Activities of research dedicated to the Minimum of Oxygen in the eastern Pacific (AMOP)

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surface ocean solas 2015 tower atmosphere study

AMOP is a trans-disciplinary project of cruise, gliders deployment, mooring and modeling, associated with an effort of experimental development (instrumentation, sensors), which aims at better understanding the Oxygen Minimum Zones (OMZs) and the ocean deoxygenation. The project focused on the OMZ off Peru started in 2012-2013 for 3 years at least.

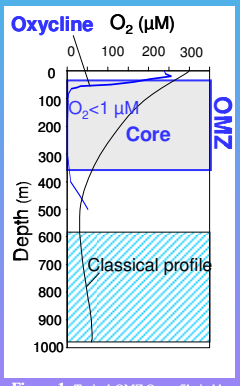


Figure 1: Typical OMZ O_2 profile in blue

SCIENTIFIC ISSUE: **OMZs** (Figures 1 and 2) are known to play a key-role on the evolution of **climate** (greenhouse gases) and on the **ecosystems** and **fisheries** (nitrogen loss, respiratory barrier). However, OMZ formation, maintaining and variability remain to be investigated and quantified, since no physical-biogeochemical coupled model manages to represent the detailed OMZ structure.

OBJECTIVE: to carry out a **complete O_2 budget** taking into account **physical** (advection/diffusion) and **biogeochemical** (e.g. O_2 consumption/production through bacteria and zooplankton) **contributions**. In particular, AMOP will document the different terms of the following equation at local/regional and daily/intra-seasonal scales:

$$\frac{\partial O_2}{\partial t} = \dot{U}.\nabla O_2 + A_H \nabla_H^2 O_2 + \frac{\partial}{\partial z}\left(A_V \frac{\partial O_2}{\partial z} \right) + F_{air-sea} - C + P + F_{sed-water}$$

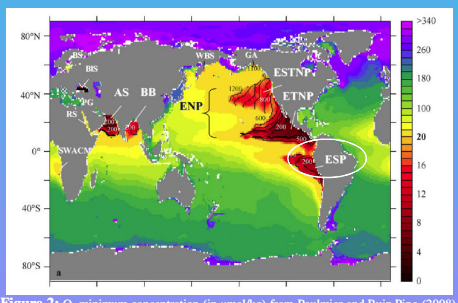


Figure 2: O_2 minimum concentration (in µmol/kg) from Paulmier and Ruiz-Pino (2008).

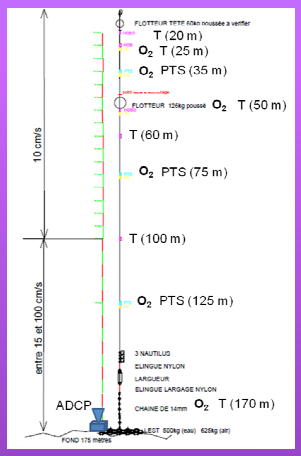
THE CENTRAL HYPOTHESIS

"The **oxycline** is the engine of an **intense but intermittent** biogeochemical and ecosystem OMZ **activity** (e.g. O_2 consumption), **driven by biological processes** that are **modulated by the physical forcing**."

3 SPECIFIC QUESTIONS:

1) Which role the **remote and local physical forcing** mechanisms have on the **variability of the oxycline activity** and of the **biogeochemical response** and its interaction with the continental shelf?
2) Does the **nano- and micro-molar O_2 concentration** play a key-role on the biogeochemical **OMZ state** and **activity**?
3) Could the chemical state and quality of **Organic Matter/particles influence** the biogeochemical activity related to the community OMZ structure?

Figure 3: Pictures of AMOP platforms: French R/V L'Atalante; Argo-floats; Peruvian R/V Jose Olaya Balandra; AMOP-mooring.



Proposed AMOP-mooring schematic:

- POSITION: 12°02'S, 77°40'W;
- SENSORS will included 6 O_2-optodes, 1 ADCP, 3 P-T-S and 6 T sensors (+ 2 fluorimeters + 2 sediment traps);
- DEPLOYMENT is expected to be done on the R/V Meteor in January 2013.

