BERING STRAIT NORSEMAN II 2024 MOORING CRUISE REPORT

Research Vessel Norseman II, Norseman Maritime Charters_*Nome-Nome, 8th-18th September 2024*

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Laramie Jensen, Randi Bundy, (UW)
Isotope Sampling:
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Phytoplankton sampling: Monica Orellana (UW)

Research vessel Norseman II during 2019 Nome on-load [Credit: Woodgate].

As part of the Bering Strait project funded by NSF-AON (Arctic Observing Network), in September 2024 a team of US scientists undertook a ~11 day cruise in the Bering Strait and southern Chukchi Sea region on the US vessel Norseman II, operated by Support Vessels of Alaska, Inc..

The primary goals/activities of the expedition were:

1) **recovery of 3 moorings** carrying physical and biogeochemical oceanographic instrumentation (Woodgate & Peralta Ferriz) and whale acoustic instrumentation (Stafford). These moorings were deployed in the Bering Strait region in 2023 from the Norseman II.

2) **deployment of 3 moorings** in the Bering Strait region, carrying physical and biogeochemical oceanographic instrumentation (Woodgate & Peralta Ferriz) and whale acoustic instrumentation (Stafford).

3) a set of **CTD sections** studying water properties in the region, with some **sampling for nutrients and salinities** (Woodgate & Peralta-Ferriz),

4) collection of **trace metal/nutrient water samples** using a pumped system at selected CTD casts (Jensen)

5) collection of accompanying ship's **underway data**, viz. surface water temperature and salinity, ADCP velocity data and meteorological data (Woodgate & Peralta-Ferriz),

6) taking of water samples to characterize **Hafnium, Neodymium, Iodine-129 and Uranium-236 isotopes** (Payne and Casacuberta),

7) taking of opportunistic samples for delta-O18, to characterize freshwater sources (Jensen, Woodgate & Peralta-Ferriz); and

8) taking of opportunistic and exploratory samples for **phytoplankton studies** (Orellana).

The cruise loaded and offloaded gear and people in Nome, Alaska.

Key Statistics:

3 moorings recovered, 3 moorings deployed,
153 CTD casts on 7 CTD lines, with 195 nutrient samples, 6 salinity samples and 9 delta-O18 samples
trace metal/nutrient water samples taken on 42 stations, with a further 18 delta-O18 samples
15 samples for Iodine-129 and Uranium-236; 5 samples for hafnium and neodymium
10 samples for phytoplankton identification and 45 samples for phytoplankton quantification

SCIENCE BACKGROUND

The ~50m deep, ~ 85km wide Bering Strait is the only oceanic gateway between the Pacific and the Arctic oceans.

The oceanic fluxes of volume, heat, freshwater, nutrients and plankton through the Bering Strait are critical to the water properties of the Chukchi [*Woodgate et al.*, 2005a]; act as a trigger of sea-ice melt in the western Arctic [*Woodgate et al.*, 2010]; provide a subsurface source of heat to the Arctic in winter, possibly thinning sea-ice over about half of the Arctic Ocean [*Shimada et al.*, 2006; *Woodgate et al.*, 2010]; are ~ 1/3rd of the freshwater input to the Arctic [*Aagaard and Carmack*, 1989; *Woodgate and Aagaard*, 2005]; and are a major source of nutrients for ecosystems in the Arctic Ocean and the Canadian Archipelago [*Walsh et al.*, 1989]. In modeling studies, changes in the Bering Strait throughflow also influence the Atlantic Meridional Overturning Circulation [*Wadley and Bigg*, 2002] and thus world climate [*De Boer and Nof*, 2004].

Quantification of these fluxes (which all vary significantly seasonally and interannually) is critical to understanding the physics, chemistry and ecosystems of the Chukchi Sea and western Arctic, including sea-ice retreat timing and patterns, and possibly sea-ice thickness. The Bering Strait oceanic heat flux has been found to be the best predictor of Chukchi sea ice retreat [*Serreze et al.*, 2016]. Understanding the processes setting these fluxes is vital to prediction of future change in this region, in the Arctic, and beyond. The Bering Strait is the only Arctic gateway where observations currently show significant interannual change [*Østerhus et al.*, 2019].

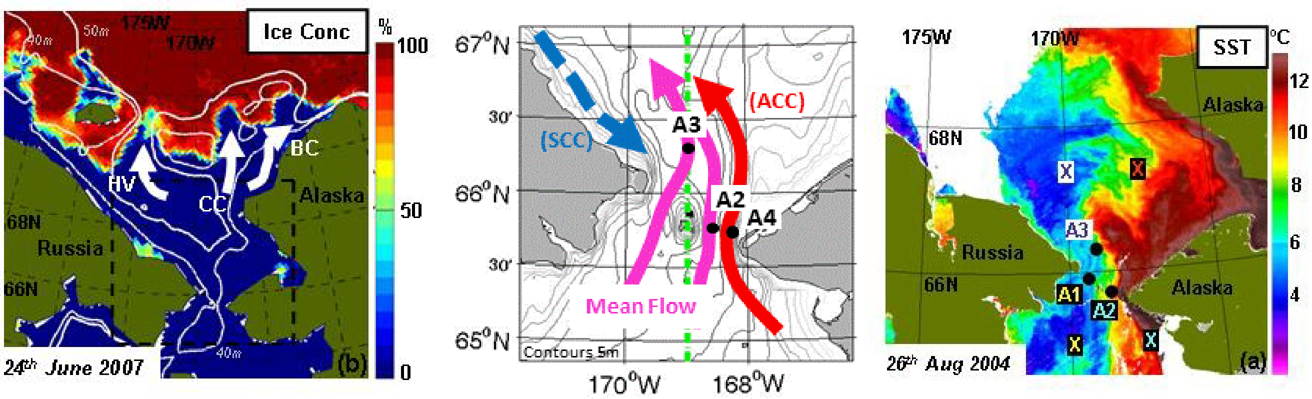


Figure 1: (Left) *Chukchi Sea ice concentration (AMSR-E) with schematic topography. White arrows mark three main water pathways melting back the ice edge [Woodgate et al., 2010].*
(Middle) *Detail of the Bering Strait, with schematic flows and mooring locations (black dots – A2, A3, A4). The main northward flow passes through both channels (magenta arrows). Topography diverts the western channel flow eastward near site A3. The warm, fresh Alaskan Coastal Current (ACC) (red arrow) is present seasonally in the east. The cold, fresh Siberian Coastal Current (SCC) (blue dashed arrow) is present in some years seasonally in the west. Green dashed line at 168º58.7'W marks the US-Russian EEZ (Exclusive Economic Zone) boundary. Note all moorings are in the US EEZ. Depth contours are from IBCAO [Jakobsson et al., 2000]. The Diomede Islands are in the center of the strait, shown here as small black dots on the green dashed line marking the US-Russian boundary.*
(Right) *Sea Surface Temperature (SST) MODIS/Aqua level 1 image from 26th August 2004 (courtesy of Ocean Color Data Processing Archive, NASA/Goddard Space Flight Center). White areas indicate clouds. Note the dominance of the warm ACC along the Alaskan Coast, and the suggestion of a cold SCC-like current along the Russian coast [Woodgate et al., 2006].*

Since 1990, year-round moorings have been maintained almost continually year-round in the Bering Strait region, supported by typically annual servicing and hydrographic cruises [*Woodgate et al.*, 2015; *Woodgate*, 2018]. These data have allowed us to quantify seasonal and interannual change [*Woodgate et al.*, 2005b; *Woodgate et al.*, 2006; *Woodgate et al.*, 2010; *Woodgate et al.*, 2012; *Woodgate*, 2018; *Woodgate and Peralta-Ferriz*, 2021], and assess the strong contribution of the Alaskan Coastal Current (ACC) to the fluxes through the strait [*Woodgate and Aagaard*, 2005; *Woodgate*, 2018]. These data also show that the Bering Strait throughflow increased ~50% from 2001 (~0.7Sv) to 2011 (~1.1Sv), driving heat and freshwater flux increases

[*Woodgate et al.*, 2012], with more recent fluxes also being high (e.g., 2014, 1.2Sv, [*Woodgate*, 2018; *Woodgate and Peralta-Ferriz*, 2021], see Figure 2).

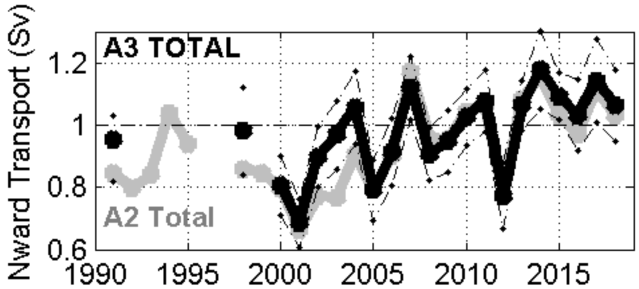


Figure 2: *Annual mean (x-axis, time in years) of Bering Strait mooring data from 1991 to 2018, showing transport for the whole strait, as estimated from A2 (grey) or A3 (black).*

Analysis [*Woodgate*, 2018] indicates this long term trend is driven by large scale changes between the Pacific and the Arctic oceans, with no significant trends in the winds in the strait. Thus, satellite-sensed data sets (winds, SST) prove insufficient for quantifying long-term variability, indicating interannual change can still only be assessed by in situ year-round measurements [*Woodgate et al.*, 2012]. The work to be accomplished on this cruise will extend this mooring time-series to mid-2023.

In addition, this cruise aims to provide a high resolution survey of the water properties of the strait and southern Chukchi Sea in early-summer. A particular goal is to quantify the early season heat and salt content of the waters, which have been unusually warm and fresh in the last 4 years (see Figure 3).

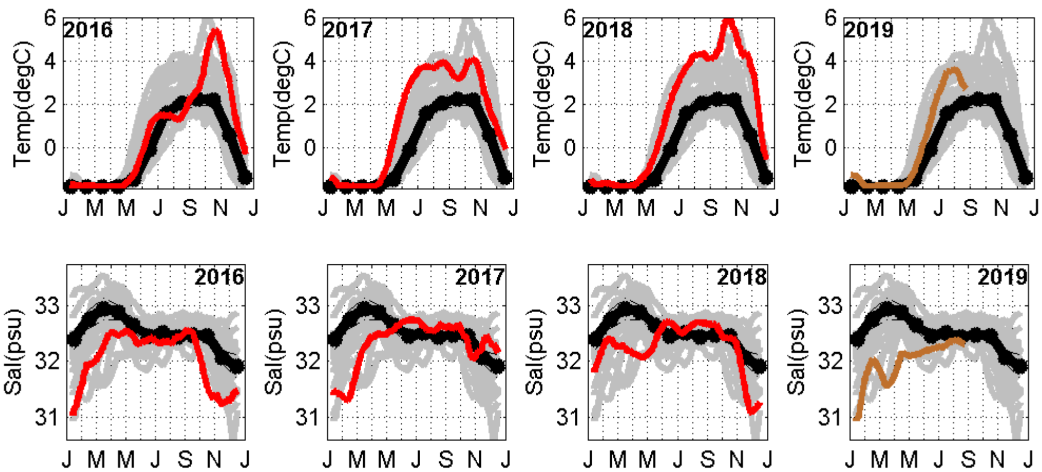


Figure 3: *30 day smoothed near-bottom A3 temperature* ***(top)*** *and salinity* ***(bottom)****, data for recent years* ***(columns)****, showing labeled year in color, climatology [Woodgate et al., 2005b] in black, and all prior years (1990-present) in grey. X-axis labels show month (J=January, etc.), [Woodgate and Peralta-Ferriz, 2021].*

The winter freshenings observed are particularly remarkable and suggest Pacific waters are entering the Arctic 50m shallower than before, and no longer refreshing the cold layer which historically protected the sea ice from warmer Atlantic waters below. The impacts of this on Arctic climate are currently unclear.

In a new addition to the project last year, we will also recover the first year-round biogeochemical measurements on the moorings, particularly to quantify the flux of oceanic nutrients through the strait. This effort will be supported by water sampling for nutrients during the cruise, to gain an understanding of the spatial variability of oceanic nutrients in the region. In addition to physical oceanographic goals, our work also supports long term marine mammal acoustic monitoring in the Strait (PI: Stafford).

International links: Maintaining the time-series measurements in Bering is important to several national and international programs, e.g., the Arctic Observing Network (AON), started as part of the International Polar Year (IPY) effort in 2007; various NSF, ONR and NPRB projects and missions in the region. For several years, the work was part of the RUSALCA (Russian-US Long Term Census of the Arctic). Some of the CTD lines are part of the international Distributed Biological Observatory (DBO) effort. The mooring work also supports regional studies in the area, by providing key boundary conditions for the Chukchi Shelf/Beaufort Sea region (a current focus on ONR Arctic programs); a measure of integrated change in the Bering Sea, and an indicator of the role of Pacific Waters in the Arctic Ocean.

2024 CRUISE SUMMARY (all times local = GMT-8):

The 2024 cruise took place in September, to allow hydrographic sections to be obtained from the end of the summer season.

The science team flew commercial to Nome on **Friday 6th September 2024**, and on **Saturday 7th September** accessed our container of equipment to complete instrument checks and start-ups. The Norseman 2 arrived in Nome on Saturday am. With the forecast being poor, they suggested we on-load early, on Saturday rather than Sunday as planned. On-load started Saturday afternoon and the heavy gear was successfully transferred before the weather degenerated to the stage the ship had to leave the dock. The rest of the gear was onloaded by small boat that evening, with the science team bringing loads to the small boat harbor, and the ship's small boat taking boat loads out the N2 standing by in the middle of the main habor. Turning the ship beam to the weather allowed shelter for onloading gear from the small boat by hand to the starboard deck of the ship.

Early (7am) on **Sunday 8th September**, the ship came again to dock, and all personnel and personal gear were safely onloaded, and we sailed from Nome 810am, headed for Port Clarence to sit out the storm and do cruise set up. Due to bad weather, most of **Monday 9th Sept** was sheltering (at anchor) in Port Clarence and setting up gear. This allowed us to identify and mitigate for issues with the underway ADCP set up (see below). Early afternoon (1:30pm), we started towards the strait, using the transit to do CTD test casts and train in tag line recoveries. The ship ran ADCP lines, along SBS and BS, and from the Diomedes through A2 and A4 (locating mooring A4 on the echosounder) until early **Tuesday 10th Sept**, when we arrived at A2 shortly before light. After a CTD calibration cast, we successfully ranged on mooring A2-23, but at sun-up, conditions were too foggy to attempt release, so we steamed instead to A4, completed the CTD calibration cast and a preliminary ranging, and then waited for better visibility. Around 1030am, we recommenced mooring operations. Although ranging was successful, releasing was not and the **mooring A4-23** had to be recovered by dragging by 1206pm. Back at A2, around 2pm, similarly ranging was successful, but releasing was not, and **mooring A2-23** also had to be dragged, with the mooring being sighted at 235pm. We then **deployed A2-24** (by 630pm), took the CTD calibration cast, returned to A4, **deployed A4-24** (by 840pm) and completed the CTD calibration cast. Overnight, we steamed ADCP lines, from A4 to the eastern edge of the strait (at 65 44.1N, 168 8.6W), back via A2 to BS11, then northeast to NBS10, and then to A3.

On **Wednesday 11th Sept**, after the CTD calibration cast before light, again we had to wait for fog, before commencing mooring operations at 8:50am. Yet again, while ranging was successful, release was not, and again the **mooring A3-23** had to be dragged, and was sighted at 1015am. We rigged and **deployed A3-24** (by around 3pm) and commenced **CTDing line AL** (including the calibration cast) towards the north east.

On **Thursday 12th September**, after completing the AL line around 1am, we steamed north west towards CS10, but encountered sea ice around 630am. This proved to be a tongue of mucky ice, likely from the East Siberian Sea, brought south by the storm and then advected eastward into the eastern Chukchi. As we worked our way through loose pack (1-3 tenths), we encountered the tourist ship the Sylvia Earle, several whales (including at least one bowhead) and possibly some walrus. Around 1pm, deciding it might not be possible to reach CS10, we started a **new CTD line (SCS),** about 10nm south of CS, working towards Pt Hope, with much larger station spacing reflecting the delays of working in the ice. This route brought us out of the ice at about 4:30pm (at 67 47.2N 168 8.0W). We completed the SCS line around 2am on **Friday 13th September** (with northern lights), but with the ice and weather forecast, instead of moving further north, we headed south back toward the BS11 (avoiding ice), commencing **CTDing the BS line** from the Diomedes towards Wales around 10pm, skipping a few high resolution stations in the middle to ensure we could complete the line.

Completing the BS line around 730am on **Saturday 14th September**, we continued **CTDing the SBSnn line** towards the south west, encountering remarkably high nutrient water, which motivated us to extend the SBSnn line towards the southwest, and **CTD a new parallel line (BC)** to the east of the SBS line to track the nutrient rich water along the Alaskan Coast. Throughout this work, winds and seas continued to rise, and by completion of the BC line (around 10pm), conditions had deteriorated enough that we again moved east to a sheltered anchorage off York Mountains, where we remained through **Sunday 15th September**. Early (~530am) on **Monday 16th September**, we raised anchor and headed back towards the strait. While weather was still too bad to CTD, we ran repeat ADCP lines west along the BS line, back east along the BS line, and back west again to BS11, noting that under these strong southward winds, the ACC had been drawn out into the strait. Back near the Diomedes by late evening, the weather was improving but still too rough, so we undertook another ADCP survey of the eddy region behind the islands, before returning to BS11 and, at around 2:30am on **Tuesday 17th September**, starting **CTDing the BS line**, under bright moonlight. We completed the BS line around 10am, and continued **CTDing the SBSnn line** again, skipping stations toward the end to ensure we could complete the line before weather forced us to cease operations around 4pm and turn for Nome.

We arrived in Nome harbor around 620am on **Wednesday 18th September**, and were able to tie up. Offload was completed by noon, and the science party left the ship by 4pm for the airport and travel home.

Summary of CTD lines.

AL *(A3 Line)* (US portion) – another previously-run line (previously run at ~ 1.7nm resolution, run this cruise once at 0.85nm resolution), just north of the Strait, running from the Russian coast, through the mooring site A3, to where the main channel of the strait shallows on the eastern (US) side. US portion only run here**. Run with trace metal/nutrient sampling, and CTD nutrient sampling.**

SCS (to Point Hope). A new line, started 10nmSE of CS10 of the CS line, running towards Point Hope, run at low resolution (~9nm) due to ice and time constraints, although with higher resolution (4-2.5nm) near the coast. This year, replaced the CS line which was inaccessible in 2024 due to ice.

BS *(Bering Strait)* (US portion) – the main Bering Strait line, run at the middle and the end of the cruise (under very different wind conditions). This line has been occupied by past Bering Strait mooring cruises. US portion only run here. This line was previously ~ 2nm resolution. On the first running of this section, we mostly used the more recent station spacing of ~1nm to better resolve the structure in the strait, although due to weather concerns, a few high resolution stations towards the center were skipped. Previous runnings of this line have included two stations (BS23 and BS24) which fall south of the main line near Prince of Wales, extending the line along (rather than across) isobaths. Neither BS23 and BS24 were taken during this cruise**. CTD nutrient samples were taken only on the first running of this line in 2024. Pumped samples for trace metals/nutrients were taken on both runnings of this line in 2024.**

SBSnn – a previous line new in 2014, run only in 2014, 2015, 2017 and 2019, and then often only in part, just south of the strait, crossing the Alaskan Coastal Current before it enters the strait proper (previously and this year run at 2.2nm resolution, run in 2019 at 1.1nm resolution). Later years run with the same alignment (i.e. from BS22 as used since 2019, and thus denoted SBSnn. (Previous SBS line started at BS24). First running in 2024 at lower resolution (~2.3nm) due to time/weather constraints. Extended by ~5.8nm to chart high nutrient water encountered.

BC (Baituk Creek) – a new line in 2024, run roughly parallel to SBSnn but ~9nm to the east, to chart high nutrient content water encountered in 2024. Run here at~1.2nm resolution. Note region of strong flow around BC2.

Re-run of BS line with trace metal/nutrient sampling (but not CTD nutrients)

Re-run of SBSnn line with CTD only.

Summary of ADCP/Underway data lines

The ship's ADCP recorded for the duration of the cruise, and between lines steams were often positioned to give more useful underway information. The following were targeted underway surveys:

At start of cruise, SBSnn towards Wales, BS towards Diomedes, from BS11 past A2 and A4, then back to A2.

After A4-24 deployment, east to shallow waters (65 44.1N, 168 8.6W), then back to A2 and BS11, then NE across the strait to NBS10, and NW back across the strait to A3.

Before final running of BS line, three crossings (westward, eastward, westward) of the BS line; and 2 N-S sections along DL and DLa lines.

See maps for details of these lines.

Prior lines not taken on this cruise:

DLS and DLN *(Diomede Line)* (previously one line DL) – two consecutive lines running north from the Diomede Islands to A3, the southern portion DLS (stations DL1-12) at 1nm spacing, the northern portion DLN (stations DL13-A3) was previously run at 2.5nm spacing, but on this cruise a station spacing of 1.25nm was used. Run both at the start and end of the cruise, although the second running is complete due to bad weather. These lines study the hypothesized eddying and mixing region north of the islands.

CS *(Cape Serdtse)* (US portion) – another cross strait line (~ 3.9nm resolution), run here from the US-Russian convention line (~168° 58.7'W) to Point Hope (US), but originally starting at Cape Serdtse-Kamen, in Russian waters. Also repeated during the cruise, both runnings adding stations to make station spacing ~1.9nm. First running done with trace metal/nutrient sampling in 2021. Not run in 2022.

NPH *(North Point Hope)* (US waters) - a line run before in 2016, and 2019, crossing from north of Point Hope to the WNW, at 1.25nm spacing near the coast, and 2.5nm spacing after NPH5, to chart the Alaskan Coastal Current transformation on its route along the Alaskan Coast. Extended in 2019 to the Convention Line (CCL). Run twice this cruise. First running westward only to station NPH13, second running (eastward) of complete line from CCL. Not run in 2022.

CD *(Cape Dyer)* (US waters) - a line new in 2016, taken also in 2017 and 2019, running west-east towards the Alaskan Coast, midway between Point Hope and Cape Lisburne, set just south of some apparent topographic irregularities, also to chart the Alaskan Coastal Current transformation on its route along the Alaskan Coast. Extended in 2019 to the Convention Line, but run in 2021 only from CD 14 to the coast. Not run in 2022.

LIS *(Cape Lisburne)* (US waters) – from Cape Lisburne towards the WNW, a previous RUSALCA line, run by us also in 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018 and 2019 and close to the CP line occupied in previous Bering Strait cruises in 2003 and 2004 (station spacing ~ 3.6nm). Note that due to the Quintillion cable, station Lis 9 is replaced by 2 new neighboring stations, Lis 8.5 and 9.5 . Run once during the 2021 cruise. Run with trace metal/nutrient sampling in 2021. Not run in 2022.

DLa and DLb – two other high resolution lines (1nm resolution), mapping the eddying/mixing region, parallel to DLS, allowing for a 2-dimensional mapping of the region.

AS – a line sampled only once before (2011) (although sometimes run for underway data), running from the eastern end of AL back towards the western end of the CS line, taken at variously 4nm or 2nm spacing (closer stations over steeper topography).

NNBS *(North North Bering Strait)* – a new line run only three times before (2015, 2017, 2019) west-east across the eastern strait, south of A3 and north of NBS, run at ~ 1.8nm resolution, to better map the Alaskan Coastal Current north of the Strait proper.

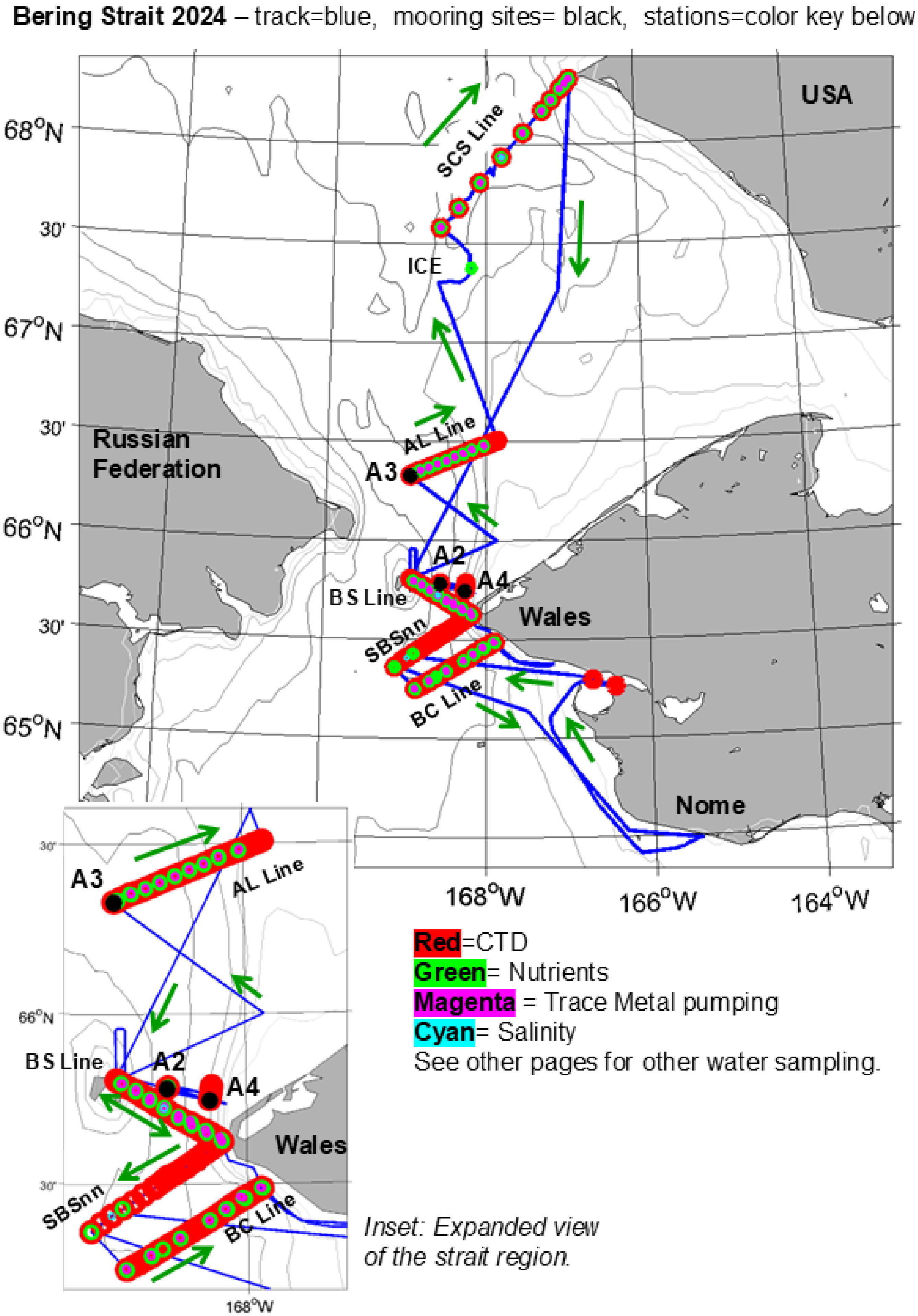
NBS *(North Bering Strait)* – an east-west cross-strait line ~ 8nm north of the Bering Strait line, run in previous years, with ~ 1.7nm resolution.

MBS *(Mid Bering Strait)* – an east-west cross-strait line ~ 10nm north of the Bering Strait line, run in previous years, with ~ 1.7nm resolution, with higher resolution near the coast

Parts of **CCL *(Chukchi Convention Line)*** (US waters) – a line running down the convention line from the end of the LIS line towards the Diomedes (also run in 2003, 2004, 2011, 2012, 2013, 2014, 2015, 2016, 2017 and 2018, and in part in 2022), typically incorporating a rerun of the high resolution DL line at the southern end, run variously at 10nm (typical) or 5nm (rarely) resolution. Run only in parts in 2021. Run in part in 2023.

CONTENTS

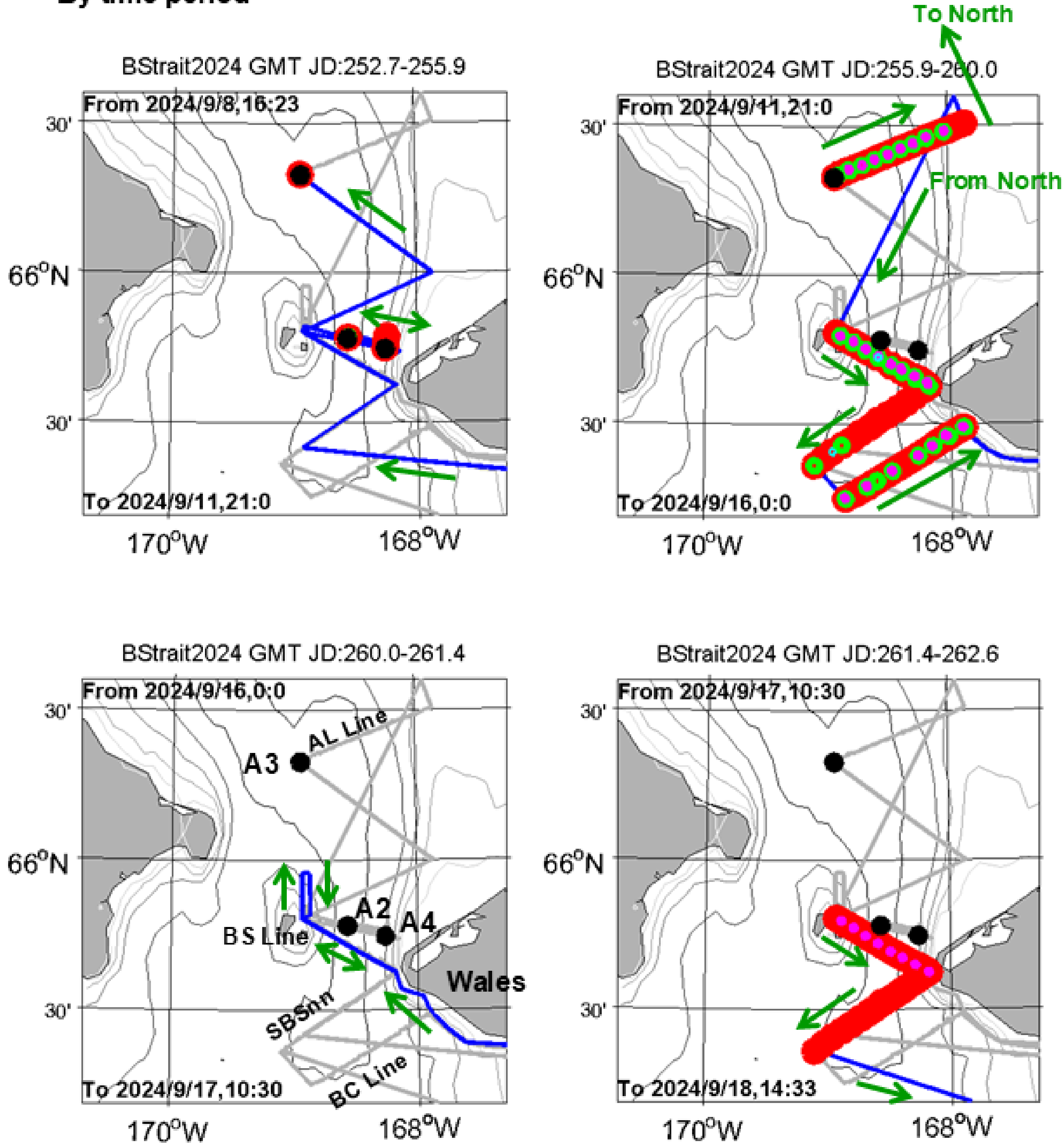
BERING STRAIT 2024 CRUISE MAPs: *Ship-track, blue. Mooring sites, black. CTD stations, red. Water samples color code as per key. Green arrows show direction of travel. Depth contours every 10m from IBCAO (International Bathymetric Chart of the Arctic Ocean [Jakobsson et al., 2000].*



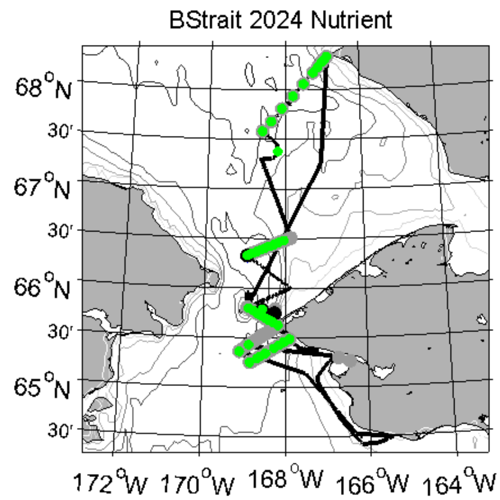
Inset: Expanded view of the strait region.

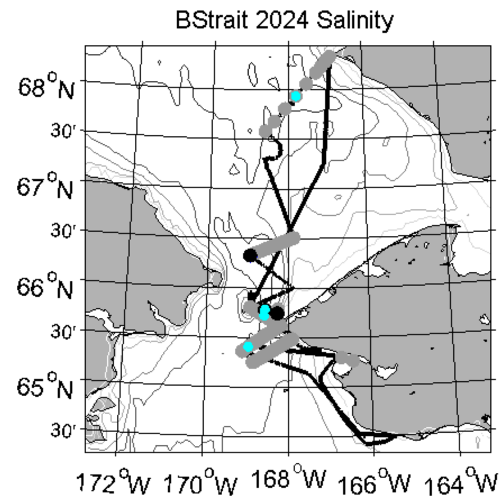
BERING STRAIT 2024 CRUISE MAPs: *Ship-track, blue. Mooring sites, black. CTD stations, red. Water samples color code as per key. Green arrows show direction of travel. Depth contours every 10m from IBCAO (International Bathymetric Chart of the Arctic Ocean [Jakobsson et al., 2000]. Split into panels for different periods of the cruise.*

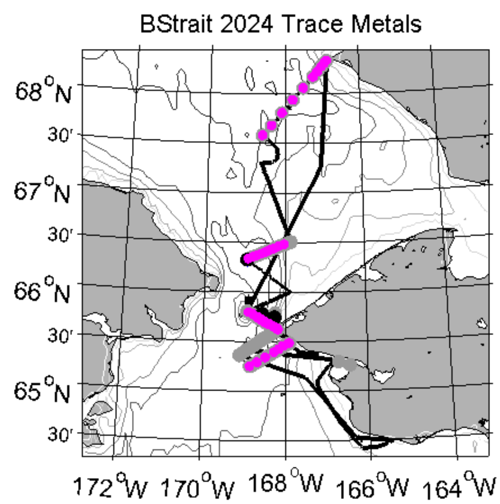
Bering Strait 2024 – track=blue, mooring sites= black, stations=color key above
By time period

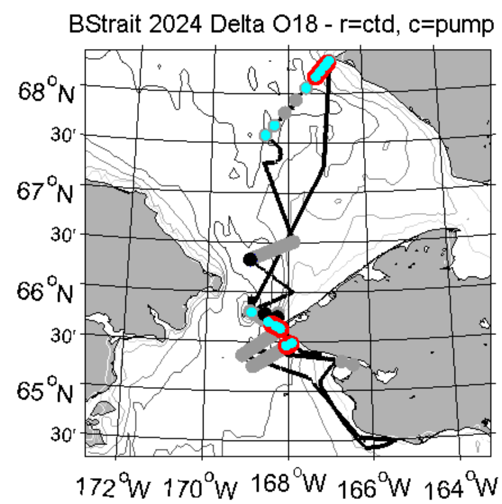


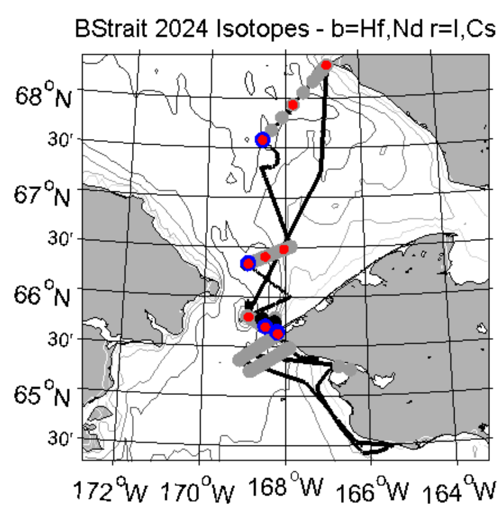
BERING STRAIT 2024 CRUISE MAPs: *Ship-track, black, showing different water sampling undertaken.*

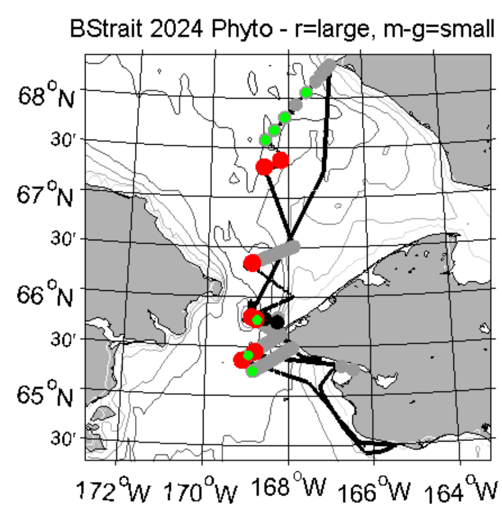




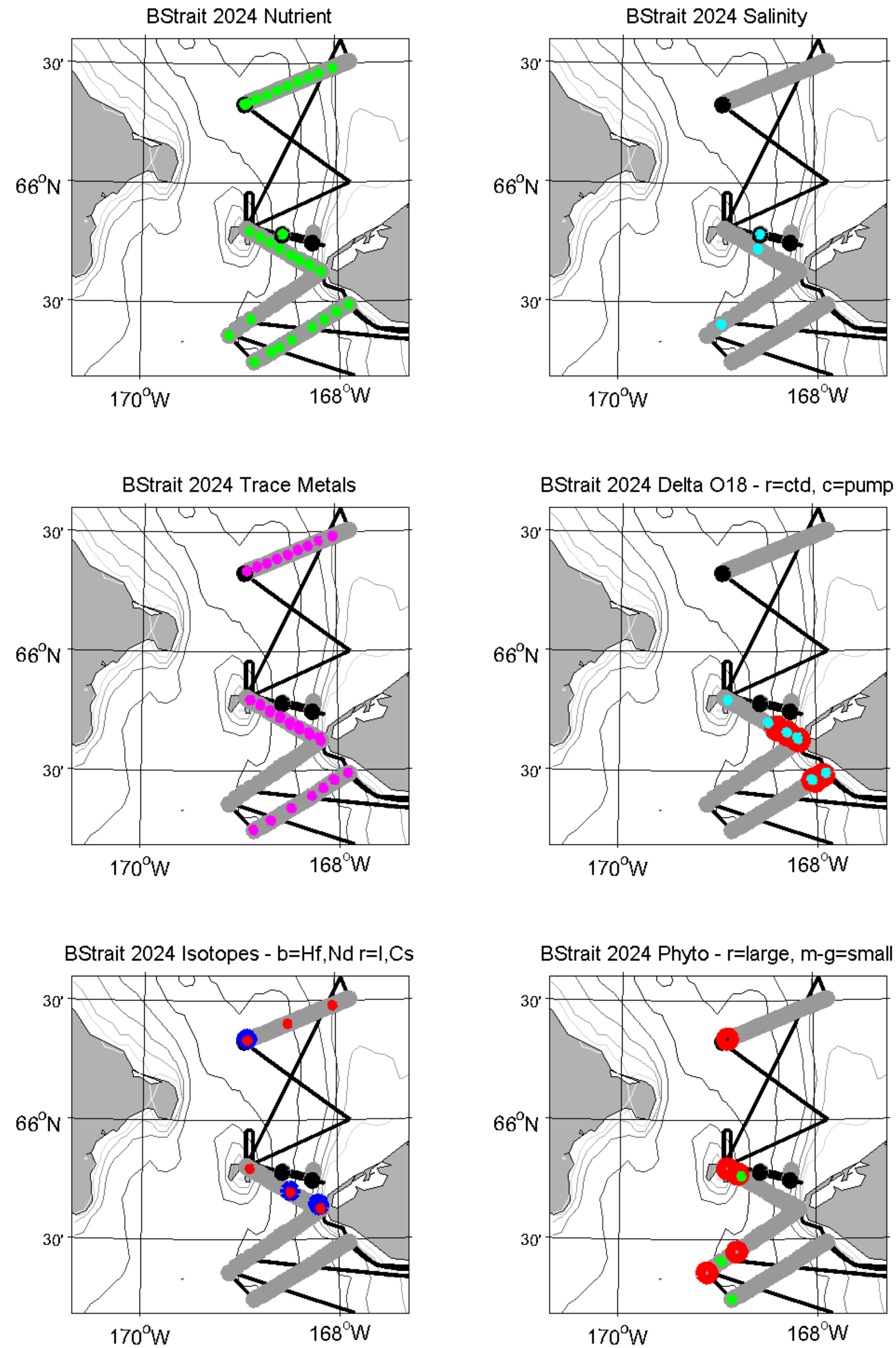




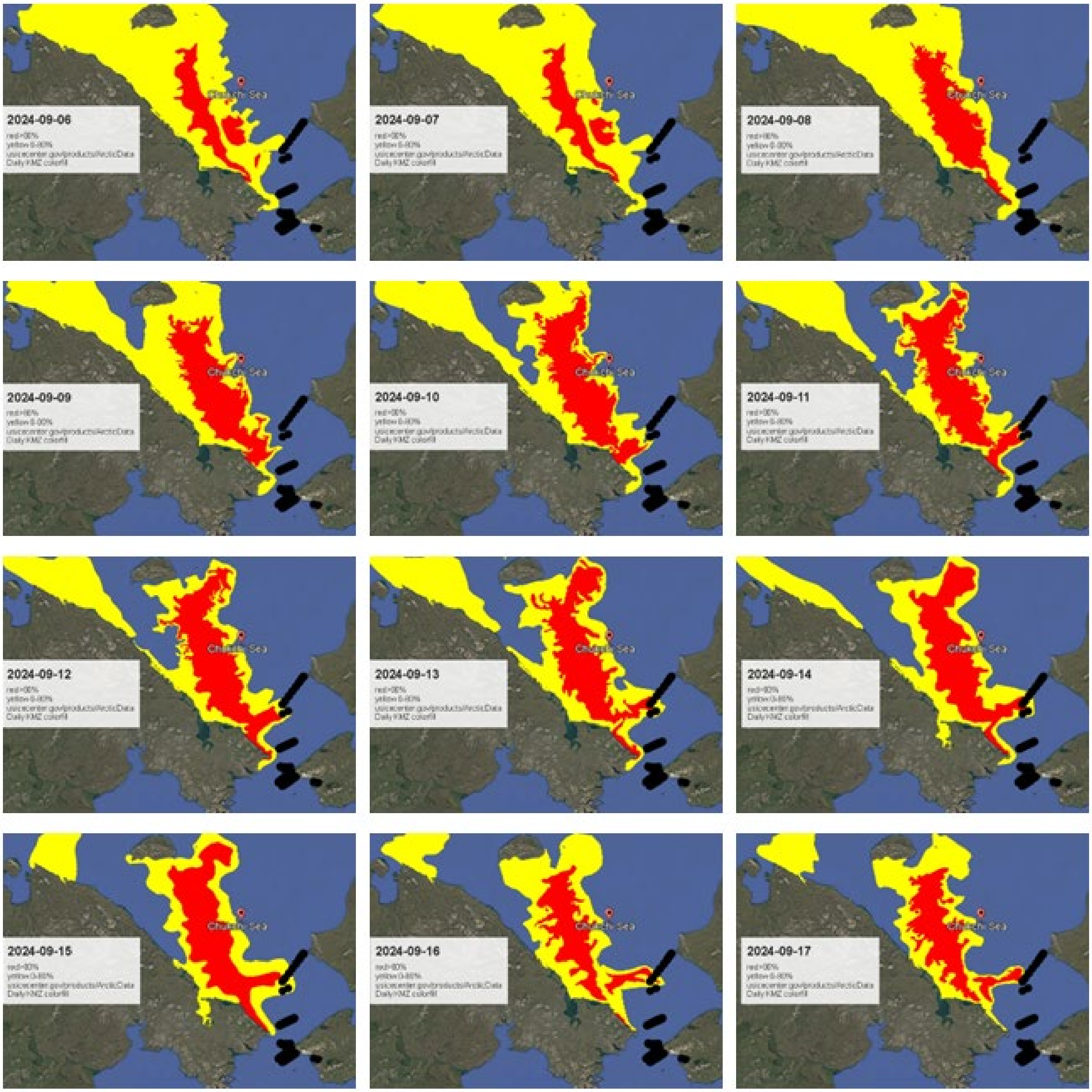




BERING STRAIT 2024 CRUISE MAPs: *Ship-track, black, showing different water sampling undertaken, zoomed in on the Bering Strait region.*



BERING STRAIT 2024 CRUISE SEA ICE CHARTS: *Google Earth composites of US Ice Center daily sea ice concentrations showing cruise CTD positions (black dot), with red and yellow showinc ice concentrations >80% and between 0 and 80% respectively. Data are kmz shape files from usicecenter.gov/Products/ArcticData*



BERING STRAIT 2024 SCIENCE PARTICIPANTS

1.	Rebecca Woodgate	UW	*Chief Scientist and UW PI*
2.	Cecilia Peralta-Ferriz	UW	*Co-Chief Scientist and UW Co-PI*
3.	Laramie Jensen (F)	UW	*UW postdoc & lead of trace metal/nutrient sampling*
4.	Katy Christensen (F)	UW	*UW graduate student & co-lead of CTD measurements*
5.	Robert Daniels (M)	UW	*UW mooring technician and cruise technical lead*
6.	Katie Kohlman (F)	UW	*UW graduate student*
7.	Annabel (Bella) Payne (F)	ETH	*ETH graduate student, lead of isotope water sampling*

UW – University of Washington, US
ETH – ETH Zürich, Switzerland

Cabin Allocations:

Main deck (Cabin 4) -	Robert
Lower deck, port aft (Cabin 8) -	Rebecca & Cecilia
Lower deck, starboard aft (Cabin 7) -	Laramie & Annabel
Lower deck, starboard forward (Cabin 5) -	Katy & Katie

BERING STRAIT 2024 NORSEMAN II CREW

1.	Mike Hastings (M)	SVA	*Master*
2.	Mike Leifeste (M)	SVA	*Mate*
3.	Jim Wells (M)	SVA	*Chief Engineer & Bosun*
4.	Casey Coates (M)	SVA	*Eng/Captain/Deck*
5.	Lars Nelson (M)	SVA	*Chef*
6.	Dakota Moonin (M)	SVA	*AB*
7.	Kerry Khur. (M)	SVA	*AB*
8.	Caleb Diaz (M)	SVA	*AB*

SVA – Support Vessels of Alaska, Inc. , https://www.supportvesselsofalaska.com

Ship contract arranged by:

CPS Polar Field Services, partner of Battelle ARO
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MOORING OPERATIONS (Woodgate/Daniels, assisted by others)

Background: The moorings serviced on this cruise are part of a multi-year time-series (started in 1990) of measurements of the flow through the Bering Strait. This flow acts as a drain for the Bering Sea shelf, dominates the Chukchi Sea, influences the Arctic Ocean, and can be traced across the Arctic Ocean to the Fram Strait and beyond. The long-term monitoring of the inflow into the Arctic Ocean via the Bering Strait is important for understanding climatic change both locally and in the Arctic. Data from 2001 to 2018 suggest that heat and freshwater fluxes are increasing through the strait [*Woodgate et al.*, 2006; *Woodgate et al.*, 2010; *Woodgate et al.*, 2012; *Woodgate et al.*, 2015; *Woodgate*, 2018; *Woodgate and Peralta-Ferriz*, 2021], with 2012 being a year of low flow, but 2013 to 2016 returning to higher flow conditions [*Woodgate*, 2015; *Woodgate et al.*, 2015; *Woodgate*, 2018]. The data recovered this cruise will indicate if recent years show further increase or a return to older conditions.

An overview of the Bering Strait mooring work (including data access) is available at http://psc.apl.washington.edu/BeringStrait.html. Data are also permanently archived at the National Oceanographic Data Center, now renamed the National Centers for Environmental Information (https://www.nodc.noaa.gov/ or https://ncei.noaa.gov).

A map of mooring stations is given above. Three UW moorings were recovered on this cruise. These moorings (all in US waters –A2-23, A4-23, and A3-23) were deployed from the Norseman II in July 2023, with mooring funding from NSF-AON (PIs: Woodgate and Peralta-Ferriz, *PLR2153942*).

Three UW moorings (A3-24, A2-24, A4-24) were deployed on this 2024 Norseman II cruise under funding from NSF-AON (PIs: Woodgate and Peralta-Ferriz, *PLR2153942*). All these deployments were replacements of recovered moorings at sites occupied since at least 2001 (A4) or 1990 (A2 and A3). Analysis of past data suggests data from these three moorings are sufficient to give reasonable estimates of the physical fluxes of volume, heat and freshwater through the strait, as well as a useful measure of the spread of water properties (temperature and salinity) in the whole strait [*Woodgate et al.*, 2015].

All moorings (recovered and deployed) carried upward-looking ADCPs (measuring water velocity in 2m bins up to the surface, ice motion, and medium quality ice-thickness); lower-level temperature-salinity sensors; and iscats (upper level temperature-salinity-pressure sensors in a trawl resistant housing designed to survive impact by ice keels). Both the recovered and deployed A3 moorings also carried marine mammal acoustic recorders. The A3-22 mooring also carried, instead of an iscat, the "Miscat", a multiple instrument version of the iscat, designed to allow instruments to be lost sequentially from nearer the surface. For a full instrument listing, see the table below.

Our most recent NSF grant supports also biogeochemical measurements on the moorings. Thus A2 and A3 (recovered and deployed) carried also SUNA optical nitrate sensors, SBE37-ODO optical sensors for dissolved oxygen and WETLABS FLNTUSB optical sensors for fluorescence and turbidity. An additional WETLABS FLNTUSB sensor was also deployed on A4 (recovered and deployed).

This coverage should allow us to assess year-round stratification in and fluxes through the strait, including the contribution of the Alaskan Coastal Current, a warm, fresh current present seasonally in the eastern channel, and known to be a major part of the heat and freshwater fluxes [*Woodgate and Aagaard*, 2005; *Woodgate et al.*, 2006; *Woodgate et al.*, 2015; *Woodgate*, 2018]. The ADCPs (which give an estimate of ice thickness and ice motion) allow the quantification of the movement of ice through the strait [*Travers*, 2012]. The marine mammal recording time-series measurements should advance our understanding of the biological systems in the region. The first year of biogeochemical sensors (2022-2023) showed winter time replenishments of nutrients [*Woodgate et al.*, submitted 2024], and we look forward to establishing the importance of interannual variability in key biological parameters.

Calibration Casts: Biofouling of instrumentation has been an on-going problem in the Bering Strait. Prior to each mooring recovery, a CTD cast was taken to allow for *in situ* comparison with mooring data. Similarly, CTD casts were taken at each mooring site immediately after deployment. These post-deployment casts will allow us to assess how effective this process is for pre-recovery calibration. Since the strait changes rapidly, and CTD casts are by necessity some 200m away from the mooring and may be as long as 1hr separated in time from the mooring reading, it is inevitable that there will be differences between the water measured by the cast and that measured by the mooring. **Action item: On recovery, check the post deployment casts to see how reliable the comparison is.**

This year (as in 2017, 2018, 2019, 2021, and 2022), an on-deck calibration tank was also used for recovered instruments. This is discussed below.

2024 Recoveries and Deployments:

Our standard procedure for mooring recoveries was the following:

First a pre-recovery CTD cast was taken starting at a safe (~200m) distance from the mooring position and drifting way. Next, for ranging, the ship positioned ~ 200m away from the mooring so as to drift towards the mooring site. Ranging was done from the port mid corner of the aft deck of the ship, with the hydrophone connecting to the deck box inside at the aft end of the port laboratory. **Action item: Re check position as regards to ship's propellers.** Once the ship had drifted over the mooring and the acoustic ranges had increased to >70m, the mooring was released**.** This procedure was followed to prevent the mooring being released too close (or underneath) the ship since in previous years the moorings have taken up to 15min to release. **Action item: Be sure to distinguish between slant and horizontal range during soundings.** As site A3 is ~0.6nm from the Russian border, prior to ranging on A3, the Norseman II's small boat was prepared for launching, to cover the eventuality that if the mooring had to be dragged, the mooring would surface and drift towards Russian waters before the ship was able to recover it. **Action item: Continue to prepare for small boat operations at site A3.**

On all moorings, we use double releases, with springs to assist the mooring release. For all moorings, our usual routine is to communicate and range with one release and then attempt to release the other release (to test both instruments).

Biofouling and other release issues have frequently resulted in the mooring release being unsuccessful. In these cases, dragging gear (around 6-8feet of weighted grapples, is attached to the ship's trawl wire. This is lowered to the sea floor and the trawl paid out as the ship drives a circle around the mooring position at a distance of ~100m (depending on the length of trawl wire used. Once this is laid, the ship steams slowly away, hauling in the trawl so as to catch the mooring with the retracting trawl. Our experience is that usually good pull on the mooring is sufficient to pull it free and typically the mooring surfaces before the trawl wire is recovered.

In all cases, once the mooring is on the surface, the ship repositions, bringing the mooring tightly down the starboard side of the ship. One boat hook and a pole with a quick releasing hook attached to a line are used to catch the mooring, typically on a pear link fastened to the chain between the float and the ADCP or on eyes welded to the float surface. The line from the hook is then passed back to through the stern A-frame, and tied with a "cat's paw" knot to a hook from the A-frame. This portion of the mooring is then elevated, allowing the second A-frame hook to be attached lower down the mooring chain, and tag lines to be attached if necessary. The iscat, if present, is recovered by hand at a convenient point in this operation, prior to recovery of most of the mooring. Then the entire mooring is then elevated, using both hooks from the aft A-frame, and recovered onto deck.

Recovery work is usually done by a deck team of 4 crew of the Norseman II – one on the A-frame controls, three on deck with on overhead safety lines ("dog runs") down each side of the deck (one of these working forward of the deck on tag lines), assisted by UW personnel further forward on the aft deck. Once on deck, the moorings are photographed to record biofouling and other issues.

Action items: Be sure to add pear-link to the chain between float and ADCP. Prepare loops of line for threading through chain/shackles to provide a lifting point. High A-frame or crane very helpful for recovery. Also helpful to review mooring movies at start of cruise. Bring extra tires for the recovered floats.

The A-frame of the Norseman II is atypically high (~ 26ft less block attachments). While this is extremely useful in fair weather, it allows for swinging of the load in rougher seas. **Action item: Continue to use tag line options for recovery in rougher weather.**

Good visibility (at least ~1nm) is required for mooring recoveries since the mooring may delay releasing due to biofouling, or the mooring may require dragging, as in previous years. Given the proximity of A3 to the US-Russian border, small boat operations may also be necessary during a dragging operation to prevent the surfaced mooring drifting out of US waters. For these reasons, it was decided typically not to commence a new mooring operation after 5pm local time. **Action item: Continue to include weather days in the cruise plan; plan also for small boat operations (including sending a battery powered release unit), considering especially if small boat operations could be used in fog. Assess causes of foggy conditions, in order to predict best strategy for finding workable visibility.**

In 2023, all three moorings were successfully recovered. All moorings were on position, but all moorings required dragging, and one release (16580 on A3-23) did not communicate at all, even on deck. **Action item: Investigate once shipment returned to Seattle**. Furthermore, it appears that A3 was dragged ~200m by the trawl before releasing from the anchor. Increasing problems with releases have caused us to significantly overhaul all our releases. We suspect successive years of biofouling has compromised sliding surfaces and possibly o-rings. Three of the 6 deployed releases have new release components (T-shafts, and latches) and rely on the 'ever-slick' anti-biofouling coating from the manufacturer. This year we will also trial a chain linkage between the double releases, in case the 'banana' design used to date is being in the currents. This seems less likely however, as the banana linkage was still present on the recovered releases, even though the release had been confirmed. The problem seems more likely either the T-shaft not turning properly or the latch not opening. Note also that two of the three moorings that were deployed Note that for several years, we have used springs on the latches to aid release. This year, for the first time, the two returned springs were highly rusted and extremely weak. **Action item: Investigate differences in springs to in prior years**.

