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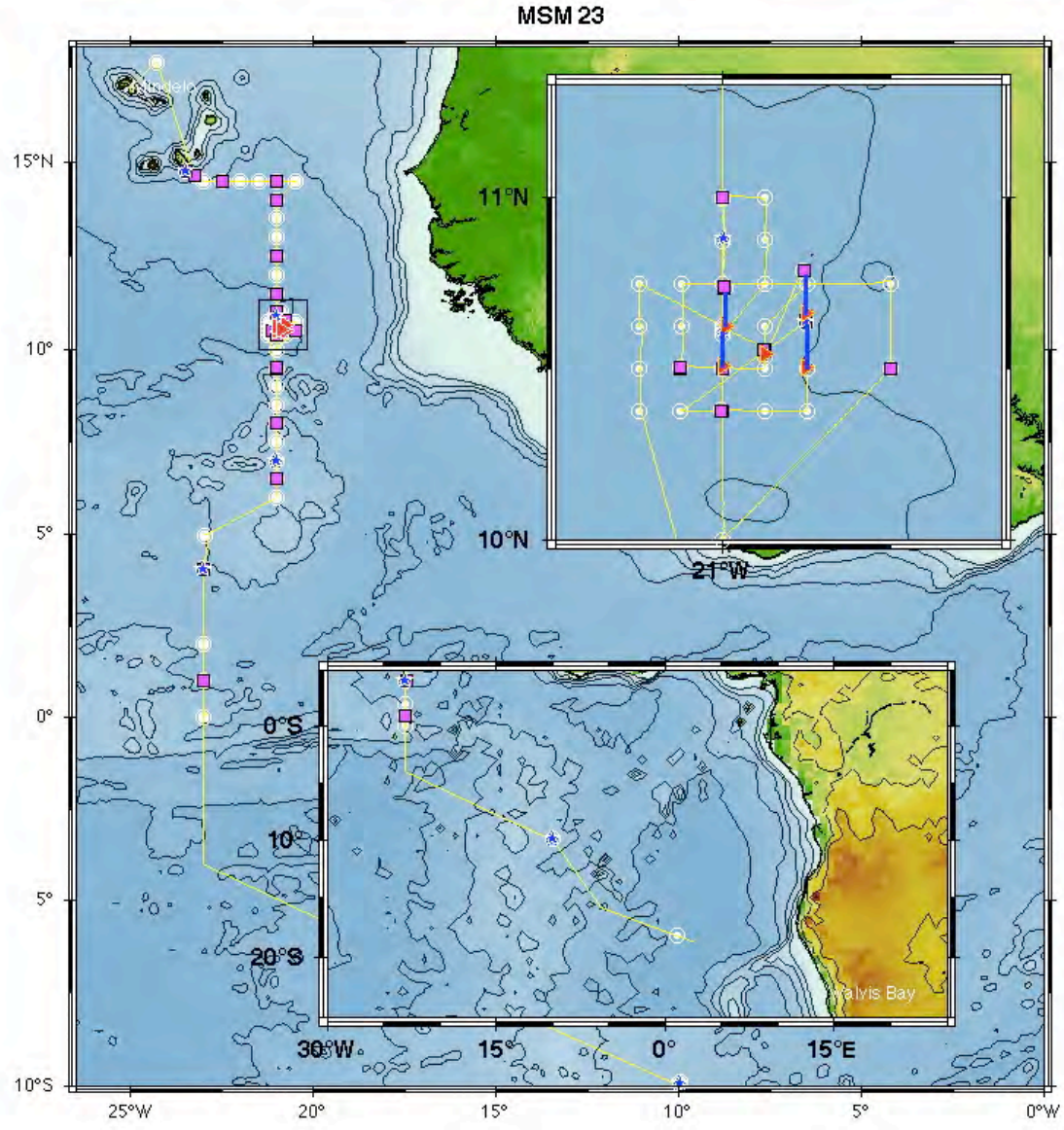
Short Cruise Report
R/V MARIA S. MERIAN MSM23 Mindelo - Walvisbay
26th November – 20rd December 2012
Chief Scientist: Prof. Dr. Martin Visbeck
Captain: Ralf Schmidt



Ship track of R/V MARIA S. MERIAN cruise MSM23 with locations of CTD/LADCP stations, tracer release (blue lines), MSS (blue stars) and net stations (pink square).

