DIRECT MEASUREMENTS OF THE TRANSPORT OF THE EAST AUSTRALIAN CURRENT

A DATA REPORT FROM THE WOCE PACIFIC CURRENT METER ARRAY 3

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ABSTRACT

The World Ocean Circulation Experiment Pacific Current Meter Array 3 (PCM3) was deployed in the East Australian Current with the main objective of obtaining direct estimates of volume transports and current variability at 30°S. The array consisted of six moorings (at 90, 200, 700, 2000, 4400, 4590 m depth), with a total of 26 recording current meters and 2 upward-looking acoustic Doppler current profilers. It was deployed in November 1991, serviced in September 1992 and recovered in March 1994. Data coverage in the first part of the deployment is better than in the second, mainly because of a failure of an acoustic release, which resulted in the loss of three deep current meters. In both years, the two moorings furthest offshore underwent very large vertical excursions lasting for periods of about two weeks. During these events the top instrument was blown down 1200 m.

The entire dataset was subjected to standard quality control and filtering procedures to remove spurious data and suppress high-frequency variability. This report presents the general characteristics of the PCM3 array and details of the valid low-passed data time series.

During the deployment period, several CTD sections were taken across the array. Though their data are not reported here, the coverage is documented for future reference.

1. INTRODUCTION

An objective of the World Ocean Circulation Experiment (WOCE) is to estimate the meridional heat and freshwater fluxes in each of the ocean basins. This requires trans-ocean hydrographic sections and concurrent direct estimates of the transport of the western boundary current (Bryden and Hall, 1980; Hall and Bryden, 1982). For WOCE purposes, one trans-ocean section and an associated western boundary current array were designated as the prime heat/freshwater flux line in each basin and given high priority in the WOCE observational plan.

For the South Pacific Ocean, the trans-Pacific section P6 was designated to measure the heat flux; its associated western boundary current meter array was designated PCM3 (Pacific Current Meter Array number 3). The P6 line was occupied during June – August 1992. Its latitude was 32° 30'S from South America to west of the deep boundary current meter array (PCM9) northeast of New Zealand and then along 30°S across the Tasman Sea.

The PCM3 current meter array was deployed to estimate the volume transport of the East Australian Current (EAC) at 30°S and to estimate the time variability of its transport[*]. In collaboration with scientists completing the P6 section, it will also be used to estimate the meridional heat and freshwater fluxes in the South Pacific.

The array was deployed during *Franklin* Cruise FR10/91 (November 15 – December 15, 1991), serviced during *Franklin* Cruise FR7/92 (September 19 – October 6, 1992) and recovered during *Franklin* cruise FR3/94 (March 10 – April 3, 1994). PCM3 consisted of six moorings with a total of 26 recording current meters (RCMs) and two acoustic Doppler current profilers (ADCPs). The six moorings were deployed close to 30°S in order to coincide with the P6 trans-Pacific section. The array was ~85 km long, covering most of the water column between the 100 m and the 4600 m isobath on the abyssal plain. Figure 1 shows the PCM3 array's location and configuration. The instrument distribution is shown in Table 1 and the mooring designs are presented in Appendix A.

[*] Preliminary estimates of EAC transports from this array are found in Tomczak et al. (1996).

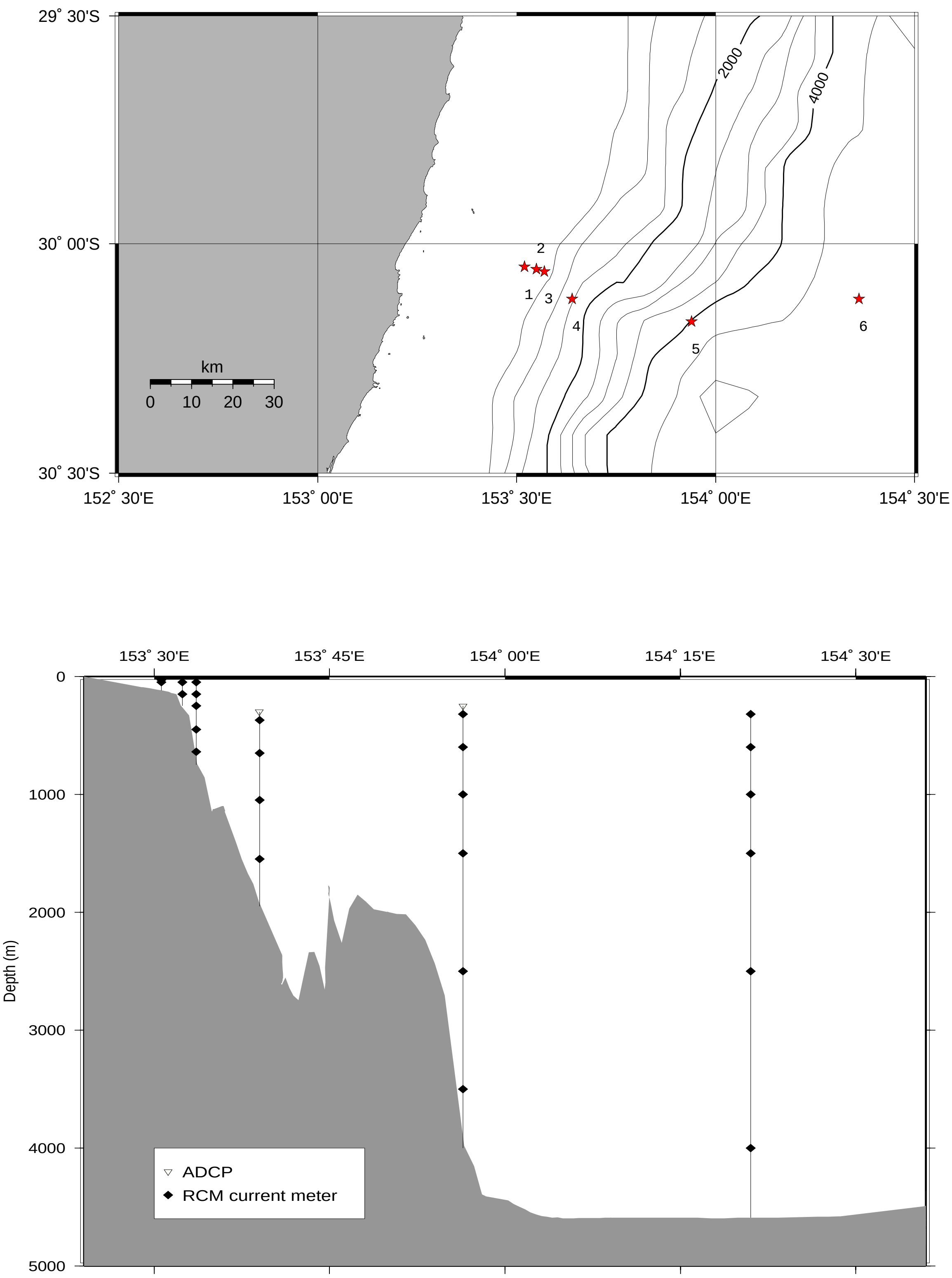

Figure 1 : PCM3 array mooring positions (top) and current meter depths (bottom)

Table 1: Instrument distribution for the array. The number in brackets indicate the instrument type used in the second deployment if it was different from the first. All RCMs were manufactured by Anderaa with "*S*" standing for current meters with a Savonious rotor. Otherwise they were fitted with the newer paddle-wheel rotor.

Mooring	1	2	3	4	5	6
water depth (m)	95	200	700	2000(2050)*	4400	4590
position	153° 30' 43"E 30° 02' 34"S	153° 25' 48"E 30° 03' 46"S	153° 33' 43"E 30° 03' 27"S	153° 38' 49"E 30° 07' 01"S	153° 56' 13"E 30° 10' 30"S	154° 19' 55"E 30° 07' 01"S
distance from shore (km)	28.2	31.9	33.8	44.4	73.1	114.9
meter depth (m)						
30	RCM4S[4]	RCM7[4]				
50	RCM7[4]	RCM7[4]	RCM4			
150		RCM5S[5]	RCM4			
250			RCM4[5]			
300				ADCP(350 m)	ADCP	
320				RCM5(370 m)	RCM5	RCM5
400			RCM5S			
600			RCM5	RCM5(650 m)	RCM5	RCM5S[5]
1000				RCM5(1050 m)	RCM5S[5]	RCM5
1500				RCM5(1550 m)	RCM5S	RCM5[5S]
2500					RCM8	RCM5S[8]
3500					RCM8[5]	
4000						RCM8

***Mooring 4 was originally intended to be deployed at 2000 m but was shifted to 2050 m.

CTD Sections

A total of 10 CTD sections (or part sections) were completed across the current meter array. The dates and the zonal extent of the CTD sections are listed in Table 2. These sections were completed during the deployment, mooring service and recovery cruises, during the occupation of the P6 section and during additional cruises part of the southwestern Pacific repeat hydrography survey line PR11. During the *Franklin* and *Knorr* cruises, a ship mounted acoustic Doppler current profiler made estimates of the current in the upper 300 m. On the *Knorr*, heading information was obtained from a three-dimensional Ashtec Global Positioning System (GPS), whereas on the *Franklin* it was obtained from the ship's gyro. All ships were equipped with GPS navigation.

Table 2: Time when CTD stations were completed over the array.

Cruise Number	Approximate dates	Extent of Section	Comment
FR 10/91	November 17 – 26, 1991	50 m isobath to 170°E	Deployment cruise
FR 10/91	December 11 – 12, 1991	50 m isobath to 153° 50'E	Section abandoned in rough weather
KN138	July 23 – 25, 1992	New Zealand to 50 m isobath	P6 western section (P6W)
KN138	July 25 – 26, 1992	80 m isobath to 155°E	Repeat of western end of P6W section
KN138	July 26 – 27, 1992	155°E to 80 m isobath	Repeat of western end of P6W section
FR 7/92	September 23 – 30, 1992	50 m isobath to 157° 40'E	Section completed during mooring service
FR 7/92	October 3 – 4, 1992	155°E to 80 m isobath	Repeat section
Ak. Lavrentyev	May 13 – June 9, 1993	50 m isobath to 173°E	Repeat cruise
FR 7/93	September 24 – October 2, 1993	50 m isobath to 173°E	Repeat section
FR 3/94	March 28 – 30, 1994	50 m isobath to 154° 29'E	Recovery cruise

2. DATA PROCESSING

All current meters recorded speed, direction and temperature, and most recorded pressure. In both deployments, the sampling interval was set to 60 minutes for all parameters and stored as binaries in the range [0, 1023]; then were later converted to velocities, temperatures and depths. Velocity components are aligned as east–west (u) and north–south (v), where *u* is positive along true east and *v* is positive along true north. The converted data were stored in netCDF format containing all information for each current meter (pre-processed file).

The next step was to look individually at each record checking for spurious data, gaps and spikes. Most spikes were removed manually. In some records, many spikes had identical amplitudes, which could be attributed to a malfunction of the mechanical analog/digital converter in the Anderaa current meters ("bit sticking"). During the second deployment, "bit sticking" affected only few current meter records and only for periods less than one month. These spikes (which represent drop outs in one of the ten bits of the binary data) could be identified by differentiating the time series, locating the affected points and replacing them with an estimate of the correct value. A computer routine was used to find and add the constant difference wherever such spikes were identified. The algorithm worked well to correct the scalar speed, temperature and pressure. The routine did not work well for the direction channel because of its "wrap around" characteristics. In those cases, spiking due to digitizer problems were removed by hand whenever possible. Gaps up to 3 hours were filled linearly. Longer gaps — up to 12 days — were filled spectrally by the EPIC* software, based on Anderson (1974).

After this initial treatment all series were low-pass filtered with a 60+1+60 point Cosine-Lanczos filter that removed the diurnal tides, inertial oscillations (23.9 hours at 30° of latitude) and all higher frequencies, leaving less than 0.5% of the energy at 25 hours. The resulting time series were sub-sampled at 6 hourly intervals and saved as another set of netCDF files.

* EPIC is developed by NOAA/PMEL laboratories.

3. RCM DATA DESCRIPTION

The first deployment (November 1991 to September 1992) gave better data returns than the second deployment (September 1992 to March 1994). Figure 2 summarizes the velocity data coverage, after quality control, for both deployments (note that the temperature and pressure records have a different coverage). The data quality for each series is described in Table 3. The valid low-passed time series for both deployments are shown in Figures 3 – 32 (pages 13 – 37).

3.1 First deployment

All moorings were recovered successfully. The only missing instrument was the top current meter, placed at 30 m on mooring 2. Some instruments failed to return the complete record or returned spurious data.

The extremely low velocity values recorded in the bottom instruments of mooring 3 (400 and 600 m) were unexpected. As instrument malfunction was not evident, the most likely cause was a canyon just north of the mooring, perturbing the flow. For the second deployment, this mooring was shifted approximately ~3.5 km to SE to a new position (153° 34' 37''E, 30° 04' 08''S) to try to minimize this interference.

An interesting feature is the presence of large mooring motions, particularly in mooring numbers 5 and 6, where the top instruments made vertical excursions up to 1500 m. These “knock downs” were caused by strong, bottom-intensified northward currents not anticipated when the moorings were designed. During the events, the bottom instruments had problems recording velocities due to cable lay over. The lay over exceeded the instruments’ capacity to correct for cable tilt, so they recorded spurious speeds. Attempts are being made to synthesize a dataset at constant pressure levels in order to overcome this problem.

Tables 4 and 5 (pages 42 and 43) show simple statistics of this data set.

3.2 Second Deployment

Moorings 1, 2, 3, 4 and 6 were successfully recovered; the acoustic release on mooring 5 failed. The top two current meters (320 m and 600 m), together with the ADCP at the top of the mooring, were located with the ship’s echo sounder and recovered by trawling. In spite of a certified pressure rating of 2000 dbar, the ADCP case had imploded, probably during a strong “knock down”. The rest of the mooring was declared lost after several attempts at recovering it.

In general, less valid data was returned from the second deployment than the first; in particular the loss of the bottom instruments in mooring 5 created a large spatial gap in the data. Top meters and buoys of moorings 2 and 3 were also not present at the time of recovery.

Tables 6 and 7 (pages 44 and 45) show simple statistics of this data set.

4. ACOUSTIC DOPPLER CURRENT PROFILERS

RDI Narrowband ADCP instruments were placed at the tops of moorings 4 and 5. Both instruments operated at a frequency of 153 kHz and were set to record 50 bins with 8 m resolution and ping interval of 36.6 s.

During the first deployment, the ADCP at mooring 5 did not record any data (probably due to a failure in the battery system soon after deployment). The instrument at mooring 4, however, returned very good quality data for ~6 months (200 days), when it ran out of power prematurely and stopped recording. The temperature sensor on the ADCP returned data for the same period. Neither instrument had a pressure sensor, so depth is inferred from the RCM 20 m below.

In the second deployment the ADCPs were switched between moorings 4 and 5 for logistical reasons. The ADCP mounted on mooring 4 returned a very good time series, but the instrument pressure housing on mooring 5 collapsed during a “knock down”, so it did not return any data. Figures 33 – 36 (pages 38 – 41) show the valid low-passed time series for both deployments.

ACKNOWLEDGEMENTS

The PCM3 data set owes its existence to many people. The moorings were designed and built by the mooring group led by Fred Boland at the then CSIRO Division of Oceanography. We thank Neil White, Kevin Miller, Danny McLaughlin and Ian Helmond for their help and expertise in deploying and recovering the array, sometimes under difficult conditions. The crew of the *Franklin* are thanked for their help and cooperation during the many cruises along the array.

Fred Boland, Neil White and Helen Beggs were instrumental in the processing and archiving of the array data. Ian Helmond and Kevin Miller helped us tackle the difficult issues of hardware and mooring behaviour relating to the quality control of the data set.

The PCM3 array was funded in part by the Australian Government's Climate Change Research Program and the CSIRO Division of Marine Research; it is an Australian contribution to the World Ocean Circulation Experiment. M. Mata is sponsored by Brazilian Research Council Ph.D. Scholarship number CNPq-200167/96-0.

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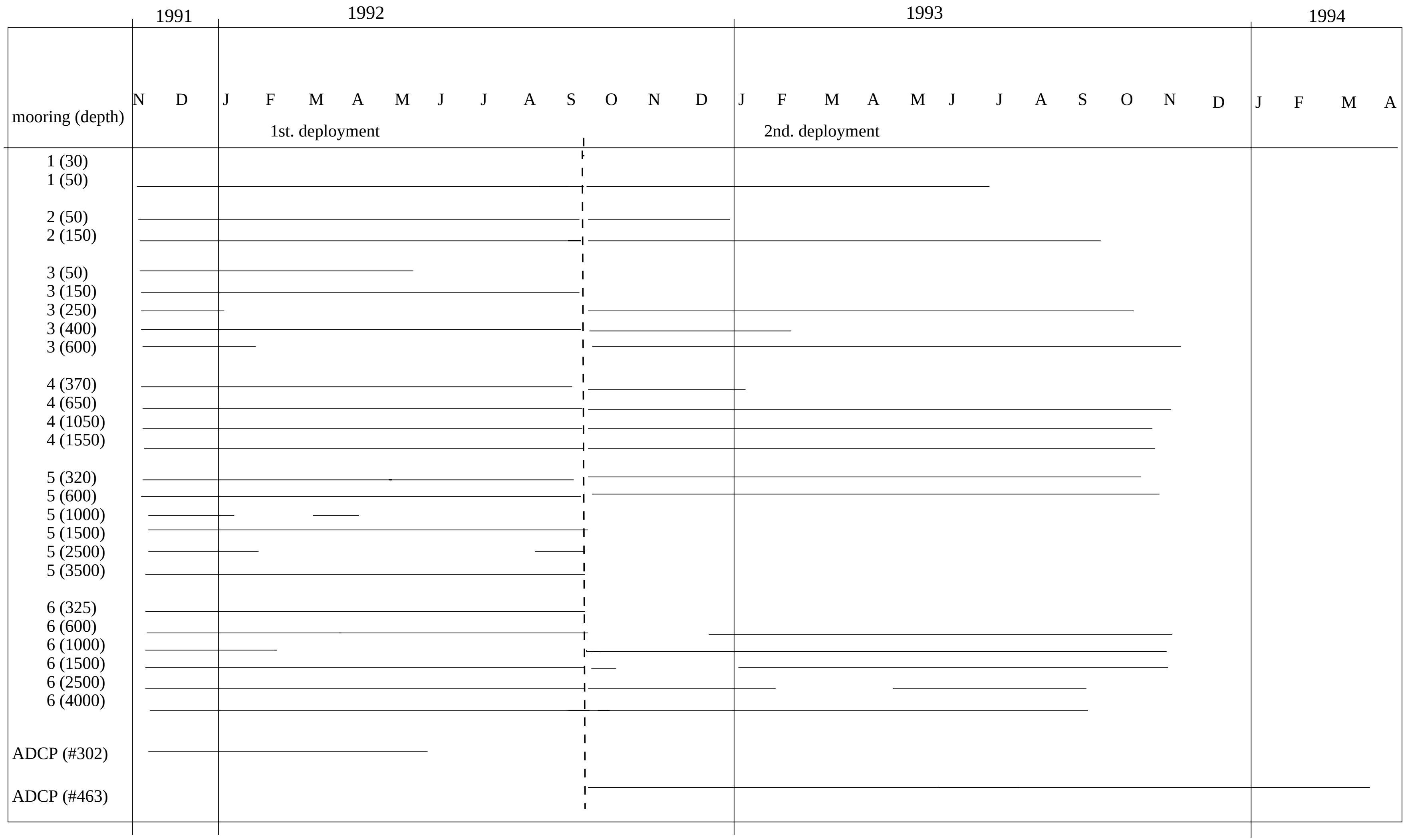

Figure 2: Velocity coverage for PCM3. Dotted line denotes when the array was serviced.

