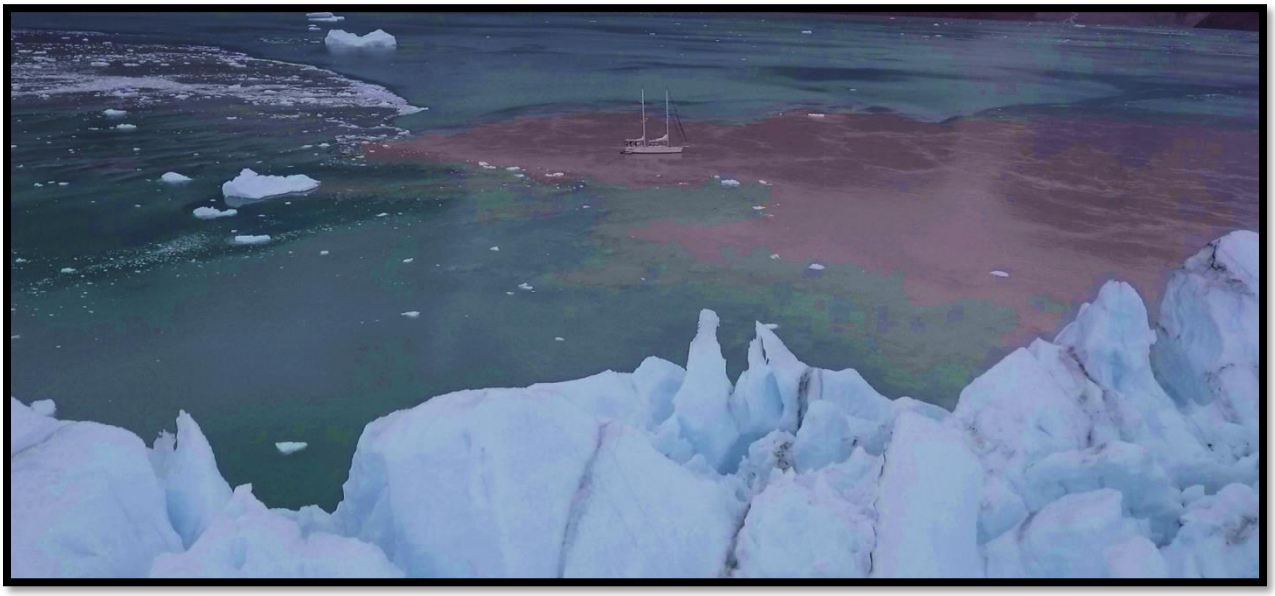
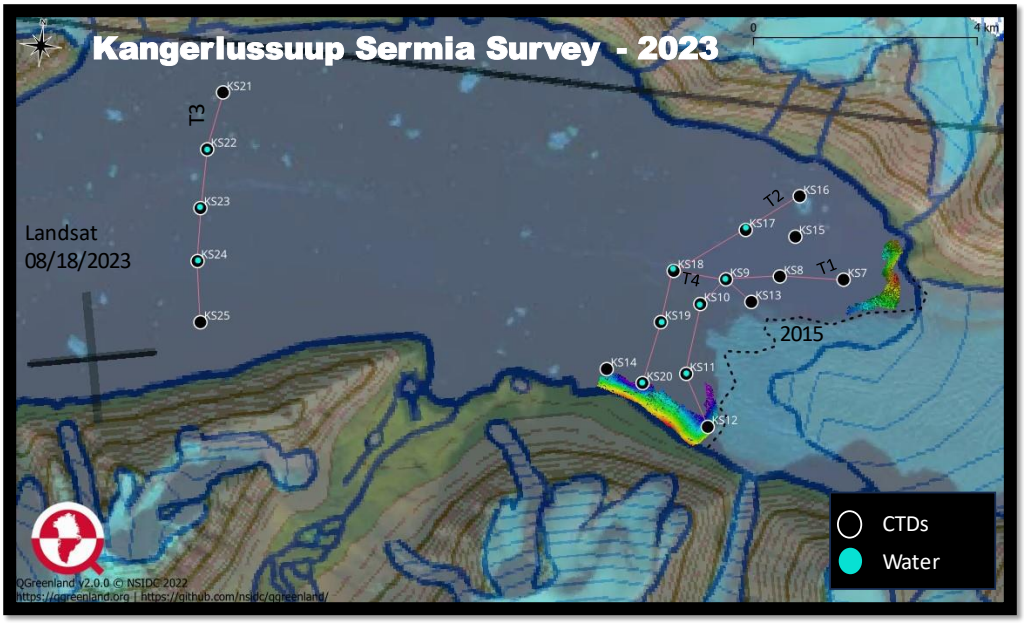
Kangerlussuup Sermia Survey - 2023

