Name: Prof. Martin Frank
Institut: IFM-GEOMAR, Leibniz Institute of Marine Sciences at the University of Kiel
Wischhofstrasse 1-3, 24148 Kiel

Tel.: 0431/6002218
Fax: 0431/6002925
email: mfrank@ifm-geomar.de

Short Report

METEOR Cruise No. 77 Leg 3

Guayaquil (Ecuador) – Callao (Peru): 27.12.2008 – 24.1.2009

Climate- Biogeochemistry interactions in the tropical ocean of the SE-American oxygen minimum zone

Chief Scientist: Prof. Martin Frank

Captain: Niels Jacobi

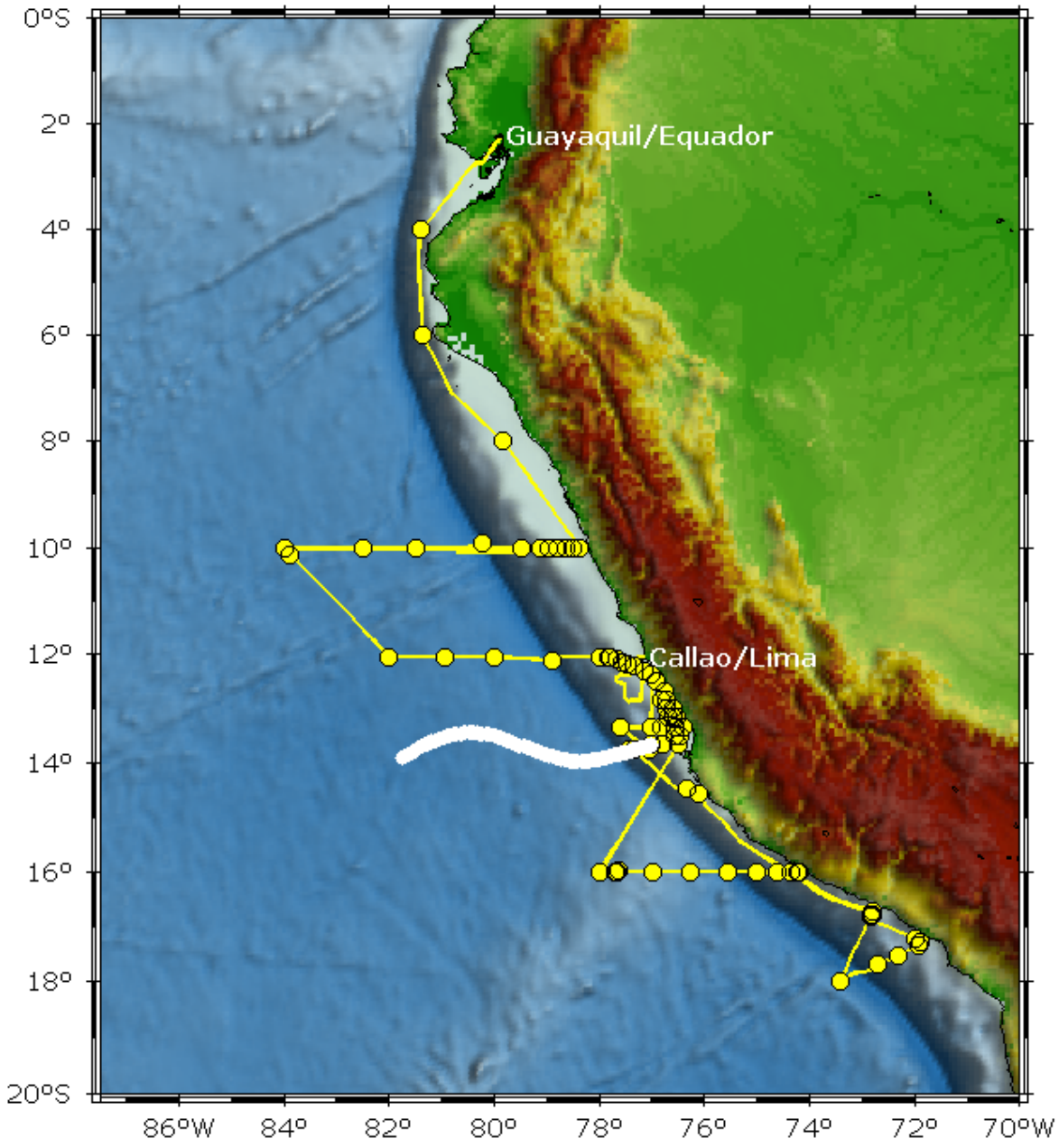

Fig. 1: Cruise track of METEOR 77/3. The white line marks the track of the glider that was released during the cruise.

1. Objectives of the cruise

Main research topic of the third leg of M77 to the south-eastern tropical Pacific was the investigation of the factors controlling extent and strength of the oxygen minimum zone (OMZ) in the water column of the coastal upwelling areas off Peru. This research is carried out in the context of the new Sonderforschungsbereich 754 at the

University of Kiel, “Climate – Biogeochemistry Interactions in the Tropical Ocean” which started in 2008 and is funded by the German Research Council (DFG).

The first objective of M77/3 was a better understanding of the supply pathways of oxygen and nutrients and their processing in the coastal upwelling area. This was tackled by a detailed investigation of the water mass structure applying physical, geochemical and isotopic methods together with oxygen and nutrient measurements along four sections perpendicular to the coastline at 10°S, 12°S, 16°S and 18°S in order to cover the main oxygen and nutrient gradients from the centres of the coastal upwelling cells into the open ocean. This was complemented by the determination of the concentration and speciation of trace metals (mainly Fe, but also Cd, Mn,) together with phosphate in order to better understand their supply pathways (such as remobilization from reducing sediments) and the mechanisms controlling their concentrations. Some of these metals act as biolimiting micronutrients and thus can in turn influence bioproductivity and redox conditions.

