METEOR-Berichte

South Atlantic Crossing (SACROSS)

Cruise No. M133

15.12.2016 – 13.01.2017

Cape Town (South Africa) – Stanley (Falklands)

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2017

Inhalt

1 Summary

The cruise M133 SACROSS (South Atlantic Crossing) was a multidisciplinary ocean survey of the South Atlantic gyre roughly along 34.5°S. This transect is covered by the international SAMOC moored array and also the path of the internationally agreed AX18 XBT line. Most of the measurements were based on using underway methods including near-surface water sampling for the determination of SST, and SSS as well as shipboard ADCP current observations. Moreover, an underway CTD allowed to sample the upper 300-400 m every hour. Chemical analysis of surface waters as well as atmospheric parameter were of scientific interest to both compare different regions with each other but also to document long term trends. At the western and eastern boundary current regime full water column water mass properties were measured. Upper ocean 10-700m plankton assemblages allow improving the calibration of sediment proxies. Water samples for later lab-based biodiversity analysis were taken. A number of smaller student projects were carried out as part of a global ocean learning and capacity building effort.

Finally, continuous swath bathymetry mapping was made, and a number of floats and drifters were launched in support of the global ocean observing system arrays. The cruise was very successful, all objectives were reached, and the measurements were carried out as planned.

Zusammenfassung

Die Reise M133 SACROSS (South Atlantic Crossing) überquerte den Südatlantik und verfolgte einen multidisziplinären Ansatz zur Untersuchung des südatlantischen Wirbels auf dem ca. 34.5°S Breitengrad.

Auf diesem Transekt befinden sich eine Reihe von SAMOC-Verankerungen (SAMOC array) sowie die AX18 XBT-Linie, auf die sich auf internationaler Ebene geeinigt wurde. Für einen Großteil der Messungen wurden Unterwegs-Methoden eingesetzt, wie z.B. Probennahmen nahe der Oberfläche mittels Durchflusssystemen, um Oberflächentemperatur und -salinität zu bestimmen sowie die Ermittlung von Strömungsgeschwindigkeiten durch einen schiffbasierten ADC-Profiler. Darüber hinaus ermöglichte der Einsatz der Unterwegs-CTD stündliche Beprobungen der oberen 300 – 400 m. Die Analyse der Chemie des Oberflächenwassers sowie atmosphärischer Parameter sind von großem wissenschaftlichem Interesse sowohl für Vergleiche verschiedener ozeanischer Regionen als auch für die Dokumentation von Langzeittrends. Die Wassermassen an den westlichen und östlichen Grenzströmungen wurden über die gesamte Wassersäule charakterisiert. Untersuchungen zu Plankton-Ansammlungen in den oberen 10-700 m werden zur Verbesserung und dem Ausbau der Kalibration von Sediment-Indikatoren beitragen. Für Biodiversitätsuntersuchungen wurden Wasserproben zur späteren Laboranalyse genommen. Es wurden kleinere Forschungsprojekte von internationalen Studenten durchgeführt unter dem Aspekt des „Capacity Building“ und des gemeinsamen Lernens über den globalen Ozean. Als Beitrag zum globalen Ozeanobservierungssystem wurden schließlich noch bathymetriebasierte Kartierungen durchgeführt sowie einige Floats und Drifter ausgesetzt.

Die Reise M133 war sehr erfolgreich, es konnten alle Ziele erreicht und alle Messungen wie geplant durchgeführt werden.

2 Participants

Name	Position/Discipline	Institute
1. Prof. Dr. Visbeck, Martin	Chief scientist	GEOMAR
2. Prof. Dr. Falk, Christine	Plankton imaging	MHH
3. Pinck, Andreas	Technician	GEOMAR
4. Hahn, Tobias	O_2, pCO_2, underway	GEOMAR
5. Canning, Anna	underway FT-System	GEOMAR
6. Seelmann, Katharina	underway TA-System	GEOMAR
7. Handmann, Patricia	ADCP/(u)CTD/XBT	GEOMAR
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9. Thölken, Elisabeth	(u)CTD/XBT	U-Kiel
10. Igelmann, Clara	(u)CTD/XBT	Pupil
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13. Dr. Groeneveld, Jeroen	MultiNet Forams	U-Bremen/MARUM
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20. Bonelli, Ana Gabriela	(u)CTD/XBT	Argentina (SHN)
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22. Orselli, Iole	(u)CTD/XBT/salinometer	FURG
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Scientific party of M133

3 Research Program

A multidisciplinary ocean survey roughly along 34.5°S was proposed to investigate the South Atlantic gyre. This section is also covered by the international SAMOC moored array and the path of the internationally agreed AX18 XBT line. Measurements were planned on using under-way methods including near-surface water sampling for the determination of SST, and SSS as well as shipboard ADCP current observations and underway CTD measurements of the upper 300-400 m. Chemical analysis of surface waters as well as atmospheric parameter were of scientific interest to both compare different regions with each other but also to document long term trends.

The main objectives of the cruise were to:

- Estimate the upper ocean meridional heat and freshwater transport along approximately 30°S
- Investigate the physical/biogeochemical characteristics of Agulhas Rings, transporting Indian Ocean Water far into the South Atlantic
- Measuring the aerosol load of the atmosphere
- Measure the surface water carbonate system parameters (pCO_2) using newly developed sensors
- The temperature and salinity observations have been uploaded into international data bases during the cruise for rapid distribution via GTS
- The expedition was used for training purposes as a "MyScience cruise"

These objectives were addressed by a multi-disciplinary research program during M133 encompassing 41 CTD stations, 55 MultiNets, underway ship-based measurements and Argo deployments.

The calcite shells of planktic foraminifera accumulate in large quantities on the seafloor, and are accordingly widely employed for reconstructions of the paleoenvironmental conditions of the world's oceans. Analyses of foraminifera shell chemistry, morphology and assemblage composition (e.g. Kucera, 2007) form the basis for the majority of methods for determining past ocean properties. In many cases these methods require species-specific calibrations, due to differences in physiology and habitat preferences among foraminifera species (e.g. Hemleben, 1989).
Despite decades of research our knowledge about foraminifera ecology and the parameters controlling their distribution in the recent oceans are far from complete. Further sampling efforts, with a consistent taxonomy and a comprehensive and accurate recording of the environmental conditions of the habitat of the sampled assemblages, are required to improve our understanding of planktic foraminifera ecology and biogeography. This knowledge can then be transferred to the interpretation of fossil assemblages and be used to ameliorate paleoenvironmental reconstructions.

The variability of planktic foraminiferal morphology has long been recognized, but only the first genetic analyses could prove the existence of distinct genetic lineages within foraminifera morphospecies (Darling and Wade, 2008). The extent and spatial structure of the genetic diversity of planktic foraminifera is only known in a limited number of species. To date, 33 out

of the 47 extant morphospecies of planktic foraminifera are known by their SSU rDNA sequence (Morard et al., 2015). In many cases, the habitat of the morphological species has been shown to be partitioned among the cryptic genetic types, which show spatially or ecologically more restricted distributions (e.g. de Vargas et al., 1999). The approach combining classical sampling and habitat characterization of morphospecies with molecular characterization of individual taxa, therefore helps to further constrain paleoceanographical and ecological interpretations based on morphological species. Using an established DNA extraction method, we are able to combine classical plankton analysis in stratified samples with the possibility to obtain DNA from all preserved specimens.

Another approach for the analysis of planktic foraminifera distribution and diversity will be the use of bulk plankton samples for next generation sequencing (NGS). The currently employed single-cell DNA analysis approach is well established and powerful, but time-consuming and sensitive to DNA degradation. It is now possible to assess the structure and spatiotemporal dynamics of the diversity in planktic foraminifera via NGS on a scale not accessible before. Part of the collected material will be used to continue the tests of the fidelity (rate of taxa identification) of this approach and establish the scaling between NGS sequence abundance and population structure by combined analysis of parallel samples by morphological taxonomy and classical sequencing.

By the combination of classical and genetic approaches, we will further constrain the habitat of key morphological species, which are frequently used for paleoceanographic reconstructions, as well as to determine the degree to which the population density and structure, on both the morphological and genetic level, can be predicted by water mass properties.

The amounts of plankton material sampled by our instruments are small, our research and sampling program complies with national (DFG-SKO) and international (i.e. OSPAR) guidelines for sustainable and responsible oceanographic research.

In summary the cruise was very successful; all planned objectives were reached and all measurements were carried out as planned.

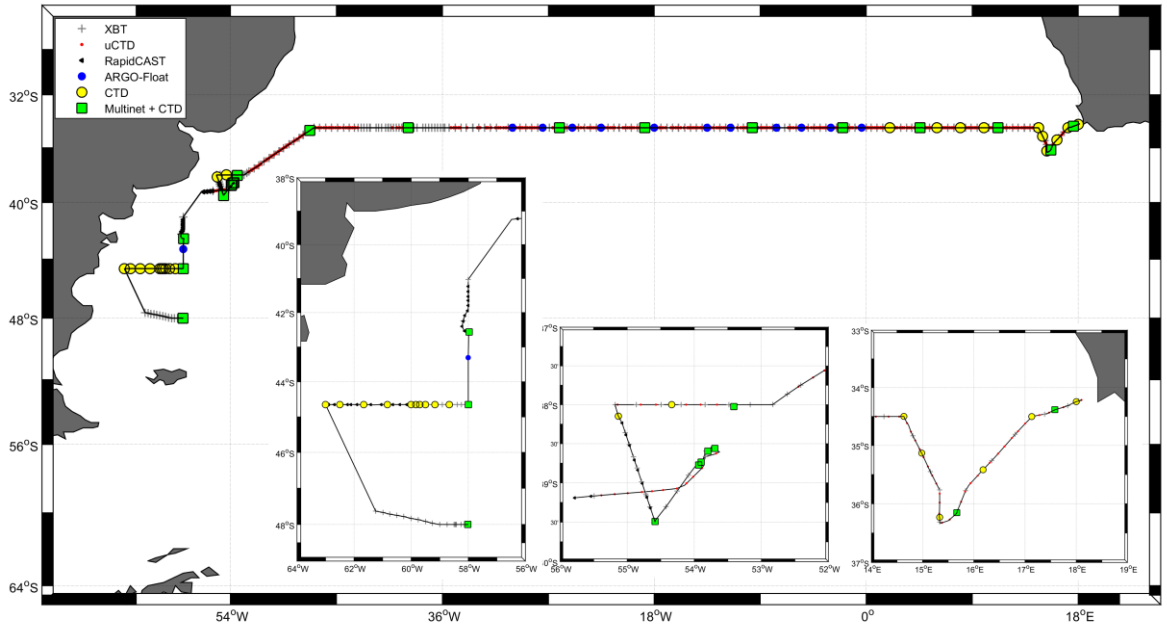

Figure 3.1 Cruise track of METEOR cruise M133 with locations of CTD stations (yellow circles), MultiNet-CTD (Green Box), UCTD (red dots), XBT (gray cross), RapidCast (black triangle) and Argo Float Deployments (Blue dots).

4 Narrative of the Cruise

R/V METEOR departed from Cape Town, South Africa on December 15, 2016 at 10:00 and sailed south to reach the starting point of the underway measurements at 34°10'S. The first goal was to survey an Agulhas Eddy southward of the crossing latitude and three floats were deployed in its center at 36°14'S and 15° 20'E. On December 12 midday we returned to the 34.5°S latitude and continued our westward survey with UCTD every hour and XBTs typically every 30nm. Every 2-3 days a MultiNet station was taken. On January 2, 2017 shortly before the Brazilian EEZ we went on a southwest course and completed the zonal crossing along 38°S until on January 4 at 16:00 we reached 38°N 55°10'W on the Patagonian shelf. Along the way we deployed several Argo floats for WHOI and BSH.

Between January 4 and January 6 we crossed the Malvinas Currents three times and performed a MultiNet transect parallel to the shelf along the Malvinas Current across the confluence zone between 39°30'S 54°35' W and 38°35'S 53°50'W targeting a range of surface temperature conditions.

From there a survey of the Malvinas Current and its fronts followed with on shelf and off shelf transects on our transit south. On January 8 and 9 we sampled along a westward transect on 44° 39'S between 58° and 63°W towards the shelf. A final crossing of the Malvinas Current System happened on January 11 with a last MultiNet and CTD station at 48°S 58°W.

We reached the port of Stanley, Falkland Islands in the morning of January 13, 2016.

5 Preliminary Results

In the following report, a detailed account of the types of observations, the methods and instruments used as well as some of the early results are given.

5.1 CTD system and calibration

(Elisabeth Thölken, Iole Orselli, Gaston Manta and Andreas Pinck, PI: Martin Visbeck and Patricia Handmann)

5.1.1 CTD-Rosette system

During M133 a total of 41 CTD-profiles and 229 salinity samples were collected. The rosette system was installed in a Seabird Rosette System frame with 24 bottles. See table below for sensor details. Depth profiles were performed up to a maximum pressure of 2762 dbar. For the majority of stations only the top 2000m of the water column were sampled. Data acquisition was done using Seabird Seasave software version 7.23.1; pre-processing was done with SBE Data Processing 7.23.1.

The first CTD profile was collected at ship station #1675. It was determined that the conductivity and temperature sensors were working well, as well as the oxygen sensor. The fluorescence sensor was not configured correctly and was not working. At station #1704, CTD profile 10, the CDOM fluorescence sensor was replaced with the ship's WETLAB AFL/FL fluorescence sensor.

During casts 8 and 9 (stations #1692 and #1701) rosette sampling failed and no samples were taken. During the down-cast in 1200dbar depth of profile 13, station #1717, the deck unit lost contact to the CTD and no samples could be taken. The cause in both cases was determined to be an interruption between the single conductive cable and the underwater connector. A new termination for the single conductive cable resolved the problem fully.

Niskin bottles #23 and #24 were detached from the rosette at station #1793 in order to be able to add the new sensors and remained detached from the CTD system for the rest of the cruise. Two HydroC *p*CO2 sensors were attached to the CTD at this station, CTD profile 18 (see chapter 5.10 for more details). Up to two uCTD probes were also attached at several stations for calibration purposes, (Stations: 8,18,19,20,23,27,32).

At ship station #34, profile 21, Niskin bottle #2 did not close correctly due to a loose upper O-Ring. The ring was reattached securely and worked well afterwards.

No further problems were recorded with the sensors or the sampling system of the CTD system. The CTD system worked without problems for all other profiles.

The exact configuration of the CTD system can be found in Table 5.1.1

Processed preliminary CTD data, 5-dbar binned, was sent in near real time to the Coriolis Data Centre in Brest, France, (via email: codata@ifremer.fr) and to NOAA (via email: francis.bringas@noaa.gov) for integration in the databases to be used for operational oceanography applications and the WMO supported GTS/TESAC system.

Table 5.1.1 Summary of CTD system SBE 9Plus configuration used during M133.

	CTD system SBE 9Plus (cast 1-9)	CTD system SBE 9Plus (cast 10-41)
Pressure sensor	# 0979	# 0979
T primary	# 5283	# 5283
T secondary	# 5272	# 5272
C primary	# 4128	# 4128
C secondary	# 4092	# 4902
O2 sensor	SBE 43 #1818	SBE 43 #1818
Altimeter	# 51861	# 51861
PAR sensor	# 70279	# 70279
CDOM FLCDRTD	# 2687-	
WET Labs ECO-AFL/FL	-	# 2718

5.1.2 CTD-conductivity calibration

Overall 229 calibration points were obtained by sampling for salinity. Salinity samples were taken by the CTD watch in 'Flensburger' bottles, which proved to be ideal for storing salt samples over a prolonged time. The limited amount of bottles required the washing and reusing of bottles. Reused bottles were used for salt samples after being cleaned. The results and description of the salt measurements are found in section 5.1.4. Due to the large amounts of samples, a simple outlier removal method was applied that discharged the largest 30% deviations between CTD and bottle samples prior to calibration. The projection from the bottle stop of the up- to the downcast was done by searching for similar potential temperatures within 50dbar pressure internal around similar pressure horizons between up- and downcast. For the critical loop edit velocity, 0.01m/s were used. The final CTD data set is composed from the primary set of sensors, apart from the CDOM Sensor, for all profiles, though the differences between sensor pairs were marginal. The conductivity calibration of the downcast data was performed using a 1^{st} order linear fit with respect to temperature, pressure and conductivity.

The calibration results in a salinity RMS-misfit for the downcast of order 0.00166 psu for the primary and 0.0023 psu for the secondary sensor. The up-cast calibration succeeds these very good values with and RMS-misfit of 0.00166 for the primary and 0.0016 for the secondary sensor.

Table 5.1.2 End of cruise salinity and pressure summary of downcast calibration information for the two CTD systems used during M133.

	CTD system SBE 9Plus (profile 1 to 41)	CTD system SBE 9Plus (profile 1 to 41)
Sensor pair	primary	secondary
RMS misfit after calibration salinity	0.0016632	0.0022758
Polynomial coefficients conductivity	Offset: -0.0048578 P1: 1.8945e-7 T1: 0.00020309 C1: -0.00177779	Offset: 0.0055533 P1: 1.6858e-7 T1: 0.00020506 C1: -0.0020282
Pressure sensor correction (decks offset)	0.26	0.26

5.1.3 Oxygen calibration

The CTD oxygen downcast for CTD systems was calibrated by using the best 60 % of the joint data pairs between downcast CTD sensor value and titrated oxygen on samples taken during the up cast (Section 5.2). For the calibration, a linear correction polynomial depending on pressure, temperature and the actual oxygen value was fitted. Due to the very highly mixed water masses in the confluence zone. The RMS misfit is relatively big for the down cast on the order of 0.92 µmol kg^{-1} for the primary SBE43 and 0.93 µmol kg^{-1} for the secondary SBE43. The up-cast calibration matched these values with and RMS-misfit of 0.86 µmol kg^{-1} for the primary SBE43 and 0.86 µmol kg^{-1} for the secondary SBE43.

Table 5.1.3 End of cruise downcast oxygen summary of calibration information for the CTD system SBE 9Plus used during M133.

	Oxygen Sensor #1818	Oxygen Sensor #1818
Sensor pair	primary	secondary
RMS misfit after calibration - oxygen	0.91783	0.92603
Polynomial coefficients - oxygen	Offset: -0.14745	Offset: -0.056855
	P1: 0.0025396	P1: 0.0024921
	T1: -0.17623	T1: -0.149
	O1: 0.043418	O1: 44.2798

5.1.4 Salinometer measurements

On board were two GEOMAR instruments: Guildline Autosal salinometer, AS8 (Model 8400B) and Guildline Autosal salinometer, AS4 (Model 8400A). Throughout the cruise, the Guildline Autosal salinometer AS4 was used until the 28 of December. After a problem in one of the switches the AS8 was used until the end of the cruise. The instrument has a manufacturer given absolute accuracy in salinity of ±0.002 psu. In total, a number of 229 samples were measured in triplicate from 41 CTD stations.

The bath temperature of both salinometers was constant throughout the cruise at 24°C in a room with controlled air temperature at 22°C. A standardization of the instrument was performed at the beginning and also during the analysis using IAPSO standard sea water (batch P159, K15=0.99988) with a respective salinity of 34.995. That value was set by adjusting a resistance to get the required conductivity measurement (potentiometer). Furthermore, a large volume of water with constant salinity was used as a substandard to track the stability of the instrument. The substandard was obtained from CTD cast 2, from 2000 dbar pressure. Successive standard measurements with IAPSO standard sea water indicated stable behavior of the instrument.

Salinity samples from the CTD and underway METEOR TS recorder were analyzed and the calibration procedures are described in section 5.1.2.

5.1.5 Exemplary results

The east-west crossing of M133 provided a good section of temperature and reasonable coverage of salinity of the upper 400m (Figure 5.1.1).

The TS-plot in Figure 5.1.2 shows the changing distribution of the water masses along the cruise track. Starting from low profile numbers, from a more stratified water column showing South Atlantic Central Water (SACW) and Antarctic Intermediate Water (AAIW) characteristics to higher profile numbers showing Patagonian Shelf Water which is very low in salinity.

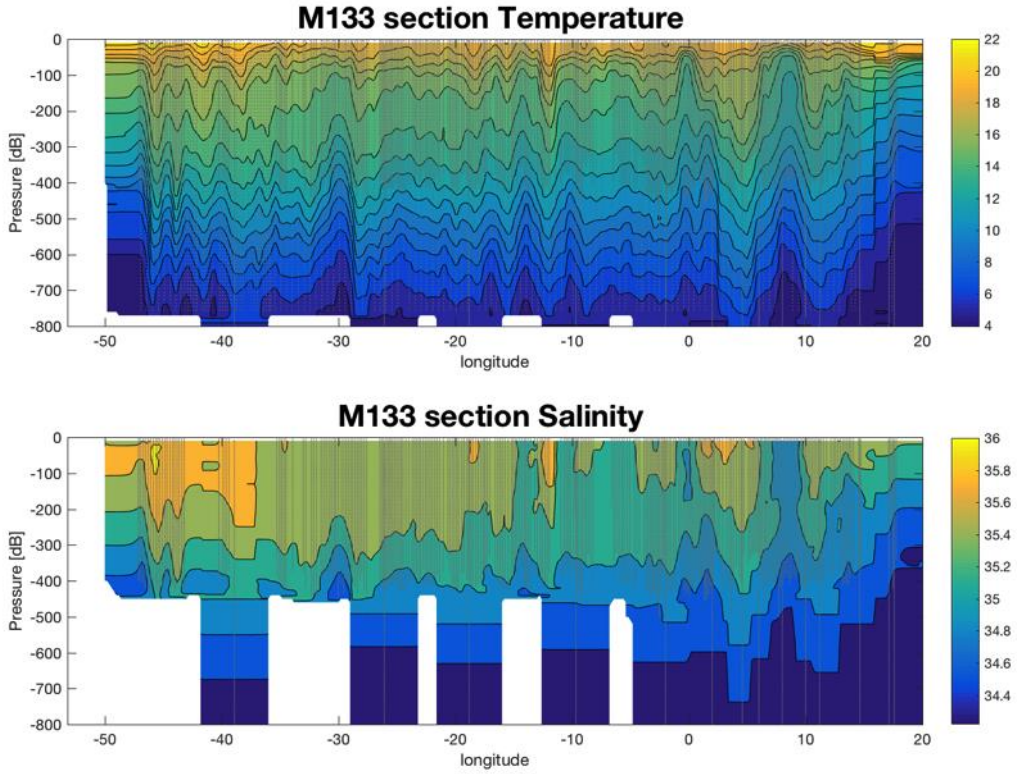

Figure 5.1.1 Top 800 dbar temperature and salinity section along 34.5°S across the Atlantic.

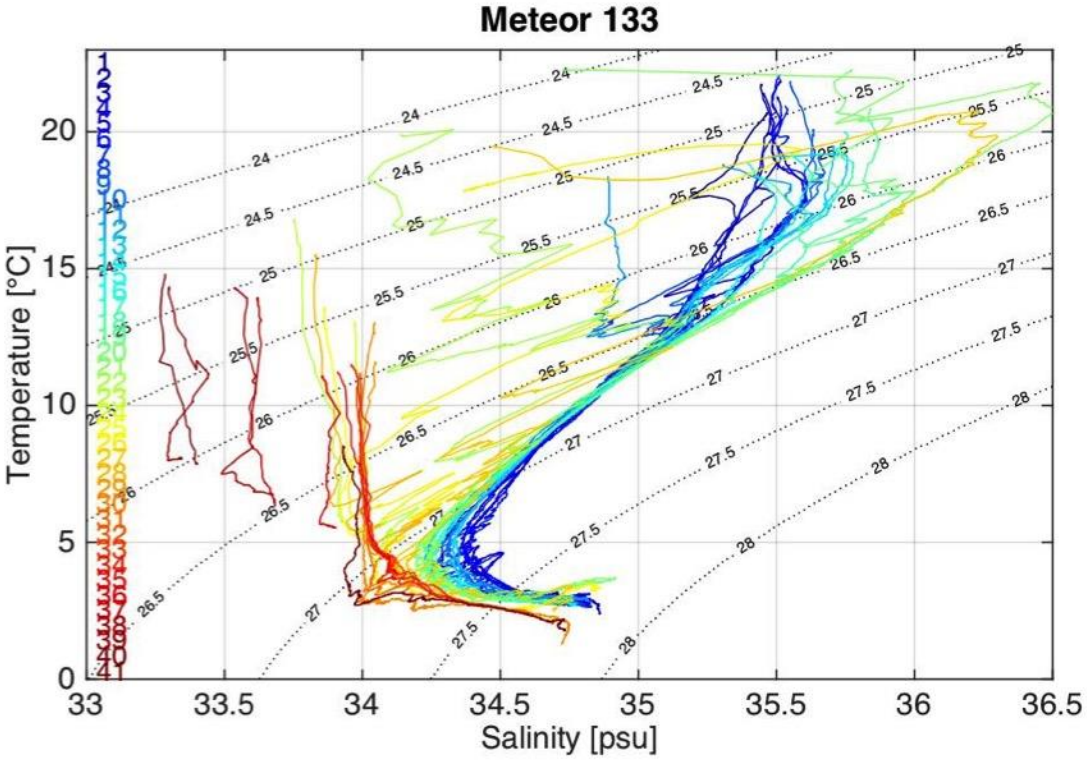

Figure 5.1.2 T-S plot with color coded profile numbers. (Temperature is potential temperature)

5.2 Measurements of Dissolved Oxygen

(PI: Tobias Hahn)

Observing and understanding the concentration of dissolved oxygen in the ocean is one of the key objectives in present oceanography. While the CTD system is capable of measuring dissolved oxygen in the ocean at high vertical resolution, the sensors need to be carefully calibrated. Thus high quality reference observations are essential. Most measurements were done by Tobias Hahn, but all interested cruise participants were given the opportunity to measure an oxygen duplicate sample that they also took from a Niskin bottle themselves.

5.2.1 Oxygen measurements

A total amount of 245 discrete water samples were taken from selected depths of 29 CTD casts for oxygen measurements in seawater by Winkler titration. Samples were taken with 100 ml wide necked WOCE glass bottles with well-defined volumes (calibrated flasks: matched pair of flask and stopper) in order to calibrate the SBE43 oxygen sensor attached to the CTD. Oxygen samples were taken immediately after the CTD cast was finished and always at first. It was ensured that the sample bottles were flushed with at least 3 times its volume and the samples were free of air-bubbles. Immediately after sampling, the seawater samples were spiked from the bottom with the fixation solution (NaOH/NaI and $MnCl_2$) and shook vigorously for at least 30 seconds.