Objectives

Cruise MSM23 is supporting the Kiel Collaborative Research Centre SFB 754 (”Climate - Biogeochemistry Interactions in the Tropical Ocean“). The main goal within the framework of the SFB 754 is the quantification of oxygen supply to the oxygen minimum zone (OMZ).

The main objectives for MSM23 was:

- High precision release of an artificial tracer as the beginning of the Oxygen Supply Tracer Release Experiment (OSTRE)
- A survey of the oxygen minimum zone in the vicinity of the tracer release area
- Recovery of gliders, that participated in a swarm experiment at the southern rim of the OMZ

Additional secondary objectives for MSM23 include

- Completion of a north-south section to observe the abundance of particles using the Underwater Vision Profiler (UVP),
- Testing of a new oxygen sensor on the microstructure probe,
- Comparison of zooplankton abundance during the night and day using plankton net hauls.
- Underway measurements of upper ocean currents with the two shipboard ADCPs and hydrographic measurements with thermosalinograph, optode, pCO2 sensor and gas tension device (GTD) will be performed.
- Full ocean depth CTD measurements to contribute to the global data set of deep ocean properties to evaluate slow long term changes.

The cruise was very successful and all objectives were reached and measurements were carried out as planned with only slight modifications.

Scientific party of the cruise MSM 23

Narrative

R/V MARIA S. MERIAN departed from Mindelo on November 26, 2012 at 8:30 and headed north between the Cape Verdean islands of São Vicente and Santo Antão. The CVOO (Cape Verde Ocean Observatory) time series site was visited. First we transferred salinity samples from the RV ISLANDIA in order to calibrate their CTD system. Then a deep CTD/O_2/tracer stations was carried out. A transit began towards 14.5°N where two CTD stations, PLANKTONNET tows and a MSS (micro structure) profiles were taken. In the evening of the 27th the journalist Gabor Paal disembarked at rolls in front of Praia with the pilot boat.

Between November 27 and 28 we completed the hydrographic section along 14.5°N between 23.5°W and 20.5°W with a CTD/Lowered ADCP/Underwater Vision Profiler (UVP) station every 0.5°. The particular focus of this section was to document the remnants of the GUTRE tracer release experiment that began in April 2008. Unfortunately we could not extend the section to the shelf of Senegal as planed, since the Senegal authorities did not send an observer to be present on R/V MARIA S. MERIAN as requested.

Between November 29 and December 1 we continued the hydrographic work mostly along a meridional section at 21°W heading south with alternating full ocean depth and 1300m deep CTD casts. This sections ended at about 10.5°N in the area of a fully developed OMZ with lowest dissolved oxygen concentrations below 40 µmol/kg. Slightly north of 11°N a eddy like feature with 0.5 m/s strong northward velocities was detected and we decided to move the injection site safely to the south of the eddy.

Between December 1 and 4 the tracer injection system OTIS was deployed five times in a box between 10° 30'N 21°W and 10°46'N 20°45'W and about 88.5 kg of SF_5CF_3 were successfully injected on the 27.04 kg/m^3 potential density surface. During the night OTIS was recharged and loaded with tracer, while a small scale CTD and SADCP survey provided excellent information about the hydrographic and oxygen conditions in the vicinity of the release site. The dissolved oxygen levels were on average close to 40 µmol/kg so we managed to reach our goal to inject the tracer into very low oxygen waters. At two stations we made microstructure measurements using the MSS in the upper 350m and successfully deployed for the first time a fast oxygen sensor in addition to the usual fast thermistor and shear probes. Every night and when possible during the day PLANKTONNET hauls completed the scientific program.

On December 5 we resumed the section work along 21°W with CTD stations every 30 nautical miles between 9°N and 6°N. This section repeats similar measurements that we have done almost exactly two years ago on R/V METEOR M83.

