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CRUISE REPORT

Open Ocean to Inner Sea - RV Falkor A Joint Expedition

Ocean Networks Canada and Schimdt Ocean Institute

August 16 to September 19, 2013

AN INITIATIVE OF University of Victoria

Executive Summary

Between August 16 and September 19, 2013 Ocean Networks Canada and the Schmidt Ocean Institute collaborated for two expeditions on the *R/V Falkor*. The objectives of the expeditions were to identify pathways that low-oxygen off-shore water might take in coming near-shore, both along the west coast of Vancouver Island and into the Salish Sea via Juan de Fuca Strait, and to study the benthic fauna along these pathways to characterize variations in community composition and adaptations. Operations were divided into two distinct legs; the first (FK009A, August 16-30, 2013) to map the water column characteristics and pathways of deep offshore water into the near-shore environment, the second (FK009B, September 4-19, 2013) utilizing the remotely operated vehicle (ROV) ROPOS to study benthic ecology from Barkley Canyon to Saanich Inlet. Researchers from across Canada and Europe participated in the expeditions, joining the ship in person or connecting via live Internet video feeds during the ROV dives.

During Leg-1 (FK009A), water column measurements were collected with the ship's Conductivity, Temperature, and Depth (CTD) and Rosette sampler, a Moving Vessel Profile (MVP) system, a thermosalinograph, and an array of acoustic systems including an Acoustic Doppler Current Profiler (ADCP), a multi-frequency echo-sounder, and a high resolution multi-beam bottom mapping sonar. Over 3000km of survey tracks were accomplished, including 40 CTD casts, 300 water samples, nearly 2800 MVP casts, and over 400 GB of acoustic data.

Leg-1 sampling sought to identify and track the pathways of deep water found beyond the shelf break (200 m isobath) up on the continental shelf and into near-shore regions. A starting hypothesis and common perception was that the Juan de Fuca and Tully Canyon systems to the south play a major role in feeding deep low-oxygen water to the central and inner continental shelf, and via Juan de Fuca Strait, the inner Salish Sea. The high resolution MVP survey revealed that tidally modulated mixing at the canyon rim was important in water mass transformations at the time of the survey. Barkley Canyon also seemed to play a major role in the transport of slope water onto the shelf. Near-bottom oxygen levels on the central shelf were very low for this time of year and suggested a relatively long local residency time for deep, mid-shelf waters.

For the second leg (FK009B), the ROV ROPOS was used to conduct a range of scientific missions, from video and image surveys, to observatory instrument manipulation and physical sample collection. The first ROV dives were in Saanich Inlet, conducting video surveys across the hypoxia boundary, collecting sediment cores, and connecting the new Inshore buoy Profiling System to the VENUS Node. Once out on the west coast of Vancouver Island, several ROV dives were used to swap out Ocean Networks Canada observatory seismometers, CTDs, ADCPs, as well as install a new command module for the Simple Cabled Instrument for Measuring Parameters Insitu (SCIMPI) borehole instrument package and clean the CTD and camera lens on Wally, a tracked seafloor rover connected to the NEPTUNE network in Barkley Canyon. A series of benthic surveys were conducted from the base of Barkley Canyon at 2000 m to the shelf break at 200 m, documenting the fauna and ecology from beneath the oxygen minimum layer to the rugged continental shelf. The ship's multibeam sonar was used to acquire detailed maps of strategic sites in the canyon, before finishing the cruise with some video survey work in the Tully Canyon.

Contents

Cruise Details

Ship Name: Research Vessel Falkor

Ship Operator: Schmidt Ocean Institute

Partner/Client: Ocean Networks Canada

Principal Investigator: Dr. Kim Juniper

Cruise Designation:

Schmidt Ocean Institute: FK009 (Leg-1: FK009A Leg-2: FK009B)

Canadian Department of Fisheries and Oceans: 2013-57

Cruise Dates:

Leg – 1: August 16 – 30, 2013

Leg – 2: September 4 – 19, 2013

Port of Entry: Victoria, British Columbia

Chief Scientists:

Leg – 1: Dr. Richard Dewey, ONC (rdewey@uvic.ca)

Leg – 2: Dr. Kim Juniper, ONC (kjuniper@uvic.ca)

Areas of Operation:

Leg – 1: Strait of Georgia, Juan de Fuca Strait, and West Coast Vancouver Island, British Columbia

Leg – 2: Saanich Inlet, and West Coast Vancouver Island, British Columbia

Original Proposal/Project Summary

Open Ocean to Inner Sea: The dynamics of hypoxia on the west coast of Canada and consequences for ocean life

Globally, oxygen-depleted zones and low-oxygen events in our oceans are increasing in number and severity as a result of human-caused nutrient pollution and climate change. Significant signs of these trends have been observed along the northwest coast of North America over the past decade.

In the summertime, off Vancouver Island, upwelling forces bring low oxygen ocean waters onto the continental shelf where they can move landward, and damage inshore ecosystems and aquaculture and negatively impact fish and crab populations. In late August and early September of 2013, R/V Falkor is hosting an international team of researchers who will be using the VENUS and NEPTUNE undersea observatory networks and other observation tools to track intrusions of low-oxygen deep-ocean waters, and study their harmful effects on seafloor ecosystems.

Leading the project is Prof. Kim Juniper, Science Director for Ocean Networks Canada at the University of Victoria. Also on board will researchers from the University of Victoria, University of British Columbia, Dalhousie University, Memorial University of Newfoundland, University du Québec à Rimouski and the Institute of Marine Sciences in Barcelona, Spain.

This collaborative research cruise represents the first time a project has exploited the full scope of the Ocean Networks Canada facility using both the VENUS and NEPTUNE observatories, to study an oceanographic phenomenon at such an ambitious scale. The team on board the Schmidt Ocean Institute's R/V Falkor plan to launch a long-term observational program with a range of operations that include: adding new sensors to the Ocean Networks Canada cabled observatories; conducting seafloor video surveys using remotely operated robots and profilers that measure water properties spanning high to low oxygen zones; and possibly deploying high-tech autonomous ocean gliders.

Scientists at the Universities of Victoria and British Columbia together with Canadian federal government oceanographers from the nearby Institute of Ocean Sciences, will leverage this mission to advance the forecasting capability of the Ocean Networks Canada observatories to mitigate the harmful effects of low-oxygen ocean waters. Ocean Networks Canada supports Schmidt's Open Science philosophy to provide open data access enabling researchers—and the public—worldwide to join in this venture.

Leg 1 (FK009A) Synopsis

The first two weeks of the FK009 cruise, designated as FK009A, focused on measurements in the water column collected through a variety of profiling techniques. In particular, the ship's CTD and Rosette were used to collect reference water property profiles and water samples at strategic stations, while a majority of the profiling was conducted under-way, using the ship's echo-sounder systems and a Moving Vessel Profiler (MVP), owned and maintained by UVic.

After calibrating the EK60 echo-sounder (August 18, 2013), we steamed to the entrance of Juan de Fuca Strait, collecting 75-kHz ADCP data along the way. A series of CTD casts were conducted, starting in Juan de Fuca Strait, and extending out to Barkley Canyon. At many of the CTD stations, water samples were also collected, using a Rosette, for dissolved Oxygen, carbon, and nutrient analyses. The MVP surveys were initiated on August 19, with a series of transects across and along specific features of interest, either bathymetric or based on water properties already assessed.

Preliminary assessment of the water column data confirmed the presence of the well know oxygen minimum layer deeper than the shelf break, extending down to nearly 2000 m, but also revealed that low oxygen values (i.e. 0.8 ml/l) can be found in the middle shelf region. This region is dominated by a slow cyclonic (counter-clockwise) circulation, often referred to as the Tully or Juan de Fuca Eddy, bounded to the North-East by an along shore surface current originating out of Juan de Fuca Strait, and to the South-West by the South-East shelf break current. The low oxygen bottom water in this eddy, is likely relatively old water, trapped on the shelf for weeks or even months, thereby having lost much of its oxygen through local bacterial decomposition. This eddy water was then characterized by its Temperature and Salinity, and the remaining MVP surveys focused on bounding and tracking sources, sinks, and exchanges with this middle shelf eddy water. Numerous surveys were conducted along the shelf break, where flows up Barkley Canyon and over the shelf break were observed to be feeding the middle shelf region, as compared with a deep water source up the Tully Canyon system.

Leg 1 (FK009A)

By the Numbers	
CTD Casts	40
Water Samples	300
MVP profiles	2763
Days	16
Scientists	9
Students	6

Leg 2 (FK009B) Synopsis

The second leg of the cruise was dedicated to dive operations with the ROV ROPOS. Delays were encountered during the first 48 hours of the cruise as a result of technical problems with the ship's gyro and a mechanical problem with the ROPOS starboard manipulator. Both problems were resolved and the dive program was adjusted to accommodate the delay. The ship left Saanich Inlet approximately 18 hours behind schedule, completed a very short dive in the Strait of Georgia to collect push-cores and then transited to the first offshore dive site at the Ocean Networks Canada (ONC) Clayoquot Slope site where planned instrument deployment and recovery operations were completed in a single dive.

A series of 4 dives were then completed in Barkley Canyon, to service instruments and complete installations of Ocean Networks Canada, deploy an in situ experiment for a graduate student, and collect representative push cores. Following these dives, ROPOS completed 7 video survey and sampling dives in Barkley Canyon, traversing the canyon floor along 1 km tracks along depth contours from 2000 m depth up to 200 m depth. Part way through this dive series, successive technical faults with ROPOS (umbilical re-termination, then an intermittent control system data telemetry fault) resulted in 36 hours of lost dive time. During this period the ship's multibeam system acquired high-resolution data coverage of Barkley Canyon region. Remaining multibeam lines in Barkley Canyon were also completed during normal ROV turnover time between dives.

No weather delays were encountered during the cruise. Dive operations were briefly interrupted on September 16 for a rendezvous at sea with a Canadian Coast Guard vessel to transfer two ROPOS pilots back to shore to support a recovery operation in the Canadian Arctic. Two replacement ROPOS pilots were brought out to the Falkor by the Coast Guard vessel. The final 24 hours of cruise operations took place in Tully Canyon. Two video survey dives were completed and multi-beam bathymetry data were collected during and between dives to provide higher resolution coverage of the area.

Acknowledgements

Both legs of the cruise were highly successful. The Captain and crew of the Falkor were enthusiastic and very flexible in accommodating our requirements and making up for lost time. The ship readily welcomed new sampling systems (i.e. the MVP) and were very helpful in accommodating a challenging and evolving program plan. Similar comments are applicable to the ROPOS team. The Falkor-ROPOS match was very productive, although there was little room on deck to do much more than deploy and recover the ROV.

Technical Cruise Report Overview

The remainder of the cruise report provides a technical overview of the plans, operations, and accomplishments of the ninth oceanographic cruise of the R/V *Falkor*. The vessel is owned and operated by the Schmidt Ocean Institute (SOI). This project was proposed by Ocean Networks Canada (ONC) to collect spatial water column and dedicated benthic surveys of the oceanographic pathways and impacts of low-oxygen off-shore waters as they migrate to near-shore and coastal regions of the Salish Sea.

The VENUS and NEPTUNE cabled ocean observatories are operated by Ocean Networks Canada and represent large infrastructure research facilities supporting a wide range of marine research in the coastal and off-shore waters of southern British Columbia. The cabled observatories provide continuous power and communications to advanced oceanographic sensor systems monitoring biological, chemical, physical, and geological properties in the ocean. Most of these systems are fixed geographically. Although the marine provinces represented by the networks are extensive, from deep spreading margins and abyssal planes to inland fjords and river deltas, understanding the processes responsible for the transport and evolution of off-shore waters above these fixed locations requires spatial surveys.

The cruise was divided into two legs, the first equipped with a variety of profiling systems to concentrate on mapping properties in the water column, the second with a scientific remotely operated vehicle (ROV) for site specific and benthic surveys of ecosystems from the continental shelf right into coastal fjords.

During Leg-1 (FK009A, August 16-30, 2013), the focus of the operations were the collection and analysis of water column measurements using a variety of profiling systems. These included the ship's conductivity, temperature, and depth (CTD) instrument, the rosette water sampler, a moving vessel profiler (MVP), and hull mounted acoustic profiling devices including an acoustic Doppler current profiler (ADCP) and a multi-frequency EK60 echo-sounder. In addition, data were collected from a surface flow-through thermosalinograph sampler, and several multibeam surveys were conducted.

During Leg-2 (FK009B, Sept. 2–20, 2013) , the ship was re-fitted with the science ROV ROPOS from the Canadian Science Submersible Facility (CSSF). This un-manned submersible is capable of full water column depth survey work (down to over 4000m), and included dual manipulators, sample collection capabilities, and a range of image and video feeds. In addition to transect surveys across, up, and within Barkley Canyon, the ROV serviced several NEPTUNE observatory instruments and deployed a dedicated incubation experiment adjacent to one of NEPTUNE's observatory cameras.

Analyses of the data, imagery, and samples collected during the two legs are on-going.

Summary of Cruise Activities – FK009A

Date	Location	Activity
Aug 16/13	Nanaimo, port	Crew arrival, loading gear, ship orientation
Aug 17/13	Nanaimo, port	Equipment and lab assembly, ship familiarization
Aug 18/13	Straits of Georgia and Juan de Fuca	EK60 calibration, CTD cast, MVP wire re-tension, transit
Aug 19/13	Juan de Fuca Strait and Continental Shelf and Slope, West Coast of Vancouver Island (WCVI)	CTD and Rosette casts
Aug 20/13	WCVI	CTD and Rosette survey, MVP Survey – A started
Aug 21/13	WCVI	MVP-A, USBL calibration, CTD, MVP-B
Aug 22/13	WCVI	MVP-B, multibeam Folger Pinnacle, MVP-C
Aug 23/13	WCVI	MVP-C, CTD, MVP-D
Aug 24/13	WCVI	MVP-D, MVP-E
Aug 25/13	WCVI	MVP-E, continues whole day
Aug 26/13	WCVI, Barkley Sound	MVP-E, CTD, MVP-G (no survey F)
Aug 27/13	WCVI	MVP-G, CTD, MVP-H
Aug 28/13	WCVI	MVP-H, MVP-I
Aug 29/13	WCVI	MVP-I, MVP-J
Aug 30/13	WCVI, Juan de Fuca Strait	MVP-J, CTD
Aug 30 – Sept 5/13	Victoria, port	Off-load MVP and crew, load ROPOS and crew

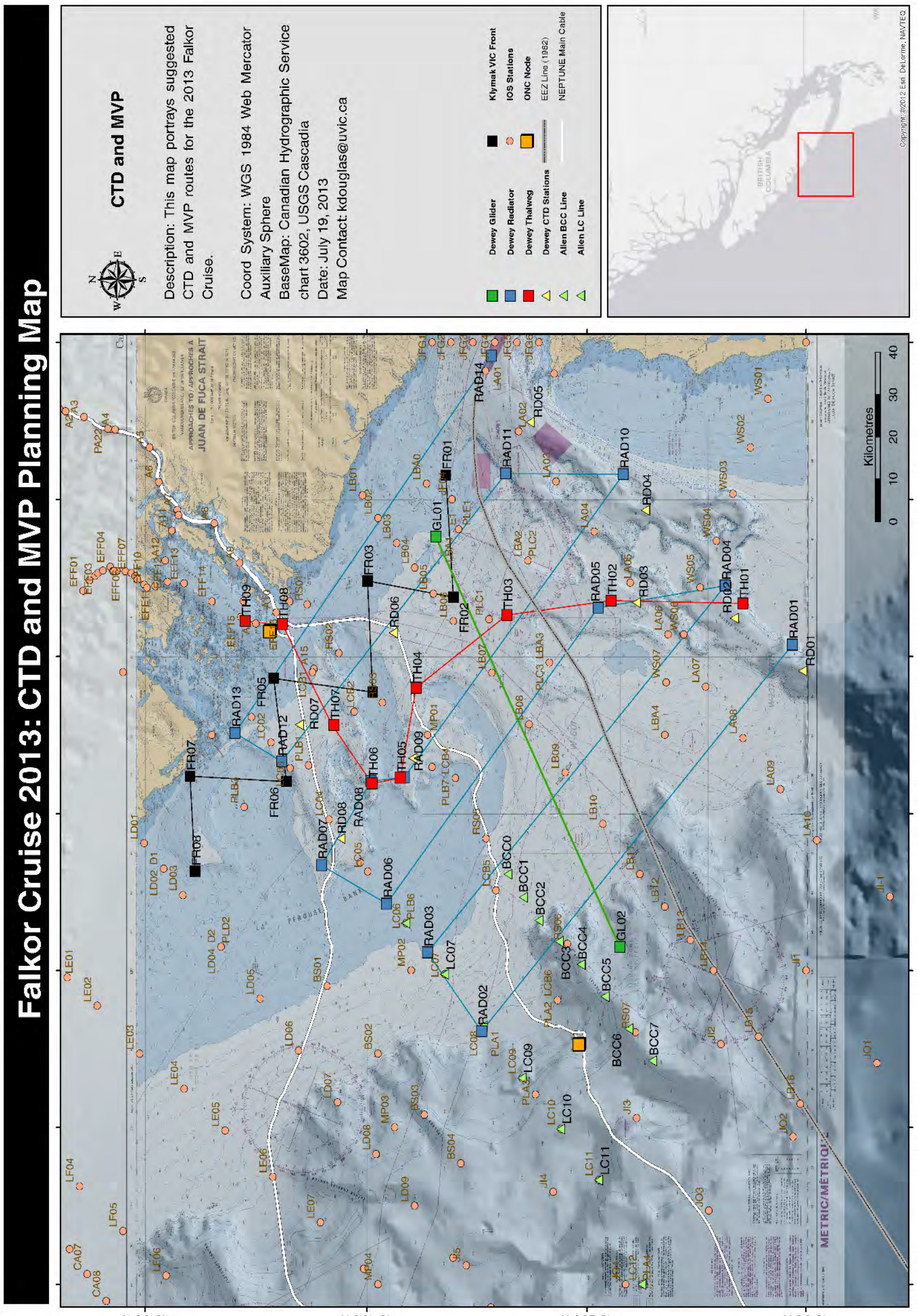
Summary Cruise Activities – FK009B

Date	Location	Activity
Sept 6/13	Victoria, Saanich Inlet	Depart Victoria, transit to Saanich Inlet
Sept 7/13	Saanich Inlet	ROV Dives 1 (R1645) & 2 (R1646), cliff surveys
Sept 8/13	Saanich Inlet and Strait of Georgia	ROV Dives 3 (R1647) & 4 (R1648), plug-in BPS, samples, 10 push cores
Sept 9/13	WCVI, Clayoquot Slope	ROV Dive 5 (R1649), CTD swap, SCIMPI command module swap, recover seismometer auxiliary platform
Sept 10/13	WCVI, Barkley Canyon	ROV Dive 6 (R1650), CTD service, deploy sonar
Sept 11/13	WCVI, Barkley Canyon	ROV Dive 7 (R1651), deploy enrichment experiment, push cores, Wally cleaning
Sept 12/13	WCVI, Barkley Canyon	ROV Dives 8 (R1652) & 9 (R1653), deploy enrichment experiment, push cores
Sept 13/13	WCVI	ROPOS technical repair day
Sept 14/13	WCVI, Barkley Canyon	ROV Dive 10 (R1654), Video transect, benthic survey, samples
Sept 15/13	WCVI, Barkley Canyon	ROV Dives 11 (R1655) & 12 (R1656), Video transect, benthic survey, samples
Sept 16/13	WCVI, Barkley Canyon	ROV Dives 13 (R1657) & 14 (R 1658), Video transect, benthic survey, samples
Sept 17/13	WCVI, Tully Canyon	ROV Dives 15 (R1659) & 16 (R1660), Video transect, benthic survey, samples
Sept 18/13	Victoria, port	Transit back to Victoria, begin off-load
Sept 19/13	Victoria, port	Off-load.

Navigational (GPS) Summaries

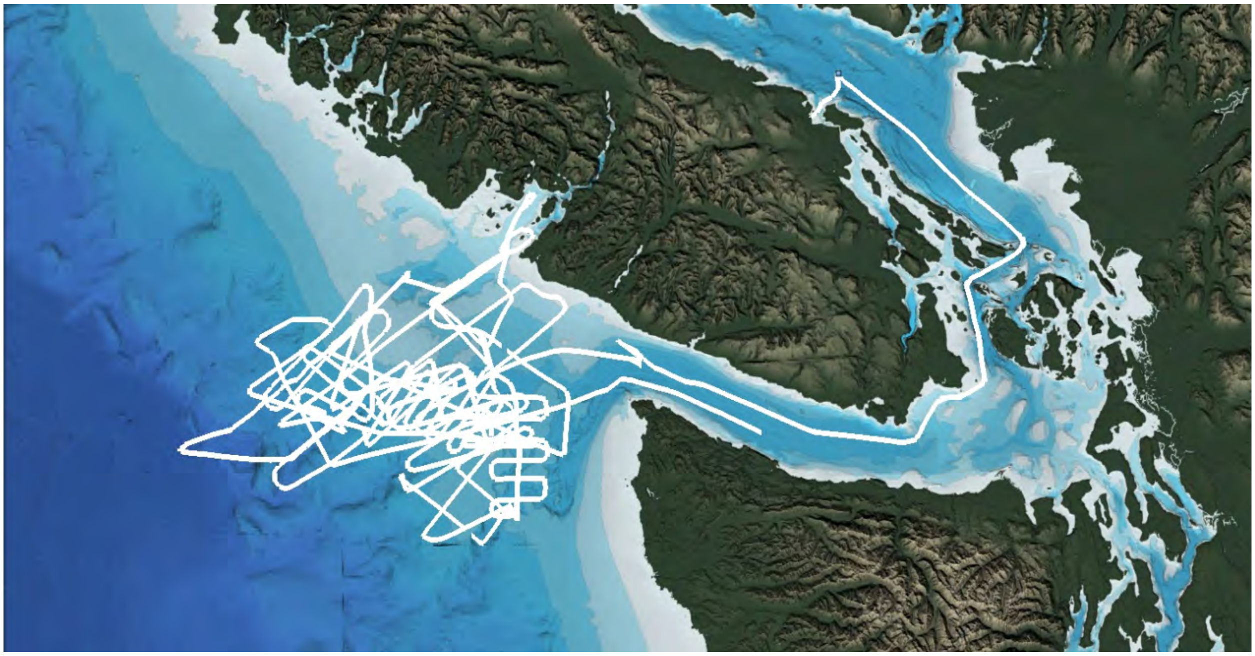
Inventory of Navigation Data Collected August 16th to September 18th, 2013	
Instrument	R/V Falkor Navigation System
ONC Device ID	11108 (Leg 1), 23238 (Leg 2)
Number of Files Collected	1397 files
File Types	NMEA files (GGA, GLL, HDT etc)
Date From	16-08-2013
Time From	23:54:58 UTC
Date To	18-09-2013
Time To	15:21:12 UTC
Upper Right Bounds	49.2829, -122.9931
Lower Left Bounds	47.9917, -126.8723
Notes	The Seapath Integrated files give the best overall position of the ship at any given time
Locations	Northeast Pacific, Juan de Fuca Strait, Strait of Georgia, Tully Canyon, Barkley Canyon, LaParouse Bank, Barkley Sound
Maps:	**FK009A-Nav and FK009B-Nav**

Survey Charts and Maps

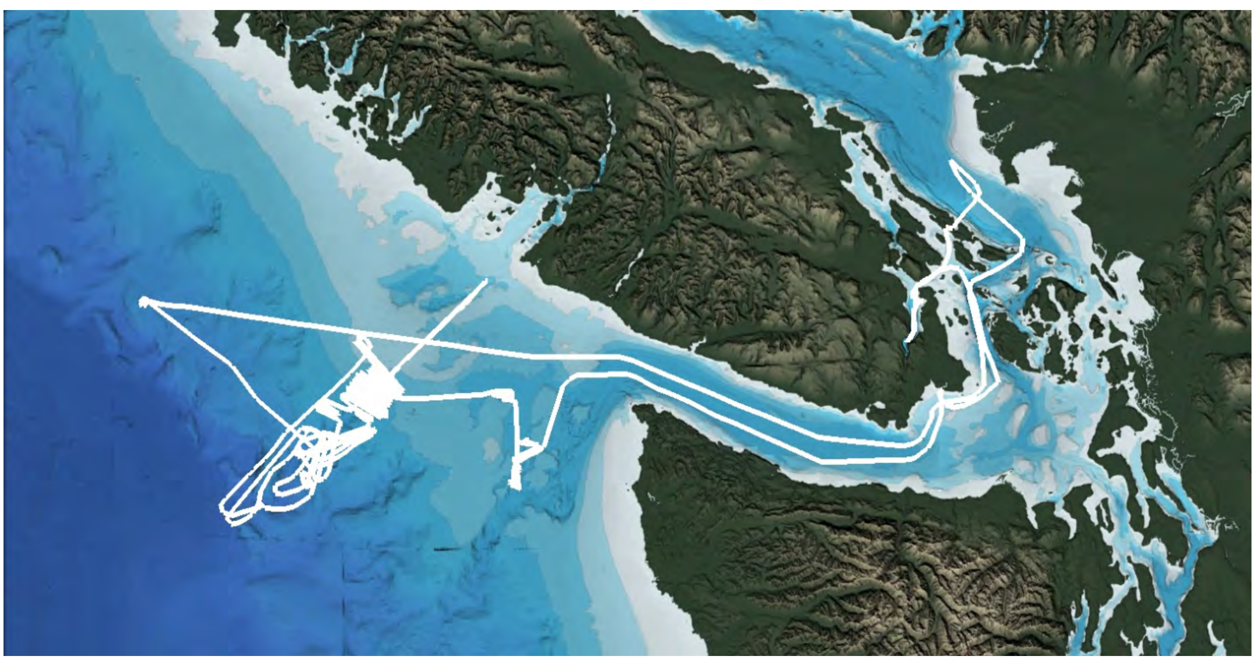


FK009A Pre-cruise planning chart, with proposed CTD stations and MVP survey lines.

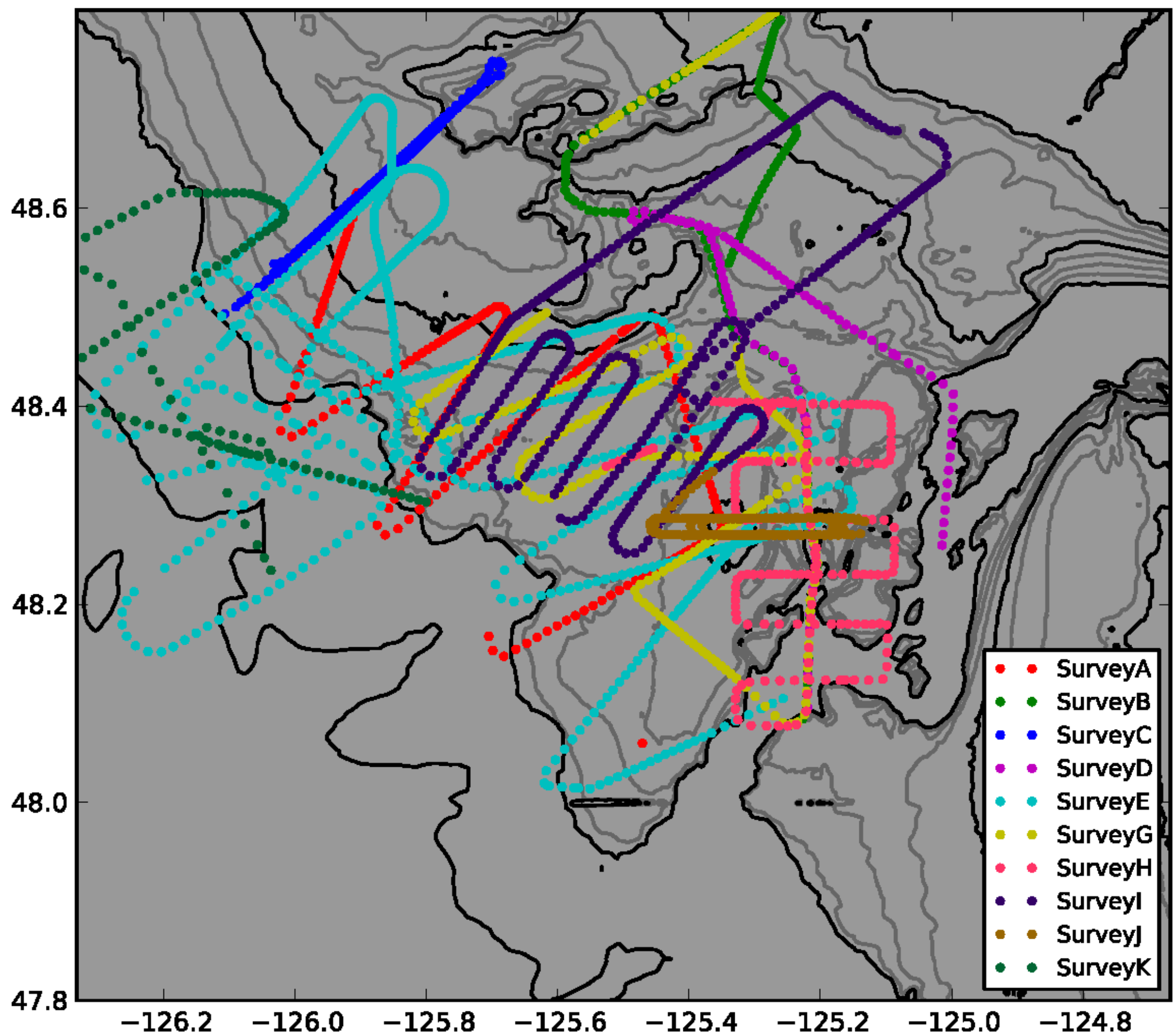
FK009A-Nav: Ship track recorded during Leg-1 (FK009A)



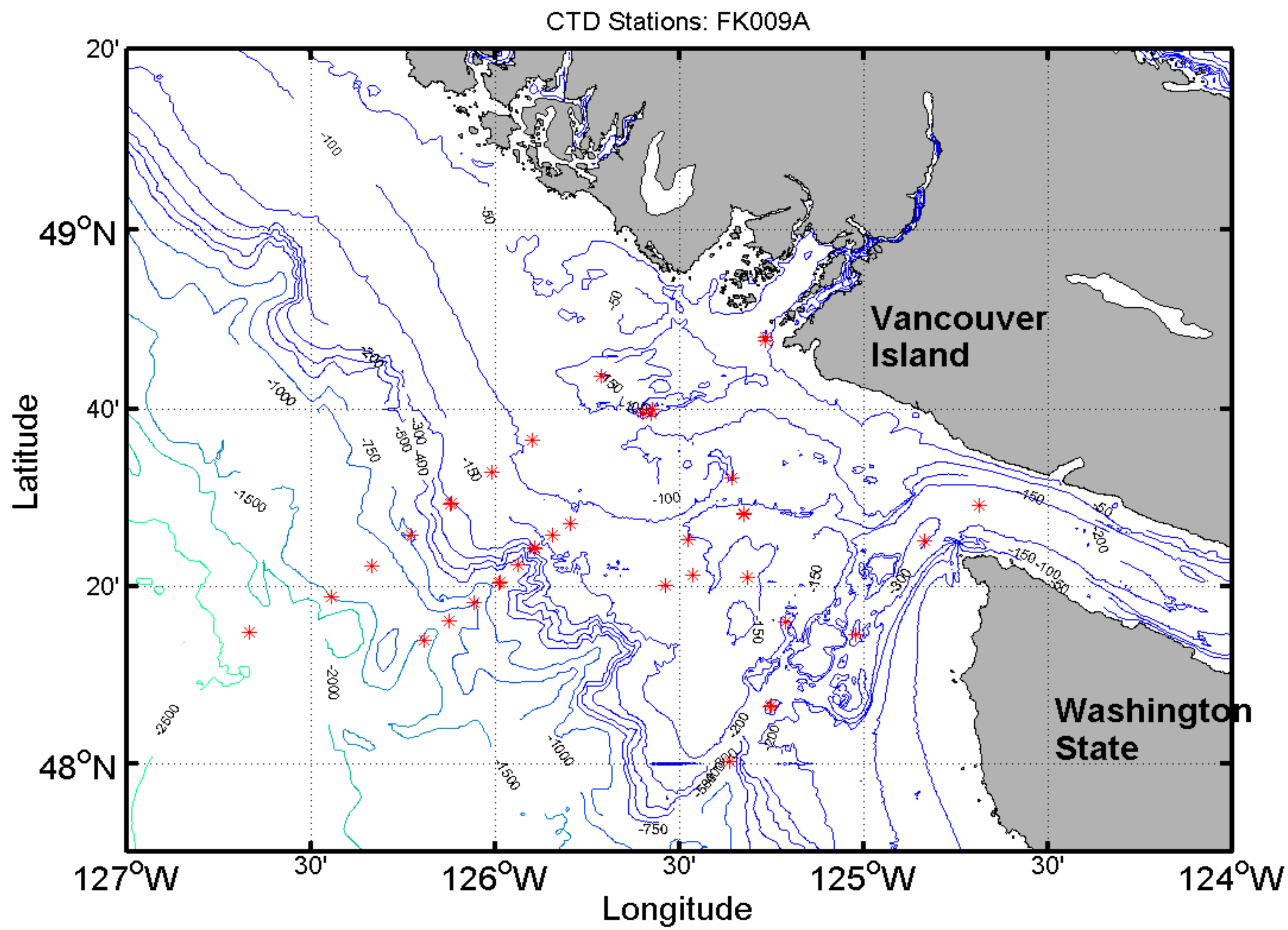
FK009B-Nav: Ship track recorded during Leg-2 (FK009B)



FK009A-MVP Survey Tracks



Moving Vessel Profiler surveys, broken into segments by colour.



FK009A CTD and Rosertte Profile Stations

Data Inventories

CTD and Rosette Stations

Filename	Station ID	Date and Time (UTC)	Latitude	Longitude	Bottles
FK009A_CTD002_20130819.cnv	JFG4a	Aug 19 2013 17:16:41	48 29.18 N	124 41.11 W	yes
FK009A_CTD003_20130819.cnv	LB08	Aug 19 2013 21:05:36	48 25.29 N	125 28.62 W	yes
FK009A_CTD004_20130819.cnv	BCC0	Aug 19 2013 22:58:10	48 27.19 N	125 47.76 W	yes
FK009A_CTD005_20130820.cnv	BCC1	Aug 20 2013 00:02:57	48 25.79 N	125 50.67 W	no
FK009A_CTD006_20130820.cnv	BCC2	Aug 20 2013 00:47:16	48 24.36 N	125 53.59 W	yes
FK009A_CTD007_20130820.cnv	BCC3	Aug 20 2013 01:53:03	48 22.51 N	125 56.25 W	yes
FK009A_CTD008_20130820.cnv	BCC4	Aug 20 2013 03:35:31	48 20.52 N	125 59.21 W	no
FK009A_CTD009_20130820.cnv	BCC5	Aug 20 2013 04:59:49	48 18.30 N	126 03.32 W	yes
FK009A_CTD010_20130820.cnv	BCC6	Aug 20 2013 07:26:03	48 16.15 N	126 07.41 W	no
FK009A_CTD011_20130820.cnv	BCC7	Aug 20 2013 09:04:09	48 13.95 N	126 11.50 W	yes

FK009A_CTD012_20130820.cnv	LC12	Aug 20 2013 14:07:47	48 14.97 N	126 39.93 W	yes
FK009A_CTD013_20130820.cnv	LC11	Aug 20 2013 18:24:28	48 18.94 N	126 26.67 W	yes
FK009A_CTD014_20130820.cnv	LC10	Aug 20 2013 20:59:06	48 22.34 N	126 20.11 W	no
FK009A_CTD015_20130820.cnv	LC09	Aug 20 2013 22:48:22	48 25.88 N	126 13.68 W	yes
FK009A_CTD016_20130821.cnv	LC08	Aug 21 2013 00:43:18	48 29.37 N	126 07.17 W	yes
FK009A_CTD017_20130821.cnv	LC07	Aug 21 2013 02:13:45	48 32.95 N	126 00.46 W	no
FK009A_CTD018_20130821.cnv	LC06	Aug 21 2013 03:21:12	48 36.44 N	125 53.99 W	yes
FK009A_CTD019_20130822.cnv	RD01	Aug 22 2013 00:31:45	48 00.28 N	125 21.83 W	yes
FK009A_CTD020_20130822.cnv	RD02	Aug 22 2013 02:27:41	48 06.54 N	125 15.11 W	yes
FK009A_CTD021_20130822.cnv	MB07	Aug 22 2013 07:08:54	48 28.20 N	125 19.49 W	yes
FK009A_CTD022_20130822.cnv	MB08	Aug 22 2013 15:14:47	48 32.21 N	125 21.41 W	yes
FK009A_CTD023_20130822.cnv	MB14	Aug 22 2013 16:56:27	48 39.91 N	125 34.44 W	yes

FK009A_CTD024_20130822.cnv	RAD08	Aug 22 2013 17:40:36	48 39.60 N	125 35.91 W	yes
FK009A_CTD025_20130822.cnv	MB16	Aug 22 2013 20:02:54	48 47.95 N	125 15.93 W	yes
FK009A_CTD026_20130823.cnv	LC05A	Aug 23 2013 01:39:36	48 43.59 N	125 42.77 W	yes
FK009A_CTD027_20130823.cnv	LC08	Aug 23 2013 05:04:48	48 29.45 N	126 07.09 W	yes
FK009A_CTD028_20130823.cnv	RD04	Aug 23 2013 19:59:51	48 14.70 N	125 01.21 W	yes
FK009A_CTD029_20130824.cnv	RD02	Aug 24 2013 06:23:34	48 06.59 N	125 15.03 W	yes
FK009A_CTD030_20130825.cnv	BCC4	Aug 25 2013 23:44:51	48 20.50 N	125 59.23 W	no
FK009A_CTD031_20130826.cnv	BCC3	Aug 26 2013 00:56:44	48 22.50 N	125 56.29 W	no
FK009A_CTD032_20130826.cnv	BCC2	Aug 26 2013 01:56:57	48 24.40 N	125 53.56 W	no
FK009A_CTD033_20130826.cnv	MB16	Aug 26 2013 16:26:48	48 47.60 N	125 15.91 W	yes
FK009A_CTD034_20130826.cnv	SA01	Aug 26 2013 21:47:53	48 39.37 N	125 34.59 W	yes
FK009A_CTD035_20130827.cnv	MB07	Aug 27 2013 00:14:51	48 28.31 N	125 19.44 W	yes

FK009A_CTD036_20130827.cnv	NN01	Aug 27 2013 17:18:49	48 20.23 N	125 32.20 W	yes
FK009A_CTD037_20130827.cnv	NN02	Aug 27 2013 18:59:00	48 21.32 N	125 27.82 W	yes
FK009A_CTD038_20130827.cnv	NN03	Aug 27 2013 20:17:29	48 21.13 N	125 18.85 W	yes
FK009A_CTD039_20130827.cnv	TC01	Aug 27 2013 23:23:36	48 16.04 N	125 12.64 W	yes
FK009A_CTD040_20130830.cnv	RD05	Aug 30 2013 19:46:04	48 25.23 N	124 50.07 W	yes

CTD Bottle Samples

Water samples were collected for: salinity, dissolved oxygen, nutrients, and carbon. An assessment of the salinity sample quality determined that the sample storage was insufficient for a salinity analysis. The oxygen analysis was performed onboard the Falkor in the wet lab. The analysis of samples for both nutrients and carbon were performed by technicians at Department of Fisheries and Oceans Institute of Ocean Sciences.

Sample No	Bottle No.	Station	Date/Time (UTC)	Pressure	Salinity	Temperature
1	1	JFG4a	Aug 19 2013 17:16:41	251.11	33.89	6.53
2	2	JFG4a	Aug 19 2013 17:16:41	230.48	33.89	6.54
3	3	JFG4a	Aug 19 2013 17:16:41	202.95	33.88	6.6
4	4	JFG4a	Aug 19 2013 17:16:41	176.4	33.8	6.72
5	5	JFG4a	Aug 19 2013 17:16:41	151.42	33.73	7.25
6	6	JFG4a	Aug 19 2013 17:16:41	126.91	33.44	7.46
7	7	JFG4a	Aug 19 2013 17:16:41	102.49	33.00	8.11
8	8	JFG4a	Aug 19 2013 17:16:41	72.31	31.98	9.48
9	9	JFG4a	Aug 19 2013 17:16:41	59.97	31.73	9.96

10	10	JFG4a	Aug 19 2013 17:16:41	51.4	31.45	10.66
11	11	JFG4a	Aug 19 2013 17:16:41	30.04	31.4	11.08
12	12	JFG4a	Aug 19 2013 17:16:41	11.01	31.41	10.86
13	13	JFG4a	Aug 19 2013 17:16:41	6.87	31.41	10.94
14	1	LB08	Aug 19 2013 21:05:36	130.95	33.91	6.34
15	2	LB08	Aug 19 2013 21:05:36	111.35	33.91	6.36
16	3	LB08	Aug 19 2013 21:05:36	102.15	33.9	6.39
17	4	LB08	Aug 19 2013 21:05:36	71.13	33.81	6.56
18	5	LB08	Aug 19 2013 21:05:36	62.18	33.71	6.78
19	6	LB08	Aug 19 2013 21:05:36	51.44	33.48	7.22
20	7	LB08	Aug 19 2013 21:05:36	31.05	32.82	8.82
21	8	LB08	Aug 19 2013 21:05:36	10.78	31.99	12.02

22	9	LB08	Aug 19 2013 21:05:36	5.56	31.81	13.09
23	1	BCC0	Aug 19 2013 22:58:10	111.45	33.92	6.64
24	2	BCC0	Aug 19 2013 22:58:10	92.13	33.8	6.72
25	3	BCC0	Aug 19 2013 22:58:10	71.69	33.62	7
26	4	BCC0	Aug 19 2013 22:58:10	50.88	33.21	7.37
27	5	BCC0	Aug 19 2013 22:58:10	31.81	32.89	7.58
28	6	BCC0	Aug 19 2013 22:58:10	21.92	32.76	7.82
29	7	BCC0	Aug 19 2013 22:58:10	5.98	32.13	12.52
30	1	BCC2	Aug 20 2013 00:47:16	166.03	33.92	6.75
31	2	BCC2	Aug 20 2013 00:47:16	147.28	33.92	6.77
32	3	BCC2	Aug 20 2013 00:47:16	126.37	33.9	6.92
33	4	BCC2	Aug 20 2013 00:47:16	100.61	33.84	7.24

34	5	BCC2	Aug 20 2013 00:47:16	73.23	33.69	7.35
35	6	BCC2	Aug 20 2013 00:47:16	51.05	33.4	7.29
36	7	BCC2	Aug 20 2013 00:47:16	30.89	33.02	7.57
37	8	BCC2	Aug 20 2013 00:47:16	20.16	32.84	8.23
38	9	BCC2	Aug 20 2013 00:47:16	5.51	32.09	13.59
39	1	BCC3	Aug 20 2013 01:53:03	602.56	34.12	5.03
40	2	BCC3	Aug 20 2013 01:53:03	583.51	34.12	5.05
41	3	BCC3	Aug 20 2013 01:53:03	506.2	34.08	5.3
42	4	BCC3	Aug 20 2013 01:53:03	404.57	34.03	5.72
43	5	BCC3	Aug 20 2013 01:53:03	303.85	33.98	6.35
44	6	BCC3	Aug 20 2013 01:53:03	202.82	33.96	6.56
45	7	BCC3	Aug 20 2013 01:53:03	176.89	33.94	6.62

46	8	BCC3	Aug 20 2013 01:53:03	151.75	33.93	6.86
47	9	BCC3	Aug 20 2013 01:53:03	102.54	33.88	7.29
48	10	BCC3	Aug 20 2013 01:53:03	53.49	33.43	7.3
49	11	BCC3	Aug 20 2013 01:53:03	30.96	32.93	7.87
50	12	BCC3	Aug 20 2013 01:53:03	22	32.7	8.5
51	13	BCC3	Aug 20 2013 01:53:03	5.83	32.08	11.87
52	1	BCC5	Aug 20 2013 04:59:49	1016.09	34.38	3.65
53	2	BCC5	Aug 20 2013 04:59:49	997.7	34.37	3.71
54	3	BCC5	Aug 20 2013 04:59:49	807.09	34.3	4.11
55	4	BCC5	Aug 20 2013 04:59:49	707.69	34.23	4.49
56	5	BCC5	Aug 20 2013 04:59:49	606.69	34.15	4.91
57	6	BCC5	Aug 20 2013 04:59:49	505.96	34.09	5.34

58	7	BCC5	Aug 20 2013 04:59:49	405.41	34.06	5.6
59	8	BCC5	Aug 20 2013 04:59:49	303.57	34.01	6.05
60	9	BCC5	Aug 20 2013 04:59:49	202.26	33.94	6.6
61	10	BCC5	Aug 20 2013 04:59:49	150.61	33.9	7.09
62	11	BCC5	Aug 20 2013 04:59:49	101.12	33.78	7.4
63	12	BCC5	Aug 20 2013 04:59:49	71.22	33.51	7.33
64	13	BCC5	Aug 20 2013 04:59:49	52.09	33.25	7.36
65	14	BCC5	Aug 20 2013 04:59:49	31.12	32.53	9.53
66	15	BCC5	Aug 20 2013 04:59:49	21.91	32.17	11.32
67	16	BCC5	Aug 20 2013 04:59:49	5.4	32	15.94
68	1	BCC7	Aug 20 2013 09:04:09	1607.15	34.53	2.44
69	2	BCC7	Aug 20 2013 09:04:09	1585.98	34.53	2.46

70	3	BCC7	Aug 20 2013 09:04:09	1520.5	34.52	2.56
71	4	BCC7	Aug 20 2013 09:04:09	1009.16	34.39	3.61
72	5	BCC7	Aug 20 2013 09:04:09	808.14	34.29	4.16
73	6	BCC7	Aug 20 2013 09:04:09	709.1	34.23	4.52
74	7	BCC7	Aug 20 2013 09:04:09	607.35	34.16	4.84
75	8	BCC7	Aug 20 2013 09:04:09	508.18	34.11	5.19
76	9	BCC7	Aug 20 2013 09:04:09	403.8	34.06	5.56
77	10	BCC7	Aug 20 2013 09:04:09	303.72	33.97	5.87
78	11	BCC7	Aug 20 2013 09:04:09	249.95	33.95	6.29
79	12	BCC7	Aug 20 2013 09:04:09	206.2	33.94	6.71
80	13	BCC7	Aug 20 2013 09:04:09	177.62	33.91	7.02
81	14	BCC7	Aug 20 2013 09:04:09	152.99	33.81	7.25

82	15	BCC7	Aug 20 2013 09:04:09	128.29	33.71	7.35
83	16	BCC7	Aug 20 2013 09:04:09	103.08	33.5	7.34
84	17	BCC7	Aug 20 2013 09:04:09	70.99	32.95	7.36
85	18	BCC7	Aug 20 2013 09:04:09	62.5	32.82	7.48
86	19	BCC7	Aug 20 2013 09:04:09	50.81	32.61	7.6
87	20	BCC7	Aug 20 2013 09:04:09	32.89	32.38	8.74
88	21	BCC7	Aug 20 2013 09:04:09	20.81	32.1	13.46
89	22	BCC7	Aug 20 2013 09:04:09	11.28	31.98	15.56
90	23	BCC7	Aug 20 2013 09:04:09	3.23	31.97	16.22
91	1	LC12	Aug 20 2013 14:07:47	2551.44	34.64	1.78
92	2	LC12	Aug 20 2013 14:07:47	2547.03	34.64	1.78
93	3	LC12	Aug 20 2013 14:07:47	2027.2	34.6	1.9

94	4	LC12	Aug 20 2013 14:07:47	1519.2	34.52	2.54
95	5	LC12	Aug 20 2013 14:07:47	1012.24	34.38	3.65
96	6	LC12	Aug 20 2013 14:07:47	807.36	34.27	4.09
97	7	LC12	Aug 20 2013 14:07:47	706.18	34.21	4.32
98	8	LC12	Aug 20 2013 14:07:47	607.08	34.17	4.8
99	9	LC12	Aug 20 2013 14:07:47	503.32	34.13	5.06
100	10	LC12	Aug 20 2013 14:07:47	404.5	34.07	5.63
101	11	LC12	Aug 20 2013 14:07:47	304.48	33.99	5.96
102	12	LC12	Aug 20 2013 14:07:47	203	33.91	6.73
103	13	LC12	Aug 20 2013 14:07:47	152.94	33.82	7.35
104	14	LC12	Aug 20 2013 14:07:47	103.83	33.3	7.31
105	15	LC12	Aug 20 2013 14:07:47	72.05	32.62	7.51

106	16	LC12	Aug 20 2013 14:07:47	53.44	32.53	8
107	17	LC12	Aug 20 2013 14:07:47	32.67	32.25	11.05
108	18	LC12	Aug 20 2013 14:07:47	19.5	32.1	13.91
109	19	LC12	Aug 20 2013 14:07:47	5.92	31.99	16.39
110	1	LC11	Aug 20 2013 18:24:28	1478.56	34.52	2.57
111	2	LC11	Aug 20 2013 18:24:28	1458.39	34.52	2.59
112	3	LC11	Aug 20 2013 18:24:28	1008.88	34.38	3.63
113	4	LC11	Aug 20 2013 18:24:28	808.59	34.27	4.18
114	5	LC11	Aug 20 2013 18:24:28	705.02	34.21	4.44
115	6	LC11	Aug 20 2013 18:24:28	606.57	34.15	4.78
116	7	LC11	Aug 20 2013 18:24:28	505.74	34.11	5.23
117	8	LC11	Aug 20 2013 18:24:28	404.97	34.06	5.76

118	9	LC11	Aug 20 2013 18:24:28	307.29	34	6.22
119	10	LC11	Aug 20 2013 18:24:28	202.55	33.92	6.79
120	11	LC11	Aug 20 2013 18:24:28	154.32	33.84	7.31
121	12	LC11	Aug 20 2013 18:24:28	102.41	33.29	7.29
122	13	LC11	Aug 20 2013 18:24:28	71.14	32.71	7.36
123	14	LC11	Aug 20 2013 18:24:28	50.77	32.5	8.02
124	15	LC11	Aug 20 2013 18:24:28	31.6	32.26	10.94
125	16	LC11	Aug 20 2013 18:24:28	22.32	32.08	13.84
126	17	LC11	Aug 20 2013 18:24:28	4.72	31.98	16.27
127	1	LC09	Aug 20 2013 22:48:22	612.98	34.18	4.71
128	2	LC09	Aug 20 2013 22:48:22	595.63	34.16	4.83
129	3	LC09	Aug 20 2013 22:48:22	506	34.11	5.21

130	4	LC09	Aug 20 2013 22:48:22	405.38	34.05	5.68
131	5	LC09	Aug 20 2013 22:48:22	305.18	34.02	6.07
132	6	LC09	Aug 20 2013 22:48:22	202.19	33.94	6.7
133	7	LC09	Aug 20 2013 22:48:22	176.52	33.92	6.85
134	8	LC09	Aug 20 2013 22:48:22	153.01	33.86	7.08
135	9	LC09	Aug 20 2013 22:48:22	102.36	33.47	7.3
136	10	LC09	Aug 20 2013 22:48:22	51.27	32.68	7.48
137	11	LC09	Aug 20 2013 22:48:22	31.67	32.39	8.7
138	12	LC09	Aug 20 2013 22:48:22	21.11	32.13	12.09
139	13	LC09	Aug 20 2013 22:48:22	5.76	31.99	16.31
140	1	LC08	Aug 21 2013 00:43:18	196.85	33.96	6.5
141	2	LC08	Aug 21 2013 00:43:18	177.4	33.96	6.5

142	3	LC08	Aug 21 2013 00:43:18	151.67	33.92	6.61
143	4	LC08	Aug 21 2013 00:43:18	126.35	33.86	6.93
144	5	LC08	Aug 21 2013 00:43:18	100.29	33.73	7.22
145	6	LC08	Aug 21 2013 00:43:18	71.19	33.5	7.3
146	7	LC08	Aug 21 2013 00:43:18	49.93	33.1	7.62
147	8	LC08	Aug 21 2013 00:43:18	31.65	32.59	8.13
148	9	LC08	Aug 21 2013 00:43:18	20.2	32.23	10.95
149	10	LC08	Aug 21 2013 00:43:18	5	32.01	15.63
150	1	LC06	Aug 21 2013 03:21:12	87.09	33.83	6.7
151	2	LC06	Aug 21 2013 03:21:12	71.3	33.82	6.74
152	3	LC06	Aug 21 2013 03:21:12	51.6	33.68	7.26
153	4	LC06	Aug 21 2013 03:21:12	40.92	33.55	7.3

154	5	LC06	Aug 21 2013 03:21:12	31.45	33.36	7.34
155	6	LC06	Aug 21 2013 03:21:12	20.7	33	8.36
156	7	LC06	Aug 21 2013 03:21:12	5.44	32.15	13.31
157	1	RD01	Aug 22 2013 00:31:45	629.08	34.23	4.54
158	2	RD01	Aug 22 2013 00:31:45	219.07	33.97	6.5
159	3	RD01	Aug 22 2013 00:31:45	110.93	33.76	7.41
160	4	RD01	Aug 22 2013 00:31:45	72.07	33.2	7.31
161	1	RD02	Aug 22 2013 02:27:41	332.74	34.01	6.1
162	2	RD02	Aug 22 2013 02:27:41	249.28	33.98	6.31
163	3	RD02	Aug 22 2013 02:27:41	144.3	33.81	7.21
164	4	RD02	Aug 22 2013 02:27:41	70.58	33	7.2
165	1	MB07	Aug 22 2013 07:08:54	159.08	33.92	6.27

166	2	MB07	Aug 22 2013 07:08:54	113.41	33.91	6.38
167	3	MB07	Aug 22 2013 07:08:54	70.72	33.81	6.55
168	4	MB07	Aug 22 2013 07:08:54	35.69	33.13	7.93
169	1	MB08	Aug 22 2013 15:14:47	147.44	33.88	6.45
170	2	MB08	Aug 22 2013 15:14:47	71.38	33.81	6.59
171	3	MB08	Aug 22 2013 15:14:47	40.3	33.55	7.1
172	4	MB08	Aug 22 2013 15:14:47	30.99	33.28	7.66
173	1	MB14	Aug 22 2013 16:56:27	176.85	33.73	6.79
174	2	MB14	Aug 22 2013 16:56:27	101.13	33.59	7.04
175	3	MB14	Aug 22 2013 16:56:27	71.05	33.52	7.18
176	4	MB14	Aug 22 2013 16:56:27	30.75	33.34	7.47
181	1	RAD08	Aug 22 2013 17:40:36	232.3	33.74	6.78

177	1	MB16	Aug 22 2013 20:02:54	94.96	33.36	7.49
178	2	MB16	Aug 22 2013 20:02:54	76.08	32.97	8.18
179	3	MB16	Aug 22 2013 20:02:54	60.03	32.4	9.04
180	4	MB16	Aug 22 2013 20:02:54	34.54	32.19	9.35
185	1	LC05A	Aug 23 2013 01:39:36	209.25	33.67	6.9
186	2	LC05A	Aug 23 2013 01:39:36	161.3	33.64	6.96
187	3	LC05A	Aug 23 2013 01:39:36	101.68	33.57	7.11
188	4	LC05A	Aug 23 2013 01:39:36	67.82	33.42	7.4
189	1	LC08	Aug 23 2013 05:04:48	195.85	33.95	6.44
190	2	LC08	Aug 23 2013 05:04:48	151.91	33.87	6.82
191	3	LC08	Aug 23 2013 05:04:48	99.54	33.55	7.29
192	4	LC08	Aug 23 2013 05:04:48	73.24	33.43	7.32

193	1	RD04	Aug 23 2013 19:59:51	351.92	33.92	6.5
194	2	RD04	Aug 23 2013 19:59:51	323.57	33.96	6.5
195	3	RD04	Aug 23 2013 19:59:51	252.38	33.95	6.58
196	4	RD04	Aug 23 2013 19:59:51	203.27	33.94	6.62
197	5	RD04	Aug 23 2013 19:59:51	176.05	33.93	6.67
198	6	RD04	Aug 23 2013 19:59:51	152.24	33.9	6.71
199	7	RD04	Aug 23 2013 19:59:51	127.03	33.86	6.82
200	8	RD04	Aug 23 2013 19:59:51	102.23	33.84	6.91
201	9	RD04	Aug 23 2013 19:59:51	71.29	33.78	7.11
202	10	RD04	Aug 23 2013 19:59:51	60.86	33.76	7.13
203	11	RD04	Aug 23 2013 19:59:51	64.03	33.66	7.21
204	12	RD04	Aug 23 2013 19:59:51	30.94	33.31	7.67

205	13	RD04	Aug 23 2013 19:59:51	20.63	32.84	8.97
206	14	RD04	Aug 23 2013 19:59:51	6.16	32.07	12.46
207	1	RD02	Aug 24 2013 06:23:34	330.08	34.01	6.15
208	2	RD02	Aug 24 2013 06:23:34	307.88	34	6.19
209	3	RD02	Aug 24 2013 06:23:34	247.11	33.95	6.47
210	4	RD02	Aug 24 2013 06:23:34	212.42	33.91	6.62
211	5	RD02	Aug 24 2013 06:23:34	150.43	33.87	6.87
212	6	RD02	Aug 24 2013 06:23:34	128.25	33.86	6.9
213	7	RD02	Aug 24 2013 06:23:34	102.55	33.79	6.86
214	8	RD02	Aug 24 2013 06:23:34	63.34	33.4	7.3
215	9	RD02	Aug 24 2013 06:23:34	50.38	33.21	7.38
216	10	RD02	Aug 24 2013 06:23:34	30.59	32.87	8.03

217	11	RD02	Aug 24 2013 06:23:34	21.39	32.21	13.08
218	12	RD02	Aug 24 2013 06:23:34	5.33	32.06	14.73
219	1	MB16	Aug 26 2013 16:26:48	106.66	33.34	7.55
220	2	MB16	Aug 26 2013 16:26:48	85.46	33.27	7.66
221	3	MB16	Aug 26 2013 16:26:48	72.04	32.94	8.19
222	4	MB16	Aug 26 2013 16:26:48	51.14	32.58	8.74
223	5	MB16	Aug 26 2013 16:26:48	32.05	32.37	9.14
224	6	MB16	Aug 26 2013 16:26:48	21.04	32.08	9.82
225	7	MB16	Aug 26 2013 16:26:48	10.52	31.57	11.64
226	8	MB16	Aug 26 2013 16:26:48	6.04	31.43	11.75
227	1	SA01	Aug 26 2013 21:47:53	193.77	33.73	6.77
228	2	SA01	Aug 26 2013 21:47:53	176.17	33.72	6.8

229	3	SA01	Aug 26 2013 21:47:53	152.64	33.68	6.89
230	4	SA01	Aug 26 2013 21:47:53	124.88	33.66	6.92
231	5	SA01	Aug 26 2013 21:47:53	100.54	33.61	7.01
232	6	SA01	Aug 26 2013 21:47:53	75.49	33.51	7.25
233	7	SA01	Aug 26 2013 21:47:53	61.22	33.23	7.93
234	8	SA01	Aug 26 2013 21:47:53	53.5	33.21	8.06
235	9	SA01	Aug 26 2013 21:47:53	31.82	32.68	8.59
236	10	SA01	Aug 26 2013 21:47:53	20.17	32.55	10.01
237	11	SA01	Aug 26 2013 21:47:53	11.37	32.57	10.44
238	12	SA01	Aug 26 2013 21:47:53	7.2	32.57	10.46
239	1	MB07	Aug 27 2013 00:14:51	151.86	33.91	6.36
240	2	MB07	Aug 27 2013 00:14:51	133.4	33.9	6.51

241	3	MB07	Aug 27 2013 00:14:51	104.76	33.88	6.55
242	4	MB07	Aug 27 2013 00:14:51	75.45	33.8	6.61
243	5	MB07	Aug 27 2013 00:14:51	62.92	33.71	6.79
244	6	MB07	Aug 27 2013 00:14:51	51.28	33.62	6.96
245	7	MB07	Aug 27 2013 00:14:51	30.81	32.92	8.78
246	8	MB07	Aug 27 2013 00:14:51	21.53	32.77	9.31
247	9	MB07	Aug 27 2013 00:14:51	10.82	32.64	9.77
248	10	MB07	Aug 27 2013 00:14:51	4.38	32.13	13.05
249	1	NN01	Aug 27 2013 17:18:49	134.5	33.91	6.76
250	2	NN01	Aug 27 2013 17:18:49	122.42	33.89	6.89
251	3	NN01	Aug 27 2013 17:18:49	102.04	33.85	7.34
252	4	NN01	Aug 27 2013 17:18:49	71.76	33.71	7.42

253	5	NN01	Aug 27 2013 17:18:49	60.95	33.63	7.52
254	6	NN01	Aug 27 2013 17:18:49	48.72	33.43	7.39
255	7	NN01	Aug 27 2013 17:18:49	30.58	33.12	7.5
256	8	NN01	Aug 27 2013 17:18:49	21.43	32.87	8.04
257	9	NN01	Aug 27 2013 17:18:49	5.33	31.78	13.81
258	1	NN02	Aug 27 2013 18:59:00	130.06	33.91	6.42
259	2	NN02	Aug 27 2013 18:59:00	109.48	33.88	6.56
260	3	NN02	Aug 27 2013 18:59:00	101.34	33.83	6.88
261	4	NN02	Aug 27 2013 18:59:00	71.21	33.6	7.27
262	5	NN02	Aug 27 2013 18:59:00	62.05	33.52	7.33
263	6	NN02	Aug 27 2013 18:59:00	51.43	33.45	7.33
264	7	NN02	Aug 27 2013 18:59:00	31.73	33.26	7.63

265	8	NN02	Aug 27 2013 18:59:00	20.92	32.81	9.21
266	9	NN02	Aug 27 2013 18:59:00	7.01	31.96	13.19
267	1	NN03	Aug 27 2013 20:17:29	114.71	33.89	6.58
268	2	NN03	Aug 27 2013 20:17:29	82.36	33.9	6.71
269	3	NN03	Aug 27 2013 20:17:29	69.26	33.75	6.74
270	4	NN03	Aug 27 2013 20:17:29	61.66	33.66	6.92
271	5	NN03	Aug 27 2013 20:17:29	52.18	33.59	7.06
272	6	NN03	Aug 27 2013 20:17:29	31.35	33.37	7.4
273	7	NN03	Aug 27 2013 20:17:29	20.74	33.3	7.54
274	8	NN03	Aug 27 2013 20:17:29	6.74	32.64	10.45
275	1	TC01	Aug 27 2013 23:23:36	204.4	33.9	6.49
276	2	TC01	Aug 27 2013 23:23:36	174.04	33.89	6.53

277	3	TC01	Aug 27 2013 23:23:36	152.12	33.9	6.65
278	4	TC01	Aug 27 2013 23:23:36	128.07	33.9	6.69
279	5	TC01	Aug 27 2013 23:23:36	91.61	33.81	6.75
280	6	TC01	Aug 27 2013 23:23:36	72.97	33.75	6.84
281	7	TC01	Aug 27 2013 23:23:36	60.57	33.61	7.1
282	8	TC01	Aug 27 2013 23:23:36	50.32	33.51	7.24
283	9	TC01	Aug 27 2013 23:23:36	30.56	33.21	7.57
284	10	TC01	Aug 27 2013 23:23:36	21.43	32.95	8.4
285	11	TC01	Aug 27 2013 23:23:36	6.32	31.9	14.46
287	1	RD05	Aug 30 2013 19:46:04	311.76	33.91	6.65
288	2	RD05	Aug 30 2013 19:46:04	290.6	33.91	6.66
289	3	RD05	Aug 30 2013 19:46:04	252.59	33.89	6.81

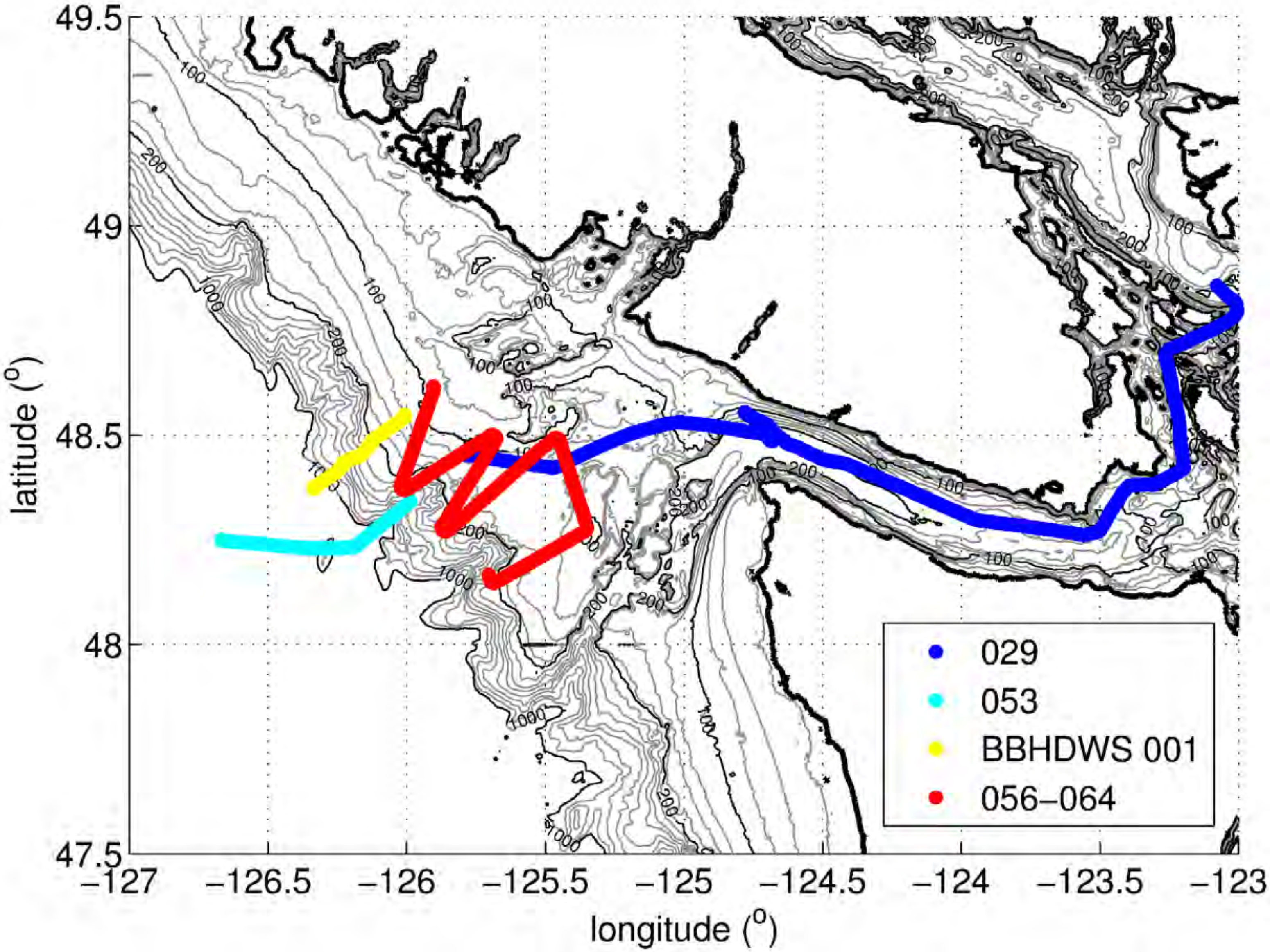
290	4	RD05	Aug 30 2013 19:46:04	202.95	33.84	7.02
291	5	RD05	Aug 30 2013 19:46:04	178.71	33.83	7.04
292	6	RD05	Aug 30 2013 19:46:04	150.05	33.81	7.13
293	7	RD05	Aug 30 2013 19:46:04	126.84	33.74	7.22
294	8	RD05	Aug 30 2013 19:46:04	101.8	33.68	7.36
295	9	RD05	Aug 30 2013 19:46:04	71.37	33.42	8.13
296	10	RD05	Aug 30 2013 19:46:04	61.42	33.33	9.02
297	11	RD05	Aug 30 2013 19:46:04	50.59	33.08	10.91
298	12	RD05	Aug 30 2013 19:46:04	30.75	32.78	12.17
299	13	RD05	Aug 30 2013 19:46:04	22.02	32.29	13.3
300	14	RD05	Aug 30 2013 19:46:04	6.86	31.88	14.49

MVP Surveys

Survey	Start (UTC)	Start Profile	End (UTC)	End Profile	Region
A	August 21 04:11	1	August 21 23:42	203	Shelf Break, NàS
B	August 22 03:40	206	August 22 14:54	373	Tully Canyon, SàN
C	August 23 02:17	379	August 23 15:42	671	Shelf Break, N
D	August 23 21:09	674	August 24 05:33	781	Tully Canyon, N-S & S-N
E	August 24 07:20	783	August 26 11:40	1496	Shelf Break, SàN, Slope SàN
F					Merged with G
G	August 26 18:28	1497	August 27 15:51	1785	Shelf and La Perouse to Tully Canyon
H	August 27 18:02	1786	August 28 11:15	1970	Tully Canyon, grid
I	August 28 11:18	1971	August 29 07:11	~2301	Shelf and Tully Eddy
J	August 29 07:14	~2302	August 30 01:11	2647	Allen Bank, line
K	August 30 03:23	2648	August 30 15:07	2763	Outer Shelf Break, N

ADCP Surveys (75 kHz Surveyor), additional plots are presenting in Appendix B. Yellow files are key data files, plotted on next page.

VMDAS Filename	File Creation Date	File Creation Time	Record Start Day	Record End Day	Gap seconds	Bin Depth	Blank Depth	Number of Bins	Ping Mode	Ensemble Median	Number of Ensembles	Notes
FK009A_OS75_011_000000.LTA	19/08/13	1:58:25	230.082	230.082	0	8	8	100	bb	NA	1	
FK009A_OS75_012_000000.LTA	19/08/13	2:00:57	230.084	230.084	152	8	8	100	bb	NA	1	
FK009A_OS75_013_000000.LTA	19/08/13	2:03:40	230.086	230.086	164	7	8	100	bb	NA	1	
FK009A_OS75_014_000000.LTA	19/08/13	2:04:47	230.087	230.087	67	15	8	50	bb	NA	1	
FK009A_OS75_015_000000.LTA	19/08/13	2:08:57	230.090	230.090	250	10	8	50	bb	NA	1	
FK009A_OS75_016_000000.LTA	19/08/13	2:10:58	230.091	230.091	121	10	8	50	bb	NA	1	
FK009A_OS75_017_000000.LTA	19/08/13	2:13:35	230.093	230.096	157	10	8	50	bb	302.35	2	
FK009A_OS75_018_000000.LTA	19/08/13	2:23:09	230.099	230.113	272	10	8	50	bb	301.36	5	
FK009A_OS75_019_000000.LTA	19/08/13	2:47:57	230.117	230.149	284	10	8	50	bb	120.46	24	- configuration settings working well
FK009A_OS75_022_000000.LTA	19/08/13	3:36:19	230.150	230.198	141	10	8	50	bb	119.25	35	
FK009A_OS75_023_000000.LTA	19/08/13	4:46:20	230.199	230.199	117	8	8	50	bb	NA	1	
FK009A_OS75_024_000000.LTA	19/08/13	4:49:17	230.201	230.202	177	8	6	50	nb	123.51	2	
FK009A_OS75_027_000000.LTA	19/08/13	4:55:36	230.205	230.205	255	10	8	50	bb	NA	1	
FK009A_OS75_029_000000.LTA	19/08/13	4:58:06	230.207	230.953	150	8	8	50	bb	119.45	538	
FK009A_OS75_030_000000.LTA	19/08/13	22:53:34	230.954	230.957	84	8	8	50	nb	121.38	3	
FK009A_OS75_031_000000.LTA	19/08/13	22:58:47	230.958	230.958	70	8	8	50	nb	NA	1	
FK009A_OS75_032_000000.LTA	19/08/13	23:01:19	230.959	230.959	152	8	8	50	nb	NA	1	
FK009A_OS75_033_000000.LTA	19/08/13	23:04:31	230.962	230.962	191	8	8	50	bb	NA	1	
FK009A_OS75_034_000000.LTA	19/08/13	23:05:47	230.962	230.965	76	8	8	50	bb	120.67	3	
FK009A_OS75_035_000000.LTA	19/08/13	23:19:44	230.972	230.972	596	8	8	50	bb	NA	1	
FK009A_OS75_036_000000.LTA	19/08/13	23:22:30	230.974	230.974	166	16	8	40	bb	NA	1	
FK009A_OS75_037_000000.LTA	19/08/13	23:28:59	230.979	230.979	389	8	8	100	bb	NA	1	
FK009A_OS75_040_000000.LTA	19/08/13	23:39:17	230.986	230.987	618	8	8	80	bb	123.06	2	
FK009A_OS75_041_000000.LTA	19/08/13	23:46:22	230.991	231.009	301	8	8	100	bb	119.05	14	- changed set-up file to : OS75BB_High_Definition_High_Res_8m_w_synchonrization
FK009A_OS75_042_000000.LTA	20/08/13	0:14:03	231.010	231.024	100	8	8	100	bb	119.47	11	
FK009A_OS75_043_000000.LTA	20/08/13	0:34:48	231.024	231.095	43	8	8	100	bb	121.28	51	-changed TP 00000 (time between bottom track and water correlation pings)
FK009A_OS75_044_000000.LTA	20/08/13	2:18:46	231.096	231.101	115	8	8	80	bb	121.28	4	-changed to 2 velocity pings and 1 bottom track ping every 10s; turned off EK710; Doppler bottom track improved
FK009A_OS75_045_000000.LTA	20/08/13	2:26:31	231.102	231.114	101	8	8	100	bb	117.63	10	
FK009A_OS75_046_000000.LTA	20/08/13	2:46:07	231.115	231.125	88	8	8	100	bb	118.03	8	- set sych with 102 22010
FK009A_OS75_046_000_000000.LTA	13/08/13	2:46:00	231.100	231.120	51	8	8	100	bb	118.00	8	
FK009A_OS75_047_000000.LTA	20/08/13	3:01:58	231.126	231.140	108	8	8	100	bb	118.03	11	-disabled 'override command file' for EA; EA = -0.32 degrees
FK009A_OS75_048_000000.LTA	20/08/13	3:26:30	231.143	231.146	268	8	8	100	bb	123.08	3	
FK009A_OS75_049_000000.LTA	20/08/13	3:32:34	231.148	231.148	118	10	8	50	bb	NA	1	- try without synchronization; Basic (no file) VMDAS
FK009A_OS75_050_000000.LTA	20/08/13	3:34:28	231.149	231.152	114	15	8	40	bb	121.28	3	-time between ensembles ~ 4.5 seconds
FK009A_OS75_051_000000.LTA	20/08/13	3:39:34	231.153	231.153	63	8	8	100	bb	NA	1	- changed set-up file to : OS75BB_High_Definition_High_Res_8m_w_synchonrization, time between ensembles ~ 8 s;
FK009A_OS75_052_000000.LTA	20/08/13	3:42:46	231.155	231.155	192	10	8	50	bb	NA	1	- time between ensembles ~ 6s
FK009A_OS75_053_000000.LTA	20/08/13	3:45:43	231.157	231.465	177	10	8	80	bb	119.85	223	
FK009A_OS75_BBHDWS_001_000000.LTA	20/08/13	21:01:19	231.876	232.095	0	16	8	40	bb	301.57	64	- configuration file reset to original from ships' systems
FK009A_OS75_056_000000.LTA	21/08/13	4:33:18	232.190	232.193	0	16	8	40	bb	303.80	2	
FK009A_OS75_057_000000.LTA	21/08/13	4:45:40	232.198	232.278	438	8	8	50	bb	300.20	24	- changed set-up file to : OS75BB_High_Definition_High_Res_8m_w_synchonrization; STA = 30s; LTA = 300s, time between ensembles ~ 4.6 sec (fast because only 400 m profile depth); seemed to loose bottom track
FK009A_OS75_058_000000.LTA	21/08/13	6:43:34	232.280	232.291	173	8	8	70	bb	298.53	4	- as above but with number of bins changed to 70; still no bottom track
FK009A_OS75_059_000000.LTA	21/08/13	7:01:29	232.293	232.480	175	8	8	70	bb	300.46	55	- trying to get bottom track; increased bin size; picking up false bottom at 34 m; perhaps issue with steep slope at head of canyon?
FK009A_OS75_060_000000.LTA	21/08/13	11:36:33	232.484	232.491	299	8	8	70	bb	301.67	3	- ADCP restarted to try to get bottom track; EK60s put into passive mode; no success with bottom track so EK60s restarted
FK009A_OS75_062_000000.LTA	21/08/13	11:47:46	232.492	232.495	70	8	8	70	bb	301.28	2	- updated configuration file to guess bottom at 200m; now get a bottom range. Correlation between beams is low (< 200);
FK009A_OS75_063_000000.LTA	21/08/13	11:55:18	232.497	232.497	151	8	8	70	bb	NA	1	- All EK instruments' pinging stopped to see if correlation imporves; EK60s changed to passive mode; does not improve beam correlation; All EK60 instruments restored to pinging; correlation threshold changed from 220 to 140; no success in getting a bottom range; depth guess changed ack to 800 m
FK009A_OS75_064_000000.LTA	21/08/13	11:58:12	232.499	232.714	174	8	8	70	bb	300.95	63	



Primary ADCP survey lines, (yellow highlights in Table).

