OneArgo Town-hall

Underpinning Ocean Knowledge for Societal Benefit: The Urgency to Implement OneArgo by 2030

The OneArgo team

One Ocean Science Congress | 3-5 June 2025, Nice, France

Opening Remarks

Hervé Claustre (herve.claustre@imev-mer.fr)

IMEV

OneArgo: From Ocean Observations to Societal Benefits

- A landmark article just released to showcase the full value of Argo to society
- OneArgo: the next-generation global ocean observing system, building on 25 years of Argo success
- This session reflects the spirit of that article: outreach, advocacy, and **co-construction**

Advancing Ocean Monitoring and Knowledge for Societal Benefit: The Urgency to Expand Argo to OneArgo by 2030

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Crossing Boundaries: Scientists & End-Users Together

- A different approach: each theme in the article pairs an Argo operator with an end-user
- Highlights the real-world impacts of Argo on climate, fisheries, carbon, and education…
- Visibility and public appropriation of Argo are key to sustained funding and long-term viability

From Data to Action: What's at Stake

- Argo underpins major services: forecasting, sea-level monitoring, ecosystem tracking
- OneArgo expands to deep ocean, polar regions, and biogeochemistry
- Enables science-based governance of the high seas through open, global ocean data
- Investing in OneArgo is investing in resilience, science, and a sustainable future

***As a summary this session brings together key actors across the value chain — from those* who generate and steward high-quality ocean data with those who turn it into impact**

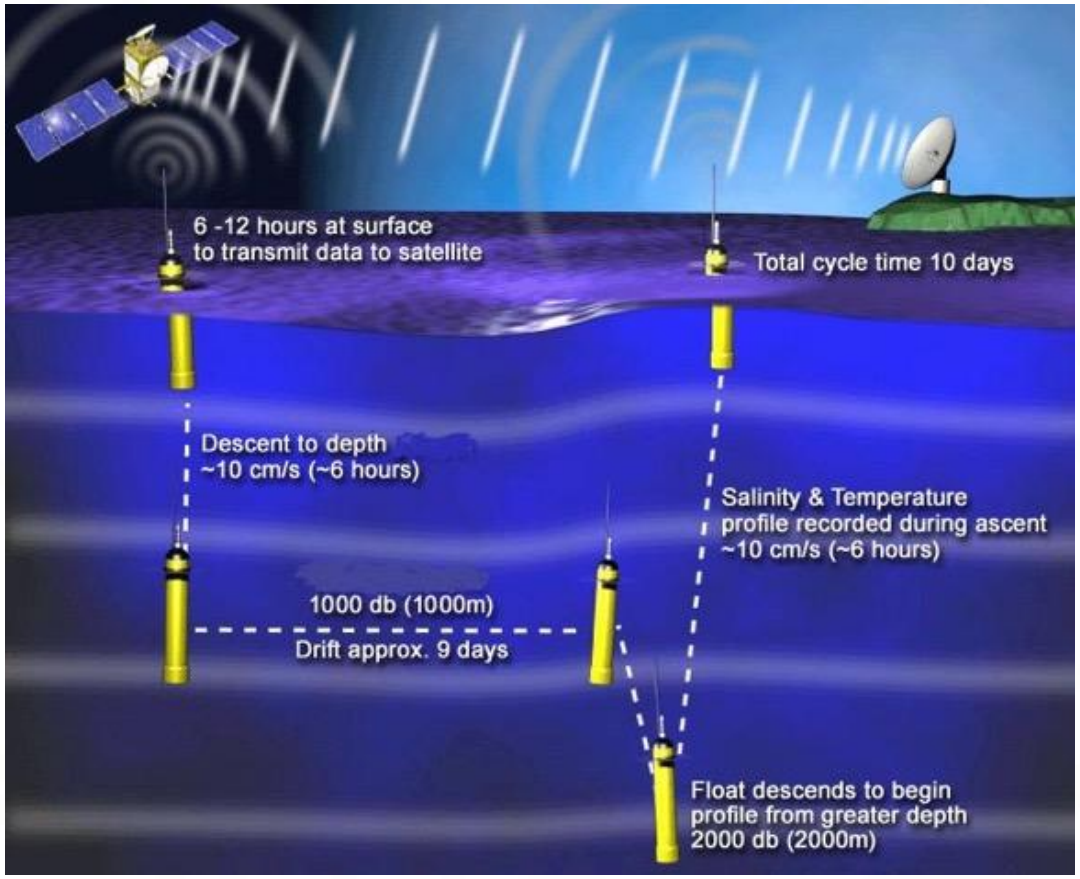
Status of Argo and OneArgo

Susan Wijjfels (swijffels@whoi.edu), Brian King

WHOI

Argo

Combines an highly efficient ocean sensing technology, a global mission and with fit-for-purpose data management system

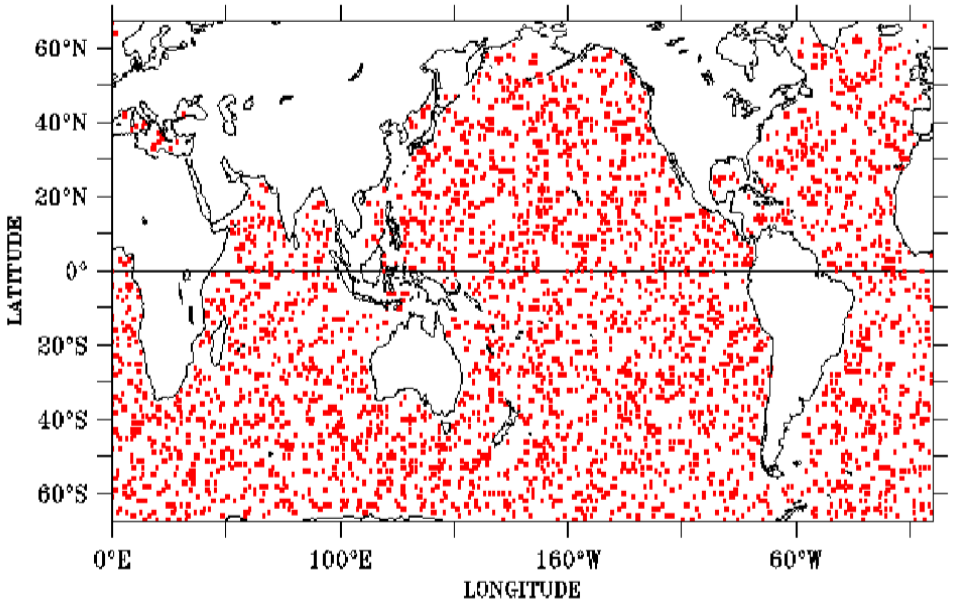


- Long lived autonomous ocean profilers with stable high-quality sensors
- A simple and effective global design
- Designed to be synergistic with satellite missions
- Open and fast data sharing
- Strives for uniform data quality
- Multiple nations operate (~30) and deploy (~52) Argo floats
- Serve both science and operational users

Argo allows ocean ‘sensing’ without relying on research vessel time.
Argo enables everyone to explore our dynamic ocean environment > 6000 research papers

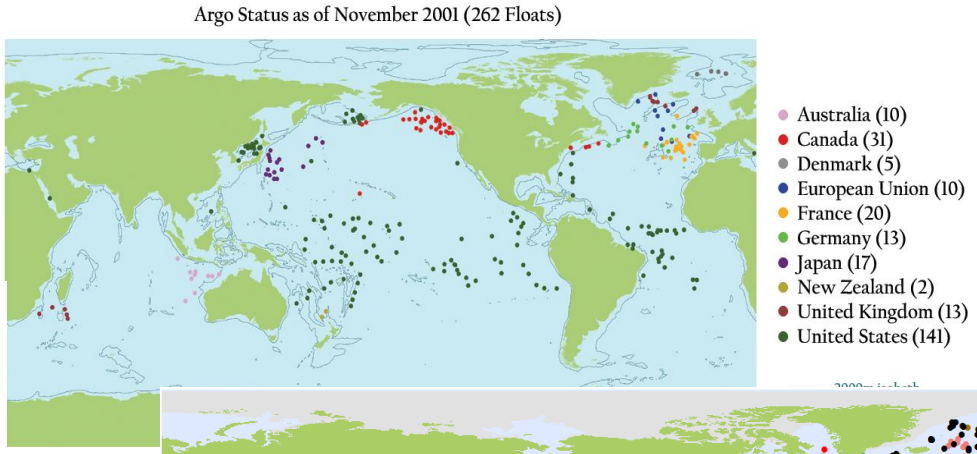
Past Argo Implementation

The first 20 years

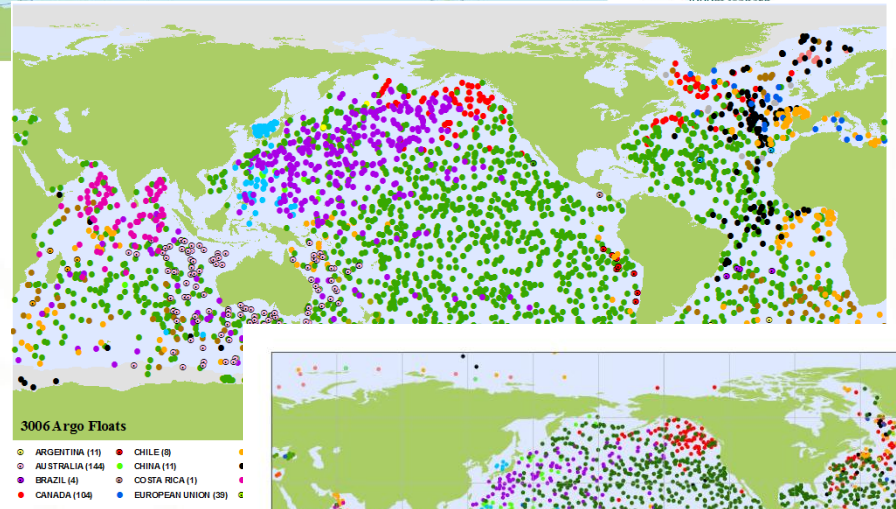


Original design – 1998

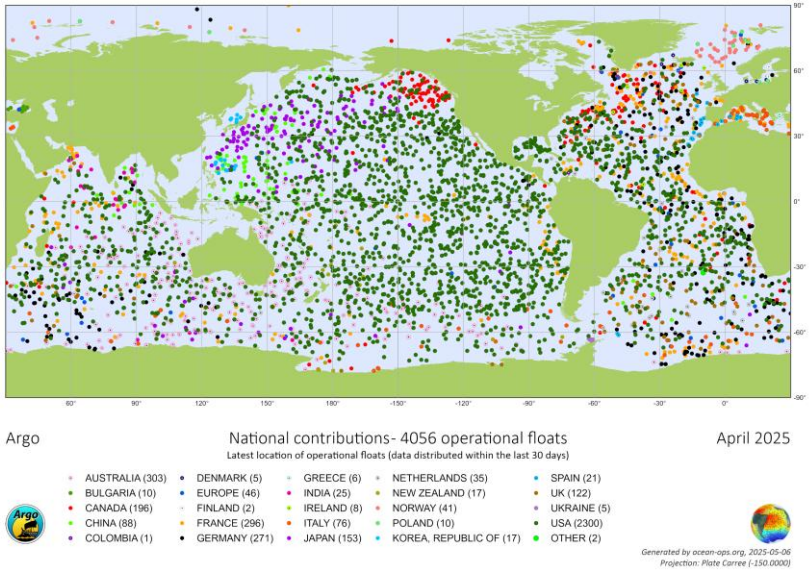
Temperature/salinity ; 0-2000m; open deep ocean



2001 - nascent



2007 - complete

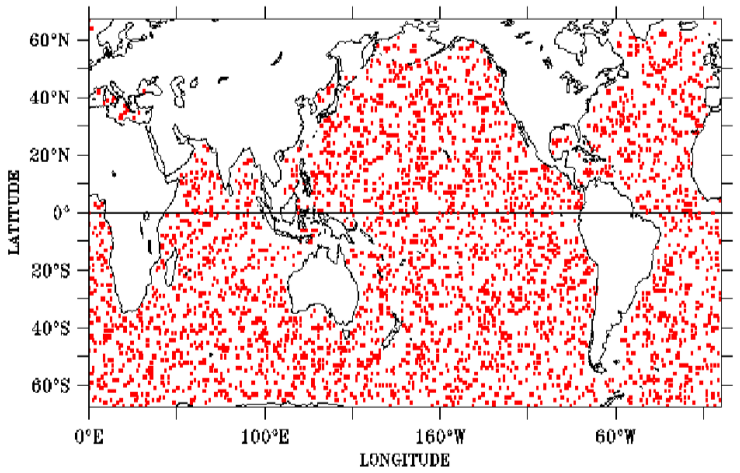


2025 – expanding global

A new design - OneArgo

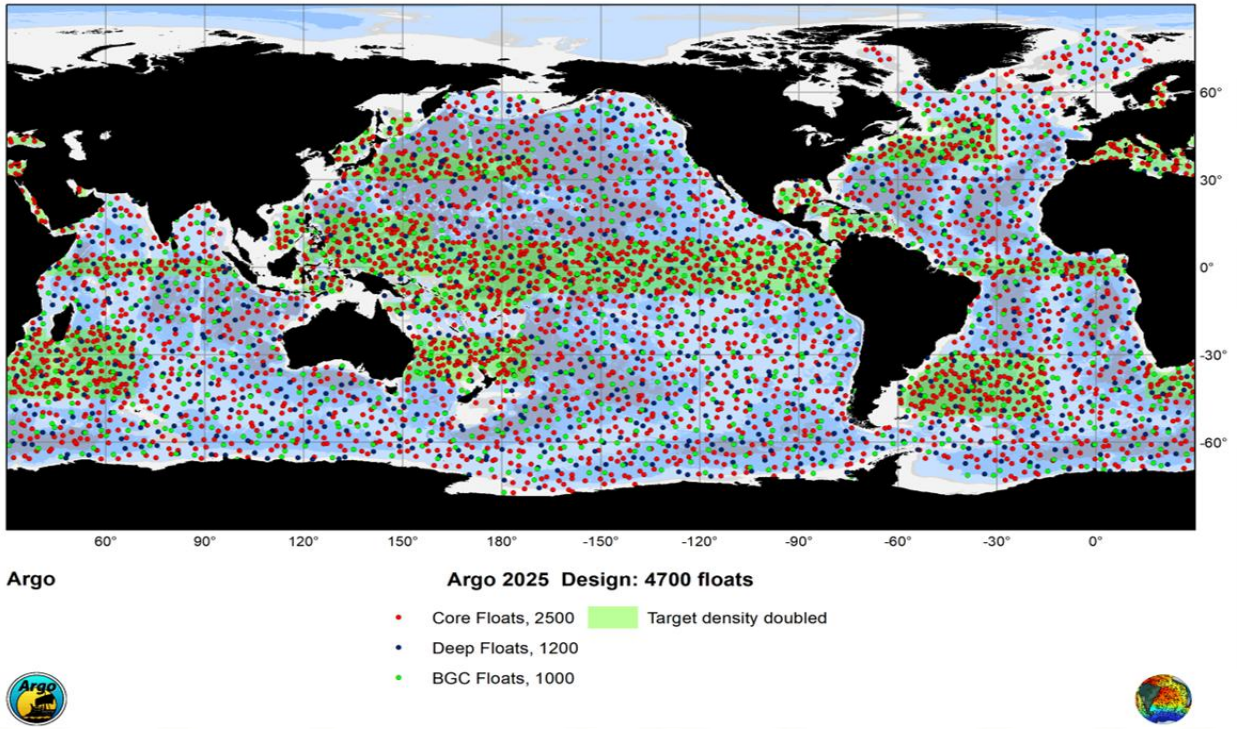
Expanding to serve new communities and support new services

Original “Core” Design



Original Design
physics in the ice-free open ocean

New “OneArgo” Design



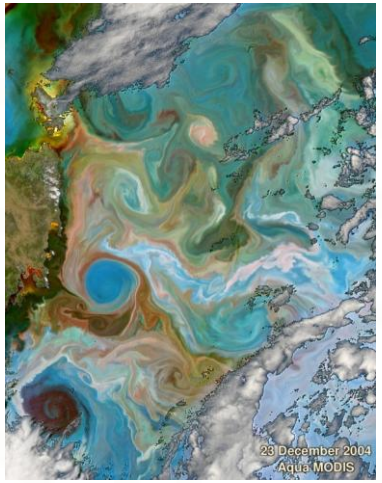
Full Depth, Global (including polar) and multidisciplinary (bio-optics, oxygen, pH, nitrate)

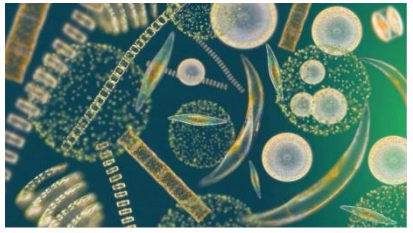
New Missions of OneArgo: targeting major blind spots

BioGeoChemical Mission

- Plankton/particles via bio-optics
- Carbon system via pH
- Ocean environment via oxygen and nitrate

Satellite partners



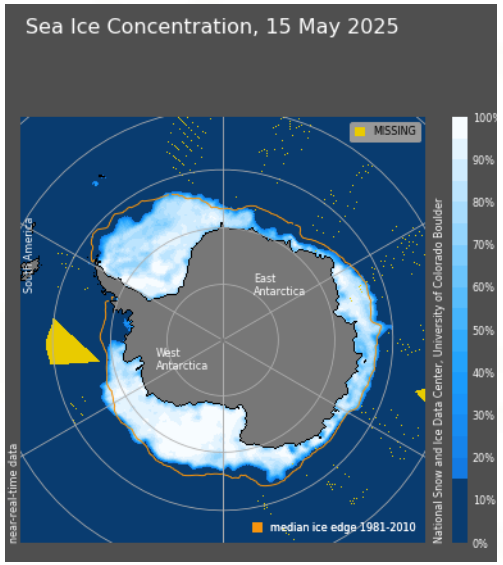


Ocean Colour

Polar Mission

- Seasonal sea-ice zones
- Developed ice-avoidance strategies
- Winter data is stored and shared in spring

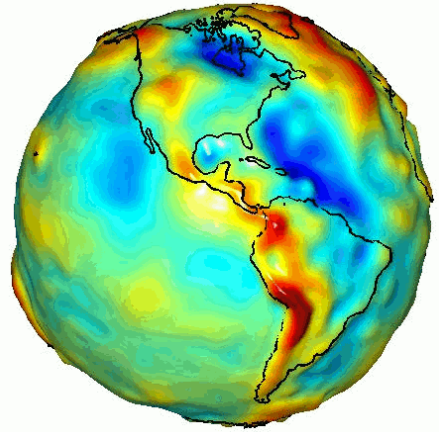
Ice Radars



Deep Mission

- Full depth sampling
- High accuracy sensors needed to track deep ocean changes

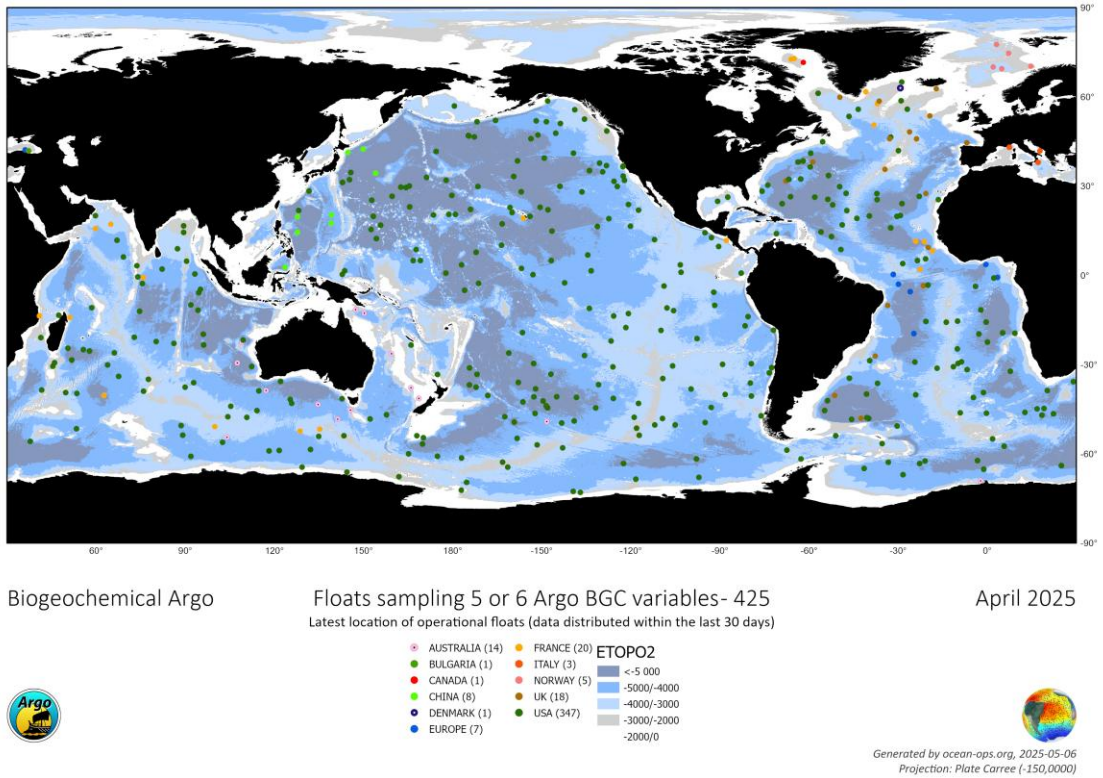
Gravity and Altimetric sea level



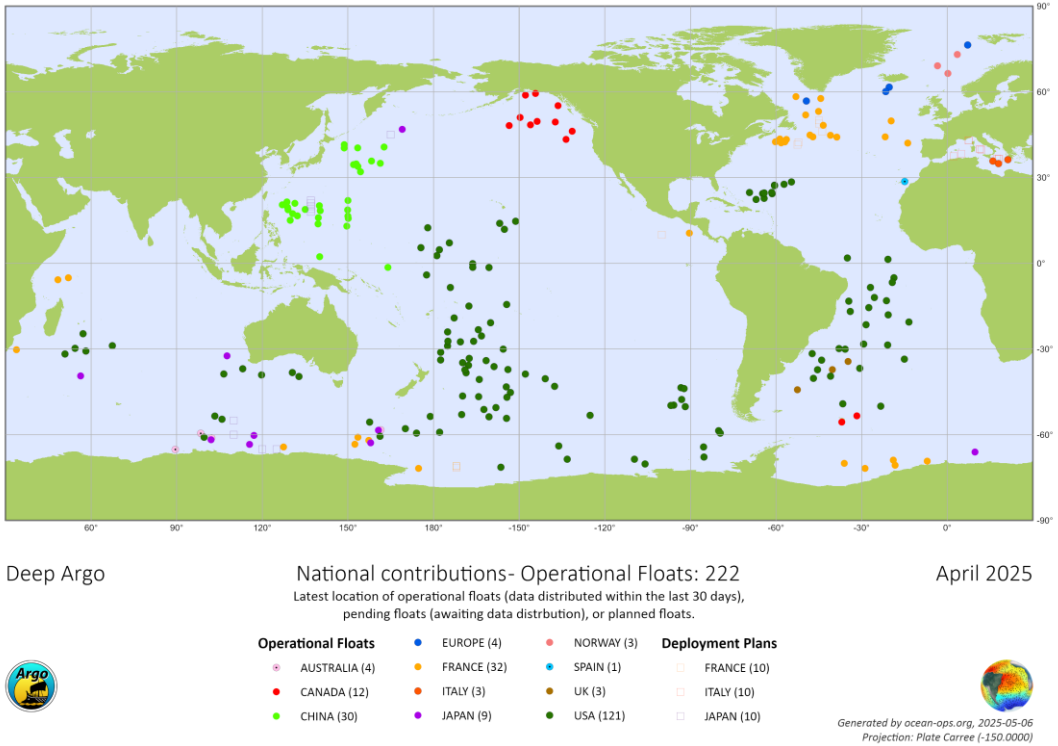
Credits: NASA

The Implementation Status

BGC ~ 40%



Deep ~ 18%



Supported by one-off research investments in large-scale pilots

Enabled technological readiness in our suppliers, our deployment teams and our data system

Where to now?

- The global Argo community has a strong track record of delivery
- Over the past 10 years, we have solved the technical, logistical and data management challenges involved in operating the new missions that comprise OneArgo
- We can accurately cost it out – 3 x the cost of original Argo ~ $100M/year globally
- The remaining challenge is to secure sustained funding for these crucial new data streams. We have a short window of time to exploit the momentum already built.

