SiCLING Ny -Ålesund Fieldwork Report

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British Antarctic Survey

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Acknowledgements

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Personnel

Kate Hendry (British Antarctic Survey) – Principal Investigator
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Katie Howe (Dauphin Island Sea Laboratory/University of South Alabama)

Scientific background

The polar regions are experiencing the most rapid climate change observed on Earth. Marine ecosystems are already responding to – and amplifying – environmental change, with important implications for carbon burial and important natural resources such as fisheries. One important type of microalgae, which form the basis of these polar ecosystems and an important conduit for carbon flow from the surface to the seafloor, are diatoms. Diatoms build their microscopic shells from silica, and so dissolved silicon (DSi) is a critical nutrient for their growth. We need a better understanding of how climate-sensitive processes within polar environments impact silicon cycling, and their consequences for regional and global systems.
SiCLING will explore novel hypotheses linking silicon and metal cycling within glacial sediments in Arctic and Antarctic fjords, resulting in a step-change in our understanding of silicon mobility and bioavailability in fjords, high-latitude nutrient balance, and the flow of nutrients into the polar coastal ocean and beyond. Our recent work has shown that glaciers are a substantial source of both dissolved silicon (DSi) and reactive particles of silica, termed ASi. However, the processes by which DSi and ASi escape glaciated fjords are under scrutiny; these processes have profound implications for the supply of DSi to coastal and open ocean ecosystems in the polar regions, and ultimately how this system will respond and change in the future. We have shown that, whilst the coastal shelf waters are very low in DSi, the interaction between shelf sediments and bottom waters is an important conduit for this critical nutrient into the overlying water column. Further inland, nearer the glaciers, our new data indicate that the DSi within the sediments themselves have a unique geochemical and isotopic fingerprint – and this fingerprint appears to be the same wherever we look: in the Arctic, Antarctic and in mid-latitude glaciated mountain regions like Chilean Patagonia. Given the extent and the nature of this signal, we propose that there is an important and ubiquitous – but yet unknown – mechanism that controls the release of DSi into fjords and then into the coastal ocean, acting as an effective trap of this important nutrient. We propose that this mechanism is likely not entirely biological, but relates to the interactions between silicon and another important element for life: iron. Iron is also released in large quantities from glacial weathering, and the iron released is highly reactive with the capability of mopping up significant quantities of DSi. This mechanism is likely to be climate sensitive (because of the glacial meltwater source and temperature/salinity effects), and understanding the underlying processes will be crucial for predicting future change especially in the context of accelerating polar warming and land-ice melting. SiCLING will be the first project to focus specifically on these previously overlooked links between dynamic silicon and iron cycling in the polar regions, incorporating cutting-edge analysis of field and laboratory samples and advanced geochemical modelling.

The Ny-Ålesund component of this project centres around the Arctic case study investigating the particle-water interactions in Kongsfjorden.

Fjord sampling

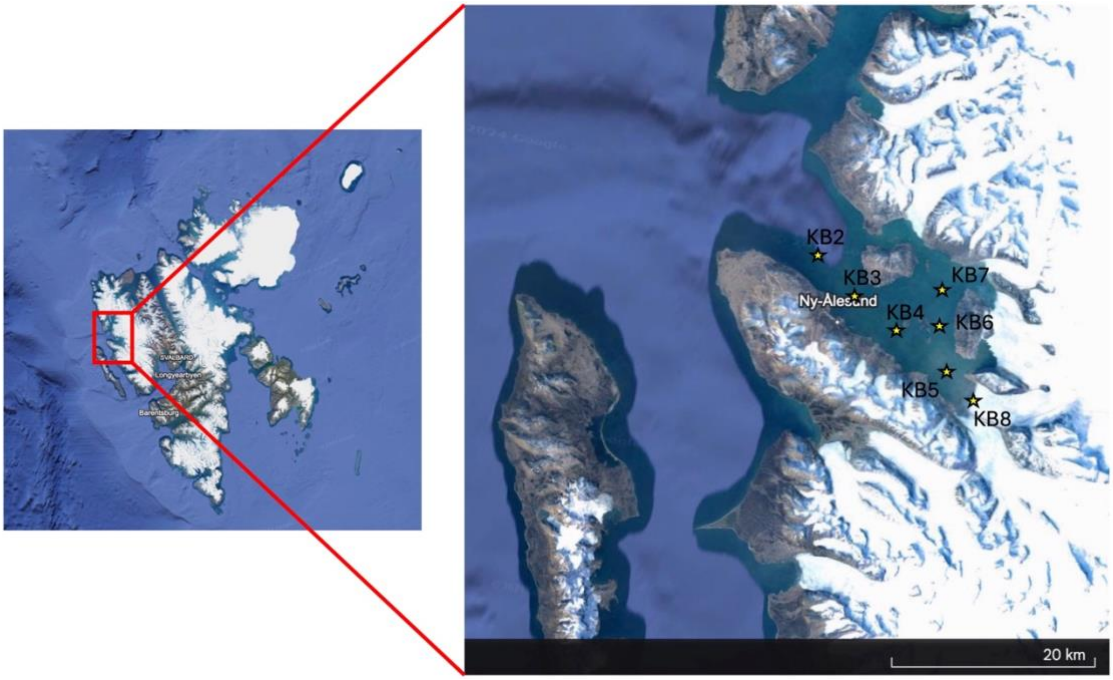

Figure 1: Map of fjord sampling locations

CTD Operations

A total of 13 successful CTD casts were undertaken using the NERC Arctic Station CTD frame. The unit consists of a SeaBird SBE 19+ V2 CTD (a pumped system), and additional sensors for chlorophyll fluorescence, particle scattering, and photosynthetically active radiation (PAR).

Between casts the CTD frame and sensors were washed in freshwater; the conductivity cell flushed through three times and then stored kept in clean tap water. Before longer term storage, the CTD was rinsed again in tap water, and the conductivity cell was cleaned in 0.1% Triton-X, flushed three times in Milli-Q water and stored dry for transport to the UK for calibration.

The deepest cast was 320m, and the shallowest cast was 45m.

CTD Instrument payload and configuration

The following sensors were installed on the CTD frame:

Parameter	Serial number
Temperature	8139
Conductivity	8139
Pressure (strain gauge)	870 psia S/N 11918058
Fluorometer	FLBBRT-6905
Photosynthetically active radiation (PAR)	2148

The battery remained above 12V and was not replaced.

The Seasave Instrument Configuration file used for all casts was 19-8139.xmlcon.


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<?xml version="1.0" encoding="UTF-8"?>
<SBE_InstrumentConfiguration SB_ConfigCTD_FileVersion="7.26.4.0" >
 <Instrument Type="11" >
  <Name>SBE 19plus V2 Seacat CTD</Name>
  <PressureSensorType>1</PressureSensorType>
  <ExternalVoltageChannels>3</ExternalVoltageChannels>
  <Mode>0</Mode>
  <!-- Serial RS-232 Sensor: 0 = None. -->
  <SerialRS232C_Sensor>0</SerialRS232C_Sensor>
  <SampleIntervalSeconds>60</SampleIntervalSeconds>
  <ScansToAverage>1</ScansToAverage>
  <SurfaceParVoltageAdded>0</SurfaceParVoltageAdded>
  <ScanTimeAdded>0</ScanTimeAdded>
  <NmeaPositionDataAdded>0</NmeaPositionDataAdded>
  <NmeaDepthDataAdded>0</NmeaDepthDataAdded>
  <NmeaTimeAdded>0</NmeaTimeAdded>
  <NmeaDeviceConnectedToPC>0</NmeaDeviceConnectedToPC>
  <SensorArray Size="6" >
   <Sensor index="0" SensorID="58" >
    <TemperatureSensor SensorID="58" >
     <SerialNumber>8139</SerialNumber>
     <CalibrationDate>19-Aug-21</CalibrationDate>
     <A0>1.27290955e-003</A0>
     <A1>2.73531459e-004</A1>
     <A2>-1.43103676e-006</A2>
     <A3>1.92848631e-007</A3>
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     <Offset>0.0000</Offset>
    </TemperatureSensor>
   </Sensor>
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    <ConductivitySensor SensorID="3" >
     <SerialNumber>8139</SerialNumber>
     <CalibrationDate>19-Aug-21</CalibrationDate>
     <UseG_J>1</UseG_J>
     <!-- Cell const and series R are applicable only for wide range sensors. -->
     <SeriesR>0.0000</SeriesR>
     <CellConst>2000.0000</CellConst>
     <ConductivityType>0</ConductivityType>
     <Coefficients equation="0" >
      <A>0.00000000e+000</A>
      <B>0.00000000e+000</B>
      <C>0.00000000e+000</C>
```

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      <M>0.0</M>
      <CPcor>-9.57000000e-008</CPcor>
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      <G>-1.01578936e+000</G>
      <H>1.51653733e-001</H>
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      <J>5.22823743e-005</J>
      <CPcor>-9.57000000e-008</CPcor>
      <CTcor>3.2500e-006</CTcor>
      <!-- WBOTC not applicable unless ConductivityType = 1. -->
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    </Coefficients>
    <Slope>1.00000000</Slope>
    <Offset>0.00000</Offset>
  </ConductivitySensor>
</Sensor>
<Sensor index="2" SensorID="46" >
  <PressureSensor SensorID="46" >
    <SerialNumber>8139</SerialNumber>
    <CalibrationDate>11-Aug-21</CalibrationDate>
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    <PA1>2.64333457e-003</PA1>
    <PA2>1.79105062e-011</PA2>
    <PTEMPA0>-7.34437919e+001</PTEMPA0>
    <PTEMPA1>4.63590679e+001</PTEMPA1>
    <PTEMPA2>3.28029126e-001</PTEMPA2>
    <PTCA0>5.24270996e+005</PTCA0>
    <PTCA1>6.10037698e+001</PTCA1>
    <PTCA2>-8.64550164e-001</PTCA2>
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    <PTCB2>0.00000000e+000</PTCB2>
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  </PressureSensor>
</Sensor>
<Sensor index="3" SensorID="20" >
  <FluoroWetlabECO_AFL_FL_Sensor SensorID="20" >
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    <CalibrationDate>6/16/21</CalibrationDate>
    <ScaleFactor>6.00000000e+000</ScaleFactor>
    <!-- Dark output -->
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  </FluoroWetlabECO_AFL_FL_Sensor>
</Sensor>
<Sensor index="4" SensorID="70" >
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      </TurbidityMeter>
     </Sensor>
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       <a1>8.0874e-001</a1>
       <Im>1.3589e+000</Im>
       <ConversionUnits>1</ConversionUnits>
       <Multiplier>1.0000e+000</Multiplier>
      </PARLog_SatlanticSensor>
     </Sensor>
    </SensorArray>
   </Instrument>
</SBE_InstrumentConfiguration>
```


Note that there was an offset in the salinity at deep sites between 2023 and 2024, indicating that a calibration could be required. it was not feasible to collect samples for salinity calibration purposes.

