MARIA S. MERIAN-Berichte

Understanding processes and long-term variability in the Labrador Sea

Cruise No. MSM129/1

25. May 2024 – 05. June 2024,
Rostock (Germany) – St. John's (Canada)
LabSeaFlow 2024

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2025

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1 Cruise Summary

1.1 Summary in English

The scientific program of the MARIA S. MERIAN MSM129/1 expedition was dedicated to improvements in data acquisition and data/metadata management aspects of the DAM "Underway Research Data" project. A case study conducted during MSM129/1 addressed the establishment of a workflow in the DAM underway data workflow to favor situation-dependent sampling. Obviously, this needs to be done without additional steaming time. The test case chosen for MSM129/1 was the mapping of 'potential seamounts', but other conceivable cases would be the sampling of mesoscale ocean structures. Upper ocean surveys were done with a profiling underway system (Moving Vessel Profiler, MVP) and for the purpose to estimate how deep the North Atlantic marine heat wave (established in 2023) is traceable. Four CTD's were acquired to calibrate mooring instruments (MSM129/leg 2) but also to estimate for the Orphan Knoll region if west/east differences in the T/S properties at the Deep Western Boundary Current core depth (approx. 2900m; referenced to the 53°N observatory) can be identified. Embedded in the DAM project thermosalinograph (TSG), Fluorometer, Acoustic Doppler Current Profiler (ADCP), FerryBox, and Bathymetry data were acquired. The expedition was a contribution to national (DAM Underway Research Data) and international projects (EU projects EuroGO-SHIP and ObsSea4Clim).

1.2 Zusammenfassung

Das wissenschaftliche Programm der Expedition MARIA S. MERIAN MSM129/1 widmete sich der Verbesserung der Datenerfassung und des Daten-/Metadatenmanagements im Rahmen des DAM-Projekts „Underway Research Data". Eine Fallstudie, die während MSM129/1 durchgeführt wurde, befasste sich mit der Etablierung eines Workflows im laufenden DAM-Datenworkflow, um situationsabhängige Stichproben zu begünstigen. Natürlich muss dies ohne zusätzliche Dämpfzeit erfolgen. Der für MSM129/1 gewählte Testfall war die Kartierung „potenzieller Seeberge", aber andere denkbare Fälle wären die Probenahme mesoskaliger Meeresstrukturen. Die Untersuchungen im oberen Ozean wurden mit einem laufenden Profiling-System (Moving Vessel Profiler, MVP) durchgeführt, um abzuschätzen, wie tief die (im Jahr 2023 eingerichtete) nordatlantische Meereshitzewelle rückverfolgbar ist. Es wurden vier CTDs erworben, um Verankerungsinstrumente (MSM129/leg 2) zu kalibrieren, aber auch um für die Region Orphan Knoll abzuschätzen, ob sich die T/S-Eigenschaften in der Kerntiefe des Deep Western Boundary Current (ca. 2900 m; Bezogen auf das 53°N-Observatorium) identifiziert werden kann. Eingebettet in das DAM-Projekt wurden Thermosalinograph (TSG), Fluorometer, Acoustic Doppler Current Profiler (ADCP), FerryBox und Bathymetry Daten erfasst. Die Expedition war ein Beitrag zu nationalen (DAM Underway Research Data) und internationalen Projekten (EU-Projekte EuroGO-SHIP und ObsSea4Clim).

2 Participants

2.1 Principal Investigators

Name	Institution
Johannes Karstensen, Dr.	GEOMAR Helmholtz Centre for Ocean Research Kiel, Germany
Michael Schlundt, Dr.	GEOMAR Helmholtz Centre for Ocean Research Kiel, Germany

2.2 Scientific Party

Name	Discipline	Institution
Dr Johannes Karstensen	Chief scientist	GEOMAR
Dr Michael Schlundt	Co-Chief scientist, DAM Lead	GEOMAR
Hannah Olbricht	PO Technik	GEOMAR
Vasile-Sorin Balan	CTD watch lead	GeoEcoMar
Dr Gerd Krahmann	Glider, lADCP, CTD	GEOMAR
Dr Abed El Rahman Hassoun	Oxygen, carbon, nutrients	GEOMAR
Kim Ripke	CTD watch	CAU Kiel
Yurid Behr	Salinometer, CTD watch	CAU Kiel
Lasse Glüsen	X-Band, CTD watch	CAU Kiel
Stefanie Brechtelsbauer	ADCP, CTD watch	CAU Kiel
Christiane Lösel	Blogs etc. CTD watch lead,	CAU Kiel
Grete Boskamp	UVP, CTD watch	IOW
Dr Marianne Rehage	DAM-Bathymetry	MARUM (PANGAEA)
Dr Julia Oelker	DAM Fluorometer	ICBM
Daniel Damaske	DAM-Bathymetrie	MARUM (PANGAEA)
Dr Kathrin Riemann-Campe	Data DAM-Oceanography	AWI (PANGAEA)
Dr Alexandra Marki	Data DAM-Oceanography	BSH
Norbert Anselm	DAM Dataflow	AWI
Emil Michels	DAM CTD	IOW
Dr Gregor Börner	DAM Sensors	GEOMAR

2.3 Participating Institutions

AWI	Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research, Bremerhaven, Germany
BSH	Bundesamt für Seeschifffahrt und Hydrographie, Hamburg, Germany
CAU Kiel	Christian-Albrechts-Universität zu Kiel, Kiel, Germany
GeoEcoMar	National Institute for Research and Development on Marine Geology and Geoecology, Constantza, Romania
GEOMAR	Helmholtz-Zentrum für Ozeanforschung Kiel, Kiel, Germany
ICBM	Institute for Chemistry and Biology of the Marine Environment, Carl von Ossietzky Universität Oldenburg
IOW	Leibniz-Institut für Ostseeforschung Warnemünde, Rostock, Germany

MARUM	MARUM – Center for Marine Environmental Sciences, Bremen, University of Bremen
PANGAEA	Data Publisher for Earth & Environmental Science

3 Research Program

3.1 Description of the Work Area

This transit cruise from Rostock Warnemünde, Germany, to St. John's, Canada, in late spring 2024 was mostly optimized for minimal distance but nevertheless did cross distinct oceanographic regions. Starting in the shallow western Baltic Sea and transiting towards the northern North Sea, via Skagerrak, a rather steady increase of the initially rather low salinity surface waters were expected. The spring time warming was very efficient in 2024 and warm surface water, with also a very shallow mixed layer, had developed. The transit through the open North Atlantic first crossed the North Atlantic Current, the northeastern extension of the Gulf Stream, and thus characterized by warm and saline surface waters. Further west the track brought us into a more subpolar dominated regime with colder and less saline surface waters. Overall, the surface water were much warmer then the long term mean (1982 to 2010) and we continued to observe from the few profile data collected, shallow mixed layers. As in 2023, the North Atlantic in 2024 continued to show the record sea surface temperature of roughly one degree warmer than ever recorded since 1980.

In respect to the bathymetry the cruise covered a number of interesting features such as the transition from the shelf sea and coastal ocean into the abyssal plain areas of the North Atlantic, the Mid Atlantic Ridge and local features (seamounts).

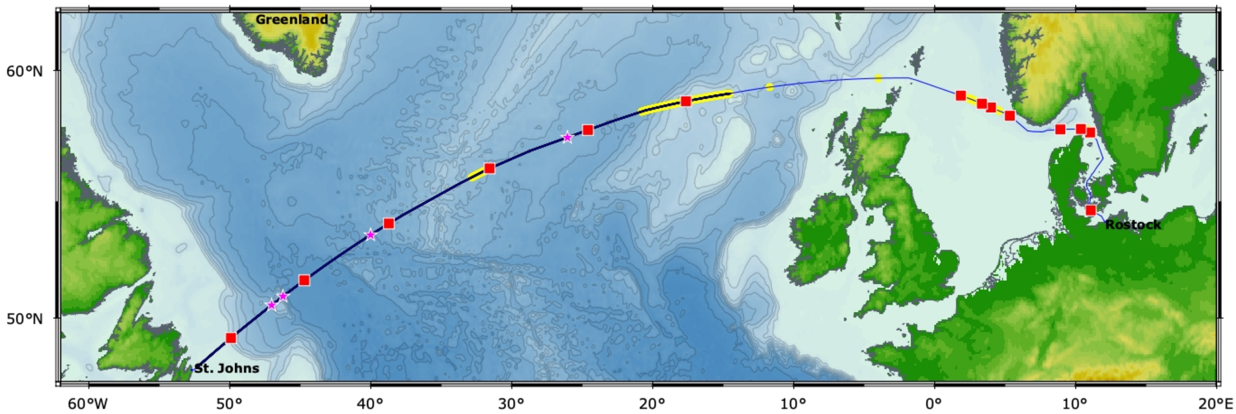


Fig. 3.1 Track chart of RV MARIA S. MERIAN MSM129/1 cruise track (blue line) and station overview. Black dots: ADCP/TSG Underway data; yellow circles: MVP data; magenta stars: CTD stations; red squares: Carbon reference samples

