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D 6.2 – Interim report on all Eurofleets+ training and education programmes

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1. Introduction

In the frame of Eurofleets+, comprehensive **training and education activities** are planned (WP6) to: support early stage researchers' careers and train the next generation of 'blue staff';

- increase the participation of less equipped countries and attract women to science;
- encourage young people to consider science careers;
- spread good scientific practices and facilitate exchange of personnel;
- attract new users to using the fleet and infrastructure.

Multiple interesting training and education activities are planned, including events on-board vessels and e-learning. By using state of the art communication tools and digital technology, Eurofleets+ will enhance **ocean literacy**, through engaging with and educating audiences ranging from young children to professionals and the public at large. This will be built on actions launched in the previous two Eurofleets projects.

The objectives of the Education and Training work package are to:

1. Build capacity in European ocean science research through a series of innovative workshops, labs and floating universities targeted at postgraduate students, early stage researchers and professionals.
2. Facilitate transfer of knowledge and technology through exchange of staff and mobility of industry personnel.
3. Increase participation of women in ocean sciences, along with users from less equipped countries.
4. Engage teachers and educators in ocean exploration to promote Eurofleets+ activities to students worldwide.
5. Attract primary and secondary school pupils to careers in ocean science, thereby inspiring the next generation of marine scientists.
6. Create an "ocean Literate" public through targeted engagement of innovative ocean exploration activities.

Eurofleets+ will utilise the unique facilities offered by the fleet, equipment and the experience and knowledge of the consortium to deliver five accredited ship-based training courses or 'Floating Universities' to postgraduate students of marine-related disciplines in specific regions and sea basins (Task 6.1). These courses will also generate on-line teaching material creating a free resource available to a great number of students/scientists. Through Co-Principal Investigator, the Marine Internship and Teacher-At-Sea programs (Task 6.2), researchers and educators will be embarked on board Eurofleets+

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TA cruises to benefit from the unique opportunity to gain experience, improve their scientific knowledge and bring marine sciences into classrooms. Applicants for TA will also be required to include emerging researchers in their proposal. Early career scientists and technicians will attend the blue skill labs and workshops enabling upskilling in new technologies and techniques and proposal development courses. New RV managers will receive training in the RV managers workshop from experienced colleagues (Task 6.3). The activities will also focus on promoting innovative methods of engagement across society by piloting state of the art communication tools and digital technology to enhance understanding of ocean science research and create a more 'Ocean Literate' public (Task 6.4). Training will have a special focus on early stage scientists and technicians and those from less equipped countries.

2. Task 6.1 – Floating Universities

From the DOW:

The aim is to implement Floating Universities onboard five of the Eurofleets+ participating research vessels, three of them additional to those included in TA, at no cost to the project. Onboard training courses were designed and implemented in the preceding Eurofleets and Eurofleets2 projects.

In close collaboration with participants across the project, we will: assemble an international group of senior instructors that will jointly organize the floating university events and outline its educational elements; define selection criteria based on previous projects; draft and publish a Call for student recruitment; and select the participating early stage researchers. Researchers must fill in an application form and their submission will be evaluated on the basis of their scientific background, training needs, and coherency between their studies and topics offered by Floating Universities. Furthermore, travel grants will be devoted to promote and increase the participation of women and people from less equipped countries.

Each Floating University course will start with introductory day(s) devoted to lectures covering the planned activities, survey design & planning and practical & safety issues. Activities will combine lectures, laboratory work and practical sampling/measurements and interpretation of data. As a follow-up, each student will contribute to the official cruise report and submit a report on the outcome of their own project work.

The following five Floating Universities are planned:

1. *Eurofleets+ Floating University onboard RV Celtic Voyager: "Mapping the Ocean Floor: An Introduction to Practical Aspects of Hydrographic Surveying" (Atlantic Ocean).*
2. *Eurofleets+ Floating University onboard RV Oceania: "Use bio-optical parameters as convenient tool to study marine biogeochemical processes" (Baltic Sea)*
3. *Eurofleets+ Floating University onboard RV Mario Ruivo: "Meeting societal needs for impartial evidence on the state and sustainable use of the ocean biological resources: the case of the Nephrops norvegicus (Norway Lobster)" (Atlantic Ocean)*
4. *Eurofleets+ Floating University onboard RV Dallaporta: Oceanography and marine biology (Mediterranean Sea*
5. *Eurofleets+ Floating University onboard RV Skagerak: Robotics and Oceanography (Baltic Sea)*

*Furthermore, the Eurofleets+ '**Research Vessel Training Toolkit**' will be produced for course directors containing common procedures and templates, to ensure a standardised approach to course development and ensuring consistent standards and high quality across all Eurofleets+ training. The*

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toolkit will include information on how to produce module descriptors, learning outcomes, organize accreditation/CPD recognition, organize pre- and post-cruise workshops, develop digital learning resources and identify on-board social media and outreach activities. Each Floating University course will be supported by a suite of e-modules.

2.1 Research Vessel Training Toolkit

The experience in design, organization and applicants' evaluation of on-board training courses represents the legacy of two previous Eurofleets projects and the starting point for the EUROFLEETS+ Floating University program, ensuring consistent standards and high quality across all Eurofleets+ training.

In view of this, the '**Research Vessel Training Toolkit**' has been launched and represents a further step towards a higher level of marine researcher training, improving and consolidating the organization and development of Floating University courses by:

⇒ Defining common procedures and templates, to ensure a standardised approach to course development

⇒ Providing information on how to produce module descriptors, learning outcomes, organize pre- and post-cruise workshops

⇒ Developing digital learning resources

⇒ Identifying on-board social media and outreach activities

⇒ Supporting the courses organizers by providing a suite of e-modules

This guide is aimed to help course organizers to plan and conduct the course by providing information on the main steps and stages in sequence from designing a training course to evaluation for feedback and further development.

All the documents and templates are available in the Eurofleets+ SharePoint to all partners but specifically for the course coordinators.

2.2 Eurofleets+ Floating University on board RV Celtic Voyager: "Mapping the Ocean Floor: An Introduction to Practical Aspects of Hydrographic Surveying"

The first Eurofleets+ Floating University "Mapping the Ocean Floor: An Introduction to Practical Aspects of Hydrographic Surveying" was hosted by the Marine Institute on board the RV Celtic Voyager in Cork Ireland, from the 19th to the 25th of February 2020.

The Eurofleets+ Floating University introduced students to the principles and methods applied to hydrographic surveying, through four days of lectures and workshops and three days training offshore

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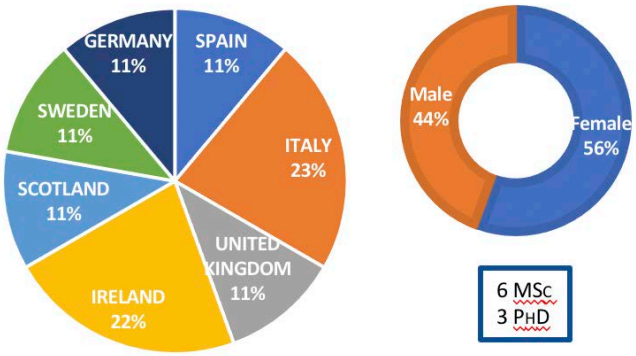
on board the RV Celtic Voyager. Students gained practical experience in seabed mapping, by operating multibeam echosounders and sub-bottom profiler systems, designing and implementing a hydrographic survey in Cork Harbour, as well as practicing data acquisition and data processing by producing a detailed model of the surveyed area.

The call for applications was published in October 2019 (**Milestone 15**) and closed on December 16th 2019 (**Annex 1**). The call template was developed and promoted throughout the Eurofleets+ Website and all social channels. The call was disseminated across partners' social channels and a direct e-mail was issued to all Eurofleets+ partners and contacts.

Open to both MSc and PhD students enrolled at European Universities, a total of 28 applications were received for eight places available. The applications were evaluated by two oceanographic experts and the course coordinator from the Marine Institute, based on set criteria. Due to the standard of application being so high and following consultation with the vessel operator, an additional applicant was accommodated bringing the total number of course participants to nine (6 MSc and 3 PhD), from 7 different nationalities.



Provisional joining instructions were issued to successful candidates on December 18th 2019 with travel and logistical information. The course was delivered over seven days, with four onshore days giving an overview of the science of seabed mapping classroom based learning ahead of practical offshore survey experience. The lectures included an Overview of seabed mapping, Fundamentals (oceanography & sampling), Marine Geohazards, Seafloor Mapping, Marine Survey Planning & Ocean mapping, Global Perspective and Seabed Classification Practical.

On-board the RV Celtic Voyager the students were rotated through each station in three groups to ensure that each student had the opportunity to learn the skills involved. Practicals on seabed sampling and data collection took place, physical sampling of the seabed at each station and sound velocity probe was lowered for MBES calibration and to establish temperature and salinity profiles of the water column, with data processing taking place on board by each student.

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Students were also tasked with an exposition of a scenario challenging them to develop a survey plan for dredging the shipping channel. Students were divided into two groups with each group roleplaying a surveying consultancy firm. Finally, students completed a poster presentation challenge and presented the results to instructors. Students were asked to complete detailed evaluation questionnaires providing feedback on their experience. The results of evaluation questionnaires indicate that all aspects of the course were well received by the participants and considered very useful.

A movie about this Floating University is available at

https://www.youtube.com/watch?v=xY271nHomrc

See **Annex 2** for the Eurofleets+ Floating University "Mapping the Ocean Floor: An Introduction to Practical Aspects of Hydrographic Surveying" report.

2.3 Eurofleets+ Floating University on board RV Oceania: "Use bio-optical parameters as a convenient tool to study marine biogeochemical processes"

Following the guidance included in the "Eurofleets+ Research Vessels Training Toolkit for course directors", the announcement on the "Floating University" opportunity on board RV Oceania (4-16 June 2020) was developed. The call for the "Use bio-optical parameters as a convenient tool to study marine biogeochemical processes" Floating University Course on board RV Oceania was launched on the Eurofleets+ website in mid-January 2020 (see **Annex 3**). The deadline for submission of applications was set for March 15, 2020. A total of 13 applications were submitted (7 females and 6 males). The selection committee, formed by OGS (Dr Andrea Caburlotto) and IOPAN (Dr Piotr Kowalczujk) granted 8 participants a place on the course and conditionally accepted 2 applicants who were added to a waiting list. Students and early career scientists from 8 nationalities were accepted (4 MSC, 3PhD and 1 PostDoc).

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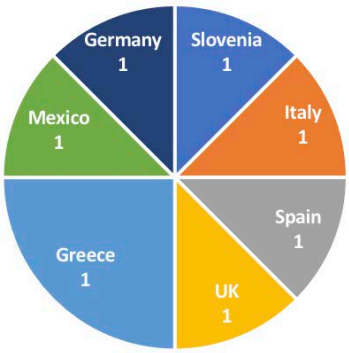
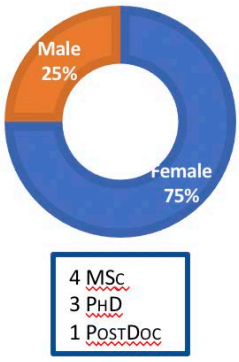
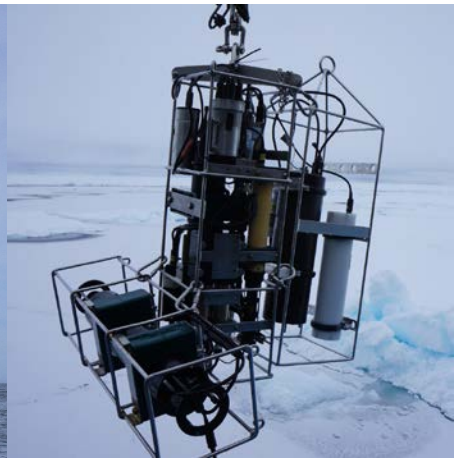




4 MSc
3 PhD
1 PostDoc

Due to the COVID-19 pandemic lockdown and effective ban on international travel to and from Poland (port of embarkation) and Norway (port of disembarkation), the Floating University on board the RV Oceania was postponed until June 2021. All accepted participants were automatically enrolled to the course without any further application process. One of the selected participants was unable to join, and was replaced with a candidate from the waiting list.



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3. Task 6.2 – Training and Education through Access and Exchange

From the DOW:

A series of training and education programmes will be implemented through access and exchange mechanisms. This will facilitate broader access to Eurofleets+ research vessels and funded cruises. Programmes will run in collaboration with WP2 and WP4. Four different programs are planned:

*The **Co-PI Programme** is a mentoring program aimed at early stage researchers who wish to carry out and execute their own research program at sea. Applicants are requested to write a TA proposal for shiptime and if successful, will be coupled with experienced Principal Investigators (PIs) within Eurofleets+ TA cruises, giving a valuable opportunity for emerging researchers to carry out their own research at sea. This experience will help them gain the experience, confidence and skills to act as Chief Scientists in their future careers.*

*The **Marine Internship Programme** will offer seagoing placements for students of marine related sciences and technologies on the research vessels, utilising spare berths. Placements can take place on dedicated research surveys being undertaken by vessels or during funded research cruises with PIs. The internships are intended primarily for marine oriented graduates, postgraduate students and early stage researchers. The programme will provide a great opportunity to gain offshore experience, develop new skills and learn on the job with established research scientists and research leaders. Interns will not conduct their own research but will have the possibility to learn how an international cruise works and about operations onboard.*

The participants will be evaluated on the basis of excellence of their CV, and coherency between their studies and the scientific topics of the selected Eurofleets+ TA cruise. Priority will be given to participation of people from less equipped countries and women.

*The **Teacher at Sea Program** aims at providing opportunities for **primary and secondary school teachers** to participate in Eurofleets+ TA cruises and to communicate their experiences to **pupils**, thereby engaging and attracting young people to careers in marine science. The teachers will immerge themselves in the experience of life at sea and research with the guidance of onboard scientists. Their students will get involved in the cruise activities by sending emails, participating in blogs, and journaling about the daily exploits of those onboard. Teachers will disseminate their experience in ocean science research and exploration to their students through a series of blogs, online interactions and classroom-based teaching to contribute to the formation of future generation of marine scientists. Teacher at Sea will further develop a similar program initiated by Eurofleets2, in collaboration with the European Geosciences Union (EGU) GIFT (Geosciences Information For Teachers) Education program.*

*The **Personnel Exchange Programme** aims at stimulating the transfer of knowledge, technology and the sharing of research infrastructures by facilitating the exchange and mobility of personnel and targeted training utilizing specific equipment and technologies on board Eurofleets+ vessels.*

3.1 Co-PI webinar

Work Package 6 and Work Package 4 planned a webinar on the *Co-PI Program*: it was scheduled after the 2nd TA regional call closed, and the full list of scheduled TA cruises were available from which Co-PI applicants can chose to apply. Due to COVID-19 pandemic lockdown and effective limitation on international travel, the webinar was postponed until Eurofleets+ TA cruises were (re)scheduled and/or confirmed.

The webinar "*How to apply for the Co-Principal Investigator (Co-PI) Programme*" took place in January 2021, and was divided into 2 sessions of 1 hour each.

The first session, led by AWI (WP4), introduced the participants to the application, explaining step by

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step the information to provide in the application form and how to complete it correctly. In the second session, led by TalTech (WP6), the participants were shown how the applications are evaluated, the critical and the strength points to highlight for a successful application.

The webinar, attended by 30 participants, is available on-line on the Eurofleets+ webpage (https://www.eurofleets.eu/education/webinars-presentations/), where at the time of reporting it has been viewed by 36 users.

3.2 Marine Internship Programme

In early 2020, in collaboration with DTU Aqua, a Marine Internship Programme on board the RV Dana was being planned. Each year, the vessel runs several periodic monitoring and observing cruises from February to November:

- IBTS – Bottom trawling, CTD, plankton sampling (North Sea)
- BITS – Bottom trawling, CTD, plankton sampling (Baltic Sea)
- HERAS – Acoustic survey pelagic trawling, CTD (Skagerrak/Kattegat)
- Norwegian Sea - Acoustic survey pelagic trawling, CTD

DTU offered spare berths to early career scientists on these cruises, giving the opportunity for young researchers to learn how an international cruise works and about operations on board.

The 2020 plan was postponed due to the Covid-19 pandemic, and will be scheduled in 2021, if the limitations and restrictions due to the pandemic allow it.

The cancellation of most of the Eurofleets+ TA cruises in 2020 due to the limitation and restrictions related to the Covid-19 pandemic, did not allow the Access programme to commence on board Eurofleets+ TA cruises as well as the *Teacher at Sea program*, organized in collaboration with the EGU GIFT (Geosciences Information For Teachers). These activities will be organized as soon as the availability to host “external personnel” on board the Eurofleets+ TA cruises is found.

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4 Task 6.3 – Blue Skills Labs and Workshops

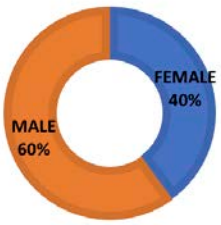
4.1 Task 6.3.1 - Blue Skills Labs

From the DOW:

During the past ten years, new technologies have remarkably extended the scope of marine research and now offer exciting novel perspectives for pioneering research. Unmanned underwater vehicles have reached a high degree of reliability and they develop towards standard equipment on modern research vessels. However, the technical complexity of the systems and their integrated scientific payload is a challenge for both the operational team and the scientists. This is addressed through proposed dedicated training courses to enable the next generation of marine researchers to fully utilize the possibilities offered by this kind of scientific instrumentation onboard European research vessels. Applications for the Blue Skills Labs will be evaluated on the basis of the scientific/technical career of the applicant and coherency between their studies and the topics in the Labs. Priority will be given to participation of people from less equipped countries and to women scientists.
The following Blue skills Labs are planned:

- *2 Robotic Labs*
- *2 ROV Labs*
- *2 Seismic Labs*
- *1 Telepresence Lab*

1st Robotic Lab at UGOT (University of Gothenburg)



The first Workshop took place from the 20th of August 2019 at the Robotics Lab workshop of Gothenburg University (UGOT) in collaboration with the Swedish Marine Robotics Centre (SMaRC) including participation of industry (Marine Mätteknik, MMT) and focused on AUV and Sea-Glider operations. Course elements included technical preparation of Autonomous Underwater Vehicles, mission planning preparation, integration of scientific payload, data acquisition and post-processing of various types of sensors with emphasize on hydroacoustic sensors (multibeam, sediment profiling, ADCP). Theoretical course elements were applied practically in a one-day boat trip in the Baltic Sea. The course received 11 applications, from where 10 candidates of 7 nationalities were selected.