Field Operation Scientist: Nicole Trenholm, Ocean Research Project
Captain: Matthew Rutherford, Ocean Research Project
***Marine Technician*:** Anna D'Agostino
Report Date: 9/11/2023
Deliverables by 10/15/2023.



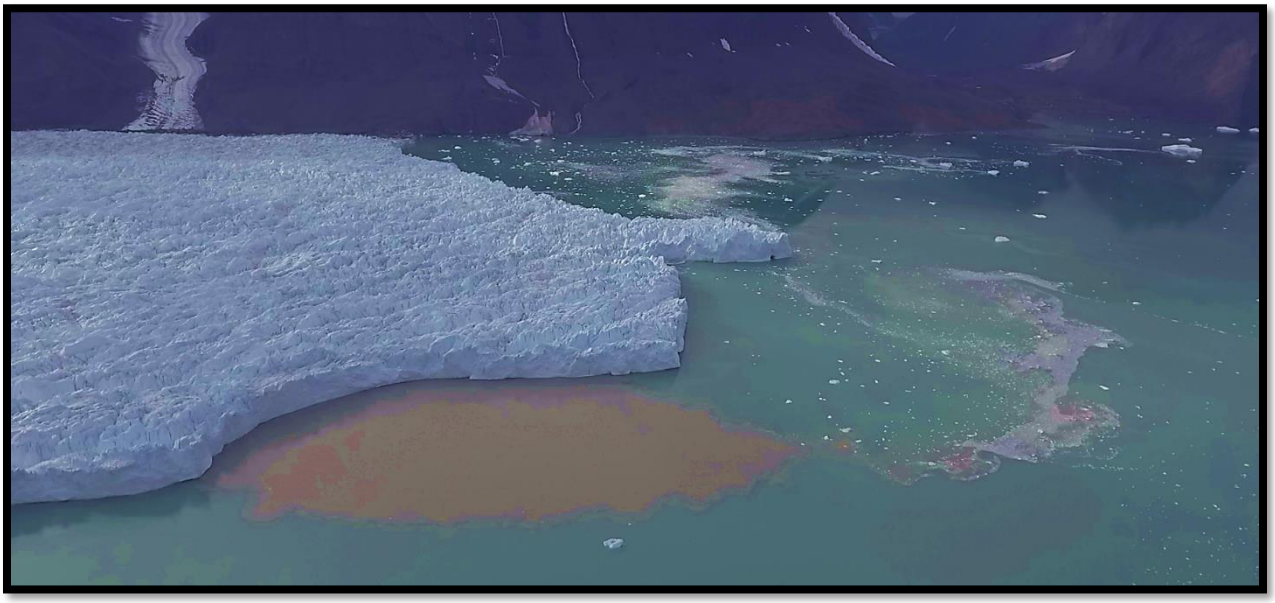


Survey operations at KS including multibeam coverage and Transects (T1-T4). Note advance of KS glacier since 2015 survey.

Survey Map:
Sampling stations in front of Kangerlussuup Sermia Glacier. Blue circles represent stations where physical samples and CTDs were collected, and black circles represent CTD-only stations. Transects Id are listed.

During the Glacier-Ocean Mapping and Research Interdisciplinary Effort (GO-MARIE) 2023 campaign, operations were led by Ocean Research Project (ORP) Inc. 501c3, under the supervision of Field Operations Scientist, Nicole Trenholm and Captain Matthew Rutherford aboard the SRV Marie Tharp. A group of cryosphere researchers organized by the University of Texas Institute of Geophysics requested the Kangerlussuup Sermia Survey within a glacial fjord of Uummannaq Bay. The survey site identified for this campaign contains a grounded ocean terminating glacier. The objective of this survey was to conduct a repeat near glacier terminus multibeam survey and hydrographic sensor profile and physical water sampling transects at approximately 500 m intervals away from the glacier face and 10 km away in an across-fjord orientation.

