biogeochemical Argo

Newsletter # 5

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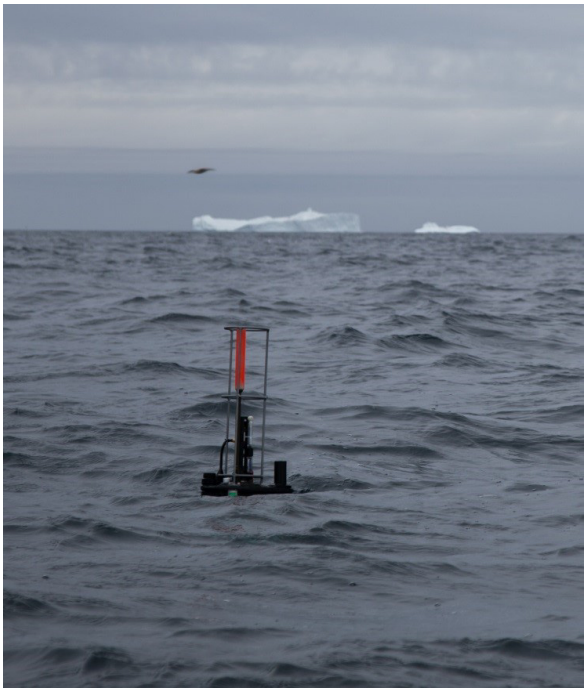
FIRST UNDER-ICE BGC PROFILES IN BAFFIN BAY (ARCTIC OCEAN)



PRO-ICE in Baffin Bay Credit P.Bourgain

Abstract

The first ever year-long time series by BCG floats were collected in Baffin Bay (Arctic Ocean), including during the 8-month long ice-covered period. Three float could survive the harsh Arctic winter and provide unique data about 1) winter vertical mixing of the upper water column due to brine rejection during sea ice growth, and the resulting nutrient reset, 2) the phytoplankton spring bloom that starts under 100% sea ice as early as April, and 3) the recurrent fall bloom.

Climate change has triggered fundamental modifications of marine biotopes in the Arctic Ocean [AO]. The decrease in the extent of the ice pack during summer has led to a 20% increase in the pan-Arctic primary production(PP) over the last decade. Phytoplankton blooms now occur earlier in the AO. In other parts, the structure of the phytoplankton community is shifting toward smaller species, typical of more oligotrophic conditions and some species found in warmer waters now migrate into the Arctic Ocean. The phytoplankton spring bloom (PSB) that develops at the ice-edge accounts for much of annual primary production in the AO and is generally associated with both large energy transfer to higher trophic levels and export of carbon to the bottom. To determine the fate of the PSB and related ecosystem features in Arctic in a context of profound changes, it is necessary to develop a mechanistic understanding of that recurrent event, i.e. how exactly it is controlled by the physical and chemical properties of sea ice and the upper water column over the course of the year.

Then only, it will become possible to develop ad hoc coupled physical-biological models that will allow predictions to be made about the future trajectory of Arctic PSBs. To study the dynamics of PSBs, year-long high-frequency time series of phytoplankton phenology and its drivers required.

Argo floats are a complementary tool to remote sensing and oceanographic cruises, to study the dynamics of ice-edge spring phytoplankton blooms as controlled by sea ice dynamics, vertical mixing, light and nutrients. Here we report on the first ever deployments of BGC floats in Baffin Bay, made to study Arctic PSBs. The GREENEDGE[1] research project was the programmatic frame for the deployment of several BGC Argo floats tested and adapted for the Arctic environment as part of the NAOS Equipex project, and of thanks to funding by the Canadian Foundation for Innovation and support by the Canada Excellence Research Chair on Arctic remote sensing (M Babin).

