# Adopt-a-Float, Canada

# Introduction to Oceanography & BGC-Argo

Lesson goals:

- Describe oceanography and traditional oceanography data collection tools
- Describe the BGC-Argo program
- Learn how to access BGC-Argo data

## Introduction to Oceanography

Oceanography is the study of ocean processes and properties. Accordingly, a person who studies oceanography is called an *oceanographer*. Oceanography should not be confused with marine biology, which refers to the study of ocean plants and animals. Instead, oceanographers typically study things that we can't see well with the naked eye – like ocean currents, temperature, phytoplankton and photosynthesis, oxygen and carbon dioxide levels, and nutrient cycling. That is, oceanographers study the physical and *biogeochemical* (biological, geological and chemical) properties of the ocean. Many oceanographers seek to understand how these properties are affected by environmental conditions and climate change.

*Oceanographers at work!*

Many ocean properties change both naturally, and due to human causes. Natural variability includes the differences in ocean properties that occur with season, depth in the ocean, and proximity to land. In combination, these natural variations mean that no two ocean regions exhibit exactly the same ocean properties! Human-caused, or *anthropogenic*, ocean changes superimpose on natural changes. Such changes include the wide-spread increases in ocean temperature, carbon dioxide levels (and in turn, ocean acidity), and decrease in oxygen levels observed throughout much of the planets' oceans.

## How do oceanographers study the ocean?

Since the mid-nineteenth century, oceanographers have used ships to collect data to study the ocean. A famous early expedition was the *1872–1876 HMS Challenger voyage*. On that expedition – which is widely considered to be a first modern oceanographic cruise – temperature measurements were obtained using a reversing thermometer, a device which enables temperature measurements at specific depths.

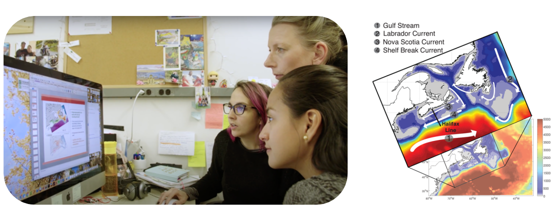
*The HMS Challenger (left) and a modern-day researcher vessel, the CCGS Tully (right).*

Since the *Challenger* expedition, research ships and oceanographic instrumentation have evolved significantly. Indeed, over the past several decades, the *CTD* and *Rosette* have become two of the most useful tools for collecting ocean data and water samples from ships. A CTD is an electrical instrument that measures the conductivity (a measure of the ocean's salinity, or saltiness), temperature and depth in the water. This is key information for understanding the distributions of heat and freshwater in the ocean. A Rosette is a large arrangement of bottles that allows oceanographers to obtain seawater samples at specific depths. The bottles can be closed automatically at different water depths, and that water is brought back to the ship, and analyzed for a variety of different properties. Watch the videos in the "more resources" section below to see a Rosette in action.


*A CTD (left) and Rosette (right).*

Using a CTD, Rosette, and other instruments, oceanographers collect "profiles" of the entire water column. A profile refers to a collection of data obtained from the ocean's surface to a maximum depth (often the sea floor).

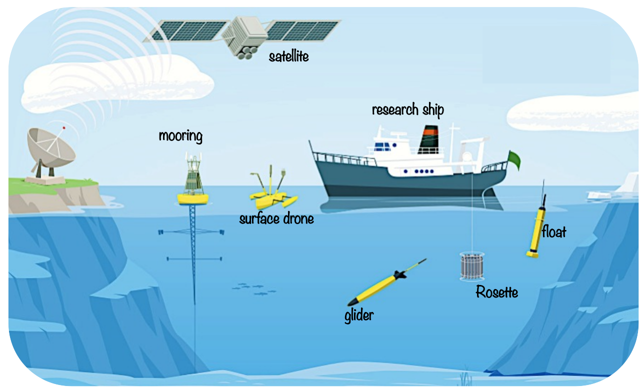
Some oceanographers also use *computer models* to study various ocean processes. These highly sophisticated mathematical (or numerical) models allow oceanographers to simulate ocean conditions and predict future changes in response to various stimuli. Learn more about models by clicking on the links in the "more resources" section below.




*Oceanographers studying a model of the NW Atlantic and Scotian Shelf region.*

However, ships are very expensive to operate, and require a lot of human oversight to obtain high-quality data. Ships are also unable to collect data from all over the ocean, at all times of the year. Models, on the other hand, require lots of data to refine them, so that they make accurate predictions.

