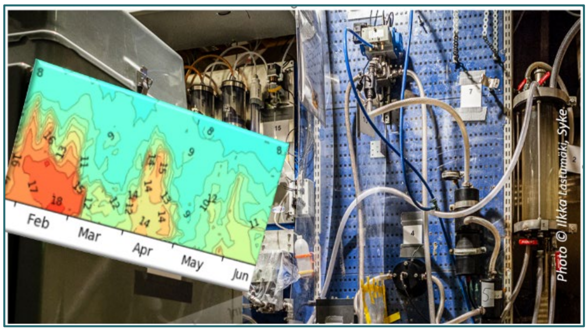
Conference Agenda

Abstracts

List of participants



12th FerryBox Workshop

1-2 October 2024

at the Finnish Meteorological Institute, Helsinki Finland

and

MINKE Metrology Workshops

30 September and 2 October 2024

Organizers and sponsors

FMI Syke EuroGOOS European Global Ocean Observing System FerryBox TaskTeam FinMARI Finnish Marine Research Infrastructure

EUROPEAN COMMISSION
Project funded by the European Commission within the Horizon 2020 Programme (2014-2020)
Grant Agreement No. 101008724

MINKE

Maa- ja vesitekniikan tuki   subCtech Subsea Technologies   bbe biological · biophysical · engineering moldaenke

List of Contents

12th FerryBox Workshop 1-2 October 2024

Contents

Agenda of MINKE workshop 30 September 2024

Metrology of fluorescence measurements

Location hotel Arthur, Vuorikatu 19, Helsinki

13:30-14:00 *Registration*

14:00	*Welcome and introduction to the workshop* Jukka Seppälä, Finnish Environment Institute
14:10	*Linking marine measurements with mainstream Metrology in Europe: the MINKE initiative* Rajesh Nair, Istituto Nazionale di Oceanografia e di Geofisica Sperimentale
14:25	*The challenge of integrating metrologically significant information in Ocean Data acquisition, reporting and exchange.* Rajesh Nair, Istituto Nazionale di Oceanografia e di Geofisica Sperimentale
14:45	Discussion and coffee
15:15	*Chlorophyll fluorescence of living phytoplankton: why chlorophyll fluorescence intensity does not correspond to concentration and why should we care* Jukka Seppälä, Finnish Environment Institute
15:45	*Fluorescence of Algae and Cyanobacteria* Tobias Boehme, bbe Moldaenke GmbH
16:15	*Fluorometer calibration experiments in MINKE.* Kai Sørensen, OceanObs AS, Norway & Norwegian Institute for Water Research
16:30	*Q&A session, Overall discussion, concluding remarks*
17:00	*Continue discussions in smaller groups at your preferred pub/restaurant in Helsinki, as you like!*

Agenda of 12th FerryBox Workshop 1-2 October 2024

Location Finnish Meteorological Institute, Dynamicum, Erik Palménin aukio 1, Helsinki

Day 1: Tuesday 1 October 2024

8:30-9:30 *Registration + coffee, setting up posters*

9:30 *Welcome & Opening words*
Sami Niemelä, Finnish Meteorological Institute
Lauri Laakso, Finnish Meteorological Institute
Jukka Seppälä, Finnish Environment Institute

Session 1 FerryBox studies in the Baltic Sea (Chair Anna Willstrand Wranne)

9:45	*Alg@line, 30+ years of FerryBox measurements in the Baltic Sea* Jukka Seppälä, Finnish Environment Institute
10:00	*Multidisciplinary research at Utö Atmospheric and Marine Research Station, the Baltic Sea* Lauri Laakso, Finnish Meteorological Institute
10:15	*Detection of filamentous cyanobacteria blooms using imaging and pulse shape flow cytometry, and optical sensors* *Kaisa Kraft*, Finnish Environment Institute
10:30	*Spatio-temporal development of cyanobacteria bloom in the Baltic Sea during summer 2023* Lumi Haraguchi, Finnish Environment Institute
10:45	*Overall discussion*
11:00-11:15	**Group photo and bio-break**
11:15	*Development of a Gas-Equilibrium – Membrane-Inlet Mass spectrometer (GE-MIMS) for continuous N2, Ar and O2 measurements on a voluntary observing ship to quantify nitrogen fixation in the Baltic Sea* Sören Iwe, Leibniz-Institute for Baltic Sea research
11:30	*An analysis of temperature, salinity and potential energy variability in the surface layer of the Estonian sea area using ten years of R/V Salme ferrybox data* Urmas Lips, Tallinn University of Technology
11:45	*Air-sea CO2 exchange at Utö in the Baltic Sea* Martti Honkanen, Finnish Meteorological Institute
12:00	*Seasonal variations of surface pH and pCO2 in the Baltic Sea and the Kattegat-Skagerrak - observations from FerryBox systems* Madeleine Nilsson, Swedish Meteorological and Hydrological Institute
12:15	*Overall discussion*

12:30-13:30 Lunch

Session 2 FerryBox in collaborative projects (Chair Kaisa Kraft)

13:30	*FerryBox Task Team* Andrew King, Norwegian Institute for Water Research:
13:45	*Next Generation Multiplatform Ocean Observing Technologies for Research Infrastructures* *Janne*-Markus Rintala, ICOS ERIC Head Office
14:00	*SailingBox: a citizen science measuring system for sailing boats and yachts* Stephan Deschner, Helmholtz-Zentrum Hereon
14:15	*Racing for the planet: Citizen Science on Racing Yachts in Global ClimateResearch* Jana Fahning, SubCtech GmbH
14:301	*All the colors of the ocean. Advancement in remote sensing technology* Urszula Kedzierska, University of Gdansk
14:45	*Impact of Storm Daniel on the Black Sea biogeochemistry* Yoana Voynova, Helmholtz-Zentrum Hereon
15:00	*Overall discussion*

15:15-15:45 Coffee

Poster Session (Chair Katri Kuuppo)

15:45	*Poster briefs*
-17:30	*Posters with some refreshments*
19:00 -	***Dinner at restaurant Zetor***

Day 2: Wednesday 2 October 2024

Session 3 FerryBox data and products (Chair Lumi Haraguchi)

9:00	*Utilizing of FerryBox data in combination with other information sources for forecasting of cyanobacterial blooms* Heikki Peltonen, Finnish Environment Institute
9:15	*FBDataM, an R package to process high resolution data from Ferry Boxes and more…* Alain Lefebvre, Ifremer
9:30	*Information Technology applied for harmonization, quality control, and dissemination of data provided by the Surface Water Sampling System of the IEO* Gonzalo Gonzales Nuevo, Instituto Español de Oceanografía
9:45	*Ferrybox data from ship to your desktop* Ludovic Drouineau, Ifremer
10:00	*Serendipity at the Strait: The discovery of a natural oil seep in the Strait of Magellan through FerryBox surveys* Danilo Astorga-Gallano, Universidad Austral de Chile
10:15	*Overall discussion*
10:30	**Coffee**

Session 4 FerryBox Technologies (Chair Andrew King)

11:00	*FerryBox plankton observations in the Baltic Sea and the Kattegat-Skagerrak using bio-optics and automated imaging in flow – focus on cyanobacteria blooms* Bengt Karlson, Swedish Meteorological and Hydrological Institute
11:15	*Advanced Phytoplankton Monitoring in Ocean Research* Tobias Boehme, bbe Moldaenke GmbH
11:30	*AlgaeOnlineAnalyzer as part of a FerryBox - technical improvements and results operating in the German Wadden Sea* Dagmar Daehne, Coastal Defense and Nature Conservation Agency
11:45	*Unattended eDNA filtering on a Ferrybox* Pierre Jaccard, Norwegian Institute for Water Research
12:00	*Advancing Ocean Observation: New Instrumentation for FerryBox Systems in the NAUTILOS Project* Manolis Ntoumas, Hellenic Centre for Marine Research
12:15	*Overall discussion*
12:30-13:30	**Lunch**

Session 4 continues: FerryBox Technologies (Chair Andrew King)

13:30	*Enhancing the traceability of fluorometer measurements; report from project MINKE including Metrology Workshop on Monday 30.9.2024* *Jukka* Seppälä, Finnish Environment Institute
13:45	*Experiences from calibration of standard bio-optical sensors* Kai Sørensen, OceanObs AS, Norway & Norwegian Institute for Water Research
14:00	*Microplastics - (almost) everywhere but still difficult to sample?* Maik Grunwald, -4H-JENA engineering GmbH
14:15	*Lessons Learned from Designing a Ferrybox with Microplastic Sampler* Karl Vene, Flydog Marine
14:30-	Discussions and overall feedback
15:30	**Coffee**
17:00	End of the workshop

Agenda of MINKE workshop 3 October 2024

Plankton imaging

Location **hotel Arthur**, Vuorikatu 19, Helsinki

8:45-9:00 ***Registration***

9:00	*Welcome and introduction to the workshop* Jukka Seppälä, Finnish Environment Institute
9:10	*Phytoplankton microscopy: tutorial* Sirpa Lehtinen, Finnish Environment Institute
9:25	*Improving the quality of plankton imaging - Introduction* Kaisa Kraft, Finnish Environment Institute
9:45	Discussion and coffee
10:15	*Improving the quality of plankton imaging - Quality Control (with discussions)* Kaisa Kraft and Lumi Haraguchi, Finnish Environment Institute
11:15	*Development of a Data Pipeline for Imaging FlowCytobot Data Integration into the European Digital Twin Ocean* Anders Torstensson Swedish Meteorological and Hydrological Institute
11:30	*Q&A session, Overall discussion, concluding remarks*

Alg@line, 30+ years of FerryBox measurements in the Baltic Sea

Seppälä J, Finnish Environment Institute

12th FerryBox Workshop 1-2 October 2024 in Helsinki celebrates over 30 years of FerryBox measurements in the Baltic Sea. Such measurements began in the late 1980s to resolve spring bloom dynamics using a flow-through system installed on a research vessel. For the first time, FerryBox systems were installed on a passenger ship (Georg Ots) in 1990. After a couple of years of experimentation, a flow-through system was installed on the ferry FINNJET, which travelled between Helsinki and Travemünde, and the Alg@line project began to systematically collect flow-through data and information on phytoplankton blooms. Since then, such measurement systems have been in use on several Baltic Sea ferry lines from time to time, but the Helsinki-Travemünde route has been active all the time, even with changes of ships over the years. Today, Alg@line is a central source of Baltic Sea data and part of the Finnish FINMARI and the European JERICO marine research infrastructures.

This presentation provides a summary of the history of Alg@line, key achievements, and milestones. Detecting the abundance of phytoplankton and especially cyanobacterial blooms has been the core task of the Alg@line, the main methods being the detection of various pigments by fluorescence and the collection of samples for microscopy. Recently, flow cytometry and imaging have also been used. Long time series of salinity, temperature and nutrients have allowed determination of climatologies and detection of anomalies, to follow the development of eutrophication and climate change effects. The data has supported remote sensing applications and algorithm development, including also measuring the spectral water leaving reflectance during the transects. Throughout the years, Alg@line FerryBox systems have served as testbed for new sensors, e.g., for measuring fluorescence proxies of primary production, spectral fluorescence, and pH. Alg@line have supported scientific cooperation between Syke, FMI and IOW in order to better understand the role of the Baltic Sea in the carbon cycle and as a source or sink of CO_2.

Multidisciplinary research at Utö Atmospheric and Marine Research Station, the Baltic Sea

Laakso L, Finnish Meteorological Institute
Honkanen M, Finnish Meteorological Institute
Rautiainen L, Finnish Meteorological Institute
Johansson M, Finnish Meteorological Institute
Stenbäck K, Finnish Meteorological Institute
Mäkelä T, Finnish Meteorological Institute
Hatakka J, Finnish Meteorological Institute
Lonka H, Finnish Meteorological Institute
Hämäläinen K, Finnish Meteorological Institute
Tyynelä J, Finnish Meteorological Institute
Lensu M, Finnish Meteorological Institute
Hellén H, Finnish Meteorological Institute
Aurela M, Finnish Meteorological Institute
Seppälä J, Finnish Environment Institute
Kraft K, Finnish Environment Institute
Ylöstalo P, Finnish Environment Institute
Kielosto S, Finnish Environment Institute
Haraguchi L, Finnish Environment Institute

Utö Atmospheric and Marine Research Station is a comprehensive, multidisciplinary station combining marine ecosystem research, sea-atmosphere interphase processes and exchange, atmospheric greenhouse gases and aerosols, and radar and communication research on electromagnetic spectrum. The station is part of ICOS, ACTRIS, HELCOM, EMEP, WMO, JERICO-RI and the Finnish Marine Research Infrastructure FINMARI.

