RV BELGICA CRUISE 2023/05 - PROGRAM

Subscribers:	Koen Degrendele (KD)[1]; Prof. Dr. Vera Van Lancker (VVL)[2], Dr. Olga Lopera (OL)[3], Sonia Papili (SP)[3]
Institutes:	[1]Federal Public Service Economy, SMEs, self-employed and Energy, Continental Shelf Service (FPS-CSS); [2]Operational Directorate Natural Environment (RBINS-OD Nature); [3]Royal Military Academy (RMA) – SIC (CISS), RAS (MECA)
Addresses:	[1]FPS-CSS: NGII - Koning Albert II Laan 16, B-1000 Brussel; [2]RBINS-OD Nature: Vautierstaat 29, B-1200 Brussels; [3]RMA: Renaissancelaan 30, B-1000 Brussels
Telephones:	+32(0)2 277 84 11 (KD); +32(0)2 627 43 45 (VVL); 02 4414149 (OL)
E-mails:	koen.degrendele@economie.fgov.be; vvanlancker@naturalsciences.be, olga.loperatellez@mil.be; Sonia.papili@mil.be

Monitoring/Geology/Education/Various
17/03/2023 - 20/03/2023
20/03/2023 – 24/03/2023

1. GENERAL FORM RV BELGICA 2023

1.	Cruise number	2023/05
2.	Date/time Zeebrugge ETD Zeebrugge ETA Zeebrugge ETD Zeebrugge ETA Zeebrugge ETD Zeebrugge ETA Zeebrugge ETD Zeebrugge ETA	**Part A** 17/03/2023 : 11h00 **All scientists present at 09<u>h30</u>** 20/03/2023: 08h00 **Part B** 20/03/2023 : 11h00* 22/03/2023: 08h00 22/03/2023: 11h00* 23/03/2023: 14h00 23/03/2023: 17h00* 24/03/2023: 15h30 *** All scientists present at <u>*-1h30</u>**
3.	Chief Scientist Participating institutes	**Part A** Koen Degrendele 2nd: Marc Roche **Part B** Vera Van Lancker 2nd: Olga Lopera **Part A** FPS-CSS, RBINS-OD Nature, VLIZ, UGent **Part B** RBINS-OD Nature, RMA, Students Oceans & Lakes
4.	Geographical area DIPCLEAR necessary	Belgian part of the North Sea NO
5.	Scientific personnel	**Part A** 17- 20/03/23: 18 **Part B** 20-22/3/2023: 22 22-23/3/2023: 23 23-24/3/2023: 22
6.	Intervention required of: - Marine scuba team - Marine medical assistance - Pilot	 NO NO NO
7.	Necessary infrastructure onboard or on the quay to embark or disembark equipment. Mobilization Zeebrugge, 17/03/23, 09h30 Demobilization Zeebrugge, 24/03/23, 15h30	*Ship's crane* Sediment Profile Imager (SPI) VPR (with separate crane from VLIZ) VPR (with separate crane from VLIZ) SPI Boxcorer

8.	Logistic assistance for CTD, data acquisition (MDM 500) or other.	Start-up MDM 500 Sub-bottom profiler, ADCP 600 kHz and MB EM2040
9.	Remarks: None	

General remarks c/o RBINS-OD Nature-Measurement Services Ostend:

i) Bed linen and towels are available on the ship.

ii) All scientists involved in deck operations need to wear appropriate safety clothing such as safety shoes/boots, gloves etc. Only safety helmets and life vests are available on board.

iii) Please note that scientists are invited to bring their own mobile devices. The RV Belgica mobile phone/sat phone will be only made available in exceptional circumstances such as communications related to operational aspects of the ongoing campaign and in case of an emergency.

iv) All participants are requested to settle their account (daily meal fee: 6€ for lunch & 6€ for dinner) aboard via a digital payment during disembarkation, no cash payments allowed. Drinks and snacks are free of charge, but soft drinks have a suggested maximum limit of 3 consumptions per day per person.

v) Following governmental and contractual regulations smoking on the ship is only allowed at the designated location, near the muster station. Smoking on other locations is prohibited, e.g. science hangar and other locations on outer decks.

vi) It is prohibited to bring and use any kind of illegal drugs onboard. In case of violation, criminal prosecution will be initiated and any further access to the ship will be denied.

vii) It is not allowed to bring and use alcoholic drinks onboard. It is also not allowed to bring food onboard or take food/drinks from board unless agreed upon by the Master and crew (cfr. special dietary requirements).

viii) It is no longer allowed to park on the quays of the Naval Base in Zeebrugge. Any violation will lead to a fine of 120 €. Please use the dedicated parking lots (ZZ or ZZZ (long term)) on the base. The guards can give information on the correct locations. For long stays (> 3 days/3 nights) a document has to be filled in and be placed clearly visible on the dashboard of the car and the car keys must be handed over to the guards of the base in a closed envelope (see document sent with this program).

ix) Via the VSAT broadband internet connection and the WIFI available onboard you can connect to your e-mail clients and surf the internet. But please keep in mind that the bandwidth is limited and that any abuse will lead to restricted internet access.

x) All participants embarking on RV Belgica should be in good health allowing them to perform their activities at sea without being an extra safety risk and/or possibly causing a loss of ship time. When in doubt of a participant's medical situation the Chief Scientist or person in question should contact the Coordinator RV Belgica prior to the campaign. The Coordinator RV Belgica will consult and decide with the Master RV Belgica if the person in question can embark on the RV Belgica campaign.

xi) All scientists need to clean their cabins and the used labs at the end of the campaign. Cleaning products and material will be provided.

xii) Scientists are not allowed to enter non-authorized areas (see indications), incl. access to galley and provision rooms.

xiii) If you have any questions address the Master, Chief Scientist and crew.

For approval RBINS-OD Nature: 13/03/2023

L. NAUDTS, Dr.-Advisor
Coordinator RV BELGICA

2. LIST OF PARTICIPANTS

Part A: 17-20/3/2023

Institute	NAME	Gender	17/03 – 20/03/23
FPS-CSS	Koen Degrendele	*M*	x
	Marc Roche	*M*	x
	Helga Vandenreyken	*F*	x
	Anne-Sophie Piette	*F*	x
RBINS-OD Nature	Vera Van Lancker	*F*	x
	Katrijn Baetens	*F*	x
	Pauline Denis	*F*	x
	Lars Kint	*M*	x
	Benjamin Van Roozendael	*M*	x
	Kyra Gesquiere	*F*	x
	Nicky Jespers	*M*	x
VLIZ	Nore Praet	*F*	x
	Jarren Goes	*M*	x
	Anouk Ollevier	*F*	x
	Steve Simmons	*M*	x
UGent	Peter Urban	*M*	x
FOD BOSA	Lieven Dejaegher	M	x
		Total participants:	17

Part B: 20-24/3/2023

Institute	Name	Gender	20-22/03	22-23/03	23-24/03
RBINS-OD NATURE	VAN LANCKER Vera	F	ch. Sc	ch. Sc	ch. Sc
	KINT Lars	M	Cabin 2	Cabin 2	Cabin2
	JESPERS Nicky	M	Cabin 2	Cabin 2	Cabin 2
	TAYMANS Céline	F		Cabin 3	Cabin 3
	DELHAYE Louise	F	Cabin 3		
	VAN DEN BRANDEN Reinhilde	F	Cabin 6		
RMA-OL	LOPERA Olga	F	2nd ch sc.	2nd ch sc.	2nd ch sc.
	PAPILI Sonia	F	Cabin 3	Cabin 3	Cabin 3
	LA GRAPPE Alexandre	M	Cabin 12	Cabin 12	Cabin 12
	LE FLECHER Emile	M	Cabin 12	Cabin 12	Cabin 12
	VLAEMYNCK Robby	M	Cabin 5	Cabin 5	Cabin 5
	VANSTECHELMAN Antony	M	Cabin 5	Cabin 5	Cabin 5
O&L Students	HERBOTS Elke	F	Cabin 6		
	DANBOBA MusaBonso	M	Cabin 11		
	AL-DAMLUJI Nada Nofal Khalid	F	Cabin 7		
	BALTHAZAR Iris	F	Cabin 7		
	BARNES Thomas Jeffery	M	Cabin 11		
	BIRNIE Iona	F	Cabin 9		
	BOBEVA Martina	F	Cabin 8		
	DOMMITZSCH Lara Victoria	F	Cabin 10		
	DUEÑAS OLVERA Rafaella Fernanda	F	Cabin 10		
	GAST Polly	F	Cabin 9		
	GAVIÑO ALVA Jenny Alexandra	F	Cabin 8		
	DA PRATO Gioele	M		Cabin 11	
	ANTONIK Max	M		Cabin 11	
	JOSE Sanjo	M		Cabin 7	
	KACHESOV Kirill	M		Cabin 7	
	KOMUHIMBO Lydia	F		Cabin 6	
	MALI Ojas	M		Cabin 8	
	MOHAMED MohamedYusuf	M		Cabin 8	
	MOLL Mary Vanessa	F		Cabin 9	
	MUGISHO KULIMUSHI Alain	M		Cabin 10	
	MUKADDAM Wissam	M		Cabin 10	
	MUNDAS Jomarie	M		Cabin 4	
	NAILI Nour Elimene	F		Cabin 9	
	NYAMBU Angeline Wanjala	F		Cabin 6	
	NZORI Maimuna Mbwan	F			Cabin 6
	OP'T ROODT Lode	M			Cabin 7
	OTIENO Nicholas Okeyo	M			Cabin 7
	RAJIB Wasim Sajjad	M			Cabin 8
	REYNS Niels	M			Cabin 8
	ROSERO MARSIGLIA Diana Alejandra	F			Cabin 9
	SOROKA Taylor Emily	F			Cabin 9
	SUAREZ MAZO Luisa Fernanda	F			Cabin 10
	TAMAYO Joseph Ricky	M			Cabin 11
	TEN NAPEL Almaru Marius	M			Cabin 11
	TZIOVARIDIS Fanny	F			Cabin 10
	WAMBURA Esther Chacha	F			Cabin 6
		TOTAL	**22**	**23**	**22**
		students	*11*	*13*	*12*

Assignment of the cabins by the Chief Scientist & Master at the start of the campaign.