3.2 Aims of the Cruise

The purpose of the cruise focused on underway data acquisition of various kinds, augmented with a few full depth CTD profiles which served the calibration of instruments to be deployed during leg 2 (MSM129/2). The major operations where embedded in the Underway Research Data project, coordinated by the German Marine Research Alliance (DAM) under its core area of Data Management and Digitalization. The Underway Research Data project has developed and implemented workflows for managing data collected by sensors routinely available on German marine research vessels. These workflows include all operations from data acquisition, near real-time data transmission, quality control and open access data publication. The data workflow has been established by individuals who are typically not participating in research cruises and the MARIA S. MERIAN 129/1 provided a great opportunity to bring these experts onboard and allowed them to optimizing the operations at-site and in particular also in dialogue with the ship, that is running the systems they supervise, and with scientists, that have expectations on and own approaches to the processing and final quality of sensors under their supervision. During the cruise various workflows from sensor, via metadata, to data transfer and quality control relevant processing were trialed. One specific trial during MARIA S. MERIAN MSM129/1 was an enroute mapping of suspected seamounts. From satellite altimetry a global but rather coarse view of seafloor bathymetry exists, but only by charting local anomalies from a ship will reveal the true bathymetric structures and help classifying them e.g., as a seamount. For this purpose, the feasibility of a routine implementation of such specific seafloor surveys was tested and that included ways to do an optimal ship track planning with only slight modification to the original track (great circle optimized), needs on dialogues with ship master and chief scientist, and need for data access to verify results.

3.3 Agenda of the Cruise

The core program of the expedition MARIA S. MERIAN MSM129/1 was dedicated to underway data sampling and the associated data and metadata flow as part of the DAM Underway data pilot project. The focus is on those sensors that are permanently installed on the German research ships. The full data life cycle is considered from the sensor and its specifications, the management from the ship side (dialogue with the Scientific Technical Service (Wissenschaftlich Technischer Dienst (WTD) on board), the data and metadata management, sending the data in a timely manner a shore, calibrating the data and archiving the data with the appropriate metadata in selected data repositories (pangaea.de). Many devices were checked and indexed (Registry, https://registry.o2a-data.de/) for the first time, which is an important contribution for the metadata and sensor management. Also samples were collected and analysed for several parameters like salinity, chlorophyll-a and turbidity to compare those with the underway observations of the onboard installed sensors. For comparison, an independent flow-through system was installed and used for cross-comparison and cross-calibration with the permanently installed sensors. The potential for making use of such transit cruises to chart the uncarted seafloor was tested with a couple of potential seamounts and marginally changing the cruise track with only a few hours additional steaming time. Also a few CTD casts were performed to calibrate instruments for the mooring deployments planned for the following leg – MSM129/2. The cruise was carried out in accordance with the declarations on responsible marine research (Appendices 1 to 3 of the GPF Cruise Proposal Preparation Instructions).

4 Narrative of the Cruise

The loading of containers for MSM129 (leg 1 and leg 2) was done on May 21st and 22nd the Moving Vessel Profiler (MVP) was set up in the aft port side. On May 22nd and 23rd many activities were on the program (incl. an open ship) and that prohibited full time working on the redistribution of boxes as well as set up of equipment. However, on 24th May the familiarization for the science crew members took place and on May 25th, at 8:30 the MARIA S. MERIAN left Rostock-Warnemünde for the leg 1 of the MSM129. After the pilot left at 08:50 a XBand radar calibration was done (within 3km to the coast and in German EEZ waters). Underway water sampling was started at 09:00 with Kreisel and membrane pump. With entered Danish waters the XBand radar was switched off and likewise all underway throughflow system within 3nm (4nm) Denmark (Norway). Moreover, all systems were switched off completely in Swedish and United Kingdom waters (no permissions applied for). Further set up of equipment followed during the following days e.g., for chemical analysis of dissolved oxygen and collection of carbon system samples as well as chlorophyll-a. A first DAM initiated meeting on data flow with all science crew participants was conducted on the May 25th. In the morning of the 26th May we entered DK water outside 3nm and prepared to start the MVP survey. However, the system was not operating as expected and attempts to detect the issues went on the whole day and part of the night incl. the relocation of the whole device on deck. Fortunately, the weather allowed so. The issue was resolved (non-functioning switch) and the survey started 27th May at 8:30am. In parallel the underway systems were operated (Thermosalinograph, FerryBox). The major objective MSM129/1 was a further optimization of workflow in context with the DAM "Underway Research Data" project and indeed the time on board was used for many meetings between the DAM experts, the ship responsible (e.g., WTD) and science crew. Further on route the ship was occasionally slowed down for engine testing reasons. In UK waters some testing (but without data archiving) of the Parasound and the MVP were done to be well prepared for starting data acquisition when entering international waters. D. Damaske (PANGAEA/AWI) prepared a proposal for surveying so far uncharted seamounts and it turned out that for a survey of seven seamounts the course modifications were really minor (less than 5nm additional track length compared with the great circle track). In international waters we started with the underway (Ferrybox, ADCP, bathymetry) data collection and MVP survey on the 29th May at around 22:00 (LT). The MVP was operated continuously 30th May 20:30 when it was stopped for regular servicing. On 31st May at 14:30 the first CTD went into the water and was limited to 2000m because of calibrating instruments (optode loggers, to be deployed on leg 2) that had a 2000m depth limit. The CTD control from the lab was done by using a new interface designed by the IOW in the framework of the DAM "Underway Research Data" project. All sampling bottles except one did work well. The groups did Chlorophyll-a filtration in the upper layer (ICBM), and oxygen and salinity sampling (GEOMAR). At 23:00 seamount #3 was crossed and surveyed. On 01st June the MVP had to be stopped after 4 hours because the spool mechanism had a problem and the barrel run uneven. This problem remained during the rest of the cruise. A deep cast CTD#2 was done after crossing the Reykjanes Ridge. During the whole cruise daily science meetings took place with interesting presentations form the cruise participants, specifically DAM data and metadata flow relevant topics were presented. Likewise, a presentation of the DAM to the ship's officers and the electronics and WTD was done, followed by fruitful discussions. CTD#3 was done on the 4th June around midnight and shortly after the CTD#4 both on opposite sides of the Orphan Knoll region. We finally received the clearance for Canada just in time to enter as planned the EEZ. The MARIA S. MERIAN moored on the 5th of June at Pier 12 of St. John's harbor and the leg 1 of MSM129 ended.

5 Preliminary Results

5.1 Multibeam & Sediment Echosounder

(Daniel Damaske, Marianne Rehage)

Two multibeam systems are available for mapping on board MARIA S. MERIAN and permanently installed at the hull of the ship. The Kongsberg EM 122 multibeam echosounder is used for deep-water surveys and the Kongsberg EM 712 multibeam echosounder for shallow to medium waters (e.g., continental shelf area or slope). Apart from mapping only the seafloor (stored in the .all format), both systems can also record the reflection layers in the water column. To do so, the recording of the water column must be enabled (data are stored in the *.wcd format). Technical descriptions of the EM122 are provided by the manufacturer (Kongsberg Maritime AS, 2011). Current documentation is also available on the Manufacturer homepage (https://www.kongsberg.com). Additional technical descriptions of the research vessel and the system are available on the homepage of the German Research Fleet Coordination Centre (Leitstelle Deutsche Forschungsschiffe) in the handbook of the MARIA S. MERIAN.

The sediment echosounder (or sub-bottom profiler) is an echosounder system, which can visualize the sedimentary layers beneath the ocean surface. The system is designed to reach a max. penetration depth of 200m and can operate from 10-11000m. The main frequencies used to generate the acoustic signals are alternating. The typical vertical resolution is around 15 cm (Teledynemarine, 2024). Further technical descriptions of the sub-bottom profiler Parasound P70 echosounder are by the manufacturer (ATLAS, H., 2007). Further documentation is also available on the Manufacturer homepage (now: Teledyne Marine www.teledynemarine.com) and additional technical descriptions of the research vessel are available on the homepage of the German Research Fleet Coordination Centre in the Handbook of the MARIA S. MERIAN.

