"From the Buoy to the data"
COCAS & COAST-HF Scientific Workshop Report

supported by ILICO-RESOMAR

Videoconference, November 23 and 24, 2020

Organizers: D. Ruiz-Pino, A. Lazar, G. Charria, F. Schmitt

Technical support: R. Bodichon and C. Karez

Participating countries

Argentina, Belgium, Benin, Brazil, Chile, China, Colombia, Germany, Italy, Finland, France, Lebanon, Mexico, Morocco, Namibia, Peru, Senegal, Spain, Togo, UK and USA

Introduction

The organizers of the two networks, COCAS and COAST-HF, wanted to set up a new framework for exchanging expertise. They organized a common workshop whose objective was to compare and valorise the acquired experiences, by sharing the approaches of the key points of the measurement devices, the quality and the accessibility of the data, and the scientific and societal valorisation, of the coastal air-sea buoy (CAB) networks.

Its specific objectives were:

- to share the networks' experience, expertise, knowledge and know-how
- to benefit from the variety of solutions to the problems that arise from high frequency and long-term observations of the coastal ocean.
- to better answer the questions that today science made in both hemispheres, for the solutions of environmental and societal problems created by climate change and pollution.

Summary of the main results achieved during the workshop

- A strengthening of the sustainability of COCAS and COAST-HF networks, through a better understanding of the diversity of challenges and solutions involved in observing in national waters.
- The initiation of a movement of convergence of approaches of CAB, between ILICO-RESOMAR members and countries of the South, convergence imposed by the scale of climate change and its impacts.
- A synergy for submitting to international calls a version of the COCAS project focused on the development of coastal moored stations in the Global South exclusive economic zones.
- An open letter describing and publicizing the COCAS network interests, accepted in the Ocean Decade special issue of ECO Magazine, published by the International Oceanographic Commission (IOC).

Program

CET	duration	title
DAY 1		
13:25	0:20	**Presentation of COCA & COAST-HF**
14:05	1:30	**Synthetical views of some ongoing buoy program**
15:35	0:30	**Technics of mooring**
16:05	0:20	**Technics of sensors I. Physics**
16:45	0:40	**Technics of sensors II. Biogeochemistry**
18:10	1:15	**Break out sessions : Moorings and physical sensors / Biogeochemical sensors**
19:25	0:30	**Virtual ice-breaker aperitivo (prepare you own relaxing glass), unformal chats**
DAY 2		
13:00	0:40	**Technics of sensors deployment III. Biology**
14:00	0:20	**Academic research**

14:20	0:45	**Five minutes presentations**
15:35	0:45	**Societal services**
16:20	0:45	**International programs and networks**
17:35	1:15	**Break-out sessions : Biological sensors / societal services development**
18:50	0:40	**results of the 4 break-out sessions and conclusion**

See the Program (annex I)

* Access to the presentations on: https://cocas-workshop.sciencesconf.org/

General conclusions

Physical, biogeochemical and biological sensors are used at different levels by COCAS & COAST-HF members. Most common sensors are physical (for both ocean and atmosphere), in second place are biogeochemical ones (fluorescence and oxygen) and the biological (phytoplankton) sensors that are used mainly by Europe. For this reason, we should start with common Essential Ocean Variables (EOV). A high frequency automated system should measure, at least, eight atmospheric variables (air temperature, humidity and atmospheric pressure, rain, wind speed and direction and short-wave radiation), and ten for the water column, temperature, conductivity, currents, turbidity, oxygen concentration, pH, pCO_2, total phytoplankton biomass - total chlorophyll, and phytoplankton functional main groups such as, diatoms, coccolithophores and dinoflagellates). These variables are also essential to make the link with policy and societal needs such as water quality assessment and physical conditions.

In additional, Coastal Essential Ocean Variables (CEOV) and Coastal Essential Biological Variables (CEBV) should be considered as the reference list to design the variables to be measured. At each site, chosen additional variables/sensors which are important for the specific research question linked to each COCAS & COAST-HF site and to the available sensors: Consultation to local (native communities) and international users to identify what data they need; relate what problem/question to the societal services provided in some region.

Concerning the data quality and output requirement, inter-comparison becomes an issue especially when different sensors are used for measure the same variable in the same coastal area and in different regions; the results need to be available to local and regional policy makers to support decision making. However, the approach to make data and results available has to be defined in a next workshop.