3. SCIENTIFIC OBJECTIVES

FPS-CSS (KD)

Surveillance and mapping of the impact of sand extraction on the Belgian part of the North Sea

This monitoring project aims to execute a continuous research on the effects of the exploitation of non-living resources of the territorial sea and the continental shelf on the sedimentary movements and the marine environment (Law of 13 June 1969 on the exploration and exploitation of non-living resources of the territorial sea and the continental shelf).

RBINS OD NATURE-VVL-ZAGRI/MOZ4 (VVL)

ZAGRI is a continuous research program on the evaluation of the effects of the exploitation of non-living resources of the territorial sea and the continental shelf. MOZ4 focuses on the monitoring of hydrodynamics and sediment transport in relation to marine aggregate extraction in a far offshore zone. Overall aim is to increase process and system knowledge of this area, with a particular focus on the compliancy of the extraction activities with respect to the European Marine Strategy Framework Directive. More specifically changes in seafloor integrity and hydrographic conditions will be assessed. An important parameter is the bottom shear stress, with knowledge needed on both natural and anthropogenically-induced variability. Results will be used for the validation of mathematical models, necessary for impact quantification. During this campaign, focus is on seabed mapping using acoustic surveying techniques complemented with terrain validation, as well as water column measurements for which cooperation is set-up with FPS-CSS and the TURBEAMS project members.

VLIZ, UGent, RBINS-OD Nature, FPS-CSS – TURBEAMS

TURBEAMS aims to establish a method to retrieve 3D information of turbidity and/or SPM in the Belgian part of the North Sea, which will be a great advantage compared to the 1D (Niskin samples) and 2D (ADCP profiles) data gathered nowadays. Within TURBEAMS, we will collect co-located datasets of the acoustic instruments of the RV Belgica (EM2040 multibeam, ADCP workhorse, EK80) and a selection of in-situ SPM and turbidity sensors (Video Plankton Recorder, LISST, OBS). Sensor frames will be tracked underwater using the onboard Hipap system. By means of extensive statistical analyses, a number of empirical relationships will be determined, allowing the conversion of multibeam backscatter values into quantitative SPM and/or turbidity volumes.

RBINS-OD NATURE-VVL-MSFD Seafloor Integrity

Within Europe's Marine Strategy Framework Directive (MSFD), progress towards Good Environmental Status (GES) needs monitoring in a most time- and cost-effective way. For the GES descriptor 6, seafloor integrity, multibeam technology in combination with sampling and visual observations is used to detect changes in the spatial extension and distribution of seafloor habitats.

RBINS-OD NATURE-VVL/UGent – TRAINING OF STUDENTS OCEANS AND LAKES

Training of students in the framework of the interuniversity Msc programme Oceans and Lakes (cursus 'In-situ and remote sensing tools in Aquatic Sciences', Lead tutor Van Lancker). University of Brussels, Ghent University and University of Antwerp.

RMA-OL Environmental Screening for Innovative Solutions in Naval Mine Countermeasures

This program covers several different scientific projects, founded by the Royal High Institute for Defence, all related to the new concept of naval mine countermeasures NMCM. The latter mainly focus on the safety of the operators and the effectiveness of the monitoring survey, using unmanned autonomous systems simultaneously and remotely. These systems are expected to be equipped with state-of-the-art acoustic, magnetic or optical sensors and should be adaptable to different environmental and operational conditions. A better understanding of the underwater environment is therefore crucial for the autonomous operation of the different unmanned vehicles and for the evaluation of their sensors performance. Acoustical and geotechnical characterization of the seafloor are foreseen for planning and evaluation of NMCM, object burial prediction and to implement new techniques in naval coastal and harbour protection. Different types of sensors will be considered: side-scan sonar, high-resolution low- and high-frequency synthetic aperture sonar, MBES and gradiometer. An improved approach for mine burial assessment will be developed, considering not only the sediment composition but also the geotechnical response of the sea bottom and discriminating the results versus potential sea mines typology. Therefore, two different free fall penetrometers will be used in dedicated test area in the Belgian coastal zone and their performances and measurements will be validated against subbottom profile recording, ground truthing, and video imaging. Possibly also dedicated tests with divers and

exercises mine will be performed. The collected data will be collocate and interrogate using a data centric architecture to facilitate real time data interoperability and data integration.

RBINS-OD Nature-KP (ICOS)

The AUMS (Autonomous Underway Measurement System) system is inspired by the success of similar systems deployed on various ships of opportunity in the framework of the European Union FerryBox project (www.ferrybox.org). The instrumentation will greatly enhance the continuous oceanographic measurements made by RV Belgica by taking advantage of the significant technological improvements since the design of the existing (salinity, temperature, fluorescence) systems (cfr. ICOS Standards). In particular, many new parameters can now be measured continuously including important ecosystem parameters such as nitrate, ammonia, silicate, dissolved oxy-gen and CO2, turbidity, alkalinity and phytoplankton pigments. In addition, the new equipment allows automatic acquisition and preservation of water samples, rendering RV Belgica operations significantly more efficient by reducing onboard human resources. Data will be available in near real-time via RBINS-OD Nature's public website (http://odnature.naturalsciences.be/belgica/en/odas) and following quality control, from the Belgian Marine Data Centre. Since 2015, the AUMS data are also delivered to the EC ESFRI project ICOS.

4. RESEARCH AREA – SAMPLING STATIONS

4.1. SEDIMENT PLUME MEASUREMENTS

The main focus of the campaign involves water column measurements of sediment plumes using a multidisciplinary approach. These measurements will be executed by FPS-CSS, RBINS OD Nature and the participating scientists from the TURBEAMS project.

Detailed description of the experiment:

The experimental design has 3 steps (see fig 4.1.):

1. The sedimentological analysis of the source of the sediment in the plumes. This is planned before the actual plume measurements, along the future track of the extraction vessel. The exact positions and number of sampling points will be defined based on the preparatory contacts with the extraction vessels. The samples will be collected with the NIOZ boxcorer to guarantee the most complete and extensive sedimentological information. Simultaneous with the sampling, acoustic water column (WC) and backscatter (BS) data from the EM2040D Multibeam echosounder (MBES) will be collected.
2. Information on the extraction activity (start and end of the pumping, overflow, screening) and on the sediments in the overflow. This will either be collected by a scientist on board the extraction vessel, or communicated by the extraction vessel crew, depending on the practicality of the organizational solution.
3. Sediment plume measurements and sampling with the RV Belgica. Once the extraction vessel creates a sediment plume, the RV Belgica will either position itself above the plume, or navigate across the plume following a zigzag pattern or along a transversal track. The exact trajectory will be decided collectively before the start of the experiment, but can be adjusted during the measurements, depending on circumstances. The measurements and navigation will be directed from the bridge, in direct communication with three teams of scientists:
    a. One is based in the operational center, responsible for all acoustic (EM2040D and EK80) measurements and the real time geographical follow-up of the involved vessels and the instantaneous modelled plume position, composition and dimensions (using QGis software).
    b. The second team will operate from the wet lab and direct all in-situ measurements in the sediment plume (continuous deployment of the carousel, water sampling with Niskin bottles, acoustic and optical sensors on the carousel, and hull-mounted ADCP WHM600).
    c. In addition to the prior set up from campaign 2022-27, simultaneous measurements with the Video Plankton Recorder (VPR) are planned from the aft deck and will be operated by a third team.

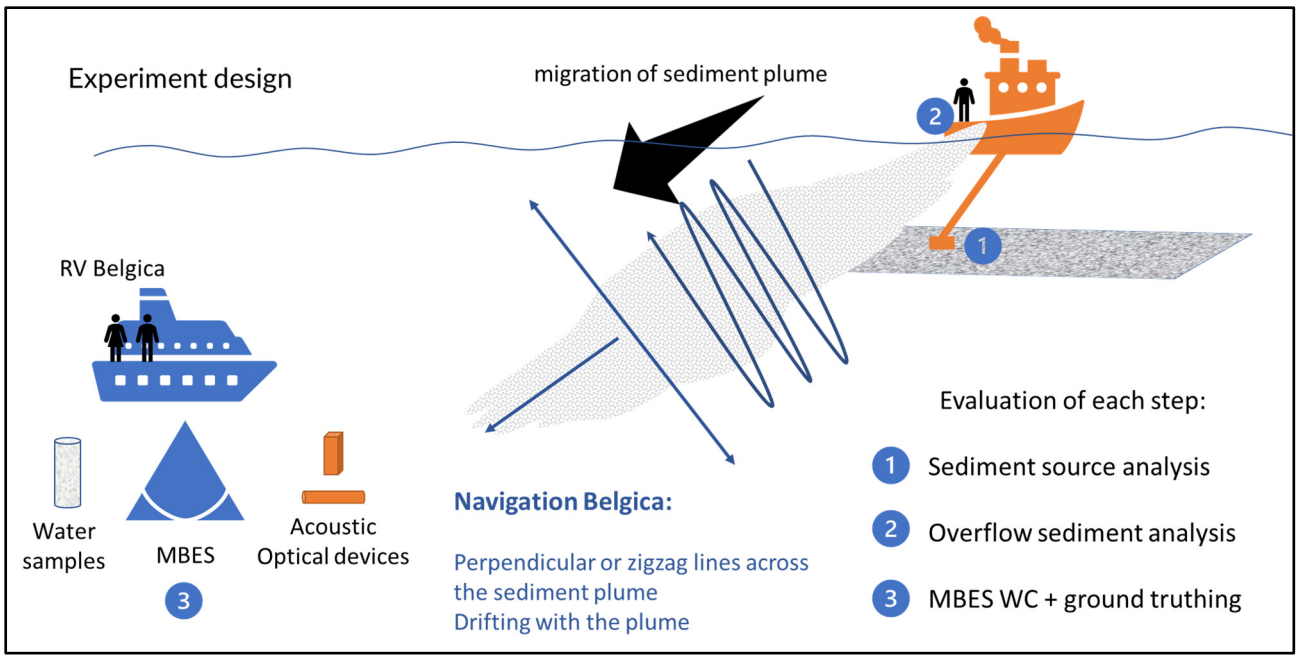

Figure 4.1.1. Design of the experiment

The organization prior and during the actual plume experiment is described in the following overview:

Sediment plume experiment on RV Belgica

Preliminary:

1. planning of the strategy of experiment (how and where will the RV Belgica measure?)
2. final tuning of carousel and instruments on it
3. preparation of MBES, EK80, WHM600, and other hull mounted equipment
4. definition of role of individual scientists in the experiment
5. communication of plan to crew

Communications during experiment via:

1. Walkie-Talkies: test of channel and reception before experiment
2. Online via open document (incl. timings IN/OUT, anomalies)
3. Sharing of information (QGis, MBES WC) via screens on Bridge and Lab, and observations

Tasks:

1. Bridge Team:
    i. Gather information from extraction vessels
    ii. Visual detection of extraction vessel and plume - recorded with on board cameras if possible
    iii. Follow-up of MBES WC and QGis on screen
    iv. Based on i to iii and planning, determine the position/course for the RV Belgica
    v. Communication with navigation crew
    vi. Feedback to OC team and Lab and Deck teams on relative location of RV Belgica, extraction vessel and visual plume (via walkie-talkie and Open Doc)
    vii. Determine the moment for deployment of Carousel/VPR and communicate it to Navigation Crew and Lab and Deck Team
    viii. Define and communicate the water sampling strategy to Lab Team

2. OC Team:
    i. Control of MBES WC and EK80
    ii. Cartography of RV Belgica, extraction vessel and plume simulations in QGis
    iii. Feedback to Bridge team and Lab and Deck team on relative position of RV Belgica, extraction vessel and modelled plume (via walkie-talkie and Open Doc)

3. Lab Team:
    i. Control of carousel and its height in the water column
    ii. Control of all sensors on the carousel
    iii. Control of ADCP
    iv. Follow up of MBES WC and QGis on screen
    v. Communication with deck crew
    vi. Deploy the carousel and execute the water sampling strategy after communication from Bridge Team
    vii. Lab team to determine themselves the height and whether or not profiles are taken
    viii. Feedback to OC team and Bridge team on carousel deployment and water sampling (via walkie-talkie and Open Doc)
4. Deck Team:
    i. Control of VPR and its height in the water column
    ii. Control of all sensors on the VPR frame
    iii. Follow up of MBES WC and QGis on screen
    iv. Communication with deck crew
    v. Deploy the VPR after communication from Bridge Team
    vi. Feedback to OC team and Bridge team on VPR deployment and water sampling (via walkie-talkie and Open Doc)

Instrumentation (to be deployed simultaneously):

- RV Belgica's SBE9plus CTD carousel, mounted with:
    - Niskin bottles for water sampling and filtration (SPM, POC/PON, salinity)
    - Aquascat 1000R (acoustic backscatter) for particle concentration
    - LISST 200x for in-situ particle size
    - LISST HOLO for particle nature and shape
    - OBS and Seapoint (optical backscatter) for fine-particle concentration

  The carousel will be kept in water during the entire experiment and descended to app. ⅔ of the depth
- Hull-mounted acoustic doppler current profiling (RDI Workhorse Mariner ADCP 600 kHz)
- GEA Westfalia seawater centrifuge (connected to seawater pump) to sample material in suspension
- Sea-Bird SBE21 thermosalinograph
- AUMS (Autonomous Underway Measurement System)
- Multibeam depth and water column data and single beam EK80
- Aquascat 1000R (COPCO) deployed next to the EM2040D drop keel, allowing it to measure inside the EM2040D's water column window
- Video Plankton Recorder (VPR) with winch on aft deck. The VPR will be equipped with OBS and LISST-200X (both from VLIZ)
- Fixed on board cameras to provide an overview of the sea surface surrounding the RV Belgica (for surficial plume detection)

Sampling

- NIOZ boxcoring for grain-size characterization at the sites of investigation

The experiment is planned in close collaboration with extraction companies and Departement Mobiliteit en Openbare Werken (MOW). Based on the already planned extraction activities for MOW in the period (2 to 3x day) the location will be sector 4a on the Noordhinder. Alternative locations are the extraction areas on the Thorntonbank and Oostdyck (see fig. 4.2.). Due to the unpredictability of the sand extraction activities, the exact location and timing can only be communicated a short period (maximum a couple of days) before the campaign. In addition, seen the innovative character of the experiment, adjustments to the proposed survey design will be discussed on board in close collaboration with the crew.

During this transit, we can already assess the possible interference between the acoustic sensors that will be used: record the EM2040 in passive mode all the time, switch on the other sensors one by one. If there is a problem with the navigation sounder, it must be switched off. If the waterline of the EM2040 is correctly entered in the inputs, the vertical depth of the EM2040 is correct and can replace the single beam echo sounder for navigation.

During nighttime EM2040D measurements will be conducted in the exploration zone (see fig. 4.2.). The exact location of navigation lines depends on results of prior campaigns (2022-32) and will be communicated on board.

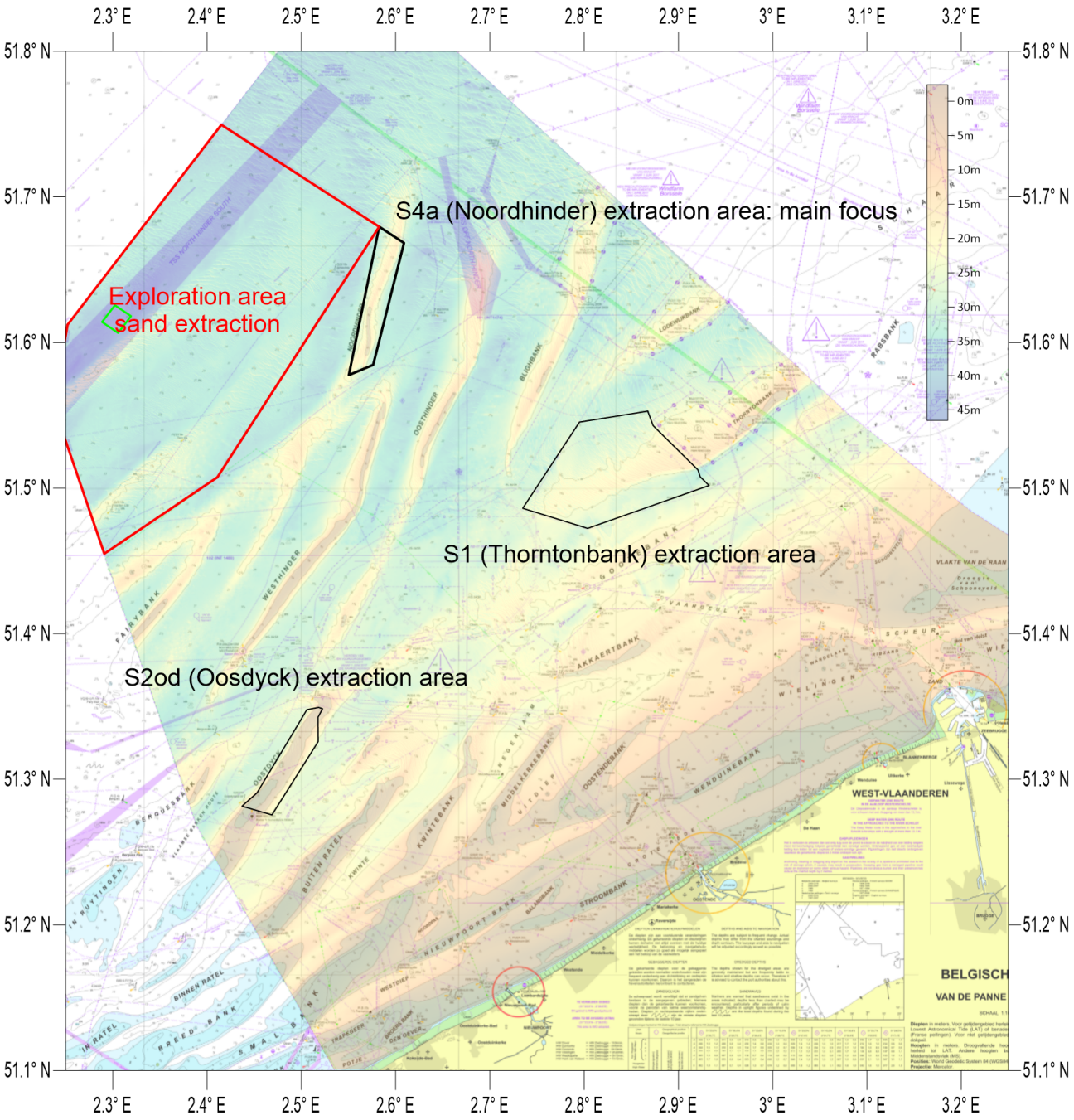

Figure 4.1.2. Location of the plume experiments (in black) and multibeam surveying during night time (in red). Background map: Vlaamse Hydrografie/Dienst Continentaal Plat.

