BOUSSOLE OVERVIEW

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OUTLINE

- > Introduction
- > Choice of the site
- > Choice of the platform
- > Choice of the instruments
- > Strategy
  - – data sampling
  - – instrument Calibration
  - – buoy and instrument maintenance
  - – staff
- > Conclusions

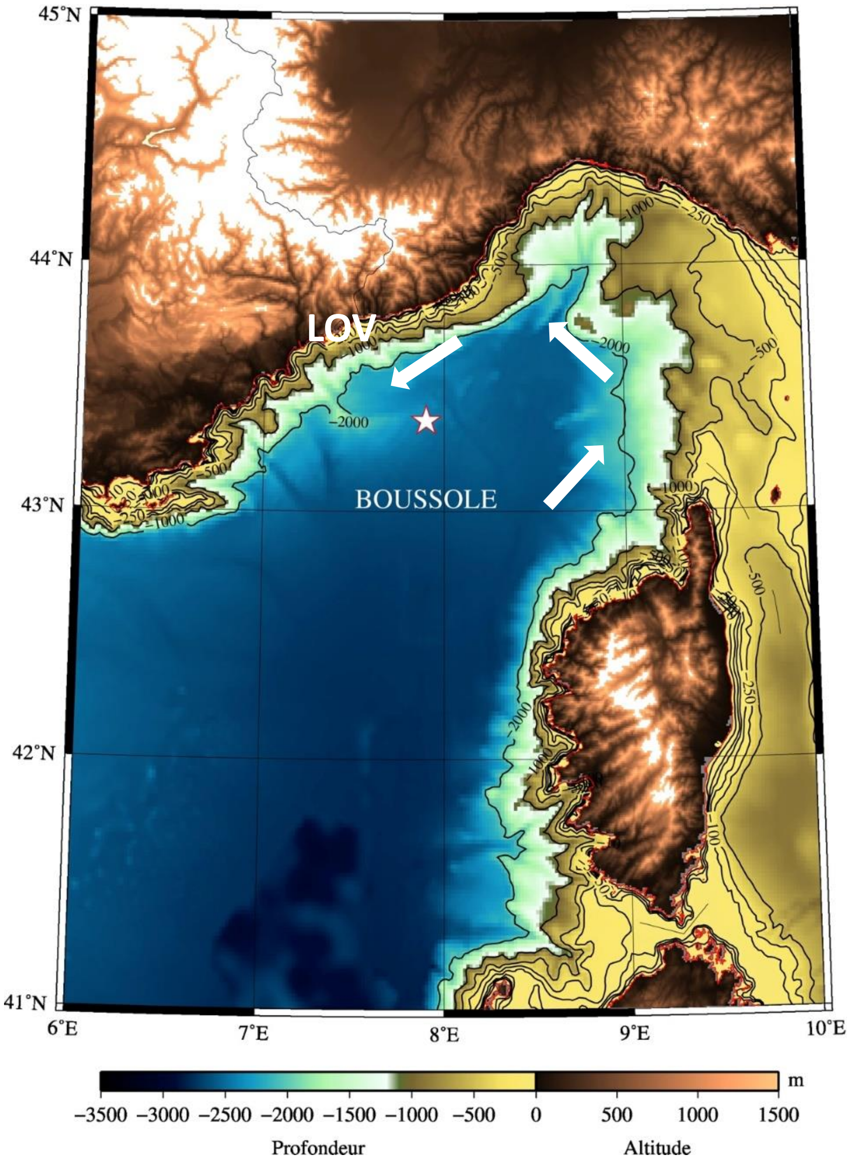
Motivation, objectives: establishing a long-term time series of optical properties (IOPs and AOPs), with two parallel objectives

SCIENTIFIC OBJECTIVE

> IOPs et AOPs documentation and understanding (bio-optics research), short-time changes...

OPERATIONAL OBJECTIVE

> Vicarious calibration of ocean color satellite observations, and validation of the Level-2 geophysical products derived from these observations (*e.g.*, chlorophyll, reflectance, optical properties...)



Site

> 43°22' N – 7°54' E
> Ligurian Sea (NW Mediterranean)
> 32 miles offshore (and from LOV facilities)
> 2440 m depth

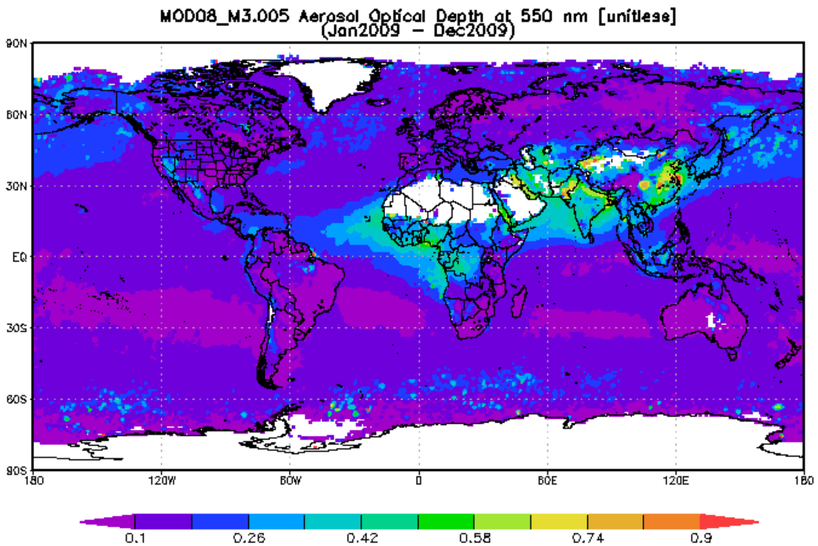
Background

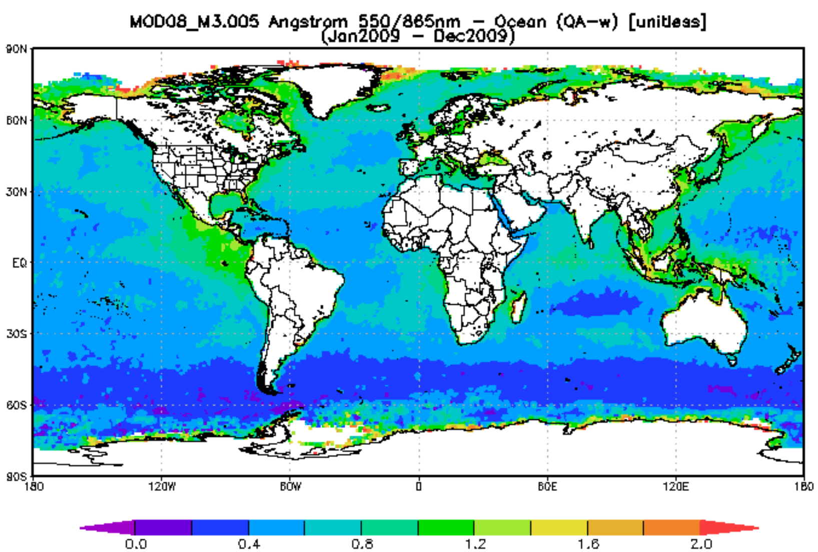
> Limit of French ZONEX area
> Area already acknowledged by authorities for scientific activity
> Meteorological buoy at 2 nm

Hazard

> Central area of the cyclonic circulation: currents < 10 cm s^{-1}
> Swell generally lower than 5 m

