Introduction to the BIO-ARGO working group

The scientific and strategic challenges of designing a program based on ARGO float technology and bio-optical sensors.

The preliminary recommendations of the WG

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Introduction to BIO-ARGO WG scientific context

Remote sensing : powerful, but some limitations

1. restricted to the upper ocean layer
   => no access to 4/5 of the so-called euphotic layer

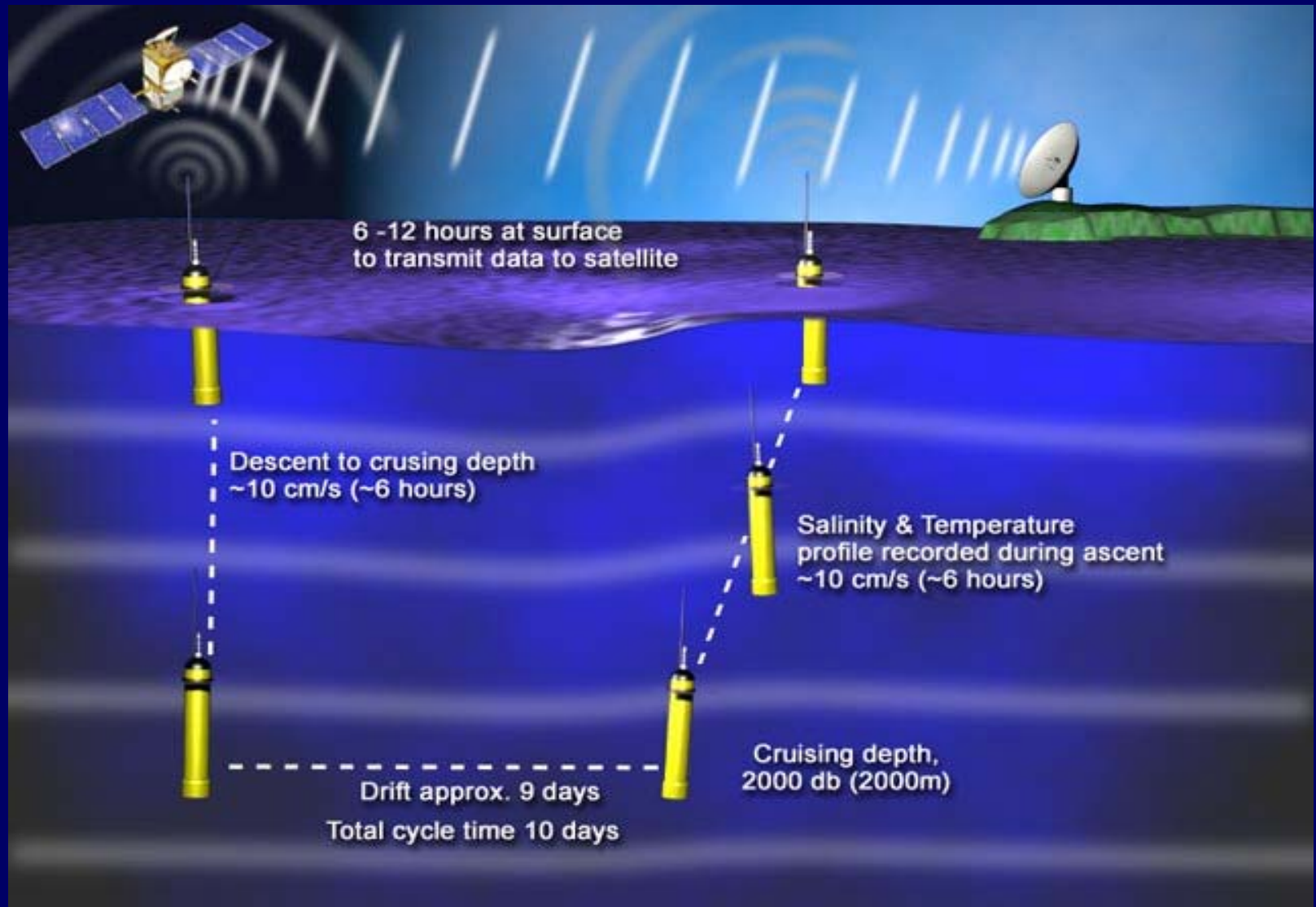
2. cloudy areas are unobservable by remote sensing
   => North Atlantic during the spring bloom