Backscatter was generally too high and not processed.

CTD operation

The CTD casts (Table 1) were carried out either from the Polarcirkel workboat or the King's Bay R/V *Teisten*. The frame was lowered and raised either using a hand-winch system (Polarcirkel) at approximately 0.5m/s, or via an electric winch system (*Teisten*) at approximately 1m/s. The CTD was lowered in a continuous movement, but rate of recovery likely varied, especially with the hand-winching system.

An initial soak of 3 minutes at 5m water depth was carried out, before winching the frame to the surface and lowering to within approximately 10m of the seafloor, with depth recorded from the onboard echosounder.

There were no major technical issues with the CTD suite, and no instruments required changing for spares.

Stn	Vessel	Date	Depth (m)	Lat (N)	Lon (E)	Filename
KB5	Teisten	17/7	60	78 53.811	12 26.444	19plus_01908139_2024_07_20_0001
KB6	Teisten	17/7	45	78 57.996	12 23.192	19plus_01908139_2024_07_20_0002
KB7	Teisten	17/7	60	78 57.996	12 22.616	19plus_01908139_2024_07_20_0003
KB8	Teisten	17/7	50	78 53.322	12.31.956	19plus_01908139_2024_07_20_0004
AWI2	Teisten	17/7	102	78 55.163	12 15.703	19plus_01908139_2024_07_20_0005
KB4	Teisten	19/7	90	78 54.651	12 10.850	19plus_01908139_2024_07_20_0006
KB3	Teisten	19/7	340	78 57.262	11 57.377	19plus_01908139_2024_07_20_0007
KB2	Teisten	19/7	300	78 58.577	11 43.760	19plus_01908139_2024_07_20_0008
AWI1	Teisten	19/7	320	78 58.077	11 52.873	19plus_01908139_2024_07_20_0009
KB4	Polarcirkel	21/7	95	78 54.643	12 11.792	19plus_01908139_2024_07_21_0010
KB5	Polarcirkel	21/7	65	78 53.769	12 26.666	19plus_01908139_2024_07_21_0011
KB6	Polarcirkel	23/7	45	78 55.786	12 23.239	19plus_01908139_2024_07_26_0012
KB7	Polarcirkel	23/7	60	78 57.952	12 22.481	19plus_01908139_2024_07_26_0013

Table 1: CTD cast summary

CTD data processing

Standard Sea-Bird processing of the raw data was completed using Sea-Bird Data Processing software, Fathom.

The processing order used was:

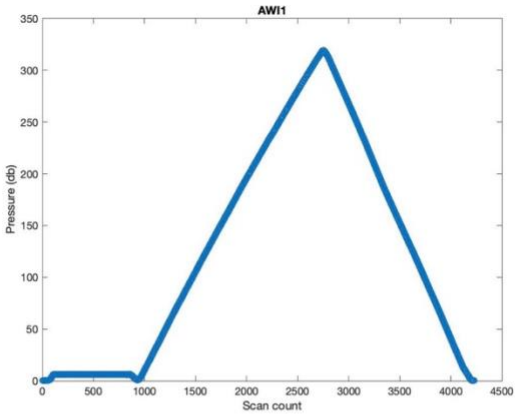
- Data Conversion
- MATLAB plot Pressure vs Time to confirm no major spikes (Fig. 2)
- Filter 0.15s on conductivity and pressure
- CellTM
- Remove surface soak

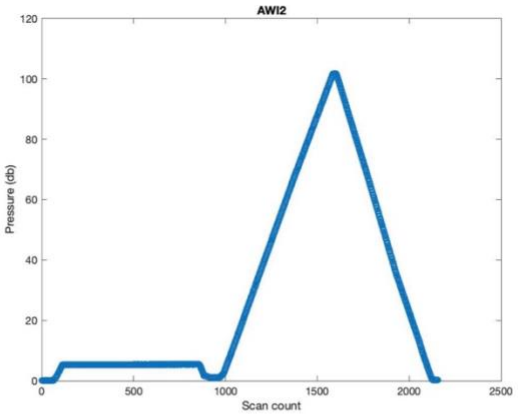
- Derive depth (latitude 79°N), salinity, and density (sigma-theta)
- Bin Average in depth down cast only 1m bins
- Remove upcast
- MATLAB saving of .mat and .csv files

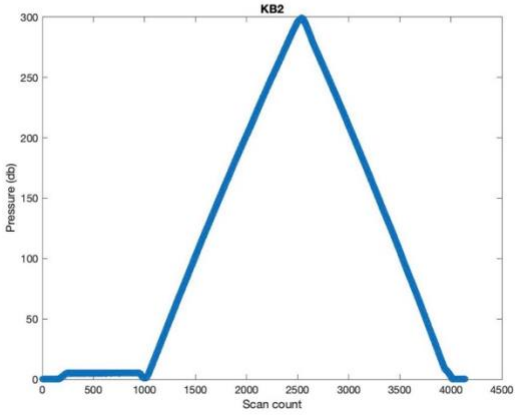
Photic zone depth was calculated by fitting a curve to ln(PAR) vs. depth, and ranged from ~10 to 30m (Table 2).

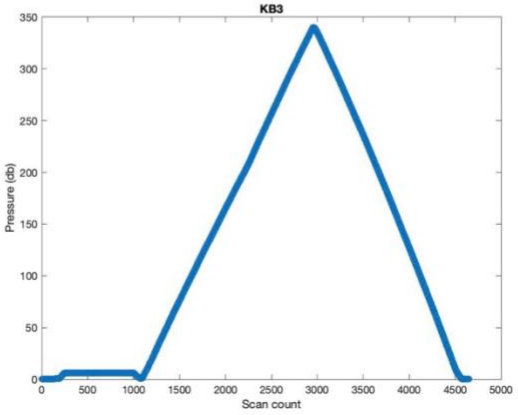
Station number	Photic Zone Depth (m)
AWI1 (19/7/24)	30
AWI2 (17/7/24)	12
KB2 (19/7/24)	24
KB3 (19/7/24)	15
KB4 (17/7/24)	13
KB4 (21/7/24)	16
KB5 (17/7/24)	12
KB5 (21/7/24)	11
KB6 (17/7/24)	13
KB6 (23/7/24)	12
KB7 (17/7/24)	13
KB7 (23/7/24)	15
KB8 (17/7/24)	11

