ESA Advance Ocean Training Course 2025

At Sea Handbook

Version 1.0 (February, 4th 2025)

Table of Contents

1 Introduction

Inside this document you will find practical arrangements for the #OTC25 At Sea course.

Our aim is to help you to exploit data from ESA and operational EO Missions for science and applications development. Ocean and atmosphere dynamic processes define the surface expressions imprinted on the sea surface or in the atmosphere that we can measure from space. In order to extract scientific knowledge from satellite data, it is fundamental to understand the processes that define the signals we can measure. This is at the very heart of the #OTC25 which has the following course aim:

To understand and interpret the ocean signatures that are measured from complementary satellite instruments in space by studying the sensor physics used to measure ocean signals and the fundamental ocean and atmosphere processes that define those signals.

During the course, we will use the following general themes to help organise our training:

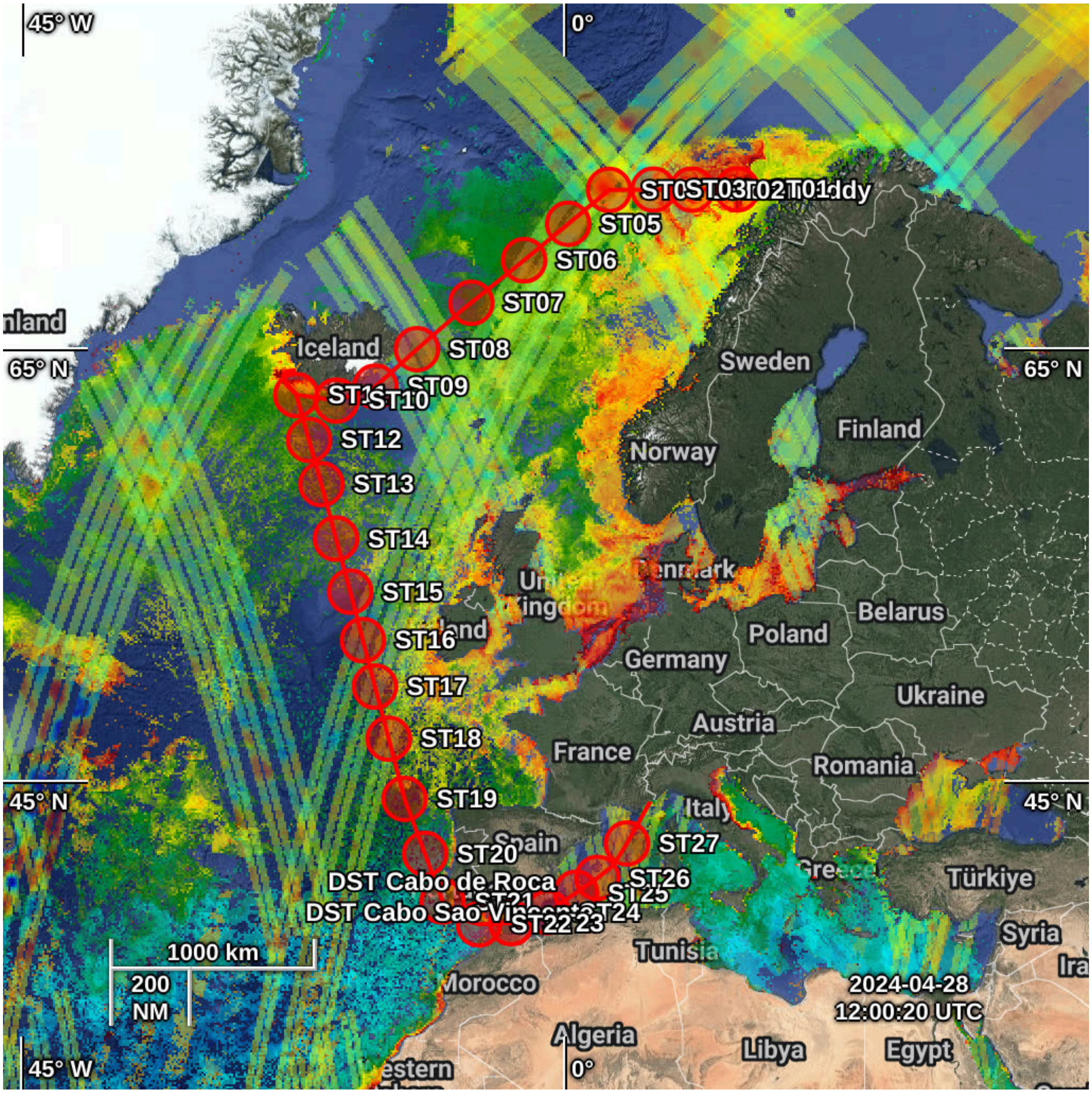
- Upper Ocean Dynamics, Mesoscale and Sub-mesoscale Structures
- Ocean bio-geo-chemistry
- Marine Meteorology and Air-Sea interaction

More details on these groups are provided in section “Description of the groups”.

Working together informally in groups is an excellent way to interact and learn from each other. Together with the lecturers of the course we will run informal group sessions that are designed to help consolidate your understanding of what you have learned during the course.

The best place to do this is on the ocean surface itself which is why the #OTC25 Training Course consists of two mandatory parts: A ship based component where measurements are made at sea to support Student projects together with group work and lectures aboard the ship. Prior to this, a shore-based component is running on-line that is focussed on explaining ocean earth observation techniques with a dedicated focus on the oceanography from space along the track to be followed during the at sea component.

The OTC25 ship-based component will take place aboard the tall ship *Statsraad Lehmkuhl* (https://lehmkuhl.no/en/) during the One Ocean expedition from Tromsø, Norway, to Nice, France, via Reykjavik, Iceland (see draft voyage track here).



Indicative route of the Tall Ship Statsraad Lehmkuhl during the #OTC25 voyage. The map shows a 3-days composite of Chlorophyll-a derived from Sentinel-3 Ocean and Land Colour Instrument (OLCI, https://sentiwiki.copernicus.eu/web/s3-olci-instrument) using the OC4ME algorithm along with Sea Level Anomaly (SLA) from SWOT L3 product (Surface Water and Ocean Topography, CNES, NASA).

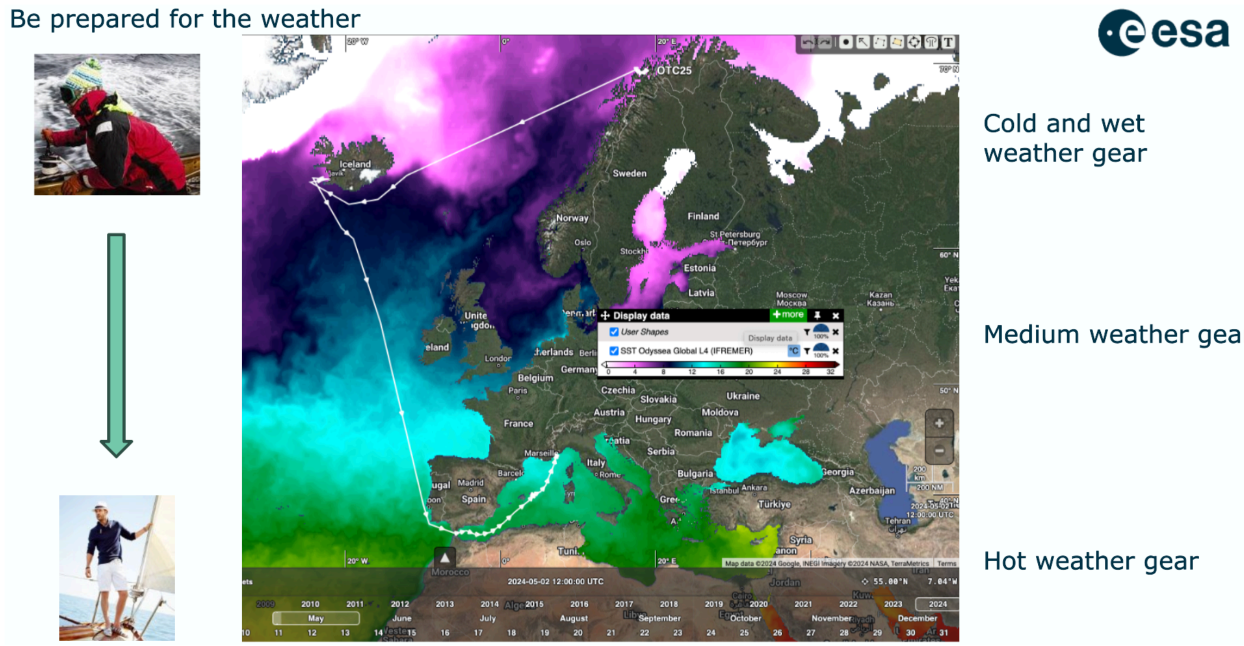
2 Logistics

2.1 Schedule

The cruise will consist of three legs:

Leg1: 14 days at sea, ~1250 nm.	
Embark ship in Tromsø, Norway:	21 April 2025 at 18:00
Depart Tromsø, Norway:	22 April 2025
Arrive Reykjavik, Iceland:	5-May 2025 10:00
Disembark Reykjavik	6-May 2025 at 10:00
Leg2: 26 days at sea, ~2530 nm.	
Embark ship in Reykjavik, Iceland:	7 May 2025 10:00
Depart Reykjavik, Iceland:	8 May 2025 14:00
Arrive Mahon	1 June 2025 10:00
VIP Embark ship in Mahon:	11:00 - 12:00
Press conference onboard	12:30 - 13:30
Leg3: 3 days at sea, ~270 nm.	
Depart Mahon:	1 June 2025 14:00
Arrive Nice, France:	3 June 2025
One Ocean Science Conference https://one-ocean-science-2025.org/	4-6 June 2025
ESAOTC25@UNOC events on ship deck	4-5 June 2025 10:00-16:00
ESA OTC25 team final dinner and social event on ship deck	5 June 2025 18:00-
Disembark Nice, France:	6 June 2025 10:00

2.2 Equipment/what to bring



There is limited space on board for personal items, so only bring those that are highly necessary. You will be assigned a locker with keys and a chest for your personal belongings. You have to pack your things in soft luggage or bags that can easily be stowed away during the voyage. Please avoid bringing large and bulky suitcases. This video shows the size of the chest and locker (Links to an external site), and the exact measurements are:

Chest (note that the opening is likely smaller):

Length: 76 cm.

Width: 57 cm.

Height: 34 cm.

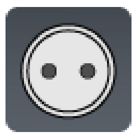
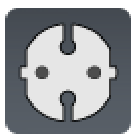
Locker (with lock, note also that there is a shelf in the middle)

Width: 35 cm.

Depth: 80 cm.

Height: 70 cm.

Things you need for studying

- A note book and pens. Ideally a pocket sized note book, so it can be carried around with you at all times (very useful!).
- Laptop computer (remember the charger - and mouse if you like). There will be a wireless intranet (**but no internet connection**), so you will need to read from your screen and also work on your assignments on your computer. You can also bring a tablet for reading if you have one. The electric plugs on board are the Norwegian/European type, 230 Volts and 50 Hz.
- 
- 
- USB memory stick for daily data transfer, plus a portable hard drive in order to take any data back home with you.
- Powerbank can be useful for recharging your tablets, camera, or other electronic equipment as plug sockets are very sparse.

For sleeping

- A sleeping bag (and pillow if you need one). You should also bring a thin sleeping bag liner to keep you warmer in the cold, which itself will most likely will be enough in the warmer conditions.

We will be moving to temperatures around 24 degrees from temperatures of around 0 degrees, so pack accordingly.

- An optional stiff sleeping mat or thin blow up mattress that can go in the bottom of the hammock (a thin mattress is provided on the ship but others have recommended taking something stiffer).
- Earplugs and sleeping mask are recommended – the hammocks are very close together on board and Craig snores :)
- Small torch and/or headtorch with a red light setting (only red light is allowed at night on the ship).

Clothes and shoes

- It will be cold when we leave Tromsø, potentially 0, or minus degrees with windchill on deck. This means that you need to bring also warm clothes - think lots of layers, wool is great as it keeps warm when wet.
- You **will** get wet when you are on deck, especially when pulling ropes. So you need to make sure you dry your clothes before you have to put them back on again for the next watch. Therefore, it is advisable to take spares of things like wool socks, so you know you will have a dry pair.
- We recommend comfortable and solid working clothes, sporty clothes that tolerate climbing the rig, pulling ropes, and some dirt. Let our dress code be "functional and cosy"!
- Thick wool/fleece jumper(s) that is warm.
- Thin wool layers (long johns & long sleeved tops). Potentially a pair to wear as pyjamas, depending on your sleeping bag warmth.
- Wool or thermal underwear, plus normal underwear.
- Leisure wear.
- Hat, gloves, scarf (good for windy days).
- Good waterproof and windproof jacket and trousers/salopettes. These need to be big enough to fit your warm clothing underneath.
- Good shoes: waterproof shoes/rubber boots that can fit good wool socks under, and sneakers/trainers and potentially sandals/thongs for the shower.
- Gloves for pulling ropes if you have sensitive hands, although note that the crew do not use gloves and recommend that you don't either (you will just have to build up the callouses on your hands!)
- There are laundry facilities on board if needed, plus you can always wash by hand. You don't need to bring laundry detergent.

Personal items

- Towel and toiletries (remember menstruation products if you need them).
- Small towel(s) to put around your neck and absorb the water when you are out on deck.
- Personal medications, sea sickness medication, contact lenses, sports tape (for hands), band aid etc.
- Sunscreen and sun glasses.
- Water bottle you can fill.
- Earphones for listening to music or audiobooks.
- Headlight with red light.

Note that it is mandatory to bring a passport that is valid at least until six months after the trip has ended.

Pack some essentials in your hand luggage in case your bags are delayed/lost en route - we will not be able to wait for them. You could consider buying a tracker for your luggage.

2.3 Administrative steps

2.3.1 Medical certificate

Due to the length of the time at sea, a seafarer's medical certificate is required for all participants. Read more on the Statsraad Lehmkuhl's website.

2.3.2 Visas

Students are responsible for checking any visa requirements for Norway, Iceland, Spain and France and procuring any necessary documentation. Please contact the course organisers if you need any documentation in order to obtain a visa, e.g. proof of onward travel.

2.3.3 Travel

All students must arrange their own travel to join and depart from the ship.

All participants must arrive into Tromsø on or before 21st April 2025 and plan their return journey from Nice, France after 6th June 2025. ESA will cover the cost of accommodation and meals aboard the ship. It is suggested to reserve your flights and any accommodation well in advance to minimise costs.

2.4 Life on Board

You will be a fellow sailor on the Statsraad Lehmkuhl and an important part of the crew. Together with an experienced and friendly permanent crew, you will perform all the necessary tasks needed to sail – without your efforts, it is actually not possible to sail a ship the size of Statsraad Lehmkuhl. If you want to have an idea of life on board for students, you can check out the full set of videos of the four month voyage over the Pacific Ocean from the University of Bergen, and read the description on the Statsraad Lehmkuhl website.

2.4.1 Accommodation in hammocks

You sleep safely and well in your hammock, side by side with your fellow sailors. Some people are a little skeptical about replacing their bed with a hammock, but you will soon discover that this is a great way to sleep, especially when the sea is not so calm. Then the hammock works like a gyro and limits much of the rocking. You need to bring your own sleeping bag and pillow, mattresses are available.

2.4.2 Being part of a watch

As a fellow sailor, you become an important part of the crew for operating and sailing the ship. Immediately after boarding, all fellow sailors are divided into three different sea watches; red watch, white watch and blue watch. This will be your regular "gang" on the trip. Together with your watch team, you have regular four-hour sea shifts twice a day.

The times for the watches are below. You will each be assigned to a watch in due time:

Red 12-16 and 00-04
White 04-08 and 16-20
Blue 08-12 and 20-00

The three watch teams are led by the ship's professional crew, who are always present on deck to ensure safety. While on watch, you receive training and participate in sail manoeuvres, helming the ship, scientific measurements, keeping lookout and serving as fire watch.

At the beginning and the end of each watch, both incoming and outgoing guards muster (meet on the deck at predefined location). This is necessary to ensure that all fellow sailors are present and well.
About half an hour before each watch change, the oncoming watch is called to muster (woken up).

During your 4 hours watch, you are assigned to one of the following sailing duties :

- 1 hour Helm: steer the ship and fell the wind/current drift
- 1 hour Fire watch: take a tour in the ship to ensure everything is OK
- 1 hour Look out watch: keeps a sharp look for any object in the water ahead to sideways of the ship
- 1 hour ManOverBoard (MOB) bow watch: keep a look at the stern in the unlikely event of a MOB, enjoy the view of the ocean (waves / color turbidity / faunae)
- Help with manoeuvers, clean ship

2.4.3 Meals

All meals are included in the ticket: breakfast, lunch, and dinner. In addition, a simple bread meal is provided for the night watch team. Meals are served buffet-style on the fore banjer room. The blue watch team sleeps here, so they take down their hammocks before going on duty.

Meal times
7:20 AM – 8:30 AM Breakfast
11:20 AM – 12:30 PM Lunch
5:30 PM – 6:30 PM Dinner

In addition, there are two scheduled 15-minute breaks each day: one at 10 AM and one at 3 PM, known as 'ti-kaffe' and 'tre-kaffe'. Along with coffee and tea, a small snack or treat is often served with the afternoon tre-kaffe.

2.4.4 Wifi and telephone

Out at sea, there is **no telephone and mobile internet coverage**. The ship's **internet connection is not available to the students and citizen scientists passengers**. The ship's own crew and the student liaison officer has daily contact with shore and can convey important messages when necessary. In special cases, the ship's satellite telephone can be used.

2.4.5 Bathroom and toilet

There are good sanitary conditions on board with separate showers. In the autumn of 2023, both the ladies' and men's bathrooms were completely renovated. Ideally bring sandals to use in the shower.

2.4.6 Details of the conditions at sea

When sailing out of Tromsø at the end of April, we expect mild temperatures and more daylight, but still cool nights. The wind can be moderate to fresh from the northwest, and the sea can be calm to moderate, but we are prepared for sudden changes in weather conditions.

On our way to Iceland, we cross the Norwegian Sea, which in May/April often offers variable weather. Here the wind can vary from a light breeze to stronger winds, and the waves can be significant, which makes for an exciting and challenging sailing experience.

As we approach Reykjavik, the waters along Iceland's coast will provide a mix of weather conditions. In May, we can encounter mild, moist winds and occasional rain, but also periods of sun and clear skies. Iceland's coastal climate provides a dynamic sailing experience with both calm and more active days.

Once we depart Reykjavik, the voyage offers many different sailing conditions, with both calm periods and strong winds with high waves. This gives you a great opportunity to experience and master a variety of sea conditions!

As we approach more southern latitudes, the climate will become milder, and temperatures will rise. We will make a brief stop at the Spanish island of Menorca to pick up a small group joining us for the final two days of the voyage. Finally, we will arrive at the sunny and elegant French Riviera, where the Mediterranean climate offers calm and pleasant sailing conditions.

All photos provided by students from the previous OTC23 trip, showing life and lectures on board.

2.4.7 More information about the ship

The Statsraad Lehmkuhl is a majestic three-masted barque, launched in 1914 and now sailing under the Norwegian flag. This historic vessel, with a length of 98 meters and over 2,000 square meters of sail area, serves as a sail training ship and ambassador for Norway.

Life on board during the One Ocean Expedition is an exhilarating blend of tradition, teamwork, and environmental stewardship. This immersive experience fosters teamwork, discipline, and a deep connection with both maritime heritage and ocean conservation.
Participants also contribute to scientific research and environmental monitoring, making this not just a sailing adventure but a meaningful contribution to ocean health.

You can also download the Statsraad Lehmkuhl handbook, there, you can discover more about life on board, the ship, and the art of sailing.
More information about life on board including a virtual tour of the Statsraad Lehmkuhl Tall ship can be found at https://oneoceanexpedition.com/life-on-board.

3 Description of the available instruments

3.1 Instruments mounted on board the ship

There will be two science coordinators onboard, hired by the ship, responsible of the sensors mounted onboard and who will be able to help for sensor calibration, maintenance and data access.

3.1.1 Mast

Measurements from sensors in the mast are done continuously. several instruments are available the list is provided in the table below:

Smart weather sensor	WS700-UMB	https://www.lufft.com/products/compact-weather-sensors-293/ws700-umb-smart-weather-sensor-1830/
Radar Precipitation Sensor	WS100	https://www.lufft.com/products/precipitation-sensors-287/ws100-radar-precipitation-sensor-smart-disdrometer-2361/

IR sensor for SST skin temperature measurements	Apogee SI-421-SS	https://www.scaledinstruments.com/shop/apogee-instruments/infrared-radiometers/apogee-si-421-ss-research-grade-sdi-12-digital-output-narrow-field-of-view-infrared-radiometer-sensor/
SeaAwarenes camera	2xKCC100, 1xKCC 200n	https://www.kongsberg.com/discovery/navigation-positioning/kongsberg-camera-cluster/
PAR	Quantum SQ-522	https://www.apogeeinstruments.com/content/SQ-522.pdf

3.1.2 CTD carousel

Measurements done using the CTD carousel can only be done at stations, when the ship is heaved in.

