3 Currents

3.1 Data Processing Methods

The current data were processed and a preliminary analysis was carried out. Currents were sampled every 10 or 30 minutes, depending on the deployment as shown in Table 1-1, and at 1 m depth intervals. As part of the quality control process, a single automated de-spiking procedure and manual de-spiking were applied to the current data. Suspect points were identified and interpolated over. Suspect points met one or more of the following criteria:

1) Error velocities exceeding 10 cm/s in absolute value;
2) Single point 'spikes' exceeding *m* cm/s. A single point spike is where two successive first difference values exceed 8 cm/s and are opposite in sign.
3) Double point 'spikes' exceeding a double spike threshold of *n* cm/s in each component of the horizontal velocities. A double spike consists of two consecutive points, both of which are either larger or smaller than the preceding and following points by more than the double spike threshold.
4) Triple point 'spikes' exceeding a triple spike threshold of *o* cm/s in each component of the horizontal velocities. A triple spike consists of three consecutive points which are smaller than the preceding and following points by more than the triple spike threshold, but whose middle points may not change by more than one third of the triple spike threshold from their respective leading neighbors.
5) Quadruple point 'spikes' exceeding a quadruple spike threshold of *p* cm/s in each component of the horizontal velocities. A quadruple spike consists of four consecutive points which are smaller than the preceding and following points by more than the quadruple spike threshold, but whose middle points may not change by more than one third of the quadruple spike threshold from their respective leading neighbours.

Despiking thresholds were varied from deployment to deployment in order to remove points which were deemed to be suspect, but not remove points which were considered reliable. The thresholds used for each of the deployments are summarized in Table 3-1. In deployments where the spike threshold was increased to preserve particular features, more manual despiking may have been required.

Table 3-1: Summary of the spike thresholds by deployment.

Spike Type	October-November	November-April	April-July	July-October
Single (*m*)	8	15	10	10
Double (*n*)	8	20	10	12
Triple (*o*)	10	25	12	15
Quadruple (*p*)	12	28	15	20

The near-bottom, mid-depth, and near-surface results from each of the deployments were then combined together for analysis. The depths of these 3 bins are given in Table 1-1. Because the sampling rate in the Nov. 2004 to April 2005 deployment was at 30 minute intervals rather than the 10 minute intervals used in the rest of the measurements, all of the current time series were interpolated to a common time interval of five minutes. Using a shorter time interval ensured that the interpolated data still represented the original time series without any inadvertent smoothing or other filtering effects. A common time step allowed data from different deployments to be combined and analyzed easily.

3.2 Ocean Currents at Near-Surface, Mid-Depth and Near-Bottom Levels

The measured ocean current directions exhibit a strong bimodal function due to the topographic constraints of the flows and the dominance of the ebb and flood tidal flows twice a day. Time series plots of the near-surface, mid-depth, and near-bottom currents are shown in Figure 3-1 through Figure 3-7 for the major, or approximately along-river direction, and minor current component, or the approximate cross-river direction. These plots indicate the highly semi-diurnal nature of the currents. The direction of the major component is computed using principal component analysis which determines the bi-modal direction axis having the largest amount of variance. The currents were rotated parallel to an axis pointed towards 27° E of North in the plots and statistics which follow.

Table 3-2 summarizes the directional variability of the major/minor coordinate system as derived for each quarter and for the entire project. Over-all, the variability is negligible, falling within ± 2.2%. For each time period, an analysis has been done considering all of the available measurements, and also only considering the measurements which exceed a 50 cm/s speed threshold. In addition to doing a principle component analysis, all currents which meet the speed threshold are sorted into either flood or ebb currents. The mean and median directions are then calculated. There is much more variability in the ebb current direction than in the flood current direction, as will be shown later in the current compass plots. When all of the ebb current speeds are considered, the mean ebb tends to be larger than the median by about 10 degrees. When a 50 cm/s threshold is used, the mean and median ebb directions agree to within a degree. The flood direction tends to be consistent to within 5 degrees independent of the method used to calculate it.

Table 3-2: Summary of the principle component analysis (PCA) direction, median and mean ebb and flood directions, and the number of points for 0 and 50 cm/s thresholds for each quarter and for the entire project at the near-surface.

Start	Stop	Threshold (cm/s)	PCA Angle	ebb median	ebb mean	flood median	flood mean	# points
10/7/2004 14:00	12/31/2004 23:55	0	24.8	27.4	36.3	198.7	196.1	24297
		50	24.9	26.2	26.5	200.2	200.1	10387
1/1/2004 0:00	3/31/2004 23:55	0	22.9	26.0	43.4	196.9	194.0	25920
		50	23.3	24.1	24.6	199.5	199.4	7297
4/1/2005 0:00	6/30/2005 23:55	0	28.6	29.5	38.8	202.7	199.9	26168
		50	28.8	28.4	28.9	204.1	204.0	13057
7/1/2005 0:00	9/30/2005 23:55	0	26.2	27.0	37.4	199.9	197.1	26258
		50	26.4	26.1	26.7	201.6	201.9	13058
10/7/2004 14:00	10/13/2005 11:00	0	25.9	27.4	38.6	199.1	196.5	106232
		50	26.3	26.2	26.8	201.1	201.4	45453

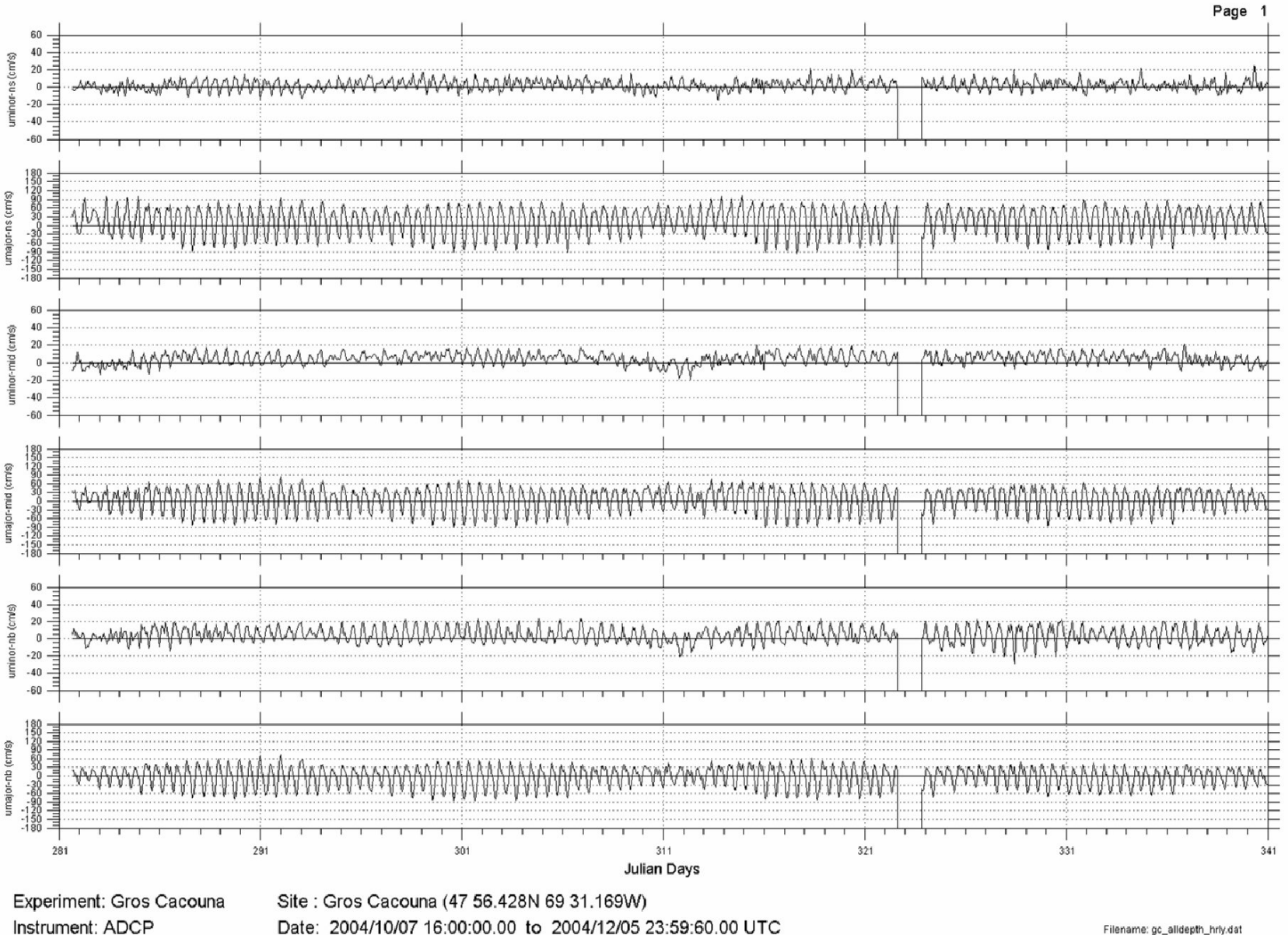


Figure 3-1 Time series plot of the major and minor components for the near-surface, mid-depth, and near-bottom between October and December, 2004.

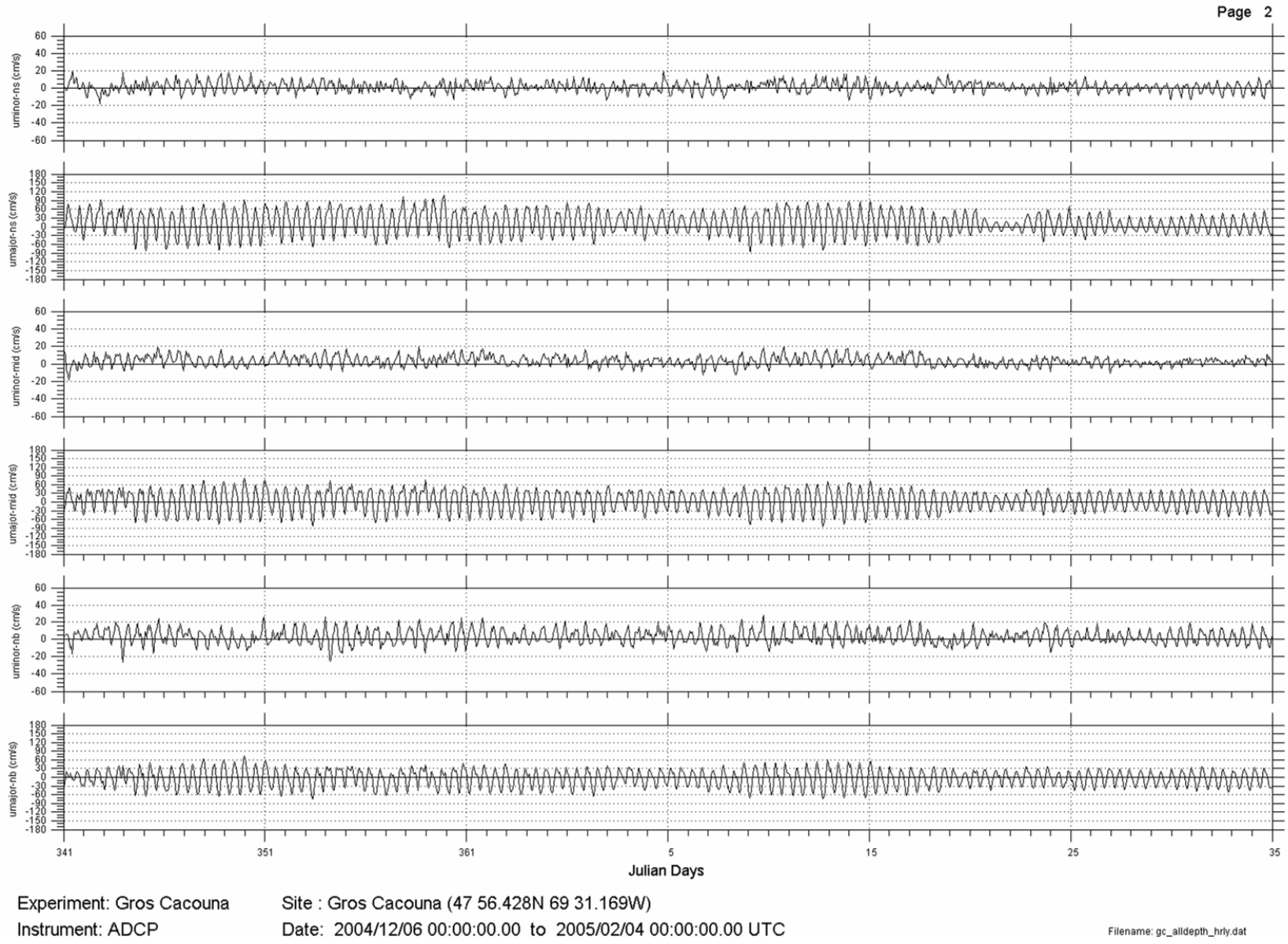


Figure 3-2 Time series plot of the major and minor components for the near-surface, mid-depth, and near-bottom between December and February.

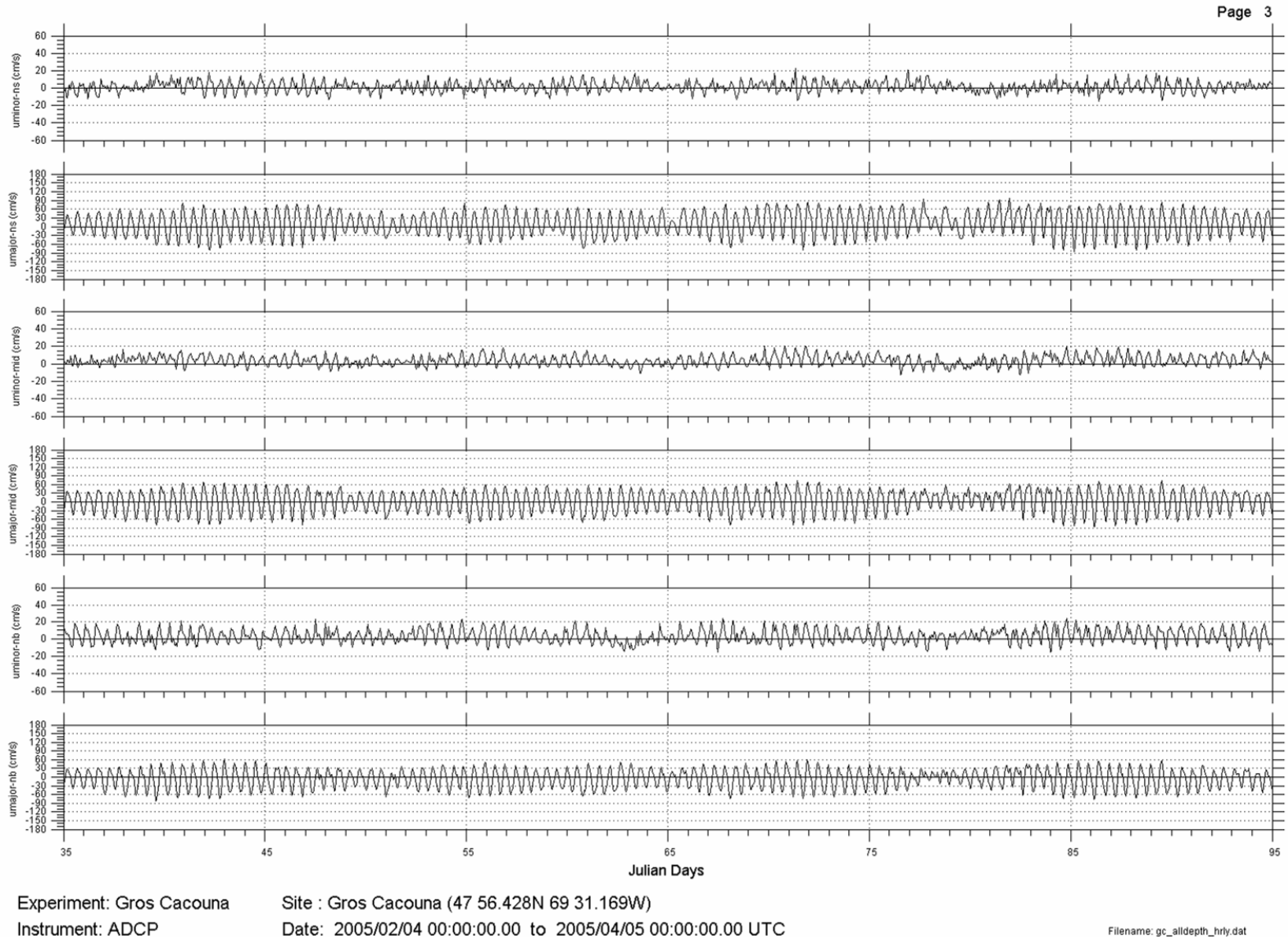


Figure 3-3 Time series plot of the major and minor components for the near-surface, mid-depth, and near-bottom between February and April, 2005.

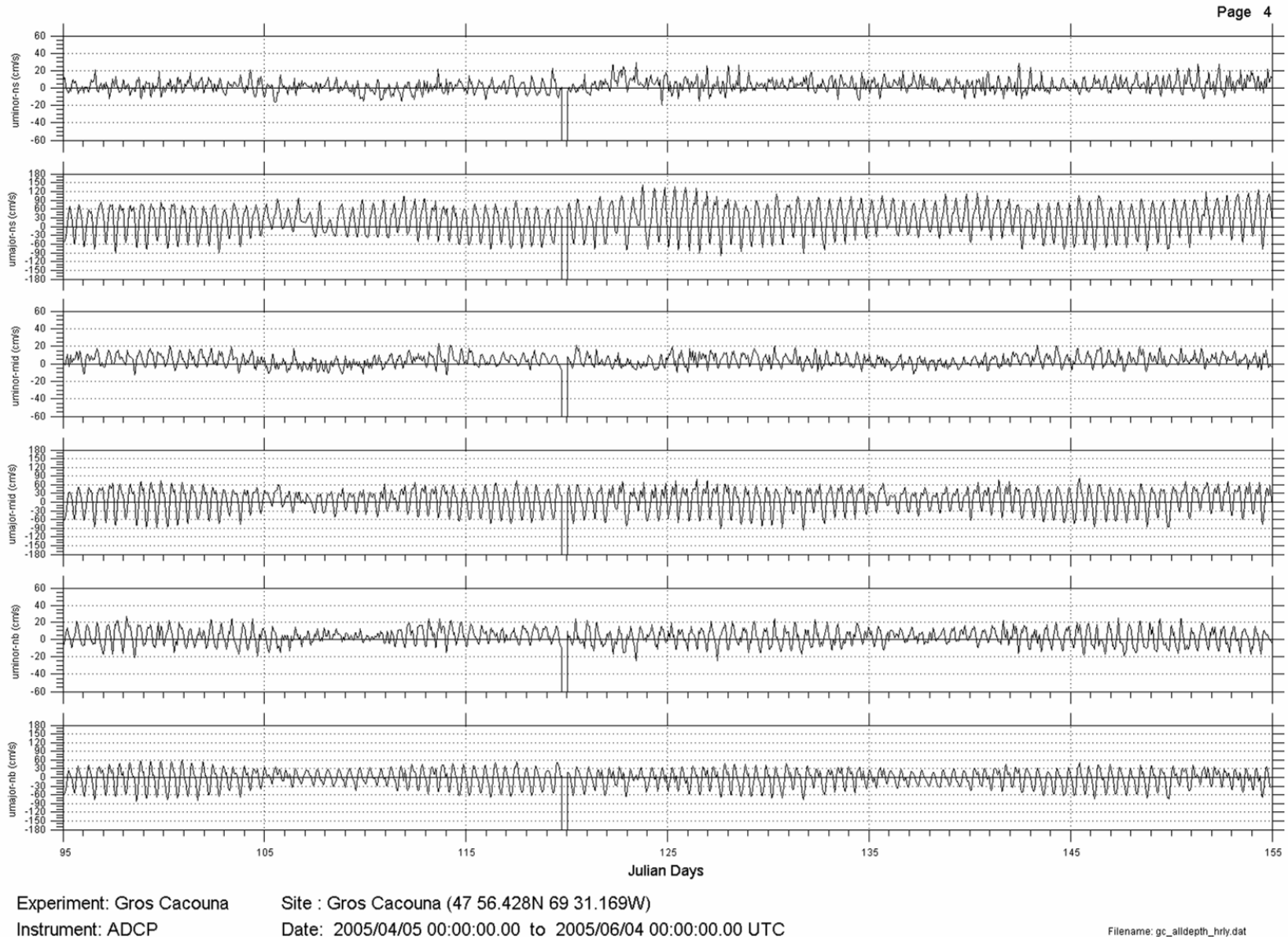


Figure 3-4 Time series plot of the major and minor components for the near-surface, mid-depth, and near-bottom between April and June, 2005.

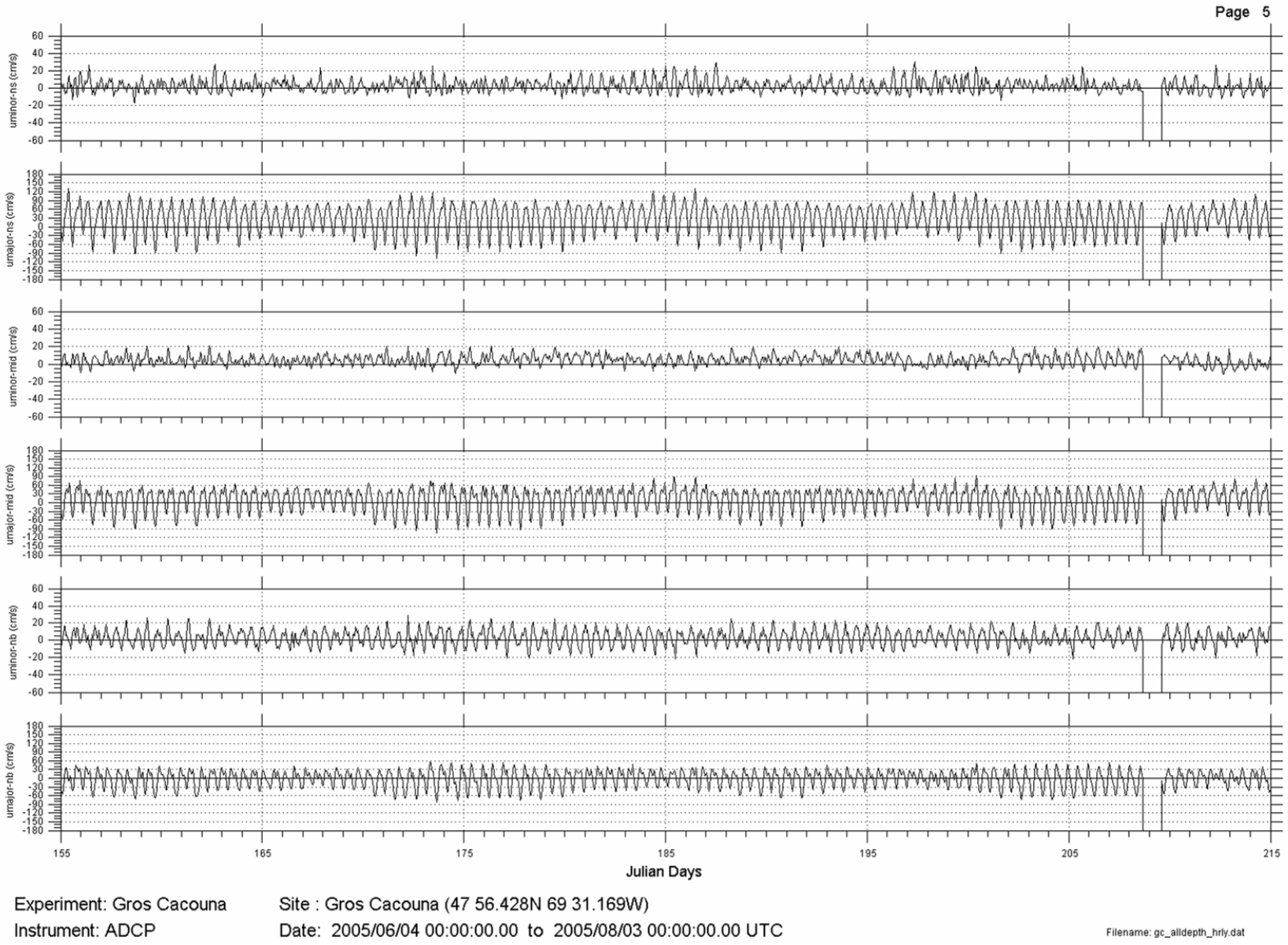


Figure 3-5 Time series plot of the major and minor components for the near-surface, mid-depth, and near-bottom between June and August, 2005.