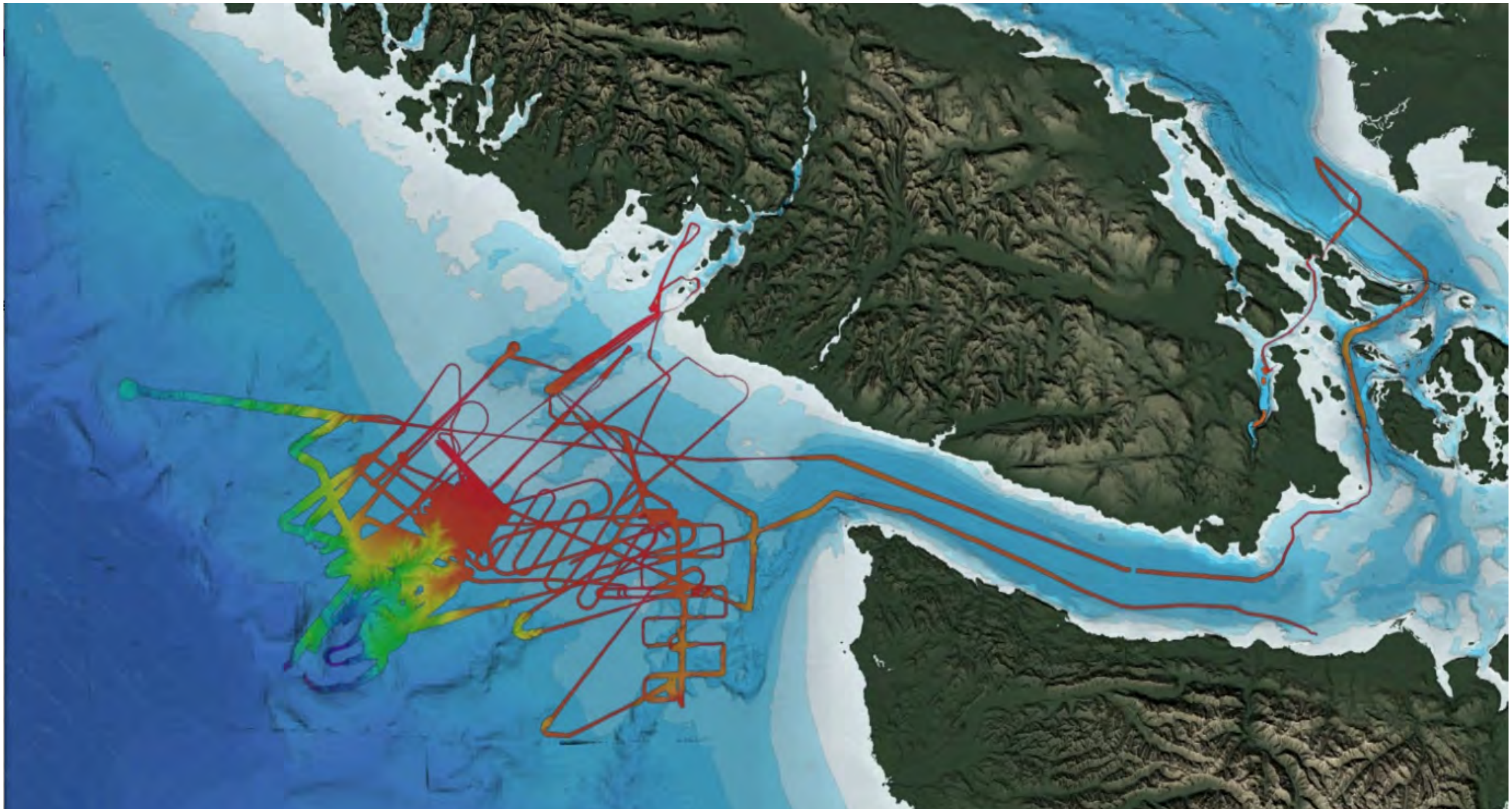
Echo-Sounder Surveys (FK009A)

Inventory of EK60 Data Collected during Leg 1, August 16th to 31st, 2013	
Instrument	Kongsberg Simrad EK60
ONC Device ID	22822
Number of Files Collected	737 files of each file type
File Types	.idx, .bot, .raw
Date From	17-08-2013
Time From	21:45:53 UTC
Date To	31-08-2013
Time To	01:58:57 UTC
Calibration Report	2013-08-18 EK60 Calibration RV Falkor.docx
Upper Right Bounds	49.2835, -123.0061
Lower Left Bounds	48.0010, -126.6732
Notes	EK60 data were collected during MVP transects
Locations	Northeast Pacific, Juan de Fuca Strait, Strait of Georgia, Tully Canyon, Barkley Canyon, LaParouse Bank, Barkley Sound

Multibeam Survey Locations

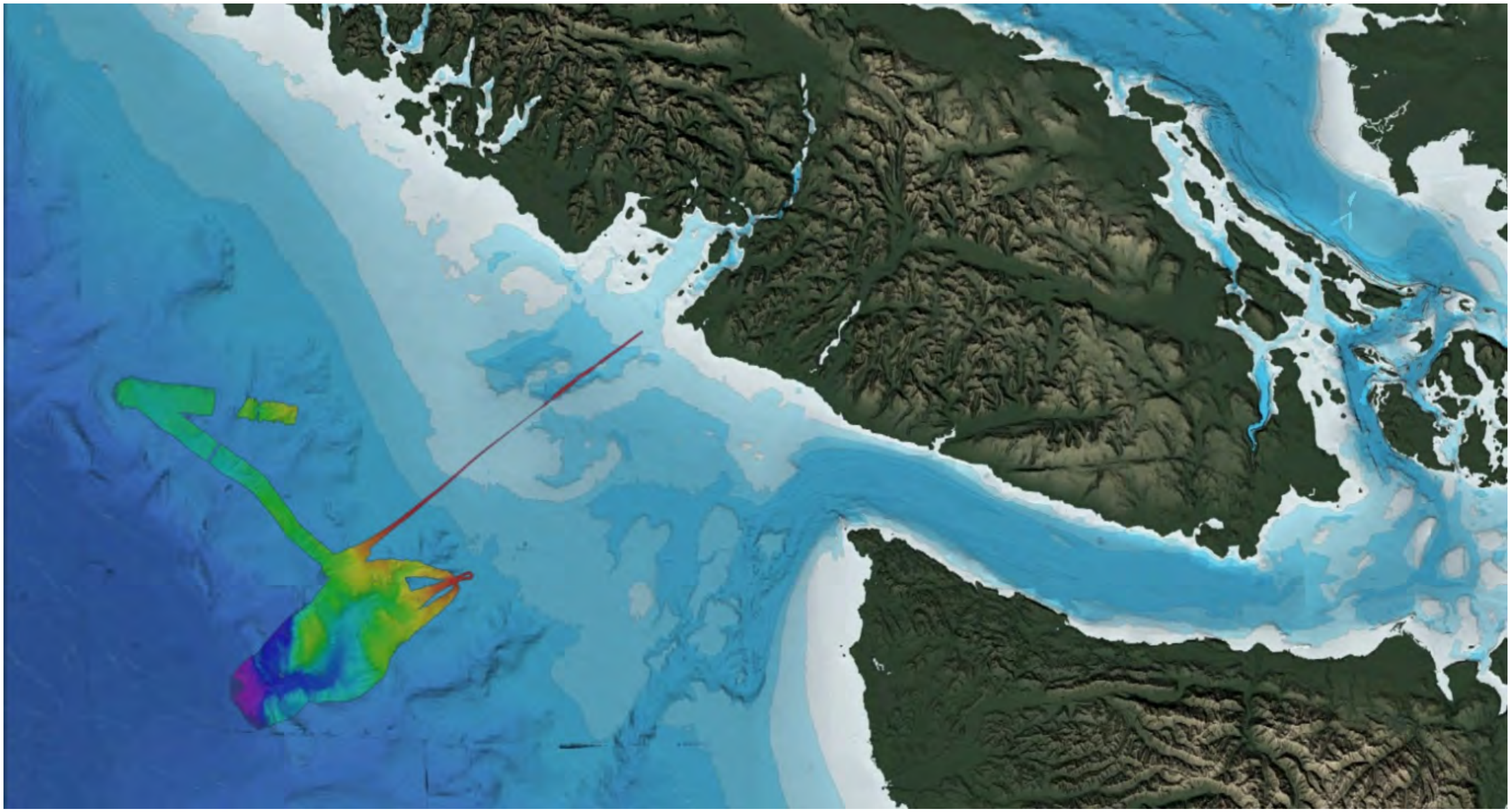
Inventory of Multibeam Sonar Data Collected, August 16th to September 18, 2013		
Instruments	Kongsberg EM 710 Multibeam Echsounder	Kongsberg EM 302 Multibeam Echosounder
ONC Device IDs	23205	23200
Number of Files Collected	406 ALL files, 387 WCD files	52 ALL files, 44 WCD files
File Types	.all, .wcd	.all, .wcd
Date From	19-08-2013	26-08-2013
Time From	23:53:16 UTC	06:15:20 UTC
Date To	18-09-2013	13-09-2013
Time To	15:05:31 UTC	07:31:07 UTC
Upper Right Bounds	49.0458, -123.0019	48.7731, -125.3084
Lower Left Bounds	48.0093. -126.8794	48.0326, -126.8991
Notes	Multibeam data were collected on an opportunistic basis during MVP transects and in between ROV dives. Therefore, significant gaps are present between survey lines in some locations.	Multibeam data were collected on an opportunistic basis during MVP transects and in between ROV dives. Therefore, significant gaps are present between survey lines in some locations.
Locations	Northeast Pacific, Juan de Fuca Strait, Strait of Georgia, Tully Canyon, Barkley Canyon, LaParouse Bank, Barkley Sound	Northeast Pacific, Tully Canyon, Barkley Canyon, LaParouse Bank, Barkley Sound

EM710 Multibeam Surveys



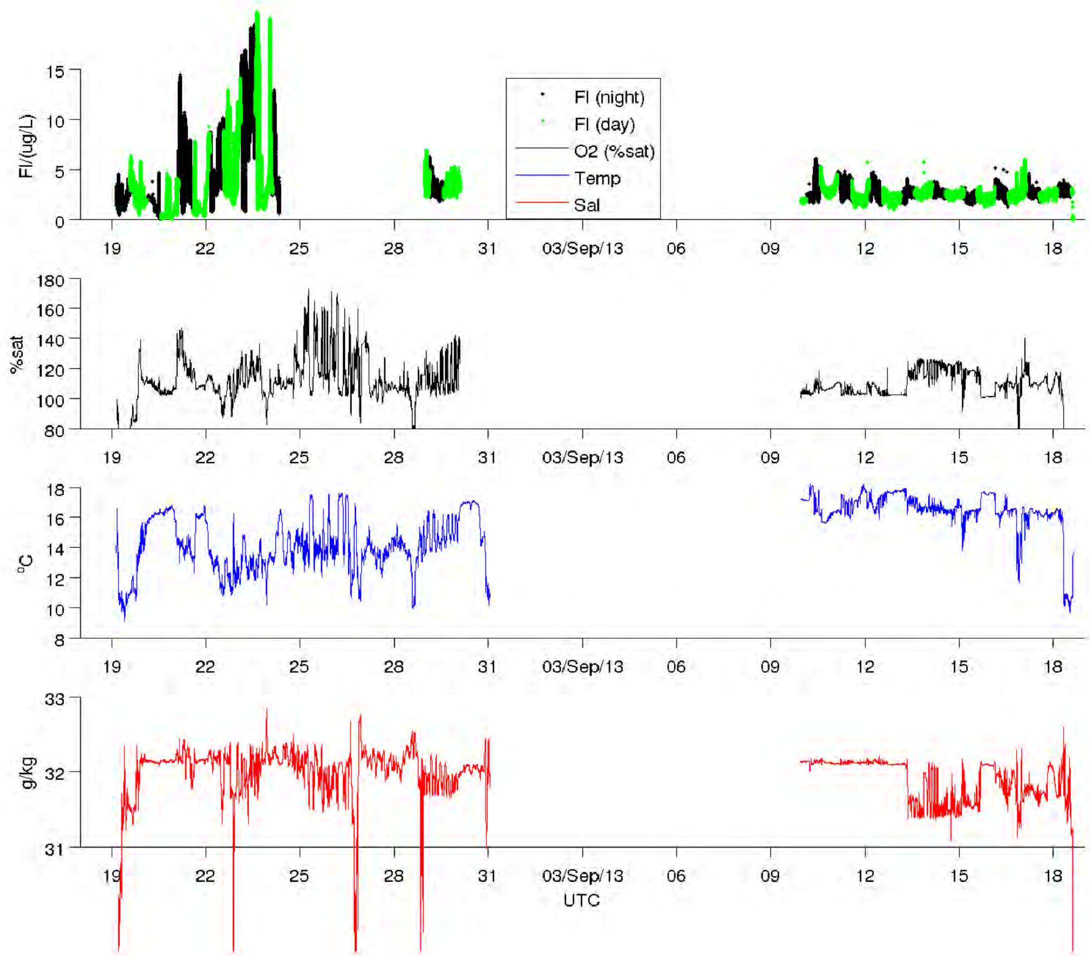
High-resolution multibeam bottom mapping survey lines and coverage. Colour (red, shallow to green, deep) represents depth.

EM302 Multibeam Surveys



Medium-resolution multibeam bottom mapping survey lines and coverage. Colour (red, shallow to purple, deep) represents depth.

Thermosalinograph Survey



Thermosalinograph data, plotted against time. Gap is between cruise legs.

ROV Dives

Dive number	**Start Date**	**End Date**	**Description**
1645	07-09-2013 13:14	07-09-2013 18:45	Transect of Patricia Bay Net samples of flatfish at deeper end of transect
1646	07-09-2013 20:46	08-09-2013 19:59	Cliff climbs at McMurdy Point and Elbow Point Collect samples
1647	08-09-2013 4:51	08-09-2013 13:44	Connect BPS Samples at Venus DISCO camera location: Close up imagery, suction sample Push cores and Niskins at Paul's Cages site Truncated transect of deeper portion of Pat Bay Transect USBL system not calibrated
1648	08-09-2013 17:30	08-09-2013 19:00	SOG East VIP Take 10 push cores
1649	09-09-2013 20:34	10-09-2013 4:52	Swap CTD for CTD-O2 Recover seismometer auxiliary platform Replace SCIMPI data logger Opportunistic organism sampling
1650	10-09-2013 14:55	11-09-2013 5:00	Deploy POD 1 autonomous CTD Survey POD 3 for sediment enrichment sites; deposit cages; collect push cores Deploy Kongsberg sonar Collect Coral Cliffs ADCPs Opportunistic organism sampling

1651	11-09-2013 14:30	12-09-2013 1:30	Deploy treatment #1 of sediment enrichment experiment Deployment of additional markers in Wallyland; push cores in Wallyland Opportunistic organism sampling
1652	12-09-2013 5:10	12-09-2013 14:08	Deployment of 2nd treatment of enrichment experiments (Neus) Taking push cores in hydrates (Neus) Opportunistic sampling or organisms.
1653	12-09-2013 18:35	12-09-2013 3:42	Conduct 1 km visual transect of Barkley Canyon at 2000 m Conduct return transect for organism sampling.
1654	14-09-2013 12:20	14-09-2013 21:50	Conduct 1 km visual transect of Barkley Canyon at 200m Conduct 250 m return transect for organism sampling Conduct 1km visual transect of Barkley Canyon at 300 m Organism sampling, depending sampling in previous transects
1655	15-09-2013 2:15	15-09-2013 13:44	Conduct 1km visual transect of Barkley Canyon at 400m with 250 return transect Opportunistic organism sampling, Conduct 1km visual transect of Barkley Canyon at 300 m with 250 m return transect, Take push cores and water samples at transect end Opportunistic organism sampling
1656	15-09-2013 17:30	16-09-2013 2:08	Conduct 1 km visual transect of Barkley Canyon at 1500 m Conduct return transect of organism sampling

1657	16-09-2013 4:11	16-09-2013 10:34	Conduct 1 km visual transect at depths of 800 m Return transect for organism sampling Push cores at the end of the transect (R. Belley)
1658	16-09-2013 13:37	16-09-2013 19:20	Conduct 1 km visual transect of Barkley Canyon at 600 m depth Conduct 250 m return transect for organism sampling
1659	17-09-2013 7:00	17-09-2013 18:05	Visual transect lines – Tully Canyon Close up imagery of key organisms.
1660	17-09-2013 20:05	18-09-2013 4:05	Visual transect lines – Tully Canyon Close up imagery of key organisms.

ROV Physical Samples

Time	Number	Identifier	Method	Scientist	Description (first observation displayed)	Latitude	Longitud e	Depth
07-09-2013 14:47	R1645-1	Organism - FAILED - NO SAMPLE - Picking up flatfish	Net and ROV arm	Jackson Chu	-	-	-	-
07-09-2013 15:00	R1645-2	Organism - Picking up flatfish - trial 2	Net and ROV arm	Jackson Chu n	Second trial to catch a flatfish using a net and the ROV arm. SAMPLE FAIL.	N48° 39.1741′	W123° 29.7569′	155.22m
07-09-2013 15:24	R1645-3	Organism - Picking up flatfish - trial 3	Net and ROV arm	Jackson Chu	Too turbid to see anything. SAMPLE FAIL.	N48° 39.1915′	W123° 29.7956′	168.13m
07-09-2013 15:30	R1645-4	Organism - Picking up flatfish - trial 4	Net and ROV arm	Jackson Chu	Picking fish off muddy bottom. SAMPLE FAIL. Fish escaped.	N48° 39.1904′	W123° 29.8118′	168.5m
07-09-2013 15:38	R1645-5	Organism - Picking up flatfish - trial 5	Net and ROV arm	Jackson Chu	Attempting to pick up a flatfish. SAMPLE FAIL.	N48° 39.1814′	W123° 29.8267′	170.57m
07-09-2013 16:01	R1645-6	Organism - Picking up flatfish - trial 6	Net and ROV arm	Jackson Chu	Picking up flatfish on muddy bottom. SAMPLE FAIL.	N48° 39.169′	W123° 29.7483′	156.56m
07-09-2013 22:37	R1646-1	Organism - Sea anemone	Suction sampler	Jackson Chu	CNIDARIA - anemone - *Synhalcuria* nov. sp. Container 6: 3 individuals	N48° 32.9032′	W123° 32.0989′	110.43m

08-09-2013 09:38	R1647-1	Organism - Sampling around DISCO quadrat	Suction sampler	Jackson Chu	DISCO site. Suction sample of specimens around quadrat (bottle # 1). Multiple animals in the same bottle. Vacuumed mud without targeting any particular species.	N48° 39.0686′	W123° 29.1755′	95.44m
08-09-2013 10:00	R1647-2	Organism - Sampling around DISCO quadrat	Suction sampler	Jackson Chu	DISCO site. Suction sample of specimens around quadrat (bottle #2). Multiple animals. Vacuumed the mud.	N48° 39.0706′	W123° 29.1747′	183.78m
08-09-2013 10:01	R1647-3	Organism - Sampling around DISCO quadrat	Suction sampler	Jackson Chu	DISCO site. Suction sampling specimens around quadrat (bottle # 3). Multiple animals in the same jar. Vacuumed the mud.	N48° 39.0704′	W123° 29.1746′	95.26m
08-09-2013 10:04	R1647-4	Organism - Sampling around DISCO quadrat	Suction sampler	Jackson Chu	DISCO site. Suction sampling of specimens around quadrat (bottle #4). Multiple animals per jar. Vacuumed the mud.	N48° 39.0704′	W123° 29.1748′	96.07m
08-09-2013 10:08	R1647-5	Organism - Sampling around DISCO quadrat	Suction sampler	Jackson Chu	DISCO site. Suction sampling of specimens around quadrat (bottle #5). Multiple animals per jar. Vacuumed the mud.	N48° 39.0706′	W123° 29.1745′	95.06m
08-09-2013 11:52	R1647-6	Organism - Slender sole, (*Lyopsetta exilis*)	Net and ROV arm	Jackson Chu	slender sole, (*Lyopsetta exilis*) Oxygen saturation: 1 ml/l	N48° 39.237′	W123° 29.2686′	99.92m
08-09-2013 12:30	R1647-7	Sediment core - white -1	Push core	Rénald Belley	Very soft, Oxygen sat: 0,97 ml/l; sal: 31.08; Temperature: 9.24	N48° 39.244′	W123° 29.1994′	96.06m
08-09-2013 12:32	R1647-8	Sediment core - black and white - 2	Push core	Rénald Belley	very soft	N48° 39.2443′	W123° 29.1995′	96.35m

08-09-2013 12:33	R1647-9	Sediment core - yellow - 3	Push core	Rénald Belley	Very soft	N48° 39.2441′	W123° 29.1994′	96.41m
08-09-2013 12:35	R1647-10	Sediment core - black - 4	Push core	Rénald Belley	Very soft	N48° 39.2439′	W123° 29.1994′	96.44m
08-09-2013 12:40	R1647-11	Sediment core - orange - 5	Push core	Rénald Belley	very soft	N48° 39.249′	W123° 29.1995′	96.23m
08-09-2013 12:42	R1647-12	Sediment core - red - 6	Push core	Rénald Belley	very soft	N48° 39.2491′	W123° 29.1997′	96.21m
08-09-2013 12:43	R1647-13	Sediment core - no tape - 7	Push core	Rénald Belley	Very soft	N48° 39.2492′	W123° 29.1995′	96.65m
08-09-2013 12:45	R1647-14	Sediment core - green - 8	Push core	Rénald Belley	Very soft	N48° 39.2496′	W123° 29.1997′	96.44m
08-09-2013 12:47	R1647-15	Sediment core - 2 black tape - 9	Push core	Rénald Belley	Very soft; bungee in the rack still attached	N48° 39.2498′	W123° 29.1997′	96.31m
08-09-2013 12:49	R1647-16	Sediment core - blue -10	Push core	Rénald Belley	Very soft	N48° 39.2497′	W123° 29.1998′	96.66m
08-09-2013 12:54	R1647-17	Water sample - blue Niskin	Niskin bottle	Rénald Belley	Water sample	N48° 39.25′	W123° 29.1998′	96.19m
08-09-2013 18:08	R1648-1	Sediment core #1	Push core	v	10 Push cores ; O2: 2.42 ml/L; temp: 9.65 Celsius; salinity: 31.02 PSU	N49° 2.556′	W123° 18.972′	164.89m

08-09-2013 18:34	R1648-2	Water sample	Niskin bottle	Rénald Belley	Took a water sample with Niskin bottle	N49° 2.5592′	W123° 18.9725′	163.72m
10-09-2013 19:40	R1650-1	Sediment core	Push core	Neus Campany a i Llovet	1st-2 blacks	N48° 18.9074′	W126° 3.5121′	900.81m
11-09-2013 20:54	R1651-1	Sediment core - black-black	Push core	Neus Campany a i Llovet	Push core for Neus at Wallyland marker 16.	N48° 18.7064′	W126° 3.9286′	859.71m
11-09-2013 21:03	R1651-2	Sediment core - blue tape	Push core	Neus Campany a i Llovet	Push core at Wallyland marker 16	N48° 18.7057′	W126° 3.9287′	862.33m
11-09-2013 21:07	R1651-3	Sediment core - green	Push core	Neus Campany a i Llovet	3rd push core taken at Wallyland marker 16.	N48° 18.7063′	W126° 3.9286′	825.81m
11-09-2013 21:17	R1651-4	Sediment core- red	Push core	Neus Campany a i Llovet	Push core #4 at Wallyland marker 16 with red taped pushcore.	N48° 18.7062′	W126° 3.9288′	862.76m
11-09-2013 21:21	R1651-5	Sediment core - black	Push core	Neus Campany a i Llovet	5th push core sample at wally land marker 16. solid black tape on handle.	N48° 18.7056′	W126° 3.929′	862.71m
11-09-2013 21:48	R1651-6	Sediment core - yellow	Push core	Neus Campany a i Llovet	6th push core - taken near Wallyland marker 14 - yellow tape on handle.	N48° 18.7085′	W126° 3.9459′	814.04m

11-09-2013 21:51	R1651-7	Sediment core - white	Push core	Neus Campany a i Llovet	pushcore #7 in this series - taken near wallyland marker 14 with WHITE handle pushcore	N48° 18.7091′	W126° 3.9456′	810.81m
11-09-2013 21:53	R1651-8	Sediment core - black white	Push core	Neus Campany a i Llovet	pushcore #8 in this series - taken near wallyland marker 14, with the black and white taped handle.	N48° 18.709′	W126° 3.9457′	844.43m
11-09-2013 21:56	R1651-9	Sediment core - orange	Push core	Neus Campany a i Llovet	-	N48° 18.709′	W126° 3.9457′	844.43m
11-09-2013 22:00	R1651-09	Sediment core - orange	Push core	Neus Campany a i Llovet	This is the GOOD pushcore for sample #9 - taken near wallyland marker 14 with the orange taped handle.	N48° 18.7094′	W126° 3.9456′	855.77m
11-09-2013 22:05	R1651-10	Sediment core - red green	Push core	Neus Campany a i Llovet	Wallyland marker 14 - final pushcore in this series, #10, taken with the red and green taped handle.	N48° 18.7089′	W126° 3.9456′	842.41m
12-09-2013 08:53	R1652-1	Sediment core - White stripe	Push core	Neus Campany a i Llovet	Very small amount	N48° 18.718′	W126° 3.961′	867.07m
12-09-2013 08:55	R1652-2	Sediment core - Black	Push core	Neus Campany a i Llovet	Black core	N48° 18.718′	W126° 3.961′	866.95m
12-09-2013 08:58	R1652-3	Sediment core - Yellow	Push core	Neus Campany a i Llovet	Yellow core	N48° 18.718′	W126° 3.961′	867.32m

12-09-2013 09:00	R1652-4	Sediment core - White	Push core	Neus Campany a i Llovet	Picking up white core	N48° 18.718′	W126° 3.961′	866.97m
12-09-2013 09:03	R1652-5	Sediment core - Orange	Push core	Neus Campany a i Llovet	Picking up orange core	N48° 18.718′	W126° 3.961′	867.15m
12-09-2013 09:24	R1652-6	Sediment core - Red	Push core	Neus Campany a i Llovet	Red core way point 2	N48° 18.7154′	W126° 3.9527′	866.01m
12-09-2013 09:29	R1652-7	Sediment core - Red and green	Push core	Neus Campany a i Llovet	Picking up the red and green (Christmas) core	N48° 18.716′	W126° 3.9527′	866.4m
12-09-2013 09:34	R1652-8	Sediment core - Green	Push core	Neus Campany a i Llovet	Green core	N48° 18.716′	W126° 3.9527′	866.35m
12-09-2013 09:40	R1652-9	Sediment core - 2-blacks	Push core	Neus Campany a i Llovet	2-blacks core	N48° 18.716′	W126° 3.9527′	866.57m
12-09-2013 09:44	R1652-10	Sediment core - Blue core	Push core	Neus Campany a i Llovet	Blue core	N48° 18.716′	W126° 3.9527′	866.44m
12-09-2013 10:09	R1652-11	Organism - shell	ROV arm	Kim Juniper	shell - biobox	N48° 18.7′	W126° 3.9243′	862.67m
12-09-2013 10:11	R1652-12	Organism - Ice worm	Suction sampler	Kim Juniper	ice worm	N48° 18.7′	W126° 3.9244′	862.58m

12-09-2013 10:16	R1652-13	Organism - Ice worm	Suction sampler	Kim Juniper	Jar 5 - ice worm	N48° 18.7′	W126° 3.9244′	862.77m
12-09-2013 10:19	R1652-14	Organism - Clam- Jar 8	Suction sampler	Kim Juniper	Clams - Jar 8	N48° 18.7′	W126° 3.9244′	862.77m
12-09-2013 10:28	R1652-15	Carbonate	ROV arm	Kim Juniper	Carbonate sample	N48° 18.6804′	W126° 3.8842′	851.1m
12-09-2013 10:46	R1652-16	Organism - Cnidarian coral samling	ROV arm	Evan Edinger	Cnidarian coral sampling	N48° 18.6316′	W126° 3.7802′	812.79m
12-09-2013 10:52	R1652-17	Organism - Coral site sample	ROV arm	Evan Edinger	Coral sampling	N48° 18.6181′	W126° 3.7993′	813.85m
12-09-2013 10:58	R1652-18	Organism - Coral sample	ROV arm	Evan Edinger	Coral sample 3	N48° 18.6181′	W126° 3.7994′	813.72m
12-09-2013 11:07	R1652-19	Organism - Sea pen samples	Suction sampler	Evan Edinger	Sea pen samples - suction jar 8, *Halipteris* sp.	N48° 18.6883′	W126° 3.8405′	834.47m
12-09-2013 11:37	R1652-20	Organism - Soft coral	ROV arm	Evan Edinger	Cnidarian: Soft coral *Umbellula* sp. - Suction Jar 8 - in same container as R1652-19 (halipteris).	N48° 18.8437′	W126° 3.6259′	868.19m
12-09-2013 23:26	R1653-1	Organism - Sea anemone #1	Scoop	Neus Campany a i Llovet	Scoop sample into portside biobox; Sea anemone #1 for Neus	N48° 7.1803′	W126° 19.245′	1948.7m

12-09-2013 23:32	R1653-2	Organism - Sea anemone #2	Scoop	Neus Campany a i Llovet	Sampling sea anemone #2 for Neus; scoop sample into portside biobox	N48° 7.1823′	W126° 19.2274′	1997.68 m
12-09-2013 23:42	R1653-3	Organism - Sea anemone #3	Scoop	Neus Campany a i Llovet	Scoop sample of sea anemone #3 for Neus; into portside of biobox	N48° 7.1795′	W126° 19.2237′	1974.23 m
12-09-2013 23:52	R1653-4	Organism - Sea cucumber white #1	Suction sampler	Neus Campany a i Llovet	Sea cucumber white #1 for Neus; portside of biobox	N48° 7.1811′	W126° 19.2209′	1961.2m
12-09-2013 23:58	R1653-5	Organism - Sea anemone unknown #1	Scoop	Françoise Gervais	Sampling unknown anemone #1 for Francoise. Starboard side of biobox.	N48° 7.1864′	W126° 19.2263′	1986.73 m
13-09-2013 00:07	R1653-6	Organism - Sea cucumber white #2	Suction sampler	Neus Campany a i Llovet	Suction sampler of sea cucumber white #2 for Neus; port side of biobox	N48° 7.1953′	W126° 19.231′	1986.61 m
13-09-2013 00:22	R1653-7	Organism - Sea cucumber white #3	Suction sampler	Neus Campany a i Llovet	-	N48° 7.1953′	W126° 19.231′	1986.61 m
13-09-2013 00:24	R1653-8	Organism - Sea cucumber white #3	Suction sampler	Neus Campany a i Llovet	Sample of sea cucumber white #3; placed into bottle #7 of suction sample for Neus	N48° 7.2083′	W126° 19.2162′	1965.81 m
13-09-2013 00:28	R1653-9	Organism - Sea anemone #4	Scoop	Neus Campany a i Llovet	Picking up a sea anemone #4; portside of biobox	N48° 7.2087′	W126° 19.2171′	1875.37 m

13-09-2013 00:35	R1653-10	Organism - Seapen #1 and Brittle stars	Suction sampler	Neus Campany a i Llovet	Suction sampled seapen and brittle stars in bottle #6	N48° 7.2121′	W126° 19.2083′	1986.59 m
13-09-2013 00:45	R1653-11	Organism - Seapen + seawhip sample	Suction sampler	Neus Campany a i Llovet	Seapen + seawhip sample with suction sampler (bottle #5)	N48° 7.2125′	W126° 19.208′	1953.46 m
13-09-2013 00:57	R1653-12	Organism - Sea pens sample	Suction sampler	Neus Campany a i Llovet	Suction sampling of seapens; bottle #4	N48° 7.2248′	W126° 19.2251′	1940.4m
13-09-2013 01:13	R1653-13	Organism - Brittle stars sample	Suction sampler	Neus Campany a i Llovet	Suction sampling of brittle stars; bottle #8	N48° 7.2364′	W126° 19.2481′	1947.96 m
13-09-2013 01:16	R1653-14	Organism - Sea cucumber dark #1	Suction sampler	Neus Campany a i Llovet	Sample sea cucumber dark #1, into portside biobox	N48° 7.2353′	W126° 19.2451′	1997.8m
13-09-2013 01:22	R1653-15	Organism - Brittle start	Suction sampler	Neus Campany a i Llovet	Suction sample of brittle stars; bottle #8	N48° 7.2372′	W126° 19.2509′	1996.78 m
13-09-2013 01:46	R1653-16	Sediment core - (2	Push core	Neus Campany a i Llovet	Push cores are taken at the end of the 1km video transect line. 2 push cores for Neus: red/green handle + black/white handle	N48° 7.1947′	W126° 19.2332′	2120.2m
14-09-2013 16:38	R1654-1	Organism - Kelp - Jar 2	Suction sampler	Myriam Lacharite	Kelp sample	N48° 24.3491′	W125° 53.3212′	169.36m

14-09-2013 16:42	R1654-2	Organism - Kelp-jar 2	Suction sampler	Myriam Lacharite	suction the last part of kelp	N48° 24.3492′	W125° 53.3209′	170.05m
14-09-2013 18:24	R1654-3	Organism - Jar 3 - organic matter	Suction sampler	Myriam Lacharite	Sampling organic matter on the sea floor	N48° 24.1525′	W125° 53.2652′	194.06m
14-09-2013 18:46	R1654-4	Organism - Bio box- fragile pink urchin	Suction sampler	Neus Campany a i Llovet	Fragile pink urchin	N48° 24.1516′	W125° 53.2657′	192.87m
14-09-2013 18:57	R1654-5	Organism - Sea cucumber	Suction sampler	Neus Campany a i Llovet	Bio box. 1 ind Sea cucumber. *Parastichopus leukothele*. ECHINODERM.	N48° 24.1516′	W125° 53.266′	192.85m
14-09-2013 19:12	R1654-6	Organism - Sea urchin	Scoop	Neus Campany a i Llovet	Fragile sea urchin. *Strongylocentrotus fragilis*. ECHINODERM. 2 individuals. Biobox	N48° 24.1531′	W125° 53.2657′	226.55m
14-09-2013 19:29	R1654-7	Sediment core - Blue	Push core	Renald Belley	60 % full. Not the whole core iBook the sediment. PC blue Oxygen = 0.96 ml Salinity = 33.8 PSU temperature = 6.9 deg C depth = 209 m	N48° 24.153′	W125° 53.2654′	305.79m
14-09-2013 19:50	R1654-8	Organism - Sea urchin	Suction sampler	Neus Campany a i Llovet	1 individual inside the sea urchin mecca. Sea cucumber ECHINODERM. *Parastichopus leukothele*	N48° 24.1652′	W125° 53.2593′	240.72m
14-09-2013 20:04	R1654-9	Organism - 5th sea cucumber	Suction sampler	Neus Campany a i Llovet	DSC: Sea cucumber no. 5	N48° 24.1734′	W125° 53.2525′	329.83m

14-09-2013 20:20	R1654-10	Water sample	Suction sampler	Neus Campany a i Llovet	Jar 7	N48° 24.2189′	W125° 53.2702′	180.27m
14-09-2013 20:25	R1654-11	Sediment core - green #6	Push core	Renald Belley	174.2 m depth. 6.9 C temperature. 33.8 psu salinity. 0.97 ml/l oxygen	N48° 24.2407′	W125° 53.2848′	176.72m
14-09-2013 20:50	R1654-12	Sediment core - 2blacks	Push core	Neus Campany a i Llovet	30% full.	N48° 24.2318′	W125° 53.2808′	174.48m
14-09-2013 20:57	R1654-13	Sediment core - black	Push core	Neus Campany a i Llovet	There was some sediment left from the 1st attempt.	N48° 24.2322′	W125° 53.2796′	178.67m
14-09-2013 21:09	R1654-14	Organism - Sea cucumber1 out of mecca	Suction sampler	Neus Campany a i Llovet	Rock box. 1 ind	N48° 24.2293′	W125° 53.2806′	177.51m
14-09-2013 21:10	R1654-15	Organism - Sea cucumber 2	Suction sampler	Neus Campany a i Llovet	Rock box. 1 ind.	N48° 24.2293′	W125° 53.2805′	175.71m
14-09-2013 21:13	R1654-16	Organism - Sea cucmber 3	Suction sampler	Neus Campany a i Llovet	Rock box. 1 individual.	N48° 24.2269′	W125° 53.281′	178.18m
14-09-2013 21:14	R1654-17	Organism - Sea cucumber 4	Suction sampler	Neus Campany a i Llovet	Rock box. 1 ind.	N48° 24.2254′	W125° 53.2805′	176.43m
14-09-2013 21:20	R1654-18	Organism - Sea cucumber 5	Suction sampler	Neus Campany a i Llovet	Rock box. 1 ind.	N48° 24.223′	W125° 53.28′	179.13m

15-09-2013 04:09	R1655-1	Organism - Kelp aggregate 1	Suction sampler	Myriam Lacharite	Suction sampling individuals on kelp into jar 4.	N48° 24.2555′	W125° 54.6515′	308.07m
15-09-2013 04:23	R1655-2	Organism - Kelp aggregate 1	ROV arm	Myriam Lacharite	Placing kelp into biobox, with a few urchins on it	N48° 24.2554′	W125° 54.6517′	313.08m
15-09-2013 04:35	R1655-3	Organism - Sea urchins on kelp 1	Suction sampler	Neus Campany a i Llovet	We picked up a few sea urchins, placed them into the biobox for isotope analysis	N48° 24.2558′	W125° 54.6517′	311.73m
15-09-2013 04:37	R1655-4	Organism - Kelp 1 community	Suction sampler	Myriam Lacharite	Suction sample of the sediment underneath the kelp aggregate 1 (bottle 7)	N48° 24.2556′	W125° 54.6514′	318.48m
15-09-2013 12:29	R1655-5	Sediment core - red	Push core	Renald Belley	Oxy: 1.06 Sal: 33.89 Temperature: 6.63	N48° 24.166′	W125° 53.8943′	297.71m
15-09-2013 12:31	R1655-6	Sediment core - red and black	Push core	Renald Belley	Push core red and black	N48° 24.166′	W125° 53.8945′	298.02m
15-09-2013 12:35	R1655-7	Sediment core-3-double black	Push core	Renald Belley	Push core double black	N48° 24.1658′	W125° 53.8946′	297.74m
15-09-2013 12:38	R1655-8	Sediment core-4-blue	Push core	Renald Belley	Push core blue	N48° 24.1654′	W125° 53.8946′	298.15m
15-09-2013 12:41	R1655-9	Sediment core-5-green	Push core	Renald Belley	Push core green	N48° 24.1655′	W125° 53.8945′	298.07m

15-09-2013 12:43	R1655-10	Sediment core-6-orange	Push core	Renald Belley	push core orange	N48° 24.1652′	W125° 53.8957′	298.23m
15-09-2013 12:45	R1655-11	Sediment core-7-red and green	Push core	Renald Belley	push core red core	N48° 24.166′	W125° 53.8942′	298.11m
15-09-2013 12:48	R1655-12	Sediment core-8-metalic	Push core	Renald Belley	Push core metallic	N48° 24.1646′	W125° 53.895′	298.21m
15-09-2013 12:50	R1655-13	Sediment core-9-black	Push core	Renald Belley	Push core black	N48° 24.1649′	W125° 53.8949′	298.29m
15-09-2013 12:52	R1655-14	Sediment core-10-black and white	Push core	Renald Belley	Push core black an white	N48° 24.1649′	W125° 53.8947′	298.14m
15-09-2013 12:53	R1655-15	water - blue niskin	Niskin bottle	Renald Belley	starboard 2 niskin	N48° 24.1645′	W125° 53.8963′	298.42m
15-09-2013 22:35	R1656-1	Organism - Seastar	ROV arm	Myriam Lacharite	Sampled white seastar into biobox.	N48° 15.386′	W126° 10.2052′	1512.48 m
15-09-2013 22:40	R1656-2	Organism - Seastar	ROV arm	Myriam Lacharite	picked up white seastar, 2nd specimen of this species, with manip into biobox.	N48° 15.3866′	W126° 10.2112′	1513.02 m
15-09-2013 22:43	R1656-3	Organism - Sea pig	Suction sampler	Myriam Lacharite	suction sampler seapig into jar 8.	N48° 15.3866′	W126° 10.2095′	1513.15 m

15-09-2013 22:47	R1656-4	Organism - Sea pig	Suction sampler	Myriam Lacharite	Suction sampler picked up seapig #2 into the biobox.	N48° 15.3891′	W126° 10.2156′	1513.41 m
15-09-2013 22:48	R1656-5	Organism - Brisingid seastar	ROV arm	Françoise Gervais	manipulator sampled seastar into biobox.	N48° 15.3882′	W126° 10.2183′	1513.38 m
15-09-2013 22:51	R1656-6	Organism - Seapen with brittlestar	ROV arm	Neus Campany a i Llovet	plucked a seapen from below the sediment with clamp manip into biobox.	N48° 15.3887′	W126° 10.2173′	1513.58 m
15-09-2013 22:54	R1656-7	Organism - Seapen with brittlestar	ROV arm	Neus Campany a i Llovet	plucked with gripforce 2 of portside manip into biobox.	N48° 15.3874′	W126° 10.2214′	1514.17 m
15-09-2013 22:57	R1656-8	Organism - Seapen with brittlestar	ROV arm	Neus Campany a i Llovet	plucked with portside manip into biobox.	N48° 15.387′	W126° 10.2268′	1514.27 m
15-09-2013 23:01	R1656-9	Organism - Seapen with brittlestar	ROV arm	Neus Campany a i Llovet	plucked with portside manip into biobox.	N48° 15.3868′	W126° 10.2252′	1514.32 m
15-09-2013 23:04	R1656-10	Organism - Seapen with brittlestar	ROV arm	Neus Campany a i Llovet	plucked with portside manip into biobox.	N48° 15.3875′	W126° 10.2275′	1514.86 m
15-09-2013 23:08	R1656-11	Organism - Seapen with brittlestar	ROV arm	Neus Campany a i Llovet	plucked with portside manip into biobox.	N48° 15.3854′	W126° 10.2317′	1515.28 m
15-09-2013 23:12	R1656-12	Organism - Seapen with brittlestar	ROV arm	Neus Campany a i Llovet	plucked with portside manip into biobox.	N48° 15.3857′	W126° 10.2334′	1515.47 m

15-09-2013 23:14	R1656-13	Organism - Seapen with brittlestar	ROV arm	Neus Campany a i Llovet	plucked with portside manip into biobox.	N48° 15.387′	W126° 10.2364′	1515.9m
15-09-2013 23:19	R1656-14	Organism - 4 small sea pigs	Suction sampler	Myriam Lacharite	suction sampled 4 small seapigs into jar 8.	N48° 15.3873′	W126° 10.2374′	1515.81 m
15-09-2013 23:26	R1656-15	Organism - Sea pig	Suction sampler	Neus Campany a i Llovet	suction sampled sea pig into jar 8.	N48° 15.4114′	W126° 10.2391′	1514.15 m
16-09-2013 00:22	R1656-16	Sediment under kelp	Suction sampler	Myriam Lacharite	suction sample of sediment underneath kelp into jar with 250 micron mesh.	N48° 15.4721′	W126° 10.2494′	1509.65 m
16-09-2013 00:30	R1656-17	Organism - Kelp	Suction sampler	Myriam Lacharite	suction sampled animals into Jar 4.	N48° 15.4739′	W126° 10.251′	1509.73 m
16-09-2013 00:36	R1656-18	Sediment core - black	Push core	Neus Campany a i Llovet	Push core black handle, near location of kelp sample.	N48° 15.4706′	W126° 10.2492′	1509.91 m
16-09-2013 0:38	R1656-19	Sediment core - white stripe	Push core	Neus Campany a i Llovet	sampled a push core with white stripe handle near kelp sample	N48° 15.4712′	W126° 10.2497′	1509.87 m
16-09-2013 8:19	R1657-1	Organism - Sea star	ROV arm	Françoise Gervais	Sampling an unknown sea star (pink, 10 arms). Placed into the biobox	N48° 20.4965′	W125° 58.6078′	743.91m
16-09-2013 8:28	R1657-3	Sediment core - metallic	Push core	Renald Belley	Push core 1. Salinity: 34.18 PSU, Temperature: 4.39 degrees celsius, oxygen: 0.21 ml/l 2.91%	N48° 20.4962′	W125° 58.6075′	743.85m

16-09-2013 8:30	R1657-4	Sediment core 2 - green	Push core	Renald Belley	Push core 2 - green handle	N48° 20.4962′	W125° 58.6075′	743.9m
16-09-2013 8:32	R1657-5	Sediment core 3 - red/black	Push core	Renald Belley	Push core #3 red/black	N48° 20.4963′	W125° 58.6078′	743.65m
16-09-2013 8:36	R1657-6	Sediment core 4 - blue	Push core	Renald Belley	Push core 4 - blue	N48° 20.4961′	W125° 58.6096′	744.32m
16-09-2013 8:39	R1657-7	Sediment core 5 - black/metallic	Push core	Renald Belley	Push core 5 - black/metallic	N48° 20.4959′	W125° 58.6095′	744.28m
16-09-2013 8:41	R1657-8	Sediment core 6 - red	Push core	Renald Belley	Push core 6 - red	N48° 20.4961′	W125° 58.6093′	744.04m
16-09-2013 8:46	R1657-9	Sediment core 7 - orange	Push core	Renald Belley	Push core 7 - orange	N48° 20.4953′	W125° 58.6114′	744.06m
16-09-2013 8:48	R1657-10	Sediment core 8 - black	Push core	Renald Belley	Push core 8 - black	N48° 20.4958′	W125° 58.6108′	744.04m
16-09-2013 8:51	R1657-11	Sediment core 9 - red/green	Push core	Renald Belley	Push core 9 - red/green	N48° 20.4925′	W125° 58.6153′	744.04m
16-09-2013 8:53	R1657-12	Sediment core 10 - white/black	Push core	Renald Belley	Push core 10 - white/black	N48° 20.4924′	W125° 58.6157′	743.98m
16-09-2013 18:03	R1658-1	Organism - Glass sponge - *Aphrocallistes vastus*	Suction sampler	Chu Jackson	glass sponge - *Aphrocallistes vastus* for Sally Ley - into J5	N48° 22.5859′	W125° 55.876′	498.31m

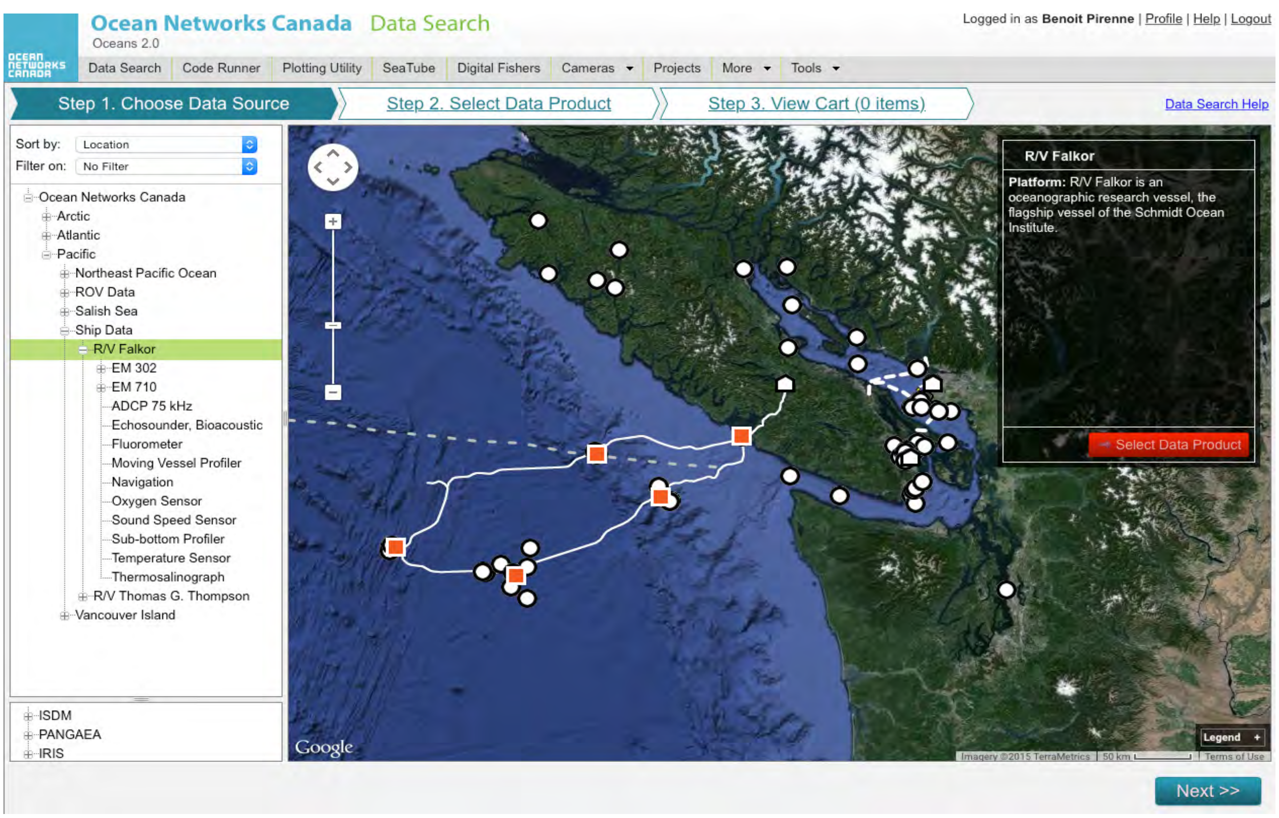
16-09-2013 18:09	R1658-2	Organism - Glass sponge - *Aphrocallistes vastus*	Suction sampler	Kim Juniper	glass sponge - *Aphrocallistes vastus* for Sally Ley - into J6	N48° 22.5863′	W125° 55.8793′	498.85m
16-09-2013 18:14	R1658-3	Organism - Kelp 1	Suction sampler	Myriam Lacharite	First kelp for Transect 600 m - into J1	N48° 22.5783′	W125° 55.8763′	507.67m
16-09-2013 18:22	R1658-4	Organism - Sea anemone (orange)	Suction sampler	Myriam Lacharite	sea anemone (orange) looks like the flap trap - into J4	N48° 22.5773′	W125° 55.8709′	507.39m
16-09-2013 18:23	R1658-5	Organism - Sea anemone (orange)	Suction sampler	Myriam Lacharite	sea anemone - into J4	N48° 22.5769′	W125° 55.8709′	507.36m
16-09-2013 18:27	R1658-6	Sediment core-1-double black	Push core	Neus Campany a i Llovet	Push core double black	N48° 22.5777′	W125° 55.8705′	507.14m
16-09-2013 18:29	R1658-7	Sediment core-2-silver	Push core	Neus Campany a i Llovet	Push core 2 silver	N48° 22.5773′	W125° 55.8708′	507.17m

Data Management and Access

Data from the cruise are now available through Ocean Networks Canada "Oceans 2.0" portal. To access, visit dmas.uvic.ca/ and select "Pacific Ocean" and then "Ship Data", and select R/V Falkor. See screenshot on the next page.

Data available for download include:

Instrument	ONC ID	# files	Data Volume (GB)
Multibeam (EM302)	23200	96	9.7
Multibeam (EM710)	23205	593	525.3
ADCP	23197	71	0.2
Echosounder	22822	736	66.3
Fluorometer	22823	26	0.1
Navigation	23238	29	0.4
Oxygen Sensor	23199	28	0.1
Sound Speed Sensor	16106	30	0.1
Temperature Sensor	22815	1	0
Thermosalinograph	23201	29	0.2
Sub-bottom Profiler	22901	8	0.1
Moving Vessel Profiler	22817	2762	0.2



Appendix A: Daily Logs

Daily Log, Aug 16 2013

R/V Falkor Cruise FK009A
Chief Scientists Log

Day 1: Loading and Settling In

Today the science crew boarded the Schmidt Ocean Institute (SOI) Research Vessel (R/V) Falkor. A large van of passengers arrived in Nanaimo from Victoria, representing Ocean Networks Canada (ONC), the Department of Fisheries and Oceans (DFO) and The University of Victoria, and several smaller groups arrived from Vancouver, representing the University of British Columbia (UBC). We loaded our gear and equipment, and started to settle in. The Falkor has a crew of twenty-two, two Pilots, and our science team of sixteen, bring the ships compliment to 42. This 83m long vessel is a state of the art research platform and will be our home for the next two weeks as we transect back and forth across the continental shelf west of Vancouver Island collecting data.

Our objectives during this first leg (FK009A) focus on the physical properties of ocean transport. We have brought aboard a sophisticated moving vessel profiler (MVP), and when combined with the ship's CTD and extensive acoustic sonars, we will have unprecedented water property mapping capabilities. We will be applying these various tools to quantify, map, and track water masses from the continental slope, some 150km off shore, across the continental shelf, and into the coastal waters of Barkley Sound and Juan de Fuca Strait. These deep offshore waters are cold, salty, rich in nutrients, relatively high in inorganic carbon and moderately low in dissolved oxygen. Regional upwelling processes this time of year bring this water into the coastal basins, where it has direct impact on marine habitats. The cold saline nature (dense) keeps it close to the bottom, the nutrients feed upper ocean phytoplankton communities, the inorganic carbon content determines the pH and how acidic the water is, and the intermediate dissolved oxygen concentrations can displace resident water that might be either higher (i.e. the Strait of Georgia) or lower (i.e. Saanich Inlet) in oxygen. We hope to better understand the pathways, evolution, and impacts of this ocean water as it permeates into the Salish Sea.

In these daily posts, I will expand on the technical capabilities of our sampling systems, highlight the discoveries and relate them to our over-arching objectives, and give a perspective of life aboard a world class research vessel.

Daily Log, Aug 17 2013

R/V Falkor Cruise FK009A
Chief Scientists Log

Day 2: Preparing For Sea

While we are still at dock in Nanaimo, it has been a busy day aboard the R/V Falkor. We have been both physically and virtually preparing for our departure at 0900 August 18.

The list of tasks to complete in order to get every sensor system assembled, configured, and tested has been quite extensive. Of high importance has been the final assembly and wiring of the Moving Vessel Profiler (MVP), which consists of a dedicated winch on the aft deck, the “fish”, cables for power and communications, a master control console, and data acquisition and display computers. In this case the fish is the sensor package, which resembles a small torpedo with a harness for tethering and a robust sensor suite.

The system works fairly autonomously once operating, with the winch letting out and retrieving wire, and the sensors recording temperature, salinity, pressure, and dissolved oxygen. Data is collected while the ship steams steadily (6-8 knots) through the ocean, resulting in a series of water property profiles from the surface to just above the ocean bottom, spaced at approximately 1 km. The controller also receives various automatic data feeds from the ship’s network, including position and water depth, and thereby controls the subsequent winch operations to ensure the fish stops above the bottom and is retrieved back to just astern of the ship. Getting all these pieces assembled and configured on a new ship takes time, and consumed the entire day for the MVP team (Chris Mackay, Rowan Fox, and Jody Klymak, UVic).

Other science personnel were equally busy setting up numerous other data acquisition and water sampling systems. Susan Allen and Jessica Spurgin (UBC) completed arrangement of the carbon fixing chemistry, so that dissolved inorganic carbon water samples collected via the Rosette could be “fixed” for later analysis.
Similarly, Stephen Romaine (DFO) and Brianna Cerkiewicz (UVic) completed assembly of the oxygen analysis station, where water samples will be analyzed as we collect them. Stéphane Gauthier (DFO) worked with the marine Technician Nathan Cunningham (SOI) to configure the data feeds and settings for the EK60, a multi-frequency echo-sounder that will map out distributions of plankton and fish. Steve Mihaly (ONC) and Stephanie Waterman (UBC) reviewed and prepared the acoustic Doppler current profiler (ADCP) systems and

data processing procedures. Finally Karen Douglas (ONC) and Nathan reviewed system configurations and drafted navigation tracks for the EM302 and EM710 multi-beam bottom mapping systems, preparing track lines across the Tully Canyon in preparation for our arrival in a few days. All systems are now getting tied down and secured for ocean travel.

We sail tomorrow morning at 0900. Our first tasks remain procedural in nature, as we will start by calibrating the echo-sounders and testing the CTD and MVP water profiling systems. Then we steam from the Strait of Georgia, through Haro and Juan de Fuca Straits to our primary destination, the continental shelf west of Vancouver Island. But now, a sunset BBQ on the upper deck for a toast by the captain and good luck wishes for the cruise.

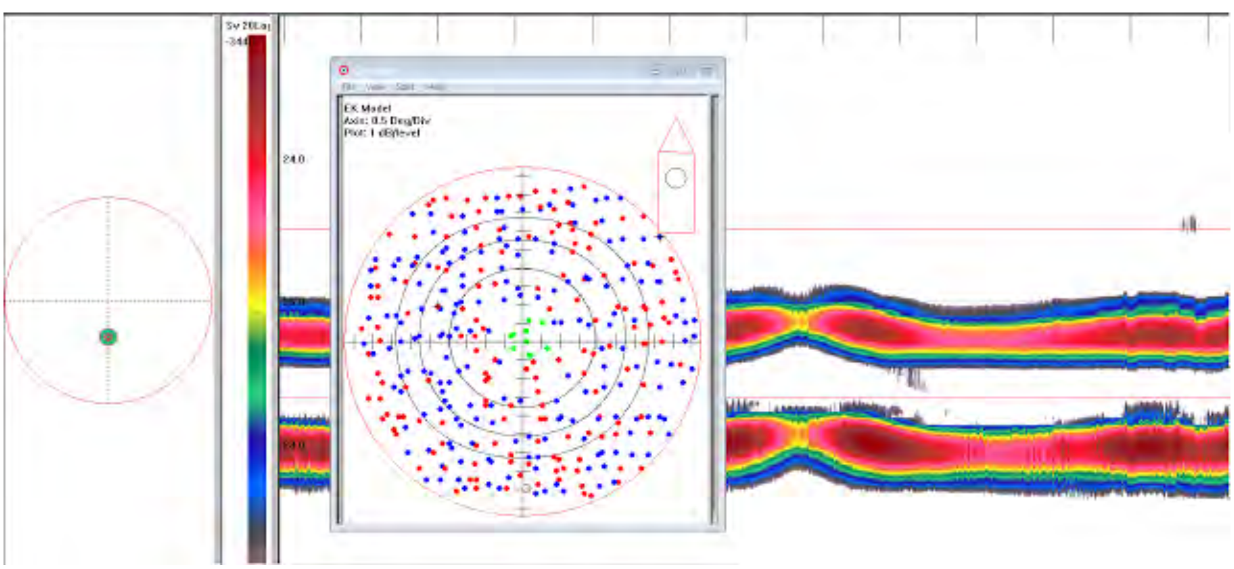
Daily Log, Aug 18 2013

R/V Falkor Cruise FK009A
Chief Scientists Log
Day 3: Away

This morning at 0900 we slipped the dock and headed north out of Nanaimo into the central Strait of Georgia. Just north of the Departure Bay – Horseshoe Bay ferry route, we parked ourselves for a few important tasks.

All science hands were on deck or in the lab as we stepped through the CTD and Rosette profiling procedures to prepare the bottles, launch the CTD, conduct the profile, and retrieve the profiler. We triggered all the Rosette bottles as a test, but did not conduct any full analysis, since the Falkor crew had only just received our risk assessment for the various chemical reagents and had not yet reviewed or signed off on them. The CTD cast protocols was fine, and we agreed that the ship's procedures were indistinguishable for those we are familiar with on our Canadian Coast Guard research vessels.

Just before lunch and aided by the workboat, we slung a 6cm diameter tungsten carbide (WC) sphere under the sonar "gondola" near the front of the ship to facilitate calibrating the EK60 multi-frequency echo-sounder. The gondola is a rigid frame under the bow, hosting a significant array of sonar transducers and receivers, including an EK60 multi-frequency echo-sounder, an EA600 sonar, the EM302 and EM710 multi-beam bottom mapping sonars, and the 75 and 300 kHz ADCP transducers. By carefully adjusting the position and depth of the sphere using three motor driven spools, we recorded the echo-sounder target strength for each frequency and will use these values to confirm or re-calibrate the echo-returns. The image shows the echo-gram (right) and the four quadrant slip-beam transducer volume (centre), spotted with target returns from the sphere as we move throughout the acoustic beam (left). This calibration process will allow us to use the echo-sounder to distinguish and track fish and plankton in the echo-grams.



The calibration takes all afternoon, and we're under way at 1800 hours. Still a few minor things to get ready for our intensive 36 hour CTD survey starting tomorrow.

Ticker-tape:
0800 - Final checks and tie-downs
0900 - Slip the dock, we're away
1000 - Into the Strait, onto EK60 calibration station
1030 - Test CTD cast, 23 or 24 bottles, and profile to 150m.
1100 - Prepare calibration lines and controllers, 63mm Tungsten Carbide (WC)
1200 - Over the bow and under the ship
1300 - Getting it centered, not easy while we hold station in central Strait of Georgia
1400 - The sphere is in the beams, the ship is in the waves, 15 knot wind, hope it doesn't build
16:00 - Changing the WC sphere for a smaller (30mm) Cu one for the 70kHz beam
17:00 - Done and pulling calibration gear aboard
18:00 - Slow ahead as we re-tension the MVP wire on the MVP winch
19:30 - Done. Ship now doing 12 knots and we get a chance to configure the ships ADCPs.

Daily Log, Aug 19 2013

R/V Falkor Cruise FK009A
Chief Scientists Log
Day 4: Steaming and Sampling

This morning at 0800 we arrived at the entrance to Juan de Fuca Strait. A light fog, but relatively calm seas. The morning briefing on the bridge confirms today's simple schedule: a final configuration of the MVP and then we start an intense CTD/Rosette survey.

The acoustic Doppler current profiler was allowed to run all night, as we steamed from the Strait of Georgia, through Haro Strait, over the sills south-east of Victoria, and out into Juan de Fuca Strait. The resulting velocity section looks good, so we have high hopes for the velocity data. After breakfast, the MVP team tows the fish a short distance behind the ship, and sets stop markers on the wire. The winch needs "messengers" attached to the wire that will tell it to automatically stop retrieval when the fish is near the ship.

This done, we find a site near the center of the Strait, tucked just inside the "J" buoy at the entrance to Juan de Fuca. With all hands either participating or watching, we take our first full CTD and Rosette bottle cast. Although the measurements from the sensors on the CTD are recorded as the instrument is lowered and raised through the water, the 24 large Niskin bottles (Rosette) are "triggered" and closed at prescribed depths to capture the water from that depth. Various samples are then drawn from the bottles once the CTD and Rosette are back on deck, with at least three separate flasks and procedures: one for measuring dissolved oxygen, the second for dissolved inorganic carbon, and the third for nutrients. Along with temperature and salinity there are at least seven distinct "tracers" we will measure (dissolved oxygen, dissolved inorganic carbon, pH/alkalinity, nitrate, and silicate) to track the pathways of the water, attempting to distinguish off-shore from in-shore sources. It is time consuming, but the team seems ready.

While the CTD team completes cast after cast, with, in some cases, no time between for either a rest or meal, a few of us (Stéphane Gauthier, Jody Klymak, and I) are in the control room, adjusting and configuring the various sonar systems to attempt to get them to cooperate. The goal is to have them each ping as quickly as possible, in order to construct a meaningful coherent series, while at the same time, not acoustically interfering with each other. This is tricky, since the echo-sounder (EK60) has a frequency at 70kHz, the Doppler operates at 75kHz, and the EM710 multi-beam system operates between 70 and 100kHz. All three occupying a rather busy frequency band. The R/V Falkor is equipped with a sophisticated “K-Sync” system for assisting with this task. However, after several hours, it seems we can either have synchronized pings, with poor temporal resolution, or high resolution data, but with interference. Our compromise at the moment is to prioritize the data types and limit the acquisition to only two of the three systems at any one time.

The present CTD survey consists of 17 stations in and north of Barkley Canyon. This survey will take us well through tomorrow before we are finished.

Ticker-tape:
0800- Arrive at Juan de Fuca entrance (west), seas calm, 2m swell.
0815- MVP team coordinates with bridge to trail "fish" and secure stop messengers on their wire
0900- We steam back to a CTD station, north of the boarder, inside the J-buoy at the western entrance to Juan de Fuca.
1000- All hands stand-by to conduct our first full CTD and bottle (Rosette) cast.
1100- Finish the cast, take the water samples, and steam to LB08 in the middle of the shelf, ETA 1400.
1400- Sunny, calm (well, at least for the Pacific Ocean), good viz, some whales and porpoises. We are into in now. The CTD stations are close and intense. Launch, cast, bottles, launch,…
2100- The sixth station, and there is no rest. We’re sampling now…

Daily Log, Aug 20 2013

R/V Falkor Cruise FK009A
Chief Scientists Log

Day 5: Oxygen Minimum Layer

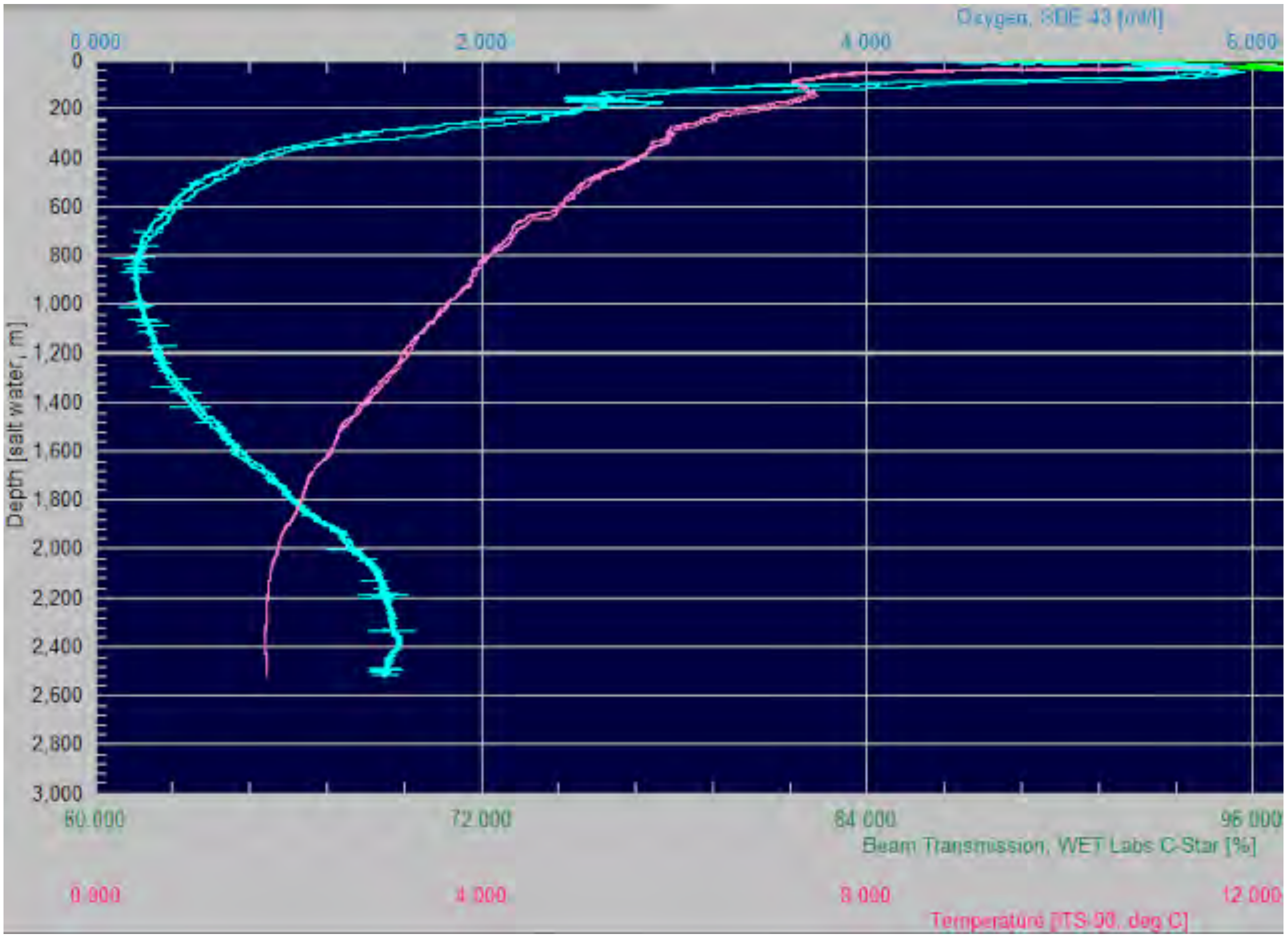
The day has been a very typical oceanographic sampling day, dominated by “classic hydrography”, which is the measurement of water properties as a function of depth at fixed stations across the ocean. Continuing from yesterday, we completed the initial CTD and Rosette survey, including portions of the Barkley Canyon and La Perouse C lines.

During the early morning hours, we continued to head off-shore into the deeper reaches of Barkley Canyon, just south of the NEPTUNE Barkley node. By breakfast we had steamed even further off-shore to our deepest and most distant station, LC12 (La Perouse C-Line). In 2,460m of water, we took a CTD and Rosette cast, lasting nearly three hours. At this off-shore site, the water is distinctly different that the coastal waters of the Salish Sea. First, it is clear and crystal blue. One might then expect it to be cold, but it is not. The very upwelling process that brings the deep water towards shore, transports coastal surface waters off-shore. So the surface water here is relatively warm, at nearly 17C. There are also more sightings of whales and now we constantly see Albatross, skimming the surface of the waves. The CTD cast at this site is representative of much of the North East Pacific, and so it will tell us the character of the “source” waters for our pathways assessment. Shown here is a screen capture of the temperature (pink) and dissolved oxygen (cyan) profiles. Temperature steadily drops with increasing depth, with a mixed layer in the bottom 200m. The oxygen profile is more interesting. It to drops in concentration from the surface, but it has a broad minimum between 700-900m depth. In fact, it is relatively low (below 1.0 ml/l) between 400 and 1600m depth. This can referred to as the Oxygen Minimum Layer (OML).

There is really only one natural source for free oxygen, and that is photosynthesis. This occurs in both the upper ocean by phytoplankton, and terrestrially by land plants (mostly trees). Both sources provide oxygen to either the surface layers of the ocean or the atmosphere (or both). There are more processes that consume oxygen, but the two of interest here are respiration by fish and zooplankton, and decomposition by microbes and bacteria as they recycle organic matter (organic carbon). The oxygen minimum zone is primarily a result of the latter (bacterial), which has worked on the deep waters in the north Pacific for many years as it circulates slowly in large ocean gyres. The same set of oxidizing processes re-cycle organic matter into nutrients, replenishing essential Nitrates, Phosphates, and Silicates. It is this deep, cold, salty, low oxygen water, rich in nutrients that we wish to follow and track, from mid-water column (400-600m) depths up onto the continental shelf and into the coastal waters. So we’ve found our source, and now we’ll follow it, as best we can.

The R/V Falkor is proving to be a wonderful scientific host. The equipment is top quality state-of-the-art and the officers and crew are skilled, accommodating, and extremely patient.

By the end of the day, after the intense CTD and bottle work, we are starting our first MVP survey. Although we had prepared possible MVP track-lines before the cruise, based on what we’ve seen so far in the CTD data, a new zigzag pattern near the continental shelf break has been drafted and we began it late this evening. The change of pace and sampling gear should require less crew support, will give everyone an early, but well deserved, break.



Ticker-tape:
0100 - Continuing the CTD lines, we near the end of the Barkley Canyon stations, progressively getting into deeper water.
0300 - We complete the BC line, steam towards the La Perouse C-Line (LC) CTD stations, starting with the furthest and deepest, LC12 in 2,460m of water.
0700 - We're out as far as we'll likely get, and begin the deepest cast. The profile is beautiful (scientifically) with a smoothly arcing Oxygen Minimum Layer between 800-900m depth.
1000 - This deep CTD and Rosette cast takes nearly 3 hours. A review suggests we will not do the USBL test today.
1400 - The science leads meet in the library to review the observations so far and develop a plan for the initial MVP survey. We'll do a zigzag along the shelf break.
1700 - Jody and I review the initial MVP plan with the captain, with track-lines across the outer shelf. We're ready for our first MVP survey tonight.
2100 - We prepare and launch the MVP, steaming slowly at first, but building to the target survey speed of 8 knots. Now we'll cover some ground, or should I say water.

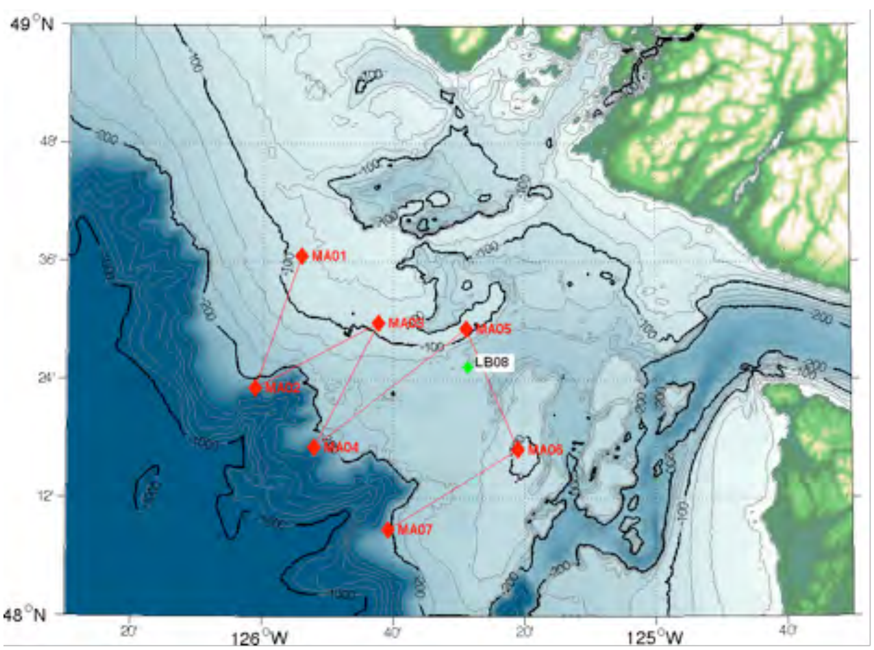
Daily Log, Aug 21 2013

R/V Falkor Cruise FK009A
Chief Scientists Log

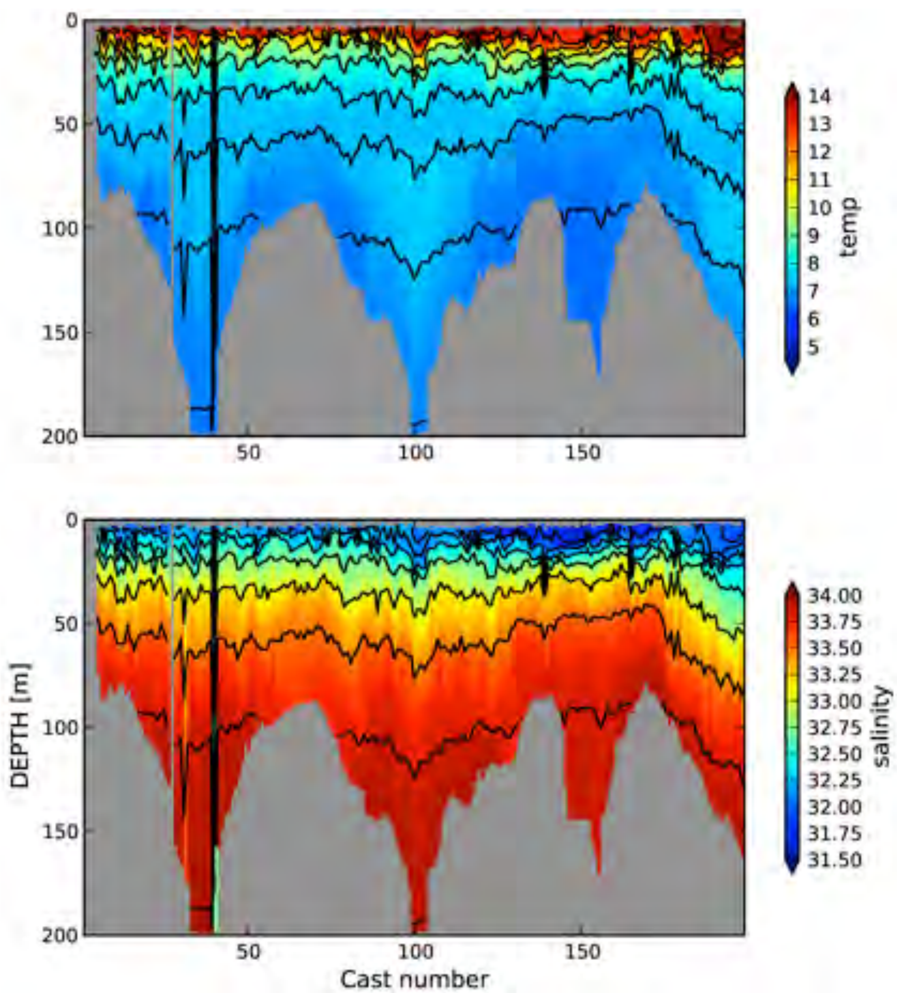
Day 6: In Through the Out Door

Late in the evening Tuesday we started the first moving vessel profiler (MVP) survey. It was completed this morning, and has given us some food for thought. The middle of the day was devoted to calibrating the ship's new ultra-short baseline (USBL) transponder, before we started an eagerly anticipated MVP transect up the Tully Canyon.

The moving vessel profiler is a system (winch, controller and instrument) that collects rapid profiles of water properties as the ship steams along on a prescribed path. Last night we had our first chance to deploy and start running the MVP transects. Unfortunately, our primary "fish", the instrument package with the sensors, did not function properly. This particular fish is equipped with an additional data channel to accommodate a fast response oxygen sensor. When we lowered this unit into the water, the temperature data was jumping around, unsatisfactorily. So we switched to a fish without the extra oxygen channel, and successfully started to measure temperature, salinity and depth (pressure). [We are attempting to repair the "O2 fish".]



A zigzag pattern had been drafted late in the afternoon, starting near the 90m isobath along the western flank of La Perouse Bank (at MA01), out to just beyond the continental shelf break, and back again, as shown in the chart. We had collected a CTD/Rosette cast in the middle (LB08 green diamond) several days ago, following the suggestion of Bill Crawford that this site often reveals the lowest oxygen values on the shelf. This is supported by our CTD data to date, and so we skirted around this site to assess the possible sources for this low oxygen mid-shelf water.



Although a little tricky to interpret, the temperature and salinity sections resulting from the nearly 200 MVP profiles collected last night provide some food for thought. In this preliminary data plot seen below, Jody Klymak shows the temperature variations in the top panel, and salinity in the lower. The ocean bottom is shaded in grey, and the lines denote surfaces of constant seawater density. These "curtains" of data could be hung along the zigzag pattern, with the shallower, near shore ends of the zags, associated with the grey peaks, and the deeper off-shore ends of the zigs with the grey valleys. Among the details of interest is the fact that the darker blues (coolest water), often representative of offshore conditions) are found during the in-shore portions. In particular, the section running between stations MA05 and MA06 parallel to shore and near CTD station LB08 (profiles 130-170), reveals cool water near the bottom, likely low in oxygen, while all the waters approaching the shelf break (at similar depths ~150m) are slightly warmer (less blue). Although not confirmed yet, we suspect that the bottom water near LB08 may be coming from the north-east, in the off-shore direction. This might suggest that the mid-shelf basin north-east of LB08 is receiving deep water from up the canyons to the east. We will refer to the small northward canyon east of station MA06 as the "Tully Canyon", and the more defined canyon joining Juan de Fuca Strait, the Juan de Fuca Canyon. We call it the Tully Canyon, in honour of John P. Tully, a pioneering Canadian oceanographer who first identified an upwelling dome in this region in the 1950s. There are other peculiarities about the water at LB08 that suggest it could be a mixture of deep off-shore and shallow in-shore water, so we're far from figuring this out just yet.

This early assessment suggests a possible backdoor pathway to site LB08 and the mid-shelf regions. After the USBL calibration, we conducted a few CTD casts in the southern reaches of the Juan de Fuca Canyon, and have just now started our quintessential 'Thalweg" (according to Captain Bernd, pronounced 'Talveg') transect up the axis of the

Tully Canyon. As our sampling proceeds, we will continue to plot, assess, interpret and adapt our sampling to refine and constrain our hypotheses.

Ticker-tape:
0100- Continue the first MVP zigzag survey, from La Perouse Bank out to the shelf break.
0500- On the mid-shelf, cutting inside LB08, a station where we saw low oxygen near the bottom.
0800- On the last leg of the zag to complete the first MVP survey.
1000- MVP coming out of the water, Jody has the section plotted within minutes, and we it appears we have some interesting observations. There is cool water behind (shoreward of) LB08, but not in front (seaward of), suggesting that the low oxygen, cool water there is coming from north of LB08 (mid-shelf), possible up the “Tully” canyon (a core hypothesis we’re testing).
1100- The ship is taking over operations for a few hours, as they deploy a beacon (moor it on the bottom in 500m of water) and then transect above and map out the orientation of the hull mounted USBL transponder.
1600- The USBL beacon is recovered and we proceed to two CTD stations at the mouth of the Juan de Fuca canyon.
1800- A 625m CTD cast in the canyon axis, likely a key source for deep water entering Juan de Fuca Strait and the Salish Sea.
1900- A penultimate CTD before we start the next MVP transect. One final CTD tonight is planned for 2300, and then it’s MVP through the night, ending in Bamfield.

Daily Log, Aug 22 2013

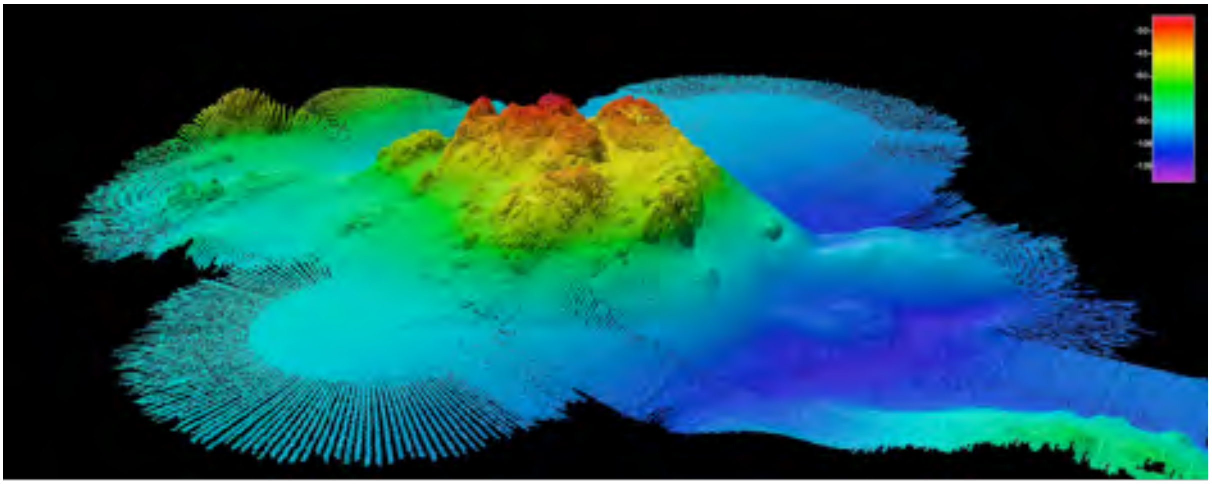
R/V Falkor Cruise FK009A
Chief Scientists Log
Day 7: Presence

We complete the second MVP survey along the centre of Tully Canyon, ending near the NEPTUNE Folger site and Bamfield. We let Stéphane Gauthier off at Bamfield, so he can get ready for another cruise. We conduct a multi-beam survey of Folger pinnacle, and start the third MVP survey. The oxygen story is both coming into focus and confirming some recent findings by Bill Crawford about the presence of very low oxygen water in the central shelf west of Vancouver Island. At the end of the day, rather dazed and less confused, we see bubbles.

We completed the first of the highly anticipated MVP canyon transects today. The route followed the deepest axis of the Tully Canyon, from depths of over 300m in the Juan de Fuca Canyon, up and over the La Perouse Bank, and ending near Barkley Sound and Bamfield. It is believed that the water deep in Juan de Fuca Canyon is the source water entering Juan de Fuca Strait, drawn in by estuarine forcing and replenishing the rest of the Salish Sea: but what about the water feeding the base of the Juan de Fuca Eddy, circulating in the central shelf at the head of the Tully Canyon and further up towards the entrance to Barkley Sound?

Our MVP profiles clearly show water branching off from the Juan de Fuca Canyon and moving up the Tully Canyon. But there is a suggestion this water is already transforming, mixing, and evolving, with subtle changes in the temperature, salinity, and oxygen as it creeps onto the middle shelf. Further along the transect we find evidence of topographic influences on the flows, with internal fronts and waves near ridges and banks. Pondering and discussions are continuous.

After six days, it is time to bid fair well to one of our team members, when in the early afternoon we drop Stéphane Gauthier off at Bamfield. He must bus back to Victoria and prepare for another cruise on the CCGS Ricker, departing in early September. Stéphane was a great help in directing and implementing the calibration and configuration of the EK60 multi-frequency echo-sounder. Thank you Stéphane.



As we leave Bamfield, there is an opportunity to collect some multi-beam bottom mapping data using the R/V Falkor's EM710 sonar. So Karen Douglas, Ocean Networks Canada's GIS specialist directs a survey over and around the Folger Deep and Folger Pinnacle regions. Shown here is the first reading of the raw multi-beam data, prior to any cleaning, gridding, or smoothing. The pinnacle is beautifully defined in this high-resolution data. ONC hosts several platforms of instruments near and on this rugged feature. This multi-beam data will assist in planning cable routes and experiments at this site.

To finish off the day, we head over these hills and far way to begin a new MVP section across a steep western ridge of La Perouse bank. During the last 24 hours, technician Chris Mackay has been working at repairing the primary MVP fish, with the extra analog channel that can accommodate a fast response oxygen sensor. So after a CTD cast, we deploy this repaired MVP fish and are pleased to find it is now reporting valid temperature, salinity, pressure and oxygen signals. Thank you Chris, as this high resolution instrument will be worked hard for the next week mapping water properties in canyons, over bumps, and across the shelf.

We finish the day repeatedly turning back and forth along a third MVP line; goodness knows how many more times in order to map the flows covering a full tidal cycle. On the second pass we see bubble plumes from the bottom, and discuss turning on even more sonars, the low-frequency sub-bottom sonar. It's a good thing this SOI ship has terabytes of disk space. I'm saving this file before it's tomorrow, which no doubt will involve new discussions and further assessments.

