Ship-based training initiatives in marine-related sciences

Expedition module

Autonomous platforms

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(D.D. n. 130/2022 - CUP B53C22002150006) Funded by EU - Next Generation EU PNRR-Mission 4 "Education and Research" - Component 2: "From research to business" - Investment 3.1: "Fund for the realisation of an integrated system of research and innovation infrastructures"

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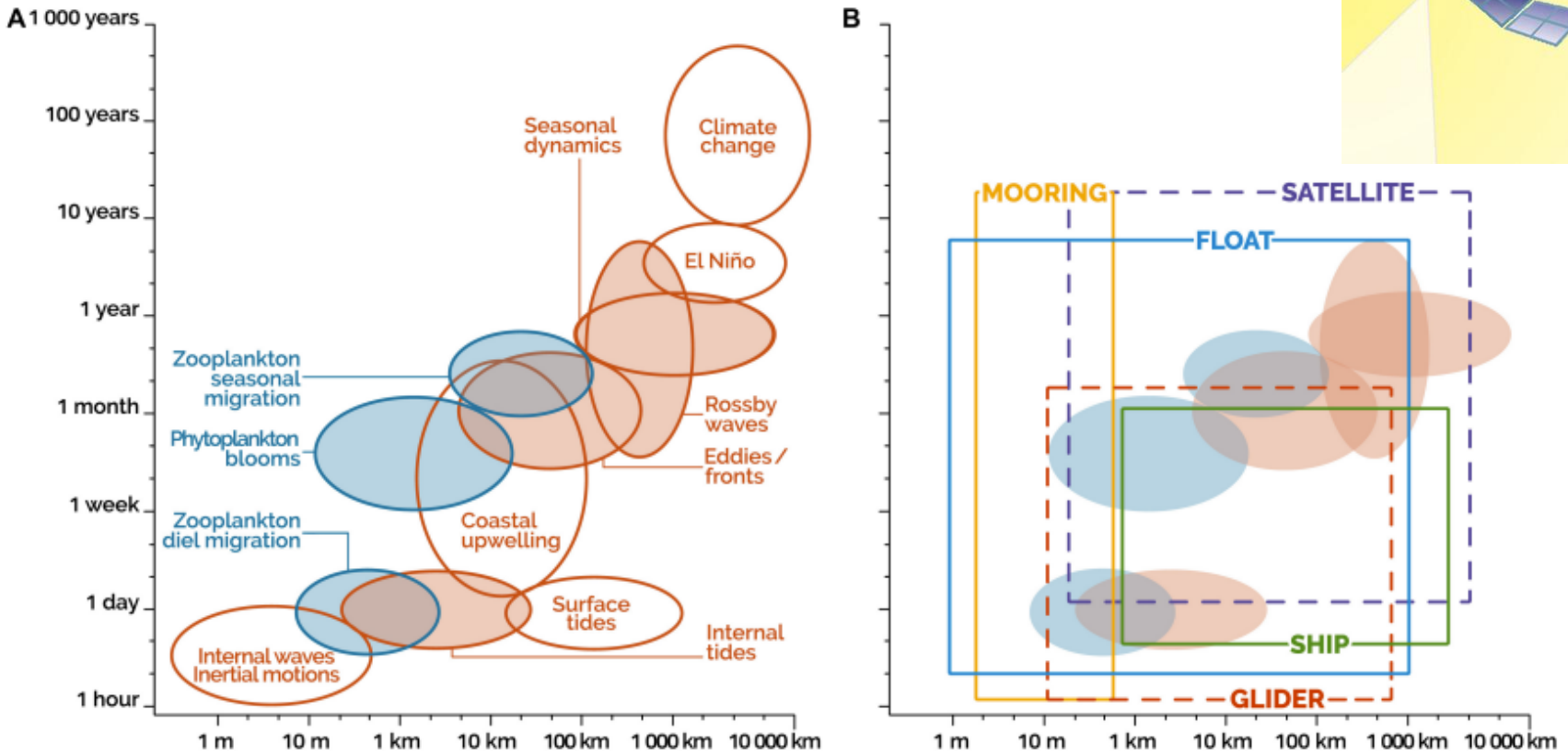
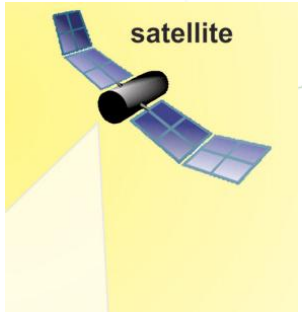
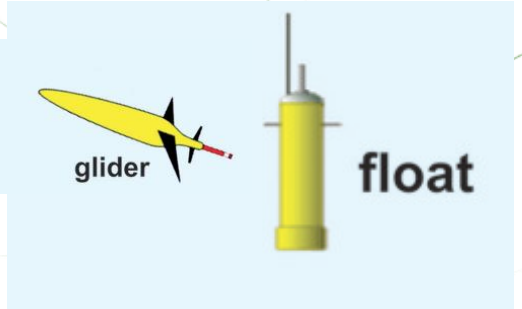
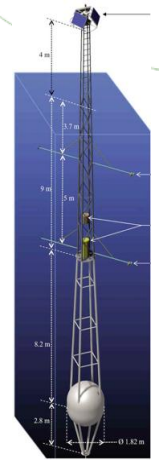
Ocean physical and biological processes







