O_2

Véronique Garçon
CNRS - LEGOS

CES ODATIS Oxygène Virtual meeting, 23 Novembre 2020

Conferences and workshops:

•Oxygen data platform scoping workshop November 11-12, 2019 in Sopot with support from IOCCP, IOC, GO_2NE, NOAA and SFB754 and one on line on November 5-6, 2020

Oxygen data platform scoping Workshop
11-12 November 2019, Sopot, Poland

Organization committee:
Denise Breitburg, Smithsonian Research Center, GO_2NE Co-Chair

Hernan Garcia, NOAA, World Ocean Database

Veronique Garçon, CNRS-Legos, IOCCP focal point for Oxygen

Marilaure Grégoire, University of Liege, GO_2NE Co-Chair

Andreas Oschlies, Geomar, SFB 754 Executive Board

Maciej Telszewski, IOCCP

Kirsten Isensee, IOC and GO_2NE Secretariat

SFB 754

Post-Sopot oxygen data platform virtual meeting
November 5-6, 2020

Building a Global Ocean Oxygen Atlas : a necessary requirement for assessing Deoxygenation and ocean health in the open and coastal ocean

…possibly a UN Decade of Ocean Science project….

BOX 1 - The United Nations Decade of Ocean Science for Sustainable Development[1]

The key societal outcomes that the Decade will strive to achieve are:

- **A safe ocean where people are protected from ocean hazards**
- **A clean ocean where sources of pollution are identified and removed.**
- **A sustainably harvested and productive ocean ensuring the provision of food supply**
- **A predicted ocean where society has the capacity to understand current and future ocean conditions**
- **A healthy and resilient ocean where marine ecosystems are mapped and protected**
- **A transparent with open access to data, information and technologies**

The GO_2AT oxygen inventory will provide easy and open access to oxygen data that can be used to identify problems with coastal eutrophication and accelerating deoxygenation in the oceans, and conversely, identify areas of good water quality.

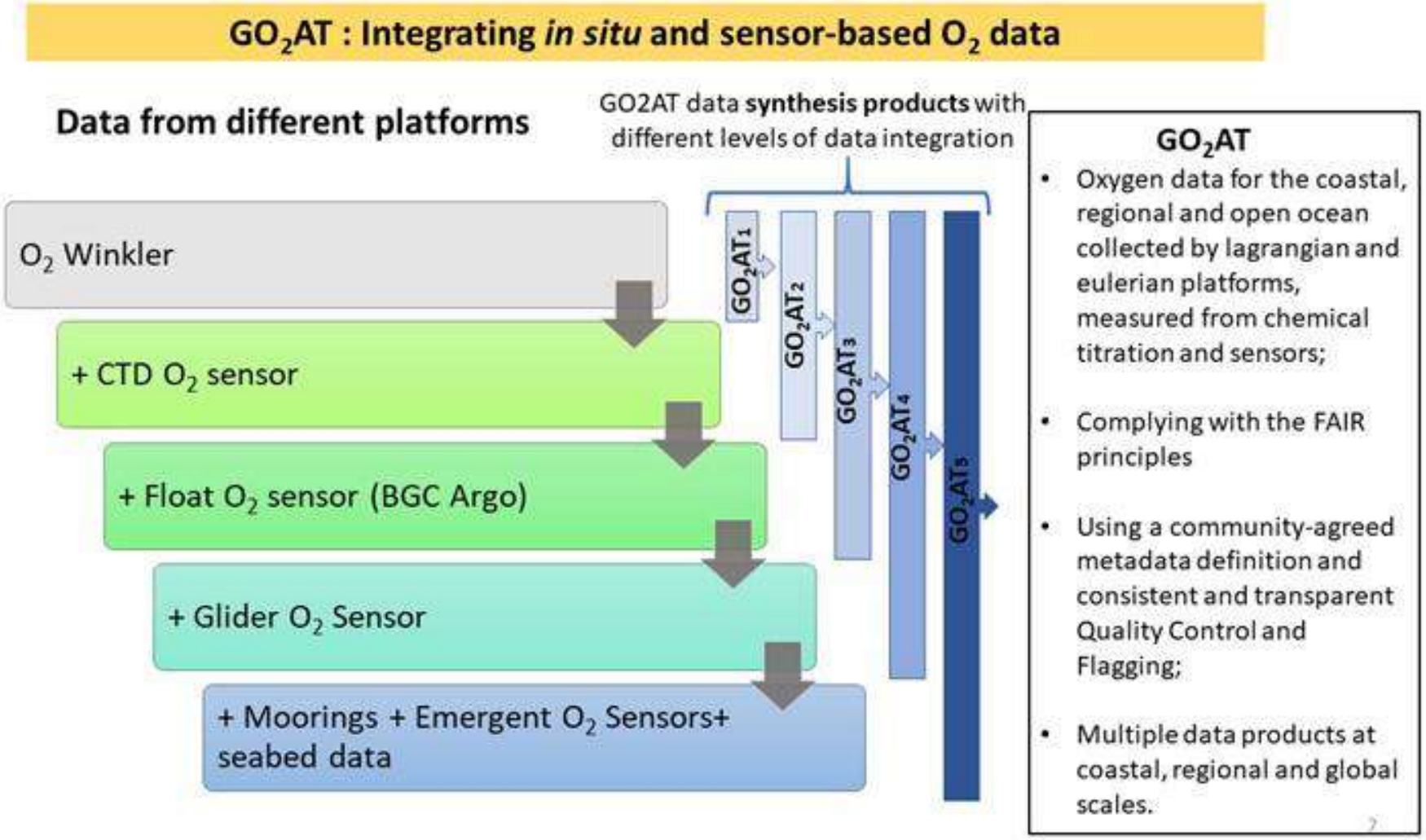
Oxygen data can also aid in the quantification of the habitat conditions and inform management of fish and shellfish to secure the provision of food supply and alternative livelihoods.