Special attention was given to sampling within and across the glacial meltwater entrainment plume which surfaced mid-way across the glacier front as a turbid sediment plume as observed by the aerial drone image below.



Primary Land Retreated Glacial Fjord Study Location: Kangerlussuup Sermia, west Greenland.
Latitude: between 71.492083 ° N & 71.447583 ° N
Longitude: between -51.710967 ° W & -51.3718358 °W
Survey Date Range: June 25-28, 2023

Number of Stations: 19 CTD stations and water was collected at discrete depths at stations 9-11, 17-20, and 22-24.

Methods:

A. *Shipboard Observations:* All data collection was acquired from the Ocean Research Project's SRV Marie Tharp, a 22 m steel schooner with water column sensor profiling, water column physical sampling, a flow-through continuous water sampling system and filtration wetlab capacity.

B. *Hydrographic CTD profiles:* Were conducted CTDs across three transects where multiple hydrographic profiles were acquired in an across-fjord orientation nearly 500 m away from the glacier terminus. Transect 1 ranged between approximately 100 m and 700 m from the glacier face. Transect 2 ranged between 500 m and 700 m from Transect 1. and Transect 3. is approximately 10 km from the glacier terminus. The hydrographic transect stations overlapped with water column sampling at stations 9-11,13, 17-20, and 22-24. Two RBR Concerto CTD instruments were lowered on the same cage to just above the seafloor. *S/N* 060671 was calibrated in June 2023 and has a turbidity sensor (NTU). The other CTD Concerto is S/N 204223 and was calibrated in spring 2022 and it has a chl a sensor. They both have traditional physical ocean measurements and an auxiliary dissolved oxygen concentration sensor. The turbidity sensor takes a measurement every 3 seconds. Since one CTD had an older calibration date both CTDs were compared for salinity and temperature at the same depths with a linear regression and they agreed to an R^2 number of 0.97. We deployed both CTDs at 19 stations total. Whereas 2 of those stations were additional CTD profiles to support the multibeam survey sound speed correction during post processing. Those CTD profiles occurred at Station 14 and 15 not on the day of hydrographic profiling or water sampling. *Refer to Appendix 1.* For Transect turbidity sections 1-4.

Station ID	Latitude	Longitude	060671 File Name	204223 File Name
KS13	71 28.100	51 25.711	060671_20230825_1627	204223_20230825_1636
KS9	71 28.289	51 26.554	060671_20230825_1731	204223_20230825_1753
KS10	71 28.025	51 27.244	060671_20230825_1818	204223_20230825_1755
KS7	71 28.413	51 23.004	060671_20230825_1359	204223_20230825_1359
KS8	71 28.375	51 24.939	060671_20230825_1522	204223_20230825_1524
KS11	71 27.340	51 27.431	060671_20230825_2009	204223_20230825_2055
KS12	71 26.855	51 26.603	060671_20230825_2119	204223_20230825_2051
KS14	71 27.299	51 29.845	060671_20230826_2123	204223_20230826_2055
KS15	71 28.773	51 24.604	060671_20230827_0031	204223_202308827_0002
KS16	71 29.166	51 24.611	060671_20230827_1425	204223_20230827_1354
KS17	71 28.784	51 26.126	060671_20230827_1503	204223_20230827_1429
KS18	71 28.313	51 28.161	060671_20230827_1603	204223_20230827_1504
KS19	71 27.808	51 28.375	060671_20230827_1717	204223_20230827_1654
KS20	71 27.204	51 28.717	060671_20230828_1842	204223_20230828_1846
KS21	71 29.525	51 42.386	060671_20230828_2029	204223_20230828_1950