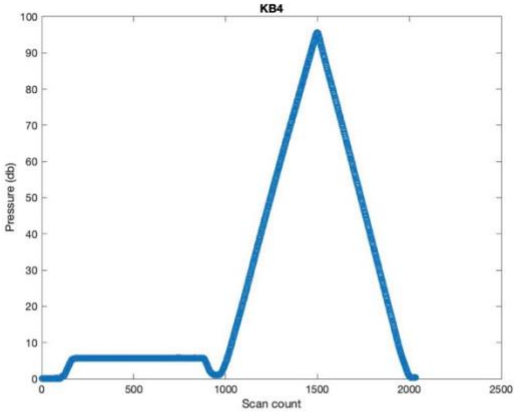
Table 2: Calculated PZD from CTD data

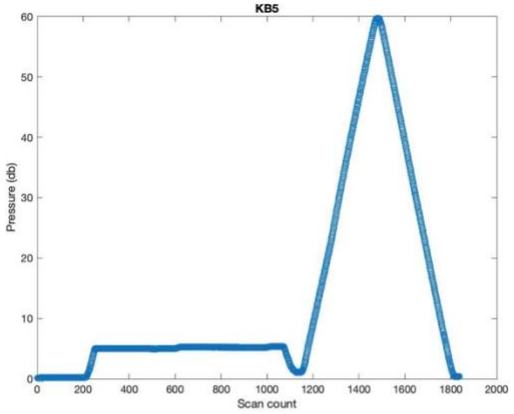

AWI1
Pressure (db)
Scan count

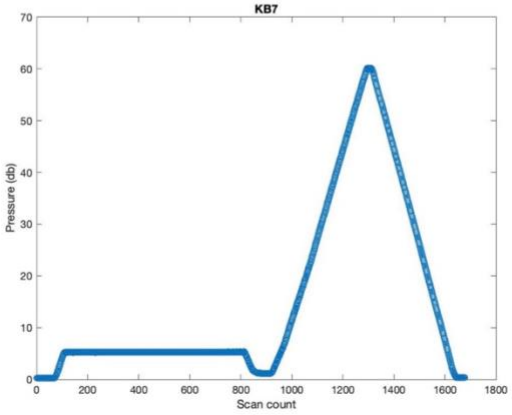

AWI2
Pressure (db)
Scan count

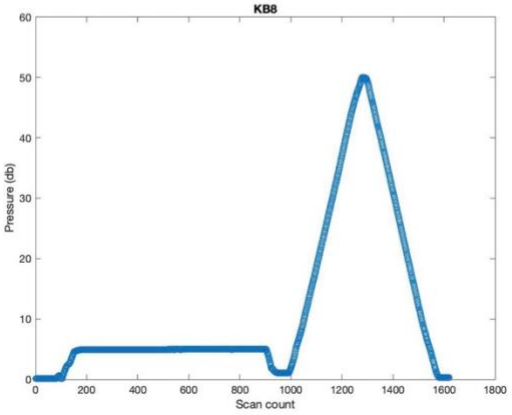

KB2
Pressure (db)
Scan count


KB3
Pressure (db)
Scan count


KB4
Pressure (db)
Scan count


KB5
Pressure (db)
Scan count


KB7
Pressure (db)
Scan count


KB8
Pressure (db)
Scan count

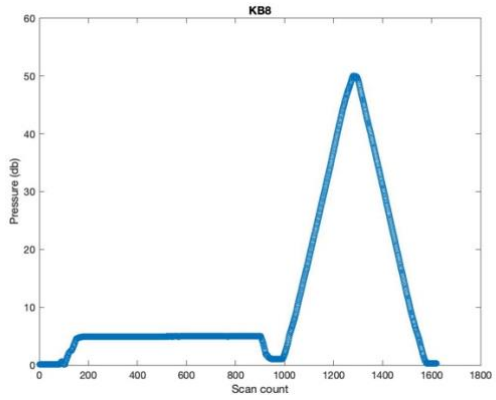


Figure 2: Quality check plots for CTD profiles

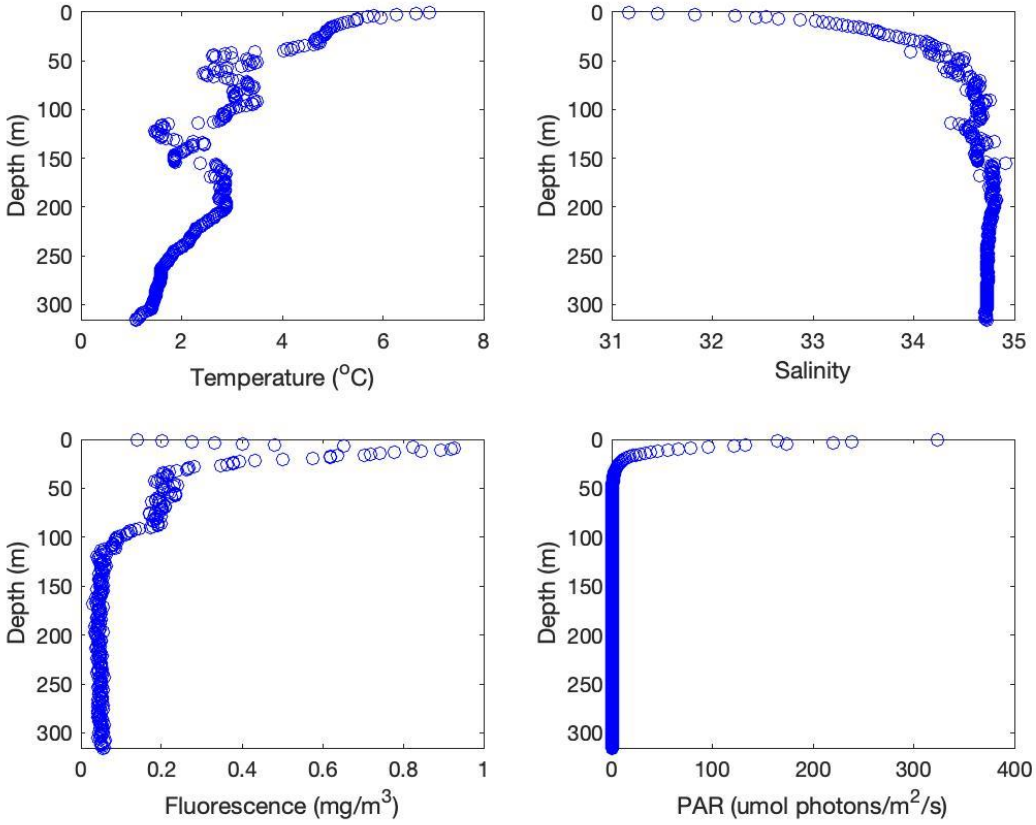


Figure 3: CTD data from AWI-1