Projection of long-term forecasts of climate-driven ecosystem conditions and the interactions of multiple stressors will need oxygen data to ensure models are well-formulated and sufficiently tested.

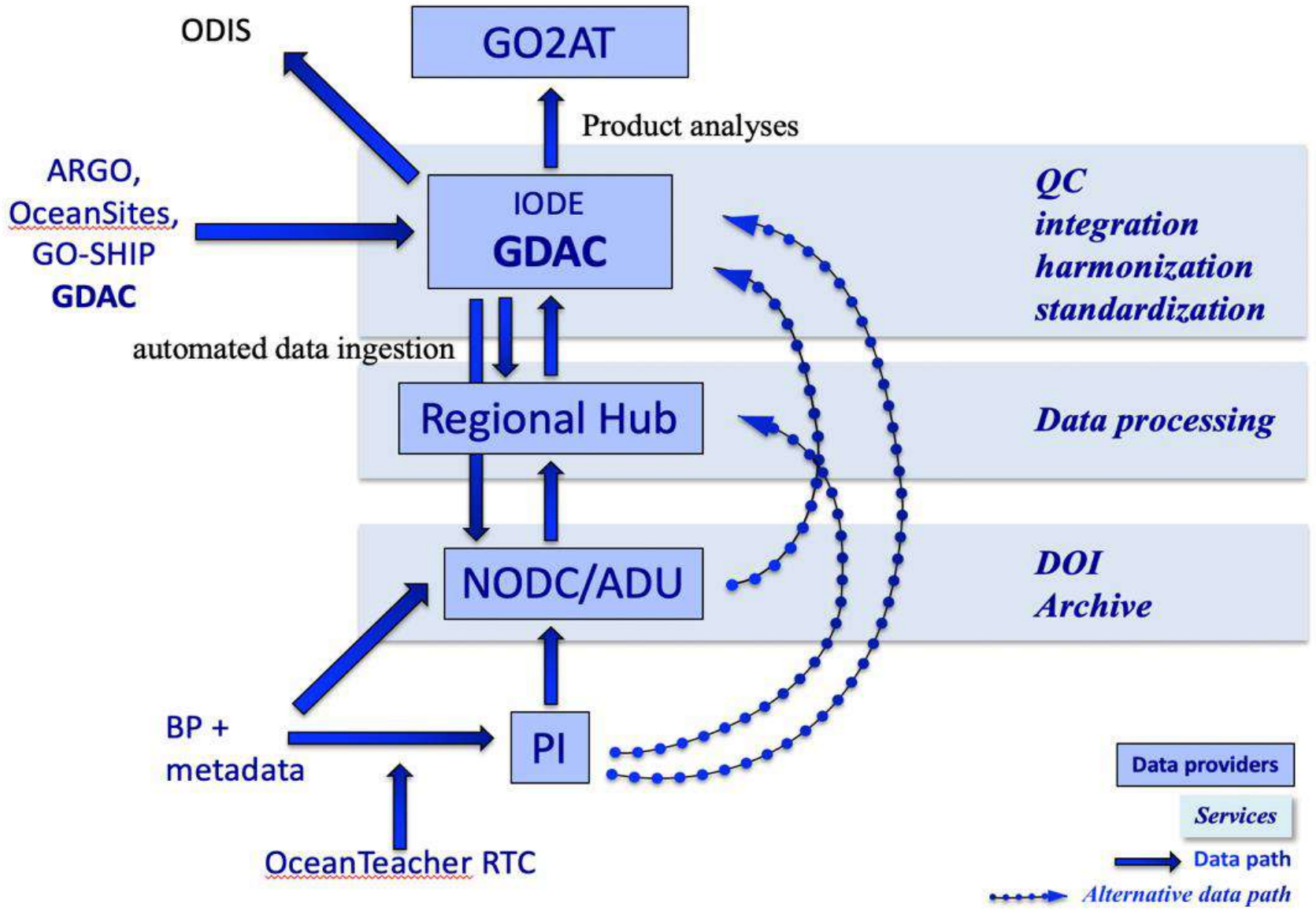
Finally, enhanced use of oxygen data will support analyses, comparative studies, and modeling to ensure the resiliency and provisioning of ocean ecosystem services and aid in the design of actions to mitigate risks from anthropogenic activities and climate change.