3. Calibration / validation : seatruthing
   => Essentially dependant on moorings or cruises (some spatio-temporal limitations)

To reach its full potential, remote sensing must be complemented with other techniques

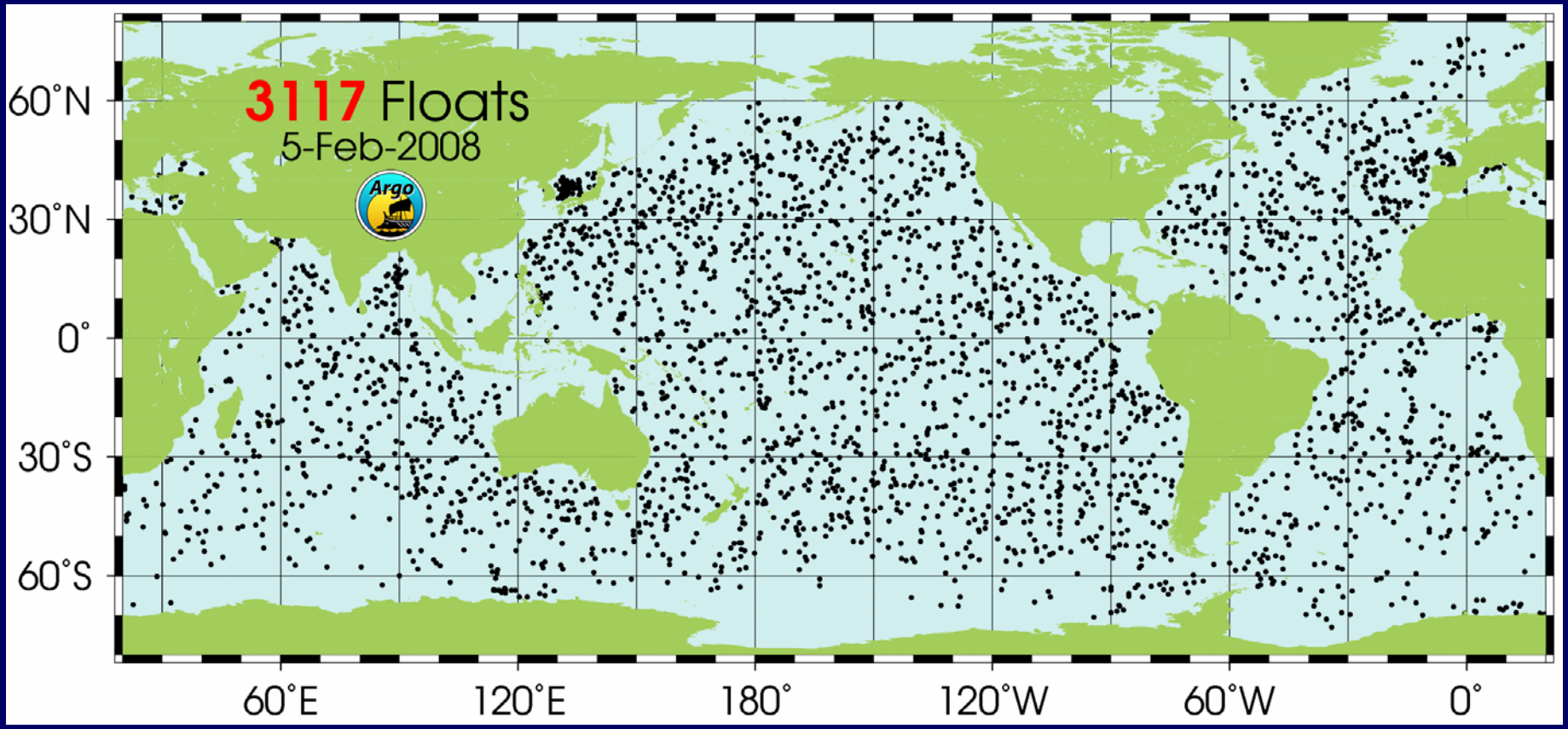
Introduction to BIO-ARGO WG scientific context

The ARGO profiling floats.