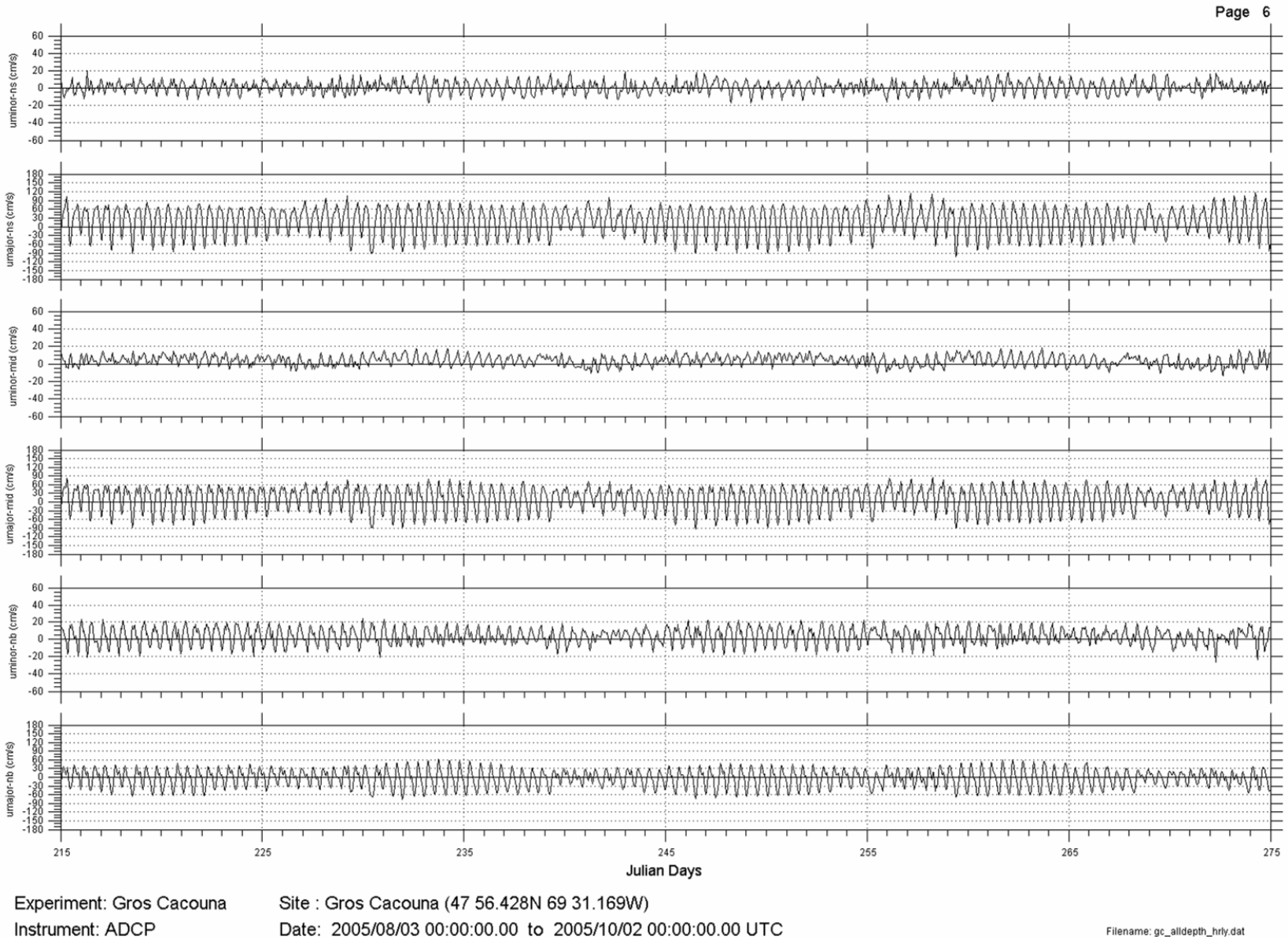


Figure 3-6 Time series plot of the major and minor components for the near-surface, mid-depth, and near-bottom between August and October, 2005.

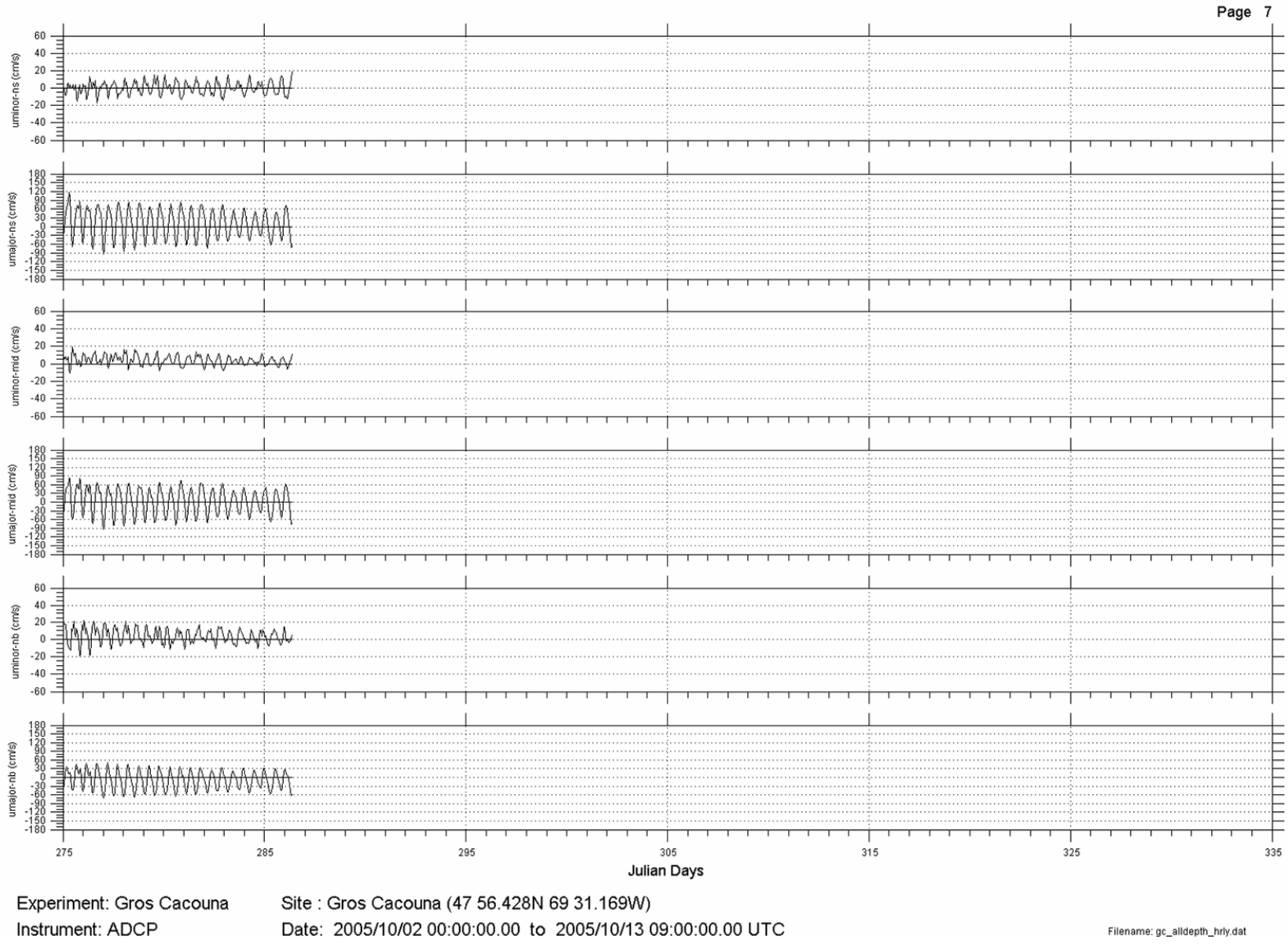


Figure 3-7 Time series plot of the major and minor components for the near-surface, mid-depth, and near-bottom between for October 2005.

3.3 Annual and Seasonal Statistics

The seasonal and annual statistics of the ocean current data sets are tabulated in this section. Statistics for the major component, minor component, and the speed are given for the near-surface, mid-depth, and near-bottom. Each table which is presented covers a specific time interval. The tabulated statistics are then followed by seasonal and annual joint frequency tables of current speed versus direction. Each element of these tables gives the relative occurrence of observations that fall within the given speed and direction interval. Appendix C.1 gives seasonal compass plots which illustrate the joint frequency tables graphically.

3.3.1 Statistical Tables

The annual major/minor current component statistics and speed statistics are given in Table 3-3. The maximum current speeds measured were in the near-surface level, and reached 159 cm/s on the ebb tide of May 2, 2005. In addition to the maximum current speed of 159 cm/s, the 95th percentile current speed was 88.5 cm/s. The moderate amounts of shear in the water column are reflected by a 95th percentile current speed of 62.3 cm/s at near-bottom. The major current component statistics indicate that at the near-surface, the largest ebb currents (84.7 cm/s 95% level) are somewhat stronger than the largest flood currents (-65.4 cm/s 5% level). At the near-bottom the situation is reversed with -60.7 cm/s flood currents (5% level) versus 44.2 cm/s ebb currents (95% level). These same patterns are also observed in each of the seasonal results which are tabulated in Table 3-4 through Table 3-7. The largest major-current component flows were observed in the April-June time interval when they reached speeds of (159) cm/s. The seasonal variability will be considered further in the next section when the monthly statistics are presented.

The vector-averaged current velocities over the entire record for near-surface, mid-depth, and near-bottom were 18.7 cm/s (33°), 7.8 cm/s (58°), and 4.7 cm/s (160.8°), respectively, and are given with the joint frequency tables. The net flow at surface is downriver, whereas the net near-bottom flow has an upriver component. This reversal in the net flow directions between near-surface and near-bottom levels is expected in an estuarine environment. The net downriver flow at surface entrains some of the water from lower levels and carries it seaward. To conserve mass, and in the absence of lateral variations in flow patterns, there must be a compensating upriver flow at depth.

Table 3-3: Statistics for the major and minor components of the near-surface, mid-depth, and near-bottom currents between October 2004 and October 2005, and the statistics for the current speeds.

Oct, 2004 - Oct, 2005

	Depth	min (cm/s)	1% (cm/s)	5% (cm/s)	25% (cm/s)	50% (cm/s)	mean (cm/s)	75% (cm/s)	95% (cm/s)	99% (cm/s)	std dev (cm/s)	max (cm/s)	# pts	Total # pts
major component	near-surface	-130.38	-87.51	-65.43	-18.60	26.72	18.57	56.36	84.70	107.36	47.84	158.64	106232	106813
	mid-depth	-120.64	-86.47	-67.67	-26.83	17.90	6.68	39.56	60.91	76.50	41.49	108.32	106232	106813
	near-bottom	-101.10	-74.68	-60.73	-30.11	2.48	-3.25	23.01	44.22	56.32	33.23	81.19	106232	106813
minor component	near-surface	-29.67	-15.45	-10.70	-3.51	1.63	2.04	7.15	16.09	24.22	8.22	49.56	106232	106813
	mid-depth	-26.91	-11.87	-7.25	-1.04	3.83	4.01	8.94	15.92	20.54	7.13	35.50	106232	106813
	near-bottom	-42.99	-20.29	-12.89	-3.56	3.22	3.39	10.46	20.02	26.07	10.12	40.19	106232	106813

Oct, 2004 - Oct, 2005

Depth	min (cm/s)	50% (cm/s)	mean (cm/s)	75% (cm/s)	95% (cm/s)	99% (cm/s)	std (cm/s)	max (cm/s)	# valid pts	Total # pts
near-surface	0.05	44.66	45.34	63.37	88.53	108.65	25.49	159.09	106232	106813
mid-depth	0.08	36.73	37.94	50.96	73.39	89.07	19.84	120.73	106232	106813
near-bottom	0.05	28.24	30.39	42.09	62.28	75.54	17.46	101.13	106232	106813

Table 3-4: Statistics for the major and minor components of the near-surface, mid-depth, and near-bottom currents between October and December, 2004 and the statistics for the current speeds.

Oct-Dec, 2004

	Depth	min (cm/s)	1% (cm/s)	5% (cm/s)	25% (cm/s)	50% (cm/s)	mean (cm/s)	75% (cm/s)	95% (cm/s)	99% (cm/s)	std dev (cm/s)	max (cm/s)	# pts	Total # pts
major component	near-surface	-108.62	-86.90	-66.78	-23.17	27.41	16.09	54.26	78.27	95.11	47.28	129.65	24297	24600
	mid-depth	-109.38	-86.29	-68.46	-28.84	17.87	5.78	39.19	60.00	75.22	41.87	93.97	24297	24600
	near-bottom	-101.10	-80.46	-64.16	-31.44	5.65	-2.35	25.31	46.98	59.51	35.51	81.19	24297	24600
minor component	near-surface	-27.35	-13.48	-9.21	-2.56	1.95	2.26	7.04	14.20	20.02	7.18	30.86	24297	24600
	mid-depth	-25.16	-12.53	-7.08	-0.59	4.58	4.45	9.53	15.84	19.49	7.12	28.28	24297	24600
	near-bottom	-39.95	-19.50	-11.71	-2.85	3.55	3.84	10.66	20.21	25.65	9.83	34.06	24297	24600

Oct-Dec, 2004

Depth	min (cm/s)	50% (cm/s)	mean (cm/s)	75% (cm/s)	95% (cm/s)	99% (cm/s)	std (cm/s)	max (cm/s)	# valid pts	Total # pts
near-surface	0.22	45.45	44.93	61.85	82.33	97.90	23.06	129.75	24297	24600
mid-depth	0.08	36.73	37.94	50.96	73.40	89.07	19.84	120.73	106232	106813
near-bottom	0.05	29.88	32.17	44.48	65.79	80.87	18.51	101.13	24297	24600

Table 3-5: Statistics for the major and minor components of the near-surface, mid-depth, and near-bottom currents between January and March, 2005 and the statistics for the current speeds.

Jan-Mar, 2005

	Depth	min (cm/s)	1% (cm/s)	5% (cm/s)	25% (cm/s)	50% (cm/s)	mean (cm/s)	75% (cm/s)	95% (cm/s)	99% (cm/s)	std dev (cm/s)	max (cm/s)	# pts	Total # pts
major component	near-surface	-99.09	-76.15	-57.09	-19.59	12.36	10.86	43.96	71.47	83.89	40.09	106.33	25920	25920
	mid-depth	-101.26	-79.09	-62.01	-29.18	7.96	1.99	33.58	54.62	66.11	37.66	82.78	25920	25920
	near-bottom	-91.89	-73.15	-59.04	-32.17	-0.21	-4.77	21.35	43.96	56.32	32.63	73.40	25920	25920
minor component	near-surface	-20.78	-14.29	-9.86	-3.16	1.53	1.58	6.14	13.56	18.96	7.06	31.02	25920	25920
	mid-depth	-17.78	-11.07	-6.55	-1.11	3.08	3.35	7.47	14.32	19.46	6.41	28.01	25920	25920
	near-bottom	-25.21	-14.52	-10.13	-3.17	2.56	3.22	9.25	18.24	24.63	8.74	36.23	25920	25920

Jan-Mar, 2005

Depth	min (cm/s)	50% (cm/s)	mean (cm/s)	75% (cm/s)	95% (cm/s)	99% (cm/s)	std (cm/s)	max (cm/s)	# valid pts	Total # pts
near-surface	0.049	33.325	36.044	52.378	74.918	86.382	21.87	107.089	25920	25920
mid-depth	0.308	32.637	33.744	46.079	66.077	79.675	18.318	101.327	25920	25920
near-bottom	0.152	27.667	29.743	41.394	60.776	73.335	17.016	92.424	25920	25920

Table 3-6: Statistics for the major and minor components of the near-surface, mid-depth, and near-bottom currents between April and June, 2005 and the statistics for the current speeds.

Apr-Jun, 2005

	Depth	min (cm/s)	1% (cm/s)	5% (cm/s)	25% (cm/s)	50% (cm/s)	mean (cm/s)	75% (cm/s)	95% (cm/s)	99% (cm/s)	std dev (cm/s)	max (cm/s)	# pts	Total # pts
major component	near-surface	-130.38	-91.43	-68.78	-14.98	34.71	24.51	64.02	96.75	120.22	51.88	158.64	26168	26208
	mid-depth	-120.64	-91.26	-69.74	-24.64	20.10	7.79	40.01	61.13	76.89	41.81	107.30	26168	26208
	near-bottom	-93.62	-76.10	-61.29	-28.05	2.94	-2.84	23.19	42.29	52.82	32.64	77.96	26168	26208
minor component	near-surface	-29.67	-15.91	-10.86	-3.48	2.03	2.77	8.15	19.26	28.07	9.14	45.40	26168	26208
	mid-depth	-26.91	-12.53	-7.97	-1.32	3.85	4.16	9.46	17.34	22.24	7.73	32.46	26168	26208
	near-bottom	-39.16	-21.51	-14.63	-4.46	3.32	3.12	10.65	20.56	27.82	10.82	40.19	26168	26208

Apr-Jun, 2005

Depth	min (cm/s)	50% (cm/s)	mean (cm/s)	75% (cm/s)	95% (cm/s)	99% (cm/s)	std (cm/s)	max (cm/s)	# valid pts	Total # pts
near-surface	0.26	49.92	50.86	70.22	99.03	121.54	28.22	159.09	26168	26208
mid-depth	0.37	36.99	38.52	51.10	75.51	91.90	20.03	120.73	26168	26208
near-bottom	0.09	27.80	29.98	40.87	62.66	76.67	17.35	93.67	26168	26208

Table 3-7: Statistics for the major and minor components of the near-surface, mid-depth, and near-bottom currents between July and October, 2005 and the statistics for the current speeds.

Jul-Oct, 2005

	Depth	min (cm/s)	1% (cm/s)	5% (cm/s)	25% (cm/s)	50% (cm/s)	mean (cm/s)	75% (cm/s)	95% (cm/s)	99% (cm/s)	std dev (cm/s)	max (cm/s)	# pts	Total # pts
major component	near-surface	-111.59	-89.84	-68.28	-15.37	34.60	22.07	61.00	87.51	110.84	49.73	146.04	29847	30085
	mid-depth	-110.06	-87.73	-69.96	-23.71	23.57	10.51	44.11	66.07	82.87	43.59	108.32	29847	30085
	near-bottom	-90.06	-69.99	-58.64	-28.88	1.75	-3.02	22.31	43.80	55.94	32.27	66.38	29847	30085
minor component	near-surface	-25.17	-17.00	-12.08	-4.77	1.04	1.63	7.47	17.03	25.58	9.02	49.56	29847	30085
	mid-depth	-22.48	-11.53	-7.37	-1.13	4.01	4.09	9.15	15.79	20.39	7.16	35.50	29847	30085
	near-bottom	-42.99	-22.60	-14.84	-3.91	3.52	3.41	11.25	20.66	26.03	10.82	35.38	29847	30085

Jul-Oct, 2005

Depth	min (cm/s)	50% (cm/s)	mean (cm/s)	75% (cm/s)	95% (cm/s)	99% (cm/s)	std (cm/s)	max (cm/s)	# valid pts	Total # pts
near-surface	0.19	49.46	48.91	67.02	91.06	111.93	25.53	149.61	29847	30085
mid-depth	0.10	39.91	40.70	54.39	76.80	92.45	20.53	110.48	29847	30085
near-bottom	0.21	27.88	29.86	41.73	60.52	71.11	16.95	90.84	29847	30085

3.3.2 Near Surface Joint Frequency Tables

Table 3-8: Joint frequency table for the near-surface currents from October 2004 to October 2005.

Location: Gros Cacouna (47 56.428N 69 31.169W) at site Gros Cacouna
Instrument: ADCP
For period: Oct.07,2004 14:00:00 to Oct.13,2005 11:00:00 UTC Sample Interval: 5 min

	Speed (cm/s)																
Direction (deg)	0 to 10	10 to 20	20 to 30	30 to 40	40 to 50	50 to 60	60 to 70	70 to 80	80 to 90	90 to 100	100 to 110	110 to 120	120 to 130	130 to 140	140 to 150	150 to 160	Row Total (%)
11.25 33.75 NNE	0.66	2.06	3.09	4.83	6.88	8.07	7.72	5.53	2.68	1.32	0.65	0.30	0.15	0.06	0.04	0.01	44.06
33.75 56.25 NE	0.67	1.59	1.88	1.85	1.75	1.42	1.00	0.82	0.64	0.52	0.31	0.15	0.10	0.03	0.02		12.76
56.25 78.75 ENE	0.56	0.79	0.70	0.28	0.11	0.07	0.04	0.02	0.00	0.00							2.56
78.75 101.3 E	0.49	0.47	0.20	0.03	0.00												1.19
101.3 123.8 ESE	0.46	0.33	0.09	0.01													0.88
123.8 146.3 SE	0.52	0.38	0.07	0.01	0.00	0.00											0.99
146.3 168.8 SSE	0.63	0.62	0.20	0.03	0.01	0.00	0.00										1.50
168.8 191.3 S	0.68	1.74	1.59	0.98	0.62	0.47	0.18	0.05	0.01								6.32
191.3 213.8 SSW	0.66	1.96	2.95	3.17	3.26	3.15	2.73	1.79	1.12	0.56	0.14	0.02	0.01	0.00			21.53
213.8 236.3 SW	0.45	0.78	0.63	0.36	0.25	0.19	0.12	0.11	0.09	0.06	0.02	0.01					3.06
236.3 258.8 WSW	0.34	0.22	0.02	0.00													0.58
258.8 281.3 W	0.27	0.05	0.00														0.32
281.3 303.8 WNW	0.24	0.05	0.00														0.29
303.8 326.3 NW	0.26	0.06	0.00														0.33
326.3 348.8 NNW	0.34	0.24	0.03	0.00													0.61
348.8 11.25 N	0.50	0.71	0.59	0.55	0.41	0.16	0.07	0.03	0.00								3.03
Column Total (%)	7.74	12.04	12.03	12.11	13.29	13.55	11.87	8.34	4.54	2.46	1.12	0.48	0.27	0.09	0.06	0.01	

No. of Non-Flagged R 1E+05 No. of Flagged Record 581
Max. Speed : 159.1 cm/s Filename: gc_ns_all_5min_ed2.dat
Mean Speed : 45.34 cm/s
Vector-averaged Spee 18.68 cm/s at 33.3 deg

Table 3-9: Joint frequency table for the near-surface currents from October to December, 2004.

