European contributions to Biogeochemical-Argo & scientific objectives

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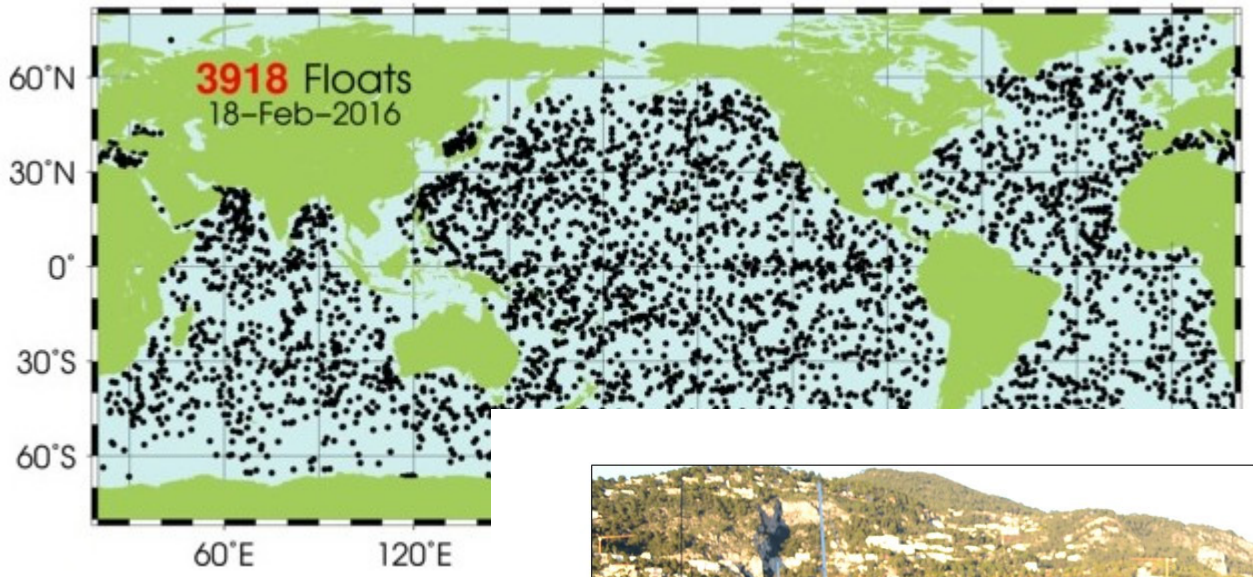
Outline

- The design and implementation of a global Biogeochemical-Argo network
- Some EU “highlights”
- Future / submitted activities

The design and implementation of global Biogeochemical-Argo network



Planning for a global network has begun. First meeting in Villefranche-sur-Mer, 11-13 January.

Draft implementation plan being written.

EOS paper submitted.

Biogeochemical-Argo Network - Group photo

The key scientific questions

Basic/climate research/Grand Challenge Question

- Ocean Carbon Cycle & biological pump
  - Carbon uptake, NCP, C export : long term (and interannual) change
  - link to biogeochemical & climate models
  - linkage to ocean color sensing (chlorophyll, NPP, functional groups)
- Ocean acidification and linkage to carbon cycle (ballast) and ecosystem processes
- Ocean oxygen/deoxygenation and linkage to nitrogen cycle

Applied research

- Ocean forecasting: living marine resources/Ecosystem/fishery models
- Improving ocean carbon budget to better constrain terrestrial changes

Six core (essential) Biogeochemical-Argo variables

- **Oxygen** [1,3,4]
- **Nitrate** [1,4]
- **pH** [1,4]
- **Chlorophyll a** [2,3,4]
- **Backscattering** [3]
- **Irradiance** [3,4]

1 Essential Ocean Variables: EOVs:
2 Biological Ecosystem Ocean Variables : Biological eEOVs
3 Biogeochemistry Ecosystem Ocean Variables: Biogeochemistry eEOVS
4 Essential Climate Variables (ECVs), either oceanic or atmospheric:

Sizing, operation and cost of the network

- ~ 1000 floats with the complete sensor suite (OSSEs, Bio-regionalization & decorrelation scale approaches)
  - 200 cycles/ 4 years
- O2-Argo floats only are Biogeochemical-Argo equivalents
- Operating in the Argo Mode (10 days, 1000 m drift, 2000m profiles
  - Possibility to increase the temporal resolution / adaptative sampling
- Annual cost of the array (including): ~ 20 M€

  = > ~ 5 M€ EU
- Link with “marginal seas” and “high latitude” task teams of Argo

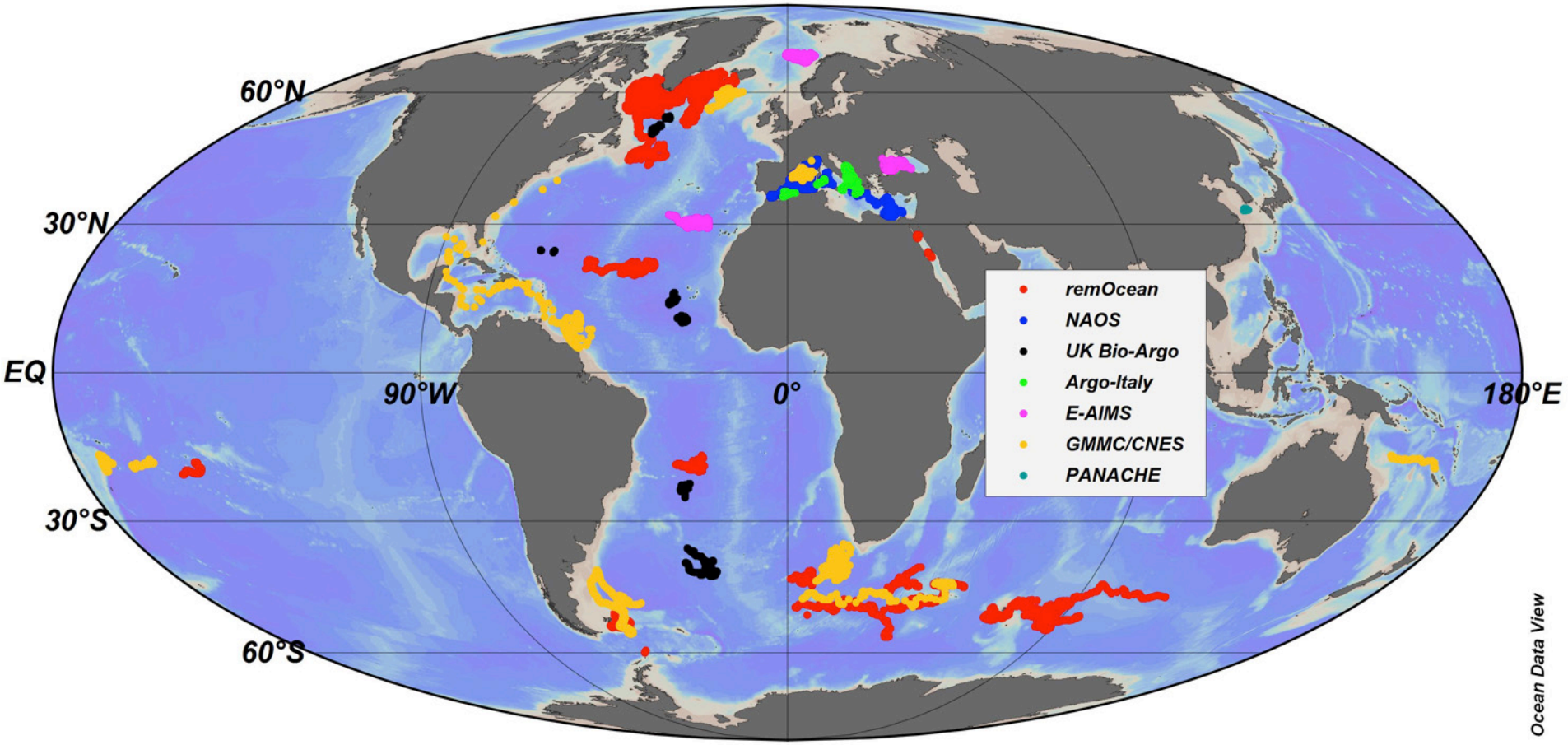
Data management status for the six variables

	Processing at the DAC level	RT-QC	DM-QC
Oxygen	DOI 10.13155/39795	DOI 10.13155/40879	DOI 10.13155/40879
Nitrate	on going	on going	on going
pH	on going	on going	on going
Chla	DOI 10.13155/39468	DOI 10.13155/35385	on going
b_b	DOI 10.13155/39459	soon	on going
radiometry	soon	soon	on going

The Biogeochemical-Argo pilot projects at the EU scale

- **FP7-EAIMS** 6: Black Sea (2), Norwegian Sea (2), Sub-tropical North Atlantic (2)
- **FP7-ERC-remOcean**: Atlantic subpolar (22), Austral (15), subtropical Atlantic (8) and Pacific (2), Red Sea (2)
- **H2020-AtlantOs**: Atlantic (7)
- **NAOS**: Mediterranean Sea (25), Arctic (14)
- **SOCLIM:** Austral (8)
- **Bio-Argo-France (4 per year)**: Med Sea, Altantic
- **Bio-Argo Italia (3 per year)**: Med Sea, Black Sea
- **Bio-Argo UK (11)**: Atlantic Ocean