The objectives that were at the origin of the request of this workshop to the COAST-HF program have been achieved, although the time for the discussions and exchanges foreseen in the Breakout Sessions (annex II) had to be reduced since all the workshop was carried out virtually and the organizers had to adjust its duration to allow the participation of different countries.

Perspectives

- A next workshop COCAS & COAST-HF, with more time for discussion sessions aiming at defining collaborative actions. Possible topics are:
    - essential common sensors
    - essential common variables
    - common quality control
    - data sharing
    - societal services
- Organize a working meeting among the four Breakout Sessions: Mooring and physical sensors, Biogeochemical sensors, Biological Sensors and How to foster societal services development? (annex II) to discuss and answer the questions proposed in the Breakout Session questionnaire (annex III).
- Submit the COCAS Network to the UN Decade of Ocean Sciences following Martin Visbeck's (member of the Ocean Decade Executive Planning Group) recommendation after his presentation in the workshop.
- Analysis of possible interactions between COCAS & COAST-HF and the European JERICO Research Infrastructure.
- Create a working group between COCAS & COAST-HF experts on biological sensors still poorly used and little known by the COCAS community.

Annex I

PROGRAM

Coastal air-sea buoys: from buoy to data. Workshop

23 & 24 November 2020, virtual

CET	duration	title	speaker	institution
DAY 1				
13:00	0:15	**Welcoming, virtual tea-coffee & unformal chat between participants**		
13:15	0:10	**Workshop introduction**	*A. Lazar, D. Ruiz-Pino*	LOCEAN-SU, France
13:25	0:20	**Presentation of COCA & COAST-HF**		LOCEAN-SU, France
13:25	0:10	the COCA network	*D. Ruiz-Pino, A. Lazar*	LOCEAN-SU, IFREMER, France
13:35	0:10	the COAST-HF network	*G. Charria*	LOCEAN-SU, IFREMER, France
13:45	1:30	**Synthetical views of some ongoing projects**	Chair: A. Lazar	
13:45	0:15	ESTOC Observatory	*A. Cianca*	ESTOC-PLOCAN, Spain
14:00	0:15	Coastal observations in EuskOOS, SE Bay of Biscay	*J. Mader*	AZTI, Spain
14:15	0:15	Coastal buoys along Brazil coast	*C. Garcia*	FURG, Brazil
14:30	0:15	Lessons from a coastal buoy off south-central Chile	*R. Garraud*	UC, Chile
14:45	0:30	**Questions & discussion, virtual coffee-tea**	Chairs: A. Lazar & C. Ricaurte	
15:15	0:30	**Technics of mooring**	Chair: G. Charria	
15:15	0:10	EOL buoy, Villefranche/Mer	*J. M. Grisoni*	LOV-CNRS, France
15:25	0:10	MOBILIS low Cost buoys	*S. Benouda*	MOBILIS, France
15:35	0:10	MOLIT buoy, Brittany	*M. Repecaud*	RDT-IFREMER, France
15:45	0:20	**Technics of sensors I. Physics**	Chairs: G. Charria & A. Osorio	
15:45	0:10	Coastal Physical Sensors	*Y. Degrés*	NKE Enterprise, France
15:55	0:10	Coastal Currents:10 years at the MESURHO Station	*I. Pairaud*	IFREMER, France
16:05	0:20	**Question & discussion**	Chairs: G. Charria, A. Osorio	
16:25	0:40	**Technics of sensors II. Biogeochemistry**	Chairs: E. Machu & F. Geißler	
16:25	0:15	Improvements in UV Nitrate Sensor measurements	*E. Achterberg*	GEOMAR, Germany
16:40	0:10	In situ calibration approaches for biogeochemical sensors	*F. Geißler*	GEOMAR, Germany
16:50	0:15	Primary Productivity and Nutrients in the Bay of Seine	*P. Claquin*	BOREA-UCN, France
17:05	***0:20***	***California coastal buoys (highlight)***	***U. Send***	***SIO, USA***

