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EVALUATION OF CURRENT MEASUREMENTS BENEATH A MODIFIED AND UNMODIFIED SUBSURFACE FLOAT

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INTRODUCTION

Moored current measurements are made without a frame of reference. They are distorted in many ways due to mooring motions induced in the subsurface float supporting the cables and instruments, and the dynamic response deficiencies of the instruments.

The subsurface float, the larger type which has 210 kg (460 lb) buoyancy, was found to be unstable. They were all modified during 1972-73. The modification consisted mainly of extending the top tail fin, and providing a new point of attachment for the mooring line so that at rest the float would assume a plough angle of around 5^{0}. A 9 kg weight was also attached underneath it to make it heavier and move the centre of gravity further towards the tail (see Figure 1).

Results obtained in the laboratory by towing both floats indicated that the modified float was more stable and towed smoothly in a velocity range from 0 to 235 cm/sec. The unmodified float, with a slight nose-up attitude when tested, was found to be unstable. It towed and pulled to the right at all times, in fact, as the towing speed increased, the resulting lifting force made the float unstable (Chiocchio, 1979).

The purpose of this study is to evaluate current measurements which were obtained from two moorings which had a modified and unmodified float. The results and part of the discussion which follow have been taken from the thesis "Evaluation of the Use of Moored Current Meters in the Great Lakes", submitted to A.P.E.O. in 1976 by the same author.

DISCUSSION

In order to evaluate this modification, two Geodyne current meters were moored at approximately 300 metres apart in very shallow waters (15 m). The subsurface float in both moorings (65A and 66A) was placed at four metres from the surface and the current meters were attached beneath it at six metres depth. The modified float (mooring 65A) had longer tail fins and the point of attachment of the mooring line was moved 10 centimetres toward the nose of the float. Both instruments were set to record continuously. The continuous mode had a recording cycle of 160 seconds. During each cycle 29 sets (five seconds interval) of rotor, compass/vane were measured for 145 seconds. A resulting velocity vector was formed every 2.6 minutes (160 secs) by vector averaging the 29 pairs of velocity readings.

A summary of the net current properties are reported in Table 1.

TABLE 1: Net Current Properties of Moorings 65A and 66A

Mooring Number	$\overline{U}$ cm/sec	$\overline{V}$ cm/sec	Mean Vel. cm/sec	Net Dir.	Vector Var. (cm/sec)	Mean Speed cm/sec	
65A006	2.7	2.3	3.5	50	11.6	4.9	Modified Sub-surface Float
66A006	3.7	2.7	4.6	54	18.7	6.8	

The mean speed reveals that the Geodyne meter suspended beneath the modified subsurface float (65A) measured 39% lower speeds than mooring 66A. The average value of the ratio of the speeds is in the order of 1.4. The net directions were not significantly different; they differed by 4^{o}. The vector variance which reflects the variability seen by the sensors was lower for mooring 65A by a factor of .620.

Regression plots of speed and direction and their differences (2048 - 2.6 minutes values) are shown in Figures 2 - 3 respectively. Plots in both figures show that measurements from mooring 66A (unmodified float) give higher scatter in the directions and higher speeds. This discrepancy can certainly be attributed to the different degree of mooring motions induced to the mooring line and instruments by the subsurface float and the different response of the sensors themselves to these high frequency oscillations.

The composite spectra of both instruments is shown in Figure 4 A mismatch of the estimated Kinetic Energies occurs throughout the frequency spectrum. From frequencies less than 1 cph, there is about 50% more energy in mooring 66A than mooring 65A. At frequencies greater than 1 cph, the difference in energy is about 5 times. The mismatch between the spectra clearly shows the response limitations of the Geodyne meter sensors and the serious effect that higher frequency motions, induced by mooring platform, have on the current measurements.

The Geodyne current meter, because of the 5-second sampling interval and its sensors' response characteristics, is unable to fully extract and describe the higher frequency variations. As a result of this, the unresolved high frequency variations alias the data by introducing a noise level which distorts high frequencies as well as low frequencies of interest. The results here show that the modified subsurface float is a more stable and better platform for current measurements and is less sensitive to the lake's surface agitation. Standard daily and overall statistics are reported in Appendix "A".