Carousel (sensors, watersamplers)	SBE 32SC SUB COMPACT CAROUSEL - 12x2.5l	
Winch for carousel	EIVA OceanEnviro	https://www.eiva.com/products/hardware/oceanenviro-winches
CTD - carousel	Seabird SBE19plus V2	https://www.seabird.com/sbe-19plus-v2-seacat-profiler-ctd/product?id=60761421596
Dissolved oxygen - carousel	SBE43 DO	https://www.seabird.com/sbe-43-dissolved-oxygen-sensor/product?id=60762467728
ChlA/turbidity/backscatter - carousel	CHL-a & TURBIDITY ECO-FLNTU	https://www.seabird.com/eco-flntu/product?id=60762467722
PAR - carousel	SATPAR PAR-LOG ICSW,	https://www.seabird.com/photosynthetically-active-radiation-par-sensor/product?id=60762467732

PAR - carousel	SATPAR SURFACE/REFERENCE PAR	https://www.seabird.com/photosynthetically-active-radiation-par-sensor/product?id=60762467732
pH - carousel	SBE18 pH	https://www.seabird.com/ph-sensors/sbe-18-ph-sensor/family?productCategoryId=54627869929
Addidtional manual CTD	Additional CTD / high res 100m (Xylem Castaway)	https://www.xylem.com/en-us/products--services/analytical-instruments-and-equipment/data-collection-mapping-profiling-survey-systems/ctds/castaway-ctd/

3.1.3 Hull mounted

Instruments mounted on the Hull Will run continuously

ADCP - 300 kHz	Kongsberg CP300	https://www.kongsberg.com/discovery/ocean-science/ocean-science-transducers/cp300/
ADCP - 75 kHz	Teledyne RDI Ocean Surveyor ADCP (75kHz)	https://www.teledynemarine.com/brands/rdi/ocean-surveyor-adcp
Hydrophone hull mounted	Ocean Sonics icListen HF	https://oceansonics.com/iclisten-hf-hydrophone/
Scientific Echosounder EK80	Kongsberg wideband scientific echosounder (WBT)	https://chelsea.co.uk/products/trilux/
Kongsberg ES38/200 Combi C echosounder transducer	38 (split-beam) and 200 kHz (single-beam) echosounder transducers	https://www.kongsberg.com/discovery/ocean-science/ocean-science-transducers/simrad-es38-18200-18c/
Kongsberg ES120-7C echosounder transducer	120 kHz split-beam echosounder transducer	https://www.kongsberg.com/discovery/fish-finding/fishery-s

		plit-beam-transducers/simrad-es120-7c/

3.1.4 Water intake below deck

The following measurements are run continuously using a water intake below deck.

SooGuard - Ferrybox	AADI SOOGUARD Ferrybox system	https://www.aanderaa.com/media/pdfs/b188-sooguard-ferry-box-system.pdf
Conductivity, salinity, density, temperature - Ferrybox	AADI 5819C	https://www.aanderaa.com/media/pdfs/d425_conductivity_sensor_5819_5819r.pdf
Pressure, temp - Ferrybox	AADI 4117A	https://www.aanderaa.com/media/pdfs/d362_aanderaa_pressure_sensor_4117_4117r.pdf
Oxygen, temp - Ferrybox	AADI 4330W	https://www.aanderaa.com/media/pdfs/d378_aanderaa_oxygen_sensor_4330w_4330_4330f_low_en.pdf
Turbidity, Chla A, phycocyanin - Ferrybox	Chelsea Trilux	https://chelsea.co.uk/products/trilux/

3.1.5 Manual sampling

The following analyses can be done when needed when the ship is underway. It includes analyzing water from the water intake (from the lab or outside sink), lowering or towing instruments.

eDNA filtration	Manual water samples water intake + towed water sampler ("torpedo")	-	Water intake / lab

eDNA extraction	Biomeme Franklin qPCR, Biomeme M1 Cartrigde	https://shop.biomeme.com/franklin-real-time-pcr-thermocycler/	
Microplastics filtration/analysis	Lab / water intake + particle sizes, number (more info coming)	Coming	Water intake / lab
Fishing equipment	Specs		Lowered
Net sampling	WP2 plankton net, mesh size of 180 micrometer		Lowered
TorpedDNA	eDNA sampler		Towed

3.1.6 Other

There are big cold chambers on the lower deck for fresh food, but there are also a freezer and a fridge for science samples, one deck lower next to the stone ballast with a ladder to get down there.

Freezer	Specs: -18ºC	
Fridge	Specs: 5ºC	

3.1.7 Access to Measurement from sensor mounted onboard

We are still waiting for information from the ship to give details about the data workflow and access. You should have access to:

- Raw and processed data for instruments from the ship
- Raw and / or processed data from instruments we are bringing

There will be two science coordinators onboard, hired by the ship, responsible of the sensors mounted onboard and who will be able to help for sensor calibration, maintenance and data access.

3.2 Observing systems brought by lecturers and students

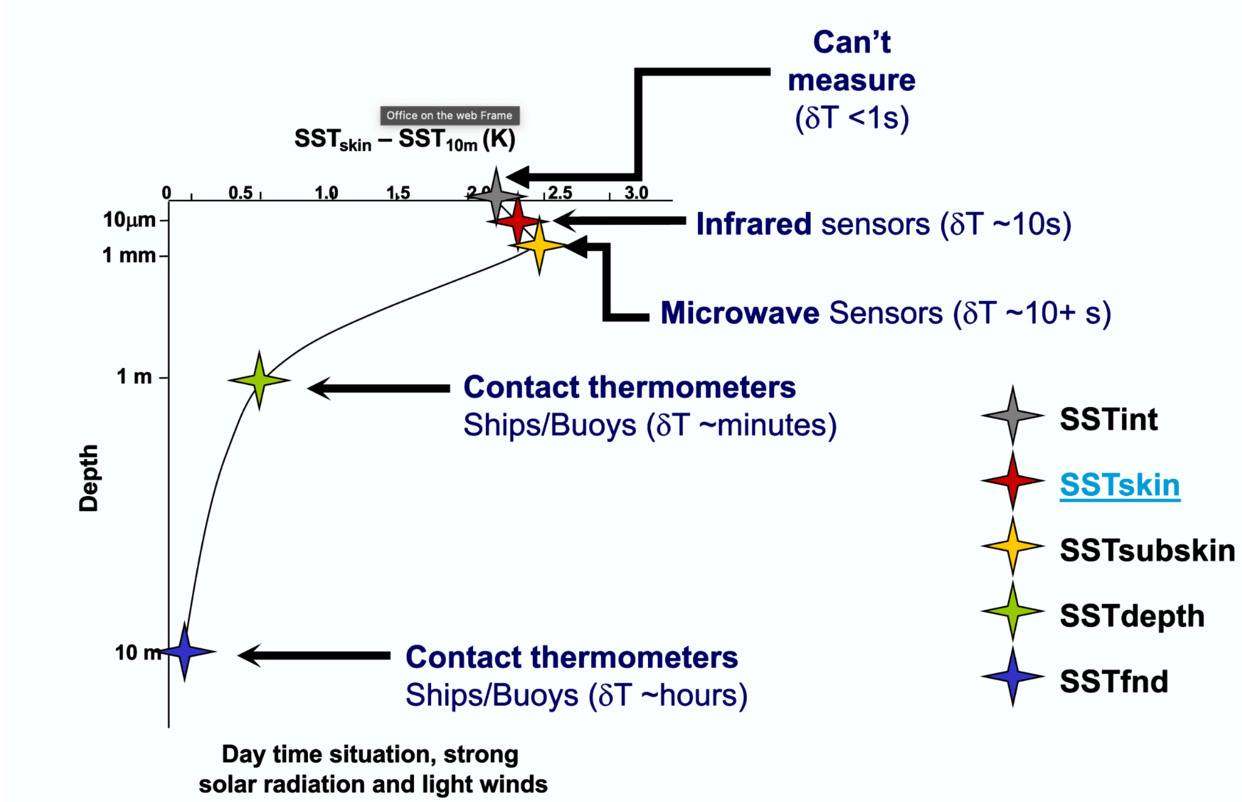
Some observing systems are provided by lecturers and students, instructions to manipulate them and log sheets will be provided by the person in charge of the instrument. This section list the instruments that will be on board during leg 1 and leg 2

3.2.1 Handheld sensors

Type	Instrument	Variable measured	Documentation / Point of Contact
Infra Red Radiometer		Skin SST	craig.donlon@esa.int
Atmospheric photometer	Calitoo	rate of aerosols	Estelle.raynal@cnes.fr, Simon.Vandevelde@cnes.fr
P-band reflector	prototype developed at ICE-CSIC/IEEC	ocean waves, altimeters, permittivity|	estel@ice.csic.es
OpenCTD	build on board	Temperature, Salinity	anton.korosov@nersc.no

3.2.1.1 Infra Red Radiometer

Objective: Measure the SST skin temperature



Instruments:

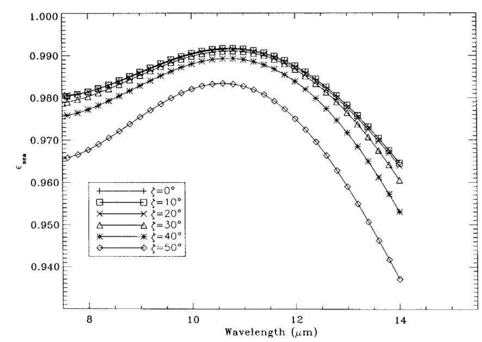


FIG. 3. Emissivity of seawater over the spectral bandwidth used by the TASCO THI-500L radiometer for different viewing geometries. Data from Masuda et al. (1988) and Downing and Williams (1975).

References:

- Donlon, S. J. Keogh, D. J. Baldwin, I. S. Robinson, I. Ridle, T. Sheasby, I. J. Barton, E. F. Bradley, T. J. Nightingale, W. Emery: Solid-State Radiometer Measurements of Sea Surface Skin Temperature, 01 Jun 1998, DOI: https://doi.org/10.1175/1520-0426(1998)015
- C. J. Donlon, P. J. Minnett, A. Jessup, I. Barton, W. Emery, S. Hook, W. Wimmer, T. Nightingale, C. Zappa: Chapter 3.2 - Ship-Borne Thermal Infrared Radiometer Systems, 2014, DOI: https://doi.org/10.1016/B978-0-12-417011-7.00011-8

3.2.1.2 Atmospheric Photometer

The Calitoo is a photometer for determining the rate of aerosols in the atmosphere and to characterize their size distribution (smoke, polluting gases, ice crystals, dust).

In this goal, the photometer measures the optical thickness of the atmosphere at different wavelengths : blue (465nm), green (540nm) and red (615nm).

The device is also equipped with a GPS, a pressure and temperature sensor. The use of components using the latest technologies, allows us to realize a low cost, accurate and portable measuring instrument.

More info on Calitoo here:
https://www.calitoo.fr/index.php?page=en

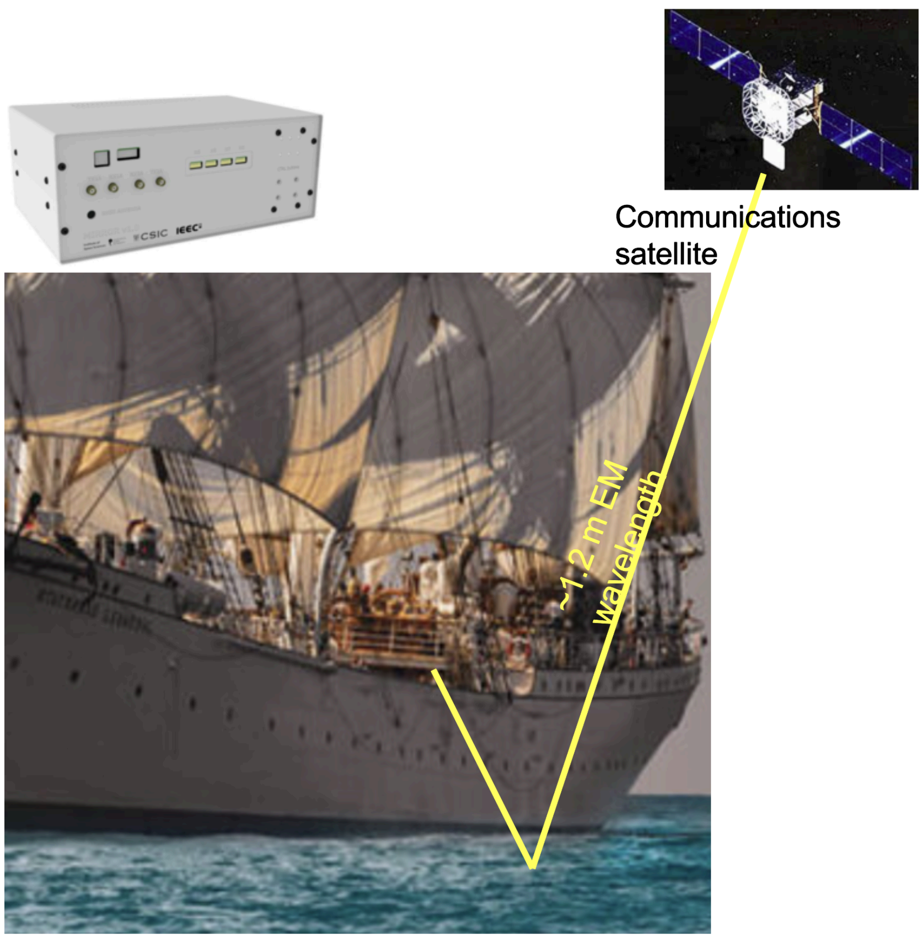
3.2.1.3 P-Band reflector

Objectives of the use of P-band reflector:

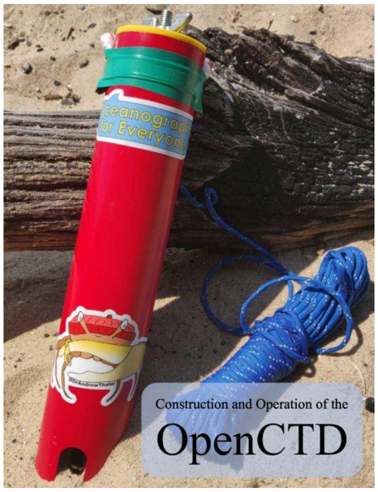
- To understand the process of developing spaceborne remote sensing techniques (you give the data for granted, but a long journey was needed from conception of the measurement concept to its satellite implementation and exploitation!)
- To investigate a completely immature measurement concept: would it be possible to estimate ocean variables with the communication signals transmitted at P-band by non-cooperating satellites? e.g., UFO COMSAT constellation working at ~250MHz, ~1.2 m wavelength (as far as I know, nobody has used these signals reflected off the ocean)

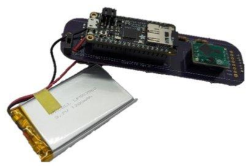
Potential variables that could be retrieved:

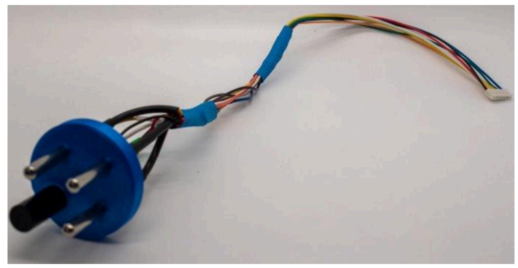
- Ocean waves?
- Precise ocean altimetry, even under extreme conditions?
- Sea water permittivity (salt content)?



3.2.1.4 OpenCTD #oceanographyforeveryone







Two CTDs will be brought: one ready-to-use and components to build a second one.

Activities:

- Building a CTD (includes soldering!)
- Parallel casting of three CTDs to measure small-scale variability
- Towing of a CTD behind the ship

3.2.2 Underway measurements

Type	Instrument	Variable measured	Point of Contact
Inline system	ACS / LISSST 200x	Absorption, attenuation and Particle distribution	pramlall.sejal@gmail.com
Inline system	NOC TA LOC + WRASSe	Total Alkalinity	Molly.Phillips@soton.ac.uk
Fluorometer	LabSTAF FLuorometer	phytoplankton photosynthesis	mro@pml.ac.uk

3.2.2.1 AC-S and LISST 200x

The an AC-S and LISST 200x instruments will be installed into a flow through system

ACS: attenuation and absorption

LISST 200x: particle distribution

These instruments will be useful for:

- Cover significant territory to develop a statistical understanding of the distribution of properties (time-space domain).
- Adaptive sampling (looking for features we want to sample).
- Sub-pixel variability for work validating satellite products.
- Mapping features such as fronts, upwelling zones, eddies to provide context

3.2.2.2 NOC TA LOC / WRASSe

The objective is to measure Total Alkalinity using the UnderWay flow through water and parameters from the Ferrybox sensors:

Two instruments will be mounted:

- NOC TA LOC sensor: National Oceanographic Center Total Alkalinity Lab On Chip, which performs high precision measurements with a single-point total alkalinity titration every 12 minutes (Schaap, A. *et al.* *(2021) 'Quantification of a subsea CO2 release with lab-on-chip sensors measuring benthic gradients', International Journal of Greenhouse Gas Control, 110.)*

- WRASSeWide Range Alkalinity Spectrophotometric Sensor which performs High frequency measurements of wide-ranging total alkalinity such as those found across coccolithophore blooms using a multi-point total alkalinity titration in 3 discrete droplets, suspended in hydrophobic oil, every 6 second

Diagram of droplets in tube. MA is titrant acid molarity. Aqueous droplets in pink (bromophenol blue and HCl with seawater) and hydrophobic oil (purple)

- Discrete samples will be taken and brought back to laboratory to be analyzed and ensure the quality of the in situ measurements
- Ferrybox continuous measurements of Conductivity and Temperature are necessary to compute the Total Alkalinity

3.2.2.3 LabSTAF Fluorometer

Lab STAF is a compact active Fluorometer. It uses Single Turnover Active Fluorometry for the quantitative assessment of phytoplankton photosynthesis.
These parameters are crucial for understanding the ocean's carbon cycle and validating ESA projects products (from SCOPE and OC4C)..

3.2.3 Water samples

Type	strategy	Point of Contact
filtering bench	filter water sample to retrieve pigments and freeze filter at -80C	
methane measurements	take water sample at surface and inject mercury	
UV filter measurement	take water sample at surface in amber glass jar and freeze it	

multi parameter photometer	multi parameter photometer	[Unyime Umoh]()

3.2.3.1 Filtering bench

The filtering bench will be mounted in the wet lab on the wall. It will enable the retrieval of pigments on filter that will be frozen to -80C until the analyses are done on land.

3.2.3.2 Methane measurements

Water will be collected at surface. The preparation of the sample for storage takes several steps as all bubbles need to be removed from the water and mercury II chloride will be injected in the bottle.

3.2.3.3 Sunscreen measurements

Surface measurements will be collected in 100mL amber glass jar. The samples will be freezed and UV filtering capacity of the water will be measured on land.

3.2.3.4 MultiParameter Photometer

3.3 Drifting buoys

Given the diversity of drifting buoys we will have on board, it would be interesting to make several experiments of deploying a diversity of buoys to look at their cohesion and assess the wind induced drift component. At least three deployments of several buoys should be done to assess the impact of the wind on the drift of the buoy:

- Low wind
- Medium wind in strong current
- High wind

One could also assess the coherent structures / divergent flows by launching two buoys of the same type in the following situations:

- in the middle of an eddy
- At the edge of the same eddy
- In the core of a current / on the Lagrangian barrer

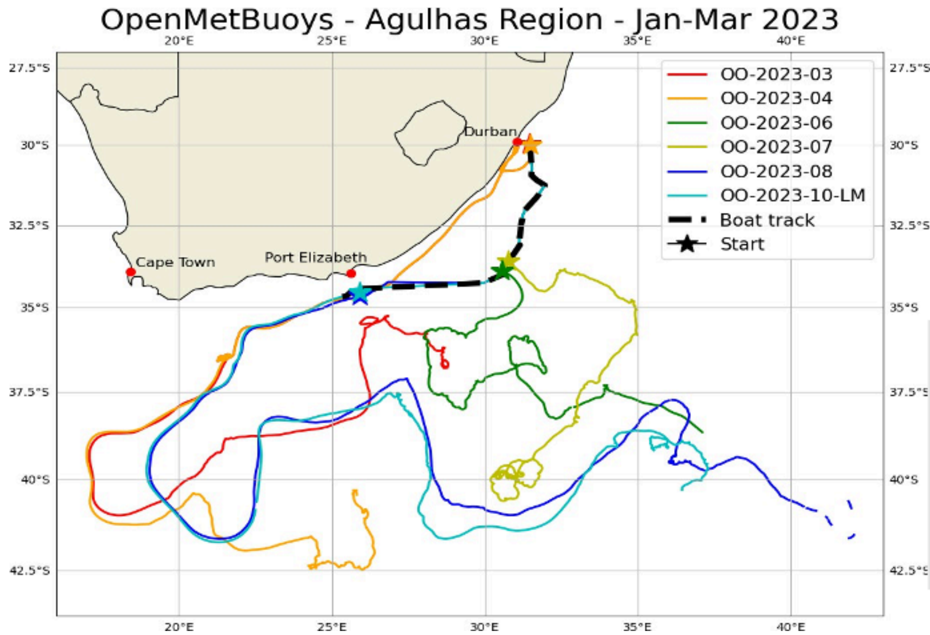
The following subsections summarize the drifters that will be available on board during Leg 1 and Leg 2.

