Final Cruise Report

Sea Breeze 2004a
RV Atlantis
Voyage #11, Leg XIV (AT 11-14)
14 June-13 July 2004
(Version 0.99 10/10/2005)

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Cruise Summary

Introduction and Objectives

A sea breeze occurs when the land surface heats more rapidly than the adjacent water, setting up an thermally driven convection current drawing a cool sea breeze over the land. We hypothesize that, in the same way, hydrothermal vents within the confines of the axial valley of central Endeavour Segment entrain ambient waters driving flow of fluid into the valley. Measures of this flow may be an effective proxy for monitoring hydrothermal output.

Within the overall Sea Breeze experiment, we will acquire two sets of complementary observations: the vertical fluxes of fluid mass, heat and salt rising from Endeavour Segment vent fields and the lateral transport of fluid mass within the axial valley. Taking advantage of the topographic constraints of the Endeavour Segment, we will use these observations to evaluate whether the mean subinertial component of the lateral fluid flux into the valley balances the upward, buoyancy-driven fluid flux from the vent fields--our "sea breeze" hypothesis.

A strong correlation could provide a means of making continuous, remote proxy measurements of the integrated fluxes from the vent fields, thereby serving as a "flux meter." In addition to testing the sea breeze hypothesis, the data will help address a number of other significant questions concerning how the flux of heat from Endeavour Segment evolves, the rates of change associated with phase separation and segregation, fluxes of substrates used as energy sources by plume microbiota, and characteristics of the regional circulation relevant to larval dispersal.

The project continues a long-standing collaboration of UW and IOS in the Canada's Endeavour Hydrothermal Vents Marine Protected Area. This research will provide an improved understanding of the fluxes of materials supporting the unique ecosystems that are present here.

This cruise is one of five related to the Sea Breeze program. The central objective is to determine the heat flux from the major vent sources within the area. Vertical fluxes are measured with an approach that taps the technological capabilities of the autonomous vehicle ABE (Autonomous Benthic Explorer) to survey a tightly-spaced grid on a horizontal plane above each source. This grid is placed ~70 meters off the seafloor to intersect buoyant hydrothermal plumes while they rise, in a regime where the time scale since discharge from the seafloor is tens of minutes. Synthetic computer-based surveys suggest that a survey at this level provides a statistically meaningful sampling density while optimizing signal-to-noise levels in the measured parameters (the velocity, temperature, salinity and hydrothermal tracer fields). Horizontal fluxes are determined by combining data from detailed CTD observations with currents measured on instruments originally placed in the area in 2003. Three principal activities were undertaken during this cruise:

ABE Surveys. Our principal targets are Mothra, Main Endeavour, High Rise, Salty Dawg and Sasquatch vent fields. We conducted 9+ dives devoted to measuring heat fluxes from these fields, providing 339 km of track line. The measurements in this grid allow estimation of the upward flux of heat and the ability to relate specific heat-salt-tracer signatures to the spatial variability of composition of fluids exiting from the vents.

CTD Operations. CTD operations were conducted both during and between ABE dives, with two main goals: 1) determining the stability of the water column in the axial valley between known vent fields, 2) determining the hydrographic character of the vertical walls of the boxes defined the vent field survey area. We occupied 46 stations: 3 conventional casts (code: SC), 10 vertically oscillating casts (code: VOC), 13 vertically oscillating tows across the valley ("fences") (code: VOTf), 14 vertically oscillating tows around areas surveyed with ABE ("curtains") (code VOTc) and 6 moving vertically oscillating casts (a series of vertically oscillating casts during which the CTD is moved between cast locations by towing horizontally) (code MVOC).

Bathymetry. ABE carried a Kongsberg Simrad SM-2000 200 kHz multibeam swath bathymetric system. 3+ ABE dives were devoted to characterizing, at ~10 cm vertical resolution, the bathymetry crest-to-crest of the axial valley in the vicinity of Mothra, and of the valley floor centered on Salty Dawg and Sasquatch.

Our cruise included the participation of seven K-12 school teachers under the auspices of the REVEL program (http//www.ocean.washington.edu/outreach/revel).