Location: Gros Cacouna (47 56.428N 69 31.169W) at site Gros Cacouna
Instrument: ADCP
For period: Oct.07,2004 14:00:00 to Dec.31,2004 23:55:00 UTC Sample Interval: 5 min

	Speed (cm/s)																
Direction (deg)	0 to 10	10 to 20	20 to 30	30 to 40	40 to 50	50 to 60	60 to 70	70 to 80	80 to 90	90 to 100	100 to 110	110 to 120	120 to 130	130 to 140	140 to 150	150 to 160	Row Total (%)
11.25 33.75 NNE	0.61	1.91	3.22	5.14	8.28	9.31	8.31	5.32	2.32	0.91	0.40	0.08	0.02				45.84
33.75 56.25 NE	0.73	1.58	1.86	2.04	2.05	1.50	0.86	0.73	0.39	0.14	0.05	0.03					11.96
56.25 78.75 ENE	0.47	0.71	0.48	0.19	0.02												1.88
78.75 101.3 E	0.47	0.40	0.16	0.01													1.03
101.3 123.8 ESE	0.38	0.31	0.09														0.79
123.8 146.3 SE	0.38	0.33	0.04	0.01													0.77
146.3 168.8 SSE	0.54	0.72	0.21	0.02													1.49
168.8 191.3 S	0.58	1.47	1.54	1.11	0.78	0.57	0.25	0.05	0.01								6.37
191.3 213.8 SSW	0.55	1.74	3.09	3.59	3.73	3.68	3.41	2.19	1.16	0.63	0.14						23.92
213.8 236.3 SW	0.35	0.67	0.61	0.19	0.12	0.11	0.05	0.02	0.02								2.14
236.3 258.8 WSW	0.28	0.12	0.00														0.41
258.8 281.3 W	0.22	0.03															0.25
281.3 303.8 WNW	0.15	0.03	0.00														0.19
303.8 326.3 NW	0.20	0.02	0.01														0.23
326.3 348.8 NNW	0.23	0.13	0.02														0.37
348.8 11.25 N	0.56	0.54	0.51	0.41	0.28	0.06											2.37
Column Total (%)	6.70	10.71	11.85	12.72	15.26	15.23	12.87	8.32	3.91	1.69	0.60	0.11	0.02	0.00	0.00	0.00	

No. of Non-Flagged R 24297 No. of Flagged Record 303
Max. Speed : 129.8 cm/s Filename: gc_ns_all_5min_ed2.dat
Mean Speed : 44.93 cm/s
Vector-averaged Spee 16.25 cm/s at 35.0 deg

Table 3-10: Joint frequency table for the near-surface currents from January to March, 2005.

Location: Gros Cacouna (47 56.428N 69 31.169W) at site Gros Cacouna
Instrument: ADCP
For period: Jan.01,2005 00:00:00 to Mar.31,2005 23:55:00 UTC Sample Interval: 5 min

	Speed (cm/s)																
Direction (deg)	0 to 10	10 to 20	20 to 30	30 to 40	40 to 50	50 to 60	60 to 70	70 to 80	80 to 90	90 to 100	100 to 110	110 to 120	120 to 130	130 to 140	140 to 150	150 to 160	Row Total (%)
11.25 33.75 NNE	1.14	3.34	4.34	5.94	6.81	6.96	5.96	3.83	1.40	0.31	0.06						40.09
33.75 56.25 NE	0.96	2.13	2.04	1.47	1.18	1.12	0.29	0.20	0.10	0.00	0.01						9.50
56.25 78.75 ENE	0.81	0.88	0.53	0.14	0.02	0.02											2.39
78.75 101.3 E	0.69	0.42	0.11	0.02													1.23
101.3 123.8 ESE	0.65	0.30	0.04	0.01													1.00
123.8 146.3 SE	0.86	0.44	0.05														1.35
146.3 168.8 SSE	1.00	0.79	0.28	0.05	0.00												2.12
168.8 191.3 S	1.15	2.98	2.65	1.30	0.61	0.41	0.09	0.02	0.01								9.21
191.3 213.8 SSW	1.10	3.37	4.42	4.14	3.90	3.07	2.17	1.18	0.53	0.17							24.07
213.8 236.3 SW	0.66	0.80	0.36	0.12	0.02	0.05	0.01	0.05	0.03								2.09
236.3 258.8 WSW	0.52	0.22															0.75
258.8 281.3 W	0.42	0.03															0.45
281.3 303.8 WNW	0.40	0.08															0.48
303.8 326.3 NW	0.45	0.11															0.56
326.3 348.8 NNW	0.55	0.36	0.01														0.92
348.8 11.25 N	0.82	0.98	0.74	0.66	0.47	0.10	0.01										3.78
Column Total (%)	12.18	17.24	15.57	13.85	13.01	11.73	8.53	5.27	2.06	0.49	0.07	0.00	0.00	0.00	0.00	0.00	

No. of Non-Flagged Records: 25920 No. of Flagged Record 0
Max. Speed : 107.1 cm/s Filename: gc_ns_all_5min_ed2.dat
Mean Speed : 36.04 cm/s
Vector-averaged Speed: 10.97 cm/s at 35.3 deg

Table 3-11: Joint frequency table for the near-surface currents from April to June, 2005.

Location: Gros Cacouna (47 56.428N 69 31.169W) at site Gros Cacouna
Instrument: ADCP
For period: Apr.01,2005 00:00:00 to Jun.30,2005 23:55:00 UTC Sample Interval: 5 min

	Speed (cm/s)																
Direction (deg)	0 to 10	10 to 20	20 to 30	30 to 40	40 to 50	50 to 60	60 to 70	70 to 80	80 to 90	90 to 100	100 to 110	110 to 120	120 to 130	130 to 140	140 to 150	150 to 160	Row Total (%)
11.25 33.75 NNE	0.42	1.55	2.23	4.01	5.57	7.36	7.40	5.95	3.73	2.25	1.39	0.71	0.33	0.22	0.18	0.05	43.36
33.75 56.25 NE	0.49	1.46	2.07	2.12	2.09	1.59	1.45	1.40	1.29	1.40	0.77	0.32	0.19	0.11	0.03		16.77
56.25 78.75 ENE	0.50	0.73	0.89	0.47	0.24	0.19	0.09	0.03									3.14
78.75 101.3 E	0.38	0.49	0.30	0.07	0.01												1.25
101.3 123.8 ESE	0.41	0.31	0.11														0.83
123.8 146.3 SE	0.36	0.38	0.06	0.01													0.82
146.3 168.8 SSE	0.56	0.38	0.13	0.01	0.02												1.10
168.8 191.3 S	0.53	1.18	1.10	0.77	0.47	0.45	0.21	0.09	0.02								4.82
191.3 213.8 SSW	0.59	1.52	2.36	2.49	2.77	2.60	2.36	1.71	1.32	0.68	0.19	0.07	0.05	0.00			18.72
213.8 236.3 SW	0.39	0.90	0.96	0.67	0.47	0.30	0.29	0.28	0.23	0.15	0.07	0.02					4.73
236.3 258.8 WSW	0.29	0.36	0.05	0.00													0.70
258.8 281.3 W	0.20	0.06	0.01														0.28
281.3 303.8 WNW	0.20	0.08															0.29
303.8 326.3 NW	0.20	0.08															0.28
326.3 348.8 NNW	0.26	0.20	0.06	0.00													0.52
348.8 11.25 N	0.34	0.59	0.41	0.34	0.36	0.28	0.07	0.02									2.39
Column Total (%)	6.11	10.28	10.74	10.96	12.01	12.77	11.88	9.47	6.58	4.47	2.42	1.13	0.58	0.33	0.21	0.05	

No. of Non-Flagged Records: 26168 No. of Flagged Record 40
Max. Speed : 159.1 cm/s Filename: gc_ns_all_5min_ed2.dat
Mean Speed : 50.86 cm/s
Vector-averaged Speed: 24.67 cm/s at 33.4 deg

Table 3-12: Joint frequency table for the near-surface currents from July - September, 2005.

Location: Gros Cacouna (47 56.428N 69 31.169W) at site Gros Cacouna
Instrument: ADCP
For period: Jul.01,2005 00:00:00 to Sep.30,2005 23:55:00 UTC Sample Interval: 5 min

	Speed (cm/s)																
Direction (deg)	0 to 10	10 to 20	20 to 30	30 to 40	40 to 50	50 to 60	60 to 70	70 to 80	80 to 90	90 to 100	100 to 110	110 to 120	120 to 130	130 to 140	140 to 150	150 to 160	Row Total (%)
11.25 33.75 NNE	0.44	1.39	2.49	4.15	6.93	8.84	9.32	6.71	3.15	1.81	0.75	0.39	0.19				46.56
33.75 56.25 NE	0.54	1.22	1.61	1.87	1.84	1.59	1.47	1.03	0.84	0.55	0.40	0.25	0.22	0.03	0.03		13.49
56.25 78.75 ENE	0.45	0.83	0.92	0.34	0.15	0.08	0.07	0.04	0.01	0.00							2.89
78.75 101.3 E	0.45	0.57	0.24	0.02													1.28
101.3 123.8 ESE	0.38	0.43	0.13	0.01													0.95
123.8 146.3 SE	0.43	0.39	0.14	0.02	0.01	0.00											0.99
146.3 168.8 SSE	0.46	0.57	0.18	0.07	0.02	0.00	0.01										1.31
168.8 191.3 S	0.41	1.29	1.02	0.69	0.53	0.43	0.18	0.03	0.01								4.59
191.3 213.8 SSW	0.43	1.36	2.00	2.51	2.68	3.13	2.86	1.93	1.30	0.74	0.18						19.12
213.8 236.3 SW	0.38	0.78	0.64	0.48	0.39	0.32	0.14	0.08	0.08	0.09	0.02						3.41
236.3 258.8 WSW	0.29	0.18	0.04														0.51
258.8 281.3 W	0.24	0.06															0.30
281.3 303.8 WNW	0.19	0.02															0.21
303.8 326.3 NW	0.21	0.06															0.26
326.3 348.8 NNW	0.31	0.28	0.02														0.61
348.8 11.25 N	0.30	0.71	0.72	0.80	0.55	0.19	0.17	0.06									3.52
Column Total (%)	5.91	10.12	10.18	10.96	13.10	14.58	14.22	9.88	5.40	3.19	1.35	0.64	0.42	0.03	0.03	0.00	

No. of Non-Flagged Records: 26258 No. of Flagged Record 238
Max. Speed : 149.6 cm/s Filename: gc_ns_all_5min_ed2.dat
Mean Speed : 49.15 cm/s
Vector-averaged Speed: 23.36 cm/s at 31.4 deg

3.3.3 Mid-Depth Joint Frequency Tables

Table 3-13: Joint frequency table for the mid-depth currents from October 2004 to October 2005.

Location: Gros Cacouna (47 56.428N 69 31.169W) at site Gros Cacouna
Instrument: ADCP
For period: Oct.07,2004 14:00:00 to Oct.13,2005 11:00:00 UTC Sample Interval: 5 min

	Speed (cm/s)																
Direction (deg)	0 to 10	10 to 20	20 to 30	30 to 40	40 to 50	50 to 60	60 to 70	70 to 80	80 to 90	90 to 100	100 to 110	110 to 120	120 to 130	130 to 140	140 to 150	150 to 160	Row Total (%)
11.25 33.75 NNE	0.61	2.48	5.20	6.73	6.25	4.32	2.51	1.12	0.44	0.14	0.04						29.85
33.75 56.25 NE	0.61	1.72	3.43	5.52	5.62	3.21	1.13	0.38	0.04	0.00							21.68
56.25 78.75 ENE	0.44	0.93	0.93	0.36	0.09	0.00											2.75
78.75 101.25 E	0.38	0.72	0.27	0.01													1.38
101.25 123.75 ESE	0.37	0.62	0.12	0.00													1.12
123.75 146.25 SE	0.37	0.71	0.16	0.00													1.25
146.25 168.75 SSE	0.42	0.91	0.52	0.05	0.00												1.90
168.75 191.25 S	0.48	1.27	1.72	1.44	0.77	0.27	0.11	0.04	0.00								6.09
191.25 213.75 SSW	0.58	1.76	2.84	3.92	4.19	4.34	3.67	2.33	1.31	0.54	0.13	0.01	0.00				25.63
213.75 236.25 SW	0.51	0.79	0.55	0.36	0.16	0.07	0.07	0.06	0.01	0.01	0.00	0.00					2.60
236.25 258.75 WSW	0.35	0.20	0.01														0.56
258.75 281.25 W	0.27	0.05	0.00														0.32
281.25 303.75 WNW	0.26	0.05															0.30
303.75 326.25 NW	0.29	0.05															0.34
326.25 348.75 NNW	0.41	0.24	0.03	0.00													0.69
348.75 11.25 N	0.54	1.20	1.11	0.45	0.15	0.07	0.02	0.00									3.55
Column Total (%)	6.90	13.70	16.91	18.85	17.23	12.29	7.52	3.92	1.81	0.69	0.18	0.01	0.00	0.00	0.00	0.00	

No. of Non-Flagged Records: 106232 No. of Flagged Rec 581
Max. Speed : 121 cm/s Filename: gc_mid_all_5min_spd_ed1.dat
Mean Speed : 37.9 cm/s
Vector-averaged Speed: 7.79 cm/s at 58.0 deg

Table 3-14: Joint frequency table for the mid-depth currents from October to December, 2004.

Location: Gros Cacouna (47 56.428N 69 31.169W) at site Gros Cacouna
Instrument: ADCP
For period: Oct.07,2004 14:00:00 to Dec.31,2004 23:55:00 UTC Sample Interval: 5 min

	Speed (cm/s)																
Direction (deg)	0 to 10	10 to 20	20 to 30	30 to 40	40 to 50	50 to 60	60 to 70	70 to 80	80 to 90	90 to 100	100 to 110	110 to 120	120 to 130	130 to 140	140 to 150	150 to 160	Row Total (%)
11.25 33.75 NNE	0.58	2.30	4.65	6.35	5.60	3.73	2.34	0.99	0.43	0.04							27.02
33.75 56.25 NE	0.51	1.35	3.55	6.71	6.45	3.54	1.06	0.35	0.05								23.57
56.25 78.75 ENE	0.33	0.95	1.21	0.40	0.02												2.93
78.75 101.25 E	0.33	0.91	0.26	0.00													1.49
101.25 123.75 ESE	0.30	0.74	0.10														1.14
123.75 146.25 SE	0.33	0.80	0.13														1.26
146.25 168.75 SSE	0.37	1.01	0.61	0.04													2.02
168.75 191.25 S	0.40	1.11	1.65	1.35	0.66	0.24	0.03	0.01									5.46
191.25 213.75 SSW	0.52	1.63	2.53	3.78	4.44	4.65	4.58	2.61	1.39	0.54	0.11						26.79
213.75 236.25 SW	0.48	0.76	0.46	0.44	0.09	0.03	0.02	0.00	0.00								2.29
236.25 258.75 WSW	0.46	0.20	0.02														0.67
258.75 281.25 W	0.35	0.05	0.00														0.41
281.25 303.75 WNW	0.30	0.03															0.33
303.75 326.25 NW	0.31	0.05															0.36
326.25 348.75 NNW	0.38	0.20	0.02														0.61
348.75 11.25 N	0.50	1.16	1.01	0.54	0.18	0.17	0.08	0.01									3.64
Column Total (%)	6.45	13.26	16.22	19.61	17.45	12.36	8.12	3.97	1.88	0.58	0.11	0.00	0.00	0.00	0.00	0.00	

No. of Non-Flagged Records: 24297 No. of Flagged Rec(303
Max. Speed : 110 cm/s Filename: gc_mid_all_5min_spd_ed1.dat
Mean Speed : 38.4 cm/s
Vector-averaged Speed: 7.29 cm/s at 64.6 deg

Table 3-15: Joint frequency table for the mid-depth currents from January to March, 2005.

Location: Gros Cacouna (47 56.428N 69 31.169W) at site Gros Cacouna
Instrument: ADCP
For period: Jan.01,2005 00:00:00 to Mar.31,2005 23:55:00 UTC Sample Interval: 5 min

	Speed (cm/s)																
Direction (deg)	0 to 10	10 to 20	20 to 30	30 to 40	40 to 50	50 to 60	60 to 70	70 to 80	80 to 90	90 to 100	100 to 110	110 to 120	120 to 130	130 to 140	140 to 150	150 to 160	Row Total (%)
11.25 33.75 NNE	0.74	2.87	6.08	7.90	5.60	3.45	1.49	0.24	0.04								28.41
33.75 56.25 NE	0.91	2.11	3.38	3.87	3.49	2.04	0.74	0.35	0.01								16.90
56.25 78.75 ENE	0.64	1.00	0.69	0.25	0.05												2.63
78.75 101.25 E	0.48	0.68	0.17														1.32
101.25 123.75 ESE	0.55	0.51	0.10														1.15
123.75 146.25 SE	0.51	0.65	0.14														1.31
146.25 168.75 SSE	0.66	0.86	0.46	0.05													2.04
168.75 191.25 S	0.71	1.50	1.69	1.41	0.64	0.17	0.03										6.14
191.25 213.75 SSW	0.84	3.00	4.56	5.93	5.29	5.03	3.40	1.80	0.74	0.16	0.01						30.76
213.75 236.25 SW	0.85	1.09	0.54	0.24	0.10	0.03											2.84
236.25 258.75 WSW	0.43	0.17															0.60
258.75 281.25 W	0.31	0.03															0.34
281.25 303.75 WNW	0.24	0.05															0.29
303.75 326.25 NW	0.39	0.03															0.42
326.25 348.75 NNW	0.56	0.27	0.01														0.83
348.75 11.25 N	0.82	1.52	1.08	0.42	0.14	0.06											4.03
Column Total (%)	9.63	16.32	18.91	20.06	15.31	10.76	5.66	2.40	0.79	0.16	0.01	0.00	0.00	0.00	0.00	0.00	

No. of Non-Flagged Records: 25920 No. of Flagged Rec(0
Max. Speed : 101 cm/s Filename: gc_mid_all_5min_spd_ed1.dat
Mean Speed : 33.7 cm/s
Vector-averaged Speed: 3.89 cm/s at 86.3 deg

Table 3-16: Joint frequency table for the mid-depth currents from April to June, 2005.

Location: Gros Cacouna (47 56.428N 69 31.169W) at site Gros Cacouna
Instrument: ADCP
For period: Apr.01,2005 00:00:00 to Jun.30,2005 23:55:00 UTC Sample Interval: 5 min

		Speed (cm/s)																
Direction (deg)		0 to 10	10 to 20	20 to 30	30 to 40	40 to 50	50 to 60	60 to 70	70 to 80	80 to 90	90 to 100	100 to 110	110 to 120	120 to 130	130 to 140	140 to 150	150 to 160	Row Total (%)
11.25	33.75 NNE	0.55	2.48	5.02	5.90	5.35	3.72	2.16	1.09	0.45	0.10	0.02						26.83
33.75	56.25 NE	0.47	1.78	3.93	6.56	7.03	3.99	1.62	0.49	0.09	0.01							25.99
56.25	78.75 ENE	0.30	0.83	1.04	0.59	0.18	0.00											2.94
78.75	101.25 E	0.30	0.71	0.41	0.03													1.44
101.25	123.75 ESE	0.31	0.62	0.18	0.00													1.12
123.75	146.25 SE	0.26	0.79	0.22	0.01													1.28
146.25	168.75 SSE	0.29	0.86	0.51	0.09													1.74
168.75	191.25 S	0.34	1.12	1.61	1.45	0.89	0.31	0.14	0.05	0.00								5.89
191.25	213.75 SSW	0.56	1.17	2.05	3.09	3.76	3.76	3.09	2.10	1.58	0.80	0.24	0.04	0.01				22.25
213.75	236.25 SW	0.37	0.88	0.91	0.65	0.36	0.19	0.22	0.15	0.02	0.02	0.01	0.00					3.78
236.25	258.75 WSW	0.30	0.34	0.03														0.67
258.75	281.25 W	0.31	0.13															0.44
281.25	303.75 WNW	0.30	0.09															0.39
303.75	326.25 NW	0.31	0.10															0.41
326.25	348.75 NNW	0.45	0.31	0.02														0.79
348.75	11.25 N	0.46	1.49	1.43	0.44	0.16	0.06	0.01										4.03
Column Total (%)		5.89	13.69	17.36	18.80	17.73	12.03	7.23	3.87	2.15	0.93	0.27	0.04	0.01	0.00	0.00	0.00	

No. of Non-Flagged Records: 26168 No. of Flagged Rec(40
Max. Speed : 121 cm/s Filename: gc_mid_all_5min_spd_ed1.dat
Mean Speed : 38.5 cm/s
Vector-averaged Speed: 8.83 cm/s at 55.1 deg

Table 3-17: Joint frequency table for the mid-depth currents from July - September, 2005.

Location: Gros Cacouna (47 56.428N 69 31.169W) at site Gros Cacouna
Instrument: ADCP
For period: Jul.01,2005 00:00:00 to Sep.30,2005 23:55:00 UTC Sample Interval: 5 min

		Speed (cm/s)																
Direction (deg)		0 to 10	10 to 20	20 to 30	30 to 40	40 to 50	50 to 60	60 to 70	70 to 80	80 to 90	90 to 100	100 to 110	110 to 120	120 to 130	130 to 140	140 to 150	150 to 160	Row Total (%)
11.25	33.75 NNE	0.58	2.28	5.34	7.03	8.21	5.99	3.54	2.03	0.79	0.35	0.13						36.26
33.75	56.25 NE	0.56	1.65	3.00	5.26	5.89	3.47	1.11	0.34	0.00	0.00							21.27
56.25	78.75 ENE	0.45	0.93	0.77	0.24	0.09	0.01											2.50
78.75	101.25 E	0.41	0.61	0.27														1.29
101.25	123.75 ESE	0.34	0.62	0.12	0.00													1.09
123.75	146.25 SE	0.37	0.62	0.16	0.01													1.16
146.25	168.75 SSE	0.39	0.94	0.54	0.04	0.00												1.91
168.75	191.25 S	0.45	1.38	1.91	1.53	0.88	0.30	0.16	0.04									6.64
191.25	213.75 SSW	0.35	1.12	2.19	2.94	3.29	3.77	3.61	2.69	1.42	0.58	0.15						22.13
213.75	236.25 SW	0.32	0.51	0.35	0.17	0.12	0.05	0.04	0.09	0.02	0.00							1.68
236.25	258.75 WSW	0.24	0.10															0.35
258.75	281.25 W	0.13	0.00															0.14
281.25	303.75 WNW	0.21	0.01															0.22
303.75	326.25 NW	0.15	0.03															0.18
326.25	348.75 NNW	0.26	0.21	0.08	0.01													0.55
348.75	11.25 N	0.37	0.63	1.02	0.47	0.13	0.01	0.01	0.00									2.64
Column Total (%)		5.58	11.65	15.75	17.69	18.62	13.60	8.47	5.18	2.24	0.94	0.27	0.00	0.00	0.00	0.00	0.00	

No. of Non-Flagged Records: 26258 No. of Flagged Rec(238
Max. Speed : 110 cm/s Filename: gc_mid_all_5min_spd_ed1.dat
Mean Speed : 40.5 cm/s
Vector-averaged Speed: 12 cm/s at 46.9 deg

3.3.4 Near-Bottom Joint Frequency Tables

Table 3-18: Joint frequency table for the near-bottom currents from October 2004 to October, 2005.

Location: Gros Cacouna (47 56.428N 69 31.169W) at site Gros Cacouna
Instrument: ADCP
For period: Oct.07,2004 14:00:00 to Oct.13,2005 11:00:00 UTC Sample Interval: 5 min

	Speed (cm/s)																
Direction (deg)	0 to 10	10 to 20	20 to 30	30 to 40	40 to 50	50 to 60	60 to 70	70 to 80	80 to 90	90 to 100	100 to 110	110 to 120	120 to 130	130 to 140	140 to 150	150 to 160	Row Total (%)
11.25 33.75 NNE	1.13	2.72	2.81	2.63	2.06	1.17	0.3	0.05	0								12.88
33.75 56.25 NE	0.94	2.88	4.67	5.36	3.3	1.21	0.23	0.01	0								18.59
56.25 78.75 ENE	0.67	1.43	1.86	1.35	0.53	0.03											5.86
78.75 101.25 E	0.52	0.77	0.64	0.17	0.02												2.12
101.25 123.75 ESE	0.4	0.67	0.43	0.05	0												1.54
123.75 146.25 SE	0.37	0.73	0.55	0.05	0												1.69
146.25 168.75 SSE	0.42	0.78	1.1	0.46	0.07	0											2.84
168.75 191.25 S	0.48	0.95	1.69	2.11	1.78	0.97	0.3	0.04									8.32
191.25 213.75 SSW	0.62	1.41	2.27	3.53	4.44	4.35	3.15	1.23	0.41	0.06	0						21.49
213.75 236.25 SW	0.82	1.74	1.7	1.32	1.06	0.65	0.37	0.13	0.05	0							7.83
236.25 258.75 WSW	0.84	0.98	0.34	0.07	0.01												2.24
258.75 281.25 W	0.81	0.63	0.09	0.01													1.53
281.25 303.75 WNW	0.82	0.61	0.1	0													1.53
303.75 326.25 NW	0.85	0.82	0.25	0.06	0												1.98
326.25 348.75 NNW	1.03	1.62	0.71	0.21	0.03	0.01											3.61
348.75 11.25 N	1.07	2.12	1.66	0.81	0.24	0.05											5.95
Column Total (%)	11.79	20.85	20.86	18.21	13.53	8.43	4.35	1.46	0.46	0.07	0	0	0	0	0	0	

No. of Non-Flagged Records: 106232 No. of Flagged Reco 581
Max. Speed : 101.1 cm/s Filename: gc_nb_all_5min_ed2.dat
Mean Speed : 30.39 cm/s
Vector-averaged Speed: 4.69 cm/s at 160.8 deg

Table 3-19: Joint frequency table for the near-bottom currents from October to December, 2004.

