BaySys 2018 Fall Cruise Report
-Mooring Retrieval-

The recovery of BaySys mooring from MV William Kennedy. One oceanographic mooring was recovered on September 13, 2018. Water samplings and CTD casts were executed at the mooring position to determine the vertical thermohaline and hydro-chemical structure.

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BaySys 2018 Mooring Program Cruise Report

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1. Introduction

1.1 Campaign objectives

BaySys is a 4-year collaboration among industry partner Manitoba Hydro (Hydro Québec and Ouranos) and the Universities of Manitoba, Northern British Columbia, Québec à Rimouski, Alberta, Calgary, Laval and Trent to conduct oceanographic research in Hudson Bay. The overarching goal of the project is to understand the role of freshwater in Hudson Bay marine and coastal systems, and in particular, to create a scientific basis to distinguish climate change effects from those of hydroelectric regulation of freshwater on physical, biological and biogeochemical conditions in Hudson Bay.

In late September 2016, five oceanographic moorings were deployed (Hornby et al., 2016)in the eastern Hudson Bay and at the entrance to James Bay (Figure 1). These moorings were supposed to be recovered in summer 2017 during the BaySys cruise onboard CCGS *Amundsen* or *R/V William Kennedy*. Later, a decision was made on turning the moorings from *R/V William Kennedy* instead of recovery. Due to the slow progress of the ship's inspection from Transport Canada, the 2017 cruise was cancelled. An opportunistic cruise onboard CCGS *Henry Larsen* was successfully conducted on October 26 – November 1, 2017, for retrieval and re-deployment of some of BaySys moorings accompanied by the concurrent CTD and water sampling (Kirillov et al., 2018, 2020; Petrusevich et al., 2020). Unfortunately, mooring JB02 was not recovered during that operation. Finally, *MV William Kennedy* was ready for field operations in 2018, therefore there was conducted a cruise on September 1-14, 2018 with the main goal of recovery of the mooring JB02 and conducting additional bathymetry surveys, water sampling and CTD casts during transects and in Nelson River estuary.

Figure 1. The array of BaySys mooring deployed in September 2016 and the initial turnaround plan for 2017-2018.

1.2 Summary of operations

The science crew (Vladislav Petrusevich, Nicole Pogorzelec and Samantha Huyghe) arrived in Churchill by September 1, 2018, and after familiarization with the vessel and safety briefing sailed off. On September 2 we arrived at Nelson River estuary. In the morning it was storming but by afternoon the wind went down to 15 knots and we started water sampling and CTD casts using rosette following the proposed sampling stations plan (Figure 2). By the end of the day, we finished a transect in Nelson River estuary. We also planned to be next morning by Cape Tatnam and do multi-beam mapping of the slope and seabed, looking for the features like ice scours and ridges.

Figure 2. Proposed sampling stations en route to the mooring JB02-16 recovery.

On September 3 morning we almost run aground while doing multibeam bottom mapping and damaging one of the stabilizers. The weather started getting worse and there was a decision made to return to Churchill, but the sea was too rough, so we have to stay in Nelson Estuary waiting for better weather. There was a gale warning for Churchill and Eastern Hudson Bay. We stayed in Nelson River Estuary waiting for better weather till September 7, winds were 30-36 knots, lost our anchor during the storm.

When the weather got better on September 7, we returned to Churchill the next day. We waited in Churchill for a good forecast for at least 4-5 days needed for a transect from Churchill to Kuujjuarapik.

2. Mooring Operations

2.1. Mooring recovery

R/V William Kennedy sailed off again on September, 10 heading straight to the mooring location JB02. We arrived on site on September 13 afternoon. The Acoustic release worked fine, and the mooring was afloat (Figure 3a). Using a grapnel, the floats were dragged to the aft section of the ship with the diving platform being lowered and then connected to the A-frame winch for retrieval (Figure 3b).