The second major objective was the systematic investigation of the nitrogen cycle, which includes the mechanisms controlling nitrogen loss and nutrient regeneration, as well as nitrogen fixation. The main part of the investigations was based on a high resolution sampling of the water column using a PUMP-CTD accompanied by the collection of particulate samples using in-situ pumps. These water samples were used to conduct a large amount of on board incubation experiments with isotopically labeled compounds involved in the nitrogen cycle. In addition, the relationship between pelagic community structure and nutrient composition (variable N:P ratios caused by enhanced P supply in the low oxygen waters) was investigated in a series of board mesocosm experiments.

2. Narrative

Cruise M77/3 started in Guayaquil/Ecuador, where the scientists from the IFM-GEOMAR in Kiel and the MPI for Marine Microbiology in Bremen arrived on the morning of the 26th December and were directly transferred to the ship. One additional scientist from the MBARI in Monterey, U.S.A. had already arrived on the 24th December and one scientist from the cooperative partner institute of IFM-GEOMAR in Peru, the IMARPE in Callao also arrived on the 26th December. The air freight had arrived almost completely and the containers were already on board so that unpacking and moving of equipment into the laboratories started immediately. Meteor left at 3:00 UTC on the 27th December to remain at anchor near the harbor of Guayaquil for another 6 hours in order to finalize the installation and testing of the PUMP-CTD of the MPI-Bremen. At 8:00 this work was finished and the technician from IOW in Warnemünde left with the customs boat.

The ship then steamed towards the endpoint of the first planned section at 10°S, 78°23’W. On the way to this station there were 3 stops (4°S, 6°S, and 8°S) to deploy the first 6 CTD casts for the collection of the water samples using the Niskin bottles

attached to the CTD-rosette and GO-FLO bottles on separate plastic-coated wire for trace metal clean sampling. The ship arrived at the endpoint of the first transect at 10°S, 78°23'W on the shelf at 7 a.m. on the 30th December, where during the following almost 24 hours a detailed sampling of the water column was undertaken using CTD rosette, PUMP-CTD and GO-FLO, as well as in situ pumps and plankton nets for the particulate fraction. On this and the following PUMP-CTD stations, which lasted between 6 and 9 hours each, the microbiologists collected a large amount of water samples to carry out incubation experiments to investigate the nitrogen cycle (nitrogen loss and nitrogen fixation). The GO-FLO casts on that day served to collect trace metal clean samples to measure the diurnal cycle of the concentrations of reduced Fe as a function of the availability of hydrogen peroxide. In addition, the on board mesocosms of the plankton biologists were for the first time filled with 900 litres of surface water from the CTD rosette to conduct cultivation experiments with different N:P ratios. On 31st December we then continued to sample 5 more stations along 10°S with a 10 nm spacing down the continental slope (Fig. 1) using CTD rosettes and 1 PUMP-CTD until a water depth of 350 m was reached. Between 21:00 on 31st December and 13:40 on the 1st of January a detailed profile of the surface water parameters was taken with the ship's CTD system and the 75 kHz ADCP in order to investigate the highly variable surface current system in this region. The section at 10°S was then continued with further 5 stations at a spacing between 20 and 90 nm until the endpoint was reached at 84°W and a water depth of 4540 m at 1:00 on 4th January (Fig. 1). Altogether 11 stations were sampled on this section including 19 CTD casts, 4 PUMP-CTD casts, 9 GO-FLO casts, 6 in situ pumps, and 7 plankton nets. There were electric problems with the cables on winches 2 and 3, which required two 3 hour test stations on 3rd and 4th January.

At 19:30 on January 5th the second section at 12°02'S started at the outermost station at 82°W. The section was continued at 12°02'S with a spacing of 30 to 90 nm until 77°47'W was reached at a water depth of 350 m (Fig. 1). Due to the minimum 5 nm distance from the coast, the section was continued from there to 12°22'S, 77°W with a closer spacing of stations of about 10 nm. The end point of the section was reached on 10th January at 3:20. Altogether 13 stations were sampled on this section including 25 CTD casts, 4 PUMP-CTD casts, 4 GO-FLO casts, 3 in situ pumps, and 5 plankton nets. For the second mesocosm experiment of the plankton biologists 900 litres of surface water from the CTD rosette were provided on the 8th January and the GO-FLOs were used to collect samples for a second set of measurements of the diurnal cycle of reduced Fe/hydrogen on that day. In addition, the towed fish was used to provide clean water for the incubation experiments of the microbiologists and one further test of the cable on winch 2 was conducted.

On the transit to the section at 16°S a glider was successfully deployed and tested at 13°40'S, 77°W between 13:30 and 18:30 on the 10th January. The glider successfully operated in autonomous mode from deployment until pick up on the following 4th leg of M77.

Work on the third section at 16°S started at 78°W on January 11th and continued until 17:00 on January 15th. The mesocosm experiments were filled with 900 litres of water for the third set of experiments on 14th January. Similar spacing of the stations on the shelf and in the open ocean as on the previous two sections resulted in 16 stations on this section (Fig. 1). 4 additional CTD casts and a plankton net on this transect were carried out to sample the water column and the plankton in a bloom of ciliates that the ship met on 11th January at 16°S, 77°40'W. In total 19 CTD casts, 3 PUMP-CTD casts, 5 GO-FLO casts, 3 in situ pumps, and 10 plankton nets were operated on the 16°S section. Two more cable tests revealed that the relatively new cable on winch 2 was broken and therefore it was suggested that the cable should be replaced by a new one in Callao in order to guarantee operations for the following 4th leg.

The ship then steamed south to the starting point of the fourth shorter section at 17°13.3'S, 72°W. On the transit three additional CTD casts and 2 plankton nets were operated to sample the narrow shelf. The section work started at 18:00 on 16th January and continued to the end point of the section at 18°S, 73°25'W at 19:00 on the 17th January. On this section 6 stations including 6 CTD casts, 1 PUMP-CTD, 3 plankton nets and 3 GO-FLO profiles were operated. The ship then steamed back to the coast in northeasterly direction to re-occupy a previous station with the PUMP-CTD but it turned out that an intrusion of open Pacific waters had completely removed all previously observed patterns including a deep chlorophyll maximum. The ship then steamed back in the direction of Callao to investigate the deep chlorophyll maximum observed by the glider at ~14°N with 2 PUMP-CTD and 2 in situ pump stations, which was carried out between 17:00 on 19th January and 23:00 on the 20th January. These casts were bracketed by a set of GO-FLO casts to collect samples for a third set of measurements of the diurnal cycle of reduced Fe/hydrogen. On the way back to shelf it was found that large areas of the water column contained H_2S and it was decided to spend the rest of the available station time for a detailed mapping of the H_2S occurrence on the shelf between 13°30'S and 12°20'S, which was done by 15 more shallow CTD stations and 2 more PUMP CTD stations between the 10:00 on the 21st January and 18:00 on the 22nd January.