Location: Gros Cacouna (47 56.428N 69 31.169W) at site Gros Cacouna
Instrument: ADCP
For period: Oct.07,2004 14:00:00 to Dec.31,2004 23:55:00 UTC Sample Interval: 5 min

	Speed (cm/s)																
Direction (deg)	0 to 10	10 to 20	20 to 30	30 to 40	40 to 50	50 to 60	60 to 70	70 to 80	80 to 90	90 to 100	100 to 110	110 to 120	120 to 130	130 to 140	140 to 150	150 to 160	Row Total (%)
11.25 33.75 NNE	1.25	3.26	3.12	2.82	1.98	1.48	0.55	0.21	0.02								14.68
33.75 56.25 NE	0.85	2.91	4.31	5.38	3.99	1.68	0.32	0									19.44
56.25 78.75 ENE	0.61	1.22	1.89	1.37	0.76	0.05											5.89
78.75 101.25 E	0.42	0.77	0.74	0.25													2.18
101.25 123.75 ESE	0.29	0.72	0.33	0.03													1.37
123.75 146.25 SE	0.24	0.79	0.54	0.01													1.58
146.25 168.75 SSE	0.31	0.71	1.08	0.44	0												2.54
168.75 191.25 S	0.33	0.73	1.43	2.14	1.37	0.77	0.28	0.05									7.1
191.25 213.75 SSW	0.55	1.28	2.14	3.01	4.84	4.51	4.11	1.63	0.91	0.21	0.01						23.19
213.75 236.25 SW	0.68	1.38	1.33	0.99	0.83	0.72	0.3	0.07									6.3
236.25 258.75 WSW	0.77	0.77	0.11	0.01													1.67
258.75 281.25 W	0.65	0.42	0														1.07
281.25 303.75 WNW	0.66	0.36	0.05														1.07
303.75 326.25 NW	0.74	0.52	0.1	0.03	0												1.4
326.25 348.75 NNW	1.07	1.68	0.66	0.14	0.06	0.03											3.64
348.75 11.25 N	1.21	2.43	1.8	0.99	0.35	0.1											6.88
Column Total (%)	10.62	19.94	19.63	17.62	14.18	9.33	5.57	1.96	0.93	0.21	0.01	0	0	0	0	0	

No. of Non-Flagged Records: 24297 No. of Flagged Records: 303
Max. Speed : 101.1 cm/s Filename: gc_nb_all_5min_ed2.dat
Mean Speed : 32.17 cm/s
Vector-averaged Speed: 4.5 cm/s at 160.8 deg

Table 3-20: Joint frequency table for the near-bottom currents from January to March, 2005.

Location: Gros Cacouna (47 56.428N 69 31.169W) at site Gros Cacouna
Instrument: ADCP
For period: Jan.01,2005 00:00:00 to Mar.31,2005 23:55:00 UTC Sample Interval: 5 min

		Speed (cm/s)																
		0 to	10 to	20 to	30 to	40 to	50 to	60 to	70 to	80 to	90 to	100 to	110 to	120 to	130 to	140 to	150 to	Row Total
Direction (deg)		10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	(%)
11.25	33.75 NNE	1.2	3.26	3.16	2.74	1.98	1.11	0.16	0.01									13.63
33.75	56.25 NE	0.86	3.45	5.41	5.35	2.58	1.26	0.35	0									19.27
56.25	78.75 ENE	0.65	1.51	1.42	0.95	0.23	0.02											4.78
78.75	101.25 E	0.52	0.82	0.53	0.08													1.96
101.25	123.75 ESE	0.38	0.63	0.42	0.04													1.47
123.75	146.25 SE	0.44	0.77	0.4	0.03													1.64
146.25	168.75 SSE	0.56	1.06	1.03	0.34	0.05												3.04
168.75	191.25 S	0.51	1.11	1.84	1.77	1.49	0.76	0.16										7.64
191.25	213.75 SSW	0.6	1.54	2.82	4.65	5.31	4.66	2.91	1.13	0.22	0.01							23.85
213.75	236.25 SW	0.83	1.83	2.39	1.95	1.55	0.52	0.35	0.09	0.04	0.01							9.57
236.25	258.75 WSW	0.74	0.92	0.2	0.02													1.88
258.75	281.25 W	0.73	0.51	0														1.25
281.25	303.75 WNW	0.83	0.46	0.01														1.29
303.75	326.25 NW	0.8	0.56	0.04														1.4
326.25	348.75 NNW	1.17	1.43	0.19														2.79
348.75	11.25 N	1.09	2.11	0.97	0.33	0.05												4.55
Column Total (%)		11.92	21.97	20.84	18.24	13.24	8.34	3.93	1.23	0.26	0.02	0	0	0	0	0	0	

No. of Non-Flagged Records: 25920 No. of Flagged Recor 0
Max. Speed : 92.42 cm/s Filename: gc_nb_all_5min_ed2.dat
Mean Speed : 29.74 cm/s
Vector-averaged Speed: 5.75 cm/s at 173.0 deg

Table 3-21: Joint frequency table for the near-bottom currents from April to June, 2005.

Location: Gros Cacouna (47 56.428N 69 31.169W) at site Gros Cacouna
Instrument: ADCP
For period: Apr.01,2005 00:00:00 to Jun.30,2005 23:55:00 UTC Sample Interval: 5 min

		Speed (cm/s)																
		0 to	10 to	20 to	30 to	40 to	50 to	60 to	70 to	80 to	90 to	100 to	110 to	120 to	130 to	140 to	150 to	Row Total
Direction (deg)		10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	(%)
11.25	33.75 NNE	0.99	2.14	2.49	2.34	1.66	0.6	0.07										10.29
33.75	56.25 NE	0.91	2.47	4.91	5.74	3.49	1.32	0.23	0.02	0								19.08
56.25	78.75 ENE	0.75	1.56	2.16	1.88	0.7	0.03											7.07
78.75	101.25 E	0.62	0.74	0.7	0.28	0.05												2.38
101.25	123.75 ESE	0.5	0.65	0.47	0.11	0												1.73
123.75	146.25 SE	0.47	0.71	0.5	0.07	0												1.76
146.25	168.75 SSE	0.52	0.67	1.02	0.36	0.08	0.02											2.66
168.75	191.25 S	0.64	1.03	1.72	1.79	1.46	0.78	0.2	0.04									7.65
191.25	213.75 SSW	0.74	1.39	2.21	3.49	3.71	3.89	2.68	1.39	0.4	0.04							19.93
213.75	236.25 SW	0.84	1.73	1.67	1.27	1.19	0.97	0.68	0.31	0.14	0							8.79
236.25	258.75 WSW	0.86	1.05	0.54	0.19	0.03												2.67
258.75	281.25 W	0.83	0.69	0.18	0.03													1.74
281.25	303.75 WNW	0.83	0.69	0.12	0													1.64
303.75	326.25 NW	0.81	0.94	0.29	0.08													2.12
326.25	348.75 NNW	0.94	1.74	0.78	0.21	0.04	0.01											3.72
348.75	11.25 N	0.91	2.29	2.15	1.1	0.27	0.04											6.76
Column Total (%)		12.14	20.49	21.89	18.95	12.68	7.65	3.86	1.75	0.54	0.04	0	0	0	0	0	0	

No. of Non-Flagged Records: 26168 No. of Flagged Recor 40
Max. Speed : 93.67 cm/s Filename: gc_nb_all_5min_ed2.dat
Mean Speed : 29.98 cm/s
Vector-averaged Speed: 4.22 cm/s at 159.3 deg

Table 3-22: Joint frequency table for the near-bottom currents from July - September, 2005.

Location: Gros Cacouna (47 56.428N 69 31.169W) at site Gros Cacouna
Instrument: ADCP
For period: Jul.01,2005 00:00:00 to Sep.30,2005 23:55:00 UTC Sample Interval: 5 min

		Speed (cm/s)																
Direction (deg)		0 to 10	10 to 20	20 to 30	30 to 40	40 to 50	50 to 60	60 to 70	70 to 80	80 to 90	90 to 100	100 to 110	110 to 120	120 to 130	130 to 140	140 to 150	150 to 160	Row Total (%)
11.25	33.75 NNE	1.11	2.32	2.45	2.57	2.62	1.61	0.47										13.15
33.75	56.25 NE	1.07	2.73	4.22	5.21	3.18	0.57	0.05										17.03
56.25	78.75 ENE	0.69	1.37	2.05	1.25	0.42	0											5.78
78.75	101.25 E	0.51	0.72	0.64	0.11	0.02												2
101.25	123.75 ESE	0.4	0.67	0.54	0.01													1.61
123.75	146.25 SE	0.3	0.66	0.76	0.06													1.78
146.25	168.75 SSE	0.3	0.69	1.3	0.73	0.11												3.13
168.75	191.25 S	0.39	0.93	1.79	2.72	2.52	1.33	0.5	0.07									10.24
191.25	213.75 SSW	0.6	1.5	1.98	2.84	3.91	4.19	2.99	0.82	0.16								18.99
213.75	236.25 SW	0.84	1.91	1.39	1.01	0.61	0.35	0.14	0.07	0.02								6.33
236.25	258.75 WSW	0.9	1.19	0.51	0.06													2.66
258.75	281.25 W	0.91	0.89	0.16														1.96
281.25	303.75 WNW	0.9	0.97	0.2	0													2.08
303.75	326.25 NW	1.04	1.28	0.54	0.1	0												2.96
326.25	348.75 NNW	0.98	1.79	1.21	0.48	0.03												4.49
348.75	11.25 N	1.08	1.78	1.81	0.82	0.26	0.05											5.8
Column Total (%)		12.02	21.38	21.54	17.99	13.68	8.1	4.15	0.96	0.18	0	0	0	0	0	0	0	

No. of Non-Flagged Records: 26258 No. of Flagged Recor 238
Max. Speed : 88.57 cm/s Filename: gc_nb_all_5min_ed2.dat
Mean Speed : 29.66 cm/s
Vector-averaged Speed: 4.1 cm/s at 152.3 deg

3.4 Monthly Statistics

The monthly statistics of the ocean current data sets are tabulated in this section. Statistics for the major component, minor component, and the speed are given for the near-surface, mid-depth, and near-bottom on a monthly basis. The tabulated statistics are then followed by time series plots of the monthly statistics. Monthly joint frequency tables between speed and direction are given in Appendix C.2 and monthly compass plots, which graphically illustrate the joint frequency tables, are given in Appendix C.3 in Volume II of this report.

3.4.1 Statistical Tables

The monthly statistics are tabulated in Table 3-23 through Table 3-26. These statistics are plotted in Figure 3-8 and in Figure 3-9 for the major and minor components and in Figure 3-10 for the speeds. The range of the major current component magnitude is largest in May through July, especially at the near-surface where the largest seasonal variation occurs (-130 to 160 cm/s). The smallest range in major component flow speeds is observed from January to March when the near-surface currents vary between -89 to 89 cm/s. This pronounced seasonal pattern is even more evident in the near-surface monthly current speeds and to a much lesser degree at mid-depth. The near-bottom major current component and current speeds exhibit comparatively small variability from month to month falling within a range of -90 to 80 cm/s and 0 to 100 cm/s for the major current component and current speeds, respectively.

The increased current speeds in May to June and reduced current speeds of January to March are likely related to the seasonal variation in the St. Lawrence River discharges. As well, the tidal current activity changes with the seasons (see below) with reduced tidal current amplitudes in winter and early spring and, at near-surface levels, larger activity in late spring and early summer.

The magnitude of the minor current component is considerably smaller than that of the major current component. At the near-surface level, the range of magnitudes is typically -25 to 40 cm/s. The 27° rotation used to obtain major and minor components is optimized for the near-surface. At the near-bottom, this coordinate system is adequate and allows for easy comparisons with the other depths, but is not ideal, as indicated by the range of minor current components being larger for near-bottom levels than for the mid-depth level. Also, the range of the minor current components is noticeably asymmetrical for the near-surface and near-bottom measurement levels. The positive minor current component magnitude increases at near-surface levels in the summer to magnitudes of nearly 50 cm/s while the negative values remain little changed. The negative minor current component exhibits marked increases in Nov. and Dec. and also from May to August while the positive component changes comparatively little. The monthly compass plots in Appendix C.3 illustrate this seasonal variability.

Table 3-23: Statistics for the major and minor current components (27 degree rotation) for October 2004 through to March 2005.

Oct-04

	Depth	min (cm/s)	1% (cm/s)	5% (cm/s)	25% (cm/s)	50% (cm/s)	mean (cm/s)	75% (cm/s)	95% (cm/s)	99% (cm/s)	std dev (cm/s)	max (cm/s)	# pts
major component	near-surface	-106.16	-91.08	-71.68	-30.19	23.49	12.45	52.27	78.42	95.58	49.25	129.65	7032
	mid-depth	-106.71	-90.32	-73.47	-34.23	16.01	3.51	37.91	62.62	77.67	44.18	93.97	7032
	near-bottom	-101.10	-86.02	-71.37	-35.65	5.42	-3.27	26.13	52.70	62.64	38.93	81.19	6744
minor component	near-surface	-27.35	-13.85	-9.31	-2.60	2.26	2.44	7.70	14.06	18.24	7.23	26.22	7032
	mid-depth	-23.00	-11.69	-7.11	-0.41	4.89	4.62	9.89	15.98	19.27	7.14	25.95	7032
	near-bottom	-22.37	-13.39	-8.75	-1.46	4.02	4.94	11.38	20.25	25.14	8.91	31.15	6744

Nov-04

	Depth	min (cm/s)	1% (cm/s)	5% (cm/s)	25% (cm/s)	50% (cm/s)	mean (cm/s)	75% (cm/s)	95% (cm/s)	99% (cm/s)	std dev (cm/s)	max (cm/s)	# pts
major component	near-surface	-108.62	-91.04	-69.14	-21.75	30.36	17.10	56.14	77.14	93.05	47.84	111.03	8337
	mid-depth	-109.38	-88.31	-70.27	-26.99	21.14	7.03	40.67	59.26	72.43	42.31	91.59	8337
	near-bottom	-100.11	-80.55	-65.40	-30.85	8.33	-1.30	26.86	45.96	56.46	35.47	70.19	8337
minor component	near-surface	-19.55	-12.91	-8.70	-2.33	2.33	2.61	7.25	14.56	20.69	7.16	30.86	8337
	mid-depth	-25.16	-13.41	-7.25	-0.04	5.43	5.00	10.19	16.31	20.01	7.34	28.28	8337
	near-bottom	-39.95	-21.13	-13.10	-3.53	3.45	3.56	11.08	20.44	25.41	10.40	32.64	8337

Dec-04

	Depth	min (cm/s)	1% (cm/s)	5% (cm/s)	25% (cm/s)	50% (cm/s)	mean (cm/s)	75% (cm/s)	95% (cm/s)	99% (cm/s)	std dev (cm/s)	max (cm/s)	# pts
major component	near-surface	-91.43	-77.94	-59.64	-19.64	27.35	18.00	54.31	78.97	95.89	44.94	113.38	8928
	mid-depth	-94.31	-76.47	-62.63	-27.43	16.62	6.39	38.62	58.18	74.86	39.45	87.11	8928
	near-bottom	-83.53	-65.86	-57.39	-29.81	3.21	-2.41	23.51	43.33	58.94	32.53	77.22	8928
minor component	near-surface	-23.49	-13.48	-9.51	-2.81	1.42	1.80	6.26	13.79	20.75	7.12	28.24	8928
	mid-depth	-21.90	-12.08	-6.90	-1.14	3.72	3.79	8.57	15.14	19.10	6.83	26.24	8928
	near-bottom	-36.66	-20.40	-12.49	-3.51	3.24	3.24	9.84	19.71	26.35	9.90	34.06	8928

Jan-05

	Depth	min (cm/s)	1% (cm/s)	5% (cm/s)	25% (cm/s)	50% (cm/s)	mean (cm/s)	75% (cm/s)	95% (cm/s)	99% (cm/s)	std dev (cm/s)	max (cm/s)	# pts
major component	near-surface	-97.11	-72.30	-52.06	-15.90	10.38	10.73	39.40	68.97	84.33	36.50	96.75	8928
	mid-depth	-98.13	-74.68	-57.07	-25.23	6.16	2.62	31.99	51.23	64.09	34.52	82.78	8928
	near-bottom	-85.39	-68.21	-53.63	-28.61	-0.69	-4.13	19.49	38.78	55.83	29.80	73.40	8928
minor component	near-surface	-19.56	-14.07	-9.74	-2.82	1.51	1.33	5.45	12.18	18.47	6.64	29.84	8928
	mid-depth	-17.27	-12.03	-6.93	-1.39	2.51	2.67	6.36	13.52	18.46	6.11	24.15	8928
	near-bottom	-25.21	-14.59	-10.05	-3.16	2.05	2.97	8.90	17.72	25.13	8.65	36.23	8928

Feb-05

	Depth	min (cm/s)	1% (cm/s)	5% (cm/s)	25% (cm/s)	50% (cm/s)	mean (cm/s)	75% (cm/s)	95% (cm/s)	99% (cm/s)	std dev (cm/s)	max (cm/s)	# pts
major component	near-surface	-88.55	-73.39	-56.24	-22.58	8.21	7.49	39.68	65.78	77.31	38.10	88.72	8064
	mid-depth	-92.36	-76.93	-63.27	-33.29	4.88	-0.53	32.10	54.40	64.26	37.97	77.45	8064
	near-bottom	-91.89	-73.89	-61.05	-34.97	-1.59	-6.08	21.64	43.44	54.69	33.43	69.52	8064
minor component	near-surface	-18.95	-14.57	-10.82	-3.48	1.70	1.49	6.53	13.57	18.09	7.28	27.32	8064
	mid-depth	-12.97	-8.62	-5.65	-0.57	3.44	3.67	7.73	13.73	17.46	5.90	22.97	8064
	near-bottom	-18.76	-12.98	-9.86	-3.15	2.67	3.24	9.20	17.91	23.86	8.48	33.07	8064

Mar-05

	Depth	min (cm/s)	1% (cm/s)	5% (cm/s)	25% (cm/s)	50% (cm/s)	mean (cm/s)	75% (cm/s)	95% (cm/s)	99% (cm/s)	std dev (cm/s)	max (cm/s)	# pts
major component	near-surface	-99.09	-80.48	-61.64	-22.26	19.07	14.03	52.33	76.21	87.49	44.75	106.33	8928
	mid-depth	-101.26	-83.00	-65.45	-30.16	12.52	3.64	36.90	57.31	69.61	40.18	80.85	8928
	near-bottom	-85.55	-74.61	-61.48	-33.96	1.48	-4.22	23.39	46.90	57.54	34.53	64.32	8928
minor component	near-surface	-20.78	-14.20	-8.98	-3.21	1.46	1.91	6.54	14.53	20.14	7.26	31.02	8928
	mid-depth	-17.78	-11.46	-7.14	-1.29	3.40	3.74	8.63	15.59	20.75	7.05	28.00	8928
	near-bottom	-20.45	-15.52	-10.55	-3.23	2.86	3.46	9.68	18.91	24.87	9.05	31.70	8928

Table 3-24: Statistics for the current speeds for October 2004 through to March 2005.

Oct-04

Depth	min (cm/s)	50% (cm/s)	mean (cm/s)	75% (cm/s)	95% (cm/s)	99% (cm/s)	std (cm/s)	max (cm/s)	# valid pts
near-surface	0.22	45.78	45.75	62.82	84.54	99.80	23.36	129.75	7032
mid-depth	0.14	37.77	39.81	55.02	77.61	91.11	21.24	106.87	7032
near-bottom	0.25	31.27	34.40	50.00	72.85	86.02	21.13	101.13	6744

Nov-04

Depth	min (cm/s)	50% (cm/s)	mean (cm/s)	75% (cm/s)	95% (cm/s)	99% (cm/s)	std (cm/s)	max (cm/s)	# valid pts
near-surface	0.361	47.401	45.953	62.913	82.893	98.316	22.965	111.293	8337
mid-depth	0.2	38.144	39.246	51.681	73.752	89.178	19.449	109.602	8337
near-bottom	0.05	30.62	32.492	43.866	66.277	80.865	18.019	100.481	8337

Dec-04

Depth	min (cm/s)	50% (cm/s)	mean (cm/s)	75% (cm/s)	95% (cm/s)	99% (cm/s)	std (cm/s)	max (cm/s)	# valid pts
near-surface	0.52	43.37	43.33	59.79	81.05	96.60	22.81	114.12	8928
mid-depth	0.08	36.39	36.43	48.20	67.68	79.97	18.18	94.57	8928
near-bottom	0.16	28.38	30.06	41.97	59.89	68.17	16.39	83.81	8928

Jan-05

Depth	min (cm/s)	50% (cm/s)	mean (cm/s)	75% (cm/s)	95% (cm/s)	99% (cm/s)	std (cm/s)	max (cm/s)	# valid pts
near-surface	0.05	27.78	32.21	47.60	71.54	86.73	21.35	97.44	8928
mid-depth	0.35	29.80	30.71	41.24	61.98	77.23	17.33	98.48	8928
near-bottom	0.15	25.09	27.31	36.82	56.96	68.81	15.57	86.04	8928

Feb-05

Depth	min (cm/s)	50% (cm/s)	mean (cm/s)	75% (cm/s)	95% (cm/s)	99% (cm/s)	std (cm/s)	max (cm/s)	# valid pts
near-surface	0.23	31.94	34.08	48.97	69.56	80.55	20.03	89.85	8064
mid-depth	0.31	33.32	34.08	46.64	66.28	77.02	18.14	92.37	8064
near-bottom	0.23	29.23	30.66	42.69	62.05	74.11	17.22	92.42	8064

Mar-05

Depth	min (cm/s)	50% (cm/s)	mean (cm/s)	75% (cm/s)	95% (cm/s)	99% (cm/s)	std (cm/s)	max (cm/s)	# valid pts
near-surface	0.43	41.24	41.65	59.47	78.69	90.08	22.83	107.09	8928
mid-depth	0.31	35.31	36.48	49.89	69.72	83.21	18.98	101.33	8928
near-bottom	0.23	29.33	31.35	44.88	62.59	74.81	17.92	86.55	8928

Table 3-25: Statistics for the major and minor current components (27 degree rotation) for April through to September, 2005.