Because of the data storage requirement, the Geodyne meter usually operates on an interval mode in which a burst of samples is collected during a time interval. The burst length is controlled by an interval selector switch. This selects intervals of 20, 40, 80 or 160 seconds during which, 1, 5, 13, or 29 rotor, compass/vane readings are recorded at 5-second intervals. A comparison between the spectra of mooring 65A and 66A when using the different burst lengths is shown in Figure 5. At frequencies greater than 0.5 cph, the difference in energy density between 20 and 160 seconds interval mode varies for both moorings by a factor of nearly 10. At frequencies between 0.1 and 0.5 cph significant differences are still found when using a 20-second sampling scheme as compared with the one using 160 seconds.

The different subsampling used does allow for the aliasing of the current measurements at frequencies higher than 0.2 cph and does not affect lower frequencies of interest. The unresolved high frequency variations produce an increase in the noise level at the high frequency end of the spectrum the shorter the interval mode used. It is also interesting to note the more distinct and higher differences between each sampling mode occurring for the high frequency range of mooring 66A which has been subjected to a higher degree of motions.

REFERENCES

Chiocchio, F. 1979. Stability and Drag Tests on the Modified and Unmodified Subsurface Float. Unpublished Report.

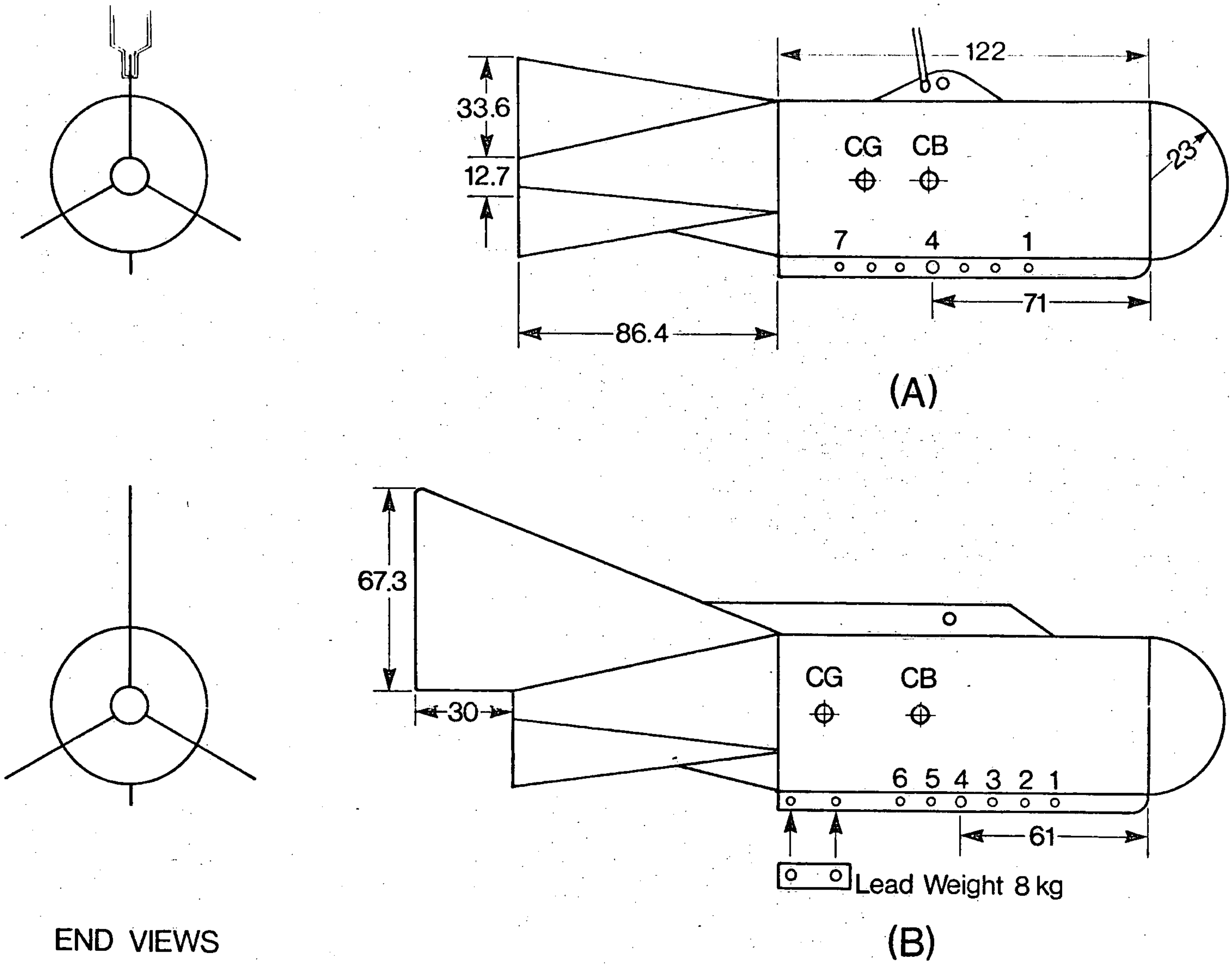


Figure 1 A) Unmodified subsurface float
B) Modified subsurface float with lead weight (8 kg)

* NOTE : Measurements are in centimetres
CG – Centre of gravity
CB – Centre of buoyancy

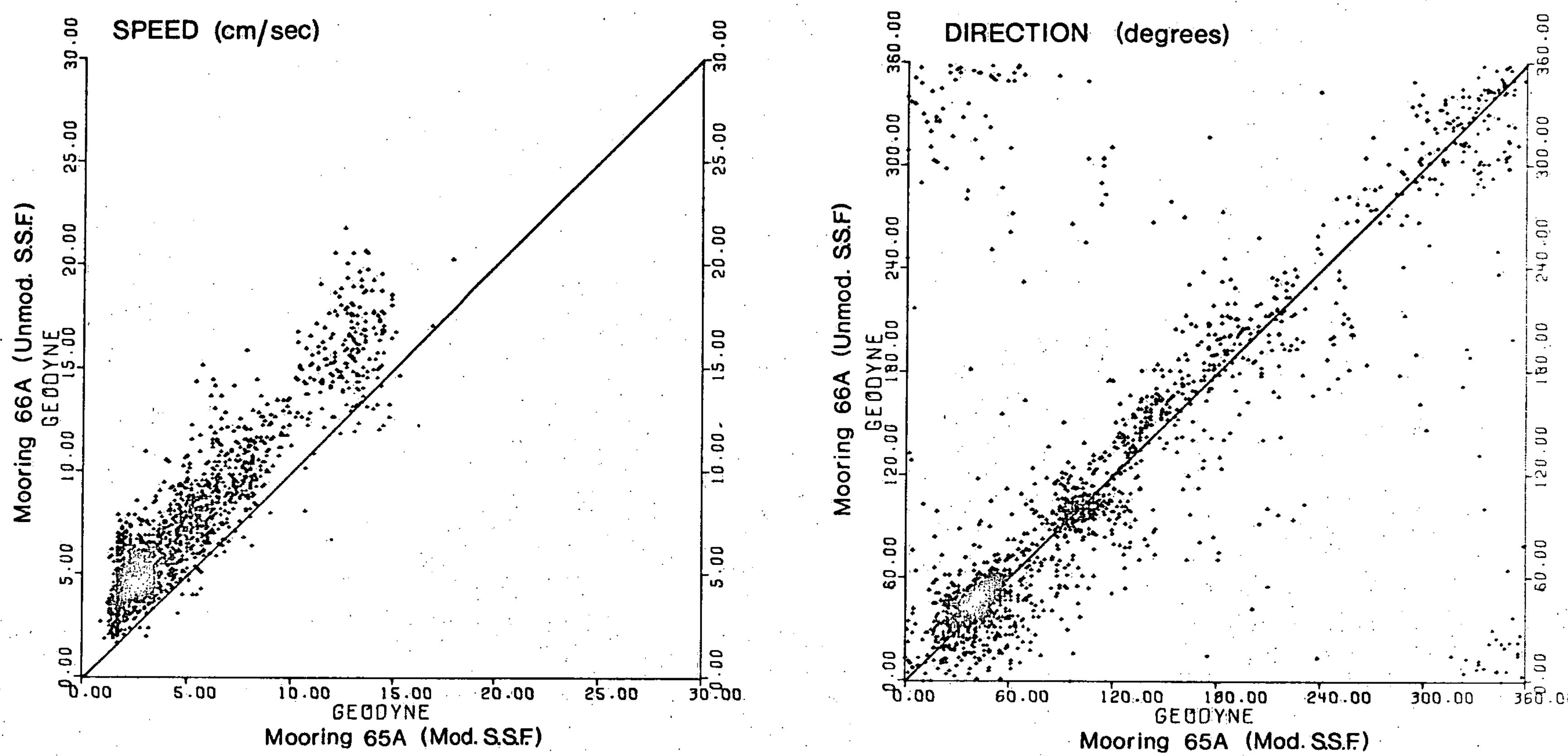
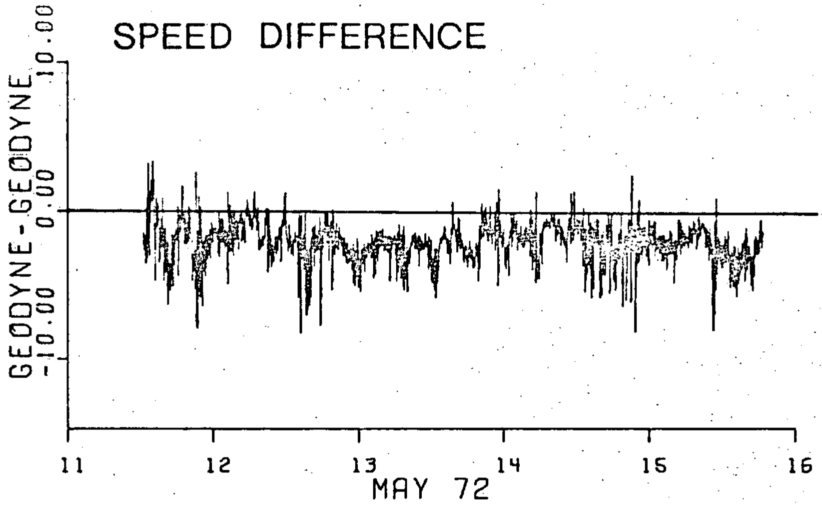