The automated continuous observations and facilities at the site include

Atmosphere: Real-time observations for meteorology, atmospheric optics, cloudiness, solar radiation, trace gases, aerosol composition, distribution and optical properties, greenhouse gases, vertical 3D-wind profile, turbulence, radioactivity, phosphorus deposition.

Marine physics and chemistry: CTD observations (profiling buoy and ship-based), waves and currents, sea ice, pO_2 and pCO_2, nutrient concentrations, pH, sea-atmosphere CO_2 flux

Marine biology: Phytoplankton biomass (chl-a), cyanobacterial pigments (phycocyanin, phycoerythrin), turbidity, community structure of phytoplankton and microbes (IFCB, Flowcam, Cytosense)

Electromagnetic space: X-band radar, AIS receivers, Software Designed Radio (SDR), ADS-B, vertical refractivity profiles, solar energy production, C-band radar (at Korppoo)

Laboratory facilities: For calibration, specific measurements and experimental work

In my presentation, I will give a short glance at the recent scientific results from the station, with a focus on the opportunities a multidisciplinary platform with a flow-through system provides.

Detection of filamentous cyanobacteria blooms using imaging and pulse shape flow cytometry, and optical sensors

Kraft K, Finnish Environment Institute
Haraguchi L, Finnish Environment Institute
Hällfors H, Finnish Environment Institute
Suikkanen S, Finnish Environment Institute
Ylöstalo P, Finnish Environment Institute
Kielosto S, Finnish Environment Institute
Skyttä A, Finnish Environment Institute
Laakso L, Finnish Meteorological Institute
Honkanen M, Finnish Meteorological Institute
Seppälä J, Finnish Environment Institute

Cyanobacteria form harmful blooms that can have adverse effects on recreational use, human and animal health, as well as ecosystem functioning. These blooms have been heavily studied for decades, but some questions related to species dynamics and the development of the entire bloom are still unresolved. Traditional monitoring methods, such as light microscopy samples, provide only sparse information not enough to improve the understanding of bloom formation, development, and dispersion. Optical phycocyanin, Chl a, and turbidity sensors for high-frequency observations have been utilized widely. Still, they lack species-level information and a reference to biovolume/biomass information with similar timescales. Emerging high-frequency imaging flow and pulse shape cytometry applications, such as Imaging FlowCytobot (IFCB) and Cytosense (CS), could provide community composition with filament-specific biovolume estimates. To better understand how these different methods describe the filamentous cyanobacteria blooms we compared multi-year biomass data collected with an IFCB with data sets collected with CS, phycocyanin and Chl a fluorescence, turbidity and light microscopy. Chl a fluorescence may provide a proxy to describe the overall phytoplankton abundance, however, it ignores cyanobacteria with low Chl a fluorescence. To detect cyanobacteria, fluorescence of their phycobilin pigments may be used instead. Accordingly, the cyanobacteria biomass from IFCB compared better with phycocyanin fluorescence than Chl a. Turbidity also followed a similar pattern with the IFCB time-series. IFCB and CS described the bloom similarly and the IFCB results were comparable with light microscopy. Understanding how the different high-frequency methods compare is important to improve filamentous cyanobacteria detection in the FerryBox systems.

Spatio-temporal development of cyanobacteria bloom in the Baltic Sea during summer 2023

Haraguchi L, Finnish Environment Institute
Kraft K, Finnish Environment Institute
Skyttä A, Finnish Environment Institute
Ylöstalo P, Finnish Environment Institute
Kielosto S, Finnish Environment Institute
Seppälä J, Finnish Environment Institute

Cyanobacteria accumulations are commonly observed in the Baltic Sea during summer, with potentially deleterious effects on human activities and ecosystem functioning. Despite the extensive research and monitoring carried out in the past decades, bloom development and species composition in the Baltic Sea is still not fully understood, which is aggravated by the multiple changes faced in the area.

To improve the understanding of the dynamics of phytoplankton communities in the Baltic Sea, an Imaging FlowCytobot (IFCB) was installed on board the ship of opportunity M/S Finnmaid during the productive season of 2023, covering multiple transects between Helsinki-Travemünde. Those observations are supplemented by multiple physico-chemical parameters obtained with a ferrybox onboard operated by the Finnish Environment Institute.

Total filamentous cyanobacteria biomass, chlorophyll a (Chla) and phycocyanin fluorescence started to increase around mid-June in the Northern Baltic Proper, peaking in the last week of June and coinciding with large surface accumulations in the area. The bloom was dominated by *Aphanizomenon flos aquae*, although in the northernmost part of the transect, *Dolichospermum* sp. also had an expressive contribution to the total filamentous cyanobacterial biomass. Subsequent and smaller biomass accumulations were observed from mid to end of July, being mostly caused by the increase of *Nodularia* and *Dolichospermum* sp. in the Northern part of the transect, and a localized patch of *Aphanizomenon* around 55°N. Under low to moderate filamentous cyanobacteria biomass, small phytoplankton such as nanoflagellates make an important part of the community and might be able to thrive using the fixed nitrogen released by the filamentous cyanobacteria.

Our preliminary results show the heterogeneity of cyanobacterial blooms in the Baltic Sea, highlighting the importance of high-frequency measurements not only for bulk parameters but also for the community composition.

Development of a Gas-Equilibrium – Membrane-Inlet Mass spectrometer (GE-MIMS) for continuous N2, Ar and O2 measurements on a voluntary observing ship to quantify nitrogen fixation in the Baltic Sea

Iwe S, Leibniz-Institute for Baltic Sea research (IOW) Warnemünde, Germany
Schmale O, Leibniz-Institute for Baltic Sea research (IOW) Warnemünde, Germany
Schneider B, Leibniz-Institute for Baltic Sea research (IOW) Warnemünde, Germany

Nitrogen fixation by cyanobacteria in the Baltic Sea plays a crucial role in the context of eutrophication, as it promotes biomass production in the absence of dissolved inorganic nitrogen (DIN). Its contribution to the N budget is comparable to the combined sum of riverine and airborne DIN input, ranging from 300 kt-N/yr to 800 kt-N/yr. The vast range is due to internal fluctuations and significant uncertainties in various techniques used to determine N2 fixation and in extrapolate local studies to entire basins. To overcome some of the limitations we introduce a new approach based on large-scale records of the surface water N2 depletion during summer.

For our studies we use a membrane contactor (Liquicel) to establish gas phase equilibrium for atmospheric gases dissolved in seawater. The mole fractions of N2, Ar and O2 in the gas phase are continuously determined by mass spectrometry, yielding the concentration of these gases by multiplication with the total pressure and the respective solubility constants.

Thorough laboratory test demonstrated that our Gas Equilibrium – Membrane-Inlet Mass Spectrometer (GE-MIMS) has sufficient accuracy and precision to detect and quantify nitrogen fixation. Consequently, the GE-MIMS was deployed on a voluntary observing ship (VOS, “Finnmaid”) during June/July of 2023, enabling repeated transects along the same route and providing high spatial and temporal resolution time series of N2 concentration changes due to nitrogen fixation. First results clearly indicate regions and episodes where N2 fixation was active.

Additionally, Ar measurements are used to account for the air-sea gas exchange and O2 measurements can be utilized to estimate the net community production (NCP) triggered by N2 fixation.

Our objectives are to identify factors initiating and limiting cyanobacteria growth, with the final goal of determining Baltic Proper's N2 fixation capacity.

An analysis of temperature, salinity and potential energy variability in the surface layer of the Estonian sea area using ten years of R/V Salme ferrybox data

Lips U, Tallinn University of Technology, Department of Marine Systems
Rünk N, Tallinn University of Technology, Department of Marine Systems
Liblik T, Tallinn University of Technology, Department of Marine Systems
Kikas V, Tallinn University of Technology, Department of Marine Systems
Salm K, Tallinn University of Technology, Department of Marine Systems
Samlas O, Tallinn University of Technology, Department of Marine Systems

Data from ferryboxes on commercial ferries traveling regularly between harbors of the Baltic Sea are used for operational forecasts and environmental assessments. Many research vessels, including those conducting regular environmental monitoring of the Baltic Sea, are also equipped with similar flow-through systems. However, the data collected has not yet been widely used. R/V Salme, employed for Estonian open sea monitoring six times a year, has carried a flow-through system for over ten years. It records surface layer (water intake is at 2 m depth) temperature, salinity, oxygen, chlorophyll and turbidity with a time step of 1 minute (corresponding to approximately 250 m in space).

We present an analysis of temperature and salinity data collected during all seasons since 2013 in the Gulf of Finland, Gulf of Riga and northern Baltic Proper. Horizontal variability is related to vertical temperature and salinity distributions acquired by an onboard CTD at monitoring stations. We describe temperature and salinity variations and their contribution to horizontal density gradients across spatial scales and seasons in these three sub-basins. We also estimate apparent potential energy (APE) from basin scale to submesoscale. The analysis allows us to reveal characteristic variability at smaller spatial scales (e.g., submesoscale) in relation to the larger-scale background (including coastal upwelling events and fronts) and suggest energy transfer regimes from basin/mesoscale to smaller scales essential for understanding horizontal and vertical mixing.

Air—sea CO2 exchange at Utö in the Baltic Sea

Honkanen M, Finnish Meteorological Institute
Aurela M, Finnish Meteorological Institute
Hatakka J, Finnish Meteorological Institute
Haraguchi L, Finnish Environment Institute
Kielosto S, Finnish Environment Institute
Mäkelä T, Finnish Meteorological Institute
Seppälä J, Finnish Environment Institute
Siiriä S-M, Finnish Meteorological Institute
Stenbäck K, Finnish Meteorological Institute
Tuovinen J-P, Finnish Meteorological Institute
Ylöstalo P, Finnish Environment Institute
Laakso L, Finnish Meteorological Institute

Coastal seas are an important part of the global carbon cycling, due to the strong input of inorganic and organic matter originating from rivers and upwelling. The Baltic Sea is a brackish water basin in northern Europe, with a complex carbonate system that contains a large spatial and temporal variability. Fixed marine stations equipped with high frequency multidisciplinary instrumentation can gather vital information on marine carbonate system, to support the observations carried out on ferrybox vessels. Utö Atmospheric and Marine Research Station observes the marine carbonate system in the southern edge of the Archipelago Sea, using an eddy covariance flux tower and a flow-through water sampling setup. Here, we present the observations of the air—sea CO2 exchange gathered at Utö during 2017—2021, supported by other biogeochemical data. The partial pressure of CO2 in the surface waters and the air—sea CO2 fluxes at Utö undergo large seasonal and diurnal variations, driven by the biological carbon fixation and respiration. On average, the sea at Utö is a net source of CO2 to the atmosphere, indicating the input of carbon originating from elsewhere. However, the net air—sea CO2 exchange showed interannual variation, mostly due to the magnitude of the biological carbon uptake.

Seasonal variations of surface pH and pCO2 in the Baltic Sea and the Kattegat-Skagerrak - observations from FerryBox systems

Nilsson M, Swedish Meteorological and Hydrological Institute
Ericson Y, Swedish Meteorological and Hydrological Institute
Wåhlström Y, Swedish Meteorological and Hydrological Institute
Viktorsson L, Swedish Meteorological and Hydrological Institute
Draca I, Swedish Meteorological and Hydrological Institute
Karlson B, Swedish Meteorological and Hydrological Institute
Willstrand Wranne A, Voice of the Ocean Foundation

Ocean acidification (OA) in the Baltic Sea region is predicted to increase in the future in response to increasing levels of anthropogenic carbon dioxide (CO2) in the atmosphere and science and stakeholders are urging for increased monitoring of necessary parameters such as pH and the partial pressure of CO2 (pCO2).

