the management and monitoring of all ODMDSs.

The Georgetown Harbor Ocean Dredged Material Disposal Site (ODMDS) was designated by the U.S. Environmental Protection Agency (EPA) in 1988 for the disposal of dredged material from the greater Georgetown, South Carolina area. Since that time approximately 4.6 million cubic yards of dredged material has been disposed at the ODMDS. As a result of disposal, significant shoaling within the ODMDS has occurred decreasing depths within the eastern half of the ODMDS from 36 feet prior to designation to 25 feet presently. Further shoaling of the ODMDS could result in a navigation hazard and would present operation problems for vessels attempting to disposal of dredged material from the Georgetown Harbor federal project. Consequently, in 2001, the USACE Charleston District (SAC) requested that EPA consider enlarging the ODMDS. Consistent with EPA's Statement of Policy for Voluntary Preparation of National Environmental Policy Act (NEPA) Documents (See 63 FR 58045 [October 29, 1998], "Notice of Policy and Procedures for Voluntary Preparation of NEPA Documents"), EPA determined that an Environmental Assessment (EA) would be the appropriate mechanism for modifying the site designation. Consistent with a Memorandum of Understanding (MOU) between EPA Region 4 and the USACE South Atlantic Division (SAD) it is the USACE's responsibility to provide EPA with the information necessary to develop the appropriate NEPA documentation. SAC in consultation with EPA Region 4 developed a study plan for collecting the information necessary for the EA including: single beam bathymetry, side-scan sonar and magnetometer surveys of a 4 nmi by 4 nmi study area; benthic and water quality sampling; and current and wave measurements. EPA Region 4, through funding from the USACE, has developed the capability to conduct wave and current measurements at ocean dredged material disposal sites. Therefore, SAC requested that EPA Region 4 conduct a one year study of the currents and waves in the vicinity of the Georgetown Harbor ODMDS in support of site designation modification.

In September 2007, EPA Region 4 and the SAC entered into an agreement to collect one year of current and wave data at the Georgetown ODMDS. This report details the results of that study.

2.0 METHODS

2.1 Study Area

The study area consists of an area approximately 11 kilometers (6 nautical miles) offshore the entrance to Winyah Bay, South Carolina. A location approximately one kilometers (0.5 nautical miles) east of the existing Georgetown ODMDS was selected for the main instrument deployment. Two additional instrument deployment locations were established for short term current measurements. One was located 1.8 kilometers (1 nautical mile) east and the other 2.2 kilometers (1.2 nautical miles) southeast of the existing Georgetown ODMDS. The coordinates and water depths of the instrument deployment locations are provided in table 1 and shown in figure 1.

Table 1: Instrument Deployment Locations

Deployment Location	Latitude (dd mm.mm)	Longitude (dd mm.mm)	Water Depth (m)
Site A (600kHz ADCP with Wave Package)	33^{o} 11.132’	79 ^{o} 04.781’	12.8
Site B (600kHz ADCP)	33^{o} 09.903’	79 ^{o} 04.757’	12.8
Site C (1200kHz ADCP)	33^{o} 10.739’	79 ^{o} 03.972’	12.2

2.2 Deployment Periods

A diver deployable fiberglass base manufactured by Ocean Science was utilized for the main instrument deployment (figure 2). The two additional instrument deployments utilized stainless steel bases designed by EPA Region 4 (figure 3). The main instrument package, which included wave measurements, required four deployments each of 3 to 4 months beginning on October 23, 2007. The deployment periods are shown in Table 2.

Table 2: ADCP Deployment Periods

First Ensemble Date-Time (UTC)	Last Ensemble Date-Time (UTC)	Duration (days)
Site A		
10/23/07 – 20:45	01/29/08 – 17:45	97.875
01/29/08 – 20:15	04/29/08 – 18:45	90.938
04/29/08 – 20:15	06/19/08 – 02:45[1]	50.271
08/05/08 – 20:45	09/14/08 – 08:45[2]	39.500
Site B		
04/30/08 – 18:30	08/05/08 – 12:30	96.75
Site C		
04/30/08 – 20:00	07/26/08 – 08:15	86.510

[1]Deployment 3 ended prematurely due to unexplained instrument failure. Wave data ended on June 19 at 02:00 hr. Current data was available until August 26, 2008 with 48 missing ensembles. The instrument recovery date was August 5, 2008.
[2]Deployment 4 ended prematurely due to an unexplained loss of battery power. The instrument recovery date was October 29, 2008.

2.3 Instrumentation

600 kHz Acoustic Doppler Current Profilers (ADCP) manufactured by RD Instruments were used to measure wave parameters and currents at the Georgetown Harbor ODMDS Site A and currents only at Site B. A 1200 kHz ADCP was used to measure currents at Site C.

ADCPs work by transmitting sound along four separate beams at a fixed frequency and listening to the echoes returned by sound scatterers, such as plankton or small particles, in the water. By calculating the Doppler shift and time of travel of the echoes, the ADCP can calculate velocities for various depths in the water. The calculations performed by the instrument split the water column into equally sized depth cells or bins (in this case the bin size was set at 0.5 m). In each bin, an average velocity vector is calculated. The raw data from the instrument is reported as a velocity magnitude and direction for each bin.

To calculate wave parameters, the wave orbital velocities below the surface are measured by the ADCP. To get a surface height spectrum the velocity spectrum is translated to surface displacement using linear wave kinematics. The ADCP can also measure wave height spectra from its pressure sensor and from echo ranging the surface. For directional spectrum, each depth cell of the ADCP can be considered to be an independent sensor that makes a measurement of one component of the wave field velocity. The ensemble of depth cells along the four beams constitutes an array of sensors from which magnitude and directional information about the wave field can be determined. (Strong, 2000)

In this study the velocity or current profile was sampled every 15 minutes and waves every hour using the ADCPs. Instrument settings are summarized in table 3.

Table 3: ADCP Settings

ADCP Setup	Site A	Site B	Site C
Number of Bins	32	27	36
Bin Size (m)	0.50 (1.6 ft)	0.50 (1.6 ft)	0.50 (1.6 ft)
Pings per Ensemble- Currents	180	210	90
Standard Deviation (cm/s)	1.02	0.94	0.73
Interval - Currents (h:m:s)	00:15:00	00:15:00	00:15:00
Burst Duration - Waves (minutes)	18	N/A	N/A
Burst Interval - Waves (h:m:s)	01:00:00	N/A	N/A
Salinity (ppt)	35	35	35
Magnetic Variation (degrees)	0*	0*	0*
Temperature (C)	20	20	20
First Bin Range (m)	1.6 (5.3 ft)	1.6 (5.3 ft)	1.1 (3.6 ft)
Last Bin Range (m)	17.1 (56 ft)	14.6 (47.9 ft)	18.6 (61.0 ft)
Battery Usage (Wh) / Maximum Deployment Duration (days)	1348 / 105	401/105	180/105
Required Storage (MB)	412	6.67	8.4
Minimum Observable Wave Period for non-directional (sec)	2.00	N/A	N/A
Minimum Observable Wave Period for directional (sec)	2.95	N/A	N/A
Samples per Wave Burst	2160	N/A	N/A
Altitude of Sensor Head above the bottom (m)	0.46 (1.5 ft)	0.41 (1.3 ft)	0.41 (1.3 ft)

*A magnetic declination of -7.9 degrees was applied during post-processing.

The ADCPs were mounted in the bases with their face oriented up at approximately 0.5 meters above the bottom. Therefore, the first bin measurement is actually approximately two meters above the bottom.

2.4 Data Analysis

2.4.1 Wave Data

Raw binary data files from the instrument were converted utilizing the RD Instruments software WaveMon® version 3.04 into binary waves data files and binary current data files utilizing the protocols and processing options outlined in the United States Geological Survey (USGS) Wave Data Processing Toolbox Manual (USGS, 2006). A magnetic declination of –7.9 degrees was applied to the data. The USGS Wave Data Processing Toolbox MATLAB® programs were used to remove out-of-water data collected during instrument deployment and recovery and to convert the statistical wave parameters to EPIC-standard variables (NOAA-PMEL, 2006) and write the data to a NetCDF file (Unidata, 2008) for distribution and archival. The NetCDF format embeds a metadata structure with the data to document pertinent information regarding the deployment and the parameters used to process the data. NetCDF data is portable to any computer platform and is viewable with public-domain freely available software (e.g. ncbrowse).

2.4.2 Current Data

Current data was processed using the USGS ADCP Data Processing System (USGS, 2005) and CMGTool (USGS, 2002). The ADCP Data Processing System consists of a series of MATLAB® programs that allows for data editing and quality assessment and converts the data into NetCDF format with embedded metadata and in an EPIC compatible format. The ADCP Data Processing System was used to check the data files for missing ensembles and to remove bad data from the beginning and end of the files. It was also used to correct for magnetic declination for sites B and C. CMGTooL provides a library of MATLAB® programs for analyzing ADCP data. These programs were used to conduct smoothing and lowpass filtering of the data.

Because the ADCP reports current data for bins beyond the surface, the bins beyond the surface need to be removed from the record. Additionally, the surface can provide scatterers in the water column that can overwhelm the side lobe suppression of the transducers. Therefore, RD Instruments (1996) cautions that data from the upper 6% of the water column can be contaminated. The water depth and surface bins were determined using the depths reported in the ADCP Data Processing System from the pressure sensor and/or the echo return intensity and any bins that appeared to be out of the water, or within the top 6% of the surface were removed. The resulting analysis determined that bins 1 through 18 at site A and bins 1 through 20 at sites B and C provide reliable current data. This correlates to 2.1 to 10.6 meters (7 to 35 feet) above the instrument face for site A, 2.1 to 11.6 meters (7 to 38 feet) for site B, and 1.6 to 11.1 meters (5 to 36 feet) for site C.

The water depth above the transducer was determined to vary from 9.8 to 12.9 meters (32.2 to 42.3 feet) at site A, 10.1 to 12.9 meters (33.1 to 42.3) at site B, and 9.5 to 12.3 meters (31.2 to 40.4 feet) at site C above the ADCP.

Surface, bottom and depth average currents were analyzed. Bin 18 (11.1 meters or 36 feet) at site A, bin 20 (12.1 meters or 40 feet) at site B, and bin 20 (11.6 meters or 38 feet) were selected to represent surface currents. Bin 1 was used to represent bottom currents at sites A and B and bin 2 and site C. All correspond to an altitude of 2.1 meters (7 feet) above the bottom. To determine average currents, the bins were averaged from bin 1 to the surface bin. To average over the bins, the north and east components were averaged for each ensemble. These average north and average east components were then used to calculate an average current magnitude and direction for each ensemble. In calculating overall summary data and statistics, current data from site A and B were combined to cover data gaps at site A. Tidal components were examined after smoothing the data over one hour periods utilizing both a low pass filter (USGS, 2002) and classical tidal harmonic analysis using a set of MATLAB® programs, T_Tide (Pawlowicz et. al., 2002). Harmonic analysis was conducted for a 326 day data record beginning October 23, 2007 using data from sites A and B for the most complete data record.

3.0 RESULTS

3.1 Waves

A wave rose for the entire deployment period is shown in figures 4 and 5 for wave height and period, respectively. Waves are predominately out of the east and few exceed 2 meters (6.6 feet) in height or 15 seconds in period. Figure 6 shows the wave roses for each quarterly deployment. Figures 7 and 8 show box plots of the monthly significant wave heights and wave periods, respectively. Monthly median significant wave heights ranged from 0.7 meters (2.3 feet) in June to 1.2 meters (3.9 feet) in October. Wave periods were typically in the 4 to 11 second range. Histograms of significant wave height and wave period are shown in figures 9 and 10. Overall, the median and mean wave heights were 0.78 and 0.86 meters (2.6 and 2.8 feet), respectively. The median and mean wave periods were both 7.3 seconds.

3.2 Currents

A current rose for depth average currents for the entire deployment period is shown in figure 11. Currents flow is predominately in the north-northwest and south-southeast direction. Quarterly current roses for depth average currents are shown in figure 12. The summer months appeared to have a more dominate northerly current and the fall months a more southerly current. Current roses for near surface and near bottom currents are shown in figure 13. Near surface currents are up to 2.3 meters (7.5 feet) below the surface depending on tidal state. Near bottom currents are approximately 2.1 meters (6.9 feet) above the bottom (1.6 meters above the instrument face). Histograms for the currents are shown in figures 14 and 15. As is typically the case, surface currents are stronger than near bottom currents. The median surface current was 24 cm/sec (0.8 ft/sec) whereas the median bottom currents was 13 cm/sec (0.4 ft/sec). The depth average median current velocity was 17 cm/sec (0.6 ft/sec). For depth averaged currents most current measurements were in the 15 to 20 cm/sec (0.5 to 0.7 ft/sec) range with 90 percent of the measurements below 35 cm/sec (1.1 ft/sec). The net direction of transport as shown by a progressive vector diagram is to the north northeast. Bottom currents have a northwestern trend and surface currents a northeastern trend (see figure 16).

Little spatial variability was seen between the three instrumented locations. Current roses for sites B and C are shown in figure 17. Figures 18 through 20 show a comparison of the current magnitude and direction of the three locations for a two week period in May 2008. The most variability is observable in the surface currents. This may be an artifact of the different water depths of the surface measurements for the different locations (see section 2.4.2).

A low pass filter was applied to data smoothed over one-hour periods to analyze non-tidal variability. T_Tide was used to analyze the tidal components. Results are summarized in tables 4 through 6 and appendix C provides the complete tidal analysis output from T_Tide. Figure 21 shows the tidal cycle as represented by water depth for both the actual data set and a synthesized data set utilizing the calculated tidal constituents. Two distinct high and low tides are seen per day. Figures 22 and 23 show the north and east depth average current components for the smoothed data, the non-tidal component and the predicted tidal component.

Table 4: Principal Tidal Constituents at the Georgetown ODMDSs

Symbol	**Name**	**Frequency (cycles/hour)**	**Period (hours)**
O_1	Principal lunar diurnal	0.0387	25.84
K_1	Lunisolar diurnal	0.0418	23.92
N_2	Lunar elliptic semidiurnal	0.0790	12.66
M_2	Principal lunar semidiurnal	0.0805	12.42
S_2	Principal solar semidiurnal	0.0833	12.00

Table 5: Summary of Harmonic Analysis of Water Depth at the Georgetown ODMDS

Symbol	**Amplitude (meters)**	**Phase (degrees)**
O_1	0.0711	192.18
K_1	0.0967	186.92
N_2	0.1553	335.49
M_2	0.6525	355.02
S_2	0.1238	21.85

Table 6: Summary of Harmonic Analysis of Currents at the Georgetown ODMDS

Symbol	Major Axis (cm/s)	Minor Axis (cm/s)	Inclination (cc from east-degrees)	Phase (degrees)
Surface Currents				
N_2	5.155	0.132	120.46	273.84
M_2	16.842	-1.643	115.63	296.10
S_2	4.093	-0.548	116.09	319.12
Bottom Currents				
N_2	3.243	-0.585	113.71	256.31
M_2	14.269	-1.710	109.74	281.09
S_2	2.591	-0.301	108.84	305.99
Depth Averaged Currents				
N_2	4.631	-0.543	115.21	266.85
M_2	19.042	-2.221	114.80	291.76
S_2	3.561	-0.597	112.17	312.93

4.0 SUMMARY AND CONCLUSIONS

Currents in the vicinity of the Georgetown ODMDS tend to have a significant semidiurnal tidal component. Tidal excursions are estimated to be 1 to 3.5 km (0.5 to 1.9 nmi) in the north/south direction and 0.5 to 1 km (0.3 to 0.5 nmi) in the east/west direction. Non-tidal currents are predominately in the along shore direction and show periodic oscillations (see figures 22 and 23) that may be related to overtides (e.g. the M_6 tidal constituent). There is a definite and consistent northerly drift to the non-tidal currents. However, there were some periods of southerly currents that occurred early in the study and during April, July and August of 2008 (see figure 16). Spring and summer currents showed a definite northerly trend. The depth averaged median current velocity was 17 cm/sec (0.6 ft/sec) with 90 percent of the measurements below 35 cm/sec (1.1 ft/sec). Based on the progressive vector diagram, the average current drift over the study period was 2.5 cm/sec (0.08 ft/sec) to the north and 2.3 cm/sec (0.07 ft/sec) to the east.