On December 7 early in the morning we reached the region if the glider swarm experiment (5°N, 23°W) and after a CTD cast repositioned very close to the first of two gliders that were released during MSM22. Glider IFM02 had stopped diving at midnight and was drifting eastwards with the surface currents reporting is position regularly. We could easily spot it during sunny and calm conditions. Within an hour the glider was recovered and safely delivered to R/V MARIA S. MERIAN using the fast rescue boat. The other glider (IFM05) was reprogrammed to perform shallower dives at midnight, but stopped reporting ever since then. Apparently none of the security features of the glider were triggered. Fortunately, both gliders were positioned to be at similar locations during the night and the

drift of IFM02 seemed like a perfect first guess at to where IFM05 might be. Within 30 minutes we were able to spot the missing glider 2 miles east of the position were we had recovered IFM02. Glider IFM05 had lost a wing and very likely was caught by a long line fishing vessel that had been seen during the night. We were very lucky!

R/V MARIA S. MERIAN headed south along 23°W towards the equator with a brief inspection stop at the 4°N PIRATA surface buoy and alternating full ocean depth and shallow CTDs. Late on December 8, the last CTD on 23°W was deployed one mile north the equator.

On December 9, the R/V MARIA S. MERIAN was placed under Neptun's command and 'cleaned' from unworthy sailor's before crossing the equator at 12:12 along 23°W. From there an SADCP section along 23°W due south south until 4°S was performed. In the early morning of December 10 R/V MARIA S. MERIAN turned south-east steaming towards Namibia passing by Ascension Island in the morning of December 12.

On December 13 we reached 10°S and 10°W and performed a MMS and deep CTD/LADCP/UVP station near a French PIRATA buoy. The first trial of the CTD case had to be aborted, because of the loss of power due to a faulty cable connecting the altimeter. After removing the altimeter the second cast worked well.

In the early hours of December 15 R/V MARIA S. MERIAN passed the island of St. Helena to the north changing course directly towards Walvis Bay. The last CTD profile was taken midday on December 16 at 18°12'S and 1°17'E at more than 5500m water depth. These measurements help to document the slow changes in deep ocean properties in regions with few CTD profiles.

During the whole cruise and transit to Namibia, underway data of dissolved gases (O_2, and total gas tension) were obtained without major interruptions. The GO pCO_2 system, however, failed on Dec 7th 2012 and could not be repaired on board. The underway measurements in the flow-through box were stopped on Dec 18th 2012 at 11:00 while the ADCP recording was stopped at 18:00 with the entry into Namibian coastal waters.

The ship arrived at the port of Walvis Bay on December 20.

Acknowledgements

We greatly appreciate the wonderful working atmosphere as well as the professionalism and seamanship of crew, officers and Captain of R/V MARIA S. MERIAN, which made this work a success. Financial support came from the German Science Foundation (DFG) as part of the SFB754 (Climate Biogeochemistry Interactions in the Tropical Ocean).

Participants MSM23

Name	Discipline	Institution
Visbeck, Martin	Chief scientist	GEOMAR
Bruenjes, Robert	CTD-Watch/Tracer	ICBM
Haase, Sabine	CTD-Watch/ Microstructure	GEOMAR
Hahn, Tobias	CTD-Watch/ Oxygen/*p*CO2	GEOMAR
Faustmann, Jannik	UVP/ Zooplankton Net	GEOMAR
Karstensen, Johannes	CTD-Watch/CTD-Processing	GEOMAR
Kinzel, Julian	CTD-Watch/ Salinometer	GEOMAR
Koellner, Manuela	CTD-Watch/ Tracer	GEOMAR
Paal, Gabor	Public Outreach	Journalist
Pinck, Andreas	Technician	GEOMAR
Poehl, Rike-Sophie	Tracer	Pupil
Reckhardt, Anja	CTD-Watch/ Underway-Data Processing	ICBM
Rulle, Linnea	Zooplankton Net	Pupil
Schaffer, Janin	CTD-Watch/ ADCP-Processing/ Glider	GEOMAR
Schaefer, Kirsten	Zooplankton Net	GEOMAR
Tanhua, Toste	Tracer	GEOMAR
Vogel, Jefim	CTD-Watch/ ADCP-Processing	GEOMAR

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Tab. 1.1: Station list of R/V MARIA S. MERIAN cruise MSM23.

