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This document has been prepared to supplement the ARSRP Acoustics Reconnaissance Cruise Report of 19 August 1991. It is devoted exclusively to the presentation of reverberation displays produce by the Monitoring Support Software (MSS) aboard the RV Cory Chouest during the reconnaissance cruise in the summer of 1991. Although not the quality of the MSS displays, we also present here selected displays from the Versatec plotter on the Cory.

These plots should provide an insight into the character of the reverberation in the ARSRP reconnaissance area and help in the quantitative analyses of the data tapes. They are also very useful in themselves for analysis and interpretation of the scattering. Some such analyses have been presented by the authors in earlier symposia of the ARSRP. Here only the plots are presented; interpretation is left for the ARSRP investigators.

Section 8 of the cruise report deals generally with the Real Time Processor (RTP) system that prepares the data that are displayed by the MSS and Versatec. On pages 222-223 brief discussions of MSS/Versatec displays are given. One might note that useful header information is given on both the MSS and Versatec displays. Here we will discuss only the characteristics of the MSS displays that are needed to interpret the reverberation plots presented in this supplement.

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MONITORING SUPPORT SOFTWARE

SUPPLEMENT

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ACOUSTICS REVERBERATION SPECIAL RESEARCH PROGRAM

ACOUSTICS RECONNAISSANCE CRUISE REPORT:

MONITORING SUPPORT SYSTEM SUPPLEMENT

PREFACE

This document has been prepared to supplement the ARSRP Acoustics Reconnaissance Cruise Report of 19 August 1991. It is devoted exclusively to the presentation of reverberation displays produce by the Monitoring Support Software (MSS) aboard the RV Cory Chouest during the reconnaissance cruise in the summer of 1991. Although not the qualtiy of the MSS displays, we also present here selected displays from the Versatec plotter on the Cory.

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TECHNICAL CHARACTERISTICS OF THE MSS DISPLAYS

Here we will discuss the contents of two primary displays of the Monitoring Support Software (MSS): The main reverberation data window covering most of the center of the page and the header window in the upper right-hand corner. On some of the displays there is an additional window at the lower left-hand corner that we will also discuss. The rest of the information on the displays is extraneous and we will ignore it.

In reviewing the MSS displays one needs to be aware that there are some inconsistencies in the software that led to occasional problems. We will point out problems that we are aware of as the discussions arise. Furthermore, there is a lack of documentation of the software and some of what we discuss is second-hand information. These problems create difficulties only in the attempt to use these plots quantitatively. Nevertheless, qualitatively, the MSS displays are very useful.

Data Window: The data window shows waterfall graphs of reverberation with round-trip travel time in seconds running across the bottom and channel vertically on the left. In most of the plots, we show only the first 30 to 40 seconds. A few, however, cover segments of data beyond 40 seconds. It might be noted that according to the scale across the top of the plots data run out to 14 to 20 nm. (Range is a nominal slant range and is not to be taken to be very accurate.)

On the plots that we present "channel" will generally be interpreted as beam. (An exception will be noted shortly.) On some of the plots, beam azimuth is given at the right. For most of the displays, 126 beams are formed from 126 hydrophones groups in the horizontal towed array. (For more detail on array characteristics see Section 3 of the cruise report.) These beams are uniformly spaced in cosine of the angle measured from forward to aft (1 to -1) in increments of 1/126. In a few of the plots 64 hydrophones groups were used and the cosine increments were then 1/64, yielding half the resolution of the full array. For the high-resolution beamforming case, the channels are labeled 0 to 127--two more than the beams. Herein lies the exception noted above--channels 0 to 125 are the beams, channel 126 is a desensitized (-48.4dB) single phone pass-through at the head of the array and channel 127 is a desensitized (-40.4dB) single phone pass-through at the tail. In the low-resolution MSS plots, only the 64 beams are displayed and they are in channels 0 to 63. Table I lists the angular spacing of the beams for the channels for the two beamforming cases.