Merging data from different areas for global scale applications

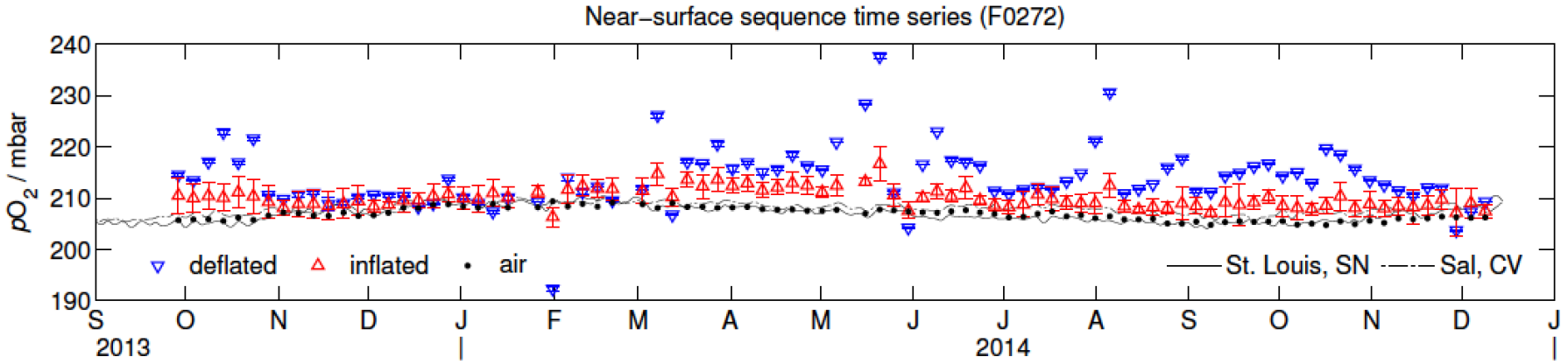


More than 13,000 profiles

Tackling oxygen optode drift: Near-surface and in-air oxygen optode measurements on a float provide an accurate in-situ reference

HENRY C. BITTIG* AND ARNE KÖRTZINGER

JAOT, 2015

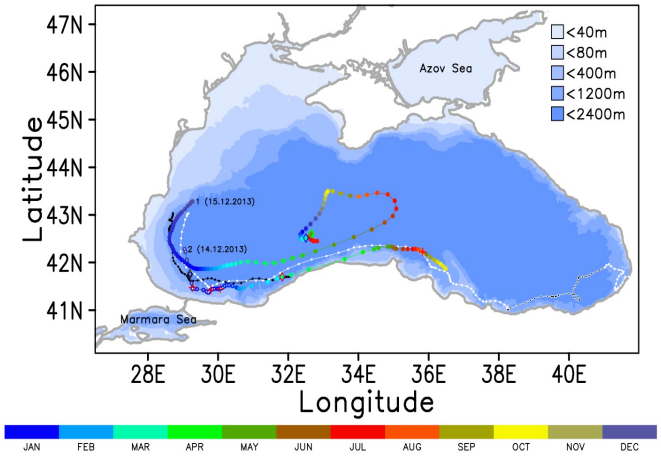


- Near surface air-sea measurements
- Over the instrument life-time, maintain a precision 0.2% of and an accuracy of 1%

E-AIMS

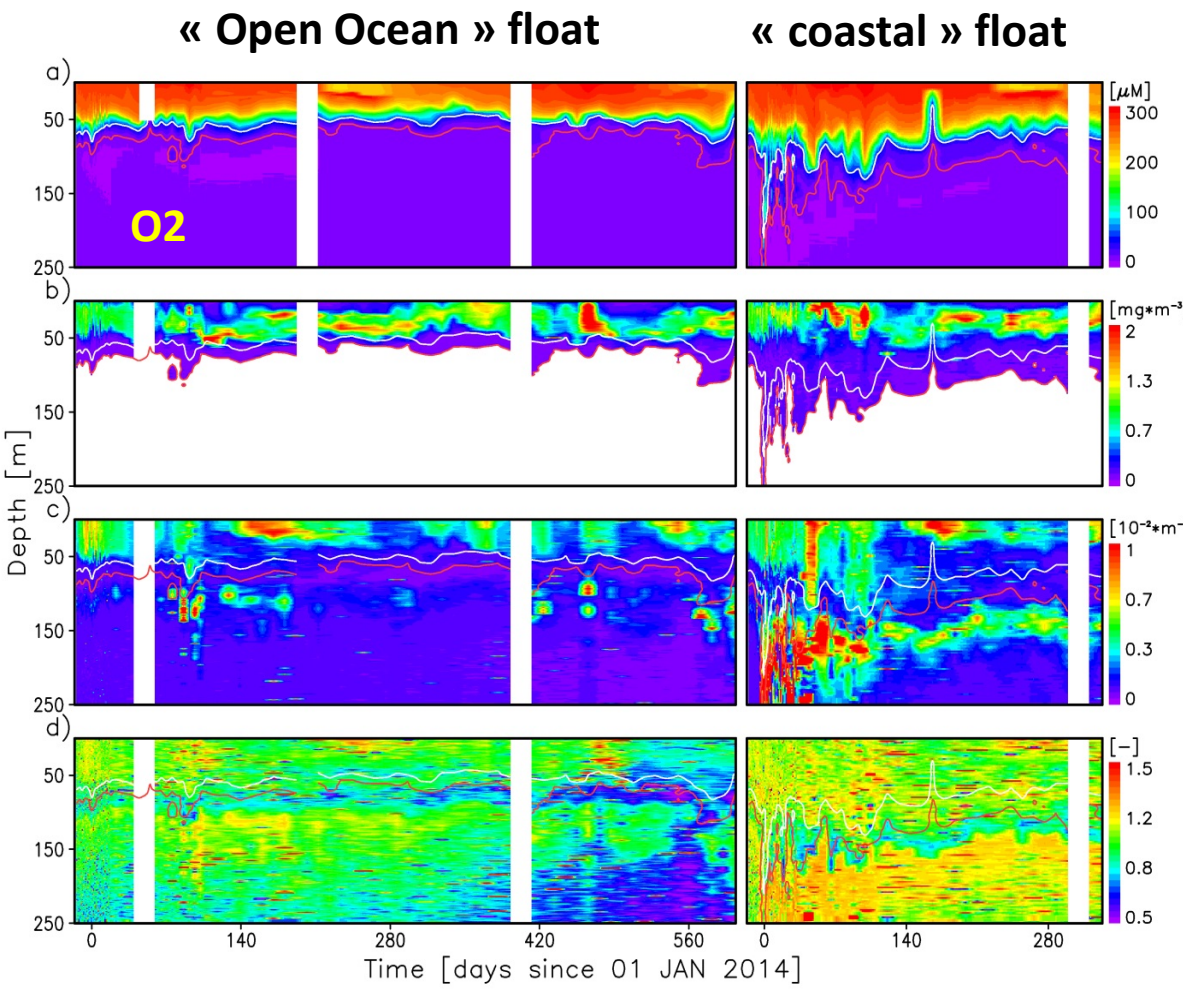
Physics and biogeochemistry of Black Sea deciphered from Bio-Argo data

Stanev et al., JGR submitted



- Deep penetration of straits inflows can be traced up to the eastern end of Black Sea.

- Particle layers and particle-dominated interfaces are continuous over large areas of the Black Sea