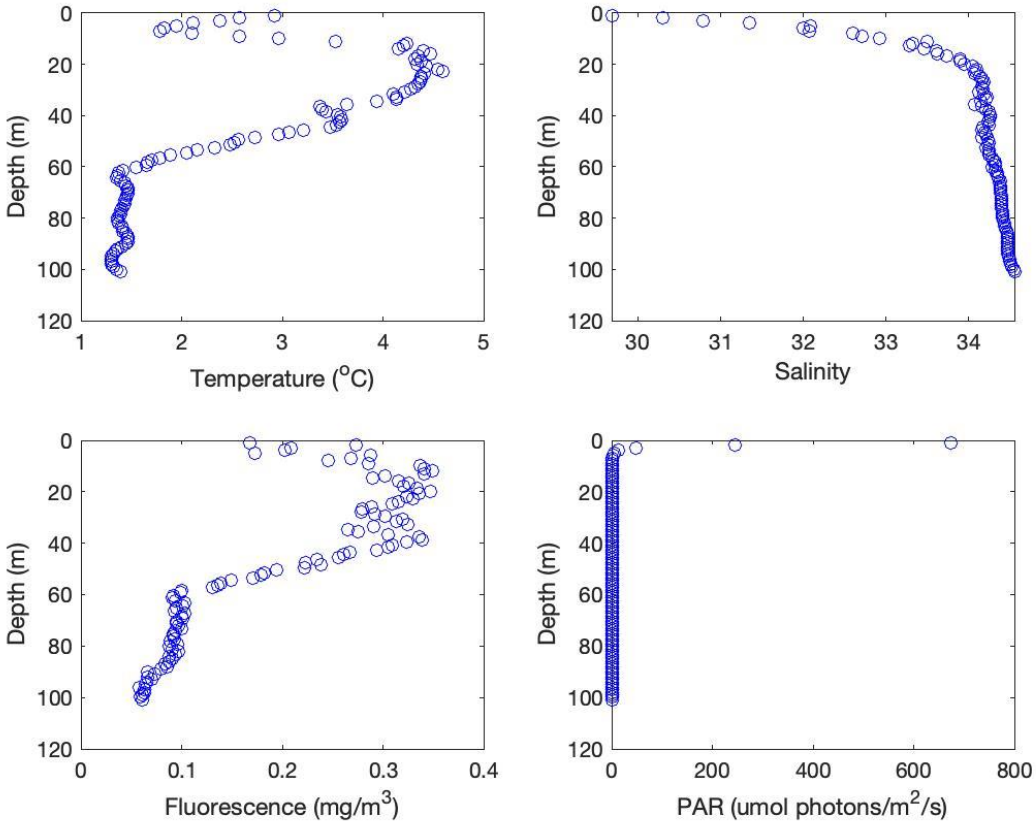


Figure 4: CTD data from AWI-2

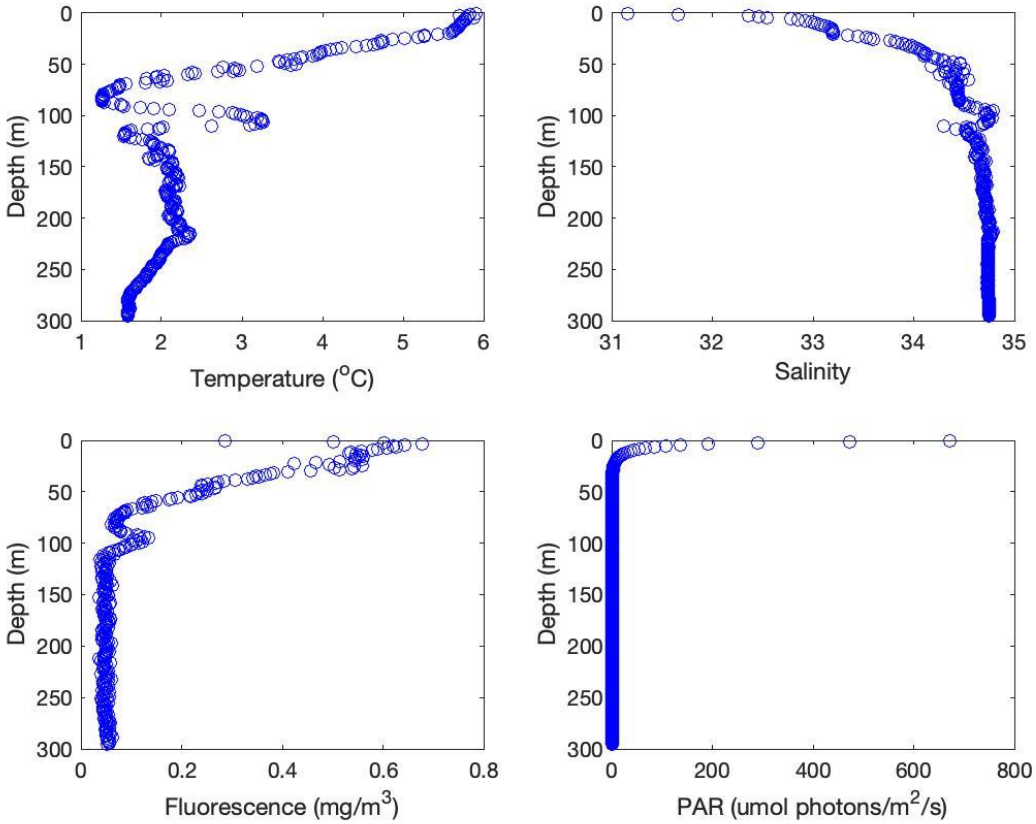


Figure 5: CTD data from KB2

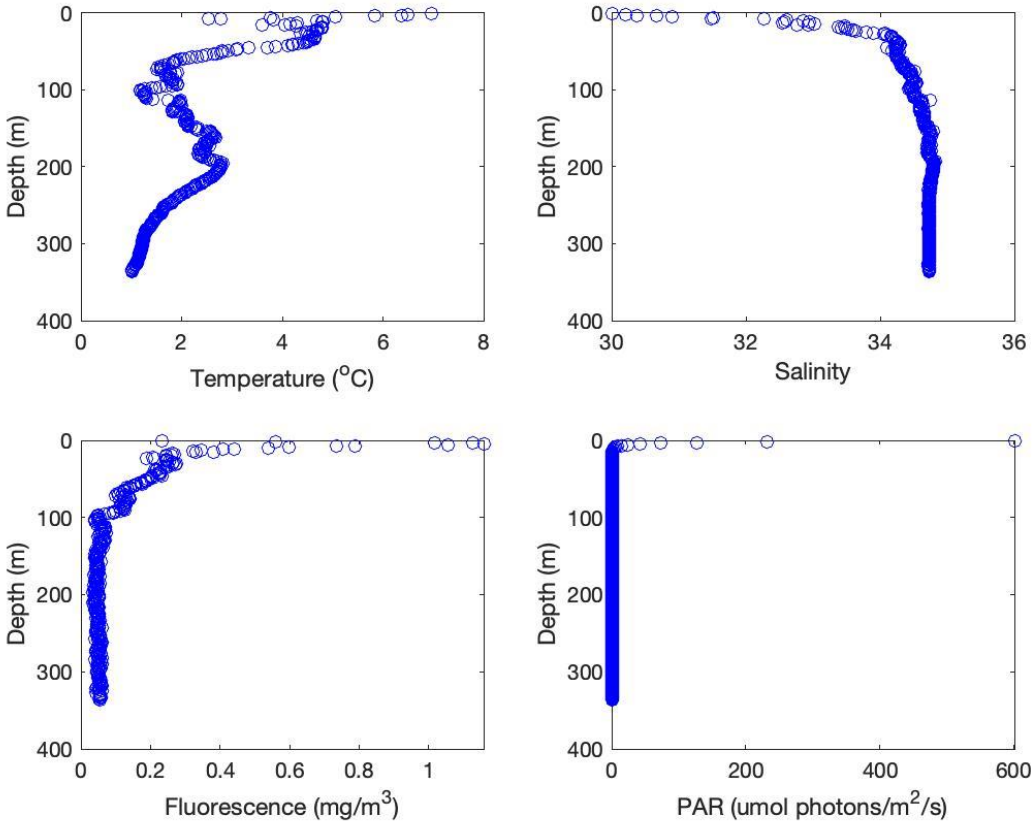


Figure 6: CTD data from KB3

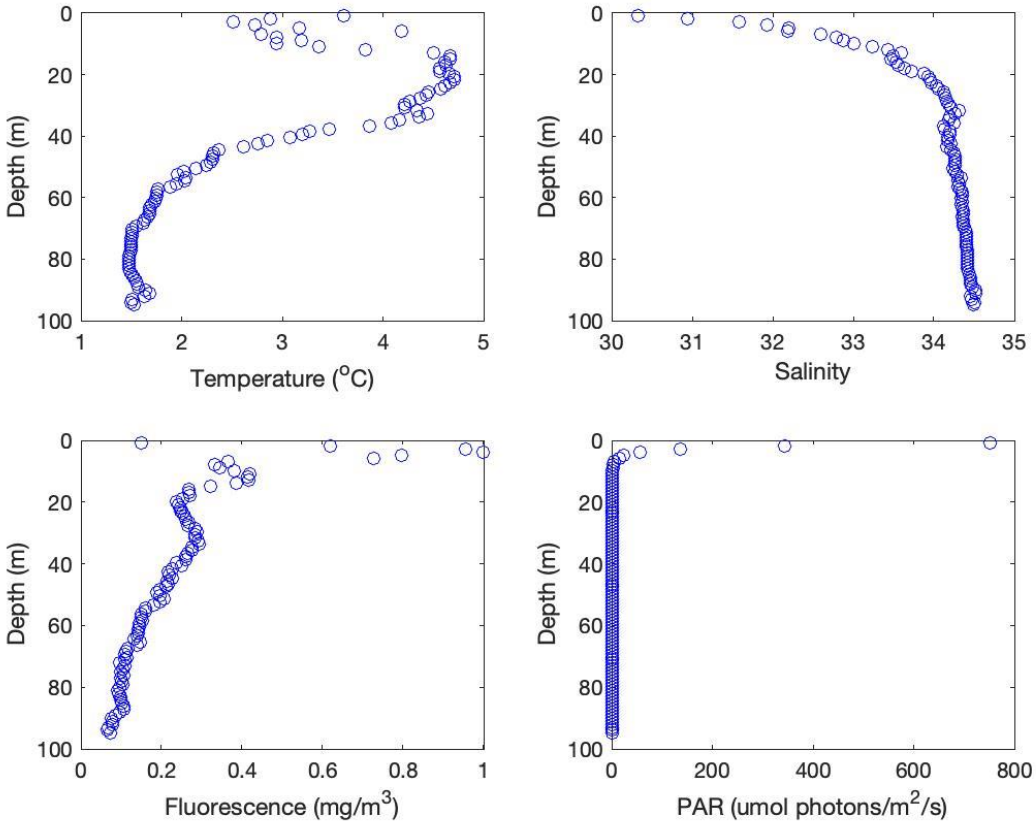


Figure 7: CTD data from KB4

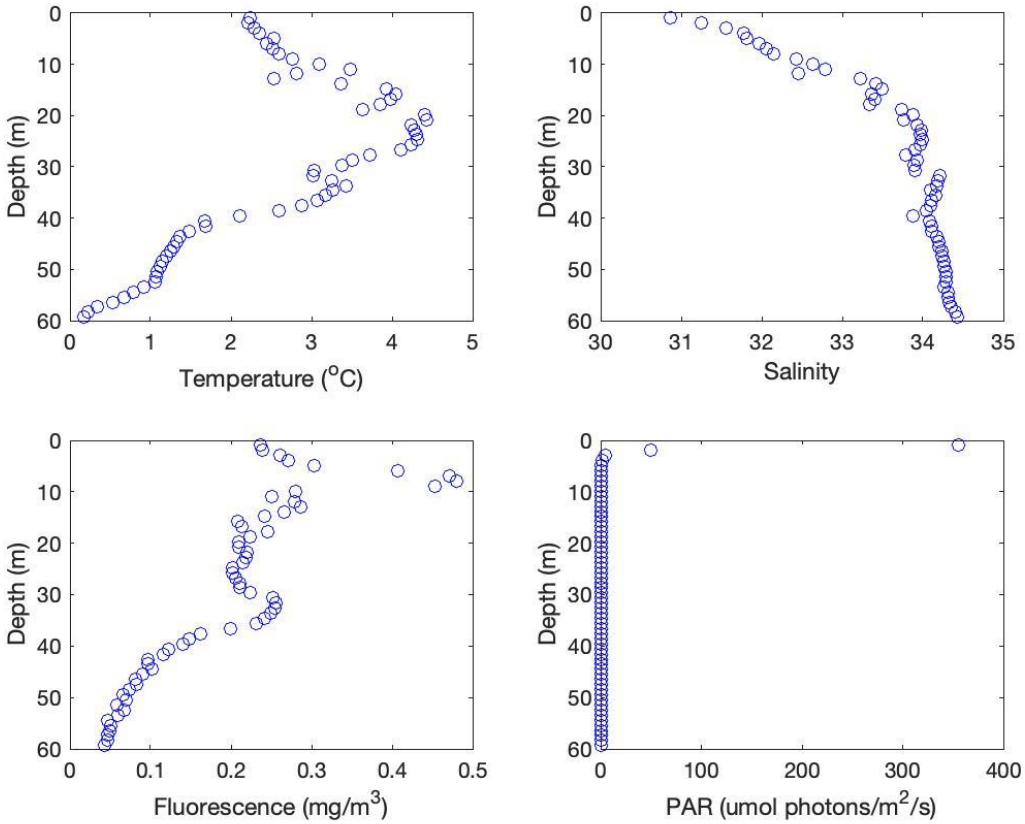


Figure 8: CTD data from KB5

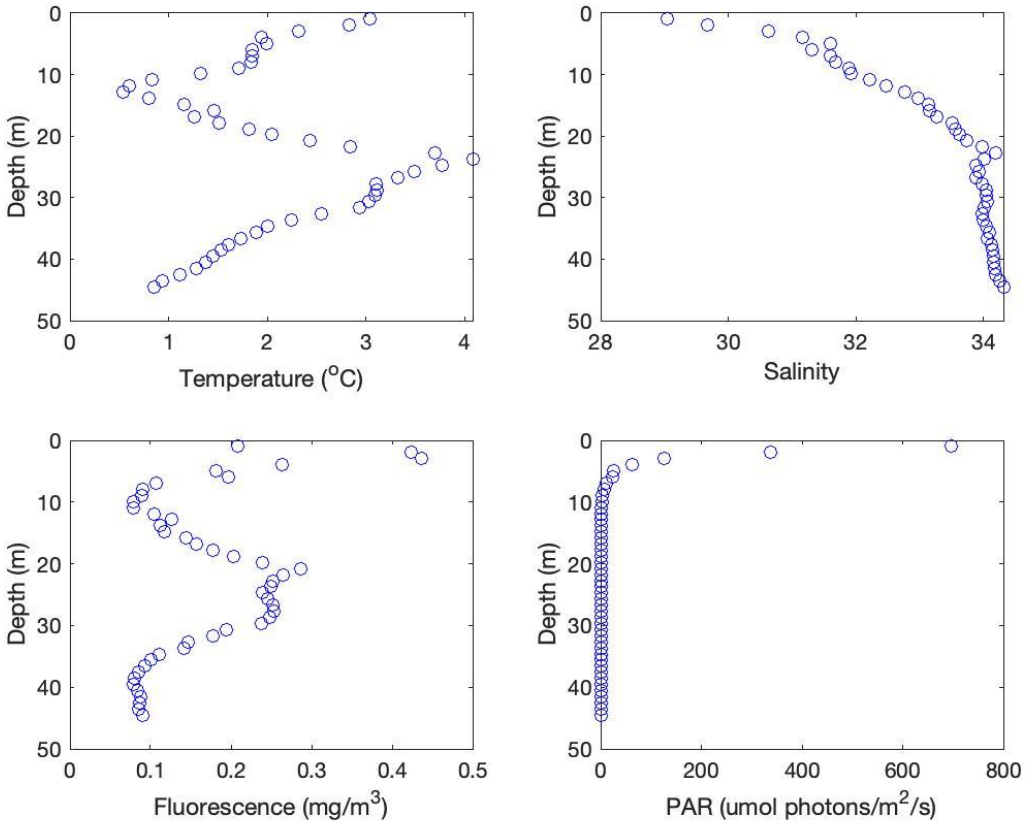


Figure 9: CTD data from KB6

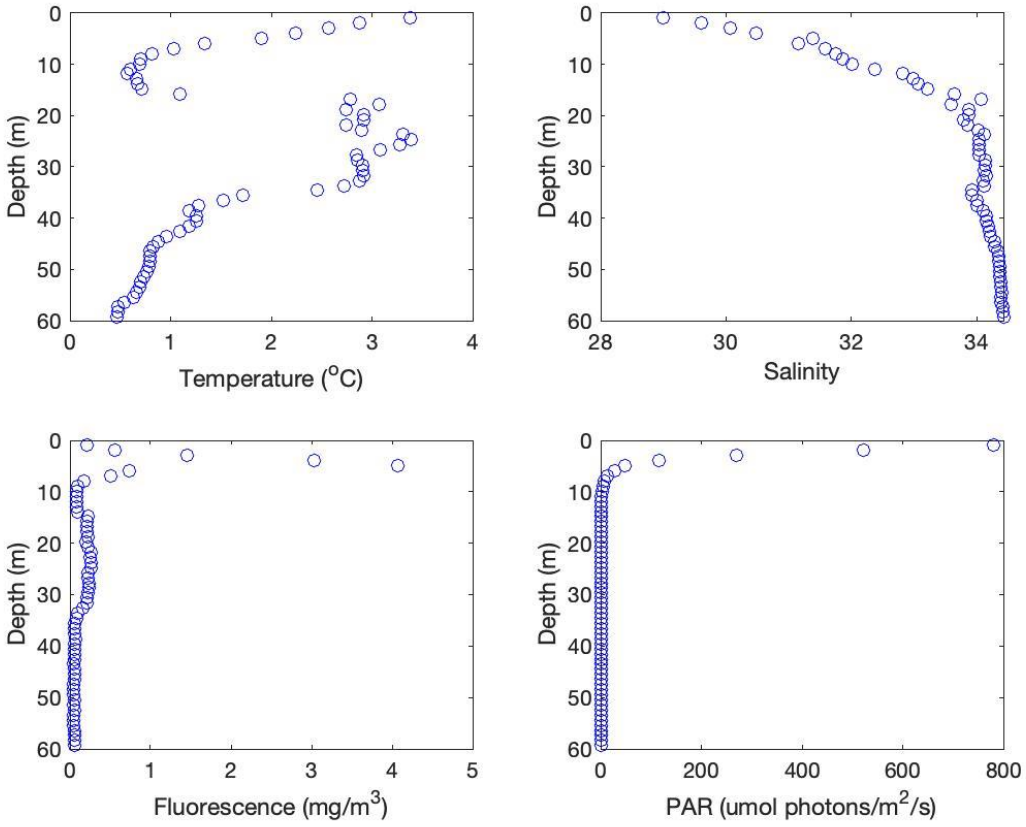


Figure 10: CTD data from KB7

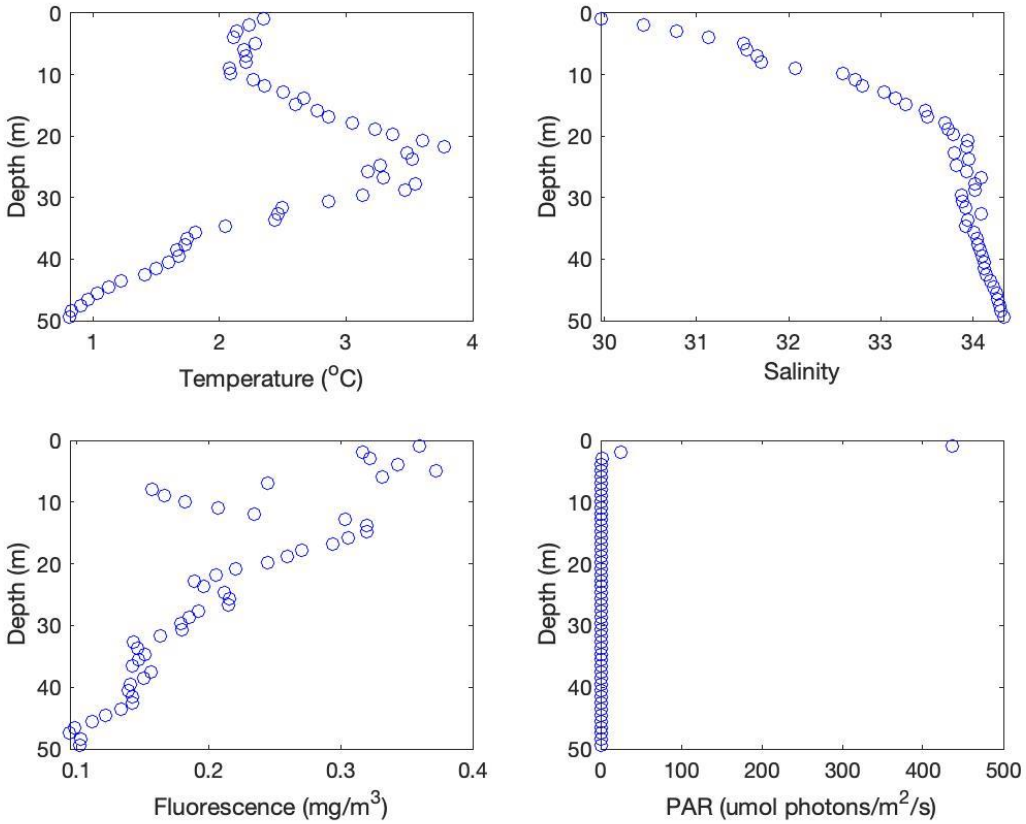
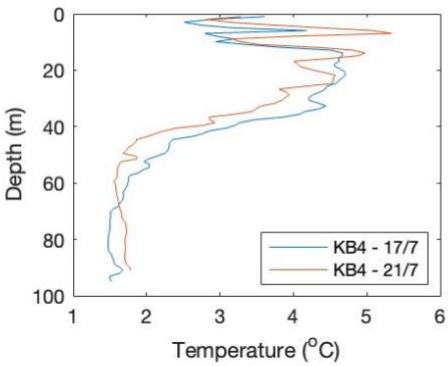
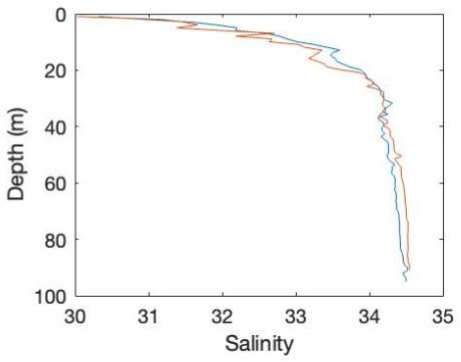


