ALPHA HELIX CRUISE HX290
(0900) Sunday 29th August 2004 – (0900) Monday 6th September 2004
Nome - Nome
BERING STRAIT CRUISE REPORT

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SCIENTIFIC PURPOSE:

This cruise had two main scientific goals.

The first (and foremost) was the recovery and redeployment of moorings in the Bering Strait. These moorings are part of a multi-year time-series (currently over 13 years long) of measurements of the flow through the Bering Strait. The properties of this flow not only influence the Chukchi and Beaufort seas, but can also be traced across the Arctic Ocean to the Fram Strait and beyond. The long-term monitoring of the inflow into the Arctic Ocean via the Bering Strait is important for understanding climatic change both locally and in the Arctic.

Three moorings (A2 and A4, in the eastern channel of the Bering Strait, and A3, ca. 35nm north of the Bering Strait), which were deployed from the Alpha Helix last year, were recovered and redeployed.

All the moorings carry conventional instrumentation - current meters (RCM or ADCP), temperature and salinity sensors (SBE16). In addition, moorings A2 and A3 carry Upward-Looking-Sonars (ULS). The mooring A4 carries an upward looking ADCP (instead of the RCM) to study the coastal jet. Mooring A3 also supported a nutrient sampler, and a transmissometer and a fluorometer (the latter two connected to the SBE16). These instruments are from UAF and the replacement mooring also carries the optical SBE16 sensors. The current meters and ULSs allow the quantification of the movement of ice and water through the strait. The nutrient sampler, the transmissometer and fluorometer should yield some of the first biophysical time-series measurements in the region, greatly advancing our understanding of the biological system in the Bering Strait and Chukchi Sea region.

The second aim of the cruise was to conduct a hydrographic and ADCP survey of the Bering Strait and the southern part of the Chukchi Sea, concentrating on sections in the vicinity of the moorings and the region north of the mooring sites, with special emphasis on cross-strait sections which sample both the main throughflow and the fresh, buoyant coastal current on the eastern side of the strait. These CTD and nutrient measurements will be used to calibrate the moored instruments and to give a framework for the analysis of the data. The hydrographic lines were repeats of sections from previous years, thus allowing an interannual comparison. (This year, no EEZ application was made to work in Russian waters, and all work took place in the US EEZ.) Note that the NOAA-organized cruise on the Pr. Khromov (Chief Scientist: Terry Whitledge, 6th - 24th August 2004, Nome-Nome) sampled in the Russian side of the Bering Strait and the Chukchi Sea just prior to our cruise.

In addition to maintaining the time-series measurements in the Bering Strait, this work also provides key boundary conditions for the Chukchi Shelf/Beaufort Sea region, the main work area of the NSF/ONR SBI (Shelf Basin Interaction) program, which is now in the final of its three major field years. As well as supporting the physical oceanography program of this cruise, the nutrient/productivity measurements augment and support a biophysical nutrient mooring in the northern Bering Sea with the goal of improving the understanding of regional productivity processes, a project supported by the NOAA Office of Arctic Research as a component of SEARCH. The cruise also complements other NSF grants and related projects. Specifically the hydrography and O-18 sampling supports not only our analysis but also the sections taken by the Little Diomede Observatory (Cooper *et al*). Sampling for O and H isotopes is part of a Center for Global Change sponsored project examining the stable isotopes in water and the trophic inputs key to the diet, habitat use, and migration patterns of bowhead whales.

CRUISE OBJECTIVES:

1. To recover moorings A2-03, A3-03 and A4-03 (see Table 1).
2. To deploy moorings A2-04, A3-04, and A4-04 (see Table 1).
3. To run hydrographic casts (CTD and nutrients) and ADCP sections in the vicinity of the moorings and in the southern region of the Chukchi Sea (see Table 2 and Figure 1).

All the cruise objectives were successfully accomplished. The moorings were recovered and redeployed, and a total of 121 CTD stations and corresponding ADCP lines were run. Sampling details are provided below.

CRUISE SCHEDULE:

Times are in AKDS (Alaskan Daylight) time, i.e. GMT-8hrs. The map in Figure 1 gives the location of the CTD and ADCP lines. Except where noted, all sections were sampled for nutrients and O18-isotope samples.

27th/28th Aug 2004 Science party arrives in Nome

29th Aug 2004
0900 Science party arrive Helix, which tied up in Nome early this am
1015 Depart Nome direction Bering Strait, while science party set up
1904 test CTD cast
2233 Start ADCP line across Bering Strait BSL6-BSL1 W-wards

30th Aug 2004
0137 End ADCP line, steam north to MBS1
0235 Start ADCP line across Bering Strait MBS1-MBS8 E-wards
0608 End ADCP line, steam to A403
0820 Start recovery of A403
0903 CTD cast for calibration at A403
1013 Finish deployment of A404, steam to A203

1120 Start recovery of A203
1205 CTD calibration cast and productivity station (1) at A2
1347 Finish deployment of A204, steam for A303
1651 Start recovery of A303
1834 Finish recovery of A303, Calibration CTD, start A3L CTD line NE-wards

31st Aug 2004 — 0117 Finish A3L CTD line at CHUK10, start A3L ADCP line SW-wards
0904 Finish ADCP line, 2 Productivity casts (2) at site A3
1101 Finish deploying A304, steam for Bering Strait
1438 Start ADCP line across Bering Strait BSL1-BSL6 E-wards
1708 Start CTD line across Bering Strait BSL6-BSL1 W-wards
Isotope samples taken on this line
2120 Finish CTD line, steam north to CHUK line