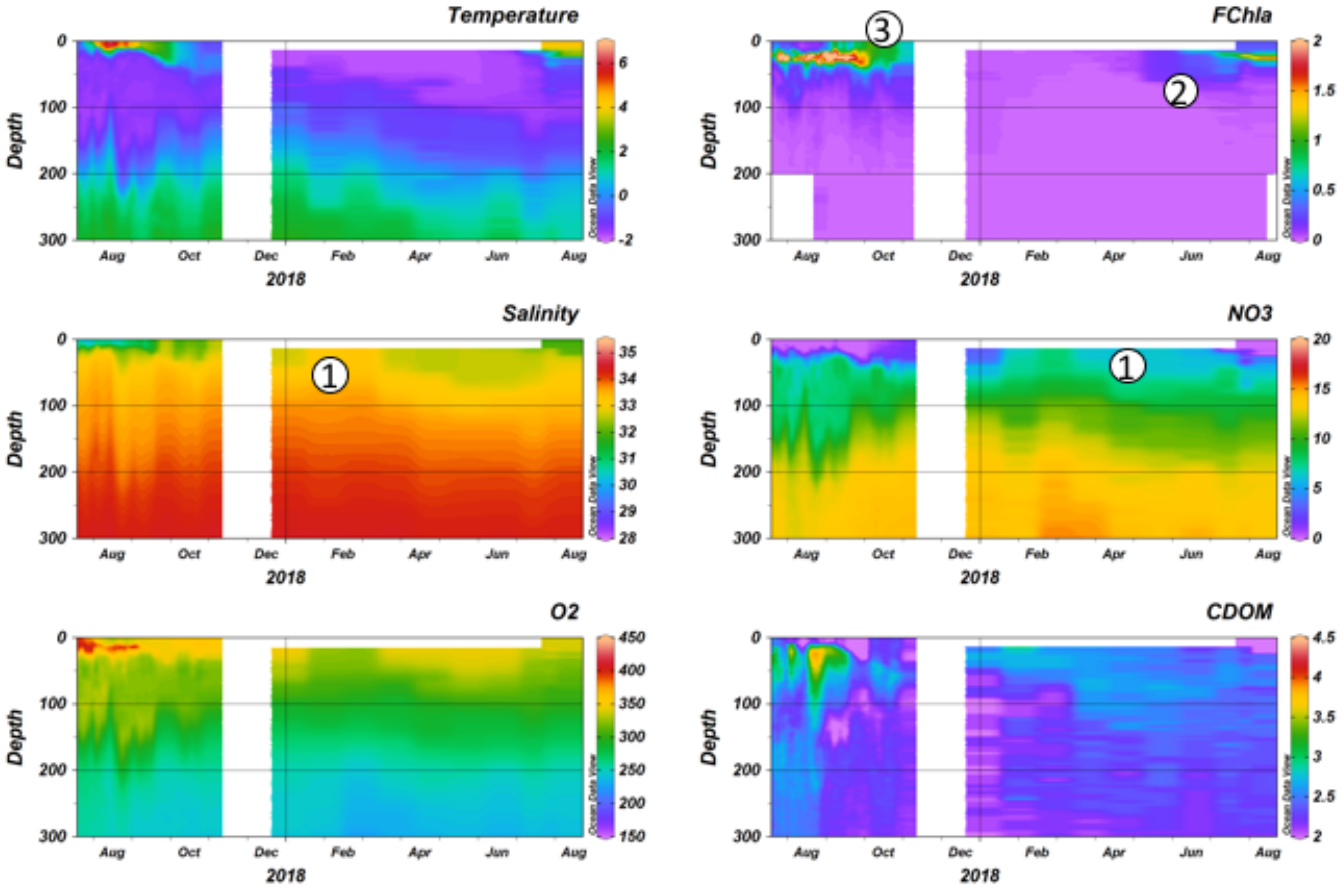


Figure 1 shows a one-year time series (July 2017 to August 2018; preliminary data) for temperature, chlorophyll a fluorescence, salinity, nitrate concentration, O2 concentration and CDOM fluorescence. During summer months (Jul-Oct), the floats profiled daily while, during winter, monthly profiles were collected. The most prominent features in these data are: 1) the winter vertical mixing of the upper water column, best seen in the salinity data, likely due to brine rejection during sea ice growth, and which leads to a reset of the nutrient as shown by nitrate data; 2) the occurrence of a PSB that starts under sea ice as early as April; and 3) a fall phytoplankton bloom concurrent with wind- and convection-driven vertical mixing and nutrient supply from underneath layers.

[1] http://www.greenedgeproject.info/

So, the selected study area involved navigational challenges for floats in terms of bathymetry, ice coverage and circulation. Testing and optimization of a float was made by LOV [2] and TAKUVIK so that operation could be conducted under ice and surfacing be postponed when sea ice was present. The PRO-ICE is a BGC float, adapted to Arctic conditions, manufactured by NKE [3]. As far as ice detection is concerned, the selected technique for the PRO-ICE floats is to combine three technologies: a reversed altimeter (active acoustics), an Ice Sensing Algorithm (Klatt et al., 2007) (ISA) based on sea-water freezing temperature, and an optical sensor developed by TAKUVIK (Lagunas et al. 2018).