Figure 2: Comparison of speed and direction measurements between two Geodyne current meters suspended beneath an unmodified and modified float. The diagonal line indicates the result if both instruments record the same speed, or the same direction.

Moorings 65A & 66A



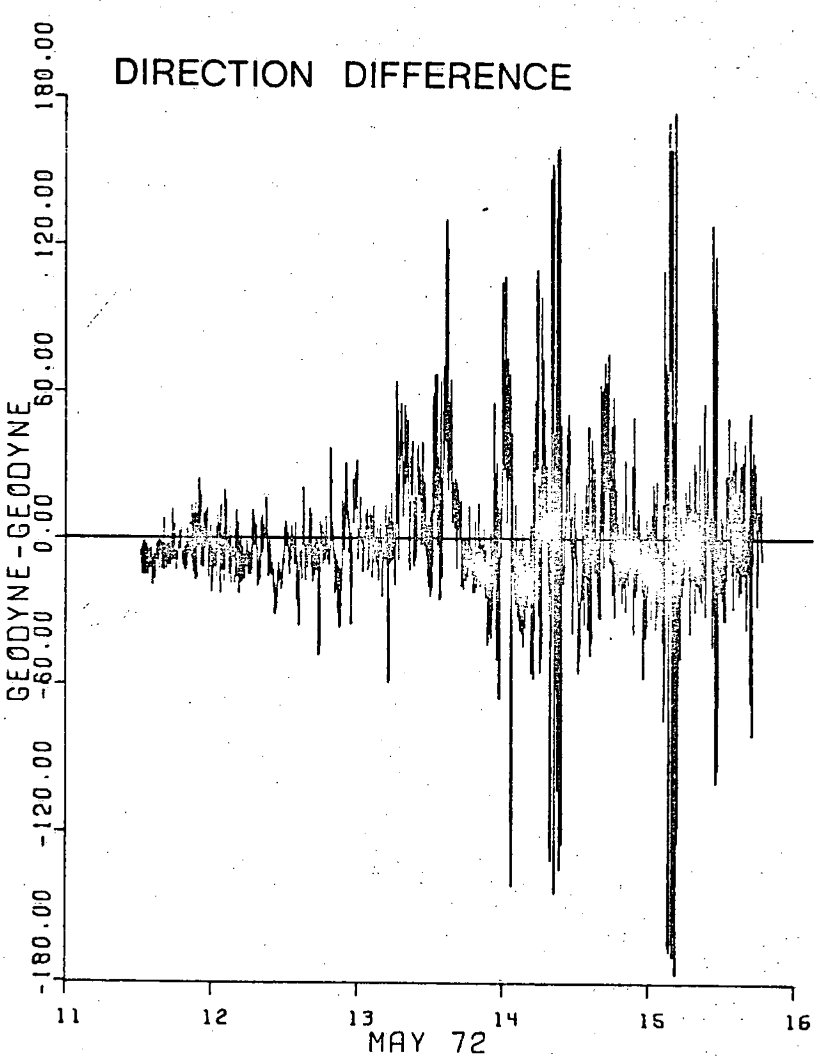


Figure 3: Speed and direction differences between two Geodyne current meters suspended beneath a modified and unmodified float.