1st Sept 2004 — 0348 Start CHUK and EEXT CTD line SE-wards
Isotope samples and net tows taken at CHUK1
1236 Productivity cast (3), isotope samples and net tows at EEXT-3
1253 End CTD line, start CHUK and EEXT ADCP line NW-wards
2252 End ADCP line, steam for PHL line

2nd Sept 2004 — 0143 Start combined CTD/ADCP line PHL N-wards
1403 2 Productivity casts (4) taken at site PHL12.5
1740 End PHL line near village of Hope, isotope samples and net tows at PHL13, steam zigzag towards start of CPL line, route determined by shallows, seas and the desire to run underway sections across the Alaskan Coastal Current front.
2120 Start combined CTD/ADCP line CPL NW-wards
2345 Quit CPL line at CPL 3 as high seas/darkness hinder CTD recovery. Continue along CPL line for underway data

3rd Sept 2004 — 0730 Divert course towards CCL23
1012 Start combined CTD/ADCP line CCL S-wards
1438 Productivity cast (5) taken at CCL 20
2217 Productivity cast (6) taken at CCL15

4th Sept 2004 — ca. 0800 strange white material in water (see below)
1208 Break off CCL line to start ADCP line along NBS E-wards
1702 Productivity cast (7) at NBS-12
1704 Start CTD line along NBS W-wards

5th Sept 2004 — 0040 Rejoin CCL line and CTD NBS1 and MBS1
0151 Start ADCP line along MBS E-wards
0457 Start CTD line along MBS W-wards
0819 Rejoin CCL line at MBS1
0858 CTD LD1 station, ending CCL line
isotope samples and net tows at LD1
0926 Start CTD line across Bering Strait BSL1-BSL6 E-wards
1119 2 productivity casts (8) at BSL-3
1412 End CTD line, start ADCP line BSL6-BSL1 W-wards (at 10kt)

1614 Start ADCP/underway line to Fairway Rock
1707 Start ADCP/underway line to Wales
1945 Turn for Nome
at ca. 65 30.29N 168 4.08W strong surface front in T,S and velocity

6th Sept 2004 0700 Tie up at Nome
0830 Science party departs ship, and later in the day, departs Nome

SCIENCE PROGRAMS:

Exceptionally good weather for this time of year allowed us to finish the mooring operations promptly and perform a CTD/ADCP survey as far north as Cape Lisburne, although the northernmost sections of this survey were curtailed by high seas.

Mooring work:
All three moorings (see Table 1) were successfully recovered and redeployed. The turn-around of moorings A2 and A4 went smoothly, other than the jamming of the automatic pelican hook release for the mooring deployment of A4. This was probably due to the pear-link used for the pelican hook being too small. The pelican hook was finally released by bumping the mooring on the bottom. On subsequent moorings, a manual, near-surface quick release was used, so the mooring was allowed to free-fall from just below the surface. Fouling on A4 and A2 was moderate, with a strong predominance of barnacles, especially on the upper instruments (see appendices). Mooring A3-03 did not come up on first release. On a second pass after repeatedly releasing the second release, the mooring did eventually surface, but only the top of the black collar of the ULS was above the water! (Our thanks to John for spotting it!) On recovery, the mooring was heavily fouled with barnacles, especially on the trifloat and the NAS package (see appendices for photos). We estimate over 100lbs (wet weight) of barnacles overcame most of the excess buoyancy of the mooring. These moorings had been in place since summer 2003, i.e. through two growing seasons, which may account for the excessive biological growth. In general, recovered instruments were in good condition, although heavily fouled. The RCM rotor on A2-03 was just able to turn still. On all moorings, the Seacat salinity cells appeared to be clear. We suggest for next year, better colouration for the collar of the ULS, and anti-fouling paint on strategic points of the moorings (i.e. within the rotor housing for the RCMs and on the top surfaces of the floatation). Also, if A3 is to be deployed in this form again, it should carry extra buoyancy. This year, due to instrument problems (see below), mooring A3-04 was deployed without a NAS, thus extra buoyancy was not deployed.

All current meters (RCM7, RCM9 and the ADCP) performed well. The Seacats on A2 and A3 were low on battery power on recovery and could only be downloaded by applying 15V external power to the input plug, as described in the manual. The A2 Seacat appears to have some power problem, and only yielded ca. 6 months of data. Other records appear to be complete. The ULSs were still working on recovery and yielded good data throughout the year.

The recovered NAS nitrate sensor was inoperable on recovery having leaked through the linear shaft and damaged the communications section of the electronics boards. Chemical consumption indicated that the NAS may have functioned for approximately 30% of the deployment period. The boards have been returned to UAF to attempt recovery of the data. The NAS nitrate sensor planned for deployment on the A3 mooring ceased working shortly before deployment due to problems with the rotary motor motion. As the problems could not be reliably overcome, the decision was made to deploy the A3 mooring without the NAS.

Preliminary time-series from the RCM current meters and the SBEs are given in the appendices.