Table I: Maximum Response Axis (MRA) for beams formed with 126-hydrophone groups and with 64-hydrophone groups.

ARSRP BEAM Maximum Response Axis for the All Beams and Half - Beams Half Phones Setups

BEAM #	MRA (°)
0	0.00
1	10.14
2	14.58
3	17.79
4	20.68
5	23.08
6	25.27
7	27.41
8	29.29
9	31.08
10	32.87
11	34.49
12	36.14
13	37.63
14	39.07
15	40.56
16	41.91
17	43.31
18	44.61
19	45.86
20	47.18
21	48.39
22	49.57
23	50.81
24	51.96
25	53.16
26	54.27
27	55.36
28	56.51
29	57.58
30	58.70
31	59.74
32	60.77
33	61.86
34	62.87
35	63.87
36	64.92
37	65.91
38	66.95
39	67.92
40	68.88
41	69.89
42	70.84
43	71.85
44	72.79
45	73.72
46	74.71
47	75.64
48	76.56
49	77.54
50	78.45
51	79.42
52	80.33
53	81.23
54	82.20
55	83.10
56	84.06
57	84.96
58	85.86
59	86.81
60	87.70
61	88.60
62	89.55
63	90.45

BEAM #	MRA (°)
64	91.40
65	92.29
66	93.19
67	94.14
68	95.04
69	95.94
70	96.90
71	97.80
72	98.76
73	99.67
74	100.58
75	101.55
76	102.46
77	103.44
78	104.36
79	105.29
80	106.28
81	107.21
82	108.15
83	109.15
84	110.11
85	111.12
86	112.08
87	113.05
88	114.09
89	115.07
90	116.13
91	117.13
92	118.14
93	119.23
94	120.26
95	121.30
96	122.42
97	123.49
98	124.64
99	125.73
100	126.84
101	128.04
102	129.18
103	130.42
104	131.61
105	132.82
106	134.13
107	135.39
108	136.68
109	138.08
110	139.44
111	140.93
112	142.37
113	143.86
114	145.51
115	147.12
116	148.92
117	150.70
118	152.58
119	154.73
120	156.91
121	159.32
122	162.20
123	165.41
124	169.86
125	180.00

BEAM #	MRA (°)
0	0.00
1	14.36
2	20.68
3	25.27
4	29.18
5	32.67
6	36.04
7	38.98
8	41.75
9	44.37
10	47.03
11	49.43
12	51.75
13	53.99
14	56.31
15	58.43
16	60.51
17	62.55
18	64.68
19	66.64
20	68.58
21	70.49
22	72.50
23	74.36
24	76.21
25	78.05
26	79.99
27	81.80
28	83.61
29	85.41
30	87.31
31	89.10
32	90.89
33	92.69
34	94.59
35	96.39
36	98.20
37	100.01
38	101.95
39	103.78
40	105.64
41	107.50
42	109.51
43	111.42
44	113.36
45	115.32
46	117.45
47	119.48
48	121.56
49	123.69
50	126.01
51	128.25
52	130.57
53	132.97
54	135.63
55	138.25
56	141.02
57	143.96
58	147.33
59	150.81
60	154.73
61	159.32
62	165.64
63	180.00

Header Window: The basic header information for the ping epoch is given in the header window in the upper right-hand corner. The first line gives the year, Julian date, and Greenwich time to the nearest minute of the onset of the ping epoch. The ping epoch was controlled by the RTP to begin precisely on the nearest minute and the MSS plots' zero time to coincide with the start of the ping. The precision of this is, however, not to be taken for granted.