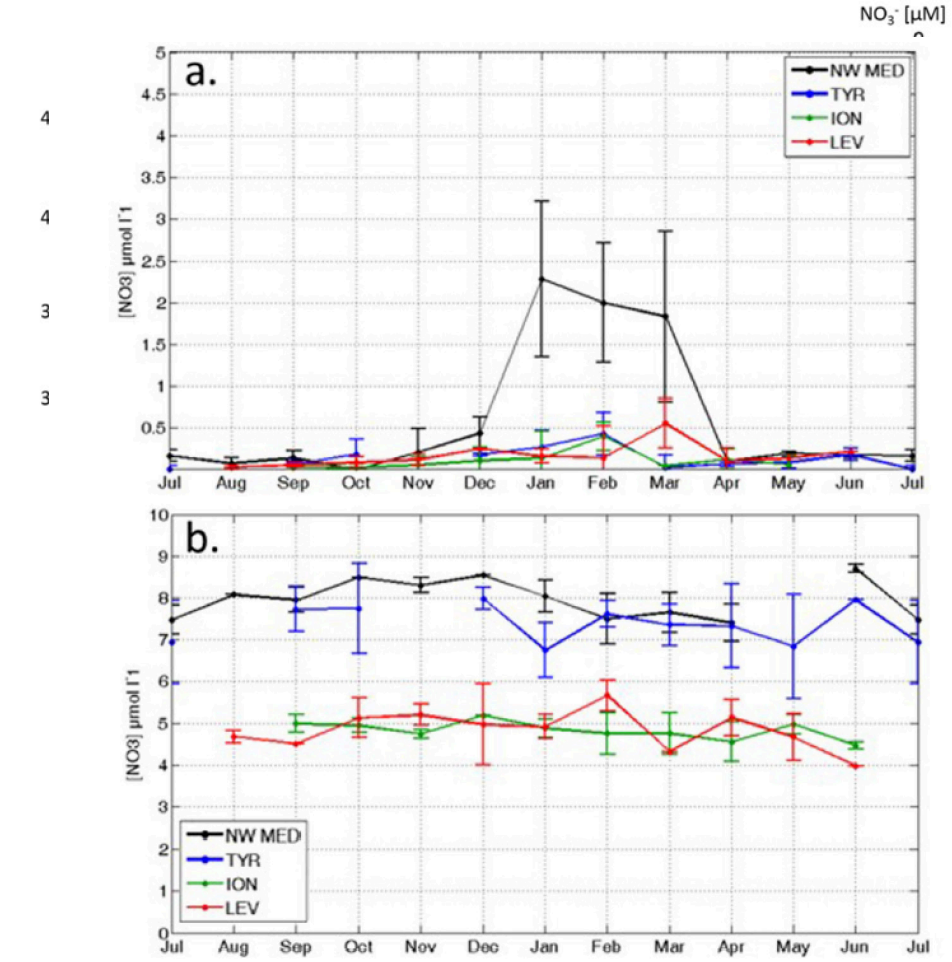


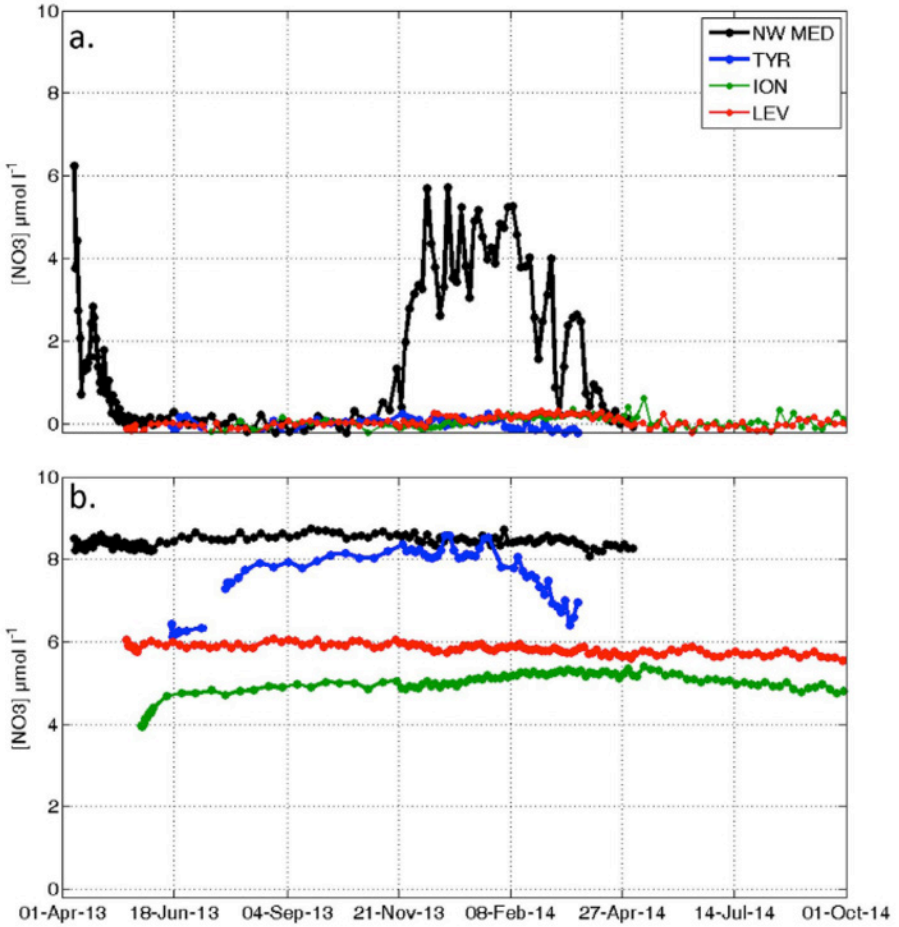
E-AIMS

Seasonal variability of nutrient concentrations in the Mediterranean Sea: Contribution of Bio-Argo floats

AGU PUBLICATIONS
Journal of Geophysical Research

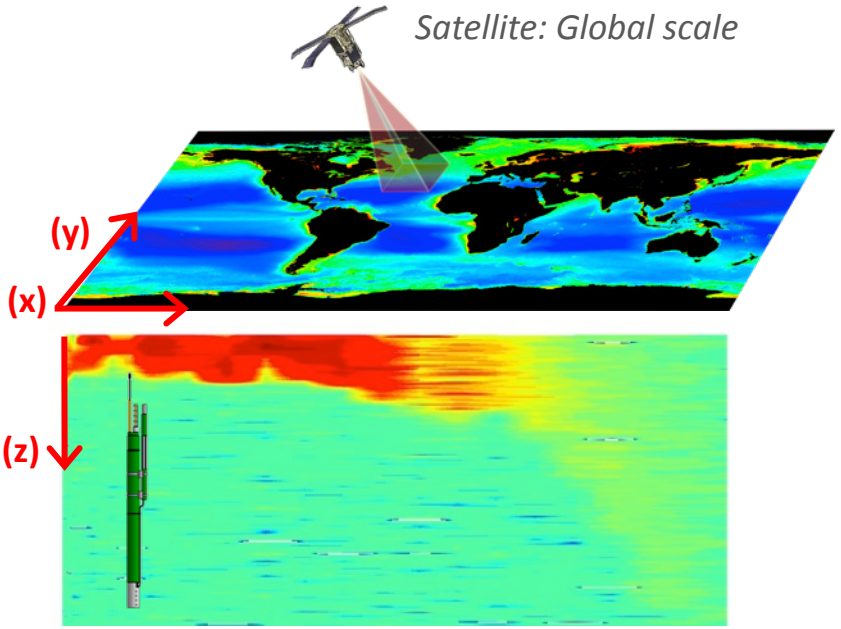
Orens Pasqueron de Fommervault[1,2,3], Fabrizio D'Ortenzio[1,2], Antoine Mangin[3], Romain Serra[3], Christophe Migon[1,2], Hervé Claustre[1,2], Héloïse Lavigne[4], Maurizio Ribera d'Alcalà[5], Louis Prieur[1,2], Vincent Taillandier[1,2], Catherine Schmechtig[1,2], Antoine Poteau[1,2], Edouard Leymarie[1,2], Aurélie Dufour[1,2], Florent Besson[1,2], and Grigor Obolensky[1,2]





A neural network-based method for merging ocean color and Argo data to extend surface bio-optical properties to depth: Retrieval of the particulate backscattering coefficient

R. Sauzède[1], H. Claustre[1], J. Uitz[1], C. Jamet[2], G. Dall'Olmo[3,4], F. D'Ortenzio[1], B. Gentili[1], A. Poteau[1], and C. Schmechtig[1]