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Cruise Participants

University of Washington
Dr. Russell McDuff, Chief Scientist and Principal Investigator
Dr. Fritz Stahr, Oceanographer
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Mr. Jonathan Kellogg, Graduate Student
Mr. Wesley Thompson, Undergraduate Student
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Woods Hole Oceanographic Institution
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Dr. Brian Bingham, Postdoctoral Associate
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Mr. Alan Duester, Electrical Engineer
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Mr. Victor Garcia, Anacortes, WA
Ms Maggie Hardgrave, New York, NY
Ms Sandra Lever, Green River, WY
Mr. Thomas Nassif, Washington, DC
Ms Diedre Young, Kelso, WA

Chronology—AT 11-14

All dates and times are UTC. Local time is PDT (–0700). Dates are expressed conventionally and as Modified Julian Day. Locations for CTD stations are the average of positions while the instrument is below 1700 meters. Locations for ABE dives are the midpoint of the bounding box for the survey track. Datum: WGS 84.

Date	*Time*	*Location*	
53170 Mon 14 Jun 2004			
	1600		Depart UW School of Oceanography Pier, Portage Bay, Seattle
	1740		Exit Locks and Transit to JdF
53171 Tue 15 Jun 2004			
	0000		Pilot Debarks
	1941	47.949867, 128.808083	CTD Stn 1 SC: Background Cast
53172 Wed 16 Jun 2004			
	0026	47.949746 -128.869221	CTD Stn 2 SC: Background Cast
	0311	47.949766 -128.935354	CTD Stn 3 SC: Background Cast
	0630		Transponder Deployments and Surveys
	1842	47.92192 -129.10882	Launch ABE 108 H: Mothra
53173 Thu 17 Jun 2004			
	0322		Recover ABE 108
	0445	47.92056 -129 10983	CTD Stn 4 MVOC: WP 1,2
	1101	47.99583 -129.06755	CTD Stn 5 MVOC 21-15
53174 Fri 18 Jun 2004			
	0201	47.89390 -129.16451	Launch ABE 109 X: Abort
	0652		Recover ABE 109
	0801	47.97104 -129.08546	CTD Stn 6 MVOC: WP 14-9
	2036	47.92265 -129.10876	Launch ABE 110 H: Mothra

	2342	47.92764 -129.10597	CTD Stn 7 VOC: WP 3
53175 ***Sat 19 Jun 2004***			
	1527	47.92345 -129.10831	CTD Stn 8 VOTc: Mothra
53176 ***Sun 20 Jun 2004***			
	0859	47.943043 - 129.102197	CTD Stn 9 MVOC: WP 6,7
	1305	47.944779 - 129.096509	CTD Stn 10 VOTc: MEF
53177 ***Mon 21 Jun 2004***			
	0208	47.94899 -129.09793	CTD Stn 11 VOTc: MEF (and WP 8)
	1312	47.92324 -129.10731	Launch ABE 112 B: Mothra
	1627	47.93273 -129.10321	CTD Stn 12 VOTf: SoMEF
53178 ***Tue 22 Jun 2004***			
	0453		Recover ABE 112
	0635	47.95596 -129.09201	CTD Stn 13 VOTf: MEFHR
	2052	47.89390 -129.16452	Launch ABE 113 X: Abort
53179 ***Wed 23 Jun 2004***			
	0130		Recover ABE 113
	0203	47.92357 -129.10978	CTD Stn 14 VOTc: Mothra
	0816	47.89390 -129.16452	Launch ABE 114 X: Abort
	1128	47.92458 -129.10610	CTD Stn 15 VOTc: Mothra
	1514		Recover ABE 114
	1732	47.92315 -129.10688	CTD Stn 16 VOTc: Mothra
53180 ***Thu 24 Jun 2004***			
	0002	47.92276 -129.10849	CTD Stn 17 VOTc: Mothra
	2030		Transponder Recovery and Redeployment