At each CTD cast, at least one triplicate from one of the Niskin bottles was taken in order to quantify sampling and titration uncertainties. Additional 247 water samples were analyzed from the underway system (see chapter 5.6 for further details) to (partly) calibrate and verify the underway oxygen sensors.

Oxygen was determined by Winkler titration within a minimum of 40 minutes and a maximum of 16 hours after sampling following standard protocols (Langdon, 2010). The concentration values were reported in $\mu mol \cdot L^{-1}$. The precision of the Winkler-titrated oxygen measurements (1σ) was $0.39\ \mu mol \cdot L^{-1}$ based on 2 duplicates and 33 triplicates, and $0.29\ \mu mol \cdot L^{-1}$ for the underway samples based on 120 duplicates, respectively. Both precisions are arithmetical averages of all standard deviations per replicate.

Standard measurements for the determination of the thiosulfate factor were carried out every one to two days depending on the volume of thiosulfate utilized since the last standard measurements.

5.2.2 Measurement setup

All titrations were performed according to the procedure set provided by our lab technician Frank Malien (GEOMAR). Therefore, the following listed reagents were used during this cruise:

- Sulfuric acid (50%)
- Zinc iodide starch solution (500 mL, Merck KGaA)
- Stock solution, pre-weighted: sodium thiosulfate pentahydrate ($49{,}5\ g \cdot L^{-1}$); stock solution was diluted by a factor of 10 to create the working solution ($0.02\ mol \cdot L^{-1}$)
- Fixation solution, all pre-weighted: manganese(II)chloride ($600\ g \cdot L^{-1}$), sodium iodide ($600\ g \cdot L^{-1}$) and sodium hydroxide ($320\ g \cdot L^{-1}$)

- Standard solution, pre-weighted: potassium hydrogen diiodate (0,325 g · L^{-1}, homemade)

Titrations were performed within the WOCE bottles using a 20 mL Piston Burette (No. 00692888) TITRONIC universal from SI Analytics GmbH. Dosing accuracy reported by the company is 0.15%, referred to the nominal volume, indicated as a measurement uncertainty with a confidence level of 95%. The iodate standard was added with a 50 mL Piston Burette (No. 00692869) TITRONIC universal SI Analytics GmbH. 1 mL of the fixation solutions (NaI/NaOH and $MnCl_2$) were dispensed with a high precision bottle-top dispenser (0.4 - 2.0 mL, Ceramus classic, Hirschmann).

5.2.3 Titration procedure

The titration procedure for each measurement was the following:

1) Switch on Piston Burettes and clear the system (dosing tubes) from air bubbles
2) Determine factor of the thiosulfate working solution by titrating the homemade standard between 3 to 5 times on a daily basis/every two days at maximum
3) Measure the actual Winkler samples
4) Analyze the reagent blank at the beginning and the end of the research cruise

Note: 5 invalid oxygen samples due to possible sampling (air bubble entry during fixation), storing (air bubble) and measuring failures were recorded. Results derived from those measurements were not considered in the final data evaluation. With respect to the amount of duplicates and triplicates, 172 valid oxygen data points can be used for the calibration of the CTD system.

5.3 Underway Measurements Vessel Mounted ADCP

(Patricia Handmann and Gaston Manta, PI: Martin Visbeck)

Underway-current measurements were performed continuously throughout the whole cruise using one vessel mounted Acoustic Doppler Current Profilers (VMADCP). The 38 kHz ADCP was not used due to technical issues that could not be resolved before the cruise.

5.3.1 System Setup

The METEOR 75kHz RDI Ocean Surveyor (OS75) mounted in the ship's hull was used. VmDas Version 1.46 was collecting the data. The 75 kHz ADCP was turned on 15nd December 2016. The Instruments then worked well and produced good data for the whole duration of the cruise. The OS75 is aligned at 45 degrees on the ship's bug.
The 75kHz ADCP was run in the more robust and less resolving narrowband (NB) mode.
The configurations of the instrument OS75 is 100 bins of 8m, pinging at 60 times per minute.
Depending on the region and sea state, the ranges covered by the instrument is around 800m. During the entire cruise the SEAPATH navigation data was of high quality. Most shipboard acoustic devises were switched *off* during the cruise to avoid acoustic interference. However, the 12kHz echosounder EM122 was in use during the whole cruise and delivered high quality bathymetry data without noticeable interference. On Multinet stations the Dolok System was

switched on, but no significant interference and data pollution could be found. Logging for the EM122 data started on 15th of December 2016. One strong source of noise which affected or even destroyed the OS75 data, due to the position in the ship hull, was the bow thruster during stations. VMDAS software was used to configure the VMADCPs and to record the VMADCP data as well as the ships navigational data. The data were processed on board and a preliminary data set was used for a number of near real time velocity products.

5.3.2 Exemplary Results

ADCP preliminary data processing is showing a turbulent and eddy rich flow throughout the whole cruise. The map in Figure 5.3.1 shows the mean velocity between 0 m and 100 m. At the transect line at 34.5°S. On the transect no strong current bands were crossed, thus the magnitude of the velocities in the upper 100m were between -0.5 m/s and 0.5 m/s. In Figure 5.3.2 the mean velocity of the upper 100m was plotted near Cape Town. An anticyclonic Agulhas eddy was crossed with an angle of about 30°. Figure 5.3.3 depicts the upper 100 m currents close to South America. High speed currents up to 1 $m.s^{-1}$ coming from the north between 33 and 40°S are associated with Brazil current. Between 40 and 45°S northerly flux is associated with the Malvinas current. In the confluence zone, where both currents meet, at around 38°S, different directions and intensity vectors associated to the turbulence of the confluence zone can be detected. Weaker southerly currents on the Patagonian shelf between 45 and 48°S were also observed.

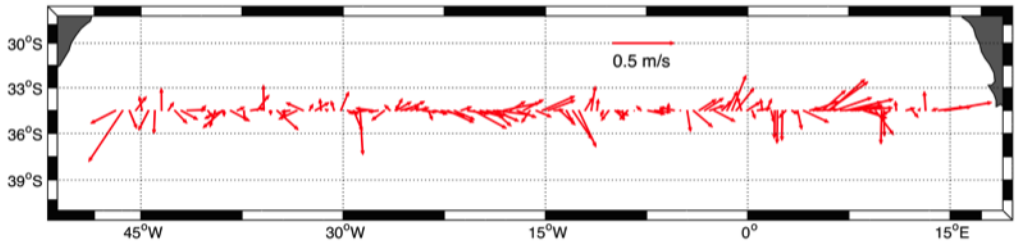

Figure 5.3.1 The Current direction and velocity obtained from the 75kHz ADCP along the transect along 34.5°S.

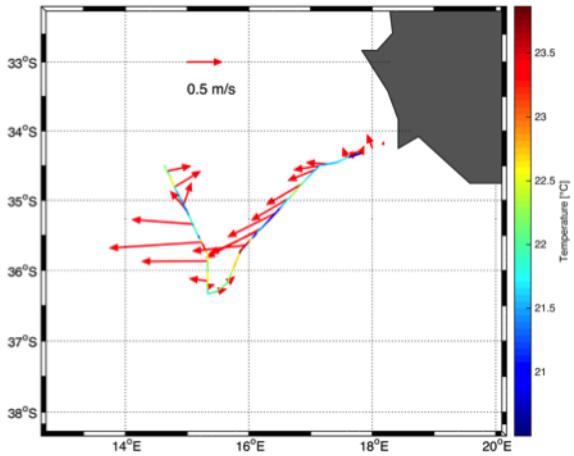

Figure 5.3.2 The current direction and velocity obtained from the 75kHz ADCP of the M133 cruise near Cape Town. Shaded colors show the measured temperature at 5 meters depth from the thermosalinograph.

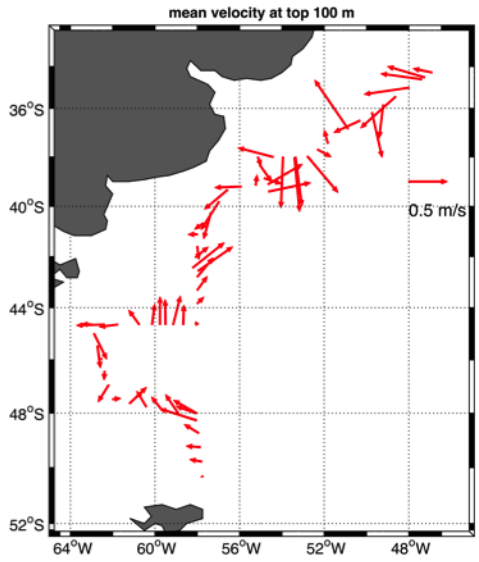

Figure 5.3.3 The current direction and velocity obtained from the 75kHz ADCP of the M133 cruise in the Southwestern Atlantic. The vectors show an average of the upper 100 meters near the Argentinian and Uruguayan coast.

5.4 Underway profiling – uCTD and XBT observations

(Patricia Handmann, Andreas Pinck, Daniela Risaro, Léa Olivier, PI: Martin Visbeck)

5.4.1 uCTD

An Oceanscience UCTD 10-400 system was used during the cruise to make measurements of upper ocean temperature and salinity while underway. The system consists of a CTD probe with a tail spool, on which the desired length of line is spooled on using a rewinder. The probe free falls through the water column, sampling temperature, conductivity and pressure at about 16 Hz Deployment and recovery of the probe are done using a winch and small davit that form part of the UCTD system. Data is recorded internally and uploaded via Bluetooth connection.

During the M133 science cruise, three different uCTD probes were used: SN 238 (probe-1), SN 054 (probe-2) and SN 192 (probe-3). On the uCTD transect, the probe SN 238 (probe-1) was used approximately every hour to do a 400 m profile of temperature and salinity. Probe-1 was lost during cast 233, on the 28th of December until the end of the cruise probe SN 54 was used. The spool was not switched to “locked” at the end of the free fall, and so the winch did not have enough power to recover the probe. The probe SN 054 (probe-2) was then used until the end of the cruise. The new line spooled onto the winch was attached with a ring-splice, to mitigate the possibility of losing the second probe by spooling too much line of the winch.

A total of 334 uCTD casts were completed during the cruise, from the 15th of December to the 9th of January 2017 (See table 5.4.1.1). Most of the profiles were done to a target depth of 400 m (385 m line spooled on, free-fall time of 100 s), except near the South African and the

Argentinian shelf where we performed shallower profiles. The depth reached by the probe varied but was generally within about 20 m of the target depth.

Table 5.4.1.1 Probe (serial number, SN) used for the mentioned profiles

SN	Profile number
238	1-233
54	234-334

No Pre-processing of the data was done. The raw uncalibrated data was controlled and the Temperature and Salinity at 6m were compared to the TSG data, which was calibrated with the calibrated CTD data (See Figure 5.4.1.1 and 5.4.1.2). Position Data was gained by matching up the uCTD profile times to the DAVIS Ship-data record.

Eight calibration casts were performed with the uCTD probes attached to the rosette during regular CTD casts to 2000 m depth and the data will be used to obtain a final calibration of the system (See table 5.4.1.2). Since probe 238 was lost, two calibration casts were performed with probe SN: 54 on CTD 19 and 20. For the usage of the uCTD probe on the rapid Cast System later on the cruise, the later calibration casts were always performed with probe SN 54 and SN 192 attached. All three probes were stable in their data collection.

Table 5.4.1.2 Probes (serial number, SN) mounted on the listed CTD casts for calibration

SN	CTD Cast
238	8, 15, 18
54	8, 19, 20, 23, 27, 32
192	8, 23, 27, 32

Different minor problems were encountered during the survey such as knots on the lines (9) and bad or no transmission of data (3,6%). The two fingers guiding the rope during the recovery stopped working, leading to a stop in uCTD casts during 2 days, before the motor could be fixed.

5.4.2 Rapid Cast

The rapid cast system is a computer controlled winch system delivered by Teledyne Oceansciences. It is capable to acquire temperature and salinity profiles at full ship speed down with a temporal resolution of 4 to 5 minutes resulting in a spatial resolution of about 1.5km. It delivers a uCTD probe to a user-specified target while the vessel is underway, and retrieves the probe automatically. Payout behavior is precisely controlled to ensure the depth of the probe at all times The Rapid Cast was mainly used on the Argentinian shelf, to cover the frontal zone between the Malvinas current and the Brazilian current. On five continuous lines the Rapid Cast was used (see Table 5.4.2.1).

Table 5.4.2.1 Longitude and latitude of the conducted rapid cast sections

Line	**1**	**2**	**3**	**4**	**5**
Lon [°W]	55.07 – 54.6	53.75 – 53.89	55.56 – 56.45	58 – 58.06	60.17 – 62.96
Lat [°S]	38.24 -39.45	38.55 – 38.76	39.17 – 39.25	41.24 - 42.56	44.65 – 44.65

Two uCTD probes SN 54 and SN 192 were deployed alternatingly. During one hour, one probe was taking measurements while the other was charged and its data was retrieved. The profiles were from 60m to 140m deep.
After the water proof caps were forgotten, the pins of SN 54 were suffering some corrosion. The corrosion was scratched, cleaned and polished and the device is still working. 37 RapidCast profiles were collected during the cruise, for a total of 27.8-h of data.

SN	Profile number
54	1,3,5,7,11,13,16,18,20,22,24,26,27,29,30,31,33,36
192	2,4,6,8,9,10,12,14,15,17,19,21,23,25,28,32,34,35,37

Table 5.4.2.2 Probes (serial numbers, SN) used for the listed profiles

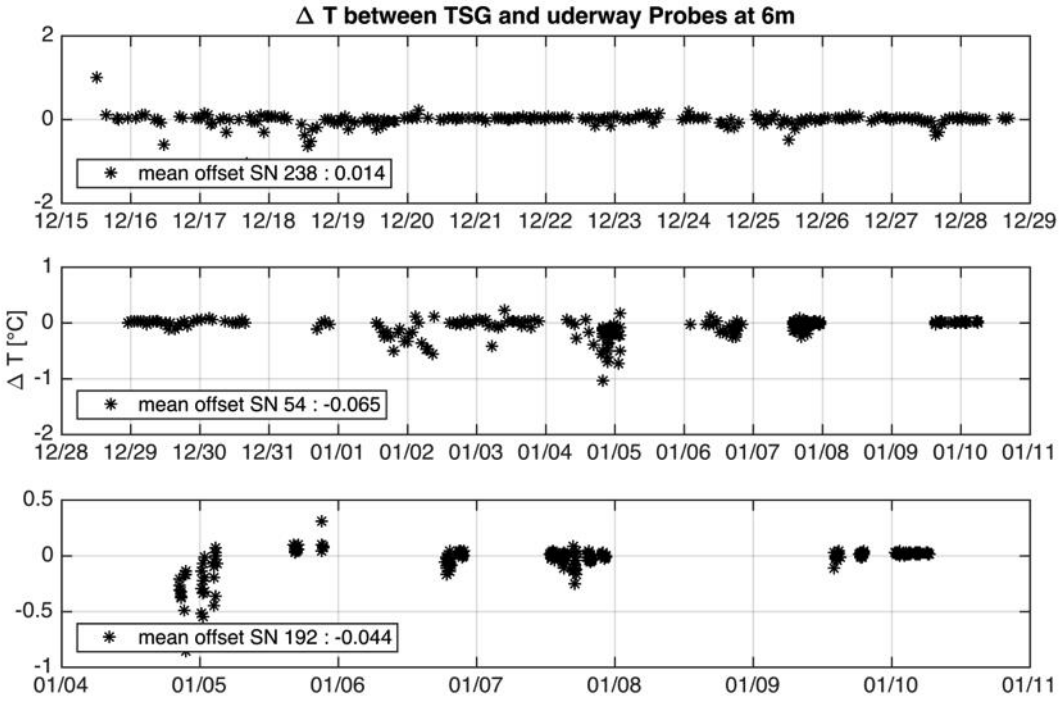

Figure 5.4.1.1 Temperature differences for all 3 uCTD probes over the duration of the cruise. The TSG Temperature was previously calibrated with the CTD data.

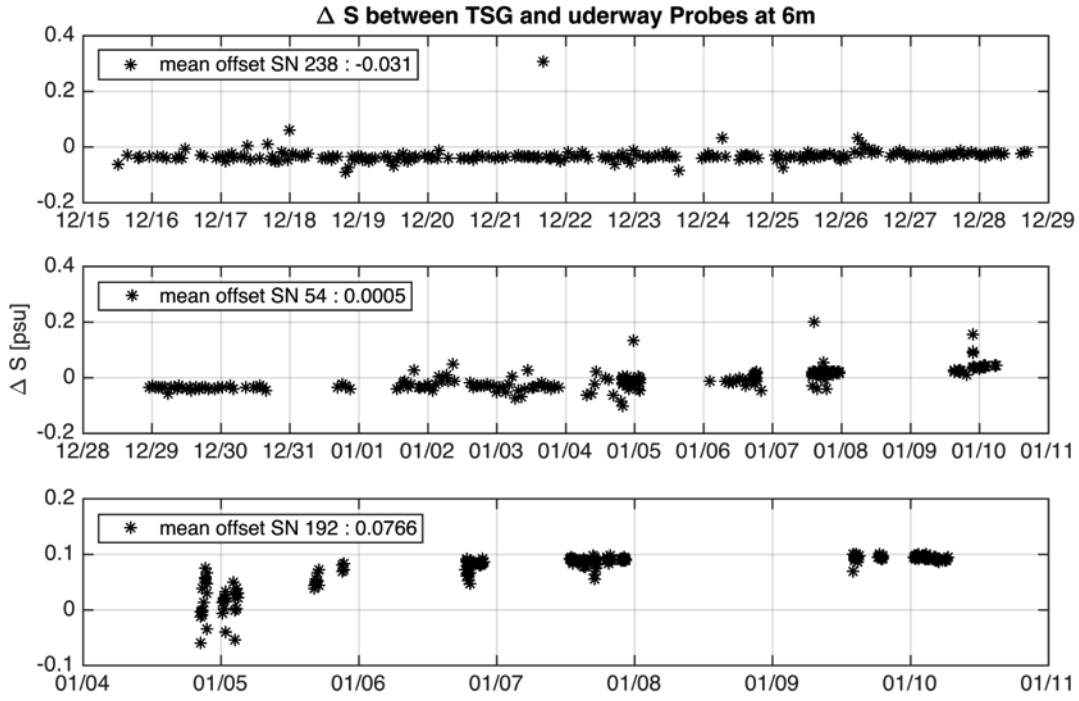

Figure 5.4.1.2 Salinity differences between TSG and uCTD probes. The Salinity of the TSG was calibrated with the CTD data previously to this calculation.

5.4.3 XBT

Expandable Bathythermograph (XBT) data was collected with a Launcher MK21 (S/N 246) owned by the RV METEOR. The data was recorded with the software WinMK21 v 3.02. The XBT is capable to acquire temperature at full ship speed to about 760m depth. During the whole cruise, we collected 213 XBT profiles. We have had about 20 failed probes during the cruise.

5.6 Continuous Underway pCO_2, O_2 and GTD Measurements

(Tobias Hahn, Clara Igelmann, *not onboard:* Tobias Steinhoff; PI: Arne Körtzinger)

A submersible pump and a temperature sensor (SBE38, SN# 3867264-0650, Sea-Bird Electronics Inc, Bellevue, USA) were installed in the ship's moon pool at approximately 5.70 m depth. The pump supplied a continuous flow of surface water which was distributed through a manifold to the various underway instruments (GO-pCO_2-System, flow-through box ("underway (UW) box"), SooGuard) and bypass for discrete sampling.

Underway measurements of surface water pCO_2 were performed using a commercially available GO-pCO_2 measuring system (Wetbox InvNr. 104661/104662 with LI-6252, Drybox InvNr. 100081, General Oceanics, Miami, FL). The instrument is described in detail in Pierrot et al. (2009). A calibration of the IR-sensor was performed approximately every three hours by using three different standard gases containing ambient air with different partial pressures of CO_2 (250.2, 449.6 and 512.6 ppm). The standard gases were calibrated against NOAA primary standards. After every control measurement, atmospheric pCO_2 was measured for several

minutes. Therefore air was pumped through a piping from the top of the ship. All temperature sensors were calibrated against international standards.

In addition 89 discrete samples for dissolved inorganic carbon (DIC) and total alkalinity (TA) were taken from the bypass and subsequently poisoned with $HgCl_2$ following the recommendations of Dickson et al. (2007). The discrete samples were analyzed in the laboratory at the GEOMAR in Kiel in May 2017. The data from the autonomous measurements of the GO-pCO_2-system started on Dec 15th 2016 at 12:17 UTC and stopped on Jan 12th 2017 at 12:38 UTC. The flow from the atmospheric tube was increased from 34 mL/min to 106 mL/min on Dec 19th 2016 at 19:37 UTC, hence atmospheric measurements from before have to be considered with care.

Underway measurements of surface water oxygen (O_2), total gas pressure (GTD) and salinity were carried out in a flow-through box. The following sensors were implemented: Oxygen optodes (model 4330, SN# 1082, Aanderaa Data Instruments AS, Bergen, Norway; model Hydroflash O2, SN# DO-0216-004, Kongsberg Maritime Contros GmbH, Kiel, Germany; model RINKO FT, SN# 0AG2002, JFE Advantech Co., Ltd, Hyogo, Japan), GTD Pro gas tension device (SN# 22-019-06, Pro Oceanus Inc., Bridgewater, Canada; turbulent water flow and mixing was ensured through an extra SBE5M pump (SN# 051137)) and conductivity sensor (model 4319, SN# 772, Aanderaa Data Instruments AS, Bergen, Norway). Temperatures were obtained from the optodes as well as the conductivity sensor. The underway measurements in the flow-through box without the Rinko FT were started on Dec 15th 2016 at 14:31 UTC and stopped on Dec 17th 2016 at 14:05 UTC. It was restarted with the RINKO FT on Dec 17th 2016 at 14:15 UTC and stopped on Jan 12th 2017 at 12:15 UTC. The measuring interval was set to one minute whereas the HydroFlash O2 recorded every 30 seconds.

Furthermore, the flow-through chamber SOOGuard was used in combination with a SMARTGUARD data logger (model 5300, SN# 20, Aanderaa Data Instruments AS, Bergen, Norway) in order to monitor oxygen, partial pressure of carbon dioxide, conductivity as well as chlorophyll a, turbidity and phycocyanin. The following sensors were operated: O_2 optode (model 4330, SN# 1365, Aanderaa Data Instruments AS, Bergen, Norway), pCO_2 optode (model 4797, SN# 68, Aanderaa Data Instruments AS, Bergen, Norway), conductivity sensor (model 4319, SN# 235, Aanderaa Data Instruments AS, Bergen, Norway) and fluorometer (model TriLux, SN# 2125-051-056, Chelsea Technologies Group Ltd, Surrey, UK). The underway measurements in the SooGuard except for the fluorometer were started on Dec 17th 2016 at 17:10 UTC and stopped on Jan 4th 2017 at 18:17 UTC with a measuring interval of one minute. The measuring interval was set to 30 seconds and the recording continued on Jan 4th 2017 at 18:25 UTC. All measurements were eventually stopped on Jan 12th 2017 at 11:54 UTC. The fluorometer running times with a measuring interval of one second are listed in the table 5.6. below.

Table 5.6. Running times of the fluorometer SN# 2125-051-056, measuring interval is one second.

Start	Stop	Status/Reason
Dec 28th 2016, 17:38 UTC	Dec 30th 2016, 17:22 UTC	Change of power supply
Dec 30th 2016, 17:24 UTC	Jan 4th 2017, 17:58 UTC	Technical problem with computer
Jan 4th 2017, 18:30 UTC	Jan 5th 2017, 6:08 UTC	Data transmitting issue
Jan 5th 2017, 6:12 UTC	Jan 10th 2017, 18:22 UTC	Power supply malfunction
Jan 11th 2017, 2:30 UTC	Jan 12th 2017, 11:25 UTC	End of measurements

247 oxygen (of which 2 are invalid), 47 salinity (of which 25 were measured) and 57 nutrient samples were taken from the bypass to compare, validate and partly (oxygen) or fully (conductivity sensors) calibrate these underway measurements. Oxygen and salinity samples were measured onboard using Winkler titration and the salinometer, respectively (see chapter 5.2 and 5.1.4 for further details). The nutrient samples were analyzed onboard M135 in March 2017.

These continuous underway measurements as described above further support instrument tests of new measurement systems which are extensively described in chapter 5.10. The complete underway setup is shown in Figure 5.6.