Bio-Argo profiling float: Vertical dimension

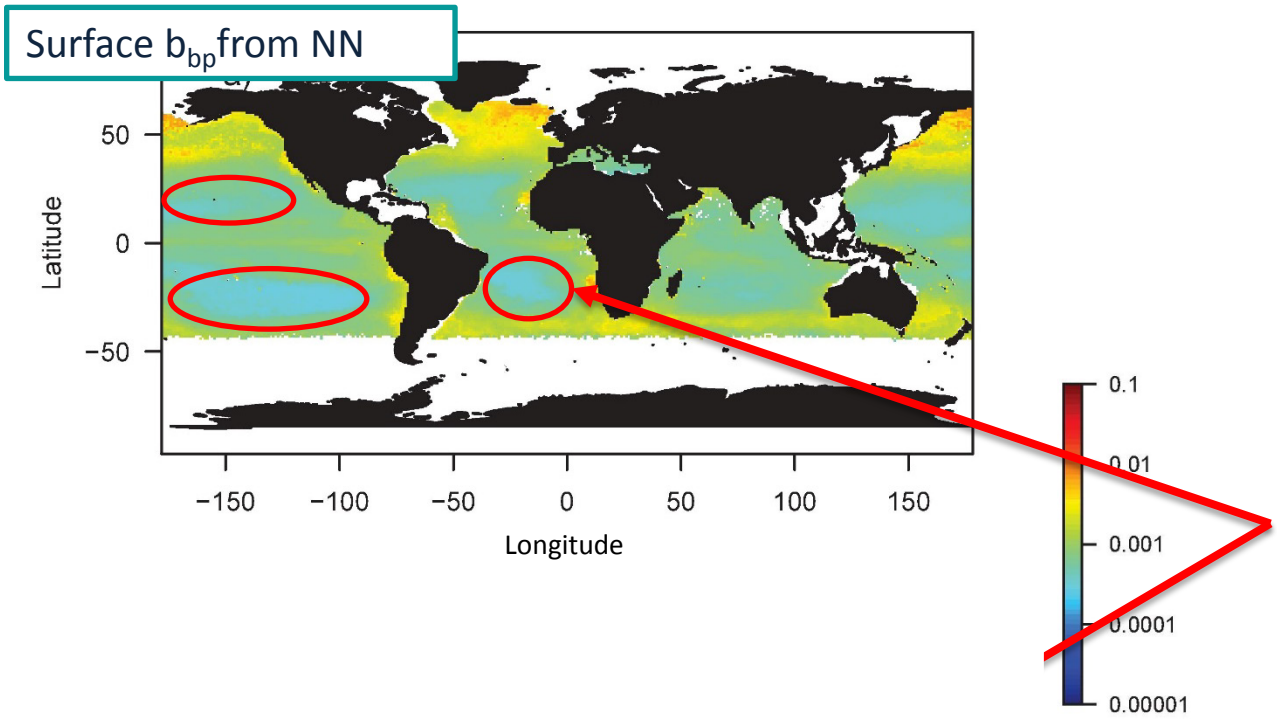
→ 3D/4D OCEAN BIOGEOCHEMISTRY

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

remOcean Remotely-Sensed Biogeochemical Cycles in the Ocean

AtlantOS

Exemple of application: retrieval of bbp at the surface

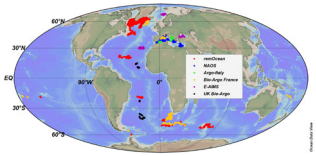


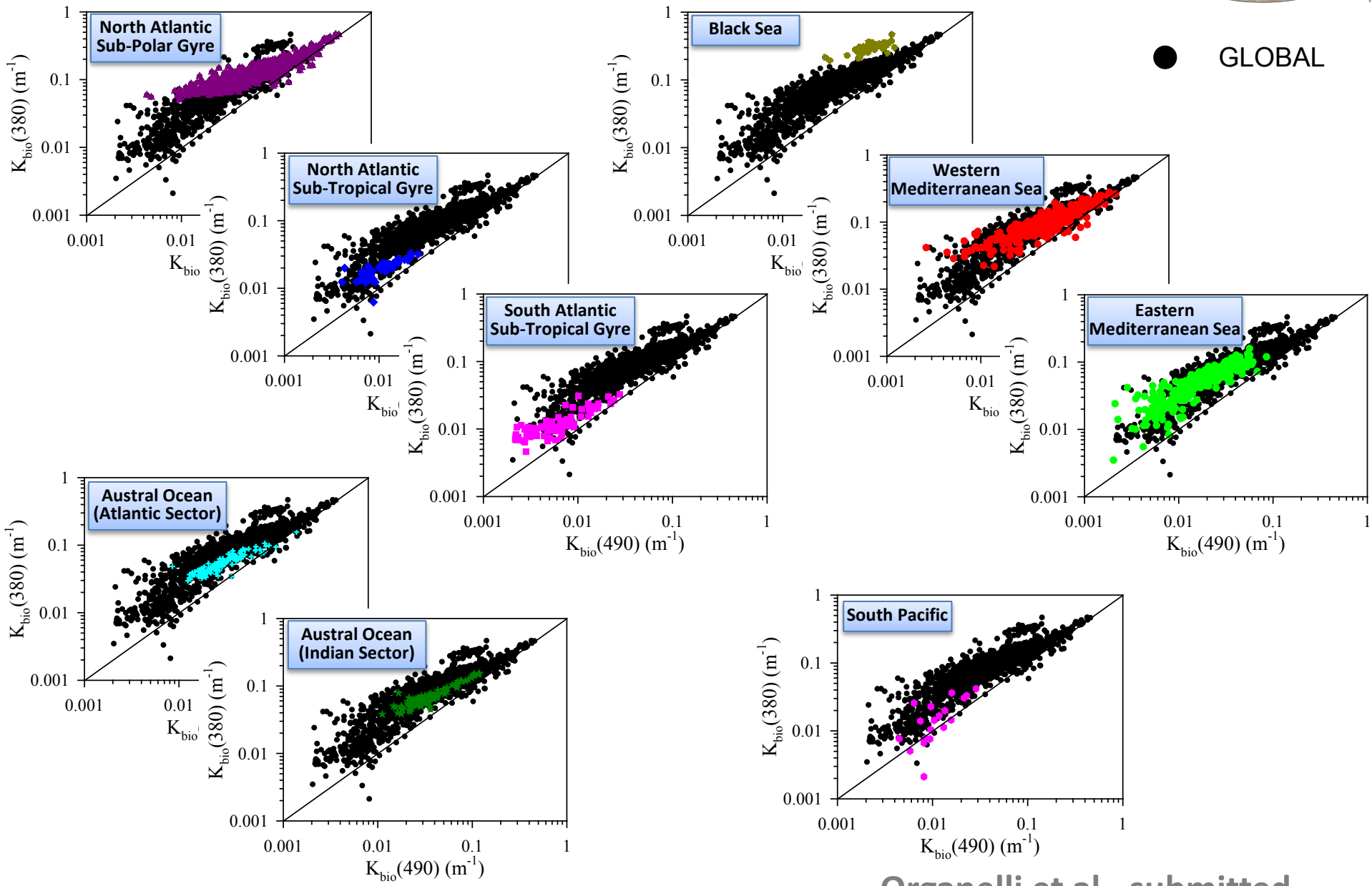
Overestimation of b_{bp} from satellite estimations: e.g. Brown *et al.*, 2008; Lee and Huot, 2014

remOcean Remotely-Sensed Biogeochemical Cycles in the Ocean

AtlantOS

Regional vs Global Kbio(490) vs Kbio(380)

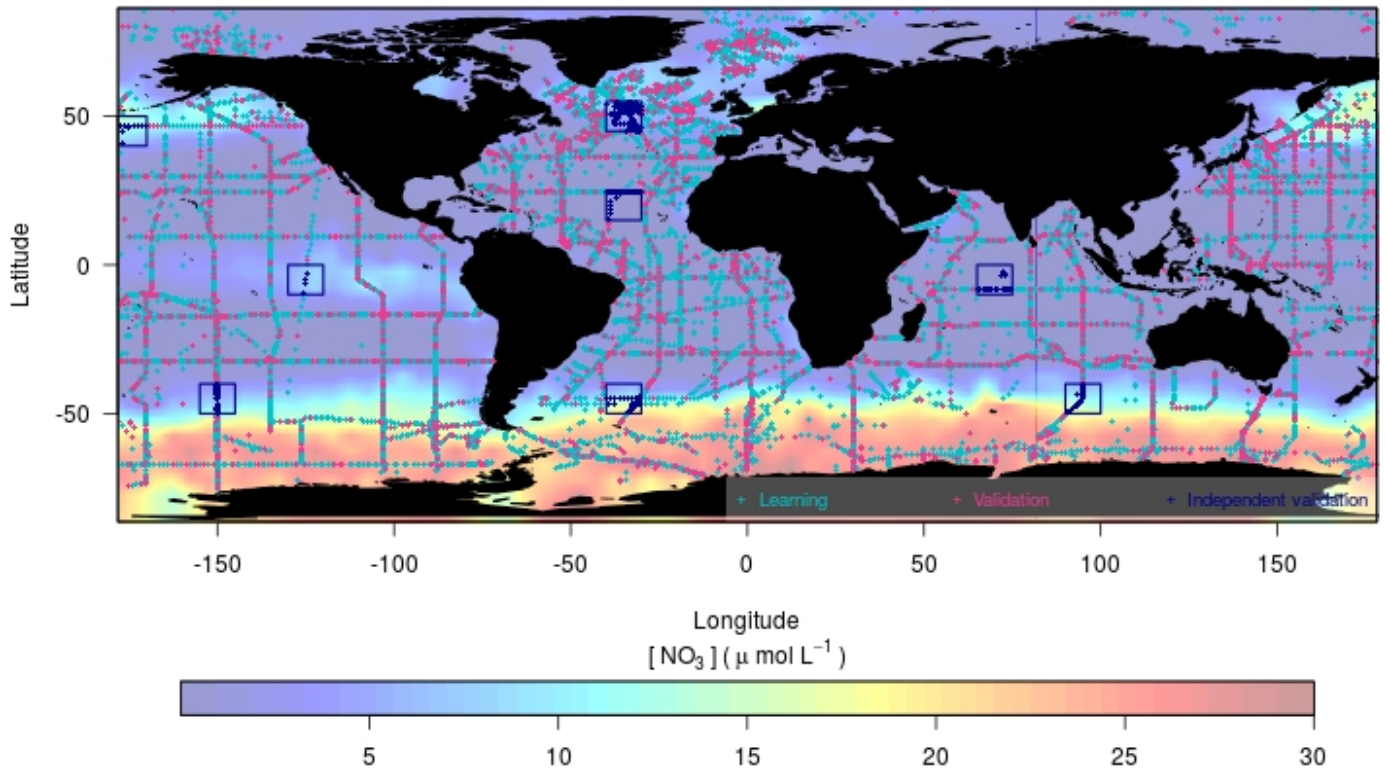




Organelli et al., submitted

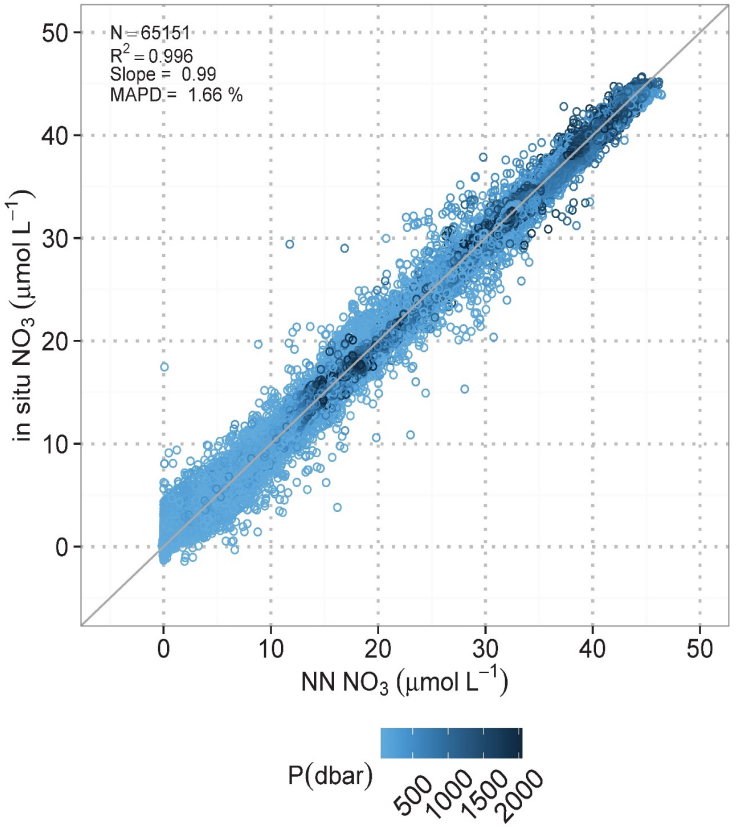
The glodap V2 data base

A uniformly calibrated open ocean data product on inorganic carbon and carbon-relevant variables