The next line is labeled "Gn/min/max" to correspond the gain, lower threshold, and upper threshold. The meaning of "gain" is uncertain; however, we have interpreted 20Log(Gn) to be an adjustment to the measured level (cursor and threshold values) to produce a calibrated intensity at the hydrophone in dB re 1 μPa/√Hz. The lower and upper thresholds establish the window on the graphed levels. All data below the lower threshold are dropped out and the region on the displays is blank space. All data above the upper threshold are also dropped out and the region is again blank space. Most of the time, but not always, it is easy to determine if the upper threshold has been exceeded or if the lower threshold has not been reached. One can most often establish the level on the graph of the lower threshold, but not always the upper. If both thresholds are established and the physical spacing between them is wide enough, one can get a calibrated level from the graph. (In the next section we discuss the calibrated cursor that is sometimes present.)

The next line concerning point decimation and averaging should provide useful information; however, it doesn't because it is always 1 and in spite of this designation there is sample averaging and decimation on some of the plots. We can determine this only by visual inspection. Generally, the averaging and decimation is done to the greatest extent on the large-scale windows. Probably for the longest time duration data, this averaging covers 16 samples. Although there is certainly averaging in the longest duration plots we display here, we do not know if it is as wide as 16 points. We feel certain that in the smallest scale windows there is no averaging and that the highest possible resolution of a few tens of meters can be discerned. There is a loss associated with the desampling. Figure 1 provides an estimate of this loss.

The next line is a repeat of the first. The fifth line gives the longitude and latitude of the source (and the receiver in this experiment) to 0.01° (0.6nm) and the heading of the horizontal line receiver array to 1° of bearing. We are not certain of the system source of these values or their path to the MSS displays and they may be in greater error than indicated above. We believe it is difficult to use this information to locate a point on the bottom precisely (say within 1nm). This problem becomes especially important when trying to match a