All applicants were successful in securing a space on the course which was delivered over six days.

See **Annex 4** for the Eurofleets+ 1st Robotic Lab report.

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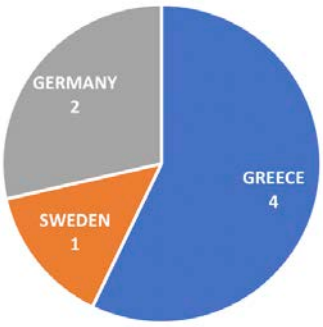
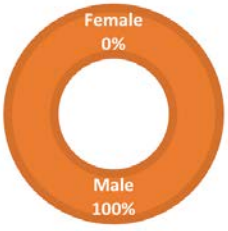
1st ROV Lab at MARUM





4 ENGINEER
1 YOUNG TECH
2 POSTDOC

The first of two planned ROV Lab courses took place from the 19th to the 21st of November 2019. 11 applications were received and 7 participants from Greece, Germany and Sweden were considered as suitable and invited. As the course was designed for 8 people, a MARUM member was invited to fill the last open place. The participants received a training lesson in using a 7-function manipulator and a scientific dive in a virtual "Black Smoker ventfield" environment was carried out in the QuestSIM simulator. During three Class Workshops, the students were shown how to prepare a cruise, what needs to be considered during the mobilisation of a ROV-System on a vessel and last but not least, the operation of ROVs at sea. Unfortunately, the planned dive with ROV-Squid in the Test-Tank was cancelled due to a broken slipring of the ROV-winch. Very positive feedback was received which will help to improve the structure and content of the course.

See **Annex 5** for the Eurofleets+ 1st ROV Lab report.

4.2 Task 6.3.2 - Blue Skills Workshops

From the Dow
6.3.2.1 Eurofleets+ TA Proposal Development: to support scientists and emerging researchers in developing Eurofleets+ TA proposals. Workshops will be broadcast live as "webinars" and archived on the project portal for future access. Training will be provided on FAIR data management in the context of Open Research Data and Open Science. Scientists will be trained to prepare a data management plan based on EARS requirement. *6.3.2.2 Research Infrastructure Management Workshop: This workshop will be delivered to marine science related staff by a pool of highly experienced RV managers from Eurofleets+ partner institutes and will aim to provide the skills and competencies required to successfully manage research vessel infrastructure and fulfil the logistical requirements of scientific operators. Workshops will be broadcast live as webinars which will widen the scope of the training for greater impact globally. A session will be devoted to the installation and use of the Eurofleets data management suite (EARS).*

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Webinar on Eurofleets+ TA Proposal development

A training webinar on "*How to write a proposal for the SEA Programme*" was developed and delivered in September by AWI (Anneli Strobel) in collaboration with TUT (Urmas Lips).

The webinar provided an overview of the Ship-Time and Marine Equipment Application (SEA) Programme, and explained how to prepare a proposal for the SEA Calls "OCEANS" and "REGIONAL". It provided a detailed overview on the different Parts and Steps necessary for a valid application under the Eurofleets+ SEA Programme. It also provided an overview of the proposal online submission system for the SEA Calls, planning of a research cruise and training and communication of Eurofleets+ cruises.

All the webinars are available here: https://www.eurofleets.eu/education/webinars-presentations/ and were recorded and freely available with supporting slides on the Eurofleets+ website (so far they collected respectively 97 and 40 visualizations).

5 Task 6.4 – Remote Access, E-Learning and Ocean Literacy

From the DOW:

This will promote innovative methods of engagement across society by piloting state of the art communication tools and digital technology to enhance understanding of ocean science research and create a more 'Ocean Literate' public. It will seek to engage, educate, inform and inspire a range of audiences including primary and secondary school pupils, teachers and educators, third-level students, early stage researchers, professionals and the public at large.

6.4.1 Eurofleets+ Ship to Shore Expedition

Eurofleets+ will pilot the first European 'Ship to Shore' ocean literacy expedition using advanced VSAT telepresence communications technology to enable live, two-way broadcasting from TA surveys. This innovative technology will stream footage in real-time live from the vessel and the seabed that will enable audiences globally to remotely access and engage with deep-sea ocean exploration. This will specifically engage existing networks of primary and secondary school pupils (e.g. Green and Blue Schools initiatives) with live, interactive 'Ask a Scientist' sessions and supporting resources. Ship to Shore broadcasts will also aim to promote marine science careers as an option for young people, particularly girls, through positive female scientist role models.

6.4.2 Eurofleets+ Ocean Classroom Portal

A variety of innovative, multimedia, online digital resources will be produced from training activities which will be collated on the Eurofleets+ Ocean Classroom Portal. The Ocean Classroom repository will include:

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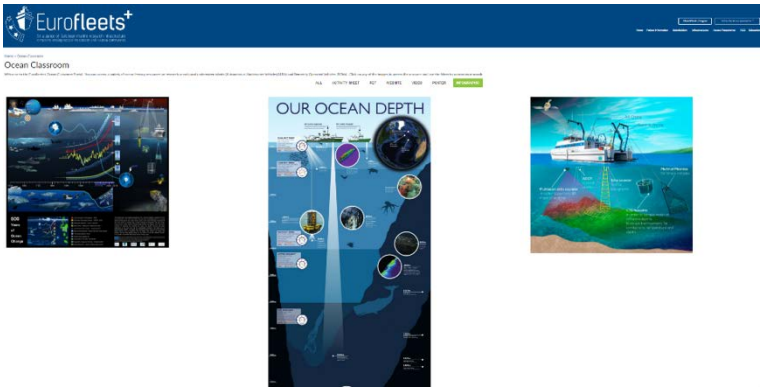
- *A suite of Ocean Literacy resources to support educators in the concept of investigating the ocean from research vessels and ROVs and bringing live and recorded Ship to Shore Expeditions to their classrooms, aimed at primary and secondary school pupils.*
- *Online e-learning digital resources, tools and webinars developed to support Floating Universities, Labs and Workshops for online access by early-stage researchers and professionals.*
- *An Alumni Forum, will allow Eurofleets+ training participants to engage, network and collaborate online. This forum will also be used to measure the effectiveness, impact and benefits of Eurofleets+ training by tracking participants and assessing the skills and career progression of alumni though follow-on questionnaires and feedback.*

5.1 Task 6.4.2 - Ocean Classroom Portal

Development of the Eurofleets+ Ocean Classroom repository commenced with a detailed desktop analysis of existing Ocean Literacy materials available through Eurofleets+ partners to assess what resources existed amongst Eurofleets+ Partners. The range and breadth of materials available is very comprehensive and has been collated to provide a key repository for informing all stakeholder categories of the role which Research vessels play in marine science. Access to materials and resources has been provided by MI, Socib, HCMR, OGS, GFOE, VLIZ, RBINS, IPMA, UDG.

Following the collation of all assets, the Marine Institute compiled an extensive database which was then analysed and grouped by theme and resource type and finally sorted by target audience. Each asset was assessed for its potential to support educators in the concept of investigating the ocean from research vessels and ROVs specifically aimed at primary and secondary schools. Additional assets have been added to the repository to convey the significant role research vessels play in ocean exploration aimed at all Eurofleets+ stakeholders at all levels.



A virtual meeting was held with OGS, EurOcean and Blue Lobster to discuss the design for the portal in May 2020 where the specification and structure was agreed. This design was then developed by the Marine Institute and Blue Lobster and finally implemented on the Eurofleets+ website where users can explore all the available resources. This will be officially launched in M20 when finalised.

The Portal was not due for publication until M36, but due to the impact of COVID19 on other activities in the project its development was brought forward and has been launched on the Eurofleets+ website (**Milestone 16**). The portal currently provides access to 38 resources such as activity sheets, educational documents, websites, videos, posters and infographics detailing how AUVs and ROVs work and are implemented.

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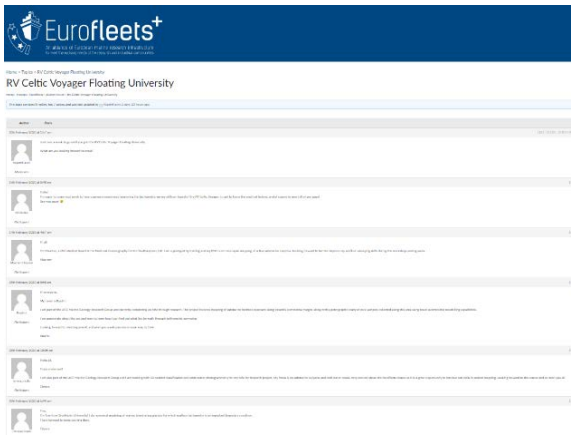
As the project progresses the portal will be updated with additional online e-learning digital resources, tools, webinars to support floating universities, labs and workshops for online access by early stage researchers and professionals as well as additional materials for primary and second level educators.



The Alumni Forum was developed and launched to coincide with the beginning of the Floating University course at the end of M13. The Alumni Forum accessed through the Eurofleets+ website providing an exclusive space to Eurofleets alumni to programmes to engage, network and collaborate. Created by Blue Lobster and moderated by the Marine Institute it is incorporated into the Eurofleets+ website and provides a space for the participants to introduce themselves prior to meeting for the first time on their respective course. It will also act as a tool to allow for impact of that the Eurofleets+ training courses have on their skills and careers progression.

6 Concluding Remarks

The successful 1st Floating University together with the applications received for the 2nd course (postponed to 2021 due to the Covid-19 pandemic) demonstrate how offshore training activities are integrated into existing national and international postgraduate schools and programmes and that the demand for these on board practical courses is in line with the previous two Eurofleets projects' activities.

The feedback received regarding the first 2 Blue Skills Labs (Robotic and ROV Labs) was very positive, showing that dedicated training courses, to enable the next generation of marine researchers and technicians to fully utilize the possibilities offered by new and emerging scientific instrumentation on board European research vessels, have been enthusiastically welcomed. This is encouraging and will assist in improving the structure and content of courses going forward.

The Covid-19 pandemic had an impact especially on the training courses involving practical activities. In 2020, 1 Floating University (on board RV Oceania) and the Seismic Lab at OGS were canceled and postponed to the following year (2021).

Due to this, the focus was on the web/on-line activities planned in the project: in particular, the development of the Ocean Classroom Portal and the webinar activities.

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The postponement of some practical training courses will have a low impact on the Eurofleets+ Education and Training program: these activities can be postponed and will be resumed as soon as the limitations and restrictions related to the pandemic will allow it.

7 List of Annexes

Annex 1 – Eurofleets+ Floating University "Mapping the Ocean Floor: An Introduction to Practical Aspects of Hydrographic Surveying" CALL

Annex 2 – Eurofleets+ Floating University "Mapping the Ocean Floor: An Introduction to Practical Aspects of Hydrographic Surveying" course REPORT

Annex 3 – Eurofleets+ Floating University onboard RV RV Oceania: "Use bio-optical parameters as convenient tool to study marine biogeochemical processes" CALL

Annex 4 - Eurofleets+ Robotic Lab REPORT

Annex 5 – Eurofleets+ ROV Lab REPORT

This project has received funding from the EU H2020 research and innovation programme under Grant Agreement No 824077

Annex 1

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EUROFLEETS+ Floating University

"Mapping the Ocean Floor: An Introduction to Practical Aspects of Hydrographic Surveying"

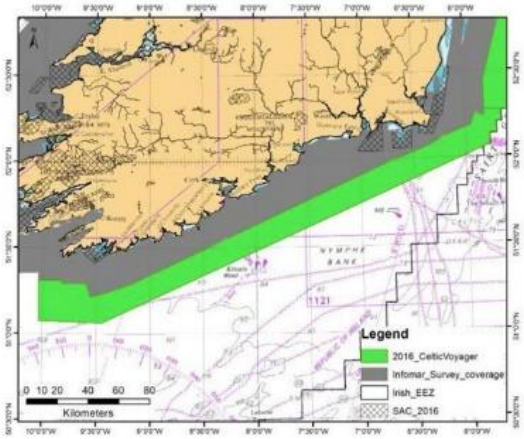
RV Celtic Voyager

Cork, Ireland, *February 19th to February 25th, 2020*

The EurofleetsPlus "Floating University"

Eurofleets+ is a unique consortium of research vessels, equipment and scientists supported by 42 marine institutes, universities, foundations and SMEs from 24 countries around the North Atlantic Ocean and Mediterranean Sea. A key objective of Eurofleets+ is the delivery of five Floating Universities for early stage researchers of marine related sciences. Floating Universities will address a range of themes and topics and focus on the applications and operation of research vessel data acquisition and sampling systems and equipment.

General course objectives



This floating University will take place on the RV Celtic Voyager in Cork Harbour and its approaches on the South Coast of Ireland. Teaching will focus on the operation of multibeam echosounders (MBES) and sub

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bottom profiling and their applications for mapping and characterising the seabed. Offshore training will be supported by lectures, workshops and online resources.

Learning objectives

The overarching objective of the training programme is knowledge transfer in state of the art hydrographic surveying from key personnel within the INFOMAR project to an emerging cohort of marine scientists and researchers. On completion, participants of this floating university will be able to:

- Demonstrate competence in designing and executing an offshore hydrographic survey
- Articulate understanding of the principles and methods applied to seabed surveying
- Practice data acquisition and data processing for MBES and Sub-bottom Profiler systems
- Operate software suites for data visualisations
- Present the applications of hydrographic data products to policy makers, managers and stakeholders
- Recognise the interpersonal skills for professional conduct on board research vessels.
- More effectively compete for studentships, research opportunities and employment in the Blue Economy

Course content

This Floating University will take place in Cork on the South Coast of Ireland from the 19th to 25th of February.

Before joining the vessel, students will attend a two-day workshop on the survey area, data acquisition systems, datasets and the integration of these in products for end users and stakeholders. Survey planning for seabed mapping, site exploration and environmental status will form a central strand of the workshop.

Offshore training will follow the workshop and occupy three days aboard the Celtic Voyager with students embarking and disembarking each day at 08:30 and 17:30 at the quays in the centre of Cork.

The first day of Celtic Voyager activities on day 3 of the Floating University will concentrate on interactive demonstrations of:

- Multibeam Echosounding to resolve the bathymetry and texture of the seafloor
- Sub-bottom profiling for charactering the materials the seafloor is composed of
- Ground truthing the acoustic classification of the seafloor with physical samples obtained with a Day grab and mini ROV imagery
- Calibration of echosounders with sound velocity probes

On day 4 students will be presented with the opportunity to practice their new skills through the medium of a team exercise tasking them with the design and implement a hydrographic survey of a potential dredging site in the Harbour approaches.

Celtic Voyager activities will conclude on day 5 with training in the operation of the Conductivity Temperature and Depth (CTD) instrument package, sampling of benthic infauna and deployments of core samplers.

Screening, exploration and analysis of the survey data will take place on days six and seven with the aim of producing a detailed model of the survey area. The programme will finish on the afternoon of day seven with presentations by the students of their data and findings.

Time plan

The course will be from the Wednesday 19th of February to Tuesday 25th of February 2020

Participants are expected to arrive on the Tuesday evening 18/02/2020 in Cork, Ireland.

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Eurofleets+ Floating University

Date	Activity	Location
Pre-Cruise		
19/02/2020	Introductory lecture, pre-cruise planning	TBC
20/02/2020	Instrumentation Orientation	TBC
RV Celtic Voyager		
21/02/2020	Offshore training	RV Celtic Voyager
22/02/2020	Offshore training	RV Celtic Voyager
23/02/2020	Offshore training	RV Celtic Voyager
Post-Cruise		
24/02/2020	Screening, analysis and visualisation of the survey data will take place on days six and seven with the aim of producing a detailed model of the survey area.	TBC
25/02/2020	Poster presentations by the students of their data and findings.	TBC

Teachers

Instruction on this EUROFLEETS+ Floating University will be from expert practitioners from the INFOMAR project (Marine Institute and Geological Survey Ireland) with guest lecturers from the National Institute of Oceanography and Applied Geophysics (OGS), Italy and others TBC.

Application

A total of 8 positions are available for European post-graduate students (students of all nationalities enrolled at European universities) and the selection will be based on the information provided in the application form.

ONLINE APPLICATION form available to access at

https://www.eurofleets.eu/applications/

Applications must be received by 22/11/19

Successful applicants will be notified by 06/12/2019

At the end of the course a certificate of completion will be delivered to all participants. This will include module descriptor of the course.

No special certification is required to apply.

Costs and travel grants

The course is funded by EU H2020 project EurofleetsPlus

The course is free of charge, but participants need to pay for their own travel expenses including accommodation and food.

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Cork is easily accessible through Cork City Airport and also has good train and bus access from Dublin.

Cork Airport Route Map

Dublin Airport to Cork Bus Route

Go Bus

Expressway

A travel reimbursement up to maximum of €300 is available after application. The support will be given on submission of proof of expenditure by each individual. Reimbursement claims should be made to Bernadette.NiChonghaile@Marine.ie

Contacts

- https://www.eurofleets.eu/
- www.marine.ie
- If you have additional questions email: Niamh Flavin (Course Coordinator) niamh.flavin@marine.ie

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Annex 2

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EUROFLEETS+ Floating University

Mapping the Ocean Floor: An Introduction to Practical Aspects of Hydrographic Surveying"

On-board the R/V Celtic Voyager

Cork, Ireland, 19th to 25th February 2020

This project has received funding from the EU H2020 research and innovation

Eurofleets+ Floating University

Scientific Participants

Name	Organization	Role
Fergal McGrath	INFOMAR	Course leader
John Boyd	SMART	Cruise Leader
Ronan O'Toole	INFOMAR	Lecturer
Dr. Silvia Ceramicola	OGS	Lecturer
David O'Sullivan	INFOMAR	Lecturer
Eoin McCraith	INFOMAR	Lecturer
Oisin McManus	INFOMAR	Lecturer
Aileen Bohan	INFOMAR	Lecturer
Mike Arrigan	INFOMAR	Lecturer
Fabio Sacchetti	INFOMAR	Lecturer
Eimear O'Keefe	INFOMAR	Lecturer
Nicola O'Brien	INFOMAR	Instructor
Niamh Flavin	Eurofleets+	Course Coordinator
Bernadette Ni Chonghaile	Eurofleets+	Course Coordinator

Name	**Role**
Francesca Giovanna Battaglia	Student/ Course Participant
Elaina O' Brien	Student/ Course Participant
Larissa Macedo Cruz de Oliveira	Student/ Course Participant
Kirsty Eleanor Black	Student/ Course Participant
Maarten Heijnen	Student/ Course Participant
Nil Rodes	Student/ Course Participant
Ruaihri Strachan	Student/ Course Participant
Stefania Bulzacchelli	Student/ Course Participant
Thomas Frank	Student/ Course Participant

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Eurofleets+ Floating University

Course and cruise objectives

This *Mapping the Ocean Floor: An Introduction to Practical Aspects of Hydrographic Surveying" Floating University* was a combination of theoretical and practical based sessions using both commercial and open source software.