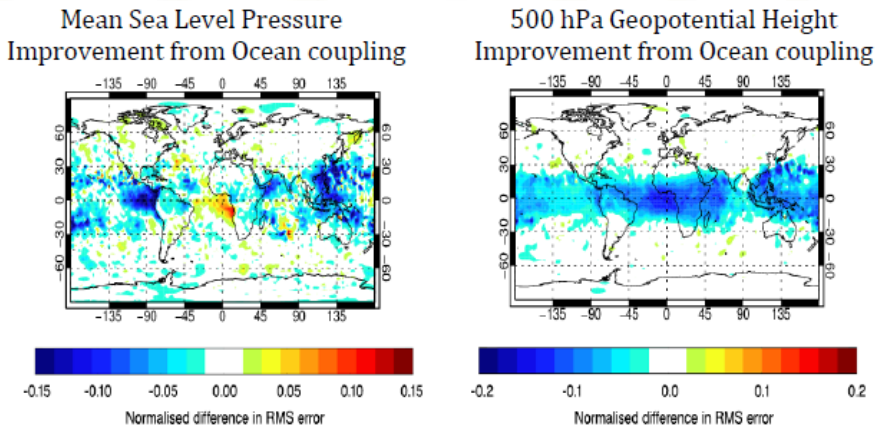
In the next talks we will hear about some of the key applications of the One Argo data streams

Effects of Argo floats data in NWP and climate monitoring

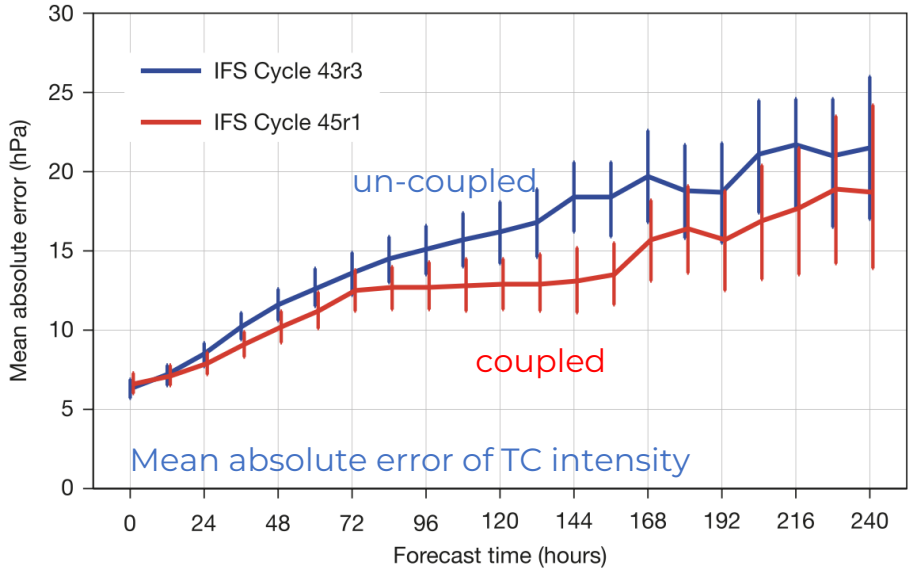
Hao Zuo (Hao.Zuo@ecmwf.int), Kristian Mogensen, Eric de Boisseson, Magdalena Alonso Balmaseda, Philip Browne, Marcin Chrust, Stephanie Johnson, Sarah Keeley and Christopher Roberts

ECMWF

ECMWF coupled forecasting system



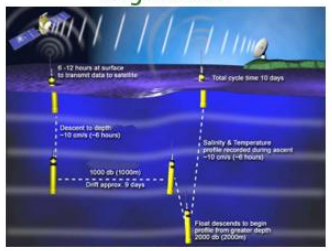
- ECMWF forecasts became coupled for all timescales since **2018** (CY45R1 HRES) - include dynamical ocean and sea-ice components (*Mogensen et al., 2018, Buizza et al., 2018*).
- Coupling with the ocean improves the weather forecast scores, with reduced RMSE (blue) in **day+5**.
- **Coupling with ocean reduces intensity error in HRES forecasts of tropical cyclone (TC).**



ECMWF Ocean DA system

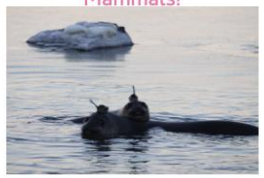
In-situ data

Argo floats



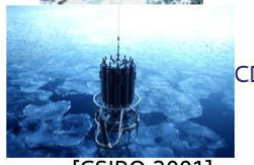
Argo operational cycle.
[Argo 2018]

Mammals!



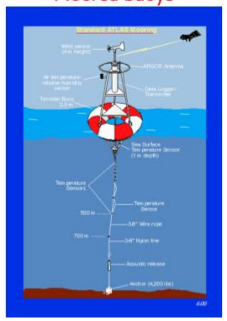
[MEOP et al. 2015]

Ship based observations



[CSIRO 2001]

Moored buoys



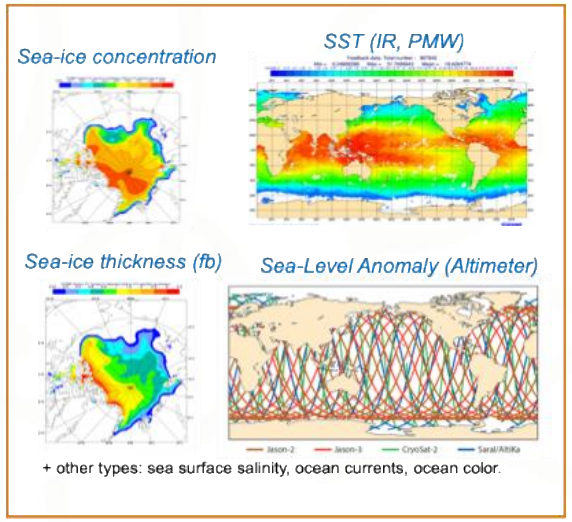
[PMEL 2018]

+ other platforms: ALAMO/AXBT, saildrone, ice-tethered profilers ...

Perturbed Observations

Observations:
- In-situ T/S prof.
- SIC
- SLA
- SST

Satellite data



ORAS6

Perturbed Forcings (hourly)

- Wind
- Net precipitation
- Solar radiation

Ensemble backgrounds

NEMOv4 + SI3

Innovations + updated $\boldsymbol{B}$

Ensemble 3D-Var

Ocean + sea-ice state variables

Increments IAU

Ensemble ocean and sea-ice analyses

Coupled Forecasts

- Ens/HRES
- SEAS6
- ERA6

Zuo et al., 2024, ECMWF NL 180

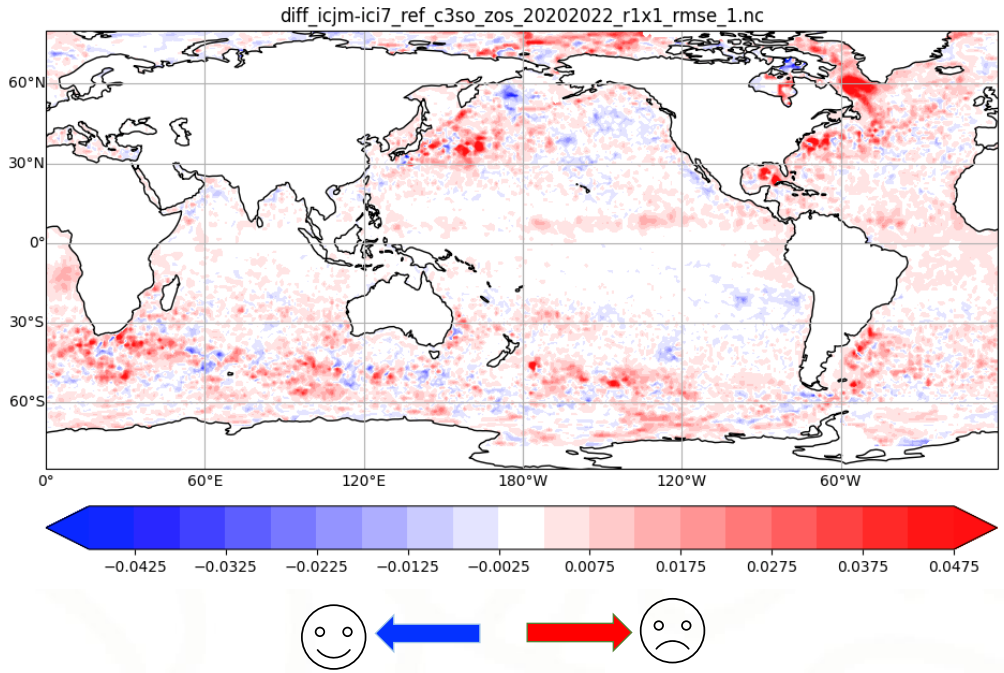
Effects of Argo data on ocean ReAnalysis

hindcasts and climate monitoring

The removal of Argo data leads to

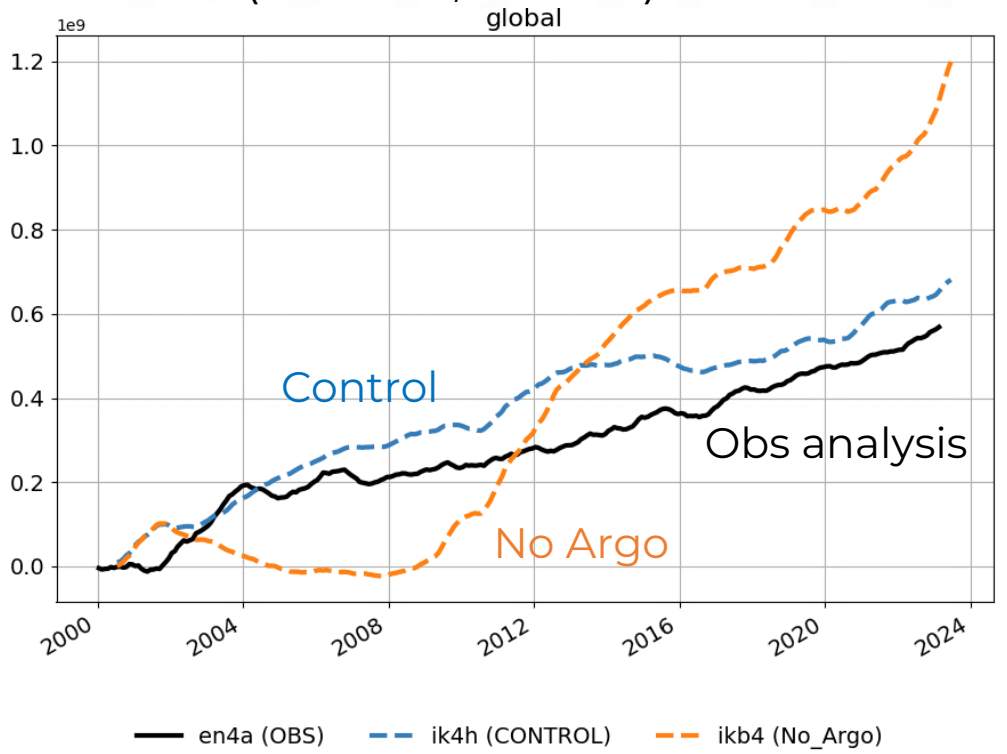
- increased errors in the sea surface states (SSH and SST)
- degraded performance in ocean heat content monitoring

SSH RMS err: Control – No Argo



Anomalies of global ocean heat content

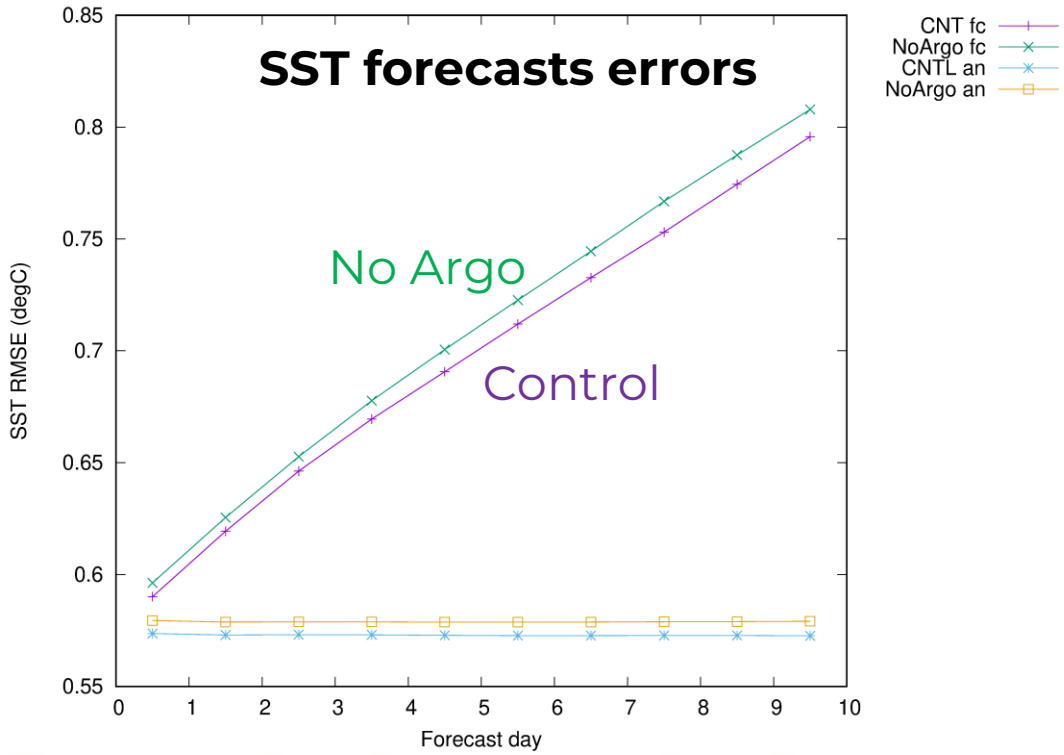
(0-700m, in J/m²)



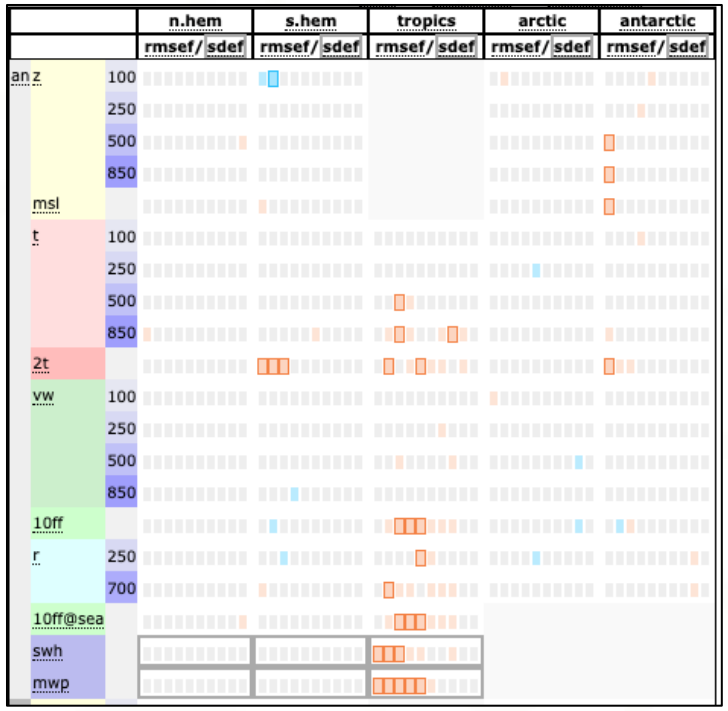
Effects of Argo data on coupled forecasts

medium-range forecasts

- The removal of ARGO data degrades the SST forecasts up to day 10.
- There are small but significant degradation of forecasted atmospheric fields. Impact of removing Argo data is **comparable to atmospheric model changes** in a typical ECMWF IFS Cycle upgrade.



Atmospheric forecasts errors: Control – No Argo



- *2m temperature (2t)*
- *mean sea level pressure (msl)*
- *temperature (t)*
- *geopotential height (z)*
- *significant wave height (swh)*
- *vector wind (vw)*
- *10m wind speed (10ff)*

Degradation

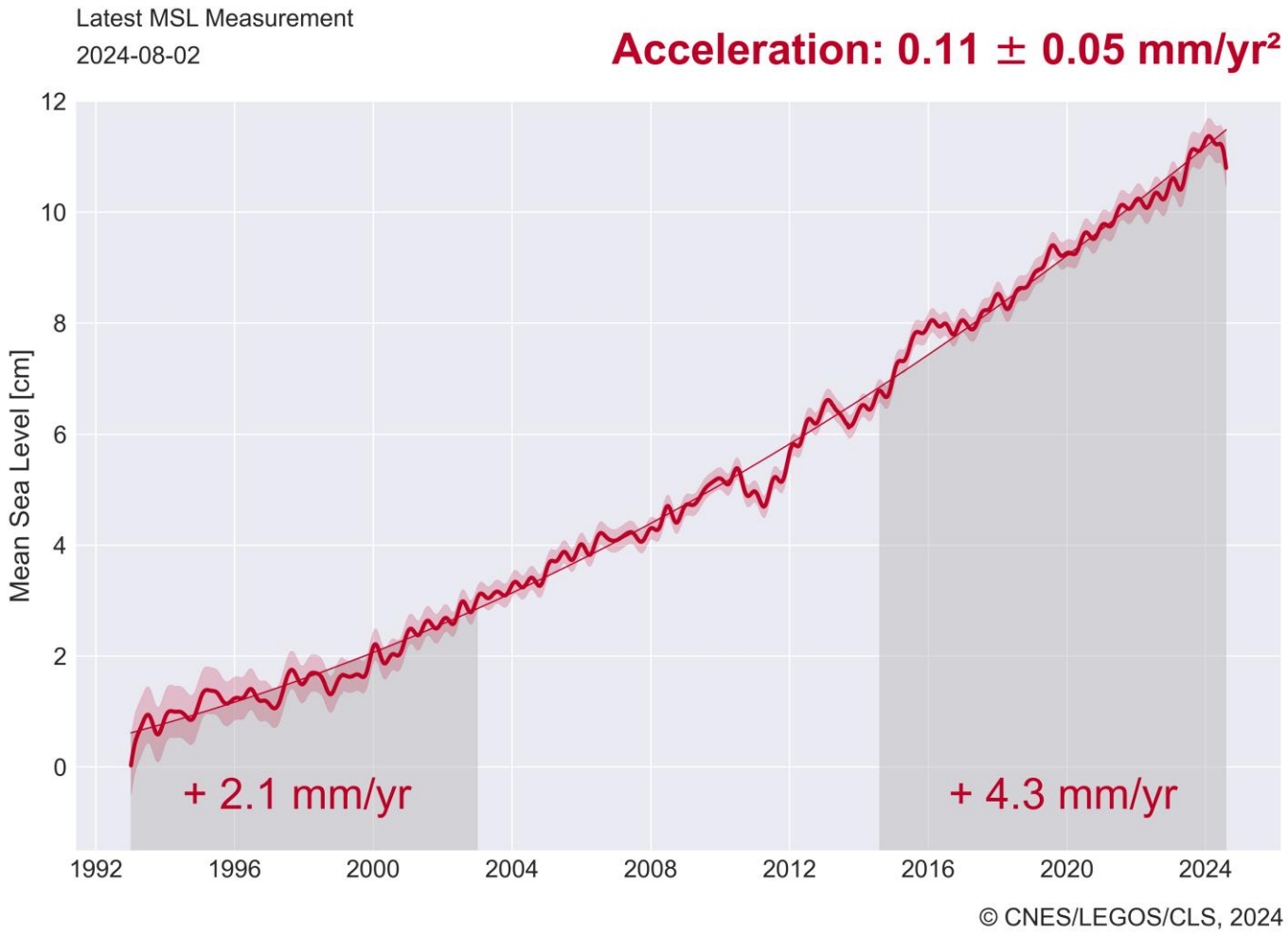
Improvement

Sea Level Rise and Ocean Warming

William Llovel (William.Llovel@ifremer.fr)

LOPS/CNRS

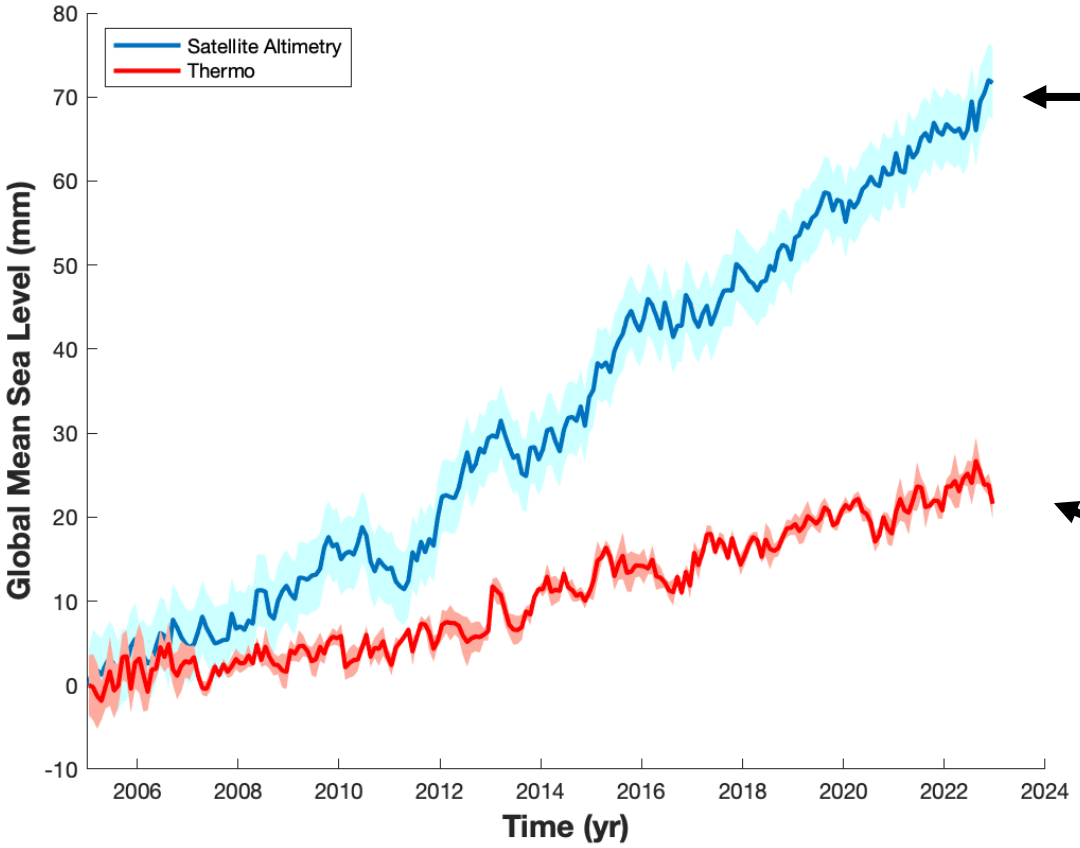
Global mean sea level rise since 1993



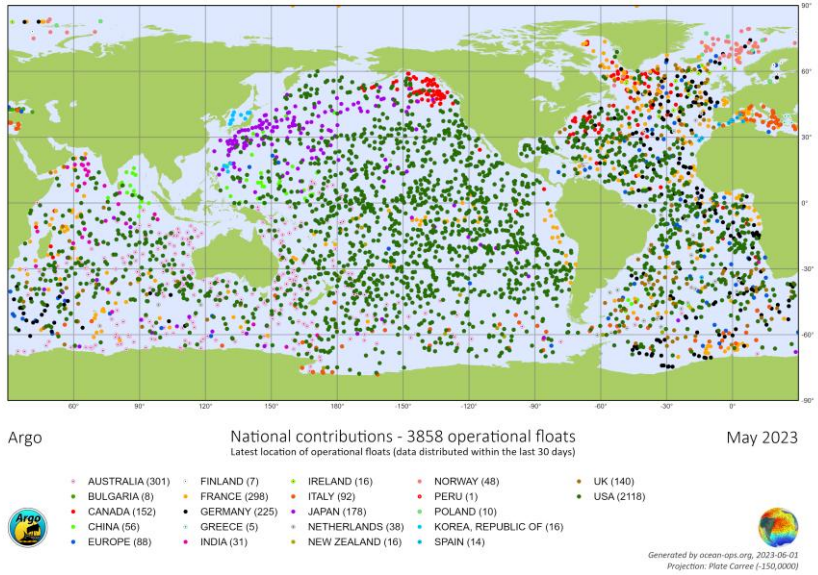
TOPEX/Poseidon (1992-2006)
Jason 1 (2001-2013)
Jason 2 (2008-2019)
Jason 3 (2016- …)
S6-MF/Jason-CS (2020-…)

Linear trend (1993-2024): 3.3 ± 0.4 mm/yr

Global mean sea level rise since 1993



Argo network



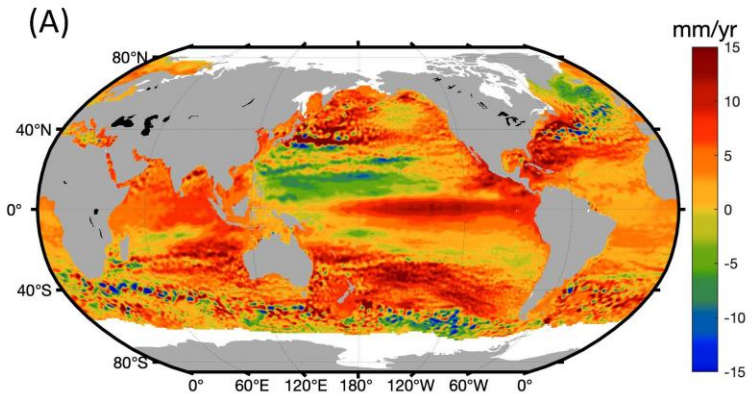
2005-2022 :

-> Global mean sea level rise 4.1 mm/yr

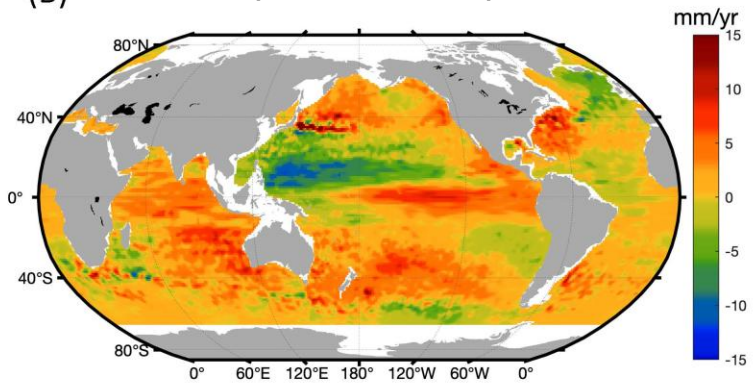
-> Global ocean warming explains 35%

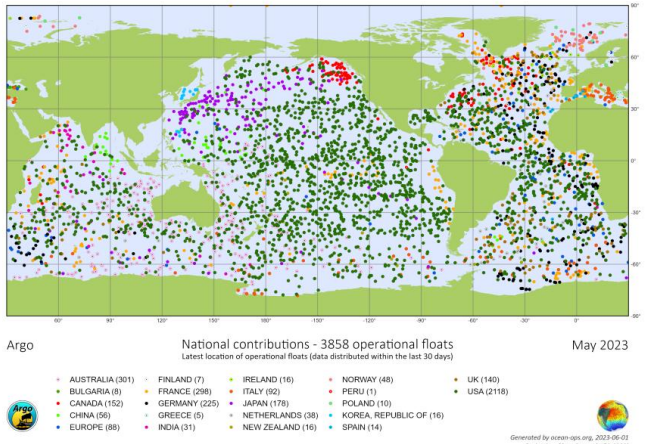
Maps of regional sea level trends over 2005-2015

Satellite altimetry

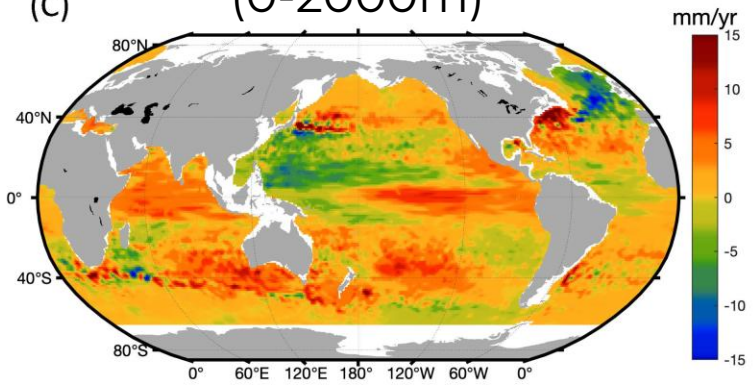


Argo-based steric sea level (0-2000m)