Figure 11: CTD data from KB8


Depth (m)
Temperature (°C)
KB4 - 17/7
KB4 - 21/7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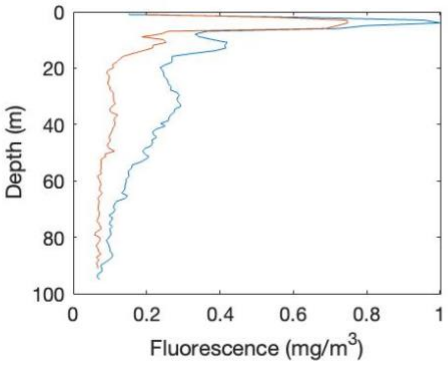
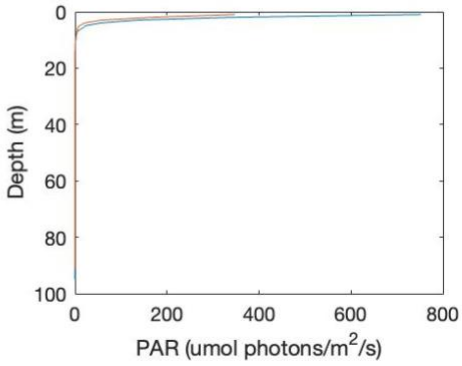
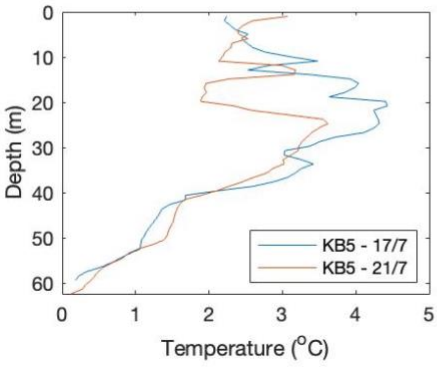
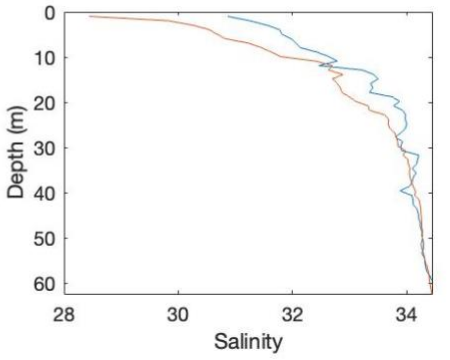
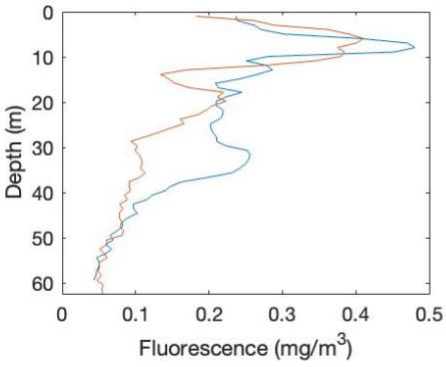
Salinity

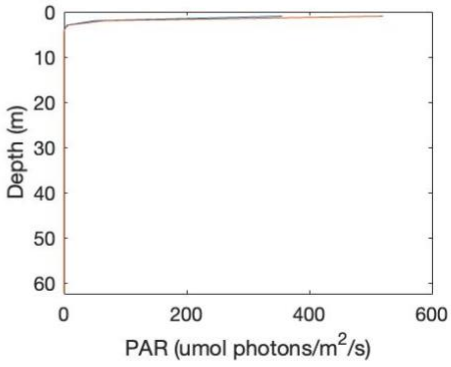

Depth (m)
Fluorescence (mg/m3)


Depth (m)
PAR (umol photons/m2/s)


Depth (m)
Temperature (°C)
KB5 - 17/7
KB5 - 21/7


Depth (m)
Salinity


Depth (m)
Fluorescence (mg/m3)


Depth (m)
PAR (umol photons/m2/s)