The ship reached the harbor of Callao on January 23rd in the afternoon (local time) and the cruise ended with the disembarking of the scientists between late afternoon and evening of the 24th of January. However, several scientists of M77/3 were still active with organizing the shipment of frozen samples through harbour authorities, customs and airport authorities until the evening of the 26th January.

3. Participants METEOR 77 Leg 3, scientific party

Name	Expertise	Institution
1. Frank, Martin	*Chief scientist*	IFM-GEOMAR
2. Baars, Oliver	*Trace metals*	IFM-GEOMAR
3. Behrens, Erik	*CTD-ADCP watch*	IFM-GEOMAR
4. Contreras Quintana, Sergio	*Nitrogen loss*	MPI-Bremen
5. Dammshäuser, Anna	*Trace metals*	IFM-GEOMAR
6. Ellrott, Andreas	*Pump-CTD operator*	MPI-Bremen
7. Franz, Jasmin	*POM/DOM, HPLC/pelagic comm.*	IFM-GEOMAR
8. Friederich, Gernot	*pCO_2/tCO_2*	MBARI
9. Fritsche, Peter	*Nutrients*	IFM-GEOMAR
10. Grasse, Patricia	*Si/Nd isotopes*	IFM-GEOMAR
11. Großkopf, Tobias	*Nitrogen fixation*	IFM-GEOMAR
12. Hauss, Helena	*Pelagic communities*	IFM-GEOMAR
13. Kalvelage, Tim	*Nitrogen loss*	MPI-Bremen
14. Klockgether, Gabriele	O_2, nutrients	MPI-Bremen
15. Krahmann, Gerd	*Glider, CTD*	IFM-GEOMAR
16. LaRoche, Julie	*Nitrogen fixation*	IFM-GEOMAR
17. Lavik, Gaute	*Nitrogen loss*	MPI-Bremen
18. Leon, Violeta	*O_2, chlorophyll, productivity*	IMARPE
19. Link, Rudolf	*CTD technics*	IFM-GEOMAR
20. Löscher, Carolin	*Nitrogen Fixation, N_2O*	IFM-GEOMAR
21. Nunes, Nuno	*CTD-ADCP watch*	IFM-GEOMAR
22. Paulmier, Aurelien	*Nitrogen loss*	MPI-Bremen
23. Schlosser, Christian	*Trace metals*	IFM-GEOMAR
24. Schunck, Harald	*Nitrogen Fixation*	IFM-GEOMAR
25. Schwarzkopf, Franziska	*CTD-ADCP watch*	IFM-GEOMAR
26. Sommer Ulrich	*Pelagic communities*	IFM-GEOMAR
27. Stumpf, Roland	*Si/Nd isotopes*	IFM-GEOMAR
28. Vogt, Martin	*CTD-ADCP watch*	IFM-GEOMAR
29. Sonnabend, Hartmut	*Meteorology*	DWD
30. Ochsenhirt, Wolf	*Meteorology*	DWD

4. Participating Institutions

DWD
Deutscher Wetterdienst
Bernhard-Nocht-Straße 76
20359 Hamburg , Germany
www.dwd.de

IFM-GEOMAR
Leibniz-Institut für Meereswissenschaften
an der Universität Kiel
Wischhofstr. 1-3
24148 Kiel, Germany
www.ifm-geomar.de

IMARPE
Instituto del Mar del Peru
Esquina Gamarra y General Valle s/n
Chucuito – Callao, Peru
www.imarpe.gop.de

MPI-Bremen
Max-Planck Institut für Marine Mikrobiologie
Celsiusstraße 1
28199 Bremen
www.mpi-bremen.de

MBARI
Monterey Bay Aquarium Research Institute
7700 Sandholdt Rd.
Moss Landing, CA 95039, U.S.A.
www.mbari.org

5. Station list

Gear acronyms in the Station list:

CTD/RO	CTD-Rosette water sampler
PCTD/RO	Pump-CTD-Rosette water sampler
GO-FLO	GO-FLO water sampler
IFISH	Towed Fish surface water sampler
ISP	In-situ pumping system
WP-2	Plankton net
GLIDER	Autonomous glider