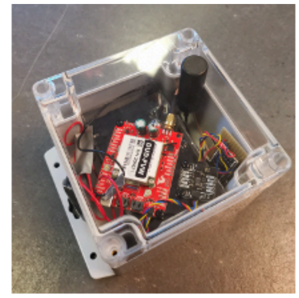
3.3.1 Drifting wave buoys

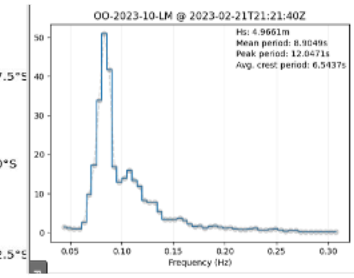
Drifting wave buoys trace the ocean current at the first few centimeters from the surface, they are equipped with additional motion sensors to measure information for the wave spectrum.

Type	Quantity	Description	Point of Contact
MELODI	20	surface floats with omnidirectional wave spectrum	Alexey Mironov from eOdyn
OpenMetBuoys	20	surface floats with omnidirectional wave spectrum	Oyvind Breivick from Met.No Johnny A. Johannessen NERSC
SPOTTER	5	surface floats with directional wave spectrum	Fabrice Collard from OceanDataLab

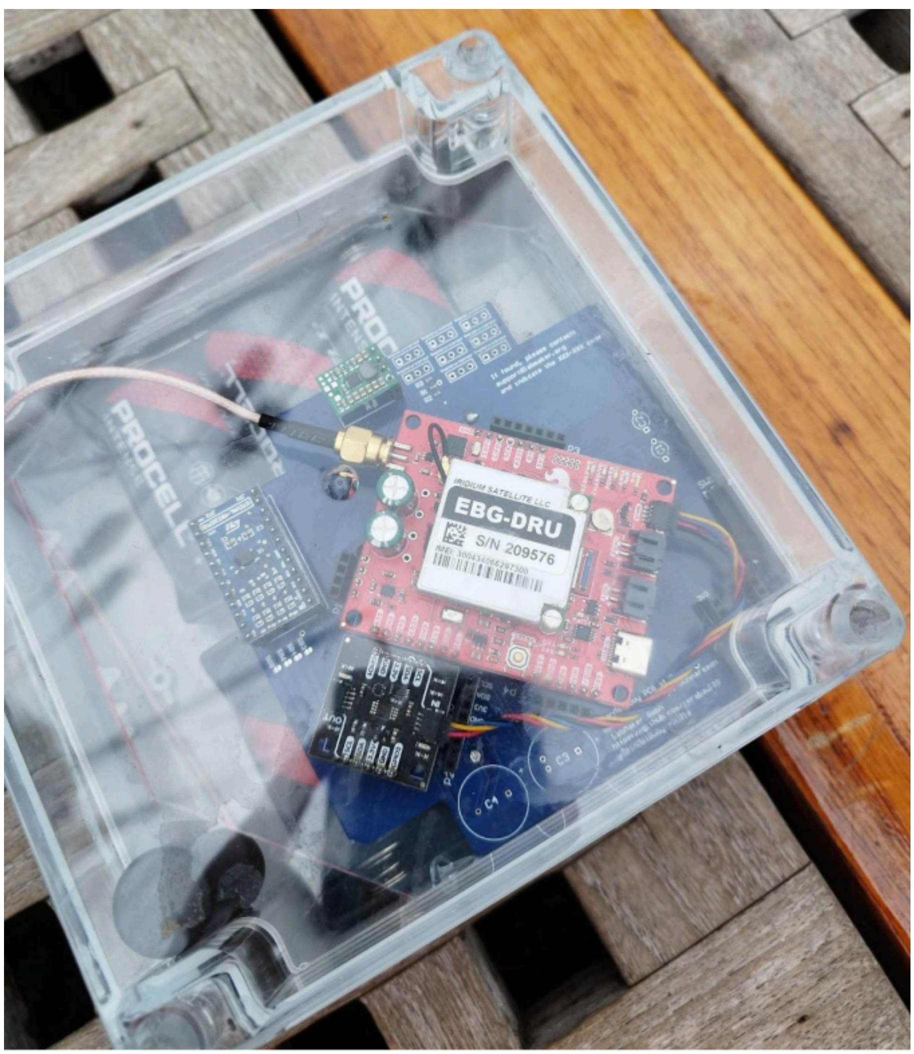
OpenMetBuoys wave drifters (Met.No)





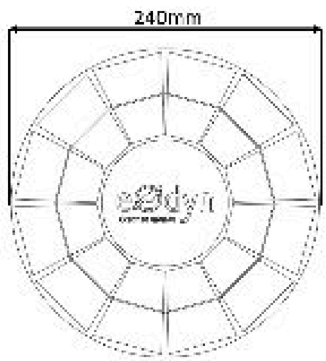


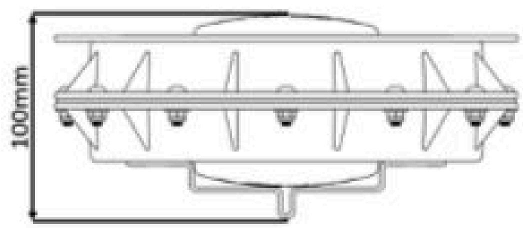
Wave spectra and position are reported every 3 hours.



MELODI wave drifters (eOdyn)

MELODI Technical Specification





Measurement Rates

Parameter Type	Max. Acquisition Freq.		Max. Transmission Freq.	
	Without wave	With wave	Without wave	With wave
GNNS	5 min	10 min	5 min	30 min
SWH	-	30 min	-	30 min
WS	-	30 min	-	30 min
SST	5 min	10 min	5 min	30 min

Specifications

- Solar powered – Autonomy > 1 year
- Iridium two-way satellite communication
- Data display/access Web portal
- Cloud data storage
- ABS or biodegradable plastic hull
- Low floater profile reduces wind drift impact
- Waves sampling rate: 3Hz
- Wave spectrum frequency range: 0.02-0.8 Hz
- Magnetic on/off switch
- 10 cm height x 25 cm diameter
- 1 kg total weight

Wave spectra, position and SST are reported every 1 to 3 hours.

SPOTTER wave drifters (SOFAR Ocean)

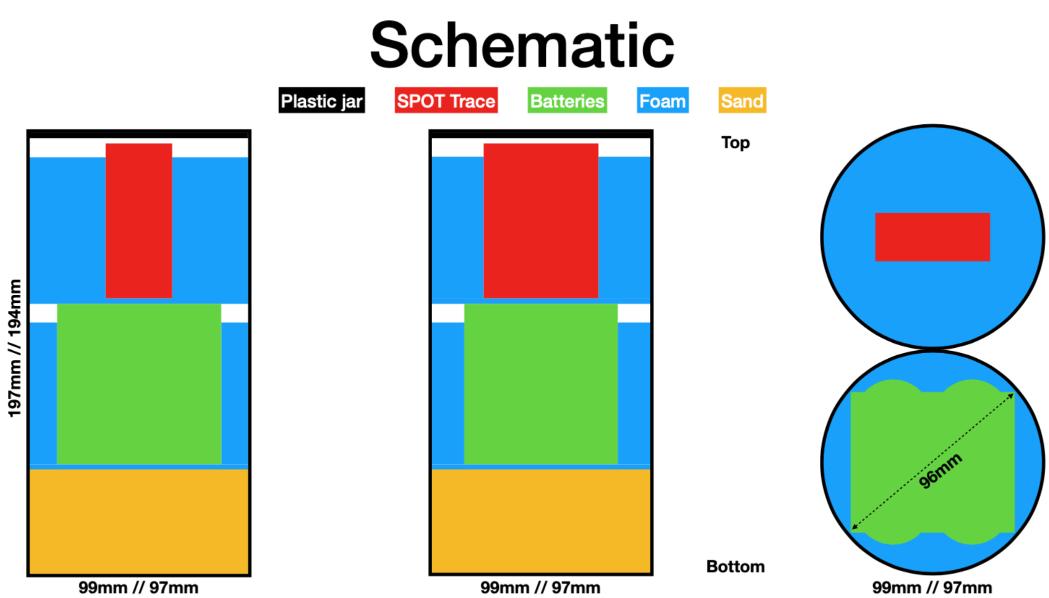
https://www.sofarocean.com/products/spotter

Spotter wave drifter reports directional wave spectra and location every 1 hour. To be deployed by hand, weight < 5kg

3.3.2 Lagrangian floats

Type	Quantity	Description	Point of Contact
Home made drifter	2-	Sealed can box with SPOT Tracer GPS	Vadim Bertrand

20 Home made GPS buoys will be brought on board. They are sealed can box with a SPOT Trace GPS that will send one point every hour to Globalstar network. Data can be retrieved in NRT using SPOT API

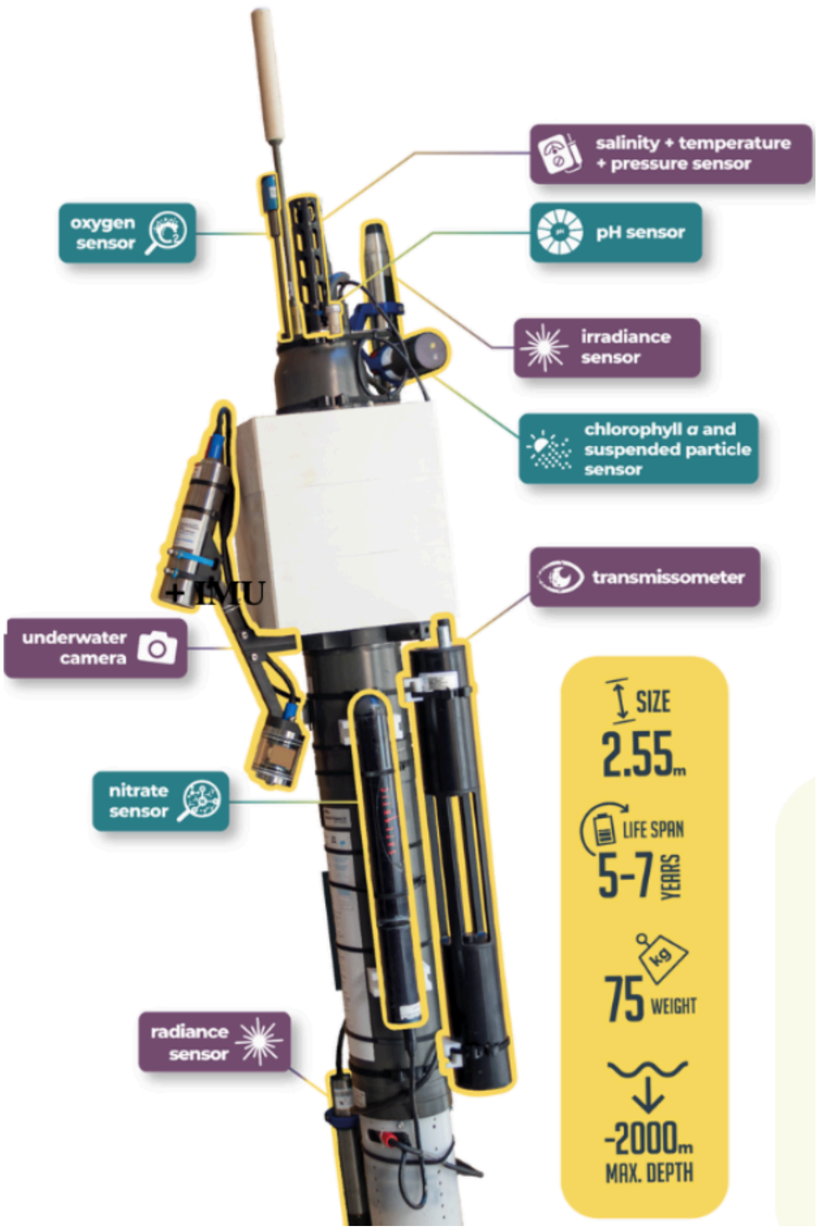


The plan is to launch an ensemble of drifters (5 sets) in 4 deployments choosing different oceanic and atmospheric conditions.

3.3.3 Bio ARGO

Type	Quantity	Description	Point of Contact
Hyperspectral float	2	Argo float equipped with chlorophyll sensor	Molly Phillips

2 Hyperspectral Argo floats equipped with chlorophyll sensor will be deployed. One in the Lofoten Eddy, and one at the entrance of Gibraltar. It will plunge every 14 days and drift at xx m depth and make profile every xx days



3.4 Drones

3.4.1 Drone operations safety

There will be two quadcopter drones available onboard for taking optical measurements.

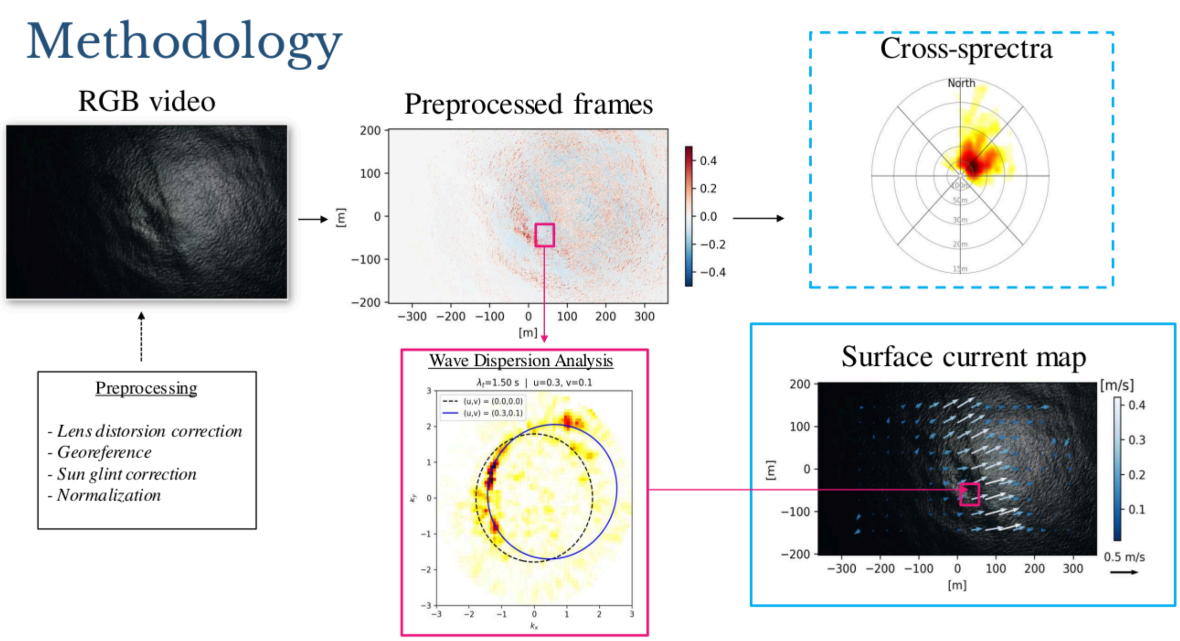
They will be operated during daylight, mainly during stations, only by their licensed pilots, with one additional spotter each, making sure that there is nobody closeby during takeoff and landing.

If you need drone measurements for your work plan, you need to get in contact directly with the drone operator.

3.4.2 DJI MAVIC 3

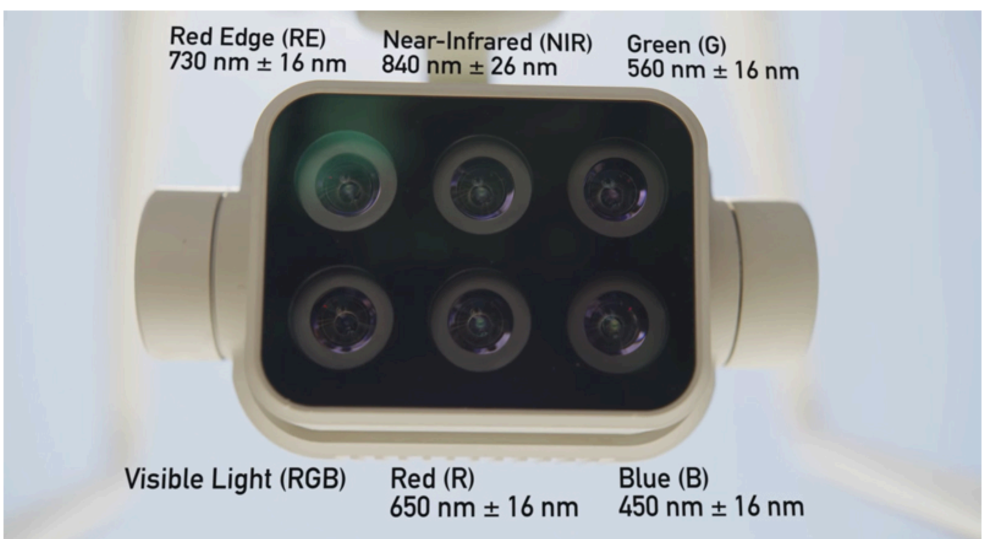
There will be one DJI MAVIC 3 operated by Fabrice Collard (aka dr.fab) from OceanDataLab
https://www.dji.com/fr/support/product/mavic-3-classic

This can be used to record sun/sky glitter on the sea surface and estimate wave and surface current parameters as was demonstrated by from Wave-current interactions group during OTC training course in 2023.



3.4.3 DJI Phantom 4 multispectral

There will be also onboard a DJI Phantom 4 multispectral (5 channels) operated by Alejandro Román, Postdoctoral researcher at ICMAN-CSIC (Spain)



DJI Phantom 4 multispectral is a high-precision drone with a seamlessly integrated multispectral imaging system, featuring five bands centered at 450 nm (blue), 560 nm (green), 650 nm (red), 730 nm (red edge), and 840 nm (NIR). This equipment will be used to conduct ocean color products calibration study using in-situ hyperspectral radiometers, scaled to satellite remote sensing, for applications in water quality studies in both open ocean and coastal areas

Details on the DJI Phantom 4 multispectral drone is available here :
https://dl.djicdn.com/downloads/p4-multispectral/20190927/P4_Multispectral_User_Manual_v1.0_EN.pdf

3.5 OVL Tools on board the ship

A local network will be available using a WLAN or Wifi connection. It will enable you to

- access the local OVL portal
- access the measurement from the ship (raw / processed)
- access data that have been downloaded (satellite, mode, in-situ) in SEAScope format. The amount of data retrieved will depend on the quality of the internet connection

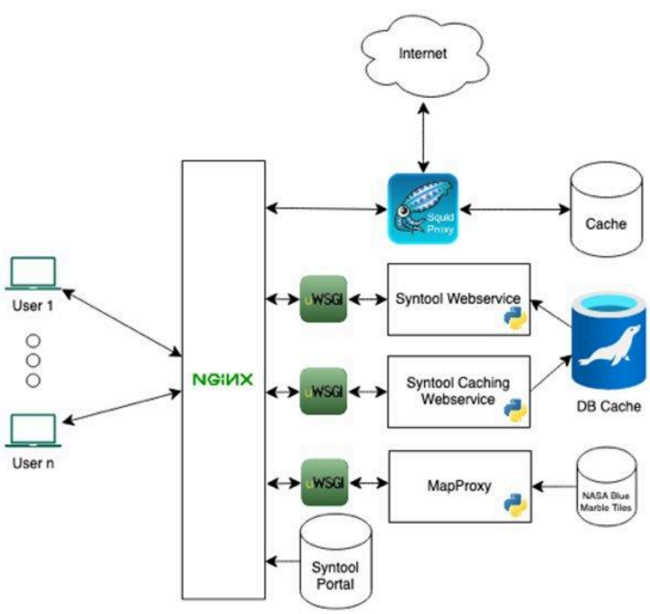
3.5.1 Local OVL portal

You will be able to connect to the local OVL portal onboard:

- Local portal address will be provided once on board, available from any web browser when connected to the local Network via Wifi.
- Data will be transferred from the global OVL backend on land to a local OVL backend on a server onboard
- From the local OVL portal, you will only have access to the data from the local OVL backend.
- Any specific need to access fresh data, including our own deployed instruments transmitting in real time, will require to ask the responsible of the local OVL backend in charge of downloading new data.

Expected fresh data to download :

- Each work group can provide a preliminary list of satellite/model/in-situ fresh data needed in the local OVL portal once onboard with the update frequency needed.
- Specific data older than the ship departure can also be downloaded prior to departure and still available once onboard.