Biofouling was moderately heavy on the 2023-2024 moorings, as expected from instrumentation deployed in July (pre/during the 2023 bloom) and recovered in the following September (post the 2024 bloom). ADCP heads were covered in barnacles, however, this should not affect the data quality. Salinity cells, the SUNA slot and the Wetlabs faceplates were clear of biofouling. Note that the latch end of the releases was also clear of biofouling, indicating that the release issues are not related to biofouling problems.

Mooring deployments were done through the aft A-frame, using the A-frame hooks for lifting. The height of the Norseman II A-frame was extremely advantageous for these deployments. Lacking such an A-frame, alternative ships might consider lifting the mooring with the crane, rather than the A-frame. The mooring was assembled completely within the A-frame. The ship positioned to steam slowly (~1 to 2knots) into the wind/current, starting between 500m and 600m from the mooring site. **Action item: This distance (greater distance in strong current) works well.** At the start of the deployment, the iscat was deployed by hand and allowed to stream behind the boat, which steamed at ~ 2knots, fast enough to maintain headway and to trail the mooring behind the ship, but not so fast as to damage the equipment being towed or pull equipment off the deck. **Action item: Feed the iscat tether unwound to the person spooling it off the deck.** The first pick (from one of the hooks of the aft A-frame) was positioned below the ADCP, except in the case of A4, where the first pick was below the top float. The second pick (from the other hook of the aft A-frame) was lower down on the mooring allowing all the mooring except the anchor to come off the deck during the lift. Then, the A-frame boomed out to lower these instruments into the water. Tag lines were used to control the instruments in the air. **Action item: use deck cleats to fair tag lines. Be sure to position the lift point on the float so it does not cause the float to roll off.** The first pick was released by a mechanical quick release, which was then repositioned to lift the anchor. (Previous years have shown that if the first pick was insufficiently high, the releases would still be on deck when the first package was in the water. The releases would then slip off the deck inelegantly. It was found that a higher lift of the instruments, and using both hooks of the A-frame, allowed the releases also to be lifted from the deck and then hang nicely behind the ship once the ADCP was placed in the water.) The anchor was lifted into the water just prior to arriving at the site. Positioning of this final pick very close to the anchor prevents the releases being pulled back over the lip of the ship when the anchor is lifted. **Action item:**

Make final pick as close as possible to the anchor. When the ship arrived on site, the anchor was dropped using the mechanical quick release. Positions were taken from a hand-held GPS on the upper aft deck, some 5m from the drop point of the mooring. **Action item: Continue to bring own GPS unit. Note that due to mooring fall back, actual mooring position may be ~ 10m from this position in the opposite direction to the steaming direction during recovery.** This information is noted on the mooring diagrams.

A team of 4-5 crew did the deployments, with one person on the A-frame, 3 on the "dog runs' assisting the instruments up into the air, and other members of the crew/science team assisting with tending the tag lines during lifting.

Action items: design pick points into the moorings for recover; continue to put 2 rings on the anchors for tag lines. Consider using chain, not line for the moorings (saves on splicing and gives extra pick points); Compute the best pick point, such that the releases are lifted free of the deck, rather than slipped over the edge. Add pick points to the mooring diagrams. Review the videos of mooring deployments before the operation.

Deployment Instrumentation issues: This year, to avoid needing a long preparation period in Nome, much of the instrumentation was started in Seattle and shipped on delayed start. (Note SBE37IM will not accept a delayed start longer than 30 days.) Exceptions were the biooptics instruments (SUNA, Wetlabs and ODOs) which have less battery endurance and so were started in Nome.

Iscat housings and tethers were assembled in Seattle, and ADCPs incorporated into the ADCP frames, leaving the only assembly work to be done in Nome/at sea the placing of the floats on the ADCP frames and the testing of the releases. **Action item: Consider in future if starting instruments in Seattle is a safe way of saving time in Nome. Note that releases could also be deck checked ashore to save time at sea.**

This year, the iscats were significantly redesigned, with the dog-bone floatation being replaced with a series of weak links to sacrificial floats, an extension of the Miscat design trialed in 2022-2023.

Recovered Data and Instrumentation issues: Data recovery on the moorings was very good.

- ISCAT SBE37IMS AND LOGGERS:
Three iscats/miscat were deployed on the recovered moorings. None of these were recovered, but logger data was good on all three moorings and showed:
- A2-23– last data 8th May 2024, iscat unplugged at the ADCP consistent with planned loss to ice
- A3-23 – last data from both upper and lower instruments 10th December 2023 06:52. Here (remarkably the logger cable plug was ripped off at the ADCP, rather than just becoming unplugged).
- A4-23 – last data 3rd Jan 2024 01:48. Wire broke above block below the iscat float.
These losses are consistent with sea-ice damage.
Logger data are of good quality, suggesting that a new test of the couplers has been successful in identifying problems.
item: continue check of all couplers in Seattle; do final coupler test before deployment, bring spare couplers to cover any last minute failures. Continue to use Lithium battery on miscat in the future.
Preliminary results (before any correction for biofouling or post cruise calibration) are plotted below. These show that the A4-23 iscat was deployed at ~7m, rather than the usual ~15m.

- *ADCPs:* The three recovered ADCPs were running on recovery and gave complete data records. These instruments were deployed with lithium batteries (and no external battery pack) and a conservative recording schedule and were expected to last the two years.
Preliminary results are plotted below.

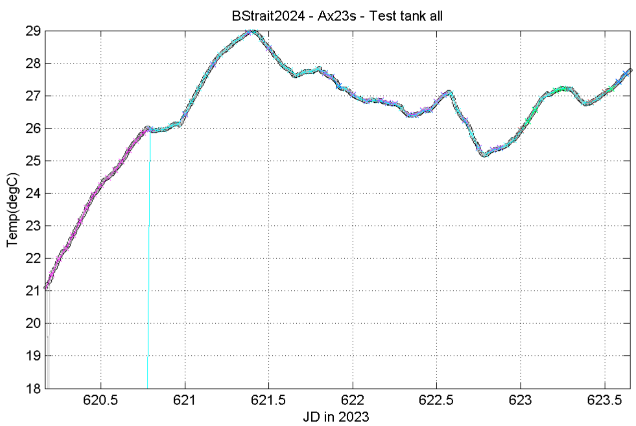
- *SBEs:* A SBE37 was recovered from each mooring. None of these instruments were pumped. All instruments were running on recovery and returned full data records **Action items: Send for calibration.**
Preliminary results (before any correction for biofouling or post cruise calibration) are plotted below.

- Biooptics instrumentation (SUNA, Wetlabs, ODOs). All biotoptic instruments were running on recovery and appear to have returned complete data records. No issues have been identified to date.

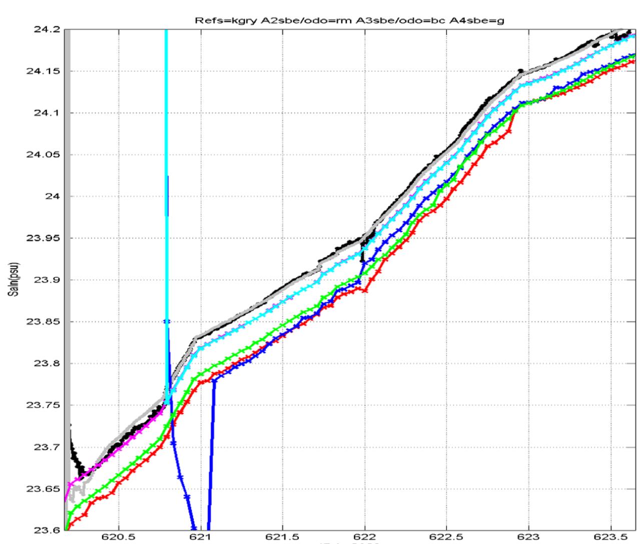
Post recovery tank calibrations: As an addition calibration test, uncleaned post-recovery SBE instruments were placed, for various periods after recovery in a large-plastic bin filled with salt water in conjunction with other recently calibrated SBE instruments. Previous versions of this test have used an SBE19 as the standard, however, frequently issues were encountered with this instrument – the external switch on the instrument made it vulnerable to being accidentally switched off; the high sampling rate required battery changes during the cruise; and the pumped system was vulnerable to air bubble issues. For this 2024 cruise, this tank was redesigned to have an internal frame (made from two IKEA wineracks) to keep instruments apart and upright. All recovered instrumentation this cruise was SBE37 (or SBE37ODO) and the recently calibrated instruments used as standards were also SBE37, making the packing of the tank much easier.

Recovered instruments were washed externally in a separate tote of salt water and then placed in the test tank with the (2) standards for several days.

This year, the rest was very effective. In the plots below, the recently calibrated instruments are in black and grey, with recovered instruments in color. (A2, A3, A4 SBE37s = red, blue, green, respectively; A2,A3 ODOs = magenta and cyan, respectively.



Temperatures (left) show remarkably good agreement (as has always been the case).
Note the tank became remarkably warm (29 degC), which must be due to the heating effect of the pump. A more powerful pump was used this year.
ACTION ITEM: Investigate if a less powerful pump can maintain the necessary flow without making the water so warm.



Salinities (left) also show good agreement, with the recently calibrated instruments ('standards') agreeing to within 0.002psu.

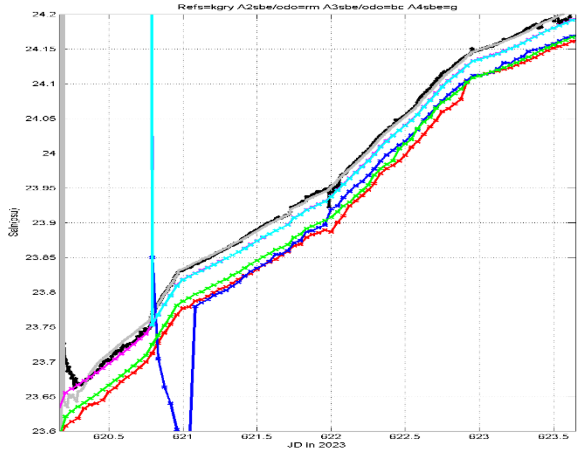
As usual, recovered instruments are biased fresh. These data are before the post-cruise calibration, which will likely reduce the discrepancy. However, from the pre-cals, it appears:
- ODOs have less drift than SBE37s (which is to be expected as the ODOs are pumped);
- ODOs are ~0.015psu fresher than the standards
- SBE 37s are 0.06-0.04psu fresher than the standards

We expect the post-calibrations to account for at least some of this discrepancy. Further investigation will be undertaken once post calibrations are available.

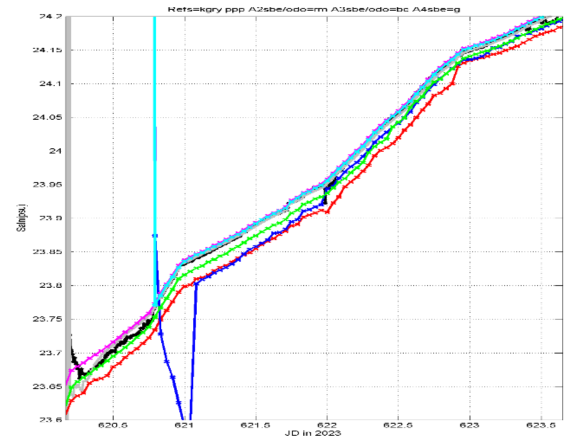
Note that moving the instruments around in the tank does appear to have an effect on salinity (about 0.01psu), and this appears to be about the limit of accuracy of this process.

March 2025: This analysis repeated with post-cruise calibrated data yields the following results:

PRE CALS

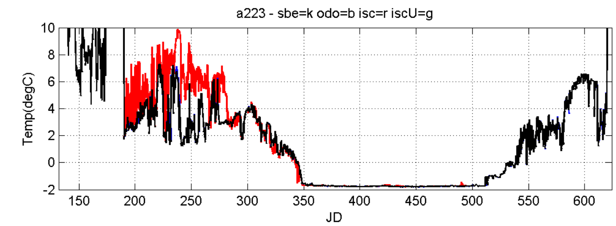


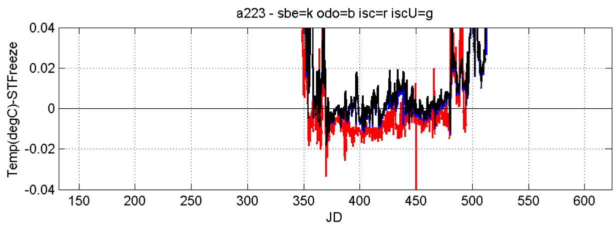
Final files (using postcal)



Along with comparing to surface freezing point, CTD casts and other instruments on the moorings, we conclude:

	A2-23 SBE	**A2-3 ODO**	**A2-22ISC**	**A3-23 SBE**	**A3-23 ODO**	**A3-23 ISCAT**	**A3-23 U-ISC**	**A4-23 SBE**	**A4-23 ISC**
Type SN	*SBE37 23132*	*SBE37 24442*	*SBE37 LOST*	*SBE37 24434*	*SBE37 24445*	*SBE37 LOST*	*SBE37 LOST*	*SBE37 24433*	*SBE37 LOST*
SAcc (psu)	*0.008*	*0.008*	*0.008*	*0.008*	*0.008*	*0.008*	*0.008*	*0.008*	*0.008*
Change between pre and post cal: indication of fouling, (which pushes data fresh), but this much is corrected for									
Ppp (psu)	0.02	0.02	NA	0.02	0.02	NA	NA	0.03	NA
Data minus test tank references – using PRE cal (so for interest only)									
TTPre (psu)	-0.055	-0.015	NA	-0.06	-0.015	NA	NA	-0.045	NA
Data minus test tank references – using PPP data (good indicator of final data quality)									
TTpp (psu)	**-0.04**	**+0.005**	NA	**-0.04**	**+0.003**	NA	NA	**-0.02**	NA
Comparison to CTD cast at deployment (CTDD) and recovery (CTDR) – not very reliable as quality check									
CTDD	-0.003	+0.06	-0.038	-0.012	-0.006	-0.022	-0.032	-0.039	+0.134
CTDR	--0.058	-0.006	NA	-0.04	-0.008	NA	NA	-0.008	-0.443
Comparison to instruments on the same mooring (expect salinity greatest at greatest depth) – good indicator									
Other (psu)	DEEP -EST	**0.0-0.05 saltier than SBE**	**0.01 Fresher than SBE**	**0.04 fresher than odo**	DEEPEST	**0.1 fresher than upper iscat**	**0.01 fresher than odo Prob ok**	DEEPEST	<0.01 fresher than SBE
Temperatures in winter compared to surface Tfreeze estimated from salinity – limited use									
Tfrz (degC)	T~tf <0.01°C	T~tf <0.01°C	**T<tf ~0.01°C**	T>tf 0.01°C	T~tf <0.01°C	NA	NA	T>tf 0.02°C	T<tf 0.01°C
CONCLUDE (psu)	**SBE 0.04psu too fresh at end**	**Prob in spec**	**Prob 0.05psu fresh at end**	**SBE 0.03-0.05 too fresh**	**Prob in spec**	**Suspect 0.1psu fresh at end**	**Prob in spec**	**Suspect 0.02 fresh at end**	**Suspect 0.02 fresh at end. fresh spike at record end not in temp.**


a223 - sbe=k odo=b isc=r iscU=g
Temp(degC)
JD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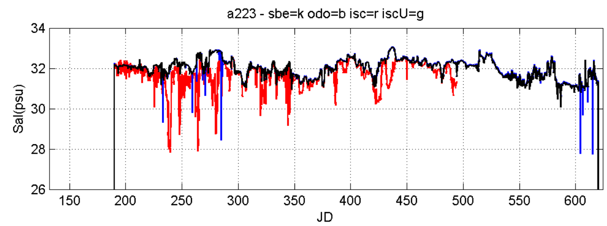
Temp(degC)-STFreeze
JD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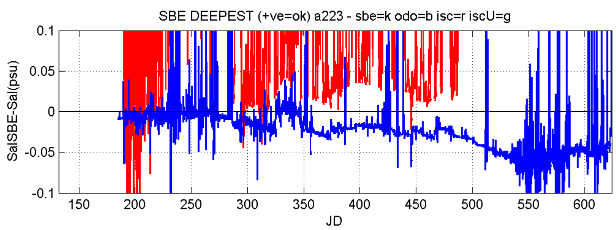
Sal(psu)
JD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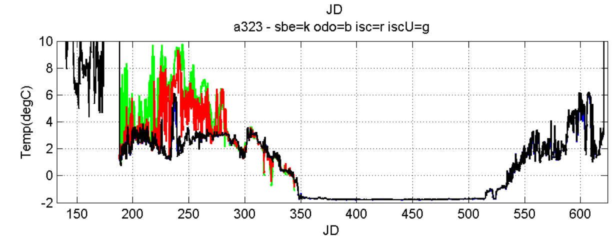
SalSBE-Sal(psu)
JD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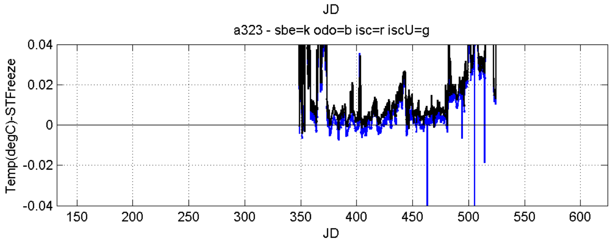
Temp(degC)
JD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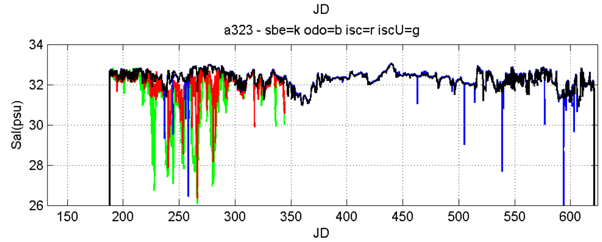
JD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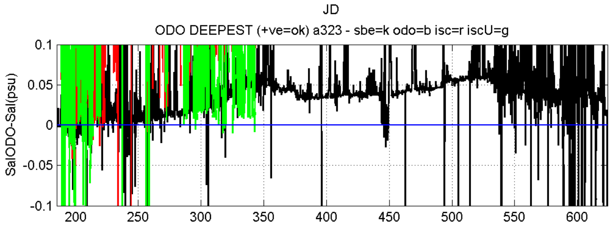
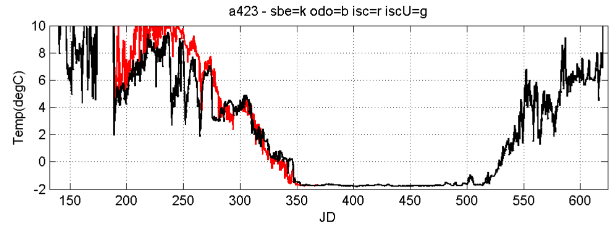
Sal(psu)
JD


ODO DEEPEST (+ve=ok) a323 - sbe=k odo=b isc=r iscU=g
SalODO-Sal(psu)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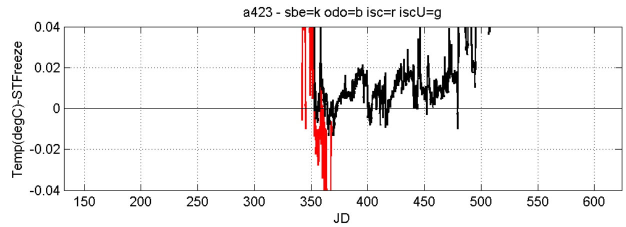
Temp(degC)
JD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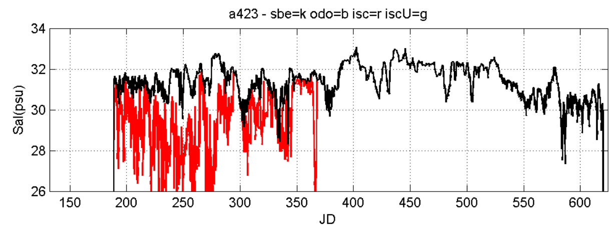
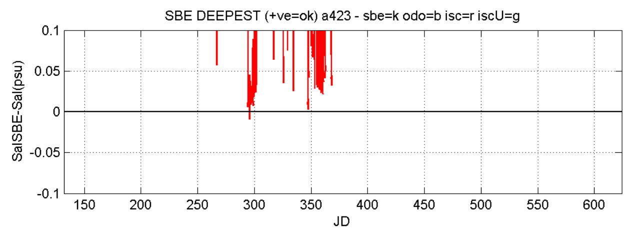
Temp(degC)-STFreeze
JD


a423 - sbe=k odo=b isc=r iscU=g
Sal(psu)
JD


SBE DEEPEST (+ve=ok) a423 - sbe=k odo=b isc=r iscU=g
SalSBE-Sal(psu)
JD

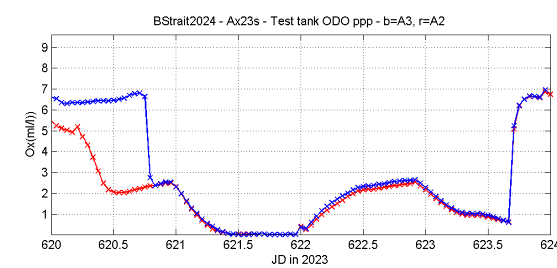
Summary table of relationship to post deployment and pre recovery CTD casts:

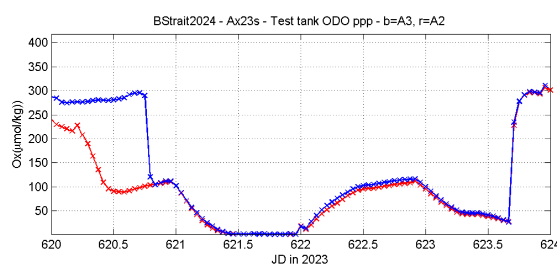
```
%********SUMMARY CAL CASTS*** run Mar2025 with postcals *****
%Mooring  CTDYr CTDNum DISTSt&E(m) Press(db)  Mooring-CTD for
%                                          T(degC)  S(psu)  Ox1mll  Ox2mll   Ox1pc   Ox2pc
% -- DEPLOYMENTs
A223sbeppp Bstrait23 007    272  324    50.1    -0.226  -0.003
A223odoppp Bstrait23 007    272  324    48.7    -0.173   0.061
A223odoppp Bstrait23 007    272  324    48.7    -0.173   0.061   0.061    0.295    0.312    3.350
A223logpre Bstrait23 007   272  324    16.7   -0.225  -0.038
A323sbeppp Bstrait23 004    180  193    43.6     0.005  -0.012
A323odoppp Bstrait23 004    180  193    46.6     0.004  -0.006
A323odoppp Bstrait23 004    180  193    46.6     0.004  -0.006   1.026    1.243   13.065   15.821
A323logpre Bstrait23 004   180  193    16.1   -0.402  -0.022
A323Ulogpre Bstrait23 004   180  193     7.5   -0.476  -0.032
A423sbeppp Bstrait23 005    484  600    41.5     0.069  -0.039
A423logpre Bstrait23 005   484  600     9.4   -0.004   0.134
%
% -- RECOVERY - SBEs
A223sbeppp Bstrait24 004    236  316    50.4     0.003  -0.058
A223odoppp Bstrait24 004    236  316    49.8     0.002  -0.006
A223odoppp Bstrait24 004    236  316    49.8     0.002  -0.006  -0.297    0.089   -3.947    1.216
A323sbeppp Bstrait24 011    234  265    43.6    -0.001  -0.040
A323odoppp Bstrait24 011    234  265    47.4    -0.002  -0.008
A323odoppp Bstrait24 011    234  265    47.4    -0.002  -0.008  -0.309    0.063   -4.070    0.843
A423sbeppp Bstrait24 005    383  469    41.6     0.314  -0.443
```

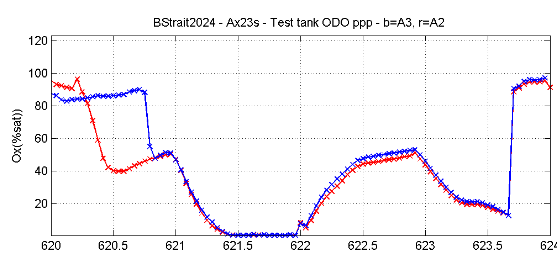
Results are not very convincing.

For Oxygen thus, we have no very good test of the Ox sensor. However, in the test tank, the **two ODOs agree to <0.1ml/l, <3µmol/kg and < 1% saturation.**

	A2-23 ODO (sbe37)	**A3-23 ODO (sbe37)**
	24442	*24445*
OxAcc	*Max of 0.07ml/L* *or 2%*	*Max of 0.07ml/L* *or 2%*
Ox ppp Ps-pr	0.28ml/l 3.5% 12µmol/kg	0.25ml/l 3.1% 11µmol/kg
CTDD (ox1,ox2)	0.1-0.3ml/l 0.3-4%%	1-1.2ml/l 13-15%
CTDR (ox1,ox2)	-3-0.1ml.l -4-1%	-0.3-0.06ml.l -4-0.8%
CONCLUDE	Probably within manufacturer's specs (based on test tank agreement)	Probably within manufacturer's specs (based on test tank agreement)







Other Recovered/Deployed Instrumentation: Other instruments on the moorings were recovered/deployed for other groups. These instruments are:

Recoveries: An ***Aural Marine Mammal Acoustic*** sensor on A3 was deployed by Kate Stafford, (UW). This instrument was cleaned and returned to Seattle for analysis.

Deployment: Only one ***Marine Mammal Acoustic*** sensor (placed on A3) was deployed this year. This instrument is deployed for Kate Stafford, UW.

Details of mooring positions and instrumentation are given below, along with schematics of the moorings, photos of the mooring fouling, and preliminary plots of the data as available.

BERING STRAIT 2024 CRUISE MOORING POSITIONS AND INSTRUMENTATION

ID	LATITUDE (N) (WGS-84)	LONGITUDE (W) (WGS-84)	WATER DEPTH /m (corrected)	INST.
2023-2024 Mooring Recoveries				
A2-23	65 46.864	168 34.062	56	ISCAT, ADCP, SBE37ODO, FLNTUSB, SUNA SBE16
A4-23	65 44.761	168 15.756	49	ISCAT, ADCP, SBE16, FLNTUSB
A3-23	66 19.600	168 56.944	58	MISCAT, ADCP with SBE16, SBE37ODO, FLNTUSB, SUNA new MMR

ID	LATITUDE (N) (WGS-84)	LONGITUDE (W) (WGS-84)	WATER DEPTH /m (corrected)	INST.
2024 Moorings deployments				
A2-24	65 46.83	168 34.08	56	ISCAT, ADCP, SBE37ODO, FLNTUSB, SUNA SBE16
A4-24	65 44.76	168 15.75	49	ISCAT, ADCP, SBE16, FLNTUSB
A3-24	66 19.628	168 57.06	58	MISCAT, ADCP with SBE16, SBE37ODO, FLNTUSB, SUNA new MMR

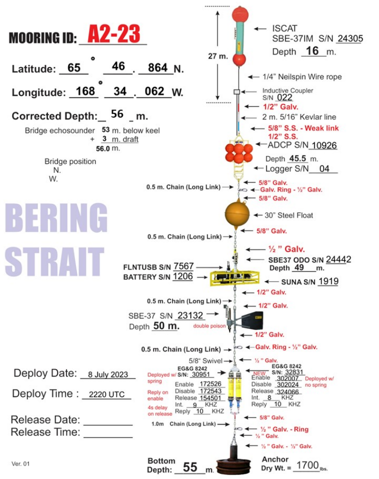
ADCP = RDI Acoustic Doppler Current Profiler
ISCAT = near-surface Seabird TS sensor in trawl resistant housing, with near-bottom data logger
MISCAT = ISCAT with two near-surface sensors (one at ~ 8m, one at ~ 16m)
SBE16 = Seabird CTD recorder,   SBE37 = Seabird CTD recorder
MMR=Marine Mammal Recorder   (new=new APL version)
SBE37ODO = Seabird CTD and dissolved oxygen recorder
FLNTUSB = Wetlabs fluorescence and turbidity recorder
SUNA = Seabird optical SUNA nitrate sensor

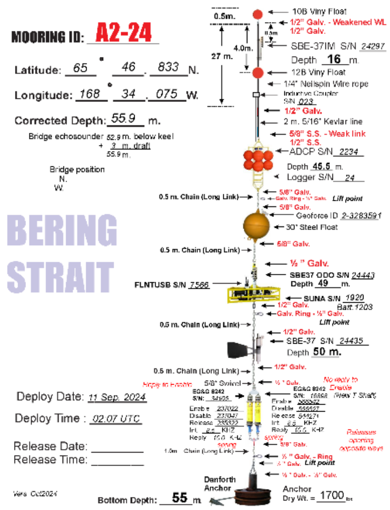
For 2023 and 2024 deployments, water depths are assuming a ship's draft of 3m.

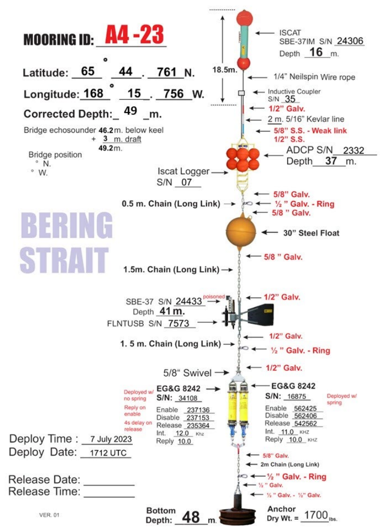
BERING STRAIT 2023 SCHEMATICS OF MOORING RECOVERIES AND DEPLOYMENTS

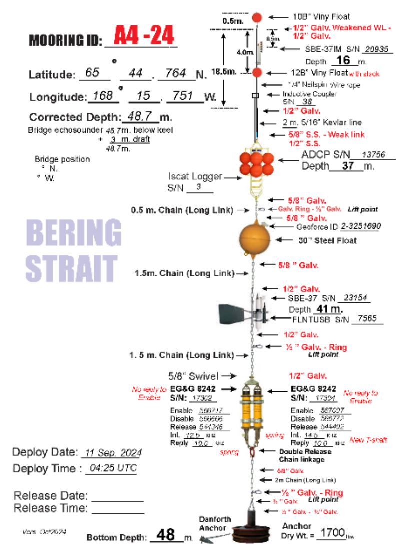
RECOVERED **DEPLOYED**

= in the eastern channel of the Bering Strait

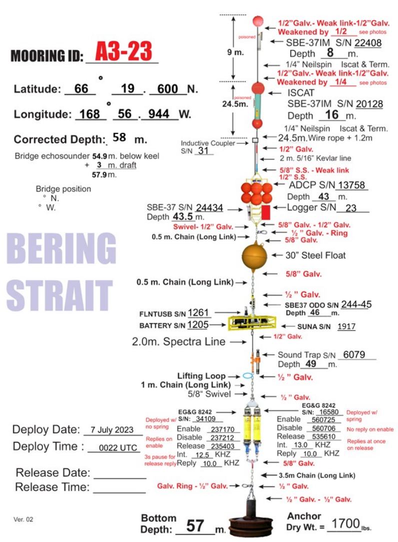


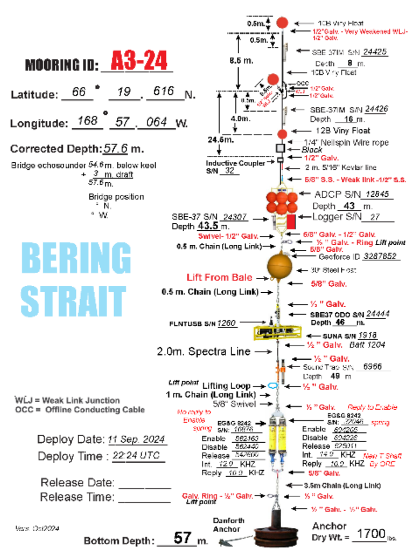






= at the climate site, ~ 60km north of the Strait

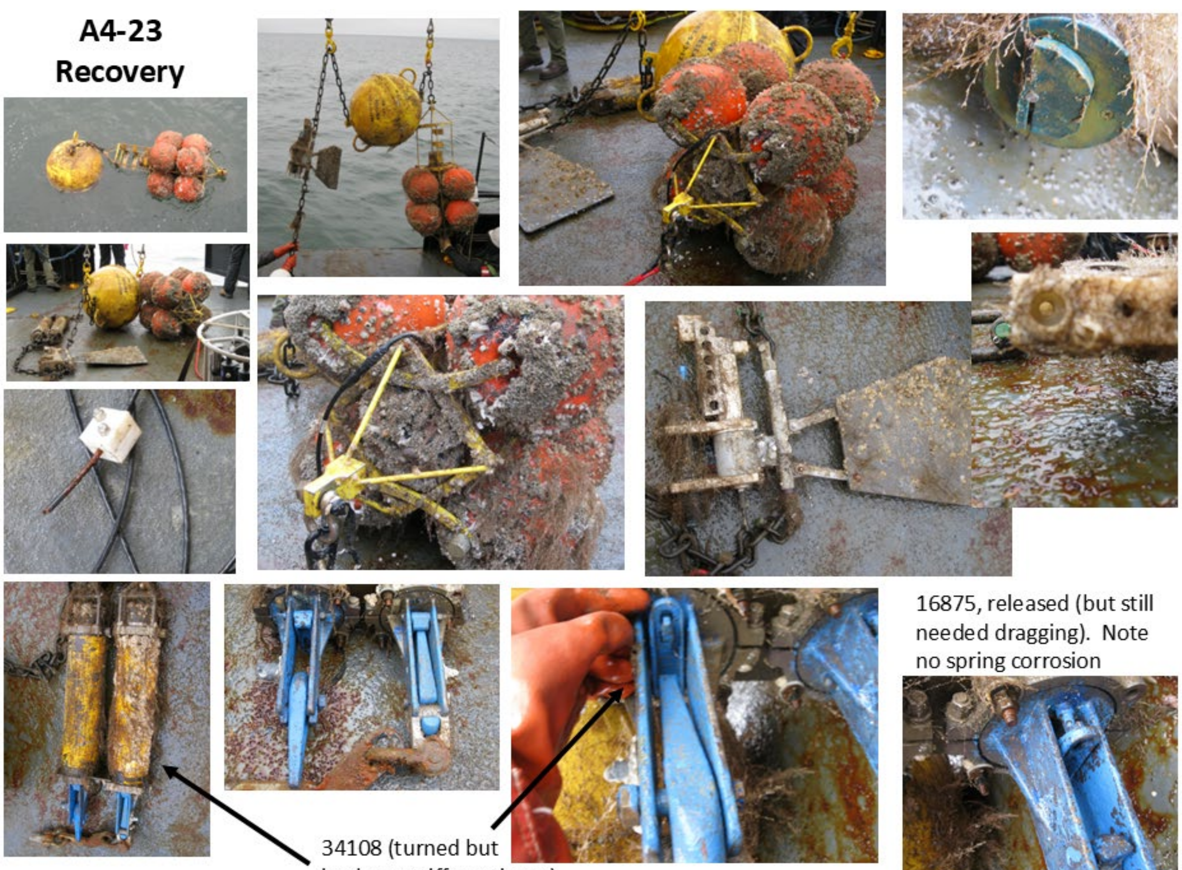




BERING STRAIT 2024 RECOVERY (Ax23s) PHOTOS

A3-23 Recovery

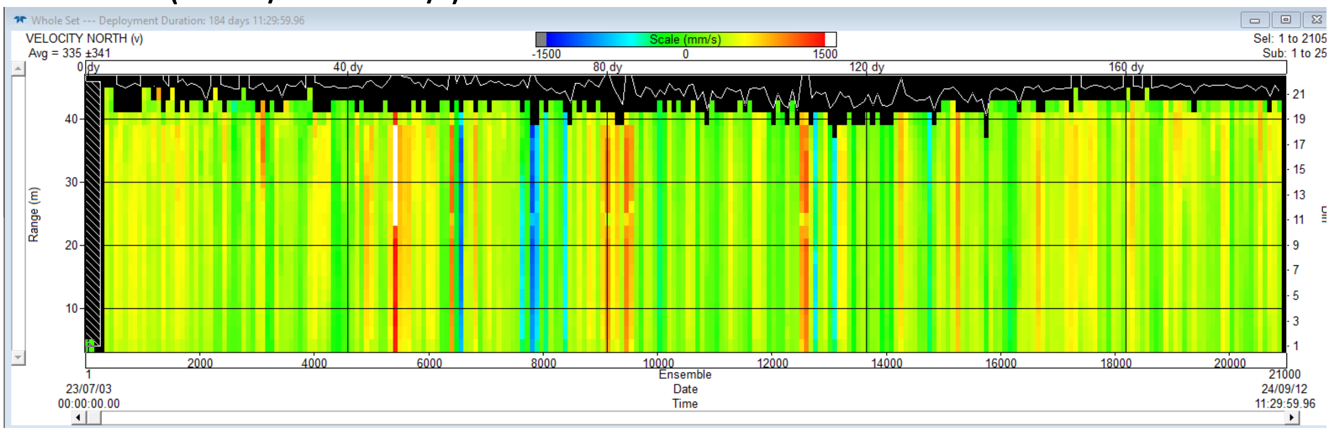
A4-23 Recovery



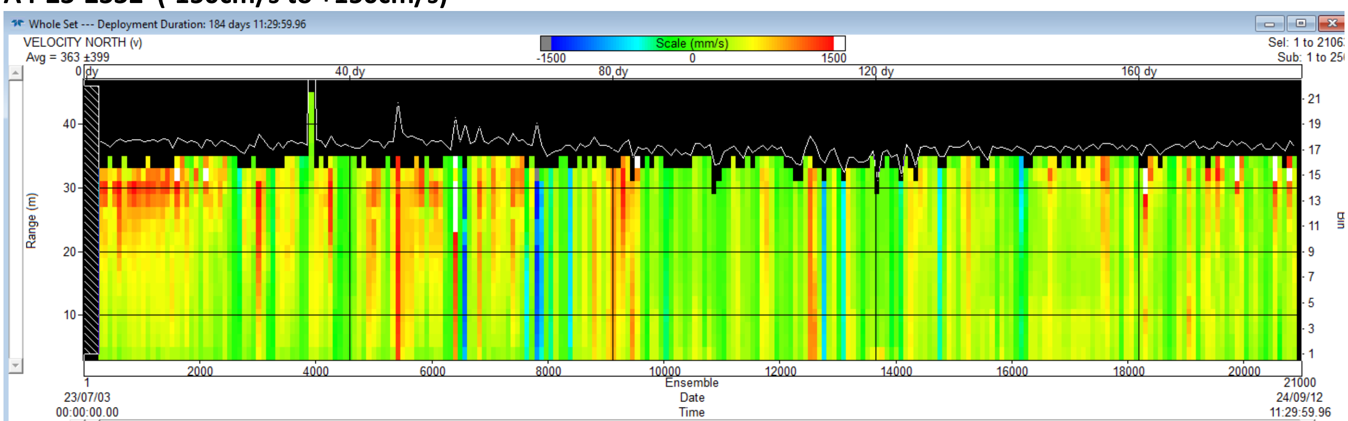
BERING STRAIT 2024 (Ax23s) PRELIMINARY ADCP RESULTS

NORTHWARD VELOCITY from Bering Strait 2023-2024 ADCPs

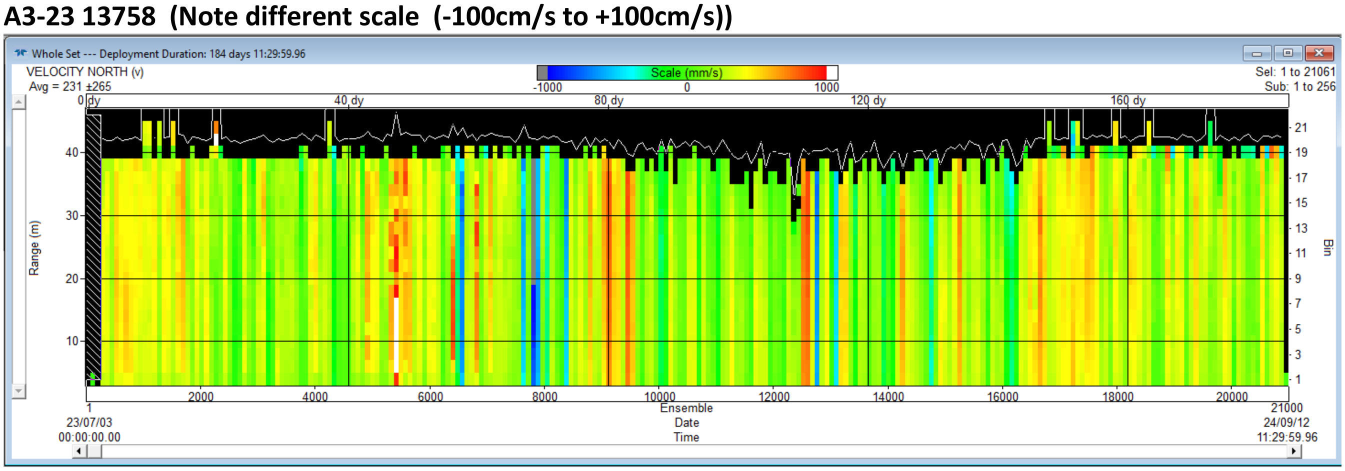
A2-23 10926 (-150cm/s to +150cm/s)



A4-23-2332 (-150cm/s to +150cm/s)



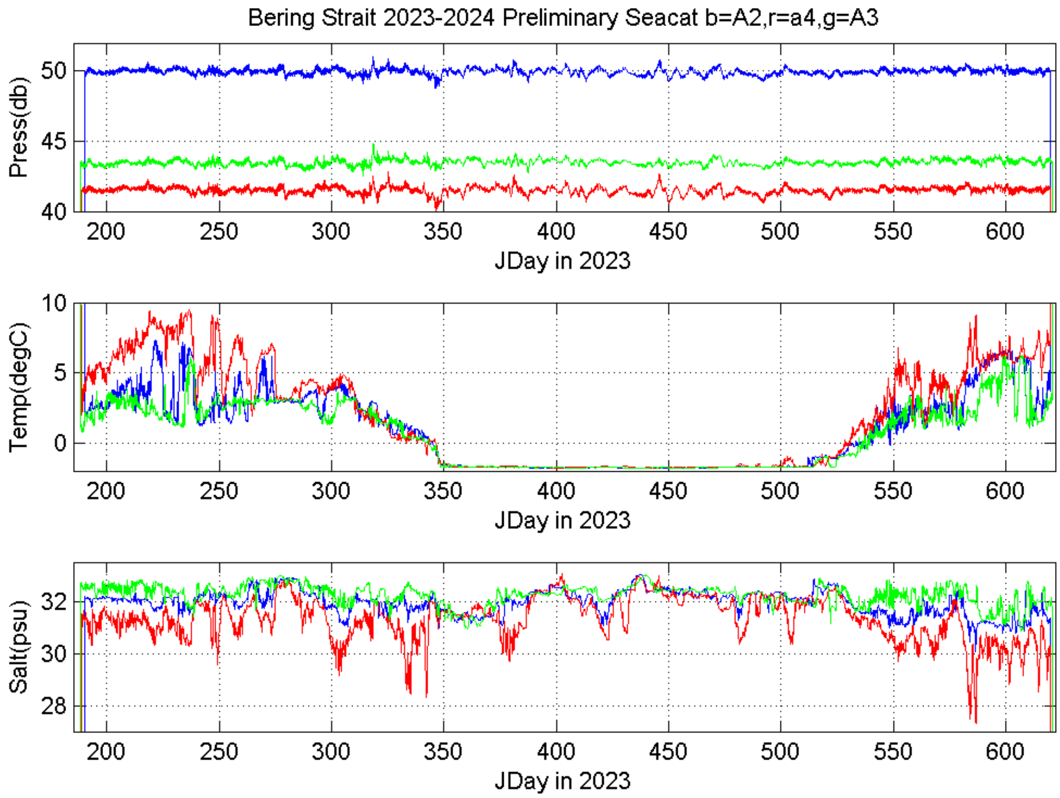
A3-23 13758 (Note different scale (-100cm/s to +100cm/s))

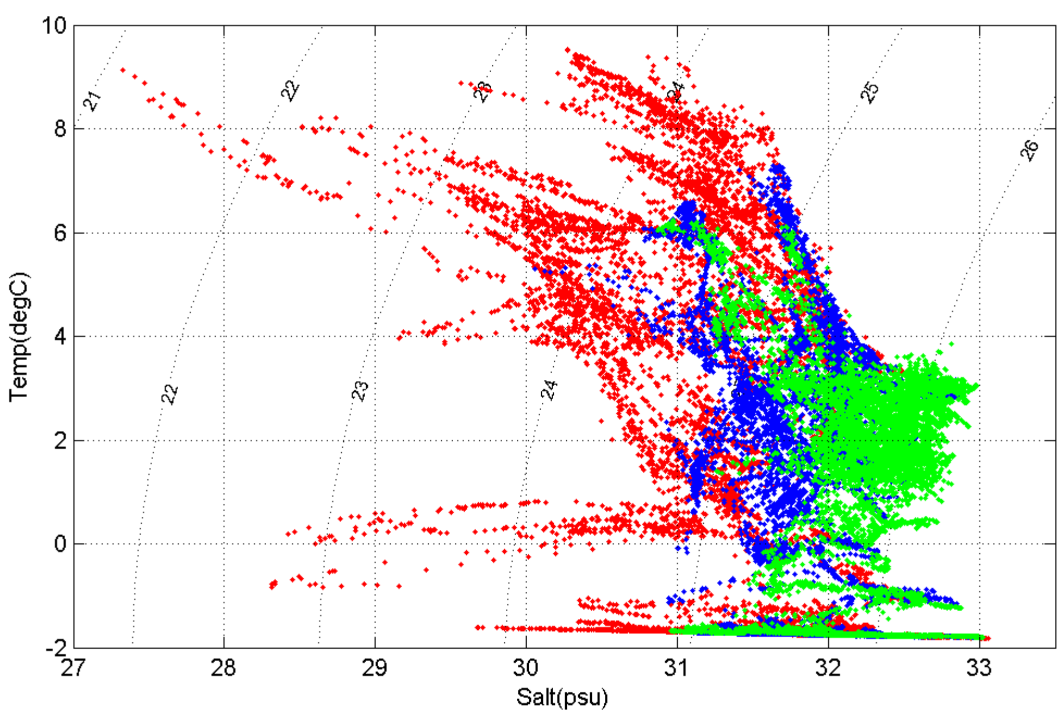


(Note large ice keels around 12000-13000, March 2024)

BERING STRAIT 2023-2024 SBE PRELIMINARY RESULTS (Ax23 data)

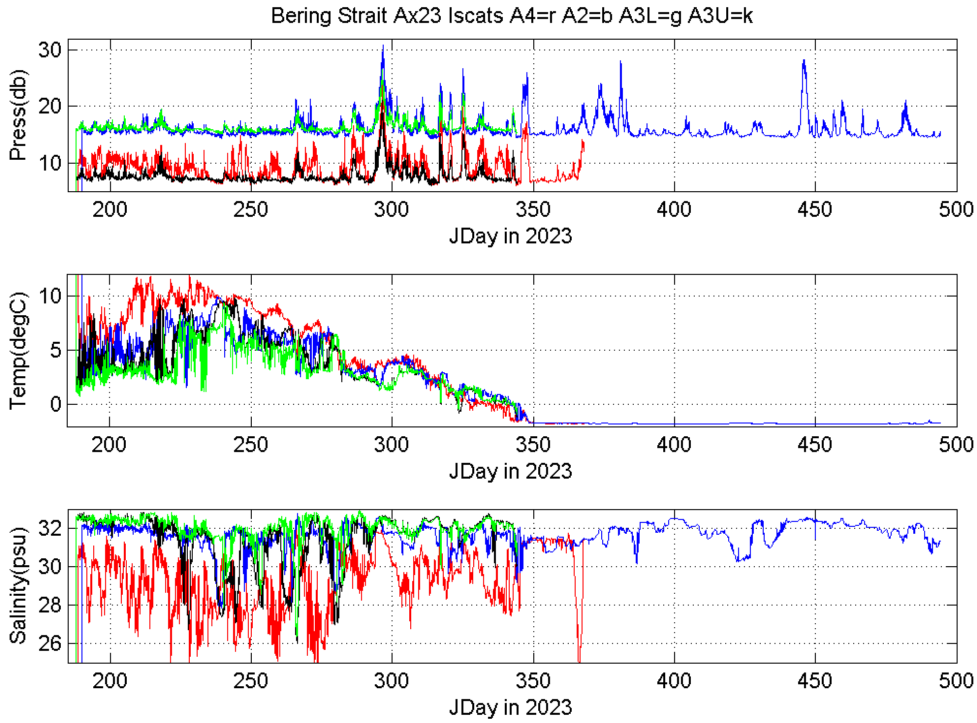
– all lower level TS Sensors

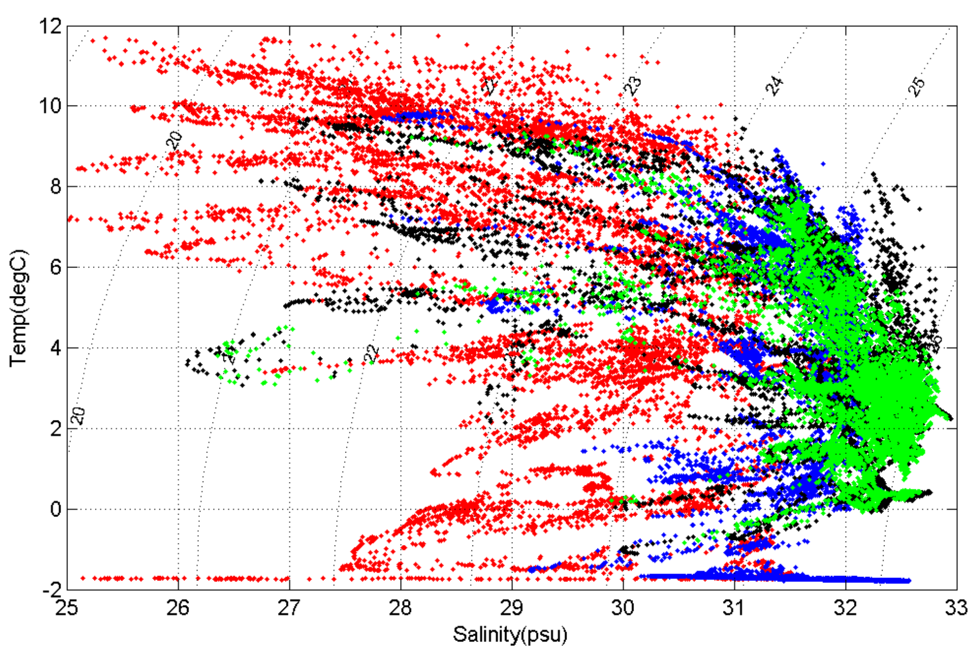




BERING STRAIT 2023-2024 ISCAT PRELIMINARY RESULTS (Ax23 data)

– all upper level TS Sensors



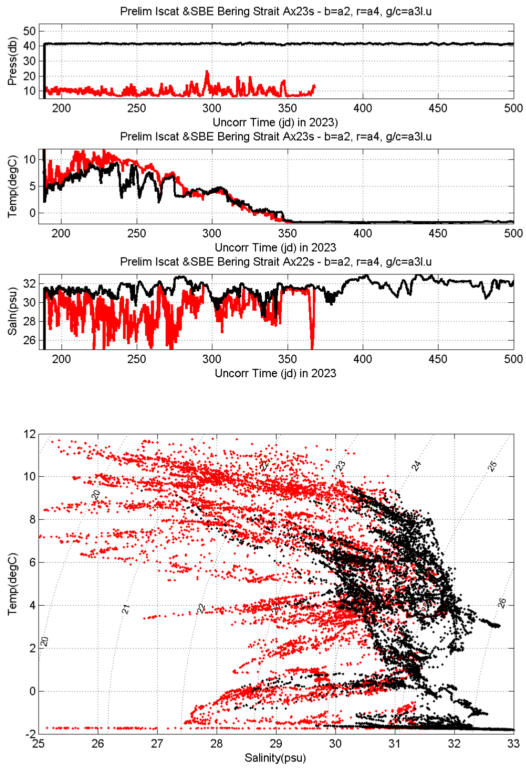


Note fresh anomaly at A3 (upper and lower) around JD 265 (22nd Sept)
Note also fresh anomaly at freezing just before A4 iscat lost (red)

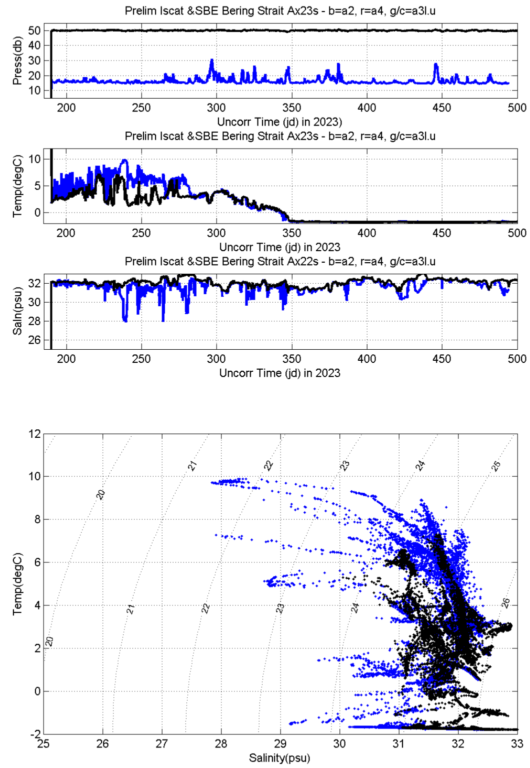
BERING STRAIT 2023-2024 ISCAT and SBE PRELIMINARY RESULTS (Ax23data)

–upper and lower TS sensors by mooring

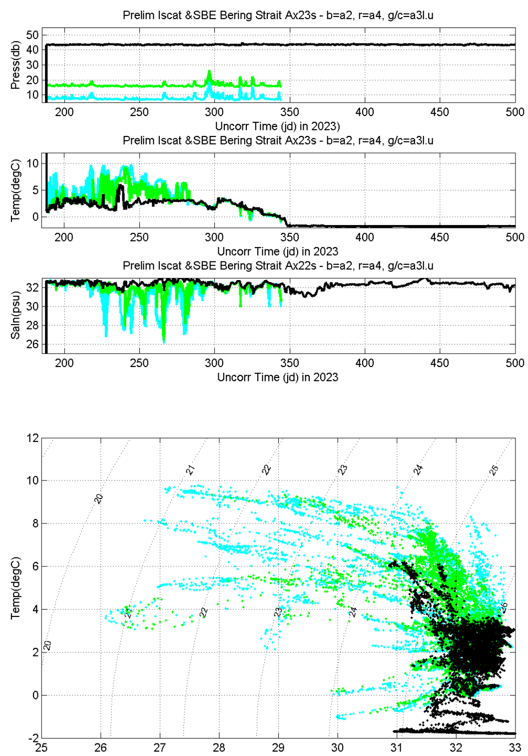
A2-23



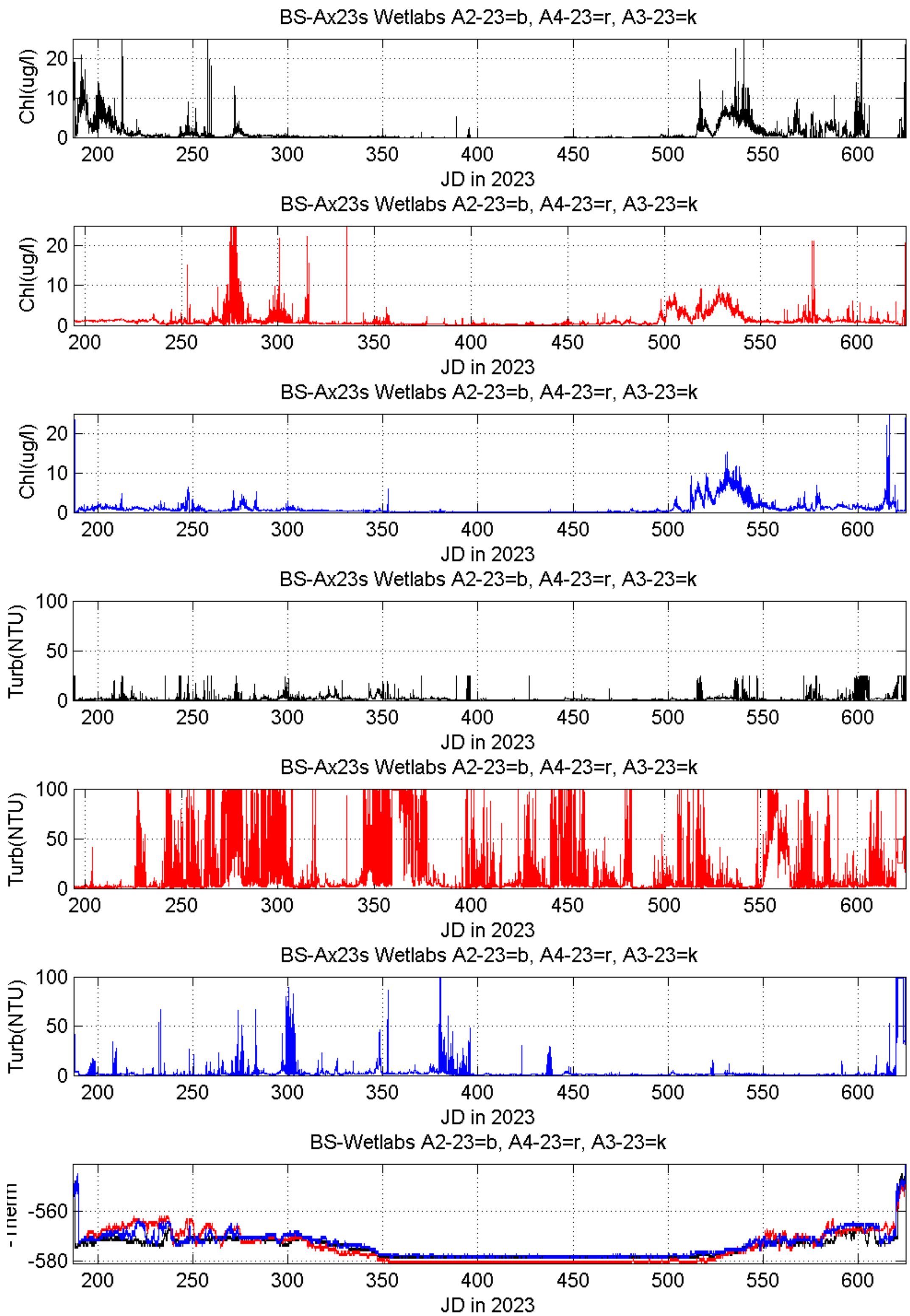
A4-23



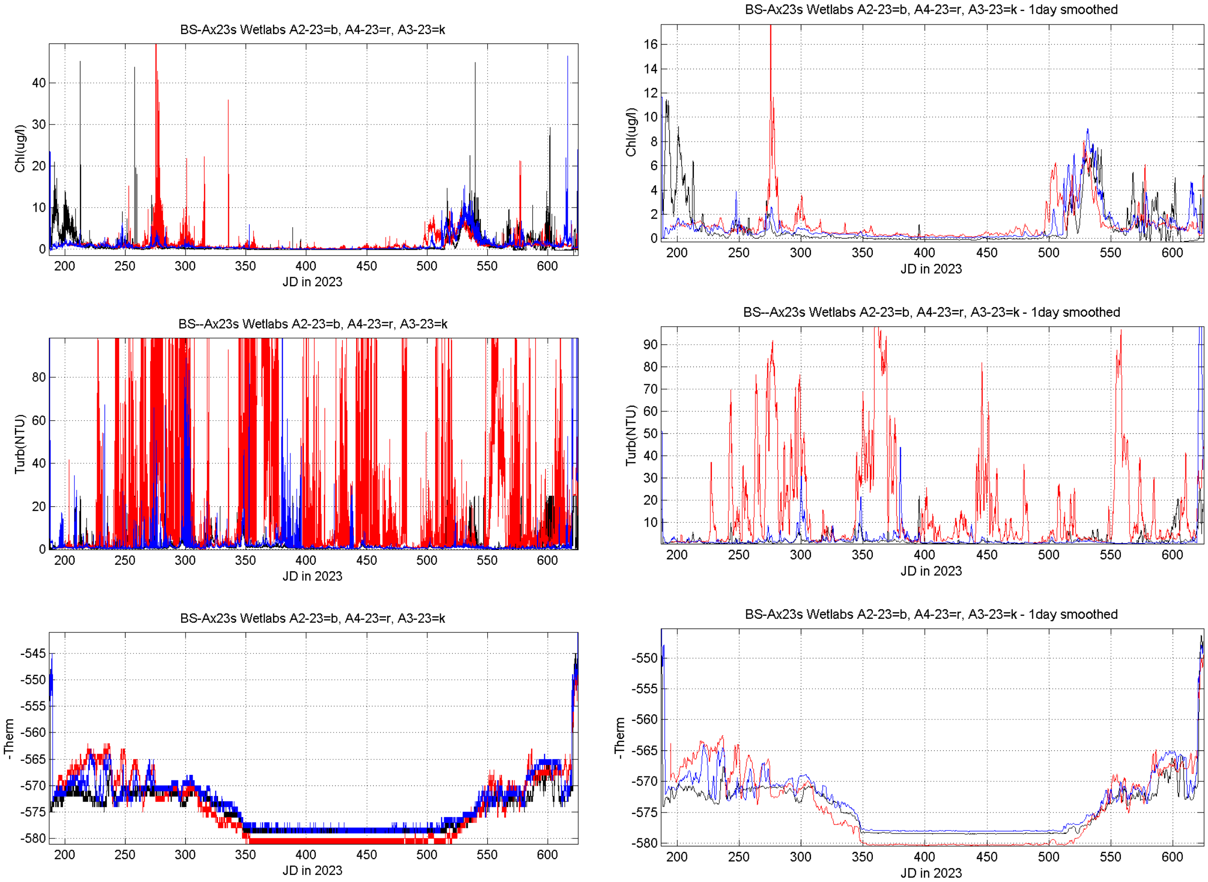
A3-23



BERING STRAIT 2023-2024 WETLABS Chlorophyll (Fluorescence) and Turbidity PRELIMINARY RESULTS (Ax23data)



Hourly data | 1 day smoothed



These data, running from July 2023 to Sept 2024, cover 2023 late summer/fall to 2024 fall.

