Argo Floats on the Northeast Greenland Shelf

National Institute of Aquatic Resources
Technical University of Denmark
Kgs. Lyngby, Denmark

Bodil Toftegård, M.Sc. Aquatic Science and Technology
Supervisor: Colin A. Stedmon

Two biogeochemical Argo floats were deployed on the Northeast Greenland Shelf (NEGS) in September 2023 as part of the Greenland Integrated Observing System project (GIOS). They are equipped with the Ice Avoidance feature, and this project evaluates their performance and the feasibility of using Argo floats in those conditions. We gained data for one month before both floats went under the sea ice. Some results are presented here and an estimation of the best values for Ice-Sensing-Algorithm.

Deployment

Two Argo floats were deployed on the NEGS at 79°N and 9°W and 11°W in Sep. 2023 on the Fram Strait cruise. We gained data until the 29th of Sep. when they both went under the ice.

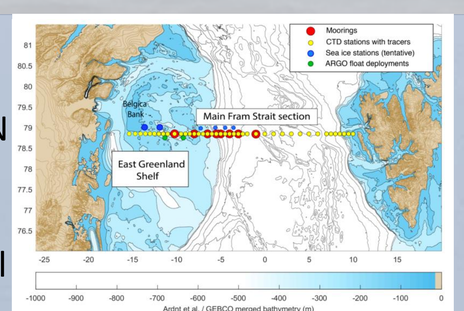

Figure 1: Map of activities on the Fram Strait cruise 2023. Argo float deployments on 79°N 9°W and 79°N 11°W.

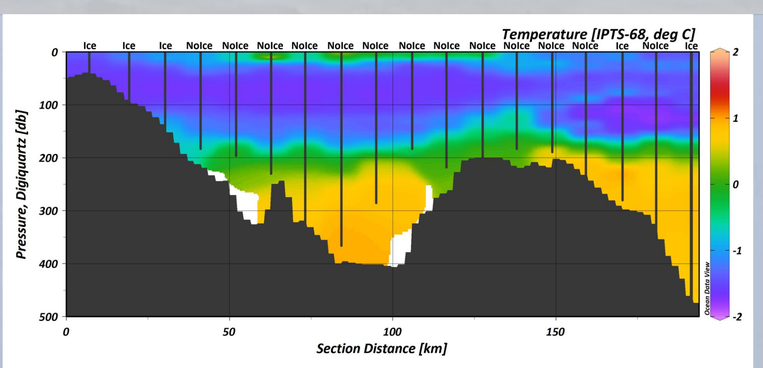

Figure 3: Section plot of the CTD stations on the shelf. The colour gradient shows the temperature, and vertical black lines the stations, Above each line the sea ice stage is marked as 'Ice' and 'NoIce' based on images.

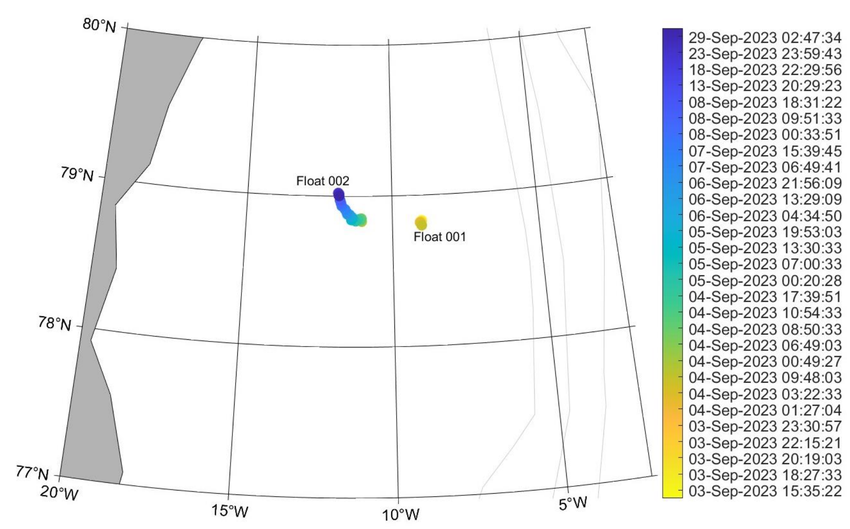

Figure 2: The time and location of the Argo floats surfacing in the Northeast Greenland Shelf. Float 1 got stuck under the ice on the 4th of September. Float 2 delivered data until the 29th of September.

ISA in the Northeast Greenland Shelf

With the CTD data collected on the cruise and sea ice images, a probability test with four cases based on the ISA threshold is made. The purpose is the choose the best collection zone and ISA threshold, by having a high chance of "Ice ISA" (blue) and "NoIce NoISA" (green) and a low chance of "NoIce ISA" (yellow) and "Ice NoISA" (red). With a threshold of -1.15°C and collection zone 30-5dbar, the float would detect ice correctly all the time and not make any false assumptions about ice according to this data.

The Ice Avoidance Feature

A new feature that will allow the float to be deployed in waters with sea ice. The avoidance strategy is trigged in three ways. Either by the ice-sensing algorithm (ISA), by collision, or if a cover prevents transmission illustrated in Figure 4.