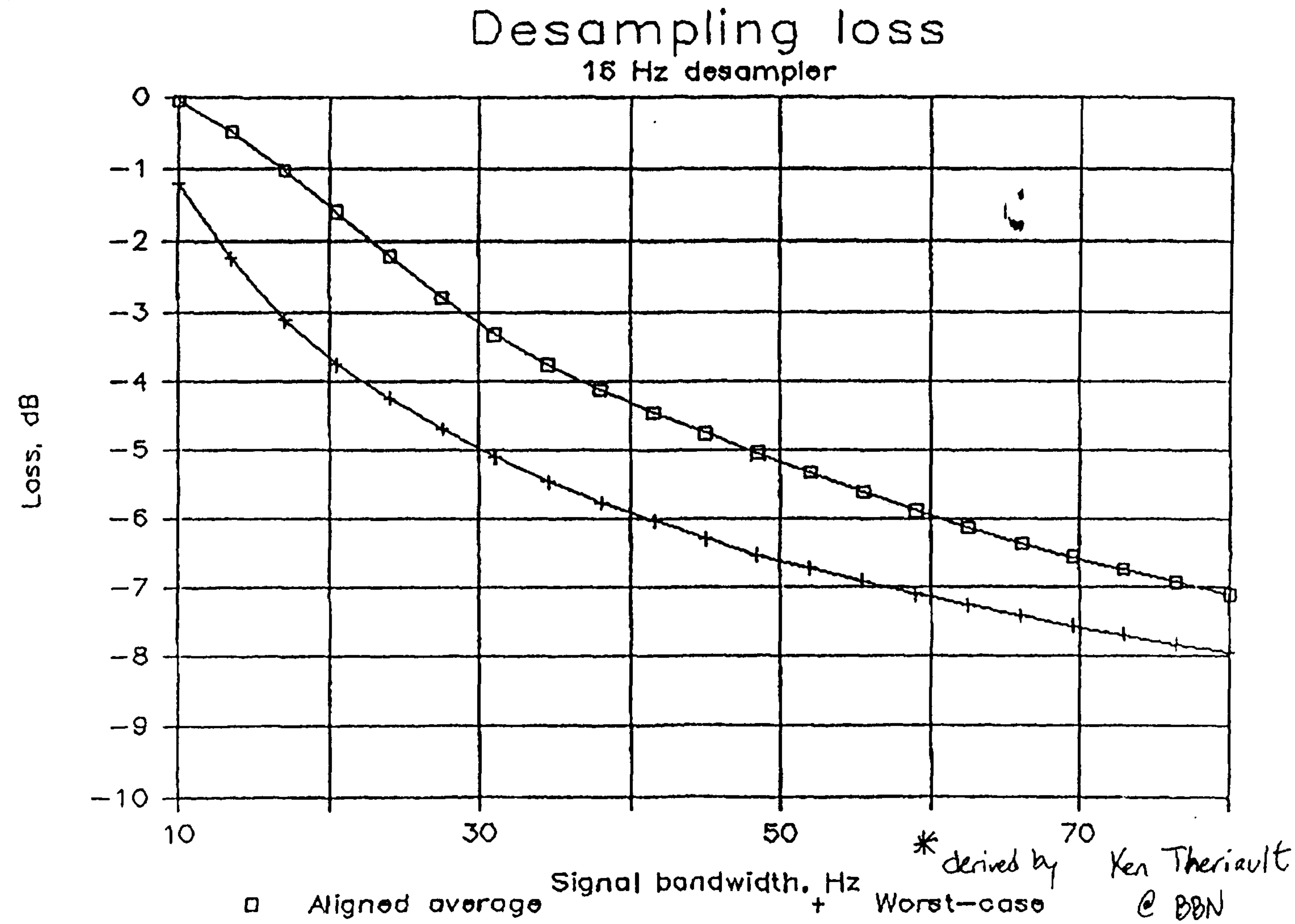

Figure 1: Plot of desampling loss versus signal bandwidth

scattering event between successive pings. Obtaining reasonable relative positions for the ship from the MSS header navigation data is difficult. For accurate navigation one should go to the master navigation data files for the location at the time of the ping.

The quality of the heading value in the display is very uncertain. If the source was the heading compasses in the array as adjusted by the output of the latest World Geomagnetic Model (supplied by the Naval Oceanographic Office and interfaced with the system computers on board) then it should be accurate to within a degree (consistent with the array beamwidth). Local magnetic variations might cause another degree of error. However, no one was certain what the source of the heading values on the displays was or how it was corrected for magnetic variation. One individual thought it came from the ship's bridge--such a heading would be very unreliable for scientific purposes, but we tend to discount the bridge as the source of the heading value on the display. With a sufficient effort to correct navigation and heading using other data sources, one might locate scattering points within 0.5nm or relative locations between pings to about 0.1nm. However, we report here heading values from various sources. You will note a <u>wide</u> range in those values, leaving much room for uncertainity.

The next two lines give the wavetrain used in the ping epoch and the replica matched for the data displayed. For details on the wavetrain and replica characteristics, refer to Section 5 of the cruise report. For all plots presented here except 220_0327, 221_0803, and 221_0835, wavetrain number SRP01AA and replica number BSS0530 were used. For those exceptions the waveforms and replicas were SRP11AA and BRP0060, respectively (see page 101 in cruise report). One should note a very distinctive difference between MSS displays of these two different signals. This difference is due to the signals' different resolving abilities.

<u>Cursor Window</u>: In the lower left-hand corner is the cursor window when it is present. When the cursor window is present, there is a cross in the data window that is the cursor. (An arrow may be there also, but this is not the cursor.) In the cursor window time, range, beam, waveform, and two dB values are given. "Time" probably is very accurate, but range is a nominal value as discussed previously. "Beam" is the beam number. "Waveform" has no value. "Value" is meant to be the dB value at the cursor, but one gains little confidence in this number as one reviews the data set. We do not know the meaning of the "raw" number. In some of the displays, the cursor is not actually set to any particular point.