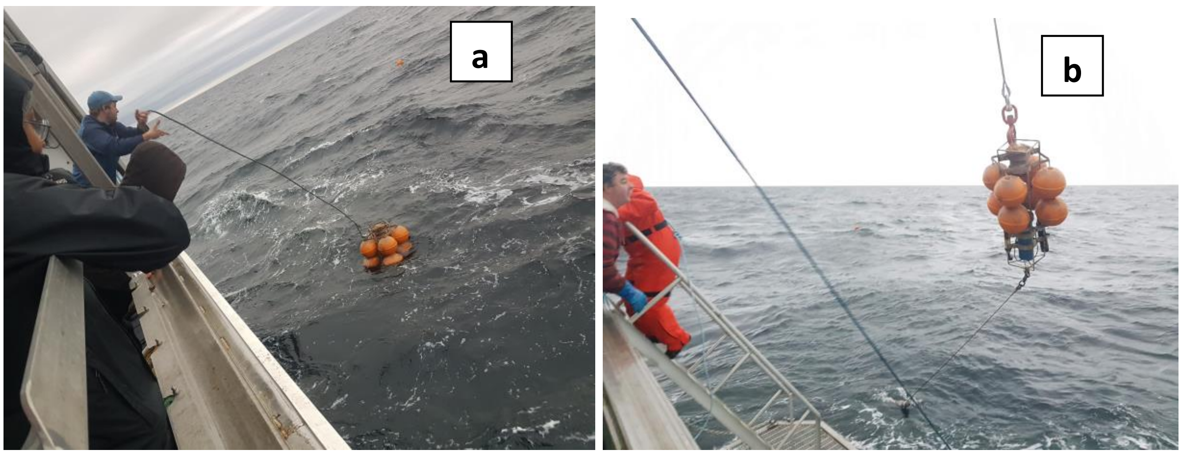
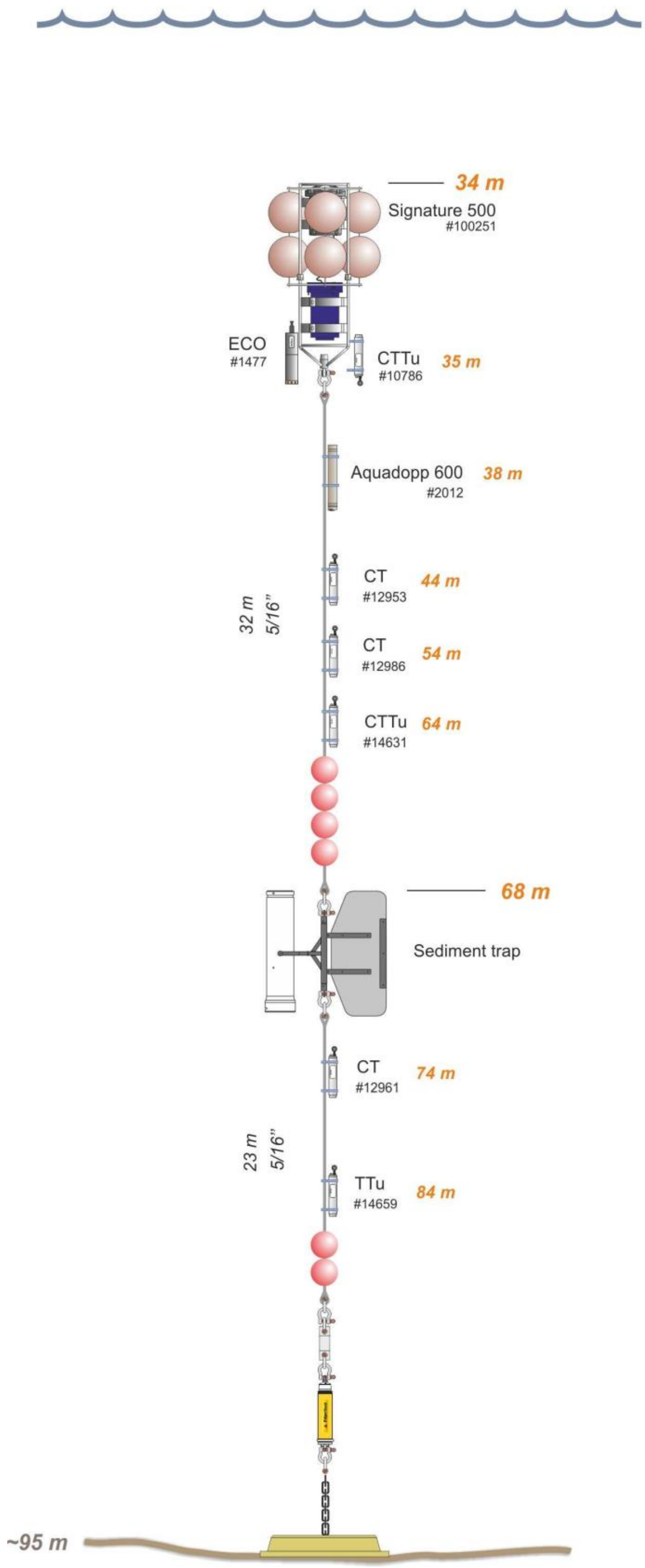


Figure 3. a) Acoustically released mooring with floats being recovered using a grapnel from R/V William Kennedy, b) Mooring being recovered using the aft winch.