Ticker-tape:
0800- We complete the all-night MVP survey up the Tully Canyon Thalweg and around the La Perouse Bank.
08:30- CTD cast at the end of rht survey, not far from our middle-shelf station of LB08. This central area would be in the Juan de Fuca/Tully eddy area, and it exhibits the low oxygen found at LB08.
10:30- A second and third CTD in central La Perouse Bank.
13:30- We let Stéphane Gauthier off the ship, running him into Bamfield using the one of the ship's Zodiacs. While we wait, we're on station near Folger Passage and conduct another CTD.
15:00- We conduct a short multi-beam survey of the NEPTUNE Folger sites, Karen Douglas now has some data to work-up.
18:30- Back out in central La Perourse Bank, we take a few more CTDs this evening and start a tidal- cycle MVP survey over one of the banks ridges.
23:30- Go ahead, turn on the sub-bottom sonar…

Daily Log, Aug 23 2013

R/V Falkor Cruise FK009A
Chief Scientists Log
Day 7: Not *Going to California*

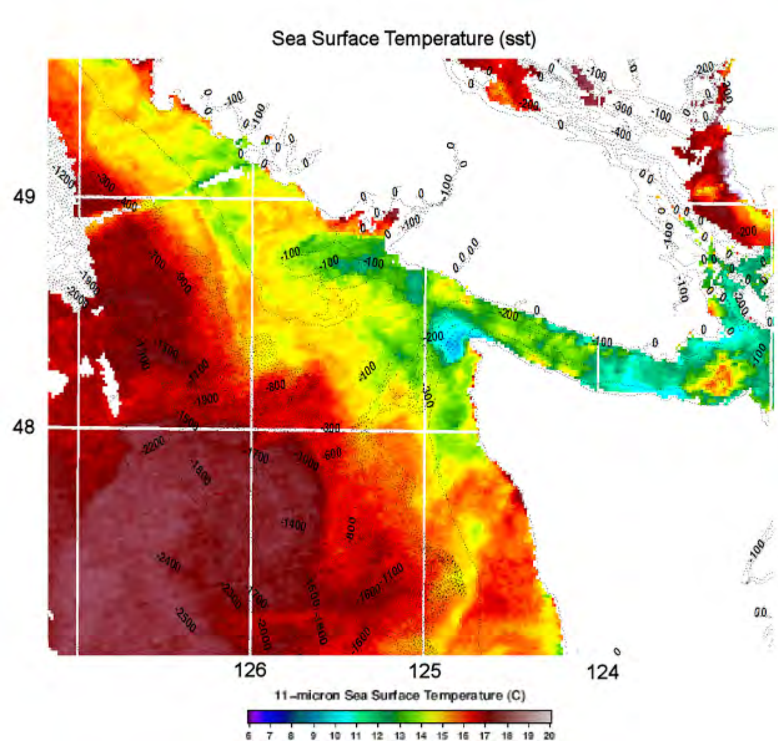
Continuing CTD and MVP surveys, and further plotting, assessment, and discussion. We think the pathway into the Salish Sea is clearly the deep flows up the Juan de Fuca canyon, into Juan de Fuca Strait. But we're not convinced we've found the definitive pathway of how the dense off-shore water gets up into the base of Juan de Fuca eddy on continental shelf west of southern Vancouver Island. Not yet anyway. But maybe…

In this, and my last few logs, I have digressed to a nerdy technical place, talking about subtle oceanographic discussions and assessments, presenting plots, and waxing about this and that. Life on this ship has many more lighter moments and aspects, some of which are coming out in the student blogs, also found on the Wiring the Abyss 2013 web site. Although I'm part of the social setting, my mind is busy keeping up with Jody, Susan, Stephanie, and Steve, as we hash-out ideas about where and how the water masses we're detecting are moving, mixing, and changing. I'm also trying my best to coordinate operations and procedures with the ship's officers and crew to make sure they have a professional and positive experience. Not only am I trying to keep up scientifically, I even need to be a little ahead, as the ship must know exactly where to go, and what to do when we get there. I enjoy this Chief Scientist role, but it's a full time gig. The ship offers beer and wine for when one is off-shift. I have not had any yet. I will take the captain and marine techs out for a beer once we return to Victoria.

OK, now, what the heck is happening in this special piece of *the ocean* we're studying?

The broad upwelling conditions that occur along the southern BC coast during the summer months, and continue all the way down to northern California, result in a long front, separating upwelled colder nutrient rich water along the coast, and warmer nutrient depleted water further off-shore. The dynamics along the front separating these waters, drives a southward current (just like an atmospheric front has a wind associated with it), from northern Vancouver Island, all the way to central California.

Shown here is a satellite image of ocean (sea) surface temperature (SST) sent to us today by Jim Gower of the Institute of Ocean Sciences. It was taken a few days ago (August 21) when the skies were clear. Thanks Jim, this is most helpful! It shows the warm off-shore water as red, and the cooler coastal waters as yellows, greens and blues. The boundary between these waters (red – yellow) nearly aligns with the shelf break, an isobath of approximately 200m. The California Current flows southward along this front. Beneath the surface expression, the front separates off-shore water from coastal water. So our present sampling plan for the next 12 hours is to use the MVP to map along this front. We are looking for frontal instabilities, and possibly "leakage" across the front. But how does one track how and where water is leaking from one region to another, and how does one quantify water mass mixing?



During our frequent discussions and assessments of the data, we've plotted up the water property data in a variety of ways. There are the standard line profiles, with water property versus depth. A few days ago (August 21, re-posted now with the figure), I showed an MVP transect as contour plots of temperature and salinity with depth and distance long the transect. We've also plotted the water properties against each other, for example salinity vs. oxygen, or temperature vs. salinity.

This latter technique is a standard oceanographic technique, known as a T-S plot and is used to track different water masses, and where they might be mixing. This led us to try to characterize the water we've been thinking of as the deep off-shore source water in some quantifiable way. It is cold and salty, low in oxygen and high in nutrients. An idea first populated by Trevor McDougall, is to refer to warm salty water as spicy. The opposite, cold and fresh is less spicy, which we might refer to as minty. So we started to plot up contours of our own spiciness, determined in such a way as to characterize the deeper off-shore water as spicy, and the mid-shelf bottom water in the Juan de Fuca eddy as less-spicy, even "bland".

When Susan Allen looked back at the "spice" plot of our first MVP transect, she noticed that there is a hint of a split in the shelf break front at an un-named ridge rising up and forming the west wall of the Tully Canyon. Some off-shore "spice" is carving off to the inner shelf. At about mid-night tonight we will start a front mapping survey near this ridge to test a new hypothesis that this ridge is shaving off a piece of spicy water at the California Current front and diverting it towards the inner shelf. If correct, then the role of the Tully Canyon may be reduced, as our MVP transects are suggesting, and a slight blocking and diversion of the California Current maybe important.

I am also counting down the days to the end of the cruise. Not because I'm tired of it, but because we still have tasks left to accomplish, and I need to schedule a timeline, backwards from the end of the cruise, to make sure we get everything done.

Ticker-tape:
00:00- We're on a line, steaming west then east, towing the MVP, now with oxygen. The question is does the tide, or a meander in the shelf current cause any deeper shelf break water to spill over the western ridge of La Perourse bank, spilling into mid-shelf basins?
08:00- We had captured the end of the flood tide early last night, but we're now into an ebb, and there is some evidence the shelf break water is getting pushed down, away from the bank, but we will not wait the full 6 hours to see the next flood.
09:00- So we break off this line, and head east back to the Juan de Fuca Canyon.

13:00- A CTD cast in the central canyon at a station we've labeled RD04, and then we deploy the MVP to transect up an alternate canyon, leading out of Juan de Fuca Canyon towards the west.
18:00- We're back up at the head of the Thalweg transect, to give this one last try. Does the deep water come up the Tully Canyon?
19:00- Susan Allen hits on something new. The first MVP transect data is examined more closely. There is something there. A split in the shelf break front/current, with indications that the ridge forming the western side of the Tully Canyon is blocking some of the shelf break current. We've got to test this new idea. Tonight.
22:30- The final CTD and bottle cast of the day. At RD02 station in Juan de Fuca Canyon. Then MVP front mapping.

Daily Log, Aug 24 2013

R/V Falkor Cruise FK009A
Chief Scientists Log

Day 9: Comfortably Numb

The day has been a gentle, long sequence of repeated MVP profiles. Counting up into the hundreds, the ship steams along at eight knots, while the profiler surfaces and sinks, again and again.

We have determined a few salient points about the waters on the shelf. Some are well known and we have re-affirmed prior characteristics and dynamical understanding. Some other features, however, we think are new. In particular, the role of the Tully Canyon in "feeding" the Tully or Juan de Fuca eddy. We have conducted several passes up and down the canyon, with only weak evidence there is much water making its way up the canyon and to the middle shelf region. We could be experiencing a period of weak upwelling, but the canyons seem to be playing a minor role for the bottom water on the middle shelf. To confirm this, we may need to wait until we have returned and complete all of the tracer analysis, looking particularly at the patterns and values of carbon and nutrients.

A particular analysis tool that has guided us this past few days has been the use of mapping out deviations in Temperature and Salinity. In particular, we have observed at least three distinct water types. (1) Off-shore water, primarily focusing on the deeper cool, salty low oxygen layers found between 150-300m depth along the upper continental slope. (2) Mid-shelf, mid-depth (50-130m) water, which is lower in oxygen and has an extremely linear and tight T-S relation, suggesting it is both stratified and mixing. This water includes that found at LB08 in the central shelf, with the lowest oxygen values at nearly 0.8 ml/l. (3) Finally, there is the upper (<50m) water layers, which are fresher and warmer, and higher in oxygen. We have defined our own "spiciness" as a departure from water type (2), such that off-shore water is spicy, and upper coastal water is actually negative in spice (minty?). The mid-depth low-oxygen mixed (Roger) water is neutral, or bland. As we transect with the MVP, we are plotting up the "spiciness", identifying where each water mass resides, where the fronts are between the water masses, and where the mixing might be concentrated.

Although we started off by focusing on where and what are the pathways for the deep sources feeding the shelf, an equally and just as critical question is, given that the surface out-flow from Juan de Fuca Strait is nearly constant, and we are seeing deep water feed the Tully eddy through several routes, where and how does mixed water exit this region? The surveys and discussions continue.

At 14:00 hours this afternoon, the ship executed a delicate exploding bathy-thermograph (XBT). The exercise was used as a training opportunity for two of the students aboard, Jo Ellen and Benjamin. The marine technicians gave them careful instructions, and the captain stood by in full fire-fighting gear, just in case the XBT failed catastrophically. It has been some time since anyone has been injured during the launch of an XBT, but the captain crouched ready with the fire extinguisher, just in case. Benjamin held the launcher, while Jo Ellen steadied him. The torpedo was released to initiate the bathythermograph, and to everyone's relief, no one was hurt.

At 15:00, more than half the ship's compliment of crew and science staff gathered to hear Professor Plump in Library with the rope. The audience was kind and patient as the professor explained some the key features and history of the VENUS and NEPTUNE cabled ocean observatories, the dominant features of the regional oceanography, the over-arching theme and goals of the research, and a preliminary assessment of the observations so far.

At 18:00, an at sea BBQ was hosted by the ship's galley crew, and a very pleasant gathering on the Teak Deck was enjoyed by all. Later the calm seas reflected the sunset, the moon rose in the east, and the MVP powered through profile number 1200.

We have mapped out the final days of the cruise, squeezing in the last series of surveys, the key remaining CTD and bottle stations, and I think I was able to identify sometime during which we should be able to conduct some multi-beam surveys of the Juan de Fuca canyon walls. The ship will need re-fueling before it docks in Victoria on Friday August 31.

Ticker-tape:
00:00- We started the day on the forth MVP survey, and I suspect we will finish it much the same way. It is a long zig-zag affair, stretching from the Juan de Fuca Canyon to the east along the shelf break to the north-west edges of La Perourse Bank.
12:00- The transect segments are long and tight, so as not to miss any feature and map out details along the shelf break edge of the Tully Eddy.
22:30- No CTDs today. We continue to proceed along this MVP transect, collecting hundreds of profiles for this survey, and surpassing 1200 for the cruise. I mapped out a sketch of the remainder of the cruise, fitting in some desired transects, time series, and CTD stations. We should have time for the multi-beam in Juan de Fuca Canyon.

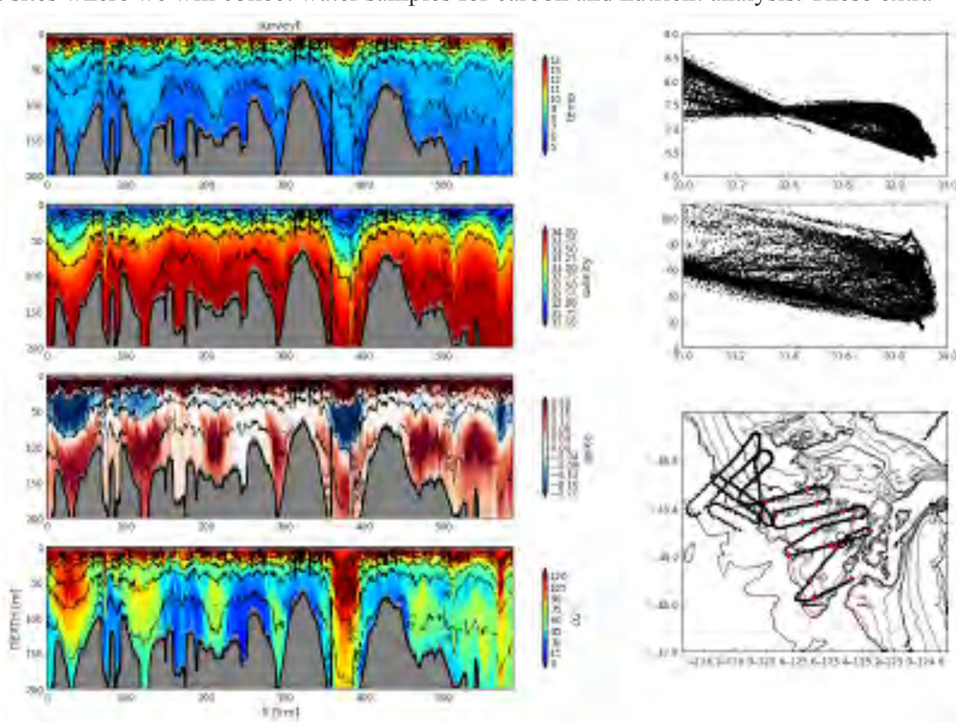
Daily Log, Aug 25 2013

R/V Falkor Cruise FK009A
Chief Scientists Log
Day 10: *Bring It On Home*

Today a plan for the remainder of the cruise was prepared. We'll see how long it lasts, events change regularly at sea. But it's a workable plan and includes the remaining cruise objectives. The adaptive science is relentless and gives me no quarter.

So we spent nearly 42 hours on a single moving vessel profiler (MVP) survey, with nearly 600 profiles. Not a record for Jody, who's done days on end on other cruises, but a record for most of us. We've been focusing on the mid to outer continental shelf boundary between the offshore water and the well mixed eddy water on the shelf. We get a short reprieve in the late afternoon to do some Conductivity, Temperature, and Depth (CTD) casts in central Barkley Canyon, near the NEPTUNE node. While we conduct these water property profiles, Jody's team (Emma, Rowan, and Chris) swapped out the MVP cable, which has conducted 1435 profiles at eight knots, under harsh working loads. We are duly, impressed with this workhorse instrument. By evening, the new cable was on the drum, re-tensioned and ready to go. We stayed near the head of Barkley Canyon tonight to locate and map one final tendril of a water along the continental shelf break. Shown here is a plot generated by Susan using Jody's MVP survey software. We pour over these displays, and many other types of plots to try to better understand these complex ocean water systems. After a very long day, one's brain begins to disappoint, and then you know it's time to get some sleep.

Still remaining, to be completed on by the end of the first leg of this cruise are the following objectives: Eight more CTD and bottle stations, at sites where we will collect water samples for carbon and nutrient analysis. These extra tracers will be very helpful in closing some of the loose ends once we get back and take an even closer look at the data. A single CTD station in the upper reaches of Juan de Fuca canyon that will quantify the deep water entering Juan de Fuca Strait and the Salish Sea. A time series of MVP profiles and sections in and across the lower reaches of the Tully Canyon. It was a core feature of our early hypotheses and although we think it has closed somewhat as a



water mass pathway, it still has very interesting characteristics that deserve a thorough mapping, especially over an entire tidal cycle..

We hope to complete these goals. We're doing well, and I give full credit to the great team of people I work with, both the science team and the ship's crew, and the effort and patience they are demonstrating in getting our objectives accomplished.

As Stéphane Gauthier said before he left us in Bamfield: "I'm a fish…. No, I'm not a fish…. Well OK, I do study fish." I think he was trying to say he is not a fisheries biologist, but a research scientist. I'm also not a fish. But then again, well, maybe, I am a fish.

Ticker-tape:
00:00- We started the day on the fifth MVP survey, much as we have the last few days. We had deployed the MVP a couple of days ago, and have been profiling ever since.
13:00- We decide to continue the MVP survey a little longer, pushing back a short line of CTDs we have on our to do list before the end of the cruise. Just a few more hours. Just a few more dozen profiles. Just a few more kilometers. Just so we can bound these water masses. Let's keep going until at least 1500.
16:00- OK, it's time to break off this MVP survey and get the CTDs at the Barkley Canyon stations one last time. But maybe we pulled the MVP too soon. We whittle the number of CTD stations down to three, which should give Jody's team (Emma, Rowan and Chris) enough time to switch the MVP cable for a new one.
19:00- Rather than steam off towards the coast, we adjust the plan yet again, and stay here to finish off finding the ends of these pockets of distinct water.
20:00- MVP is back in the water and we're re-tensioning the new cable. Once that's done, we on for about another 8 hours of MVP before we pull it and steam to collect a CTD and bottle samples near Folger Passage.

Daily Log, Aug 26 2013

R/V Falkor Cruise FK009A
Chief Scientists Log

Day 11: The Ocean

There has been a standing forecast the last couple of days for gale force winds. They started to build last night, and outside of Barkley Sound, we are seeing a steady 30 knots. Both the MVP and CTD seem game at first, so the sampling program should not be affected, but we will take a little more care with deck operations.

So far, the flat and calm ocean surface has provided us with some opportunities to see whales, dolphins, fish, sea birds, and wonderful sunsets. But if one looks directly down, there is an oceanographic story in the ocean colour. When we are very near shore, and even in protected basins, such as the Strait of Georgia or Barkley Sound, the ocean is green. Sometimes a cloudy brownish-green, other times an aqua-green. In these coastal opaque waters we lose sight of the CTD within metres of the surface. This green colour is caused by the phytoplankton, the microscopic plants which are the base of most marine food webs, and importantly, through photosynthesis, they take up carbon dioxide from the water and produce dissolved oxygen. When we transect further offshore, across the coastal front, and more so across the continental shelf break front, we reach the open ocean, where the water colour is distinctly blue. The reds are absorbed, and what passes through and is reflected back is the blue part of the spectrum. One also notes that this ocean water is distinctly more translucent and the CTD is visible 10, 20, even 30 metres below the sea's surface. But when the wind picks up, like today, and the sea state builds, the surface becomes this feature rich and bumpy affair. I'd not call it rough quite yet, but the observation deck is empty now and most would not call the cool, wet conditions outside comfortable. There won't be much whale watching today, and I doubt anyone will care what colour the ocean appears.

After finishing a long stint of MVP surveys along the outer continental shelf break, we headed in towards Barkley Sound, for some near-shore measurements. The first CTD and bottle cast today was next to the NEPTUNE Folger Pinnacle site. We then headed further inland, entering Imperial Eagle Channel, and reaching the entrance to Effingham Inlet. Observations earlier this summer from the CCGS John P. Tully included many CTD casts and several ROV dives in this protected and scenic fjord. That data suggested a recent renewal event had replenished the deep recesses with higher oxygen water. Our water pathways analyses will include an assessment of the extent which shelf and coastal waters reach into Barkley Sound and deep inlets, such as Effingham. In among the mountains, the wind and sea are calm, and the sun is even trying to break through. We all dream of the day when we might return for sailing, kayaking or camping among the islands of the Broken Group.

The MVP is launched just outside Effingham Inlet, and we tow and profile out to the entrance to Barkly Sound and back onto the shelf. The wind and sea greet us, there is no mistake; we're on the ocean.

By the mid-afternoon the sea is a little "rougher". We have just completed the last CTD of the day, and my cabin windows are frequently being washed by the sea. The wind is a steady 35 knots. Nothing too extraordinary, but the sea state is a little more "developed". We are steaming into the wind and sea as we profile with the MVP, allowing us to continue to collect data. The CTD and Rosette assembly is configured more optimally for the last cruise, where they routinely profiled to 5000m. In this sea, and off the stern through the A-frame, the CTD cable was experiencing some snap loads as the ship pitches and heaves over the waves. We do not want to damage or risk the CTD with still a few days left, so we'll wait until tomorrow for further casts, when the forecast is for this system to pass, and for only 20 knot winds.

I was pleasantly surprised to see nearly a full house (mess) for dinner. The students are made of pretty strong stuff. Or they are hungry, which is certainly a well-known student condition. The MVP survey down the Thalweg continues, which for now is good, since it puts us on a south-east (SE) heading, directly into the nose of the wind. But later tonight we plan to turn, and map the location of the outer-shelf front. This could well put us on a course to the SW, and the ship into the "troughs". In this unfavourable alignment, the roll from side to side will be significant. So the captain will make an announcement that everyone should check and re-secure all lab and personal gear so that it does not fall to the deck and break.

The front tracking tonight is twofold. First, we want to know how variable the front is, since we were here a couple of days ago. Second, we plan to take specific CTD and bottle profiles tomorrow at locations to the west, middle, and east of the front.

Just before sunset, I head up to the observation deck, checking in with the bridge and taking a radio. I find two other brave souls up there, Rowan and Jessica. The bow of the ship crashes through some big waves, spraying the entire front of the ship, including us, four decks up. Rowan has his GoPro, I take a few still shots. And then we see a few humpbacks playing in the waves. They are a few hundred metres from the ship, and seem to be having a good time. OK, so it's always a good time to whale watch on the ocean.

Ticker-tape:
00:00- The MVP was launched only an hour ago, and we're finishing off a very long survey along the continental shelf break. The boundary, or front between the off-shore water and the shelf water has developed both a meander and a tendril. We'll map this tendril and then head into Barkley Sound
04:30- The tendril was defined, so we're done on the shelf break for now. The MVP is coming aboard, and we'll steam to Barkley Sound.
09:30- At our CTD station near Folger Pinnacle at the entrance to Barkley Sound. The CTD cast will include bottles for later carbon and nutrient analysis. We're in a very different water mass here, fresh and coastal. Also high in

nutrients, but these nutrients have come out of Juan de Fuca Strait, having been mixed vertically into surface layers by the tidal mixing near Victoria and Haro Strait.
10:30- We're now heading into Barkley Sound, up Imperial Eagle Channel to the entrance to Effingham Inlet. We've been asked by Rich Pawlowicz of UBC to connect this region with the coastal current and the rest of the shelf. So we'll start an MVP survey here and head out.
11:30- Some weed, kelp, and logs in the water, so it's a little concerning for the MVP team. We have several people at the aft rail (taffrail) to watch and monitor the MVP cable for any unexpected tension events.
14:00- We're out passing the coastal current/front, soon to bring the MVP aboard to conduct a CTD cast.
15:30- The CTD and bottle cast is done, and it's about an hour and a half to the next CTD station. Jody has convinced Susan and me we will have time to put the MVP in after that, and profile down the Thalweg to the next CTD/bottle station. Then it will be MVP mapping of the outer shelf near the head of Nitinat Canyon to fix the ideal CTD/bottle stations for tomorrow.
21:00- The wind is already starting to ease to under 30. A good sign for the sampling and those not feeling 100%.

Daily Log, Aug 27 2013

R/V Falkor Cruise FK009A

Chief Scientists Log

Day 12: The Ship

The bumpy sea abated through the night, and by morning, the winds were light and the sea a confused wash of old and dying waves. We steam along at our preferred MVP speed of eight knots, and sample with particular purpose. The MVP is used to find exact locations across the continental shelf front for our final set of CTD casts. We are very pleased with these samples. By the end of the day, we have started a marathon of an MVP survey, very likely our last hurrah. If we never give up, luck will find us.

The R/V Falkor (http://www.schmidtocean.org/ships) has proven to be a wonderful vessel for oceanographic research. No doubt the technical staff and engineers who conceived, design, and modified her over the last couple of years had this very objective in mind. She was launched in 1981 as a German fisheries patrol vessel, and was extensively modified for her present purpose between 2009 and 2012. She underwent extensive sea trials and system certification in 2012 and started conducting oceanographic research in earnest in 2013.

She is a very nice size. There are some major research vessels around the world that are larger. Some are longer, wider, and others taller. But often those extra dimensions come at a cost. Either in windage, fuel, or handling. The Falkor is relatively long and narrow for her tonnage. This character reminds me of classic sailing ships, which were always long and sleek: A very natural shape for efficient and fast passage through the water. The Falkor is driven by two variable pitch propellers, and a single bow thruster. The bow thruster is either stealthy quite or we have had no need to use it yet, in either case this is a testament to the balanced handling of the ship. She rides beautifully, and given our most recent experience, handles rougher seas very well. She has a very subtle and gentle motion over a range of sea states, which is lulling many of us to a deep and restful sleep during our off-watch.

The Falkor has several lab areas for the science staff to either set-up apparatus for sample analysis, data acquisition systems, and computers for data analysis and office functions. Then there is the large and well equipped control room, with over thirty dedicated large monitors for watching the dozens of data feeds, the ships navigational and operating status, the weather and external conditions, and the many video feeds covering all major deck locations. There is a large common library and meeting room, and a large mess hall for communal eating. There is a gym and sauna, and laundry services are provided. There is the large upper “Teaki” deck, ideal for social gatherings or even watching an outdoor movie. Above the bridge is the marine mammal observation deck, offering nearly 300 degrees of unobstructed views to the horizon. The cabins are well appointed and comfortable. The living and work quarters are excellent.

The services are also top notch. We have had three new and varied meals each day, with no repeats of the soups, main courses, and deserts (OK, there is rice and at least three salads each dinner :). They are also putting out a mid-night dinner for those working the late shift. The galley staff and stewards are always busy making sure all the common spaces are spotless and tidy, and they even assist with laundry. There are always abundant supplies of snacks, candies, cookies, sandwich fixings, and cereal available at any time. As are beverages, pop, juices, tea, and espresso.

The science gear provided by and maintained on the Falkor is spectacular. The list is too long to repeat here, but I will high-light the few we have used. I have already mentioned in earlier posts the vast array of acoustic sensors, including echo-sounders, Dopplers, and bottom mapping arrays. All calibrated and certified to world class standards. There is a surface sampling flow through system, which we added an oxygen sensor to in order to capture surface variations in dissolved oxygen. The CTD and Rosette are the world standard built by SeaBird electronics, and they can profile full ocean depth from either a side J-frame or the full width aft A-frame. Equally as important as the array of installed scientific gear, the ship and crew have accommodated us effortlessly in supporting our Moving Vessel Profiler (MVP), and during the next leg, the Remotely Operated Platform for Ocean Sciences (ROPOS).

Finally there is the Falkor crew. Each member is polite, helpful and eager to make sure everyone gets exactly what they need, from a three-phase electrical socket, to a cup of cocoa. The officers on the bridge are extremely professional and handle the ship calmly and with exact precision. The marine technicians are knowledgeable, patient, and ready at every turn to assist and make our challenging science program a success. The deck hands and Bosun are easy to work with, responsive, and ready to assist with every deployment and recovery. Finally, there is our Captain. Bernd is clearly in charge, yet always polite, calm, friendly, and fun. He is a pleasure to be around, as are all the ship’s crew.

I will leave it to the student bloggers to explore and present some of the folklore about the namesake of the ship, a dragon from the Never Ending Story. For me, I am already planning the next expedition, and several more beyond that.

Ticker-tape:
00:00- Yet again the MVP system plows through the night, profile after profile, mile after mile. Once again we are mapping out the edge of the front separating offshore and inshore water, but our purpose tonight is a little more direct.
09:00- By mid-morning we have identified the locations for our last set of CTD and bottle stations, along a line heading shoreward, NE from the head of Nitinat Canyon. So we label these stations “NN”, for Nitinat.
10:00 - We take a CTD cast on the seaward side, in the middle of the front, and on the shoreward side, bracketing the front and capturing the water properties of key and central importance. These casts include a full set of bottle samples, for the analysis of dissolved oxygen, carbon, and nutrients.
11:00- We use the MVP between the CTD stations, to aid us in ensuring we get the samples exactly in the right locations. So we profile along, look at the data, determine that yes, a short distance back was the right site, we mark the spot (easy with digital navigation systems), recover the MVP, turn the ship around, and head back to conduct the CTD/Rosette cast. This works so well, we regret not using it more often during the early CTD surveys.
16:00- By late afternoon, we have taken our last CTD cast for a few days. I will insist on one more to finish of the cruise, just in the upper reaches of the Juan de Fuca Canyon, making one final connection to the Salish Sea.
18:00- The MVP has been back in the water for an hour, and we are starting a rather detailed back-and-forth mapping of the Tully Canyon. “Mowing the lawn” as we turn and sweep out a square zig-zag up the canyon,

crossing over the top of each wall before turning. The recesses of Canyon seems to fill with dense water from both down-canyon, and from spilling over the walls. We ponder a dedicated set of expeditions looking at canyon flows. 22:00- This will be a massive survey. We are a little way up the Tully Canyon, which we will finish later tonight. Early tomorrow we'll finish the canyon survey and head north across the shelf towards Vancouver Island, making two passes through the buoyant coastal front flowing out of Juan de Fuca Strait and hugging the Island. Then we'll cut across La Perouse bank and complete yet another outer-shelf front survey. This will leave us one final block of time. The science team will meet, we'll discuss these latest observations, and we'll decide where and what the last 12 hours should examine.

Daily Log, Aug 28 2013

R/V Falkor Cruise FK009A
Chief Scientists Log

Day 13: The Science Team

Today the edits to the plan were minor, and we have started our final push. The weather is grey, with low clouds, irregular seas, and cool temperatures. The forecast calls for an increase in the SE wind. The MVP remains in the water nearly all day, with periodic checks on the fish to inspect for kelp and wear. Our adaptive sampling has a few days left to map some of the key features one last time.

The majority of oceanographic cruises I have been involved with have been one of two varieties. There are 'home-institution' cruises, which include Ocean Networks Canada's maintenance cruises, where a well-trained team of co-workers head out several times a year, with fairly well developed and understood plans, procedures, and responsibilities to recover, service, and redeploy oceanographic moorings and platforms. There are similar maintenance, monitoring, or routine programs at many oceanographic institutions, where the cruise tasks and the crew are familiar and execution can be routine and straight forward. Then there are cruises that have mostly new participants, involving collaborations across institutions and disciplines, and a science plan that is likely innovative and some-what unproven. This Falkor cruise is of the latter variety, and it has a distinctive character that will remain with us for many years to come.

The lead science personnel on this first leg of the 2013 R/V Falkor cruise (FK009A) includes Drs. Jody Klymak (UVic), Susan Allen (UBC), Steve Mihaly (ONC), Stephanie Waterman (UBC), Stéphane Gauthier (Institute of Ocean Sciences), Mr. Stephen Romaine (also IOS), and of course, myself. Not on the ship, but certainly providing leadership and guidance for planning the science program are Drs. Rich Pawlowicz (UBC), Debby Ianson (IOS), Ken Denman (ONC), and Kim Juniper (ONC). Most of us have known each other professionally for many years, or even decades, but this is the first major field program for this group as a whole. This group includes leading physical, chemical, and biological oceanographers, the major branches of water column ocean science.

A special mention of the interactions we've had and a flavour of the discussions directing our science program on the ship. Although I am keeping more or less regular working hours (07:00 to 23:00), the remainder of the science team is split into two teams, working 12 hour watches, switching at 03:00 in the morning and 15:00 in the afternoon/evening. The "morning" watch is led by Jody, Stephanie, and Stephen, while Susan and Steve lead the "evening" gang. Between roughly noon and 18:00 the entire science brain trust is up and engaged, and this is when we discuss the data and what our next steps should be. Jody is a master at manipulating the data in near real time, so that we have spatial and diagnostic plots generated and visible within seconds of each MVP cast. Susan and Stephanie have been working off-line to assess MVP and CTD profile data collected yesterday and the days prior. Always pressing is the interpretation of the latest section, transect or frontal crossing, what are the data revealing, is there a new feature, do the data confirm our most recent hypothesis, how do they guide us for the next turn, the next transect, and the next survey. We discuss published papers for this region, we hash over the layers of physics working this water at this very minute, we assess the fine details in the data, and negotiate what we should do next. It is science at its best, both fun and challenging. We are mindful of the significant logistical effort granted us to be free explorers.

The essential technical and graduate student teams are standing or sitting nearby, and watching/helping us “do science”. They include Chris Mackay (SyTech Research), Rowan Fox (UVic), Karen Douglas (ONC), Jessica Spurgin (UBC), Benjamin Schiefele (UBC), Emma Murowinsky (UVic), Brianna Cerkiewicz (UVic), and Jo Ellen Machesky (Pearson College). The program we are executing would not be possible without their tireless assistance. When we are doing CTD and bottle casts, each one has a designated task and responsibility, conscientiously executed. During MVP surveys everyone participates in one and a half hour shift we call a “watch”, intently monitoring dozens of real-time displays and indicators, ready to hit the big red “stop” button if something goes awry. These intense monitoring duties are interspersed with a brief reprieve of an hour or so. When we mobilize for an MVP or CTD deployment or recovery, it is all hands on deck or to station. Most of this group I have not worked with before. With others, our collaborations span my entire professional career: Chris Mackay built the microstructure profiler I used for my thesis work thirty years ago, and was on many of my first cruises starting in 1984.

When we first boarded the ship, some two weeks ago, we went out for an evening together in Nanaimo. I bought the first round, and although it seemed generous then, it seems pale and insufficient now I’ve see the commitment, dedication, and hard work they put into executing our science plan. When we get back to Victoria, we will disperse back to our homes, friends, and loved ones.

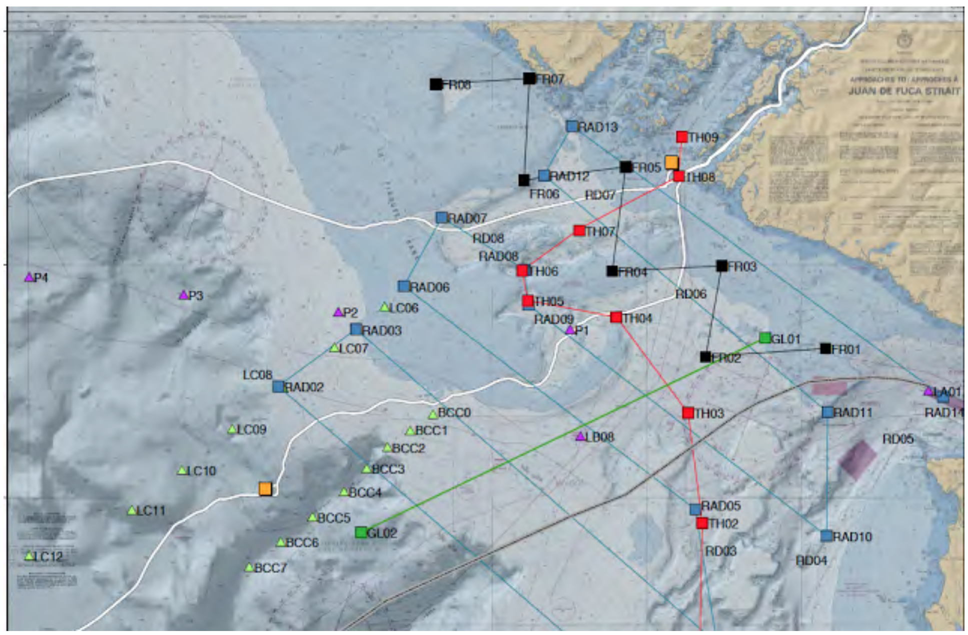
Ticker-tape:
00:00- We continue the stair-case survey up the Tully canyon that will end later this morning.
04:00- Having reached the top of the canyon, we head off to cross the inner shelf and the front identifying the Vancouver Island Coastal current.
07:00- Traversing northward long the coastline of Vancouver Island, we are just off the shores of the Pacific Rim National Park. I cannot see any hikers, but the Pachena Pt. Lighthouse is just off our starboard bow. We are following the 50m isobath, and although we are still several kilometers from shore, the water is full of kelp and logs, and we must keep a vigilant eye out for flotsam in the water that might hang up on the MVP wire.
10:00- Back outward bound, crossing La Perouse Bank. The coastal front seems drawn out and wide compared to our crossings of a few days ago. Perhaps we'll put this front on the list of things to survey during our last 24 hours.
11:00- "Good morning from 100km west of Vancouver Island…", yours truly gives a live radio interview on Victoria's CFAX 1070. I call in using the ships Voice Over Internet Protocol (VOIP) phone system. I gather after an initial pause, it came through loud and clear.
18:00- Back out on the shelf break, we predetermine a rather smooth zig-zag course, determining when to turn by our relative position to the outer shelf front. Once we cross the front, we assess if it is sharp of diffuse, and then keep going for a while to affirm we are on the other side. Then we call up to the bridge for a turn. We instruct them to turn based on the radius desired, either "tight" at ½ a nautical mile, out to wide at 2mn, as is the case for this particular survey.
22:00- We're more than half way done along the shelf break, heading east, and will be heading shortly to the "Zeppelin Bank" on the west ridge of the Tully Canyon to begin a tidal time series. Thus named for the music we were listening to during our initial surveys there and the frequent references to their material in my earlier blogs.

Daily Log, Aug 29 2013

R/V Falkor Cruise FK009A
Chief Scientists Log
Day 14: The CTD

As the penultimate science day, we are really ticking off the boxes of what needs to be accomplished. Yesterday we did a little run along the coastal front next to Vancouver Island. We then zig-zagged yet again along the shelf break, and finally we did a nice tidal time series over the Zeppelin Bank and across the Tully canyon over a flood tide. The final MVP survey tomorrow will be relatively short (12 hours), before we bang off our last CTD and head for home.

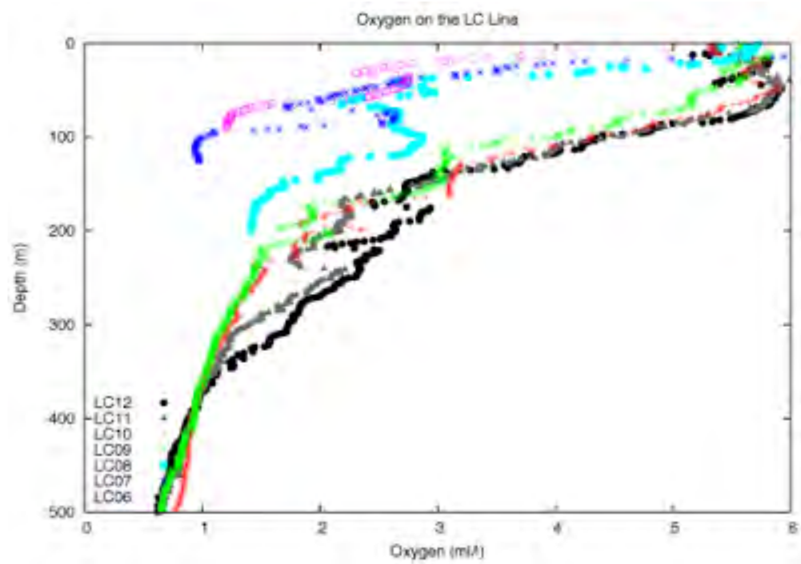
Having logged some commentary about the ocean, the ship and the team, I'll return for these last couple of logs to wrapping up the data we've collected. The analysis is by no means finished, but the data acquisition is nearly complete. We have tried valiantly to plot and interpret the data in near real time, so as to optimize our sampling and survey the existing and most scientifically interesting features.

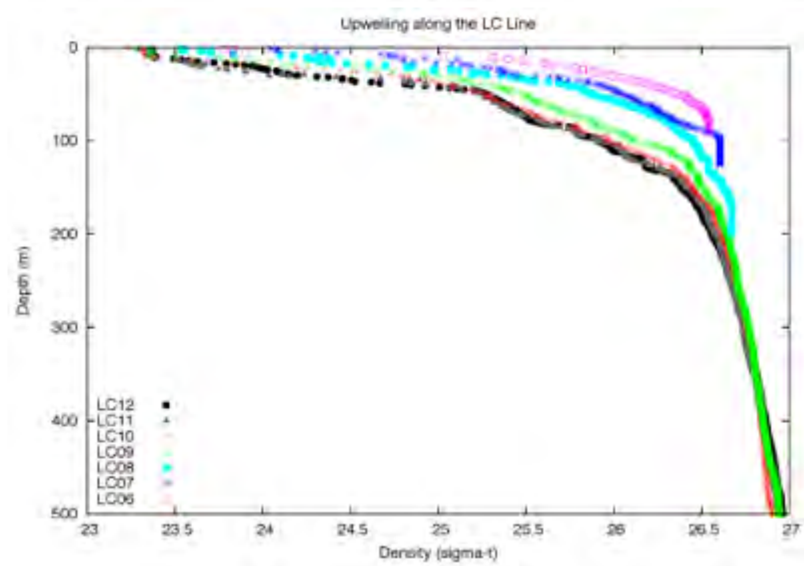


The "classic" oceanographic tool we have used is referred to as the "CTD". This stands for Temperature, Conductivity, and Depth, the three core sensors/measurements returned up the wire. We have augmented these sensors with a dissolved Oxygen probe and a Fluorometer for measuring the concentration of chlorophyll. From T, C, and D (actually pressure, P) we can calculate the salinity concentration (S), since more dissolved salts tends to make the seawater more electrically conductive. From T, S, and P we can calculate the seawater density (rho), which is dynamically important, but only a part of our story of tracking pathways. Accompanying the CTD is the "Rosette", a bracket holding 24 large 12-litre bottles, which can be closed when the CTD is at specific depths. The bottled water will be analyzed for oxygen, carbon, and nutrients.

Shown here are some “profiles” of seawater density and dissolved oxygen as measured by our CTD along the La Perouse “C” line, a string of stations running seaward from Barkley Sound. Depth is plotted as the vertical axis in both plots, and density in units of kilogram per cubic metre on the x-axis of one, and dissolved oxygen in units of millilitre per litre [ml/l] on the other. Each coloured symbol represents a different station, with deeper profiles acquired further from shore in deeper water. Oxygen is seen to generally decrease with depth, while density increases. Although there is nothing preventing oxygen from increasing with depth (as demonstrated by the data from LC08), dense always underlies lighter water, a condition known as stably stratified. These types of profile plots give us our first assessment of which type of water is occupying which spatial region, either laterally, or in depth.

What the CTD data has told us is that there are at least 4 distinct water masses swirling around and mixing over the continental shelf west of Vancouver Island; including, fresh cold high oxygen waters coming out of Juan de Fuca Strait, warm fresh high oxygen surface waters off Cape Flattery, mixed low oxygen water in the central shelf (eddy water), and warm salty off-shore water along the shelf break. There are possibly three other “source” waters hinted at in our CTD data, including a northern cool salty shelf water mass, a deep cool salty low oxygen layer down near 800m depth, and a warmer deep low oxygen layer coming northward as an under-current to the surface California Current. Our profile data should allow us to tease out some of the interactions, but this will require a more careful investigation of both the profile data and the carbon and nutrient analysis.





Tomorrow I’ll show spatial plots generated from the MVP, which made nearly 2800 profiles, covering approximately 3400km of transects. This data suggests various roles for the numerous canyons in the area, and where the Tully Eddy might be getting injections of off-shore water.

Ticker-tape:
00:00- We continue MVP survey that started with a stair-case survey up the Tully Canyon, In across the coastal front along Vancouver Island and off the Pacific Rim National Park, out across the shelf crossing La Perouse bank, zig-zagging SE along the shelf break, and up back over the rim of the Tully Canyon.

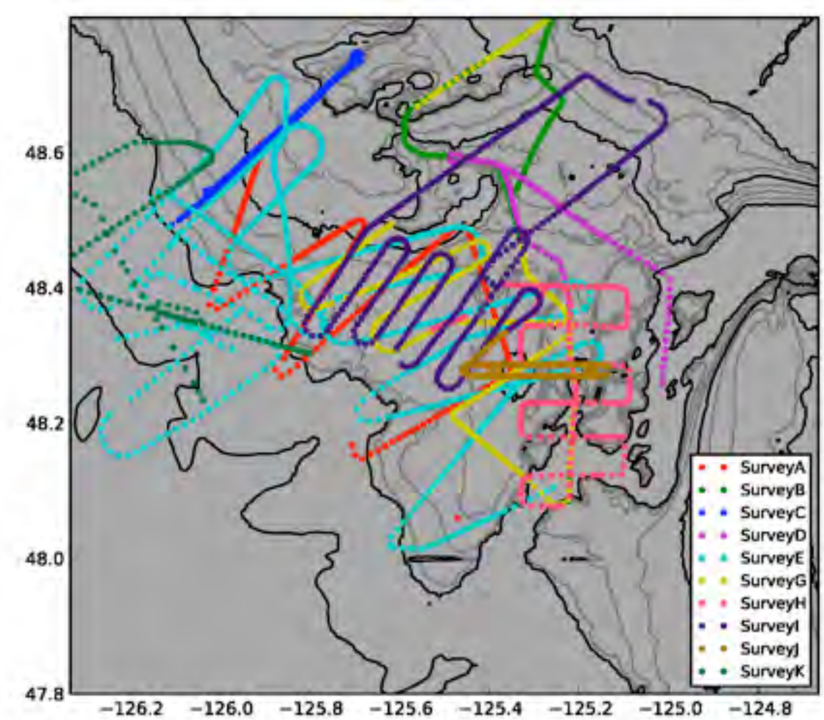
08:00- The MVP is well over 2400 profiles! We're transecting back and forth across the Tully Canyon, mapping out the flows over Zeppelin Bank and into the canyon over a tidal cycle. This time series started early in the morning and flood tide is in a couple of hours. The off-shore front is off the bank lip now, but we expect it might get pushed over the canyon wall during flood.
11:00- Sure enough, the front seems to spill water into the canyon during flood tide, dumping a significant amount of dense and salty water into the canyon from over Zeppelin bank, than seems to be coming up the canyon right now.
13:00- Although the flood tide ended some hours ago, the spilling flow is only now subsiding. We'll continue this time series until about 18:00, when the captain has booked another BBQ!
18:00- OK, time to cut this very long survey that start a couple of days ago. We haul the MVP out of the water and steam east to start the very last and final MVP survey, mapping the last fix for the shelf break front.
21:00- MVP is back in, and we're still heading east. This survey needs to end by breakfast in order to get the last CTD done by lunch.

Daily Log, Aug 30 2013

R/V Falkor Cruise FK009A
Chief Scientists Log

Day 15: The MVP

Prior to our most recent exposure to this special oceanographic system, MVP is most often a reference to Most Valuable Player. It is an award, often handed out annually in a sports league, to a player who has contributed the most in a team's effort to achieve their goals. The MVP on this cruise was, in both senses, the Moving Vessel Profiler.

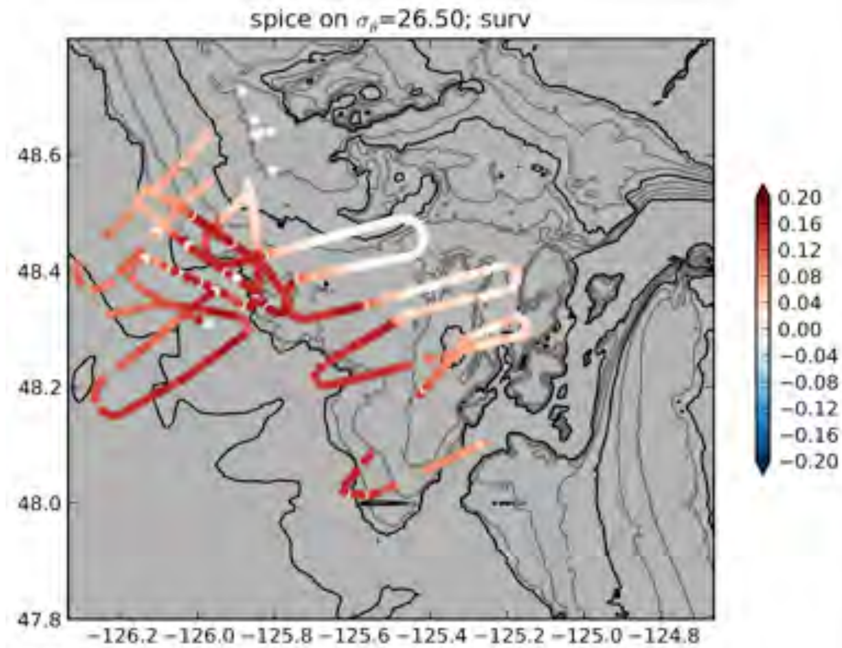


Today we finished the science sampling program of FK009A. As with most days over the last two weeks, the day started with a continuation of an MVP survey. On this day, we had decided to head out to the north-western most reaches of our survey region to get a final snap shot of what the shelf break front was doing. This is primarily because we feel one of the more interesting and therefore publishable findings will be our assessment of the character of the shelf front as it approaches and interacts with the wide southern continental shelf off southern Vancouver Island.

The MVP system was a real champion. It had a rough start when we first deployed it and found the fish that could accommodate the fast response Rinko oxygen sensor was misbehaving. So our first survey "A" was conducted using a back-up fish, without oxygen. But after some repairs we re-deployed our primary fish, and proceeded to collect nearly 2800 profiles. The ship speed was usually 8 knots, but at times we slowed to 4 knots to increase the profile density, and other times we sped up to 10 knots to cover more ground. On average, we would get a vertical profile every kilometer along our track. In all we covered nearly 2500 kilometers of transect length.

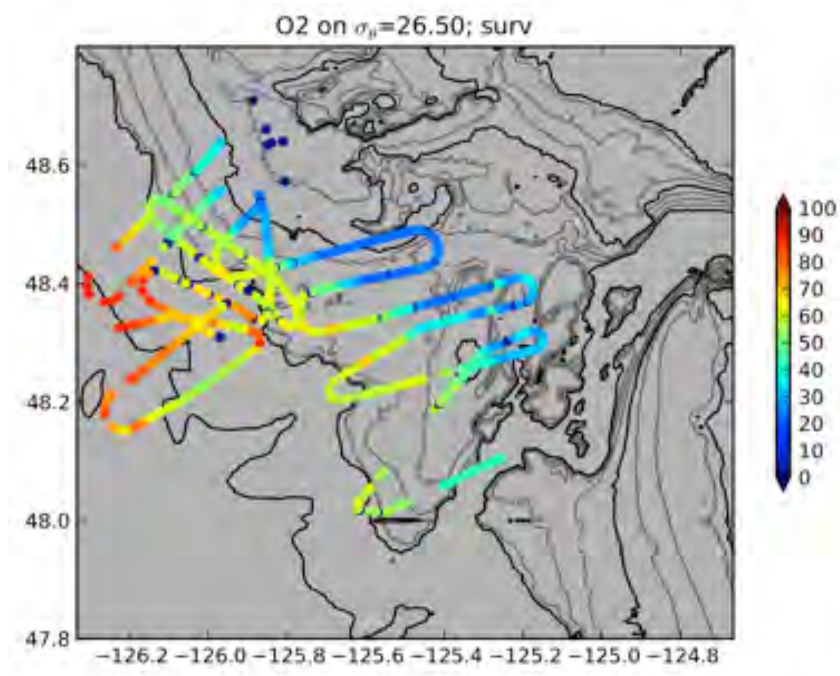
Shown in the first figure are the ten official surveys, "A" to "K". Some of these surveys lasted 12 hours, while others last nearly 40. At all times there were three dedicated science personnel concentrating on the graphic and digital displays of the MVP systems, reporting all diagnostics and parameters streaming in from both the fish, winch, and ship telemetry sources. We would rotate duties each half hour to avoid any loss of attention. There is real danger to the system if the fish hits the bottom (it falls at nearly 4 m/s and we had it stopping 7m off the bottom), fails to stop upon winching in, or the cable snags any debris drifting in the ocean.

The MVP watch personnel would be in near constant communication with the bridge to plan turns, adjust speed, or just as importantly, to identify and avoid logs and kelp that could break the cable. We are very thankful to the Falkor officers for their continual attention to debris and their warnings to us if they spotted something of concern. We had only minor incidences when we would bring the fish to check if everything was alright, or to reset the automatic retrieval system. The Moving Vessel Profiler was a real MVP.



Shown in the next two plots are examples of some processed data from survey "E". Shown are the "spiciness" of the water on the (irregular) density surface of 1026.5 kg/m^3, and the dissolved oxygen in % of saturation, also on the density surface 1026.5 kg/m^3. These density surfaces are at depths of about 2/3 the water depth over much of this region, but they are not flat. The spiciness is calculated as the deviation of both temperature and salinity from a pure mixed T-S line characterizing the water we consistently found over the middle part of the shelf (where ever the spice is zero and plotted as white). Red is more spicy (representing off-shore water), pink an intermediate partially mixed water (interesting), and blue would be minty near shore, fresher water. Our task now is to sift through the mountains of information, and tease out the most meaningful interpretation of how the waters are moving, mixing, and exchanging with the inner shelf.

I must take this opportunity to thank everyone involved with this expedition; from those that were not able to join us but have helped in planning and will help us in analysis, the ship's crew, and mostly the science team who worked so hard to make this a very successful cruise. Thanks!



Ticker-tape:

00:00- Continuing the last MVP survey. We are way out at the farthest reaches of the southern shelf.

08:00- Jody and I are both looking at the clock. In about half an hour we must recover the MVP if we are to make it back to port on time

08:30- The MVP is recovered for the last time. What a champion. We steam to the entrance to Juan de Fuca Strait.
12:30- We are at a station labeled RD05 just at the southern entrance to Juan de Fuca Strait. Cape Flattery is just visible in the fog. The CTD cast is different than anything we've seen so far, so it may prove either valuable or misguiding.
13:30- We're done with the CTD. There are 14 bottles to draw water from, and then analyze. We have already started to tear down the lab.
19:30- We pull into Port Angeles to re-fuel. Tomorrow morning we will head back to Victoria and off-load. This is my last entry. Thanks for following, the first leg of the R/V Falkor Cruise FK009.

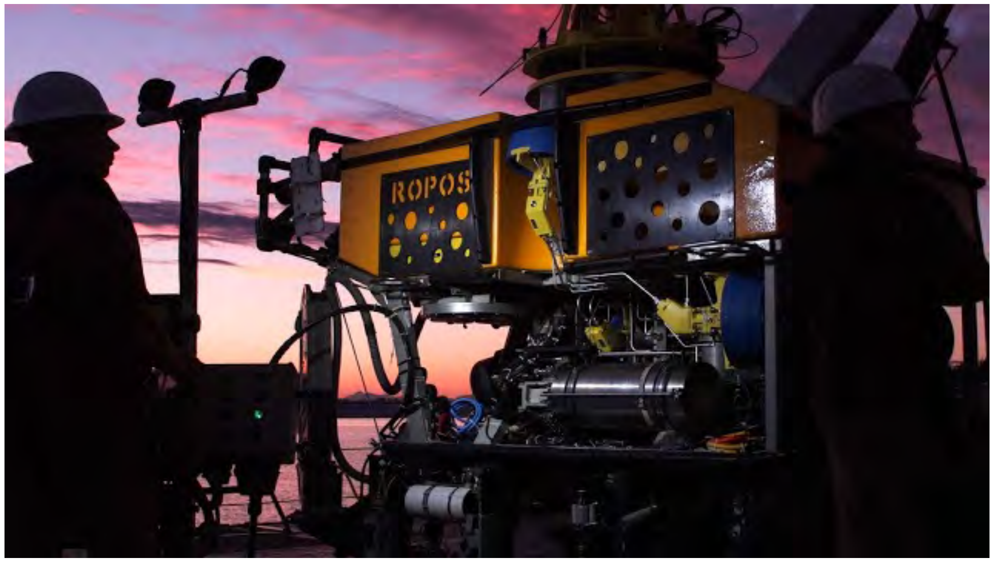
Daily Log, Sept 6 2013

Leg 2 - FK009B
Chief Scientist's Daily Log

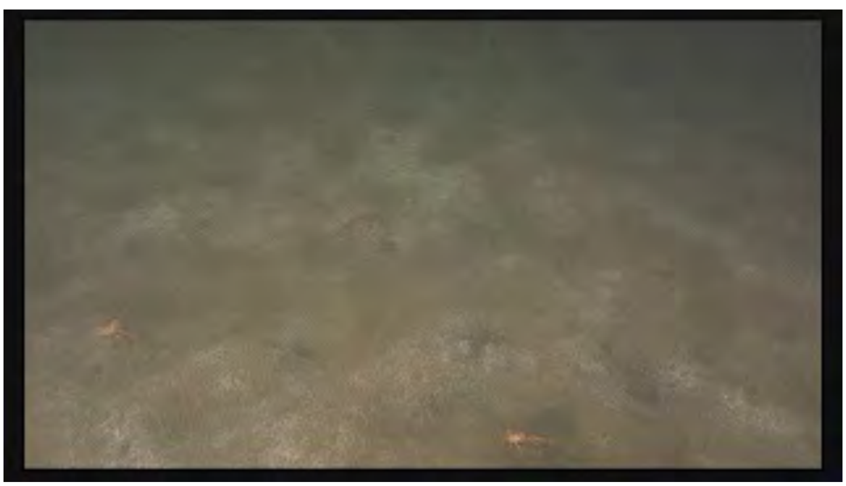
Day 1 Leg 2 – We departed the Ogden Point wharf in Victoria on time this morning and headed into the fog, en route for our first ROV dive in Saanich Inlet. During the transit, the Falkor's fog horn was joined by higher pitch electronic alarms on the bridge, alerting the crew to problems with a satellite data feed. The vessel is now at anchor in Patricia Bay, Saanich Inlet; an unplanned but necessary diversion. Ever the wonderful hosts, the Falkor crew took advantage of our being at anchor to serve our first evening meal *al fresco*, in the lounge on the ship's upper deck. Most of us are enjoying a sublime sunset whilst an electronic technician, just arrived from Vancouver, bends over the bridge electronic consoles, trouble-shooting the faulty data feed. The electronic problem has curtailed plans for afternoon and overnight dives with ROPOS. We are now looking at beginning our dive program at first light tomorrow.

Daily Log, Sept 7 2013

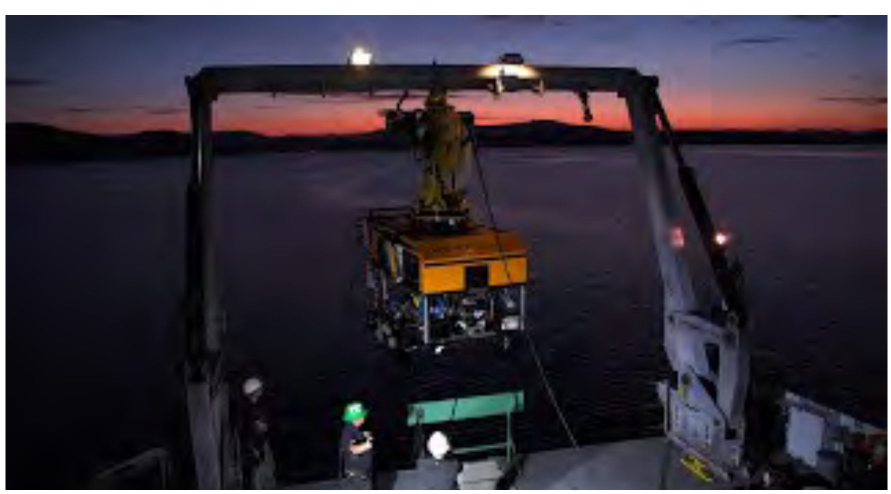
FK009B – Chief Scientist's Daily Log



Day 2 – Two ROV dives accomplished so far today and a third to launch before midnight. This morning, at first light we undertook a survey of the bottom fauna up the slope of the central basin of Saanich Inlet, running from the completely anoxic bottom waters at 184 metres depth, up to the much more oxygenated habitats on the slopes of Patricia Bay, to 52 metres depth.



Our major goal was to document the distribution of flatfish *Lyopsetta exilis*, the slender sole, in relation to dissolved oxygen concentration. We also tried, unsuccessfully, to capture a few flatfish with a net held in the ROPOS starboard manipulator arm, for pilot experiments on their tolerance of low oxygen concentrations. At midday, the Falkor steamed to the upper reaches of Saanich Inlet, where the inlet becomes more fjord-like, with spectacular forested cliffs above the water and equally spectacular rock walls beneath the sea surface that drop precipitously down to 200 metres depth.

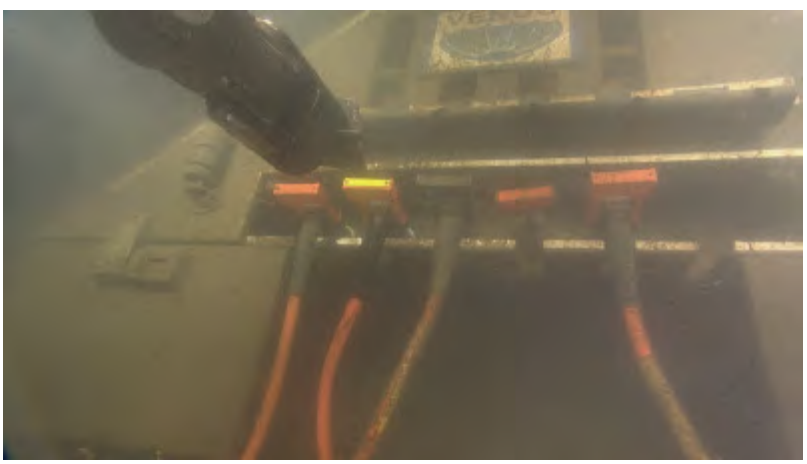


We used ROPOS to visually survey the fauna on these underwater rock walls, from the anoxic bottom up to more oxygenated waters near 30 metres depth. These underwater 'cliff climbs' repeated surveys conducted in the early 1980's by Dr. Verena Tunnicliffe of the University of Victoria. Revisiting these transects will enable University of Victoria graduate student Jackson Chu to evaluate benthic ecosystem shifts that have occurred in this part of the fjord, since the first surveys. Tonight’s dive will return to Patricia Bay to connect a new Ocean Networks Canada instrument platform to the undersea node, collect sediment cores and repeat a section of the flatfish survey to test a hypothesis about day-night differences in their distribution up and down the slopes the inlet.

Daily Log, Sept 8 2013

FK009B – Chief Scientist's Daily Log

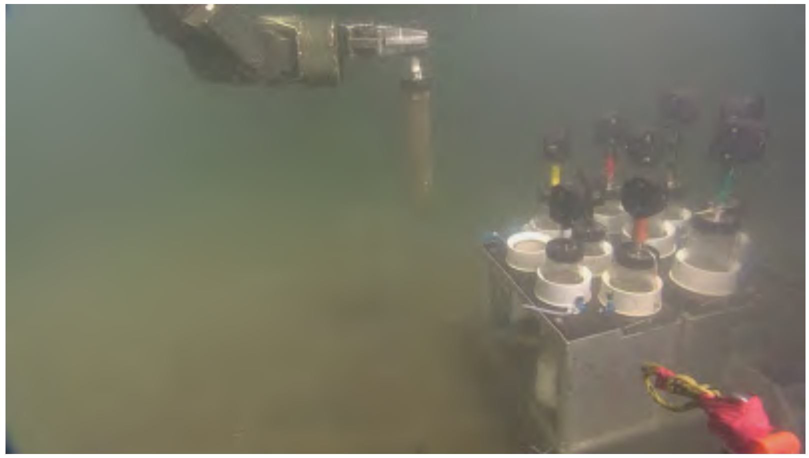
Day 3 – The research vessel Falkor is currently steaming toward our first offshore destination after two final inshore dives with the remotely operated vehicle ROPOS, in Saanich Inlet and the Strait of Georgia. The overnight dive in Saanich Inlet returned to Patricia Bay to connect Ocean Networks Canada's new Buoyed Profiler System to the undersea VENUS node. Once connected, ONC engineer Paul Macoun, back on shore, powered up the node port and confirmed that we had power and communications to the 'BPS'. Congratulations on a job well done, to all who have been contributing to this project.



The BPS is a remotely controlled, floating platform that will lower an instrument package from the surface to the bottom of Saanich Inlet, 180 metres down, several times per day, to measure a suite of seawater properties. Over the next few years, data from this instrument platform will enable researchers to closely monitor the cycle of plankton growth and hypoxia in Saanich Inlet.

After the BPS success, ROPOS collected sediment cores for laboratory incubations to measure oxygen consumption by sediment organisms, then repeated a section of the flatfish survey to test a hypothesis about day-night differences in their distribution up and down the slopes the inlet. The highlight of the survey was the capture of a single flatfish using a net held in ROPOS' robotic arm. The flatfish, 'Vince Junior', was transferred to a chilled aquarium at the University of Victoria Aquatic Facility, where it is currently doing very well. UVic PhD student Jackson Chu will use the fish in pilot experiments to perfect his technique for obtaining precise measurements of fish respiration, under the low oxygen conditions encountered in Saanich Inlet.

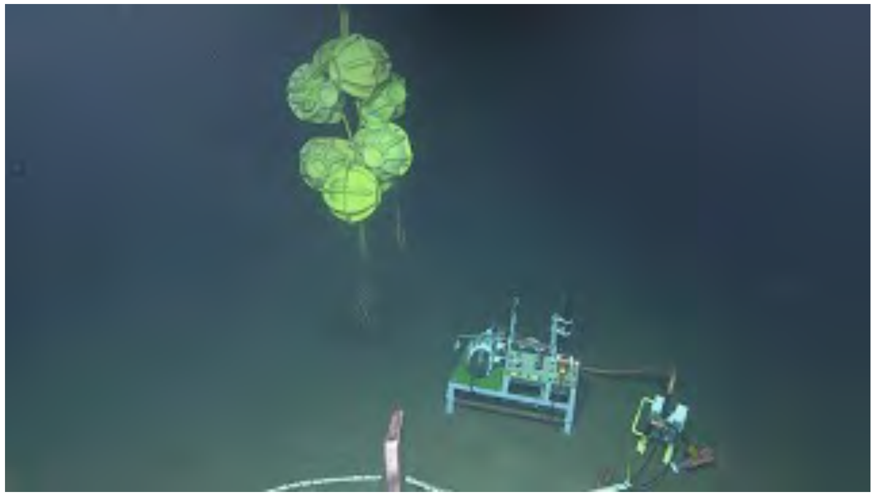
A quick afternoon dive in the Strait of Georgia collected another 10 sediment cores for PhD student Rénald Belley to incubate in the shipboard lab, to compare oxygen consumption rates with cores from Saanich Inlet.



We are anticipating arrival at our next destination, Clayoquot Slope, at around 06:00 tomorrow morning when we will calibrate the ship's new acoustic navigation head before launching ROPOS. Accurate tracking of the movements of ROPOS at this 1200 metre deep site requires that the Falkor's new acoustic transducer be precisely calibrated. We then hope to launch ROPOS near midday, for a short, technical dive to deploy and recover instruments.

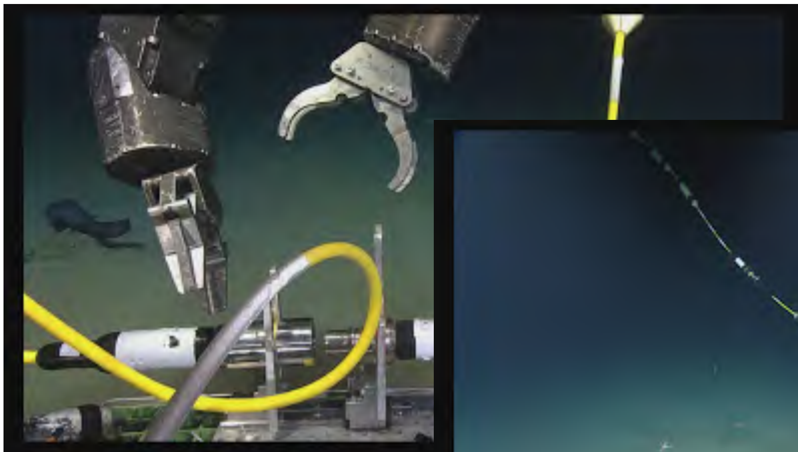
Daily Log, Sept 9 2013

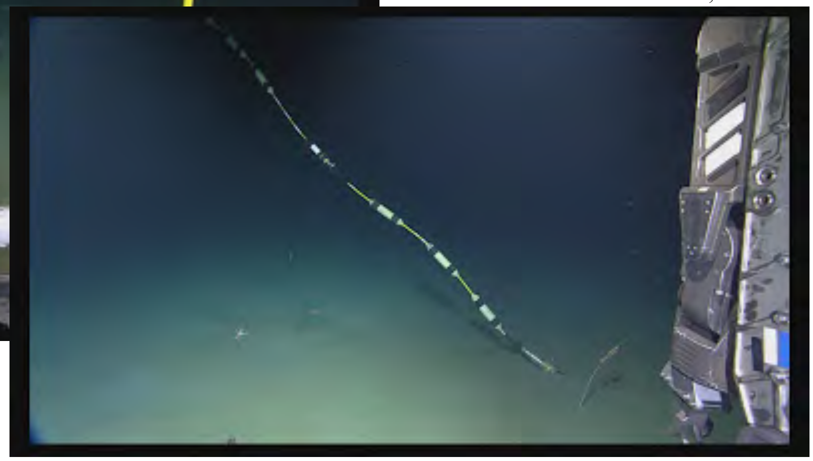
FK009B – Chief Scientist's Daily Log



Day 4 – Our first full day offshore on the Falkor. We arrived at the Clayoquot Slope site at first light where the Falkor crew immediately deployed a complex floatation package over the side of the vessel, that free fell to the seafloor. The package consisted of a cluster of yellow glass sphere floats, a lifting harness, a descent weight and an acoustic beacon, the latter was for calibrating the ship's Ultra-Short Baseline (USBL) sonar transducer that is used to locate the ROV on the seafloor. The Falkor steamed a grid pattern over the beacon for the next five hours while the USBL system ranged on the seafloor beacon. Once the Schmidt Ocean marine technicians were satisfied with the calibration, we launched the ROPOS remotely operated vehicle, laden with a new command module for the SCIMPI borehole instrument and a replacement CTD for the Clayoquot instrument platform.

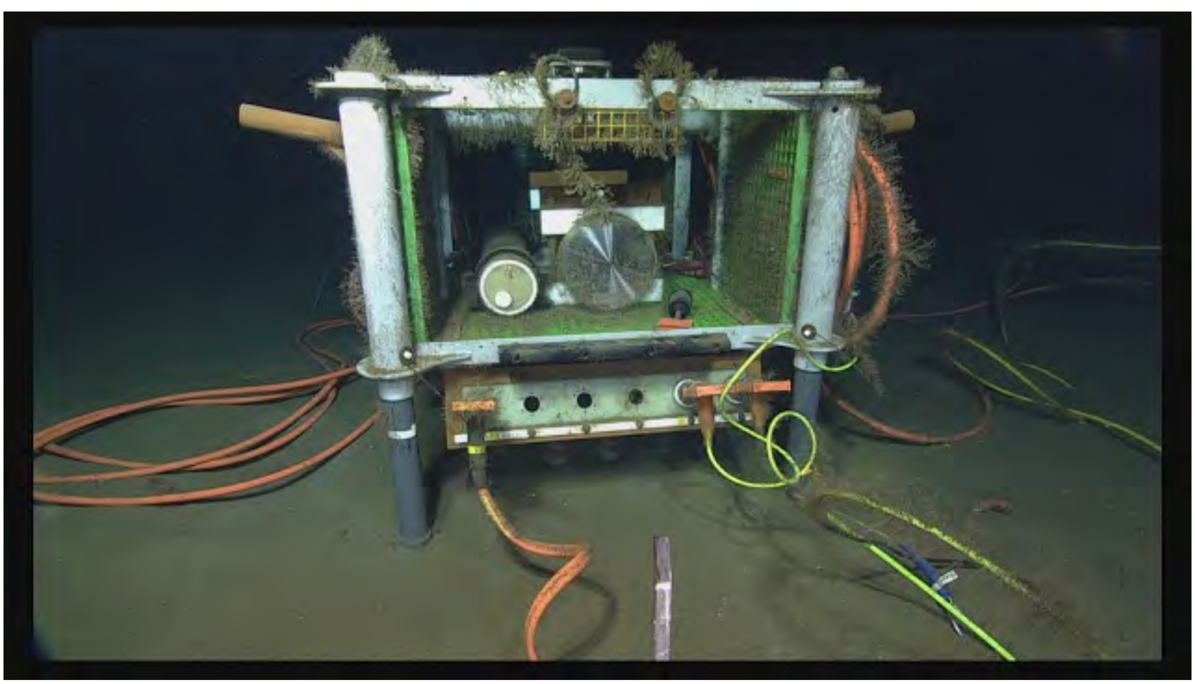
Once on the bottom, the first order of business in this strictly technical dive was to locate the floatation package, and transport it over to the payload that it would carry to the surface. The payload in this case, was an auxiliary seismometer platform that has been malfunctioning. Once ROPOS had disconnected the seismometer that was to remain on the seafloor, the auxiliary platform was hooked onto the floatation package. ROPOS then pulled a pin to release the descent weight. The floatation package swung over top of its payload, pulled by its buoyancy, and then stalled. In the middle of my panicked mental calculations of buoyancy versus payload, the whole assembly rose from the seafloor, as the platform's feet broke free of the muddy bottom. Twenty minutes later the package was on the surface, where the Falkor's rescue boat towed it back to the ship for recovery.





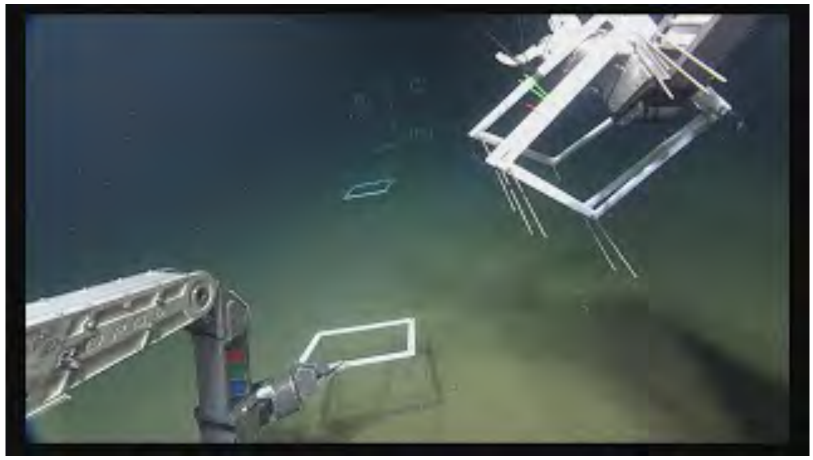
Our next task was to swap out the command module of SCIMPI, a new borehole instrument that was installed four months ago, by the scientific drillship JOIDES Resolution. The command module was at the end of a floating arc of cable that protruded from the borehole. The ROPOS pilots secured SCIMPI's subsea connectors in a special cradle mounted to the front platform of the ROV, pulled apart the two halves and mated a new command module to the connector.

The final task of the dive was to remove the CTD from the Clayoquot instrument platform and replace it with a CTD equipped with an oxygen sensor, to support our growing study of hypoxia on the continental margin off Vancouver Island. After a few anxious moments on the telephone with the ONC Systems group, when the new CTD appeared to be faulty, it was confirmed that the instrument was operating and delivering data, freeing us to secure the SCIMPI command module and terminate the dive. Next stop, Barkley Canyon sometime in the wee small hours of tomorrow morning.



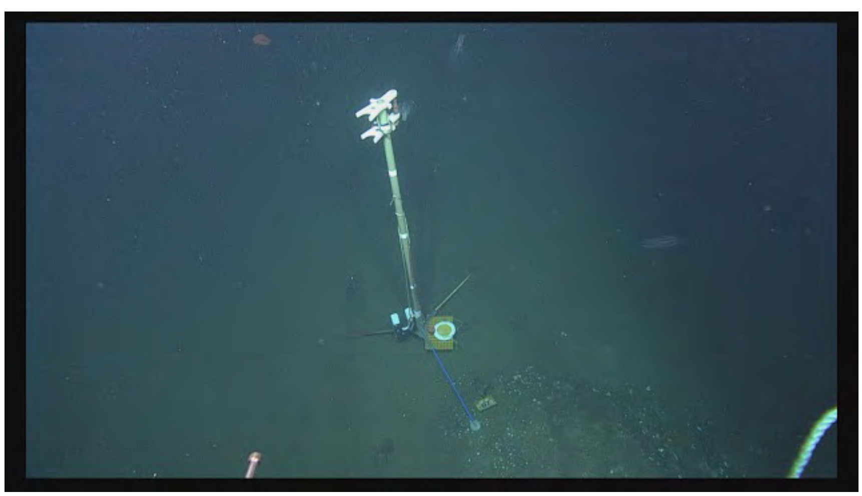
Daily Log, Sept 10 2013

FK009B – Chief Scientist's Daily Log



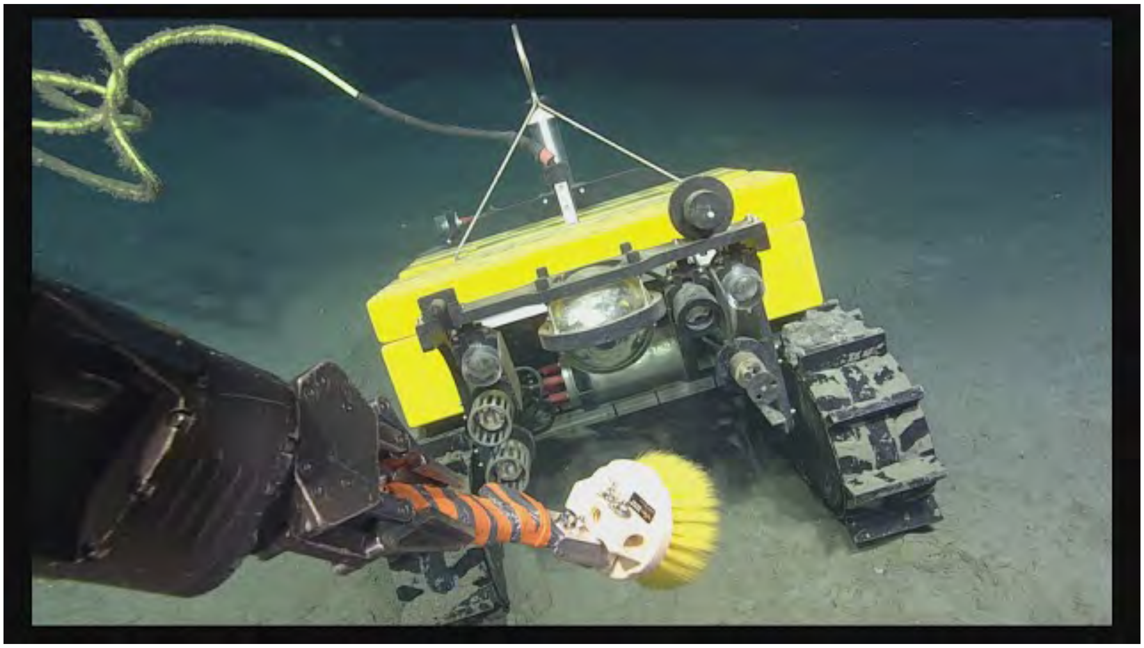
Day 5 – This morning we undertook our first dive in Barkley Canyon, a submarine canyon that cuts into the continental shelf, dropping from 300 metres depth at its landward head, down to 2000 metres at its seaward extremity where it opens into the abyss. Today we dove in the mid-section of the canyon, at around 1000 metres depth. Our first task was to deploy an autonomous CTD and oxygen sensor at our Pod 1 in the canyon axis, to complete our dissolved oxygen monitoring network in Barkley Canyon. From Pod 1 the ROV transited along the seafloor up onto a bench at the base of the north wall of the canyon, where there are several other Ocean Networks Canada experiments and instrument pods. There, near Pod 3, we deployed the first stage of a complex experiment for PhD student Neus Campanya i Llovet from Memorial University of Newfoundland. The ROPOS team worked through the night to find a way to mount her 18 experimental cages on the ROV, to be deployed in three radiating spokes of six cages each, centred around the camera tripod near Pod 3. The deployment went very smoothly. A set of sediment cores was collected between the spokes, as a time-zero reference, to be compared with cores taken within the cages that will receive different experimental additions of nutrients, to determine how the sediment fauna responds to sudden arrivals of food in the form of plankton debris.

Cages deployed, ROPOS moved another 600 metres to a field a gas hydrates where it set up a sonar tower that will be used to navigate the tracked vehicle Wally, as it moves around the hydrate field making faunal and geological observations and taking water property measurements. The sonar tower was connected to the 'hydrates' junction box and our shore based team reported that the sonar had been powered up and was operating nominally.



The ROV was then tasked to meet up with Wally face to face, to give the tracked vehicle a thorough cleaning so that its cameras and instruments could make it through another year on the seafloor unaffected by accumulating biofilms and sediment. Wally's two camera domes received a brisk scrubbing with a yellow toilet brush held in the one of ROPOS' manipulators, and the sensor heads were blasted clean with a water jet.

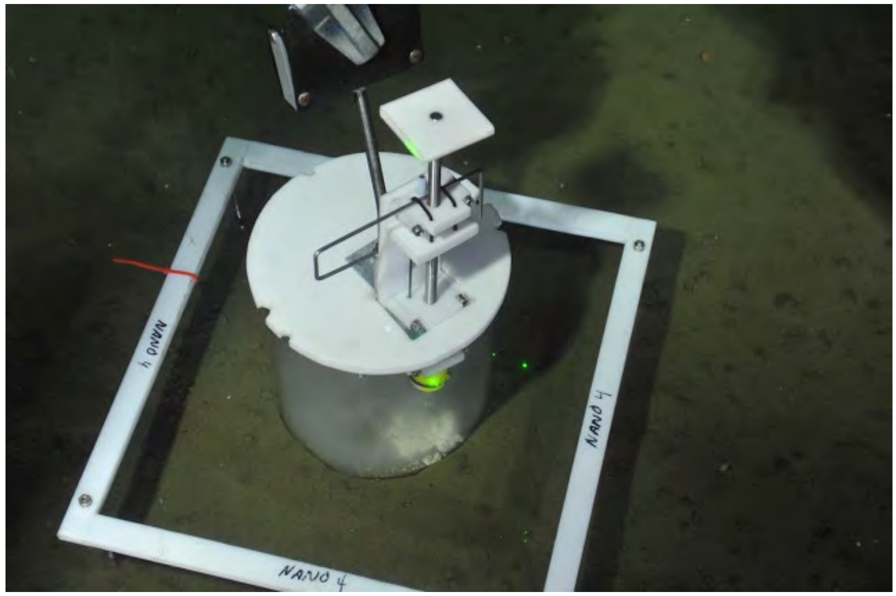
We then directed the ROV to the edge of the plateau that hosts the hydrate field, to an area where there are strong



currents, steep cliffs and a garden of deep-water corals. An hour was spent scouting and defining the perimeter of the coral garden, for future mapping work, following which we recovered an autonomous current metre that had been deployed in the corals during our cruise in May of this year. A second current metre could not be located. We will search again on the next dive.

