MSM123 "BELS"

Halifax – St. John's

23 November – 27 December 2023

4th Weekly Report (11.12.2023 - 17.12.2023)

This week we spent some time assessing the data that we have gathered so far. One of our successful deployments involved a sensor equipped wave glider (aka 'Martin', *Figure 1*). The platform spent almost a week enduring high waves and winds while measuring dissolved gases in the surface and subsurface layers. The wave glider is part of the extensive research field program out of Dalhousie University and the University of Victoria (Canada). The goal is to measure dissolved gases (total dissolved gas pressure (TDGP), dissolved oxygen (O_2), seawater carbon dioxide (pCO_2), noble gases (Ne, Ar, Kr), and nitrogen (N_2)) and turbulence at the ocean surface and subsurface when bubble-mediated exchange is most significant. When combined with the data of bubble presence, movement, and distribution from the bubble buoy and the waverider by the BELS-UK team, these measurements will provide better understanding of the bubble-mediated processes needed to improve current air-sea gas exchange estimates and to reduce overall flux uncertainty.

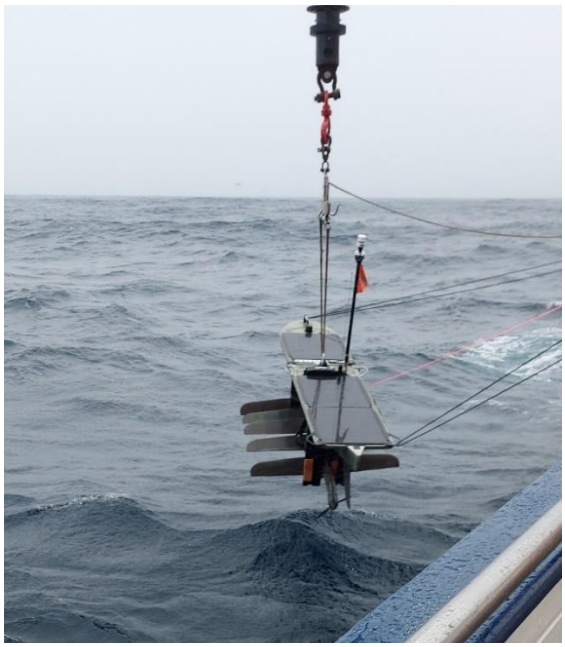

Figure 1: Wave Glider SV3-1071 ('Martin') deployed from the RV MARIA S. MERIAN.

The wave glider system is a mature autonomous surface platform developed by Liquid Robotics, US that is designed to capture wave energy for its main propulsion using a two-part motion capture system; the float, which sits at the surface, and a sled that transfers wave energy into a constant 'angle of attack' that sits at 8m with a powered tether that connects the two units together. Typically, a wave glider mission is designed to be deployed for up to 6 months at a time, traveling on average 1000 nautical miles a month. However, due to the low solar angle and the high energy

requirements of the onboard science packages, a mission endurance of 6 to 7 days at a time was planned.

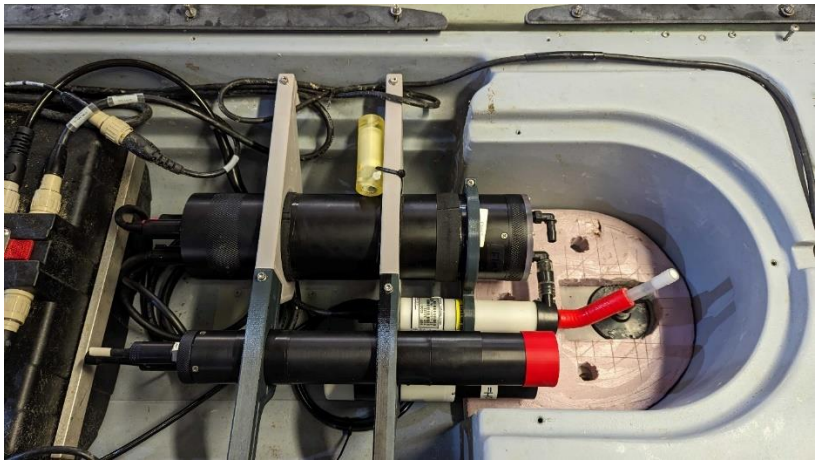

Figure 2: Float mounted pCO_2, TDGP, and pH sensors that take water in via a pump through the glider's moon pool.