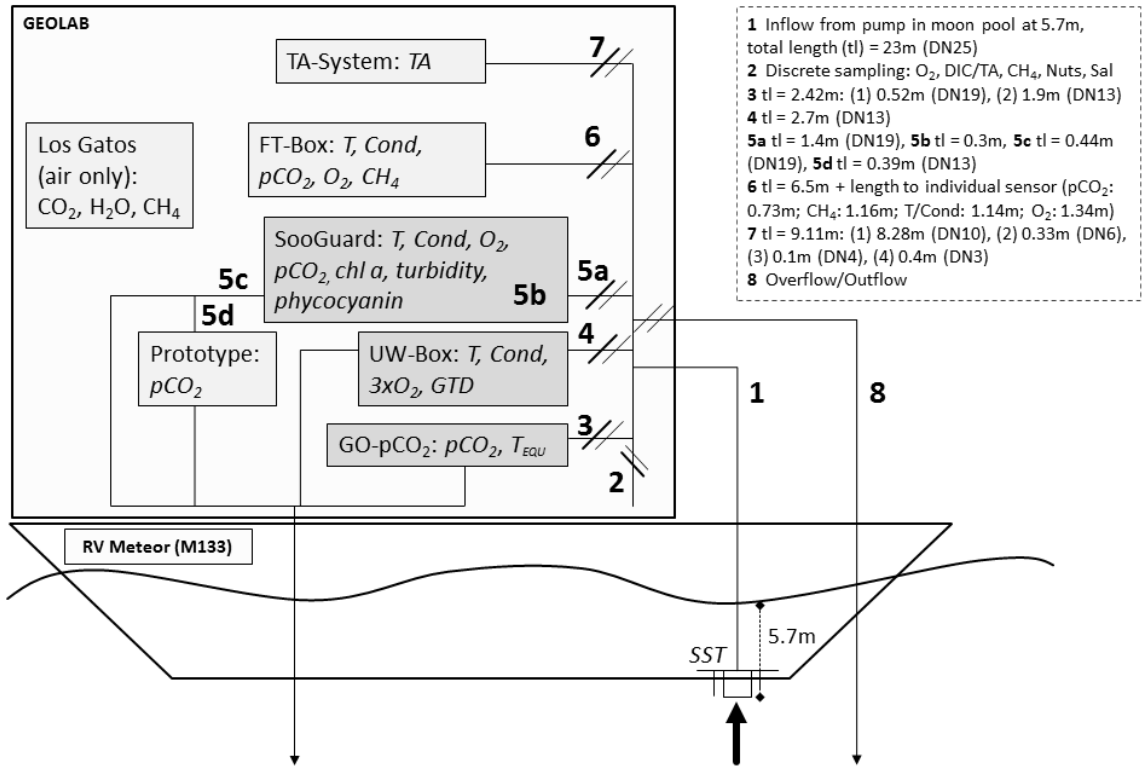

Figure 5.6 Scheme of underway setup during RV METEOR cruise M133; dark shaded boxes in the GEOLAB indicate established measurements as described in this chapter 5.6; light shaded boxes indicate instrument tests as described in chapter 5.10

5.7 Multi-Plankton-Sampler

(Michael Siccha, Jeroen Groeneveld, Heather Johnstone, Manuel Weinkauf, Maximilian Papp)

Planktic foraminifera for molecular genetic studies and habitat characterization were sampled with a Multi-Plankton-Sampler (MPS, HydroBios, Kiel). The used device has a 50 × 50 cm opening, 100 µm net mesh diameter and five net bags. Closing depths for all strict vertical hauls were based on depth readings from the pressure sensor on the MPS body. Lowering and hoisting was done at 0.5 m/s rope speed. The net bags were washed with sea water and inspected for damage after each MPS haul; the net cups were rinsed and cleaned between deployments. Three standard sampling depth schemes with fixed sampling interval boundaries were used; a deep cast with maximum depth of 700 m (700 – 500 – 300 – 200 – 100 – 0 m sampling interval boundaries), a shallow cast with a maximum depth of 100 m (100 – 80 – 60 – 40 – 20 – 0 m sampling interval boundaries), and an intermediate cast with a maximum depth of 500 m (500–300–150–80–40–0 m sampling interval boundaries).

A CTD M90 (*Sea and Sun Technologies, Trappenkamp, serial number CTD 979*) was mounted on the MPS body during all deployments. The instrument measured pressure, temperature, salinity and chlorophyll-*a* at pressure change intervals of 0.5 decibar. Oxygen and pH sensors were also included in the sensory array of the CTD, but review of the obtained data from these sensors showed that they did not measure correctly. Repeated attempts at re-calibration and repair of these sensors failed and all oxygen and pH measurements were thus discarded.

The MPS was also equipped with a side mounted water sampler with five 1.8 L Niskin bottles. The water sampler closed the bottles simultaneously with the opening of the MPS nets, that is at the base of each MPS sampling interval. Water sampled with the water sampler was analysed for pH and alkalinity (see Figure 5.7.3).

The MPS deployments were controlled via custom software. The software controlled the opening of the nets according to set sampling intervals and continuously recorded all parameters from the MPS and various parameters of the DSHIP system, such as wind speed, water temperature etc., broadcasted via a custom NMEA protocol. The co-registration of instrument depth, rope length and the ship's transversal and longitudinal speed through water allowed for some rough telemetry of the MPS position in the water during deployment (Figure 5.7.1).

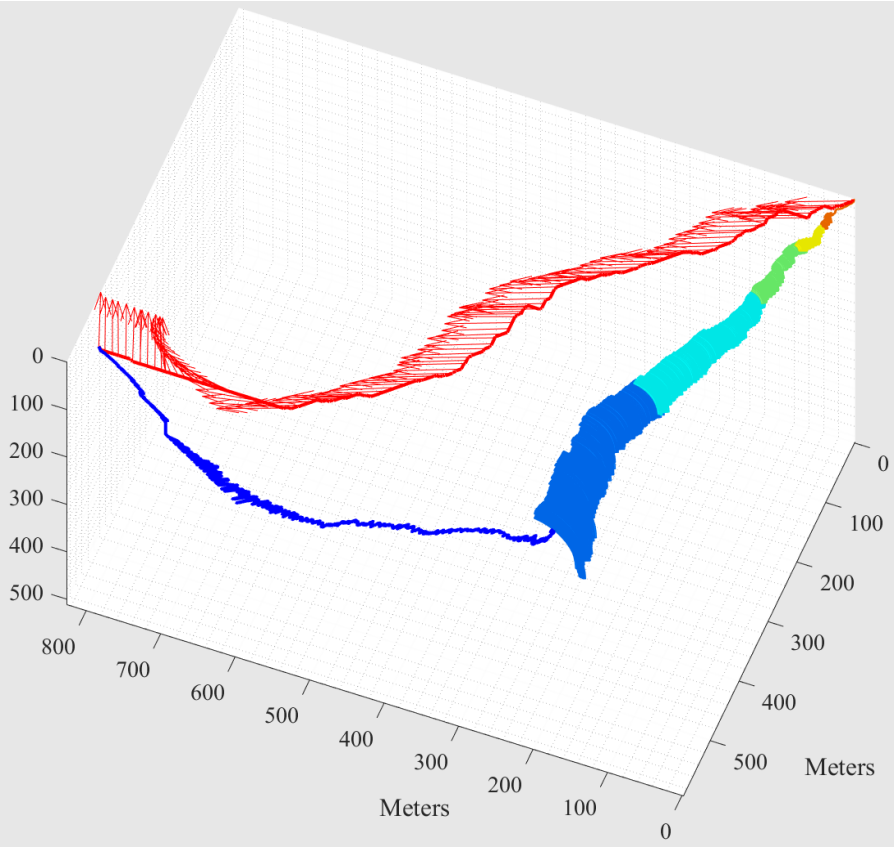

Figure 5.7.1. MPS telemetry at station MP11-3. The ship's path relative to the surface current and the ship's bearing are indicated in red. Downcast path of the MPS is displayed as a blue line; upcast path and approximated sampling area for the five nets are displayed as coloured arcs.

The plankton samples obtained from the MPS casts were examined in the ship's laboratory and the planktic foraminifera were extracted under stereo-microscopes and transferred onto micropaleontological cardboard sample slides. Due to time constraints and the sometimes difficult working conditions for microscopy on a ship, we did not attempt an identification on species level, but only recorded the number of individuals, and differentiated between live (with cytoplasm) and dead individuals (empty shells). For storage, these slides were deep frozen at -80 °C. The last sample (100 m – 0 m) of the deep cast is conserved as bulk concentrate for reference purposes. The samples of the third, intermediate depth MPS haul at each station were dedicated to the genetic analysis via Next-Generation-Sequencing (NGS). The obtained plankton concentrates from this MPS haul were filtered over 8-12 µm pore size cellulose filters in the vacuum filtration system. Larger organisms (>1 cm), such as Euphausiids, were manually

removed from the sample before filtration. The canisters and filter caskets were cleaned with ethanol between filtration of different samples to avoid contamination. The obtained filters were deep frozen and stored at -80 °C. All types of frozen samples will be shipped on dry ice via courier to the University of Bremen.

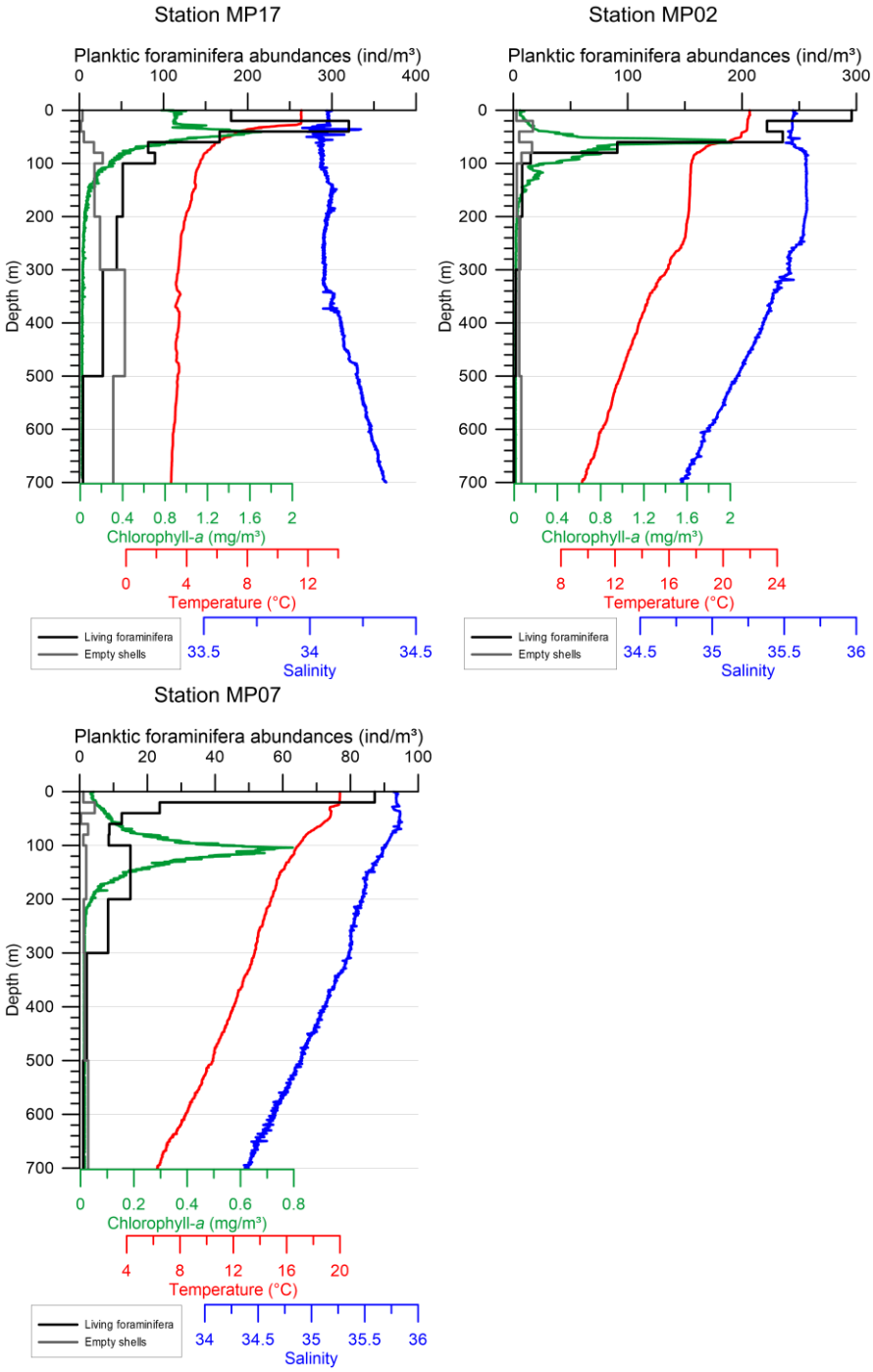

Figure 5.7.2
Example station plots of planktic foraminifera abundances, combining the deep and shallow casts, and the data from the MPS mounted CTD. MP02 was located in the sampled Agulhas ring, MP07 in the central South Atlantic and MP17 in the Malvinas Current.

Table 5.7.1. MPS station list

Date (UTC)	Ship station	Station	Latitude	Longitude	Casts (N)	Bulk samples (N)	Picked samples (N)	Env. samples (N)	Alk. samples (N)	Picked foraminifera
15/12/16	ME1330/1678	MP01	34° 22.98' S	017° 35.07' E	1	0	3	2	0	NA
16/12/16	ME1330/1685	MP02	36° 09.17' S	015° 40.02' E	3	1	9	5	5	7110
18/12/16	ME1330/1701	MP03	34° 30.04' S	011° 11.91' E	3	1	9	5	9	234
20/12/16	ME1330/1717	MP04	34° 30.03' S	004° 35.00' E	3	1	9	5	9	404
22/12/16	ME1330/1733	MP05	34° 29.99' S	001° 59.96' W	3	1	9	5	0	715
24/12/16	ME1330/1753	MP06	34° 29.87' S	009° 39.73' W	3	1	9	5	9	850
26/12/16	ME1330/1775	MP07	34° 30.22' S	018° 48.01' W	3	1	9	5	9	1752
28/12/16	ME1330/1793	MP08	34° 29.92' S	026° 04.50' W	3	1	9	5	9	3367
31/12/16	ME1330/1828	MP09	34° 30.04' S	038° 54.38' W	3	1	9	5	9	1210
02/01/17	ME1330/017	MP10	34° 42.21' S	047° 15.18' W	3	1	9	5	0	4491
04/01/17	ME1330/034	MP11	38° 01.13' S	053° 24.75' W	3	1	9	5	9	2745
05/01/17	ME1330/052	MP12	39° 29.63' S	054° 34.97' W	3	10	0	5	9	-
05/01/17	ME1330/056	MP13	38° 46.33' S	053° 57.38' W	3	1	9	5	7	4953
05/01/17	ME1330/058	MP14	38° 35.61' S	053° 48.17' W	3	10	0	5	5	-
05/01/17	ME1330/059	MP15	38° 33.37' S	053° 42.10' W	3	10	0	5	9	-
06/01/17	ME1330/061	MP16	38° 45.08' S	053° 53.36' W	3	10	0	5	9	-
07/01/17	ME1330/065	MP17	42° 33.92' S	057° 58.43' W	3	1	9	5	9	15595
08/01/17	ME1330/068	MP18	44° 39.00' S	057° 59.99' W	3	5	5	5	9	8262
11/01/17	ME1330/106	MP19	47° 59,94' S	058° 01,51' W	3	10	0	5	9	-

In total 19 stations were sampled with 55 individual MPS casts. The obtained plankton samples of twelve and a half of these stations were processed, i.e. the planktic foraminifera extracted, onboard the ship. The limited time between stations at the intense sampling effort conducted at the Brazil-Malvinas Confluence (BMC) made a full processing of all stations impossible. The first set of sampled stations formed a transect across the south Atlantic. The cruise track diverted south in order to pass through an Agulhas ring (ring #7) and station MP02 was located inside of the ring. Eight stations, MP03 to MP10, were situated on a transect between -18 ^{o} and 53 ^{o} west across the south Atlantic at ~34 ^{o} south. The next six stations (MP12 to MP18) aimed to capture the full range of surface water temperatures across the frontal zone of the BMC. The last station MP19 was taken on the final part of the transit towards the Falkland Islands.

Samples from the transit across the south Atlantic yielded between 234 and 4,491 foraminifera tests per station. The number was much larger in the sample from the Agulhas ring which gave 7,110 tests. Common species included *Globigerinoides ruber, Trilobatus sacculifer, Orbulina universa, Globorotalia scitula, Globorotalia truncatulinoides, Globorotalia menardii* and *Neogloboquadrina dutertrei.* Numbers of foraminifera were slightly higher in samples from the Malvinas confluence zone than in the transect across the Atlantic. The highest number of tests, 15,595, came from for the sample with lowest sea surface temperature (11.8 ^{o}C) in this set.

Common species included *Globigerina bulloides, Neogloboquadrina pachyderma* and *Turborotalita quinqueloba*. The lowest number of foraminifera tests, 2,745, came from the sample with highest sea surface temperature (22.3 ^{o}C). The number of tests obtained from the surface sample, taken from 0-20 m water depth, usually made up a significant portion of the total. The average contribution of this part of the sample to the total was 17%, but it varied between 3% in MP10 at the western end of the south Atlantic transect and 35% in MP18 from the BMC zone. There was no consistent relationship between maximum foraminifera abundance and the deep chlorophyll maximum. Highest numbers of foraminifera in a sample could occur above, e.g. MP07, or coincide, e.g. MP02 and MP17, with the DCM (Figure 5.7.2).

5.7.1 Alkalinity measurements

(Jeroen Groeneveld)

The aim of measuring alkalinity and pH throughout the water column was to broaden the available information, and hence potential impacts, on the incorporation of trace metals and isotopes into planktic foraminifera. Combining the CTD data with alkalinity and pH allows to calculate the different parameters of the carbonate system in the water column and its impact on, for example, Mg/Ca in foraminifera collected with the MPS. The effects of dissolution (low carbonate saturation state) and the carbonate ion effect (increasingly important for the incorporation of Mg in deeper living foraminifera species) are relatively well-known for benthic foraminifera, but the effect on planktic foraminifera is largely unknown. Determining these parameters will improve the calibration of foraminiferal test geochemistry vs. water mass conditions.

Water samples were taken from the MPS mounted water sampler. Additionally, occasional extra samples were taken from the deployments of the shipboard CTD water sampler rosette either to provide data for additional water depths or when the MPS mounted water sampler failed. For each cast up to ten samples were collected into 100 mL bottles, which were rinsed with MilliQ once and with the sea water to be sampled twice. Alkalinity determination should ideally be performed as soon as possible after collection. Starting with the deepest (i.e. furthest away from atmospheric equilibrium) sample, the pH was measured (TIM900 Titration manager Titralab, calibrated once a day), after which a manual titration was performed using 10 mMol HCl. At a pH between 3.5-4 the final pH was measured and alkalinity calculated. For each sample this procedure was repeated twice to calculate errors of determination. Combining the alkalinity and pH with the temperature and salinity data of the CTD the remaining parameters of the carbonate system can be calculated (i.e. dissolved inorganic carbon, carbonate ion concentration and saturation state, and the state of saturation (Omega)).

Initial alkalinity measurements resulted in anomalous results, which could be tracked back to the in-precise characterization of the HCl used (indicated as 30-33%). Switching to a different acid (HCl, 0.1M, Eydam) resulted in more realistic measurements. Additionally, before each station a certified standard (Reference material for oceanic CO_2 measurements – Batch 143, provided by K. Seelmann) was analyzed three times. Alkalinity of the samples was then normalized to this standard.

Table 5.7.2. Stations and sampled water depths for which alkalinity and pH were determined.

Station	Sampled water depths (m)
MP01	40, 80, 150, 300, 500
MP02	80, 100, 150, 200, 300
MP03	20, 60, 80, 100, 150, 300, 500, 700
MP04	20, 60, 80, 100, 150, 300, 500, 700
MP05	20, 40, 60, 80, 100, 150, 200, 300, 500, 700
MP06	20, 60, 80, 100, 150, 300, 500, 700
MP07	20, 60, 80, 100, 150, 300, 500, 700
MP08	20, 60, 80, 100, 150, 300, 500, 700
MP09	20, 60, 80, 100, 150, 300, 500, 700
MP10	10*, 20*, 60*, 80*, 100*, 150*, 300*, 500*, 700*, 1000*, 1500*, 2000*
MP11	20, 60, 80, 100, 150, 300, 500, 700
MP12	20, 60, 80, 100, 150, 300, 500, 700
MP13	20, 60, 80, 100, 150, 300, 500, 700*, 1000*
MP14	20, 60, 80, 100, 150, 300, 500, 700*, 1000*
MP15	20, 60, 80, 100, 150, 300, 500, 700
MP16	20, 60, 80, 100, 150, 300, 500, 700
MP17	20, 60, 80, 100, 150, 300, 500, 700
MP18	20, 60, 80, 100, 150, 300, 500, 700
MP19	20, 60, 80, 100, 150, 300, 500, 700

Asterisk (*) indicates water samples which were taken from the ship CTD water sampler rosette instead of the MPS mounted water sampler.

In a total of 159 samples (19 stations, 557 titrations including standards and test samples) alkalinity and pH were determined. Each sample was measured three times to calculate errors of determination of 0.035 µmol kg^{-1} (1.4%) for alkalinity and 0.017 (0.2%) for pH. The hydrochloric acid which was purchased for the titration (30-33%, Orlichem) did give unrealistic results, probably due to the incorrect characterization of the acid. Comparison with another, classified acid (0.1M HCl Eydam) revealed a bias of 12-21% in alkalinity using either the 30% or 33% indication. Stations MP01-05 were corrected for this difference, but absolute values may not be fully reliable. Further stations were all analyzed using the Eydam acid. The normalization correction to the “Batch 143” reference material varied between 0.03-7.73%.

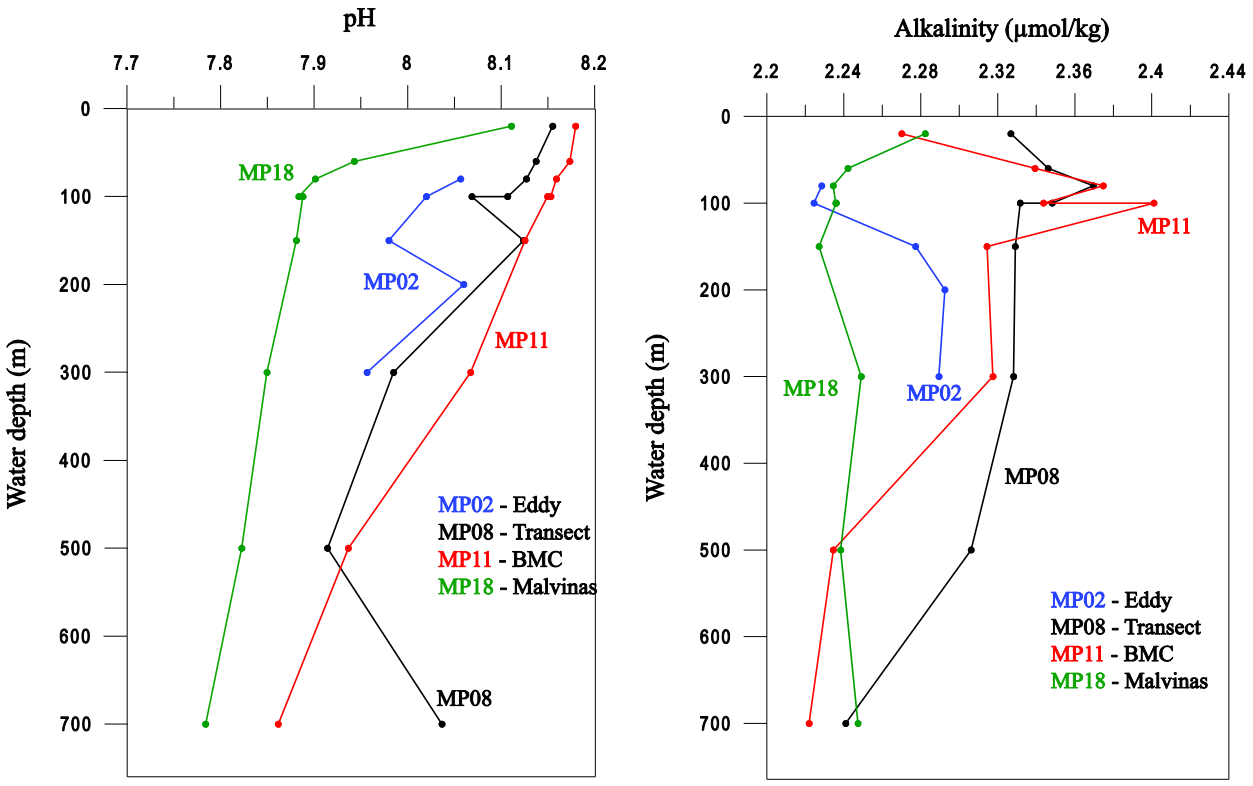

Figure 5.7.3 a) Typical pH profiles vs. water depth for the Agulhas ring (MP02), the transect across the South Atlantic (MP08), the Brazil-Malvinas Confluence Zone (BMC; MP11), and the Malvinas Current (MP18); **b)** Typical alkalinity profiles vs. water depth for the Agulhas ring (MP02), the transect across the South Atlantic (MP08), the Brazil-Malvinas Confluence (BMC; MP11), and the Malvinas Current (MP18)

pH values were with 8.1 to 8.2 highest at the surface and depending on station either decreased within 50 meters (e.g. MP18, south of the BMC) to <8 or remained >8 down to 200-300 m water depth (e.g. MP11) (Figure 5.7.3a). In general water masses south of the BMC are lower in pH than north of the BMC and across the South Atlantic. Characteristic alkalinity profiles can be separated into four areas, i.e. the Agulhas eddy, the South Atlantic transect, the Brazil-Malvinas Confluence (BMC), and the Malvinas Current area. Alkalinity north of the BMC is generally higher than south of the BMC and decreased with water depth. In the BMC zone itself, a low alkalinity surface layer could be distinguished, probably related to the presence of Rio de La Plata river water.

5.7.2 Water sampling for oxygen and hydrogen isotopes

(Jeroen Groeneveld)

Samples for the analysis of stable oxygen and hydrogen isotopes in sea water were taken daily. Samples were roughly taken at the same time (early evening UTC time) from the sea water tap in the laboratory (approx. 5 m water depth). Samples were stored in 2 mL glass vials which were rinsed three times with sea water. Additionally, the sample vials for hydrogen isotopes were sterilized before rinsing using a butane gas-burner. Samples were stored in a fridge. A total of 27 samples for both oxygen and hydrogen isotopes were taken.

Table 5.7.3. List of oxygen and hydrogen sample stations.