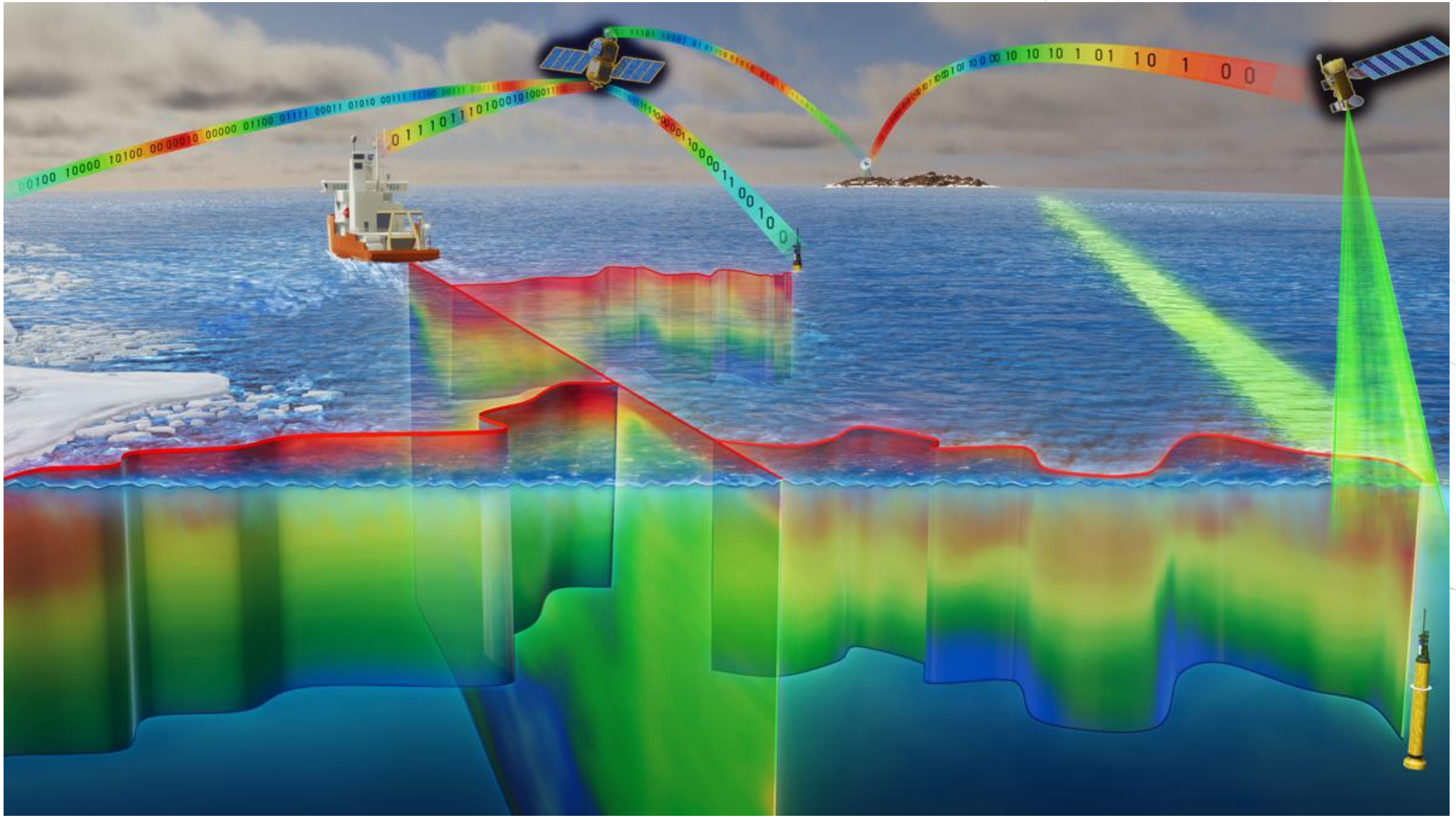


Mooring

Lagrangian drifter

FIGURE 1 | Semiquantitative representation of spatial (geographical, horizontal) and temporal scales of important marine physical dynamic (red ellipses) and ecosystem (blue ellipses) processes (modified from Chai et al., 2020, Figure 2). **(A)** Filled ellipses: processes of significance to BCPs. **(B)** BCP-relevant processes from panel **(A)** (ellipses) and spatio-temporal ranges of five observation platforms (rectangles): satellites, ships, floats, gliders, and moorings. The geographical ranges of fleets of mobile platforms and mooring networks will be wider than those of individual mobile platforms and moorings illustrated in panel **(B)**.