The course was taught within three broad areas:

i. Ocean remote sensing, marine survey framework and applications.
ii. Irish national seabed mapping programme, INFOMAR (www.infomar.ie), detailing the current and future science and technologies employed in ocean mapping
iii. Datasets and spatial data management tools for ocean remote sensing.

Lecture Topics included; INFOMAR overview, ocean science policy framework; historical development of ocean remote sensing; platforms and systems; marine survey planning; processing bathymetry and backscatter data, habitat and ecosystem product derivation, data interpretation, mapping products, data quality framework, data connectivity and impact, stakeholders and users.

Practical sessions included shipboard and laboratory training in survey operations, multibeam-echosounder data acquisition, sediment sampling, habitat mapping, data processing and analysis.

On successful completion of the module, students were able to:

- Contrast the science of marine remote sensing with terrestrial techniques.
- Identify key systems and practices used in the field of marine remote sensing.
- Recognize the range of integrated data and products associated with marine remote sensing, as well as constraints and limitations, both on individual datasets, and merged products.

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- Demonstrate an appreciation of mapping scales, data resolutions and density in the context of seabed mapping.
- Analyse system performance characteristics and assess data quality.
- Select and apply suitable seabed mapping workflows. Propose image processing techniques for correcting and analysing marine remote sensing datasets.
- Detail the user requirements, stakeholders and added value products in the INFOMAR catalogue
- Identify the policy framework underpinning ocean science and Identify and source additional marine data and supports via repositories such as the Copernicus Marine Environment Service

Nature of the course and work carried out on the course

The EuroFleets+ Floating University introduced students to the principles and methods applied to hydrographic surveying, through four days of lectures and workshops and three days of training offshore on board the RV Celtic Voyager. Students gained practical experience in seabed mapping, by operating multibeam echosounders and sub-bottom profiler systems, designing and implementing a hydrographic survey in Cork Harbour, as well as practicing data acquisition and data processing by producing a detailed model of the area surveyed.

The hydrographic surveying component of the Eurofleets+ Floating University is part of a postgraduate module (Level 9) developed by INFOMAR, Ireland's seabed mapping programme, a partnership between Geological Survey Ireland and the Marine Institute.

Students engaged in workshops led by expert practitioners from INFOMAR and guest lecturers from the National Institute of Oceanography and Applied Geophysics (OGS) Italy, SMART Sea School, and supported and hosted by University College Cork.

Outcome and benefits of the Eurofleets+ training survey include but are not restricted to:

- Extends the opportunity to train on a national research vessel for early career stage researchers from Irish and European Higher Education Institutes.
- Provides necessary experience for young scientists to identify career and research pathways, realise their potential and contribute to the sustainable development of the blue economy.
- Makes available a fully equipped platform for the collections of real time data for project work and module practical sessions with a comprehensive suite of mechanical, acoustic and hydrographic equipment and instrumentation.
- A structured offshore learning environment for developing a critical understanding of the provenance of hydrographic data sets.
- Delivers authentic experience of offshore operations, vessel management and survey design and planning to emerging hydrographers.
- Produces a cohort with an enhanced offshore skill set and increased ability to compete for employment across different sectors of the marine economy.
- Puts an international RV fleet at the disposal of an international student body through the collaboration of international research partners around the North Atlantic Basin.

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- Builds international capacity for the conservation and sustainable development of marine natural resources.
- Consolidates and builds on the achievements of previous EUROFLEETS programmes in extending opportunities for training in offshore data collection to an international student community.
- Fosters collaborative marine research between key marine agencies and institutes on a national, European and international level.

Full Course Outline.

EDUCATIONAL ACTIVITIES		
Learning and teaching methods	Topic	Hours
Presentations	**Presentation 1** Eurofleets+ Overview **Presentation 2** "Ocean mapping: A Global Perspective "	2.5hrs
Lectures	**Topic 1**: "Overview of seabed mapping" **Topic 2:** "Fundamentals (oceanography & sampling)" **Topic 3**: "Marine Geohazards" **Topic 4:** "Seafloor Mapping " **Topic 5**: "Marine Survey Planning" **Topic 6**: "Products & Dissemination" **Topic 7:** "Impact of Seabed Mapping"	14hrs
Fieldwork (Ship)	**Topic 1**. Vessel Safety Tour and Orientation **Topic 2.** Marine Mammal Observation **Topic 3.** Drylab Overview **Topic 4.** Sound Velocity Profile **Topic 5.** Sedimentology **Topic 6.** Benthic Ecology **Topic 7.** MBES/SB Data Acquisition **Topic 8**. MBES Data Processing Practical **Topic 9.** Sub-bottom Profiling Data Processing Practical **Topic 10.** Bridge Tour **Topic 11.** Presentation of Scenario **Topic 12.** FMGT Practical **Topic 13.** Ground-truthing Survey **Topic 14.** Mini-ROV Investigation **Topic 15.** Gravity and Box Core Practical Session **Topic 16.** Beam Trawl Fisheries and Megabenthos Practical **Topic 17.** Survey Report Overview	24 hrs
Laboratory Practical	"Seabed Classification"	2hrs
Group project	Importance of Seabed Mapping Presentations	3 hrs
Report	Cruise Report	6hrs

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ASSESMENT

- Presentation of the on-board activity and preliminary results by students
- Pre- and post-course evaluation test

Course and cruise Log

Onshore Lectures

The onshore lectures provided an overview of the science of seabed mapping by providing class based learning ahead of practical offshore survey experience.

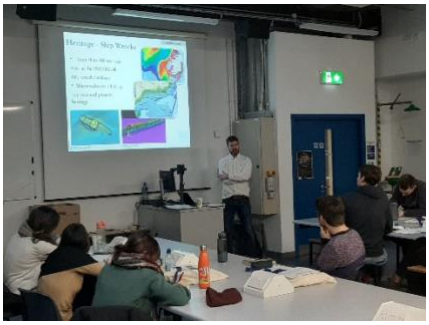
The course outlined the importance and impact of seabed mapping, and featured a range of topics outlined below delivered over three 4 days:

Pre-Cruise

Day 1 Training Activities –

- **Overview of seabed mapping,**

An introduction to seabed mapping, and more specifically Ireland's seabed mapping programme efforts over the past twenty years were presented including examples of different applications of seabed mapping. Introduction to other National mapping efforts around the globe were also presented. The lecture also introduced the importance of our ocean resources and their value in terms of blue growth for the marine sector.



- **Fundamentals (oceanography & sampling)**

This lecture introduced the physical characteristics of the ocean, its effect on other Earth systems and discussed the interdisciplinary nature of oceanography. Topics included the origin of oceans/seas and seafloor features/landforms (tectonic plates, mid-ocean ridges and subduction zones & ocean currents (surface and deep-water) and their influence. The basic principles of seabed sediment classifications and composition were discussed together with the methods and techniques for ground truthing seabed sediments. International projects relating to ocean science are presented.

- **Marine Geohazards**

Marine Geohazards are conditions which exist at the seabed or within the seabed subsurface that have the potential to cause significant disruption to marine operations (e.g. exploration, seabed mapping, hydrographic survey, offshore installation).

This lecture introduced the different types of marine geohazards that are encountered in the course of offshore operations. The major marine geohazards are shallow gas and associated escape structures,

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mud volcanoes, diapirism, earthquakes, submarine landslides, subsidence, tsunamis, and bedforms (sand waves).

Day 2 Training Activities

- **Seafloor Mapping**

This lecture provided an overview on the history and evolution of underwater acoustics, how sound waves travel and interact with the seabed and three of the main modern methods we have for seabed mapping – singlebeam echosounder (SBES), side scan sonar (SSS) and multibeam echosounder (MBES). It begins with the emergence of underwater acoustic science from the 19th century, followed by an examination of how sound propagates through water, its frequency, wavelength, spreading and absorption properties and how these relate to the resolution of our mapping. With these topics covered, the lecture moves on to the principles of echosounding, on which seabed mapping technology is based. This gives us the fundamental knowledge of how depth can be measured using sound, from which we describe how various mapping technologies work and present an overview of the various types of data that are output from multibeam echosounder surveys and their applications.

- **Marine Survey Planning & Ocean mapping: A Global Perspective**

This lecture covered a wide range of aspects in relation to survey planning, all of which must be considered when mapping an area of seabed for any application. An overview of different applications and their respective survey needs were presented first, from nautical charting to dredging and offshore renewable energy. This was followed by survey planning considerations – legal aspects such as environmental legislation with regard to vulnerable species and potential diplomatic clearances that may be needed, followed by looking at considerations such as the marine environment itself and safety at sea. The second section of the lecture dealt with survey specification, such as the accuracy and resolution requirements for different surveys depending on the intended use of the data, following which we deal with the task of choosing the appropriate vessel from a wide range of platforms such as large offshore vessels, smaller inshore craft and autonomous or remotely operated vehicles. Once the vessel and instruments were selected, the next task to be discussed was mobilisation of the equipment and the different ways it can be mounted on the vessel. Finally, considerations about weather and sea state were discussed in the context of survey planning.

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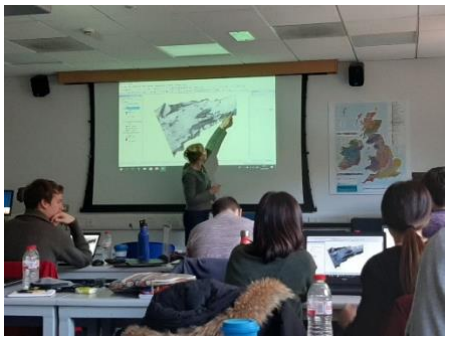
Post Cruise

Day 6 Training Activities

- **Products & Dissemination**

This lecture provided a clear and interactive overview of the INFOMAR data life cycle.
Key data concepts were introduced with a focus on the various datasets created and showcased the various solutions implemented by INFOMAR to deliver data and services. This was followed by an overview of the data integration programme describing how various national and international portals and initiatives utilise seabed mapping data and handle data visualisation including novel methods such as 3d virtual solutions, sand boxes and augmented reality.

- **Seabed Classification Practical**

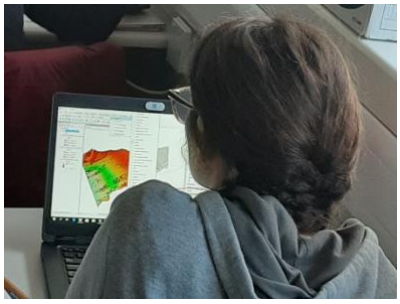


This practical provided a step-by-step guide on how to classify MBES bathymetry and backscatter into a substrate map using ArcGIS tools divided into 3 main sections:

1. Tracing rock outcrops from a shaded relief image of the bathymetry.
2. Classifying backscatter into discrete acoustic classes corresponding to different sediment types using isoclustering.
3. Ground-truthing acoustic classes into sediment classes using sample data.

An additional exercise on estimating the area of potential kelp habitat using the extent of rock substrate and calculated infralittoral depth zone was also provided.

Day 7 Training Activities



A detailed knowledge of the seafloor contributes to an understanding of the marine environment and underpins marine spatial planning decisions relating to range of sectors including Navigation & Safety at Sea, Fisheries, Aquaculture, Renewable Energy and Habitat Mapping to name a few. This lecture explored and discussed the wider impacts and benefits of seabed mapping and provided practical examples based on the learnings and experience of the wider INFOMAR team. From the lecture the students gained a clear understanding in societal, environmental and economic contexts of the impacts of seabed mapping.

On board operation

Day 3 Training Activities

Training on day 3 began with embarkation at 08:30 at Horgan's Quay. After embarkation there was a safety tour followed by round table introductions of instructors and students, lay out of training objectives and schedule, and a presentation on the Cork Harbour study area. Students then divided into two groups for

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toolbox talAB on the vessel data acquisition systems and Marine Mammal Observation guidelines for acoustic surveys.

Seabed sampling and data collection practicals took place in the shipping channel of the tidal River Lee between Ringaskiddy and Cobh. Weather conditions confined sampling and data collection to this area. Physical sampling of the seabed was carried out with a day grab and sought to characterise the geophysical and biological properties of sediments in the shipping channel at three stations between Ringaskiddy and Cobh. At each of these stations a sound velocity probe was lowered for MBES calibration and to establish temperature and salinity profiles of the water column. Students were rotated through these stations in three groups to ensure that each student had the opportunity to learn the skills involved.
On completion of station data collection and sampling students broke into two groups for alternating practical sessions of MBES and Sub-Bottom Profiling data acquisition and, MBES data processing. Data acquisition took place in the dry lab and processing utilised the mess.
The return transit to Cork was occupied with exposition of a scenario challenging students to develop a survey plan for dredging the shipping channel. For this students again separated into two groups with each group roleplaying a surveying consultancy.
Students disembarked at 17:00.

Day 4 Training Activities
Students boarded the vessel at 08:30 and divided into two teams to formulate and present to instructors their responses to the channel dredging scenario laid out the previous day.

Following this student divided into two groups and carried out a survey of the shipping channel between Ringaskiddy and Cobh using elements of their own presentations and practicing the sampling and ground truthing skills taught on day 1. For this students divided into two groups and alternated between acoustic data acquisition using MBES and SBP in the drylab and ground truthing using the day grab on the deck and in the wetlab. A key element of day two of SMART lead student training programmes is that practical sessions are student led.

Additional activities on day 2 included an exposition of wheelhouse operations concentrating on the pivotal role of the vessel crew in ships navigation, instrument deployment and delivery of the survey's goals. Passage back to the ship's berth at Horgan's quay were taken up with the exposition of a poster composing challenge. For this students divided into two teams where each team was tasked with the production of a poster to present the products and societal benefits of seabed mapping. Design and layout of the poster was discussed on the return passage to the Port of Cork with drawing and production

Students disembarked at 17:00.

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Day 5 Training Activities

Students boarded the vessel at 08:30 and divided into two teams to complete the poster challenge and present to instructors.

Following this a station was occupied in the Anchorage off Spike Island to launch the Videoray mini ROV and to collect Core samples using a 2m gravity core and Reineck Box Corer. The high sediment load and strong currents generated by heavy catchment rainfall and strong winds in the harbour constrained clear images of the seabed. Of the cores, the Reineck was the most successful in penetrating the seabed and obtaining a sample.

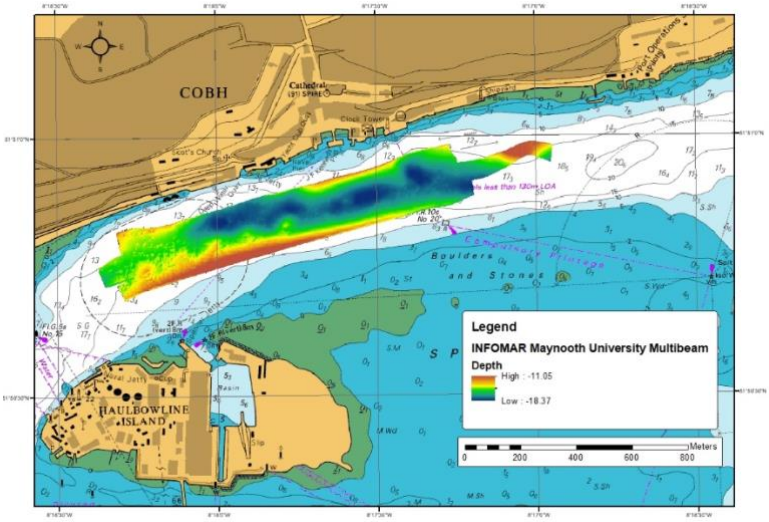

Figure 1Survey Area with student bathymetric data

Operations then progressed to deployment of a 4m beamtrawl to demonstrate fishery and megabenthos sampling. For this students again divided into two groups and rotated through fisheries and benthic data collection practical's.

The return passage to the Port of Cork was occupied by a recapitulation of the day's activities and a Multiple Choice Question (MCQ) quiz on acoustic data acquisition and seabed surveying. Students were also asked to evaluate the training experience through an online form.

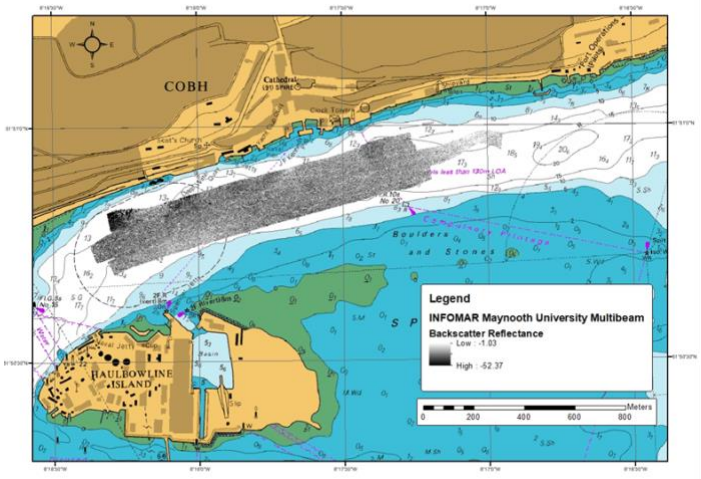

Figure 2 Survey Area with student backscatter data

It should be noted that weather conditions at the time of the survey would have prevented it taking place in any location other than Cork Harbour.

Figures 1 and 2 show survey transects and data products from multibeam and sub-bottom profiling.

