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CURRENT MEASUREMENTS AT THE STORFJORDEN SILL
76° 58′N, 19° 15′E, SEPTEMBER 2003 – AUGUST 2004

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1. Introduction

Under the Polar Ocean Climate Processes (ProClim) project, an acoustic Doppler current profiler (ADCP) was deployed at the sill separating the Storfjorden in Svalbard Archipelago and Storfjordrenna north of Storfjordbanken on the Barents Sea shelf (Figure 1). Storfjorden, through its polynya activity, produces highly saline water near the freezing temperature which fills the fjord to the sill level (115 m) and initiates a gravity driven overflow (Quadfasel et al., 1988; Schauer, 1995; Schauer and Fahrbach, 1999; Fer et al., 2003; Fer et al., 2004; Skogseth et al., 2005a). The overflow water is dense enough to penetrate below the Atlantic Water at the region. Because Storfjorden-origin water is occasionally observed in the deep Fram Strait (Quadfasel et al., 1988), it is considered to contribute to the ventilation of the Arctic Ocean. The objective of the deployment is to monitor the overflow, its (estimate of) volume flux, its interannual variability (through scheduled deployments every year) as well as high and low frequency variability at the sill.

For future reference, here we report on the data acquired, processing details, data quality and observed velocity statistics, inferred tides and frequency domain descriptions derived from the data. Scientific discussions of the data are deliberately excluded.

2. The instrumentation, deployment and recovery

A self-contained 307.2 KHz broadband Workhorse, Sentinel, RD Instruments ADCP was deployed at 76° 58′ N, 19° 15′E at the 111 m isobath (Figure 1) on 4 September 2003, 17:30 UTC. The deployment was conducted from R.V. G.O. Sars, during the last leg of the cruise 2003010 (01.09 – 14.09 2003). The instrument was recovered from R.V. G.O. Sars on 19 August 2004.

The instrument is installed in an aluminum trawl-proof frame, attached to a concrete block of 2.5x2.5x0.37 m dimensions (Figure 2). The weight of the concrete block is about 2.5 (1.6) tones in air (water). The frame with instruments (acoustic release, ADCP and the battery pack) and floatation elements installed is 300 kg in air. The instruments are summarized in Table 1. Overall height of the installation is 86 cm. The picture on the front page is taken during deployment.

Table 1. Deployed instruments

Instrument	**Description**
ADCP	RDI Workhorse Sentinel, 300 kHz Model: WHS300-I-UG70 s/n: 3505
Battery module	Model: 717-3027-00 s/n: 3088 2 battery packs (type 757K6023-00)
Acoustic release	IXSEA AR 861 B2S s/n: 138 arm code: 04B2

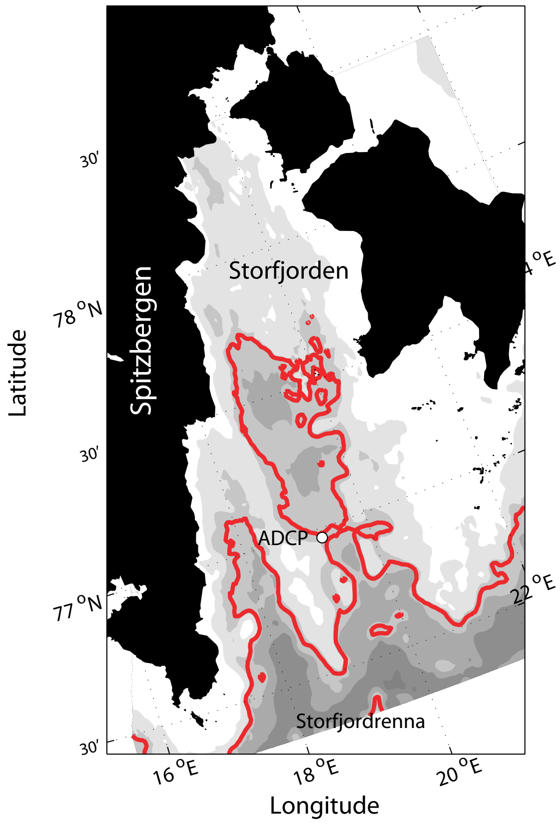
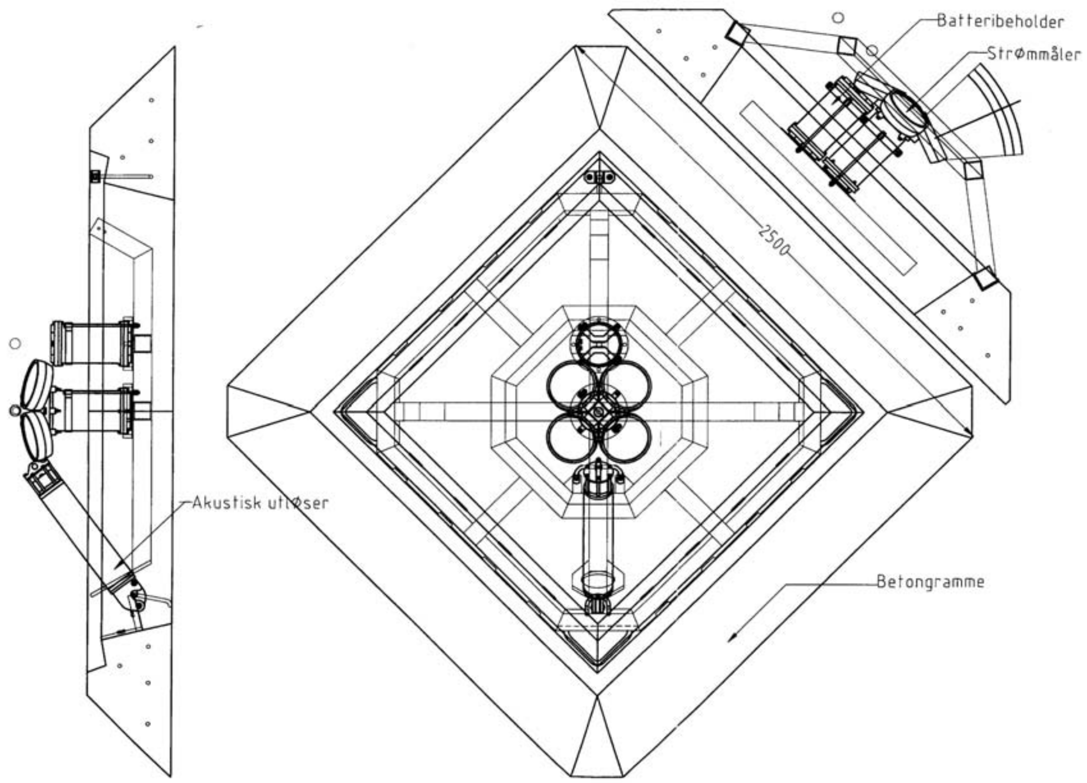


Figure 1 (left). Map of the region. Isobaths, shaded at 50-m intervals, are derived from the recent high-resolution bathymetry (Skogseth et al., 2005b). Red isobath (= 120 m) is shown to identify the sill. ADCP position is marked by the circle.

Figure 2 (bottom). The sketch, to-scale, of the trawl-proof frame also showing the installed concrete frame (betongramme), acoustic release (akustik utløser), battery pack (batteribeholder) and the ADCP (strømmåler). The units are in mm. The views are (left) transect across the center, (middle) plan view and (upper right) side transect. Note that only the octagonal in the middle is open and the frame shown on the side transect is excluded from the central transect.



The configuration of the ADCP is detailed in Appendix A. Four beams (transducers) are slanted at 20° from horizontal, in Janus configuration. ADCP sampled at 4-m depth cell size (bins hereafter) averaging data (33 pings per ensemble) at 10 min intervals. The first bin was centered at about 6 mab (meter above bottom). The data are recorded in Earth co-ordinates. In addition to profiling the horizontal and vertical velocity components ADCP is equipped with temperature (mounted on transducer, precision ±4°C, resolution 10 mK), tilt (accuracy ±0.5°, resolution 0.01°) and compass (accuracy ±2°, resolution 0.01°) sensors. When sampled at 4-m bins the ADCP has a typical range of 86-113 m with a single ping standard deviation of 3 cm s^{-1}. Because random error is uncorrelated from ping to ping, averaging reduces the standard deviation of the velocity error by the square root of the number of pings (RDI, 1996), in our case by a factor $(33)^{-1/2} = 0.174$, yielding 0.5 cm s^{-1}.

3. Data processing

Data are flagged when the percent good of 3 and 4 beam solutions are less than 70 or the magnitude of the error velocity[1] is greater than 5 cm s^{-1} or any of the velocity components exceeded 10 m s^{-1}. Flagged data are treated as missing values and portions with gaps less than 1 hour duration (6 ensembles) are interpolated. Larger portions remain as gaps in the data.

Spikes in velocity components and temperature data are detected and removed in two runs. In the first (second) run, points exceeding 2.5 (3) times the standard deviation of de-meaned data at 40 scan moving windows are detected, removed, and interpolated. The difference between the original data and de-spiked data is calculated. In each run, the original data are retained when the magnitude of this difference was less than twice its rms value over the whole record.

The sound speed used by the ADCP, C_{ADCP}, was set for S = 35 and T = 5°C at 115 dbar pressure. Assuming constant S = 35 and using the bottom temperature measured by the ADCP we calculate the sound speed, C_{real}, and correct the horizontal velocity components by a factor C_{real}/C_{ADCP} for each ensemble (RDI, 1996). The sound speed is not sensitive to salinity and S = 35 is adequate for the site.

The surface is detected as the bin with the maximum echo intensity[2]. The strong echo from the surface (or from ice when present) can overwhelm the side lobe suppression of the transducer. For 20° beam angle the last 6% of the range to the surface is contaminated and is removed from the data. In practice we report on only the first 23 bins, i.e. 94 mab, which excludes the last 15% of the water depth of 111 m.

The horizontal velocity components are rotated to account for the magnetic declination. At the mooring location the magnetic declination at the deployment and recovery was 6°43′E and 6°59′E, respectively. Because the rate of change of the magnetic declination is negligible throughout the sampling period, the value at the mid-time of the experiment is used.

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[1] The fourth beam of the ADCP provides for a redundant estimate of the vertical velocity. The error velocity is the difference between the two estimates of vertical velocity. It allows us to evaluate whether the assumption of horizontal homogeneity, within the depth bin, is reasonable.

[2] Echo intensity is the signal strength of the echo returning from the ADCP's transmit pulse

4. Data quality

Average vertical profiles of parameters describing the data quality are shown in Figure 3. The percent good of 3 or 4 beam solutions, the average correlation over 4 beams are shown both for the raw and cleaned (flagged, interpolated, de-spiked) data. The statistics of the parameters for each bin as well as the total percent of flagged (and cleaned) data are tabulated in Table 2. In the lower 50 m, data quality is very good with echo intensity between 79-129 counts, on the average, and only <1% of the data from each bin is flagged. Between 50-66 m typically within 10% of the data is excluded. At bins above 70 mab standard deviation of the error velocity is about 1-2 cm s^{-1} and echo intensity is significantly reduced.

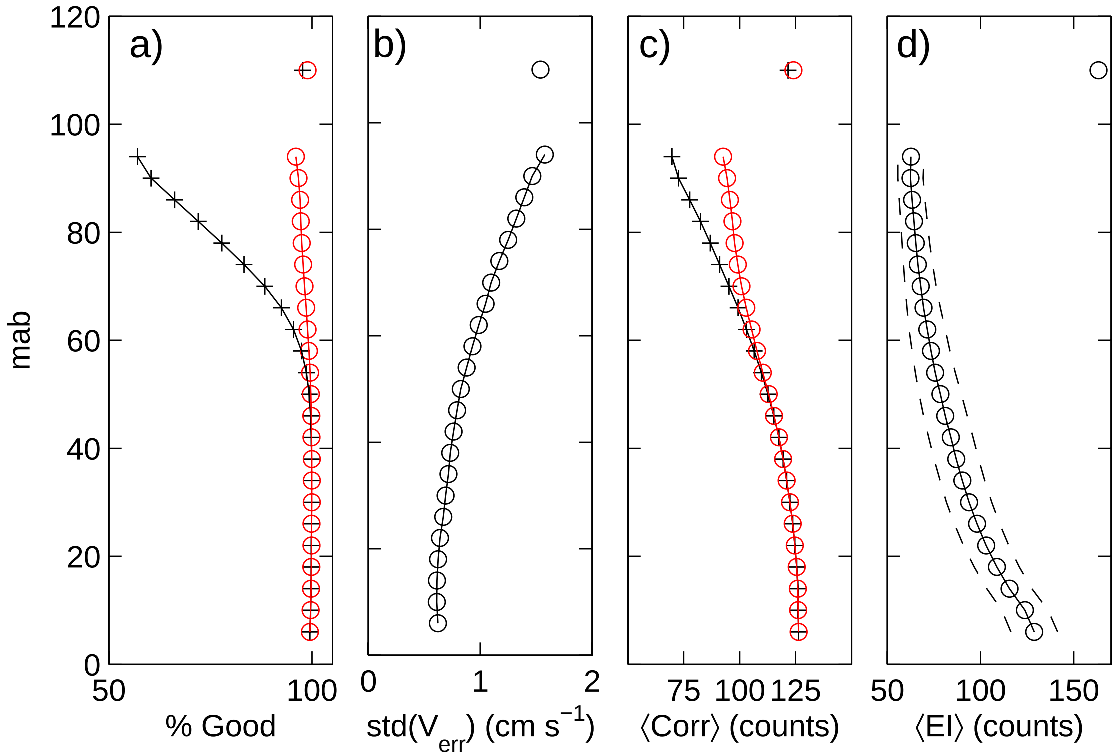

Figure 3. Time and 4-beam averaged profiles of data quality parameters. Vertical axis is the height above bottom in (meters above bottom, mab) and the uppermost bin is the inferred surface bin. Three bins between bin 23 and the surface are of poor quality and are excluded in the report. The profiles shown are a) percent of good 3 or 4 beam solutions (black, raw; red, clean data set), b) standard deviation of the error velocity, c) correlation between the beams (black, raw; red, clean data set), and d) echo intensity (EI) with one standard deviation envelope.

Table 2. Data quality statistics for each bin. Second column is the total percent of the flagged (bad) data. Error velocity, percent good and echo intensity are summarized with 5% and 95% quantiles, the mean and the standard deviation.

Bin	Flagged(%)	Error velocity (cm s^{-1})				Percent Good (%)				Echo Intensity (counts)			
		5 %tile	95%tile	Mean	Std	5%tile	95%tile	Mean	Std	5%tile	95%tile	Mean	Std
1	0	-1	1	0	0.62	96	100	99.46	1.51	111	152	128.84	12.48
2	0	-1	1	0	0.61	96	100	99.64	1.28	106	147	123.81	12.41
3	0.01	-1	1	-0.01	0.62	99	100	99.74	1.14	97	136	115.54	12.09
4	0.03	-1	1	0	0.62	99	100	99.8	1.09	89	128	108.74	12.08
5	0.04	-1.1	1.1	0	0.64	100	100	99.84	1.05	83	122	103.02	12.14
6	0.05	-1.1	1.1	-0.01	0.67	100	100	99.88	1	79	117	98.17	12.17
7	0.07	-1.1	1.1	0	0.69	100	100	99.9	0.93	75	113	93.88	12.11
8	0.08	-1.2	1.2	0	0.72	100	100	99.9	0.9	72	110	90.31	11.99
9	0.12	-1.2	1.2	0	0.73	100	100	99.89	1.03	70	107	87.04	11.94
10	0.16	-1.2	1.2	0	0.76	100	100	99.86	1.13	68	105	84.13	11.91
11	0.36	-1.3	1.3	0.01	0.79	99	100	99.79	1.45	66	102	81.23	11.7
12	0.76	-1.3	1.3	0.01	0.83	99	100	99.67	1.88	64	99	78.55	11.3
13	1.61	-1.4	1.4	0	0.88	99	100	99.5	2.32	63	96	76.03	10.64
14	3.04	-1.5	1.5	0.01	0.93	96	100	99.21	3.03	62	93	73.89	10.04
15	5.51	-1.6	1.6	0	0.99	93	100	98.9	3.65	62	90	72.12	9.49
16	9.25	-1.7	1.7	-0.01	1.05	90	100	98.53	4.34	61	87	70.57	8.76
17	14.4	-1.8	1.7	-0.02	1.1	87	100	98.13	4.87	61	85	69.41	8.06
18	20.55	-1.9	1.9	0	1.17	84	100	97.8	5.22	60	83	68.51	7.54
19	26.62	-2	2	-0.01	1.25	84	100	97.46	5.63	60	82	67.82	7.03
20	33.14	-2.2	2.2	-0.01	1.32	81	100	97.24	5.84	60	81	67.3	6.65
21	39.43	-2.4	2.3	-0.02	1.4	81	100	97.06	5.95	60	80	66.81	6.44
22	45.69	-2.4	2.4	-0.02	1.47	81	100	96.66	6.3	60	80	66.36	6.32
23	50.26	-2.7	2.6	-0.02	1.58	78	100	96	6.75	60	79	66.12	6.07
surface	20.64	-2.9	2.7	-0.07	1.54	93	100	98.91	3.44	135	181	161.73	15.47

5. Bottom temperature, heading, pitch and roll

Hourly averaged time series of bottom temperature and data from the tilt sensors are presented in Figure 4. Over the duration of the record the average (± one standard deviation) values are heading = 73.1 (± 0.3)°, roll = -0.53 (±0.01)°, pitch = -0.28 (±0.01)°, temperature = -0.76 (±1.25) °C. The average roll and pitch values are not significantly different than each other or from zero given the ±0.5° accuracy of the sensors. The roll and pitch sensors appear to be sensitive to variations in water temperature (note the fluctuations corresponding with temperature prior to April 2004 followed by relatively quiescent record when bottom temperature is nearly constant close to the freezing point), hence the variability throughout the record is possibly non-physical.

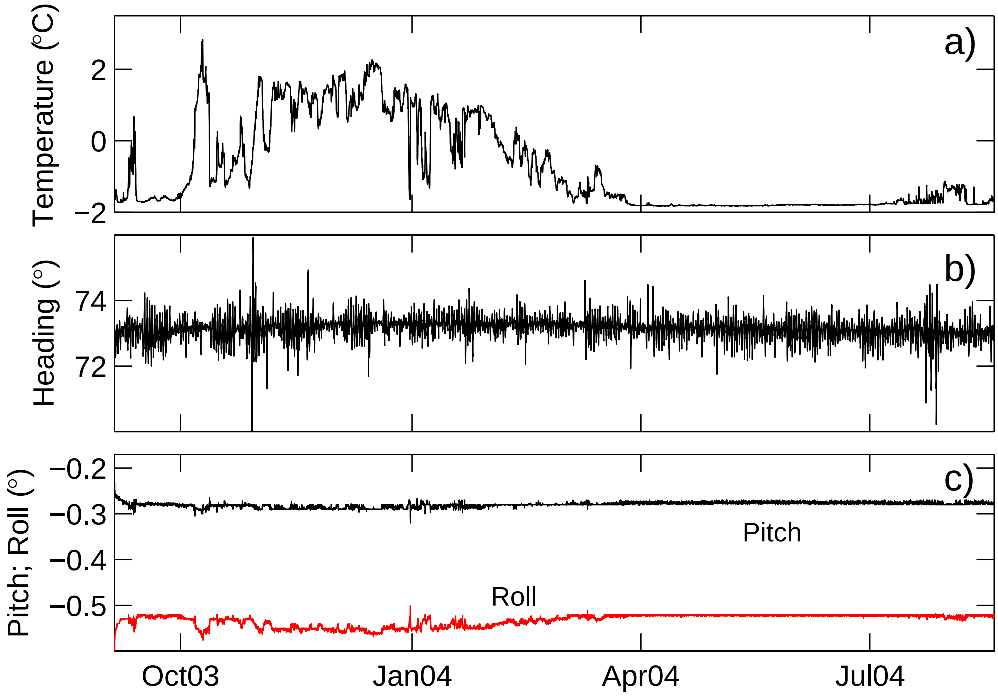

Figure 4. Hourly averaged time series of a) temperature b) heading c) pitch (black) and roll (red) for the complete duration of the deployment.

6. Current measurements

The mean and one standard deviation of the east (u), north (v), and vertical (w) velocity components, horizontal speed ($[u^2+v^2]^{1/2}$), and direction over the duration of the record are summarized in Table 3 for each bin. The percent of gap in the data in each bin and the stability factor, SF, defined as the ratio of the length of the average current vector to the average speed, is also given. The gap is the portions of missing data after interpolation of the flagged bad data with less than 1 h duration. The difference in the second columns of Table 2 and Table 3 indicates how much interpolation is carried out. A similar summary for the monthly data is given in Appendix B.