Operations

Date acquisition started leaving the EEZ of the UK on 2024-05-29 22:07:57h UTC. The data was then continuously recorded and switched off before entering the EEZ of Canada on 2024-06-05 08:54:23h UTC. In total data have been collected for 144 hours (bathymetry .all files & water column data .wcd files). In that time, the device was not monitored all the time during data acquisition (only throughout the day and during seamount survey, see below). The device did not have any system failure at that time and logging of the data was only switched off four times at CTD Stations (MSM129/1_3-1, MSM129/1_6-1, MSM129/1_7-1 & MSM129/1_8-1).

For sound velocity profiles (SVP) the World Ocean Atlas (WOA09) was used using the Sound Speed Manager SSM 2024.03 (www.hydroffice.org/soundspeed/) and imported on a daily basis to the Seafloor Information system (SIS). We used as initial reference point the UK EEZ exit position and later the seamount nav-points as a reference for SVP calculation. For later data quality control the SVP profiles from the four CTD stations will be used. We operated the system most of the time with the following SIS runtime parameters (at seamount locations only the swath angle was occasionally adjusted and set to 70°):

Max.angle (deg.): 65%, starboard and port direction, Angular Coverage mode: AUTO, Beam Spacing: IN-BETWEEN, Dual swath mode: DYNAMIC, Ping Mode: AUTO,FM disable: "not checked" Pitch stabilisation: "check", Along Direction (deg.): 2, Auto tilt: OFF, Yaw Stabilization: Mode REL.MEAN HEADING, Heading 0.0, Heading filter: MEDIUM, Min.swath Dist.(m): 0.0, External trigger "not checked", 3D Scanning: Enable scanning "not checked", Min (deg.): -5, Max (deg):5, Step (deg.) 0.0. The *Min.Depth* and *Max.Depth* were set to 20-5000m most of the time.

Preliminary data quality check suggests a very good and no reflection error has been observed throughout the data acquisition. However, this needs further proof during data processing.

Seamount surveys:
The aim of this cruise was to test, whether it is possible with neglectable or minor adjustments to the course to map seamounts which have been predicted our reference database (Gevorgian et al. 2023a). As we were unable to confirm by checking known international databases that all data for the seamounts we selected to survey were indeed available and that the seamounts were fully mapped, the database categories, whether "chartered" or "uncharted", were mostly disregarded for this test.

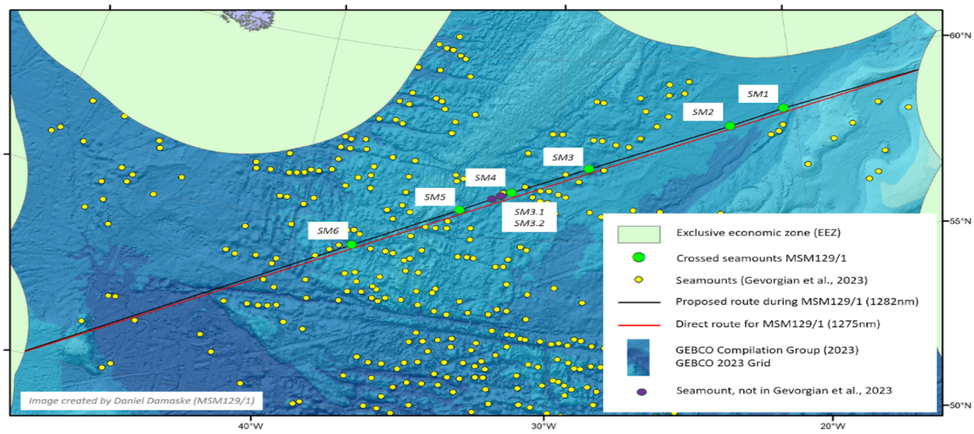


Fig. 5.1 Overview chart of seamounts surveyed during MSM129/1

In total 1275 nm of survey was performed during the transit in international waters, although the actual direct route towards St. Johns would have been taken only 1268 nm in the original cruise planning (figure 5.1). During MSM129/1 we could survey 6 of those suspected seamounts (see figure 5.2, table 5.1). Simultaneously, these seamounts were also investigated using the Parasound system. This device was switched on average 2-4 nm before and switched off 2-4 nm after the estimated position of the seamount. The first seamount (SM1) has been charted before and is visible by looking at the Global Multi-Resolution Topography (GMRT) data compilation product (https://www.gmrt.org/), but it seems that the specific data tile used to create the data compilation can not be accessed. The second seamount (SM2) has also been chartered before, which could be seen in the data layer of the IHO Data Centre for Digital Bathymetry (DCDB) with access to the original data (https://iho.int/en/data-centre-for-digital-bathymetry). However, since this seamount caused no delay, this seamount was also mapped including the usage of the Parasound System. In general, the seamounts closer to the mid-ocean ridge (MOR) (SM 3, 5, 6 except SM4), apparently not fully mapped before, show a more brittled shape (ridge-like structure), whereas the seamounts close to the continental shelf (SM1, 2) show a perfect rounded shape structure. Seamount SM3-6 did not show much sedimentary layering. SM1 showed some sedimentary layering covering the top and SM 2 showed some sedimentary layering only in the center of the seamount. We identified 2 more seamounts not in the database of Gevorgian et al. 2023a (SM 4.1/SM 4.2). They also show an almost perfectly rounded shape. SM4.2 shows a caldera-like structure in the center.

Table 5.1 Overview table of seamounts surveyed during MSM129/1

Name on board	Seamount name	Longitude (dd)	Latitude (dd)
SM1	SIO2-00001	-20.4583	58.55833
SM2	SIO-00344	-22.7917	58.15833
SM3	KW-12160	-28.675	57.025
SM4	SIO2-03351	-31.7417	56.29167
SM5	KW-12187	-33.725	55.725
SM6	KW-13040	-37.6583	54.475
SM4.1	*not in database*	-32.049	56.215
SM4.2	*not in database*	-32.4	56.107

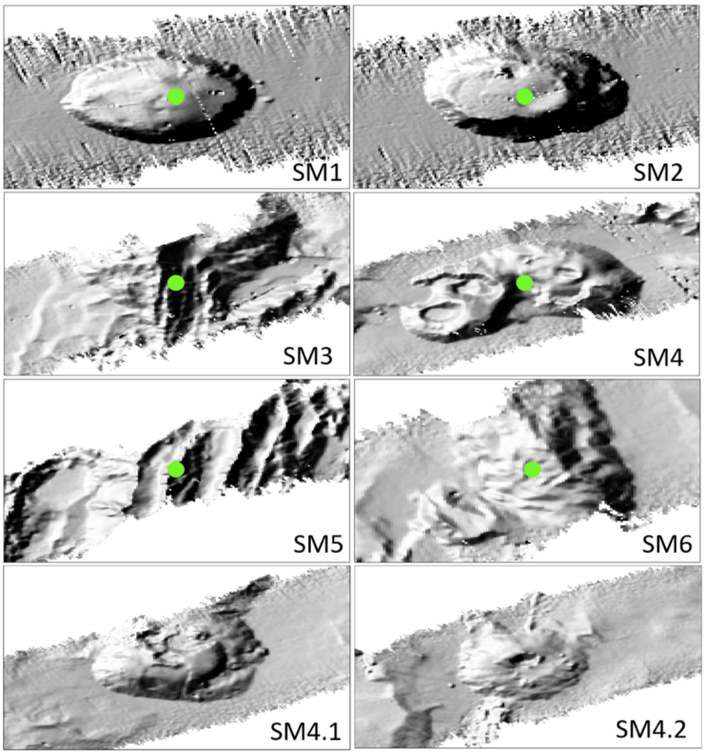


Fig. 5.2 Overview images of seamounts surveyed during MSM129/1 All images have the same scale. Green dots are the locations of the predicted seamounts in Gevorgian et al. (2023). The images shown here are based on plain MBES raw data (EM122).

Note, that the description here is only based on one survey line above the features. No direct information around the surrounding area is available, therefore more survey lines would be necessary to make a more decisive description of those features.

The Parasound system was not operated continuously during MSM129/1. The Parasound system was only switched on 2-4 nm before and after the specific seamount surveys. The data showed sometimes thin sedimentary layering, but was not further investigated on board.