Station No.	Gear No.	Date 2008/09	Position start Lat. [°S]	Long. [°W]	Time [UTC]	Depth [m]	Position end Lat. [°S]	Long. [°W]	Time [UTC]	Depth [m]
804-1	CTD/RO-1	28.12.	3°59,98'	81°23,52'	09:05	1079	4°00,02'	81°23,48'	10:07	1081
804-2	CTD/RO-2	28.12.	4°00,00'	81°23,48'	11:00	1082	4°00,02'	81°23,48'	11:26	1085
805-1	CTD/RO-3	28.12.	6°00,01'	81°21,70'	22:35	1001	6°00,02'	81°21,67'	22:41	998
805-2	CTD/RO-4	28.12.	6°00,01'	81°21,67'	23:09	999	6°00,01'	81°21,67'	23:58	999
805-3	CTD/RO-5	29.12.	6°00,01'	81°21,67'	00:57	995	6°00,01'	81°21,67'	01:52	989
805-4	GO-FLO-0	29.12.	6°00,01'	81°21,67'	02:13	992	6°00,01'	81°21,67'	03:08	991
806-1	CTD/RO-6	29.12.	8°00,02'	79°50,70'	17:06	138	8°00,03'	79°50,69'	17:23	137
806-2	IFISH-1	29.12.	8°00,07'	79°50,67'	17:32	138	8°00,25'	79°46,68'	18:04	130
807-1	CTD/RO-7	30.12.	10°00,00'	78°22,89'	07:02	110	10°00,01'	78°22,85'	07:16	113
807-2	GO-FLO-1	30.12.	10°00,01'	78°22,82'	08:04	111	10°00,01'	78°22,82'	08:36	112
807-3	PCTD/RO-1	30.12.	10°00,01'	78°22,82'	09:24	111	10°00,01'	78°22,82'	17:01	111
807-4	GO-FLO-2	30.12.	10°00,05'	78°22,82'	17:16	111	10°00,06'	78°22,82'	17:40	110
807-5	CTD/RO-8	30.12.	10°00,06'	78°22,82'	17:51	111	10°00,05'	78°22,82'	18:07	111
807-6	CTD/RO-9	30.12.	10°00,05'	78°22,82'	18:22	111	10°00,05'	78°22,82'	18:27	111
807-7	CTD/RO-10	30.12.	10°00,06'	78°22,82'	18:42	111	10°00,05'	78°22,82'	18:47	111
807-8	CTD/RO-11	30.12.	10°00,05'	78°22,82'	18:58	112	10°00,05'	78°22,82'	19:03	111
807-9	CTD/RO-12	30.12.	10°00,05'	78°22,82'	19:15	111	10°00,05'	78°22,82'	19:19	111
807-10	WP2-1	30.12.	10°00,05'	78°22,82'	19:48	111	10°00,05'	78°22,82'	19:58	111
807-11	GO-FLO-3	30.12.	10°00,05'	78°22,82'	20:08	111	10°00,05'	78°22,82'	20:36	112
807-12	ISP-1	30.12.	10°00,05'	78°22,82'	20:52	111	10°00,05'	78°22,82'	23:37	112
807-13	GO-FLO-4	30.12.	10°00,05'	78°22,82'	23:45	112	10°00,05'	78°22,82'	00:10	111
807-14	ISP-2	31.12.	10°00,05'	78°22,82'	00:55	112	10°00,05'	78°22,82'	03:40	112
807-15	GO-FLO-5	31.12.	10°00,05'	78°22,82'	03:44	112	10°00,05'	78°22,82'	04:13	112
807-16	WP2-2	31.12.	10°00,05'	78°22,82'	04:20	111	10°00,07'	78°22,81'	04:39	111
808-1	CTD/RO-13	31.12.	10°00,00'	78°29,94'	05:33	147	10°00,0'	78°29,90'	05:51	148
809-1	CTD/RO-14	31.12.	10°00,01'	78°37,98'	06:45	149	10°00,00'	78°37,98'	08:19	149
810-1	CTD/RO-15	31.12.	9°59,98'	78°48,03'	09:36	151	9°59,97'	78°48,02'	09:52	147
811-1	CTD/RO-16	31.12.	9°59,99'	78°58,01'	11:56	138	10°00,01'	78°58,00'	12:14	139
811-2	PCTD/RO-2	31.12.	10°00,01'	78°58,00'	13:30	138	10°00,01'	78°58,00'	19:08	138
811-3	CTD/RO-17	31.12.	10°00,02'	78°58,00'	19:23	138	10°00,01'	78°57,98'	19:37	137
812-1	CTD/RO-18	31.12.	9°59,98'	79°08,00'	20:40	331	9°59,98'	79°08,00'	21:13	333
001-1	GO-FLO-6	01.01.	9°59,99'	79°28,01'	13:40	1659	10°00,01'	79°28,00'	14:21	1657
001-2	CTD/RO-19	01.01.	10°00,01'	79°28,00'	14:27	1662	10°00,01'	79°28,00'	16:23	1657
001-3	GO-FLO-7	01.01.	10°00,01'	79°28,00'	16:31	1668	10°00,01'	79°28,00'	17:36	1661
001-4	WP2-3	01.01.	10°00,01'	79°28,00'	17:42	1655	10°00,01'	79°28,00'	17:50	1669
001-5	WP2-4	01.01.	10°00,01'	79°28,00'	18:00	1658	10°00,01'	79°28,01'	18:10	1662
002-1	CTD/RO-20	02.01.	9°55,31'	80°13,44'	01:44	6296	9°55,31'	80°13,44'	03:08	6317
002-2	CTD/RO-21	02.01.	9°55,31'	80°13,44'	03:30	6296	9°55,31'	80°13,44'	03:44	6303
003-1	CTD/RO-22	02.01.	10°00,03'	81°30,10'	10:53	4713	10°00,03'	81°30,10'	12:02	4708
003-2	ISP-3	02.01.	10°00,02'	81°30,01'	13:18	4714	10°00,00'	81°30,00'	18:04	4695