Apr-05

	Depth	min (cm/s)	1% (cm/s)	5% (cm/s)	25% (cm/s)	50% (cm/s)	mean (cm/s)	75% (cm/s)	95% (cm/s)	99% (cm/s)	std dev (cm/s)	max (cm/s)	# pts
major component	near-surface	-94.28	-84.17	-63.59	-20.44	26.48	17.43	55.03	80.12	96.59	46.35	112.14	8600
	mid-depth	-101.06	-86.36	-65.26	-24.85	16.77	5.96	36.59	59.87	71.62	39.73	84.27	8600
	near-bottom	-93.62	-76.22	-61.44	-27.41	3.11	-2.25	23.73	45.30	56.84	33.17	65.29	8600
minor component	near-surface	-26.03	-16.32	-11.20	-4.22	0.81	1.05	6.01	13.94	21.20	7.70	35.63	8600
	mid-depth	-22.34	-13.47	-8.29	-1.48	3.77	3.91	9.23	16.68	21.45	7.66	32.46	8600
	near-bottom	-25.79	-19.41	-11.70	-2.95	4.17	4.08	11.07	19.72	26.62	9.84	39.30	8600

May-05

	Depth	min (cm/s)	1% (cm/s)	5% (cm/s)	25% (cm/s)	50% (cm/s)	mean (cm/s)	75% (cm/s)	95% (cm/s)	99% (cm/s)	std dev (cm/s)	max (cm/s)	# pts
major component	near-surface	-120.09	-92.10	-69.46	-13.53	36.33	26.99	67.79	104.40	134.44	54.52	158.64	8928
	mid-depth	-110.46	-89.76	-69.56	-24.91	20.09	7.97	40.06	61.60	81.35	42.16	107.31	8928
	near-bottom	-88.87	-73.82	-59.87	-27.07	1.07	-3.61	22.20	39.98	48.50	31.49	77.96	8928
minor component	near-surface	-28.46	-16.56	-10.86	-2.52	3.19	4.02	9.88	21.50	30.59	9.80	45.40	8928
	mid-depth	-26.92	-12.66	-8.75	-2.16	3.23	3.67	9.17	17.56	22.96	8.01	31.17	8928
	near-bottom	-39.16	-22.58	-16.11	-5.32	2.86	2.63	10.48	20.80	27.70	11.18	39.60	8928

Jun-05

	Depth	min (cm/s)	1% (cm/s)	5% (cm/s)	25% (cm/s)	50% (cm/s)	mean (cm/s)	75% (cm/s)	95% (cm/s)	99% (cm/s)	std dev (cm/s)	max (cm/s)	# pts
major component	near-surface	-130.38	-96.41	-74.26	-9.26	41.88	29.01	69.34	99.56	120.82	53.52	142.08	8640
	mid-depth	-120.64	-94.11	-75.15	-24.01	24.62	9.41	42.11	61.81	77.19	43.36	89.91	8640
	near-bottom	-90.67	-77.54	-63.03	-29.62	4.31	-2.64	23.53	41.59	52.25	33.25	67.08	8640
minor component	near-surface	-29.67	-14.64	-10.58	-3.66	2.33	3.19	8.84	20.81	28.92	9.50	38.21	8640
	mid-depth	-19.30	-11.27	-6.50	-0.50	4.52	4.92	10.02	17.82	22.32	7.45	31.49	8640
	near-bottom	-32.78	-22.83	-15.22	-5.39	2.95	2.69	10.48	21.48	28.96	11.29	40.19	8640

Jul-05

	Depth	min (cm/s)	1% (cm/s)	5% (cm/s)	25% (cm/s)	50% (cm/s)	mean (cm/s)	75% (cm/s)	95% (cm/s)	99% (cm/s)	std dev (cm/s)	max (cm/s)	# pts
major component	near-surface	-104.87	-87.77	-63.11	-5.48	40.02	28.90	66.15	95.57	119.38	49.53	146.04	8690
	mid-depth	-109.81	-85.40	-66.65	-19.92	25.02	11.71	42.51	63.47	85.95	41.55	108.32	8690
	near-bottom	-88.43	-69.79	-57.92	-24.30	5.22	-0.91	23.19	42.00	52.45	31.12	63.63	8690
minor component	near-surface	-24.62	-15.32	-10.80	-4.00	1.91	3.15	9.33	21.24	31.53	9.93	46.70	8690
	mid-depth	-21.92	-11.34	-6.52	-0.64	4.96	4.94	10.19	16.83	21.36	7.31	35.51	8690
	near-bottom	-34.30	-22.58	-14.96	-4.57	2.88	2.74	10.23	20.49	25.85	10.79	35.07	8690

Aug-05

	Depth	min (cm/s)	1% (cm/s)	5% (cm/s)	25% (cm/s)	50% (cm/s)	mean (cm/s)	75% (cm/s)	95% (cm/s)	99% (cm/s)	std dev (cm/s)	max (cm/s)	# pts
major component	near-surface	-104.48	-87.81	-67.19	-14.31	36.25	22.01	59.87	83.19	101.88	48.32	125.81	8928
	mid-depth	-105.90	-86.21	-69.43	-20.19	25.78	12.33	45.06	66.27	81.68	42.97	102.31	8928
	near-bottom	-87.15	-69.07	-57.67	-27.11	2.18	-1.87	23.39	44.14	58.42	32.03	66.38	8928
minor component	near-surface	-21.93	-16.99	-12.39	-4.94	0.70	1.01	6.56	15.27	21.75	8.46	49.56	8928
	mid-depth	-19.79	-11.34	-7.72	-1.30	3.70	3.64	8.44	14.85	19.42	6.89	27.08	8928
	near-bottom	-42.99	-23.06	-15.25	-3.67	3.74	3.52	11.51	20.78	25.86	10.94	35.28	8928

Sep-05

	Depth	min (cm/s)	1% (cm/s)	5% (cm/s)	25% (cm/s)	50% (cm/s)	mean (cm/s)	75% (cm/s)	95% (cm/s)	99% (cm/s)	std dev (cm/s)	max (cm/s)	# pts
major component	near-surface	-109.74	-92.18	-70.47	-18.86	31.96	18.97	58.87	82.78	106.24	49.78	126.04	8640
	mid-depth	-105.24	-87.73	-70.81	-24.88	22.89	9.84	44.55	67.81	81.74	44.56	100.60	8640
	near-bottom	-82.13	-71.00	-59.57	-30.29	-0.54	-4.34	20.75	46.16	57.03	32.88	64.84	8640
minor component	near-surface	-21.87	-17.90	-12.70	-4.85	1.03	1.20	7.12	15.55	21.64	8.61	33.11	8640
	mid-depth	-20.82	-12.12	-7.95	-1.49	3.65	3.74	9.03	15.59	19.60	7.25	28.35	8640
	near-bottom	-33.29	-22.08	-14.66	-3.80	4.07	3.77	11.80	20.82	26.30	10.85	34.40	8640

Table 3-26: Statistics for the current speeds for April through to September, 2005.

Apr-05

Depth	min (cm/s)	50% (cm/s)	mean (cm/s)	75% (cm/s)	95% (cm/s)	99% (cm/s)	std (cm/s)	max (cm/s)	# valid pts
near-surface	0.26	43.85	44.11	62.11	83.48	97.39	23.79	113.05	8600
mid-depth	0.37	34.40	36.28	49.21	70.76	86.39	19.28	101.17	8600
near-bottom	0.39	27.27	29.90	42.02	63.18	76.74	18.02	93.67	8600

May-05

Depth	min (cm/s)	50% (cm/s)	mean (cm/s)	75% (cm/s)	95% (cm/s)	99% (cm/s)	std (cm/s)	max (cm/s)	# valid pts
near-surface	0.45	52.07	53.78	74.65	105.79	135.85	30.34	159.09	8928
mid-depth	0.41	37.10	38.80	51.95	76.36	92.24	20.32	111.28	8928
near-bottom	0.13	27.19	29.21	39.72	60.86	74.84	16.84	91.04	8928

Jun-05

Depth	min (cm/s)	50% (cm/s)	mean (cm/s)	75% (cm/s)	95% (cm/s)	99% (cm/s)	std (cm/s)	max (cm/s)	# valid pts
near-surface	0.43	54.64	54.55	74.92	102.60	122.37	28.81	142.33	8640
mid-depth	0.59	39.26	40.47	52.13	78.76	94.13	20.25	120.73	8640
near-bottom	0.09	29.05	30.87	41.11	63.88	77.76	17.15	90.67	8640

Jul-05

Depth	min (cm/s)	50% (cm/s)	mean (cm/s)	75% (cm/s)	95% (cm/s)	99% (cm/s)	std (cm/s)	max (cm/s)	# valid pts
near-surface	0.33	51.61	51.36	70.26	97.23	121.42	27.53	149.61	8690
mid-depth	0.22	38.87	39.48	50.53	75.14	95.13	19.56	109.85	8690
near-bottom	0.21	27.00	28.80	39.74	58.93	70.06	16.24	88.57	8690

Aug-05

Depth	min (cm/s)	50% (cm/s)	mean (cm/s)	75% (cm/s)	95% (cm/s)	99% (cm/s)	std (cm/s)	max (cm/s)	# valid pts
near-surface	0.43	49.34	48.18	65.28	87.12	102.62	23.87	125.86	8928
mid-depth	0.19	40.07	40.69	54.40	76.48	89.81	20.09	107.48	8928
near-bottom	0.28	27.94	29.69	41.32	60.30	70.26	16.73	87.24	8928

Sep-05

Depth	min (cm/s)	50% (cm/s)	mean (cm/s)	75% (cm/s)	95% (cm/s)	99% (cm/s)	std (cm/s)	max (cm/s)	# valid pts
near-surface	0.19	48.64	47.92	66.12	88.74	107.13	24.82	126.04	8640
mid-depth	0.12	40.27	41.29	56.37	77.42	91.52	21.06	106.08	8640
near-bottom	0.53	27.75	30.49	43.13	61.58	71.68	17.38	82.72	8640

3.4.2 Time Series Plots

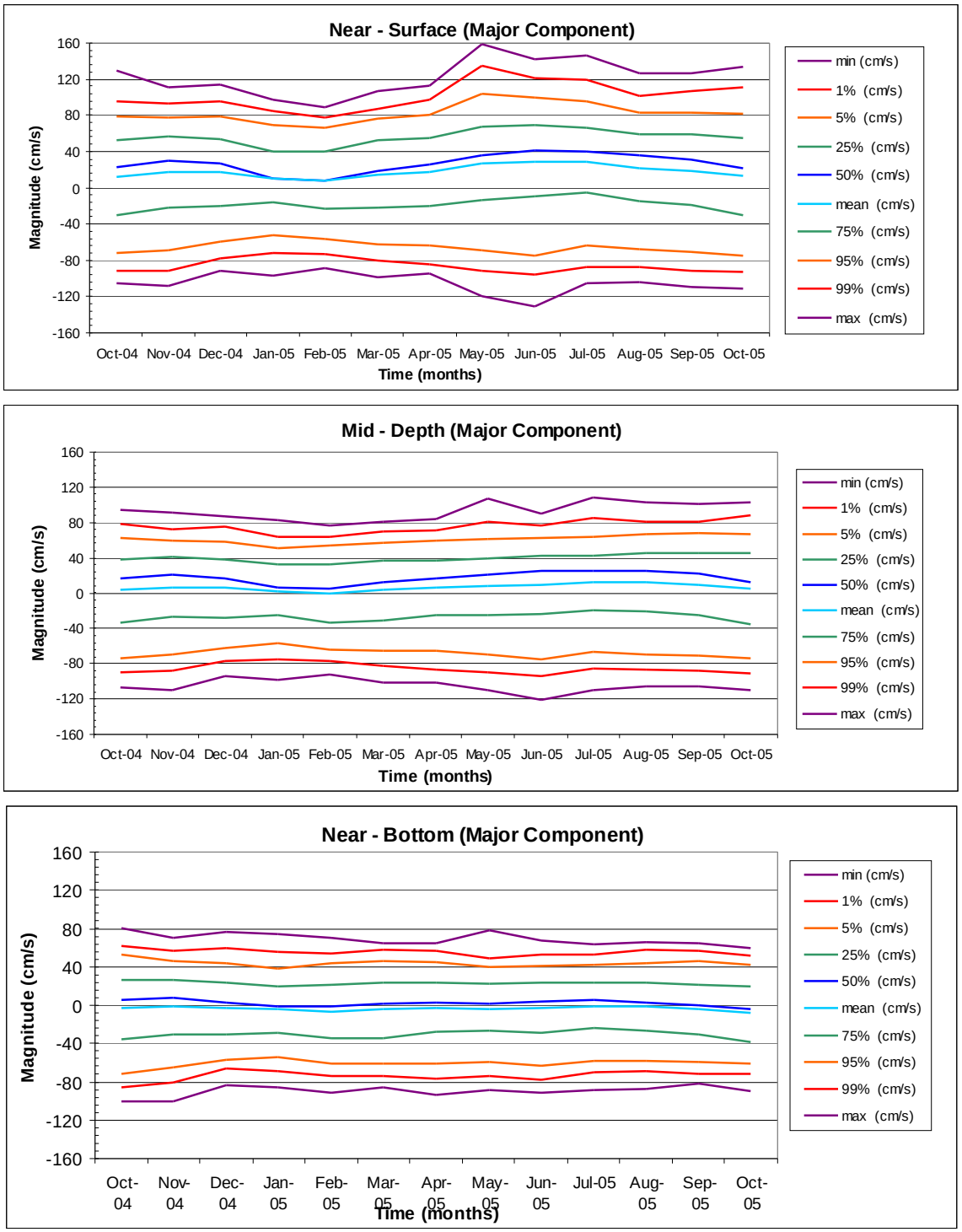


Figure 3-8: Time series of the monthly statistics for the major current component (27 degree rotation).

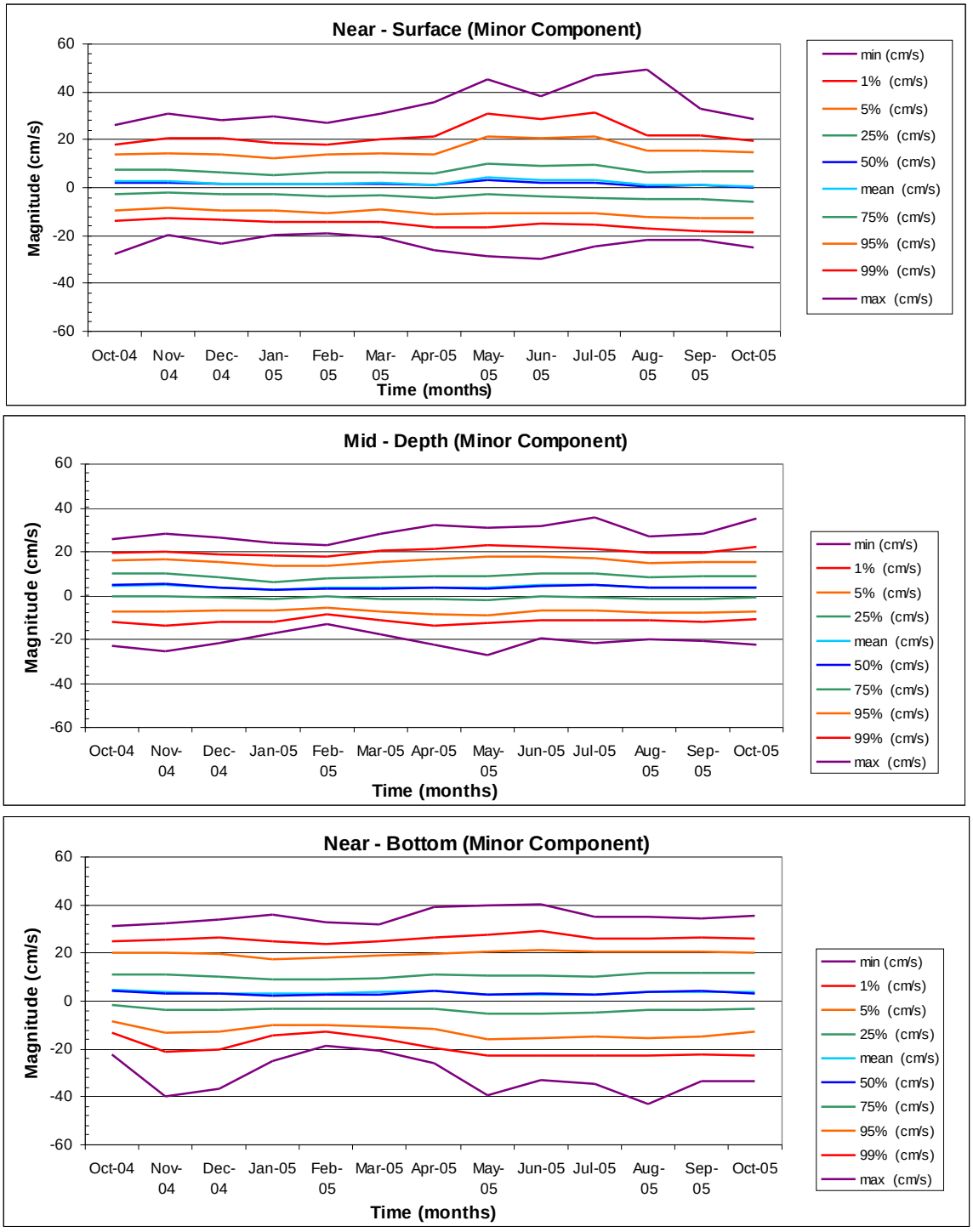
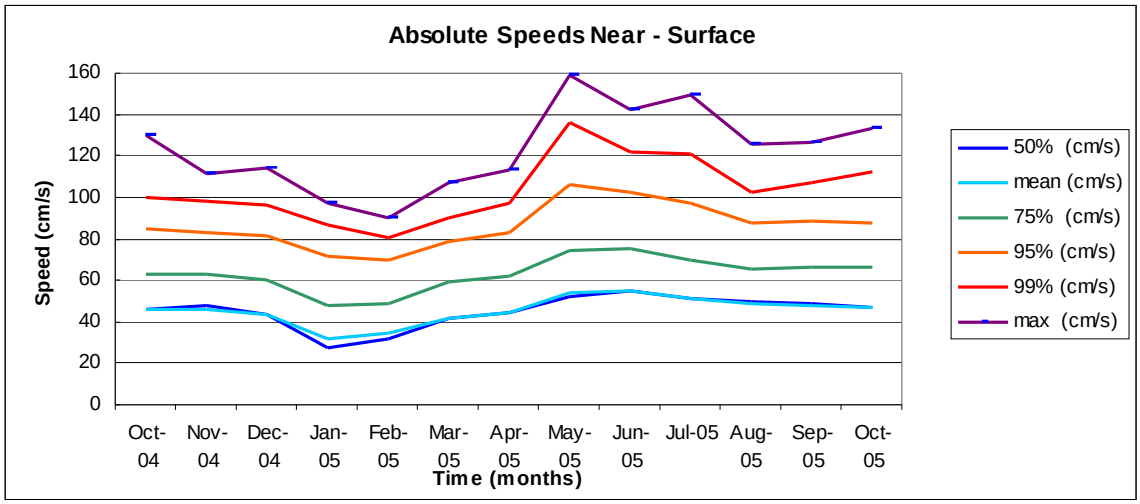
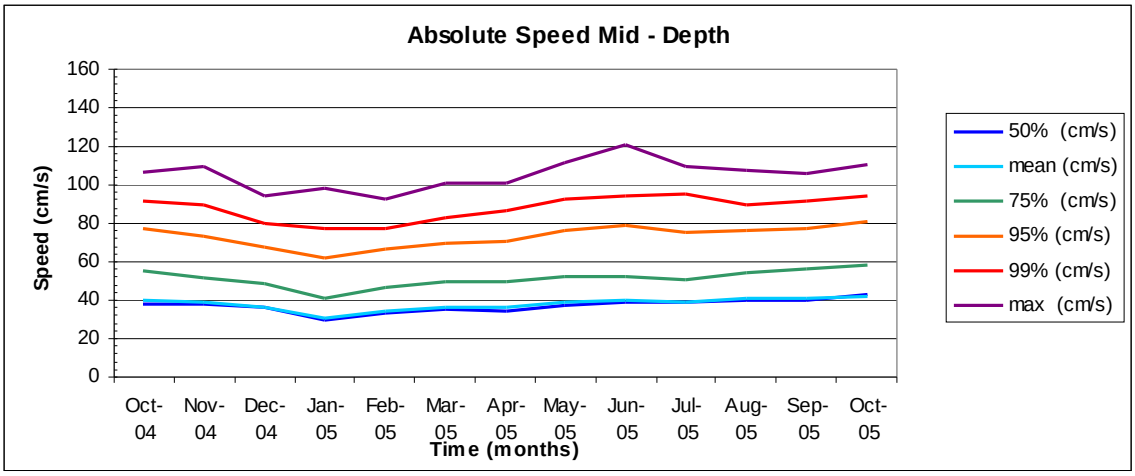


Figure 3-9: Time series of the monthly statistics for the minor current component (27 degree rotation).





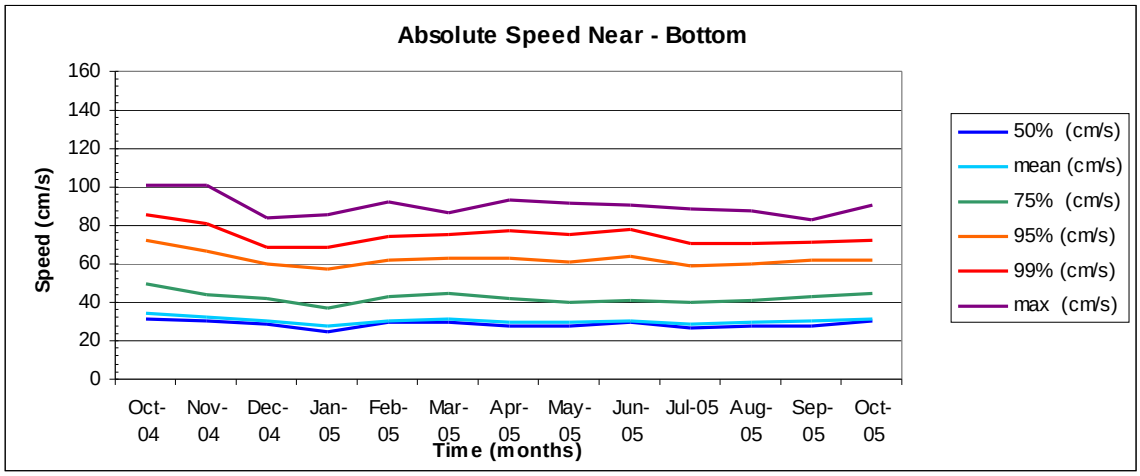


Figure 3-10: Time series of the monthly statistics for the current speeds.

3.5 Tidal and Residual Currents

3.5.1 Tidal Constituents

For the near bottom, mid-depth, and near surface water column bins, the tidal currents have been analyzed for each deployment using Foreman's tidal analysis and prediction package (Foreman, 1977). The near-surface tidal constituents are given in Table 3-27 for the July to October, 2005 deployment.

The tidal currents are dominated by the semi-diurnal tidal constituents, largely the M2, followed by the S2 constituent. Examination of the amplitude and phase for each of the 4 deployment periods, Table 3-28 and Figure 3-11 shows that the combined major semi-diurnal tidal constituents (M2 & S2) exhibit large variability in amplitudes of up to 30% with the time of year. However the variations in the phase angle are much smaller at only a few degrees. Large variations are also found in the diurnal tidal constituents, but this may also be related to the reduced signal levels. The major semi-diurnal tidal current amplitudes are reduced in winter and early spring and, at near-surface levels, larger in spring to early summer. The seasonal pattern is different at the mid-depth and near-bottom levels where the smaller tidal amplitudes occur through winter and spring.

The large variations of the major tidal constituent amplitudes between instrument deployments indicates that tidal analyses and predictions should be done in a piece-wise fashion over the year to provide accurate prediction of tidal currents for future and past times.

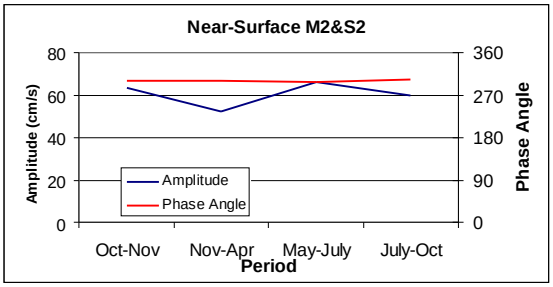
Table 3-27: Tidal constituents, in units of cm/s, for the near surface (3 m depth LLW). Inferred constituents not shown since the inference values used are only a first estimate.