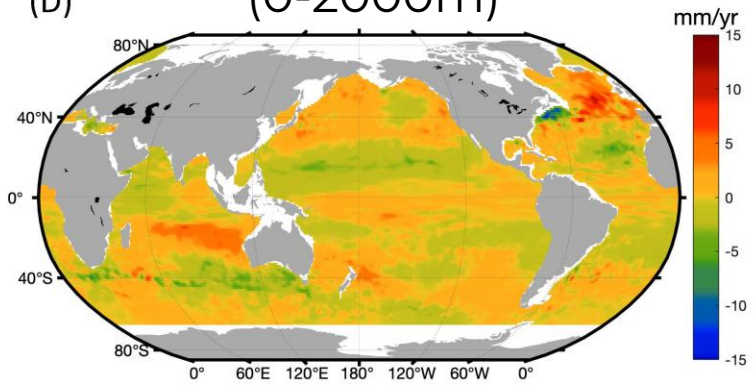




Argo-based thermosteric sea level (0-2000m)

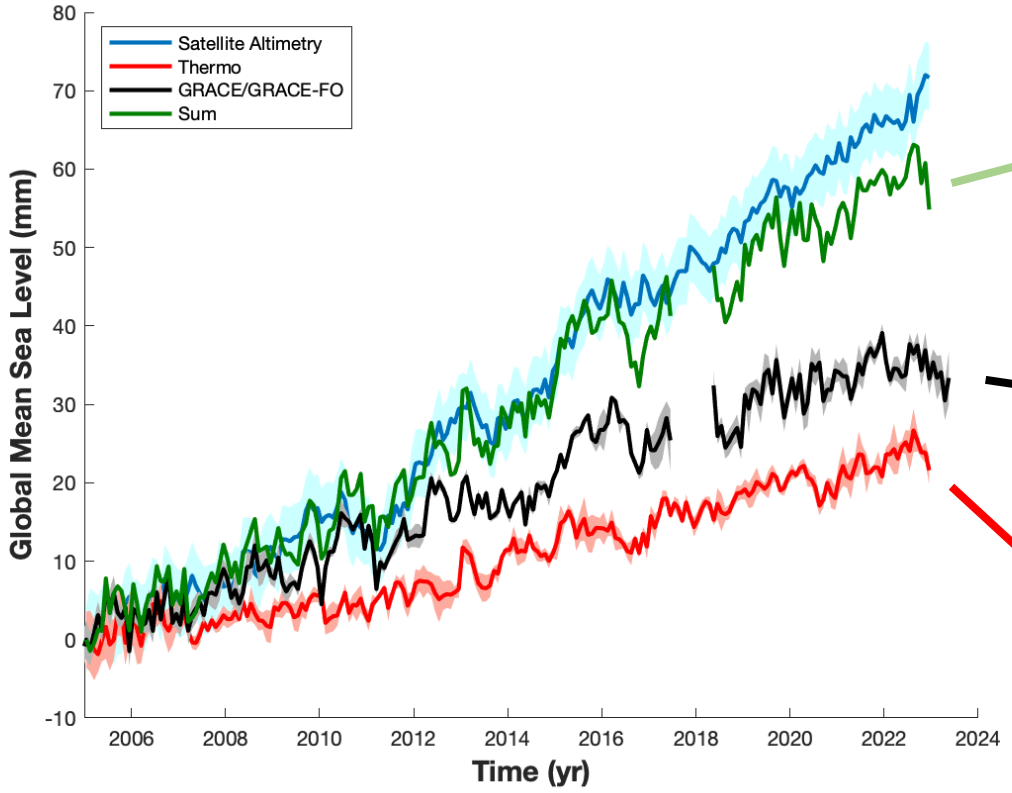


Argo-based halosteric sea level (0-2000m)

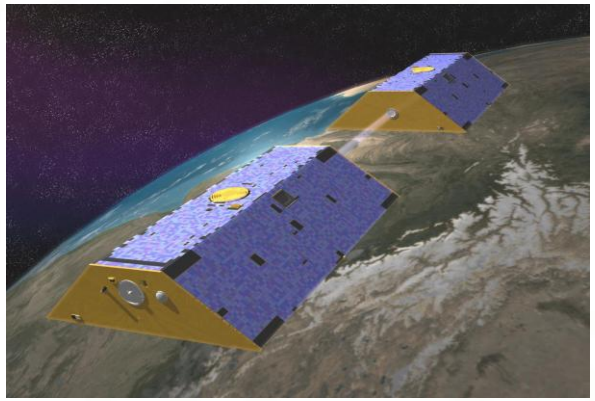


-> Regional variability in observed sea level trends
-> Steric origin
-> Mainly explained by temperature

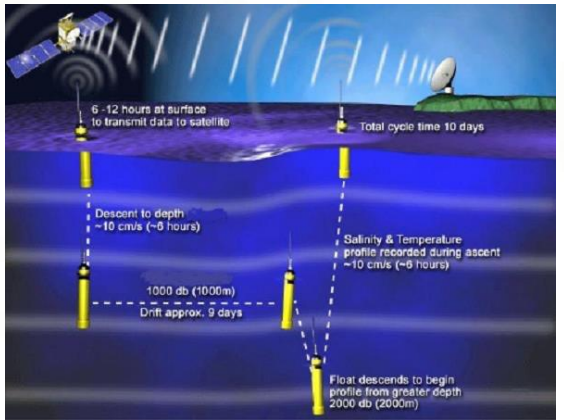
Global Mean Sea Level Budget over 2005-2020



Argo + GRACE/GRACE-FO



GRACE / GRACE-FO



Argo floats

OneArgo for the Deep-Ocean

Nathalie Zilberman (nzilberman@ucsd.edu) and Virginie Thierry on behalf of the Deep Argo Mission Team

Scripps Institution of Oceanography, UCSD

The deep ocean is a dynamic environment impacting ocean heat, climate projections, and marine habitats …

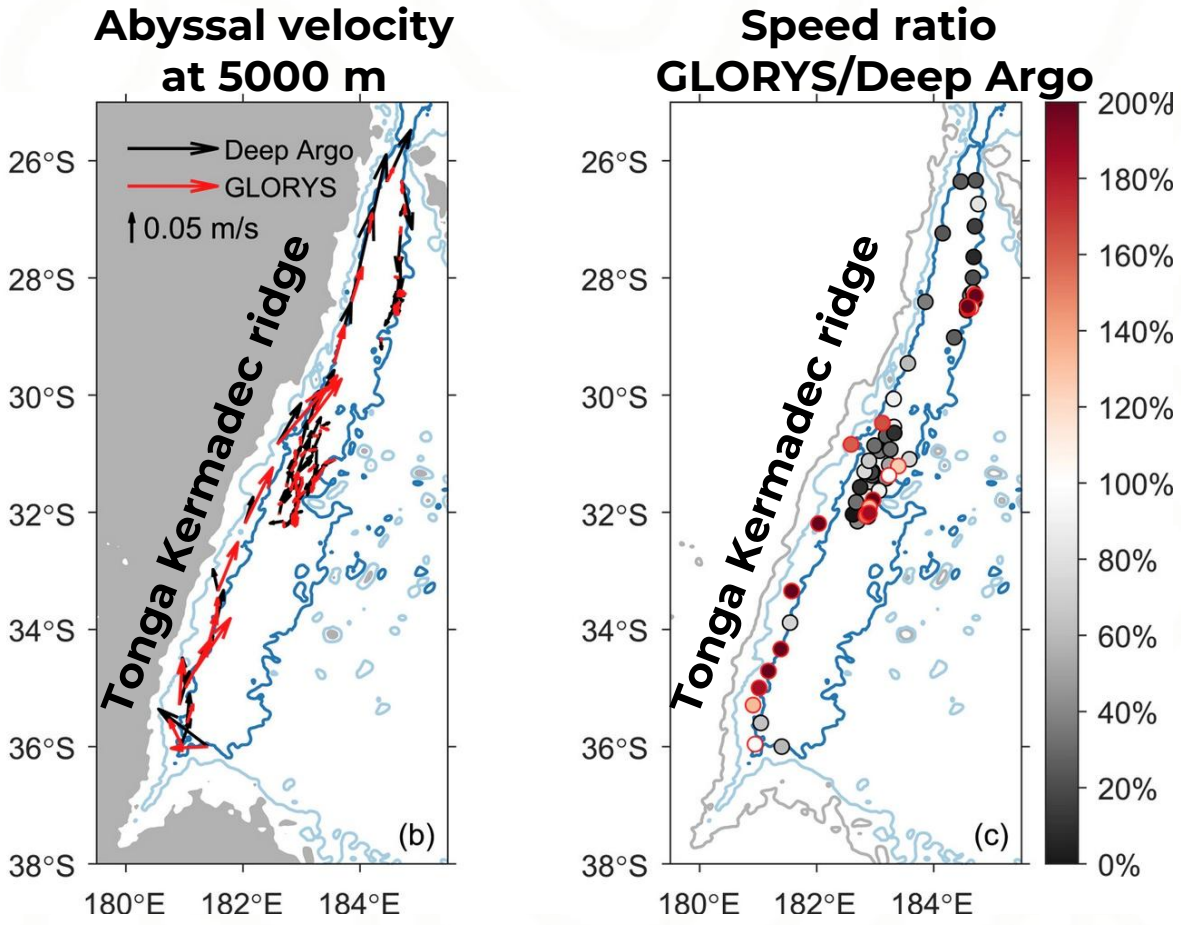
- The deep ocean carries heat between the northern and southern hemispheres and among ocean basins, impacting the upper ocean and influencing ocean interactions with the atmosphere
- Seasonal to interannual fluctuations of wind forcing at the surface can control deep ocean temperature to near the seafloor
- The deep ocean influences sea level variability
- The absorbtion of atmopsheric heat extends to the abyss
- The morphology of the seafloor plays a leading role in ocean circulation, storm surge propagation, ocean mixing, marine habitats, and tectonic evolution

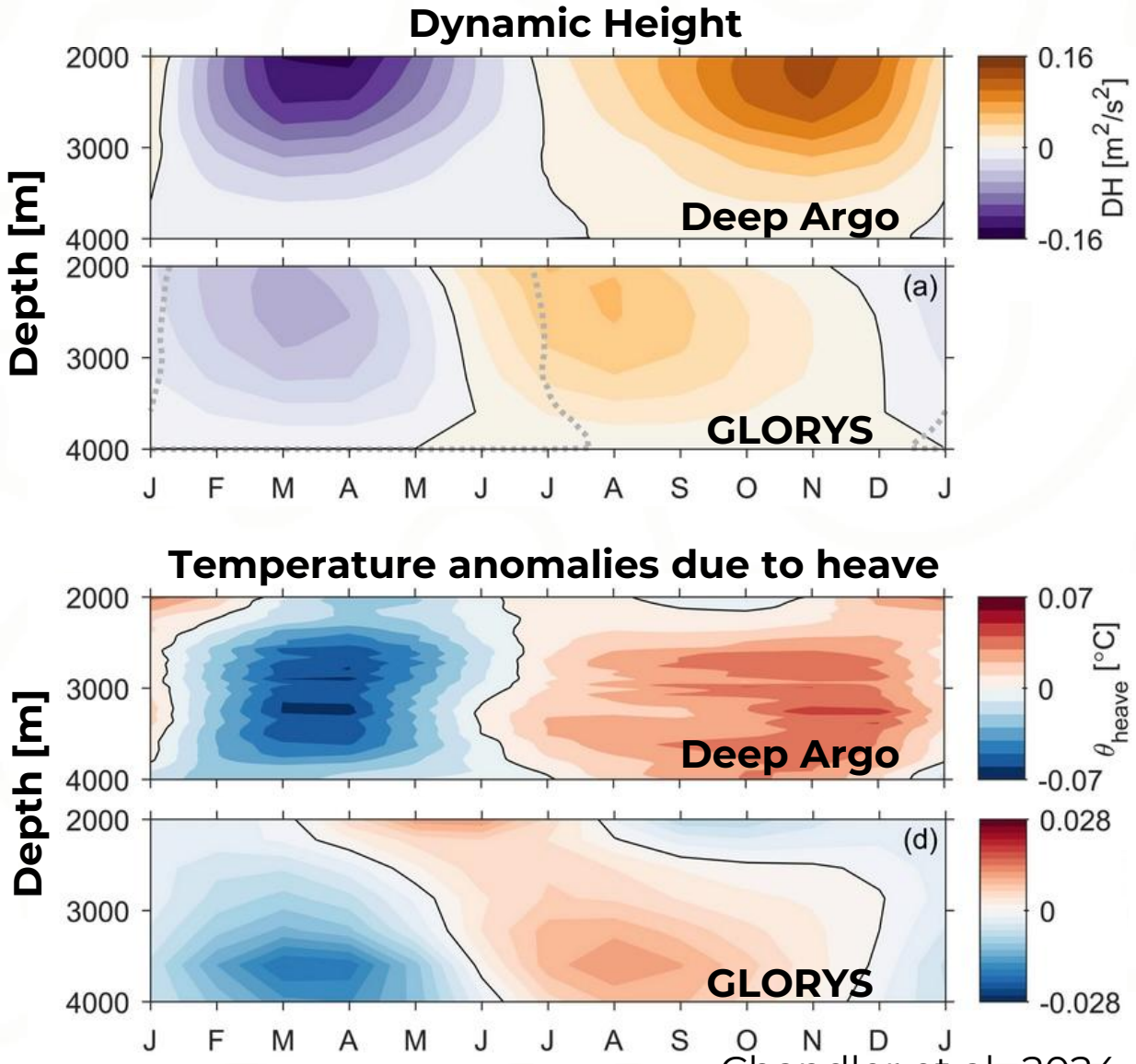
… but despite its instrumental role for ocean's health and society, only 27% of the deep ocean volume is measured

Deep Argo has the ability to fill this observational gap

Photo credit: Scripps Institution of Oceanography

Seasonal changes of temperature due to wind forcing at the surface can penetrate to near the seafloor

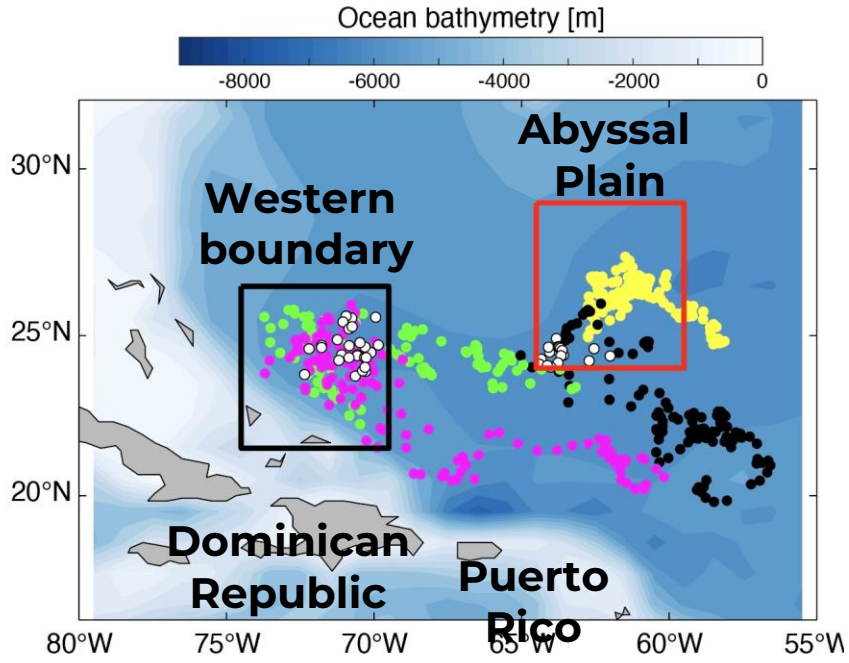




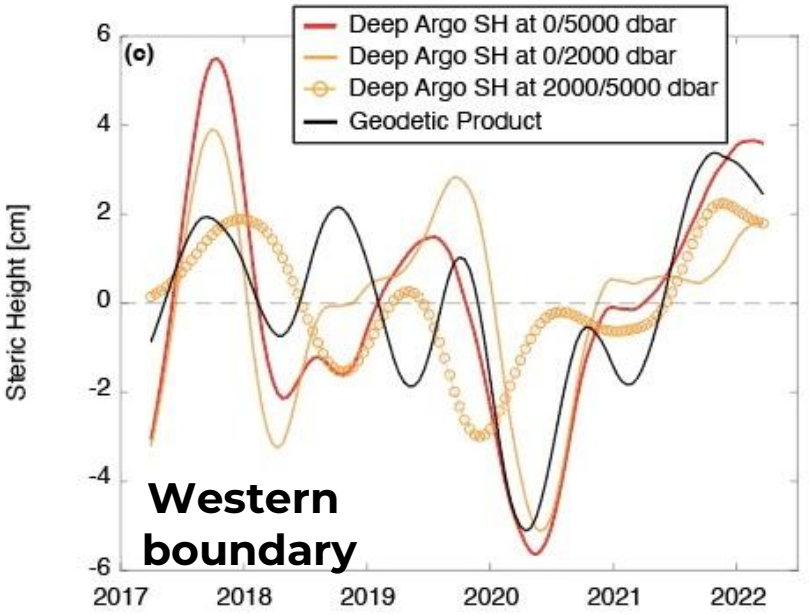
Due to the dearth of deep ocean observations, the temporal variability of deep ocean temperature and circulation is underestimated in ocean models

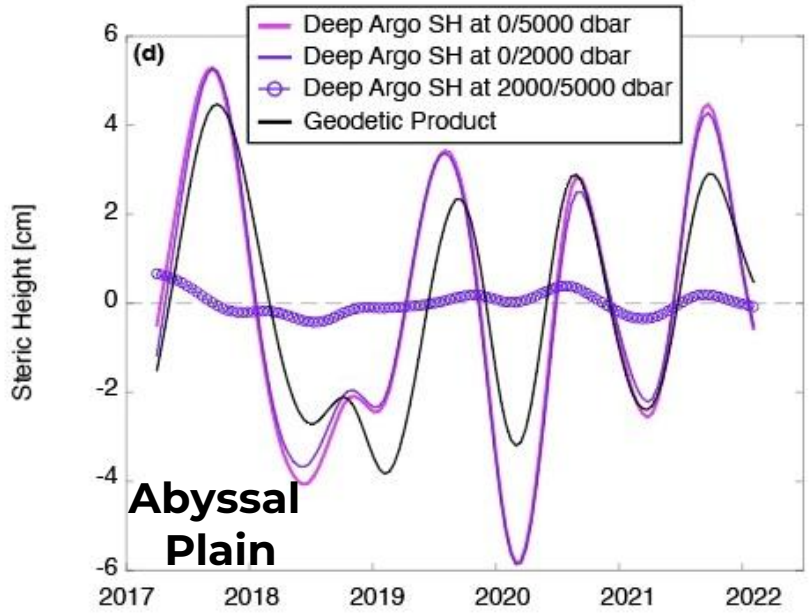
Chandler et al., 2024

The contribution of the deep ocean to interannual sea level varies between abyssal plains and ocean boundaries



Deep ocean contribution to sea level change due to temperature



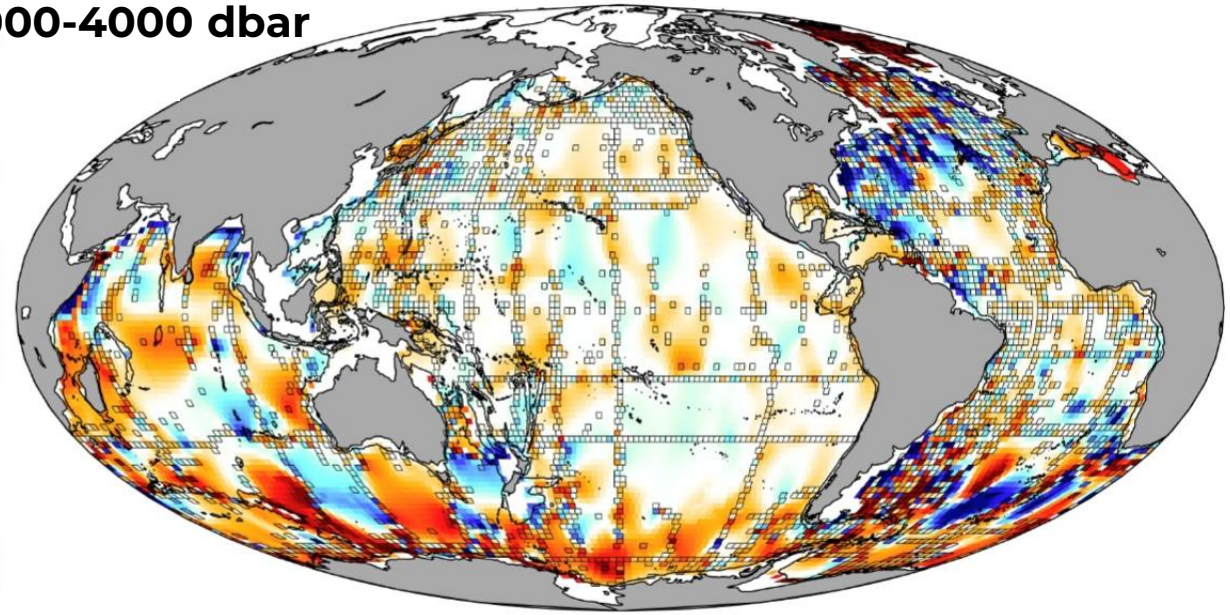


- Deep ocean contribution to interannual sea level variability is 7 times larger at the western boundary than over the abyssal plain
- Full depth Deep Argo profiles are complementary to satellite measurements and improve our understanding of regional sea level budgets

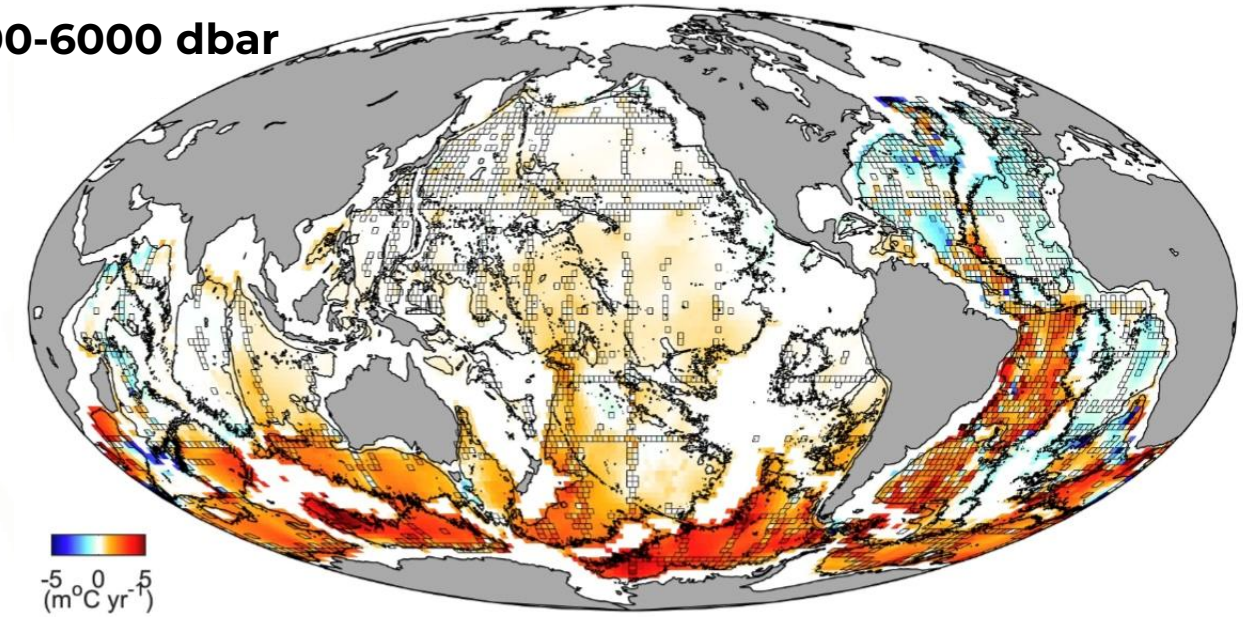
Zilberman et al., 2025

Ocean warming extends to the seafloor

2000-4000 dbar



4000-6000 dbar

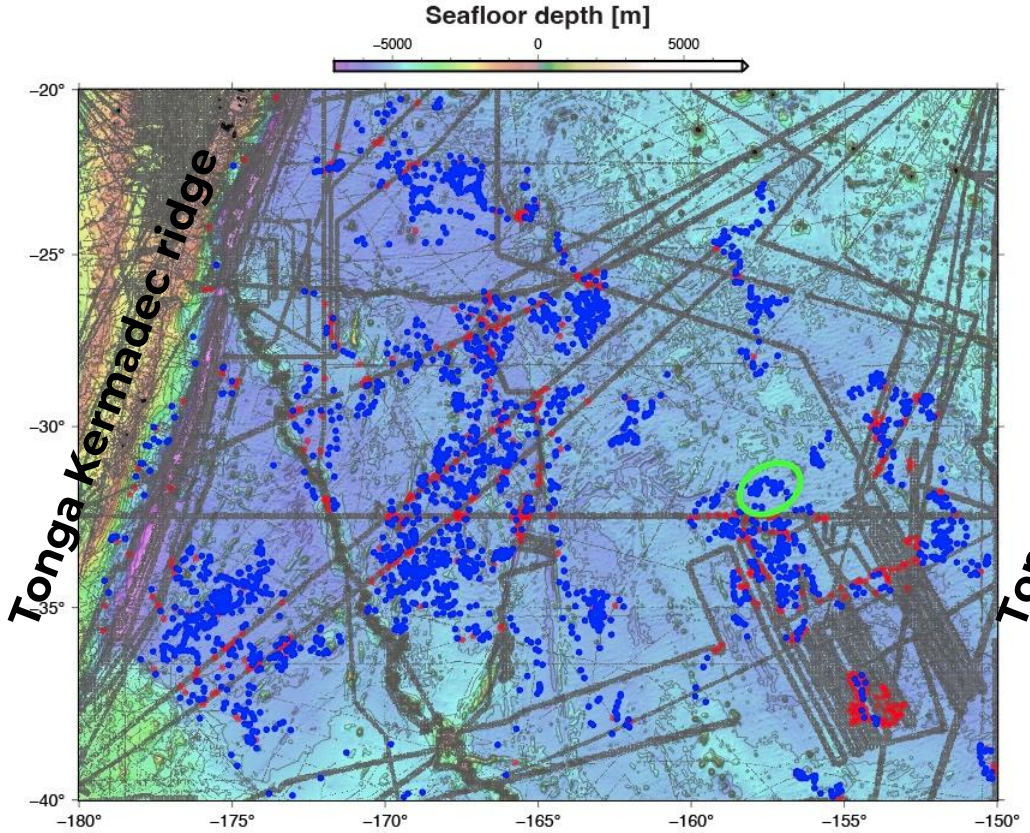


- The deepest waters of the ocean have warmed from the mid-1980s to the mid-2010s
- Deep warming follows deep western boundary currents and decreases with distance from deep water formation regions located at high latitudes
- Deep Argo has reduced uncertainties in deep ocean warming trends by 50%
- Deep ocean warming is predicted to accelerate in the future