4.2. RBINS-OD NATURE-VVL-ZAGRI/MOZ4

Sediment characterization Bligh Bank

- Multibeam bathymetry and backscatter as reconnaissance of the sediment sampling
- Reineck boxcoring
- Kongsberg HiPAP 502 High Precision Hydro-Acoustic Position Reference System

Table 4.2.1. Preliminary multibeam tracks on the Bligh Bank. Multibeam lines are 5000 m long (NNE-SSW), resulting in a survey time of 20' + turning time of 10 to 15' per track. Parallel lines need to be sailed from A (sandbank crest) to B (trough) via Lee slope, and to C (trough) via Stoss slope. Number of parallel lines depend on the multibeam swath and water depth.

ID	Lat (DD MM,mmm)	Lon (DD MM,mmm)
A_start	51 33.735	2 44.756
A_end	51 36.203	2 46.516
B_start	51 33.517	2 45.548
B_end	51 35.985	2 47.308
C_start	51 34.062	2 43.569
C_end	51 36.531	2 45.327

Table 4.2.2. Preliminary sampling (i.e. Reineck box core or Van Veen) locations on the Bligh Bank. Positions may be adapted and prioritized based on the acquired multibeam bathymetry and backscatter, and on the time schedule. Locations are at average 500 m (NW-SE) and 1200 to 1400 m (NNE-SSW) apart, resulting in a sampling + travel time of 10 to 15' per sample. Total +/- 6h.

	Lat (DD MM,mmm)	Lon (DD MM,mmm)
BB1	51 36.274	2 45.580
BB2	51 36.138	2 45.973
BB3	51 35.999	2 46.366
BB4	51 35.871	2 46.673
BB5	51 35.734	2 47.024
BB6	51 35.651	2 44.974
BB7	51 35.519	2 45.554
BB8	51 35.417	2 45.950
BB9	51 35.247	2 46.191
BB10	51 35.187	2 46.681
BB11	51 35.030	2 44.372
BB12	51 34.880	2 45.104
BB13	51 34.743	2 45.418
BB14	51 34.711	2 45.776
BB15	51 34.639	2 46.223
BB16	51 34.175	2 43.808
BB17	51 34.101	2 44.502
BB18	51 34.009	2 44.948
BB19	51 33.977	2 45.256
BB20	51 33.838	2 45.644
BB21	51 33.559	2 43.370
BB22	51 33.465	2 43.948
BB23	51 33.362	2 44.399
BB24	51 33.290	2 44.837
BB25	51 33.238	2 45.283

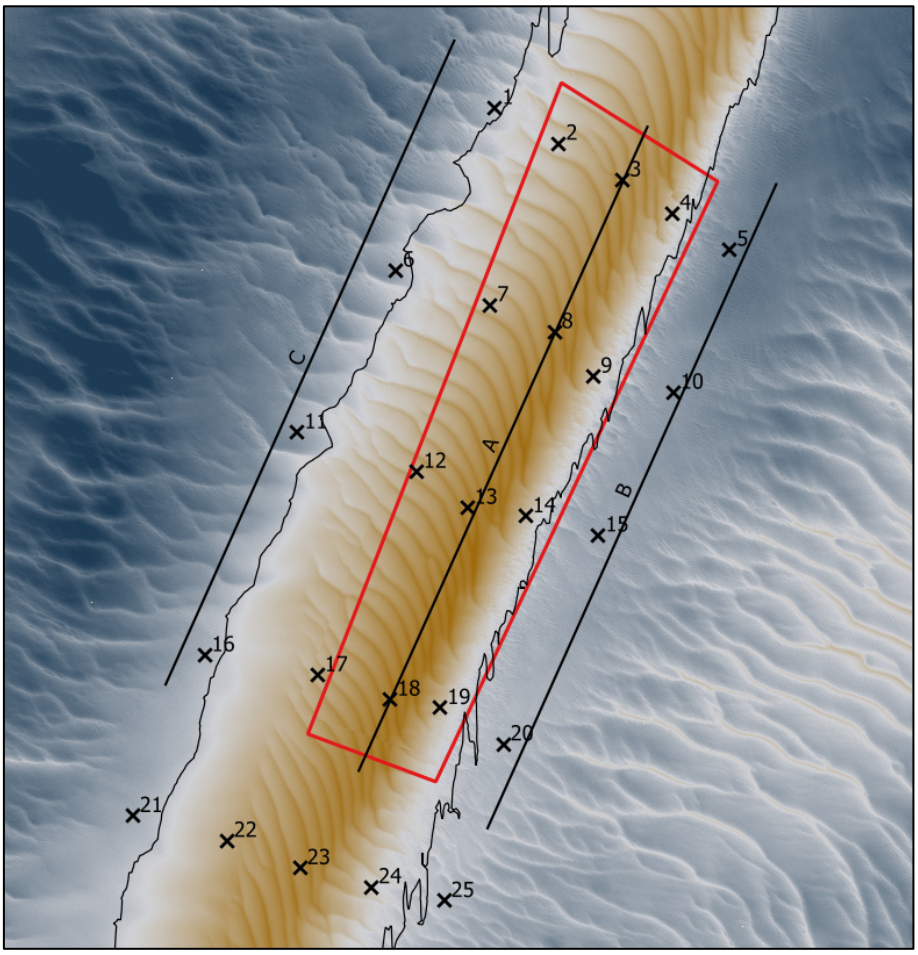

Figure 4.2.1. Overview of preliminary multibeam tracks on the sandbank crest (A) and in the trough (B and C), and of preliminary sampling locations on the Bligh Bank. A number of parallel lines need to be sailed between crest and trough dependent on the multibeam swath and water depth. Sampling locations may be adapted and prioritized based on the acquired multibeam bathymetry and backscatter, and on the time schedule.

4.3. RBINS-OD NATURE-VVL-MSFD Seafloor Integrity

Seabed mapping along the MSFD Seafloor Integrity network SI-NET

SI-NET is a network of transects for acoustic surveying that has been designed to validate sediment changes (mud, sand, mixed, coarse sediment) along the Belgian part of the North Sea. It is a network of opportunity that can be used to sail from A to B, however with the advantage that time series are build up through time.

Focus of this campaign is to select a few of the SI-NET transects that particularly cross the mud-sand transition. In those transition zones first a series of Seabed Profile Imagery (SPI) will be taken, flowed by boxcores at selected locations.

- Transect mapping using:
    - Drop keel: Kongsberg EM2040-04 Dual RX, Single Swath Shallow Water Multibeam Echosounder
    - Hull-mounted: TOPAS PS18 Parametric Sub-Bottom Profiler
- A selection of SPI/boxcores near some of the SI-NET points (location based on new acoustic results)
    - Boxcorer NIOZ model (alternatively the Reineck boxcorer)
    - Sediment Profile Imaging (SPI) (VLIZ)

Table 4.3.1: Coordinates (WGS84) of the monitoring network on seafloor integrity (SI-NET). Focus of this campaign is the offshore part. The coastal transects will only be considered in case of adverse weather. The sailing order will be decided on board.

Main Area	Transect point	Type	ID	LAT DD	LAT MM.mmm	LON DD	LON MM.mmm
MOW1	x		NN20	51	21.500	3	7.500
Oostende	x		EE12	51	14.709	2	54.988
Transect	x		AA15	51	17.382	2	49.768
Transect	x		GG20	51	21.258	2	57.749
Transect	x		KK23	51	24.472	3	3.386
Transect	x		OO21	51	22.785	3	9.763
Transect	x		OO22	51	23.509	3	8.563
Transect	x		P20	51	21.166	2	34.855
Transect	x		PP21	51	22.163	3	10.819
Transect	x		V22	51	23.056	2	42.968
Transect	x		Z19	51	20.282	2	49.005
Zeeland Banks		Full-coverage box	AA24	51	25.133	2	49.202
Zeeland Banks		Full-coverage box	AA26	51	27.105	2	49.378
Zeeland Banks		Full-coverage box	CC27	51	27.938	2	52.925
Zeeland Banks		Full-coverage box	CC29	51	29.486	2	52.197
Zeeland Banks	x		FF30	51	30.198	2	56.368
Zeeland Banks	x		GG29	51	28.972	2	58.273
Zeeland Banks		Full-coverage box	Y24	51	25.415	2	47.451
Zeeland Banks	x		Y27	51	28.027	2	47.218
Zeeland Banks		Full-coverage box	Z24e	51	24.733	2	48.171
Zeeland Banks		Full-coverage box	Z24w	51	25.205	2	48.528
Zeeland Banks		Full-coverage box	Z25	51	25.815	2	48.481
Zeeland Banks		Full-coverage box	Z28	51	28.653	2	48.650
Flemish Banks	x	Full-coverage box	M16	51	17.933	2	30.897
Flemish Banks		Full-coverage box	N15	51	17.594	2	31.519
Flemish Banks	x	Full-coverage box	N17	51	19.112	2	32.233
Flemish Banks		Full-coverage box	O17	51	18.780	2	32.874
Flemish Banks	x		Q13	51	15.419	2	35.473
Flemish Banks	x	Full-coverage box	R14	51	16.709	2	37.589
Flemish Banks		Full-coverage box	R15	51	16.864	2	37.132
Flemish Banks		Full-coverage box	R16	51	17.971	2	37.993
Flemish Banks	x	Full-coverage box	S16	51	17.828	2	38.492
Flemish Banks	x		U19	51	20.682	2	41.228
Hinder Banks	x		L22	51	23.553	2	29.590
Hinder Banks	x		L23	51	23.994	2	28.643
Hinder Banks	x		M22	51	23.375	2	29.987
Hinder Banks	x		O27	51	27.371	2	32.819
Hinder Banks	x		P27e	51	27.329	2	34.914
Hinder Banks	x		P27w	51	27.341	2	34.300
Hinder Banks	x		R27	51	27.270	2	37.951
Anchor zone south	x	Full-coverage box	P22	51	23.433	2	34.246
Anchor zone south		Full-coverage box	P23	51	23.953	2	34.247
Anchor zone south	x	Full-coverage box	Q22	51	23.452	2	35.723
Anchor zone south		Full-coverage box	Q23	51	23.953	2	35.723