Claustre et al. (2021)



Schofield et al. (2022)

Lagrangian drifters

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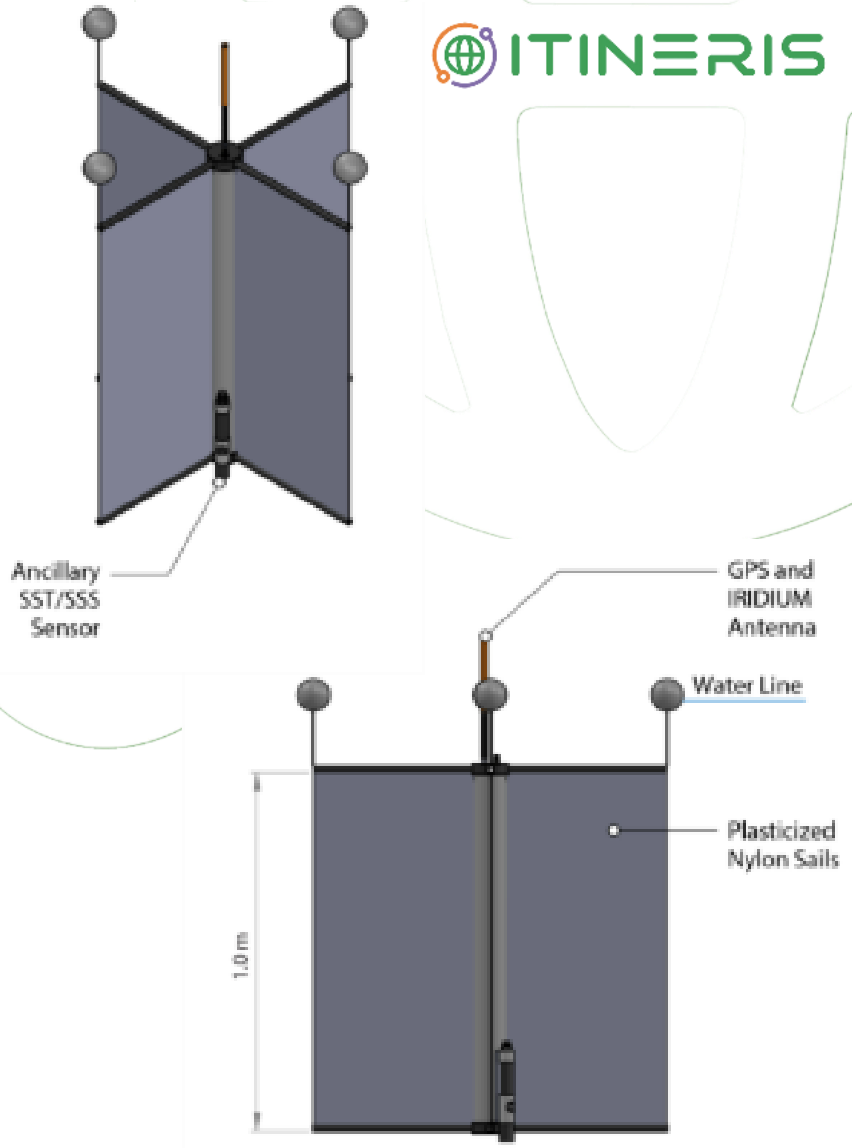
Lagrangian drifters - CARTHE

- CARTHE drifters have a drogue centered at 40 cm below the sea surface
- Lifetime at sea is on the order of weeks to a few months
- CARTHE drifters are expected to follow the surface sea currents that respond faster to wind forcing
- Measurements: GPS
- Deployment requires one person. Using a rope, the drifter is carefully lowered to the surface of the sea. Once properly positioned, the rope is released and retrieved on board
- Ship speed is not critical during deployment

Design by Pacific Gyre Inc. (USA)

Lagrangian drifters - CODE

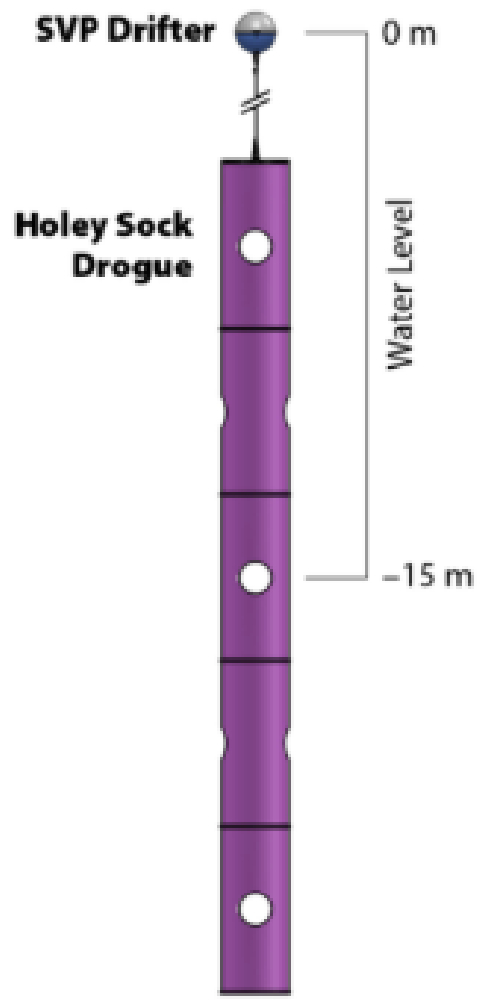
- CODE drifters have a 1-meter-long drogue
- Lifetime at sea is on the order of weeks to a few months
- CODE drifters are expected to follow the surface sea currents that respond faster to wind forcing
- Measurements: GPS
- Deployment requires one person. The drifter is thrown directly into the water, ensuring that the weighted bottom enters first to maintain correct orientation.
- Ship speed is not critical during deployment



Design by OGS (Italy)