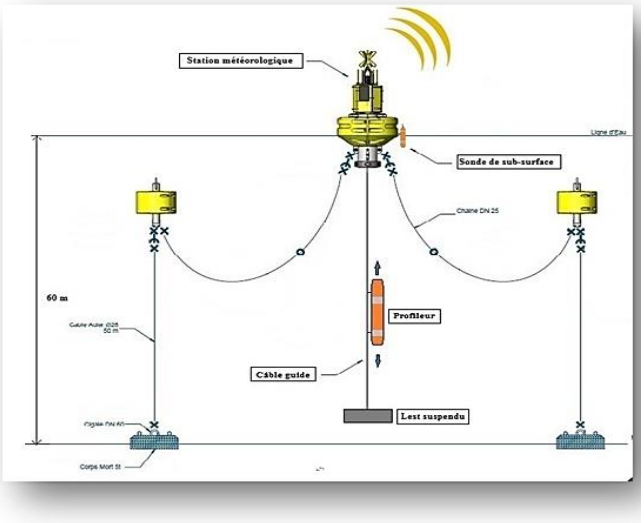
17:25	0:25	**Question & discussion during snack break**	Chairs: E. Machu & F. D'Artigas	
17:50	1:15	**Break out sessions**		
	1:15	Biogeochemical sensors	Chairs: E. Machu & F. Geißler	
	1:15	Mooring and physical sensors	Chairs: G. Charria & A. Osorio	
19:05	**0:30**	**Virtual ice-breaker aperitivo (prepare you own relaxing glass), unformal chats**		
DAY 2				
13:00	0:40	**Technics of sensors deployment III. Biology**	Chairs : A. Lefebvre & P. Zapata	
13:00	0:10	Automated monitoring of phytoplankton : advantages and challenges	*F. Artigas*	LOG-ULCO
13:10	0:10	Use of machine learning to (semi-)automatically plankton samples and digital image analysis	*P. Grosjean*	Université de Mons
13:20	0:10	Platforms and sensors to monitor phytoplankton events in the Baltic Sea	*J. Seppälä*	SYKE, Finland
13:30	0:10	Monitoring phytoplankton at the single-cell level : a flow cytometer in the Gulf of Naples	*A. Louchart*	LOG-IFREMER, France
13:40	0:20	**Questions & discussion during coffee**	Chairs : A. Lefebvre & P. Zapata	
14:00	0:20	**Academic research**	Chairs : D. Ruiz Pino & F. Schmitt	
14:00	0:10	Statistical analysis methods	*Schmitt, F*	LOG-CNRS, France
14:10	0:10	High Variability of Oxygen at MELAX (Senegal Buoy)	*Machu, E.*	LOPS-IRD, France-Senegal
14:20	0:45	**Five minutes presentations**	Chairs: D. Ruiz Pino & F. Schmitt	
14:20	0:05	Acquisition project of a meteo-ocean buoy off the togolese coast	*E. Panassa*	University of Kara, Togo
14:25	0:05	Reloncaví marine observatory (OMARE) in Patagonian fjord.	*I. Perez-Santos*	Centro i-mar, Chili
14:30	0:05	INVEMAR Meteo-marine system	*C. Ricaurte-Villota*	INVEMAR, Colombia
14:35	0:05	Coastal Patagonian productive shelf buoys project	*A.P. Osiroff*	Hydrografia Naval, Argentina
14:40	0:05	Why an oceanography buoy deployment in front of La Guajira, Colombia?	*G. Bernal*	Universidad Nacional, Colombia
14:45	0:05	Climate-induced changes in extreme events: A focus on winter salinity in the Bay of Brest	*C. Poppeschi*	IFREMER, France
14:50	0:05	Seasonal and inter-annual ONSET Sea Surface Temperature variability, northern coast of Guinea Gulf	*Z. Sohou*	IRHOB, Benin
14:55	0:05	Naples elastic beacon and NEREA Augmented Osbervatory + Introduction to AtlantEco	*R. Casotti*	Observatorio Biologico Napoly, Italia
15:00	0:05	Sustainable development and collaboration south-South: capabilities in Caribbean fisher communities	*L. Barrios*	Manchester Metropolitan University, UK
15:05	0:05	Hypoxic bottom waters as a carbon source to atmosphere during a typhoon passage over the East China Sea, a buoy time series study	*L. Dewang*	SIO, China
15:05	0:30	**Questions & discussion during tea time**	Chairs: D. Ruiz Pino & F. Schmitt	