Further echosounder related work included the update of the GEBCO_2022 dataset (GEBCO Compilation Group 2022 https://www.gebco.net/data_and_products/gridded_bathymetry_data/gebco_2022/) with the GEBCO_2024 dataset (GEBCO Compilation Group 2024 https://www.gebco.net/data_and_products/gridded_bathymetry_data/gebco_2024/) but that could not be finalized due to some technical constrains. Also, the Kongsberg Telegram to monitor the system status via Near-Realtime data access could not be implemented due to technical constraints, but may be integrated in the future. One reason was that it is not entirely clear when the observed .wcd files with 0 kb, 4kb or 8kb are generated and therefore a proper simulation of the system failed. However, it was reported on board that certain settings in the SIS are causing these artifacts. These files are neglected in the data publication at PANGAEA.

5.2 Underway Clean Seawater System

(Michael Schlundt, Julia Oelker, Yurid Behr)

The data collected by the sensors with the underway clean seawater system ("Reinseewassersystem", RSWS) are routinely quality controlled on a cruise-by-cruise basis by data stewards in the framework of the DAM project "Underway Research Data". The workflows are based on standard operating procedures (e.g., Schlundt and Glemser, 2023). Quality controlled data sets are eventually archived in the PANGAEA data repository, from where they are further distributed to international data portals.

Objectives during MSM129/1 were:

- Get a detailed understanding of all parts and functions of the RSWS
- Check which RSWS settings can be changed for improved quality control
- Test functionality of RSWS ECO-FNLTU sensors for which online monitoring prior to the cruise has shown large discrepancies between sensors
- NRT data transfer
- Take reference samples (salinity, chlorophyll-a, suspended particulate matter) for calibration of sensors to achieve high quality data sets

The data stewards of the DAM project "Underway Research Data" are usually not on-board during expeditions. The aim to participate as data stewards of the RSWS in MSM129/1 was to understand the workflow related to RSWS in application and to check options to optimize the system further (e.g., by changing settings of the RSWS control system or the data saving processes) with respect to post quality control processes. Reference samples are taken for validating these activities and for calibrating the sensors such that a data set with high quality can be provided for the scientific community after the cruise.

In past and recent measurements of the ECO-FLNTU sensors, large differences between the sensors were observed. Through online monitoring of the sensors prior to the cruise it was discovered that the ECO-FLNTU sensor with serial number 1944 gives much lower chlorophyll-a values than the other two ECO-FLNTU sensors (serial numbers 1942 and 1943). Through communication with the WTD, we found that these problems have occurred often in the past and that the manufacturer states that the sensor is working properly (Sensors are sent regularly to the manufacturer for maintenance and calibration). We investigate possible reasons for this behaviour during MSM129/1.

TSG (as part of the RSWS) data from the previous day are automatically sent to the Global Ocean Surface Underway Data (GOSUD) program, a part of the CORIOLIS Service. The data are automatically exported on a 1-sec-resolution from the DSHIP system and sent to GEOMAR and AWI via a mail relay at BRIESE RESEARCH. After processing at GEOMAR they are finally averaged into two-minute-means. The final files are sent via mail to GOSUD in a particular format, where they are collected and shared with the Global Telecommunication System (GTS). One goal of the cruise MSM129/1 was to test whether there are other ways to get the data from the ship to land. The underway clean seawater system consists of two separate measurement containers for measuring standard surface water properties, namely temperature, conductivity, chlorophyll-a, and turbidity, as part of the RSWS (Figure 5.3). A detailed description can be found in the ship's manual (https://www.ldf.uni-hamburg.de/merian/technisches/dokumente-tech-merian/handbuch-merian-deu.pdf). This system is an installation that sucks in seawater continuously to provide the laboratories as well as the two measurement containers with seawater. The temperature is measured by sensors (SBE38 Digital Oceanographic Thermometer, Sea-Bird Electronics) placed directly at the water intake points. The system is generally operated using two intake points between 6.2 and 6.8 m below surface ("deep 1" and "deep 2"). The laboratory strand is separated from the measurement container strands after the intake points. They each have their own pumps, ventilation and debubbling system. Following instruments are installed in both measurement containers:

- Sound velocity probe: Smart SVTX, AML Oceanographic Ltd.
- Micro-Thermosalinograph: SBE 45 MicroTSG, Sea-Bird Electronics
- Fluorometer and turbidity meter: ECO-FLNTU, Sea-Bird Scientific

The measurement containers measure alternatingly. While one container is measuring, the other one is being cleaned. Switching between boxes follows the order: the inactive container starts measuring while the active container is still running (parallel operation period, 400 s). The previously active container then stops measuring and undergoes the "general cleaning" procedure which consists of a pre-wash (flushing with fresh water, 60 s), adding of bleach (55 s), cleaning (5 min), rinsing (flushing with fresh water, 60 s). After the "general cleaning" the container is inactive. Shortly before the container becomes active again to replace the other container, the container undergoes another cleaning cycle termed "Warm-Up" which is similar to the "general cleaning": pre-wash (0 s), adding bleach (55 s), cleaning (10 min), rinsing (60 s). The time periods given in brackets are adjustable through the control panel by Rochem.

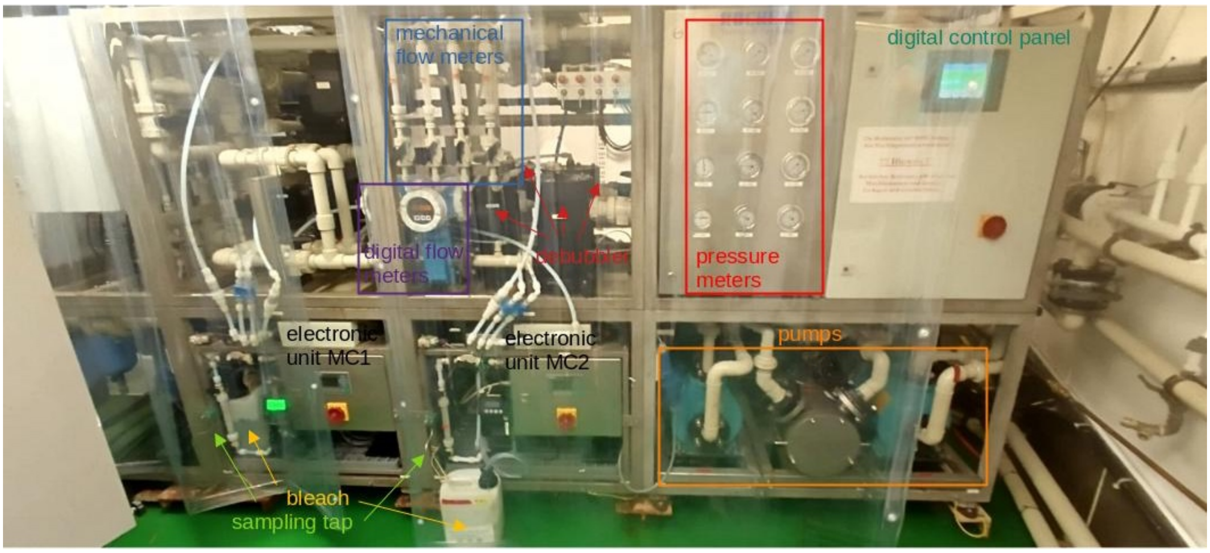


Fig. 5.3 The underway clean seawater system with its components referred to in the text being high-lighted

The function of all installation parts was explained as well as the connections of the water flow system in a detailed tour about the underway clean seawater system given by the 2nd engineer. The description under methods above is partially a result of this tour. A detailed look through the control panel by Rochem revealed changeable settings of the RSWS. One of the adjustable parameters is the parallel operation time of the two measurement containers before the container that has been measuring during the previous hours is switched off. On R/V SONNE, this parallel operation time has a duration of one hour. It has shown to improve the quality assurance and quality control (QAQC) of R/V SONNE underway data. After communicating with IOW (owner of the RSWS), Briese Research, LDF, and the captain, the parallel operation time of the RSWS was changed from 400 seconds to one hour. This change was initially granted for MSM129/1 and MSM129/2 to investigate benefits for QAQC.