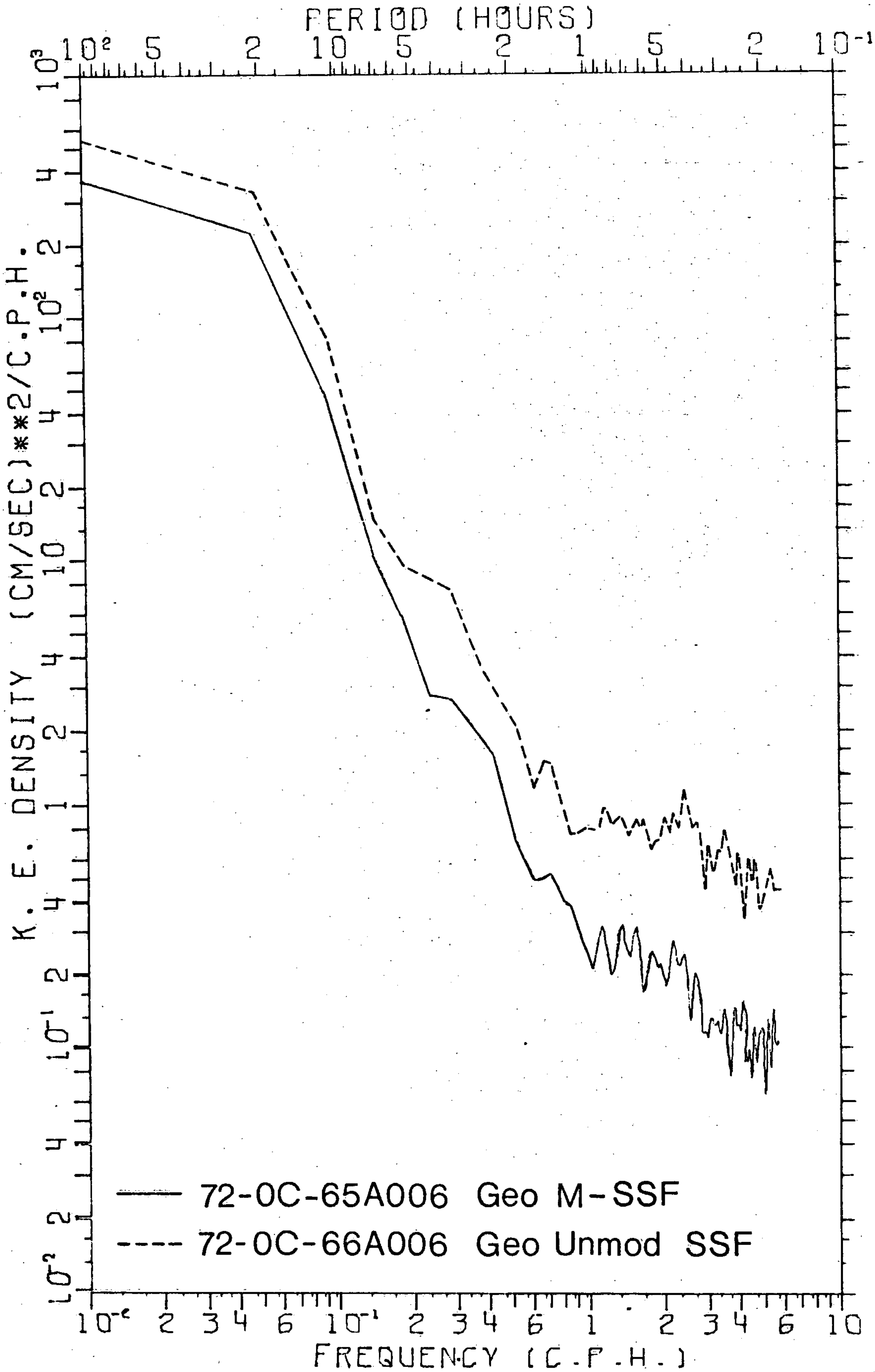


Figure 4: Comparison of spectra of 2.6 minute measurements (2048 values) between two Geodynes suspended from a modified and unmodified float.