53181 Fri 25 Jun 2004			
	0256	Check Box Center	Launch ABE 115 B: Mothra
	0604	47.94590 -129.09903	CTD Stn 18 VOTc: MEF
	1600	47.95061 -129.09885	CTD Stn 19 VOTc: MEF
	2018		Recover ABE 115
	2030		Transponder Survey
	2300		Transit to Neah Bay for ship, science spares needed for repairs
53182 Sat 26 Jun 2004			
	1430		Small boat exchange at Neah Bay
53183 Sun 27 Jun 2004			
	0812	47.91811 -129.11107	CTD Stn 20 VOTf: SoMoth
	2014	Fix location	Launch ABE 116 H: Mothra
	2324	47.94896 -129.09884	CTD Stn 21 VOTc: MEF
53184 Mon 28 Jun 2004			
	1210		Recover ABE 116
	1012	47.94710 - 129.09831	CTD Stn 22 VOTc: MEF
53185 Tue 29 Jun 2004			
	0219	47.92266 -129.10869	Launch ABE 117 H: Mothra
	0532	47.92772 -129.10661	CTD Stn 23 VOTf: NoMoth
	2208		Recover ABE 117
	2337	47.96761 - 129.08670	CTD Stn 24 VOTc: HR
53186 Wed 30 Jun 2004			
	1243	47.94953 -129.09789	Launch ABE 118 H: MEF
	1553	47.96540 -129.08740	CTD Stn 25 VOTf: SoHigh

53187 Thu 1 Jul 2004			
	0501	47.95261 -129.09560	CTD Stn 26 VOTf: NoMEF
	1422		Recover ABE 118
	1625	47.96815 -129.08613	CTD Stn 27 VOTc: HR
53188 Fri 2 Jul 2004			
	0528	47.89390 -129.16452	Launch ABE 119 H: Mothra
	0835	47.95267 -129.09603	CTD28 VOTf: MEF
	2340		Recover ABE 119
53189 Sat 3 Jul 2004			
	0000		Transponders B,C Recovered, Redeployed, Surveyed
	0635	47.93382 -129.10426	CTD Stn 29 MVOC: WP 4,5
	1212	47.949251 -129.09785	Launch ABE 120 H: MEF
	1520	47.97302 -129.08558	CTD Stn 30 VOTf: NoHigh
53190 Sun 4 Jul 2004			
	0452	47.95258 -129.09597	CTD Stn 31 VOC: NoMEF
	1723		Recover ABE 120
	2127	47.92401 -129.01965	CTD Stn 32 MVOC: Hole in the Ocean
53191 Mon 5 Jul 2004			
	0000		Fourth of July BBQ Commences
	1110		Launch ABE 121 H: HR
	1428	47.98595 -129.07536	CTD Stn 33 VOTf: NoSalt
53192 Tue 6 Jul 2004			
	0300		Transponders A,D Deployed
	0457	47.97267 -129.08381	CTD Stn 34 VOC: WP 14
	1556		Recover ABE 121

	After recovery		Transponder Survey
	2051	47.97172 -129.08749	CTD Stn 35 MVOC: delineate upper depth of HR plume
53193 ***Wed 7 Jul 2004***			
	0718	47.982670 -129.07334	Launch ABE 122 B: SD/S
	1050	47.99198 -129.06979	CTD Stn 36 VOC: NoSalt @ Sill
	1520		Recover ABE 122
	1530		Recover, Deploy, Survey Transponder A
	2015	47.99950 - 129.04758	CTD Stn 37 SC: WestSquatch vicinity of methane anomaly in prior cruise AT11-13
	2342	47.99172 -129.06468	Launch ABE 123 B: SD/S
53194 ***Thu 8 Jul 2004***			
	0302	47.99197 -129.06981	CTD Stn 38 VOC: NoSalt @ Sill
	1617		Recover ABE 123
	1730	48.00033 -129.06049	CTD Stn 39 VOTf: NoSquatch
53195 ***Fri 9 Jul 2004***			
	0709	47.96771 -129.08735	Launch ABE 124 H: HR
	1119	47.98128 -129.07781	CTD Stn 40 VOTc: SD
53196 ***Sat 10 Jul 2004***			
	0251	47.99742 -129.06798	CTD Stn 41 VOTc: Sasquatch
	0604		Recover ABE 124
	0747	47.91801 -129.11108	CTD Stn 42 VOC: NoSalt @ Sill
53197 ***Sun 11 Jul 2004***			
	0026	47.97283 -129.08609	Launch ABE 125 H: SD and Jakuba Tests
	0351	47.96535 -129.08936	CTD Stn 43 VOC: south of High Rise at WP12