We investigated the RSWS data of MSM129/1 during the parallel operation time. We found that elongating the duration of the parallel operation time from 400 sec to 1 hour is beneficial for QAQC due to following reasons:

- Switching-on of the other measurement container disturbs the system, influencing measurement values in both containers (see Figure 5.4). No useful information can be obtained for QAQC. The signal is generally disturbed for about 10 minutes. The parallel operation time should be longer than 10 minutes.
- Functioning of the sensors can be monitored well during the undisturbed 50 minutes of the parallel operation time. The correlation between the two sensors is very high and agrees well with data from the PocketFerryBox (see Figure 5.4, latter only checked for chlorophyll-a and turbidity). It can be concluded that the ECO-FLNTU sensor 1944 is taking useful measurements. Before, with only 400 sec parallel operation time, this conclusion was impossible to draw, especially remotely.
- Comparative measurements from the PocketFerryBox show that the parallel operation does not disturb the measurements in general.
- It facilitates taking reference samples during parallel operation mode. These samples are especially interesting and meaningful for QAQC. A short parallel operation time makes

sampling difficult due to other obligations of the scientific party, the time it takes to get a sample, etc.

These results were compiled in a detailed report and sent to responsible entities after the cruise, asking for permission to permanently operate the RSWS with one-hour parallel operation time in the future.

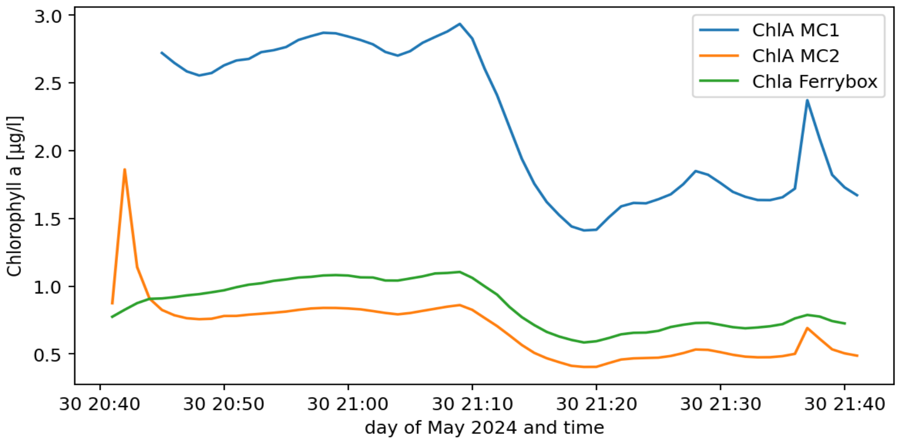
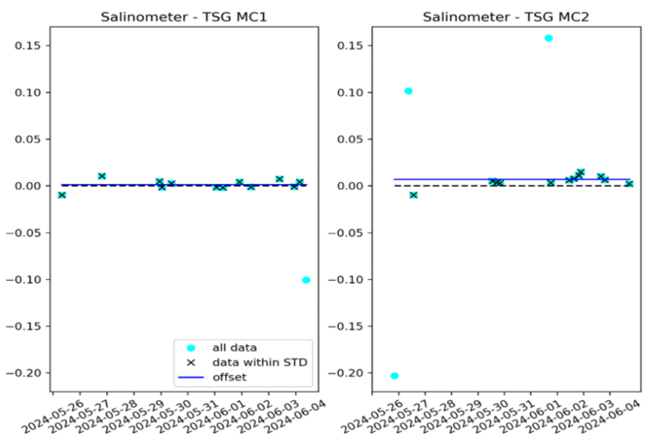


Fig. 5.4 Chlorophyll-a from ECO-FLNTU sensors 1942 (MC1) and 1944 (MC2) during parallel operation time. The peak at the beginning of the parallel operation time seen in MC2 values after MC1 is switched on shows the disturbance of the system. Note that all sensors are factory and not field-calibrated. They show large differences in absolute values, but are highly correlated.

Salinity samples were taken whenever it was possible. Up to 6 samples per day have been taken with three-time steps, at which both containers were active and one sample per container has been taken. Overall, 31 samples were obtained and measured on the following cruise MSM129/2 with an OPTIMARE Precision Salinometer (OPTIMARE Systems GmbH). The measured samples were used to calibrate the TSG data (Figure 5.5) and eventually the resulting offsets (TSG1: 0.001414; TSG2: 0.006973) were added to the data. As a reference for calibrating the ECO-FLNTU sensors (chlorophyll-a and turbidity), the samples from the outflow of the Ferrybox



system will be used.

Fig. 5.5 Differences of water samples and TSG salinities for TSG1 (left) and TSG2 (right). The cyan dots show all available data, while the black crosses show only data, which are within one standard deviation. The blue line shows the offset, which is eventually applied to the TSG salinity data.

Verifying ECO-FLNTU functionality:
After the RSWS system was switched off at the end of leg 1, the ECO-FLNTU sensors were uninstalled and tested in the laboratory with the help of the WTD. Measurement counts were recorded for both sensors in two black buckets filled with fresh water and with RSWS water, respectively, covered with aluminum foil to shield surrounding light. The raw counts of the two sensors (serial numbers 1944 and 1942) differ significantly although calibration coefficients provided by the manufacturer are almost identical. Through this test we can exclude that the difference in the measurements originates from the RSWS system (e.g., electrical supply, data transfer, interferences with other instruments, contamination of the measurement containers). The reason for the large differences in absolute values of the sensors remains unclear. Relative values are fine for both sensors (see above).

5.3 Ferrybox

(Julia Oelker, Martina Gehrung*, Yoana Voynova*, Abed El Rahman Hassoun)

A PocketFerryBox by -4H- JENA engineering GmbH system was brought on board to serve as a model instrument for following objectives:

- Investigate possibilities of near-real-time (NRT) data transfer workflows for instruments brought on board by the scientific party. A plug-and-play solution is envisioned that covers a wide range of instruments with low/medium data load. The idea is that the scientific party can use infrastructure provided by the project "Underway" Research Data to realize NRT data transfer of their instruments without having to bring special technical equipment and having to find individual solutions (see section "(Meta) Data Flow").
- Explore cross-validation practices with ferrybox and RSWS sensors measuring the same parameters as a method for quality control. In this respect, the ferrybox is also used to evaluate any setting changes of the RSWS (see above).
- Test the Mobile Event App for logging reference samples for the ferrybox system in Registry and evaluate its benefits in terms of automatic generation of sample lists, e.g. for cruise report.

The PocketFerryBox by 4HJENA engineering GmbH (serial number 752001) was installed in the hangar. It was supplied by the underway clean seawater system (Reinseewassersystem) using the ship's sinus pump to measure surface water parameters, namely temperature, salinity, chlorophyll-a, colored dissolved organic matter (CDOM), turbidity, and oxygen. Chlorophyll-a, CDOM, and turbidity were measured by Seapoint sensors (chlorophyll fluorometer, turbidity meter, ultraviolet fluorometer). Temperature and salinity were recorded by an SBE45 Micro thermosalinograph and oxygen via an Aanderaa oxygen optode. The ship's water inlet pumped water from a depth between 6.2 and 6.8 m. The flow rate was always recorded (around 4-5 l/min).

The system operated autonomously without problems during the entire leg. Operations were stopped in EEZ waters where no permission was applied for. The system was running shortly in German waters, then in Norwegian waters, and in international waters. During transit through UK

* not on board during cruise

waters for which there was no measurement permit and once on the transit in international waters, the system was flushed with fresh water and a fresh water reference was recorded.

Discrete seawater samples were taken from the outflow of the PocketFerryBox up to six times per day and filtered for chlorophyll-a (0.5 to 2.5 liters) and suspended particulate matter (SPM) (1 to 6.5 liters) for post-cruise calibration of the chlorophyll-a and turbidity sensors, respectively (36 samples in total, Table 5.2). Filters were frozen at -80°C. They will be analyzed after the cruise in laboratories of the Carl von Ossietzky Universität Oldenburg using a Turner fluorometer (method EPA 445). The sample taking was logged in Registry using the Mobile Event App developed by the Alfred-Wegener-Institute.

Table 5.2 Information on discrete water samples taken from CTD Niskin bottles and filtered for chlorophyll-a to calibrate fluorometer.

Station	Bottle No	Depth [m]
MSM129/1_3-1	21	10
	19	25
	17	50
	15	75
	14	100
MSM129/1_6-1	7	10
	6	20
	5	40
	4	60
	3	100
MSM129/1_7-1	15	10
	14	20
	13	35
	12	50
	11	70

Sampling that augmented the Ferrybox

The aim of this installation is to observe the biogeochemical variability in surface waters. Our goal during this cruise was to capture the variability of the carbonate system, the changes driven by biological processes, and to provide underway surface pCO2 measurements reported within DAM. Therefore additional sensors were connected to the underway clean seawater system in parallel to the PocketFerryBox. They are therefore also supplied by the ship's sinus pump with water intake at a depth between 6.2 and 6.8 m. The sensors measured surface seawater pCO2 (Contros HydroC CO2-FT, 4HJENA engineering GmbH), total alkalinity (HydroFIA-TA, 4HJENA engineering GmbH), salinity (FSI, Teledyne), and pH (Isfet; by Endres+Hauser).