A preliminary comparison to the prior year of data suggest:

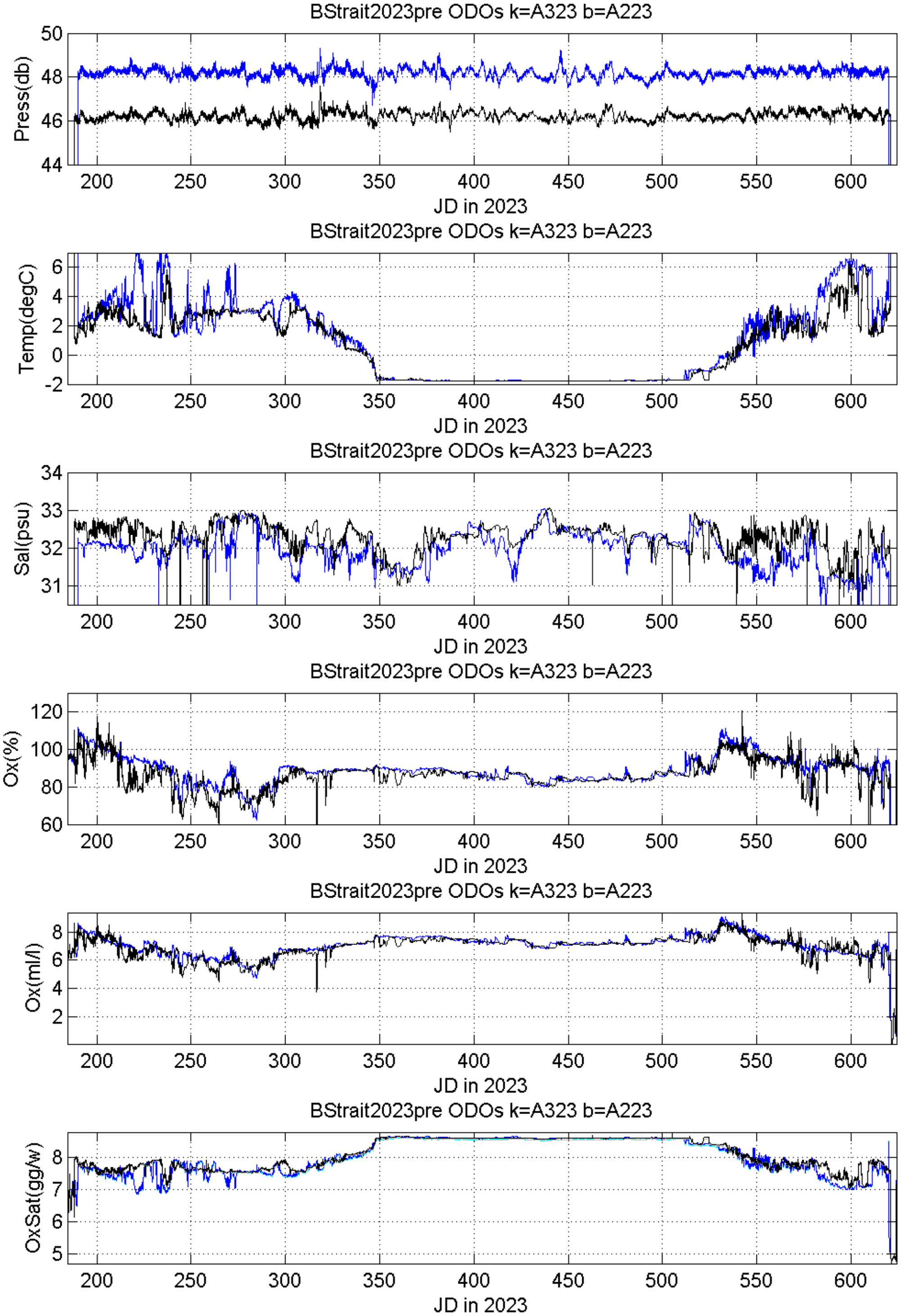
- the strait experiences a spring/summer bloom (from mid May in 2023, and early June in 2024) lasting at lower levels through the summer at A3 (to mid August in 2023 and early September (at least) in 2024).

- with the bloom at A3 is somewhat weaker in 2024 than in 2023, but possibly lasts longer.

- fluorescence peaks are also seen as waters start to cool in the fall (Sept/October) in 2023, particularly at A4. #

- turbidity is much greater at A4 in 2023 onwards. (While winter 2022-2023 had almost zero turbidity, this was not the case in winter 2023-2024).

BERING STRAIT 2023-2024 SBE37-ODO (Dissolved Oxygen)
PRELIMINARY RESULTS (Ax23data)



The dissolved oxygen (DO) timeseries show similar key features to those noted in Woodgate et al., [submitted 2024], viz:

- oversaturation during the spring bloom,
- DO levels falling through summer (secondary production)
- DO levels replenishing in later fall, but not reaching 100%
- Modest decrease during ice covered times,
- And return to oversaturation with the spring bloom.

Mar2025: Notes on SUNAs

SUNAs on the mooring were processed by the following steps

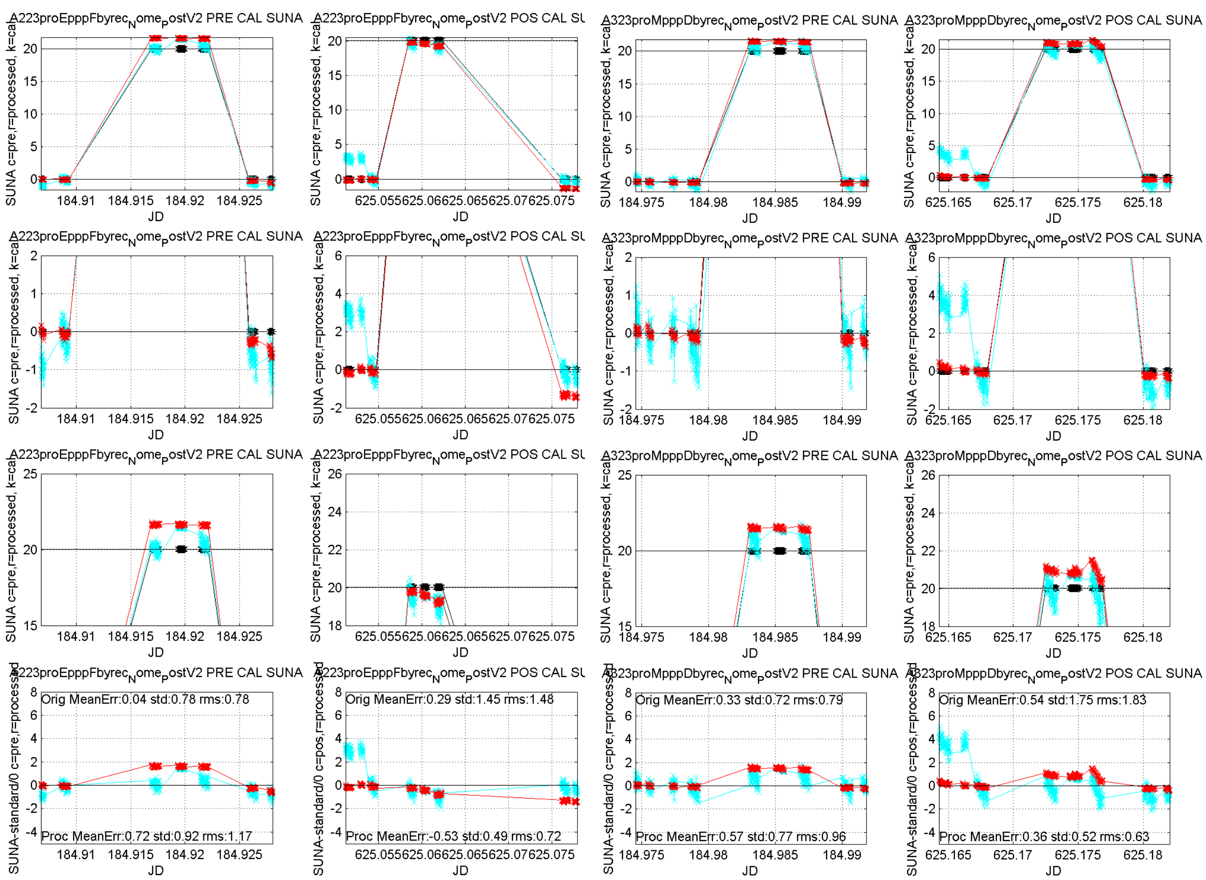
- pre and post deployment, reference updates were run and stored to the instrument. During these tests a UW nitrate standard, (20.02µM) was used to test the SUNA readings. Full details are in plots below, but for all our instruments, we find TS corrected SUNA reading are ~22µM with this standard. The cause of this discrepancy is unknown.
- using temperature and salinity (TS) data from the final SBE37ODO data file, SUNA files are corrected for TS [*Sakamoto et al.*, 2009] using the Seabird Software package UCI. This is a substantial correction, typically reducing the SUNA values by ~5µM. This processing is run for both the pre and post deployment references. The difference between the resultant records is a constant. In this year, ~4µM for both instruments.

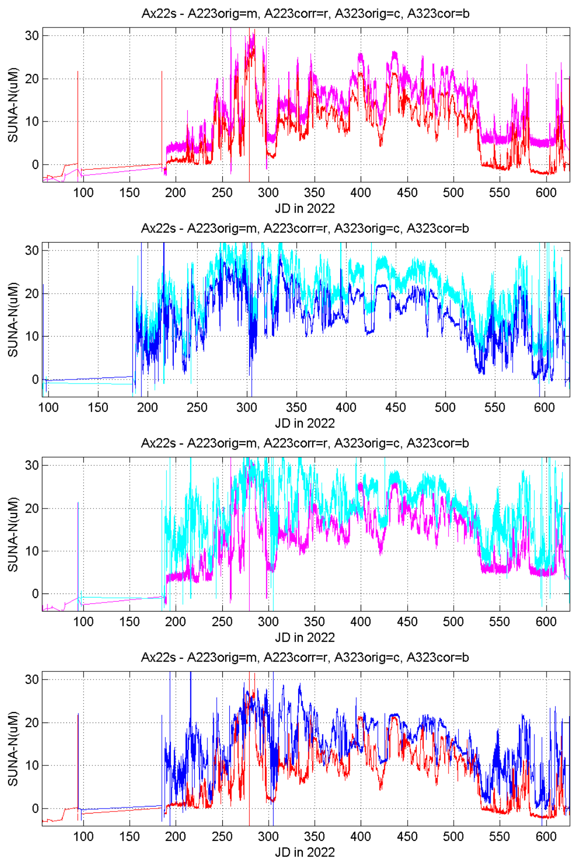
The final data file is created by ramping linearly with record number from the pre to the post deployment reference (For A2-23, 1919, cals E to F; for A3-23, 2017, cals M to N).

Final files are compared to the reference (i.e. distilled water) and standard runs, performed in Seattle pre shipping, in Nome pre cruise and on the ship after recovery, and compared to duplicate nutrient samples taken from CTD casts post deployment and prior to recovery. (Note these casts do not always agree well with T and S, but agreement to nitrate values is generally encouraging.)

Manufacturer's estimated accuracy is 2µM.

In 2024, we find A3-23 SUNA (1917) agrees to <1µM with CTD casts and reference runs. The A2-23 SUNA (1919) appears to read ~2µM too low by recovery. We suggest this may be corrected by applying a linear ramping from 0-2µM over the duration of the deployment.

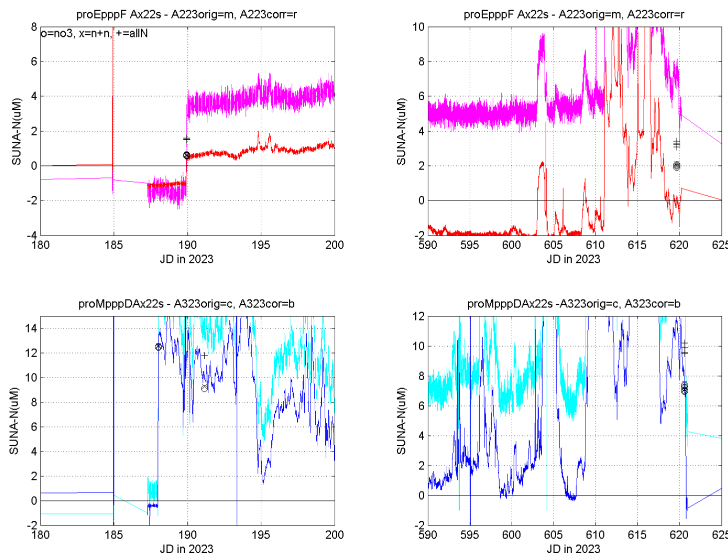




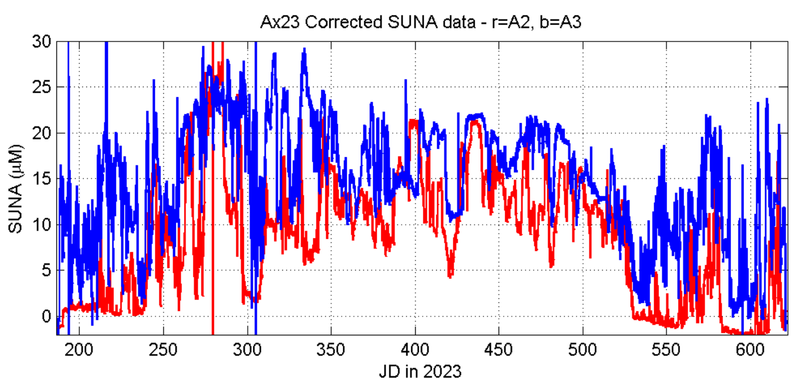
LEFT: Comparison of raw to TS corrected data.

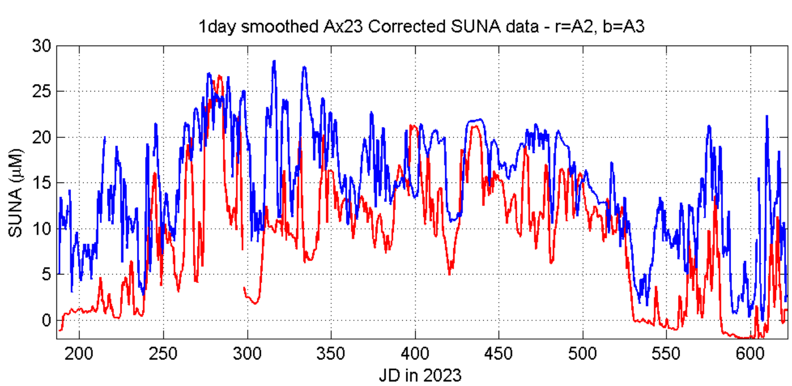
Red= A2final, Magenta = A2 before TS correction.
Blue = A3 final, Cyan = A3 before TS correction**.**

BELOW: Comparison to bottle samples
Circle= nitrate, x= nitrate + nitrate, +=All N.



Final timeseries – (top full resolution, bottom 1 day averaged).
Note drift in A2 (red) to negative values at end of record.





On equipment being returned to Seattle, it was found that both SUNA battery packs had flooded, one catastrophically. These packs were new from the manufacturer, but appears to have flooded due to o-rings being too dry. We hypothesize that a minor leak at depth was arrested by pressure build up in the battery pack, but once the instrument returned to the surface, the vent plug opened and the packs then leaked. We are extremely fortunate that this has not lost any data from the deployment.
ACTION ITEM: Check all o-rings on future battery packs.

CTD OPERATIONS (Whole Science Team)

As in previous years, in 2024 the moorings were supported by annual CTD sections. This year, these sections were run with a CTD rosette system to allow bottle samples to be taken. This is in addition to the separate pumped system was used to take trace metal and nutrient samples, and a few isotope samples.

The CTD rosette system used on this cruise was loaned from APL-UW and, used the same instrumentation as in previous years, other than the altimeter was replaced with a SUNA nitrate sensor with external battery pack (which required the space of one of the bottles of the rosette). Serial numbers and calibration dates are given here. Note the system was sent for calibration in Winter22/Spring23 and these calibrations are used for the plots in this report.

one SBE9+ with pressure sensor

(SN26451 – calibration 17th June 2019 (Not calibrated pre cruise)

two SBE3 temperature sensors

(T1 = SN0843 – calibration 21st Dec 2022)

(T2 = SN0844 – calibration 21st Dec 2022)

two SBE4 conductivity sensors

(S1 = SN0484 – calibration 13th Dec 2022)

(S2 = SN0485 – calibration 14th Feb 2023)

two SBE43 oxygen sensors

(Ox1 = SN1753 – calibration 21st Feb 2023)

(Ox2 = SN1754 – calibration 21st Feb 2023)

one Wetlabs FLNTURT fluorescence/turbidity sensor (SN1622 – calibration 11th March 2010)

on SUNA nitrate sensor (SN1916, calibrated by Seabird spring 2024, reference update pre cruise)

two Seabird pumps (believed to be SN50340, SN55236, but not confirmed)

one EG&G transponder (D-CAT SN31892, Interrogate: 11.0kHz, Reply: 13.5kHz)

The temperature, conductivity and oxygen probes were paired as last year, viz:

	Temperature	**Conductivity**	**Oxygen**	**Pump**
Primary	#843	#484	#1753	SN NA
Secondary	#844	#485	#1754	SN NA

With the rosette system, the sensors are mounted horizontally below the rosette. Care must be taken that they are installed the correct way around as the rosette frame is not symmetric, and only in one orientation are the sensors protected by the cage. **Action item Check mounting before shipping from Seattle**.

The CTD was connected to a conducting wire winch on the ship. This winch (Rapp Hydema NW, SOW 160 5000m capacity, with 3 conductor 0.322”diameter wire), was new on the Norseman II in 2014. Chris Siani, APL, assisted with wiring and CTD tests of this system while the ship was in Seattle in April 2014. In 2022, we found the termination had been changed by the prior cruise. We reterminated, but the test cast failed however, and eventually this was traced to a leak in the termination. A second retermination was successful. In 2023 and 2024, no retermination was necessary. **Action item: Bring several termination kits.**

The winch was connected to an SBE11 deckbox, which in turn was linked via serial ports and USB-serial connectors to a dedicated PC, running the software package Seasave v7. Data were recorded in standard hexadecimal SBE format, incorporating NMEA GPS input from the Norseman II. **Action item: Check which GPS used, and that the date is not subject to the roll over error.** In 2024, jumpy mouse issues were resolved by unplugging the GPS cable from the ship’s socket, restarting the computer, and then replugging in the GPS at the wall as the system was starting.

An event log (copied attached at the end of this report) was maintained on the CTD computer, including comments on data quality and other issues. The log, the data files, and a screen dump of the end-of-cast Seasave image were copied to a thumb drive as a backup after each cast.

The CTD console was set on the port side of the interior lab. The package was deployed through the aft A-frame using a special block supplied by the ship. During the cruise, this block needs to be repeatedly lowered and remounted to accommodate other operations/to stow for transit. The block has hinged strain relief fairleads, and we noticed that at times it has been mounted incorrectly so the wire wears on the fairlead metal rather than on the pulley on these fairleads, with the strain having bend the fairleads such that the wire can only be removed by prising the fairlead open. By removing the wire from the fairleads and lifting the block, one can swap the two hinged strait relief fairleads ensuring the wire runs on the pulleys, **Action Item: Check if block needs repair. Ensure block is correctly mounted for future operations**. Although a Pentagon ULT unit had been mounted inside by the CTD console for lowering and raising the CTD, in practice, the winch driving was done by a crew member on deck, directed by the CTD operator using radio commands. This was deemed more efficient given the shortness of the casts (50m or less).

As in previous years, in 2024 the crew operated the winch from a remote console on the deck by the A-frame. The lowering (and raising) rate we seek is ~30 or 40m/min. There is no readout of winch speed at the remote console and winch drivers had to estimate speed either from the sound of the winch or from feedback from the scientist in the lab. **Action item: Be sure to calibrate in winch speed early in the cruise, preferably with some scale on the winch so the speed is consistent between operators. Update ship's winch so as to provide a speed readout by the remote console. Also, train CTD driver to check winch speed on read-out beside CTD console both for lowering and raising.**

For the casts done during mooring operations, the CTD was hand-carried forward after each cast to the port-forward corner of the aft-deck, to clear the aft-deck for mooring work. Once all the mooring work was complete, the CTD package was kept on the aft deck.

Once mooring work was complete, CTD operations were run 24hrs, using a team (per watch) of 1 science team member driving the CTD, and up to 3 personnel (2 ship, 1 science) on deck - one (ship's crew) driving the winch, one ship's crew on starboard side of deck, one scientist on port side of deck. Since the aft doors were open so as to not lift the CTD too high, all personnel on deck wore harnesses and were attached to the "dog runs" overhead wires. Early in the cruise, we trained the team in tag-line operations, where the two people on deck (not driving the winch) used APL-supplied snap hooks on poles to get a line onto the frame of the rosette. **Action item: Continue to train this early in the cruise.**

A surface soak depth of ~5m has become standard for us, although some casts this year only used 2m. **Action item: Add target soak depth of 5-10m to CTD instructions**. (Two m is too shallow and could cause issues if we have heavy seas.)

The efficiency of the crew made for very speedy CTD operations, and combined with the fast winch speed, resulted in commendably fast times for running line, though significantly slower than using the non-rosette system. If pumped samples were to be taken, this operation followed on immediately after the CTD cast without the ship repositioning. **Action item: Make sure the CTD is recovered and out of the water before the pump system is deployed, otherwise ship's manoeuvrability is compromised**.

Prior to each cast the turbidity sensor was cleaned by rinsing with soapy water and freshwater and wiping.

On several casts, jellyfish (ono) became stuck in the seawater intake of the CTD, requiring flushing of the cell on deck using a syringe. **Action item: Continue to bring syringe with better fit for flushing the CTD cell.**

While bottles generally functioned well, there were some issues:

- internal rubbers had to be tightened on several bottles. **Action item: NEVER leave the CTD cocked for any length of time. Check these before shipping. Carry several spares. Continue to bring the spare bottle**
- spigots on some bottles became very hard to open. **Action item: Check out.**
- check vents at top of bottle, some needed to be done up very tight to be airtight. **Action item: Check out.**
- bring better CTD mat. **Action item: Order CTD mat**

Ship's draft was estimated at 2m, and this should be taken into account in viewing the data. Also given that sea states were often significant and the altimeter on the CTD (which usually rarely functioned) was not used this year, some casts stop 5m-6m above the bottom. **Action item: Investigate altimeter use in future years.**

As in 2022, a SUNA nitrate sensor was added to the CTD package. As this requires significant current on start up, it was powered by an external, rechargeable battery, as per a design from Seth Danielson. When the CTD powers on, this activates a relay in the external battery which turns on power to the SUNA. Two battery packs were constructed so one could be charging while one was in use. A newly charged SUNA battery is ~12.8V. We aim to swap the battery before it falls below 11.9V. We estimate that a safe usage time for the battery before reaching this threshold is 500minutes, and on-time of the SUNA is logged in the event log. **Action item: Make summing of SUNA time automatic in event log.** The SUNA returned a voltage to SeaSave, which gives a rough estimate of nitrate. Proper calibration of this data stream is still required. **Action item: Process SUNA data once CTD data final.** Plots in this report use preprocessed SUNA data.

As discussed below, in 2024 the SUNA failed to return good data to the CTD on two casts (123 & 124, BS16.5 and BS17 on last running of the BS line). This problem was fixed by cleaning the connections on the cable between the CTD and the SUNA. The SUNA battery was swapped at this point, and had a voltage of 12.3V,after an on time of 316min.

Overall, CTD data this year are clean, although the following issues were encountered:

- Ox2 was frequently extremely noisy – Action item: send for calibration
- Ox 1 was typically 5-7% saturation greater than Ox2, which is outside manufacturer's specs.
- there appears to be an offset of 0.05PSU on some casts. Action item: revisit when salinity samples are processed.

March2025 note: Salinity samples suggest that the best data are using the combination of T2, S2 and Ox1

- Oxygen align was found to be best with 2 as in previous years, although the observed range of oxygen values was very low, making this investigation somewhat inconclusive.
- specific issues by cast are given below.

Processing details (given below) are as in previous years, with the addition of the corrections of the SUNA data to be added once the post-cruise CTD calibration is complete.

<u>BStrait 2024 CTD PROCESSING – 21st Oct 2024 (using precruise cals)</u>

Have 154 hex files from cruise, and logs tell us 154 casts too with

1 = deck test in teller
2 = water test in teller
3 – water test in teller

And

6 – test cast for CTD driver training near A4 (so still good data, just not on a line)
7 – test cast for CTD driver training near A4 (so still good data, just not on a line)
8 – test cast for CTD driver training near A4 (so still good data, just not on a line)

And

12 – test cast for bottles, near A3 – may not go to depth?
13 – test cast for bottles, near A3 – may not go to depth?

End up processing 154 files

<u>2024 ISSUES by cast (from event log;</u> with info from going through cast by cast)

Conclude go with T2, S2 (maybe 0.05saltier) and Ox1 all downcasts for plotting.

SALINITY (barring odd spike) – S2 gives good data on all downcasts. Maybe 0.005saltier than S1

S1 bad on down
- 84 and 85 (SBSnn10.5 and SBSnn11.5) – S1 bad, use S2
- 144 SBSnn6 – S1 bad, use S2

S1 bad on up for those all AND
- 101 (S2 ok)

S2 bad - 6 upcast
- 30 upcast

OXYGEN – strong offset, but Ox1 ok on all downcasts

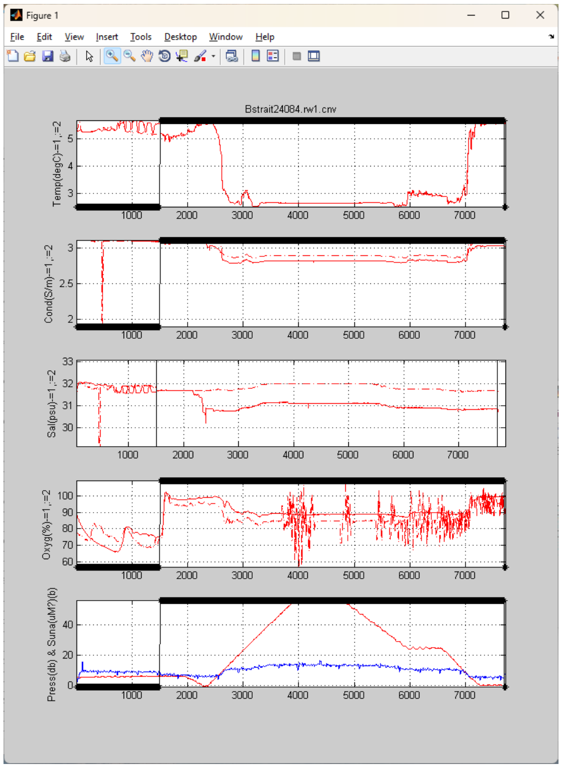
Ox1 bad on up for – cast 30 (Ox2 ok)
Ox2 very frequently very noisy, though not always. But not really usable.
5-7% off set between Ox1 and Ox2, with Ox 2 being lower

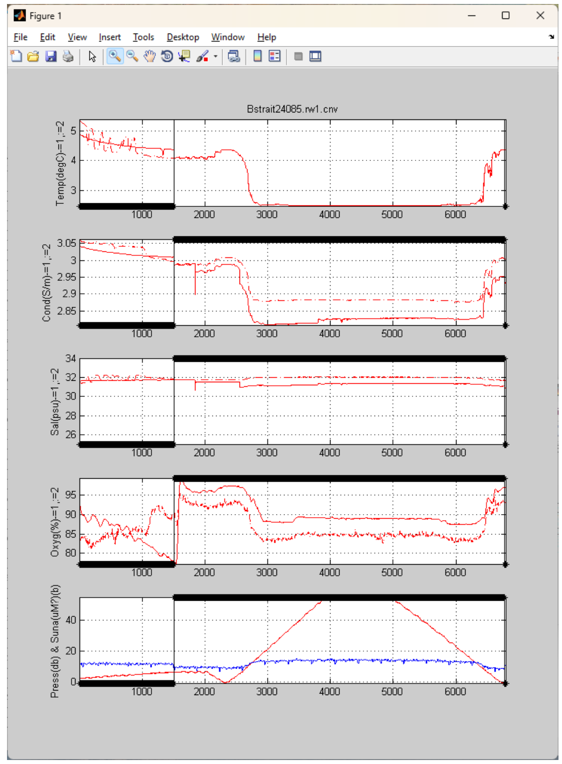
ISSUES BY CAST

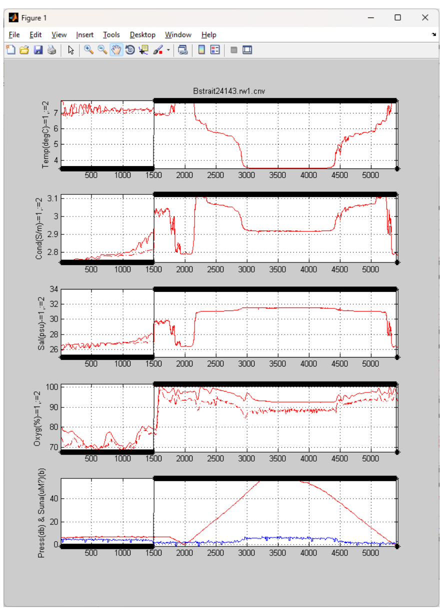
6 – S2 bad part of way up.
29 – Ox2 is 20% off
30 – S2 bad part of way up - OX1 bad on ALL up.
Very interesting temperature inversion at ~40m
31 – Surface only S not converged, so brought back on board and cleaned. Ditch this cast
32 – offset, S2 fresher by 0.05 **
66 – S1 and S2 disagreed – took salinity sample to resolve issue later.
(S1 is only 0.05psu fresher. This might be sensor difference).
Feb2025: S samples show S2 correct, S1 too fresh
67 – S2 noisy with amplitude 0.02, and 0.02-0.04psu saltier than S1 (BS17.5)
83 – S2 bad at bottom of up cast **
84 – salinity sensors disagree – S1 bad on down cast
85 – salinity sensors disagreed – took salinity sample to resolve issue later– S1 bad on down cast
Feb2025: S samples show S1 too fresh. S2 saltier than sample by 0.15psu. Did bottle leak?
101 – S1 salinity bad on up (jellyfish?) - S1 ok on down, but bad half way up.
120 – Ox2 issue (zigzagging) RW This is on more casts than just these two!
122 – Ox 2 issue (zigzagging)
123 – SUNA FAILS

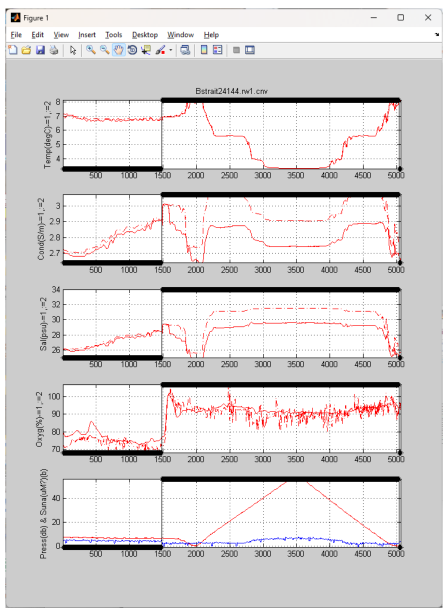
124 – SUNA FAILS

144 – salinities not converging (S1 bad, S2 ok)
145 – salinities not converging - didn't to to depth, but moved on cos of weather





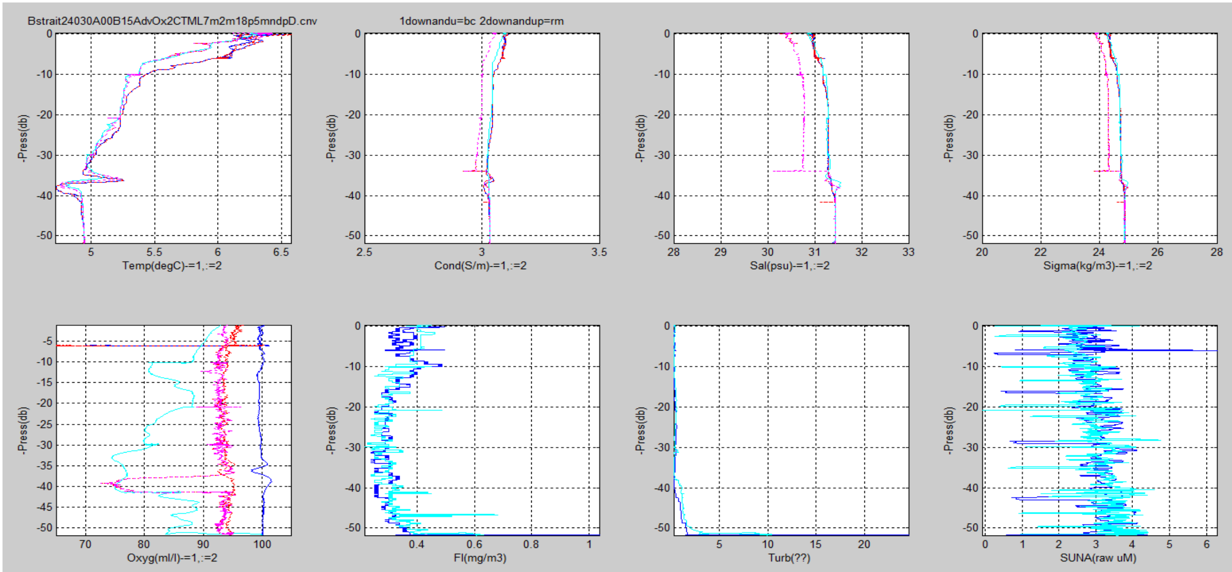




142 – S at depth = 31.25 and Ox1=92 and T=4.9
143 – S at depth = 31.5 and ox1 =92.5 and T=3.5
144 – S1 =29.5 S2 = 31.5 and Ox1=91 and T=3.3
145 didn't go down
146 – S at depth 31.5 and Ox1 92-94 and T 3.3

So conclude S2 is ok for 144.

Cast 30



Bstrait24030A00B15AdvOx2CTML7m2m18p5mndpD.cnv
1downandu=bc 2downandup=rm
Temp(degC)-=1,.:=2
Cond(S/m)-=1,.:=2
Sal(psu)-=1,.:=2
Sigma(kg/m3)-=1,.:=2
Oxyg(ml/l)-=1,.:=2
Fl(mg/m3)
Turb(??)
SUNA(raw uM)
-Press(db)

<u>NOTES ON BERING STRAIT 2024 CTD PROCESSING </u> Rebecca Woodgate (based on 2019processing)
Start with files from SeaSave for each cast, i.e.,
Bstrait24nnnn.hex and Bstrait24nnnn.hdr
Then run through 9 steps (8 of them with SBEDataProcessing program from Seabird).

(2024 Have 154 casts and so 770 CTD files in processing directory?

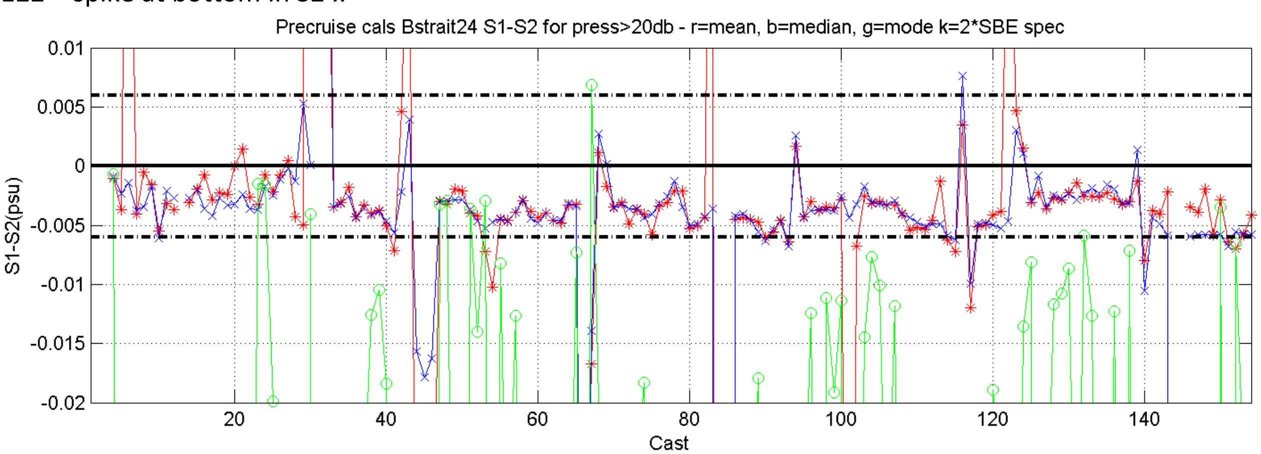
=== 1) First make up a file to be used for quick plotting. This contains all variables, but is not corrected in any way.
IN SBEDATA PROCESSING, RUN: DATA CONVERSION
(PSA file for this = 001_DatCnvBStrait2024_allvarswithSUNA.psa)
Inputs are: BStrait24nnnn.hex and BStrait24nnnn.hdr
*In FILE SETUP
-- CHECK box on match instrument to configuration file
-- Choose input file (should be .HEX) and directory
-- Name append .rw1
-- Choose output directory
*In DATA SETUP
-- Convert data from:UP and downcast *(Last year we just did down as we were firing no bottles. Here we do both, noting that upcasts may differ because of water being swept up with the CTD.)*
-- Create file types: data (.CNV) only *** NOW Cast and bottle data ... *** USING .BL File
...—Merge Header file
-- Select output variables... we use
-- 1) Pressure, Digiquartz (db)
-- 2) Temperature (ITS-90, degC)
-- 3) Temperature,2 (ITS-90, degC)
-- 4) Conductivity (S/m)
-- 5) Conductivity, 2 (S/m)
-- 6) Oxygen raw, SBE 43 (Volts)
-- 7) Oxygen, SBE 43 (saturation)
-- 8) Oxygen raw, SBE 43, 2(Volts)
-- 9) Oxygen, SBE 43, 2(saturation)
-- 10) Fluorescence WET Labs WET star (mg/m^3)
-- 11) Upoly 0, FLNTURT
12) Scan Count % This was done in 2018, but not recorded in the write up
-- 13) Salinity, Practical (PSU)
-- 14) Salinity, Practical, 2 (PSU)
-- 15) Time, NMEA (seconds)
-- 16) Latitude (deg)
-- 17) Longitude (deg)
-- 18) Altimeter (m) *** NOW USER POLY 2, which is SUNA
-- 19) Pump Status
-- Source for start time in output .cnv header: Select NMEA time
*In MISCELLANEOUS
-- Keep all defaults. Note the Oxygen is Window size (2s), Apply Tau Correction, Apply Hysteresis.
But now we want
A) to replace Alt with SUNA ...in col 18
b) to do bottle file also. ... so ---- do bottle and data
--- source is bl file

THIS GIVES files called: BStrait24nnn.rw1.cnv
BStrait24nnn.rw1.ros – for casts with fired bottles

=== 2) Do first basic quality control by plotting everything in Matlab
Matlab master code = **testplotsBStrait2018RW.m** which calls subroutine **CTDQCpump.m**
Inputs are: BStrait18nnn.rw1.cnv
Checks here include:
--- that the pump comes on
--- that the altimeter is working
--- that T1=T2, S1=S2 and Ox1=Ox2
--- preliminary identification of spikes and other issues.

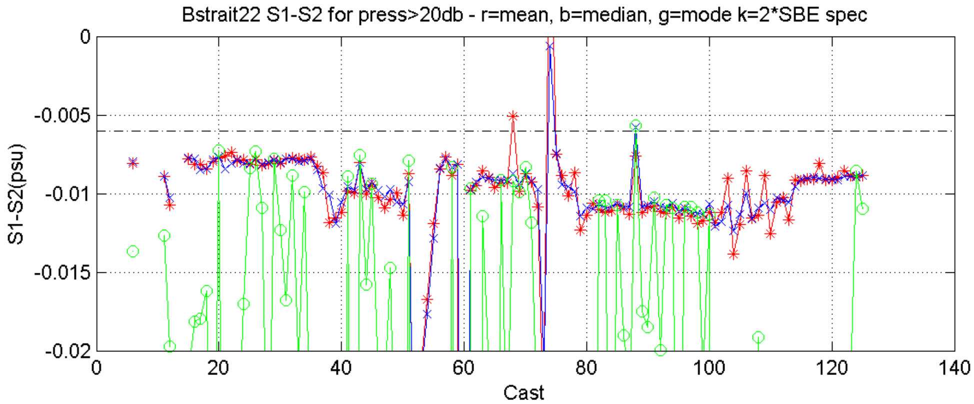
.. mostly ok – see summary of notes above.

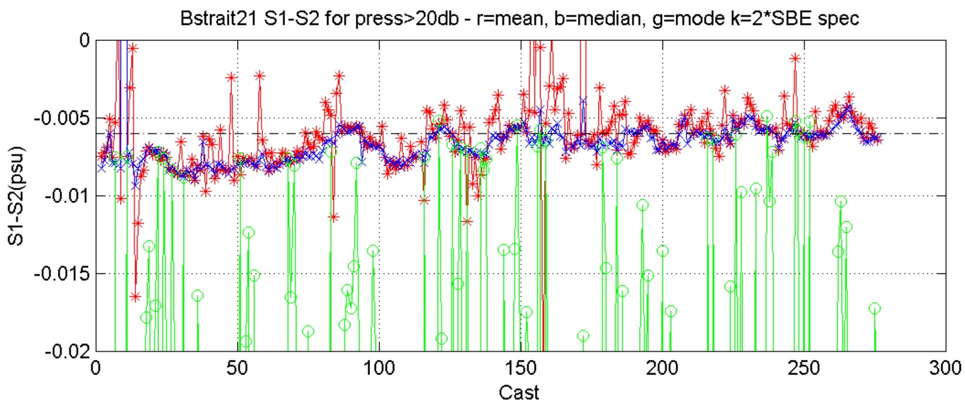
Then look at Sdiff, which flags also some others of which we decide the following are ok (rest are in list above).
28 – spike
29 – S2 off at top of up cast
44 – just very nosiy at surface
46 – noisy on upcast at surface
84.85 know about
90 – spikes
117 – seems ok
But Green is MODE, so not necessarily relevant – look at where mean (red) or median (blue) fall outside the specs.
6, 30, 32,43,44,45,46,66,67,83, 84,85,101, 122,144
Of which unknown are (take 67 up to main list)
43,44,45,46,67,122
43,44,45,46, – likely just variability - end of AL line
122 – spike at bottom in S2 ..

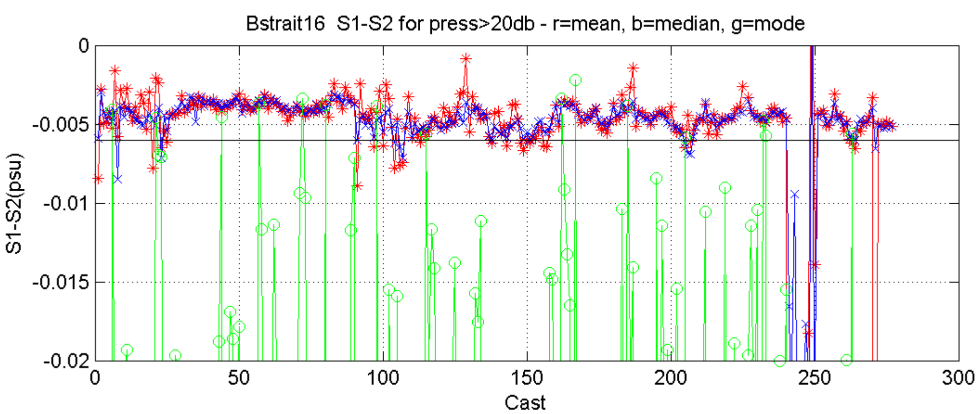


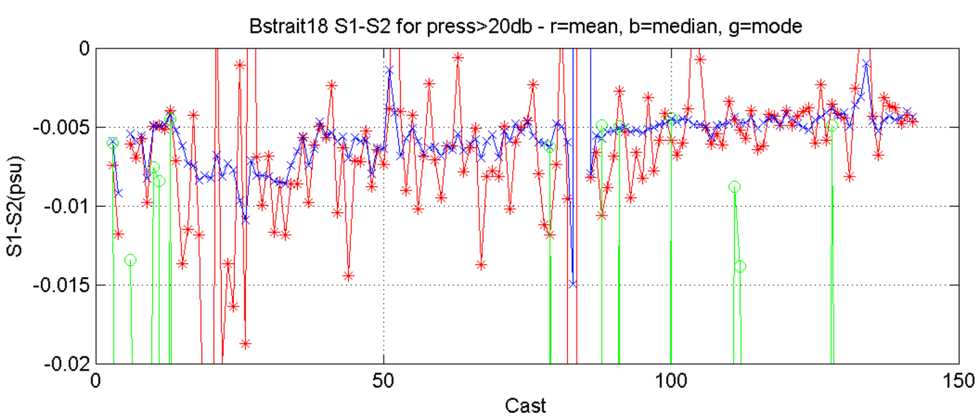
This is near limit, so recalibration is advisable.