In coastal seas, the parameters of the marine CO2 system can be more variable than in the open ocean as a consequence of e.g. increased primary productivity caused by eutrophication. This makes it harder to resolve seasonal as well as long term trends. Therefore, more high-resolution data is needed to explore such variations.

With the arrival of the new research vessel (RV) Svea in the end of 2019, a new era of Swedish marine monitoring started. With new technologies onboard, such as the FerryBox system measuring underway in combination with intense field campaigns we have now access to higher resolution observations of the marine CO2 system than ever before. The FerryBox system on RV Svea is equipped with sensors that measure pH and pCO2, which makes a great addition to the traditional water sampling performed at the monitoring stations. RV Svea operates in the Baltic Sea and Kattegat-Skagerrak. In addition, the merchant vessel (MV) Tavastland, operating in the Baltic Sea region, including the Bothnian Bay also has a FerryBox system installed that measures pCO2. Since 2021 the system is a part of the European research infrastructure ICOS (Integrated Carbon Observing System).

Here we will present measurements from these systems to look at seasonal variations of surface water pH and pCO2 and together with salinity, temperature, and chlorophyll a fluorescence investigate possible drivers of the marine CO2 system in the Baltic Sea and the Kattegat-Skagerrak. Further we will compare observations from the FerryBox system with the traditional water sampling and analysis of pH and investigate possible discrepancies.

EuroGOOS FerryBox Task Team

King A, Norwegian Institute for Water Research
Wranne A, Voice of the Ocean

The EuroGOOS FerryBox Task Team is composed of 16 partners who operate FerryBoxes on ships of opportunity and fixed platforms. FerryBoxes are used for observing a variety of physical, biogeochemical, and biological Essential Ocean Variables (EOVs), usually as a flow-through system that pumps seawater across sensors. Here we will provide an overview of the projects and initiatives to which FerryBoxes contribute as well as activities of the FerryBox Task Team.

Next Generation Multiplatform Ocean Observing Technologies for Research Infrastructures

Rintala J-M, ICOS ERIC Head Office,
Loucaides S, National Oceanographic Centre, UK
Mowlem M, Clearwater Sensors, UK
Coppola L, Sorbonne University, Villefranche-sur-Mer, France
Edouard Leymarie E, CNRS, Villefranche-sur-Mer, France
Schuster U, University of Exeter, UK
Becker M, University of Bergen, NO Sanders R, NORCE, NO
Cusi S, EMSO ERIC
Lanteri N, IFREMER, FR
Männistö T, University of Helsinki, FI
Sinikallio L, University of Helsinki, FI
Luhtaniemi M, ICOS ERIC Head Office
de Roeck Y-H, EURO-ARGO ERIC

EURO-ARGO ERIC Ocean observing research infrastructures (RIs) in Europe (i.e. ICOS, EMSO, Euro-Argo) have successfully implemented a world-leading system of standardized Ocean observations over the past 15 years building on more of a century of experiences by the involved marine institutes. This community has joined forces in the GEORGE project proposal to take them to the next level of technology: systematic long-term autonomous observations. GEORGE aims to develop and demonstrate a state-of-the-art biogeochemical, multi-platform observing system operated across ERICs that can carry out integrated biogeochemical observations for characterisation of the Ocean carbon system. Large improvements in oceanic observations are necessary to deliver a fit-for-purpose observing system capable of real-time estimates of the uptake of carbon by all relevant parts of the ocean. This includes the deep sea and coastal zone and will in turn support better decision-making relevant to both climate (the scale and timing of mitigation and adaptation measures) and food production (the scale and location of aquaculture). The challenges include developing better technologies and improving network organization and standardization. Advances will provide more consistent data streams with greater accessibility to support and improve the related science and assessment associated with the state and variability of the oceans. The main aim of the GEORGE project is to develop and demonstrate a state-of-the-art biogeochemical, multi-platform observing system operated across ERICs that can carry out integrated biogeochemical observations for characterisation of the ocean carbon system. One of the project's principal aims is to advance the technology readiness level of state-of-the-art sensors, enabling for the first time systematic autonomous, in situ, seawater CO2 system characterisation and determination of CO2 fluxes on moving and fixed platforms. Together with sensor manufacturers, GEORGE will optimise sensor technologies for measurements on platforms operated by ERICs and according to their operational requirements. Technology will be co-developed between industry and ERICs ensuring a direct route to market and potential for scalability. The technologies will be validated according to a rigorous TRL progression engineering process and demonstrated at sea as an integrated multi-platform observing system during several field campaigns where ERICs are active. Latest updates and news: please see: https://george-project.eu/.

SailingBox: a citizen science measuring system for sailing boats and yachts

Deschner S, Helmholtz-Zentrum Hereon
Voynova Y, Helmholtz-Zentrum Hereon

As part of the SOOP (Shaping an Ocean Of Possibilities -- for science-industry collaboration) project, we have developed a tiny, low-cost, low-power multi-parameter measurement system for sailboats and yachts.

The SailingBox has the potential to increase the data pool for scientific, forecasting and prediction purposes, as well as providing useful data for sailors themselves. The modularity of the system is reflected in its hardware parts as well as in the easy application of different sensors. Proper functionality is shown in Volume of Fluid (VoF) simulations to ensure a continuous exchange of the water parcels. It is also used to reveal possible spots for air bubble accumulation. Within these results we conclude that the design, the different components as well as a minimum sampling rate are properly chosen, and the system works as expected.

We demonstrate some first results of the system on a small test cruise, where the SailingBox is part of a network of similar instruments, namely the CAMOS (Citizen Atmospheric Measuringbox On Sea) and the MetBox (Meteorological Measuringbox).

Racing for the planet: Citizen Science on Racing Yachts in Global Climate Research

Fahning J, SubCtech GmbH

The presentation explores the integration of citizen science on racing yachts during regattas around the globe, especially the southern ocean and its impact on global climate research. In collaboration with scientists, crews collect crucial environmental data such as sea surface temperature, salinity and carbon dioxide with the use of miniature FerryBoxes, that are specifically designed for these yachts together with the sailors and researchers.

The cutting edge technology allows the collection of high-quality data from remote and challenging areas on board of vessels without the need of trained crews and scientists.

The presentation highlights how these initiatives enhance our understanding of climate change and how we can benefit from collaborations between industries, science and sports.

All the colors of the ocean. Advancement in remote sensing technology.

Kedzierska U, University of Gdansk

Remote sensing technology uses satellite images to view, understand, and describe changes in land and ocean. The color of the ocean depends on the interaction of sunlight with substances or molecules present in seawater, such as chlorophyll. Since the ocean is dark, most of the signals received by satellites come from the atmosphere. Therefore, processing and analyzing this data is a significant challenge. In vivo measurements from FerryBoxs and floats can play a key role in validating products and developing new algorithms that describe changes in different plankton populations in the ocean.

Remote sensing of water parameters has conventionally used data from multispectral sensors (e.g., Aqua-MODIS, Landsat-OLI, Sentinel-3 OLCI, Sentinel-2 MSI) with a limited number of spectral bands. This year, a new satellite, Plankton, Aerosol, Cloud, Ocean, Ecosystem (PACE), was launched, carrying instruments to measure ocean color, enabling us to monitor the global distribution and abundance of plankton in unprecedented detail. Providing the ability to identify from space events such as phytoplankton blooms, zooplankton accumulations, or harmful cyanobacteria blooms and describe them based on broad spectral signature. Integrating satellite data with In vivo data will help us better understand the complex systems that drive ocean ecology.

Impact of Storm Daniel on the Black Sea biogeochemistry

Voynova Y, Helmholtz-Zentrum Hereon
Macovei V, Helmholtz-Zentrum Hereon
Drumeva N, IO-BAS
Slabakova V, IO-BAS
Stefanova K, IO-BAS

Anthropogenic warming has already reached an estimated 1°C above pre-industrial levels in 2017, with many regions experiencing higher temperature increases (IPCC, 2018). This has resulted in an increase in the occurrence of marine heatwaves, higher risk of droughts and more intense and more frequent heavy precipitation events. It is projected that a further 1.5-2.0°C of warming will intensify these effects, and data and models suggest that heavy precipitation events in 2023 can be directly linked to human-induced climate change (Zachariah et al. 2024). We examine the impacts of an extreme storm on the biogeochemistry of the western Black Sea, with a focus on the potential drivers, as well as the multifaceted ecosystem responses.

We focus on a recent storm in September 2023, which caused the most intense rainfall on record for the southern Bulgarian Black Sea coast. Through a collaborative German – Bulgarian Partnership, funded by the Helmholtz Association for Grand Challenges, a station within the Institute of Oceanology, at the Bulgarian Academy of Science was outfitted with a FerryBox since summer of 2022. We used the continuous data from this station, located north of the storm rainfall, but close enough to investigate regional changes, to evaluate the storm effects on the Black Sea biogeochemistry. They included a large-scale regional temperature change following the storm, as well as dissolved oxygen undersaturation and change in pCO_2 and air-sea fluxes. Sea surface temperature record from the NASA Giovanni web portal indicate that temperature in the region has been increasing at a faster rate than previously assessed, and this could contribute to the occurrence of more intense storms in the future.

Utilizing of FerryBox data in combination with other information sources for forecasting of cyanobacterial blooms

Peltonen H, Finnish Environment Institute

Cyanobacteria, also known as blue-green algae, produce harmful blooms in large areas of the Baltic Sea. For many uses of marine space and resources, for management and for science it is of interest to know bloom risks in different areas and learn from the mechanisms contributing to the bloom intensity.It has been stated that the harmful blooms will become more frequent and intense and occur in larger areas as climate change is increasing water temperatures and the flow of nutrients to coastal seas.

The current study applied information from multiple data sources together with machine learning to forecast bloom risks in the northern Baltic Sea during the summer 2024. The spatial explanatory material in modeling consisted of raster maps of nutrient concentrations interpolated from scientific monitoring and FerryBox (Alg@line) data and from weather reanalysis data. The response variable was the spatially accurate bloom data from satellite images classified in four intensity levels. The material for model learning was from 2003-2023 and for forecasts from winter and spring 2023-2024. In the bloom forecasting also seasonal temperature forecasts from multiple weather models were applied. Multinomial logistic regression and random forest were applied as the modeling tools, and the final forecast was produced as a combination from these two estimates. The performance of the classification models was evaluated, and the forecast was compared to the realized bloom levels during the summer 2024.

FerryBox measurements provide a useful addition to the spatial and temporal coverage of the data from monitoring cruises and could also be valuable for updating bloom forecasts during summer.

FBDataM, an R package to process high resolution data from Ferry Boxes and more...

Lefebvre A, Ifremer, COAST, Fr-62200 Boulogne sur mer
Devreker D, Ifremer, COAST, Fr-62200 Boulogne sur mer

The FerryBoxdataManager (FBdataM) graphical user interface was developed in the R programming language to easily synchronize and merge files produced by the (Pocket)FerryBoxes (4H-JENA) and some on-board software (navigation, meteorological data, …) from Research Vessels such as the 'Thalassa', 'Côtes de la Manche' from the French Oceanographic Fleet, and some ships of opportunity. The interface also allows the users to integrate in situ data from CTD casts as well as files from Ocean Colour Observations and modelling.

The interface allows the users to easily and quickly process high resolution and complementary data providing the most common statistic summary, and figures to identify the main characteristics of water encountered during a cruise:

- T-S diagrams,
- scatter plots with the associated descriptive statistics,
- Regression between parameters,
- CTD profiles linked to a given location,
- Plot of the cumulative proportions of spectral phytoplankton groups and the associated total eq-chlorophyll-*a* concentration (as provided by an Algae Online Analyzer – BBE moldaenke), with cartographic identification of points of interest selected by the user,
- a cartographic module that displays the variation of parameters along the boat route, including discrete or CTD measurement as well as rasters (remote sensing or modelling) data. Data interpolation can also be done for visual representation.