Lagrangian drifters - SVP

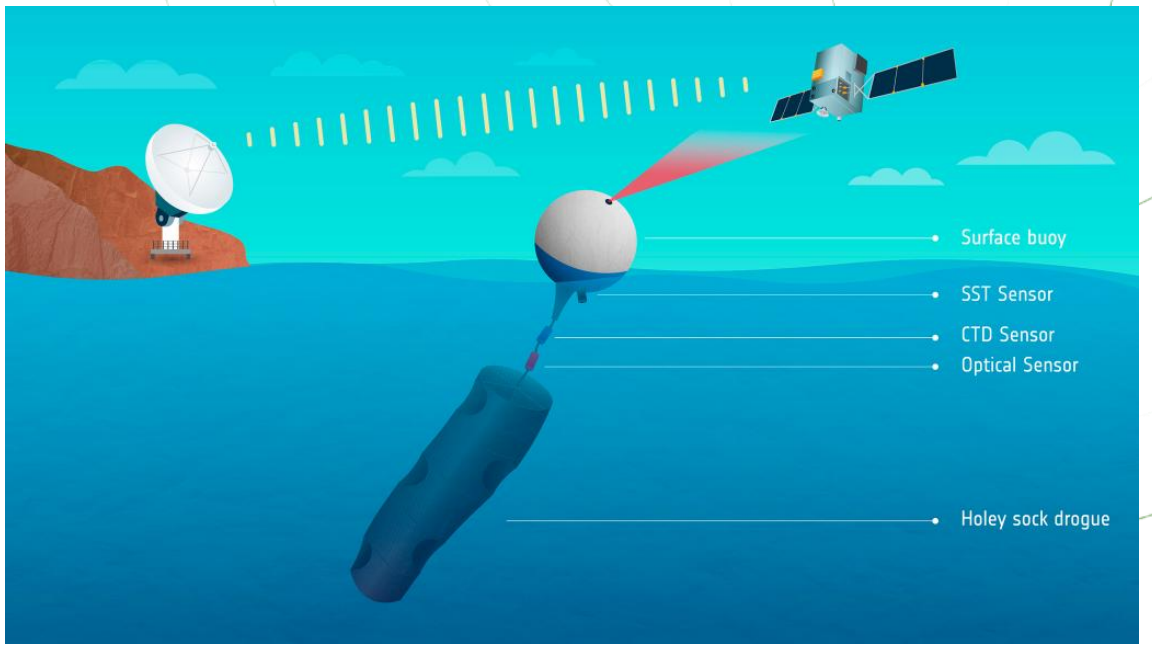
- SVP (Surface Velocity Program) drifters have a drogue centered at a depth of 15 meters
- SVP drifters are expected to follow the sub-surface currents
- Lifetime at sea is on the order from a few months to a year
- Measurements: GPS, Sea Surface Temperature (SST), Wind
- Deployment requires two persons. One operator holds the drogue while the other holds the surface buoy. The SVP is deployed by simultaneously releasing both parts into the water.
- Ship speed is not critical during deployment



Design by Scripps University (USA)

Lagrangian drifters – BGC-SVP

- BGC-SVP drifters, as SVP, have a drogue centered at a depth of 15 meters and body with biogeochemical sensors installed at 9-m depth
- BGC-SVP drifters are expected to follow the sub-surface currents
- Lifetime at sea is on the order from a few months to a year
- Measurements: GPS, Wind, Sea Surface Temperature (SST); and at 9 m: Temperature, Salinity, Dissolved Oxygen, Phytoplankton Chlorophyll, Optical Backscattering
- Deployment requires a minimum of three operators. Each component is held by a different person. The sensor payload, which includes biogeochemical instruments, is supported using a rope threaded through one of its lifting points. It is lowered as close as possible to the sea surface. The drogue must be released into the water before the payload. The payload is then carefully released. Finally, the surface buoy is deployed.
- Ship speed must be reduced



Design by Scripps University (USA)

BioGeoChemical-Argo and Deep-Argo floats

https://argo.ucsd.edu/

https://biogeochemical-argo.org/

https://www.euro-argo.eu/

https://fleetmonitoring.euro-argo.eu/

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BioGeoChemical-Argo floats

- BGC-Argo floats drift at a parking depth of 1000 meters, profiling the water column from a depth of 2000 m to the surface, up to every 10 days
- Lifetime at sea is on the order of 4-5 years
- Measurements - 6 core BGC variables: Oxygen, pH, Nitrates, Phytoplankton Chlorophyll, Radiometry, Suspended particles (via optical backscattering)
- Deployment of each BGC-Argo float requires three operators plus a crane operator. The float is attached to a quick-release hook, which is controlled via a rope. It is lowered over the stern of the vessel using a crane. Once the float buoyancy is confirmed, the release mechanism is activated and the rope is retrieved on board
- Ship speed must be reduced

Bittig et al. (2019)

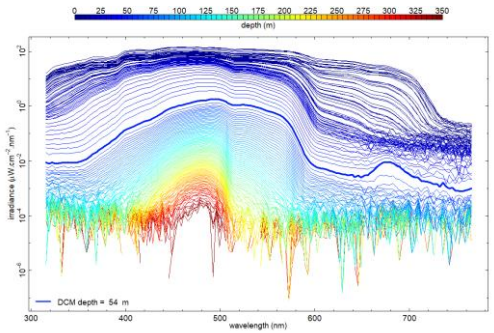
FIGURE 8 | Examples for biogeochemical sensor attachments and implementations on different float platforms. Note that BGC sensors can be vertically displaced relative to the CTD pressure sensor. This displacement should be recorded in the float's meta data.