LOCATING THE REVERBERATION SITES

Figure 2 is a chart showing the location of the reverberation sites for the MSS and Versatec displays. These sites are labeled by their ping number--a convenient label for most of the analyses the ARSRP investigators are doing, but one that is rather elusive in the RTP setups and listings. We have extracted it from the handwritten logs and use it to label the MSS displays. This number corresponds to the ping ID # given in the tape charts from page 183 to 186.

Table II provides an index to the MSS/Versatec displays and gives additional header parameters. Also shown is the heading (labeled "°T" occasionally) logged into the RTP log. This value is very far off and its source is unknown.

Shown in Table III are positions calculated from a three-minute average of navigation data and heading that was determined from smoothing the ship's track. (The area being in the Sargassos Sea, we don't expect the array heading to be too different from the smoothed ship's track.) Figure 3 shows the positions of the ship in Run 5 as given by the MSS header and the position based on the smoothed navigation data. Several of these positions differ by over 0.5nm. Run 5 was singled out for this additional attention because here we have the best sequences of pings. With greater accuracy in relative positioning the ship during the sequence, the points might be located to within 0.1nm between pings.

RECOMMENDATIONS

There was a certain amount of learning we underwent as we developed the plots we display here, so you will see a varying degree in the quality of our results. We strongly recommend that future ARSRP investigators embarking on the RV Cory Chouest be trained to use the MSS and to produce optimum plots on it, and that a watch for the MSS be set along with the other experimental activities. Planning for final experimental reporting should include the production and rapid distribution of a report, such as this, of those displays.