Daily Log, Sept 11 2013

FK009B – Chief Scientist's Daily Log



Day 6 – Today's primary theme was seafloor experimentation. Two ROPOS dives were dedicated to completing the addition of nutrient enrichments to experimental cages that had been set out in radiating spokes on the seafloor centred around a NEPTUNE Observatory camera tripod, some 650 metres to the northeast of Wallyland. The nutrient enrichments, a mixture of algal cells and clay, were added to the cages using six, pre-loaded 'spreaders' that ROPOS transported down to the seafloor. The spreaders are essentially transparent acrylic cylinders closed at the top by a reservoir and injection mechanism. Once the spreader was placed in the experimental cage, with the lower edge of the cylinder inserted into the sediment, ROPOS pumped a plunger on the reservoir to disperse the algal mixture over the sediment within the cylinder. When all six spreaders had been placed and triggered, they were left in place to settle for a few hours, during which ROPOS went off to complete tasks in Wallyland and the adjacent Coral Cliffs. Such was the itinerary for two successive dives. The first dive took down the six spreaders with one concentration of algal mixture and the following dive added a higher concentration to another set of six seafloor cages.

On today's first dive, during the spreader settling period, ROPOS was tasked with completing two items of unfinished business from the previous dive. We began with an unusual meeting of two operating robotic vehicles on the seafloor. An engineer in Bremen, Germany was operating Wally the crawler over the Internet, and communicating with the ship by Skype, while ROPOS monitored Wally's movements with its cameras. The objective of this exercise was to untangle the turns that had accumulated in Wally's floating tether, as a result of a year where right hand turns had been more frequent than left hand turns. Under the guidance of our team on the Falkor, watching the video feed from ROPOS hovering a few metres above the tracked vehicle, Wally's operator in Germany took the crawler through a series of left hand rotations, until the tether had been straightened. ROPOS then flew down to the seafloor to meet Wally nose to nose, so that the two vehicles could film one another with their respective cameras. Photo-op completed, ROPOS was tasked with returning to Coral Cliffs to search for the second ADCP (acoustic current metre) that had been deployed in May. We had been unsuccessful in locating the ADCP on the previous dive. To the delight of Dr. Len Zedel of Memorial University of Newfoundland, following the dive online, we quickly found his missing instrument, following which we returned to Wallyland to collect push cores in an area that has been monitored by Wally's instruments for several years. The push cores are for PhD student Neus Campanya i Llovett, who will be studying the fauna found in the sediments between the mounds of outcropping gas hydrates. Push coring completed, ROPOS returned to the experimental site to collect the spreaders.

The second dive of the day was similar to the first, beginning with deploying the spreaders at the experimental site, with a side trip to Wallyland for push coring. Before returning to pick up the spreaders we collected biological samples, first from a hydrate mound where the ROPOS suction sampler was used to sample an unusual assemblage of worms and snails that was colonizing the bacterial mats that covered the hydrates. Following this, we collected two specimens of the black coral that was the most common coral in the Coral Cliffs area. The specimens were collected for Dr. Evan Edinger of Memorial University, along with a small piece of carbonate rock to which they were attached.

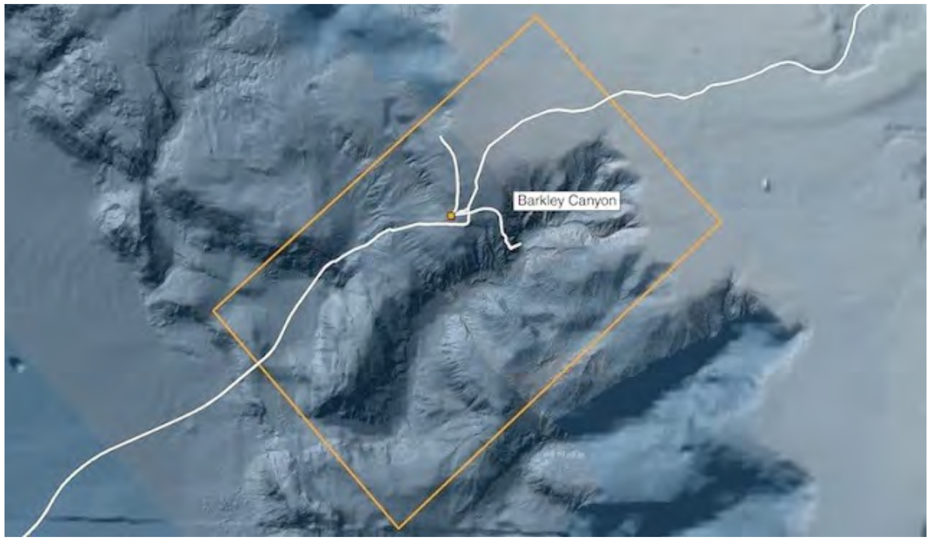
This marked the end of our technical dive series, where ROPOS was configured to deploy instruments and experiments. Tomorrow we shift the science program to a series of survey and sampling transects, across the axis of Barkley Canyon, beginning with our deepest dive of the cruise, near the canyon mouth at 2000 metres depth.

Daily Log, Sept 12 2013

FK009B – Chief Scientist's Daily Log

Day 7 – Today we conducted our deepest dive of the cruise, at 2000 metres depth, near the mouth of Barkley Canyon where it opens onto the lower continental slope and the adjacent abyssal plain. This was the first in a planned series of survey dives where ROPOS flies a 1 km transect at just under 2 metres of altitude above the bottom, with all of onboard cameras trained on the seafloor in fixed positions. We then shift to a shorter parallel survey line to provide duplicate visual information, following which we collect samples of the larger organisms on the seafloor for species identifications and for analysis of their tissues to determine their food sources. During the visual transects, two pumps are collecting suspended particles from the water above the bottom, so that this potential food source can be identified chemically and compared to the tissues of the bottom creatures.

This dive to 2000 metres took us below the core of the oxygen minimum layer, where expected to encounter a different biological community than we'd been used to seeing at 800-1000 metres near the NEPTUNE instruments in Barkley Canyon. We were not surprised. The most common megafauna (large organisms) on the flat, muddy bottom were two species of holothurians (sea cucumbers) that we'd not seen before, two sea pens, two sea anemones and at least one fish species, the Pacific Flatnose, that was not very common at the shallower sites. Specimens of these and other organism were collected using a scoop or the ROPOS suction sampler, along with 2 push cores for chemical characterization of the organic matter in the sediments that serves as a food source for many of the seafloor animals.



Flying the video survey transect with ROPOS at a constant speed (0.25 knots) required considerable coordination between the Falkor bridge and the ROPOS team. The ship moved slowly along a path parallel to the transect, slowing down and speeding up, on request, to maintain a fixed distance from the vehicle to avoid unfavourable angles in the umbilical cable that connects ROPOS to the Falkor.

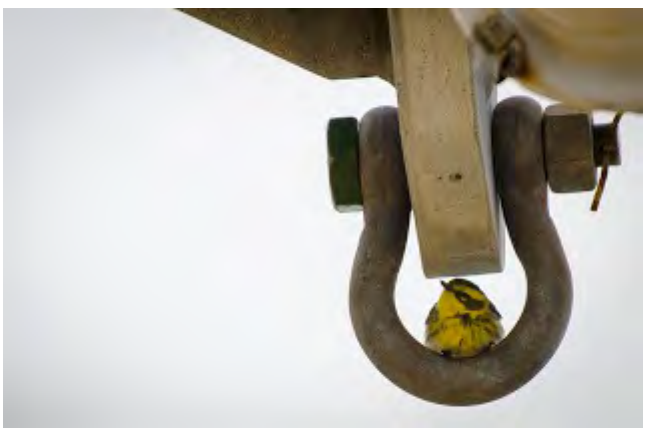
As submersible was being recovered at the end of the dive, the ROPOS team noticed a triple twist in the umbilical cable that connects ROPOS to the Falkor, providing power and communications. The twist, which had to be removed, was about 100 metres up the umbilical from the vehicle. The ROPOS team immediately went into cable re-termination mode. The damaged section of cable was removed, following which the optical fibres and electrical conductors had to be re-connected to ROPOS. This operation normal requires 18-20 hours, during which the Falkor will be using its multi-beam sonar system to complete our seafloor map of the upper sections of Barkley Canyon.

Daily Log, Sept 13 2013

FK009B – Chief Scientist's Daily Log

Day 8 – Today was definitely a Friday, the 13th when it came to ROV operations. The first sign that the day would be different came in the morning. Three ROPOS-coloured yellow warblers (*Dendroica petechial*) appeared on the aft deck of the ship and began hopping around the submersible: unusual, but not necessarily ominous. The tiny birds, 75 km from their nearest land habitat, perched on ROPOS as it was being launched for the first dive of the day. Moments later, telemetry was lost to the vehicle and the following 16 hours were spent trouble-shooting a difficult electrical problem. Tarps were erected around ROPOS to protect electronics from the light drizzle as pressure housings were opened, and the Falkor shifted to multi-beam mapping of the seafloor around the head of Barkley Canyon.

We made great progress mapping the head of the canyon and the adjacent continental shelf, identifying several channel-like features that could be pathways for the flow of low-oxygen water moving up through the canyon during upwelling events. The high-resolution multi-beam system on the Falkor also revealed an uncharted rocky pinnacle near our 100-metre dive site. As midnight approached and



Friday, the 13th came to an end, the ROPOS team was zeroing in on the source of the telemetry problem and the prospect of an early morning resumption of dive operations had us optimizing the multi-beam mapping grid to keep the ship close to the next dive site.

Daily Log, Sept 14 2013

FK009B – Chief Scientist's Daily Log

Day 9 – Two dives today in the upper reaches of Barkley Canyon to support a study of how dissolved oxygen concentrations affect the capacity of the benthic ecosystem to respond to food inputs from surface waters. In the upper canyon, we were focussing on surveying the distribution of kelp debris that French researcher Marjolaine Matabos had first noticed in imagery from the NEPTUNE camera in the axis of Barkley Canyon. Researchers speculated that deep currents were transporting dead kelp down the canyon from coastal waters and that the canyon was acting as a funnel for offshore transport of kelp debris. The kelp could therefore be an important food source for the bottom fauna in the canyon. Which species could take advantage of this food source could depend on local dissolved oxygen conditions in areas of the canyon where the kelp debris was accumulating. These were the basic ideas behind our surveys with ROPOS at 200, 300 and 400 metres depth. During our first dive, that crossed the canyon at 200 metres depth, we discovered a large concentration of the fragile pink sea urchin, *Strongylocentrotus fragilis*. A quick survey with ROPOS determined that this 'herd' of urchins covered an area of at least 10,000 square metres. A close-up examination of the seafloor with the ROPOS down-looking camera revealed the bottom here to be covered with fluffy, brownish 'phytodetritus', debris from surface phytoplankton blooms. Clearly it was time for a new working hypothesis to explain the presence of the herd of pink sea urchins. Out went the kelp debris explanation, at least for this site. Instead, we reverted to a more classic idea of food transfer to the seafloor by the sinking of debris from single-celled phytoplankton.

On our next dive, that ran transects at both 400 and 300 metres depth, the kelp story came back into focus. At the beginning of the dive, we discovered a large mass of kelp debris that was swarming with pink sea urchins, tiny amphipods and a few sh rimp. Here, the kelp was clearly serving as a food oasis for several species, albeit in a limited area. ROPOS spent a couple of hours surveying and then collecting samples from the kelp debris before heading off to complete the video surveys. Small plateaus and gentler slopes in this area also supported a sizeable population of halibut.

The remainder of the dive was like a field trip in submarine canyon geology, with the dissolved oxygen story layered on top. Our north-south transects took us down steep topography one side of the canyon into lower oxygen waters in the canyon axis, then back up spectacular cliffs on the other side that were colonized by corals, feather stars, sponges and the occasional Giant Pacific Octopus. The seafloor in the deeper, oxygen-poor canyon axis was almost barren in comparison with the cliffs and plateaus of the canyon walls. Our next dive will return to the deeper waters of Barkley Canyon, for a 1 km long transect at 1500 metres.

Daily Log, Sept 15 2013

FK009B – Chief Scientist's Daily Log

Day 10 – Another two dives today, to continue mapping fauna and habitat distribution in Barkley Canyon and documenting the distribution of kelp debris, all in support of our study of how ocean hypoxia affects biodiversity and ecosystem processes.

The first dive returned to the deeper waters of Barkley Canyon, for a 1 km long transect at 1500 metres. The bottom seawater at this location corresponds to the lower limit of the oxygen minimum layer. The bottom fauna here was dominated visually by a 'forest' of 60 cm high sea pens, most with a brittle star companion wrapped around the upper portion of their stalk. We sampled these sea pen/brittle star 'combos' and other species for identification and for analysis (stable isotope ratios, lipid profiles) of their tissues to determine their food sources. Kelp debris was rather scarce in this lower part of Barkley Canyon.

Our second dive took us up to a transect line that crossed the canyon floor at a point where it is 800 metres deep. The canyon is narrower at this point, so that our transect took us down the lower edge of the canyon wall, across the canyon floor and part way up the other side. During the descent onto the canyon floor, ROPOS encountered the underwater equivalent of a dust storm. A strong current coming up the canyon from the south was transporting so much resuspended sediment particles that it was difficult to see the bottom with the ROPOS cameras. The area affected by this 'turbidity event' was quite substantial, at least 200 metres across the axis of the canyon and up to at least 20 metres above the canyon floor. Eventually as ROPOS approached to opposite wall of Barkley Canyon the sediment storm diminished, although the current remain strong. We ended by dive by collecting 10 push cores for Rénald Belley who was celebrating his birthday yesterday and celebrating the fact that these would be the last push cores of his PhD project. Tomorrow we will complete our transect series in Barkley Canyon with a dive at the 600 metre mark.

Daily Log, Sept 16 2013

FK009B – Chief Scientist's Daily Log

Day 11 – Today was marked by a final underwater transect in Barkley Canyon, a rendezvous at sea and the completion of our multi-beam mapping program in Barkley Canyon.

ROPOS dive 1658 took us across the floor of Barkley Canyon along the 600-metre depth contour. Once again the narrowness of the canyon at this point resulted in our 1km transect beginning and ending on the lower slopes of the canyon walls, where we were treated to more visually spectacular topography than out on the flat, muddy floor of the canyon axis. Kelp debris was more abundant along this transect than we had seen anywhere else in Barkley Canyon but there were no large accumulations of kelp; only isolated fragments of individual 'plants' most of which appeared to be in transit. We did perform a short survey centred on one kelp fragment, to determine if it had been stationary for long enough to affect the local distribution of benthic organisms. This kelp section was slurped up with the suction sampler for further study. After collecting a couple of glass sponge samples, and a final two push cores, we ended the dive to prepare for our transit to coastal waters off Barkley Sound, where we had a scheduled 15:00 rendezvous at sea with a launch from the Canadian Coast Guard.

We met up with the CCGS Cape Calvert three miles off the coast, at the edge of the pilotage zone. The meeting of the two vessels had been organized by the Canadian Coast Guard to enable two ROPOS pilots to disembark and travel to Victoria from where they would travel to Resolute, in the Arctic, to be available to operate a remotely operated vehicle on the Canadian icebreaker CCGS Amundsen. If ice conditions permit, the Amundsen will be tasked with using its small onboard ROV to locate the wreckage of the Amundsen's own helicopter that went down in the icy waters of McClure Strait on Sept. 9, with a tragic loss of life. The Cape Calvert positioned itself off Falkor's starboard beam while we launched a small boat to transfer personnel between the two vessels.

A quick trip offshore after our meeting with the Cape Calvert allowed us to fill in a gap in the multi-beam coverage of the area around the head of Barkley Canyon. We then headed southeast for our final two dives of the cruise, in Tully Canyon, located in U.S. waters.

Appendix B: MVP, ADCP, and CTD Summaries and Plots

The following pages were compiled from a TeX document summarizing the sections and data collected from the Moving Vessel Profiler (MVP), the Acoustic Doppler Current Profiler (ADCP), and the Conductivity, Temperature, and Depth (CTD) profiler.

Pathways 2013 MVP cruise report

PI: Jody Klymak
Chief Scientist: Richard Dewey
Co-PIs: Susan Allen and Stephanie Waterman

March 21, 2014

Personel Chris MacKay Technical, Rowan Fox Technical, Emma Murrowinski Graduate Student

1 Introduction and Setting

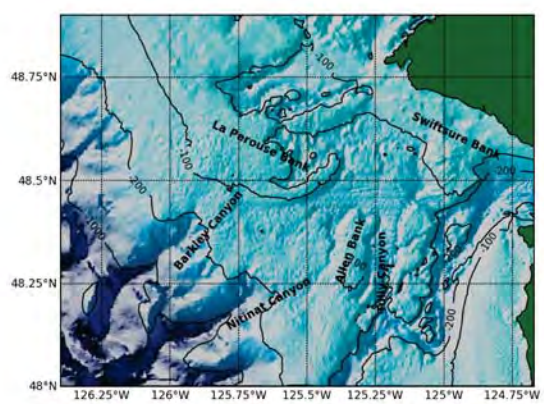


Figure 1: Southern Vancouver Island shelf, bounded by Juan de Fuca canyon in the east and south, and Barkley and Nitinat Canyons to the west.

The MVP surveying largely focused on the western edge of the Juan de Fuca Eddy region between Swiftsure bank and La Perouse Bank (figure 1 and figure 2).

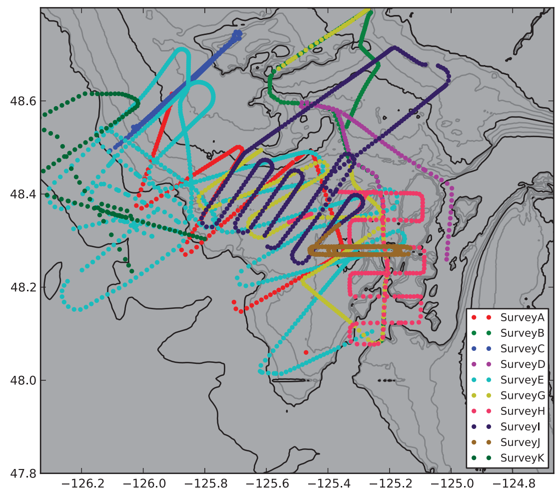


Figure 2: Survey Tracks for the MVP during Pathways 2013 cruise

We particularly emphasized the Tully Canyon, the strong and persistent front between the well-mixed water in the eddy and the shelf water that ran SE from LaPerouse to "Zeppelin Bank" or "Allen Bank".

Water mass characteristics on the shelf were relatively clearly divided between "Eddy" water along a mixing line, and shelf water. As we see below, the shelf water had two flavors, that which was on the shelf south of Barkley Canyon, and that which was on the shelf north of Barkley Canyon (figure 3). We use this definition of the water mass to identify water that is "spicy" compared to the straight T/S line found in the eddy. Thus all the water that is to the right of the T/S line is positive spice, and all that to the left is negative spice. The units of spice are defined as locally linear as $\gamma = \rho_0(\alpha(T - T_0) + \beta(S - S_0))$, where $\rho_0\alpha \approx 0.2$ and $\rho_0\beta \approx 0.77$ are the expansion coefficients due to temperature and salt. It should be clear from figure 3 that the linear approximation is relatively valid. Note that the T/S curves cross at approximately $\sigma_\theta = 26.1\,\mathrm{kg\,m^{-3}}$, leading to a null in "spice" at this isopycnal in the plots below. They also meet at about $\sigma_\theta = 26.67\,\mathrm{kg\,m^{-3}}$ in the deeper waters.

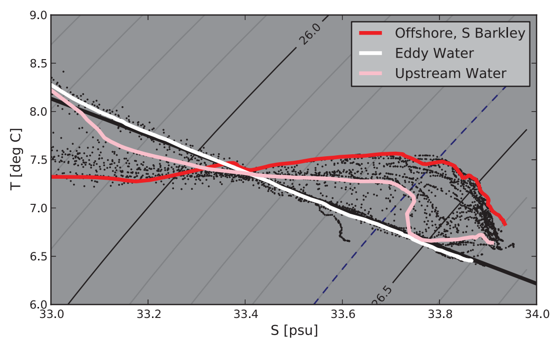


Figure 3: TS plot from SurveyA, with three water masses identified. Red is water found on the shelf south of Barkley Canyon, Pink is found north, or upstream of Barkley Canyon on the shelf, and there is no “red” water observed that far north. White represents the water found in the Tully Eddy.

2 MVP surveys

2.1 Survey A: Western lower shelf quick survey.

21 Aug 04:11 to 21 Aug 23:42

This was done after an intensive time surveying Barkley Canyon with CTDs. Both BCC and LC lines were sampled with lots of chemistry and CTDs. This line was to give a quick view of the shelf downstream from LC line.

Survey A clearly delineated the front on the west side of the Eddy. The front was relatively far offshore, and very sharp. Eddy water was very much along the T/S line (white along $\sigma_\theta = 26.4\,\mathrm{kg\,m^{-3}}$ figure 12). The transition from upstream of Barkley Canyon to downstream is very obvious, with spicy water downstream, and less spicy (pink) upstream. This is true at all depths.

A little later, this lead us to realize that the “pink” water has to go somewhere.

The velocities are generally southwards (figure 6) along the shelf, but the northern-most section indicates offshore flow north of Barkley canyon.

Note that our O2 sensor-fish had a loose connection causing the temperature signal to be very noisy, so we had to use a single-sensor fish for this survey and SurveyB. Hence no O2 signal.

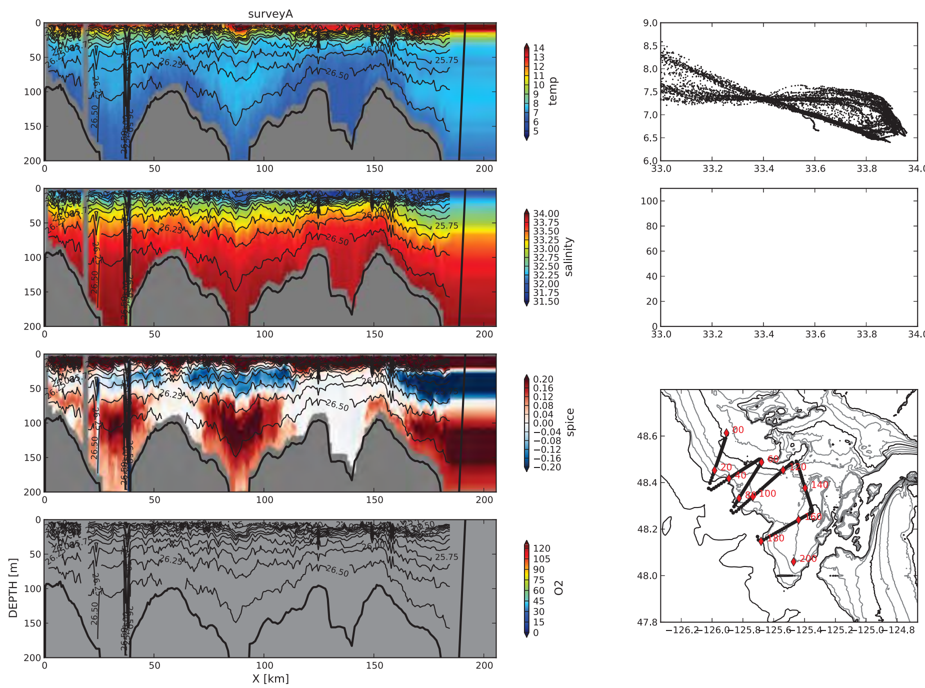


Figure 4:

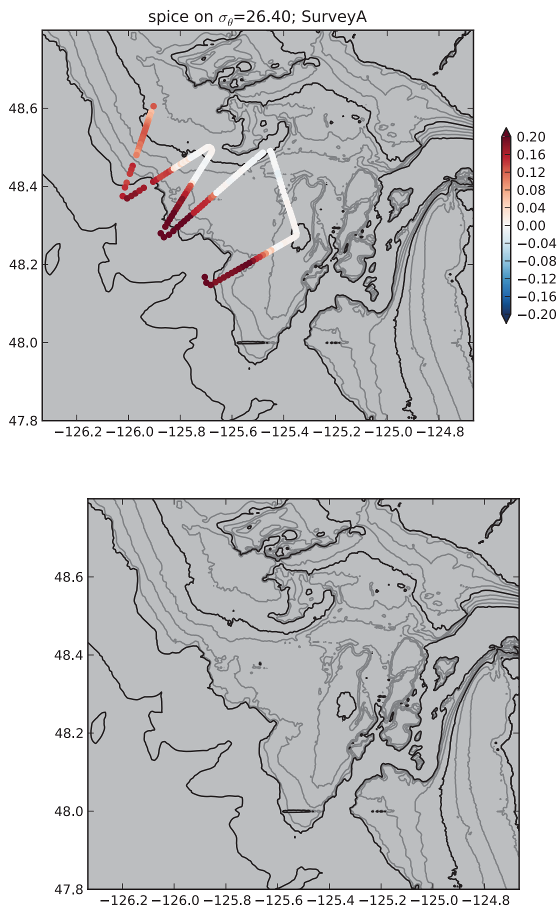


Figure 5: Spice along the $\sigma_\theta = 26.4\,\mathrm{kg\,m^{-3}}$ isopycnal during survey A. This is representative of the depth of the largest spice anomaly in TS space. For the other plots there are places where spice anomalies are not vertically homogenous, which should make for an interesting story, but as a short hand for front position and water masses this is pretty effective.

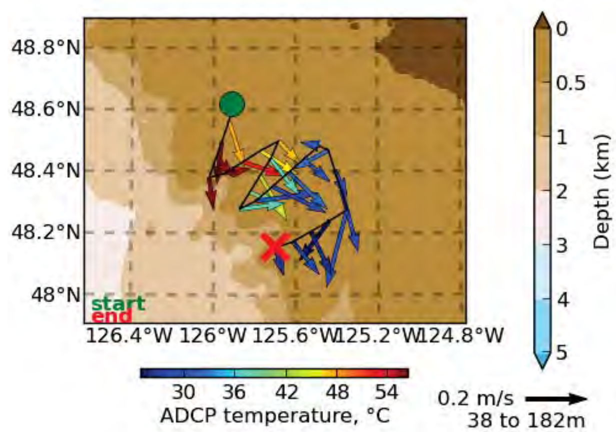


Figure 6: ADCP during SurveyA. Note the offshore transport just north of Barkley Canyon. A little care should be taken here, as these velocities probably do not have a proper heading correction to them.

2.2 Survey B:

22 Aug 03:40 to 22 Aug 14:54

This survey was to see what was in Tully Canyon. We clearly transitioned quickly from “shelf water” to “eddy water” quite quickly up the canyon (figure 7). By X=20 km there is a blob of non-eddy water just east of “Allen Bank” a process we explore below. Relatively quickly the interior of the eddy falls along the mixing line. There appears to be a bit of a hydraulic blockage at “Finger Bank” and then evidence of hydraulics at the “neck” just to the north.

We then swung east across the inner basin and crossed the fresh Vancouver Island current. There is a clear density front here. We swung S to resample it on the other side of east La Perouse Bank. There was clearly some structure in this signal.

These observations are clearly seen in the spatial map (figure 8), with an blob of spicy water just N of Allen Bank in the canyon.

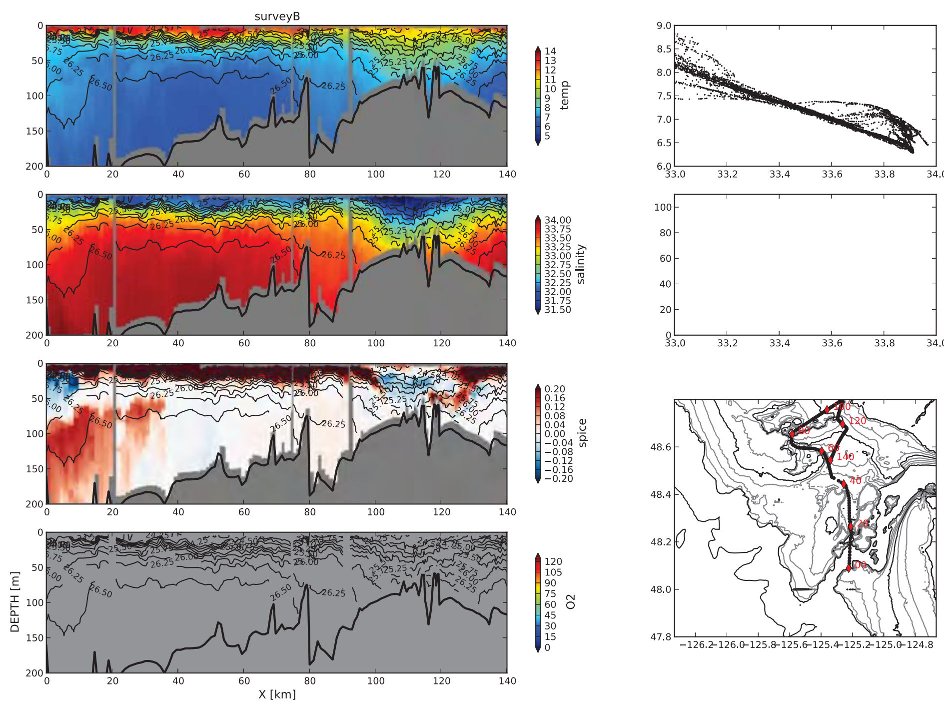


Figure 7: Survey B property maps.

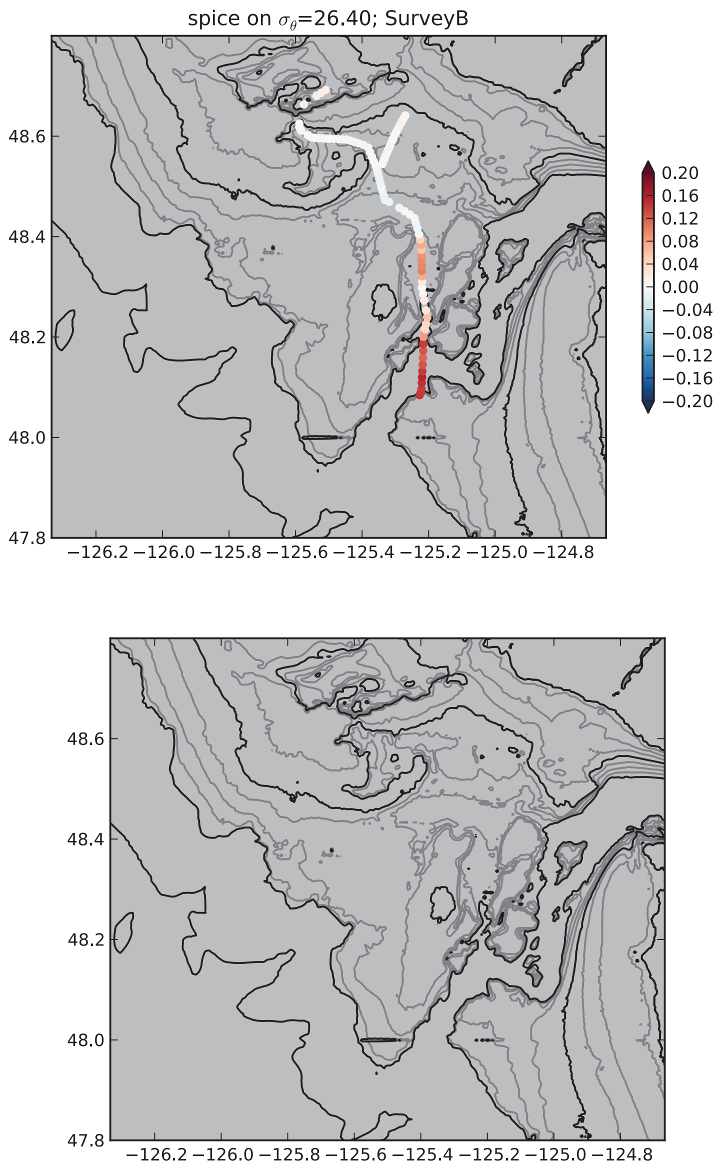


Figure 8: Survey B water properties along $\sigma_\theta = 26.4\,\mathrm{kg\ m^{-3}}$ isopycnal.

2.3 Survey C: tidal survey along LC line

23 Aug, 02:17 to 23 Aug, 15:42

We did this short tidal survey over LC line for 14h for five passes over the bank with the tide. Motion up and down the bank was modest, so we didn't continue this time series. The tide probably pushes this water over, but the survey started after peak "flood" and waiting another 15 h to capture the next flood was not practical.

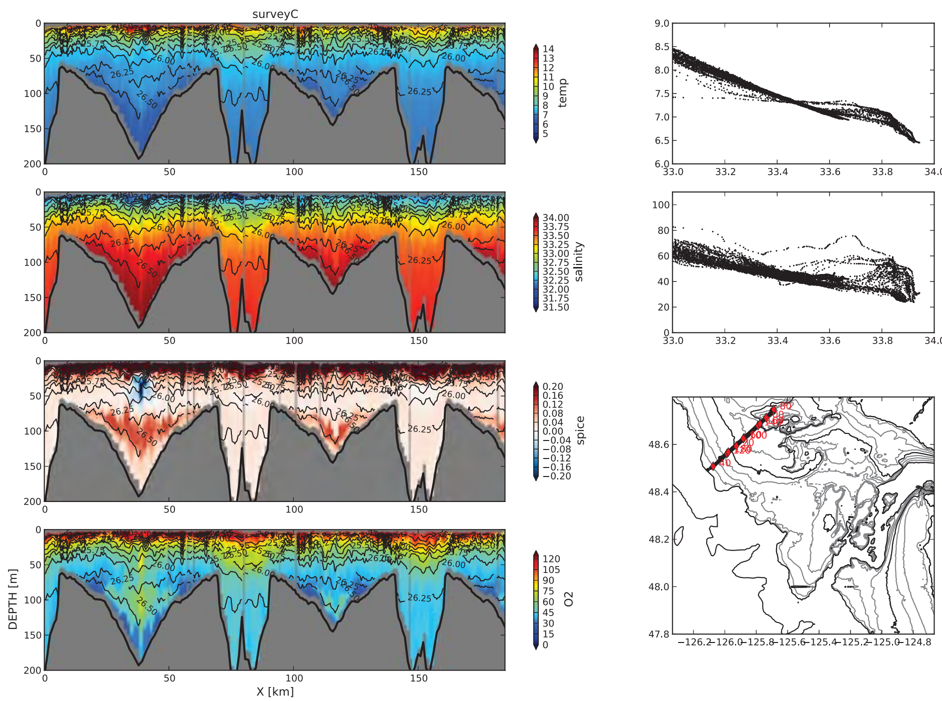


Figure 9: Survey C

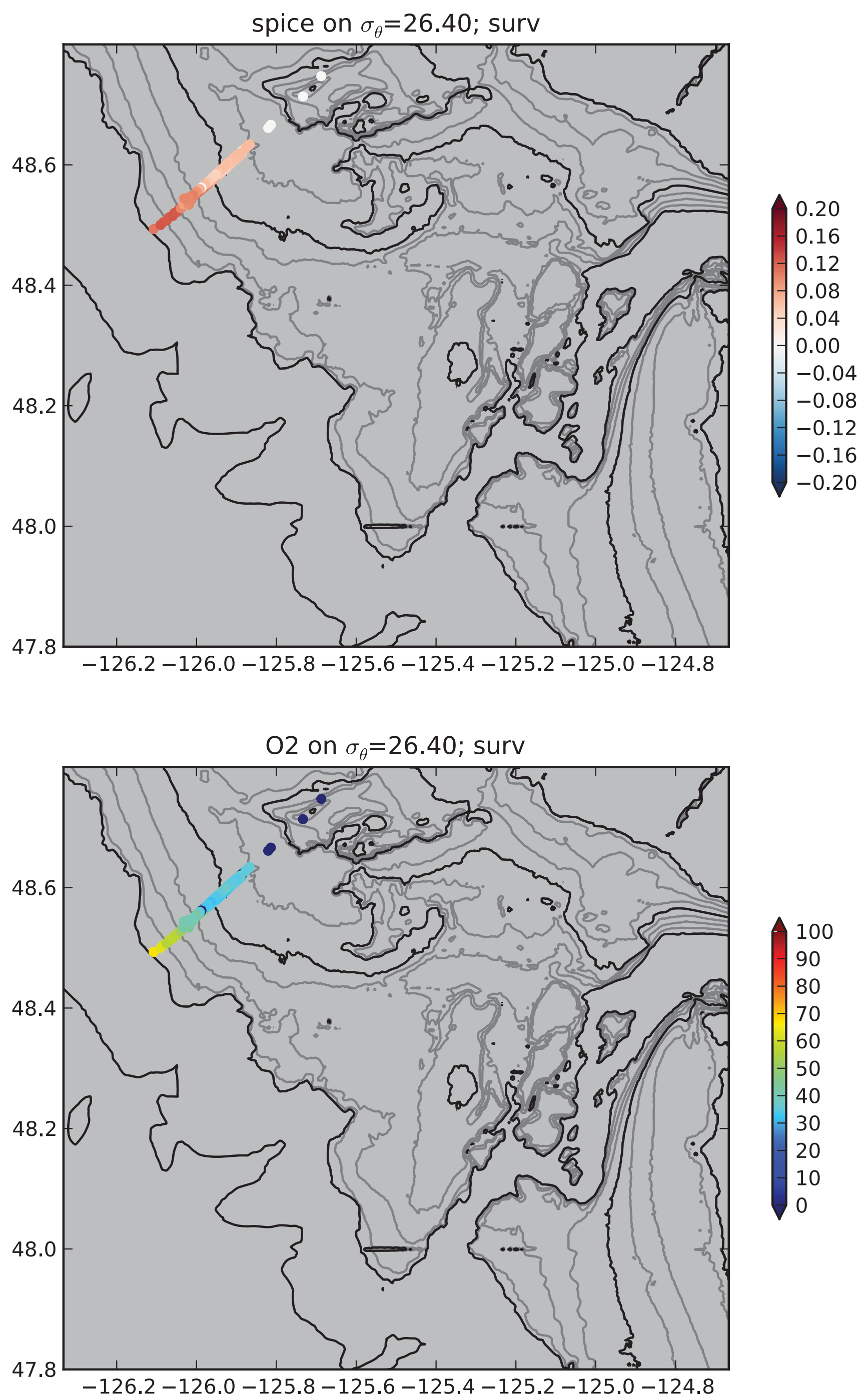

spice on σ_θ=26.40; surv
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Figure 10:

2.4 Survey D: North entrance and Tully Canyon

23 Aug 21:09 to 24 Aug 05:33

Some CTDs were done, and then this survey was executed to see the differences in the canyon. Worth checking the tides to see where we were wrt the flood into the canyon. There is a blob of high-spice water just north of Allen Bank at $x = 95$km.

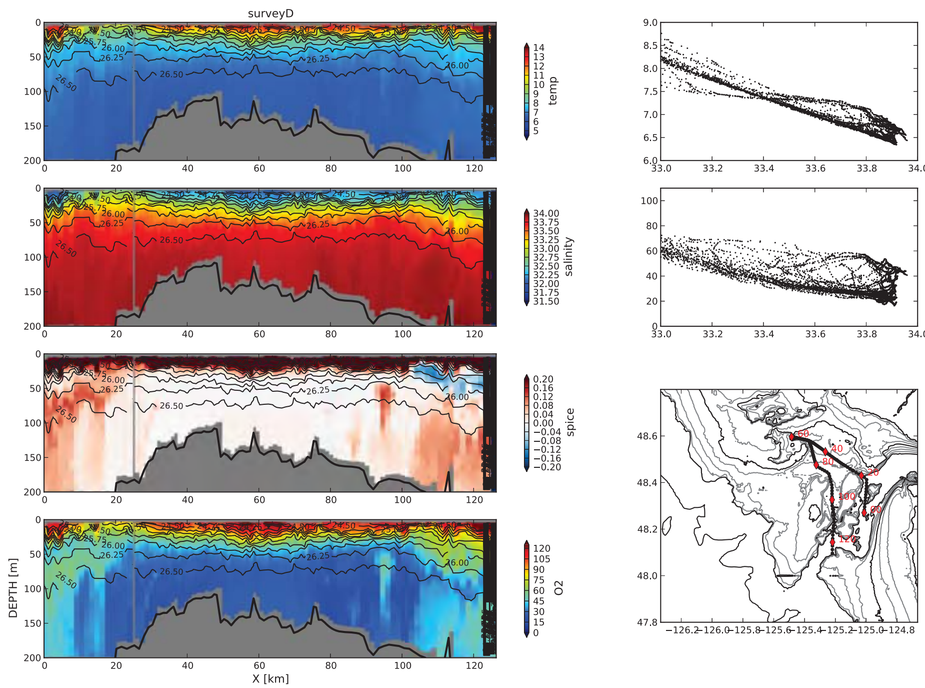

Figure 11:

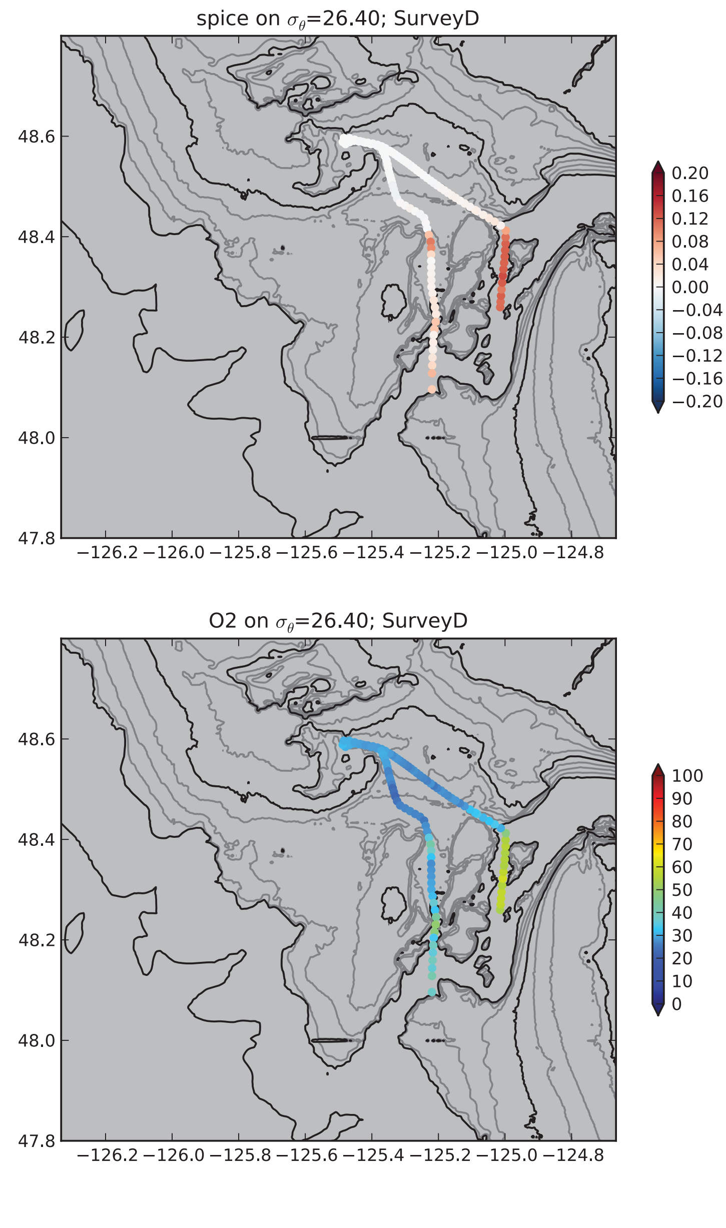
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Figure 12:

2.5 Survey E: Large survey west shelf

24 Aug 07:20 to 26 Aug 11:40

This survey was very extensive and was largely designed to 1) study the western front, and 2) figure out where the “pink” upstream water went, since it did not appear to come down onto the southern shelf. The latter parts of the survey indicate that this water is pushed offshore in a tongue or “squirt” just north of Barkley Canyon. The shelf water is replaced by offshore water brought into the area by canyon “upwelling” though this also has to be a lateral process.

Susan’s models indicate cyclonic vorticity is generated at the canyon head, so this is consistent. There is still a bit of a question as to where the water goes as it cannot laterally mix to become “spicy” water. Its possible there is even spicier water further offshore?

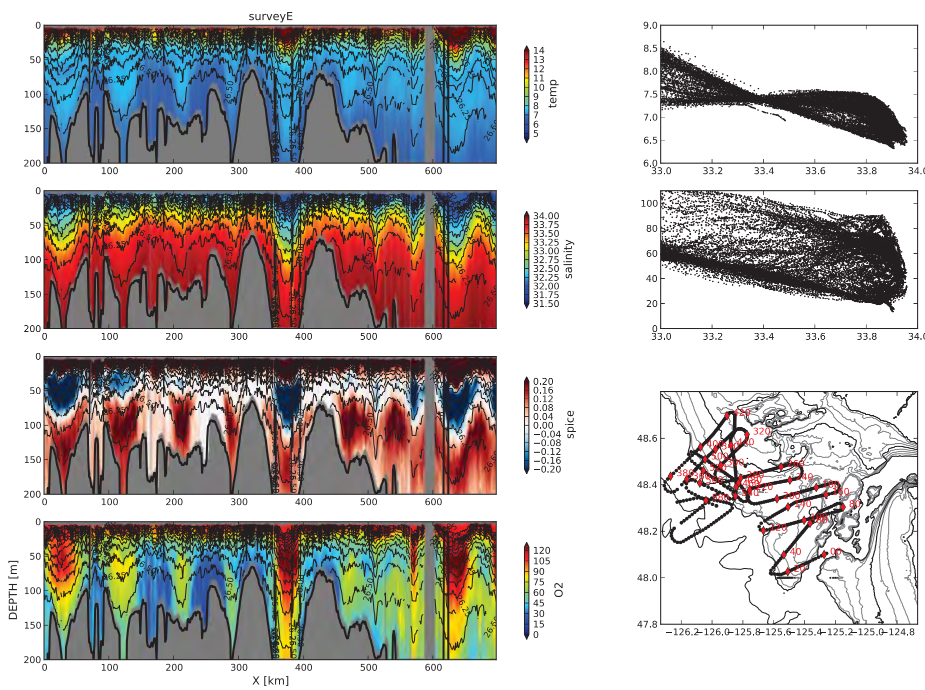


Figure 13: Survey E property sections.

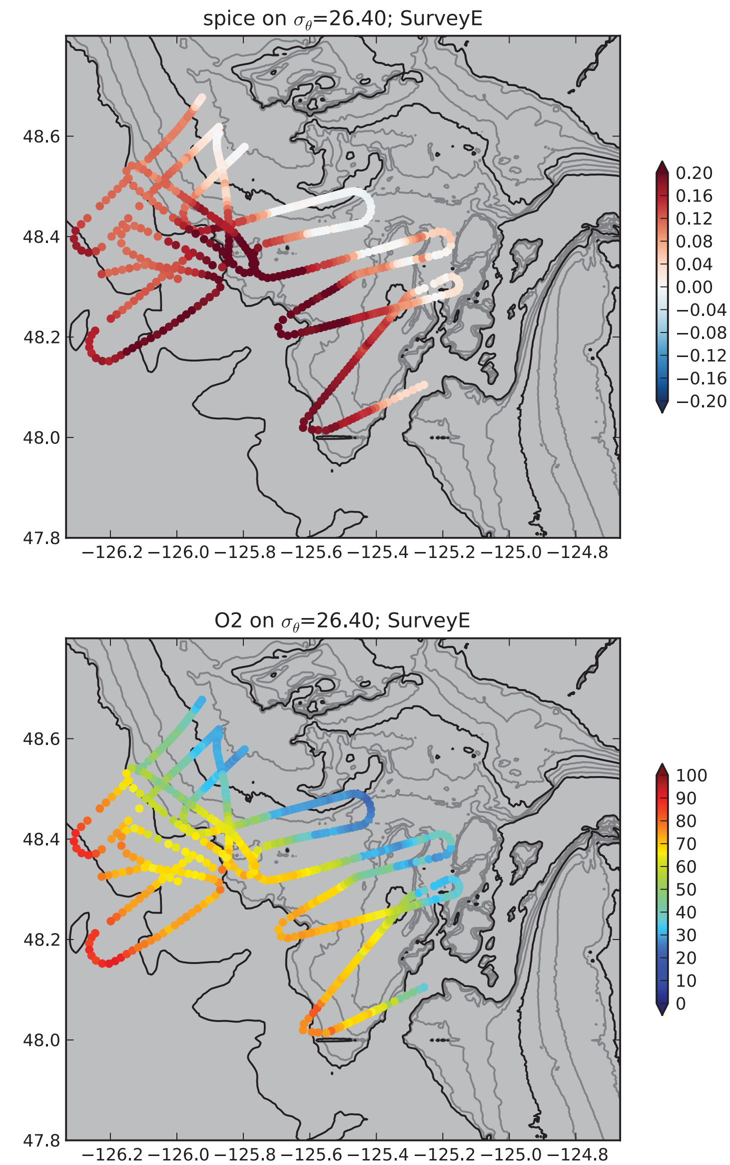


Figure 14: Survey E spice survey at $\sigma_\theta = 26.4\,\text{kg m}^{-3}$.

2.6 Survey G: Western Front Resurvey

26 Aug 18:28 to 27 Aug 15:51

NOTE: No survey F - G was made part of "F".

This survey started in Imperial Eagle Inlet and ran out through the VIC. Note the two-fronts with low O2 water inside the VIC. As Rich asked, how does it get there? What is the exchange through here? Given that its lower than the basin just SW, one wonders if it is long residence time?

This water is not captured on the $\sigma_\theta = 26.4\,\mathrm{kg\ m^{-3}}$ isopycnal.

Most of the survey was recharacterizing the western front of the eddy.

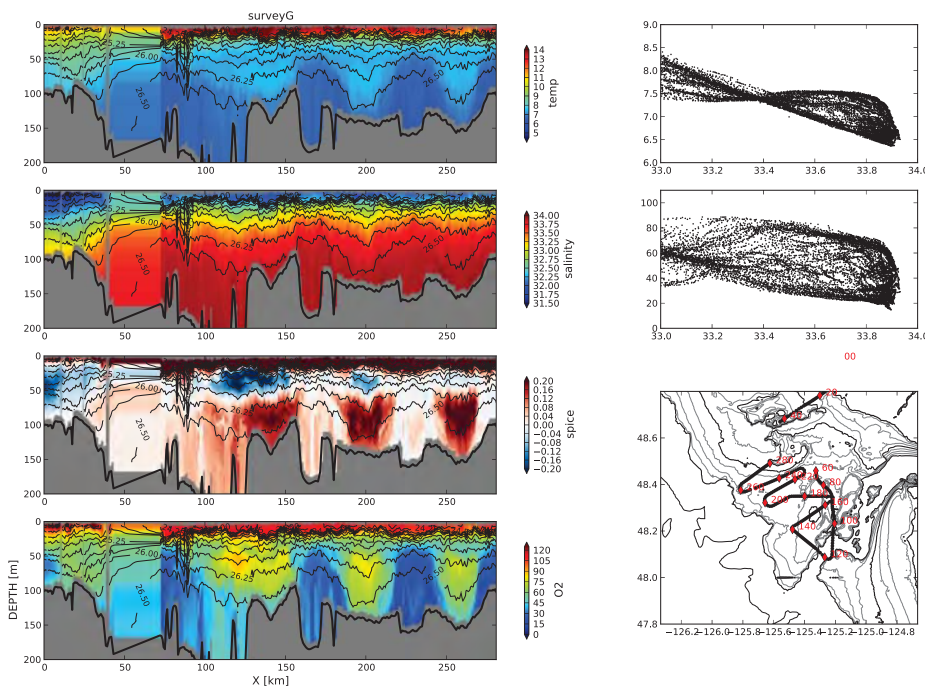


Figure 15: Survey G properties.

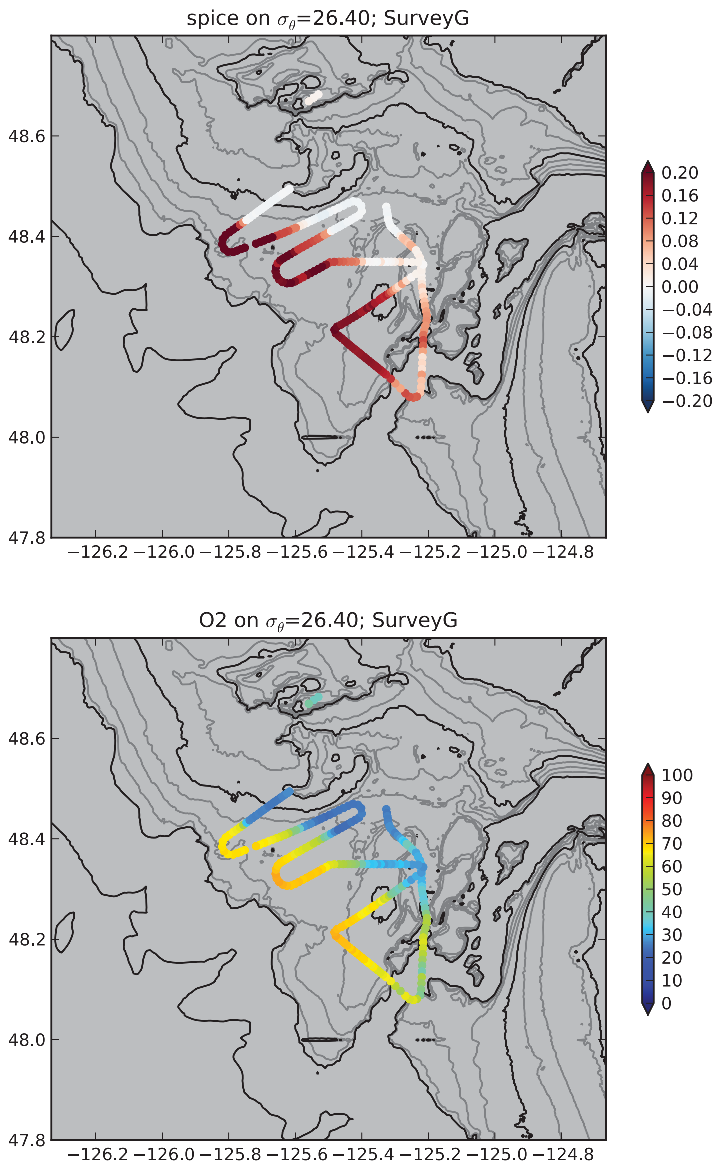


Figure 16: Survey G properties on $\sigma_\theta = 26.4\,\mathrm{kg\,m^{-3}}$.

2.7 Survey H: Tully Canyon cross-canyon structure

27 Aug 18:02 to 28 Aug 11:15

This survey mapped the cross-canyon water masses in Tully canyon. Again, there was strong along-channel variability, likely correlated w/ flow over the bank.

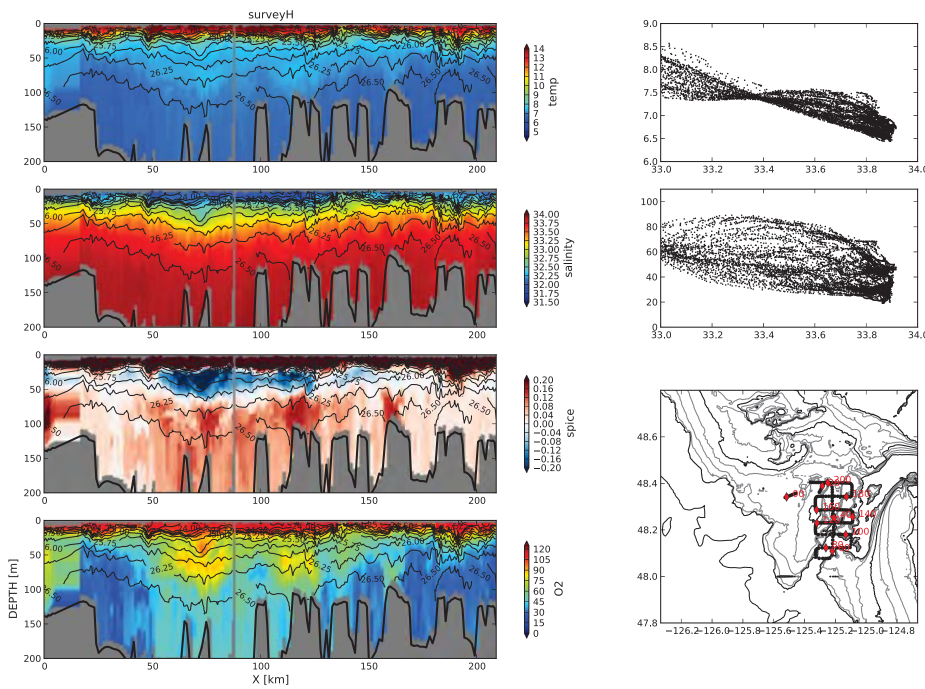


Figure 17: Survey H properties.

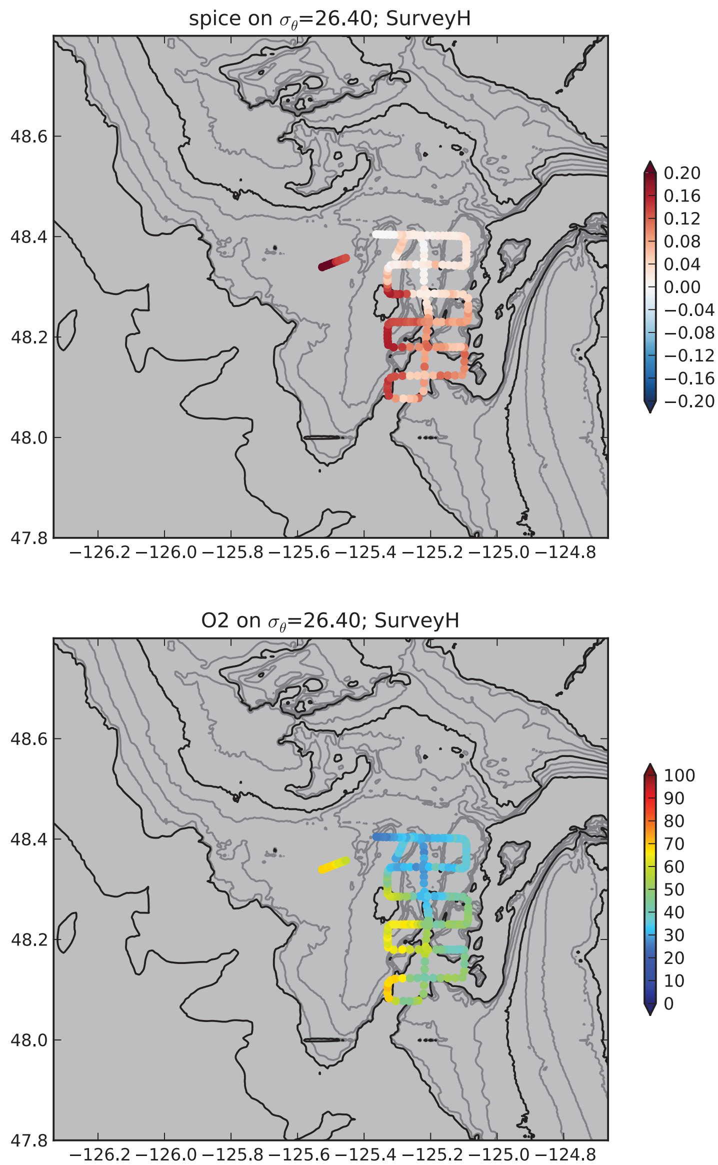


Figure 18: Survey H properties on $\sigma_\theta = 26.4\,\mathrm{kg\ m^{-3}}$.

2.8 Survey I: Finescale survey of Western Front

This survey also crossed the JdF Eddy twice, and caught the VIC. A fine-scale map was made of the front w/ approx 2nm spacing. A filament was tracked along the front, though it seems very small scale. I haven't looked at the front slope very carefully. The front is more mixed towards Allen Bank.

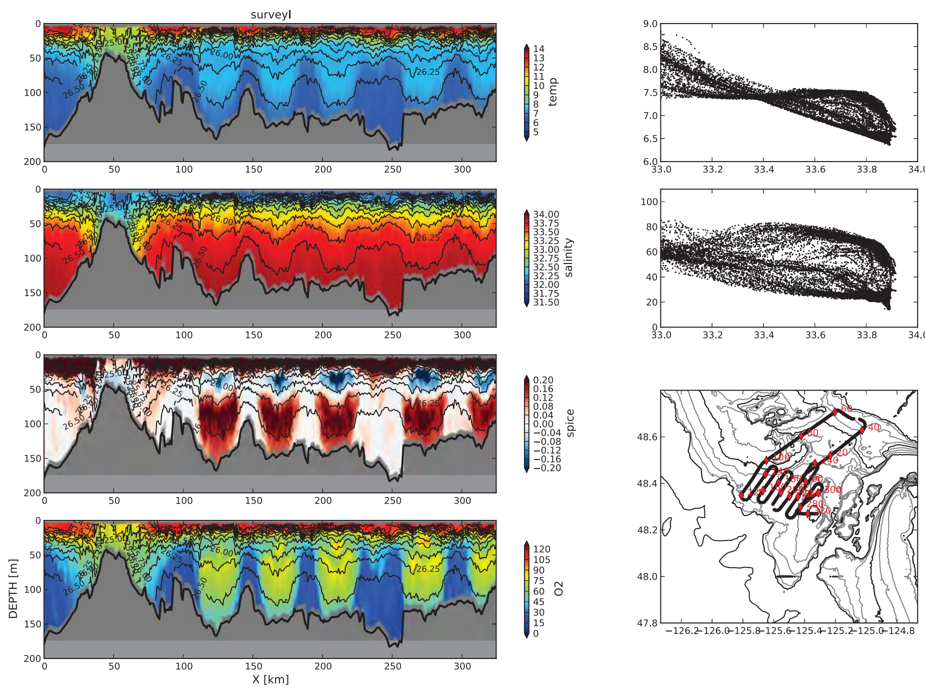


Figure 19: Survey I properties.

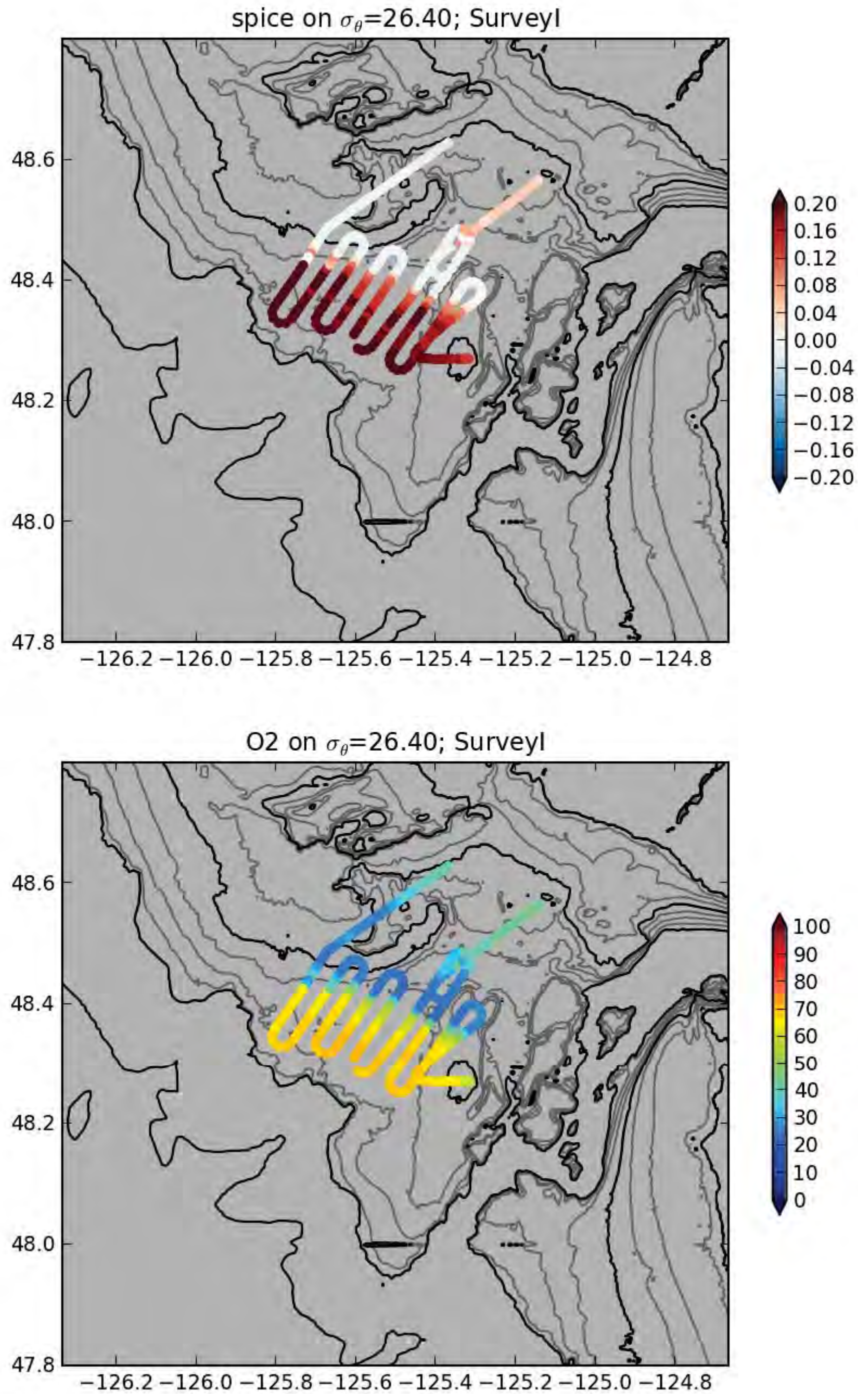


Figure 20: Survey I properties on $\sigma_\theta = 26.4\,\mathrm{kg\ m^{-3}}$.

2.9 Survey J: Allen Bank Tidal Survey

This was spectacular, with good time and space variability captured. There was a large 70 m tall lee wave during off-bank flow, and clear evidence of local mixing in the T/S properties.

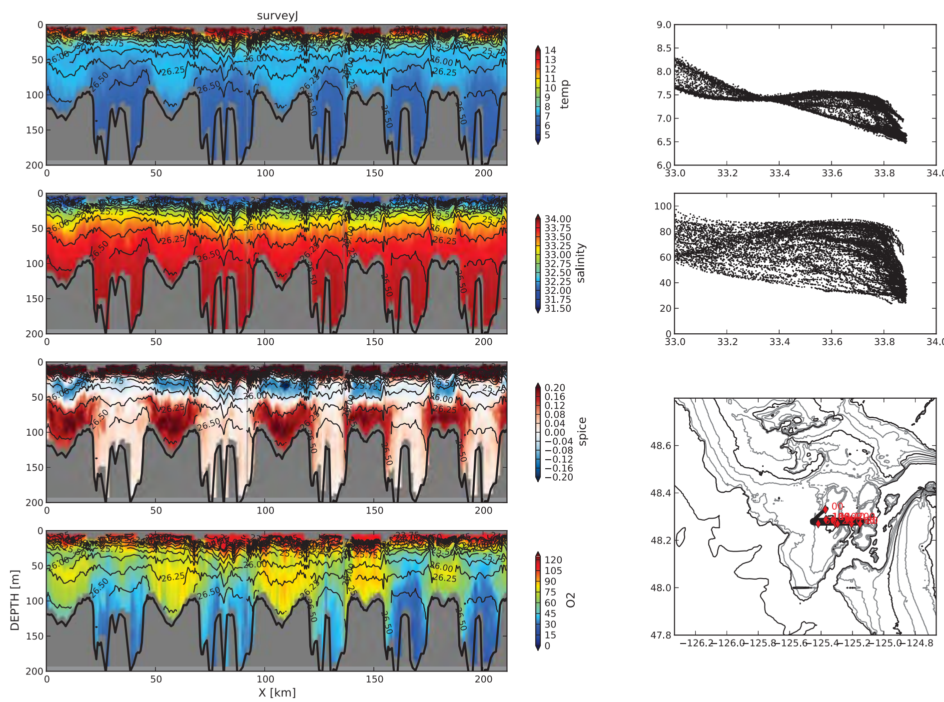
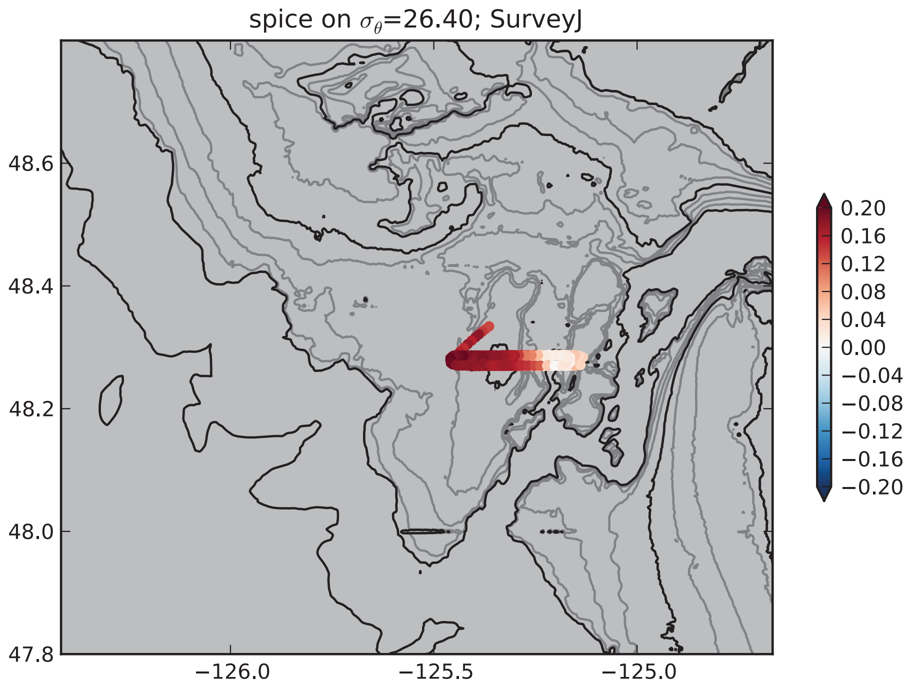


Figure 21: Survey J properties.



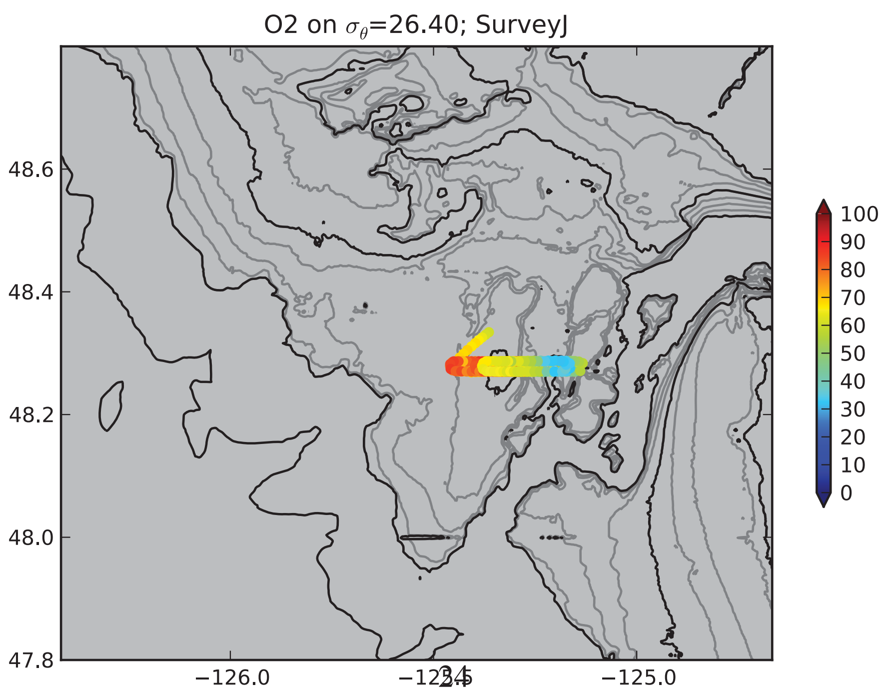


Figure 22: Survey J properties on $\sigma_\theta = 26.4\,\mathrm{kg\ m^{-3}}$.

2.10 Survey K: Tongue re-survey

30 August 03:23 to 30 August 15:07
The tongue was still there!

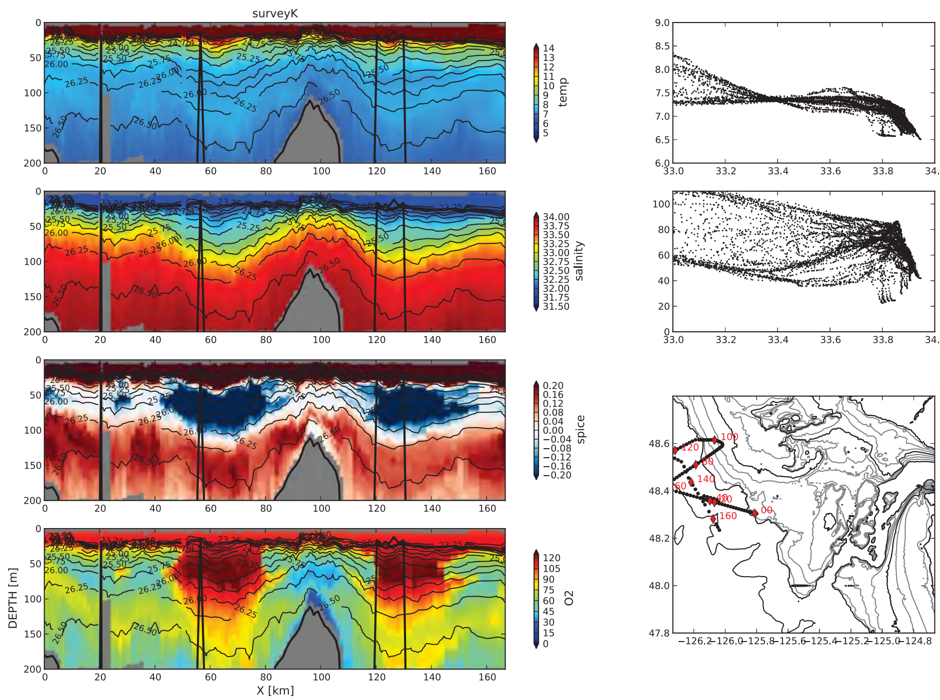


Figure 23: Survey K properties

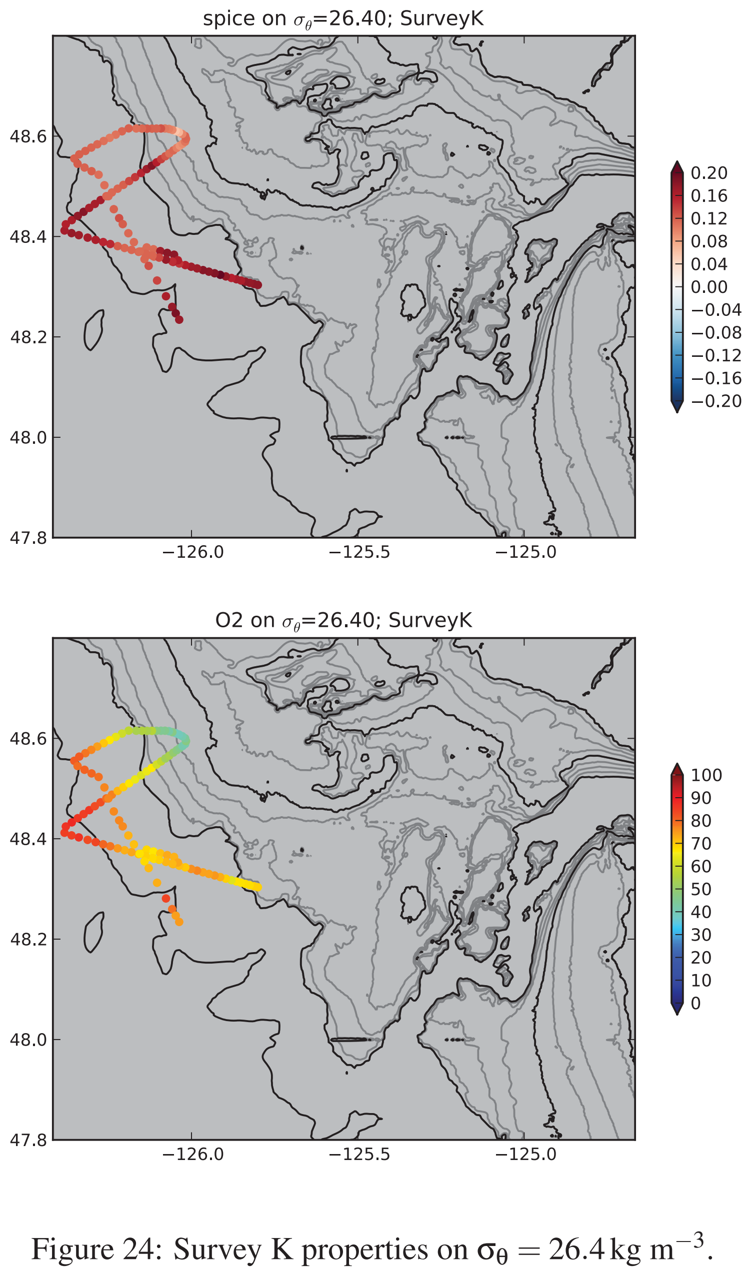


Figure 24: Survey K properties on $\sigma_\theta = 26.4\,\mathrm{kg\ m^{-3}}$.

2.11 Western Front

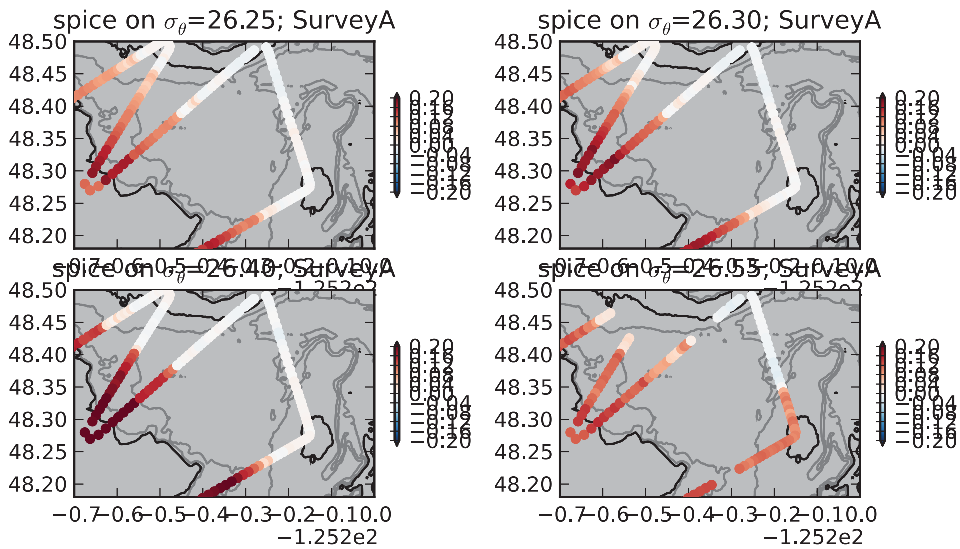


Figure 25:

Note that the shelf water is denser in Survey E than survey I, such that dense water is able to get into the Tully Eddy. It was not able to in SurveyI.