The wave glider was equipped with a sensor package within its float that consisted of a pCO_2 sensor, TDGP (both Pro-Oceanus Systems, Inc, Canada), and pH sensor (Pyroscience, Germany) that passed water from the upper surface layer and into the hull of the platform (*Figure 2*). This was coupled with a SeaBird GPCTD/43F DO system measuring high-frequency salinity, temperature and dissolved oxygen, as well as an Airmar 200WX weather station 1m off of the sea surface. The subsurface science package, which sits nominally 8m below the sea surface, consisted of a flow through GPCTD/43F DO sensor, pCO_2, and TDGP (*Figure 3*).

The wave glider was able to stay on mission for 6 days and collected data in the vicinity of ship-based tracer survey, the Slocum glider 'Polly' (equipped with CTD/DO and a Rockland Scientific MicroRider to measure turbulence), and the bubble buoy deployed by the UK group onboard from UCL and University of Leeds (*Figure 4*). During its mission it collected data in wave heights measured at over 10 m and wind speeds of over 20 m/s. These heavy sea conditions represent the highest sea states the glider has been deployed in without critical structural failures, but it was not without its challenges.

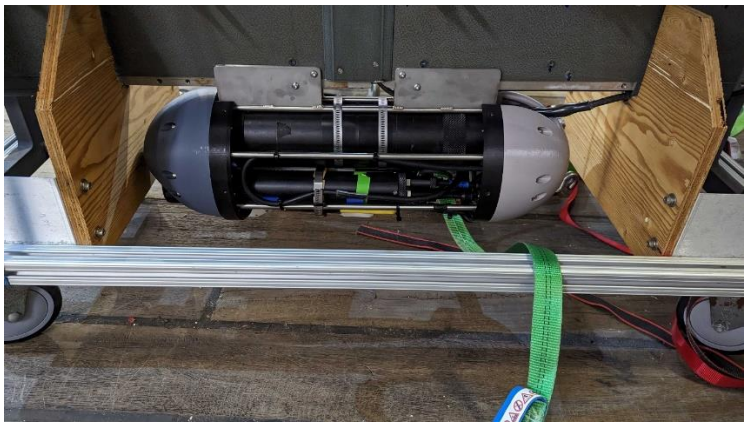

Figure 3: Sub mounted pCO_2, TDGP, GPCTD/DO sensors.

Overall, the data gathered from its mission will be valuable in providing a greater understanding of the air-sea interactions during high wind conditions. The near surface gradients in gas concentrations, especially pCO_2, oxygen and total gas pressure, in combination with near-surface turbulence carry information about the rates of gas exchange under varying hydrological conditions and atmospheric forcings, such as wind and waves.

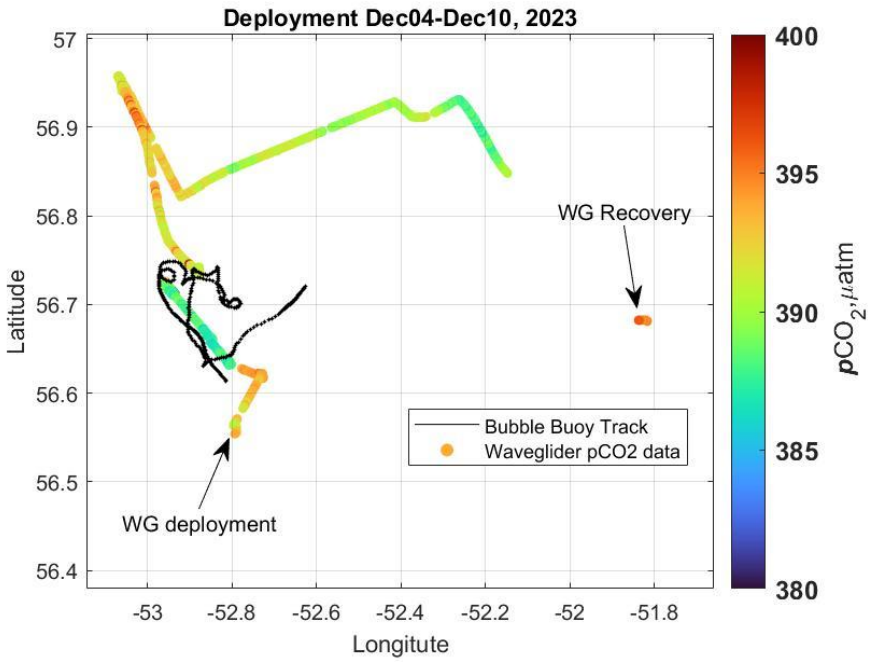

Figure 4. Tracks of the wave glider and bubble buoy, illustrating the pCO_2 distribution measured by the wave glider.

Greetings from an energetic Labrador Sea,

Christa Marandino

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