Here are older Salinity plots to compare:









=== 3) Now work through the 7 steps of SBEDataConversion. Start by applying the calibrations to get the converted files, but this time excluding all the derived variables.
IN SBEDATA PROCESSING, RUN: DATA CONVERSION
(PSA file for this = DatCnvBStrait2024_CTDforprocess.psa)
Inputs are: BStrait24nnnn.hex and BStrait24nnnn.hdr
*In FILE SETUP
-- CHECK box on match instrument to configuration file
-- Choose input file (should be .HEX) and directory
-- Name append NONE
-- Choose output directory
*In DATA SETUP
-- Convert data from:UP and downcast *(Last year as here, we do both, noting that upcasts may differ because of water being swept up with the CTD.) *** ADD WiTH BOTTLES AND ** ADD .BT FILE*
-- Create file types: data (.CNV) only
...—Merge Header file
-- Select output variables... for 2018 we use
-- 1) Pressure, Digiquartz (db)
-- 2) Temperature (ITS-90, degC)
-- 3) Temperature,2 (ITS-90, degC)
-- 4) Conductivity (S/m)
-- 5) Conductivity, 2 (S/m)
-- 6) Oxygen raw, SBE 43 (Volts)
-- 7) Oxygen raw, SBE 43, 2(Volts)
-- 8) Fluorescence WET Labs WET star (mg/m^3)
-- 9) Upoly 0, FLNTURT
-- 10) Scan Count
-- 11) Time, NMEA (seconds)
-- 12) Latitude (deg)
-- 13) Longitude (deg)
-- 14) Altimeter (m) ** REPLACE WITH SUNA (UPoly2)
-- 15) Pump Status
** 16) BOTTLES FIRED
-- Source for start time in output .cnv header: Select NMEA time
*In MISCELLANEOUS
-- Keep all defaults. Note the Oxygen is Window size (2s), Apply Tau Correction, Apply Hysteresis.
THIS GIVES files called: BStrait24nnnn.cnv and BStrait24nnn..ros

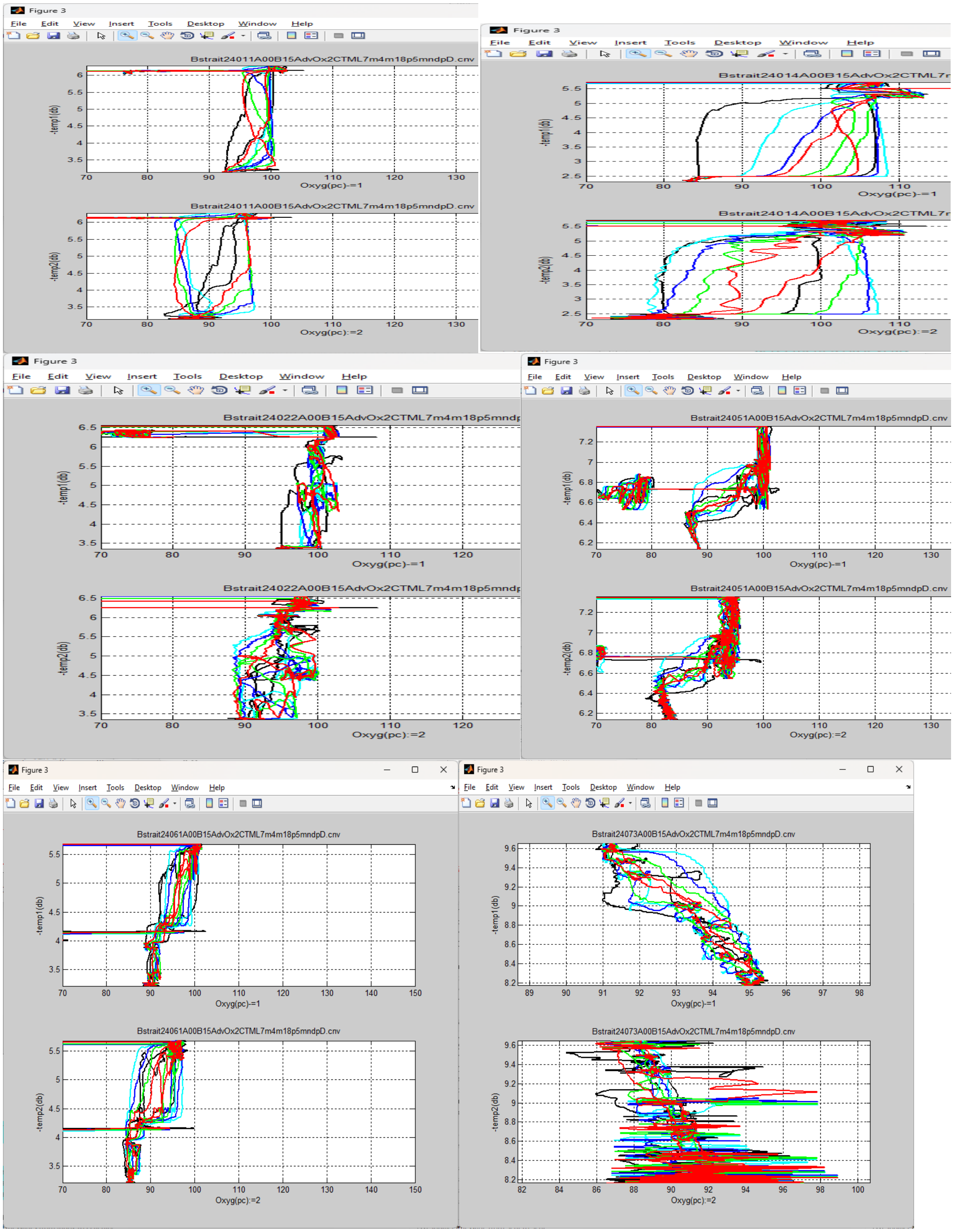
=== 4) Second step of SBEDataProcessing. Apply a time filtering to the data.
This step allows us to time-filter (i.e., smooth) the data. Routine allows us to select two filters, A and B. In 2014, we used A = 0.5 sec and B=0.15 sec, but in 2015 this appeared to remove too much variability.
Manual for the SBE9plus suggests to not filter Temperature and Conductivity, but to filter pressure at 0.15s. So set A=0, and B=0.15 and then only filter pressure *(this is now the same as 2015, but different to 2014).*
Note these filters should be applied to the raw data (e.g., Ox voltage, Conductivities), not the derived data (e.g., salinity, oxygen saturation, etc).
IN SBEDATA PROCESSING, RUN: FILTER
(PSA file for this = FilterBStrait2024_CTDforprocess.psa)
**** Might filter SUNA here ... and not sure what to do about bottle files**

Inputs are: BStrait24nnnn.cnv

*In DATA SETUP
-- Lowpass filter A(sec): 0.0 *(was 0.5 in 2014, but this seemed too smooth in 2015, so used 0, as here)*
-- Lowpass filter B(sec): 0.15 *(This is as per the manual for SBE9plus)*
--> SPECIFY FILTERS
-- Pressure: Lowpass filter B
-- Temperature: None
-- Temperature, 2: None
-- Conductivity: None
-- Conductivity,2: None
-- Oxygen raw: None
-- Oxygen raw,2: None
-- All others: None ... including SUNA
*In FILE SETUP
-- Name append = A00B15 *... this indicates data was filtered (Note: makes only small changes to the data)*
THIS GIVES files called: BStrait22nnnnA00B15.cnv

=== 5) Third step of SBEDataProcessing. Align the timeseries in time.
This step is to compensate for the delay between the water passing the various sensors in the pumped pathway. For the SBE9plus, the manuals suggest that
- the temperature advance relative to pressure =0
- that the salinity advance relative to pressure is 0.073s, but this advance is set in the SBE11plus by factory settings, and thus for this program we use conductivity advance =0. ***Action item: Check this is what is set in the SBE11 plus.***
- that the oxygen advance should be between +2and +5. This should be done on the Oxygen voltage.
IN SBEDATA PROCESSING, RUN: ALIGN
(PSA file for this = AlignCTDBStrait2024_CTDforprocessOx2.psa)
Inputs are: BStrait24nnnnA00B15.cnv
*In DATA SETUP
--> Enter Advance values
-- Oxygen: 2 *(as recommended in SBE9+ manual (2 to 5), and tests suggest in 2014 and 2015)*
-- All others: 0
*In FILE SETUP
-- Append added = AdvOx5
THIS GIVES files called: BStrait22nnnnA00B15AdvOx2.cnv

So, of these, it is suggested we investigate the various oxygen options. This we run this step with various values for the oxygen advance (2-5) and, by plotting oxygen against temperature, see which advance value gives the most consistent reading comparing the up and down casts.
RUN 04Align, 05CTM, 06LoopEdit, 07Derive, and then plot in matlab to get this
R=2,g=3,b=4,c=5



Ox range very small on this cruise, so often very hard to tell. Ox2 also a lot of noise.
As in previous years Ox1 much better behaved than Ox2
Ox1 – clear winner is red (Offset=2, 25 clear cases), next green (Offset=3, 4 clear cases)
Ox2 – red seems to be slightly more common than green, but the data are so noisy, hard to tell.
GO WITH RED (Offset2) for both channels as in previous years (apart from 2020), but remember spread between up and down cast is easily 5% or more.

=== 6) Fourth step of SBEDataProcessing. Correct for thermal mass of the cell

This is a standard SBE correction to compensate for thermal mass of the cell. Assumes the pump is at 3000 rpm. ***Action Item: Check this.*** Then manual suggests for SBE9+ Alpha=0.03, 1/beta=7.
IN SBEDATA PROCESSING, RUN: CELL THERMAL MASS
(PSA file for this = CellTMBStrait2024_CTDforprocess.psa)
Inputs are: BStrait24nnnnA00B15AdvOx2.cnv
*In DATA SETUP (correct both Primary and Secondary values)
-- Thermal anomaly amplitude [alpha]: 0.03 *(suggested for SBE9+)*
-- Thermal anomaly time constant [1/beta]: 7 *(suggested for SBE9+)*
*In FILE SETUP
-- Append added = CTM
THIS GIVES files called: BStrait24nnnnA00B15AdvOx2CTM.cnv

== 7) Fifth step of SBEDataProcessing. Remove pressure loops from the casts.
This step is to take out pressure looping, stalls in lowering, and the surface soak. To run this, you must have filtered the pressure first (as we did above). This does not remove any data, it just marks looped data with a bad data flag of -99e-26.
In 2015, we instigated a 5m depth for the initial surface soak, returning after that soak to the surface to start the downcast. Thus the used values were L5m2m6m (soak, min, max) and were used including deck pressure, and that seemed to work well with this routine. Prior years just used a 2m soak depth and that might be less successful with this routine.
In 2016 the soak was about 4m .. checks show this works with this routine and these settings.
In 2017, soak is about 7m, but sometimes much deeper. Previous settings (L5m2m6m) did not work well with this data set. After investigation, we learn the following:
- likely best not to include the deck pressure as offset - our system is never on while in air, and thus this will just introduce a non-intuitive offset.
- the max must be deeper than the deepest soak, yet shallower than the maximum depth of the shallowest cast. In 2017, the shallowest casts were (Cast1 and 2, tests, and thus not considered; 113(19.6m), 114(19.6m), 115(19.5m), 117(18.7m). Our deepest soaks were cast 20(18.25m), cast 31(16m). Thus, we set max to be 18.5m
- the min must be deep enough to separate the going-in-the-water oscillations from the soak. 2m and 3m were found to be too shallow in 2017, but by inspection 4m works well.
Finally settings for 2017 were thus: 7m soak, min 4m, max 18.5m. (Note if you specify max and min, the program is not supposed to use soak depth at all.)
In2018 these settings gave a good result and were used without further testing.
In 2022 and 2022, we again adopted these settings
In 2024, some casts (46 and 103-113) only went to 2m to soak, but this can be adapted for using 2m minimum soak depth. (Use Matlab to check this is doing what it should.)

IN SBEDATA PROCESSING, RUN: LOOP EDIT
(PSA file for this = LoopEditBStrait2024_CTDforprocess.psa)
Inputs are: BStrait24nnnnA00B15AdvOx2CTM.cnv
Must run filter on pressure first. Flag surface soak with -9.99e-26 ..
*In DATA SETUP
-- Minimum ctd velocity (m/s) = 0.25
--> Check box Remove Surface soak
-- Surface soak depth (m) = 7
-- Minimum soak depth (m) = 2 THIS FOR 2024 (was 4 previously)
-- Maximum soak depth (m) = 18.5
--> UNCheck box Use deck pressure as pressure offset
--> Check box Exclude scans marked bad

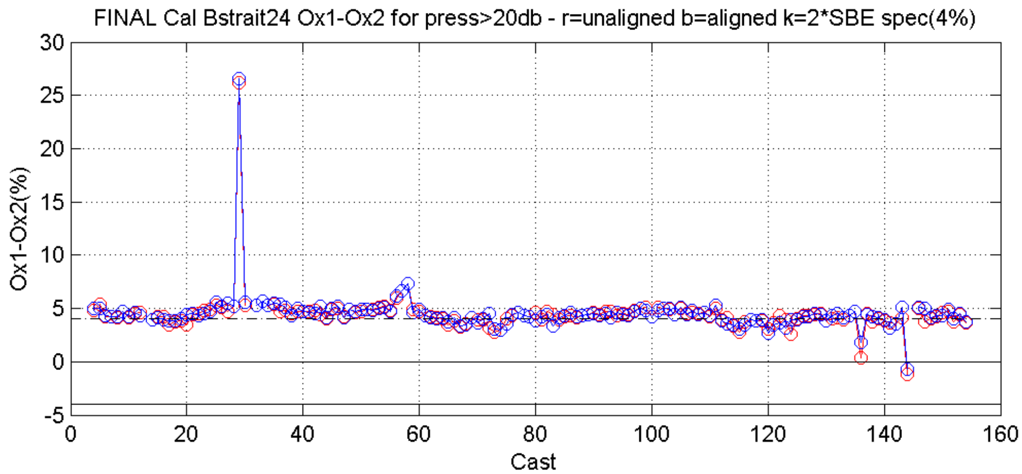
*In FILE SETUP
-- Append added = L7m2m18p5mndp
THIS GIVES files called: BStrait22nnnnA00B15AdvOx2CTM L7m2m18p5mndp.cnv

=== 8) Sixth step of SBEDataProcessing. Derive the parameters you want.
This step takes the raw data and calculates derived parameters, such as salinity, density, oxygen values, etc.
IN SBEDATA PROCESSING, RUN: DERIVE
(PSA file for this = DeriveCTDBStrait2024_CTDforprocess.psa)
Inputs are: BStrait24nnnnA00B15AdvOx2CTML7m2m18p5mndp.cnv
-- CHECK box on match instrument to configuration file (Prior notes says to check this box, however, in 2016 this crashed if the box was checked, so instead uncheck the box, **BUT MUST MAKE SURE IS USING A CURRENT CALIBRATION FILE**). If ever change sensors during cruise, will have to do something different here. Check these files to make sure the .con files are consistent.
*In DATA SETUP
--> Select derived variables... add:
-- Salinity (psu)
-- Salinity,2 (psu)
-- Salinity difference
-- Sigma theta (kg/m3)
-- Sigma theta,2 (kg/m3)
-- Sigma theta difference
-- Oxygen, SBE 43 (ml/l)
-- Oxygen, SBE 43 (saturation)
-- Oxygen, SBE 43, 2 (ml/l)
-- Oxygen, SBE 43, 2 (saturation)
*In FILE SETUP
-- Append added = D
THIS GIVES files called: BStrait24nnnnA00B15AdvOx2CTM L7m2m18p5mndp D.cnv

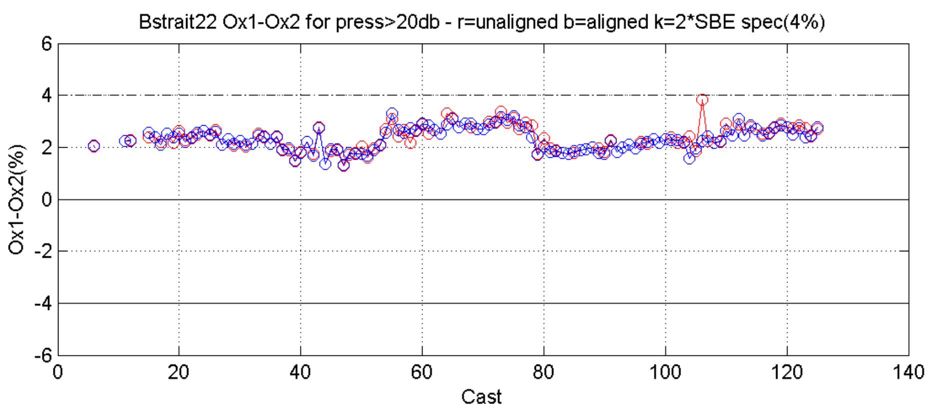
Check the Ox difference .. – off set between them is 5-7% and Ox2 is often very noisy

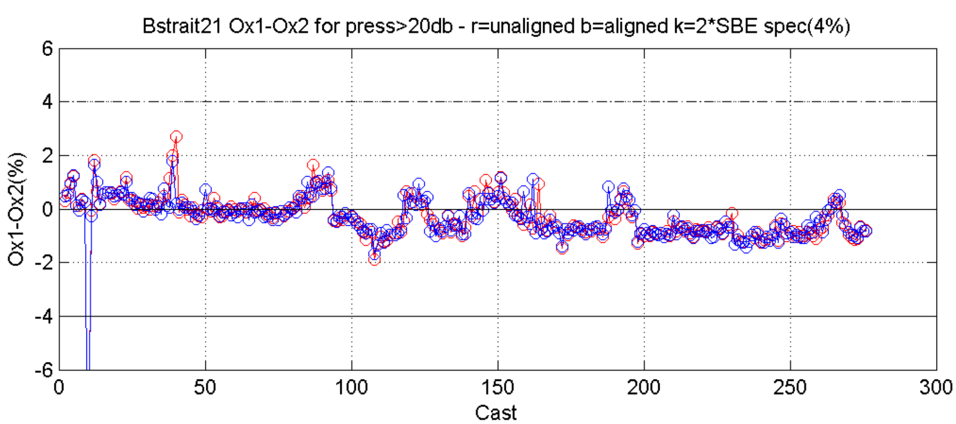
Finally conclude:

- at this stage will use Ox1, as it shows less spread than Ox2 and is a much cleaner signal
- alignment is generally best at +2.
- recognize that up and down casts may differ by 5%-10% .
- agreement between sensors much worse than previously, and just outside manufacturer's specifications (twice 2% saturation) so system should go to seabird for calibration and to repair the noise issue.



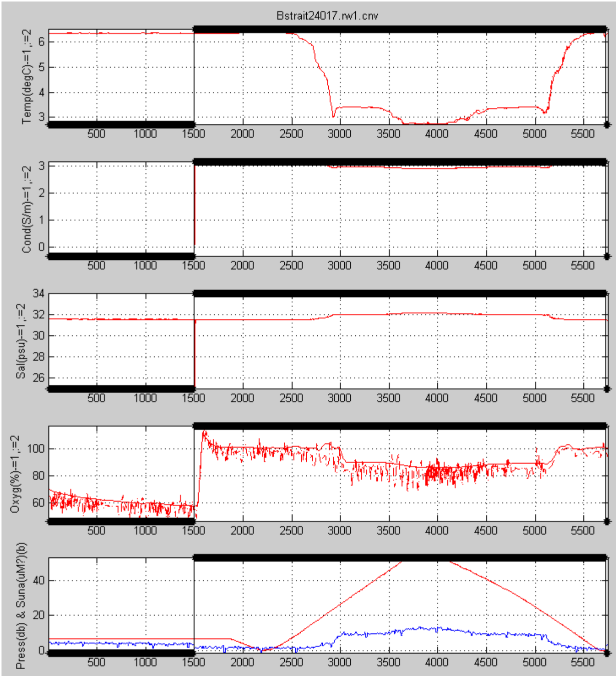
And previous for comparison

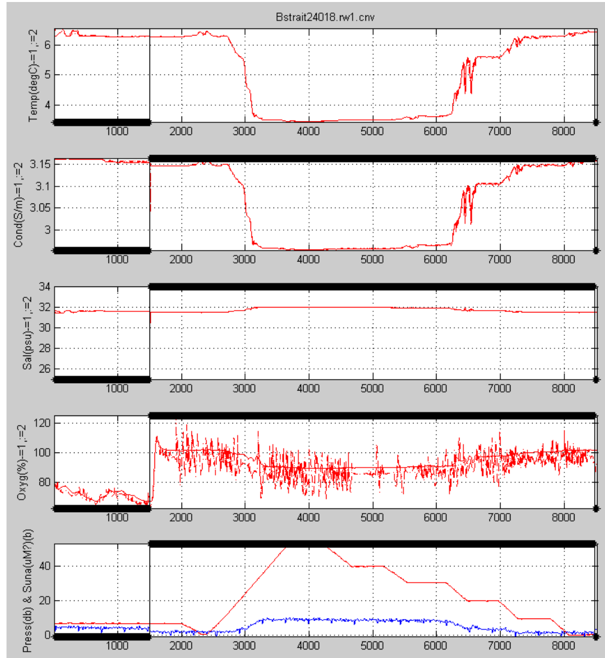




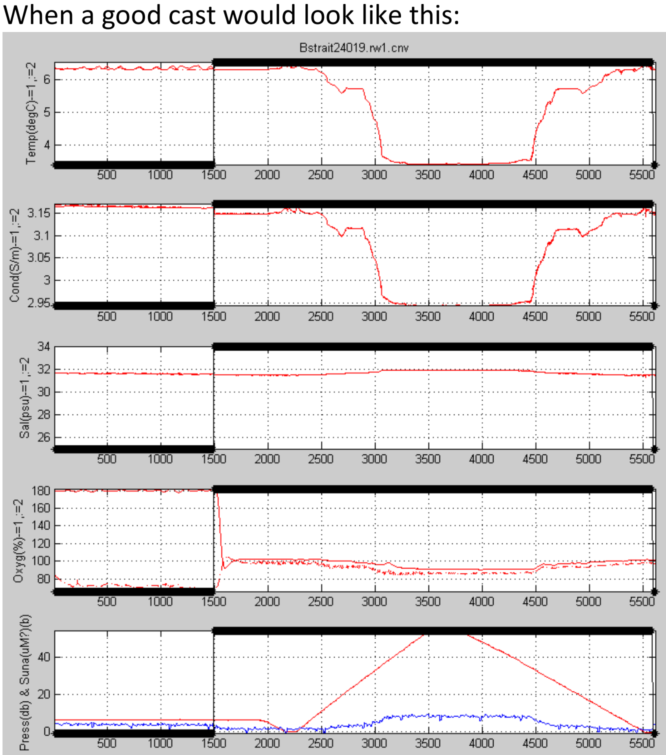
What is the message for Seabird?

Ox2 shows excessive noise, but only on some casts, e.g., compare casts 17, 18 (noisy) and 19 (ok again)





When a good cast would look like this:



Could stop here, and use these files, but to be more useful want to have Bin averages and despike, and the combination of the two of those processes. So, first look at the despiking options. SBEDataProcessing includes a file called "Wild Edit", but the manual describes that as "not the faint of heart" and says much trial and error is necessary to get good results. Thus, instead use something more automatic, Window Filter.

=== 9) Twelfth step of SBEDataProcessing. Use Window Filter to despike.
This is an attempt at automatic despiking. If just try so smooth over a spike, you will flatten it, but the bad data will still remain. Here we make one basic attempt, as outlined in the manual. This takes a window of data points, and for each window, replaces the central (?) point with the median of all the points. In some way thus, this is smoothing over the data points, but one that neglects extreme values. Their example suggests 17 points, and we have used that. Sampling rate is 24Hz. Drop rate is ~ 1m/s. So this is roughly equivalent to smoothing at 0.7 sec, or 70cm.
IN SBEDATA PROCESSING, RUN: WINDOW FILTER
(PSA file for this = W_FilterCTDBStrait2024_CTDforprocess_MF17.psa)
Inputs are: BStrait24nnnnA00B15AdvOx2CTM L7m2m18p5mndp D.cnv
 *In DATA SETUP
 --> Select Exclude scans marked bad
 --> Specify Window Filters:
 Type: Median Parameters: 17
 For variables: Temp1, Temp2, Cond1, Cond2, Oxraw1, Oxraw2, Fluorescence, Upoly (Turbidity/Transmissivity), Latitude, Longitude, Salinity1, Salinity2, Density1, Density2, Ox1ml/l, Ox1%, Ox2ml/l, Ox2%,Upoly2(rawSUNA)
 -- Append added = MF17
THIS GIVES files called: BStrait24nnnnA00B15AdvOx2CTM L7m2m18p5mndpDMF17.cnv

=== 9.5) SUNA postprocessing. During profiling, the SUNA returns a voltage to Seasave which can be plotted at a nominal calibration. Final corrected SUNA data are however obtained directly from the SUNA instrument, where data are stored internally at higher resolution allowing for postprocessing. The steps of that post processing are given briefly here, with full details below. Data processing has been checked against bottle samples, with the final agreement of SUNA data to the bottle samples being ~0.6uM, somewhat better than the manufacturer's specifications of 2uM.
SUNA processing summary:
 ** Very important to ensure SUNA clock is correct to NMEA time
 Pre deployment,
 - run SUNA reference update
 - run test runs of DI water, standard solution (ours made up at UW to 20uM), and DI water again
 Post-deployment
 - run test runs of DI water, standard solution (ours made up at UW to 20uM), and DI water again
 - run SUNA reference update

Use matlab routines to create from the final CTD data a file of temperature and salinity data on timestamps matching the SUNA data that was recorded internally on the SUNA

Run the Seabird UCI program to correct SUNA data for temperature and salinity, using both the pre-deployment reference update and the post-deployment reference update. The resultant timeseries will differ by a constant.

Linearly interpolate (by record number) between the pre and the post cal. (Test against bottle data show this product has an RMS error to the bottle data of 0.9uM).

Calculate the mean offset (-0.6µM) between the bottles and the SUNA and apply that as correction to the SUNA data. (Prior years have used the offset between pre and post DI and standard runs. However, in 2024, that correction would result in greater discrepancy between the SUNA and the bottle samples.)

In 2024, this final data set has an RMS error to the bottle samples of 0.64µM..
Use matlab routine to update .cnv files with corrected SUNA data.

=== 10) Seventh step of SBEDataProcessing. Bin average all the data.
All data files prior to this have been the 24Hz data up and down casts. Here we separate out the downcasts only, exclude the data marked bad by loop edit, and create 1m bin averages. We chose here to create a surface sample, however often the number of scans in that sample is small and in any case surface stirring by the ship must also be considered.
IN SBEDATA PROCESSING, RUN: BIN AVERAGE
(PSA file for this = BinAvgBStrait2024_CTDforprocess.psa)
Inputs are: –BStrait24nnnnA00B15AdvOx2CTM L7m2m18p5mndpDMF17.cnv
*In DATA SETUP
-- Bin type = Pressure
-- Bin size = 1
--> Select Exclude scans marked bad
→ Select include number of scans per bin
-- Scans to skip over = 0
-- Cast to process = **Downcast**
-> Include surface bin 0,1,0
*In FILE SETUP
-- Append added = BADCS010
THIS GIVES files called: BStrait24nnnnA00B15AdvOx2CTM L7m2m18p5mndp DMF17BADCS010.cnv

==== 11) Eighth step ... do Bin average up also? - not this year, as too many problems on theupcast
~~**THIS GIVES files called: BStrait22nnnnA00B15AdvOx2CTM L7m4m18p5mndp DMF17BADCS010.cnv**~~

In 2024 this marks the end of the CTD pre processing.

This file will be appended with SUNA information when the post-cruise calibrations are available.
==== Note on Bottle processing:
- during cast, seasave writes   .bl file, which has bottle fire scan number, and that plus 36 (1.5s)
- seabird dataconversion, creates a .ros file from .bl .. (option of how long for averaging bottle (2s)
  This is extracted lines from .cnv for 2s after bottle files
- bottle summary, ..takes the .ros file and makes a .btl using 49 scans per bottle
  Options: Select all averaged variables
                 Apply Tau correction

So one could extract bottle information from either:
- the bottle summary (Advantage: Standard. Disadvantage: Does not include correction)
- or from a separate program which extracts the same data from the final calibrated data.

We opt to do the second, in matlab, allowing us to easily combine the bottle information with the nutrient (and where taken, salinity) sample data into one ascii file.

<u>SUMMARY OF 2024 CTD SUNA processing - 8th March 2025</u>

AT SEA Suna 1916

- deployed on profiling SBE 9-11 CTD
- using a custom battery set up, modelled on that used by Seth Danielson,
  - power up voltage from SBE9 switches on power to SUNA from independent battery
  - prevents large current draw required for SUNA overpowering CTD
- preliminary data are recorded in Seasave .. however
  - this uses just a nominal calibration and a linear fit to voltage
    (these data are ~2µM higher than bottle data)
  - has some data dropouts, possibly due to water in the connector?
- raw data are recorded at full resolution on the SUNA itself
  - **** VERY IMPORTANT to ensure SUNA is on NMEA TIME ****
- pre and post cruise, run SUNA checks including:
  - **updating the reference spectra using DI water ** VERY IMPORTANT****
  - **running a standard solution (made at UW to 20uM concentration)**
- water samples taken at standard depths, during cruise and analysed for standard nutrients
- SUNA is recording Nitrate+some function of nitrite. As nitrite values are low (<0.2µM this year), the SUNA can be considered to effectively be reading nitrate. .
- SUNA data are corrected for temperature and salinity effects using Seabird's UCI software, applying the correction of Sakamoto et al., [2009]. The conversion is run for the pre-cruise (cal M) and post cruise (cal N) reference updates (calM) and the record is linearly interpolated (by sample number) between these calibrations.
- The resultant data fit bottle samples closer, but remain biased low. In previous years, pre and post distilled water readings have been used to correct this bias, however, in 2024 such a correction would increase the difference between the nutrient samples and the SUNA. Thus instead a constant of 0.6250µM (the mean of the SUNA-bottle differences has been added to the SUNA data.

Data Type	Mean SUNA-Bottles	STD (SUNA-Bottles)	RMS ERROR SUNA to bottles
RAW as recorded by CTD	2.2µM	1.1µM	2.4µM
Pre cruise Reference update (M)	0.01µM	0.8µM	0.8µM
Post cruise Reference update (N)	-1.7µM	0.8µM	1.9µM
Interpolate from M to N using record number	-0.6µM	0.6µM	0.9µM
And remove offset to bottle data.	0µM (by construction)	0.64µM	0.64µM FINAL DATA ACCURACY

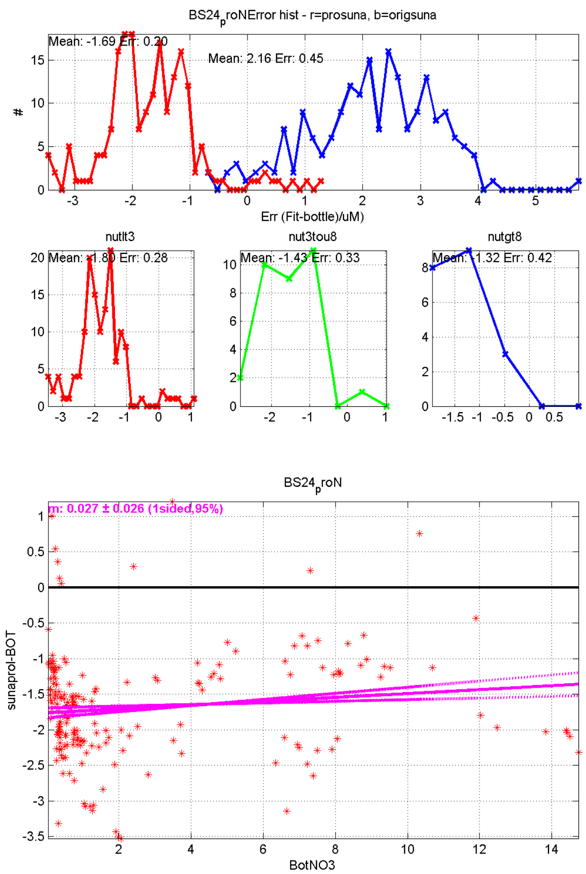
With this final calibration:

Final data accuracy is ~0.6µM, as in past years.
Distilled water readings are ~1µM pre cruise and ~1.5µM post cruise
UW standard (20µM) reads ~22µM pre cruise and post cruise, (consistent with prior readings of this standard).

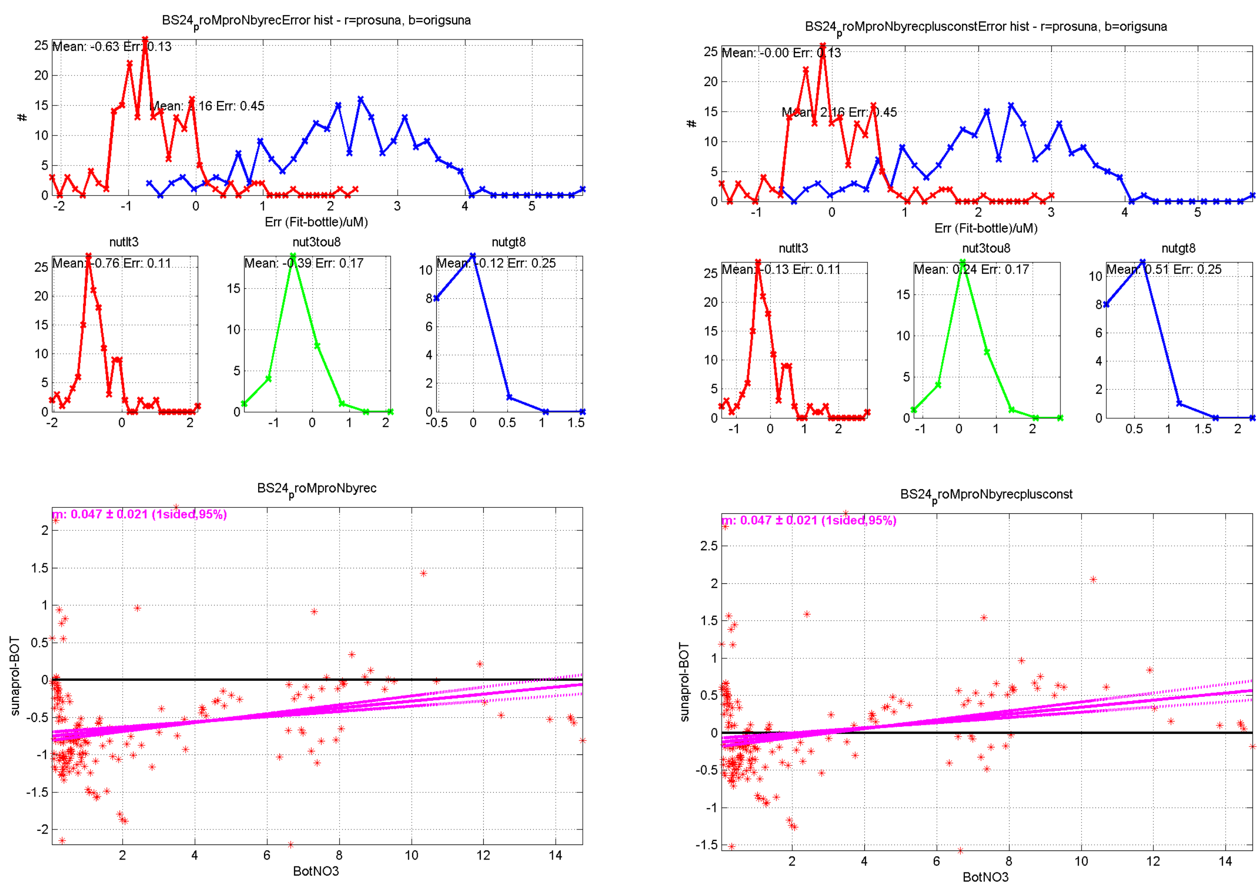
SUNA-bottle differences are significantly correlated with:

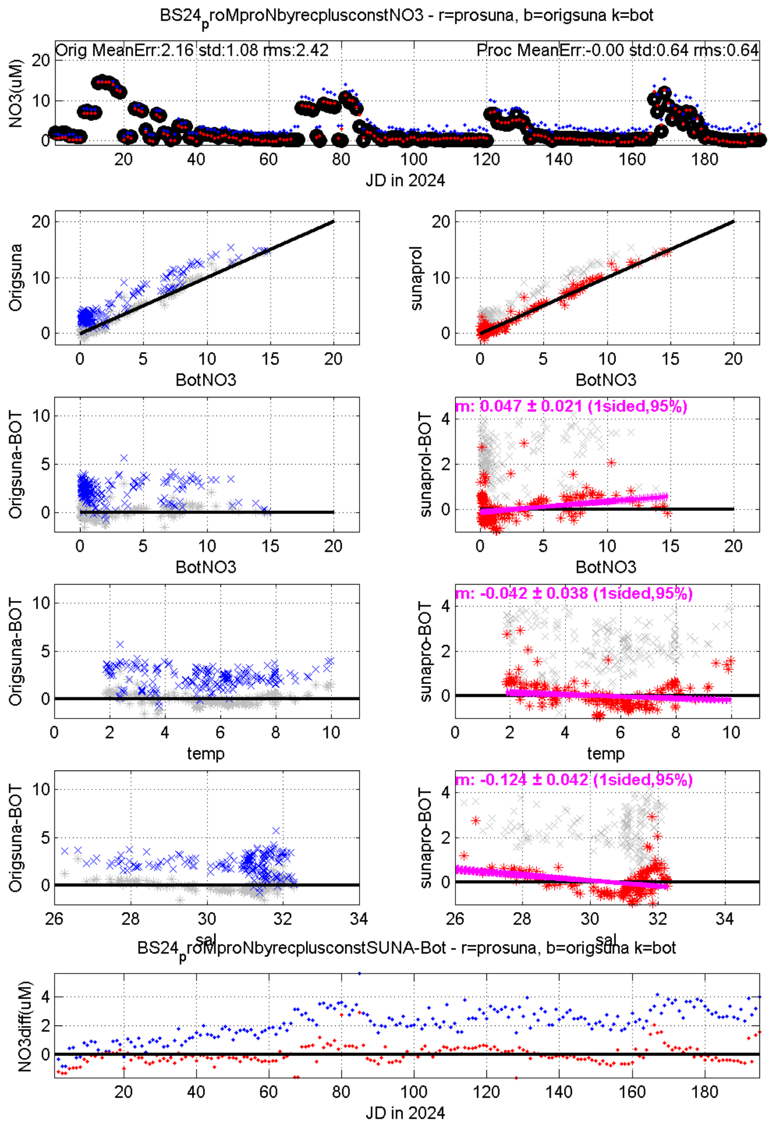
Nitrate	(m=0.047µM/µM),	equivalent to at 20 µM nitrate, SUNA reads ~ 1µM high
Temperature	(m=-0.042µM/degC),	equivalent to for 5deg warmer, SUNA reads ~0.2µM low
Salinity	(m=-0.12µM/psu),	equivalent to for 4 psu fresher, SUNA reads ~0.8µM high

CNV and Bin-average files are updated with corrected SUNA data.
Bottle data are updated for corrected SUNA data

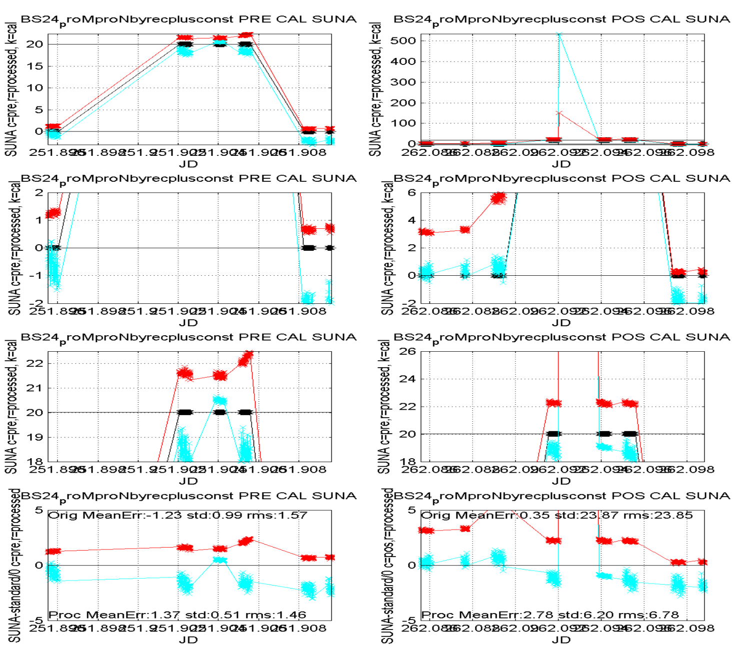


ABOVE: left=N, right=M. BELOW: left: NtoMinterpolated by record number, right: plus constant





For FINAL DATA



Norseman2 – CTD operation notes **Version 22/10/2024**

0. Coming onto station
- pre fill Event Log (Excel file)
- In Seasave - Real time data, Start, Begin archiving data immediately
  - Select Output Data File Name: Bstrait21nnn.hex, *** NOTE NAME 17, not 2017
  - Start
    - fill in header
      - Ship: Norseman 2, Station name (e.g., BS24), Operator
  - then WAIT
- **Driver to Deck:** "**clean wetlabs sensor**"
- **Deck to Driver:** "**sensor cleaned**"
- **Driver to Deck:** "**Are all bottles primed?**"
- **Deck to Driver:** "**Bottles are primed**"

1. On station confirmed from bridge "**on station**",
- **Driver to deck**, "**Ready to Deploy**"

CTD in the water (**Deck to Driver**: "**CTD in water and at 5m**") (**Driver: double click radio**)
- Power on CTD Deck Unit, check get readout of "10" (01<u>10</u>)
- OK on SeaSave header, wait until SeaSave gray windows close
- Real-time Control, Pump on (to turn pump on manually) ** CHECK SOAK IS 5-10m **
- Fill out rest of Event log (Excel file) for deployment (including time).
- Driver to deck, "**Please note wave height(m), clear or fog, and depth lose sight of ctd"**
- WAIT until –"11", "Pump on", Data ok (incl S and position), check #'s agree
- check target depth ~ water depth under keel
- **Driver to Deck**: "**return to surface and go down to xxx meters**" (GET SURFACE WIRE OUT)
- **Deck to Driver**: "**Going down**"
- Check lower speed (want 30/40 m/min) on winch readout

3. CTD lowers
- watch pressure ... *(resist temptation to analyze the cast on the way down) .. focus only on the pressure*
- **Driver to Deck**: "**3 2 1 stop**" for target depth
- **Deck to Driver**: "**CTD stopped**" (GET BOTTOM WIRE OUT)
- wait ~2sec or if want bottom bottle, wait 10s, and fire bottle(s)
- **Driver to Deck**: "**Come to surface/ come up xxm**" AND CHECK CTD COMES UP

4. CTD comes up
- if firing bottles,

Driver to Deck: "**3 2 1 stop**" for target depth, WAIT 10S, fire bottle, **Driver to Deck**: "**Come up xxm"**

If time, ** COMPARE SENSOR PAIRS - decide if data good enough to leave

When at surface (**Deck to Driver: "At surface"**) (**Driver: double click radio**)
- real time control – Pump off
- real time data – STOP
- Power off CTD Deck Unit
- **Driver to deck**: "**Recover CTD and proceed to next station/stay on station for pumping**"
- OR IF may have to recast .. add "**We have CTD issues, do not leave after this cast"**
- fill in Event Log for up cast (including time), while
- **Deck to Driver** "**CTD recovered SUNA off, bottle issues**, **wave height, fog, depth seeing ctd**."

THEN
- screen dump to paint (Alt-print screen, Cntrl V, save as BStrait21nnn.png); F12 (save as);
- QUIT paint.
- Copy the 4 files (.hex, .hdr, .xmlcon, .png) to USB Backup file directory

(Start event log for next cast)

**CHANGE SUNA BATTERY AT 500min (about 50 casts)

Deck responsibilities every cast:

- checking sensor cleaned and bottles correctly primed, including
  caps correctly position, spigots out and vent plugs tight.
- checking depth of surface soak
- watch wire (out aft is ok, under ship is not, far to side near ship not)
- keep winch operator focused
- count CTD as it goes down, listen for 3 2 1 stop and make sure winch stops

- At Bottom, make sure winch comes UP (e.g., watch wheel)
- Watch for tape on way up,

- Observe and report surface issues (e.g., broke surface, ask for repeat soak if out of water for more than 4 sec)
- report - clarity of water (max range at which you can see CTD in m)
  - fog
  - wave height if exciting
- report bottle issues once CTD is on deck.
- report if jelly fish remains on salinity cells

- make sure secure on deck.
- every 50 casts, check all CTD bolts

- do water sampling as required
- report any bottle problems (e.g. leaking).
- if bottle is leaking, do not sample from it unless it is the surface bottle.

BERING STRAIT 2024 CTD LINES

Severn CTD lines, including rerunnings of the BS line and the SBSnn lines were run on the cruise

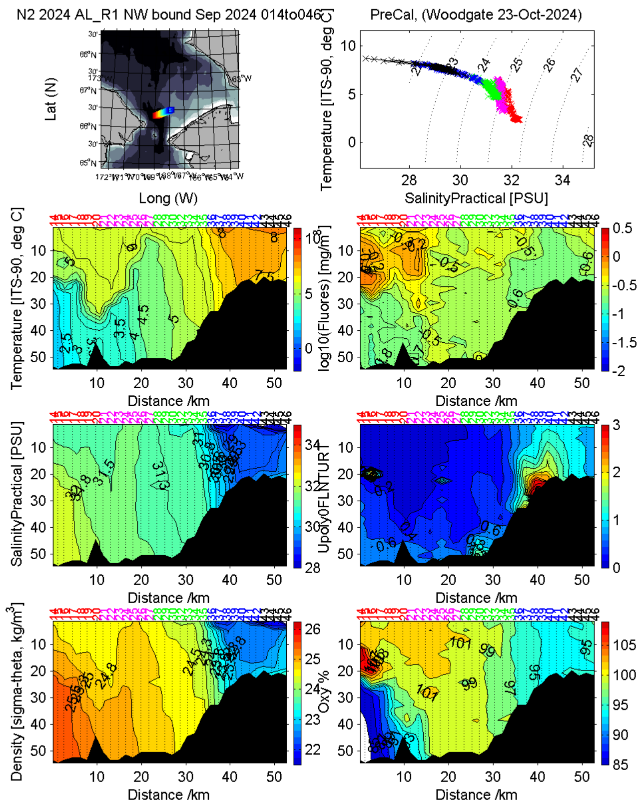
Sections were plotted using code from An Nguyen from the processed data and the quality control procedures outlined above to give 1m bin averages for plotting.

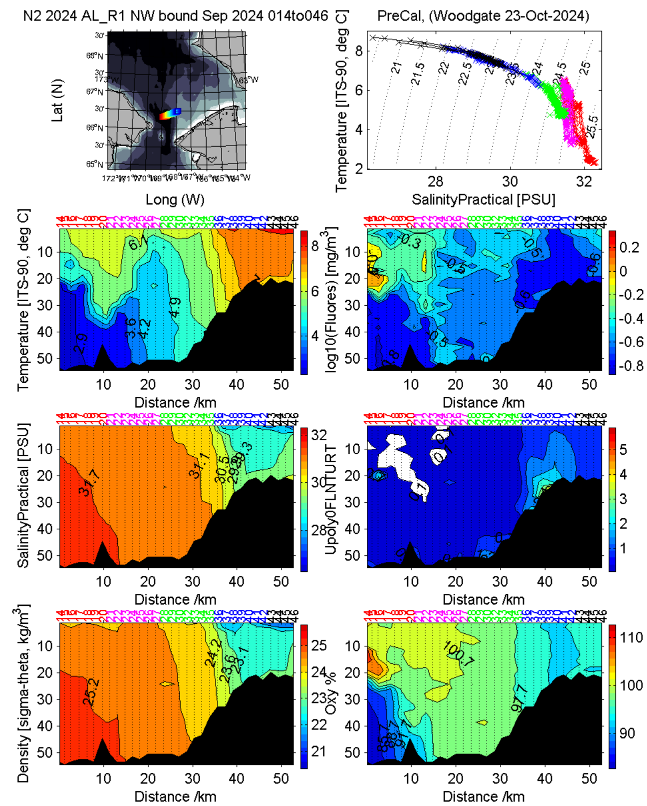
March 2025: Plots have been updated with Corrected SUNA data, which is estimated to have a ~0.6µM final accuracy, although note negative values are obviously errorneous.

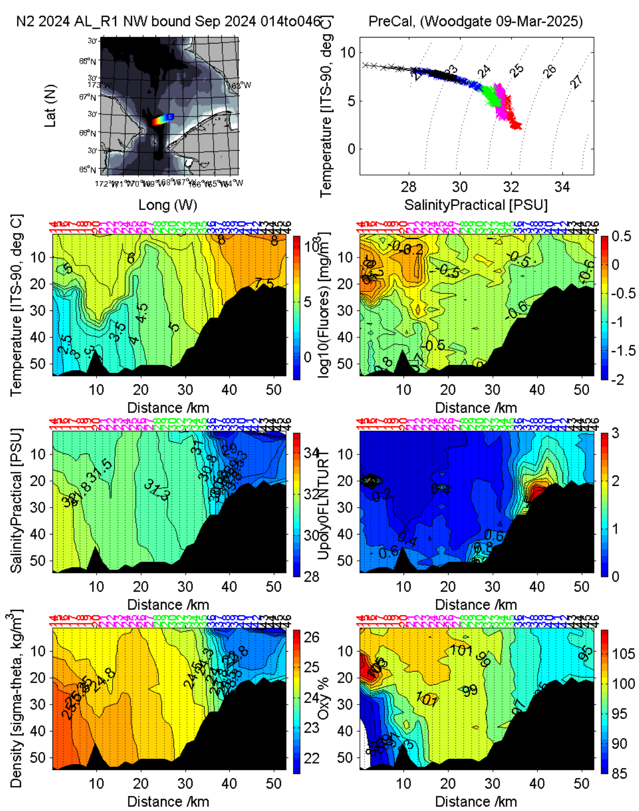
The plots below give all sections on the same scales (left) and on a scale for that section (right), presented in order of data acquisition. Note that:
- this uses the S1 and Ox1 data, uncorrected for issues on casts 84 and 85
- typically stops 2 to 3+ m above the bottom.

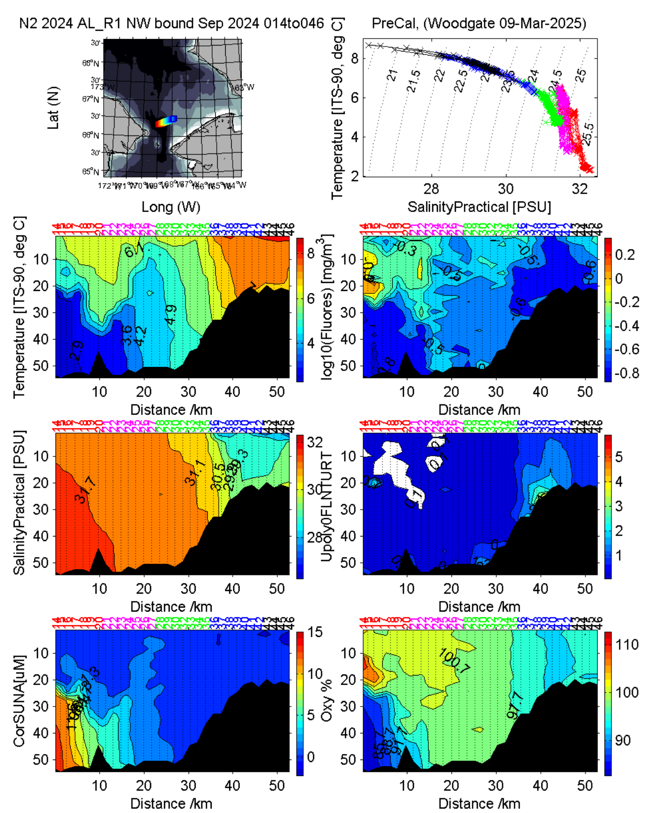
For full positions and times see event log and data file headers.