Station No.	Gear No.	Date 2008/09	Position start Lat. [°S]	Long. [°W]	Time [UTC]	Depth [m]	Position end Lat. [°S]	Long. [°W]	Time [UTC]	Depth [m]
003-3	WP2-5	02.01.	10°00,00'	81°30,00'	18:10	4695	10°00,00'	81°30,00'	18:16	4695
003-4	WP2-6	02.01.	10°00,00'	81°30,00'	18:22	4695	10°00,07'	81°30,06'	18:32	4713
003-5	PCTD/RO-3	02.01.	10°00,10'	81°30,12'	18:50	4695	10°00,13'	81°30,14'	01:57	4698
003-6	ISP-4	03.01.	10°00,13'	81°30,14'	05:42	4697	10°00,13'	81°30,14'	10:11	4697
003-7	ISP-5	03.01.	10°00,06'	81°30,50'	13:14	4716	10°00,06'	81°30,50'	16:45	4697
003-8	ISP-6	03.01.	10°00,06'	81°30,50'	17:14	4696	10°00,06'	81°30,51'	21:00	4699
004-1	CTD/RO-23	04.01.	9°59,99'	82°29,99'	02:27	4444	10°00,00'	82°30,00'	04:19	4438
004-2	CTD/RO-24	04.01.	10°00,00'	82°30,00'	04:49	4453	10°00,00'	82°30,01'	05:08	4451
005-1	GO-FLO-8	04.01.	10°00,01'	84°00,01'	13:00	4523	10°00,01'	84°00,01'	14:08	4534
005-2	CTD/RO-25	04.01.	10°00,01'	84°00,01'	14:11	4537	10°00,01'	84°00,01'	15:36	4537
005-3	GO-FLO-9	04.01.	10°00,01'	84°00,01'	15:53	4532	10°00,01'	84°00,01'	16:33	4538
005-4	WP2-7	04.01.	10°00,01'	84°00,01'	16:43	4530	10°00,03'	83°59,99'	16:50	4527
005-5	WP2-8	04.01.	10°00,02'	84°00,00'	16:55	4531	10°00,05'	83°59,99'	17:03	4528
005-6	PCTD/RO-4	04.01.	10°00,03'	84°00,01'	17:22	4521	10°00,03'	84°00,01'	22:38	4529
006-1	CTD/RO-26	05.01.	10°07,53	83°52,83	00:00	4550	10°07,53	83°52,83	03:40	4550
007-1	WP2-9	05.01.	12°01,95'	82°00,01'	19:32	4744	12°01,94'	82°00,01'	19:38	4752
007-2	GO-FLO-10	05.01.	12°01,98'	81°59,97'	19:48	4751	12°01,98'	81°59,99'	21:10	4760
007-3	CTD/RO-27	05.01.	12°01,98'	81°59,99'	21:15	4749	12°01,98'	81°59,99'	22:36	4749
007-4	GO-FLO-11	05.01.	12°01,98'	81°59,99'	23:30	4748	12°01,98'	81°59,99'	00:15	4746
007-5	IFISH-2	06.01.	12°02,67'	81°59,98'	00:35	4750	12°01,97'	80°56,80'	08:56	4687
008-1	CTD/RO-28	06.01.	12°01,97'	80°56,80'	09:00	4683	12°02,00'	80°56,79'	10:29	4683
008-2	CTD/RO-29	06.01.	12°02,00'	80°56,79'	10:55	4677	12°02,00'	80°56,80'	11:15	4685
008-3	ISP-7	06.01.	12°02,00'	80°56,80'	11:51	4679	12°02,00'	80°56,80'	14:02	4684
008-4	WP2-10	06.01.	12°02,00'	80°56,80'	14:13	4679	12°02,00'	80°56,80'	14:22	4679
008-5	WP2-11	06.01.	12°02,00'	80°56,79'	14:25	4687	12°02,00'	80°56,80'	14:33	4678
008-6	PCTD/RO-5	06.01.	12°02,00'	80°56,80'	15:10	4677	12°02,00'	80°56,80'	20:52	4679
009-1	CTD/RO-30	07.01.	12°02,00'	80°00,00'	02:00	4765	12°02,00'	80°00,00'	03:40	4756
010-1	CTD/RO-31	07.01.	12°07,02'	78°54,02'	10:00	6030	12°07,00'	78°54,00'	11:22	6029
010-2	CTD/RO-32	07.01.	12°07,00'	78°54,00'	12:00	6038	12°07,00'	78°54,00'	13:12	6029
010-3	WP2-12	07.01.	12°07,00'	78°54,00'	13:17	6033	12°07,00'	78°54,01'	13:23	6033
010-4	WP2-13	07.01.	12°07,00'	78°54,01'	13:30	6037	12°07,00'	78°54,02'	13:36	6026
010-5	CTD/RO-33	07.01.	12°07,00'	78°54,01'	13:51	6035	12°07,00'	78°54,00'	18:08	6032
011-1	GO-FLO-12	08.01.	12°02,00'	78°00,00'	00:55	1768	12°02,00'	78°00,00'	02:11	1766
011-2	CTD/RO-34	08.01.	12°02,00'	78°00,00'	02:18	1766	12°02,00'	78°00,01'	03:39	1768
011-3	GO-FLO-13	08.01.	12°02,00'	78°00,01'	03:46	1767	12°02,00'	78°00,00'	04:24	1765
011-4	CTD/RO-35	08.01.	12°02,00'	78°00,01'	04:28	1764	12°02,01'	78°00,00'	05:47	1761
012-1	CTD/RO-36	08.01.	12°02,04'	77°48,91'	07:14	734	12°02,02'	77°48,93'	08:00	724
013-1	CTD/RO-37	08.01.	12°02,03'	77°47,34'	08:34	355	12°02,03'	77°47,34'	09:11	352
013-2	PCTD/RO-6	08.01.	12°02,03'	77°47,34'	10:25	354	12°02,05'	77°47,34'	16:40	352
013-3	CTD/RO-38	08.01.	12°02,05'	77°47,33'	16:58	350	12°02,06'	77°47,34'	17:32	353