	1508	47.99724 -129.06699	CTD Stn 44 VOTc: Curtain around Sasquatch with x-pattern across box
53198 ***Mon 12 Jul 2004***			
	0226	47.94187 -129.09198	CTD Stn 45 VOC: gap on the eastern wall SE of MEF
	0604		Recover ABE 125
	0727	47.93971 -129.08589	CTD Stn 46 VOTf: Fence along the gap on the eastern wall SE of MEF
	1145		Transponder Recovery
	1536		Begin Transit
53199 ***Tue 13 Jul 2004***			
	1130		Pilot Aboard
	1800		Enter Locks
	1945		Secure at NOAA/PMC, Lake Union, Seattle
	2300		Post Cruise Dinner

Abbreviations:

For CTD Stations

SC: standard cast
VOC: vertically oscillating cast
MVOC: moving vertically oscillating cast
VOT: vertically oscillating tow
VOTc: VOT making a curtain on surfaces of a control volume
VOTf: VOT making a fence on a control surface

For ABE Dives

H: optimized for heat flux determination
B: optimized for bathymetry
X: aborted dive

Principal Results

FROM NSF PROGRESS SUBMISSION

Publications

Digital Data

Navigation

The *RV Atlantis* uses a p-code GPS receiver as its primary navigation system. The datum is WGS84.

Acoustic Transponder Network

ABE operations were navigated within a long baseline acoustic navigation network that was deployed for this program and survey relative to the ship's GPS positioning.

Configuration

Date	*channel a*	*channel b*	*channel c*	*channel d*
15-Jun-2004	A1	B1	C1	D1
16-Jun-2004	A1	B1	C1	D1
17-Jun-2004	A1	B1	C1	D1
18-Jun-2004	A1	B1	C1	D1
19-Jun-2004	A1	B1	C1	D1
20-Jun-2004	A1	B1	C1	D1
21-Jun-2004	A1	B1	C1	D1
22-Jun-2004	A1	B1	C1	D1
23-Jun-2004	A1	B1	C1	D1
24-Jun-2004	A1	B2	C1	D1
25-Jun-2004	A1	B2	C1	D1
26-Jun-2004	A1	B2	C1	D1
27-Jun-2004	A1	B2	C1	D1
28-Jun-2004	A1	B2	C1	D1
29-Jun-2004	A1	B2	C1	D1
30-Jun-2004	A1	B2	C1	D1
1-Jul-2004	A1	B2	C1	D1
2-Jul-2004	A1	B2	C1	D1
3-Jul-2004	A1	B3	C2	D1
4-Jul-2004	A1	B3	C2	D1
5-Jul-2004	A2	B3	C2	D2
6-Jul-2004	A2	B3	C2	D2
7-Jul-2004	A2	B3	C2	D2
8-Jul-2004	A3	B3	C2	D2
9-Jul-2004	A3	B3	C2	D2
10-Jul-2004	A3	B3	C2	D2
11-Jul-2004	A3	B3	C2	D2
12-Jul-2004	A3	B3	C2	D2

Transponder Locations

Identifier	*Latitude*	*Longitude*	*Depth*	*local x*	*local y*	*local z*
A1	47.93681	-129.11652	1886.2	3586.5	4769.3	1886.2
B1	47.92267	-129.09771	1963.3	4990.8	3198.1	1963.3
C1	47.95610	-129.08333	1881.0	6064.0	6913.0	1881.0
D1	47.93416	-129.09110	1946.6	5484.3	4474.4	1946.6
B2	47.92243	-129.09836	1959.8	4942.3	3170.9	1959.8
B3	47.97512	-129.07631	1903.0	6587.8	9027.4	1903.0
C2	47.97914	-129.09153	1880.0	5452.1	9474.4	1880.0
A2	48.00820	-129.06844	1960.1	7175.2	12704.5	1960.1
D2	47.99325	-129.07542	1934.8	6654.6	11042.8	1934.8
A3	47.98463	-129.06224	1940.9	7638.1	10084.4	1940.9

The local coordinate system follows the ALVIN conventions for Long Base Line navigation in a Cartesian grid. Locations are in meters north and east of an origin located at 47°53.634'N, 129°09.870'W. The work area is in UTM Zone 9U.