Since the interface only depends on files provided by the users then real time data processing is feasible. This allows the users to adapt the sampling strategy during the cruise when facing some unexpected results. When back at lab, information contains in the data acquired during several days/week are quickly available for the scientific community that will be able to engage further deeper statistical analysis since the main characteristics and patterns are still available.

Information Technology applied for harmonization, quality control, and dissemination of data provided by the Surface Water Sampling System of the IEO

González-Nuevo G, Instituto Español de Oceanografía
Marcote D, Instituto Español de Oceanografía.
Lamas A, Instituto Español de Oceanografía.
Fraga I, Instituto Español de Oceanografía.
Nieto M, Instituto Español de Oceanografía.
Tel E, Instituto Español de Oceanografía.
García L, Instituto Español de Oceanografía.
Ruiz-Villarreal M, Instituto Español de Oceanografía.

The Spanish Institute of Oceanography operates a continuous surface water sampling network composed of two coastal vessels (RV Lura, RV Mytilus), three regional vessels (RV Navarro, RV Alvariño and RV Margalef), and two oceanic vessels (RV Miguel Oliver, RV Vizconde de Eza) owned by the Spanish Secretary for Fisheries.

Currently, the RV Lura is being used as a testing platform both for the implementation of new sensors, for the automatisation and improvement of the efficiency of the systems and for data harmonization and dissemination generated by the sampling network. Besides basic hydrographical sampling (temperature, salinity, and fluorescence), additional biochemical parameters such as oxygen, turbidity, CDOM, pH, and CO2 have been added to the sampling system providing data on the spatial and temporal variability of the NW Iberian upwelling system.

To improve data management systems, the possibilities of using new messaging platforms are being explored. In this regard, work has been focused on three main areas: keeping people involved in the sampling network informed, facilitating interaction with the network's automated processes and quality control (QC), and making information dissemination more user-friendly.

The use of these technologies provides an efficient and user-friendly mechanism for the communication of information about events within the observation system and automated processing, such as the monitoring of the success of tasks, data processing issues, quality control-related events, as well as equipment malfunctions.

Additionally, the interaction of the management team members with the automated system does not require advanced programming skills and therefore it simplifies the retrieval of information, data and graphs necessary for manual quality control in a user-friendly manner.

Finally, the use of messaging platforms allows both raw information and derived products to be disseminated in a more natural way for end users. This sets the stage for the development of interaction systems based on natural language in conjunction with artificial intelligence systems.

Ferrybox data from ship to your desktop

Drouineau L, Ifremer

Ferrybox systems, installed on commercial and research vessels, provide valuable high-frequency in situ oceanographic data along regular maritime routes. These autonomous systems continuously measure key parameters such as sea surface temperature, salinity, chlorophyll-a, turbidity, and dissolved oxygen. The data collection process begins with sensors installed on ships, which record measurements during the vessel's regular operations. These data are then transmitted to shore in near real-time via satellite or mobile networks.

Once received by an oceanographic data center, quality control (QC) procedures are applied in real-time to ensure their reliability. One of the strengths of Copernicus Marine In Situ TAC is to rely on these data centers to aggregate in one unique place and one unique format, this marine in situ data. Once a year, ferrybox data are submitted to expert evaluation to produce delayed mode datasets (one for temperature salinity and one for biogeochemical data). This process identifies and flags inconsistencies, sensor drifts, and potential biases, ensuring the integrity of the final datasets. Key steps include validation against other in situ and satellite data sources, as well as the application of climatological checks to assess deviations from expected values.

The validated Ferrybox data are made accessible through the Copernicus Marine Service In Situ TAC as well as through the Global Ocean Surface Underway Data (GOSUD) program under the International Oceanographic Data and Information Exchange (IODE) initiative. The entire catalog can be freely accessed via Python scripts or command line interface, as well as through an evolving web data portal. These datasets support a wide range of applications, from marine forecasting and climate research to operational oceanography.

Serendipity at the Strait: The discovery of a natural oil seep in the Strait of Magellan through FerryBox surveys

Giesecke R, Institute of Marine and Limnological Science, Austral University of Chile, Centro FONDAP de Investigación en Dinámica de Ecosistemas Marinos de Altas Latitudes (IDEAL)
Galbán-Malagón C, GEMA, Center for Genomics, Ecology & Environment, Universidad Mayor; Anillo en Ciencia y Tecnología Antártica POLARIX; Institute of Environment, Florida International University, University Park
Salamanca M, Facultad de Ciencias Naturales y Oceanografía, Universidad de Concepción; Laboratorio de Oceanografía Química (LOQ), Universidad de Concepción
Chandia C, Facultad de Ciencias Naturales y Oceanografía, Universidad de Concepción; Laboratorio de Oceanografía Química (LOQ), Universidad de Concepción
Ruiz C, Instituto de Fomento Pesquero (IFOP)
Bahamondes S, Escuela de Biología Marina, Universidad Austral de Chile
Astorga-Gallano D, Escuela de Biología Marina, Universidad Austral de Chile

We present the first documented occurrence of a natural crude oil seep plume associated with river discharge along the Strait of Magellan in southern Patagonia in modern times. Hydrocarbon signals were detected using a crude oil sensor integrated into a FerryBox system that traversed which has been conducting continuous monitoring along the Strait of Magellan and Patagonian channels since September 2022. The highest and most consistent crude oil signals were observed in the mid-basin of the Strait of Magellan. These signals exhibited a strong negative correlation with sea surface salinity, coinciding with the water discharge from the San Juan River, especially during periods of high river discharge, exceeding 15 m^3 s^{-1}. Conversely, when river discharge fell below this threshold, no noticeable crude oil signal was observed. As river discharge decreased and winds intensified during austral summer, the crude oil signal gradually dissipated. This observation suggests that the dispersion of crude oil becomes limited during periods of low river discharge, as buoyant currents remain confined close to the coast. A satellite-based approach is currently being used to assess the dynamics and dispersal of the plume over the past two years in a semi-enclosed bay near the river's mouth. Historical records indicate that this seep has been releasing hydrocarbons into the Strait of Magellan for at least the past 120 years, implying a long history of chronic crude oil input into this relatively isolated region of the world. This finding highlights the potential of automated FerryBox systems to enhance our understanding of marine ecosystem dynamics and pollution in poorly studied regions by enabling high-resolution spatial and temporal surveys.

FerryBox plankton observations in the Baltic Sea and the Kattegat-Skagerrak using bio-optics and automated imaging in flow - focus on cyanobacteria blooms

Karlson B, Oceanography, Swedish Meteorological and Hydrological Institute
Arneborg L, Oceanography, Swedish Meteorological and Hydrological Institute
Draca I, Oceanography, Swedish Meteorological and Hydrological Institute
Håkansson J, Oceanography, Swedish Meteorological and Hydrological Institute
Karlberg M, Oceanography, Swedish Meteorological and Hydrological Institute
Linders J, Oceanography, Swedish Meteorological and Hydrological Institute
Nilsson M, Oceanography, Swedish Meteorological and Hydrological Institute
Nordström M, Oceanography, Swedish Meteorological and Hydrological Institute
Skjevik A-T, Oceanography, Swedish Meteorological and Hydrological Institute
Torstensson A, Oceanography, Swedish Meteorological and Hydrological Institute
Viktorsson L, Oceanography, Swedish Meteorological and Hydrological Institute
Waldh F, Oceanography, Swedish Meteorological and Hydrological Institute
Willstrand-Wranne A, Voice of the Ocean Foundation
Rollo C, Voice of the Ocean Foundation
Garefelt K, Science for Life Laboratory/KTH
Andersson A, Science for Life Laboratory/KTH
Sullivan J, Science for Life Laboratory/KTH
Koszalka I, Department of Meteorology, Stockholm University

Phytoplankton form the base of the marine food web. Fast growth of phytoplankton results in algal blooms. The blooms are often short lived and may be overlooked in low frequency marine monitoring programs. Some of the blooms cause problems, the term HAB (harmful Algal Blooms) is used. In the Baltic Sea the toxin-producing cyanobacteria *Nodularia spumigena* is an important HAB species. High frequency sampling from FerryBox systems on R/V Svea and the merchant vessel Tavastland was used to investigate the cyanobacteria bloom dynamics in the Baltic Sea. Traditional water sampling from R/V Svea, with microscope analysis on land, gave additional detailed information. *N. spumigena*, *Aphanizomenon flos-aquae* and *Dolichospermum* spp. were the dominant cyanobacteria contributing up to approximately half of the total phytoplankton biomass in summer 2023. Results from the Imaging Flow Cytobot (IFCB), part of the Ferrybox system on R/V Svea, gave detailed information on the horizontal distribution of the cyanobacteria species. Vertical profiles of phycocyanin-fluorescence, a proxy for cyanobacteria biomass, indicated that the cyanobacteria were restricted to the upper 20 metres. In summer 2024 a phycocyanin sensor was mounted also on an ocean glider operated southwest of Gotland showing the temporal and spatial development of the cyanobacteria bloom in the area. The results from different bio-optical sensors, the IFCB etc. will be presented.

Advanced Phytoplankton Monitoring in Ocean Research

Boehme T, bbe Moldaenke GmbH

Changes in climate lead to increasingly faster adaptation of microalgae and cyanobacteria in the oceans. The early and extensive recognition of these changes are a challenge for the current research. The phytoplankton represents the major portion of the biomass in the sea and is subjected to significant reduction since more than 60 years. Advanced tools are needed to collect meaningful data about quantity and distribution of this biomass. Fluorescence measurement enables a fast and reliable method to determine phytoplankton *in situ* with maximum sensitivity. A submersible sonde was developed for prolonged underwater deployment in the rough seas. The new titanium housed FluoroProbe is highly resistant to corrosion. The depth range covers the photic zone completely down to 100 m. Up to 5 algae classes are determined simultaneously in real-time. A turbidity correction compensates for the attenuation of the exciting light. The FluoroProbe is operated with easy-to-use software and optionally equipped with Blue Tooth. A wiper prevents interfering influences of biofouling. The FluoroProbe is calibrated with microalgae from real algae cultures and is open to include further customized algae classes.

AlgaeOnlineAnalyzer as part of a FerryBox - technical improvements and results operating in the German Wadden Sea

Daehne D, Coastal Research Station of the Lower Saxony Water Management, Coastal Defense and Nature Conservation Agency (NLWKN)
Luitjens L, Coastal Research Station of the Lower Saxony Water Management, Coastal Defense and Nature Conservation Agency (NLWKN)

The installed FerryBox onboard the governmental research vessel „Burchana" is operating since summer 2016 in the Lower Saxony Wadden Sea area, an intertidal, partly turbid sand and muds flat system. Results of the FerryBox are showing seasonal and regional changes in the biogeochemical processes within the Regularly repeating cruises within the Wadden Sea show seasonal and regional changes in phytoplankton concentrations, but also a very local pattern of different Phytoplankton concentrations. Results from the AlgaeOnlineAnalyzer as part of the FerryBox deviated from phytoplankton identification by microscopy in the same area determined frequently within a monitoring program done also by the NLWKN.

This talk presents the technical modifications made in the AlgaeOnlineAnalyzer to improve the identification of the algae groups. Furthermore, phytoplankton results are presented in context with other biogeochemical processes.

Unattended eDNA filtering on a Ferrybox

Jaccard P, Norwegian Institute for Water Research
Tangen Ødegaard Ø, Norwegian Institute for Water Research
Engesmo A, Norwegian Institute for Water Research
Egge E, Norwegian Institute for Water Research
Kistenich S, Norwegian Institute for Water Research

A programmable plankton sampler has been used for filtering and fixating eDNA samples in an unmanned manner on a Ferrybox. While not designed for being deployed on a Ferrybox, a few issues had to be understood and solved before it was operational. A test with parallel manual sampling has been carried out and general results presented.