OWF-PEZ	x		E23	51	24.405	2	18.964
OWF-PEZ	x		F26	51	26.366	2	21.407
OWF-PEZ	x		F27	51	27.610	2	20.910
OWF-PEZ	x		H25	51	26.094	2	24.155
OWF-PEZ	x		I25	51	25.927	2	24.510
OWF-PEZ	x		J24e	51	24.940	2	26.613
OWF-PEZ	x		J24w	51	25.209	2	26.042
OWF-PEZ	x		J27w	51	27.515	2	25.634
OWF-PEZ	x		J27e	51	27.505	2	26.141
OWF-PEZ	x		L27	51	27.448	2	28.864
OWF-PEZ	x		M27	51	27.429	2	29.803
Coastal	x		BB14	51	16.216	2	51.337
Coastal	x		LL17	51	19.197	3	5.622
Coastal	x		LL18	51	19.967	3	4.998
Coastal	x		M4	51	7.772	2	31.167
Coastal	x		NN31	51	31.111	3	8.451
Coastal	x		P7	51	10.129	2	35.272
Coastal	x		PP29	51	29.042	3	10.658
Coastal	x		QQ24	51	25.101	3	12.125
Coastal	x		R6	51	9.485	2	37.604
Coastal	x		SS25	51	25.627	3	14.375
Coastal	x		V12	51	14.532	2	42.455
Coastal	x		Y10	51	13.339	2	46.918
Coastal	x		Y9	51	12.022	2	47.706

Line M16-Q13 is the start line of a full-coverage box as well (direction south).

An area of particular interest is the aquaculture zone south of Nieuwpoort Bank where SPI imaging is targeted.

Table 4.3.2: Coordinates (WGS84) for SPI observations south of Nieuwpoortbank (priorities to be set on board). Depth of the points are all between 10m and 14.5m LAT.

id	Lat/Lon DD MM.mmm (WGS84)		Priority
TC_W	51°10.086	2°36.595	1
T_W	51°09.565	2°36.497	(1)
TC_E	51°10.462	2°38.667	1
T_E	51°10.324	2°38.476	(1)
C	51°10.282	2°38.532	
0	51°11.009	2°40.547	
75	51°11.023	2°40.086	2
150	51°11.037	2°40.118	2
225	51°11.051	2°40.149	
325	51°11.067	2°40.191	
425	51°11.089	2°40.233	
525	51°11.101	2°40.275	
675	51°11.136	2°40.338	
825	51°11.164	2°40.401	2

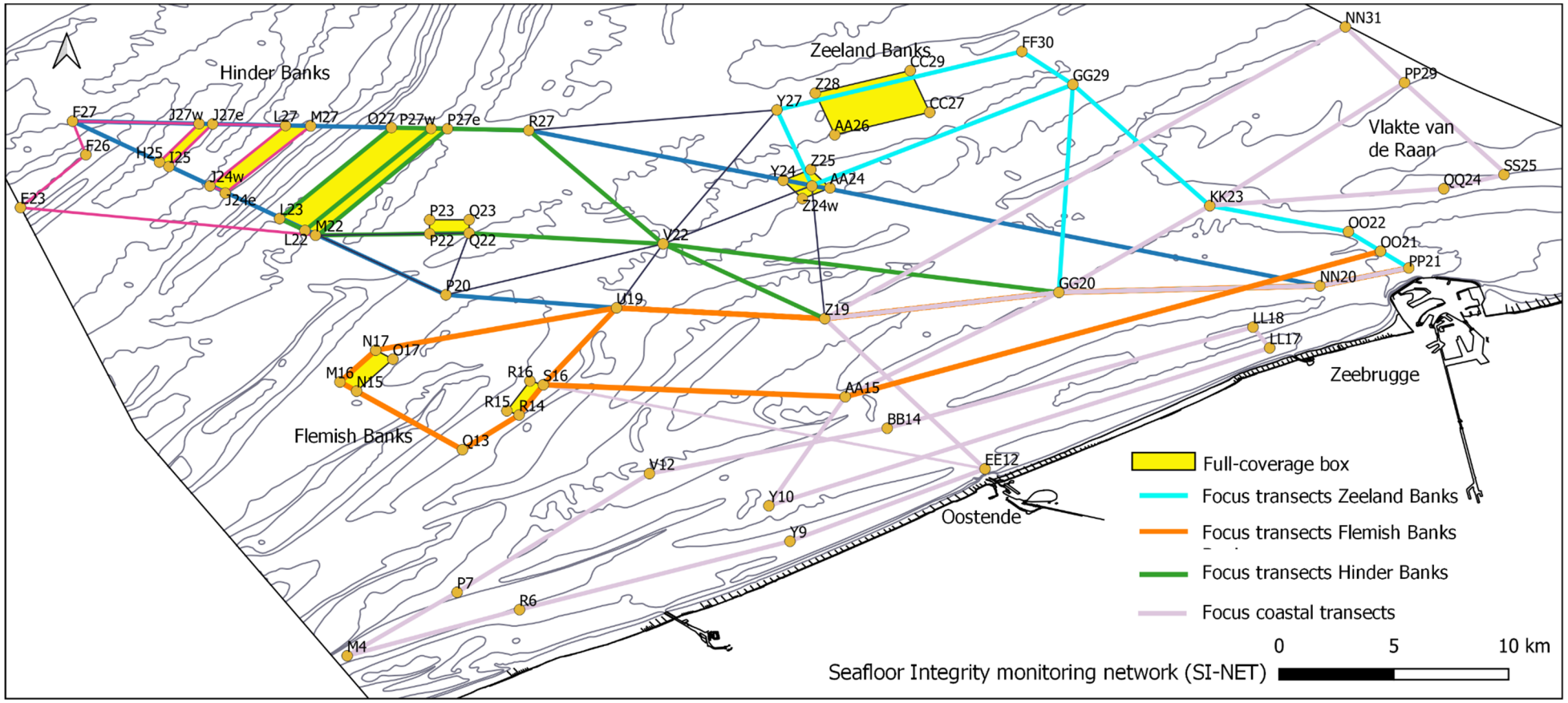

Figure 4.3.1: Monitoring network on seafloor integrity (SI-NET).

4.4. RMA-OL

Priority 1

Fig 4.3.1 shows a test area and 3 lines in it. The area is in the vicinity of the port and it is really shallow. All operations will be performed during daylight and high water.

1) Box Cores 1-10 (estimated time 5h) Table 4.3.2 shows the coordinates for the box cores.

2) STING measurements 1-10, 19-20-21(estimated time 3.5h) Table 4.3.2 shows the coordinates for the STING (ideally during slack water)

3) MB recording together with Sub-bottom profile for test AREA MOW 1. At least 4 hours recording**.**

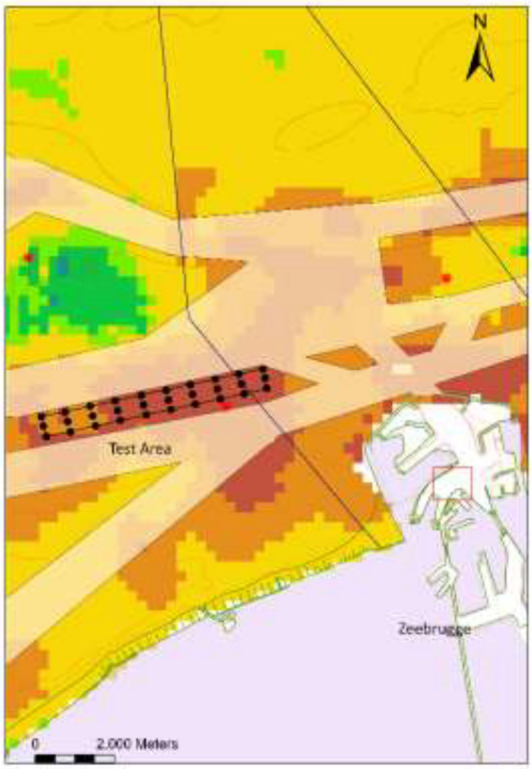

Figure 4.3.1 Test Area MOW1

Table 4.4.1: Coordinates Test Area (Box 1) (4h)

BOX 1		Lat	Long
	A	51 21,49 N	3 3,02 E
	B	51 22,15 N	3 7,89 E
	E	51 21,87 N	3 7,89 E
	F	51 21,22 N	3 3,13 E

Table 4.4.2: Coordinates STING (3.5h) and Box Coring (5h)

ID Sting Measurements		Lat	Long
1		51 21,49 N	3 3,02 E
2		51 21,56 N	3 3,55 E
3		51 21,64 N	3 4,10 E
4		51 21,71 N	3 4,64 E
5		51 21,79 N	3 5,21 E
6		51 21,86 N	3 5,76 E
7		51 21,93 N	3 6,29 E
8		51 22,00 N	3 6,84 E
9		51 22,07 N	3 7,36 E
10		51 22,15 N	3 7,89 E

11		51 21,36 N	3 3,07 E
12		51 21,42 N	3 3,60 E
13		51 21,50 N	3 4,15 E
14		51 21,58 N	3 4,69 E
15		51 21,66 N	3 5,27 E
16		51 21,72 N	3 5,81 E
17		51 21,80 N	3 6,35 E
18		51 21,87 N	3 6,89 E
19		51 21,94 N	3 7,42 E
20		51 22,02 N	3 7,93 E
21		51 21,22 N	3 3,13 E
22		51 21,29 N	3 3,66 E
23		51 21,37 N	3 4,21 E
24		51 21,44 N	3 4,75 E
25		51 21,52 N	3 5,33 E
26		51 21,59 N	3 5,88 E
27		51 21,66 N	3 6,40 E
28		51 21,73 N	3 6,95 E
29		51 21,80 N	3 7,48 E
30		51 21,87 N	3 7,97 E

Priority 2 (15h)

Fig 4.4.2 shows the BigGino area and BigSouth for the measurements with MBES and sub-bottom profiler. Tracks will be defined on board (continuation of work started during campaigns 2022.)