O Sample	D Sample	Date	Time (UTC)	Latitude	Longitude
d18O-1	deltaD-1	16/12/2016	16:50	36°10.18' S	015°39.40' E
d18O-2	deltaD-2	17/12/2016	16:30	34°30.00' S	014°2.23' E
d18O-3	deltaD-3	18/12/2016	18:35	34°30.02' S	010°00.09' E
d18O-4	deltaD-4	19/12/2016	17:25	34°30.00' S	006°31.53' E
d18O-5	deltaD-5	20/12/2016	17:10	34°30.00' S	003°33.23' E
d18O-6	deltaD-6	21/12/2016	16:45	34°30.00' S	000°24.61' E
d18O-7	deltaD-7	22/12/2016	18:10	34°30.00' S	002°48.37' W
d18O-8	deltaD-8	23/12/2016	18:20	34°30.00' S	007°12.95' W
d18O-9	deltaD-9	24/12/2016	18:40	34°30.00' S	010°52.21' W
d18O-10	deltaD-10	25/12/2016	22:50	34°30.00' S	015°57.67' W
d18O-11	deltaD-11	26/12/2016	22:15	34°30.00' S	019°50.07' W
d18O-12	deltaD-12	27/12/2016	19:50	34°30.00' S	023°56.81' W
d18O-13	deltaD-13	28/12/2016	21:25	34°30.00' S	027°20.33' W
d18O-14	deltaD-14	29/12/2016	21:45	34°30.00' S	031°53.16' W
d18O-15	deltaD-15	30/12/2016	19:50	34°30.00' S	036°04.48' W
d18O-16	deltaD-16	31/12/2016	21:45	34°30.00' S	040°24.81' W
d18O-17	deltaD-17	01/01/2017	20:30	34°30.01' S	044°38.65' W
d18O-18	deltaD-18	02/01/2017	22:50	35°40.51' S	048°54.23' W
d18O-19	deltaD-19	03/01/2017	19:40	37°37.56' S	052°11.18' W
d18O-20	deltaD-20	04/01/2017	02:24	38°22.00' S	055°01.50' W
d18O-21	deltaD-21	05/01/2017	12:00	38°33.39' S	053°42.08' W
d18O-22	deltaD-22	06/01/2017	20:10	39°13.17' S	056°08.14' W
d18O-23	deltaD-23	07/01/2017	20:40	42°17.53' S	058°11.27' W
d18O-24	deltaD-24	08/01/2017	21:10	44°38.91' S	058°03.07' W
d18O-25	deltaD-25	09/01/2017	21:45	44°39.06' S	061°27.93' W
d18O-27	deltaD-27	11/01/2017	22:14	48°00.02' S	058°02.23' W
d18O-28	deltaD-28	12/01/2017	21:22	51°19.29' S	057°37.25' W

5.8 Microplastics

(Jaqueline Trassierra, Clara Igelmann, Anna Frühling, Heather Johnstone, Elisabeth Thölken)

During the RV Meteor Cruise M133 microplastics were counted along the 34°S transect between Cape Town and the Shelf of Argentina. The main objective was to compare the numbers of microplastics found along different stations, particularly focusing on eddies and the plastic gyre found in the Atlantic Ocean (Figure 5.8.1).

A procedure established during M124 was largely followed where by remnants of the foraminifera samples collected on the M133 cruise were used to analyse the microplastic numbers. Samples from the upper 100 meter catches were analysed. Five different depths were collected, 100-80m, 80-60m, 60-40m, 40-20m and 20-0m. Each depth sample was sieved through a 100micron sieve and transferred into a glass cup to minimise the volume of sample. A 2ml glass pipette was used to transfer part of the sample into a small glass container. The

containers were then placed under a stereo microscope and microplastics were counted. Plastic counts were split into microfibers and primary/secondary microplastics (Table. 5.8.1).
A total of 9 sites were sampled with 5 depths per site. A total of 1035 microplastics was counted with microfibers making up 85% of the total count. Primary and secondary microplastics only accounted for 15% of the count.

Total numbers of microplastics were added up to give a total count per site (Figure 5.8.2). The first station at 36°09'S and 15°40'E and was positioned in an eddy showed the highest number, 289, of microplastics.
The average number of microplastics per depth range was compared and shows a decrease in microplastics with depth (Figure 5.8.3).
Numbers of microplastics could be off as there may have been contamination from the initial sampling of Foraminiferas. Ideally one would want a sample to come straight from the net and into an airtight glass container to avoid further contamination.

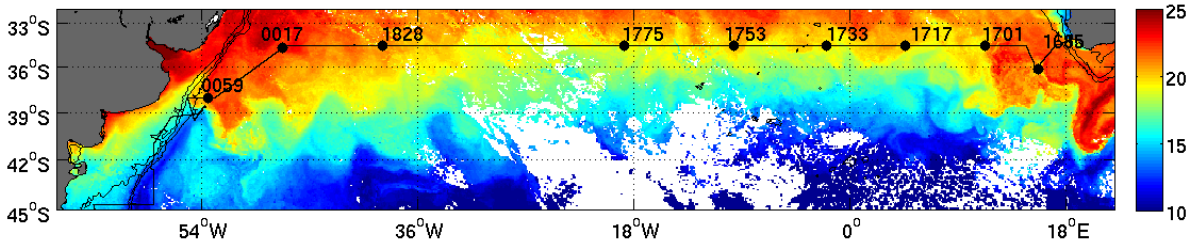

Figure 5.8.1 Station number and location of counted microplastics.

Table 5.8.1. Microfiber and primary/secondary microplastics counts for each station at the different depth ranges

Date	Site	Latitude	Longitude	Depth	Microfibers	Microplastics	Total
16/12/2016	1685	36° 09,14' S	015° 39,97' E	0-20	45	1	46
				20-40	122	2	124
				40-60	59	0	59
				60-80	29	0	29
				80-100	27	4	31
18/12/2016	1701	34° 30,01' S	011° 11,91' E	0-20	22	6	28
				20-40	8	0	8
				40-60	6	4	10
				60-80	11	1	12
				80-100	13	0	13
20/12/2016	1717	34° 30,03' S	004° 35,00' E	0-20	13	10	23
				20-40	20	0	20
				40-60	19	5	24
				60-80	11	13	24
				80-100	19	2	21
22/12/2016	1733	34° 29,99' S	001° 59,96' W	0-20	21	4	25
				20-40	16	0	16
				40-60	23	12	35
				60-80	19	7	26
				80-100	13	2	15
24/12/2016	1753	34° 29,87' S	009° 39,73' W	0-20	19	13	32
				20-40	31	0	31
				40-60	12	4	16
				60-80	23	1	24
				80-100	18	4	22

26/12/2016	1775	34° 30,22' S	018° 48,01' W	0-20	6	1	7
				20-40	5	0	5
				40-60	5	0	5
				60-80	12	0	12
				80-100	7	0	7
31/12/2016	1828	34° 30,04' S	038° 54,38' W	0-20	28	7	35
				20-40	28	0	28
				40-60	33	2	35
				60-80	22	0	22
				80-100	24	3	27
02/01/2017	0017	34° 42,20' S	047° 15,16' W	0-20	22	7	29
				20-40	3	1	4
				40-60	5	3	8
				60-80	10	0	10
				80-100	2	2	4
04/01/2017	0059	38° 33,26' S	053° 42,31' W	0-20	12	24	36
				20-40	12	1	13
				40-60	9	1	10
				60-80	1	11	12
				80-100	11	1	12

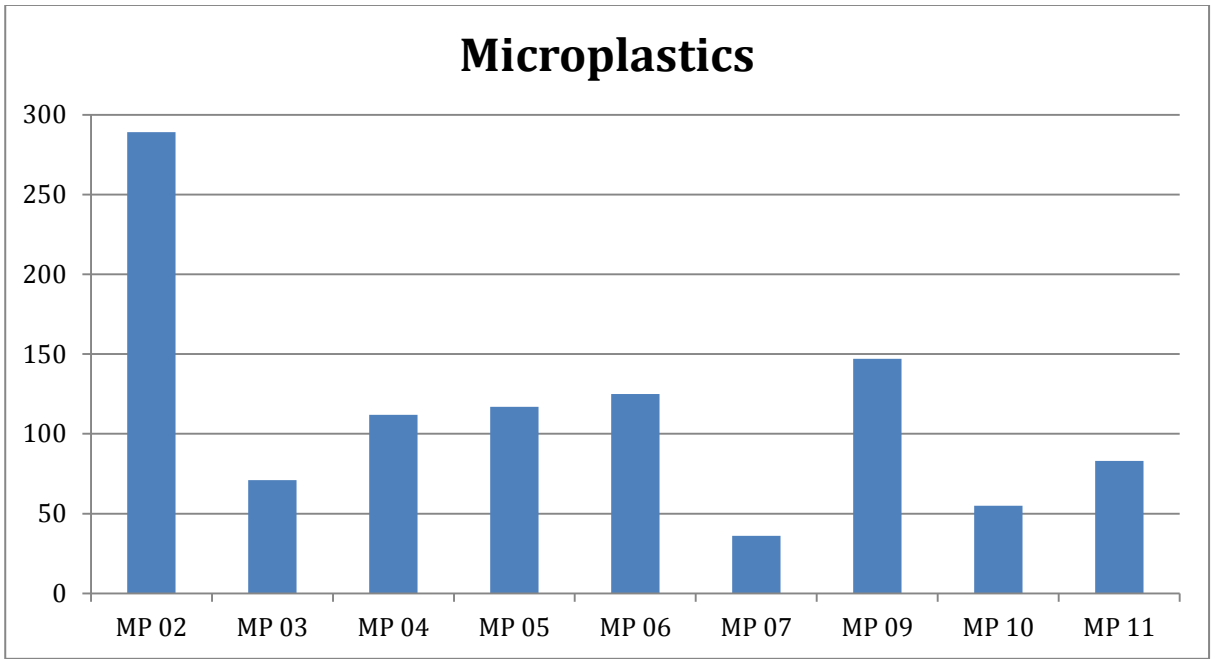

Figure 5.8.2. Total count of microplastics across the Atlantic transects.

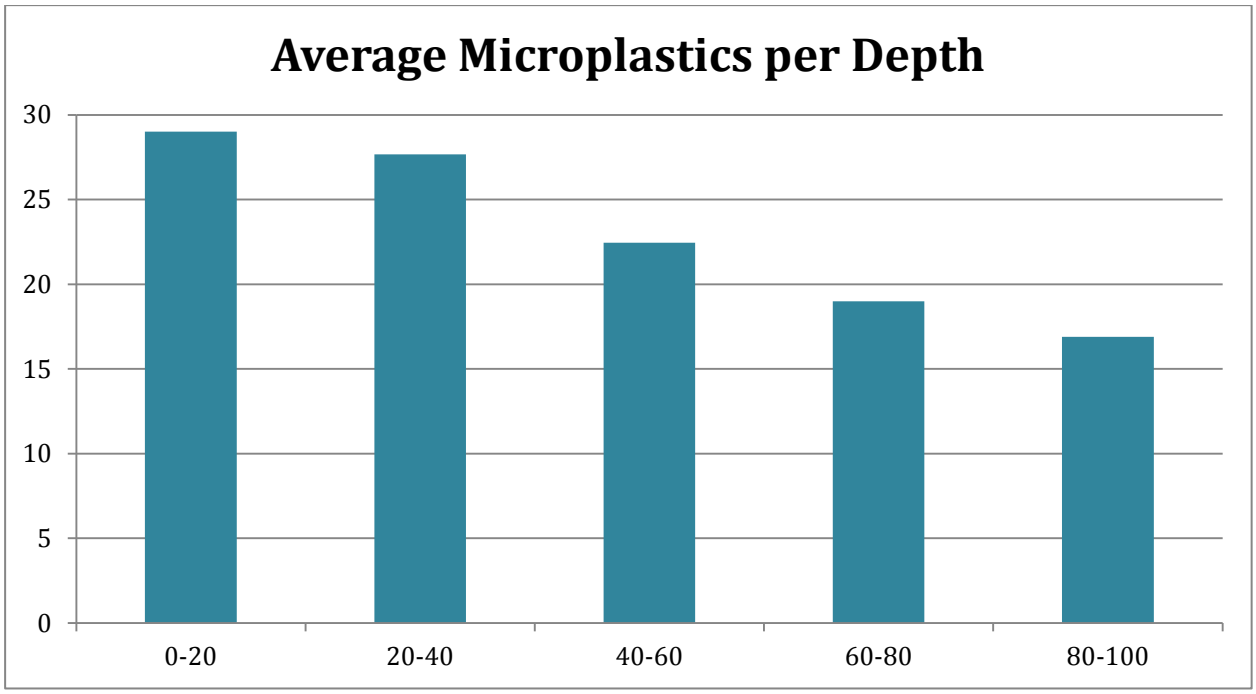

Figure 5.8.3. Total average of microplastics per depth range.

5.9 Phytoplankton Fixation

(Christine Falk)

The phytoplankton project was focusing on fixation procedures of phytoplankton on board of the Meteor for further analyses with the FlowSight System at Hannover Medical School (MHH). Thus, the core part of the project was to collect phytoplankton from different sources and procedures during the cruise and to test preservation methods suitable for stabilization of the samples in order to measure them later on at MHH. According to the literature using the Flow Sight or Image Stream systems for phytoplankton imaging using material derived from warf tows, formaldehyde fixation was superior compared to Lugol's solution or glutaraldehyde fixation. Therefore, we focused on paraformaldehyde fixation of phytoplankton obtained from water sampled of CTD Niskin bottles or MultiNet samples (collaboration with the foraminifera group of Michael Siccha Rojas & colleagues). Since fine-scale profiles of particle and zooplankton distribution were not possible due to technical problems of the Underwater Vision profiler (UVP), phytoplankton could be determined only by light microscopy. The major goal of this project was to generate a protocol for sampling and fixation of phytoplankton for further analyses using FlowSight or ImageStream (Amnis-Meck/Millipore©) systems at laboratories of GEOMAR, MHH and other institutes.

5.9.1. Phytoplankton – sources and microscopical characterization

Phytoplankton in the South Atlantic is of particular interest due to unique constellations in a) Agulhas Eddies migrating westwards in the South Atlantic and b) the Brazilian-Malvinas confluence zone and the near Patagonian shelf. Recent publications using modeling and in situ sampling of a young Agulhas ring indicated strong vertical mixing as one driving force for complex nitrogen cycling, shaping community metabolism and biogeochemical signatures as the

ring and associated plankton transit westwards. The peculiar local environment inside Agulhas rings is suggested in this study to provide a selective mechanism contributing to the limited dispersal of Indian Ocean plankton populations into the Atlantic (Villar et al, Science, 348:6237, 1261447-1, 2015). In a recent publication, the phytoplankton composition in the Patagonian shelf was investigated regarding the influence of the seasons and primarily flagellates, dinoflagellates, coccolithophores, haptophytes and chrysophycophyte (diatoms) were identified in this region and found to be associated with seasonal changes (Goncalvez-Araujo et al. Continental Shelf Research 124, 2016, 142–152, Goncalvez-Araujo et al., Journal of Plankton Research, 0: 0; 1–17, 2012). Therefore, we aimed to collect, concentrate and store water samples of one Agulhas Eddy that was approached at the beginning of the M133 cruise and samples of the Brazilian-Malvinas confluence zone and the Patagonian shelf (see station overview in Table 5.9.1).
Since the concentration of phytoplankton in CTD Niskin bottles turned out to be far too low for concentration by this mild centrifucation method, the main source of plankton during M133 was material obtained by a Multiple Plankton Sampler (MPS, HydroBios, Kiel) with 50 cm opening, 100 µm mesh size and 5 cod-ends, which allowed sampling of water at different depth ranging from deep water (700-300) m, shallower water (300-100 m) to surface water (100-0 m).

Table 5.9.1 Overview of sampling at M133 stations:

station	date	Source	depth	Fixation / volume	candidates for FlowSight
#1678	15.12.16	MultiNet tank A5 (wash out)	20 m	-	-
#1685	16.12.16	MultiNet tank A5 (wash out)	10 m		Y (n=1)
#1690	17.12.16	CTD tank A5		-	Y (n=1)
#1701	18.12.16	MultiNet (A1; B1)	700-80 m	1% PFA, 800µl	Y (n=1)
#1717	20.12.16	MultiNet (A1-4)	700-100 m	1% PFA, 800µl	Y (n=2)
#1733	20.12.16	MultiNet (A1-4, mix A1-4, B2)	700-80 m	1% PFA, 800µl	Y (n=8)
#1775	26.12.16	MultiNet (A1-4, mix B1-5)	700-10 m	1% PFA, 800µl	Y (n=3)
#1793	28.12.16	MultiNet (mix A1-4, mix B1-5)	700-10 m	1% PFA, 800µl	Y (n=2)
#1828	31.12.16	MultiNet (mix A1-2)	700-200 m	1% PFA, 800µl	Y (n=1)
#0017	02.01.17	MultiNet (mix A1-2, A3-4)	700-100 m	1% PFA, 800µl	Y (n=2)
#0034	04.01.17	MultiNet (mix A1-2, A3-4)	700-100 m	2% PFA, 800µl	Y (n=2)
#0056	05.01.17	MultiNet A5 (100µm filter)	100-0 m	2% PFA, 800µl	Y (n=2)
#0068	08.01.17	MultiNet B1-3; B4+5	100 – 0 m	2% PFA, 800µl	Y (n=4)

After picking foraminifera from these samples by the group of Michael Sichha Rojas, the remaining samples were collected, zooplankton and particles > 200-300 µm were removed by filtration through a gaze mesh. The procedure was standardized for 50 ml with 5-6 centrifugation rounds in 6 x 1.5 ml Eppendorf tubes in a microcentrifuge at 6000 rpm (~ 800g, 5 minutes) and collection of the pellets containing phytoplankton in 600-1000 µl sea water. Fixation was performed using 1-2% formaldehyde (PFA), which was diluted from 32-34% stock solutions. Storage was performed at 4°C in the dark. The relative density of phytoplankton was determined using a "Neubauer" cell counting chamber with defined volume of 0.0025 mm^2 and 0.100 mm depth resulting in minimal countable cell numbers of $1x10^4$ cells per ml. In MultiNet samples

from different stations, a broad spectrum of phytoplankton could be detected. In some samples, a remarkable enrichment of zooplankton (size < 100µm) could be observed and representative images of phytoplankton directly after centrifugation are shown in Figure 5.9.1 A. After 1-2 weeks of fixation in 1-2% PFA, new images were taken and the phytoplankton samples were assigned to the respective stations (Figure 5.9.1 B).

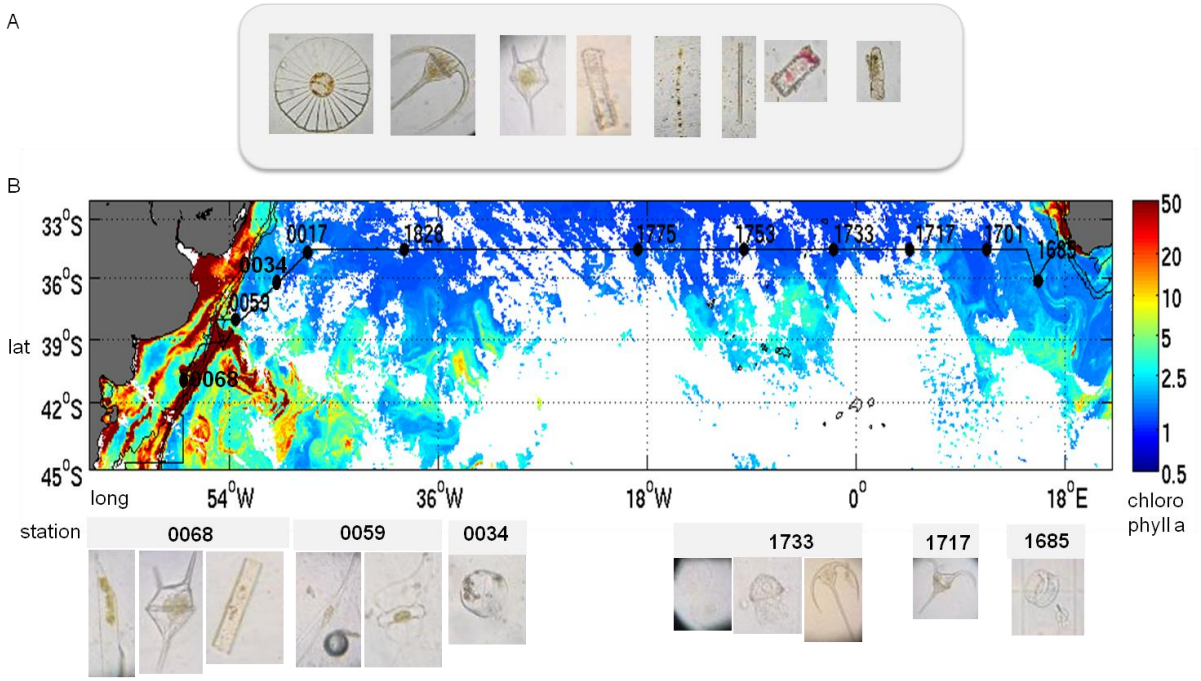

Figure 5.9.1 Representative images of phytoplankton and zooplankton obtained from several stations before (A) and after fixation (B). The MatLab map was coloured according to the chlorophyll a intensity obtained from climatology data (kindly provided by Daniela Risaro).

5.9.2 Technical information of the FlowSight / ImageStream technology for phytoplankton analyses

The FlowSight/ ImageStream technology represents a combination of flow cytometrforward scatter (FSC), sideward scatter (SSC) and colors that can be excited by 488nm such as fluorescein isothiocyanat (FITC), phycoerythrin (PE), allophycocyanin and others. The light microscope is simultaneously taking images from all events that are detected by the laser which allows a unique combination of flow cytometry statistics and imaging by light microscopy.

This technology was invented for combined analyses of cell morphology, function and fluorescence-based classification and, thus, the applications range from life science with respect to cell characterization and function to ocean science with respect to plankton biodiversity. For the investigation of phytoplankton, initial studies with samples obtained from *in vitro* culture of algae or phytoplankton isolated from wharf tow have demonstrated the feasibility of this technology for ocean and environment research (Traller et al., 2013). Besides morphological characteristics like cell shape, additional fluorescence-based parameters such as silica staining with Rhodamine123 or other dyes, i.e. Hoechst or Bodipy, can be added in order to allow staining of nuclei or other subcellular structures. Since neither the small Flow Sight, nor the

more advanced Image Stream system can be utilized on a moving ship due to the necessity of precise and tightly fixed spectral offset and image calibration, chemical fixation of phytoplankton on board followed by measurements with the FlowSight at the Institute of Transplant Immunology, MHH, remained the only choice for testing this method with samples collected from the south Atlantic Ocean.

5.9.3 Preliminary results

Therefore, the main purpose of the project on M133 cruise was to compare sample collection and fixation methods and to develop a protocol for sampling and storage of phytoplankton for subsequent measurement with the FlowSight.

In brief, the protocol is based on sampling using the MultiNet or other plankton net systems, filtering through gaze of plastic filters, followed by concentration through centrifugation at + 800g for 5 min in 5-6 consecutive rounds and collection in one tube with ca. 800-900µl phytoplankton solution, fixed by 2% formaldehyde.
At the end of the M133 cruise on January 12th 2017, all fixed samples were reevaluated with the light microscope in order to determine the integrity of the individual samples and selection of samples, suitable for shipment to MHH for subsequent analysis with the FlowSight system. Samples derived from stations 1685, 1717, 1733, 0034, 0059 and 0068 were chosen. Representative images are shown in Figure 5.9.1. The results of the subsequent FlowSight measurements at MHH will be available through C. Falk, MHH.

5.10 Instrument Tests for Underway Measurements

(Tobias Hahn, Anna Canning, Katarina Seelmann; PI: Arne Körtzinger)

Besides the established underway measurements as described in chapter 5.6, additional instrument tests of underway measurement systems were performed during M133. Each system is described in detail in the following sub-chapters. All systems are included in the underway measurement setup which is shown in Figure 5.6.

5.10.1 pCO_2 Optode Prototype

(Tobias Hahn)

A prototype of a planar pCO_2 mini-sensor spot Optode (*SN DCO2-1116-001,* PreSens batch SN: CD1-144001-01-OC_1510, calibrated at 987 hPa, Medium: 0.9% aqueous NaCl solution), Kongsberg Maritime Contros GmbH, Kiel, Germany) was directly installed after the SOOGuard chamber. Optical, continuous pCO_2 measurements with this prototype were carried out throughout the cruise in a self-made flow-through chamber with a simultaneous temperature recording. The measuring interval was30 seconds and all details of the running times are listed in Table 5.10.1.

Table 5.10.1. Running times of the pCO_2 optode prototype SN# DCO2-1116-001, measuring interval was 30 seconds; data between Dec 28th 2016 and Jan 5th 2017 is lost.

Start	Stop	Status/Reason
Dec 18th 2016, 5:18 UTC	Dec 28th 2016, 19:52 UTC	Data save and restart
Jan 5th 2017, 6:14 UTC	Jan 12th 2017, 11:42 UTC	End of measurement

5.10.2 Flow-Through System for pCO_2, O_2 and CH_4

(Anna Canning)

The purpose of the Flow-through system on board was to ensure and test if all sensors (stated below) ran precisely and accurately over a longer period of time. In addition discrete samples for Dissolved Inorganic Carbon (DIC) & Total Alkalinity (TA) as well as oxygen (O_2) (see chapter 5.6) and 36 Methane (CH_4) duplicates were collected on a regular basis to allow for sensor calibration. The DIC, TA and CH_4 samples will be analyzed back in the laboratory in Kiel.

The Flow-Through box containing Kongsberg Maritime CONTROS gas measurement sensors (model: HydroC pCO2 SN# CO2FT-1015-003, model: HydroC pCH4 SN# CH4FT-0416-001, model: HydroFlash™ O2 SN# DO-0516-001), measured pCO_2, pCH_4 and O_2 respectively from the surface waters, between 15.12.2016 17:37 UTC -11.01.2017 19:39 UTC. The surface waters were pumped in from the moonpool (see Figure 5.6) to a manifold within the geolab. The water was then split into 7 lines (including the outline and discrete measurement outflow), and flows set accordingly between the lab. Included was a SBE thermosalinograph (model: SBE 45 MicroTSG thermosalinograph, SN# 45-0559). They were all measured in unison every 60 seconds from 15.12.2016 UTC 17:37 until 5.1.2017 at approximately UTC 03:51. Due to higher rates of change in the water, the HydroC pCO_2 and HydroC pCH_4 resolution was changed to record every 1 second from 5.1.2017 at UTC 03:51 until 11.1.2017 UTC 19:38.