CTD and Other Shipboard Observations

CTD operations focused on two objectives: 1) determining the stability of the water column in the axial valley between known vent fields, 2) determining the hydrographic character of the vertical walls of the box defined by the survey area. We occupied 46 stations: 3 conventional casts (code: SC), 10 vertically oscillating casts (code: VOC), 13 vertically oscillating tows across the valley ("fences") (code: VOTf), 14 vertically oscillating tows around areas surveyed with ABE ("curtains") (code VOTc) and 6 moving vertically oscillating casts (a series of vertically oscillating casts during which the CTD is moved between cast locations by towing horizontally) (code MVOC).

Station	***Operation***
ctd1	SC: Background Cast ~22km off axis ENE
ctd2	SC: Background Cast ~17km off axis ENE
ctd3	SC: Background Cast ~12km off axis ENE
ctd4	MVOC: Axial Valley Waypoints 1-2
ctd5	MVOC: Axial Valley Waypoints 21-15
ctd6	MVOC: Axial Valley Wapoints 14-8
ctd7	VOC: NoMoth (Waypoint 3)
ctd8	VOTc: Mothra curtain
ctd9	MVOC: Axial Valley Waypoints 6-7
ctd10	VOTf: Fence SoMEF
ctd11	VOTc: MEF curtain
ctd12	VOTf: Fence South SoMEF (north of current meters)
ctd13	VOTf: Fence North NoMEF (south of current meters)
ctd14	VOTc: Mothra curtain
ctd15	VOTc: Mothra curtain
ctd16	VOTc: Mothra curtain
ctd17	VOTc: Mothra curtain
ctd18	VOTc: MEF curtain
ctd19	VOTc: MEF curtain
ctd20	VOTf: Fence SoMoth
ctd21	VOTc: MEF curtain
ctd22	VOTc: MEF curtain
ctd23	VOC: NoMoth (Waypoint 3)
ctd24	VOTc: High Rise curtain
ctd25	VOTf: Fence SoHigh
ctd26	VOTf: Fence NoMEF
ctd27	VOTc: High Rise curtain
ctd28	**VOTf: Fence MEF- begin at west end**
ctd29	MVOC: Axial Valley Waypoints 4-5
ctd30	VOTf: Fence NoHigh
ctd31	VOC: NoMEF (Waypoint 9)

ctd32	MVOC: Hole in the Ocean Stratification
ctd33	VOTf: Fence NoSalt
ctd34	VOC: NoHigh (Waypoint 14)
ctd35	MVOC: Look for high plume at High Rise vent field
ctd36	VOC: NoSalt
ctd37	SC: Check on high methane area found during AT11-13
ctd38	VOC: VOC NoSalt
ctd39	VOTf: Fence NoSquatch
ctd40	VOTc: Salty Dawg curtain
ctd41	VOTc: Sasquatch curtain
ctd42	VOC: VOC north of Salty Dawg in the middle of sill
ctd43	VOC: VOC south of High Rise at WP12
ctd44	VOTc: curtain around Sasquatch with X-pattern through center of box
ctd45	VOC: in gap on the eastern wall SE of MEF
ctd46	VOTf: fence in gap on the eastern wall SE of MEF

Terminology:
Station = a period of time defined by (A) when the CTD enters/exits the water, or (B) the nature of the CTD operations changes while the CTD is still in the water.
Cast = a period of time during a station defined by (A) when the CTD begins moving deeper during a VOT, or (B) when the ship and/or CTD change direction (moving towards a new waypoint).