1) Estimated time for **sub-bottom profiler and MBES** (measurements on BigGino): 15h. Night or daylight.

Figure 4.4.2 Priority 2: BigGino area and BigSouth box

Table 4.4.3: Coordinates for measurements.

BigSouth

Lat (DD MM,MMM)	Long (DD MM,MMM)
51°27.310	2°42.360
51°26.492	2°43.185
51°27.853	2°43.587
51° 27.241	2°44.56

BigGino

Lat (DD MM,MMM)	Long (DD MM,MMM)
51°28.030	2°41.240
51°29.347	2°43.874
51°27.885	2°45.84
51°26.492	2°43.185

4.5. RBINS-OD NATURE-VVL/UGent – TRAINING OF STUDENTS OCEANS AND LAKES

Students participate in the research activities of the above-mentioned programs of RBINS.

5. OPERATIONAL COURSE

All times are given in local time (UTC+1). All coordinates in WGS84. Tentative program; priority or observations may change according to tidal and weather conditions and/or technical constraints. Tidal measurements with reference to Zeebrugge. Sunrise around 6h45. Sunset around 19h.

Part A

On all locations of the sediment plume measurements, additional measurements of the natural background of sediment concentrations will be performed. Before sediment plume measurements samples of the seabed sediments will be collected.

The timing of the sediment plume measurements will depend on the activity of the cooperating extraction vessel and will be decided on board. This will impact the scheduling of the other activities. Therefore the drafted schedule is purely indicative. During the preparation of the experiment it will be adjusted and all changes communicated to RBINS-OD Nature and RV Belgica crew.

Each evening at 6:00PM a meeting between the scientific teams and the Master will be organized to establish a final planning for the following night and day.

Part B

Surveying and sampling of RBINS monitoring network SI-NET can be adjusted according to the prevailing water levels.

Part A: 17-20/3/2023

Friday 17/03/2023

HW 09h31; LW 16h04; HW 22h18

08:00h-10:00h	Zeebrugge Embarkation equipment and personnel
11:00h	Departure from Zeebrugge Transit to Hinderbanken area (if time efficient along offshore SI-net network of transects; to be communicated onboard) During this transit, the possible interference between the acoustic sensors that will be used will be assessed
14:00h-19:00h	Preparation of sediment plume experiment Sediment sampling on sediment plume location
19:00h-03:00h	EM2040D measurements (FPS-CSS) on the southern part of sector 4a (Noordhinder) and/or the exploration area.

Saturday 18/03/2023

LW 04h43; HW 10h54; LW 17h13; HW 23h26

03:00h-05:00h	Sediment plume experiment (limited to acoustics) during extraction by Pedro Alvares Cabral on the northern part of sector 4a (Noordhinder).
05:00h-09:00h	EM2040D measurements (FPS-CSS) on the southern part of sector 4a (Noordhinder) and/or the exploration area.
09:00h-14:30h	*Preparation of the sediment plume experiment* *Sediment sampling on sediment plume location* *To be confirmed*
14:30h-15:30h	Preparation of the sediment plume experiment
15:30h-17:30h	Sediment plume experiment during extraction by Pedro Alvares Cabral on the northern part of sector 4a (Noordhinder).
17:30h-03:00h	EM2040D measurements (FPS-CSS) on the southern part of sector 4a (Noordhinder) and/or the exploration area. Evaluation of the sediment plume experiments

Sunday 19/03/2023

LW 05h46; HW 11h54; LW 18h10

04:00h-06:00h	Sediment plume experiment (limited to acoustics) during extraction by Pedro Alvares Cabral on the northern part of sector 4a (Noordhinder).
06:00h-09:00h	EM2040D measurements (FPS-CSS) on the southern part of sector 4a (Noordhinder) and/or the exploration area.
09:00h-15:15h	*Preparation of the sediment plume experiment* *Sediment sampling on sediment plume location* *To be confirmed*

15:15h-16:15h Preparation of the sediment plume experiment

16:15h-18:15h Sediment plume experiment during extraction by Pedro Alvares Cabral on the northern part of sector 4a (Noordhinder).

18:15h-05:00h EM2040D measurements (FPS-CSS) on the southern part of sector 4a (Noordhinder) and/or the exploration area.
Evaluation of the sediment plume experiments

Monday 20/03/2023

HW 00h15; LW 06h37; HW 12h39

05:00h-08:00h Transit to Zeebrugge (if time efficient along offshore SI-net network of transects; to be communicated onboard)

08:00h Arrival Zeebrugge
Disembarkation of instruments and personnel

End of Part A of the campaign

Part B: 20-24/3/2023

08h-11h Zeebrugge
Change of personnel: disembarkation FPS Economy, and TURBEAMS teams VLIZ/UGent; RBINS Benjamin Van Roozendael, Katrijn Baetens, Pauline Denis, and Kyra Gesquiere
Embarkation RBINS-OD Nature Louise Delhaye
Embarkation RMA team

Embarkation Group 1 students **(on board latest at 09h30)**

Transit to MOW1

11h30-15h RMA: MB recording together with Sub-bottom profile for test AREA MOW 1
HW: 12h39

15h30-16h30 RMA: STING measurements 1-10, 19-20-21 (first part of the estimated time 3.5h) AREA MOW 1
slack

Transit nearshore-offshore

17h-19h RBINS: SI-NET transect NN20-AA24
LW 18h56 Around AA24 (south of Gootebank) a sequence of SPI imagery in one direction of the transect. Upon return boxcores at a selection of locations. Locations to be determined from new multibeam.

18h30-19h00 Meeting scientific team

Transit towards Bligh Bank

20h-00h RBINS Acoustic surveying Bligh Bank (4h)

Tuesday 21/03/2023

HW 00h56; LW 07h21; HW 13h20 (4.67); LW 19h37

00h-04h RMA: Acoustic surveying Big Gino/Big South (4h)

Transit to Kwinte Bank, KWGS area (via Y27-V22-U19-S16)

05h-06h30 RBINS: Calibration lines Kwinte Bank KWGS (parallel lines to S16-R14 in westward direction)

06h30-11h30 RBINS: Acoustic surveying along SI-NET transects to MOW1 (via S16-U19-Z19-GG20-NN20)
LW 07h21 Around GG20 a sequence of SPI imagery in one direction of the transect. Upon return boxcores at a selection of locations. Locations to be determined from new multibeam.

12h-14h RMA: Continuation RMA: MB recording together with Sub-bottom profile for test AREA MOW 1
HW: 13h20

14h-16h RMA: Boxcoring MOW1 area (#5)

16h30-17h30 RMA: STING measurements 1-10, 19-20-21 (second part of the estimated time 3.5h)
slack

Transit to Bligh Bank via SI-NET transects 0021-OO22-KK23-GG29-FF30-Bligh Bank

18h00 - 18h30 Meeting scientific team

19h-22h RBINS: Bligh Bank Reineck boxcoring
LW 19h37

22h-02h RBINS: Acoustic surveying Bligh Bank (3h)

Wednesday 22/03/2023

HW 01h36; LW 08h03; HW 14h01 (4.81m); LW 20h18

Transit to area north of Gootebank

02h-06h RMA: Acoustic surveying Big Gino/Big South (4h)

Transit to Zeebrugge

08h-11h T&G at Zeebrugge
LW 08h03
Switch RBINS personnel
Disembarkation Group 1 students
Embarkation Group 2 students **(on board latest at 09h30)**

12h-14h30 RBINS: Surveying along SI-NET transect OO21-AA15 (back and forth)
HW: 14h01 Along the transect a sequence of SPI imagery in one direction of the transect. Upon return boxcores at a selection of locations. Locations to be determined from new multibeam.

14h30-16h30 RMA: Boxcoring MOW1

17h-18h RMA: STING measurements 1-10, 19-20-21 (third part of estimated time 3.5h) MOW1
Slack

18h30-19h00	Meeting scientific team

Transit to Bligh Bank via SI-NET transect NN20-GG20-V22-Bligh Bank

20h-01h RBINS: Acoustic surveying Bligh Bank
LW: 20h18

Thursday 23/03/2023

HW 02h16; LW 08h45; HW 14h42 ***(4.86m);*** *LW 20h59*

01h-05h RMA: Acoustic surveying Big Gino/Big South (4h)

Transit to North Vlakte van de Raan

06h-10h RBINS: Acoustic surveying North of Vlakte van de Raan (KK26-KK28)
LW 08h45 West of KK26 a sequence of SPI imagery in one direction of the transect. Upon return boxcores at a selection of locations. Locations to be determined from new multibeam.