[1]The Science We Need for the Ocean We Want: The United Nations Decade of Ocean Science for Sustainable Development (2021-2030). Paris. 2019. 24 pp. (English) IOC Brochure 2018-7 (IOC/BRO/2018/7 Rev).

Scheme of integration of oxygen data sets from different platforms and sensors in different levels oxygen data synthesis products



Anticipated data flow for O_2 data towards GO_2AT



IOCCP and the UN Decade
Global Ocean Oxygen Network

Objectives of the UN Ocean Decade:

Objective 1 : Identify required knowledge for sustainable development, and increase the capacity of ocean science to deliver needed ocean data and information.

Objective 2 : Build capacity and generate comprehensive knowledge and understanding of the ocean including human interactions, and interactions with the atmosphere, cryosphere and the land sea interface.

Objective 3 : Increase the use of ocean knowledge and understanding, and develop capacity to contribute to sustainable development solutions.

It is multi-partner, multi-national, multi-institutions, will require a long-term international effort, with multi-stakeholders groups, it will be cross generational combining early career scientists with senior scientists, and will be managed by IOCCP,GO_2NE, PICES, IUCN, etc.. paying a particular attention to capacity developments.

Expected outcomes:

- **Increased capacity to measure, document, map, monitor and understand ocean deoxygenation.**
- **Increased knowledge about impacts of deoxygenation, including ecological and socio-economic vulnerabilities and resilience, biogeochemistry-climate feedbacks, and possible tipping points in the context of multiple stressors.**
- **Indicators for safe operating spaces and extension of the concepts of planetary boundaries and planetary health to marine oxygen.**
- **Actionable strategies to mitigate ocean deoxygenation.**

IOCCP and the UN Decade
Global Ocean Oxygen Network

This could lead to several Projects within this umbrella Programme:

1. **Deoxygenation and ocean life: identifying, understanding and resolving threats**
   Understand how deoxygenation affects ocean life from species to ecosystems

2. **Deoxygenation, water quality and the climate system**
   Understand how deoxygenation impacts the chemical budgets, including nutrients, pollutants, climate-relevant volatiles, develop indicators for safe-operating spaces, monitoring and risk management

