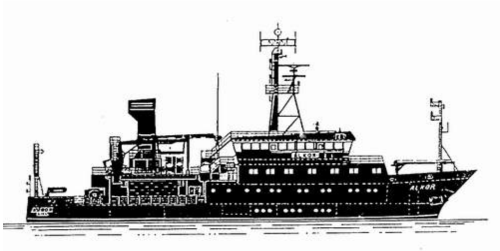
Report

ALKOR Cruise No.355



Redox-dependent nutrient and nitrogen cycles at the benthic boundary layer of the eastern Gotland Basin.

Kiel – Visby – Ventspils - Kiel: 29. 05. – 21. 06. 2010

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Abstract

Cruise ALKOR 355 (AL-355) was carried out within the framework of the EU FP-7 project "HYPOX" (In situ monitoring of oxygen depletion in hypoxic ecosystems of coastal and open seas, and land-locked water bodies). The scientific objectives focused on redox-dependent nutrient and nitrogen cycles in the benthic boundary layer of the suboxic to anoxic Gotland Basin. The scientific party comprised of scientist from the IFM-GEOMAR, Kiel (Germany). Main objectives were to study release rates and inventories of nutrients and nitrogen compounds under varying degrees of bottom water oxygenation in the anoxic to suboxic eastern Gotland Basin (central Baltic). Another goal was to quantify source/sink mechanisms of the benthic boundary layer for nitrogen species and nutrients under changing oxygen conditions to assess potential feedbacks on the upper mixed layer processes.

In order to obtain these goal, we monitored the water column, sampled surface sediments and deployed several landers along a transect from oxygenated to suboxic and anoxic to sulfide benthic boundary layer conditions in the Latvian EEZ of the eastern Gotland Basin in a depth range from 49m to 235m.

II. Narrative of the cruise

Saturday, 29-05-10: R/V ALKOR left the Schwentine Pier at IFM-GEOMAR in Kiel at noon starting expedition No. 355. On board was a group of 12 scientists and technicians from IFM-GEOMAR. The destination was the Latvian EEZ in the eastern Gotland Basin.

Sunday, 30-05-10: We continued our passage through the Baltic Sea to the eastern Gotland Basin.

Monday, 31-05-10: We reached the first station (area C) in the Latvian EEZ at 06:00h and started station work with a CTD/Rosette Water Sampler (CTD/RO) cast (Stat. 305) in 94m. Next came a test of the functioning of the Deep-Sea Observatory Lander (DOS) attached to the wire (Stat. 306). Since all systems functioned well the DOS was deployed soon after the retrieval for a period of 20 days to measure near bottom variability of the oxygen and current regime (Stat. 307). Afterward we took sediment samples with the TV-multi corer (MUC, Stat. 307) and took video and still photograph pictures along a transect across area C with the towed Ocean Floor Observation System (OFOS, Stat. 308). Station work ended with the deployment of the BIGO-Lander (Stat. 309). The Biogeochemical Observatory (BIGO-II) is a lander system which measures in situ sediment-water interface fluxes of gases and nutrients in benthic chambers.

Tuesday, 01-06-10: We started work at area B with a CTD/Ro cast (Stat.310) at 65m, which was followed by sediment sampling with the MUC (Stat. 311). The surrounding of these stations was than surveyed by an OFOS transect (Stat. 312). The second BIGO-Lander (BIGO-I) was deployed on the OFOS transect line in 65m (Stat. 313) followed by another OFOS survey (Stat, 314) and a CTD/RO cast at 73m (Stat. 315).

Wednesday, 02-06-10: Station work started with the retrieval of the BIGO-II lander deployed on Monday (Stat. 316). We then drove two OFOS transects at 98m-97m respectively 86m-83m) Stat, 317, 318). Station work ended with the deployment of a lander (PROFI-L) with sediment profiling micro-electrodes to measure the diffusive oxygen flux between water and sediment at 68m (Stat. 319).

Thursday, 03-06-10: Station work started with the retrieval of the BIGO-I lander deployed on Tuesday (Stat. 320). During the day we drove a series of OFOS Transects in area B at 65m-66m (Stat 321), 72m-77m (Stat. 322) and in area D at 124m-125m (Stat. 323). We finished the day with a CTD/RO cast at 124m (Stat. 224).

Friday, 04-06-10: Station work continued in area D starting with another deployment of the BIGO-II lander (Stat. 325). A multiple corer sample was taken afterwards near the Lander position (Stat. 326). We then progressed further down slopes to run two OFOS survey lines by 140m (Stat.327) respectively by 160m-170m (Stat. 328). A CTD/RO and a MUC cast were also taken on the second OFOS track line by 172m (Stat. 329) respectively 169m (Stat. 330). Station work finished with the retrieval of the PROFI-L lander (Stat. 331).