1) A3L line (AL) – only running, Northeastward

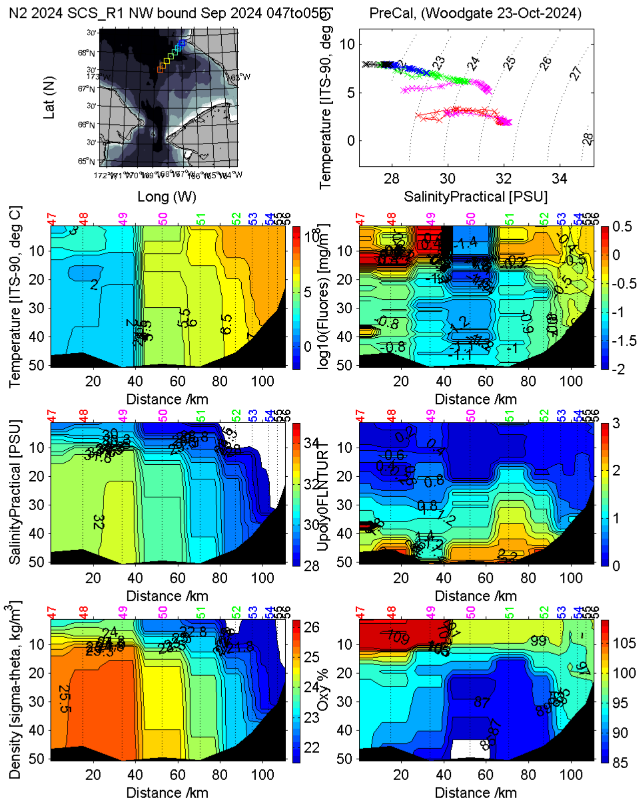


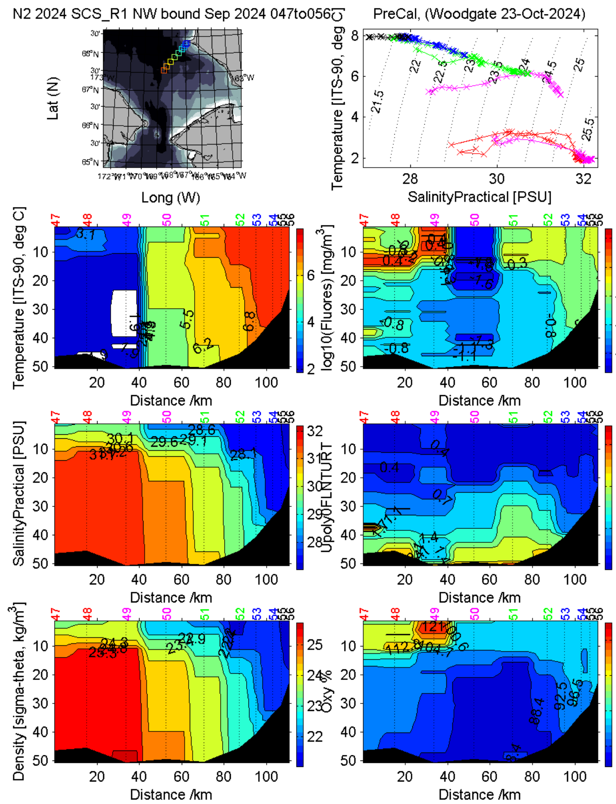


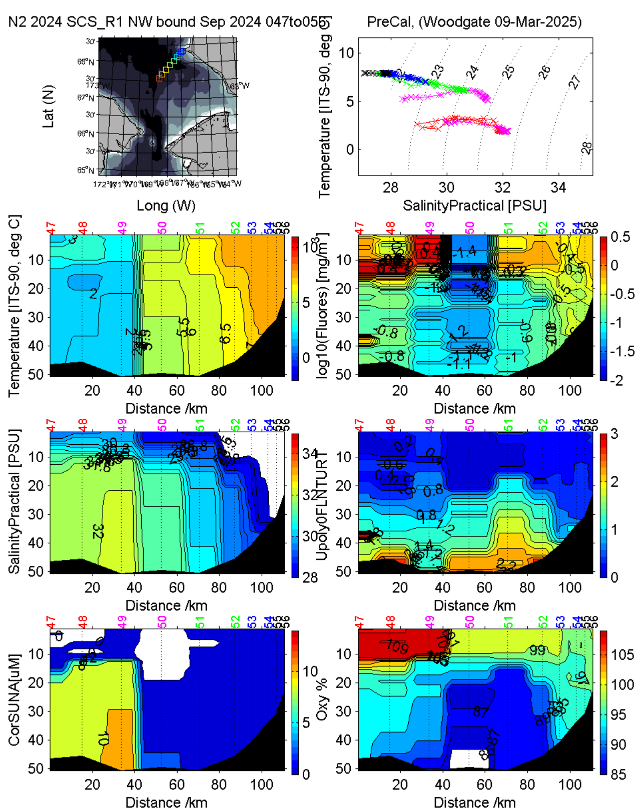


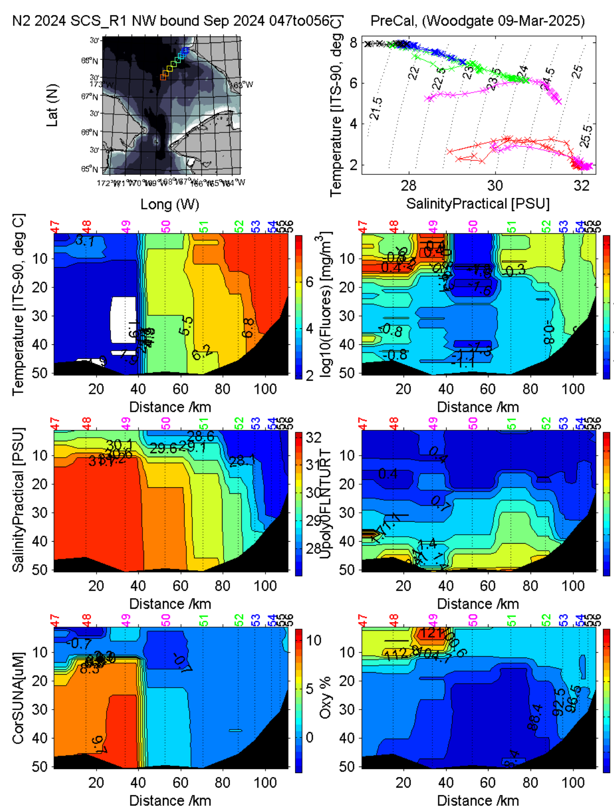


2) South of the Chukchi Sea line (displaced due to ice), (SCS) – only running, Northeastward

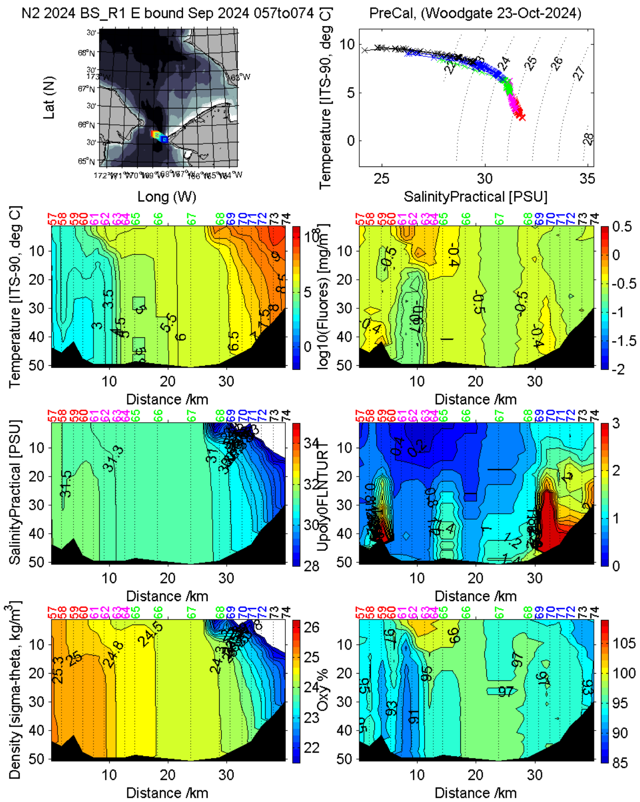


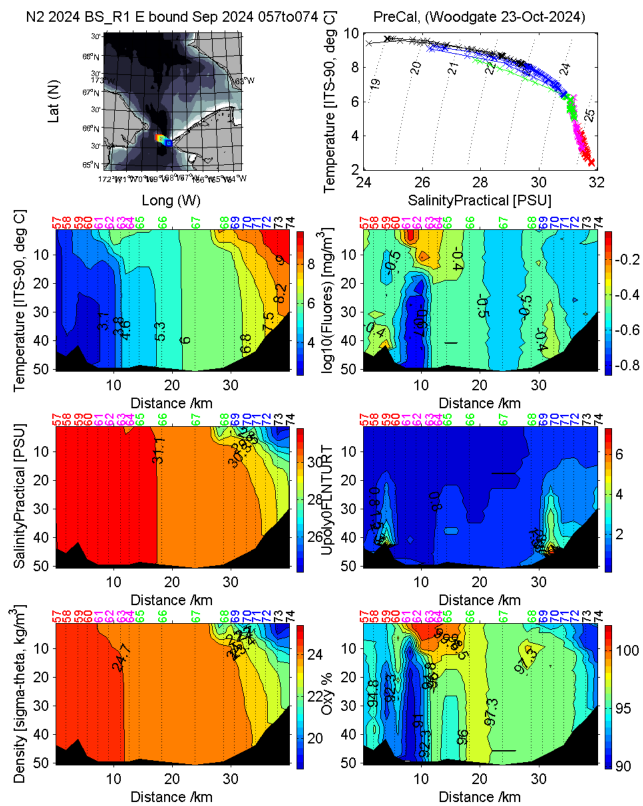


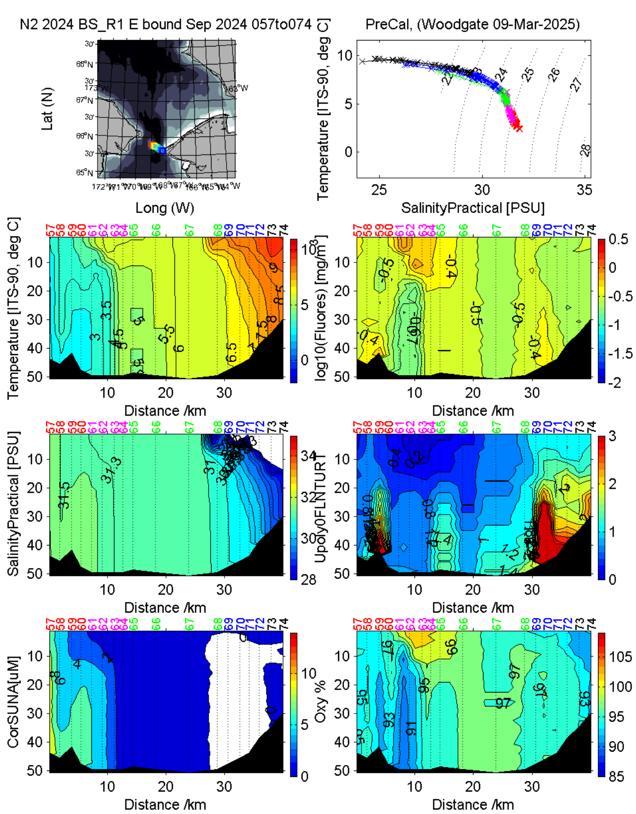


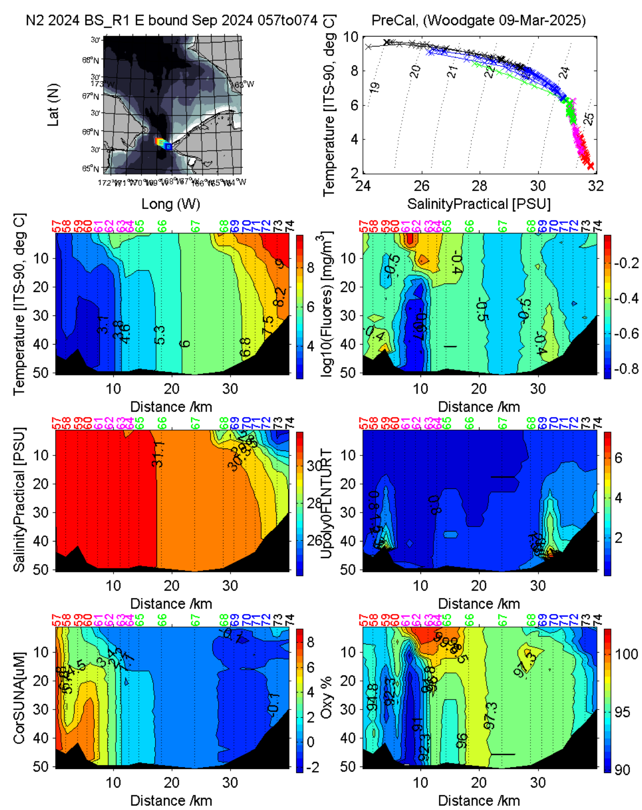


3) Bering Strait line (BS) – first running, Eastward

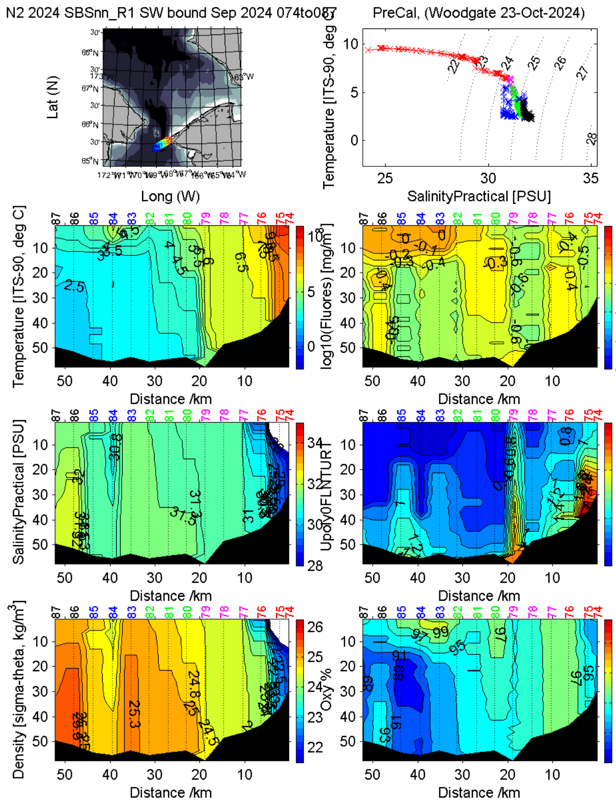


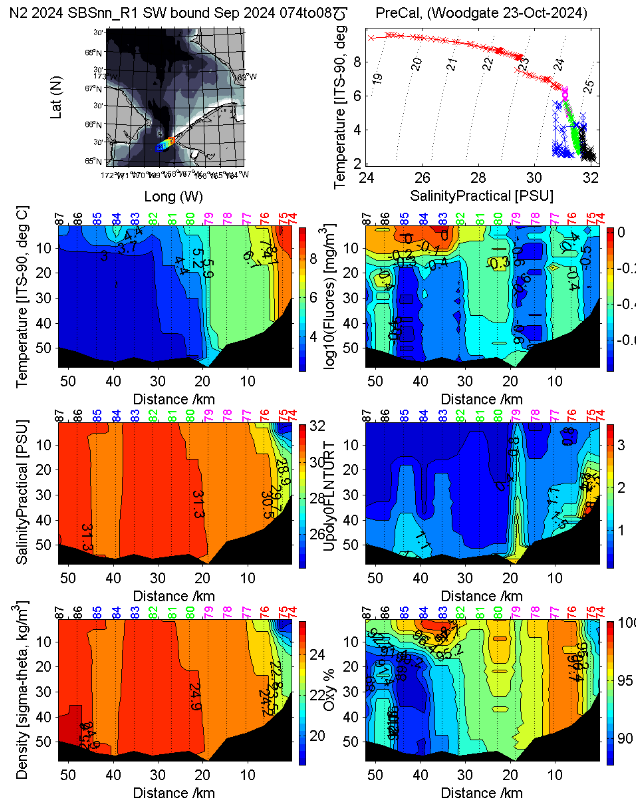


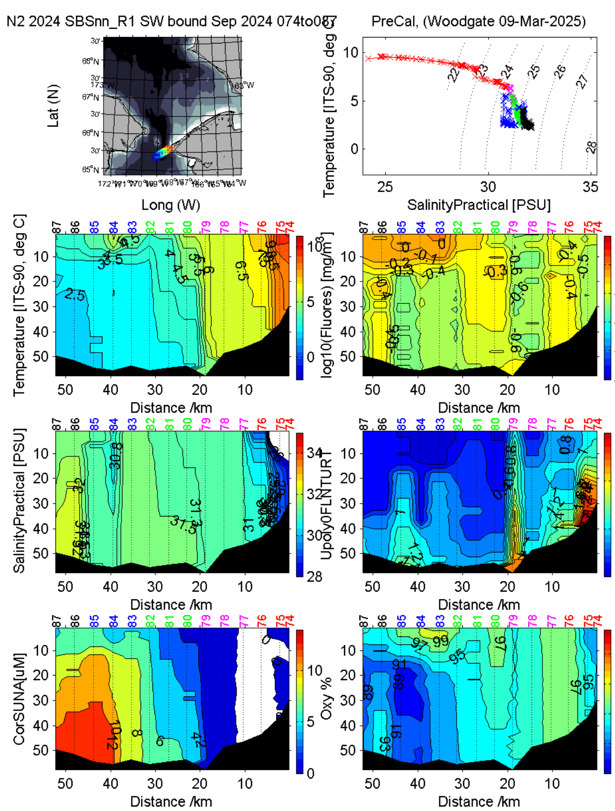


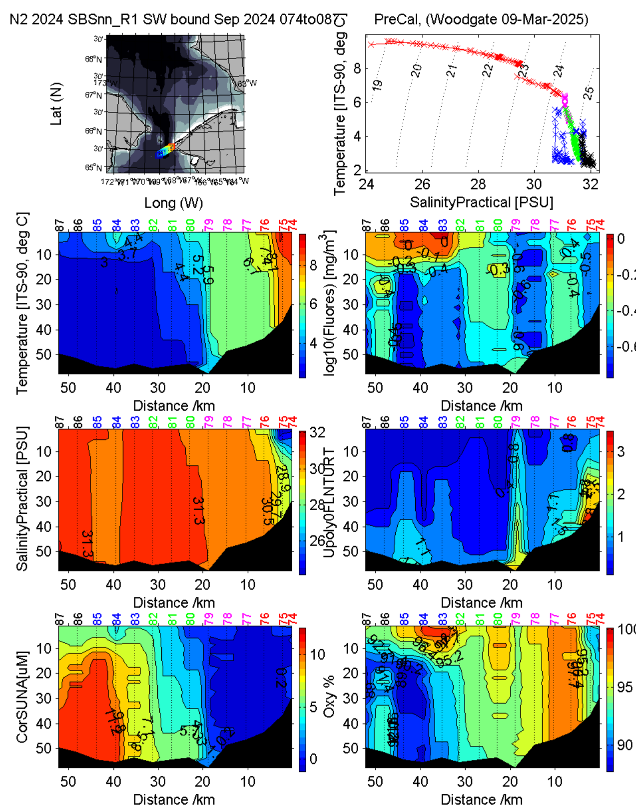


4) South Bering Strait line (SBSnn) – first running, Southwestward

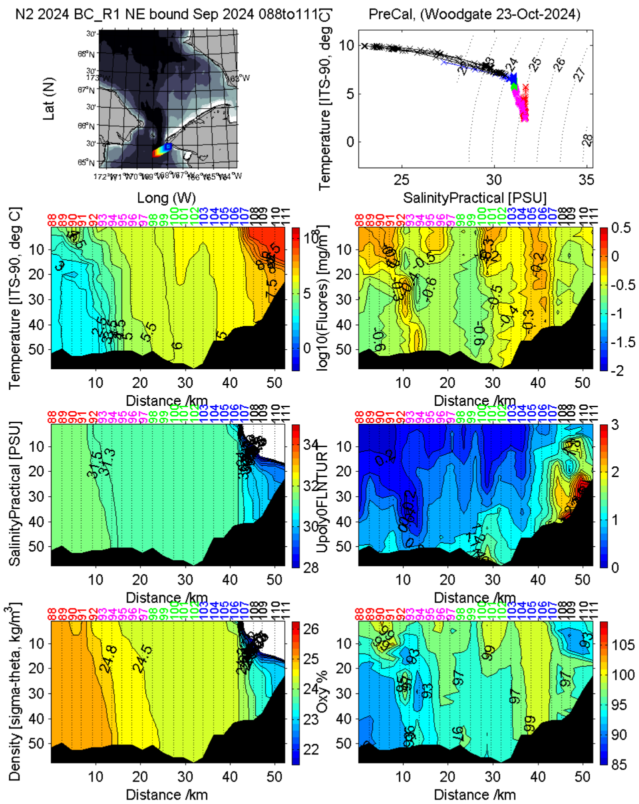


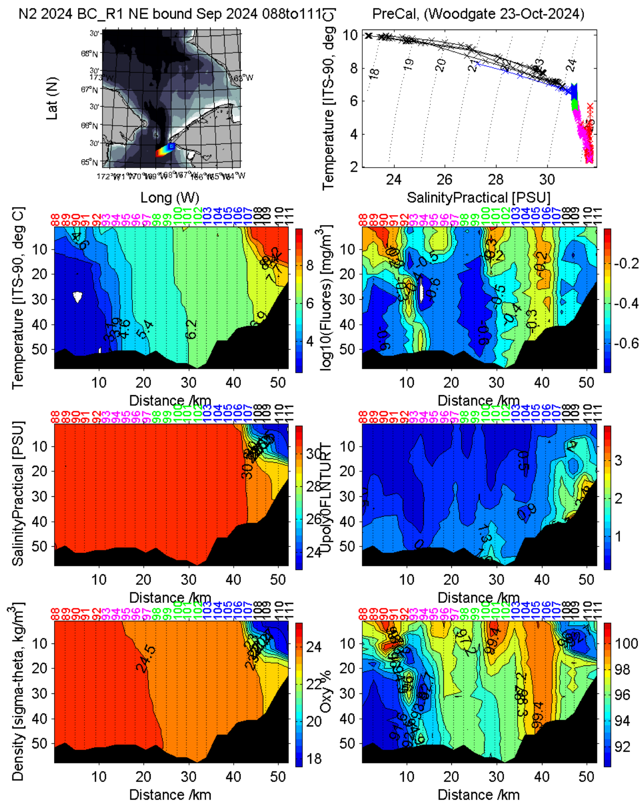


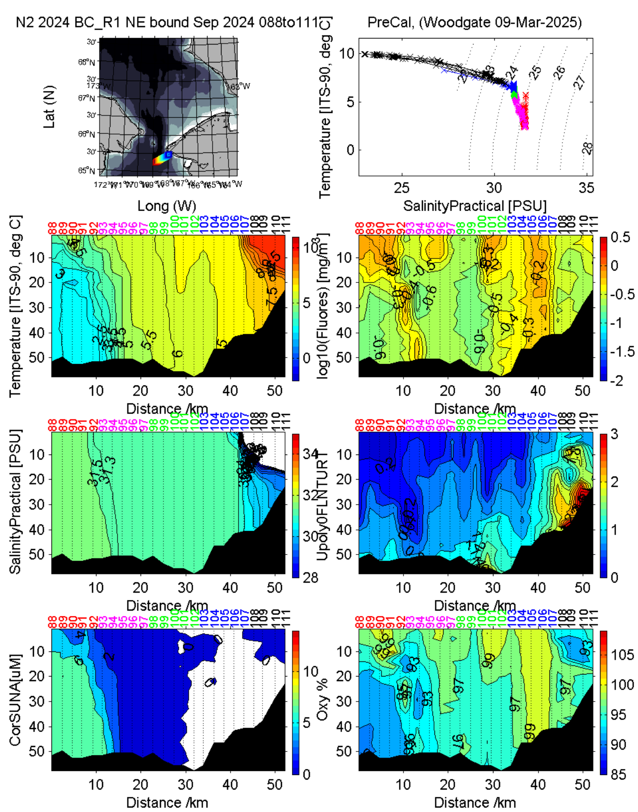


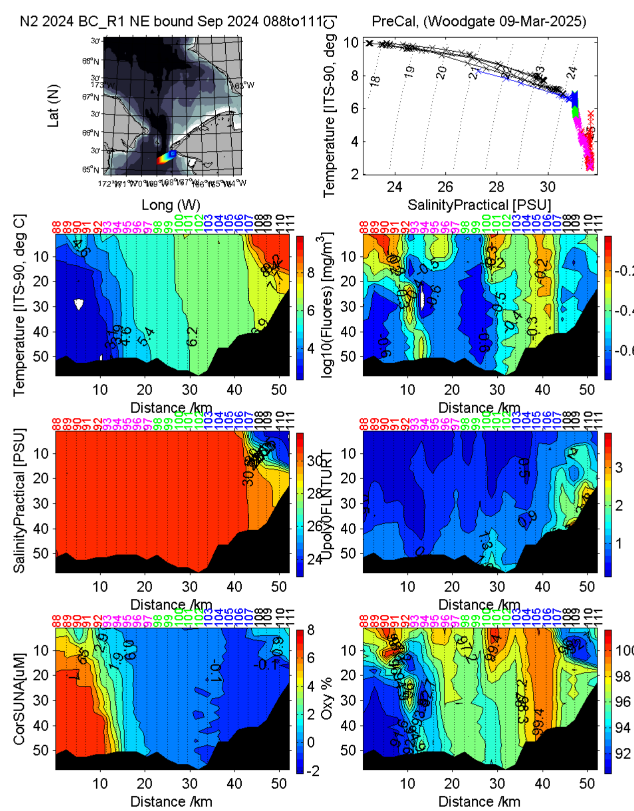


5) Baituk Creek line (BC) – only running, Northeastward

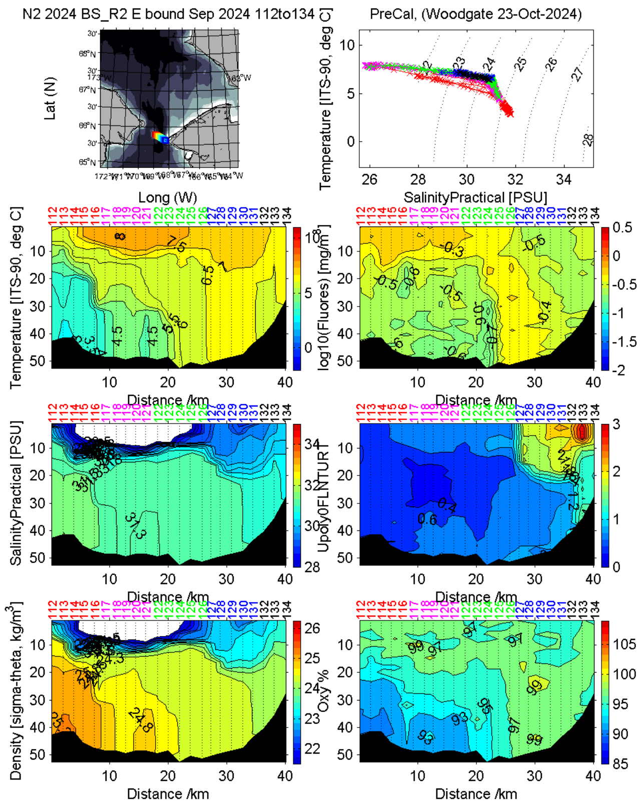


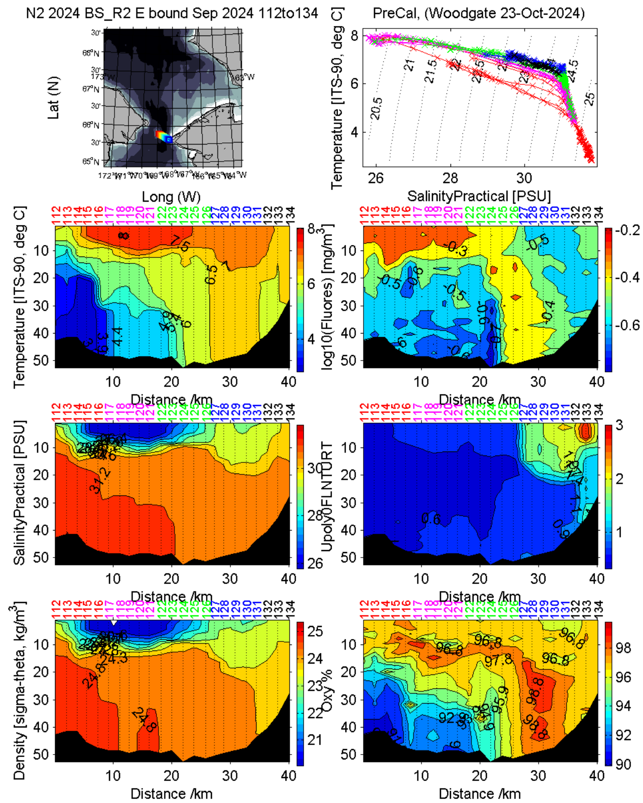


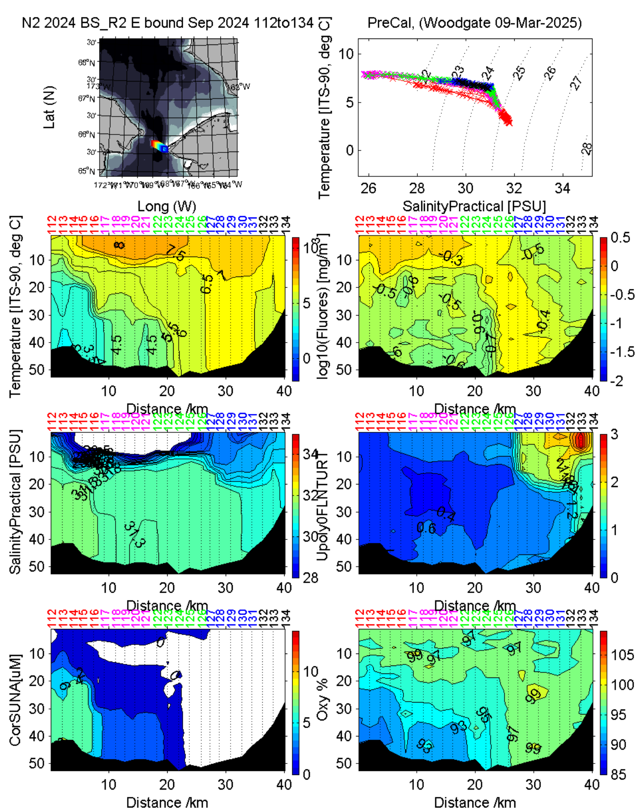


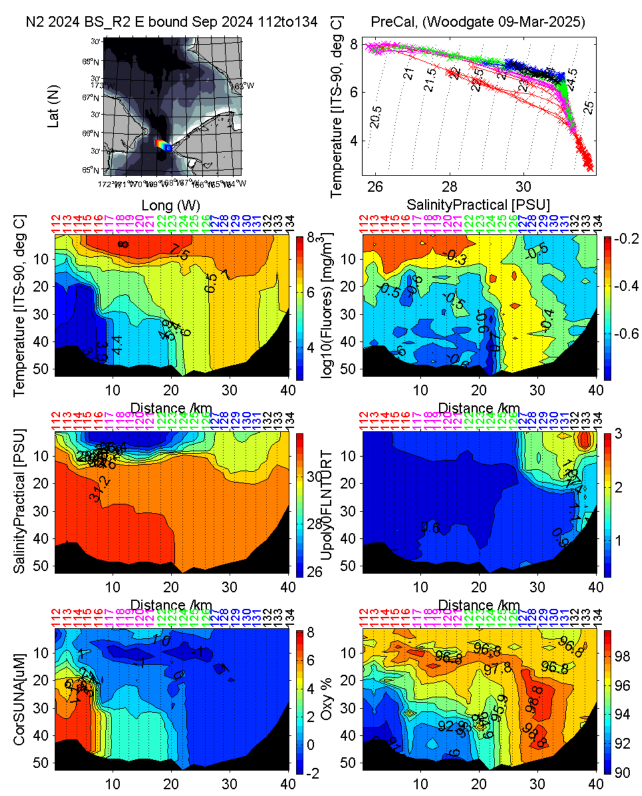


6) Bering Strait line (BS) – second running, Eastward

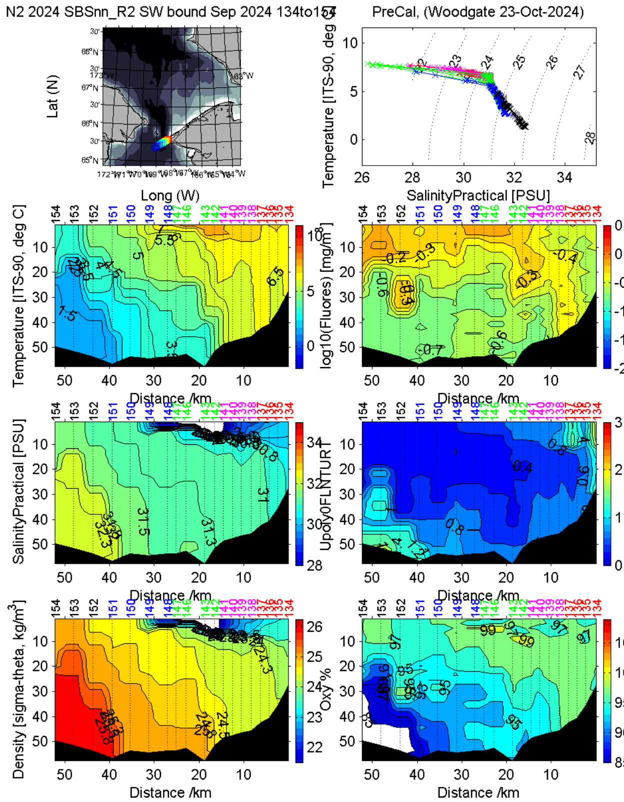


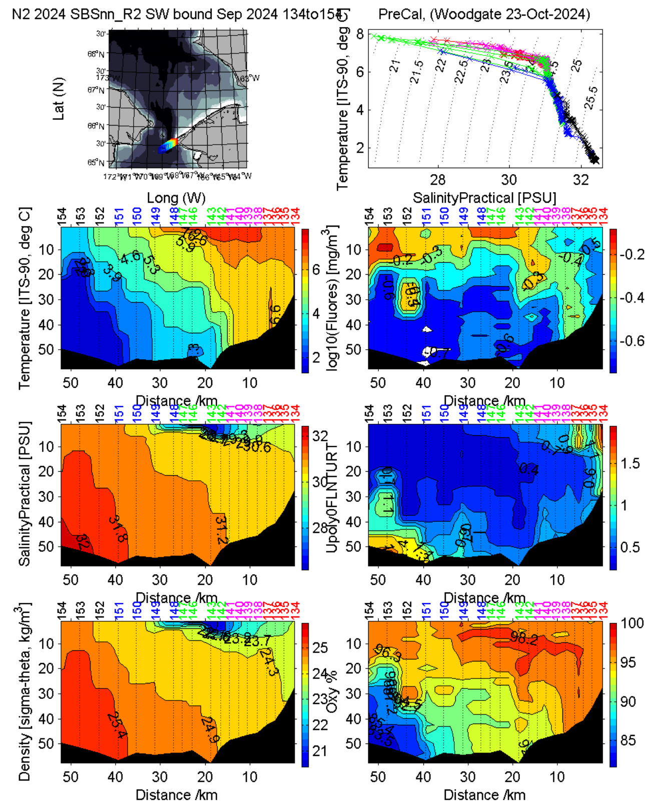


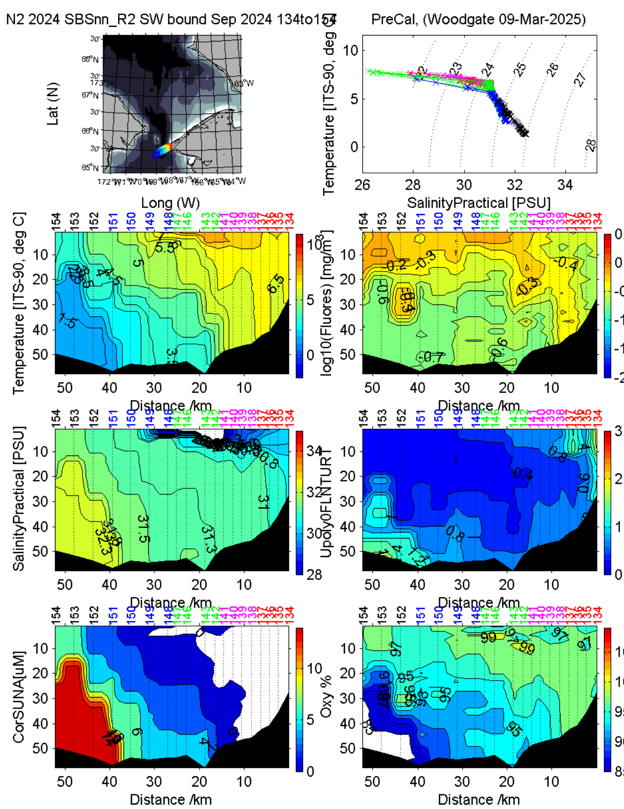


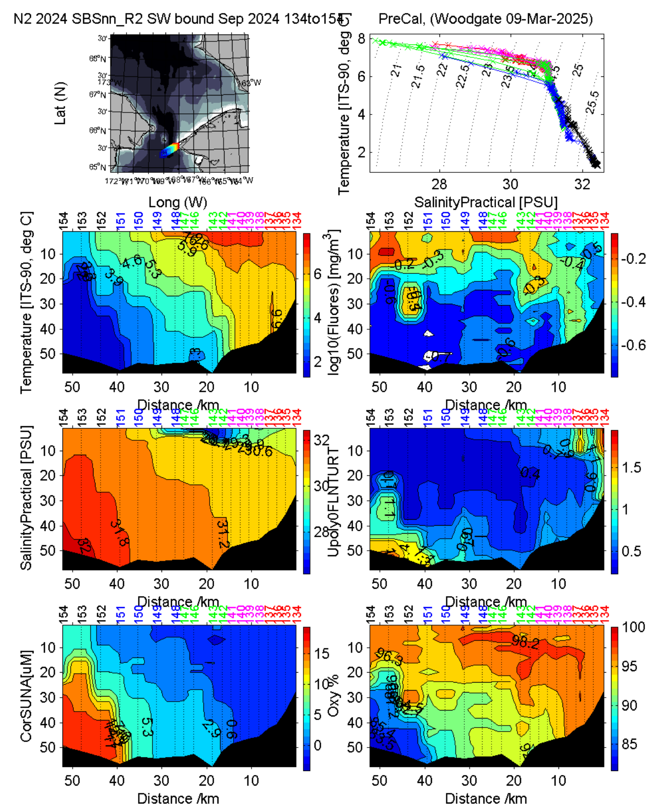


7) South Bering Strait line (SBSnn) – second running, Southwestward



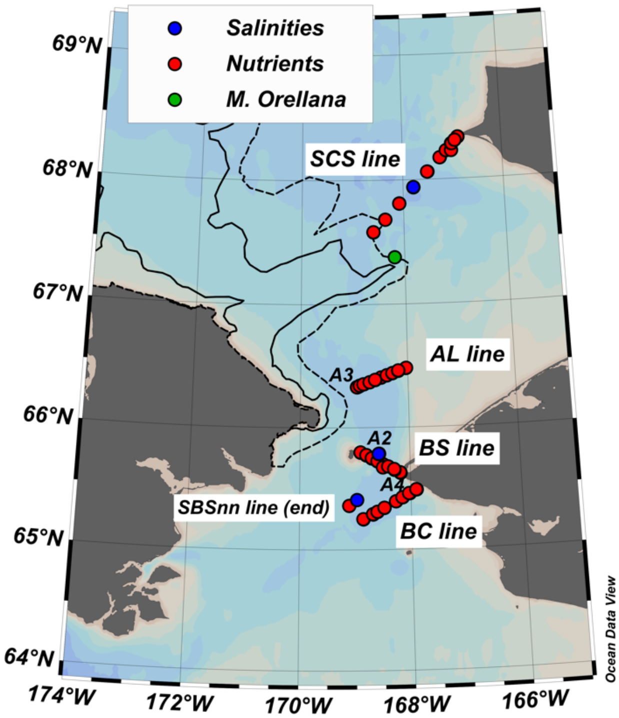






BERING STRAIT 2024 WATER SAMPLING: CTD nutrient and salinity and delta O18 samples.

Rebecca Woodgate, Cecilia Peralta Ferriz and Laramie Jensen (UW)



Map of nutrient samples taken in 2024. Blue dots indicate salinities were also taken; green dot is a station sampled at the surface by bucket for filtered and unfiltered nutrients. Lines are the marginal ice zone on 9/12/24 from the U.S. National Ice Center showing 1/10ths ice coverage (dashed) and 8/10ths ice coverage (solid). (For final positions, see maps at start of report.)

Starting in 2022, nutrient sampling became a standard part of the Bering Strait Mooring Program alongside the new addition of Seabird SUNA sensors (2022-2024 moorings and the accompanying hydrographic sections) to measure nitrate in the water column. Water samples were again taken in 2024 for nitrate, nitrite, ammonium, silicate, and phosphate to be analyzed at the UW Marine Chemistry Lab. Additionally, salinity samples were taken in order to calibrate sensors at select stations.

Water was taken from the rosette on select CTD casts **as shown in the map below for a total of 194 filtered and 1 unfiltered nutrient samples, including duplicates, and 6 salinity samples**. These stations also overlapped with trace metal pumping stations, allowing for comparison between "pumped" nutrients and "bottle" nutrients. A 12-position rosette fitted with 11 x 1.5L Niskin bottles (position 6 remained open to accommodate the SUNA instrument and battery) was deployed from the aft as described in the CTD report. Bottles were fired (tripped) on the upcast, after waiting 10s at the desired depth (see 2022 cruise report for justification of this wait time). At most, six total depths (at 10m intervals) were chosen, depending on bottom depth. For example, if the bottom depth was 54m then bottles were tripped at 52m, 40m, 30m, 20m, 10m, and 0m. Generally, two bottles were fired at each depth and one at the surface.

Samples were taken along, the AL line, SCS line, the BS line (first running), SBSnn line, and BC line. During transit to the SCS line nutrients (filtered and unfiltered (1)) were taken by surface bucket alongside samples for M. Orellana (green dot, map above). Typically, SBSnn and BC lines are not sampled for nutrients but an interesting SUNA feature was present close to the EEZ and thus merited additional nutrient casts. At mooring sites A2 and A3, where SUNA nitrate sensors are deployed on the moorings, duplicate nutrient samples were taken 1m above and 1m below the expected SUNA depth at the mooring recovery and deployment CTDs (8 samples total)

Nutrients: Upon recovery bottles were checked for signs of leaking from the bottom and by opening the outlet without loosening the gas valve to ensure that the bottle was airtight (precautions were taken before shipping: all O-rings were replaced and bottles were tested). A 60 CC plastic syringe was then rinsed with water from the desired bottle three times and fitted with a 0.45um Sterlitech syringe filter (luer lock). The 60 mL HDPE sample bottle was then rinsed three times with filtered water (~5-10 mL) and filled to approximately 45 mL. Immediately upon collection, samples were logged and bagged in sets of 5 and put into a -22degC freezer upright. After they were frozen, samples were combined into larger bags and transported in a cooler back to Seattle as hold luggage and placed in UW freezers until being transferred to UW Marine chemistry for analysis on the 2nd October 2024.

Salinities: Six Salinity samples were taken during the cruise, to check the CTD calibration, targeting homogeneous layers at the start, middle and end of the cruise. Thus, duplicate samples were taken at depth on

cast 4 (start of cruise) and cast 50 (middle of cruise). Subsequently, as it became apparent that poor weather would reduce the number of casts taken, salinity samples were taken instead on casts where the primary and secondary conductivity sensors disagreed, in order to be able to ascertain which was correct (casts 6 and 85).
Samples were taken into traditional salinity bottles, supplied by UW Marine Chemistry and stored cap-down until sampling. For sampling, each bottle was well shaken, rinsed three times with unfiltered water from the sampled Niskin (about 1/3rd volume of sample bottle per rinse), and then filled to the shoulder, and the cap securely fastened. These samples are returning with the container to Seattle and then will be analyzed by UW Marine Chemistry.

Delta O18: The remarkable freshness of some waters encountered motivated the taking of samples for subsequent analysis of delta O18 (the isotopes of oxygen, which can help distinguish between river water and ice melt. Samples were taken from the CTD surface bottle at 9 casts – 4 at the east end of the SCS line, 5 at the east end of the BS line. See table below. Note that additionally. the trace metal pumping sampling also took a further 18 delta O18 samples.
These samples were collected (unfiltered) into 60ml HDPE nutrient sample bottles, after three rinses. Bottles were filled to the top (no head space) and caps were sealed with parafilm. Samples were brought back to Seattle with the nutrient samples. They will be shipped to a US lab for analysis in fall 2024.

Issues encountered at sea:
== Niskin bottles leaking after first few casts, especially #5.
 - **Solution:** After cast 13, bottles 1, 3, 4, 5, 8, 9, 10, 11, 12 were disassembled and new knots were added in rubber tubing under the cap to ensure that both caps snapped close completely when fired.
 - **Follow-up:** Bottle #12 continued to leak and was replaced with spare bottle #6 after cast 14 (hereafter labeled as #12).

== Bottle #5 leaked again on Cast 41 and thus Bottle #7 was sampled instead. This was repeated on future casts where #5 was leaky on deck.

== Bottle #11 failed to fire on casts 14 and 111
 - **Solution:** On cast 14, it had been cocked and pulled to the side near one of the blocks that supports the CTD for shipping and thus had been prevented from closing. This was noted and remediated in the future. It was not immediately clear what caused the misfire in cast 111.

== Presence of jellyfish caused build-up of biological material on CTD rosette and bottles and multiple cases of blocked pumps for the salinity sensors (evident by diverging values for C1 and C2).
 - **Solution:** Manual cleaning of the CTD rosette between casts and of the bottles before sampling for nutrients by deck personnel. Flushing of the salinity sensors by syringe was done on casts 31, 66, 84, 85, 101, 144, 145. On cast 146 the "soak" was done at a deeper depth to avoid jellyfish.

== Weight of samples when hand-carrying back to Seattle. In previous years, this often exceeded the checked baggage limit of 50 lbs.
 - **Solution this year:** Mechanical kitchen scale (limit 350 lbs) was brought and assembled on deck. Once all nutrient samples were collected and frozen, coolers were assembled and weighed on deck. Both coolers were between 46 and 48 lbs upon check-in in Nome.

SUMMARY TABLES OF WATER SAMPLES. SEE ALSO APPENDIX.

== Nutrients (195 total):

Station	Sampling date	Latitude	Longitude	Cast	Niskin	Target Depth	Nutrient sample
#	**UTC**	**(degN)**	**(degW)**	**#**	**#**	**(db)**	**#**
A2-23	9/10/24	65.785	168.567	4	3	50	1030
A2-23	9/10/24	65.785	168.567	4	3	50	1031
A2-23	9/10/24	65.785	168.567	4	5	48	1032
A2-23	9/10/24	65.785	168.567	4	5	48	1033
A2-24	9/10/24	65.786	168.561	9	1	50	1034
A2-24	9/10/24	65.786	168.561	9	1	50	1035
A2-24	9/10/24	65.786	168.561	9	3	48	1036
A2-24	9/10/24	65.786	168.561	9	3	48	1037
A3-23	9/11/24	66.328	168.950	11	2	47	1038
A3-23	9/11/24	66.328	168.950	11	2	47	1039
A3-23	9/11/24	66.328	168.950	11	3	45	1040
A3-23	9/11/24	66.328	168.950	11	3	45	1041
A3-24	9/11/24	66.328	168.947	14	1	47	1042
A3-24	9/11/24	66.328	168.947	14	1	47	1043
A3-24	9/11/24	66.328	168.947	14	7	45	1044
A3-24	9/11/24	66.328	168.947	14	7	45	1045
AL12.5	9/11/24	66.334	168.923	15	1	55	1046
AL12.5	9/11/24	66.334	168.923	15	3	40	1047
AL12.5	9/11/24	66.334	168.923	15	5	30	1048
AL12.5	9/11/24	66.334	168.923	15	8	20	1049
AL12.5	9/11/24	66.334	168.923	15	10	10	1050
AL12.5	9/11/24	66.334	168.923	15	12	0	1051
AL14	9/12/24	66.353	168.833	18	1	54	1052
AL14	9/12/24	66.353	168.833	18	3	40	1053
AL14	9/12/24	66.353	168.833	18	5	30	1054
AL14	9/12/24	66.353	168.833	18	8	20	1055
AL14	9/12/24	66.353	168.833	18	10	10	1056
AL14	9/12/24	66.353	168.833	18	12	0	1057
AL15.5	9/12/24	66.369	168.715	21	1	50	1058
AL15.5	9/12/24	66.369	168.715	21	3	40	1059
AL15.5	9/12/24	66.369	168.715	21	5	30	1060
AL15.5	9/12/24	66.369	168.715	21	8	20	1061
AL15.5	9/12/24	66.369	168.715	21	10	10	1062
AL15.5	9/12/24	66.369	168.715	21	12	0	1063
AL17	9/12/24	66.389	168.611	24	1	54	1064
AL17	9/12/24	66.389	168.611	24	3	40	1065

AL17	9/12/24	66.389	168.611	24	5	30	1066
AL17	9/12/24	66.389	168.611	24	8	20	1067
AL17	9/12/24	66.389	168.611	24	10	10	1068
AL17	9/12/24	66.389	168.611	24	12	0	1069
AL18.5	9/12/24	66.406	168.501	27	1	52	1070
AL18.5	9/12/24	66.406	168.501	27	3	40	1071
AL18.5	9/12/24	66.406	168.501	27	5	30	1072
AL18.5	9/12/24	66.406	168.501	27	8	20	1073
AL18.5	9/12/24	66.406	168.501	27	10	10	1074
AL18.5	9/12/24	66.406	168.501	27	12	0	1075
AL20	9/12/24	66.424	168.393	30	1	51	1076
AL20	9/12/24	66.424	168.393	30	3	40	1077
AL20	9/12/24	66.424	168.393	30	5	30	1078
AL20	9/12/24	66.424	168.393	30	8	20	1079
AL20	9/12/24	66.424	168.393	30	10	10	7192
AL20	9/12/24	66.424	168.393	30	12	0	7193
AL21.5	9/12/24	66.440	168.287	34	1	43	7194
AL21.5	9/12/24	66.440	168.287	34	3	40	7195
AL21.5	9/12/24	66.440	168.287	34	5	30	7196
AL21.5	9/12/24	66.440	168.287	34	8	20	7197
AL21.5	9/12/24	66.440	168.287	34	10	10	7198
AL21.5	9/12/24	66.440	168.287	34	12	0	7199
AL23	9/12/24	66.458	168.178	37	1	32	7210
AL23	9/12/24	66.458	168.178	37	3	30	7211
AL23	9/12/24	66.458	168.178	37	5	20	7212
AL23	9/12/24	66.458	168.178	37	8	10	7213
AL23	9/12/24	66.458	168.178	37	10	0	7214
AL25	9/12/24	66.479	168.032	41	1	20	7201
AL25	9/12/24	66.479	168.032	41	3	10	7202
AL25	9/12/24	66.479	168.032	41	5	0	7203
Ice edge 67N	9/12/24	67.378	168.193	NaN	Bucket	0	7200
Ice edge 67N	9/12/24	67.378	168.193	NaN	Bucket	0	7204*
SCS10	9/12/24	67.582	168.599	47	1	48	6178
SCS10	9/12/24	67.582	168.599	47	3	40	6179
SCS10	9/12/24	67.582	168.599	47	4	30	6180
SCS10	9/12/24	67.582	168.599	47	5	20	6181
SCS10	9/12/24	67.582	168.599	47	10	10	6182
SCS10	9/12/24	67.582	168.599	47	12	0	6183
SCS11	9/12/24	67.681	168.362	48	1	47	6168
SCS11	9/12/24	67.681	168.362	48	3	40	6169
SCS11	9/12/24	67.681	168.362	48	4	30	6170

SCS11	9/12/24	67.681	168.362	48	7	20	6171
SCS11	9/12/24	67.681	168.362	48	10	10	6172
SCS11	9/12/24	67.681	168.362	48	12	0	6173
SCS12	9/13/24	67.809	168.082	49	1	47	6174
SCS12	9/13/24	67.809	168.082	49	3	40	6175
SCS12	9/13/24	67.809	168.082	49	4	30	6176
SCS12	9/13/24	67.809	168.082	49	7	20	6177
SCS12	9/13/24	67.809	168.082	49	8	10	6184
SCS12	9/13/24	67.809	168.082	49	12	0	7205
SCS13	9/13/24	67.933	167.792	50	1	53	7206
SCS13	9/13/24	67.933	167.792	50	3	40	7207
SCS13	9/13/24	67.933	167.792	50	5	30	7208
SCS13	9/13/24	67.933	167.792	50	8	20	7209
SCS13	9/13/24	67.933	167.792	50	10	10	7215
SCS13	9/13/24	67.933	167.792	50	12	0	7216
SCS14	9/13/24	68.059	167.504	51	1	52	7217
SCS14	9/13/24	68.059	167.504	51	3	40	7218
SCS14	9/13/24	68.059	167.504	51	4	30	7219
SCS14	9/13/24	68.059	167.504	51	5	20	7220
SCS14	9/13/24	68.059	167.504	51	8	10	7221
SCS14	9/13/24	68.059	167.504	51	12	0	7222
SCS15	9/13/24	68.171	167.247	52	1	46	7223
SCS15	9/13/24	68.171	167.247	52	3	30	7224
SCS15	9/13/24	68.171	167.247	52	5	20	7225
SCS15	9/13/24	68.171	167.247	52	8	10	7226
SCS15	9/13/24	68.171	167.247	52	10	0	7227
SCS16	9/13/24	68.226	167.121	53	1	42	7228
SCS16	9/13/24	68.226	167.121	53	3	30	7229
SCS16	9/13/24	68.226	167.121	53	5	20	7230
SCS16	9/13/24	68.226	167.121	53	8	10	7231
SCS16	9/13/24	68.226	167.121	53	10	0	7232
SCS17	9/13/24	68.281	167.001	54	1	36	7233
SCS17	9/13/24	68.281	167.001	54	3	30	7234
SCS17	9/13/24	68.281	167.001	54	5	20	7235
SCS17	9/13/24	68.281	167.001	54	8	10	7236
SCS17	9/13/24	68.281	167.001	54	10	0	7237
SCS18	9/13/24	68.306	166.935	55	1	32	7238
SCS18	9/13/24	68.306	166.935	55	3	20	7239
SCS18	9/13/24	68.306	166.935	55	5	10	7240
SCS18	9/13/24	68.306	166.935	55	8	0	7241
SCS19	9/13/24	68.332	166.878	56	1	26	7243

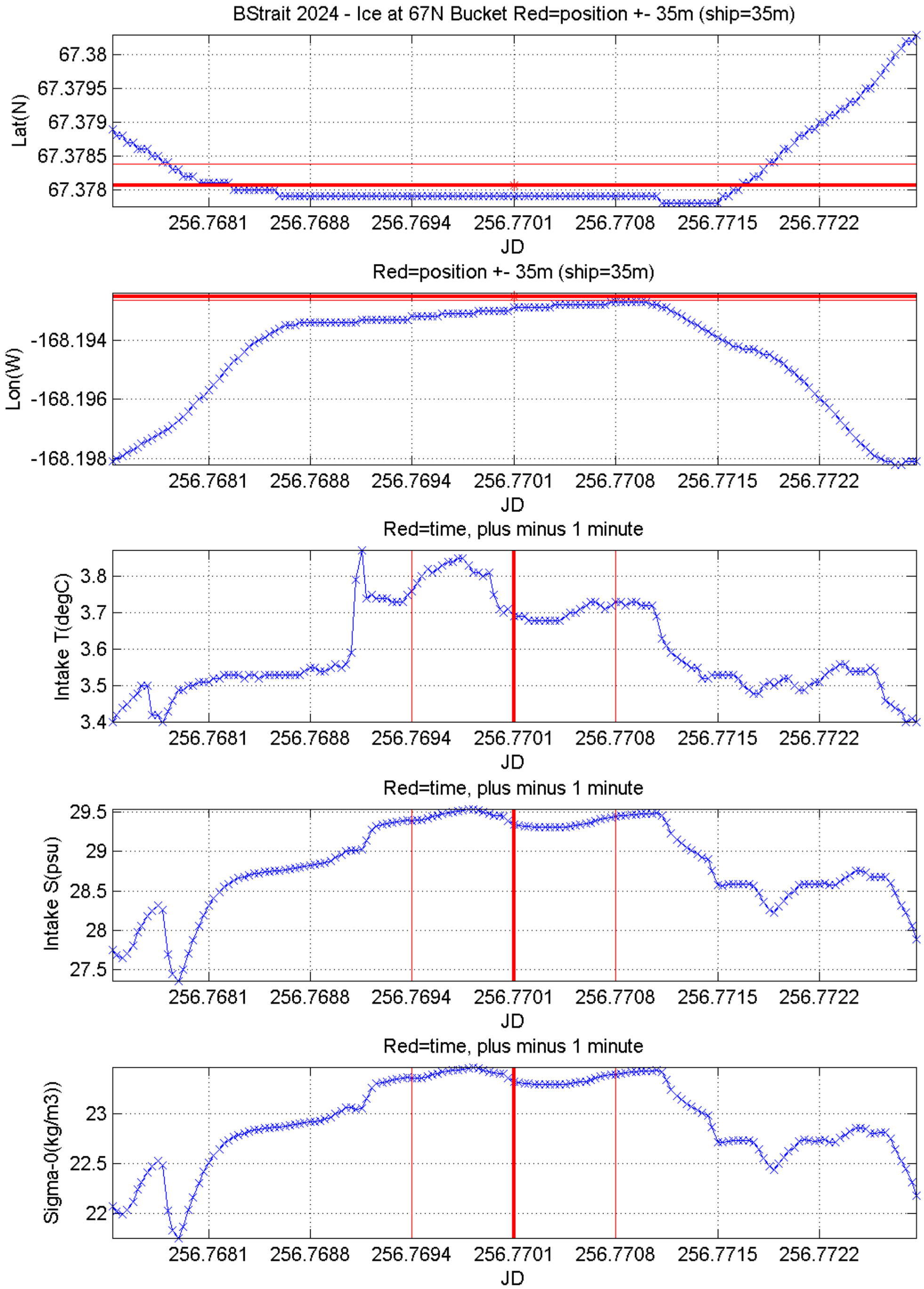
SCS19	9/13/24	68.332	166.878	56	3	10	7244
SCS19	9/13/24	68.332	166.878	56	5	0	7245
BS11.5	9/14/24	65.797	168.899	58	1	46	7242
BS11.5	9/14/24	65.797	168.899	58	3	40	7246
BS11.5	9/14/24	65.797	168.899	58	5	30	7247
BS11.5	9/14/24	65.797	168.899	58	8	20	7248
BS11.5	9/14/24	65.797	168.899	58	10	10	7249
BS11.5	9/14/24	65.797	168.899	58	12	0	7250
BS13	9/14/24	65.773	168.793	61	1	50	7251
BS13	9/14/24	65.773	168.793	61	3	40	7252
BS13	9/14/24	65.773	168.793	61	5	30	7253
BS13	9/14/24	65.773	168.793	61	8	20	7254
BS13	9/14/24	65.773	168.793	61	10	10	7255
BS13	9/14/24	65.773	168.793	61	12	0	1409
BS14.5	9/14/24	65.750	168.693	64	1	50	1410
BS14.5	9/14/24	65.750	168.693	64	3	40	1411
BS14.5	9/14/24	65.750	168.693	64	5	30	1412
BS14.5	9/14/24	65.750	168.693	64	9	20	1413
BS14.5	9/14/24	65.750	168.693	64	10	10	1414
BS14.5	9/14/24	65.750	168.693	64	12	0	1415
BS16	9/14/24	65.726	168.589	66	1	50	1416
BS16	9/14/24	65.726	168.589	66	3	40	1417
BS16	9/14/24	65.726	168.589	66	5	30	1418
BS16	9/14/24	65.726	168.589	66	8	20	1419
BS16	9/14/24	65.726	168.589	66	10	10	1420
BS16	9/14/24	65.726	168.589	66	12	0	1421
BS17.5	9/14/24	65.698	168.487	67	1	52	1422
BS17.5	9/14/24	65.698	168.487	67	3	40	1423
BS17.5	9/14/24	65.698	168.487	67	5	30	1424
BS17.5	9/14/24	65.698	168.487	67	7	20	1425
BS17.5	9/14/24	65.698	168.487	67	9	10	1426
BS17.5	9/14/24	65.698	168.487	67	11	0	1427
BS19	9/14/24	65.679	168.399	68	1	50	1428
BS19	9/14/24	65.679	168.399	68	3	40	1429
BS19	9/14/24	65.679	168.399	68	5	30	1430
BS19	9/14/24	65.679	168.399	68	8	20	1431
BS19	9/14/24	65.679	168.399	68	10	10	1432
BS19	9/14/24	65.679	168.399	68	12	0	1433
BS20.5	9/14/24	65.650	168.286	71	1	45	1434
BS20.5	9/14/24	65.650	168.286	71	3	30	1435
BS20.5	9/14/24	65.650	168.286	71	5	20	1436

BS20.5	9/14/24	65.650	168.286	71	7	10	1437
BS20.5	9/14/24	65.650	168.286	71	9	0	1438
BS22	9/14/24	65.630	168.177	74	1	30	1439
BS22	9/14/24	65.630	168.177	74	3	20	1440
BS22	9/14/24	65.630	168.177	74	5	10	1441
BS22	9/14/24	65.630	168.177	74	8	0	1442
SBSnn 10.5	9/14/24	65.429	168.889	84	1	57	1443
SBSnn 10.5	9/14/24	65.429	168.889	84	3	25	1444
SBSnn 10.5	9/14/24	65.429	168.889	84	5	0	1445
SBSnn 13.5	9/14/24	65.361	169.110	87	1	51	1446
SBSnn 13.5	9/14/24	65.361	169.110	87	3	20	1447
SBSnn 13.5	9/14/24	65.361	169.110	87	5	0	1448
BC12.5	9/14/24	65.250	168.860	88	1	52	1449
BC12.5	9/14/24	65.250	168.860	88	3	25	1450
BC12.5	9/14/24	65.250	168.860	88	10	0	1451
BC10.5	9/14/24	65.290	168.686	92	1	52	1452
BC10.5	9/14/24	65.290	168.686	92	3	23	1453
BC10.5	9/14/24	65.290	168.686	92	9	0	1454
BC9.5	9/14/24	65.310	168.606	94	1	51	1455
BC9.5	9/14/24	65.310	168.606	94	3	25	1456
BC9.5	9/14/24	65.310	168.606	94	7	0	1457
BC8	9/15/24	65.342	168.480	97	1	53	1458
BC8	9/15/24	65.342	168.480	97	3	25	1459
BC8	9/15/24	65.342	168.480	97	7	0	1460
BC5.5	9/15/24	65.393	168.269	102	1	58	1461
BC5.5	9/15/24	65.393	168.269	102	3	25	1462
BC5.5	9/15/24	65.393	168.269	102	5	0	1463
BC4	9/15/24	65.426	168.154	105	1	46	1464
BC4	9/15/24	65.426	168.154	105	3	23	1465
BC4	9/15/24	65.426	168.154	105	7	0	1466
BC2.5	9/15/24	65.457	168.020	108	1	41	1467
BC2.5	9/15/24	65.457	168.020	108	3	25	1468
BC2.5	9/15/24	65.457	168.020	108	5	0	1469
BC1	9/15/24	65.488	167.900	111	1	26	1470
BC1	9/15/24	65.488	167.900	111	4	20	1471
BC1	9/15/24	65.488	167.900	111	9	0	1472