CTD and ADCP work:

A total of 121 CTD casts were taken along 8 different sections (see Figure 1 and sections in the appendices). The Bering Strait line (BSL) was CTDed twice, once at the start and once at the end of the cruise. At each major section (BSL, MBS, NBS, A3L, CHUK and EEXT), the CTD line was either preceded or followed immediately by an ADCP line run at 7 knots. The longer sections (PHL, CPL and CCL) could not be traversed twice and thus transit between CTD sections was undertaken at a compromise speed of ca. 8-10 knots, to acquire reasonable ADCP data whilst still maintaining quasi-synopticity of the line. In the shallow, changeable shelf system, the latter is important, as witnessed by the differences between various stations (especially A3 and the BSL line) taken days apart. The final ADCP lines (the western part of the repeat of the BSL line, and lines south of the Bering Strait) were also run at 10 knots.

The CTD package carried sensors for temperature, conductivity, fluorescence, PAR and transmissivity. Preliminary sections for these parameters are in the appendices and final calibrated data will be available at the project website http://psc.apl.washington.edu/BeringStrait.html. Duplicate salinity samples were taken from the bottom bottle fired on 14 casts to check the salinity calibration of the CTD. After cast 4, all salt samples had new bottle caps.

Some bottle firing problems were encountered with the CTD (Table 3).

- on casts 63 (CCL22), 68 (CCL18) and 79 (CCL7), one bottle on each cast failed to fire. CCL22 was recast (cast 64). CCL18 and CCL7 were not recast. Analysis of salinity samples will be necessary to confirm which bottle failed to trip.
- on 36 casts, a confirmation of bottle firing was not received at one or more bottle trips, meaning there is no electronic record of the exact firing depth of the bottle, and the depth must be taken from the paper logs (see Table 3). For some of these casts, a separate electronic mark was made at the same wire out (see Table 3), although, since at times the CTD was moving up to 4m up and down through the water column, these depths can also only be taken as approximate. Note that in all these cases, the correct number of bottles closed. The source of this problem was never isolated. It appeared to be alleviated temporarily by a replugging of CTD connections, although it probably relates to something more significant than this.

For casts 24 (BSL3.0), 37 (CHUK9) and 61 (CPL3), the CTD program also failed to record a latitude. In the listing of Table 2, these latitudes are recreated from the bridge logs.

The sections show, for example, the warm fresh coastal current on the US coast. The strength of this current is seen qualitatively also by increased ship drift during CTD casts in this area. The deviations of the nutrient-rich western waters into the eastern side of the Chukchi Sea are also evident. The changes in the BSL section over just a few days indicates the fast response to wind forcing.

Nutrient Analysis work (Lee, Thornton, Moreland):
A total of 745 nutrient samples were collected and analyzed on board for silicate, phosphate, nitrate, nitrite and ammonium by Lee, Thornton and Moreland. Nutrients were taken on all stations except for the 0.5 stations on the rerun of the BSL line. In addition, at every station (except BSL2.5, 3.5, and 4.5 on the second running of the BSL line) samples were taken at surface, mid-water column and bottom for chlorophyll. At 22 stations, including 8 productivity stations, samples were taken at surface, mid-water column and bottom for size-fractionated chlorophyll (>20μm, 20-5μm and 5-0.7 μm) to study the general distribution of phytoplankton sizes in the different water masses in the research area. At the 8 sites (A2, A3, EEXT3, PHL12.5, CCL20, CCL15, NBS12 and BSL3), primary productivity experiements were conducted using a ^{13}C-^{15}N dual tracer technique. To check the physiology status of phytoplankton, large volume productivity experiments were executed for the end products of photosynthesis at the 3 stations (A3, PHL12.5 and BSL3).

Oxygen isotope sampling (Morrow and deHart for Cooper, Tennessee):
A total of 368 water samples were taken for O18 sampling. Samples were taken at bottom, 5m and (where appropriate) midwater column at all stations except some of the productivity stations (see bottle list in the appendices). Higher vertical resolution was taken on the first BSL line. These samples were sealed with parafilm and shipped to Lee Cooper at the University of Tennessee for later analysis. To ensure the integrity of the bottle samples, when possible salinity samples (ca. 180) were taken from the bottles used for O18 samples.

Isotope and plankton sampling (deHart, UAF):
As part of the doctoral research of Pieter deHart, UAF, into the trophic fractionation effects of the environment throughout the migration route of the bowhead whale, net tows were taken for phytoplankton and zooplankton, and water samples were collected for O and H isotopic analysis. Water samples were collected along the initial BSL line (at 10m depths at stations BSL1 - BSL 5.5 inclusive and at the surface for BSL1, 2, 3, 4, 5) and at PHL13 (5m) and EEXT (5m). Both phytoplankton and zooplankton net tows and water samples were taken at the three mooring locations A2, A3 and A4. In addition, one water sample and two plankton tows were conducted at the westmost and eastmost point of the CHUK/EEXT line (i.e. CHUK1 and EEXT3), the eastern tip of the Point Hope Line (PHL13), and at the location between the Diomede Islands (LD1). A total of 18 water and 10 plankton samples were obtained to be processed at the University of Alaska Fairbanks for their Oxygen-18 and Deuterium composition. The O18 isotope analysis will coordinate with samples run by Cooper.