SC = standard cast = hold ship position, lower/raise only once
VOC = vertically-oscillating cast = hold ship position, lower/raise with the winch many times
VOT = vertically-oscillating tow = move ship @ 0.2-1 knot and lower/raise CTD.
During this cruise conducted as either a
VOTf = a fence across the axial valley, traversed multiple times
VOTc = a vertical curtain around a survey area, traversed multiple times
MVOC = a sequence of operations consisting of vertical casts at set waypoints with a horizontal tow path between way points, generally at the depth of the neutrally buoyant portion of the hydrothermal plumes
Mothra = Mothra Field
MEF = Main Endeavour Field
HR = High Rise Field
SD = Salty Dawg Field
S = Sasquatch (Squatch) Field

Raw Data

The following systems are operated by the Woods Hole Oceanographic Institution Shipboard Science Support Group.

CTD. The RV Atlantis carries a Seabird Electronics Inc. (SBE) 911plus CTD system mounted on a 24-position rosette equipped with a SBE 32 carousel water sampler. The system is controlled via SBE 33 and SBE36 deck units using SBE SEASOFT software.

ADCP. The RV Atlantis carries a RD Instruments **150 kHz acoustic Doppler current profiler (RD-VM150).** The system runs routinely; we made no use of the data collected.

DAS. The RV Atlantis utilizes the WHOI "Athena" data acquisition system to integrate data streams from a variety of ship sensors and systems. These streams include:

```
GPS Navigation data (GPS)
  Complete NMEA data output from the primary GPS receiver.
  NMEA GPS_GGA data sentence:  Header, UTC of position, Latitude, N/S,
Longitude, E/W, Quality indicator, Number of satellites in use,
Horizontal dilution, Altitude, M (meters), Geoidal seperation, M
(meters), Age of differential data (secs), Differential reference
station I.D. * checksum.
  NMEA GPS-VTG data sentence:  Header, Course, T (degrees true),
Course, M (magnetic), Speed, N (knots), Speed, K (km/hr) * checksum.

GPS course over ground (GPS_COG)
  Course over ground (true) obtained from NMEA GPS_VTG
data sentence.
  NMEA GPS-VTG data sentence:  Header, Course, T (degrees true),
Course, M (magnetic), Speed, N (knots), Speed, K (km/hr) * checksum.

GPS speed over ground (GPS_SOG)
  Speed over ground (knots) obtained from NMEA GPS_VTG data sentence.
  NMEA GPS-VTG data sentence:  Header, Course, T (degrees true),
Course, M (magnetic), Speed, N (knots), Speed, K (km/hr) * checksum.

Gyro heading (Gyro)
  Ship's heading (degrees true) obtained from the HEHDT primary sensor.

IMET Air Temperature (Air_Temp)
  Data is obtained from IMET_HRH primary sensor.

IMET Barometric Pressure (IMET_BPR)

IMET Humidity (IMET_HRH)

IMET Precipation (IMET_PRC)

IMET Shortwave Radiation (IMET_SWR)

IMET Wind (IMET_WND)

IMET relative humidity (HRH)

Latitude (GPS_LAT)

Longitude (GPS_LON)
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NMEA Gyro (HEHDT)
  Ship's heading obtained from the Sperry Gyro.

Salinity (Salinity)
  Salinity calculated from SSTMP and SSCND data values in accordance
with UNESCO 44.

Sea Surface Conductivity (SSCND)