Saturday, 05-06-10: Station work started at area B with the deployment of a BIGO-I lander in 65m (Stat. 332). Afterwards we steamed to the deepest part of the eastern Gotland Basin where we made a combined CTD/RO cast and OFOS survey by 223m (Stat. 333, 334) and by 235m (Stat. 335, 336).

Sunday, 06-06-10: In the morning we retrieved the BIGO-II lander at area D which was deployed on Friday (Stat. 337). We then progressed more inshore to make a CTD/RO cast (Stat. 338) and an OFOS survey (Stat. 339) at 50m water depth. In the afternoon we went to Ventspils (Latvia) where we were moored for the rest of Sunday.

Monday, 07-06-10: We left Ventspils harbor at 06:00h and headed directly to area B to retrieve the BIGO-I lander deployed on Saturday (Stat. 340). We continued with another OFOS-survey in area B (Stat. 341) and deployed the PROFI-L lander in the afternoon (Stat. 342). Afterwards we shifted position to area E for a CTD/RO cast by 173m (Stat. 343).

Tuesday, 08-06-10: We stayed at area E to deploy another BIGO-II lander in the morning (Stat. 344). We then progressed down slope to 223m to take a CTD/RO cast (Stat. 345). Afterwards we stopped station work to steam to Visby which we reached at 19:00h.

Wednesday, 09-06-10: Alkor stayed at Visby harbor for an exchange of personnel of the scientific crew and to deliver samples for our Swedish project partners of Göteborg University.

Thursday, 10-06-10: We left Visby at 08:00h and steamed back to the Latvian EEZ in the eastern Gotland Basin. We reached area C in the late afternoon where we deployed a BIGO-I lander (Stat. 346). Afterwards we changed to area B and picked up the PROFI-L lander deployed on the 7th (Stat. 347).

Friday, 11-06-10: Station work started with the retrieval of the BIGO-II lander deployed on the 8th (Stat. 348). Next came an OFOS survey by 100m to 104m (Stat. 349). The last action of the day was a CTD/RO cast by 152m (Stat. 350).

Saturday, 12-06-10: During the night weather conditions had changed rapidly. The wind was blowing with force 7-8Bft and a high swell had already developed. We had to cancel the planned deployment of a BIGO-II lander and had to abandon all sampling activities. We sought shelter in Ventspils harbor where we arrived in the mid-morning.

Sunday, 13-06-10: The bad weather conditions continued and in consequence we stayed in Ventspils.

Monday, 14-06-10: We left Ventspils in the morning and headed towards the working area to deploy a BIGO-II lander by 80m (Stat. 351). Afterwards we changed position to area C and retrieved the BIGO-I deployed on the 10th (Stat. 352). Last station of the day was a CTD/RO cast in the deep basin by 220m (Stat 353).

Tuesday, 15-06-10: In the morning the BIGO-I lander was re-deployed by 152m (Stat. 354). Afterwards we steamed again to the deep basin for a CTD/RO cast (Stat.355). We then changed position to area D for a MUC sample by 122m (Stat. 356). In the late afternoon we deployed the frame for the eddy correlation module (ECM-V) to measure H_2S flux in the sulfidic bottom water beyond area E (Stat, 356).

Wednesday, 16-06-10: The first action of the day was the recovery of the BIGO-II lander deployed on the 14th (Stat. 358). Afterwards we steamed to area A for a series of MUC samples (Stat. 359-361). We returned to area D for an OFOS transect (Stat. 362). Station work of the day was finished with the recovery of the eddy correlation module deployed the day before (Stat. 363).

Thursday, 17-06-10: Station work started with the deployment of the BIGO-II lander by 110m (Stat. 364). This was followed by two MUC casts in area B (Stat. 365) and area C (Stat 366). In the afternoon the frame for the eddy correlation module was deployed again near area B by 65m (Stat. 367). The deployment of the Profiler lander at area C by 94m was the last action of this day (Stat. 368).

Friday, 18-06-10: The BIGO-I lander deployed on the 15th was successfully retrieved (Stat. 369). During the day followed a series of three MUC casts by 94m (Stat. 370), by 123m (Stat. 371) and by 160m (Stat. 372). Station work of the day ended with the recovery of the Profiler Lander deployed the day before (Stat. 373).

Saturday, 19-06-10: Station work was exclusively dedicated to the retrieval of landers namely the DOS lander (Stat. 374), the eddy frame (Stat. 375) and the BIGO-II lander (Stat. 376). At noon we finished our field work and left the working area thus starting our home journey.

Sunday, 20-06-10: We continued our passage through the Baltic Sea back to Kiel.

Monday, 21-06-10: We arrived at the Schwentine Pier in Kiel in the morning and finished expedition ALKOR 355 with the unloading of the scientific equipment.