Advancing Ocean Observation: New Instrumentation for FerryBox Systems in the NAUTILOS Project

Ntoumas M, Hellenic Centre for Marine Research
Seppälä J, Finnish Environment Institute
Marty S, Norwegian Institute for Water Research
King A, Norwegian Institute for Water Research

Existing European observing tools and services have significant potential to exploit cutting-edge technologies to provide a wider range of data with much higher spatial resolution and temporal consistency. The H2020 project NAUTILOS is advancing this potential by developing a new generation of sensors and samplers tailored to key physical, chemical and biological ocean variables, including micro- and nanoparticles. NAUTILOS has integrated the latest advances in marine technologies across different observing platforms and deployed them in innovative and cost-effective ways in a wide range of critical environmental conditions and EU policy-driven applications. A key highlight of the project is the addition of new instrumentation to the FerryBox systems. Throughout the NAUTILOS project, these sensors and samplers have undergone development, laboratory validation and field testing, culminating in their integration on Ships of Opportunity equipped with FerryBox systems. Notable achievements include the development of a flow-through pH sensor system for SYKE FerryBoxes, the integration of a phytoplankton/suspended matter and microplastics sampler with NIVA FerryBoxes, and the deployment of a downward facing SST sensor for operation on an HCMR FerryBox.

Enhancing the traceability of fluorometer measurements; report from project MINKE including Metrology Workshop on Monday 30.9.2024

Seppälä J, Finnish Environment Institute
Pensieri S, Consiglio Nazionale delle Riserche
Bozzano R, Consiglio Nazionale delle Riserche
Frangoulis C, Hellenic Centre for Marine Research
Tsakalakis I, Hellenic Centre for Marine Research
Sørensen K, Norwegian Institute for Water Research
Valestrand L, Norwegian Institute for Water Research
King A, Norwegian Institute for Water Research
Salaün J, Service Hydrographique et Oceanographique de la Marine
Laloux M, Service Hydrographique et Oceanographique de la Marine
Maunula P, Finnish Environment Institute
Haavisto N, Finnish Environment Institute
Lescroart E, Finnish Environment Institute
Ylöstalo P, Finnish Environment Institute
Pipinis Troupakis M, Finnish Environment Institute

EU-project MINKE will integrate key European marine metrology research infrastructures, to coordinate their use and development and propose an innovative framework of “quality of oceanographic data” for the different European actors in charge of monitoring and managing the marine ecosystems. MINKE proposes a new vision in the design of marine monitoring networks considering two dimensions of data quality, accuracy and completeness, as the driving components of the quality in data acquisition.

One task within MINKE has been enhancing traceability of fluorometer calibration aiming to improve data quality of sensor-based fluorescence measurements. This talk summarizes joint research actions, summarizing the current methods which the partners are using when they calibrated their sensors, and which have been the developments during the MINKE project. It also reports the MINKE Metrology Workshop held on MOn 30.9. 2024 adjacent to the FerryBox Workshop.

Experiences from calibration of standard bio-optical sensors

Sørensen K, OceanObs AS & Norwegian Institute for Water Research
Wranne A, Voice of the Ocean
Valestrand L, Norwegian Institute for Water Research
Viktorsson L, Swedish Meteorological and Hydrological Institute
Karlson B, Swedish Meteorological and Hydrological Institute

Bio-optical sensors for measuring fluorescence properties of chlorophyll-a (Chl-a), phycocyanin (PC) and colored dissolved organic material (cDOM), as well as turbidity (Turb) has been in use for decades on different oceanographic platforms. The metrology around sensors and transferring the sensor proxies to the geo-physical quantities are still a challenge. Monitoring the data quality from sensors deployed on remote platform need specific attention and use of secondary standards. We will present our experience from calibration and validation on sensors delivered by Turner Designs, TriOS and WetLabs.

For the Chl-a and PC-fluorescence we will show results from algal cultures of phytoplankton species found in Skagerrak and Baltic waters. The results show high variation in the Chl-a fluorescence/Chl-a ratio between species that make this difficult to use as a universal method. The variation in this ratio using a single species grown under standard condition show promising results and can be used together with secondary standards and field samples. Calibration of PC-sensors can be performed with a standard chemical pure PC.

For calibration of cDOM fluorescence the classical standard Quinine Sulfate (QS) methods are stable over time and can be used operationally together with a secondary standard. Some sensors have severe problems with the acidic QS-solution so other methods to monitor the sensors drift like fluorescein has been investigated. Using secondary standards to transfer calibration from one sensor to another need attention on variation of e.g. temperature.

For turbidity sensors the standard Formazin methods works well and are easy to implement. We have experimented with a NIVA produced secondary standard to use on remote installation. The experience achieved are implemented as standard operating procedure for sensors on Ferrybox and will be considered for gliders and buoys to improve the data quality and products.

Microplastics - (almost) everywhere but still difficult to sample?

Grunwald M, -4H-JENA engineering
Gerdts G, Alfred-Wegener-Institut

Microplastics, defined as plastic particles smaller than 5 millimeters, have become an omnipresent contaminant in the environment. These tiny particles are generated from the breakdown of larger plastic objects or are directly introduced into the environment as microplastics, such as those found in cosmetic products. The contamination by microplastics is particularly widespread in aquatic systems, including oceans, rivers, and lakes. The impact on marine organisms is well-documented: microplastics can be ingested by fish, mussels, and other aquatic organisms, leading to physical damage, toxic reactions, and potential accumulation in the food chain. This poses a significant risk to humans as well, since microplastics can enter the human body through contaminated food and water.

Continuous water sampling for microplastic analysis is crucial to understanding the extent of this pollution and to developing appropriate countermeasures. In this context, specific microplastic sampling devices for water have been developed, enabling the systematic and precise collection of microplastic particles. The initial phase of this project focused on a semi-automatic sampling device. This device efficiently collected water samples, reducing manual labor while improving the accuracy of sampling. The semi-automatic functionality allowed the device to be used in various water bodies to gather representative data on the distribution of microplastic particles.

Building on this experience, a fully automatic microplastic sampling device was developed in collaboration of -4H-JENA engineering and Gunnar Gerdts from the Alfred Wegener Institute (AWI) in the framework of NAMC (North Atlantic Microplastics Center; NORCE, Norway). This advanced device offers significant improvements in sampling technology. It operates autonomously and continuously collects water samples, significantly enhancing the accuracy and reliability of the results. Additionally, it minimizes potential errors that can occur with manual or semi-automatic sampling methods. Another advantage of the fully automatic system is its ability to collect a larger number of samples in a shorter time, enabling a more comprehensive monitoring of microplastic contamination across different aquatic environments.

The ability to collect water samples continuously is particularly valuable for subsequent laboratory analysis. In laboratories, these samples can be examined in detail to determine the concentration, size, shape, and chemical composition of microplastic particles. This data is essential to creating an accurate picture of microplastic pollution in various water bodies and to observing long-term trends. Moreover, the fully automatic sampling device supports the standardization of sampling procedures, which is crucial for the comparability of research results and the creation of global monitoring data.

The development of the fully automatic microplastic sampling device represents a significant advancement in environmental research. It not only helps increase efficiency and accuracy in sampling but also provides a robust foundation for future research focused on the ecological and health impacts of microplastics.

Overall, the continuous advancement of microplastic sampling devices for water is of central importance to addressing the global challenge of microplastic pollution. These technologies provide valuable data that not only enhance the understanding of the distribution and impacts of microplastics but also support the development of more effective strategies to combat this environmental threat.

Lessons Learned from Designing a Ferrybox with Microplastic Sampler

Vene K, Flydog Marine

Ferryboxes, used for automated water quality monitoring, are often customized to suit specific vessels and scientific goals. Achieving a design where the system operates efficiently for the user, rather than creating additional challenges, can be difficult. Flydog shares an honest account of the many pitfalls and unexpected errors encountered throughout the process. This presentation will cover the multiple design iterations and modifications that were essential to ensure system reliability, with insights into ship preparation, mechanical integration, sensor performance, controller, telemetry, user interface, and real-time data visualization. Key suggestions will also be provided on defining requirements when developing a new ferrybox system.

Data quality control of underway Ferrybox data from the sailing yacht Eugen Seibold

Aardema H, Max Planck Institute for Chemistry, Germany & ETH Zurich, Switzerland
Slagter H, Max Planck Institute for Chemistry, Germany
Walter D, Max Planck Institute for Chemistry, Germany
Heins L, Max Planck Institute for Chemistry, Germany
Hrabe de Angelis I, OceanX (USA) & Max Planck Institute for Chemistry, Germany
Calleja M, University of the Balearic Islands, Spain & Max Planck Institute for Chemistry, Germany
Dragoneas A, Max Planck Institute for Chemistry, Germany
Haug G, Max Planck Institute for Chemistry, Germany & ETH Zurich, Switzerland
Schiebel R, Max Planck Institute for Chemistry, Germany

The *S/Y Eugen Seibold* is a purpose-built research vessel for scientific research conducting oceanographic cruises on the open ocean. The vessel sails transects over large environmental gradients sampling continuously from approximately 3 m water depth using an OceanPack Ferrybox (SubCtech, Germany). The collected dataset will be used as supportive data in topical papers on concurrently collected datasets. The data from the OceanPack is stored locally on the deckunit and transferred in per second resolution to the onboard SQL database (L0 data). The database stores each record with a synchronized timestamp from the onboard GPS time server. Synchronized timestamps in all data records facilitate full comparability of the data and provide reliability when analyzing data sets of varying temporal resolution. The following data quality control workflow is currently under development and is written in the free software environment R. The current focus is on a select parameter set (sea surface temperature, salinity, pH, dissolved oxygen, chlorophyll fluorescence, FDOM, and Photosynthetically Active Radiation) and water flow is used as an additional quality control parameter. A flagging scheme was adopted that aligns with other large oceanographic data projects. Quality controlled data will be published open access according to the FAIR (Findable, Accessible, Interoperable, Reusable) principles on the *PANGAEA* database in collaboration with the *German Marine Research Alliance* (Deutsche Allianz Meeresforschung, DAM). At this workshop the goal is to receive feedback and discuss the quality control workflow with the wider Ferrybox user community.

Monitoring of algal blooms and environmental changes in Oslofjord with the FerryBox in 2023

Berezina A, Norwegian Institute for Water Research NIVA
Eikrem W, Norwegian Institute for Water Research NIVA
Valestrand L, Norwegian Institute for Water Research NIVA
Norli M, Norwegian Institute for Water Research NIVA
Frigstad H, Norwegian Institute for Water Research NIVA
Harvey T, Norwegian Institute for Water Research NIVA
Saesin P, Norwegian Institute for Water Research NIVA
King A, Norwegian Institute for Water Research NIVA

This study presents the results from the 2023 "Monitoring with FerryBox and satellite data", the yearly monitoring undertaken for the Inner Oslofjord Research Council that utilized NIVA's FerryBox system for continuous measurements and sampling.

High-resolution sensor data from the FerryBox with observations every other day illustrate well the frequency and intensity of the algae blooms in the fjord and that the blooms with a duration of less than 2 weeks. With monthly sampling, one can miss observations of several blooms. The other sensor data show the seasonal variability of additional environmental and climate variables. Due to anomalously high rainfall in 2023, low salinity water masses were observed in the spring, summer and especially in the autumn months. Nutrient values were highest in winter, and in connection with the extreme weather event "Hans", and high concentrations of dissolved organic carbon were measured (August-October), and total nitrogen and total phosphorus (August). There was a significant spring bloom of diatoms in the central part of the inner Oslo Fjord in March and a substantial diatom bloom in October in the wake of the extreme weather event "Hans" that was in connection to a high freshwater flux event.

Construction of a hose sampling system for an Imaging Flow Cytobot (IFCB)

Conrad M, Leibniz Institute for Freshwater Ecology and Inland Fisheries (IGB)

In order to obtain a high-resolution long-term data series of phytoplankton organisms, the plankton ecology research group of the Leibniz Institute IGB, led by Dr. Jens Nejstgaard, decided to use the Imaging Flow Cytobot (IFCB) as a detection device to achieve high frequency vertically resolved phytoplankton data from lake Stechlin.

To ensure a precise ecological picture of the plankton composition in the water layers, turbulence around the sampling site must be avoided. Therefore, the entire IFCB cannot be attached to a profiler that moves it vertically through the water column. One solution is to construct a suction system through a sample tube. It directs the water from a certain depth through a hose into an intermediate storage container on the surface, from which the IFCB takes a sample. The construction of this sampling system raises many engineering tasks and biotechnological research questions. The main technical problems, that the design is intended to solve, are:

- Combat gas bubble formation
- Retain algae and bacterial growth on the water exposed surfaces
- Guiding the sample hose in open water and preventing bends
- Pump technology and control of flow rate
- Cooling mechanism of the system
- Timing and process control between profiler, pump and sample interval of the IFCB
- Evaluate grazing effects

The following explanations refer to the current planning status of the construction and the initial considerations of the research group regarding the technical design.