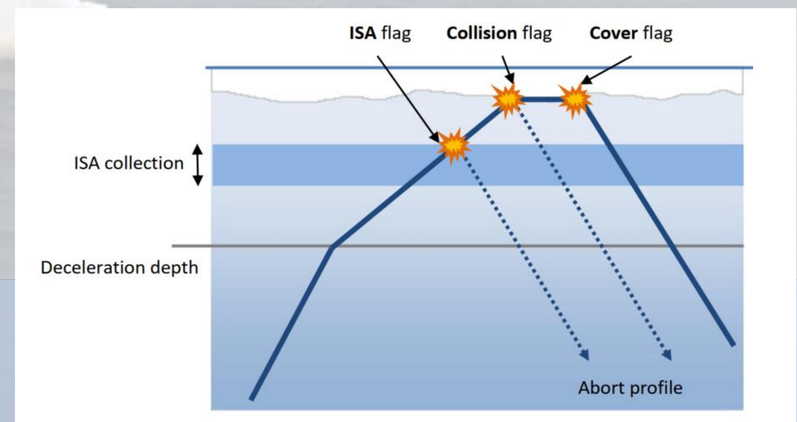

Figure 4: Explanation of the ice avoidance feature on new floats. It is triggered in three different ways; the **ISA** flag, which is by the ice-sensing-Algorithm, the **Collision** flag, if the float tries to ascent but does not move shallower, or the **Cover** flag, which triggers if the float is at the surface and cannot gain satellite connection, hence an ice cover.

Ice-Sensing-Algorithm (ISA)

It works by evaluating the median temperature in a selected collection zone. If the measured mean temperature is lower than a pre-set threshold then the float aborts the ascent and dives again.

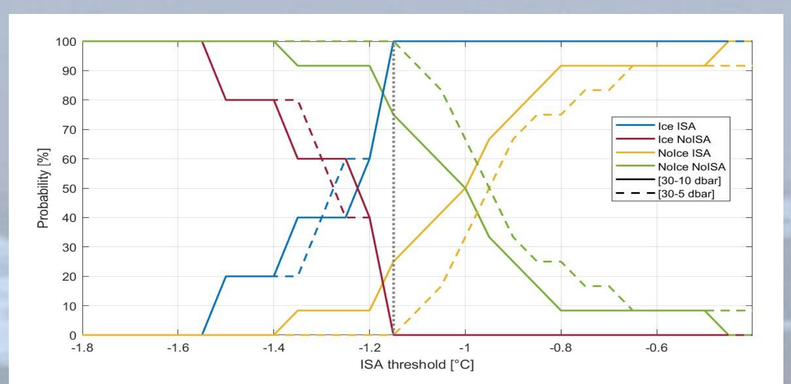

Figure 5: An analysis of the ISA based on CTD stations on the shelf. The probability of four cases is calculated: "Ice ISA" when there is ice and the ISA detects it, "Ice NoISA", when there is ice, but the ISA does not detect it, "NoIce ISA" when there is no ice, but the ISA thinks there is, and "NoIce NoISA" when there is no ice and it is not detected. The dashed line er with a collection zone from 30-5dbar and solid is 30-10dbar.

Water layers

The different water layers on the Northeast Greenland Shelf have been identified and are shown in figure 6. On the surface down to around 10m there is fresher and fairly cold water. An intermediate water layer from around 10dbar to 110dbar consists of polar water which is characterized by being very cold and fresh. At the bottom, we see warmer and more saline water which comes from the Atlantic water. The pycnoclines between the three layers seem to be very stable in the period of observations in September.

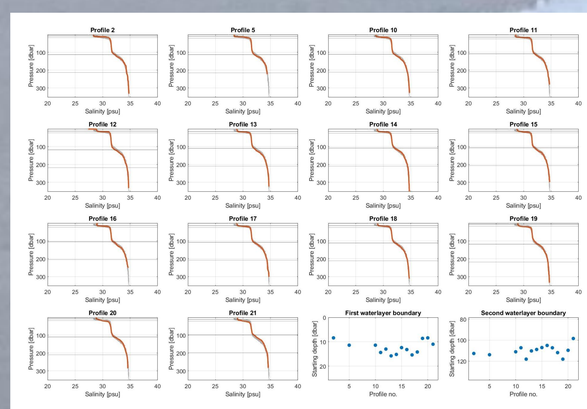

Figure 6: Detection of pycnoclines. Surface water goes down to around 10dbar. Intermediate polar water goes from 10-110dbar. Stable bottom water starts around 210dbar. Only profiles deeper than 220dbar are evaluated.

Parameters in water layers over time

Based on the water layers, the mean of different parameters is calculated.