Discrete samples for DIC and total alkalinity were collected during the cruise to calibrate the measurements of the underway system. 14 reference samples have been collected from the Baltic Sea, North Sea, and the North Atlantic Ocean transect (see Figure 3.1). Samples will be processed in the lab by Hereon after the cruise.

5.4 PANGAEA Data Flow Trials

(Marianne Rehage, Kathrin Riemann-Campe)

The PANGAEA data information system (https://www.pangaea.de/) is worldwide one of the leading data repositories for Earth & Environmental data hosted by the Alfred-Wegener-Institute, Helmholtz Centre for Polar and Marine Research (AWI), and the Center for Marine Environmental Sciences (MARUM), University of Bremen (Felden et al. 2023). Over the last 25 years, PANGAEA archived and published - supervised by scientific data editors – hundreds of thousands of datasets from all over the world from different scientific disciplines and research domains, including a vast amount of raw and processed data from scientific cruise data of the German research vessel fleet.

Data curation at PANGAEA includes quality control of metadata and the development of ontologies and vocabularies according to international protocols and standards, ensuring data publication in compliance with the FAIR data principles. Metadata are extensive and each dataset can be cited using a universally unique DOI. PANGAEA holds a mandate from the World Meteorological Organization (WMO) and is accredited as a World Radiation Monitoring Center (WRMC). It was further accredited as a World Data Center by the International Council for Science (ICS) in 2001 and has been certified with the Core Trust Seal (https://www.coretrustseal.org/) since 2019.

PANGAEA also provides an overview of expeditions and event lists for large and medium-sized vessels of the German research fleet (https://www.pangaea.de/expeditions/). The event lists are derived from DSHIP ActionLogs which are recorded during each expedition. ActionLogs include information about when and where a certain device or sensor was taking samples or recording data and will soon also provide a link to O2A registry (https://registry.o2a-data.de/), thus providing all information of the state of a certain device/sensor. PANGAEA event lists serve as a basis for further data archiving and may be used for reporting.

During MSM129/1, we trialed complete data flow cases from described devices/sensors via the O2A registry to publication of FAIR datasets in PANGAEA. The workflow will serve as a blueprint for future expeditions and will be base for automatization of the data archiving workflow. In order to provide expedition metadata and data as fast and automatized as possible, a faster workflow for archiving and provision of event lists by PANGAEA was tested/established.

During MSM129/1, we engaged in thorough discussions with all parties involved to expedite the creation of a comprehensive sampling event list. One goal was to ensure that the event list is sufficiently detailed and complete which in turn will allow streamlining and simplifying all subsequent applications. After the cruise, the complete ActionLog was provided by the bridge immediately and additional information from the scientists on board, i.e., internal names of CTD operations, were included and the complete event list was archived and publicly available at PANGAEA the following day (https://www.pangaea.de/expeditions/events/MSM129%2F1).

5.5 DSHIP System

(Gregor Börner)

DSHIP is a software system, developed by the company Werum, that is tailored for managing, acquiring, visualizing, and analyzing scientific data on research vessels. It is essential for marine research data management, enabling real-time monitoring and documentation of equipment and environmental data. The system supports a variety of scientific instruments, offering automated data collection, a digital logbook for operations, centralized data storage, and advanced visualization tools. During our time on board the MARIA S. MERIAN a key objective was to further adapt the system to the specific needs of nautical crews, scientists, and data managers, while continuously refining processes, the user interface, and data output.

During the MSM129/1 our primary focus was to engage with the different parties—nautical crews, scientists, and data managers—integrating DSHIP into their workflows and gathering feedback on its functionality and user experience. This direct collaboration allowed us to assess the system's data output quality and enhance its capabilities as a vital tool for scientific research. Furthermore, we worked to establish new workflows that would streamline data collection and analysis, ensuring that DSHIP evolves to meet the diverse and changing needs of all users on board. This also included preparing a harmonized list of devices to be selectable at the bridge for action control. This list was further hermonozed and reviewed during a dedicated meeting between officers and chief-scientists.

5.6 (Meta)Data flow

(Norbert Anselm)

The live-review of the (Meta)Data flow included assisting other DAM members with their tasks with regards to network and interface access on board. That was the case e.g., for the integration of the ferrybox into the board network or the DShip Manida interface for CTD processing.

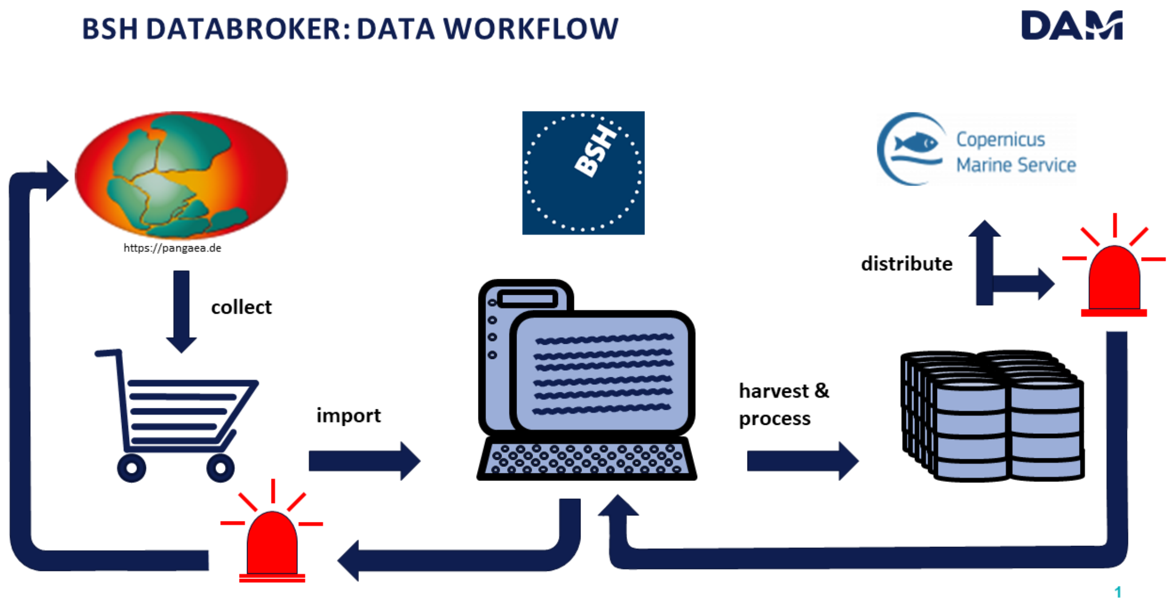
Another task was to refine and test the concept of a so-called "live-MDM". It comprises a set of folders whose content is essential for different tasks on land. This includes device documentation, namely when was which item set operational e.g., in the RSWS, what are the calibration coefficients, and when was the item calibrated. Furthermore, it contains a complete excerpt of the final actionlog (as approved by the nautical officers), and certain measurement data that need to be prioritized, e.g., for instant access.

The standard MDM aboard was facilitated to host a share of the *public_wiss* network. This was exclusively created and organized for DAM purposes and is called dam-underway. The content of dam-underway was synchronized via incremental backup via *ssh* tunnel with a dedicated virtual server on land at AWI. This server was prepared and configured for Underway Research Data use cases exclusively. By experiencing the local network configuration, the live-MDM concept was further shaped and defined.

5.7 BSH DataBroker

(Alexandra Marki)

The MSM129/1 cruise aimed to gain an improved understanding of the workflow and processes from acquisition to publication at PANGAEA of ship-based sensor data. At present, the BSH DataBroker is engaged in the harvesting of metadata from published DAM "Underway Research Data Project" datasets, originating from large and medium-sized German research vessels, including the MARIA S. MERIAN, METEOR, SONNE and ALKOR. In order to facilitate wider distribution of the datasets to international data portals (e.g. Copernicus Marine Service (CMS)), particular emphasis is placed on VM-ADCP (vessel-mounted ADCP), TSG, (bio)optical, CTD and Ferrybox datasets, although the latter are not yet published (see Figure 5.6). Subsequently, the BSH DataBroker transforms the datasets into the format required by the portal in question, namely so far that of the Copernicus Marine Service (CMS), and disseminates them to the relevant



international data portal.