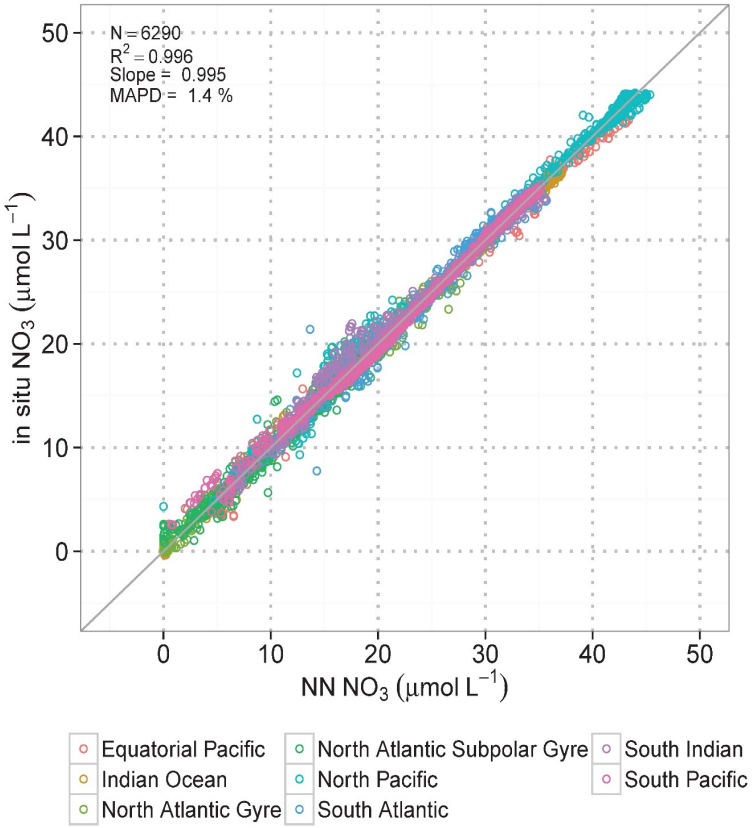


Sustained ocean observing for the next decade

Neural network for Inferring NO3 profile from P, T, S, O2 & Geolocation



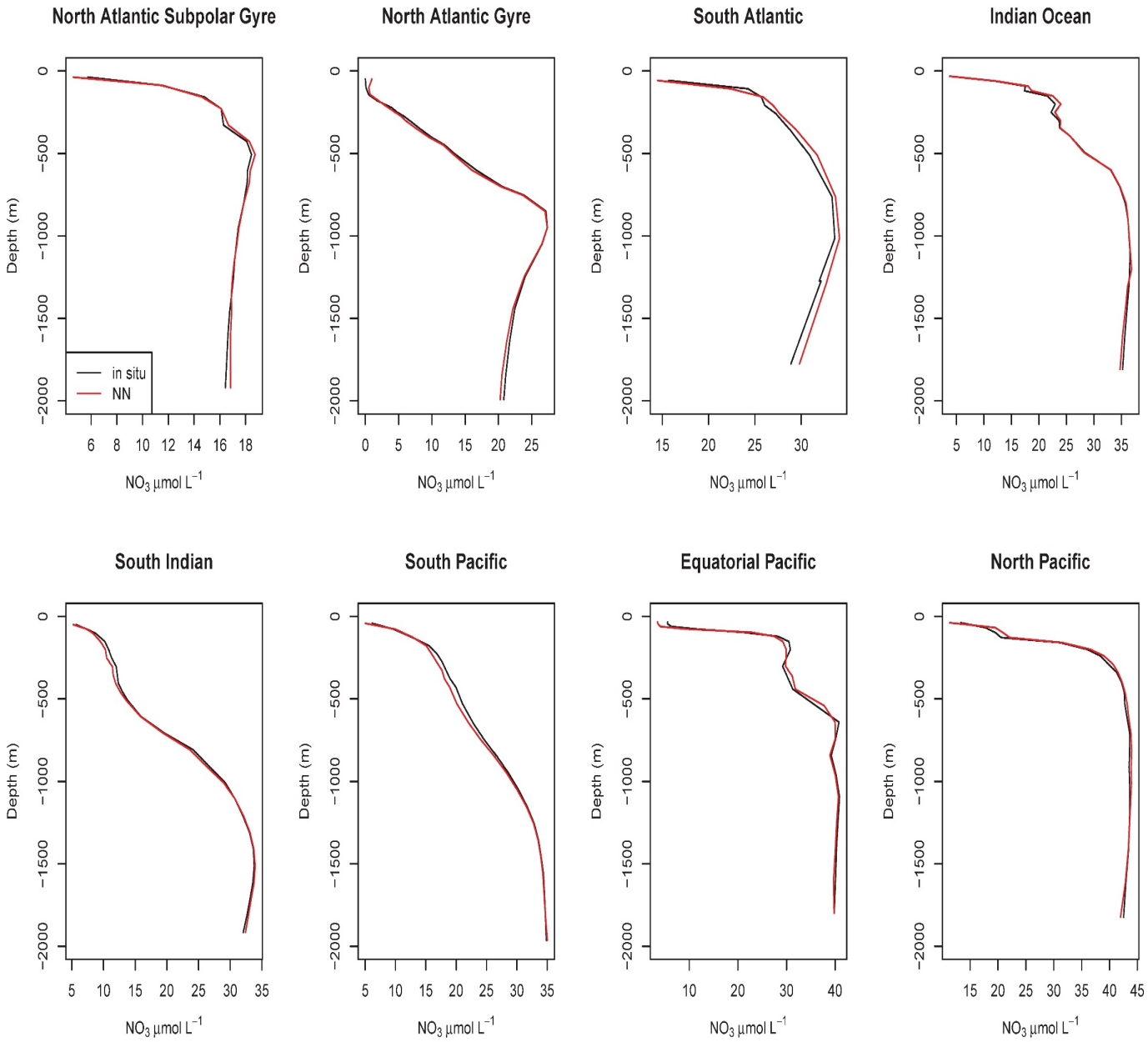
Validation on 20% of the global data base (did not serve for the NN training)



Validation on independent data base

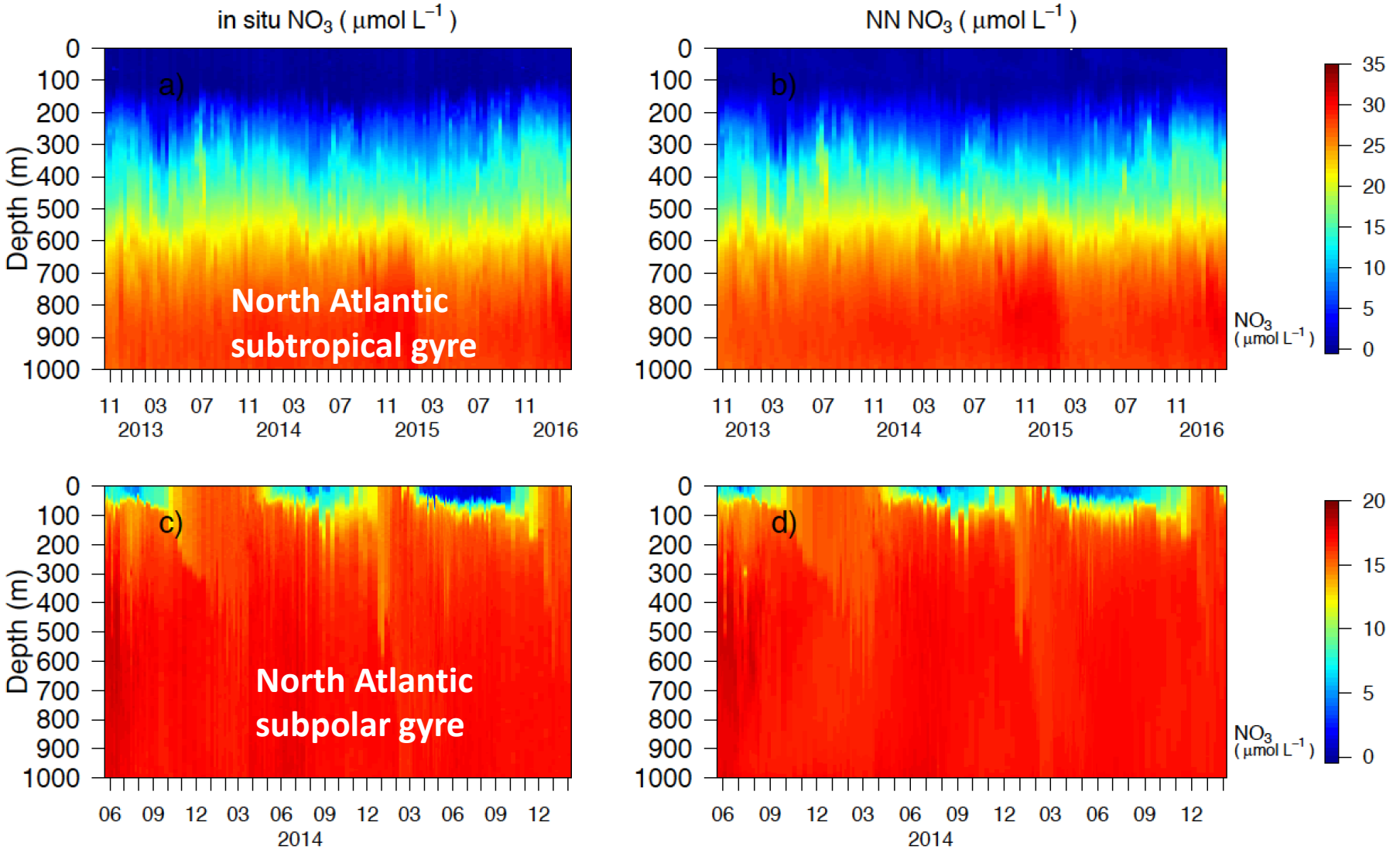
Accuracy of the retrieval ~ 1 µM kg^{-1}