Waves in the vicinity of the Georgetown ODMDS are out the east. The highest measured waves were in excess of 2.5 meters (8.2 feet) and occurred in September. Ninety percent of the wave measurements were less than 1.3 meters (4.3 feet) with wave periods in the 4 to 11 second range. Figure 24 compares the measured ocean wave height to the Wave Information Study (WIS) hindcast data from 1980 through 1999 for station 333 23.4 km (12.6 nmi) east of the ODMDS (U.S. Army, 2009). In general, measured wave heights were less than those in the WIS especially during the winter months. The most frequent wave period was 9 seconds. Based on linear wave theory, wave periods in excess of 4 seconds are of sufficient length to influence bottom velocities at the depths of the ODMDS (USACE, 1984) and therefore waves are likely to affect resuspension and transport of dredged material at the ODMDS.

Data from this study will be used to characterize the disposal, as input parameters for site capacity models (e.g. MDFATE, MPFATE and LTFATE) and as input for water quality models for evaluating dredged material (e.g. STFATE). Using the median values in this report, recommend STFATE model input parameters for dredged material evaluations are provided in Table 7.

Table 7: Recommended STFATE ambient velocity parameters for the Georgetown ODMDS

Depth[1] (ft)	Magnitude	Direction
7.5	0.80	15^{o} from North
31.8	0.4	330^{o} from North

[1] Total water depth is 38.7 feet

5.0 ACKNOWLEDGEMENTS

Mel Parsons of the EPA Region 4 Science and Ecosystem Support Division led the field efforts for deployment and recovery of the instruments. Doug Jager, Sarah Waterson and Drew Kendall of the EPA Region 4 Dive Team and Nadia Lombardero of ANAMAR Environmental Consulting provided additional diving support. Phil Wolf with the SAC provided technical oversight as well as field support.

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APPENDIX A

FIGURES

List of Figures

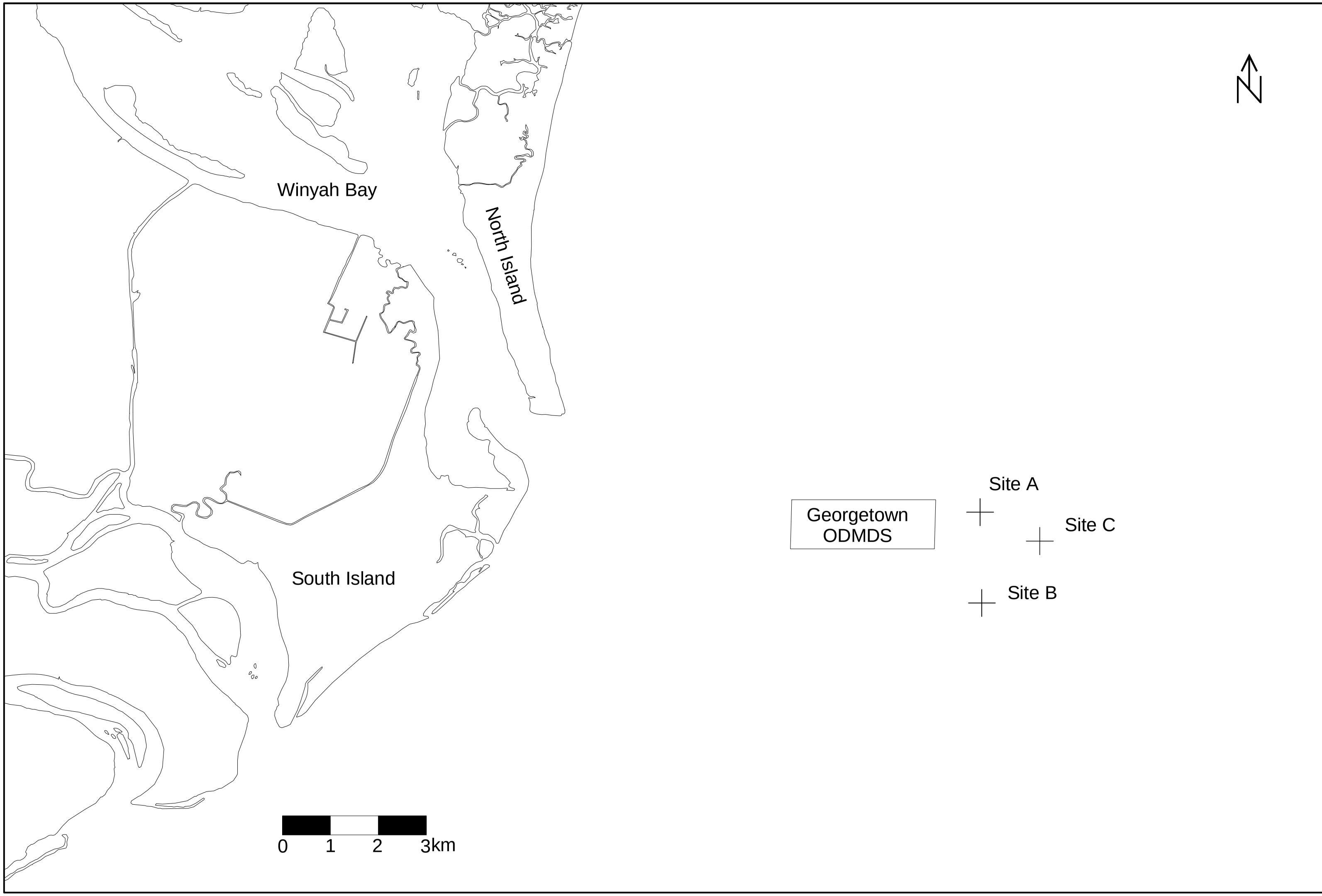


Figure 1: Instrument Location Map

Figure 2: Ocean Science fiberglass ADCP Base at Site A

Figure 3: EPA Region 4 ADCP Base at Sites B and C

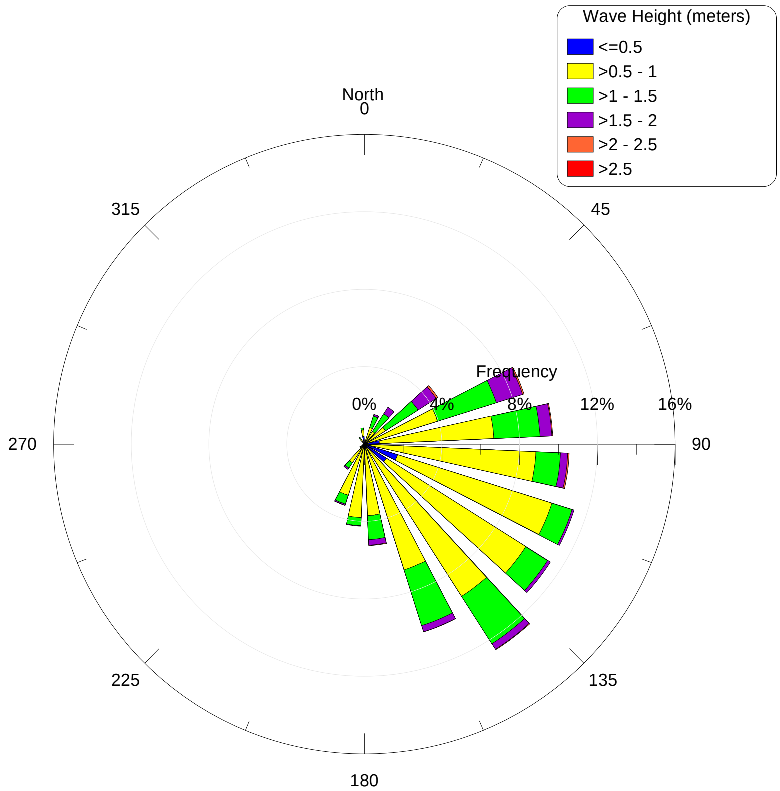


Figure 4: Georgetown ODMDS Wave Rose for Significant Wave Height.
The figure represents the direction from which the waves are approaching.

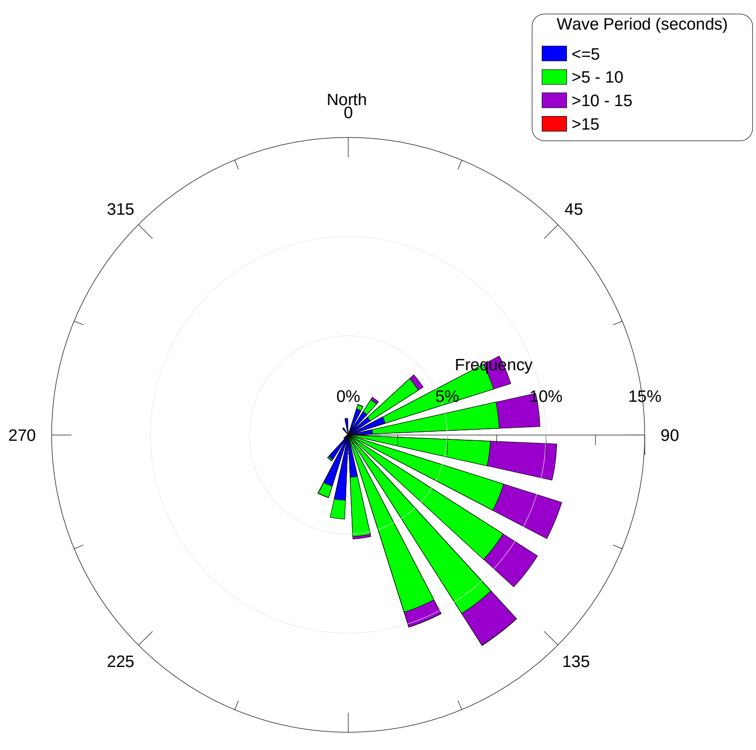


Figure 5: Georgetown ODMDS Wave Rose for Peak Wave Period.
The figure represents the direction from which the waves are approaching.

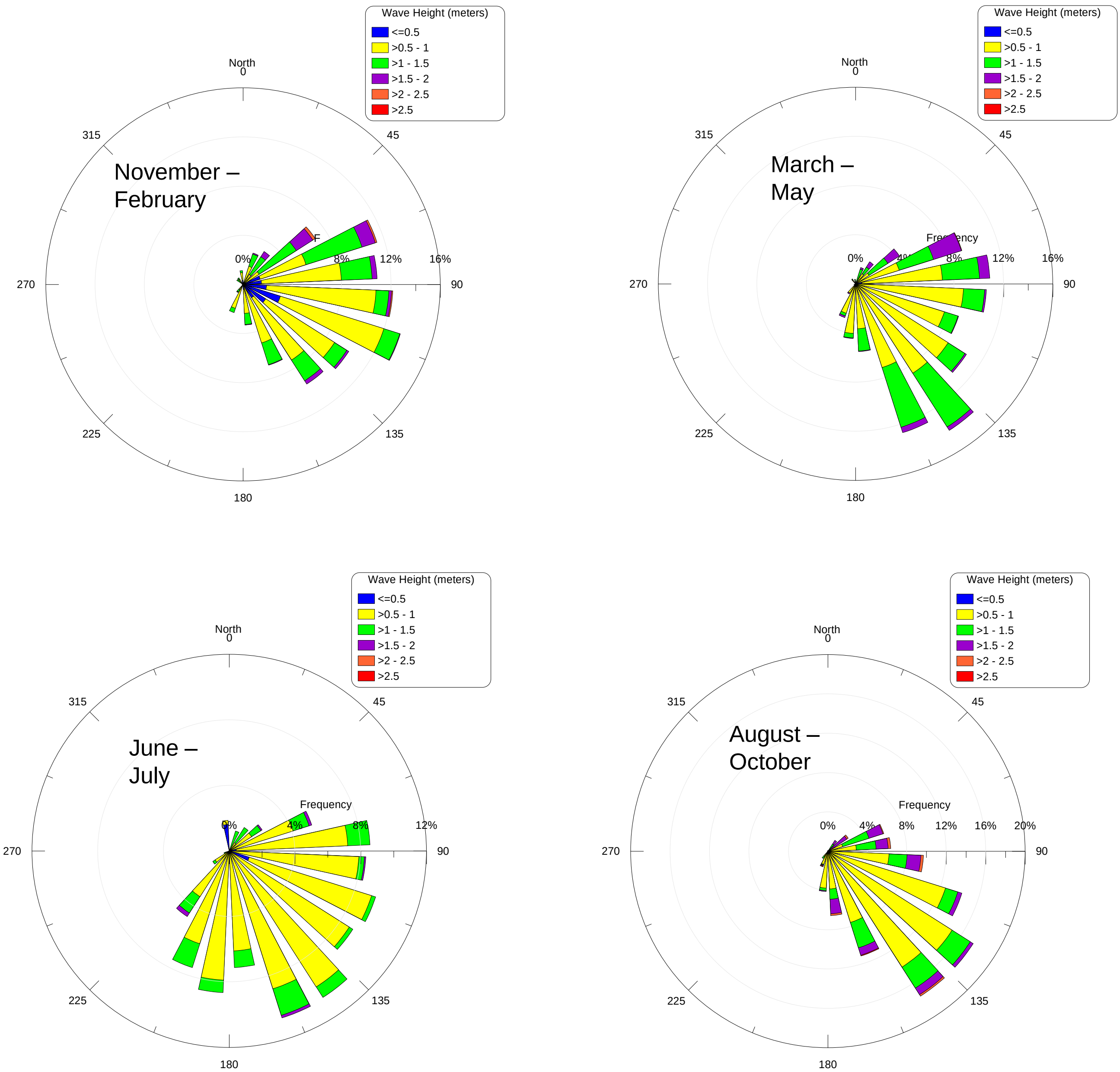


Figure 6: Georgetown ODMDS Quarterly Wave Rose Diagrams for Significant Wave Height. The figures represents the direction from which the waves are approaching. The last two quarters are from incomplete data (see table 2).

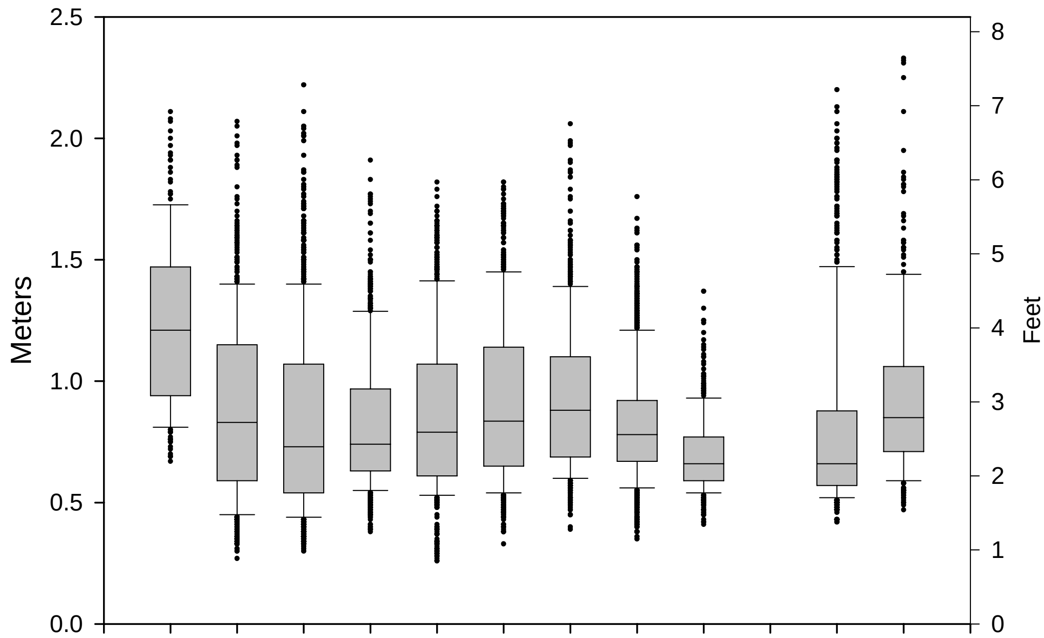


Figure 7: Georgetown ODMDS Monthly Significant Wave Heights
* Incomplete data record.