Sea Surface Temperature (SSTMP)

Sound velocity (SSV)
  Sea surface sound velocity (meters/second) calculated from
SSTMP and SSCND data values.  Intermediate salinity calculations
are made in accordance with UNESCO 44.

True wind direction (Wnd_Dir)

True wind speed (Wnd_Spd)

True wind speed & direction (TWind)
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Full information on data formats for these data streams can be found in the documentation directory (`./docs/`) on the data disks.

While at sea, raw data was processed to create a number of secondary products. These include depth-bin averaged profiles in ASCII format.

These data are contained on **DVD-R AT11-04 Disks 1 and 2.**

ABE Dives

ABE, Autonomous Benthic Explorer, was used to survey the upper surface and sides of control volumes established over the five known vent fields on central Endeavour Segment: from south to north Mothra Field, Main Endeavour Field (MEF), High Rise Field, Salty Dawg Field, and Sasquatch Field. Survey areas were chosen to enclose all areas of known venting. The upper surface of the control volume was placed ~70 meters above the tallest vent structures.

To have adequate topographic information to insure the safety of ABE, several dives were optimized for obtaining bathymetric data.

dive	startdate	starttime	enddate	endtime	time	track	power	code	comment
abe108	6/16/04	18:42	6/17/04	03:22	3	7	1	hI	Mothra
abe109	6/18/04	02:01	6/18/04	06:52	0	0	1	XI	--
abe110	6/18/04	20:36	6/19/04	12:36	11	23	3	HI	Mothra
abe111	6/20/04	05:30	6/20/04	23:07	13	26	3	HI	MEF
abe112	6/21/04	13:12	6/22/04	04:53	10	20	3	BI	Mothra
abe113	6/22/04	20:52	6/23/04	01:30	0	0	0	XI	--
abe114	6/23/04	08:16	6/23/04	15:14	0	0	1	XI	--
abe115	6/25/04	02:56	6/25/04	20:18	11	23	4	BI	Mothra
abe116	6/27/04	20:14	6/28/04	12:10	11	23	3	HI	Mothra
abe117	6/29/04	02:19	6/29/04	22:08	15	31	3	HI	Mothra
abe118	6/30/04	12:43	7/1/04	14:22	21	43	3	Hi	MEF
abe119	7/2/04	05:28	7/2/04	23:40	13	27	2	H-	Mothra
abe120	7/3/04	12:12	7/4/04	17:23	24	52	4	Hi	MEF
abe121	7/5/04	18:10	7/6/04	22:56	24	52	5	H-	HR
abe122	7/7/04	07:18	7/7/04	15:20	3	7	1	hI	SD/S
abe123	7/7/04	23:42	7/8/04	16:17	12	23	3	BI	SD/S
abe124	7/9/04	07:09	7/10/04	06:04	18	39	4	Hi	HR
abe125	7/11/04	00:26	7/12/04	06:04	25	43	3	Hi	SD/S

Code
First Character
H: hydrothermal flux primary
h: hydrothermal flux secondary
B: bathymetry primary
Second Character
I: bathymetric imagery on
i: bathymeric imagery on, part of dive

Survey Time in hours
Survey Track in km
Power Consumption in kW h

Data from Autonomous Benthic Explorer (ABE)

All data from ABE are transferred from the vehicle upon recovery and processed within the Matlab programming environment (http://www.mathworks.com). Two sets of files are generated: ks*nnn*.mat, postatt*nnn*.mat, and sci*nnn*.mat. The **ks** file contains processed navigation. The **postatt** files contain primary, unfiltered navigation data. The **sci** files contain data of scientific interest.

ks files: Processed Navigation and Attitude Structure

These files contain a matlab structure named ks

