Let the ocean breathe again – Responding to ever-increasing need to protect and sustainably manage ocean services by fully harnessing the expanding volumes of ocean oxygen data

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Oxygen dissolved in seawater supports the largest ecosystems on the planet. It is alarming that the **ocean is losing oxygen, termed ocean deoxygenation**, at a rapid rate, primarily **due to global warming** by anthropogenic greenhouse gas emissions, and **pollution by nutrients and organic wastes** particularly in coastal waters.
The **Global Ocean Oxygen Decade (GOOD)** will raise global awareness about ocean deoxygenation, **provide knowledge for action** and **develop mitigation and adaptation strategies** and solutions to ensure continued provision of ecosystem services, and **minimize impacts on the ocean economy** through local, regional, and global efforts, including transdisciplinary research, innovative outreach, and ocean education and literacy.

Why is a global database for ocean oxygen needed?

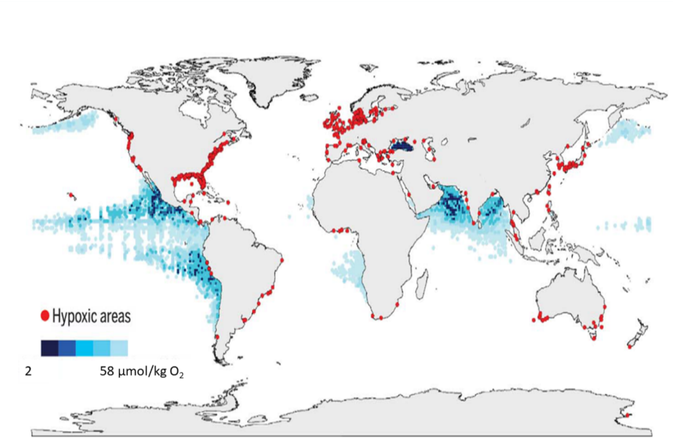


Figure 1: Global distribution of low oxygen areas (i.e. O_2 < 60 µmol kg^{-1}) in the coastal and global ocean (from Breitburg et al., 2018). In the coastal area, more than 500 sites have been inventoried with low O_2 conditions in the past half century (red dots) while in the open ocean the extent of low O_2 waters amounts to several millions km^3 (the blue dots refer to conditions at 300 m).

With the ever-increasing need to protect and sustainably manage ocean services, we continue to expand the global ocean observing system to meet these needs (Fig.1. In order to fully harness the increasing volumes of O_2 data already delivered and in anticipation of much higher quantities of data from autonomous platforms in the open ocean and coastal areas we developed a blueprint/roadmap for the **Global Ocean Oxygen Data Atlas (GO_2DAT)**.

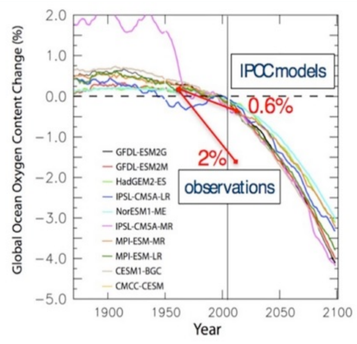


Figure 2: Projected global ocean O_2 content change from various models (IPCC AR5). Models indicate a 0.6% decrease (1960-2000s) whereas compilations of observations, such as Schmidtko et al,. (2017) indicate greater changes, by a factor of about 3. Figure from Andreas Oschlies (2018) 4th International Symposium on the Effects of Climate Change on the World's Oceans 4 (ECCWO) meeting in Washington, D.C., USA "Reconciling systematic differences between observed and simulated ocean deoxygenation" and discussed in Oschlies et al., (2018).

GO_2DAT will **support the development of advanced biogeochemical models and data synthesis products** significantly improving our mapping, understanding and forecasting capabilities. Figure 2 illustrates the need for reconciling model-based oceanic oxygen projections with observations.