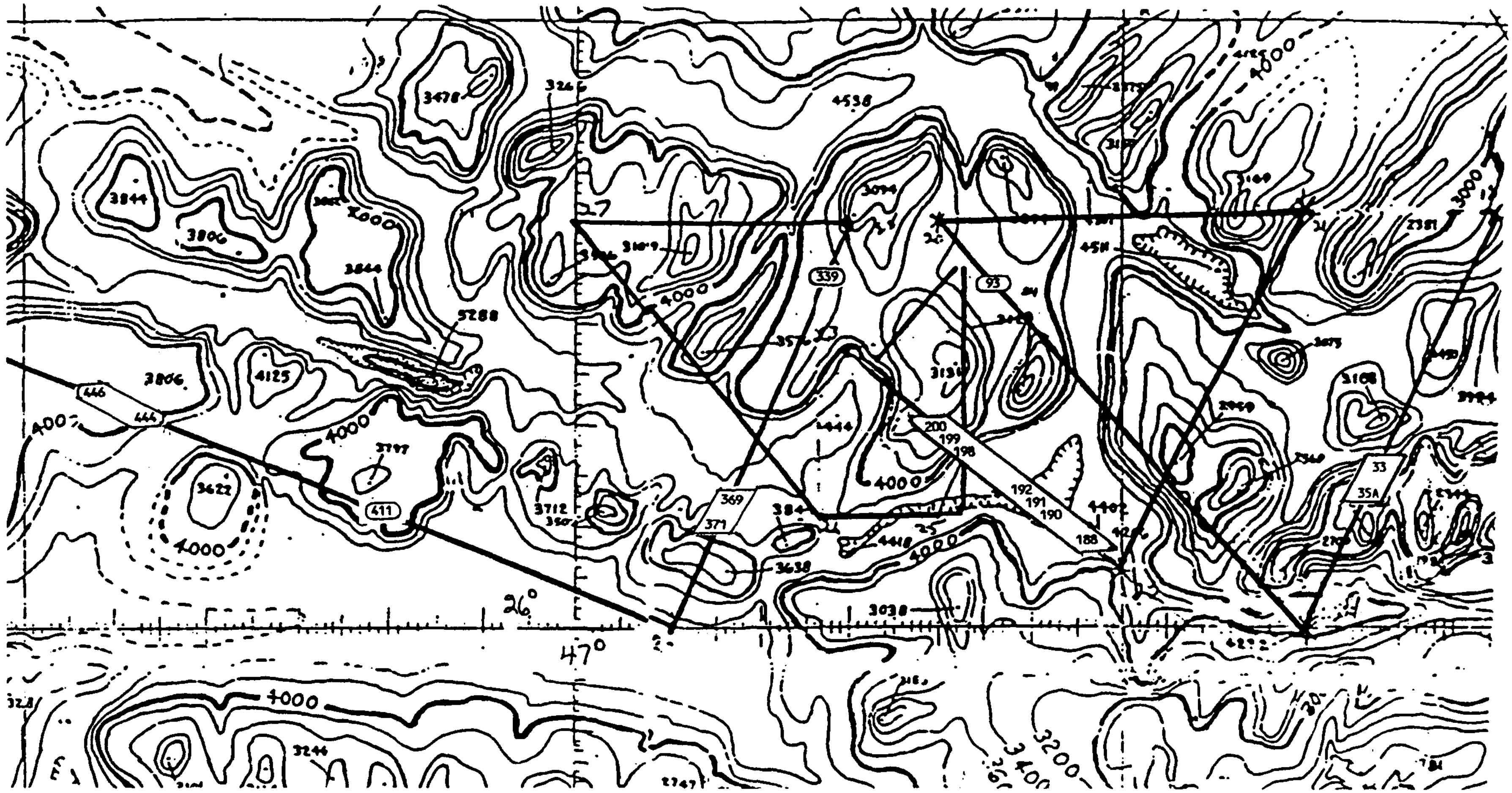

Figure 2: Chart showing part of the ARSRP reconnaissance track and the positions for the MSS displays.