The time-mab maps of hourly averaged velocity components are given in Figure 5, for the approximate first half of the period, 4 September 2003 – 1 March 2004, and in Figure 6 for the rest of the record. The low frequency variability is presented in Figure 7 after applying a 4^{th} order phase-preserving low-pass Butterworth filter with a 5-days cutoff period. Using the low-passed horizontal velocity components, the magnitude of (low-passed) shear is calculated as $Sh = [(du/dz)^2 + (dv/dz)^2]^{1/2}$, by first differencing between adjacent bins with dz = 4 m (Figure 8).

On the average, the flow is remarkably barotropic with flow speed of ~ 10 cm s^{-1} directed out fjord ~ 190°T, with slight enhancement near the bottom. The stability factor is ~0.5 at the bottom 40 m and decreases away from the bottom. The monthly mean profiles show considerable vertical structure (Figure 10), expect from those on December 2003, January, July and August 2004. The shear is typically near zero in mid-water and is enhanced near the bottom and the surface. Enhanced shear near the bottom extend up to 50 mab during September-October 2003 whereas the signal in 2004 reaches similar depths only in May

(Figure 8). Overflow observed during August-October is typically of episodic nature and is of the remnants of the dense water produced in winter which is captured behind the sill (Skogseth et al., 2005a). When compared with remnants of an expectedly stronger overflow in 2003, year 2004 is characterized by weak overflow conditions (see also transport estimates, section 8).

The mesoscale signature is more easily observed in the low-passed time series (Figure 7). In contrast to 2004, vertical velocity component is stronger during late 2003. Typical south-west directed flow at the sill during winter and spring 2004 is interrupted by two pulses of in-fjord flow on 20 January and 14 March. The largest bottom enhanced overflow signals and vertical shear are recorded on September 2003, February and May 2004 (Figure 8, Figure 10 and Appendix B).

Table 3. Statistics (mean and standard deviation over the total duration of the record) of the velocity components (cm s^{-1}), speed (cm s^{-1}), direction (°T) and stability factor, SF, for each bin. The percent of gaps in the data in each bin is given in the second column.

Bin	Gap	East		North		Vertical		Speed		Direction		SF
	%	mean	std	mean	std	Mean	std	mean	Std	mean	Std	
1	0.00	-2.45	6.66	-5.34	9.43	0.04	0.41	11.60	5.76	195.7	74.6	0.51
2	0.00	-3.29	7.40	-5.60	9.54	0.00	0.41	12.19	6.27	198.6	75.4	0.53
3	0.00	-3.44	7.47	-5.51	9.14	-0.01	0.41	11.93	6.27	199.3	75.6	0.55
4	0.00	-3.32	7.37	-5.30	8.79	-0.03	0.42	11.53	6.14	199.2	76.2	0.54
5	0.00	-3.04	7.20	-5.02	8.50	-0.04	0.43	11.07	5.99	198.5	77.2	0.53
6	0.00	-2.76	7.02	-4.75	8.26	-0.06	0.43	10.65	5.87	197.2	78.5	0.52
7	0.00	-2.50	6.87	-4.48	8.07	-0.07	0.43	10.27	5.75	196.1	80.0	0.50
8	0.00	-2.29	6.71	-4.19	7.85	-0.08	0.43	9.91	5.59	195.2	81.3	0.48
9	0.00	-2.07	6.56	-3.95	7.66	-0.08	0.43	9.60	5.43	194.0	82.2	0.46
10	0.03	-1.87	6.43	-3.76	7.50	-0.09	0.44	9.34	5.30	192.5	83.4	0.45
11	0.12	-1.72	6.32	-3.55	7.37	-0.10	0.44	9.09	5.20	190.5	84.9	0.43
12	0.27	-1.57	6.27	-3.30	7.25	-0.10	0.43	8.89	5.12	189.3	86.1	0.41
13	0.65	-1.43	6.25	-3.06	7.10	-0.10	0.43	8.70	5.02	188.3	86.6	0.39
14	1.49	-1.28	6.29	-2.86	6.97	-0.09	0.43	8.57	4.95	187.7	87.1	0.37
15	3.16	-1.19	6.36	-2.75	6.85	-0.08	0.43	8.52	4.88	186.3	87.3	0.35
16	5.69	-1.15	6.48	-2.59	6.71	-0.08	0.43	8.48	4.82	186.7	87.5	0.33
17	9.17	-1.17	6.64	-2.45	6.60	-0.07	0.43	8.48	4.82	187.6	87.1	0.32
18	14.54	-1.19	6.86	-2.35	6.52	-0.07	0.43	8.55	4.85	187.7	86.9	0.31
19	20.12	-1.21	7.15	-2.23	6.53	-0.06	0.44	8.69	4.97	188.0	86.7	0.29
20	25.79	-1.18	7.58	-2.09	6.68	-0.05	0.45	8.95	5.25	186.3	87.5	0.27
21	32.08	-1.30	8.06	-2.00	6.88	-0.04	0.46	9.29	5.62	186.2	88.1	0.26
22	38.00	-1.41	8.57	-1.93	7.23	-0.03	0.48	9.76	6.00	187.3	88.5	0.25
23	40.96	-1.51	9.03	-1.83	7.40	-0.02	0.58	10.07	6.36	187.9	88.5	0.24

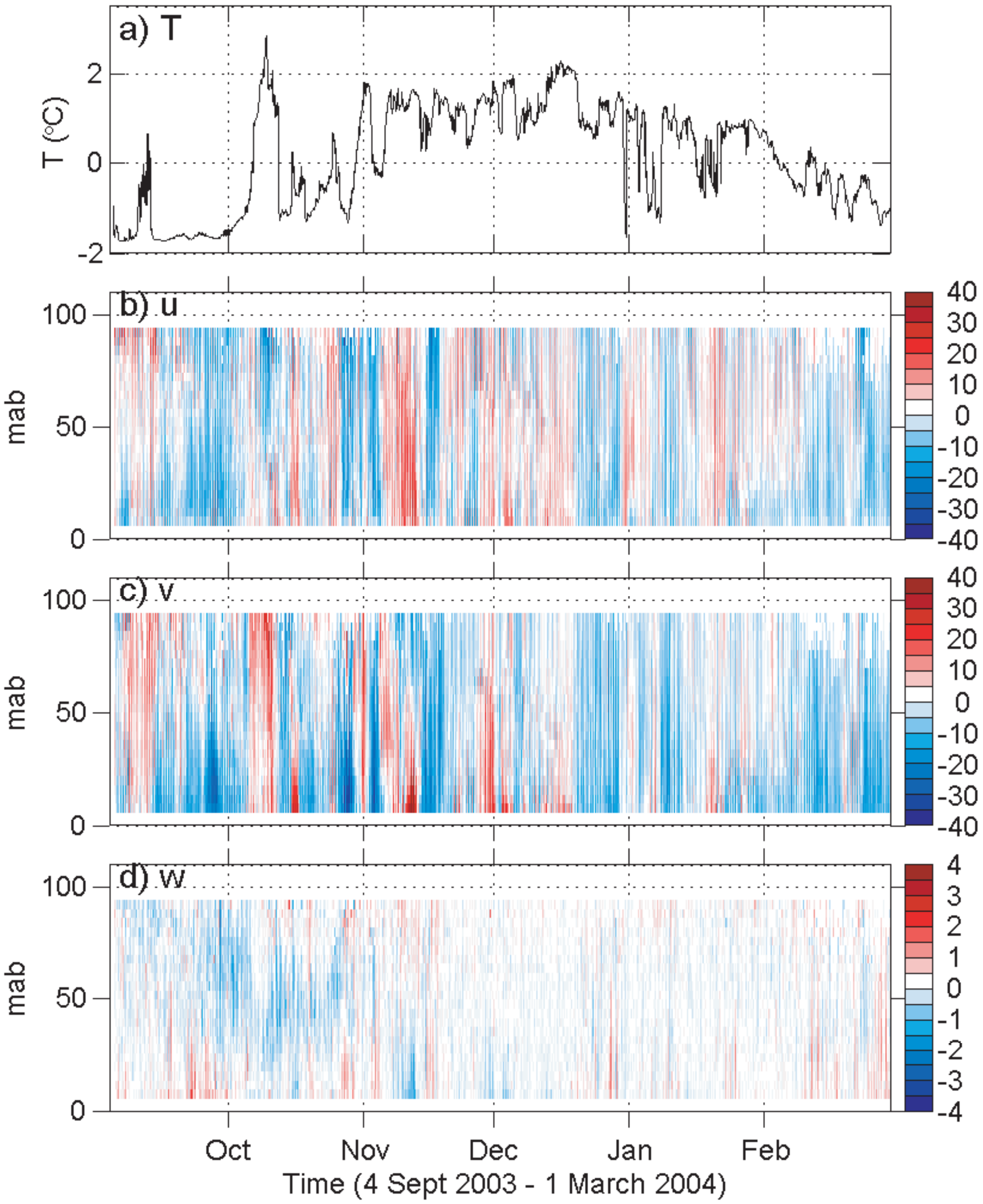

Figure 5. Hourly averaged a) bottom temperature, b) east (u), c) north (v) and d) vertical (w, positive upwards) components of the velocity for the approximate first half of the record (4 September 2003– 1 March 2004). The units on the colorscale are in cm s^{-1}.

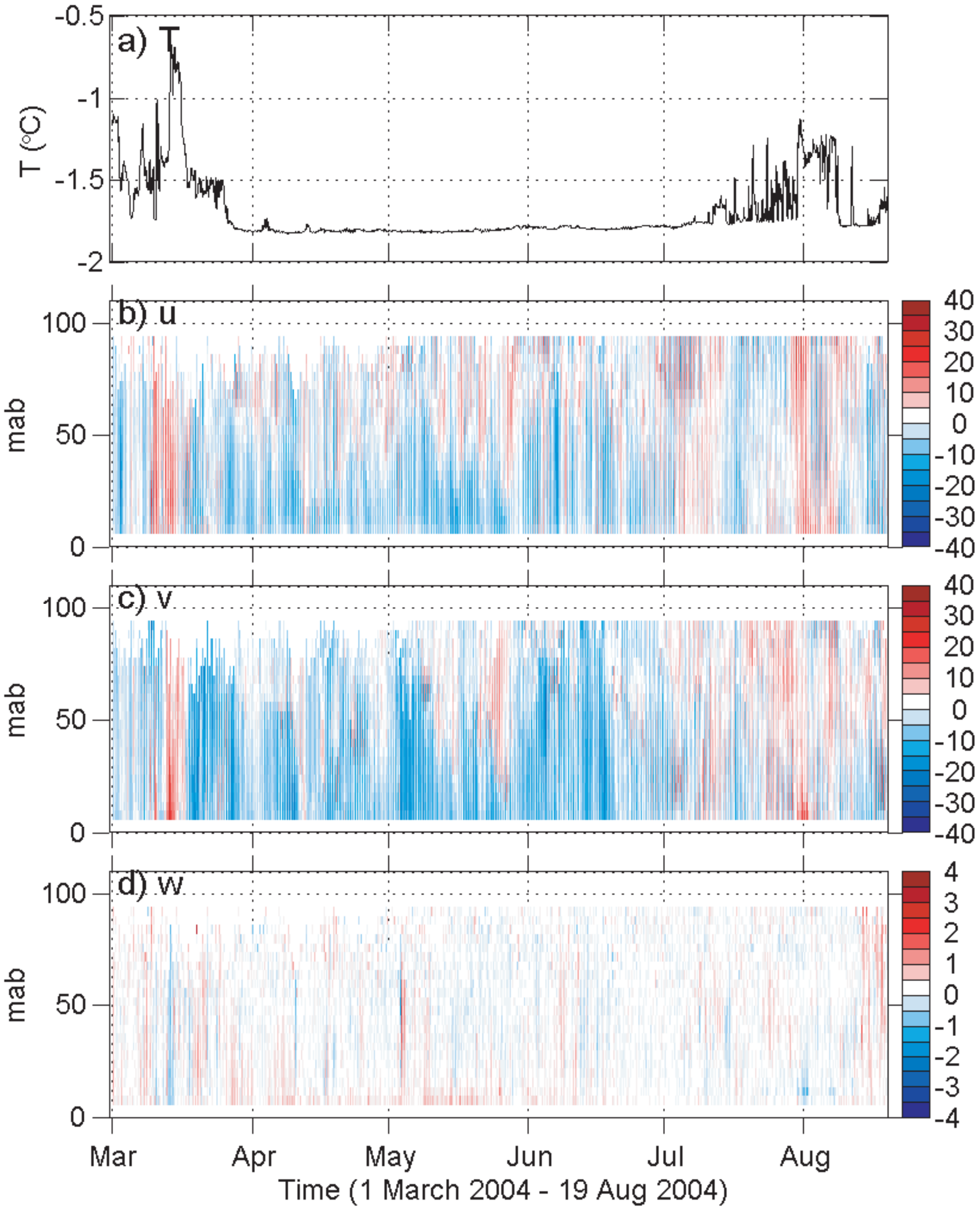

Figure 6. Same as Figure 5, but for the second half of the record : 1 March – 19 Aug 2004.

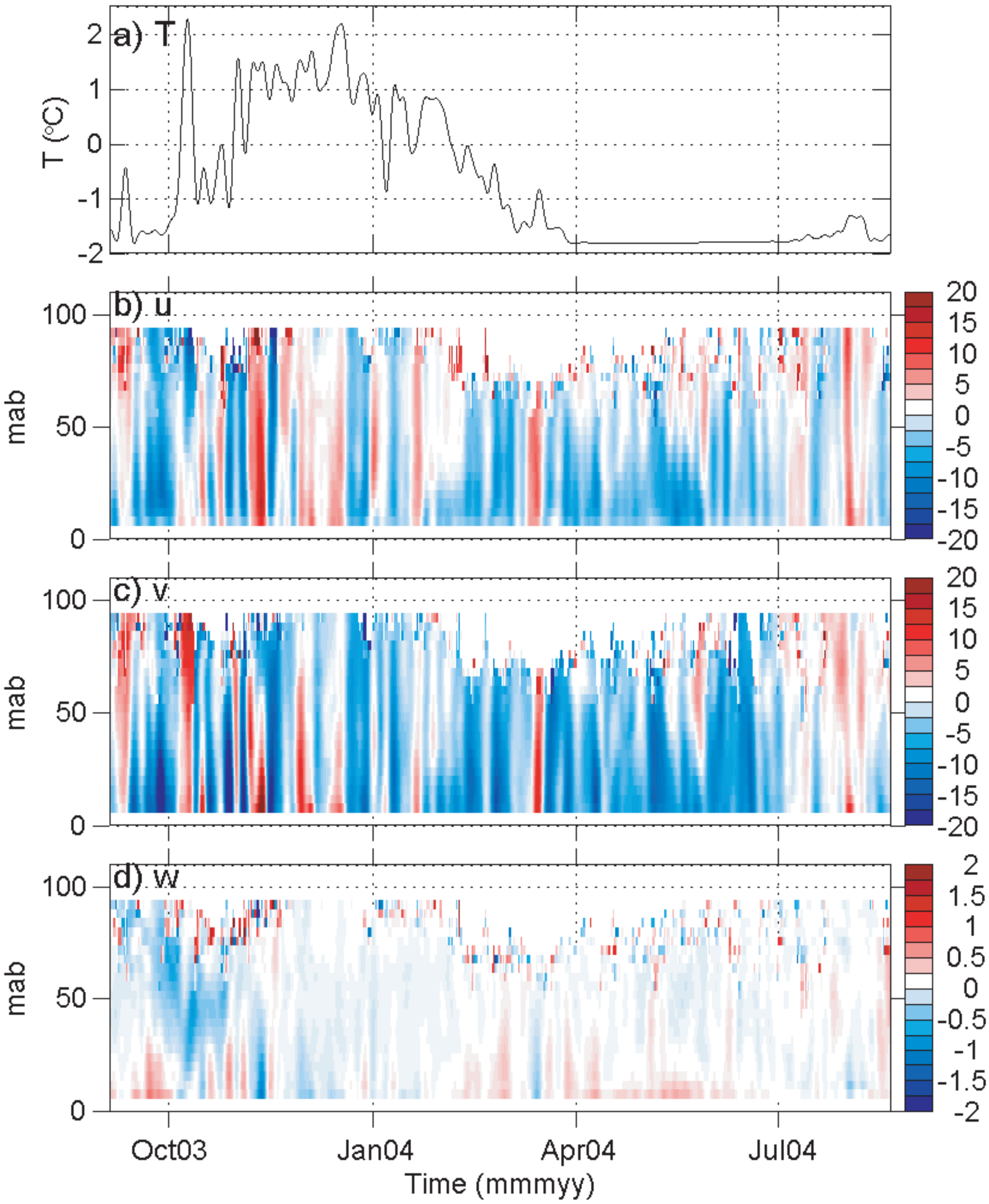

Figure 7. 5-days low-passed a) bottom temperature, b) u, c) v, and d) w components recorded by the ADCP for the complete duration of the deployment. The unit of the colorscales is in cm/s. The noisy features at bins farther from the bottom are portions that could not be filtered due to short length of the data (due to gaps).

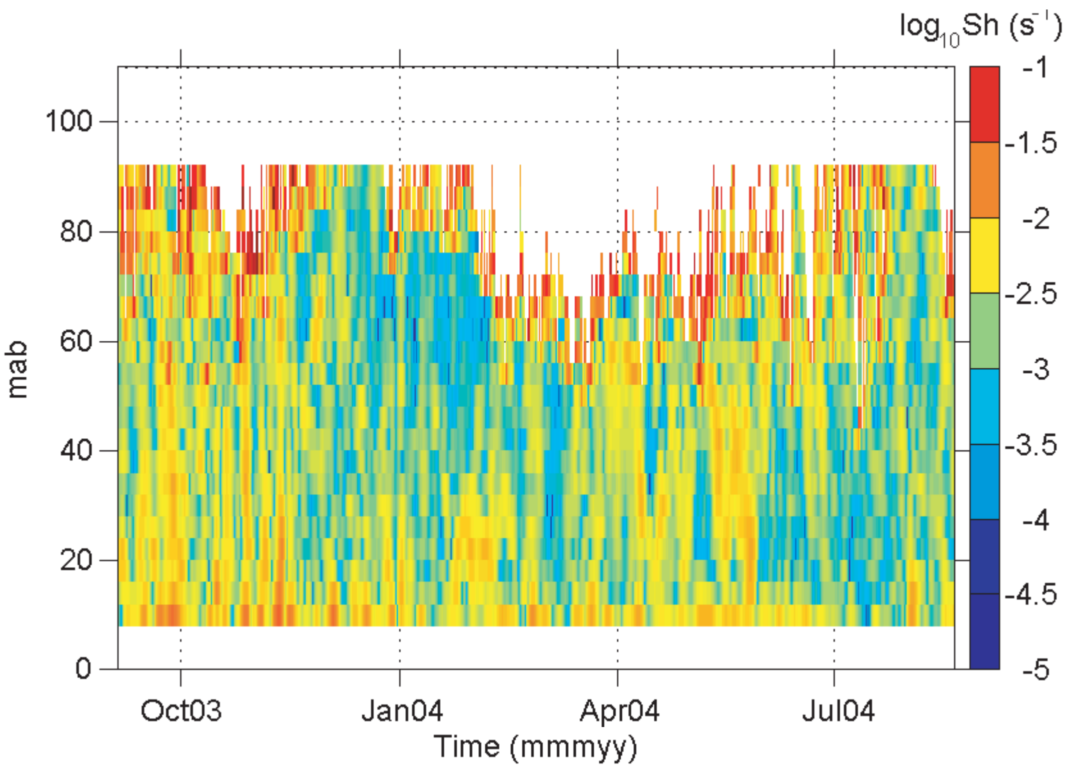

Figure 8. Height above the bottom (mab) versus time map of log-10 base magnitude of the vertical shear of the horizontal velocity. Shear is calculated by first differencing (from first bin closest to the bottom and moving farther) each horizontal velocity component and then taking the modulus.