Table 3: Comments on individual data records for PCM3.

Mooring	Depth	S/N	Comments	
	metres	Deploy (1/2)	First deployment	Second deployment
M1	30	6914/4232	No speed or direction; reason not known	Capstan fouled; no useful data written.
	50	9302/3522	The original temperature values were very high (over 29° C). Probably wrong calibration constants were used. Fixed with re-calibration. The velocity values show unexpected westward velocities. This might be related with the mooring 'knock downs', when the cable angle is greater than the maximum gimbal angle of the instrument (27°).	Rotor fouled on recovery. The raw record shows a significant fouling and 'bit sticking directions' after July 1993. Bad data removed during filtering.
M2	30	9303/1562	No data record. Meter lost probably due to failed spindle.	No record. This meter was lost together with the float on the top of the mooring.
	50	9305/5453	Good record.	Rotor fouled on recovery. 'bit sticking' made the record after December 1992 useless.
	150	7203/5454	Like Mooring 1, velocity values show unexpected westward values, possibly due to mooring 'knock downs'. The raw data had a wrong speed calibration, which was corrected before filtering.	Good record. Signs of fouling towards the very end of record.
M3	50	1276/571	Good record.	No record. This instrument and the top float were not present by the time of recovery.
	150	571/7839	Good record.	Flat battery. No data record
	250	7199/6560	Short record. Less than two months.	Good record.
	400	7664/7664	Good record. However, the very weak currents recorded were unexpected. Probably the instrument was in the lee of an underwater canyon or rise.	Capstan fouled. A slight leak was noticed during recovery. Recording stopped around 4 months after deployment.
	600	7155/7155	Extremely weak currents. Same effect as current meter above.	Good record.
M4	ADCP	302/463	Good record. Instrument ran out of battery power around six months after deployment	Good record.
	370	7156/6166	Good record.	Short record. No rotor was present on recovery and a slight leak was noticed. The beginning of the record showed some 'bit sticking' and was corrected whenever possible.
	650	7157/7776	Good record.	Good record.
	1050	6617/7773	Good record. Gimbal mounting on swivel detached from cage; probably towards the end of the deployment.	Good record.
	1550	7154/7837	Good record.	Good record.

Table 3: Cont.

M5	ADCP	463/302	No record.	No record. Instrument housing collapsed on recovery. Although it was rated as 2000 dbar, most likely to have happened during a 'knock down'.
	320	7777/7156	Good record. Very strong 'knock downs' observed.	Good record. Very strong 'knock downs' observed. Acoustic release failed; instrument recovered by trawling.
	600	7778/7157	Good record. Very strong 'knock downs' observed.	Good record. Very strong 'knock downs' observed. Acoustic release failed; instrument recovered by trawling.
	1000	7778/6167	Speed channel dropped out for long periods. Very strong 'knock downs' observed.	Acoustic release failed; instrument lost.
	1500	7662/7154	Good record. Very strong 'knock downs' observed.	Acoustic release failed; instrument lost.
	2500	9161/9327	Speed channel dropped out for long periods. During mooring 'knock-downs', probably the speed and direction measurements degraded due to cable lay over.	Acoustic release failed; instrument lost.
	3500	7838/9326	Good record. During mooring 'knock-downs', probably the speed and direction measurements degraded due to cable lay over.	Acoustic release failed; instrument lost.
M6	320	7776/7777	Good record. Mooring 'knock-downs'	Short velocity record. No rotor on recovery. Temperature and pressure look ok. . Mooring 'knock-downs'.
	600	7621/7778	Good record. Mooring 'knock-downs'	Good record. Mooring 'knock-downs'
	1000	6166/7662	Short record in all channels.	Speed and direction had some 'bit sticking' and spiking that was corrected wherever possible. The record had a speed gap of 15 days in August 1994, that was filled with spectral interpolation.
	1500	7773/7830	Good record.	Good record. Long gap in the speed and direction channels.
	2500	8671/9161	Good record.	Speed and direction had some 'bit sticking that was corrected wherever possible. Big gap in all channels.
	4000	9326/7838	Good record.	Good record.

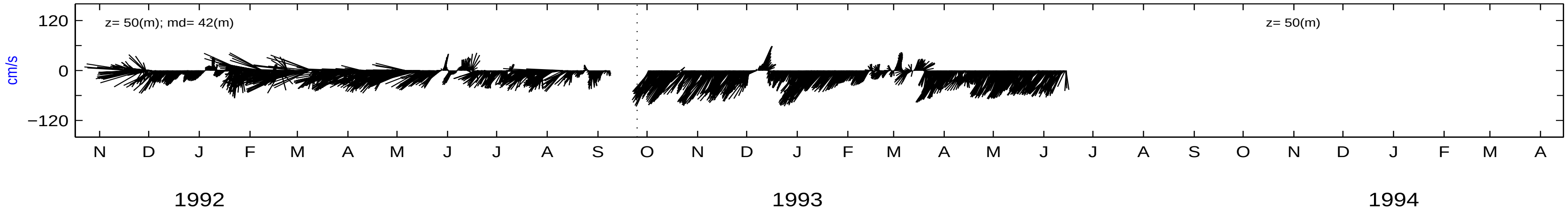

Figure 3: Mooring 1 – velocity vectors. Where *z* is the nominal depth and *md* the median of recorded depth (same for all figures).

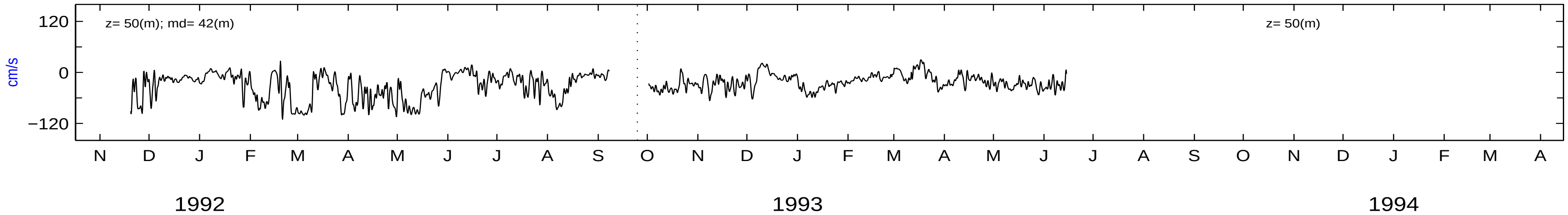

Figure 4: Mooring 1 – eastward component (u)

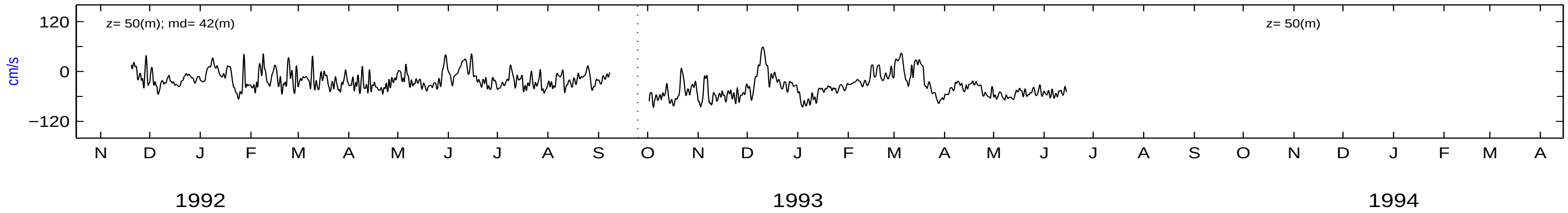

Figure 5: Mooring 1 – northward component(v)

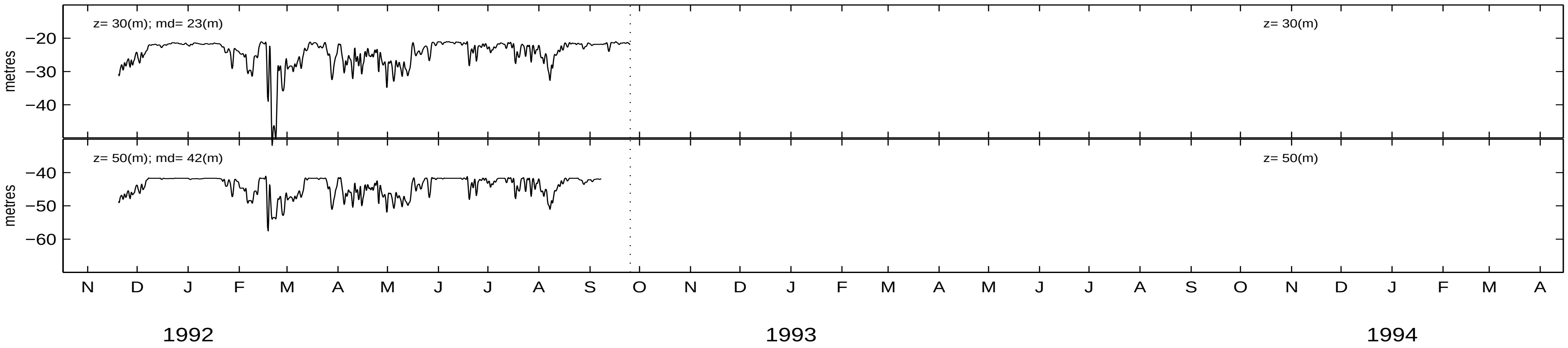

Figure 6: Mooring 1 – depth

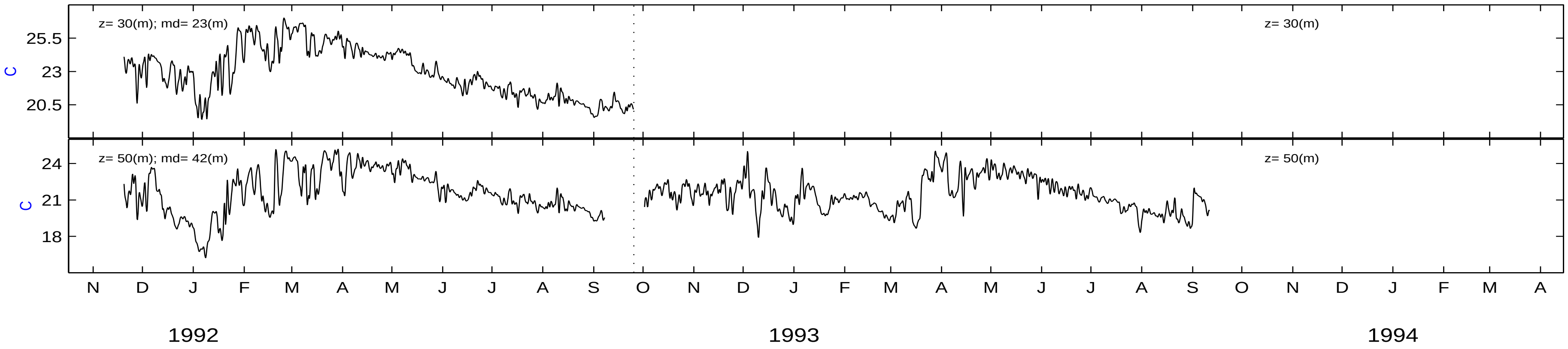

Figure 7: Mooring 1 – temperature

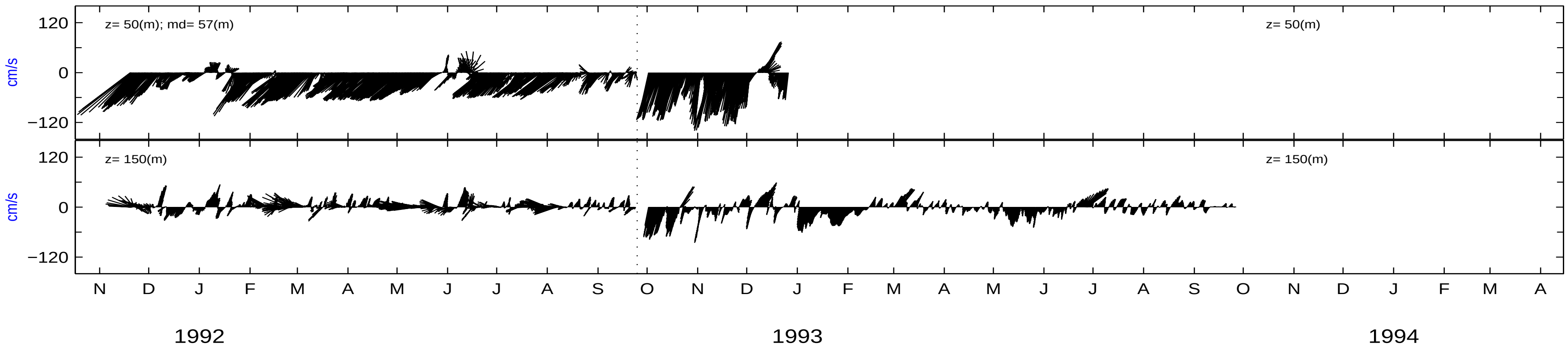

Figure 8: Mooring 2 – velocity vectors

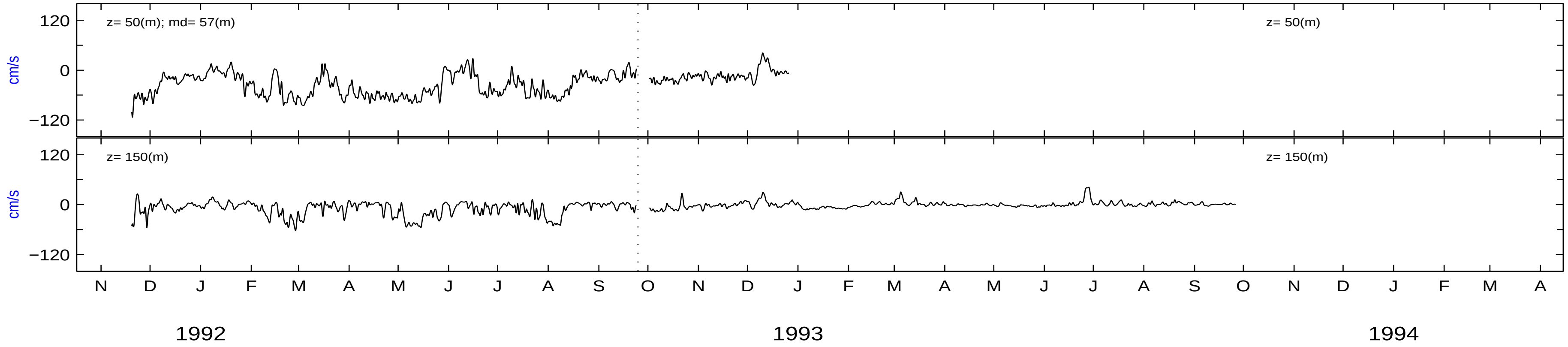

Figure 9: Mooring 2 – eastward component (u)

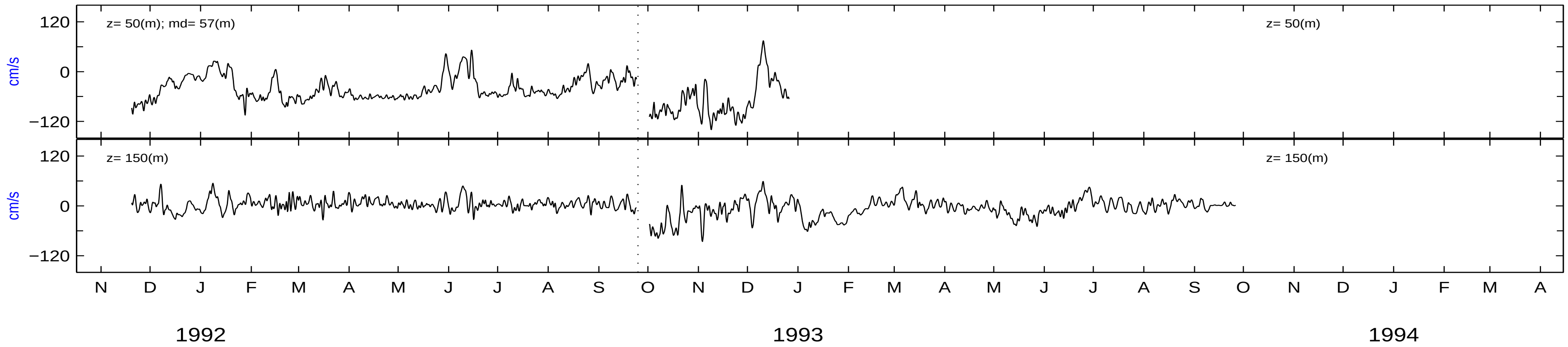

Figure 10: Mooring 2 – northward component (v)

