

Objectives

The main aim of the MSM95 research expedition was to investigate and map physical impacts on the arctic seafloor in two distinct and contrasting Arctic areas (The Svalbard shelf edge and the HAUSGARTEN time series stations in the FRAM strait) with a range of research equipment. A 'nested' data approach was conducted in each research area, with broad seafloor mapping conducted initially with the MARIA S. MERIAN onboard acoustic systems (The EM122 and EM712 bathymetric systems), followed by focused subsequent mapping conducted by PAUL 3000 automated underwater vehicle (AUV) sidescan and camera deployments, Ocean Floor Observation and Bathymetry System (OFOBS) towed sidescan and camera trawls and finally with very high resolution investigations conducted with a new mini-ROV launched directly from the OFOBS for close seafloor visual analysis. These data will be used to produce spatial distribution maps of iceberg and fishery impacts on the seafloor at three locations to the north, south and west of the Svalbard Archipelago, as well as maps of drop stone and topography variations across several of the HAUSGARTEN stations.

The second aim of MSM95 was to repeat three of the regular seafloor transects conducted with towed cameras across the HAUSGARTEN stations within the Fram straight, with these transects to be subsequently analysed and compared with transects conducted over the last 15 years, to gauge changes in megafauna abundance and community composition.

Our third aim was to conduct water column work across our research areas. We conducted numerous water column camera trawls to image inhabitants at various depths, with a focus on identifying squid populations throughout the Arctic water column. We also sampled waters via CTD from throughout the water column, to continue the microbial observatory work (MicrObs) time series work carried out as part of the FRAM project by AWI and MPI researchers, to investigate the eDNA composition of the waters for analysis of squid presence / absence and bacterial community structure.

Further opportunistic work was conducted between stations, with floating litter surveys conducted to input into the ongoing records being collated by the AWI. An inspection of the NOMAD tracked vehicle, deployed last year in the Hausgarten area was made, which observed the vehicle to be stuck on a stone obstruction. By reconfiguring OFOBS with hooked ropes, the NOMAD was manually freed from the obstruction by the captain and crew of MSM95.

Narrative (All times Local Time, LT, if not otherwise stated).

On the morning of 7th September the scientific party and a number of the crew joined RV Maria S. Merian at the docks in Emden, Germany. The previous 4 days had been spent in quarantine hotels (Ostfriesen Hof, Leer for the scientific party), during which participants were tested for the COVID-19 virus in isolation in individual rooms. Two transport containers were delivered to the ship on the morning of the 8th September containing the Ocean Floor Observation and Bathymetry System (OFOBS), the Autonomous Underwater Vehicle "PAUL 3000" and the equipment and technical supplies required by the remaining expedition participants. This equipment was unloaded and divided between laboratories on the afternoon of the 8th.

On the morning of the 9th September we cast off and passed through the sea lock, together with RV Meteor, at 10:30 CET. We then proceeded north at 10 kts until disembarking the Friesland island pilot, after which we started our ~5 day transect into the Svalbard archipelago, with an average speed of 12 Kts. Much of the transit was spent preparing our technical equipment ready for deployment and integrating our online systems with the ships network. On the morning of the 10th, at 8 am, we entered international waters and commenced underway data acquisition with the ships bathymetric and TSG systems. For several days we experienced winds of 7 – 9 Bf as we made our way from the North Sea into the Norwegian sea, with weather conditions improving on the 12th September. During the evening of the 12th September a prominent display of northern lights was evident at 69 N.

The time was spent on the transit familiarizing ourselves with the ship, the crew and the wave conditions. By 14th September all of us had acclimatized to the onboard conditions and were eager to start station work. At 6:00 (UTC) on the 15th September we arrived within our first research area, north of Svalbard and commenced our station work with a CTD. CTD waters were collected for researchers on board from GEOMAR, AWI and MPI, and the sound velocity profiles generated from cruise CTDs particularly important as much of our research work was conducted with acoustic sensing equipment (ship systems, AUV PAUL 3000, OFOBS) for which scientific data and position accuracy is increased with accurate and recent sound velocity profiles generated by the CTD. We stayed in the Svalbard North working area until the evening of the 16th September, conducting several successful AUV dives, testing our OFOBS equipment and mapping the seafloor with the ships EM712 system. On the evening of the 16th September we set a course for our second research area, Svalbard West, where we conducted a CTD and carried out EM712 mapping until the afternoon of the 17th, when we continued on to our southernmost research area, Svalbard South.

Arriving in Svalbard South during the early hours of the 18th September we commenced CTD and EM712 mapping until 07:15 am, at which point we commenced a full day OFOBS deployment, followed by EM712 mapping and a night of OFOBS deployment. The 19th September was also spent deploying OFOBS in the area, then we left the site for the southern greater Hausgarten area. The 20th – 22nd September were spent in this area conducting CTD, EM712, OFOS and AUV surveys, before returning to the Svalbard South area on the evening of the 22nd September. 23rd – 24th September were taken up with CTD, EM712, AUV and OFOBS surveys of the Svalbard South region. Poor weather resulted in some damage to the AUV system on recovery on the 23rd September.