3. **Assessing and valuing the impact of deoxygenation on ecosystem services**
   Provisioning services: fisheries (including meso- and bathypelagic fishes), aquaculture, mariculture
   Regulating services: climate regulation, nutrient cycling
   Maintaining biodiversity, biodiversity, water quality (e.g. HABs, pollution), tourism, cleaning of water, absorbing and detoxifying pollutants, storing and cycling of nutrients, composition of atmosphere, cultural values

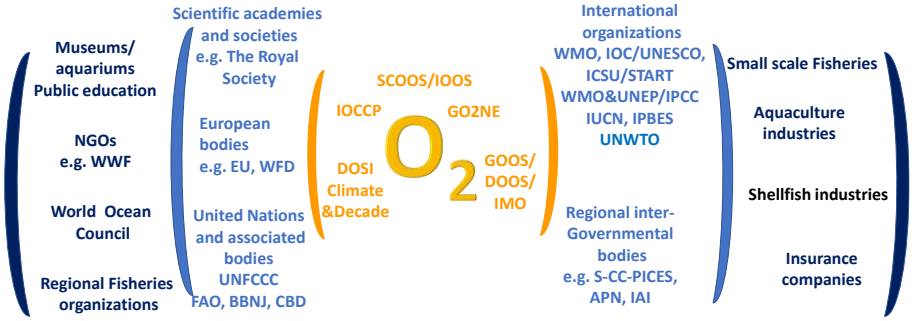
4. **Economic and societal consequences of deoxygenation**
   How to value the impact of deoxygenation on ecosystem services (food provisioning, climate regulation) and blue growth activities (aquaculture, fisheries)?
   including links with economic and social science and to improve our understanding of the link between deoxygenation and human welfare Impact on societies

5. **A Digital Twin Ocean for oxygen across scales from coastal to global**
   Atlas, modelling, development of a sustained observing system
   Model simulations & development (land-ocean-atmosphere-sediment coupling, redox, interfaces - benthic-pelagic, coastal-open ocean, ocean-atmosphere,
   Global Ocean Oxygen Atlas (GO2AT) containing gridded products integrating oxygen data from ships, moorings, Argo, gliders, for delivering information with an unprecedented resolution for the global and coastal ocean.

7. **Develop Solution to monitor, mitigate deoxygenation in a multiple stressors context including climate change**
   Restore and protect ecosystems against these stressors and to increase ecosystem resilience and preserving the delivering of ecosystem services under deoxygenation, in the coastal and global ocean (develop an observing system for oxygen, early warning systems, forecasting hypoxia, projecting deoxygenation in a warming climate, restoration, resilience, risks assessment (e.g. assessment of the risks that aquaculture creates hypoxia index of oxygen debt), detection of tipping points, ..

Instrumental for the Programme:

Develop an active **"oxygen stakeholder network"** to ensure sustainable ecosystem services in providing solutions to deal with climate change

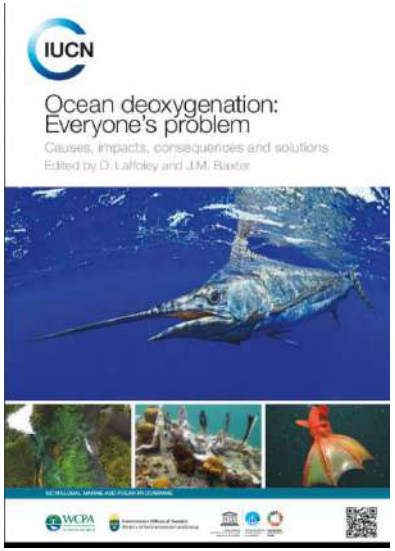


Tentative EOV Oxygen stakeholders network

Build an **efficient and constructive dialogue with society and policy makers** based on modelling results being validated for the present with the existing oxygen observations: **World Wide View Citizens consultations, hackatons**

→ **Action: Build a business plan focusing on economic values of the oxygen data platform products and produce a short brief for stakeholders, end-users and policy makers, and develop funding search actions, keeping in line with guidelines agreed upon internationally.**

*Ocean deoxygenation: Everyone's problem- Causes, impacts, consequences and **solutions**, 2019,* "Laffoley D. and Baxter J.M." (eds.) Gland, Switzerland: IUCN, 155-170, 562 pp



Which solutions (Chapter 11) presented in IUCN report could be implemented with IOCCP contribution?