3.5.2 Downloaded data for SEAScope

We are considering mostly data that can be visualised on the OVL portal:

- Models: current, wind, SST, SSS, Chlorophyll
- In-situ: ARGo profilers, drifters, wave drifters
- Satellite: SAR Sea Surface Roughness, Chlorophyll, Ocean Color, SST, SSS, SSH, Currents

They will be downloaded in SEAScope IDF netCDF format, so that data are lighter.
We will systematically retrieve data that are light enough in a rectangle around us when the connection is good enough (see list of Daily Download). Additionally. when we spot something interesting in the OVL, we will consider Downloading L1 or L2 at high resolution SEAScope IDF-format (see list in “Spot something nice”). Finally we can exceptionally retrieve data in their native format when it is needed for new products for example (see list “Exceptionally”)

1. Daily Download:
    a. In-situ drifter, ARGO profiles
    b. ECMWF wind
    c. MFWAM wave model
    d. GlobCurrent velocity
    e. Odyssea L4 SST
    f. GMI / AMSR L3U SST
2. If we see something nice on local OVL portal:
    a. Sentinel-3 OLCI L2 Chl-a
    b. Sentinel-3 SLSTR SST
    c. SEVIRI L3C SST, AVHRR L3C SST
    d. Sentinel-1 roughness
    e. Mercator surface current, SST, SSS
    f. CMEMS mapped SSH
3. Exceptionally, if available under our track:
    a. SWOT L3
    b. CFOSAT SWIM wave spectra (L2S)

If you have other needs for satellite or model data necessary while at sea, let us know.

4 Description of the research groups

You have been split into three groups, depending on your area of expertise:

- Physics
- Air Sea interaction
- Biology

As there are more biology people than the rest, we cannot keep those groups for the watch, so you me be assigned to a watch that is different to your group study

4.1 Group study

Into each group study, we have suggested subgroups so that those working in a similar thematic or with complementary objectives can work together.

4.1.1 Suggested Physics sub-groups

- SSH / current reconstruction: Valentin Bellemin-Laponnaz, Elisabet Verger-Miralles, Jerome Lemelin, Juan Manuel Lopez Contreras, Kim Monoury
- submesoscales processes / 3D processes: Brishan Kalyan, Jakub Michalski, Perrine Bauchot
- eddy tracking and analyses: Jemma Johnson, Marie Christin Juhl, Martin Cornille, Victoria Zoeller
- Microplastics distribution: Charlotte Cunci, Lena Schaffeld

4.1.2 Suggested Air-Sea interaction sub-groups

- Wave current interaction : Maturin SIMONNEAU, Ines Larroche, Emma Bedossa
- Drifter trajectories : Samantha Kucher, Vadim Bertrand
- pCO2 spatial distribution, gaz fluxes and biological carbon pump : João Vitor Langorte Bueno, Kevin McGraw, Marianna Giustino, Molly Phillips (you will need to adapt to the fact that there might be no pCO2 instrument present onboard according to Geir Pedersen, in charge of onboard instruments)
- Marine heat wave, heat fluxes and MLD : Manal Hamdeno and Iason Theodorou, Ida Haven
- Wind and wind stress : Meike de Nooij, Tran-Vu La

4.1.3 Suggested Biology sub-groups

Biology sub groups TBD

4.2 Watch vs. Group

You might be assigned to a watch not corresponding to your group as there are more students in the biology group and we have to balance the watches, you don't have to modify your research plan to adapt but this could be a good opportunity to extend your study using cross-disciplinarity.

4.3 Watch/Science schedule

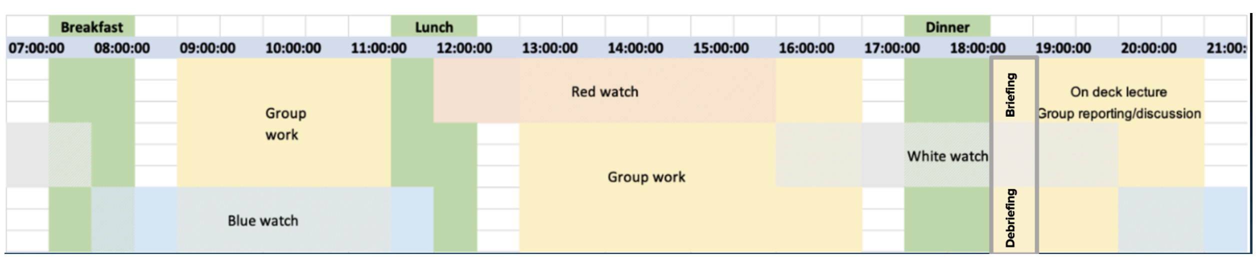
Red Watch: 00h-04h | 12h-16h
White Watch: 04h-08h | 16h-20h
Blue Watch: 08h-12h | 20h-00h

During your watch, on top of the sailing duties you will have some science duties:

- Science watch: take note of key parameters: wind / wave / current / temperature
- Look at the ocean (waves / color turbidity / faunae)
- Help with handling of instruments and to take samples

Watches will be rotated for each group between Leg1 and Leg 2

Group	Watch Leg 1	Watch Leg 2
Physics	Red	White
Air-sea	White	Blue
Biology	Blue	Red



The daily briefing and debriefing right after dinner is for all watches. It will consist of a summary of the activity of the day and a discussion of the planning for the following days.

The list of on deck lectures will be provided later in a future version of this Handbook.

5 Oceanography of the voyage

5.1 Leg 1 from Tromso to Reykjavik

Lead Scientist : Prof. Johnny A. Johannessen

Introduction: The duration of this leg is from 22 April to 5 May 2025. During this 14 days sail voyage we will execute studies around the three agreed research themes, notably:

- Upper Ocean Dynamics, Mesoscale and Sub-mesoscale Structures
- Ocean bio-geo-chemistry
- Marine Meteorology and Air-Sea interaction

The Leg will take us across the Norwegian Sea which implies that we will encounter a number of upper ocean current systems including the Norwegian Coastal Current (NCC), the Norwegian Atlantic slope current (NwASC) and the Norwegian Atlantic front current (NwAFC) (see Figure **1**). These currents are partly steered by topography and known to be highly rich on mesoscale variability as first documented by the reference to puzzling waves in the paper by Helland-Hansen and Nansen (1909) on “The Norwegian Sea: Its physical oceanography” based upon the field work they conducted between 1900–1904. As further noticed in Figure **1** the Norwegian Sea is bounded by land, semi-enclosed seas and open ocean. Clockwise from the south they include the North Sea, the North Atlantic, the Icelandic Sea, the Greenland Sea, the Arctic Ocean, the Barents Sea and the northwest coast of Norway. In particular, the separation from the North Atlantic is by a submarine ridge running between Iceland and the Faroe Islands, while the Jan Mayen Ridge separates it from the Greenland Sea.

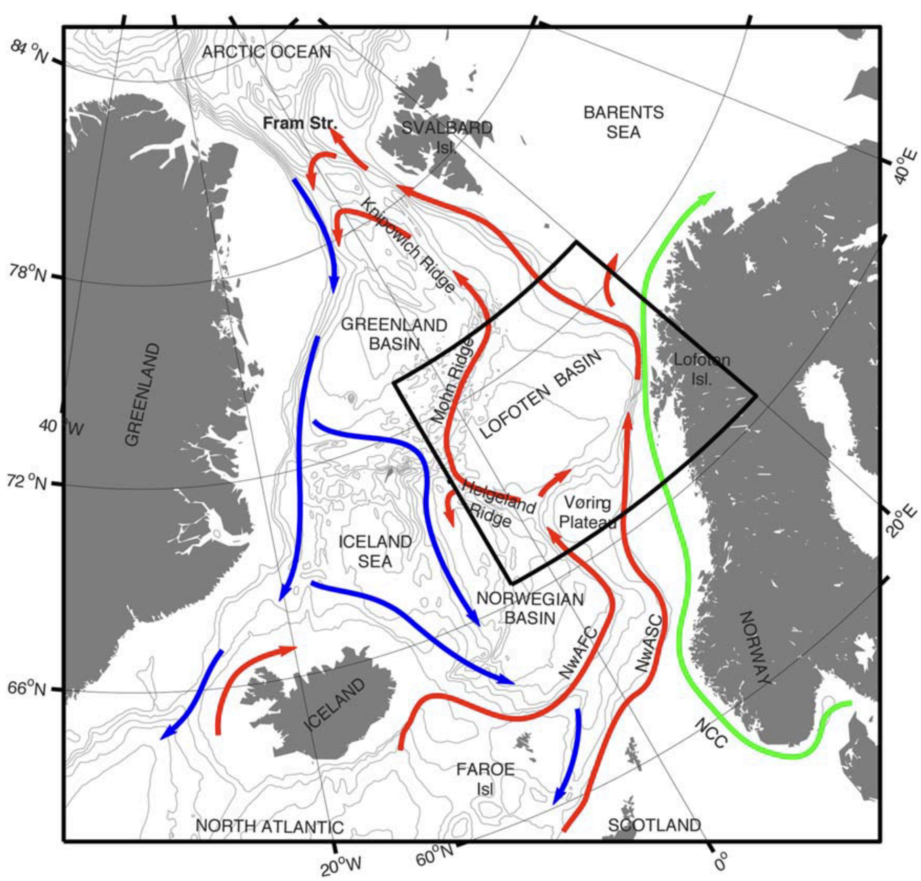


Figure 1. *The Nordic Seas with schematic pathways indicating the overturning circulation from warm inflowing Atlantic Water in the surface (red) to cold and dense overflows to the deep North Atlantic (blue). The Norwegian Atlantic slope current (NwASC) and the Norwegian Atlantic front current (NwAFC) are represented by red arrows. The fresh Norwegian Coastal Current (NCC) is indicated in green. Gray isobaths are drawn for every 600 m. (Courtesy Raj et al., 2016).*

Although the direct length of Leg 1 is about 1250 nautical miles (nm) the weather conditions will certainly impact the total distance that we will have to cover. As such we will also have to carefully plan the in-situ data collection and corresponding number of stations, implying that we have to be flexible and adjust the sampling. A tentative number of stations is shown In Figure **2** and listed in Table **1.** If we assume that each station on average will take 5 hours we will in total spend 55 hours for 11 stations. Combined with a mean ship speed of 5 knots it will take us 305 hours or nearly 13 days to cover the direct 1250 nm distance from Tromsø to Reykjarvik.

From the beginning of March 2025 we will start routine near real-time monitoring within the area to be covered by Leg 1. This will support all the three research themes. Multi-satellite sensor data will be collocated and analysed to identify 2D surface expressions of permanent to semi-permanent mesoscale features. Further colocation with in-situ surface drifter data and Argo profiling floats will enable additional analyses of the transition from 2D to 3D expressions. The outcome of this pre-voyage analysis will ensure optimum preparation for the near real-time planning and execution of the Leg 1 sail voyage that will start on 22 April 2025 and take us from Tromsø to Reykjavik. It will also inform the decision on selection of optimum location for deployment of up to 10 surface drifting buoys (see section 3.3. Drifting buoys). A review of this pre-voyage analysis will be presented onboard at the start of Leg1 (either in the evening of 21 April or the morning of 22 April - TBC).

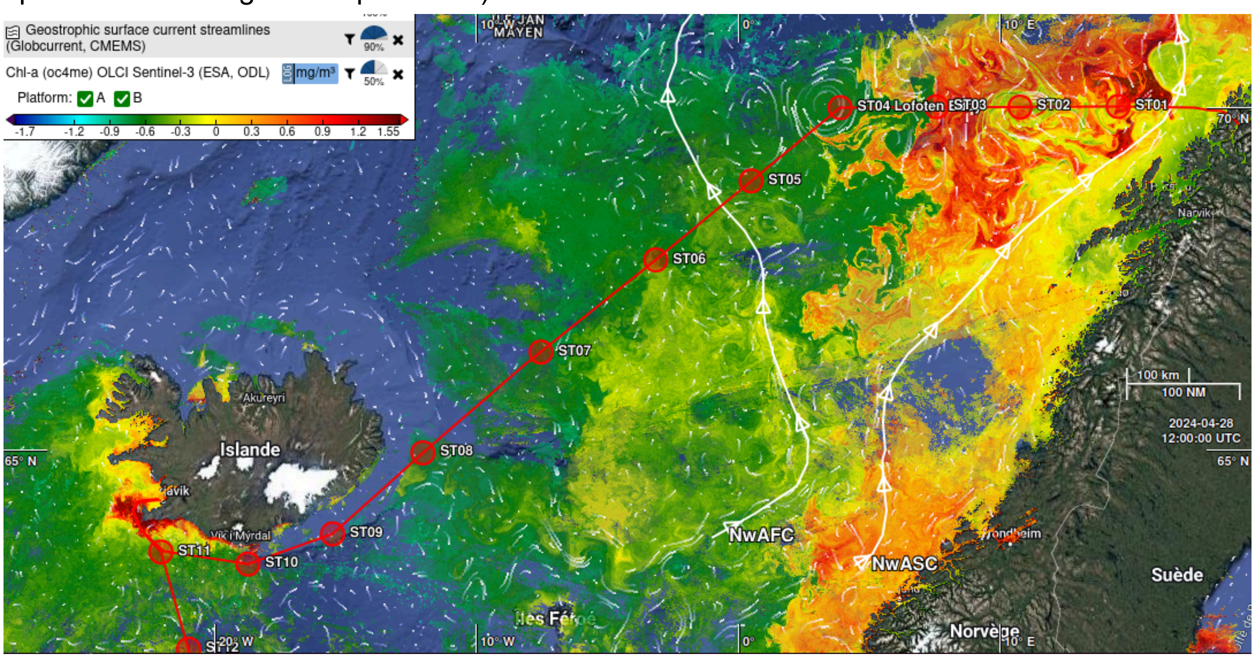


Figure 2. *Snapshot image taken from ESA Ocean Virtual Laboratory showing the chlorophyll distribution and concentration for the Leg 1 Tromsø - Reykjavik with the possible sail voyage route (red line) and number of stations (red circles) overlaid.*

Lofoten Basin: The Lofoten Basin is the most eddy rich region in the Norwegian Sea as clearly noticed in Figure X (ST01-ST04). The basin is a well-defined topographic depression of about 3250 m depth. Two major ocean currents are found bordering the basin, notably the Norwegian Atlantic Slope Current (NwASC) and the Norwegian Atlantic Front Current (NwAFC). They play a key role in the presence of the permanent anticyclonic Lofoten Vortex, also called Lofoten Basin Vortex or Lofoten Basin Eddy that we plan to sample at station ST04. The presence of this permanent vortex features a localised area with distinct warm sea surface temperature anomalies and strong gradients in chlorophyll concentrations as well as distinct sea surface height and eddy kinetic energy. The estimated radius of the vortex is around 15–20 km and presents a 1200 m deep core of Atlantic Water (warm and saline) swirling at velocities that can reach 0.8 m/s in the deeper 600–800 m part. The local currents inside the vortex and the strong convection observed during winter generate a hot spot rich in nutrients, affecting the surrounding marine biology (Bosse et al., 2019). Moreover, due to its extraordinary persistence and location, the Lofoten Vortex is also likely to influence the dense water formation in the region (Issufo et al., 2015).

Table 1. *List of in-situ stations for Leg 1.*

Station Name	Lat (ºN)	Lon (ºE)	Comments
ST01	70	14.55	Potential phytoplankton bloom, test equipment
ST02	70	10.6	Potential phytoplankton bloom
ST03	70	7.65	Potential phytoplankton bloom
ST04	70	4	Anticyclonic Lofoten Vortex, or Lofoten Basin Eddy
ST05	69.05	0.5	
ST06	67.9	-3.23	
ST07	66.5	-7.5	
ST08	65	-12	Flow from north Iceland current
ST09	63.6	-15.5	Coastal bench
ST10	63.1	-18.6	Fresh water from Iceland
ST11a	63.33	-22	Station resampled during Leg 2

Roshin et al., (2016) applied a satellite altimeter-based automated method to identify 1695/1666 anticyclonic/cyclonic eddies in the Lofoten Basin in the period from 1995 and 2013. The eddies are found to be predominantly generated and residing locally. In particular, barotropic energy conversion rates reveal energy transfer from the slope current to the eddies during winter. The anticyclonic eddies in the Lofoten Basin are the most long-lived eddies (> 60 days), especially in the western part of the basin. Colocation of surface drifters and Argo profiling floats that may be trapped inside the altimeter-based eddies will be examined to corroborate the orbital speed and vertical structure of the anticyclonic and cyclonic eddies. Combination of multi-sensor satellite data (e.g. altimetry, imaging spectrometry, IR radiometry, roughness, Doppler shift), Argo floats, surface drifter data and ship-based in-situ data and drone video-recordings will therefore be invoked in a data driven co-variability analyses approach to study the role of eddies in the

Lofoten Basin in regards to the three research themes. This will in particular focus on the variables listed in Table 2 and imply routine use of local OVL portal and SEAScope.

Satellite Sensors	Variables				
	SST	Chlorophyll	SSH	Currents	Surface roughness
IR radiometer	X (cloud limited)				
Spectrometer		X (cloud and light limited)			
Altimetry (nadir)			X	Geostrophic	
SWOT			X	Geostrophic	
SWOT (Doppler)				Range directed total surface current	
SAR (NRCS)					X (frontal boundaries)
SAR (Doppler)				Range directed total surface current	

Norwegian Sea: The warm and saline North Atlantic Current (including the NwASC and NaAFC) ensures fairly steady volume transport (around 3-4 Sv) into the Norwegian Sea and the relatively large heat capacity acts as a highly important source for Norway's mild winters (Gislason and Silva,2012). Moreover, the coastal zones along the boundary of the Norwegian Sea are famous both for their rich ecosystem, fisheries and spawning grounds for cod. This is also the case for the waters surrounding the southern and southeastern shores of Iceland that are influenced by relatively warm and saline waters from the North Atlantic.

From the Lofoten Basin we will transit the remaining sector of the Norwegian Sea on the way to Reykjavik as shown in Figure 2. This sea reaches a maximum depth of about 3,970 m and it maintains a typical sea surface temperature around 4 to 6 C and a surface salinity of about 35 parts per 1,000 during April. A submarine ridge linking Greenland, Iceland, the Faroe Islands, and north Scotland separates the Norwegian Sea from the North Atlantic to the south. Weather permitting we plan to do up to 7 stations along this segment of Leg 1.