III. Participants

	Name	Function	Affiliation
1.	Pfannkuche, Olaf Dr.	chief scientist I	IFM-GEOMAR
2.	Bannert, Bernhard	video technician-	IFM-GEOMAR
3.	Bodenbinder, Andrea	lab. technician	IFM-GEOMAR
4.	Cherednichenko, Sergiy-	electr. engineer	IFM-GEOMAR
5.	Cordt, Hans*****	lab. technician	IFM-GEOMAR
6.	Dibbern, Meike	lab. technician	IFM-GEOMAR
7.	Kriwanek, Sonja	lab. technician	IFM-GEOMAR
8.	Lippke, Daniel	student assistant	IFM-GEOMAR
9.	Schorp,Tanja	Ph. D. student	IFM-GEOMAR
10.	Sommer, Stefan Dr.	scientist	IFM-GEOMAR+
11.	Türk, Mathias	electr. engineerI	FM-GEOMAR
12.	Walther, Stefanie	student assistant	IFM-GEOMAR

*****Replaced by Daniel McGinnis, IFM-GEOMAR on 9. June 2010

IFM-GEOMAR: Leibniz-Institut für Meereswissenschaften, an der Universität Kiel, Wischhofstr. 1-3, 24148 Kiel, Germany

IV First Results

Key issues of our investigations were:

1. Determination of the actual oxygen concentration in the benthic boundary layer with CTD/RO casts and determination of the temporal variability of the oxygen concentration with a lander observatory at 93m.

2. In situ determination of natural fluxes of nitrogen species (N_2, NH_4^+, NO_3^-, NO_2^-), as well as O_2 and SO_4^{2-} and phosphate across the sediment water interface at natural gradients from low oxic to anoxic conditions using state-of-the-art lander technology and undisturbed multicorer sediment samples.

3. Photographic mapping of the distribution and compositions of benthic habitats and fauna along the benthic oxygen gradient.

4. Determination of meiofaunal community composition along environmental gradients of oxygen availability. Quantification of their role in the overall benthic carbon cycle under different oxygen conditions.

OFOS (Ocean floor Observation System)

Sediment imaging with was conducted using a towed camera system (OFOS, Fig. 1). The frame carries an on-line video camera and a digital still camera taking photos in 10sec intervals. The system is towed 1,5m above the sea floor.

Fig. 1: The OFOS System for seafloor imaging.

Sediment sampling

Undisturbed sediment cores were sampled under on-line video-control with the multiple corer (MUC, Fig. 2). Samples were used for chemical pore water analysis.

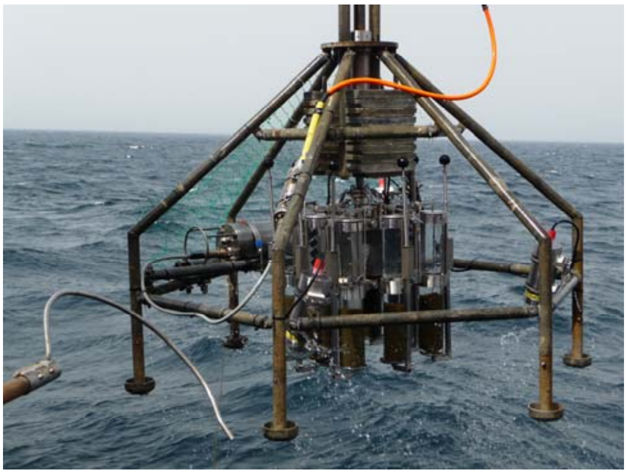

Fig 2: The multiple corer with on-line video camera.

Lander deployments

Several deployments with GEOMAR modular landers were made. Each lander frame was instrumented specifically for the scientific question

<u>BIGO (Biogeochemical observatory)</u>

BIGO (Fig. 3) measures sediment water interface fluxes in benthic chambers. It retrieves water samples from the enclosed chamber water at predefined time intervals. At the end of the flux measurement the incubated sediments are kept inside the chamber for further on-board sub-sampling. Geochemical measurements in the sediments included the following parameters: O_2, SO_4^{2-}, HS^-, NO_3^-, NO_2^-, NH_4^+, PO_4^{3-},Fe_2^+, Si, Br^-, I^-, total alkalinity, the determination of physical properties of the sediment as well as the sediment C/N ratio, content of plant pigments and meiofauna. Geochemical parameters that were measured in the bottom/chamber water include O_2, N_2, Ar, N-compounds, PO_4^{3-}, Si, SO_4^{2-} and physical parameters (temperature, density, salinity). From the chamber water concentration gradients of the above listed parameters the respective interfacial fluxes are calculated and compared with fluxes derived from pore water profiles.