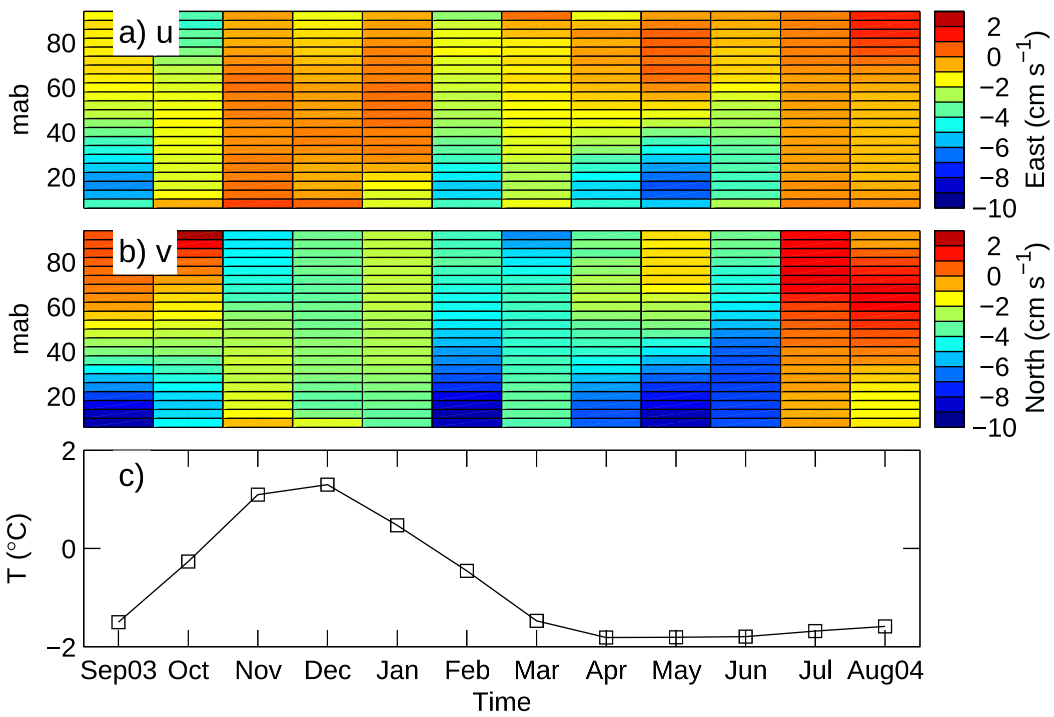

Figure 9. Height above bottom (mab) versus time maps of monthly averaged a) east and b) north component of the velocity. Lowest panel is the bottom temperature. Note that the color scales in a-b are different.

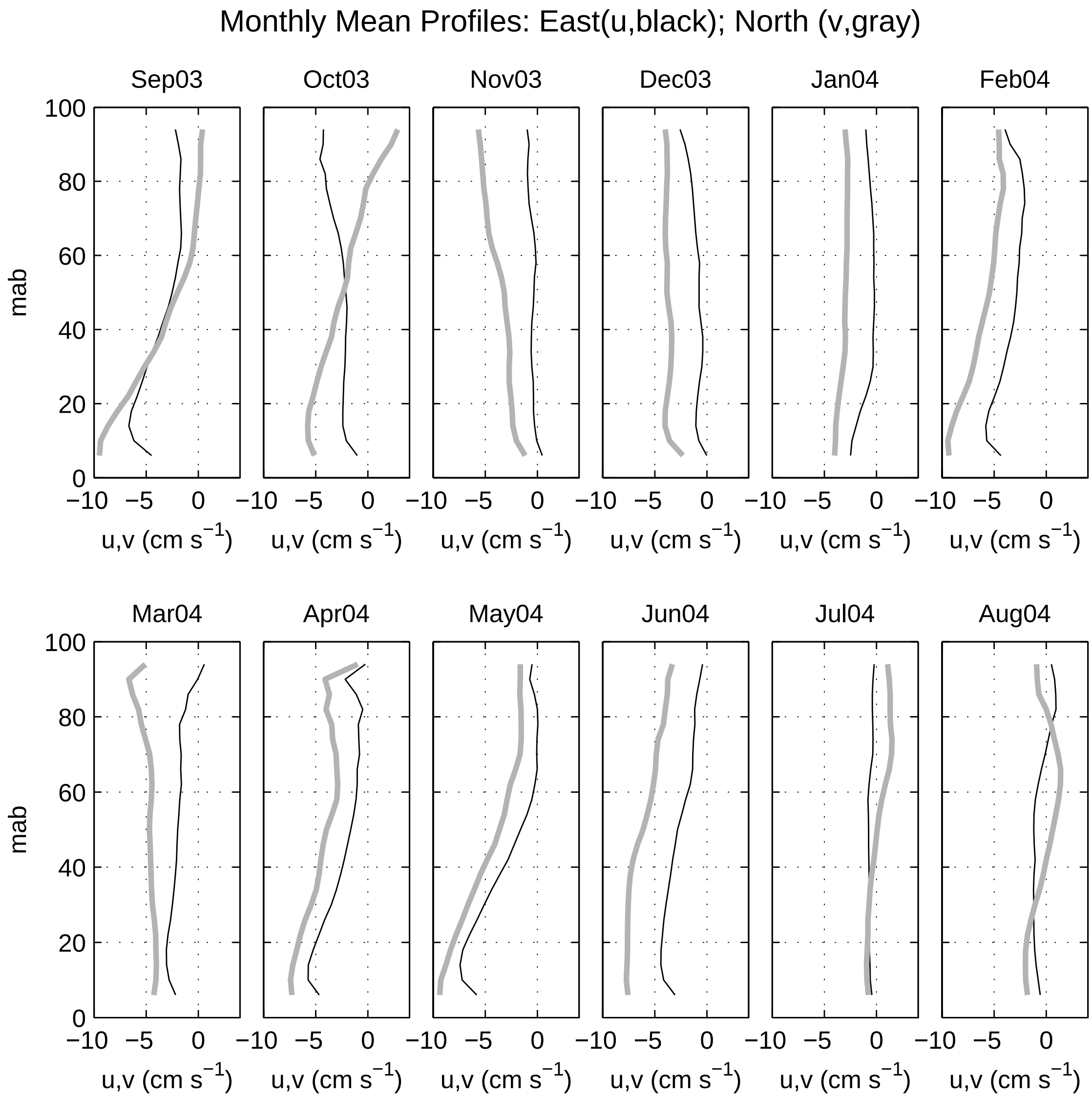

Figure 10. Monthly-averaged profiles of east (black) and north (gray) component of the velocity. The month is indicated on top of each panel, starting from September 2003.

7. Progressive vector diagrams

Progressive vector diagrams (pvd) are generated using 2-days low-passed hourly averaged current vectors. The pvd for the bottom current (6 mab, first bin) is shown in Figure 11, color-coded for the bottom temperature. The cold bottom waters, less than 0°C, are associated with out-fjord flow (negative North component), with a westward component, possibly due to the Coriolis effect. Monthly pvds for arbitrarily selected bins 6, 22, 42 and 62 mab are given in Figure 12, to show the variability in depth and in time. The largest integrated downstream distance is covered in May 2004.

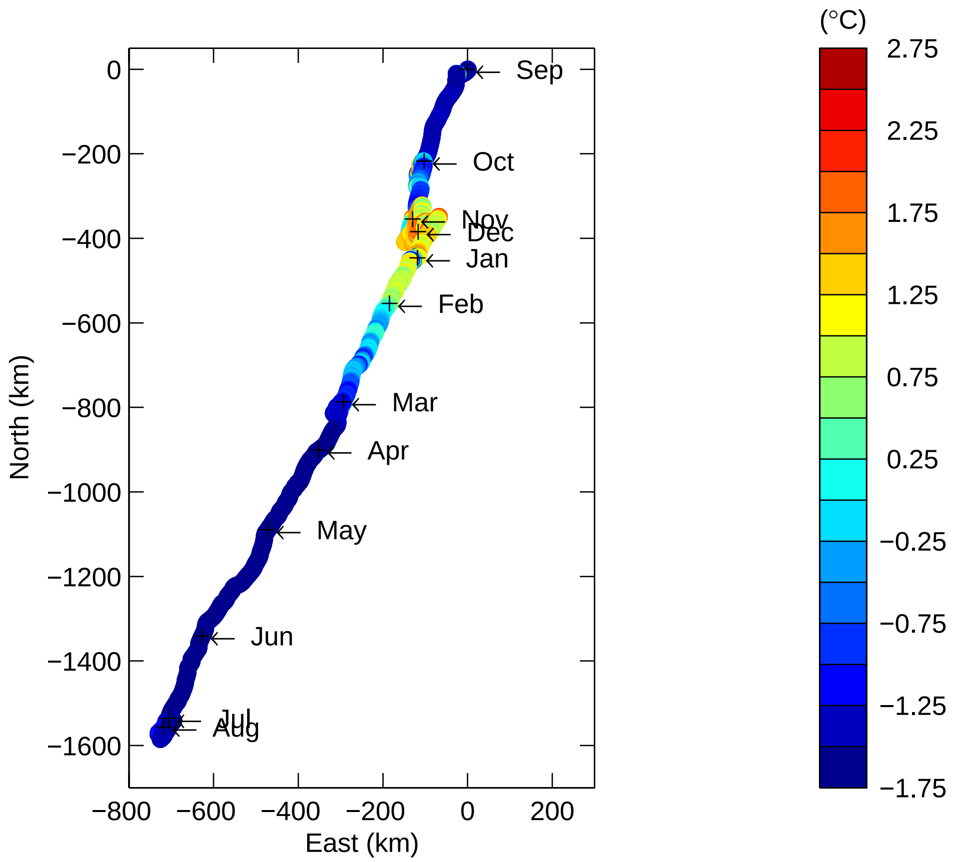

Figure 11. Progressive vector diagram derived for the lowest bin (6 mab) of the ADCP data. The trace is color-coded for bottom temperature. Start of each month is indicated starting from (4) September 2003 and ending in August 2004.

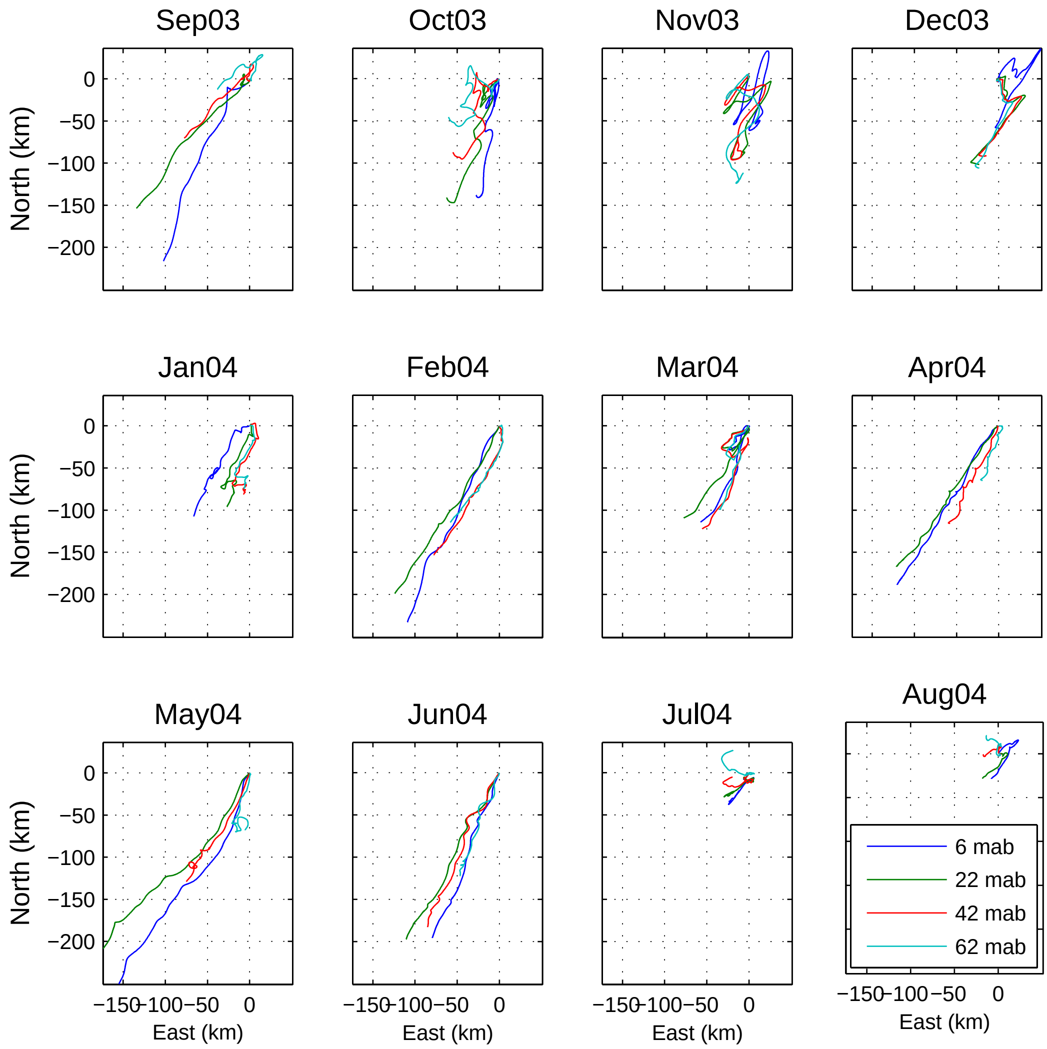

Figure 12. Monthly progressive vector diagrams for bins 6, 22, 42, and 62 mab. The aspect ratio of the panels is unity. The corresponding month and year (mmmyy) is indicated on top of each panel.

8. Overflow volume transport

Hourly averaged horizontal velocity components are 2-day low passed and aligned with the principal axis prior to volume transport calculations. The principal axis, derived for typical outflow period [Feb-Jun] for the bottom 7 bins (30 mab, typical thickness of the overflow plume at the sill), is directed along 214 °T (major/minor axis half lengths are 5.2/ 2.3 cm s^{-1}). When derived over the bottom-most bin only, over the same period, the corresponding values are comparable: 206 °T and 5.0/ 2.4 cm s^{-1}. The volume transport, $Q = \langle V_{out} \rangle hB$, where V_{out} is the outflow component of the velocity along the principal axis, h is the thickness and B is the width of the plume and angle brackets denote averaging over the thickness of the plume. The thickness, h, is estimated as the mab where V_{out} first falls below 2 cm s^{-1}. The overflow is assumed to occur when the bottom 22 m averaged V_{out} exceeds 2 cm s^{-1} (to ensure an outflow activity sufficiently greater than the error levels) and T is colder than a threshold (we report two estimates, T<0°C and T<-1.5°C). The width of the plume is assumed constant, equal to 15 km (Schauer, 1995). The transport in Sverdrups, (1 Sv ≡ 10^6 m^3 s^{-1}), is then calculated every hour. Daily averages of the velocity component along the principal axis (positive, out-fjord), the thickness of the plume and the estimated transport are shown in Figure 13 for T < 0 °C and in Figure 14 for T < -1.5 °C. Monthly averages of V_{out}, its maximum value, h and Q are tabulated in Table 4 (T<0 °C) and Table 5 (T<-1.5 °C). From February to June, outflow with bottom T < 0°C occurred 80-100% of the time, whereas there is no overflow with T < -1.5°C in February. The continuous overflow (insensitive to the choice of T) between April and May amounts to a volume transport of ~0.06 – 0.08 Sv. The largest observation of V_{out} in 2004 is ~ 20 cm s-1 in April, significantly less than previously reported observations (Schauer, 1995).

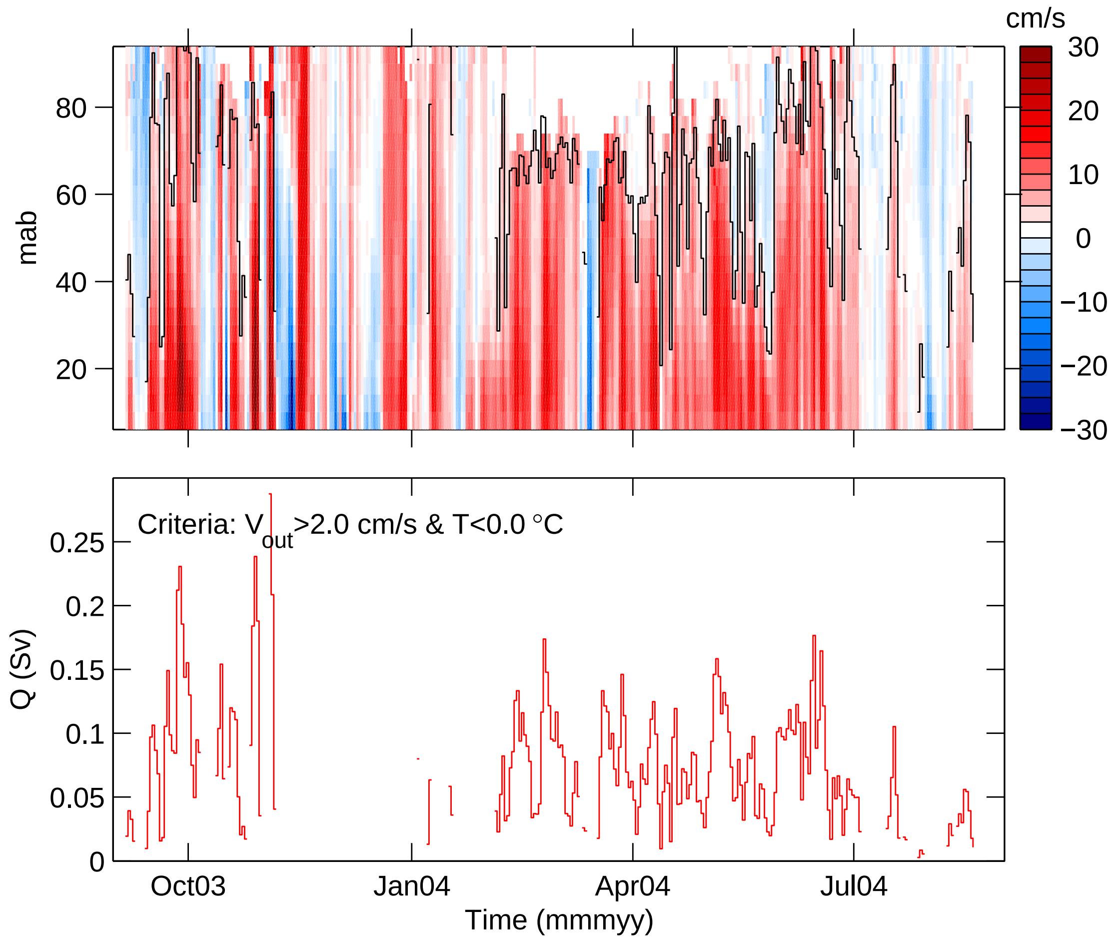

Figure 13. Daily averages of (upper panel) velocity component along 214°T (color-coded, positive out of the fjord) for each bin and estimated plume thickness (black), (lower panel) volume transport assuming 15 km width, for the times when the bottom temperature was less than 0°C.

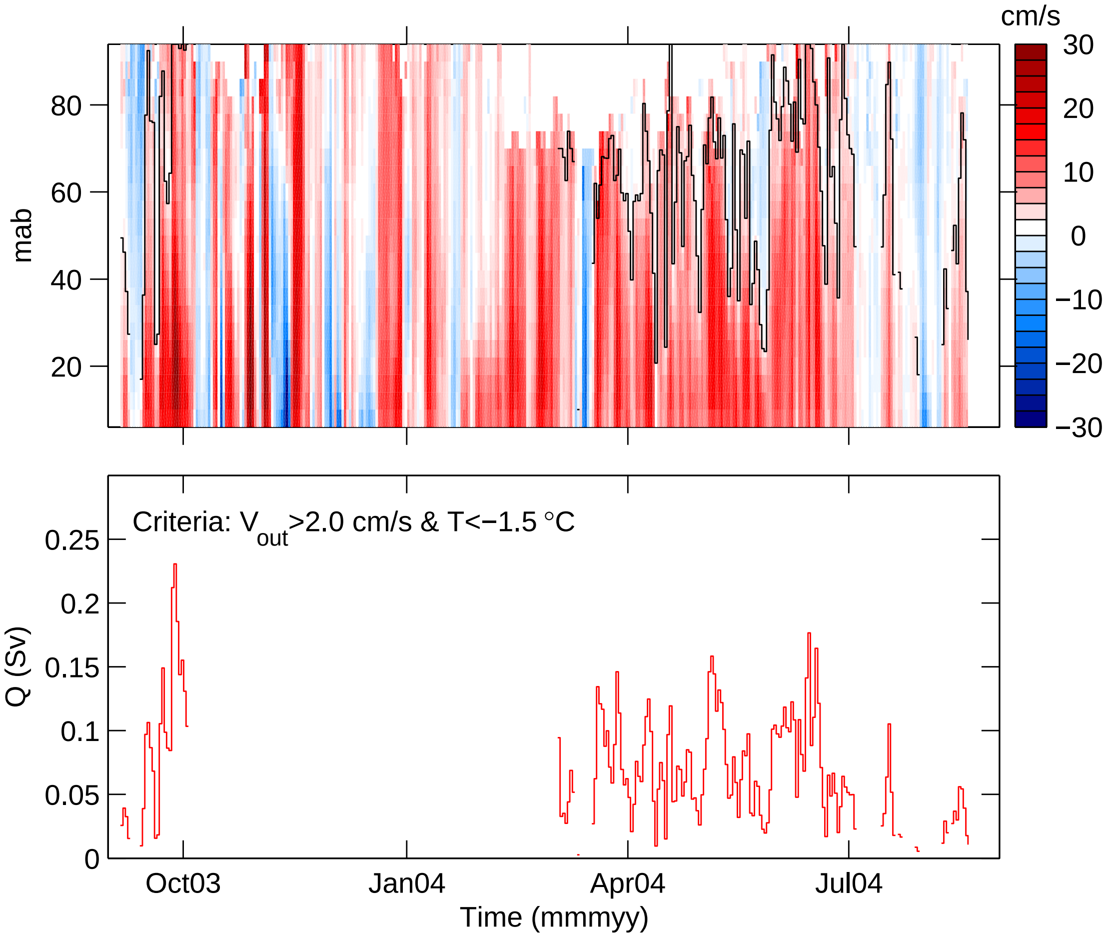

Figure 14. Same as Figure 13 but using bottom T < -1.5°C.