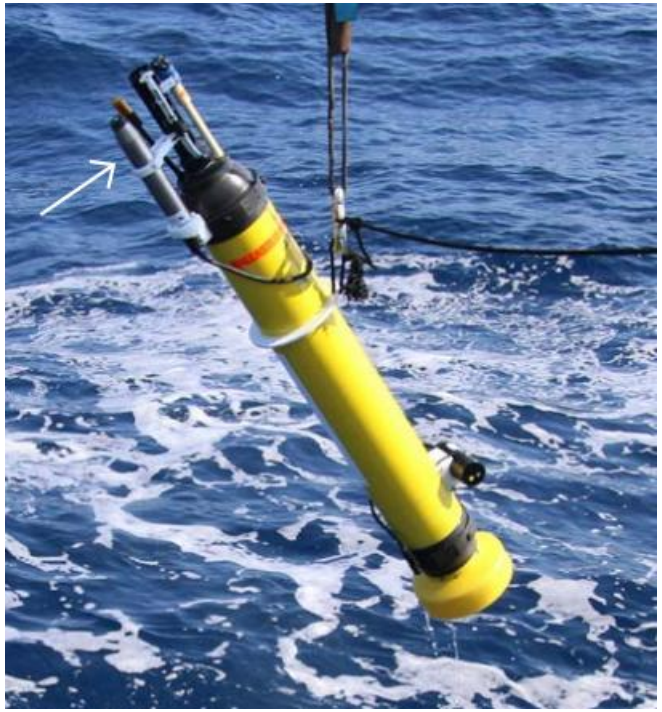
BioGeoChemical-Argo floats – The newest payloads

- Hyperspectral radiometry (for phytoplankton diversity)
- Under Water Vision (UVP6) profiler (for zooplankton)

Hyperspectral radiometer
RAMSES
Produced by TRIOS
(Germany)

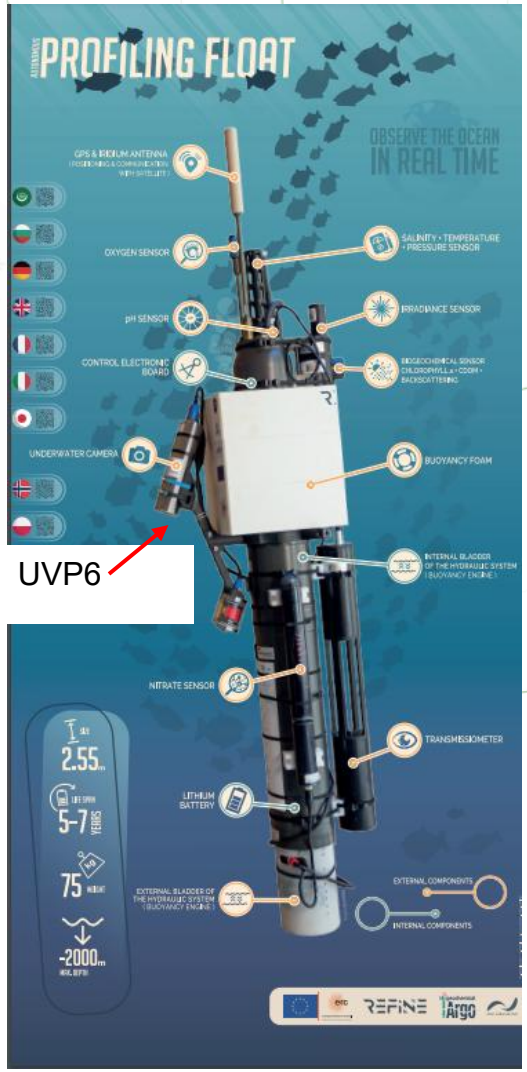
Mediterranean Sea





Organelli et al. (2021)

Produced by Hydroptics
(France)