Fig 3: Video-controlled deployment of a BIGO-Lander

PROFI-L (Transecting profiler for O_2 micro-gradients)

A novel transecting profiler which allows to measure oxygen micro-gradients across the sediment water interface was deployed at the lower boundary of the OMZ mounted to a lander (Fig. 4). The profiling unit consists of a lower and upper glass fiber frame, which are connected by four glass fiber poles. The upper frame extends about 50 cm towards the front defining an area across which sensors can be moved in mm increments along the x- and the y-axis. Along the vertical z-axis, the sensors can be moved at freely selectable increments. Commercially available oxygen micro-sensors (tip diameters: ~ 100 µm. Unisense, DK) were used to measure in-situ oxygen concentration profiles. The sensors were connected to individual miniaturized amplifier units which were jointly developed with Unisense, DK.

Fig.4: Lander carrying the transecting profiler to conduct 3-dimensional micro-scale measurements of oxygen, sulfide and pH in sediments.

DOS-L (Deep sea observation lander)

This Lander carrying a 350 kHz up-looking ADCP for the measurement of current velocities and direction and several optodes to measure near bottom oxygen variation in 10cm - to 1m above the seafloor was deployed for the duration of the expedition at 96m water depth.

First results

Seafloor observation: Extended sea floor imaging revealed that microbial mats around the oxycline were ubiquitous and very likely occurs along the entire oxic-anoxic fringe of the Gotland Basin (Fig 5). Their presence has distinct implications for the benthic nitrogen cycle as these organisms are able to store high amounts of nitrate. For the oxidation of sulfide these organisms can switch from using oxygen as a terminal electron acceptor to nitrate. During this dissimilatory nitrate reduction to ammonium, DNRA, high amounts of ammonium can be released into the bottom water. In contrast to denitrification or anammox where reactive nitrogen is lost from the ecosystem as N_2 gas, DNRA recycles nitrate into another reactive nitrogen species that is retained in the ecosystem. The released ammonium contributes to enhanced primary production potentially leading to eutrophication and promoting fast oxygen depletion.

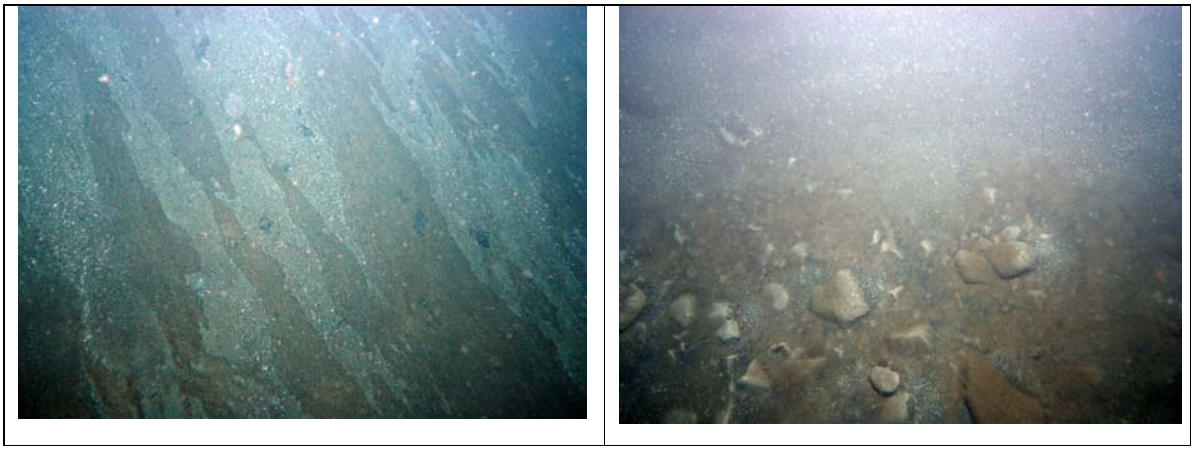

Fig. 5: Bacterial mats on soft bottom and stony bottom at 85m water depth.

Several lander deployments were conducted to measure the temporal and spatial variability of fluxes comprising 9 deployments of the BIGO type lander (benthic chamber), 3 Profiler deployments (oxygen micro-profiles), and 2 Eddy flux devices (high resolution measurements of O_2 flux). Overall a depth range of 65m to 173m was covered, including the oxic as well as the deeper anoxic, sulfidic zones of the Gotland Basin. For the duration of the entire cruise a further lander (DOS) was deployed at 96m (~ oxycline) to record currents, physical parameters and oxygen concentrations in the bottom water. It was further equipped with a camera system. The DOS lander was deployed at the same station where a lander was accidently deployed for four month during Alkor cruise 346. In addition to these lander deployments several multiple corers and CTD casts were conducted to determine water column and pore water geochemistry. Scientific highlights can be detailed as follows:

Oxygen variability in the bottom water: The comparison of the two long-term oxygen records retrieved during AL346 and AL355 revealed that during the stormy fall in 2009 oxygen variability ranged between severe hypoxia (< 4 µM) and up to 180 µM whereas during the June cruise in 2010 oxygen varied between hypoxia and up to 14 µM. The strong oxygenation events in 2009 can be clearly related to storm events indicating enhanced transport and mixing of oxygenated surface water to greater depths caused by seiche movements, internal waves, up- and down-welling events, and vertical turbulent mixing with wind as the major driving force.