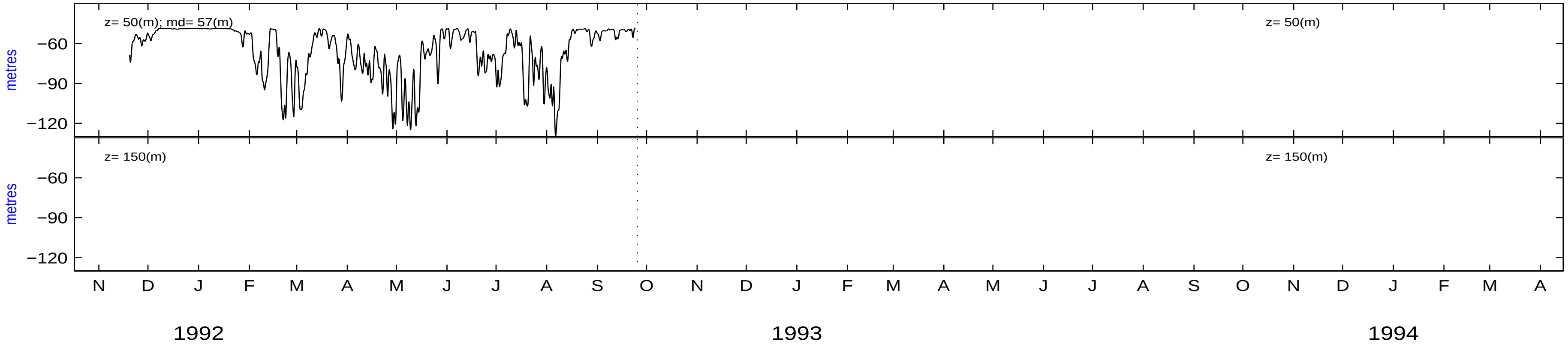

Figure 11: Mooring 2 – depth

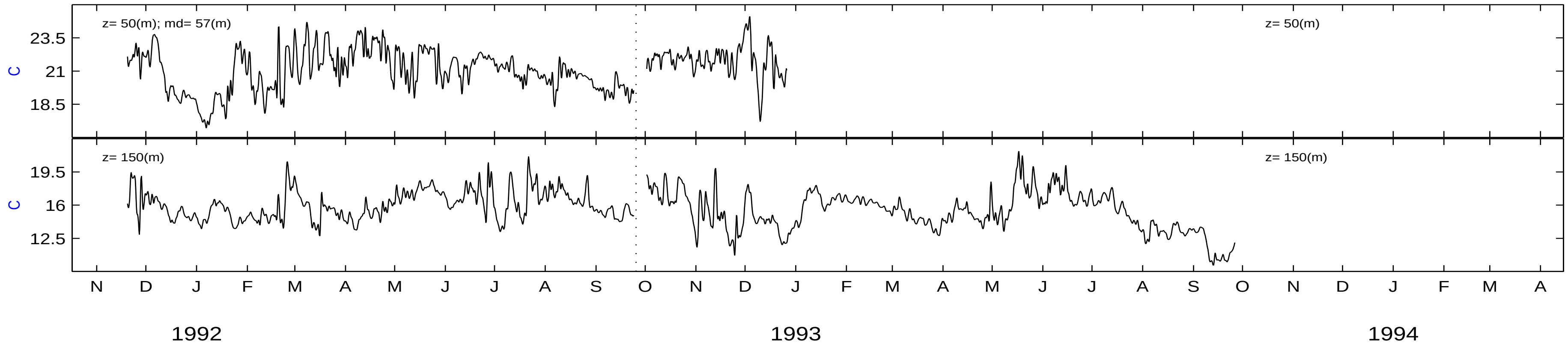

Figure 12: Mooring 2 – temperature

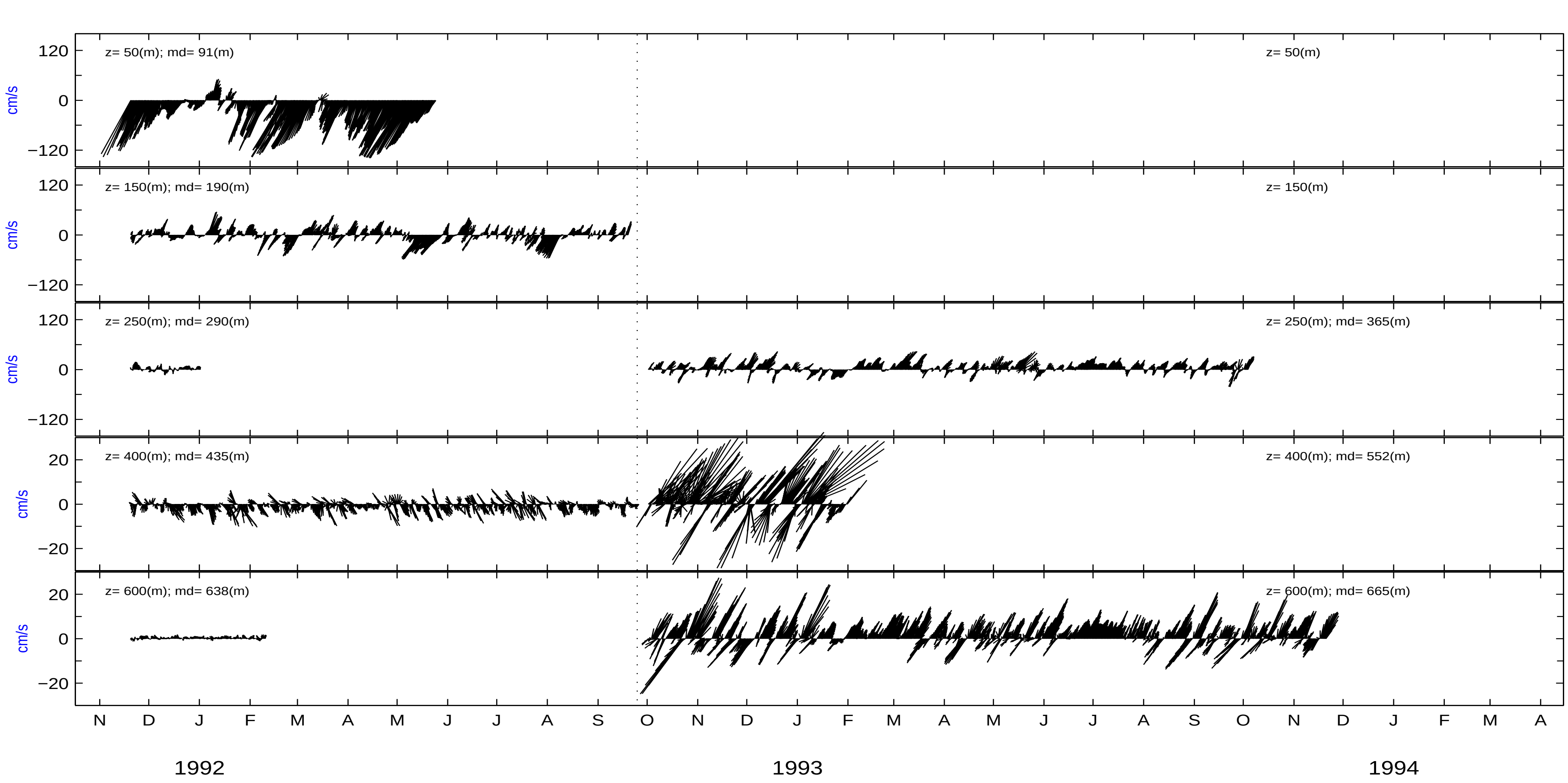

Figure 13: Mooring 3 – velocity vectors

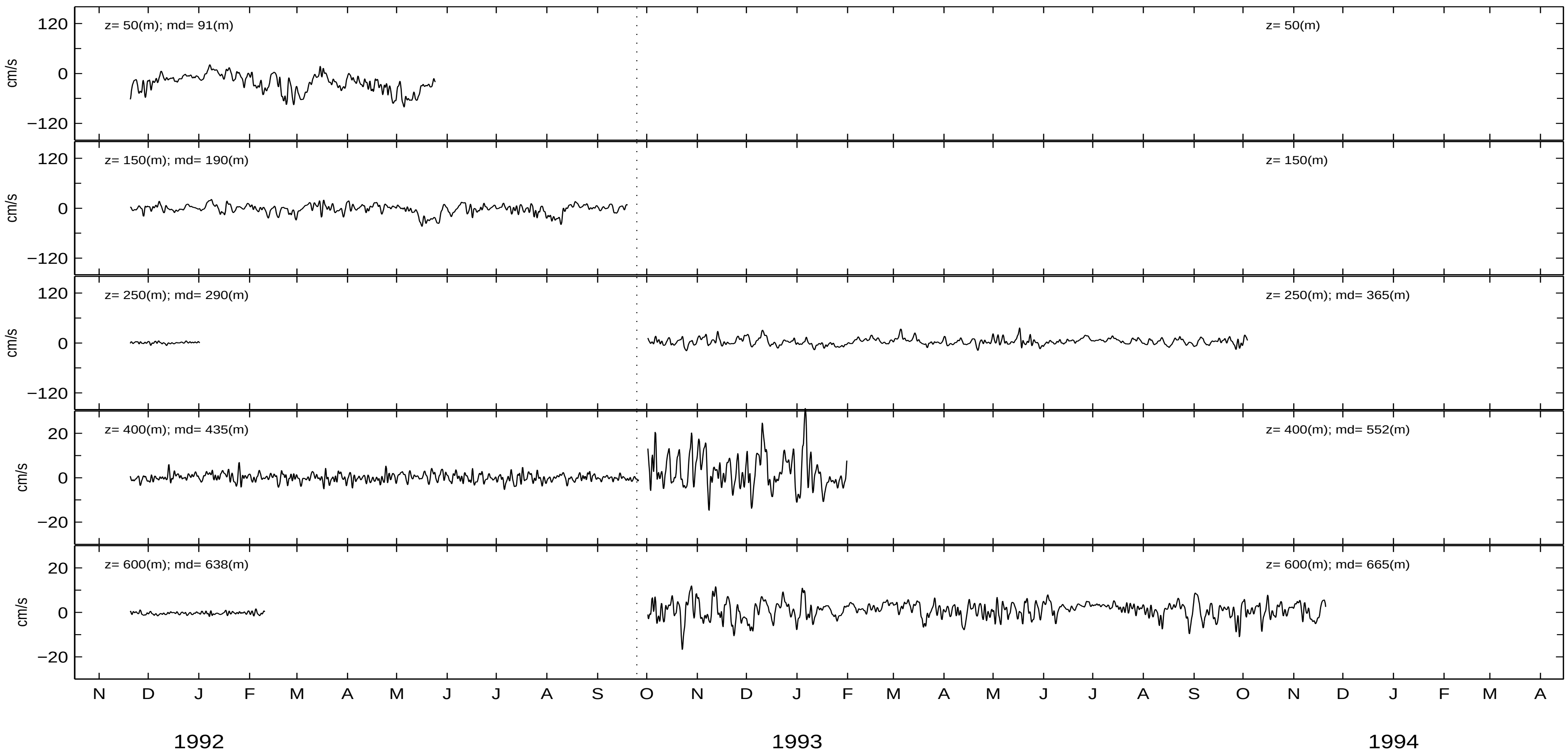

Figure 14: Mooring 3 – eastward component (u)

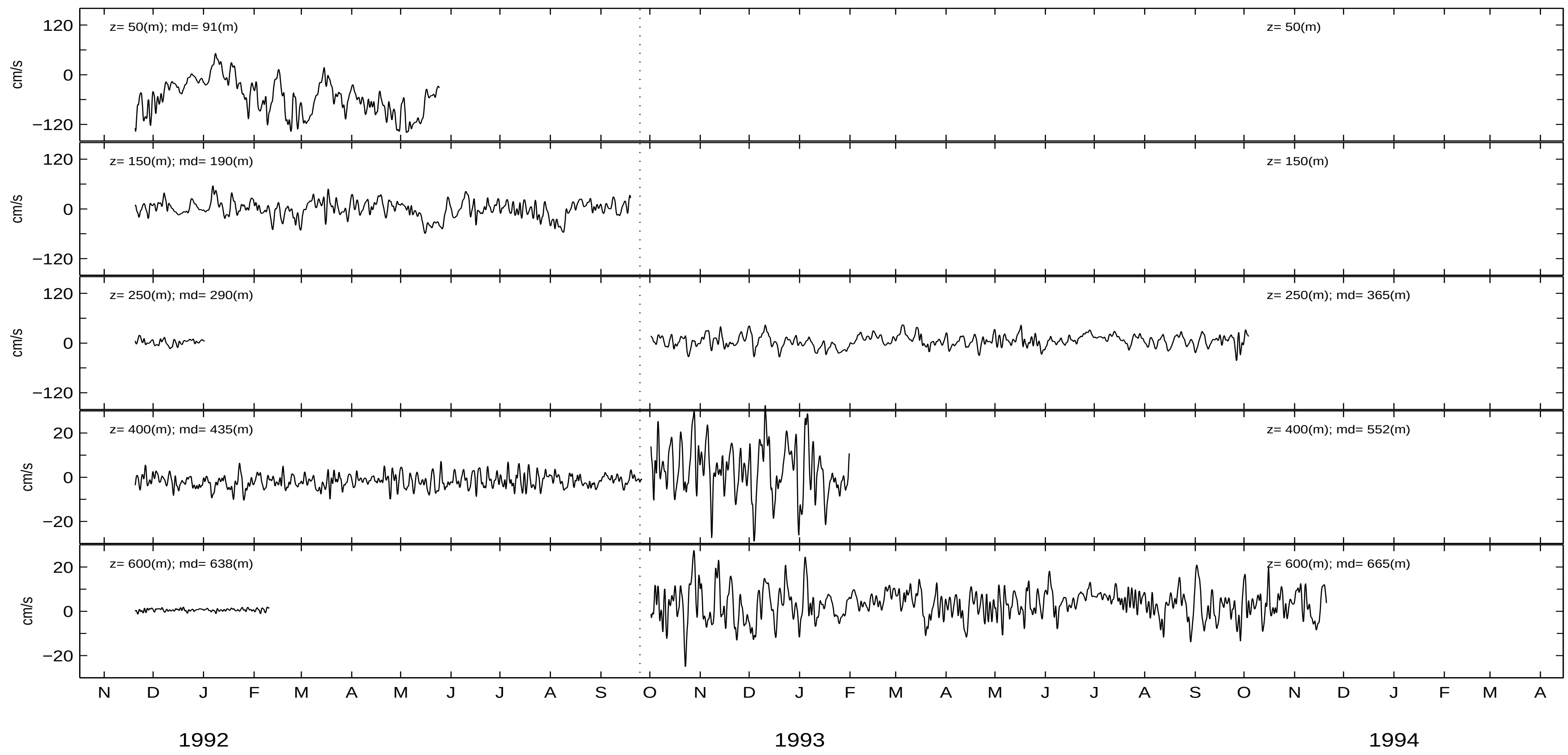

Figure 15: Mooring 3 – northward component (v)