Station No.		Date	Gear	Time	Latitude	Longitude	Station	Remarks
		2012		UTC	[]	[]	Depth	
760_1		26.11	Boat	15:36	17° 35,99' N	24° 17,71 W	-	Getting salinity samples from Islandia
760_2	01	26.11	CTD1/LADCP/UVP	18:02	17° 36,17' N	24° 17,96' W	3596	Station CVOO: Sal,O2, CF3SF5,SF6,CFC-12, DIC, PFOS
761_1		27.11	Net	10:09	14° 37,44' N	23° 14,95' W	120	
761_2	02	27.11	CTD1/LADCP/UVP	11:40	14° 37,44' N	23° 14,92' W	3749	Sal,O2,CF3SF5,SF6, CFC-12, PFOS
762_1		27.11	Net	14:26	14° 45,00' N	23° 30,00' W	120	
762_2	03	27.11	CTD1/LADCP/UVP	15:09	14° 45,00' N	23° 30,01' W	1300	Sal,O2,CF3SF5,SF6, CFC-12
762_3		27.11	MSS	15:55	14° 45,15' N	23° 29,88' W	355	
763_1	04	27.11	CTD1/LADCP/UVP	22:51	14° 30,01' N	23° 00,02' W	4125	Sal,O2
764_1		28.11	Net	02:59	14° 30,00' N	22° 30,00' W	120	
764_2	05	28.11	CTD1/LADCP/UVP	03:48	14° 30,01' N	22° 30,00' W	1300	Sal,O2
765_1	06	28.11	CTD1/LADCP/UVP	07:31	14° 30,04' N	22° 00,06' W	1300	Sal,O2,CF3SF5,SF6, CFC-12
766_1	07	28.11	CTD1/LADCP/UVP	11:14	14° 30,11' N	21° 30,14' W	1500	Sal,O2,CF3SF5,SF6, CFC-12
767_1		28.11	Net	14:37	14° 30,00' N	21° 00,02' W	120	
767_2		28.11	Net	14:51	14° 30,00' N	21° 00,00' W	120	
767_3	08	28.11	CTD1/LADCP/UVP	16:14	14° 30,00' N	21° 00,00' W	4274	Sal,O2
768_1	09	28.11	CTD1/LADCP/UVP	20:43	14° 30,02' N	20° 30,00' W	1300	Sal,O2,CF3SF5,SF6, CFC-12
769_1		29.11	Net	00:47	14° 00,01' N	21° 00,02' W	120	
769_2		29.11	Net	01:04	14° 00,01' N	21° 00,02' W	120	
769_3	10	29.11	CTD1/LADCP/UVP	02:41	14° 00,17' N	21° 00,04' W	4411	Sal,O2
770_1	11	29.11	CTD1/LADCP/UVP	07:03	13° 29,98' N	20° 59,93' W	1300	Sal,O2
771_1	12	29.11	CTD1/LADCP/UVP	12:35	13° 00,00' N	21° 00,00' W	4644	Sal,O2,CF3SF5,SF6, CFC-12
772_1		29.11	Net	16:41	12° 29,99' N	21° 00,04' W	120	
772_2		29.11	Net	16:54	12° 30,04' N	21° 00,09' W	120	
772_3	13	29.11	CTD1/LADCP/UVP	17:36	12° 30,09' N	21° 00,18' W	1300	Sal,O2
773_1	14	29.11	CTD1/LADCP/UVP	22:12	12° 00,04' N	21° 00,02' W	4891	Sal,O2
774_1		30.11	Net	02:30	11° 30,00' N	21° 00,00' W	120	
774_2		30.11	Net	02:49	11° 30,01' N	21° 00,04' W	120	
774_3	15	30.11	CTD1/LADCP/UVP	03:31	11° 30,02' N	21° 00,07' W	1300	Sal,O2
775_1	16	30.11	CTD1/LADCP/UVP	08:09	10° 59,99' N	21° 00,15' W	5058	Sal,O2, CF3SF5,SF6, CFC-12,PFOS
776_1		30.11	Net	12:29	10° 30,00' N	21° 00,05' W	120	
776_2		30.11	Net	12:43	10° 30,06' N	21° 00,10' W	120	
776_3	17	30.11	CTD1/LADCP/UVP	13:21	10° 30,09' N	21° 00,12' W	1300	Sal,O2
777_1	18	01.12	CTD1/LADCP/UVP	17:59	10° 00,00' N	21° 00,00' W	5046	Sal,O2
778_1		01.12	Net	00:06	10° 30,00' N	20° 30,00' W	120	
778_2		01.12	Net	00:17	10° 30,00' N	20° 30,00' W	120	
778_3	19	01.12	CTD1/LADCP/UVP	00:58	10° 30,00' N	20° 30,00' W	1300	Sal,O2
779_1	20	01.12	CTD1/LADCP/UVP	03:22	10° 44,99' N	20° 30,00' W	1300	Sal,O2
780_1	21	01.12	CTD1/LADCP/UVP	06:49	10° 45,02' N	20° 59,99' W	1300	No sampling
781_1	22	01.12	CTD1/LADCP/UVP	08:36	10° 37,48'N	21° 00,05' W	1300	No sampling
782_1	23	01.12	CTD1/LADCP/UVP	10:20	10° 29,96' N	21° 00,05' W	1000	Sal,O2
782_2		01.12	OTIS	11:50	10° 30,44' N	21° 00,07' W	415	OTIS Cast 1, Tracer injected: 24,5 kg
783_1	24	01.12	CTD1/LADCP/UVP	19:09	10° 36,96' N	21° 00,21' W	1300	Sal,O2