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Table 1. Timetable for offshore Day 1 training activities

Vessel Op	Start Time	End Time	Deck Ops	Student Activity			Duration
Alongside	08:30	08:45		Students join vessel			15
	08:45	09:00		On-board Safety Tour			15
Depart & passage	09:00	09:40		Welcome and vessel / team orientation. Intro to the day & Learning Outcomes (JB/OM). Story map of Cork (AB/JB).			40
Group split into 2				**Red Watch**	**Green Watch**		
Passage	09:40	10:00	MMO	MMO Deck watch (JB)	Drylab Overview (AB)		20
Passage	10:00	10:20	MMO	Drylab Overview (AB)	MMO Deck watch (JB)		20
	10:20	10:30		Break			10
Group split into 3				**Red Watch**	**Green Watch**	**Blue Watch**	
Marino Point	10:30	11:15	Grabs/SVP	SVP - Drylab (OM)	Sedimentology – Wetlab (AB)	Benthic Ecology – Deck (JB)	30
Marino Point	11:15	12:00	Grabs/SVP	Benthic Ecology – Deck (JB)	SVP - Drylab (OM)	Sedimentology – Wetlab (AB)	30
Steam to Whitegate	12:00	12:45		Lunch			45
Marino Point	12:45	13:30	Grabs/SVP	Sedimentology – Wetlab (AB)	Benthic Ecology – Deck (JB)	SVP - Drylab (OM)	30
Group split into 2				**Red Watch**	**Green Watch**		
On station Near Whitegate	13:30	14:45	SVP	MBES/SBP Data acquisition. (AB)	MBES Data Processing Practical (OM)		75
On station Whitegate	14:45	16:00	SVP	MBES Data Processing Practical (OM)	MBES/SBP Data acquisition. (AB)		75
	16:00	16:30		Exposition of seabed survey dredging scenario (T			30
	16:30	17:00		Group discussion / planning of scenario			30
	17:00	17:15		Disembark			15

Table 2. Timetable for offshore Day 2 training activities

Vessel Op	Start Time	End Time	Deck Ops	Student Activity	Duration

This project has received funding from the EU H2020 research and innovation

Alongside	08:30	08:45		Students join vessel		15
Depart & passage	08:45	09:45		Survey design & planning – group preparation. (All)		55
	09:45	10:15		Survey plan presentations X 2		20
Group split into 2				**Red Watch**	**Green Watch**	
	10:30	11:30	Grab SVP	Survey (MBES/SVP/SBP)(AB)	FMGT practical (OM)/ groundtruthing (JB)	60
	11:30	12:30		Lunch break		60
	12:30	13:00		Wheelhouse operations exposition		30
Group split into 2				**Red Watch**	**Green Watch**	
	13:00	14:30	Grab SVP	FMGT practical (OM) / groundtruthing (JB)	Survey (MBES/SVP/SBP) (AB)	60
	14:30	15:30	Grab SVP	Survey (MBES/SVP/SBP) (AB)	FMGT practical (OM) / groundtruthing (JB)	60
	15:30	15:45		Break		15
Passage to Cork	15:45	16:30		Seabed Mapping Poster Challenge		45
	16:30	17:30		Disembark		30

Table 3. Timetable for offshore Day 3 training activities

Vessel Op	Start Time	End Time	Deck Ops	Student Activity	Duration
Alongside	08:30	08:45		Students join vessel	15
Depart & passage	08:45	09:45		Poster Production (All)	6
	09:40	10:00		Poster presentations X 2 (All)	20
Group split into 2				**ALL**	
	10:00	11:30	ROV	Video Ray Mini ROV Demonstration (All & Brendan Barry)	30
	11:30	12:30		Lunch break	60
	12:30	13:30	Cores	Gravity Core and Box Core	60

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	13:30	12:30		Lunch break		60
Group split into 2				**Red Watch**	**Green Watch**	
	13:00	14:30	Beam Trawl	Fisheries Beam Trawl (JB & AB)	Benthos Beam Trawl (JB & AB)	60
	14:30	15:30		Benthos Beam Trawl (JB & AB)	Fisheries Beam Trawl (JB & AB)	60
	15:30	15:45		Break		15
Passage to Cork & alongside	15:45	16:00		Multiple choice test		15
Alongside	16:00	16:30		Closure discussion Debrief about experience, future career. Feedback questionnaire.		30
Alongside	16:30	16:45		Disembark		15

Preliminary results

The samples and data acquired during the course of the survey were worked up in a series of practical's provided on day 6 of the course during the "Seabed Classification" laboratory practical.

Data sets collected include:

- SVP data
- Sediment data for geophysical characterisation
- MBES and Sub-bottom Profiling Products

Evaluation of student learning

Students participated in a Pre-cruise Pre Evaluation of Participant Learning Test to establish a baseline knowledge of the participants to estimate whether the key learning objectives of the EUROFLEETS+ Floating University *"Mapping the Ocean Floor: An Introduction to Practical Aspects of Hydrographic Surveying"* were met. The Participant Learning Test consisted of 21 multiple choice questions based on the key learning objectives for the Floating University. Participants were also tasked with developing and presenting their understanding of Sea Bed Mapping while working collaboratively in teams to the instructors. The results of which can be seen in Appendix 1. Additional students had the opportunity to each present their specific area of study to the instructors and the participants as an exercise during the course.

Students course evaluation

The students were invited to provide feedback for the course on the final day, and submitted their answers through an online form, the results of which are detailed in the table below.

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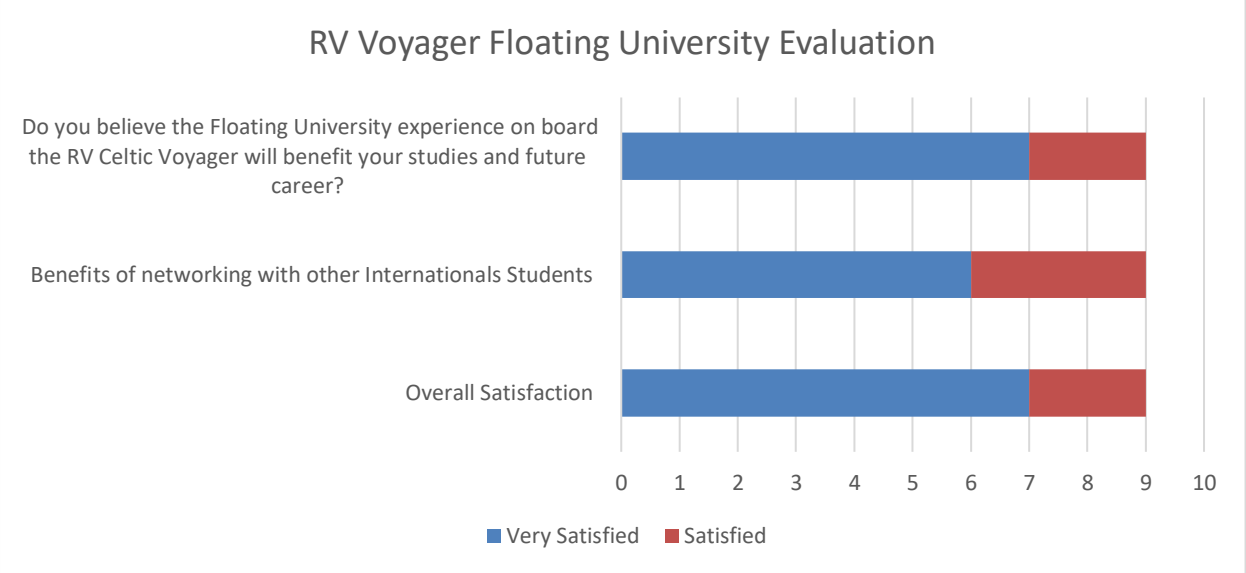
Overall the response to the delivery of the Eurofleets+ RV Mapping the Ocean Floor: An Introduction to Practical Aspects of Hydrographic Surveying Floating University was highly rated with 78% of participants Very Satisfied and 22% satisfied. Although all students felt that they benefited from networking with other international students, some felt that the group was small and that they had an expectation that there would be more PhD students taking part. However, the majority of students were confident that the experience would benefit their studies and future careers.

Student highlights were their experience on board the RV Voyager and the opportunity to put into practice first hand their knowledge and skills, and complemented the depth of experience and the openness of the lecturer both on board and in class. It was suggested that an improvement could be more time devoted to Sub-bottom Profiling Data and Processing as well as more time on-board the vessel.

A video capturing the students experience was made and can be found here: [RV Celtic Voyager Floating University Eurofleets+]



On Board Activities Evaluation Survey Response

Programme Elements	Very Satisfied	Satisfied	Neutral	Unsatisfied	Very unsatisfied	Total
Sound Velocity Profile	8	1	0	0	0	9
Beam Trawl Fisheries & Benthos Practical	8	1	0	0	0	9
Sedimentology -Wetlab	7	1	1	0	0	9
Benthic Ecology-Deck	7	2	0	0	0	9
MBES/SB Data Acquisition- Drylab	7	2	0	0	0	9
MBES Data Processing Practical	7	2	0	0	0	9
Bridge Tour	7	2	0	0	0	9
Ground-truthing Survey	7	2	0	0	0	9
Drylab Overview	6	3	0	0	0	9
Presentation of Scenario	6	3	0	0	0	9
FMGT Practical	6	3	0	0	0	9
Poster Production Practical	6	3	0	0	0	9

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Marine Mammal Observation	5	4	0	0	0	9
Gravity and Box Core Practical Session	5	2	1	1	0	9
Survey Report Overview	5	4	0	0	0	9
Vessel Safety Tour and Orientation	4	5	0	0	0	9
Sub-bottom Profiling Data Processing Practical	4	2	0	2	1	9
Mini-ROV Investigation	4	3	2	0	0	9
Whole Survey	4	3	2	0	0	9

Classroom Based Learning Activity Survey Response

Programme Elements	Very Satisfied	Satisfied	Neutral	Unsatisfied	Very unsatisfied	Total
Overview of seabed mapping	6	3	0	0	0	9
Fundamentals oceanography & sampling	4	4	1	0	0	9
Marine Geohazards	4	4	0	1	0	9
Seafloor Mapping	5	4	0	0	0	9
Marine Survey Planning]	4	4	1	0	0	9
Products & dissemination	5	4	0	0	0	9
Seabed Classification Practical	6	2	1	0	0	9
ArcGIS Practical	6	2	1	0	0	9
Impact of Seabed Mapping	6	2	1	0	0	9

Concluding remarks

Overall the floating university provided an overview of remote sensing techniques, helping them to understand bathymetric data products, to recognize data limitations, and to identify key systems and practices used in the field of seafloor surveying. Students also developed a technical grounding in mapping at different resolutions, and the importance of instrumentation calibration, quality control and processing of bathymetry datasets, before product delivery to end users.

The course was taught within the context of end users, stakeholders and the policy framework underpinning ocean science and Ocean Literacy, highlighting both the relevance and importance of mapping the Earth's seafloor.

Eurofleets+ would like to sincerely thank and acknowledge the INFOMAR, Marine Institute, Geological Survey Ireland, SMART Sea School (GMIT) and UCC School of Biological, Earth and Environmental Sciences teams for their outstanding support in delivering the first Eurofleets+ Floating University Mapping the Ocean Floor: An Introduction to Practical Aspects of Hydrographic Surveying" On board the R/V Celtic Voyager.

Appendix 1Poster Presentation

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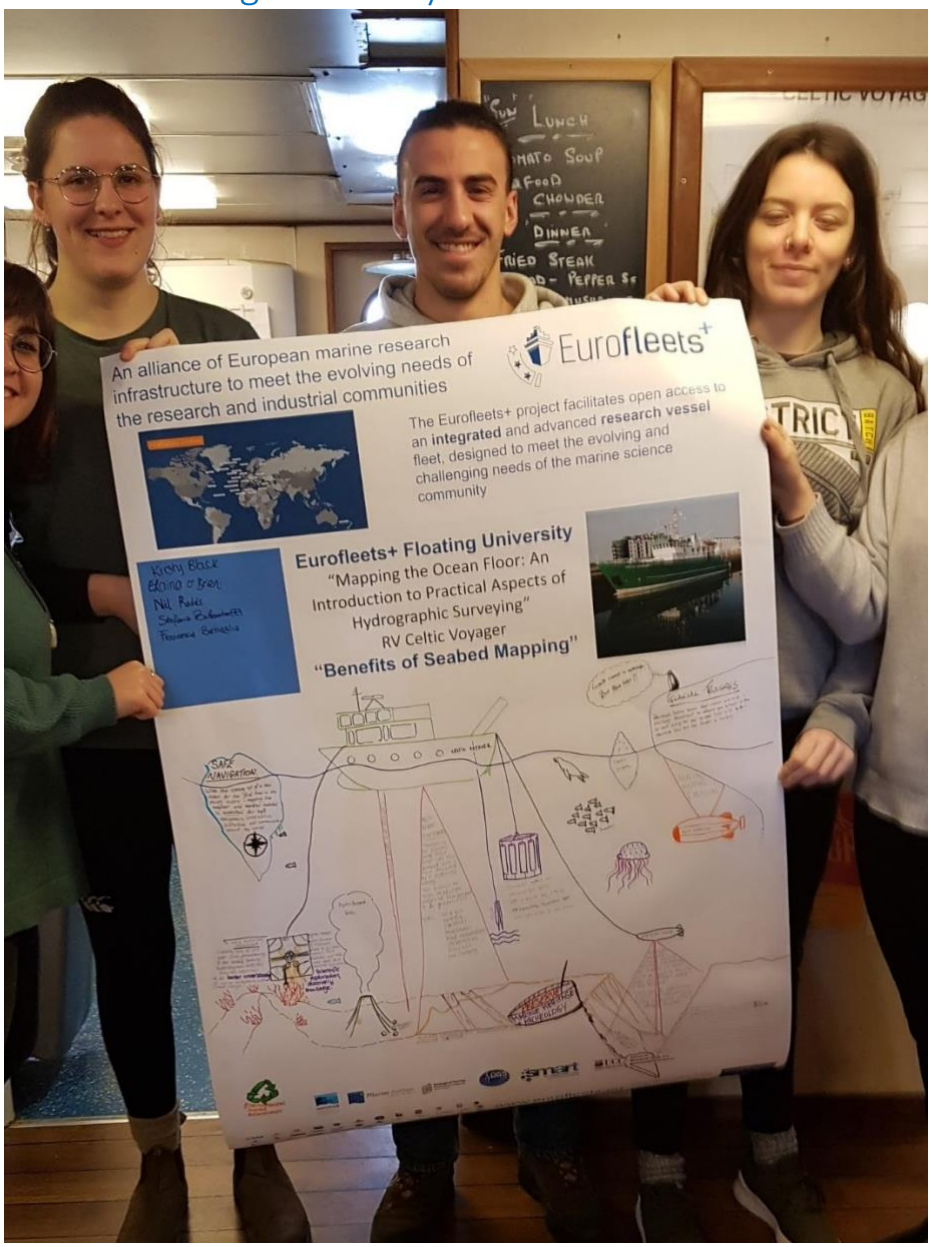

Sebed Mapping Poster Group 1

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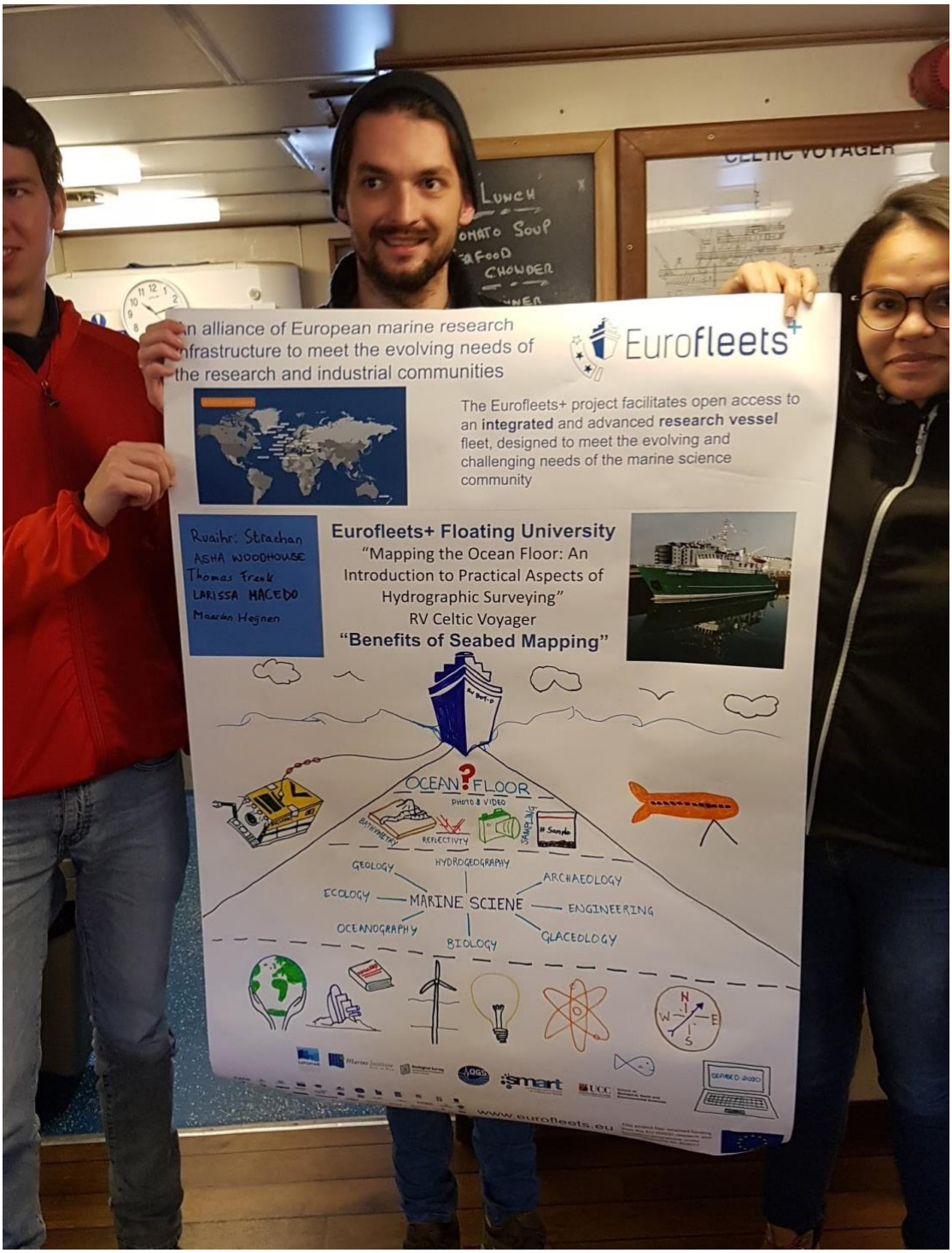

Sebed Mapping Poster Group 2

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Appendix 2 Images From Offshore Activity

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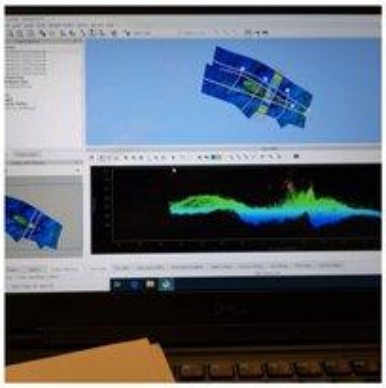




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Appendix 3 Certificate of Participation

Appendix 4 RV Celtic Voyager Floating University Eurofleets+ Video

Annex 3

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EUROFLEETS+ Floating University

"Use bio-optical parameters as convenient tool to study marine biogeochemical processes "

Onboard the R/V Oceania

during the passage from Gdansk, Poland to Tromso, Norway 4-16 June 2020..