Table 4. Monthly averaged transport of the overflow using the criteria V_{out} > 2 cm s^{-1} and T<0 °C. V_{out} is the velocity component out of the fjord along the principal axis, V_{max} is its maximum recorded value during the month, h is the thickness of the overflow, Q is the volume transport assuming a width of 15 km, duration is the percent of the month when overflow was detected. The values of/all indicate the averages over the duration of the overflow and those over the whole month (i.e. overflow properties set to nil when not observed), respectively. The last row is the average over all months.

Month (mmmyy)	**V_{out} (of/all) (cm s^{-1})**	**V_{max} (cm s^{-1})**	**h (of/all) (m)**	**Q (of/all) (Sv)**	**Duration (%)**
Sep03	8.7/ 6.8	28.9	67.5/52.6	0.10/ 0.08	77.8
Oct03	9.2/ 5.4	36.5	68.4/40.0	0.10/ 0.06	58.5
Nov03	15.2/ 1.2	30.0	64.8/ 5.0	0.17/ 0.01	7.6
Dec03	0.0/ 0.0	0.0	0.0/ 0.0	0.0/ 0.00	0.0
Jan04	4.2/ 0.3	9.9	77.2/ 5.4	0.05/ 0.00	7.0
Feb04	8.6/ 6.9	19.7	64.1/51.5	0.08/ 0.07	80.3
Mar04	8.0/ 6.1	19.0	64.7/49.9	0.08/ 0.06	77.2
Apr04	6.9/ 6.6	20.1	59.9/57.7	0.06/ 0.06	96.4
May04	8.4/ 8.4	18.8	58.1/58.1	0.08/ 0.08	100.0
Jun04	7.3/ 7.3	18.7	74.8/74.8	0.08/ 0.08	100.0
Jul04	4.1/ 1.4	17.5	58.0/19.5	0.04/ 0.01	33.6
Aug04	4.2/ 2.2	18.6	49.6/26.4	0.03/ 0.02	53.2
Ave.	**7.7/ 4.4**	**21.6**	**64.3/36.7**	**0.08/ 0.04**	**57.6**

Table 5. Same as Table 4, but using T < -1.5 °C.

Month (mmmyy)	**V_{out} (of/all) (cm s^{-1})**	**V_{max} (cm s^{-1})**	**h (of/all) (m)**	**Q (of/all) (Sv)**	**Duration (%)**
Sep03	8.7/ 6.7	28.9	67.6/51.5	0.10/ 0.08	76.1
Oct03	8.8/ 0.2	17.2	94.0/ 1.8	0.12/ 0.00	1.9
Nov03	0.0/ 0.0	0.0	0.0/ 0.0	0.0/ 0.00	0.0
Dec03	0.0/ 0.0	0.0	0.0/ 0.0	0.0/ 0.00	0.0
Jan04	0.0/ 0.0	0.0	0.0/ 0.0	0.0/ 0.00	0.0
Feb04	0.0/ 0.0	0.0	0.0/ 0.0	0.0/ 0.00	0.0
Mar04	8.2/ 4.5	19.0	64.8/35.6	0.08/ 0.04	55.0
Apr04	6.9/ 6.6	20.1	59.9/57.7	0.06/ 0.06	96.4
May04	8.4/ 8.4	18.8	58.1/58.1	0.08/ 0.08	100.0
Jun04	7.3/ 7.3	18.7	74.8/74.8	0.08/ 0.08	100.0
Jul04	4.1/ 1.3	17.5	58.7/19.1	0.04/ 0.01	32.5
Aug04	4.2/ 2.2	18.6	49.6/26.4	0.03/ 0.02	53.2
Ave.	**7.1/ 3.1**	**19.8**	**65.9/27.1**	**0.07/ 0.03**	**42.9**

9. Principal component analysis

In order to extract the vertical structure that characterizes the baroclinic current, a principal component analysis is conducted by calculating empirical orthogonal functions (EOF) for time-depth varying east and north baroclinic components. The analysis is applied at monthly windows to check the seasonal variability which is expected to respond to changes in stratification. The structures from the first three dominant modes are given in Figure 15. The variance explained by each mode is shown in Figure 16. While both east and north components trace comparable first mode vertical structure during most of the time, they are completely out of phase in October-November 2003, March-May 2004. All three modes have identical east-north vertical structures in January and June 2004. Both components explain comparable amount of the total variance associated with each component, first mode alone accounting for to within 40-70%.

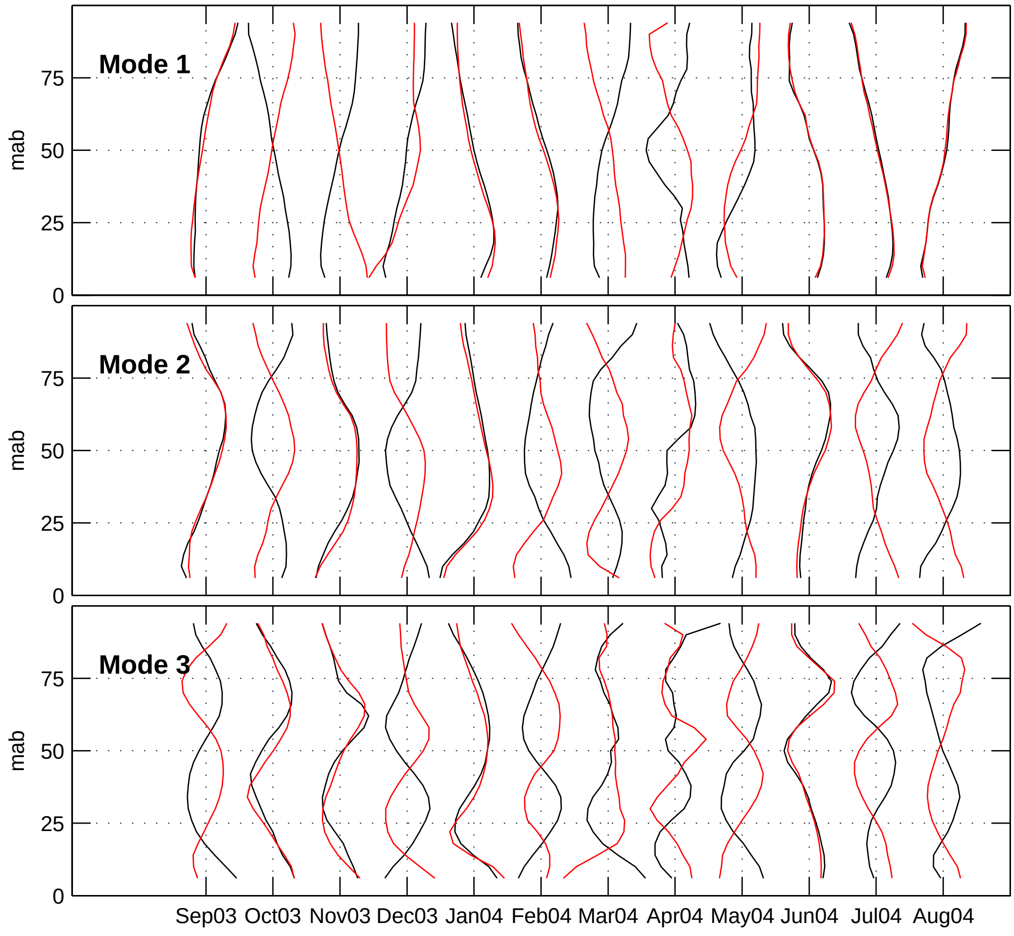

Figure 15. Profiles of factor loading for the first three EOF modes of the baroclinic east (black) and north (red) component derived at monthly segments.

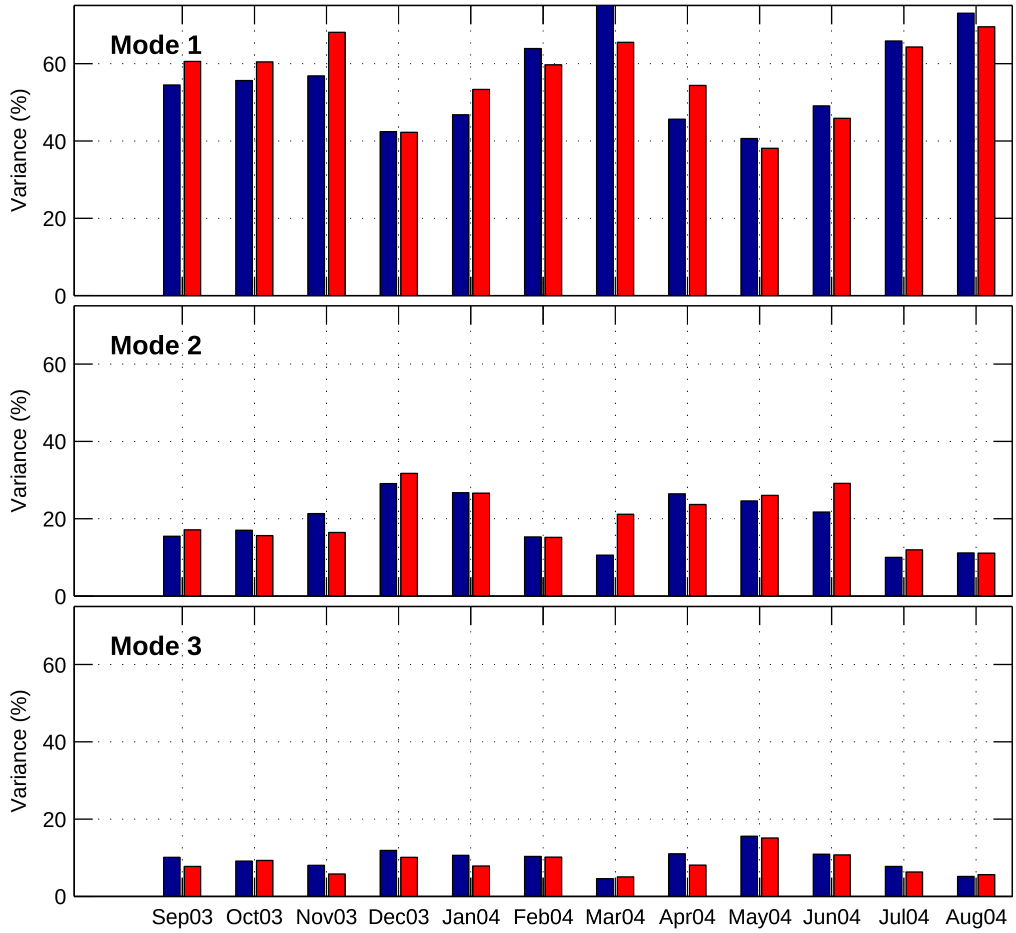

Figure 16. The percentage of the total (baroclinic) variance explained by the first three EOF modes of the east (blue) and north (red) component.

10. Spectral analysis

The spectral analysis is conducted using the barotropic (depth-averaged) and baroclinic (depth-average removed from each bin at each time) time series. Rotary components (clockwise, CW, and counter-clockwise, CCW) of the spectra are calculated using 10-min data using half-overlapping 14 day windows (2016 ensembles). Each window is de-meaned and Hanned.

Figure 17 shows the average barotropic spectra for the rotary components of the horizontal velocity and the vertical components of the velocity (a, c) and depth averaged baroclinic spectra. Each spectrum is averaged over all available 14 day spectra. Barotropic spectra (both horizontal and vertical components) show significant peaks at diurnal and semidiurnal band (also near-inertial) as well as MK_3, M_4 and M_6 tidal frequencies. The CW component is dominating in the mean baroclinic spectrum at all frequencies.

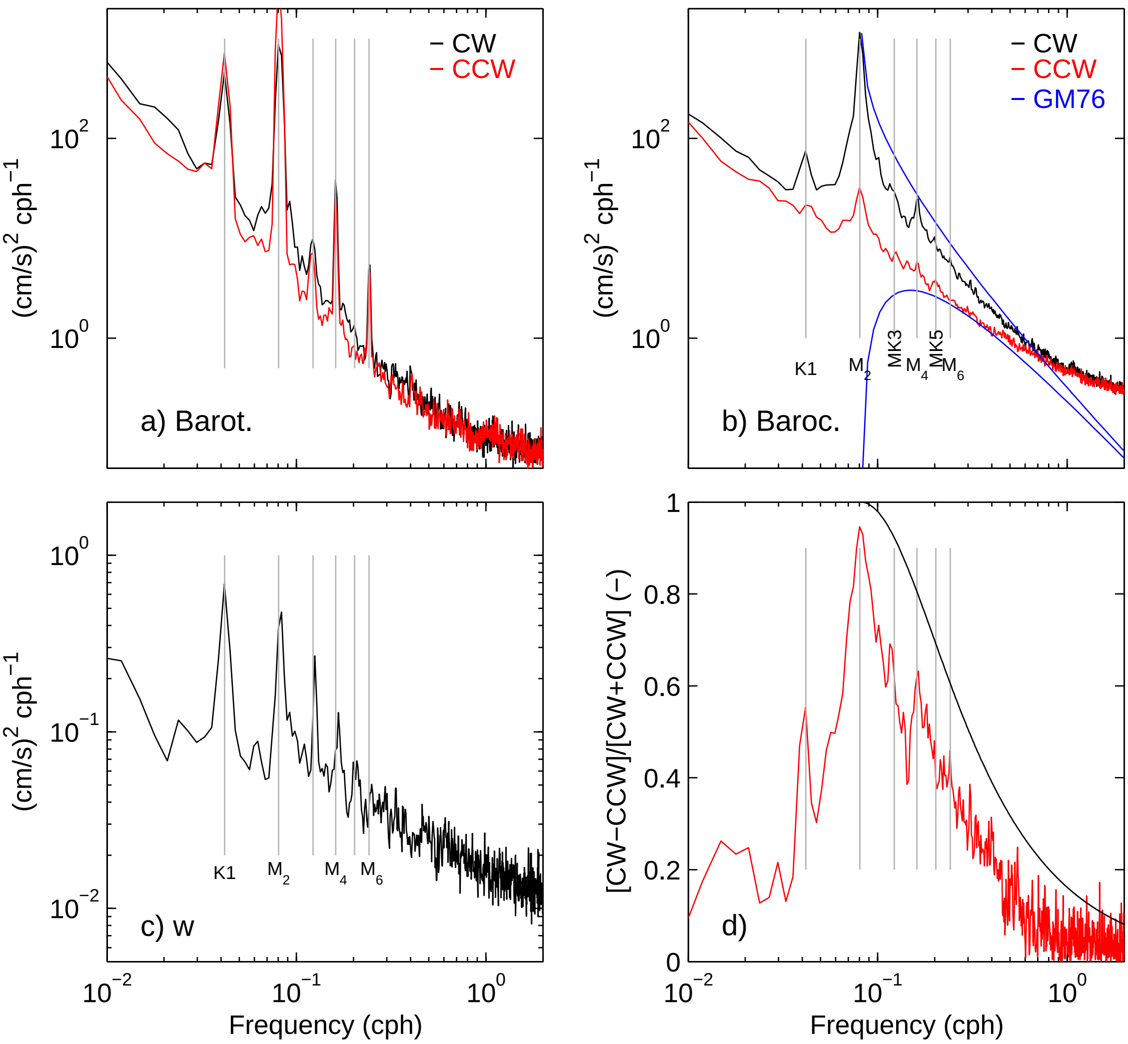

Figure 17. Frequency spectra for a) CW and CCW components of the barotropic (depth averaged) horizontal current, b) CW and CCW components of baroclinic (observed minus barotropic) horizontal current, c) vertical component of the velocity and d) the rotary coefficient (CW-CCW)/(CW+CCW) for the baroclinic CW and CCW spectra shown in b. In all panels K_1, M_2, MK_3, M_4, MK_5, and M6 tidal constituents are indicated. The blue curves in b) are the corresponding Garrett-Munk spectrum (Levine et al., 1985). The black curve in d) is the relation expected from a linear internal wave (van Haren, 2003).

The frequency-depth distribution of the baroclinic spectral variance for the CW and CCW components are shown in Figure 18 for two selected months, March and July 2004 when the vertical structure of the first baroclinic empirical mode (Figure 15) and the distribution of baroclinic tidal ellipses are significantly different (see Figure 22 introduced later). The baroclinic spectra for selected bins (6, 30, 50, 66 mab) are summarized in Figure 19 for each month (i.e., typically 4 spectra averaged).

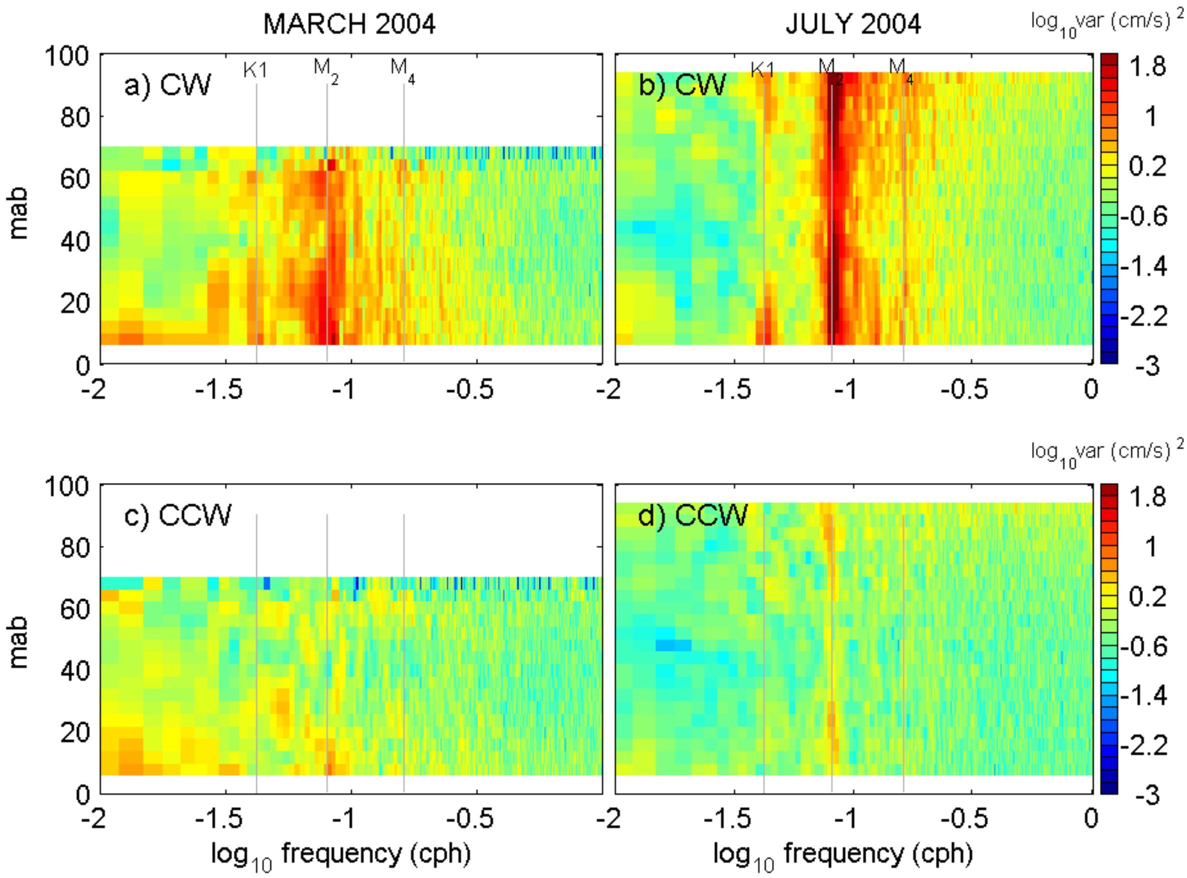

Figure 18. Frequency- height above bottom distribution of the variance of (a-b) CW (c-d) and CCW component of the baroclinic velocity derived in (a-c) March 2004 and (c-d) July 2004. The log-10 base variance is color-coded. K_1, M_2 and M_4 tidal constituent frequencies are indicated.