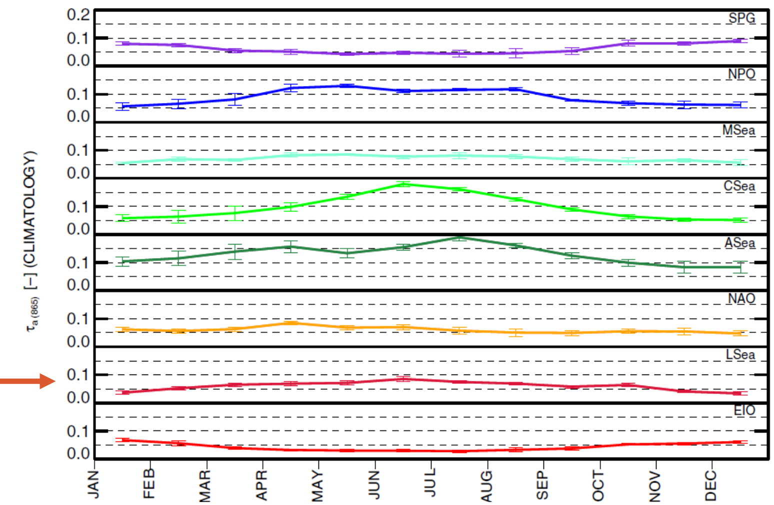
Images were produced with the Giovanni online data system, developed and maintained by the NASA GES DISC.
J. G. Acker and G. Leptoukh, “Online Analysis Enhances Use of NASA Earth Science Data”, Eos, Trans. AGU, Vol. 88, No. 2 (9 January 2007).

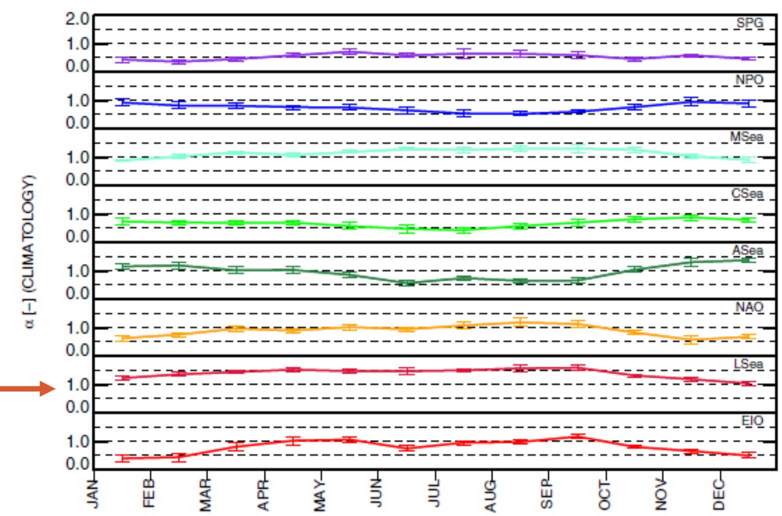




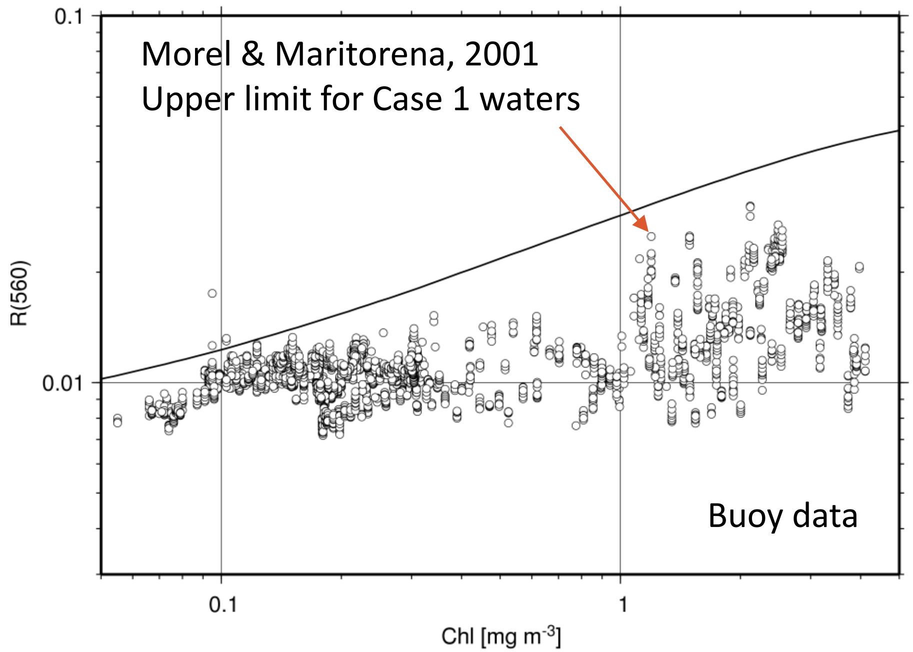
Atmospheric Regime

- Not far from a pure oceanic site in terms of atmospheric conditions (aerosols)
- Low cloudiness
- Only episodic dust events