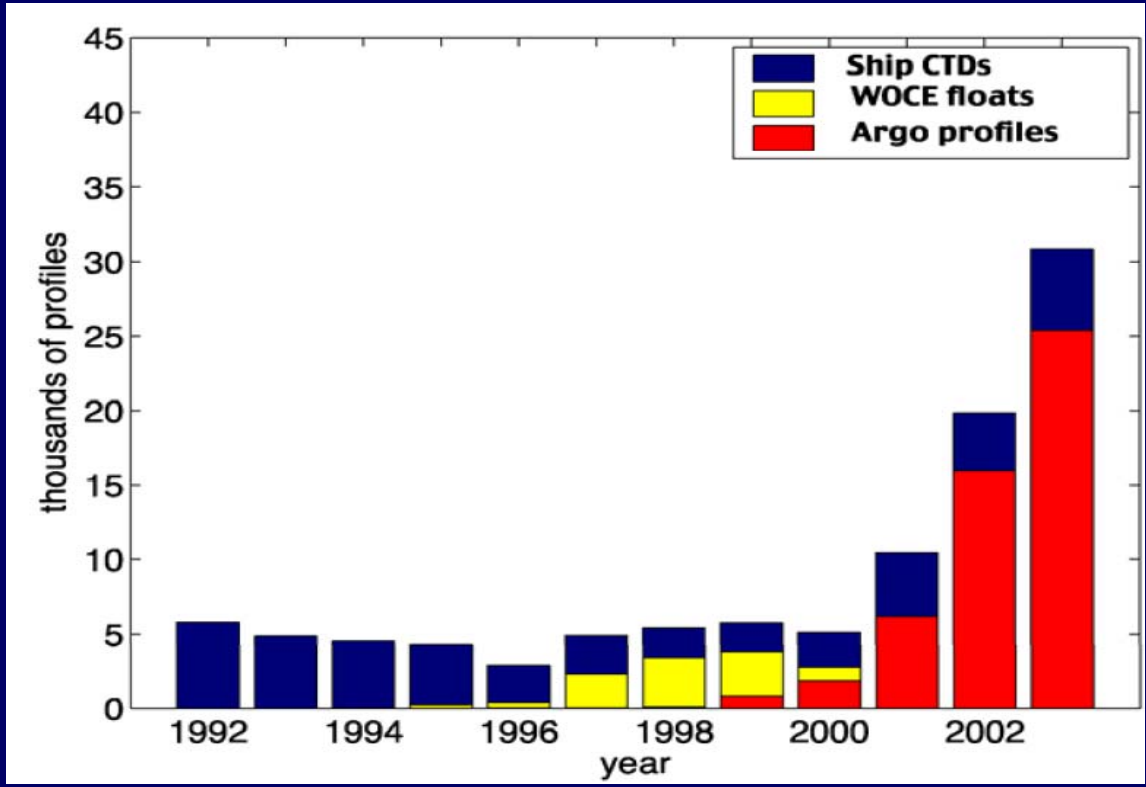
Introduction to BIO-ARGO WG scientific context

Until recently, undersampling of physical properties was the rule but then came the ARGO program, based on the use of profiling floats.



Introduction to BIO-ARGO WG scientific context

Thanks to the ARGO program / floats, there has been a spectacular increase in the number of observations (T, S)



An important reason for the success of ARGO is that the cost of a T,S profile is much less using a float than a ship-based platform