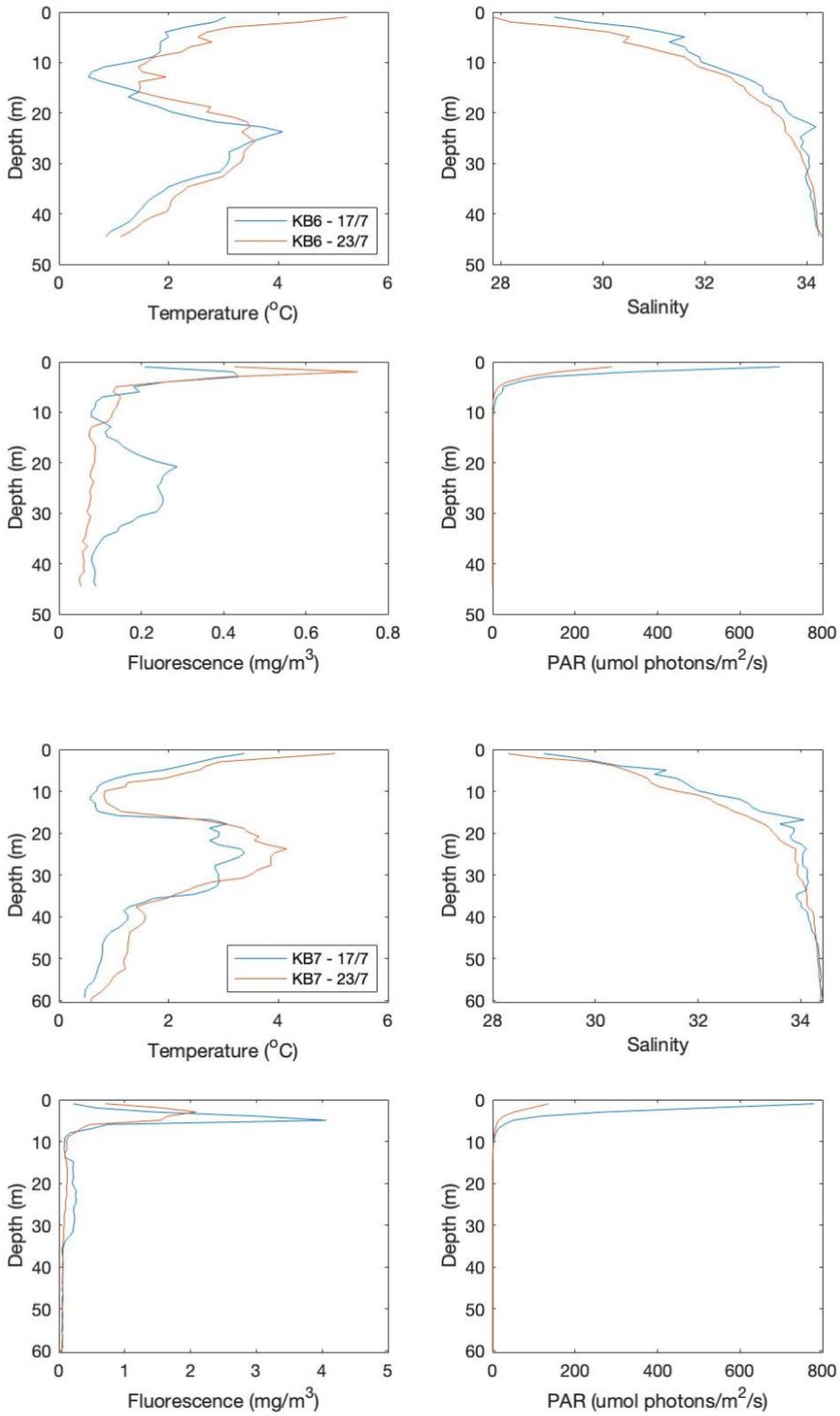


Figure 12: Comparison of CTD profiles of stations that had repeat profiles taken on different days.

MATLAB code for CTD processing

```
% Code for plotting SiCLING Ny-Alesund CTD data
% K Hendry July 2024
%
% This script is for processing CTD data from 2024
%

clear all
close all

%% Enter station and filename here
station = 'KB5';
filename = '19plus_01908139_2024_07_20_0001';

%% Checking quality

open_name = strcat(filename,'.csv');
num = readtable(open_name);

temp = num(:,1);
temp = table2array(temp);
cond = num(:,2);
cond = table2array(cond);
press = num(:,3);
press = table2array(press);
chl = num(:,4);
chl = table2array(chl);
par = num(:,5);
par = table2array(par);

n = length(temp);

for lpJ = 1:n
    scan_count(lpJ,1) = lpJ;
end
```

```
figure
plot(scan_count,press,'o');
xlabel('Scan count')
ylabel('Pressure (db)')
title(station)

save_name = strcat(station,'_check.jpg');
saveas(gcf,save_name,'jpeg')

%% Look at data

open_name = strcat(filename,'bin.csv');
num = readtable(open_name);

temp = num(:,1);
temp = table2array(temp);
cond = num(:,2);
cond = table2array(cond);
press = num(:,3);
press = table2array(press);
chl = num(:,4);
chl = table2array(chl);
par = num(:,5);
par = table2array(par);
sigma = num(:,7);
sigma = table2array(sigma);
salinity = num(:,8);
salinity = table2array(salinity);

% derive depth

lat = ones(size(temp));
lat = 79 * lat;
depth = sw_dpth(press,lat);
```

```
% extracting max_depth and corresponding index from matrix

[max_depth, ind] = max(depth(:,1));

depth = depth(1:ind,:);
cond = cond(1:ind,:);
chl = chl(1:ind,:);
par = par(1:ind,:);
press = press(1:ind,:);
salinity = salinity(1:ind,:);
sigma = sigma(1:ind,:);
temp = temp(1:ind,:);

% Plot up data

figure
subplot(2,2,1)
plot(temp,depth,'bo')
xlabel('Temperature (^oC)')
ylabel('Depth (m)')
set(gca, 'YDir','reverse')

subplot(2,2,2)
plot(salinity,depth,'bo')
xlabel('Salinity')
ylabel('Depth (m)')
set(gca, 'YDir','reverse')

subplot(2,2,3)
plot(chl,depth,'bo')
xlabel('Fluorescence (mg/m^3)')
ylabel('Depth (m)')
set(gca, 'YDir','reverse')

subplot(2,2,4)
plot(par,depth,'bo')
```

```
xlabel('PAR (umol photons/m^2/s)')
ylabel('Depth (m)')
set(gca, 'YDir','reverse')

saveas(gcf,station,'jpeg')

%% Calculate photic zone depth

% Enter depth of interest

n = 30;

% Get data for top 100m only

par_day_100 = par(1:n,:);
y = depth(1:n,:);

% Calculate photic zone depth

l = log(0.01);

for lpJ = 1:n
    ln_E(lpJ,1) = log(par_day_100(lpJ,1));
end

c = polyfit(ln_E,y,1);

% figure % Uncomment to plot curve
% plot(ln_E,y)
% set(gca, 'Ylim', [0 100])
% set(gca, 'YDir','reverse')
% ylabel('Depth (m)')
% xlabel('ln(E)')

q = c(1,1);
```

```
PZD = abs(l.*q);

%% Tidy up

clearvars C num open_name y q par_day_100 n lpJ ln_E l c

%% Save .mat file

save_name = strcat(station,'.mat');
save(save_name)

%% Making .csv

Pressure_db = press; Pressure_db = array2table(Pressure_db);
Depth_m = depth; Depth_m = array2table(Depth_m);
Temp_deg_C = temp; Temp_deg_C = array2table(Temp_deg_C);
Cond_S_per_m = cond; Cond_S_per_m = array2table(Cond_S_per_m);
Salinity = salinity; Salinity = array2table(Salinity);
Fl_mg_per_m3 = chl; Fl_mg_per_m3 = array2table(Fl_mg_per_m3);
PAR_W_per_m2 = par; PAR = array2table(PAR_W_per_m2);

T = [Pressure_db Depth_m Temp_deg_C Cond_S_per_m Salinity Fl_mg_per_m3 PAR];
T.Properties.VariableNames = {'Pressure_db' 'Depth_m' 'Temp_deg_C' 'Cond_S_per_m' 'Salinity'
'Fl_mg_per_m3' 'PAR'};

% Save csv
save_name = strcat(station,'_final.csv');
save(save_name)
writetable(T,save_name,'Delimiter',',','QuoteStrings',true);

% END
```

Water sampling

Seawater samples were collected from 5m, mid-depth (20 or 30m) and bottom waters where possible using a 5L Niksin bottle (Polarcirkel) or 10L Niskin bottle (*Teisten*) (Table 3). The valves and caps were checked before deployment. The bottle was deployed using the

same winch system as for the CTD, with an added weight attached to the shackle in each case. The bottles were fired using a messenger system.

The bottles were recovered to the boat in each case, and immediately sampled for nutrients and total alkalinity, filtering through a 0.8/0.2 μm Acrodisk filter into an acid-cleaned, rinsed plastic bottle and a rinsed 50ml centrifuge tube respectively. Unfiltered samples were then taken for oxygen isotopes in rinsed plastic bottles. The remaining seawater was collected in an acid-rinsed 5L bottles for later processing.

In the laboratory, the nutrients samples were frozen immediately at -20°C. A subsample was filtered immediately for dissolved δ^{30}Si through 0.8/0.2 μm Acrodisk filters into an acid-cleaned, rinsed plastic bottle. Phytoplankton cell count samples were subsampled and fixed with 1.5ml lugols and parafilmed. The oxygen isotope samples were sealed with electrical tape. Water samples were filtered through GF/Fs for particulate organic carbon and nitrogen (POC/PON) and phosphorus (POP) and through 0.8 μm polycarbonate filters for reactive silica. Water was additionally filtered through 0.2 μm PES filters for particulate trace metal analyses using a plastic covering to minimise contamination. At three 'super' stations additional water was filtered through 0.2, 0.4 and 0.8 μm polycarbonate filters for i) size fractionated reactive silica analyses and ii) synchrotron analyses. MilliQ blanks were taken for all particulate samples, and a MilliQ blank was additionally taken for the nutrient vials.

Stn	Vessel	Date	Depth	Lat (N)	Lon (E)	Temperature (°C)	Salinity
KB5	Teisten	17/07/2024	60m	78 53.811	12 26.444	0.2	34.5
KB5	Teisten	17/07/2024	30m	78 53.811	12 26.444	3.1	33.9
KB5	Teisten	17/07/2024	5m	78 53.811	12 26.444	2.4	32
KB6	Teisten	17/07/2024	45m	78 57.996	12 23.192	0.8	34.3
KB6	Teisten	17/07/2024	20m	78 57.996	12 23.192	2.3	33.7
KB6	Teisten	17/07/2024	5m	78 57.996	12 23.192	1.8	31.3
KB7	Teisten	17/07/2024	60m	78 57.996	12 22.616	0.46	34.4
KB7	Teisten	17/07/2024	30m	78 57.996	12 22.616	2.9	34.1
KB7	Teisten	17/07/2024	5m	78 57.996	12 22.616	1.6	31
KB8	Teisten	17/07/2024	45m	78 53.322	12.31.956	1	34.3
KB8	Teisten	17/07/2024	20m	78 53.322	12.31.956	3.5	33.9
KB8	Teisten	17/07/2024	5m	78 53.322	12.31.956	2.2	31.5
AWI-2	Teisten	17/07/2024	100m	78 55.163	12 15.703	1.3	34.5
AWI-2	Teisten	17/07/2024	30m	78 55.163	12 15.703	4.2	34.2
AWI-2	Teisten	17/07/2024	5m	78 55.163	12 15.703	1.9	32.1
KB3	Teisten	19/07/2024	340m	78 57.262	11 57.377	1	34.7
KB3	Teisten	19/07/2024	160m	78 57.262	11 57.377	2.7	34.8
KB3	Teisten	19/07/2024	30m	78 57.262	11 57.377	4.6	34.2
KB3	Teisten	19/07/2024	5m	78 57.262	11 57.377	5.1	30.4
KB2	Teisten	19/07/2024	300m	78 58.577	11 43.760	1.6	34.8
KB2	Teisten	19/07/2024	160m	78 58.577	11 43.760	2.2	34.7
KB2	Teisten	19/07/2024	30m	78 58.577	11 43.760	4.6	33.9