Example of NO_3 prediction for random profiles in the 8 independent boxes



Sauzède, Pasqueron de Fommervault, Claustre et al, in prep

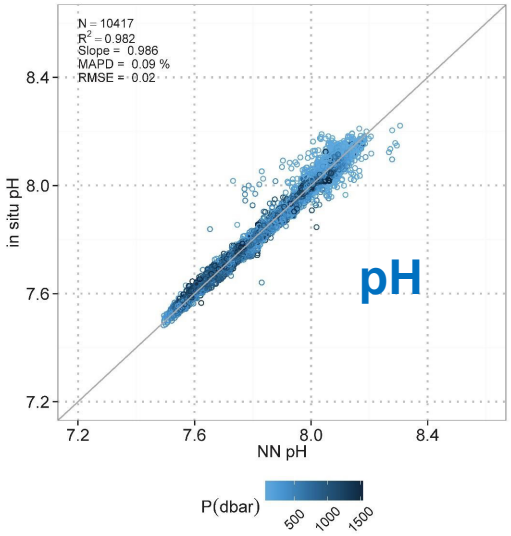
Float application

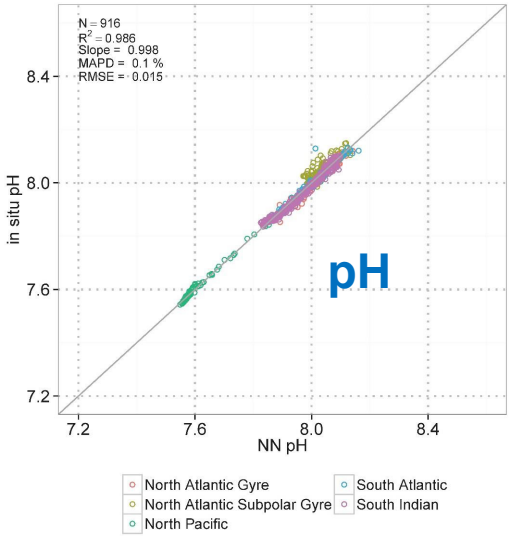


Remotely-Sensed Biogeochemical Cycles in the Ocean

Sauzède, Pasqueron de Fommervault, Claustre et al, in prep

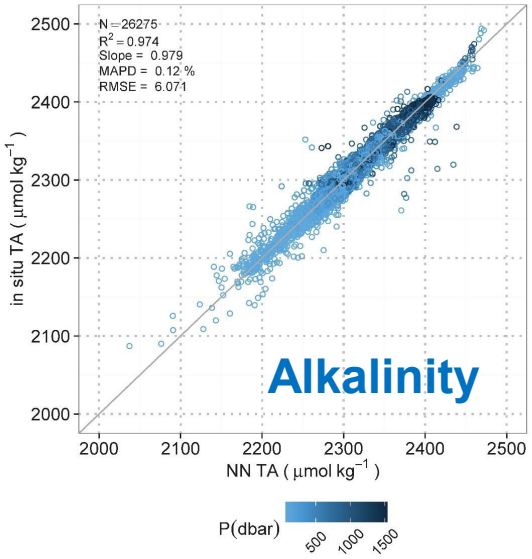
Inferring pH and alkalinity profiles from P, T, S, O2 & Geolocation

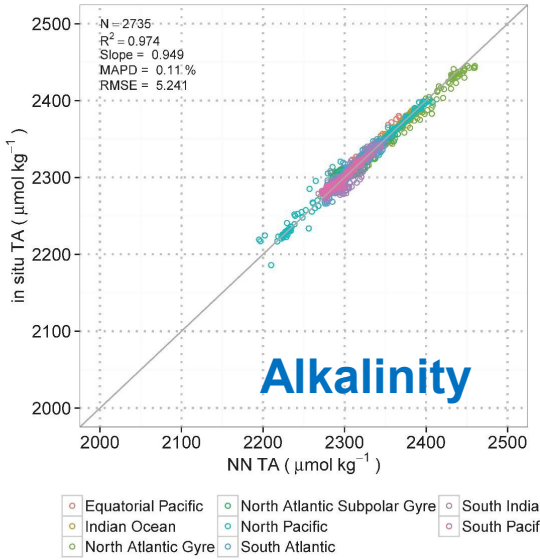


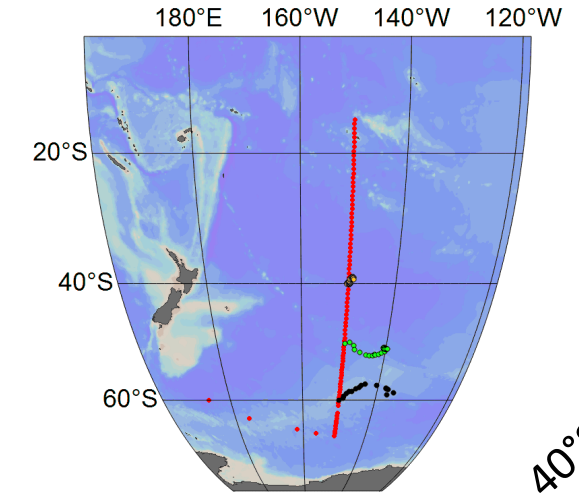


Accuracy of retrieval
0.02 pH unit

Accuracy of retreival
6 µmole kg^{-1}







Extend decadal-scale GO-SHIP carbon observations into the seasonal and interannual domain with BGC floats. Link the data to high res. models.