2.2. The configuration of recovered moorings

A bottom-anchored oceanographic mooring JB02-16 (Figure 4) was deployed at 95 m depth ~165 km south-west from Kuujjuarapik, QC (54°40.973'N 80°11.226'W) on 1 October 2016 and recovered on 13 September 2018. The mooring setup consisted of (i) one upward-looking 5-beam Signature 500 ADCP by Nortek placed at 35 m depth, one (ii) downward-looking 3-beam 600 kHz Aquadopp ADCP by Nortek placed at 38 m depth and (iii) one Gurney Instrument "Baker Type" sequential sediment trap (Baker & Milburn, 1983) at 68 m with a collection area of 0.032 m^2. Several conductivity-temperature, conductivity-temperature-turbidity and temperature-turbidity sensors were also deployed at various depths on the mooring.



JB02	
target depth:	100 m
depth of deployment:	101 m
latitude:	54° 40.973′ N
longitude:	80° 11.226′ W
date of deployment:	Oct 1, 2016
time of deployment:	17:03 UTC

Figure 4. Schematic illustration of the mooring JB02-16 configurations as recovered.

Signature 500 ADCP placed at 35 m depth was covered by hydroid (possibly seapen or sponge) species (Figure 5).

Figure 5. Biofouling of Signature 500 ADCP.

2.3. Sediment Traps

The objective of the sediment trap program, as part of BaySys Team 4/5, was to determine the sinking fluxes of particulates (organic and lithogenic) through the water column. Four Gurney Instrument "Baker Type" sequential type sediment traps were deployed from the *CCGS Des Groseilliers* in 2016 fixed to moorings AN01, NE02, NE03 and JB02 at depths ranging from 28 to 85 m below the water surface. All four sediment traps were programmed to start a collection on 4 October 2016 0:00 CST with intervals of 35 days for each vial collected. The Sediment traps on moorings AN01, NE02 and NE03 were successfully recovered during the 2017 fall cruise and JB02 during the current 2018 fall cruise.

Once onboard (Figure 6a), the trap was dismantled, first removing the PVC tube that houses an asymmetrical funnel, the stabilizing fins and then the sample vials from the rosette.

Figure 6. a) Sediment trap from mooring JB02-16 being hoisted onboard R/V William Kennedy. b) The vials from the sediment traps in the vial rack.

The samples were placed into a vial rack numbered from 1 to 10 (Figure 6b). The vials were then emptied into labelled amber jars which were then packed and stored in cooler on the deck. The sediment traps were then reassembled, cleaned with fresh water and then packed in their respective boxes for transport. The samples collected have been placed in cold storage (-4°C) and are yet to be analyzed for captured sediments and zooplankton taxonomy identification (Petrusevich et al., 2020).

2.4. Early Results from Mooring

The CT sensors deployed at different depths captured the seasonal changes in vertical thermohaline structure at the mooring location. These changes correspond to the impact of different processes such as: the vertical mixing and redistribution of heat from the surface to the deeper layers in autumn; cooling of water column and the following salinity increase due to the sea ice growth in winter; the freshening and warming associated with sea ice melting/river runoff and solar heating in summer (Figure 7).