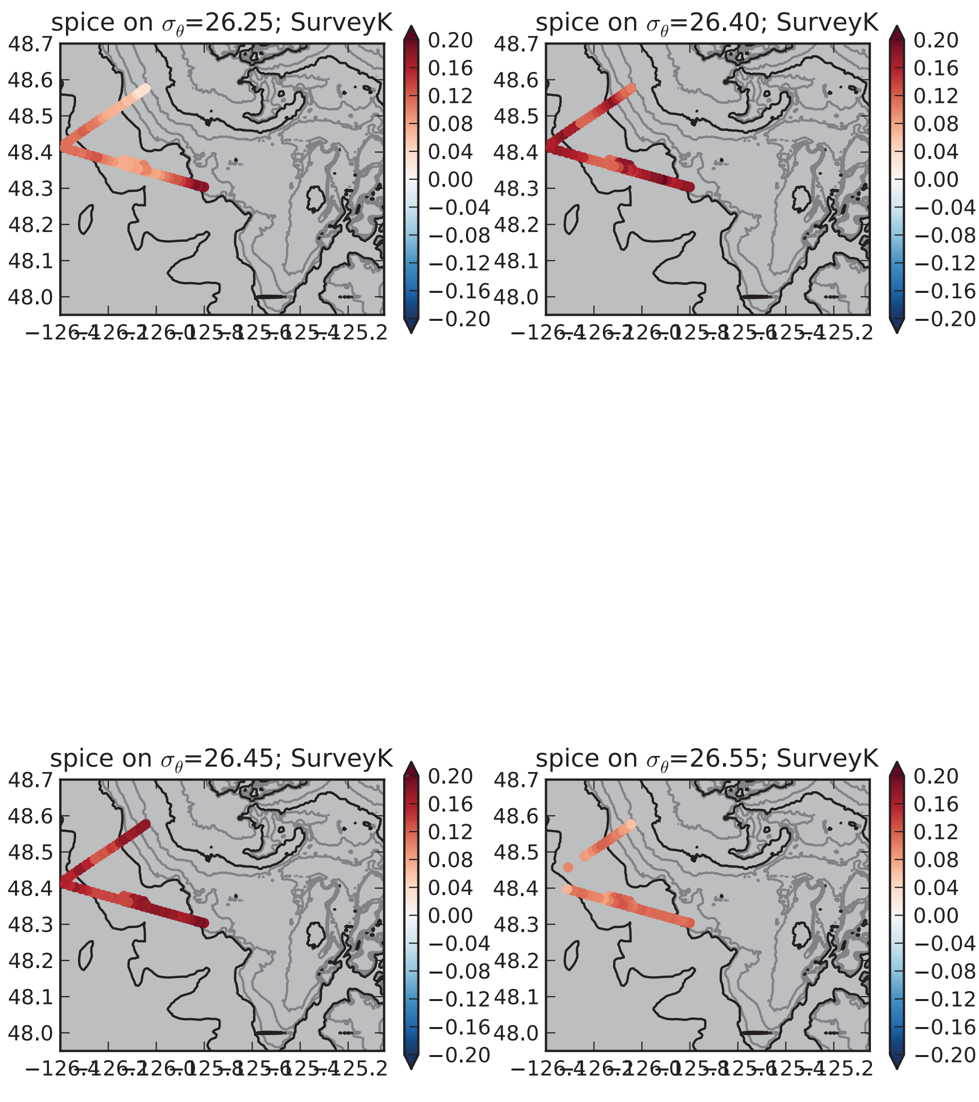

spice on σ_θ=26.25; SurveyK
spice on σ_θ=26.40; SurveyK
spice on σ_θ=26.45; SurveyK
spice on σ_θ=26.55; SurveyK

Figure 26:

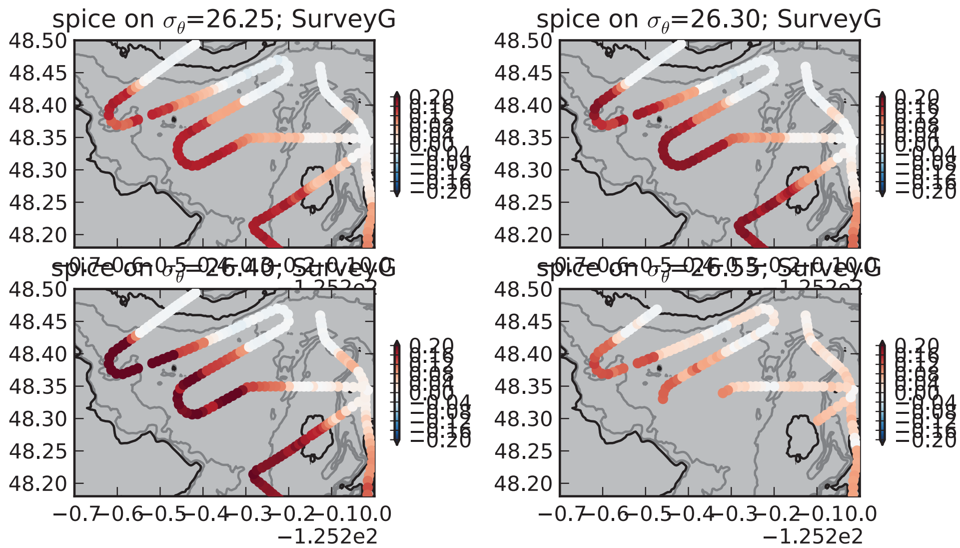


Figure 27:

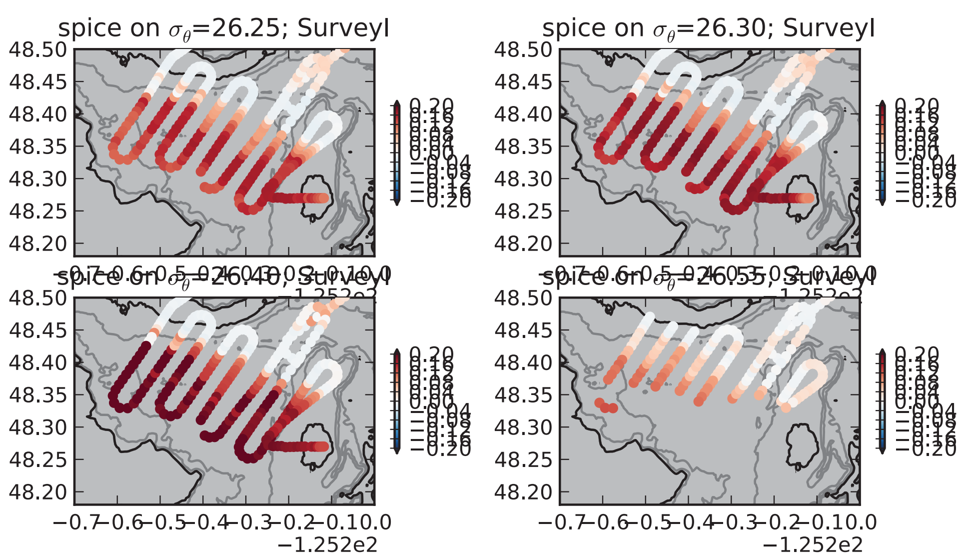


Figure 28:

3 FK009A Vessel-Mounted ADCP Operations

Stephanie Waterman, Richard Dewey, Jody Klymak

3.1 Operations overview

The R/V Falkor has two vessel mounted Teledyne RD Instrument Ocean Surveyor (OS) Acoustic Doppler Current Profiler (ADCP) instruments operating at 75 kHz and 300 kHz respectively. During FK009A, the 300 kHz instrument was not operational. The 75 kHz instrument operated for approximately 2.5 days at the beginning of the cruise. On 21 August 2013, one of its four transducers failed (suspected beam forming card issues) making the 75 kHz instrument also nonoperational for the duration of the cruise.

During the short period when the 75kHz instrument was operating, data was collected on a near-continuous basis. The majority of this time was spent trying to optimise the ADCP configuration settings and the operation mode as a function of which other acoustic instruments were on at the time. As a consequence, a large number of raw ADCP data files were written (note that to change a configuration setting, the ADCP must be be stopped and restarted and VMDAS (the ADCP data acquisition software) increments the filename number each time the ADCP is switched on.) Relevant filenames for the FK009A dataset span the range from 11 to 64, and cover a variety of configuration settings (for example bin size, number of bins and ping mode), as well as operational conditions (water depth, scatterer density, whether other acoustic instruments were also on and whether these instruments were in“sync mode” or not, *etc*.) A summary of key configuration settings and operational notes for each working filename is provided in Table 1. More detailed notes on the settings for select filenames are recorded in the ADCP log, a copy of which is stored in the Falkor’s FK009A PublicData directory.

Many of these data files correspond to records that are of very short duration, and as such are not helpful in characterising either the ADCP performance or the observed currents at the time. The exception are four coherent records that span a reasonable duration of time and as such have a significant number of short-term average ensembles in the record. The files that form this “working data set” are indicated in Table 1. Their geographical location is illustrated in Figure 1.

VMDAS Filename	File Creation Date	File Creation Time	Record Start Day	Record End Day	Gap seconds	Bin Depth	Blank Depth	Number of Bins	Ping Mode	Ensemble Median	Number of Ensembles	Notes
FK009A_OS75_011_000000.LTA	19/08/13	1:58:25	230.082	230.082	0	8	8	100	bb	NA	1	
FK009A_OS75_012_000000.LTA	19/08/13	2:00:57	230.084	230.084	152	8	8	100	bb	NA	1	
FK009A_OS75_013_000000.LTA	19/08/13	2:03:40	230.086	230.086	164	7	8	100	nb	NA	1	
FK009A_OS75_014_000000.LTA	19/08/13	2:04:47	230.087	230.087	67	15	8	50	bb	NA	1	
FK009A_OS75_015_000000.LTA	19/08/13	2:08:57	230.090	230.090	250	10	8	50	bb	NA	1	
FK009A_OS75_016_000000.LTA	19/08/13	2:10:58	230.091	230.091	121	10	8	50	bb	NA	1	
FK009A_OS75_017_000000.LTA	19/08/13	2:13:35	230.093	230.096	157	10	8	50	bb	302.35	2	
FK009A_OS75_018_000000.LTA	19/08/13	2:23:09	230.099	230.113	272	10	8	50	bb	301.36	5	
FK009A_OS75_019_000000.LTA	19/08/13	2:47:57	230.117	230.149	284	10	8	50	bb	120.46	24	- configuration settings working well
FK009A_OS75_022_000000.LTA	19/08/13	3:36:19	230.150	230.198	141	10	8	50	bb	119.25	35	
FK009A_OS75_023_000000.LTA	19/08/13	4:46:20	230.199	230.199	117	8	8	50	bb	NA	1	
FK009A_OS75_024_000000.LTA	19/08/13	4:49:17	230.201	230.202	177	8	6	50	nb	123.51	2	
FK009A_OS75_027_000000.LTA	19/08/13	4:55:36	230.205	230.205	255	10	8	50	bb	NA	1	
FK009A_OS75_029_000000.LTA	19/08/13	4:58:06	230.207	230.953	150	8	8	50	bb	119.45	538	
FK009A_OS75_030_000000.LTA	19/08/13	22:53:34	230.954	230.957	84	8	8	50	nb	121.38	3	
FK009A_OS75_031_000000.LTA	19/08/13	22:58:47	230.958	230.958	70	8	8	50	nb	NA	1	
FK009A_OS75_032_000000.LTA	19/08/13	23:01:19	230.959	230.959	152	8	8	50	nb	NA	1	
FK009A_OS75_033_000000.LTA	19/08/13	23:04:31	230.962	230.962	191	8	8	50	bb	NA	1	
FK009A_OS75_034_000000.LTA	19/08/13	23:05:47	230.962	230.965	76	8	8	50	bb	120.67	3	
FK009A_OS75_035_000000.LTA	19/08/13	23:19:44	230.972	230.972	596	8	8	50	bb	NA	1	
FK009A_OS75_036_000000.LTA	19/08/13	23:22:30	230.974	230.974	166	16	8	40	bb	NA	1	
FK009A_OS75_037_000000.LTA	19/08/13	23:28:59	230.979	230.979	389	8	8	100	bb	NA	1	
FK009A_OS75_040_000000.LTA	19/08/13	23:39:17	230.986	230.987	618	8	8	80	bb	123.06	2	
FK009A_OS75_041_000000.LTA	19/08/13	23:46:22	230.991	231.009	301	8	8	100	bb	119.05	14	- changed set-up file to : OS75BB_High_Definition_High_Res_8m_w_synchonization
FK009A_OS75_042_000000.LTA	20/08/13	0:14:03	231.010	231.024	100	8	8	100	bb	119.47	11	
FK009A_OS75_043_000000.LTA	20/08/13	0:34:48	231.024	231.095	43	8	8	100	bb	121.28	51	-changed TP 00000 (time between bottom track and water correlation pings)
FK009A_OS75_044_000000.LTA	20/08/13	2:18:46	231.096	231.101	115	8	8	80	bb	121.28	4	-changed to 2 velocity pings and 1 bottom track ping every 10s; turned off EK710; Doppler bottom track improved
FK009A_OS75_045_000000.LTA	20/08/13	2:26:31	231.102	231.114	101	8	8	100	bb	117.63	10	
FK009A_OS75_046_000000.LTA	20/08/13	2:46:07	231.115	231.125	88	8	8	100	bb	118.03	8	- set sych with 10222010
FK009A_OS75_046_000_000000.LTA	13/08/13	2:46:00	231.100	231.120	51	8	8	100	bb	118.00	8	
FK009A_OS75_047_000000.LTA	20/08/13	3:01:58	231.126	231.140	108	8	8	100	bb	118.03	11	-disabled 'override command file' for EA; EA = -0.32 degrees
FK009A_OS75_048_000000.LTA	20/08/13	3:26:30	231.143	231.146	268	8	8	100	bb	123.08	3	
FK009A_OS75_049_000000.LTA	20/08/13	3:32:34	231.148	231.148	118	10	8	50	bb	NA	1	- try without synchronization; Basic (no file) VMDAS
FK009A_OS75_050_000000.LTA	20/08/13	3:34:28	231.149	231.152	114	15	8	40	bb	121.28	3	-time between ensembles ~ 4.5 seconds
FK009A_OS75_051_000000.LTA	20/08/13	3:39:34	231.153	231.153	63	8	8	100	bb	NA	1	- changed set-up file to : OS75BB_High_Definition_High_Res_8m_w_synchonization; time between ensembles ~ 8 s;
FK009A_OS75_052_000000.LTA	20/08/13	3:42:46	231.155	231.155	192	10	8	50	bb	NA	1	- time between ensembles ~ 6s
FK009A_OS75_053_000000.LTA	20/08/13	3:45:48	231.157	231.465	177	10	8	80	bb	119.85	223	
FK009A_OS75_BBHDWS_001_000000.LTA	20/08/13	21:01:19	231.876	232.096	0	16	8	40	bb	301.57	64	- configuration file reset to original from ships' systems
FK009A_OS75_056_000000.LTA	21/08/13	4:33:18	232.190	232.193	0	16	8	40	bb	303.80	2	
FK009A_OS75_057_000000.LTA	21/08/13	4:45:40	232.198	232.278	438	8	8	50	bb	300.20	24	- changed set up file to : OS75BB_High_Definition_High_Res_8m_w_synchonization; STA = 30s; LTA = 300s; time between ensembles ~ 4.6 sec (fast because only 400 m profile depth); seemed to loose bottom track
FK009A_OS75_058_000000.LTA	21/08/13	6:43:34	232.280	232.291	173	8	8	70	bb	298.53	4	- as above but with number of bins changed to 70; still no bottom track
FK009A_OS75_059_000000.LTA	21/08/13	7:01:29	232.293	232.480	175	8	8	70	bb	300.46	55	- trying to get bottom track; increased bin size; picking up false bottom at 34 m; perhaps issue with steep slope at head of canyon?
FK009A_OS75_060_000000.LTA	21/08/13	11:36:33	232.484	232.491	299	8	8	70	bb	301.67	3	- ADCP restarted to try to get bottom track; EK60s put into passive mode; no success with bottom track so EK60s restarted
FK009A_OS75_062_000000.LTA	21/08/13	11:47:46	232.492	232.495	70	8	8	70	bb	301.28	2	- updated configuration file to guess bottom at 200m; now get a bottom range. Correlation between beams is low (< 200)
FK009A_OS75_063_000000.LTA	21/08/13	11:55:18	232.497	232.497	151	8	8	70	bb	NA	1	- All EK instruments pinging stopped to see if correlation improves; EK60s changed to passive mode; does not improve beam correlation. All EK60 instruments restored to pinging; correlation threshold changed from 220 to 140; no success in getting a bottom range; depth guess changed back to 800 m
FK009A_OS75_064_000000.LTA	21/08/13	11:58:12	232.499	232.714	174	8	8	70	bb	300.95	63	

Figure 29: Summary of configuration settings and operational notes for each VM-DAS filename. Files corresponding to the "working data set" are highlighted in yellow.

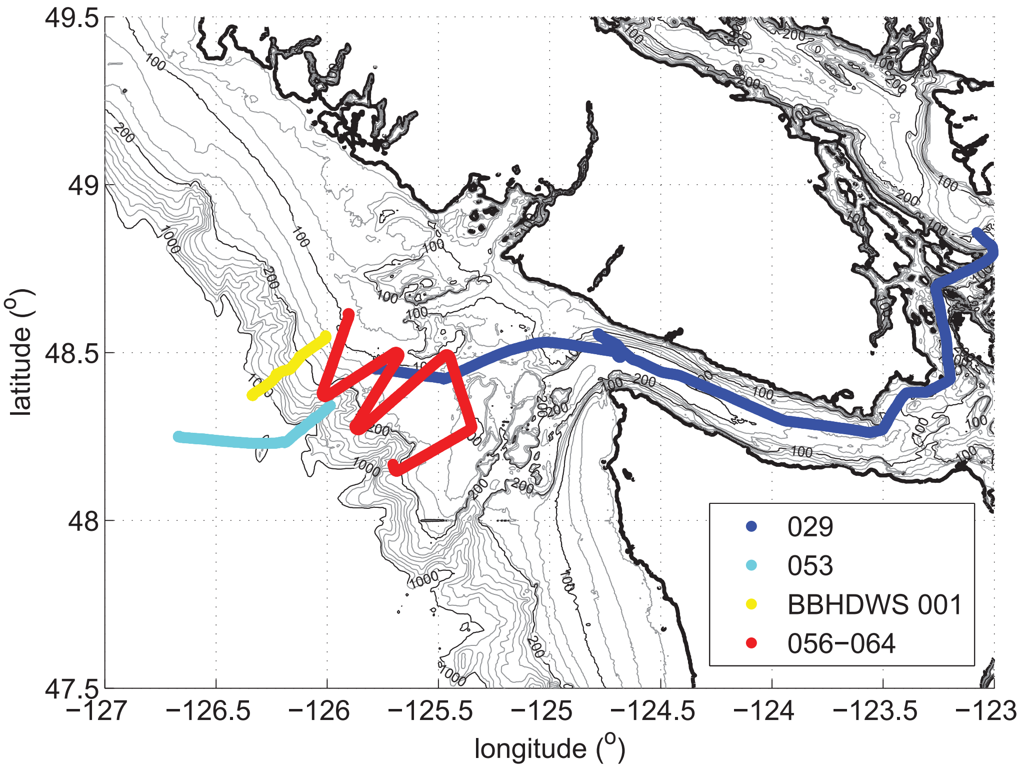


Figure 30: Vessel track for the four coherent ADCP records. Corresponding raw ADCP data file numbers are indicated in the legend.

3.2 Preliminary processing overview

For the four coherent data records, a preliminary round of processing was performed on board. This involved passing the raw VmDAS ENR (single ping) data recorded by the ship's systems through the CODAS ADCP data basic processing steps as described in the "*Processing from scratch: VmDAS ENR (single ping data) processing example*" in the CODAS documentation (see `http://currents.soest.hawaii.edu/docs/doc/codas_doc/qpy_demos/examples/04_enr_fromscratch/enr_fromscratch_instructions.html`). A step-by-step list of the processing steps performed is provided in the Appendix to this report.

The CODAS processing routine produces Matlab files `vector_xy.mat`, `vector_uv.mat`, `contour_xy.mat` and `contour_uv.mat`, as well as a series of `all_bins_*.mat` outputs. The latter collection contain the complete dataset including the processed velocity data, date and time information, navigation data, information used at intermediate steps of the processing (such as the measured velocity, ship velocity and reference layer velocity), as well as various diagnostics of data quality (such as the signal return amplitude, error velocity, and correlation amplitude) at raw data resolution (every bin and every profile). This data can be read by the matlab program `load_getmat.m` that can be obtained at `http://currents.soest.hawaii.edu/docs/doc/adcp_access/READING/MATLAB/GETMAT/index.html`. The `vector_*.mat` and `contour_*.mat` files contain averaged time, longitude, latitude, u and v velocity data averaged in 15 minute intervals in the case of `contour_*.mat` files and in 1 hour intervals in the case of `vector_*.mat` files. Instructions on how to load this data into Matlab are given at `http://currents.soest.hawaii.edu/docs/doc/adcp_access/READING/MATLAB/ADCPSECT/index.html`. The depth-averaged contour data for each of the four coherent data records are displayed in Figures 2-5. These outputs are stored in the Falkor's FK009A `PublicData/Data/ADCP.OS75/Processed` directory.

3.3 Future work

The processed data represents a first pass processing stage, and further post-processing is required to make the data useable in scientific analysis. Tilt and roll information (recorded by the ship and stored in the .N1R and .N2R files in the raw VmDas data directory) still need to be incorporated, and a refined heading correction still needs to be applied. Details on the recommended steps for CODAS post-processing are outlined at `http://currents.soest.hawaii.edu/docs/doc/`

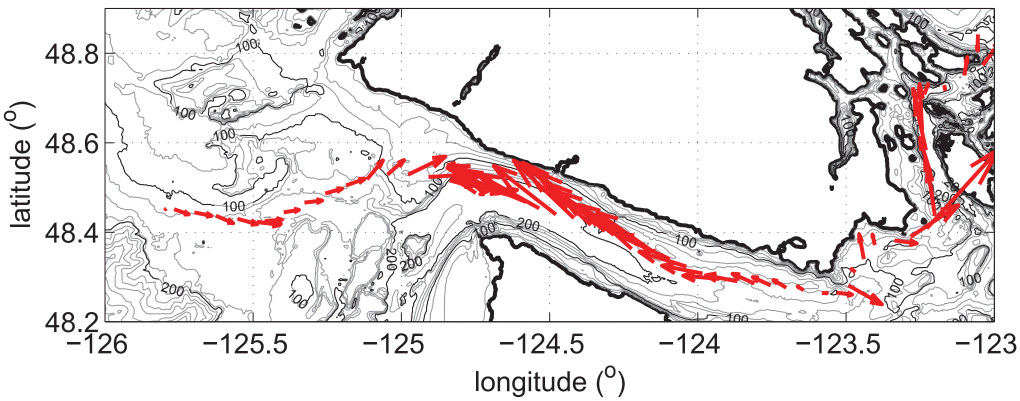


Figure 31: Long-term averaged (∼15 minute) depth averaged current vectors output by the CODAS processing routine in `contour_uv.mat` and `contour_xy.mat` for raw file number 029.

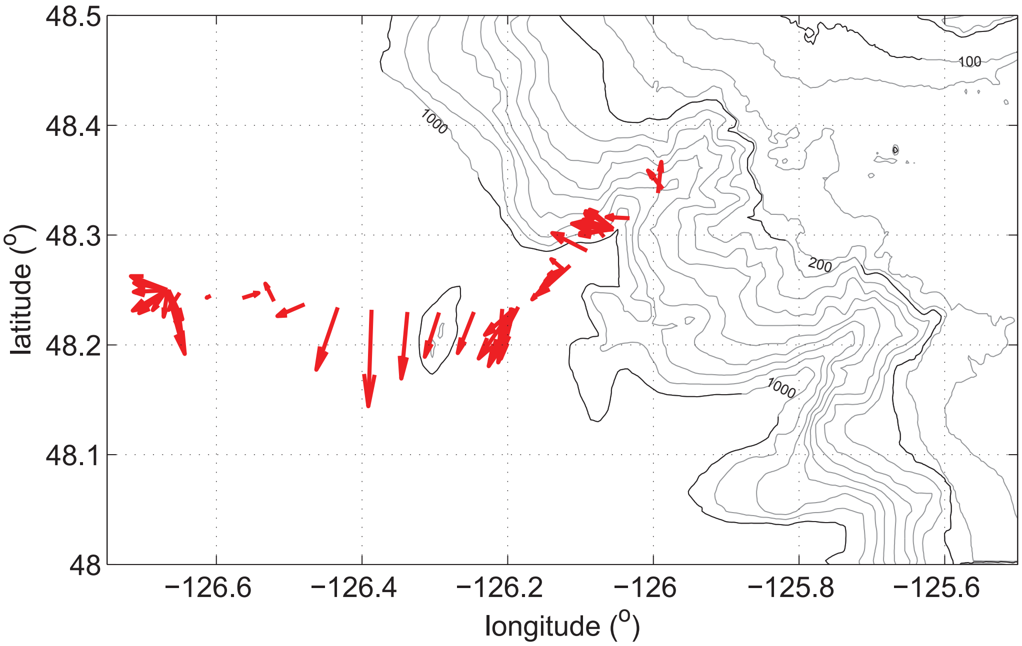


Figure 32: As in Figure 2 for raw file number 053.

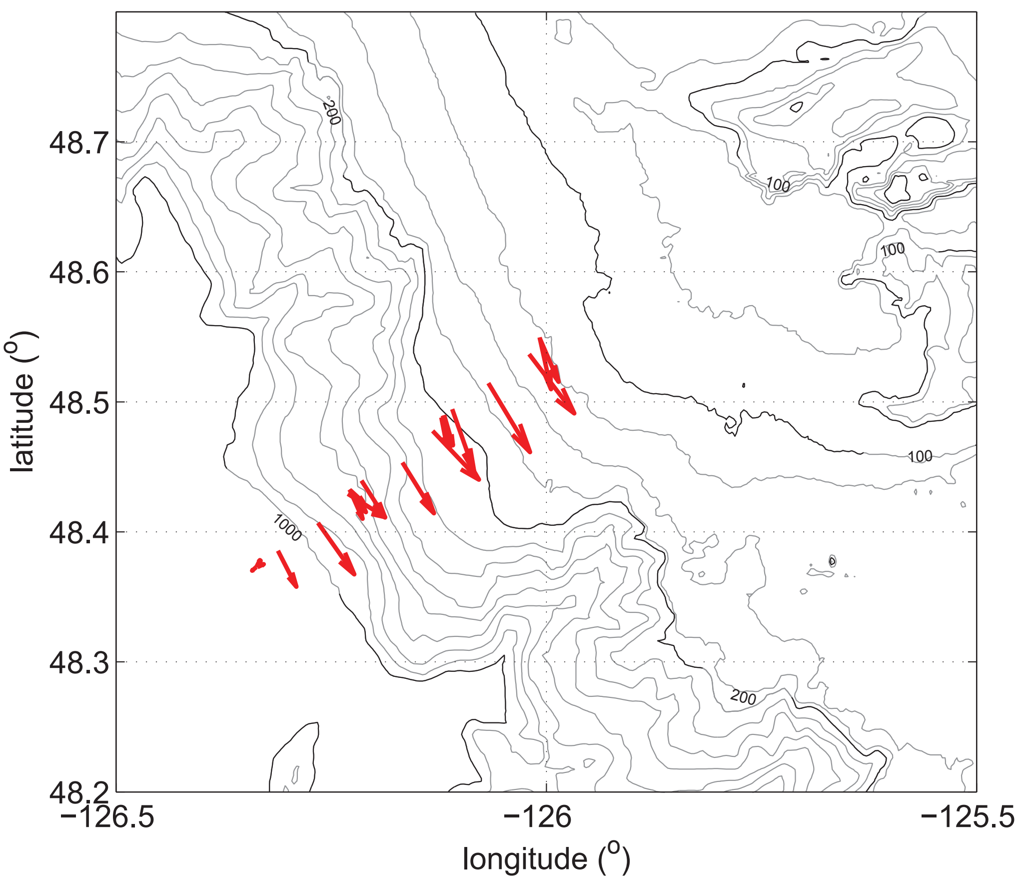


Figure 33: As in Figure 2 for raw file number BBHDWS 001.

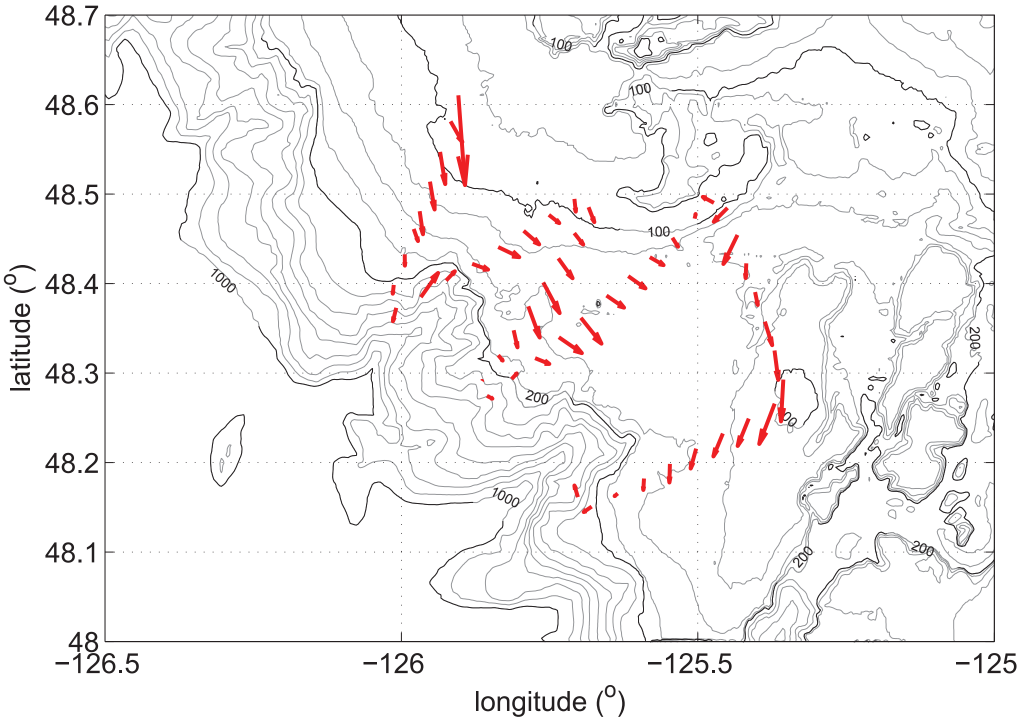


Figure 34: As in Figure 2 for raw file numbers 056-064.

codas_doc/qpy_demos/examples/01_postproc_figs/post_process_instructions.html.

Stephanie Waterman will work with Jules Hummond at the University of Hawaii to post-process the data from file numbers 056-064 (files collected during MVP Survey A) so that the ADCP data can be used in future analysis related to the cruise's frontal surveys. The remaining three data records can be post-processed if and when needed.

4 FK009A CTD Results

Susan Allen

4.1 Overview

Forty CTD casts were made throughout the two weeks, see Table below. All casts were made using the Falkor's Seabird 911 plus mounted below a 24 bottle rosette. The CTD was lowered to 10 minutes and allowed to soak there. One MT turned on the pumps at this depth. The CTD was returned to the surface; the other MT turned on the pumps at this depth. (Differences made batch processing difficult). The downcast was started at 0.33 m/s but usually increased to 1 m/s at depth. Bottles were fired on the upcast. Bottle depths and the sample numbers are included in an appendix.

CTD Station List

Filename	Station	Date/Time UTC	Latitude	Longitude	Rosette
FK009A_CTD002_20130819.cnv	JFG4a	Aug 19 2013 17:16:41	48 29.18 N	124 41.11 W	yes
FK009A_CTD003_20130819.cnv	LB08	Aug 19 2013 21:05:36	48 25.29 N	125 28.62 W	yes
FK009A_CTD004_20130819.cnv	BCC0	Aug 19 2013 22:58:10	48 27.19 N	125 47.76 W	yes
FK009A_CTD005_20130820.cnv	BCC1	Aug 20 2013 00:02:57	48 25.79 N	125 50.67 W	
FK009A_CTD006_20130820.cnv	BCC2	Aug 20 2013 00:47:16	48 24.36 N	125 53.59 W	yes
FK009A_CTD007_20130820.cnv	BCC3	Aug 20 2013 01:53:03	48 22.51 N	125 56.25 W	yes
FK009A_CTD008_20130820.cnv	BCC4	Aug 20 2013 03:35:31	48 20.52 N	125 59.21 W	
FK009A_CTD009_20130820.cnv	BCC5	Aug 20 2013 04:59:49	48 18.30 N	126 03.32 W	yes
FK009A_CTD010_20130820.cnv	BCC6	Aug 20 2013 07:26:03	48 16.15 N	126 07.41 W	
FK009A_CTD011_20130820.cnv	BCC7	Aug 20 2013 09:04:09	48 13.95 N	126 11.50 W	yes
FK009A_CTD012_20130820.cnv	LC12	Aug 20 2013 14:07:47	48 14.97 N	126 39.93 W	yes
FK009A_CTD013_20130820.cnv	LC11	Aug 20 2013 18:24:28	48 18.94 N	126 26.67 W	yes
FK009A_CTD014_20130820.cnv	LC10	Aug 20 2013 20:59:06	48 22.34 N	126 20.11 W	
FK009A_CTD015_20130820.cnv	LC09	Aug 20 2013 22:48:22	48 25.88 N	126 13.68 W	yes
FK009A_CTD016_20130821.cnv	LC08	Aug 21 2013 00:43:18	48 29.37 N	126 07.17 W	yes
FK009A_CTD017_20130821.cnv	LC07	Aug 21 2013 02:13:45	48 32.95 N	126 00.46 W	
FK009A_CTD018_20130821.cnv	LC06	Aug 21 2013 03:21:12	48 36.44 N	125 53.99 W	yes
FK009A_CTD019_20130822.cnv	RD01	Aug 22 2013 00:31:45	48 00.28 N	125 21.83 W	yes
FK009A_CTD020_20130822.cnv	RD02	Aug 22 2013 02:27:41	48 06.54 N	125 15.11 W	yes
FK009A_CTD021_20130822.cnv	MB07	Aug 22 2013 07:08:54	48 28.20 N	125 19.49 W	yes
FK009A_CTD022_20130822.cnv	MB08	Aug 22 2013 15:14:47	48 32.21 N	125 21.41 W	yes
FK009A_CTD023_20130822.cnv	MB14	Aug 22 2013 16:56:27	48 39.91 N	125 34.44 W	yes
FK009A_CTD024_20130822.cnv	RAD08	Aug 22 2013 17:40:36	48 39.60 N	125 35.91 W	yes
FK009A_CTD025_20130822.cnv	MB16	Aug 22 2013 20:02:54	48 47.95 N	125 15.93 W	yes
FK009A_CTD026_20130823.cnv	LC05-A	Aug 23 2013 01:39:36	48 43.59 N	125 42.77 W	yes
FK009A_CTD027_20130823.cnv	LC08	Aug 23 2013 05:04:48	48 29.45 N	126 07.09 W	yes
FK009A_CTD028_20130823.cnv	RD04	Aug 23 2013 19:59:51	48 14.70 N	125 01.21 W	yes
FK009A_CTD029_20130824.cnv	RD02	Aug 24 2013 06:23:34	48 06.59 N	125 15.03 W	yes
FK009A_CTD030_20130825.cnv	BCC4	Aug 25 2013 23:44:51	48 20.50 N	125 59.23 W	
FK009A_CTD031_20130826.cnv	BCC3	Aug 26 2013 00:56:44	48 22.50 N	125 56.29 W	
FK009A_CTD032_20130826.cnv	BCC2	Aug 26 2013 01:56:57	48 24.40 N	125 53.56 W	
FK009A_CTD033_20130826.cnv	MB16	Aug 26 2013 16:26:48	48 47.60 N	125 15.91 W	yes
FK009A_CTD034_20130826.cnv	Susan01	Aug 26 2013 21:47:53	48 39.37 N	125 34.59 W	yes
FK009A_CTD035_20130827.cnv	MB07	Aug 27 2013 00:14:51	48 28.31 N	125 19.44 W	yes
FK009A_CTD036_20130827.cnv	NN01	Aug 27 2013 17:18:49	48 20.23 N	125 32.20 W	yes
FK009A_CTD037_20130827.cnv	NN02	Aug 27 2013 18:59:00	48 21.32 N	125 27.82 W	yes
FK009A_CTD038_20130827.cnv	NN03	Aug 27 2013 20:17:29	48 21.13 N	125 18.85 W	yes
FK009A_CTD039_20130827.cnv	TC01	Aug 27 2013 23:23:36	48 16.04 N	125 12.64 W	yes
FK009A_CTD040_20130830.cnv	RD05	Aug 30 2013 19:46:04	48 25.23 N	124 50.07 W	yes

4.2 Processing

The data were processed using the Seabird processing software. Spikes were present in the data in most of the variables. Many of these were removed but it would be good if all the profiles were properly de-spiked. Pressure was filtered using a time constant of 0.15 s. Oxygen was aligned using 4 s which appeared to be the correct value at 7oC. It is perhaps too short for colder temperatures and too long for warmer temperatures. Temperature and salinity were not aligned during processing as they were aligned on-board. Only one cast was de-looped (see below). Salinity, density and potential temperature were derived. The scan with the minimum depth was found (python script) and used to eliminate scans near the surface. This was adjusted to more scans if the top of the TS curve looked unrealistic. One meter bins were used.

4.3 Notes on Particular Casts

During cast #2 in the mouth of Juan de Fuca it was noticed that the surface water was completely different between the up and downcast. So both were processed.

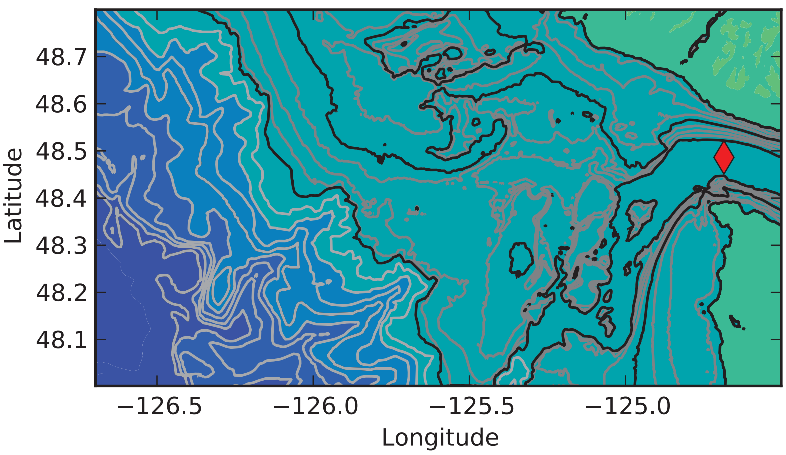
All casts were done in reasonably stable conditions except #35, a return to MB07. For this cast processing including de-looping. The top of the downcast was still contaminated with bubbles, so the upcast was also processed.

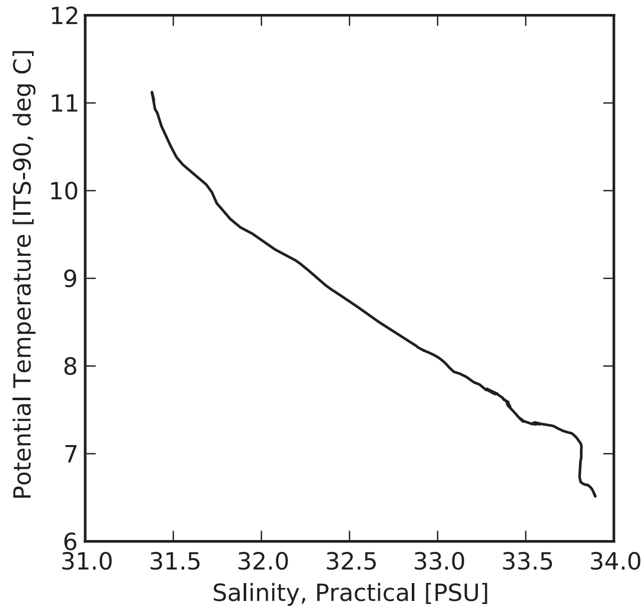
4.4 Plots

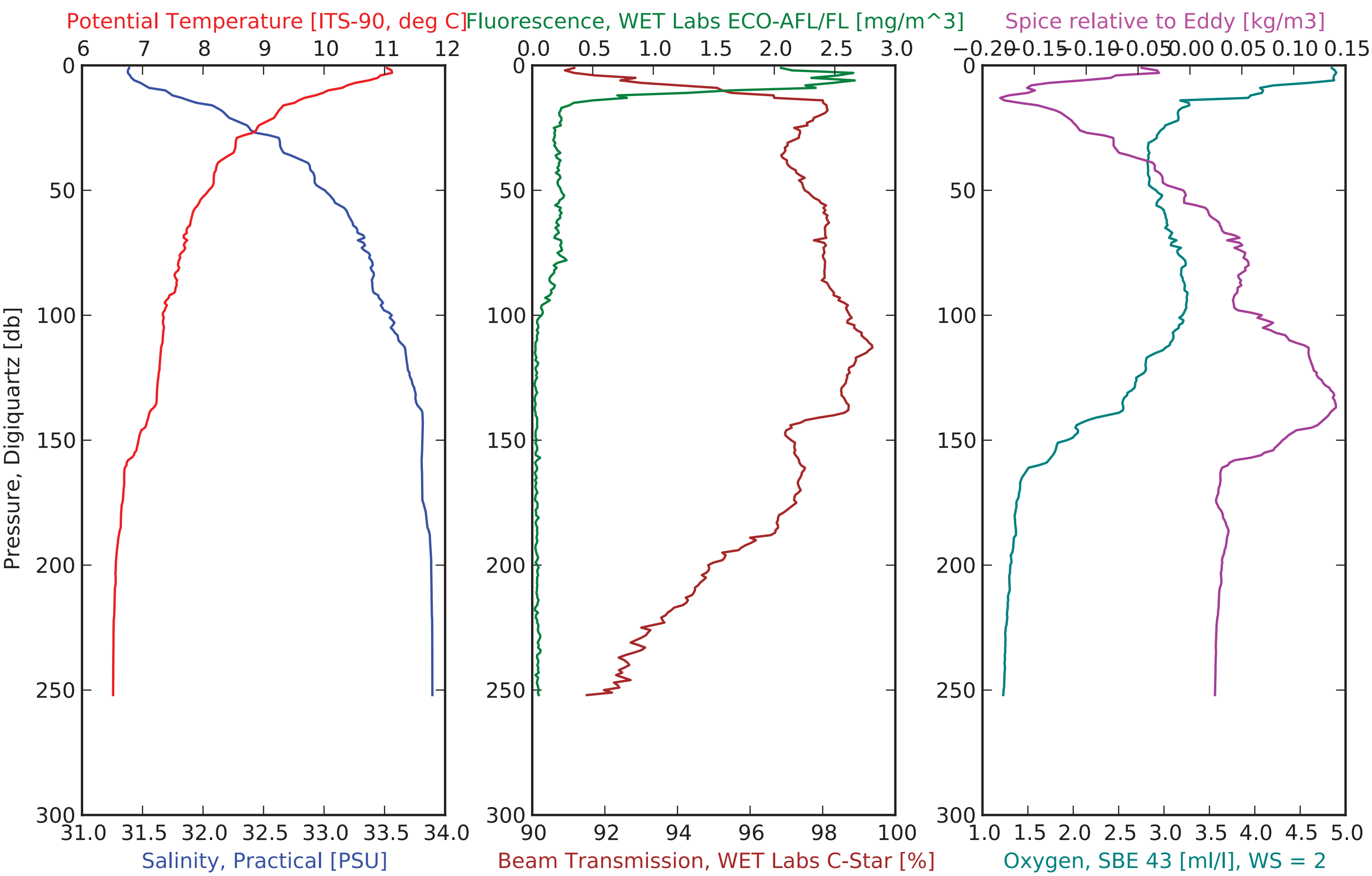
Station: JFG4a down at 48 29.18 N,124 41.11 W

On: Aug 19 2013 17:16:41UTC

Filename: FK009A_CTD002_20130819.cnv



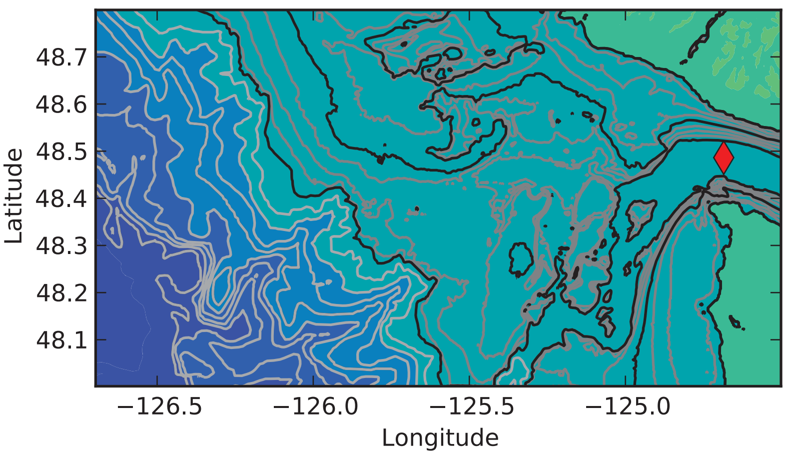


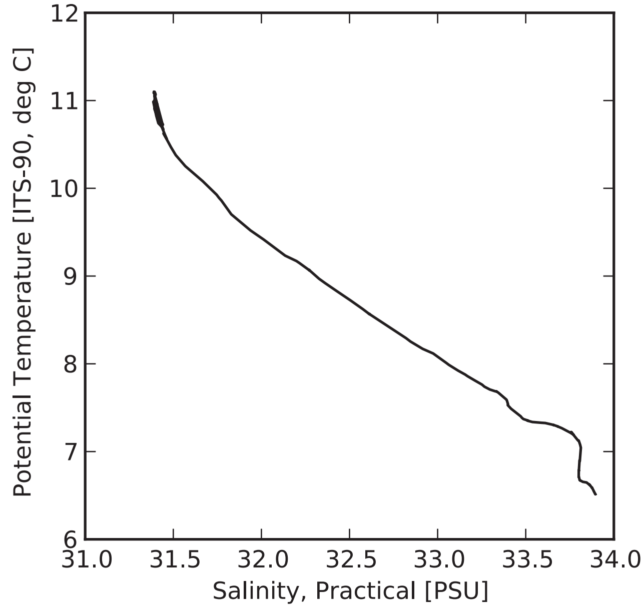


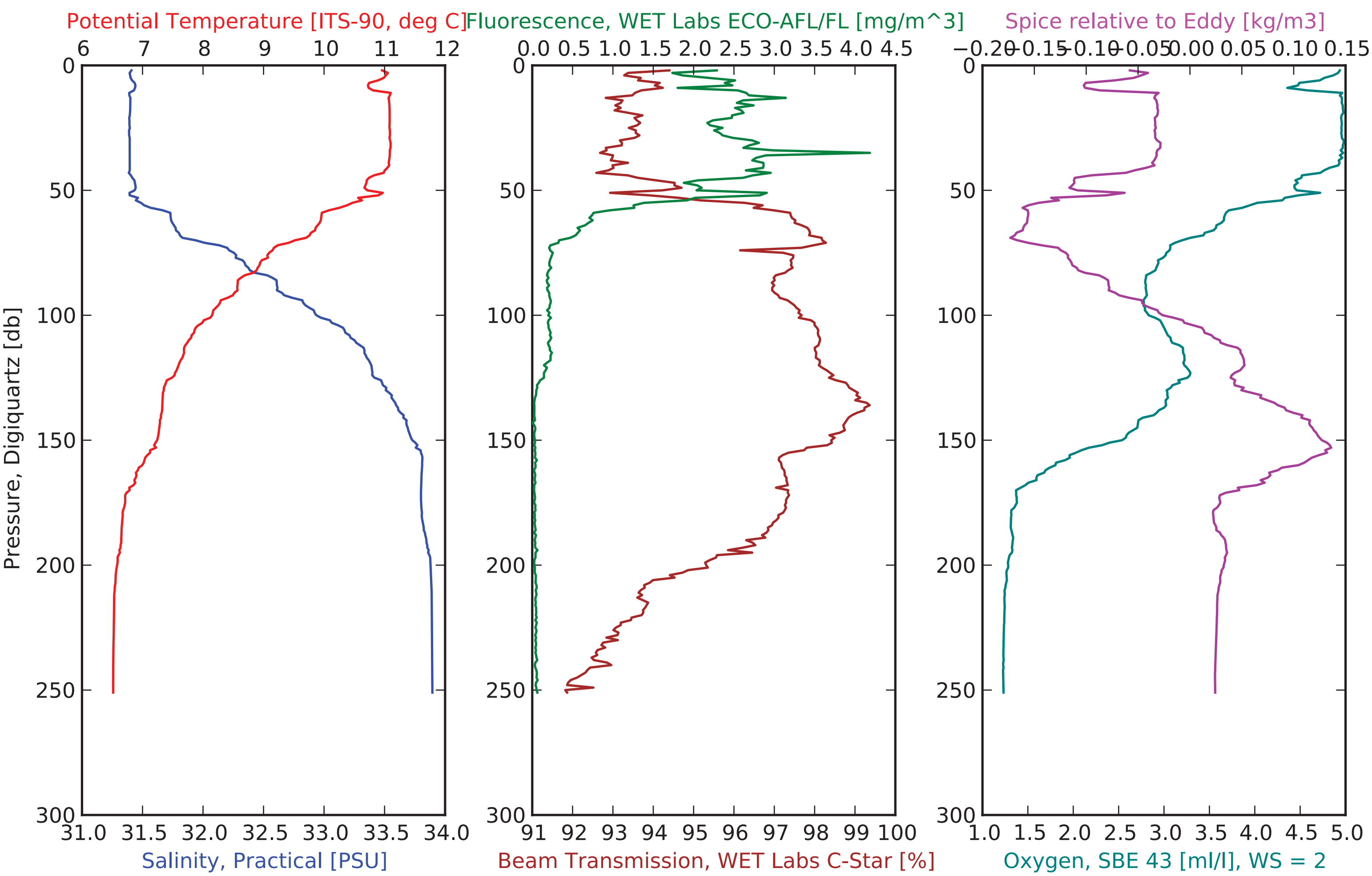
Station: JFG4a up at 48 29.18 N,124 41.11 W