15:35	0:45	**Societal services**	L. Barrios & T. Brochier	
15:35	0:10	Artisanal fisheries management and coastal buoys	*T. Brochier*	UMMISCO-IRD, France-Senegal
15:45	0:15	Decade of Ocean Science for Sustainable Development (2021-2030)	*M. Visbeck*	U.N. / GEOMAR, Germany
16:00	0:10	French coastal observations: users and services	*G. Charria*	IFREMER, France
16:10	0:10	Filling the gap between local and oceanographic knowledges in coastal areas management	*T. Dahou*	PALOC-IRD, France-Morocco
16:20	0:45	**International programs and networks**	J. Mader & A. Lazar	
16:20	0:15	JERICO research infrastructure	*L. Delauney & I. Puillat*	IFREMER, France
16:35	0:15	LAOCA-GOA-ON Acidification Network	*C. Berghoff & C. A. Vargas*	Universidad de Concepcion, Chile
16:50	0:15	SCOR Activities	*M.-A. Sicre*	SCOR / LOCEAN-CNRS, France
17:05	0:30	**Questions & discussion during snack break**	L. Barrios & T. Brochier	
17:35	1:15	**Break-out sessions**		
	1:15	Biological sensors	Chairs: A. Lefebre & P. Zapata	
	1:15	How to foster societal services development ?	Chairs: T. Brochier & L. Barrios	
18:50	0:40	**results of the 4 break-out sessions**	respective chairs	
19:30	0:10	**General conclusion, virtual diner**	organizing team	

Annex II
Content summary of Breakout Sessions (BS)

BS 1. Moorings and physical sensors

Chairs: G. Charria & A. Osorio



Example of Buoys

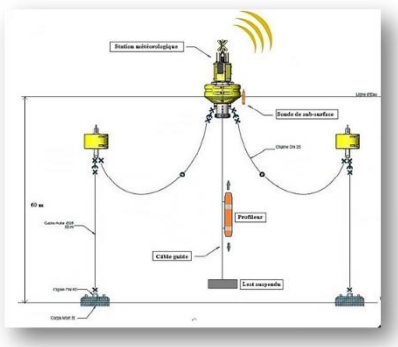
Specific topic

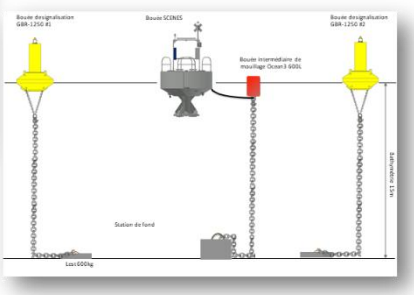
Draw the baseline of «best practices» for coastal moorings and physical sensors

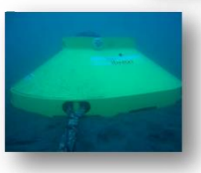
Moorings: Main questions

a. Which mooring for which application?

b. What are the strengths, weaknesses and limitations of each solution?







Physical sensors: Main questions

a. Which parameters: Essential Ocean Variables (EOV) => Coastal Essential Ocean Variables (CEOV)?

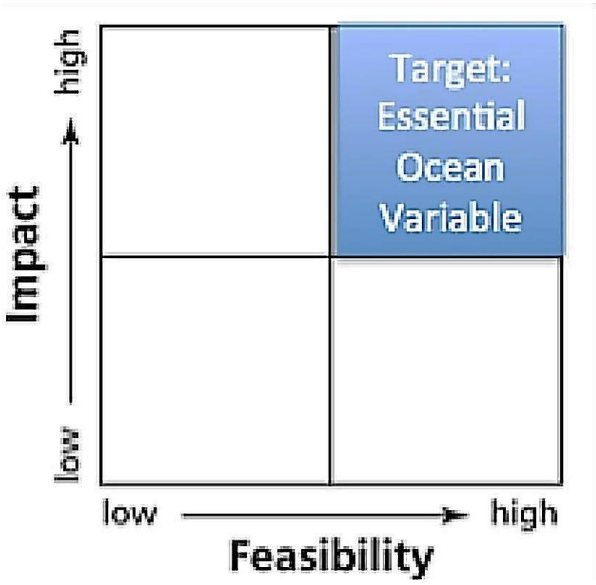
b. Which sensor for which parameter (EOV)?