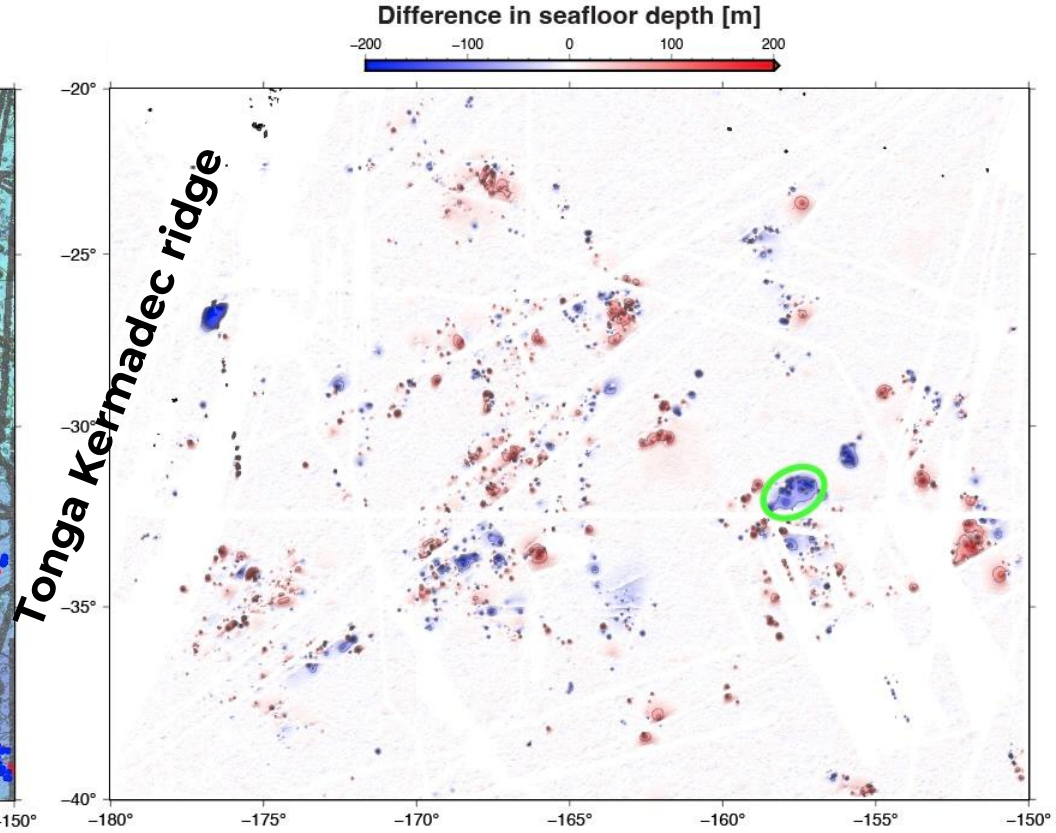
Johnson and Purkey, 2024

Deep Argo is a new ocean bathymetry data source in GEBCO grid

Locations of soundings and Deep Argo measurements in GEBCO_2024 bathymetry



Differences in ocean bathymetry before and after integrating Deep Argo



- Nominal horizontal uncertainty of ocean bathymetry from Deep Argo, < 1.5 km, is 3 times larger than echo sounders but 10 times lower than satellite altimetry
- Vertical accuracy (4 m at 6000 m) is higher than echo sounders (12 m at 6000 m)
- Deep Argo generates 50-200-m range improvement in the GEBCO grid

Zilberman et al., 2025

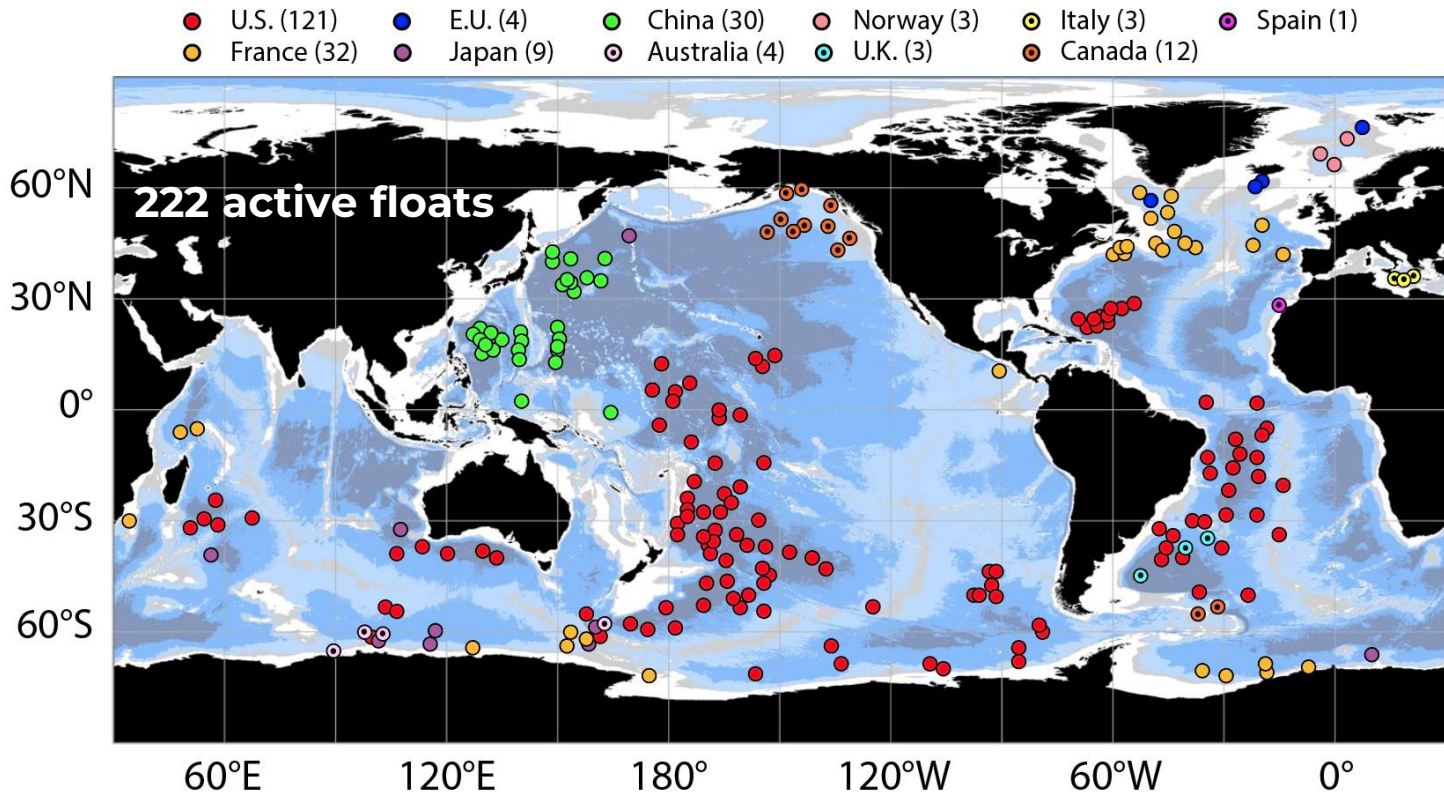
New applications will increase the interdisciplinary value of Deep Argo

26% of Deep Argo floats are measuring oxygen to 4000 m depth. Oxygen sensor integration on 6000-m float models is under development to resolve deep ocean deoxygenation

Future plans include testing of optical scattering sensors on Deep Argo floats to study sediment transport

Although the need to implement Deep Argo is recognized at the international level, only 18% of the global Deep Argo array is implemented with no long-term sustained funding

➠ Significant additional support is urgently needed



OceanOPS

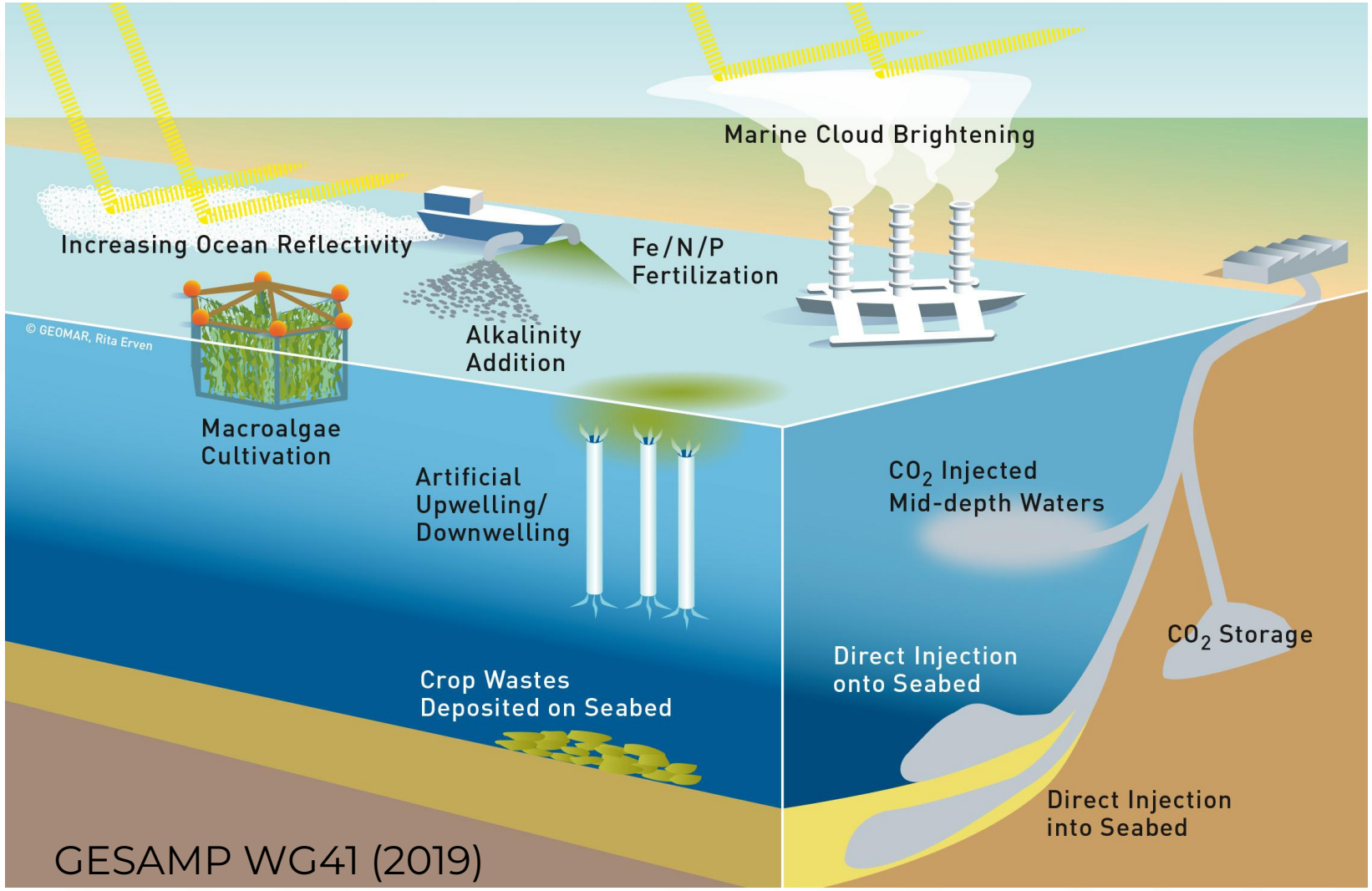
Ocean Carbon and mCDR – Contribution of OneArgo

Philip Boyd (Philip.Boyd@utas.edu.au)

IMAS/UTAS

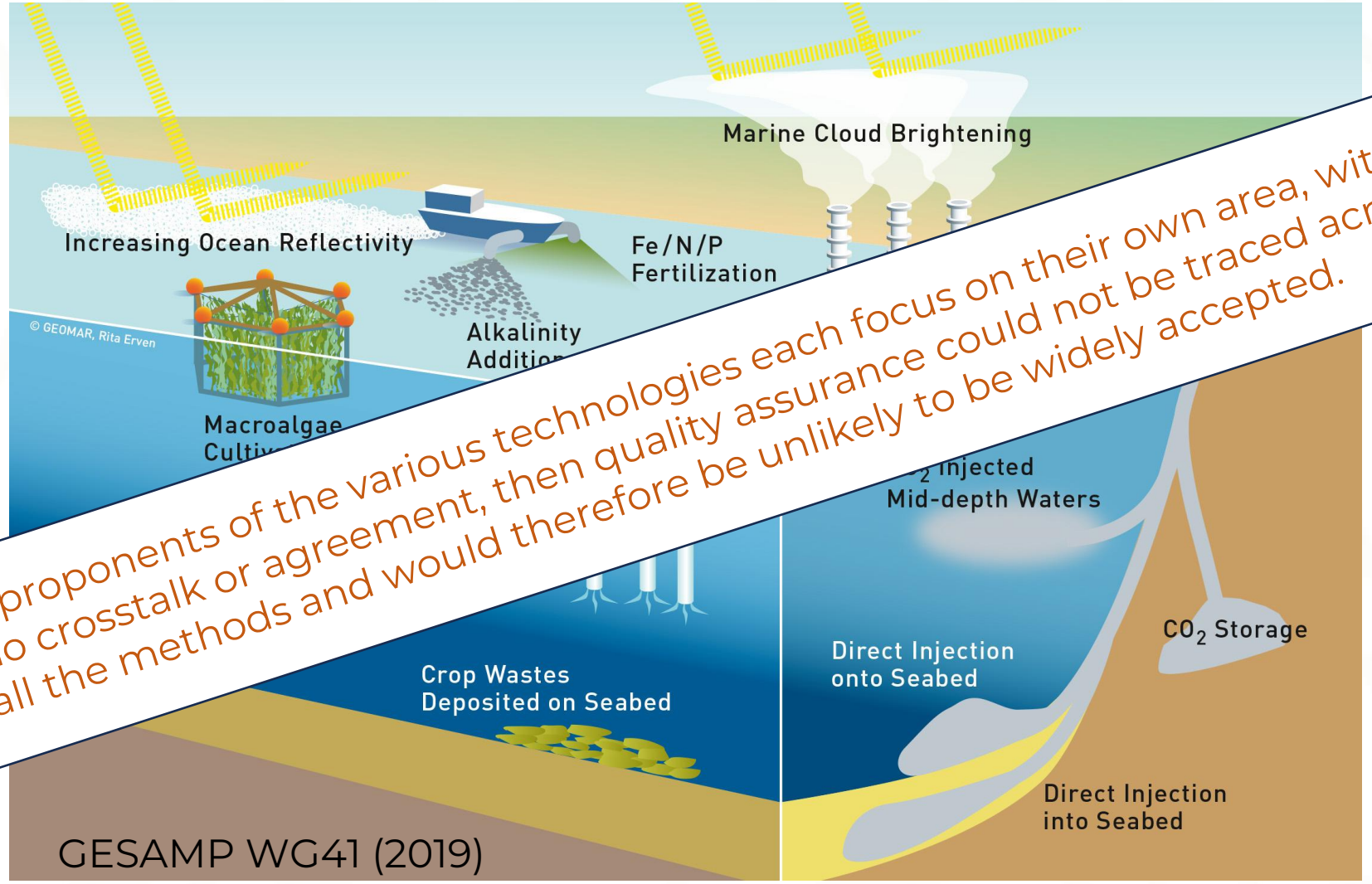
"The deployment of carbon dioxide removal (CDR) to counterbalance hard-to-abate residual emissions is unavoidable if net zero CO_2 or GHG emissions are to be achieved..... (high confidence)." *IPCC WG3 AR6 2023*

A wide range of marine CDR methods have been proposed – involving ocean physics, chemistry, biology and/or ecology



Prior to upscaling, each candidate mCDR method must demonstrated to be SAFE, DURABLE and VERIFIABLE

A wide range of marine CDR methods have been proposed – involving ocean physics, chemistry, biology and/or ecology

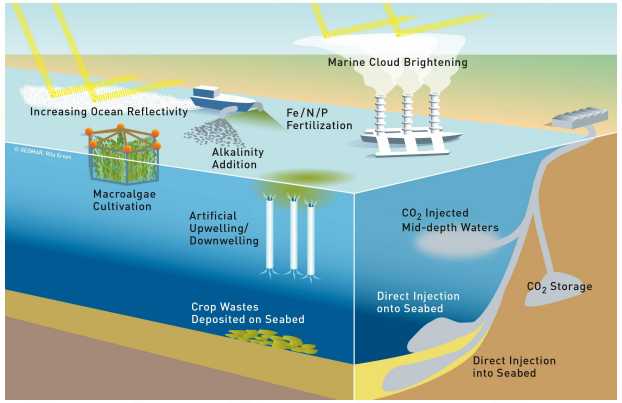


If proponents of the various technologies each focus on their own area, with no crosstalk or agreement, then quality assurance could not be traced across all the methods and would therefore be unlikely to be widely accepted.

Prior to upscaling, each candidate mCDR method must demonstrated to be SAFE, DURABLE and VERIFIABLE

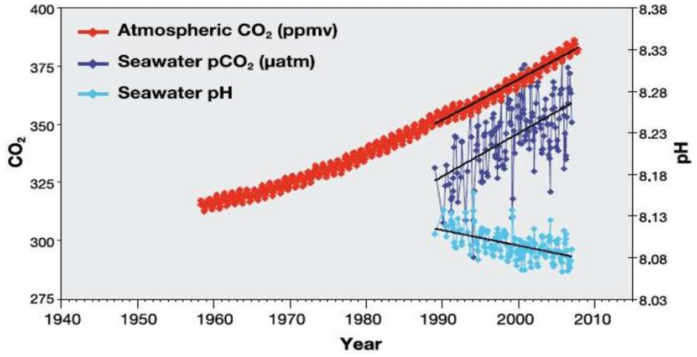
The needs of a Monitoring Reporting and Verification system

Third-party independent verification.

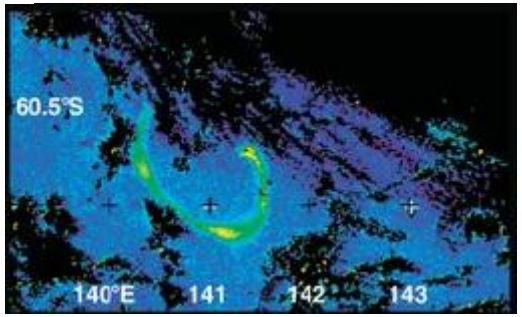


A versatile observational system – ocean physics, chemistry, biology & ecology.

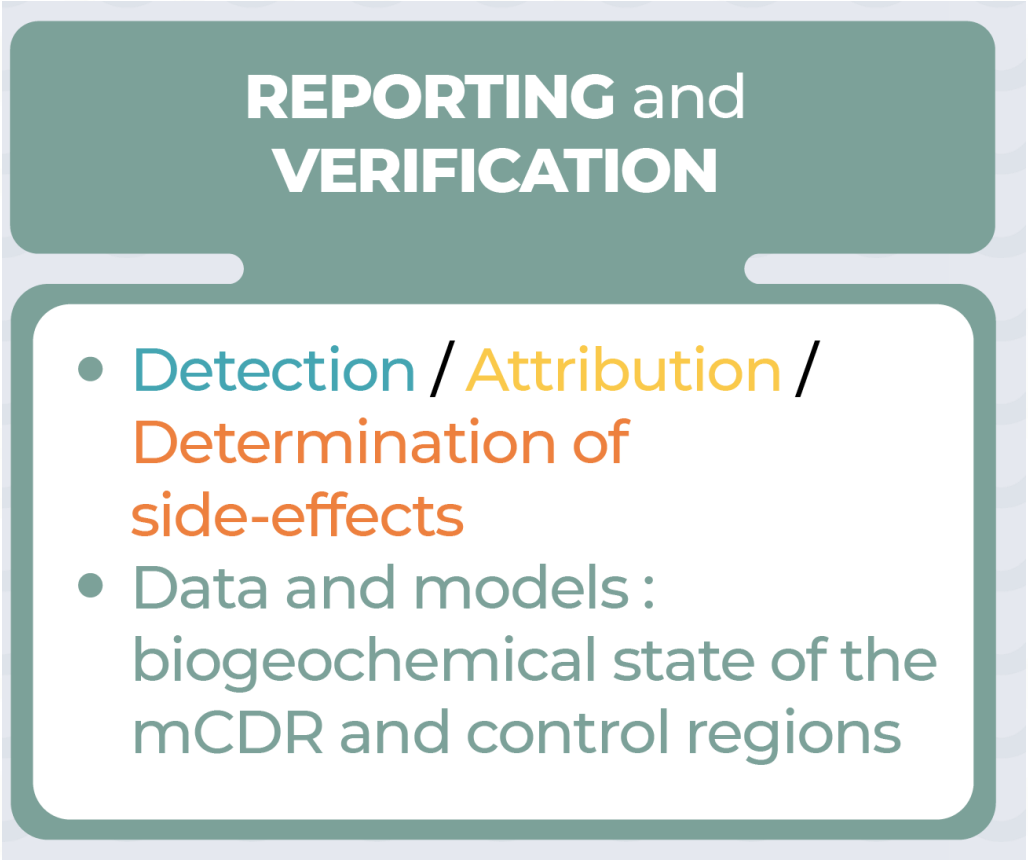
Additionality of CDR – relative to a baseline or ‘benchmark’.



A system that can operate across many scales – from 10 - >10,000 km length scale (i.e., pilot study to deployment).



The needs of a Monitoring Reporting and Verification system



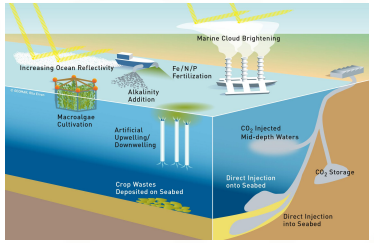
Detection - To quantify the amount of carbon sequestered as Dissolved Inorganic Carbon (DIC).

Attribution - To assign the detected carbon sequestration solely to a particular mCDR deployment.

Side Effects - To identify and quantify ecological & environmental impacts of the mCDR – so-called eMRV.

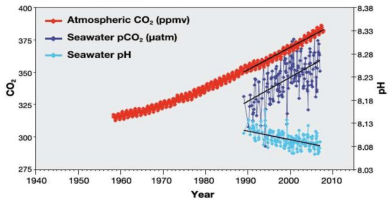
The solution - Adapt current observing networks - Extend ARGO

ARGO is global, open access and interoperable.



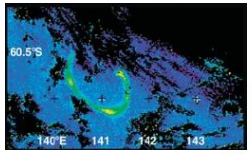
ARGO is versatile with sensor constellations to provide Detection, Attribution and eMRV.

New and improved sensor development is ongoing.

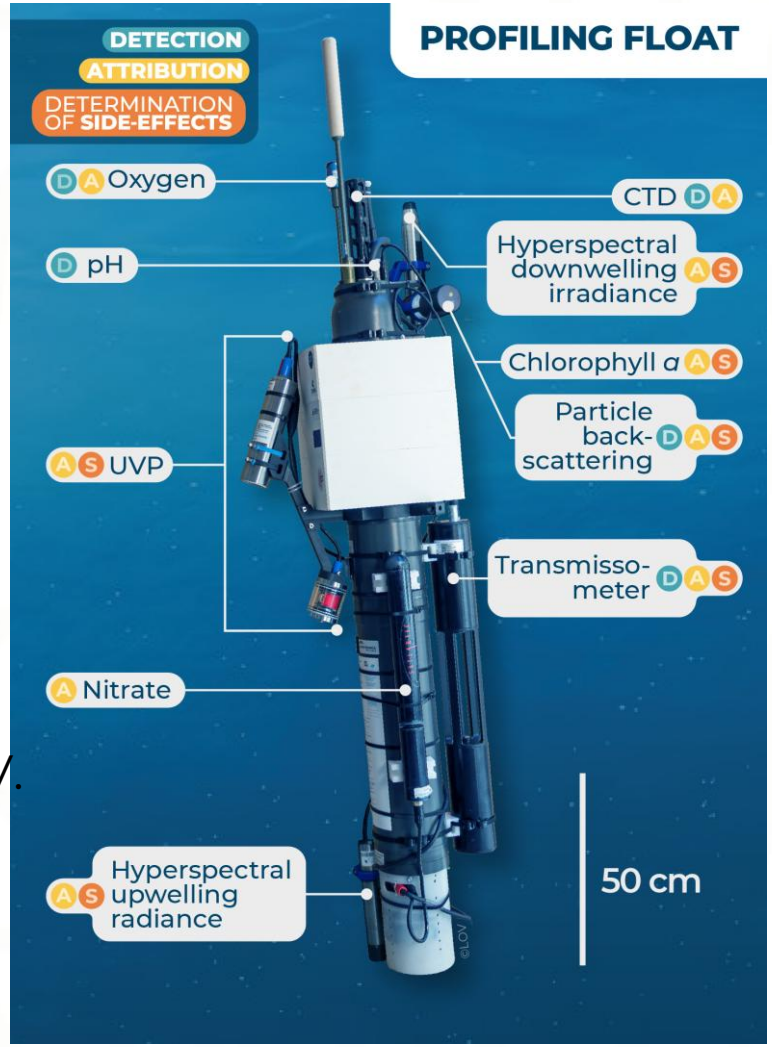


ARGO characteristics provide an unprecedented point of departure to establish a background benchmark for mCDR – essential to detect and attribute mCDR & eMRV.

ARGO has the flexibility to cover all scales from ensemble release of floats to basin scale coverage.