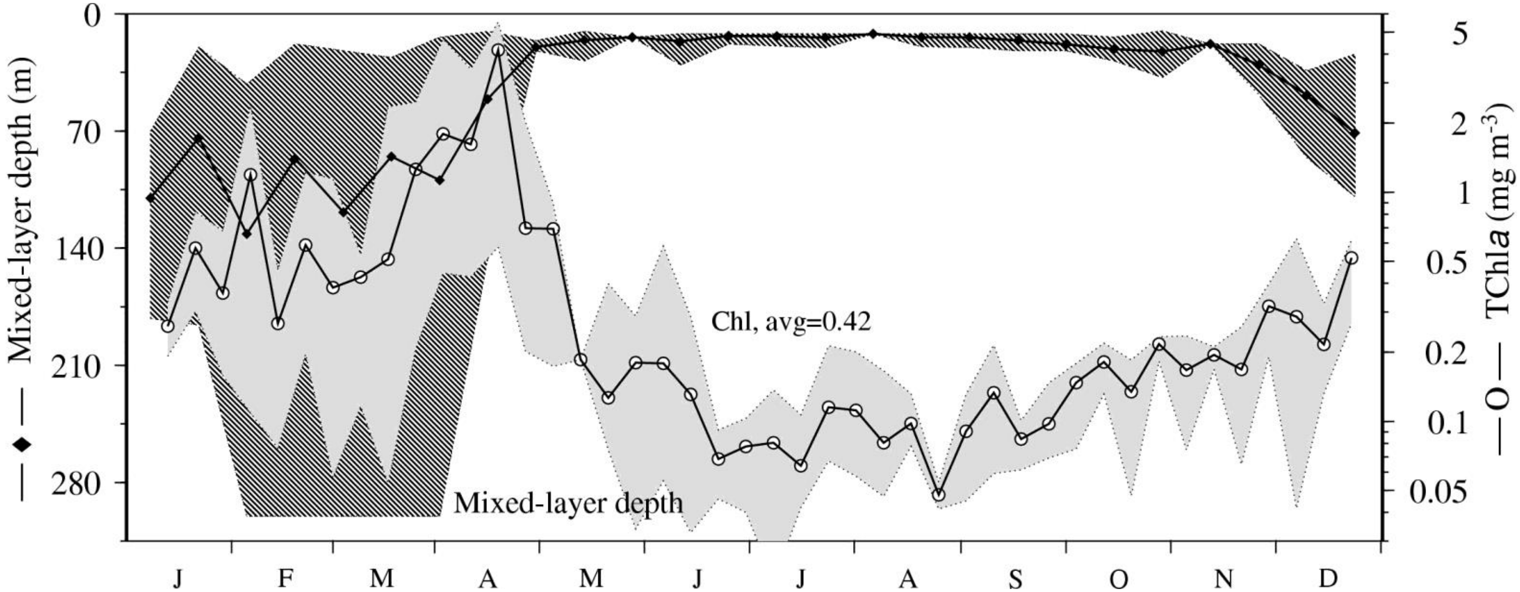
Zibordi & Melin, 2017

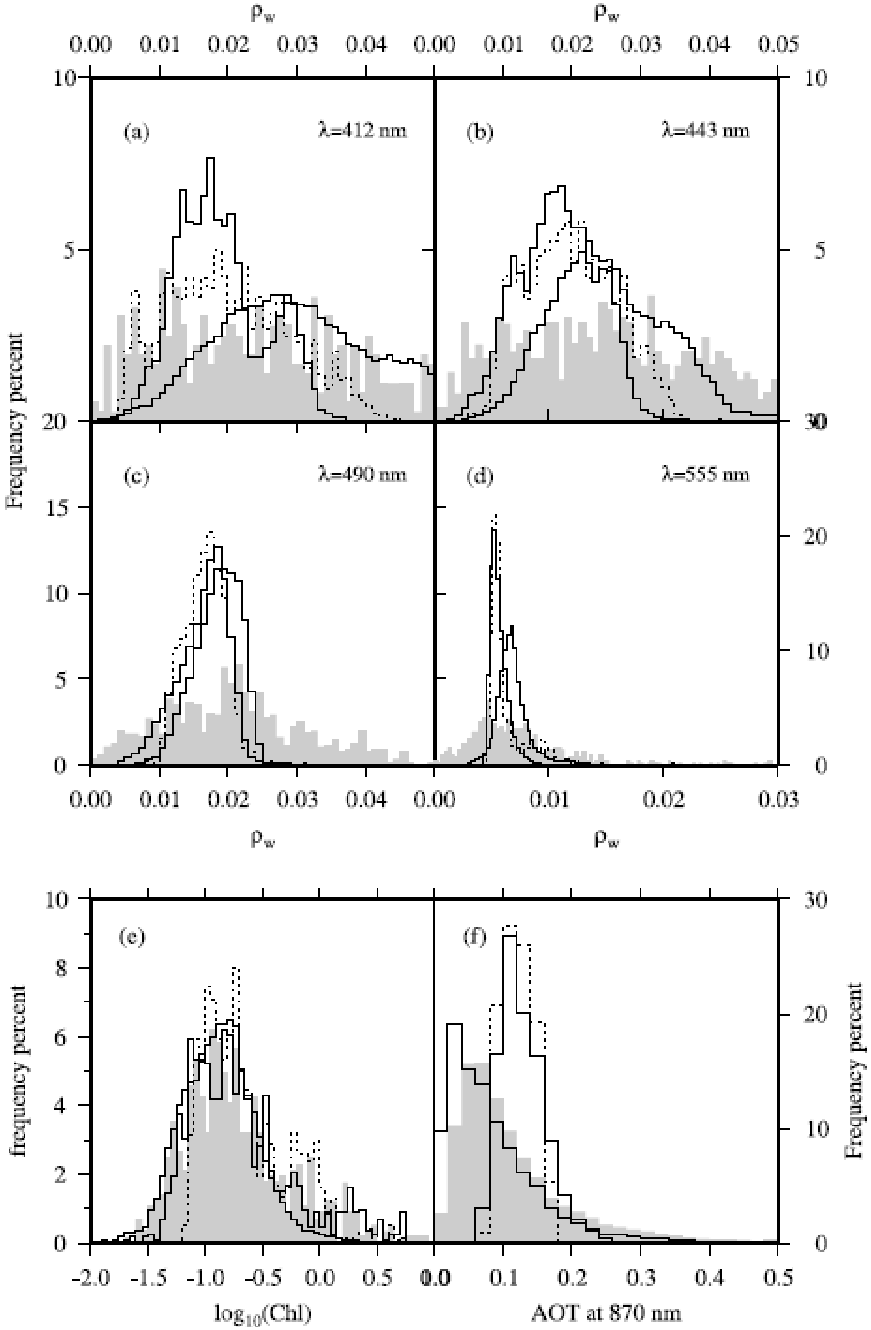


Bio-optical Regime

> Case-I Waters (the Ligurian current limits coastal advection)