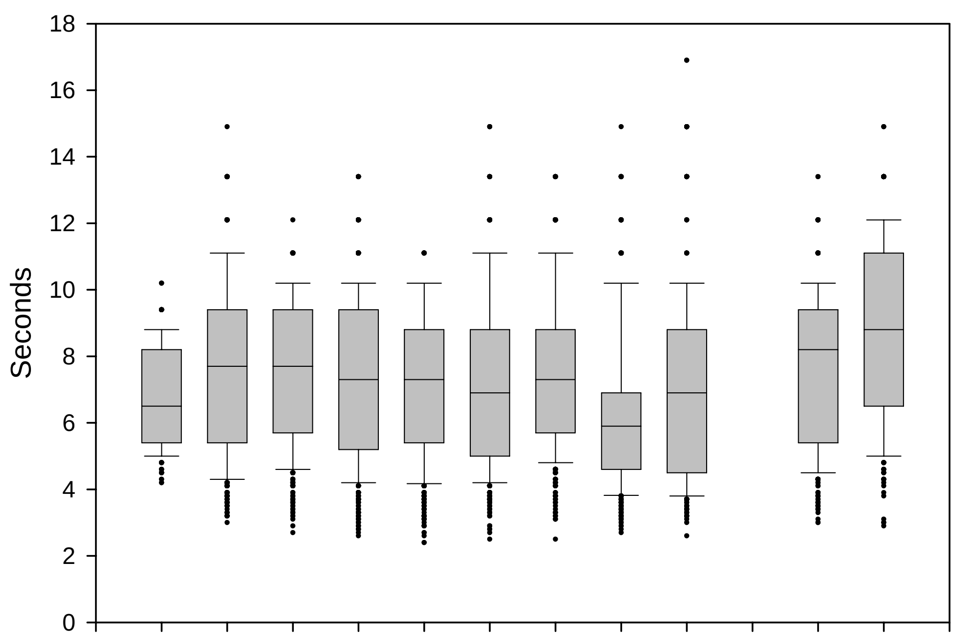


Figure 8: Georgetown ODMSD Monthly Peak Wave Periods
* Incomplete data record.

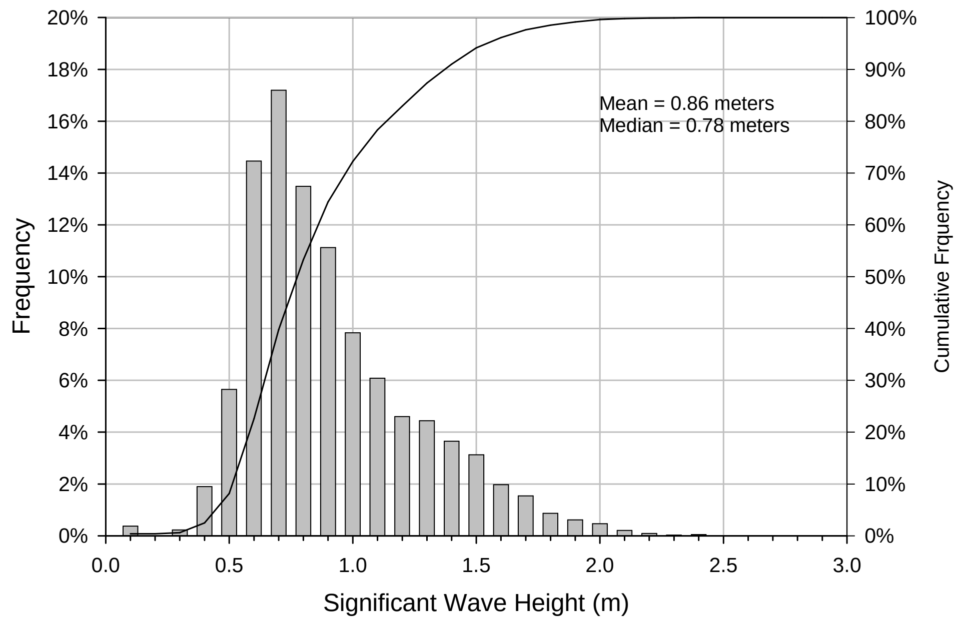


Figure 9: Georgetown ODMDS Histogram of Significant Wave Height

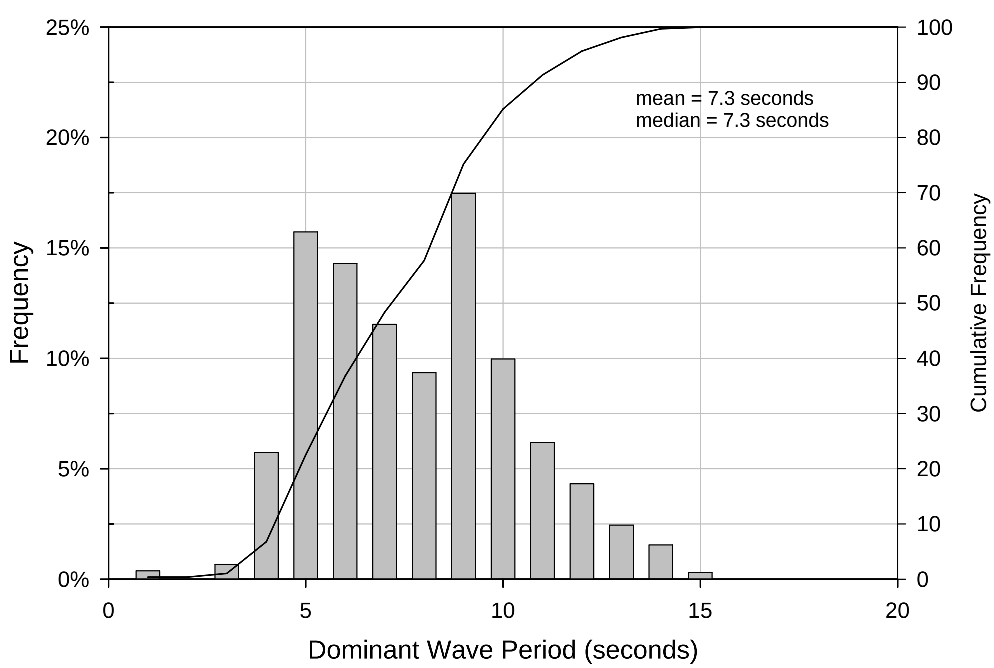


Figure 10: Georgetown ODMDS Histogram of Peak Wave Period

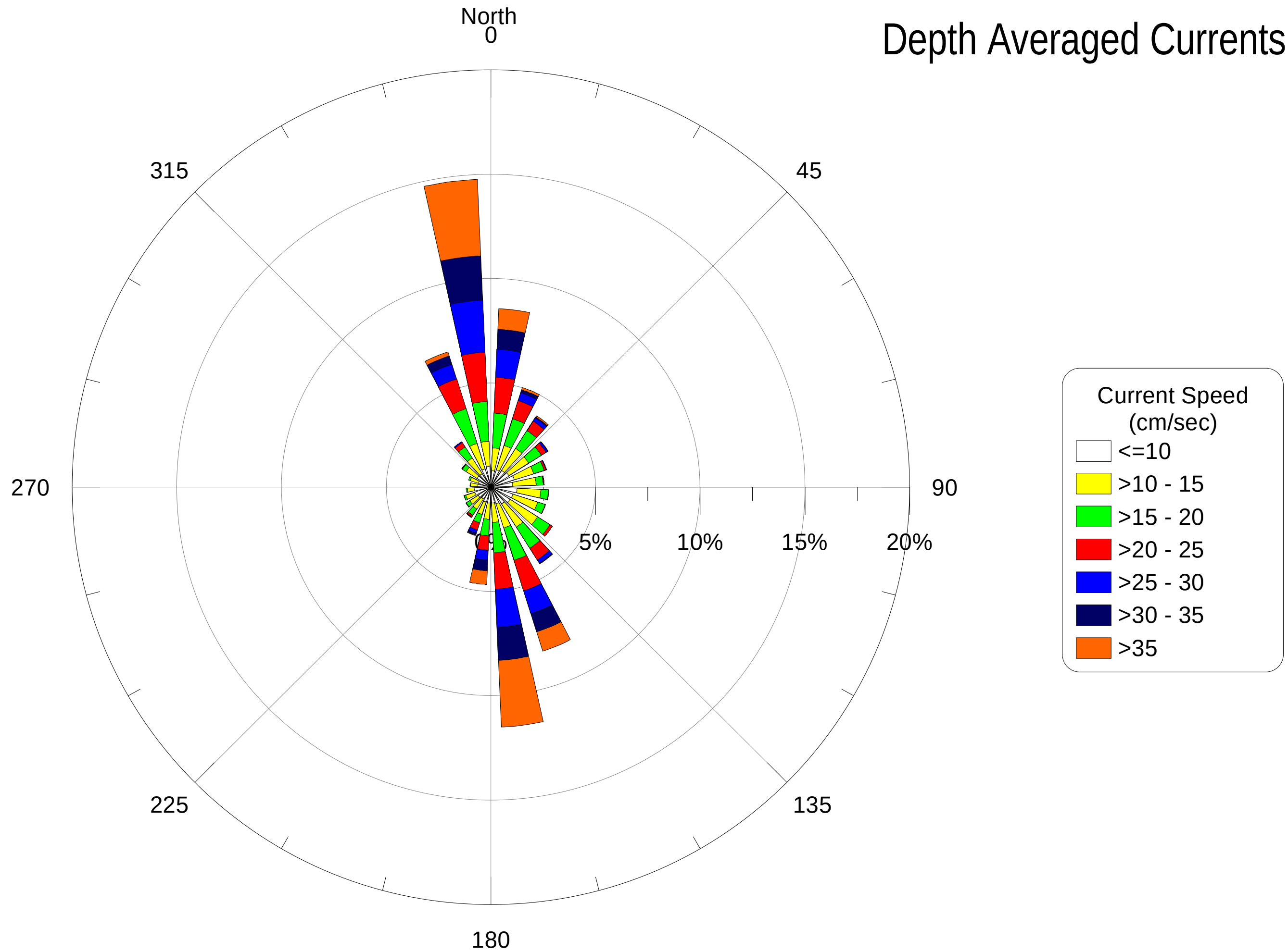


Figure 11: Georgetown ODMDS Depth Averaged Current Rose Diagram. Diagram indicates direction currents are flowing.

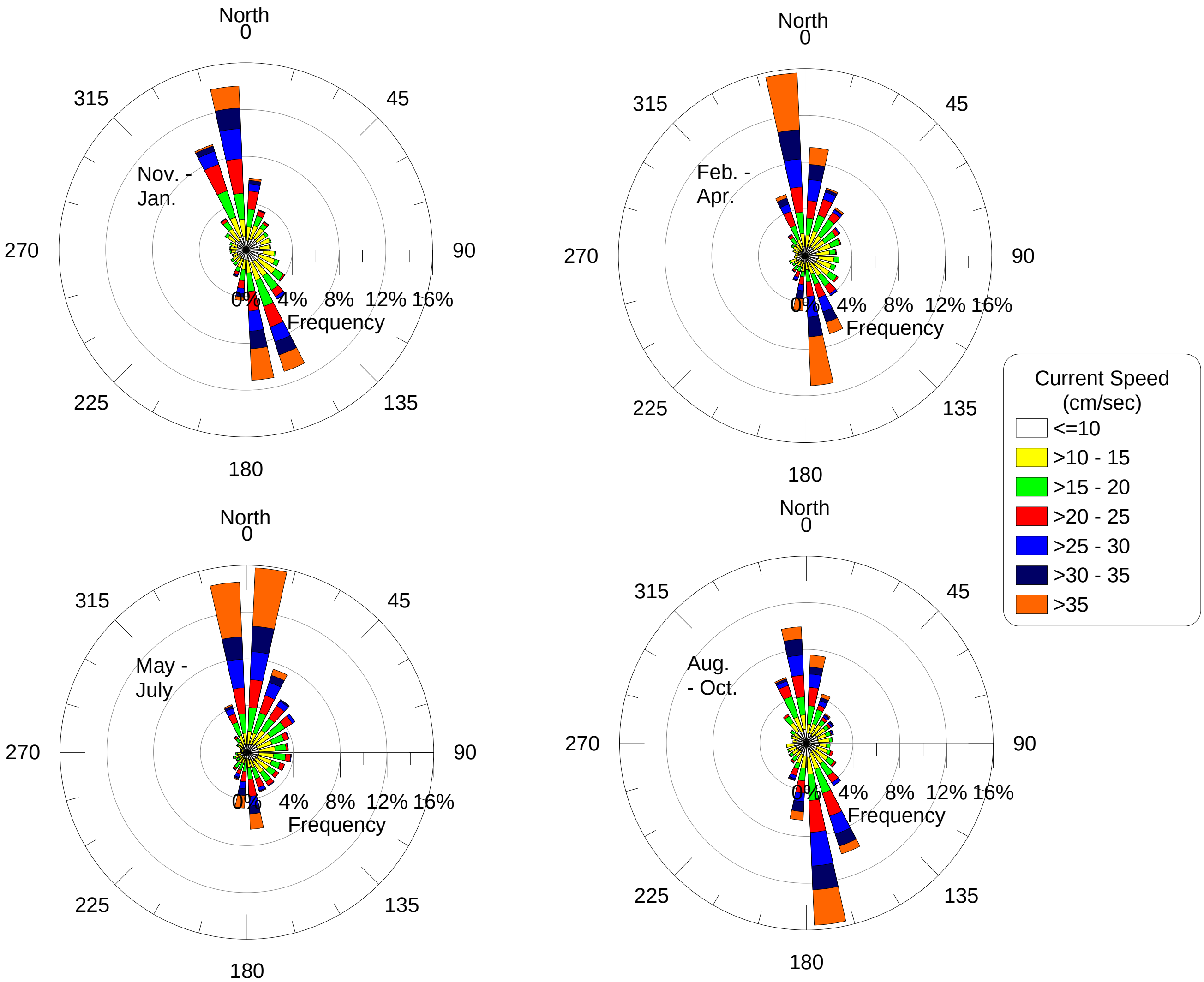


Figure 12: Georgetown ODMDS Quarterly Current Rose Diagrams for Depth Averaged Currents. Diagram indicates direction currents are flowing.