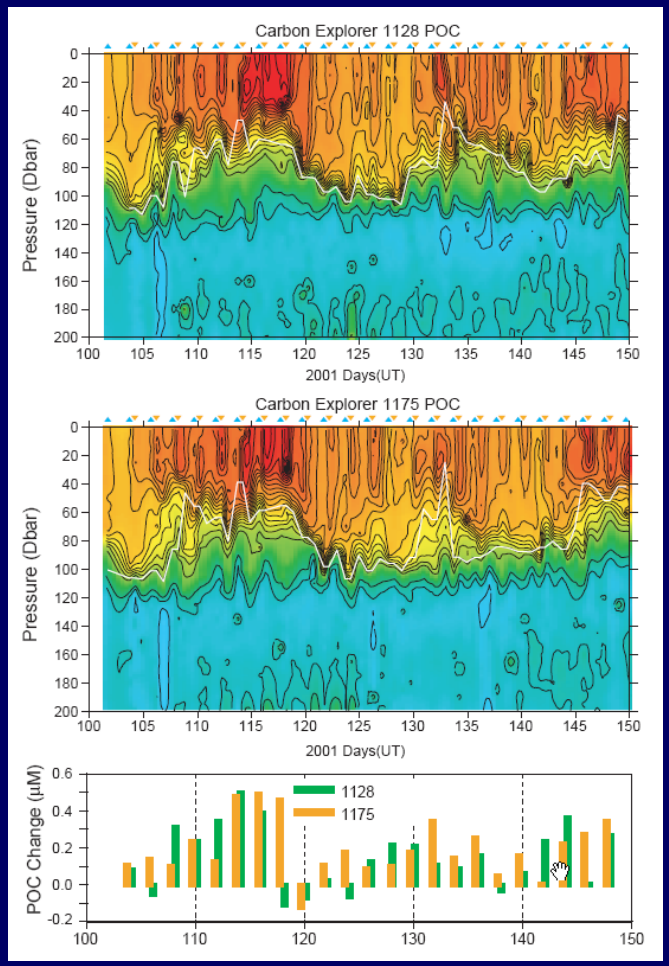
Introduction to BIO-ARGO WG scientific context

Recent development of low-consumption and miniature neutrally buoyant sensors (oxygen, radiometers, backscattering meters, fluorometers, transmissiometers…) provides good candidates for mounting on floats.

…and biogeochemists have begun to implement these sensors on ARGO floats for dedicated local or regional studies. (examples)

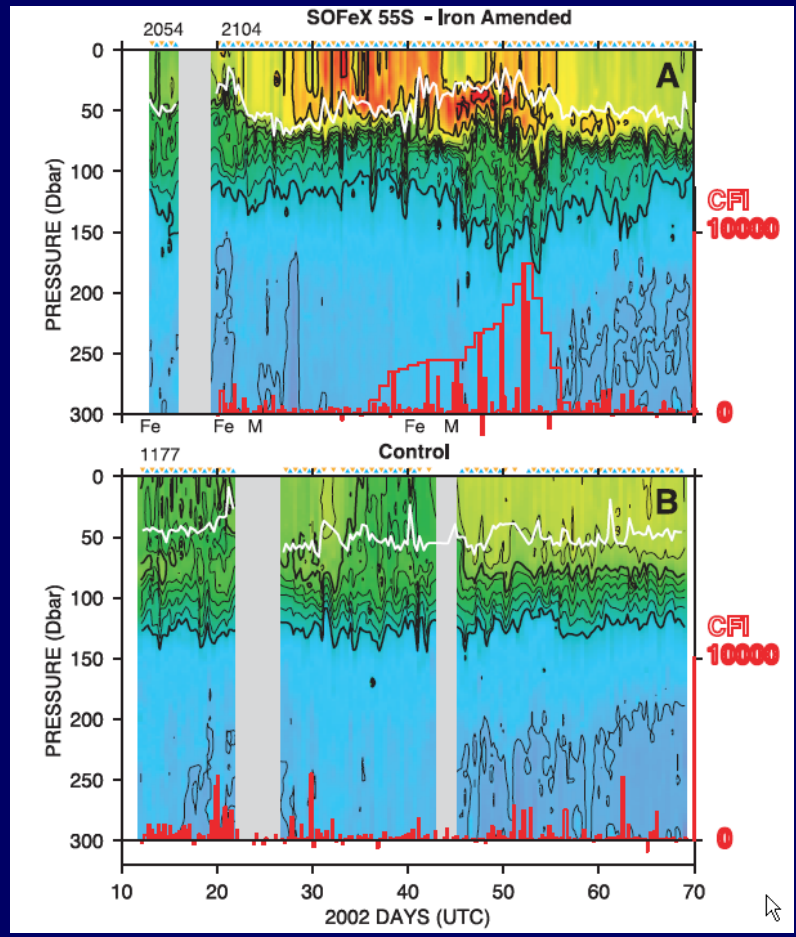
Introduction to BIO-ARGO WG scientific context