> Mainly oligotrophic though with strong seasonal cycle

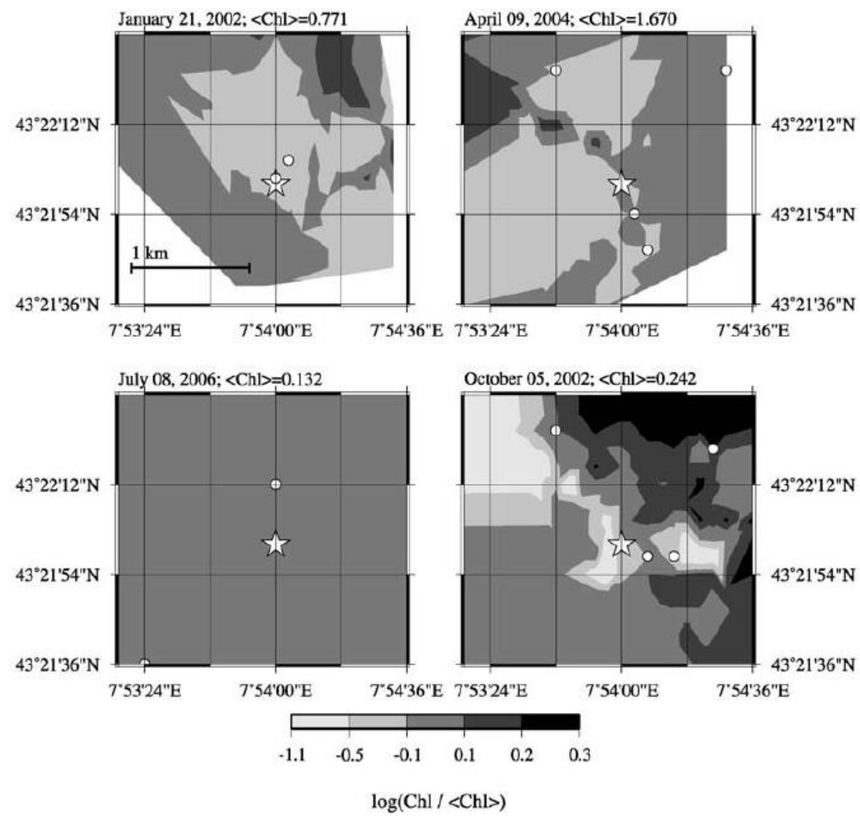




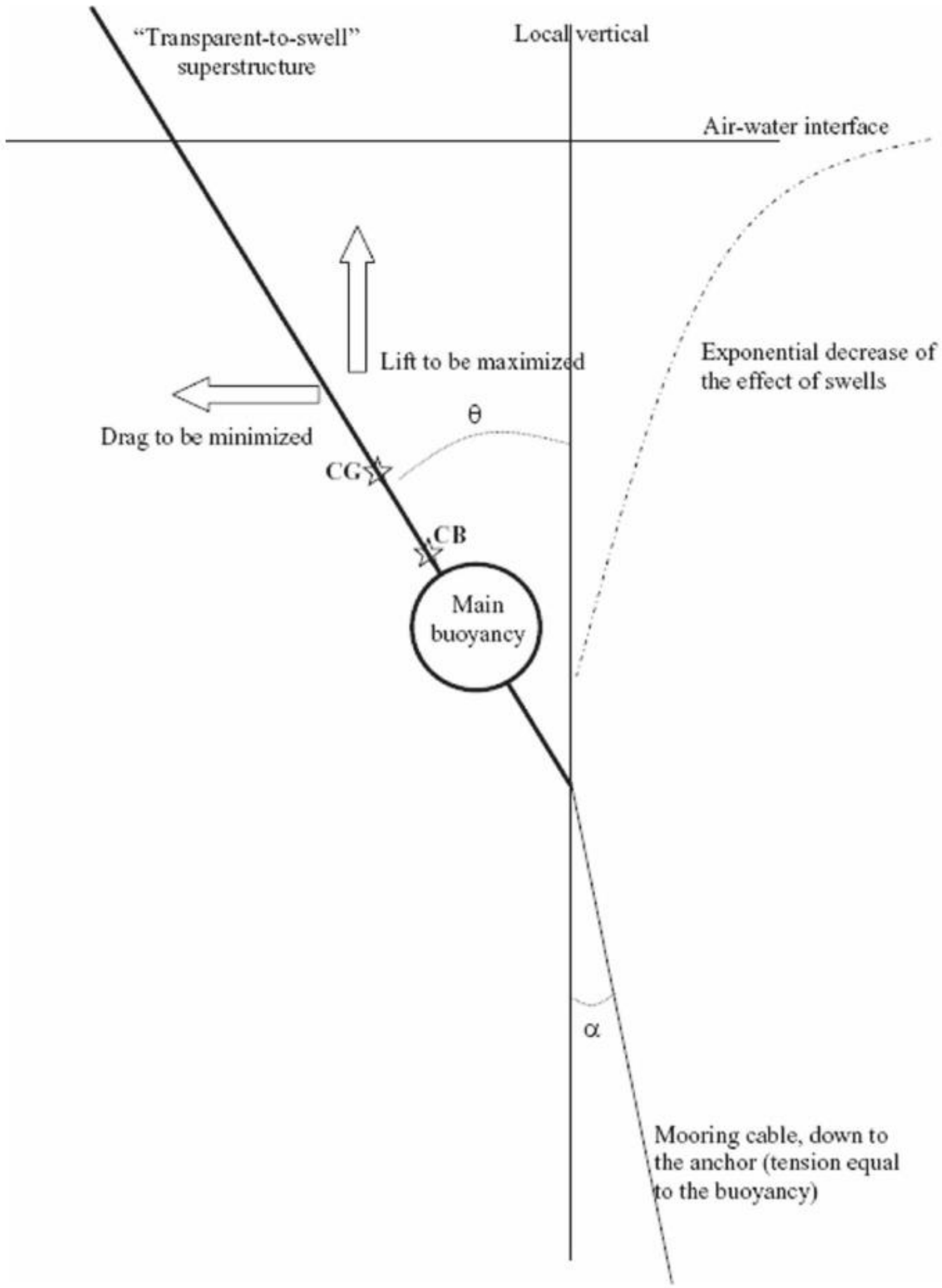
BIO-OPTICAL REGIME

> The range of bio-optical properties is representative of global Case-I waters

> Spatial homogeneity during the oligotrophic season

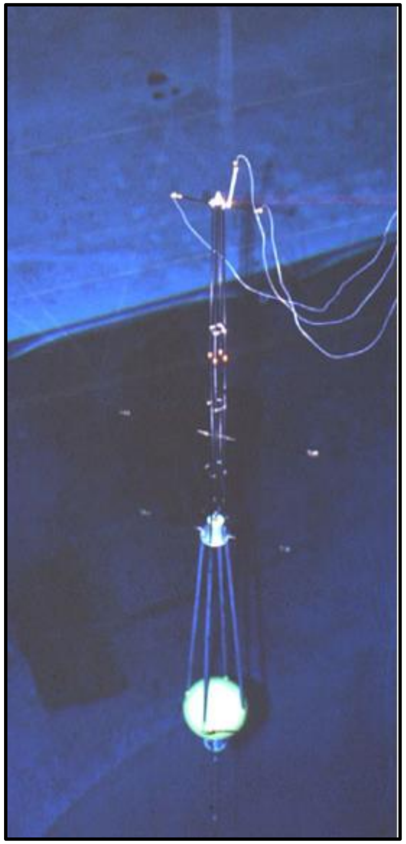


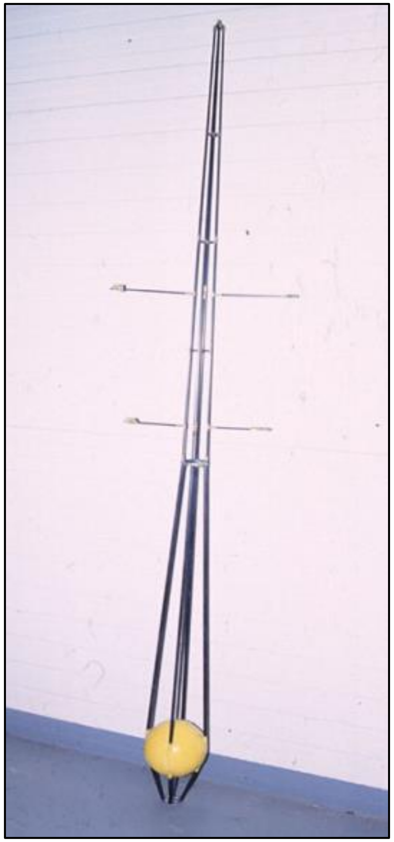
Choice of the Platform

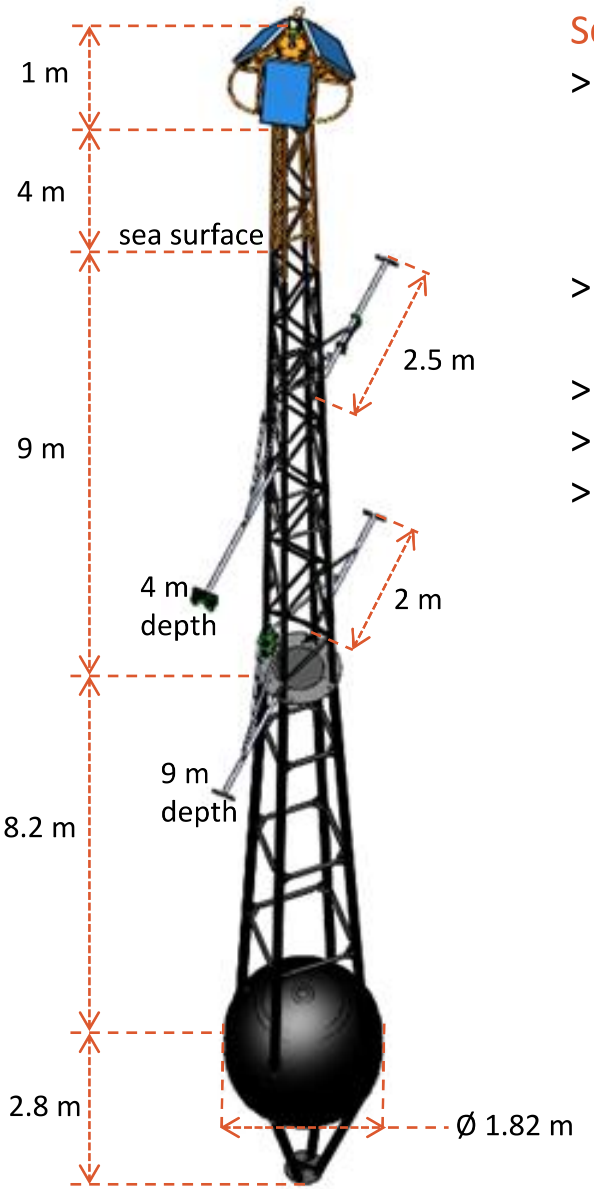


Constraints

- > Minimizing shading
- > Maximizing stability (minimum resistance to swell and currents)
- > Surface reference not impacted by sea spray