During the past 50 years an increase of the mean annual wind speed over the Baltic Sea was observed with much of the change takes place during the winter time. Results of global scenario simulations investigating the influence of expected anthropogenic climate change on the climatic forcing conditions for Northern Europe suggests that a strengthening of the polar front, and thus intensification of the North Atlantic Oscillation can be expected. In this context the above data are important to understand the consequences of increasing wind speed on possible regime shifts in the benthic turnover and internal loading with reactive nitrogen compounds, phosphorus, Fe and trace metals into the water column.

Eddy flux measurements revealed highly variable oxygen fluxes that range from almost no uptake up to ~ 20 mmol m^{-2} d^{-1}. A few hundred oxygen micro-profiles were obtained from the transecting profiler. These profiles enable to elucidate fine scale spatial variability of oxygen consumption in the sediment as well as the temporal variability of diffusive oxygen flux.

Fluxes of major elements: At the shallowest site (65m) just above the oxycline the total oxygen uptake was variable and ranged between ~ 5 to ~22 mmol m^{-2} d^{-1} (Fig. 6). Below the oxycline at ~ 120m sulfide starts to become released from the sediment into the bottom water reaching a maximum flux of 2.8 mmol m^{-2} d^{-1} in 173m water depth. Maximum fluxes of silicate, phosphate, ammonium and di-nitrogen were clearly associated with the depth distribution of the microbial mats that were observed from ~ 80m down to ~ 125m. Another peak of ammonium release was found at the deepest site associated with the highest sulfide flux. This release likely is caused by ammonification during organic matter degradation, whereas the ammonium release at 123m might be also related to DNRA facilitated by the microbial mats. Please note that the fluxes presented above are preliminary and needs further correction.

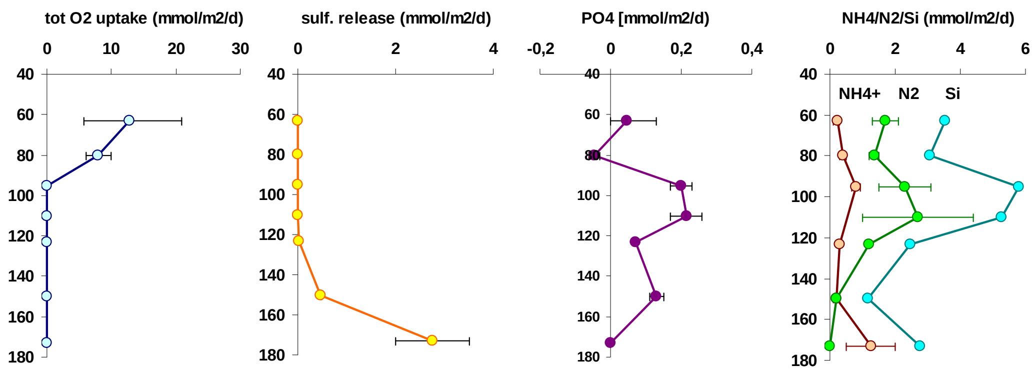

Fig. 6: Average fluxes of O_2, sulfide, phosphate, silicate, ammonium and di-nitrogen across the sediment water interface measured in situ using benthic chambers. The oxycline is located at ~ 70m water depth. Microbial mats were distributed from ~ 80m to 125m. Error bars represent min. and max. values.

N_2/Ar measurements: A key to understand the source/sink function of benthic environments for reactive nitrogen is the measurement of the total loss of nitrogen from these sites. This is not a trivial task and typically is done by measuring the N_2 release using membrane inlet mass spectrometry. However, to date such measurements are very scarce since they a prone to manifold artifacts and are technologically demanding. To improve our N_2 measurements, first we developed a new water sampling system for the lander, second we improved the membrane inlet of the mass spectrometer and third we thoroughly checked the quality of the water samples for contamination during the mass spectrometrical analysis.

An example of N_2/Ar measurements in the water column is shown in Figure 7. Excess nitrogen in the water column is indicated by an atmospheric equilibrium ratio of N_2/Ar > 1, whereas a value < 1 indicates under-saturation. One would expect that the surface waters are in equilibrium with the atmosphere (N_2/Ar ≈ 1) which was not observed. We assume that N_2-fixing cyanobacteria which we observed in the surface water caused this deviation. Below the thermocline at ~ 25m (data not shown) excess N_2 was observed throughout the entire water column.