Clearly, oceanographers need other approaches to collecting data! Fortunately, oceanographers now have a variety of other tools and sensors at their disposal. These include robotic instruments like *floats* and *gliders*, *moorings* and even *satellites*.




*Oceanographers' tools.*

Collectively, and independently, these instruments allow oceanographers to obtain data profiles automatically, filling data gaps caused by patchy sampling on ships. A new program, called the *Biogeochemical Argo program*, is a great example of how oceanographers can exploit robotic sampling infrastructure to collect data from all over the planet.

### Introduction to BGC-Argo

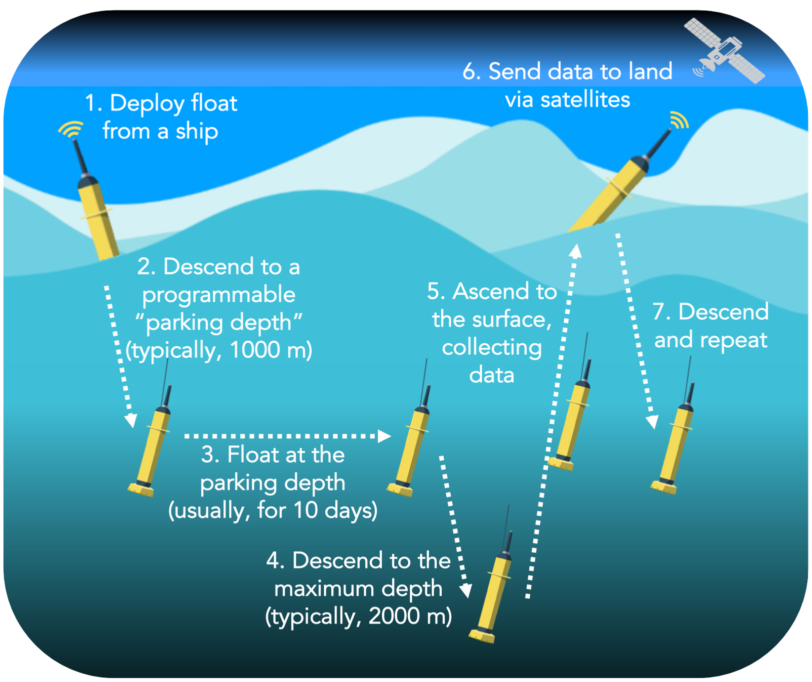
*Biogeochemical-Argo* (BGC-Argo, for short) is an international program of scientists that use robotic floats, to study various biogeochemical ocean properties. The program developed during the 2010's from the original *Core-Argo* program. Core Argo consists of floats that exclusively measure the salinity and temperature in the ocean. Developments in miniaturized sensor technology, however, mean that biogeochemical variables can now be measured autonomously on floats. Both the BGC-Argo and

Core-Argo programs consist of scientist from all around the world, with many nations contributing to funding and managing the program. The Canadian BGC-Argo program is led by Dr. Katja Fennel, a researcher at Dalhousie University, and includes scientists from across the country. Read more about the Canadian program here: https://bgc-argo.ocean.dal.ca/.

### What are BGC-Argo floats?

BGC-Argo floats are free-drifting robots that measure physical and biogeochemical properties like water temperature, saltiness (salinity), acidity (pH), oxygen and nutrient levels, and phytoplankton abundance. Read more about the properties measured by floats in the links at the end of this document. The floats ascend and descend in the ocean at programmable interval, drifting with ocean currents, and collecting data as they go. When the floats reach the ocean surface, they send their data back to land via satellite transmission. In this way, scientists can view the float data in near-real time! The standard operating cycle takes about 10 days, with floats travelling up-and-down between the ocean surface and 2000 m. At this interval, floats can collect data from over 300 vertical *profiles* (remember, a profile is a set of measurements from the surface to a specified maximum depth), lasting upwards of 5 years! However, the float cycle is fully programmable, and scientists can choose the float depths and the time between each cycle to answer specific questions about the ocean.