Takuvik's Argo floats collected an amazing set of data in Baffin Bay, some with under-ice data. This is an unprecedented set of data collected in the Arctic Ocean to understand the phenology of phytoplankton in Baffin Bay. The Data collected by the PRO-ICE floats will provide in situ data for physical observations, modelling, and also biology. All this will contribute to long–term initiatives.

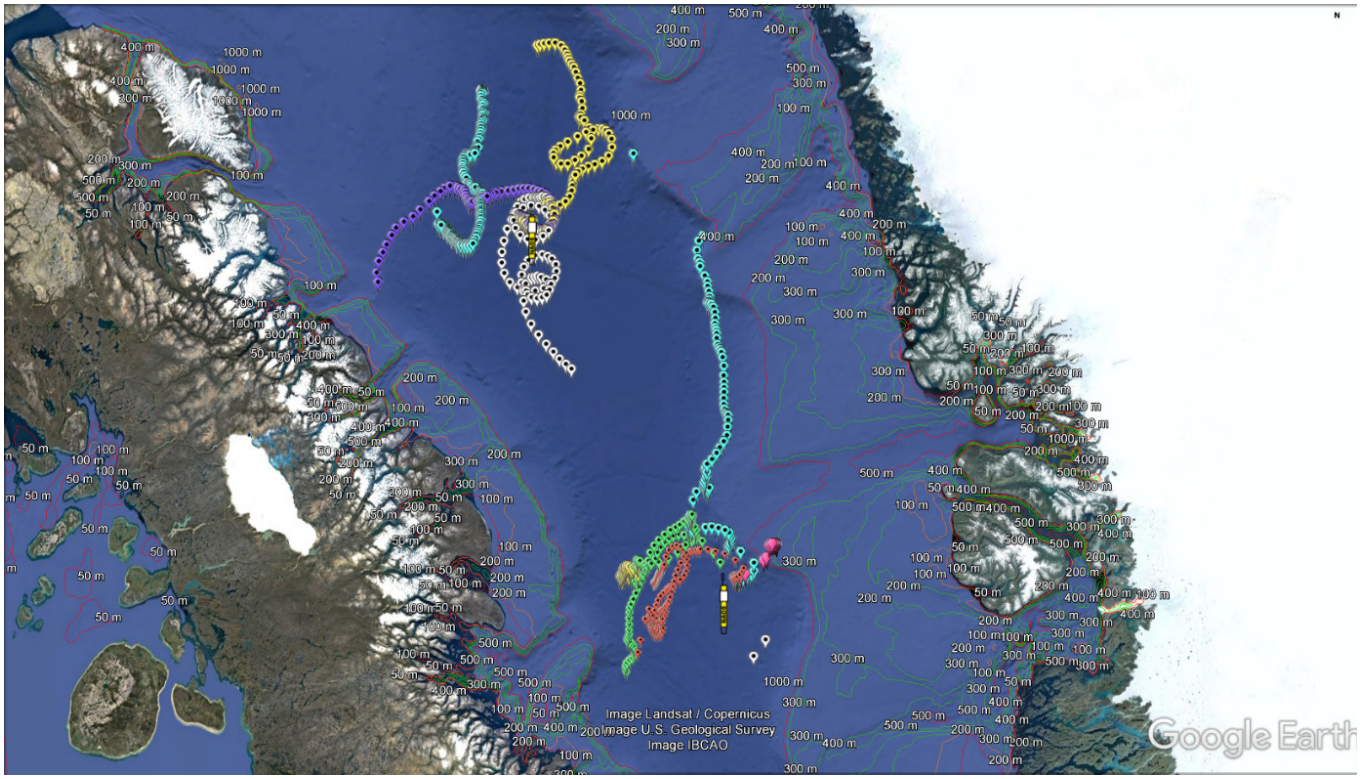


Figure 2: routes of PRO-ICE deployed in 2017

[2] http://lov.obs-vlfr.fr/
[3] http://www.nke-instrumentation.com/