5.2 Leg 2 from Reykjavik to Nice

Lead Scientist : Dr. Craig Donlon

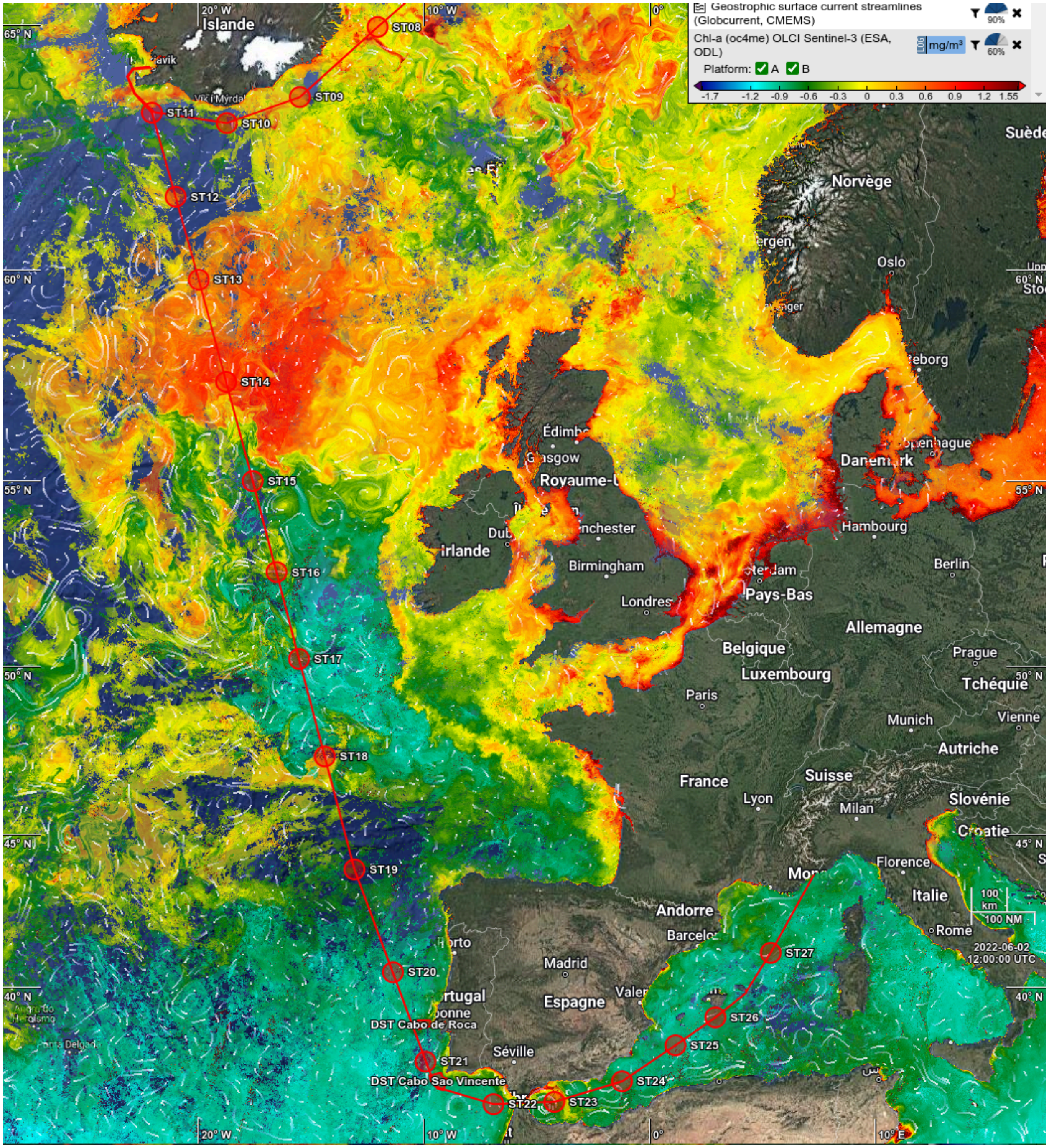
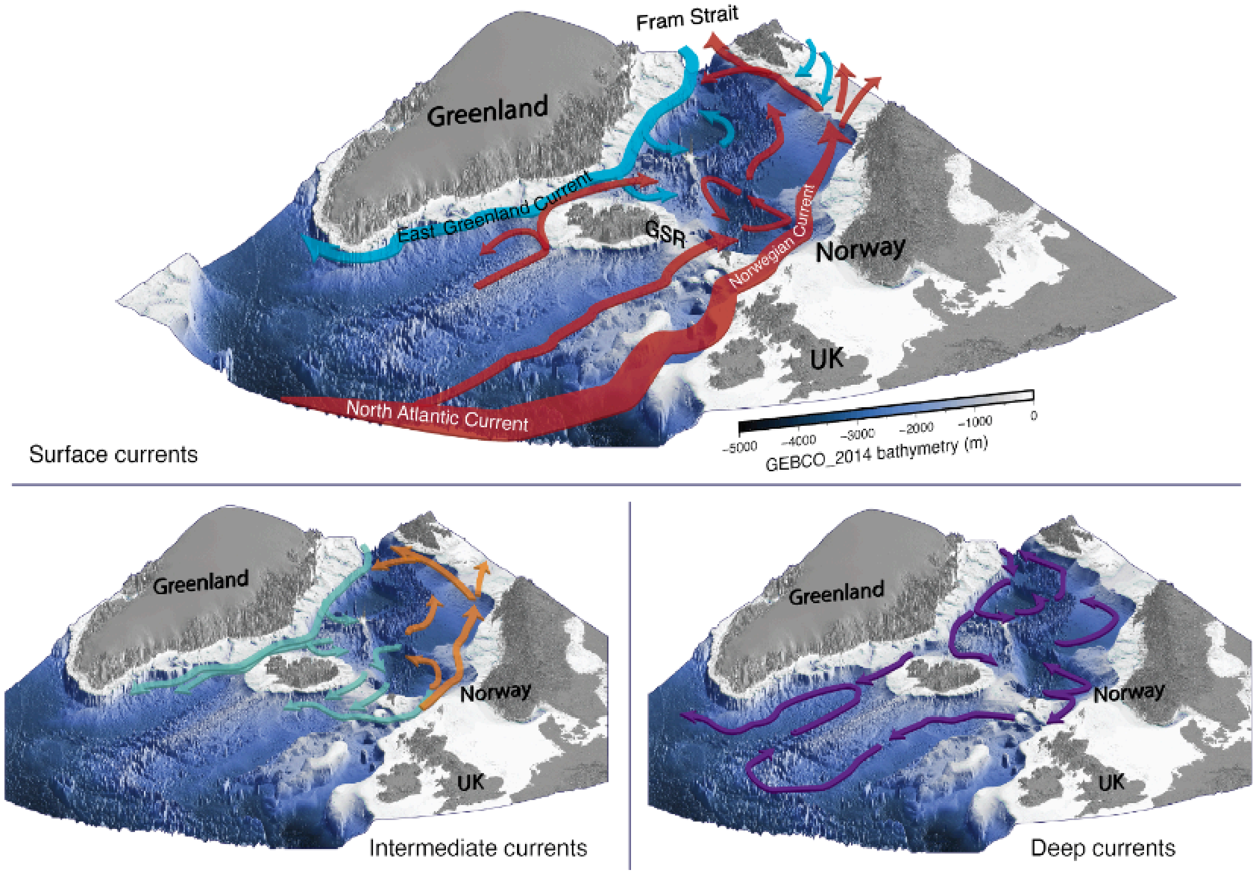


Figure 3. *Snapshot image taken from ESA Ocean Virtual Laboratory showing the chlorophyll distribution and concentration for the Leg 2 Reykjavik - Nice with the possible sail voyage route (red line) and number of stations (red circles) overlaid.*

This second Leg will take us across the Eastern part of the North Atlantic Ocean which implies that we will encounter the eastern extension of the Gulf stream or the North Atlantic Current.

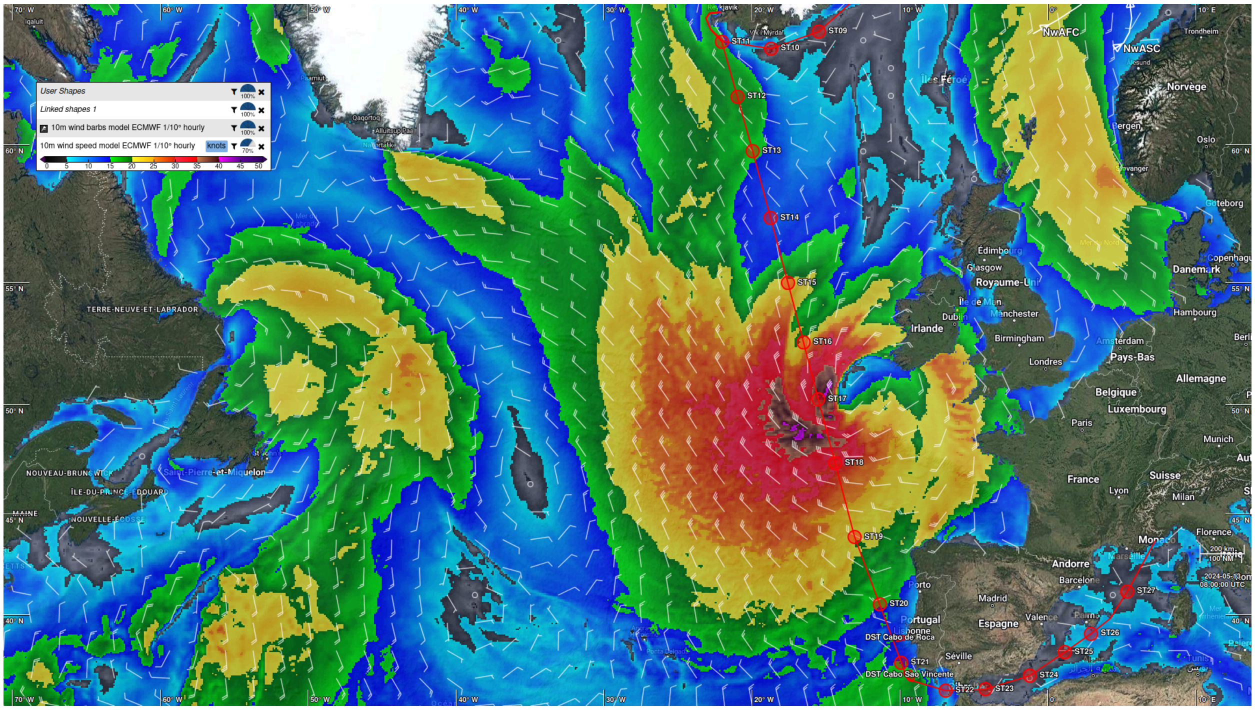
- The North Atlantic Current is part of the subtropical gyre, which includes the Gulf Stream as the western boundary current that directs warm water towards the North Atlantic.
- The strength and path of the current can vary seasonally, with a generally stronger flow in the winter and weaker flow in the summer.
- The North Atlantic Current transports warm, saline water from the tropical and subtropical regions to the North Atlantic, contributing to milder winter temperatures in northwestern Europe.
- The North Atlantic Current (NAC) system is composed of three main branches, referred to as the northern, central and southern branches.



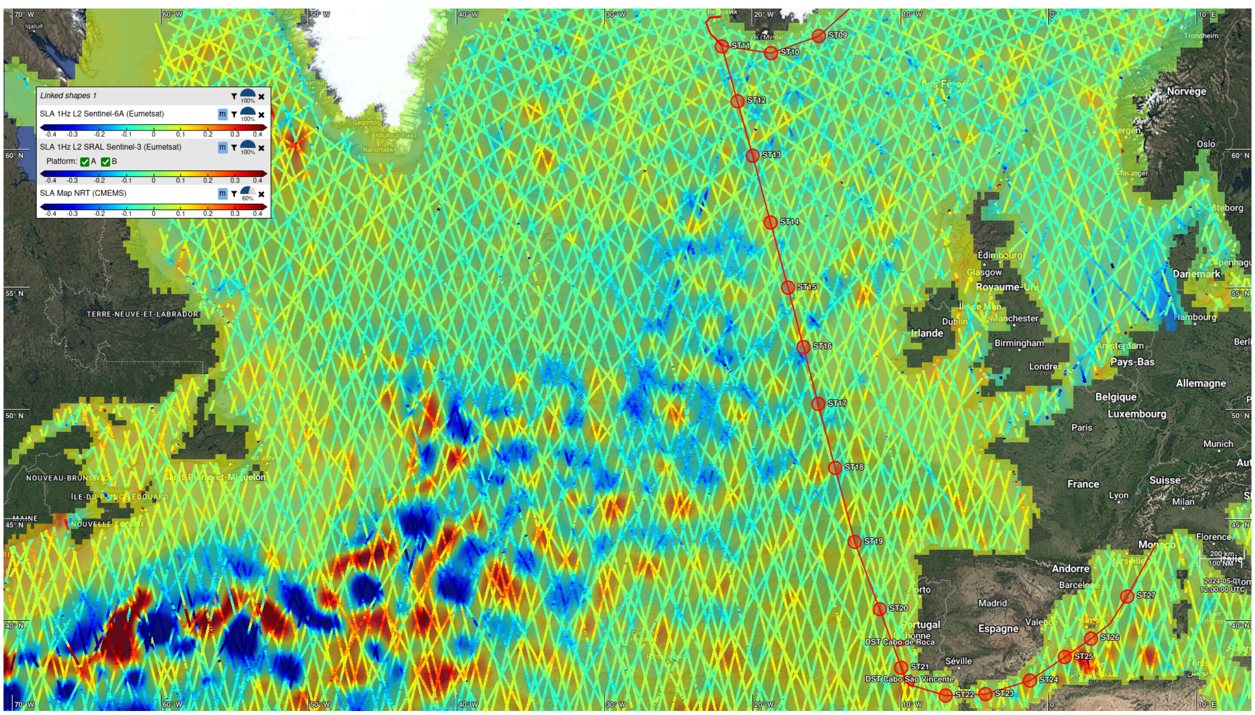
(Graphic by Eivind O. Straume from Straume (2020) is available via the open-access s-Ink repository)

Surface current will be composed of a main North Atlantic drift but also many eddies triggered by the vorticity of the Gulf stream extension.

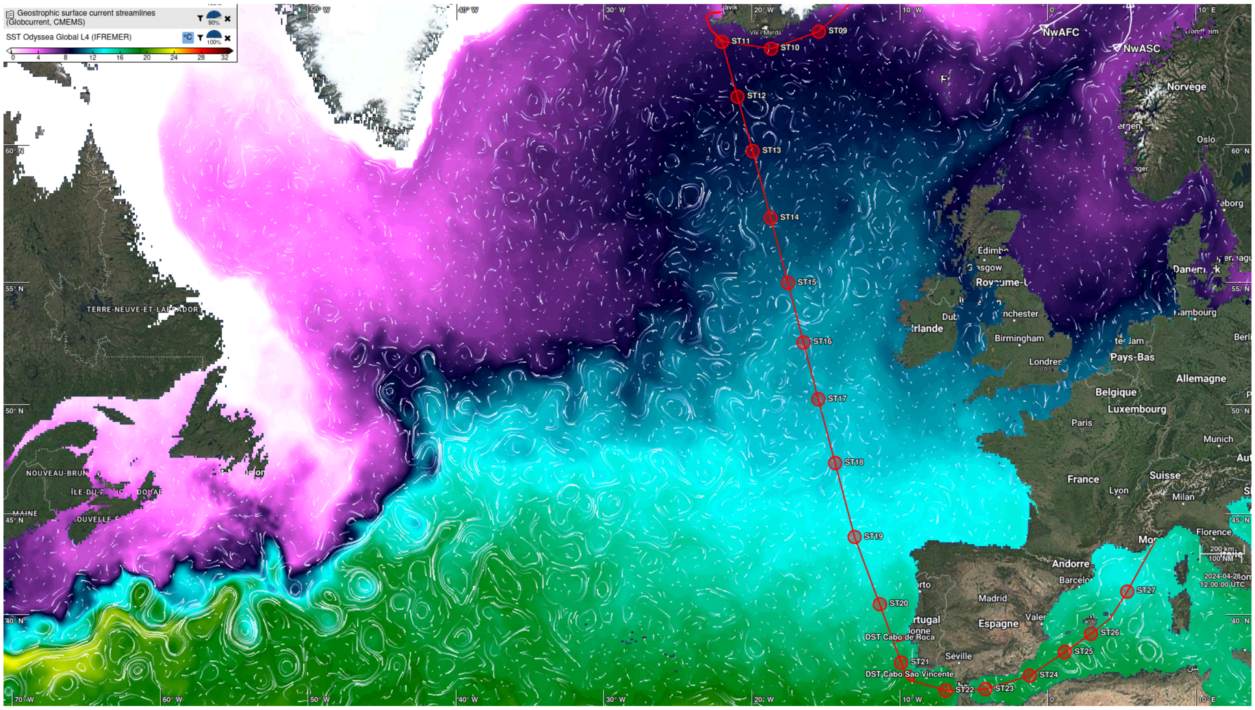
Hereafter you find a series of charts about the typical Met-Ocean conditions along this second Leg for the month of May. Some maps are derived from May 2024, some from May 2022.



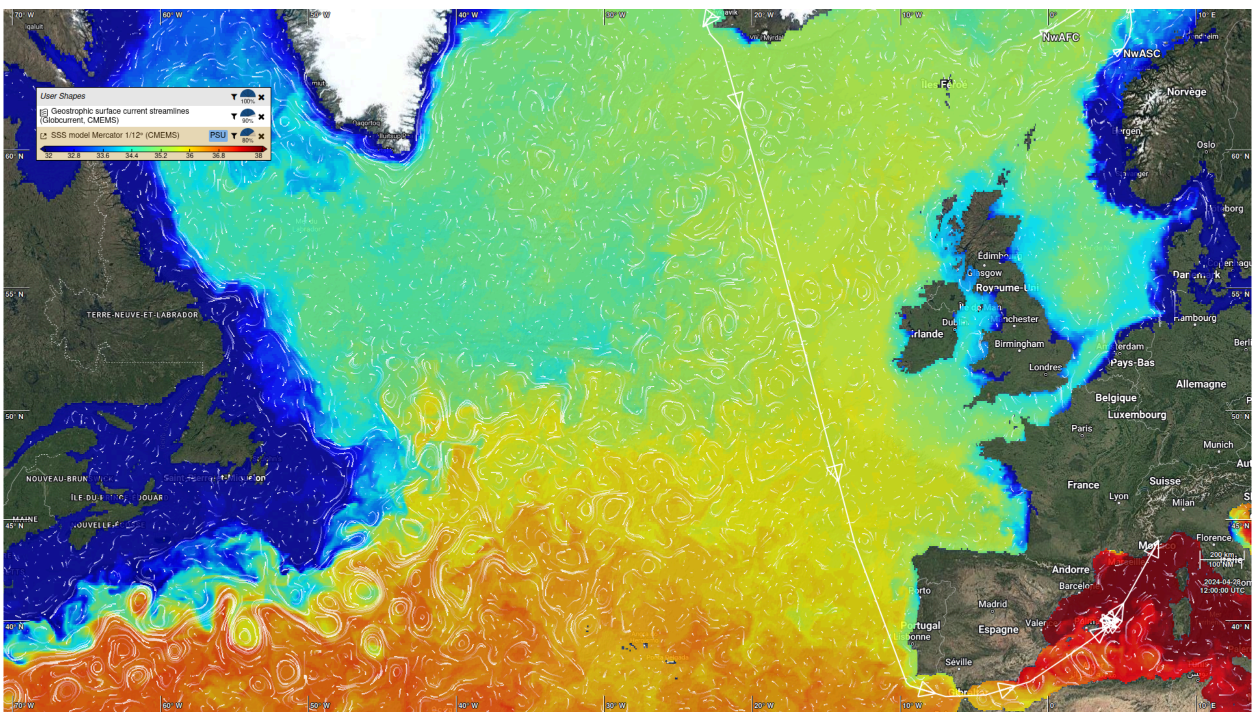
Typical wind pattern in mid May with a North Atlantic storm



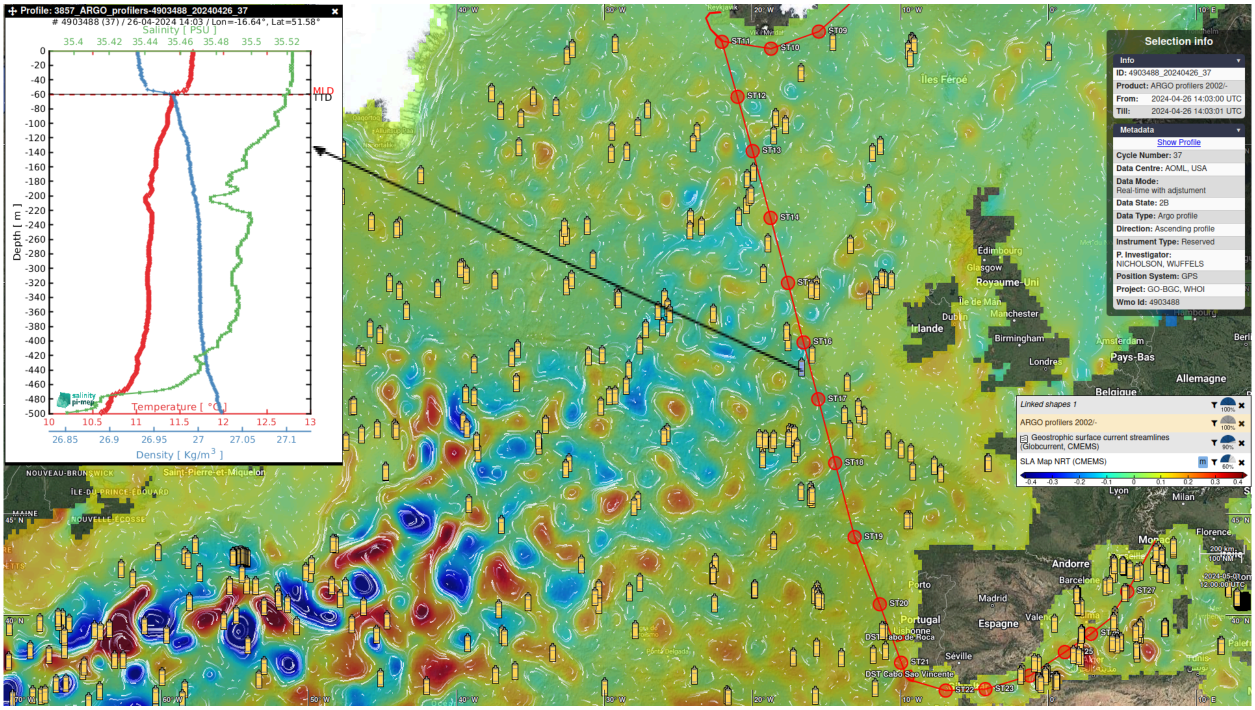
Typical sea level anomaly map in mid May from Sentinel-3A/B and Sentinel-6 altimeters.



