PROJECT SUMMARY REPORT - 2016 SERF CAMPAIGN

Subproject: In situ, continuous measurement of CO_2 and pH in the near-surface water

Actual field dates: February, 8-26, 2016
Field site: Sea-ice Environmental Research Facility (SERF), University of Manitoba, Winnipeg (Canada)
Number of man-days in the field: 20

Summary:
The carbonate cycle in sea ice systems is complex given the dynamic exchange mechanisms between the solid, liquid, and gaseous phases during ice formation and eventual melting. In particular, CO_2 is expelled from growing ice crystals into the brine-filled pores, after which it can migrate upwards to the atmosphere, downwards due to gravity driven flow, or be precipitated in situ as ikaite, depending on the permeability profile of the evolving ice structure, the temperature, and the mineral saturation state. Documenting these processes in an evolving system is difficult, however this information is critical to better understand kinetics and short-term cycling of CO_2 in natural sea ice environments.

To this end, a total of eight GasPro sensors, developed by Sapienza University of Rome (see doi: 10.1021/es500666u), were modified for real-time, in situ monitoring of pCO_2 and temperature in sea ice during its formation. To our knowledge this is the first experiment of its kind, as manual sampling and analysis has always been performed in the past. Two multi-level units were built consisting of four pCO_2 / T sensors spaced 10 cm apart, allowing us to monitor these two parameters at about 5, 15, 25, and 35 cm below the water surface at two points in the SERF pool. The two units were installed about 1 m apart on the day that the water heating system was turned off and were left in place as the ice formed around them over the following 18 days. Having two identical units gave us the opportunity to assess reproducibility and precision of the sensors as well as test different warm-up/analysis/sleep cycles given the fact that the internal Non Dispersive Infrared sensors generate heat when on (which may influence the temperature of the immediate surroundings). The majority of data was collected either with the unit always on and an analysis every minute, or with the sensors on for 15 minutes every 1 or 2 hours. In addition, researchers from the University of Manitoba provided ice thickness, water/ice salinity and air temperature data, and performed X-ray analysis on core to estimate brine content at the end of the experiment.

Despite the fact that anomalously warm weather resulted in only 12-13 cm of total ice thickness (compared to the hoped-for 35-40 cm), this preliminary experiment yielded interesting data related to both sea ice CO_2 dynamics as well as GasPro system optimisation for future sea ice monitoring

Figure 1

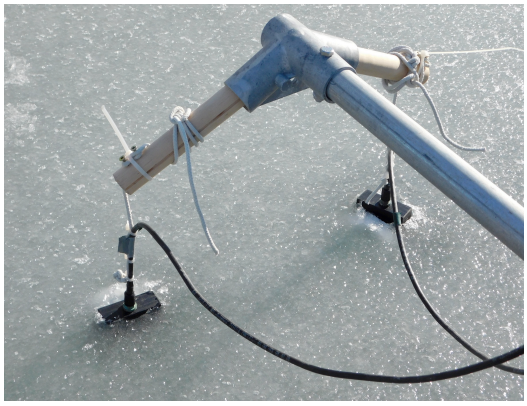

Figure 2

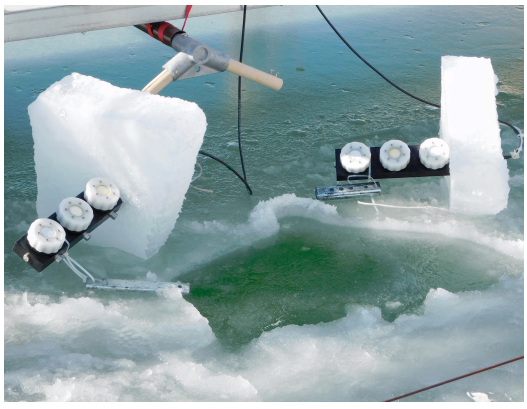

Figure 3

Photos:

Fig.1: The two multi-level GasPro pCO_2 sensor units prior to deployment. Credit: Stan Beaubien

Fig. 2: The two multi-level GasPro pCO_2 sensor units deployed in the SERF pool, with the first sensor located at a mid-point depth of about 5 cm. Cables go from each unit to a computer for real-time monitoring. Credit: Stan Beaubien

Fig. 3: The two multi-level GasPro pCO_2 sensor units encased in sea ice at the end of the experiment. For each unit the first sensor was totally in the ice while the other three remained in water. Credit: Stan Beaubien

Participants:

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Acknowledgements:

Funding for this research was provided by the Università di Roma "La Sapienza" and the affiliated research institute C.E.R.I. We would also like to acknowledge the scientific, technical, and logistical support provided by personnel of CEOS and the University of Manitoba, in particular SERF site manager Dave Binne..

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