Boyd et al. (2023)
https://www.nature.com/articles/d41586-023-02649-8



Boyd et al. (2023)
https://doi.org/10.5670/oceanog.2023.s1.2

OneArgo and Ocean Prediction

Elisabeth Remy (eremy@mercator-ocean.fr), Jean-Michel Lellouche, Mounir Benkiran, Alexandre Mignot

Mercator Ocean

Argo and Ocean Prediction

A schematic view of an ocean prediction system

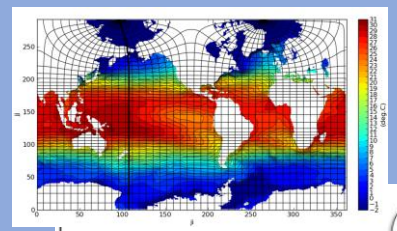
Atmospheric forcings and river runoffs

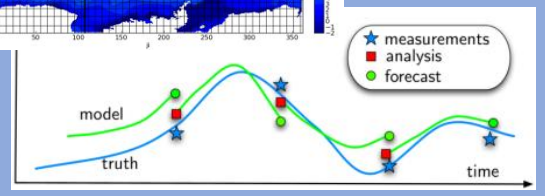
SATELLITE Observations (SST, SLA, Sea Ice Conc., Ocean Colour, ...)

IN SITU observations

...

Ocean Monitoring and Forecasting System

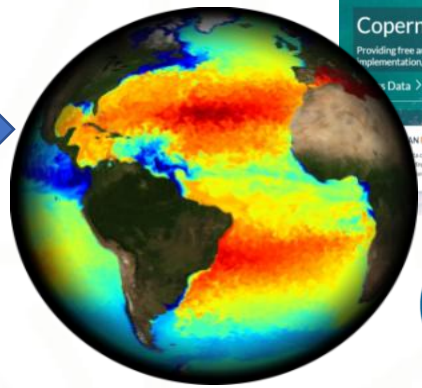


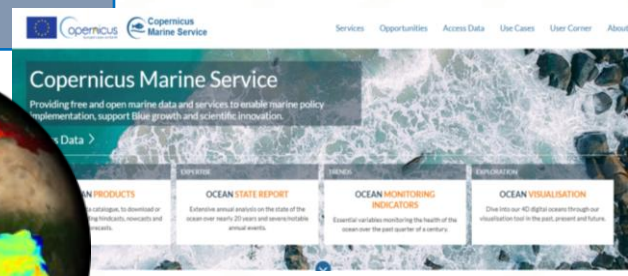


Data assimilation into a physical ocean and sea ice models

Ocean, sea-ice and BGC analysis and forecasts

Mercator Ocean real time global 1/12° system





Copernicus Marine Service

Feedback from ocean monitoring centers to observing networks.

Observations have multiple use in Ocean Prediction:

- Initialization of the model,
- assimilation to constrain the model forecast,
- evaluation of the quality of the model and the distributed ocean analysis and forecasts, ...

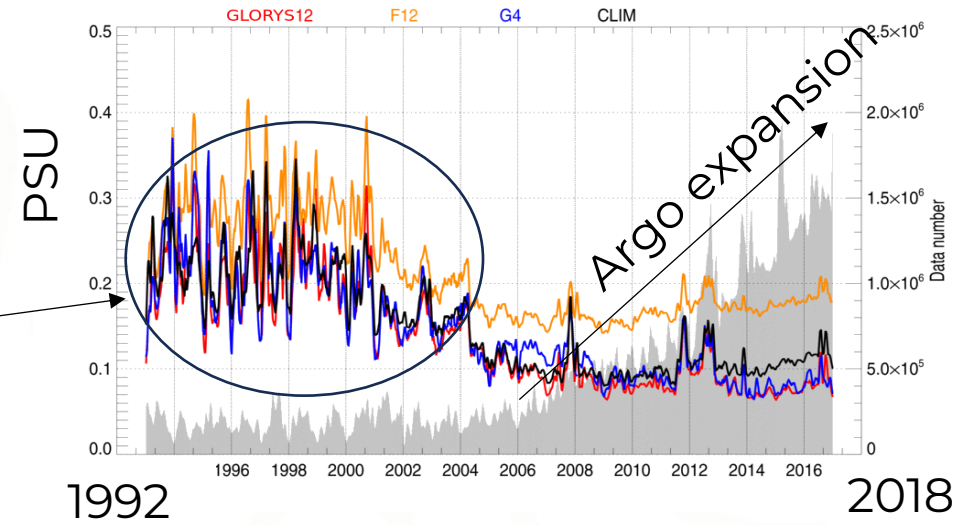
Argo and Ocean Prediction

Argo: the primary source of information on the ocean water column in real time at global scale

The accuracy of the ocean analysis and forecasts highly rely on the **availability and quality** of the assimilated **observations**.

Not enough observation for accurate uncertainty estimates before the Argo era

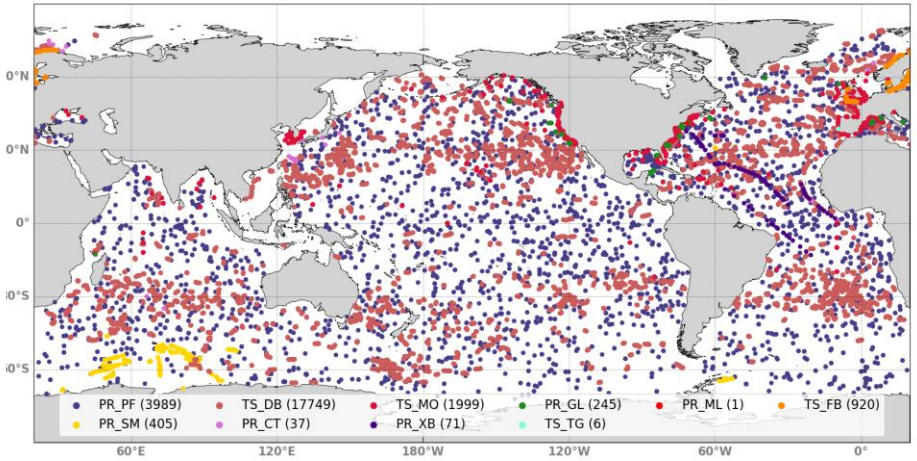
0-2000m salinity : Models – Observations in RMS



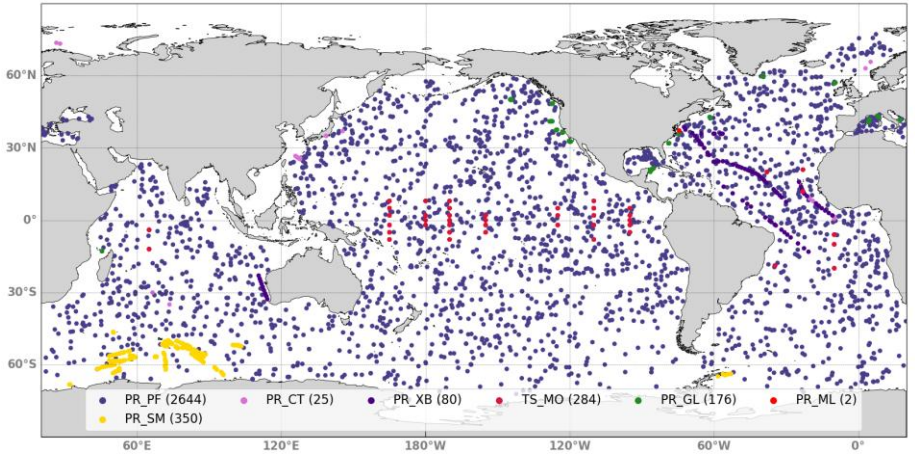
In Situ temperature observations assimilated for a week in 2024 in the global ocean 1/12° system

In color the type of platforms:
drifting buoys,
sea mammals,
Argo floats,
moorings,
gliders,
ferry-box, ...

surface



300 m depth

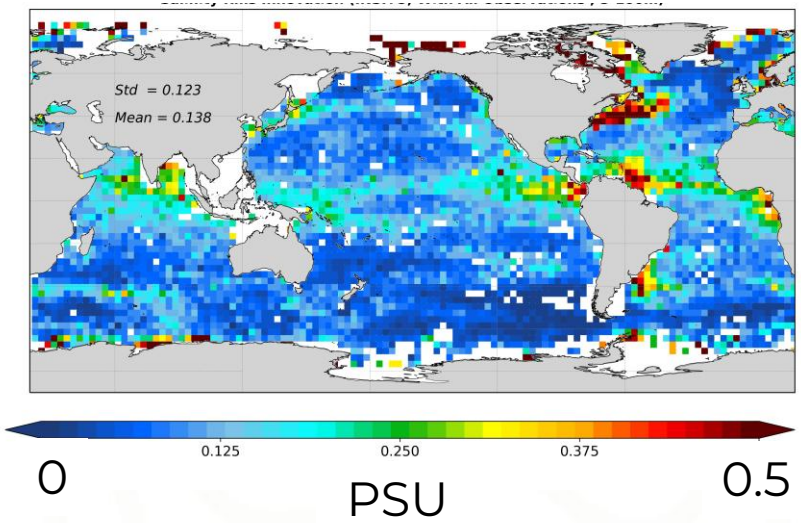


Argo and Ocean Prediction

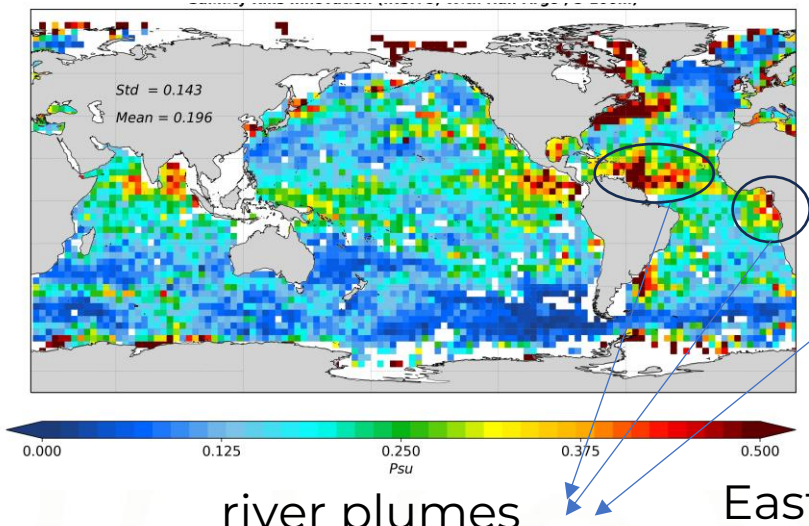
How Argo physical observations improve the model forecast?

***Differences** in RMS between the 1/12° ocean model **forecasts and in situ salinity** observations between 5 and 100 m over the period sept. 2023 – sept. 2024*

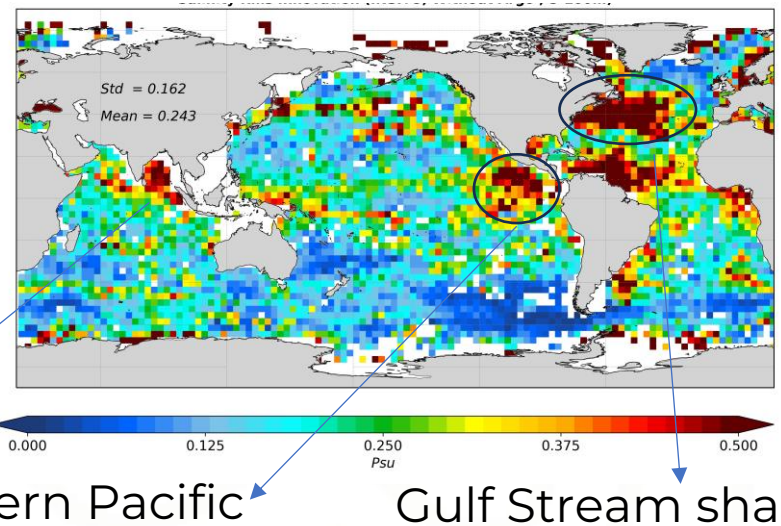
All Argo obs. assimilated



Half Argo obs. assimilated



No Argo obs. assimilated

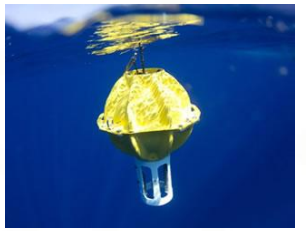


- **Significant degradation of the ocean analysis and forecast quality when reducing the number of assimilated Argo observations**.

In those experiments, altimetry, sea surface temperature and other than Argo in situ observations are still assimilated as for the real time production.

Benkiran M., work in progress

Argo and Ocean Prediction



How the deep OneArgo array will improve the global ¼° ocean (re)analysis?

Below 2000 m depth, ocean model analysis are underconstrained and can show unrealistic deep trends

*Zonal mean **temperature biais** in ocean model analysis (2009-2013)*

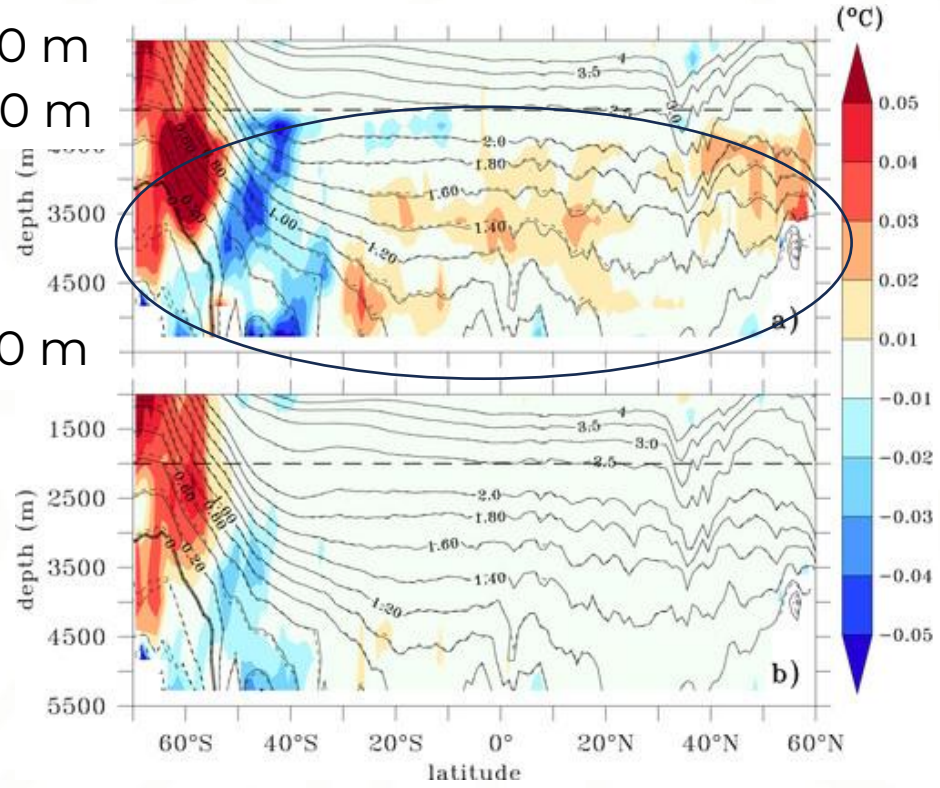
1000 m

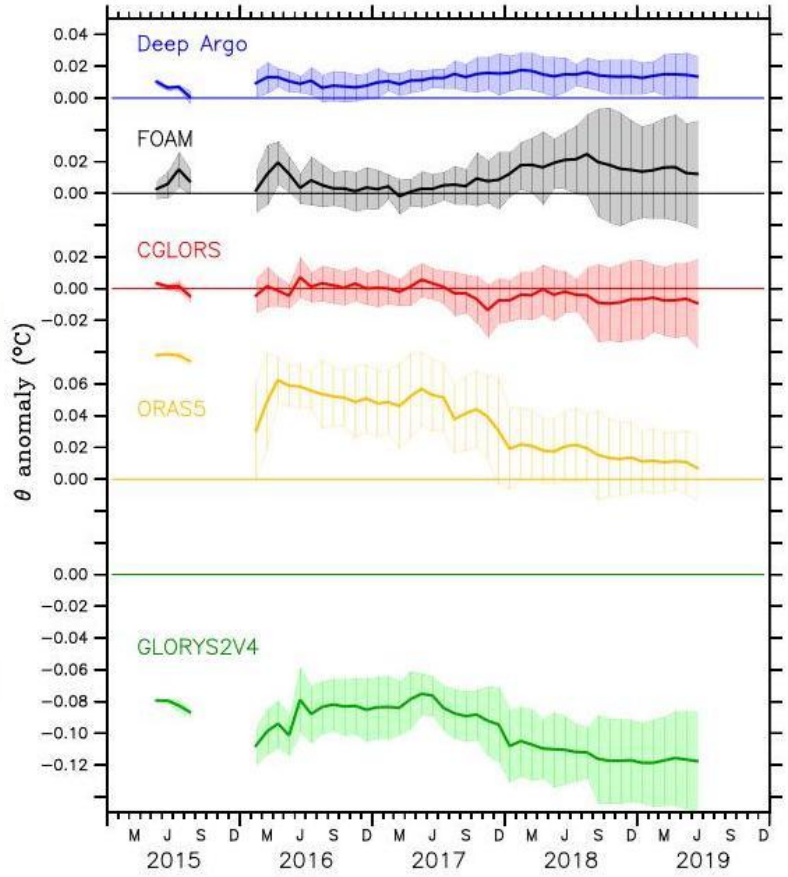
2000 m

without deep Argo *observations assimilated*

5500 m

with planned deep OneArgo *observations assimilated*





➢ **Deep Argo observations can significantly reduce analysis and forecast errors in the deep ocean** when assimilited.

Gasparin et al., J. Climate, 2019

*Time-evolution of the **5000-m potential Temp. θ anomaly in different reanalysis** from 2015 to 2019. (F. Gasparin et al., 2020*

Argo and Ocean Prediction

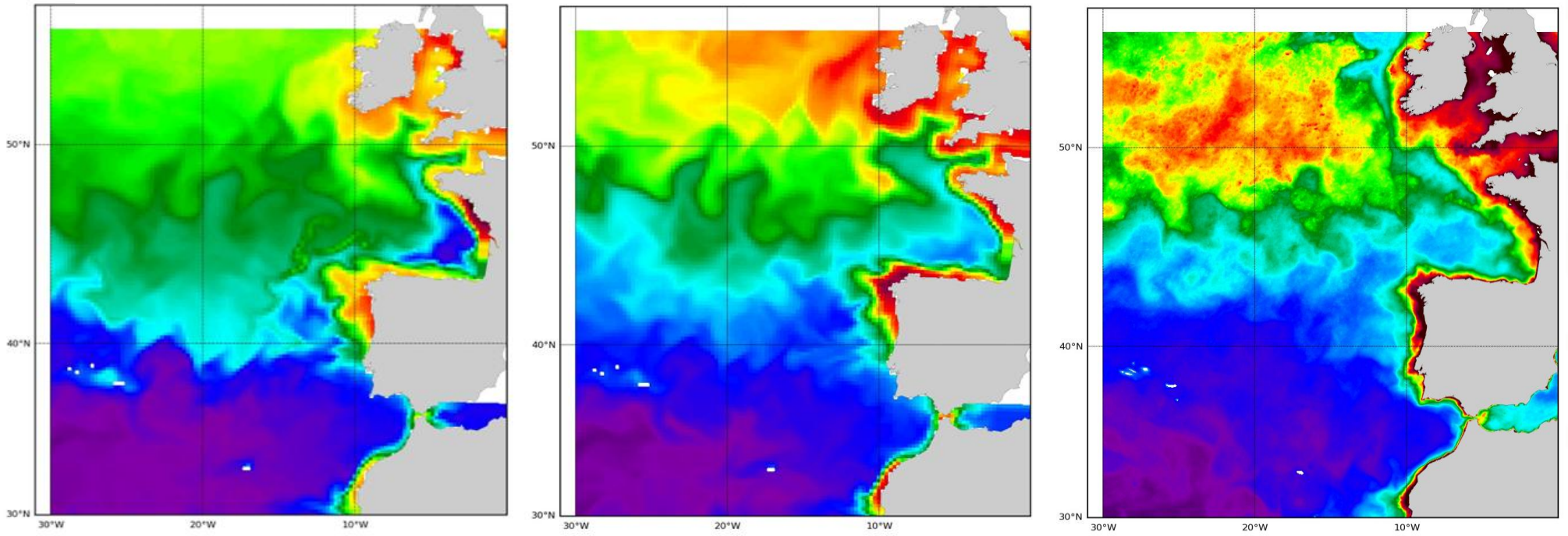
Optimization of the BioGeoChemical PISCES model parameters with Argo observations

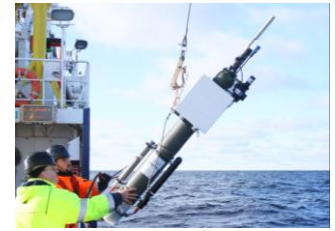
Chlorophyll-a - September 2018

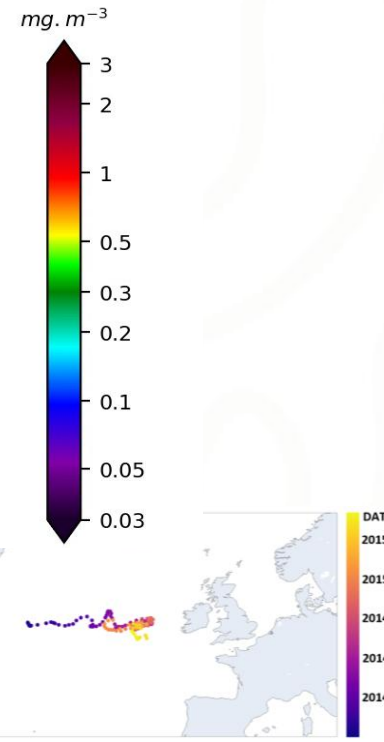
global model ***initial parameters***

global model with ***Optimised parameters***

Satellite Observations







- **Improved representation of the North Atlantic bloom** compared to satellite observations with the optimized model parameters:
- Better representation on the South-North Chlorophyll-a gradient
- Reduction of the normalized BIAS by 30 % and the RMSE by 10%.

Q. Hyvernat, work in progress

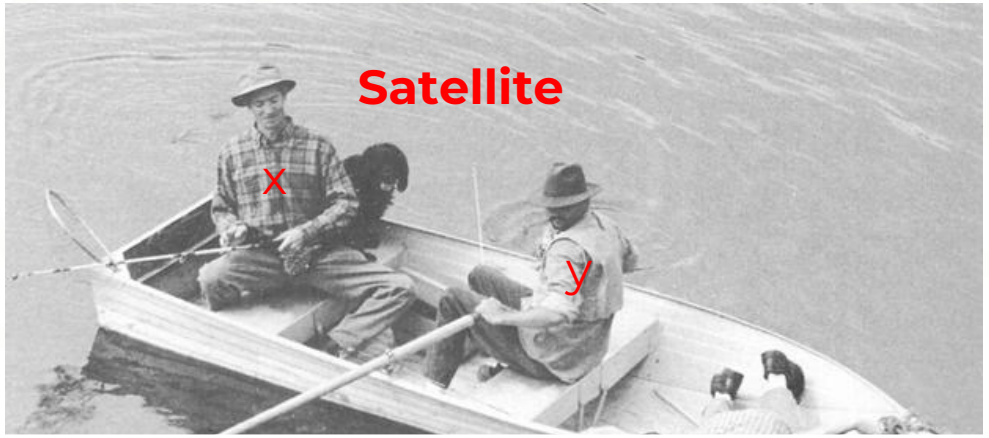
Synergies between BGC-Argo and Ocean Colour Remote Sensing

Antoine Mangin (antoine.mangin@acri-st.fr)

ACRI-ST

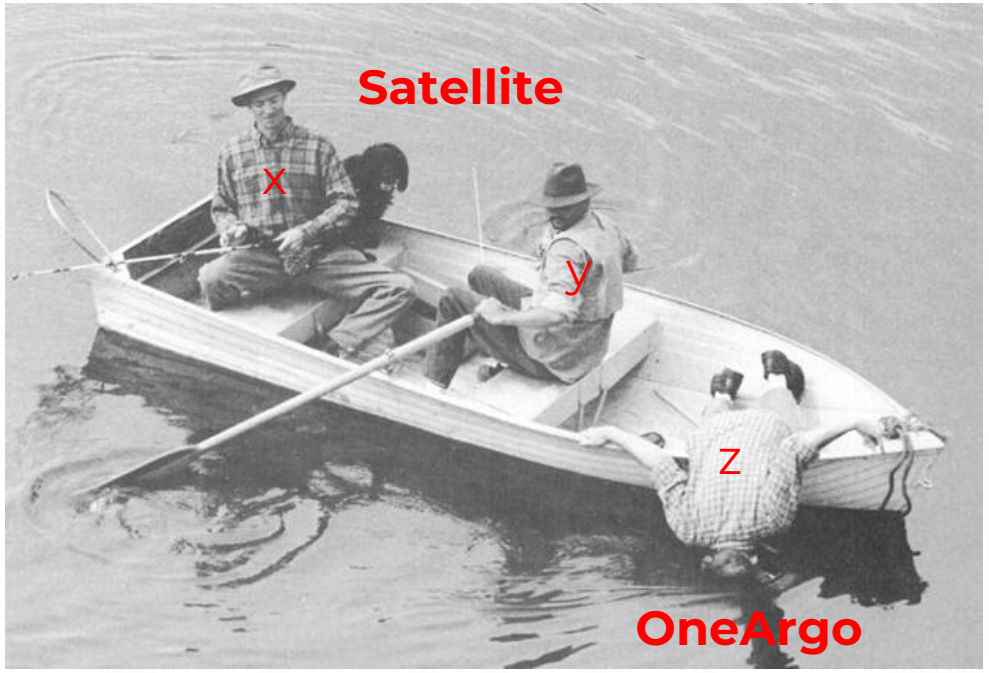
Synergies between BGC-Argo and Ocean Colour Remote Sensing

The monitoring of the ocean by satellite provides the observation of the surface (the X and Y dimensions)



Synergies between BGC-Argo and Ocean Colour Remote Sensing

The monitoring of the ocean by satellite provides the observation of the surface (the X and Y dimensions)