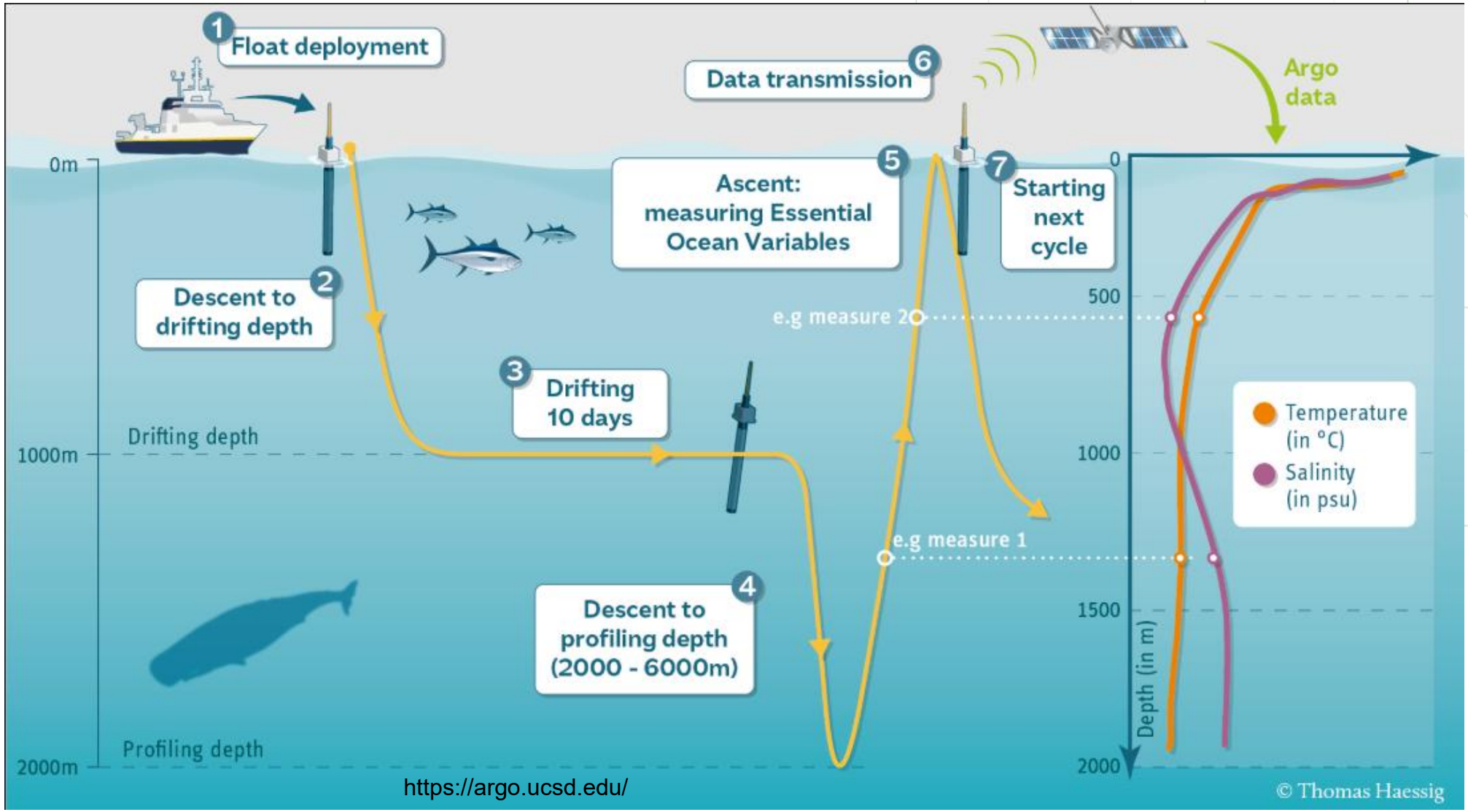
@ ERC Refine

Deep-Argo floats

- Deep-Argo floats drift at a parking depth of 1000 meters, profiling the water column from a depth of 6000 m to the surface, every 10 days
- Lifetime at sea is on the order of 3-4 years
- Measurements: Temperature, Salinity, Depth, Dissolved Oxygen
- Deployment of each BGC-Argo float requires one operator and no crane. The float is directly launched from the vessel's stern
- Ship speed must be reduced

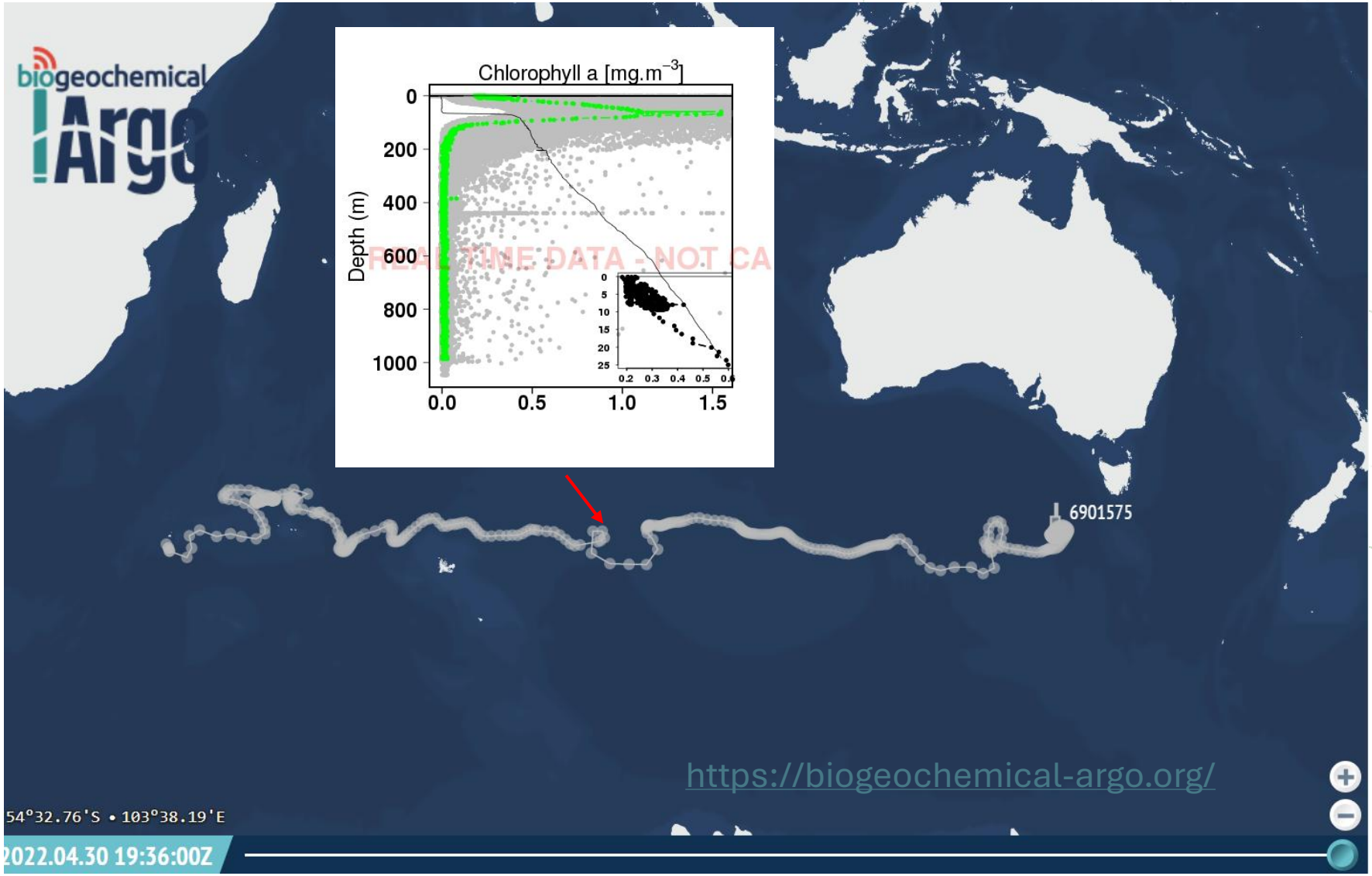
Designed by NKE Instrumentation (France)