784_1	25	01.12	CTD1/LADCP/UVP	21:37	10° 52,48' N	21° 00,04' W	1300	Sal,O2
784_2		01.12	MSS	22:40	10° 52,87' N	20° 59,75' W	240	
785_1		02.12	Net	00:02	11° 00,04' N	21° 00,04' W	120	
785_2		02.12	Net	00:18	11° 00,15' N	21° 00,09' W	120	
785_3	26	02.12	CTD1/LADCP/UVP	01:04	11° 00,31' N	21° 00,15' W	1300	Sal,O2
786_1	27	02.12	CTD1/LADCP/UVP	02:48	11° 00,01' N	20° 52,50' W	1300	Sal,O2
787_1	28	02.12	CTD1/LADCP/UVP	04:49	10° 52,50' N	20° 52,50' W	-	Cast stopped – Tubes still on CTD
787_1	29	02.12	CTD1/LADCP/UVP	04:49	10° 52,50' N	20° 52,50' W	1300	Sal,O2
788_1	30	02.12	CTD1/LADCP/UVP	06:36	10° 45,02' N	20° 52,54' W	1305	Sal
789_1	31	02.12	CTD1/LADCP/UVP	08:43	10° 36,03' N	21° 00,08' W	1300	Sal
789_2		02.12	MSS	09:58	10° 36,21' N	20° 59,99' W	347	Three Casts: 347m, 250m and 275m
789_3		02.12	OTIS	11:07	10° 37,63' N	20° 59,68' W	420	OTIS Cast 2, Tracer injected: 18,5 kg
790_1	32	02.12	CTD1/LADCP/UVP	18:10	10° 44,08' N	20° 59,72' W	1300	Sal,O2
790_2		02.12	Net	18:54	10° 44,17' N	20° 59,80' W	120	
790_3		02.12	Net	19:07	10° 44,32' N	20° 59,90' W	120	
790_4		02.12	Phytoplankton	19:15	10° 44,41' N	20° 59,96' W	10	
791_1	33	02.12	CTD1/LADCP/UVP	20:38	10° 45,02' N	21° 07,51' W	1300	Sal,O2
792_1	34	02.12	CTD1/LADCP/UVP	22:33	10° 37,56' N	21° 07,57' W	1300	Sal,O2
793_1		03.12	Net	00:01	10° 30,07' N	21° 07,55' W	120	
793_2		03.12	Net	00:15	10° 30,24' N	21° 07,57' W	120	
793_3	35	03.12	CTD1/LADCP/UVP	00:57	10° 30,37' N	21° 07,61' W	1300	Sal
794_1	36	03.12	CTD1/LADCP/UVP	03:17	10° 30,00' N	20° 52,52' W	1300	Sal,O2
795_1	37	03.12	CTD1/LADCP/UVP	04:57	10° 37,50' N	20° 52,50' W	1300	Sal
796_1	38	03.12	CTD1/LADCP/UVP	06:58	10° 44,97' N	20° 45,02' W	1300	Sal
797_1	39	03.12	CTD1/LADCP/UVP	09:15	10° 29,94' N	20° 45,02' W	1300	Sal,O2 UVP did not work