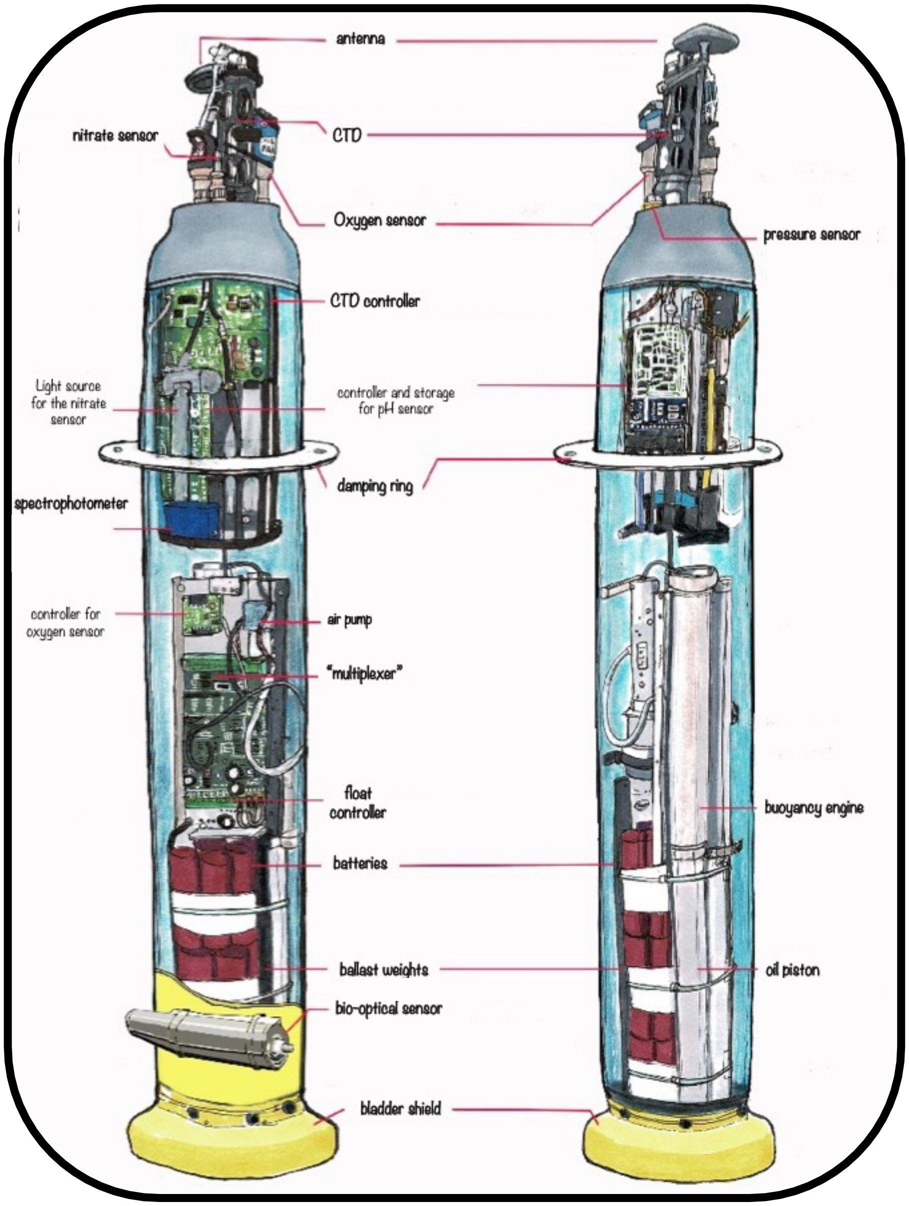
Because floats can operate autonomously, they are used to collect data from all over the ocean, and in all seasons. Usually, the cost of ships and bad weather limit the amount of data that oceanographers can collect. Imagine being on a boat in the middle of the Labrador Sea during a January storm! Yuck! Also, when compared with traditional methods of collecting ocean data, data from BGC-Argo are cheaper and are freely available to the public (find out for yourself, below). Finally, because the floats produce so much data, they are very useful for improving models – much like the way that data from airplanes or offshore buoys help to improve weather forecast models.




*The life-cycle of a BGC-Argo float.*

## The innards of a BGC-Argo float

The graphic below shows the components of a BGC-Argo float. Can you guess what each component does?

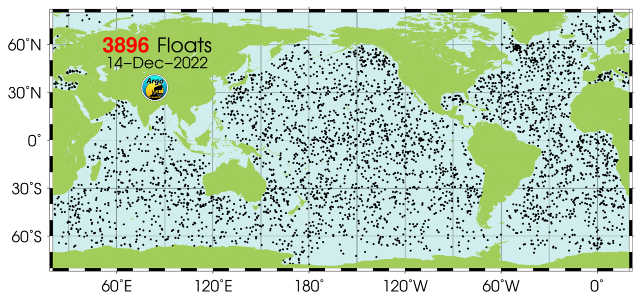



Follow the links below to learn what each part is used for.