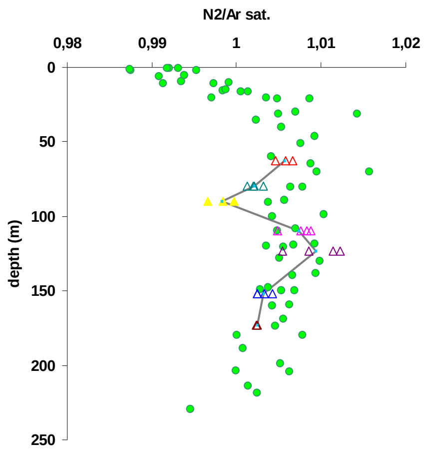

Fig. 7: Atmospheric equilibrium ratio measured in water samples retrieved from CTD casts (green circles) and from bottom water sampled during different lander deployments (triangles).

V. Map of working area and station list

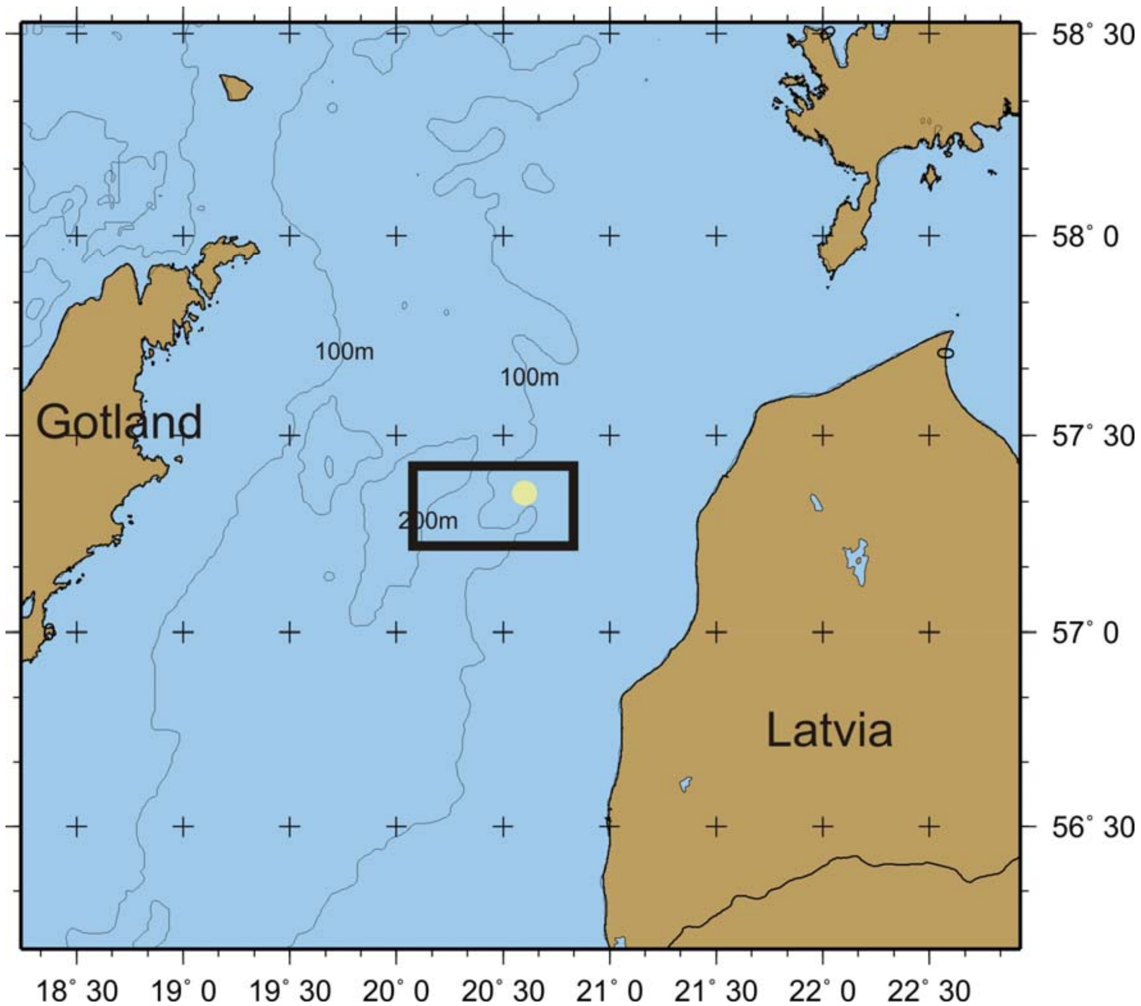

Fig 8: Working area of ALKOR 355 in the eastern Gotland Basin (Latvian EEZ).