10h-11h30 RBINS: SI-NET transects KK26-KK23-OO22-OO21

11h30-13h30 RMA: Continuation MB recording together with Sub-bottom profile for test AREA MOW 1

14h-17h T&G Zeebrugge
HW: 14h42 Disembarkation Group 2 students
Switch RBINS personnel.
Embarkation Group 3 students **(on board latest at 15h30)**

17h30-18h30 RMA: STING measurements 1-10, 19-20-21 (fourth part of estimated time 3.5h) MOW1

18h30-19h00	Meeting scientific team

Transit to Bligh Bank for Reineck boxcoring

20h-23h RBINS: Bligh Bank Reineck boxcoring
LW 20h59
23h- RBINS: Acoustic surveying Bligh Bank

Friday 24/03/2023

HW 02h58 (4.82m); LW 09h27; HW 15h25

-01h End Bligh Bank

Transit to north of Gootebank

02-06h RMA: Acoustic surveying Big Gino/Big South (4h)

Transit to Nieuwpoort bank

08h-11h RBINS: SPI imaging south of Nieuwpoortbank
LW 09h27

11h30-15h RBINS: Acoustic surveying following SI-NET transect P7-V12-BB14
Around BB14 a sequence of SPI imagery in one direction of the transect. Upon return boxcores at a selection of locations. Locations to be determined from new multibeam.
BB14-Zeebrugge (most efficient connection to transect AA15-OO21)

Sail to Zeebrugge

15h30 Arrival Zeebrugge
HW: 15h25 Disembarkation of instruments and personnel

End of campaign

6. OCCUPATION OF SCIENTIFIC SPACES

Deck 9: Crow's Nest	
Deck7: Wheelhouse – Chief Scientist Desk	FPS-CSS; RBINS-OD Nature; TURBEAMS team
Deck 6: Operational Center	A: FPS-CSS; RBINS-OD Nature; TURBEAMS team B: RBINS-OD Nature (+students), RMA
Deck 6: Scientific Lab	A: FPS-CSS; RBINS-OD Nature; TURBEAMS team B: RBINS-OD Nature (+students), RMA
Deck 6: Forward Deck	B: RMA
Deck 4: Lab 1	A: RBINS-OD Nature: Filtration, Hach measurements B: RBINS-OD Nature (+students), RMA
Deck 4: Lab 2	
Deck 4: CTD Hangar	A: RBINS-OD Nature: water sampling
Deck 4: Wet Lab	A: RBINS-OD Nature; TURBEAMS team B: RBINS-OD Nature (+students), RMA
Deck 4: Science Hangar	
Deck 4: Diver's Store	
Deck 4: Starboard Deck	A: FPS-CSS; RBINS-OD Nature: sampling B: RBINS-OD Nature (+students), RMA
Deck 4: Aft Deck	A: RBINS-OD Nature; TURBEAMS team: sampling B: RBINS-OD Nature (+students), RMA
Deck 4: Seismic Room	A: TURBEAMS team: deck unit VPR
Deck 4: Aerosol Lab	
Deck 3: Clean Lab 3	
Deck 3: Wet Fish Lab	
Deck 3: Dry Fish Lab	
Deck 3: Freezer Room -20°C	
Deck 3: Cool Room +4°C	
Deck 3: Scientific Store	
Deck 2 & 1: AUMS Lab	

7. USE OF INFRASTRUCTURE AND INSTRUMENTATION

Equipment RV BELGICA:

Hydro-Acoustic Equipment	Hull mounted:	
	Kongsberg HiPAP 502 High Precision Hydro-Acoustic Position Reference System (5000 m)	x
	Drop Keel	
	Kongsberg EM2040-04 Dual RX, Single Swath Shallow Water Multibeam Echosounder (600 m)	x
	Kongsberg EK80 Scientific Split Beam Echosounder (> 5000 m)	x
	Teledyne RD Instruments Workhorse Mariner, 600 kHz ADCP (50 m)	x
	Hull and Drop Keel	
	Kongsberg Noise Monitoring System	x
Auxiliary Sensors	Seapath 380-R3 Position, Speed, Motion, Time and Heading System	x
	Valeport Sound Velocity Sensors:	x
	MiniSVS (3x) (2 x Drop Keel, 1 x Hull mounted),	x
	MIDAS SVX2 (1x)	x
Scientific Networks	KVM System: Visualization and control of scientific systems in scientific areas.	x
	Signal Distribution Box + Signal Remote boxes: Distribution of PPS, Position, Water Depth, etc. in scientific areas.	x
	Scientific Network: Storage, backup and distribution of scientific data.	x
	Kongsberg MDM500	x
	KSync	x
AUMS	Parameters measured by the Autonomous Underway Measurement System: turbidity, oxygen, pH, chlorophyll, blue algae, CDOM, salinity, pCO2, fluorescence, Par, hyperspectral irradiance, NO3, NH3, PO4, SiO2 and NO2	x
Weather Station	Campbell Scientific Weather station installed on foldable mast.	x
CTD equipment	SBE9plus CTD carousel with Niskin bottles	x
	Sea- Bird SBE21 thermosalinograph	x
Sediment sampling	boxcorer NIOZ model (with maximum spares)	x
	Van Veen grab with receptable	x
	Reineck corer (with maximum spares)	x
Laboratory equipment	Millipore Milli-Q IQ 7000 (2x),	x
	Memmert Drying/Sterilizing oven (3x),	x
	Tritec Refrigerator (600 l),	x
	GEA Westfalia seawater centrifuge	x

Additional equipment RBINS-OD Nature:

- Aquascat 1000R (acoustic backscatter) for particle concentration
- LISST 200x for in-situ particle size (ENTIRE PERIOD)
- LISST HOLO for particle nature and shape
- Filtration equipment ECOCHEM
- HACH Turbidity meter (ENTIRE PERIOD)
- Sieving table MARECO (TBC) (ENTIRE PERIOD)

Additional equipment VLIZ

- Video Plankton Recorder (VPR) with winch
- LISST-200X (mounted on VPR)
- Hach (mounted on VPR)
- Sediment Profile Imager (SPI) (TBC)

Additional equipment COPCO:

- Aquascat 1000R (acoustic backscatter) for particle concentration

8. SAMPLING - ON BOARD ANALYSIS

RBINS OD-Nature

- Hach turbidity meter
- Particle analysis with LISST-200x
- Description, photography and sieve analysis of sediment samples

9. AUTOMATIC DATA ACQUISITION: continuous measurements

Instrument	Telegram	MDM ID	Parameter	Acquisition rate MDM500	
				standard	extra
				10 sec.	1 sec.
Seapath 380-R3 GNSS receiver with MGC motion sensor	ZDA	4701001	Time (HHMMSS.SSS)	x	x
	ZDA	4701002	Time zone (HH)	x	x
	GGA	4702001	Time (HHMMSS.SSS)	x	x
	GGA	4702002	Latitude (D.D)	x	x
	GGA	4702003	Latitude (N/S)	x	x
	GGA	4702004	Longitude (D.D)	x	x
	GGA	4702005	Longitude (E/W)	x	x
	GGA	4702006	Quality (#)	x	x
	GGA	4702007	Number of Satellites (#)	x	x
	VTG	4704001	True heading (deg)	x	x
	VTG	4704002	Magnetic heading (deg)	x	x
	VTG	4704003	Ground speed (kn)	x	x
	HDT	4705001	True heading (deg)	x	x
	SXN23	4707001	Pitch (deg)	x	x
	SXN23	4707002	Roll (deg)	x	x
	SXN23	4707003	Heading (deg)	x	x
	SXN23	4707004	Heave (m)	x	x
Saab R5 GNSS system #1	GGA	4204001	Time (HHMMSS.SSS)	x	x
	GGA	4204002	Latitude (D.D)	x	x
	GGA	4204003	Latitude (N/S)	x	x
	GGA	4204004	Longitude (D.D)	x	x
	GGA	4204005	Longitude (E/W)	x	x
	GGA	4204006	Quality (#)	x	x
	VTG	4205001	True heading (deg)	x	x
	VTG	4205002	Magnetic heading (deg)	x	x
	VTG	4205003	Ground speed (kn)	x	x
Saab R5 GNSS system #2	GGA	4304001	Time (HHMMSS.SSS)	x	x
	GGA	4304002	Latitude (D.D)	x	x
	GGA	4304003	Latitude (N/S)	x	x
	GGA	4304004	Longitude (D.D)	x	x
	GGA	4304005	Longitude (E/W)	x	x
	GGA	4304006	Quality (#)	x	x
	GGA	4304007	Number of Satellites (#)	x	x
	VTG	4305001	True heading (deg)	x	x
	VTG	4305002	Magnetic heading (deg)	x	x
	VTG	4305003	Ground speed (kn)	x	x
Navigat 200 gyro #1	HDT	3601001	True heading (deg)	x	x
	ROT	3602001	Rate of turn (deg/s)	x	x
Navigat 200 gyro #2	HDT	5301001	True heading (deg)	x	x
	ROT	5302001	Rate of turn (deg/min)	x	x
IMU-108 motion sensor #1	EM3000	6701001	Pitch (deg)	x	x
	EM3000	6701002	Roll (deg)	x	x
	EM3000	6701003	Heave (m)	x	x
	EM3000	6701004	Heading (deg)	x	x