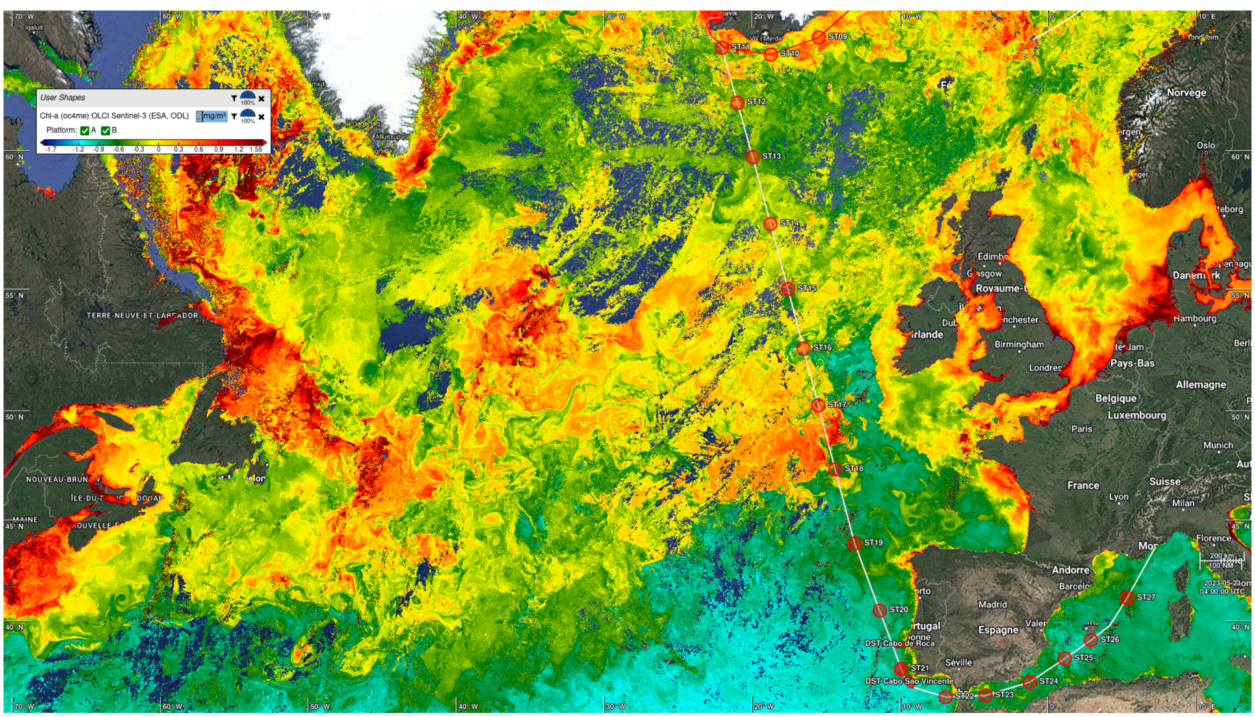
Sea surface temperature map in mid May from satellite observations. Streamlines are geostrophic currents derived from sea level map.



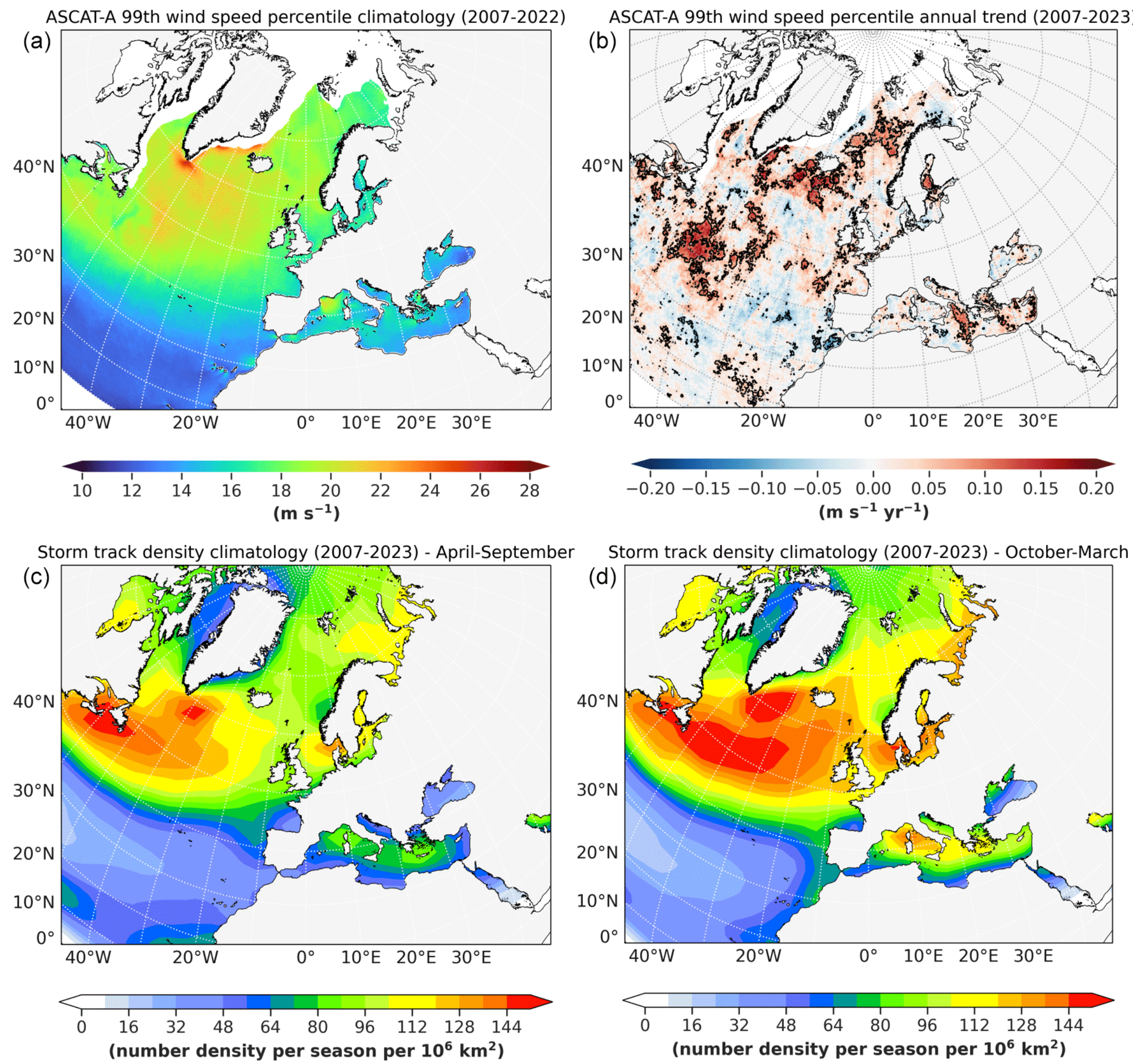
Sea surface salinity map in mid May from CMEMS global ocean model. Streamlines are geostrophic currents from sea level map.



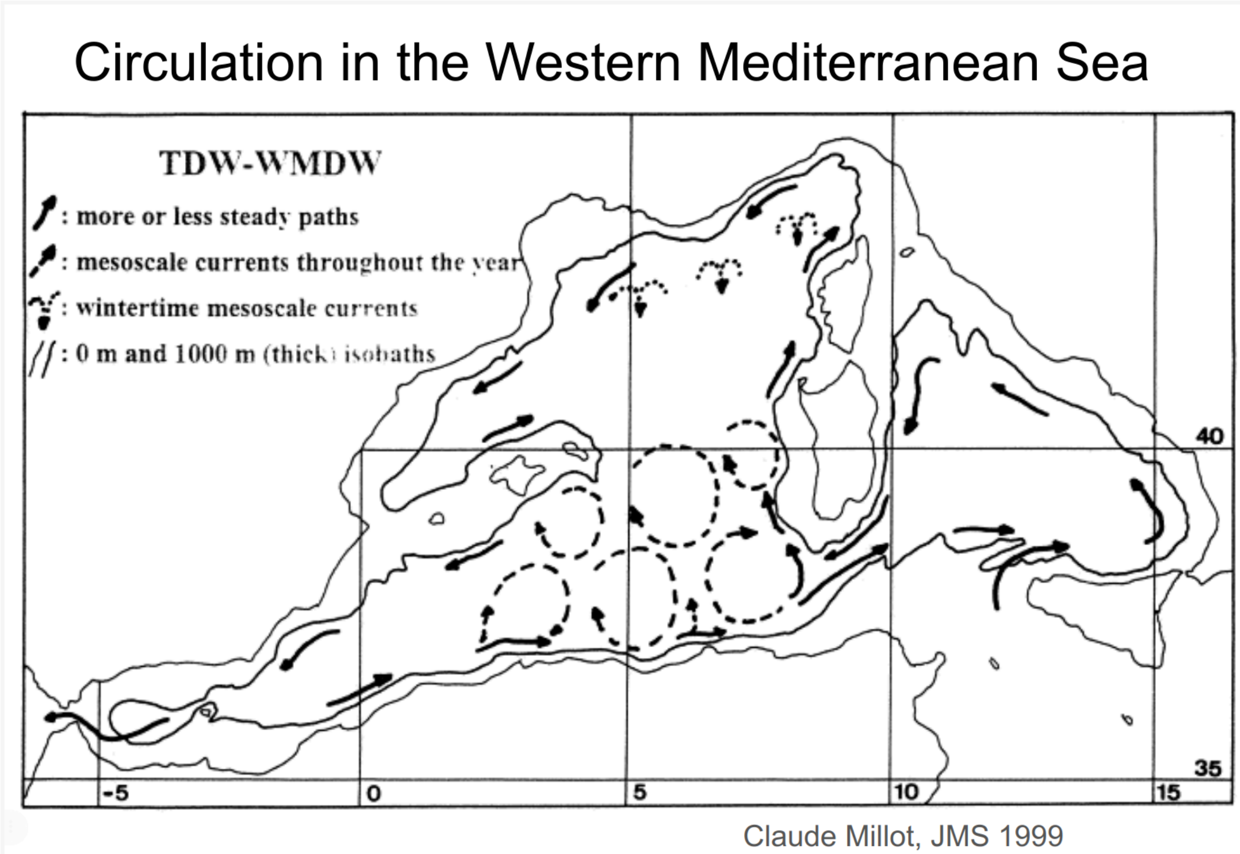
Argo floats mapping for two weeks around mid May. Streamlines are geostrophic currents from sea level map. The top of the thermocline depth (TTD) is defined as the depth at which temperature decreases from its 10 m-depth value by 0.2C.

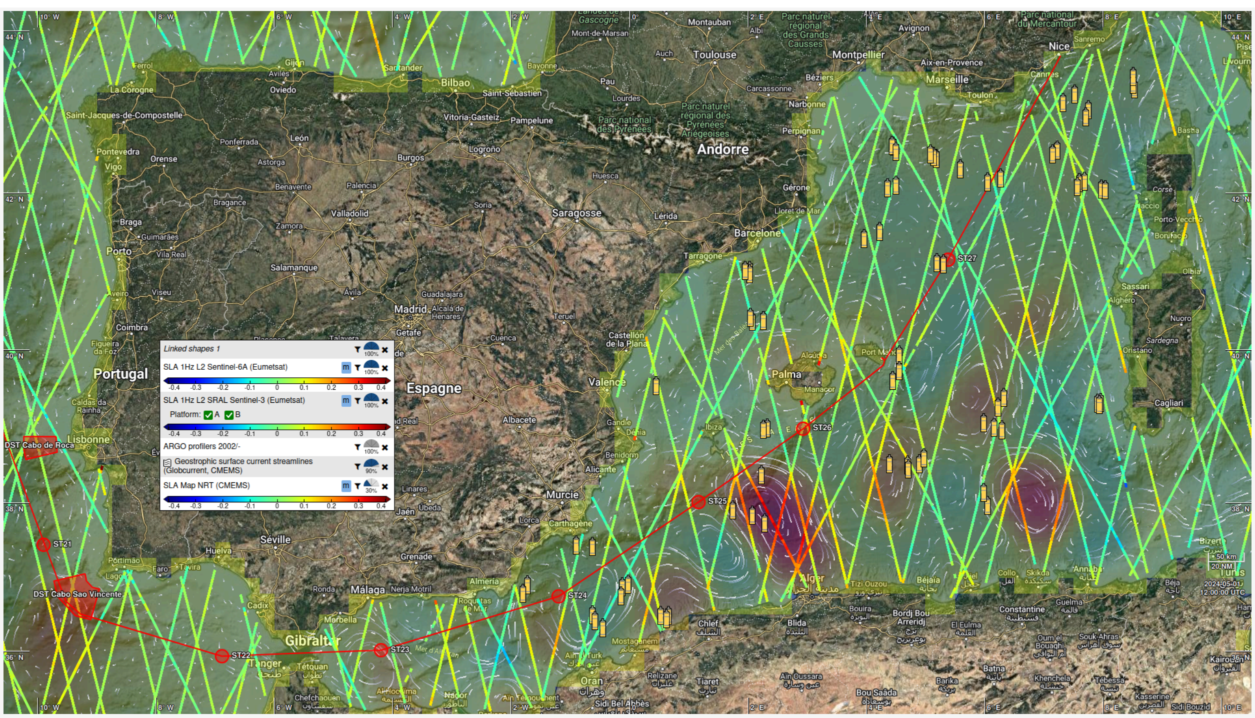


Typical Chlorophyll concentration map for two weeks around mid May from Sentinel-3A/B OLCI.

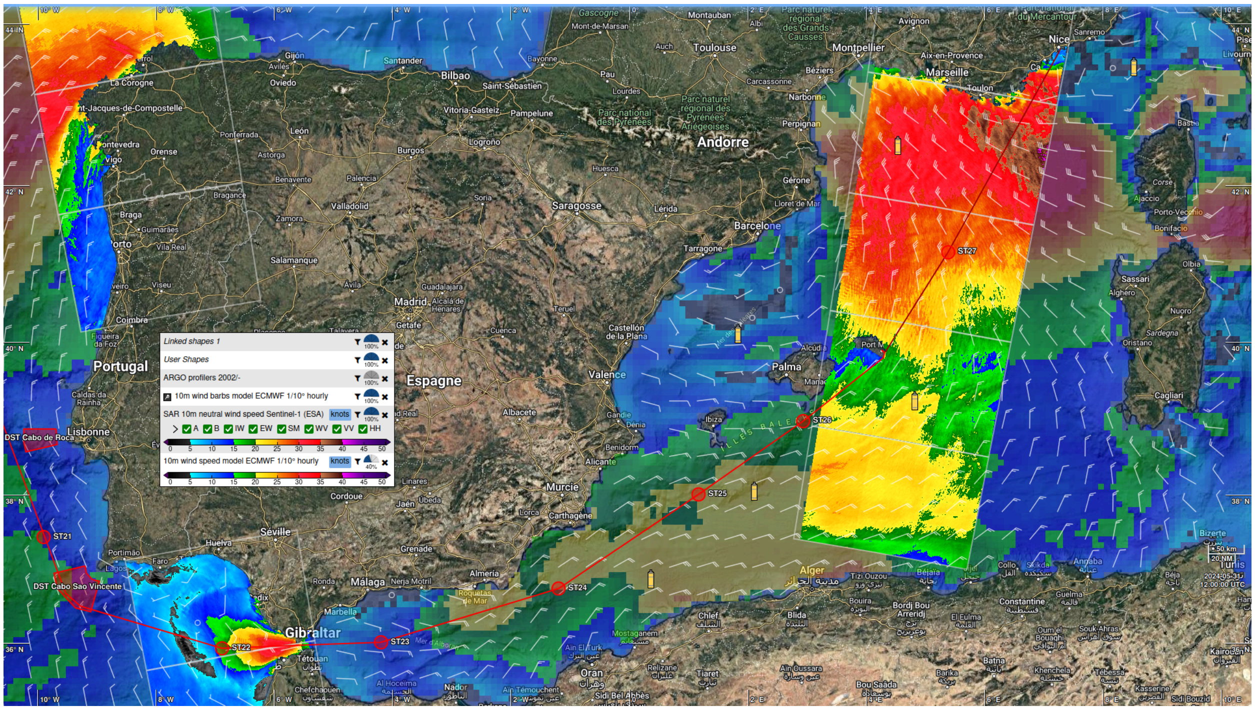


The 99th wind speed percentile (a) climatology (2007–2022) and (b) annual trend (2007–2023). Areas with trends significant above the 90 % confidence level are outlined in black. Computation at 0.125° resolution from scatterometer wind product (ASCAT-A) following the method of Giesen and Stoffelen (2022). (c, d) Seasonal storm track density climatology over the period 2007–2023, for spring–summer (April to September c) and autumn–winter (October to March, d), in units of number density per season per unit area, where the unit area is a 5° radius spherical cap (i.e. about 106 km2), based on the storm tracks detected from 850 hPa relative vorticity product with a threshold of 10−5 s−1 for the 850 hPa relative vorticity at T63 resolution, considering systems that last longer than 1 d and travel more than 500 km, following Hodges (1999, 1995) and Hoskins and Hodges (2002). From “The state of the ocean in the northeastern Atlantic and adjacent seas” Karina von Schuckmann et al. 2024.

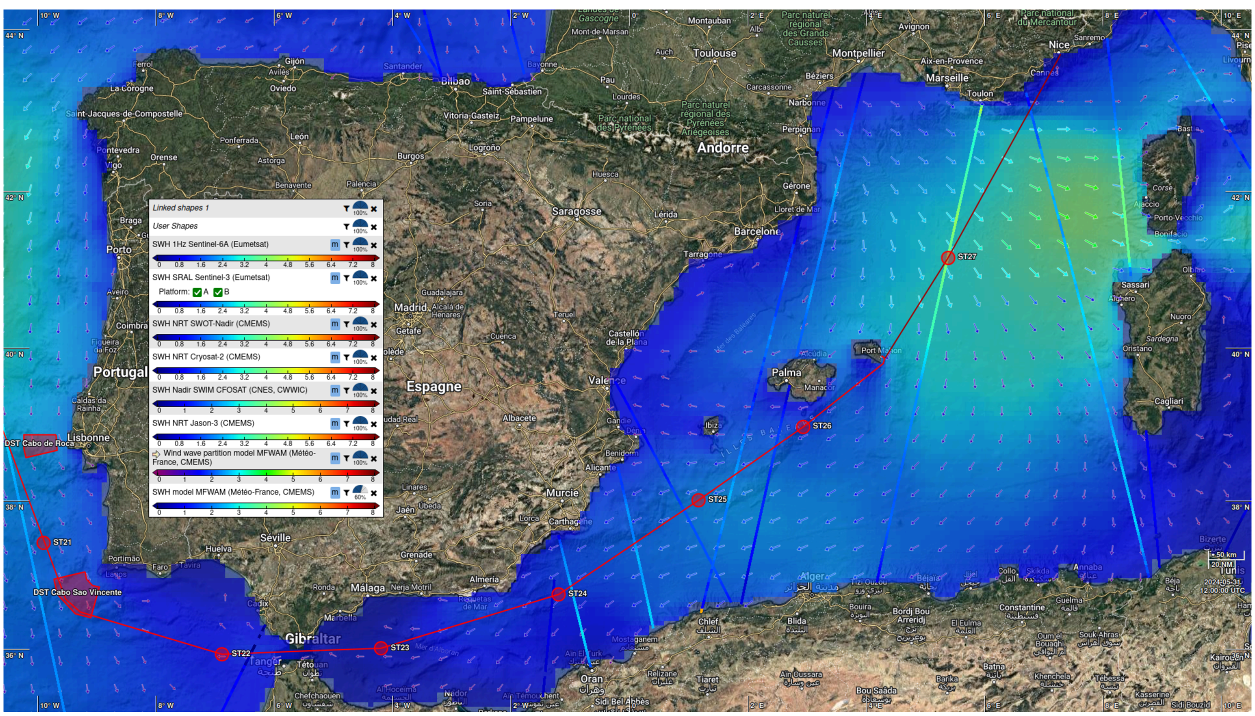




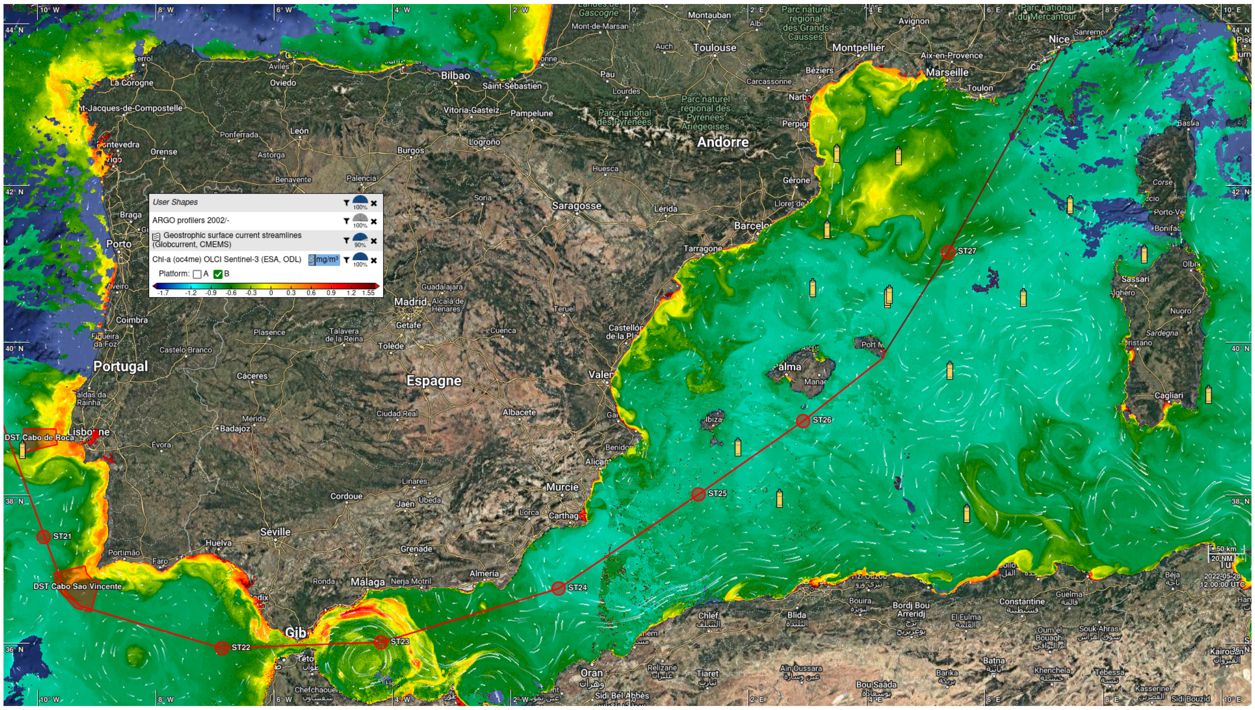
Sea level anomalies from 10 days of along track altimetry and derived SLA mapping at the end of May 2024 in the Western Med. Streamlines are showing the geostrophic current derived from sea level map.