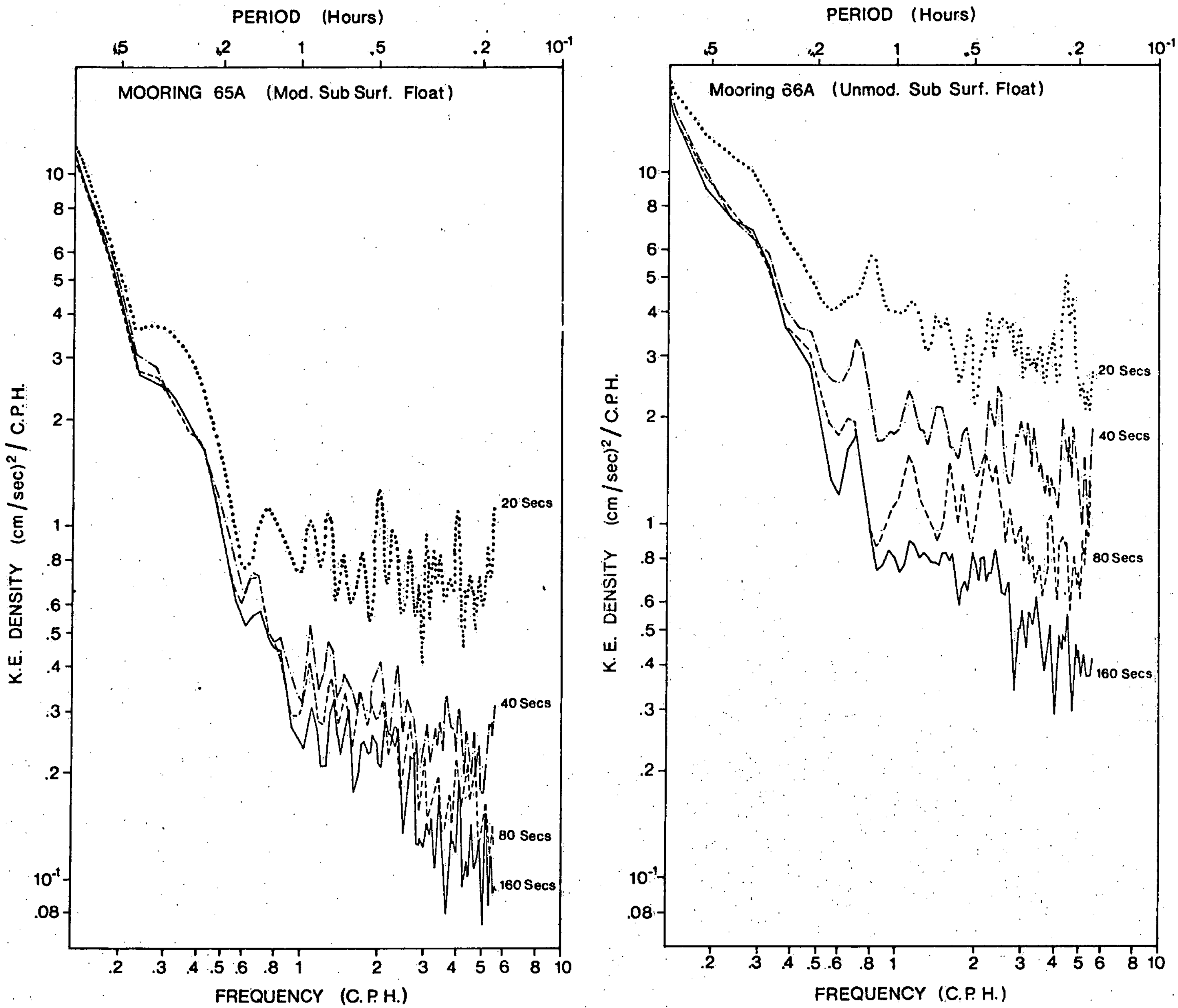
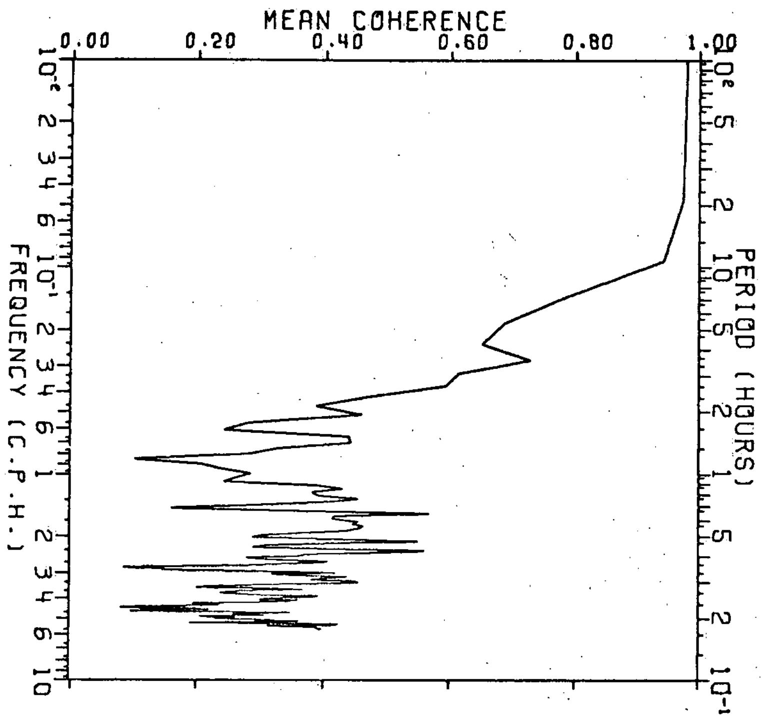