797_2		03.12	OTIS	10:30	10° 30,37' N	20° 45,04' W	415	OTIS Cast 3, Tracer injected: 21,5 kg
798_1		03.12	Net	18:39	10° 38,31' N	20° 45,05' W	120	
798_2		03.12	Net	18:52	10° 38,38' N	20° 45,14' W	120	
798_3	40	03.12	CTD1/LADCP/UVP	19:35	10° 38,45' N	20° 45,22' W	1300	Sal,O2
799_1	41	03.12	CTD1/LADCP/UVP	22:54	10° 22,58' N	21° 07,64' W	1300	Sal,O2
800_1		04.12	Net	00:21	10° 22,52' N	21° 00,10' W	120	
800_2		04.12	Net	00:38	10° 22,64' N	21° 00,21' W	120	
800_3	42	04.12	CTD1/LADCP/UVP	01:19	10° 22,76' N	21° 00,32' W	1300	Sal
801_1	43	04.12	CTD1/LADCP/UVP	03:04	10° 22,53' N	20° 52,52' W	1300	Sal
802_1	44	04.12	CTD1/LADCP/UVP	04:50	10° 22,54' N	20° 45,06' W	1300	Sal
803_1	45	04.12	CTD1/LADCP/UVP	07:19	10° 38,04' N	20° 45,11' W	1300	Sal
803_2		04.12	MSS	08:04	10° 38,29' N	20° 45,28' W	308	Three Casts: 220m, 308m and 290m
803_3		04.12	OTIS	09:42	10° 39,82' N	20° 45,23' W	405	OTIS Cast 4, Tracer injected: 24 kg
804_1		04.12	Net	17:08	10° 47,14' N	20° 45,38' W	120	
804_2		04.12	Net	17:21	10° 47,30' N	20° 45,51' W	120	
804_3	46	04.12	CTD1/LADCP/UVP	18:11	10° 47,59' N	20° 46,02' W	1300	Sal,O2
805_1	47	04.12	CTD1/LADCP/UVP	20:47	10° 31,99' N	20° 52,56' W	1300	Sal,O2
805_2		04.12	OTIS	21:57	10° 32,46' N	20° 52,57' W	400	OTIS Cast 5, no tracer released – problems with pumps
805_3		04.12	Net	22:59	10° 33,27' N	20° 52,59' W	120	
805_4		04.12	Net	23:13	10° 33,38' N	20° 52,63' W	120	
806_1	48	05.12	CTD1/LADCP/UVP	02:03	10° 45,09' N	21° 15,06' W	1300	Sal,O2
807_1	49	05.12	CTD1/LADCP/UVP	03:52	10° 37,54' N	21° 15,02' W	1300	Sal,O2
808_1	50	05.12	CTD1/LADCP/UVP	05:43	10° 29,99' N	21° 15,03' W	1300	Sal
809_1	51	05.12	CTD2/LADCP/UVP	07:36	10° 22,47' N	21° 15,01' W	1300	Sal,O2