GENERAL STRATEGY based on 4 approaches (Figures 3 and 4):

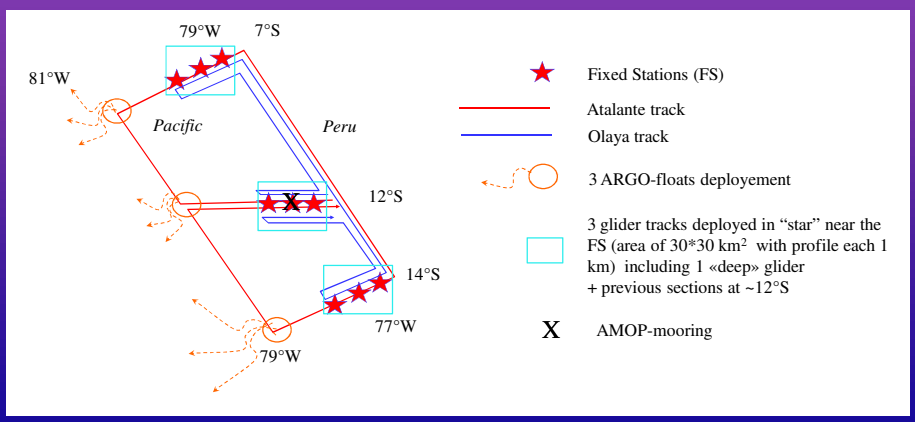
1) A process-oriented **cruise** of ~30 days focused on **9 fixed stations** of 72h located on 3 cross-shore transects and on a rectangular box track, **with two R/V ships** and **ARGO-floats**. The cruise will document simultaneously the contribution in O_2 for each component of the OMZ system as well as the coastal and open ocean configurations, forcing and responses;

2) Experiments with **4 gliders** in order to document the submesoscale and the horizontal advection/diffusion terms at each fixed station;

3) A complementary subsurface **mooring at a fixed "reference" station** on the central historical radial for a high temporal and vertical resolution monitoring of the OMZ structure, which is to become an international open transdisciplinary platform. The AMOP mooring will be visited and recovered during short cruises each 1-3 months during 3 years minimum, in a collaborative effort associated with the German SFB754 program (2nd phase in 2013).

4) A high-resolution biogeochemical coupled **modeling platform** that will provide guidance for the sampling strategy during the experiment, as well as assisting the interpretation of the whole AMOP data set documenting the "scale gaps".

3 WORKPACKAGES (WP): **1) WP1** "OMZ: characterization, variability and O_2 conditions"; **2) WP2** "Physical dynamics: O_2 fluxes and forcing"; **3) WP3** "Biogeochemistry and ecology: O_2 consumption, and biological and chemical properties".



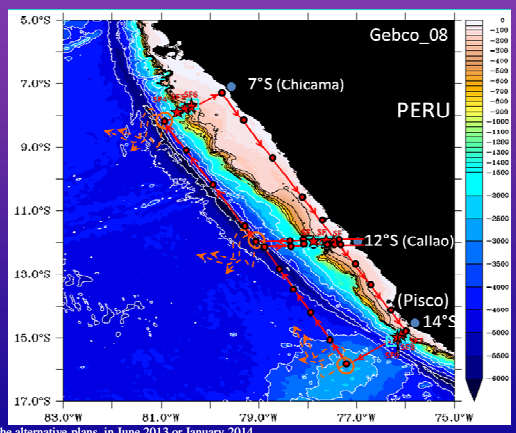


Figure 4: The general AMOP strategy (schematic and with bathymetry). For the cruises, the initial plan is to start in December 2012 / January 2013, and the alternative plans in June 2013 or January 2014.

GLOBAL OVERVIEW (cf the logos for details of the AMOP team):

- **Team involved in the 28 days sea operations**: 33, 16 and 8 scientists and engineers onboard the R/V Atalante, R/V Olaya and involved in the glider missions, respectively.
- **Full team**: 90 scientists and engineers involved in the global project
- **12 laboratories** from **12 Institutes** involved in France
- **2 Institutes** involved in **Peru**: IGP and IMARPE including the participation of **6 Research Units** (Physics, Biology, Chemistry, Modeling, Acoustics, Ecology)
- 8 foreign Institutions in **6 other countries**.

INTERNATIONAL FRAMEWORK: **France-Peru** cooperation – Mid-term strategy OMZ-EBUES **SOLAS** – Collaboration with the **German SFB754** « Climate-biogeochemistry Interactions in the Tropical Ocean ».

AMOP website soon available

REFERENCES: Paulmier, A., and D. Ruiz-Pino (2008), Oxygen Minimum Zones (OMZs) in the Modern Ocean, Progress in Oceanography, doi:10.1016/j.pocean.2008.08.001.