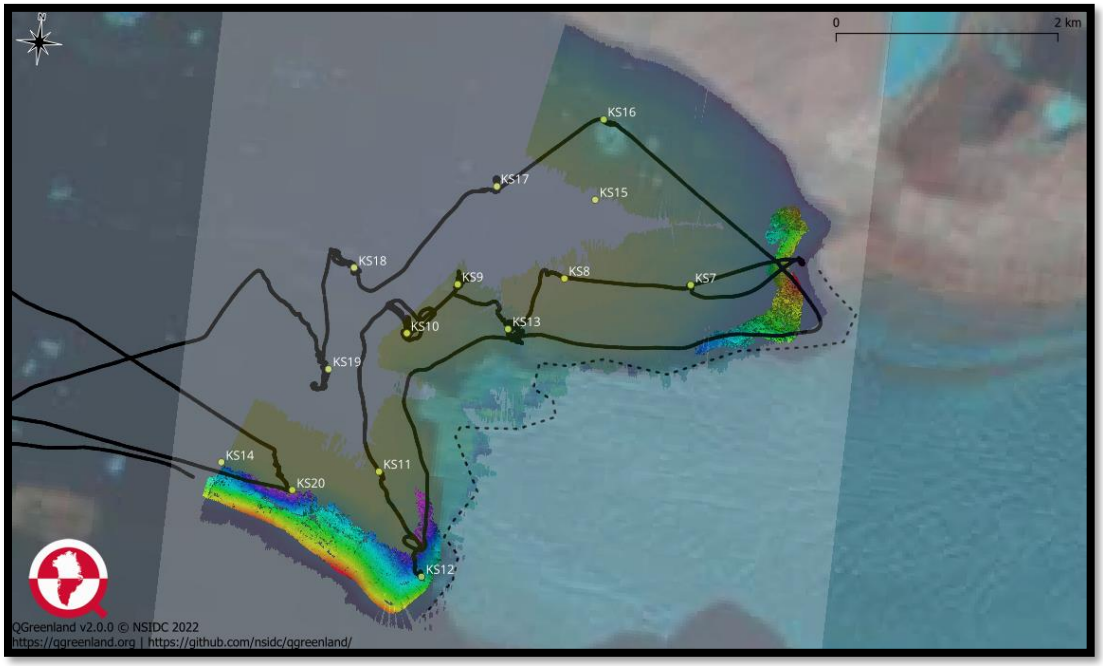
KS22	71 28.961	51 42.662	060671_20230828_2123	204223_20230828_2033
KS23	71 28.391	51 42.658	060671_20230828_2236	204223_20230828_2207
KS24	71 27.880	51 42.558	060671_20230828_2335	204223_20230828_2304
KS25	71 27.297	51 42.253	060671_20230829_0038	204223_20230829_0037

C. *Niskin Bottle*: Manual 5L- Niskin bottle with trigger weight. Collected water samples at the 1m below the surface, at an intermediate depth and a deeper depth. We determined the intermediate and deeper depth based on the CTD results relative to the turbidity plume feature. Peak turbidity feature occurred around 25 m close on the northern side of the fjord then deepened to the southern side. Samples were collected at 11 different stations at 9-11, 13, 17-20, and 22-24.

Date	Time	Station ID	Water Sample Depths (m)	Filter ID
8252023	16:00	KS13	1	JJUF-25
8252023	17:15	KS9	1	JJUF-26
8252023	17:15	KS9	25	JJUF-27
8252023	17:15	KS9	100	JJUF-28
8252023	18:03	KS10	1	JJUF-29
8252023	18:03	KS10	50	JJUF-13
8252023	18:03	KS10	200	JJUF-30
8252023	19:53	KS11	1	JJUF-14
8252023	19:53	KS11	50	JJUF-15
8252023	19:53	KS11	100	JJUF-16
8272023	14:43	KS17	1	JJUF-17
8272023	14:43	KS17	25	JJUF-18
8272023	14:43	KS17	125	JJUF-19

8272023	15:42	KS18	1	JJUF-20
8272023	15:42	KS18	100	JJUF-21
8272023	15:42	KS18	275	JJUF-22
8272023	17:17	KS19	1	JJUF-07
8272023	17:17	KS19	50	JJUF-23
8282023	18:22	KS20	1	JJUF-24
8282023	18:22	KS20	75	JJUF-08
8282023	18:22	KS20	175	JJUF-09
8282023	20:39	KS22	1	JJUF-10
8282023	20:39	KS22	25	JJUF-11
8282023	20:39	KS22	100	JJUF-12
8282023	22:30	KS23	1	JJUF-01
8282023	22:30	KS23	25	JJUF-02
8282023	22:30	KS23	100	JJUF-03
8282023	23:09	KS24	1	JJUF-04
8282023	23:09	KS24	25	JJUF-05
8282023	23:09	KS24	125	JJUF-06

D. *Singlebeam Echosounder*: We have a Ray Marine/ AIRMAR Frequency (50-200 kw) EchoSounder with DGPS ship positioning. The singlebeam depth data was collected to advise in the water column profiling maximum depth and water sampling activity. The depth data can also be used to observe the across-track change in bathymetry near the glacier face and across each transect. Data coordinate system is in WG84 4326.