Carbon explorer : SOLO float + transmissiometer



55°N;145°W

Bishop et al., *Science*, 2002

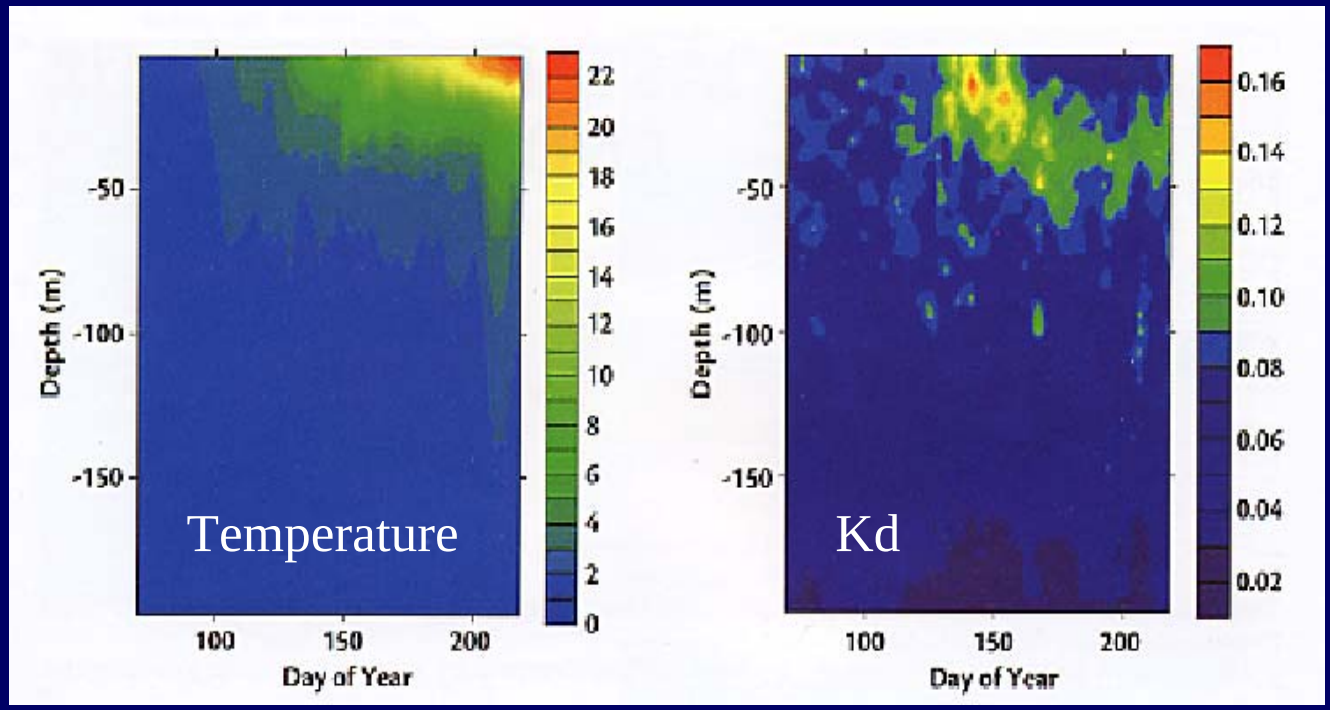


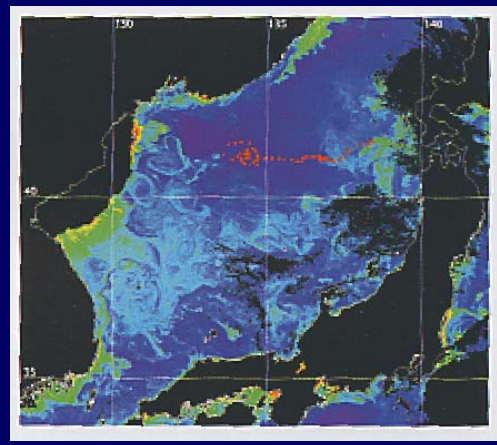
55°S ;170°W

Bishop et al., *Science*, 2004

Introduction to BIO-ARGO WG scientific context

K-SOLO : SOLO float + radiometer

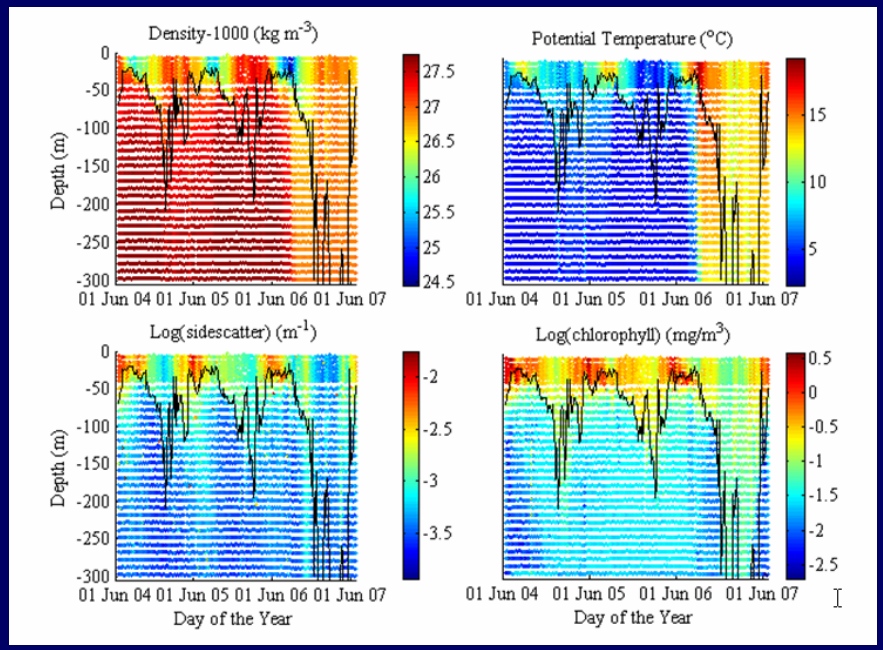


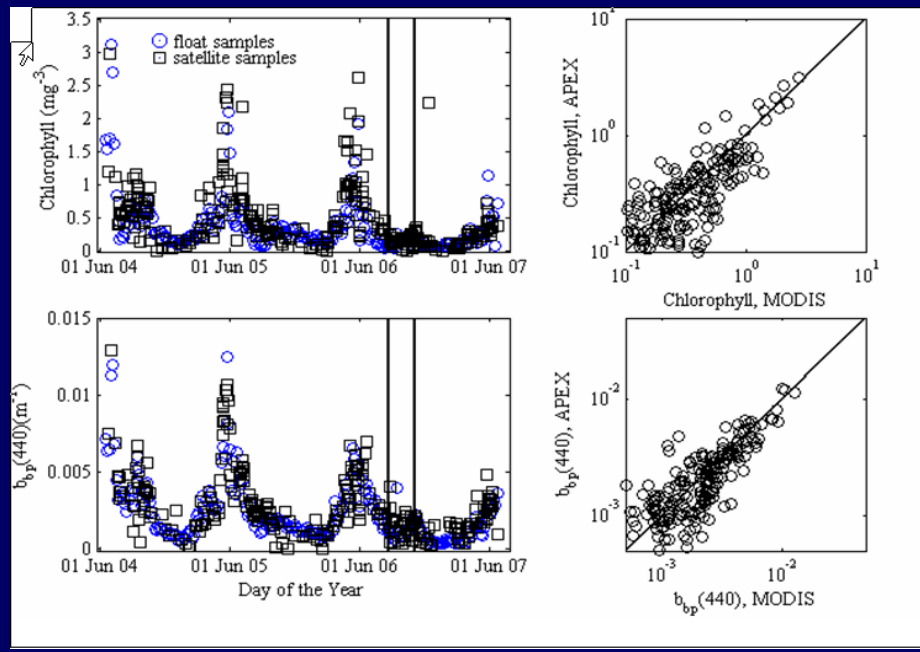


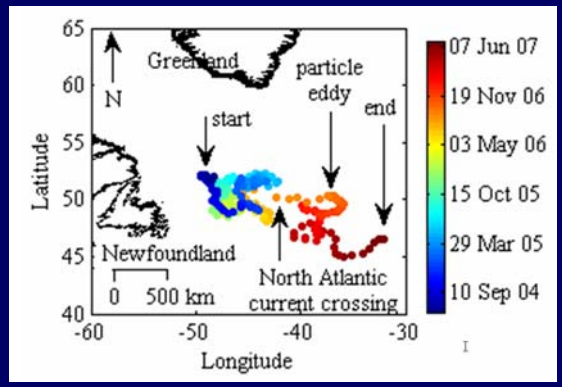
Experiment in the Japan Sea (Mitchell et al, 2003)

Introduction to BIO-ARGO WG scientific context

Apex float + optical package







Boss et al., 2008, *L & O*, in review

Introduction to BIO-ARGO WG scientific context

ARGO floats with optical / biogeochemical sensors have a very large potential to provide high density bio-optical-geochemical data.

- ARGO floats provide the vertical dimension of properties that is missed by satellites
- ARGO floats can provide information from anywhere anytime, including under cloudy conditions (North Atlantic during the spring bloom)
- ARGO floats have an extensive global coverage (limit of 3000)
- ARGO floats could provide large amounts of data for validation purposes

Thus ARGO technology together with new sensors represent a very promising avenue for synergetic applications with remote sensing of ocean color. IOCCG asked us to investigate this topic and make recommendations.

Introduction to BIO-ARGO WG strategic context