810_1	52	05.12	CTD2/LADCP/UVP	13:10	09° 29,98' N	21° 00,00' W	1300	Sal,O2
810_2		05.12	Net	13:46	09° 30,04' N	21° 00,02' W	120	
810_3		05.12	Net	13:58	09° 30,16' N	21° 00,04' W	120	
811_1		05.12	Phytoplankton	16:36	08° 59,98' N	21° 00,02' W	10	
811_2	53	05.12	CTD2/LADCP/UVP	17:10	09° 00,00' N	21° 00,00' W	1300	Sal,O2
812_1	54	05.12	CTD2/LADCP/UVP	21:38	08° 30,06' N	21° 00,04' W	4059	Sal,O2
813_1		06.12	Net	01:48	08° 00,00' N	21° 00,00' W	120	
813_2		06.12	Net	02:07	08° 00,06' N	21° 00,05' W	120	
813_1	55	06.12	CTD2/LADCP/UVP	02:58	08° 00,09' N	21° 00,08' W	1300	Sal,O2
814_1	56	06.12	CTD2/LADCP/UVP	06:33	07° 29,98' N	21° 00,01' W	1300	Sal,O2
815_1	57	06.12	CTD2/LADCP/UVP	10:50	07° 00,00' N	21° 00,00' W	1305	Sal,O2
815_2		06.12	MSS	12:21	07° 00,22' N	21° 00,00' W	3919	
816_1		06.12	Net	15:57	06° 30,00' N	20° 59,97' W	120	
816_2		06.12	Net	16:07	06° 29,95' N	20° 59,91' W	120	
816_3	58	06.12	CTD2/LADCP/UVP	16:43	06° 29,96' N	20° 59,91' W	1300	Sal,O2
817_1		06.12	Phytoplankton	19:44	06° 00,01' N	20° 59,95' W	10	
817_2	59	06.12	CTD2/LADCP/UVP	20:20	06° 00,01' N	20° 59,73' W	1300	Sal,O2
818_1	60	07.12	CTD2/LADCP/UVP	08:40	04° 58,00' N	22° 58,93' W	1300	Sal,O2
819_1		07.12	Glider	10:15	05° 00,77' N	22° 53,93' W	-	IfM02
819_2		07.12	Glider	11:09	05° 01,37' N	22° 51,06' W	-	IfM05
820_1		07.12	Net	16:54	04° 02,38' N	22° 59,47' W	120	
820_2		07.12	Net	17:06	04° 02,37' N	22° 59,47' W	120	
820_3		07.12	MSS	20:21	04° 03,47' N	22° 59,94' W	210	Three casts: 170m, 200m, 210m
820_4	61	07.12	CTD2/LADCP/UVP	21:24	04° 04,20' N	23° 00,05' W	1300	Sal,O2
821_1	62	08.12	CTD2/LADCP/UVP	09:43	01° 59,99' N	23° 00,07' W	4386	Sal,O2
822_1	63	08.12	CTD2/LADCP/UVP	16:31	00° 59,76' N	23° 00,07' W	1300	Sal,O2
822_2		08.12	Net	17:31	00° 59,71' N	23° 00,10' W	120	
822_3		08.12	Net	17:41	00° 59,71' N	23° 00,09' W	120	
823_1	64	09.12	CTD2/LADCP/UVP	00:12	00° 00,99' N	23° 00,99' W	3993	Sal,O2,PFOS
824_1		13.12	Phytoplankton	09:35	09° 54,97' S	09° 59,31' W	10	
824_2		13.12	CTD2/LADCP/UVP	09:52	09° 54,97' S	09° 59,31' W	100	Cast stopped - Tubes still on CTD
824_3	65	13.12	CTD2/LADCP/UVP	10:22	09° 54,98' S	09° 59,32' W	1000	Cast stopped – communication error with CTD
824_4		13.12	MSS	11:41	09° 55,45' S	09° 59,06' W	373	Three casts: 323m, 327m, 373m
824_5	66	13.12	CTD2/LADCP/UVP	14:44	09° 55,04' S	09° 58,41' W	3750	Sal,O2,PFOS
825_1		16.12	Phytoplankton	12:30	18° 11,56' S	01° 00,18' E	10	
825_2	67	16.12	CTD2/LADCP/UVP	14:17	18° 11,56' S	01° 00,18' E	5708	Sal,O2,PFOS