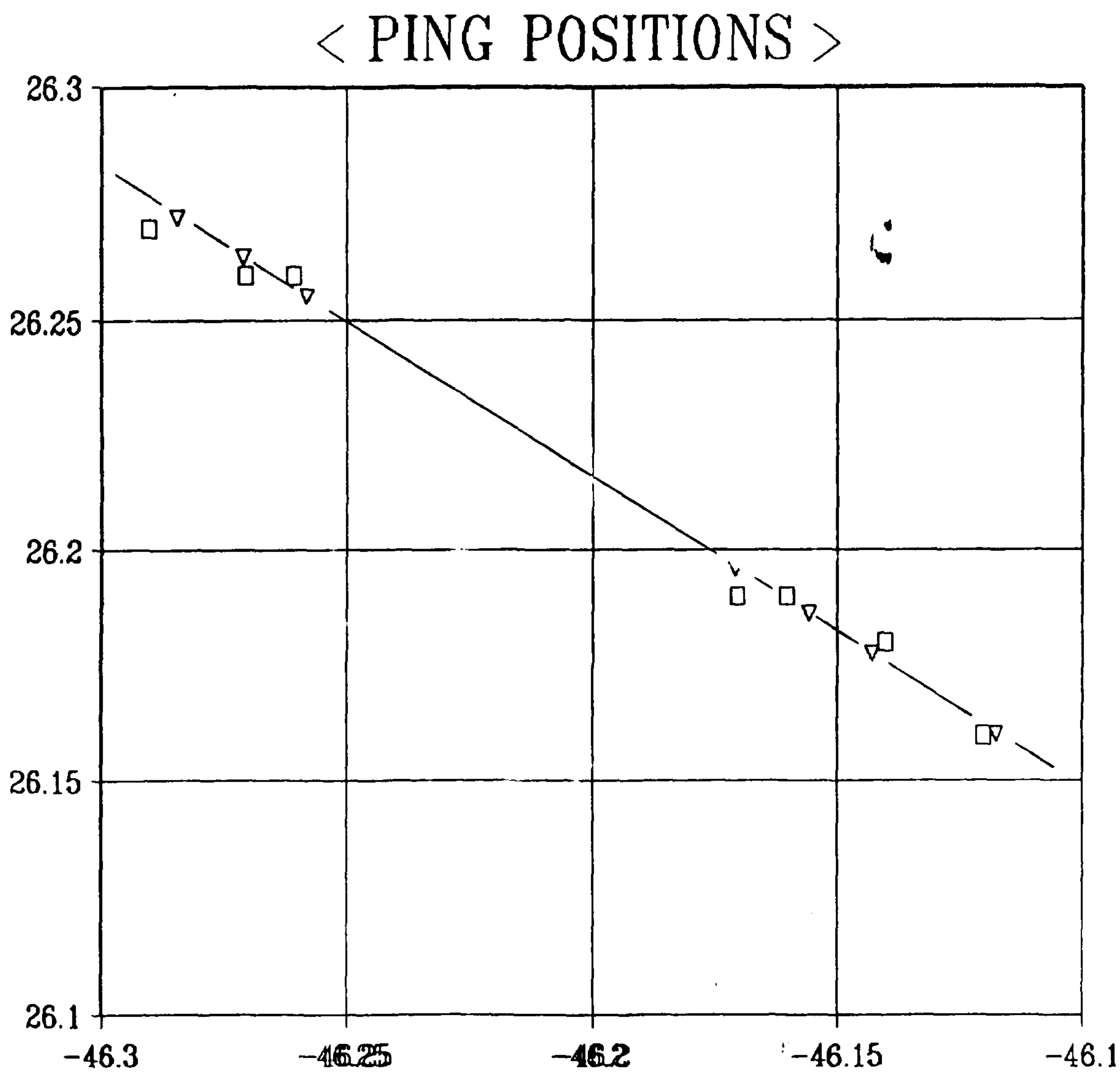

Figure 3: Chart of smoothed ship positions during Run 5 showing the inaccuracy of the DMSS displayed position. (The instantaneous position is not distinguishable from the smoothed position on this plot.)

Table II: Index to MSS and Versatec displays and additional relevant information.

Run Nu.	Ping ID #	Julian Time Z	# of MSS	Plts VER	<-------MSS-------> Long.	Lat.	Hdg	Log Hdg
1	33	216_1330	14		45.54	26.25	196	224
1	35A[a]	216_1415	10		45.56	26.21	192	225
2	93	217_0620	6		46.18	26.51	318	334
5	188	218_091	6	4	46.12	26.16	314	328
5	190	218_0948	6	4	46.14	26.18	314	327
5	191	218_1003	4		46.16	26.19	314	326
5	192	218_1018	4		46.17	26.19	316	325
5	198	218_1203	4		46.26	26.26	314	323
5	199	218_1218	4	4	46.27	26.26	310	323
5	200	218_1233	4		46.29	26.27	312	323
11	339	220_0327	6		46.54	26.59	200	225
11	369[b]	220_1023	4	5	46.72	26.22	200	223
11	371[b]	220_1053	8	5	46.73	26.19	200	225
12	411	220_2331	18	5	47.36	26.19	293	312
12	444	221_0803	4	5	47.88	26.33	285	305
12	446	221_0835	12	5	-not given-		285	308

[a]RTP failed to process this ping in the original run, but did record it. It was re-run later and these MSS/Versatec plot were produced.

[b]The logged time of these pings does not match the MSS ping times. These epochs were 16 min vice 15 min; the could have been a problem in times transferred to MSS/Versatec.

Table III: Index to MSS and Versatec displays and additional relevant information.

Ping ID #	Julian Time Z	<------Smoothed-----> Long.	Lat.	Hdg	MSS Hdg	Log Hdg
188	218_0918	46.117	26.160	307.2	314	328
190	218_0948	46.144	26.178	306.6	314	327
191	218_1003	46.156	26.186	306.3	314	326
192	218_1018	46.170	26.195	306.6	316	325
198	218_1203	46.258	26.255	307.5	314	323
199	218_1218	46.271	26.263	305.0	310	323
200	218_1233	46.285	26.272	306.2	312	323