The EurofleetsPlus "Floating University"

Costly Trans National Access (TNA) of Global/Ocean class Research Vessels (RVs) cannot be assigned on the basis of need, but have to be obtained only on the base of scientific excellence. This presupposes adequate planning and implementation of high-return first-class scientific research. However, less equipped countries cannot compete for TA with the countries that own, manage and access Global/Ocean class Research Vessels to perform first-class scientific research.

Eurofleets+ will utilise the unique facilities offered by the fleet and equipment and the experience and knowledge of the consortium to deliver five 'Floating Universities', a series of ship-based training initiatives in marine related sciences areas such as scientific instrumentation, the collection and processing of samples, data analysis, quality control, and processing.

General course objectives

The general objective of the course is to provide theoretical background and practical experience in conducting instrumental measurements of inherent and apparent optical properties in marine waters and collecting water samples for determination of concentrations of optically significant sea water constituent. Student will be familiarized with latest IOCCG measurements and sampling protocols and

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state of the art optical instrumentation. Training will be conducted during the passage cruise from Gdansk, Poland to Trømso Norway, on board of R/V Oceania which is operated by Institute of Oceanology Polish Academy of Science, Sopot, Poland. The traditional measurement and sampling will be done on selected sites in Norwegian Fjords (see Figure) and as underway measurement along ship track on the Baltic Sea Danish Strait and Norwegian Sea.

Learning objectives

The course is addressed to post-graduates student conducting education and research for development of Master of Science and Ph.D. degree

Students participating in this course will learn to:

- *measure inherent optical properties of sea water using set of state of the art instruments integrated into optical- hydrological probe*
- *process acquired instrumental data performing spectral and noise corrections.*
- *maintain routines of optical instruments.*
- *collect water samples for laboratory measurements, to determine the concentrations of optically significant sea water constituents*
- *laboratory routines for spectroscopic measurements of concentrations of optically significant sea water constituents*
- *conduct measurement of apparent optic properties using profiling radiometer and floating radiometer*
- *Process acquired instrumental data to derive spectral remote sensing reflectance and downwelling irradiance diffuse attenuation coefficient*
- *collect sediment core using standard Niemisto corer*

Course content

The course is composed of a combination of lectures, laboratory work and practical sampling/measurements, and interpretation of optical and bio-geochemical data. Before the cruise, trainees will attend two introductory days (June 4 and June 5, 2020) at Institute of Oceanology Polish Academy of Sciences in Sopot (Poland), with lectures covering the theoretical background in ocean optics and geochemistry, and practical training in laboratory measurements. A description of planned experimental work, survey design & planning, and practical issues will be carried before boarding the research vessel. We will be muster on board RV Oceania on June 6, 2020 in the morning, and leave the Gdansk harbour the same day around noon. On board students will work in two teams/groups conducting measurements and water and sediments sampling on selected station in Norwegian fjords and along the ship track during passage from Gdansk to Norway. Data acquisition and processing workshops will be conducted in the evenings together with lectures presenting the scientific aspects of the study area. Analysis and interpretation of the instrumental measurements data collected during the cruise will begin on board and continue until the last day on-board. The course will end in Trømso (Norway), with a presentation/open discussion on the data collected, and the compilation of the cruise report by students on the last day on-board. Students are expected to return to their home institutions immediately after disembarkation in Trømso on June 16, 2020.

Time Plan

- The course will be from the June 4 to June 16 2020.

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- Participants are expected to arrive to the Institute of Oceanology Polish Academy of Sciences, Sopot Poland on June 4 before noon.
- 1st day: June 4, 2020, in the afternoon at the Institute of Oceanology Polish Academy of Sciences, Sopot Poland the introductory lectures in ocean optics, sampling protocols and safety briefing will be given.
- 2nd day: June 5, 2020, at the Institute of Oceanology Polish Academy of Sciences, Sopot Poland in the morning sampling and instrumental measurements in the Gulf of Gdansk on board of the small research vessel r/v Sonda II, in the afternoon processing water samples and spectroscopic measurements in laboratory (on land)
- From June 6, 2020 to June 14, 2020 on-board activities on r/v Oceania
- June 15, on board post-cruise onshore activities, data interpretation, writing cruise report.
- June 16, 2020 in the morning, arrival to Trømso
- June 16, 2020 in the afternoon, departure to home institutions

Teachers

- Assoc. prof. Piotr Kowalczuk, course leader, chief scientists on board R/V Oceania, training and lectures on ocean optics and inherent optical properties
- Marta Konik - apparent optical properties and in water radiometry
- Joanna/Stoń-Egiert - water sampling, processing, lab measurements
- Dr. Małgorzata-Szymczak Żyła / Dr Ludwik Lubecki – lectures on geochemistry, instruction on collection and processing of sediment cores
- Dr Ludwik Lubecki - lectures on persistent organic compounds pollution

Application

A total of 8 positions are available for European post-graduate students (students of all nationalities enrolled at European universities) and the selection will be based on the information provided in the application form.

ONLINE APPLICATION form available to access at

https://www.eurofleets.eu/applications/

Applications must be received ***by MARCH 15, 2020***

Successful applicants will be notified by APRIL 24, 2020

At the end of the course a certificate of completion will be delivered to all participants. This will include module descriptor of the course.

Costs and travel grants

The course is funded by EU H2020 project Eurofleets+

The course is free of charge, but participants need to pay for their own travel expenses to Sopot (Poland) and return from Trømso (Norway) to their home destination. The accommodation in Sopot on June 4 and June 5 will be provided by course organizers. Lunches during the course activities on June 4 and June 5, and dinner on June 5 will be provided by organizers. The access to laboratories and to the small research vessel r/v Sonda II on June 5 will be provided by Floating University organizer's

Contacts

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- https://www.eurofleets.eu/
- Course organizer Institution: Institute of Oceanology, Polish Academy of Sciences, Sopot, Poland, http://www.iopan.gda.pl/
- on board of R/V Oceania http://www.iopan.gda.pl/oceania.html

For any additional questions, please contact the Course Coordinator:

Piotr Kowalczuk
Assistant Professor
Institute of Oceanology PAS,
ul Powstancow Warszawy 55
81-712, Sopot, Poland
phone: ++48 58 7311 817
e-mail: piotr@iopan.gda.pl

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Annex 4

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under Grant Agreement No 824077

EUROFLEETS+Floating University

"AUV courseLab"

at UGOT - University of Gothenburg

Gothenburg, 18th - 23rd of August 2019

Scientific Participants

Anna Wåhlin (UGOT, instructor)

Johan Rolandsson (UGOT/MMT, intstructor)

Gunnar Svensson (UGOT/MMT, instructor)

Niklas Andersson (UGOT, administrator)

Matthias Obst (UGOT, instructor)

Yixi Zheng

Silas Dean

Gioannis Morfis

Raisa Turja

Mathias Roltz

Sebastian Ritz

Jose-Maria Cordero Ros

Niklas Conen

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Course objectives

Participants of the AUV course in front of the UGOT field station on Kristineberg

Autonomous underwater vehicles (AUVs) have been observing the ocean independently for more than 30 years. The potential of using AUVs in oceans with rough sea condition and extreme weather has been well shown in the last decades. The aim of this course was to teach young scientists in the use of one of the larger AUV systems available, a Kongsberg 'Hugin' AUV. The detailed course schedule can be found in Appendix 1, and two selected course reports are found in Appendix 2 and Appendix 3. Scientists participating in this workshop will learn to:

- Learning (-by-doing) the logistical challenges and advantages with AUVs as research tools
- Acoustic methods for biotope classification and GIS charting
- Limitations and opportunities of AUVs as platforms
- Importance of the AUV sensor suite

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1) Introduction day (Aug 19th)
The participants met in the Big Lecture Hall at Kristineberg field station. They were divided into two groups and everyone made sure the software (HuginOS) and necessary maps were installed on their laptops. Those that needed to borrow laptops or other equipment were given that. The goal of the first day was to get acquainted with the mission planning software and agree on small number of missions that the group wanted to perform. At the end of the day everyone assembpled and the missions were brought up on the big screen and quality-controlled with respect to risk factors, payload requirements etc. The evening assignment was that the two groups merge their missions into four joint missions that would be performed over the coming days.

2) First field day (Aug 20th)
Participants met in the morning on RV Skagerrak, after which we wnet over to Lysekil to load the AUV. A lecture on acousitc methods for identifying biotopes was given by Matthias Obst, and one lecture on Basics of multibeam and sidescan processing was given by José Maria Cordero Ros. Due to difficulties with loading of the AUV, the first mission was postponed until Wednesday morning. Workshop participants worked on a common guide to post processing of the course data (Appendix 4).

3) Second field day, first AUV mission (Aug 21st)
AUV launched for its first mission. Workshop 'huddles' and completes post processing guide (Appendix 4). Revision of mission plans for second mission and download of data from first mission. Participants participated in launch, guard keeping over emergency messages, and recovery.

4) Third field day, second AUV missions (Aug 22nd)
AUV launched for its second mission. Workshop participants wrking on data post processing from first mission and report writing. After recovery, data from second mission Revision of mission plans for second mission and download of data from first mission. Participants participated in launch, guard keeping over emergency messages, and recovery. Arrival at port late at night.

5) Last day, post processing and data analyses
Participants working on report: describing a question, method, limitation or advantage of using AUV, optimal frequency for your application, or similar. Wrapping up on post processing document.
Post processing:

Infrastructure used/shown during the workshop:

The AUV at The University of Gothenburg – called Ran – has good navigation accuracy and carries high resolution acoustic sonars and other mapping instruments. There are only a few AUV:s in the world with Ran's capacity, accessible to science. Thanks to the navigational properties, it can accomplish under-ice missions, and it has been used successfully in Antarctica and under ice in Baltic sea coastal waters.

Ran is a part of the national research infrastructure MUST (Mobile Underwater System Tools), financed by the Knut and Alice Wallenberg Foundation. The infrastructure is open for external users for research purposes. Ran can also, under certain circumstances, be rented by commercial companies.

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Basic data:

Model: Hugin (Kongsberg)

Length: 7.5 metres

Weight: 1850 kg (dry)

Speed: 1-7 knots, cruise speed 4 knots

Maximum dive depth: 3000 metres

Maximum dive length and time: 300 km and 36 h

Sensor suite:

multibeam echo sounder, Multibeam Kongsberg EM2040, 200-400 kHz, 0.7° x 0.7° beam width, swath coverage sector up to 140°

conductivity, temperature and depth sensor (CTD), dual systems SeaBird 911 19plusv2

oxygen sensor, SeaBird SBE43 (dual system)

carbon dioxide sensor, Contros HydroC

nitrate sensor, SeaBird Deep SUNA

chlorophyll/turbidity sensor, SeaBird WetLabs ECOtriplet (FLBBCD)

side scan sonar (= acoustic ”camera”), EdgeTech 2205. Frequencies 75/410 kHz (1-6 km range)

bottom-penetrating sonar (= acoustic ”X-ray camera”), EdgeTech DW216 with configurable chirp

navigation system: DVL-supported Honeywell Hg9900, gives accuracy of better than 0.08% of distance travelled

acoustic communication below surface, 2-3 km between ship and AUV

satellite, radio and WiFi communication in surface mode

Concluding remarks

We believe that the course was a success. Feedback was very positive and we are confident, that the next course will be a success as well. Many people have already shown their interest of joining the upcoming AUV workshop this summer. We will keep the general structure and content of the course, because we believe that it is good that way

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Eurofleets AUV workshop / curse, detailed plan

Group A:
Yixi Zheng
Silas Dean
Gioannis Morfis
Raisa Turja

Group B:
Mathias Roltz
Sebastian Ritz
Jose-Maria Cordero Ros
Niklas Conen

During field work, each group takes turn being 'on shift'. Two persons from each group are outside, two persons inside (then you rotate).

Monday:
Meet in large lecture hall at 10.00 - everyone should have HuginOS installed on a laptop and tested
Each group produces one or several mission plans for Koster Fjord. Save them as .mp files. Monday afternoon (starting at 15.00) we will bring the mission plans up on the screen and have a look together. Then we will discuss how to merge these plans into one or two. Monday night groups work to merge the plans, and the goal is to launch Tuesday morning / lunchtime near the mission area. The missions should be planned so that we minimize the number of launch and recovery operations, but still allow resting time for the crew and technical staff. For example one launch in the morning and recovery early night, or if we need two missions in one day perhaps aim at launch early morning, recover at lunch, launch after lunch and the recovery in time to get a good nights sleep.

Tuesday: On RV Skagerrak. Meet in mess at 9.00
Missions and some lectures. Matthias Obst: Acousitc methods for identifying biotopes
José Maria: Basic of multibeam and sidescan processing
Planning wednesday missions

Downloading data and starting with the post-processing
Google doc for post processing:
https://docs.google.com/document/d/1nHQVdNetEJ8HMSiGWhOyHfPbSxn99W-RVRszcdPgZtg/edit?usp=sharing
Everyone fills in their tips and tricks for post processing

Wednesday: On RV Skagerrak. Meet in mess at 9.00
Missions and some lectures. Matthias Obst: Acousitc methods for identifying biotopes
Student 'huddles': Post processing - fill in Google docs (https://docs.google.com/document/d/1nHQVdNetEJ8HMSiGWhOyHfPbSxn99W-RVRszcdPgZtg/edit?usp=sharing)
Planning thursday missions
Downloading data and starting with the post-processing

Thursday: On RV Skagerrak. Meet in mess at 9.00. Returning to Kristineberg at night
Missions and post processing
Downloading data and working with the post-processing

Friday:
9.00: Summary discussion on post processing. Meet in mess at 9.00
Wrapping up: Make sure you have all the data you need and have done all the post processing steps you need. Start writing your report. Diploma.
Report: 2-5 pages describing a question, method, limitation or advantage of using AUV, optimal frequency for your application, or similar. One take-away message from the week. Reports are due Aug 30th but if possible try to finish them on the flight back - they should not be extensive (but comprehensive)

Post processing:
Google docs where you can share tips and tricks (and let each other know who has what software):
https://docs.google.com/document/d/1nHQVdNetEJ8HMSiGWhOyHfPbSxn99W-RVRszcdPgZtg/edit

Comparison between Measurements from Ship-based and Hugin-based Sensors for Temperature and Salinity

Yixi Zheng[1] and Anna Wåhlin[2]

1. *Centre for Ocean and Atmospheric Sciences, School of Environmental Sciences, University of East Anglia, Norwich, United Kingdom*
2. *Department of Marine Sciences, University of Gothenburg, Gothenburg Sweden*

Abstract

Hugin AUV has the potential to be used in regions with the worst environments. A Hugin AUV named Ran went below the Thwaites Ice Shelf (TIS) and measured the properties of water beneath TIS where no hydrographic data has been made before. As a newly-launched scientific observation platform, an assessment of the performance of Ran's scientific sensors has not yet been made by any third party. This study uses data from two short missions in an estuary in Västra Götaland County, Sweden collected by both ship-based and Ran-based hydrographic sensors to make a comparison between these two sensor-sets. As the ship-based CTD sensor do not have a correct record of time in these missions, the time lag of the measurements cannot be thoroughly evaluated. Further investigation is required to accurately assess the errors. However, in general, Ran achieves a very good accuracy according to the ship-based CTD data.

1. Introduction

Autonomous underwater vehicles (AUVs) have been observing the ocean independently for more than 30 years. The potential of using AUVs in oceans with rough sea condition and extreme weather has been well shown in the last decades (e.g. Griffiths et al., 1998; Dowdeswell et al., 2018; Stone et al., 2018)

In February 2019, a team from the University of Gothenburg working under the Thwaites-Amundsen Regional Survey and Network (TARSAN) project made the very first deployment of AUVs below the Thwaites Ice Shelf. Ran, the Hugin AUV built by Kongsberg for the University of Gothenburg, dove into the ice cavity and measured the properties of water beneath ice shelf. This ground-breaking dataset will help us to better understand the circulation and water masses exchange below the Thwaites Ice Shelf which are almost completely unknown. However, Ran is Kongsberg's first Hugin to be made for scientific research and the first Hugin equipped with conductivity-temperature-depth (CTD) sensors - as a newly-operated observing system, it has not yet been assessed by any third party.

In August 2019, Eurofleets+ Hugin AUV training course cruise took place on the R/V Skagerak in an estuary in Västra Götaland County, Sweden. We obtained ship-based CTD measurements and deployed Ran in two test missions. Some measurements from ship-based CTD and Ran were collected at about the same time and same place which allows us to compare the performance between the hydrographic sensors in ship and Ran. The CTD data collected by both sensor sets are then analysed and a basic comparison is made. This study aims to contribute to the assessing and calibration of hydrographic data collected by Ran.

2. Data

The observations were obtained on 20-21 August 2019 from the Swedish R/V Skagerak under the Eurofleets+ Hugin AUV training course in an estuary in Västra Götaland County, Sweden (fig 1). We deployed Ran twice and the ship-based CTD three times during this short cruise. Station 1 was measured on the 20th of Aug and station 2 and 3 were measured on the 21st. The ship-based CTD measurements were obtained with Sea-Bird Scientific SBE 911 tool with a CTD

sensor and Ran is equipped with a dual Sea-Bird SBE-19 plus V2 sensors.

The temperature and salinity data collected by Ran with two CTD sensors passed a low-pass median filter (with cut-off frequency 0.5 Hz) separately and were averaged and binned into 2-second interval. The data collected by the ship-based CTD sensor has binned by pressure with 0.25-dbar interval and we only use downcast profiles here.