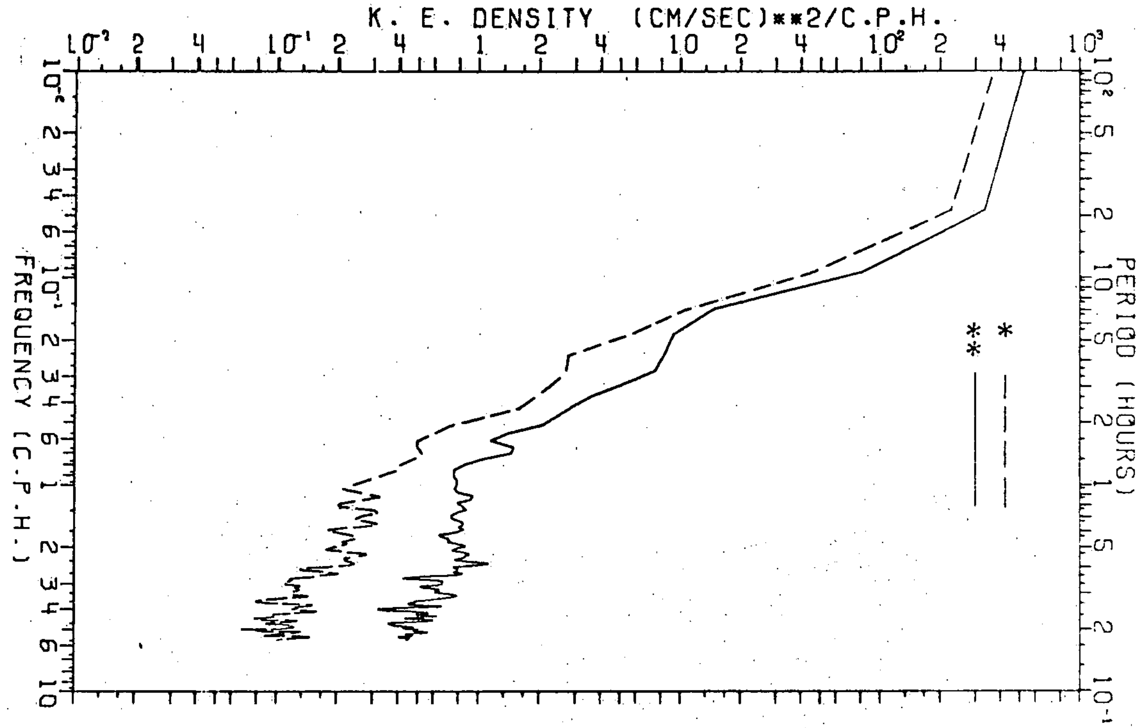