Station No.	Gear No.	Date 2008/09	Position start Lat. [°S]	Long. [°W]	Time [UTC]	Depth [m]	Position end Lat. [°S]	Long. [°W]	Time [UTC]	Depth [m]
013-4	WP2-14	08.01.	12°02,06'	77°47,34'	17:40	353	12°02,06'	77°47,34'	17:48	354
013-5	WP2-15	08.01.	12°02,06'	77°47,34'	17:52	354	12°02,06'	77°47,33'	17:58	352
013-6	CTD/RO-39	08.01.	12°02,06'	77°47,33'	18:06	351	12°02,05'	77°47,33'	18:12	351
013-7	CTD/RO-40	08.01.	12°02,05'	77°47,33'	18:26	351	12°02,05'	77°47,33'	18:30	349
013-8	CTD/RO-41	08.01.	12°02,06'	77°47,33'	18:42	351	12°02,06'	77°47,33'	18:48	352
013-9	CTD/RO-42	08.01.	12°02,06'	77°47,33'	18:58	350	12°02,06'	77°47,33'	19:03	350
013-10	CTD/RO-43	08.01.	12°02,06'	77°47,33'	20:13	352	12°02,06'	77°47,33'	20:38	352
013-11	CTD/RO-44	08.01.	12°02,05'	77°47,33'	23:22	353	12°02,06'	77°47,33'	00:00	351
013-12	PCTD/RO-7	09.01.	12°02,06'	77°47,32'	00:29	350	12°02,05'	77°47,32'	02:15	351
013-13	ISP-8	09.01.	12°02,06'	77°47,33'	03:00	350	12°02,09'	77°47,32'	05:15	354
013-14	ISP-9	09.01.	12°02,09'	77°47,32'	06:26	354	12°02,14'	77°47,32'	10:00	355
014-1	CTD/RO-45	09.01.	12°05,28'	77°40,22'	11:00	424	12°05,27'	77°40,23'	11:15	417
015-1	CTD/RO-46	09.01.	12°07,82'	77°33,93'	12:16	166	12°07,84'	77°33,92'	12:35	165
016-1	CTD/RO-47	09.01.	12°10,40'	77°27,68'	13:28	152	12°10,40'	77°27,66'	13:47	151
017-1	CTD/RO-48	09.01.	12°12,93'	77°21,35'	14:43	132	12°12,94'	77°21,34'	15:03	132
018-1	CTD/RO-49	09.01.	12°18,16'	77°08,75'	16:30	100	12°18,16'	77°08,75'	16:51	100
019-1	CTD/RO-50	09.01.	12°21,76'	77°00,09'	18:02	100	12°21,79'	77°00,05'	18:20	101
019-2	WP2-16	09.01.	12°21,80'	77°00,06'	18:30	99	12°21,80'	77°00,05'	18:38	100
019-3	PCTD/RO-8	09.01.	12°21,81'	77°00,01'	21:05	100	12°21,81'	77°00,01'	02:53	100
019-4	CTD/RO-51	10.01.	12°21,81'	77°00,01'	03:02	101	12°21,81'	77°00,01'	03:17	100
020-1	GLIDER-1	10.01.	13°39,95'	77°00,04'	13:34	879	13°41,02'	77°01,14'	18:30	1294
020-2	CTD/RO-52	10.01.	13°40,50'	77°00,91'	15:50	1008	13°40,50'	77°00,91'	16:30	1008
021-1	CTD/RO-53	10.01.	13°39,97'	76°47,09'	20:06	337	13°40,00'	76°47,10'	20:38	337
021-2	WP2-17	10.01.	13°40,00'	76°47,10'	20:42	338	13°40,00'	76°47,10'	20:50	339
021-3	WP2-18	10.01.	13°40,00'	76°47,10'	21:00	339	13°40,00'	76°47,10'	21:08	339
022-1	CTD/RO-54	10.01.	13°39,99'	76°30,81'	22:58	128	13°40,00'	76°30,80'	23:27	131
023-1	WP2-19	11.01.	15°59,98'	78°00,00'	15:30	3425	15°59,90'	78°00,04'	15:48	3437
023-2	CTD/RO-55	11.01.	16°00,00'	78°00,04'	16:20	3420	15°59,90'	78°00,04'	17:43	3445
024-1	CTD/RO-56	11.01.	16°00,28'	77°39,85'	19:47	2868	16°00,27'	77°39,84'	19:52	2868
025-1	CTD/RO-57	11.01.	16°00,04'	77°40,16'	20:35	2907	15°59,98'	77°40,15'	20:54	2905
025-2	WP2-20	11.01.	16°00,14'	77°40,16'	21:14	2893	16°00,12'	77°40,17'	21:17	2908
026-1	CTD/RO-58	11.01.	16°01,14'	77°42,60'	21:47	2822	16°01,17'	77°42,57'	22:06	2832
027-1	CTD/RO-59	11.01.	15°59,00'	77°38,23'	22:57	2628	15°59,00'	77°38,23'	23:17	2612
028-1	GO-FLO-14	12.01.	15°59,99'	77°00,02'	02:47	2362	16°00,09'	76°59,72'	04:03	2349
028-2	CTD/RO-60	12.01.	15°59,96'	76°59,95'	04:16	2354	15°59,96'	76°59,93'	05:42	2357
028-3	GO-FLO-15	12.01.	15°59,96'	76°59,93'	05:48	2353	16°00,00'	76°59,84'	06:58	2348
028-4	PCTD/RO-9	12.01.	16°00,00'	76°59,84'	07:30	2352	16°00,00'	76°59,84'	13:55	2351
028-5	CTD/RO-61	12.01.	16°00,00'	76°59,84'	14:06	2353	16°00,00'	77°00,00'	16:05	2359
028-6	ISP-10	12.01.	16°00,00'	77°00,00'	16:13	2359	16°00,00'	77°00,00'	20:16	2365
028-7	WP2-21	12.01.	16°00,00'	77°00,00'	20:19	2361	16°00,00'	77°00,00'	20:25	2360