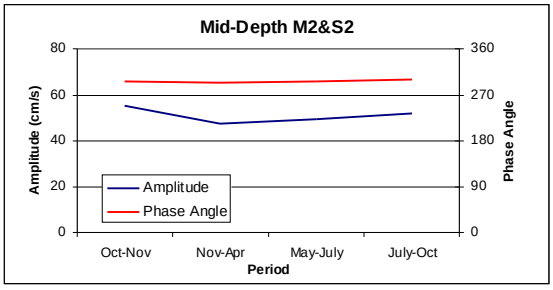
FOR STATION 2005, GrosCac ,AT THE LOCATION 47 56, -69 31
OVER THE PERIOD OF 15HR 29/ 7/ 5 TO 9HR 13/10/ 5
AMPLITUDES HAVE BEEN SCALED: ORIGINAL DT= .00000 HR FILTERS = 6 6 7
GREENWICH PHASES ARE FOR TIME ZONE GMT

	NAME	SPEED	MAJOR	MINOR	INC	G	G+	G-
1	Z0	0	19.46	0	60	360	300	60
2	MM	0.001512	2.781	0.209	64.8	167	102.2	231.8
3	MSF	0.002822	7.423	-0.464	66.2	254.8	188.6	321
4	ALP1	0.034397	1.588	-0.018	58.9	277	218	335.9
5	2Q1	0.035706	1.468	0.092	69.7	97.7	28	167.4
6	Q1	0.037219	3.157	0.13	64.1	205.1	140.9	269.2
7	O1	0.038731	2.739	0.025	74.7	207.6	132.9	282.4
8	NO1	0.040269	1.343	0.56	57.5	240.6	183	298.1
9	K1	0.041781	4.148	-0.049	68.8	248.3	179.4	317.1
10	J1	0.043293	1.349	0.162	55	132.4	77.4	187.4
11	OO1	0.044831	0.431	-0.128	22.1	127.4	105.3	149.5
12	UPS1	0.046343	0.888	0.079	75.1	62.2	347.2	137.3
13	EPS2	0.076177	1.484	-0.558	92.5	245	152.5	337.4
14	MU2	0.077689	5.892	-0.046	68	10.7	302.7	78.7
15	N2	0.078999	12.783	-0.498	73	159.3	86.4	232.3
16	M2	0.080511	57.338	-1.599	69.1	183.1	114	252.1
17	L2	0.082024	6.827	-1.233	56.6	256.4	199.7	313
18	S2	0.083333	19.757	0.759	67.5	212.8	145.2	280.3
19	ETA2	0.085074	3.773	-0.257	69.2	17.9	308.8	87.1
20	MO3	0.119242	0.886	0.149	23.6	72.7	49.1	96.3
21	M3	0.120767	0.466	0.294	38.2	356.5	318.3	34.7
22	MK3	0.122292	0.44	0.019	20.1	187.1	166.9	207.2
23	SK3	0.125114	0.901	-0.122	103.1	27.3	284.2	130.4
24	MN4	0.159511	5.262	-0.074	59.7	178.8	119.1	238.5
25	M4	0.161023	11.46	0.357	62.5	188.1	125.6	250.6
26	SN4	0.162333	3.69	0.773	59	326.2	267.1	25.2
27	MS4	0.163845	4.13	0.413	69.7	227.3	157.6	297.1
28	S4	0.166667	0.491	0.144	22.4	1.2	338.8	23.6
29	2MK5	0.202804	0.883	-0.204	80.6	150	69.4	230.7
30	2SK5	0.208447	0.349	0.022	16.7	72.6	55.9	89.3
31	2MN6	0.240022	1.194	-0.384	59.4	175.2	115.7	234.6
32	M6	0.241534	1.6	-0.433	81.8	110.5	28.7	192.2
33	2MS6	0.244356	2.158	-0.111	60.9	167.2	106.3	228.1
34	2SM6	0.247178	0.765	0.284	104.5	203	98.6	307.5
35	3MK7	0.283315	0.357	0.007	14.8	95.2	80.4	110
36	M8	0.322046	0.173	0.037	83.7	142.2	58.5	225.9
37	M10	0.402557	0.294	0.219	49.8	85.2	35.3	135

Table 3-28: Amplitudes (cm/s) and phases for the M2, S2, K1, and O1 tidal constituents for each of the 4 deployment periods.

Near-Surface	Amplitudes				Phases			
Time Interval	M2	S2	K1	O1	M2	S2	K1	O1
Oct-Nov, 2004	61.12	16.66	5.87	2.44	298.8	320.7	322.8	305.4
Nov-Apr	50.45	12.99	3.16	3.21	297.0	333.5	326.3	294.4
May-July	64.08	15.96	6.53	5.57	296.3	315.7	271.8	247.7
July-Oct	57.30	17.00	4.69	2.75	299.0	328.6	303.5	264.3
Mid-depth	Amplitudes				Phases			
Time Interval	M2	S2	K1	O1	M2	S2	K1	O1
Oct-Nov, 2004	53.42	14.86	4.31	2.67	294.5	318.1	324.7	280.7
Nov-Apr	46.02	11.78	2.40	2.57	292.1	329.2	313.3	286.0
May-July	47.61	12.75	4.37	4.87	293.7	319.2	272.6	240.0
July-Oct	49.59	15.62	4.86	2.20	296.8	329.2	301.3	263.7
Near-Bottom	Amplitudes				Phases			
Time Interval	M2	S2	K1	O1	M2	S2	K1	O1
Oct-Nov, 2004	46.58	12.07	2.91	1.89	285.1	313.9	315.3	267.2
Nov-Apr	39.05	9.62	1.87	1.89	280.2	321.6	301.4	276.1
May-July	35.17	8.76	3.12	3.26	273.9	321.0	262.6	226.5
July-Oct	39.89	10.51	2.53	1.20	276.5	321.9	293.5	245.4





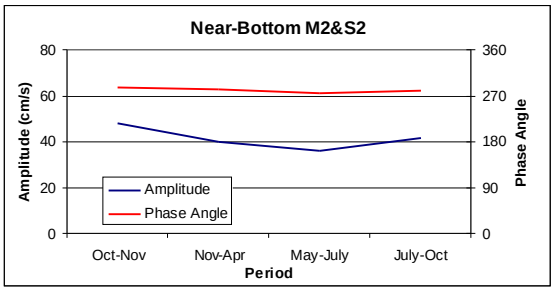


Figure 3-11: Seasonal variability of the amplitude and phase angle of the combined M2 and S2 tidal constituents. (Looks to me like it is only M2, NOT combined M2 & S2)

3.5.2 Residual Current Statistics and Time Series Plots

Following the tidal analysis, the detided currents were obtained by subtracting the predicted tidal currents from the measured near-surface currents. A low pass digital filter (3-pass moving average) was applied to remove the remaining tidal variations, and this gave the residual currents. The coordinate system was rotated by 27 degrees so that the major component was oriented towards 31° true. Plots of the major and minor residual current components are illustrated in Figure 3-16 through Figure 3-18. The predominantly positive major residual currents indicate down-river flow, consistent with estuarine down-stream net flow at the surface. The variability in the residual currents consists of fluctuations over periods of a few to several days with typical amplitudes of 10 – 20 cm/s and a longer period quasi-seasonal variation with typical amplitudes of 20 cm/s.

The seasonal and monthly residual current statistics are tabulated in Table 3-29 and Table 3-30 respectively. Figure 3-15 illustrates the monthly major residual current statistics. The maximum residual currents are in June (28, 42 [mean/max cm/s]), though a smaller local minimum is found in December (18, 31 [mean/max cm/s]). In January, February, and March, negative major residual currents are observed, but the means are still positive (down-river) in these months.

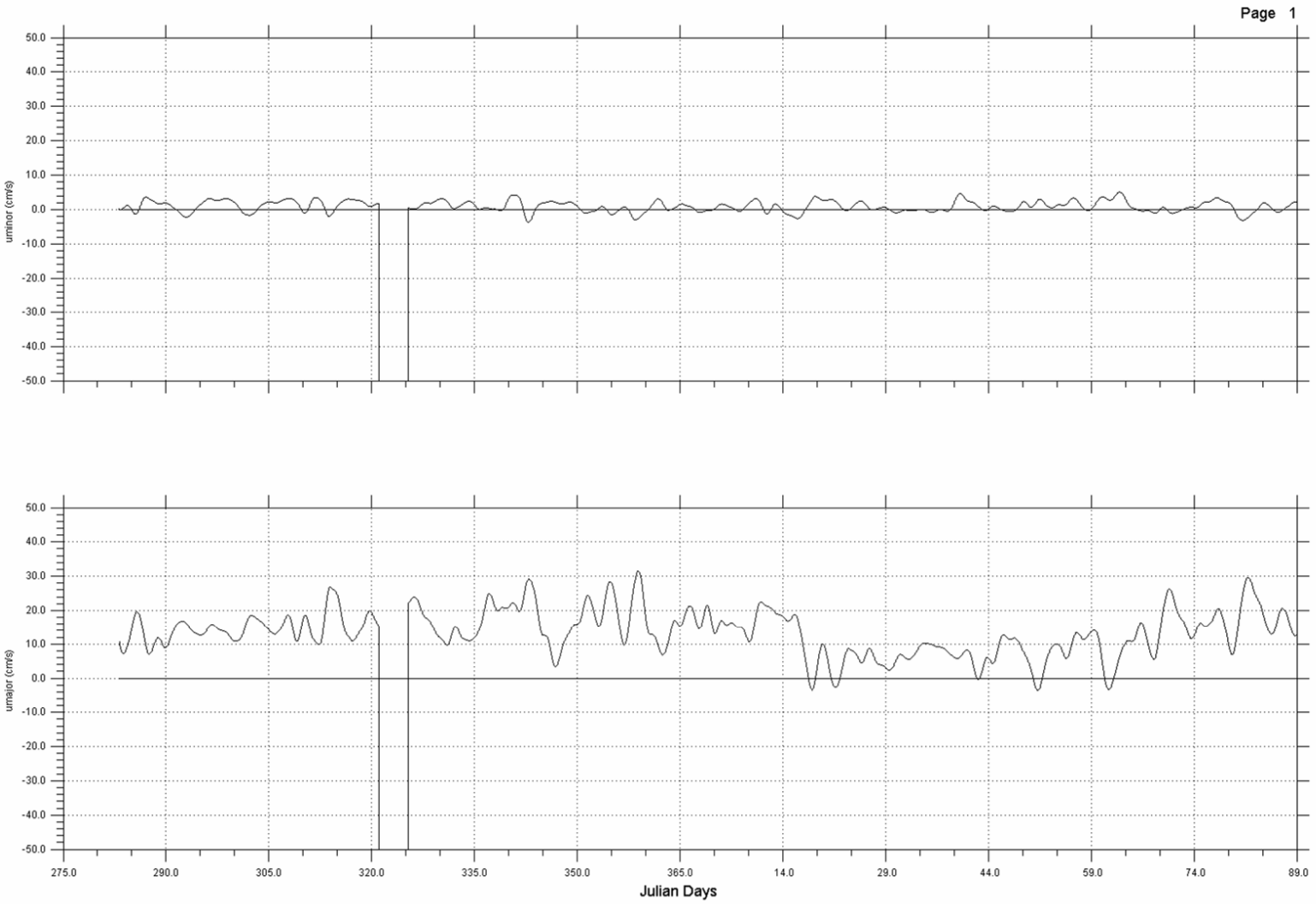


Figure 3-12: Time series plot of the minor (top) and major (bottom) components of the near-surface residual currents.

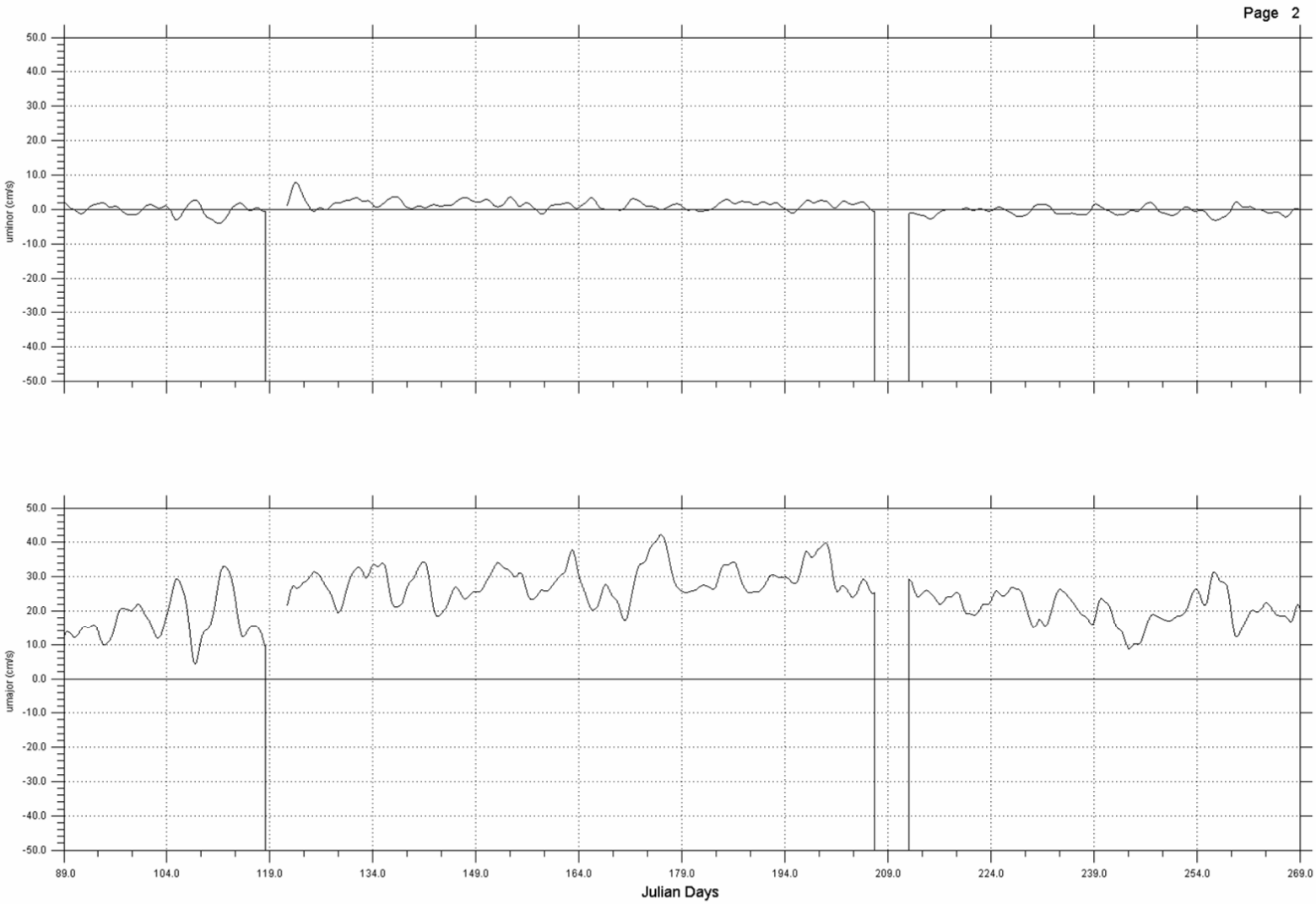


Figure 3-13: Time series plot of the minor (top) and major (bottom) components of the near-surface residual currents.

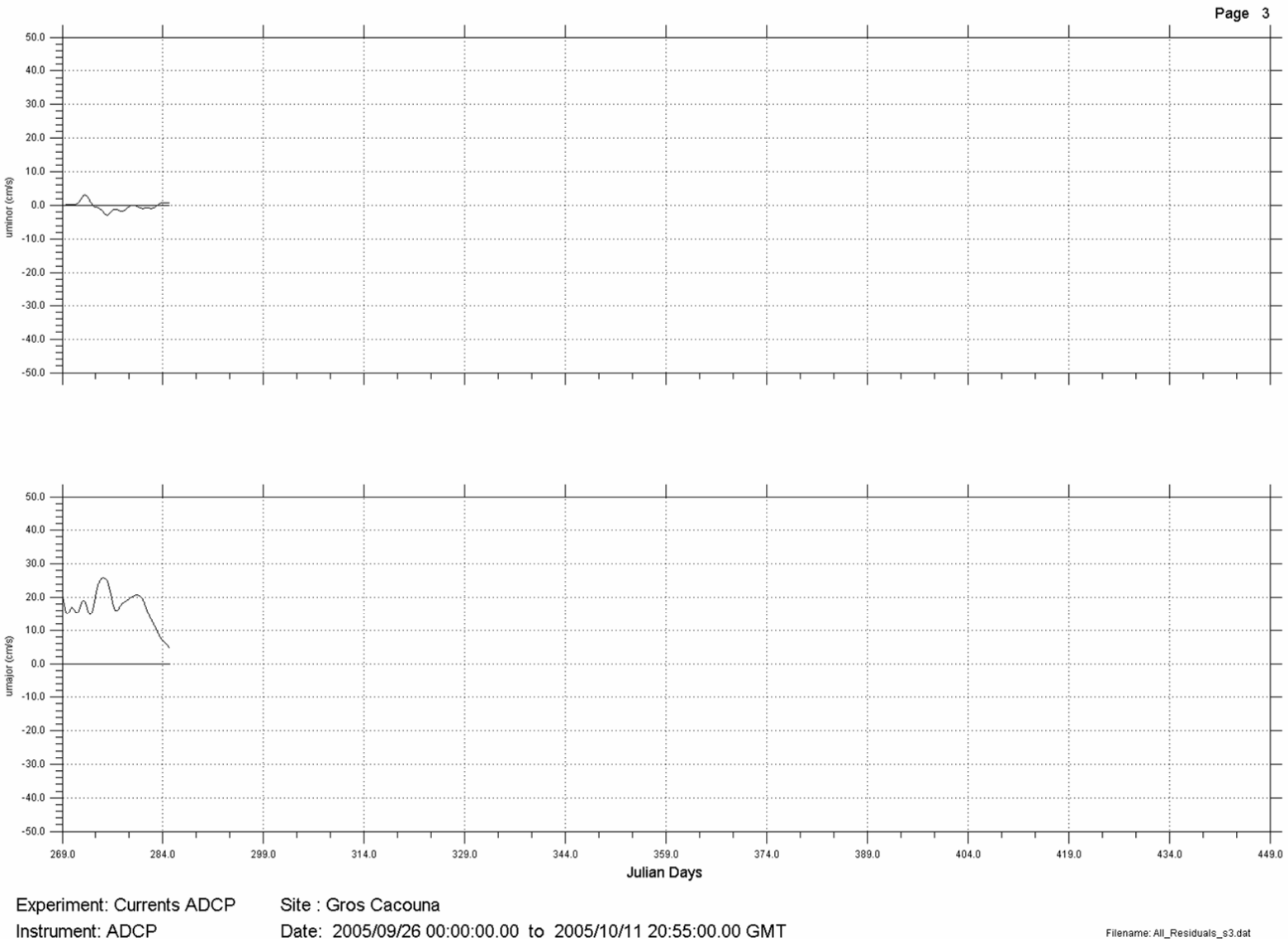


Figure 3-14: Time series plot of the minor (top) and major (bottom) components of the near-surface residual currents.

Table 3-29: Seasonal statistics for the major and minor residual near-surface current components.

cm/s	min	1%	5%	25%	50%	mean	75%	95%	99%	std	max	# valid	total #
	10/09/2004 3:55 to 12/31/2004 23:55												
uminor	-1.65	-1.05	-0.28	1.20	2.32	2.20	3.20	4.21	5.65	1.41	5.75	22942	24144
umajor	3.15	4.70	8.09	11.96	15.15	15.90	19.43	26.41	29.57	5.43	31.72	22942	24144
	1/1/2005 0:00 to 3/31/2005 23:55												
uminor	-1.42	-1.31	-0.45	0.58	1.36	1.61	2.64	4.18	5.08	1.41	5.56	25919	25919
umajor	-3.86	-3.36	-0.71	6.28	10.86	11.11	15.86	22.21	28.19	6.84	29.75	25919	25919
	4/1/2005 0:00 to 6/30/2005 23:55												
uminor	-2.06	-1.79	-0.13	1.80	2.90	2.83	3.88	5.24	8.70	1.80	9.82	25272	26207
umajor	4.12	7.15	12.23	20.16	25.61	24.71	30.07	34.85	41.08	7.27	42.10	25272	26207
	7/1/2005 0:00 to 10/11/2005 20:55												
uminor	-1.11	-0.86	-0.52	0.47	1.44	1.67	2.60	4.54	5.33	1.57	5.41	28188	29628
umajor	4.81	7.09	11.90	18.15	22.29	22.42	26.27	33.64	38.37	6.37	39.52	28188	29628

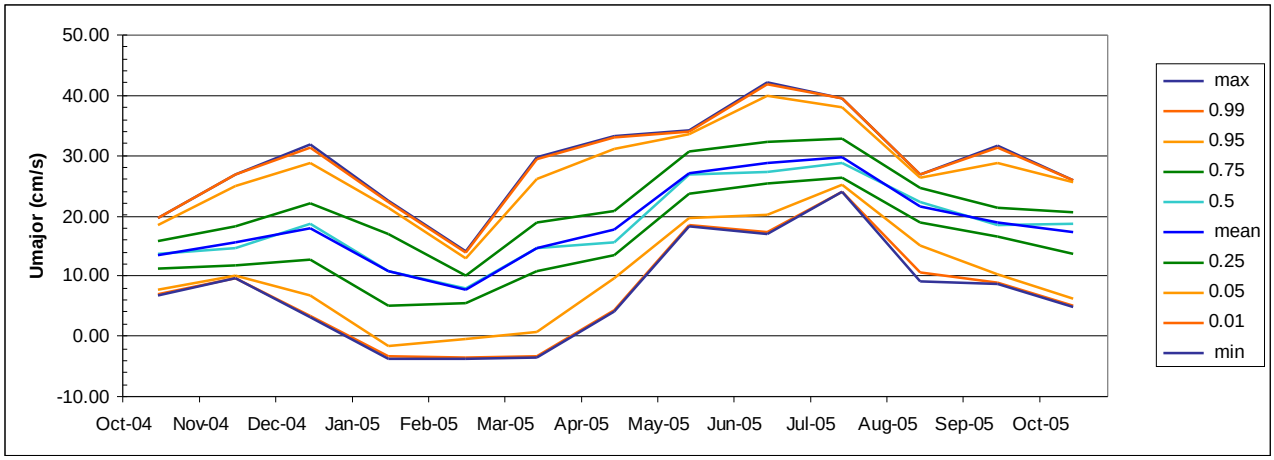


Figure 3-15: Time series of the monthly major residual near-surface current statistics.