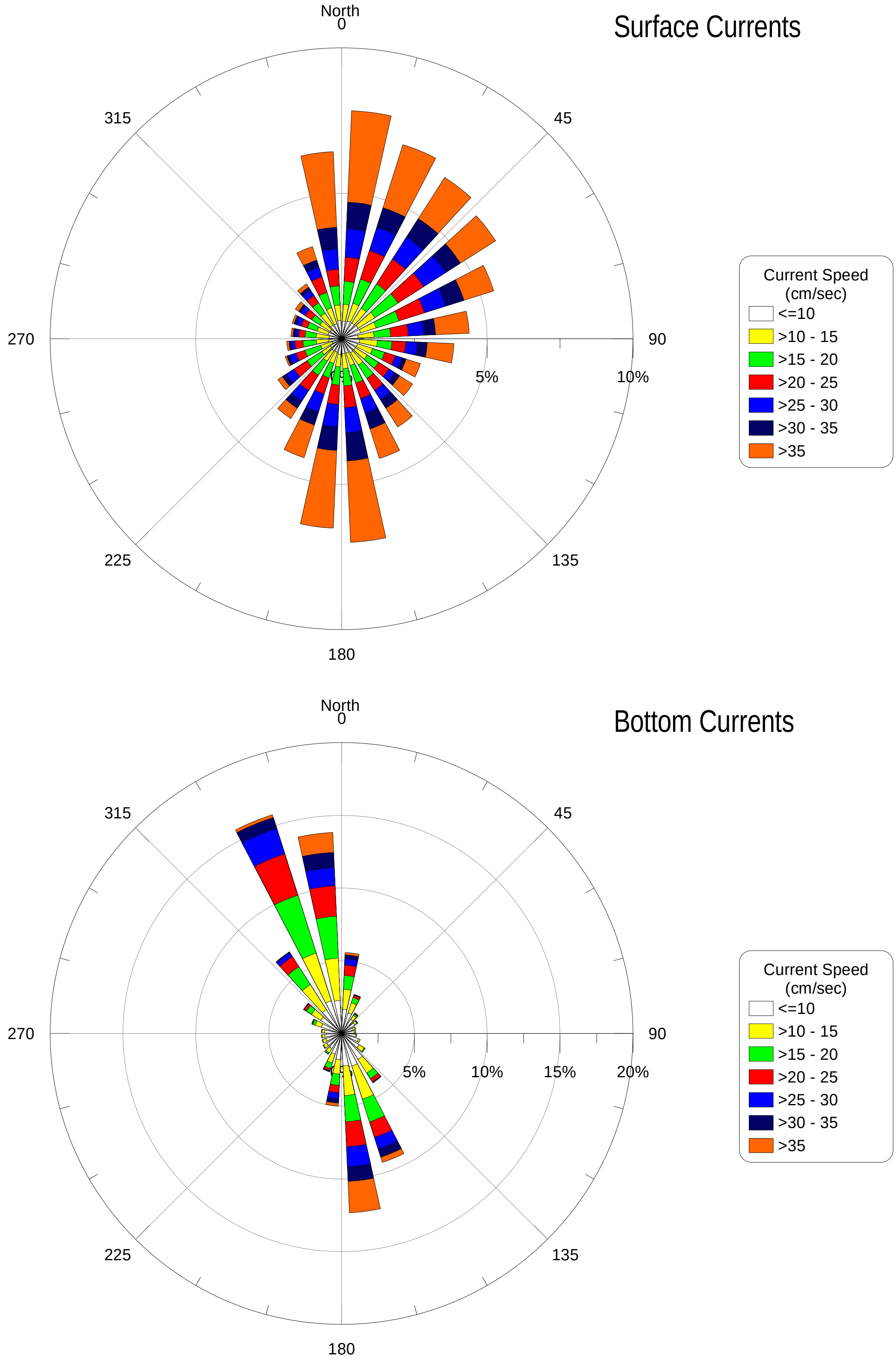


Figure 13: Georgetown ODMDS Current Rose for Surface and Near Bottom Currents. Diagrams indicate direction currents are flowing.

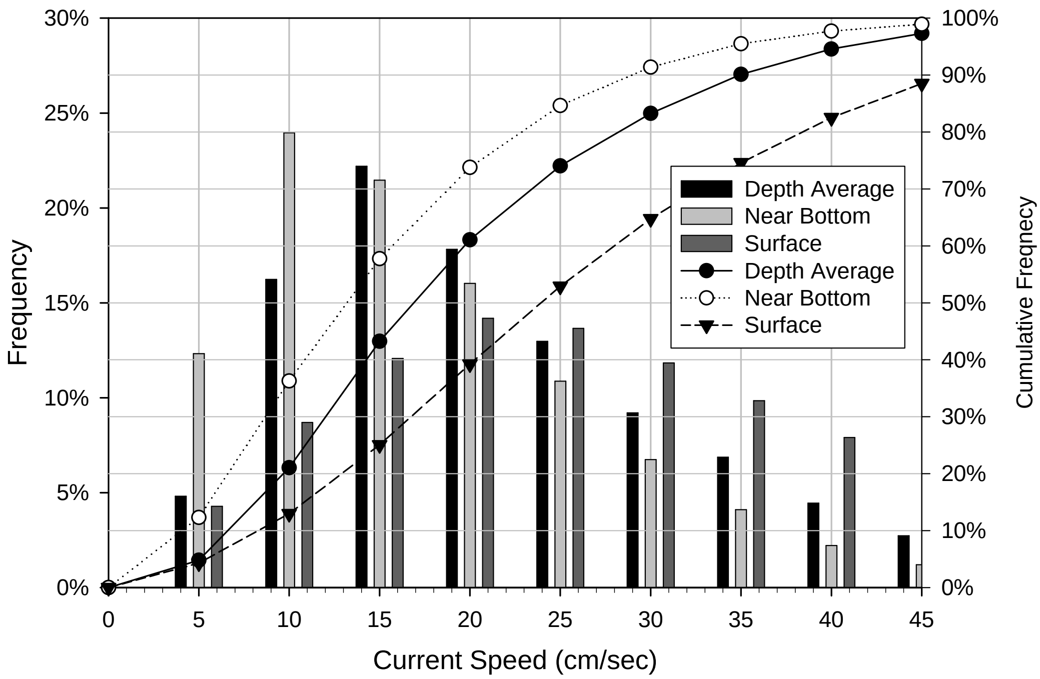


Figure 14: Georgetown ODMDS Current Magnitude Histogram

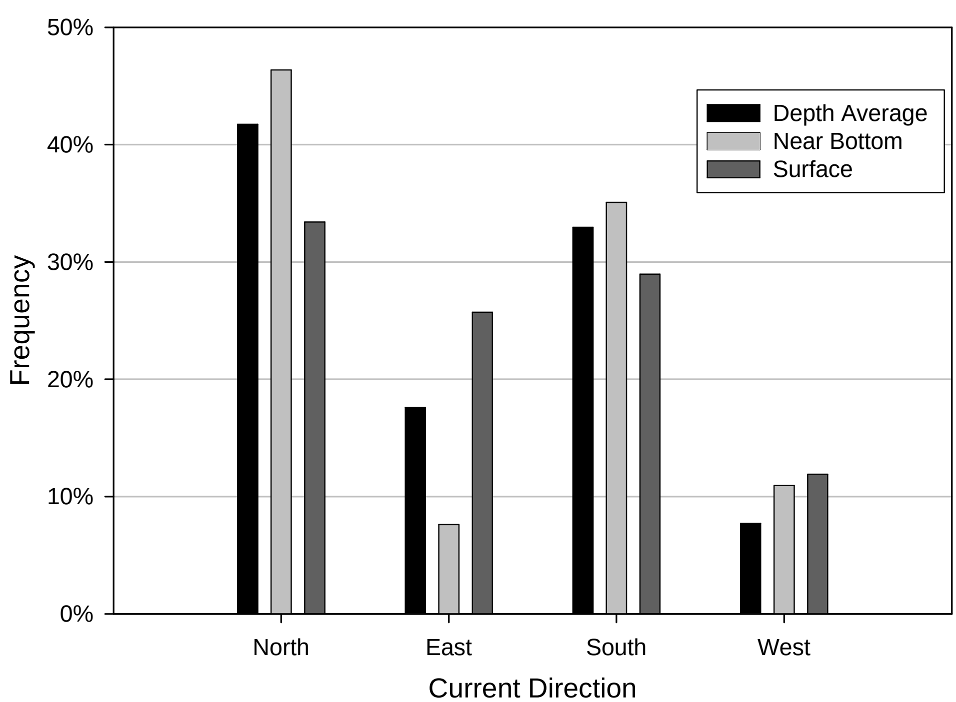
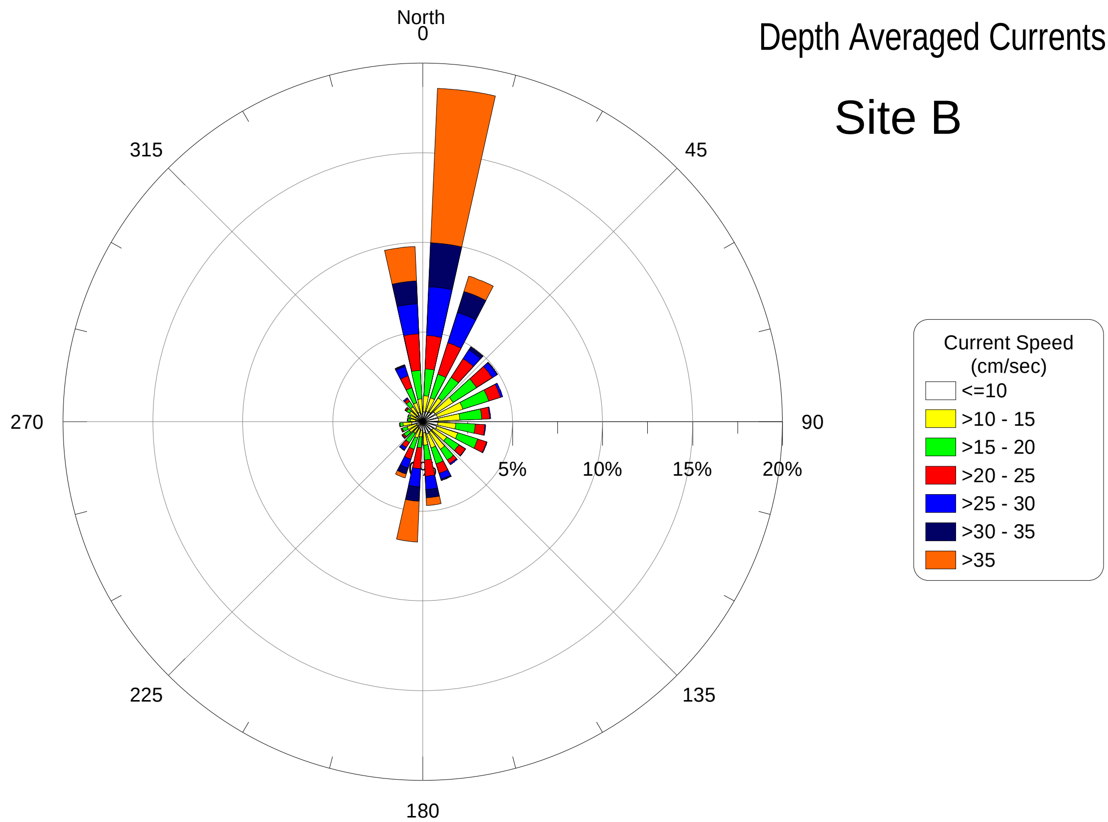


Figure 15: Georgetown ODMDS Current Direction Histogram



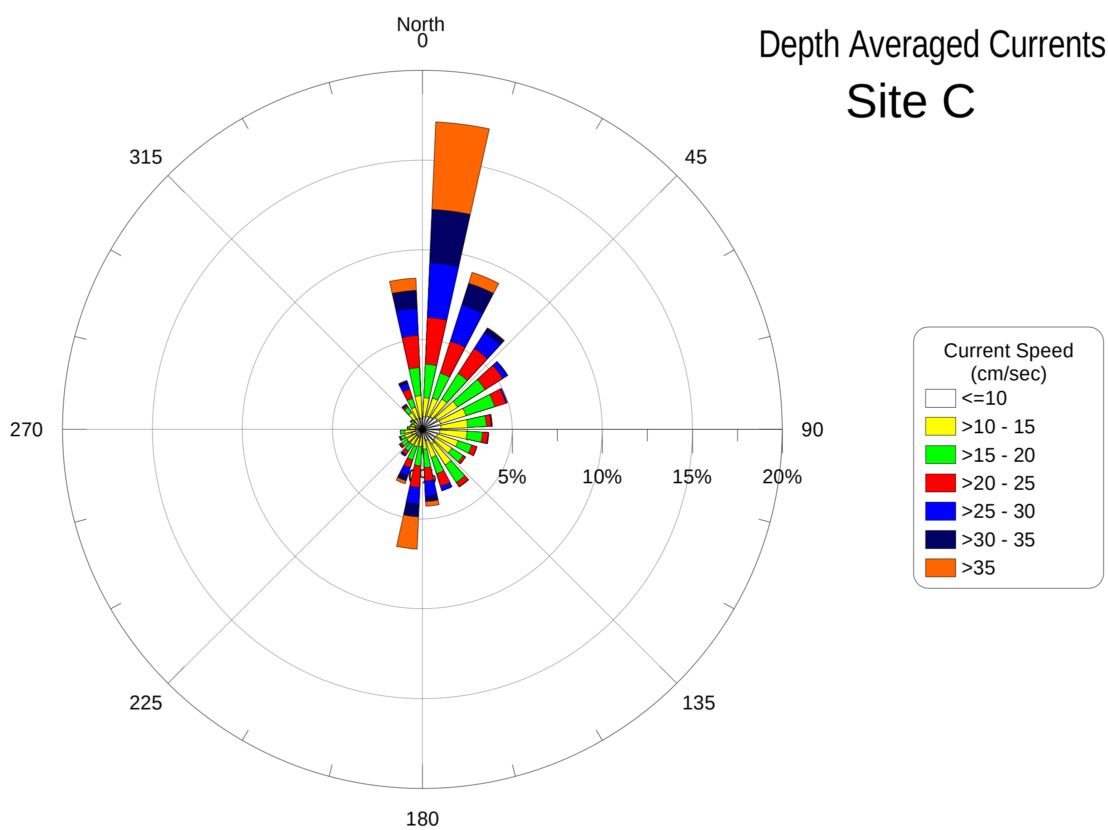


Figure 17: Georgetown ODMDS Depth Averaged Current Roses for Sites B and C. Diagrams indicate direction currents are flowing.