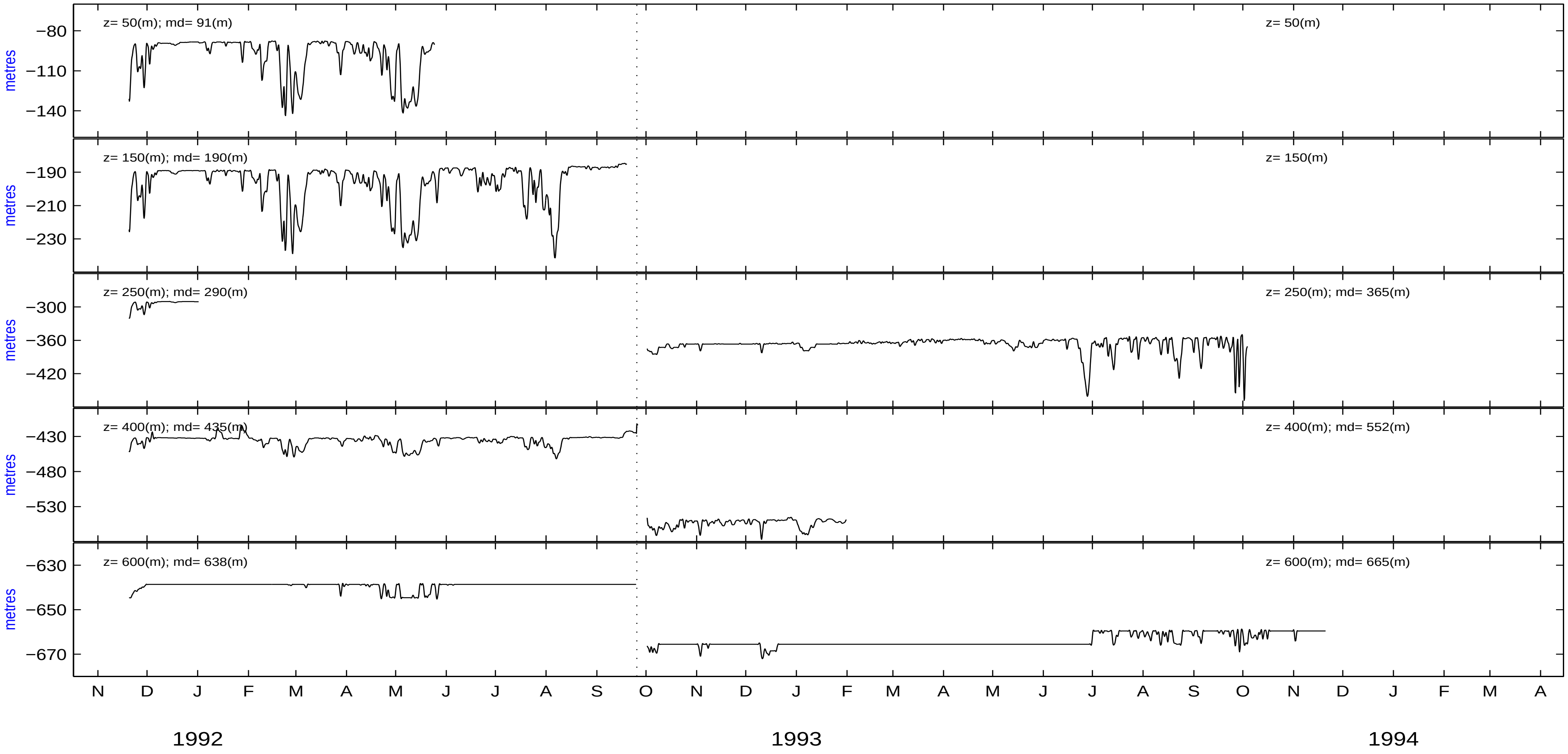

Figure 16: Mooring 3 – depth

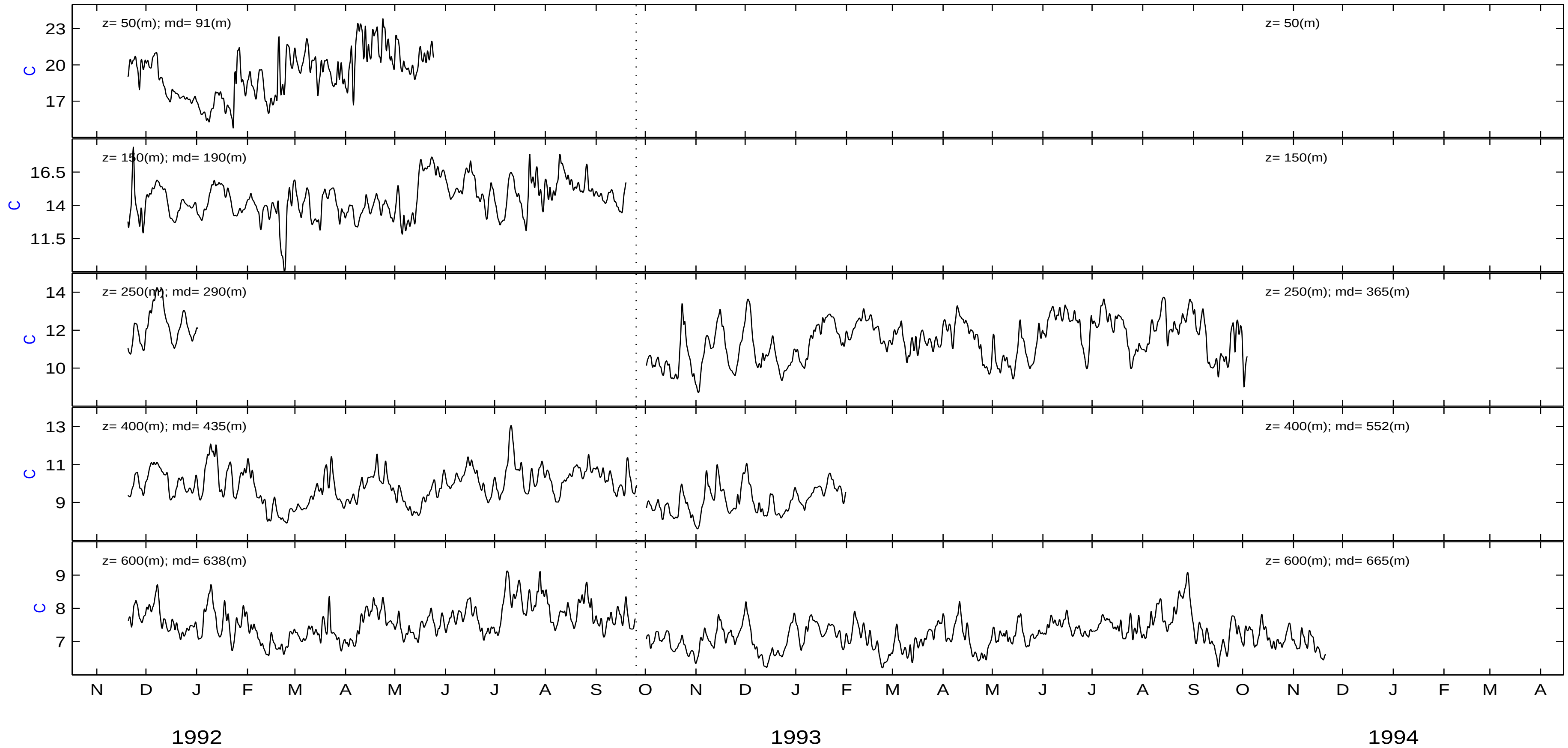

Figure 17: Mooring 3 – temperature

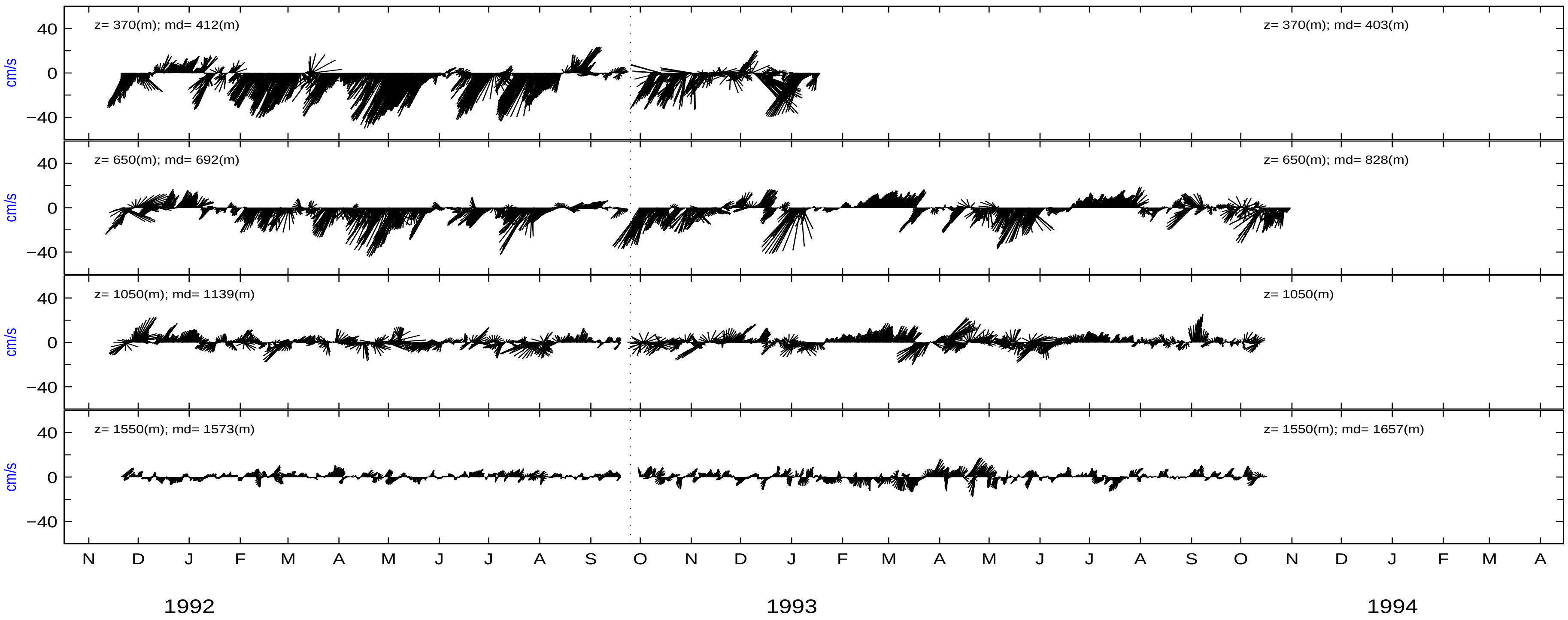

Figure 18: Mooring 4 – velocity vectors

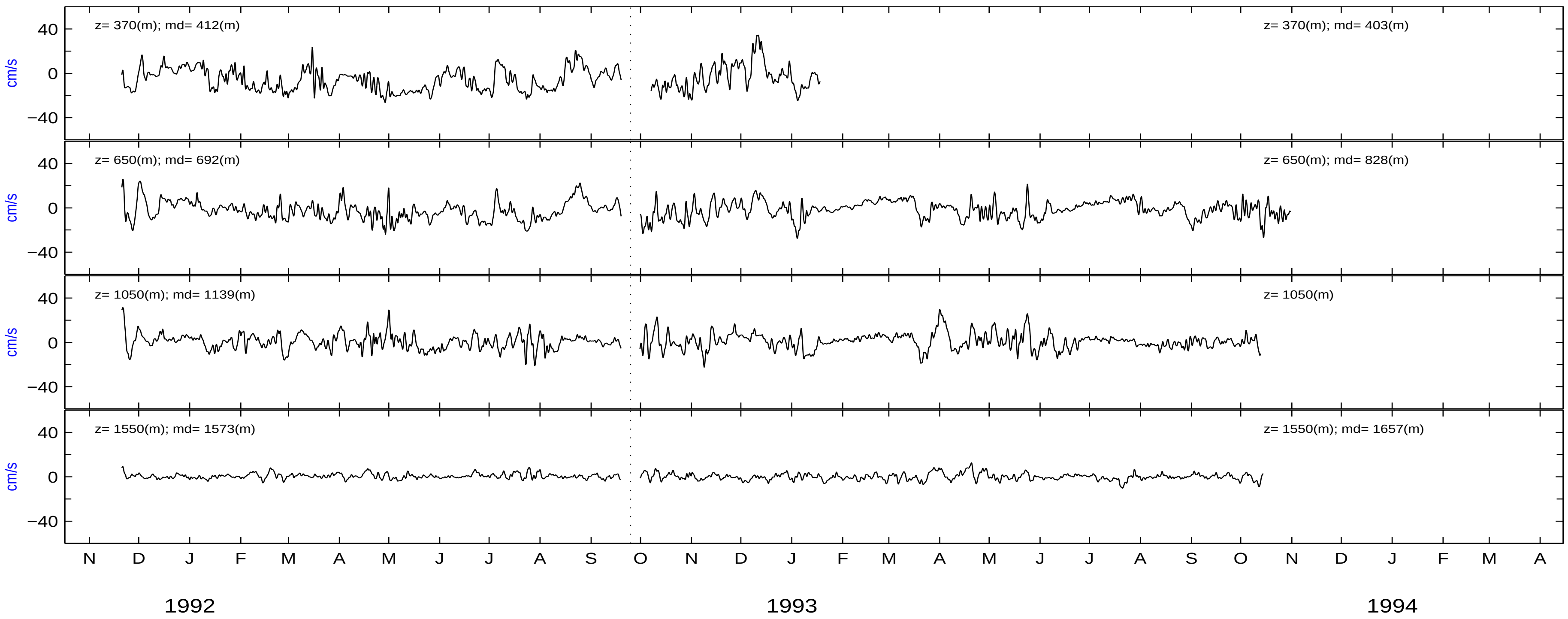

Figure 19: Mooring 4 – eastward component (u)

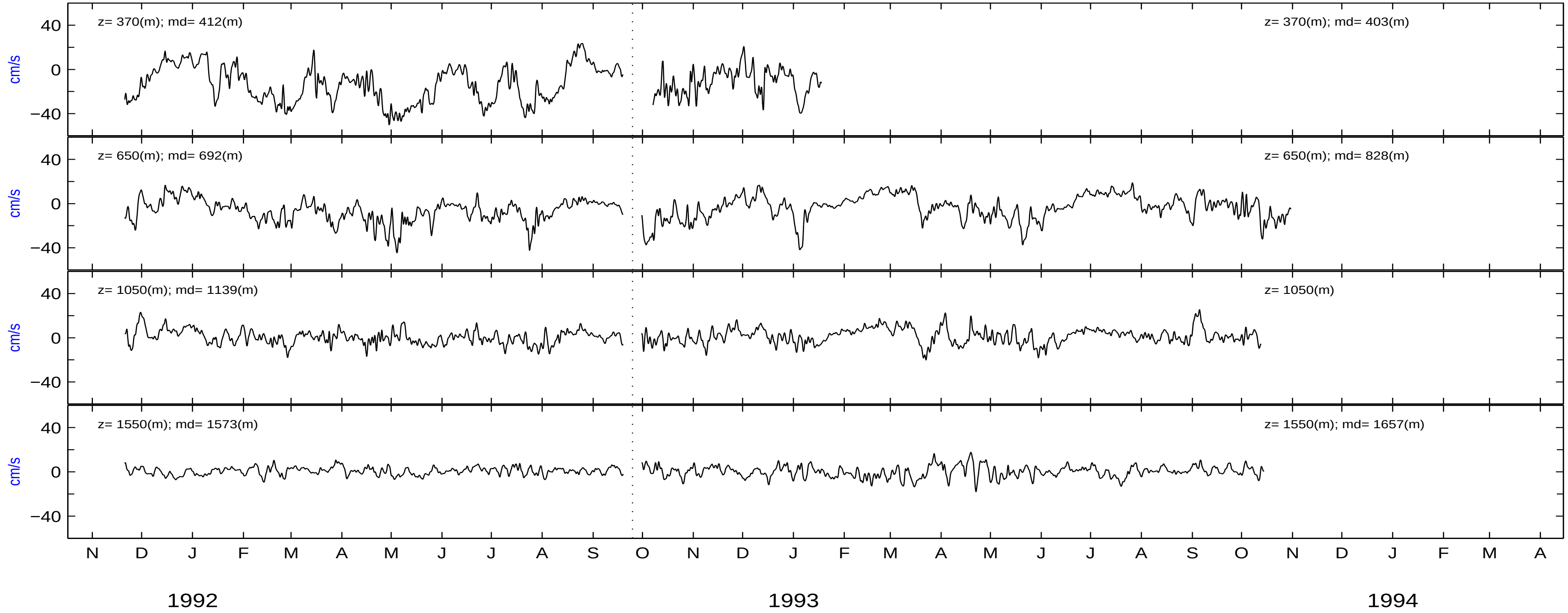

Figure 20: Mooring 4 – northward component (v)