On: Aug 19 2013 17:16:41UTC

Filename: FK009A_CTD002up_20130819.cnv



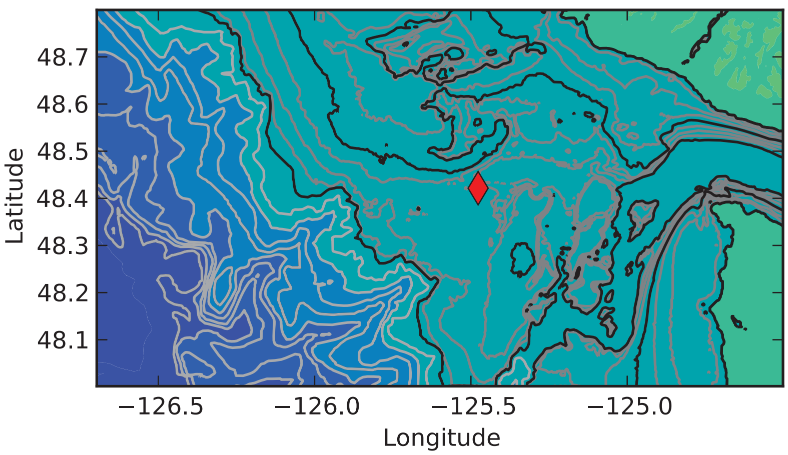


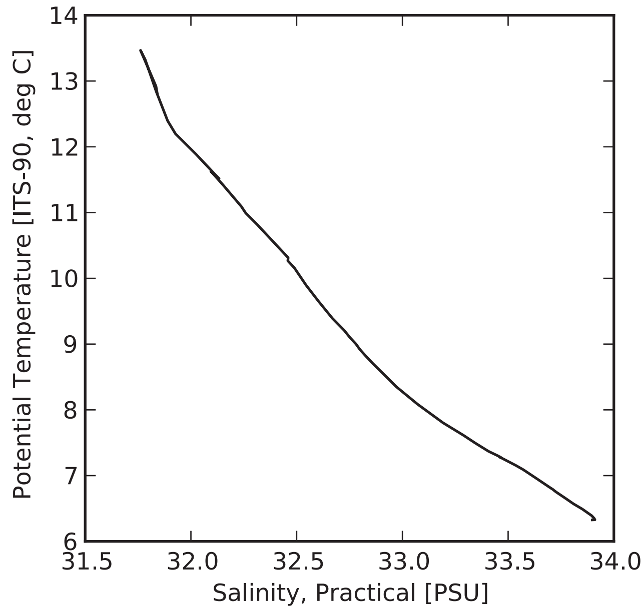


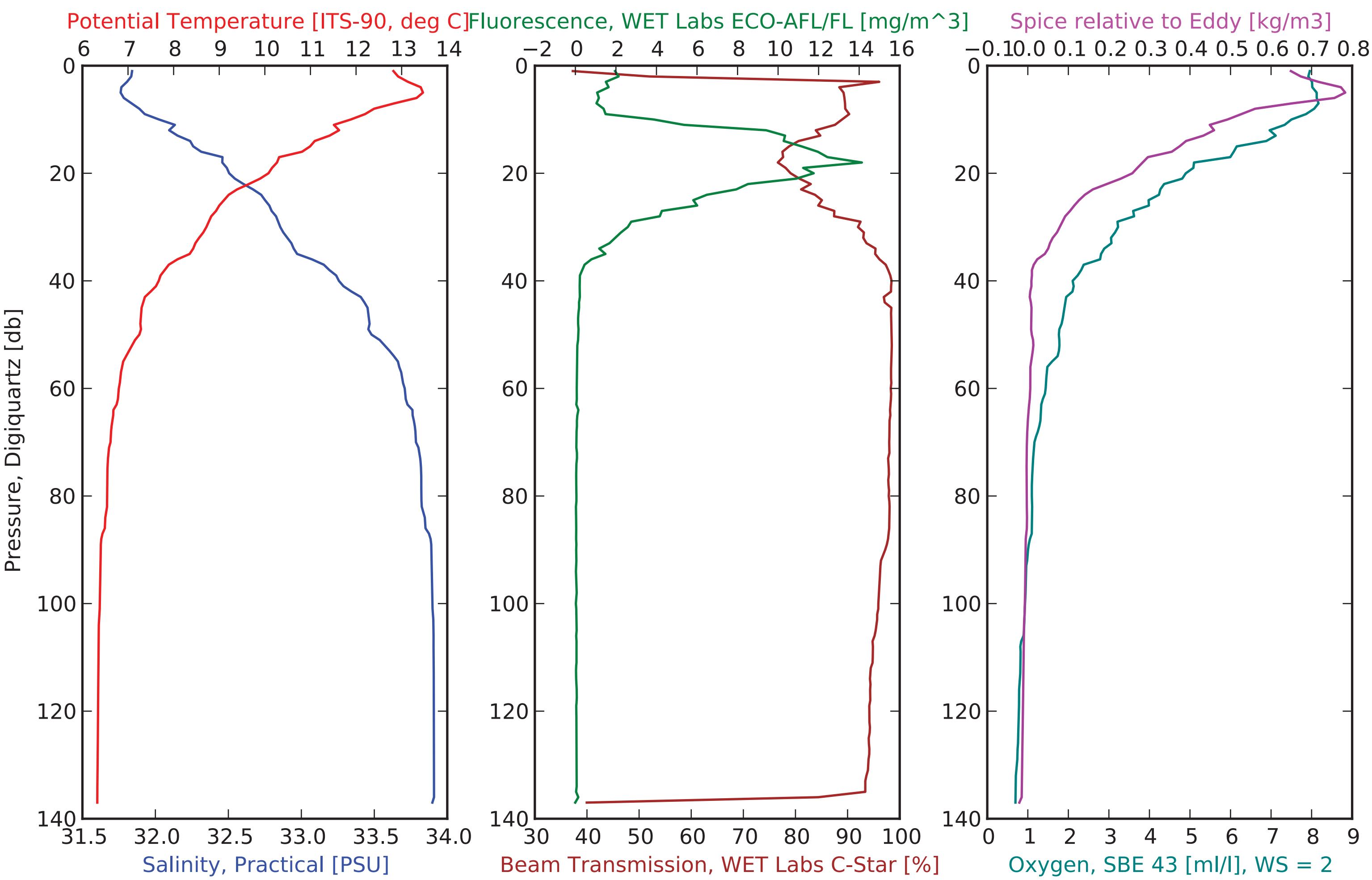
Station: LB08 at 48 25.29 N,125 28.62 W

On: Aug 19 2013 21:05:36UTC

Filename: FK009A_CTD003_20130819.cnv



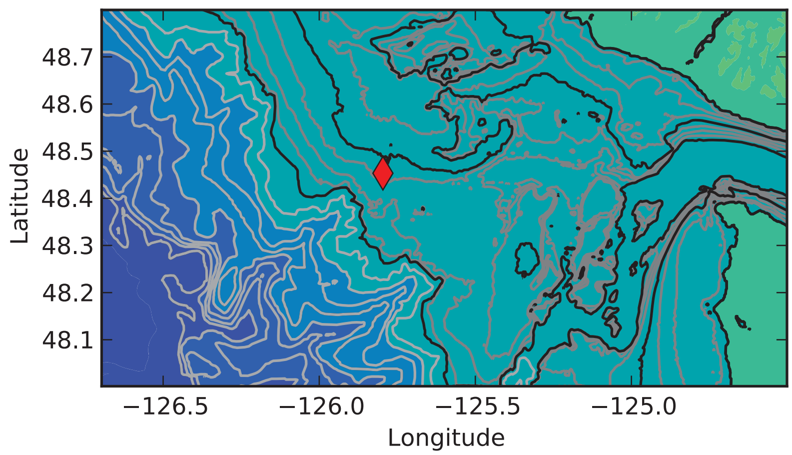


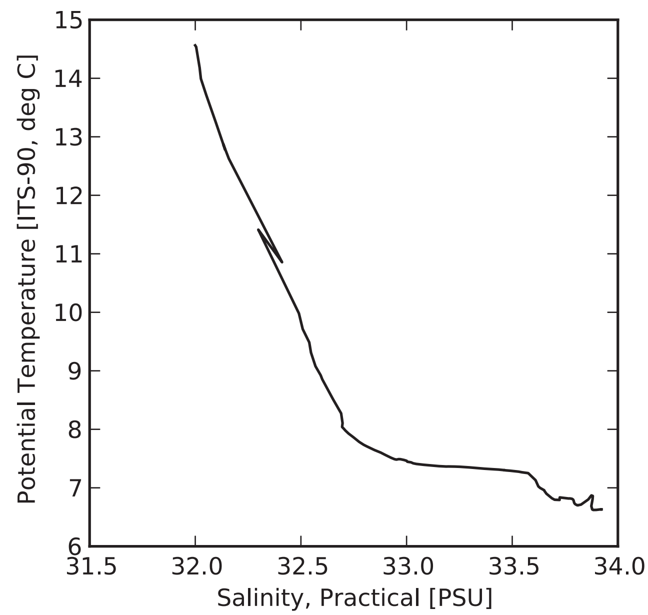


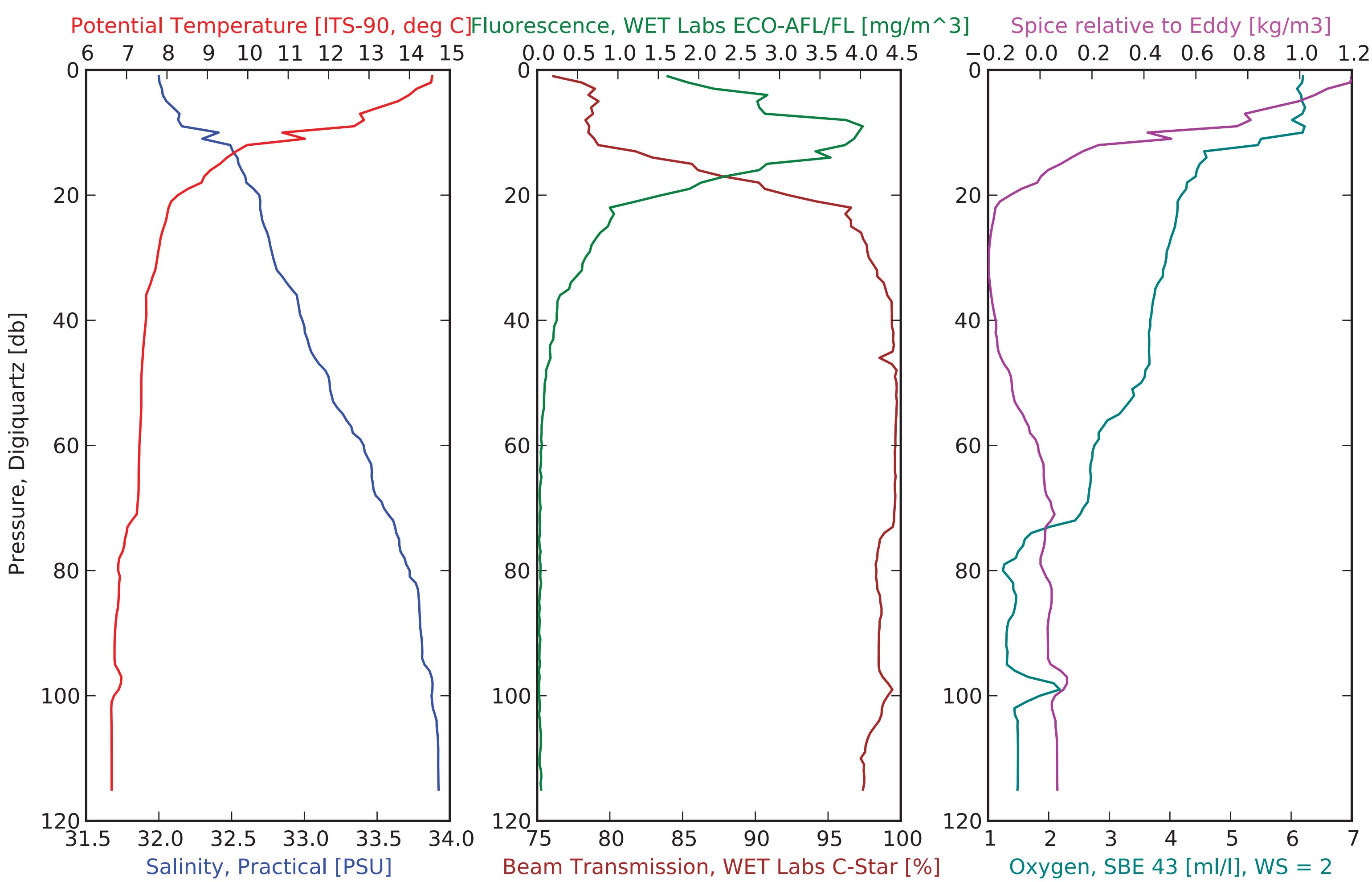
Station: BCC0 at 48 27.19 N,125 47.76 W

On: Aug 19 2013 22:58:10UTC

Filename: FK009A_CTD004_20130819.cnv



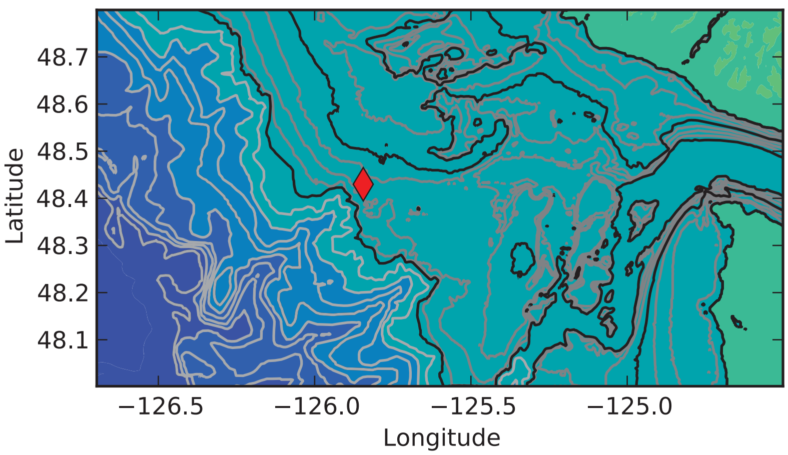


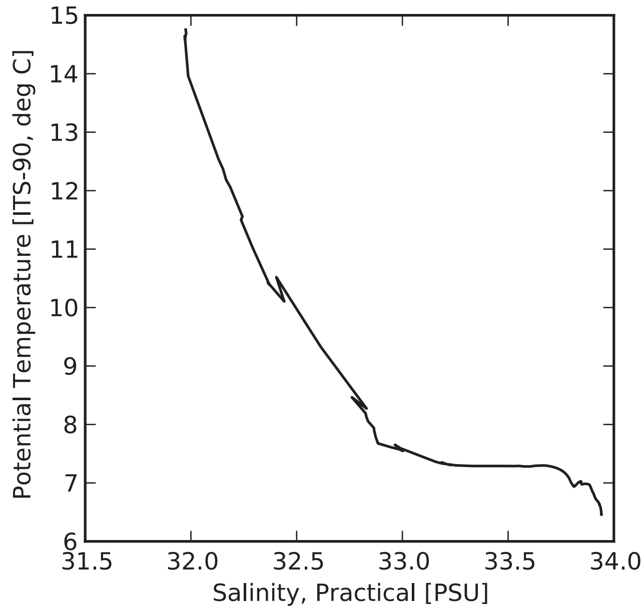


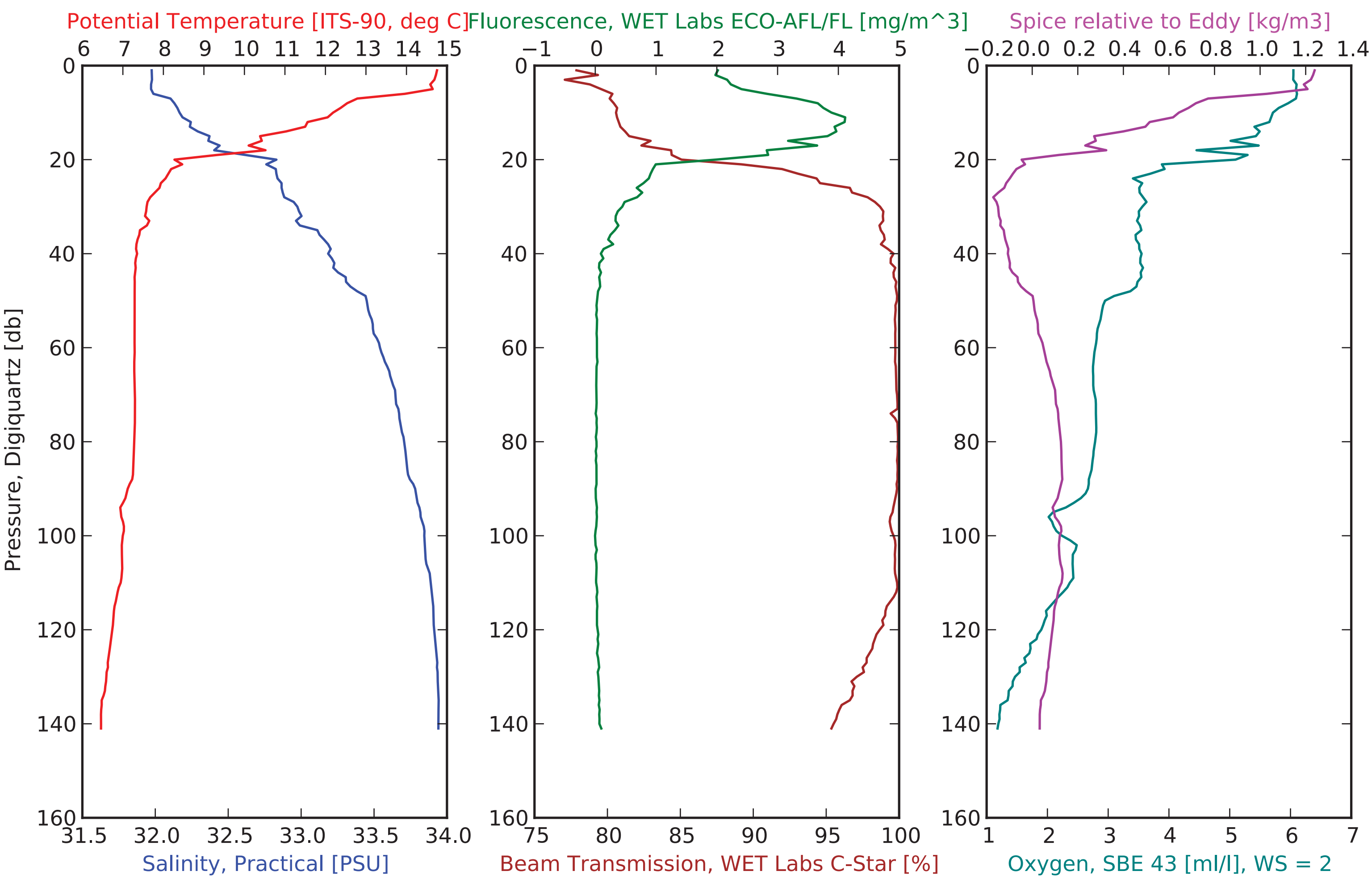
Station: BCC1 at 48 25.79 N,125 50.67 W

On: Aug 20 2013 00:02:57UTC

Filename: FK009A_CTD005_20130820.cnv



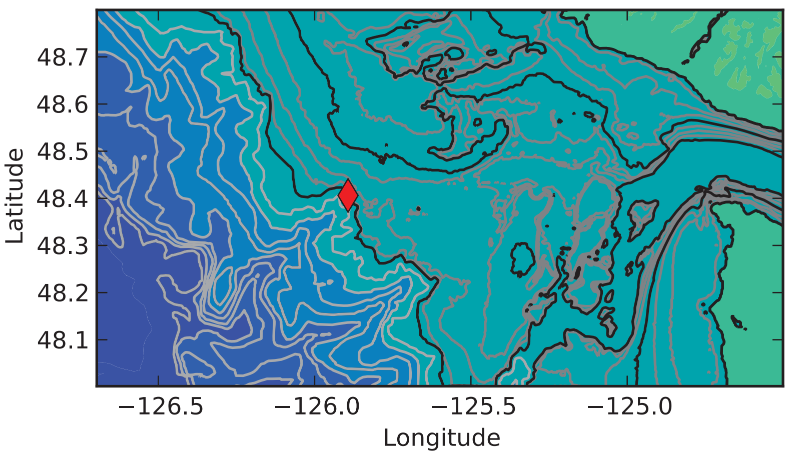


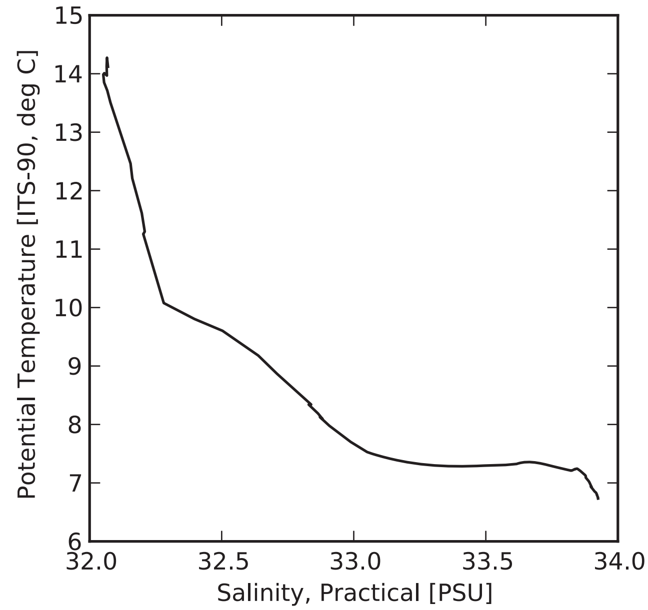


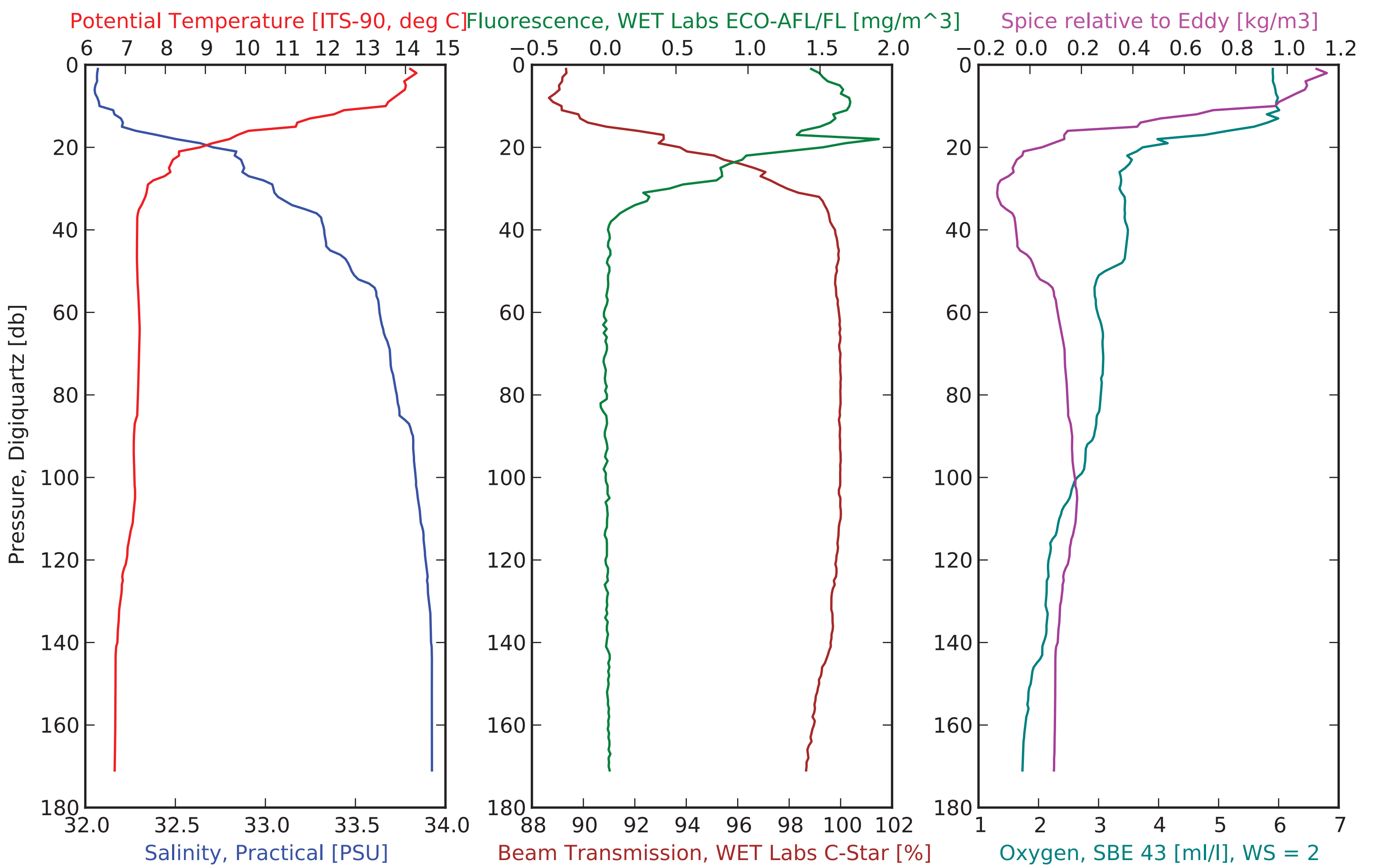
Station: BCC2 at 48 24.36 N,125 53.59 W

On: Aug 20 2013 00:47:16UTC

Filename: FK009A_CTD006_20130820.cnv



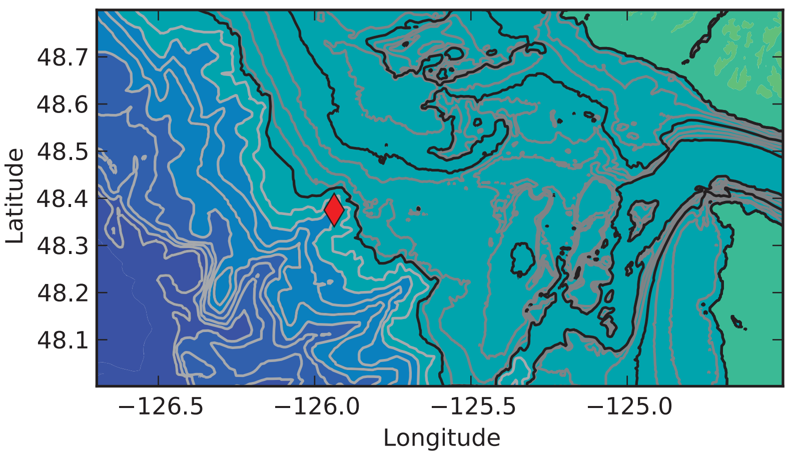


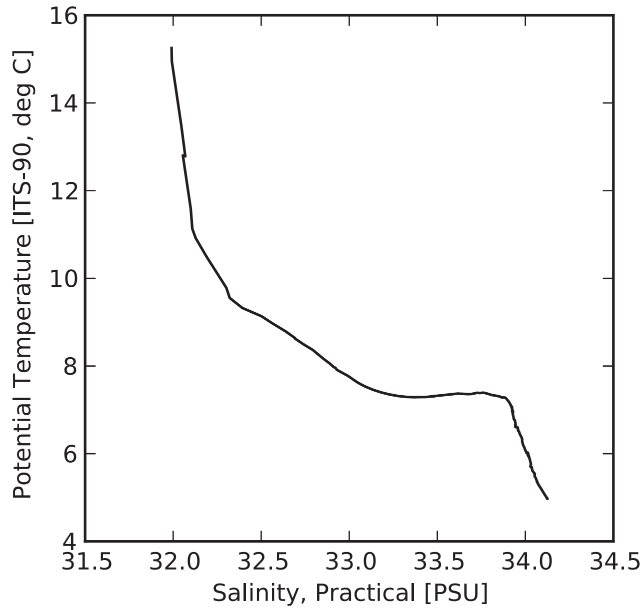


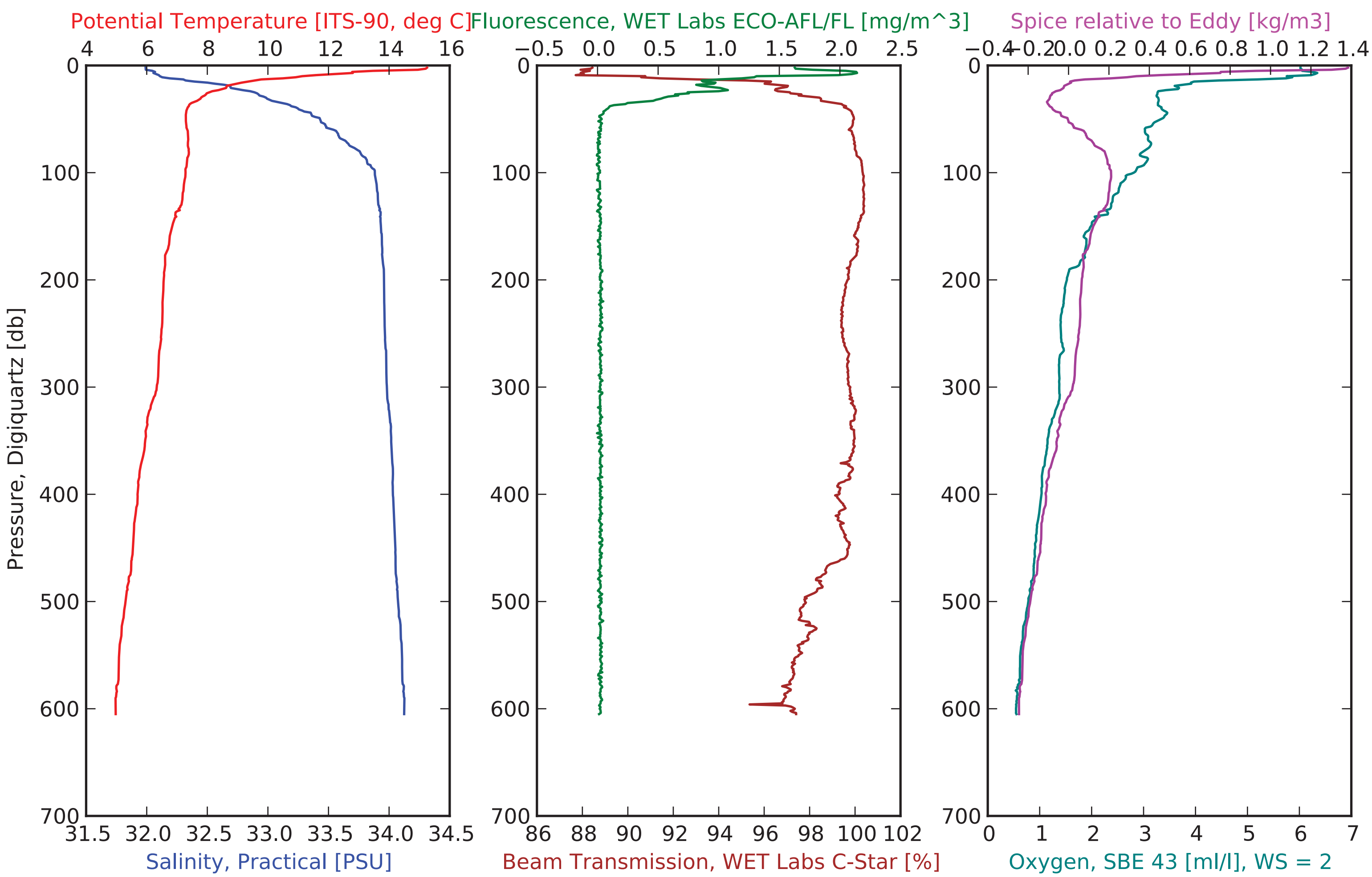
Station: BCC3 at 48 22.51 N,125 56.25 W

On: Aug 20 2013 01:53:03UTC

Filename: FK009A_CTD007_20130820.cnv



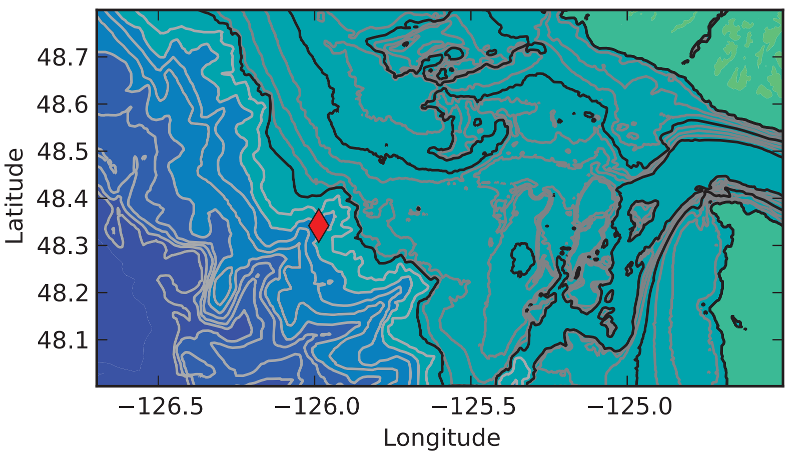


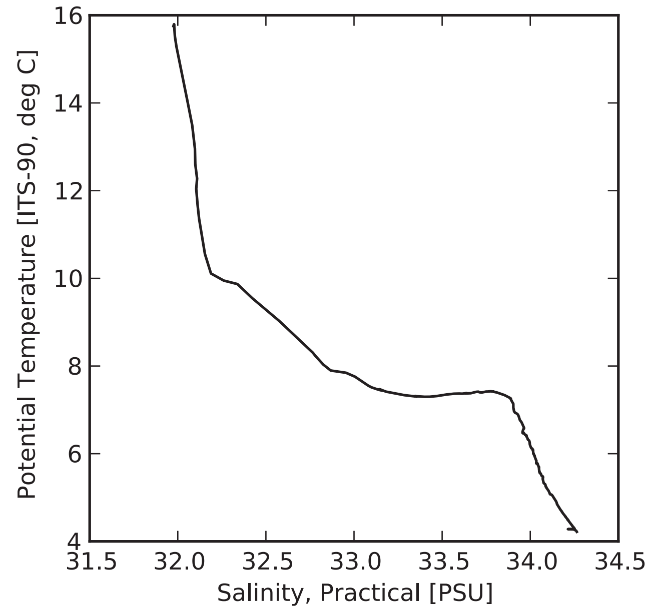


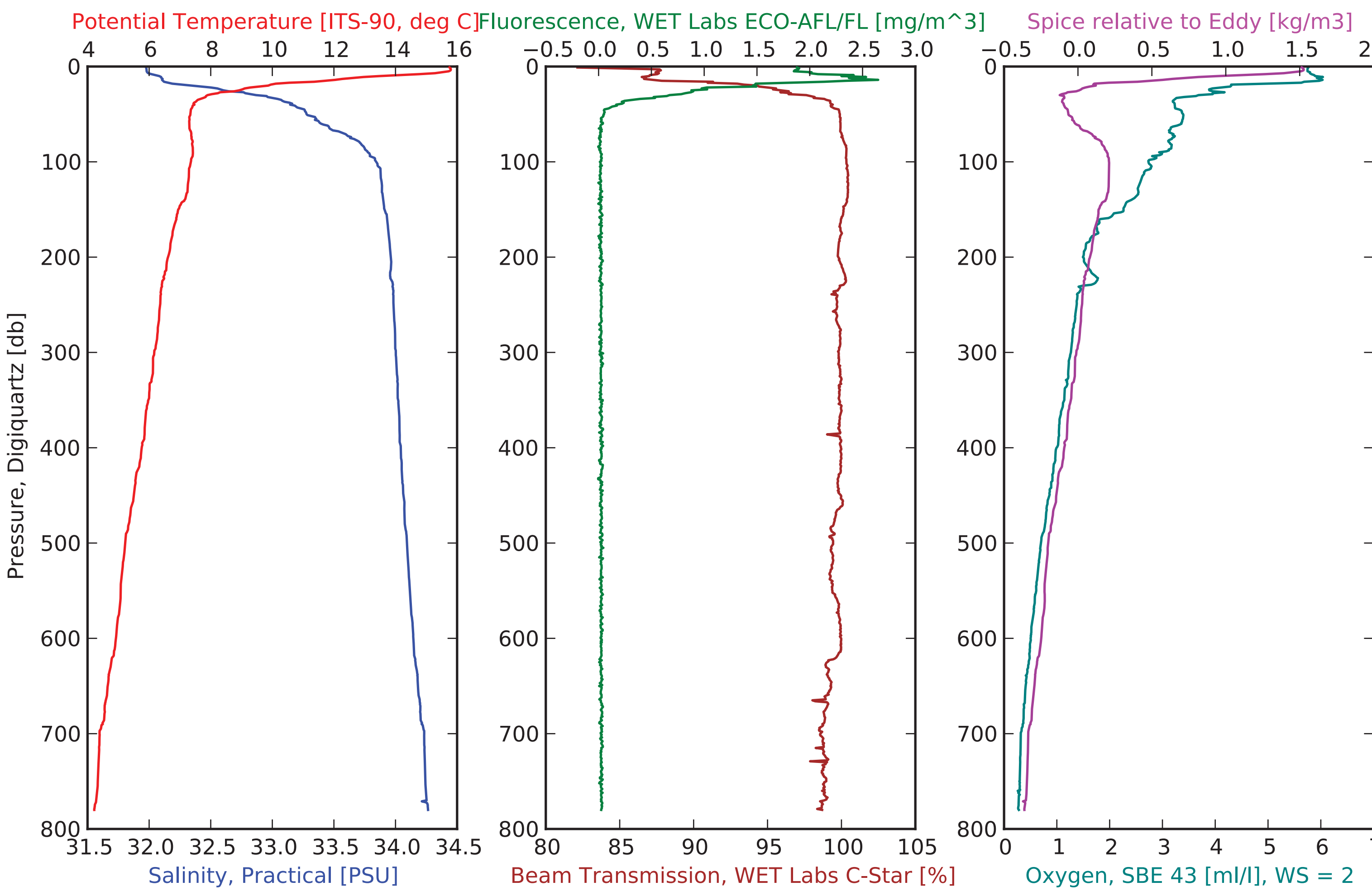
Station: BCC4 at 48 20.52 N,125 59.21 W

On: Aug 20 2013 03:35:31UTC

Filename: FK009A_CTD008_20130820.cnv



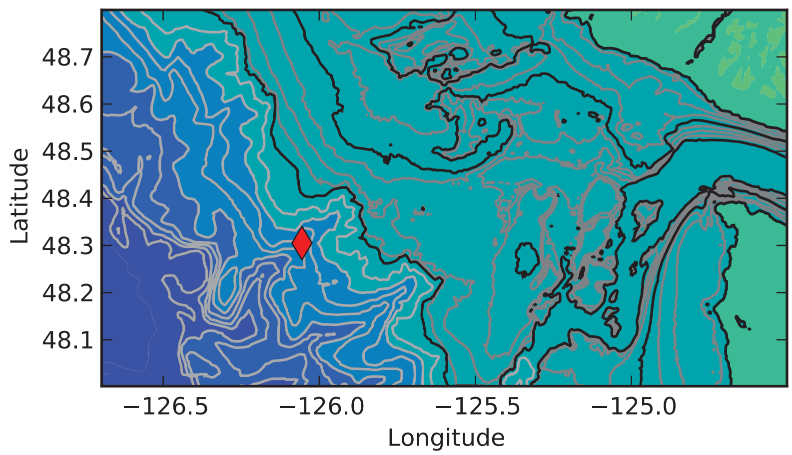


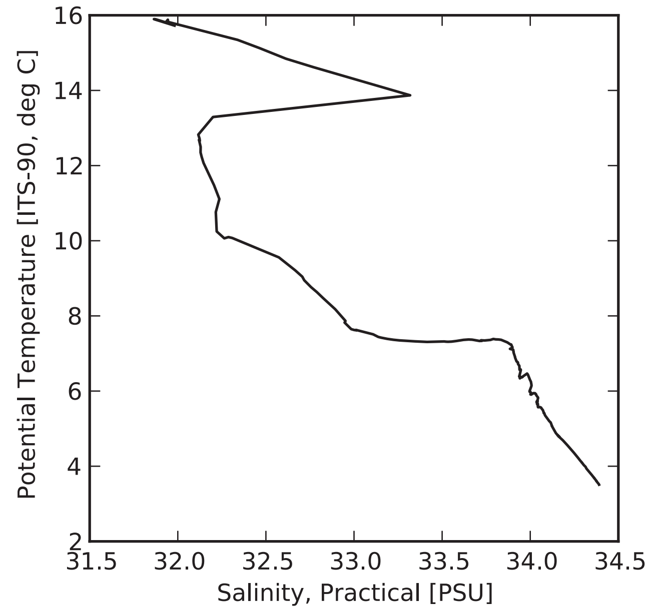


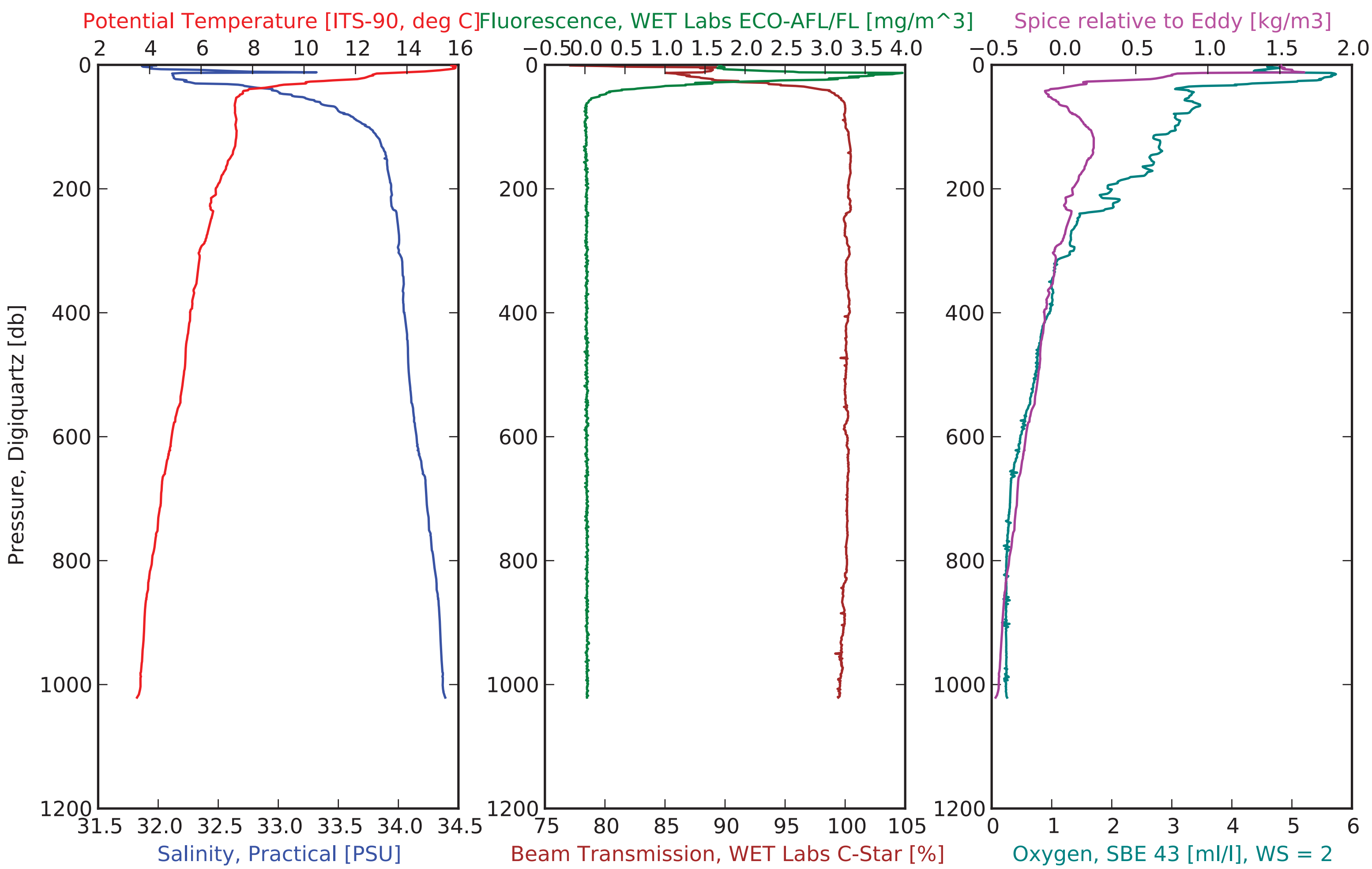
Station: BCC5 at 48 18.30 N,126 03.32 W

On: Aug 20 2013 04:59:49UTC

Filename: FK009A_CTD009_20130820.cnv



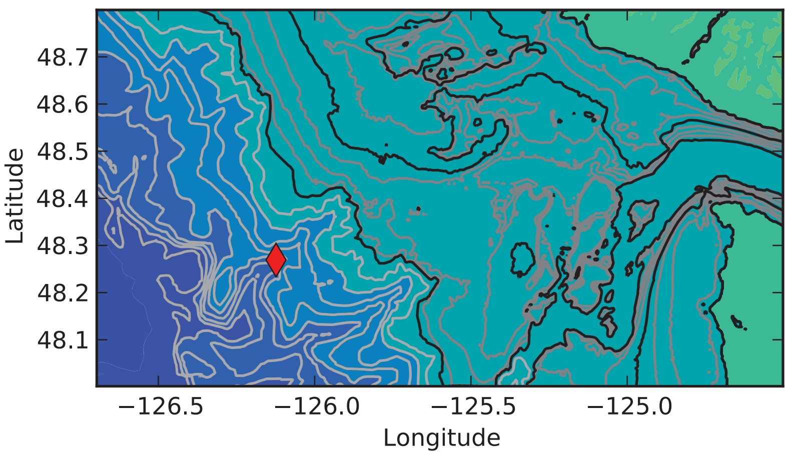


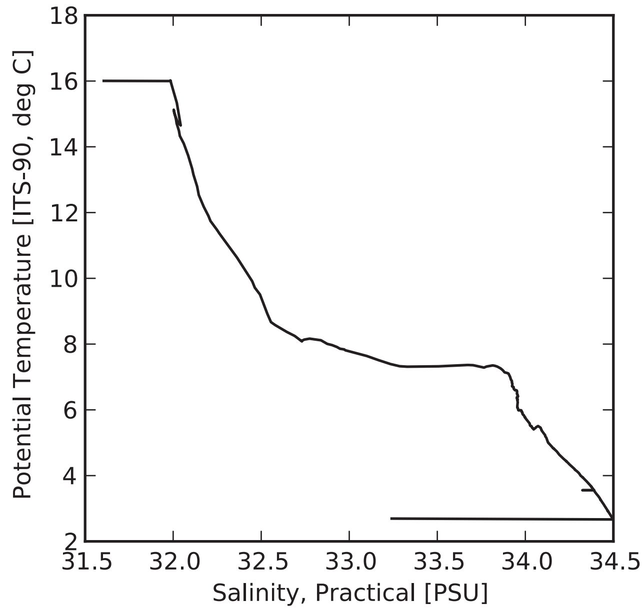


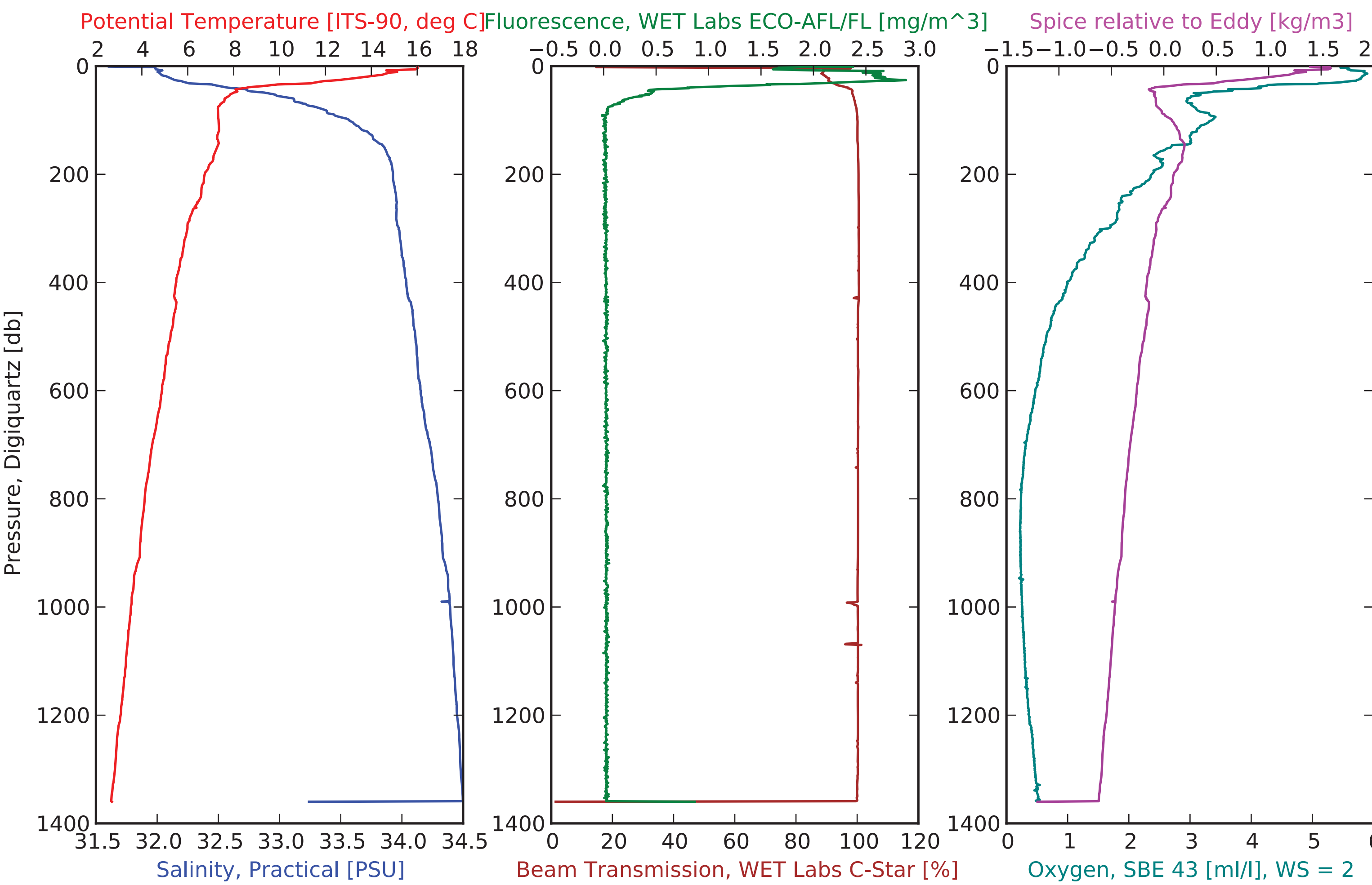
Station: BCC6 at 48 16.15 N,126 07.41 W

On: Aug 20 2013 07:26:03UTC

Filename: FK009A_CTD010_20130820.cnv



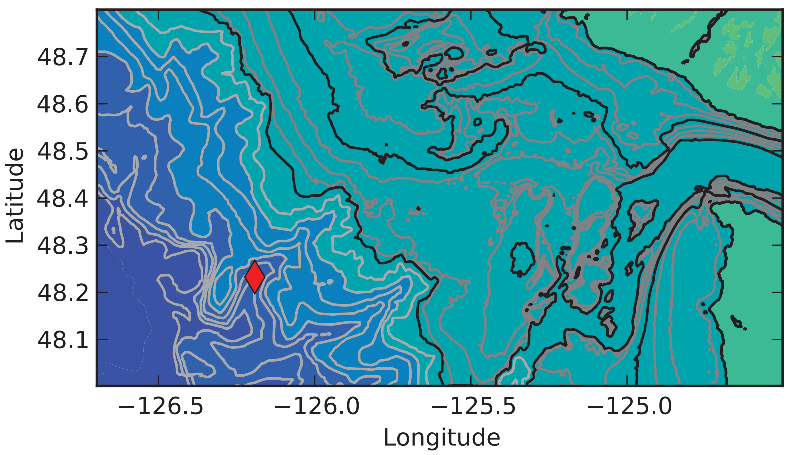


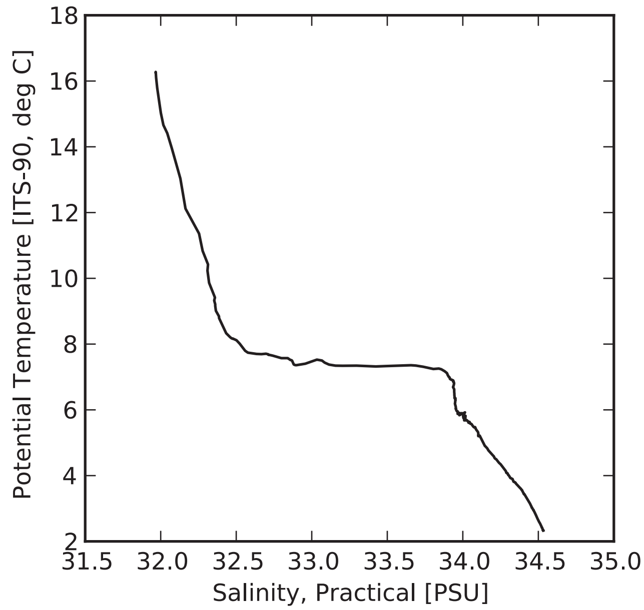


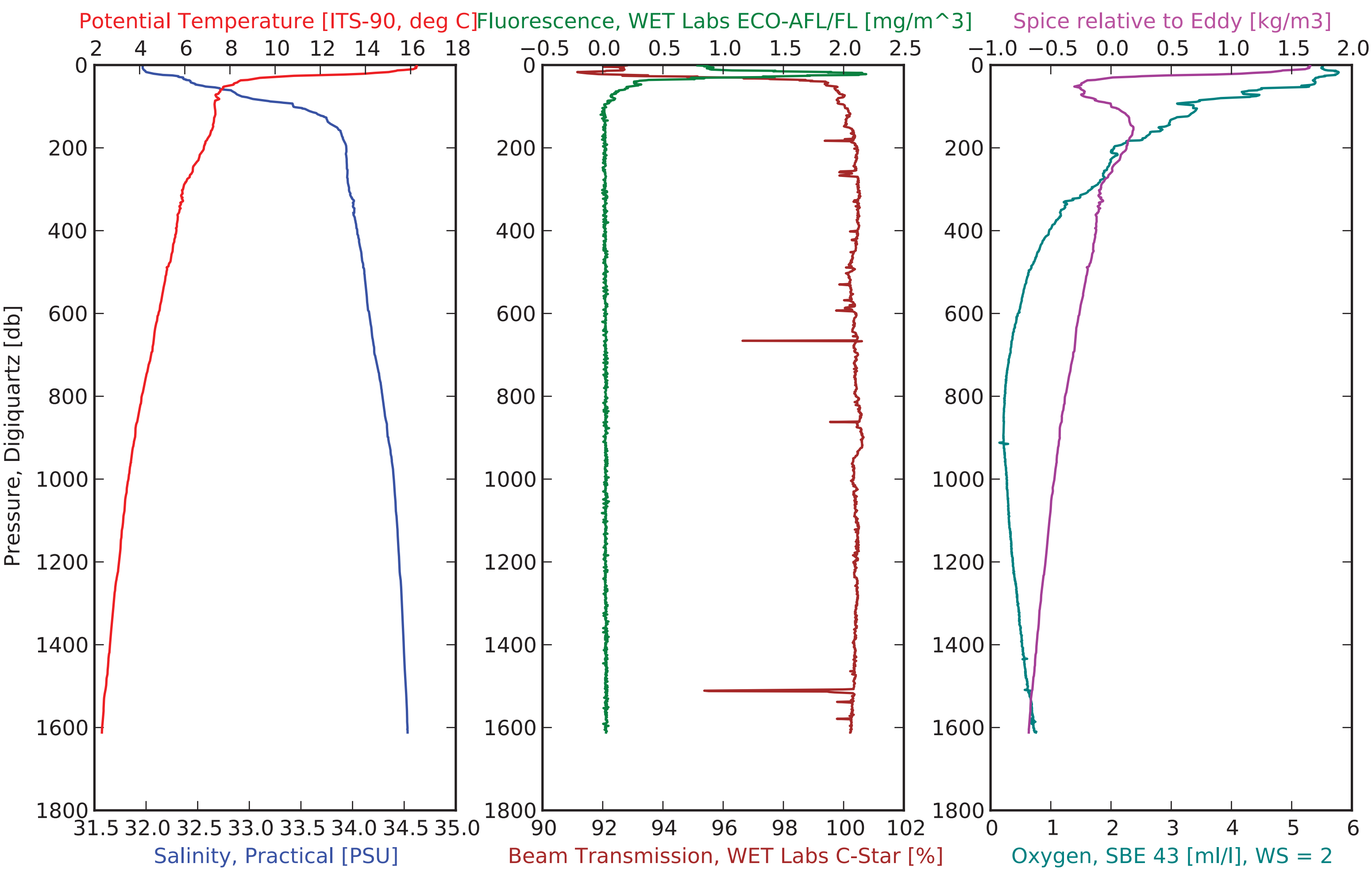
Station: BCC7 at 48 13.95 N,126 11.50 W

On: Aug 20 2013 09:04:09UTC

Filename: FK009A_CTD011_20130820.cnv



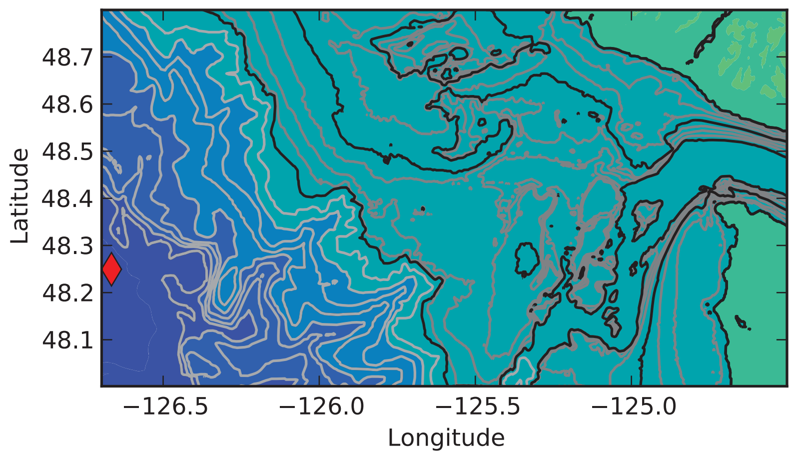


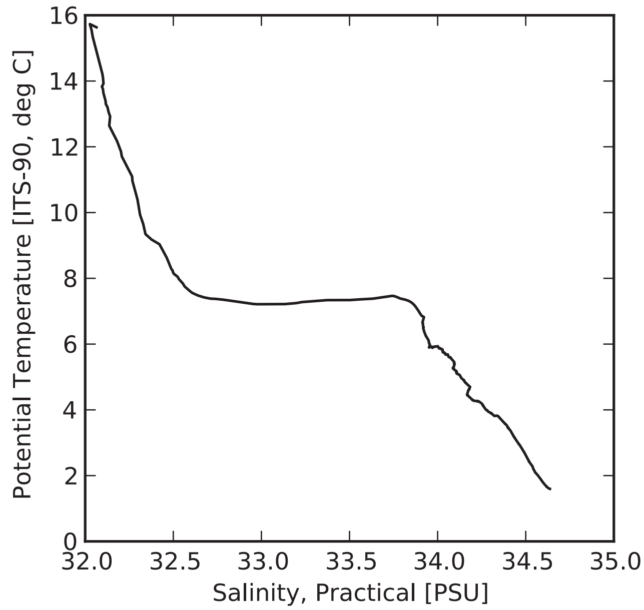


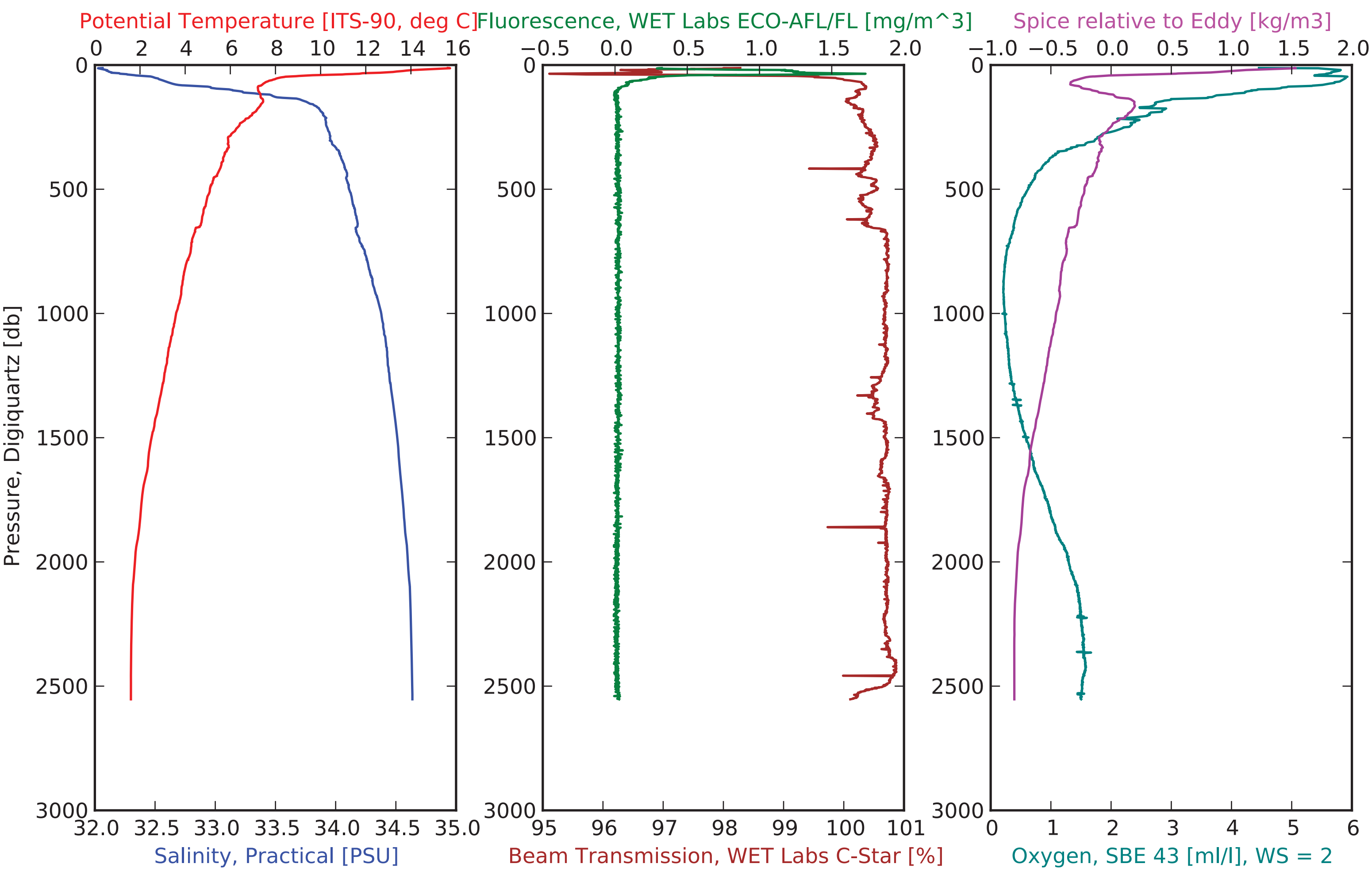
Station: LC12 at 48 14.97 N,126 39.93 W

On: Aug 20 2013 14:07:47UTC

Filename: FK009A_CTD012_20130820.cnv



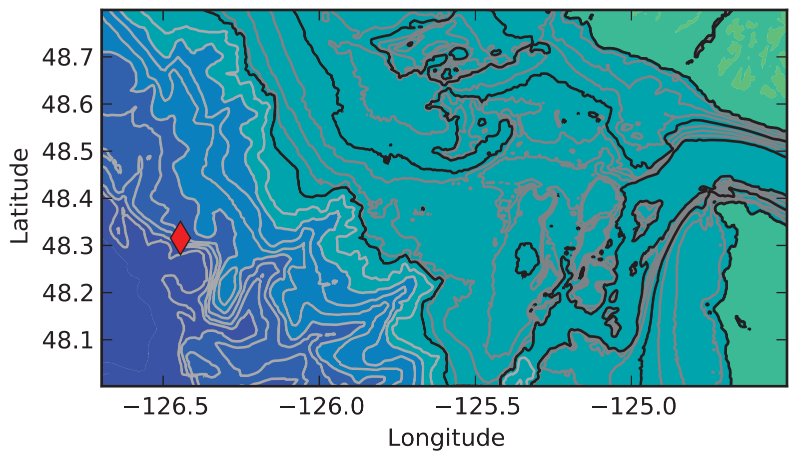


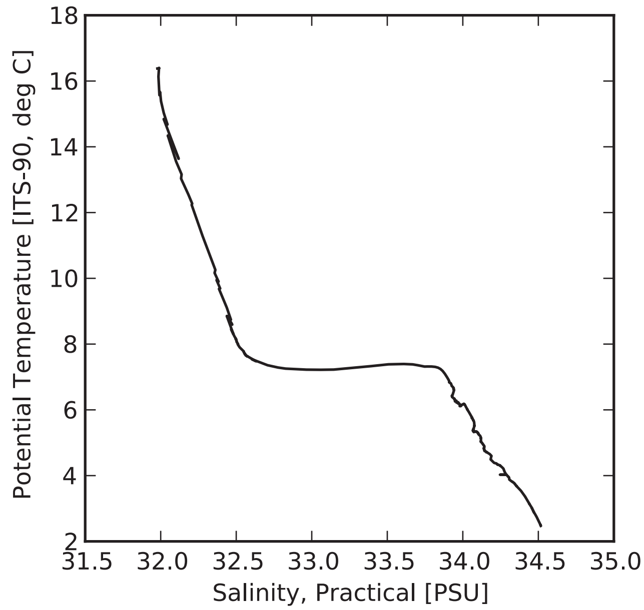


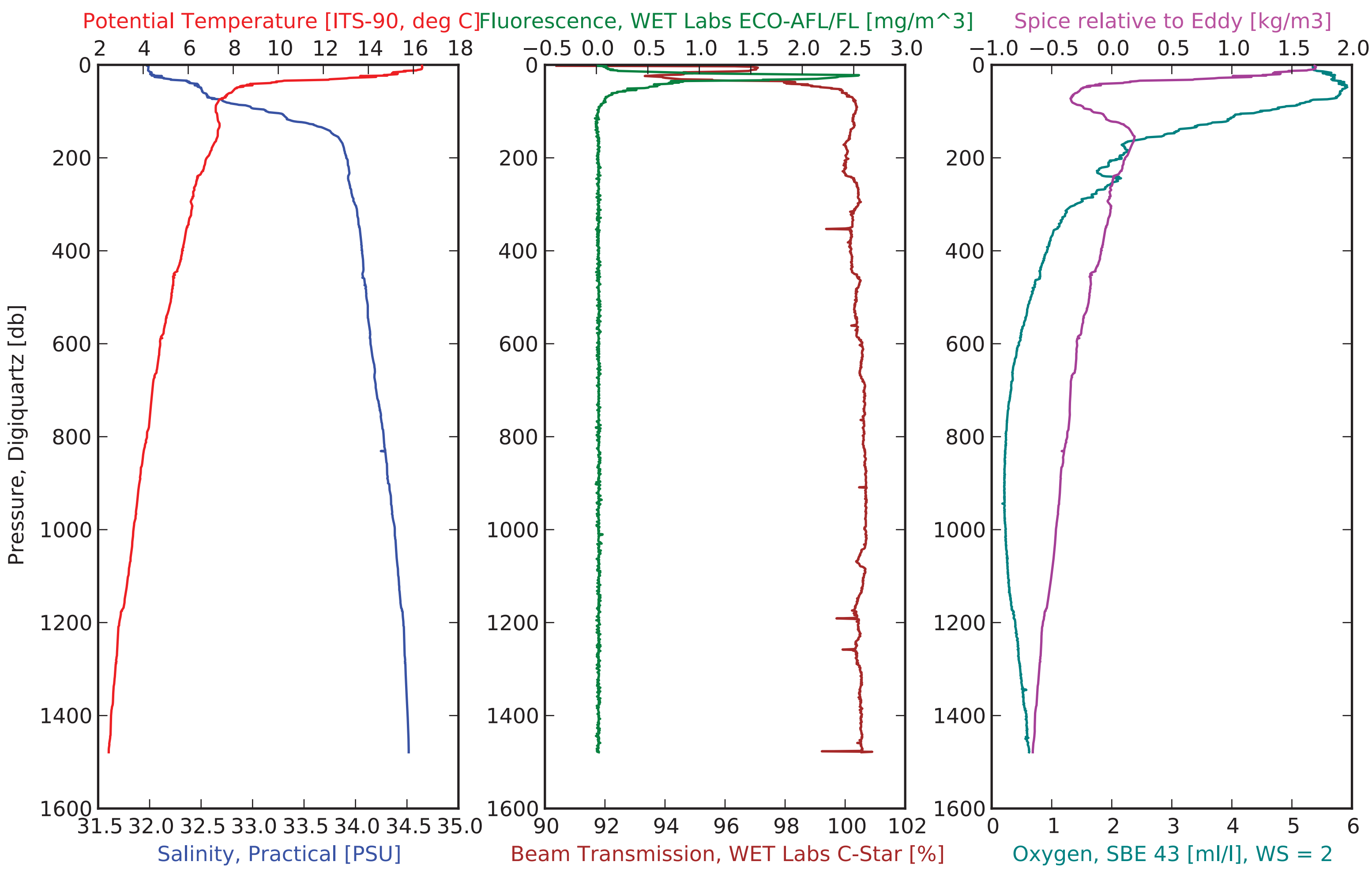
Station: LC11 at 48 18.94 N,126 26.67 W

On: Aug 20 2013 18:24:28UTC

Filename: FK009A_CTD013_20130820.cnv



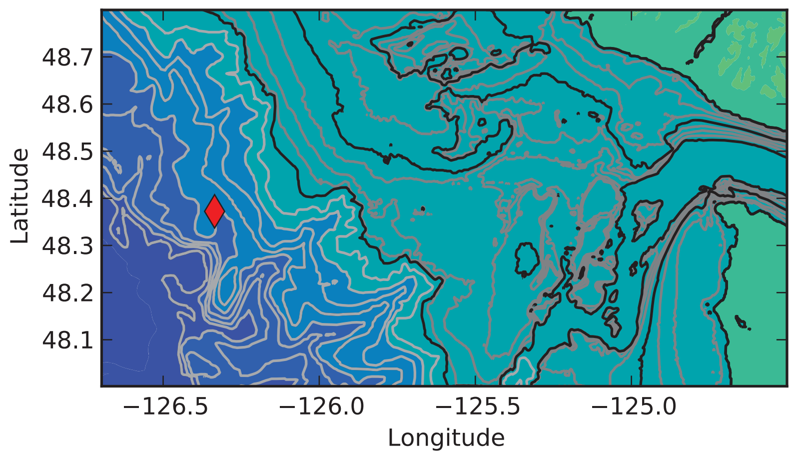


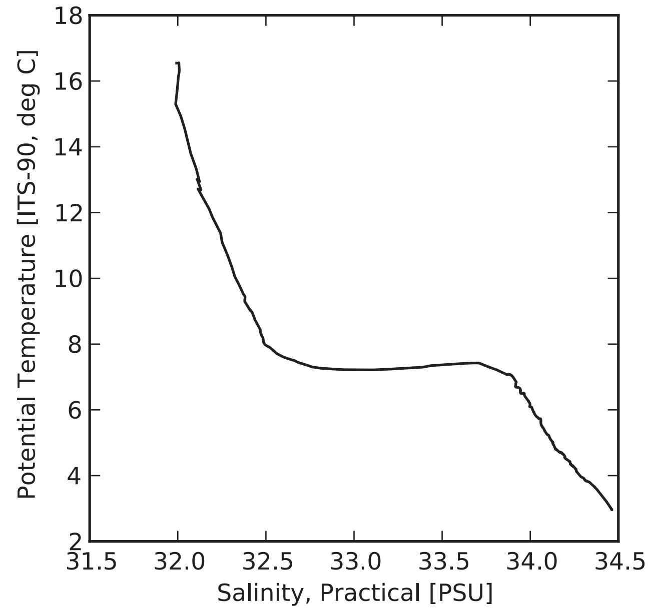


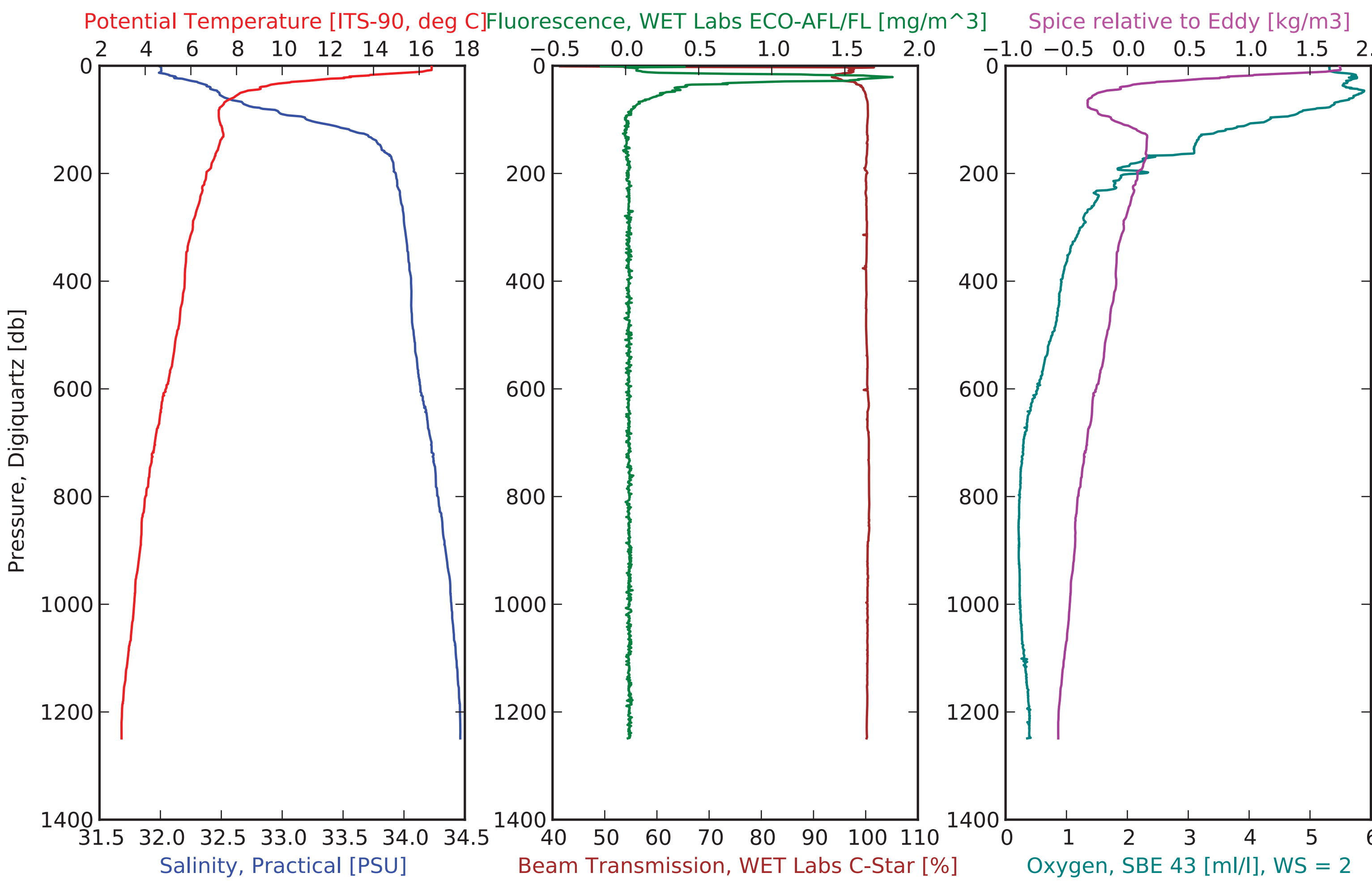
Station: LC10 at 48 22.34 N,126 20.11 W

On: Aug 20 2013 20:59:06UTC

Filename: FK009A_CTD014_20130820.cnv



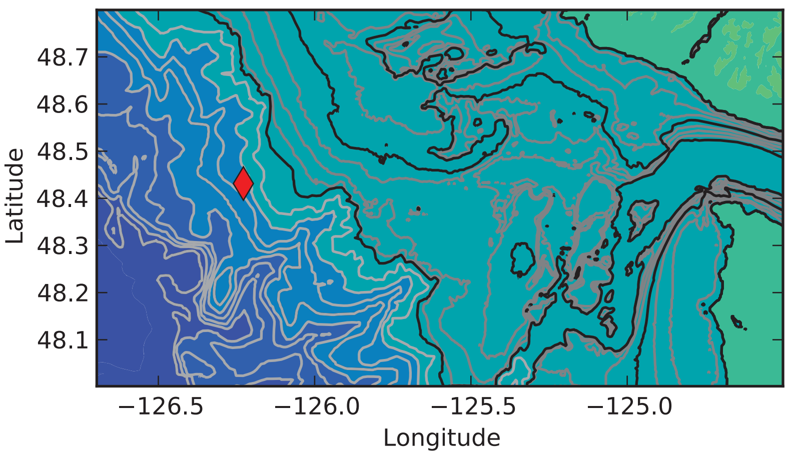


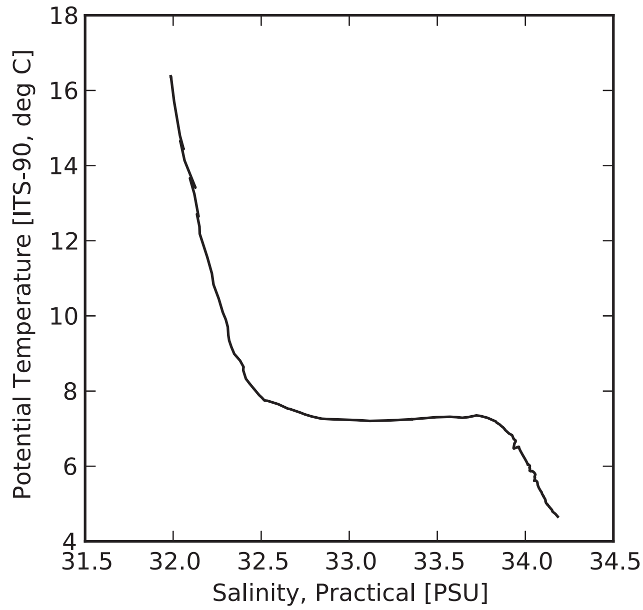


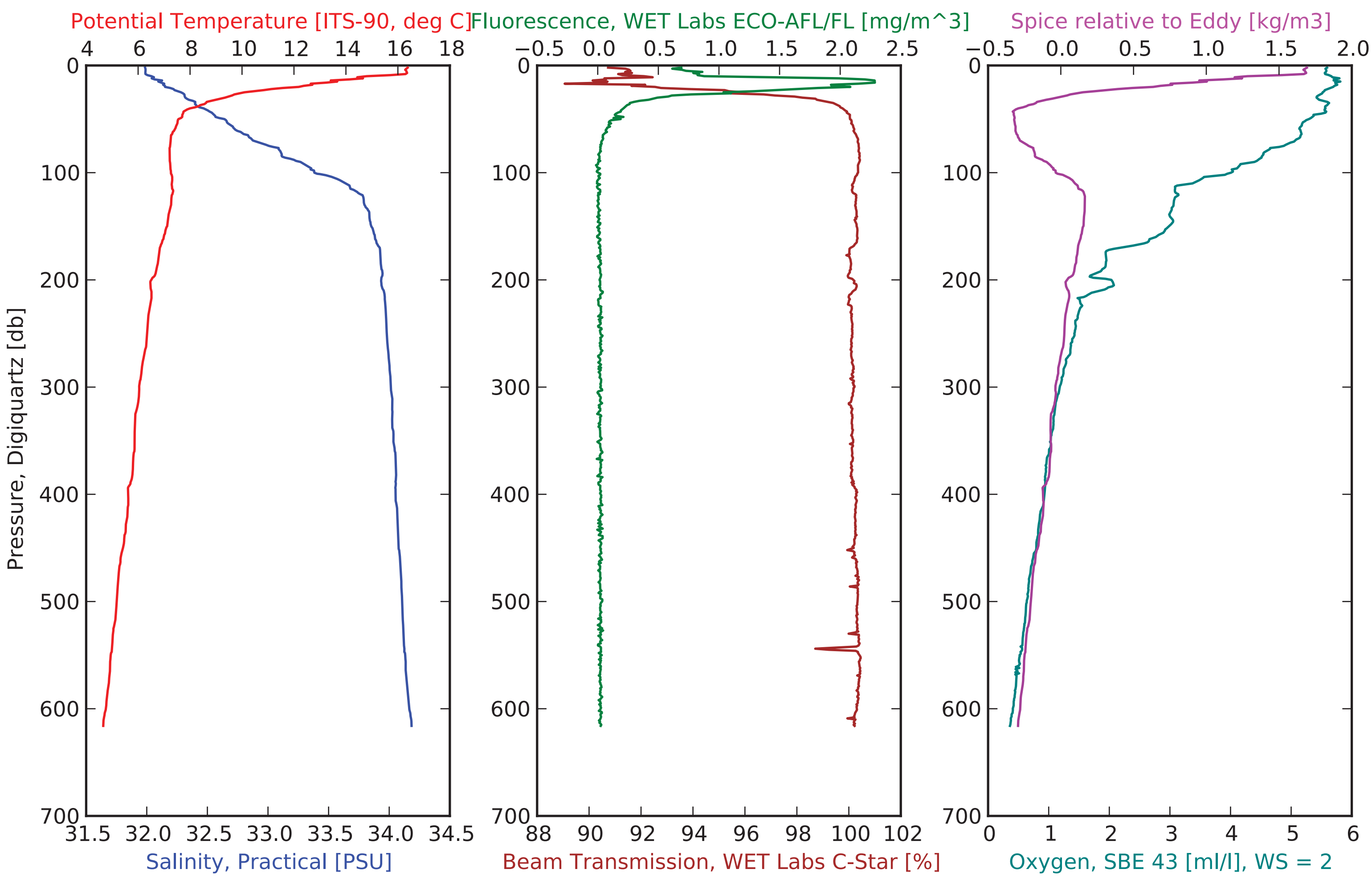
Station: LC09 at 48 25.88 N,126 13.68 W

On: Aug 20 2013 22:48:22UTC

Filename: FK009A_CTD015_20130820.cnv



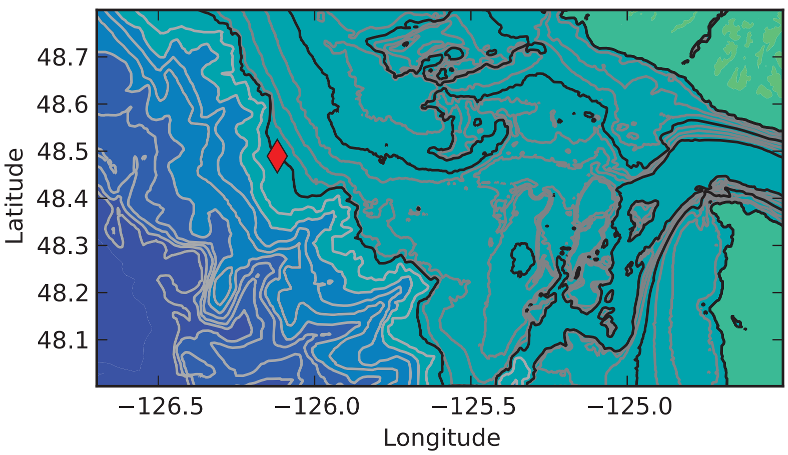


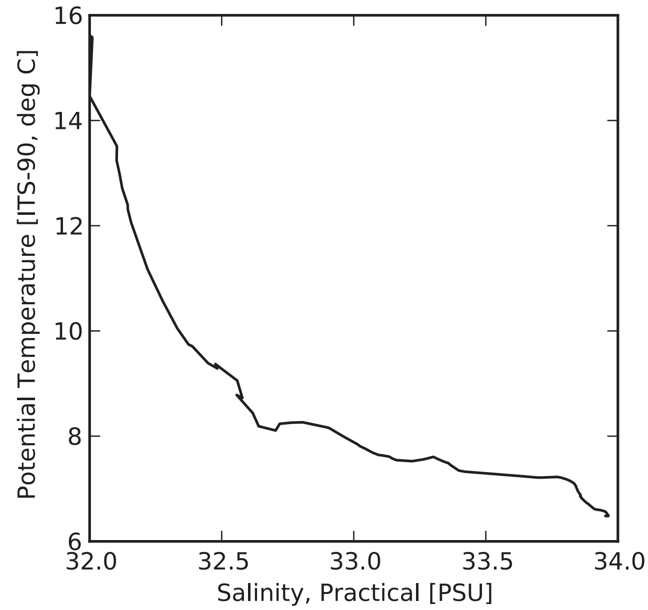


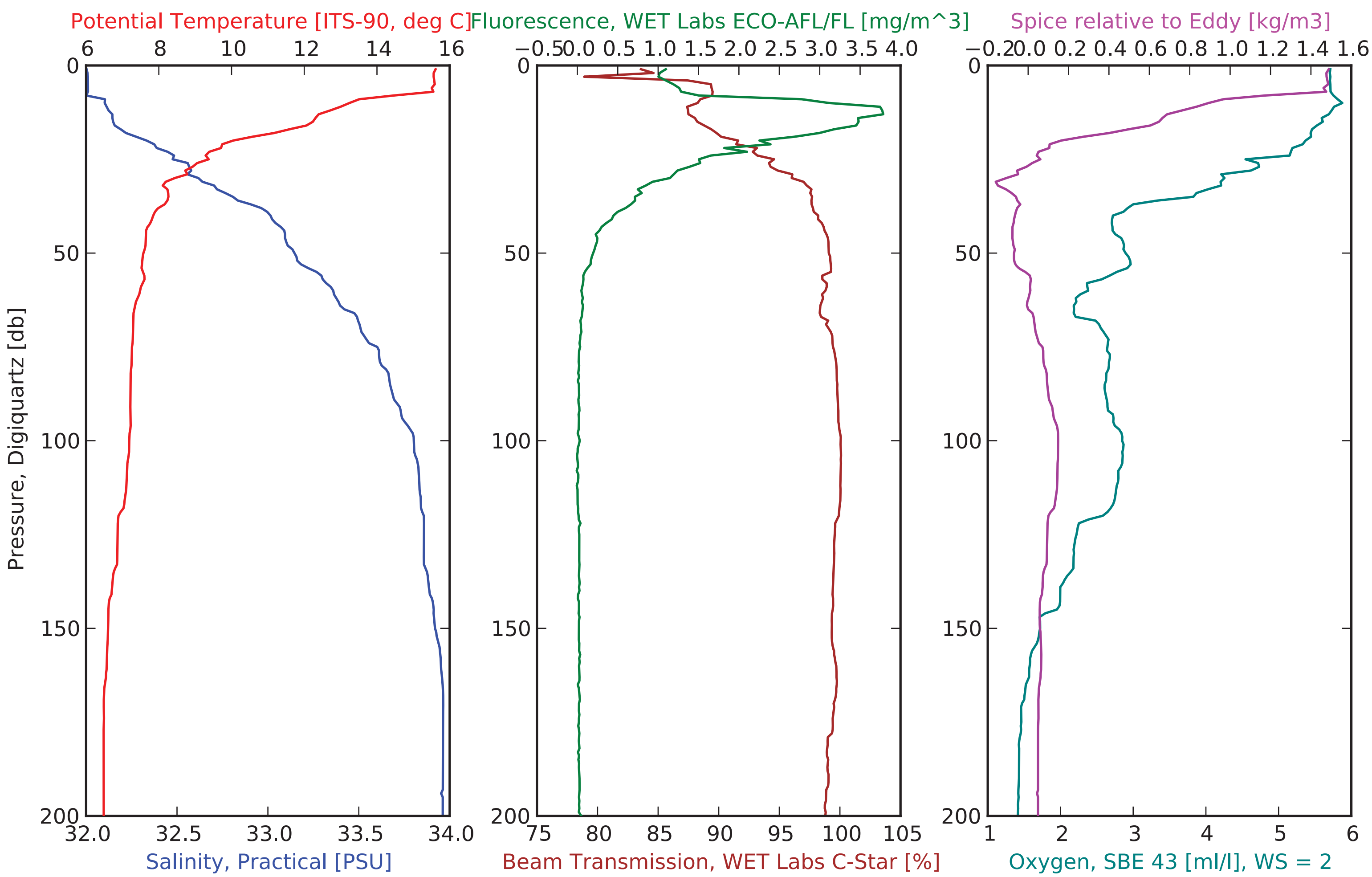
Station: LC08 at 48 29.37 N,126 07.17 W

On: Aug 21 2013 00:43:18UTC

Filename: FK009A_CTD016_20130821.cnv



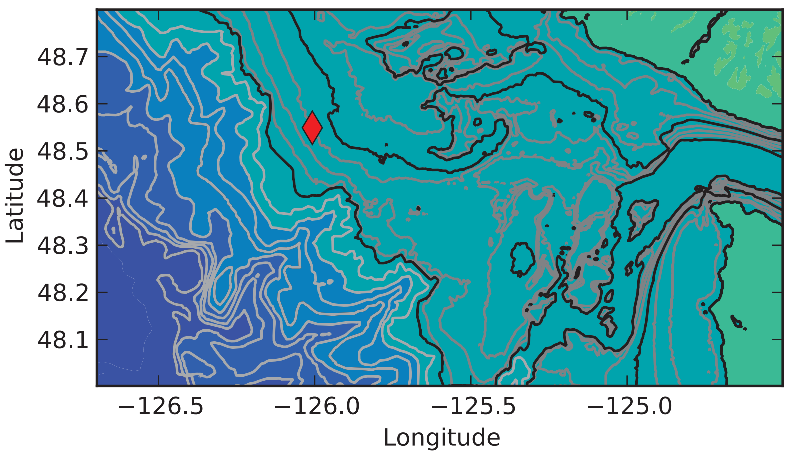


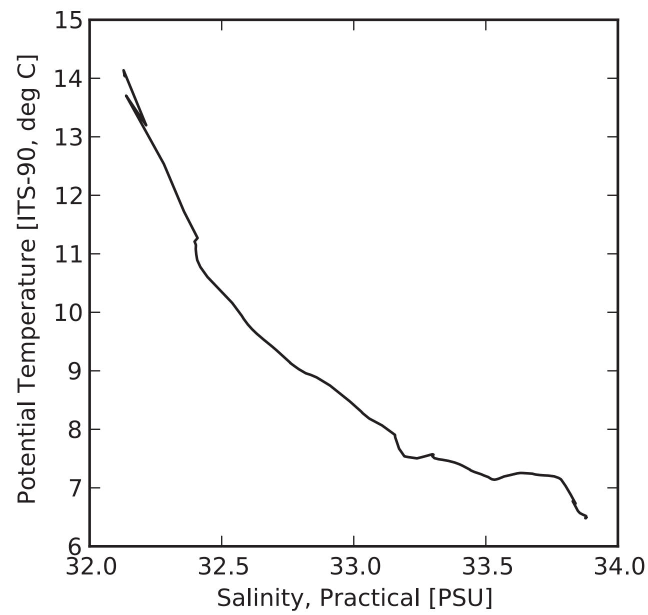


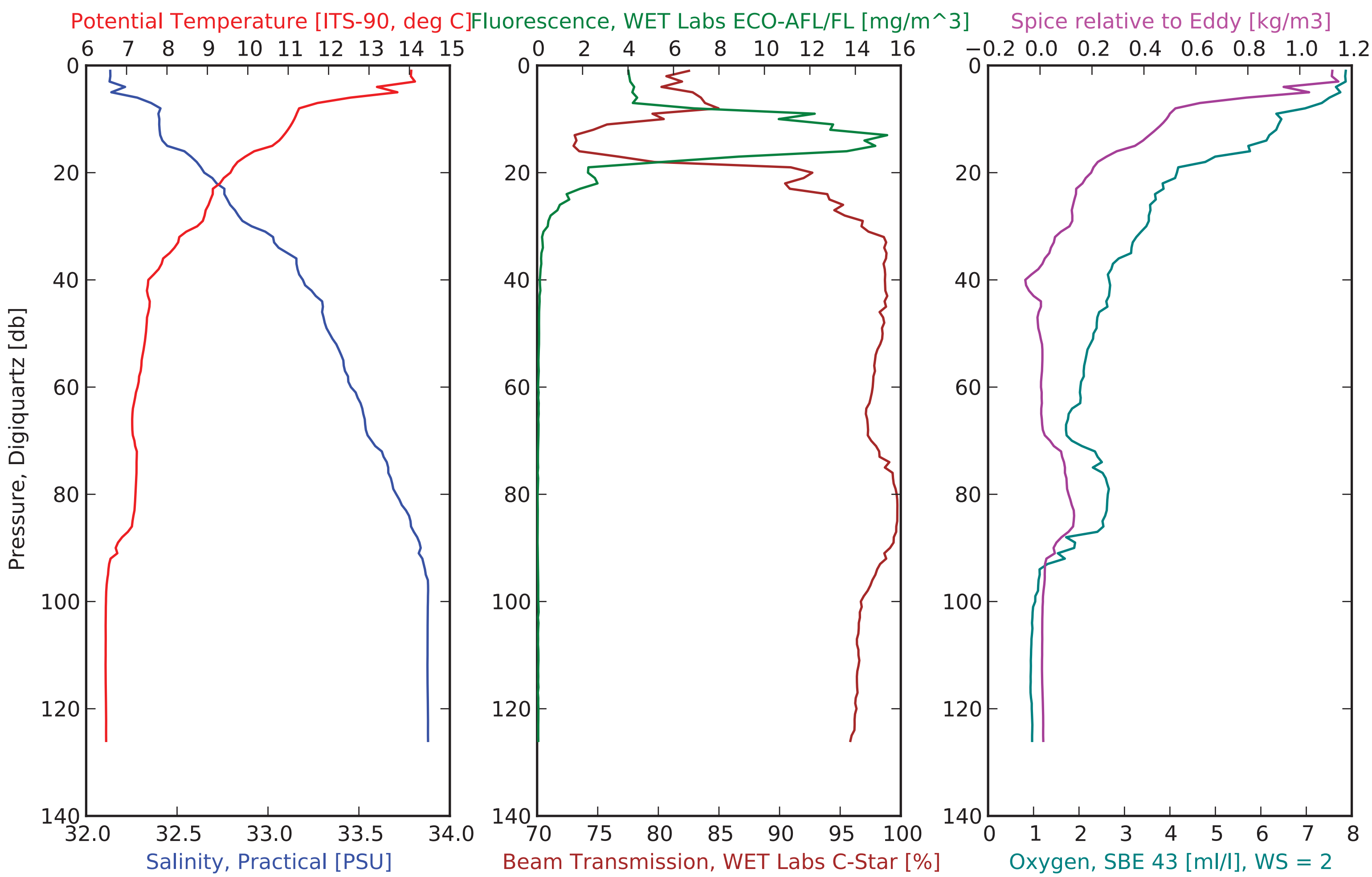
Station: LC07 at 48 32.95 N,126 00.46 W

On: Aug 21 2013 02:13:45UTC

Filename: FK009A_CTD017_20130821.cnv



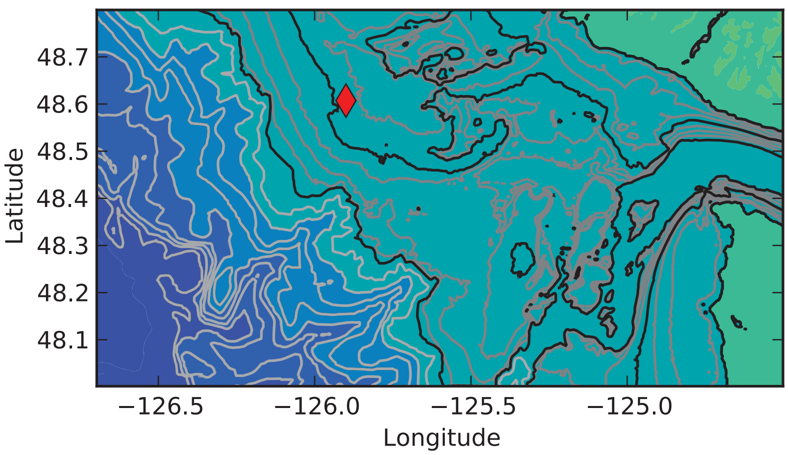


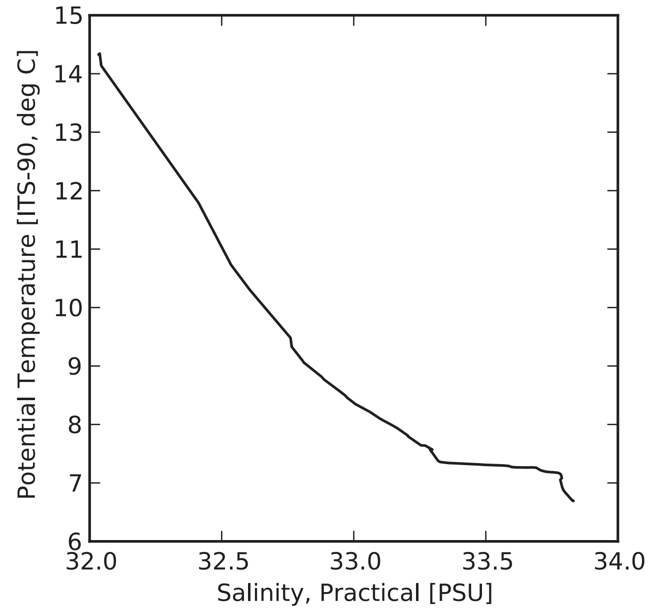


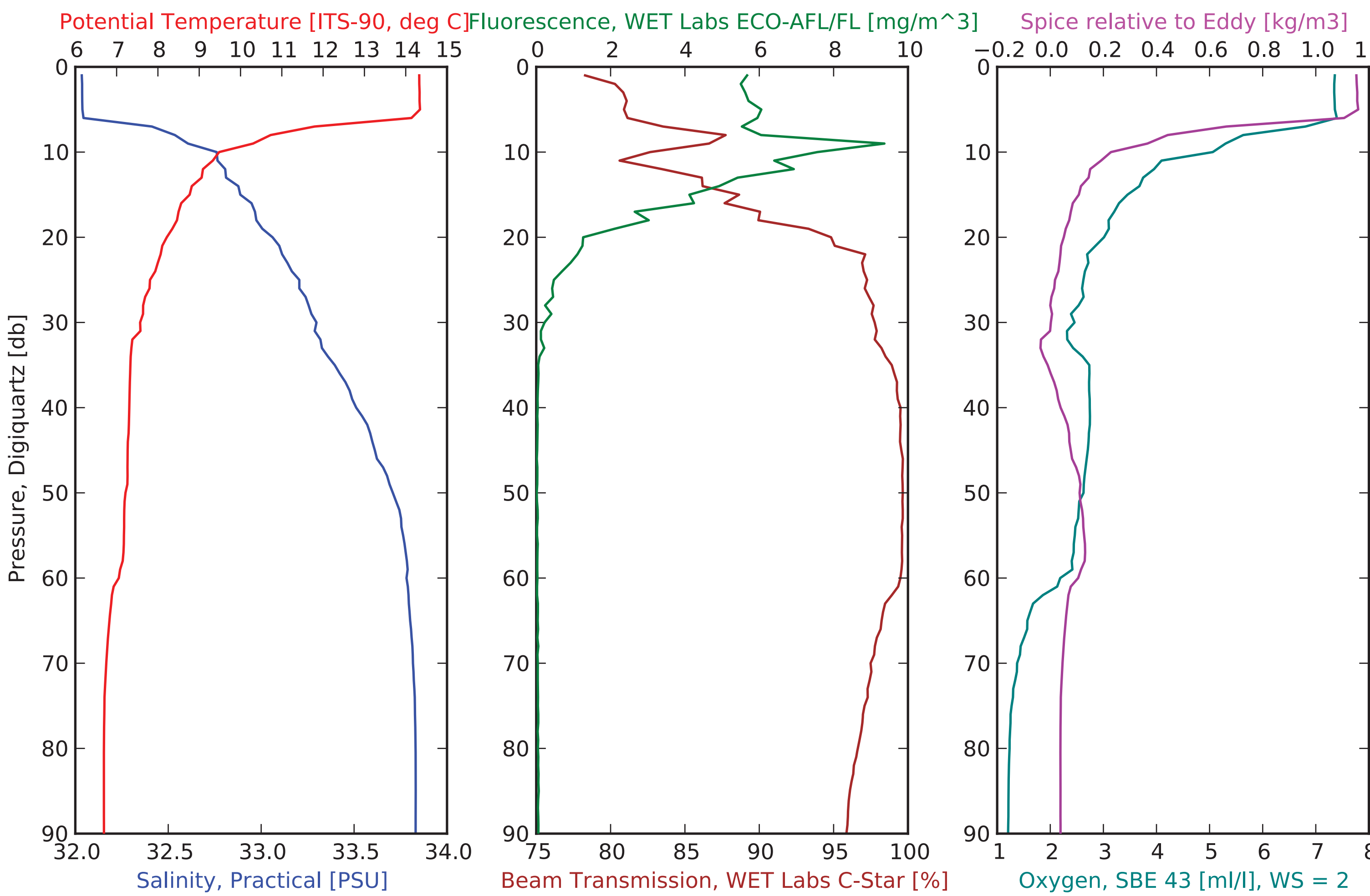
Station: LC06 at 48 36.44 N,125 53.99 W