A personal statement from the chairman : In the ocean, biological and biogeochemical processes depend on physical forcing. A **BIO-ARGO** program should not be a side program, independent of the ARGO physical program. Optimally, it should be clearly defined and then implemented in close association with the physical community.

- **BUT** : are there any reasons why physical oceanographers should share their « ARGO system » with others?

Introduction to BIO-ARGO WG strategic context

The response is likely **no** because :

• Presently ARGO is a well organized, mature program, BIO-ARGO is only a concept.

• Physical processes (generally) do not depend on biological and biogeochemical processes => no scientific interest is a priori expected from physical oceanographers.

• Additional new measurements (beside T, S):

- Might be technically challenging (buoyancy change, transmission issues…) and could perturb the regular functioning of « classical » T, S data acquisition
- Might be costly : new sensors, additional transmission costs, additional resources for data base management…

We will need to provide (strong) arguments to convince the physical ARGO community of the interest in working together

Introduction to BIO-ARGO WG strategic context

Our working group is involved in the preliminary steps before envisaging an (eventual) BIO-ARGO program. We will need to make two types of recommendations

(1) **Clear scientific and technical recommendations** (TOR), keeping in mind that our first objective is linked to ocean color remote sensing (this is the first mission given to us by our IOCCG sponsor)

(2) **Strategic recommendations which enhance the value of our work in a more multidisciplinary context**

Introduction to BIO-ARGO WG preliminary recommandations after the meeting

WG : E.Boss, J. Bishop, S. Bernard, C. Coattanoan, J.F. Berthon, H. Claustre. (O. Ulloa not present)

Invited:

(1) P. M. Poulain (univ of Trieste): responsible for the MED-ARGO program

(2) M. Belbeoch (ARGO technical coordinator)

- positive message from Dean Roemich, ARGO
- many information related to the implementation and, functionning of Argo.

Introduction to BIO-ARGO WG
preliminary recommandations after the meeting

The 11 terms of reference identified by IOCCG have been reviewed and discussed.

Beside the technical points addressed during these discussions some important additional complementary points have emerged:

Introduction to BIO-ARGO WG preliminary recommandations

A : Three types of ARGO like floats have been identified for bio-optical / bio-geochemical activities

B : Recommendation for a BIO-ARGO mission simulator to be implemented

C : Recommendation for a preparatory phase for the “validation” of different floats

D : Recommendation for a pilot study, before developing large scale applications

E : Recommendation for opening the group to others scientists / community.