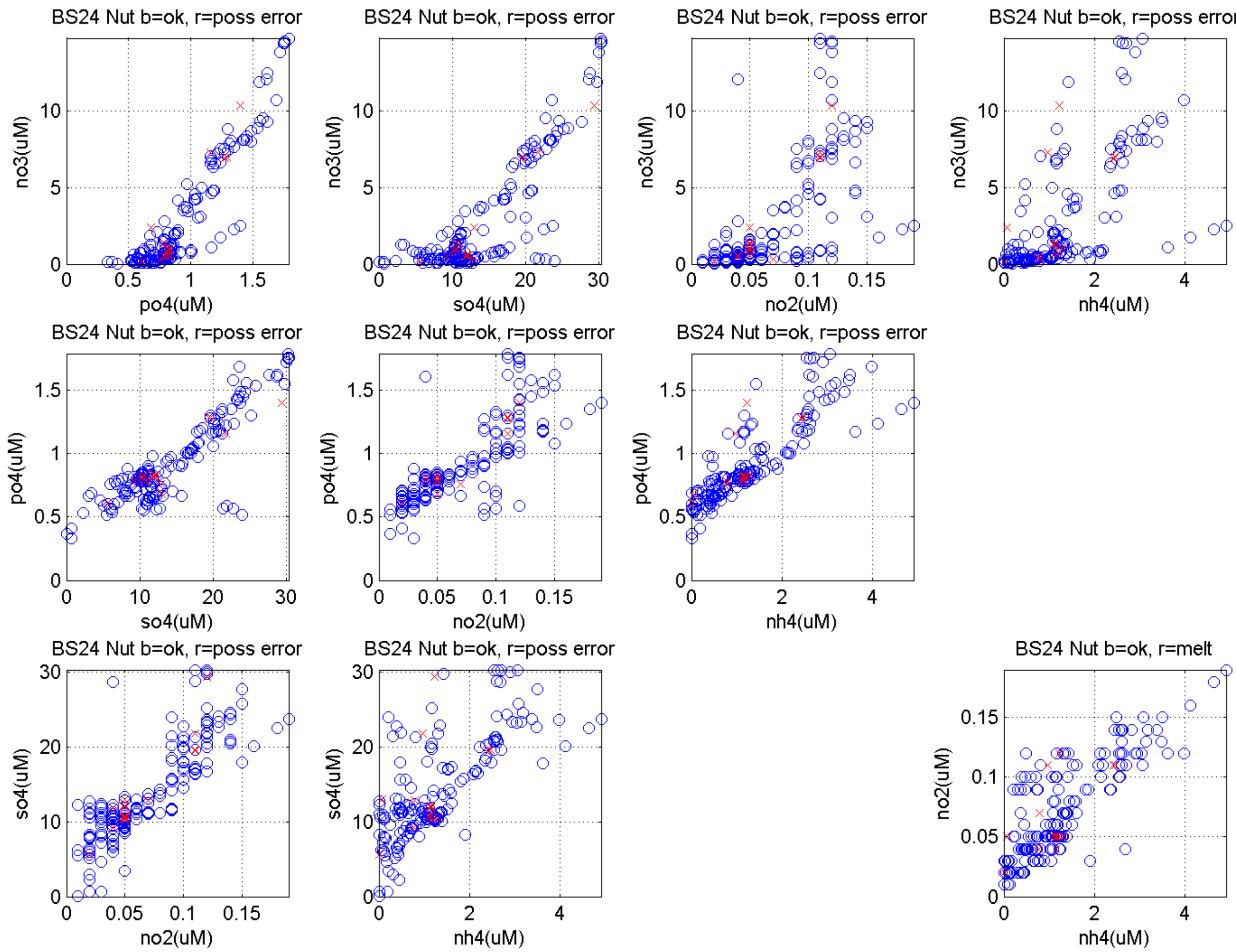
*unfiltered

Nutrient sample notes – March 2025

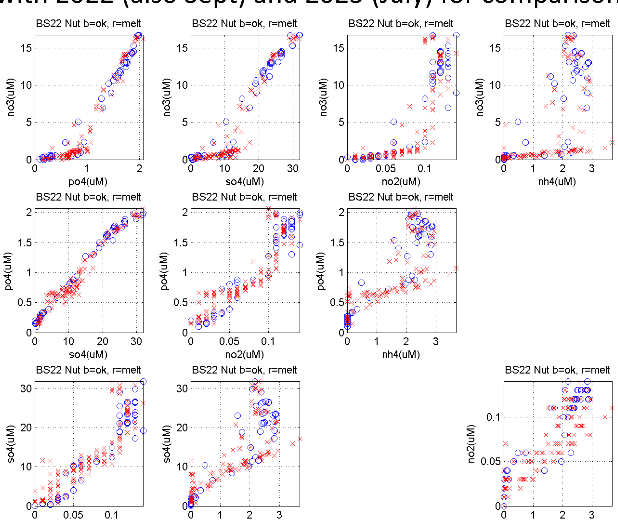
1) During the cruise, the TSG was running with a 2016 calibration, as the newer calibration had not been loaded. Thus, Bucket sample parameters noted in log are using the wrong TSG calibration. Here is the TSG around the bucket sample, from which we extract parameters (T=3.7degC, S=29.3psu) for the final nutrient sample log. Note the very large variability on short space scales. (3.4 to 3.9 deg C, and 27.5 to 29.5 psu)

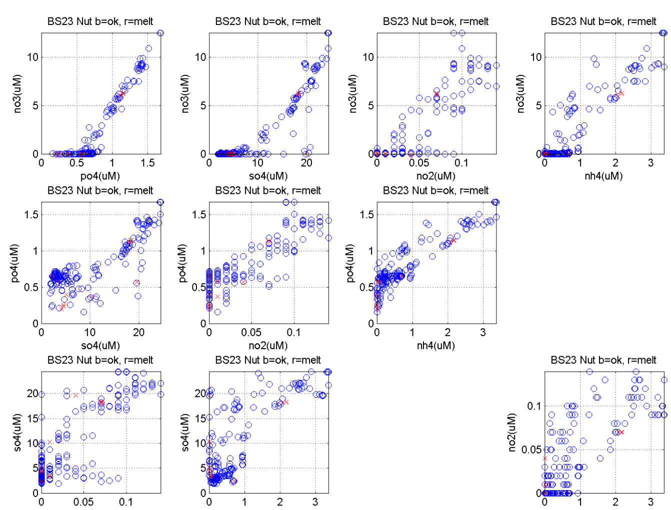


March 2025: Received analyzed nutrients from UW. Here are some preliminary plots:

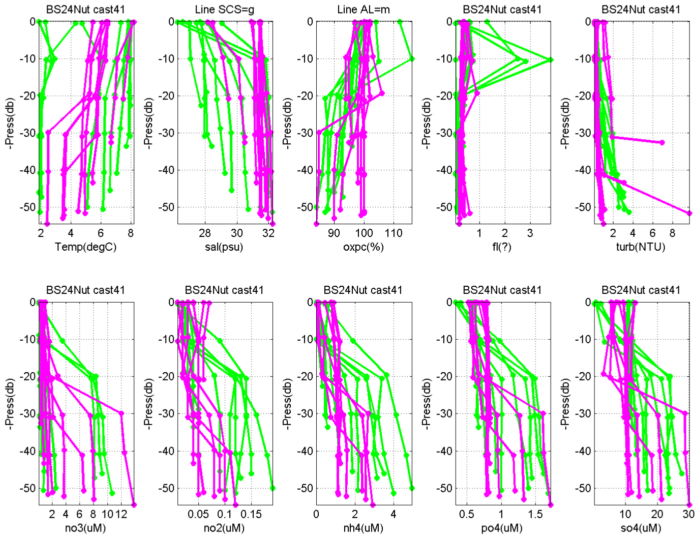


with 2022 (also Sept) and 2023 (July) for comparison

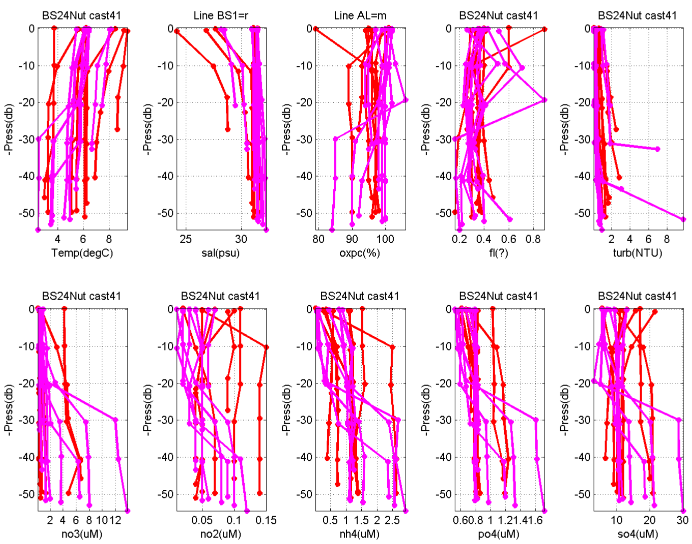




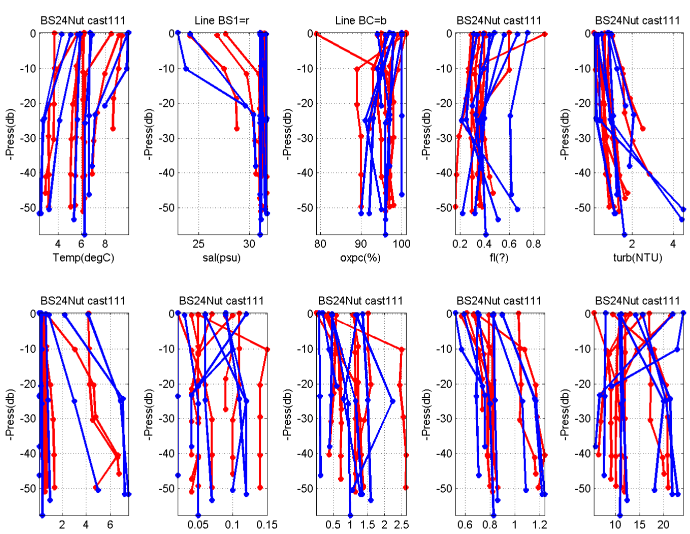
Compare also different lines:



SCS in green, AL in magenta

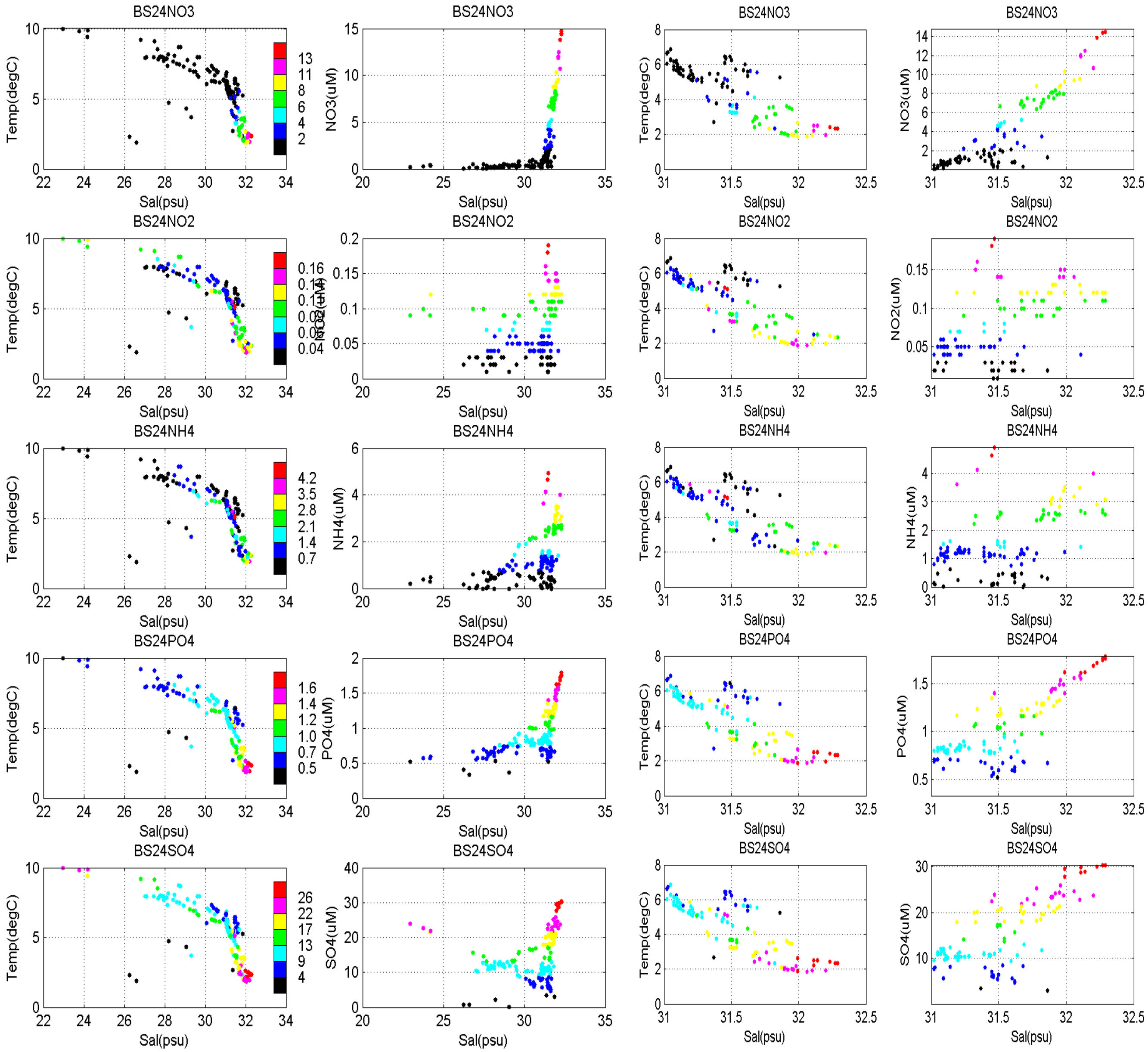


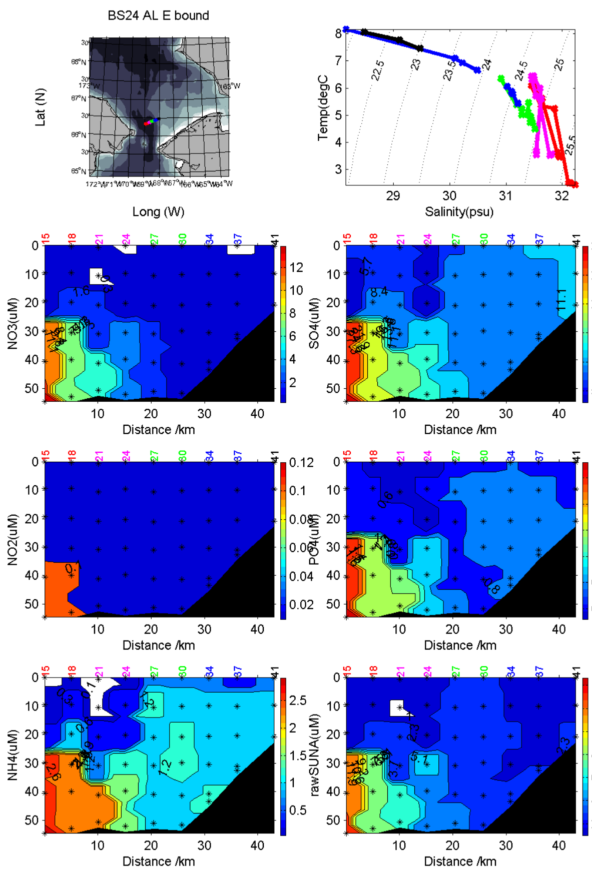
AL in magenta, BS in red

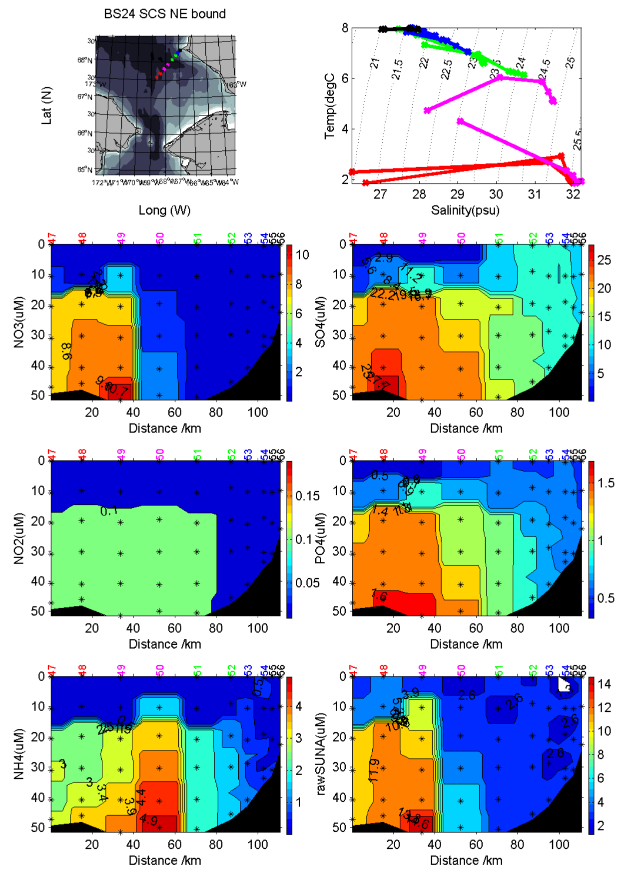


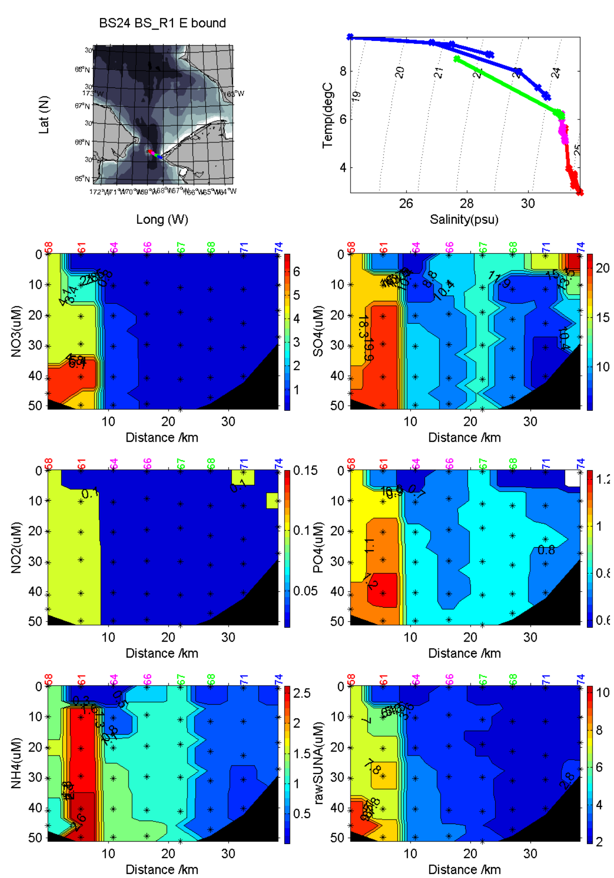
BS in red, BC in blue

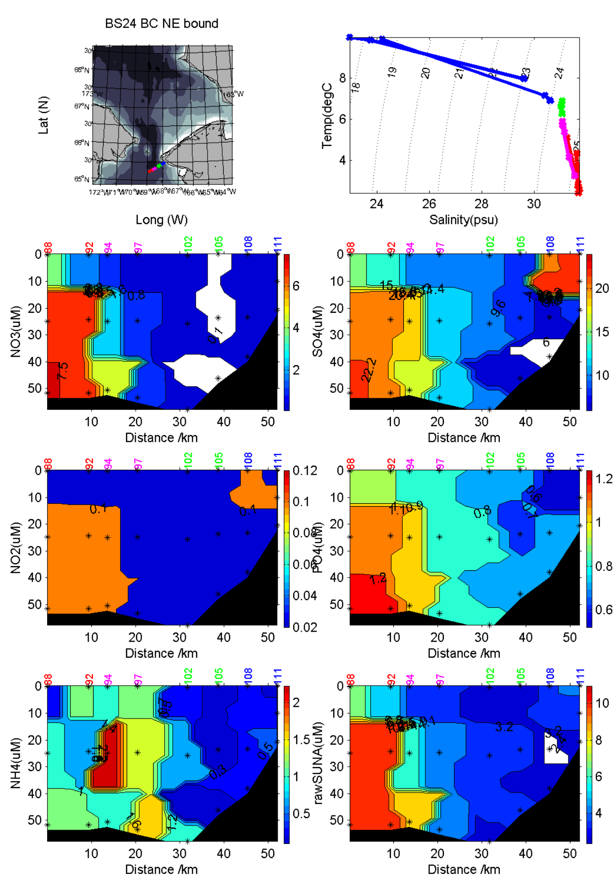
And against salinity:




BS24 AL E bound
Lat (N)
Long (W)
Temp(degC
Salinity(psu)
NO3(uM)
SO4(uM)
NO2(uM)
PO4(uM)
NH4(uM)
rawSUNA(uM)
Distance /km


BS24 SCS NE bound
Lat (N)
Long (W)
Temp(degC
Salinity(psu)
NO3(uM)
SO4(uM)
NO2(uM)
PO4(uM)
NH4(uM)
rawSUNA(uM)
Distance /km


BS24 BS_R1 E bound
Lat (N)
Long (W)
Temp(degC
Salinity(psu)
NO3(uM)
SO4(uM)
NO2(uM)
PO4(uM)
NH4(uM)
rawSUNA(uM)
Distance /km


BS24 BC NE bound
Lat (N)
Long (W)
Temp(degC
Salinity(psu)
NO3(uM)
SO4(uM)
NO2(uM)
PO4(uM)
NH4(uM)
rawSUNA(uM)
Distance /km

== Salinities (6 total):

Station	Sampling date	Lat.	Long.	Cast	Nis kin	Target Depth	Salinity sample	Purpose	25 Feb 2025 Analysis	CTD sensor minus bottle
#	UTC	(degN)	(degW)	#	#	(db)	#		psu	psu
A2-23	9/10/24	65.785	168.567	4	1	53	261	CTDcal	31.390	-0.003 (1) -0.002 (2)
A2-23	9/10/24	65.785	168.567	4	1	53	262	CTDcal	31.390	ditto
SCS13	9/13/24	67.937	167.792	50	1	53	249	CTDcal	31.469	-0.002 (1) +0.001 (2)
SCS13	9/13/24	67.937	167.792	50	1	53	250	CTDcal	31.469	ditto
BS16	9/14/24	65.726	168.589	66	1	50	255	Sens.cal	31.117	**-0.06 (1)** -0.0005 (2)
SBSnn 11.5	9/14/24	65.408	168.966	85	1	51	256	Sens.cal.	31.875 31.882	**-0.6 (1)** **+0.15 (2)**

28th Feb 2025 Update: Samples are

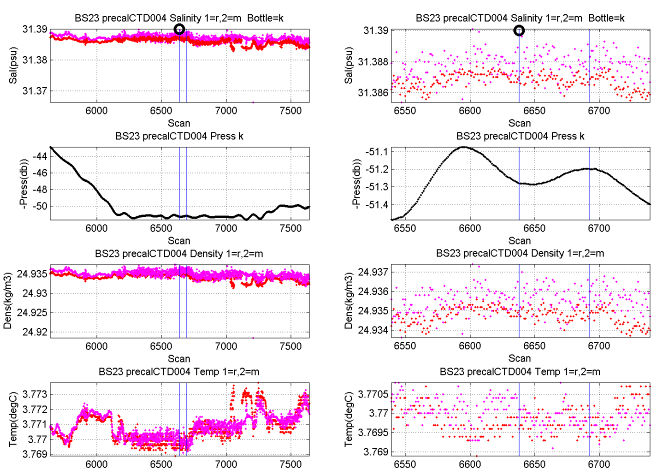
- two sets of duplicates (taken at start and middle of cruise for CTD calibration), and
- two individual samples, taken to resolve discrepancies between the sensors on the CTD.

First running of the samples 24th Feb 2025, showed duplicates differing by 0.01 and 0.03psu, and values 0.4-1.2psu off the CTD values. Prior work [*Sy and Hinrichsen*, 1986] has suggested that long-term storage of samples before analysis can lead to erroneously salty readings (0.005psu in 6 months) and an increase in standard deviation of duplicates (~same magnitude). However, those changes are much smaller than the discrepancy here. However, when the salinometer heater bulbs were replaced, much more consistent readings were obtained. See table above and plots below.

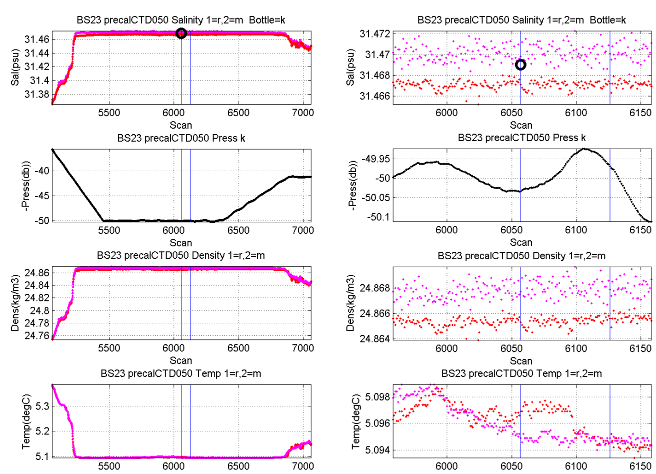
- Duplicates are now in agreement to <0.001psu.
- **Duplicates agree with the CTD to <0.003psu (manufacturer's specification is equivalent to 0.003psu).**
- **Cast 66 shows S1 to be reading erroneously**, but S2 is in agreement with the bottle
- **Cast 85** show significant disagreement to both S1 and S2, with the CTD S2 being saltier than the bottle. This suggests that **S1 is erroneous** (as we expect jellyfish to bias the CTD fresh), and that **the bottle may have leaked** to entrain fresher waters on the upcast or at the surface.

UW Marine chemistry reran the sample, obtaining 31.882 on the second run (compared to 31.875 on the first)

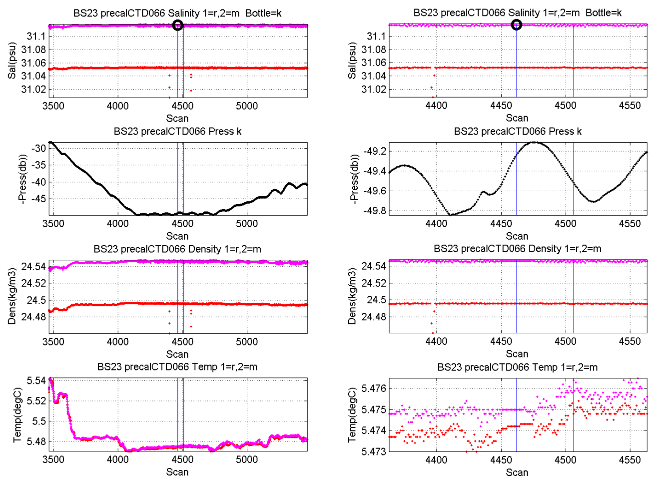
CAST 4



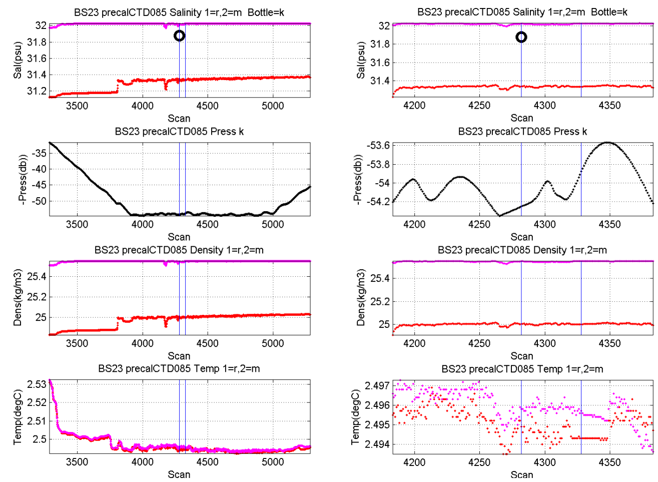
CAST 50



CAST 66



CAST 85



== Oxygen isotope samples collected from the rosette (9 total):
(note a further 18 were taken at trace metal pumping stations – see that report for full list)

Station	Sampling date	Latitude	Longitude	Cast	Bot	Target Depth	Sample	Pump or CTD	Delta O18 Vsmow ‰
name	local	degN	degW	#	#	m	#		
SCS15	9/12/24	68.171	167.247	52	11	0	2679A*	CTD	-4.37
SCS16	9/12/24	68.226	167.121	53	11	0	2681A	CTD	-4.00
SCS17	9/13/24	68.281	167.001	54	12	0	2683A	CTD	-3.96
SCS18	9/13/24	68.306	166.935	55	9	0	2685A	CTD	-4.01
BS19	9/14/24	65.667	168.356	68	12	0	1081A	CTD	-4.39
BS20.5	9/14/24	65.650	168.286	71	9	0	1083A	CTD	-4.56
BS22	9/15/24	65.630	168.177	74	8	0	1086A	CTD	-6.35
BC2.5	9/14/24	65.457	168.020	108	7	0	1087A	CTD	-6.39
BC1	9/12/24	65.488	167.901	110	9	0	6142	CTD	-6.93

* Paper logs record this erroneously as 7228A. Corrected in digital version

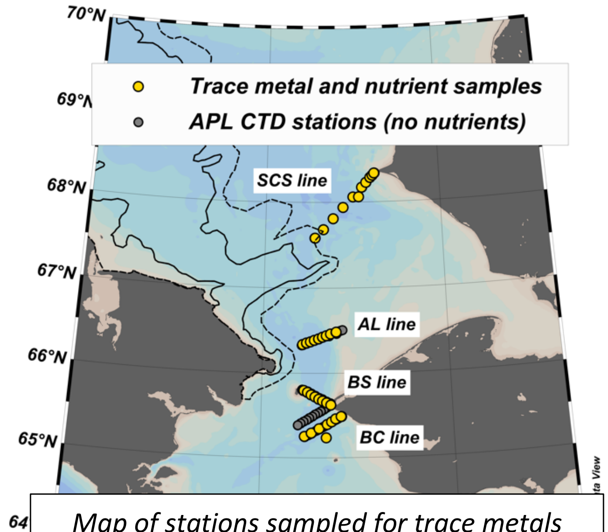
28th Feb 2025 Update: Oxygen isotope samples were shipped to UC Davis Stable Isotope Facility in November 2024, and data were returned in late December 2024. Data are given as last column in table above. Expected uncertainty is 0.2‰

BERING STRAIT 2024 TRACE METAL (plus nutrients and delta O18) PUMPING REPORT

Laramie Jensen (UW)

Quick summary: 42 Stations sampled for trace metals and nutrients (yellow dots in map below), 86 trace metal samples and 84 nutrient samples collected at the surface (5m) and bottom (variable depending on bottom depth), and 27 oxygen-18 water isotopes collected at select stations.

Background: The objective of this sampling is to take high quality/high resolution trace metal (iron, zinc, nickel, copper, cadmium, manganese, lead) and macronutrient (nitrate, phosphate, silicate) samples alongside the CTD and mooring temperature and salinity sampling. Trace metals (found in small or trace concentrations, ~10^{-9}mol/L) may be useful in deciphering water mass circulation or provenance. Many, like iron, are biologically important for phytoplankton in the surface waters. Importantly, the Bering and Chukchi shelves provide a large source of these trace metals to the Western Arctic Ocean.



Map of stations sampled for trace metals and nutrients by trace metal clean pump. BS line was sampled twice, 4 days apart. Dashed lines are the marginal ice zone on 9/12/24 from the U.S. National Ice Center showing 1/10ths ice coverage (outer) and 8/10ths ice coverage (inner). (For final positions, see maps at start of report.)

Moreover, the inventory of these trace metals appears to increase moving from the North Pacific/Bering Sea through the Bering Strait and onto the Chukchi Shelf. Sources for these metals are primarily sediment resuspension (export of organic matter to the sediments release trace metals through diagenesis or non-reductive dissolution) or riverine input. Freshwater intrusions (salinity <30psu) were observed throughout the CTD transects close to the Alaskan Coast (lines BS, AL, SCS, BC). Rivers may act as a source or diluent for metals and nutrients. Variations in temperature and salinity indicate the presence of multiple water masses observed along the CTD lines sampled. The major objective of this high-resolution sampling is to assess if or to what extent trace metals and nutrients vary across these different water masses feeding into the Bering Strait. Trace metals could be used to trace water mass movement further north where currents are complicated by bathymetric features and become more difficult to track. The BS line was sampled twice (13th September and 17th September) after a storm on the 16th September. Preliminary CTD showed surface freshwater feature near BS11.5 rpt (near Little Diomede), indicating possible detachment of ACC due to winds.

Pump sampling of trace metals: Sampling was done using a trace metal clean PTFE double diaphragm pump (Wilden, see picture below) with a max flow capacity at 56 liters/minute at 125 psi air supply. Tubing both in and out of the water was Grainger 1/2in OD (polyethylene) connected to the pump with PVDF 1/2in compression fittings (all acid cleaned prior to the cruise). Tubing was cut to ~70m and marked with tape up to 60m from the surface and attached to 3/8in Nylon line. An 8lb kettleball weight was attached directly to the Nylon rope and a RBR Concerto^3 CTD was lashed to the rope with Dynacon line (see figure). Thus the tubing sat approximately 1m above the kettleball weight.

Air was supplied by the ship service air connection on the starboard side and pressure was ultimately controlled using an air regulator (see picture) before entering the pump. Pumping at max capacity, pump was cleared in 80 seconds, estimated by introducing a bubble before surface cast to mark "new water" being sampled. Thus, before each surface and deep sample the pump was flushed for at least 90 seconds at max capacity/speed. Larger capacity Acropaks were used (Acropak-1500 0.2 μm filter) again this year instead of the Acropak-200 used in 2021. These filters did not clog (one was used, LL, as back-up JJ had a potential issue during sampling) and thus there was very little pressure on the pump and tubing. Additionally, the same acid clean Masterflex L/S

24 tubing implemented in 2022 was used rather than the C-flex tubing from 2021 that has a thinner outer diameter and thus "wears out" more easily in response to any back pressure. Both the filtered and unfiltered flow were attached to the main Grainger tubing via a plastic wye split and the Masterflex tubing connection was reinforced by zipties. Flow between the filtered and unfiltered tubing was controlled by plastic hose clamps. After flushing the system, flow was reduced to ~60 psi via the regulator to comply with the pressure ratings on the filter and alleviate back pressure.

Filtered samples (trace metals and nutrients) were filtered directly into 250 mL (TMs) and 60 mL (nuts) Nalgene bottles (pre-cleaned) following 2-3 10% volume rinses as water budget allowed. Nutrients were only filled to approximately 45 mL. Samples were bagged in two poly bags. Nutrient samples were placed in -20°C freezer inside one poly bag within 10 minutes of sampling. Trace metal samples were double bagged in poly bags in increments of 12 and nutrient samples in increments of 5. Nutrient samples remained frozen until they could be analyzed in the Marine Chemistry Lab at the University of Washington. Trace metal samples were all acidified to pH 1.8 using 500 μL of Optima HCl (12M) under a Class 100 laminar flow hood (OSB 443) on 09/23/24. Note that volume was estimated for incomplete samples (clearly less than 250 mL volume) and acidification volume was adjusted accordingly (i.e., if only 50 mL of seawater was collected, 100 μL of Optima HCl was used).

Oxygen-18 isotope samples (opportunistic) were collected in 60 mL Nalgene bottles (pre-cleaned) supplied by the Marine Chemistry Laboratory. 29 samples were collected total (see table below).

Issues encountered during sampling and possible modifications:

New in 2024:

- **Ease of sampling:** The past four years have yielded successful and rapid sample collection. However, it would be easier to sample with a few simple additions such as a filter rig/filter holder that could be secured on deck and hold the filter and unfiltered lines in place. This would allow sampling with both hands and less potential contamination of samples (dropping filter, using "dirty" hand to turn the pump on and off, etc.).
  - **Solution in 2024:** Modified to "hang" tubing through release handles (taped with black electrical tape to mitigate contamination) allowing filtered and unfiltered flow to hang freely. Thus, sampler's hands were free while sampling rather than holding both the filter and the sample bottle.
  - **In the future:** Build a filter rig or modify existing rigs such as the "SBE Stand" used by PI Woodgate to hold instruments during mooring data download or calibration. Ideally, a slot for the 1500 Acropak and potentially a space for the unfiltered flow to be secured. Pressure through the pump causes tubes to wiggle or bounce and this would help that situation.
- **Oxygen sensor wet-connection on RBR CTD:** On the BC line (station BC2.5, see table below), the oxygen sensor wet connection to the oxygen electrode came undone while in the water. No oxygen data collected on this cast.
  - **Solution at sea:** Robert Daniels helped to dry off connections on deck and apply a light layer of silicone grease to both ends. The connection was repaired, the cover to the connection tightened, and the mount for the oxygen electrode tightened as well. RBR data showed no error in oxygen casts after this reconnection.

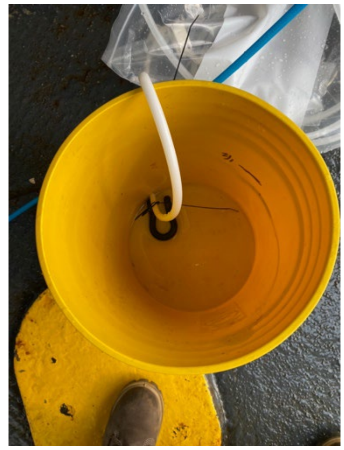
Consistent since 2021:

- **Hauling in the apparatus:** One 8lb weight plus the 1.5 kg (3.3 lbs) RBR CTD was about at the limit for one person to haul in comfortably and repeatedly. However, sometimes the weight was not enough to get the tubing down to desired depth.
  - **In the future:** Discussion September 17th with Robert Daniels (APL-OE, on-board) about procuring davit and suitable block for next year from APL stock.
- **Flow recirculation between filtered and unfiltered lines:** During sampling, the wye split allowed for flow to recirculate between the filtered and unfiltered tubing, i.e., the pulses of water back-flowed into the wye split and into the other side. To minimize the chance that water that touched the "dirty" unfiltered tube came into contact with the clean tubing and filter, the clamp was placed directly below the wye split. This way, the flow recirculation.
  - **In the future:** Continue to clamp conservatively. Also, ensure that all tubing is acid washed prior to field sampling.
- **Back pressure on filters**: As described above, the max pressure output of 125 psi from the Wilden pump was too strong for the Acropak capsule filters.

- **Solution(s) at sea:** Reduced pressure to ~80 psi when actively sampling. Also, only slightly closed the unfiltered tubing so that some pressure was relieved that way. Tubing was reinforced with zipties rather than plastic hose clamps. Larger capacity filters were used this year (1500 vs 200) and this was a prodigious solution for backpressure due to clogging. Stronger tubing (Masterflex L/S 24) were also used to great effect.
- **End of tubing staying clean:** The ship's crew did an excellent job of making sure the end of the tubing attached to the Nylon rope did not hit the side of the ship upon recovery. However, this meant that when recovering the weight/CTD/end of the tubing one must lean out over the side of the ship and not use the ship railing as a counterbalance.
- **In the future:** Results from 2021 suggest very minimal contamination of samples, so end of tubing is likely not a major contamination source if it stays clean during sampling effort.
- **Trace metal cleanliness:** Ideally, sampling would be done in a clean, positive pressure environment. Occasionally, filter apparatus and sample bottles were exposed to seaspray, water on the deck, surfaces inside the ship, or ungloved hands.
- **Solutions at sea:** Using plastic bags and gloves as much as possible to protect samples from potential contamination.
- **In the future:** Trying to set up a small environment on the ship where samples could be re-bagged or sorted in a clean way. Even better, creating a way for the entire sampling process to be done indoors in a clean space. Some ideas for this include having the tubing go through a window or other opening and sampling into the sink in a small "bubble" environment.

Pump set up during sampling in 2024. *Picture credit: K. Kohlman.*

Modified filter set up (before sampling BS, BC, and BS repeat lines) in 2024. Notice that the release handle has been wrapped in black electrical tape and the filtered and unfiltered lines now hang from this handle, allowing more hands-free sampling. Bella Payne pictured sampling here.



View of coiled rope and tubing with tape markings (left) and mini RBR CTD (red, white, black). Bucket used to collect unfiltered flow during flushing with shackle attached to restrict the “bouncing” of the white C-flex tubing that occurs due to the pump pressure.

Close up of pump with air regulator and air hose (blue) sitting on the mooring release pallets. It was necessary to use a ratchet strap to stabilize the pump so it did not move during sampling. Plastic bags were used as an extra precaution against contamination.

Picture of weight (blue), RBR CTD (red, white) being secured to the rope roughly 2m and 0.5m from the bottom of the tubing (far right), respectively.

== **Nutrients collected by pumping (84 total):**

Station	Sampling date	Latitude	Longitude	Cast	Target Depth	Sample
name	**local**	**degN**	**degW**	**#**	**m**	**#**
AL12.5 surf	9/11/24	66.337	168.925	1	5	2626
AL12.5 bot	9/11/24	66.338	168.926	1	50	2625
AL14 surf	9/11/24	66.354	168.822	2	5	2627
AL14 bot	9/11/24	66.356	168.824	2	45	2628
AL15.5 surf	9/11/24	66.369	168.716	3	5	2629
AL15.5 bot	9/11/24	66.370	168.717	3	45	2630
AL17 surf	9/11/24	66.387	168.611	4	5	2631
AL17 bot	9/11/24	66.388	168.611	4	45	2632
AL18.5 surf	9/11/24	66.403	168.497	5	5	2633
AL18.5 bot	9/11/24	66.406	168.499	5	35	2634
AL20 surf	9/11/24	66.424	168.393	6	5	2635
AL20 bot	9/11/24	66.426	168.394	6	45	2636
AL21.5 surf	9/11/24	66.441	168.288	7	5	2637
AL21.5 bot	9/11/24	66.442	168.290	7	40	2638
AL23 surf	9/11/24	66.462	168.178	8	5	2639
AL23 bot	9/11/24	66.462	168.178	8	30	2640
AL25 surf	9/12/24	66.481	168.029	9	5	2641
AL25 bot	9/12/24	66.483	168.026	9	20	2642
SCS10 surf	9/12/24	67.583	168.598	10	5	2643
SCS10 bot	9/12/24	67.583	168.597	10	45	2644
SCS11 surf	9/12/24	67.681	168.361	11	5	2650
SCS11 bot	9/12/24	67.682	168.360	11	40	2651
SCS12 surf	9/12/24	67.809	168.082	12	5	2652
SCS12 bot	9/12/24	67.809	168.081	12	45	2653
SCS13 surf	9/12/24	67.939	167.795	13	5	2654
SCS13 bot	9/12/24	67.940	167.796	13	45	2655
SCS14 surf	9/12/24	68.060	167.509	14	5	2656
SCS14 bot	9/12/24	68.060	167.346	14	45	2657
SCS15 surf	9/12/24	68.171	167.249	15	5	2658
SCS15 bot	9/12/24	68.171	167.251	15	45	2659
SCS16 surf	9/12/24	68.226	167.124	16	5	2645
SCS16 bot	9/12/24	68.225	167.129	16	40	2646
SCS17 surf	9/13/24	68.281	167.003	17	5	2647
SCS17 bot	9/13/24	68.282	167.004	17	30	2648
SCS18 surf	9/13/24	68.307	166.936	18	5	2649
SCS18 bot	9/13/24	68.307	166.938	18	30	2660
SCS19 surf	9/13/24	68.332	166.878	19	5	2661

SCS19 bot	9/13/24	68.332	166.885	19	20	2662
BS11.5 surf	9/13/24	65.797	168.899	20	5	2663
BS11.5 bot	9/13/24	65.797	168.899	20	43	2664
BS13 surf	9/13/24	65.777	168.792	21	5	2665
BS13 bot	9/13/24	65.780	168.790	21	40	2666
BS14.5 surf	9/14/24	65.751	168.692	22	5	2667
BS14.5 bot	9/14/24	65.754	168.691	22	40	2668
BS16 surf	9/14/24	65.726	168.589	23	5	2669
BS16 bot	9/14/24	65.729	168.587	23	40	2670
BS17.5 surf	9/14/24	65.699	168.487	24	5	2671
BS17.5 bot	9/14/24	65.703	168.487	24	45	2672
BS19 surf	9/14/24	65.682	168.401	25	5	2673
BS19 bot	9/14/24	65.688	168.405	25	40	2674
BS20.5 surf	9/14/24	65.660	168.295	26	5	6122
BS20.5 bot	9/14/24	65.237	168.299	26	40	6123
BS22 surf	9/14/24	65.632	168.186	27	5	6124
BS22 bot	9/14/24	65.639	168.193	27	30	6125
BC12.5 surf	9/14/24	65.251	168.861	28	5	6126
BC12.5 bot	9/14/24	65.253	168.864	28	45	6127
BC10.5 surf	9/14/24	65.291	168.686	29	5	6128
BC10.5 bot	9/14/24	65.293	168.689	29	45	6129
BC8 surf	9/14/24	65.342	168.481	30	5	6130
BC8 bot	9/14/24	65.344	168.485	30	45	6131
BC5.5 surf	9/14/24	65.394	168.272	31	5	6132
BC5.5 bot	9/14/24	65.394	168.276	31	50	6133
BC4 surf	9/14/24	65.426	168.156	32	5	6134
BC4 bot	9/14/24	65.427	168.161	32	40	6135
BC2.5 surf	9/14/24	65.460	168.039	33	5	6136
BC2.5 bot	9/14/24	65.462	168.054	33	35	6137
BC4 surf	9/14/24	65.488	167.901	34	5	6138
BC4 bot	9/14/24	65.489	167.910	34	23	6139
BS11.5 rpt surf	9/17/24	65.797	168.891	35	5	6143
BS11.5 rpt bot	9/17/24	65.797	168.887	35	45	6144
BS13 rpt surf	9/17/24	0.000	168.791	36	5	6145
BS13 rpt bot	9/17/24	65.774	168.791	36	45	6146
BS14.5 rpt surf	9/17/24	65.746	168.694	37	5	6147
BS14.5 rpt bot	9/17/24	65.746	168.695	37	45	6148
BS16 rpt surf	9/17/24	65.722	168.591	38	5	6149
BS16 rpt bot	9/17/24	65.721	168.592	38	45	6150
BS17.5 rpt surf	9/17/24	65.694	168.489	39	5	6151
BS17.5 rpt bot	9/17/24	65.693	168.492	39	40	6152

BS19 rpt surf	9/17/24	65.673	168.393	40	5	6153
BS19 rpt bot	9/17/24	65.673	168.396	40	40	6154
BS20.5 rpt surf	9/17/24	65.649	168.286	41	5	6155
BS20.5 rpt bot	9/17/24	65.650	168.291	41	40	6156
BS22 rpt surf	9/17/24	65.625	168.178	42	5	6157
BS22 rpt bot	9/17/24	65.625	168.181	42	25	6158

== Oxygen isotope samples collected (27 total): (including 9 taken from CTD rosette)

Station	Sampling date	Latitude	Longitude	Cast	Target Depth	Sample	Pump or CTD
name	**local**	**degN**	**degW**	**#**	**m**	**#**	
BS17.5 surf	9/14/24	65.699	168.487	24	5	1080	pump
BS19	9/14/24	65.667	168.356	68	0	1081A	CTD
BS20.5 surf	9/14/24	65.660	168.295	26	5	1082	pump
BS20.5	9/14/24	65.650	168.286	71	0	1083A	CTD
BS22	9/15/24	65.630	168.177	74	0	1086A	CTD
BS22 surf	9/14/24	65.632	168.186	27	5	1084	pump
BS22 bot	9/14/24	65.639	168.193	27	30	1085	pump
BC2.5	9/14/24	65.457	168.020	108	0	1087A	CTD
BC2.5 surf	9/14/24	65.460	168.039	33	5	1088	pump
SCS10 surf	9/12/24	67.583	168.598	10	5	2675	pump
SCS11 surf	9/12/24	67.681	168.361	11	5	2676	pump
SCS14 surf	9/12/24	68.060	167.509	14	5	2677	pump
SCS15 surf	9/12/24	68.171	167.249	15	5	2678	pump
SCS15	9/12/24	68.171	167.247	52	0	2679A*	CTD
SCS16 surf	9/12/24	68.226	167.124	16	5	2680	pump
SCS16	9/12/24	68.226	167.121	53	0	2681A	CTD
SCS17 surf	9/13/24	68.281	167.003	17	5	2682	pump
SCS17	9/13/24	68.281	167.001	54	0	2683A	CTD
SCS18 bot	9/13/24	68.307	166.938	18	30	2684	pump
SCS18	9/13/24	68.306	166.935	55	0	2685A	CTD
SCS19 surf	9/13/24	68.332	166.878	19	5	2686	pump
BS11.5 surf	9/13/24	65.797	168.899	20	5	2687	pump
BS11.5 bot	9/13/24	65.797	168.899	20	43	2688	pump
BS17.5 bot	9/14/24	65.703	168.487	24	45	6121	pump
BC1 surf	9/14/24	65.488	167.901	34	5	6140	pump
BC1 bot	9/14/24	65.489	167.910	34	23	6141	pump
BC1	9/12/24	65.488	167.901	110	0	6142	CTD

* Paper logs record this erroneously as 7228A. Corrected in digital version

BERING STRAIT 2024 WATER SAMPLING: ^{129}I & ^{236}U Sampling Report

Annabel Payne, ETH Zürich, Switzerland

Summary: In 2024, 15 stations along the AL, SCS, and BS lines were sampled for the anthropogenic radionuclides 129I and 236U. Two stations along each line targeted the surface (5m) and bottom water (variable depth), and at the eastern end of each line (AL25, SCS19, and BS22), only the surface was sampled.

Station Name	Cast #	Bottle #	Target Depth	Sample Name	Water Mass Targeted
Al12.5	15	1	54.6m	ETH-BS1	Anadyr Water
		12	0m	ETH-BS2	Anadyr Water
AL18.5	27	1	52.2m	ETH-BS3	Bering Sea Water
		12	0m	ETH-BS4	Bering Sea Water
AL25	41	8	0m	ETH-BS5	Alaskan Coastal Water
SCS10	47	1	47.8m	ETH-BS6	Anadyr Water
		12	0m	ETH-BS7	Anadyr Water (but likely Siberian Coastal Water)
SCS13	50	1	52.9m	ETH-BS8	Bering Sea Water
		12	0m	ETH-BS9	Bering Sea Water
SCS19	56	5	0m	ETH-BS10	Alaskan Coastal Current Water
BS11.5	58	1or2	45.9m	ETH-BS11	Anadyr Water
		11or12	0m	ETH-BS12	Anadyr Water
BS17.5	67	1	52m	ETH-BS13	Bering Sea Water
		11	0m	ETH-BS14	Bering Sea Water (but likely Alaskan Coastal Water)
BS22	74	8or9	0m	ETH-BS15	Alaskan Coastal Water

Background: The anthropogenic radionuclides have two different release histories, leading to different concentrations observed in the Pacific, Arctic and North Atlantic.

In the 1950s and 1960s, nuclear weapons testing released ~ 1000 kg of ^{236}U and ~ 50 kg of ^{129}I into the atmosphere, leading to a low-level global fallout signal (~ 1 – 7 atoms / L x 10^7) observed in all the global oceans. This low-level signal is what labels the Pacific Ocean waters. In Europe, the nuclear reprocessing facilities Sellafield and La Hague have released both isotopes to the Atlantic since the 1970s; these waters then travel up to the Nordic seas, labelling the Atlantic-sourced waters in the Arctic Ocean with concentrations 1 - 3 orders of magnitude higher than the global fallout signal. However, only in the last decade or so have measurements of ^{236}U from small-volume samples become possible, thanks to Accelerator Mass Spectrometry. While ^{129}I has been measured in the Bering Strait and across the Arctic for the last 30+ years, no measurements of ^{236}U exist in the Bering Strait. The Bering Strait 2024 cruise provides the first opportunity to measure the inflow of both tracers, specifically in the different branches, allowing us to define end-member concentrations for Pacific Water circulating in the Arctic. This is particularly important when estimating water-mass composition, mixing, and transport time scales.

Sampling: Samples were taken from the rosette, combining two bottles where necessary to reach the required 2 L volume. After being triple-rinsed with water from the Niskin, samples were collected directly into 2 L LDPE containers. For surface samples with only one Niskin available, a bucket of surface water was collected from the vessel's side for rinsing. Samples were then stored at ambient temperatures for transport to ETH Zürich for analysis.

No issues were encountered during sampling due to the tracers' biologically inert nature and the absence of risk of contamination from other sources.

BERING STRAIT 2024 WATER SAMPLING: Hafnium and Neodymium Report

Annabel Payne, ETH Zürich, Switzerland

Summary: In 2024, four stations were sampled for lithogenic Hafnium and Neodymium isotopes. At AL12.5, SCS10, and BS17.5, the bottom water was sampled, and at BS22, the surface was sampled.

Station Name	CTD Cast prior to sampling #	Target Depth	Sample Name	Water Mass Targeted
Al12.5	15	Bottom layer	ETH-AL12.5	Anadyr Water
SCS10	47	Bottom layer	ETH-SCS10	Anadyr Water
BS17.5	67	Bottom layer	ETH-BS17.5	Bering Sea Water
BS22	74	Surface layer (5m)	ETH-BS22	Alaskan Coastal Water

Background:

Isotopes of hafnium and neodymium in seawater may provide insights into a rapidly evolving environment like the Arctic. The distinct Hf / Nd isotopic signatures of Pacific and Atlantic waters and individual Arctic rivers can be used to estimate the proportions of fresh surface water inputs to the basin, especially when combined with additional tracers such as the anthropogenic radionuclide ^{129}I. The Bering Strait 2024 cruise provides the first-ever opportunity for sampling of both Hafnium and Neodymium in the Bering Strait, allowing us to define the end-member waters inflowing to the Arctic.

Weathering of the Nd system can be considered congruent, providing a robust indicator of the source terrain. In contrast, Hf exhibits incongruent weathering behavior. Enhanced physical weathering from glaciation may release un-radiogenic Hf, leading to un-radiogenic signals in the dissolved fraction carried by rivers to the ocean. We have observed a distinct change in the isotopic signature of both the Polar Mixed Layer and Pacific Summer Water in the Canada Basin; we will utilize these tracers to identify if there has been any change in the inputs to the Canada Basin of the Arctic Ocean over the past two decades, given the rapidly evolving arctic environment, with the melt of permafrost and glacial retreat possibly releasing increased volumes of well-weathered material into riverine systems, and also investigate the transformation of both the Nd and Hf signal across the Bering and Chukchi Seas due to seafloor interaction.

Sampling:

Samples were collected using the same setup as the trace metals sampling, i.e., using a trac metal clean PTFE double diaphragm pump (Wilden) to draw water from depth via tubing lowered by hand over the side of the ship after the CTD cast. The depth of the end of the tube was ascertained using an RBR Concerto CTD lashed to the line supporting the tubing (see Trace metal report for more details). 20 L samples were collected into acid-cleaned LDPE cubic containers and filtered through an Acropak-1500 0.2 μm filter to obtain the pure dissolved fraction. Samples were acidified to < pH 2 with ultrapure HCl (Fischer Optima) to preserve them, then stored at ambient temperatures and shipped to ETH Zürich for analysis.