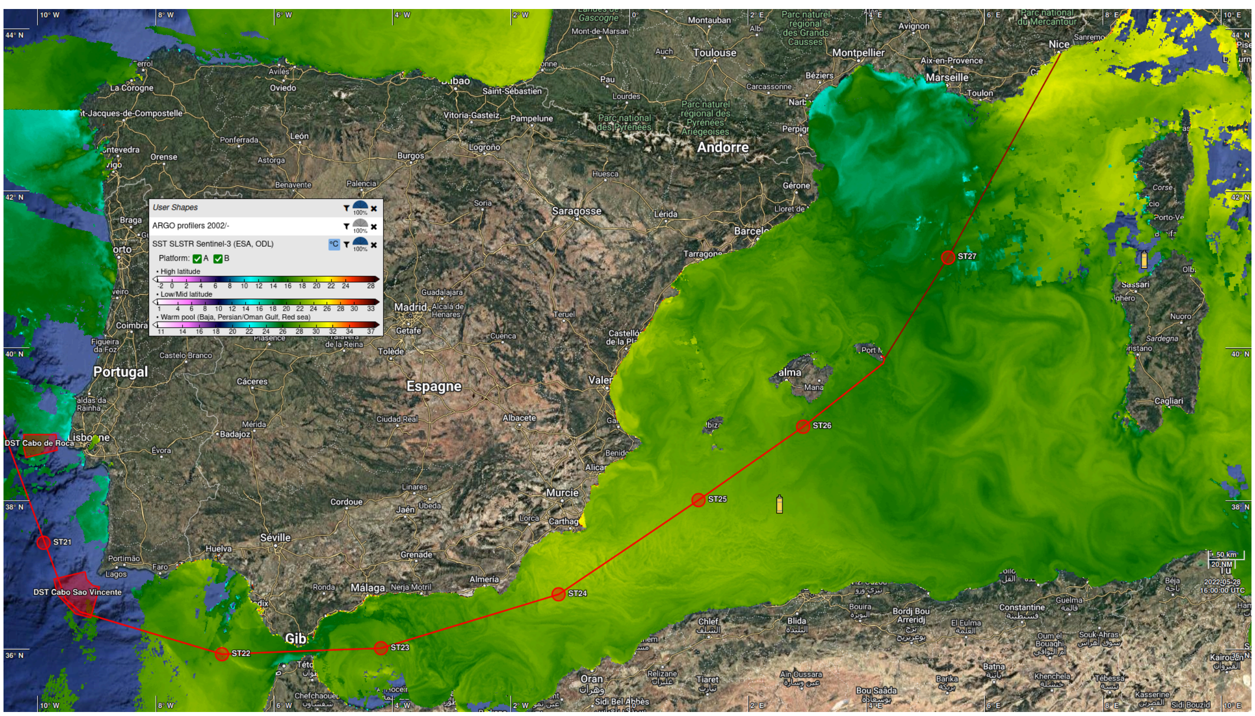
Typical wind pattern at the end of May in the Western Med. from ECMWF model, with high resolution zoom from Sentinel-1.



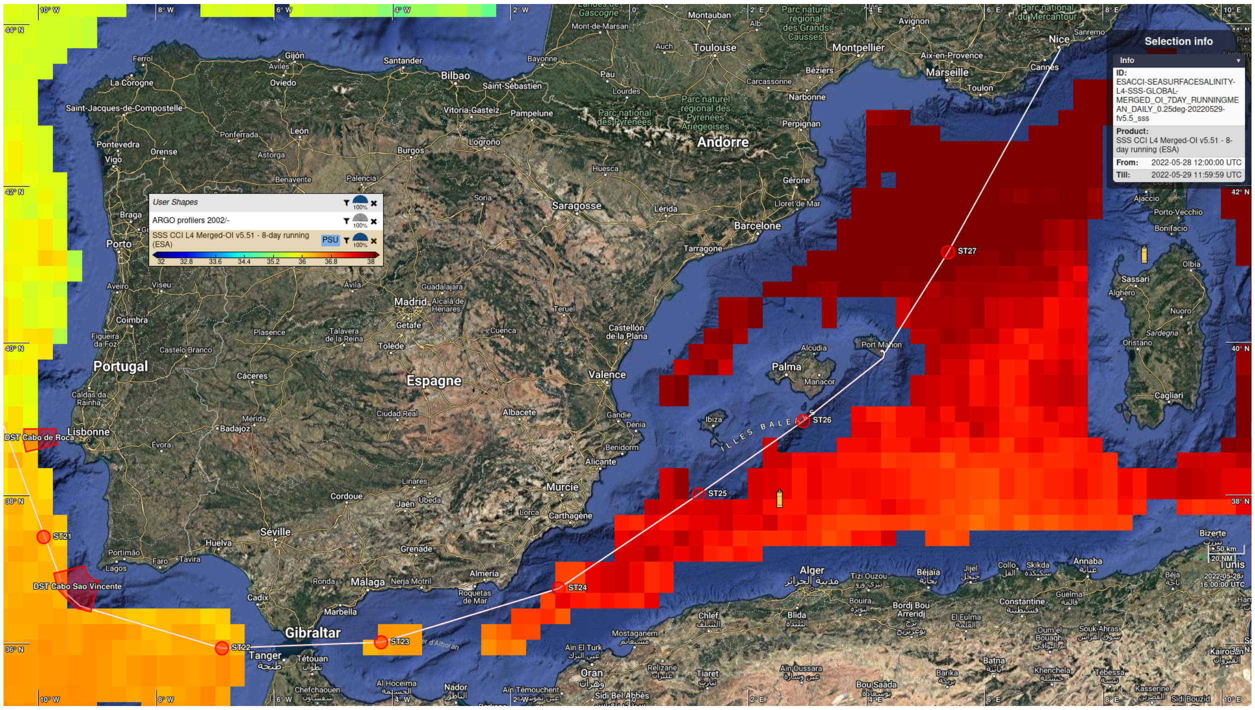
Typical wave height pattern at the end of May in the Western Med. From CMEMS MFWAM model and altimeters along track.



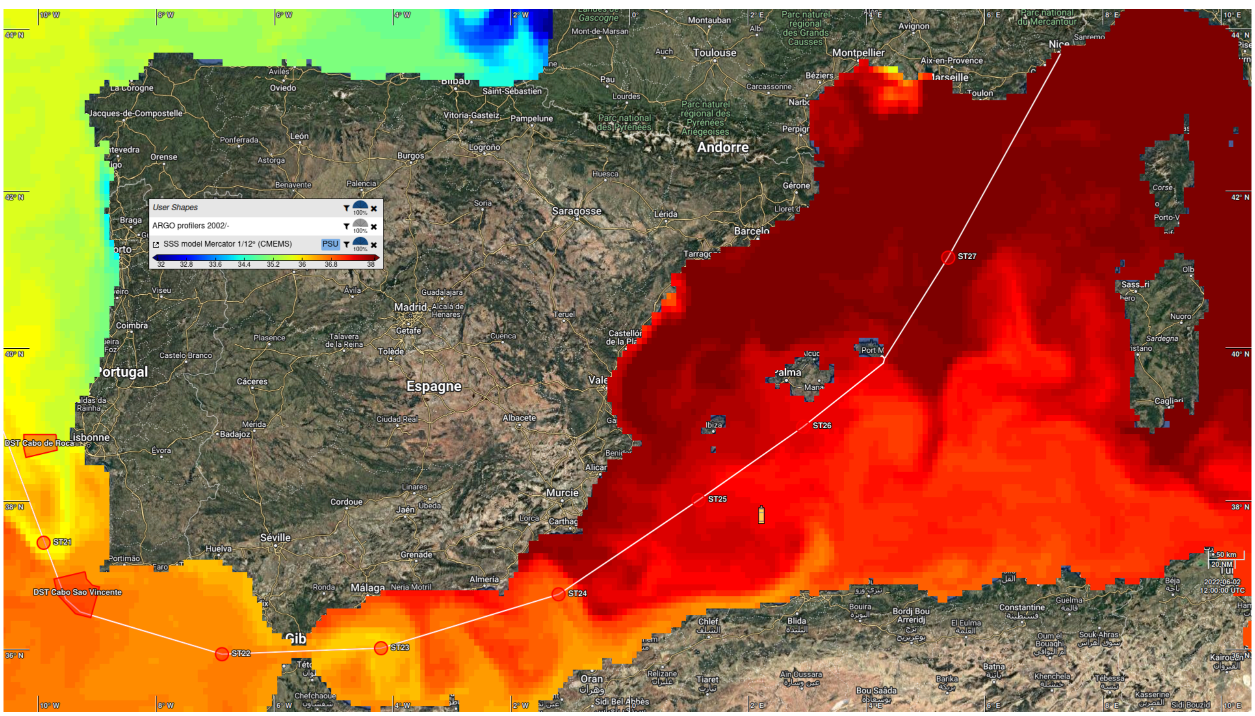
Typical Chlorophyll concentration pattern at the end of May in the Western Med. Streamlines are showing the geostrophic current from altimeters sea level map.



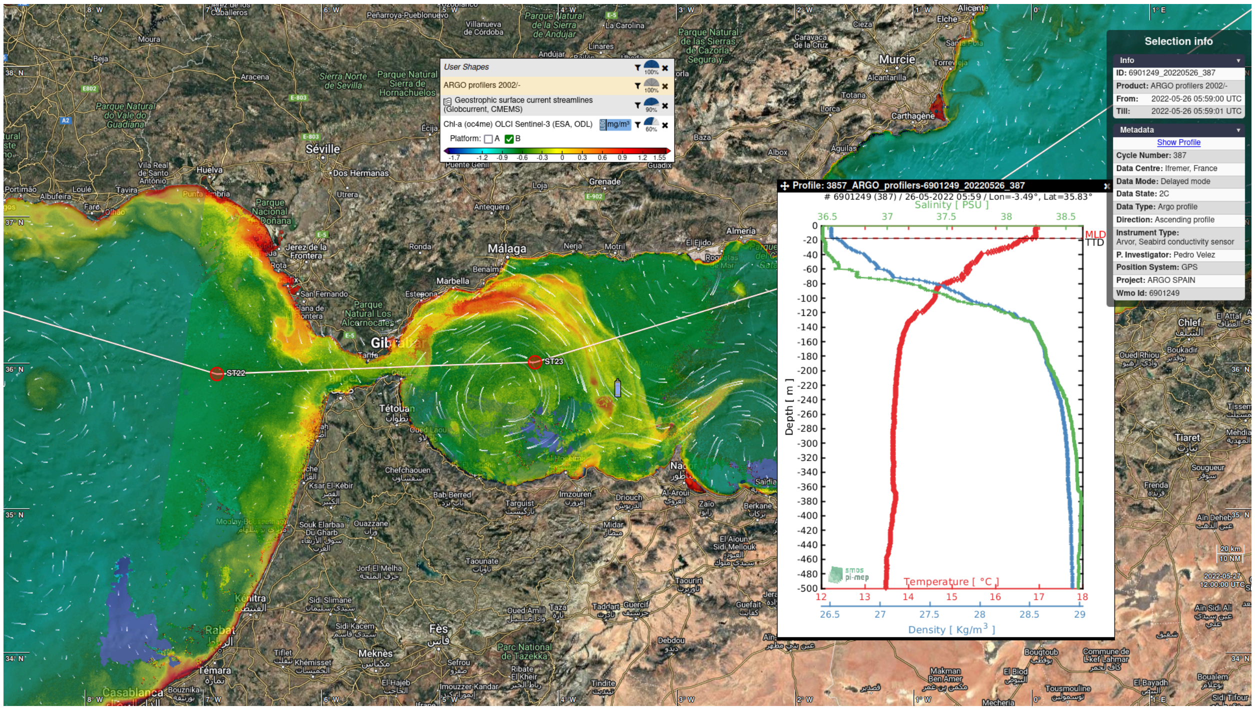
Typical SST pattern at the end of May in the Western Med, from Sentinel-3 SLSTR. Streamlines are showing the geostrophic current from altimeters sea level map.



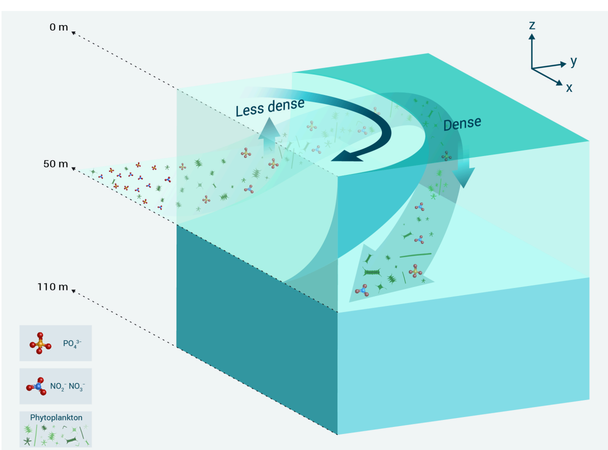
Typical Sea Surface salinity pattern at the end of May in the Western Med. From merged satellite observations (SMOS/SMAP).

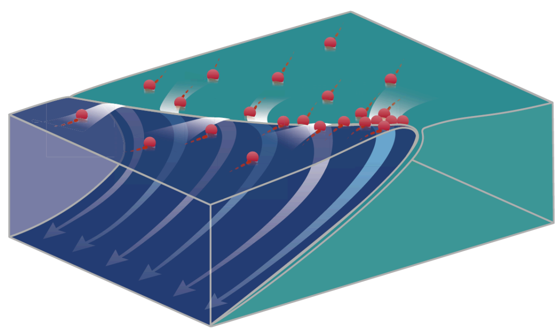


Typical Sea Surface salinity pattern at the end of May in the Western Med. From CMEMS global model.



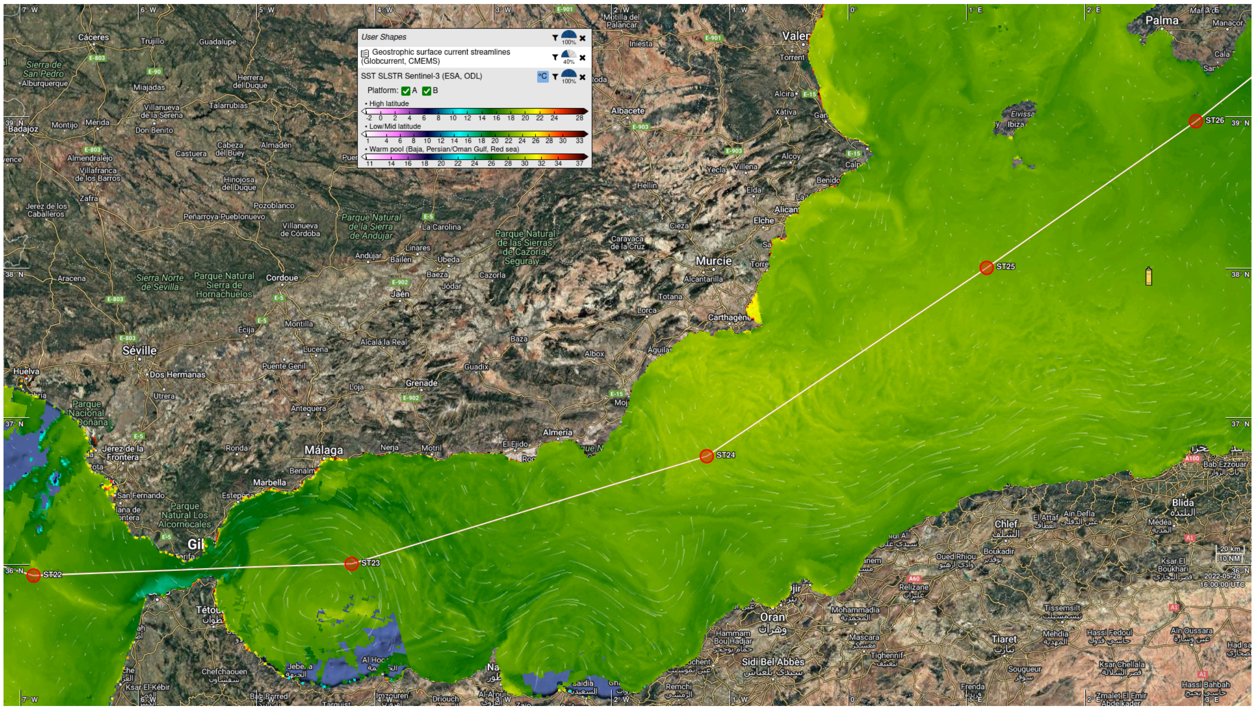
Chlorophyll concentration zoom on the Alboran Sea at the end of May. Temperature and Salinity profile from an Argo float at the edge of the Alboran gyre.