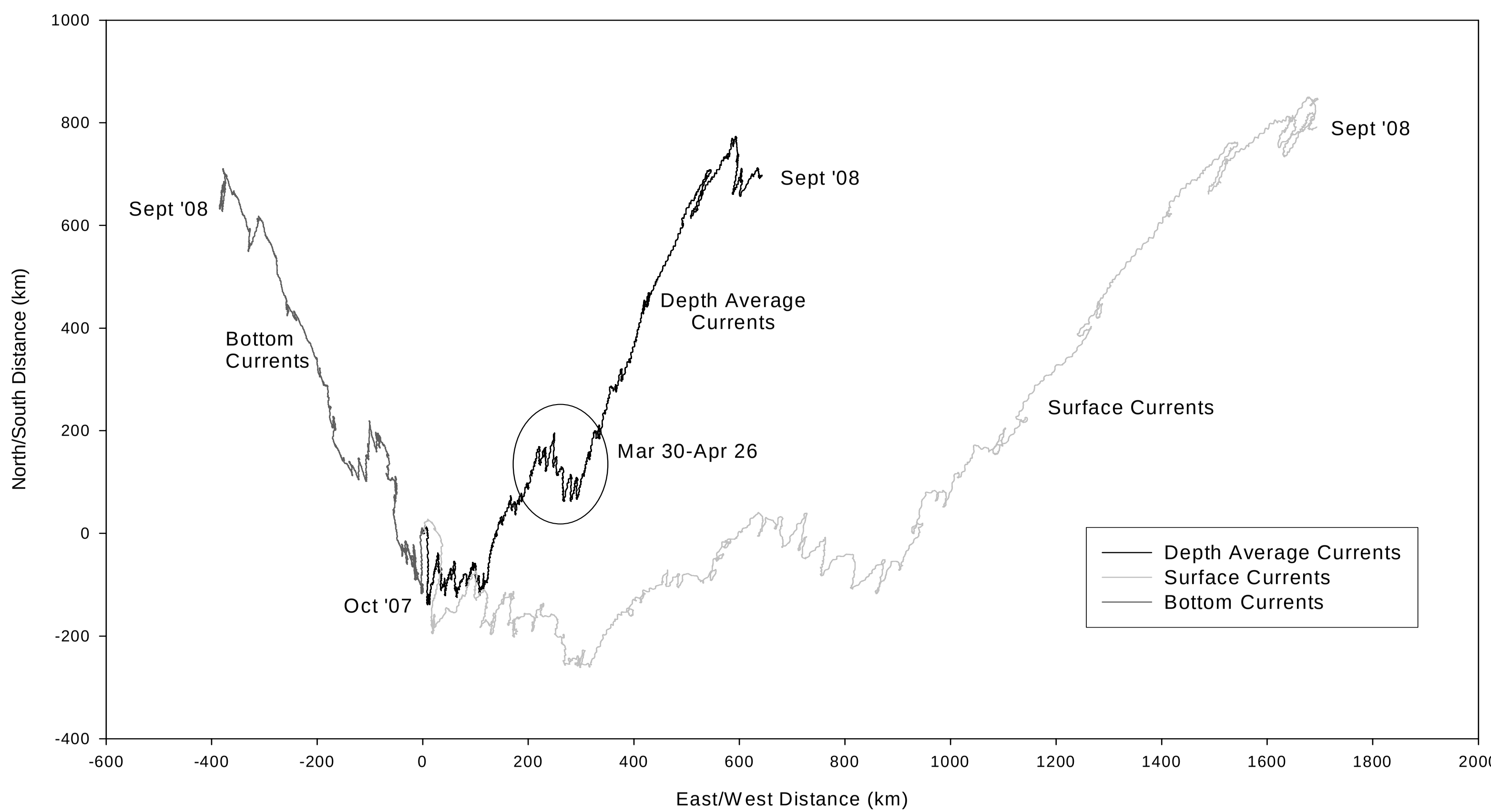


Figure 17: Georgetown ODMDS Progressive Vector Diagram

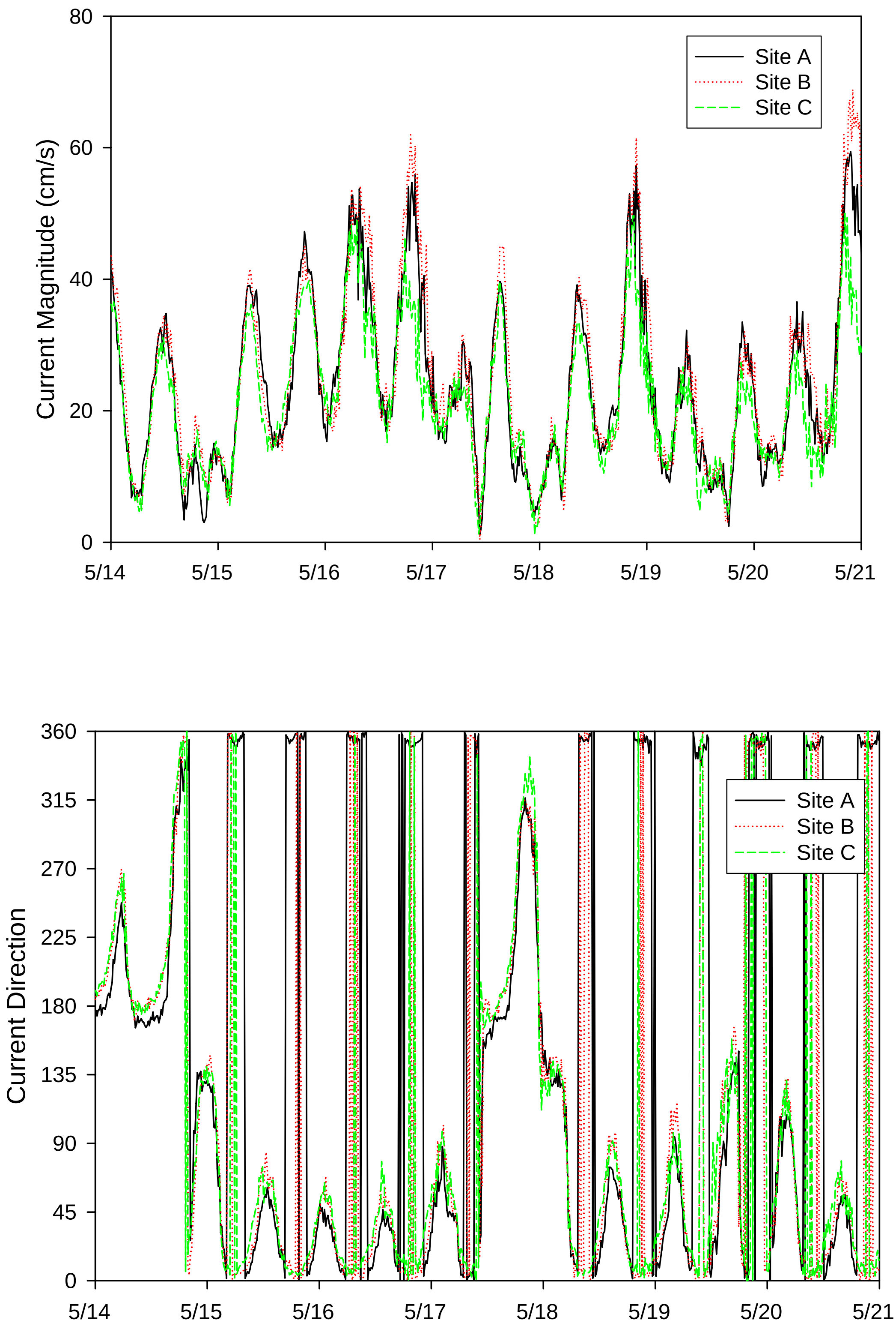
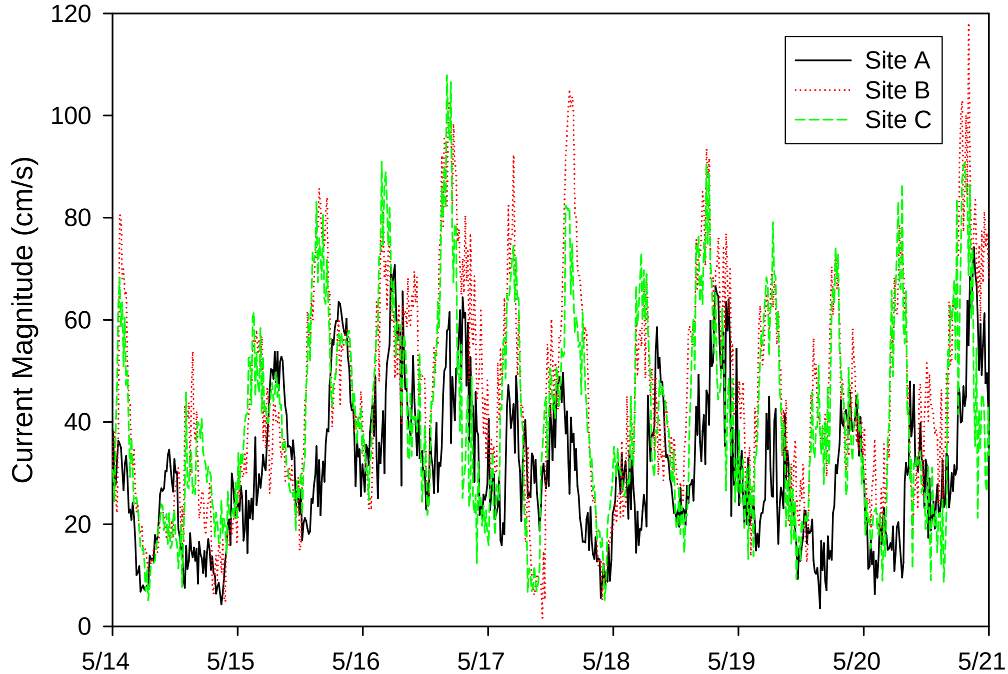


Figure 18: Comparison of Depth Averaged Currents at Sites A, B and C.



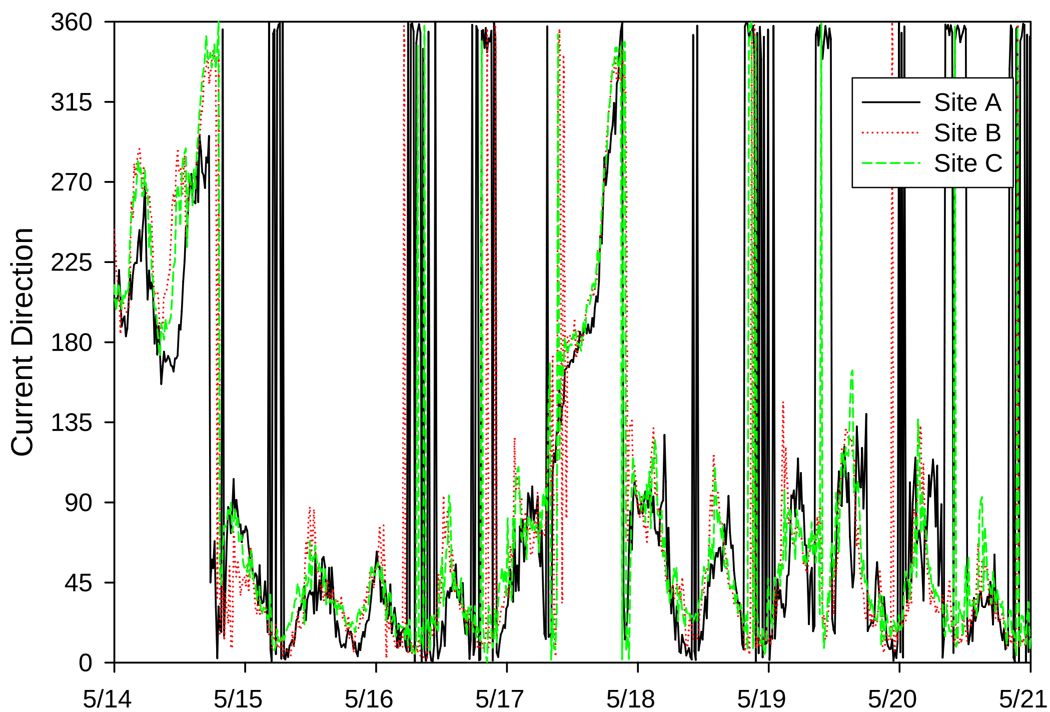


Figure 18: Comparison of Surface Currents at Sites A, B and C.

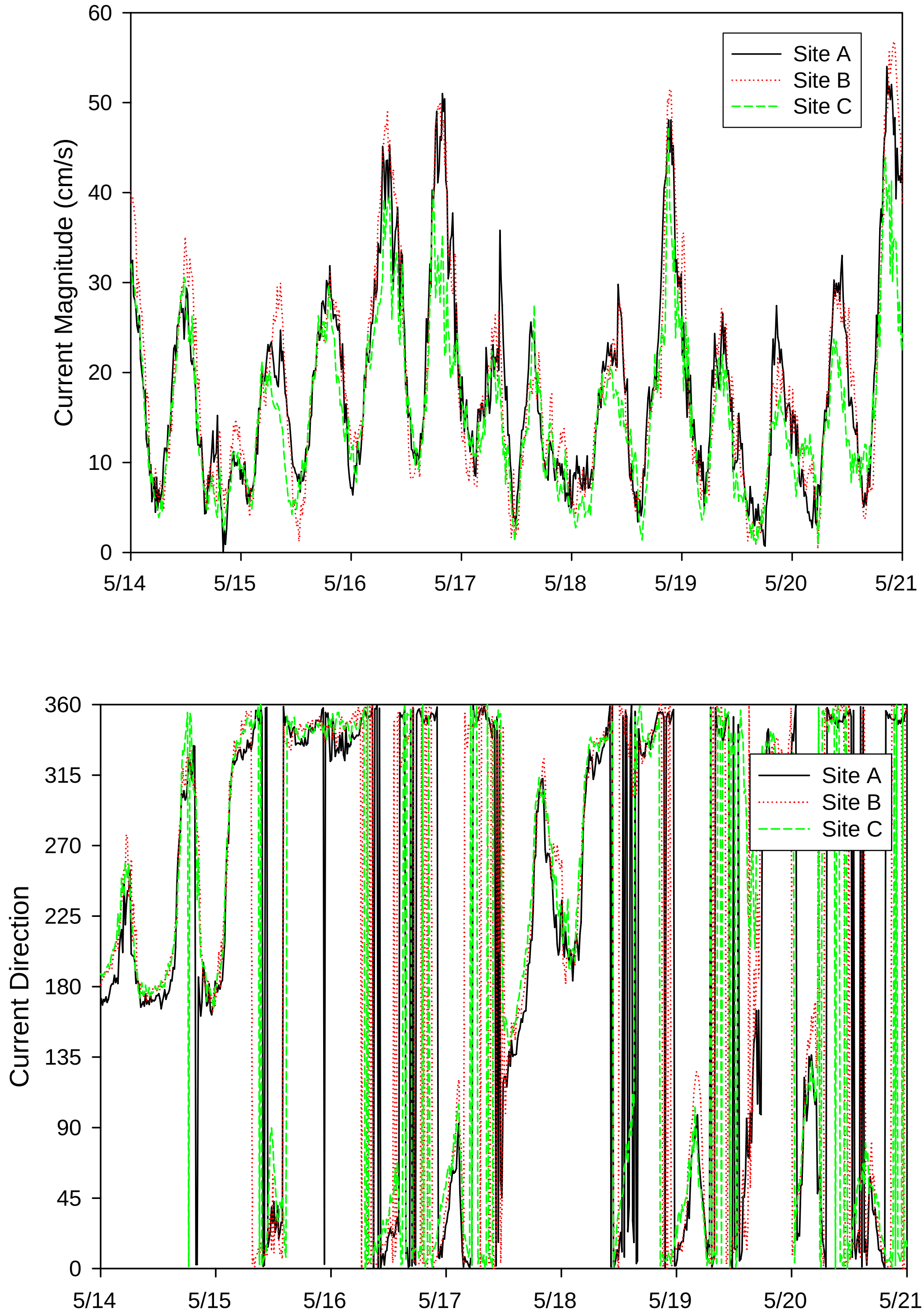


Figure 20: Comparison of Near Bottom Currents at Sites A, B and C.

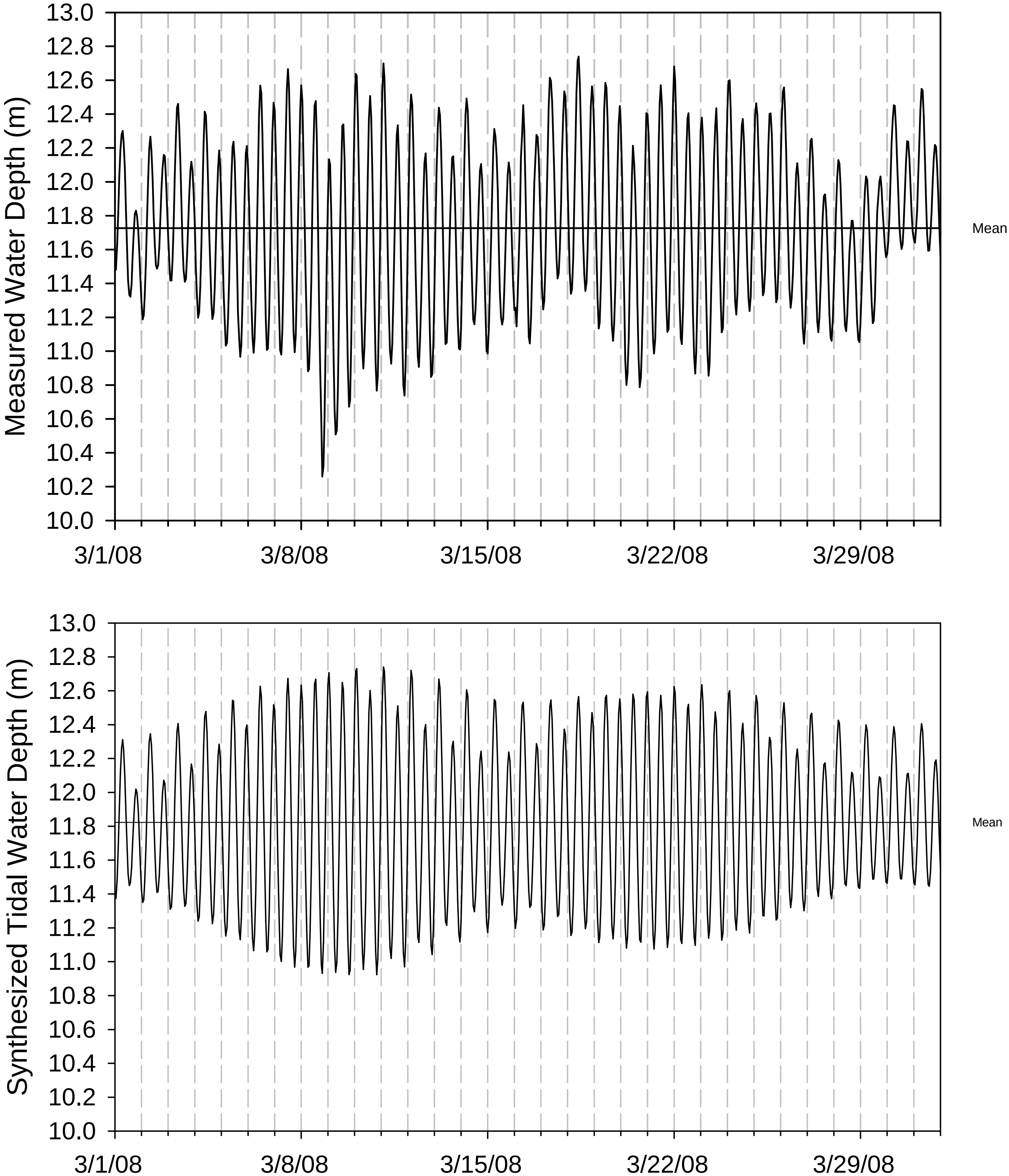


Figure 21: Georgetown ODMDS Tides for March, 2008.