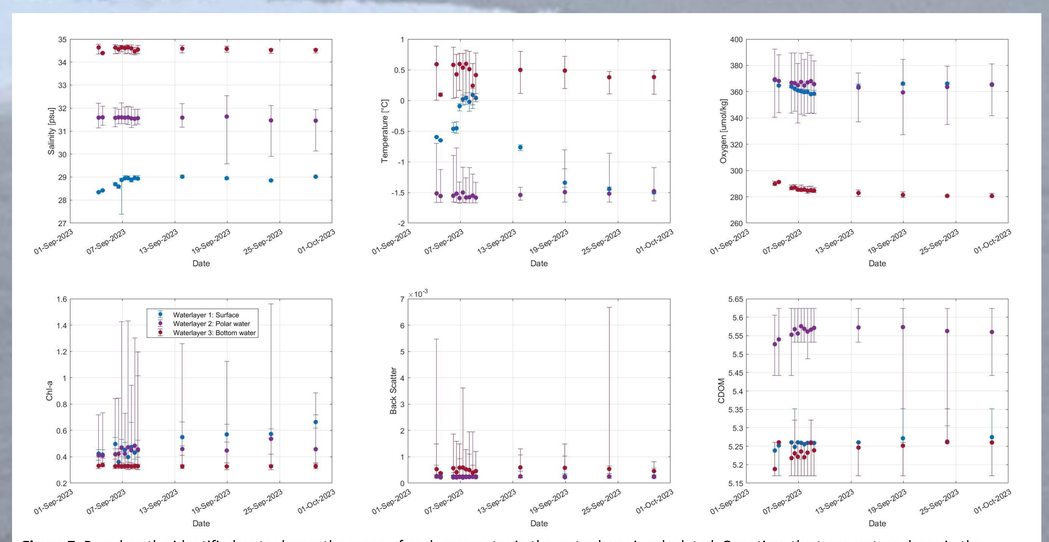

Figure 7: Based on the identified water layers the mean of each parameter in the water layer is calculated. Over time the temperature drops in the surface water. The oxygen and Chl-a increase in the surface indicating mixing. Salinity, CDOM, and Backscatter do not change much.

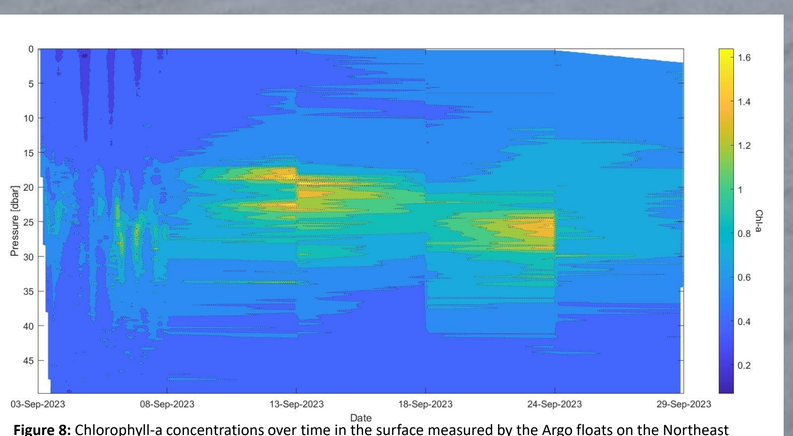

Figure 8: Chlorophyll-a concentrations over time in the surface measured by the Argo floats on the Northeast Greenland Shelf. An autumn bloom is revealed and combined with the temperature data we see that some mixing with the surface layer happens. The concentrations slightly increase in the top 15dbar over time.

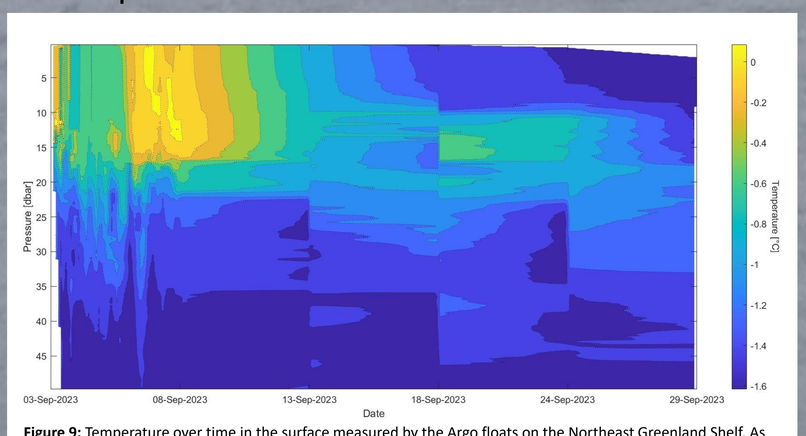

Figure 9: Temperature over time in the surface measured by the Argo floats on the Northeast Greenland Shelf. As September passes the surface temperatures drop significantly, which causes mixing. On the last profile, we think the float has encountered some ice because we don't have data on the top 2 dbar and the temperature is very low.

Figure 7 shows the mean of salinity, temperature, oxygen, Chl-a, backscatter, and CDOM in each water layer. The most noteworthy parameters are temperature, where the surface layer cools down to the same temperature as the polar water, which most likely will cause some mixing, and the Chl-a level, which shows an increase in the surface layer with time indicating mixing. Figure 8 also shows a late autumn bloom in September at around 20-25dbar. Salinity stays very stable leading to well-defined water layers.

Contact: s173872@student.dtu.dk