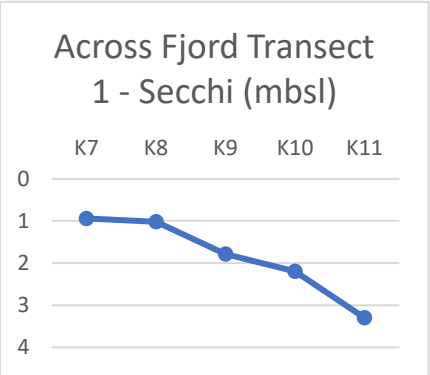
Singlebeam Echosounder Coverage (black), 2023 and 2015multibeam coverage,

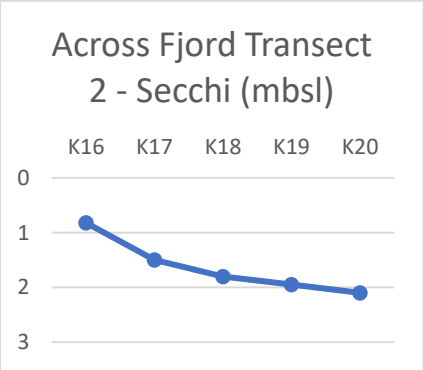
with CTD stations and 2015 glacier terminus extent (dotted black line)

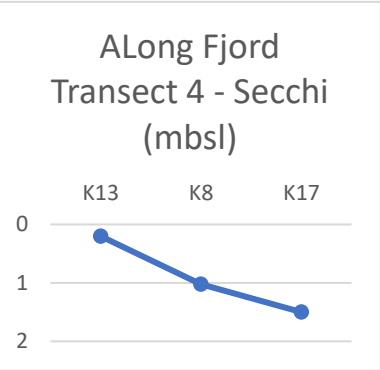
E. *Secchi Disk:* Measurements were taken at the following stations meters below sea level (mbsl) at Transect 1, 2 and 4.

Table Secchi Station Measurements

Station	Secchi (mbsl)
K7	0.94
K8	1.02
K9	1.79
K10	2.2
K11	3.3
K16	0.82
K17	1.5
K18	1.8
K19	1.95
K20	2.1
K21	2
K22	2
K13	0.2







F. *Shipboard Lab Filtration:*

At designated water sampling stations water was collected to be filtered that will eventually support the analyses of disaggregated suspended matter grain size lead by Dr. Jaeger. 250-500 ml of water from each sampling depth was filtered using a 0.8-micron Millipore cellulose filters and water samples are stored at 4 °C. There are 30 water samples. Filtration apparatus used to accomplish this task was rinsed with ship prepared lab water. We define lab water as ship desalination water that has then been pre-filtered by 0.7- and 0.2-micron GF/F. The volume of water filtered (ml) was logged in the project's master KS Fjord Log.xlsx along with station and filter ID.

G. *Multibeam Echosounder:*

A Reson 7125 V4 200 khz sonar with an Ekinox SBG Inertial Motion Unit and Trimble DGPS with Omnistar positioning was utilized to collect repeat coverage of

the 2015 multibeam coverage. Due to AMSAT and SASAT satellite constellation operational azimuth and elevation limited access at this survey site, relative to high altitude fjord cliffs the satellite positioning accuracy was between 1-3 m therefore, resultant bathymetric grids were generated to 3m. CTD sound velocity profiles were utilized for sound speed correction at the nearest in time and position. Data coordinate system is in WGS-84 ellipsoid UTM 22 North.