KB2	Teisten	19/07/2024	5m	78 58.577	11 43.760	5.8	32.7
AWI-1	Teisten	19/07/2024	320m	78 58.077	11 52.873	1.1	34.7
AWI-1	Teisten	19/07/2024	160m	78 58.077	11 52.873	2.8	34.8
AWI-1	Teisten	19/07/2024	30m	78 58.077	11 52.873	4.7	34.1
AWI-1	Teisten	19/07/2024	5m	78 58.077	11 52.873	5.7	32.6
KB4	P-cirkel	21/07/2024	100m	78 54.643	12 11.792	1.8	34.5
KB4	P-cirkel	21/07/2024	30m	78 54.643	12 11.792	3.9	34.2
KB4	P-cirkel	21/07/2024	5m	78 54.643	12 11.792	4.4	31.4
KB5	P-cirkel	21/07/2024	65m	78 53.769	12 26.666	0.1	34.4
KB5	P-cirkel	21/07/2024	30m	78 53.769	12 26.666	3.2	33.8
KB5	P-cirkel	21/07/2024	5m	78 53.769	12 26.666	2.4	30.7
KB6	P-cirkel	23/07/2024	45m	78 55.786	12 23.239	1.1	34.2
KB6	P-cirkel	23/07/2024	20m	78 55.786	12 23.239	2.7	33.3
KB6	P-cirkel	23/07/2024	5m	78 55.786	12 23.239	2.5	30.5
KB7	P-cirkel	23/07/2024	60m	78 57.952	12 22.481	0.6	34.4
KB7	P-cirkel	23/07/2024	30m	78 57.952	12 22.481	3.4	33.9
KB7	P-cirkel	23/07/2024	5m	78 57.952	12 22.481	2.6	30.6

Table 3: Water sampling events

Samples for δ^{30}Si were acidified (0.1% v/v trace metal grade nitric acid) and parafilmed.

Samples for nutrients and δ^{18}O were taken from the AWI* stations for James Bradley.

Iceberg sampling

Surface water samples near a sediment-laden iceberg (Fig. 13) was collected by hand near KB6 (23/7/24). In the laboratory, the sample was processed as for a ‘super station’ seawater sample.

Figure 13: Sediment-laden iceberg near KB6, sampled on 23/7/24

Sediment sampling

Sediment surface samples were collected using a Van Veen Grab on the R/V Teisten. The sediment samples were scooped with a plastic scoop into clean plastic bags and stored in the dark. In the laboratory, subsamples were frozen at -20°C, and aliquots used in the core incubation study (see below).

At KB4, a UWITEC gravity corer was used to collect two sediment cores (Figs. 14, 15), which were capped and kept in the dark until processing. Rhizon samplers were used to extract porewaters from both cores, which were i) frozen at -20°C for nutrients, ii) parafilmed and stored for alkalinity, or iii) acidified (0.1% v/v trace metal grade nitric acid) for trace metals and δ^{30}Si and parafilmed.

Station	Date	Activity	Lat (N)	Lon (E)	Notes
GLAC1	18/07/2024	Proglacial sampling	78 55.997	11 50.200	Sediment incubation C
BIOPOLE12	23/07/2024	Proglacial sampling	78 55.837	12 33.996	Sediment incubation E
BIOPOLE8	23/07/2024	Proglacial sampling	79 0.212	12 16.396	Sediment incubation F
KB4	19/07/2024	Sediment core	78 54.643	12 11.792	Porewaters
KB4	19/07/2024	Sediment core	78 54.643	12 11.792	Porewaters
KB5	17/07/2024	Sediment grab	78 53.811	12 26.444	Sediment incubation B

KB6	17/07/2024	Sediment grab	78 57.996	12 23.192	
KB7	17/07/2024	Sediment grab	78 57.996	12 22.616	
KB8	17/07/2024	Sediment grab	78 53.322	12.31.956	Sediment incubation A
KB4	17/07/2024	Sediment grab	78 54.651	12 10.850	
KB3	19/07/2024	Sediment grab	78 57.262	11 57.377	
KB2	19/07/2024	Sediment grab	78 58.577	11 43.760	Sediment incubation D

Table 4: Sediment sampling events

Figure 14: Core KB4 C1

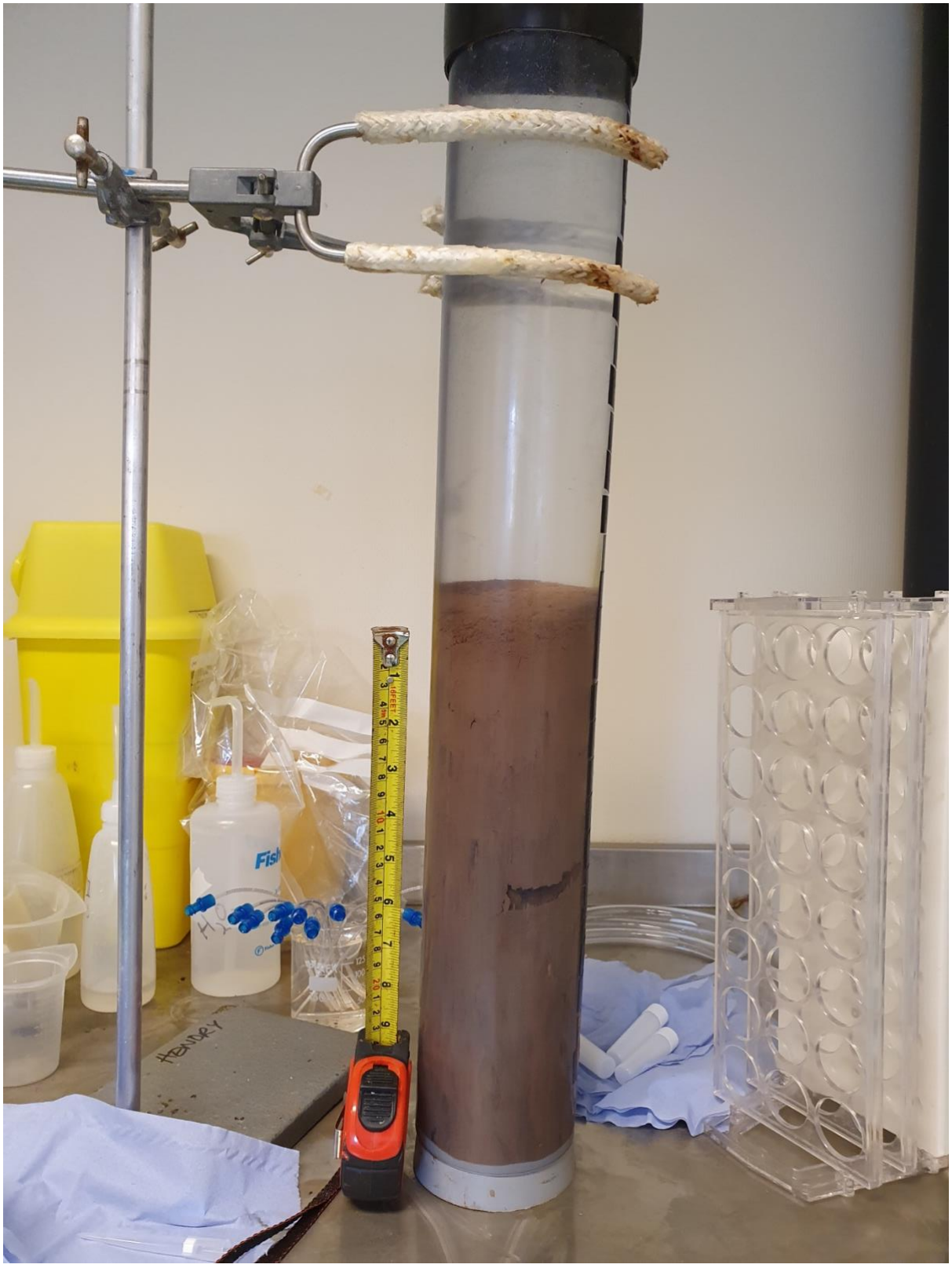


Figure 15: Core KB4 C2

River sampling

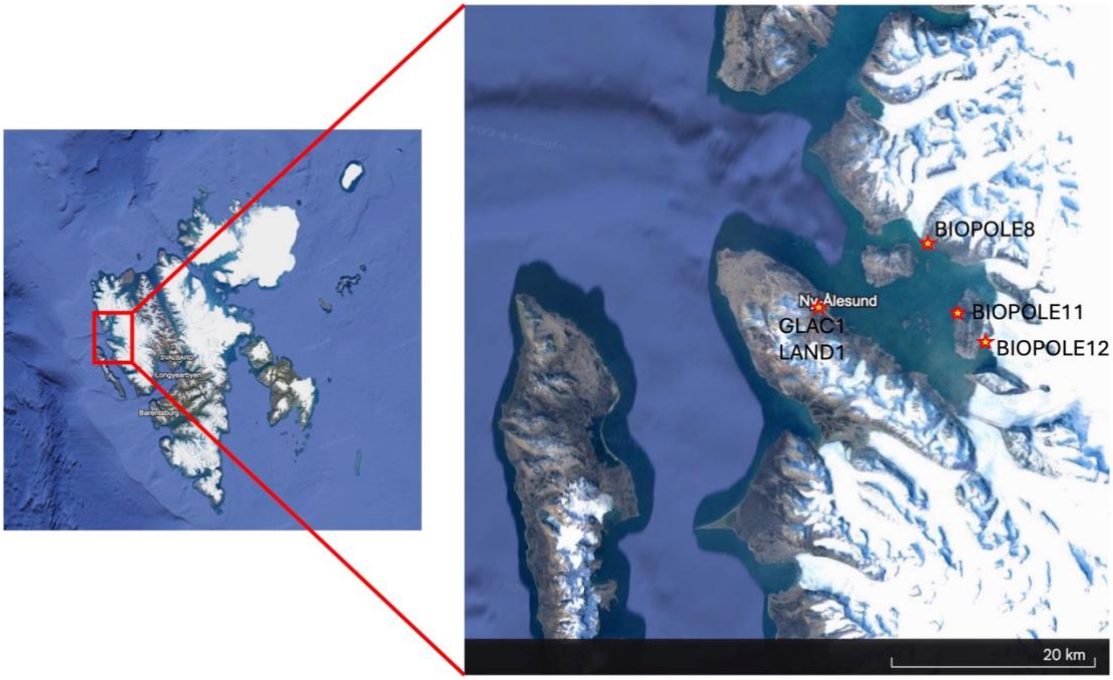


Figure 16: River sampling locations

Physical properties

Temperature, conductivity, pH and dissolved oxygen were measured as part of the BIOPOLE project work by Nathan Callaghan. Salt gauging was used to assess flow rates.