Argo float profiling cycle

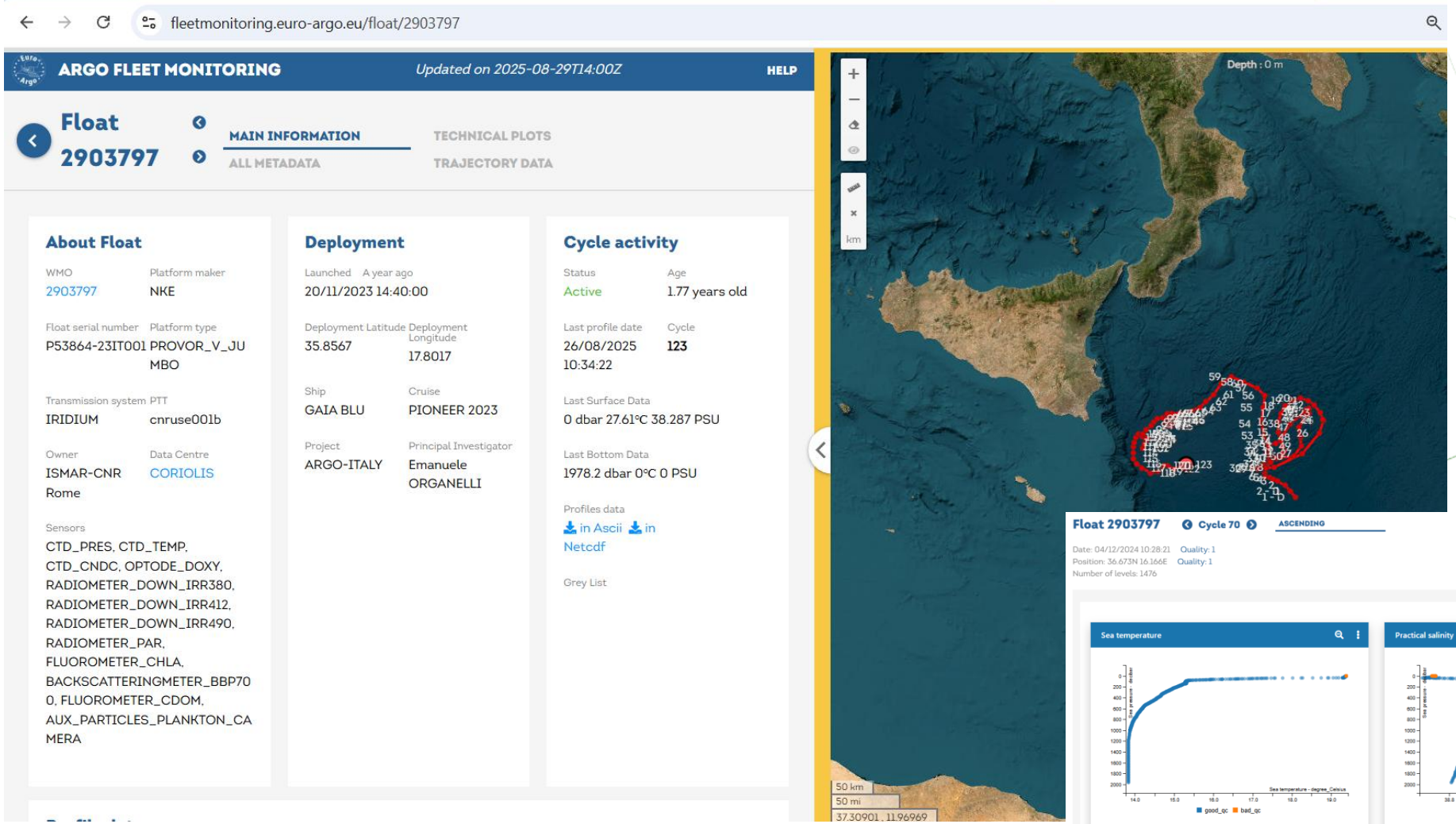


https://argo.ucsd.edu/

Trajectory and profiles

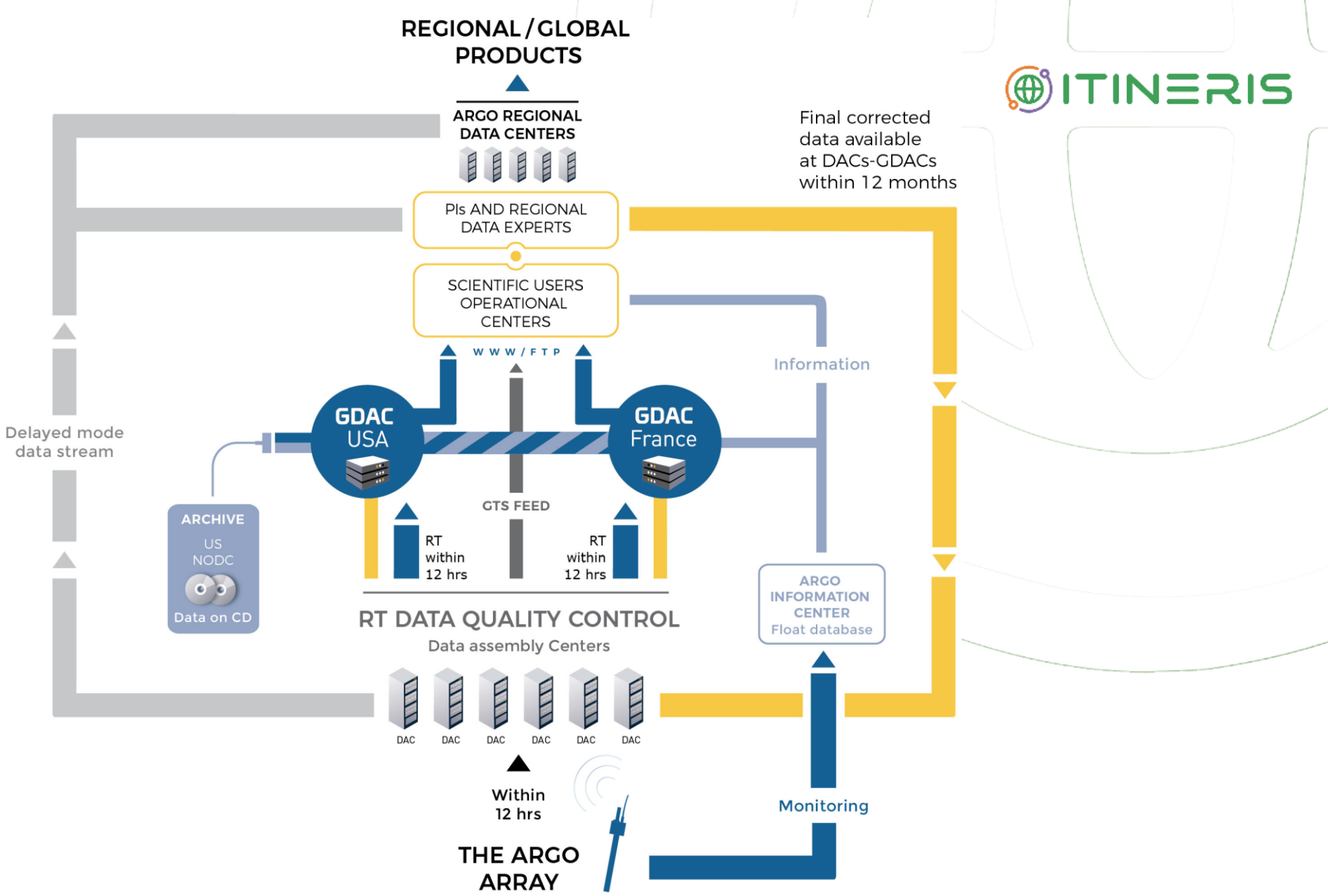


The fleet monitoring tool of EuroArgo ERIC



https://fleetmonitoring.euro-argo.eu/

Data processing and QC (Real Time and Delayed Mode)



Data are delivered from 11 different DACs (Data Assembly Centers) that apply the same QC protocols


biogeochemical
Argo
TOTAL PROFILES
2025 PROFILES
346218
TOTAL O_2 PROFILES
23878
2025 O_2 PROFILES ACQUIRED BY
933 ACTIVE SENSORS
100063
TOTAL NO_3 PROFILES
12147
2025 NO_3 PROFILES ACQUIRED BY
529 ACTIVE SENSORS
78909
TOTAL PH PROFILES
11952
2025 PH PROFILES ACQUIRED BY
536 ACTIVE SENSORS
163600
TOTAL CHL A PROFILES
15730
2025 CHL A PROFILES ACQUIRED BY
648 ACTIVE SENSORS
161039
TOTAL SUSPENDED PARTICLES PROFILES
15704
2025 SUSPENDED PARTICLES PROFILES ACQUIRED BY
647 ACTIVE SENSORS
63549
TOTAL DOWNWELLING IRRADIANCE PROFILES
3965
2025 DOWNWELLING IRRADIANCE PROFILES ACQUIRED BY
133 ACTIVE SENSORS
Since 2012

THANKS!

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