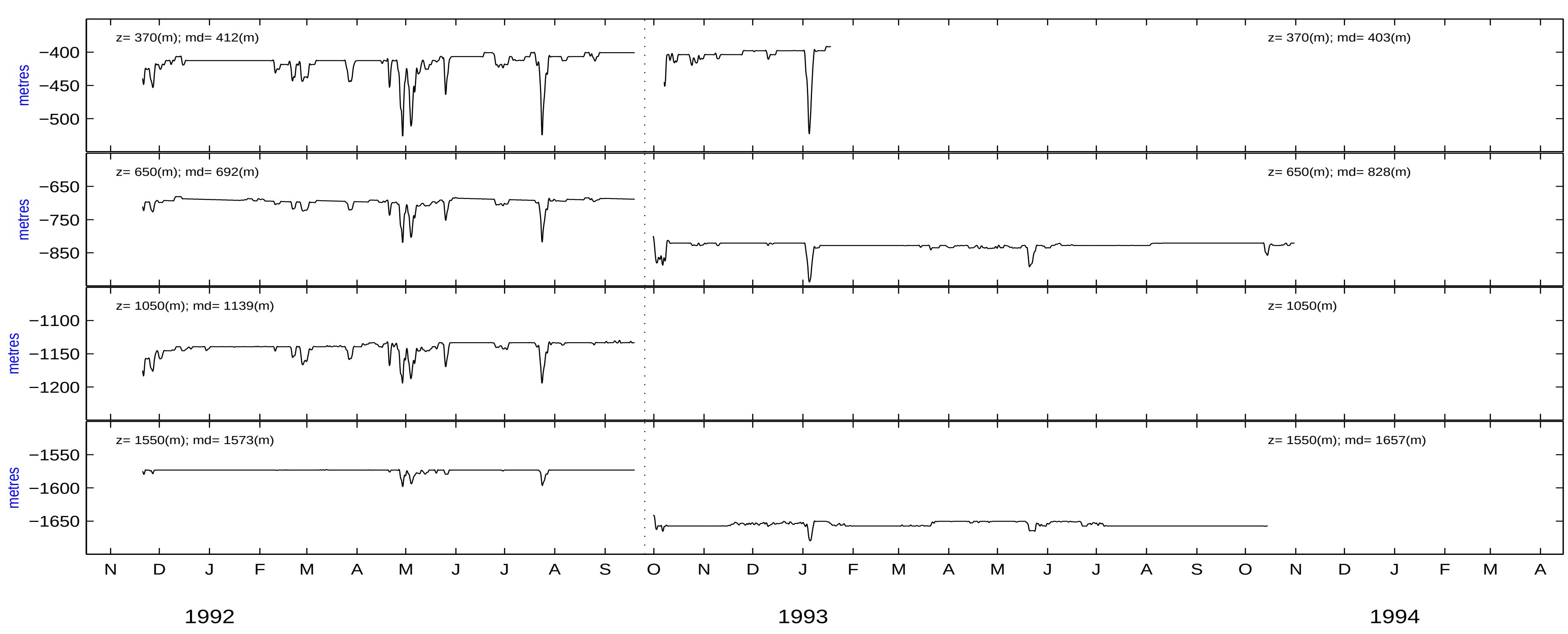

Figure 21: Mooring 4 – depth

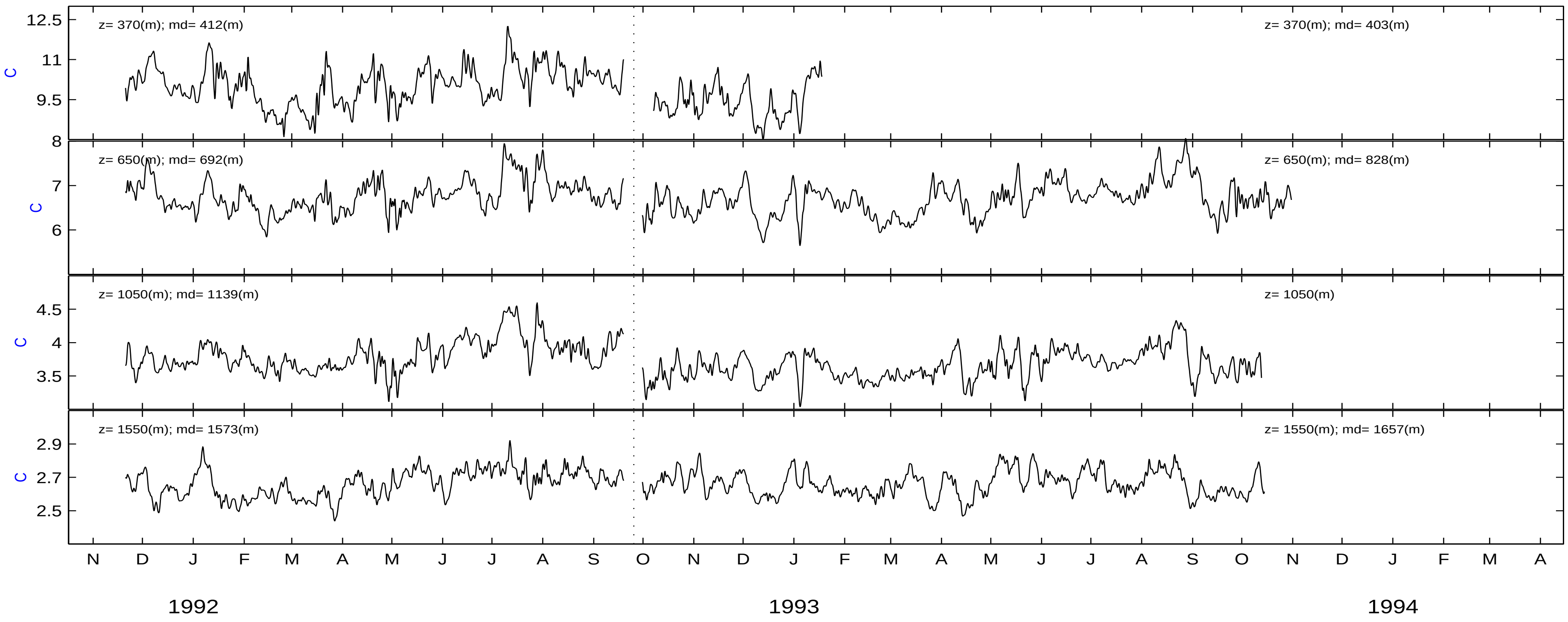

Figure 22: Mooring 4 – temperature

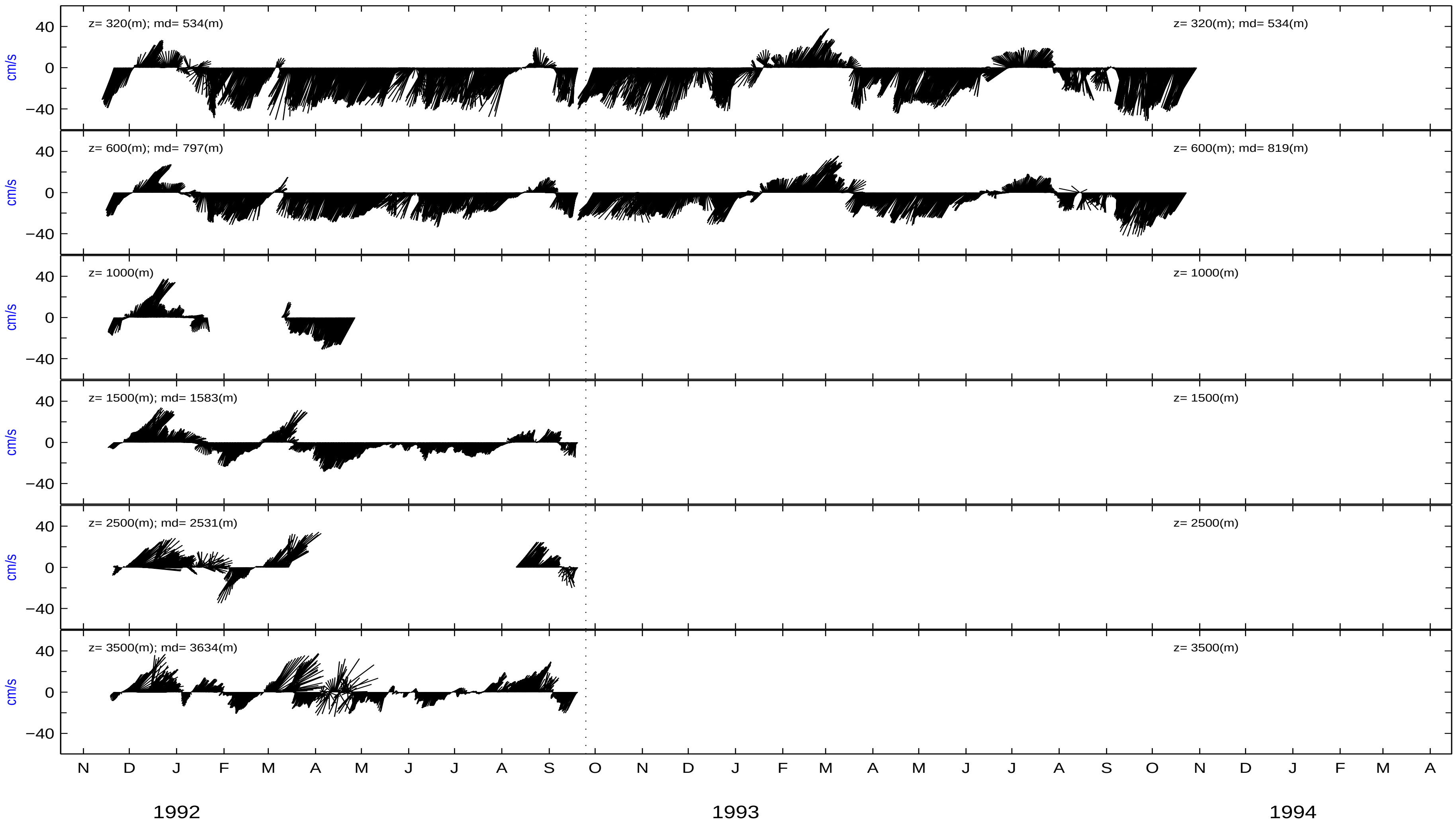

Figure 23: Mooring 5 – velocity vectors

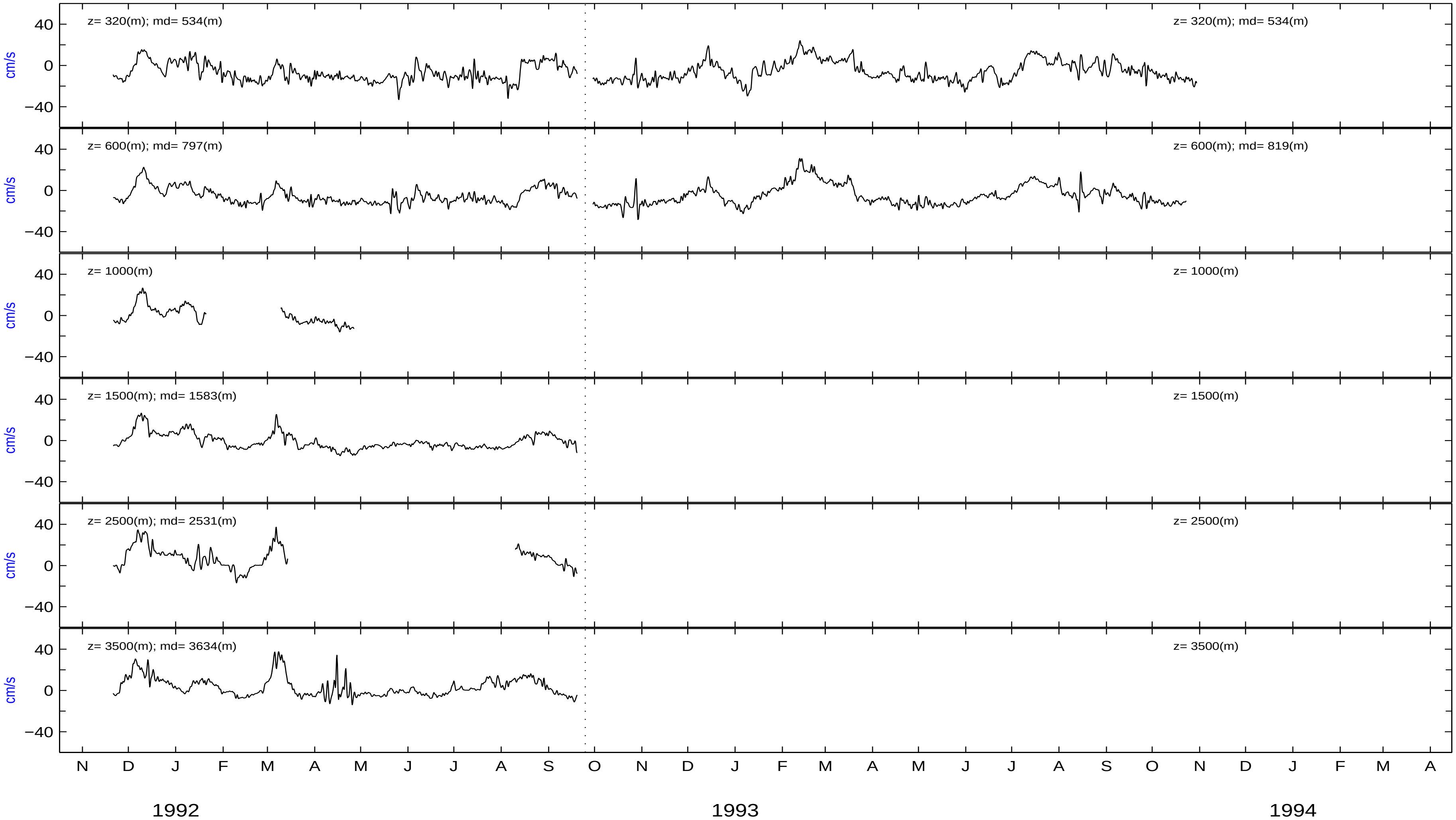

Figure 24: Mooring 5 – eastward component(u)