The flow for the HydroC pCO_2 and pCH_4 was run between 6-7.8 L/min, averaging around 6.7-7 L/min. The flow for the SBE and HydroFlash™ O_2 was controlled using pressure valves from a split off before the flow meter for the two HydroC's. The pressure valves had been set to a rough standard (SBE set to around 1L/min, and HydroFlash™ O_2 set up approximately +2 L/min), with the water flow observed via the data given and consistent observation of the pipe lines. All instruments were connected to one laptop via an external comport, with the data being collected every 2-3 days around midnight (depending on shift work and what the concentrations were looking like at the time). The structure itself held all sensors upright, with the membranes facing upwards. The HydroFlash™ O_2 was held within a Flow-Through casing of its own, holding roughly 1L of water, cone-shaped within so all water would flow out and with the intention no bubbles should be created within. The casing for the HydroFlash™ O_2 and Flow-Through box itself was built by Technology- and Logistic centre (TLZ), GEOMAR, Kiel, Germany.

The HydroFlash™ O_2 was logged using a program called TeraTerm VT, the SBE using the SeaTerm version 1.59, and the HydroC pCO_2 and pCH_4 using the CONTROS software: DETECT 2.05.

Shorthand Specifications:

HydroFlash™ O2
Logged every 60 seconds: 15.12.2016-11.01.2017
SN: DO-0516-001

SBE 45 MicroTSG Thermosalinograph
Logged every 60 seconds: 15.12.2016-11.01.2017
SN: 45-0559

HydroC CO_2
Logged every 60 seconds: 15.12.2016-11.01.2017
Logged every 1 second: 5.1.2017-11.01.2017
Programmed to:
Warm-up: 30 minutes
Zero: 2 minutes, send every 10 seconds
Flush: 10 minutes, send every 5 seconds
Measure: 480 minutes, send every 60s then every 1 second (see above)
No internal Logger
SN: CO2FT-1015-003

HydroC CH4
Logged every 60 seconds: 15.12.2016-11.01.2017
Logged every 1 second: 5.1.2017-11.01.2017
Programmed to:
Warm-up: N/A
Zero: N/A
Flush: N/A
Measure: 1440 minutes, send every 60s then every 1 second (see above)
Internal Logger Enabled
SN: CH4FT-0416-001

Software:
TeraTerm VT
DETECT 2.05
SeaTerm Version 1.59

Los Gatos

The Los Gatos (model: 908-00111-0002 SN# 12-0047) supported and ran alongside the instrument test. It was connected to a gas manifold measuring air concentrations of CO_2, H_2O and CH_4, with 3 connections to it: one from the lower deck just outside the Geolab door, facing

off the ship: One on the 3rd deck, connected to the walkway railing also facing off the ship and the third was connected to the reference gas (5ppm CH_4, 500ppm CO_2). It was set up for the following cruise (M134, Susan Mau, Bremen University, Germany), with only two real time air measurements taken (between 15.12.2016-11.1.2017). Each day the laser offset was checked and every other day the reference gas measured. Measurements were taken every 1 second. All data was collected for Bremen University, and retrieved after the cruise M133.

5.10.3 HydroC CO_2

(Anna Canning, Tobias Hahn)

Two HydroC CO2 (SN# CO2-1016-002 & SN# CO2-1016-003) were deployed on 8 CTD profiles. They were both connected to a battery pack (model: CONTROS HydroB SN# POW 1116-001) between Niskin bottle number 1 and 22 having removed numbers 23 and 24. They were programmed to:

Warm-up: 10-5 minutes (this was changed accordingly to when the CTD would be deployed)
Zero: 2 minutes, average 5 seconds, send and save every 10 seconds
Flush: 14 inutes, average 1 second, send and save every 1 second
Measure: 718 minutes, average 1 second, send and save every 1 second
Internal Logger Enabled

For profile 18 (28.12.2017), the first deployment, the logging was set up to one minute intervals with the battery not being sufficiently charged. This caused the sensors to have inadequate data/very little data in terms of resolution, yet nearly a whole profile. After the second deployment (Profile 19, 31.12.2016), CO2-1016-003 failed to log or connect to the laptop for data to be retrieved. Sensor CO2-1016-002 continued to log, however data had errors within. It continued to be logged and ran for profiles 20-25 (02.01.2017 - 05.01.2017), however after Profile 25, 05.01.2017 both sensors were removed from the CTD to be dried and looked at to see the problem. They were no longer used after this. Their data is deemed unreliable.

5.10.4 KM CONTROS HydroFIA TA System

(Katharina Seelmann)

In order to characterize the performance of the autonomous measurement system HydroFIA TA (SN#: TA-0615-001, Kongsberg Maritime Contros GmbH, Kiel, Germany) for the Total Alkalinity in seawater several experiments and continuous underway seawater measurements were carried out.

The experiments and measurements are explained in the following text and documented in Table 5.10.2. Problems, special observations and incidents are documented in Table 5.10.3.
Because the system was flushed with MQ-water for storage and transport a seawater Substandard which was taken onboard from the underway seawater flow was measured 30 times after the very first start to determine the drift after the long idle time of over 1 month. After the

measurements were stable (standard deviation < 2 µmol/kg) the system was calibrated with a Dickson Standard (Batch: CRM-143). After the change of the cartridges the system had to be recalibrated with the same batch of Dickson standard. Furthermore, the integration time of the spectrophotometer was adjusted from 0.04 seconds to 0.08 seconds to get higher intensities in the spectra.

To get more information about the behavior of the drift after a MQ-water flush the system was flushed with MQ-water and stood without any measurement for 48 hours. After that the Substandard was measured several times in row until stable TA values occurred (standard deviation < 2 µmol/kg).

To get some information about the behavior of the system under continuous measurement conditions the Total Alkalinity of steady pumped underway seawater (depth: 5 m) was measured when no special experiment was carried out. The measuring interval was 7 minutes. At the last third of the cruise it was extended to 10 minutes to save the chemicals in the cartridges (see Table 5.10.2). The underway seawater was filtered through a 50 µm nylon filter. In order to determine the precision of the system over the whole continuous measurement period the Substandard was measured in the morning and evening several times (five to six) in row.

To characterize the sensitivity of the system a titration experiment was carried out. Therefore, 250 mL substandard was titrated with a known amount of HCl-solution 0.1 M. Five titration levels were each measured five times. This experiment was carried out four times over the whole cruise (see Table 5.10.2).

Table 5.10.2 Timetable of experiments and measurements for instrument test of HydroFIA TA system

Date and Time (UTC)		**Experiment / Measurements**
Start	**End**	
2016-12-15 14:36:22	2016-12-15 17:59:22	First start of system Measure Substandard until stable TA
2016-12-15 18:14:41	2016-12-15 18:41:04	Calibration with CRM-143
2016-12-15 19:03:44	2016-12-15 22:21:10	Titration experiment
2016-12-15 22:34:33	2016-12-20 20:11:06	Continuous underway seawater measurements (with Substandard measurements in between every morning and evening)
2016-12-21 09:43:54	2016-12-21 11:56:55	Titration experiment
2016-12-22 08:14:38	2016-12-23 08:14:52	Continuous underway seawater measurements (with Substandard measurements in between every morning and evening)
2016-12-23 09:03:32	2016-12-25 13:17:57	Flush with MQ-water No measurements for 48h

		Measure Substandard until stable TA
2016-12-25 13:56:02	2016-12-26 08:34:00	Continuous underway seawater measurements (with Substandard measurements in between every morning and evening)
2016-12-26 11:40:21	2016-12-26 12:06:57	Recalibration with CRM-143 because of empty HCl-Cartridge
2016-12-26 13:03:58	2016-12-27 09:42:59	Long time measurement of Substandard for precision determination
2016-12-29 00:40:52	2016-12-30 11:20:22	Continuous underway seawater measurements (with Substandard measurements in between every morning and evening)
2016-12-30 12:22:05	2016-12-30 12:48:53	Recalibration with CRM-143 because of empty BCG-Cartridge
2016-12-30 13:21:22	2016-12-31 10:11:28	Continuous underway seawater measurements (with Substandard measurements in between every morning and evening)
2016-12-31 10:11:28	2017-01-02 13:11:48	Flush with MQ-water No measurements for 48h Measure Substandard until stable TA
2017-01-02 14:48:50	2017-01-04 03:38:42	Continuous underway seawater measurements (with Substandard measurements in between every morning and evening)
2017-01-04 03:49:46	2017-01-04 05:57:30	Titration experiment
2017-01-04 06:05:18	2017-01-05 11:45:46	Continuous underway seawater measurements (with Substandard measurements in between every morning and evening)
2017-01-05 11:57:13	2017-01-05 14:48:45	Titration experiment
2017-01-05 15:48:41	2017-01-10 12:20:29	Continuous underway seawater measurements (with Substandard measurements in between every morning and evening)
2017-01-10 12:40:24	2017-01-10 16:13:47	Titration experiment
2017-01-10 16:34:10	2017-01-11 11:02:02	Continuous underway seawater measurements

Table 5.10.3 Problems, special observations and incidents with HydroFIA TA system

Date	**Problem/ Observation/ Incident**
2016-12-12	One of the two HCl 0.1 M Cartridges was damaged at the transport Some HCl 0.1 M Solution ran out (approximately 10 to 20 mL) Bag of the damaged HCl 0.1 M Cartridge could be installed in the system without the housing for doing measurements
2016-12-16	First little leakage at the degasser occurred Could be solved with a HCl 0.1 M Flush
2016-12-20 to 2016-12-21	Bigger leakage at the degasser occurred HCl 0.1 M Flush did not solve the problem Several tries to solve the problem -> nothing helped
2016-12-22 to 2017-01-10	System run with the leakage -> tissue around the degasser (changed it two times per day)
2016-12-27	No measurements the whole day to dry the system inside
2016-01-11	Flush System with MQ water for transport

5.11 Argo Float Deployments

(Léa Olivier, Andreas Pinck and Martin Visbeck; PI: EURO-ARGO, WHOI, BSH)

During the cruise M133, 25 Argo floats were deployed. Three of them were deployed for the EURO-ARGO program in one of the Agulhas eddies (details in table 5.11.1), after a deep (>2000dbar) CTD station. The floats were ARVOR-Iridium floats with serial numbers #AI2600-16FR064 to #AI2600-16FR066. The Argo floats were deploy-ready provided. Three protective plugs, the adhesive tape and a magnet were removed prior deployment. Deployment was made by crane, releasing the float in the upward position at a safe distance from the ship, during slow speed through the water (<2 knots) at the location of the CTD station.

Table 5.11.1 Details about the deployed ARVOR - Iridium floats

WMO number	Serial number	Latitude of deployment	Longitude of deployment	CTD number	CTD station number
39011901	AI2600-16FR064	36° 14.01' S	15° 19.56' E	6	1687_2
3901902	AI2600-16FR065	36°13,97’ S	15°19,69’ E	6	1687_2
3901903	AI2600-16FR066	36°13,90’ S	15°19,86’ E	6	1687_2

Seven Argo floats were deployed for the German Bundesamt für Seeschifffahrt und Hydrographie (BSH) at the positions as recorded in table 5.11.2 The floats were APEX floats with serial numbers #7946 to #7951 and #7957. The Argo floats were not quite deploy-ready provided. The start of missions were initiated by a terminal program using a current loop interface. The plastic bag and the three plugs of the CTD sensor were removed. Deployment was made by throwing the float bottom first from the back of the ship during normal speed through the water (~10knots).

Table 5.11.2 Details about the deployed APEX floats

WMO number	Serial number	Latitude of deployment	Longitude of deployment
7900496	7946	34.5° S	0.38° W
7900497	7947	34.5° S	3° W
7900498	7948	34.5° S	7.61° W
7900499	7949	34.5° S	18° W
7900450	7950	34.5° S	25° W
7900451	7951	34.5° S	30° W
7900452	7957	43.3° S	58° W

Fifteen Argo floats were deployed for the Woods Hole Oceanographic Institute (WHOI) at the positions as recorded in table 5.11.3. The floats were SOLO-II floats with serial numbers recorded in the same table. The Argo floats were deploy-ready provided. Deployment was made by lowering the float bottom first from the back of the ship during slow speed (2 knots) at the location of a water depths >2000dbar. Sometimes a CTD station happened near the deployment location.

Table 5.11.3 Details about the deployed SOLO II floats

Serial number	Latitude of deployment	Longitude of deployment	CTD number	Ship station
7391	34°30.14’S	009°59.96‘E	10	1704-1
7407	34°30.01’S	007°59.98’E	11	1709-2
7390	34°29.98’S	005°59.89’E	12	1714-2
7397	34°30.49’S	002°00.19’E	14	1721-2
7404	34°29.97’S	001°29.94’E	no	1731-1

7394	34°29.99’S	005°30.52’W	no	1742
7401	34°29.99’S	009°30.00’W	no	1752
7389	34°29.99’S	011°31.01’W	no	1758
7396	34°30.00’S	013°30.30’W	no	1763
7399	34°30.00’S	022°30.10’W	no	1784
7395	34°29.99’S	027°30.01’W	no	1797
7326	34°42.50’S	047°15.60’W	20	017-5
7398	42°38.28’S	057°58.86’W	29	066
7402	44°38.80°S	058°00.00°W	30	069
7298	48°00.01°S	058°03.01W	41	106-5

5.12 Sun-Photometric Aerosol Optical Depth (AOD) Measurements

(Hanna Campen, PI: Stefan Kinne MPI-MET)

In collaboration with the National Aeronautics and Space Administration Goddard Space Flight Center (NASA-GSFC) and the Max Planck Institute for Meteorology, MICROTOPS-II hand-held sun photometer measurements have been conducted as part of the Maritime Aerosol Network (MAN), which has been developed as a component of the Aerosol Robotic Network (AERONET). Measurements offer required ocean reference data for satellite remote sensing and simulated aerosol properties in global models. Smirnov et al. (2009) describe details about the AERONET-MAN program.

RV Meteor's research transit-voyage M133 across the subtropical South Atlantic region allowed the survey of atmospheric properties in this scarcely sampled region. Measurements have been undertaken with a hand-held MICROTOPS-II sun-photometer (#19746), calibrated unit of NASA-GSFC, in combination with a GPS unit. The monitoring device was manually operated on the ship's upper deck to have an unobstructed view to the sun disk. At assured cloud-free conditions AOD was measured daily by pointing the instrument's solar sensors directly into the sun. Therefore, a continuous monitoring of the sky as well as a correct pointing to the sun was required while scanning. If possible, we measured in 15 minutes intervals. Each measurement consisted of 10 consecutive direct radiation scans (samples) lasting for about 2 minutes in total. The MICROTOPS-II data has been sent to a NASA-GSFC archive where the preliminary aerosol measurements become visible and accessible via web.

It is important to perform direct surface based measurements of aerosol optical depths to calibrate the indirect radiometric aerosol measurements by satellites over ocean areas. The Maritime Aerosol Network has gathered sun-photometric aerosol measurements from research cruises in all ocean basins and all seasons since 2004. Aerosol measurements in the South Atlantic, however, are still rare. The M133 cruise increased the number of surface based aerosol

measurements in this region substantially. During M133 the Microtops II sun photometer was used for the measurements, the quality assurance applied on R/V METEOR and at GSFC/NASA, the measurements taken, and shows results in terms of aerosol optical depths varying over a day and along the ship track.

5.12.1 Measurements & data processing

Measurements were taken every day during day light hours when the sun was not obscured by clouds. If possible, series of 10 to 15 measurements were taken in intervals of 10 to 15 minutes – always separated by 2 minutes breaks to make sure the instrument would recognize them as several series. Measurements within a series vary mostly due to the sun pointing error, while measurements across all series resolve the variations along the ship track. No measurements were possible on December 17, 20, 21, 23, 26, 28, 30, 31 and on January 01, 03, 08, 09 due to cloudy conditions. Table 5.12.1 shows the number of measurements and series taken during the M133 cruise. In total 1029 measurements were taken, resulting in a total of 101 level 1.5 series and during a total of 15 of measurement days.

In general measurement points are grouped temporally into series. If the interval between two points in a measurement sequence is more than two minutes, then these points are placed into different series. A series can have one or more measurement points (typically five or more). A series is considered a single data point (an average of the measurement points in the group); and a sequence of series in a day may be used to compute the daily average.

The sun photometer measurements are screened in three steps. Definitions are as follows:

Level 1.0 AOD (Unscreened)
Unscreened and may not have final calibration applied

Level 1.5 AOD (Cloud Screened)
Automatically cloud cleared and pointing error free, but may not have final calibration applied. These data are not quality assured

Level 2.0 AOD (Quality Assured)
Pre- and post-field calibration applied, automatically cloud cleared and manually inspected

Hence, level 1.0 happens on board, the remaining data were regularly submitted to Dr. Alexander Smirnov at GSFC/NASA for level 1.5 cloud screening. Preliminary daily averages were published online on the according website. For those outliers are removed by an algorithm. It compares single measurements to a series mean and the series standard deviation. This data reduction is done separately for each frequency.

Level 2.0 screening will be applied after the cruise when the instrument was handed back for post-calibration at GSFC/NASA.

Table 5.12.1 Number of measurements for all days of the cruise and resulting number of measurement series after Level 1.5 screening.

Date	Number of measurements Lev 1.0	Number of series Lev 1.5	Number of days Lev 1.5	Comments
15.12.16	30	3	1	
16.12.16	70	7	1	
18.12.16	50	5	1	
19.12.16	130	13	1	Includes sunrise
20.12.16	10	1	1	1st measurement may did not have GPS
22.12.16	30	3	1	Some clouds
24.12.16	20	3	1	Maybe some clouds
25.12.16	20	2	1	
27.12.16	60	6	1	
29.12.16	65	5	1	187 bad data
02.01.17	70	7	1	
04.01.17	10	1	0	
05.01.17	40	4	1	
06.01.17	80	8	1	
07.01.17	213	21	1	
10.01.17	121	12	1	
Total	1019	101	15	

5.13 "My Science Cruise" capacity building

(Hanna Campen, PI: Martin Visbeck)

The cruise had a strong educational and capacity building component. As Ocean Observations are one of the cornerstones for understanding, assessing and predicting ocean change the MyScience-Cruise provided the unique opportunity of a practical hands on-training on ocean observation and ocean research in the South Atlantic for 7 students from 6 different nations (Table 5.13.1). Students from Bachelor to PhD level attended.

During the cruise an "expert training" on a variety of observing instrumentation as well as lectures covering a range of topics in oceanography as well as instrumental applications were provided. All scientists as well as all students gave talks about their background, science interests and current projects. The three CTD/uCTD/XBT/rapid cast/MICROTOPS shifts were covered with one expert (Patricia Handmann, Andreas Pinck, Hanna Campen, all GEOMAR) and three MyScience cruise students each. At the beginning of the cruise the "experts" primarily trained the students but soon the experts took over to the observer's position and the students were fully operating the shifts.

Table 5.13.1 Participant list for the M133 "My Science Cruise" capacity building program

Name	Country
Elisabeth Thölken	Germany
Iole Orselli	Brazil
Gastón Manta	Uruguay
Lèa Olivier	France
Jaqui Trassierra	South Africa
Daniela Rosari	Argentina
Ana-Gabriela Bonelli	Argentina

Each student was selected to deepen their knowledge about a certain instrument to then share and teach what they learned to the other students. For this he/she prepared a presentation about the instruments purpose, functioning, usage of data, dealing also with how to calibrate the data and with quality control procedures.

The presentations were given during the cruise when all students already got some concrete hands on experience with the instruments presented. During the cruise all students worked with the instruments somehow.

In addition to usual shift operations the students actively participated in the research conducted during M133. They took part in the weekly science meetings presenting data from the several instruments applied during M133 and showed preliminary results of their own little research projects. For the latter the students formed groups with which they worked on a specific science theme, as the Agulhas eddies, dynamics at the Malvinas front, Microplastic distribution, throughout the cruise (Table 5.13.2). The final results were presented to all cruise participants within a special science session in the last week of the cruise. And each group submitted a short written report of the scientific results.

Table 5.13.2 List of student's science topics

Name	**Science topic**
Iole Orselli Lèa Olivier	Agulhas eddies
Jaqui Trassierra Elisabeth Thölken	Microplastics
Gastón Manta Ana-Gabriela Bonelli Daniela Rosari	Malvinas' frontal dynamics

Outreach activities

Before the cruise all students and participants met for a preparational pre-cruise event at the University of Cape Town (UCT), South Africa where the scientific aims of the cruise, procedures and work on board were introduced in detail. During this, participants had not only the chance to get to know each other already but also to get in contact with local UCT scientists and their research. There was also a tour organized for all to learn about Cape Town and its surrounding. As a highlight of those days all cruise participants were invited to attend an international reception on the rare occasion of two German research vessels, the R/V Polarstern and the R/V Meteor, meeting in the port of Cape Town, which was organized by the German embassy. It had talks by highly reputated scientists and included the visit of Stefan Müller, state secretary and representative of the German Ministry for Education and Research (BMBF). Further it provided the opportunity of exchange with international students of a recent floating university cruise on R/V Polarstern, revealing a similar educational approach like the MyScience Cruise.

During the cruise daily reports by the students about life at sea and their experiences have been published on the MyScience Cruise blog (http://www.oceanblogs.org/mysciencecruise/) which is embedded in a network called "Oceanblogs" (operated by GEOMAR) and which was shared on a variety of social media.

6 Ship's Meteorological Station

(Carola Heitmann-Bacza and Christian Rohleder, Meteorological Office RV METEOR)

The cruise M133 started on the Dec 15th 2016 at 10:00 am from Cape Town with south-westerly wind about 4 Bft and 23°C air temperature.

At first the research vessel sailed southwestward to 33°53'S 018°24'E. After two further waypoints near 36°25'S 015°20'E and then 34°30'S 014°38'E the cruise along 34°30'S began. This first part of the cruise was influenced by a ridge (1015 hPa) of a large subtropical high across the Southern Atlantic.

This high (with centre pressure between 1022 and 1028 hPa) was located slightly north of the cruise track across the Southern Atlantic to the sea area west of the Río de la Plata until 02nd January 2017. The water temperature rose from 12°C to 21°C after leaving waters around Cape Town. During the South Atlantic crossing water temperature fluctuated between 18°C and 21°C,

air temperature was between 17°C and 21°C. A mainly south-westerly wind 4 to 5 Bft blew, also gentle breeze from several directions at times. The sea state was mostly between 2 to 3 m, with a main swell from southwest.

Gales moved south of the sailing area to east again and again. Associated troughs shifted to the research area and caused cloud cover and rain or showers. In front of a trough a strong to near gale north-westerly wind 6 to 7 Bft was measured from Dec 21st to 22nd 2016 and in the night to the Dec 24th 2016. These lows caused higher swell, due to 2 to 3 m reached the sailing area. Therefore sea state rose temporarily up to 4 m on Dec 21th 2016.

After occasional showers sunny spells with 19°C were present on Dec 24th and 25th 2016. An approaching warm front, of a gale (970 hPa) near 48°S 030°W, produced rain at times on Dec 26th 2016. Fog occurred temporarily during the morning until afternoon on Dec 27th 2016. The cold front with occasional showers crossed from Dec 27th afternoon until Dec 28th 2016. After this cold front a ridge of the subtropical high expanded to the Río de la Plata. During the further cruise this ridge moved to the northeast and weak high pressure temporarily dominated. A new trough followed with rain at times and temporarily strong Wind 6 Bft during Dec 31rt 2016.

When sailing to the southwest and later to the south local highs moved from mainland to the northeast and troughs, of eastwards travelling lows, followed. Therefore, a strong to near gale north-westerly wind 6 to 7 Bft with isolated gale force gusts 9 Bft changed with weakly south-westerly wind about 4 Bft. The sea state was between 2 to 3 m, swell mainly from southwest, with northerly directions at times. A gentle breeze and decreasing sea about 1 m appeared only on Jan 01rt and 04th 2017 for a short time. The air and water temperature changed either by wind directions or the Malvinas Current.

A special weather phenomena was observed on Jan 05th 2017, a "Shelf Cloud". It was weakening, when it reached our area and wind increased only a little for a time.

Photo: Christian Rohleder

When approaching to the Falkland Islands the sailing area of the RV "Meteor" was in a strong westerly air stream about 6 Bft and sea with swell 2 to 3.5 m from Jan 10th to 11th 2017. A

lee-low developed north of the track on Jan 12th 2017 and at the south-western flank a gentle to moderate westerly wind blew. With this gentle breeze the RV "Meteor" arrived the Bay of Port Stanley.

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7 Station List M133

Station List: of R/V METEOR cruise M133.