Underway ADCP data:
The Alpha Helix is now using a new 150 kHz hull-mounted ADCP. This collected data for the duration of the cruise. Particular lines (BSL, MBS, NBS, A3L and CHUK/EEXT) were run at ca. 7 knots to give better spatial resolution. Other lines (PHL, CPL, CCL and the western part of the repeat of the BSL line) were run at 8-10 knots due to cruise time limitations. At the end of the cruise, two further ADCP lines - one from BSL1 to Fairway Rock, just south of the Bering Strait and one from Fairway Rock to Wales on the Alaskan coast - were run at 10 knots.
In the WinADCP viewing of the data during collection, a strong current artifact was present in the bottom/near bottom bin for most if not all of the cruise. (A CTD cast near the start of the cruise showed no density structure in the bottom layer, reinforcing the assumption that this bottom bin velocity is erroneous.)
The Alaskan Coastal Current (ACC) was clearly evident in the ship's ADCP data as a pronounced northward flow on the easternside of most of the sections. Within the Bering Strait, BSL5 and 5.5 are within the ACC, whilst BSL6 is out of the core of the flow. Similarly, at the

eastern extent of the PHL line, PHL12.5 is within the current whilst PHL13 is shoreward of the core of the flow.

Underway sampling:
Seachest data and standard underway meteorological sampling was conducted for the duration of the cruise. These data will be combined with the CTD and ADCP data to elucidate spatial structures. Prior to 3rd September (i.e. all transit before Cape Lisburne) intermittent problems with the seachest sensors resulted in extremely low salinities. This was traced to the vortex debubbler drain on the O3 system (used to defoul the system) drawing evaporator discharge back into the seachest. This valve was secured on 3rd September, but underway seachest data should be quality controlled against the CTD data.

Satellite (SEAWIFs and MODIS) imagery:
Satellite data of the region is extremely helpful in visualizing the horizontal structure of the flow. Mike Schmidt kindly watched over the SeaWifs and Modis imagery from land for the duration of the cruise, but cloud cover in the region obscured the satellite images during the trip. A pre-cruise MODIS temperature image is given in the appendices, indicating the extent of the warm Alaskan Coastal Current and a manner in which it spreads over the southern Chukchi. The extreme front just south of the Bering Strait was evident during our transit of the region (see Special Features).

Special Features:
Two unusual surface features were observed during the cruise.

- on 4th September 2004, around 8am at ca. 66° 30.16N, 168° 57.63 W, (seachest temperature 5.16°C, 30.43 psu) a strange patch of white water was observed (see appendices for photos). Surface bucket samples were collected of the white, floating particles, which were about the size and shape of rice grains, but soft to the touch, easily squashed into a soapy/oily paste. Brief microscope analysis did not discern any cellular structure. The patch also contained dead seabirds, a large number of small (ca. 7cm x 1cm) feathers and rubbish, such as small green bottles. This site was the highest concentration of the white particles, however, they were still present at much lower concentrations south until at least the NBS line (when we turned east) and up to ca. NBS2. The spatial distribution appeared consistent with this material matching the location of the western channel waters. Some samples were taken for shipping back to UW.

- on 5th September 2004, late evening, at 65° 30.29N, 168° 4.08 W, the ship crossed an extreme surface front that was clearly evident to the eye, due to changes in ocean colour and smoothness (see appendices for photos). The front occurred ca. 3.5nm off the coast, just south of Wales and seachest data indicate a change from 12°C and 26.7 psu to 10°C and 29.3 psu. Consideration of ship's speed over ground implied that shoreward of the front, there was a ca. 2 knot northward current at the surface, while seaward of the front, the surface velocity was 0.5 to 1 knots northward. Ship's ADCP data indicated a 1.5 knot current at ca. 20m depth. This is presumably the fresh, warm Alaskan Coastal Current water evident in the sea surface temperature MODIS map in the appendices.

Whale Observation Program:
Given the increased interest in the possible presence of bowhead whales in the Chukchi Sea, an informal whale observing program was part of the cruise. There were extremely few whale

sightings, but POP forms were completed for these sightings and forwarded to Sue Moore, PMEL. These sightings were:

29th Aug 04, ca. 1700	64° 56.7N 167° 30.57W	Grey whale	Chance Miller
3rd Sept 04, ca. 2230	67° 49.9N 168° 56.9 W	whales blowing	Rebecca Woodgate
4th Sept 04,	ca. 66° 30N, 168° 58W	dead whale	
4th Sept 04, ca.1215	65° 59.0N 168° 58.2W	Humpback mother & calf	Pieter deHart

Educational Outreach:

Two students took part in the cruise.

Pieter deHart, a graduate student from UAF, sampled for O and H isotopes and for plankton as discussed above.

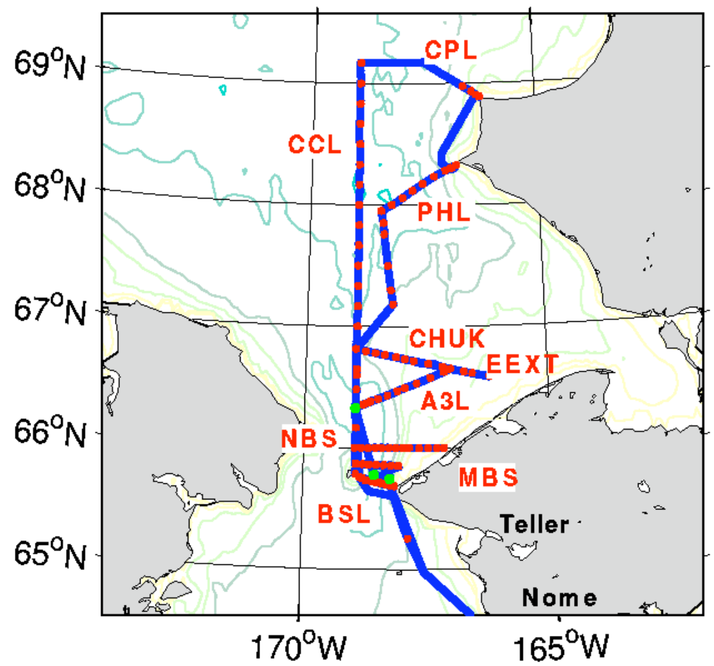
Lee Morrow, (a trainee Marine Science Technician from the M.A.T.E. (Marine Advanced Technology Education) Center, Monterey Peninsula College, California) gained experience of CTD and mooring work during the cruise, including water sampling and CTD operations.