Operational and Preliminary Data Observation Notes:

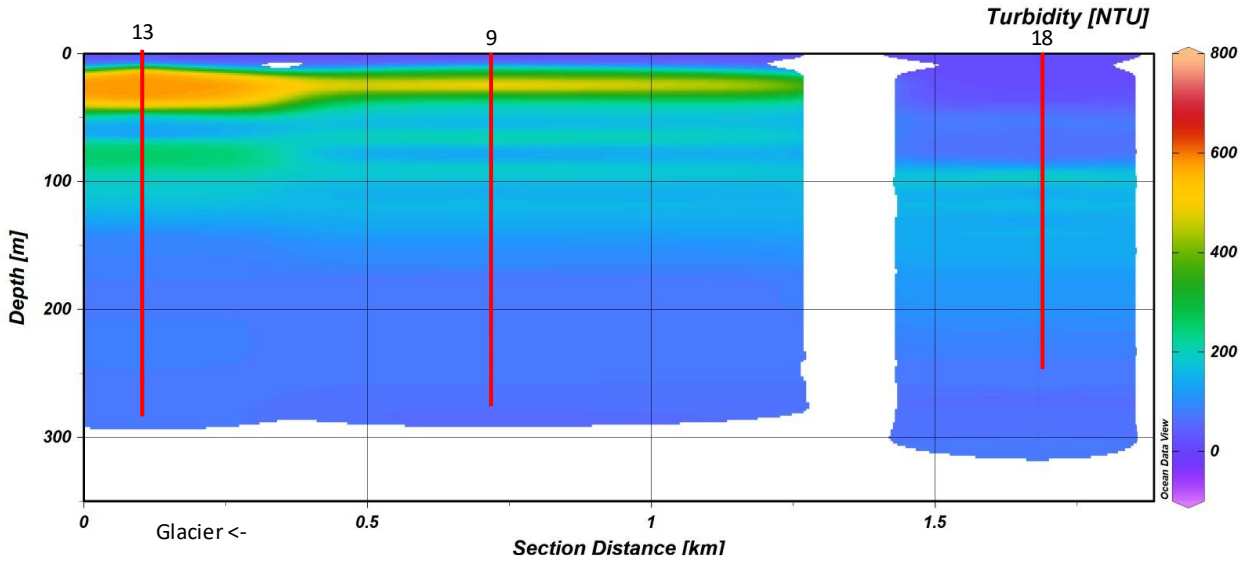
- The expected performance of the multibeam was 500 m but the sonar performance proved to not be able to acquire high density data coverage at more than 275 m. Additionally the since the glacier terminus surged in position atop the shallower pre-existing multibeam coverage the surveyable area for SRV Marie Tharp was even more greatly reduced. Many features of interest for this survey are now underneath where the glacier has advanced by 0.72 km since 2015. The glacier had advanced in the center and southern edge of the glacier between 0.2 and 0.72 km since that time.
- The SRV Marie Tharp attempted to occupy KS fjord three times once in mid-July, late July but as the fjord was late for the landfast ice to clear and the ice mélange to clear we did not conduct the survey till late August.
- ADCP data collection is limited to shallower than 70 m therefore the ADCP could not be utilized during this survey.
- While not requested, gravity coring was attempted 2-3 times at Stations 13 and 12. Station 13's strong upwelling current likely faltered the success of a core acquisition while station 12 conditions were optimal but very coarse seabed sediment was expected the halter the success of a gravity core collection.
- Intense upwelling current speed at Station 13 near the glacier face made for additional water sampling besides the 1 m water sample and CTD unmanageable.
- Secchi surface observations indicated within the entrainment surface plume was 0.2 m at Station 13.
- Turbidity within the water column plume was most prevalently observed from the fjord center to the northern side of the fjord.

Deliverables:

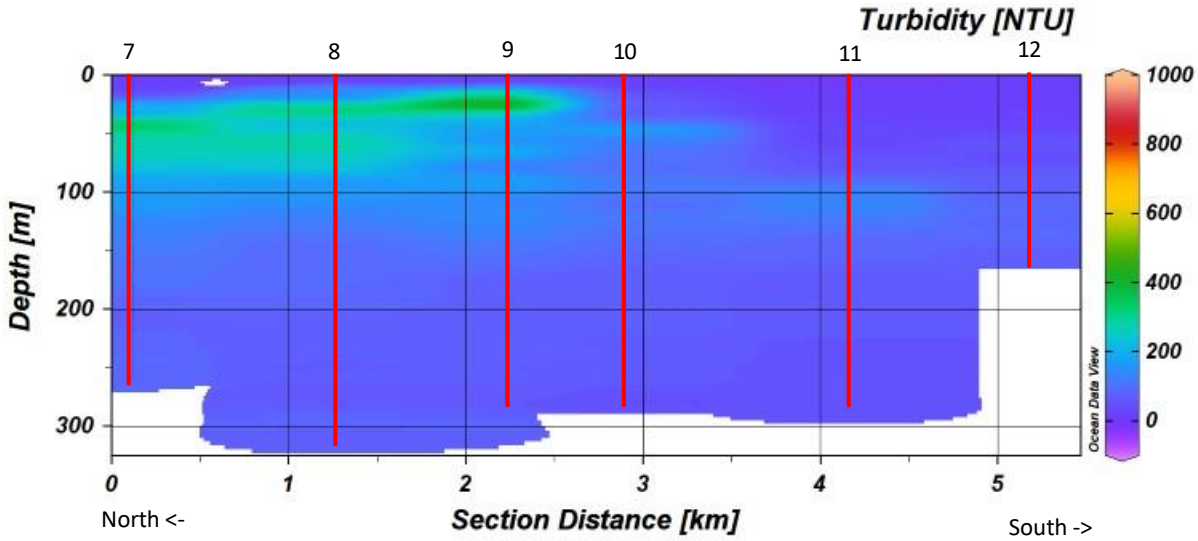
- A multibeam echosounder (. xyz and .kmz)
- A singlebeam echosounder (.csv)
- CTD files (.txt)
- Station and water sampling spreadsheet. (KS Fjord Log.xlsx)
- Shipped water samples (filters)

Appendix 1: Turbidity Transect Sections

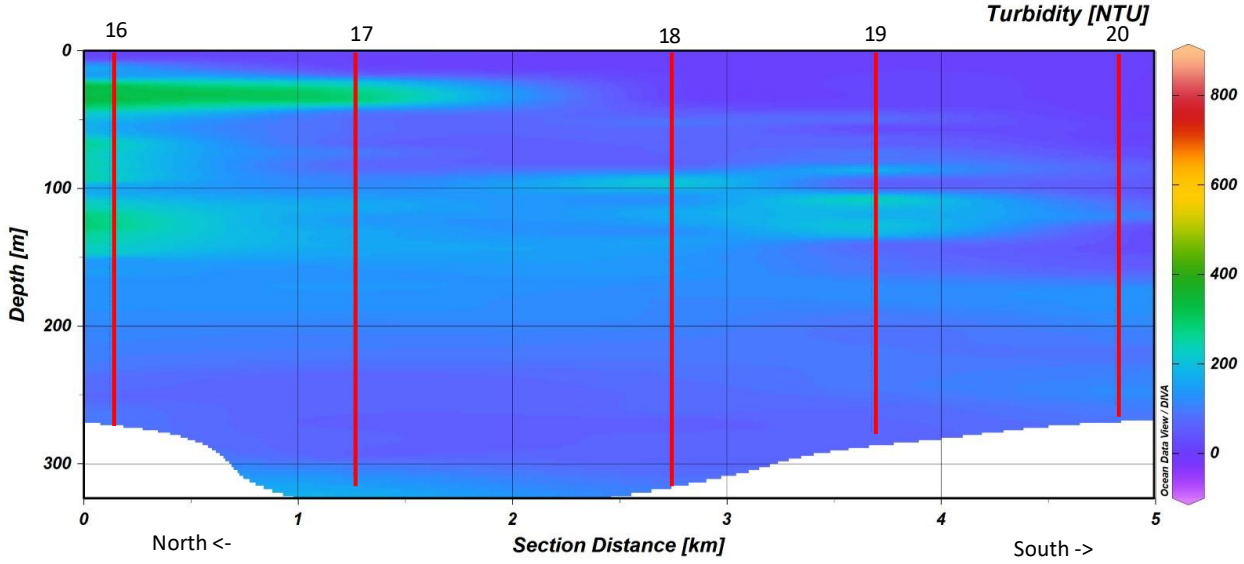
Along Fjord -Transect 4: Stations 13,9, & 18



Across Fjord - Transect 1: Stations 7-12



Across Fjord - Transect 2: Station 16-20



Across Fjord - Transect 3: Stations 21-25

Turbidity concentrations (NTU) for hydrographic transects where red lines represent CTD profiles.