Introducing the first GRIL autonomous buoy, Lac Simoncouche, spring 2013

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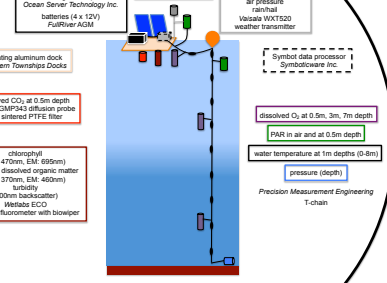
Probes and variables

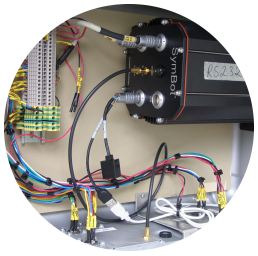


In collaboration with the NSERC Industrial Research Chair in Carbon Biogeochemistry of Boreal Aquatic Systems (CarBBAS), held by Paul del Giorgio, the Groupe de recherche interuniversitaire en limnologie et en environnement aquatique (GRIL) will soon have an autonomous research buoy!

The GRIL buoy, which will be installed on Lac Simoncouche in spring 2013, is very similar to the CarBBAS buoy, which was first deployed on Lac Croche in 2011 (see photo).

Data collection and transmission

At a user-defined frequency (eg. every 60 min), the Symbot data processor polls the probes for data, reads and logs the results, and then transmits them via satellite to a server, which can be accessed online via Symsite (Symboticware Inc.). At this point, communication is one-way, but we are exploring the possibility of bi-directional communication with the buoy to turn sensors on and off, or to change the polling frequency.



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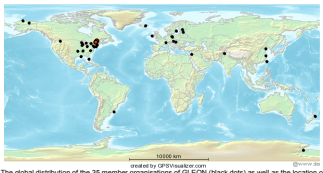
Data sharing and collaborations



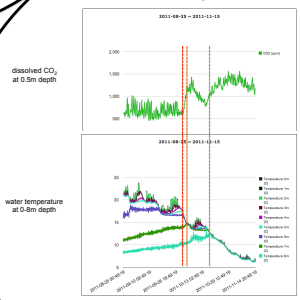
The global distribution of the 35 member organisations of GLEON (black dots) as well as the location of the GRIL and CarBBAS buoy sites, which will soon be contributing data to GLEON (red dots).

Data collected by the GRIL and CarBASS buoys will be shared with the Global Lake Ecological Observatory Network (GLEON), a grassroots network of limnologists, ecologists, information technology experts, and engineers. This group of more than 260 individuals from 35 member organisations (see map) aims to build a network of lake ecology observatories, in order to improve understanding and management of lake ecosystems. Lac Croche and Simoncouche will be the next two Canadian sites to join the GLEON network of more than 60 lakes, many of which are also equipped with buoys collecting high-frequency data. Becoming part of GLEON will increase the visibility of the GRIL and create opportunities for collaborations world-wide.

GLEON
A NSF-funded LTER network

www.gleon.org

Viewing data online on the Symsite

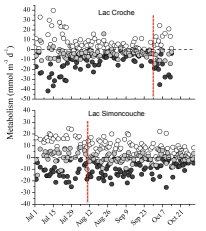


The stratification and stability of Lac Croche degrade at fall turnover when the 6m metalimnion layer and the 7m hypolimnion layer join the upper mixed layer, followed by the 8m hypolimnion layer. These mixing events coincide with large increases in dissolved CO_2 in the upper mixed layer.

Symsite provides acces to raw data on the server for viewing or downloading. The user can specify which variables to view and over what time frame (see two examples of views above). We are developing a script that will scan the downloaded raw data for anomalies (as defined by preset criteria) and send questionable data to an "outlier data" matrix. The research assistant will then check this subset of outlying values to decide when a value should be removed and when it can be replaced with an interpolated value. The final data set will then be made available to end users.

This process not only cleans the data set but also provides early detection of problems with data collection and transmission.

Temporal patterns in lake metabolism



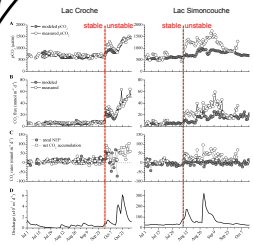
Episodic events that change the stability of the lake, such as storms and fall turnover, coincide with shifts in the metabolic balance of the lakes. In Lac Croche, fall turnover led to greater heterotrophy and more variability in the metabolic balance, while in Lac Simoncouche, a mid-summer storm caused the lake to shift from net autotrophic to net heterotrophic.

Detection of these seasonal patterns and episodic shifts in the lake's physical and biological properties was made possible using long-term and high-frequency data from autonomous buoys, combined with periodic sampling of lake profiles and gas fluxes.

Daily epilimnetic metabolic rates expressed as respiration (black dots), gross primary production (white dots) and net ecosystem production (grey dots). Respiration was calculated from the net decrease in dissolved O_2 during the night, while gross primary production was calculated from the increase in dissolved O_2 during the day, minus respiration. Net ecosystem production was calculated as the average change in dissolved O_2 per day. Positive rates indicate that O_2 was produced in the epilimnion and negative rates indicate that it was consumed.

D. Vachon and P. A. del Giorgio, in prep

Temporal patterns in CO_2 concentrations and fluxes



From weekly CO_2 profiles and calculations of lake stability, a relationship was determined between lake stability and %total CO_2 mass found in the epilimnion during a stable period. This relationship was then used to model surface water pCO_2 on a daily basis, during both stable and unstable periods. Because the model keeps the mass of CO_2 in the lake constant, it allows us to estimate the contribution of hypolimnetic CO_2 to surface water pCO_2 (see panel A). During the unstable period, a large portion of the measured surface water pCO_2 and CO_2 flux cannot be explained by hypolimnetic upwelling and thus must be due to CO_2 being generated within the lake by metabolic processes, or external CO_2 arriving via lateral inputs (panel B). In Lac Croche, metabolism explains most of the daily CO_2 accumulation in the epilimnion, whereas in Lac Simoncouche, more CO_2 accumulates in the epilimnion than can be explained by metabolism, suggesting external sources of CO_2 play a role (panel C). In Simoncouche, the greatest changes in CO_2 dynamics coincide with increased discharge flowing into and out of the lake (panel D).

Measured (white dots) and modeled (grey dots) values for (**A**) average daily surface water pCO_2 and (**B**) CO_2 flux to the atmosphere. (**C**) Areal rates of net CO_2 accumulation in the epilimnion, calculated by mass balance (white dots), and net CO_2 production in the epilimnion, obtained from the diel cycle in surface O_2 (grey dots). (**D**) Daily discharge measurements at the lake outlets.

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Research questions requiring long-term data

- what is the annual cycle of CO_2 in the lake?
- what are the temporal patterns in lake metabolism (respiration, net ecosystem production, respiratory quotient)?
- what are the seasonal patterns in CDOM and DOC and how do they correlate with hydrology, light, and lake metabolism?

Research questions requiring high-frequency data

- what is the influence of lake metabolism on CO_2 fluxes?
- how are CO_2 dynamics and fluxes related to water column turbulence and physical structure?
- what is the relationship between wind speed and/or direction (fetch) and water turbulence near the air-water interface?
- what is the influence of episodic and extreme events on gas concentrations and fluxes between water and air?