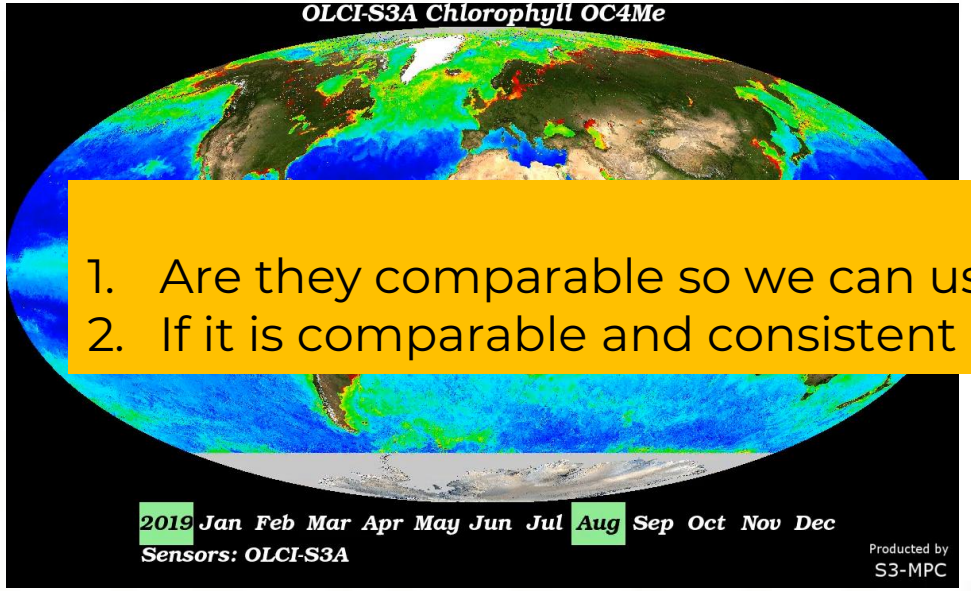


while OneArgo give the « visibility » in the Ocean in the Z-dimension (vertical)

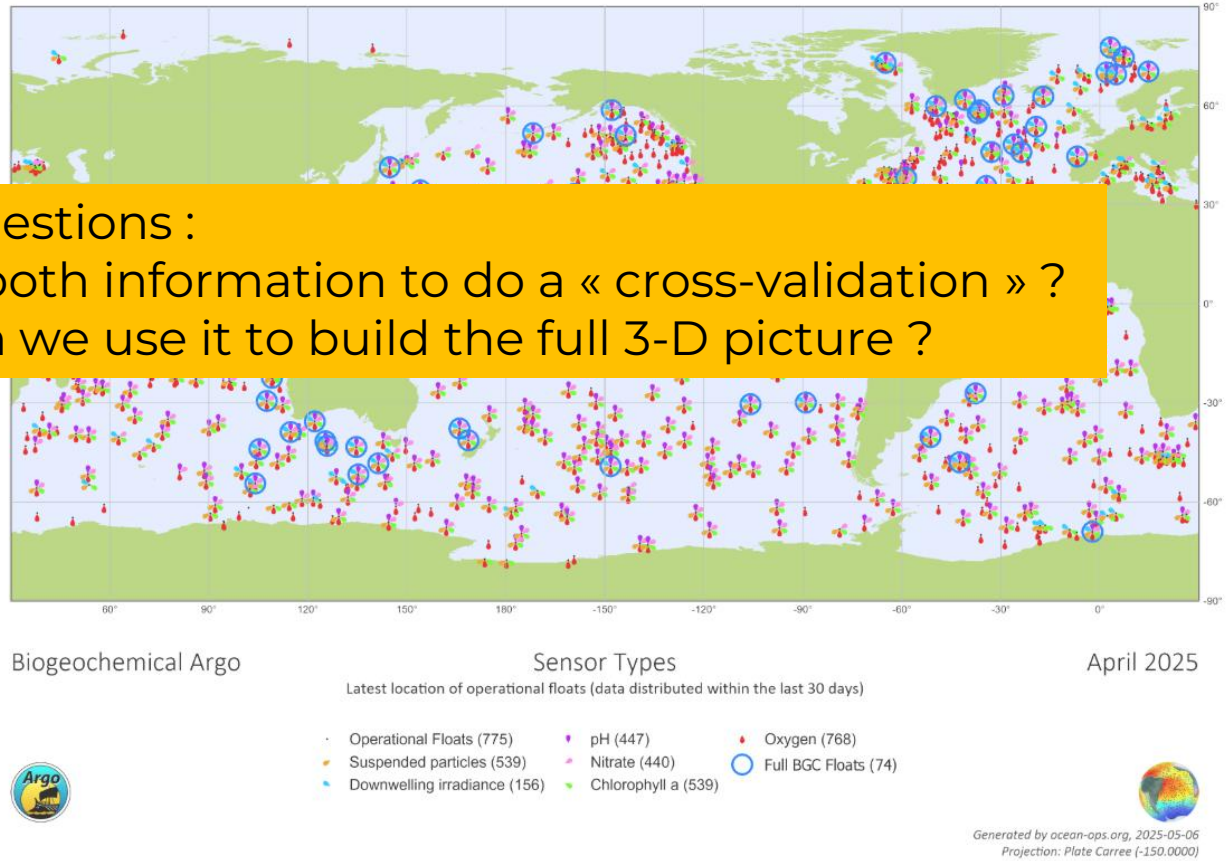
Synergies between BGC-Argo and Ocean Colour Remote Sensing

Why don’t we merge the 2 ?

Ocean colour from satellite
(Chl-a, transparency, Kd…)



BGC Argo optically-derived parameters



Questions :

1. Are they comparable so we can use both information to do a « cross-validation » ?
2. If it is comparable and consistent can we use it to build the full 3-D picture ?

Synergies between BGC-Argo and Ocean Colour Remote Sensing

Are they comparable for « cross-validation »

EU projets : E-Arise, Eurosea

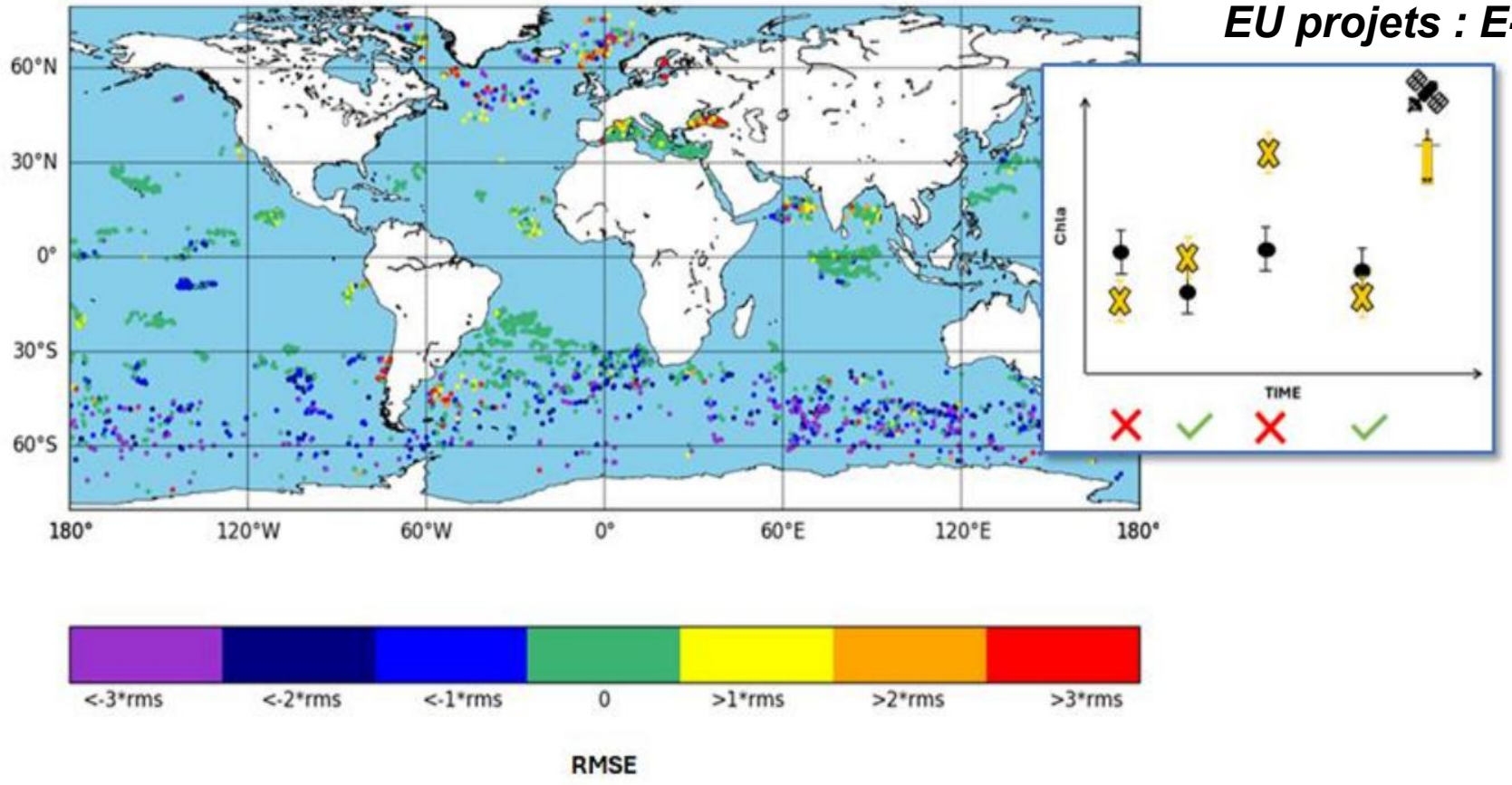
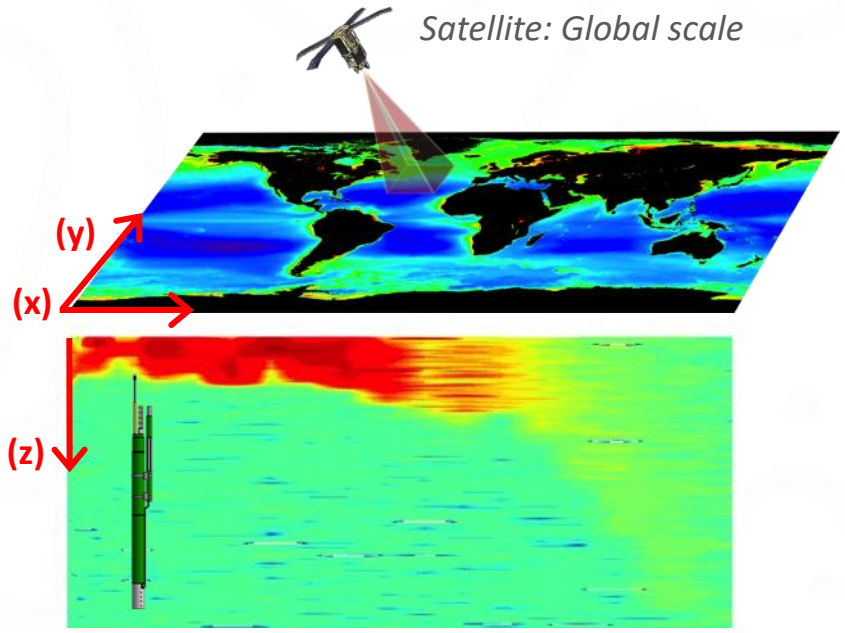


Figure 4: Schematic information available through the webtool dashboard. Map of BGC-Argo and satellite matchups. The colour of the dots corresponds to the thresholds of the difference between satellite and BGC-Argo surface data. And on the right panel, Chla timeseries for a particular float, and comparison with satellite observations. The error bars correspond to the uncertainty and allow to identify suspicious profiles.

QC (RT et DM) - yes
Validation - partially
Calibration - no

Synergies between BGC-Argo and Ocean Colour Remote Sensing

If it is comparable and consistent can we use it to build the full 3-D picture ?



Bio-Argo profiling float: Vertical dimension

- The neural network (NN) **only** requires as input **Argo T/S** profiles and surface remote sensing products (**Chla and bbp**) to retrieve **bbp profile**
- **Training** and **validation** of the NN with **Bio-Argo data** (T/S and bbp)
- Validation highly satisfactory which supports its application to the **global ocean 3D/4D reconstruction of POC** => validation of BGC models

→ 3D/4D OCEAN BIOGEOCHEMISTRY

Journal of Geophysi
Research, 121
doi:1

First step of a novel approach - SOCA

ed method for merging ocean color and
surface bio-optical properties to depth:
Retrieval of the particulate backscattering coefficient
zio[1], B. Gentili[1],

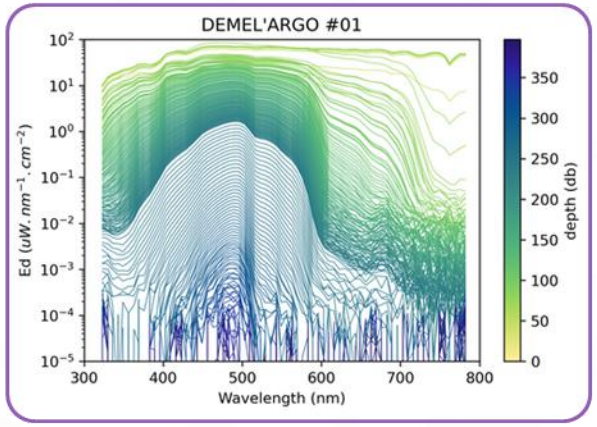
Now in the Copernicus Marine Service Catalogue

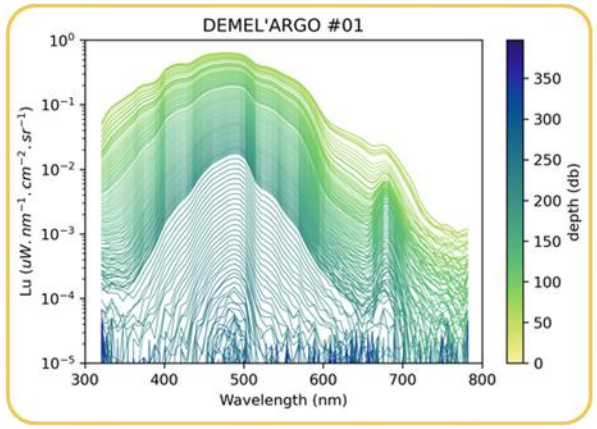
Synergies between BGC-Argo and Ocean Colour Remote Sensing

And now ?

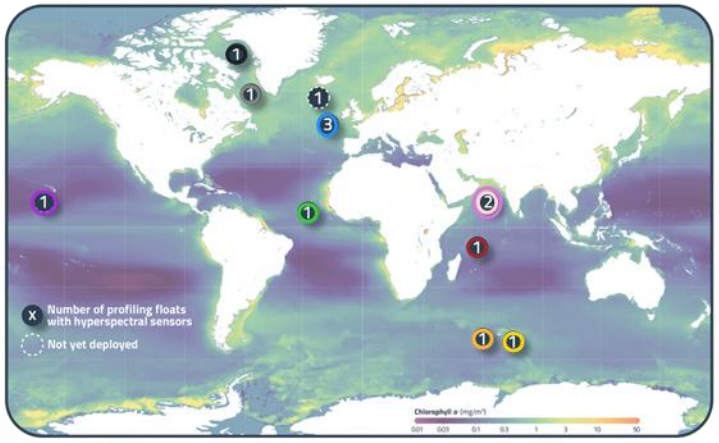
Hyperspectral payload on floats to serve hyperspectral payload on satellite and to complete the hyperspectral view of our ocean

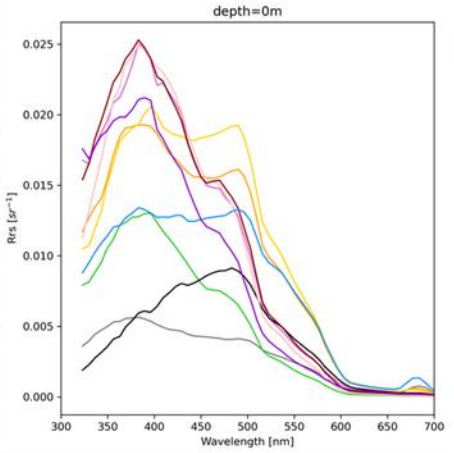
Radiometric profils
Hyperspectral from 0 to 300m





TODAY :
~15 FLOATS





ERC REFINE

Synergies between BGC-Argo and Ocean Colour Remote Sensing

To conclude

The combination of Ocean colour from Satellite and BGC-Argo is essential

Today

- For Quality checking of both systems of observation
- To build the 3D vision of the ocean

Tomorrow

- For Qualification (and validation *and calibration ?*) of satellite missions
- To build our CONTINUOUS and (qualified) vision of the 3D-Ocean
- To add novel capacity of detection thanks to hyperspectral capabilities

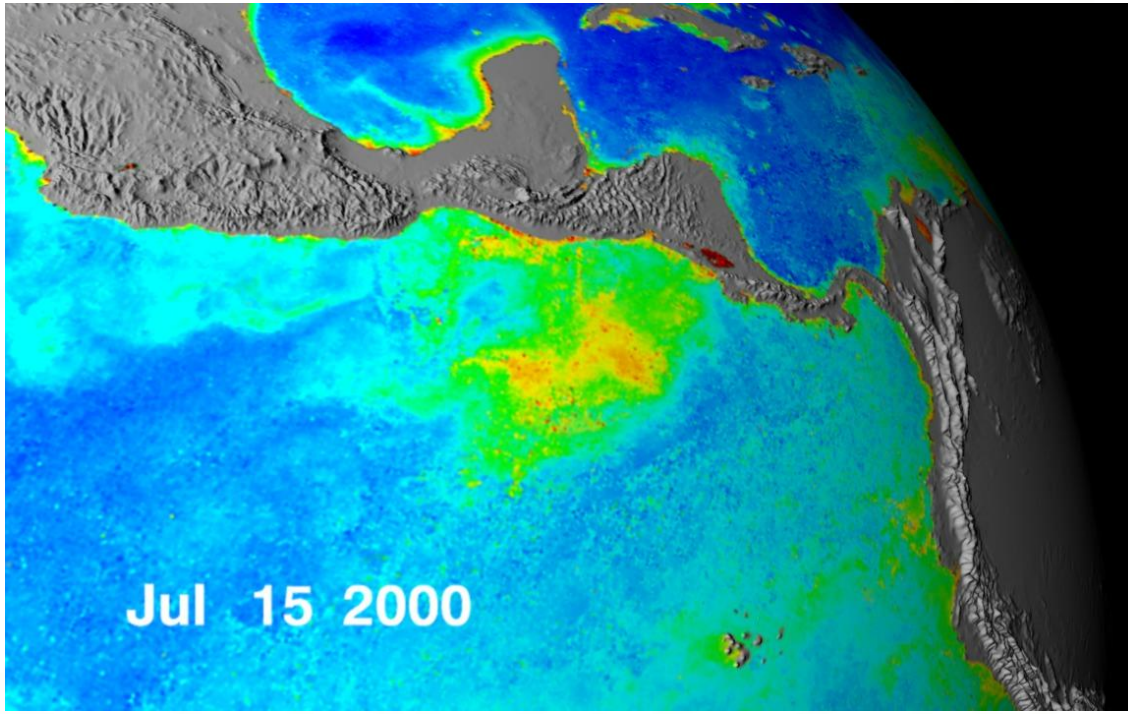
Ocean Observation and High Seas Governance: The Argo Dome project

Sergio Cambronero (sergio.cambronero@imev-mer.fr),
Vincent Taillandier, Hervé Claustre, Joachim Claudet

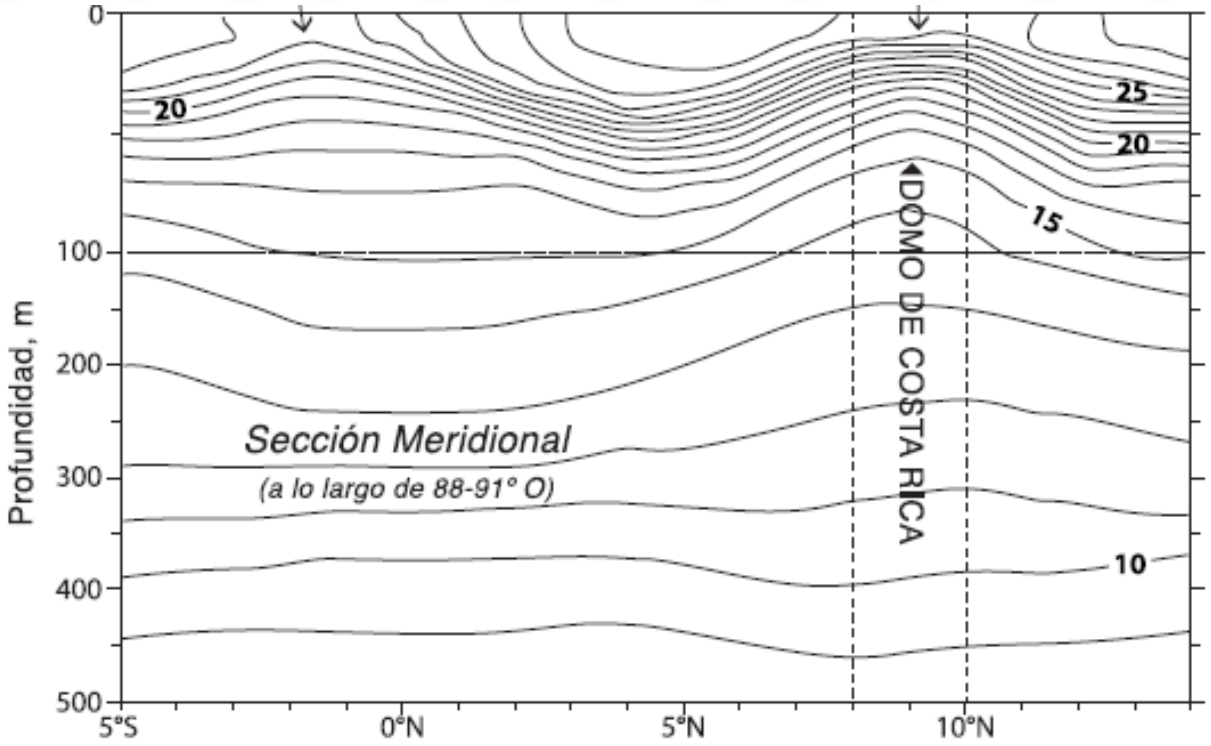
IMEV

Rationale - the thermal dome

High off-shore productivity

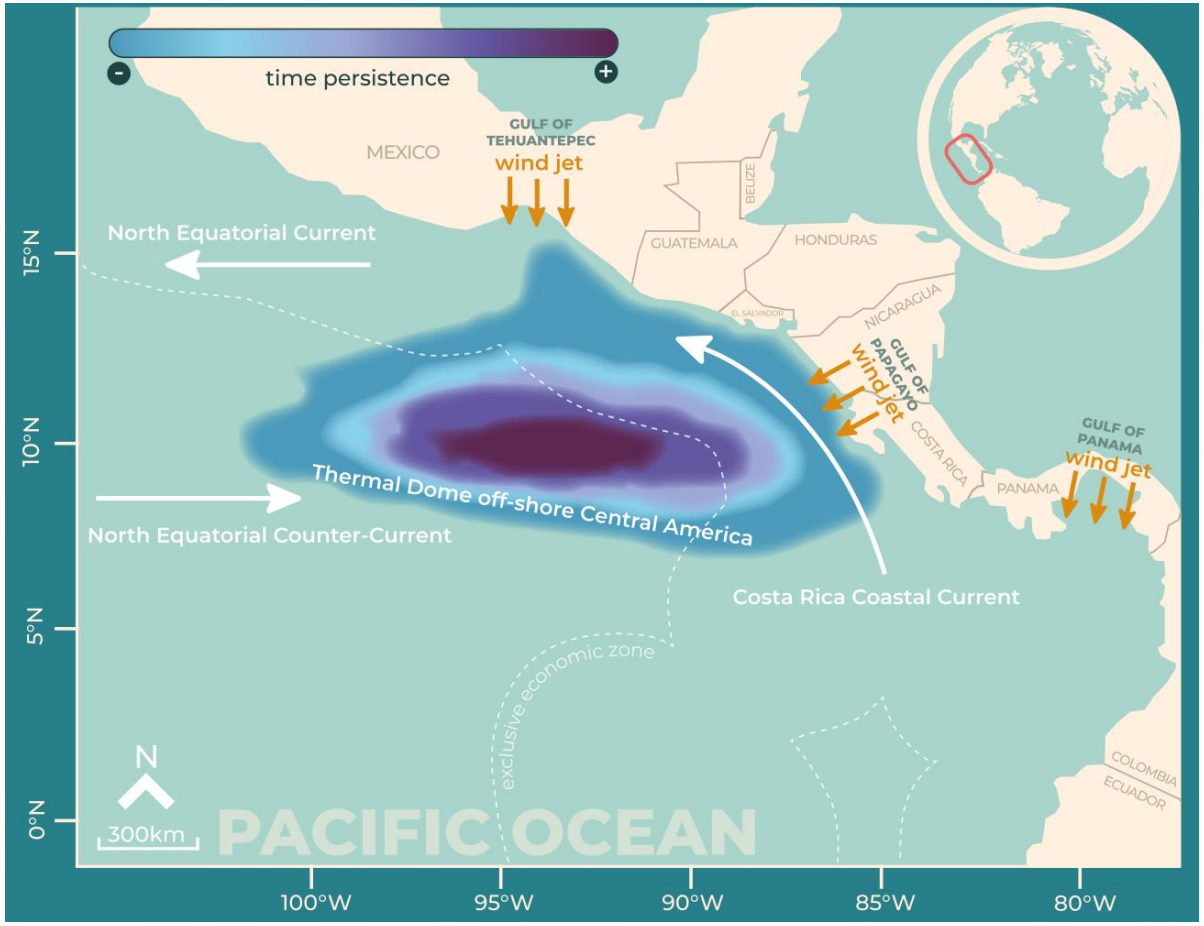


Dome shape of thermocline

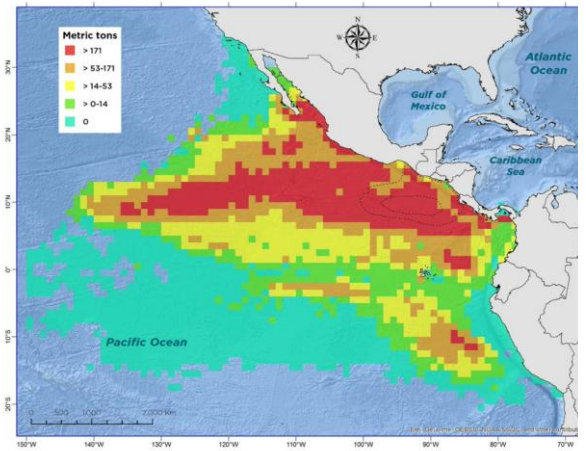


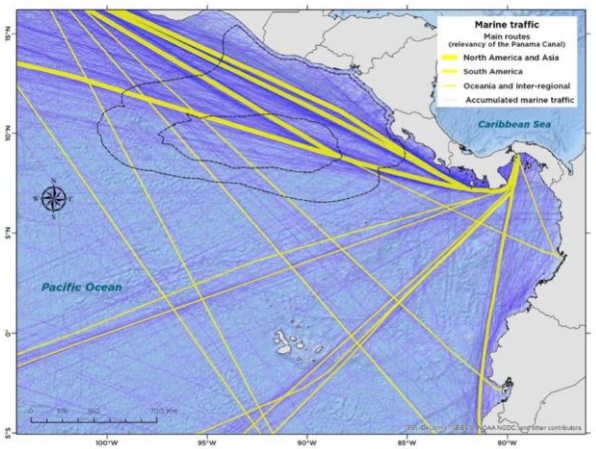
Rationale – Why the Thermal Dome ?