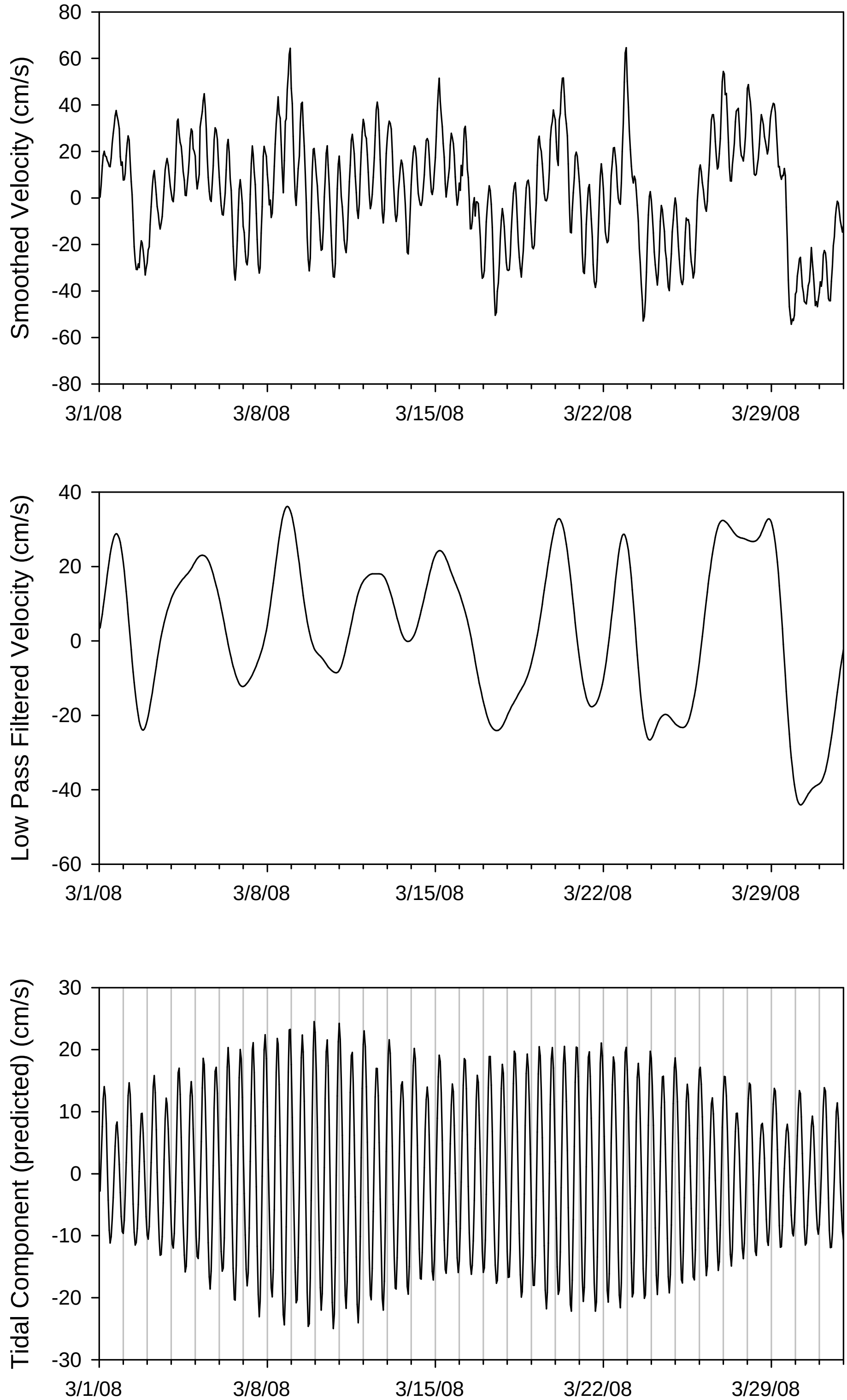


Figure 22: Georgetown ODMDS Filtered and Tidal Currents (north/south component) for March 2008.

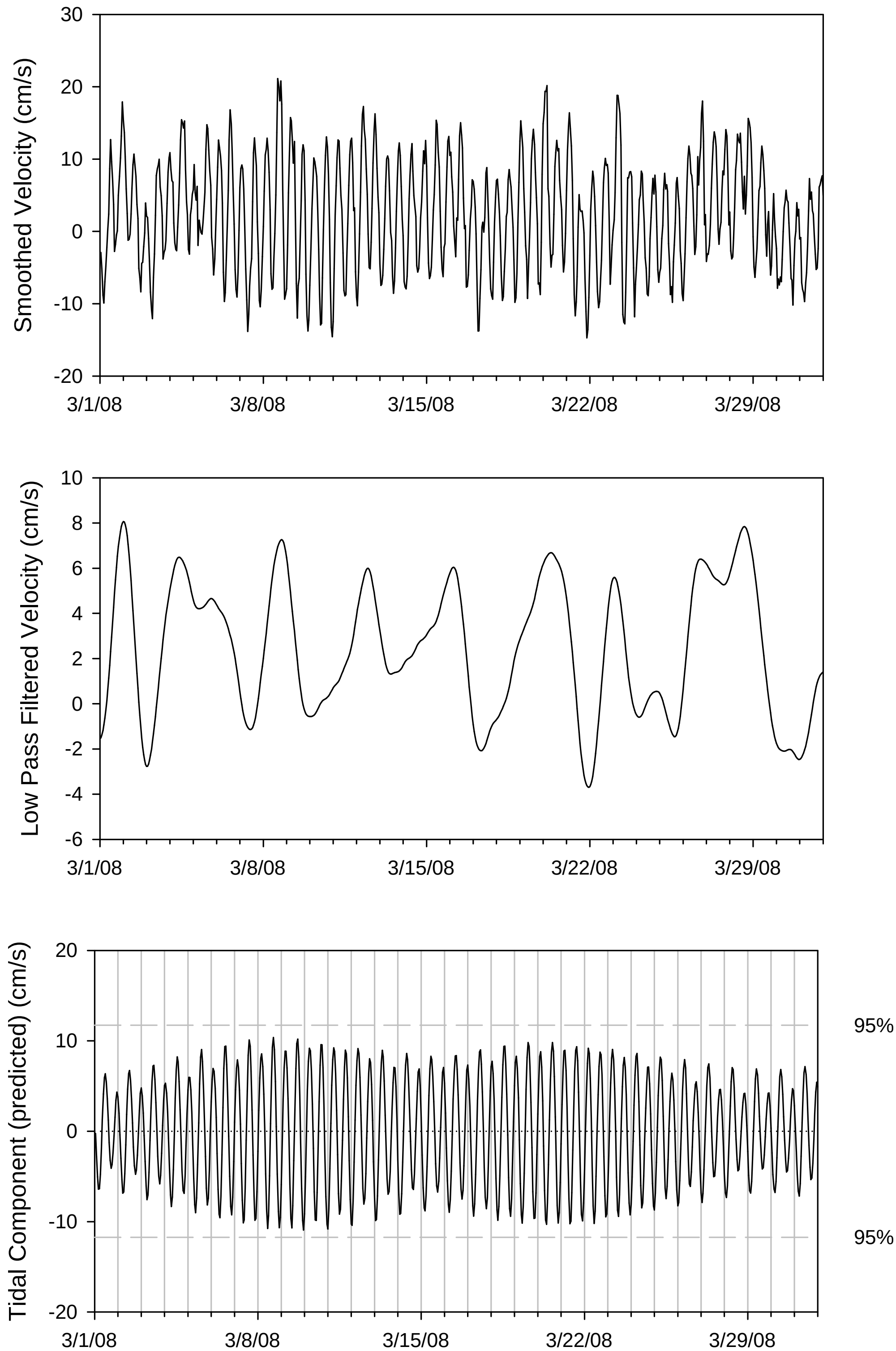


Figure 23: Georgetown ODMDS Filtered and Tidal Currents (east/west component) for March 2008.

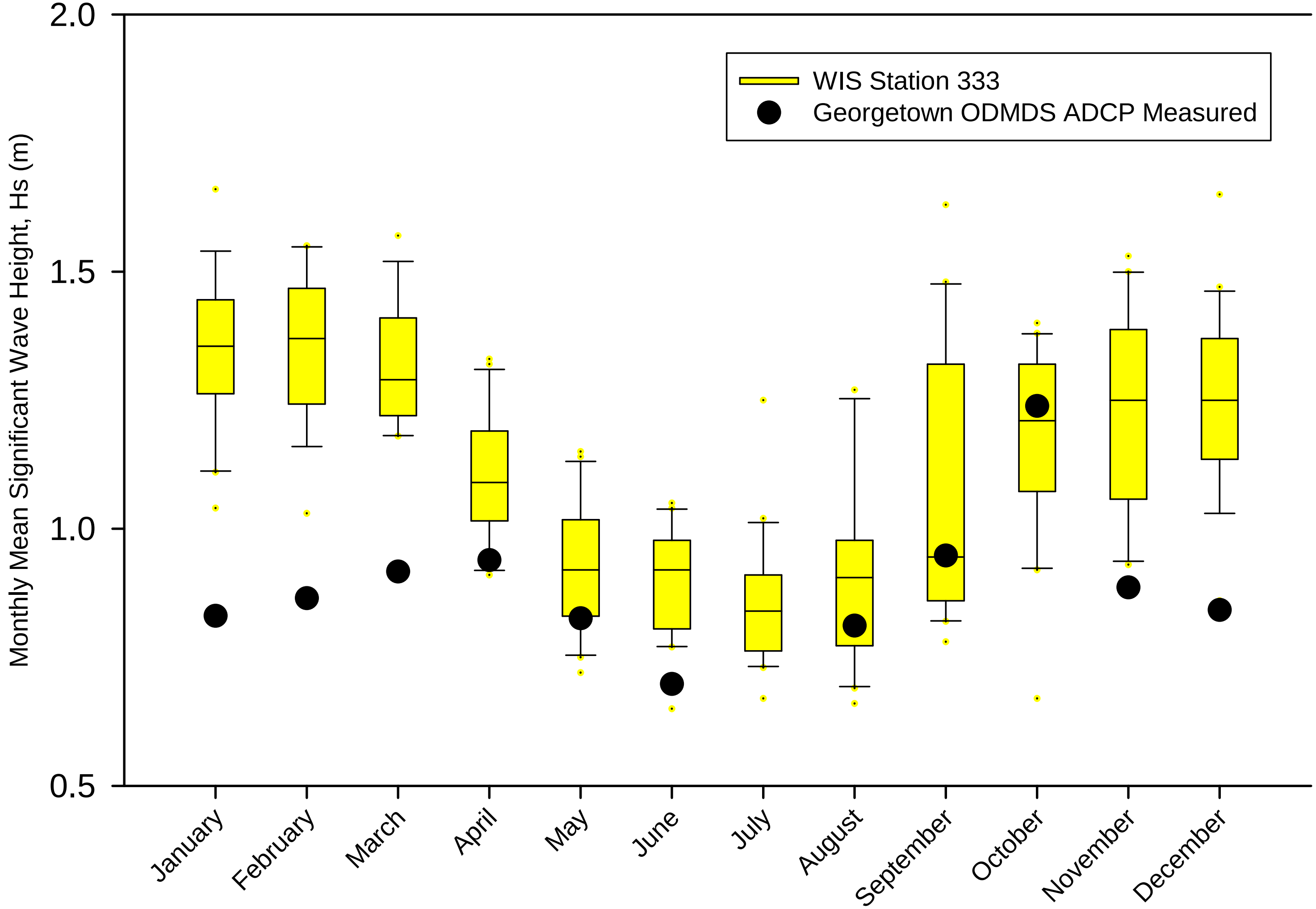


Figure 24: Comparison of Measure Mean Wave Height to Wave Information Study (WIS) Hindcast Mean Wave Heights (1980-1999).

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APPENDIX B

DATA FILES

DATA FILES

Georgetown_ODMDS_Wave&Current_Study.pdf .... Study Report

Georgetown ODMDS Processed Data CSV Files

GeorgetownODMDS_Waves.csv	.... Wave Statistic Output
GeorgetownODMDS_Currents_15min.csv	. Depth averaged and individual bin u & v currents and surface, bottom and depth averaged current magnitude and direction every 15 minutes. Data record from 10/23/07 to 9/14/08.
GeorgetownODMDS_Currents_1hr.csv	. Depth averaged and individual bin u & v currents and surface, bottom and depth averaged current magnitude and direction averaged over one hour periods. Data record from 10/23/07 to 9/14/08.

Georgetown ODMDS Processed Data Excel Files

Current Files	.... 15 minute and one hour interval current record at sites A, B, and C.
GTOD_Waves_all.xls	Wave and water depth parameters by season.