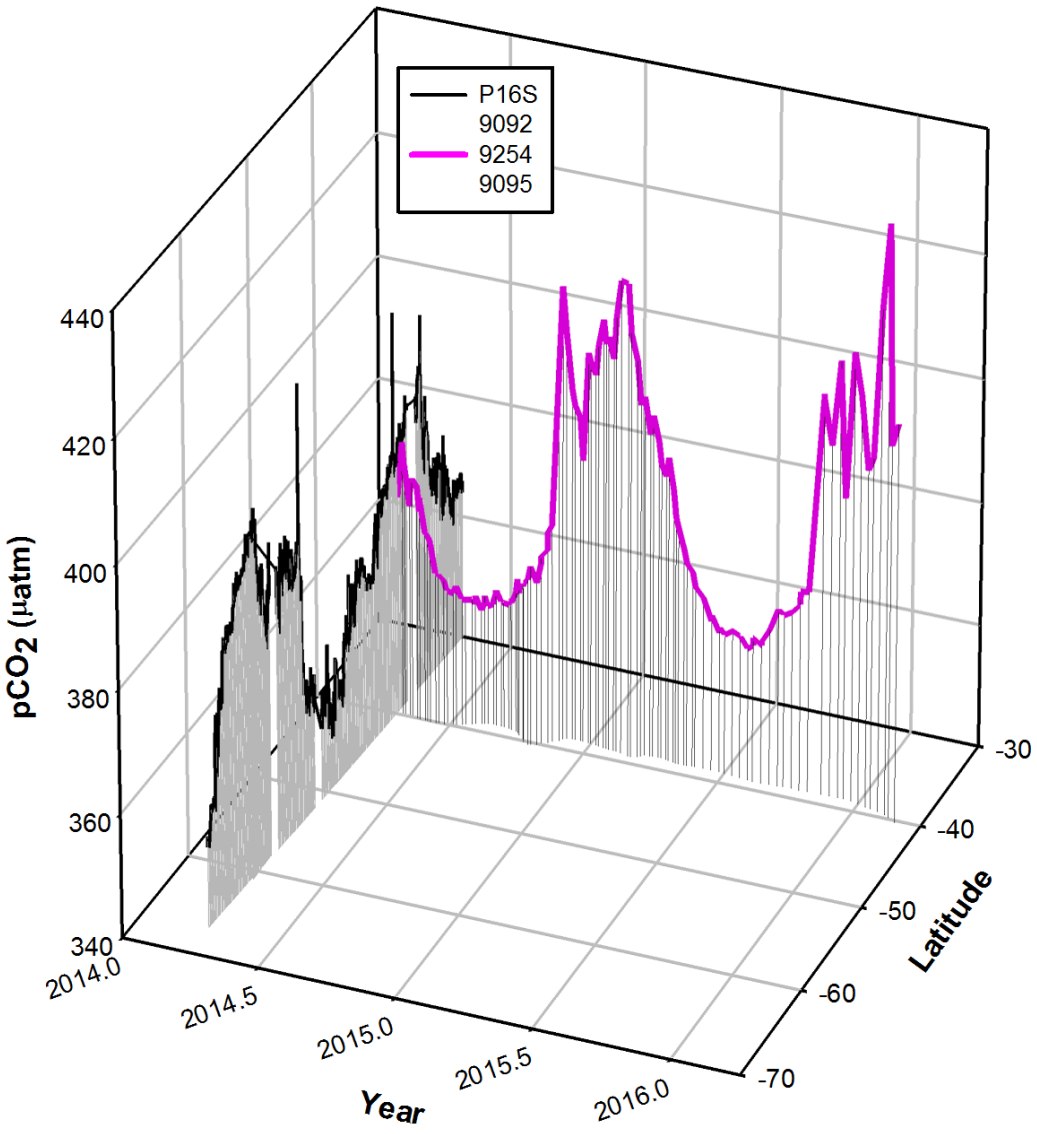
Float 9254

Float 9095

Float 9092

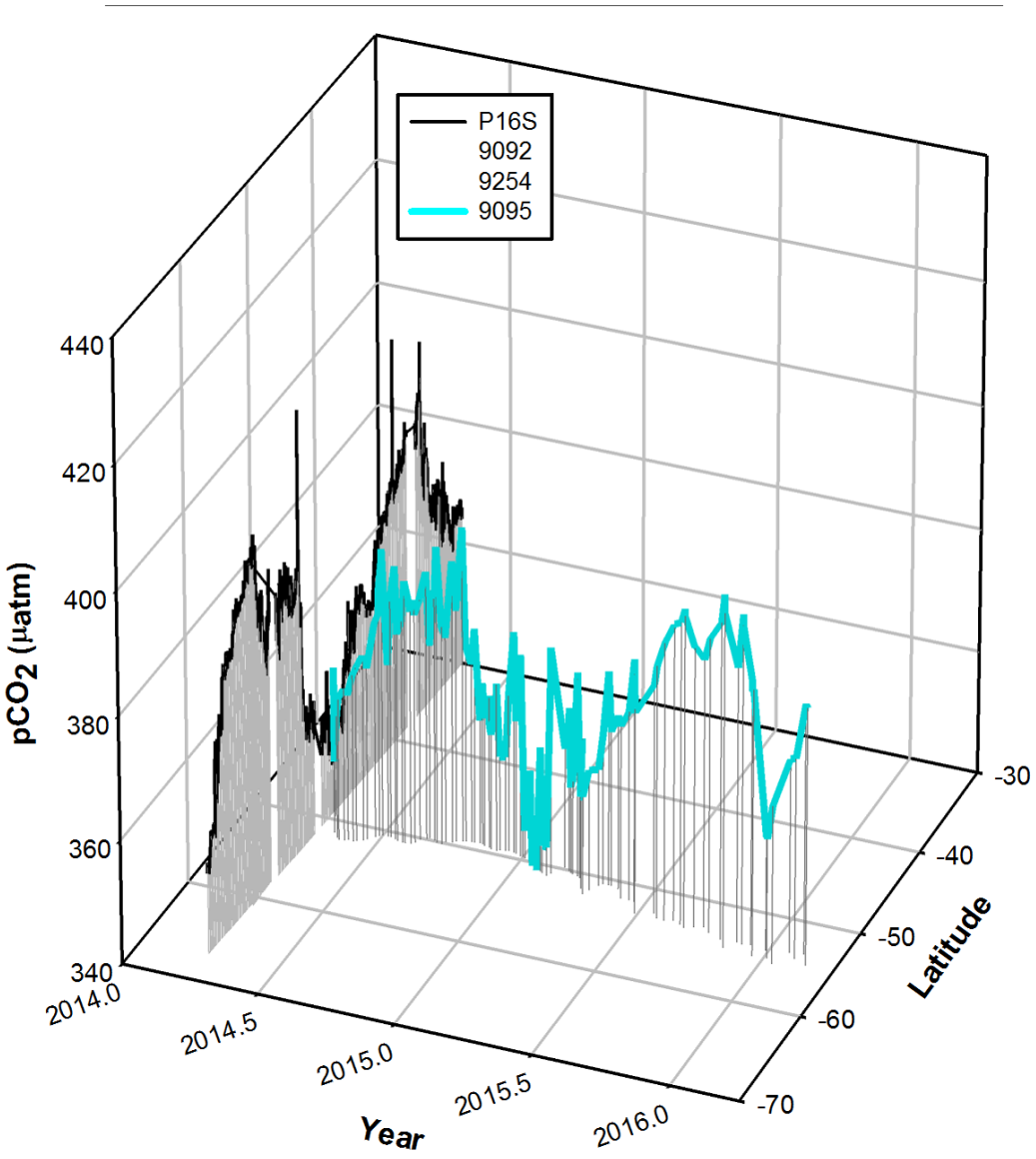
SOCCOM

Courtesy of Ken Johnson



Courtesy of Ken Johnson

SOCCOM



Courtesy of Ken Johnson

SOCCOM

O2 measurements on floats

- The least expensive measurement from the array
- Accurate measurement: easily and periodically calibrated over float life-time
- Helps in modelling NO3 with reasonable accuracy
  - When NO3 measured on float: O2 helps in DM-QC
- Helps in modelling pH & Alkalinity with reasonable accuracy
  - When pH measured on float: O2 helps in DM-QC
  - When pH measured= > assess oceanic CO2 pump through alkalinity

Optimizing and Enhancing the Integrated Atlantic Ocean Observing System

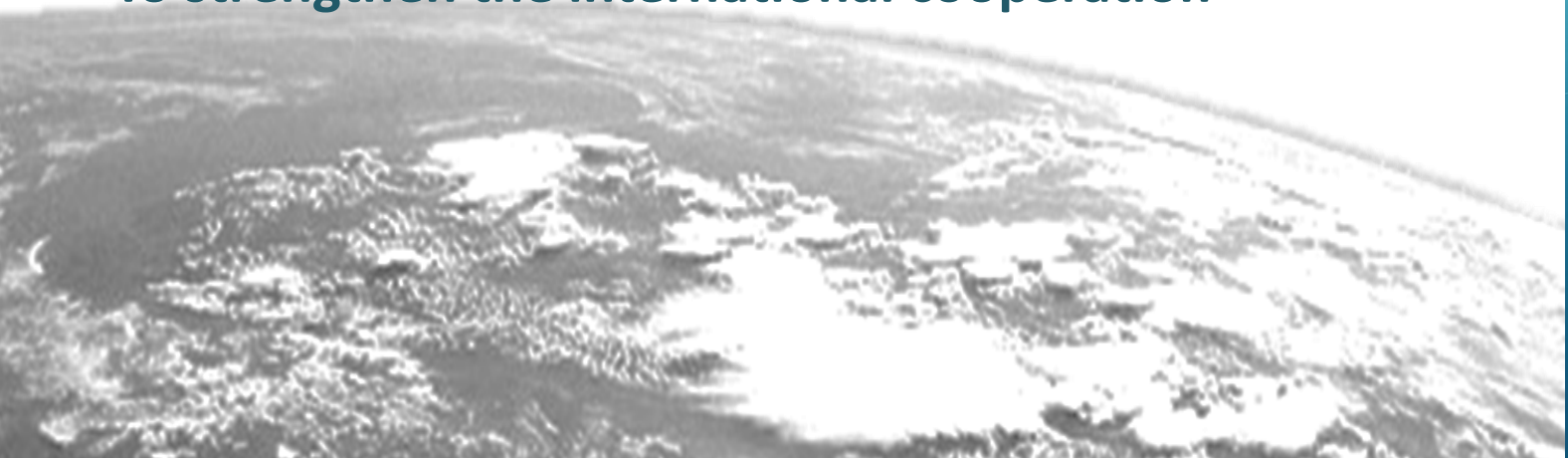
- **WP3: Enhancing autonomous network**
  - Task 3.1 Argo (ERIC is the lead)
    - DM Data base for Biogeochemical-Argo in the Atlantic
    - Implementing pH sensor
    - Testing other sensor (NO3 sensor from TRIOS)
    - 7 Biogeochemical floats to be deployed (ERIC, GEOMAR, PML, LOV)
- **WP7: data flow and integration**
  - Task 7.5 Product Development (EOV based assessments)
    - Ocean color Biogeochemical float data merging: 3D view for biogeochemical variable

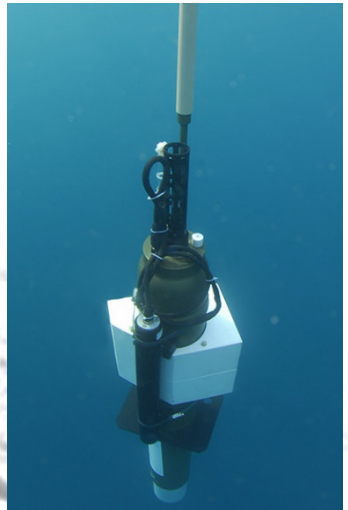
MARIE SKŁODOWSKA-CURIE ACTIONS - Innovative Training Networks "ARGONAUTS"