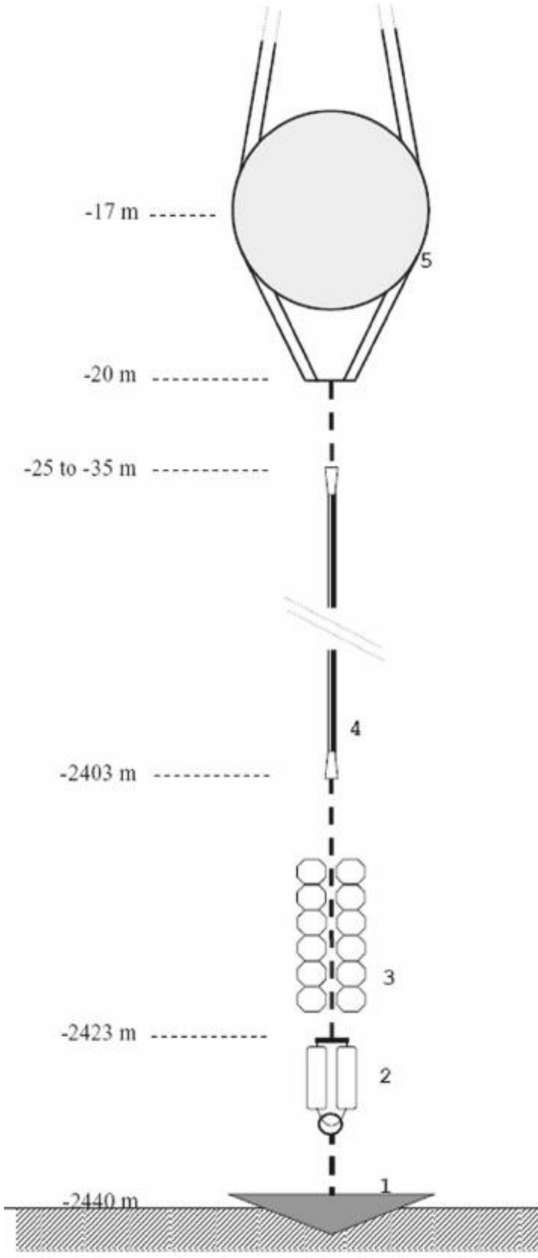






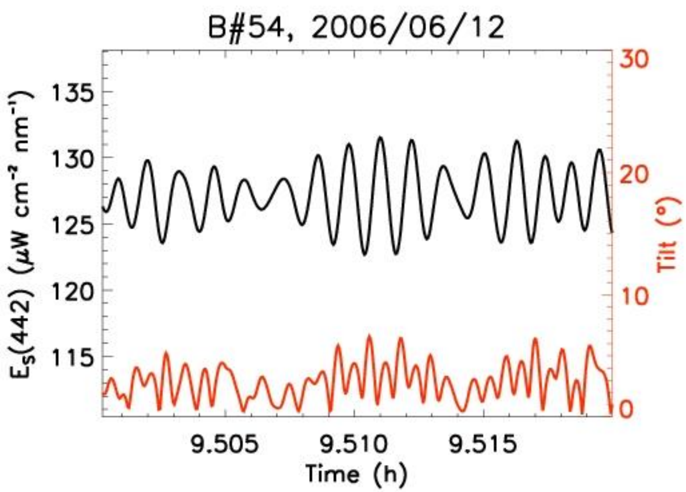
Solution

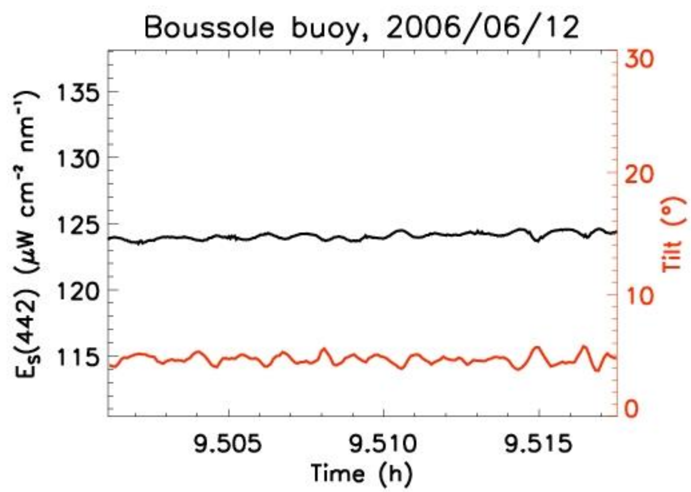
- > Taut mooring (reversed pendulum) with Archimede thrust provided by a large sphere at a depth out of the effect of most swells
- > Transparent to swell tubular superstructure
- > Neutrally buoyant cable
- > No large body shading the surface
- > Arms for hosting radiometers far from the structure influence



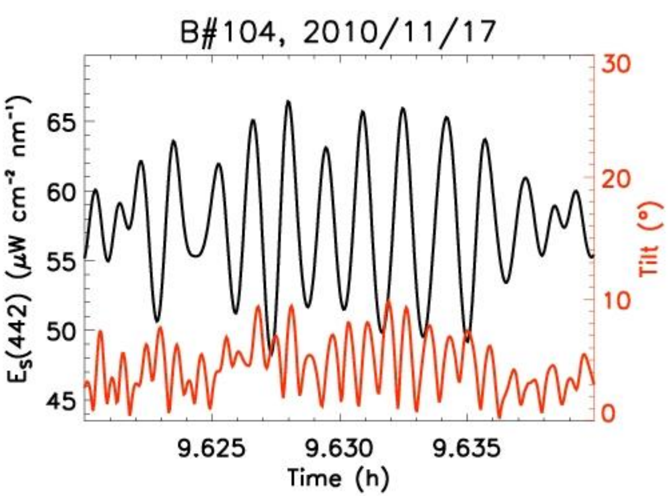
SHIP VS MOORING

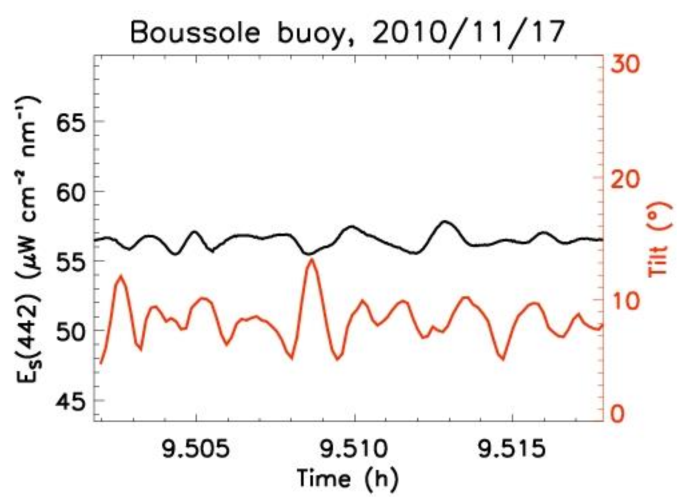
> Examples of short (order of minute) contemporary records from ship and buoy surface irradiance