On: Aug 21 2013 03:21:12UTC

Filename: FK009A_CTD018_20130821.cnv



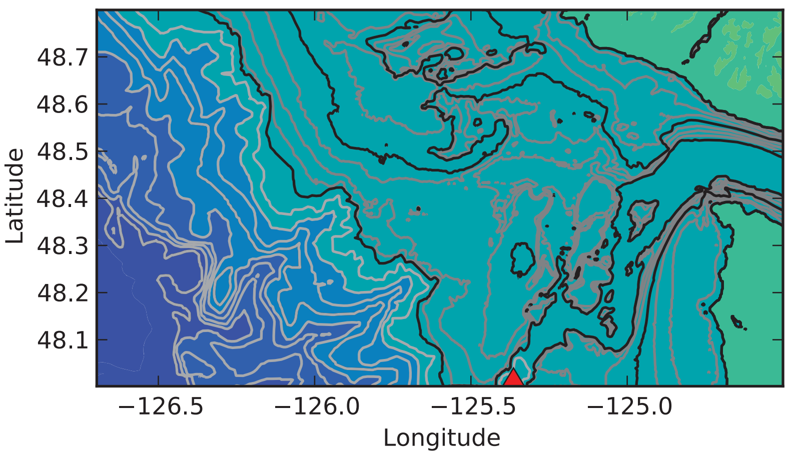


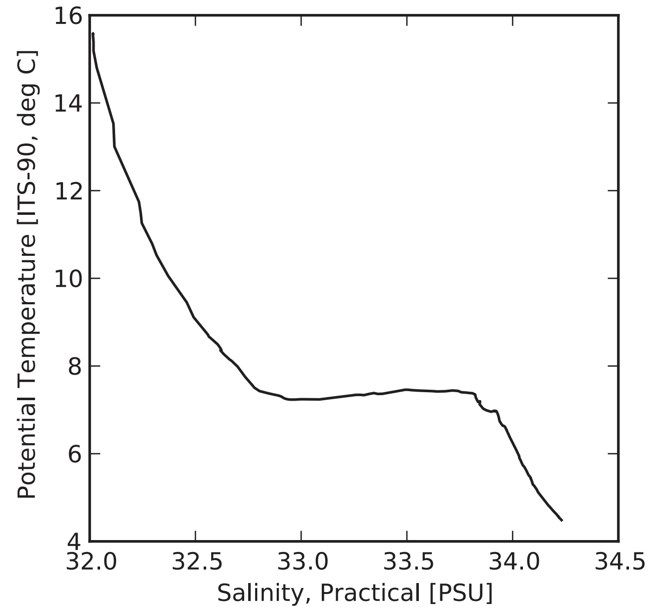


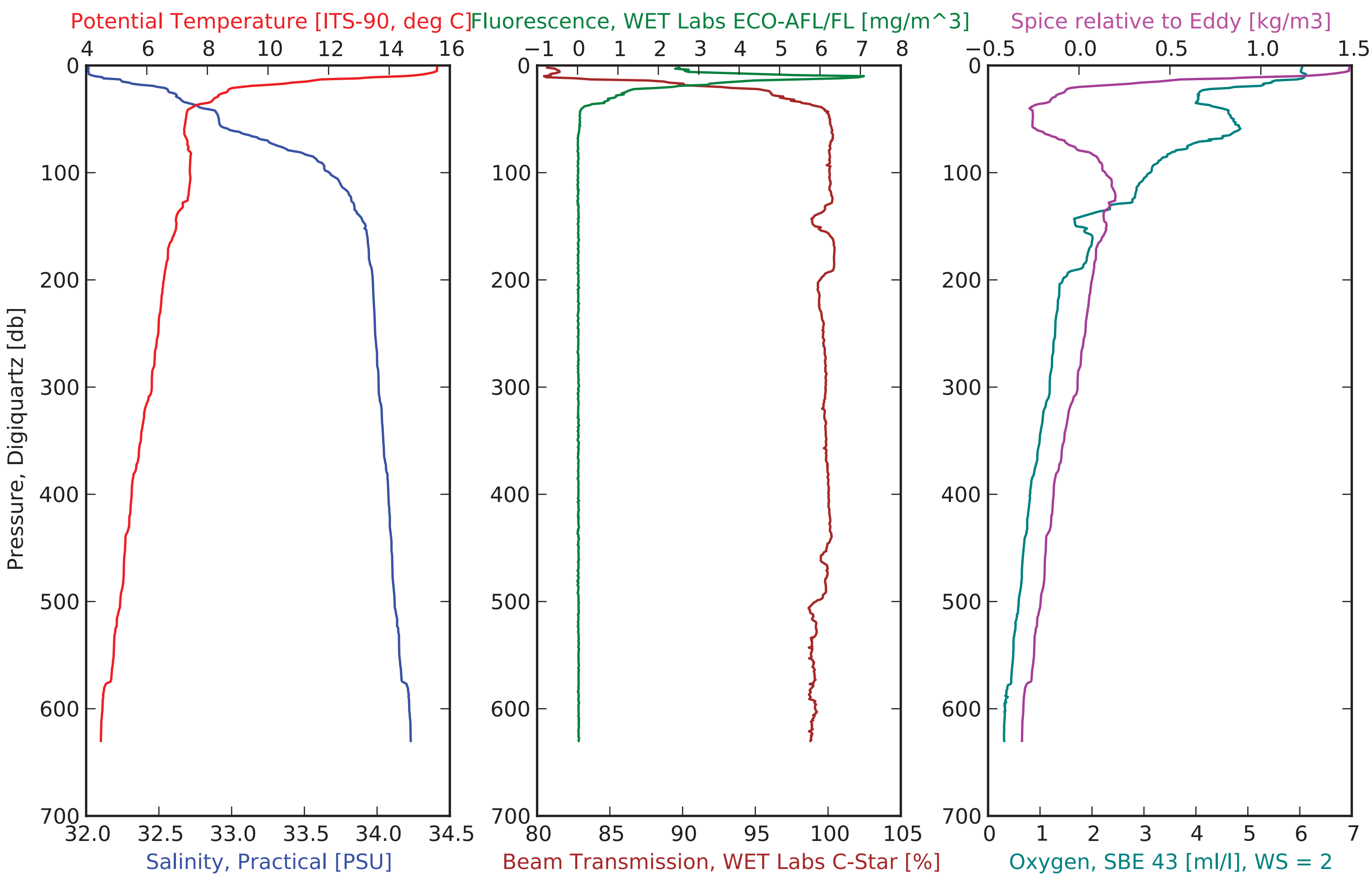
Station: RD01 at 48 00.28 N,125 21.83 W

On: Aug 22 2013 00:31:45UTC

Filename: FK009A_CTD019_20130822.cnv



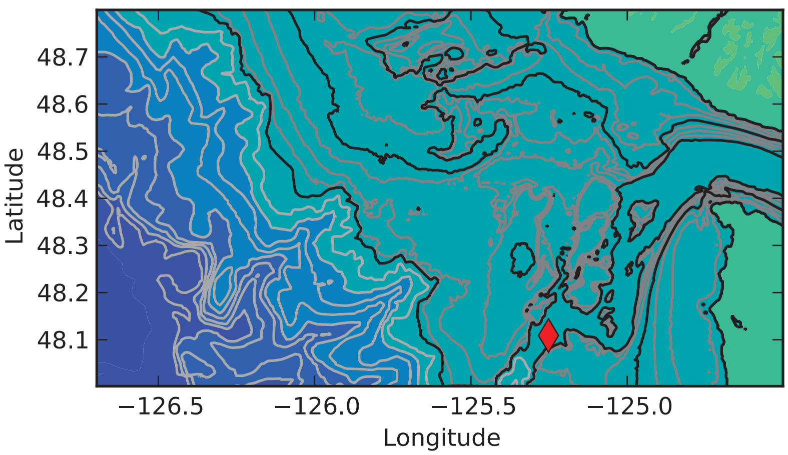


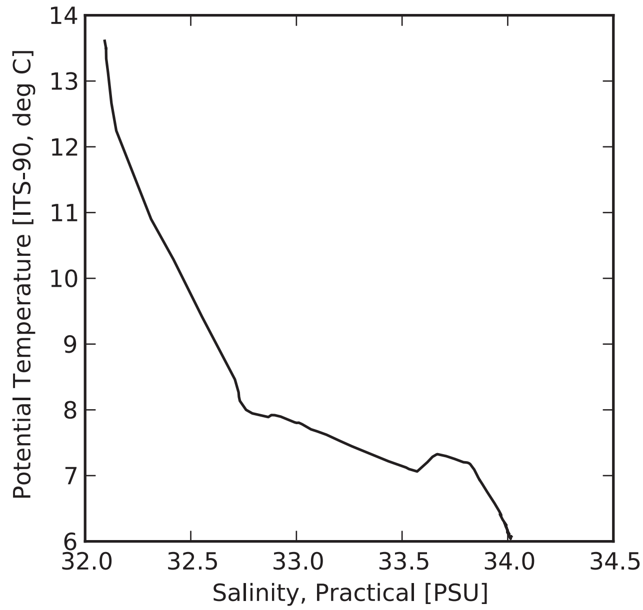


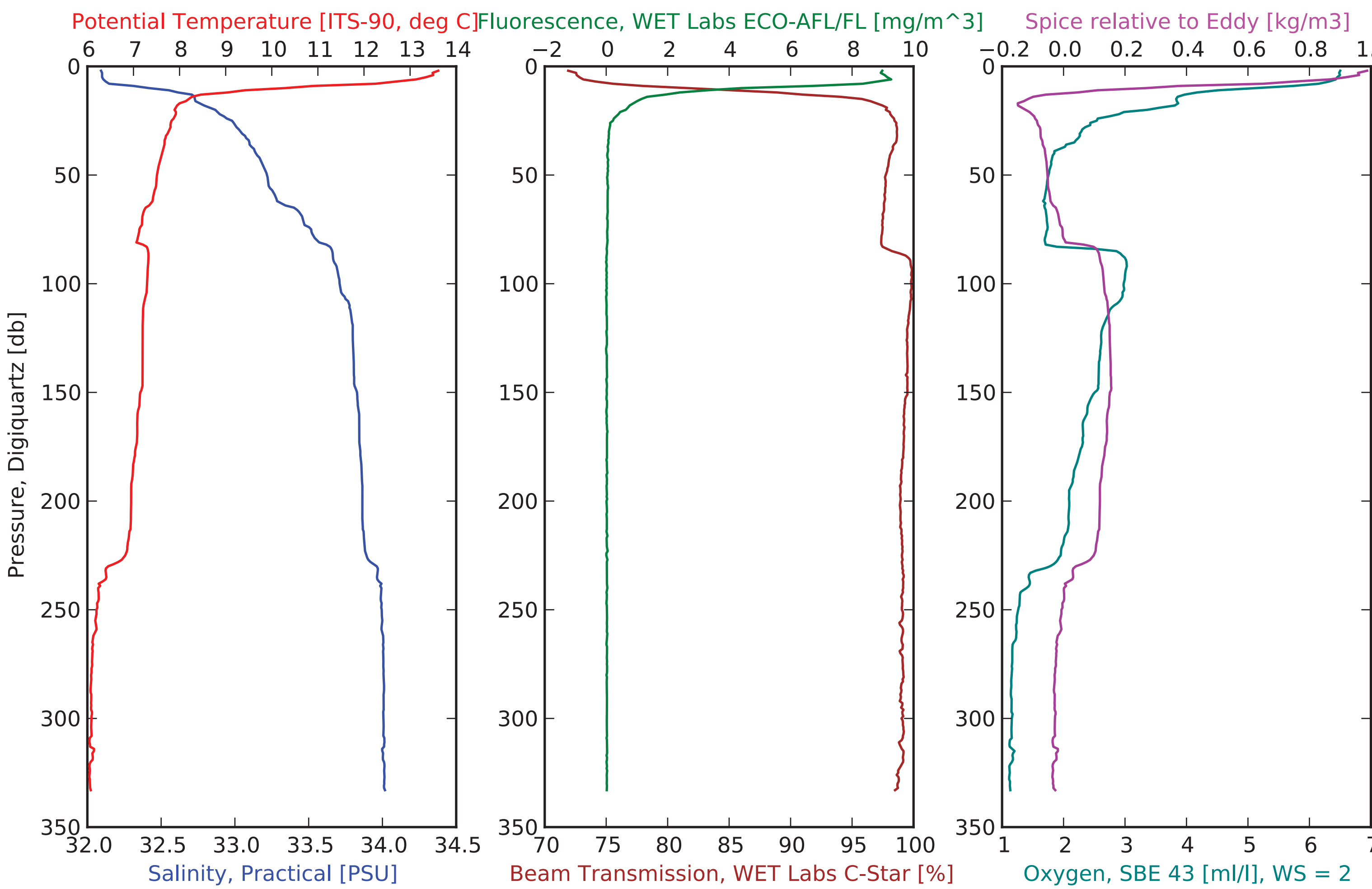
Station: RD02 at 48 06.54 N,125 15.11 W

On: Aug 22 2013 02:27:41UTC

Filename: FK009A_CTD020_20130822.cnv



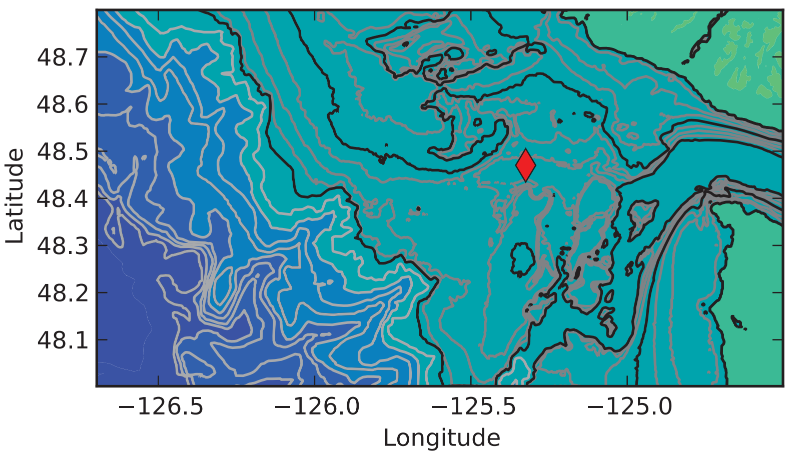


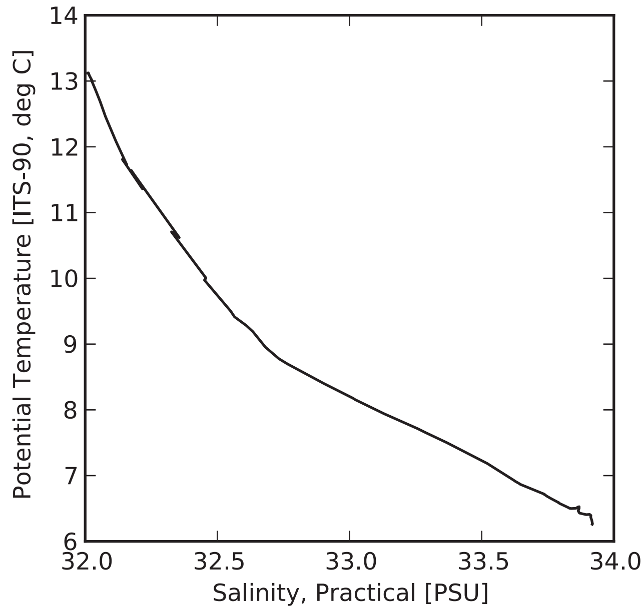


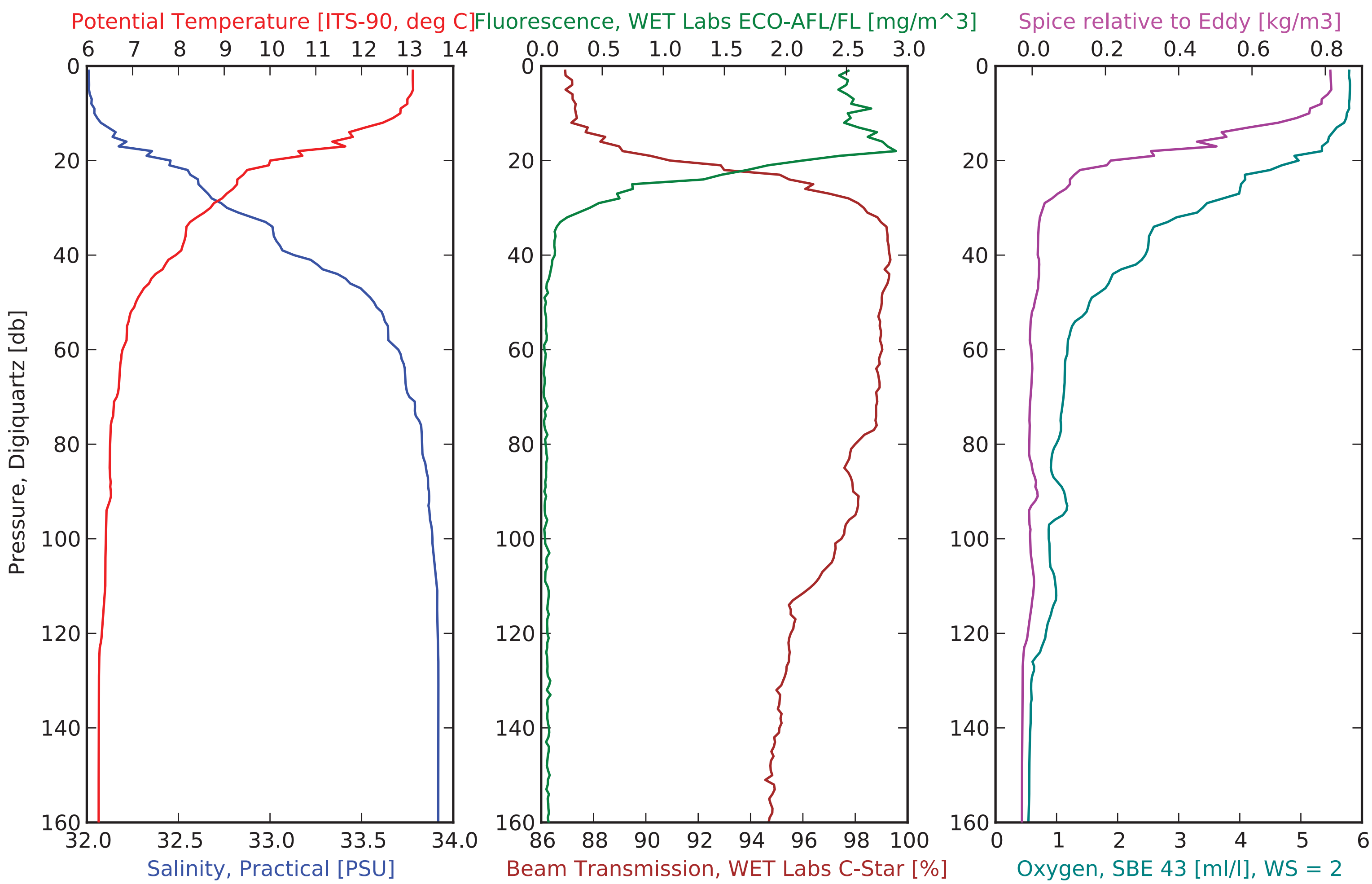
Station: MB07 at 48 28.20 N,125 19.49 W

On: Aug 22 2013 07:08:54UTC

Filename: FK009A_CTD021_20130822.cnv



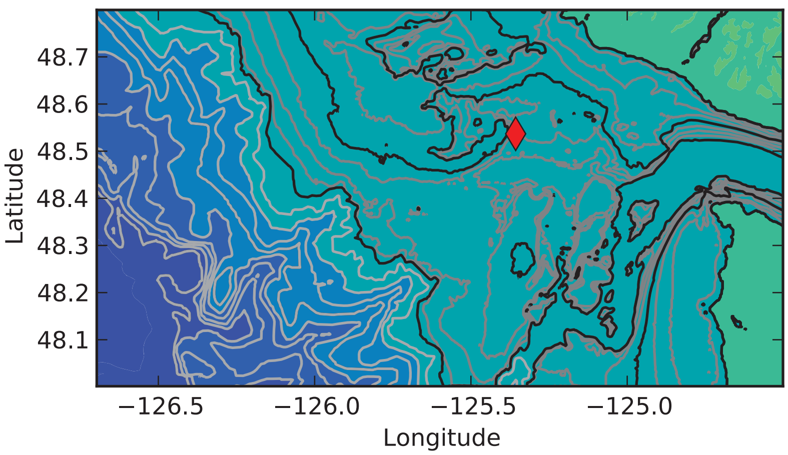


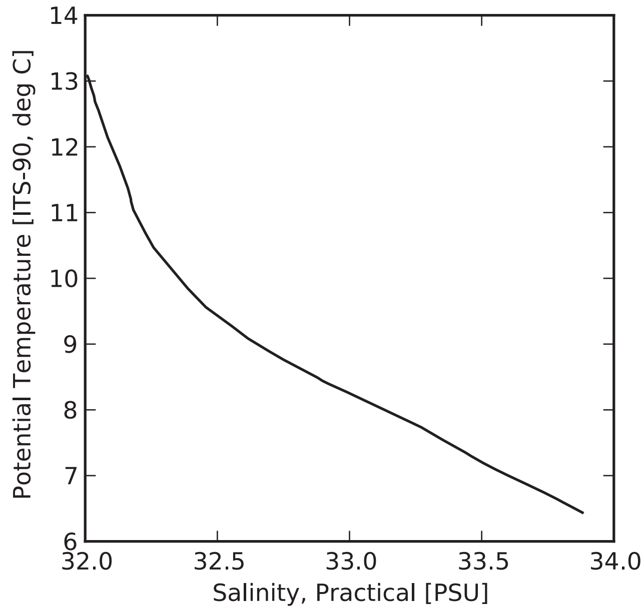


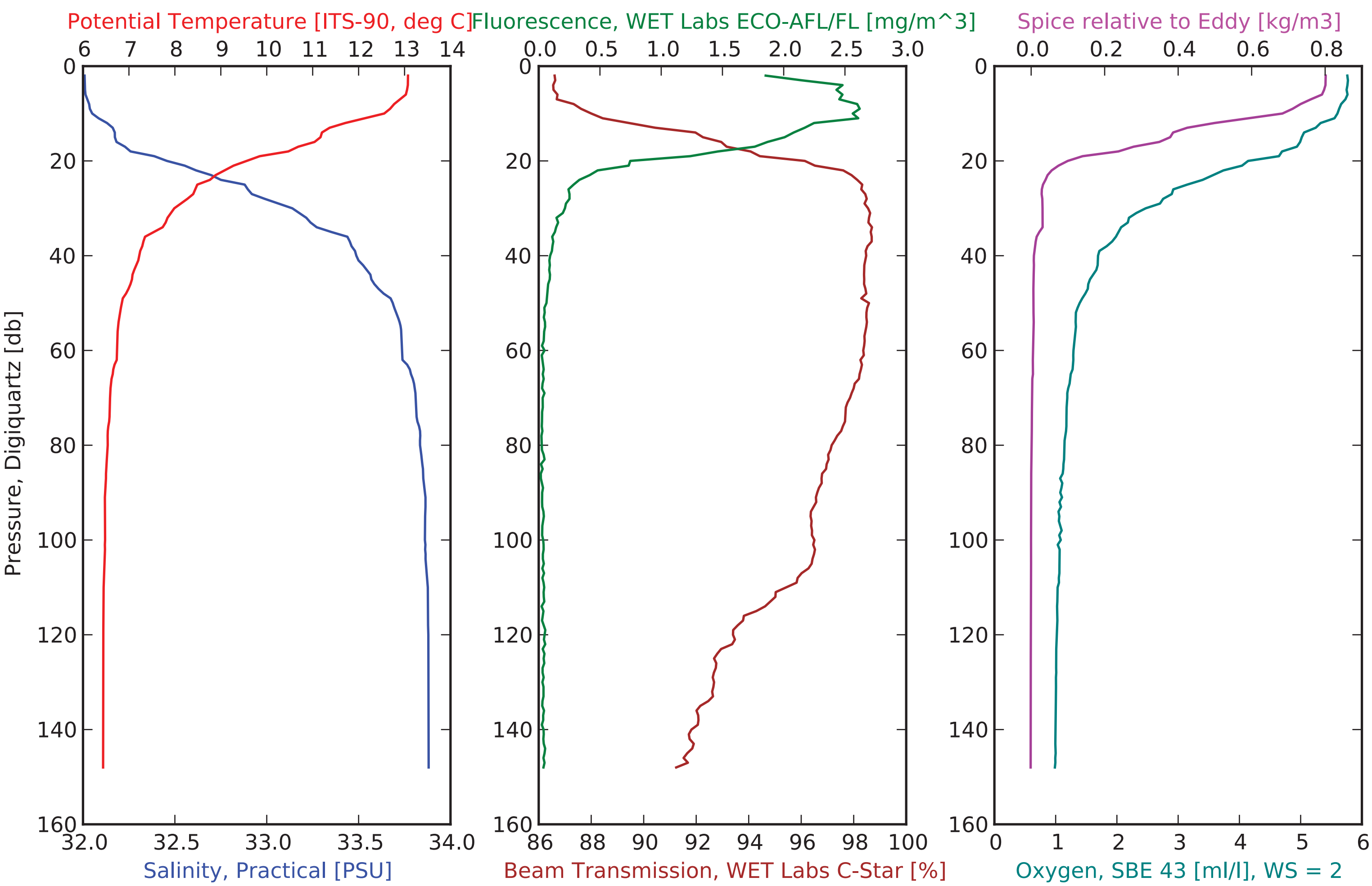
Station: MB08 at 48 32.21 N,125 21.41 W

On: Aug 22 2013 15:14:47UTC

Filename: FK009A_CTD022_20130822.cnv



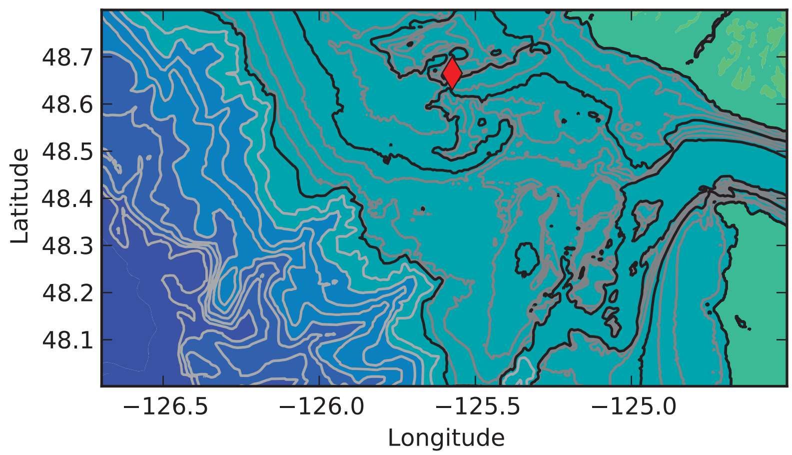


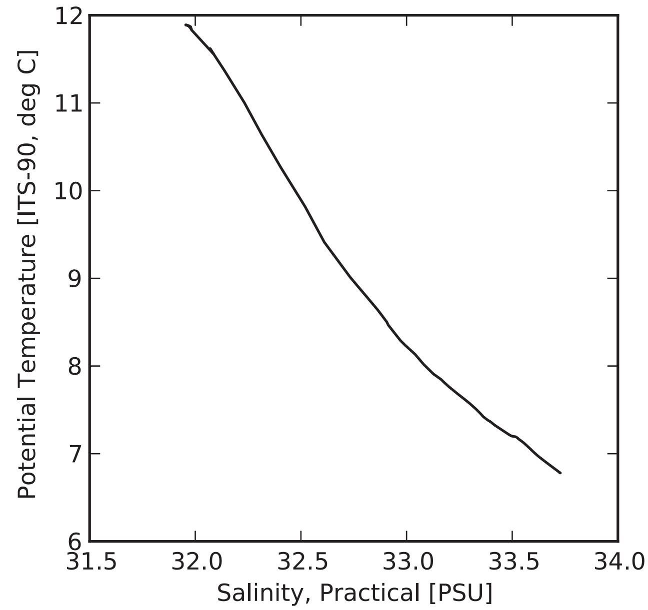


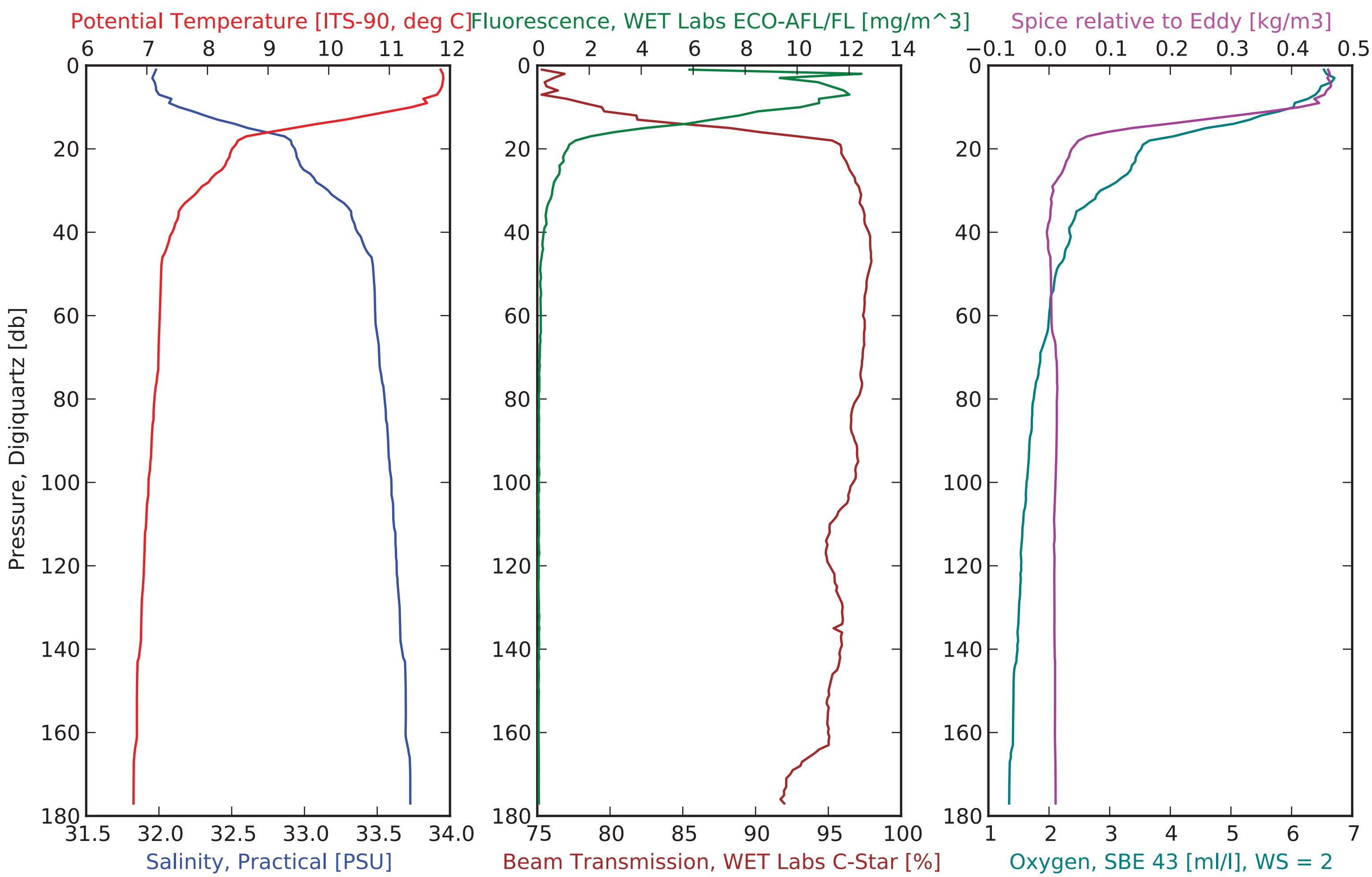
Station: MB14 at 48 39.91 N,125 34.44 W

On: Aug 22 2013 16:56:27UTC

Filename: FK009A_CTD023_20130822.cnv



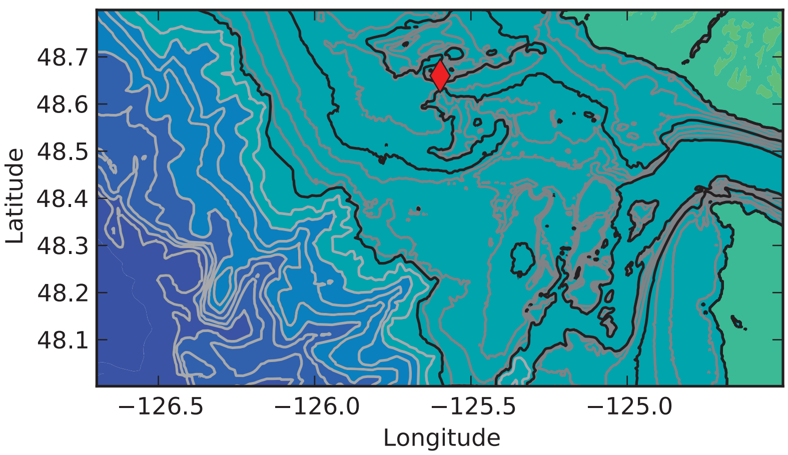


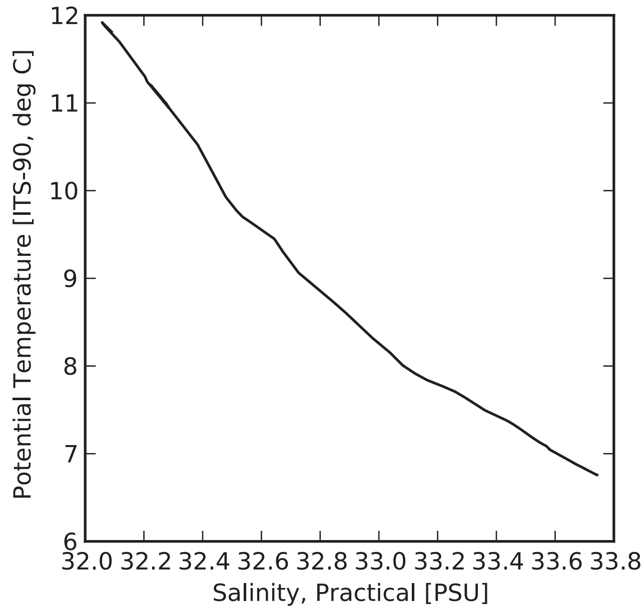


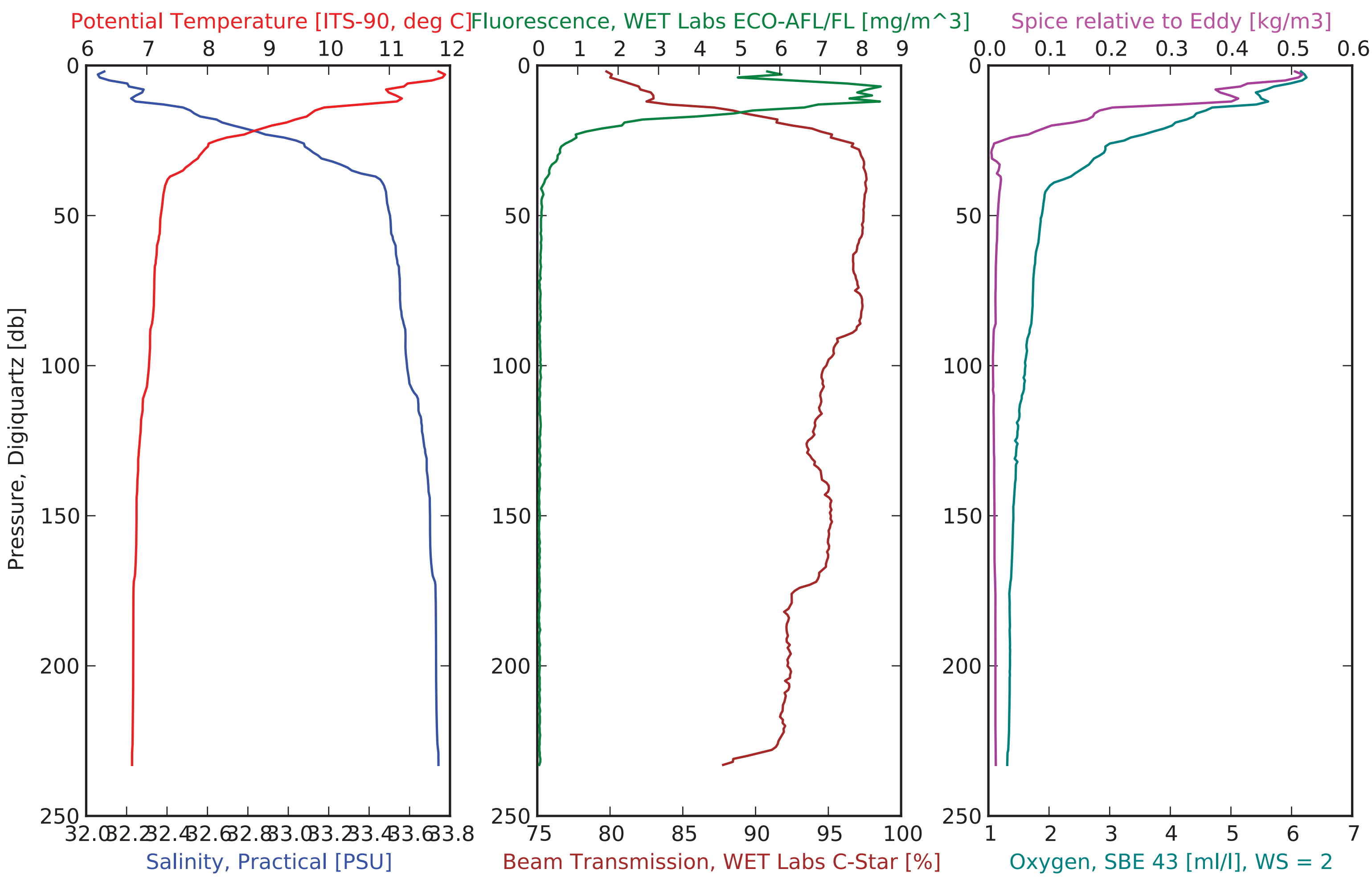
Station: RAD08 at 48 39.60 N,125 35.91 W

On: Aug 22 2013 17:40:36UTC

Filename: FK009A_CTD024_20130822.cnv



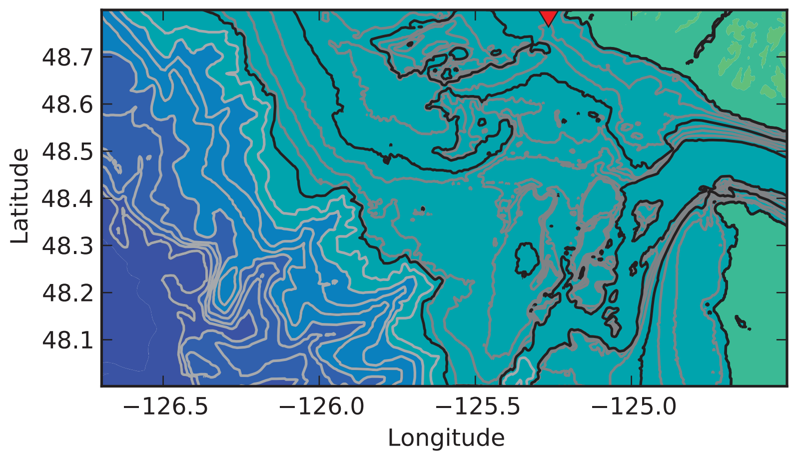


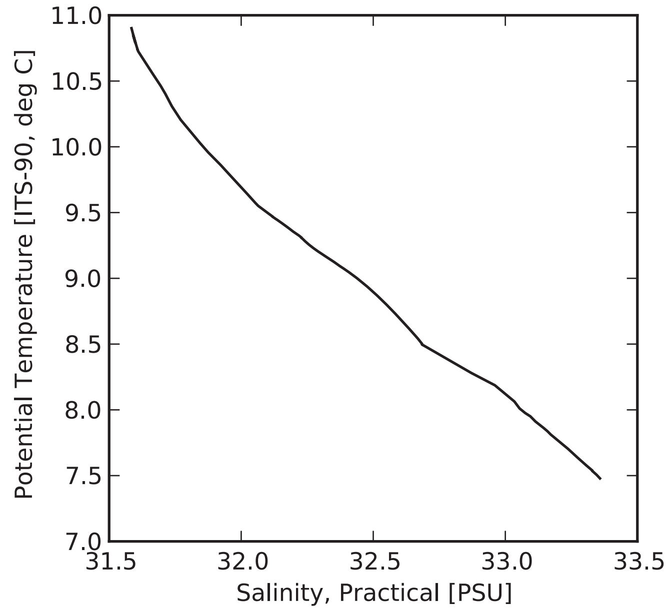


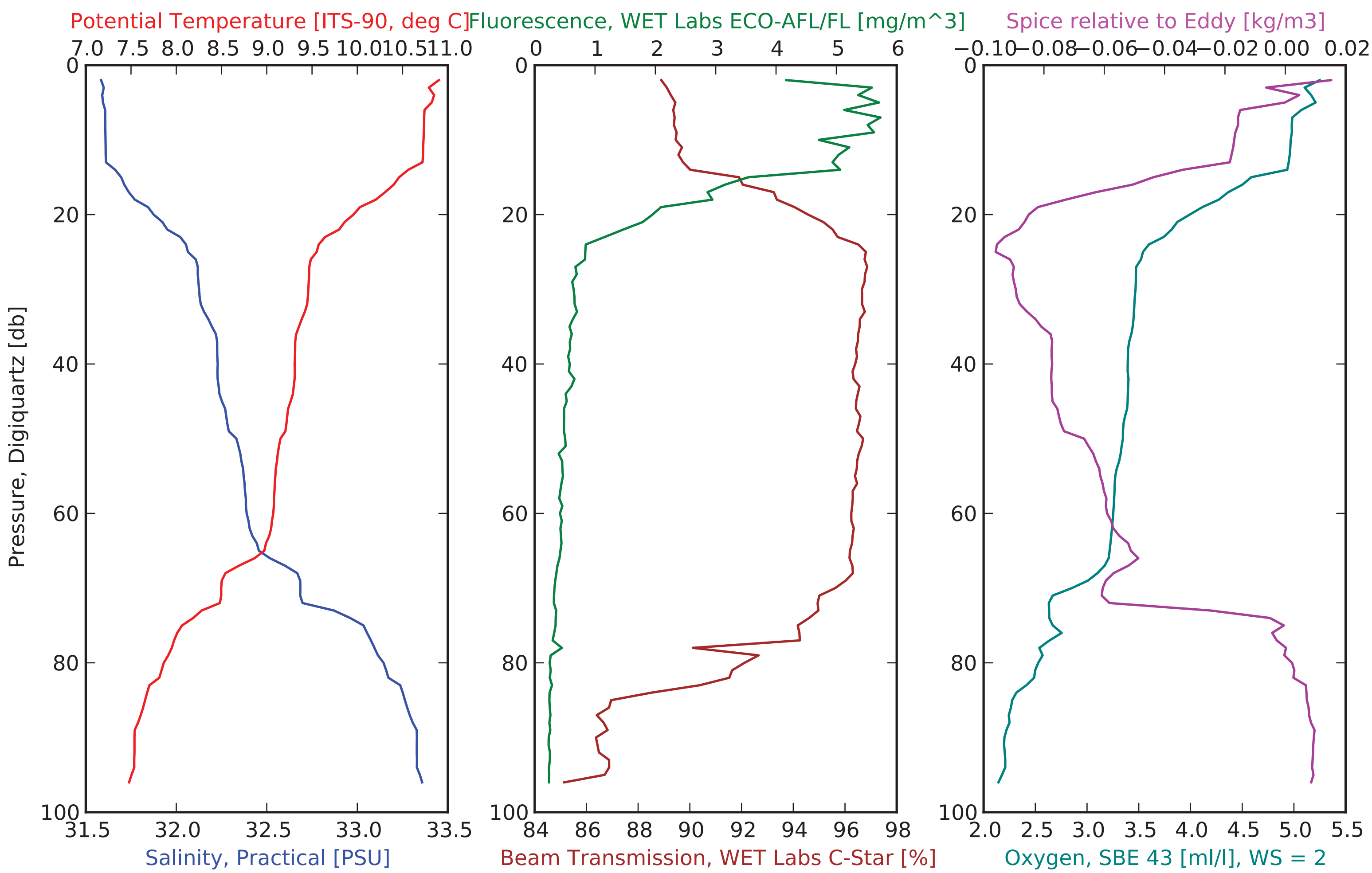
Station: MB16 at 48 47.95 N,125 15.93 W

On: Aug 22 2013 20:02:54UTC

Filename: FK009A_CTD025_20130822.cnv



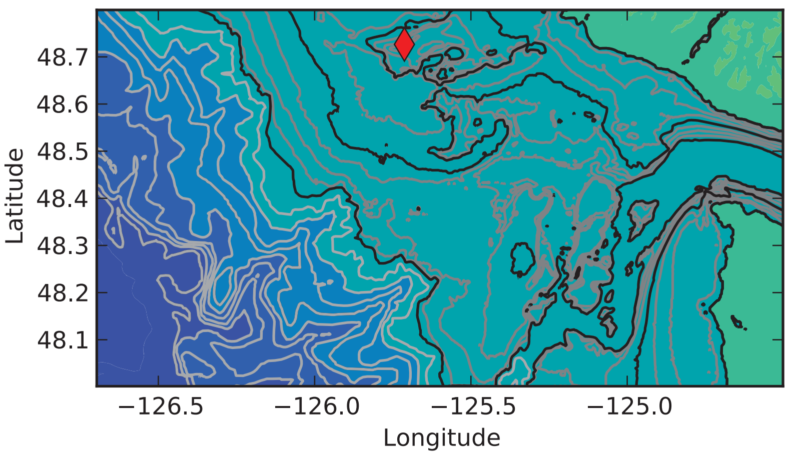


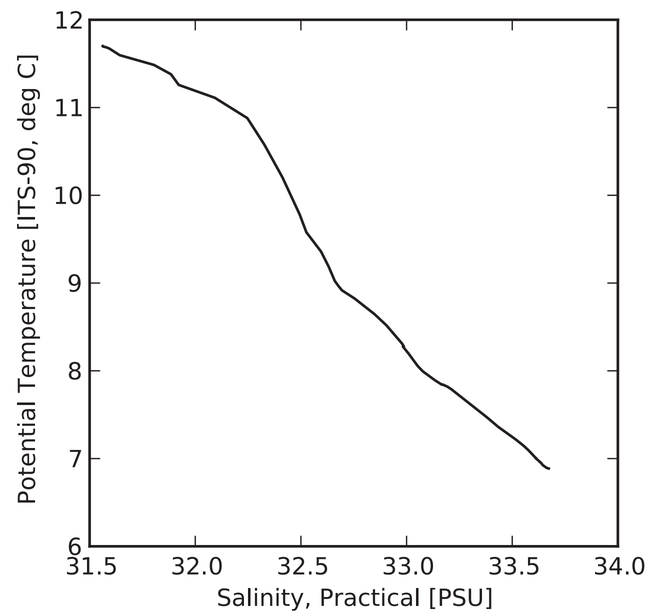


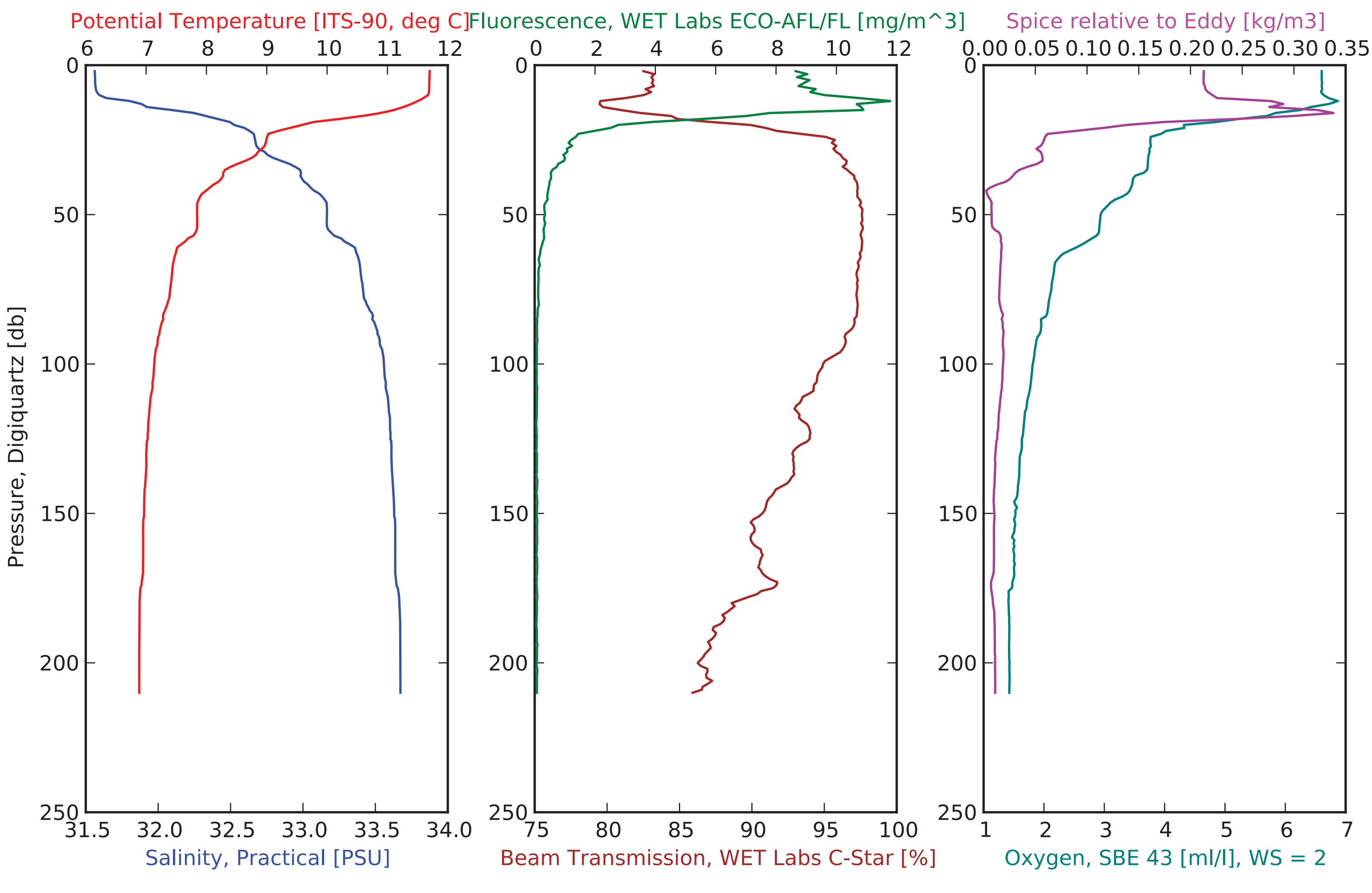
Station: LC05-A at 48 43.59 N,125 42.77 W

On: Aug 23 2013 01:39:36UTC

Filename: FK009A_CTD026_20130823.cnv



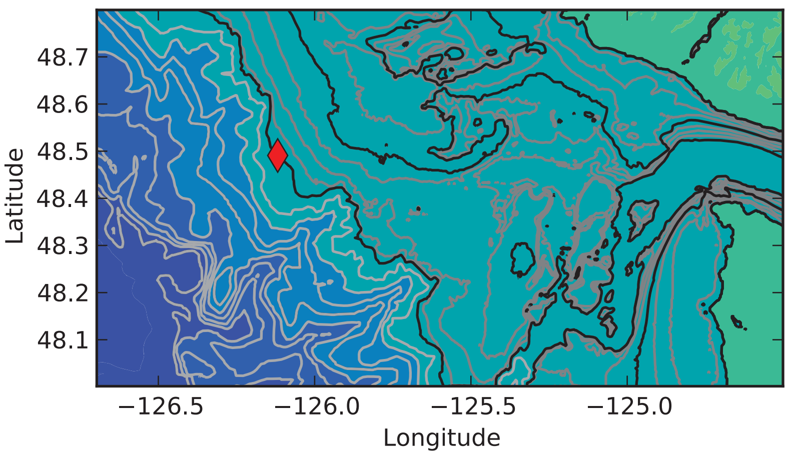


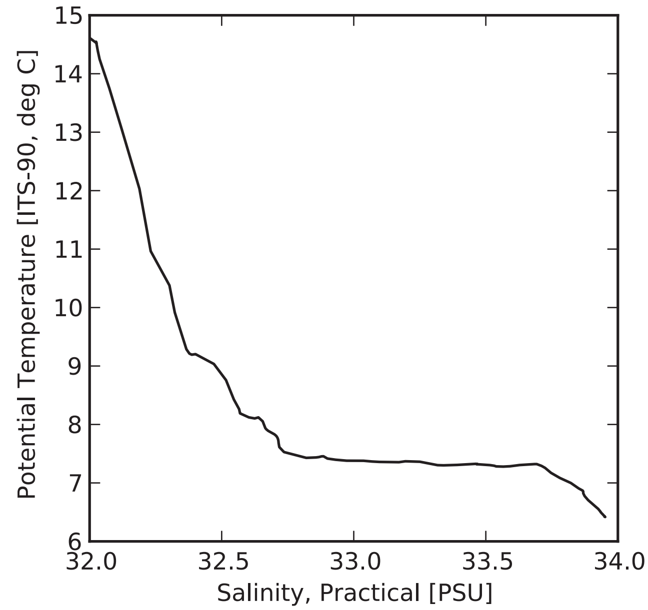


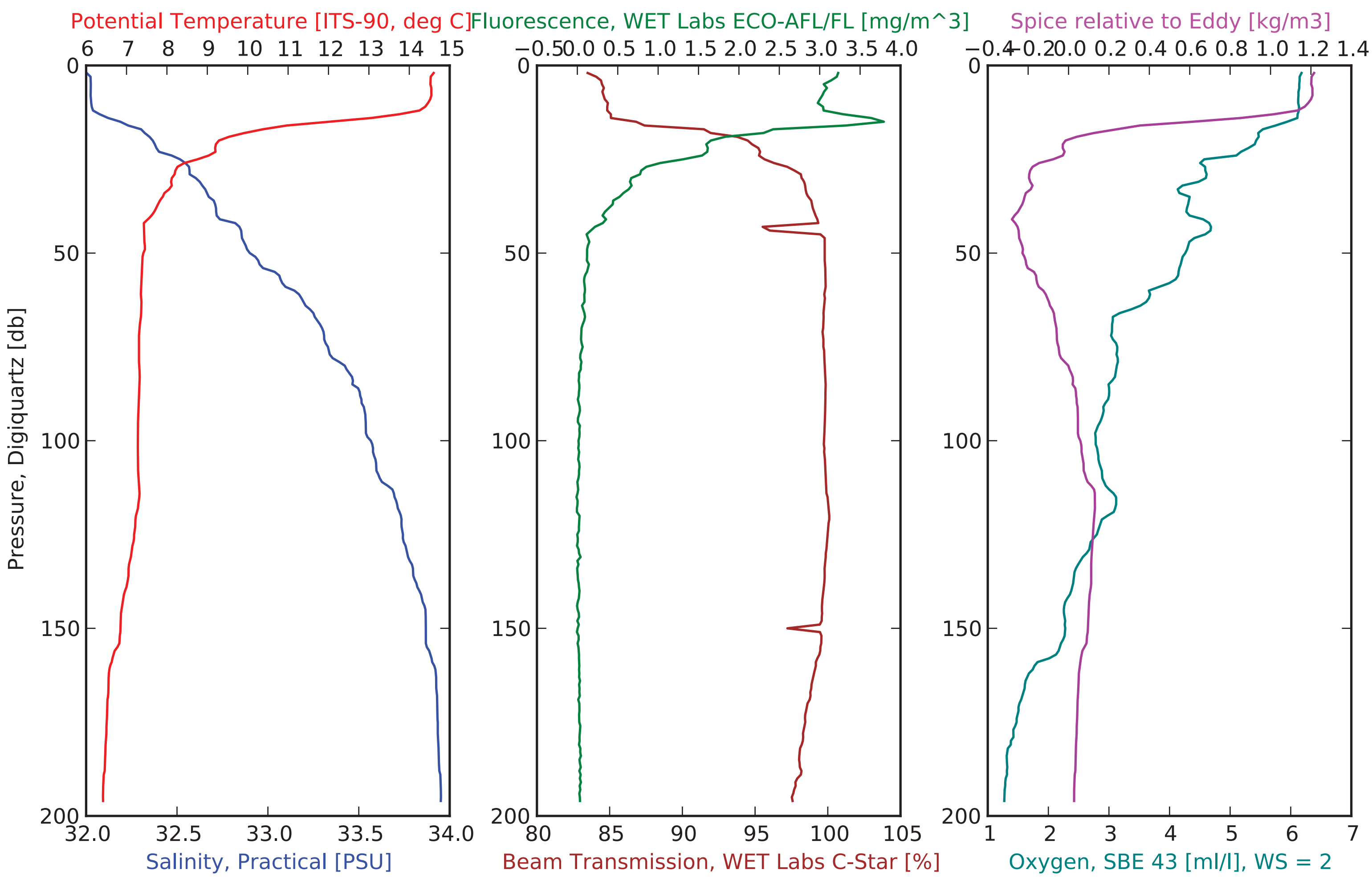
Station: LC08 at 48 29.45 N,126 07.09 W

On: Aug 23 2013 05:04:48UTC

Filename: FK009A_CTD027_20130823.cnv



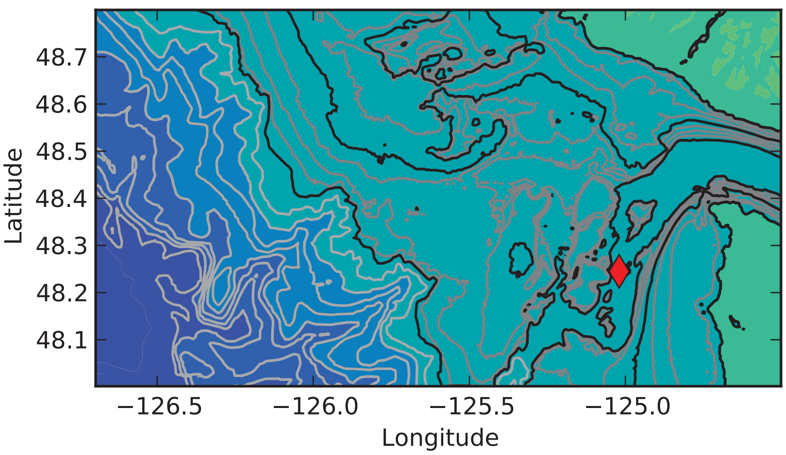


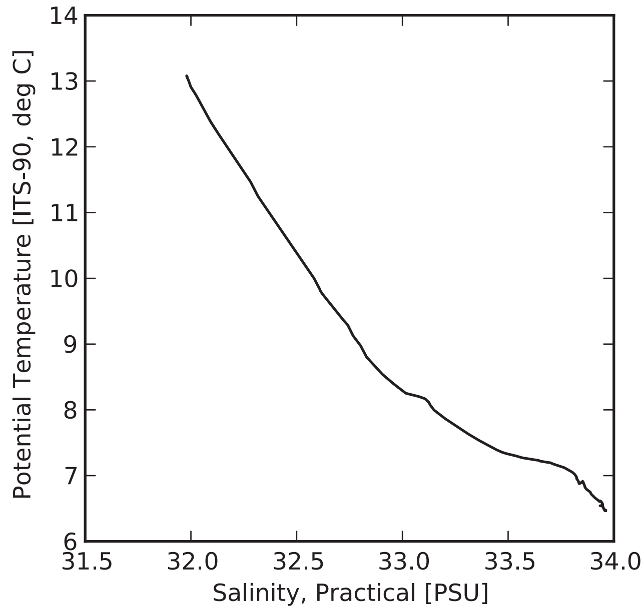


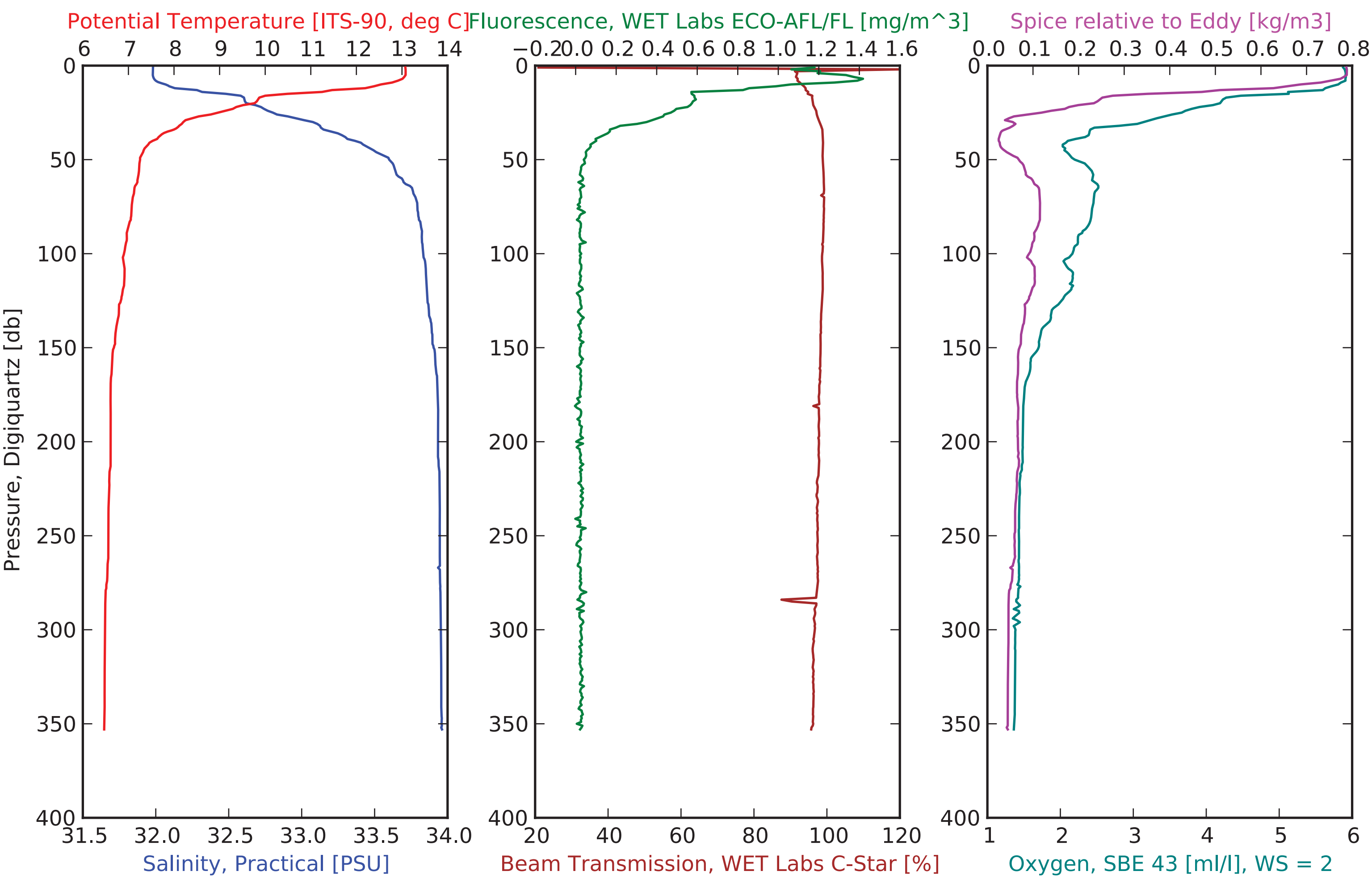
Station: RD04 at 48 14.70 N,125 01.21 W

On: Aug 23 2013 19:59:51UTC

Filename: FK009A_CTD028_20130823.cnv



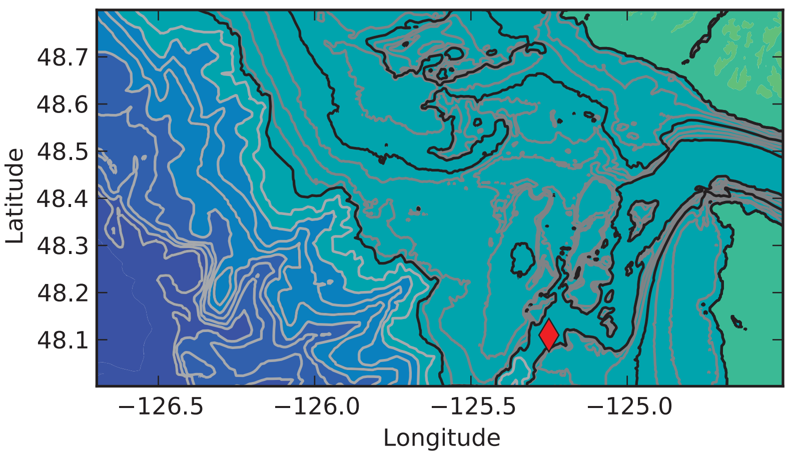


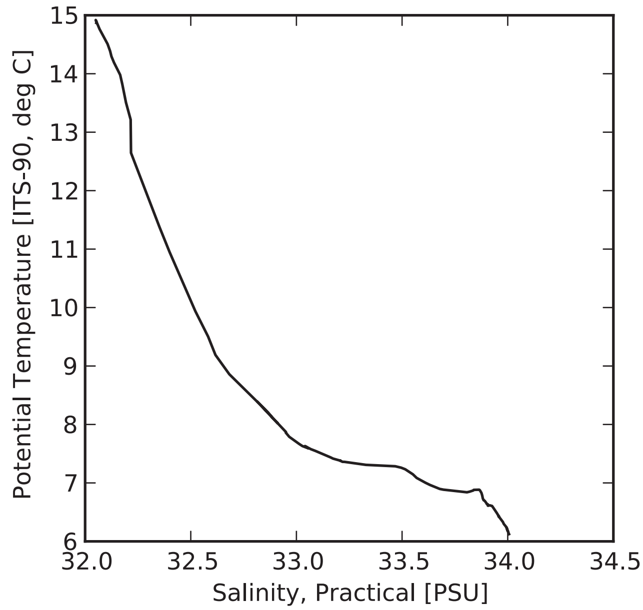


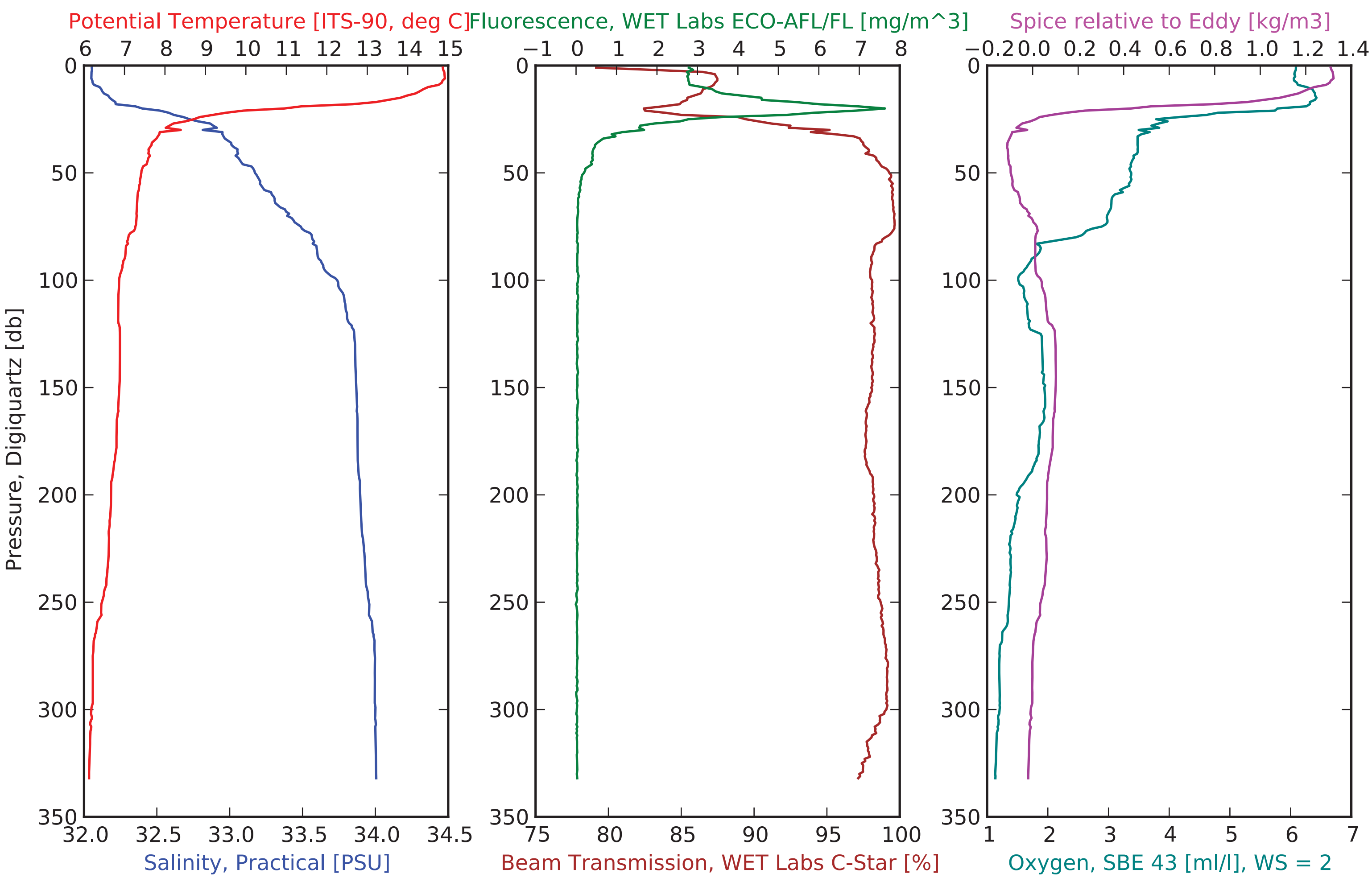
Station: RD02 at 48 06.59 N,125 15.03 W

On: Aug 24 2013 06:23:34UTC

Filename: FK009A_CTD029_20130824.cnv



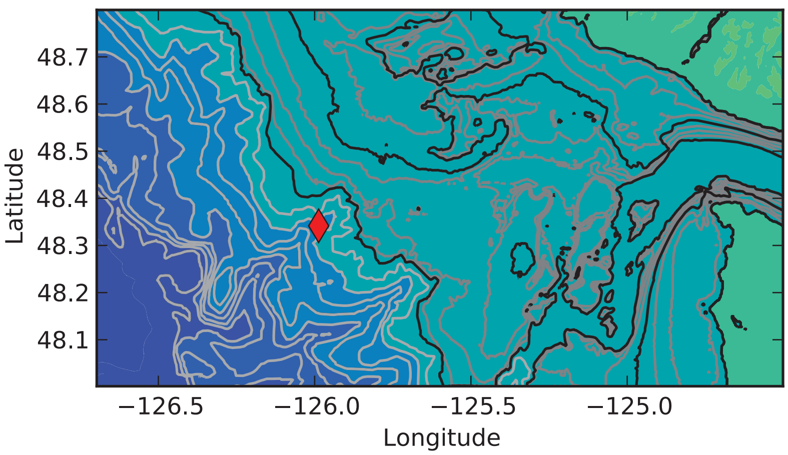


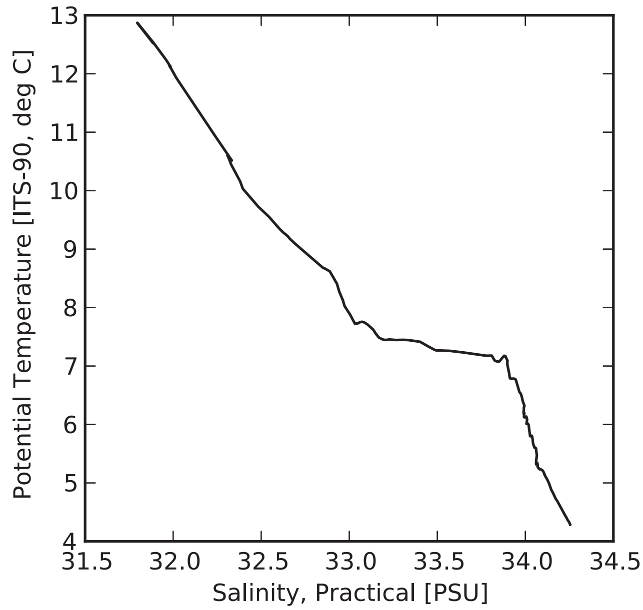


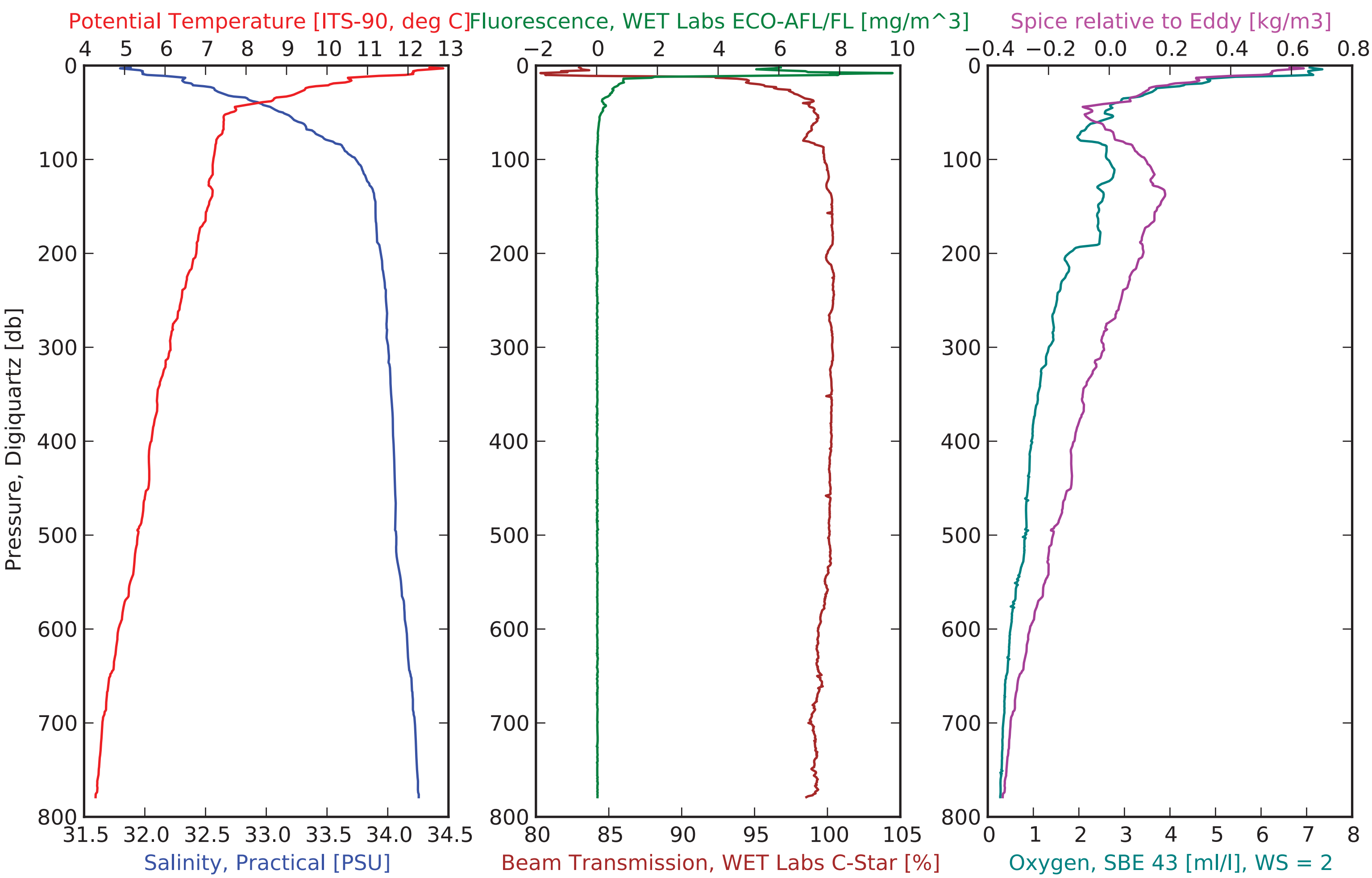
Station: BCC4 at 48 20.50 N,125 59.23 W

On: Aug 25 2013 23:44:51UTC

Filename: FK009A_CTD030_20130825.cnv



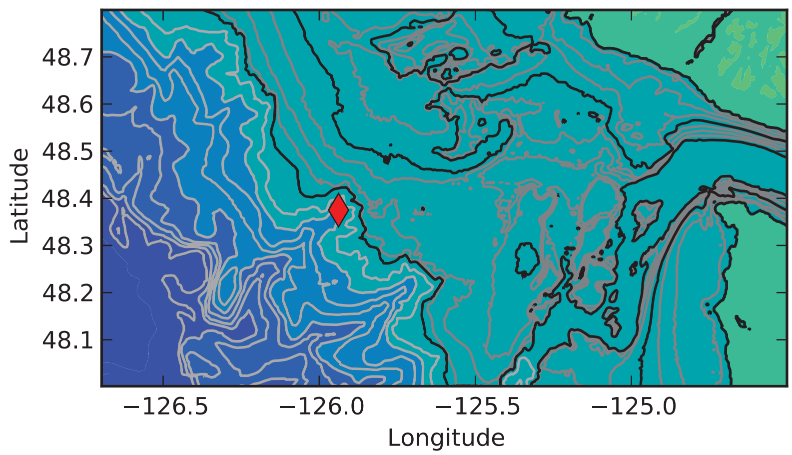


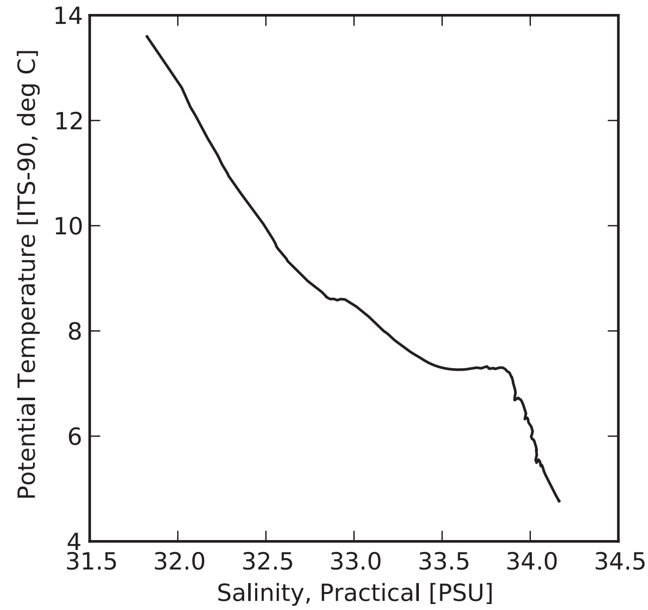


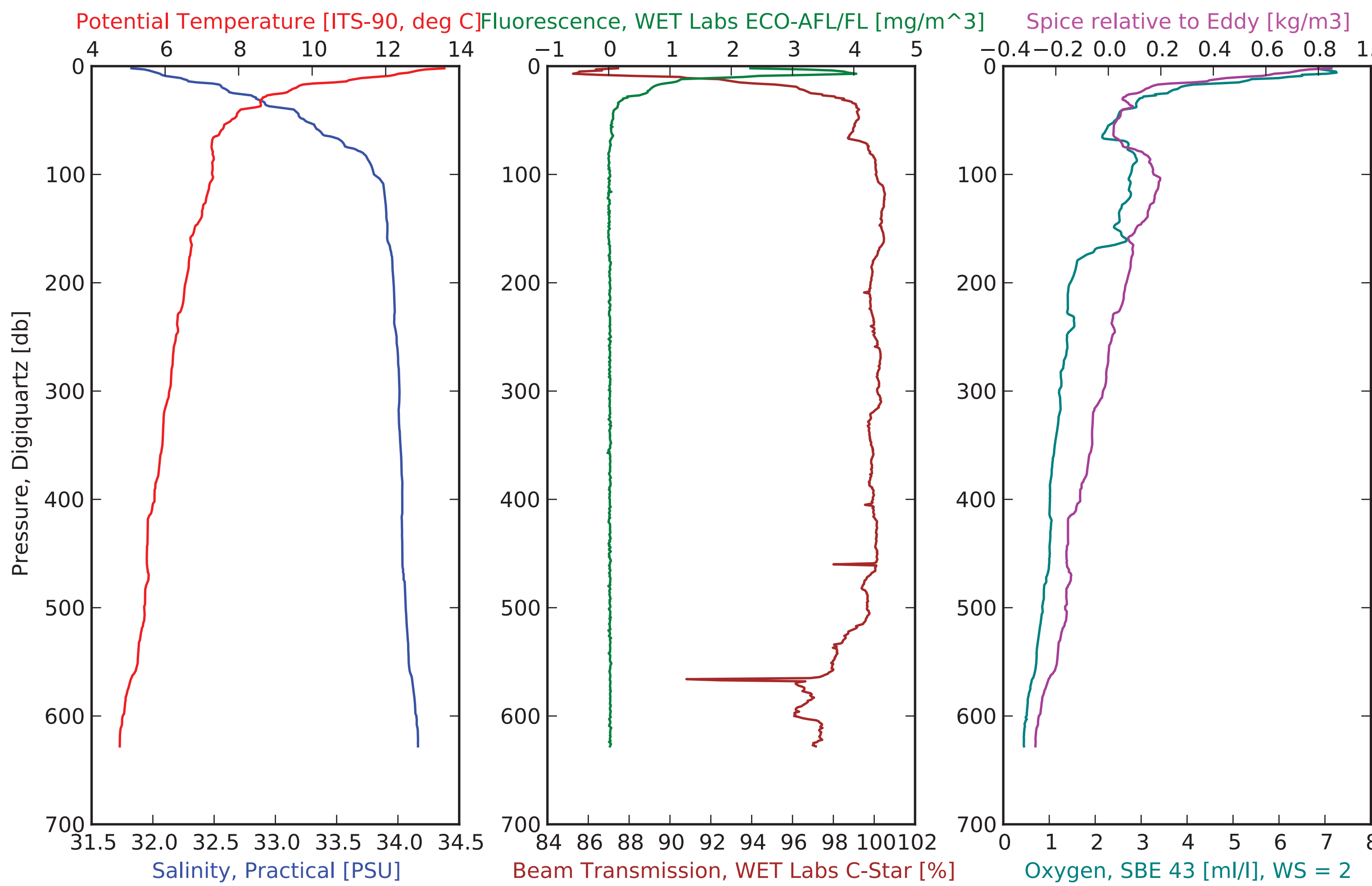
Station: BCC3 at 48 22.50 N,125 56.29 W

On: Aug 26 2013 00:56:44UTC

Filename: FK009A_CTD031_20130826.cnv



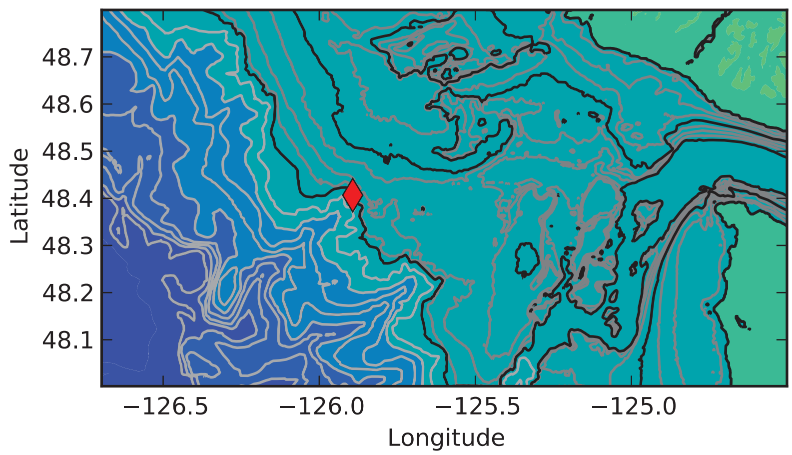


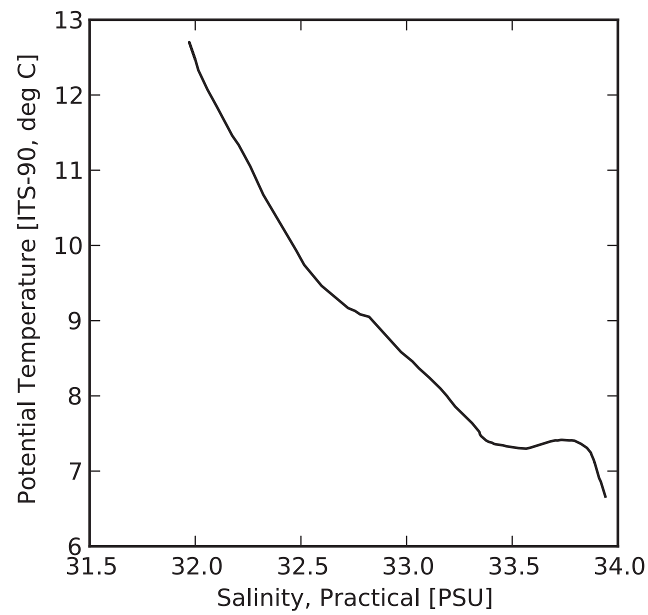


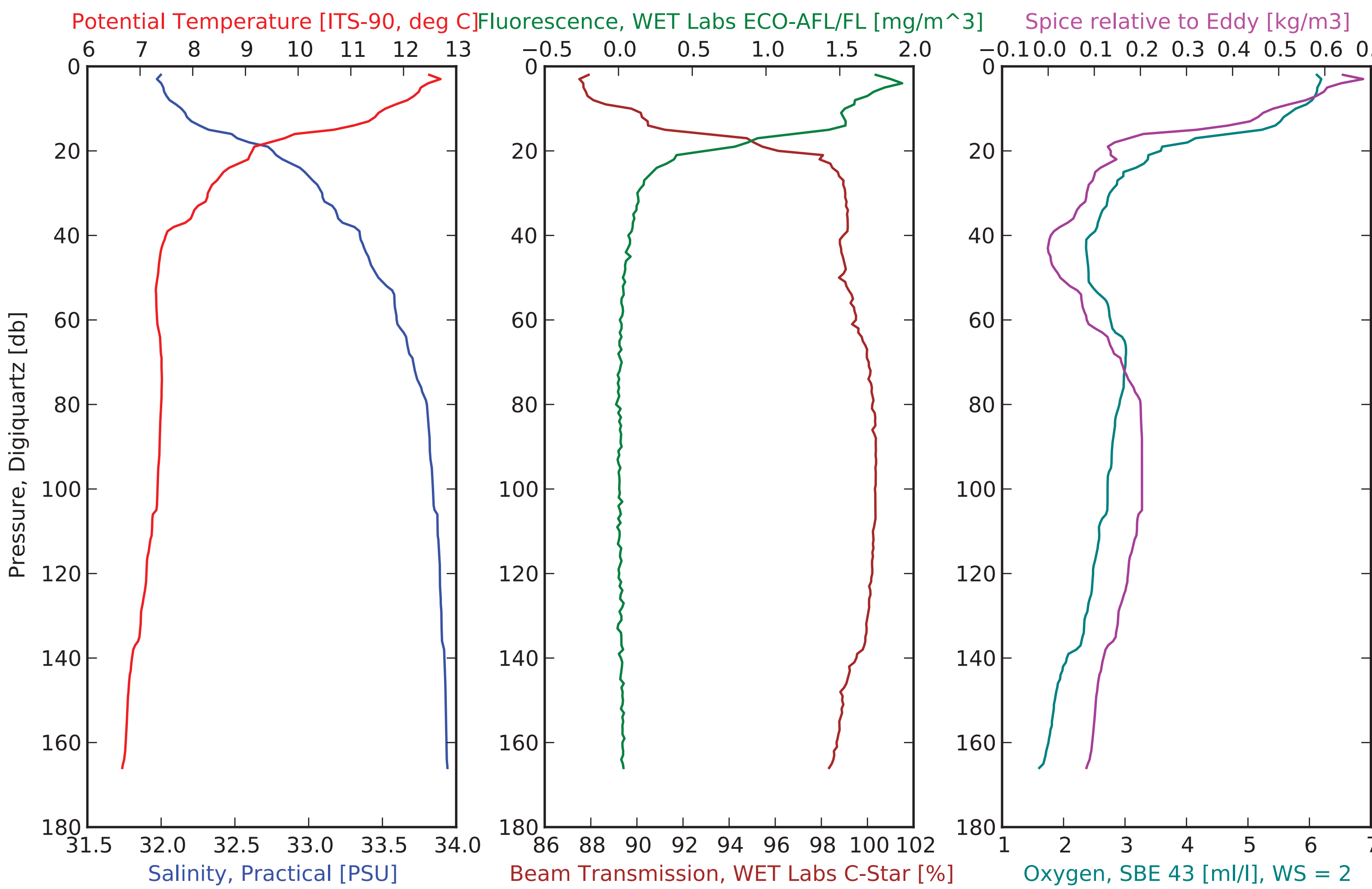
Station: BCC2 at 48 24.40 N,125 53.56 W

On: Aug 26 2013 01:56:57UTC

Filename: FK009A_CTD032_20130826.cnv



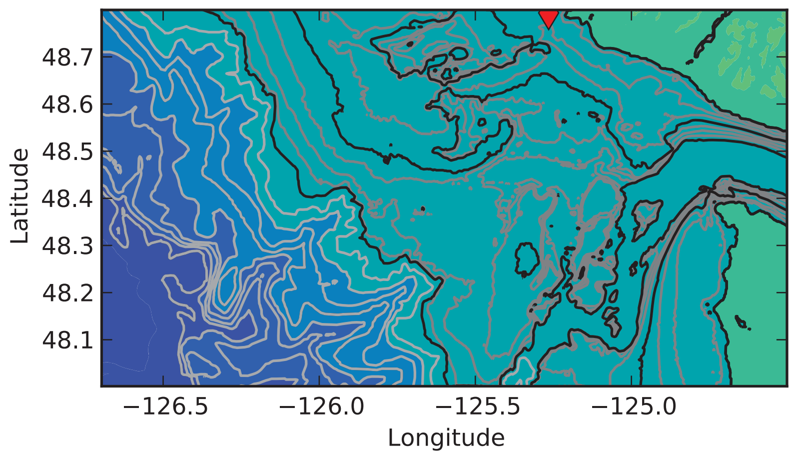


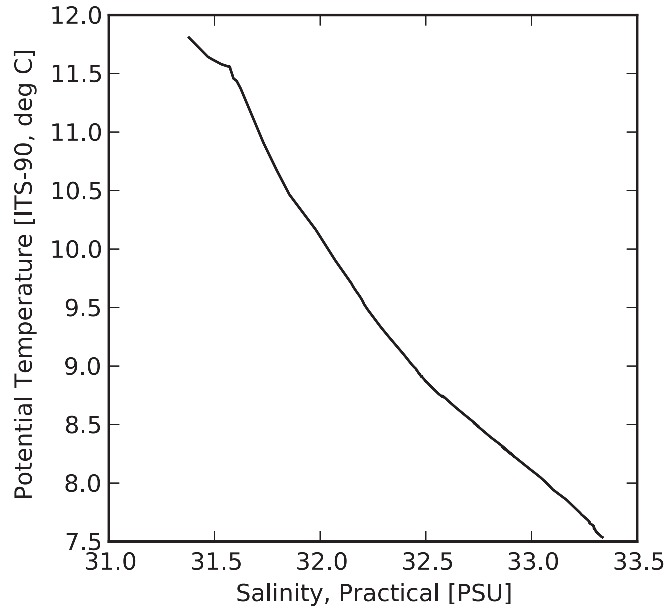


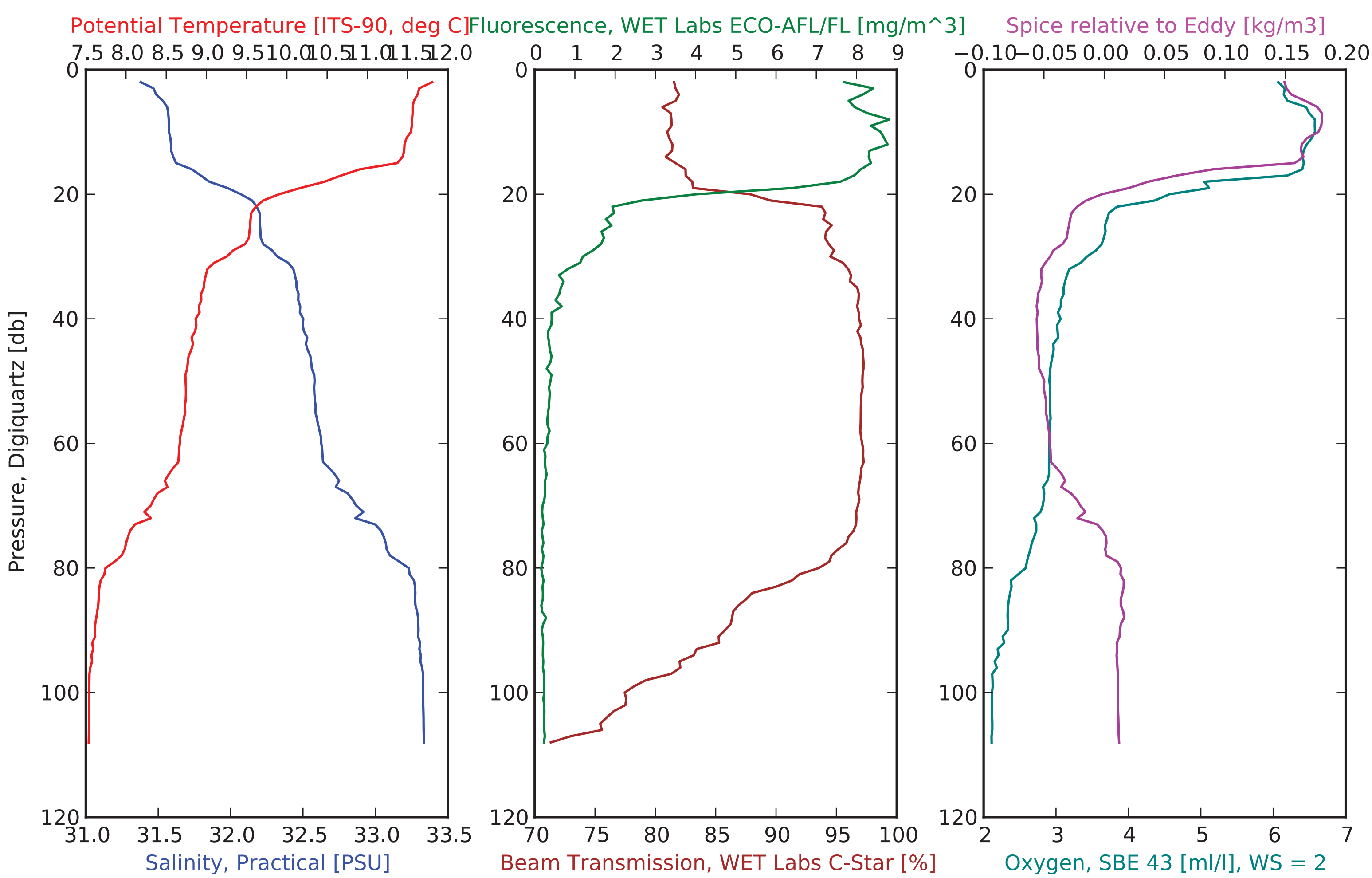
Station: MB16 at 48 47.60 N,125 15.91 W

On: Aug 26 2013 16:26:48UTC

Filename: FK009A_CTD033_20130826.cnv



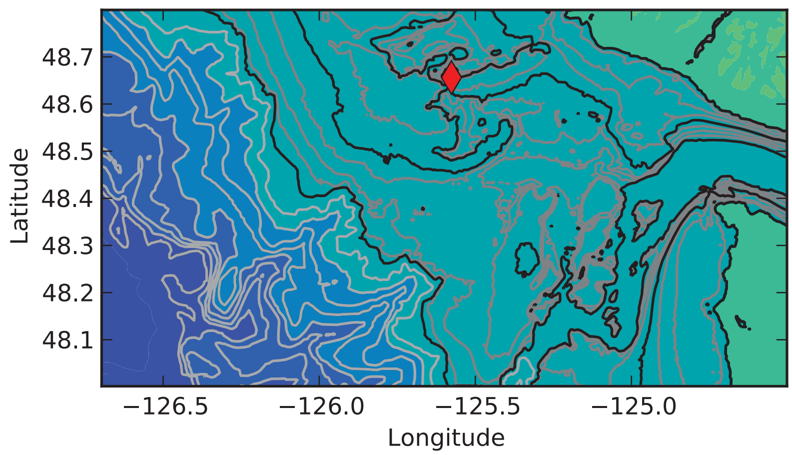


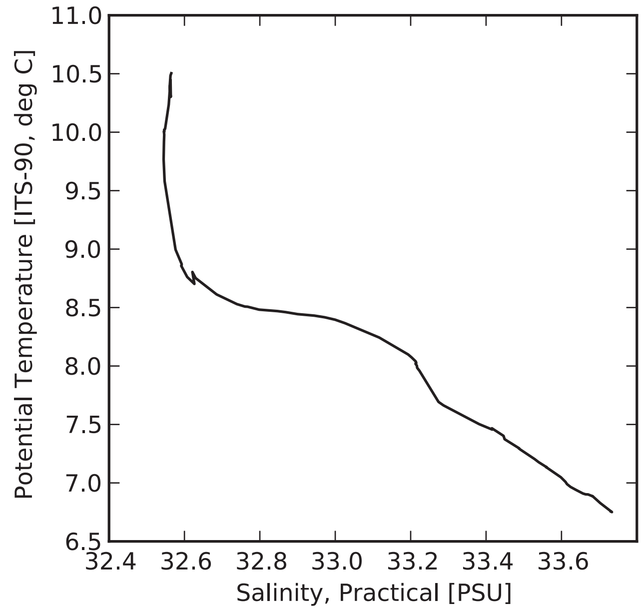


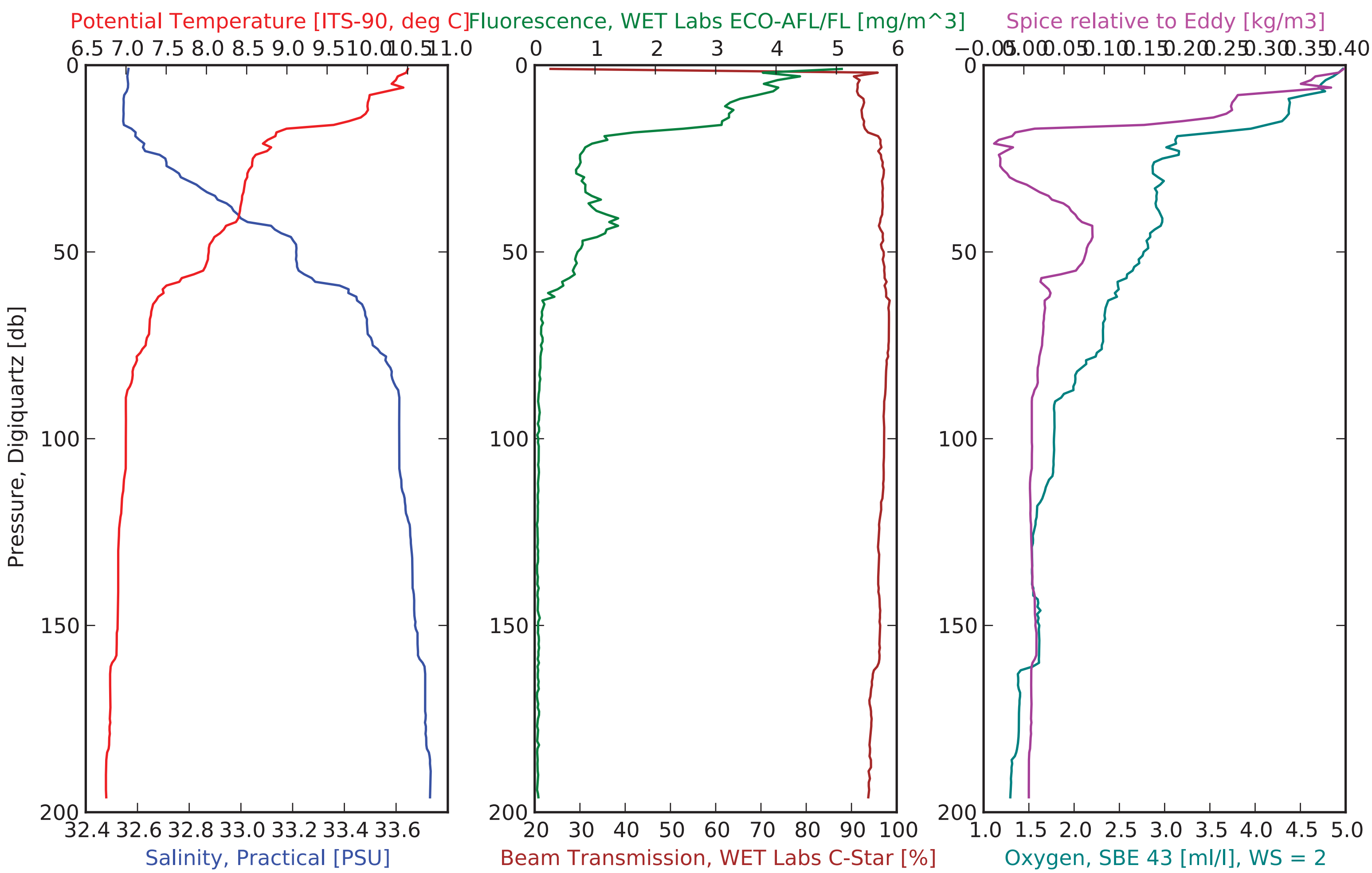
Station: Susan01 at 48 39.37 N,125 34.59 W