Station M133	Type	#	Date (2017)	Time UTC	Latitude	Longitude	Station depth [m]	Parameters
1673-1	uCTD	1	15/12	12:14	34° 12' S	18° 06' E	~400	T,S,P
1674-1	XBT	1	15/12	12:32	34° 13' S	18° 03' E	~760	T,P
1675-1	CTD/RO	1	15/12	13:14	34° 14' S	18° 00' E	253	T,S,P,O2,Fl,TA
1676-1	XBT	2	15/12	14:53	34° 18' S	17° 50' E	~760	T,P
1677-1	uCTD	2	15/12	15:22	34° 20' S	17° 45' E	~400	T,S,P
1678-1	MultiNet	1	15/12	16:27	34° 22' S	17° 35' E	515	T,S,P,Fl,TA, Plank, Foram
1678-2	CTD/RO	2	15/12	17:23	34° 22' S	17° 35' E	1103	T,S,P,O2,Fl,TA
1677-1	uCTD	3	15/12	19:03	34° 25' S	17° 28' E	~400	T,S,P
1679-1	XBT	3	15/12	19:32	34° 27' S	17° 23' E	~760	T,P
1677-1	uCTD	4	15/12	20:02	34° 28' S	17° 17' E	~400	T,S,P
1680-1	CTD/RO	3	15/12	21:02	34° 30' S	17° 08' E	2755	T,S,P,O2,Fl,TA
1677-1	uCTD	5	15/12	23:00	34° 30' S	17° 08' E	~400	T,S,P
1677-1	uCTD	6	15/12	23:54	34° 37' S	17° 01' E	~400	T,S,P
1677-1	uCTD	7	16/12	00:59	34° 45' S	16° 52' E	~400	T,S,P
1681-1	XBT	4	16/12	01:24	34° 48' S	16° 49' E	~760	T,P
1677-1	uCTD	8	16/12	01:54	34° 52' S	16° 44' E	~400	T,S,P
1677-1	uCTD	9	16/12	03:03	35° 01' S	16° 36' E	~400	T,S,P
1677-1	uCTD	10	16/12	04:04	35° 08' S	16° 28' E	~400	T,S,P
1682-1	XBT	5	16/12	04:59	35° 15' S	16° 21' E	~760	T,P
1677-1	uCTD	11	16/12	05:15	35° 18' S	16° 19' E	~400	T,S,P
1683-1	CTD/RO	4	16/12	06:17	35° 25' S	16° 11' E	2001	T,S,P,O2,Fl,TA
1677-1	uCTD	12	16/12	08:25	35° 31' S	16° 04' E	~400	T,S,P
1677-1	uCTD	13	16/12	09:25	35° 39' S	15° 56' E	~400	T,S,P
1684-1	XBT	6	16/12	10:19	35° 46' S	15° 50' E	~760	T,P
1677-1	uCTD	14	16/12	10:24	35° 47' S	15° 50' E	~400	T,S,P
1677-1	uCTD	15	16/12	11:36	35° 58' S	15° 45' E	~400	T,S,P
1677-1	uCTD	16	16/12	12:36	36° 06' S	15° 41' E	~400	T,S,P
1685-1	MultiNet	2	16/12	13:06	36° 09' S	15° 40' E	720	T,S,P,Fl,TA, µPlast, Plank, Foram
1685-2	MultiNet	3	16/12	14:06	36° 09' S	15° 40' E	110	T,S,P,Fl,TA, µPlast, Plank, Foram
1685-3	MultiNet	4	16/12	14:23	36° 09' S	15° 40' E	520	T,S,P,Fl,TA, µPlast, Plank, Foram
1685-4	CTD/RO	5	16/12	15:11	36° 09' S	15° 40' E	1999	T,S,P,O2,Fl,TA
1677-1	uCTD	17	16/12	17:06	36° 11' S	15° 38' E	~400	T,S,P
1677-1	uCTD	18	16/12	17:59	36° 16' S	15° 32' E	~400	T,S,P
1677-1	uCTD	19	16/12	19:00	36° 19' S	15° 23' E	~400	T,S,P
1686-1	XBT	7	16/12	19:46	36° 18' S	15° 20' E	~760	T,P

1687-1	CTD/RO	6	16/12	20:21	36° 13' S	15° 20' E	2001	T,S,P,O2,Fl,TA
1687-2	ARGO-Float	1	16/12	21:52	36° 13' S	15° 20' E		T,S,P
1687-2	ARGO-Float	2	16/12	22:00	36° 13' S	15° 20' E		T,S,P
1687-2	ARGO-Float	3	16/12	22:07	36° 13' S	15° 20' E		T,S,P
1677-1	uCTD	20	16/12	22:36	36° 10' S	15° 20' E	~400	T,S,P
1677-1	uCTD	21	16/12	23:40	35° 58' S	15° 20' E	~400	T,S,P
1677-1	uCTD	22	17/12	00:34	35° 49' S	15° 20' E	~400	T,S,P
1688-1	XBT	8	17/12	00:57	35° 45' S	15° 20' E	~760	T,P
1677-1	uCTD	23	17/12	01:39	35° 39' S	15° 16' E	~400	T,S,P
1677-1	uCTD	24	17/12	02:32	35° 31' S	15° 11' E	~400	T,S,P
1689-1	XBT	9	17/12	02:58	35° 27' S	15° 09' E	~760	T,P
1677-1	uCTD	25	17/12	03:32	35° 21' S	15° 06' E	~400	T,S,P
1677-1	uCTD	26	17/12	04:32	35° 12' S	15° 01' E	~400	T,S,P
1690-1	CTD/RO	7	17/12	05:05	35° 07' S	14° 59' E	2000	T,S,P,O2,Fl,TA, Plank
1677-1	uCTD	27	17/12	07:00	35° 04' S	14° 56' E	~400	T,S,P
1677-1	uCTD	28	17/12	07:58	34° 54' S	14° 52' E	~400	T,S,P
1691-1	XBT	10	17/12	08:29	34° 49' S	14° 49' E	~760	T,P
1677-1	uCTD	29	17/12	08:57	34° 45' S	14° 46' E	~400	T,S,P
1677-1	uCTD	30	17/12	10:06	34° 36' S	14° 42' E	~400	T,S,P
1692-1	CTD/RO	8	17/12	11:06	34° 30' S	14° 38' E	2006	T,S,P,O2,Fl,TA
1677-1	uCTD	31	17/12	13:37	34° 30' S	14° 32' E	~400	T,S,P
1677-1	uCTD	32	17/12	14:45	34° 30' S	14° 20' E	~400	T,S,P
1693-1	XBT	11	17/12	15:14	34° 30' S	14° 15' E	~760	T,P
1677-1	uCTD	33	17/12	16:06	34° 30' S	14° 05' E	~400	T,S,P
1694-1	XBT	12	17/12	17:04	34° 30' S	13° 55' E	~760	T,P
1677-1	uCTD	34	17/12	17:17	34° 30' S	13° 53' E	~400	T,S,P
1677-1	uCTD	35	17/12	18:06	34° 30' S	13° 44' E	~400	T,S,P
1677-1	uCTD	36	17/12	19:00	34° 30' S	13° 33' E	~400	T,S,P
1695-1	XBT	13	17/12	19:37	34° 30' S	13° 26' E	~760	T,P
1696-1	XBT	14	17/12	19:44	34° 30' S	13° 25' E	~760	T,P
1677-1	uCTD	37	17/12	20:00	34° 30' S	13° 22' E	~400	T,S,P
1677-1	uCTD	38	17/12	20:57	34° 30' S	13° 10' E	~400	T,S,P
1677-1	uCTD	39	17/12	22:03	34° 30' S	12° 57' E	~400	T,S,P
1697-1	XBT	15	17/12	22:21	34° 30' S	12° 53' E	~760	T,P
1677-1	uCTD	40	17/12	23:03	34° 30' S	12° 45' E	~400	T,S,P
1677-1	uCTD	41	17/12	23:59	34° 30' S	12° 34' E	~400	T,S,P
1698-1	XBT	16	18/12	00:49	34° 30' S	12° 26' E	~760	T,P
1677-1	uCTD	42	18/12	00:57	34° 30' S	12° 24' E	~400	T,S,P
1677-1	uCTD	43	18/12	02:10	34° 30' S	12° 10' E	~400	T,S,P
1677-1	uCTD	44	18/12	03:08	34° 30' S	11° 58' E	~400	T,S,P
1699-1	XBT	17	18/12	03:27	34° 30' S	11° 55' E	~760	T,P
1677-1	uCTD	45	18/12	04:02	34° 30' S	11° 48' E	~400	T,S,P
1677-1	uCTD	46	18/12	04:59	34° 30' S	11° 37' E	~400	T,S,P
1677-1	uCTD	47	18/12	05:25	34° 30' S	11° 32' E	~400	T,S,P
1700-1	XBT	18	18/12	06:05	34° 30' S	11° 25' E	~760	T,P

1700-2	XBT	19	18/12	06:12	34° 30' S	11° 23' E	~760	T,P
1700-3	XBT	20	18/12	06:16	34° 30' S	11° 22' E	~760	T,P
1677-1	uCTD	48	18/12	06:27	34° 30' S	11° 20' E	~400	T,S,P
1701-1	MultiNet	5	18/12	07:21	34° 30' S	11° 12' E	730	T,S,P,Fl,TA, µPlast, Plank, Foram
1701-2	MultiNet	6	18/12	08:20	34° 30' S	11° 12' E	110	T,S,P,Fl,TA, µPlast, Plank, Foram
1701-3	MultiNet	7	18/12	08:36	34° 30' S	11° 12' E	515	T,S,P,Fl,TA, µPlast, Plank, Foram
1701-4	CTD/RO	9	18/12	09:22	34° 30' S	11° 12' E	2001	T,S,P,O2,Fl,TA
1677-1	uCTD	49	18/12	11:19	34° 30' S	11° 07' E	~400	T,S,P
1677-1	uCTD	50	18/12	12:18	34° 30' S	10° 56' E	~400	T,S,P
1702-1	XBT	21	18/12	12:39	34° 30' S	10° 52' E	~760	T,P
1702-2	XBT	22	18/12	12:56	34° 30' S	10° 49' E	~760	T,P
1677-1	uCTD	51	18/12	13:22	34° 30' S	10° 44' E	~400	T,S,P
1677-1	uCTD	52	18/12	14:18	34° 30' S	10° 34' E	~400	T,S,P
1703-1	XBT	23	18/12	15:06	34° 30' S	10° 25' E	~760	T,P
1677-1	uCTD	53	18/12	15:17	34° 30' S	10° 23' E	~400	T,S,P
1677-1	uCTD	54	18/12	16:24	34° 30' S	10° 11' E	~400	T,S,P
1704-1	CTD/RO	10	18/12	17:25	34° 30' S	10° 00' E	1998	T,S,P,O2,Fl,TA
1704-2	ARGO-Float	4	18/12	18:51	34° 30' S	10° 00' E		T,S,P
1705-1	XBT	24	18/12	19:21	34° 30' S	09° 56' E	~760	T,P
1677-1	uCTD	55	18/12	19:32	34° 30' S	09° 53' E	~400	T,S,P
1677-1	uCTD	56	18/12	20:28	34° 30' S	09° 43' E	~400	T,S,P
1677-1	uCTD	57	18/12	21:30	34° 30' S	09° 32' E	~400	T,S,P
1706-1	XBT	25	18/12	22:05	34° 30' S	09° 26' E	~760	T,P
1677-1	uCTD	58	18/12	22:37	34° 30' S	09° 20' E	~400	T,S,P
1677-1	uCTD	59	18/12	23:23	34° 30' S	09° 12' E	~400	T,S,P
1677-1	uCTD	60	19/12	00:28	34° 30' S	09° 01' E	~400	T,S,P
1707-1	XBT	26	19/12	01:07	34° 30' S	08° 54' E	~760	T,P
1677-1	uCTD	61	19/12	01:31	34° 30' S	08° 50' E	~400	T,S,P
1677-1	uCTD	62	19/12	02:32	34° 30' S	08° 40' E	~400	T,S,P
1677-1	uCTD	63	19/12	03:31	34° 30' S	08° 30' E	~400	T,S,P
1708-1	XBT	27	19/12	03:57	34° 30' S	08° 26' E	~760	T,P
1677-1	uCTD	64	19/12	04:34	34° 30' S	08° 19' E	~400	T,S,P
1677-1	uCTD	65	19/12	05:28	34° 30' S	08° 10' E	~400	T,S,P
1709-1	CTD/RO	11	19/12	06:50	34° 30' S	08° 00' E	2001	T,S,P,O2,Fl,TA
1709-2	ARGO-Float	5	19/12	08:13	34° 30' S	08° 00' E		T,S,P
1710-1	XBT	28	19/12	08:44	34° 30' S	07° 55' E	~760	T,P
1710-2	XBT	29	19/12	08:49	34° 30' S	07° 55' E	~760	T,P
1710-3	XBT	30	19/12	08:52	34° 30' S	07° 54' E	~760	T,P
1677-1	uCTD	66	19/12	08:59	34° 30' S	07° 53' E	~400	T,S,P
1677-1	uCTD	67	19/12	10:00	34° 30' S	07° 43' E	~400	T,S,P
1677-1	uCTD	68	19/12	11:02	34° 30' S	07° 33' E	~400	T,S,P
1711-1	XBT	31	19/12	11:45	34° 30' S	07° 26' E	~760	T,P

1677-1	uCTD	69	19/12	12:00	34° 30' S	07° 24' E	~400	T,S,P
1677-1	uCTD	70	19/12	12:53	34° 30' S	07° 16' E	~400	T,S,P
1677-1	uCTD	71	19/12	14:00	34° 30' S	07° 05' E	~400	T,S,P
1712-1	XBT	32	19/12	15:01	34° 30' S	06° 55' E	~760	T,P
1677-1	uCTD	72	19/12	15:12	34° 30' S	06° 53' E	~400	T,S,P
1677-1	uCTD	73	19/12	16:05	34° 30' S	06° 45' E	~400	T,S,P
1677-1	uCTD	74	19/12	17:05	34° 30' S	06° 35' E	~400	T,S,P
1677-1	uCTD	75	19/12	17:48	34° 30' S	06° 28' E	~400	T,S,P
1713-1	XBT	33	19/12	18:30	34° 30' S	06° 23' E	~760	T,P
1677-1	uCTD	76	19/12	19:03	34° 30' S	06° 18' E	~400	T,S,P
1677-1	uCTD	77	19/12	19:55	34° 30' S	06° 10' E	~400	T,S,P
1714-1	CTD/RO	12	19/12	21:00	34° 30' S	06° 00' E	1998	T,S,P,O2,Fl,TA
1714-2	ARGO-Float	6	19/12	22:26	34° 30' S	06° 00' E		T,S,P
1677-1	uCTD	78	19/12	23:04	34° 30' S	05° 55' E	~400	T,S,P
1677-1	uCTD	79	20/12	00:06	34° 30' S	05° 44' E	~400	T,S,P
1677-1	uCTD	80	20/12	01:05	34° 30' S	05° 35' E	~400	T,S,P
1677-1	uCTD	81	20/12	01:55	34° 30' S	05° 26' E	~400	T,S,P
1715-1	XBT	34	20/12	02:15	34° 30' S	05° 23' E	~760	T,P
1677-1	uCTD	82	20/12	03:04	34° 30' S	05° 15' E	~400	T,S,P
1677-1	uCTD	83	20/12	04:00	34° 30' S	05° 05' E	~400	T,S,P
1716-1	XBT	35	20/12	06:03	34° 31' S	04° 55' E	~760	T,P
1716-2	XBT	36	20/12	06:22	34° 30' S	04° 51' E	~760	T,P
1677-1	uCTD	84	20/12	07:05	34° 29' S	04° 44' E	~400	T,S,P
1717-1	MultiNet	8	20/12	08:06	34° 30' S	04° 35' E	720	T,S,P,Fl,TA, µPlast, Plank, Foram
1717-2	MultiNet	9	20/12	09:03	34° 30' S	04° 35' E	110	T,S,P,Fl,TA, µPlast, Plank, Foram
1717-3	MultiNet	10	20/12	09:18	34° 30' S	04° 35' E	515	T,S,P,Fl,TA, µPlast, Plank, Foram
1717-4	CTD/RO	13	20/12	10:02	34° 30' S	04° 35' E	1169	T,S,P,O2,Fl,TA
1677-1	uCTD	85	20/12	11:37	34° 30' S	04° 30' E	~400	T,S,P
1677-1	uCTD	86	20/12	12:37	34° 30' S	04° 20' E	~400	T,S,P
1677-1	uCTD	87	20/12	14:09	34° 30' S	04° 05' E	~400	T,S,P
1718-1	XBT	37	20/12	15:22	34° 30' S	03° 52' E	~760	T,P
1677-1	uCTD	88	20/12	15:37	34° 30' S	03° 50' E	~400	T,S,P
1677-1	uCTD	89	20/12	16:43	34° 30' S	03° 38' E	~400	T,S,P
1677-1	uCTD	90	20/12	17:38	34° 30' S	03° 28' E	~400	T,S,P
1719-1	XBT	38	20/12	17:54	34° 30' S	03° 26' E	~760	T,P
1677-1	uCTD	91	20/12	19:03	34° 30' S	03° 14' E	~400	T,S,P
1677-1	uCTD	92	20/12	19:57	34° 30' S	03° 04' E	~400	T,S,P
1720-1	XBT	39	20/12	20:46	34° 30' S	02° 56' E	~760	T,P
1677-1	uCTD	93	20/12	20:58	34° 30' S	02° 53' E	~400	T,S,P
1677-1	uCTD	94	20/12	23:30	34° 30' S	02° 38' E	~400	T,S,P
1677-1	uCTD	95	21/12	00:37	34° 30' S	02° 28' E	~400	T,S,P
1677-1	uCTD	96	21/12	01:56	34° 30' S	02° 16' E	~400	T,S,P

1677-1	uCTD	97	21/12	02:17	34° 30' S	02° 13' E	~400	T,S,P
1677-1	uCTD	98	21/12	03:00	34° 30' S	02° 06' E	~400	T,S,P
1721-1	CTD/RO	14	21/12	03:51	34° 30' S	02° 00' E	1998	T,S,P,O2,Fl,TA
1721-2	ARGO-Float	7	21/12	05:13	34° 30' S	02° 00' E		T,S,P
1722-1	XBT	40	21/12	06:13	34° 30' S	01° 53' E	~760	T,P
1677-1	uCTD	99	21/12	06:22	34° 30' S	01° 52' E	~400	T,S,P
1677-1	uCTD	100	21/12	07:21	34° 30' S	01° 44' E	~400	T,S,P
1677-1	uCTD	101	21/12	08:40	34° 30' S	01° 35' E	~400	T,S,P
1677-1	uCTD	102	21/12	09:38	34° 30' S	01° 27' E	~400	T,S,P
1723-1	XBT	41	21/12	09:57	34° 30' S	01° 24' E	~760	T,P
1677-1	uCTD	103	21/12	10:36	34° 30' S	01° 19' E	~400	T,S,P
1677-1	uCTD	104	21/12	11:29	34° 30' S	01° 11' E	~400	T,S,P
1677-1	uCTD	105	21/12	12:44	34° 30' S	01° 01' E	~400	T,S,P
1724-1	XBT	42	21/12	13:29	34° 30' S	00° 55' E	~760	T,P
1724-2	XBT	43	21/12	13:33	34° 30' S	00° 55' E	~760	T,P
1677-1	uCTD	106	21/12	13:43	34° 30' S	00° 53' E	~400	T,S,P
1677-1	uCTD	107	21/12	14:45	34° 30' S	00° 43' E	~400	T,S,P
1677-1	uCTD	108	21/12	15:55	34° 30' S	00° 33' E	~400	T,S,P
1725-1	XBT	44	21/12	16:41	34° 30' S	00° 26' E	~760	T,P
1677-1	uCTD	109	21/12	17:06	34° 30' S	00° 22' E	~400	T,S,P
1677-1	uCTD	110	21/12	18:10	34° 30' S	00° 11' E	~400	T,S,P
1677-1	uCTD	111	21/12	19:06	34° 30' S	00° 03' E	~400	T,S,P
1726-1	XBT	45	21/12	19:28	34° 30' S	00° 01' E	~760	T,P
1677-1	uCTD	112	21/12	20:00	34° 30' S	00° 06' W	~400	T,S,P
1677-1	uCTD	113	21/12	21:05	34° 30' S	00° 16' W	~400	T,S,P
1727-1	ARGO-Float	8	21/12	21:52	34° 30' S	00° 23' W		T,S,P
1728-1	XBT	46	21/12	22:03	34° 30' S	00° 25' W	~760	T,P
1677-1	uCTD	114	21/12	22:18	34° 30' S	00° 27' W	~400	T,S,P
1677-1	uCTD	115	21/12	23:42	34° 30' S	00° 40' W	~400	T,S,P
1677-1	uCTD	116	22/12	00:45	34° 30' S	00° 51' W	~400	T,S,P
1729-1	XBT	47	22/12	02:02	34° 30' S	00° 57' W	~760	T,P
1677-1	uCTD	117	22/12	03:07	34° 30' S	01° 08' W	~400	T,S,P
1677-1	uCTD	118	22/12	04:07	34° 30' S	01° 17' W	~400	T,S,P
1730-1	XBT	48	22/12	04:57	34° 30' S	01° 25' W	~760	T,P
1677-1	uCTD	119	22/12	05:47	34° 30' S	01° 31' W	~400	T,S,P
1677-1	uCTD	120	22/12	06:50	34° 30' S	01° 41' W	~400	T,S,P
1677-1	uCTD	121	22/12	08:01	34° 30' S	01° 52' W	~400	T,S,P
1732-1	XBT	49	22/12	08:19	34° 30' S	01° 55' W	~760	T,P
1733-1	MultiNet	11	22/12	08:54	34° 30' S	02° 00' W	720	T,S,P,Fl,TA, µPlast, Plank, Foram
1733-2	MultiNet	12	22/12	09:53	34° 30' S	02° 00' W	110	T,S,P,Fl,TA, µPlast, Plank, Foram
1733-3	MultiNet	13	22/12	10:12	34° 30' S	02° 00' W	515	T,S,P,Fl,TA, µPlast, Plank, Foram
1733-4	CTD/RO	15	22/12	11:04	34° 30' S	02° 00' W	1998	T,S,P,O2,Fl,TA

1677-1	uCTD	122	22/12	12:54	34° 30' S	02° 04' W	~400	T,S,P
1677-1	uCTD	123	22/12	13:50	34° 30' S	02° 12' W	~400	T,S,P
1677-1	uCTD	124	22/12	14:53	34° 30' S	02° 21' W	~400	T,S,P
1734-1	XBT	50	22/12	15:57	34° 30' S	02° 30' W	~760	T,P
1734-2	XBT	51	22/12	16:04	34° 30' S	02° 31' W	~760	T,P
1677-1	uCTD	125	22/12	16:15	34° 30' S	02° 32' W	~400	T,S,P
1677-1	uCTD	126	22/12	17:14	34° 30' S	02° 40' W	~400	T,S,P
1677-1	uCTD	127	22/12	18:19	34° 30' S	02° 49' W	~400	T,S,P
1735-1	XBT	52	22/12	18:55	34° 30' S	02° 55' W	~760	T,P
1736-1	ARGO-Float	9	22/12	19:29	34° 30' S	03° 00' W		T,S,P
1677-1	uCTD	128	22/12	19:35	34° 30' S	03° 00' W	~400	T,S,P
1677-1	uCTD	129	22/12	20:33	34° 30' S	03° 09' W	~400	T,S,P
1677-1	uCTD	130	22/12	21:33	34° 30' S	03° 19' W	~400	T,S,P
1737-1	XBT	53	22/12	22:11	34° 30' S	03° 24' W	~760	T,P
1677-1	uCTD	131	22/12	22:40	34° 30' S	03° 29' W	~400	T,S,P
1677-1	uCTD	132	22/12	23:40	34° 30' S	03° 39' W	~400	T,S,P
1677-1	uCTD	133	23/12	00:42	34° 30' S	03° 49' W	~400	T,S,P
1738-1	XBT	54	23/12	01:11	34° 30' S	03° 55' W	~760	T,P
1677-1	uCTD	134	23/12	01:46	34° 30' S	04° 01' W	~400	T,S,P
1677-1	uCTD	135	23/12	02:55	34° 30' S	04° 13' W	~400	T,S,P
1739-1	XBT	55	23/12	03:54	34° 30' S	04° 24' W	~760	T,P
1739-2	XBT	56	23/12	04:01	34° 30' S	04° 25' W	~760	T,P
1677-1	uCTD	136	23/12	04:13	34° 30' S	04° 28' W	~400	T,S,P
1677-1	uCTD	137	23/12	05:14	34° 30' S	04° 39' W	~400	T,S,P
1740-1	XBT	57	23/12	06:30	34° 30' S	04° 54' W	~760	T,P
1677-1	uCTD	138	23/12	06:45	34° 30' S	04° 57' W	~400	T,S,P
1677-1	uCTD	139	23/12	07:16	34° 30' S	05° 03' W	~400	T,S,P
1677-1	uCTD	140	23/12	08:20	34° 30' S	05° 16' W	~400	T,S,P
1741-1	XBT	58	23/12	09:18	34° 30' S	05° 25' W	~760	T,P
1742-1	ARGO-Float	10	23/12	09:42	34° 30' S	05° 30' W		T,S,P
1677-1	uCTD	141	23/12	09:58	34° 30' S	05° 33' W	~400	T,S,P
1677-1	uCTD	142	23/12	10:58	34° 30' S	05° 45' W	~400	T,S,P
1743-1	XBT	59	23/12	12:00	34° 30' S	05° 56' W	~760	T,P
1677-1	uCTD	143	23/12	12:07	34° 30' S	05° 58' W	~400	T,S,P
1677-1	uCTD	144	23/12	13:15	34° 30' S	06° 12' W	~400	T,S,P
1677-1	uCTD	145	23/12	14:15	34° 30' S	06° 24' W	~400	T,S,P
1744-1	XBT	60	23/12	14:39	34° 30' S	06° 29' W	~760	T,P
1744-2	XBT	61	23/12	14:44	34° 30' S	06° 30' W	~760	T,P
1677-1	uCTD	146	23/12	15:16	34° 30' S	06° 36' W	~400	T,S,P
1745-1	XBT	62	23/12	16:51	34° 30' S	06° 55' W	~760	T,P
1746-1	XBT	63	23/12	19:18	34° 30' S	07° 24' W	~760	T,P
1747-1	ARGO-Float	11	23/12	20:23	34° 30' S	07° 37' W		T,S,P
1748-1	XBT	64	23/12	21:55	34° 30' S	07° 55' W	~760	T,P
1677-1	uCTD	147	23/12	22:22	34° 30' S	08° 00' W	~400	T,S,P
1677-1	uCTD	148	23/12	23:13	34° 30' S	08° 11' W	~400	T,S,P
1677-1	uCTD	149	24/12	00:17	34° 30' S	08° 24' W	~400	T,S,P