Introduction to BIO-ARGO WG preliminary recommandations

1 Three types of ARGO like Floats have identified

 # 1 : VAL-ARGO : VALidation activities only (Berthon, Stewart, Boss)

- Iridium T, S float
- Ed (top), Lu (bottom) sensors ~ 5 λ
- Chla fluorescence, CDOM fluorescence, b_b meter
- Parking depth : 300-400 m
  - saving energy with respect to 1000-2000 m (and hence increase of profile nb)
  - dark currents measurements for potential drift
- Iridium transmission
  - adaptative sampling : precise matching with satelite overpass
  - changing the frequency of sampling (e.g. according to wheather forecast)

- cost estimation : ~ 40 k$ (including float)

Introduction to BIO-ARGO WG preliminary recommandations

 # 2 : BGC-ARGO : BioGeochemiCal Argo float (Boss, Claustre)

- to fit with (and to disturb the less possible) the ARGO array (~low cost)
- ARGOS => ARGOS 3 => Iridium T, S float
- Chla fluorescence, CDOM fluorescence, b_b meter (or beam c-meter)
  => proxy of Chla / DOC / POC biogeochemical applications
- vertical propagation of remotely detected properties
- dedicated to a biogeochemical (operational) end user community
- objective of large dissemination => 3000 (!)
- objective of buidling very large data base from which (long) trends will be extracted
- **together with IOCCG, also concerns ARGO, IOCCP and other end-user (operational partners)**
- ~ 25 k$ float (including float)

Introduction to BIO-ARGO WG preliminary recommandations

 # 3 : C-ARGO : carbon ARGO (Bishop, Claustre)

- ARGOS => ARGOS 3 / Iridium T, S float

- PIC / POC sensor for biomass
- Proxies of PP can be derived using diel cycle in optical properties
- flux measurement at parking depth

- dedicated to the measurement of standing stock and flux in the context of carbon cycle (e.g. acidification)
- possibly more oriented towards process (JGOFS-like,) process studies with emphasis is put on selected site

- **together with IOCCG, also concerns IOCCP, SOLAS, IMBER and ARGO**

- ~ 30 k$ float (including float)

B : Recommendation for a BIO-ARGO mission simulator to be implemented

For interacting efficiently with the Argo program we need to provide objective elements regarding the additional costs (with respects to “routine” Argo) associated with implementation of optical sensors

As part of this working group, a bio-ARGO mission simulator has to be developed to evaluate these costs (many related to energy costs) according to various configurations / missions including :

- type of sensors
- max depth of the profile and resolution
- cost (and duration) of the transmission (Argos vs iridium)

The issues of the additional costs of data management will be examined too.

C Recommandation for a preparatory phase for the "validation" of different floats

As Soon as possible…

Where ? Med Sea, close to BOUSSOLE / DYFAMED

- **Boussole Mooring** for absolute cal/val
- historical series (17 years of hydro-biogeochemical acquisition)
- strong seasonality

- 2 VAL-ARGO
- 2 C-ARGO
- 2 BGC-ARGO
- Some fundings issues, nevertheless manageable

D : Recommendation for a pilot study, before developing large scale applications

Oxygen Minimum zone, a likely candidate

• large biomass at the surface (and associated messocale patterns), interest in OC remote sensing

• A vertical continuum can be explored though Bio-Argo floats including biomass / production issues in the surface layer and the connection between O2 depletion below

• Beside an obvious scientific interest, also a strategic one by associating, through the use of bio-ARGO floats, the O2 community (friend of oxygen on ARGO) together with the optical one.

• Chile-Peru vs **Arabian Sea** have been discussed: priority to the second one as it might involve Asian countries.

E : Recommendation for opening the group to others scientists / community.

Two new members should be associated :

• still a strong need to associate Asian countries: Argo propose to help us in identifying the good person interested in Bio-ARGO

• K Johnson : MBARI: development of an optical sensor of nitrate (ISUS-like) that is already profiling on an ARGO float

Need to interact with :

• “the friend of oxygen on ARGO group”, sponsored by IOCCP

• end users of Bio-ARGO data, in particular modelers

proposition to invite N. Gruber, C. Lequéré, A. Kortzinger (and/ or others) to the next IOCCG meeting (*November 2008 in Villefranche*)