c. For turbidity (CEOV), which sensor? Optic or acoustic sensor?

www.goosocean.org/eov

PHYSICS	SENSOR
Sea state	Waverider buoy (dedicated)
Ocean surface stress	Meteorological station
Sea ice	From buoys?
Sea surface height	Tide gauges
Sea surface temperature	Temperature sensors (Auton)
Subsurface temperature	Temperature sensors + profili
Surface currents	ADCP and ?
Subsurface currents	ADCP and ?
Sea surface salinity	Conductivity sensors + profili
Subsurface salinity	Conductivity sensors + profili
Ocean surface heat flux	From buoys?

Moorings and physical sensors



Conclusions

In practice 7 active participants

Mooring types

- Suitable to micro-tidal / macro-tidal seas
- 2 vs 3 vs ... anchor point chains, catenary

Physical sensor types

- Temperature, salinity and multiparameters
  - NKE / Seabird Microcat
  - Thermistance chain
- Costs / low cost sensors

BS 2. Biochemical sensors

Biochemical sensors

Chairs: E. Machu & F. Geißler

In situ calibration - O_2

Specific topics

- Propose the importance of measuring additional variables (O2, pH)
- Reduce price of sensors to cover more variables
- Build up a database with used and commercially available sensor as basis for collaboration and intercomparison activities sensors

Biogeochemical sensors: Main questions

Biochemical sensors

a. How to choose sensor? (variable as well as type of sensor)

- First task should be to think about the variables/sensors which are important for your research question
- Different variables of interest between countries from northern and southern hemisphere (Climate vs. Ecosystem Ecology)
  → Funding issue/special interests: pollution, industry, ecology….
- For overall picture we need the coupling of different variables/sensors

b. How to choose sensor? (variable as well as type of sensor)

- Strong demand for measuring environmental variables, demand that companies are struggling to meet
- Open ocean vs. coastal waters
- Reduction in price à loose some control of quality
- Lower cost of optical sensors
- Replaceable components, easy to maintain
- 3D printing industry???

c. How to ensure data intercomparison?

- Becomes an issue especially when different sensors are used for the same variable (e.g. open ocean vs. coastal water)
  "Ocean Best Practices" need to be applied (https://www.oceanbestpractices.org/)
  → Standardization, Traceability …
  → Distribution to different countries/scientific communities
- Traceable documentation

Conclusions

- Goal for COCAS: Propose the importance of measuring additional variables
- With reduced price of sensors/buoys more variables can be covered
- Goal for COCAS: Database with used and commercially available sensors as basis for collaboration and intercomparison activities
- Database with used and commercially available sensors to foster:
  → Collaboration
  → Intercomparison
  → Exchange of experience

BS 3. Biological Sensors

Biological sensors

Chairs: A. Lefebre & P. Zapata

Algae Online Analyzer (AOA, bbe©)

Specific topics

- Know the current advances in terms of existing sensors for the measurement of primary producers' (phytoplankton).
- Present the state of the art of the strengths, weaknesses and progress necessary to be able to use the existing sensors COCAS buoys.

Biological sensors: Main questions

Biological sensors

a. What are the technical readiness levels of sensors/devices:
(i) the Algae Online Analyzer (AOA) and the fluoroprobe (bbe Moldaenke) which allow monitoring of phytoplankton biomass and phytoplankton spectral groups.
(ii) the Imaging in flow Cytometer.

- Both systems were successfully implemented on research vessels and buoys but further works are still needed to improve harmonization and standardization of calibration procedure, vocabulary.
- Tools for data processing and results sharing already exist.
- GitHub and Jupyter notebook are highlighted as interesting support for collaborative coding and experimenting.

b. Which parameters should be chosen to start on?
A high frequency automated system should measure, at least, temperature, conductivity, turbidity, oxygen and fluorescence. These parameters are considered as the common ones within IR ILICO COAST-HF in France. They are also essential to make the link with policy and societal needs such as water quality assessment.

c. Which other important biological variables should be considered?
Other cross-cutting variables should also be considered according to the studied area and the scientific objectives. Ocean Color (for example, to define meso-scale eco-hydro-regions) and Sound (for example, to monitor marine mammals) are also cited as useful. EOV and EBV should be considered as the reference list to design the variables to be measured.

d. How do we transfer all knowledge acquired to COCAS?