Spatio-temporal variable feature



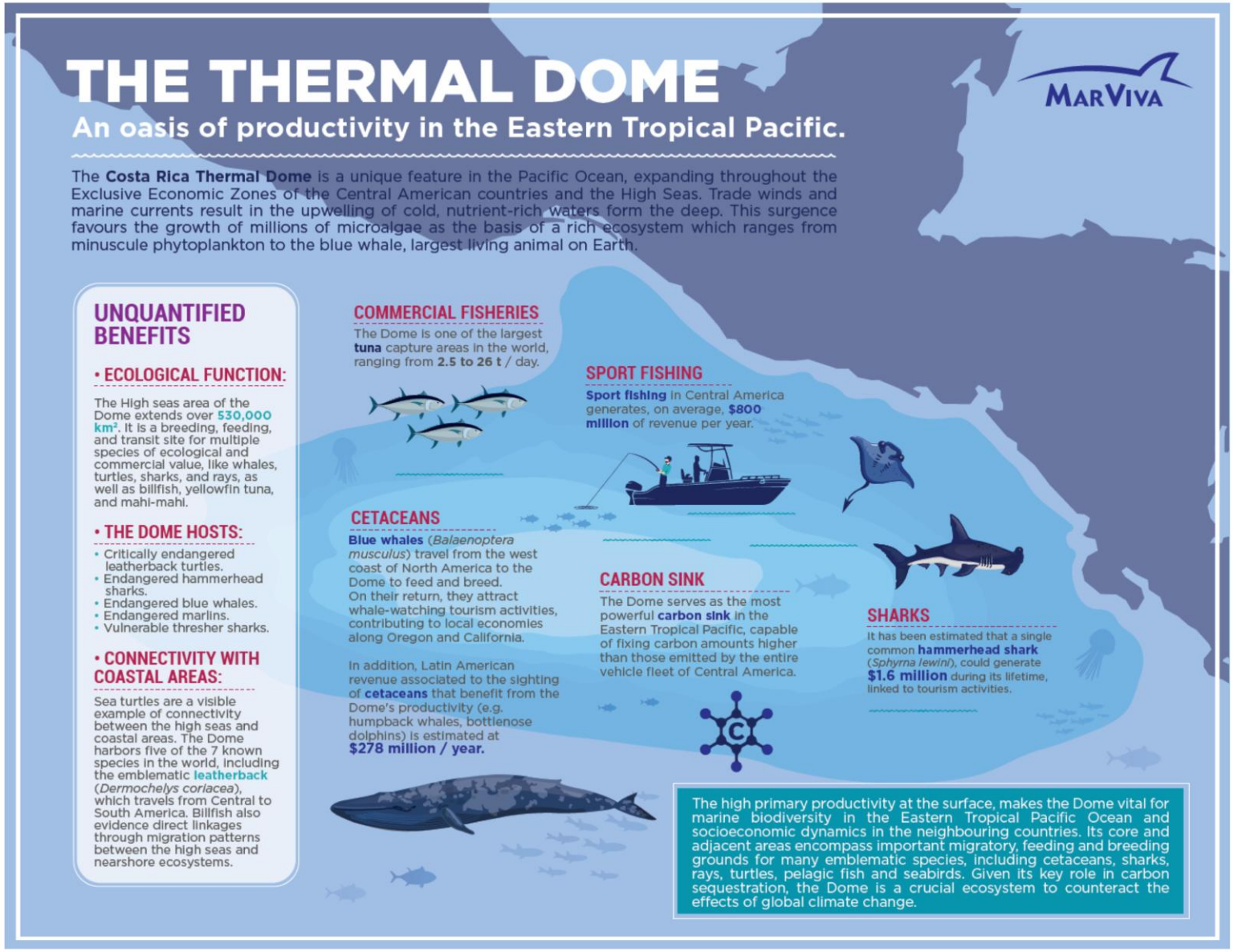
Off-shore biodiversity hotspot





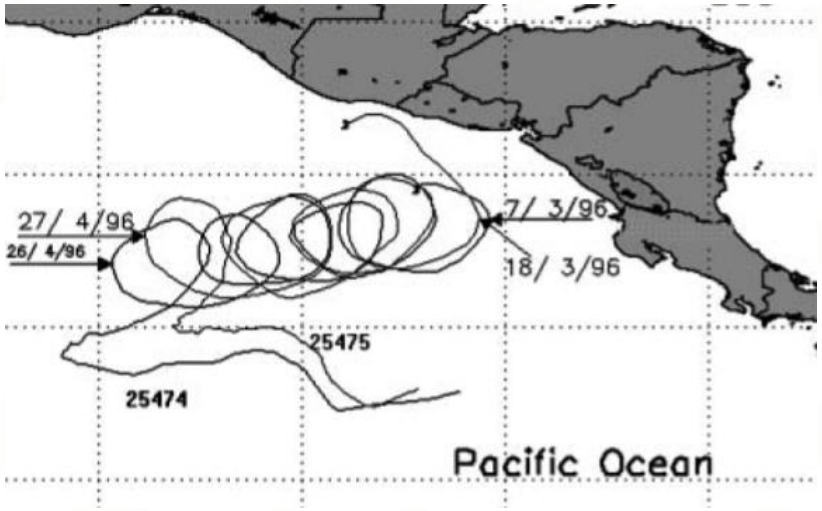
Illustrations: ©Thomas Boniface / MarViva Foundation

Rationale – Ecosystem services

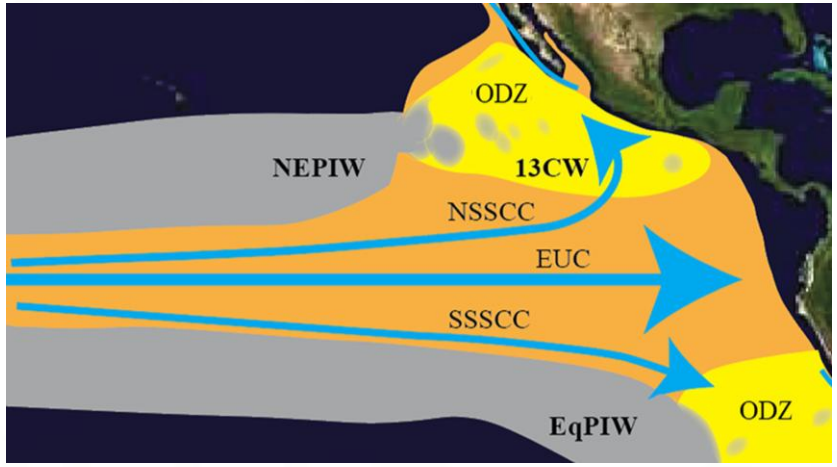


Illustrations: ©Thomas Boniface / MarViva Foundation

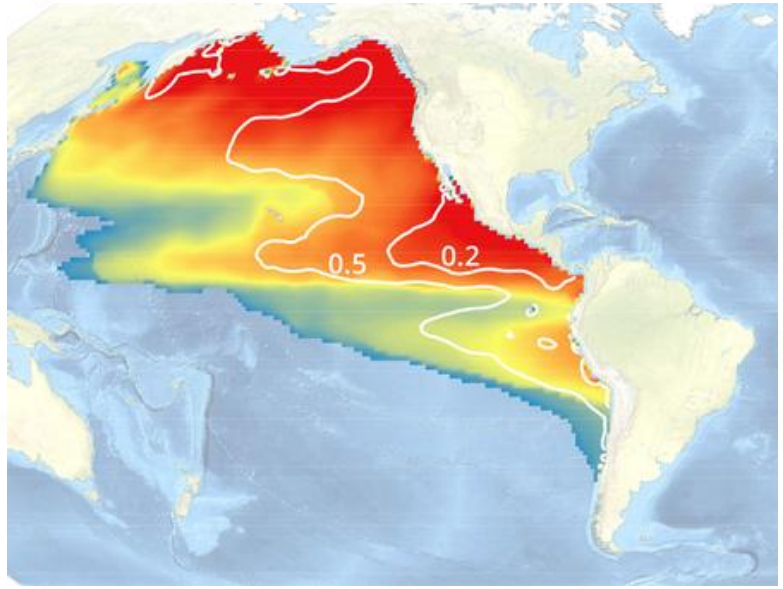
physics and Biogeochemistry- Mesoscale & water masses

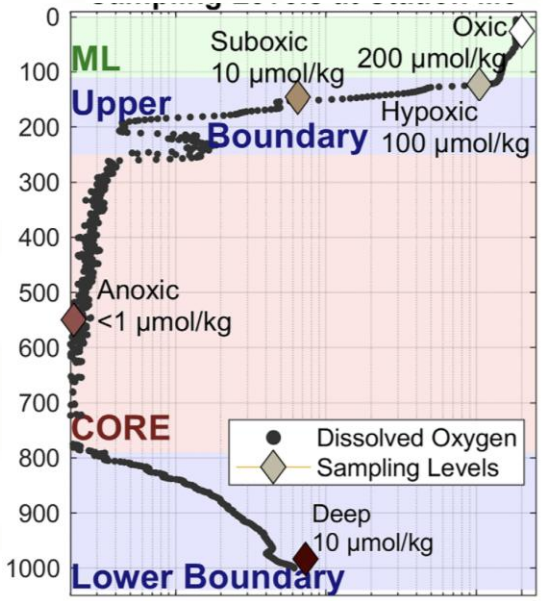


Anticyclonic eddies (Ballestero & Coen, 2004)



Fronts of water masses (13CW) - Evans *et al.* 2020





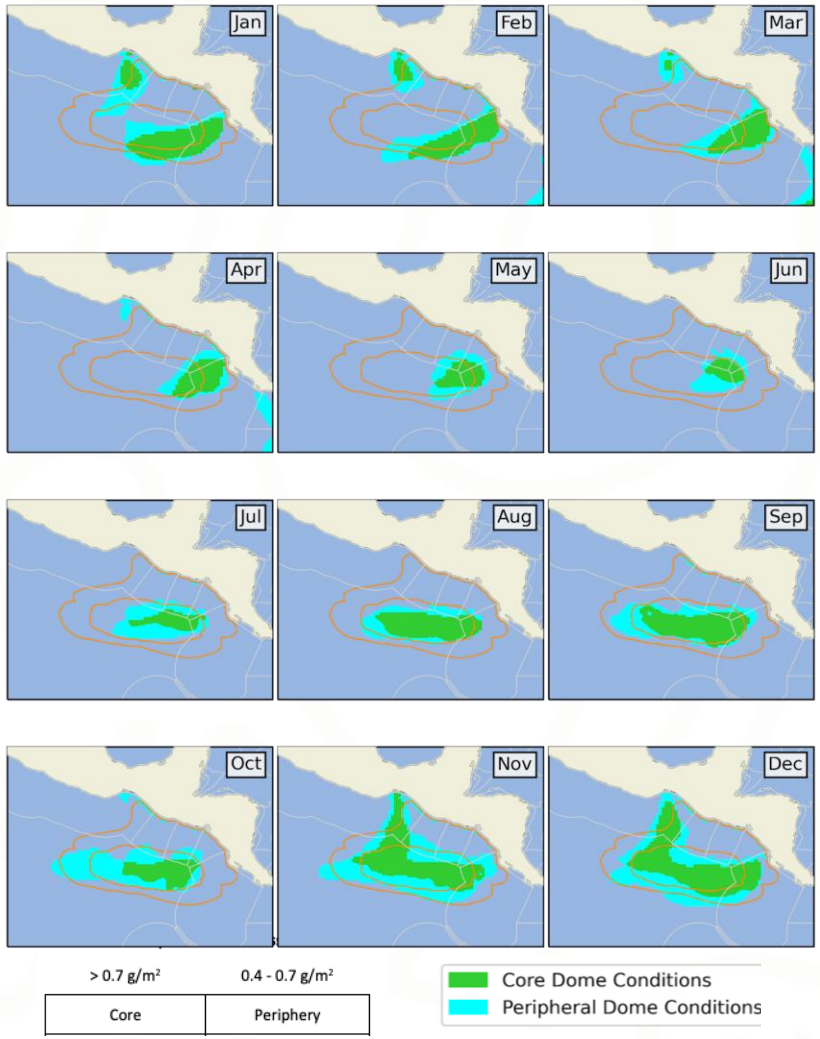
Largest OMZ in the world - Moffitt *et al.* 2015; Gutierrez-Bravo *et al.* 2024

Rationale - water column and deep-sea biodiversity

Credit: ©Schmidt Ocean Institute / Octopus Odyssey / Costa Rica Desconocida

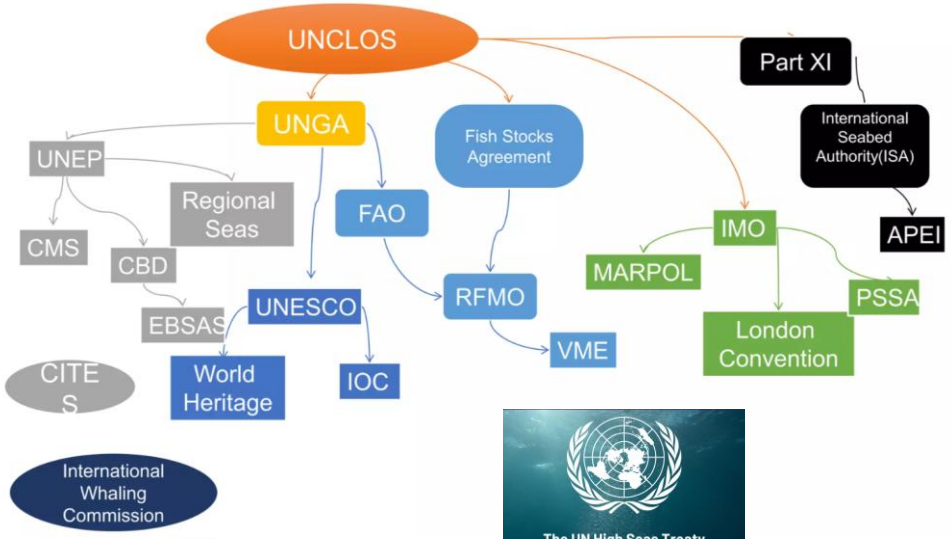
Rationale - Management challenges

Transboundary nature



Governance cohesiveness

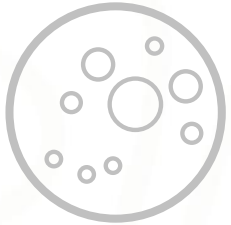
- **ABNJ**: 531 000 km²
- **Costa Rica**: 155 000 km²
- **Guatemala**: 104 000 km²
- **El Salvador**: 89 000 km²
- **Mexico**: 65 000 km²
- **Nicaragua**: 56 000 km²



Thesis chapters and research questions

1. Spatiotemporal variability of the Thermal Dome

Q/ What are the dominant spatial and temporal modes of variability structuring the Dome, and how can they be assessed using Argo floats and satellite data?



2. Biological Carbon Pump and ecosystem services

Q/ What are the key features of the Biological Carbon Pump in the Dome, and how does it regulate ecosystem services?

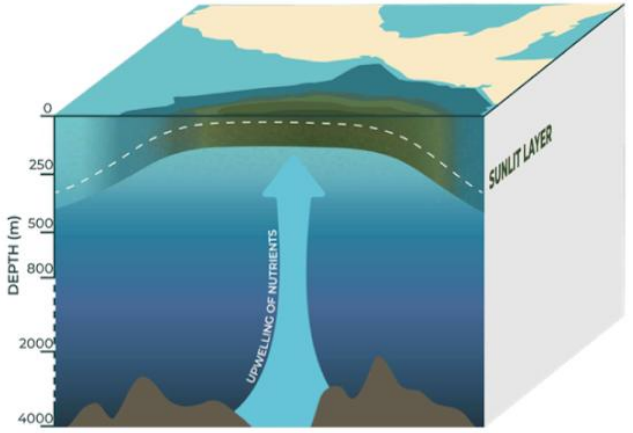
3. Indicators for ecosystem-based 3-D management

Q/ How can ecological and social factors influencing the Dome be translated into indicators for an ecosystem-based management in ABNJ?

4. Three dimensional integrated framework for ABNJ governance

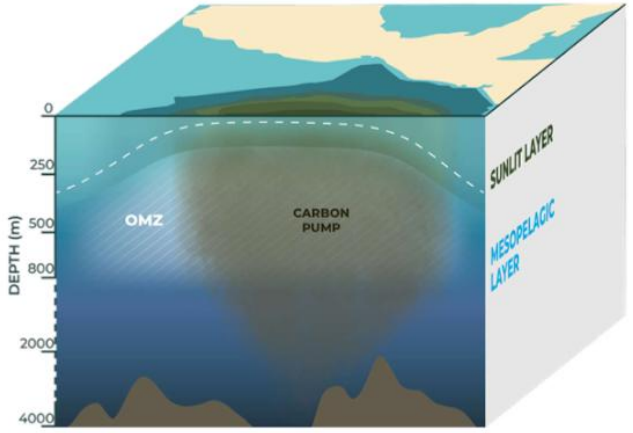
Q/ How can these assessments be incorporated into a three-dimensional dynamic management approach to inform ocean governance and conservation policies in ABNJ?

Rationale - Three dimensional dynamics | boundaries and mechanisms



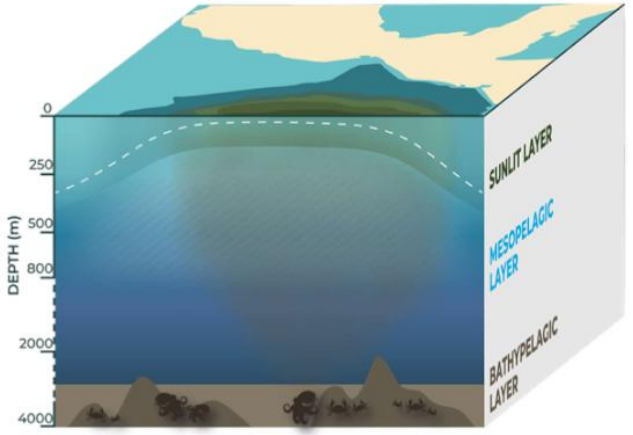
Associated to regional circulation and trade winds, an upwelling of cold and nutrient-rich waters enhances the growth of phytoplankton in the sunlit layer at the ocean surface. The resulting phytoplankton biomass drives an outstanding biodiversity within the core of the Dome.

?



Below, the mesopelagic layer is characterized by a permanent oxygen minimum zone (OMZ), as a long-term result of bacterial respiration fueled by biological carbon pump. This "steady state" OMZ now protects from further respiration the biological carbon passing through it.

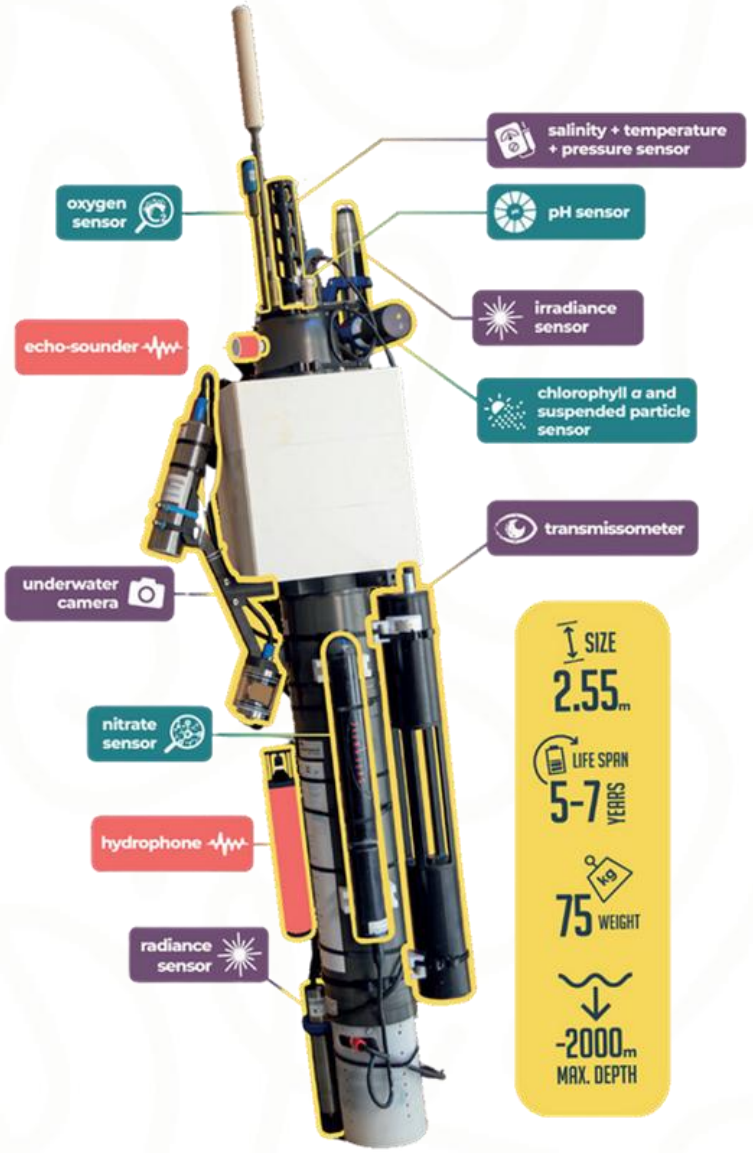
?

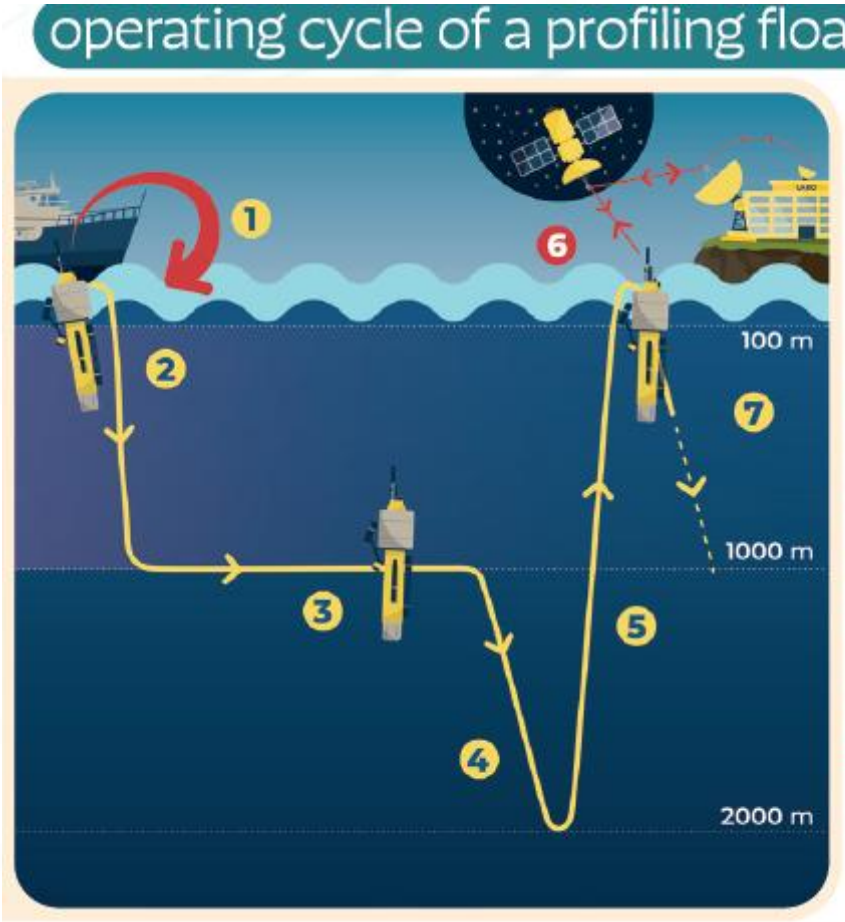


A significant amount of carbon thus escapes from the OMZ and continues its sinking journey to the bathypelagic layer. There, it fuels and sustains the requirements of a deep biodiversity hotspot particularly linked to seamounts.