Table 3-30: Monthly statistics for the near-surface major and minor residual current components.

cm/s	min	1%	5%	25%	50%	mean	75%	95%	99%	std	max	# valid	total #
	10/09/2004 03:55 to 10/31/2004 23:55												
uminor	-1.06	-1.04	-0.50	0.73	2.38	2.04	3.28	4.19	4.29	1.54	4.31	6577	6577
umajor	6.75	6.87	7.66	11.19	13.58	13.45	15.71	18.50	19.55	3.13	19.67	6577	6577
	11/1/2004 0:00 to 11/30/2004 23:55												
uminor	-0.13	-0.05	0.58	1.99	2.95	2.74	3.63	4.20	4.48	1.07	4.50	7438	8640
umajor	9.54	9.58	10.11	11.74	14.62	15.59	18.25	24.88	26.74	4.54	26.90	7438	8640
	12/1/2004 0:00 to 12/31/2004 23:55												
uminor	-1.65	-1.50	-0.57	0.93	1.84	1.86	2.67	4.87	5.73	1.42	5.75	8928	8928
umajor	3.15	3.43	6.80	12.83	18.71	17.97	22.06	28.67	31.37	6.53	31.72	8928	8928
	1/1/2005 0:00 to 1/31/2005 23:55												
uminor	-1.38	-1.33	-0.59	0.44	1.18	1.41	2.51	3.81	4.48	1.35	4.56	8927	8927
umajor	-3.68	-3.25	-1.72	5.06	10.80	10.86	16.97	21.28	22.27	7.10	22.39	8927	8927
	2/1/2005 0:00 to 2/28/2005 23:55												
uminor	-0.06	-0.04	0.11	0.50	1.20	1.52	2.28	4.13	5.03	1.25	5.10	8064	8064
umajor	-3.86	-3.64	-0.49	5.59	8.02	7.58	10.18	13.04	13.93	3.96	14.02	8064	8064
	3/1/2005 0:00 to 3/31/2005 23:55												
uminor	-1.42	-1.38	-0.58	0.78	1.61	1.89	3.05	4.73	5.48	1.55	5.56	8928	8928
umajor	-3.44	-3.25	0.67	10.86	14.55	14.53	18.85	26.19	29.52	6.95	29.75	8928	8928
	4/1/2005 0:00 to 4/30/2005 23:55												
uminor	-2.06	-2.03	-1.55	0.18	1.47	1.17	2.31	2.91	3.09	1.35	3.12	7860	8639
umajor	4.12	4.45	9.69	13.42	15.54	17.77	20.90	31.03	33.09	6.49	33.19	7860	8639
	5/1/2005 0:00 to 5/31/2005 23:55												
uminor	1.76	1.82	2.14	2.92	3.90	4.03	4.85	6.90	9.68	1.53	9.82	8773	8928
umajor	18.29	18.38	19.56	23.78	26.75	27.00	30.70	33.41	34.06	4.29	34.15	8773	8928
	6/1/2005 0:00 to 6/30/2005 23:55												
uminor	0.55	0.60	1.29	2.08	3.30	3.13	3.79	5.12	5.77	1.18	5.83	8640	8640
umajor	17.07	17.25	20.09	25.29	27.38	28.69	32.38	39.89	41.98	5.71	42.10	8640	8640
	7/1/2005 0:00 to 7/31/2005 23:55												
uminor	0.69	0.96	1.08	2.61	3.79	3.51	4.34	5.28	5.39	1.24	5.41	7487	8927
umajor	23.84	23.92	25.09	26.43	28.63	29.64	32.69	37.96	39.38	4.09	39.52	7487	8927
	8/1/2005 0:00 to 8/31/2005 23:55												
uminor	-0.84	-0.80	-0.53	0.16	1.15	1.03	1.75	2.57	2.94	0.99	2.98	8928	8928
umajor	9.08	10.52	15.04	18.82	22.27	21.47	24.65	26.25	26.83	3.86	26.91	8928	8928
	9/1/2005 0:00 to 9/30/2005 23:55												
uminor	-0.90	-0.87	-0.68	0.31	1.29	1.18	1.85	3.27	4.29	1.16	4.40	8640	8640
umajor	8.73	8.90	10.21	16.63	18.56	19.03	21.40	28.74	31.26	4.82	31.50	8640	8640
	10/1/2005 0:00 to 10/11/2005 20:55												
uminor	-1.11	-1.10	-0.92	-0.07	0.43	0.41	1.03	1.44	1.52	0.71	1.53	3132	3132
umajor	4.81	5.14	6.29	13.60	18.58	17.24	20.59	25.72	25.86	5.78	25.87	3132	3132

3.5.3 Residual Currents in Response to Wind Forcing

Wind measurements were obtained at nearby sites on shore. The first meteorological station (Cacouna1) was started on December 22, 2004, but valid wind measurements did not begin until December 30, 2004. In March, a second anemometer (Cacouna2) was located on the order of 100 m inshore of the original meteorological station, which had been found to somewhat overestimate the winds due to the proximity to a breakwater. The inland measurements were collected at 47° 56.12' N, 69° 30.93' W. This second set of measurements started on May 9, 2005. Environment Canada maintains a meteorological station on Île-Rouge about 8 nautical miles to the north-north-east at 48° 4'N, 69° 33'W.

The winds at Gros Cacouna and Île-Rouge were rotated into the same frame of reference as the major residual currents (31° E), and were reversed into directions to which the wind is blowing instead of the direction from which the wind is blowing. The resulting time series of "major wind" component was then overlain on the major residual current component. Generally the response to the winds was very weak, even when the wind major component reached speeds of 15 to 20 m/s, depending on the meteorological station (Figure 3-16). Marginal correlations were found in January and March, as illustrated in Figure 3-17 and Figure 3-18. For example, on January 1 the Cacouna1 major winds reach about -10 m/s, and the residual currents reach a local minimum. The major winds then reverse direction and reach 5-10 m/s, and the residual currents reach a local maximum, before returning to a local minimum on the 3rd when the Cacouna major winds reach -10 m/s. The residual currents also follow the trend of the winds from January 17 to 22.

Overall, the response of near-surface residual currents to direct wind forcing appears to be weak and marginal in terms of possible correlations. Most of the variability in the residual near-surface currents apparently results from processes other than a direct linear response to wind forcing, such as variations in the St. Lawrence River discharge values.

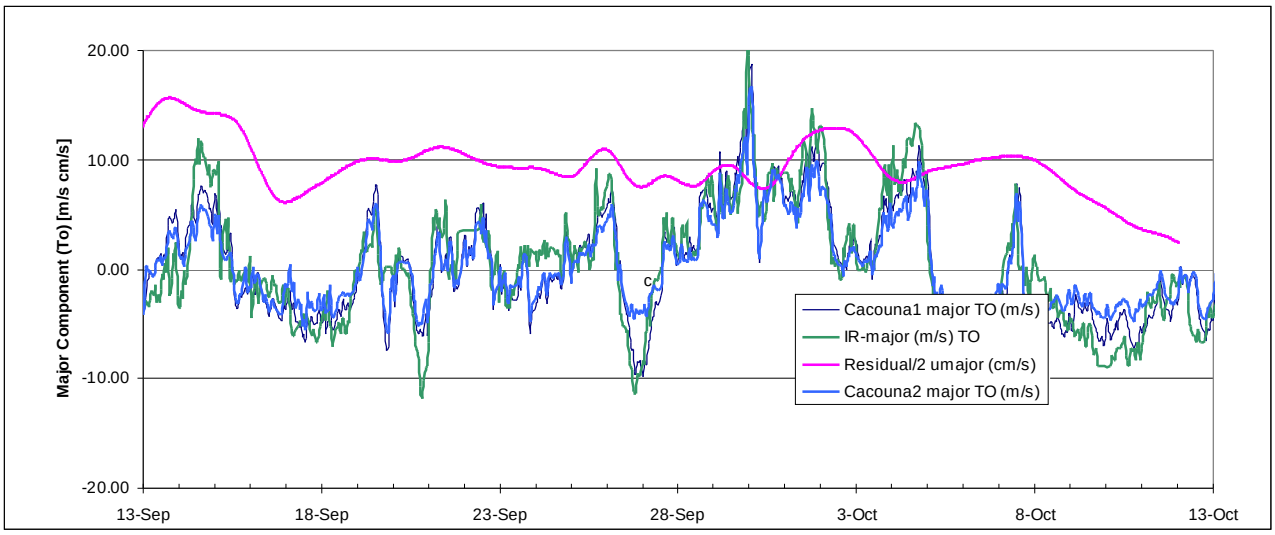


Figure 3-16: The major component of the residual currents scaled by 0.5 (purple), and the major component of the measured winds at Cacouna1 (black), Cacouna2 (blue), and Île-Rouge (green) between September 13 and October 13, 2005.

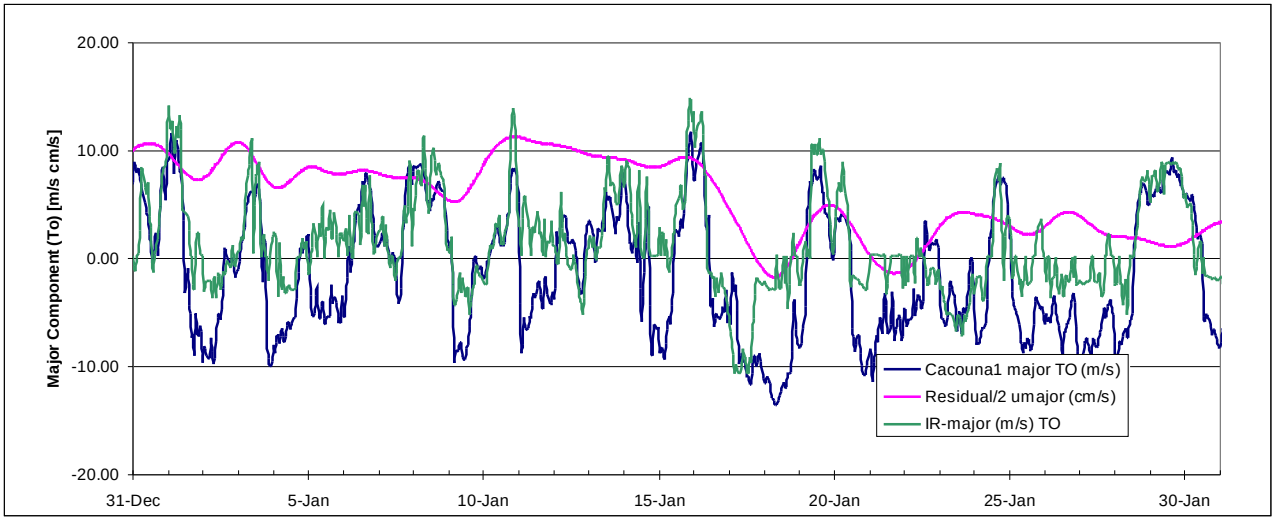


Figure 3-17: The major component of the residual currents scaled by 0.5 (purple), and the major component of the measured winds at Cacouna1 (black), Cacouna2 (blue), and Île-Rouge (green) for January, 2005.

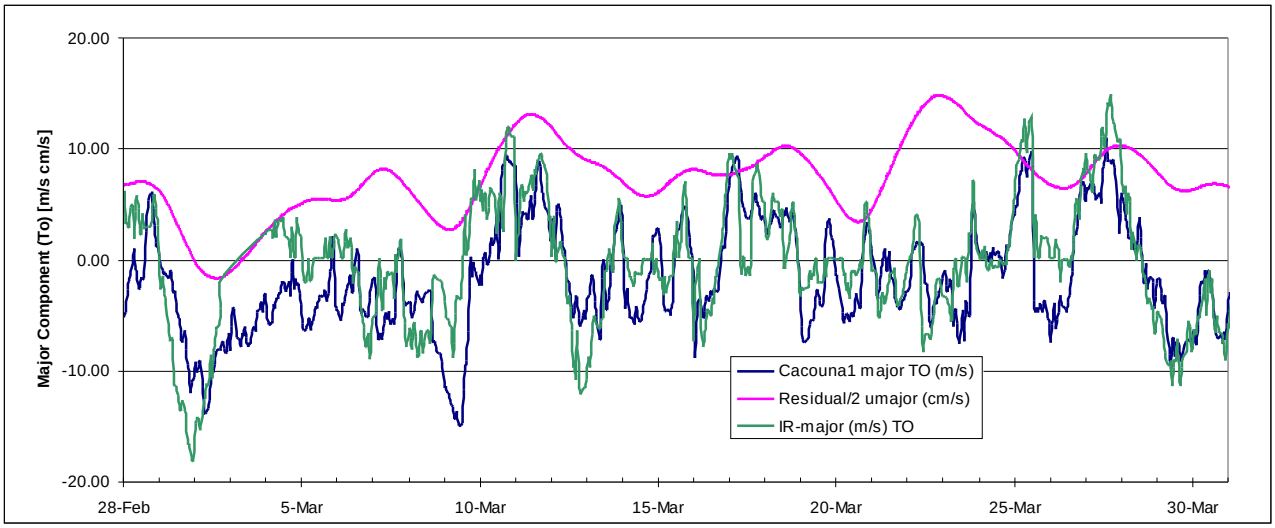


Figure 3-18: The major component of the residual currents scaled by 0.5 (purple), and the major component of the measured winds at Cacouna1 (black), Cacouna2 (blue), and Île-Rouge (green) for March, 2005.

3.5.4 High Pass Currents

One more time series was generated, for the July-October, 2005 deployment, which contained contributions at frequencies higher than tidal. This time series was calculated by subtracting the low pass filtered residual currents from the detided currents. A time series of these high pass currents is given in Figure 3-19, using major and minor components where the major component is aligned with 27° E.

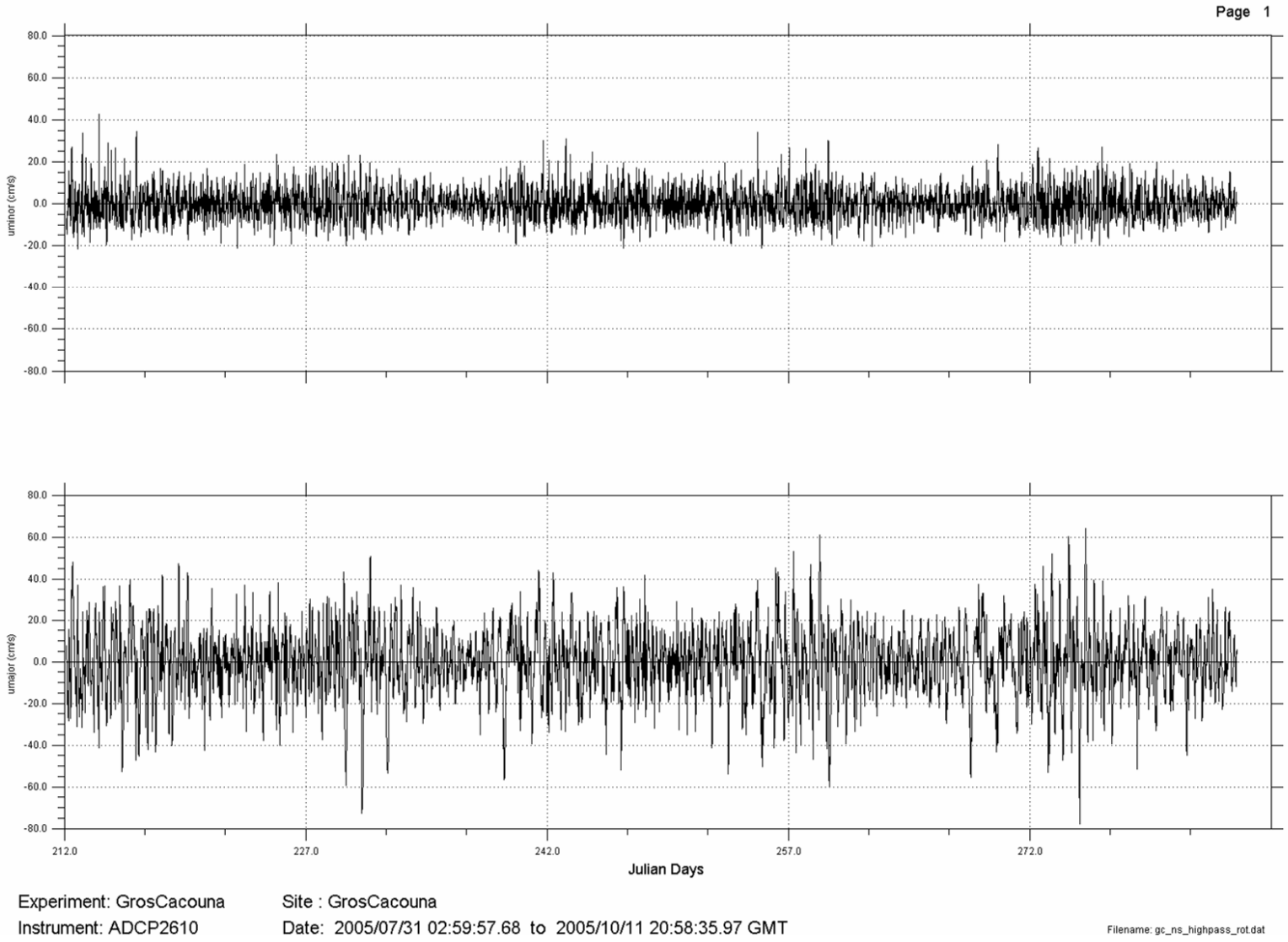


Figure 3-19: High pass residual currents from the July-October deployment.

The statistics for the major and minor components of the measured, tidal, residual, and high pass currents are given in Table 3-31. For all of the current types, the variance is at least twice as much in the major-component as in the minor-component. The predicted tidal currents account for most of the major-component variance, the high-pass currents account for about 10%-15%, and the residual currents account for the remaining variance. Considering the current speeds rather than current components for each of the current types gives similar results, as shown in Table 3-32.

Overall, for the July to October measurement period, for the full measured near-surface current signal (100%), the predicted tidal portion of the signal accounts for 81% of the signal in terms of variance or 22.2 cm/s of 24.6 cm/s in terms of standard deviations. The remaining detided currents represent only 19% of the total variance, corresponding to a standard deviation of 10.9 cm/s. Of the detided currents, the low passed portion (residual currents) amounts to only 4% of the variance of 4.8 cm/s standard deviation while the high passed portion of the detided current (internal, non-predictable tides and higher frequency current variations) accounts for 16% of the variance or 9.8 cm/s in standard deviation. Even though the currents are highly dominated by the predictable tidal currents, the effects of the non-tidal phenomena can still be large at times as seen by the comparison of the maximum observed near-surface currents of 134 cm/s for the full signal, 86 cm/s for the maximum tidal current, 78 cm/s for the high pass portion of the detided current and 32 cm/s for the low pass (residual) portion of the detided current (Table 3-31).

Table 3-31: Statistics for the major and minor components of the measured, tidal, residual, and high pass currents for the July-October deployment.

Major Component (cm/s)	min	1%	5%	25%	50%	mean	75%	95%	99%	std	max	# valid	total #
Measured (10 min)	-112.6	-90.7	-69.4	-18.3	32.5	19.6	58.8	82.8	103.6	49.3	133.8	11077	11077
Tidal (hourly)	-85.9	-76.8	-60.9	-16.9	31.1	19.9	57.8	75.2	81.2	44.4	84.8	1819	1848
Residual (10 min)	5.3	6.9	10.5	17.3	19.9	20.1	24.2	26.9	30.4	4.9	31.5	10478	10478
High Pass (10min)	-78.0	-44.6	-27.2	-9.2	0.5	0.0	10.0	24.8	37.7	15.9	64.2	10477	10477

Minor Component (cm/s)	min	1%	5%	25%	50%	mean	75%	95%	99%	std	max	# valid	total #
Measured (10 min)	-25.6	-17.7	-12.8	-5.2	0.6	1.0	7.0	15.9	22.2	8.8	49.6	11077	11077
Tidal (hourly)	-10.7	-9.0	-7.3	-3.0	1.2	1.0	4.9	8.8	11.5	5.1	13.0	1819	1848
Residual (10 min)	-1.1	-0.9	-0.6	0.1	1.0	1.0	1.7	2.8	3.8	1.1	4.4	10478	10478
High Pass (10min)	-21.5	-14.9	-10.7	-4.7	-0.3	0.0	4.3	11.6	17.9	6.9	42.8	10477	10477

Table 3-32: Statistics for the speeds of the measured, tidal, residual, and high-pass currents for the July-October deployment.

Speed (cm/s)	min	50%	mean	75%	95%	99%	std	max	# valid	total #
Measured (10 min)	0.3	48.4	47.8	65.6	87.8	104.8	24.6	134.1	11077	11077
Tidal (hourly)	0.5	45.8	43.6	62.3	76.6	82.1	22.2	86.2	1819	1848
Residual (10 min)	5.4	20.0	20.2	24.2	26.9	30.4	4.8	31.5	10478	10478
High Pass (10min)	0.1	12.0	14.3	18.6	34.0	48.3	9.8	78.1	10477	10477

4 Water Levels

The water levels are derived from the bottom pressure measured by the ADCP. The atmospheric pressure measured at Environment Canada's Rivière-du-Loup (47° 48'N, 69° 33'W) meteorological station were removed from the measured pressure, leaving the pressure due to the water only. The pressures were converted to heights by dividing by the acceleration due to gravity and a representative mean density. Conductivity-temperature-depth (CTD) measurements taken at the start and end of deployments were used to estimate the mean density. The largest uncertainty in identifying the water depth absolutely was due to small changes in the location and local water depth of the ADCP deployment location for each deployment. The uncertainties due to this positioning would introduce height variations larger than any seasonal variations, so the water levels from each deployment were referenced to the mean average value of water level for each deployment record prior to combining into a year-long time series record. The effect of this averaging for each deployment period is to reduce somewhat the seasonal variability in the water levels.

The water levels have all been interpolated onto a common hourly time scale which extends over the year. The water levels from each deployment were usually collected on an hourly basis with the waves, as tabulated in Table 1-1, but the November to April deployment measured water levels every 90 minutes. The water levels were interpolated onto a 5 minute time scale before combining.

Figure 4-1 through Figure 4-3 illustrate the highly semi-diurnal nature of the water levels which were measured in this project. Table 4-1 tabulates the seasonal and annual water level statistics, and Table 4-2 tabulates the monthly water level statistics. The lowest water level observed over the project was -3.03 m (January 13), and the highest water level was 3.0 m (December 12). At the 5%-95% level, the water level range was 3.5 m. Figure 4-4 illustrates the monthly statistics. The largest water levels were observed between December and February.

Table 4-1: Seasonal and annual water level statistics.

	min	1%	5%	25%	50%	mean	75%	95%	99%	std	max	valid	totalnum
07-Oct-2004 15:00 to 31-Dec-2004 23:50	-2.46	-2.06	-1.67	-0.93	-0.06	-0.02	0.84	1.73	2.32	1.08	2.96	24276	24587
01-Jan-2005 to 31-Mar-2005 23:50:00	-3.03	-2.10	-1.72	-0.89	-0.04	-0.01	0.86	1.80	2.38	1.11	2.86	25919	25919
01-Apr-2005 to 30-Jun-2005 23:50:00	-2.39	-2.00	-1.61	-0.83	0.01	0.05	0.89	1.82	2.32	1.07	2.72	26164	26207
01-Jul-2005 to 13-Oct-2005 15:00:00	-2.50	-2.14	-1.69	-0.89	-0.04	-0.02	0.84	1.72	2.26	1.08	2.71	29840	30133

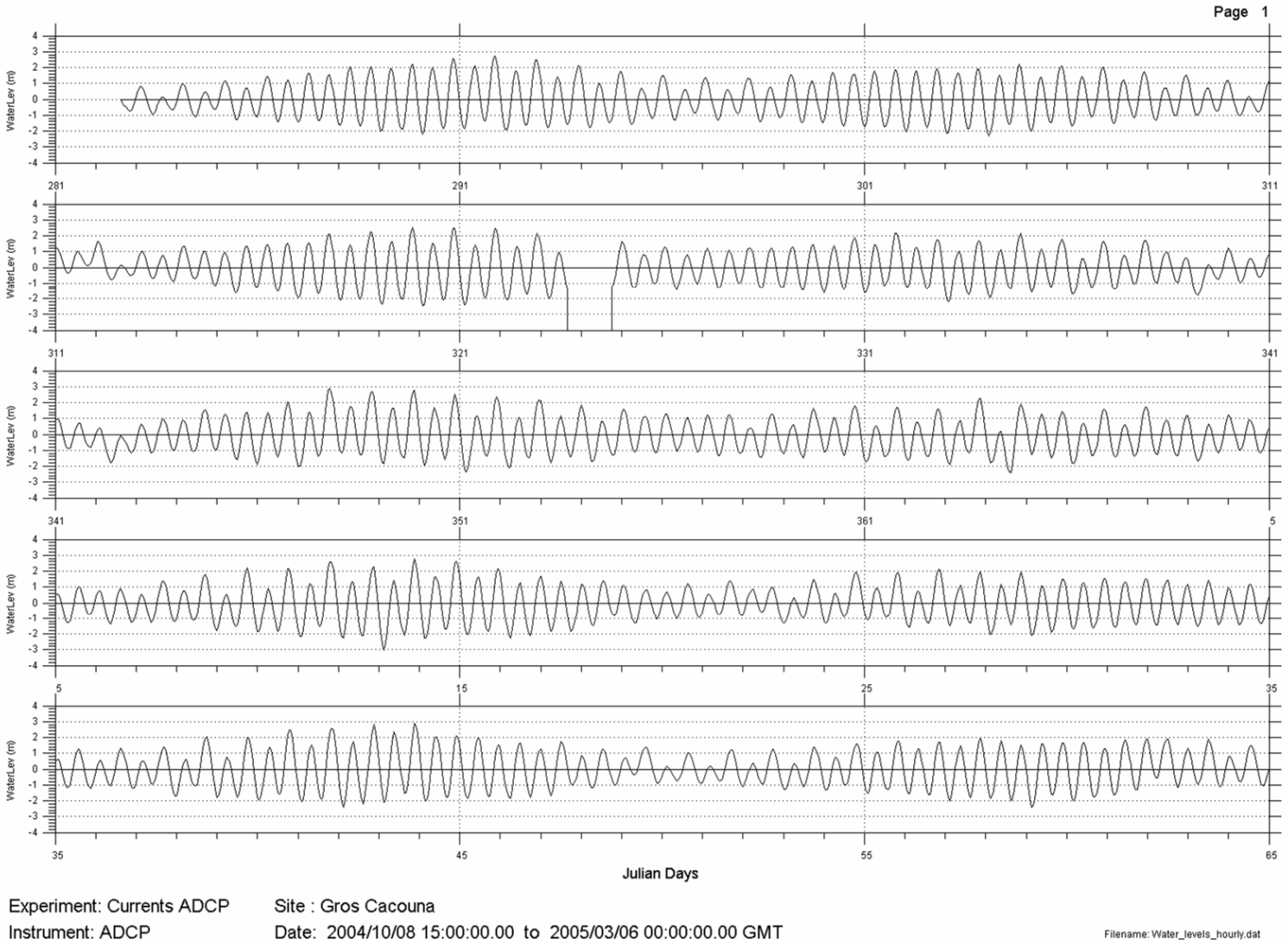


Figure 4-1: Atmospheric pressure corrected water levels between October, 2004 and March, 2005.