- Sharing experiences gained from research project from northern to southern regions, but also from southern COCAS partners to other southern partners were identified as useful to build the monitoring system step by step, keeping in mind that there is no one-size-fits-all approach/strategy.
- Trans National Access (TNA) actions from JERICO S3 were also identified as opportunity to test new technologies (and associated knowledge) in a given area prior to additional new human and financial resources being incurred.

BS 4. How to foster societal services development?

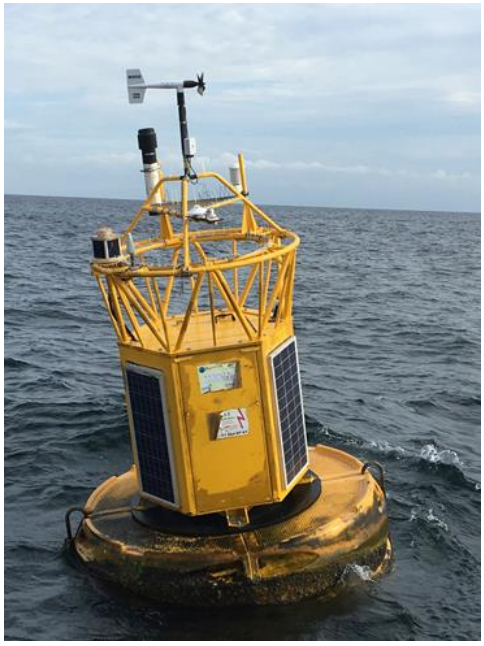
Societal services

Chairs: T. Brochier & L. Barrios

Dr. Lina Barrios training a person of her team on coral reef surveys in the barrier reef (20 m depth) of Albuquerque Atoll (Colombia).

Specific topic

Apply coastal ocean observations to develop societal services



Senegal-Melax buoy

Data moorings from COCAS

→ Atmospheric data: air pressure, humidity, wind speed, [CO_2]

→ Coastal Oceanographic: T°C, S‰, DO, pCO_2, pH, fluorescence, turbidity

Data collection and validation proposals

→ Data collection: buoys maintenance and collection by communities

→ Processing: partly by communities

→ Data analysis and validation: COCAS scientists

Societal services: Main questions

a. Which types of societal applications are you currently developing with your research? (past to present)
Warning system; early warning system-water quality; aid for decision tool-fishermen; early warning system for coral bleaching and fisheries; ecological restoration of coral reef environments (see Table of questionnaire filled below).

b. Which types of applications could be achieved in the near future with your research? (present to future)
Warning system; early warning system for coral bleaching and fisheries; ecological restoration of coral reef environments.

c. Which organisms or marine communities are you studying as models?
Phytoplankton, fishes, coral reefs.

d. How are you developing (planning to develop) the applications? Which institutes or stakeholders are you approaching?
Buoys and stations already deployed/identified will continue working in a foreseeable future, with support from social science academies, local population and traditional communities. Stakeholders are: water agencies, Ministry of Environment, oil companies, local fishermen associations, tourists.

Conclusions

The group agreed that the process of connecting with institutions and stakeholders in each country (national or local government, academia/research/universities, local communities and other stakeholders such as NGOs) was more about or should include:

- Exchange of data more than offer of data and services; consultation to local users (native communities) to identify what data they need rather than imposing our believes on what they need.
- The societal services we offer need to confirm the reasons (cause?) of identified problems in the area. The results need to be available (how?) to local and regional policy makers to support decision making.
- There was a floating question during the debate (the elephant in the room) about how to approach the local communities to interact with stakeholders (government, academia/research/universities, others) in data collection; how to delegate into local/native communities for maintenance, data collection and first steps of analysis, and to ensure that the data collection is not bias. These would allow the COCAS members more time and resources for further data analyses and modelling and to disseminate into the local communities.