The only possible issues with sampling are the same as those for the trace metals; contamination from the environment is possible; however, given the efforts to keep a clean environment, contamination will unlikely be a significant issue.

Acidification of the sample without a laminar flow hood also presents a safety issue. However, this was minimized by wearing PPE, only opening the pre-measured vial of acid after the sample was opened, and immediately transferring the acid to the sample. The empty acid vials were then re-packed in the shipping materials for disposal at UW.

BSTRAIT 2024 WATER SAMPLING: Opportunistic samples for Phytoplankton, for Monica Orellana (UW)
Report by Cecilia Peralta-Ferriz for Monica Orellana.

During this cruise we supported a preliminary research study on phytoplankton on behalf of Dr. Monica Orellana, a Biological Oceanographer at PSC/APL/UW. For this effort, we collected a total of 55 water samples:
- 10 water samples (25-30ml) for identification of phytoplankton species, and
- 45 water samples (2.5-3ml) for quantification of phytoplankton cells.

The 10 larger samples (25-30ml each) for species identification were collected unfiltered from Niskin bottles, or sometimes, when the sample was taken from the surface, from a surface sample collected by bucket. These samples were collected into bottles containing ~20ml of nutrient media (i.e., enriched artificial sea water medium (ESAW, Berges et al. 2001)) to enhance cell growth. The media was added in the bottle prior to the addition of the water sample. As noted below, in some of these bottles, the media partially leaked during shipping.

The 45 smaller samples (~2.5-3ml each) for quantification of cells were also collected unfiltered, using a small hose attached to the spigot of the Niskin bottle to slow down the flow and minimize cell rupture and disturbance as waters entered the vial. These samples were preserved in 0.002% gluteraldehyde solution, which had been added to the vial prior to sampling. These samples are expected to be analyzed using an Influx flow cytometer/sorter back at UW.

Surface light flux was measured (3 consecutive readings) at most sampling locations using a light meter (brand LICOR). The sampling date/time, location, station ID, depth, light measurement and corresponding comments were included in the hydrography bottle log and are listed below in Tables I and II for the larger and smaller samples, respectively.

All samples were returned to Seattle post-cruise in coolers as hold luggage on an overnight flight and placed into at UW fridge.

(*Note salinities are from uncorrected underway data and are 1.1-1.8psu too fresh.)

Table I. Large (25-30ml) samples for identification of phytoplankton species. Light absorbance is measured in µmol photons per m^2/s.

Sample No.	Date (UTC)	Time (UTC)	Lat. deg	Lat. min	Long. deg	Long. min	Cast #	Bottle #	Apprx Depth (m)	Light 1	Light 2	Light 3	Station ID
1	9/12/2024	00:18	66	20.45	168	53.90	16	2	20	29.1	29	28.9	AL13
2	9/12/2024	16:15	67	18.56	168	37.07	n/a	bucket	0	0.12	0.13	0.13	near AS15
3	9/12/2024	18:40	67	22.68	168	11.55	n/a	bucket	0	4.8	4.8	4.9	IceEdge67N
4	9/14/2024	06:32	65	47.80	168	53.91	58	1	46	0	0	0	BS11.5
5	9/14/2024	06:32	65	47.80	168	53.91	58	bucket	0	0	0	0	BS11.5
6	9/14/2024	07:37	65	46.36	168	47.57	61	12	0	0	0	0	BS13
7	9/14/2024	19:01	65	26.88	168	48.48	83	1	0	7.9	7.9	7.9	SBSnn9.5
8	9/14/2024	20:40	65	21.65	168	6.602	87	1	50	6.01	6.06	6.16	SBSnn13.5

Table I. Continued.

Sample No.	Comments
1	Taken at Chlorophyll max, at 20m.
2	Taken with Bucket on the ice edge; TSG: T=-0.45; S=25.23psu*. On the ice edge – 'marine snow'. Lots of whales and jelly fish. TSG: T=3.4C; S=26.8psu*.
3	Taken with Bucket on the surface. Nutrients samples were taken, filtered and unfiltered. Ice edge, jellies, marine snow, whales, brownish clumps in water
4	Taken at the Bottom - catching Anadyr Water - Increase in Fluorescence - DARK/night
5	Taken at the surface - NOT Anadyr Water- less Fluorescence. Pitch dark/night
6	Surface had a Chl max. Dark/Night. Likely within an eddy.
7	Media leaked - down to ~5ml (from 20ml) - Sample taken in the Chl Max at the surface
8	Media leaked - down to ~5ml (from 20ml) - Sample taken at the Bottom, in Chl spike, high enough to turn filter brown (though these samples are all unfiltered).

Table II. Samples for quantification of phytoplankton cells. *n/m* = not measured.

Sample No.	Date (UTC)	Time (UTC)	Lat. deg	Lat. min	Long. deg	Long. min	Cast #	Bottle #	Appx. Depth (m)	Light 1	Light 2	Light 3	Station ID
1	9/12/2024	21:36	67	34.939	168	35.93	47	5	20	*n/m*	*n/m*	*n/m*	SCS10
2	9/12/2024	21:36	67	34.939	168	35.93	47	5	20	*n/m*	*n/m*	*n/m*	SCS10
3	9/12/2024	21:36	67	34.939	168	35.93	47	10	10	*n/m*	*n/m*	*n/m*	SCS10
4	9/12/2024	21:36	67	34.939	168	35.93	47	10	10	*n/m*	*n/m*	*n/m*	SCS10
5	9/12/2024	21:36	67	34.939	168	35.93	47	12	0	*n/m*	*n/m*	*n/m*	SCS10
6	9/12/2024	21:36	67	34.939	168	35.93	47	12	0	*n/m*	*n/m*	*n/m*	SCS10
7	9/12/2024	23:16	67	40.879	168	21.709	48	7	20	14.1	14.2	14.3	SCS11
8	9/12/2024	23:16	67	40.879	168	21.709	48	7	20	14.1	14.2	14.3	SCS11
9	9/12/2024	23:16	67	40.879	168	21.709	48	9	10	14.1	14.2	14.3	SCS11
10	9/12/2024	23:16	67	40.879	168	21.709	48	9	10	14.1	14.2	14.3	SCS11
11	9/12/2024	23:16	67	40.879	168	21.709	48	12	0	14.1	14.2	14.3	SCS11
12	9/12/2024	23:16	67	40.879	168	21.709	48	12	0	14.1	14.2	14.3	SCS11
13	9/13/2024	1:11	67	48.565	168	4.919	49	5	20	16.5	16.4	16.6	SCS12
14	9/13/2024	1:11	67	48.565	168	4.919	49	5	20	16.5	16.4	16.6	SCS12
15	9/13/2024	1:11	67	48.565	168	4.919	49	9	9	16.5	16.4	16.6	SCS12
16	9/13/2024	1:11	67	48.565	168	4.919	49	9	9	16.5	16.4	16.6	SCS12
17	9/13/2024	1:11	67	48.565	168	4.919	49	12	0	16.5	16.4	16.6	SCS12
18	9/13/2024	1:11	67	48.565	168	4.919	49	12	0	16.5	16.4	16.6	SCS12
19	9/13/2024	5:20	68	3.559	167	30.22	51	7	20	*n/m*	*n/m*	*n/m*	SCS14
20	9/13/2024	5:20	68	3.559	167	30.22	51	7	20	*n/m*	*n/m*	*n/m*	SCS14
21	9/13/2024	5:20	68	3.559	167	30.22	51	9	8	*n/m*	*n/m*	*n/m*	SCS14
22	9/13/2024	5:20	68	3.559	167	30.22	51	9	8	*n/m*	*n/m*	*n/m*	SCS14
23	9/13/2024	5:20	68	3.559	167	30.22	51	12	0	*n/m*	*n/m*	*n/m*	SCS14
24	9/13/2024	5:20	68	3.559	167	30.22	51	12	0	*n/m*	*n/m*	*n/m*	SCS14
25	9/14/2024	8:00	65	45.88	168	45.54	62	1	20	0	0	0	BS13.5
26	9/14/2024	8:00	65	45.88	168	45.54	62	1	20	0	0	0	BS13.5

27	9/14/2024	8:00	65	45.88	168	45.54	62	3	8	0	0	0	BS13.5
28	9/14/2024	8:00	65	45.88	168	45.54	62	3	8	0	0	0	BS13.5
29	9/14/2024	8:00	65	45.88	168	45.54	62	5	0	0	0	0	BS13.5
30	9/14/2024	8:00	65	45.88	168	45.54	62	5	0	0	0	0	BS13.5
31	9/14/2024	22:12	65	15.003	168	51.593	88	7	15	15.8	16	16	BC12.5
32	9/14/2024	22:12	65	15.003	168	51.593	88	7	15	15.8	16	16	BC12.5
33	9/14/2024	22:12	65	15.003	168	51.593	88	9	4	15.8	16	16	BC12.5
34	9/14/2024	22:12	65	15.003	168	51.593	88	9	4	15.8	16	16	BC12.5
35	9/14/2024	22:12	65	15.003	168	51.593	88	10	0	15.8	16	16	BC12.5
36	9/14/2024	22:12	65	15.003	168	51.593	88	10	0	15.8	16	16	BC12.5
37	9/17/2024	23:42	65	25.7	168	57.8	152	1	44	14.9	14.8	14.7	SBSnn11.5
38	9/17/2024	23:42	65	25.7	168	57.8	152	1	44	14.9	14.8	14.7	SBSnn11.5
39	9/17/2024	23:42	65	25.7	168	57.8	152	7	27	14.9	14.8	14.7	SBSnn11.5
40	9/17/2024	23:42	65	25.7	168	57.8	152	7	27	14.9	14.8	14.7	SBSnn11.5
41	9/17/2024	23:42	65	25.7	168	57.8	152	7	27	14.9	14.8	14.7	SBSnn11.5
42	9/17/2024	23:42	65	25.7	168	57.8	152	9	17	14.9	14.8	14.7	SBSnn11.5
43	9/17/2024	23:42	65	25.7	168	57.8	152	9	17	14.9	14.8	14.7	SBSnn11.5
44	9/17/2024	23:42	65	25.7	168	57.8	152	10	0	14.9	14.8	14.7	SBSnn11.5
45	9/17/2024	23:42	65	25.7	168	57.8	152	10	0	14.9	14.8	14.7	SBSnn11.5

Table II. Continued.

Sample No.	Comments
1	Taken below Chl Max (3.0)
2	Taken below Chl Max (3.0)
3	At Chl Max (3.0)
4	At Chl Max (3.0)
5	Taken above the CHl Max (~0.8)
6	Taken above the CHl Max (~0.8)
7	Taken below Chl Max (5.0 mg/l)
8	Taken below Chl Max (5.0 mg/l)
9	Taken at Chl Max (5.0 mg/l)
10	Taken at Chl Max (5.0 mg/l)
11	Taken above Chl Max
12	Taken above Chl Max
13	Taken below Chl Max (8.0 mg/l)
14	Taken below Chl Max (8.0 mg/l)
15	Taken at Chl Max
16	Taken at Chl Max
17	Taken above Chl Max
18	Taken above Chl Max
19	Taken below Chl Max
20	Taken below Chl Max
21	Taken at Chl Max
22	Taken at Chl Max

23	Taken above Chl Max
24	Taken above Chl Max
25	Taken below Chl Max, but dark/night, light 0. But under ship lights readings are 0.1, 0.1 and 0.2.
26	Taken below Chl Max, but dark/night, light 0. But under ship lights readings are 0.1, 0.1 and 0.2.
27	Taken at Chl Max
28	Taken at Chl Max
29	Taken above Chl Max
30	Taken above Chl Max
31	Taken below Chl Max
32	Taken below Chl Max
33	Taken at Chl Max at ~4m
34	Taken at Chl Max at ~4m
35	Taken above Chl Max
36	Taken above Chl Max
37	Taken below Chl Max
38	Taken below Chl Max
39	At Chl Max
40	At Chl Max
41	At Chl Max
42	At min between subsurface Chl Max and surface Chl max layer
43	At min between subsurface Chl Max and surface Chl max layer
44	Surface (in secondary Chl Max)
45	Surface (in secondary Chl Max)

Reference:

Berges, J.A., Franklin, D.J. and Harrison, P.J. (2001), EVOLUTION OF AN ARTIFICIAL SEAWATER MEDIUM: IMPROVEMENTS IN ENRICHED SEAWATER, ARTIFICIAL WATER OVER THE LAST TWO DECADES. Journal of Phycology, 37: 1138-1145. https://doi.org/10.1046/j.1529-8817.2001.01052.x

BERING STRAIT 2024 UNDERWAY DATA REPORT – Woodgate (UW)

Underway CTD, ADCP and some meteorological data were collected during the cruise using the Norseman II's ship-based systems. These systems are set up by the Norseman II crew at the start of the cruise. **Action item: Pre-cruise, develop checksheets for the setup of these instruments to ensure settings are as desired. Check the setups as soon as the ship leaves port.**

ADCP: This year, as last year, we collected data from the Norseman II's Teledyne RD Instruments 300kHz Workhorse Mariner ADCP (SN 19355), which is equipped with high accuracy bottom tracking. The ADCP is mounted 3m below the water line. This system was operational for the cruise, running with 1m bins and bottom track. The following file types are available for processing (file information copied from http://po.msrc.sunysb.edu/SBI/Healy_ADCPs.htm)

*.ENR – raw binary ADCP data which contains every ping
*.ENS – Binary ADCP data after the data has been preliminarily screened for backscatter and correlation
*.ENX - Binary ADCP data after screening and rotation to earth coordinates
*.STA - Binary ADCP ensemble data that has been averaged into short term averages
*.LTA - Binary ADCP ensemble data that has been averaged into long term averages
*.N1R - Raw NMEA ASCII data from the primary navigation source
*.N2R - Raw NMEA ASCII data from the secondary navigation source, if available, and which should include Ashtech heading data
*.NMS - Binary screened and averaged navigation data
*.VMO - This ASCII file is a copy of the *.ini options file that was used during the data collection
*.LOG - ASCII file containing a log of any errors the ADCP detected during the session

Preliminary data plots will be added to this report once available. Bottom track data was logging during this deployment. **Action item: Ensure that bottom tracking is turned on. Process ADCP data.** Note also that since heading information is given by the ship's GPS position, it is not necessary to correct for magnetic declination. **Action item: Check prior data for magnetic declination issue.**

This year (2024), on day 2 of the cruise, it was found that the cruise data were being logged to some restricted location (c:/Progam Files (x86)/RD Instruments/VmDas), and were only visible from winADCP, and could not be located through other means (e.g., directory structure, Dos window, etc). This was as the output path in the data acquisition program (VmDas) had been set to this location, rather than the usual data disc. Having fixed the output path, much time was expended attempting to find a way to copy the other files. Eventually, it was found they could be copied by opening the 'Open File' option in winADCP, and then using keyboard commands (control C, Control V) copy the files into ANOTHER 'Open file' window on a second winADCP application which was looking at a file location which was generally accessible.
Action item: At start of cruise, check where all underway files are being written

On the 17th September, VMDAS quit working and had to be restarted.

Thus, for the cruise, there are three directories of data:
- ADCPpreTeller (the hidden files), and then ADCP_20240909 (most of the cruise) and ADCP20240917 (the rest of the cruise after the system restarted). **Action item: On processing, check that the data options are the same in the preTeller case to the rest of the cruise (which was reset to the set up file use in previous years.**

MET DATA: The Norseman2 had South Central Radar install a new Meteorological sensor package in 2021, as the previous sensors failed. The new version is an Airmar 220WX instrument Weather caster 153 (https://www.airmar.com/weather-description.html?id=153, https://www.airmar.com/uploads/InstallGuide/17-

461-01.pdf) running WeatherCaster 3 software. Trouble shooting of these sensors in 2021 (and comparison to ERA, JRA and NCEP data) concluded that the unit was reading:
- too high for wind speed (by about 2m/s on average, i.e., about 4 knots)
- too low for temperature (by about 2degC on average)
- too low for pressure (by ~ 2hPa).

These differences are all greater than the stated accuracy of the sensor https://www.airmar.com/weather-description.html?id=153 (0.5m/s for speed; 1.1degC for temperature, 0.5hPa for pressure).
Note the instrument calculates true wind direction and speed (and this is not reproducible exactly from relative wind and ship heading. In 2021, a compass calibration was performed off Nome in less than ideal conditions, and this may have contributed to the errors in the 2021 data. For 2022, a better calibration was performed pre cruise, in suitable conditions. It is not clear if the system has been calibrated subsequently. It is possible thus that the 2023 and 2024 data are of higher quality than in 2021 but this should be confirmed with comparison to the model wind products: Note that the temperature and wind chill temperature reported remain identical, which is clearly erroneous. **Action item: Repeat comparison to ERA, JRA and NCEP wind data.**
As can be seen in the plots below (which start on 6th September (JD250) as ship was transiting to Nome to start the cruise (on 8th September (JD252)), winds were strong at the start and end of the cruise, being northward for the start of the cruise (causing us to shelter in Teller), and southward at the end of the cruise (causing us to shelter near York). Wind direction should be taken into account when considering the hydrographic sections. Particularly note the strong southward winds at the end of the cruise displaced the Alaskan Coastal Current into the western part of the eastern strait. **Action item: Add wind direction to the CTD sections. .**

UNDERWAY TEMPERATURE AND CONDUCTIVITY DATA: The Norseman II used an Seabird SBE21 temperature conductivity sensor mounted 3.4m below the water line (slightly to port of the ship's ADCP, in the center of the ship) to collect underway data throughout the cruise, also logging position information and depth. A separate temperature sensor (SBE38) is placed closer to the intake to measure the temperature (recorded as temperature 2) before it is warmed by the ship. **Action item: Ensure depth is always logged in this file.** An hourly watch was kept on these data to ensure no loss of data. **Action item: Continue hourly monitoring of underway data while at sea. Check the temperature and salinity data to the CTD casts.**

The calibration file used during the cruise was the December 2016 calibration (which results in data 1.2 to 1.75psu fresher than the 2023 calibration), so handwritten salinities in bottle logs need to be corrected. The data presented here has been processed with the 2023 calibration. (Note this change only affects salinity, not the intake temperature). **Action item: Ensure the most recent calibration is used in the field.** Data were logged every 3 seconds.

Preliminary plots of the underway temperature and salinity data are given below

.

Note the NMEA data string logged by the underway temperature and salinity SB21 shows the same GPS roll over error that was present in 2021. This means that the raw data dates start from 23rd January 2005, rather than 8th September 2024. It is only the date that is in error. The time is correct. The date is corrected in post processing. **Action item: Correct this problem with the GPS**

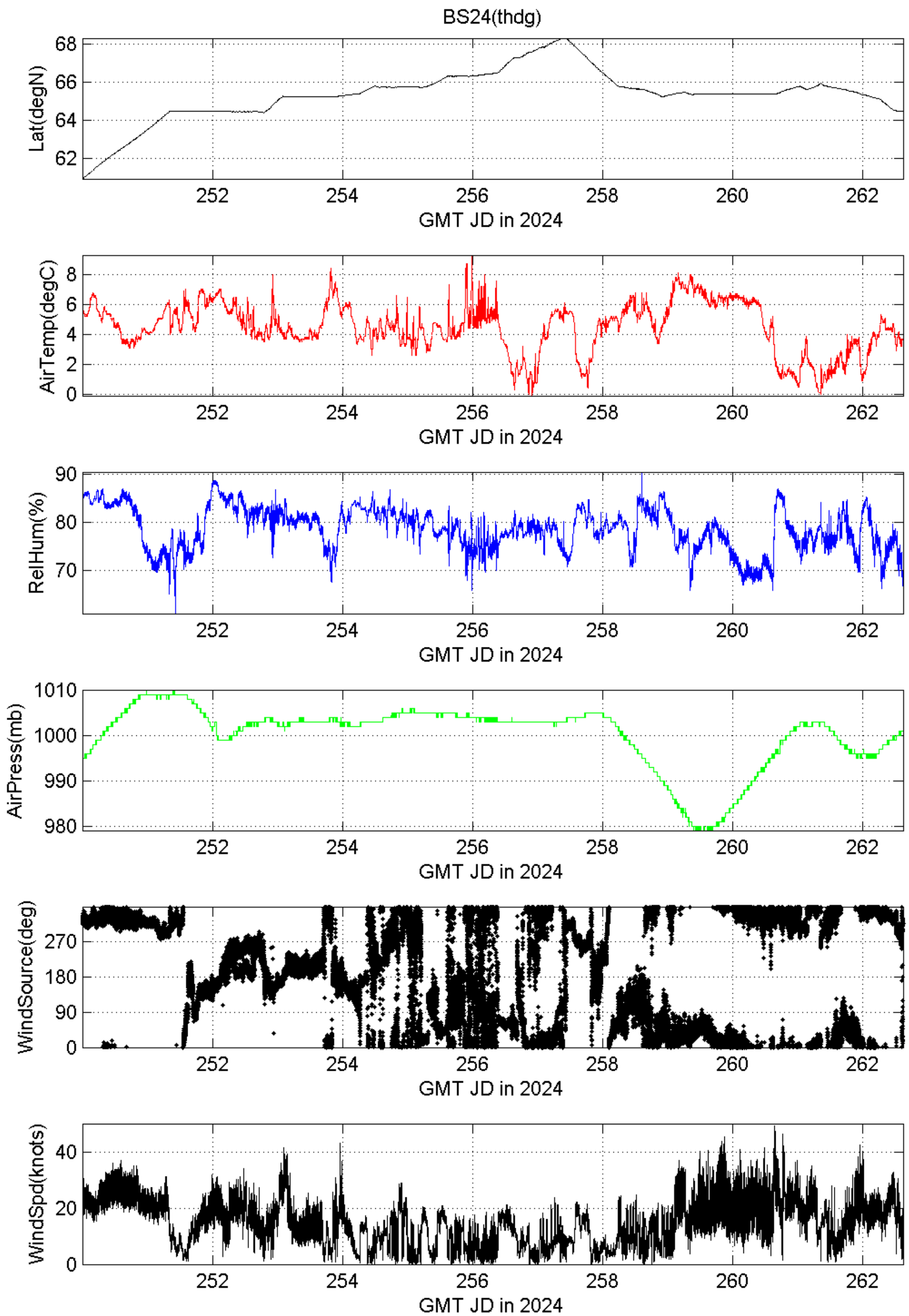
It is very important to remember when interpreting these data, that they are taken over the many days of the cruise, and the oceanographic conditions change significantly during this time, as is evidenced by the plots of the various crossings of the Bering Strait also shown below. **Action item: Examine surface salinities and temperatures, especially in conjunction with prior data.**

Once CTD data are final, a comparison of underway values to surface CTD values will be completed. **Action item: Do this.**

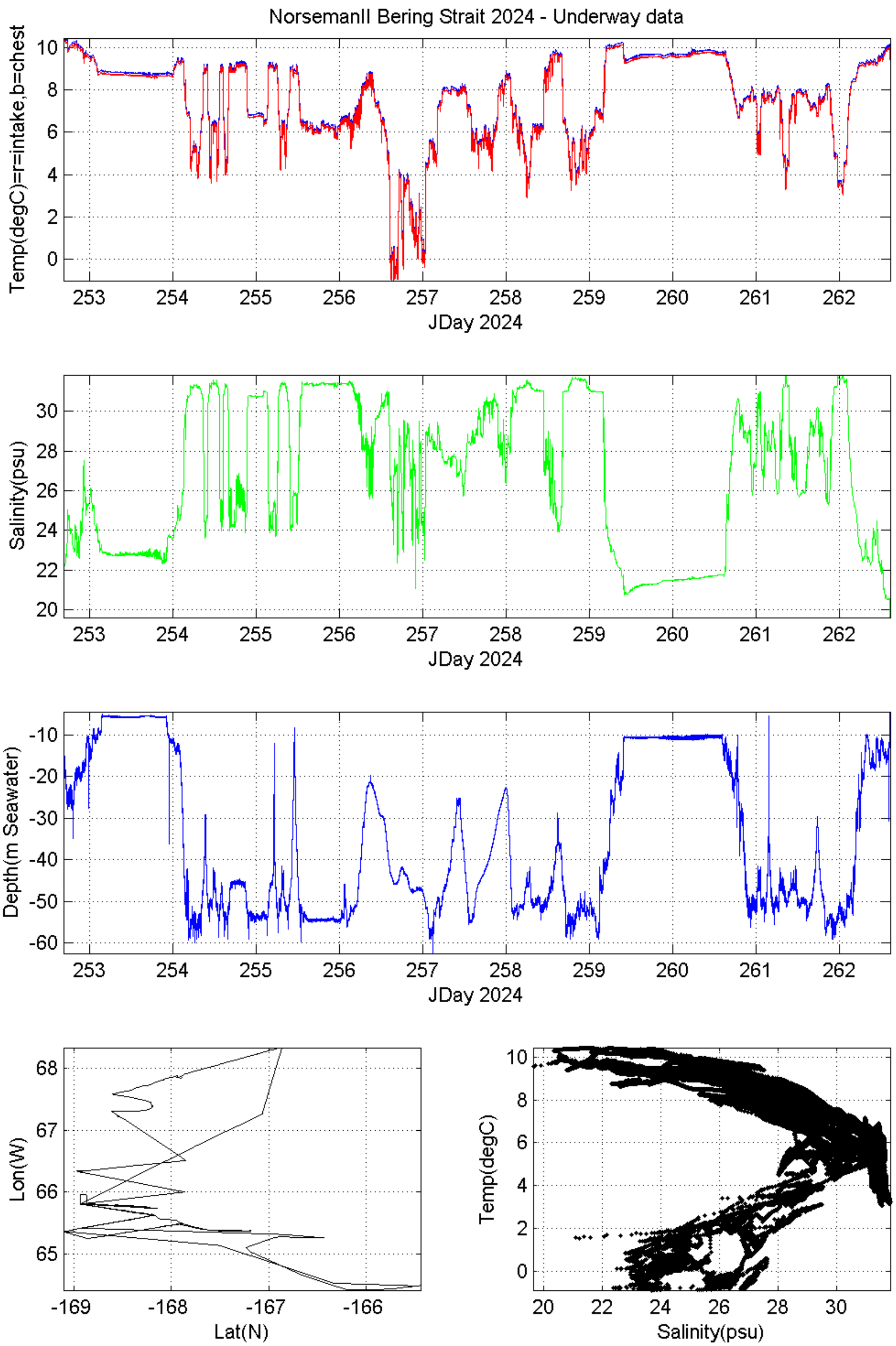
For dates and times, see cruise schedule at start of report.

BERING STRAIT 2024 METEOROLOGICAL DATA PLOTS

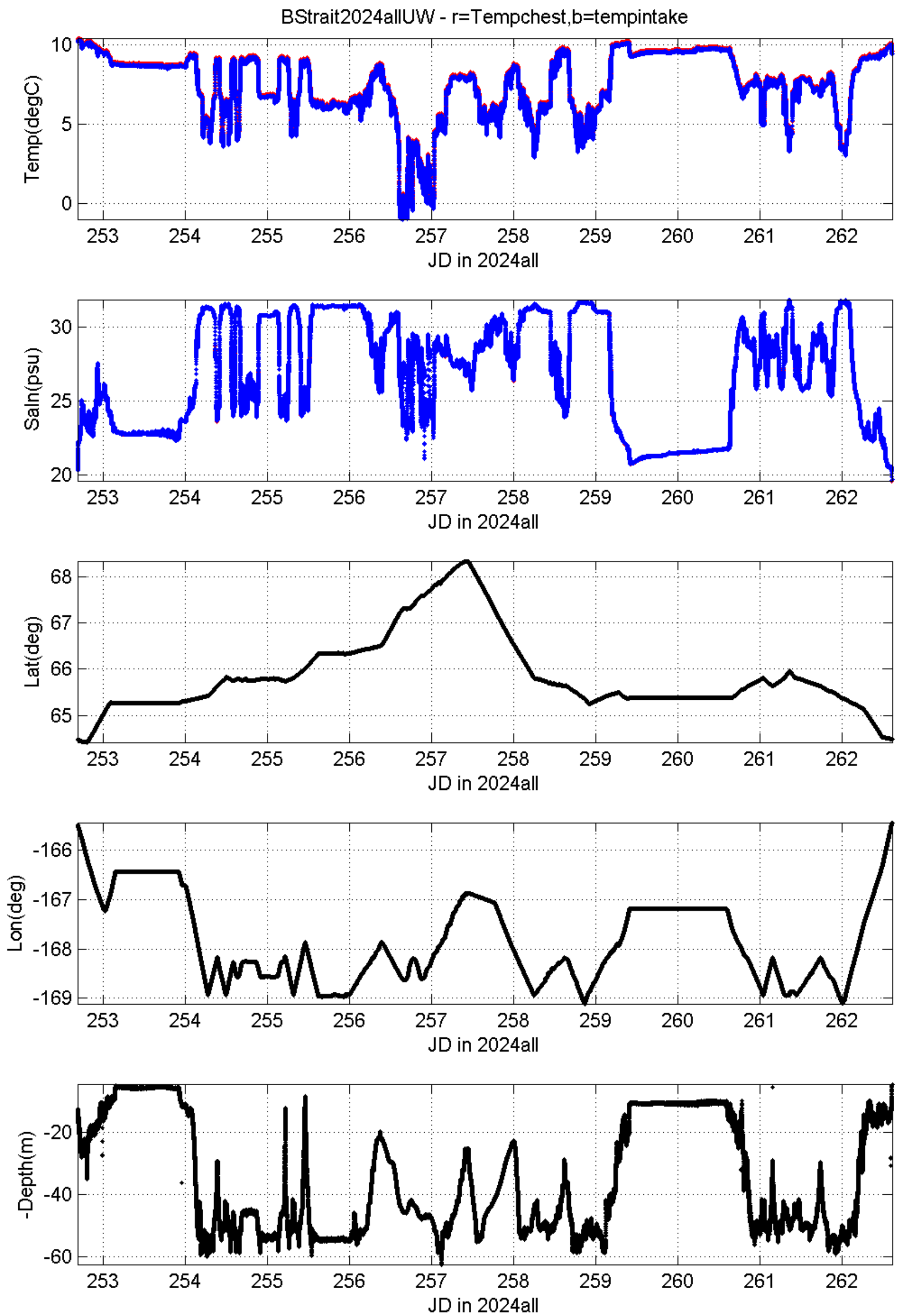
Stated accuracy of the sensor https://www.airmar.com/weather-description.html?id=153 (0.5m/s for speed; 1.1degC for temperature, 0.5hPa for pressure), but 2021 analysis suggests these accuracies are over optimistic. Note the instrument calculates true wind direction and speed (and this is not reproducible exactly from relative wind and ship heading



BERING STRAIT 2024 UNDERWAY TEMPERATURE SALINITY DATA

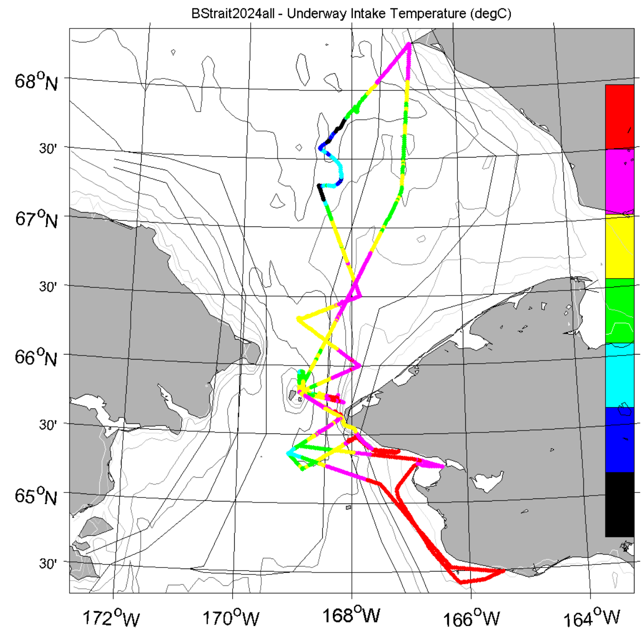


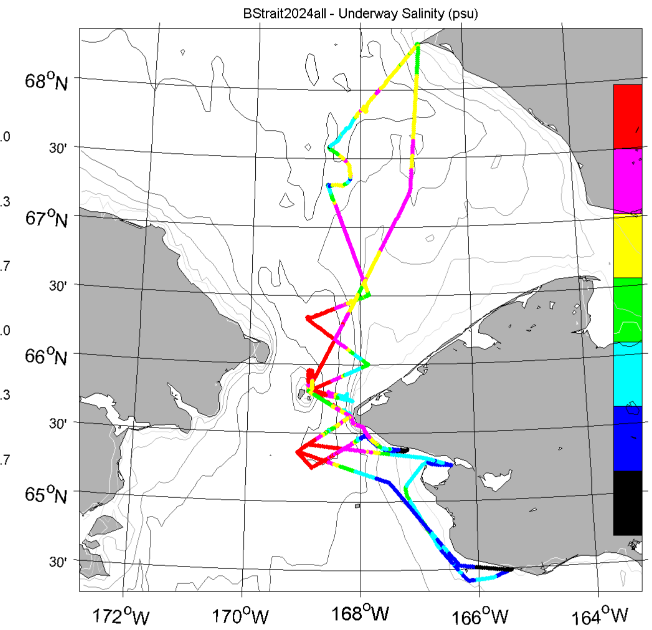
BERING STRAIT 2024 UNDERWAY TEMPERATURE SALINITY DATA (continued)

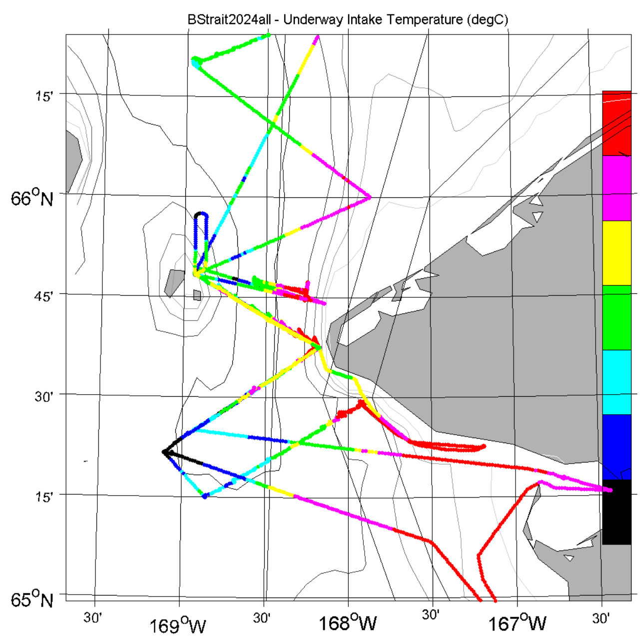


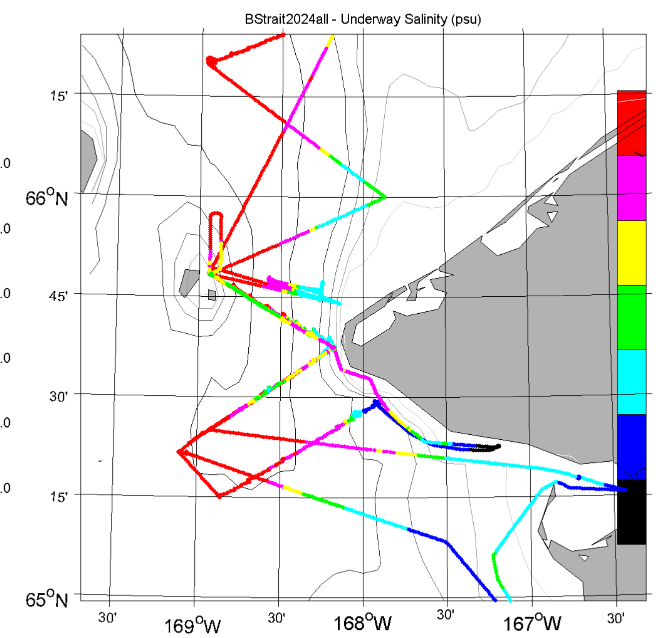
BERING STRAIT 2024 UNDERWAY TEMPERATURE SALINITY DATA (continued)

(Note multiple runnings of the Bering Strait (and other) lines are masked in these plots.)



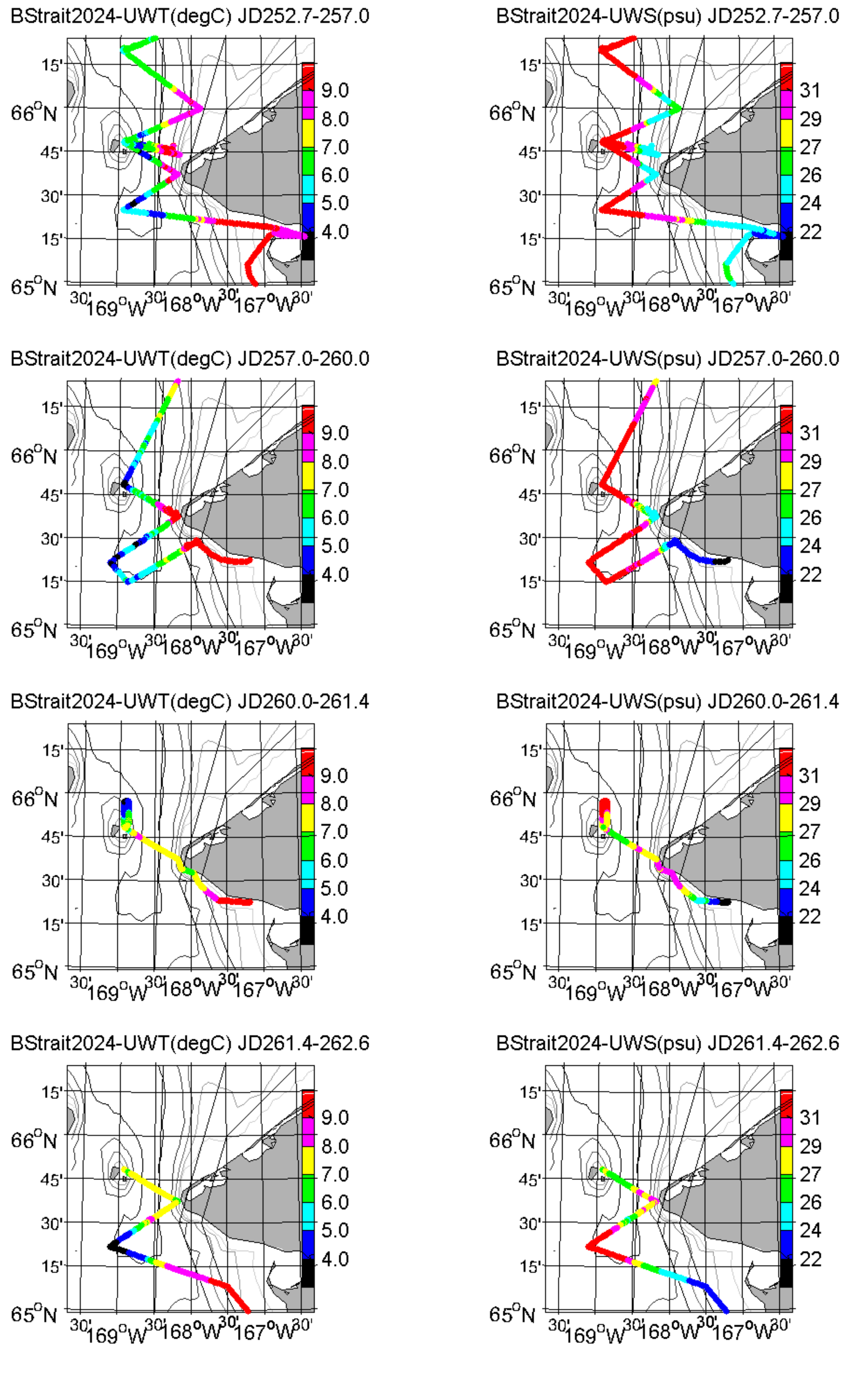




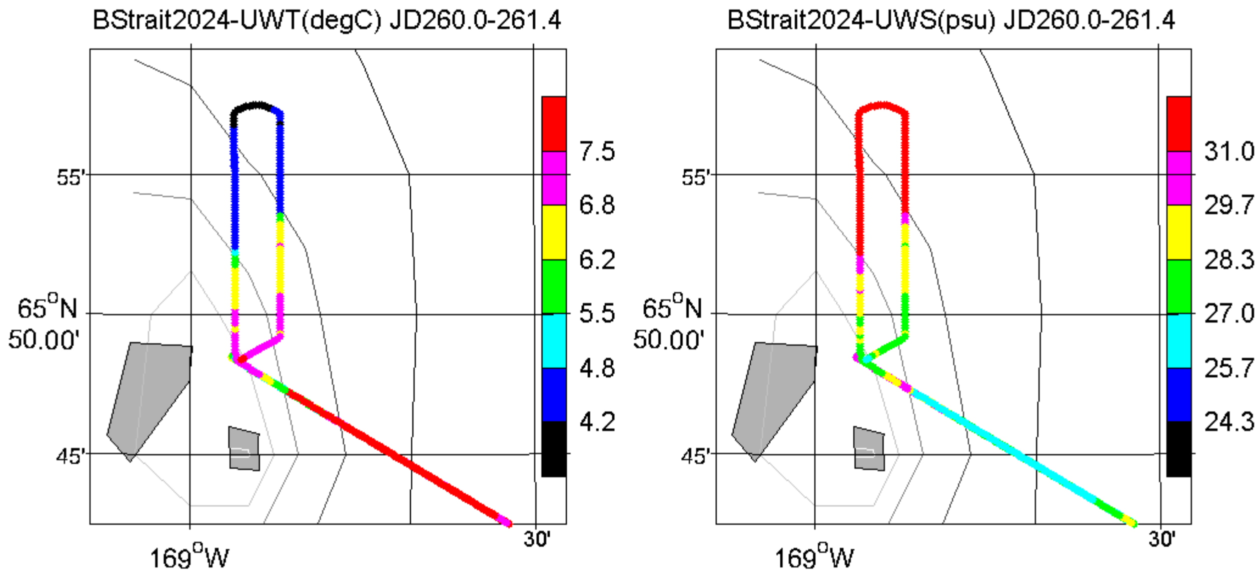


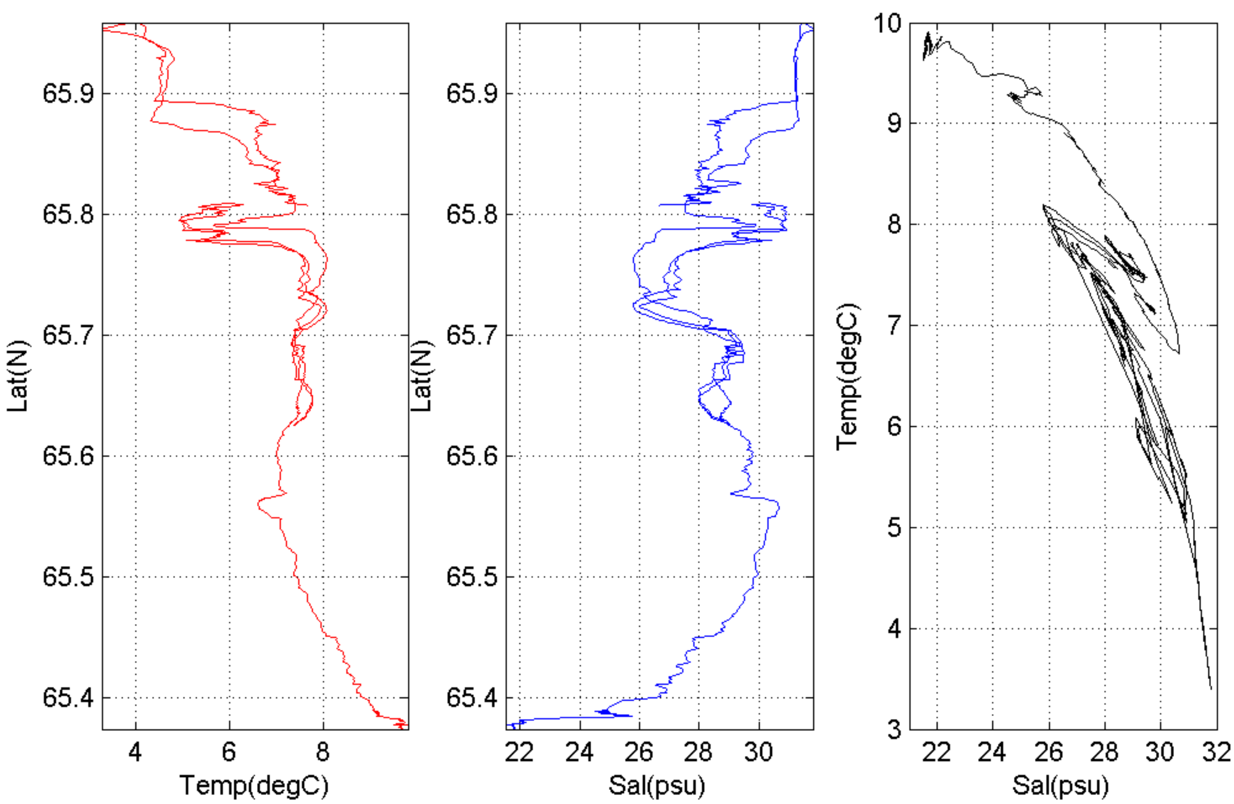
BERING STRAIT 2024 UNDERWAY TEMPERATURE SALINITY DATA (continued)

By time period



BERING STRAIT 2024 UNDERWAY TEMPERATURE SALINITY DATA (continued)
Showing end of cruise survey behind the Diomede Islands.





BERING STRAIT 2024 MARINE MAMMAL REPORT –

This year, there was no marine mammal observer on the cruise. However, marine mammals were observed at various points in the cruise, some of which are noted below: (times are local)

Thursday 12th Sept, 2024, , in sea ice, ca 10am local time, ad onwards
From 67 18.335N, 168 22.060W
- bowhead (1 or 2) (seen by RW, and identifiable by distinctive double peak
- suspected humpback (identified by Captain)

From 67 19.51 168 15.49
-- 3 walrus like form, hauled out on ice and sitting up like walruss/sealions. Too far to identify

From 67 24.10N 168 12.378W
-- more whales (?Humpback?)

From 67 34.228N 168 35.5 W, around 1239
-- many birds in the rough ice.

From 67 38.774N 168 24.605W around 1429
-- whales again (including bowhead, identified by bulge on head)

From SCS11 around 1530
-- more whales

From 67 41.024N 168 18.834
-- baby seal.

Friday 13th Sept 2024
From 67 6.207N, 167 16.09W (enroute from CS19 to BS11)
-- whale

Tuesday 17th Sept 2024
From 65 18.325N 168 40.837W (crossing of BC line) at around 5:58pm local
-- Whale (possibly fin).

BERING STRAIT 2024 TARGET CTD POSITIONS
(BS2024_Norseman2_PlannedStations_CTDmoorings_31stJuly2024WithCruiseAdditions.txt)

```
%==========================================================
% Stations for BStrait Mooring Cruise 2024 NorsemanII
%==========================================================
% Vers: 31st July2024
%
% US-Russian convention line is at 168deg 58.7'W.
% All stations in this file are in US waters.
% (Let me know if any points are too close to border for you.)
%
% Time estimates are based on the 2013 NorsemanII cruise.
%==========================================================
% INCLUDING NEW LINES FROM 2017 CRUISE, viz
% - higher res DL north
% - higher res A3L
% - higher res SBS
% - LIS redone to avoid cable at LIS9
%==========================================================
% *****   MOORING POSITIONS *****
%==========================================================
% In likely order of servicing, i.e.,
% - recoveries from east to west in strait, then northern site;
% - deployments northern site, the west to east in strait.
% == 3 moorings to recover
% == 3 moorings to deploy
%------------------------------------------
% RECOVERIES of moorings deployed in 2023
%------------------------------------------
%NAME      Lat(N)        Long (W)      Water   Top
%          deg min       deg min       depth   Float
% A2-23    65  46.864    168  34.062    56m    16m
% A4-23    65  44.761    168  15.756    49m    16m
% A3-23    66  19.600    168  56.944    58m     8m
%---------------------------------
% DEPLOYMENTS for this 2024 cruise
%---------------------------------
% Target same as 2012 positions.
%NAME     Lat(N)       Long (W)     Water
%         deg min      deg min      depth
% A3-24   66  19.61    168  57.05    58m
% A2-24   65  46.86    168  34.07    56m
% A4-24   65  44.75    168  15.77    49m
%
%-----------------------
% INTERMOORING DISTANCES
%-----------------------
% A2 - A4 ~ 8nm
%------------
```

```
% To A3 from
%------------
%   A2  - 34nm
%   A4  - 39nm
%-------------
% To Nome from
%-------------
%   A4 - 120nm
%   CS1 - 200-220nm
%===========================================================
%
%===========================================================
% *****   HISTORIC CTD SECTIONS *****
%===========================================================
% There are 14 historic CTD lines here.
% These are the same positions as suggested in 2017, with
% the addition of 3 lines run in 2017 and the moving of
% one line (a change also made on the 2017 cruise).
% We may not have time for all of these, in which case
% we will do a subset.  But I've included
% them all, so you have the positions in advance.
% If operations/science dictate, then there
% might be different lines proposed while at sea.
%
% Some lines are given here at a high resolution and low
% resolution.  Time permitting we will run lines at high
% resolution.
%
% Naming is based on historic data.
% "+net" also refers to historic operations and
% is not relevant for this cruise.
% "no bottles" refers to historic operations and
% is not relevant for this cruise.
%
% On this cruise we will take CTD bottles
% a) for nutrients on lines BS, DI and AL lines only, and only on the
% first running.  These stations are marked *NUT22

% b) for salinity on approx 6 stations, to be decided in real time
% c) for delta O18, to be decided in real time
% d) for iodine and uranium, to be decided in real time

% Additionally, at ~32 stations on the BS, AL, CS and LIS lines,
% after some casts, we will take trace metal samples using the
% hand lowered pumped system. These stations are marked *PUMP22

% Additionally, at ~3-4 stations on the BS and AL lines, to be
% decided in real time, we will take 20l samples for hafnium and
% neodymium using the trace metal pump.
```

```
% Known Hazards are indicated.
%
% Stay a safe distance (300m?) from all deployed
% moorings.
%
% Except for around moorings or for mooring work,
% within 200m is ok for positions.
%
%
%==============================================================
% BS = Bering Strait Line (US portion)
%==============================================================
% - 15 stations
% - station spacing generally ~ 2nm
% Distances: - BS11-BS22 21.7nm
%          - BS22-BS24  3.1nm
% Total length 24.8nm
%--
% Time from NorsemanII, 6 hrs running W, 5 hrs running E
% Time from Khromov 10.5hrs
%-------------------------------------------------
% Lat (N) Long (W)   Lat (N)    Long (W)    Name
%                deg min     deg   min
%-------------------------------------------------
% LOW RESOLUTION VERSION
%-------------------------------------------------
  65.805  168.933   65  48.31   168  55.96  % BS11
  65.788  168.860   65  47.26   168  51.62  % BS12
  65.772  168.794   65  46.33   168  47.64  % BS13
  65.755  168.721   65  45.28   168  43.29  % BS14
  65.739  168.663   65  44.35   168  39.80  % BS15
  65.722  168.591   65  43.29   168  35.46  % BS16 + net
  65.704  168.521   65  42.23   168  31.28  % BS17
  65.695  168.486   65  41.70   168  29.16  % BS17S
  65.686  168.449   65  41.18   168  26.94  % BS18
  65.672  168.391   65  40.35   168  23.44  % BS19
  65.655  168.318   65  39.29   168  19.09  % BS20
  65.642  168.250   65  38.53   168  14.97  % BS21
  65.625  168.177   65  37.48   168  10.63  % BS22 + net
  65.599  168.161   65  35.96   168   9.66  % BS23
  65.582  168.117   65  34.91   168   7.00  % BS24
%-------------------------------------------------
% HIGH RESOLUTION VERSION (with nutrient sampling plan)
%-------------------------------------------------
%65.805         168.933         65      48.31   168     55.96   %       BS11
65.797  168.897         65      47.79   168     53.79   %       BS11.5 *NUT22 *PUMP22
65.788  168.86  65      47.26   168     51.62   %       BS12
65.780  168.827         65      46.8    168     49.63   %       BS12.5
65.772  168.794         65      46.33   168     47.64   %       BS13     *NUT22 *PUMP22
65.764  168.758         65      45.81   168     45.47   %       BS13.5
```

65.755 168.721 65 45.28 168 43.29 % BS14
65.747 168.692 65 44.82 168 41.55 % BS14.5 *NUT22 *PUMP22
65.739 168.663 65 44.35 168 39.8 % BS15
65.731 168.627 65 43.82 168 37.63 % BS15.5
65.722 168.591 65 43.29 168 35.46 % BS16 *NUT22 *PUMP22
65.713 168.556 65 42.76 168 33.37 % BS16.5
65.704 168.521 65 42.23 168 31.28 % BS17
65.695 168.486 65 41.7 168 29.16 % BS17.5 *NUT22 *PUMP22
65.686 168.449 65 41.18 168 26.94 % BS18
65.679 168.42 65 40.77 168 25.19 % BS18.5
65.672 168.391 65 40.35 168 23.44 % BS19 *NUT22 *PUMP22
65.664 168.355 65 39.82 168 21.27 % BS19.5
65.655 168.318 65 39.29 168 19.09 % BS20
65.649 168.284 65 38.91 168 17.03 % BS20.5 *NUT22 *PUMP22
65.642 168.25 65 38.53 168 14.97 % BS21
65.634 168.214 65 38.01 168 12.8 % BS21.5
65.625 168.177 65 37.48 168 10.63 % BS22 *NUT22 *PUMP22
65.599 168.161 65 35.96 168 9.66 % BS23
65.582 168.117 65 34.91 168 7 % BS24
%
%
%===
% DL = Diomede Line (US only, 1nm east of border)
%===
% This line is to map eddying area north of the Diomedes
% - 19 stations
% - station spacing ~ 1nm in South,
% ~ 2.5nm in north
% Distance: - DL1 to DL19 28.7nm
%--
% Time from NorsemanII - 5.5 hrs running N; 9hrs running S
% Time from Khromov to DL19 ~10hrs
%---
% Lat (N) Long (W) Name
% deg min deg min
%---
% LOW RESOLUTION VERSION
%---
0 0 65 49.28 168 56.2 % DL1 *NUT22
0 0 65 50.26 168 56.2 % DL2
0 0 65 51.23 168 56.2 % DL3
0 0 65 52.21 168 56.2 % DL4 *NUT22 + net
0 0 65 53.18 168 56.2 % DL5 - no bottles
0 0 65 54.15 168 56.2 % DL6
0 0 65 55.13 168 56.2 % DL7 *NUT22 - no bottles
0 0 65 56.10 168 56.2 % DL8
0 0 65 57.08 168 56.2 % DL9 - no bottles
0 0 65 58.05 168 56.2 % DL10 *NUT22
0 0 65 59.03 168 56.2 % DL11- no bottles
0 0 66 0.00 168 56.2 % DL12