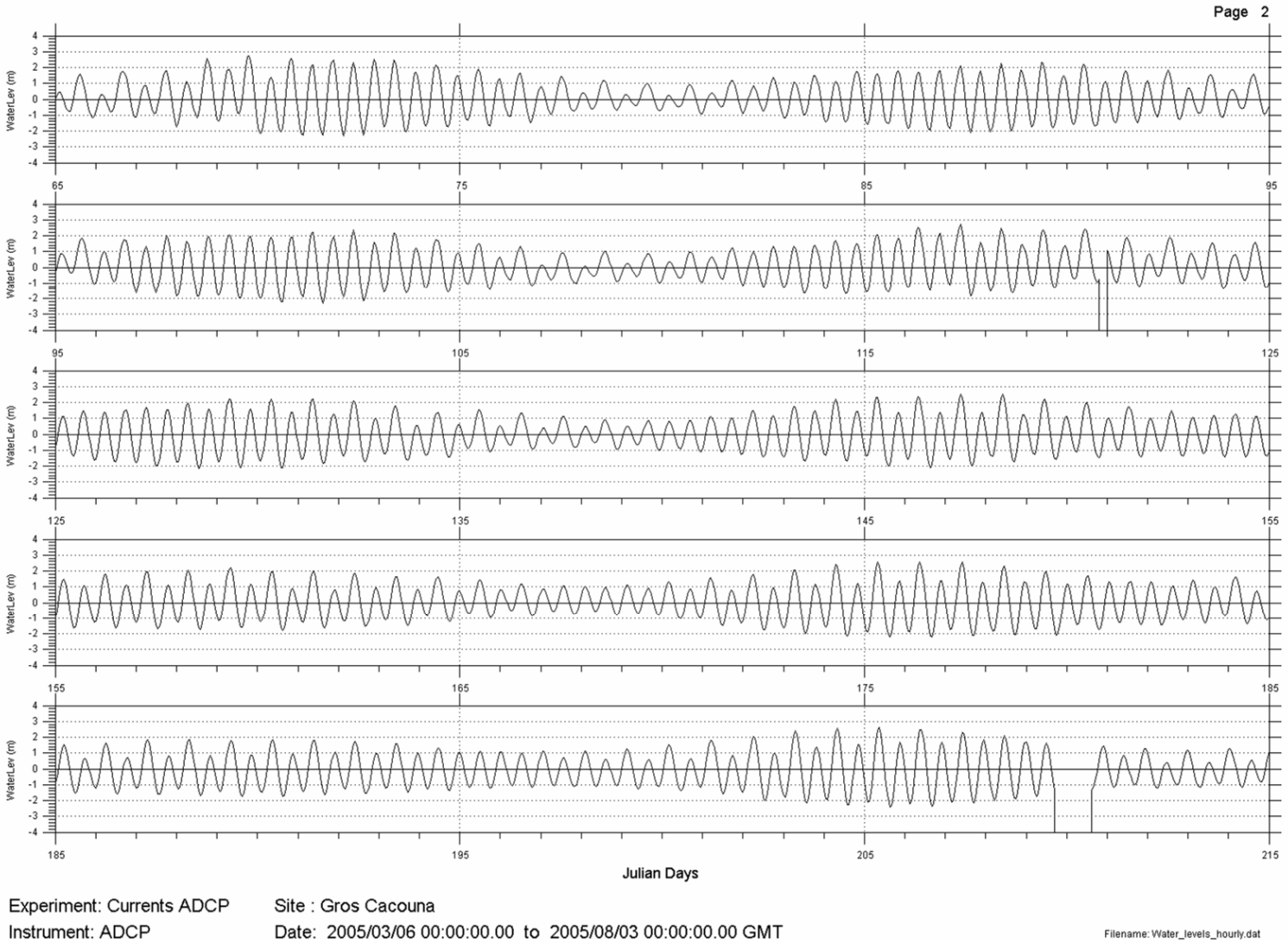


Figure 4-2: Atmospheric pressure corrected water levels between March, 2005 and August, 2005.

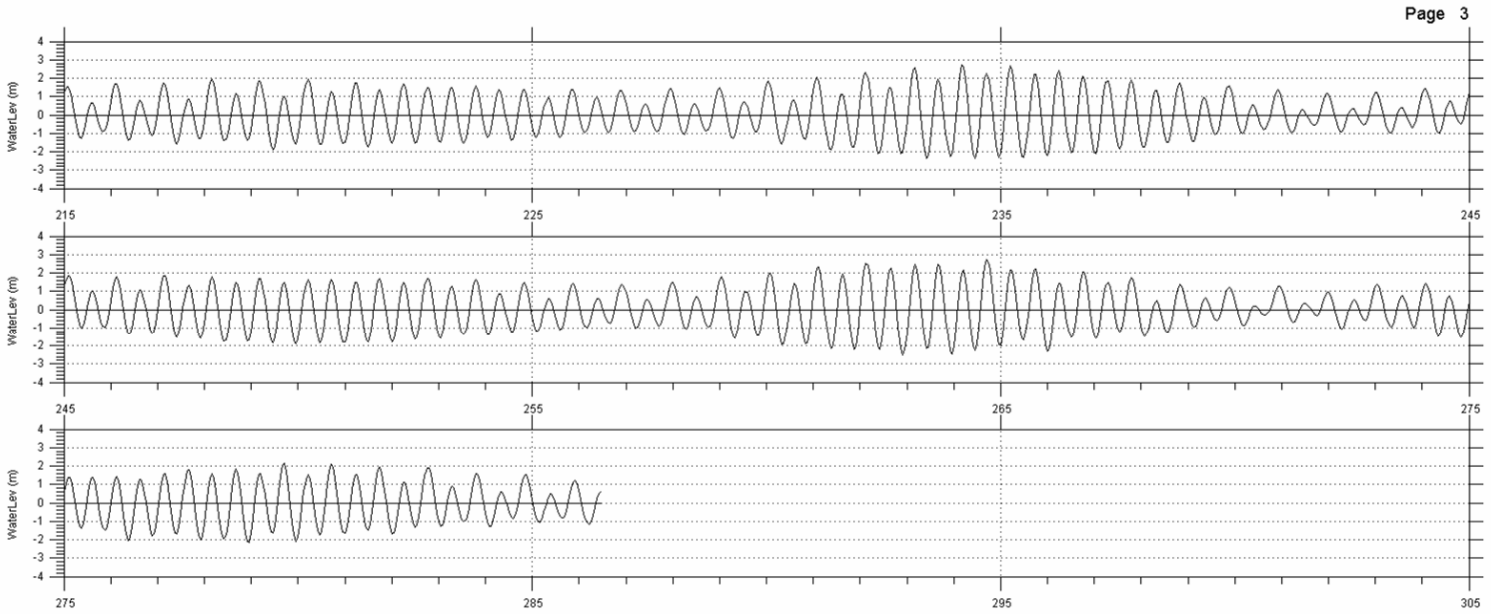
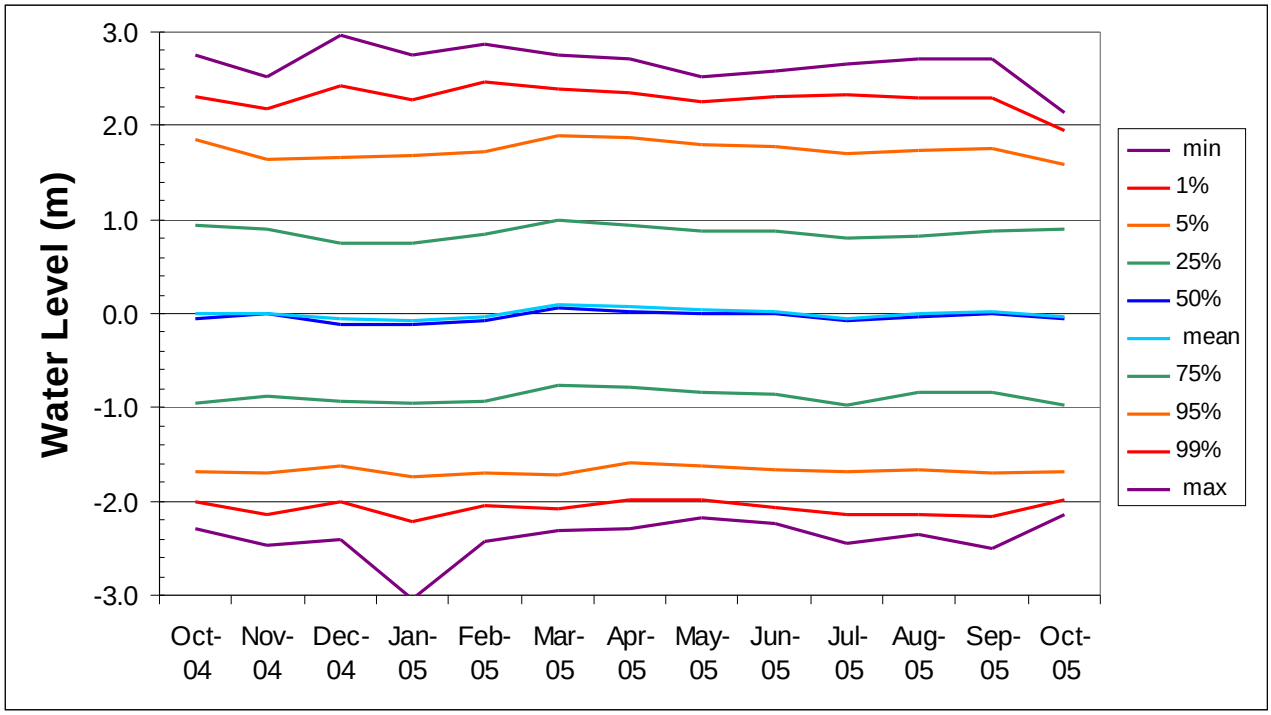


Figure 4-3: Atmospheric pressure corrected water levels between August, 2005 and October, 2005.

Table 4-2: Monthly water level statistics.

	min	1%	5%	25%	50%	mean	75%	95%	99%	std	max	valid	totalnum
10/08/2004 15:00 to 10/31/2004 23:55	-2.30	-2.01	-1.69	-0.95	-0.05	0.00	0.93	1.85	2.32	1.14	2.75	6732	6732
11/1/2004 0:00 to 11/30/2004 23:55	-2.46	-2.15	-1.71	-0.87	0.00	0.00	0.89	1.65	2.18	1.07	2.52	8329	8640
12/1/2004 0:00 to 12/31/2004 23:55	-2.42	-2.01	-1.63	-0.94	-0.12	-0.06	0.75	1.67	2.43	1.06	2.96	8928	8928
1/1/2005 0:00 to 1/31/2005 23:55	-3.03	-2.21	-1.74	-0.95	-0.11	-0.09	0.75	1.69	2.27	1.08	2.76	8928	8928
2/1/2005 0:00 to 2/28/2005 23:55	-2.43	-2.05	-1.71	-0.93	-0.07	-0.03	0.84	1.73	2.46	1.10	2.86	8064	8064
3/1/2005 0:00 to 3/31/2005 23:55	-2.31	-2.08	-1.72	-0.77	0.06	0.09	1.00	1.89	2.40	1.13	2.76	8928	8928
4/1/2005 0:00 to 4/30/2005 23:55	-2.29	-1.98	-1.58	-0.79	0.03	0.08	0.93	1.88	2.35	1.08	2.72	8597	8640
5/1/2005 0:00 to 5/31/2005 23:55	-2.18	-2.00	-1.62	-0.85	-0.01	0.03	0.87	1.80	2.25	1.07	2.51	8928	8928
6/1/2005 0:00 to 6/30/2005 23:55	-2.24	-2.07	-1.65	-0.87	0.01	0.01	0.87	1.77	2.32	1.08	2.58	8640	8640
7/1/2005 0:00 to 7/31/2005 23:55	-2.44	-2.15	-1.68	-0.97	-0.09	-0.05	0.81	1.71	2.32	1.08	2.65	8683	8928
8/1/2005 0:00 to 8/31/2005 23:55	-2.35	-2.14	-1.65	-0.85	-0.04	0.00	0.83	1.74	2.30	1.07	2.71	8928	8928
9/1/2005 0:00 to 9/30/2005 23:55	-2.50	-2.16	-1.71	-0.84	0.00	0.03	0.88	1.75	2.29	1.09	2.71	8640	8640
10/1/2005 0:00 to 10/14/2005 11:00	-2.13	-1.99	-1.68	-0.98	-0.06	-0.04	0.91	1.59	1.94	1.08	2.14	3589	3589

Figure 4-4: Time series plot of the monthly water level statistics.



5 Summary and Conclusions

This report presents the results of a year-long project for current profile, wave, water level and other oceanographic measurements at Gros Cacouna, Quebec, from October 7 2004 to October 13 2005. The measurements and data analysis obtained from this site investigation study have been conducted for a proposed LNG offloading terminal. The data and results presented in this report represent the fourth of four phases within a one year long study of currents, waves and ice conditions at the proposed terminal site, as well as provide a summary of results for the full year of measurements.

The measurements were made with an RDI Acoustic Doppler Current Profiler, mounted on the riverbed in 17.5 m water depth (LLW). Wave measurements were determined using the wave orbital velocities, which generally demonstrated good agreement with the surface tracking measurements.

Waves

Ocean waves at the terminal site are generated by regional wind events in the St. Lawrence River and in the adjoining area of the Gulf of St. Lawrence. The waves are highly episodic with a strong seasonal modulation. While the median significant wave height (Hs) was only 0.13 m, there were 18 wave events in which Hs exceeded 1.1 m. The largest single wave event had an Hs value of 3.04 m, as recorded on Dec. 11, 2004.

Waves are considerably larger in winter (Jan.-Mar.) than any other season. The median value of Hs is 0.40 m in winter as compared to 0.19 m and 0.17 m in fall (Oct.-Dec.) and spring (Apr.-June) respectively. In summer, the waves are the smallest with a median Hs value of only 0.08 m. The largest waves follow the same seasonal pattern of being largest in winter. The Hs value for the 95th percentile is 1.18 m in winter vs. 0.81 and 0.82 m in fall and spring and only 0.41 m in summer.

For the largest wave events, the peak periods range from 5 to 9 seconds with the very largest wave events tending to have larger periods. At Hs values of < 1m, the most frequent peak periods are less than 5 s. For Hs values of 1 to 1.6 m, the most frequent peak periods are in the 5-6 s range, and for Hs values of 1.6-1.8 m and 1.8-2.0 m, the most frequent peak period classes increase to 7-8 s and 10-11 s respectively. The wave spectra for the full year reveal that significant low frequency contributions are rarely below 0.08 Hz and never below 0.06 Hz, corresponding to infrequent activity from waves with periods greater than 12.5 seconds and never any activity from waves at periods exceeding 16.7 seconds. Other than in relation to the increase of wave period with wave heights, the wave peak periods exhibit only minor variations with the seasons.

For the mean wave directions, the values range from the southwest sector or up-river (3 events), through the north-west (6 events) and from the north (9 events). Refractive steering of waves, approaching the shoreline, contribute to the wave events that have directions that originate from the northwest and north. These wave events can result from waves traveling up the river or down the river. Mean wave directions exhibit a seasonal variation with the typical median wave direction being from the northwest in fall, winter and spring (302, 313 and 299 º respectively) while the median value is usually from the southwest to south in summer (250 º)

Large Wind and Wave Events

The local winds within this segment of the St. Lawrence River were examined using weather station measurements at Gros Cacouna available through the project and Environment Canada wind observations available from Île Rouge immediately across the River on its north side. Over the study period, the largest sustained measured wind speed was 25.3 m/s or 49 knots on December 14, 2004. The largest measured wind speed in the vicinity of the Gros Cacouna terminal site was about 20 m/s or 39 knots.

To examine the waves and winds, an analysis of the 18 largest wave events (with Hs > 1.1 m) and an additional 8 events in which the local winds exceeded 30 knots (15.5 m/s) was carried out. Large wave and wind events almost always coincide. However, there is little in the way of a consistent correspondence between the peak wind speed and largest significant wave height. Much of the variability between wave heights and local winds arises from the dominant contributions to wave generation being beyond the local portion of the St. Lawrence River from Gros Cacouna to Île Rouge. In most cases examined, the peak of the local wind occurs a few hours before the maximum measured wave heights. However, the peak wave heights can vary by a factor of two or more for the same peak wind speeds among the cases examined. In most of the cases the large waves were from the north-northwest and the coincident winds were from the northwest, north or northeast, although there are a few cases where both the dominant winds and the waves originate from the southwest, or from up-river.

Some cases exhibit large wave events in which the peak values of Hs are elevated by 50 to 100% from the adjoining values on time scales of an hour. The very largest wave event of Dec. 11, 2004 (Hs of 3.04 m) is one of these cases, characterized by complex directional wave properties with several distinct peaks in the spectral wave densities for different combinations of wave frequency and direction. Other cases in late April and late May 2005, exhibit very large values of Hs in two and three distinct ensembles, respectively relative to the overall envelope of the broad wave peak which has a duration of about 2 days. In all three of these cases, the peak Hs value appears to be higher relative to the local wind speeds than is the case with the other wind/wave episodes examined. It is suggested that these particular high wave events are the result of a more complicated set of wave generation mechanisms in term of the source of the wave generation and the route by which the waves arrive at the measurement site. Further analysis of the data collected in this study, along with regional wave modeling could lead to a better understanding of wave properties in response to storm patterns and the historical understandings of storm climatology of the lower St. Lawrence River and the northern Gulf of St. Lawrence.

Currents

The currents are strongly directed by the local bathymetry, and the related shoreline orientation, to have the largest flows at 27º east of North in the down-river direction (positive) and 207º in the up-river direction (negative), which are associated with the ebb and flood directions of the tide, respectively. The orientation of the ebb and flood directions vary seasonally, with the flood directions varying by about 5 degrees and the ebb directions varying by about 10 degrees over the full year.

The maximum current speeds occurred at the near-surface level reaching 159 cm/s on the ebb tide of May 2, 2005. At the 95th percentile level, the current speed was 88.5 cm/s. The moderate amount of shear in the water column is reflected by a 95th percentile current speed of 62.3 cm/s at near-bottom. The major current component statistics indicate that at the near-surface level, the largest ebb currents (84.7 cm/s 95% level) are somewhat stronger than the largest flood currents (-65.4 cm/s 5% level). At the near-bottom the situation is reversed with -60.7 cm/s flood currents (5% level) versus 44.2 cm/s ebb currents (95% level).

The vector-averaged current velocities over the entire record for near-surface, mid-depth, and near-bottom were 18.7 cm/s (33°), 7.8 cm/s (58°), and 4.7 cm/s (160.8°), respectively. The net flow at surface is downriver, whereas the net near-bottom flow has an upriver component. This reversal in the net flow directions between near-surface and near-bottom levels results from the estuarine nature of the St. Lawrence River flow regime, with the stronger down-river flows at the surface due to the fresh water outflows at the surface and a compensating up-river flow at depth.

The measured currents are very much dominated by the tidal flows, which are primarily semi-diurnal (two tidal cycles per day) in nature in this area. The tidal analyses show that the combined major semi-diurnal tidal constituents (M2 & S2) exhibit large variability in amplitudes of up to 30% according to the time of year. However the variations in the phase angle are much smaller at only a few degrees. The major semi-diurnal tidal current amplitudes are reduced in winter and early spring and, at near-surface levels, are larger in spring to early summer. The seasonal pattern is different at the mid-depth and near-bottom levels where the smaller tidal amplitudes occur through winter and spring. The large variations in the major tidal constituent amplitudes indicate that tidal analyses and predictions should be done in a piece-wise fashion over the year to provide accurate prediction of tidal currents for future and past times.

Of the full measured near-surface current signal (100%) as computed for the most recent deployment period of late July to October, the predicted tidal portion of the signal accounts for 81% of the signal in terms of variance or 22.2 cm/s of 24.6 cm/s in terms of standard deviations. The remaining "detided" currents represent only 19% of the total variance, corresponding to a standard deviation of 10.9 cm/s.

Of the detided currents, we can separate this into two parts: the low passed portion (residual currents having periods > 1-2 days) which amounts to only 4% of the variance, or 4.8 cm/s standard deviation; and the high passed portion of the detided current (associated with internal, non-predictable tides and higher frequency current variations) which accounts for 16% of the variance or 9.8 cm/s in standard deviation. Even though the currents are highly dominated by the predictable tidal currents, as seen by the high percentage of the total variance accounted for, the effects of the non-tidal phenomena can still be large occasionally as indicated by the comparison of the maximum observed near-surface currents of 134 cm/s for the full signal, 86 cm/s for the maximum tidal current, 78 cm/s for the high pass portion of the detided current and 32 cm/s for the low pass (residual) portion of the detided current. Further analyses of the detided high pass currents for the remainder of the year, other than August to mid-October 2005, may be useful to better characterize typical and maximum magnitudes of these short duration currents.

Further examination of the residual low frequency detided currents indicate down-river flow at near-surface levels. The variability in the near-surface residual currents consists of fluctuations over periods of a few to several days with typical amplitudes of 10 – 20 cm/s and a longer period quasi-seasonal variation with typical amplitudes of 20 cm/s. The maximum residual currents occurred in June (28, 42 [mean/max cm/s]), while a smaller local minimum is found in December (18, 31 [mean/max cm/s]).

A comparison was made of local winds with the residual currents at near-surface levels. The response of residual currents to direct wind forcing appears to be weak and marginal in terms of possible correlations. Most of the variability in the residual near-surface currents apparently results from processes other than a direct linear response to wind forcing such as variations in the St. Lawrence River discharge.

Water Levels

Water levels were derived from the ADCP bottom pressure measurements after correcting for the effect of local atmospheric pressure changes. Due to the small changes in location and local water depth between deployments, the water levels are referenced to the average value of each the four instrument deployments, which will tend to reduce somewhat the variability that can be resolved at seasonal time scales. The lowest water levels observed over the project was -3.03 m (January 13), and the highest water level was 3.0 m (December 12). At the 5%-95% level, the total water level range was 3.5 m. The largest water levels were observed between December and February.

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