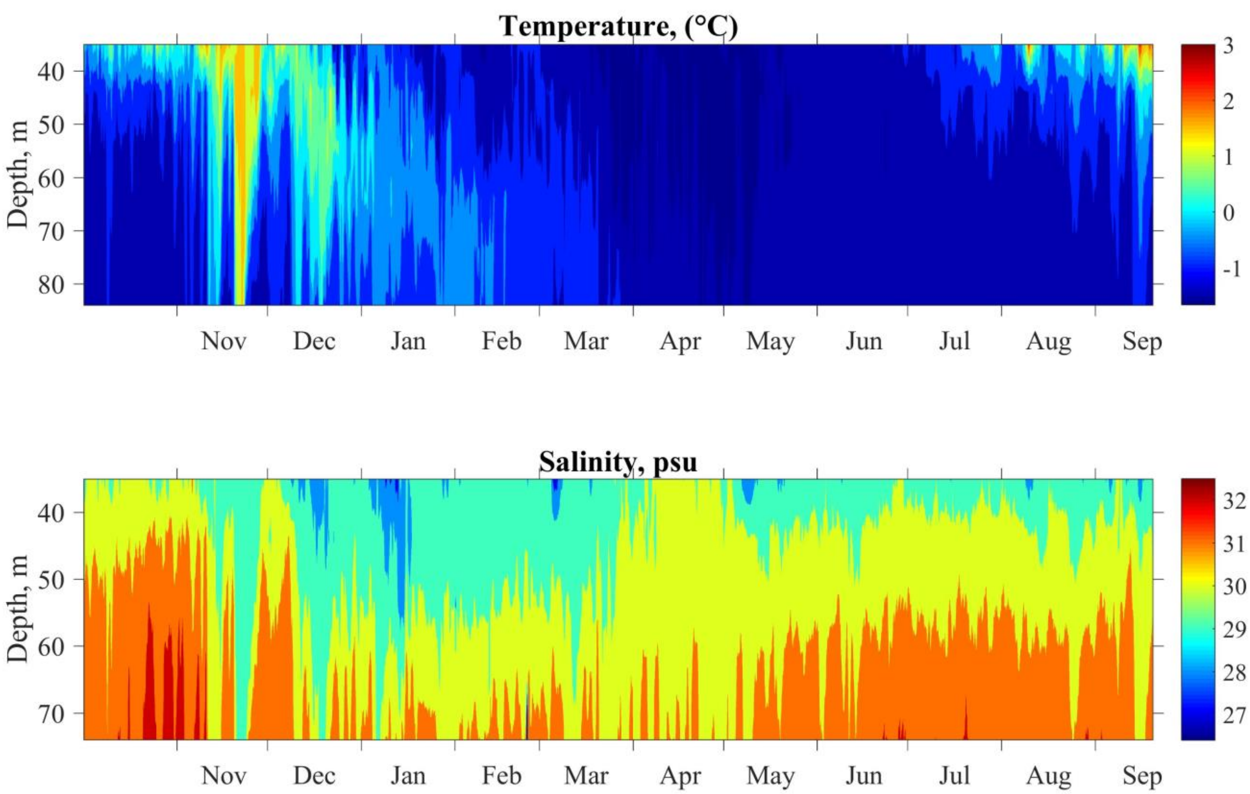


Figure 7. The one-year evolution of vertical thermohaline structure at JB02-16 mooring

The mooring carried an upward-looking five-beam acoustic Doppler current profiler (ADCP, Nortek Signature 500), which in addition to currents measured the distance from the instrument to either the sea surface or the ice bottom when sea ice floes drifted over the profiler during the ice-covered period. The thickness of sea ice at the mooring location was estimated from the ice draft evaluated from the distance to the ice-ocean interface measured by the ADCP. The acoustic-derived thicknesses were corrected for ADCP tilt, sea surface height and atmospheric pressure (Krishfield et al., 2014) and for the speed of sound. The extreme outliers were excluded, and the mean daily ice thicknesses were calculated for further analysis (Figure 6) (Kirillov et al., 2020).