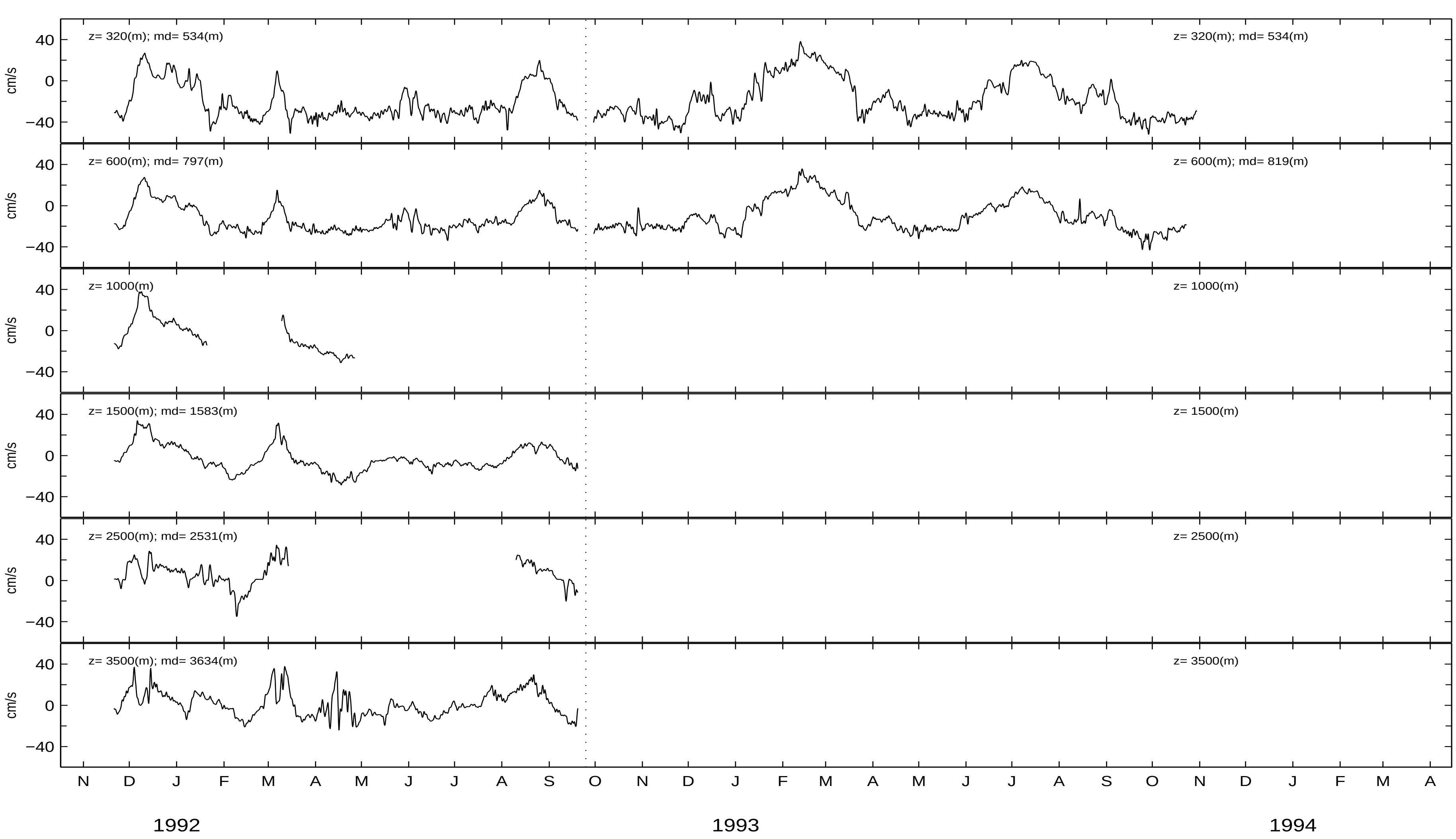

Figure 25: Mooring 5 – northward component

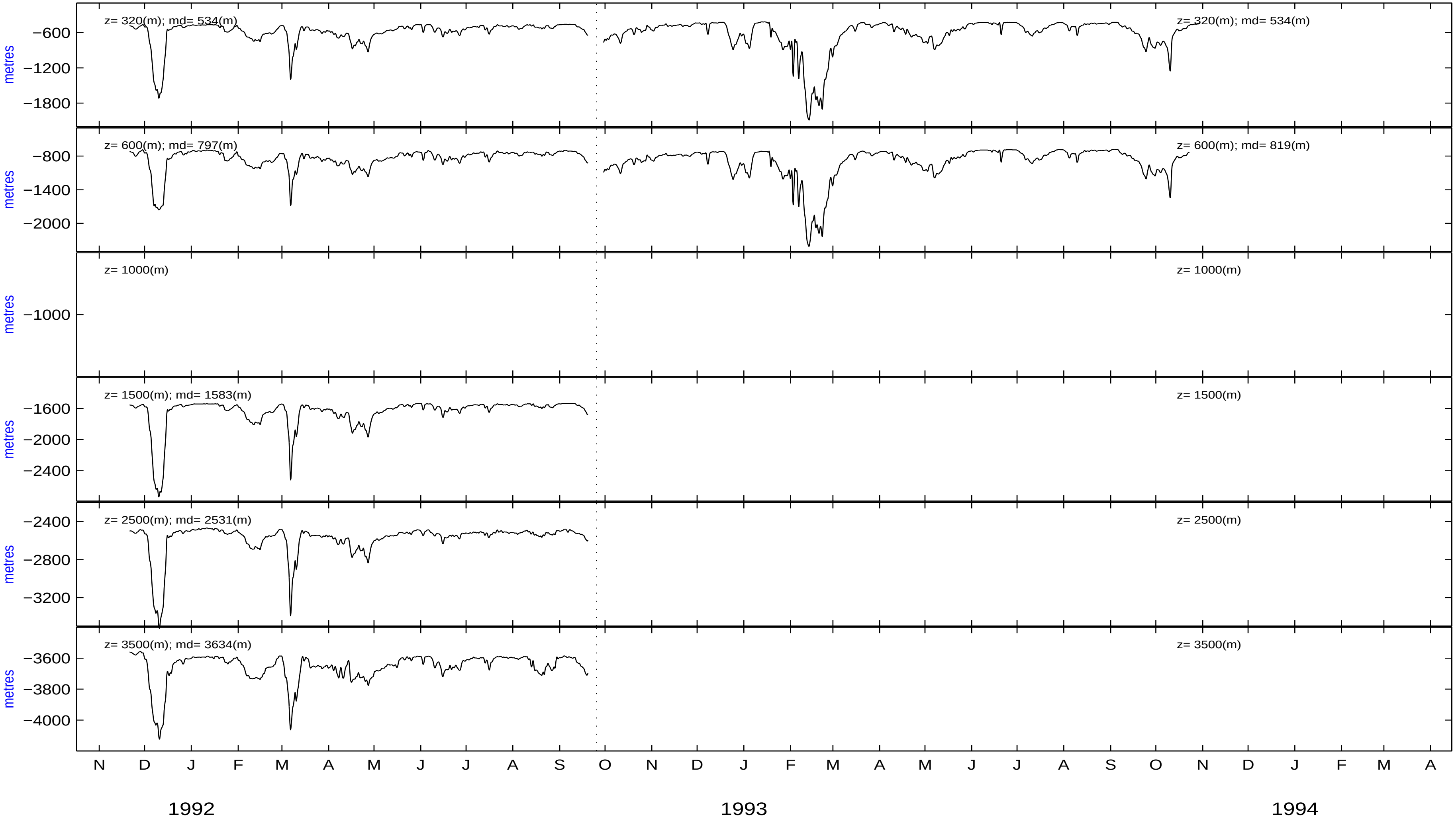

Figure 26: Mooring 5 – depth

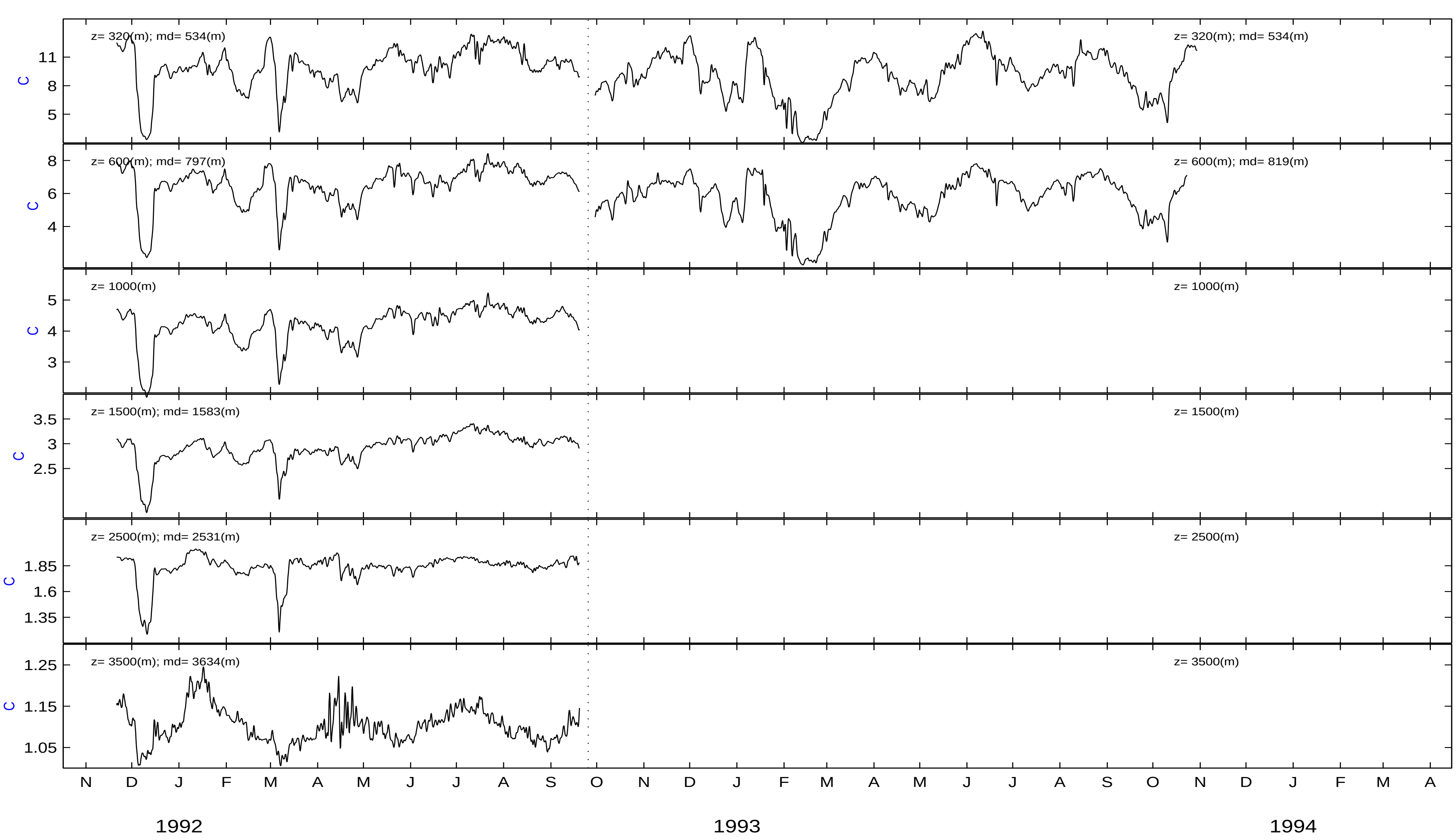

Figure 27: Mooring 5 – temperature

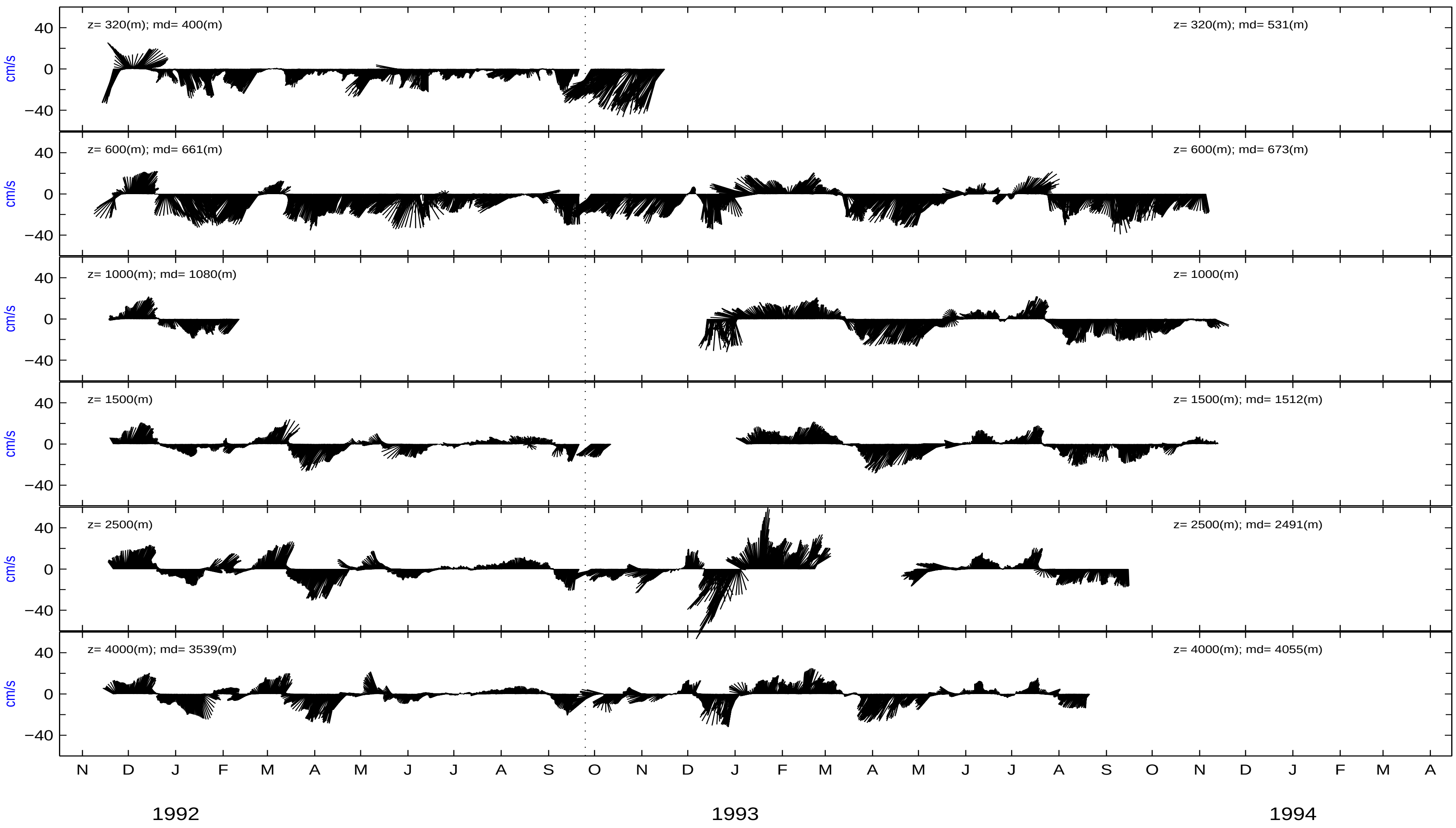

Figure 28: Mooring 6 – velocity vectors

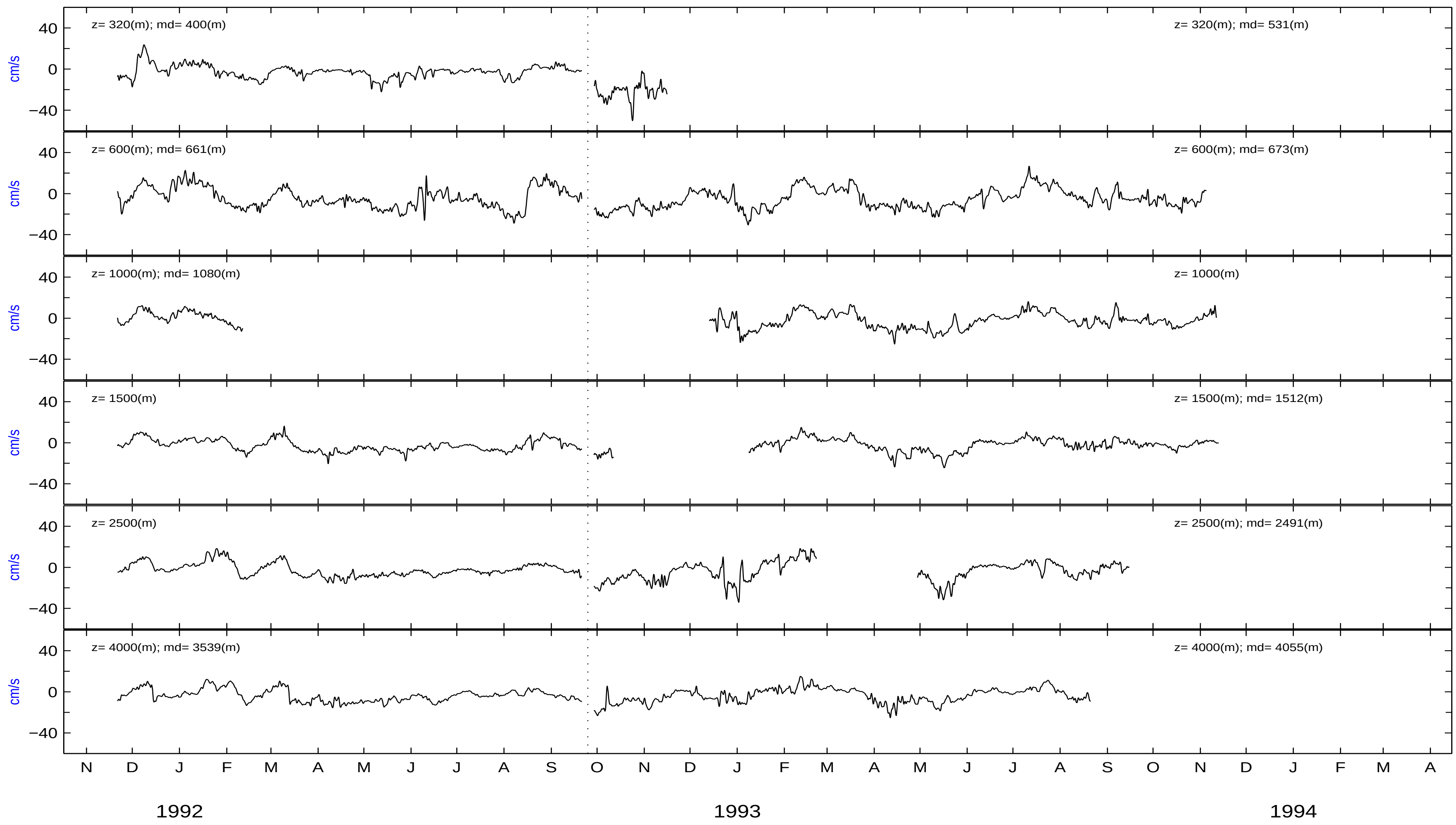

Figure 29: Mooring 6 – eastward component (u)

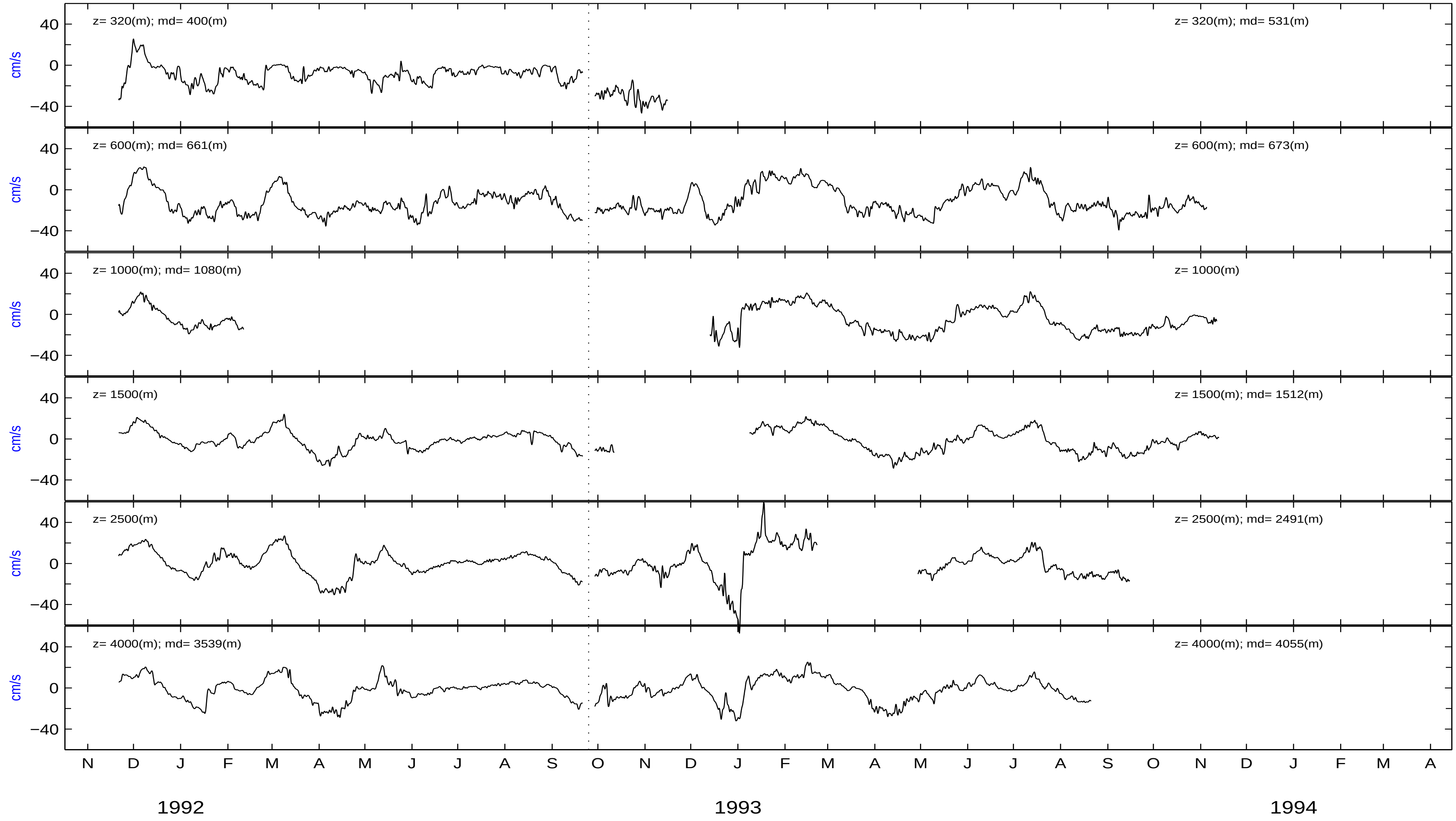

Figure 30: Mooring 6 – northward component (v)