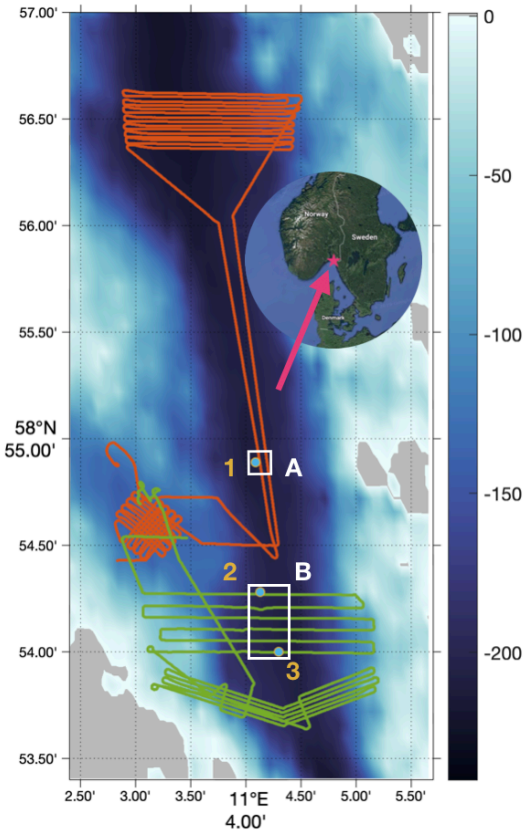

Fig 1. **Map of the study region.** Trajectories of Ran are indicated by the green line (mission on the 20th of Aug) and the orange line (mission on the 21st Aug). Ship-based CTD stations are marked in blue dots with station numbers in yellow. Bathymetry data from EMODnet (EMODnet Bathymetry Consortium, 2018) is shaded in colour scale on the righthand side with grey patches indicating the land. White rectangles indicate the data that would be presented in fig.2 and fig.3. Insect map shows the location of the estuary in Västra Götaland County (obtained on the 4th of Nov, 2019, Google Maps).

3. Results

Here we only compare the data collected by Ran in regions close to the ship-based CTD stations (see fig.1, white rectangles).
The data from region A are shown in fig. 2.

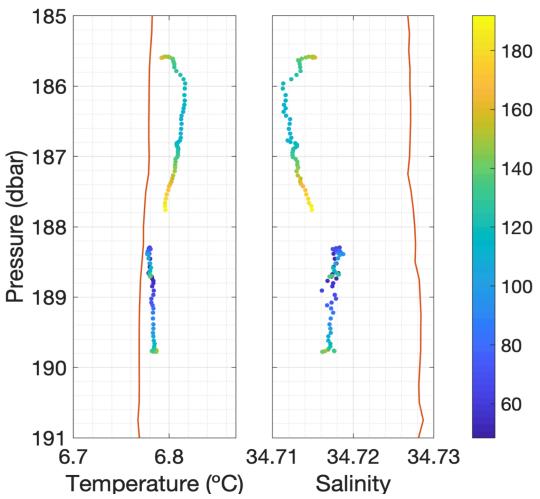

Fig 2. **The comparison between Ran's data and the data collected in ship-based CTD station 1.** Data collected by Ran are indicated by the dots coloured by the distance (in meter) away from CTD station 1. Profile collected by ship-based CTD profile is presented by the orange line.

There are two green lines inside region A. Ran dove to 188-190 dbar (shown in fig.2 as the dots concentrate in deeper level) along the line closer to CTD station 1 and 185-188 dbar (shown in fig.2 as the dots concentrate in shallower level) along the line further away from CTD station 1.

The difference among the dots along the same line does not have a significant pattern. Considering that the water is flowing along the channel, and the sensitivity of sensors, this difference is negligible. Near CTD station 1, the differences are generally smaller along the green line that is closer to CTD station. Within 100 meters away from CTD station, Ran's temperature difference is about 0.03 ºC higher than the ship-based CTD data and salinity is about 0.01 lower than the ship-based CTD data.

The data from region B are shown in fig.3. Note that, in fig. 3 Ran's data are coloured by the distance away from the zonal line where

CTD station 3 (profile coloured in purple) locates. Dots that are shaded in dark blue indicate the measurements that were made close to the station 3 (southmost) and dots in bright yellow indicate the measurements that were made close to station 2 (northmost).

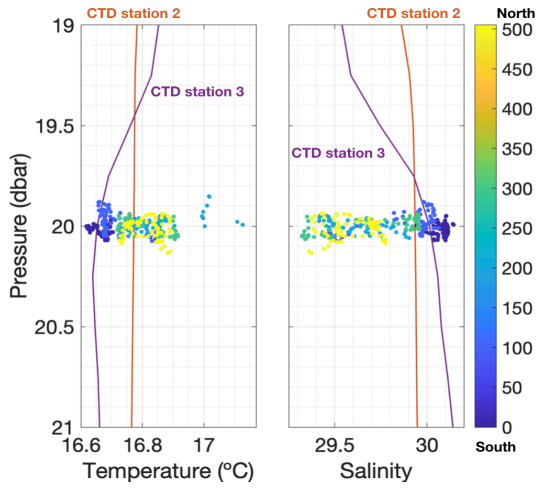

Fig 3. The comparison between Ran's data and the data collected in ship-based CTD station 2 and 3. Data collected by Ran are indicated by the dots coloured by the distance (in meter) away from the zonal line where CTD station 3 locates. Profiles collected by ship-based CTD are presented by the orange line (station 2) and the purple line (station 3).

The water is warmer and fresher in the north than in the south. As we can see from this fig. 3, strangely, while the dots in dark blue have very similar value with the purple profile, showing that at Ran's data being consistent with ship-based CTD's data well in the south; dots in bright yellow have higher temperature and lower salinity compare to the orange profile, suggesting the same pattern of the systematic error as region 1, but in a greater value. The salinity difference is higher in region B than in region A. This could be explained by the rainfall that we encountered on the 21st of Aug as there was a time lag between the time when we made the CTD cast, and the time when Ran passed this region, which allows the freshwater to accumulate. However, Ran's data show a warmer sign of water in the north which is not shown in ship-based CTD data. This might be caused by the temporal variation of water but more test mission is needed to achieve a better answer.

4. Discussion

The limitation of this study is that the CTD casts do not have a correct time record, as the student (Yixi…) mishandled the SBE toolbox. As the result, error induced by the temporal variation of the water in the study region cannot be properly evaluated. The results shown in region A might suggest a systematic error between sensors from Ran and Skagerak which should be calibrated before next mission. The results from region B seen quite suspicious – the water in the north is much warmer than ship-based CTD measurements - more investigation n. After all, Ran's data and ship-based CTD's data are very similar and show the same pattern (warm and fresh water near the sea surface, cold and saline water near the seabed). Ran obtained good measurements.

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6. Acknowledgement

Special thanks will be given to Anna, Filip, Gunna (wrong spelling...), the crew members and all students! <3

Bathymetry data are downloaded from EMODnet Bathymetry Consortium (2018): EMODnet Digital Bathymetry (DTM), see http://doi.org/10.12770/18ff0d48-b203-4a65-94a9-5fd8b0ec35f6 for details.

Title Multi-scale and Multi-agent Geomorphological Landform and Stratigraphy Detection using AUV acoustic sensors

Name: Silas Dean

Affiliation: University of Pisa

Abstract

Training missions in Skagerrak offshore Bohuslän, SW Sweden with the University of Gothenberg and Eurofleet's Kongsberg Hugin AUV "Ran" demonstrate this platform's viability to simultaneously detect geomophological land forms at different scales created by different formation agents. The study area is an uplifting Precambrian granite peneplain dominated by joint-valleys and rocky hills in both submerged and emerged zones, and as such the fjords and areas between islands offer a high range of slopes and environments to gather data with sub-bottom profiler, sidescan sonar, and multibeam echo-sounder. Features detected included large-scale fjord slopes underneath sediment via CHIRP, underwater debris slides/flows and detailed images of granite rocks with sidescan sonar, and striations and sediment accumulations with multibeam. Both the multibeam and sidescan were even able to detect microscale anthropogenic features in the form of trawl marks.

1. Introduction

Bohuslän is located in SW Sweden, opposite Denmark, between which runs the Skagerrak strait. This area of Scandinavia is a peneplain of Precambrian rocks preserved under later sediments then subsequently exhumed in the Paleogene or Neogene (Lidmar-Bergström 1995). Bohuslän is typified by Bohus granite dating to the Sveconorwegian orogeny ~920 Ma, and the emerged landscape is dominated by joint-valleys, often infilled with up to 40 m of Quaternary sediments and glaciomarine clays (Johansson, Migon, and Olvmo 2001). Estimates based on models and observations agree on an isostatic rebound or uplift rate of between 2-3 mm/a; a steady but decreasing rate of relative sea-level drop since 15 ka from 120 m asl to present levels, though gaps in observational data exist, and GIA models do not account for tectonic inputs. (Peltier, Argus, and Drummond 2015).

The Gullmar fjord runs NE to SW ~20km and generally 1-2 km across. High productivity in this and other fjords results in organic rich sediments and hypoxic environments (Polovodova Asteman and Nordberg 2013), which rapidly infill fjords and other near-shore channels. The high sedimentation rate of organic-rich clay sediments provides a high-resolution record for palaeoclimate research, in which centenniel scale fluctuations such as the Medieval Warm Period (Polovodova, Nordberg, and Filipsson 2011; Harland, Polovodova Asteman, and Nordberg 2013) and more recent, shorter-term climate changes (Filipsson and Nordberg 2004) are archived.

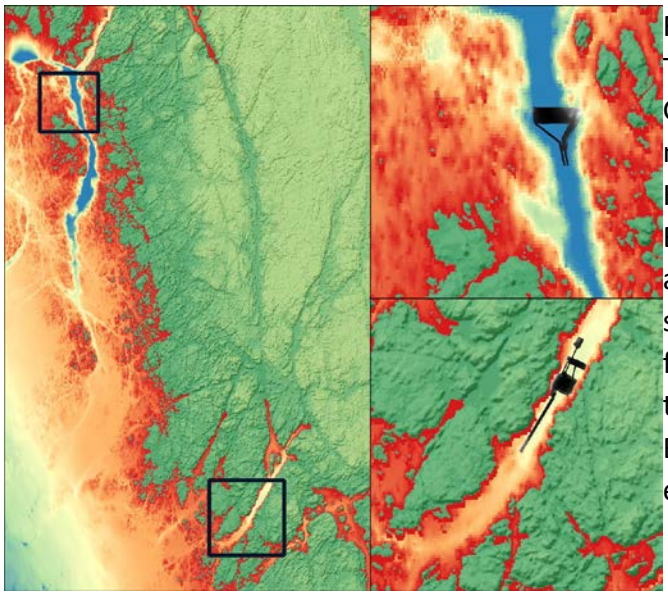


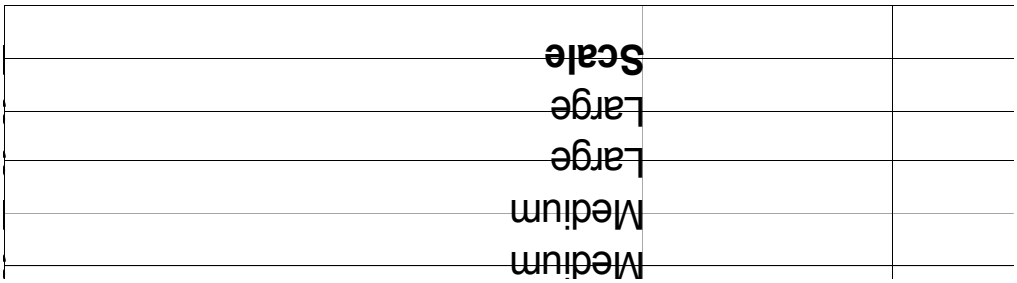
Figure 1. Study area. The southern box is Gullmar fjord. The northern box is Koster channel. Black represents areas of bathymetric surveys. Topography from SRTM and terrestris; Bathymetry from emodnet.eu.

2. Methods

The AUV launched from an inclinable holding frame mounted on the aft deck of the University of Gothenberg's R/V Skagerrak, a 38 m long, 9 m beam, steel-hulled platform for marine science applications with a single screw and bow thruster. The AUV was positioned 15m above the sea floor for these surveys, generally at a speed of 2 m/s. Survey data was collected using Kongsberg EM2040 bathymetric multibeam in 400 kHz and 300 kHz frequencies, and an Edgetech 2205 with sidescan sonar capable of 75 kHz to 1600 kHz frequencies and CHIRP sub bottom profiler capable of 500Hz to 24 kHz frequencies. After extensive post processing, multibeam bathymetry was analyzed with QGIS 3.4.11, while sidescan and CHIRP profiles were viewed using Edgetech Explorer and Kongsberg Reflection.

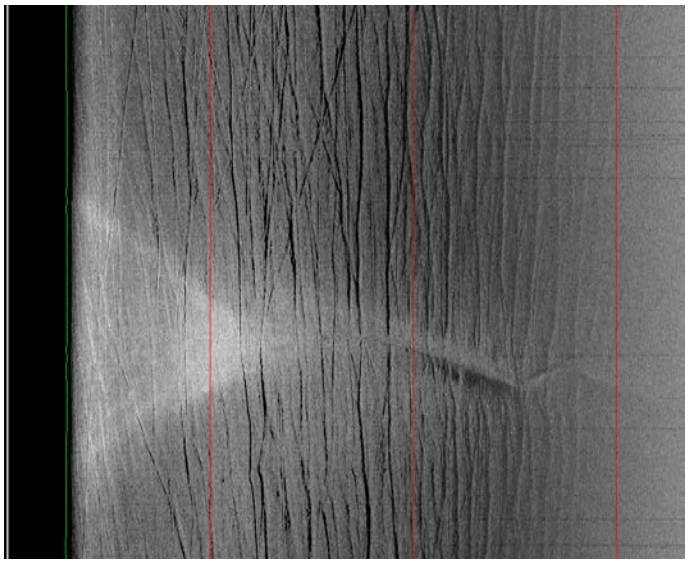
3. Results

The surveys produced a number of results, despite challenges imposed by sea conditions which restrict AUV insertion/extraction locations and therefore increase ship-to-target travel times, and software malfunctions on Mission 1 which prevented the AUV from collecting any sidescan or CHIRP data. The multibeam bathymetry resulted in digital elevation maps of resolutions approximately 1 m after extensive post-processing by subject matter experts. Sidescan images were likely of even higher resolution, while CHIRP data offered exciting glimpses into the stratigraphic record. The types of land forms that could be mapped by the different sensors are presented in the following table, with discussion of some of the most notable finds below. Note that all interpretations of CHIRP data should be subject to additional expert analysis before conclusions are drawn.



4. Discussion

Due to concerns with Ran's collision avoidance capabilities as well as its ability to capture good bathymetric data in extremely high relief areas, mission plans did not include areas of shallow, rocky hills and bedrock stuctures. Instead, deeper areas of the Gullmar fjord and Koster trench were scanned. In Gullmar fjord, the AUV did lengthwise and athwart transects of the fjord channel at the approximate location of one of the deeper cores taken there by previous researchers – core 9004 (Filipsson and Nordberg 2010), though this core was only 8.5 m long and additional post processing and expertise with CHIRP data is necessary to detect high resolution sedimentary sequences. A brief discussion of some of the more



interesting finds from the acoustic sensors follows below.

Figure 2. Sidescan sonar image of submerged landslide in Gullmar fjord. This structure is perpendicular to a fluvial outlet in the fjord wall and lies underwater between 0-100 m depth. The feature is well defined and with proper post processing, accurate measurements of size and morphometric parameters would be possible. Of particular interest is the higher reflectivity of the material in the debris fan at the left side of the image. This area and others like it could provide a sediment record of different resolution and characteristics than the deeper area of the fjord. Since this region is uplifting and the bottom sediments are soft marine silts/clays, this feature presumably formed underwater from higher energy inputs by the valley abutting the fjord at this location. Note also over cutting the feature apparently deep striations parallel with fjord orientation, and trawl marks at oblique angles in sets of two.

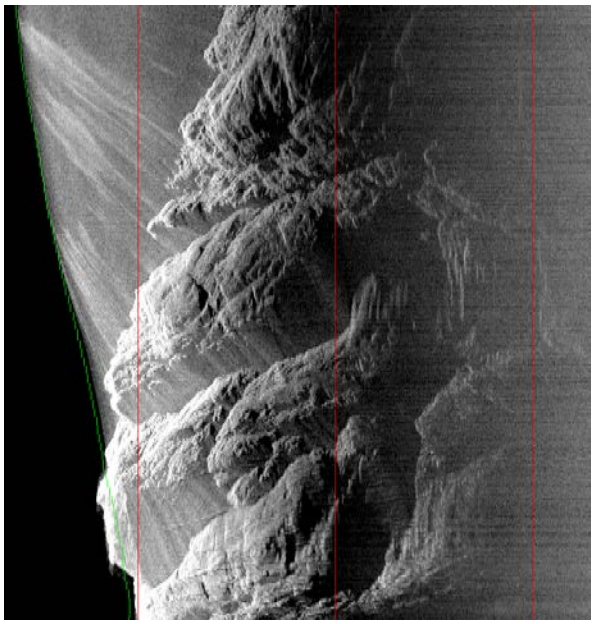


Figure 3. Exposed bedrock/granite hill in Koster channel. The sidescan sonar records these features in great detail despite the high relief, and shows the granite peneplain partially covered by marine sediments. In Gullmar fjord, sidescan images also showed scour patterns of marine sediments around similar rocky residual hills.

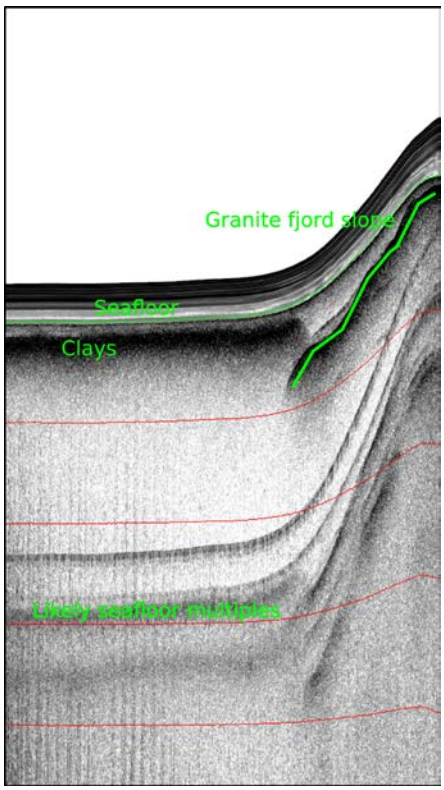


Fig4. CHIRP of half of lateral transect across Gullmar fjord. In all CHIRP illustrations, red lines are 50ms intervals, which should correspond approximately to 37.5 m assuming a 1500 m/s speed of sound. The CHIRP image, at least without further post processing and changes to gain, does not immediately illustrate a detailed sediment sequence down to bedrock. Bedrock is only visible at the periphery (right side) of the fjord, since the bottom lines in the image are presumably seafloor multiples. In the middle of the channel, a poorly delineated but distinct return, seen in the image as a thick, diffuse line seems to occur at about 10 ms below the surface. Whether this is truly a distinct lithological unit, or merely a result of the increasing sediment density due to compaction as depth increases in these types of sediments (Gyllencreutz, Jakobsson, and Backman 2005) is unclear. The Gullmar fjord Core 9004 (Polovodova, Nordberg, and Filipsson 2011) at 8.5m max depth may not penetrate deep enough for a full comparison, and core lithology examined was relatively homogeneous with sand fraction between 0-9 %., aside from a clay/silt/sand horizon at 404-407 m depth, which Polovodova et al. (2011) ascribe to the Medieval Warm Period (MWP). A distinct lithological unit does seem to appear above the bedrock but beneath the sea floor on the right side of the image.