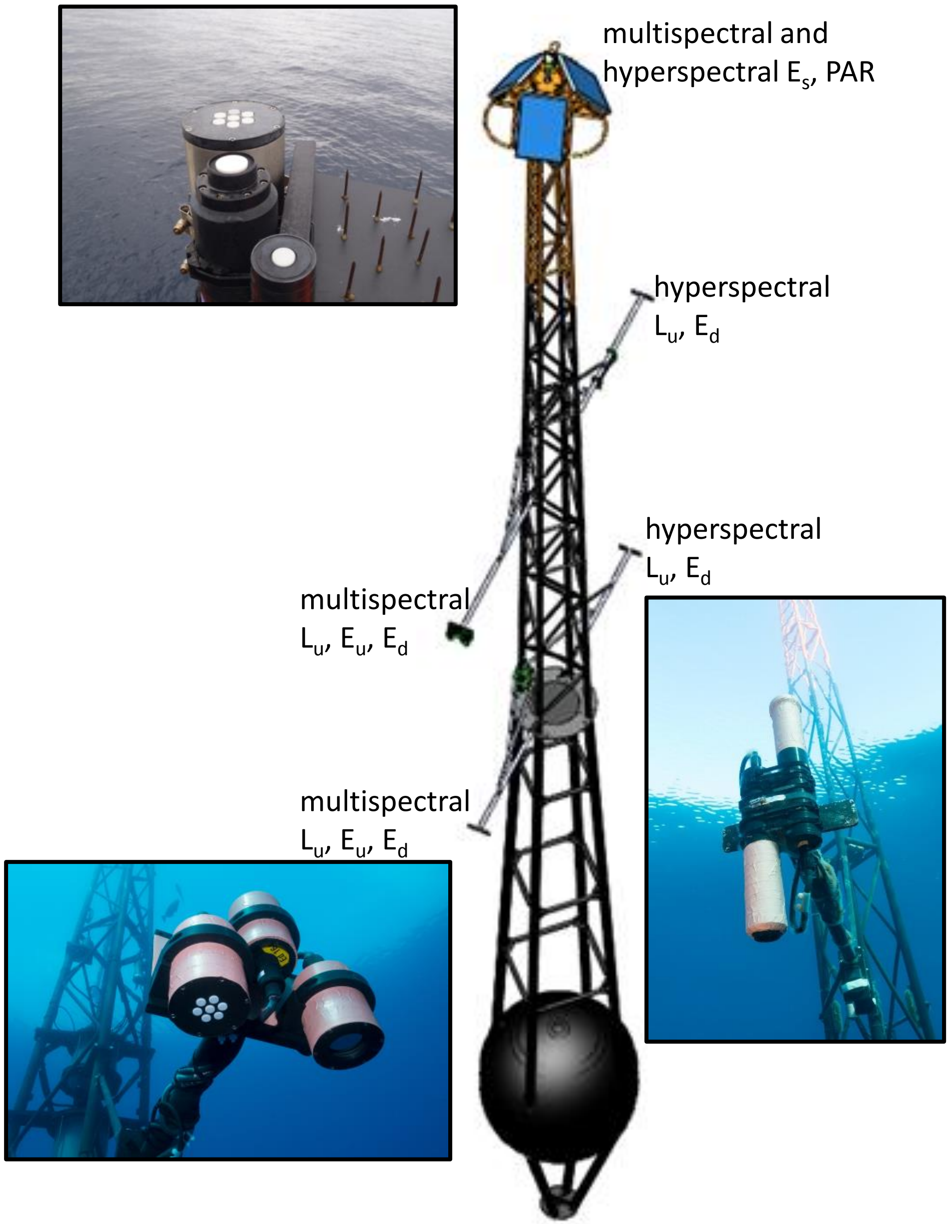


H1/3 = 0.5 m
Wind speed = 6 kn





H1/3 = 1.5 m
Wind speed = 11 kn



RADIOMETRY (SATLANTIC)

> 200 series: [412, 443, 490, 510, 555, 560, 665, 670, 683 nm] fixed gain

> Hyper-OCR series 350:3:800 nm (after 2007), auto integration time

> PAR (400-700 nm) (after 2007)

DATA LOGGERS (SATLANTIC)

> DACNet Acquisition Node (prototype)

> DATA-100 series (OCPs, MVD)

> STOR-X (after 2007)

ANCILLARY

> Sea-Bird, SBE-37 CTD

> AOSI, EZ-compass III (tilt, heading)

> Garos, Strain gauge

DATA TRANSMISSION

> ARGOS beacon (data sample)

> CISCO wireless

> ARGOS emergency beacons (position)

IOPs

> Wetlabs, C-Star (c_p, 660 nm)

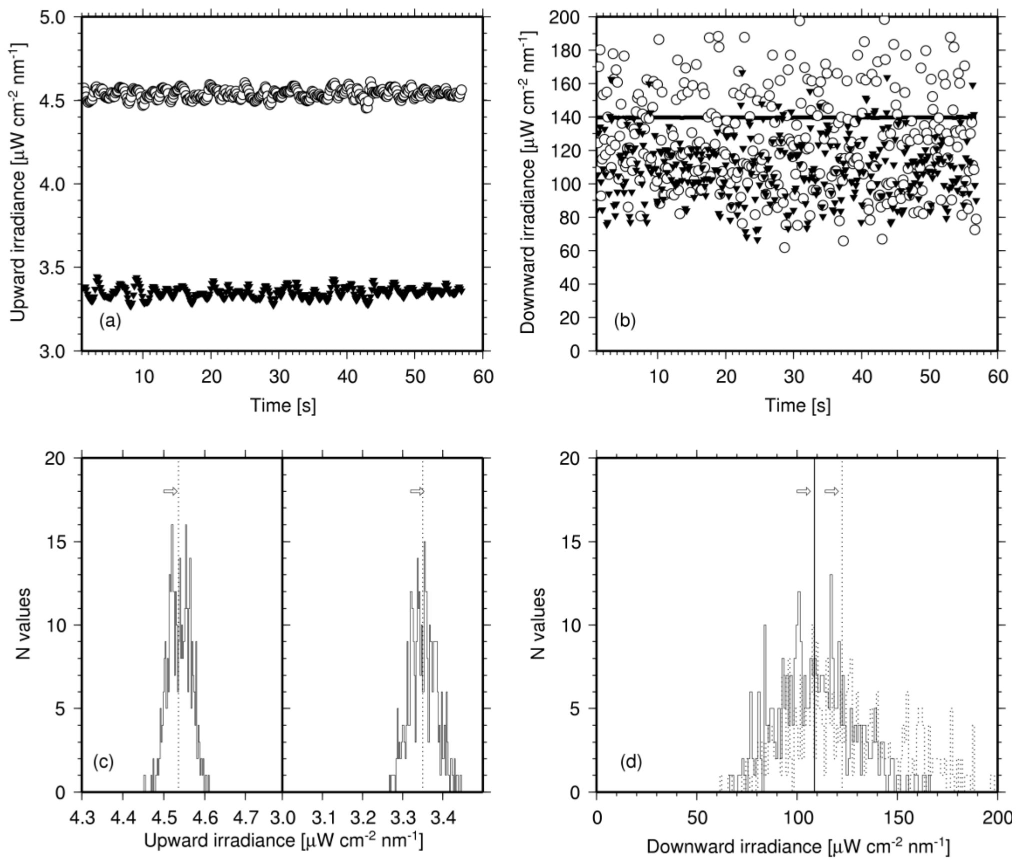
> Hobilabs, HS-IV (442,488,555,620 nm)