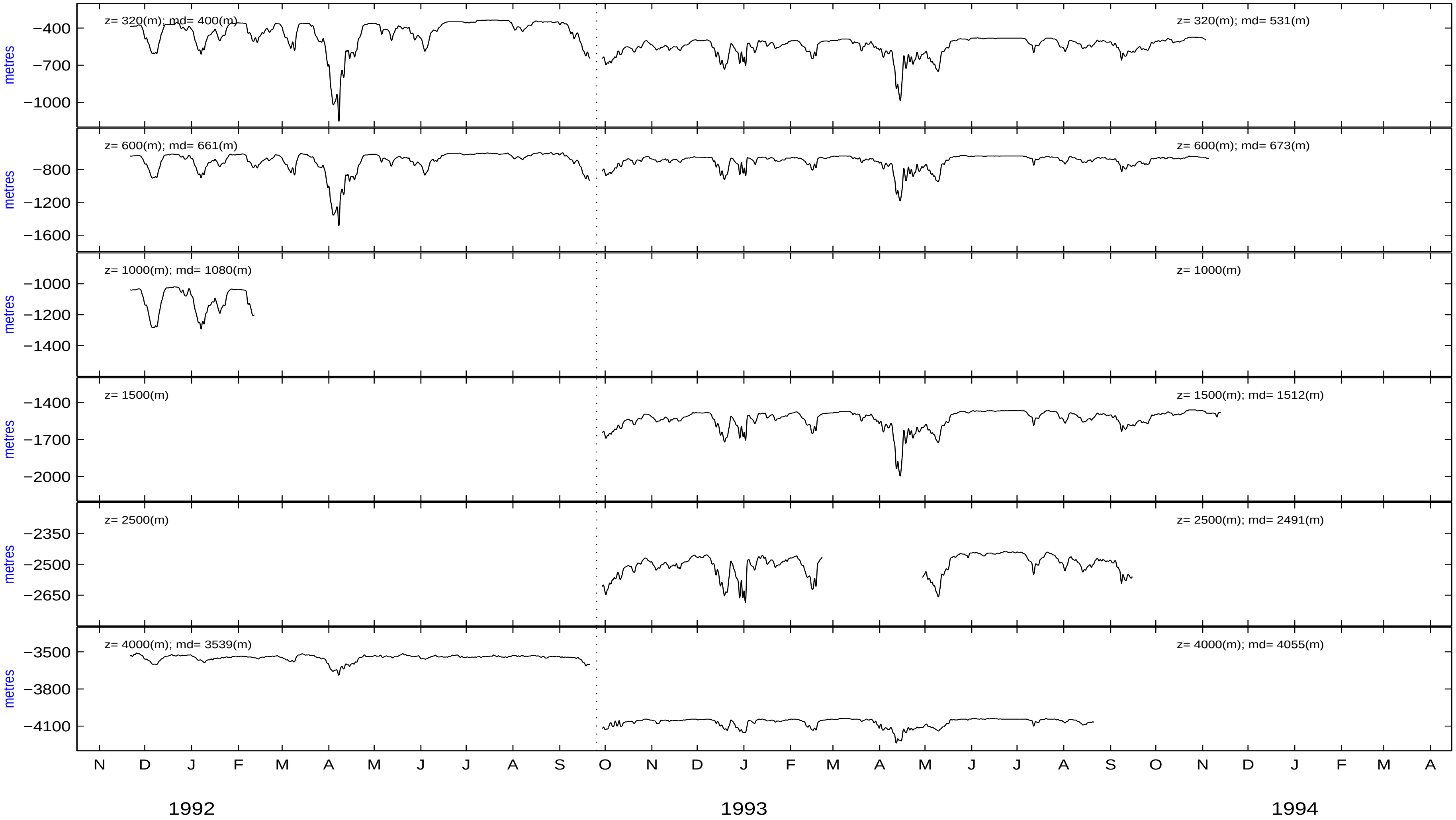

Figure 31: Mooring 6 – depth

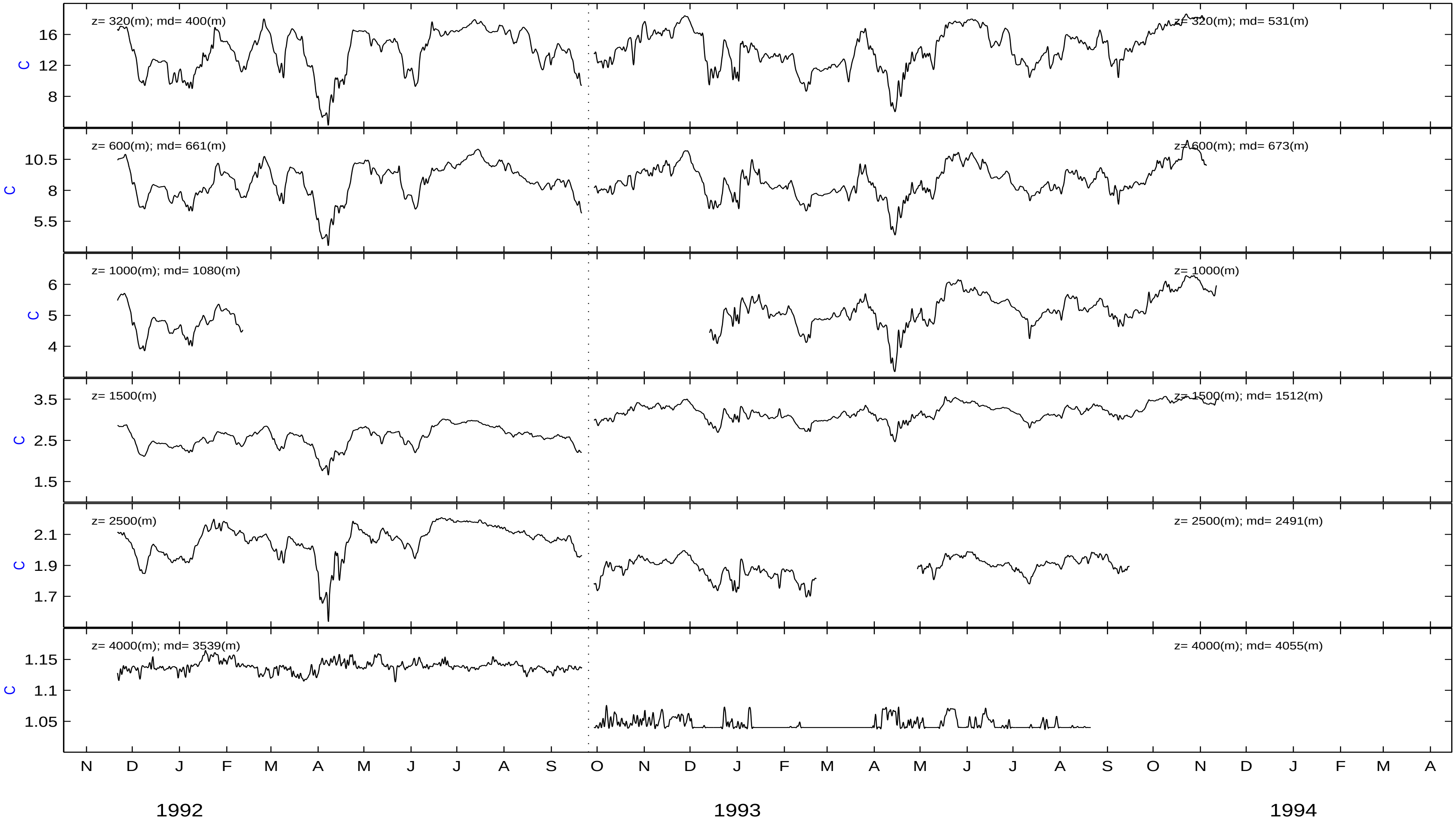

Figure 32: Mooring 6 – temperature

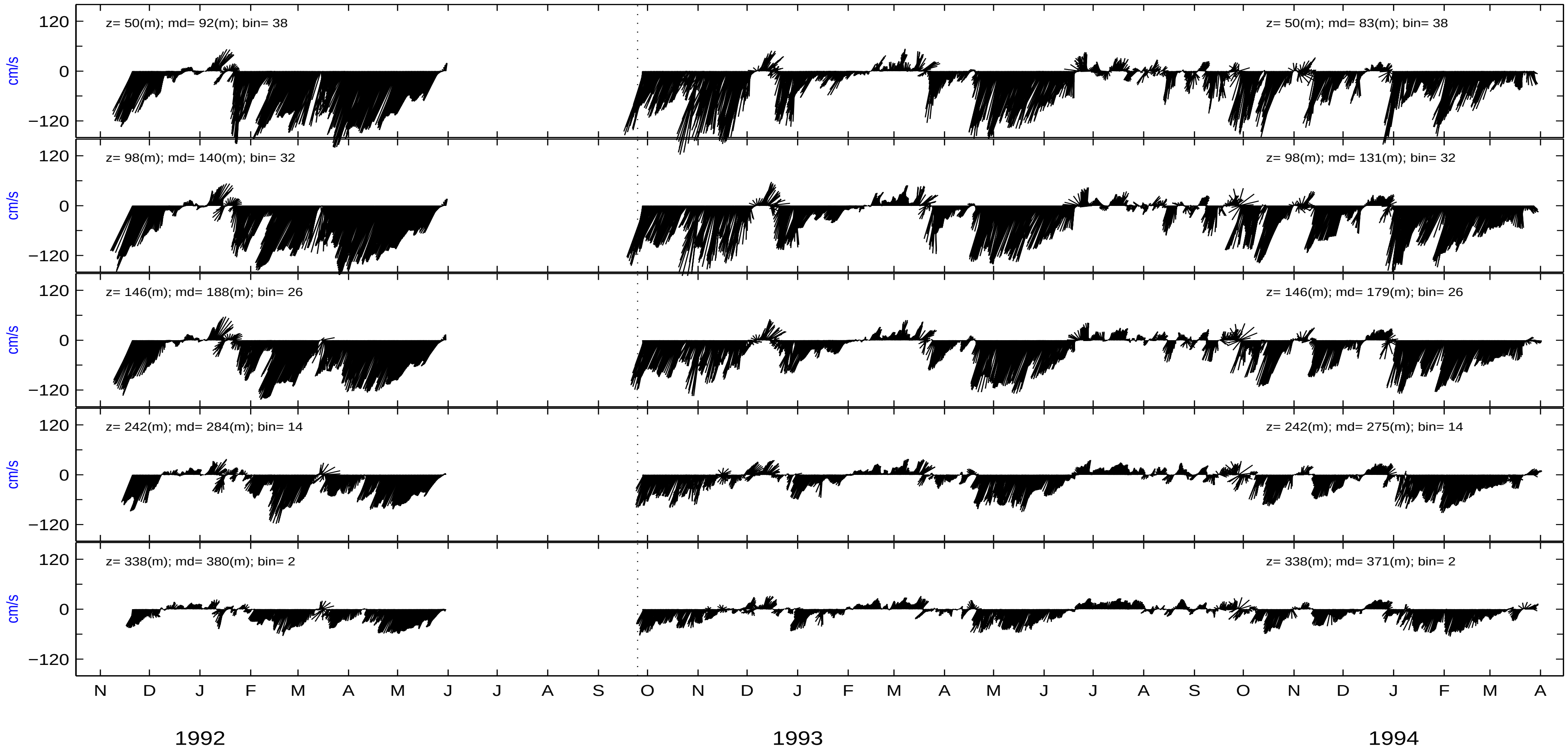

Figure 33: Mooring 4 – ADCP velocity vectors for selected bins.

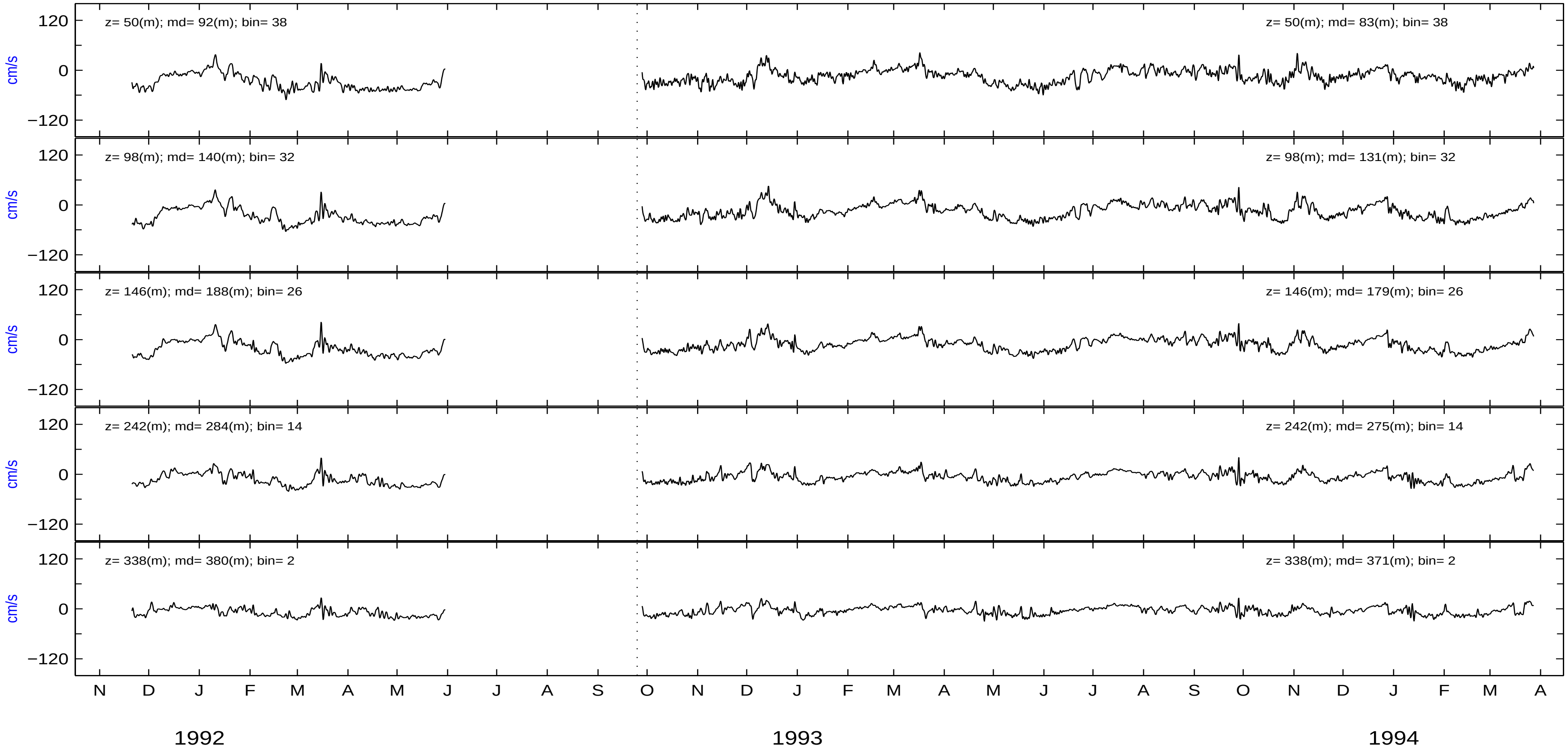

Figure 34: Mooring 4 – ADCP eastward component(u)

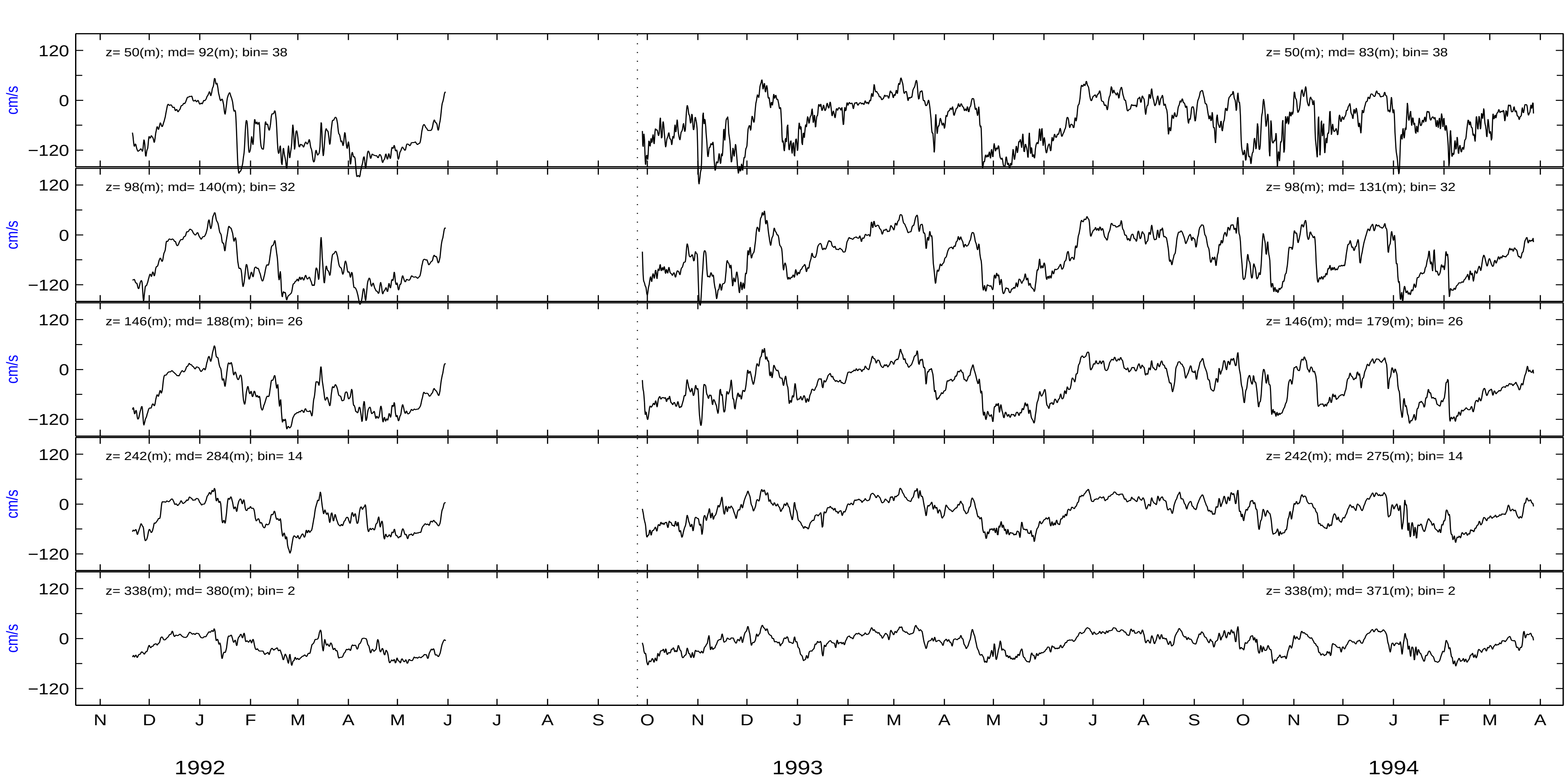

Figure 35: Mooring 4 – ADCP northward component(v)

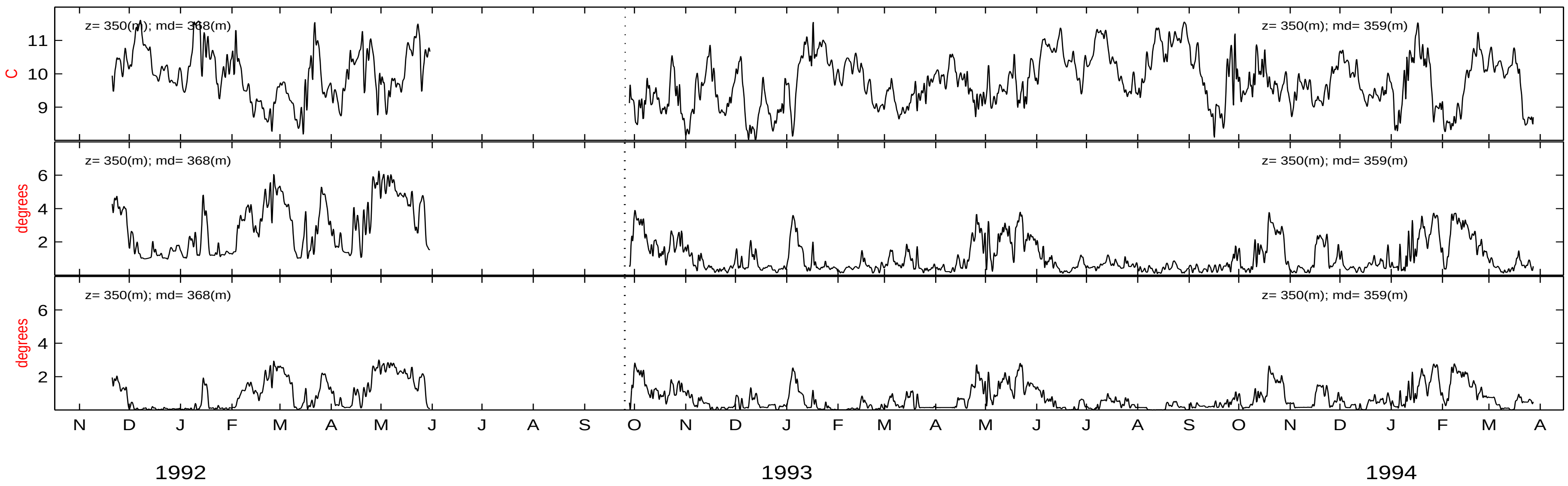

Figure 36: Mooring 4 – ADCP temperature (top), pitch (middle) and roll (bottom)

Table 4: Simple statistics for first deployment low-passed data. For all tables, *N* is the number of *6-hourly* data used, *u* is the eastward component (positive to the east), *v* is the northward component (positive to the north), *d* is depth and *T* is temperature (same for all tables).