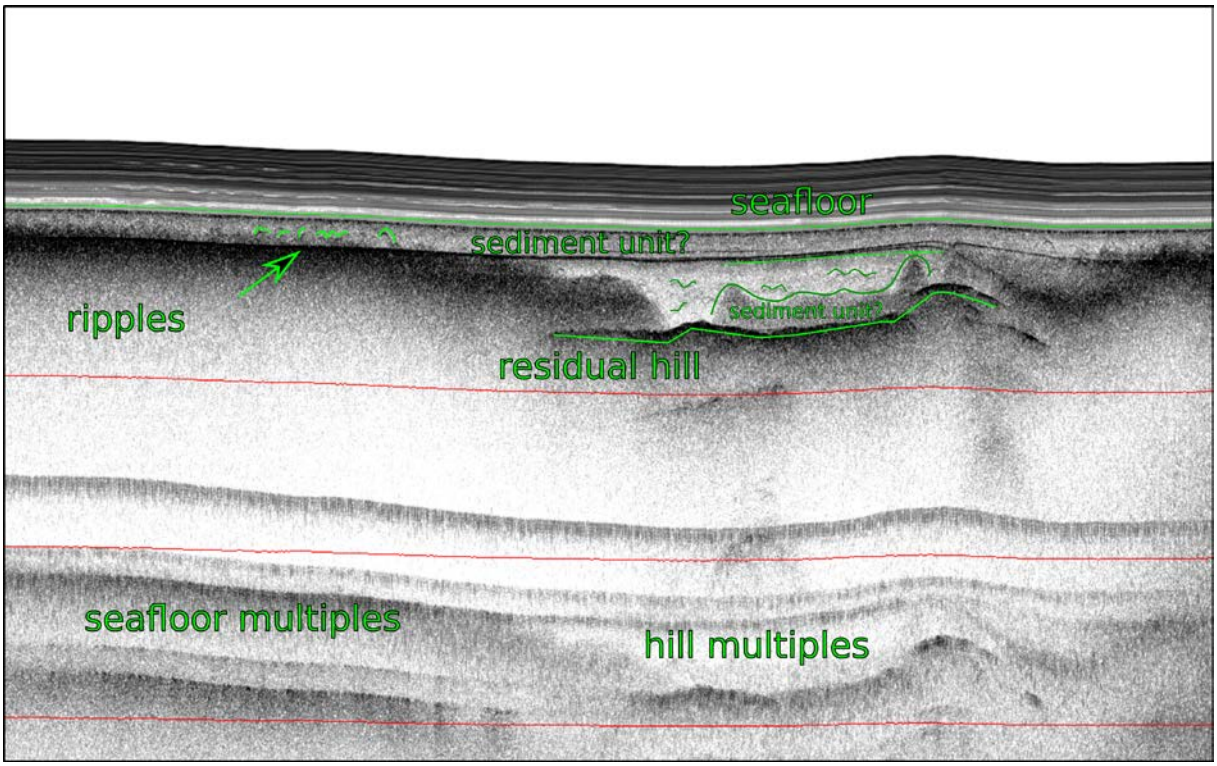


Fig 5. CHIRP of small portion of lengthwise transect through Gullmar fjord, with residual hill from granite peneplain. This piece of the transect passes by a partially exposed residual granite hill, and Ran's CHIRP is able to detect a complex, irregular rippled stratigraphy which may result from the complex depositional environment forced by scouring and currents around the hill. A very thin, distinct reflection is detected at approximately 10ms again. Whether this corresponds to the MWP horizon at ~4m depth detected by Polovodova et al (Polovodova, Nordberg, and Filipsson 2011) or another, deeper unit is unclear.

In the more distal environment of the Skagerrak strait, 4 distinct sedimentary units were detected (Gyllencreutz, Jakobsson, and Backman 2005) above the bedrock or a dense layer of till/diamicton, with the topmost two units being attributed to postglacial sediments. Gullmar likely has a much higher sedimentation rate, so no significant lithological discontinuities were discovered in the 8.5m core 9004 spanning some 2500 years (Polovodova, Nordberg, and Filipsson 2011) it seems likely that the reflections visible in these images represent only a small portion of the Holocene stratigraphy.

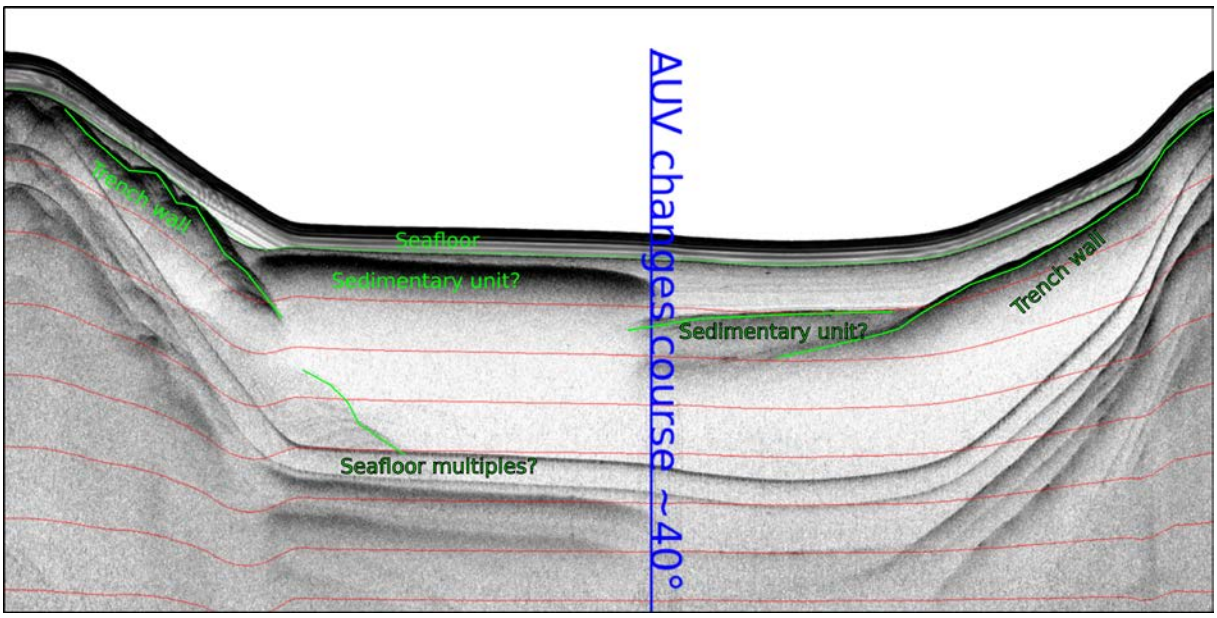


Fig 6. CHIRP transect of Koster trench. Koster trench indicates similar characteristics to Gullmar, but as the trench is deeper and more distal from the coast, a lower energy environment can be assumed. Nevertheless, rippled reflections (too small to be visible in this image) can also be observed in the topmost unit. It is possible these ripples are the result of bioturbation by organisms living in the soil, or by trawling.

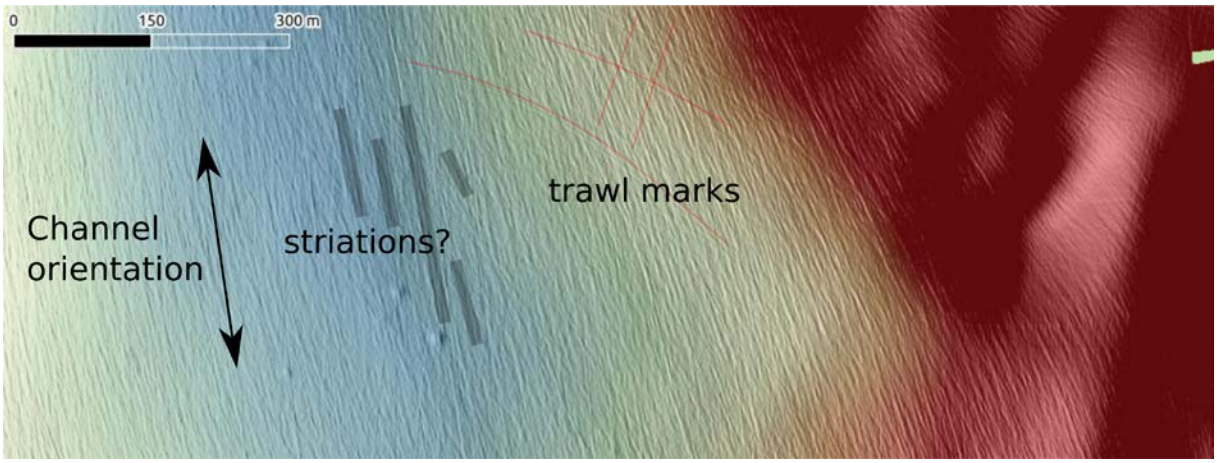


Fig 7. Multibeam bathymetry of Koster trench showing sediment mounds on right side, possibly with rocky hills underneath. CHIRP data was not available from this mission. Long, linear forms going in directions oblique to the channel orientation are certainly trawl marks. More frequent striations (a few are highlighted in the image, but they occur throughout the sea bed) in the soft marine sediment that follow channel orientation may be natural due to current/deposition processes, if not also caused by trawling activity. Study and comparison with the bottom morphology in the marine protected area nearby Koster, where trawling is not allowed, is necessary to assess this. Such study would help determine the rates at which both sedimenation and recovering benthic ecosystems can efface anthropogenic traces and impact bottom morphology.

Overall, the trainning missions demonstrate the excellent capabilities of the "Ran" AUV to supplement existing research and concurrent projects with bathymetric and sub-bottom data, as well as opening up possibilities for multi scale morphometric analyses.

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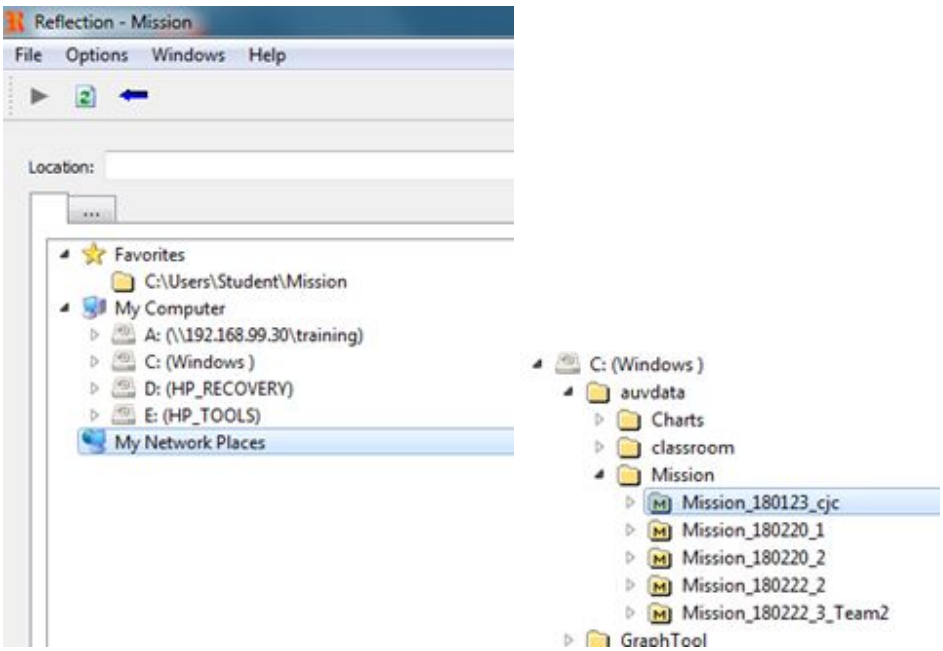
Post processing of acoustic sensor data from Hugin

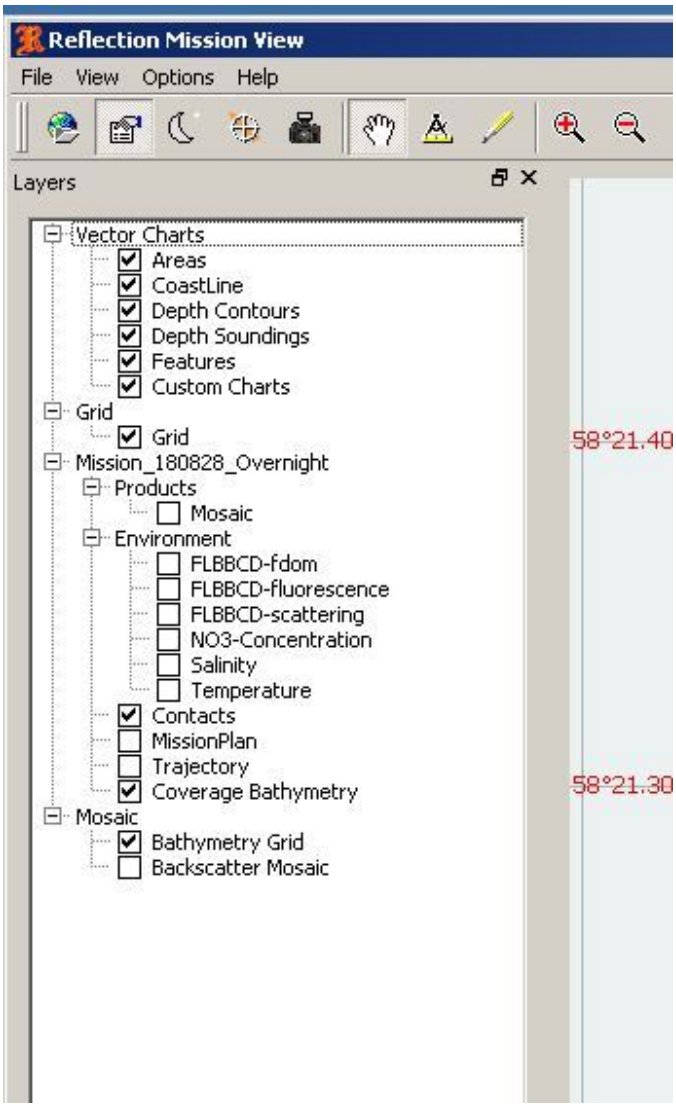
Hardware:
Multibeam: Kongsberg EM2040
Side Scan Sonar: Edgetech 2205
Sub Bottom Profiler: Edgetech 2205

Software:
Reflection
Caris
EIVA

Reflection:
Very user-friendly software that you can install on your laptop and use provided you are connected to the license server (switch in the 'CTD room'). However, only useful to get a first quick view of data - can not export any gridded products or anything.
Download installation media here:
https://www.dropbox.com/s/esfz2d7ypesfjk8/Reflection.zip?dl=0

To get a first view of data, mark the mission folder and then chose the type of data you want to look at (if no choice is made, several types of data is displayed simultaneously)





Exctract depth contours:

1. Right-click in 'Mosaic' menue Bathymetry Grid, chose 'Extract depth contours'

2. Right-click again: 'Save Depth contours'

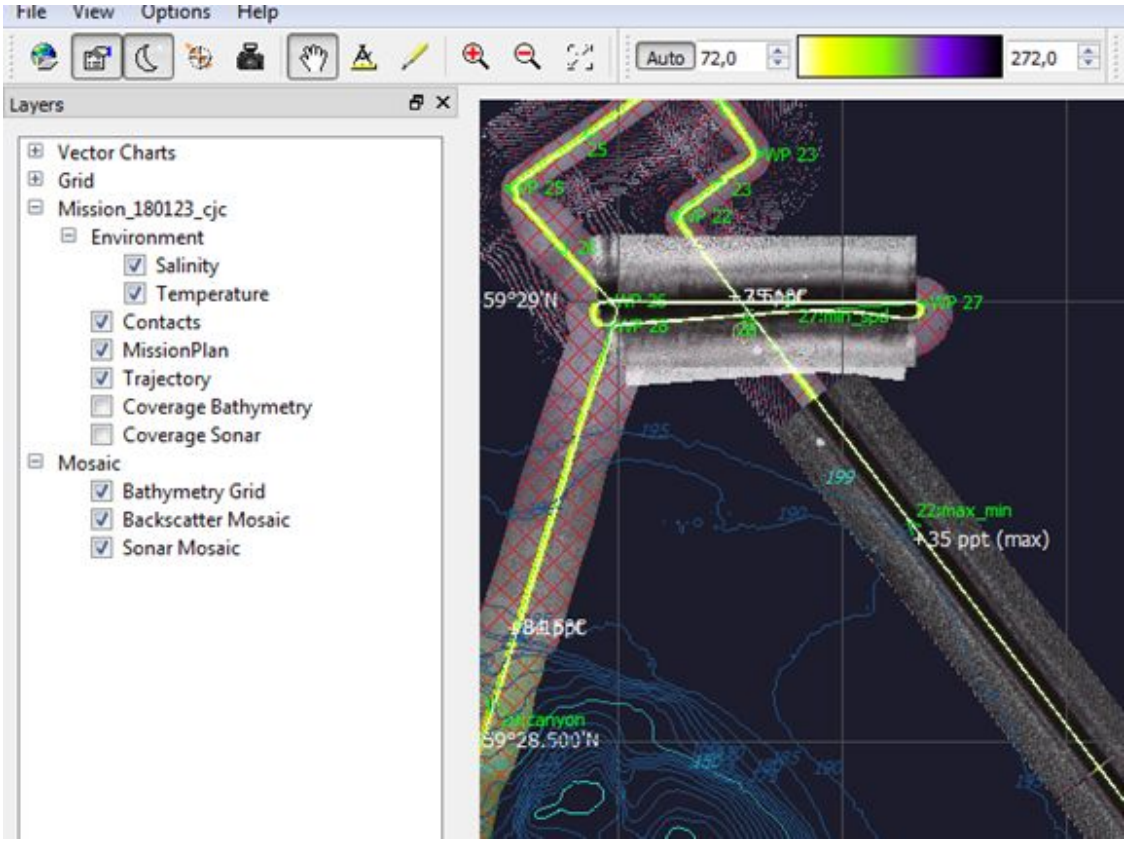
Save depth contours in 'products' folder belonging to that mission

Double-click in movie => target view. Can go closer, go to 3D view etc

Generate report

Environment sensors:

To get a first view, check boxes for environment sensors



GLOBE

GLOBE (GLobal Oceanographic Bathymetry Explorer) is a free application developed by IFREMER for processing and displaying oceanographic data. GLOBE offers processing and display solutions of multi-sensor data within a single 3D environment represented as a globe. Currently, the software is mainly used for processing, analyzing and displaying acoustic data, as well as moving tectonic plates.