Fig. 5.6 Schematic of data flow from PANGAEA via the BSH DataBroker to Copernicus Marine Service The two feedback mechanisms that monitor the successful data transmission are represented by the emergency lights in the event of discrepancies.

MSM129/1 provided a comprehensive and detailed explanation of the most crucial data collection, transfer, and measurement workflows. Seeing how the instruments work in practice, along with daily meetings and discussions with the subject matter experts, made it clear how the data transfer workflows should be done. Furthermore, the bi-directional exchange made it clear that stable database and data set parameters are essential to avoid operational interruptions of the BSH Data Broker. Stable conditions are vital to maintain data integrity and enable the automation of data transfer to international data portals. In addition, we developed a routine to inventory and identify possible additional PANGAEA datasets not belonging to the Underway Research Data Research data to distribute to CMS and further to other data portals.

5.8 CTD Rosette sample

(Emil Michels, Gerd Krahmann, Christiane Lösel, Vasile-Sorin Balan)

During MSM129/1 a GEOMAR CTD-Rosette was used that hold a SeaBird SBE 911 CTD, a SBE 32 carousel water sampler with 22 bottle mounted and a lADCP system. In total 4 CTD-profiles were acquired. Data acquisition on the CTD was done using Seabird Seasave Version 7.26.7.121. The system was equipped with double temperature, conductivity and oxygen SBE43F, and a single pressure sensor (S/N 1162). In addition, a combined chlorophyll and turbidity sensor (FLNTURTD-3219) from Wetlabs were installed.

No problems occurred with the CTD sensors and the rosette bottle sampler during the cruise. During the cruise the preliminary calibrated CTD data (with 5-dbar resolution) was sent via email: codata@ifremer.fr and in near real time to the Coriolis Data Centre in Brest, France. This procedure was automatic using a self programed MS DOS Batch script. This way the data was made available for integration into the GTS/TESAC system and thus operational oceanography applications.

CTD operations in the DAM context

CTD data must be treated somewhat differently from other underway measuring devices and methods. This is primarily due to the discrete nature of its measurement process, which requires the research vessel to come to a complete stop and involves a significant amount of manual labor. In contrast, most other underway devices operate continuously and autonomously.

To ensure uniform data acquisition, it's crucial to minimize the influence of the human operator, who is often the greatest variable. CTD operators typically work in shifts, leading to frequent changes in personnel during the same research cruise. Additionally, the measurement process allows for considerable flexibility, often resulting in operator-specific variations. While best practices can be developed and taught, they cannot always be consistently enforced due to the shift-based nature of the work. As a result, the datasets produced can be highly heterogeneous and challenging to compare, particularly when the background of the data is unknown.

To address these challenges, a software framework called "CTD-Client" has been developed. This framework serves as an interface for CTD measurements, enforcing a standardized measuring protocol and best practices while adding metadata to the data files. This approach enables data processors who were not part of the original measurement process to work with CTD data using a consistent processing protocol.

The "CTD-Client" software has been successfully deployed on the RV Elisabeth Mann Borgese. While efforts by the DAM to standardize IT infrastructure across different German research vessels are ongoing, there is still considerable variability among ships. Therefore, the main objective of this cruise was to test the CTD-Client aboard the MARIA S. MERIAN. After installing and configuring the CTD-Client on the measurement computer, the first use of the software revealed a key difference in the workflow: the start point of a 'station' in DSHIP did not align with the start point of the CTD sensor's measurements. As a result, the usual injection of DSHIP metadata was not possible. To accommodate this workflow, the CTD-Client was updated during the cruise and redeployed at a later CTD station.

Moreover, the efforts to standardize CTD data acquisition are ongoing. Another objective of this cruise was to gain a deeper understanding of the CTD measurement workflow aboard the

MARIA S. MERIAN. As part of this, the feasibility of calibrating the fluorescence sensor was explored by collecting reference samples.

Calibration of the conductivity and the oxygen sensor were done jointly, for the leg 1 (here) and the leg 2 of the MSM129 cruise. This way, a much larger set of reference data was available and more robust calibrations could be derived.

5.9 Acoustic Doppler Current Profiler

(Michael Schlundt, Robert Kopte*)

Current velocities of the upper water column along the cruise track of MARIA S. MERIAN cruise MSM129/1 were collected by two vessel-mounted RDI Ocean Surveyor ADCPs at 38 kHz and 75 kHz (Kopte et al. 2022a, b).

The ADCP transducers were located at 6.0 m below the water line. The 38 kHz ADCP was operated in broadband mode (WM1) with a bin size of 16 m, a blanking distance of 16 m, and a total of 80 bins, the 75 kHz ADCP was operated in broadband mode (WM1) with a bin size of 8 m, a blanking distance of 8 m, and a total of 100 bins. Beam velocities as recorded by the data acquisition software VmDAS were transformed to ship coordinates and after merging with the navigation data from the ship's Motion Reference Unit and Global Positioning systems into earth coordinates.

Accuracy of the ADCP velocities mainly depends on the quality of the position fixes and the ship's heading data. Further errors stem from a misalignment of the transducer with the ship's centerline. All acquired raw data were processed using standardized water track calibration routines of the Python toolbox OSADCP (V2.0.0, Kopte et al. 2024a). For the 38 kHz ADCP a misalignment angle of 0.5122°+/-0.2667° and a scaling factor of 0.9986 +/-0.0075 was determined, for the 75 kHz ADCP the applied misalignment correction was -47.2247°+/-0.3048 and the scaling factor was 0.9979+/-0.0055. Transducer ringing was found to contaminate the upper 4 and 3 cells of the 38 kHz ADCP and the 75 kHz ADCP, respectively. The final datasets containing 120-s ensemble averages are made available to the general public as part of the German Marine Research Alliance's underway research data project (Kopte et al., 2024b).

5.10 Moving Vessel Profiler

(Neele Sanders, Lasse Glüsen, Gerd Krahmann)

At portside astern a Moving Vessel Profiler from AML was operated. The MVP30-350 (S/N M12399 owned by GEOMAR) was used with a CTD probe (MVP-X 9068 owned by Dalhousie University, Halifax, Canada) that is a new probe that also can be used with oxygen sensor. The MVP winch was mounted in a frame designed from stage scaffolding parts and constructed by GEOMAR. The original plan was to operate the device shortly after leaving the port in Rostock/Warnemünde but because of technical problems that did not work out. However, the MVP was intermittently operated from May 26th to June 01st with even 10kn and reached depths of about 70 m (see Figure 5.7 as an example). Then operations stopped because of a problem with the spool winch that could not be fixed while at sea. In total 490 T, C, P, oxygen profiles have been acquired during leg 1 and the data was processed using an inhouse routine (provided by Gerd Krahmann, GEOMAR) that correct for the thermal lag effect of temperature when calculating

* Not on board during MSM129/1

salinity from conductivity measurements. However, some of the casts had bad conductivity values which were flagged manually.