-Reduction in GHG emissions
-Nutrient reduction (agriculture, sewage) : coastal ocean

-Expanding oxygen observations in the open ocean and coastal waters,

-Experiments and observations to improve understanding of critical mechanisms that control the patterns and effects of oxygen declines,

-Numerical modeling to better predict current effects of low oxygen and other stressors at local, regional and global scales,

-Assessment of effects on human economies and societies where oxygen declines threaten aquaculture, fisheries and livelihoods,

-Development of a data management system with rigorous QC and leadership with a globally recognized oceanography data centre and open access for use in science and policy,

-Continuous improvement of oxygen sensors with focus on ultra-low oxygen concentrations and low cost sensors for extensive monitoring in undersampled coastal waters,

-Capacity building in coastal areas of the developing world for observations on core oceanographic parameters, including oxygen,

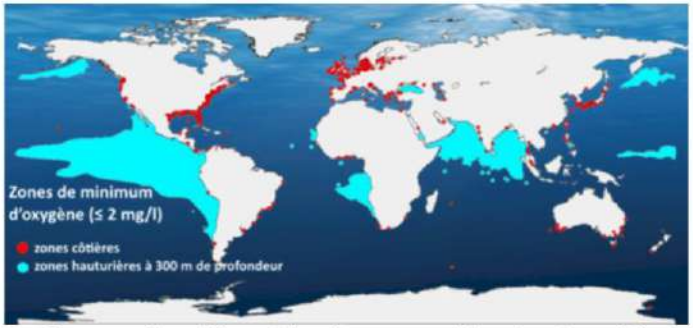
CES Oxygène dissous

CES Oxygène dissous

Le **Consortium d'Expertise Scientifique (CES) Oxygène dissous** a été mis en place début 2019 afin de mettre en réseau et fédérer les acteurs scientifiques au niveau national, voire international, autour de la thématique **Désoxygénation de l'océan hauturier et côtier** et d'établir une base exhaustive et qualifiée des données nationales d'oxygène dissous océanique. Il est porté par Véronique Garçon (LEGOS, CNRS), Joël Sudre (LEGOS, CNRS) et Sabine Schmidt (EPOC, CNRS), Laurent Coppola (LOV, CNAP), voir leurs contacts dans l'onglet ci-dessous.

L'oxygène est essentiel à la santé de la planète. Il affecte les cycles du carbone, de l'azote et d'autres éléments clés, et est une exigence fondamentale pour la vie aquatique. Néanmoins, la désoxygénation s'aggrave dans l'océan côtier et ouvert (plus d'information sur l'oxygène dissous : description, actualités, collecte et instruments de mesures, ...)

A terme, ce produit synthétique devra inclure toutes les observations eulériennes et lagrangiennes, i.e. les mesures de titration Winkler, les données des capteurs oxygène implantés sur des CTD et sur les mouillages fixes/observatoires de fond/séries temporelles, les capteurs oxygène sur les profileurs BGC-ARGO, sur les gliders et wavegliders ou sur tout autre type de véhicule/plateforme autonome. Une stratégie possible serait de se concentrer dans un premier temps sur les données eulériennes, puis dans un second temps travailler sur les données lagrangiennes. La philosophie est de s'inspirer de l'approche SOCAT, une initiative communautaire développée et maintenue par les fournisseurs et utilisateurs des données.



En rouge, sites côtiers où les charges en nutriments ont causé la décroissance du contenu en oxygène jusqu'à des concentrations < 2 mg/l et, en bleu, zones de minimum d'oxygène à 300 m de profondeur. Crédit: illustration adaptée du groupe de travail GO2NE. Data from World Ocean Atlas 2013 and provided by R. J. Diaz.