The most dominant features observed in Figure 18 are that more variance is observed at both CW and CCW components at sub-inertial frequencies in March and more broadly distributed (in frequency) variance in March compared to K_1, M_2 and M_4 narrow-band structure in July.

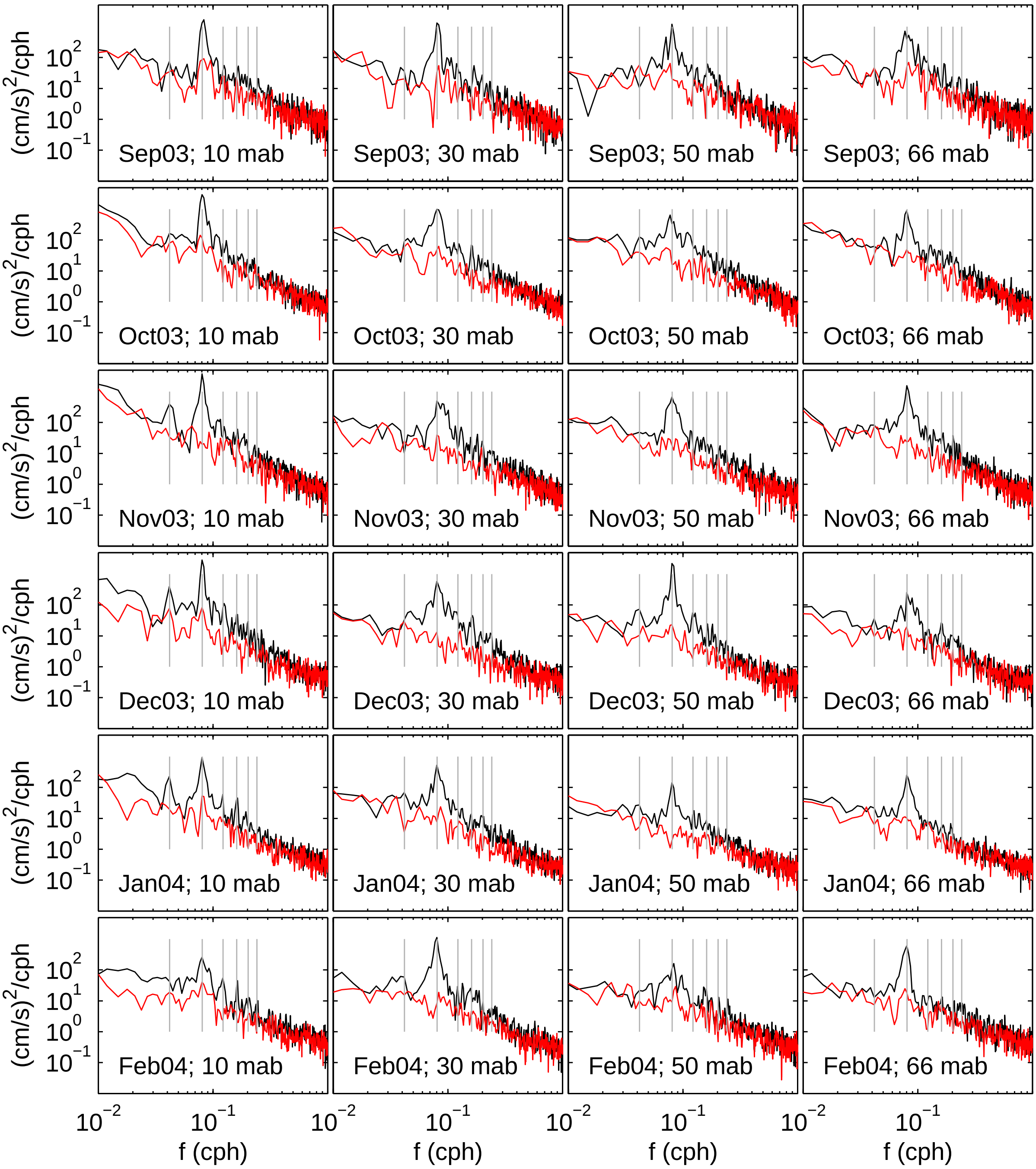

Figure 19. Frequency spectra of CW (black) and CCW (red) rotary components of the horizontal baroclinic velocity for selected depth bins (columns: 10, 30, 50 and 66 mab) for each month (rows). Gray vertical lines mark (from left to right) K_1, M_2, MK_3,M_4, MK_5, and M_6 frequencies.

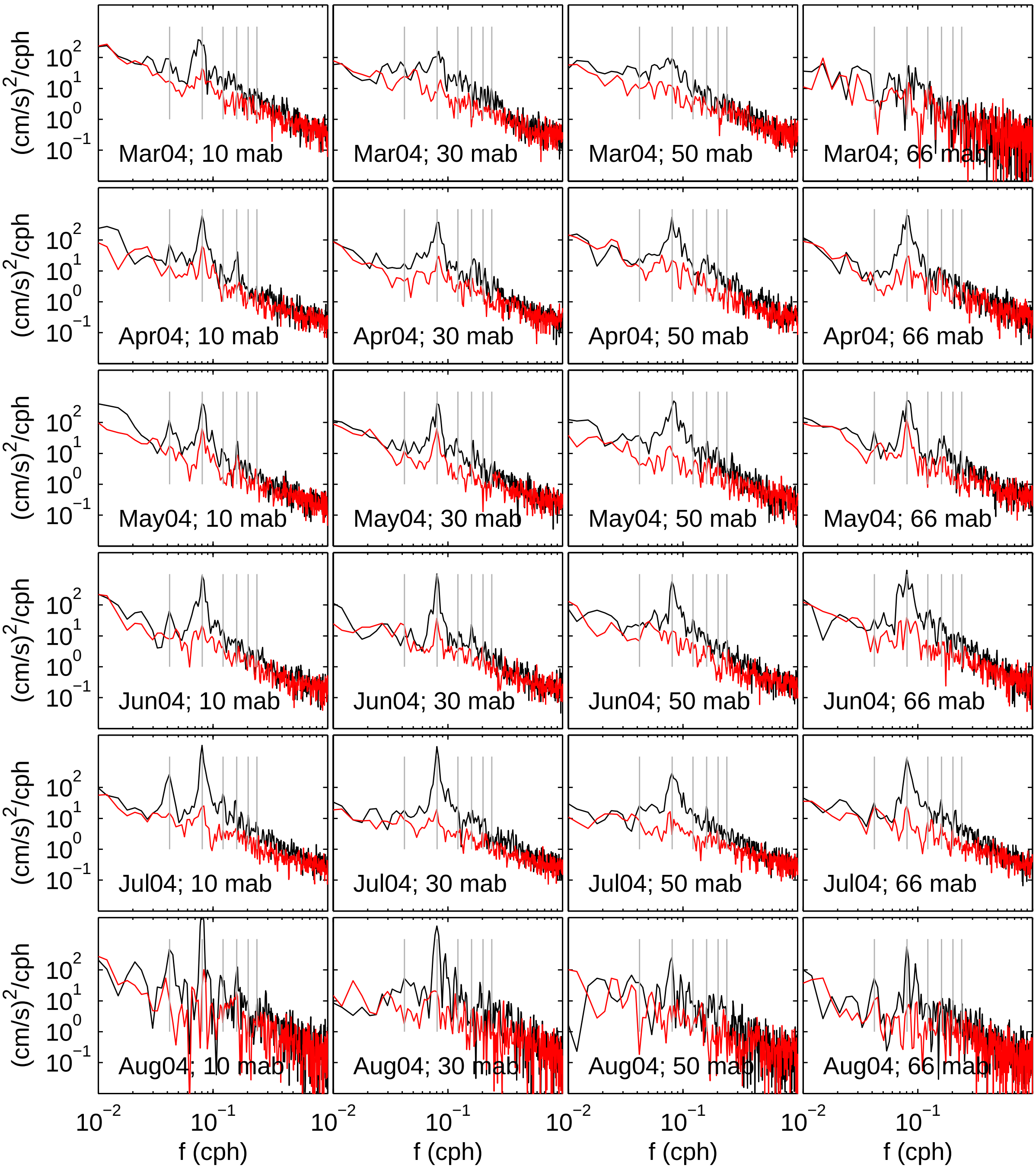

Figure 19. Continued.

11. Tidal analysis

Tidal analysis is conducted using harmonic analysis (Pawlowicz et al., 2002) of hourly averaged time series in monthly segments (first day to last day of each month). Because September 2003 and August 2004 are not fully covered, 4 days from October 2003 and 12 days from July 2004 are included, respectively, to complete one month duration.

11.1. Barotropic tides

Barotropic current is approximated by depth averaging over all bins every hour. The properties of the tidal ellipses for constituents Q_1, O_1, K_1, N_2, M_2, S_2, M_4 and M_6 are calculated for the barotropic current. Monthly time series of the barotropic tidal ellipses are shown in Figure 20 for the three dominant constituents, M_1, M_2, and S_2. Semi-major and semi-minor amplitudes, ellipse orientation, phase relative to Greenwich, signal-to-noise ratio and the variance accounted for each constituent are tabulated in detail, together with 95% confidence intervals for all 8 constituents in Table 6.

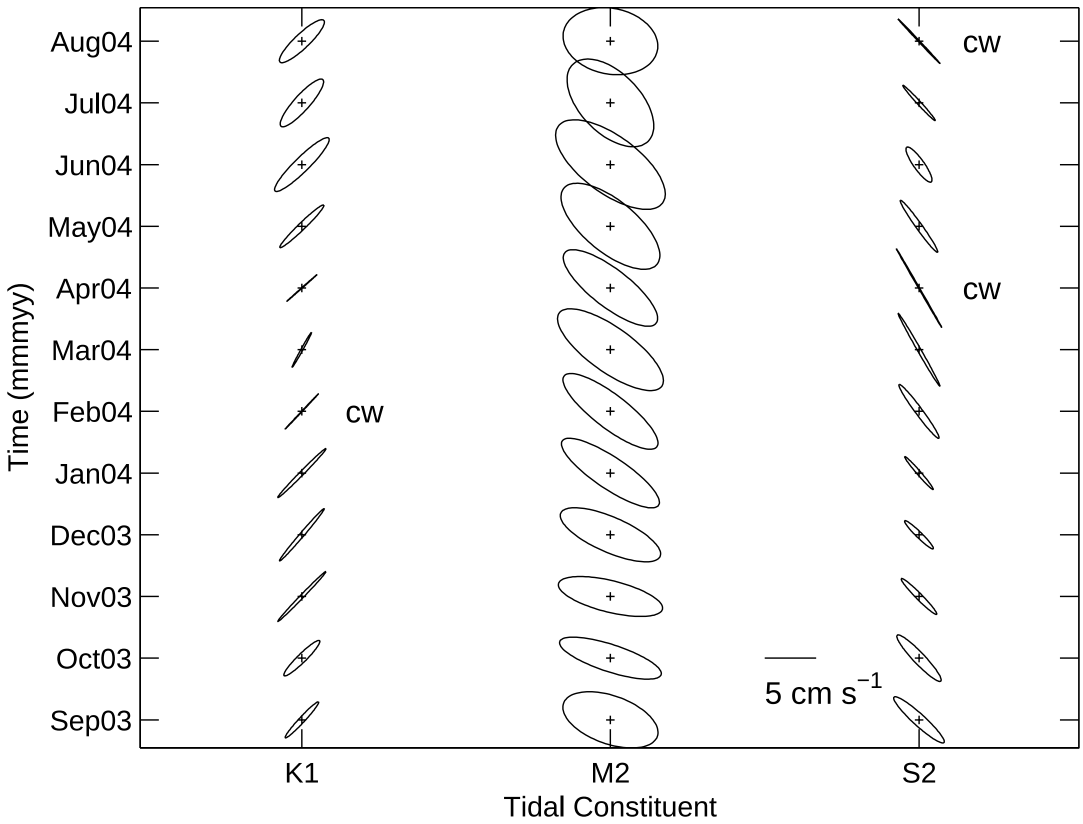

Figure 20. Monthly tidal ellipses derived from the barotropic currents for K_1, M_2 and S_2 tidal constituents. The aspect ratio of the axes is unity and ellipses are not distorted. All ellipses but those marked by cw are counter-clockwise rotating.

Table 6. Barotropic tide properties for the given months (first column) and constituents (second column). The properties shown are the amplitude of the major axis (M), minor axis (m), the ellipse orientation (Phi) and phase, signal-to-noise ratio (SNR) and the percentage of variance accounted for each constituent (VA). Figures following ± are 95% confidence intervals.

Month	Constituent	M (cm s^{-1})	m (cm s^{-1})	Phi (°)	Phase (°)	SNR	VA (%)
Sep. 03	Q1	0.32 ±0.39	0.19 ±0.33	31.2 ± 74.6	294.5 ±111.9	0.6	0.1
	O1	0.66 ±0.34	0.16 ±0.48	48.5 ± 44.2	198.3 ± 36.5	3.7	0.3
	K1	2.38 ±0.48	0.27 ±0.48	47.1 ± 10.8	235.6 ± 12.2	24.7	4.2
	N2	0.59 ±0.52	0.19 ±0.61	21.5 ± 90.8	81.2 ± 70.0	1.3	0.3
	M2	4.84 ±0.56	2.34 ±0.78	160.5 ± 12.1	236.3 ± 10.9	74.6	21.2
	S2	3.28 ±0.72	0.57 ±0.60	137.7 ± 12.4	289.4 ± 13.7	20.9	8.1
	M4	0.69 ±0.09	-0.14 ±0.11	103.8 ± 9.8	7.2 ± 9.6	55.3	0.4
	M6	0.19 ±0.11	0.00 ±0.09	95.9 ± 33.3	336.6 ± 30.9	2.9	0.0
Oct. 03	Q1	0.31 ±0.31	-0.15 ±0.33	13.0 ±103.4	287.4 ± 72.0	1.0	0.1
	O1	1.05 ±0.37	-0.31 ±0.34	53.4 ± 22.3	174.0 ± 23.7	8.3	0.6
	K1	2.42 ±0.42	0.42 ±0.39	44.5 ± 9.6	228.5 ± 9.4	33.4	2.8
	N2	1.17 ±0.39	-0.11 ±0.76	0.7 ± 40.1	57.2 ± 21.0	8.8	0.7
	M2	5.19 ±0.39	1.32 ±0.68	162.0 ± 8.3	240.6 ± 5.1	177.6	13.5
	S2	3.08 ±0.68	0.55 ±0.54	133.6 ± 10.1	265.6 ± 10.8	20.4	4.6
	M4	0.67 ±0.20	0.02 ±0.14	102.4 ± 13.4	358.4 ± 16.3	11.5	0.2
	M6	0.13 ±0.13	0.01 ±0.10	119.7 ± 38.0	333.1 ± 58.0	1.1	0.0
Nov. 03	Q1	0.71 ±1.01	-0.51 ±0.94	129.1 ± 97.4	232.3 ±127.9	0.5	0.3
	O1	0.16 ±0.94	-0.10 ±0.66	122.8 ± 70.6	108.4 ±210.3	0.0	0.0
	K1	3.37 ±1.30	0.17 ±1.23	46.1 ± 23.9	223.1 ± 22.3	6.8	4.5
	N2	1.36 ±0.52	0.30 ±0.51	165.2 ± 24.9	228.9 ± 23.4	6.8	0.8
	M2	5.21 ±0.48	1.54 ±0.55	166.2 ± 7.2	240.2 ± 6.1	119.6	11.7
	S2	2.44 ±0.50	0.30 ±0.49	134.7 ± 11.7	264.3 ± 13.0	24.2	2.4
	M4	0.68 ±0.26	-0.15 ±0.12	97.5 ± 13.8	6.0 ± 20.8	6.7	0.2
	M6	0.24 ±0.11	-0.05 ±0.11	87.6 ± 31.1	326.3 ± 33.5	4.6	0.0
Dec. 03	Q1	0.52 ±0.38	-0.02 ±0.39	36.2 ± 53.2	314.0 ± 45.7	1.9	0.2
	O1	0.49 ±0.38	-0.01 ±0.36	41.3 ± 50.4	189.2 ± 47.2	1.6	0.2
	K1	3.35 ±0.44	0.20 ±0.40	49.5 ± 6.3	230.9 ± 7.0	59.1	9.1
	N2	1.25 ±0.40	0.63 ±0.54	153.4 ± 36.2	194.3 ± 31.4	9.5	1.6
	M2	5.27 ±0.41	1.72 ±0.54	156.5 ± 7.3	235.5 ± 5.9	162.5	24.9
	S2	1.95 ±0.47	0.28 ±0.55	135.6 ± 14.9	271.4 ± 15.8	16.8	3.1
	M4	0.78 ±0.11	-0.02 ±0.09	97.2 ± 6.9	14.7 ± 8.8	49.3	0.5
	M6	0.22 ±0.10	-0.03 ±0.05	103.4 ± 15.0	350.6 ± 23.2	5.1	0.0
Jan. 04	Q1	0.47 ±0.52	0.12 ±0.53	31.5 ±105.0	359.6 ± 78.7	0.8	0.2
	O1	0.65 ±0.54	-0.00 ±0.59	22.9 ± 64.0	181.2 ± 52.3	1.4	0.4
	K1	3.34 ±0.69	0.19 ±0.64	45.5 ± 10.2	241.3 ± 11.6	23.3	11.5
	N2	1.05 ±0.37	0.06 ±0.52	173.6 ± 29.6	202.3 ± 18.7	8.2	1.1
	M2	5.63 ±0.45	1.55 ±0.45	146.3 ± 6.0	229.6 ± 5.0	159.3	35.3
	S2	2.11 ±0.45	0.19 ±0.39	130.9 ± 13.7	294.5 ± 13.2	22.3	4.6
	M4	0.67 ±0.12	-0.03 ±0.11	102.4 ± 9.9	4.9 ± 8.9	31.2	0.5
	M6	0.22 ±0.09	-0.01 ±0.08	89.4 ± 19.9	341.0 ± 24.0	5.9	0.1
Feb. 04	Q1	0.50 ±0.45	-0.18 ±0.43	75.7 ± 78.7	338.5 ± 71.4	1.2	0.3
	O1	0.43 ±0.42	-0.10 ±0.41	9.9 ± 77.5	133.8 ± 81.1	1.0	0.2
	K1	2.37 ±0.54	-0.03 ±0.54	46.7 ± 14.4	250.4 ± 13.1	19.1	5.8
	N2	0.93 ±0.37	0.01 ±0.71	170.7 ± 59.0	199.7 ± 29.6	6.5	0.9
	M2	5.67 ±0.55	1.65 ±0.72	142.6 ± 7.6	227.8 ± 6.3	105.6	36.3
	S2	3.26 ±0.66	0.34 ±0.53	126.5 ± 9.6	298.0 ± 10.1	24.2	11.2