Tab 1: ALKOR 355, list of employed gear with abbreviations

The acronyms listed here are used in the station list below.

Acronym	**Gear**
CTD/RO	CTD-Rosette water sampler
MUC	TV-multiple corer
OFOS	Ocean floor observation system
BIGO-L	Biogeochemistry laboratory-lander
PROFI-L	Lander + micro electrode profiler
DOS-L	Deep-Sea Observation System /Lander
ECM-V	Eddy Correlation Module

Tab. 2: Station list ALKOR-355, 29.5. -21. 6. 2010.

Station	Gear	No.	Area	Date	Time	Coordinates 1		Depth	Coordinates 2		Depth	Time
AL355-No.				2010	(UTC)	Lat. °N	Long. °E	(m)	Lat. °N	Long. °E	(m)	(UTC)
305	CTD/RO	1	C	31.05.	04:08	57°20.72´	20°35.34´	94				
306	DOS-L Test	1	C	31.05.	07:05	57°20.70´	20°35.32´	95				
307	DOS-L Depl	2	C	31.05.	08:19	57°20.73´	20°35.31´	96				
308	MUC	1	C	31.05.	10:00	57°20.88´	20°35.25´	94				
309	BIGO-II Depl	1	C	31.05.	13:32	57°20.76´	20°35.22´	97				
310	CTD/RO	2	B	01.06.	06:06	57°26.48´	20°43.50´	65				
311	MUC	2	B	01.06.	08:00	57°26.49´	20°43.49´	65				
312	OFOS	1	B	01.06.	08:41	57°26.28´	20°43.41´	66	57°26.61´	20°43.56´	67	09:21
313	BIGO-I Depl	1	B	01.06.	12:24	57°26.49´	20°43.51´	66				
314	OFOS	2	B	01.06.	13:27	57°26.27´	20°43.48´	65	57°26.67´	20°43.50´	65	14:11
315	CTD/RO	3		01.06.	14:59	57°21.44´	20°43.06´	73				
316	BIGO-II Retr	1	C	02.06.	06:45	57°20.77´	20°35.42´	97				
317	OFOS	3	C	02.06.	11:06	57°20.46´	20°35.32´	98	57°20.82´	20°35.18´	97	11:48
318	OFOS	4		02.06.	12:26	57°21.47´	20°35.55´	86	57°21.78´	20°35.74´	83	13:40
319	PROFI-L Depl	1	B	02.06.	16:10	57°24.44´	20°43.68´	65				
320	BIGO-I Retr	1	B	03.06.	08:40	57°26.40´	20°43.48´	66				
321	OFOS	5	B	03.06.	08:45	57°26.27´	20°43.62´	66	57°26.54´	20°43.46´	65	09:25
322	OFOS	6		03.06.	10:41	57°23.41´	20°36.97´	72	57°23.64´	20°36.53´	77	11:27
323	OFOS	7	D	03.06.	12:33	57°18.86´	20°33.04´	124	57°19.08´	20°32.85´	125	13:03
324	CTD/RO	4	D	03.06.	13:31	57°18.85´	20°33.08´	124				
325	BIGO-II Depl	2	D	04.06.	06:33	57°18,54´	20°33.04´	124				
326	MUC	3	D	04.06.	07:01	57°18.68´	20°33.00´	123				
327	OFOS	8		04.06.	08:41	57°14.99´	20°27.18´	139	57°15.25´	20°27.11´	141	08:50
328	OFOS	9	E	04.06.	10:35	57°20.79´	20°28.40´	160	57°21.06´	20°28.11´	170	11:15
329	CTD/RO	5	E	04.06.	11:32	57°21.07´	20°27.98´	172				