```
ks =

t: [Nx1 double]
x: [Nx1 double]
y: [Nx1 double]
z: [Nx1 double]
heading: [Nx1 double]
pitch: [Nx1 double]
roll: [Nx1 double]
fu: [Nx1 double]
t0: [Nx1 double]
th: [Nx1 double]
tm: [Nx1 double]
```

where
t: the time in Unix seconds (t=0 corresponds to 1 January 1970)
x,y: the position estimates from the kalman smoother
z: the depth, as computed using the fixed formula used by Jason and Alvin
heading: corrected, postprocessed heading from the ABE magnetometer
pitch and roll: from the inclinometer in the ABE compass
fu: forward thrust estimate (used in Kalman smoother)
t0: time in seconds, where t0=0 corresponds to 0000 of the day of the dive, (this is handy for plotting, using Unix seconds for your x axis is messy)
th: time in hours, same convention as t0
tm: time in minutes, same convention as t0

sci files: Science Data

The sci files contain two data structures, sci and star:

The sci structure contains all data gathered on the sci serial bus, the values were logged at 1 second intervals. Fields contained in the file scixxx.mat (or scixxx.txt for the flat ascii equivalent) are:

```
sci =

t: [Nx1 double]
mag_vx: [Nx1 double]
mag_vy: [Nx1 double]
mag_vz: [Nx1 double]
obs: [Nx1 double]
aux1: [Nx1 double]
aux2: [Nx1 double]
ground_fault: [Nx1 double]
depth: [Nx1 double]
x: [Nx1 double]
y: [Nx1 double]
pressure: [Nx1 double]
altitude: [Nx1 double]
t0: [Nx1 double]
th: [Nx1 double]
tm: [Nx1 double]
```

where:
t, t0, tm, th: same conventions as the ks structure
max_vx, mag_vy, mag_vz: 3 axis magnetometer values
obs: voltage from optical backscatter sensor
aux1: Nakamura eH sensor
aux2: Nakamura obs sensor (not working)
ground_fault: (not connected)
depth: interpolated from the ks structure, see the star structure for raw pressure, which should be used for detailed analysis
x,y: interpolated position from ks structure
pressure: real time pressure estimate
altitude: distance from the seafloor

The star structure contains data logged from the star serial bus, which serviced the two ctd and originally the mavs (we eventually used self-logging for the mavs to avoid noise problem). The star bus was sampled at 0.38 second intervals and all samples were time stamped and recorded for each measurement.

```
star =

t: [Nx1 double]
paro_counts: [Nx1 double]
ct1_ft: [Nx1 double]
ct1_fc: [Nx1 double]
```

```
ct2_ft: [Nx1 double]
ct2_fc: [Nx1 double]
t0: [Nx1 double]
th: [Nx1 double]
tm: [Nx1 double]
ft1: [Nx1 double]
fc1: [Nx1 double]
ft2: [Nx1 double]
fc2: [Nx1 double]
p1: [Nx1 double]
p2: [Nx1 double]
z1: [Nx1 double]
z2: [Nx1 double]
C1: [Nx1 double]
T1: [Nx1 double]
C2: [Nx1 double]
T2: [Nx1 double]
x: [Nx1 double]
y: [Nx1 double]
```

where:
paro_counts: raw paro counts, 1 count = 0.01 decibars. Note that the paro is logged by the nav bus, which runs at 10 hz. The star process logs the most recent value, and time stamps it with the current time.
ct1_ft, ct1_fc, ct2_ft, ct2_fc: these are the raw counts logged from the sail interfaces to the ct sensors. These map to frequency, but are not frequency
ft1, fc1, ft2, fc2: frequency counts
the following field are derived from the fields above using matlab seawater package
p1, p2: processed pressure
z1, z2: processsed depth, using the seawater package and the actual latitude (not the depth computed by Alvin, Jason, etc);
T1, T2, ITS-90, as per Seabird calibration sheets
C1, C2, Siemens/meter, as per Seabird calibration sheets
x,y: position, interpolated from ks structure.

Processed Data

A variety of preliminary processed products are also available as plots.

ABE Digital Data

ABE data can be found on **DVD-R AT11-04 Disk 2**

Metadata

The U.S. component of the Sea Breeze Program is funded by the National Science Foundation as part of the RIDGE 2000 program. A condition of this funding is submission of metadata describing the data sets that are collected to the mgDMS (marine geoscience data management system) at Lamont-Doherty Geological Observatory (<http://www.marine-geo.org/>). These metadata are provided on **DVD-R AT11-04 Disk 2.**

Contents of DVD-R AT11-04 Disks 1 and 2

Directory	***Contents***
Disk 1	
`./CRUISE_ID`	text file with cruise designator
`./docs/`	information on file formats
`./adcp/`	ADCP ping data
`./athena`	underway data
`./athena90`	old version format of selected underway data
`./scripts`	WHOI utilities for working with Athena files
`./ctd`	raw CTD data
`./software` **`NEED TGT files`**	directory with Windows software for reading and manipulating CTD and ADCP data. **Unpack files by running the two .EXE files; program to examine data is SEASAVE.EXE**

Directory	***Contents***
Disk 2	
`./science`	partially processed CTD data (post cruise calibration of sensors has not been applied). See documents in root of this directory tree for more information.
`./abe/`	data from ABE
`./abe/abe`*`nnn`*	subdirectories for each ABE dive
`./abe/abe`*`nnn`*`/data`	data
`./abe/abe`*`nnn`*`/plots`	plots of selected data
`./abe/mfiles`	Matlab utilities for working with data
`./abe/missionscripts`	ABE program for each dive
`./abe/xpndrs`	transponder configuration
`./metadata`	metadata submitted to mgDMS
`./sb04a-cruise_report.pdf`	this document