FIGURE 1: Cruise Map

HX290
Alpha Helix
Aug/Sept
2004

● = mooring
● = CTD
— = track

(depth contours 10m, IBCAO)



extract of cruise track near Bering Strait

(depth contours 10m, IBCAO)

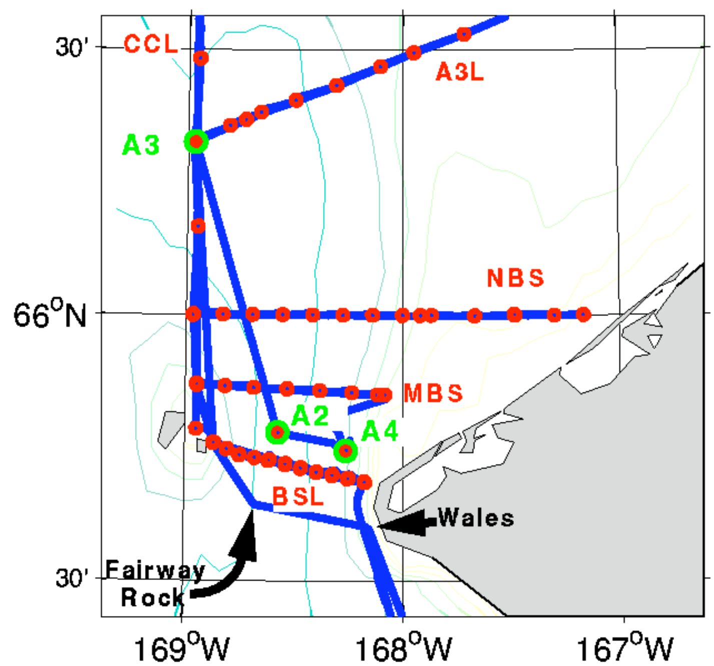


TABLE 1: Mooring positions and instrumentation

ID	LATITUDE (N)	LONGITUDE (W)	WATER DEPTH /m	INST.
Recover				
A2-03	65° 46.76'	168° 34.51'	55 (uc 52)	ULS RCM7 SBE16
A3-03	66° 19.57'	168° 58.03'	57 (uc 54)	ULS RCM9 SBE/TF NAS-2E
A4-03	65° 44.70'	168° 15.78'	48 (uc 45)	ADCP SBE16
Deploy				
A2-04	65° 46.78'	168° 34.48'	55 (uc 51)	ULS RCM7 SBE16
A3-04	66° 19.54'	168° 58.03'	57 (uc 54)	ULS RCM11 SBE/TFP
A4-04	65° 44.72'	168° 15.71'	47 (uc 43)	ADCP SBE16

ULS = APL Upward Looking Sonar
RCM7 = Aanderaa Mechanical Recording Current Meter
RCM9 and RCM11 = Aanderaa Acoustic Recording Current Meter
SBE16 = Seabird CTD recorder
SBE/TF = Seabird CTD recorder with transmissometer and fluorometer
SBE/TFP = Seabird CTD recorder with transmissometer, fluorometer and PAR sensor
NAS-2E = Nutrient Analyzer
ADCP = RDI Acoustic Doppler Current Profiler
uc = uncorrected for ship's draft (3m)