Water sampling

River water was sampled in situ for nutrients and total alkalinity using a plastic syringe, filtering through a 0.8/0.2 μm Acrodisk filter into an acid-cleaned, rinsed plastic bottle and a rinsed 50ml centrifuge tube respectively. Unfiltered samples were then taken for oxygen isotopes in rinsed plastic bottles. The remaining seawater was collected in an acid-rinsed 5L bottles for later processing.

In the laboratory, the nutrients samples were frozen immediately at -20°C. A subsample was filtered immediately for dissolved δ^{30}Si through 0.8/0.2 μm Acrodisk filters into an acid-cleaned, rinsed plastic bottle. Phytoplankton cell count samples were subsampled and fixed with 1.5ml lugols and parafilmed. The oxygen isotope samples were sealed with electrical tape. Water samples were filtered through GFFs for particulate organic carbon and nitrogen (POC/PON) and phosphorus (POP) and through 0.8 μm polycarbonate filters for reactive silica. Water was additionally filtered through 0.2 μm PES filters for particulate trace metal analyses using a plastic covering to minimise contamination. At three 'super stations' additional water was filtered through 0.2, 0.4 and 0.8 μm polycarbonate filters for i) size fractionated reactive silica analyses and ii) synchrotron analyses. MilliQ blanks were taken for all particulate samples.

Station	Date	Activity	Lat (N)	Lon (E)	Notes
GLAC1	18/07/2024	River sampling	78 55.997	11 50.200	Red river
LAND1	18/07/2024	River sampling	78 56.145	11 49.985	Clear river
BIOPOLE8	24/07/2024	River sampling	79 0.212	12 16.396	Sediment laden glacial river
BIOPOLE11	24/07/2024	River sampling	78 57.050	12 26.085	Clear river from lake
BIOPOLE12	24/07/2024	Subglacial sampling	78 55.952	12 34.881	Subglacial river discharge
BIOPOLE11	27/7/2024	River sampling	78 57.050	12 26.085	Clear river from lake

Table 5: Water sampling events

Sediment sampling

Sediments were collected from pro-glacial systems using a plastic scoop, and were processed as for the fjord sediments, and used in incubation experiments (see below). Sampling events are listed in Table 4.

Incubation experiments

Sediment incubation experiments were carried out on sediments collected from pro-glacial systems and the fjord floor (Table 6,7). The following protocol was used.

1. Use vinyl gloves at all times.
2. Prepare 1 x 250 mL bottle with of filtered site bottom water (filtered through 0.65 μm polycarbonate filters) and sediment (Solid:solution g L-1 ~10).
3. Prepare 1 x 250 mL bottle with of 50% filtered site bottom water and 50% Milliq-Q, and sediment (Solid:solution g L-1 ~10).
4. Add stir bar and use stir plate to keep in constant movement to ensure suspension, before pulling sample.
5. Pipette 10 mL of each solution into 15x15ml centrifuge tubes.

3 replicates for δ^{30}Si and metals
1 replicate for nutrients
4 time points (1 hour, 2 days, 4 days, 6 days)
2 salinities (SW + 50%SW/50%MQ)
4 SW blanks (one per time interval)
4 SW/MQ blanks (one per time interval)

6. Shake daily to resuspend sediment. Vent daily to oxygenate.

7. At each sampling event, use a small syringe to remove the supernatant and filter through a 0.8/0.2 Acropak disc into vials: 7ml into 8ml vials (isotopes and metals) and 3ml into nutrient vials.
8. Acidify the 8ml vial samples with concentrated trace metal clean nitric acid (0.1% v/v), seal tightly, parafilm, and store under cool, dark conditions.
9. Freeze the nutrient vials at -20°C.

Note that the last two experiments were stopped after 4 days due to time constraints.

Paired incubation experiments using ^{32}Si additions were carried out in the King's Bay Marine Laboratory by Katie Howe.

Experiment	Location	Started	Day 2	Day 4	Day 6
A	KB8	17/7/24	19/7/24	21/7/24	23/7/24
B	KB5	17/7/24	19/7/24	21/7/24	23/7/24
C	GLAC1	18/7/24	20/7/24	22/7/24	24/7/24
D	KB2	19/7/24	21/7/24	23/7/24	25/7/24
E	BIOPOLE12	24/7/24	26/7/24	28/7/24	-
F	BIOPOLE8	24/7/24	26/7/24	28/7/24	-

Table 6: Sediment incubation experiments

Station	Date collected	Date of extraction	Sample type	#	Notes

KB5	17/07/2024	17/07/2024	Blank	2	1 hour after experiment
KB5	17/07/2024	17/07/2024	Nuts	2	1 hour after experiment
KB5	17/07/2024	17/07/2024	δ^{30}Si/TM	6	1 hour after experiment
KB8	17/07/2024	17/07/2024	Blank	2	1 hour after experiment
KB8	17/07/2024	17/07/2024	Nuts	2	1 hour after experiment
KB8	17/07/2024	17/07/2024	δ^{30}Si/TM	6	1 hour after experiment
GLAC1	18/07/2024	18/07/2024	Blank	2	1 hour after experiment
GLAC1	18/07/2024	18/07/2024	Nuts	2	1 hour after experiment
GLAC1	18/07/2024	18/07/2024	δ^{30}Si/TM	6	1 hour after experiment
KB5	17/07/2024	19/07/2024	Blank	2	2 days after experiment
KB5	17/07/2024	19/07/2024	Nuts	2	2 days after experiment
KB5	17/07/2024	19/07/2024	δ^{30}Si/TM	6	2 days after experiment
KB8	17/07/2024	19/07/2024	Blank	2	2 days after experiment
KB8	17/07/2024	19/07/2024	Nuts	2	2 days after experiment
KB8	17/07/2024	19/07/2024	δ^{30}Si/TM	6	2 days after experiment
KB2	19/07/2024	19/07/2024	Blank	2	1 hour after experiment
KB2	19/07/2024	19/07/2024	Nuts	2	1 hour after experiment
KB2	19/07/2024	19/07/2024	δ^{30}Si/TM	6	1 hour after experiment
KB2	19/07/2024	19/07/2024	Blank	2	1 hour after experiment
KB2	19/07/2024	19/07/2024	Nuts	2	1 hour after experiment
KB2	19/07/2024	19/07/2024	δ^{30}Si/TM	6	1 hour after experiment
GLAC1	18/07/2024	20/07/2024	Blank	2	2 days after experiment
GLAC1	18/07/2024	20/07/2024	Nuts	2	2 days after experiment
GLAC1	18/07/2024	20/07/2024	δ^{30}Si/TM	6	2 days after experiment
KB5	17/07/2024	21/07/2024	Blank	2	4 days after experiment
KB5	17/07/2024	21/07/2024	Nuts	2	4 days after experiment
KB5	17/07/2024	21/07/2024	δ^{30}Si/TM	6	4 days after experiment
KB8	17/07/2024	21/07/2024	Blank	2	4 days after experiment
KB8	17/07/2024	21/07/2024	Nuts	2	4 days after experiment
KB8	17/07/2024	21/07/2024	δ^{30}Si/TM	6	4 days after experiment
KB2	19/07/2024	21/07/2024	Blank	2	2 days after experiment
KB2	19/07/2024	21/07/2024	Nuts	2	2 days after experiment
KB2	19/07/2024	21/07/2024	δ^{30}Si/TM	6	2 days after experiment
GLAC1	18/07/2024	22/07/2024	Blank	2	4 days after experiment
GLAC1	18/07/2024	22/07/2024	Nuts	2	4 days after experiment
GLAC1	18/07/2024	22/07/2024	δ^{30}Si/TM	5	4 days after experiment; sample lost
KB5	17/07/2024	23/07/2024	Blank	2	6 days after experiment
KB5	17/07/2024	23/07/2024	Nuts	2	6 days after experiment
KB5	17/07/2024	23/07/2024	δ^{30}Si/TM	6	6 days after experiment
KB8	17/07/2024	23/07/2024	Blank	2	6 days after experiment
KB8	17/07/2024	23/07/2024	Nuts	2	6 days after experiment
KB8	17/07/2024	23/07/2024	δ^{30}Si/TM	6	6 days after experiment

KB2	19/07/2024	23/07/2024	Blank	2	4 days after experiment
KB2	19/07/2024	23/07/2024	Nuts	2	4 days after experiment
KB2	19/07/2024	23/07/2024	δ^{30}Si/TM	6	4 days after experiment
BIOPOLE12	23/07/2024	24/07/2024	Blank	2	1 hour after experiment
BIOPOLE12	23/07/2024	24/07/2024	Nuts	2	1 hour after experiment
BIOPOLE12	23/07/2024	24/07/2024	δ^{30}Si/TM	6	1 hour after experiment
BIOPOLE8	23/07/2024	24/07/2024	Blank	2	1 hour after experiment
BIOPOLE8	23/07/2024	24/07/2024	Nuts	2	1 hour after experiment
BIOPOLE8	23/07/2024	24/07/2024	δ^{30}Si/TM	6	1 hour after experiment
GLAC1	18/07/2024	24/07/2024	Blank	2	6 days after experiment
GLAC1	18/07/2024	24/07/2024	Nuts	2	6 days after experiment
GLAC1	18/07/2024	24/07/2024	δ^{30}Si/TM	5	6 days after experiment; sample lost
KB2	19/07/2024	25/07/2024	Blank	1	6 days after experiment; blank lost
KB2	19/07/2024	25/07/2024	Nuts	2	6 days after experiment
KB2	19/07/2024	25/07/2024	δ^{30}Si/TM	6	6 days after experiment
BIOPOLE12	23/07/2024	26/07/2024	Blank	2	2 days after experiment
BIOPOLE12	23/07/2024	26/07/2024	Nuts	2	2 days after experiment
BIOPOLE12	23/07/2024	26/07/2024	δ^{30}Si/TM	6	2 days after experiment
BIOPOLE8	23/07/2024	26/07/2024	Blank	2	2 days after experiment
BIOPOLE8	23/07/2024	26/07/2024	Nuts	2	2 days after experiment
BIOPOLE8	23/07/2024	26/07/2024	δ^{30}Si/TM	6	2 days after experiment
BIOPOLE12	23/07/2024	28/07/2024	Blank	2	4 days after experiment
BIOPOLE12	23/07/2024	28/07/2024	Nuts	2	4 days after experiment
BIOPOLE12	23/07/2024	28/07/2024	δ^{30}Si/TM	6	4 days after experiment
BIOPOLE8	23/07/2024	28/07/2024	Blank	2	4 days after experiment
BIOPOLE8	23/07/2024	28/07/2024	Nuts	2	4 days after experiment
BIOPOLE8	23/07/2024	28/07/2024	δ^{30}Si/TM	6	4 days after experiment

Table 7: Incubation samples