Developed in Java, GLOBE is a multiplatform application (Windows, Linux, Mac) whose architecture allows users to develop and add with ease new modules for processing bathymetric data , generating digital elevation models and correcting for tides.

The software is used by the European project EMODnet Hydrography for manipulating and creating digital elevation models.

https://www.flotteoceanographique.fr/en/The-Fleet/Shipboard-software/GLOBE

MBSystem

MB-System is an open-source software package for the processing and display of bathymetry and backscatter imagery data derived from multibeam, interferometry, and sidescan sonars.It is a collaborative effort between the Monterey Bay Aquarium Research Institute (MBARI)

The source code for MB-System is freely available (for free) by anonymous ftp (including "point and click" access through these web pages). A complete description is provided in web pages accessed through links below.

https://www.mbari.org/products/research-software/mb-system/

EIVA Navisuite

EIVA NaviSuite is a software suite for offshore survey and construction operations. It provides acquisition, processing and visualization of multibeam and LIDAR datasets.

Academic licenses, free of charge, can be obtained by accessing the following link https://www.eiva.com/products/special-offers.

Annex 5

This project has received funding from the EU
H2020 research and innovation programme
under Grant Agreement No 824077

EUROFLEETS+Blue Skills Lab

"ROV Lab"

at MARUM - University of Bremen

Bremen, 19th - 21st of November 2019

Scientific Participants

Nicolas Nowald (MARUM, Instructor)

Volker Ratmeyer (MARUM, Instructor)

Christian Seiter (MARUM, Instructor)

Emmanouil Kallergis (HCMR, Participant)

Leonidas Manusakis (HCMR, Participant)

Joel White (UGot, Participant)

Christian Katlein (AWI, Participant)

Nikos Mauromatis (Uni. Patras, Participant)

Nikolaos Georgiou (Uni. Patras, Participant)

Henrich Preuß (IOSB AST, Participant)

Sophia Schillai (MARUM, Participant)

This projecthasreceivedfundingfr omthe EU H2020

Course objectives

Participants of the ROV Lab from left to right: J. White, N. Georgiou, N. Mauromatis, C. Katlein, S. Schillai, L. Manousakis, N. Nowald, V. Ratmeyer and E. Kallergis. Not in the image: H. Preuß, C. Seiter

Scientific ROV Teams do not only need a solid technological background and detailed understanding of their system, but also need to handle the special requirements of scientific ROV operations and requests of the scientific community. Scientific ROV operations differ decisively from those in the oil and gas industry in terms of cruise/dive planning, payload integration, post dive procedures to name but a few. The EurofleetsPlus ROV Lab was addressing to the specific demands of scientific ROV diving in several Class-Workshops and hands on practice which are usually not covered by offshore ROV training courses. The course was offered to ROV Pilots/Technicians with no or basic experience of ROV operations and divided into three Class-Workshops and practical training:

Class-Workshops:

Class-Workshop I: Mobilization, Setup, Telemetry

Class-Workshop II: Operations at sea:

- Dive preparation
- Dive operation
- Post dive procedures

Class-Workshop III: Cruise preparation

This projecthasreceivedfundingfr omthe EU H2020

Aim of the Class-Workshops was to give an comprehensive overview of what needs to be considered in the run-up of the cruise (e.g. working area, payload integration, etc.), during mobilization (adaptation, power conditioning, etc.) and operation at sea (deployment procedures, Vessel - ROV coordination, etc.)

Practical training:

Training with the Schilling Robotics Orion 7P manipulator

Troubleshooting

Scientific training mission in the Quest-SIM

Pre-Dive check on ROV Squid

Training dive with ROV Squid

Aim of the practical exercises was to train the participants on basic flying and navigating a ROV, to handle a manipulator and to take samples, Pilot to Co-Pilot coordination and to pre-dive check a system prior to diving.

Unfortunately, the planned training dive with ROV-Squid could not be carried out, due to a failure in the slipring of the ROV winch.

Seven participants from three European Institutions (Greece, Sweden, Germany) have successfully applied for the ROV Lab. The course was designed for eight. Most participants have a technical background and were into ROV operations since several years, even decades. Others were just starting into the ROV business hence, expertise in ROV operations ranged from little to very experienced. We received eleven applications all together out of which seven were selected and considered as "suitable". Five more applicants missed the deadline or could not join due to temporal reasons. Mrs. Schillai from MARUM joined the course outside EF+ to fill the 8th place but thus, received no EF+ certificate of completion. In terms of gender we had seven male and one female participant.

Nature of the course and work carried out on the course

Our intention was to show and to share our knowledge of how we at MARUM operate ROVs, how we prepare our cruises and everything related to it. We showed and explained course related Powerpoint slides and moderated them to initiate discussion as well as the exchange of experience. The Class-Workshops took place with all participants in a MARUM seminar room.

During the practical exercises, the participants were divided into two or three groups, depending on the exercises.

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Three groups were arranged for the Orion 7P manipulator training and the introduction to ROV Quest and ROV Squid.

Two groups were arranged for ROV-Squid Training dive and the ROV-Quest simulator. As already stated, the training dive with ROV-Squid could not be carried out due to the broken slipring of the winch. The time was used to systematically search the error, as one would do offshore, which turned out to be a good exercise for the group.

All members were present during the pre-dive check of ROV-Squid.

Infrastructure used/shown during the EF+ ROV Lab:

- Orion 7P manipulator training stand
  The training stand consists of a hydraulic power unit, two Pan & Tilt units with color zoom cameras, the Orion 7P, fully proportional, hydraulic manipulator and the corresponding master arm to operate the unit. The training stand requires two pilots. One is operating the arm, while the other is moving the cameras so that the arm operator can fully focus on the sampling and has good visuals on the arm and objects to be sampled.

- ROV Marum-Quest (4000 m)
  Quest was presented as an example for a work-class ROV, designed for heavy deep-sea research. The system was also used to troubleshoot a ground leak of a 24V device.

- ROV Marum-Squid (2000 m)
  The 2000 m light work-class ROV Squid was also presented as an example for a smaller ROV system. In addition, the entire group performed a pre-dive check on the vehicle. As already stated, the planned training dive in the test-tank could, unfortunately, not be carried out.

- Quest-SIM, ROV training simulator
  The training simulator is a 1:1 copy of the MARUM-Quest control van in which scientific dives can be carried out in a virtual environment. It consists of the simulation running on a dedicated computer with projection screens for cameras, additional monitors and computers for navigation and sonar, a master arm controller for the virtual Orion 7P and input devices to fly the ROV. Several scenarios can be loaded into the simulation, like a Black Smoker vent field. Apart from navigating and flying the ROV, objects can be manipulated to train e.g. scientific sampling.

Course and cruise Log

1st day (19th of November 2019)

In the morning, all participants gathered in a seminar room at MARUM. After the welcome, we presented the workshop program. In the run-up of the course, we asked the participants to prepare a 10 minutes presentation about their Institute, the ROVs they are operating and their activities. The participants from the HCMR for example, were very experienced pilots and operating ROVs since the mid-90ies. We also asked everyone what they expect from the workshop. Some started more or less from scratch in terms of

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ROV operations, the more experienced participants were interested of how we organize and operate our systems.

After the introduction, we started with the first Class-Workshop:"Mobilization, Setup, Telemetry". Slides were shown of what needs to be considered during mobilization. Especially the challenges when mobilizing on different vessels, the adaptation of LARS to the lifting gear of the vessel or the power supply. Also, organizing the 2 to 3 days lasting procedure was explained.

After the lunch break around noon, the participants were divided into three groups.

The first group got an introduction to the 4000m Work-Class ROV MARUM-Quest. The second group was introduced in parallel to the 2000 m depth rated, light Work-Class ROV MARUM-Squid. The two systems were shown and explained, their technical specifications and also their different field of application. The third group was trained on the Orion 7P manipulator training stand. The training stand is operated by two pilots. One is operating the arm, while the other moves the two cameras which are installed on individual pan and tilt units. We explained the manipulator and showed how to operate the arm via the master controller. In the next step, the participants were trained to grab and to place objects. Also the usage of a more complex tool, like a temperature lance dummy, was trained. One major goal of the session was to demonstrate, how important it is that both pilots need to coordinate actions and work together in order to be able to successfully take samples. After 1.5h the groups were switched.

C. Seiter (far right) explaining sampling techniques with the Orion7P manipulator to N. Mauromatis (left) and H. Preuß (middle)

2nd day (20th of November 2019)

At 09:00 the second Class-Workshop was held: *Operations at Sea*. This workshop was split into three sub-sessions. In the *Dive preparation* session, we explained in detail of how we prepare each dive. Special focus was put on the pre-dive check of the ROV, which is the most crucial procedure prior to the deployment. In addition, we showed several documents such as a Dive Plan from the science party or bathymetrical maps of different study areas that serve as the base for navigation. Furthermore, we talked about evaluating weather conditions or how to organize shifts for the pilots during longer dives.

In the *Dive operation* session we described the deployment and recovery procedures of our ROVs or how to coordinate a tethered ROV system with a vessel. Furthermore, we discussed decision making for aborting a dive or not during failures and how we recover a "dead vehicle" when control over the system is lost.

Post dive procedures covered everything that needs to be done after a dive such as the treatment of the recorded data and videos or how to organize repairs on a vessel in case something on the ROV is broken.

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After the lunch break, the entire group performed a pre-dive check on ROV-Squid, using the pre-dive checklist shown in the previous session. During this procedure, every single component (cameras, thrusters, etc.) of the ROV is checked for full functionality. Before powering up the system, the participants were asked to install sampling tools (Markers and Nets) inside the ROVs sample drawer box. After powering up the vehicle, we observed that one the three phases supplying the vehicle with electricity, showed different values compared to the other two. As the pre-dive check could not be continued because the system was not running, we used the time to systematically locate the error. Together, we pinned the error down to the winch slipring. The continuity check on one phase failed and the slipring was uninstalled and shipped to the manufacturer for repairs after the ROV Lab course.

L. Manousakis, E. Kallergis, N. Nowald and J. White (from left to right) preparing the installation of tools inside the sample tool box of ROV Squid before the pre-dive check.

At 15:30, we all gathered back in the seminar room for the last Class-Workshop: *Cruise preparation*. During this session, we described what needs to be discussed with the scientific team before an expedition such as the working area, expected weather conditions or the payload that needs to be adapted to the ROV.

3rd day (21th of November 2019)

We assembled at 09:00 in the morning. Unfortunately, Mr. H. Preuß got sick and could not participate. Usually it was planned to prepare ROV-Squid with the entire group for the training dive in the outside test-tank. Because this was not possible, we decided to train the participants of how to troubleshoot a ground leak of a 24V device. For this purpose, a camera was modified to generate bad resistance values on the 24V Line Insulation Monitoring system of ROV-Quest. The participants were asked to locate the bad device with help from our side.

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J. White, L. Manousakis, E. Kallergis and V. Ratmeyer (from left to right) troubleshooting a bad device on ROV MARUM-Quest

After this exercise, one group started with the simulated training dive in the Quest-SIM. The other group received an additional manipulator training on the Orion 7P in parallel instead of diving with ROV Squid. Groups were switched after ~2.5h. During the simulated dive, the participants were introduced in the controls (input devices), displays and control system of ROV-Quest. In the Quest-SIM, the trainees navigated to and through a Black Smoker vent field. The usage of tools with the virtual manipulator was also part of the simulated dive. Apart from flying and manipulation, we pointed out the importance of the coordination between pilot and co-pilot.

C. Katlein and S. Schillai in the Quest-SIM container

Afterwards we assembled in the seminar room for concluding discussion and handed over the certificates of completion. The workshop ended around 18:00.

On board operation

No description onboard operation can be presented, as the course took place onshore.

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Preliminary results

No results can be presented due to the nature of the course. (No sample collection and/or analysis)

Evaluation of student learning

No tests were conducted as the course was designed to e.g. share our experiences during ROV operations or to demonstrate how to operate a manipulator - not to teach educational knowledge in the classical sense or way. Testing the participants within our course structure was not applicable.

Students course evaluation

Feedback from the participants was extremely good. Unfortunately, not all participants filled out the evaluation form. One participant checked the very unsatisfying box several times, but we believe that this was a mistake. In the feedback module same participant stated, that he benefited from the course and that it was a "good presentation" and a "nice workshop with ROV Quest and Squid".

Referreing to Q6 and Q7 on the feedback module	**Number of votes**				
Course Element	Very satisfying	Satisfying	Neutral	Unsatisfied	Very unsatisfied
Class-Workshop I: Mobilization, Setup, Telemetry	4	1			1
Class-Workshop II: Operations at sea	5				1
Class-Workshop III: Cruise preparation	4				1
Manipulator training	5				1
Quest-SIM	4	1			1
Troubleshoot (replaced the training dive with Squid)	2	1		1	

Feedbacks stated in Q11 (comment highlights & lowlights) were all the way positive, for example "Everything was perfect", "Great workshop" or "Very friendly and professional people". Some participants would even recommend a longer duration/extension of the course.

Concluding remarks

We believe that the course was a success. Feedback was very positive and we are confident, that the next course will be a success as well. Many people have already shown their interest of joining the upcoming ROV Lab.

We also believe that the participants liked the way of how we presented and organized the course. We did not pretend that the way we organize and operate ROVs is the right way. We just showed how we at MARUM do it.

This allowed a lively, very open discussion and conversation even during the class-courses. In that respect we have to say, that we also learned a lot from the participants.

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We will keep the general structure and content of the course, because we believe that it is good that way. However, minor tweaks on the Class-courses, especially the slides, will be done.

Appendix

- Course program

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EUROFLEETS+
"ROV Lab"
at
University Bremen - MARUM, Bremen, Germany
19th - 21st November 2019

Nicolas Nowald - Volker Ratmeyer - Christian Seiter

I will pick you up at 09:00 in the Marum main entrance hall. We will have our first session in Room 3030 which is located on the 3rd floor.

Nico´s mobile: +49-1575-3351243

It has proven to be more effective to split the participants into two groups at the different training stations (e.g. Manipulator, Simulation).

Our suggestion would be:

Group 1:
Leonidas Manusakis (HCMR)
Emmanouil Kallergis (HCMR)
Joel White (UoG)
Christian Katlein (AWI)

Group 2:
Nikos Mauromatis (Univ. Patras)
Nikolaos Georgiou (Univ. Patras)
Henrich Preuß (IOSB AST)
Sophia Schillai (MARUM)

During the manipulator training and introduction to the ROVs on the 19th, having three groups would be best:

Group 1:
Leonidas Manusakis (HCMR)
Emmanouil Kallergis (HCMR)
Joel White (UoG)

Group 2:
Nikos Mauromatis (Univ. Patras)
Nikolaos Georgiou (Univ. Patras)
Henrich Preuß (IOSB AST)

Group 3:
Christian Katlein (AWI)
Sophia Schillai (MARUM)

Let us know, if you wish another combination.

WORKSHOP PROGRAM

Tuesday, 19th of November 2019

09:00 Begin of workshop

Groups	Location	Topic
All	Room 3030	Welcome Who is who Workshop program Participant presentations (10 mins each) Expectations from workshop

11:30 Class Workshop I: Mobilisation, Setup, Telemetry

Groups	Location	Topic
All	Room 3030	- Adaptation and mobilization - Power conditioning - Safety - Telemetry - Payload - Data administration - Display and control, etc.

Move to room 0190 after session

13:00 Lunch break in the Mensa

14:00 Manipulator Training / Introduction to ROV-Squid & ROV-Quest

Groups	Location	Topic
Group 1	MARUM II	Manipulator training with the Orion 7PE
Group 2	MARUM II	Introduction to ROV-Squid: vehicle, control system, etc.
Group 3	MARUM II	Presentation of ROV-Quest
		Switch groups after 1.5h

Afterwards: optional tour through MARUM

Wednesday, 20th of November 2019

09:00 Class workshop II: Operation at sea

Groups	Location	Topic
All	Room 3030	**Dive preparation** - dive plan from the science party - pre dive check - payload - navigation map - dive log - evaluating weather conditions - meeting with the bridge - meeting with the rov team - team positions - shifts, etc. **Dive operation** - deployment - diving to the depth of operation - coordinating vessel and rov - cable management - recovery - aborting a dive - dead vehicle recovery, etc. **Post dive procedures** - organizing repairs - checking video & data - dive report, etc.

13:00 Lunch break in the Mensa

14:00 Pre-dive check of ROV-Squid

Groups	Location	Topic
All	MARUM II	For the upcoming training dive with ROV-Squid: run through the check-list and prepare the vehicle for the dive

15:30 Class Workshop III: Cruise preparation

Groups	Location	Topic
All	Room 3030	In the run up to the cruise: meeting with chief scientist and scientific team to discuss - working area - season -operation depths - number of planned dives - payload, etc. Onshore payload/sensor sensor preparation/integration

Thursday, 21st of November 2019

09:00 Preparation of ROV-Squid for the training dive

Groups	Location	Topic
All	Room 2060	Gathering, change clothes
All	MARUM II	Pre-dive check of ROV-Squid Move vehicle to the outside test-tank, pay out cable, etc. Deployment procedure Dive

10:30 Training dives in the QuestSIM and test-tank with ROV-Squid

Groups	Location	Topic
Group 1	MARUM II, Test-tank	Training dive with ROV-Squid - flying the vehicle, use/deploy tools (marker, nets, etc) with the Orion, etc.
Group 2	QuestSIM Container	Simulated training dive with ROV-Quest - Black Smoker field scenario
		Switch groups after ~2.5 hours

Lunch-break in between when feasible

16:30 Recovery of ROV-Squid

Groups	Location	Topic
All	MARUM II	Recover ROV-Squid Move vehicle back into MARUM II hall

Group foto

17:00 Concluding discussion, Handover Certificates of Completion

End of workshop