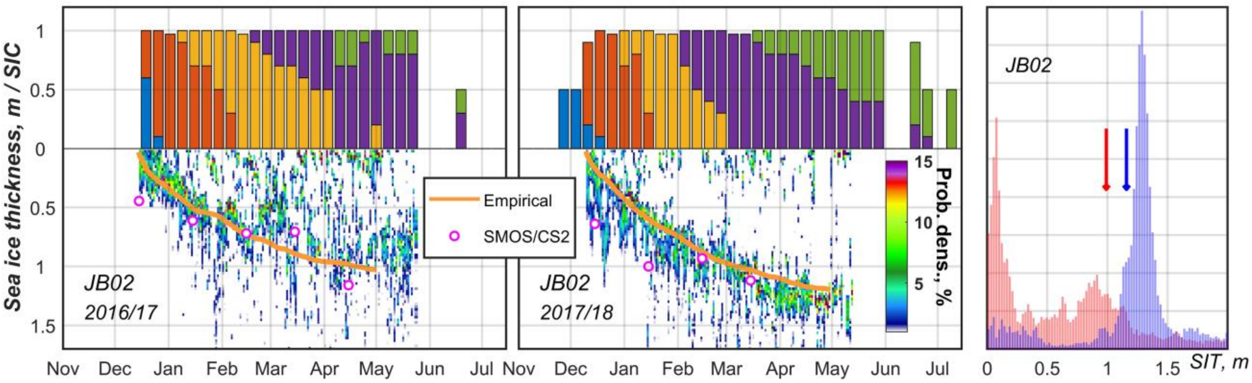
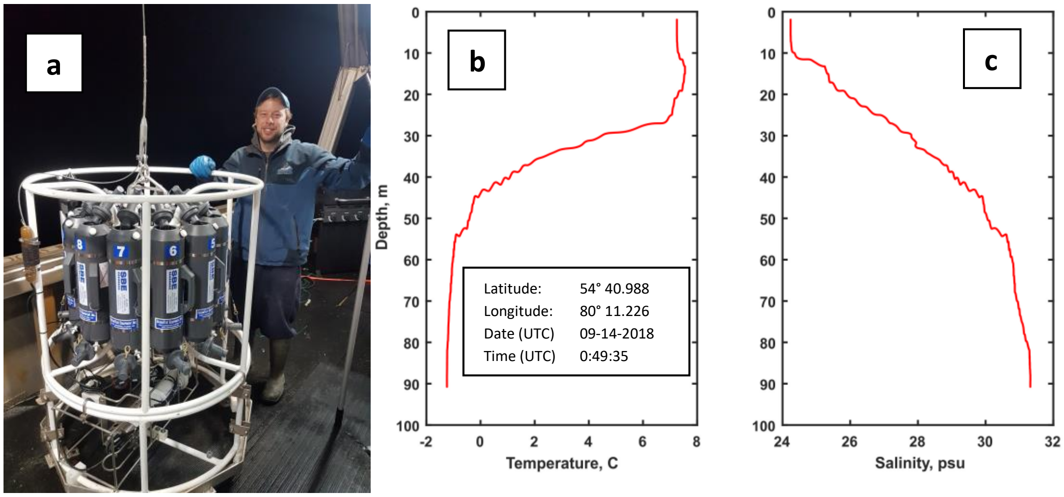


Figure 6. Evolution of sea ice thicknes (SIT) recorded by upward-looking Nortek ADCP and ice types at JB02-16 during winters 2017 and 2018. The measured SITs are shown as a percent occurrence, and those maxima (from green to red colours) correspond to the peak probability of daily SIT at 2-cm bin spacing. The monthly mean CS2/SMOS data are presented as magenta circles at the center of every month. Daily mean SIT estimated from empirical thermodynamic growth is shown with an orange line. CIS data on the partial concentration of different types of sea ice are shown with colour bars (new < 10 cm, young < 10–30 cm, FYI thin 30–70 cm, FYI medium 70–120 cm, and FYI thick > 120 cm). The availability of OSI-405-c ice drift data is shown with pink horizontal bars at the top of the figure. The normalized frequency distributions of measured SIT at 2-cm bin spacing in April 2017 and 2018 are shown in the right panels together with arrows indicating the April-averaged empirical SITs (Kirillov et al., 2020).

3. CTD Sampling

For the hydrological measurements, we used the ship's CTD-rosette fitted with twelve 5L Niskin bottles and Seabird CTD (Figure 7a). Sensors on the CTD allowed it to take profiles of water temperature and salinity (Figure 7b and 7c) at JB02-16 mooring location and additionally chlorophyll fluorescence, photosynthesis-active radiation (PAR) and dissolved oxygen concentration.



a) CTD Rosette onboard R/V William Kennedy, b) Temperature and c) salinity profiles collected at the mooring location.

4. Water Sampling

The water samples were collected using CTD rosette at the mooring location. Initial plan included water sampling for CDOM, O18, NO^3, NO^2, Si, PO^4 at the multiple sites along the ship's track en route to the mooring location (Figure 2), but it was cancelled due to the weather/logistics issues. The results of the water sampling from the mooring location are not yet available.

5. Acknowledgements

The BaySys teams would like to thank the Arctic Research Foundation for their extraordinary collaboration to make this happen and the Captain David McIsaac (Captain), First Mate Daniel McIsaac and crew of the R/V William Kennedy for their commitment to this field project and ensuring safe deployment and recovery of the mooring. We would like to acknowledge Manitoba Hydro for their extensive logistical and in-kind support to this field program. Lastly, we are grateful to the Natural Sciences and Engineering Research Council of Canada (NSERC).

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