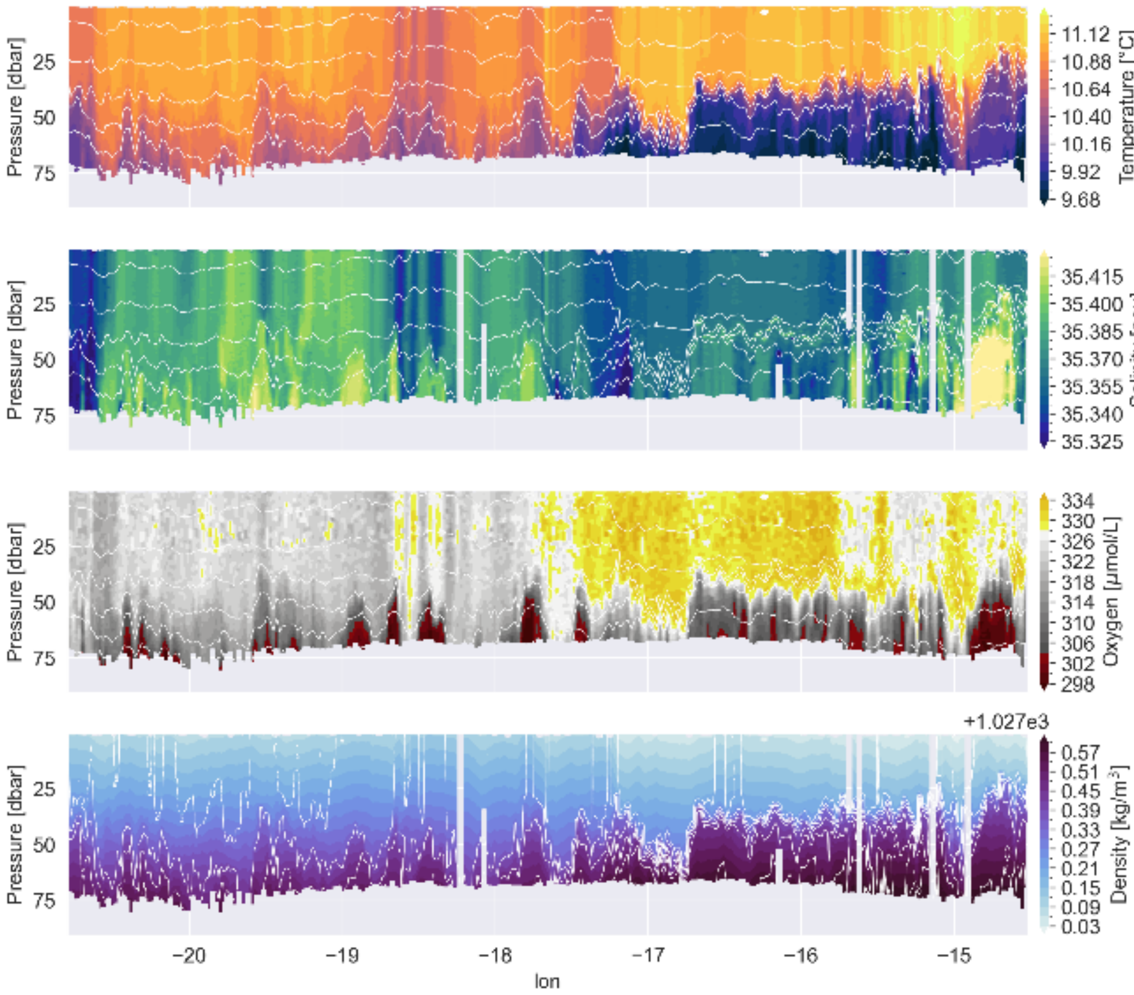


Fig. 5.7 Longest continuous MVP transect during leg 1 (approx. 14°W to 20°W, see Figure 3.1). (From upper to lower plot) Temperature, salinity, oxygen and the calculated density.

6 Station List

Gear coding:

CTD: Conductivity, temperature, depth sonde TSG: Thermosalinograph, EM122: Deep-Sea Multibeam Echosounder; ATLAS: ATLAS Parasound P70 Deep-Sea Parametric Sub-Bottom; ADCP: Acoustic Doppler Current Profiler (with Frequency noted); MVP: Moving vessel Profiler; X-Band: Hereon X-Band radar

Station No.	Gear	Date & time [YYYY-MM-DD UTC]	Latitude [°N]	Longitude [°E]	Water Depth [m]	Remarks
MSM129/1_0_Underway-2	TSG	2024-05-25T07:00:00	54.22555	12.04579	-28	Start
MSM129/1_0_Underway-3	FerryBox	2024-05-25T07:00:38	54.22711	12.04415	-28	Start
MSM129/1_0_Underway-4	X Band	2024-05-25T07:00:48	54.22753	12.04373	-28	Start
MSM129/1_0_Underway-5	ADCP (38 kHz	2024-05-26T11:25:00	57.85947	10.65583	-120	Start
MSM129/1_0_Underway-6	ADCP [75 kHz]	2024-05-26T11:25:00	57.85947	10.65583	-120	Start
MSM129/1_1-1	MVP	2024-05-27T09:42:51	58.53298	4.61078	-276	
MSM129/1_0_Underway-7	EM122	2024-05-29T22:07:57	59.1716	-14.509	-1007	Start
MSM129/1_2-1	MVP	2024-05-29T22:09:30	59.17123	-14.51212	-1007	
MSM129/1_0_Underway-8	ATLAS	2024-05-30T17:47:08	58.57204	-20.35182	-2900	Start
MSM129/1_3-1	CTD	2024-05-31T15:25:43	57.53612	-26.02936	-2774	
MSM129/1_4-1	MVP	2024-06-01T11:02:53	56.31771	-31.63767	-2355	
MSM129/1_5-1	MVP	2024-06-02T10:31:01	54.12052	-38.66679	-2770	
MSM129/1_6-1	CTD	2024-06-02T16:57:31	53.63094	-39.99517	-3456	
MSM129/1_7-1	CTD	2024-06-03T19:14:29	50.96949	-46.21025	-2817	
MSM129/1_8-1	CTD	2024-06-04T02:00:39	50.5718	-47.01953	-2969	
MSM129/1_0_Underway-2	TSG	2024-06-05T08:54:04	47.66152	-52.35826	-179	Stop
MSM129/1_0_Underway-3	FerryBox	2024-06-05T08:46:19	47.67141	-52.34198	-116.8	Stop
MSM129/1_0_Underway-4	X Band	2024-06-04T03:36:19	50.51248	-47.13886	-2920	Stop
MSM129/1_0_Underway-5	ADCP (38 kHz	2024-06-05T08:54:34	47.66091	-52.35936	-181	Stop
MSM129/1_0_Underway-6	ADCP [75 kHz]	2024-06-05T08:54:26	47.66107	-52.35907	-180	Stop
MSM129/1_0_Underway-7	EM122	2024-06-05T08:54:23	47.6611	-52.358	-180	Stop
MSM129/1_0_Underway-8	ATLAS	2024-06-02T07:23:26	54.4402	-37.75945	-179	Stop

7 Data and Sample Storage and Availability

(GEOMAR Data management: datamanagement@geomar.de)

Data and sample handling during this cruise follow standardized workflows and rules that have been developed at GEOMAR (see data policy, GEOMAR Direktorium, 2022) and in the marine community (DAM) to make data and samples findable, accessible, interoperable and reusable according to the FAIR principles. Metadata according to ISO 19115 are collected together with the measurements and are visible in the exchange repository OSIS and the data publisher PANGAEA. Quality assessment and control is done in several steps: underway, during the internal processing and exchange and in the process of data publication. After the cruise, GEOMARs existing in-house data management service OSIS ("Ocean Science Information System")– a central information and research data sharing system for marine research projects – will be used for the management and tracking of all cruise related research data and metadata, including DSHIP. It is publicly accessible and can be utilized by all cruise participants, including national and international collaborators. OSIS merges information on expeditions, experiments and numerical models with peer review publications and available research data. The view of all information in OSIS is open to the public while access to actual data in ongoing research projects may be protected by login for predefined periods of time (moratorium). However, the submission status of data files including the responsible investigator as contact person is visible to the public to foster collaborations with interested researchers. DSHIP data will be transferred ashore and archived for the long term, accessible via the GEOMAR DSHIP land system (http://dship.geomar.de/) and the BSH system (http://dship.bsh.de/). Link to the expedition in OSIS: https://osis.geomar.de/app/expeditions/365142

Type	Intern available	Free Access	Contact
Mastertrack	09/2024	https://doi.org/10.1594/PANGAEA.972524	See doi
CTD O_2 data	12/2024	08/2025	jkarstensen@geomar.de
EM122 multibeam echosounder	08/2024	https://doi.org/10.1594/PANGAEA.971634	See doi
ATLAS Parasound P70 Deep-Sea Parametric Sub-Bottom Profiler	08/2024	https://doi.org/10.1594/PANGAEA.971648	See doi
vmADCP data	12/2024	https://doi.org/10.1594/PANGAEA.973864	See doi
Mooring data	06/2025	08/2026	jkarstensen@geomar.de
lADCP data	03/2025	08/2026	jkarstensen@geomar.de
TSG data	12/2024	https://doi.org/10.1594/PANGAEA.973934	See doi

8 Acknowledgements

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10 Abbreviations

ADCP	Acoustic Doppler Current Profiler
CTD	Conductivity-Temperature-Depth Sonde
BMBF	Bundesministerium für Bildung und Forschung
DFG	Deutsche Forschungsgemeinschaft
DSOW	Demark Strait Overflow Water
EM122	Deep-Sea Multibeam Echosounder (station table)
GEOMAR	Helmholtz Center for Ocean Research Kiel
GPF	Gutachterpanel Forschungsschiffe
Live-MDM	Set of folders on a central ship drive but whose content is essential for at-land operations
MOOR	Mooring operations (station table)
RSWS	Underway clean seawater system
SVP	Surface Velocity Drifter Programm
TSG	Thermosalinograph