NetCDF Files

NCBrowse

ncBrowse_install_rel1_6_3.exe

This software can be used to view the NetCDF files (*.nc). This software was developed at the Joint Institute for the Study of the Atmosphere and Ocean (JISAO), a joint institute of the University of Washington (UW) and the National Oceanic and Atmospheric Administration's (NOAA) Pacific Marine Environmental Laboratory (PMEL), and funded by NOAA/ESDIM, NOAA/HPCC, NSF, and NOAA/PMEL. Help, updates and a users guide can be found at: http://www.epic.noaa.gov/java/ncBrowse/

Georgetown ODMDS Processed NetCDF Wave Data Files

GT01Wavesp-cal.nc	.... Deployment 1 Time series of pressure & velocities
GT02Wavesp-cal.nc.nc	.... Deployment 2 Time series of pressure & velocities
GT03Wavesp-cal.nc.nc	.... Deployment 3 Time series of pressure & velocities
GT04Wavesp-cal.nc.nc	.... Deployment 4 Time series of pressure & velocities
GT01Wavesr-cal.nc	..............Deployment 1 Time series of statistical wave parameters
GT01Wavesr-cal.nc	..............Deployment 2 Time series of statistical wave parameters
GT01Wavesr-cal.nc	..............Deployment 3 Time series of statistical wave parameters
GT01Wavesr-cal.nc	..............Deployment 4 Time series of statistical wave parameters

Georgetown ODMDS Processed NetCDF Current Data Files

GT00_001.nc .... Deployment 1 EPIC NetCDF Best Basic Version (BBV)
GT00_002.nc .... Deployment 2 EPIC NetCDF Best Basic Version (BBV)
GT00_003a.nc . Deployment 3, Site A, EPIC NetCDF Best Basic Version (BBV)
GT00_003b.nc . Deployment 3, Site B, EPIC NetCDF Best Basic Version (BBV)
GT00_003c.nc . Deployment 3, Site C, EPIC NetCDF Best Basic Version (BBV)
GT00_004.nc .... Deployment 4 EPIC NetCDF Best Basic Version (BBV)

Binary Files

Georgetown ODMDS RD Instruments Raw Binary Data
GTOD1001.000 .... Deployment 1 binary ADCP Data
GTOD2A00.000 .... Deployment 2 binary ADCP Data
GTOD3000.000 .... Deployment 3 binary ADCP Data
GTOD4000.000 .... Deployment 4 binary ADCP Data

Georgetown ODMDS RD Instruments Binary Current Data
GTOD_001_000_CUR.PD0 .... Deployment 1 binary ADCP current data
GTOD_002_000_CUR.PD0 .... Deployment 2 binary ADCP current data
GTOD_003_000_CUR.PD0 .... Deployment 3, Site A, binary ADCP current data
GTODB000.000 .... Deployment 3, Site B, binary ADCP current data
GTODC000.000 .... Deployment 3, Site C, binary ADCP current data
GTOD_004_000_CUR.PD0 .... Deployment 4 binary ADCP current data

Georgetown ODMDS RD Instruments Binary Wave Data
GTOD_001_000.wvs
GTOD_001_001.wvs
GTOD_001_002.wvs
GTOD_001_003.wvs
GTOD_001_004.wvs
GTOD_001_005.wvs
GTOD_001_006.wvs
GTOD_001_007.wvs
GTOD_001_008.wvs
GTOD_001_009.wvs
GTOD_001_010.wvs
GTOD_001_011.wvs
GTOD_001_012.wvs
GTOD_001_013.wvs
GTOD_001_014.wvs
GTOD_001_015.wvs .... Deployment 1 binary wave data

GTOD_002_000.wvs
GTOD_002_001.wvs
GTOD_002_002.wvs
GTOD_002_003.wvs
GTOD_002_004.wvs
GTOD_002_005.wvs
GTOD_002_006.wvs
GTOD_002_007.wvs
GTOD_002_008.wvs
GTOD_002_009.wvs
GTOD_002_010.wvs
GTOD_002_011.wvs
GTOD_002_012.wvs
GTOD_002_013.wvs
GTOD_002_014.wvs .... Deployment 2 binary wave data

GTOD_003_000.wvs
GTOD_003_001.wvs
GTOD_003_002.wvs
GTOD_003_003.wvs
GTOD_003_004.wvs
GTOD_003_005.wvs
GTOD_003_006.wvs
GTOD_003_007.wvs
GTOD_003_008.wvs .... Deployment 3 binary wave data

GTOD_004_000.wvs
GTOD_004_001.wvs
GTOD_004_002.wvs
GTOD_004_003.wvs
GTOD_004_004.wvs
GTOD_004_005.wvs
GTOD_004_006.wvs .... Deployment 4 binary wave data

APPENDIX C

COMPLETE TIDAL ANALYSIS OUTPUT FROM T_TIDE

T_TIDE output includes the following columns:

- tide: tidal constituent
- freq: frequency (cycles/hour)

Currents

- major: major axis of tidal ellipse (cm/sec)
- emaj: error estimate (95% confidence limit) for major axis (cm/sec)
- minor: minor axis of tidal ellipse (cm/sec)
- emin: error estimate (95% confidence limit) for minor axis (cm/sec)
- inc: inclination of major axis (counter clockwise from east in degrees)
- einc: error estimate (95% confidence limit) for inclination (degrees)

Water Depth

- amp: amplitude (meters)
- amp_err: error estimate (95% confidence limit) for amplitude (meters)

- phase: constituent phases (degrees relative to Greenwich)
- epha: error estimate (95% confidence limit) of phase (degrees)
- snr: signal to noise ratio

<u>Georgetown ODMDS Bottom Currents</u>

```
file name: GTBin1.out
date: 08-Jul-2009
nobs = 7835,  ngood = 7820,  record length (days) = 326.46
start time: 23-Oct-2007 22:00:00
rayleigh criterion = 1.0
Greenwich phase computed with nodal corrections applied to amplitude \n and phase relative to
center time

x0= -1.31, x trend= 0

var(x)= 30.6279   var(xp)= 13.8501   var(xres)= 16.7985
percent var predicted/var original= 45.2 %

y0= 2.2, x trend= 0

var(y)= 275.6886    var(yp)= 93.9076  var(yres)= 182.0207
percent var predicted/var original= 34.1 %

ellipse parameters with 95%% CI estimates
```

tide	freq	major	emaj	minor	emin	inc	einc	pha	epha	snr
SSA	0.0002282	2.096	2.309	-0.164	0.82	97.17	20.29	204.18	76.63	0.82
MSM	0.0013098	1.501	2.359	0.253	0.72	92.19	24.06	270.29	101.61	0.4
MM	0.0015122	0.783	2.095	-0.040	0.77	88.83	27.47	301.40	163.92	0.14
MSF	0.0028219	0.904	1.894	-0.148	0.85	105.90	31.29	180.36	151.60	0.23
MF	0.0030501	1.399	2.087	-0.140	0.76	87.30	22.68	331.33	117.00	0.45
ALP1	0.0343966	0.640	0.562	-0.005	0.28	106.41	27.57	28.06	51.82	1.3
2Q1	0.0357064	0.339	0.463	-0.088	0.27	80.68	45.84	138.02	103.22	0.54
SIG1	0.0359087	0.390	0.493	0.170	0.26	89.62	46.66	168.24	101.29	0.63
Q1	0.0372185	0.355	0.505	0.099	0.25	90.40	35.44	341.37	107.84	0.49
RHO1	0.0374209	0.258	0.441	0.021	0.23	96.23	42.90	324.24	116.67	0.34
O1	0.0387307	0.527	0.489	-0.166	0.35	117.13	44.59	132.29	78.97	1.2
TAU1	0.0389588	0.371	0.671	0.015	0.39	74.90	44.35	353.00	156.67	0.31
BET1	0.0400404	0.638	0.516	-0.149	0.25	88.36	28.46	344.48	62.18	1.5
NO1	0.0402686	0.169	0.513	-0.009	0.29	65.31	47.89	347.91	191.25	0.11
CHI1	0.0404710	0.306	0.436	0.018	0.32	54.86	49.43	249.37	95.23	0.49
P1	0.0415526	0.558	0.640	0.148	0.31	105.12	33.01	5.05	87.47	0.76
*K1	0.0417807	1.156	0.542	-0.149	0.34	109.52	16.88	122.73	32.04	4.5
PHI1	0.0420089	0.691	0.607	0.152	0.32	104.09	32.40	183.95	68.04	1.3
THE1	0.0430905	0.306	0.452	-0.118	0.29	112.47	53.29	1.02	129.44	0.46
J1	0.0432929	0.226	0.421	-0.004	0.23	103.55	45.08	29.85	133.68	0.29
SO1	0.0446027	0.045	0.401	0.034	0.24	159.20	51.61	341.73	222.51	0.013
OO1	0.0448308	0.231	0.349	0.023	0.19	89.79	33.29	95.13	116.20	0.44
UPS1	0.0463430	0.119	0.308	0.020	0.19	58.88	56.25	93.15	167.74	0.15
OQ2	0.0759749	0.206	0.283	0.020	0.31	114.18	94.81	103.70	111.85	0.53
EPS2	0.0761773	0.195	0.315	-0.105	0.30	32.82	128.03	37.83	143.33	0.38
*2N2	0.0774871	0.524	0.323	0.012	0.33	111.75	43.52	235.56	43.49	2.6
MU2	0.0776895	0.203	0.313	-0.056	0.35	115.17	115.72	243.84	142.50	0.42
*N2	0.0789992	3.243	0.435	-0.585	0.46	113.71	7.28	256.31	8.37	56
*NU2	0.0792016	0.579	0.374	-0.204	0.35	99.08	56.47	237.62	59.27	2.4
*M2	0.0805114	14.269	0.439	-1.710	0.46	109.74	1.69	281.09	1.85	1.1e+003
*MKS2	0.0807396	0.500	0.316	-0.023	0.35	138.32	41.42	357.46	47.03	2.5
LDA2	0.0818212	0.521	0.407	-0.229	0.41	106.68	55.49	333.18	65.67	1.6
*L2	0.0820236	0.709	0.352	-0.186	0.34	129.62	33.39	272.68	31.06	4.1
*S2	0.0833333	2.591	0.457	-0.301	0.40	108.84	9.75	305.99	9.08	32
*K2	0.0835615	0.661	0.306	0.072	0.29	105.53	29.73	336.50	28.33	4.7
MSN2	0.0848455	0.130	0.310	-0.027	0.26	3.69	139.98	261.54	167.68	0.18
ETA2	0.0850736	0.084	0.181	0.042	0.17	153.13	122.48	222.91	149.70	0.21
*MO3	0.1192421	0.275	0.185	-0.013	0.15	126.62	39.86	1.09	43.04	2.2
*M3	0.1207671	0.349	0.214	0.041	0.18	104.12	30.00	302.27	37.70	2.7
SO3	0.1220640	0.115	0.135	-0.059	0.13	118.18	88.10	334.99	119.03	0.73
MK3	0.1222921	0.113	0.131	0.076	0.14	13.79	137.58	147.86	122.93	0.75
*SK3	0.1251141	0.310	0.197	0.062	0.16	124.82	30.94	250.82	40.35	2.5
MN4	0.1595106	0.134	0.162	-0.043	0.14	89.29	75.50	29.71	107.23	0.69
*M4	0.1610228	0.359	0.200	0.058	0.19	111.78	27.70	107.61	35.29	3.2
SN4	0.1623326	0.108	0.138	-0.012	0.13	142.73	98.82	48.88	105.23	0.61
*MS4	0.1638447	0.626	0.191	0.048	0.16	96.11	15.01	140.27	20.31	11
MK4	0.1640729	0.138	0.127	0.019	0.12	99.65	54.08	164.68	80.20	1.2
*S4	0.1666667	0.295	0.179	0.019	0.16	100.35	35.25	329.08	46.06	2.7
SK4	0.1668948	0.163	0.143	-0.012	0.11	113.54	46.96	314.37	55.65	1.3

2MK5	0.2028035	0.057	0.095	0.002	0.09	119.61	89.19	315.26	139.86	0.36
2SK5	0.2084474	0.122	0.106	0.006	0.11	40.34	60.70	293.73	63.60	1.3
*2MN6	0.2400221	0.158	0.099	-0.066	0.12	127.77	55.01	189.80	58.96	2.5
*M6	0.2415342	0.206	0.112	-0.020	0.11	93.93	35.98	187.12	34.32	3.3
2MS6	0.2443561	0.100	0.105	-0.055	0.09	170.15	99.16	350.59	121.92	0.9
2MK6	0.2445843	0.044	0.066	-0.000	0.06	62.95	108.62	151.18	137.05	0.44
2SM6	0.2471781	0.042	0.076	0.020	0.07	141.72	120.89	137.33	147.45	0.3
MSK6	0.2474062	0.022	0.058	0.003	0.05	115.53	122.78	52.90	203.75	0.14
3MK7	0.2833149	0.108	0.080	0.015	0.07	127.84	47.41	181.75	48.25	1.8
M8	0.3220456	0.080	0.069	-0.009	0.07	81.11	55.01	31.76	56.20	1.4

total var= 306.3165 pred var= 107.7577
percent total var predicted/var original= 35.2 %

Georgetown ODMDS Surface Currents

file name: GTBin18.out
date: 08-Jul-2009
nobs = 7835, ngood = 7820, record length (days) = 326.46
start time: 23-Oct-2007 22:00:00
rayleigh criterion = 1.0
Greenwich phase computed with nodal corrections applied to amplitude \n and phase relative to center time

x0= 5.98, x trend= 0

var(x)= 244.097 var(xp)= 35.8049 var(xres)= 207.5579
percent var predicted/var original= 14.7 %

y0= 2.52, x trend= 0

var(y)= 594.0849 var(yp)= 133.0113 var(yres)= 460.8576
percent var predicted/var original= 22.4 %

ellipse parameters with 95%% CI estimates

tide	freq	major	emaj	minor	emin	inc	einc	pha	epha	snr
SSA	0.0002282	3.259	3.716	0.353	2.42	82.68	38.48	189.67	75.15	0.77
MSM	0.0013098	2.608	3.002	-0.265	2.59	43.27	73.85	299.60	92.13	0.75
MM	0.0015122	2.639	3.498	-1.659	2.13	90.16	64.77	304.53	120.84	0.57
MSF	0.0028219	0.890	2.388	0.492	2.17	173.83	127.70	5.32	201.16	0.14
MF	0.0030501	3.244	3.801	0.147	2.25	73.86	50.28	312.29	82.04	0.73
*ALP1	0.0343966	1.229	0.801	-0.344	0.88	59.95	57.76	324.29	49.67	2.4
2Q1	0.0357064	0.377	0.704	0.161	0.69	82.25	102.35	140.44	129.74	0.29
SIG1	0.0359087	0.860	0.860	-0.293	0.79	70.39	76.98	170.40	80.86	1
Q1	0.0372185	0.676	0.762	0.236	0.84	14.09	91.28	292.35	87.20	0.79
RHO1	0.0374209	0.619	0.774	0.394	0.68	105.67	107.61	324.34	130.52	0.64
O1	0.0387307	1.310	0.948	-0.818	0.95	90.74	73.67	172.82	80.95	1.9
TAU1	0.0389588	1.428	1.279	-0.111	1.18	113.35	72.10	333.18	63.05	1.2
BET1	0.0400404	0.684	0.764	0.241	0.77	60.88	91.07	315.82	90.98	0.8
NO1	0.0402686	0.459	0.878	0.303	0.94	167.75	135.36	99.55	159.04	0.27
CHI1	0.0404710	1.089	0.786	-0.195	0.76	99.10	53.43	288.90	58.73	1.9
P1	0.0415526	1.467	1.066	-0.600	0.90	88.18	68.95	239.56	65.75	1.9
*K1	0.0417807	2.545	1.052	-0.942	1.04	102.75	25.52	117.03	28.94	5.8
PHI1	0.0420089	1.163	0.886	-0.492	1.09	47.18	78.15	145.13	78.92	1.7
THE1	0.0430905	0.759	0.775	0.043	0.80	24.01	82.51	323.37	78.61	0.96
J1	0.0432929	0.381	0.669	0.009	0.58	30.45	124.98	216.40	133.32	0.32
SO1	0.0446027	0.291	0.667	-0.245	0.71	80.39	123.60	232.01	175.61	0.19
OO1	0.0448308	0.301	0.527	0.023	0.51	167.84	121.94	195.27	163.35	0.33
UPS1	0.0463430	0.329	0.515	0.001	0.53	99.04	115.46	34.16	142.48	0.41
OQ2	0.0759749	0.752	0.758	0.413	0.71	18.70	101.14	43.12	99.86	0.98
EPS2	0.0761773	0.802	0.818	0.189	0.89	103.55	91.75	261.83	78.77	0.96
2N2	0.0774871	0.921	0.726	0.084	0.88	72.96	67.65	268.88	63.37	1.6
MU2	0.0776895	0.867	0.913	-0.286	0.79	125.51	95.51	297.44	93.33	0.9
*N2	0.0789992	5.155	0.905	0.132	1.17	120.46	13.89	273.84	11.92	32
NU2	0.0792016	0.946	0.874	-0.283	0.94	130.13	81.80	289.07	85.54	1.2
*M2	0.0805114	16.842	1.060	-1.643	1.22	115.63	3.79	296.10	2.97	2.5e+002
MKS2	0.0807396	0.733	0.803	-0.032	0.64	168.69	59.67	96.21	90.27	0.83
LDA2	0.0818212	0.357	0.738	0.096	0.76	3.40	88.29	323.01	158.17	0.23
L2	0.0820236	0.246	0.590	-0.153	0.52	2.42	118.76	343.26	174.36	0.17
*S2	0.0833333	4.093	0.979	-0.548	0.99	116.09	16.22	319.12	14.21	17
*K2	0.0835615	1.322	0.663	-0.110	0.80	114.12	39.33	315.43	34.30	4