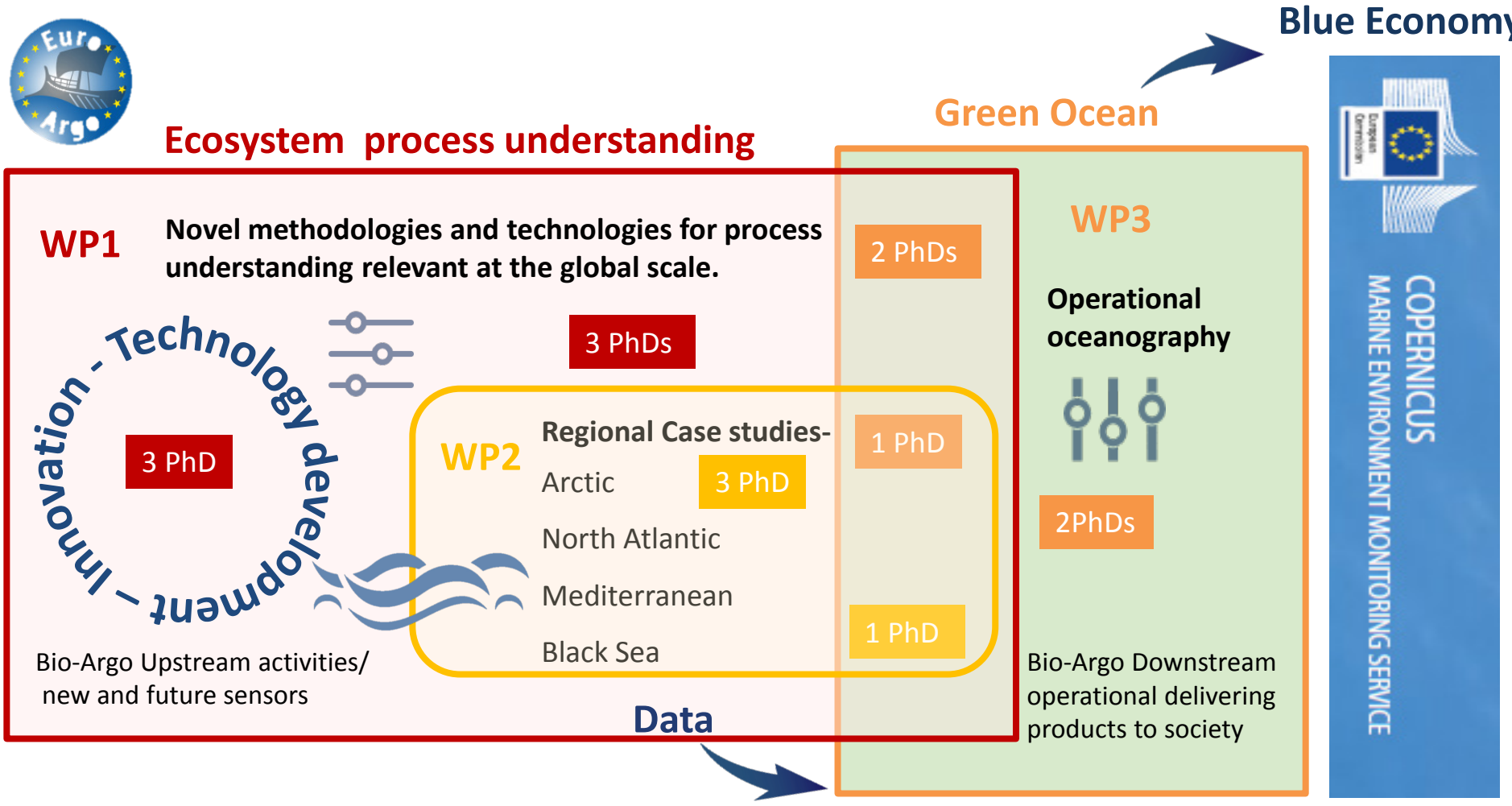
Argo -Ocean Network and Training

Marie Skłodowska-Curie Actions

- To educate the new generation of creative students (15)
- To facilitate the acquisition of interdisciplinary skills
- To design the observing system
- To improve the robotic technology
- To make optimum use of the resulting data
- To strengthen the international cooperation

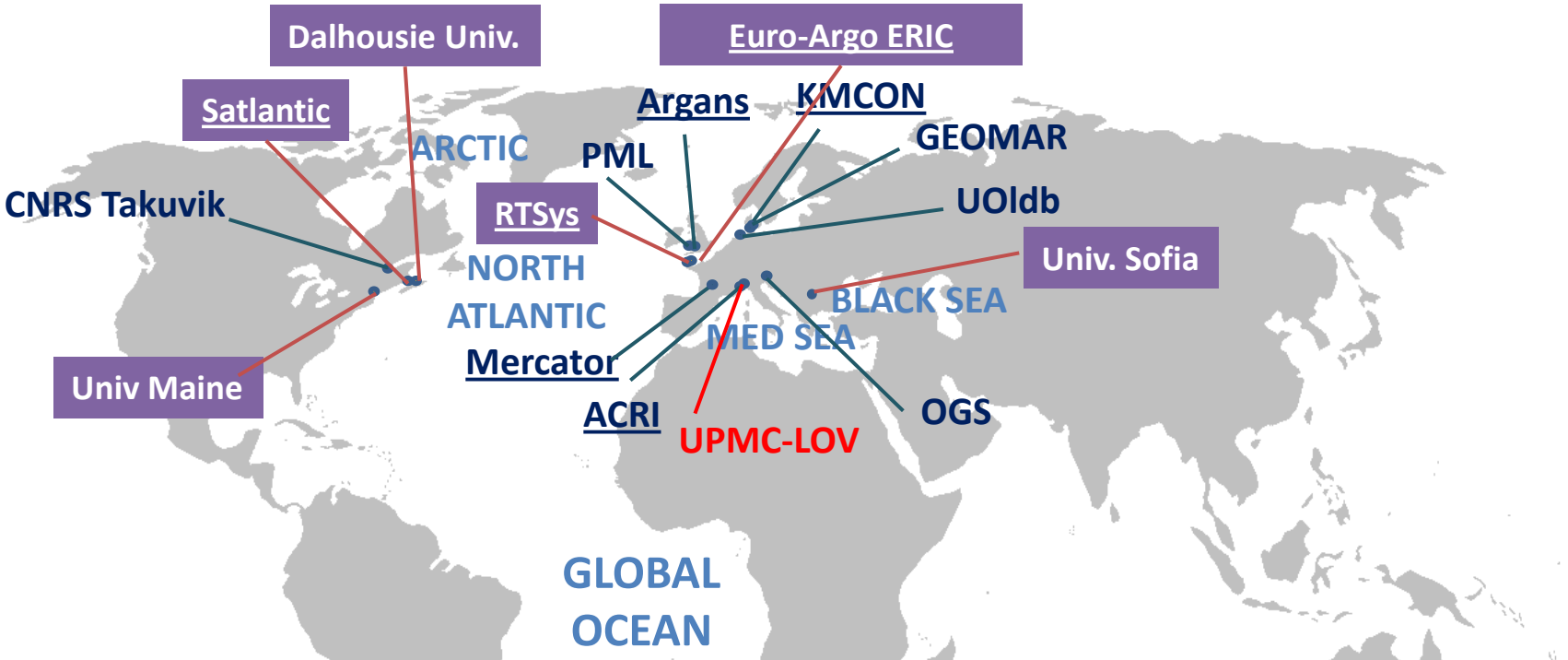





Blue Economy
Green Ocean
Ecosystem process understanding
WP1
Novel methodologies and technologies for process understanding relevant at the global scale.
3 PhDs
Technology development - Innovation
3 PhD
WP2
Regional Case studies-
Arctic
3 PhD
North Atlantic
Mediterranean
Black Sea
1 PhD
1 PhD
2 PhDs
WP3
Operational oceanography
2PhDs
Bio-Argo Upstream activities/ new and future sensors
Bio-Argo Downstream operational delivering products to society
Data
COPERNICUS
MARINE ENVIRONMENT MONITORING SERVICE
KMCON GEOMAR UPMC-LOV PML CNRS-Takuvik OGS UOLDB ACRI ARGANS Mercator Ocean

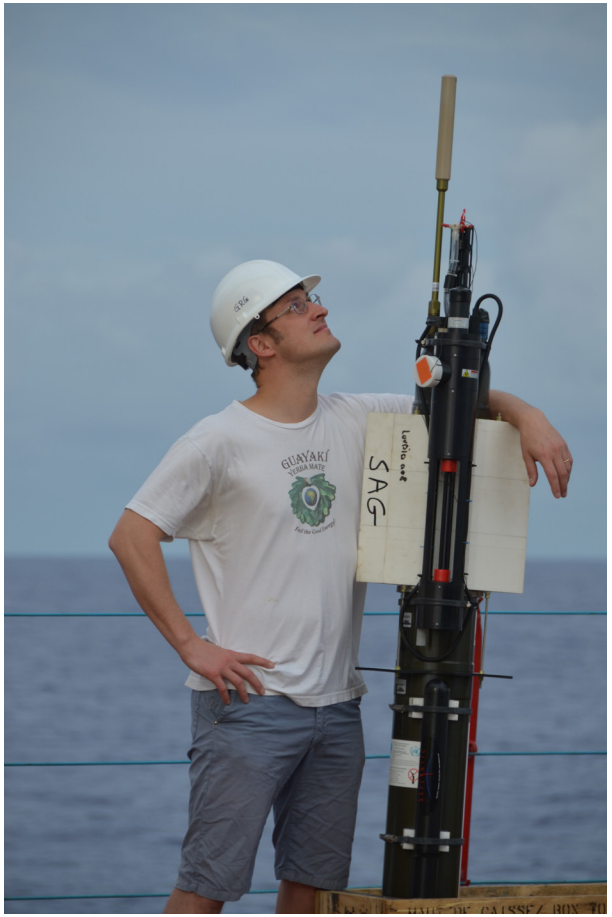
Triple I dimension of Argonauts – International, Interdisciplinary, Inter-sectorial location of Argonauts partners, in Europe and North America

Coordination: LOV



SENSORS MODELLING INFRASTRUCTURE O2 MIN. ZONE CHEMISTRY OCEAN COLOUR GAS SENSORS INTEGRATION METHODS OPTIMIZATION PHYSICS OPERATIONAL OPTICAL SENSORS MODELLING POLAR SYSTEM ACOUSTIC SENSORS BIOGEOCHEMISTRY SATELLITE SYNERGIES REMOTE SENSING SYSTEM INTEGRATION METHODS OPTIMIZATION

Thank you for your attention



Delayed mode quality control and link with Ocean colour remote sensing