> Wetlabs ECOFLNTUs (fluorescence $470_{ex}/695_{em}$, turbidity 700 nm)

Sampling

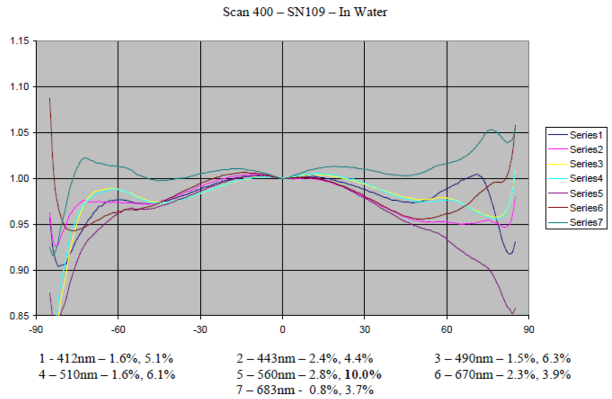
> Multispectral instruments, ancillary, IOPs: 1' bursts at 6Hz every 15’ night and day

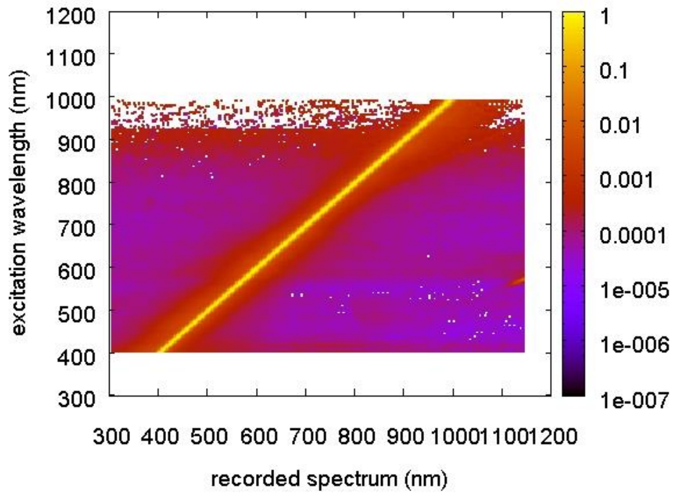
> Hyperspectral instruments: 1' records at varying integration time every 15’

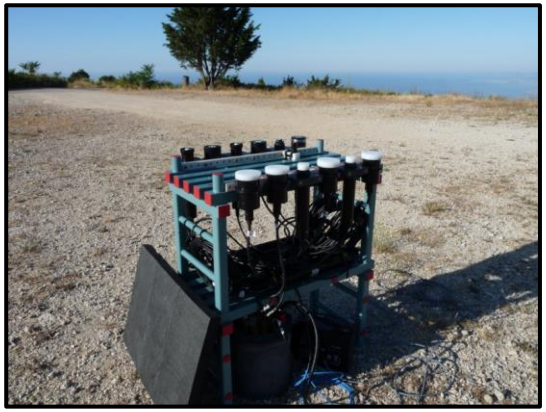


CALIBRATION

- Absolute calibration at factory (NIST traceable) every 6-12 months
- Cosine response scans (since 2012)
- Inter-calibration verification before deployment (since 2011)
- Collaboration with NPL for radiometers characterization (since 2013)
- Calibration facility at LOV used for test







TWIN BUOYS ROTATIONS

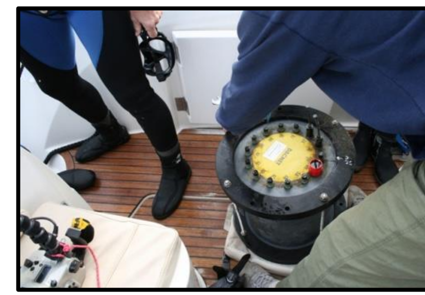
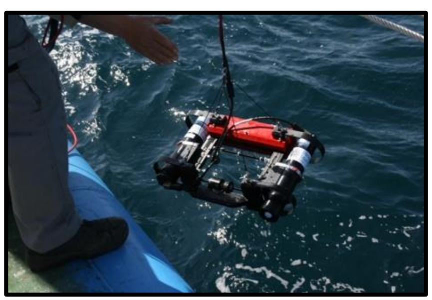
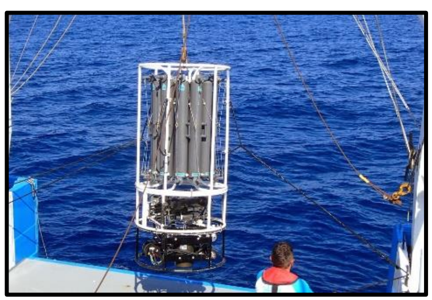
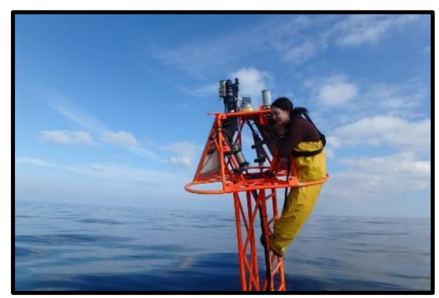
> Buoy upper superstructure rotation every 6-12 months (on demand scuba, ship and helicopter)

> Structure verification and renovation of paint (boatyard at 30 km from LOV)

CRUISES

- 3 to 5 days monthly cruises onboard *Tethys II* R/V (CNRS-INSU, occasionally other ships of the French R/V float): buoy maintenance, data download, and auxiliary data collection (AOPs and IOPs profiles + HPLC, a_p, CDOM & TSM samples)
- 8 to 12 on demand 1-day cruises per year on ships of opportunity for buoy maintenance or troubleshooting



