Open Sea-02: A degassing chamber to monitor the dissolved CO2

Type of the project
Semester project

Laboratory
Smart Environmental Sensing in Extreme Environnements – SENSE

Professor
Professor Jérôme Chappelaz

Supervisor
Professor Jérôme Chappelaz

Contact person at Sailowtech
Vadim Paccaud

Student
To be determined

Context

Sailowtech is an association and a MAKE project that aims to raise awareness of environmental issues, particularly those relating to aquatic environments. It promotes frugal and participative field science, open-source science, and low-tech approach. To achieve this, Sailowtech organizes scientific sailing expeditions in lakes, seas, and oceans to discover field science, test the protocols and devices build by students during the semester.

Understanding the dissolution of greenhouse gases in the ocean is crucial because it directly influences ocean acidity, which has profound implications for marine ecosystems and biodiversity. Additionally, the ocean serves as a significant carbon sink, playing a key role in regulating Earth's climate by mitigating the impact of excess atmospheric greenhouse gases.
Although common in-situ measurement methods of dissolved greenhouse gases exists for a while, there is no standard open source design proposed to implement it. The idea of this project is to take advantage of simpler sensors that measure the concentration of CO2 in the gas phase, by developing a device that allows liquid samples to be transferred **from the liquid to the gas phase**. Such equipment would be affordable and portable, enabling its use in sailing expeditions such as those organized by Sailowtech.

Description of the project

The open SeaO2 is a device for measuring the flow of CO2 between the atmosphere and the ocean. It follows a low-tech philosophy, meaning it is open-source, durable, useful, and low-cost.
Its operation is based on an equilibrium chamber in which seawater and air continuously circulate. Two pumps manage the inflow and outflow of water, while an air pump supplies a NDIR sensor that measures CO_2 concentration, allowing the calculation of the partial pressure pCO_2 in the water. A ToF distance sensor maintains a constant water level via microcontroller-based regulation. The system, initially designed by Alexandre Tellier and later improved by Yanis Mouzaoui, has been fully redesigned to increase reliability, simplicity, and autonomy. The prototype is finished but was never tested in the field.

Phase 1 – Priority
The instrument needs to be **tested intensively in the laboratory and in the field**. This semester project will focus on validating the collected data (data analysis) by comparing it with reference measurements. Both short-term and long-term tests will be conducted to assess potential time drift.
Laboratory tests will be conducted in SENSE facilities at EPFL Sion. Field tests will be carried out on the EXPLORE platform or during boat cruises.

Phase 2 – Next Development Steps
It is recommended to:

- Design a waterproof and robust enclosure to protect all electronic components.
- Improve the plexiglass protection and enhance its aesthetics.
- Replace the auxiliary tube with a rigid tube to ensure more reliable ToF distance measurements.
- Implement an anti-humidity system in the closed air loop to protect the NDIR sensor.

The ideal profile for this project is an autonomous, proactive student, interested initially in prototyping work, then in calibration and measurement in the laboratory. This project has been set up in partnership with Prof. Jérôme Chappellaz's SENSE laboratory. The student will have to travel to Sion for the characterization phase once the prototype is complete; the lab will pay for the transport. The other stages of the project can be carried out on the EPFL campus in Lausanne.

Indicative calendar

Sem1&2 : Meet J.Chappellaz and Sebastien Lavanchy of the SENSE Lab.
Sem 3: Get to know the project and the various modifications to finalize the system
Sem 4&5&6: Field and Laboratory tests
Sem 7: Intermediate presentation with Sailowtech
Sem 8&9&10: Data analysis
Sem 11&12&13: Start the calibration and characterization. Developpment phase.
Sem 14: Final presentation with Sailowtech

Deliverables

1. A calibrated degassing chamber that can be used on a future Sailowtech cruise.
2. An oral presentation at the end and in the middle of the semester to present the results of the project.
3. A document explaining the changes made to the device to make it reproducible as well as presenting the characterization results.
4. Complete the Sailowtech's Github that we will used as documentation

Documentation

As a starting point, you can find the documentation to our present Sea-O2 version on: https://kdrive.infomaniak.com/app/drive/1213921/shared-with-me/1213921/9546/preview/pdf/9621

Planned interaction with Sailowtech

The objective of this project is to develop a device that can be used during a Sailowtech cruise or instruments tests campaign. Consequently, there will be several meetings with Sailowtech (approximately seven per semester, or as required) to monitor

progress. Furthermore, the relevant technical staff at Sailowtech will be available for advice and assistance.
Finally, you will be counted as a member of Sailowtech, and will therefore be able to take part in the various activities and potentially test the device during one of our expeditions.

Contact

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