

- *ArcticNet project profile (2008-11)*
- *Scientific priority issues*

**Tim Papakyriakou**



*Tim is a member of the Centre for Earth Observation Science and an associate professor in the Department of Environment and Geography at the University of Manitoba (Photo, P. Calamai).*

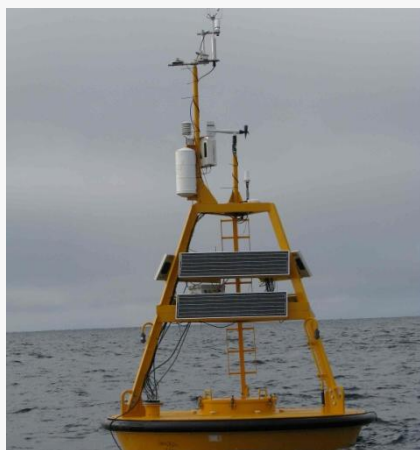


## Project profile #12 – March 2011

## Effects of climate change on carbon exchange dynamics in the Arctic

## Summary

The absorption and release of carbon dioxide by the oceans is one of the primary factors controlling the concentration of CO<sub>2</sub> in the atmosphere. CO<sub>2</sub> is a major contributor to the planet's greenhouse effect. In the ocean, the CO<sub>2</sub> concentration is controlled by biological organisms, the circulation of the water, as well as basic water properties including temperature and salinity.



### Meteorological buoy with flux system

There exists a startling amount of variability in sea surface CO<sub>2</sub> concentration, both from place to place, and with season at any one location. In general we expect regions of the Arctic Ocean, including its peripheral seas to actively take in atmospheric CO<sub>2</sub>.

High rates of CO<sub>2</sub> uptake have been reported in northern seas and polynyas, hence it is important that we understand the extent to which CO<sub>2</sub> is exchanged with the atmosphere in the Arctic, and why, to ensure that both our understanding of the marine carbon cycle, and our atmospheric CO<sub>2</sub> budgets are accurate. The latter requires us to have accurate models of the carbon cycle for Arctic regions, and a means to observe sea surface CO<sub>2</sub> on a regular basis, and over large areas. Satellite remote sensing is the best means to achieve the latter.

Measurements from the CGS Amundsen as part of its annual ArcticNet cruise are helping us understand something of the variation in surface seawater CO<sub>2</sub> concentration across the Canadian coastal Arctic, including Hudson Bay, and we are learning how features like sea ice and river plumes affect seawater CO<sub>2</sub> concentration, and the air-sea flux.

We measure not only CO<sub>2</sub> in the air and sea water, but also important water properties (e.g., salinity, temperature, dissolved oxygen, biology), meteorological parameters and the flows of heat and radiation (e.g., sunlight) so that we can relate the CO<sub>2</sub> concentration, and associated flux to the local environment. We are working towards bettering the way the CO<sub>2</sub> concentration a flux is represented in ocean models.

We are also developing the means to monitor the air-sea flux using satellite remote sensing. Pronounced changes in the seawater's CO<sub>2</sub> concentration and air-sea flux will be indicative of fundamental changes to the region's ecosystem and may come about with changing sea ice concentration and thickness, as well as through changing seawater circulation and properties, all of which are tied to climate change.

## Study site locations

Monitoring systems have been installed on the CGS Amundsen and we obtain a continuous stream of data while the ship is underway. Ice camp experiments have been conducted in Barrow Strait, near to Resolute, Nunavut.

## Local collaborations

We collaborate extensively with virtually all ArcticNet ship-based teams given that the CO<sub>2</sub> concentration in the sea water depends on the chemical, physical and biological make-up of the ocean and its surface (e.g., sea ice). In return, our team is able to supply others with valuable information on many of the ocean and atmosphere's near-surface physical and biochemical properties.

## Questions to Researchers

ArcticNet recognizes the importance of framing climate change issues from various perspectives. Below we are asking a few questions to the project leaders in order to identify scientific priority issues and demonstrate how the research results can be used by policy and decision-makers in terms of community and climate change adaptation planning in the Eastern Canadian Arctic.

*1) From your own research perspective can you identify and describe the key issues that are (will be?) affecting social, economic or environmental conditions in the Eastern Canadian Arctic?*

Despite dramatic changes in sea ice extent, concentration and thickness, it remains a defining feature of the Arctic, and from our perspective the priority science issues revolve around the role of sea ice on the air-sea CO<sub>2</sub> flux. Several processes remain sketchy, including: 1) the nature of CO<sub>2</sub> exchange that directly occurs between sea ice and air, and the associated CO<sub>2</sub> source and sink associated with the flux.

For example, what happens to the CO<sub>2</sub> that is taken in by the sea ice? Conversely, where is the CO<sub>2</sub> coming from in the event of CO<sub>2</sub> outgas by sea ice to the atmosphere? 2) What is the nature of the air-surface CO<sub>2</sub> exchange in areas with partial ice cover? 3) What happens to the CO<sub>2</sub> exchange during periods of rapid sea ice growth and melt?

We don't have satisfactory answers to these questions and it follows that none of the processes are represented in marine carbon cycle models. An additional suite of questions are associated with river water's effect on carbon cycling in the polar marine environment. By volume the Arctic Ocean receives more river runoff than any other of the world's oceans and the effect of the massive introduction of organic material of terrestrial origin on the marine carbon cycle is not obvious.

*2) How will your ArcticNet project contribute to a better understanding of these issues affecting the Eastern Canadian Arctic?*

Our project will produce information necessary to improve the modeling and monitoring of sea water CO<sub>2</sub> and the air-sea flux. Because CO<sub>2</sub> is such an important component of the atmosphere and ocean, the work has spin-off benefits to our understanding of climate and the marine ecosystem.

*3) Provide an example of how the results of your project may contribute to the decision-making process with respect to these issues.*

Our contributions here lie with our objectives to learn more about carbon cycling in the Arctic, and to improve our ability to represent these processes in models. The quality of forecast on the response of the Arctic environment to change is directly related to the quality of the model used for the forecast.

## General information

Contact us if you have suggestions, feedback or questions regarding the research projects presented in this newsletter.

## Project contact information:

### Tim Papakyriakou

Member of the Centre for Earth Observation Science  
Associate professor in the Department of Environment and Geography at the University of Manitoba  
[papakyri@cc.umanitoba.ca](mailto:papakyri@cc.umanitoba.ca)

## ArcticNet IRIS-2 contact

### Philippe LeBlanc

ArcticNet IRIS Coordinator  
Eastern Arctic Region  
Memorial University of Newfoundland  
[pleblanc@mun.ca](mailto:pleblanc@mun.ca)

## Upcoming Newsletter

### Researcher

#### Rob Huebert

### Research project

*The emerging Arctic security environment*