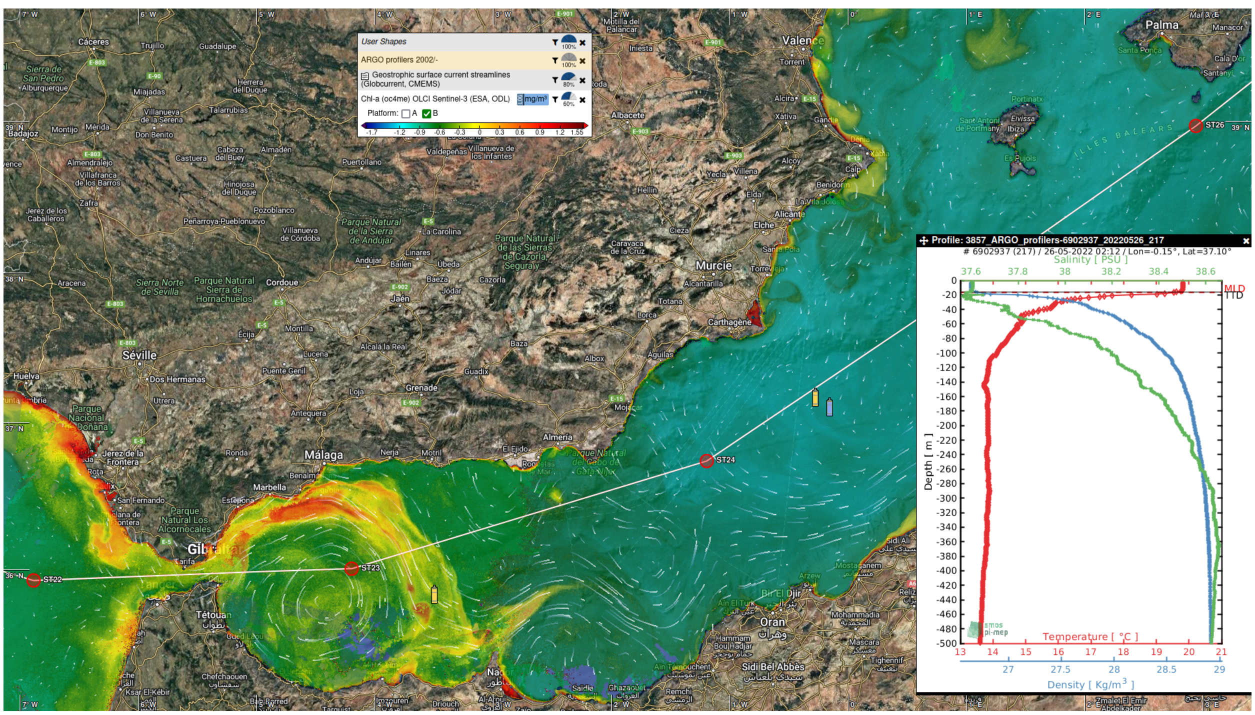


Subduction occurs in three-dimensional pathways

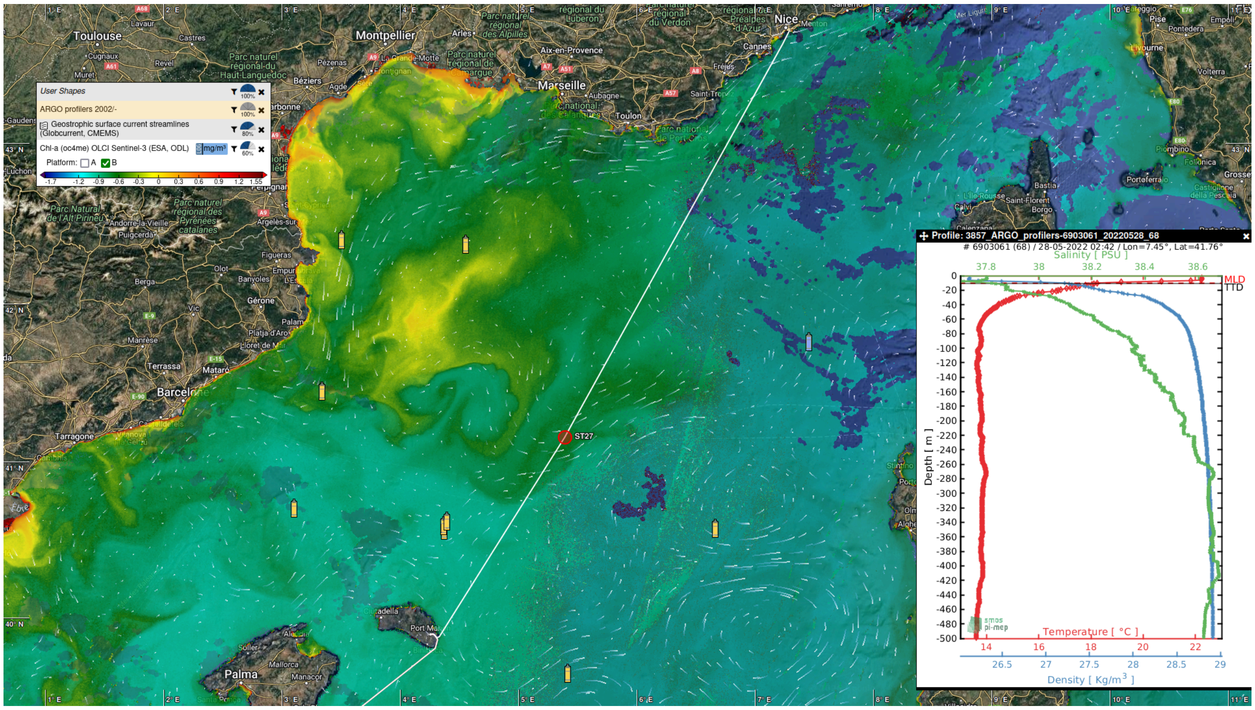
D’Asaro et al. 2017



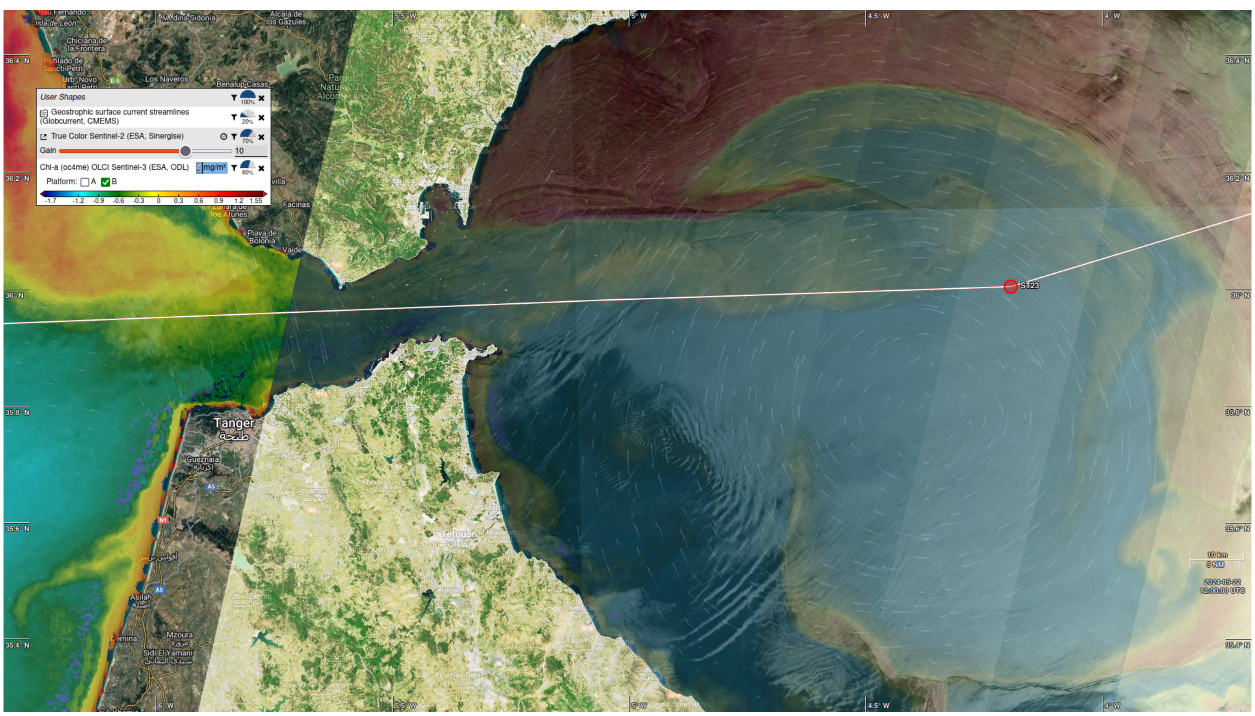
Typical SST pattern at the end of May in the Alboran Sea, from Sentinel-3 SLSTR.



Chlorophyll concentration zoom on the Alboran Sea at the end of May. Temperature and Salinity profile from an Argo float in the eastern end of the Alboran Sea.

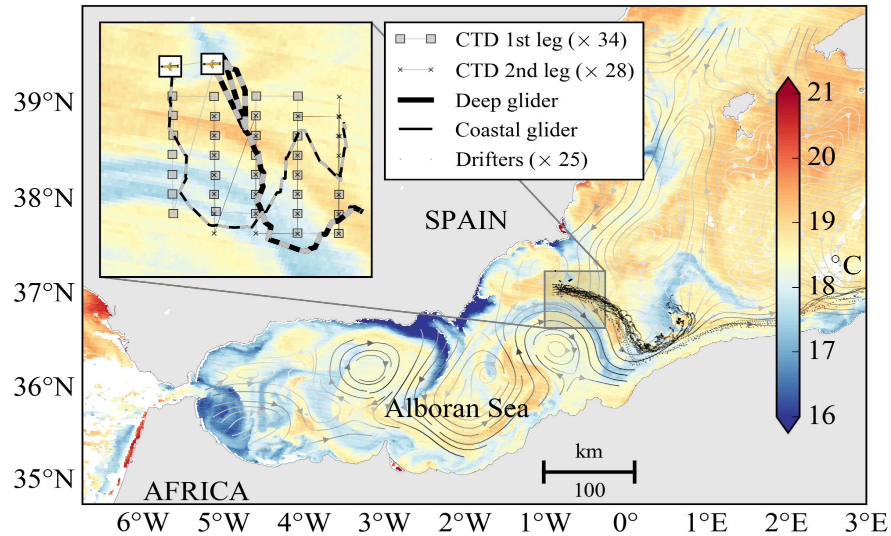


Chlorophyll concentration zoom on the Gulf of Lyon at the end of May. Temperature and Salinity profile from an Argo float between France and Sardinia.



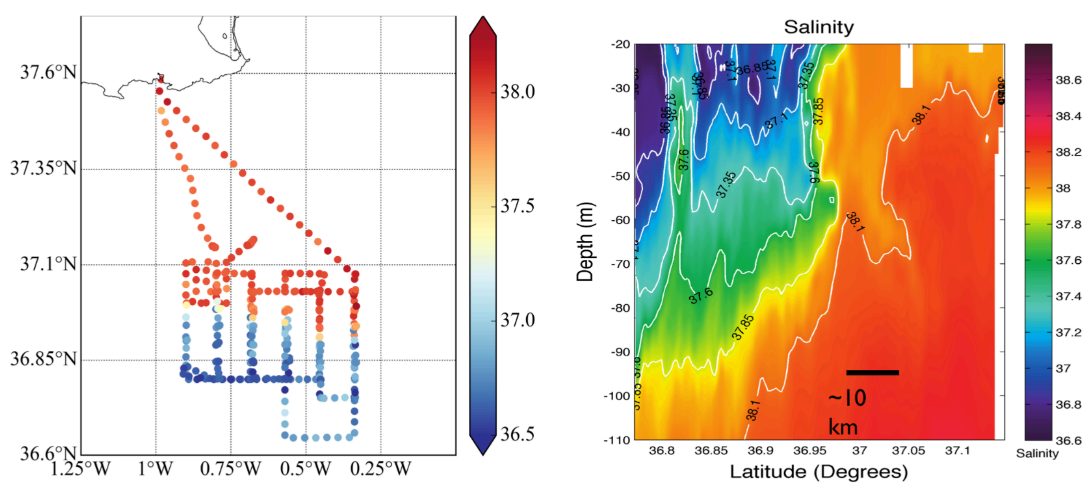
Chlorophyll concentration zoom on the Alboran Gyre at the end of May. Internal wave signature on sun glitter from Sentinel-2 image.

Vertical motions are also occurring at submesoscale at the location of fronts. This has been documented in the Multiplatform Experiment to Unravel Meso and Submesoscale processes in an Intense Front Alborex, with PI Ananda Pascual and Simon Ruiz.



Alborex sampling map in Eastern Alboran Sea, 25-30 May 2014

AlborEx: Salinity front



Thermosalinograph – surface salinity

Glider salinity vertical section

Table 2. *List of in-situ stations for Leg 2.*

Station Name	Lat (ºN)	Lon (ºE)	Comments
ST11b	63.33	-22	Station resampled during Leg 2
ST12	61.7	-21	Féroé latitude
ST13	59.7	-20	Oslo latitude
ST14	57.4	-18.7	Scotland latitude
ST15	55	-17.5	North Irlande latitude
ST16	52.6	-16.55	South Irlance latitude
ST17	50.2	-15.5	Cornwall latitude
ST18	47.4	-14.3	Nantes latitude
ST19	44	-13.1	Toulouse latitude
ST20	40.5	-11.3	Offshore Portugal, Madrid latitude
ST21	37.5	-10	Upwelling Portugal, Seville latitude
ST22	36	-6.9	Entrance Gibraltar
ST23	36	-4.15	Alboran Gyre
ST24	36.8	-1.2	East Alboran Sea
ST25	38	1.1	South Ibiza
ST26	39	3	South Majorque
ST27	41.1	5.3	Between Mahon and Nice

6 Research plans

Detailed plan in Annex 1 and in the Sharepoint.
Have a look to other research plan to identify possible collaborations.
Please also check if you have questions or remarks concerning your research plan in the following file on the Sharepoint.
ResearchPlan-Fesibility-analysis-v1.0.xlsx

7 Annex 1: Research plan documents

8 Annex 2: Instructions for instruments brought by lecturers and students

8.1 Calitoo

A quick start guide is available here
https://www.calitoo.fr/uploads/documents/en/quickstart_en.pdf

8.2 Home made Drifters

How to deploy Instructions:

1. Power on the SPOT GPS tracer by pressing the Power button
2. Wait for the self-test to complete (~ max 2 minutes)
    a. both leds should blink green
    b. then only the power led should blink green
    c. in case of GPS acquisition or message transmission error, LEDs will blink red
3. If (2) succeeds, place the inner seal and close the lid
4. Apply tape to prevent the lid from unscrewing

8.3 Hyperspectral floats

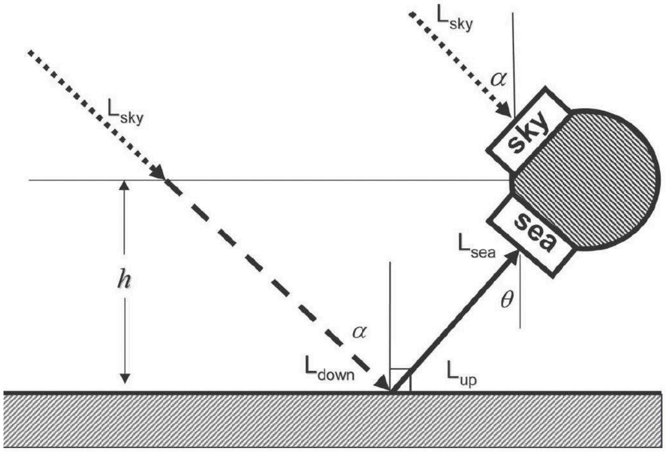
8.4 P-band reflector

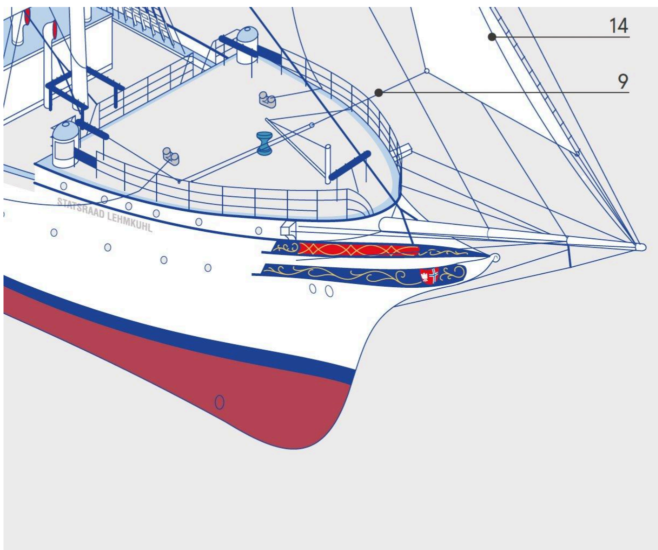
The instrument that will be used is a prototype developed at ICE-CSIC/IEEC (shoebox size)

- At ‘station’ stops, take the instrument out, take a few minutes of data from the ship's deck railing, and store again until next ‘station’.

- Between stations: process the data to find information about the reflected electromagnetic signal, and analyse it.

8.5 Infra Red Radiometer





For Processing algorithm, see Donlon et al 2007: DOI:
https://doi.org/10.1175/2007JTECHO505.1

An Infrared Sea Surface Temperature Autonomous Radiometer (ISAR) for Deployment aboard Volunteer Observing Ships (VOS)

C. Donlon,* I. S. Robinson,+ M. Reynolds,# W. Wimmer,+ G. Fisher,+ R. Edwards,# and T. J. Nightingale@

*National Centre for Ocean Forecasting, Met Office, Exeter, United Kingdom
+National Oceanography Centre, University of Southampton, Southampton, United Kingdom
#Brookhaven National Laboratory, Long Island, New York
@Rutherford Appleton Laboratory, Chilton, Didcot, Oxon, United Kingdom

(Manuscript received 9 June 2006, in final form 1 August 2007)

8.6 NOC TA LOC and WRASSe

Leg 1 - Tromsø to Reykjavik

- Continuous monitoring for 13 days
- Daily discrete sample

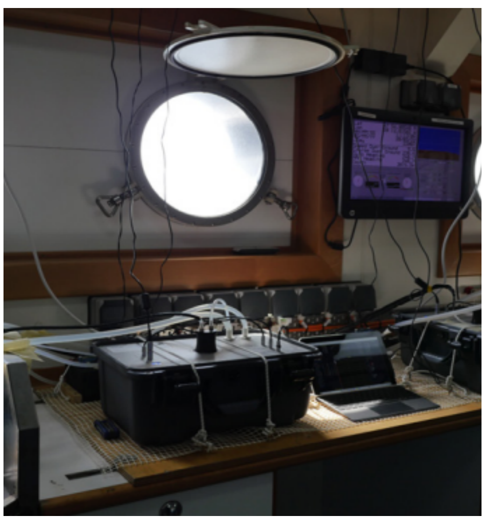
Port Call – Reykjavik

- Remove SD card and save data
- Replace oil, titrant and waste bags
- Secure used waste bag

Leg 2 - Reykjavik – Nice

- Continuous monitoring for 13 days
- REPLACE FLUIDS AT SEA
- Continuous monitoring for 13 days

8.7 Lab STAF



Sampling Options:

- Handles sample volumes up to 20 mL per unit.
- Or fully automated when connected to the ship's underway water supply system.

Data Logging:

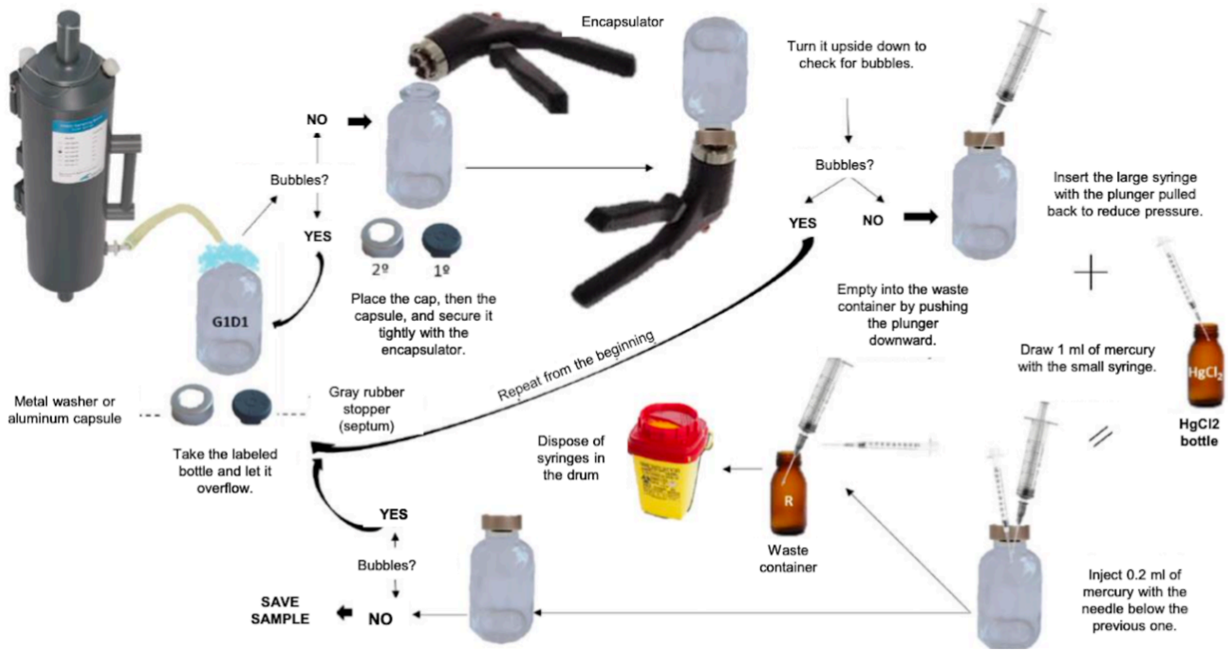
- Equipped with Windows-based software for data logging on a laptop (which will be prepared for the trip).

Water Requirements:

- Discrete samples of 20 mL each (triplicates)
- Or operated with a continuous flow of ambient temperature water.

8.8 Water sample for methane determination

How to deploy



8.9 water samples for UV filtering determination

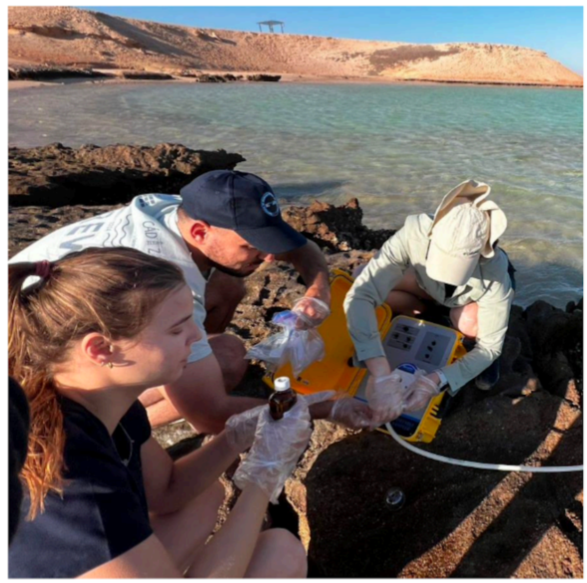
How to deploy

Once surface water has been collected by the rosette at each station, simply fill the amber glass jar with non-filtered surface water without reaching its maximum capacity (80 mL). For storage, keep the samples refrigerated in a freezer. Samples should be collected in triplicate. To use as a blank, a single sample (80 mL) is taken from the greatest depth reached by the rosette.

Water Requirements

A total of 21 rosette stations are planned for the entire survey. Single samples (80 mL each) will be collected at the surface from each rosette station, along with a single blank sample (80 mL). In total, 21 surface samples (80 mL each) and 4 blank samples will be collected.

X1 surface water sample



9 Annex 3: Log Sheet

9.1 Calitoo

Log sheets are available here

9.2 Infra Red Radiometer