Figure 5: Comparison of spectra from a Geodyne meter when using different sampling periods of 20, 40, 80, or 160 seconds to form a velocity vector every 2.6 minutes. The data from moor 65A and 66A has been used.





* MOORING NUMBER 72-0C-65A006 GEODYNE
** MOORING NUMBER 72-0C-66A006 GEODYNE

E = EAST UNITS = CM/SEC
N = NORTH UNITS = CM/SEC

DAY	MEAN (E)		MEAN (N)		VECTOR MEAN		DIRECTION		VARIANCE (E)		VARIANCE (N)		VECTOR VARIANCE		COVARIANCE (E+N)		SPEED MEAN		SPEED VARIANCE	
	*	**	*	**	*	**	*	**	*	**	*	**	*	**	*	**	*	**	*	**
11	8.7	10.6	8.6	9.0	12.2	13.9	45	50	3.9	6.0	1.9	3.9	2.9	5.0	1.3	1.2	12.2	14.0	4.2	6.4
12	3.8	5.6	3.1	3.4	4.9	6.6	50	59	2.1	2.1	6.8	10.4	4.5	6.3	2.4	1.6	5.3	7.2	4.9	4.1
13	1.4	2.2	-1.3	-1.3	1.9	2.6	133	121	2.0	4.9	4.2	13.5	3.1	9.2	0.2	2.4	2.8	4.8	1.7	1.8
14	0.4	0.3	2.2	3.0	2.3	3.0	10	5	4.4	11.3	7.6	15.1	6.0	13.2	2.8	4.9	3.7	5.4	3.5	5.6
15	1.9	3.3	1.3	2.9	2.3	4.3	56	49	0.9	5.4	1.2	8.2	1.0	6.8	-0.3	-3.0	2.6	5.5	0.6	1.6

	MEAN		VARIANCE		STD DEV		STD ERR		COVARIANCE		CORR COEFF	
	*	**	*	**	*	**	*	**	*	**	*	**
EAST	2.7	3.7	9.5	16.6	3.1	4.1	0.0680	0.0900				
NORTH	2.3	2.7	13.8	20.8	3.7	4.6	0.0821	0.1008				
SPEED	4.9	6.8	11.9	12.1	3.5	3.5	0.0764	0.0769				
VECTOR MEAN	3.5	4.6	11.6	18.7	3.4	4.3						
EAST+NORTH									7.8	9.3	0.6821	0.5005

SAMPLE SIZE 2048 POINTS GMT START 1239/11/ 5/72 STOP 737/15/ 5/72

STOP