The IFCB has a low tolerance for fine gas bubbles in the sample, what justifies many design components, which are described in the following part. The bubbles occur, for example, during decompression or warming of the water, when it is pumped from the depths. To sample as few gas bubbles as possible, the water should rest to degas for some time. An intermediate storage container is to be built for this purpose. To keep the influence of the environment as low as possible, the container is externally cooled, and a non-transparent material is chosen. The probe-unit, consisting of the container and IFCB, is cooled with water from the corresponding depth of the sampling. The options are either to place both components in a water tank or to use a hose spiral to wind around them. Both solutions must be pumped continuously. In terms of algae growth and ease of maintenance, the hose variant appears to be more promising. To protect the plankton organisms, a negative pressure system with low to medium volume flow is provided In terms of material selection of the components and technical properties of the electronic devices, the project is still in the research stage. The sampling system is to be installed on the IGBLakeLab, in addition to the already existing profiling systems. (YSI-EXO sondes and LiCor sensors).

First FerryBox observation at the Western Black Sea (Bulgarian) coast: drivers of oxygen dynamics in nearshore waters

Drumeva N, Institute of Oceanology "Prof. Fridtjof Nansen" - Bulgarian Academy of Sciences,
Macovei V, Institute of Coastal Research, Helmholtz-Zentrum Geesthacht, Geesthacht, Germany
Labakova N, Institute of Oceanology "Prof. Fridtjof Nansen" - Bulgarian Academy of Sciences
Voynova Y, Institute of Coastal Research, Helmholtz-Zentrum Geesthacht, Geesthacht, Germany
Naumov T, Institute of Oceanology "Prof. Fridtjof Nansen" - Bulgarian Academy of Sciences,
Doncheva V, Institute of Coastal Research, Helmholtz-Zentrum Geesthacht, Geesthacht, Germany
Nikolova T, Institute of Oceanology "Prof. Fridtjof Nansen" - Bulgarian Academy of Sciences
Gehrung M, Institute of Coastal Research, Helmholtz-Zentrum Geesthacht, Geesthacht, Germany
Rust H, Institute of Coastal Research, Helmholtz-Zentrum Geesthacht, Geesthacht, Germany

Dissolved oxygen in seawater is an important indicator of the ecological status of water bodies in two European directives. The oxygen concentration and its variation are linked to 1) climate shifts, which can manifest as seawater warming and to 2) eutrophication, which results from elevated anthropogenic inputs (e.g. inorganic nutrients) to coastal waters.

The main goal of our research is to collate data derived from a stationary installed self-cleaning FerryBox system of Helmholtz-Zentrum Hereon in Shkorpilovsti (Bulgarian Black Sea coast) and from regular (in two weeks) monitoring for samples analyzed in the “Marine Chemical laboratory” of IO-BAS. Since 2022, within the SeaReCap project, we have installed a FerryBox system at the IO-BAS Shkorpilovsti station (on a pier). In parallel we collected in-situ data from the FerryBox outflow for dissolved oxygen, nutrients in seawater, chl-a and physicochemical parameters (temperature, pH, salinity).

The collected data give us opportunity to do daily, seasonal and annual monitoring of changes of dissolve oxygen in coastal seawater. But also we observe alterations in the oxygen saturation related to some unusual events at the western Black Sea such as the upwelling in 2023, and an elevated annual bloom, supported by chlorophyll fluorescence data, as well as with accompanying changes in other observed parameters.

The data from the two sources differ in value, but coincide with the observed trends, which makes them promising and reliable source for conducting monitoring of the state of the respective sea water body and Bulgarian coastal zone as a whole.

Acknowledgements: This work was funded by the SEA-ReCap project - Helmholtz Association Program for Advanced Challenges and European Partnership, and by National Geoinformation Center for monitoring, evaluation and forecasting of natural and anthropogenic risks and disasters - National Roadmap for Scientific Infrastructure, ContractД01-164/28.07.2022г; ДО1-321/30.11.2023

Phytoplankton dynamics and distribution at high spatial resolution by an integrated approach combining continuous and discrete automated analysis in the English Channel and North Sea

Fauvel L, ULCO CNRS LOG, Wimereux, FR
Artigas L, ULCO CNRS LOG, Wimereux, FR
Chomienne L, ULCO CNRS LOG, Wimereux, FR
Malsot-Wimmer V, ULCO CNRS LOG, Wimereux, FR
Libeau A, ULCO CNRS LOG, Wimereux, FR
Palazot M, ULCO CNRS LOG, Wimereux, FR
Levoy O, ULCO CNRS LOG, Wimereux, FR
Hubert Z, ULCO CNRS LOG, Wimereux, FR
Schmidt I, ULCO CNRS LOG, Wimereux, FR
Cottronéo M, ULCO CNRS LOG, Wimereux, FR
Perrein I, ULCO CNRS LOG, Wimereux, FR
Gallot C, CNRS MOI, Marseille, FR
Lefebvre A, IFREMER LER Boulogne sur Mer, FR
Navon M, IFREMER LER Port en Bessin, FR
Claquin P, Uni Caen CNRS BOREA, Caen, FR
Kraft K, Finnish Environment Institute, Helsinki, FI

Automated approaches and techniques are of paramount interest for addressing phytoplankton dynamics and distribution at high resolution, especially in coastal systems that face a combination of global change and local stressors. In particular, the eastern English Channel and southern North Sea show significant connectivity to adjacent seas, strong hydrodynamics, and high riverine inputs, influencing biogeochemical and biological processes like high productivity and recurring phytoplankton blooms. This area is a target of European (IBTS, JERICO S3, OBAMA NEXT) and French national (RioMAR, FutureOBS) and local (CARPARC) projects and includes a Marine Protected Area (EPMO).

A multispectral fluorometer, an automated “pulse shape-recording” flow cytometry, and an automated imaging system were deployed in a continuous and/or discrete mode during winter and spring cruises on board the “Thalassa” and “Côte de la Manche” R.V (French Oceanography Fleet). The present work focuses on phytoplankton diversity addressed by automated imaging from Imaging FlowCytoBot (IFCB) analysis by combining SYKEPIC script and pipeline and the ECOTAXA for automated classification purposes. After the first prediction, a score is written on each image to check the confidence threshold of the proposed identification. In case of low confidence, it is possible to reclassify the image based on expert knowledge. Data analyses were carried out using the R software to characterize the distribution of phytoplankton genera/species in the different ecosystems targeted by the different cruises during two seasons, particularly defining the differences encountered but also the early or late start/settlement of phytoplankton blooms. It was possible to define the diversity across estuarine-influenced areas to offshore waters. The automated imaging approach applied on a continuous recording basis allowed the processing of a high amount of information on phytoplankton diversity and distribution, despite possible misclassification or misidentification due to poor quality of some imported images or the time required to reclassify them thanks to taxonomic expertise. The presence of more than one organism per image is also an issue, even though the assignment to dedicated categories gives information about interactions amongst species.

Linking coastal biodiversity, carbon cycling, and climate feedback: hotspots and hot moments

Geilfus N-X, University of Helsinki
Brunberg M, University of Helsinki
Norkko J, University of Helsinki
Spencer K, University of Helsinki
Humborg C, Stockholm University
Norkko A, University of Helsinki

The pressing challenges posed by biodiversity loss and climate change underscore the critical need for a deeper understanding of their intricate interactions. Coastal ecosystems are highly productive and dynamic in terms of carbon exchange between the ocean and the atmosphere. Due to their potential for carbon capture, those ecosystems hold significant potential as nature-based solution to mitigate climate change. Yet, their effects on carbon cycling and greenhouse gas (GHG) dynamics, including carbon dioxide (CO2) and methane (CH4), remain inadequately understood. This knowledge gap is compounded by substantial heterogeneity in marine biodiversity, further complicating the issue.

In response to these challenges, the CoastClim initiative aims to quantify how spatial variations in biodiversity and ecosystem state, alongside with long-term (i.e., seasonal) and short-term (e.g., marine heatwaves events) variations, trigger the occurrence of hot spots and/or hot moments for interactions between marine biodiversity and GHG dynamics in coastal environments, in the Southern Finland.

At the Tvärminne Zoological Station, we measure at high-resolution and continuously seawater concentration of CO2 and CH4 to investigate how seasonal cycles, influencing the type and intensity of primary and secondary production, will impact the production and consumption of GHG in the water column, and thereby affect their air-sea exchange (i.e., hot moments).

In August 2023, field measurements performed across a land to sea gradient highlights the presence of hotspots where changes in coastal biodiversity could directly impact the observed surface seawater concentration of GHG, ranging from 160 to 2500 µatm for CO2 and from 20 to 470 nmol/L for CH4.

Fungal parasites infecting phytoplankton along a Baltic Sea salinity gradient

Kangas J, University of Turku, Turku, Finland
Haraguchi L, Finnish Environment Institute, Helsinki, Finland
Kraft K, Finnish Environment Institute, Helsinki, Finland
Bilik S, Lappeenranta University of Technology, Lappeenranta, Finland
Mehrshad M, Swedish University of Agricultural Sciences
Sjöqvist C, Åbo Akademi University, Turku, Finland
Van den Wyngaert S, University of Turku, Turku, Finland

Parasites of phytoplankton are an integral part of marine ecosystems, yet they are often overlooked in the ecological studies of phytoplankton blooms. Chytrid fungi are known parasites of phytoplankton. They reproduce via motile zoospores and are often host specific and highly virulent, with infections typically leading to death of the host. In freshwater ecosystems, chytrid parasites are recognized for their significant role in regulating phytoplankton blooms, shaping food webs, and influencing biogeochemical cycles. However, in marine and brackish water ecosystems, little is known about the diversity and ecology of chytrid parasites infecting phytoplankton despite growing evidence of their presence across a wide range of marine habitats.

To address this knowledge gap, we aimed to (i) characterize the diversity and abundance of chytrid parasites infecting phytoplankton, and (ii) identify potential drivers of their occurrence and diversity during a phytoplankton spring bloom in the Baltic Sea.

We collected samples during five research cruises and from 15 stations along a north-south salinity gradient (5-14 PSU) between the Gulf of Finland and the Southern Baltic Proper. For sampling we used the FINMARI Alg@line infrastructure on board of MS Finnmaid, which is organized by the Finnish Environmental Institute (Syke). We applied high throughput quantification and sequencing methods as well as cultivation and single cell sequencing of individual host-parasite associations to characterize the spatial and temporal distribution patterns of chytrid parasites and their phytoplankton hosts along the Baltic Sea horizontal salinity gradient.

First results based on rDNA metabarcoding and single cell sequencing showed that chytrid parasites are driven by their host distributions, which differ spatially and temporally between northern and southern parts of the sampled salinity gradient.

First FerryBox based CO2 measurements in the Eastern Mediterranean

Ktistaki G, Institute of Oceanography, Hellenic Centre for Marine Research
Frangoulis C, Institute of Oceanography, Hellenic Centre for Marine Research
Stamataki N, Institute of Oceanography, Hellenic Centre for Marine Research
Pettas M, Institute of Oceanography, Hellenic Centre for Marine Research
Michelinakis S, Institute of Oceanography, Hellenic Centre for Marine Research
Petihakis G, Institute of Oceanography, Hellenic Centre for Marine Research

The POSEIDON FerryBox (PFB) is installed on a Heraklion–Piraeus ferry route (daily frequency, 170 nautical miles). To our knowledge, up to now (2024) this is the only FerryBox system in operation in the Eastern Mediterranean. This automated, flow-through system includes sensors for temperature, salinity, oxygen, fluorescence, and turbidity. Measurements are taken at 5 m depth (inlet) approximately every 700 m. Data are delivered in near-real time (NRT). In 2023, the system was upgraded to also include a sampler and a pCO2 analyzer (calibrated daily with two non-zero reference gases and a zero cartridge). The PFB CO2 observations are combined with other carbonate observations from sensors (CO2, pH) placed on one of the POSEIDON fixed platforms, as well as regular R/V missions at the same location (discrete sampling of pH, total dissolved inorganic carbon, and total alkalinity). The CO2 PFB data, covering an area under the influence of various water masses, will contribute to studying the spatial variability of the carbonate system, to testing and improving carbonate algorithms and to improving air-sea flux calculation in the area (Frangoulis et al. 2024). The CO2 data are currently being processed for submission to SOCAT database. Future perspectives include the inclusion of the CO2 data in the POSEIDON NRT data product, the addition of a pH and/or alkalinity sensor to the PFB system and the use of the PFB sampler for discrete sampling (e.g. for alkalinity), which will further improve and reduce the uncertainty in estimates of the Mediterranean Sea’s role in the carbon pump.