Station No.	Gear No.	Date 2008/09	Position start Lat. [°S]	Long. [°W]	Time [UTC]	Depth [m]	Position end Lat. [°S]	Long. [°W]	Time [UTC]	Depth [m]
028-8	WP2-22	12.01.	16°00,00'	77°00,00'	20:27	2357	16°00,00'	77°00,00'	20:34	2359
028-9	ISP-11	12.01.	16°00,00'	77°00,00'	20:44	2357	16°00,00'	77°00,00'	00:37	2359
029-1	CTD/RO-62	13.01.	15°59,95'	76°16,05'	07:32	3315	15°59,96'	76°16,08'	08:57	3313
030-1	CTD/RO-63	13.01.	16°00,00'	75°33,00'	13:01	6164	16°00,00'	75°33,00'	14:26	6169
030-2	CTD/RO-64	13.01.	16°00,00'	75°33,00'	15:13	6165	16°00,00'	75°33,00'	16:45	6164
030-3	CTD/RO-65	13.01.	16°00,00'	75°33,00'	17:18	6166	16°00,00'	75°33,00'	21:13	6166
030-4	WP2-23	13.01.	16°00,00'	75°33,00'	21:19	6161	16°00,00'	75°32,99'	21:27	6159
030-5	WP2-24	13.01.	16°00,00'	75°32,99'	21:30	6167	15°59,99'	75°32,96'	21:35	6168
030-6	CTD/RO-66	13.01.	15°59,98'	75°32,93'	21:52	6166	15°59,95'	75°32,93'	22:15	6162
031-1	CTD/RO-67	14.01.	16°00,00'	74°36,64'	04:07	1501	16°00,06'	74°36,55'	05:19	1462
032-1	CTD/RO-68	14.01.	15°59,96'	74°20,92'	06:51	706	15°59,98'	74°20,93'	07:53	706
033-1	CTD/RO-69	14.01.	15°59,92'	74°14,69'	08:54	250	15°59,92'	74°14,69'	09:22	250
033-2	CTD/RO-70	14.01.	15°59,92'	74°14,69'	09:43	253	15°59,92'	74°14,69'	10:10	249
033-3	GO-FLO-16	14.01.	15°59,92'	74°14,69'	10:30	250	15°59,92'	74°14,69'	11:13	249
034-1	CTD/RO-71	14.01.	16°00,01'	74°10,97'	11:49	116	16°00,01'	74°10,97'	12:03	116
034-2	WP2-25	14.01.	16°00,01'	74°10,97'	12:08	116	16°00,01'	74°10,97'	12:14	116
034-3	WP2-26	14.01.	16°00,01'	74°10,97'	12:19	116	16°00,01'	74°10,97'	12:26	116
035-1	RO-1	14.01.	16°00,01'	74°37,04'	14:45	1622	16°00,01'	74°37,04'	14:49	1624
035-2	RO-2	14.01.	16°00,01'	74°37,04'	15:01	1622	16°00,01'	74°37,04'	15:05	1624
035-3	RO-3	14.01.	16°00,01'	74°37,04'	15:14	1622	16°00,01'	74°37,04'	15:18	1624
035-4	RO-4	14.01.	16°00,01'	74°37,04'	15:28	1622	16°00,01'	74°37,04'	15:32	1624
036-1	CTD/RO-72	14.01.	16°00,02'	74°59,95'	18:40	2801	16°00,03'	74°59,98'	19:40	2856
036-2	PCTD/RO-10	14.01.	16°00,01'	75°00,00'	20:10	2835	16°00,01'	75°00,00'	02:04	2845
036-3	GO-FLO-17	15.01.	16°00,01'	75°00,00'	02:24	2854	16°00,05'	74°59,83'	03:08	2780
037-1	ISP-12	15.01.	16°00,02'	74°11,00'	08:01	116	16°00,02'	74°10,99'	11:11	115
037-2	CTD/RO-73	15.01.	16°00,02'	74°11,00'	11:27	115	16°00,01'	74°11,00'	11:41	118
038-1	PCTD/RO-11	15.01.	16°00,00'	74°14,70'	13:01	252	16°00,00'	74°14,70'	16:17	252
038-2	WP2-27	15.01.	16°00,00'	74°14,70'	16:30	254	16°00,00'	74°14,69'	16:37	250
038-3	WP2-28	15.01.	16°00,00'	74°14,69'	16:38	250	16°00,00'	74°14,67'	16:46	246
039-1	CTD/RO-74	16.01.	16°43,58'	72°47,53'	10:37	135	16°43,59'	72°47,50'	10:47	127
040-1	CTD/RO-75	16.01.	16°46,30'	72°49,17'	11:24	121	16°46,38'	72°49,14'	11:38	122
041-1	CTD/RO-76	16.01.	16°49,14'	72°50,49'	12:13	255	16°49,21'	72°50,34'	12:40	251
041-2	WP2-29	16.01.	16°49,21'	72°50,34'	12:49	251	16°49,21'	72°50,34'	12:56	254
041-3	WP2-30	16.01.	16°49,21'	72°50,34'	12:58	253	16°49,21'	72°50,34'	13:03	248
042-1	CTD/RO-77	16.01.	17°13,36'	72°00,08'	18:02	163	17°13,36'	72°00,10'	18:20	165
043-1	CTD/RO-78	16.01.	17°17,71'	71°54,21'	19:30	121	17°17,71'	71°54,21'	19:44	121
044-1	CTD/RO-79	16.01.	17°20,69'	71°56,39'	20:24	277	17°20,71'	71°56,42'	20:50	284
044-2	WP2-31	16.01.	17°20,71'	71°56,42'	20:54	280	17°20,71'	71°56,42'	21:00	281
044-3	PCTD/RO-12	16.01.	17°20,71'	71°56,42'	22:05	284	17°20,71'	71°56,39'	02:05	256
045-1	CTD/RO-80	17.01.	17°31,51'	72°19,15'	05:10	1546	17°31,52'	72°19,15'	06:21	1548