1749-1	XBT	65	24/12	00:35	34° 30' S	08° 27' W	~760	T,P
1677-1	uCTD	150	24/12	01:18	34° 30' S	08° 36' W	~400	T,S,P
1677-1	uCTD	151	24/12	02:17	34° 30' S	08° 47' W	~400	T,S,P
1750-1	XBT	66	24/12	02:56	34° 30' S	08° 54' W	~760	T,P
1677-1	uCTD	152	24/12	03:14	34° 30' S	08° 57' W	~400	T,S,P
1677-1	uCTD	153	24/12	04:36	34° 30' S	09° 10' W	~400	T,S,P
1677-1	uCTD	154	24/12	05:40	34° 30' S	09° 19' W	~400	T,S,P
1751-1	XBT	67	24/12	06:13	34° 30' S	09° 24' W	~760	T,P
1677-1	uCTD	155	24/12	06:38	34° 30' S	09° 27' W	~400	T,S,P
1752-1	ARGO-Float	12	24/12	06:57	34° 30' S	09° 30' W		T,S,P
1677-1	uCTD	156	24/12	07:29	34° 30' S	09° 34' W	~400	T,S,P
1753-1	MultiNet	14	24/12	08:16	34° 30' S	09° 39' W	720	T,S,P,Fl,TA, µPlast, Foram
1753-2	MultiNet	15	24/12	09:15	34° 30' S	09° 39' W	110	T,S,P,Fl,TA, µPlast, Foram
1753-3	MultiNet	16	24/12	09:34	34° 30' S	09° 39' W	515	T,S,P,Fl,TA, µPlast, Foram
1753-4	CTD/RO	16	24/12	10:25	34° 30' S	09° 39' W	1998	T,S,P,O2,Fl,TA
1677-1	uCTD	157	24/12	12:14	34° 30' S	09° 43' W	~400	T,S,P
1677-1	uCTD	158	24/12	13:09	34° 30' S	09° 53' W	~400	T,S,P
1754-1	XBT	68	24/12	13:27	34° 30' S	09° 56' W	~760	T,P
1677-1	uCTD	159	24/12	14:29	34° 30' S	10° 08' W	~400	T,S,P
1677-1	uCTD	160	24/12	15:18	34° 30' S	10° 17' W	~400	T,S,P
1755-1	XBT	69	24/12	15:58	34° 30' S	10° 25' W	~760	T,P
1677-1	uCTD	161	24/12	16:17	34° 30' S	10° 28' W	~400	T,S,P
1677-1	uCTD	162	24/12	17:17	34° 30' S	10° 39' W	~400	T,S,P
1756-1	XBT	70	24/12	18:51	34° 30' S	10° 54' W	~760	T,P
1677-1	uCTD	163	24/12	19:08	34° 30' S	10° 57' W	~400	T,S,P
1757-1	XBT	71	24/12	21:31	34° 30' S	11° 23' W	~760	T,P
1757-2	XBT	72	24/12	21:37	34° 30' S	11° 24' W	~760	T,P
1757-3	XBT	73	24/12	21:41	34° 30' S	11° 25' W	~760	T,P
1758-1	ARGO-Float	13	24/12	22:17	34° 30' S	11° 31' W		T,S,P
1759-1	XBT	74	25/12	00:33	34° 30' S	11° 55' W	~760	T,P
1677-1	uCTD	164	25/12	00:45	34° 30' S	11° 57' W	~400	T,S,P
1677-1	uCTD	165	25/12	01:38	34° 30' S	12° 07' W	~400	T,S,P
1677-1	uCTD	166	25/12	02:38	34° 30' S	12° 18' W	~400	T,S,P
1760-1	XBT	75	25/12	03:15	34° 30' S	12° 24' W	~760	T,P
1677-1	uCTD	167	25/12	03:51	34° 30' S	12° 31' W	~400	T,S,P
1677-1	uCTD	168	25/12	04:48	34° 30' S	12° 41' W	~400	T,S,P
1761-1	XBT	76	25/12	05:57	34° 30' S	12° 54' W	~760	T,P
1677-1	uCTD	169	25/12	06:17	34° 30' S	12° 58' W	~400	T,S,P
1677-1	uCTD	170	25/12	07:28	34° 30' S	13° 10' W	~400	T,S,P
1762-1	XBT	77	25/12	08:35	34° 30' S	13° 24' W	~760	T,P
1763-1	ARGO-Float	14	25/12	09:11	34° 30' S	13° 30' W		T,S,P
1763-1	ARGO-Float	15	25/12	09:11	34° 30' S	13° 30' W		T,S,P
1677-1	uCTD	171	25/12	09:30	34° 30' S	13° 33' W	~400	T,S,P

1677-1	uCTD	172	25/12	10:34	34° 30' S	13° 45' W	~400	T,S,P
1764-1	XBT	78	25/12	11:26	34° 30' S	13° 54' W	~760	T,P
1677-1	uCTD	173	25/12	11:38	34° 30' S	13° 57' W	~400	T,S,P
1677-1	uCTD	174	25/12	12:25	34° 30' S	14° 05' W	~400	T,S,P
1677-1	uCTD	175	25/12	13:28	34° 30' S	14° 17' W	~400	T,S,P
1765-1	XBT	79	25/12	14:10	34° 30' S	14° 25' W	~760	T,P
1677-1	uCTD	176	25/12	14:30	34° 30' S	14° 29' W	~400	T,S,P
1677-1	uCTD	177	25/12	15:32	34° 30' S	14° 40' W	~400	T,S,P
1677-1	uCTD	178	25/12	16:34	34° 30' S	14° 51' W	~400	T,S,P
1766-1	XBT	80	25/12	16:52	34° 30' S	14° 54' W	~760	T,P
1677-1	uCTD	179	25/12	17:38	34° 30' S	15° 02' W	~400	T,S,P
1677-1	uCTD	180	25/12	18:28	34° 30' S	15° 10' W	~400	T,S,P
1767-1	XBT	81	25/12	19:49	34° 30' S	15° 24' W	~760	T,P
1677-1	uCTD	181	25/12	20:08	34° 30' S	15° 28' W	~400	T,S,P
1677-1	uCTD	182	25/12	21:41	34° 30' S	15° 44' W	~400	T,S,P
1768-1	XBT	82	25/12	22:39	34° 30' S	15° 55' W	~760	T,P
1768-2	XBT	83	25/12	22:42	34° 30' S	15° 55' W	~760	T,P
1768-3	XBT	84	25/12	22:46	34° 30' S	15° 56' W	~760	T,P
1677-1	uCTD	183	25/12	22:57	34° 30' S	15° 58' W	~400	T,S,P
1677-1	uCTD	184	25/12	23:53	34° 30' S	16° 09' W	~400	T,S,P
1677-1	uCTD	185	26/12	00:57	34° 30' S	16° 21' W	~400	T,S,P
1769-1	XBT	85	26/12	01:22	34° 30' S	16° 27' W	~760	T,P
1677-1	uCTD	186	26/12	02:00	34° 30' S	16° 34' W	~400	T,S,P
1770-1	XBT	86	26/12	03:52	34° 30' S	16° 55' W	~760	T,P
1677-1	uCTD	187	26/12	04:35	34° 30' S	17° 03' W	~400	T,S,P
1677-1	uCTD	188	26/12	05:44	34° 30' S	17° 16' W	~400	T,S,P
1771-1	XBT	87	26/12	06:26	34° 30' S	17° 25' W	~760	T,P
1677-1	uCTD	189	26/12	06:39	34° 30' S	17° 27' W	~400	T,S,P
1677-1	uCTD	190	26/12	07:08	34° 30' S	17° 33' W	~400	T,S,P
1677-1	uCTD	191	26/12	08:10	34° 30' S	17° 46' W	~400	T,S,P
1772-1	XBT	88	26/12	08:53	34° 30' S	17° 54' W	~760	T,P
1773-1	ARGO-Float	16	26/12	09:17	34° 30' S	17° 59' W		T,S,P
1677-1	uCTD	192	26/12	09:25	34° 30' S	18° 01' W	~400	T,S,P
1677-1	uCTD	193	26/12	10:33	34° 30' S	18° 14' W	~400	T,S,P
1774-1	XBT	89	26/12	11:21	34° 30' S	18° 24' W	~760	T,P
1677-1	uCTD	194	26/12	11:38	34° 30' S	18° 28' W	~400	T,S,P
1677-1	uCTD	195	26/12	12:28	34° 30' S	18° 37' W	~400	T,S,P
1775-1	MultiNet	17	26/12	13:31	34° 30' S	18° 48' W	750	T,S,P,Fl,TA, µPlast, Plank, Foram
1775-2	MultiNet	18	26/12	14:29	34° 30' S	18° 48' W	110	T,S,P,Fl,TA, µPlast, Plank, Foram
1775-3	MultiNet	19	26/12	14:45	34° 30' S	18° 48' W	515	T,S,P,Fl,TA, µPlast, Plank, Foram
1775-4	CTD/RO	17	26/12	15:38	34° 30' S	18° 48' W	2002	T,S,P,O2,Fl,TA
1677-1	uCTD	196	26/12	17:15	34° 30' S	18° 49' W	~400	T,S,P

1776-1	XBT	90	26/12	17:44	34° 30' S	18° 55' W	~760	T,P
1677-1	uCTD	197	26/12	18:06	34° 30' S	19° 00' W	~400	T,S,P
1677-1	uCTD	198	26/12	19:16	34° 30' S	19° 14' W	~400	T,S,P
1777-1	XBT	91	26/12	20:06	34° 30' S	19° 24' W	~760	T,P
1677-1	uCTD	199	26/12	20:18	34° 30' S	19° 27' W	~400	T,S,P
1677-1	uCTD	200	26/12	21:41	34° 30' S	19° 43' W	~400	T,S,P
1677-1	uCTD	201	26/12	22:31	34° 30' S	19° 52' W	~400	T,S,P
1778-1	XBT	92	26/12	22:48	34° 30' S	19° 56' W	~760	T,P
1677-1	uCTD	202	26/12	23:33	34° 30' S	20° 04' W	~400	T,S,P
1677-1	uCTD	203	27/12	00:33	34° 30' S	20° 15' W	~400	T,S,P
1779-1	XBT	93	27/12	01:21	34° 30' S	20° 24' W	~760	T,P
1677-1	uCTD	204	27/12	01:41	34° 30' S	20° 28' W	~400	T,S,P
1677-1	uCTD	205	27/12	02:35	34° 30' S	20° 37' W	~400	T,S,P
1780-1	XBT	94	27/12	04:19	34° 30' S	20° 58' W	~760	T,P
1780-2	XBT	95	27/12	04:22	34° 30' S	20° 58' W	~760	T,P
1780-3	XBT	96	27/12	04:26	34° 30' S	20° 59' W	~760	T,P
1677-1	uCTD	206	27/12	04:31	34° 30' S	21° 00' W	~400	T,S,P
1677-1	uCTD	207	27/12	06:12	34° 30' S	21° 20' W	~400	T,S,P
1781-1	XBT	97	27/12	06:37	34° 30' S	21° 25' W	~760	T,P
1677-1	uCTD	208	27/12	07:20	34° 30' S	21° 33' W	~400	T,S,P
1677-1	uCTD	209	27/12	08:15	34° 30' S	21° 44' W	~400	T,S,P
1782-1	XBT	98	27/12	09:06	34° 30' S	21° 54' W	~760	T,P
1677-1	uCTD	210	27/12	09:22	34° 30' S	21° 57' W	~400	T,S,P
1677-1	uCTD	211	27/12	10:22	34° 30' S	22° 09' W	~400	T,S,P
1677-1	uCTD	212	27/12	11:26	34° 30' S	22° 22' W	~400	T,S,P
1783-1	XBT	99	27/12	11:48	34° 30' S	22° 26' W	~760	T,P
1783-2	XBT	100	27/12	11:55	34° 30' S	22° 27' W	~760	T,P
1784-1	ARGO-Float	17	27/12	12:09	34° 30' S	22° 30' W		T,S,P
1677-1	uCTD	213	27/12	12:24	34° 30' S	22° 32' W	~400	T,S,P
1677-1	uCTD	214	27/12	13:24	34° 30' S	22° 44' W	~400	T,S,P
1785-1	XBT	101	27/12	14:17	34° 30' S	22° 54' W	~760	T,P
1677-1	uCTD	215	27/12	14:32	34° 30' S	22° 57' W	~400	T,S,P
1677-1	uCTD	216	27/12	15:24	34° 30' S	23° 07' W	~400	T,S,P
1677-1	uCTD	217	27/12	16:23	34° 30' S	23° 18' W	~400	T,S,P
1786-1	XBT	102	27/12	16:56	34° 30' S	23° 25' W	~760	T,P
1677-1	uCTD	218	27/12	17:21	34° 30' S	23° 29' W	~400	T,S,P
1677-1	uCTD	219	27/12	18:22	34° 30' S	23° 40' W	~400	T,S,P
1787-1	XBT	103	27/12	19:39	34° 30' S	23° 55' W	~760	T,P
1677-1	uCTD	220	27/12	20:02	34° 30' S	23° 59' W	~400	T,S,P
1677-1	uCTD	221	27/12	21:25	34° 30' S	24° 13' W	~400	T,S,P
1788-1	XBT	104	27/12	22:29	34° 30' S	24° 25' W	~760	T,P
1788-2	XBT	105	27/12	22:36	34° 30' S	24° 26' W	~760	T,P
1677-1	uCTD	222	27/12	22:48	34° 30' S	24° 28' W	~400	T,S,P
1677-1	uCTD	223	27/12	23:40	34° 30' S	24° 37' W	~400	T,S,P
1677-1	uCTD	224	28/12	00:42	34° 30' S	24° 48' W	~400	T,S,P
1789-1	XBT	106	28/12	01:23	34° 30' S	24° 55' W	~760	T,P
1789-2	XBT	107	28/12	01:26	34° 30' S	24° 55' W	~760	T,P
1790-1	ARGO-	18	28/12	01:43	34° 30' S	24° 58' W		T,S,P

	Float							
1677-1	uCTD	225	28/12	01:50	34° 30' S	24° 59' W	~400	T,S,P
1677-1	uCTD	226	28/12	02:59	34° 30' S	25° 10' W	~400	T,S,P
1677-1	uCTD	227	28/12	04:09	34° 30' S	25° 21' W	~400	T,S,P
1791-1	XBT	108	28/12	04:34	34° 30' S	25° 24' W	~760	T,P
1677-1	uCTD	228	28/12	05:15	34° 30' S	25° 30' W	~400	T,S,P
1677-1	uCTD	229	28/12	06:14	34° 30' S	25° 39' W	~400	T,S,P
1677-1	uCTD	230	28/12	07:16	34° 30' S	25° 47' W	~400	T,S,P
1792-1	XBT	109	28/12	08:15	34° 30' S	25° 55' W	~760	T,P
1677-1	uCTD	231	28/12	08:30	34° 30' S	25° 57' W	~400	T,S,P
1793-1	MultiNet	20	28/12	09:33	34° 30' S	26° 04' W	720	T,S,P,Fl,TA, Plank, Foram
1793-2	MultiNet	21	28/12	10:29	34° 30' S	26° 04' W	110	T,S,P,Fl,TA, Plank, Foram
1793-3	MultiNet	22	28/12	10:48	34° 30' S	26° 04' W	515	T,S,P,Fl,TA, Plank, Foram
1793-4	CTD/RO	18	28/12	11:45	34° 30' S	26° 04' W	1996	T,S,P,O2,Fl,TA
1677-1	uCTD	232	28/12	14:23	34° 30' S	26° 08' W	~400	T,S,P
1677-1	uCTD	233	28/12	15:26	34° 30' S	26° 18' W	~400	T,S,P
1794-1	XBT	110	28/12	16:16	34° 30' S	26° 25' W	~760	T,P
1677-1	uCTD	234	28/12	16:27	34° 30' S	26° 27' W	~400	T,S,P
1677-1	uCTD	235	28/12	17:35	34° 30' S	26° 37' W	~400	T,S,P
1795-1	XBT	111	28/12	19:15	34° 30' S	26° 55' W	~760	T,P
1796-1	XBT	112	28/12	21:57	34° 30' S	27° 24' W	~760	T,P
1677-1	uCTD	236	28/12	22:11	34° 30' S	27° 27' W	~400	T,S,P
1797-1	ARGO-Float	19	28/12	22:32	34° 30' S	27° 30' W		T,S,P
1677-1	uCTD	237	28/12	23:09	34° 30' S	27° 36' W	~400	T,S,P
1677-1	uCTD	238	29/12	00:17	34° 30' S	27° 48' W	~400	T,S,P
1798-1	XBT	113	29/12	00:55	34° 30' S	27° 55' W	~760	T,P
1677-1	uCTD	239	29/12	01:21	34° 30' S	28° 00' W	~400	T,S,P
1677-1	uCTD	240	29/12	02:23	34° 30' S	28° 11' W	~400	T,S,P
1677-1	uCTD	241	29/12	03:21	34° 30' S	28° 22' W	~400	T,S,P
1799-1	XBT	114	29/12	03:40	34° 30' S	28° 25' W	~760	T,P
1677-1	uCTD	242	29/12	04:25	34° 30' S	28° 34' W	~400	T,S,P
1677-1	uCTD	243	29/12	05:34	34° 30' S	28° 47' W	~400	T,S,P
1800-1	XBT	115	29/12	06:16	34° 30' S	28° 55' W	~760	T,P
1677-1	uCTD	244	29/12	06:30	34° 30' S	28° 57' W	~400	T,S,P
1677-1	uCTD	245	29/12	07:36	34° 30' S	29° 10' W	~400	T,S,P
1677-1	uCTD	246	29/12	08:30	34° 30' S	29° 20' W	~400	T,S,P
1801-1	XBT	116	29/12	08:51	34° 30' S	29° 24' W	~760	T,P
1677-1	uCTD	247	29/12	09:30	34° 30' S	29° 31' W	~400	T,S,P
1677-1	uCTD	248	29/12	10:30	34° 30' S	29° 43' W	~400	T,S,P
1802-1	XBT	117	29/12	11:28	34° 30' S	29° 54' W	~760	T,P
1802-1	XBT	118	29/12	11:31	34° 30' S	29° 54' W	~760	T,P
1677-1	uCTD	249	29/12	11:59	34° 30' S	30° 00' W	~400	T,S,P
1803-1	ARGO-Float	20	29/12	12:18	34° 30' S	30° 04' W		T,S,P
1677-1	uCTD	250	29/12	13:07	34° 30' S	30° 13' W	~400	T,S,P

1677-1	uCTD	251	29/12	13:53	34° 30' S	30° 22' W	~400	T,S,P
1804-1	XBT	119	29/12	14:13	34° 30' S	30° 26' W	~760	T,P
1677-1	uCTD	252	29/12	15:04	34° 30' S	30° 36' W	~400	T,S,P
1677-1	uCTD	253	29/12	16:05	34° 30' S	30° 48' W	~400	T,S,P
1677-1	uCTD	254	29/12	17:22	34° 30' S	31° 03' W	~400	T,S,P
1677-1	uCTD	255	29/12	18:25	34° 30' S	31° 16' W	~400	T,S,P
1806-1	XBT	120	29/12	19:09	34° 30' S	31° 24' W	~760	T,P
1677-1	uCTD	256	29/12	19:33	34° 30' S	31° 28' W	~400	T,S,P
1677-1	uCTD	257	29/12	21:44	34° 30' S	31° 52' W	~400	T,S,P
1807-1	XBT	121	29/12	22:00	34° 30' S	31° 55' W	~760	T,P
1677-1	uCTD	258	29/12	23:09	34° 30' S	32° 07' W	~400	T,S,P
1677-1	uCTD	259	30/12	00:12	34° 30' S	32° 18' W	~400	T,S,P
1808-1	XBT	122	30/12	00:55	34° 30' S	32° 25' W	~760	T,P
1677-1	uCTD	260	30/12	03:04	34° 30' S	32° 48' W	~400	T,S,P
1809-1	XBT	123	30/12	03:40	34° 30' S	32° 55' W	~760	T,P
1677-1	uCTD	261	30/12	04:11	34° 30' S	33° 01' W	~400	T,S,P
1810-1	XBT	124	30/12	06:16	34° 30' S	33° 24' W	~760	T,P
1810-2	XBT	125	30/12	06:22	34° 30' S	33° 25' W	~760	T,P
1677-1	uCTD	262	30/12	08:47	34° 30' S	33° 55' W	~400	T,S,P
1811-1	XBT	126	30/12	09:04	34° 30' S	33° 58' W	~760	T,P
1812-1	XBT	127	30/12	11:12	34° 30' S	34° 24' W	~760	T,P
1677-1	uCTD	263	30/12	11:36	34° 30' S	34° 29' W	~400	T,S,P
1677-1	uCTD	264	30/12	12:29	34° 30' S	34° 39' W	~400	T,S,P
1677-1	uCTD	265	30/12	13:35	34° 30' S	34° 52' W	~400	T,S,P
1813-1	XBT	128	30/12	13:57	34° 30' S	34° 55' W	~760	T,P
1677-1	uCTD	266	30/12	14:35	34° 30' S	35° 02' W	~400	T,S,P
1677-1	uCTD	267	30/12	15:48	34° 30' S	35° 16' W	~400	T,S,P
1814-1	XBT	129	30/12	16:34	34° 30' S	35° 25' W	~760	T,P
1814-2	XBT	130	30/12	16:38	34° 30' S	35° 26' W	~760	T,P
1815-1	XBT	131	30/12	18:22	34° 30' S	35° 47' W	~760	T,P
1816-1	XBT	132	30/12	19:00	34° 30' S	35° 54' W	~760	T,P
1817-1	XBT	133	30/12	20:13	34° 30' S	36° 09' W	~760	T,P
1818-1	XBT	134	30/12	21:32	34° 30' S	36° 24' W	~760	T,P
1819-1	XBT	135	30/12	22:47	34° 30' S	36° 39' W	~760	T,P
1820-1	XBT	136	31/12	00:07	34° 30' S	36° 54' W	~760	T,P
1821-1	XBT	137	31/12	01:24	34° 30' S	37° 10' W	~760	T,P
1821-2	XBT	138	31/12	01:28	34° 30' S	37° 10' W	~760	T,P
1822-1	XBT	139	31/12	02:46	34° 30' S	37° 26' W	~760	T,P
1823-1	XBT	140	31/12	03:56	34° 30' S	37° 40' W	~760	T,P
1824-1	XBT	141	31/12	06:21	34° 30' S	38° 09' W	~760	T,P
1824-2	XBT	142	31/12	06:24	34° 30' S	38° 09' W	~760	T,P
1825-1	XBT	143	31/12	07:40	34° 30' S	38° 24' W	~760	T,P
1826-1	XBT	144	31/12	08:56	34° 30' S	38° 39' W	~760	T,P
1826-2	XBT	145	31/12	09:05	34° 30' S	38° 41' W	~760	T,P
1827-1	XBT	146	31/12	10:03	34° 30' S	38° 52' W	~760	T,P
1828-1	MultiNet	23	31/12	10:20	34° 30' S	38° 54' W	720	T,S,P,Fl,TA, µPlast, Plank, Foram
1828-2	MultiNet	24	31/12	11:16	34° 30' S	38° 54' W	110	T,S,P,Fl,TA,

								µPlast, Plank, Foram
1828-3	MultiNet	25	31/12	11:32	34° 30' S	38° 54' W	515	T,S,P,Fl,TA, µPlast, Plank, Foram
1828-4	CTD/RO	19	31/12	12:27	34° 30' S	38° 54' W	2000	T,S,P,O2,Fl,TA
1829-1	XBT	147	31/12	15:58	34° 30' S	39° 11' W	~760	T,P
1677-1	uCTD	268	31/12	16:50	34° 30' S	39° 22' W	~400	T,S,P
1830-1	XBT	148	31/12	17:11	34° 30' S	39° 27' W	~760	T,P
1677-1	uCTD	269	31/12	18:00	34° 30' S	39° 37' W	~400	T,S,P
1831-1	XBT	149	31/12	18:17	34° 30' S	39° 41' W	~760	T,P
1677-1	uCTD	270	31/12	19:03	34° 30' S	39° 51' W	~400	T,S,P
1832-1	XBT	150	31/12	19:20	34° 30' S	39° 55' W	~760	T,P
1833-1	XBT	151	31/12	20:29	34° 30' S	40° 09' W	~760	T,P
1677-1	uCTD	271	31/12	20:56	34° 30' S	40° 15' W	~400	T,S,P
1834-1	XBT	152	31/12	21:39	34° 30' S	40° 24' W	~760	T,P
1835-1	XBT	153	31/12	22:39	34° 30' S	40° 36' W	~760	T,P
1835-2	XBT	154	31/12	22:45	34° 30' S	40° 37' W	~760	T,P
1836-1	XBT	155	31/12	23:47	34° 30' S	40° 49' W	~760	T,P
1837-1	XBT	156	1/01	01:26	34° 30' S	41° 09' W	~760	T,P
0001-1	XBT	157	1/01	03:25	34° 30' S	41° 25' W	~760	T,P
0002-1	XBT	158	1/01	04:40	34° 30' S	41° 38' W	~760	T,P
0003-1	XBT	159	1/01	07:26	34° 30' S	42° 07' W	~760	T,P
0004-1	XBT	160	1/01	07:46	34° 30' S	42° 10' W	~760	T,P
0005-1	XBT	161	1/01	08:57	34° 30' S	42° 24' W	~760	T,P
0006-1	XBT	162	1/01	10:20	34° 30' S	42° 40' W	~760	T,P
0007-1	XBT	163	1/01	11:33	34° 30' S	42° 54' W	~760	T,P
0008-1	XBT	164	1/01	12:50	34° 30' S	43° 09' W	~760	T,P
1677-1	uCTD	272	1/01	13:02	34° 30' S	43° 12' W	~400	T,S,P
1677-1	uCTD	273	1/01	14:08	34° 30' S	43° 25' W	~400	T,S,P
0009-1	XBT	165	1/01	14:23	34° 30' S	43° 28' W	~760	T,P
0009-2	XBT	166	1/01	14:26	34° 30' S	43° 28' W	~760	T,P
1677-1	uCTD	274	1/01	15:09	34° 30' S	43° 37' W	~400	T,S,P
1677-1	uCTD	275	1/01	16:04	34° 30' S	43° 48' W	~400	T,S,P
0010-1	XBT	167	1/01	16:41	34° 30' S	43° 55' W	~760	T,P
1677-1	uCTD	276	1/01	17:12	34° 30' S	44° 01' W	~400	T,S,P
1677-1	uCTD	277	1/01	18:07	34° 30' S	44° 11' W	~400	T,S,P
0011-1	XBT	168	1/01	19:10	34° 30' S	44° 23' W	~760	T,P
1677-1	uCTD	278	1/01	19:21	34° 30' S	44° 25' W	~400	T,S,P
1677-1	uCTD	279	1/01	20:40	34° 30' S	44° 40' W	~400	T,S,P
1677-1	uCTD	280	1/01	21:30	34° 30' S	44° 50' W	~400	T,S,P
0012-1	XBT	169	1/01	21:50	34° 30' S	44° 54' W	~760	T,P
1677-1	uCTD	281	1/01	22:42	34° 30' S	45° 04' W	~400	T,S,P
1677-1	uCTD	282	1/01	23:50	34° 30' S	45° 17' W	~400	T,S,P
0013-1	XBT	170	2/01	00:31	34° 30' S	45° 24' W	~760	T,P
1677-1	uCTD	283	2/01	00:49	34° 30' S	45° 28' W	~400	T,S,P
1677-1	uCTD	284	2/01	01:44	34° 30' S	45° 37' W	~400	T,S,P
1677-1	uCTD	285	2/01	02:51	34° 30' S	45° 51' W	~400	T,S,P
0014-1	XBT	171	2/01	03:14	34° 30' S	45° 55' W	~760	T,P