On: Aug 26 2013 21:47:53UTC

Filename: FK009A_CTD034_20130826.cnv



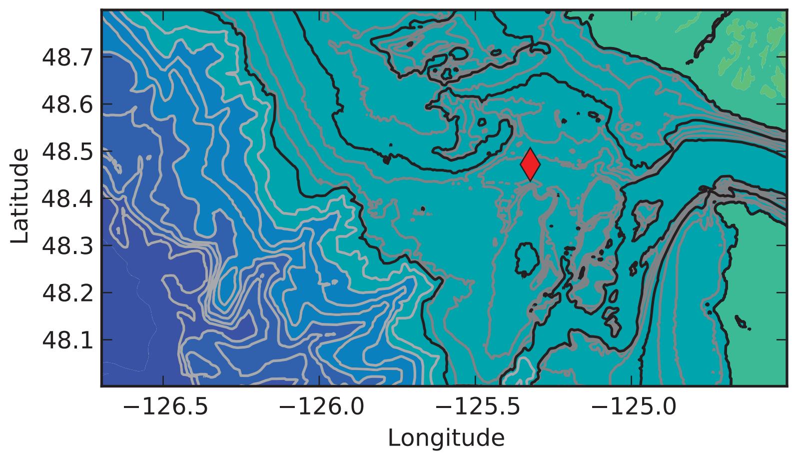


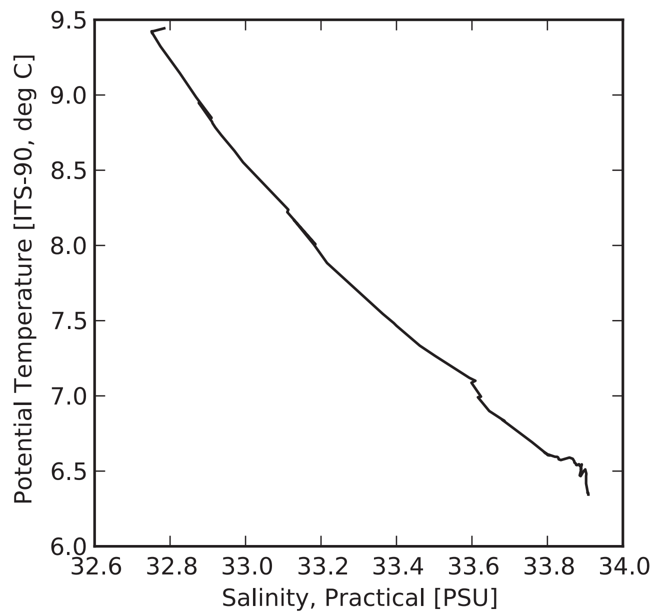


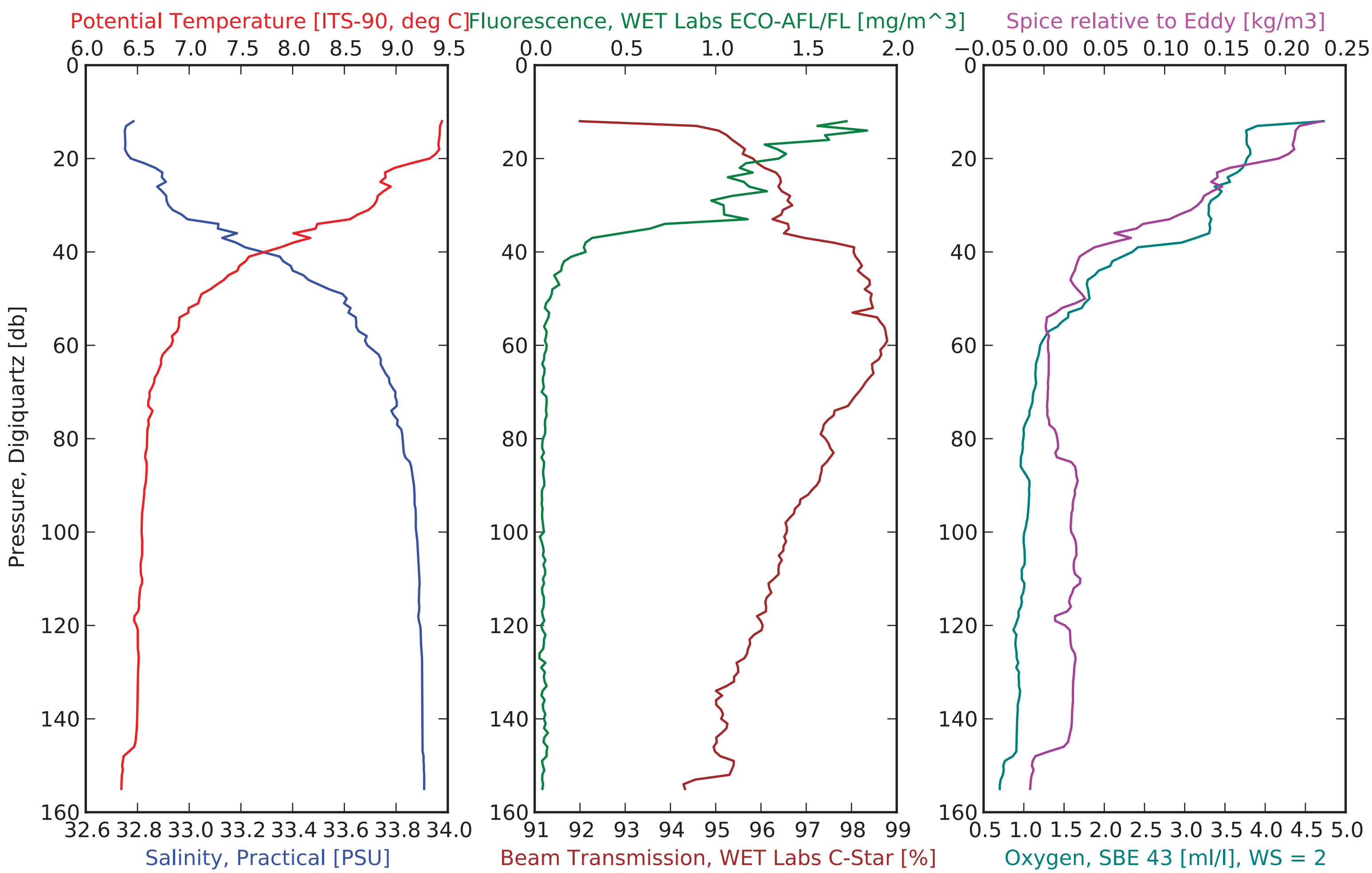
Station: MB07 down at 48 28.31 N,125 19.44 W

On: Aug 27 2013 00:14:51UTC

Filename: FK009A_CTD035_20130827.cnv



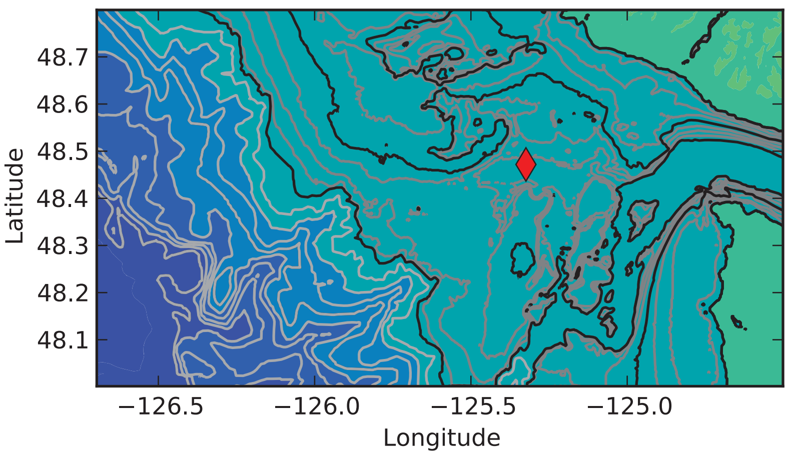


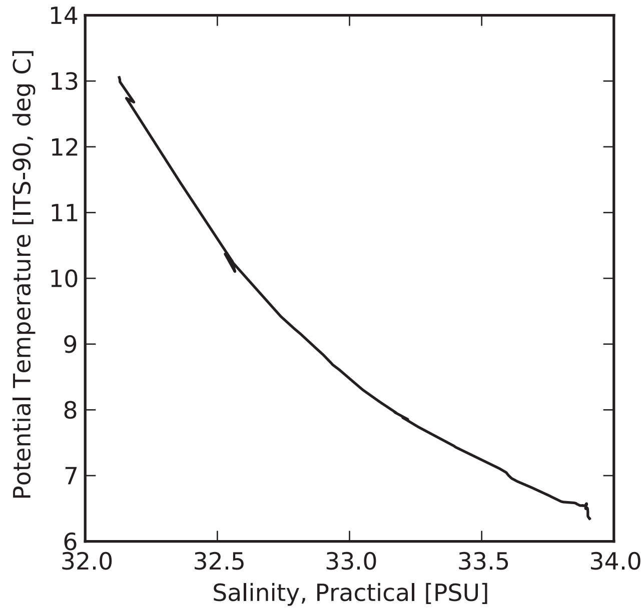


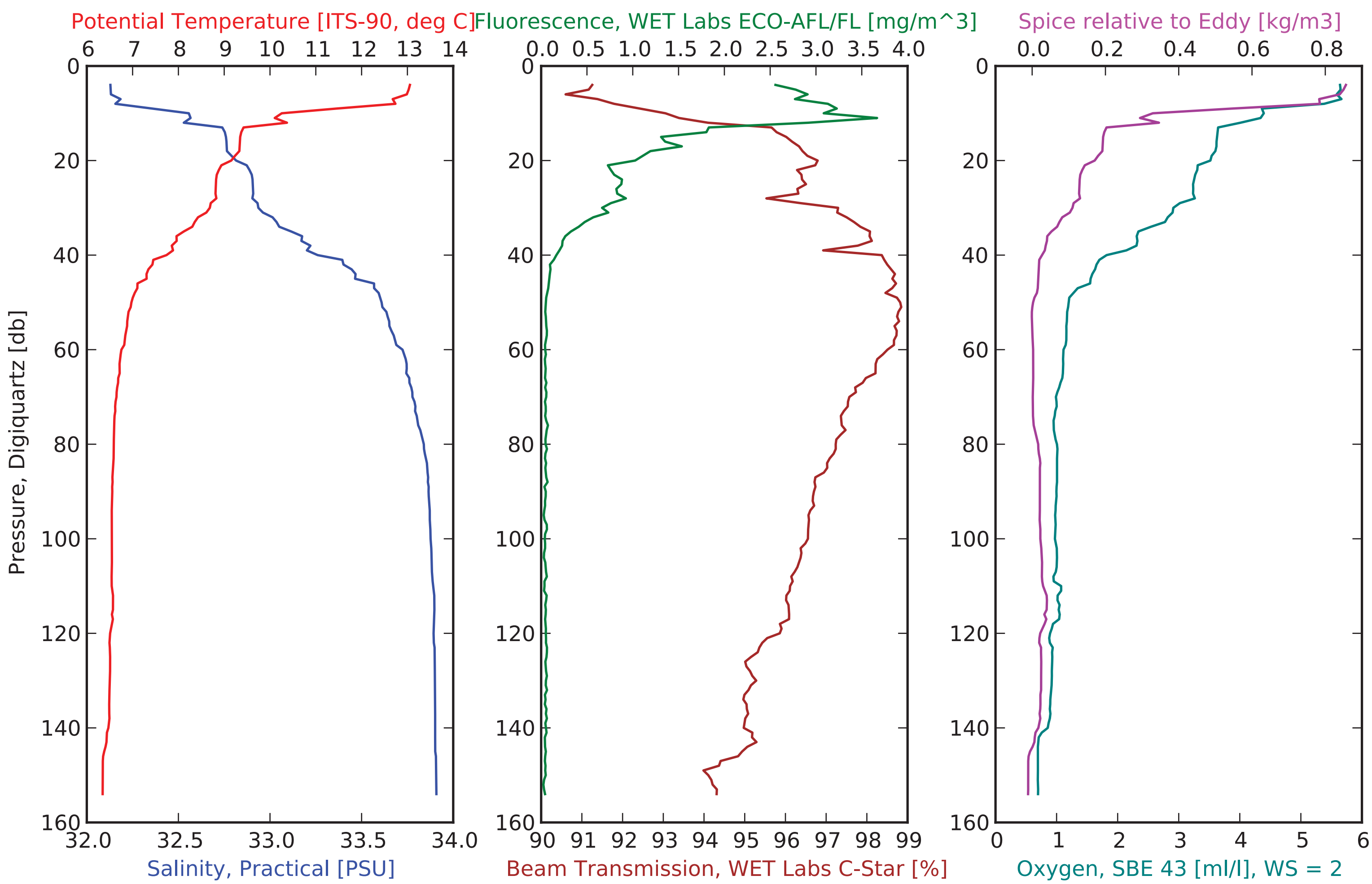
Station: MB07 up at 48 28.31 N,125 19.44 W

On: Aug 27 2013 00:14:51UTC

Filename: FK009A_CTD035up_20130827.cnv



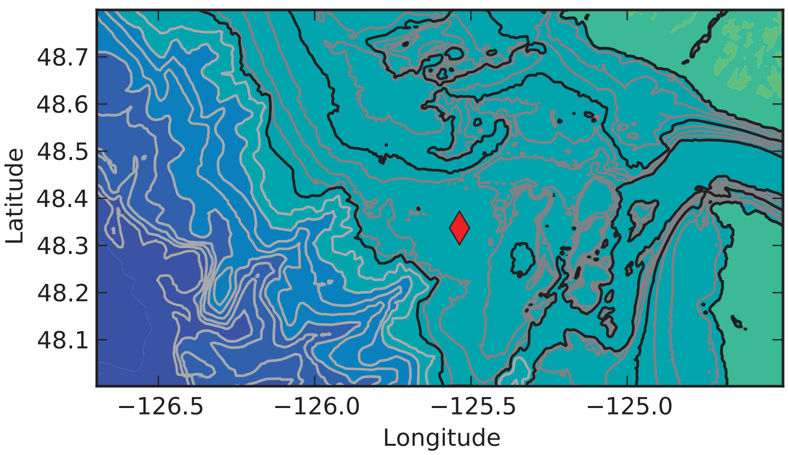


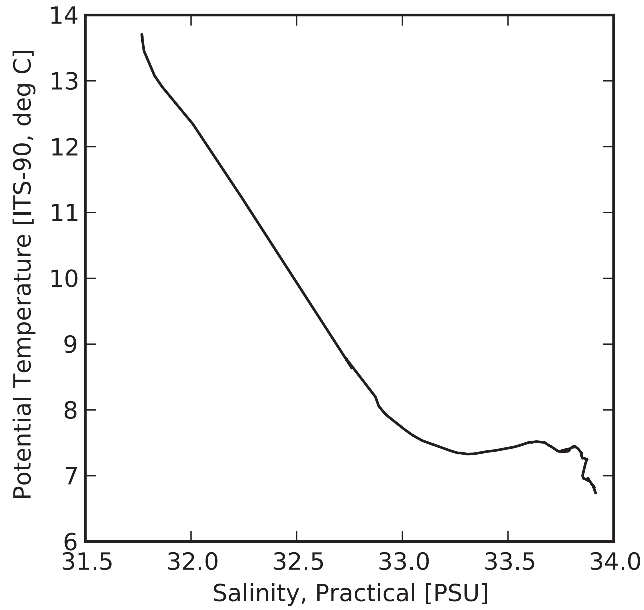


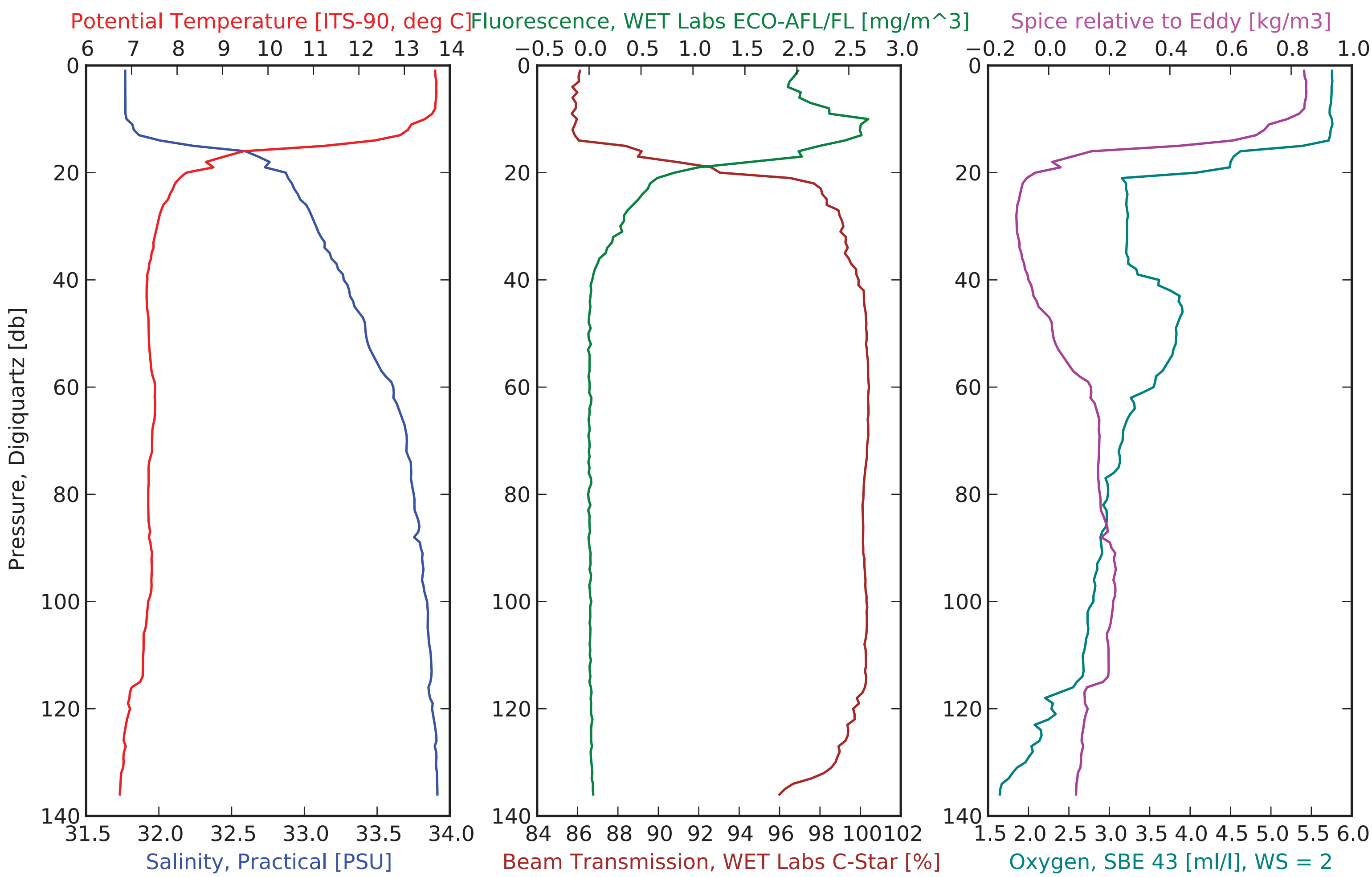
Station: NN01 at 48 20.23 N,125 32.20 W

On: Aug 27 2013 17:18:49UTC

Filename: FK009A_CTD036_20130827.cnv



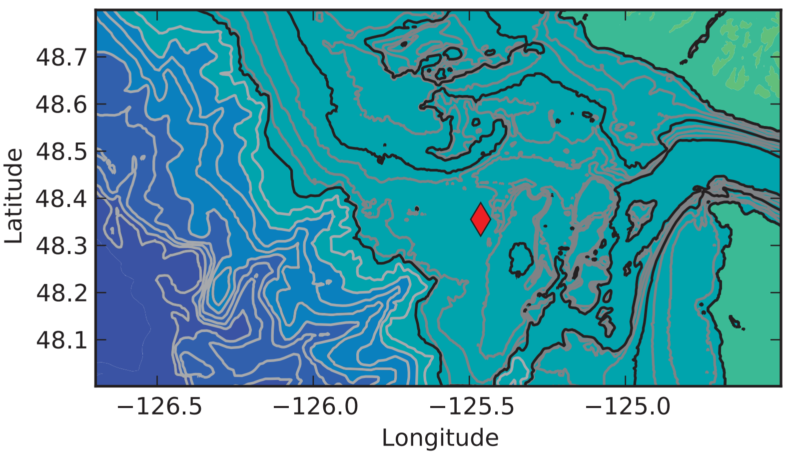


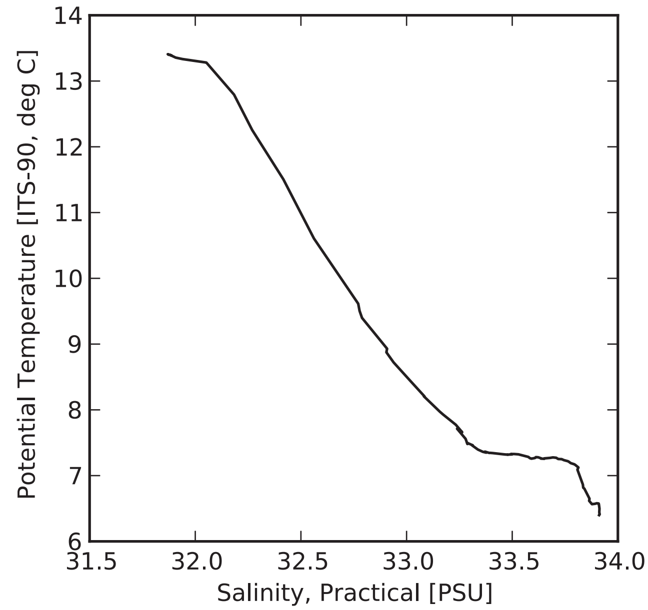


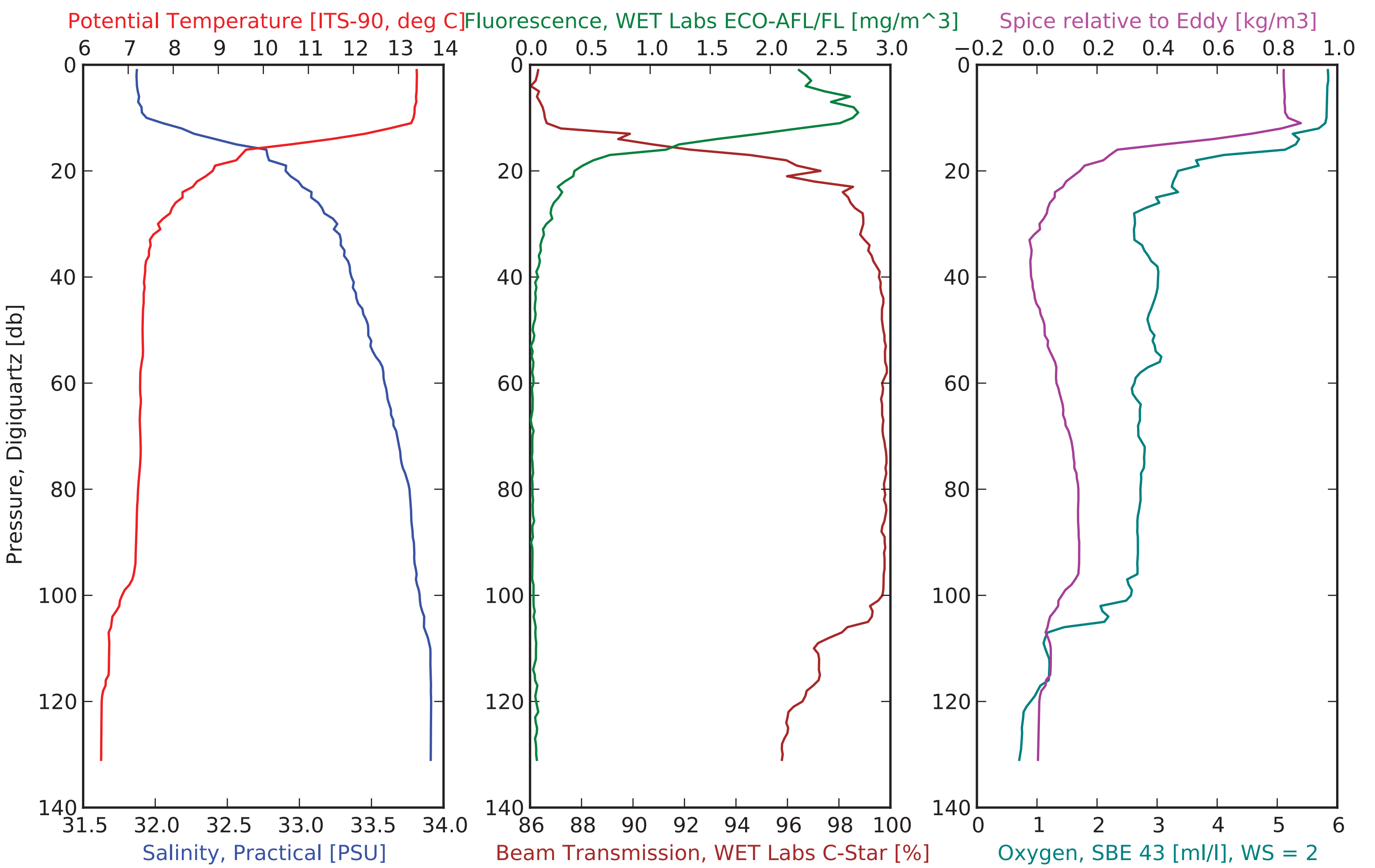
Station: NN02 at 48 21.32 N,125 27.82 W

On: Aug 27 2013 18:59:00UTC

Filename: FK009A_CTD037_20130827.cnv



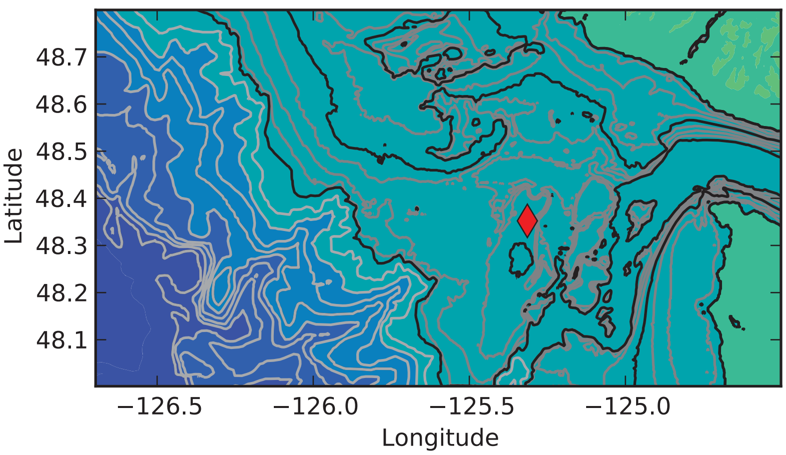


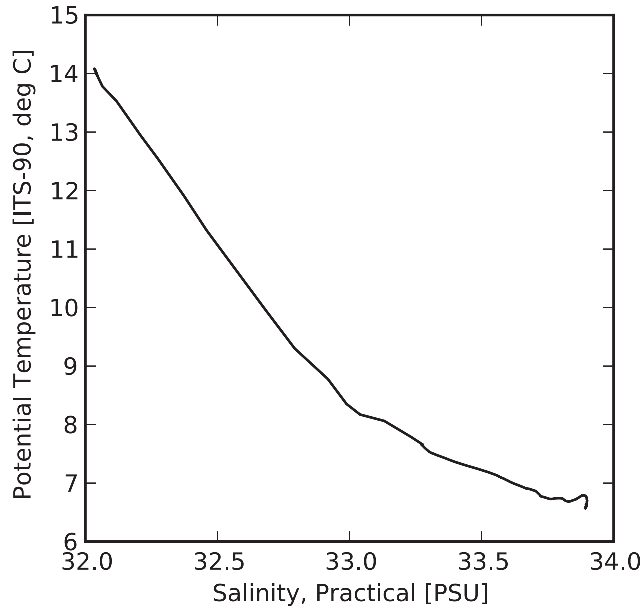


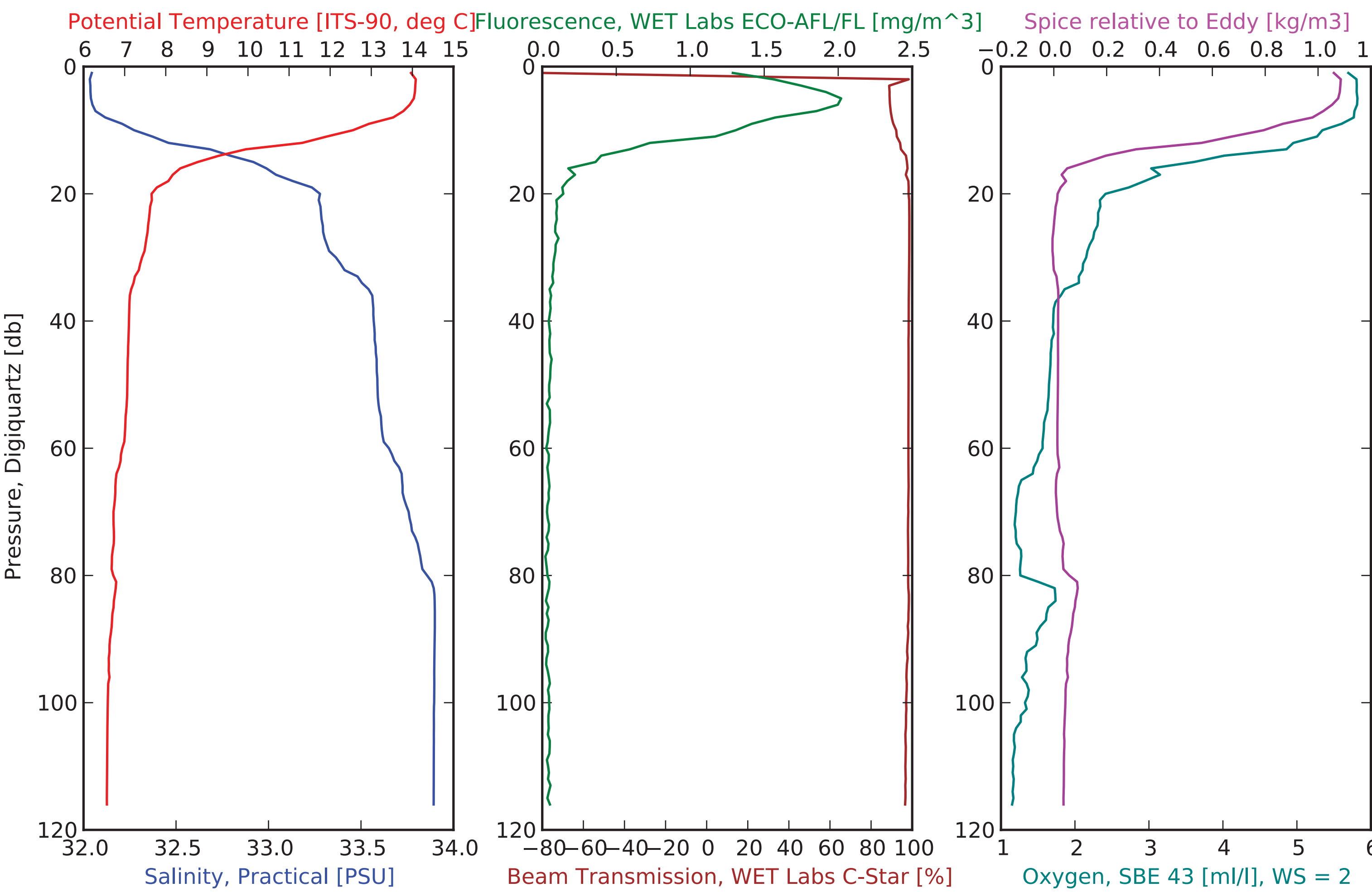
Station: NN03 at 48 21.13 N,125 18.85 W

On: Aug 27 2013 20:17:29UTC

Filename: FK009A_CTD038_20130827.cnv



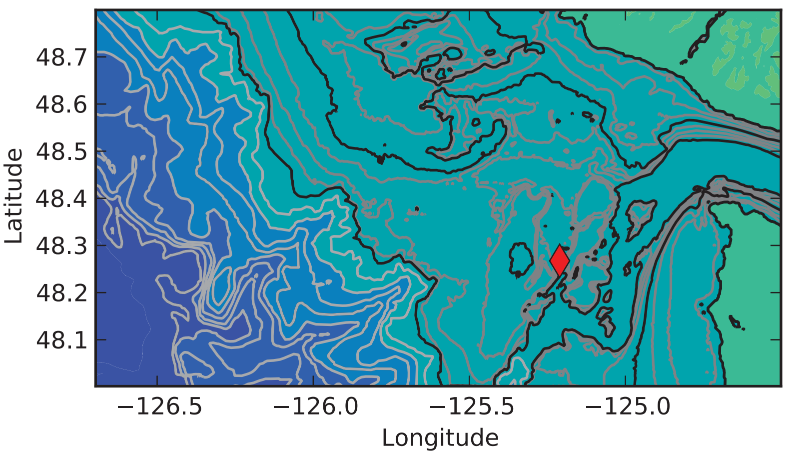


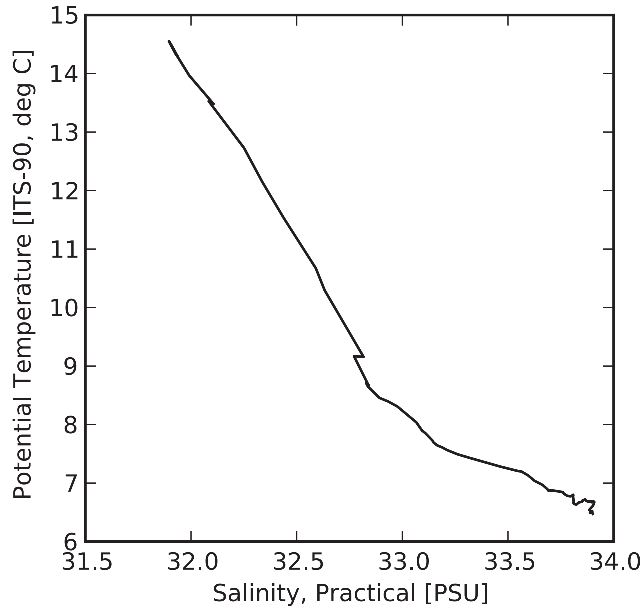


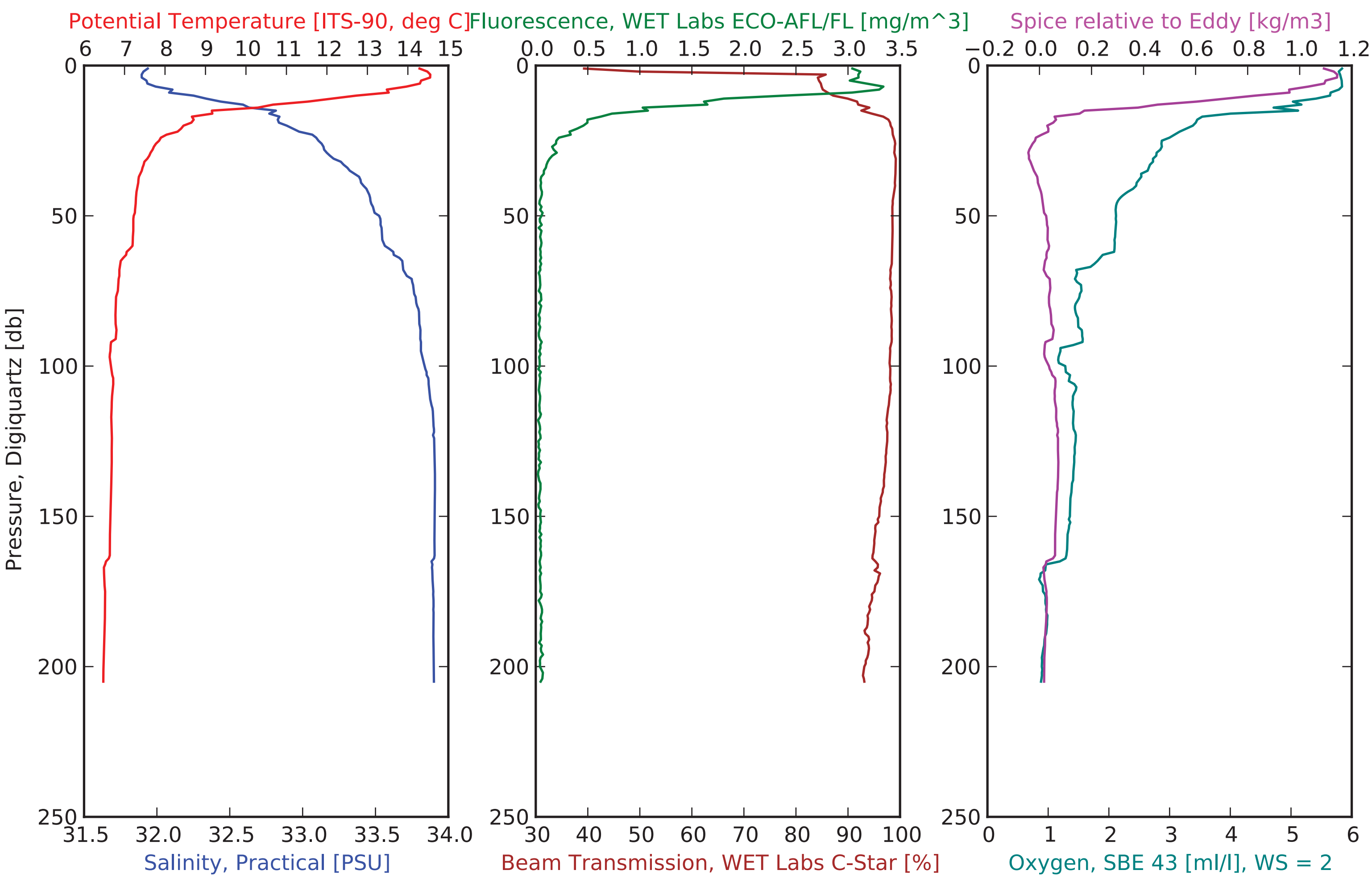
Station: TC01 at 48 16.04 N,125 12.64 W

On: Aug 27 2013 23:23:36UTC

Filename: FK009A_CTD039_20130827.cnv



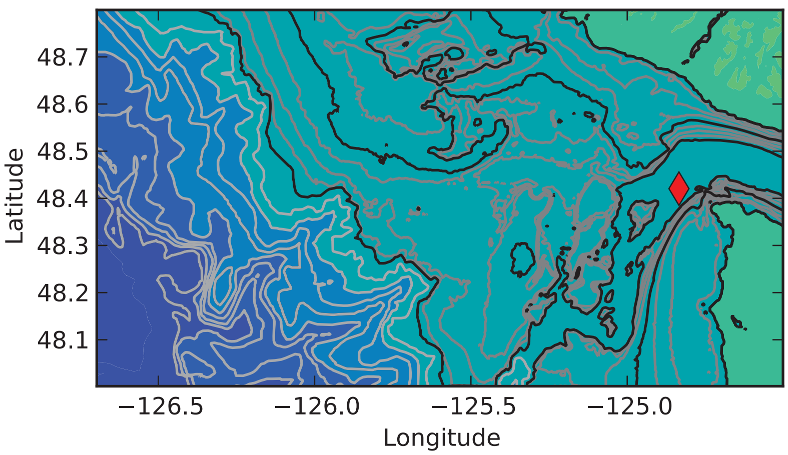


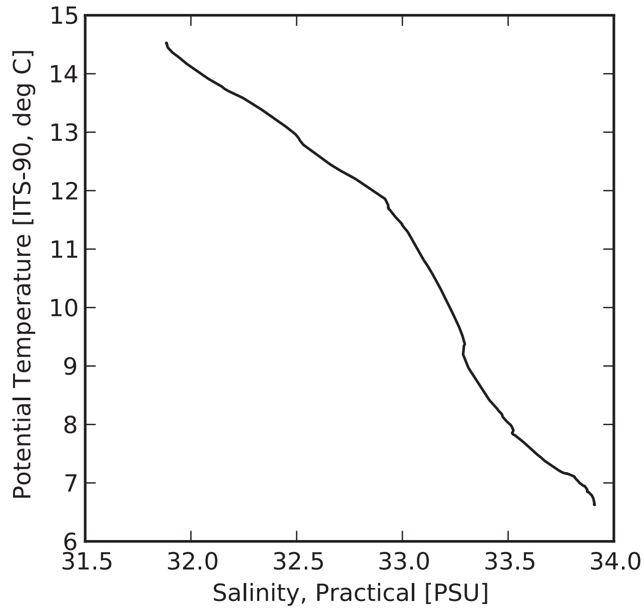


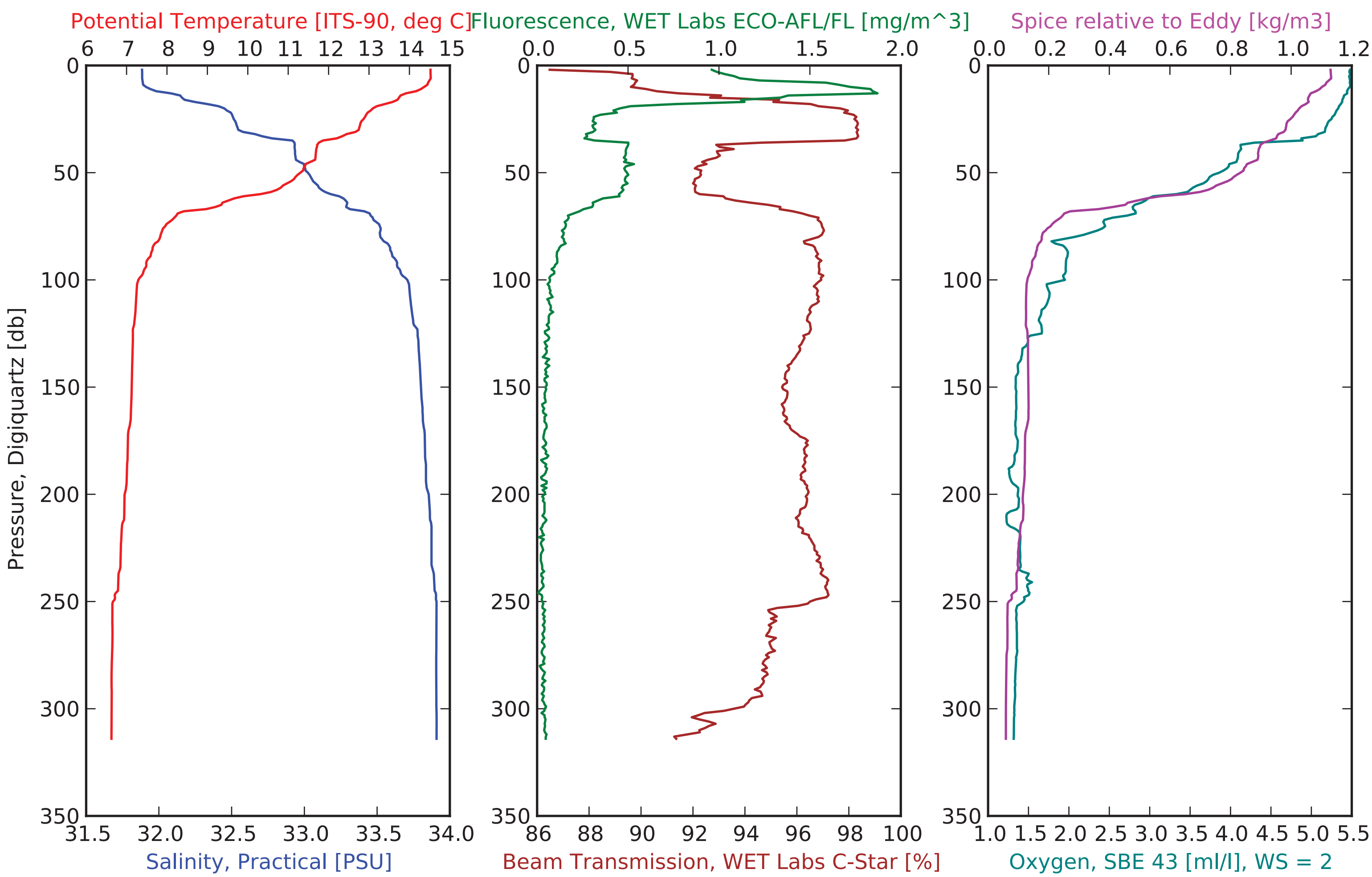
Station: RD05 at 48 25.23 N,124 50.07 W

On: Aug 30 2013 19:46:04UTC

Filename: FK009A_CTD040_20130830.cnv







4.5 CTD- Appendix: Sample Numbers

Water Sample List

Pressure :Pressure, Digiquartz [db]
Salinity :Salinity, Practical [PSU]
Temperature :Temperature [ITS-90, deg C]

Sample No.	Bottle No.	Station	Date/Time (UTC)	Pressure	Salinity	Temperature
1	1	JFG4a	Aug 19 2013 17:16:41	251.11	33.89	6.53
2	2	JFG4a	Aug 19 2013 17:16:41	230.48	33.89	6.54
3	3	JFG4a	Aug 19 2013 17:16:41	202.95	33.88	6.60
4	4	JFG4a	Aug 19 2013 17:16:41	176.40	33.80	6.72
5	5	JFG4a	Aug 19 2013 17:16:41	151.42	33.73	7.25
6	6	JFG4a	Aug 19 2013 17:16:41	126.91	33.44	7.46
7	7	JFG4a	Aug 19 2013 17:16:41	102.49	33.00	8.11
8	8	JFG4a	Aug 19 2013 17:16:41	72.31	31.98	9.48
9	9	JFG4a	Aug 19 2013 17:16:41	59.97	31.73	9.96
10	10	JFG4a	Aug 19 2013 17:16:41	51.40	31.45	10.66
11	11	JFG4a	Aug 19 2013 17:16:41	30.04	31.40	11.08
12	12	JFG4a	Aug 19 2013 17:16:41	11.01	31.41	10.86
13	13	JFG4a	Aug 19 2013 17:16:41	6.87	31.41	10.94
14	1	LB08	Aug 19 2013 21:05:36	130.95	33.91	6.34
15	2	LB08	Aug 19 2013 21:05:36	111.35	33.91	6.36
16	3	LB08	Aug 19 2013 21:05:36	102.15	33.90	6.39
17	4	LB08	Aug 19 2013 21:05:36	71.13	33.81	6.56
18	5	LB08	Aug 19 2013 21:05:36	62.18	33.71	6.78
19	6	LB08	Aug 19 2013 21:05:36	51.44	33.48	7.22
20	7	LB08	Aug 19 2013 21:05:36	31.05	32.82	8.82
21	8	LB08	Aug 19 2013 21:05:36	10.78	31.99	12.02
22	9	LB08	Aug 19 2013 21:05:36	5.56	31.81	13.09
23	1	BCC0	Aug 19 2013 22:58:10	111.45	33.92	6.64
24	2	BCC0	Aug 19 2013 22:58:10	92.13	33.80	6.72
25	3	BCC0	Aug 19 2013 22:58:10	71.69	33.62	7.00
26	4	BCC0	Aug 19 2013 22:58:10	50.88	33.21	7.37
27	5	BCC0	Aug 19 2013 22:58:10	31.81	32.89	7.58
28	6	BCC0	Aug 19 2013 22:58:10	21.92	32.76	7.82

Sample No.	Bottle No.	Station	Date/Time (UTC)	Pressure	Salinity	Temperature
29	7	BCC0	Aug 19 2013 22:58:10	5.98	32.13	12.52
30	1	BCC2	Aug 20 2013 00:47:16	166.03	33.92	6.75
31	2	BCC2	Aug 20 2013 00:47:16	147.28	33.92	6.77
32	3	BCC2	Aug 20 2013 00:47:16	126.37	33.90	6.92
33	4	BCC2	Aug 20 2013 00:47:16	100.61	33.84	7.24
34	5	BCC2	Aug 20 2013 00:47:16	73.23	33.69	7.35
35	6	BCC2	Aug 20 2013 00:47:16	51.05	33.40	7.29
36	7	BCC2	Aug 20 2013 00:47:16	30.89	33.02	7.57
37	8	BCC2	Aug 20 2013 00:47:16	20.16	32.84	8.23
38	9	BCC2	Aug 20 2013 00:47:16	5.51	32.09	13.59
39	1	BCC3	Aug 20 2013 01:53:03	602.56	34.12	5.03
40	2	BCC3	Aug 20 2013 01:53:03	583.51	34.12	5.05
41	3	BCC3	Aug 20 2013 01:53:03	506.20	34.08	5.30
42	4	BCC3	Aug 20 2013 01:53:03	404.57	34.03	5.72
43	5	BCC3	Aug 20 2013 01:53:03	303.85	33.98	6.35
44	6	BCC3	Aug 20 2013 01:53:03	202.82	33.96	6.56
45	7	BCC3	Aug 20 2013 01:53:03	176.89	33.94	6.62
46	8	BCC3	Aug 20 2013 01:53:03	151.75	33.93	6.86
47	9	BCC3	Aug 20 2013 01:53:03	102.54	33.88	7.29
48	10	BCC3	Aug 20 2013 01:53:03	53.49	33.43	7.30
49	11	BCC3	Aug 20 2013 01:53:03	30.96	32.93	7.87
50	12	BCC3	Aug 20 2013 01:53:03	22.00	32.70	8.50
51	13	BCC3	Aug 20 2013 01:53:03	5.83	32.08	11.87
52	1	BCC5	Aug 20 2013 04:59:49	1016.09	34.38	3.65
53	2	BCC5	Aug 20 2013 04:59:49	997.70	34.37	3.71
54	3	BCC5	Aug 20 2013 04:59:49	807.09	34.30	4.11
55	4	BCC5	Aug 20 2013 04:59:49	707.69	34.23	4.49
56	5	BCC5	Aug 20 2013 04:59:49	606.69	34.15	4.91
57	6	BCC5	Aug 20 2013 04:59:49	505.96	34.09	5.34
58	7	BCC5	Aug 20 2013 04:59:49	405.41	34.06	5.60
59	8	BCC5	Aug 20 2013 04:59:49	303.57	34.01	6.05
60	9	BCC5	Aug 20 2013 04:59:49	202.26	33.94	6.60
61	10	BCC5	Aug 20 2013 04:59:49	150.61	33.90	7.09
62	11	BCC5	Aug 20 2013 04:59:49	101.12	33.78	7.40
63	12	BCC5	Aug 20 2013 04:59:49	71.22	33.51	7.33

Sample No.	Bottle No.	Station	Date/Time (UTC)	Pressure	Salinity	Temperature
64	13	BCC5	Aug 20 2013 04:59:49	52.09	33.25	7.36
65	14	BCC5	Aug 20 2013 04:59:49	31.12	32.53	9.53
66	15	BCC5	Aug 20 2013 04:59:49	21.91	32.17	11.32
67	16	BCC5	Aug 20 2013 04:59:49	5.40	32.00	15.94
68	1	BCC7	Aug 20 2013 09:04:09	1607.15	34.53	2.44
69	2	BCC7	Aug 20 2013 09:04:09	1585.98	34.53	2.46
70	3	BCC7	Aug 20 2013 09:04:09	1520.50	34.52	2.56
71	4	BCC7	Aug 20 2013 09:04:09	1009.16	34.39	3.61
72	5	BCC7	Aug 20 2013 09:04:09	808.14	34.29	4.16
73	6	BCC7	Aug 20 2013 09:04:09	709.10	34.23	4.52
74	7	BCC7	Aug 20 2013 09:04:09	607.35	34.16	4.84
75	8	BCC7	Aug 20 2013 09:04:09	508.18	34.11	5.19
76	9	BCC7	Aug 20 2013 09:04:09	403.80	34.06	5.56
77	10	BCC7	Aug 20 2013 09:04:09	303.72	33.97	5.87
78	11	BCC7	Aug 20 2013 09:04:09	249.95	33.95	6.29
79	12	BCC7	Aug 20 2013 09:04:09	206.20	33.94	6.71
80	13	BCC7	Aug 20 2013 09:04:09	177.62	33.91	7.02
81	14	BCC7	Aug 20 2013 09:04:09	152.99	33.81	7.25
82	15	BCC7	Aug 20 2013 09:04:09	128.29	33.71	7.35
83	16	BCC7	Aug 20 2013 09:04:09	103.08	33.50	7.34
84	17	BCC7	Aug 20 2013 09:04:09	70.99	32.95	7.36
85	18	BCC7	Aug 20 2013 09:04:09	62.50	32.82	7.48
86	19	BCC7	Aug 20 2013 09:04:09	50.81	32.61	7.60
87	20	BCC7	Aug 20 2013 09:04:09	32.89	32.38	8.74
88	21	BCC7	Aug 20 2013 09:04:09	20.81	32.10	13.46
89	22	BCC7	Aug 20 2013 09:04:09	11.28	31.98	15.56
90	23	BCC7	Aug 20 2013 09:04:09	3.23	31.97	16.22
91	1	LC12	Aug 20 2013 14:07:47	2551.44	34.64	1.78
92	2	LC12	Aug 20 2013 14:07:47	2547.03	34.64	1.78
93	3	LC12	Aug 20 2013 14:07:47	2027.20	34.60	1.90
94	4	LC12	Aug 20 2013 14:07:47	1519.20	34.52	2.54
95	5	LC12	Aug 20 2013 14:07:47	1012.24	34.38	3.65
96	6	LC12	Aug 20 2013 14:07:47	807.36	34.27	4.09
97	7	LC12	Aug 20 2013 14:07:47	706.18	34.21	4.32
98	8	LC12	Aug 20 2013 14:07:47	607.08	34.17	4.80
99	9	LC12	Aug 20 2013 14:07:47	503.32	34.13	5.06

Sample No.	Bottle No.	Station	Date/Time (UTC)	Pressure	Salinity	Temperature
100	10	LC12	Aug 20 2013 14:07:47	404.50	34.07	5.63
101	11	LC12	Aug 20 2013 14:07:47	304.48	33.99	5.96
102	12	LC12	Aug 20 2013 14:07:47	203.00	33.91	6.73
103	13	LC12	Aug 20 2013 14:07:47	152.94	33.82	7.35
104	14	LC12	Aug 20 2013 14:07:47	103.83	33.30	7.31
105	15	LC12	Aug 20 2013 14:07:47	72.05	32.62	7.51
106	16	LC12	Aug 20 2013 14:07:47	53.44	32.53	8.00
107	17	LC12	Aug 20 2013 14:07:47	32.67	32.25	11.05
108	18	LC12	Aug 20 2013 14:07:47	19.50	32.10	13.91
109	19	LC12	Aug 20 2013 14:07:47	5.92	31.99	16.39
110	1	LC11	Aug 20 2013 18:24:28	1478.56	34.52	2.57
111	2	LC11	Aug 20 2013 18:24:28	1458.39	34.52	2.59
112	3	LC11	Aug 20 2013 18:24:28	1008.88	34.38	3.63
113	4	LC11	Aug 20 2013 18:24:28	808.59	34.27	4.18
114	5	LC11	Aug 20 2013 18:24:28	705.02	34.21	4.44
115	6	LC11	Aug 20 2013 18:24:28	606.57	34.15	4.78
116	7	LC11	Aug 20 2013 18:24:28	505.74	34.11	5.23
117	8	LC11	Aug 20 2013 18:24:28	404.97	34.06	5.76
118	9	LC11	Aug 20 2013 18:24:28	307.29	34.00	6.22
119	10	LC11	Aug 20 2013 18:24:28	202.55	33.92	6.79
120	11	LC11	Aug 20 2013 18:24:28	154.32	33.84	7.31
121	12	LC11	Aug 20 2013 18:24:28	102.41	33.29	7.29
122	13	LC11	Aug 20 2013 18:24:28	71.14	32.71	7.36
123	14	LC11	Aug 20 2013 18:24:28	50.77	32.50	8.02
124	15	LC11	Aug 20 2013 18:24:28	31.60	32.26	10.94
125	16	LC11	Aug 20 2013 18:24:28	22.32	32.08	13.84
126	17	LC11	Aug 20 2013 18:24:28	4.72	31.98	16.27
127	1	LC09	Aug 20 2013 22:48:22	612.98	34.18	4.71
128	2	LC09	Aug 20 2013 22:48:22	595.63	34.16	4.83
129	3	LC09	Aug 20 2013 22:48:22	506.00	34.11	5.21
130	4	LC09	Aug 20 2013 22:48:22	405.38	34.05	5.68
131	5	LC09	Aug 20 2013 22:48:22	305.18	34.02	6.07
132	6	LC09	Aug 20 2013 22:48:22	202.19	33.94	6.70
133	7	LC09	Aug 20 2013 22:48:22	176.52	33.92	6.85
134	8	LC09	Aug 20 2013 22:48:22	153.01	33.86	7.08
135	9	LC09	Aug 20 2013 22:48:22	102.36	33.47	7.30

Sample No.	Bottle No.	Station	Date/Time (UTC)	Pressure	Salinity	Temperature
136	10	LC09	Aug 20 2013 22:48:22	51.27	32.68	7.48
137	11	LC09	Aug 20 2013 22:48:22	31.67	32.39	8.70
138	12	LC09	Aug 20 2013 22:48:22	21.11	32.13	12.09
139	13	LC09	Aug 20 2013 22:48:22	5.76	31.99	16.31
140	1	LC08	Aug 21 2013 00:43:18	196.85	33.96	6.50
141	2	LC08	Aug 21 2013 00:43:18	177.40	33.96	6.50
142	3	LC08	Aug 21 2013 00:43:18	151.67	33.92	6.61
143	4	LC08	Aug 21 2013 00:43:18	126.35	33.86	6.93
144	5	LC08	Aug 21 2013 00:43:18	100.29	33.73	7.22
145	6	LC08	Aug 21 2013 00:43:18	71.19	33.50	7.30
146	7	LC08	Aug 21 2013 00:43:18	49.93	33.10	7.62
147	8	LC08	Aug 21 2013 00:43:18	31.65	32.59	8.13
148	9	LC08	Aug 21 2013 00:43:18	20.20	32.23	10.95
149	10	LC08	Aug 21 2013 00:43:18	5.00	32.01	15.63
150	1	LC06	Aug 21 2013 03:21:12	87.09	33.83	6.70
151	2	LC06	Aug 21 2013 03:21:12	71.30	33.82	6.74
152	3	LC06	Aug 21 2013 03:21:12	51.60	33.68	7.26
153	4	LC06	Aug 21 2013 03:21:12	40.92	33.55	7.30
154	5	LC06	Aug 21 2013 03:21:12	31.45	33.36	7.34
155	6	LC06	Aug 21 2013 03:21:12	20.70	33.00	8.36
156	7	LC06	Aug 21 2013 03:21:12	5.44	32.15	13.31
157	1	RD01	Aug 22 2013 00:31:45	629.08	34.23	4.54
158	2	RD01	Aug 22 2013 00:31:45	219.07	33.97	6.50
159	3	RD01	Aug 22 2013 00:31:45	110.93	33.76	7.41
160	4	RD01	Aug 22 2013 00:31:45	72.07	33.20	7.31
161	1	RD02	Aug 22 2013 02:27:41	332.74	34.01	6.10
162	2	RD02	Aug 22 2013 02:27:41	249.28	33.98	6.31
163	3	RD02	Aug 22 2013 02:27:41	144.30	33.81	7.21
164	4	RD02	Aug 22 2013 02:27:41	70.58	33.00	7.20
165	1	MB07	Aug 22 2013 07:08:54	159.08	33.92	6.27
166	2	MB07	Aug 22 2013 07:08:54	113.41	33.91	6.38
167	3	MB07	Aug 22 2013 07:08:54	70.72	33.81	6.55
168	4	MB07	Aug 22 2013 07:08:54	35.69	33.13	7.93
169	1	MB08	Aug 22 2013 15:14:47	147.44	33.88	6.45
170	2	MB08	Aug 22 2013 15:14:47	71.38	33.81	6.59

Sample No.	Bottle No.	Station	Date/Time (UTC)	Pressure	Salinity	Temperature
171	3	MB08	Aug 22 2013 15:14:47	40.30	33.55	7.10
172	4	MB08	Aug 22 2013 15:14:47	30.99	33.28	7.66
173	1	MB14	Aug 22 2013 16:56:27	176.85	33.73	6.79
174	2	MB14	Aug 22 2013 16:56:27	101.13	33.59	7.04
175	3	MB14	Aug 22 2013 16:56:27	71.05	33.52	7.18
176	4	MB14	Aug 22 2013 16:56:27	30.75	33.34	7.47
181	1	RAD08	Aug 22 2013 17:40:36	232.30	33.74	6.78
177	1	MB16	Aug 22 2013 20:02:54	94.96	33.36	7.49
178	2	MB16	Aug 22 2013 20:02:54	76.08	32.97	8.18
179	3	MB16	Aug 22 2013 20:02:54	60.03	32.40	9.04
180	4	MB16	Aug 22 2013 20:02:54	34.54	32.19	9.35
185	1	LC05-A	Aug 23 2013 01:39:36	209.25	33.67	6.90
186	2	LC05-A	Aug 23 2013 01:39:36	161.30	33.64	6.96
187	3	LC05-A	Aug 23 2013 01:39:36	101.68	33.57	7.11
188	4	LC05-A	Aug 23 2013 01:39:36	67.82	33.42	7.40
189	1	LC08	Aug 23 2013 05:04:48	195.85	33.95	6.44
190	2	LC08	Aug 23 2013 05:04:48	151.91	33.87	6.82
191	3	LC08	Aug 23 2013 05:04:48	99.54	33.55	7.29
192	4	LC08	Aug 23 2013 05:04:48	73.24	33.43	7.32
193	1	RD04	Aug 23 2013 19:59:51	351.92	33.92	6.50
194	2	RD04	Aug 23 2013 19:59:51	323.57	33.96	6.50
195	3	RD04	Aug 23 2013 19:59:51	252.38	33.95	6.58
196	4	RD04	Aug 23 2013 19:59:51	203.27	33.94	6.62
197	5	RD04	Aug 23 2013 19:59:51	176.05	33.93	6.67
198	6	RD04	Aug 23 2013 19:59:51	152.24	33.90	6.71
199	7	RD04	Aug 23 2013 19:59:51	127.03	33.86	6.82
200	8	RD04	Aug 23 2013 19:59:51	102.23	33.84	6.91
201	9	RD04	Aug 23 2013 19:59:51	71.29	33.78	7.11
202	10	RD04	Aug 23 2013 19:59:51	60.86	33.76	7.13
203	11	RD04	Aug 23 2013 19:59:51	64.03	33.66	7.21
204	12	RD04	Aug 23 2013 19:59:51	30.94	33.31	7.67
205	13	RD04	Aug 23 2013 19:59:51	20.63	32.84	8.97
206	14	RD04	Aug 23 2013 19:59:51	6.16	32.07	12.46
207	1	RD02	Aug 24 2013 06:23:34	330.08	34.01	6.15
208	2	RD02	Aug 24 2013 06:23:34	307.88	34.00	6.19

Sample No.	Bottle No.	Station	Date/Time (UTC)	Pressure	Salinity	Temperature
209	3	RD02	Aug 24 2013 06:23:34	247.11	33.95	6.47
210	4	RD02	Aug 24 2013 06:23:34	212.42	33.91	6.62
211	5	RD02	Aug 24 2013 06:23:34	150.43	33.87	6.87
212	6	RD02	Aug 24 2013 06:23:34	128.25	33.86	6.90
213	7	RD02	Aug 24 2013 06:23:34	102.55	33.79	6.86
214	8	RD02	Aug 24 2013 06:23:34	63.34	33.40	7.30
215	9	RD02	Aug 24 2013 06:23:34	50.38	33.21	7.38
216	10	RD02	Aug 24 2013 06:23:34	30.59	32.87	8.03
217	11	RD02	Aug 24 2013 06:23:34	21.39	32.21	13.08
218	12	RD02	Aug 24 2013 06:23:34	5.33	32.06	14.73
219	1	MB16	Aug 26 2013 16:26:48	106.66	33.34	7.55
220	2	MB16	Aug 26 2013 16:26:48	85.46	33.27	7.66
221	3	MB16	Aug 26 2013 16:26:48	72.04	32.94	8.19
222	4	MB16	Aug 26 2013 16:26:48	51.14	32.58	8.74
223	5	MB16	Aug 26 2013 16:26:48	32.05	32.37	9.14
224	6	MB16	Aug 26 2013 16:26:48	21.04	32.08	9.82
225	7	MB16	Aug 26 2013 16:26:48	10.52	31.57	11.64
226	8	MB16	Aug 26 2013 16:26:48	6.04	31.43	11.75
227	1	Susan01	Aug 26 2013 21:47:53	193.77	33.73	6.77
228	2	Susan01	Aug 26 2013 21:47:53	176.17	33.72	6.80
229	3	Susan01	Aug 26 2013 21:47:53	152.64	33.68	6.89
230	4	Susan01	Aug 26 2013 21:47:53	124.88	33.66	6.92
231	5	Susan01	Aug 26 2013 21:47:53	100.54	33.61	7.01
232	6	Susan01	Aug 26 2013 21:47:53	75.49	33.51	7.25
233	7	Susan01	Aug 26 2013 21:47:53	61.22	33.23	7.93
234	8	Susan01	Aug 26 2013 21:47:53	53.50	33.21	8.06
235	9	Susan01	Aug 26 2013 21:47:53	31.82	32.68	8.59
236	10	Susan01	Aug 26 2013 21:47:53	20.17	32.55	10.01
237	11	Susan01	Aug 26 2013 21:47:53	11.37	32.57	10.44
238	12	Susan01	Aug 26 2013 21:47:53	7.20	32.57	10.46
239	1	MB07	Aug 27 2013 00:14:51	151.86	33.91	6.36
240	2	MB07	Aug 27 2013 00:14:51	133.40	33.90	6.51
241	3	MB07	Aug 27 2013 00:14:51	104.76	33.88	6.55
242	4	MB07	Aug 27 2013 00:14:51	75.45	33.80	6.61
243	5	MB07	Aug 27 2013 00:14:51	62.92	33.71	6.79

Sample No.	Bottle No.	Station	Date/Time (UTC)	Pressure	Salinity	Temperature
244	6	MB07	Aug 27 2013 00:14:51	51.28	33.62	6.96
245	7	MB07	Aug 27 2013 00:14:51	30.81	32.92	8.78
246	8	MB07	Aug 27 2013 00:14:51	21.53	32.77	9.31
247	9	MB07	Aug 27 2013 00:14:51	10.82	32.64	9.77
248	10	MB07	Aug 27 2013 00:14:51	4.38	32.13	13.05
249	1	NN01	Aug 27 2013 17:18:49	134.50	33.91	6.76
250	2	NN01	Aug 27 2013 17:18:49	122.42	33.89	6.89
251	3	NN01	Aug 27 2013 17:18:49	102.04	33.85	7.34
252	4	NN01	Aug 27 2013 17:18:49	71.76	33.71	7.42
253	5	NN01	Aug 27 2013 17:18:49	60.95	33.63	7.52
254	6	NN01	Aug 27 2013 17:18:49	48.72	33.43	7.39
255	7	NN01	Aug 27 2013 17:18:49	30.58	33.12	7.50
256	8	NN01	Aug 27 2013 17:18:49	21.43	32.87	8.04
257	9	NN01	Aug 27 2013 17:18:49	5.33	31.78	13.81
258	1	NN02	Aug 27 2013 18:59:00	130.06	33.91	6.42
259	2	NN02	Aug 27 2013 18:59:00	109.48	33.88	6.56
260	3	NN02	Aug 27 2013 18:59:00	101.34	33.83	6.88
261	4	NN02	Aug 27 2013 18:59:00	71.21	33.60	7.27
262	5	NN02	Aug 27 2013 18:59:00	62.05	33.52	7.33
263	6	NN02	Aug 27 2013 18:59:00	51.43	33.45	7.33
264	7	NN02	Aug 27 2013 18:59:00	31.73	33.26	7.63
265	8	NN02	Aug 27 2013 18:59:00	20.92	32.81	9.21
266	9	NN02	Aug 27 2013 18:59:00	7.01	31.96	13.19
267	1	NN03	Aug 27 2013 20:17:29	114.71	33.89	6.58
268	2	NN03	Aug 27 2013 20:17:29	82.36	33.90	6.71
269	3	NN03	Aug 27 2013 20:17:29	69.26	33.75	6.74
270	4	NN03	Aug 27 2013 20:17:29	61.66	33.66	6.92
271	5	NN03	Aug 27 2013 20:17:29	52.18	33.59	7.06
272	6	NN03	Aug 27 2013 20:17:29	31.35	33.37	7.40
273	7	NN03	Aug 27 2013 20:17:29	20.74	33.30	7.54
274	8	NN03	Aug 27 2013 20:17:29	6.74	32.64	10.45
275	1	TC01	Aug 27 2013 23:23:36	204.40	33.90	6.49
276	2	TC01	Aug 27 2013 23:23:36	174.04	33.89	6.53
277	3	TC01	Aug 27 2013 23:23:36	152.12	33.90	6.65
278	4	TC01	Aug 27 2013 23:23:36	128.07	33.90	6.69

Sample No.	Bottle No.	Station	Date/Time (UTC)	Pressure	Salinity	Temperature
279	5	TC01	Aug 27 2013 23:23:36	91.61	33.81	6.75
280	6	TC01	Aug 27 2013 23:23:36	72.97	33.75	6.84
281	7	TC01	Aug 27 2013 23:23:36	60.57	33.61	7.10
282	8	TC01	Aug 27 2013 23:23:36	50.32	33.51	7.24
283	9	TC01	Aug 27 2013 23:23:36	30.56	33.21	7.57
284	10	TC01	Aug 27 2013 23:23:36	21.43	32.95	8.40
285	11	TC01	Aug 27 2013 23:23:36	6.32	31.90	14.46
287	1	RD05	Aug 30 2013 19:46:04	311.76	33.91	6.65
288	2	RD05	Aug 30 2013 19:46:04	290.60	33.91	6.66
289	3	RD05	Aug 30 2013 19:46:04	252.59	33.89	6.81
290	4	RD05	Aug 30 2013 19:46:04	202.95	33.84	7.02
291	5	RD05	Aug 30 2013 19:46:04	178.71	33.83	7.04
292	6	RD05	Aug 30 2013 19:46:04	150.05	33.81	7.13
293	7	RD05	Aug 30 2013 19:46:04	126.84	33.74	7.22
294	8	RD05	Aug 30 2013 19:46:04	101.80	33.68	7.36
295	9	RD05	Aug 30 2013 19:46:04	71.37	33.42	8.13
296	10	RD05	Aug 30 2013 19:46:04	61.42	33.33	9.02
297	11	RD05	Aug 30 2013 19:46:04	50.59	33.08	10.91
298	12	RD05	Aug 30 2013 19:46:04	30.75	32.78	12.17
299	13	RD05	Aug 30 2013 19:46:04	22.02	32.29	13.30
300	14	RD05	Aug 30 2013 19:46:04	6.86	31.88	14.49

A Appendix 1: File contents of the FK009A/PublicData/ Data/ADCP/OS75 Directory

The OS75 directory contains raw and processed ADCP data from the OS75 kHz ADCP on the R/V Falkor from cruise FK009A. It contains:

- `vmdas_info.txt` which outlines key info on the various VmDas data files written

- the directory `/Configuration_Files` which contains the various configuration settings for the OS75 instrument, some of which set the ADCP settings for various periods of data collection. Those that start with "OS75BB" were on the ship's systems. Those that start with "FK009A" were modified on the cruise in attempt to optimise the ADCP data collection. The ADCP log book, a copy of which is stored in the Falkor's FK009A PublicData directory, should outline which configuration file was used for each VmDas file number.

- the directory `/Raw` contains the raw VmDas data collected by the ship. A new file (with an incremented file number) is created each time the instrument is restarted. In general, the instrument was stopped either because other acoustic instruments had the priority at that time, or because we wanted to change the ADCP settings.

- the directory `/SemiProcessed` contains, for select file numbers corresponding to records of significant duration, the various outputs generated by processing the VmDas data with the CODAS processing system. Processing was done by Stephanie Waterman (snw@alum.mit.edu). The end product of the CODAS processing is found in each os75bb subdirectory.

- the directory `/Processed` contains the CODAS first-pass processed data for the four coherent data records discussed above. This includes `.mat` files and `.png` images. See the CODAS documentation (`http://currents.soest.hawaii.edu/docs/doc/`) for more details.

- `FK009A_ADCP_Processing_SetUp_Notes_Individual_Station_Processing.txt` outlines the processing steps taken to produce the semi-processed and processed data from the raw VmDas data recorded by the ship's systems.

- FK009A_ADCP_Processing_Warnings.txt lists the warnings that were output during the CODAS processing.

- ADCP_Processing_Questions.txt outlines outstanding things to do to fully process the data.

B Appendix 2: ADCP data processing steps carried out on board during FK009A

On the ADCP Processing computer:

1. Mount the ship's cruisedata/FK009a directory via:

   sudo mount -t cifs '//10.23.9.200/cruisedata/FK009A' /mnt/cifs
   Password for adcpproc: codas3; Password: codas3

   Path to RAW data is now:

   /mnt/cifs/AcouticSystems/ADCP75KHZ/RAW

2. rsync the data to a local vmdas_data directory in the processing directory /home/adcpproc/FK009A/adcp_pyproc:

   rsync -avz /mnt/cifs/AcousticSystems/ADCP75KHZ/RAW/* /home/adcpproc/FK009A/adcp pyproc/vmdas data/

3. Set up the directory structure for individual station analysis and copy VmDas data to station directory:

   cd /home/adcpproc/FK009A/adcp pyproc

   mkdir 0XX

   cd 0XX

   mkdir config

   mkdir fake uhdas data

   mkdir vmdas data

   cp /home/adcpproc/FK009A/adcp pyproc/vmdas data/FK009A OS75 00X/* /home/adcpproc/FK009A/adcp pyproc/00X/vmdas data/

4. From inside the FK009/adcpproc/0XX/config directory collect information from the VmDas data by running vmdas info.py via:

   cd config

   vmdas info.py os /home/adcpproc/FK009A/adcp pyproc/0XX/vmdas data/*LTA > vmdas info.txt

   It should write a .txt file, vmdas_info.txt, in the config directory with warnings and information regarding the VmDas data.

5. Convert the VmDas data to UHDas data by running reform vmdas.py then vmdas2uhdas.py via:

   reform vmdas.py /home/adcpproc/FK009A/adcp pyproc/0XX

   A GUI will pop up asking for:

   - vmdas source directory: /home/adcpproc/FK009A/adcp_pyproc/0XX/vmdas_data/
   - uhdas directory: /home/adcpproc/FK009A/adcp_pyproc/0XX/fake_uhdas_data
   - ship ID: zzz
   - instrument: os75
   - cruise name: FK009A_OS75_0XX

   Press the GREEN button. It should write reform_defs.py and vmdas2uhdas.py into the config directory. Then run vmdas2uhdas via:

   python vmdas2uhdas.py

   It should create N1R and N2R directories in the vmdas_data directory and populate the fake_uhdas_data directory with the reformatted UHDas data in raw and rbin directories.

6. create a UHDas processing configuration file for the new fake UHDas data via:

   proc starter.py reform defs.py

   In the pop-up GUI enter:

   - clockwise transducer angle = 0.0 or -0.32
   - transducer depth = 6

- position = (‘N1R’,‘gps’)
- heading = (‘N1R’,‘hdg’)

7. run UHDas single-ping processing:

   Go up one directory level (into processing directory):

   ```
   cd ..
   ```

   Create a processing directory via running `adcptree.py`:

   ```
   adcptree.py os75bb --datatype uhdas --cruisename FK009A OS75
   0XX
   ```

   Copy `CRUISENAME_proc.py` from `config` directory to new processing directory:

   ```
   cp config/FK009A OS75 0XX proc.py os75bb/config
   ```

   Copy `q_py.cnt` file to new processing directory:

   ```
   cp /home/adcpproc/FK009A/adcp pyproc/q py.cnt /home/adcpproc/FK009A/adcp
   pyproc/0XX/os75bb
   ```

   Edit `q_py.cnt` file accordingly.

   Run `quick_adcp.py` via:

   ```
   quick adcp.py --cntfile q py.cnt
   ```

8. Copy the processed data to a directory for easy export

   ```
   cd ..
   ```

   ```
   mkdir export
   ```

   ```
   dataviewer.py
   ```

   ```
   cp cal/botmtrk/btcal.png /home/adcpproc/FK009A/adcp_pyproc/
   0XX/export
   ```

   ```
   cp edit/nping_plot.png /home/adcpproc/FK009A/adcp_pyproc/0XX/
   export
   ```

   ```
   cp contour/*.mat /home/adcpproc/FK009A/adcp_pyproc/0XX/export
   ```

   ```
   cp vector/*.mat /home/adcpproc/FK009A/adcp_pyproc/0XX/export
   ```

9. Copy data for export to the `publicdata` directory via:

   `sudo mount -t cifs '//10.23.9.200/publicdata' /mnt/shares`

   Then from the local export directory:

   `cp * /mnt/shares/Data/ADCP/OS75/0XX`