Month	Constituent	M (cm s^{-1})	m (cm s^{-1})	Phi (°)	Phase (°)	SNR	VA (%)
	M4	0.51 ±0.18	-0.08 ±0.16	115.9 ± 19.4	16.8 ± 29.8	7.6	0.3
	M6	0.19 ±0.13	-0.02 ±0.10	91.9 ± 34.1	334.5 ± 43.8	2.2	0.0
Mar. 04	Q1	0.31 ±0.70	0.23 ±0.56	170.1 ±127.4	68.3 ±134.9	0.2	0.1
	O1	0.50 ±0.59	-0.04 ±0.61	164.8 ± 99.0	11.8 ± 88.6	0.7	0.1
	K1	1.94 ±0.89	0.09 ±0.62	61.0 ± 25.4	252.9 ± 24.7	4.7	2.1
	N2	1.49 ±0.86	-0.13 ±0.89	7.2 ± 35.9	44.3 ± 34.9	3.0	1.2
	M2	6.13 ±0.85	2.18 ±0.92	144.5 ± 9.7	231.9 ± 11.7	52.5	23.1
	S2	4.08 ±0.79	0.17 ±0.96	119.8 ± 12.5	280.7 ± 13.3	26.6	9.1
	M4	0.66 ±0.23	-0.04 ±0.15	107.3 ± 13.7	10.6 ± 18.6	7.9	0.2
	M6	0.21 ±0.12	0.03 ±0.09	98.7 ± 24.4	341.3 ± 39.7	2.8	0.0
Apr. 04	Q1	0.29 ±0.38	-0.02 ±0.27	99.0 ± 47.5	350.3 ± 85.4	0.6	0.1
	O1	0.36 ±0.28	-0.05 ±0.35	15.5 ± 77.7	211.5 ± 59.5	1.7	0.2
	K1	1.94 ±0.42	0.02 ±0.40	41.5 ± 12.1	206.7 ± 11.7	21.6	4.2
	N2	1.11 ±0.38	-0.02 ±0.48	152.3 ± 25.2	221.8 ± 22.5	8.3	1.4
	M2	5.61 ±0.46	1.85 ±0.47	142.4 ± 5.9	229.4 ± 4.6	150.9	39.4
	S2	4.42 ±0.50	-0.05 ±0.41	120.0 ± 4.6	270.9 ± 6.1	78.5	22.0
	M4	0.63 ±0.20	-0.13 ±0.13	108.8 ± 11.4	12.1 ± 21.0	10.1	0.5
	M6	0.12 ±0.11	0.03 ±0.08	98.0 ± 49.4	321.2 ± 68.9	1.3	0.0
May 04	Q1	0.63 ±0.32	-0.08 ±0.43	53.6 ± 45.6	340.6 ± 39.9	3.8	0.4
	O1	0.58 ±0.41	0.03 ±0.29	31.9 ± 29.9	159.3 ± 41.4	2.1	0.3
	K1	2.97 ±0.41	0.33 ±0.44	44.1 ± 7.1	210.4 ± 8.5	53.3	8.6
	N2	1.45 ±0.33	0.37 ±0.41	142.6 ± 15.7	220.8 ± 15.7	19.2	2.2
	M2	5.85 ±0.31	2.53 ±0.40	140.8 ± 5.0	225.9 ± 4.5	345.2	39.2
	S2	3.10 ±0.36	0.30 ±0.28	125.6 ± 5.9	265.4 ± 6.6	74.0	9.4
	M4	0.57 ±0.18	-0.02 ±0.15	113.7 ± 14.0	11.7 ± 19.9	10.1	0.3
	M6	0.20 ±0.12	-0.02 ±0.07	99.8 ± 18.4	324.3 ± 36.4	2.7	0.0
Jun. 04	Q1	0.28 ±0.24	0.09 ±0.25	163.8 ± 74.8	125.1 ± 75.0	1.3	0.1
	O1	0.49 ±0.28	0.09 ±0.27	40.1 ± 40.4	170.1 ± 36.6	3.1	0.2
	K1	3.66 ±0.26	0.71 ±0.29	44.5 ± 5.0	228.7 ± 4.8	191.2	13.1
	N2	1.60 ±0.30	0.71 ±0.39	126.7 ± 20.8	169.3 ± 17.7	29.1	2.9
	M2	6.30 ±0.46	2.78 ±0.35	143.6 ± 4.1	226.8 ± 4.9	185.4	44.7
	S2	2.07 ±0.32	0.51 ±0.42	125.4 ± 12.1	275.6 ± 10.3	42.7	4.3
	M4	0.64 ±0.10	-0.02 ±0.09	106.7 ± 8.0	10.1 ± 11.0	37.4	0.4
	M6	0.25 ±0.09	-0.03 ±0.06	107.4 ± 15.2	313.7 ± 26.0	7.2	0.1
Jul. 04	Q1	0.26 ±0.17	0.07 ±0.15	47.0 ± 41.9	3.7 ± 39.5	2.5	0.1
	O1	0.42 ±0.16	0.16 ±0.15	37.6 ± 26.7	180.3 ± 22.2	6.7	0.2
	K1	3.04 ±0.17	0.75 ±0.17	48.1 ± 3.7	245.9 ± 3.5	318.1	11.4
	N2	1.39 ±0.47	0.53 ±0.58	151.7 ± 37.3	175.8 ± 27.6	8.8	2.6
	M2	5.23 ±0.58	2.93 ±0.55	134.4 ± 10.5	208.5 ± 11.6	80.6	41.8
	S2	2.33 ±0.60	0.17 ±0.50	132.6 ± 14.0	295.4 ± 15.5	15.1	6.4
	M4	0.71 ±0.17	-0.06 ±0.08	106.6 ± 7.8	4.5 ± 12.7	18.2	0.6
	M6	0.22 ±0.06	0.05 ±0.07	106.8 ± 19.0	326.6 ± 20.2	11.5	0.1
Aug. 04	Q1	0.27 ±0.15	0.07 ±0.18	174.5 ± 53.9	106.4 ± 44.6	3.2	0.1
	O1	0.61 ±0.17	0.15 ±0.20	34.1 ± 19.3	181.5 ± 18.0	12.6	0.5
	K1	2.94 ±0.20	0.71 ±0.19	43.5 ± 4.0	247.6 ± 3.9	221.7	11.4
	N2	0.87 ±0.46	0.28 ±0.58	163.1 ± 47.1	174.6 ± 44.5	3.6	1.0
	M2	4.65 ±0.50	3.19 ±0.56	168.7 ± 15.8	237.5 ± 15.1	85.0	39.8
	S2	2.97 ±0.52	-0.06 ±0.51	133.3 ± 10.9	297.1 ± 11.5	32.8	11.0
	M4	0.74 ±0.14	0.01 ±0.19	108.1 ± 14.5	4.6 ± 12.7	26.7	0.7
	M6	0.17 ±0.10	0.01 ±0.07	109.3 ± 18.8	341.6 ± 37.9	3.0	0.0

11.2. Baroclinic tides

Baroclinic current is approximated by removing the depth-mean profile at each time from each bin. The properties of the tidal ellipses for dominant constituents are then calculated for the baroclinic current. Here only K_1 and M_2 constituents are reported. Monthly time series of the baroclinic tidal ellipses for each bin are shown in Figure 21 for K_1 and in Figure 22 for M_2. There is significant variability both with depth and with time, especially for the semi-diurnal constituent. Semi-major and semi-minor amplitudes, ellipse orientation, phase relative to Greenwich, signal-to-noise ratio and the variance accounted for these constituents at each resolved depth bin are tabulated in detail, together with 95% confidence intervals in Table 7 and Table 8. Only the months March and August 2004, which show significant differences in vertical structure, are summarized for brevity.

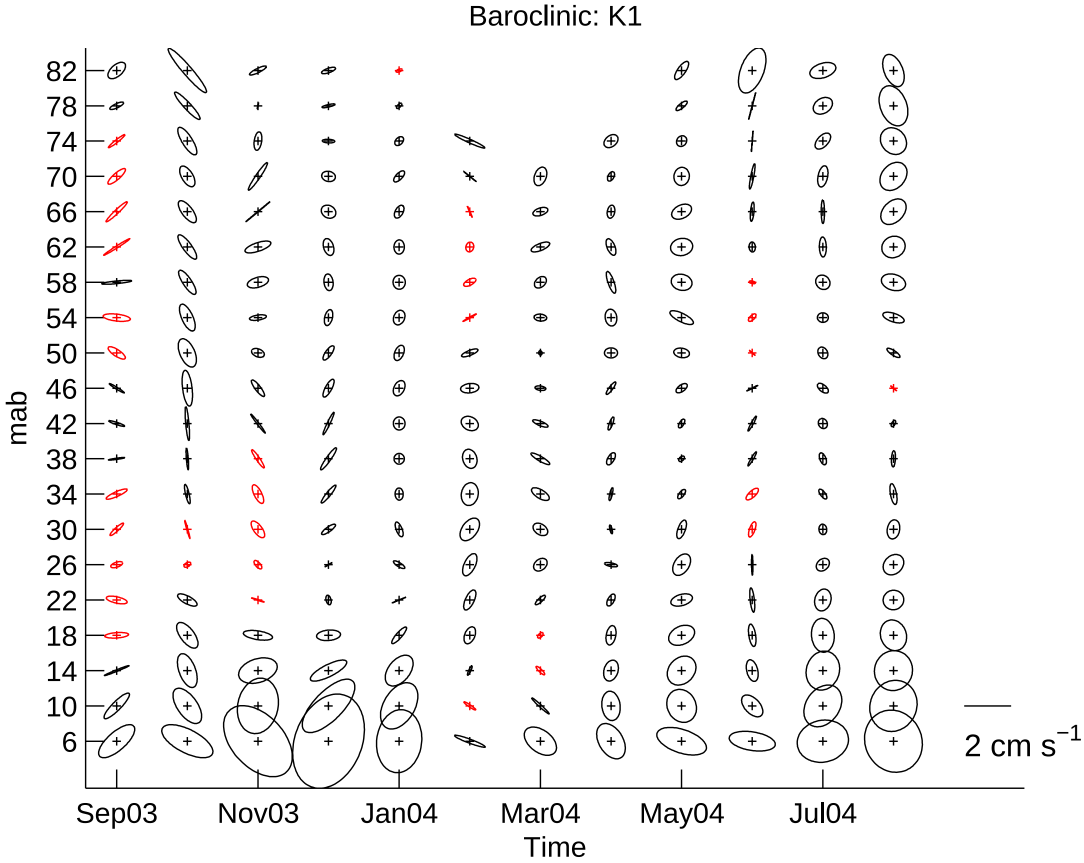

Figure 21. Baroclinic tidal ellipses derived for the K_1 constituent at each bin (vertical axis, mab) for each month (horizontal axis) of the record. The rotation of the ellipses in black (red) is clockwise (counter-clockwise).

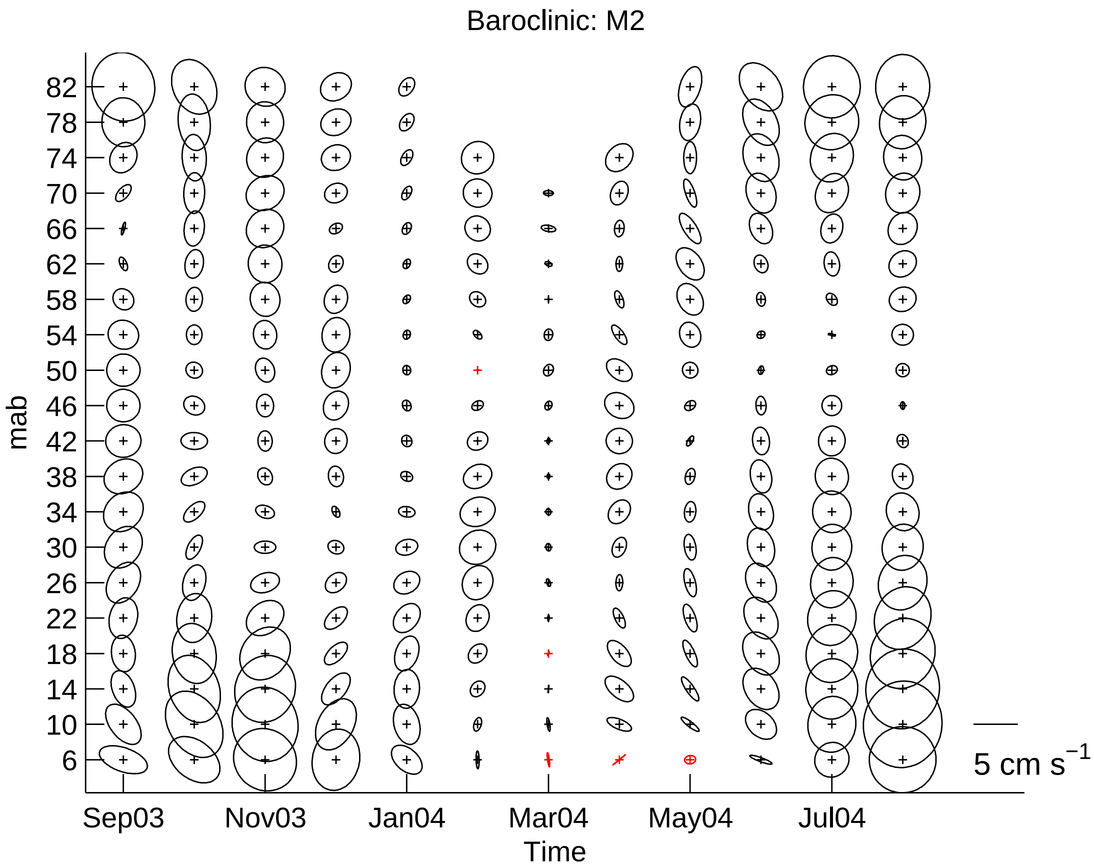

Figure 22. Same as Figure 21, but for the M_2 constituent. Note the different scale.

Table 7. Baroclinic tide properties for the K_1 constituent for March and August 2004 at resolved vertical bins. The properties shown are the amplitude of the major axis (M), minor axis (m), the ellipse orientation (Phi) and phase, signal-to-noise ratio (SNR) and the percentage of variance accounted for each constituent (VA). Figures following ± are 95% confidence intervals

Month	mab	M (cm s^{-1})	m (cm s^{-1})	Phi (°)	Phase (°)	SNR	VA (%)
Mar. 04	6.0	0.78 ±0.55	-0.47 ±0.56	143.1 ± 85.8	305.0 ± 89.3	2.0	1.4
	10.0	0.50 ±0.41	-0.05 ±0.39	137.4 ± 65.4	328.9 ± 62.5	1.5	0.5
	14.0	0.25 ±0.30	0.06 ±0.28	135.9 ± 88.7	352.2 ± 95.3	0.7	0.2
	18.0	0.15 ±0.32	0.08 ±0.22	45.4 ± 84.1	296.0 ±160.9	0.2	0.1
	22.0	0.28 ±0.36	-0.08 ±0.37	42.5 ± 66.3	281.4 ± 97.5	0.6	0.3
	26.0	0.32 ±0.31	-0.23 ±0.30	39.2 ± 99.1	285.4 ±108.0	1.1	0.6
	30.0	0.34 ±0.28	-0.22 ±0.26	147.3 ± 86.1	165.8 ± 81.1	1.5	0.8
	34.0	0.43 ±0.30	-0.18 ±0.30	149.0 ± 60.8	154.4 ± 50.4	2.1	1.2
	38.0	0.46 ±0.26	-0.10 ±0.28	149.9 ± 33.5	167.4 ± 39.8	3.1	1.4
	42.0	0.35 ±0.39	-0.10 ±0.28	158.4 ± 57.7	165.0 ± 87.4	0.8	0.9
	46.0	0.23 ±0.41	-0.09 ±0.36	172.4 ± 75.0	164.0 ±128.1	0.3	0.4
	50.0	0.10 ±0.38	-0.07 ±0.36	96.8 ±139.8	344.7 ±205.3	0.1	0.1
	54.0	0.27 ±0.38	-0.15 ±0.35	175.2 ±151.1	325.8 ±145.1	0.5	0.4
	58.0	0.29 ±0.28	-0.20 ±0.28	41.7 ± 97.6	131.8 ± 96.6	1.1	0.4
	62.0	0.42 ±0.40	-0.15 ±0.43	22.0 ± 88.1	167.6 ± 81.5	1.1	0.5
	66.0	0.33 ±0.36	-0.16 ±0.40	18.2 ±110.4	155.5 ± 89.7	0.8	0.3
	70.0	0.41 ±0.51	-0.25 ±0.39	69.9 ± 62.6	128.4 ±121.2	0.6	0.4
Aug. 04	6.0	1.34 ±0.31	-1.20 ±0.33	114.7 ± 71.6	304.8 ± 80.7	18.3	3.5
	10.0	1.10 ±0.37	-0.98 ±0.37	66.1 ± 80.9	347.2 ± 86.4	8.7	2.3
	14.0	0.85 ±0.34	-0.81 ±0.34	73.1 ±105.1	340.8 ±109.4	6.4	1.7
	18.0	0.66 ±0.28	-0.54 ±0.19	109.1 ± 61.9	297.3 ± 79.2	5.5	1.1
	22.0	0.44 ±0.17	-0.41 ±0.18	11.5 ±118.9	31.5 ±114.6	6.3	0.6
	26.0	0.48 ±0.25	-0.38 ±0.28	43.8 ± 92.2	6.0 ± 93.8	3.7	0.8
	30.0	0.41 ±0.25	-0.26 ±0.28	79.7 ± 92.8	339.4 ± 72.0	2.7	0.6
	34.0	0.45 ±0.23	-0.13 ±0.32	100.6 ± 57.4	322.1 ± 34.6	3.8	0.7
	38.0	0.34 ±0.27	-0.08 ±0.29	86.7 ± 63.4	306.7 ± 59.1	1.7	0.5
	42.0	0.15 ±0.17	-0.07 ±0.20	59.7 ±102.9	322.9 ±105.1	0.8	0.1
	46.0	0.17 ±0.17	0.01 ±0.16	139.9 ± 89.9	78.5 ± 76.5	1.0	0.2
	50.0	0.33 ±0.20	-0.10 ±0.26	146.6 ± 49.3	53.1 ± 54.1	2.8	0.6
	54.0	0.47 ±0.26	-0.18 ±0.31	161.6 ± 50.7	30.7 ± 45.3	3.3	1.2
	58.0	0.52 ±0.25	-0.34 ±0.37	163.8 ± 85.6	31.5 ± 62.6	4.5	1.5
	62.0	0.51 ±0.21	-0.45 ±0.19	26.1 ±108.2	182.2 ± 86.0	5.6	1.5
	66.0	0.63 ±0.15	-0.43 ±0.17	45.8 ± 39.2	183.2 ± 38.1	16.9	1.8
	70.0	0.67 ±0.16	-0.49 ±0.17	48.8 ± 41.3	189.6 ± 38.3	17.9	2.0
	74.0	0.60 ±0.15	-0.51 ±0.16	131.5 ± 65.2	118.5 ± 63.5	17.2	1.6
	78.0	0.88 ±0.17	-0.56 ±0.19	110.7 ± 26.3	146.0 ± 22.0	26.8	2.0

Table 8. Same as Table 7 but for the M_2 constituent.