Mooring	Depth	Record length		Means				Std. Deviations				Minimum Values				Maximum Values			
	metres	Days	N	u	v	d	T	u	v	d	T	u	v	d	T	u	v	d	T
M1	30	310.75	1243			24.5	22.93			4.1	1.87			21.0	19.40			52.2	27.01
	50	293.25	1173	-33.2	-19.3	44.2	21.65	31.6	19.6	2.8	1.81	-109.9	-66.4	41.1	16.23	26.4	45.5	57.5	25.19
												0							
M2	50	309.5	1238	-37.6	-39.7	66	20.95	26.9	27.5	19.2	1.56	-113.2	-104.6	48.3	16.72	27.8	51.6	129.1	24.66
	150	309.5	1238	-10.4	4.1		16.01	16.7	13.5		1.49	-61.9	-33.7		12.77	25.5	54.3		21.10
M3	50	187	748	-23.4	-54.4	98.7	19.24	20.7	41.4	14.5	1.91	-80.4	-139.2	87.6	14.78	21.0	51.2	143.7	23.81
	150	304.5	1218	-2.2	-58.9	196.3	14.47	10.7	19.2	12	1.34	-43.5	-58.9	184.6	9.00	20.7	55.6	241.4	18.38
	250	42.75	171	0.5	2.4	294	12.25	2	6.4	6.5	0.96	-5.9	-13.4	290.1	10.73	4.9	18.6	320.5	14.25
	400	311.25	1242	0.05	-1.7	435.7	9.93	1.6	2.9	9.1	0.87	-5.3	-10.4	413.6	7.91	6.8	7.2	462.4	13.06
	600	82.5	330	-0.3	0.6	639.2	7.61	0.6	0.5	1.6	0.48	-1.8	-1.3	638.1	6.57	1.5	1.9	645.3	9.13

Table 5: Simple statistics for first deployment low-passed data (continued from Table 4). Where *D* stands for ADCP, with velocity statistics determined at bin 32 at a nominal depth of 98m and temperature values obtained at a nominal depth of

Mooring	Depth	Record length		Means				Std. Deviations				Minimum Values				Maximum Values			
	metres	Days	N	U	v	d	T	u	v	d	T	u	v	d	T	u	v	d	T
M4	D(98m)	192	768	-27.2	-73.5		9.99	19.6	50.9		0.74	-63.8	-166.7		8.19	36.5	53.2		11.60
	370	303.75	1215	-5.9	-13.5	416.2	10.06	9.6	16.4	16.7	0.69	-26.4	-50.0	400.1	8.11	23.4	23.6	526.1	12.24
	650	303.75	1215	-2.6	-6.8	697.6	6.77	8.2	10.1	17.5	0.35	-23.9	-44.5	680.4	5.84	25.6	16.5	819.1	7.94
	1050	303.75	1215	0.6	0.4	1141	3.81	6.7	6.1	10.2	0.24	-21.1	-17.8	1129.9	3.11	31.3	23.1	1194.1	4.59
	1550	303.75	1215	0.6	0.7	1574.1	2.66	2.2	3.4	2.9	0.08	-5.5	-9.3	1572.4	2.43	9.4	10.7	1598.0	2.91
M5	320	304	1216	-7.2	-21.3	593.2	9.93	8.5	16.6	191.1	2.07	-33.2	-50.9	459.9	2.34	15.3	26.8	1717.9	13.40
	600	304	1216	-5.6	-13.3	851.4	6.55	7.5	12.5	181.9	1.10	-22.6	-33.9	689.1	2.12	22.5	27.4	1761.4	8.43
	1000	109.5	438	-0.04	-4.4		4.20	8.8	16.7		0.57	-16.0	-31.2		1.86	26.6	37.7		5.23
	1500	304	1216	-0.9	-3.3	1646.8	2.91	7.5	12.1	193.7	0.28	-14.8	-28.6	1532.8	1.61	26.5	33.8	2745.0	3.40
	2500	155.25	621	7.5	6.2	2580.9	1.83	10.1	11.8	161.5	0.13	-16.9	-34.8	2467.4	1.18	37.2	34.3	3542.2	2.01
	3500	304	1216	3.2	1.3	3657.4	1.10	8.9	12.0	90.8	0.04	-13.8	-23.9	3556.6	1.01	37.4	37.7	4124.3	1.24
M6	320	305	1220	-2.5	-8.2	439.5	13.75	6.1	8.4	120.6	2.77	-22.1	-33.7	334.7	4.28	23.7	25.6	1553.1	18.00
	600	305	1220	-4.1	-13.3	705.6	8.65	10.1	11.7	132.8	1.43	-28.9	-35.5	596.7	3.53	22.6	22.2	1485.7	11.32
	1000	82.5	330	1.3	-3.1	1109.5	4.76	5.9	10.2	81.8	0.43	-12.7	-19.1	1019.2	3.85	12.2	21.6	1292.7	5.71
	1500	305	1220	-2.6	-1.2		2.56	5.6	8.9		0.25	-20.4	-26.6		1.66	16.2	21.0		3.01
	2500	305	1220	-2.3	0.2		2.06	6.3	11.6		0.10	-15.7	-30.5		1.54	18.3	26.7		2.21
	4000	305	1220	-3.6	-1.4	3548	1.14	5.8	10.3	26.4	0.01	-15.4	-28.6	3509.3	1.11	12.2	21.6	3689.5	1.17

Table 6: Simple statistics for second deployment low-passed data.

Mooring	Depth	Record length		Means				Std. Deviations				Minimum Values				Maximum Values			
	metres	Days	N	u	v	d	T	u	v	d	T	u	v	d	T	u	v	d	T
M1	30																		
	50	256	1024	-22.1	-38.6		21.43	17.2	27.1		1.32	-66.4	-86.4		17.91	29.7	58.6		25.02
M2	50	85.75	343	-13.4	-70.5		21.79	14.6	43.5		1.15	-36.4	-139.9		17.21	41.5	74.4		25.10
	150	359.5	1438	-29.1	-6.8		15.25	7.5	22.5		2.09	-17.9	-85.7		9.69	41.7	58.9		21.66
M3	50																		
	150																		
	250	367.25	1469	3.4	5.3	367.90	11.45	7.8	13.9	13.9	1.08	-18.6	-42.1	349.6	8.71	35.9	43.6	468.3	13.73
	400	122	491	2.8	3.2	553.1	9.13	7.5	11.2	12.9	7.16	-14.6	-28.8	417.5	7.62	31.1	32.4	576.0	11.06
	600	415	1660	1	3.3	664	7.19	3.6	6.6	2.7	4.31	-16.7	-24.9	658.7	6.21	11.9	27.4	672.0	9.08

Table 7: Simple statistics for second deployment low-passed data (continued from Table 6).

Mooring	Depth	Record length		Means				Std. Deviations				Minimum Values				Maximum Values			
	metres	Days	N	u	v	d	T	u	v	d	T	u	v	d	T	u	v	d	T
M4	D(98m)	546	2184	-14.1	-47.6		9.76	17.0	50.9		0.75	-51.6	-169.1		8.01	44.7	56.9		11.55
	370	103	412	-3.3	-11.3	405.7	9.42	12.0	11.8	17.1	0.64	-24.6	-39.5	391.3	8.01	34.4	20.7	522.9	10.95
	650	395.75	1583	-1.7	-3.5	828.3	6.68	7.6	11.1	12.3	0.38	-27.5	-41.7	799.3	5.65	21.2	18.8	938.1	8.06
	1050	377.5	1510	0.9	1.6		3.64	7.0	6.7		0.21	-22.5	-20.0		3.04	29.7	25.4		4.33
	1550	379.25	1517	-0.1	0.2	1655.4	2.66	3.0	5.1	3.5	0.07	-10.3	-18.0	1641.4	2.47	12.5	17.5	1679.7	2.85
M5	320	395.25	1581	-5.7	-17.7	620.9	8.96	9.4	20.1	271.8	2.44	-29.5	-51.8	420.2	2.04	24.1	38.1	2087.0	13.71
	600	388.5	1554	-4.9	-10.5	910.9	5.74	9.7	15.4	286.7	1.30	-28.3	-43.0	681.9	1.68	31.0	35.6	2408.8	7.81
	1000																		
	1500																		
	2500																		
	3500																		
M6	320	48.25	193	-21.8	-30.8	549.4	14.17	7.8	6.4	70.5	2.47	-50.2	-46.5	473.7	6.01	-19.1	-14.3	986.4	18.64
	600	402.25	1609	-5.6	-10.9	702.3	8.76	9.3	13.1	78.3	1.26	-30.6	-39.2	631.2	4.39	26.6	21.7	1184.1	12.04
	1000	333	1332	-2.7	-5.8		5.20	7.6	12.8		0.52	-25.3	-32.3		3.18	16.2	22.0		6.28
	1500	321.5	1286	-2.2	-2.3	1535.2	3.18	6.2	10.9	73.6	0.20	-24.4	-28.5	1460.2	2.46	14.8	21.7	1996.6	3.57
	2500	285.5	1142	-4.2	-0.5	2504.1	1.89	9.4	15.6	51.9	0.06	-34.1	-67.9	2437.7	1.69	18.2	59.6	2686.0	19.96
	4000	326.25	1305	-3.7	-2.0	4070.3	1.04	6.9	11.1	34.7	0.01	-25.3	-32.0	4037.2	1.04	14.9	25.1	4237.7	10.76

APPENDIX A – MOORING DESIGNS

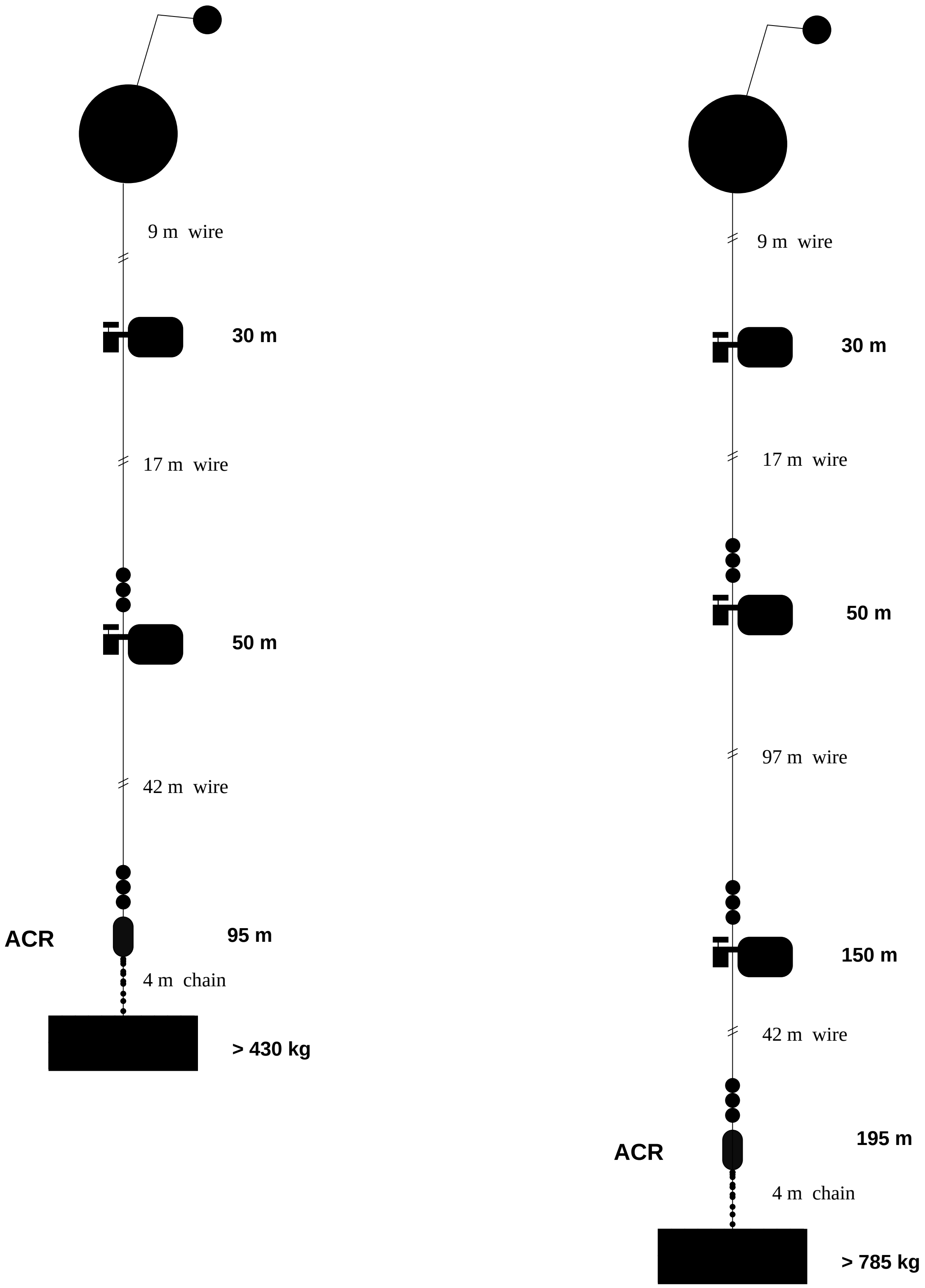

Figure A-1: Hardware configuration for Mooring 1 (left) and Mooring 2 (right)

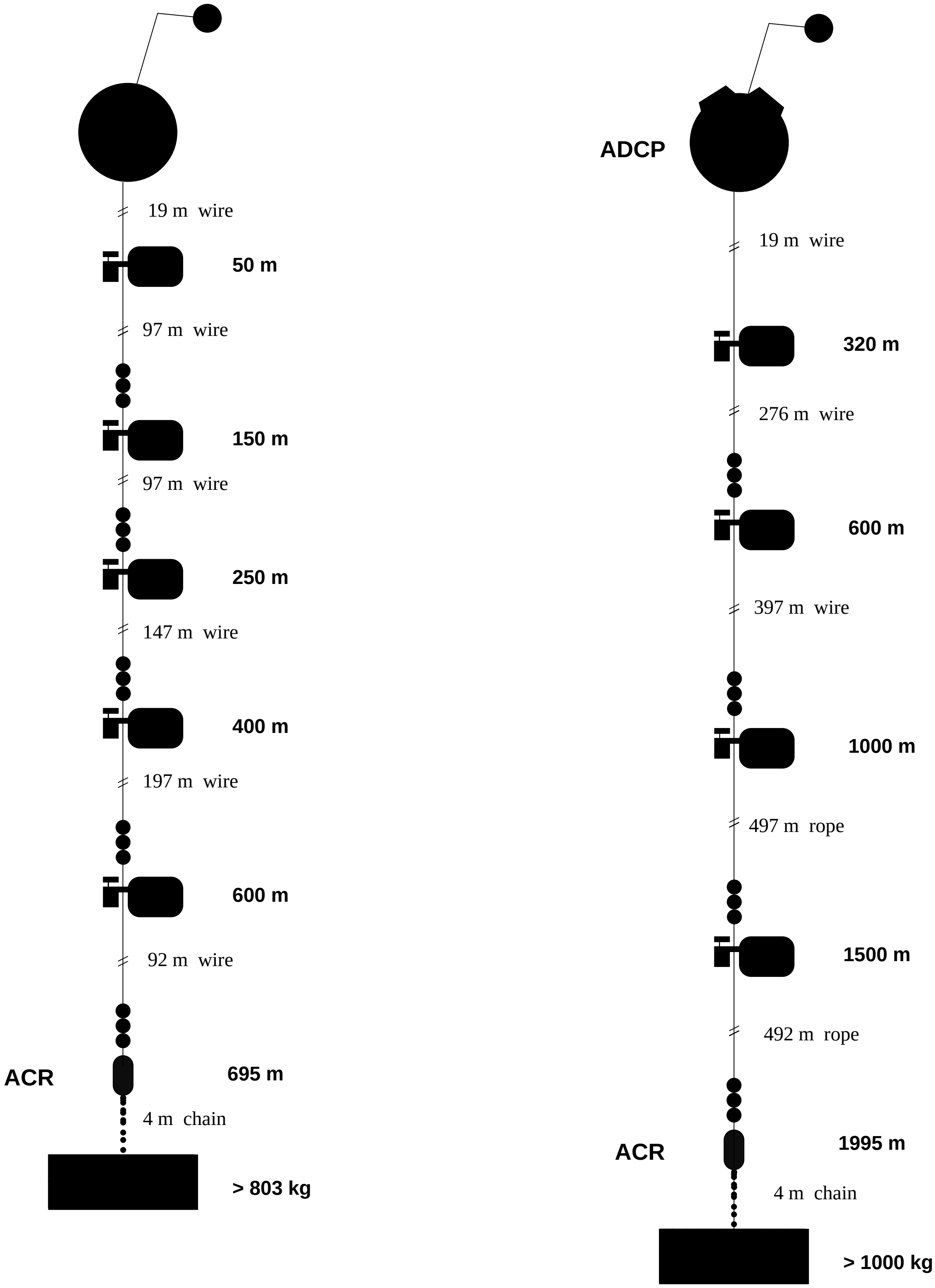

Figure A-2: Hardware configuration for Mooring 3 (left) and Mooring 4 (right)

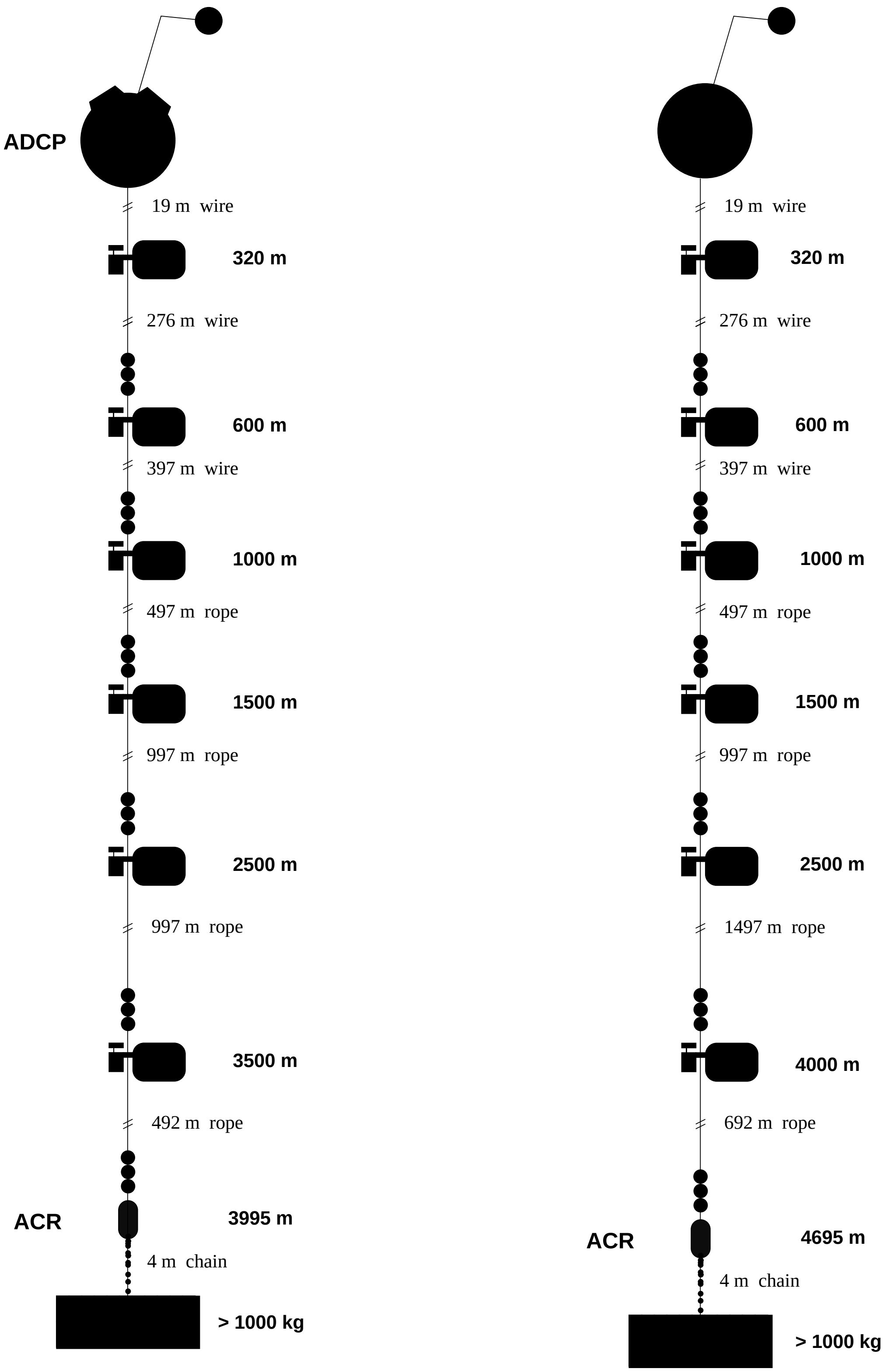

Figure A-3: Hardware configurations for Mooring 5 (left) and Mooring 6 (right)