Frangoulis C, Stamataki N, Pettas M, Michelinakis S, King AL, Giannoudi L, Tsiaras K, Christodoulaki S, Seppälä J, Thyssen M, Borges AV and Krasakopoulou E (2024) A carbonate system time series in the Eastern Mediterranean Sea. Two years of high-frequency in-situ observations and remote sensing. Front. Mar. Sci. 11:1348161.doi: 10.3389/fmars.2024.1348161

KvarkenData - Utilization of Environmental Data in Kvarken Area

Kunttu L, University of Vaasa
Nieminen J, University of Vaasa
Mäki-Turja T, University of Vaasa
Huculak E, University of Vaasa
Özcan C, University of Vaasa

KvarkenData project explores the research and business possibilities of environmental data from Kvarken area. Aurora Botnia, a ship of Wasaline, operating between Vaasa and Umeå acts as a sensor observing the state of the environment by collecting maritime and environmental data along its route. In addition, the utilization of other data sources (for example weather and satellite data) in monitoring the marine environment is also being investigated.

Finnish Marine Research Infrastructure FINMARI

Kuuppo K, Finnish Environment Institute
Seppälä J, Finnish Environment Institute
Norkko J, Tvärminne Zoological Station, University of Helsinki
Kotilainen A, Geological Survey of Finland
Uusitalo L, Natural Resources Institute Finland
Tuomi L, Finnish Meteorological Institute
Snickars M, Husö Biological Station Åbo Akademi University
Hänninen J, Archipelago Research Institute University of Turku

The Finnish Marine Research Infrastructure (FINMARI) brings together Finnish marine research know-how and the most important players into a distributed, interdisciplinary infrastructure network of field stations, research vessels and laboratory facilities, ferryboxes, fixed measurement platforms and buoys. FINMARI, allies research infrastructures of Finnish Environment Institute, Natural Resources Institute Finland, Geological Survey of Finland, Finnish Meteorological Institute, Tvärminne Zoological Station of the University of Helsinki, Archipelago Research Institute of the University of Turku, and Husö Biological Station of the Åbo Akademi University.

FINMARI supports practically all marine research and researcher education in Finland, across a wide variety of environmental disciplines from biology, geology, fisheries, chemistry, physics, and geography to development of multidisciplinary environmental monitoring and management strategies.

FINMARI provides a unique hub for observational and experimental marine research platforms and facilities (Open Access) and FAIR data and will increasingly offer services to the research community and other users, the focus areas being marine diversity, the Baltic Sea in the changing climate, blue economy, and the effects of pollution.

Phytoplankton communities in the Gulf of Finland based on environmental DNA and RNA compared with microscopy

Leesmäe P, Department of Marine systems, Tallinn University of Technology
Kikas V, Department of Marine systems, Tallinn University of Technology
Sarmiento Guerin M, Department of Chemistry and Biotechnology, Tallinn University of Technology
Nigul L, Department of Chemistry and Biotechnology, Tallinn University of Technology
Lips U, Department of Marine systems, Tallinn University of Technology
Sildever S, Department of Marine systems, Tallinn University of Technology

This project investigates phytoplankton communities in the Gulf of Finland using environmental DNA and RNA as well as traditional microscopy-based identification. While phytoplankton species detection has historically relied on differences in species morphology, it does not allow identification of species that lack clear morphological characteristics and are too small (< 20 µm) to be reliably detected using light microscopy. At the same time eDNA has the potential to detect all organisms in the sample containing DNA, however it also detects organisms that are not active if their DNA is still present. eRNA allows to focus only on the organisms that are active at the time of sampling, while also not being restricted by the morphology of the organisms.

All samples were collected using the FerryBox flow-through system onboard the ferry traversing between Tallinn and Helsinki in 2020 and 2023 within the framework of Estonian National Monitoring. The phytoplankton sample collection and analysis follow the HELCOM (2023) guidelines. For eDNA and eRNA samples 500 mL of water was filtered through 1 µm and 0.22 µm polycarbonate filters. The eRNA samples were fixed with RNALater to maintain the RNA present in the sample. DNA and RNA were extracted using commercial kits and two molecular markers targeting the 18S and 28S ribosomal RNA genes were used. To compare morphology-based data with the results from eDNA and ERNA samples, the phytoplankton data from the

Environmental Monitoring Information System (KESE) is used to assess species diversity.

This study explores the potential of eDNA/eRNA to enhance the resolution of phytoplankton monitoring. Additionally, this work aims to integrate molecular methods into marine monitoring, which further enhances our ability to detect harmful and invasive species as well as changes in the bottom of the food web.

Spatial and temporal dynamics of spring phytoplankton functional traits in Baltic sea

Lescroart E, Finnish Environment Institute & Ifremer
Seppälä J, Finnish Environment Institute
Haraguchi L, Finnish Environment Institute

Phytoplankton community structures and dynamics are important for understanding primary production, complex biogeochemical cycling processes, food web connections and harmful algal bloom. Yet, the understanding of the structure and dynamics of phytoplankton communities at sub-meso and daily scales are still limited due to the lack of high spatial and temporal resolution sampling. Our aim was to describe the spatio-temporal distribution of phytoplankton communities in the Baltic Sea during the spring bloom. Phytoplankton communities were determined by flow cytometry (CytoSense) and described by cell abundances, shape, size, fluorescence signals (chlorophyll-a *a*nd phycobilins) and cell complexity. Samples were taken hourly from surface waters over March and April 2023. During the studied period 13 cytometric groups were defined on the basis of phytoplankton functional traits, and 15 phytoplankton communities were identified in the spatio-temporal sampling grid using a non-metric multidimensional scaling (NMDS) to group similar samples together. Environmental variables such as temperature, salinity, turbidity and colored dissolved organic matter (CDOM) were used to explain community distribution and dynamics in spring. The composition and succession of phytoplankton communities described the evolution of the spring bloom from south to north, showing different communities depending on their latitude, revealing short-lived local communities and describing the succession and replacement of communities throughout the spring.

First Ferrybox Installation in Türkiye & TÜBİTAK's Future Perspectives

Mutlu S, TÜBİTAK Marmara Research Center, Climate Change and Sustainability VP, Marine Studies & Technologies Research Group, Kocaeli
Özsu E, TÜBİTAK Marmara Research Center, Climate Change and Sustainability VP, Marine Studies & Technologies Research Group, Kocaeli
Tan I, TÜBİTAK Marmara Research Center, Climate Change and Sustainability VP, Marine Studies & Technologies Research Group, Kocaeli

Marine Research and Technologies Research Group (MRT-RG) operating the research vessel named «RV TÜBİTAK MARMARA» with the highest number of scientific expedition days (i.e., 257 cruise days in 2021) in Türkiye aims to gain a new measurement system «Ferrybox» to enhance its monitoring ability and knowledge in surrounding seas. Using Ferrybox (FB) technologies, it is anticipated that sea surface data will be continuously collected throughout the research missions.

RV TÜBİTAK MARMARA covered the 75% of Turkish coastline and even had missions in Bulgarian and Romanian coastal waters in 2021. However, only CTD stations (~1K) provided data for the surface. In geophysical surveys as there were no CTD stations, no surface data regarding to water quality was collected, which means that opportunities in such surveys are missed. On the other hand, if such a system had been installed earlier, more data would have been collected en route. With the financial support of the Strategy and Budget Directorate of Türkiye, MRT-RG is going to install a FB on the research vessel and start to collect surface data between CTD stations by the end of 2024. Additionally, this FB will be the first FB system in Turkish seas.

The FB in the RV TÜBİTAK MARMARA will be called «TUBIBOX». TUBIBOX will initially collect basic water quality parameters such as temperature, salinity, dissolved oxygen, chlorophyll-a, pCO_2, and pH. After gaining some experience with FB, more parameters will be added to TUBIBOX in the next decade, such as phosphate, nitrite/nitrate, silicate and so on.

TUBITAK also plans to establish collaborations between maritime research institutions and private maritime companies in the Black Sea region to expand FB applications as there is only one fixed FB in Varna operated by IO-BAS and no mobile FB in the Black Sea. A project proposal (called "BLACKBOX") has been submitted to Interreg Next Black Sea Basin Programme in order to fill FB gap. The proposal envisages the installation of 4 fixed FBs in Constanta (by NIMRD), Varna (by IO-BAS), Istanbul (by TÜBİTAK & MEXT) and Poti (GMG/FoE-GE), as well as 1 mobile FB on board an ARKAS LINE vessel operating between Istanbul and Poti. The data to be collected as part of the project will be subject to FAIR guidelines, making it more comfortable than ever for marine scientists to access high resolution surface data.

Keywords: Black Sea, research vessel, TÜBİTAK's future perspectives.

Mapping Phytoplankton Blooms Using an Imaging FlowCytobot (IFCB) on a Ship of Opportunity (SOOP)

Norli M, Norwegian Institute for Water Research (NIVA)
Eikrem W, Norwegian Institute for Water Research (NIVA)
Jaccard P, Norwegian Institute for Water Research (NIVA)
Stig Hansen P, Norwegian Institute for Water Research (NIVA)
Bhakta D, Norwegian Institute for Water Research (NIVA)
King A, Norwegian Institute for Water Research (NIVA)

Since 2021, an Imaging FlowCytobot (IFCB) has been deployed periodically on the FerryBox platform onboard the MS Color Fantasy for observation of phytoplankton. The IFCB collects a 5 mL sample every 20-30 minutes, then captures images of phytoplankton as they are pushed through a flow cell. To automate the classification of these images, we have implemented a machine learning pipeline based on convolutional neural networks (CNNs), leveraging a pretrained ResNet18 architecture using the PyTorch framework. This approach enables efficient image classification and semi-quantitative analysis of the observed phytoplankton species. In this work, we present preliminary results from the spring of 2024, demonstrating the progress made in refining our classifier, through manual annotation of species and image augmentation. The preliminary results show interesting bloom dynamics between Oslo and Kiel, including *Skeletonema* spp., *Guinardia delicatula*, *Dactyliosolen fragilissimus* and *Cerataulina pelagica*.

From the Seafloor to the Stars: 33 Years of Innovation in measurement technology and Over 20 Years of Ocean Systems Engineering

Posner U, -4H-JENA engineering GmbH

For over three decades, -4H-JENA engineering GmbH has been a leader in marine technologies, specializing in the development, manufacturing, and distribution of measurement systems for marine and seawater research. With more than 20 years of experience in Ocean Systems Engineering, we provide innovative solutions for global environmental monitoring and research. The widely recognized -4H-FerryBox enables automated, long-term monitoring of key water parameters such as temperature, salinity, pCO2, oxygen, and chlorophyll, used extensively in coastal and oceanic environments.

Complementing the FerryBox are CONTROS sensors, offering precise measurements of pCO2, CH4, pH, and alkalinity, crucial for climate and ecological studies. Our mesocosm systems support controlled experimentation in natural marine environments, advancing the understanding of environmental processes and their role in climate science.

These systems are deployed globally by research institutions, universities, and government agencies, making significant contributions to marine science, biogeochemistry, and climate modeling.