- The innards of a BGC-Argo float: https://adopt-a-float.ocean.dal.ca/innards.png
- Interactive float description: http://www.monoceanetmoi.com/web/index.php/en/float
- What is a Float?: http://www.go-bgc.org/wp-content/uploads/2020/12/SOCCOM_What_Is_A_SOCCOM_Float_8_2016.pdf
- Testing a BGC-Argo float (video): https://www.youtube.com/watch?v=7AVOr-wPdqs
- Glossary of terms: https://sites.google.com/view/adopt-a-float-ca/learning-materials/glossary

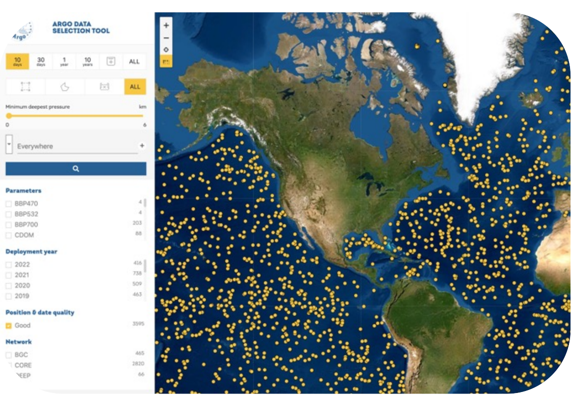
### Where are the floats?

The international Argo community plans to deploy 1000 BGC-Argo floats, and ~3000 temperature- and salinity-floats all over the ocean in the coming years. The floats are deployed in almost every ocean basin, and several *marginal seas*, like the Mediterranean Sea. Follow this link (https://biogeochemical-argo.org/float-map-network-status-maps.php) to see how many BGC-Argo floats are currently in the water, and where they are located.




*This map shows the locations of all Argo floats, as of December, 2022. (source: https://argo.ucsd.edu/about/status/)*

An interactive map (https://dataselection.euro-argo.eu/) shows where the floats are currently located, and where they have travelled over their lifetime.



*An interactive map allows scientists and the public to view float locations and their data.*

As you'll see, the floats aren't stationary. In fact, a float's path, or *trajectory*, closely follows ocean currents.

*This trajectory of a single float shows where it has travelled over its lifetime.*

### Exploring float data

One of the great benefits of the BGC-Argo program is that the data are 100 % open access: anyone can view, download, and analyze the data.

All floats are identified by a unique *ID number*, which is sometimes referred to as the WMO number. Every Argo float has an ID number that is assigned when the float is manufactured, and no two floats have the same number. Knowing a float's ID number will help to identify the float in data tables and on various interactive float maps and data dashboards.

Using the interactive map (above), the adopted floats table (https://sites.google.com/view/adopt-a-float-ca/data-explorer) and other resources on the Canadian Adopt-a-Float website (adopt-a-float.ocean.dal.ca) YOU can explore a float's recent activity and data. Check out the Adopt-a-Float data access and analysis tutorials (https://sites.google.com/view/adopt-a-float-ca/data-explorer#h.d0zmwzkdl4sh), and try exploring some float data for yourself!

**Additional resources**

Watch a CTD/Rosette in action:

1. https://www.youtube.com/watch?v=ZctFcQFjq7A
2. https://www.youtube.com/watch?v=U-8D8WgXDZU
3. https://www.youtube.com/watch?v=wfLGAb-r6W8

Learn more about ocean numerical models:

1. https://www.youtube.com/watch?v=oY5wNUYqYCM
2. https://www.youtube.com/watch?v=DPdTCv8vALI

The Canadian BGC-Argo program: https://bgc-argo.ocean.dal.ca/

BGC Properties measured by floats: https://biogeochemical-argo.org/measured-variables-general-context.php

Additional reading:

1. *How Do We Choose Technologies to Study Marine Organisms in the Ocean?* By E. Boss
   https://kids.frontiersin.org/articles/10.3389/frym.2020.00003
2. *Global Ocean Climate Change: Observing From Ships by L. Talley*
   https://kids.frontiersin.org/articles/10.3389/frym.2021.495240

Read through the FAQs and Glossary on the Adopt-a-Float page:
https://sites.google.com/view/adopt-a-float-ca/learning-materials