Instrument	Telegram	MDM ID	Parameter	Acquisition rate MDM500	
				standard	extra
				10 sec.	1 sec.
	EM3000	6701005	Status	x	x
IMU-108 motion sensor #2	EM3000	6601001	Pitch (deg)	x	x
	EM3000	6601002	Roll (deg)	x	x
	EM3000	6601003	Heave (m)	x	x
	EM3000	6601004	Heading (deg)	x	x
	EM3000	6601005	Status	x	x
Skipper EML224 doppler log	VHW	3502001	True heading (deg)	x	x
	VHW	3502002	Magnetic heading (deg)	x	x
	VHW	3502003	Speed (kn)	x	x
	VHW	3502004	Speed (km/h)	x	x
	VBW	3503001	Longitudinal water speed (kn)	x	x
	VBW	3503002	Transversal water speed (kn)	x	x
	VBW	3503003	Longitudinal ground speed (kn)	x	x
	VBW	3503004	Transversal ground speed (kn)	x	x
Skipper ESN200 echosounder	DBT	3701001	Depth from transducer (m)	x	x
	DBS	3702001	Depth from surface (m)	x	x
	DBK	3703002	Depth from keel (m)	x	x
	DPT	3704003	Depth (m)	x	x
	DPT	3704004	Offset (m)	x	x
Kongsberg EM 2040D depth	DPT	4101001	Depth (m)	x	x
	DPT	4101002	Offset (m)	x	x
Kongsberg ME70 depth	DPT	8501001	Depth (m)	x	
	DPT	8501002	Offset (m)	x	
Kongsberg EK80 echosounder	CHAN1	1701001	Depth (m)	x	x
	CHAN1	1701002	Hardness (dB)	x	x
	CHAN1	1701003	Density (m2/nmi2)	x	x
	CHAN2	1702001	Depth (m)	x	x
	CHAN2	1702002	Hardness (dB)	x	x
	CHAN2	1702003	Density (m2/nmi2)	x	x
	CHAN3	1703001	Depth (m)	x	x
	CHAN3	1703002	Hardness (dB)	x	x
	CHAN3	1703003	Density (m2/nmi2)	x	x
	CHAN4	1704001	Depth (m)	x	x
	CHAN4	1704002	Hardness (dB)	x	x
	CHAN4	1704003	Density (m2/nmi2)	x	x
	CHAN5	1705001	Depth (m)	x	x
	CHAN5	1705002	Hardness (dB)	x	x
	CHAN5	1705003	Density (m2/nmi2)	x	x
	CHAN6	1706001	Depth (m)	x	x
	CHAN6	1706002	Hardness (dB)	x	x
	CHAN6	1706003	Density (m2/nmi2)	x	x
Kongsberg EM304 depth	DPT	6901001	Depth (m)	x	
	DPT	6901002	Offset (m)	x	
Campbell Scientific weather station #1	MWV	6801001	Wind angle (deg)	x	
	MWV	6801002	Wind angle (R/T)	x	
	MWV	6801003	Wind speed (m/s)	x	
	XDR	6802001	Air temperature (degC)	x	
	XDR	6802002	Relative humidity (%)	x	
	XDR	6802003	True Wind speed (m/s)	x	
	XDR	6802004	True Wind direction (deg)	x	
	XDR	6802005	Air pressure (hPa)	x	
	XDR	6802006	Solar radiation density (W/m2)	x	
	XDR	6802007	Solar radiation total (J/m2)	x	
Campbell Scientific weather station #2	MWV	7801001	Wind angle (deg)	x	
	MWV	7801002	Wind angle (R/T)	x	
	MWV	7801003	Wind speed (m/s)	x	
	XDR	7802001	Air temperature (degC)	x	
	XDR	7802002	Relative humidity (%)	x	
	XDR	7802003	True Wind speed (m/s)	x	
	XDR	7802004	True Wind direction (deg)	x	
	XDR	7802005	Air pressure (hPa)	x	
	XDR	7802006	Solar radiation density (W/m2)	x	
	XDR	7802007	Solar radiation total (J/m2)	x	
Sea-Bird SBE21 thermosalinograph #1	SBETSG	6501001	Scan count (#)	x	x
	SBETSG	6501004	Temperature SBE21 (degC)	x	x
	SBETSG	6501005	Temperature SBE38 (degC)	x	x

Instrument	Telegram	MDM ID	Parameter	Acquisition rate MDM500	
				standard	extra
				10 sec.	1 sec.
	SBETSG	6501006	Conductivity (S/m)	x	x
	SBETSG	6501007	Salinity (PSU)	x	x
	SBETSG	6501008	Density sigma-theta (kg/m3)	x	x
	SBETSG	6501009	SV chen millero (m/s)	x	x
	SBETSG	6501010	Water flow (m3/h)	x	x
	SBETSG	6501015	Alarm	x	x
Sea-Bird SBE21 thermosalinograph #2	SBETSG	8101001	Scan count (#)	x	x
	SBETSG	8101004	Temperature SBE21 (degC)	x	x
	SBETSG	8101005	Temperature SBE38 (degC)	x	x
	SBETSG	8101006	Conductivity (S/m)	x	x
	SBETSG	8101007	Salinity (PSU)	x	x
	SBETSG	8101008	Density sigma-theta (kg/m3)	x	x
	SBETSG	8101009	SV chen millero (ms)	x	x
	SBETSG	8101010	Water flow (m3/h)	x	x
	SBETSG	8101015	Alarm	x	x
MiniSVS hull	SSV	5801001	Sound speed (m/s)	x	x
	SSV	5801002	Temperature (degC)	x	x
	SSV	5801003	Pressure (dBar)	x	x
MiniSVS PS drop keel	SSV	5901001	Sound speed (m/s)	x	x
	SSV	5901002	Temperature (degC)	x	x
	SSV	5901003	Pressure (dBar)	x	x
MiniSVS SB drop keel	SSV	7701001	Sound speed (m/s)	x	x
	SSV	7701002	Temperature (degC)	x	x
	SSV	7701003	Pressure (mBar)	x	x
Teledyne OS75 ADCP	DBT	2901002	Depth (m)	x	
	HDT	2902001	True heading (deg)	x	
	VBW	2903001	Longitudinal water speed (m/s)	x	
	VBW	2903002	Transversal water speed (m/s)	x	
	VBW	2903003	Longitudinal ground speed (m/s)	x	
	VBW	2903004	Transversal ground speed (m/s)	x	
Teledyne WHM600 ADCP	DBT	3001002	Depth (m)	x	
	HDT	3002001	True heading (deg)	x	
	VBW	3003001	Longitudinal water speed (m/s)	x	
	VBW	3003002	Transversal water speed (m/s)	x	
	VBW	3003003	Longitudinal ground speed (m/s)	x	
	VBW	3003004	Transversal ground speed (m/s)	x	
Sea-Bird SBE9plus CTD #1	SBECTD	8001001	Scan Count (#)	x	
	SBECTD	8001002	Latitude (D.D)	x	
	SBECTD	8001003	Longitude (D.D)	x	
	SBECTD	8001004	Temperature (degC)	x	
	SBECTD	8001005	Conductivity (S/m)	x	
	SBECTD	8001006	Depth (m)	x	
	SBECTD	8001007	Salinity (PSU)	x	
	SBECTD	8001008	Density sigma-theta (kg/m3)	x	
	SBECTD	8001009	SV chen millero (m/s)	x	
	SBECTD	8001010	Oxygen (mg/l)	x	
	SBECTD	8001011	Turbidity (NTU)	x	
	SBECTD	8001012	Altimeter (m)	x	
	SBECTD	8001013	Bottles fired (#)	x	
	SBECTD	8001014	Descent rate (m/s)	x	
Sea-Bird SBE9plus CTD #2	SBECTD	8301001	Scan count (#)	x	
	SBECTD	8301002	Latitude (D.D)	x	
	SBECTD	8301003	Longitude (D.D)	x	
	SBECTD	8301004	Temperature (degC)	x	
	SBECTD	8301005	Conductivity (S/m)	x	
	SBECTD	8301006	Depth (m)	x	
	SBECTD	8301007	Salinity (PSU)	x	
	SBECTD	8301008	Density sigma-theta (kg/m3)	x	
	SBECTD	8301009	SV chen millero (m/s)	x	
	SBECTD	8301010	Oxygen (mg/l)	x	
	SBECTD	8301011	Turbidity (NTU)	x	
	SBECTD	8301012	Altimeter (m)	x	
	SBECTD	8301013	Bottles fired (#)	x	
	SBECTD	8301014	Descent rate (m/s)	x	
	SDS1	8801013	Temperature SBE45 (degC)	x	
	SDS1	8801014	Conductivity SBE45 (mS/cm)	x	

Instrument	Telegram	MDM ID	Parameter	Acquisition rate MDM500	
				standard	extra
				10 sec.	1 sec.
AUMS Oceanpack	SDS1	8801015	Salinity SBE45 (PSU)	x	
	SDS1	8801016	O2 concentration (umol)	x	
	SDS1	8801017	Air saturation (%)	x	
	SDS1	8801018	Air temperature (degC)	x	
	SDS1	8801019	pH	x	
	SDS1	8801020	pH temperature (degC)	x	
	SDS1	8801021	Turbidity Eco Triplet (NTU)	x	
	SDS1	8801025	Turbidity Campbell (NTU)	x	
	SDS1	8801027	CHL Eco triplet (ug/l)	x	
	SDS1	8801028	CHL-A NanoFlu (ug/l)	x	
	SDS1	8801029	CDOM Eco Triplet (ppb)	x	
	SDS1	8801032	Water flow (l/min)	x	
	SDS1	8801033	CO2 LI-COR (ppm)	x	
	SDS2	8802010	PAR (umol)	x	

10. CHEMICALS

N/A