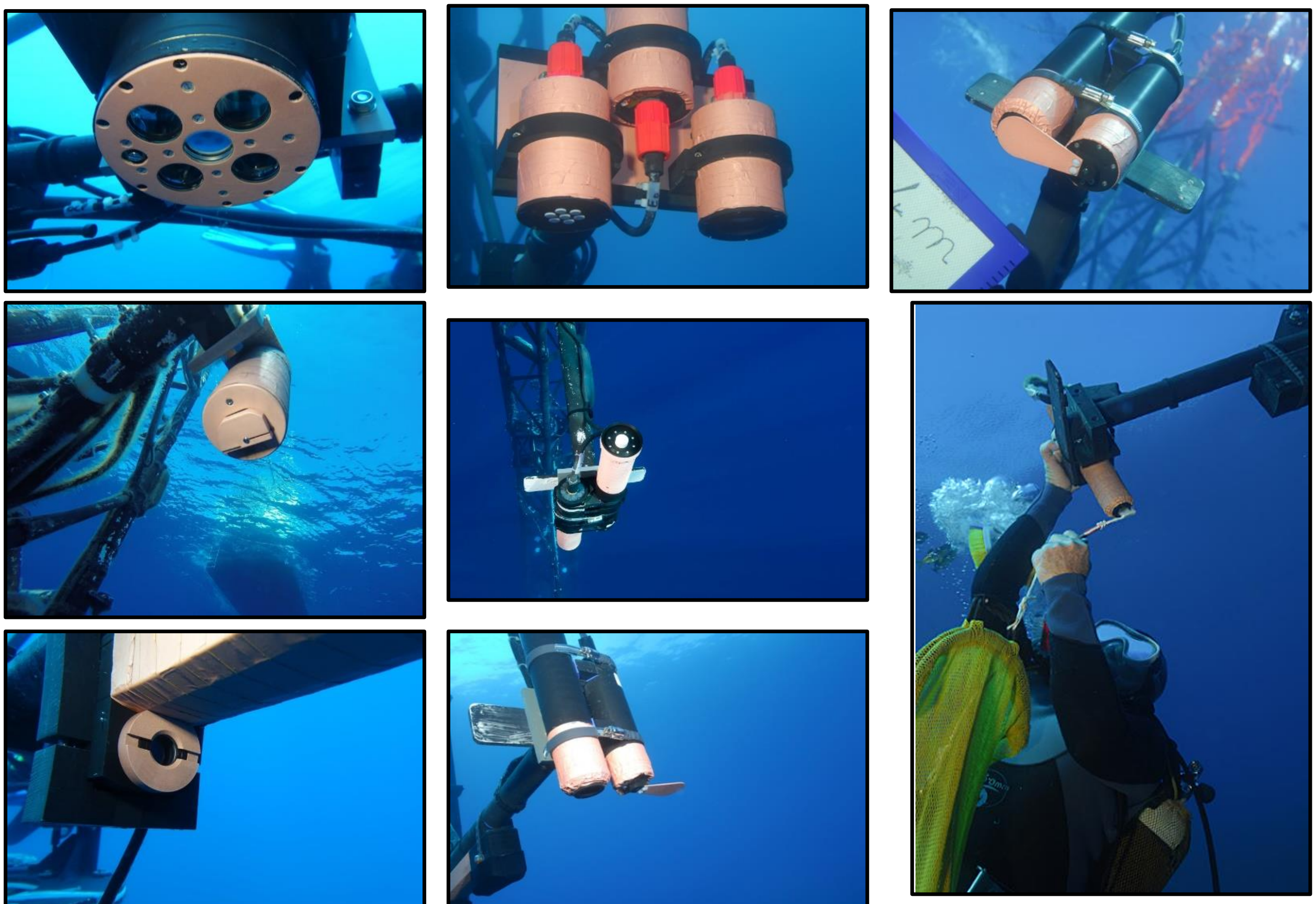







FOULING MITIGATION

> Copper tape, plates, rings, shutters

> Antifouling paint of the buoy upper and lower superstructures

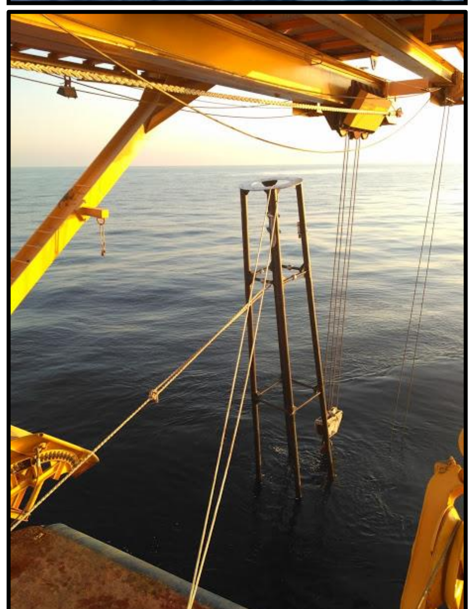
> Sensor cleaning with scuba



MOORING ROTATION

> Every 3 years on board CASTOR 2 ship equipped with dynamic positioning system (FOSELEV MARINE)

> New Kevlar cable, dead weight, chains, shackles etc.



MOORING ROTATION

> Revision of the buoy lower superstructure and acoustic release system






RESEARCH STAFF	PROJECT RESPONSIBILITIES	%
David ANTOINE	Project PI	20
Annick BRICAUD	CDOM measurements, IOPs expertise	10
TECHNICALSSTAFF		
Vincenzo VELLUCCI	Project Management, buoy deployments, data processing	100
Melek GOLBOL	Responsible for monthly cruises, AOPs & IOPs acquisition and processing	100
Eduardo SOTO	CTD monthly cruises, technical support	25
Céline DIMIER	HPLC, a_p measurements	5
Josephine RAS	HPLC, a_p measurements	5
Vincent TAILLANDIER	CTD maintenance and post-processing	5
Edouard LEYMARIE	*Montecarlo* simulations	5
Guillaume DE LIEGE	Management of diving operations on the buoy, technical support	10
David LUQUET	Diving operations on the buoy	5
Didier ROBIN	Diving operations on the buoy	5
POSTDOC		
Marco BELLACICCO	Phytoplankton photo--adaptation and diel cycles	50

About 3.5 FTE

History

1998	First thoughts about developing an optics mooring
1999	Buoy conception & design (->engineering pool tests), in search of funding supports
	1st grant from CNES (TOSCA)
	Development essentially made from remainder money from past ESA contracts
2000	Construction buoy “v0”, qualification deployment, still in search for funding
2001	1st “CDD” (CNES), start of monthly cruises (July 2001)
	June 2001: signature of the UPMC/NASA LOA
	First specific ESA funding for BOUSSOLE
2002	1st deployment of the instrumented buoy → failed (total loss, construction defect)
	Reimbursement by our insurance: continuation of the project
	Complementary engineering studies (IFREMER/MARINTEK) → buoy version 2
	Launch of ENVISAT
2003	Construction of the new buoy
	Operational deployment: September 2003
2003-…	Operational period (2 sister buoys & instrumentations; rotations every 6 months)
	Progressive development of scientific exploitation of the data
	Unsuccessful request to being “labelled” as a “SO” at INSU
2008	Collision with a boat, recovery of the entire mooring
2009	Long-term commitment from CNES (2019 at least) in the frame of Sentinel-3
2011	Start of the “BIOCAREX” project funded by ANR (2011-2014)
2013	1st permanent position staff (UPMC) 100% on the project
2015	Unsuccessful request to join the MOOSE observing network
2016	Launch of S3

> ~20 years of existence
> 15+ years of operational data production (94% success rate for data acquisition in the last 6 years)
> Currently the 2nd site for vicarious calibration of satellite ocean colour, along with MOBY
> A unique radiometry + optics + BGC data set
> A model for how science & operational objectives come together for mutual benefits
> Permanent effort towards increased data quality (calibration, characterization, QA/QC in general etc…)
> A small, yet highly efficient, technical staff team
> A number of scientific users (publications)
> In good standing to continue for the coming decade, though with need to renovate buoys and instrumentation

Thanks for Attention

D. Antoine – PI
V. Vellucci – Project Manager
M. Golbol, E. Soto, E. Diamond – Cruises
V. Taillander – CTD processing
C. Dimier, J. Ras – HPLC
B. Gentili – Code development
A. Bialek – Uncertainties
E. Leymarie – Montecarlo simulations
Bricaud – CDOM
G. De Liege, D. Luquet, D. Robin – Diving
S. Marty – Calibrations
J. Uitz, H. Claustre, F. D'Ortenzio – Expertise
L. Fere, C. Poutier, I. Courtois – Administration