TABLE 2: CTD Positions

Name	Date	GMT	Latitude	Longitude	Cast Name	D
hx290001.HDR	Aug 30 2004	03:09:12	65 15.28 N	167 54.13 W	adcptest	31
hx290002.HDR	Aug 30 2004	17:06:22	65 44.82 N	168 15.52 W	a4	45
hx290003.HDR	Aug 30 2004	20:08:50	65 46.80 N	168 34.37 W	A2	52
hx290004.HDR	Aug 31 2004	02:39:15	66 19.64 N	168 57.92 W	a3	54
hx290005.HDR	Aug 31 2004	03:16:01	66 21.44 N	168 48.43 W	a3-2	53
hx290006.HDR	Aug 31 2004	03:39:05	66 22.12 N	168 43.94 W	a3-2.5	48
hx290007.HDR	Aug 31 2004	04:02:14	66 22.97 N	168 39.72 W	a3-3	55
hx290008.HDR	Aug 31 2004	04:39:06	66 24.34 N	168 30.01 W	a3-4	52
hx290009.HDR	Aug 31 2004	05:17:00	66 26.03 N	168 18.65 W	a3-5	46
hx290010.HDR	Aug 31 2004	05:55:53	66 28.16 N	168 06.29 W	a6	26
hx290011.HDR	Aug 31 2004	06:24:58	66 29.74 N	167 56.94 W	a3-7	21
hx290012.HDR	Aug 31 2004	07:05:12	66 31.83 N	167 42.72 W	a3-8	23
hx290013.HDR	Aug 31 2004	07:54:03	66 34.76 N	167 25.35 W	a3-9	28
hx290014.HDR	Aug 31 2004	08:41:07	66 37.42 N	167 09.26 W	a3-10	31
hx290015.HDR	Aug 31 2004	09:10:30	66 39.06 N	167 00.84 W	chuk-10	31
hx290016.HDR	Aug 31 2004	17:20:44	66 19.90 N	168 57.78 W	a3	54
hx290017.HDR	Aug 31 2004	17:51:02	66 19.60 N	168 57.90 W	a3	54
hx290018.HDR	Sep 01 2004	01:15:01	65 41.27 N	168 10.66 W	bsl6	23
hx290019.HDR	Sep 01 2004	01:44:11	65 41.63 N	168 14.92 W	bsl5.5	42
hx290020.HDR	Sep 01 2004	02:13:13	65 41.95 N	168 19.41 W	bsl5	51
hx290021.HDR	Sep 01 2004	02:42:26	65 42.28 N	168 23.81 W	bsl4.5	50
hx290022.HDR	Sep 01 2004	03:05:26	65 42.73 N	168 28.11 W	bsl4	50
hx290023.HDR	Sep 01 2004	03:27:12	65 43.13 N	168 32.36 W	bsl3.5	54
hx290024.HDR	Sep 01 2004	03:52:15	65 43.59 N	168 36.93 W	bsl3	49
hx290025.HDR	Sep 01 2004	04:15:53	65 43.92 N	168 40.74 W	bsl2.5	50
hx290026.HDR	Sep 01 2004	04:37:48	65 44.18 N	168 44.98 W	bsl2	51
hx290027.HDR	Sep 01 2004	05:00:05	65 44.89 N	168 48.55 W	bsl1.5	50
hx290028.HDR	Sep 01 2004	05:21:53	65 45.58 N	168 52.20 W	bsl1	41
hx290029.HDR	Sep 01 2004	11:51:02	66 48.89 N	168 58.14 W	chuk-1	44
hx290030.HDR	Sep 01 2004	12:30:21	66 47.88 N	168 45.89 W	chuk-2	40
hx290031.HDR	Sep 01 2004	13:11:04	66 46.87 N	168 33.91 W	chuk-3	31
hx290032.HDR	Sep 01 2004	13:52:39	66 45.95 N	168 22.04 W	chuk-4	30
hx290033.HDR	Sep 01 2004	14:38:30	66 44.93 N	168 07.97 W	chuk-5	28
hx290034.HDR	Sep 01 2004	15:15:04	66 43.93 N	167 56.93 W	chuk-6	26
hx290035.HDR	Sep 01 2004	15:52:11	66 42.99 N	167 45.92 W	chuk7	27
hx290036.HDR	Sep 01 2004	16:44:04	66 41.52 N	167 27.91 W	chuk8	29
hx290037.HDR	Sep 01 2004	17:37:21	66 40.05 N	167 10.56 W	chuk9	31
hx290038.HDR	Sep 01 2004	18:11:26	66 38.99 N	167 01.07 W	chuk10	30
hx290039.HDR	Sep 01 2004	19:02:32	66 37.61 N	166 43.72 W	eext1	28
hx290040.HDR	Sep 01 2004	19:35:41	66 36.69 N	166 33.70 W	eext2	22
hx290041.HDR	Sep 01 2004	20:38:31	66 35.05 N	166 11.98 W	eext3	15
hx290042.HDR	Sep 02 2004	09:47:02	67 10.96 N	168 11.97 W	phl1	38
hx290043.HDR	Sep 02 2004	10:57:48	67 17.98 N	168 14.95 W	phl2	42
hx290044.HDR	Sep 02 2004	12:43:52	67 30.00 N	168 19.02 W	phl3	46
hx290045.HDR	Sep 02 2004	14:43:51	67 45.58 N	168 23.81 W	phl4	49
hx290046.HDR	Sep 02 2004	15:31:35	67 51.08 N	168 25.13 W	phl5	51
hx290047.HDR	Sep 02 2004	16:21:31	67 57.09 N	168 28.06 W	phl6	57
hx290048.HDR	Sep 02 2004	17:09:52	68 00.06 N	168 14.06 W	phl7	57