Digital Infrastructure for FerryBox Platforms: The NIVAcloud-FerryBox Platform

Protsenko E, Norwegian Institute for Water Research
Rudjord Z, Norwegian Institute for Water Research
Leirvik K, Norwegian Institute for Water Research
Jaccard P, Norwegian Institute for Water Research
Merlina A, Norwegian Institute for Water Research
King A, Norwegian Institute for Water Research

The NIVAcloud-FerryBox platform is an advanced digital infrastructure that supports automated ocean observation systems installed on ships of opportunity. This platform efficiently handles data collection, quality control, storage, and visualization across multiple vessels, providing a robust solution for both researchers and the public. By ensuring that the data adheres to FAIR (Findable, Accessible, Interoperable, and Reusable) principles, the platform facilitates seamless data access and sharing.

A key feature of NIVAcloud is its ability to organize data in a way that ensures it is reproducible and can be effectively used across a wide range of research projects. It optimizes data sharing through metadata catalog integration, reducing the need for redundant data distribution to multiple databases. The platform also offers comprehensive automated and manual data quality control, following recommendations for real-time biogeochemical measurements. Additionally, near-real-time data monitoring is made accessible through Grafana dashboards, enhancing error detection and system reliability. The use of open-source software underscores NIVAcloud’s commitment to cost-effective, scalable solutions for scientific research.

The platform’s capabilities extend from internal data sharing via API and Python wrappers to external data exposure through microservices and public sharing via the Thredds server and Arctic Data Center.

Keywords: NorSOOP, JERICO-RI, AquaInfra

AQUARIUS Transnational Access calls

Seppälä J, Finnish Environment Institute
Hänninen P, Finnish Environment Institute
Closset I, Finnish meteorological institute
Tikka K, Finnish meteorological institute
Laakso L, Finnish meteorological institute
King A, Norwegian Institute for Water Research
Petihakis G, Hellenic Center for Marine Research
Frangoulis C, Hellenic Center for Marine Research
Ntoumas M, Hellenic Center for Marine Research

EU-project AQUARIUS will provide access to a comprehensive and diverse suite of integrated research infrastructures to address challenges and explore opportunities for the long-term sustainability of our marine and freshwater ecosystems. AQUARIUS will launch two robust and transparent Transnational Access (TA) funding calls, inviting research and innovation project proposals that convincingly demonstrate how they will integrate Research Infrastructures and contribute to the defined TA Call Challenges (based on the core policy objectives of Mission 'Restore our Ocean and Waters').

TA Call 1 – Open: 11 November 2024 – 20 January 2025

TA Call 2 – Open: 2 September 2025 – 28 October 2025

TA Calls are open to scientists from research and academia, from industry, and from citizen science groups, according to the defined eligibility criteria.

The integration of these RI services reflects a critical need for a more holistic approach to support research and innovation towards achieving healthy, sustainable and protected oceans and waters.

We present a set of posters highlighting available AQUARIUS infrastructures, especially those for FerryBox-platforms and for the Baltic Sea.

More details of the call can be found at https://aquarius-ri.eu/access/

Use of Ferrybox chlorophyll fluorescence for validation of Sentinel 3 ocean colour products in the Northwestern Black Sea

Slabakova V, Institute of oceanology, Bulgarian Academy of Sciences, Bulgaria
Macovei V, Helmholtz-Zentrum Hereon, Germany
Voynova Y, Helmholtz-Zentrum Hereon, Germany
Gehrung M, Helmholtz-Zentrum Hereon, Germany
Rust H, Helmholtz-Zentrum Hereon, Germany
Slabakova N, Institute of oceanology, Bulgarian Academy of Sciences, Bulgaria
Petkov I, Institute of oceanology, Bulgarian Academy of Sciences, Bulgaria
Drumeva N, Institute of oceanology, Bulgarian Academy of Sciences, Bulgaria
Stefanova K, Institute of oceanology, Bulgarian Academy of Sciences, Bulgaria

The proxy for phytoplankton biomass, Chlorophyll a (Chl a) plays a central role as environmental status assessment indicator of Water Framework Directive (WFD) and Marine Strategy Framework Directive (MSFD). One of the main challenges in its practical application however is the need of data with frequency corresponding to the natural spatial and temporal scales of phytoplankton variability. The majority of in situ observations that are commonly used for ecological monitoring of the Black Sea are generally based on near-shore monitoring programmes or irregular oceanographic cruises. These gaps can be filled in by satellite ocean colour observations which provide extensive coverage and excellent space/time resolution data. However prior to use the satellite-derived Chl a products for monitoring of the Black Sea, rigorous assessments of algorithm performance are necessary.

In this study, we use the underway flourometric Chl a measurements in the Northwestern Black Sea collected with a FerryBox installed onboard the R/V Mare Nigrum during a H2020 DOORS project cruise (September 2023). These underway data were used for assessment of Sentinel 3 OLCI estimates of chlorophyll a concentration. One of the main advantages of such measurements is their sampling rate – the 10 days of the underway measurements resulted in 51 matchups, compared to only 6 measurements from discrete water sampling. Three Chl a algorithms for OLCI were validated: 1) maximum band ratio algorithm (OC4Me); 2) neural network inverse radiative transfer model (NN) and 3) regional band ratio empirical algorithm (BSCHL). The result indicated that the standard OCME4 and NN algorithms significantly overestimate the in situ data (>130% mean difference) while the Chl a concentrations derived from BSCHL algorithm showed reasonable estimates (<15%).

The obtained results indicate that underway Chl a measurements can support validation activities of satellite ocean colour products in the Black Sea.

Acknowledgements: This research was supported by the SEA-ReCap project and EU Horizon 2020 DOORS project, contract No 101000518.

SMHI IFCB Data Pipeline

Torstensson A, Swedish Meteorological and Hydrological Institute
Hedblom M, Swedish Meteorological and Hydrological Institute
Karlson B, Swedish Meteorological and Hydrological Institute

At the Swedish Meteorological and Hydrological Institute (SMHI), we are advancing our understanding of marine ecosystems through continuous data collection during monthly monitoring cruises in the Skagerrak, Kattegat, and Baltic Sea. Since 2021, the integration of the Imaging FlowCytobot (IFCB) with the FerryBox system aboard the R/V Svea has greatly enhanced our observational capabilities. This innovative in-flow imaging technology has transformed the field, enabling automated, high-frequency monitoring of phyto- and microzooplankton. Utilizing advanced AI-assisted image analysis, the system processes high-resolution images of plankton (≥5 µm), providing rapid species- or genus-level identification. The IFCB operates autonomously, sampling every 25 minutes with minimal crew intervention, delivering unprecedented temporal resolution in plankton monitoring. Here, we introduce the first draft of a semi-automated data pipeline that channels IFCB data from the R/V Svea to the Swedish NODC database at SMHI, facilitating integration with broader platforms like EMODnet Biology and the Digital Twin Ocean (DTO). Our goal is to continuously feed these databases with evolving datasets as classification models improve, allowing for increasingly accurate plankton identification over time.

List of participants
12th FerryBox Workshop 1-2 October 2024

Last name	First name	Institute (as displayed in badge)	12th FerryBox WS 1-2 oct	Oral	Poster	MINKE Fluorometry WS 30 Sep	MINKE Imaging WS 3 Oct
Aardema	Hedy	MPIC	1	0	1	1	1
Astorga-Gallano	Danilo	UnivAustral de Chile/IDEAL	1	1	0	1	1
Berezina	Anfisa	NIVA	1	0	1	1	0
Boehme	Tobias	bbe Moldaenke	1	1	0	1	1
Braun	Philipp	IOW	1	0	0	1	1
Conrad	Marcel	Univ Bremerhaven / IGB	1	0	1	1	1
Daehne	Dagmar	NLWKN	1	1	0	1	1
Deschner	Stephan	Hereon	1	1	0	0	0
Drouineau	Ludovic	IFREMER	1	1	0	0	0
Drumeva	Nadezhda	IO-BAS	1	0	1	0	0
Ehrhart	Sebastian	Syke	1	0	0	1	1
Eikrem	Wenche	NIVA	1	0	0	0	1
Elovaara	Samu	Syke	1	0	0	1	1
Fahning	Jana	SubCtech GmbH	1	1	0	0	0
Fauvel	Lucie	ULCO	1	0	1	1	1
Geilfus	Nicolas-Xavier	Univ of Helsinki	1	0	1	0	0
Gonzáles-Nuevo	Gonzalo	IEO-CSIC	1	1	0	0	0
Grunwald	Maik	-4H-JENA engineering GmbH	1	1	0	0	0
Grönroos	Päivi	Syke	1	0	0	0	0
Haavisto	Noora	FMI	0	0	0	1	0
Haraguchi	Lumi	Syke	1	1	0	0	1
Hartogs	Marc	Rijkswaterstaat	1	0	0	0	0
Haugland	Kristina	NIVA	1	0	0	1	0
Honkanen	Martti	FMI	1	1	0	1	1
Hällfors	Heidi	Syke	0	0	0	0	1
Immonen	Maria	Univ Helsinki	1	0	0	0	1
Iso-Kuusela	Juho	Ekonia Oy	1	0	0	1	0
Iwe	Sören	IOW	1	1	0	1	0
Jaccard	Pierre	NIVA	1	1	0	1	1
Jokiniemi	Anni	FMI	1	0	0	0	0
Kaitala	Seppo	Syke	1	0	0	0	0
Kangas	Jonna	Univ Turku	1	0	1	0	0
Karaca	Deniz	EuroGOOS	1	0	0	0	0
Karlson	Bengt	SMHI	1	1	0	0	1
Kedzierska	Urszula	Univf Gdansk	1	1	0	1	1
Kielosto	Sami	Syke	1	0	0	0	0
Kikas	Villu	TalTech	1	0	1	1	0
King	Andrew	NIVA	1	1	0	1	0
Kraft	Kaisa	Syke	1	1	0	0	1
Ktistaki	Georgia	AUTh/HCMR	1	0	1	1	1
Kunttu	Leena	Univ Vaasa	1	0	1	0	1
Kuuppo	Katri	Syke	1	0	1	1	1
Laakso	Lauri	FMI	1	1	0	1	1

Laloux	Marine	SHOM	1	0	0	1	1
Leesmae	Pille	TalTech	1	0	1	1	0
Lefebvre	Alain	Ifremer	1	1	0	0	0
Lehtinen	Sirpa	Syke	0	0	0	0	1
Lehto	Anne-Mari	Syke	1	0	0	0	0
Lescroart	Elsa	Ifremer	1	0	1	1	1
Lips	Urmas	TalTech	1	1	0	0	0
Luitjens	Lara	NLWKN	1	0	0	1	1
Maunula	Petri	Syke	1	0	0	0	0
Mutlu	Sabri	TÜBITAK	1	0	1	0	1
Nilsson	Madeleine	SMHI	1	1	0	0	0
Norli	Marit	NIVA	0	0	1	0	0
Ntoumas	Manolis	HCMR	1	1	0	0	0
Peltonen	Heikki	syke	1	1	0	0	0
Posner	Uwe	-4H-JENA engineering GmbH	1	0	1	0	0
Protsenko	Elizaveta	NIVA	1	0	1	0	0
Rintala	Janne-Markus	ICOS ERIC	1	1	0	0	0
Rust	Hendrik	Hereon	1	0	0	0	0
Rünk	Nelli	TalTech	1	0	0	1	0
Salaün	Joelle	SHOM	1	0	0	1	1
Seppala	Jukka	Syke	1	1	1	1	1
Skyttä	Annaliina	Syke	1	0	0	0	1
Slabakova	Violeta	IO-BAS	1	0	1	0	0
Spence	Kurt	Univ Helsinki	0	0	0	1	0
Suikkanen	Sanna	Syke	0	0	0	0	1
Sørensen	Kai	NIVA	1	1	0	1	0
Tikka	Kimmo	FMI	1	0	0	1	1
Torstensson	Anders	SMHI	1	0	1	0	1
Vanharanta	Mari	Syke	1	0	0	0	1
Vene	Karl	Flydog Solutions OÜ	1	1	0	0	0
Voynova	Yoana	Hereon	1	1	1	0	0
Väkevä	Sakari	Syke	1	0	0	0	0
Willstrand Wranne	Anna	VOTO	1	0	0	1	0