Illustration: ©Thomas Boniface

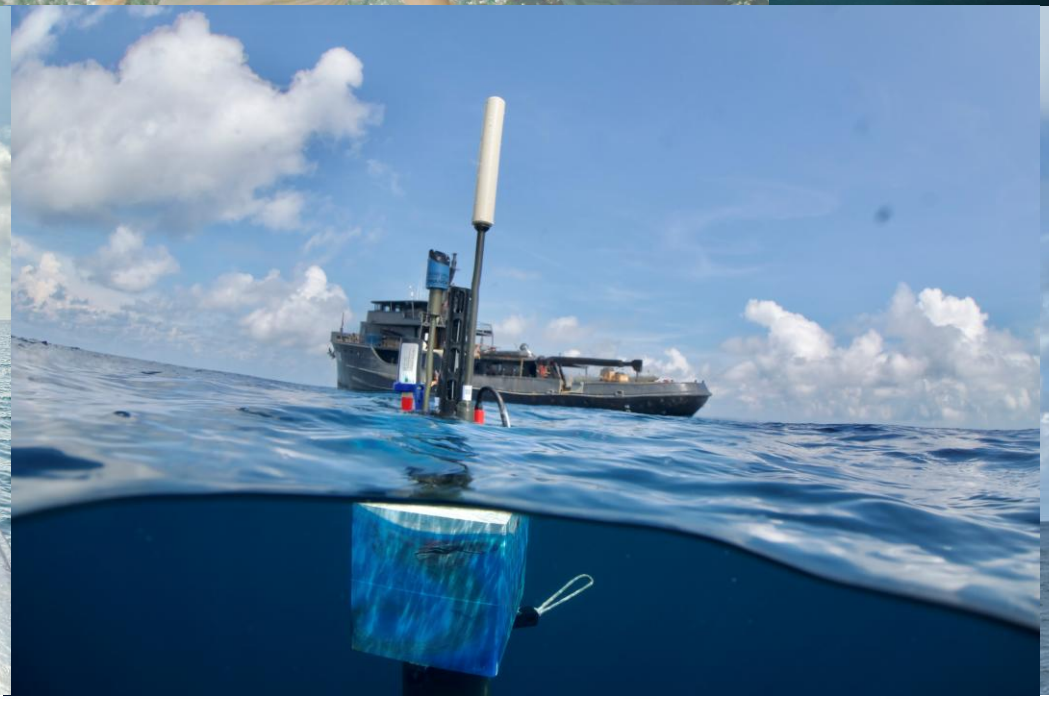
The profiling float - argo program





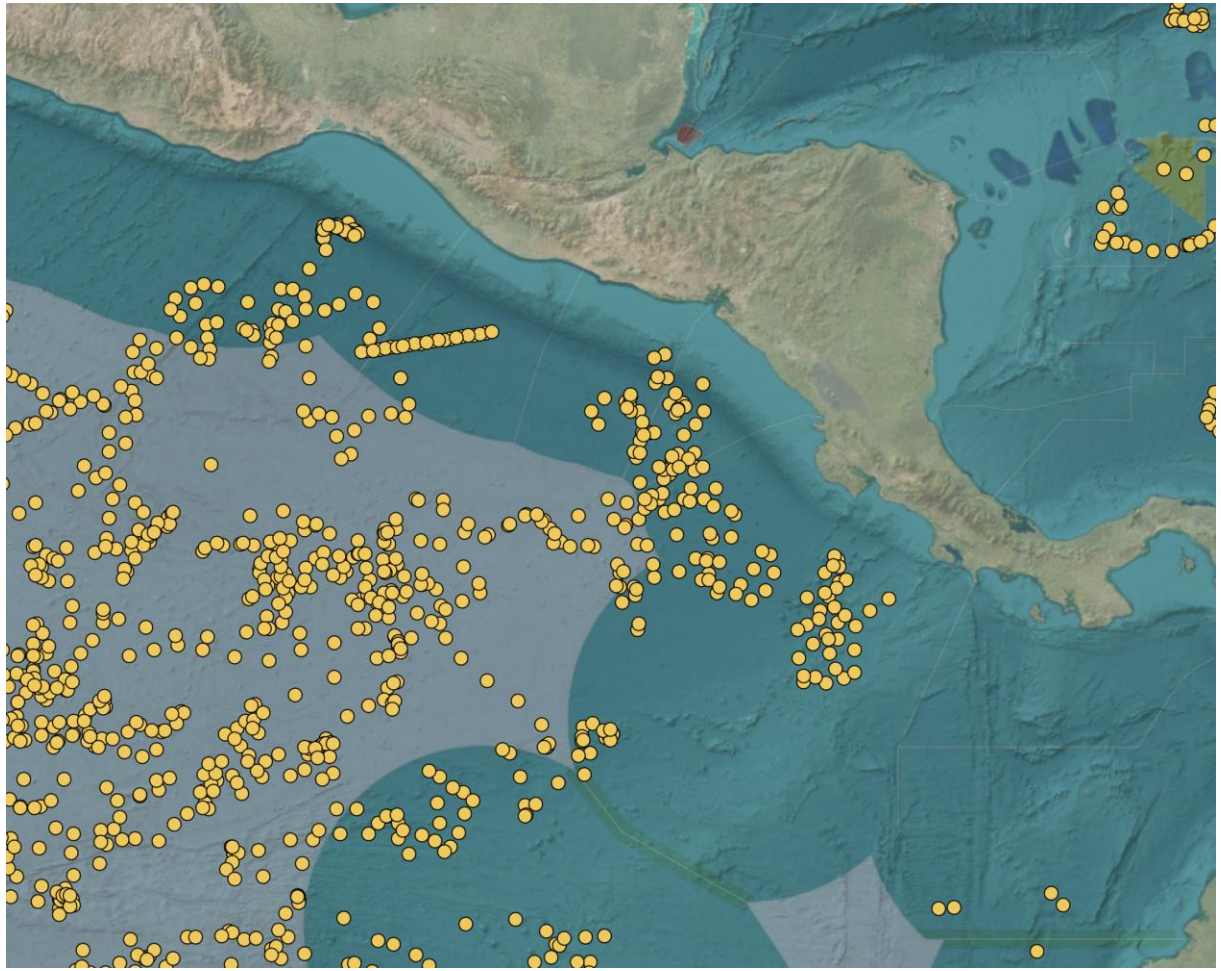
1. Deployment from a ship
2. Descent to 1000 m
3. Drifting at 1000 m for 9 days and sound recording
4. Descent to 2000 m
5. Ascent to the surface and activation of sensors for data collection: the stage when sensors measure the different properties
6. Data transmission to shore through satellite
7. The cycle begins again

Methodology and Argo Deployments | LEFE-GMMC Partnership



Density of argo profiles

2023



2023-2025

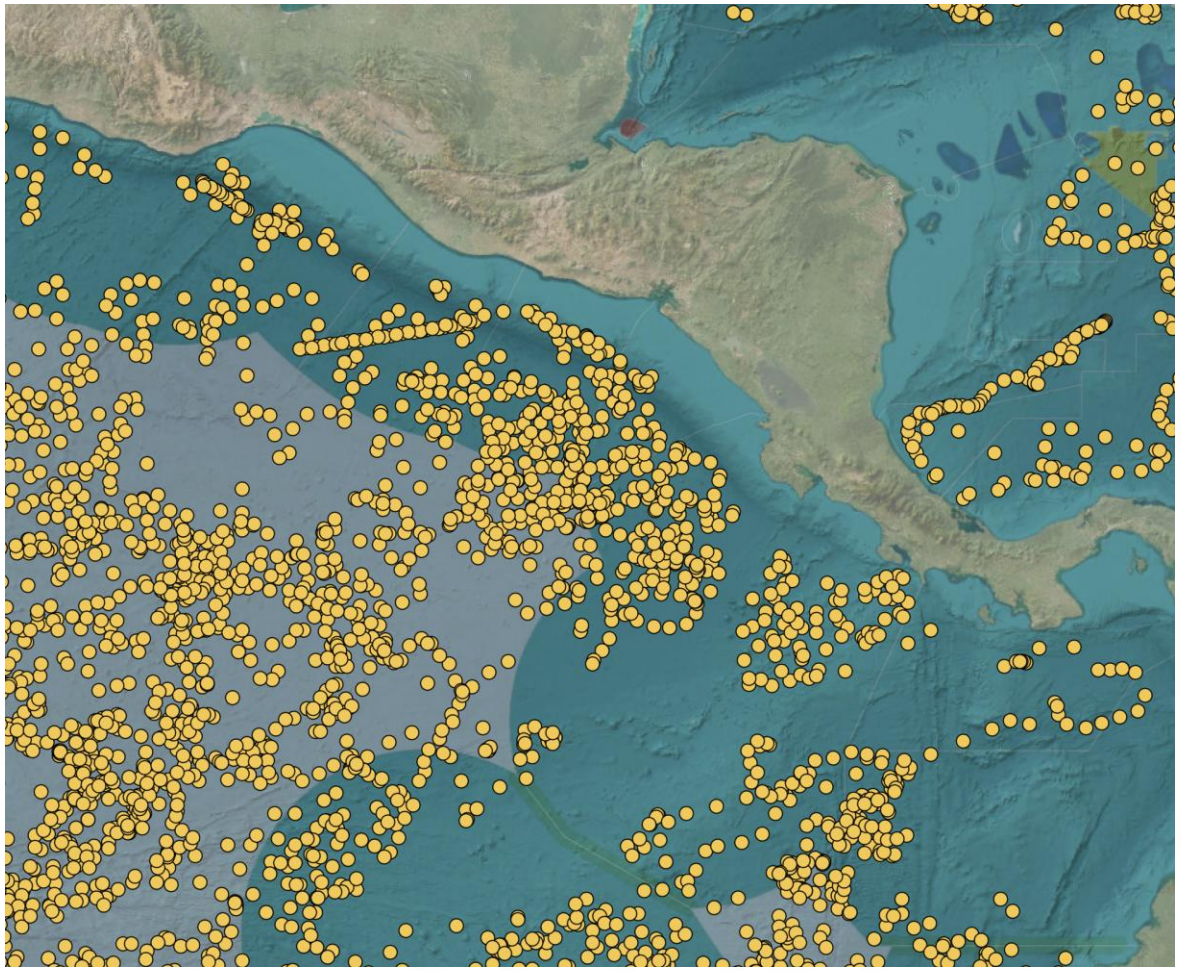


Illustration: ©Thomas Boniface

techno-method backbone - data and outputs

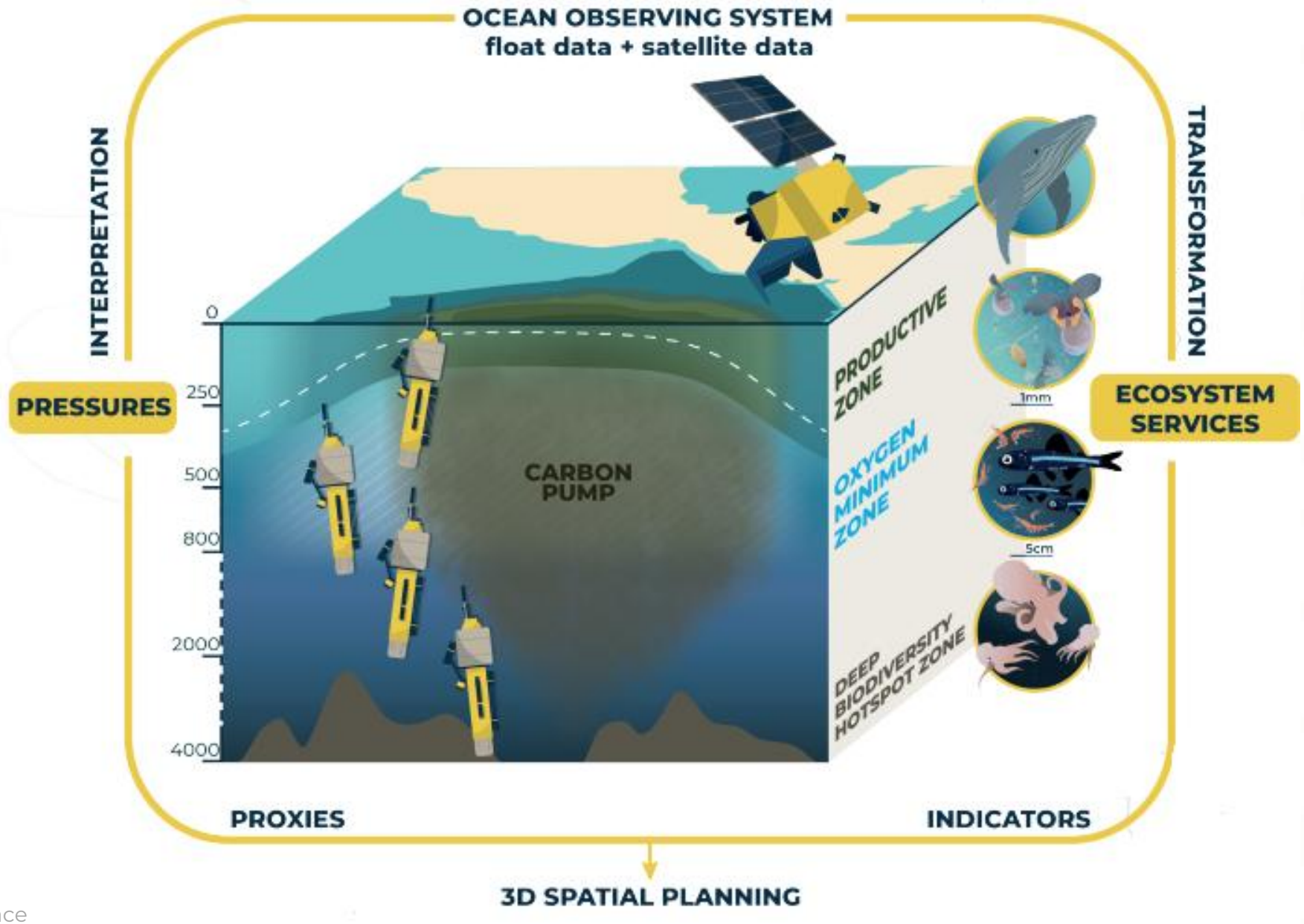


Illustration: ©Thomas Boniface

Area Based Management Tools - Inspection, Compliance, Enforcement

BBNJ ABMT Criteria Indicators

Uniqueness
- Rarity
- Special importance for life history stages
- Special importance of species
- Importance for threatened species

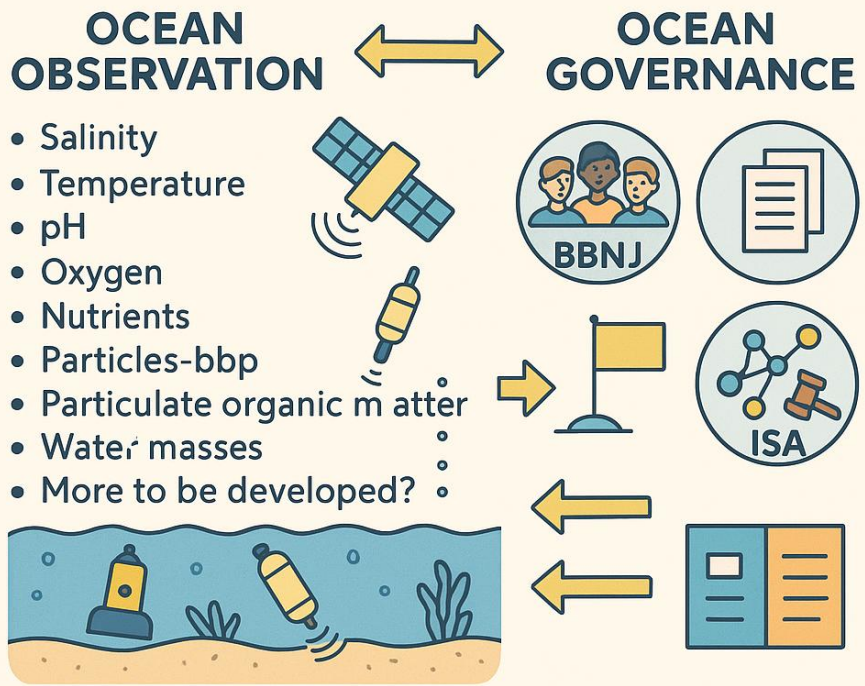
Connectivity & Representation
- Biological diversity and productivity
- Representativeness
- Dependency
- Naturalness
- Ecological connectivity

Vulnerability & Resilience
- Biological diversity and productivity
- Representativeness
- Dependency
- Naturalness
- Ecological connectivity
- Important ecological processes
- Adequacy and viability
- Replication

Socio-Economic & Cultural
- Economic and social factors
- Cultural factors

OCEAN OBSERVATION ← OCEAN GOVERNANCE

Essential ocean variables and international collaboration

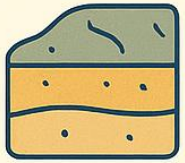


Applications to Governance - BBNJ & ISA - Water Column and Seafloor

- Align indicators
- Open-access portals
- Third-party nodes
- Automated analytics
- Capacity-building

AREA DEFINITION & BOUNDARIES

Bathymetry & Terrain Rugosity



Substrate Type

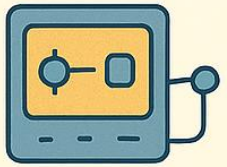
Salinity profile (3D)

Dissolve d oxygen (3D)

Dissolved oxygen (3D)

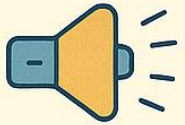
Sediment deposition rate

DYNAMIC MANAGEMENT



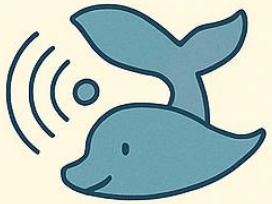
Chlorophyll-a concentration

Particle backscatter / turbidity



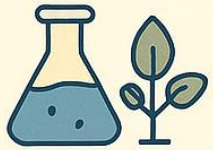
Sediment deposition rate

BIODIVERSITY



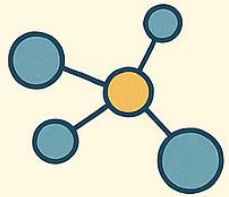
Acoustic soundscape

eDNA diversity metrics



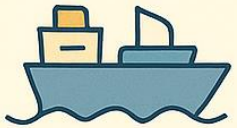
Nutrient concentrations (NO_3, PO_4)

CONNECTICV COMPLIANCE



Current velocity & direction

Vessel-tracking (AIS/VMS)



Satellite AIS, VMS feeds

Conclusions - Main take home messages

- The Thermal Dome, traditionally viewed as an epipelagic feature, functions ecologically throughout the full water column.
- Emerging technologies offer improved insights into the 3D functioning of the high seas, necessitating a reevaluation of boundary-defining proxies
- Effective dynamic ecosystem-based management requires distinguishing between physical drivers and biogeochemical processes
- Managing these open ocean ecosystems demand continuous data to support guiding decisions, e.g ecosystem services as the Biological Carbon Pump
- How to achieve a 3D management of the water column? Should this be the ultimate goal of ABMTs?

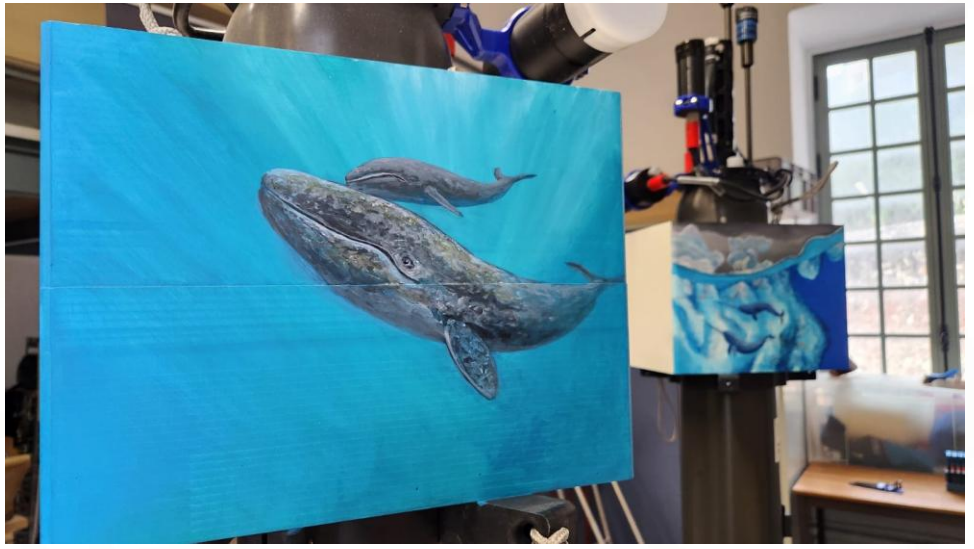
Additional - Link of the Project with Operational Oceanography

CROCO

Coastal and Regional Ocean COmmunity model

Illustration: ©Thomas Boniface

Additional - Capacity Building, Technology Transfer, Outreach - transversal Actions

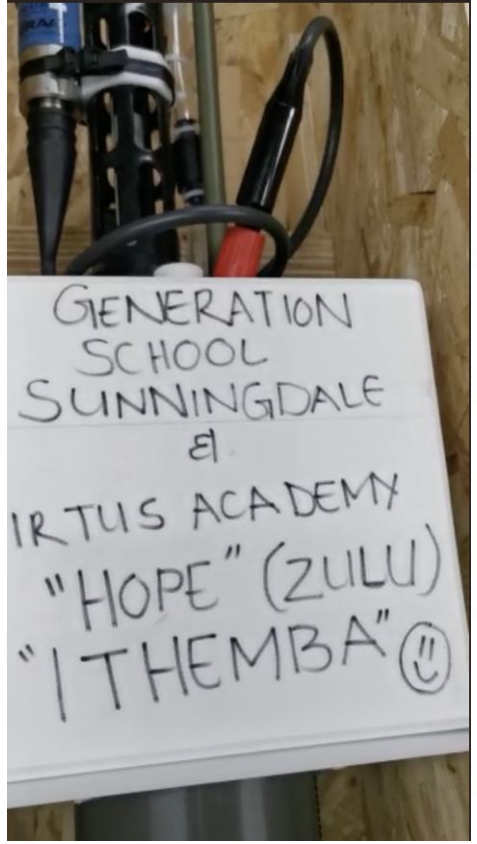


Oceans in Classrooms

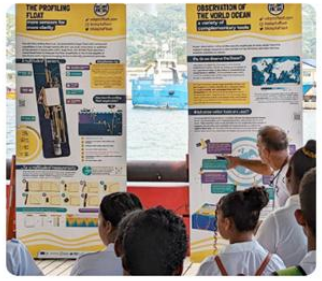
Tammy Morris (t.morris@saeon.nrf.ac.za)

SAEON

Argo in the Classrooms

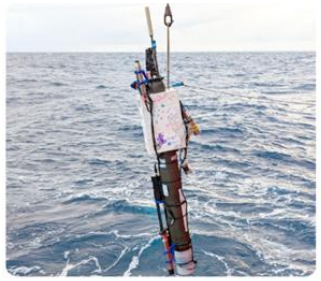


adopt a float



adopt a float in brief

Share ocean knowledge with students ...



The profiling float

Our flagship robot of Ocean observation ...

The school year

Events throughout the school year ...

How to adopt a profiling float ?

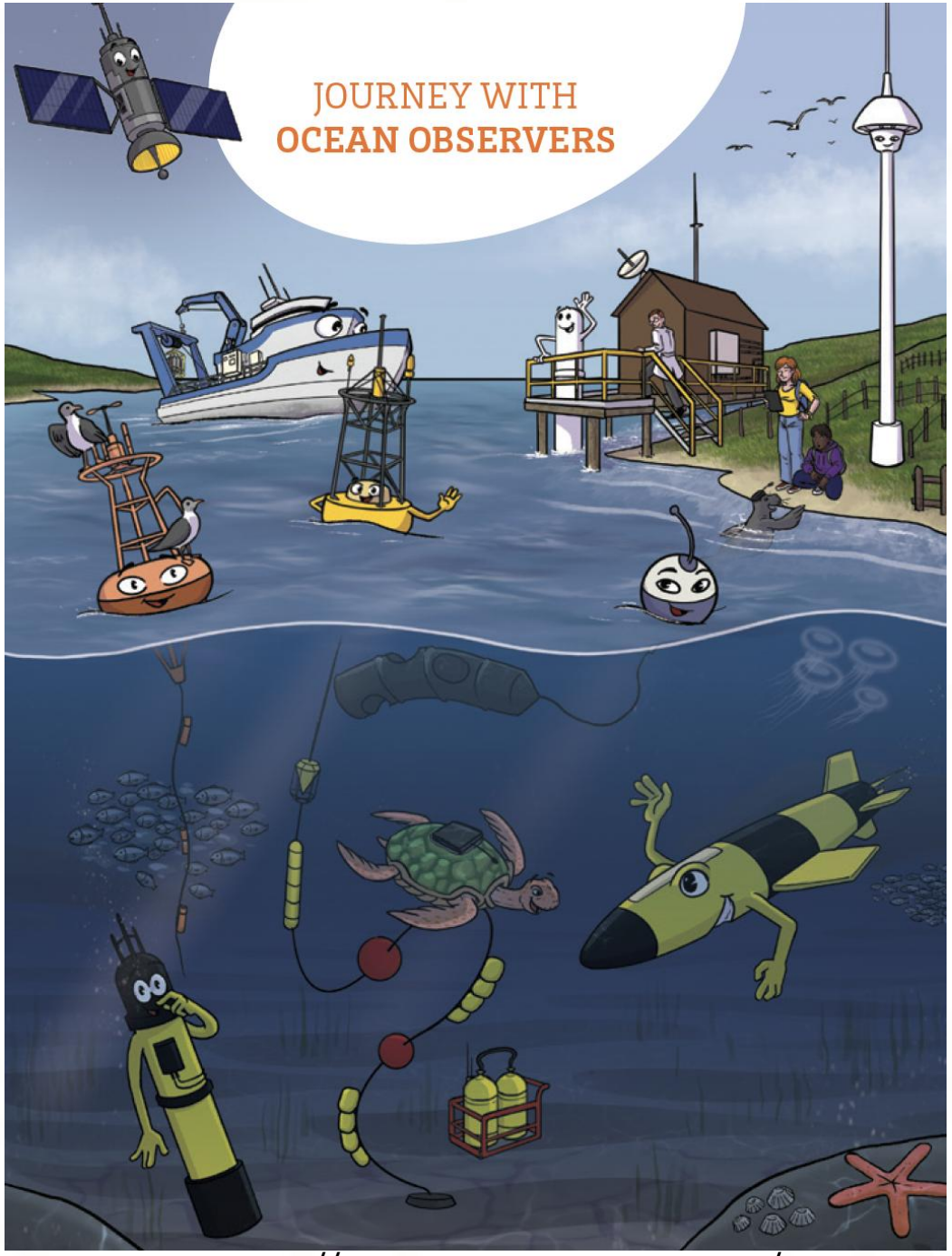
Simple procedure to adopt ...

Our flagship scientific program

ERC (European Research Council) REFINE ...

https://adoptafloat.com/

https://argo.ucsd.edu/outreach/argo-in-schools/



https://oceanobservers.org/

SEREAD

Argo online School

https://argo.ucsd.edu/outreach/education-materials/

https://www.youtube.com/watch?v=WGbanFvBX38

Thank you

- Round table -

Questions and discussion

Toshio Suga(suga@tohoku.ac.jp)

Conclusion & Call to Action

Toshio Suga(suga@tohoku.ac.jp)

Ocean Prediction → Argo observations are crucial for accurate ocean reanalysis and real-time forecasts. We must sustain Argo and expand it through OneArgo to cover the deep ocean, polar regions, and biogeochemical parameters, to enhance model accuracy.

Deep Ocean →The deep ocean is vital for ocean heat storage and sea level prediction, climate projections, and marine habitat resilience, yet 73% remain unmeasured. It is imperative to prioritize Deep Argo and close this crucial observational gap to make environmentally-informed and proactive decision making.

Ocean literacy → using Argo float technology is incredibly valuable at all levels of formal education, including tertiary, but also for the public to understand and appreciate the ocean, and help to conserve it for future generations.

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