On the evening of the 24th September we moved on to the central Hausgarten area and spent the rest of our expedition time conducting EM122, CTD and OFOBS deployments across the FRAM time series stations. On the 28th and 29th of September we located a mobile tracked vehicle deployed in 2019 on the seafloor and visited it for a study with the OFOBS system. Observing the vehicle to be stuck on a rock, OFOBS was rigged with hooks and an attempt made to retrieve the vehicle to deck. Unfortunately, poor weather

prevented this, so the vehicle was returned to the seafloor, ideally to continue its timed operations until August 2021 and recovery by POLARSTERN. During the last week of station time detailed hydroacoustic maps of the region were made of various areas of the Hausgarten area and three annually imaged seafloor transects were resurveyed with OFOBS.

Our final station was conducted at the Molloy Deep in the Hausgarten area during the early morning of the 1st October. Following this station, we started our homeward journey to the port of Emden, Germany, arriving on the morning of the 7th October following a week of strong winds and wave action. Container and sample unloading commenced immediately thereafter.



Scientific crew participants of the MSM95 expedition

Acknowledgements

We thank Captain Ralph Schmidt, his officers and the crew of MARIA S. MERIAN for the hospitality, assistance and enthusiasm for our work program throughout the expedition. Deck and engine crews adapted to our changing work schedules well, and the catering team provided first class food and care 24/7. This cruise was supported by the Alfred Wegener Institute's program orientated research and the Helmholtz Infrastructure Initiative FRAM. Special thanks to Ingo Schewe, the AWI logistics and ships co-ordination team, the DFG, the German Research Fleet Coordination Centre, Briese Research and the Leitstelle team for being so helpful in arranging this cruise so smoothly on short notice during the COVID-19 pandemic. Great assistance is also acknowledged from our land based colleagues in the AWI deep sea research and technology group, particularly from Normen Lochthofen for essential logistical assistance whilst all participants in quarantine.

Participants

1. Purser, Autun	Fahrtleiter / <i>Chief Scientist</i>	AWI
2. Hoge, Ulrich	OFOBS	AWI
3. Busack, Michael	AUV	AWI
4. Hagemann, Jonas	AUV	AWI
5. Lehmenhecker, Sascha	AUV	AWI
6. Dauer, Erik	CTD, microbial community	AWI
7. Korfman, Niklas	CTD, microbial community	AWI
8. Boehringer, Lilian	OFOBS, litter	AWI, UniBremen
9. Merten, Véronique	CTD, eDNA, megafauna	GEOMAR
10. Priest, Taylor	CTD. Microbial community	MPI
11. Dreutter, Simon	Bathymetry	AWI
12. Warnke, Fynn	Bathymetry	AWI
13. Hehemann, Laura	OFOBS / Bathymetry	AWI

Institutes

AWI	Alfred Wegener Institute, Bremerhaven, Germany
UniBremen	University of Bremen, Bremen, Germany
GEOMAR	GEOMAR, Kiel, Germany
MPI	Max Planck Institute for Marine Microbial Research, Bremen, Germany

Stationsliste

Gear coding:

CTD: CTD / rosette sampler

AUV: Autonomous Underwater Vehicle

OFOS: Ocean Floor Observation and Bathymetry System

EM712: Shallow-Sea Multibeam Echosounder

EM122: Deep-Sea Multibeam Echosounder

CRAWL: Deep-Sea crawler inspection / reposition

ADCP: Acoustic Doppler Current Profiler

Activity Station No.	Date/Time (UTC)	Gear	Latitude deg (N)	Longitude deg (E)	Depth (m)
MSM95_1-1	15/09/2020 06:07	CTD	80° 31.284'	12° 58.287'	707.3
MSM95_1-2	15/09/2020 07:28	AUV	80° 31.291'	12° 58.310'	703
MSM95_2-1	15/09/2020 09:20	AUV	80° 31.847'	14° 22.612'	140.3
MSM95_2-2	15/09/2020 13:14	AUV	80° 31.853'	14° 22.507'	142.7
MSM95_2-3	15/09/2020 17:05	OFOS	80° 31.828'	14° 24.585'	130.8
MSM95_2-4	15/09/2020 18:05	OFOS	80° 31.777'	14° 25.031'	130.8
MSM95_3-1	15/09/2020 19:26	EM712	80° 24.149'	13° 59.967'	133.6
MSM95_4-1	16/09/2020 08:04	AUV	80° 24.149'	13° 59.856'	134.3
MSM95_5-1	16/09/2020 11:14	OFOS	80° 28.122'	13° 28.991'	330.2
MSM95_6-1	16/09/2020 14:29	CTD	80° 31.286'	12° 58.318'	701.8
MSM95_7-1	16/09/2020 16:58	OFOS	80° 31.456'	13° 0.048'	696.5
MSM95_8-1	17/09/2020 05:11	CTD	78° 24.817'	9° 12.440'	865.1
MSM95_9-1	17/09/2020 06:22	EM712	78° 24.852'	9° 13.096'	859.7
MSM95_10-1	17/09/2020 12:01	CTD	78° 27.350'	10° 15.385'	159
MSM95_11-1	18/09/2020 01:36	CTD	76° 24.877'	14° 0.022'	997.5
MSM95_12-1	18/09/2020 02:46	EM712	76° 24.879'	14° 0.033'	1000.5
MSM95_13-1	18/09/2020 07:15	OFOS	76° 28.777'	14° 32.121'	220.6
MSM95_14-1	18/09/2020 21:30	EM712	76° 28.947'	14° 32.580'	230.7
MSM95_15-1	18/09/2020 23:40	OFOS	76° 26.382'	14° 32.671'	666.5
MSM95_16-1	19/09/2020 07:32	EM712	76° 28.671'	14° 20.465'	575.3
MSM95_17-1	19/09/2020 12:47	CTD	76° 24.830'	14° 0.028'	1003.3
MSM95_18-1	19/09/2020 13:45	OFOS	76° 24.848'	14° 0.010'	1004.1
MSM95_19-1	20/09/2020 07:19	AUV	78° 27.020'	9° 48.427'	191.8
MSM95_20-1	20/09/2020 09:05	OFOS	78° 26.394'	9° 36.428'	432.9
MSM95_20-2	20/09/2020 13:39	OFOS	78° 26.623'	9° 15.479'	783.9
MSM95_21-1	20/09/2020 18:09	OFOS	78° 25.898'	9° 12.440'	812.6
MSM95_22-1	20/09/2020 23:27	EM712	78° 23.574'	9° 16.053'	855
MSM95_23-1	21/09/2020 08:26	AUV	78° 27.168'	9° 28.756'	506.1
MSM95_24-1	21/09/2020 10:37	OFOS	78° 27.150'	9° 29.007'	503.9
MSM95_25-1	21/09/2020 21:10	CTD	78° 59.911'	8° 14.828'	880.4
MSM95_26-1	22/09/2020 01:40	CTD	78° 36.059'	5° 3.666'	2300.6
MSM95_27-1	22/09/2020 03:53	OFOS	78° 36.958'	5° 8.698'	2313.8
MSM95_28-1	22/09/2020 09:30	EM122	78° 32.698'	4° 25.349'	2326.6
MSM95_29-1	23/09/2020 08:37	AUV	76° 19.771'	14° 55.249'	326.3
MSM95_30-1	23/09/2020 09:47	OFOS	76° 20.855'	14° 54.081'	385.8
MSM95_31-1	23/09/2020 18:44	OFOS	76° 24.917'	14° 49.056'	237.7

MSM95_32-1	24/09/2020 06:44	CTD	76° 20.801'	14° 53.152'	405
MSM95_33-1	24/09/2020 07:32	EM712	76° 21.581'	15° 4.626'	257
MSM95_34-1	24/09/2020 12:50	OFOS	76° 21.369'	15° 1.522'	283.3
MSM95_35-1	25/09/2020 12:48	OFOS	79° 3.236'	4° 12.971'	2460.3
MSM95_35-2	25/09/2020 18:15	OFOS	79° 4.277'	4° 8.580'	2446.1
MSM95_36-1	25/09/2020 19:27	CTD	79° 4.282'	4° 8.556'	2447.3
MSM95_37-1	25/09/2020 22:20	EM122	79° 4.854'	4° 56.502'	1856.6
MSM95_38-1	26/09/2020 09:07	OFOS	79° 1.134'	4° 6.634'	2645.7
MSM95_39-1	26/09/2020 18:29	CTD	79° 29.261'	4° 51.040'	2752.1
MSM95_40-1	26/09/2020 20:13	EM122	79° 29.302'	4° 51.182'	2746.9
MSM95_41-1	27/09/2020 08:38	CTD	79° 44.199'	4° 19.547'	2724.8
MSM95_42-1	27/09/2020 12:34	OFOS	79° 34.171'	5° 15.387'	2606.6
MSM95_43-1	27/09/2020 21:22	OFOS	79° 4.655'	4° 4.571'	2483.1
MSM95_44-1	28/09/2020 08:59	CTD	79° 6.607'	4° 37.685'	1899.5
MSM95_45-1	28/09/2020 10:33	EM122	79° 6.601'	4° 37.827'	1978.1
MSM95_46-1	28/09/2020 17:54	OFOS	79° 4.109'	4° 12.355'	2396.3
MSM95_46-2	29/09/2020 03:03	OFOS	79° 4.083'	4° 12.361'	2386.3
MSM95_47-1	29/09/2020 06:30	CRAWL	79° 4.056'	4° 11.094'	2402.6
MSM95_48-1	30/09/2020 02:30	EM122	78° 50.017'	4° 11.784'	2367.7
MSM95_49-1	30/09/2020 10:37	CTD	79° 7.315'	4° 42.246'	1754.4
MSM95_50-1	30/09/2020 12:05	ADCP	79° 7.290'	4° 42.223'	1755.5
MSM95_51-1	30/09/2020 17:39	CTD	79° 7.310'	4° 42.227'	1748.2
MSM95_52-1	30/09/2020 20:37	OFOS	79° 7.666'	5° 12.812'	1357.9
MSM95_53-1	01/10/2020 06:19	CTD	79° 6.699'	3° 0.106'	5498.9