hx290049.HDR	Sep 02 2004	18:06:26	68 03.56 N	168 00.01 W	phl8	54
hx290050.HDR	Sep 02 2004	18:56:01	68 07.02 N	167 47.08 W	phl9	51
hx290051.HDR	Sep 02 2004	19:48:42	68 10.49 N	167 33.52 W	phl10	47
hx290052.HDR	Sep 02 2004	20:43:19	68 14.01 N	167 18.15 W	phl11	44
hx290053.HDR	Sep 02 2004	21:35:31	68 17.01 N	167 03.08 W	phl12	37
hx290054.HDR	Sep 02 2004	22:07:22	68 18.28 N	166 55.55 W	phl12.5	32
hx290055.HDR	Sep 02 2004	22:34:34	68 18.20 N	166 55.56 W	phl12.5	32
hx290056.HDR	Sep 02 2004	22:46:13	68 17.99 N	166 55.43 W	phl12.5	32
hx290057.HDR	Sep 02 2004	23:40:38	68 19.42 N	166 48.47 W	phl13	22
hx290058.HDR	Sep 03 2004	05:23:42	68 53.11 N	166 15.47 W	CPL0	16
hx290059.HDR	Sep 03 2004	05:56:53	68 54.20 N	166 19.87 W	CPL1	26
hx290060.HDR	Sep 03 2004	06:37:22	68 55.91 N	166 26.22 W	CPL2	32
hx290061.HDR	Sep 03 2004	07:41:14	68 58.50 N	166 37.80 W	CPL3	38
hx290062.HDR	Sep 03 2004	18:15:36	69 09.99 N	168 57.00 W	ccl23	52
hx290063.HDR	Sep 03 2004	19:38:03	68 59.96 N	168 57.06 W	ccl2	52
hx290064.HDR	Sep 03 2004	20:04:34	68 59.94 N	168 57.01 W	ccl22	51
hx290065.HDR	Sep 03 2004	21:25:27	68 49.95 N	168 57.04 W	ccl21	51
hx290066.HDR	Sep 03 2004	22:39:47	68 39.96 N	168 57.07 W	ccl20	51
hx290067.HDR	Sep 04 2004	00:23:08	68 29.97 N	168 56.97 W	ccl19	53
hx290068.HDR	Sep 04 2004	01:42:02	68 19.97 N	168 57.06 W	ccl18	54
hx290069.HDR	Sep 04 2004	03:55:34	68 10.05 N	168 56.88 W	ccl-17	56
hx290070.HDR	Sep 04 2004	05:10:11	67 59.99 N	168 56.90 W	ccl-16	56
hx290071.HDR	Sep 04 2004	06:20:42	67 49.96 N	168 56.88 W	ccl-15	49
hx290072.HDR	Sep 04 2004	07:34:27	67 40.02 N	168 56.88 W	ccl-14	48
hx290073.HDR	Sep 04 2004	08:44:45	67 30.00 N	168 56.94 W	ccl-13	48
hx290074.HDR	Sep 04 2004	09:58:06	67 19.99 N	168 56.90 W	ccl12	48
hx290075.HDR	Sep 04 2004	11:09:32	67 10.01 N	168 57.00 W	ccl11	47
hx290076.HDR	Sep 04 2004	12:22:52	67 00.00 N	168 56.89 W	ccl10	47
hx290077.HDR	Sep 04 2004	13:43:00	66 48.91 N	168 58.00 W	chuk-1	43
hx290078.HDR	Sep 04 2004	14:55:24	66 39.01 N	168 57.04 W	ccl8	41
hx290079.HDR	Sep 04 2004	15:25:17	66 35.98 N	168 57.03 W	ccl7	44
hx290080.HDR	Sep 04 2004	16:34:57	66 28.97 N	168 57.05 W	ccl6	55
hx290081.HDR	Sep 04 2004	17:42:48	66 19.52 N	168 58.06 W	a3	55
hx290082.HDR	Sep 04 2004	18:53:04	66 10.00 N	168 57.09 W	ccl4	53
hx290083.HDR	Sep 04 2004	20:02:35	65 59.99 N	168 58.12 W	nbs1	51
hx290084.HDR	Sep 05 2004	01:05:23	66 00.06 N	167 28.96 W	nbs12	17
hx290085.HDR	Sep 05 2004	01:13:46	66 00.14 N	167 29.11 W	nbs12	17
hx290086.HDR	Sep 05 2004	02:09:36	66 00.04 N	167 09.94 W	nbs14	11
hx290087.HDR	Sep 05 2004	02:37:25	66 00.01 N	167 18.05 W	nbs13	14
hx290088.HDR	Sep 05 2004	03:12:20	66 00.03 N	167 29.09 W	nbs12	17
hx290089.HDR	Sep 05 2004	03:45:59	66 00.01 N	167 40.11 W	nbs11	15
hx290090.HDR	Sep 05 2004	04:25:17	66 00.07 N	167 52.08 W	nbs10	9
hx290091.HDR	Sep 05 2004	04:42:00	66 00.05 N	167 55.16 W	nbs9	20
hx290092.HDR	Sep 05 2004	05:01:30	66 00.06 N	168 00.11 W	nbs8	32
hx290093.HDR	Sep 05 2004	05:30:43	66 00.08 N	168 08.37 W	nbs7	45
hx290094.HDR	Sep 05 2004	06:01:44	66 00.07 N	168 16.61 W	nbs6	51
hx290095.HDR	Sep 05 2004	06:35:04	66 00.10 N	168 24.97 W	nbs5	55
hx290096.HDR	Sep 05 2004	07:07:00	66 00.11 N	168 33.25 W	nbs4	52
hx290097.HDR	Sep 05 2004	07:40:22	66 00.11 N	168 41.58 W	nbs3	51
hx290098.HDR	Sep 05 2004	08:11:18	66 00.11 N	168 49.83 W	nbs2	51
hx290099.HDR	Sep 05 2004	08:42:55	66 00.09 N	168 58.09 W	nbs1	51