Month	mab	M (cm s^{-1})	m (cm s^{-1})	Phi (°)	Phase (°)	SNR	VA (%)
Mar. 04	6.0	0.81 ±1.10	0.10 ±0.91	97.9 ± 71.8	29.1 ±103.0	0.6	1.2
	10.0	0.77 ±1.01	-0.15 ±1.16	98.4 ±114.0	359.2 ±102.2	0.6	1.3
	14.0	0.40 ±0.89	-0.01 ±0.79	82.2 ±122.9	342.6 ±146.7	0.2	0.4
	18.0	0.24 ±0.78	0.02 ±0.78	66.3 ±132.0	302.8 ±186.2	0.1	0.2
	22.0	0.33 ±0.79	-0.09 ±0.76	86.0 ±141.1	263.3 ±167.1	0.2	0.3
	26.0	0.44 ±0.80	-0.20 ±0.79	108.8 ±112.3	247.3 ±141.0	0.3	0.8
	30.0	0.43 ±0.73	-0.28 ±0.60	97.4 ±101.1	255.6 ±151.9	0.3	1.2
	34.0	0.36 ±0.51	-0.27 ±0.54	99.7 ±116.1	238.9 ±161.1	0.5	1.2
	38.0	0.26 ±0.39	-0.15 ±0.42	84.6 ±106.0	222.4 ±154.6	0.5	0.6
	42.0	0.31 ±0.43	-0.17 ±0.37	75.2 ± 68.8	179.1 ±111.6	0.5	0.9
	46.0	0.53 ±0.50	-0.36 ±0.48	64.1 ± 94.8	173.6 ±102.3	1.1	2.5
	50.0	0.68 ±0.64	-0.52 ±0.59	61.0 ±109.0	173.5 ±120.2	1.1	3.8
	54.0	0.65 ±0.75	-0.48 ±0.70	79.7 ±115.7	158.2 ±139.0	0.7	2.7
	58.0	0.26 ±0.76	-0.03 ±0.75	89.4 ±109.4	167.4 ±201.7	0.1	0.2
	62.0	0.42 ±0.92	-0.23 ±0.81	158.5 ±140.0	247.2 ±143.7	0.2	0.6
	66.0	0.83 ±0.92	-0.35 ±0.92	169.7 ± 91.7	253.4 ±113.0	0.8	1.6
	70.0	0.56 ±0.90	-0.28 ±0.90	177.8 ±105.5	237.4 ±145.5	0.4	0.7
Aug. 04	6.0	3.78 ±0.83	-3.73 ±0.79	24.2 ±142.2	299.4 ±145.4	20.5	30.6
	10.0	4.90 ±0.96	-4.43 ±0.91	80.2 ± 78.0	240.2 ± 80.8	26.2	45.1
	14.0	4.53 ±1.06	-4.14 ±1.01	78.2 ± 94.4	236.6 ±100.6	18.3	45.7
	18.0	4.03 ±1.05	-3.58 ±1.05	65.5 ±102.3	246.5 ±105.4	14.7	42.7
	22.0	3.63 ±1.36	-3.10 ±1.18	63.9 ± 84.6	247.0 ± 85.4	7.2	39.5
	26.0	3.14 ±1.48	-2.69 ±1.29	69.3 ± 97.9	242.4 ± 95.9	4.5	34.4
	30.0	2.61 ±1.57	-2.31 ±1.34	78.9 ±107.8	232.2 ±117.7	2.7	29.0
	34.0	2.16 ±1.23	-1.82 ±1.07	106.4 ± 96.1	203.9 ±103.8	3.1	24.4
	38.0	1.45 ±0.99	-1.12 ±0.96	112.6 ±100.3	191.3 ±103.1	2.2	14.4
	42.0	0.77 ±0.83	-0.60 ±0.77	114.4 ±113.4	167.5 ±115.0	0.9	5.0
	46.0	0.43 ±0.78	-0.25 ±0.66	92.0 ±100.2	119.8 ±133.4	0.3	1.4
	50.0	0.75 ±0.64	-0.74 ±0.69	145.9 ±135.8	9.3 ±143.1	1.4	6.0
	54.0	1.22 ±0.45	-1.17 ±0.48	169.8 ±125.6	332.9 ±117.1	7.4	12.9
	58.0	1.54 ±0.48	-1.35 ±0.50	23.3 ± 81.2	115.2 ± 77.8	10.3	15.7
	62.0	1.65 ±0.50	-1.37 ±0.45	38.3 ± 75.7	103.7 ± 69.8	10.7	15.2
	66.0	1.87 ±0.49	-1.58 ±0.44	62.2 ± 60.0	82.9 ± 60.1	14.8	18.7
	70.0	2.27 ±0.77	-1.92 ±0.73	77.4 ± 86.0	65.9 ± 86.2	8.8	25.6
	74.0	2.52 ±1.13	-2.15 ±1.03	97.3 ± 99.0	39.9 ± 99.7	5.0	27.4
	78.0	3.01 ±1.53	-2.61 ±1.29	79.4 ±109.1	57.9 ±117.5	3.9	28.8
	82.0	3.65 ±1.84	-3.05 ±2.07	89.2 ± 90.6	51.5 ± 97.4	3.9	30.7

12. APPENDIX A: Configuration of Sentinel ADCP

CR1	*Parameters set to factory defaults*
CF11101	*Flow control*
EA0	*Heading alignment*
EB0	*Heading bias*
ED0	*Transducer depth*
ES35	*Salinity*
EX11111	*Coordinate transformation*
EZ1111111	*Sensor source*
WB0	*Bandwidth control*
WD1111000000	*Data out*
WF176	*Blank after transmission*
WN30	*Number of depth cells*
WP33	*Pings per ensemble*
WS400	*Depth cell size*
WV170	*Ambiguity velocity*
TE00:10:00.00	*Time per ensemble*
TF03/09/04 12:00:00	*Time of first ping*
TP00:18.18	*Time between pings*
CK	*Parameters save as USER defaults*
CS	*START*

;
;Instrument = Workhorse Sentinel
;Frequency = 307200
;Beam angle = 20
;Temperature = 5.00
;Deployment hours = 7200.00
;Battery packs = 2
;Automatic TP = YES
; Memory size [MB] = 256
;
;Consequences generated by PlanADCP version 2.01:
;First cell range = 5.96 m
;Last cell range = 121.96 m
;Max range = 111.53 m
;Standard deviation = 0.54 cm/s
;Ensemble size = 748 bytes
;Storage required = 32.31 MB
;Power usage = 669.32 Wh
;Battery usage 1.5

13. APPENDIX B: Monthy Current Profile Statistics

See Table 3 for caption.

SEPTEMBER 2003

Bin	Gap	East		North		Vertical		Speed		Direction		SF
	%	mean	std	mean	std	mean	std	mean	std	mean	Std	
1	0.00	-4.57	7.08	-9.67	8.68	0.28	0.43	14.22	6.12	207.3	58.4	0.75
2	0.00	-6.30	7.91	-9.56	9.76	0.16	0.36	15.29	7.42	207.3	64.4	0.75
3	0.00	-6.78	7.90	-8.84	9.71	0.13	0.39	14.96	7.56	209.4	66.4	0.75
4	0.00	-6.53	7.80	-7.90	9.70	0.09	0.40	14.25	7.54	208.5	71.1	0.72
5	0.00	-5.98	7.48	-6.86	9.52	0.05	0.40	13.27	7.29	209.2	73.2	0.69
6	0.00	-5.47	7.12	-6.06	9.09	-0.01	0.38	12.33	6.92	205.5	77.6	0.66
7	0.00	-5.00	6.78	-5.25	8.75	-0.04	0.38	11.55	6.45	207.6	79.6	0.63
8	0.00	-4.49	6.45	-4.34	8.36	-0.09	0.37	10.73	5.94	208.3	83.0	0.58
9	0.00	-3.94	6.18	-3.61	8.10	-0.12	0.37	10.03	5.62	208.9	85.9	0.53
10	0.00	-3.45	6.01	-3.16	7.90	-0.15	0.37	9.54	5.42	203.2	89.5	0.49
11	0.00	-2.94	5.80	-2.66	7.62	-0.17	0.36	9.04	5.06	200.7	92.4	0.44
12	0.00	-2.54	5.58	-2.02	7.35	-0.20	0.37	8.57	4.72	198.3	95.7	0.38
13	0.16	-2.23	5.57	-1.38	7.14	-0.22	0.37	8.21	4.64	199.7	98.2	0.32
14	0.32	-1.98	5.84	-0.82	7.05	-0.23	0.38	8.16	4.66	195.4	102.3	0.26
15	0.47	-1.71	6.18	-0.52	7.12	-0.25	0.38	8.33	4.76	194.8	103.7	0.21
16	1.42	-1.64	6.43	-0.40	7.15	-0.26	0.41	8.55	4.71	184.7	104.9	0.20
17	1.90	-1.70	6.66	-0.23	7.11	-0.26	0.41	8.70	4.69	183.7	103.7	0.20
18	2.53	-1.79	7.12	-0.08	6.97	-0.27	0.41	8.97	4.68	186.5	104.3	0.20
19	3.01	-1.81	7.89	0.08	6.93	-0.29	0.42	9.52	4.77	190.7	101.5	0.19
20	4.11	-1.73	8.85	0.22	7.14	-0.28	0.42	10.34	5.03	183.7	102.0	0.17
21	4.75	-1.69	9.61	0.26	7.61	-0.26	0.42	11.17	5.32	187.1	102.8	0.15
22	4.11	-1.87	10.41	0.24	8.20	-0.24	0.40	12.16	5.56	191.9	100.8	0.16
23	3.64	-2.26	11.04	0.33	8.80	-0.27	0.47	12.98	5.99	198.2	99.8	0.18

OCTOBER 2003

Bin	Gap	East		North		Vertical		Speed		Direction		SF
	%	mean	std	mean	std	mean	Std	mean	std	mean	std	
1	0.00	-1.03	6.52	-5.24	12.91	-0.02	0.40	13.62	7.20	185.0	88.4	0.39
2	0.00	-2.10	7.55	-5.81	13.66	-0.03	0.38	14.62	8.25	192.5	88.3	0.42
3	0.00	-2.44	7.94	-5.88	12.85	-0.04	0.39	14.19	8.20	188.2	88.0	0.45
4	0.00	-2.44	8.01	-5.75	11.84	-0.09	0.40	13.40	7.98	189.4	86.3	0.47
5	0.00	-2.38	7.82	-5.34	11.12	-0.15	0.42	12.59	7.76	191.1	84.9	0.46
6	0.00	-2.34	7.62	-4.98	10.61	-0.22	0.42	11.93	7.65	192.4	83.6	0.46
7	0.00	-2.22	7.42	-4.58	10.12	-0.29	0.41	11.32	7.42	191.0	85.1	0.45
8	0.00	-2.18	7.24	-4.07	9.56	-0.35	0.41	10.73	7.06	188.2	88.8	0.43
9	0.00	-2.16	7.00	-3.56	9.04	-0.40	0.44	10.22	6.60	191.6	89.7	0.41
10	0.00	-2.07	6.86	-3.30	8.69	-0.44	0.45	10.06	6.04	192.3	89.4	0.39
11	0.00	-2.01	6.77	-2.91	8.67	-0.44	0.44	9.99	5.81	192.6	91.0	0.35
12	0.00	-2.13	6.89	-2.40	8.81	-0.43	0.45	10.04	5.87	195.3	93.9	0.32
13	0.27	-2.26	7.09	-2.00	8.61	-0.41	0.45	10.05	5.71	196.1	93.0	0.30
14	0.54	-2.38	7.20	-1.89	8.35	-0.38	0.45	10.00	5.55	202.5	90.5	0.30
15	0.94	-2.57	7.36	-1.68	8.35	-0.33	0.45	10.14	5.51	206.2	91.2	0.30
16	1.61	-2.87	7.52	-1.18	8.37	-0.29	0.44	10.23	5.60	204.7	93.5	0.30
17	2.02	-3.32	7.69	-0.75	8.52	-0.25	0.42	10.43	5.87	210.8	92.3	0.33
18	4.17	-3.68	8.18	-0.45	8.77	-0.20	0.40	10.87	6.27	211.3	92.2	0.34
19	7.80	-4.03	8.83	-0.22	9.26	-0.15	0.41	11.57	6.78	212.9	93.1	0.35
20	12.50	-4.20	9.61	0.37	9.93	-0.12	0.43	12.39	7.42	212.6	98.0	0.34
21	20.70	-4.88	10.76	1.18	10.37	-0.12	0.44	13.47	8.16	213.7	101.7	0.37
22	29.17	-4.94	11.47	2.02	11.42	-0.08	0.51	14.28	9.29	210.7	106.3	0.37
23	37.90	-4.62	11.86	2.83	11.23	-0.27	0.95	14.85	8.67	197.2	113.1	0.36

NOVEMBER 2003

Bin	Gap	East		North		Vertical		Speed		Direction		SF
	%	mean	std	mean	std	mean	Std	mean	std	mean	std	
1	0.00	0.48	8.29	-1.19	15.04	-0.21	0.46	15.15	8.17	169.5	98.9	0.08
2	0.00	-0.06	9.62	-2.04	14.61	-0.18	0.49	15.24	8.81	166.0	97.2	0.13
3	0.00	-0.26	9.69	-2.39	13.52	-0.17	0.48	14.41	8.63	163.7	95.7	0.17
4	0.00	-0.37	9.54	-2.44	12.41	-0.16	0.44	13.64	8.06	163.2	96.6	0.18
5	0.00	-0.37	9.35	-2.59	11.43	-0.14	0.41	13.04	7.39	164.3	96.4	0.20
6	0.00	-0.41	9.23	-2.73	10.78	-0.14	0.37	12.62	7.04	167.8	95.1	0.22
7	0.00	-0.54	9.18	-2.73	10.45	-0.13	0.35	12.41	6.86	169.6	94.5	0.22
8	0.00	-0.60	9.12	-2.67	10.16	-0.12	0.33	12.18	6.73	167.8	94.2	0.22
9	0.00	-0.57	9.00	-2.77	9.88	-0.10	0.31	11.98	6.54	166.7	93.1	0.24
10	0.00	-0.52	8.79	-2.95	9.65	-0.10	0.29	11.76	6.38	165.1	91.9	0.25
11	0.00	-0.41	8.62	-3.11	9.36	-0.09	0.28	11.48	6.31	163.7	91.4	0.27
12	0.00	-0.33	8.49	-3.21	9.10	-0.08	0.28	11.22	6.26	163.1	91.4	0.29
13	0.00	-0.28	8.44	-3.47	8.87	-0.08	0.29	11.08	6.26	164.6	89.4	0.31
14	0.00	-0.13	8.38	-3.88	8.67	-0.07	0.30	11.00	6.26	161.4	84.7	0.35
15	0.00	-0.19	8.51	-4.37	8.31	-0.05	0.31	11.03	6.22	160.7	79.8	0.40
16	0.14	-0.33	8.76	-4.72	7.76	-0.04	0.31	11.11	6.00	166.0	76.0	0.43
17	0.28	-0.58	8.89	-4.86	7.29	-0.04	0.31	11.06	5.82	173.9	75.5	0.44
18	1.53	-0.81	8.97	-4.98	7.03	-0.00	0.31	11.04	5.76	175.1	73.8	0.46
19	3.33	-0.88	9.09	-5.19	6.80	0.01	0.31	11.13	5.70	178.2	71.4	0.47
20	6.81	-0.97	9.50	-5.28	6.72	0.01	0.34	11.35	5.93	177.7	71.0	0.47
21	12.78	-0.89	9.58	-5.43	6.76	0.02	0.32	11.48	5.98	178.1	70.7	0.48
22	19.44	-0.83	10.05	-5.64	7.08	0.01	0.36	11.93	6.41	180.5	70.7	0.48
23	26.67	-1.02	10.39	-5.83	7.47	-0.01	0.43	12.36	6.75	182.9	70.4	0.48

DECEMBER 2003.

Bin	Gap	East		North		Vertical		Speed		Direction		SF
	%	mean	Std	mean	std	mean	std	mean	std	mean	std	
1	0.00	-0.02	7.54	-2.34	10.36	-0.15	0.32	11.96	5.14	163.1	91.9	0.20
2	0.00	-0.77	7.69	-3.64	8.92	-0.08	0.32	11.22	5.17	166.4	87.8	0.33
3	0.00	-1.07	7.27	-4.07	7.67	-0.09	0.31	10.12	5.18	165.4	84.6	0.42
4	0.00	-1.02	6.92	-4.05	6.94	-0.11	0.29	9.40	5.00	169.1	84.1	0.44
5	0.00	-0.88	6.76	-3.83	6.72	-0.11	0.28	9.08	4.88	170.5	84.0	0.43
6	0.00	-0.70	6.68	-3.62	6.67	-0.12	0.27	8.92	4.81	169.3	83.9	0.41
7	0.00	-0.48	6.56	-3.49	6.59	-0.12	0.25	8.70	4.81	165.6	83.1	0.41
8	0.00	-0.40	6.44	-3.43	6.45	-0.12	0.23	8.49	4.76	164.6	81.7	0.41
9	0.00	-0.40	6.37	-3.40	6.31	-0.12	0.22	8.39	4.65	165.3	78.9	0.41
10	0.00	-0.56	6.29	-3.46	6.23	-0.11	0.21	8.29	4.67	167.1	79.7	0.42
11	0.00	-0.75	6.28	-3.70	6.17	-0.11	0.22	8.33	4.72	166.6	78.0	0.45
12	0.00	-0.76	6.28	-3.88	6.18	-0.11	0.21	8.40	4.74	164.8	76.5	0.47
13	0.00	-0.75	6.05	-3.86	6.06	-0.11	0.20	8.18	4.68	166.6	77.0	0.48
14	0.00	-0.72	6.08	-3.83	5.83	-0.09	0.19	8.11	4.51	169.0	76.7	0.48
15	0.00	-0.90	6.01	-3.99	5.50	-0.09	0.20	7.96	4.45	174.6	74.6	0.51
16	0.00	-1.07	5.98	-4.04	5.39	-0.08	0.20	7.96	4.35	179.0	74.9	0.53
17	0.00	-1.18	6.18	-4.02	5.41	-0.06	0.20	8.14	4.32	183.1	75.5	0.51
18	0.27	-1.30	6.34	-3.94	5.45	-0.06	0.20	8.31	4.25	187.3	75.4	0.50
19	1.21	-1.40	6.25	-3.90	5.39	-0.05	0.22	8.28	4.07	188.1	74.8	0.50
20	3.63	-1.56	6.27	-3.83	5.24	-0.05	0.21	8.25	3.99	190.0	74.3	0.50
21	5.78	-1.81	6.36	-3.85	5.16	-0.03	0.21	8.28	4.07	190.6	73.9	0.51
22	8.74	-2.12	6.59	-3.88	4.97	-0.01	0.21	8.39	4.15	192.4	72.3	0.53
23	11.96	-2.60	7.03	-4.05	4.76	0.02	0.24	8.62	4.57	198.7	69.2	0.56

JANUARY 2004

Bin	Gap	East		North		Vertical		Speed		Direction		SF
	%	mean	std	mean	std	mean	std	mean	std	mean	std	
1	0.00	-2.51	6.08	-4.06	7.41	-0.07	0.24	9.72	4.48	203.1	76.3	0.49
2	0.00	-2.38	6.19	-3.98	7.66	-0.05	0.25	9.75	4.82	202.5	81.1	0.48
3	0.00	-1.96	5.90	-3.95	7.51	-0.06	0.24	9.34	4.81	197.9	83.2	0.47
4	0.00	-1.56	5.62	-3.82	7.51	-0.07	0.24	9.02	4.85	196.0	85.8	0.46
5	0.00	-1.01	5.44	-3.63	7.30	-0.07	0.23	8.53	4.92	186.2	86.4	0.44
6	0.00	-0.59	5.40	-3.43	6.99	-0.08	0.21	8.18	4.81	179.8	87.0	0.43
7	0.00	-0.33	5.45	-3.23	6.68	-0.08	0.20	7.93	4.67	180.0	87.2	0.41
8	0.00	-0.31	5.49	-3.04	6.32	-0.09	0.19	7.65	4.58	183.9	86.6	0.40
9	0.00	-0.32	5.54	-3.01	6.00	-0.08	0.19	7.48	4.45	182.5	85.0	0.40
10	0.00	-0.25	5.52	-3.07	5.68	-0.09	0.19	7.32	4.31	180.2	82.8	0.42
11	0.00	-0.19	5.43	-3.05	5.39	-0.09	0.19	7.10	4.17	178.7	81.6	0.43
12	0.00	-0.19	5.36	-3.00	5.14	-0.09	0.19	6.92	4.04	180.9	79.9	0.44
13	0.00	-0.25	5.34	-2.95	4.96	-0.09	0.18	6.81	3.92	183.0	79.6	0.43
14	0.00	-0.23	5.35	-2.91	4.79	-0.10	0.18	6.76	3.79	183.7	78.6	0.43
15	0.00	-0.25	5.35	-2.86	4.57	-0.09	0.18	6.67	3.64	181.9	77.5	0.43
16	0.00	-0.25	5.37	-2.85	4.43	-0.08	0.19	6.63	3.56	182.5	76.5	0.43
17	0.00	-0.35	5.39	-2.84	4.34	-0.07	0.19	6.63	3.48	183.9	76.0	0.43
18	0.00	-0.43	5.45	-2.82	4.21	-0.05	0.19	6.63	3.41	184.7	75.2	0.43
19	0.54	-0.57	5.54	-2.80	4.11	-0.03	0.21	6.67	3.36	188.3	74.6	0.43
20	3.90	-0.69	5.60	-2.79	4.08	-0.01	0.22	6.73	3.31	189.7	75.1	0.43
21	7.80	-0.80	5.79	-2.78	3.95	0.03	0.25	6.81	3.31	190.5	74.4	0.42
22	11.42	-0.94	6.09	-2.93	3.91	0.04	0.25	7.10	3.37	191.2	73.0	0.43
23	14.52	-1.03	6.34	-3.04	3.86	0.09	0.24	7.25	3.58	190.6	71.8	0.44