1677-1	uCTD	286	2/01	04:04	34° 30' S	46° 04' W	~400	T,S,P
1677-1	uCTD	287	2/01	05:08	34° 30' S	46° 17' W	~400	T,S,P
0015-1	XBT	172	2/01	05:44	34° 30' S	46° 25' W	~760	T,P
1677-1	uCTD	288	2/01	06:20	34° 30' S	46° 32' W	~400	T,S,P
1677-1	uCTD	289	2/01	07:18	34° 30' S	46° 45' W	~400	T,S,P
0016-1	XBT	173	2/01	08:02	34° 30' S	46° 54' W	~760	T,P
1677-1	uCTD	290	2/01	08:27	34° 31' S	46° 58' W	~400	T,S,P
1677-1	uCTD	291	2/01	09:22	34° 37' S	47° 07' W	~400	T,S,P
0017-1	MultiNet	26	2/01	10:23	34° 42' S	47° 15' W	730	T,S,P,Fl,TA, µPlast, Plank, Foram
0017-2	MultiNet	27	2/01	11:18	34° 42' S	47° 15' W	110	T,S,P,Fl,TA, µPlast, Plank, Foram
0017-3	MultiNet	28	2/01	11:33	34° 42' S	47° 15' W	515	T,S,P,Fl,TA, µPlast, Plank, Foram
0017-4	CTD/RO	20	2/01	12:26	34° 42' S	47° 15' W	2007	T,S,P,O2,Fl,TA
0017-5	ARGO-Float	21	2/01	13:52	34° 42' S	47° 15' W		T,S,P
0018-1	XBT	174	2/01	14:22	34° 45' S	47° 20' W	~760	T,P
1677-1	uCTD	292	2/01	14:38	34° 46' S	47° 23' W	~400	T,S,P
1677-1	uCTD	293	2/01	15:44	34° 54' S	47° 34' W	~400	T,S,P
1677-1	uCTD	294	2/01	16:35	34° 59' S	47° 44' W	~400	T,S,P
0019-1	XBT	175	2/01	16:56	35° 01' S	47° 48' W	~760	T,P
0019-2	XBT	176	2/01	17:00	35° 01' S	47° 49' W	~760	T,P
0019-3	XBT	177	2/01	17:04	35° 02' S	47° 49' W	~760	T,P
1677-1	uCTD	295	2/01	17:34	35° 05' S	47° 55' W	~400	T,S,P
1677-1	uCTD	296	2/01	18:36	35° 12' S	48° 06' W	~400	T,S,P
0020-1	XBT	178	2/01	18:58	35° 15' S	48° 10' W	~760	T,P
1677-1	uCTD	297	2/01	19:47	35° 20' S	48° 19' W	~400	T,S,P
1677-1	uCTD	298	2/01	20:51	35° 27' S	48° 31' W	~400	T,S,P
0021-1	XBT	179	2/01	21:12	35° 30' S	48° 36' W	~760	T,P
1677-1	uCTD	299	2/01	21:27	35° 31' S	48° 39' W	~400	T,S,P
1677-1	uCTD	300	2/01	22:53	35° 40' S	48° 54' W	~400	T,S,P
0022-1	XBT	180	2/01	23:31	35° 44' S	49° 01' W	~760	T,P
1677-1	uCTD	301	2/01	23:57	35° 47' S	49° 05' W	~400	T,S,P
1677-1	uCTD	302	3/01	01:03	35° 53' S	49° 16' W	~400	T,S,P
1677-1	uCTD	303	3/01	02:04	35° 59' S	49° 25' W	~400	T,S,P
0023-1	XBT	181	3/01	02:22	36° 01' S	49° 28' W	~760	T,P
1677-1	uCTD	304	3/01	03:01	36° 04' S	49° 34' W	~400	T,S,P
1677-1	uCTD	305	3/01	04:10	36° 11' S	49° 46' W	~400	T,S,P
0024-1	XBT	182	3/01	04:45	36° 15' S	49° 51' W	~760	T,P
0024-2	XBT	183	3/01	04:48	36° 15' S	49° 52' W	~760	T,P
1677-1	uCTD	306	3/01	05:07	36° 16' S	49° 55' W	~400	T,S,P
1677-1	uCTD	307	3/01	06:22	36° 24' S	50° 08' W	~400	T,S,P
0025-1	XBT	184	3/01	07:15	36° 30' S	50° 18' W	~760	T,P
1677-1	uCTD	308	3/01	07:27	36° 31' S	50° 19' W	~400	T,S,P
1677-1	uCTD	309	3/01	08:30	36° 37' S	50° 31' W	~400	T,S,P

0026-1	XBT	185	3/01	09:37	36° 45' S	50° 42' W	~760	T,P
1677-1	uCTD	310	3/01	09:49	36° 46' S	50° 44' W	~400	T,S,P
1677-1	uCTD	311	3/01	11:00	36° 52' S	50° 55' W	~400	T,S,P
1677-1	uCTD	312	3/01	12:06	36° 58' S	51° 06' W	~400	T,S,P
0027-1	XBT	186	3/01	12:33	37° 00' S	51° 09' W	~760	T,P
1677-1	uCTD	313	3/01	14:20	37° 10' S	51° 24' W	~400	T,S,P
1677-1	uCTD	314	3/01	15:20	37° 16' S	51° 32' W	~400	T,S,P
0028-1	XBT	187	3/01	15:39	37° 18' S	51° 34' W	~760	T,P
0028-2	XBT	188	3/01	15:43	37° 18' S	51° 35' W	~760	T,P
1677-1	uCTD	315	3/01	16:26	37° 21' S	51° 42' W	~400	T,S,P
1677-1	uCTD	316	3/01	17:34	37° 27' S	51° 52' W	~400	T,S,P
0029-1	XBT	189	3/01	18:16	37° 30' S	51° 58' W	~760	T,P
1677-1	uCTD	317	3/01	18:52	37° 33' S	52° 03' W	~400	T,S,P
1677-1	uCTD	318	3/01	20:03	37° 39' S	52° 13' W	~400	T,S,P
0030-1	XBT	190	3/01	21:19	37° 45' S	52° 24' W	~760	T,P
1677-1	uCTD	319	3/01	21:34	37° 46' S	52° 27' W	~400	T,S,P
0031-1	XBT	191	3/01	22:42	37° 51' S	52° 36' W	~760	T,P
0032-1	XBT	192	4/01	00:16	38° 00' S	52° 49' W	~760	T,P
0033-1	XBT	193	4/01	02:17	38° 00' S	53° 10' W	~760	T,P
0034-1	MultiNet	29	4/01	03:48	38° 00' S	53° 25' W	720	T,S,P,Fl,TA, µPlast, Plank, Foram
0034-2	MultiNet	30	4/01	04:45	38° 01' S	53° 24' W	110	T,S,P,Fl,TA, µPlast, Plank, Foram
0034-3	MultiNet	31	4/01	05:02	38° 01' S	53° 24' W	525	T,S,P,Fl,TA, µPlast, Plank, Foram
0034-4	CTD/RO	21	4/01	05:53	38° 01' S	53° 24' W	2000	T,S,P,O2,Fl,TA
1677-1	uCTD	320	4/01	07:31	38° 01' S	53° 24' W	~400	T,S,P
0035-1	XBT	194	4/01	07:54	38° 00' S	53° 28' W	~760	T,P
1677-1	uCTD	321	4/01	08:42	38° 00' S	53° 39' W	~400	T,S,P
0036-1	XBT	195	4/01	09:30	38° 00' S	53° 50' W	~760	T,P
1677-1	uCTD	322	4/01	09:48	38° 00' S	53° 54' W	~400	T,S,P
1677-1	uCTD	323	4/01	10:45	38° 00' S	54° 07' W	~400	T,S,P
0037-1	XBT	196	4/01	11:05	38° 00' S	54° 12' W	~760	T,P
0038-1	CTD/RO	22	4/01	11:50	38° 00' S	54° 20' W	1246	T,S,P,O2,Fl,TA
0039-1	XBT	197	4/01	13:40	38° 00' S	54° 29' W	~760	T,P
1677-1	uCTD	324	4/01	14:01	38° 00' S	54° 34' W	~400	T,S,P
1677-1	uCTD	325	4/01	15:02	38° 00' S	54° 48' W	~400	T,S,P
0040-1	XBT	198	4/01	15:21	38° 00' S	54° 51' W	~760	T,P
1677-1	uCTD	326	4/01	16:41	38° 00' S	55° 08' W	~400	T,S,P
0041-1	XBT	199	4/01	16:52	38° 00' S	55° 10' W	~760	T,P
0042-1	CTD/RO	23	4/01	18:07	38° 09' S	55° 07' W	537	T,S,P,O2,Fl,TA
0043-1	RCast	1	4/01	19:25	38° 14' S	55° 04' W	101	T,S,P
0044-1	XBT	200	4/01	20:08	38° 21' S	55° 01' W	~760	T,P
0043-1	RCast	2	4/01	20:19	38° 23' S	55° 01' W	98	T,S,P
0045-1	XBT	201	4/01	21:03	38° 30' S	54° 58' W	~760	T,P
0043-1	RCast	3	4/01	21:08	38° 31' S	54° 57' W	101	T,S,P

0046-1	XBT	202	4/01	22:04	38° 40' S	54° 54' W	~760	T,P
0043-1	RCast	4	4/01	22:20	38° 42' S	54° 53' W	95	T,S,P
0047-1	XBT	203	4/01	22:58	38° 48' S	54° 51' W	~760	T,P
0043-1	RCast	5	4/01	23:08	38° 50' S	54° 50' W	98	T,S,P
0048-1	XBT	204	5/01	00:03	38° 59' S	54° 46' W	~760	T,P
0043-1	RCast	6	5/01	00:10	39° 00' S	54° 46' W	97	T,S,P
0049-1	XBT	205	5/01	01:01	39° 08' S	54° 43' W	~760	T,P
0049-2	XBT	206	5/01	01:09	39° 09' S	54° 42' W	~760	T,P
0043-1	RCast	7	5/01	01:17	39° 11' S	54° 42' W	94	T,S,P
0050-1	XBT	207	5/01	02:02	39° 18' S	54° 39' W	~760	T,P
0043-1	RCast	8	5/01	02:08	39° 19' S	54° 39' W	93	T,S,P
0051-1	XBT	208	5/01	03:06	39° 28' S	54° 35' W	~760	T,P
0052-1	MultiNet	32	5/01	03:31	39° 30' S	54° 34' W	725	T,S,P,Fl,TA, Foram
0052-2	MultiNet	33	5/01	04:28	39° 29' S	54° 34' W	110	T,S,P,Fl,TA, Foram
0052-3	MultiNet	34	5/01	04:45	39° 29' S	54° 34' W	525	T,S,P,Fl,TA, Foram
0052-4	CTD/RO	24	5/01	05:35	39° 29' S	54° 34' W	NaN	T,S,P,O2,Fl,TA
0052-4	CTD/RO	25	5/01	05:50	39° 29' S	54° 34' W	2031	T,S,P,O2,Fl,TA
0053-1	XBT	209	5/01	08:39	39° 18' S	54° 25' W	~760	T,P
0054-1	XBT	210	5/01	10:03	39° 06' S	54° 15' W	~760	T,P
0055-1	XBT	211	5/01	11:22	38° 54' S	54° 04' W	~760	T,P
0056-1	MultiNet	35	5/01	12:25	38° 46' S	53° 58' W	720	T,S,P,Fl,TA, Plank, Foram
0056-2	MultiNet	36	5/01	13:28	38° 46' S	53° 56' W	110	T,S,P,Fl,TA, Plank, Foram
0056-3	MultiNet	37	5/01	13:47	38° 46' S	53° 55' W	525	T,S,P,Fl,TA, Plank, Foram
0056-4	CTD/RO	26	5/01	14:39	38° 46' S	53° 54' W	2024	T,S,P,O2,Fl,TA
0043-1	RCast	9	5/01	16:13	38° 46' S	53° 54' W	87	T,S,P
0057-1	XBT	212	5/01	17:14	38° 36' S	53° 49' W	~760	T,P
0058-1	MultiNet	38	5/01	17:34	38° 34' S	53° 49' W	745	T,S,P,Fl,TA, Foram
0058-2	MultiNet	39	5/01	18:43	38° 35' S	53° 48' W	110	T,S,P,Fl,TA, Foram
0058-3	MultiNet	40	5/01	19:00	38° 36' S	53° 48' W	550	T,S,P,Fl,TA, Foram
0058-4	CTD/RO	27	5/01	19:56	38° 36' S	53° 47' W	1037	T,S,P,O2,Fl,TA
0043-1	RCast	10	5/01	21:02	38° 36' S	53° 46' W	91	T,S,P
0059-1	MultiNet	41	5/01	21:41	38° 31' S	53° 43' W	814	T,S,P,Fl,TA, µPlast, Foram
0059-2	MultiNet	42	5/01	22:46	38° 33' S	53° 42' W	109	T,S,P,Fl,TA, µPlast, Foram
0059-3	MultiNet	43	5/01	23:03	38° 33' S	53° 41' W	590	T,S,P,Fl,TA, µPlast, Foram
0059-4	CTD/RO	28	5/01	23:57	38° 34' S	53° 39' W	2121	T,S,P,O2,Fl,TA
1677-1	uCTD	327	6/01	02:00	38° 37' S	53° 40' W	~400	T,S,P
0060-1	XBT	213	6/01	03:04	38° 40' S	53° 49' W	~760	T,P
0061-1	MultiNet	44	6/01	03:50	38° 44' S	53° 54' W	520	T,S,P,Fl,TA,

								Foram
0061-2	MultiNet	45	6/01	04:41	38° 45' S	53° 53' W	120	T,S,P,Fl,TA, Foram
0061-3	MultiNet	46	6/01	05:07	38° 45' S	53° 53' W	730	T,S,P,Fl,TA, Foram
0061-4	CTD/RO	29	6/01	06:10	38° 46' S	53° 52' W	1057	T,S,P,O2,Fl,TA
1677-1	uCTD	328	6/01	07:19	38° 48' S	53° 53' W	~400	T,S,P
1677-1	uCTD	329	6/01	08:24	38° 55' S	54° 01' W	~400	T,S,P
1677-1	uCTD	330	6/01	09:17	39° 00' S	54° 07' W	~400	T,S,P
1677-1	uCTD	331	6/01	10:19	39° 04' S	54° 15' W	~400	T,S,P
1677-1	uCTD	332	6/01	11:29	39° 05' S	54° 28' W	~400	T,S,P
1677-1	uCTD	333	6/01	12:25	39° 06' S	54° 37' W	~400	T,S,P
1677-1	uCTD	334	6/01	13:28	39° 07' S	54° 46' W	~400	T,S,P
1677-1	uCTD	335	6/01	14:35	39° 07' S	54° 59' W	~400	T,S,P
1677-1	uCTD	336	6/01	15:37	39° 09' S	55° 11' W	~400	T,S,P
1677-1	uCTD	337	6/01	16:36	39° 09' S	55° 22' W	~400	T,S,P
0062-1	XBT	214	6/01	17:08	39° 10' S	55° 29' W	~760	T,P
0043-1	RCast	11	6/01	17:22	39° 10' S	55° 32' W	100	T,S,P
0043-1	RCast	12	6/01	18:32	39° 11' S	55° 46' W	85	T,S,P
0043-1	RCast	13	6/01	19:44	39° 12' S	56° 02' W	67	T,S,P
0043-1	RCast	14	6/01	20:53	39° 13' S	56° 16' W	61	T,S,P
0063-1	XBT	215	7/01	11:16	41° 01' S	58° 00' W	~760	T,P
0043-1	RCast	15	7/01	12:38	41° 14' S	58° 00' W	59	T,S,P
0043-1	RCast	16	7/01	13:41	41° 23' S	58° 00' W	69	T,S,P
0043-1	RCast	17	7/01	14:42	41° 31' S	58° 00' W	74	T,S,P
0043-1	RCast	18	7/01	15:34	41° 39' S	58° 00' W	79	T,S,P
0043-1	RCast	19	7/01	16:39	41° 47' S	58° 00' W	104	T,S,P
0043-1	RCast	20	7/01	17:49	41° 57' S	58° 01' W	99	T,S,P
0043-1	RCast	21	7/01	19:00	42° 05' S	58° 07' W	141	T,S,P
0064-1	XBT	216	7/01	20:13	42° 14' S	58° 10' W	~760	T,P
0043-1	RCast	22	7/01	20:18	42° 15' S	58° 10' W	134	T,S,P
0043-1	RCast	23	7/01	21:34	42° 24' S	58° 13' W	135	T,S,P
0043-1	RCast	24	7/01	22:47	42° 31' S	58° 07' W	126	T,S,P
0065-1	MultiNet	47	7/01	23:33	42° 34' S	57° 59' W	720	T,S,P,Fl,TA, Foram
0065-2	MultiNet	48	8/01	00:28	42° 34' S	57° 58' W	110	T,S,P,Fl,TA, Foram
0065-3	MultiNet	49	8/01	00:46	42° 33' S	57° 58' W	520	T,S,P,Fl,TA, Foram
0065-4	CTD/RO	30	8/01	01:40	42° 33' S	57° 57' W	1001	T,S,P,O2,Fl,TA
0067-1	ARGO-Float	22	8/01	07:48	43° 18' S	58° 00' W		T,S,P
0068-1	MultiNet	50	8/01	16:49	44° 39' S	58° 00' W	720	T,S,P,Fl,TA, Plank, Foram
0068-2	MultiNet	51	8/01	17:46	44° 39' S	58° 00' W	110	T,S,P,Fl,TA, Plank, Foram
0068-3	MultiNet	52	8/01	18:02	44° 39' S	58° 00' W	515	T,S,P,Fl,TA, Plank, Foram
0068-4	CTD/RO	31	8/01	18:54	44° 39' S	58° 00' W	2826	T,S,P,O2,Fl,TA
0069-1	ARGO-	23	8/01	20:49	44° 39' S	58° 00' W		T,S,P

	Float							
0070-1	XBT	217	8/01	21:11	44° 39' S	58° 04' W	~760	T,P
0071-1	XBT	218	8/01	21:57	44° 39' S	58° 14' W	~760	T,P
0072-1	XBT	219	8/01	22:35	44° 39' S	58° 23' W	~760	T,P
0073-1	XBT	220	8/01	23:24	44° 39' S	58° 34' W	~760	T,P
0074-1	CTD/RO	32	9/01	00:03	44° 39' S	58° 40' W	2009	T,S,P,O2,Fl,TA
0075-1	XBT	221	9/01	01:56	44° 39' S	58° 45' W	~760	T,P
0076-1	XBT	222	9/01	02:44	44° 39' S	58° 54' W	~760	T,P
0077-1	XBT	223	9/01	03:34	44° 39' S	59° 04' W	~760	T,P
0077-2	XBT	224	9/01	03:37	44° 39' S	59° 05' W	~760	T,P
0078-1	CTD/RO	33	9/01	04:17	44° 39' S	59° 10' W	1562	T,S,P,O2,Fl,TA
0079-1	XBT	225	9/01	05:58	44° 39' S	59° 15' W	~760	T,P
0079-2	XBT	226	9/01	06:01	44° 39' S	59° 15' W	~760	T,P
0080-1	XBT	227	9/01	06:42	44° 39' S	59° 24' W	~760	T,P
0080-2	XBT	228	9/01	06:46	44° 39' S	59° 25' W	~760	T,P
0081-1	CTD/RO	34	9/01	07:12	44° 39' S	59° 30' W	1310	T,S,P,O2,Fl,TA
0082-1	XBT	229	9/01	08:34	44° 39' S	59° 34' W	~760	T,P
0083-1	CTD/RO	35	9/01	09:15	44° 39' S	59° 42' W	1162	T,S,P,O2,Fl,TA
0084-1	XBT	230	9/01	10:22	44° 38' S	59° 43' W	~760	T,P
0085-1	CTD/RO	36	9/01	10:56	44° 39' S	59° 49' W	760	T,S,P,O2,Fl,TA
0086-1	XBT	231	9/01	12:11	44° 39' S	59° 54' W	~760	T,P
0087-1	CTD/RO	37	9/01	12:47	44° 39' S	60° 00' W	182	T,S,P,O2,Fl,TA
0088-1	XBT	232	9/01	13:35	44° 39' S	60° 04' W	~760	T,P
0088-2	XBT	233	9/01	13:38	44° 39' S	60° 05' W	~760	T,P
0043-1	RCast	25	9/01	13:58	44° 39' S	60° 09' W	93	T,S,P
0043-1	RCast	26	9/01	15:09	44° 39' S	60° 24' W	91	T,S,P
0043-1	RCast	27	9/01	16:40	44° 39' S	60° 38' W	94	T,S,P
0089-1	CTD/RO	38	9/01	17:53	44° 39' S	60° 49' W	98	T,S,P,O2,Fl,TA
0043-1	RCast	28	9/01	18:23	44° 39' S	60° 51' W	79	T,S,P
0043-1	RCast	29	9/01	19:22	44° 39' S	61° 03' W	78	T,S,P
0043-1	RCast	30	9/01	21:28	44° 39' S	61° 25' W	88	T,S,P
0090-1	CTD/RO	39	9/01	22:58	44° 39' S	61° 40' W	94	T,S,P,O2,Fl,TA
0043-1	RCast	31	9/01	23:35	44° 39' S	61° 42' W	73	T,S,P
0043-1	RCast	32	10/01	00:34	44° 39' S	61° 54' W	75	T,S,P
0043-1	RCast	33	10/01	01:39	44° 39' S	62° 07' W	74	T,S,P
0043-1	RCast	34	10/01	02:14	44° 39' S	62° 13' W	75	T,S,P
0091-1	CTD/RO	40	10/01	03:42	44° 39' S	62° 30' W	89	T,S,P,O2,Fl,TA
0043-1	RCast	35	10/01	04:07	44° 39' S	62° 30' W	74	T,S,P
0043-1	RCast	36	10/01	05:02	44° 39' S	62° 42' W	76	T,S,P
0043-1	RCast	37	10/01	06:01	44° 39' S	62° 53' W	76	T,S,P
0092-1	CTD/RO	41	10/01	06:48	44° 39' S	63° 00' W	75	T,S,P,O2,Fl,TA
0093-1	XBT	234	11/01	05:42	47° 37' S	61° 14' W	~760	T,P
0094-1	XBT	235	11/01	06:42	47° 40' S	60° 59' W	~760	T,P
0095-1	XBT	236	11/01	07:43	47° 43' S	60° 45' W	~760	T,P
0096-1	XBT	237	11/01	08:49	47° 45' S	60° 30' W	~760	T,P
0097-1	XBT	238	11/01	09:54	47° 46' S	60° 15' W	~760	T,P
0098-1	XBT	239	11/01	11:03	47° 49' S	60° 00' W	~760	T,P
0099-1	XBT	240	11/01	12:11	47° 52' S	59° 45' W	~760	T,P
0100-1	XBT	241	11/01	13:19	47° 55' S	59° 30' W	~760	T,P

0101-1	XBT	242	11/01	14:23	47° 58' S	59° 15' W	~760	T,P
0102-1	XBT	243	11/01	15:29	48° 00' S	59° 00' W	~760	T,P
0103-1	XBT	244	11/01	16:31	48° 00' S	58° 45' W	~760	T,P
0104-1	XBT	245	11/01	17:30	48° 00' S	58° 30' W	~760	T,P
0104-2	XBT	246	11/01	17:38	48° 00' S	58° 28' W	~760	T,P
0104-3	XBT	247	11/01	17:44	48° 00' S	58° 26' W	~760	T,P
0104-4	XBT	248	11/01	17:50	48° 00' S	58° 25' W	~760	T,P
0105-1	XBT	249	11/01	18:30	48° 00' S	58° 15' W	~760	T,P
0106-1	MultiNet	53	11/01	19:43	48° 00' S	58° 00' W	720	T,S,P,Fl,TA, Foram
0106-2	MultiNet	54	11/01	20:52	48° 00' S	58° 00' W	110	T,S,P,Fl,TA, Foram
0106-3	MultiNet	55	11/01	21:07	48° 00' S	58° 01' W	515	T,S,P,Fl,TA, Foram
0106-4	CTD/RO	42	11/01	21:52	48° 00' S	58° 01' W	2473	T,S,P,O2,Fl,TA
0107-1	ARGO-Float	24	11/01	23:30	48° 00' S	58° 03' W		T,S,P
0108-1	XBT	250	11/01	23:39	48° 00' S	58° 04' W	~760	T,P

8 Data and Sample Storage and Availability

In Kiel a joint Data-management-Team is active, which stores the data from various projects and cruises in a web-based multi-user-system. Data gathered during M133 are stored at the Kiel data portal. The MultiNet data are handled at the MARUM data center. All data will be submitted to PANGAEA within 3 years, i.e. by January 2020. Preliminary CTD, UCTD and all XBT data were submitted to CORIOLIS (France) and NOAA (USA) and from there to the GTS during the cruise for real time oceanographic analysis and Argo calibration.

Table 8.1 List of contacts for data storage and availability

Data	Contact person	Present affiliation	email
CTD ADCP uCTD/RapidCast TSG XBT	Gerd Krahmann	GEOMAR	gkrahmann@geomar.de
Oxygen Carbonate system	Arne Körtzinger	GEOMAR	akoertzinger@geomar.de
MultiNet	Michael Siccha	MARUM	msiccha@marum.de
Plankton Diversity	Christine Falk	MH Hannover	Falk.Christine@mh-hannover.de

9 Acknowledgements

We like to thank captain Rainer Hammacher, his officers and crew of RV METEOR for their support of our measurement program and for creating a very friendly, supportive and professional work atmosphere on board. The ship time of METEOR was provided by the German Science Foundation (DFG) within the core program METEOR/MERIAN. Financial support for the different projects carried out during the cruise was provided through the DFG, BMBF (SACUS), EU AtlantOS project and Inter American Institute (IAI).

10 References

During the cruise we followed the guidelines recently developed by the GO-SHIP group, particularly did we consider the guides for best practices:

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