Station	Gear	No.	Area	Date	Time	Coordinates 1		Depth	Coordinates 2		Depth	Time
AL355-No.				2010	(UTC)	Lat. °N	Long. °E	(m)	Lat. °N	Long. °E	(m)	(UTC)
330	MUC	4	E	04.06.	07:01	57°21.00´	20°28.13´	169				
331	PROFI-L Retr	1	B	04.06.	16:30	57°26.35´	20°43.68´	65				
332	BIGO-I Depl	2	B	05.06.	08:33	57°26.53´	20°43.54´	65				
333	CTD/RO	6		05.06.	10:25	57°22.00´	20°19.00´	223				
334	OFOS	10		05.06.	11:30	57°22.99´	20°19.03´	223	57°22.89´	20°18.88´	224	11:45
335	CTD/RO	7		05.06.	14:08	57°21.31´	20°08.62´	235				
336	OFOS	11		05.06.	14:53	57°21.42´	20°08.76´	234	57°21.26´	20°08.73´	235	15:10
337	BIGO-II Retr	2	D	06.06.	06:40	57°18,85´	20°33.00´	124				
338	CTD/RO	8	A	06.06.	08:47	57°29.99´	20°56.00´	50				
339	OFOS	12	A	06.06.	09:10	57°29.96´	20°56.07´	49	57°29.79´	20°56.07´	235	09:35
340	BIGO-I Retr	2	B	07.06.	09:15	57°26.54´	20°43.47´	65				
341	OFOS	13	B	07.06.	10:33	57°27.38´	20°43.00´	62	57°27.41´	20°43.33´	62	10:53
342	PROFI-L Depl	2	B	07.06.	14:21	57°27.37´	20°42.99´	62				
343	CTD/RO	9	E	07.06.	15:47	57°21.05´	20°27.95´	173				
344	BIGO-II Depl	3	E	08.06.	06:43	57°21.06´	20°27.97´	173				
345	MUC	5		08.06.	07:36	57°22.99´	20°18.98´	223				
346	BIGO-I Depl	3	C	10.06.	16:38	57°20.87´	20°35.23´	96				
347	PROFI-L Retr	2	B	10.06.	17:45	57°27.36´	20°42.94´	62				
348	BIGO-II Retr.	3	E	11.06.	06:45	57°21.09´	20°27.91´	173				
349	OFOS	14		11.06.	10:39	57°20.70´	20°35.14´	100	57°20.39´	20°34.98´	104	11:00
350	CTD/RO	10		11.06.	15:50	57°21.08´	20°28.98´	152				
351	BIGO-II Depl	4		14.06.	08:31	57°21.82´	20°35.87´	80				
352	BIGO-I Retr	3	C	14.06.	08:58	57°20.95´	20°36.11´	96				
353	CTD/RO	11		14.06.	14:40	57°22.99´	20°18.98´	223				
354	BIGO-I Depl	4		15.06.	06:45	57°20.99´	20°29.00´	150				
355	CTD/RO	12		15.06.	09:55	57°23.00´	20°19.00´	223				

Station	Gear	No.	Area	Date	Time	Coordinates 1		Depth	Coordinates 2		Depth	Time
AL355-No.				2010	(UTC)	Lat. °N	Long. °E	(m)	Lat. °N	Long. °E	(m)	(UTC)
356	MUC	6	D	15.06.	12:16	57°18.71´	20°32.95´	122				
357	ECM-V Depl	1		15.06.	15:05	57°20.77´	20°26.30´	180				
358	BIGO-II Retr	4		16.06.	ß6:40	57°21.82´	20°35.87´	80				
359	MUC	7	A	16.06.	10:16	57°30.06´	20°56.04´	50				
360	MUC	8	A	16.06.	10:34	57°29.97´	20°56.01´	50				
361	MUC	9	A	16.06.	10:51	57°29.98´	20°56.02´	50				
362	OFOS	15	D	16.06.	12:51	57°19.05´	20°32.78´	123	57°18.98´	20°32.34´	122	13:21
363	ECM-V Retr	1		15.06.	15:05	57°20.75´	20°26.41´	180				
364	BIGO-II Depl	5		17.06.	06:46	57°20.59´	20°34.34´	110				
365	MUC	10	B	17.06.	08:10	57°26.49´	20°43.51´	65				
366	MUC	11		17.06.	09:11	57°20.52´	20°34.22´	111				
367	ECM-V Depl	2	B	17.06.	11:00	57°25.86´	20°42.23´	64				
368	PROFI-L Depl	3	C	17.06.	14:46	57°20.80´	20°35.25´	97				
369	BIGO-I Retr	4		18.06.	06:35	57°28.96´	20°29.00´	152				
370	MUC	12	C	18.06.	08:56	57°20.74´	20°35.35´	94				
371	MUC	13	D	18.06.	10:32	57°18.70´	20°33.00´	123				
372	MUC	14	E	18.06.	11:36	57°20.80´	20°28.39´	160				
373	PROFI-L Retr	3	C	18.06.	15:07	57°20.87´	20°35.27´	95				
374	DOS-L Retr	2	C	19.06.	05:10	57°20.93´	20°35.31´	96				
375	ECM-V Retr	2	B	19.06.	07:40	57°25.84´	20°42.29´	64				
376	BIGO-II Retr	5		19.06.	08:35	57°20.56´	20°34.29´	111				

A	ca 50m oxic
B	ca 65m oxic to suboxic
C	ca 95m anoxic to suboxic
D	ca 123m anoxic
E	ca 165m sulfidic

Coordinates 1: CTD/RO, MUC, Lander, ECM-V: position of deployment or bottom sample

OFOS: start of bottom view, start of OFOS transect

Coordinates 2: OFOS: end of bottom view, end of OFOS transect