MSN2	0.0848455	0.705	0.949	0.241	0.92	168.35	101.74	344.41	134.43	0.55
ETA2	0.0850736	0.485	0.562	-0.063	0.46	163.15	70.14	311.52	87.07	0.74
MO3	0.1192421	0.341	0.408	-0.052	0.45	136.46	97.51	79.79	119.04	0.7
M3	0.1207671	0.583	0.550	-0.135	0.55	148.61	66.05	337.52	81.41	1.1
*SO3	0.1220640	0.775	0.469	-0.003	0.57	135.39	42.95	46.25	40.88	2.7
MK3	0.1222921	0.594	0.536	-0.217	0.58	124.79	72.53	132.77	71.92	1.2
SK3	0.1251141	0.442	0.495	-0.073	0.48	129.25	79.89	260.80	96.12	0.8
*MN4	0.1595106	1.268	0.523	-0.730	0.60	165.33	53.03	197.31	53.89	5.9
*M4	0.1610228	2.796	0.646	-1.674	0.68	140.22	23.33	251.44	23.64	19
SN4	0.1623326	0.294	0.451	-0.032	0.41	77.74	108.48	49.77	121.84	0.42
MS4	0.1638447	0.841	0.655	-0.012	0.64	158.64	44.82	224.50	50.76	1.6
MK4	0.1640729	0.268	0.382	-0.047	0.39	148.81	94.69	220.85	128.96	0.49
S4	0.1666667	0.294	0.414	-0.111	0.42	144.37	130.90	251.29	135.18	0.51
SK4	0.1668948	0.470	0.376	-0.167	0.40	129.83	75.04	236.77	75.20	1.6
2MK5	0.2028035	0.282	0.258	-0.220	0.31	139.87	124.93	243.13	121.42	1.2
2SK5	0.2084474	0.283	0.273	-0.184	0.26	124.07	97.17	254.88	103.52	1.1
*2MN6	0.2400221	0.493	0.333	0.028	0.33	14.34	47.13	156.49	51.07	2.2
*M6	0.2415342	0.596	0.364	-0.227	0.35	38.55	47.56	174.02	50.90	2.7
*2MS6	0.2443561	0.519	0.328	-0.229	0.33	70.46	55.95	176.29	53.96	2.5
2MK6	0.2445843	0.079	0.210	-0.031	0.20	72.97	147.87	129.09	192.79	0.14
2SM6	0.2471781	0.126	0.260	-0.026	0.27	61.99	120.80	208.09	142.83	0.23
MSK6	0.2474062	0.228	0.241	-0.071	0.22	133.29	85.68	151.37	75.61	0.9
3MK7	0.2833149	0.158	0.194	-0.061	0.19	148.28	89.97	248.73	108.43	0.66
*M8	0.3220456	0.423	0.203	-0.018	0.20	129.08	28.74	53.29	25.38	4.4

total var= 838.1819   pred var= 168.8162
percent total var predicted/var original= 20.1 %

Georgetown ODMDS Depth Average Currents

file name: GT_avg.out
date: 08-Jul-2009
nobs = 7835, ngood = 7820, record length (days) = 326.46
start time: 23-Oct-2007 22:00:00
rayleigh criterion = 1.0
Greenwich phase computed with nodal corrections applied to amplitude \n and phase relative to center time

x0= 2.26, x trend= 0

var(x)= 54.2753   var(xp)= 35.998   var(xres)= 18.2038
percent var predicted/var original= 66.3 %

y0= 2.26, x trend= 0

var(y)= 425.8302   var(yp)= 158.5881 var(yres)= 267.6427
percent var predicted/var original= 37.2 %

ellipse parameters with 95%% CI estimates

tide	freq	major	emaj	minor	emin	inc	einc	pha	epha	snr
SSA	0.0002282	2.450	3.133	-0.114	0.82	85.67	13.74	194.22	70.37	0.61
MSM	0.0013098	2.158	2.708	-0.417	1.27	67.50	27.26	281.29	98.60	0.64
MM	0.0015122	1.323	2.768	-0.497	0.92	78.79	28.12	307.88	154.94	0.23
MSF	0.0028219	1.030	2.383	-0.194	1.11	65.29	27.61	203.23	184.87	0.19
MF	0.0030501	2.042	2.953	0.098	0.73	81.72	16.79	311.58	102.73	0.48
ALP1	0.0343966	0.736	0.654	0.064	0.26	79.63	17.19	2.79	55.66	1.3
2Q1	0.0357064	0.279	0.507	0.024	0.23	68.91	31.37	156.11	112.02	0.3
SIG1	0.0359087	0.607	0.580	0.028	0.25	74.47	21.69	167.19	62.81	1.1
Q1	0.0372185	0.365	0.481	0.158	0.25	73.22	47.08	325.15	120.43	0.58
RHO1	0.0374209	0.458	0.528	0.139	0.26	81.18	30.37	326.93	98.72	0.75
*O1	0.0387307	0.766	0.538	-0.512	0.29	116.30	57.63	140.75	86.05	2
TAU1	0.0389588	0.750	0.907	0.223	0.32	81.67	27.99	317.93	72.83	0.68
BET1	0.0400404	0.862	0.656	-0.141	0.32	71.15	19.31	337.44	45.85	1.7
NO1	0.0402686	0.275	0.646	-0.127	0.36	55.35	51.39	324.32	161.48	0.18
CHI1	0.0404710	0.377	0.531	-0.085	0.24	77.19	30.82	269.95	95.77	0.5
P1	0.0415526	0.620	0.454	0.180	0.50	37.31	56.59	276.41	59.71	1.9
*K1	0.0417807	1.940	0.729	-0.365	0.35	113.07	10.76	125.63	21.88	7.1
PHI1	0.0420089	0.645	0.806	-0.007	0.34	69.70	24.89	148.32	71.28	0.64
THE1	0.0430905	0.406	0.564	0.086	0.24	89.56	25.53	20.11	112.29	0.52
J1	0.0432929	0.190	0.495	-0.009	0.19	86.11	30.16	6.27	172.67	0.15
SO1	0.0446027	0.213	0.366	0.012	0.27	38.09	62.31	211.87	144.03	0.34

OO1	0.0448308	0.234	0.376	-0.005	0.16	85.76	26.72	86.43	124.25	0.39
UPS1	0.0463430	0.084	0.339	-0.017	0.17	111.98	34.36	81.55	212.70	0.062
OQ2	0.0759749	0.289	0.316	0.042	0.22	61.12	52.20	74.40	82.29	0.84
EPS2	0.0761773	0.239	0.320	-0.001	0.22	84.35	59.86	277.92	104.59	0.56
*2N2	0.0774871	0.736	0.401	-0.048	0.27	102.94	19.89	252.31	30.34	3.4
MU2	0.0776895	0.292	0.337	-0.152	0.26	78.33	76.03	298.73	116.60	0.75
*N2	0.0789992	4.631	0.425	-0.543	0.32	115.21	4.63	266.85	4.99	1.2e+002
*NU2	0.0792016	0.754	0.401	-0.144	0.31	118.31	27.99	277.05	33.28	3.5
*M2	0.0805114	19.042	0.409	-2.221	0.31	114.80	1.06	291.76	1.24	2.2e+003
*MKS2	0.0807396	0.699	0.271	0.183	0.29	137.49	31.24	351.81	25.51	6.7
LDA2	0.0818212	0.430	0.359	0.062	0.28	92.30	41.80	338.60	58.51	1.4
*L2	0.0820236	0.630	0.229	-0.113	0.30	131.21	31.00	312.24	29.59	7.5
*S2	0.0833333	3.561	0.449	-0.597	0.30	112.17	5.97	312.93	6.76	63
*K2	0.0835615	1.023	0.285	-0.002	0.21	105.71	15.18	327.38	17.54	13
MSN2	0.0848455	0.258	0.319	0.028	0.24	100.04	61.46	249.57	101.61	0.66
ETA2	0.0850736	0.183	0.179	-0.016	0.18	138.73	71.70	233.80	86.45	1
*MO3	0.1192421	0.366	0.183	-0.049	0.13	123.49	21.19	359.14	28.44	4
*M3	0.1207671	0.597	0.219	-0.017	0.16	119.41	15.49	332.07	18.65	7.5
*SO3	0.1220640	0.237	0.153	-0.061	0.12	116.16	39.30	25.01	48.35	2.4
MK3	0.1222921	0.108	0.129	0.066	0.13	136.57	90.72	319.61	119.67	0.7
*SK3	0.1251141	0.339	0.190	-0.040	0.13	118.95	26.98	258.76	34.98	3.2
MN4	0.1595106	0.159	0.123	0.026	0.14	142.38	62.41	155.32	63.25	1.7
*M4	0.1610228	0.557	0.172	0.230	0.14	111.00	17.14	147.00	25.56	11
SN4	0.1623326	0.130	0.119	-0.001	0.13	133.95	55.67	49.77	73.01	1.2
*MS4	0.1638447	0.802	0.196	0.110	0.12	98.23	8.63	152.17	14.69	17
*MK4	0.1640729	0.241	0.155	0.106	0.09	101.82	33.51	165.36	59.04	2.4
S4	0.1666667	0.246	0.185	-0.036	0.11	98.02	23.56	306.55	50.04	1.8
SK4	0.1668948	0.117	0.122	-0.041	0.08	99.18	46.55	264.82	79.81	0.92
2MK5	0.2028035	0.077	0.082	-0.034	0.09	133.33	100.37	299.51	101.47	0.88
*2SK5	0.2084474	0.150	0.102	-0.052	0.08	58.96	41.83	331.37	52.52	2.2
2MN6	0.2400221	0.131	0.095	-0.028	0.09	114.44	50.48	166.69	50.40	1.9
*M6	0.2415342	0.206	0.101	-0.034	0.09	108.17	28.67	158.60	29.90	4.2
2MS6	0.2443561	0.082	0.073	-0.052	0.09	28.54	110.62	163.42	94.32	1.3
2MK6	0.2445843	0.049	0.065	-0.012	0.05	99.04	83.95	144.02	87.94	0.57
2SM6	0.2471781	0.031	0.070	0.012	0.06	132.81	126.03	193.50	139.90	0.2
MSK6	0.2474062	0.060	0.063	-0.049	0.06	109.51	103.68	164.73	104.55	0.9
3MK7	0.2833149	0.039	0.057	0.028	0.05	131.20	96.51	156.69	148.65	0.46
M8	0.3220456	0.077	0.063	0.007	0.05	89.14	41.83	27.52	52.76	1.5

total var= 480.1055   pred var= 194.5861
percent total var predicted/var original= 40.5 %

Georgetown ODMDS Water Depth

file name: GT_depth.out
date: 08-Jul-2009
nobs = 5741, ngood = 5737, record length (days) = 239.21
start time: 23-Oct-2007 22:00:00
rayleigh criterion = 1.0
Greenwich phase computed with nodal corrections applied to amplitude \n and phase relative to center time

x0= 11.8, x trend= 0

var(x)= 0.26337   var(xp)= 0.23797   var(xres)= 0.024755
percent var predicted/var original= 90.4 %

tidal amplitude and phase with 95% CI estimates

tide	freq	amp	amp_err	pha	pha_err	snr
*SSA	0.0002282	0.0831	0.044	62.92	27.67	3.6
MSM	0.0013098	0.0210	0.032	11.08	133.11	0.43
MM	0.0015122	0.0496	0.042	93.56	54.19	1.4
MSF	0.0028219	0.0132	0.032	230.87	141.89	0.16
MF	0.0030501	0.0263	0.035	154.82	91.72	0.56
ALP1	0.0343966	0.0021	0.004	188.87	155.16	0.25
2Q1	0.0357064	0.0028	0.005	189.33	133.02	0.29
SIG1	0.0359087	0.0049	0.006	44.85	80.31	0.72
*Q1	0.0372185	0.0171	0.007	185.04	18.73	6.5
RHO1	0.0374209	0.0055	0.006	189.79	67.68	0.85
*O1	0.0387307	0.0711	0.007	192.18	4.54	1.2e+002
TAU1	0.0389588	0.0024	0.007	193.60	176.32	0.11

BET1	0.0400404	0.0007	0.004	185.31	214.19	0.035
NO1	0.0402686	0.0070	0.007	210.57	57.61	0.93
CHI1	0.0404710	0.0016	0.004	197.31	168.47	0.14
*P1	0.0415526	0.0374	0.007	191.01	11.28	28
*K1	0.0417807	0.0967	0.006	186.92	3.94	2.3e+002
PHI1	0.0420089	0.0009	0.006	139.23	203.66	0.026
THE1	0.0430905	0.0018	0.005	223.19	185.40	0.14
J1	0.0432929	0.0068	0.007	186.51	50.57	1
SO1	0.0446027	0.0030	0.005	113.09	105.99	0.38
OO1	0.0448308	0.0029	0.004	268.31	96.24	0.5
UPS1	0.0463430	0.0015	0.003	236.06	133.96	0.18
OQ2	0.0759749	0.0039	0.004	298.21	85.12	0.82
EPS2	0.0761773	0.0080	0.006	3.54	41.74	1.9
*2N2	0.0774871	0.0190	0.006	313.85	17.18	11
*MU2	0.0776895	0.0207	0.006	341.10	16.95	12
*N2	0.0789992	0.1553	0.005	335.49	2.13	8e+002
*NU2	0.0792016	0.0346	0.006	330.41	10.86	30
*M2	0.0805114	0.6525	0.006	355.02	0.53	1.2e+004
MKS2	0.0807396	0.0038	0.004	108.63	67.34	0.79
LDA2	0.0818212	0.0065	0.006	353.78	58.57	1.3
*L2	0.0820236	0.0194	0.005	12.75	15.48	16
*S2	0.0833333	0.1238	0.006	21.85	2.85	3.7e+002
*K2	0.0835615	0.0320	0.005	15.37	7.34	44
MSN2	0.0848455	0.0029	0.005	74.85	117.54	0.35
ETA2	0.0850736	0.0025	0.003	334.57	86.26	0.56
*MO3	0.1192421	0.0069	0.004	109.80	35.82	3.1
*M3	0.1207671	0.0127	0.005	55.95	23.75	6.2
SO3	0.1220640	0.0036	0.004	135.42	63.92	1
MK3	0.1222921	0.0020	0.004	281.75	112.99	0.29
*SK3	0.1251141	0.0082	0.004	346.80	31.06	3.4
*MN4	0.1595106	0.0043	0.002	326.08	27.09	4
*M4	0.1610228	0.0057	0.002	322.89	21.00	6.7
SN4	0.1623326	0.0007	0.001	354.45	154.03	0.21
*MS4	0.1638447	0.0051	0.002	269.04	23.84	6.4
MK4	0.1640729	0.0018	0.002	292.08	53.36	1.3
S4	0.1666667	0.0025	0.002	82.70	48.81	1.5
SK4	0.1668948	0.0012	0.001	13.68	82.12	0.86
2MK5	0.2028035	0.0006	0.001	308.39	106.58	0.37
2SK5	0.2084474	0.0008	0.001	268.05	82.35	0.74
*2MN6	0.2400221	0.0030	0.002	256.66	31.37	3.3
*M6	0.2415342	0.0031	0.002	312.00	29.63	3.9
*2MS6	0.2443561	0.0028	0.001	40.18	29.24	4.1
2MK6	0.2445843	0.0014	0.001	350.00	48.20	1.7
2SM6	0.2471781	0.0007	0.001	155.42	138.86	0.31
MSK6	0.2474062	0.0007	0.001	156.57	83.67	0.59
3MK7	0.2833149	0.0004	0.001	281.46	127.91	0.33
M8	0.3220456	0.0001	0.000	301.25	210.95	0.029