Societal services answers to the questionnaire

Societal service1	Variables used & Methodology	Why choose this method?	Location/ country	Informations on the societal partner(s)	Key advantages that convinced the societal partner	Efforts needed to furnish the service on regular basis	Duration of partnership		Main issues
Warning system	Harmful algal blooms (bottom DO, multiparameter RT)	Warning system	France	Water agencies	Opportunities for partners (adaptative regulation)	To define the threshold values for each ecosystem because it is not the same for everything	buoys deployed in 2008 and will continue working in foreseeable future	14 stations (partnership for each buoy)	We need to find funds to maintain the system
Early warning system-water quality	REDCAM-INVEMAR (temperature, salinity. DO, nutrients)	UNGRD-support government to predict changes in water quality in Caribbean and Pacific	Colombia	Ministry of Environment/ CARs/AUNAP	Monthly				
Aid for decision tool-fishermen	Temperature, waves, thermocline, currents, Chlorophyll, Fluorescence	Instantaneous measurements, simulations (Mercator), 15 days forecast	Senegal						
Pollution from Land (pollution from agriculture) and influence on fishing activities									
Early warning system for coral bleaching and fisheries	Temperature (SST and near reef), salinity, nutrients, pH, sedimentation, DO, alkalinity	UNGRD-support government levels and community-based management to predict changes in water quality in Caribbean related to potential changes in coral reef from where artisanal communities depend on (future to expand to Pacific)	Colombia	UNAP/Ministry of Environment, CARs, DIMAR, companies (oil companies) ANLA, Local fishermen associations	weekly and monthly (depending on parameters and support from local communities)	Stipend/salary for local communities, more buoys in identified reefs	buoys and stations already deployed/identified and will continue working in foreseeable future, with support from communities	4 potential stations in the Caribbean, 2 potential stations in the Pacific site	We need to find funds to maintain the system
Ecological restoration of Coral Reef Environments	Physics and geology, physical and biochemical parameters (nutrients, pH, metals, sediments, TA, aragonite, light intensity) data series of 3 years in Tayrona Park, future sensor for carbonate system	Identify reference reefs and potential reefs for restoration in Caribbean (Potential to expand to the Pacific)	Colombia: Buoys in Cartagena and another one in San Andres	UNAP/Ministry of Environment, CARs, DIMAR, companies (oil companies) ANLA, Local fishermen associations	weekly and monthly (depending on parameters and support from local communities)	Stipend/salary for local communities, more buoys in identified reefs	buoys and stations already deployed/identified and will continue working in foreseeable future, with support from communities	4 potential stations in the Caribbean, 2 potential stations in the Pacific site	We need to find funds to maintain the system

Annex III

Questionnaire of Breakout Sessions

Sensors

- Variable measured
- Sensor: name & technology
- Advantage of this sensor
- Location/environment
- Platform
- Maintenance frequency & procedure
- Intercalibrations?
- Duration of operation
- Operation rate
- Main issues
- Publications and/or useful literature
- Who: Institute and person in charge?

Societal services

- Societal service
- Variables used & Methodology why choose this method?
- Location/country
- Information on the societal partner(s)
- Key advantages that convinced the societal partner
- Efforts needed to furnish the service on regular basis
- Duration of the partnership
- Main issues
- Who: Institute and person in charge?"

Annex IV

Participants of the workshop

LASTNAME	FIRSTNAME	MAIL	INSTITUTION	COUNTRY
Arbilla	Lisandro	lisandroarb@gmail.com	CONICET - UBA - Servicio de Hidrografía Naval	AR
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Kahl	Lucia	carolina.kahl@gmail.com	Servicio de Hidrografía Naval	AR
Osiroff	Ana	anapo62@gmail.com	Servicio de Hidrografía Naval	AR
Saraceno	Martin	saraceno@cima.fcen.uba.ar	CONICET-UBA	AR
Grosjean	Philippe	philippe.grosjean@umons.ac.be	University of Mons	BE
Sohou	Zacharie	zsohou@yahoo.fr	Institut de Recherches Halieutiques et Océanologiques du Bénin (IRHOB)	BJ
Cardoso Jr	Iran	iran.junior@mctic.gov.br	MCTI - Ministry of Science, Technology and Innovations	BR
Garcia	Carlos	garcia.io.furg@gmail.com	SiMCosta - Universidade Federal do Rio Grande (FURG)	BR
Karez	Claudia	claudia.karez@gmail.com	Instituto Jardim Botânico do Rio de Janeiro	BR
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