Station No.	Gear No.	Date 2008/09	Position start Lat. [°S]	Long. [°W]	Time [UTC]	Depth [m]	Position end Lat. [°S]	Long. [°W]	Time [UTC]	Depth [m]
046-1	CTD/RO-81	17.01.	17°41,98'	72°41,98'	08:48	3231	17°41,98'	72°41,99'	10:13	3240
046-2	IFISH-3	17.01.	17°42,61'	72°42,35'	10:30	3790	17°59,94'	73°24,89'	15:05	4850
047-1	GO-FLO-18	17.01.	18°00,00'	73°25,01'	15:16	4841	18°00,00'	73°25,01'	16:32	4841
047-2	CTD/RO-82	17.01.	18°00,00'	73°25,01'	16:34	4836	18°00,00'	73°25,01'	17:58	4842
047-3	GO-FLO-19	17.01.	18°00,00'	73°25,01'	18:08	4851	18°00,00'	73°25,01'	18:44	4841
047-4	WP2-32	17.01.	18°00,00'	73°25,01'	18:50	4839	18°00,00'	73°25,01'	18:56	4837
047-5	WP2-33	17.01.	18°00,00'	73°25,01'	18:58	4841	18°00,00'	73°25,01'	19:05	4840
048-1	CTD/RO-83	18.01.	16°49,04'	72°50,55'	10:00	257	16°49,03'	72°50,55'	10:18	254
049-1	CTD/RO-84	18.01.	16°46,30'	72°49,00'	11:26	119	16°46,30'	72°48,98'	11:39	119
050-1	WP2-34	18.01.	16°09,32'	74°08,04'	19:08	766	16°09,31'	74°08,04'	19:13	765
051-1	CTD/RO-85	19.01.	14°34,97'	76°06,04'	07:39	137	14°34,95'	76°06,01'	07:54	129.0
052-1	CTD/RO-86	19.01.	14°29,26'	76°20,58'	09:30	247	14°29,26'	76°20,59'	09:56	248
053-1	CTD/RO-87	19.01.	13°45,01'	77°20,04'	17:20	3389	13°45,02'	77°20,05'	17:45	3390
053-2	WP2-35	19.01.	13°45,01'	77°20,03'	17:52	3399	13°45,02'	77°20,06'	18:00	3390
053-3	WP2-36	19.01.	13°45,02'	77°20,05'	18:08	3387	13°45,02'	77°20,07'	18:14	3390
054-1	CTD/RO-88	19.01.	13°45,10'	77°02,05'	20:03	1890	13°45,11'	77°02,05'	20:30	1896
054-2	PCTD/RO-13	19.01.	13°45,10'	77°02,05'	21:18	1892	13°45,10'	77°02,05'	02:25	1888
054-3	CTD/RO-89	20.01.	13°45,10'	77°02,05'	02:32	1888	13°45,10'	77°02,05'	02:54	1889
055-1	CTD/RO-90	20.01.	13°45,00'	77°25,34'	05:15	3967	13°45,01'	77°25,35'	07:46	3966
056-1	CTD/RO-91	20.01.	13°45,03'	77°02,02'	10:06	1886	13°45,00'	77°02,00'	10:19	1887
056-2	ISP-13	20.01.	13°45,00'	77°02,00'	10:43	1894	13°44,99'	77°01,97'	14:17	1878
056-3	CTD/RO-92	20.01.	13°44,99'	77°01,96'	14:22	1884	13°44,99'	77°01,97'	14:44	1877
056-4	CTD/RO-93	20.01.	13°44,99'	77°01,97'	15:04	1877	13°44,99'	77°01,97'	16:07	1879
056-5	PCTD/RO-14	20.01.	13°44,99'	77°01,97'	16:28	1877	13°44,99'	77°01,97'	18:46	1877
056-6	CTD/RO-94	20.01.	13°44,99'	77°01,97'	19:02	1881	13°44,99'	77°01,97'	19:20	1878
056-7	WP2-37	20.01.	13°44,99'	77°01,96'	19:26	1876	13°44,99'	77°01,96'	19:34	1877
056-8	WP2-38	20.01.	13°44,99'	77°01,95'	19:38	1876	13°44,99'	77°01,94'	19:46	1877
056-9	ISP-14	20.01.	13°45,00'	77°01,95'	20:30	1874	13°45,01'	77°01,95'	23:40	1878
057-1	CTD/RO-95	21.01.	13°20,99'	77°35,02'	03:25	3071	13°20,99'	77°35,02'	04:47	3070
058-1	CTD/RO-96	21.01.	13°20,97'	77°00,05'	07:52	1165	13°21,00'	77°00,02'	08:50	1175
059-1	CTD/RO-97	21.01.	13°20,77'	76°48,36'	10:29	250	13°20,77'	76°48,37'	10:54	250
060-1	CTD/RO-98	21.01.	13°20,99'	76°34,00'	12:24	121	13°20,99'	76°34,00'	12:38	121
061-1	CTD/RO-99	21.01.	13°21,01'	76°23,38'	13:59	164	13°21,01'	76°23,38'	14:12	154
061-2	WP2-39	21.01.	13°21,01'	76°23,38'	14:14	159	13°21,01'	76°23,37'	14:20	162
061-3	WP2-40	21.01.	13°21,01'	76°23,37'	14:24	162	13°21,01'	76°23,37'	14:30	161
062-1	PCTD/RO-15	21.01.	13°21,00'	76°44,89'	17:04	160	13°21,00'	76°44,90'	21:28	160
063-1	CTD/RO-100	21.01.	13°29,98'	76°34,01'	23:16	127	13°29,98'	76°34,01'	23:31	127
064-1	CTD/RO-101	22.01.	13°29,98'	76°27,51'	00:21	107	13°29,98'	76°27,50'	00:34	108
065-1	PCTD/RO-16	22.01.	13°20,99'	76°30,00'	01:43	108	13°21,00'	76°30,00'	04:43	110
066-1	CTD/RO-102	22.01.	13°09,96'	76°31,03'	06:03	96	13°09,98'	76°31,00'	06:16	93

Station No.	Gear No.	Date 2008/09	Position start Lat. [°S]	Long. [°W]	Time [UTC]	Depth [m]	Position end Lat. [°S]	Long. [°W]	Time [UTC]	Depth [m]
067-1	CTD/RO-103	22.01.	13°09,99'	76°35,99'	06:51	114	13°10,00'	76°36,00'	07:04	115
068-1	CTD/RO-104	22.01.	13°09,99'	76°42,02'	07:46	129	13°09,98'	76°42,00'	07:58	130
069-1	CTD/RO-105	22.01.	13°00,04'	76°44,02'	09:11	130	13°00,04'	76°44,02'	09:25	130
070-1	CTD/RO-106	22.01.	13°00,08'	76°36,54'	10:19	105	13°00,08'	76°36,54'	10:31	104
071-1	CTD/RO-107	22.01.	12°49,98'	76°43,00'	11:47	113	12°49,97'	76°43,00'	12:00	115
072-1	CTD/RO-108	22.01.	12°49,99'	76°50,01'	12:45	142	12°49,99'	76°50,01'	13:00	141
073-1	CTD/RO-109	22.01.	12°40,00'	76°46,01'	14:20	102	12°39,99'	76°46,01'	14:34	104
073-2	WP2-41	22.01.	12°39,99'	76°46,01'	14:41	106	12°39,99'	76°46,01'	14:49	103
073-3	WP2-42	22.01.	12°39,99'	76°46,01'	14:50	100	12°39,99'	76°46,01'	14:55	104
074-1	CTD/RO-110	22.01.	12°30,01'	76°55,02'	16:27	120	12°30,01'	76°55,01'	16:42	115
075-1	CTD/RO-111	22.01.	12°21,77'	77°00,00'	17:48	100	12°21,78'	76°59,97'	18:00	100