hx290100.HDR	Sep 05 2004	09:44:03	65	52.24	N	168	56.88	W	mbs1	43
hx290101.HDR	Sep 05 2004	13:00:04	65	51.08	N	168	04.99	W	mbs8	30
hx290102.HDR	Sep 05 2004	13:16:25	65	51.09	N	168	07.09	W	mbs7	39
hx290103.HDR	Sep 05 2004	13:43:21	65	51.32	N	168	14.06	W	mbs6	45
hx290104.HDR	Sep 05 2004	14:18:34	65	51.54	N	168	22.92	W	mbs5	51
hx290105.HDR	Sep 05 2004	14:50:37	65	51.72	N	168	31.97	W	mbs4	51
hx290106.HDR	Sep 05 2004	15:21:41	65	51.84	N	168	41.12	W	mbs3	50
hx290107.HDR	Sep 05 2004	15:51:49	65	52.01	N	168	49.07	W	mbs2	49
hx290108.HDR	Sep 05 2004	16:20:38	65	52.10	N	168	56.80	W	mbs1	43
hx290109.HDR	Sep 05 2004	17:00:33	65	47.14	N	168	56.91	W	ld1	32
hx290110.HDR	Sep 05 2004	17:28:09	65	45.63	N	168	51.96	W	bsl1	41
hx290111.HDR	Sep 05 2004	17:47:01	65	44.92	N	168	48.41	W	bsl1.5	50
hx290112.HDR	Sep 05 2004	18:08:48	65	44.24	N	168	44.88	W	bsl2.0	52
hx290113.HDR	Sep 05 2004	18:28:49	65	43.91	N	168	40.76	W	bsl2.5	52
hx290114.HDR	Sep 05 2004	18:48:39	65	43.72	N	168	36.75	W	bsl3.0	49
hx290115.HDR	Sep 05 2004	19:21:42	65	43.68	N	168	36.66	W	bsl3.0	49
hx290116.HDR	Sep 05 2004	19:50:45	65	43.29	N	168	32.32	W	bsl3.5	45
hx290117.HDR	Sep 05 2004	20:12:16	65	42.81	N	168	27.99	W	bsl4	51
hx290118.HDR	Sep 05 2004	20:34:16	65	42.35	N	168	23.76	W	bsl4.5	50
hx290119.HDR	Sep 05 2004	20:57:03	65	42.06	N	168	19.38	W	bsl5	51
hx290120.HDR	Sep 05 2004	21:33:19	65	41.60	N	168	15.22	W	bsl5.5	43
hx290121.HDR	Sep 05 2004	22:02:31	65	41.15	N	168	10.54	W	bsl6	22

D=approximate water depth in m

TABLE 3: CTD casts with bottle firing problems

Cast #	Name	Bottle # no confirm	Bottle# marked	#s no rec.*	Comments (target depths in m)
4	A3	7	-	7	b7 @ 5m
5	a3l-2	8	-	8	b8 @ surface
6	a3l2.5	8	-	8	b8 @ surface
7	a3l-3	6,7,8	-	6,7,8	b6,7,8 @ 10, 5, surface
8	a3l-4	6	-	6	b6 @ 10
9	a3l-5	6	-	6	b6 @ 10
24	bsl3.0	4	-	4	b4 @ 30
28	bsl1	7	-	7	b7 @ surface
38	chuk10	1	-		b1 redundant, duplicate fired
40	eext2	5	-		b5 redundant, duplicate fired
42	phl1	6,7	-	6,7	b6,7 @ 5, surface
43	phl2	7	-	7	b7 @ 5
44	phl3	7,8	-	7,8	b7,8 @ 5, surface
52	phl11	7,8	-	7,8	b7,8 @ surface, surface
55	phl12.5	3,4			recast as 56
61	cpl3	6	-	6	b6 @ surface
62	ccl23	5,6,8	-	5,6,8	b5,6,8 @ 19, 10, surface
63	ccl22	3-10			fired 10, only 9 closed, recast
64	ccl22	3,4,7,8	3,4,7,8	-	marked at same wire out b @ 49, 47, 42, 31, 20, 10, 5 surface
65	ccl21	4,6,8	1-8	-	all fires marked for comparison b @ 46, 44, 40, 30, 20, 10, 5, surface
66	ccl20	2,3,4,11, 12	1-11	12	b @ 49, 40, 34, 34, 22, 16, 9, 9, 5, 5, 0, 0
68	ccl18	1,3,4,5	1,3-8	-	Fired 8, only 7 bottles closed fired @ 51, 49, 40, 30, 20, 10, 5, surface
73	ccl13	4,5,6	4,5,6	-	b4,5,6 @ 30, 20, 10
76	ccl10	7	7	-	b7 @ surface
77	chuk1	7	7	-	b7 @ surface
79	ccl7	2-7	2-7		Fired 7, only 6 bottles closed fired @ 43, 41, 30, 20, 10, 5, surface
84	nbs12	2,3,4,	-	-	recast as 85
87	nbs13	1,2,3	1,2,3	-	b1,2,3 @ 13, 12, 5
94	nbs6	5,6	5,6	-	b5,6 @ 20, 10
96	nbs4	2,3	2,3	-	b2,3 @ 49, 40
97	nbs3	1,2	1,2	-	b1,2 @ 51, 49
98	nbs2	4	4	-	b4 @ 30
100	mbs1	4,5,7	4,5,7	-	b4,5,7 @ 20, 10, surface
105	mbs4	3	3	-	b3 @ 40
119	bsl5	6,7,8	6,7,8		ship repositioning on downcast b6,7,8 @ 10, 5, surface
120	bsl5.5	2,3,4	2,3	4	b2,3,4 @ 42, 40, 30

***no rec -** these bottles have no electronic log of depth of firing

APPENDICES:

A) CTD sections for A3L
BSL(1)
CHUK + EEXT
PHL
CPL
CCL
NBS
MBS
BSL(2)

Each page shows temperature, salinity, sigma-theta, fluorescence, transmissivity and PAR. Vertical axis is pressure in dbar. This data is preliminary, post-cruise, without significant quality control.

B) Preliminary RCM Current meter and SBE Results
Results using rough calibrations only.

C) SeaWifs/MODIS images

D) O18 bottle logs (paper copy only)

E) Cruise photos of instrument fouling.

F) Photos of the white patch of surface particles discussed above

G) Photos of the freshwater front south of Wales.

H) Other cruise photos