BOUSSOLE OVERVIEW

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21-23 February 2017 – FRM4SOC
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...)

BOUSSOLE RATIONALE

intro – site – platform – instruments – strategy – conclusion
**CHOICE OF THE SITE**

**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.


**ATMOSPHERIC REGIME**

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

Zibordi & Melin, 2017

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**CHOICE OF THE SITE**

Morel & Maritorena, 2001
Upper limit for Case 1 waters

**BIO-OPTICAL REGIME**

- Case-I Waters (the Ligurian current limits coastal advection)
- Mainly oligotrophic though with strong seasonal cycle

**BUOY DATA**

Mixed-layer depth (m)

Chl, avg=0.42

Mixed-layer depth

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### CHOICE OF THE SITE

#### 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
**Choice of the Platform**

**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

**B#54, 2006/06/12**

- \( H_1^{1/3} = 0.5 \) m
- Wind speed = 6 kn

**B#104, 2010/11/17**

- \( H_1^{1/3} = 1.5 \) m
- Wind speed = 11 kn
**MULTISPECTRAL AND HYERSPECTRAL**

- **E<sub>s</sub>, PAR**
- **L<sub>u</sub>, E<sub>d</sub>**

**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<sub>p</sub>, 660 nm)**
- **Hobilabs, HS-IV (442,488,555,620 nm)**
- **Wetlabs ECOFLNTUs (fluorescence 470<sub>ex</sub>/695<sub>em</sub>, 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 STRATEGY

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
**MAINTENANCE STRATEGY**

**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)
**MAINTENANCE STRATEGY**

- **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
MAINTENANCE STRATEGY

FOULING MITIGATION

- Copper tape, plates, rings, shutters
- Antifouling paint of the buoy upper and lower superstructures
- Sensor cleaning with scuba
**MAINTENANCE STRATEGY**

**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
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<th>PROJECT RESPONSIBILITIES</th>
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<td>Project PI</td>
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<td>Annick BRICAUD</td>
<td>CDOM measurements, IOPs expertise</td>
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<td>Vincenzo VELLUCCI</td>
<td>Project Management, buoy deployments, data processing</td>
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<td>Melek GOLBOL</td>
<td>Responsible for monthly cruises, AOPs &amp; IOPs acquisition and processing</td>
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<td>Eduardo SOTO</td>
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<td>Didier ROBIN</td>
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<td>Marco BELLACICCO</td>
<td>Phytoplankton photo--adaptation and diel cycles</td>
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**About 3.5 FTE**
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 2\textsuperscript{nd} 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
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A. Bialek – Uncertainties
E. Leymarie – Montecarlo simulations
B. Bricaud – CDOM
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S. Marty – Calibrations
J. Uitz, H. Claustre, F. D’Ortenzio – Expertise
L. Fere, C. Poutier, I. Courtois – Administration

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