FEBRUARY 2004

Bin	Gap	East		North		Vertical		Speed		Direction		SF
	%	mean	std	mean	std	mean	std	mean	std	mean	std	
1	0.00	-4.42	4.41	-9.46	5.50	0.13	0.29	11.91	4.12	207.5	35.5	0.88
2	0.00	-5.78	4.54	-9.60	6.03	0.10	0.30	12.67	4.68	214.9	35.7	0.88
3	0.00	-5.88	4.56	-9.21	6.20	0.10	0.32	12.43	4.92	216.4	37.8	0.88
4	0.00	-5.59	4.83	-8.73	6.38	0.08	0.33	12.04	5.14	215.6	42.5	0.86
5	0.00	-5.04	4.95	-8.09	6.66	0.06	0.35	11.48	5.29	212.6	50.7	0.83
6	0.00	-4.51	5.08	-7.50	6.82	0.03	0.34	10.99	5.31	210.1	57.2	0.80
7	0.00	-4.15	5.18	-7.13	6.77	0.01	0.33	10.64	5.23	209.0	59.9	0.78
8	0.00	-3.84	5.17	-6.83	6.53	-0.00	0.33	10.25	5.06	205.6	59.8	0.76
9	0.00	-3.47	5.17	-6.58	6.23	-0.01	0.32	9.86	4.86	203.0	60.8	0.75
10	0.00	-3.17	5.17	-6.22	6.00	-0.04	0.32	9.43	4.75	201.7	61.2	0.74
11	0.00	-3.00	5.20	-5.86	5.81	-0.04	0.31	9.04	4.72	203.1	61.7	0.73
12	0.00	-2.87	5.30	-5.52	5.59	-0.04	0.29	8.73	4.67	204.6	62.1	0.71
13	0.14	-2.79	5.44	-5.33	5.45	-0.03	0.29	8.63	4.57	206.2	60.9	0.70
14	0.43	-2.62	5.60	-5.13	5.36	-0.03	0.28	8.57	4.44	205.1	60.4	0.67
15	2.16	-2.57	5.68	-5.00	5.38	-0.04	0.28	8.60	4.33	205.1	62.0	0.65
16	6.32	-2.39	5.80	-4.91	5.37	-0.03	0.30	8.61	4.25	203.7	62.3	0.63
17	15.80	-2.35	5.97	-4.69	5.36	-0.02	0.30	8.66	4.10	204.1	62.6	0.61
18	27.30	-2.11	6.17	-4.47	5.39	-0.01	0.31	8.60	4.18	204.6	63.1	0.57
19	36.35	-2.13	6.66	-4.18	5.16	0.02	0.33	8.64	4.26	205.3	62.7	0.54
20	44.40	-2.30	7.20	-4.19	5.00	0.05	0.35	8.95	4.41	203.6	62.9	0.53
21	49.86	-2.51	7.60	-4.52	5.05	0.07	0.35	9.33	4.78	203.5	62.7	0.55
22	53.02	-3.48	8.15	-4.56	5.18	0.11	0.33	9.87	5.35	204.9	65.6	0.58
23	51.72	-4.00	8.30	-4.63	5.43	0.16	0.35	10.15	5.71	209.1	63.7	0.60

MARCH 2004

Bin	Gap	East		North		Vertical		Speed		Direction		SF
	%	mean	std	mean	std	mean	std	mean	std	mean	std	
1	0.00	-2.20	6.53	-4.35	8.53	0.02	0.32	10.57	5.23	195.9	73.8	0.46
2	0.00	-2.85	7.44	-4.15	8.68	0.01	0.34	11.16	5.60	196.7	76.4	0.45
3	0.00	-3.09	7.68	-4.08	8.66	0.00	0.32	11.29	5.71	196.7	77.3	0.45
4	0.00	-3.11	7.78	-4.14	8.75	0.00	0.32	11.42	5.77	198.6	78.0	0.45
5	0.00	-2.96	7.76	-4.16	8.79	-0.01	0.32	11.40	5.79	197.9	78.5	0.45
6	0.00	-2.72	7.71	-4.29	8.63	-0.01	0.32	11.26	5.74	195.3	78.4	0.45
7	0.00	-2.52	7.61	-4.47	8.36	-0.02	0.32	11.07	5.62	194.4	78.0	0.46
8	0.00	-2.37	7.54	-4.57	8.04	-0.02	0.30	10.88	5.43	194.2	76.7	0.47
9	0.00	-2.23	7.39	-4.61	7.77	-0.02	0.29	10.65	5.27	194.2	76.2	0.48
10	0.00	-2.13	7.15	-4.66	7.55	-0.03	0.29	10.38	5.15	195.0	76.0	0.49
11	0.00	-2.08	6.84	-4.72	7.46	-0.03	0.28	10.08	5.22	195.8	76.7	0.51
12	0.13	-2.00	6.63	-4.76	7.39	-0.03	0.27	9.85	5.29	196.1	75.8	0.52
13	0.40	-1.89	6.44	-4.73	7.39	-0.03	0.28	9.71	5.24	195.7	76.1	0.52
14	3.23	-1.80	6.42	-4.59	7.32	-0.02	0.28	9.62	5.14	195.7	78.2	0.51
15	7.93	-1.66	6.24	-4.55	7.14	-0.01	0.29	9.47	4.86	195.8	77.7	0.51
16	15.59	-1.70	6.23	-4.57	7.10	-0.00	0.29	9.44	4.88	195.0	77.8	0.52
17	27.15	-1.69	6.13	-4.75	6.96	0.01	0.31	9.35	4.88	199.1	74.4	0.54
18	42.74	-1.83	5.97	-5.11	6.83	0.02	0.30	9.36	4.91	193.5	71.8	0.58
19	59.54	-1.82	5.98	-5.50	6.56	0.07	0.33	9.38	4.92	198.2	65.4	0.62
20	72.45	-1.23	5.99	-5.80	6.59	0.17	0.45	9.43	5.03	191.8	63.7	0.63
21	82.93	-1.05	5.98	-6.42	7.41	0.14	0.34	10.02	5.66	190.8	67.0	0.65
22	86.83	-0.02	6.66	-6.59	7.89	0.22	0.40	10.59	6.09	181.5	70.1	0.62
23	85.08	0.60	7.16	-5.16	7.21	0.23	0.36	9.51	6.25	180.8	71.8	0.55

APRIL 2004

Bin	Gap	East		North		Vertical		Speed		Direction		SF
	%	mean	std	mean	std	mean	std	mean	std	mean	std	
1	0.00	-4.75	4.85	-7.44	5.57	0.19	0.22	10.68	4.29	212.0	41.5	0.83
2	0.00	-5.85	5.60	-7.57	6.24	0.07	0.19	11.79	4.77	216.7	42.5	0.81
3	0.00	-5.82	5.97	-7.34	6.31	0.05	0.21	11.81	4.88	216.7	43.4	0.79
4	0.00	-5.35	5.96	-6.95	6.36	0.03	0.22	11.32	4.96	215.5	45.4	0.77
5	0.00	-4.78	5.70	-6.60	6.29	0.00	0.22	10.65	5.00	214.6	46.1	0.77
6	0.00	-4.24	5.41	-6.13	6.36	-0.01	0.22	10.07	4.90	213.7	51.5	0.74
7	0.00	-3.57	5.22	-5.55	6.60	-0.02	0.22	9.53	4.85	212.4	59.2	0.69
8	0.00	-3.07	4.94	-5.05	6.81	-0.03	0.20	9.11	4.75	211.3	65.0	0.65
9	0.00	-2.67	4.82	-4.78	7.01	-0.04	0.19	8.91	4.80	212.7	67.6	0.62
10	0.00	-2.31	4.71	-4.59	7.02	-0.05	0.19	8.62	4.84	208.5	71.8	0.60
11	0.00	-1.99	4.63	-4.37	6.82	-0.06	0.17	8.30	4.70	206.2	73.9	0.58
12	0.00	-1.66	4.75	-4.04	6.24	-0.07	0.18	7.84	4.36	194.9	77.5	0.56
13	0.56	-1.38	4.99	-3.49	5.59	-0.06	0.18	7.36	4.00	196.0	76.6	0.51
14	2.08	-1.14	5.14	-3.02	5.20	-0.06	0.18	6.98	3.89	195.1	78.3	0.46
15	4.72	-1.02	5.24	-2.93	5.07	-0.04	0.21	6.96	3.79	196.4	77.9	0.45
16	9.44	-1.02	5.29	-3.03	4.90	-0.03	0.21	7.01	3.61	196.9	78.0	0.46
17	14.86	-0.82	5.38	-3.11	4.75	-0.02	0.21	7.05	3.48	193.8	76.2	0.46
18	25.00	-0.87	5.61	-3.43	4.67	-0.02	0.23	7.33	3.47	192.1	73.0	0.48
19	37.78	-0.86	5.69	-3.53	4.66	-0.03	0.24	7.45	3.42	192.9	71.8	0.49
20	56.25	-0.45	5.76	-4.07	4.64	-0.05	0.25	7.68	3.51	187.1	71.2	0.53
21	73.75	-1.15	5.84	-3.70	4.65	-0.06	0.26	7.53	3.71	194.7	74.8	0.51
22	91.81	-2.08	5.61	-4.18	5.14	-0.04	0.31	7.83	4.21	194.4	72.4	0.60
23	83.47	-0.23	3.83	-0.98	2.17	0.24	0.26	2.75	3.57	184.2	82.2	0.37

MAY 2004

Bin	Gap	East		North		Vertical		Speed		Direction		SF
	%	mean	std	mean	std	mean	std	mean	std	mean	std	
1	0.00	-5.93	5.13	-9.56	4.94	0.25	0.22	12.65	4.13	212.5	28.9	0.89
2	0.00	-7.37	5.80	-9.46	5.64	0.16	0.22	13.71	4.61	218.3	30.1	0.87
3	0.00	-7.57	5.97	-8.95	5.97	0.07	0.22	13.64	4.74	220.5	33.4	0.86
4	0.00	-7.28	5.92	-8.51	6.18	0.02	0.23	13.26	4.79	221.0	35.8	0.84
5	0.00	-6.64	5.93	-7.96	6.39	-0.00	0.25	12.59	4.98	220.7	39.8	0.82
6	0.00	-5.90	5.93	-7.36	6.73	-0.02	0.27	11.96	5.13	219.0	47.3	0.79
7	0.00	-5.22	5.85	-6.79	6.94	-0.04	0.26	11.33	5.21	218.4	52.7	0.76
8	0.00	-4.48	5.72	-6.18	7.11	-0.04	0.27	10.65	5.29	210.4	62.9	0.72
9	0.00	-3.69	5.69	-5.59	7.25	-0.04	0.26	10.09	5.30	205.3	69.3	0.66
10	0.00	-2.87	5.85	-4.91	7.33	-0.05	0.27	9.65	5.20	197.0	76.3	0.59
11	0.00	-2.26	5.85	-4.19	7.39	-0.07	0.27	9.26	5.06	189.9	82.3	0.51
12	0.13	-1.65	5.74	-3.70	7.44	-0.07	0.25	9.00	4.86	186.8	85.7	0.45
13	0.54	-1.02	5.61	-3.23	7.34	-0.09	0.24	8.63	4.72	183.9	87.6	0.39
14	0.54	-0.54	5.44	-2.96	7.28	-0.09	0.22	8.33	4.70	177.8	88.6	0.36
15	1.34	-0.23	5.27	-2.66	6.82	-0.08	0.20	7.90	4.35	176.5	88.7	0.34
16	2.69	-0.01	5.16	-2.12	5.97	-0.08	0.21	7.25	3.77	172.9	89.7	0.29
17	6.05	-0.05	5.23	-1.70	5.35	-0.07	0.20	6.82	3.50	176.1	90.7	0.25
18	10.22	-0.04	5.50	-1.57	4.85	-0.06	0.19	6.71	3.35	176.4	89.6	0.23
19	16.53	0.07	5.63	-1.56	4.43	-0.05	0.22	6.57	3.25	175.3	88.3	0.24
20	20.83	0.01	5.80	-1.61	4.16	-0.04	0.22	6.53	3.29	178.3	87.0	0.25
21	32.26	-0.27	6.13	-1.73	3.91	-0.04	0.23	6.68	3.35	180.9	83.9	0.26
22	47.45	-0.77	6.25	-1.68	4.00	-0.00	0.23	6.81	3.48	191.0	85.0	0.27
23	58.06	-0.52	6.14	-1.67	4.33	0.03	0.27	6.75	3.71	189.6	87.2	0.26

JUNE 2004

Bin	Gap	East		North		Vertical		Speed		Direction		SF
	%	mean	std	mean	std	mean	std	mean	std	mean	std	
1	0.00	-3.13	5.40	-7.72	5.31	0.09	0.16	10.47	4.12	204.1	43.8	0.80
2	0.00	-4.22	6.21	-7.89	5.72	0.03	0.16	11.49	4.40	209.8	43.4	0.78
3	0.00	-4.50	6.60	-7.82	5.87	0.00	0.18	11.78	4.55	211.7	44.1	0.77
4	0.00	-4.49	6.69	-7.77	5.95	-0.01	0.19	11.81	4.60	211.6	45.4	0.76
5	0.00	-4.34	6.65	-7.78	6.10	-0.02	0.21	11.79	4.67	210.6	46.5	0.76
6	0.00	-4.20	6.56	-7.74	6.18	-0.04	0.21	11.68	4.71	210.5	47.7	0.75
7	0.00	-4.01	6.51	-7.71	6.26	-0.05	0.22	11.55	4.86	209.8	48.7	0.75
8	0.00	-3.79	6.53	-7.64	6.37	-0.05	0.22	11.45	4.97	208.4	49.4	0.74
9	0.00	-3.55	6.55	-7.50	6.46	-0.05	0.22	11.31	5.06	207.4	51.5	0.73
10	0.00	-3.34	6.50	-7.22	6.54	-0.05	0.22	11.03	5.17	208.1	53.8	0.72
11	0.00	-3.11	6.39	-6.80	6.70	-0.05	0.21	10.68	5.25	204.7	60.6	0.70
12	0.28	-2.87	6.19	-6.25	6.85	-0.05	0.21	10.25	5.24	201.3	65.7	0.67
13	0.83	-2.47	5.95	-5.83	6.81	-0.04	0.21	9.76	5.17	195.0	70.1	0.65
14	1.39	-2.08	5.88	-5.48	6.77	-0.03	0.21	9.40	5.13	192.4	70.5	0.62
15	4.17	-1.63	5.93	-5.23	6.65	-0.04	0.20	9.12	5.11	185.8	72.3	0.60
16	7.22	-1.40	5.76	-5.02	6.57	-0.03	0.20	8.78	5.13	182.2	72.4	0.59
17	9.17	-1.36	5.78	-4.95	6.40	-0.04	0.20	8.64	5.10	181.5	70.9	0.59
18	13.06	-1.28	5.59	-4.77	6.08	-0.04	0.21	8.44	4.61	183.2	72.0	0.59
19	14.58	-1.18	5.24	-4.27	5.73	-0.04	0.20	7.95	4.10	184.8	74.9	0.56
20	16.94	-1.15	5.66	-4.04	5.54	-0.02	0.22	7.93	4.16	184.3	75.1	0.53
21	17.50	-1.01	5.77	-3.85	5.58	-0.02	0.20	7.87	4.28	185.0	78.0	0.51
22	21.11	-0.69	6.20	-3.82	5.51	-0.03	0.19	7.96	4.52	179.2	76.2	0.49
23	22.78	-0.42	6.39	-3.37	4.76	0.02	0.24	7.56	4.22	183.1	75.7	0.45

JULY 2004

Bin	Gap	East		North		Vertical		Speed		Direction		SF
	%	mean	std	mean	std	mean	std	mean	std	mean	std	
1	0.00	-0.44	5.03	-0.78	6.58	-0.03	0.16	7.37	3.88	199.4	97.5	0.12
2	0.00	-0.60	5.30	-0.92	7.09	-0.09	0.19	7.96	4.01	201.6	97.7	0.14
3	0.00	-0.63	5.43	-0.95	7.30	-0.08	0.18	8.19	4.13	203.0	97.1	0.14
4	0.00	-0.69	5.45	-0.89	7.29	-0.07	0.18	8.17	4.16	205.3	96.7	0.14
5	0.00	-0.69	5.39	-0.82	7.16	-0.06	0.19	8.05	4.06	205.7	97.3	0.13
6	0.00	-0.71	5.20	-0.82	6.93	-0.04	0.20	7.76	4.00	204.4	98.3	0.14
7	0.00	-0.76	5.01	-0.71	6.69	-0.03	0.20	7.43	3.96	204.0	99.5	0.14
8	0.00	-0.73	4.92	-0.62	6.42	-0.02	0.20	7.21	3.77	202.1	100.0	0.13
9	0.00	-0.71	4.85	-0.47	6.12	-0.00	0.21	6.98	3.58	198.8	100.3	0.12
10	0.13	-0.73	4.81	-0.25	5.82	0.02	0.21	6.74	3.48	199.7	102.4	0.11
11	0.67	-0.76	4.82	-0.09	5.54	0.02	0.21	6.56	3.38	193.4	104.1	0.12
12	1.34	-0.75	4.90	0.08	5.30	0.03	0.20	6.49	3.24	193.2	105.6	0.12
13	2.02	-0.78	4.96	0.25	5.21	0.03	0.20	6.49	3.20	190.6	106.6	0.13
14	2.55	-0.83	5.07	0.52	5.16	0.02	0.21	6.54	3.23	191.2	106.8	0.15
15	3.49	-0.71	5.26	0.88	5.15	0.01	0.20	6.63	3.38	187.9	108.3	0.17
16	3.23	-0.56	5.69	1.26	4.96	-0.01	0.19	6.83	3.48	189.9	110.9	0.20
17	2.82	-0.36	6.20	1.48	4.47	-0.05	0.17	6.90	3.62	189.2	111.3	0.22
18	2.02	-0.32	6.50	1.54	4.20	-0.07	0.18	6.95	3.73	191.2	111.1	0.23
19	1.21	-0.35	6.82	1.36	4.18	-0.06	0.18	7.14	3.87	189.9	109.6	0.20
20	2.28	-0.39	7.00	1.33	4.33	-0.03	0.17	7.34	3.95	185.8	108.8	0.19
21	2.02	-0.42	7.30	1.32	4.40	-0.02	0.18	7.60	4.09	183.4	109.4	0.18
22	2.15	-0.36	7.58	1.25	4.22	-0.03	0.20	7.73	4.15	179.5	110.4	0.17
23	2.42	-0.22	8.35	1.10	4.49	-0.02	0.24	8.46	4.42	178.3	107.6	0.13

AUGUST 2004

Bin	Gap	East		North		Vertical		Speed		Direction		SF
	%	mean	std	mean	std	mean	std	mean	std	mean	std	
1	0.00	-0.58	6.83	-1.82	7.34	0.04	0.21	9.38	3.98	193.3	88.9	0.20
2	0.00	-0.78	7.38	-2.02	7.44	-0.09	0.26	9.91	4.01	196.0	89.4	0.22
3	0.00	-1.00	7.06	-2.02	6.99	-0.04	0.21	9.33	4.08	197.9	88.4	0.24
4	0.00	-1.12	6.74	-2.02	6.59	-0.01	0.21	8.86	3.95	198.9	87.2	0.26
5	0.00	-1.18	6.60	-1.83	6.23	0.00	0.22	8.48	3.90	200.0	87.1	0.26
6	0.00	-1.22	6.43	-1.49	5.98	0.01	0.23	8.08	3.93	203.1	88.1	0.24
7	0.00	-1.21	6.24	-1.10	5.78	0.01	0.26	7.69	3.96	199.6	90.9	0.21
8	0.00	-1.23	5.99	-0.65	5.50	0.01	0.28	7.33	3.77	202.3	93.7	0.19
9	0.00	-1.20	5.63	-0.29	5.28	0.03	0.30	7.00	3.46	198.4	97.9	0.18
10	0.00	-1.08	5.34	0.02	5.28	0.05	0.29	6.84	3.27	192.8	102.3	0.16
11	0.00	-1.16	5.40	0.35	5.21	0.04	0.27	6.88	3.23	192.7	105.4	0.18
12	0.00	-1.21	5.55	0.65	5.13	0.04	0.27	6.93	3.30	185.7	107.0	0.20
13	0.00	-1.20	5.79	0.95	5.04	0.05	0.26	7.05	3.39	184.6	108.1	0.22
14	0.00	-1.06	6.06	1.22	4.72	0.06	0.25	7.05	3.43	184.8	110.7	0.23
15	0.00	-0.79	6.13	1.40	4.49	0.05	0.25	6.97	3.42	179.1	113.3	0.23
16	0.23	-0.47	6.17	1.41	4.60	0.06	0.25	7.01	3.49	175.1	112.5	0.21
17	1.13	-0.10	6.17	1.16	4.89	0.07	0.26	7.07	3.64	170.6	109.2	0.17
18	3.17	0.22	6.13	0.81	5.03	0.07	0.28	7.12	3.59	167.0	105.6	0.12
19	5.88	0.54	6.34	0.48	5.63	0.08	0.27	7.56	3.90	163.4	102.3	0.10
20	9.05	0.94	6.38	0.02	6.13	0.07	0.34	7.88	4.11	152.6	96.9	0.12
21	14.25	0.94	6.81	-0.73	6.32	0.01	0.29	8.20	4.52	150.1	90.3	0.14
22	18.33	0.89	7.57	-0.84	6.49	0.02	0.29	8.96	4.51	148.9	89.0	0.14
23	17.65	0.51	8.12	-0.96	6.78	0.04	0.32	9.45	4.84	158.6	93.0	0.11

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