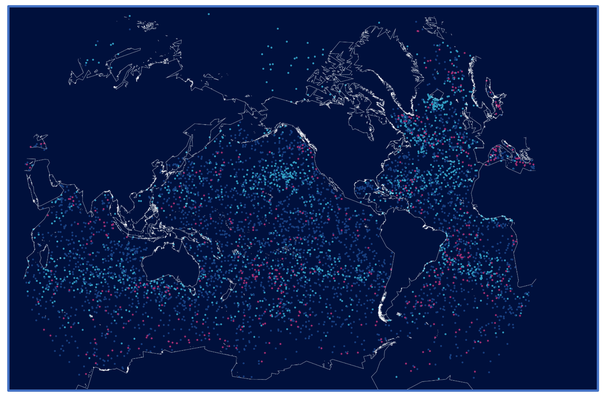
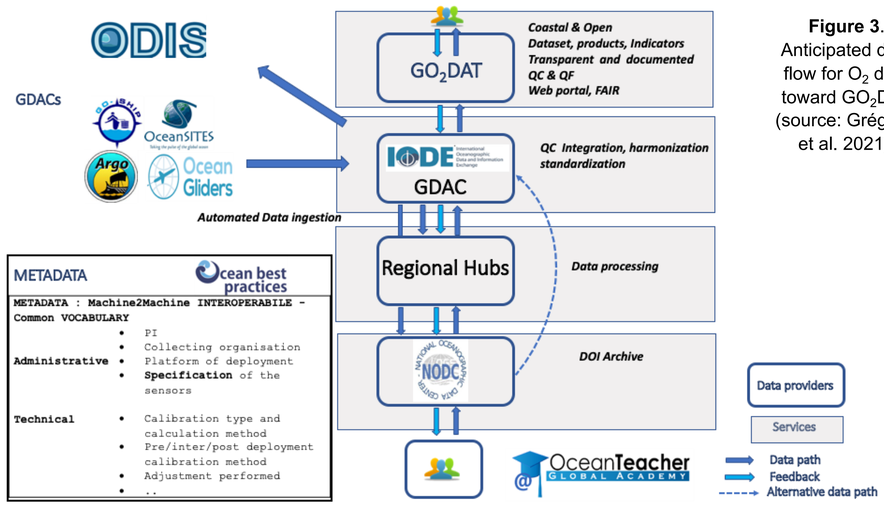


Figure 3. OceanOPS data source as of June 2021: operational platforms latest location: pink dots - biogeochemistry and deep floats Argo measuring O_2, light blue dots – drifting and polar buoys –DBCP not measuring O_2; dark blue dots – profiling floats – Argo not measuring O_2. Symbols size is not to scale, in the map they are exaggerated to an order of hundreds kilometers for readability (source: Ocean Obs report card 2021).

Roadmap towards the implementation of the global oxygen database and atlas



METADATA	Ocean best practices
METADATA : Machine2Machine INTEROPERABILE - Common VOCABULARY	
Administrative	• PI • Collecting organisation • Platform of deployment • **Specification** of the sensors
Technical	• Calibration type and calculation method • Pre/inter/post deployment calibration method • Adjustment performed • ..

Figure 3. Anticipated data flow for O_2 data toward GO_2DAT (source: Grégoire et al. 2021).

The proposed data submission will be two-fold: a centralized data submission to existing GDACs and a bottom–up data flow via NODCs (Figure 3).
GO_2DAT requires human resources and engagement from the scientific community, data providers, data managers and end-users. Engagement around GO_2DAT will be promoted by the **UN Decade Global Ocean Oxygen Decade (GOOD) program**. It also requires dedicated infrastructure to enable smooth incorporation with WOD, EMODnet, CMEMS, GLODAP and other currently operating, disconnected databases.
GO_2DAT will **support the development of climate and ocean health indicators** allowing for knowledge-based decision-making processes aimed at sustaining a healthy, productive and resilient ocean as prioritized by international policies and initiatives (e.g., UN SDG 14, the EU MFSD, the UN Decade of Ocean Science for Sustainable Development).

For more information, please visit:
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Breitburg, D., Levin, L.A., Oschlies, A., Grégoire, M., Chavez, F.P., Conley, D.J., et al., (2018). Declining oxygen in the global ocean and coastal waters. Science, 359: 6371 [doi: 10.1126/science.aam7240].
Schmidtko, S., Stramma, L. and Visbeck, M., (2017). Decline in global oceanic oxygen 1525 content during the past five decades. Nature 542, 335-339
Oschlies, A., Brandt, P., Stramma, L. and Schmidtko, S., (2018). Drivers and mechanisms of ocean deoxygenation. Nature Geoscience 11: 467-473.
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Global Ocean Oxygen NEtwork