Ateliers | Actualités | Ressources | Contacts

Atelier #2 - Novembre 2020

Caroline Mercier : externe.caroline.mercier@thales-services.fr

Thank you for your attention

Outreach :

- Interview by France Culture on Ocean deoxygenation, RadioFrance, La Méthode Scientifique, December 2019, https://www.franceculture.fr/emissions/le-journal-des-sciences/le-journal-des-sciences-du-lundi-09-decembre-2019
- Inteview by swiss Radio RTS , CQFD program, on Ocean deoxygenation, December 2019, https://www.rts.ch/play/radio/cqfd/audio/les-oceans-suffoquent?id=10901266
- Interview by France Inter on Ocean deoxygenation, La Terre au Carré, December 2019, https://www.franceinter.fr/emissions/la-terre-au-carre/la-terre-au-carre-30-decembre-2019
- Interview by La Dépêche newspaper, Les chercheuses toulousaines en océanographie, December 2019
- IFREMER/French Office of Biodiversity Colloquium on « Together, protecting marine biodiversity : knowledge for action", Clos des Bernardins, Paris,12 March 2020, Member of Panel 2 : Research challenges, "If you cannot breathe, nothing else matters", https://wwz.ifremer.fr/journeebiodiversiteifremerofb/Revivre-le-colloque, https://www.youtube.com/watch?v=DQz8Hyfra-Q
- Interview by Marc Guillaume, Economist and editor, Descartes Editions, for his upcoming book on Ultra-green energies, on the role of oxygen injection into dead zones, June 2020
- Interview by Ludovic Jolivet, journalist for Les Cahiers d'administration, edition of the Review « Administration de l'Association du Corps préfectoral et des Hauts-Fonctionnaires du Ministère de l'Intérieur » for a special issue on the "National strategy for the sea and the oceans", Improving our ocean knowledge to better protect, July 2020, issue to be published in October 2020.

http://www.ioccp.org/oxygen

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International Ocean Carbon Coordination Project
Towards a sustained global observation network for marine biogeochemistry

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- Surface CO_2 Observations
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- Synthesis Activities
- Ocean Acidification
- Nutrients
- Oxygen
- Framework for Ocean Observing
- Data and Information Access Services
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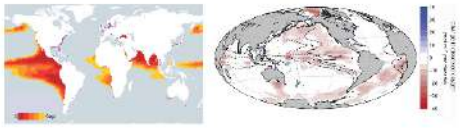
Oxygen

Oxygen (O_2) is essential for nearly all multicellular life. Subsurface oxygen concentrations reflect a balance between supply through circulation and ventilation and consumption by respiratory processes. Changes in either of these processes is susceptible to lead to changes in O_2 distribution. A global ocean O_2 observing network will act as a sensitive early warning system for trends that climate change is causing. Ocean deoxygenation (decline in O_2 concentration) is under way in part because of ocean warming and increased stratification, but also because of increased nutrient loads in the coastal ocean. Deoxygenation has been largely under the radar to most people including policy advisers and decision makers. Yet it is deoxygenation that will have profound implications not just for ecosystems but also for communities and economies that depend on a healthy ocean. It is one of the prices we are now paying for the fact that the ocean has been shielding us from the worst effects of climate change which would otherwise have resulted from the continuing excessive emissions of carbon dioxide and other greenhouse gases.

To find out about IOCCP's role in coordinating global ocean O_2 observations, click on the Current IOCCP Activities tab below.

Changes in ocean oxygen content



(left) Global map showing coastal sites (purple dots) and open ocean sites (red to yellow, at 300 m of depth) where O_2 levels are below 2 mg-L^{-1} (Adapted from Breitburg et al., 2018). (right) Change in oxygen content of the global ocean in mol-O_2 m^{-2}-decade^{-1}. (From Breitburg et al., 2018)

Véronique Garçon
Responsible
SSG Member

OXYGEN EOV
Specification Sheet

Information Exchange:
www.ocean-oxygen.org

Calendar

IOCCP meetings, IOCCP-related meetings as well as events related to a wider scope in marine biogeochemistry.

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Institute of Oceanology of Polish Academy of Sciences, Powstańców Warszawy 55, 81-712 Sopot, Poland

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