%-----
0 0 66 2.55 168 56.2 % DL13- no bottles
0 0 66 5.10 168 56.2 % DL14
0 0 66 7.65 168 56.2 % DL15- no bottles
0 0 66 10.19 168 56.2 % DL16
0 0 66 12.74 168 56.2 % DL17- no bottles
0 0 66 15.29 168 56.2 % DL18
0 0 66 17.84 168 56.2 % DL19- no bottles
%---
% HIGH RESOLUTION VERSION (with nutrient sampling plan)
%---
0 0 65 49.28 168 56.2 % DL1 *NUT22
0 0 65 50.26 168 56.2 % DL2
0 0 65 51.23 168 56.2 % DL3
0 0 65 52.21 168 56.2 % DL4 *NUT22 + net
0 0 65 53.18 168 56.2 % DL5 - no bottles
0 0 65 54.15 168 56.2 % DL6
0 0 65 55.13 168 56.2 % DL7 *NUT22 - no bottles
0 0 65 56.10 168 56.2 % DL8
0 0 65 57.08 168 56.2 % DL9 - no bottles
0 0 65 58.05 168 56.2 % DL10 *NUT22
0 0 65 59.03 168 56.2 % DL11- no bottles
0 0 66 0.00 168 56.2 % DL12
%--
0 0 66 1.28 168 56.2 % DL12.5 *NUT22
0 0 66 2.55 168 56.2 % DL13
0 0 66 3.83 168 56.2 % DL13.5
0 0 66 5.10 168 56.2 % DL14 *NUT22
0 0 66 6.38 168 56.2 % DL14.5
0 0 66 7.65 168 56.2 % DL15
0 0 66 8.92 168 56.2 % DL15.5 *NUT22
0 0 66 10.19 168 56.2 % DL16
0 0 66 11.47 168 56.2 % DL16.5
0 0 66 12.74 168 56.2 % DL17 *NUT22
0 0 66 14.02 168 56.2 % DL17.5
0 0 66 15.29 168 56.2 % DL18
0 0 66 16.57 168 56.2 % DL18.5 *NUT22
0 0 66 17.84 168 56.2 % DL19
0 0 66 18.73 168 56.2 % DL19.5
% Ending at A3
0 0 66 19.61 168 57.05 % A3mooring *NUT22
% *** Adjust this first position to be safe distance (300m?) from A3 mooring
%
%
%==
% DL A and B lines (Diomede A and B lines)
%==
% These lines, with DL, form a grid to map
% eddying N of the Diomedes.
% - each line 12 stations

% - station spacing ~ 1nm
% Distances: - each line ~ 11nm
%--
% Estimate for NorsmanII for each line ~3.5hrs
% Time from Khromov for each line ~5hrs
%--
% Lat (N) Long (W) Name
% deg min deg min
% Northbound leg
0 0 65 49.30 168 52.2 % DLa 1
0 0 65 50.27 168 52.2 % DLa 2
0 0 65 51.25 168 52.2 % DLa 3
0 0 65 52.22 168 52.2 % DLa 4
0 0 65 53.19 168 52.2 % DLa 5
0 0 65 54.16 168 52.2 % DLa 6
0 0 65 55.14 168 52.2 % DLa 7
0 0 65 56.11 168 52.2 % DLa 8
0 0 65 57.08 168 52.2 % DLa 9
0 0 65 58.05 168 52.2 % DLa 10
0 0 65 59.03 168 52.2 % DLa 11
0 0 66 0.00 168 52.2 % DLa 12
% Southbound leg
0 0 66 0.00 168 48.2 % DLb 12
0 0 65 59.03 168 48.2 % DLb 11
0 0 65 58.05 168 48.2 % DLb 10
0 0 65 57.08 168 48.2 % DLb 9
0 0 65 56.11 168 48.2 % DLb 8
0 0 65 55.14 168 48.2 % DLb 7
0 0 65 54.16 168 48.2 % DLb 6
0 0 65 53.19 168 48.2 % DLb 5
0 0 65 52.22 168 48.2 % DLb 4
0 0 65 51.25 168 48.2 % DLb 3
0 0 65 50.27 168 48.2 % DLb 2
0 0 65 49.30 168 48.2 % DLb 1
%
%
%==
% AL = A3 Line (US portion)
%==
% Hazards on this line:
% == First station on this line is at mooring A3-17, so exact
% position needs to be altered to be a safe distance (300m?)
% from mooring A3-17 site.
%--
% - 13 stations including cast at A3mooring site
% - station spacing ~ 1.9nm
% Distance: - A3 to AL24 = 22.2nm
% --
% Time from NorsemanII ~5.5hrs
% Time from Khromov ~9hrs

```
%---------------------------------------------------
% Lat (N) Long (W)   Lat (N)     Long (W)     Name
%               deg min     deg   min
%------------------------------------------------
% LOW RESOLUTION VERSION
%------------------------------------------------
  66.327  168.951   66  19.61    168   57.05  % A3-17
% *** Adjust this first position to be safe distance (300m?) from A3-17
  66.340  168.895   66  20.39    168   53.71  % AL13
  66.352  168.823   66  21.09    168   49.40  % AL14
  66.363  168.752   66  21.80    168   45.09  % AL15
  66.375  168.680   66  22.51    168   40.78  % AL16
  66.387  168.608   66  23.21    168   36.47  % AL17 + net
  66.399  168.536   66  23.92    168   32.16  % AL18
  66.410  168.464   66  24.63    168   27.84  % AL19
  66.422  168.392   66  25.33    168   23.53  % AL20
  66.434  168.320   66  26.04    168   19.22  % AL21
  66.446  168.249   66  26.75    168   14.91  % AL22 + net
  66.458  168.177   66  27.45    168   10.60  % AL23
  66.469  168.105   66  28.16    168    6.29  % AL24
%------------------------------------------------
% HIGH RESOLUTION VERSION (with nutrient sampling plan)
%------------------------------------------------
  66.3270  168.9510   66   19.6100  168   57.0500    % A3 mooring
% *** Adjust this first position to be safe distance (300) from A3 mooring
  66.3335  168.9230   66   20.0000  168   55.3800    % new AL12.5  *NUT22 *PUMP22
  66.3400  168.8950   66   20.3900  168   53.7100    % AL13
  66.3460  168.8590   66   20.7400  168   51.5550    % new AL13.5
  66.3520  168.8230   66   21.0900  168   49.4000    % AL14       *NUT22 *PUMP22
  66.3575  168.7875   66   21.4450  168   47.2450    % new AL14.5
  66.3630  168.7520   66   21.8000  168   45.0900    % AL15
  66.3690  168.7160   66   22.1550  168   42.9350    % new AL15.5  *NUT22 *PUMP22
  66.3750  168.6800   66   22.5100  168   40.7800    % AL16
  66.3810  168.6440   66   22.8600  168   38.6250    % new AL16.5
  66.3870  168.6080   66   23.2100  168   36.4700    % AL17       *NUT22 *PUMP22
  66.3940  168.5657   66   23.6400  168   33.9400    % new AL17.5  % AND MOVED OFF Q CABLE
  66.3990  168.5360   66   23.9200  168   32.1600    % AL18
  66.4045  168.5000   66   24.2750  168   30.0000    % new AL18.5  *NUT22 *PUMP22
  66.4100  168.4640   66   24.6300  168   27.8400    % AL19
  66.4160  168.4280   66   24.9800  168   25.6850    % new AL19.5
  66.4220  168.3920   66   25.3300  168   23.5300    % AL20       *NUT22 *PUMP22
  66.4280  168.3560   66   25.6850  168   21.3750    % new AL20.5
  66.4340  168.3200   66   26.0400  168   19.2200    % AL21
  66.4400  168.2845   66   26.3950  168   17.0650    % new AL21.5  *NUT22 *PUMP22
  66.4460  168.2490   66   26.7500  168   14.9100    % AL22
  66.4520  168.2130   66   27.1000  168   12.7550    % new AL22.5
  66.4580  168.1770   66   27.4500  168   10.6000    % AL23       *NUT22 *PUMP22
  66.4635  168.1410   66   27.8050  168    8.4450   % new AL23.5
  66.4690  168.1050   66   28.1600  168    6.2900   % AL24
  66.4745  168.0690   66   28.5150  168    4.1350   % new AL24.5
```

```
  66.4800  168.0330   66   28.8700  168    1.9800    % AL25       *NUT22 *PUMP22
  66.4855  167.9970   66   29.2250  167   59.8200    % new AL25.5
  66.4910  167.9610   66   29.5800  167   57.6650    % AL26
  66.4965  167.9250   66   29.9350  167   55.5100    % new AL26.5
  66.5020  167.8890   66   30.2900  167   53.3550    % AL27
  66.5075  167.8530   66   30.6450  167   51.2000    % new AL27.5
%
%
%===============================================================
% AS = from AL to CS Line
%===============================================================
% Across-topography line linking Al line with CS
% - 20 stations (counting first of CS line)
% - station spacing
%       AS1-7 at ~ 4nm spacing.
%       AS7-14 at 2nm spacing,
%       A14 to end 4nm
% Distances: - AS1 to CS10 64.7nm
%--
% Time from Khromov (12casts, odds+2&18) ~11hrs
% Estimate for NorsmanII 20 casts ~ 12hrs
% Estimate for Khromov 20 casts ~ 14hrs
%-------------------------------------------
%    Lat (N)       Long (W)      Name
%    deg min        deg   min
0 0   66   41.47    167   38.86   % AS 1
0 0   66   45.01    167   43.78   % AS 2-no bottles
0 0   66   48.55    167   48.70   % AS 3
0 0   66   52.09    167   53.62   % AS 4-no bottles
0 0   66   55.63    167   58.55   % AS 5
0 0   66   59.17    168    3.47   % AS 6-no bottles
0 0   67    2.71    168    8.39   % AS 7
%                   (2nm spacing over slope)
0 0   67    4.48    168   10.85   % AS 8-no bottles
0 0   67    6.25    168   13.31   % AS 9
0 0   67    8.02    168   15.77   % AS 10-no bottles
0 0   67    9.78    168   18.23   % AS 11
0 0   67   11.55    168   20.69   % AS 12-no bottles
0 0   67   13.32    168   23.15   % AS 13
0 0   67   16.86    168   28.07   % AS 14
%                   (back to 4nm spacing)
0 0   67   20.40    168   32.99   % AS 15-no bottles
0 0   67   23.94    168   37.92   % AS 16
0 0   67   27.48    168   42.84   % AS 17-no bottles
0 0   67   31.02    168   47.76   % AS 18
0 0   67   34.56    168   52.68   % AS 19-no bottles
0 0   67   38.10    168   56.00   % CS10US
%
%
%===============================================================
```

```
% SAS = S extension of AS line
%=================================================================
% Adding another 8 stations at 4nm spacing south
% from AS1 to the coast.
%--
% Estimate for NorsemanII 8 casts ~ 4hrs
% Not run yet
%------------------------------------------
%    Lat (N)       Long (W)      Name
%    deg min       deg   min
0 0   66   37.91    167   34.00   % SAS 1
0 0   66   34.35    167   29.14   % SAS 2
0 0   66   30.79    167   24.29   % SAS 3
0 0   66   27.23    167   19.43   % SAS 4
0 0   66   23.68    167   14.57   % SAS 5
0 0   66   20.12    167    9.72   % SAS 6
0 0   66   16.56    167    4.86   % SAS 7
0 0   66   13.00    167    0.00   % SAS 8
%
%
%=================================================================
% CS = Cape Serdtse Kamen to Point Hope Line (US portion)
%=================================================================
% Hazards on this line:
% == Final station CS19 is shallow.  Check on
% modern charts to see if deep enough for NorsemanII.
% (this station was too shallow for the Khromov, but
% was ok for the NorsemanII in 2013).
% == NOAA mooring at:
%         67 54.712N, 168 11.628W
%---------------------------------------------------------
% - 16 or 17 stations
% - station spacing ~ 5nm in the central Chukchi,
%               ~ 2.2nm near the coast
% Distances: - CS10US to CS18 60.8nm
%          - CS18 to CS19    2.2nm
%--
% Time from NorsemanII (toCS19) ~ 10.5 hrs
% Time from Khromov (toCS18) ~12hrs
%---------------------------------------------------------
%    Lat (N)    Long (W)      Name
%    deg min     deg   min
%------------------------------------------------
% LOW RESOLUTION VERSION
%------------------------------------------------
0 0   67   38.1   168   56.0    % CS10US + net
0 0   67   41.7   168   48.1    % CS10.5  - no bottles
0 0   67   45.3   168   39.9    % CS11
0 0   67   48.9   168   29.4    % CS11.5  - no bottles
0 0   67   52.5   168   18.8    % CS12 + net
```

```
0 0   67   55.9   168    9.1    % CS12.5  - no bottles
0 0   67   59.3   167   59.4    % CS13
0 0   68    2.7   167   49.7    % CS13.5  - no bottles
0 0   68    6.1   167   39.9    % CS14 + net
0 0   68    9.1   167   30.7    % CS14.5  - no bottles
0 0   68   12.1   167   21.4    % CS15
0 0   68   13.6   167   16.8    % CS15.5  - no bottles
0 0   68   15.0   167   12.2    % CS16
0 0   68   16.6   167    7.6    % CS16.5  - no bottles
0 0   68   18.0   167    2.9    % CS17 + net
0 0   68   18.9   166   57.6    % CS18
0 0   68   19.9   166   52.3    % CS19 *** SHALLOW **
%              CS19 too shallow for Khromov.
%-------------------------------------------------
% HIGH RESOLUTION VERSION (with nutrient sampling plan)
%-------------------------------------------------
% - 27 stations
% - station spacing ~ 2.5nm in the central Chukch (0.25 stations)
%                ~ 2.2nm near the coast
% Distances: - CS10US to CS18 60.8nm
%          - CS18 to CS19    2.2nm
% Time from NorsemanII (toCS19) ~ 11hrs
%--------------------------------------------------------
%    Lat (N)    Long (W)      Name
%    deg min     deg   min
0 0   67   38.1   168   56.0    % CS10US + net *PUMP22
0 0   67   39.9   168   52.0  % new CS10.25
0 0   67   41.7   168   48.1    % CS10.5  - no bottles
0 0   67   43.5   168   44.0  % new CS10.75
0 0   67   45.3   168   39.9    % CS11        *PUMP22
0 0   67   47.1   168   34.6  % new CS11.25
0 0   67   48.9   168   29.4    % CS11.5  - no bottles
0 0   67   50.7   168   24.1  % new CS11.75
0 0   67   52.5   168   18.8    % CS12 + net   *PUMP22
0 0   67   54.2   168   13.9  % new CS12.25
0 0   67   55.9   168    9.1    % CS12.5  - no bottles
0 0   67   57.6   168    4.2  % new CS12.75
0 0   67   59.3   167   59.4    % CS13        *PUMP22
0 0   68    1.0   167   54.5  % new CS13.25
0 0   68    2.7   167   49.7    % CS13.5  - no bottles
0 0   68    4.4   167   44.8  % new CS13.75
0 0   68    6.1   167   39.9    % CS14 + net   *PUMP22
0 0   68    7.6   167   35.3  % new CS14.25
0 0   68    9.1   167   30.7    % CS14.5  - no bottles
0 0   68   10.6   167   26.0  % new CS14.75
0 0   68   12.1   167   21.4    % CS15        *PUMP22
0 0   68   13.6   167   16.8    % CS15.5  - no bottles
0 0   68   15.0   167   12.2    % CS16        *PUMP22
0 0   68   16.6   167    7.6    % CS16.5  - no bottles
0 0   68   18.0   167    2.9    % CS17 + net   *PUMP22
```

```
0 0   68   18.9   166   57.6    % CS18
0 0   68   19.9   166   52.3    % CS19 *** SHALLOW ** %
%
%
%===================================================================
% SCS line
%===================================================================
% in 2024 ice prevented us reaching the CS line.
% This line started 10nm SE of CS10 of the CS line, and ran towards
% Point Hope
% - resolution ~9nm due to ice.
%        Lat (N)       Long (W)      Name
%      deg   min      deg   min
0 0    67          34.884   168     36.028  %        SCS10
0 0    67          40.849   168     21.908  %        SCS11
0 0    67          48.578   168     4.991   %        SCS12
0 0    67          56.219   167     47.545  %        SCS13
0 0    68          3.558    167     30.22   %        SCS14
0 0    68          10.26    167     14.8    %        SCS15
0 0    68          13.555   167     7.259   %        SCS16
0 0    68          16.819   166     59.827  %        SCS17
0 0    68          18.352   166     56.049  %        SCS18
0 0    68          19.897   166     52.437  %        SCS19


%===================================================================
% LIS = Cape Lisburne Line (redone to avoid Qcable at Lis9)
%===================================================================
% - 18 stations (including first of CCL line)
% - station spacing ~ 2nm near coast,
%           ~ 3nm and ~ 5nm away from coast
% Distances: - LIS1 to CCL22 57.2nm
%--
% Time from NorsemanII, ~ 10hrs
% Time from Khromov ~11hrs
% (Times different now added stations)
%--------------------------------
%    Lat (N)       Long (W)     Name
%    deg min      deg   min
  0   0        68  54.40   166   19.80  % LIS 1 + net *PUMP22
  0   0        68  54.80   166   25.15  % LIS 2      *PUMP22
  0   0        68  55.20   166   30.51  % LIS 3      *PUMP22
  0   0        68  55.80   166   38.54  % LIS 4
  0   0        68  56.40   166   46.57  % LIS 5
  0   0        68  57.00   166   54.60  % LIS 6 + net
  0   0        68  57.60   167    1.95  % LIS 6.5 - no bottles *PUMP22
  0   0        68  58.20   167    9.30  % LIS 7
  0   0        68  58.80   167   16.65  % LIS 7.5 - no bottles
  0   0        68  59.40   167   24.00  % LIS 8      *PUMP22
  0   0        69  00.20   167   33.8   % NEW ** LIS 8.5
```

```
%DO NOT DO LIS 9
% 69    0.60    167   38.70  % LIS 9  ** on Q cable - do not do
%DO NOT DO LIS 9
   0   0        69    1.00    167   43.60  % NEW ** LIS 9.5
   0   0        69    1.80    167   53.40  % LIS 10 + net
   0   0        69    1.35    168    7.95  % LIS 11      *PUMP22
   0   0        69    0.90    168   22.50  % LIS 12
   0   0        69    0.45    168   37.05  % LIS 13      *PUMP22
   0   0        69    0.23    168   46.62  % LIS 14n + net
   0   0        69    0.00    168   56.00  % CCL22n % was 56.2  *PUMP22
%
%
%=================================================================
% CCL = Chukchi Convention Line
%=================================================================
% Hazards on this line:
% == First station on this line is the same as last station
% included in the LIS line above.  It does not need to be
% repeated.
% == Last station on this line is at mooring A3-14, so exact
% position needs to be altered to be a safe distance (300m?)
% from mooring A3-14 site.
% == There are 2 JAMSTEC moorings ~ 3nm east of station
% CCL16 on this line.  Those positions are:
% SCH13  68 2.002N   168 50.028W
% SCH13w 68 3.006N   168 50.003W
%-------------------------------------
% Line running from northern most point
% due south, ~ 1nm US side of conventionline
% - 20 stations (counting arriving at A3-14)
% - station spacing ~ 10nm until CCL8,
%     then reducing to ~5nm and ~2.5nm
% Distances: - CCL22 to A3-13 ~ 161nm
%--
% Time from NorsemanII, 21.5hrs
% Time from Khromov ~26hrs
%--------------------------------------
% MAIN LINE STARTS IN N WITH THESE
%--------------------------------------
%     Lat (N)       Long (W)     Name
%     deg   min      deg   min
0 0    69     0.0     168  56.0   % CCL22
0 0    68    50.0     168  56.0   % CCL21
0 0    68    40.0     168  56.0   % CCL20
0 0    68    30.0     168  56.0   % CCL19
0 0    68    20.0     168  56.0   % CCL18 + Net
0 0    68    10.0     168  56.0   % CCL17
0 0    68    00.0     168  56.0   % CCL16
0 0    67    50.0     168  56.0   % CCL15
0 0    67    38.1     168  56.0   % CCL14 (same as CS10US) + Net + Prod
```

```
%--------------------------------------------------
% THEN EITHER - LOW RESOLUTION VERSION
%--------------------------------------------------
0 0   67   30.0    168  56.0   % CCL13
0 0   67   20.0    168  56.0   % CCL12
0 0   67   10.0    168  56.0   % CCL11
0 0   67   00.0    168  56.0   % CCL10 + Net
0 0   66   50.0    168  56.0   % CCL9
0 0   66   40.0    168  56.0   % CCL8
%       - spacing now 5nm
0 0   66   35.0    168  56.0   % CCL7
0 0   66   30.0    168  56.0   % CCL6
0 0   66   25.0    168  56.0   % CCL5
%       - spacing now 2.5nm
0 0   66   22.3    168  56.0   % CCL4
0 0   66   19.61   168  57.05  % A3-17
% *** Adjust this position to be safe distance (300m?) from A3-17
%--------------------------------------------------
%  - OR HIGH RESOLUTION VERSION
% (halves from 8.5 to 13.5 are new)                    73nm ..
%--------------------------------------------------
0 0   67   35.0    168  56.0   % CCL13.5
0 0   67   30.0    168  56.0   % CCL13
0 0   67   25.0    168  56.0   % CCL12.5
0 0   67   20.0    168  56.0   % CCL12
0 0   67   15.0    168  56.0   % CCL11.5
0 0   67   10.0    168  56.0   % CCL11
0 0   67   05.0    168  56.0   % CCL10.5
0 0   67   00.0    168  56.0   % CCL10 + Net
0 0   66   55.0    168  56.0   % CCL9.5
0 0   66   50.0    168  56.0   % CCL9
0 0   66   45.0    168  56.0   % CCL8.5
0 0   66   40.0    168  56.0   % CCL8
%       - spacing now 5nm
0 0   66   35.0    168  56.0   % CCL7
0 0   66   30.0    168  56.0   % CCL6
0 0   66   25.0    168  56.0   % CCL5
%       - spacing now 2.5nm
0 0   66   22.3    168  56.0   % CCL4
0 0   66   19.61   168  57.05  % A3-17
% *** Adjust this position to be safe distance (300m?) from A3-17
%
%
%=================================================================
% MBSn = Mid Bering Strait line
%=================================================================
% Just north of the Bering Strait line
% - 14 stations
% - station spacing 1.7nm, less near coast
% Distance: - 21.0nm total
```

```
%--
% Time from Helix (8casts only) ~2.5hrs
% - Estimate NorsemanII (8 casts only) ~ 4hrs
% - Estimate NorsemanII (14 casts)  ~ 6hrs
% - Estimate Khromov (8casts only)~5.5hrs
% - Estimate Khromov (14casts) ~7hrs
%-------------------------------------
%     Lat (N)       Long (W)     Name
%     deg   min     deg   min
0 0    65    52.1    168  56.0   % MBSn1 % was 57.0
0 0    65    52.0    168  52.5   % MBSn1.5
0 0    65    51.9    168  49.1   % MBSn2
0 0    65    51.8    168  45.0   % MBSn2.5
0 0    65    51.7    168  40.9   % MBSn3
0 0    65    51.6    168  36.4   % MBSn3.5
0 0    65    51.5    168  31.9   % MBSn4 % was 51.6
0 0    65    51.4    168  27.5   % MBSn4.5
0 0    65    51.3    168  23.0   % MBSn5 % was 51.4
0 0    65    51.2    168  18.5   % MBSn5.5
0 0    65    51.1    168  13.9   % MBSn6
0 0    65    51.1    168  10.4   % MBSn6.5
0 0    65    51.0    168   6.9   % MBSn7
0 0    65    50.9    168   5.0   % MBSn8
%
%
%=================================================================
% NBS - North Bering Strait line
%=================================================================
% Hazards on this line:
% == Section crosses shallow waters.
% Beware of shallows from NBS9 and eastwards.
% (Helix diverted N to avoid shallows between
% stations NBS10 and NBS11)
% == Consider terminating line at NBS9
%----------------------------------------
% Another cross strait line, run previously
% at lower resolution (i.e. without the 0.5 stations).
% - stations 9 (NBS1-9) to 16 (NBS1-9 with 0.5s)
%    to 21 (full section, including shallows).
% - station spacing (with 0.5s) ~ 1.7nm
% Distance: - NBS1-9  25.8nm
%           - NBS1-14 44.1nm
%--
% Time from Helix to NBS9, 9 casts ~5.5hrs
% - Estimate for NorsemanII to NBS9, 9 casts, 6hrs
% - Estimate for NorsemanII to NBS9, 16 casts, 7.5hrs
% - Estimate Khromov to NBS9, 9 casts ~6.5hrs
% - Estimate Khromo to NBS9, 16 casts ~8hrs
% Time from Helix to NBS14, 14 casts ~8.5hrs
% - Estimate for NorsemanII to NBS14, 14 casts, 9hrs
```

% - Esimate for NorsemanII to NSB14, 21 casts, 10.5hrs
% - Estimate Khromov to NBS14, 14 casts ~10hrs
% - Estimate Khromov to NBS14, 21 casts ~13hrs
%---
% Lat (N) Long (W) Name
% deg min deg min
0 0 66 0.0 168 56.0 % NBS1 % was 58.1
0 0 66 0.0 168 53.0 % NBS1.5
0 0 66 0.0 168 49.9 % NBS2
0 0 66 0.0 168 45.8 % NBS2.5
0 0 66 0.0 168 41.6 % NBS3
0 0 66 0.0 168 37.4 % NBS3.5
0 0 66 0.0 168 33.2 % NBS4
0 0 66 0.0 168 29.1 % NBS4.5
0 0 66 0.0 168 25.0 % NBS5
0 0 66 0.0 168 20.7 % NBS5.5
0 0 66 0.0 168 16.4 % NBS6
0 0 66 0.0 168 12.4 % NBS6.5
0 0 66 0.0 168 8.4 % NBS7
0 0 66 0.0 168 4.2 % NBS7.5
0 0 66 0.0 168 0.0 % NBS8 - 34m water
0 0 66 0.0 167 55.1 % NBS9 - 20m water
% (consider terminating line here)
0 0 66 0.0 167 52.0 % NBS10 - 12m water
% (Helix diverted N to avoid shallows between these stations)
0 0 66 0.0 167 40.1 % NBS11 - 15m water
0 0 66 0.0 167 29.1 % NBS12 - 18m water
0 0 66 0.0 167 18.1 % NBS13 - 13m water
0 0 66 0.0 167 10.2 % NBS14 - 10m water
%
%
%===
% North North Bering Strait Line (NNBS)
%===
% A section across the ACC and main flow between
% the A3L line and the NBS line.
% With the 0.5s, at 1.76nm spacing
% 22.8nm length
%----------------------------------
% Run for the first time in 2015 - check water depths on
% the eastern (NNBS7.5) end)
% Dovetails with DL line. NNBS1 is the same as DL16
% Now has one extra shallower station in the east NNBS8

66.170 168.937 66 10.19 168 56.20 %NNBS1
66.170 168.865 66 10.19 168 51.88 %NNBS1.5
66.170 168.793 66 10.19 168 47.55 %NNBS2
66.170 168.721 66 10.19 168 43.23 %NNBS2.5
66.170 168.648 66 10.19 168 38.91 %NNBS3
66.170 168.576 66 10.19 168 34.58 %NNBS3.5

```
 66.170 168.504   66   10.19 168   30.26  %NNBS4
 66.170 168.432   66   10.19 168   25.94  %NNBS4.5
 66.170 168.360   66   10.19 168   21.62  %NNBS5
 66.170 168.288   66   10.19 168   17.29  %NNBS5.5
 66.170 168.216   66   10.19 168   12.97  %NNBS6
 66.170 168.144   66   10.19 168    8.65  %NNBS6.5
 66.170 168.072   66   10.19 168    4.32  %NNBS7
 66.170 168.000   66   10.19 168    0.00  %NNBS7.5
 66.170 168.000   66   10.19 167   55.70  %NNBS8   *** NEW
%
%
%==================================================================
% NPH - North Point Hope Line
%==================================================================
%  Crossing from Point Hope to the ENE roughly.
% - 11 stations,
%    from 1-5 and 1.25nm spacing
%    for the rest of the line at 2.5nm
% - Distance 21nm
% - new in 2016
%   - ** CHECK DEPTH OF SHALLOWEST  NPH1
%
% Run from east (NPH1) to west (NPH11)
% - estimate 3hrs 15min
%----------------------------------------------
%    Lat (N)     Long (W)     Name
%    deg min     deg min
0 0   68  22.40    167  07.93   % NPH1
0 0   68  22.64    167  11.31   % NPH2
0 0   68  22.87    167  14.68   % NPH3
0 0   68  23.11    167  18.06   % NPH4
0 0   68  23.35    167  21.44   % NPH5
0 0   68  23.83    167  28.19   % NPH6
0 0   68  24.30    167  34.95   % NPH7
0 0   68  24.77    167  41.71   % NPH8
0 0   68  25.25    167  48.46   % NPH9
0 0   68  25.73    167  55.22   % NPH10
0 0   68  26.20    168  01.97   % NPH11
%-- with extension to the west (20nm, 8 stations, 4hrs)
0 0   68  26.68    168  08.72   % NPH11.5
0 0   68  27.15    168  15.47   % NPH12
0 0   68  27.63    168  22.23   % NPH12.5
0 0   68  28.10    168  28.98   % NPH13
0 0   68  28.58    168  35.74   % NPH13.5
0 0   68  29.05    168  42.49   % NPH14
0 0   68  29.53    168  49.25   % NPH14.5
0 0   68  30.00    168  56.00   % CCL19
%
%
%==================================================================
```

```
% CD- Cape Dyer
%================================================================
%  Crossing east west, midway between Point Hope
% and Cape Lisburne (near Cape Dyer) and trying
% to avoid some topographic irregularites just
% N of the line on the charts.
% - originally 14 stations, 2nm spacing
% - Distance 26nm
% - new in 2016
%   - ** CHECK DEPTH OF SHALLOWEST  CD1
%---------------------------------------------
% extended to the west, by angling to meet CCL20
% at the Convention line.
% - Total distance 54nm, 27 stations
%     Lat (N)      Long (W)     Name
%     deg min      deg min
%---------------------------------------------
% STARTING FROM WEST EXTENSION
%---------------------------------------------
0 0   68  40.00    168  56.0   % CCL20
%**NEW
0 0   68  39.79    168  50.6   % CD27
0 0   68  39.57    168  45.3   % CD26
0 0   68  39.36    168  39.9   % CD25
0 0   68  39.14    168  34.6   % CD24
0 0   68  38.93    168  29.2   % CD23
0 0   68  38.71    168  23.9   % CD22
0 0   68  38.50    168  18.5   % CD21
0 0   68  38.29    168  13.1   % CD20
0 0   68  38.07    168   7.8   % CD19
0 0   68  37.86    168   2.4   % CD18
0 0   68  37.64    167  57.1   % CD17
0 0   68  37.43    167  51.7   % CD16
0 0   68  37.21    167  46.4   % CD15
%---------------------------------------
%*END OF NEW, carry on with orig stations
0 0   68  37.00    167  41.0   % CD14
0 0   68  37.00    167  35.5   % CD13
0 0   68  37.00    167  29.9   % CD12
0 0   68  37.00    167  24.4   % CD11
0 0   68  37.00    167  18.8   % CD10
0 0   68  37.00    167  13.3   % CD9
0 0   68  37.00    167   7.8   % CD8
0 0   68  37.00    167   2.2   % CD7
0 0   68  37.00    166  56.7   % CD6
0 0   68  37.00    166  51.2   % CD5
0 0   68  37.00    166  45.6   % CD4
0 0   68  37.00    166  40.1   % CD3
0 0   68  37.00    166  34.5   % CD2
0 0   68  37.00    166  29.0   % CD1
```

%
%%===
% NCD - North Cape Dyer Line
%===
% 2nm near the coast NCD1-16
% 2.5nm on out to CCL21 (which is NCD 26)
%---
% Length to CCL21 is 55.4nm
%---

```
% Lat(N)   Lon  (W)    Lat (N)       Lon (W)      NAME
% decdeg  decdeg    deg      min     deg   min
 68.753 166.422     68   45.20     166   25.30  %NCD1
 68.757 166.513     68   45.39     166   30.78  %NCD2
 68.760 166.604     68   45.59     166   36.26  %NCD3
 68.763 166.696     68   45.78     166   41.74  %NCD4
 68.766 166.787     68   45.97     166   47.22  %NCD5
 68.769 166.878     68   46.17     166   52.70  %NCD6
 68.773 166.970     68   46.36     166   58.18  %NCD7
 68.776 167.061     68   46.55     167    3.66  %NCD8
 68.779 167.152     68   46.75     167    9.14  %NCD9
 68.782 167.244     68   46.94     167   14.62  %NCD10
 68.786 167.335     68   47.13     167   20.10  %NCD11
 68.789 167.426     68   47.33     167   25.58  %NCD12
 68.792 167.518     68   47.52     167   31.06  %NCD13
 68.795 167.609     68   47.71     167   36.54  %NCD14
 68.798 167.700     68   47.91     167   42.02  %NCD15
 68.802 167.792     68   48.10     167   47.50  %NCD16  2nm up to here, 2.5nm after
 68.805 167.906     68   48.29     167   54.35 %NCD17
 68.808 168.020     68   48.48     168    1.20 %NCD18
 68.811 168.134     68   48.67     168    8.05 %NCD19
 68.814 168.248     68   48.86     168   14.90 %NCD20
 68.817 168.363     68   49.05     168   21.75 %NCD21
 68.821 168.477     68   49.24     168   28.60 %NCD22
 68.824 168.591     68   49.43     168   35.45 %NCD23
 68.827 168.705     68   49.62     168   42.30 %NCD24
 68.830 168.819     68   49.81     168   49.15 %NCD25
 68.833 168.933     68   50.00     168   56.00 %NCD26
```

%
%
%===
% - South Bering Strait section (NOW REPLACED BY SBSnn)
%===
% First ran in 2014 and 2015 and then only partly
% Run in full in 2017
% To catch ACC before it enters the strait
% - 22.5nm long
% - 21 stations including halves
%---
% Lat(N)   Lon (W)   Lat (N)   Lon (W)   NAME
% decdeg decdeg   deg   min   deg   min

```
 65.5818  168.1167       65        34.91    168        7.00     % SBS1 = BS24
 65.5736  168.1571       65        34.42    168        9.43     %  SBS1.5
 65.5655  168.1975       65        33.93    168       11.85     % SBS2
 65.5573  168.2379       65        33.44    168       14.28     %  SBS2.5
 65.5491  168.2784       65        32.95    168       16.70     % SBS3
 65.5409  168.3188       65        32.45    168       19.13     %  SBS3.5
 65.5327  168.3592       65        31.96    168       21.55     % SBS4
 65.5245  168.3997       65        31.47    168       23.98     %  SBS4.5
 65.5163  168.4401       65        30.98    168       26.40     % SBS5
 65.5081  168.4805       65        30.49    168       28.83     %  SBS5.5
 65.5000  168.5209       65        30.00    168       31.26     % SBS6
 65.4918  168.5614       65        29.51    168       33.68     %  SBS6.5
 65.4836  168.6018       65        29.02    168       36.11     % SBS7
 65.4754  168.6422       65        28.52    168       38.53     %  SBS7.5
 65.4672  168.6826       65        28.03    168       40.96     % SBS8
 65.4590  168.7231       65        27.54    168       43.38     %  SBS8.5
 65.4508  168.7635       65        27.05    168       45.81     % SBS9
 65.4426  168.8039       65        26.56    168       48.24     %  SBS9.5
 65.4345  168.8444       65        26.07    168       50.66     % SBS10
 65.4263  168.8848       65        25.58    168       53.09     %  SBS10.5
 65.4181  168.9252       65        25.09    168       55.51     % SBS11
%
%
%=================================================================
% - South Bering Strait section  redone - SBSnn
%=================================================================
% First ran in 2014 and 2015 and then only partly
% Run in full in 2017
% Re aligned in 2019 to start from BS22
% 2019 stations slightly off this (SBSn)
% To catch ACC before it enters the strait
%  - 22.5nm long
%  - 21 stations including halves
%---------------------------------------------------------------
% Lat(N)   Lon  (W)    Lat (N)       Lon (W)      NAME
% decdeg  decdeg    deg      min     deg   min
 65.625 168.177     65   37.48    168   10.63 % SBSnn1 = BS22
 65.614 168.215     65   36.86    168   12.87 % SBSnn1.5
 65.604 168.252     65   36.24    168   15.12 % SBSnn2
 65.594 168.289     65   35.62    168   17.36 % SBSnn2.5
 65.583 168.327     65   35.00    168   19.61 % SBSnn3
 65.573 168.364     65   34.38    168   21.85 % SBSnn3.5
 65.563 168.402     65   33.76    168   24.09 % SBSnn4
 65.552 168.439     65   33.14    168   26.34 % SBSnn4.5
 65.542 168.476     65   32.52    168   28.58 % SBSnn5
 65.532 168.514     65   31.90    168   30.83 % SBSnn5.5
 65.521 168.551     65   31.29    168   33.07 % SBSnn6
 65.511 168.589     65   30.67    168   35.31 % SBSnn6.5
 65.501 168.626     65   30.05    168   37.56 % SBSnn7
 65.490 168.663     65   29.43    168   39.80 % SBSnn7.5
```

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 65.480 168.701     65   28.81     168   42.05 % SBSnn8
 65.470 168.738     65   28.19     168   44.29 % SBSnn8.5
 65.459 168.776     65   27.57     168   46.53 % SBSnn9
 65.449 168.813     65   26.95     168   48.78 % SBSnn9.5
 65.439 168.850     65   26.33     168   51.02 % SBSnn10
 65.428 168.888     65   25.71     168   53.27 % SBSnn10.5
 65.418 168.925     65   25.09     168   55.51 % SBSnn11
% and extra stations added 2024
0          0              65      24.471    168   57.84     % SBSnn11.5
0          0              65      23.071    169     2.366   % SBSnn12.5
0          0              65   21.601    169        6.53    % SBSnn13.5
%
%
%===============================================================
% - Baituk Creek Line  - BC
%===============================================================
% First ran in 2024
% To catch ACC before it enters the strait,
% set approximately parallel to SBSnn, but ~9nm to east.
% To map the nigh nutrient content water found on SBSnn in 2024.
%  - 27.6nm long
%  - 24 stations including halves
%  - resolution ~1.2nm
%------------------------------------------------------------
%                    Lat(N)   Lon  (W)           NAME
% 0 0     deg     min  deg   min
0  0      65        14.928  168      51.448  %         BC12.5
0  0      65        15.593  168      48.716  %         BC12
0  0      65        16.09    168      46.157  %         BC11.5
0  0      65        16.698  168      43.777  %         BC11
0  0      65        17.292  168      40.996  %         BC10.5
0  0      65        17.977  168      38.735  %         BC10
0  0      65        18.561  168      36.212  %         BC9.5
0  0      65        19.207  168      33.831  %         BC9
0  0      65        19.828  168      31.292  %         BC8.5
0  0      65        20.476  168      28.744  %         BC8
0  0      65        21.085  168      26.299  %         BC7.5
0  0      65        21.729  168      23.696  %         BC7
0  0      65        22.383  168      21.073  %         BC6.5
0  0      65        22.95    168      18.718  %         BC6
0  0      65        23.587  168      16.169  %         BC5.5
0  0      65        24.215  168      13.75    %         BC5
0  0      65        24.884  168      11.259  %         BC4.5
0  0      65        25.531  168      8.74      %         BC4
0  0      65        26.209  168      6.353    %         BC3.5
0  0      65        26.832  168      3.746    %         BC3
0  0      65        27.396  168      1.2        %         BC2.5
0  0      65        27.933  167      59.182  %         BC2
0  0      65        28.681  167      56.135  %         BC1.5
0  0      65        29.188  167      53.579  %         BC1
```

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% Bering Strait 2024 NORSEMAN2 log CTD

%Date Time 1 Cast NO wn(1),Up Depth (Lat (de Lat (min) Lon (de Lon(min) % StationID Windspeed Winddir Opera Wave H Fog Distance t Comments

knots (m) 0 = clear; (m)

%Please fill in all data for every event (CTD/net tow) %

%There should be one line for the beginning of the event and one line for the end %

%Date is GMT and has the format yyyymmdd %

%Time is GMT and has the format hhmm %

%Ty=Type: 1=CTD | 2=Net tow | 4=prod cast x | 5=LaramieTM | 6=CTD w Nuts | 7=CTD w Sal | 8=CTD w Sal + Nuts | 9=Monica Bucket | 10=Bella w pump | 11=CTD w Nuts + Bella | 12=CTD w Nuts + Bella+Sal | 13=Monica Bucket with nutrients | 14=CTD w Monica

%#,Number is consecutive for that event type %

%In/out (I/O): 1=In / 2=Out %

%Dep=waterdepth(m) from Furuno readout by CTD which is depth below keel, keel is 3m (10ft)

%LatD and LatM are Latitude Degrees and Minute and are positive N %

%LonD and LonM are Longitude Degrees and Min and are positive W %

%St is the name of the station (Line ID then station number) %

% SS = CTD operator estimate of sea state (Beaufort Scale)

%WSp=wind speed in m/s; WD=Wind direction from bridge

%Op=CTD operator

% when 3 lines for NET, dep indicates wire out for net

% Altimeter = 0 if complete rubbish, 0.5 if some good readings, 1 if good both up and down

%Fill in any comments if needed. % KNOTS

%%%%%%%%% STARTING HERE FOR 2024 **AND GET A WIRE TO CLEAN PUMPS WHEN NEEDED** **Changeat500min**

SET LAPTOP TIME TO GMT **SUNA BA** **(make this autosum)**

%Date	Time	Type	Cast NO	Down(1) Up(2)	Depth (m)	Lat (deg)	Lat (min)	Lon (deg)	Lon (min)	%	StationID	SUNA bat s/n	SUNA min on	SUNA Sum on	Windspeed	Winddir	Who	Wave H (m)	Clear (0) Fog(1)	Water clarity (m)	Comments
20240908	402	1	1	1	5.6	65	15.688	166	25.901	%	teller deck test	1			15.2	218.9	KC		0		
20240908	404	1	1	2	5.6	65	15.688	166	25.901	%	teller deck test	1	2	2	14.2	223	KC		0		
20240908	420	1	2	1	5.6	65	15.681	166	25.881	%	teller in water test	1			19.3	203	KC	0.5	0		testing bottles, no samples taken
20240908	423	1	2	2	5.6	65	15.687	166	25.909	%	teler in water test	1	3	5	22.7	217.7	KC	0.5	0		5 leaked, all else okay. Robert tightening 5.
20240909	2318	1	3	1	11.5	65	17.722	166	42.54	%	teller in water test 2	1			28.3	174.6	KC	0.5	0		testing 5 leaky bottle, taking test samples at 5m, but discarding
20240909	2320	1	3	2	11.5	65	17.719	166	42.582	%	teller in water test 2	1	2	7	20.2	201.2	KC	0.5	0		no leaks, practice redploye/recovered multiple times without turning on instruments
20240910	1510	8	4	1	53.4	65	46.97	168	34.057	%	A2-23 recovery	1			13.3	248.8	KC	1	1	4	
20240910	1518	8	4	2	54	65	47.072	168	34.002	%	A2-23 recovery	1	8	15	11.4	249.5	KC	1	1	4	lot of jellyfish, no bottle issues
20240910	1633	1	5	1	45.9	65	44.92	168	15.835	%	A4-23 recovery	1			10	271.7	KC	0.5	1	3	
20240910	1638	1	5	2	45.9	65	45.072	168	15.584	%	A4-23 recovery	1	5	20	4.4	225.8	KC	0.5	1	3	
20240910	1656	1	6	1	46.4	65	45.826	168	15.288	%	A4 KK Practice	1			7.1	267.6	KK	0.5	1	2	
20240910	1703	1	6	2	45.7	65	46.126	168	15.221	%	A4 KK Practice	1	7	27	9.3	261.1	KK	0.5	1	2	fired 2 bottles at bottom, stopped at every 10m on the way up (no bottles)
20240910	1711	1	7	1	45.6	65	46.427	168	15.128	%	A4 AP Practice	1			7.6	275.7	AP	0.5	1	2	
20240910	1719	1	7	2	45.6	65	46.749	168	15.039	%	A4 AP Practice	1	8	35	9.1	283.3	AP	0.5	1	2	fired 2 bottles at bottom, stopped at every 10m offest 5m on the way up (no bottles)
20240910	1728	1	8	1	45.8	65	47.036	168	14.946	%	A4 AP Practice 2	1			6.7	271.7	AP	0.5	1	2	
20240910	1735	1	8	2	45.8	65	47.298	168	14.85	%	A4 AP Practice 2	1	7	42	4.4	310	AP	0.5	1	2	testing down an up speeds for winch
20240911	218	6	9	1	53.7	65	47.045	168	33.697	%	A2-24 deploy	1			6.2	41.1	AP	0.5	1	3	
20240911	224	6	9	2	53.9	65	47.138	168	33.631	%	A2-24 deploy	1	6	48	1.3	233.3	AP	0.5	1	3	
20240911	433	1	10	1	45.8	65	44.906	168	15.775	%	A4-24 deploy	1			9.3	90	AP	0.5	0	1	
20240911	437	1	10	2	46	65	45.155	168	15.861	%	A4-24 deploy	1	4	52	8.7	83.1	AP	0.5	0	1	
20240911	1505	6	11	1	54.7	66	19.708	168	57.024	%	A3-23 Recovery	1			9.1	32	AP	0.5	0	5	
20240911	1510	6	11	2	54.6	66	19.773	168	57.143	%	A3-23 Recovery	1	5	57	6.7	16.4	AP	0.5	0	5	4 leaking on recovery, 1 & 3 leaked at bottom when open valve. Sampled from2 & 3. Added one knot to 1, 3, 4
20240911	1601	1	12	1	54.7	66	19.693	168	57.099	%	A3-23 bottle test	1			12.4	80.6	KC	0.5	0	8	9, 10, and 1 looser than the others
20240911	1607	1	12	2	54.6	66	19.755	168	57.2	%	A3-23 bottle test	1	6	63	12.6	59.1	KC	0.5	0	8	1,3,5,12 leaking. 3 stuck on knot, knot cut off 3
20240911	1619	1	13	1	54.5	66	19.786	168	57.055	%	A3-23 bottle test 2	1			12.4	99.4	KC	0.5	0	8	no pump, just bottles fired at 5m
20240911	1620	1	13	2	54.5	66	19.786	168	57.055	%	A3-23 bottle test 2	1	1	64	11.6	101.3	KC	0.5	0	8	12 leaking at bottom; 5,8,9,10,11 leaking at bottom when open valve. New knots for 5, 8, 9, 10, 11. 12 needs more repairs.
20240911	2258	6	14	1	54.8	66	19.694	168	56.77	%	A3-24 deploy	1			15.1	92	KC	0.5	0	5	firing all bottles (1-5 at 47m, 7-11 at 45m). Bottle 12 off for repairs.
20240911	2305	6	14	2	54.6	66	19.753	168	56.813	%	A3-24 deploy	1	7	71	14	52.8	KC	0.5	0	5	11 is jammed on something
20240911	2322	11	15	1	54.9	66	19.95	168	55.316	%	AL12.5	1			4.9	206.9	KC	0.5	0	5	
20240911	2329	11	15	2	54.6	66	20.06	168	55.374	%	AL12.5	1	7	78	4.5	23.7	KC	0.5	0	5	surface bucket taken for Bella sampling, Bella samples from surface and bottom
20240911	2231	5	1	1	54.6	66	20.199	168	55.479	%	AL12.5 Laramie						KC				
20240911	2346	5	1	2	54.6	66	20.302	168	55.588	%	AL12.5 Laramie						KC				
20240911	2350	10	1	1	54.6	66	20.361	168	55.638	%	AL12.5 Bella						KC				
20240911	2358	10	1	2	54.6	66	20.481	168	55.738	%	AL12.5 Bella						KC				This is first Bella station, pumping using Laramie's pump
20240912	9	14	16	1	54.7	66	20.383	168	53.791	%	AL13	1			13.3	154.4	KC	0.5	0	8	
20240912	14	14	16	2	54.7	66	20.457	168	53.896	%	AL13	1	5	83	9.2	161.2	KC	0.5	0	8	Saw chl spike around 20m, took a Monica 1 sample
20240912	24	1	17	1	53.2	66	20.742	168	51.505	%	AL13.5	1			2.1	350.1	KC	0.5	0	8	
20240912	28	1	17	2	53.2	66	20.823	168	51.504	%	AL13.5	1	4	87	5.6	20.1	KC	0.5	0	8	
20240912	38	6	18	1	53.7	66	21.102	168	49.25	%	AL14	1			9.6	35.6	KC	0.5	0	8	
20240912	44	6	18	2	53.8	66	21.188	168	49.96	%	AL14	1	6	93	15.5	90.4	KC	0.5	0	8	
20240912	46	5	2	1	54	66	21.227	168	49.329	%	AL14 Lararmie						KC				
20240912	56	5	2	2	53.8	66	21.389	168	49.453	%	AL14 Lararmie						KC				
20240912	107	1	19	1	53.4	66	21.44	168	47.293	%	AL14.5	1			10.8	166.4	KC	0.5	0	5	
20240912	111	1	19	2	53.4	66	21.488	168	47.33	%	AL14.5	1	5	98	11.4	121.5	KC	0.5	0	5	
20240912	120	1	20	1	46.1	66	21.755	168	44.931	%	AL15	1			5.8	322.1	KC	0.5	0	5	

20240912	123	1	**20**	2	46.3	66	21.809	168	44.923 %	AL15	1	3	101	1.3	278.8	KC	0.5	0	5	
20240912	132	6	**21**	1	50.6	66	22.099	168	42.921 %	AL15.5	1			3.4	320.1	KC	0.5	0	4	
20240912	138	6	**21**	2	50.4	66	22.139	168	42.916 %	AL15.5	1	6	107	13.8	9.6	KC	0.5	0	4	
20240912	140	5	**3**	1	50.3	66	22.152	168	42.939 %	AL15.5 Laramie						KC				
20240912		5	**3**	2	50.1	66	22.212	168	43.008 %	AL15.5 Laramie						KC				
20240912	159	1	**22**	1	55.9	66	22.464	168	40.721 %	AL16	1			6.9	349.3	KC	0.5	0	4	
20240912	203	1	**22**	2	55.7	66	22.486	168	40.676 %	AL16	1	4	111	12.3	5.5	KC	0.5	0	4	
20240912	214	1	**23**	1	55.5	66	22.85	168	38.621 %	AL16.5	1			6.1	2.6	KC	0.5	0	4	
20240912	218	1	**23**	2	55.5	66	22.886	168	38.618 %	AL16.5	1	4	115	4	257.1	KC	0.5	0	4	
20240912	228	6	**24**	1	54.3	66	23.189	168	36.598 %	AL17	1			4.4	272	rw				
20240912	235	6	**24**	2	54.2	66	23.24	168	36.638 %	AL17	1	7	122			rw				
20240912	238	5	**4**	1	54.1	66	23.239	168	36.644 %	AL17 Laramie						KC				
20240912	245	5	**4**	2	54.2	66	23.277	168	36.651 %	AL17 Laramie						KC				
20240912	256	1	**25**	1	53.3	66	23.54	168	34.678 %	AL17.5	1			4.4	120.7	KC	0.5	0	4	
20240912	300	1	**25**	2	53	66	23.608	168	34.627 %	AL17.5	1	4	126	4.2	94.4	KC	0.5	0	4	
20240912	311	1	**26**	1	51.9	66	23.905	168	32.238 %	AL18	1			7.5	316	KC	0.5	0	3.5	
20240912	315	1	**26**	2	51.9	66	23.96	168	32.254 %	AL18	1	4	130	6.2	313.5	KC	0.5	0	3.5	lots of jellyfish, tentacles on the rosette
20240912	325	11	**27**	1	52.2	66	24.244	168	30.044 %	AL18.5	1			7.8	136	KC	0.5	0	3	
20240912	333	11	**27**	2	52.2	66	24.348	168	30.068 %	AL18.5	1			6.6	303.8	KC	0.5	0	3	
20240912	336	5	**5**	1	52.1	66	24.204	168	29.834 %	AL18.5 Laramie						KC				
20240912	343	5	**5**	2	52.1	66	24.352	168	29.938 %	AL18.5 Laramie						KC				
20240912	354	1	**28**	1	52.4	66	24.564	168	27.874 %	AL19	1			10.1	335.5	KC	0.5	0	4	
20240912	400	1	**28**	2	52.5	66	24.676	168	27.859 %	AL19	1	6	136	7	309.8	KC	0.5	0	4	large jellyfish in water, spike in S (likely from jelly)
20240912	411	1	**29**	1	51.5	66	24.945	168	25.667 %	AL19.5	1			12.6	351.9	KC	0.5	0	4	
20240912	416	1	**29**	2	51.5	66	25.013	168	25.608 %	AL19.5	1	5	141	11.9	100	KC	0.5	0	4	
20240912	427	6	**30**	1	51.3	66	25.325	168	23.577 %	AL20	1			8.5	349.3	KC	0.5	0	3	
20240912	434	6	**30**	2	51.2	66	25.422	168	23.588 %	AL20	1	7	148	6.4	313.4	KC	0.5	0	3	
20240912	437	5	**6**	1	51.2	66	25.443	168	23.595 %	AL20 Laramie						KC				
20240912	445	5	**6**	2	51.2	66	25.541	168	23.622 %	AL20 Laramie						KC				
20240912	456	1	**31**	1	50.1	66	25.624	168	21.39 %	AL20.5	1			17.4	12.1	KC	0.5	0	3	
20240912	456	1	**31**	2	50.2	66	25.641	168	21.364 %	AL20.5	1	1	149	15.2	41.1	KC	0.5	0	3	S ~1psu different with pump on, CTD recovered for repairs without going down. Removed jellyfish goo from c2
20240912	506	1	**32**	1	49.3	66	25.714	168	21.371 %	AL20.5 redo	1			18.6	25.7	KC	0.5	0	3	
20240912	510	1	**32**	2	50	66	25.756	168	21.417 %	AL20.5 redo	1	4	153	16.6	43.3	KC	0.5	0	3	salinities better.
20240912	521	1	**33**	1	46.8	66	25.958	168	19.272 %	AL21	1			9	3.5	KC	0.5	0	2.5	
20240912	525	1	**33**	2	46.7	66	26.004	168	19.242 %	AL21	1	4	157	9.8	10.9	KC	0.5	0	2.5	
20240912	536	6	**34**	1	43	66	26.316	168	17.168 %	AL21.5	1			1.3	329.2	KC	0.5	0		
20240912	543	6	**34**	2	43.1	66	26.41	168	17.229 %	AL21.5	1	6	163	6.2	4.7	KC	0.5	0		
20240912	545	5	**7**	1	43	66	26.449	168	17.26 %	AL21.5 Laramie						KC				
20240912	552	5	**7**	2	42.9	66	26.541	168	17.379 %	AL21.5 Laramie						KC				
20240912	606	1	**35**	1	39.7	66	26.705	168	14.884 %	AL22	1			2.1	202.5	KK	0.5	0	2	
20240912	610	1	**35**	2	39.6	66	26.765	168	14.88 %	AL22	1	4	167	3.7	335.6	KK	0.5	0	2	
20240912	620	1	**36**	1	36.4	66	27.06	168	12.785 %	AL22.5	1			11.2	22.1	KK	0.5	0	2	
20240912	624	1	**36**	2	36.3	66	27.162	168	12.798 %	AL22.5	1	4	171	11.6	53.1	KK	0.5	0	2	
20240912	634	6	**37**	1	32.4	66	27.452	168	10.569 %	AL23	1			11.9	59.2	KK	0.5	0	2	
20240912	641	6	**37**	2	32.1	66	27.618	168	10.642 %	AL23	1	5	176	12.1	63.5	KK	0.5	0	2	
20240912	644	5	**8**	1	31.8	66	27.74	168	10.672 %	AL23 Laramie						KK	0.5	0		
20240912	653	5	**8**	2	31.8	66	27.74	168	10.672 %	AL23 Laramie						KK	0.5	0		Depth and position taken from start of pumping
20240912	712	1	**38**	1	28.4	66	27.777	168	8.497 %	AL23.5	1			13.2	57.8	KK	0.5	0	1.5	
20240912	716	1	**38**	2	28.3	66	27.887	168	8.44 %	AL23.5	1	4	180	14.1	59.4	KK	0.5	0	1.5	
20240912	727	1	**39**	1	26.2	66	28.1	168	6.203 %	AL24	1			10.2	7.4	KK	0.5	0	1.5	
20240912	731	1	**39**	2	26	66	28.184	168	6.12 %	AL24	1	4	184	10.7	31.5	KK	0.5	0	1.5	
20240912	741	1	**40**	1	24.1	66	28.428	168	4.033 %	AL24.5	1			10.1	19.5	KK	0.5	0	2	
20240912	745	1	**40**	2	24	66	28.499	168	3.958 %	AL24.5	1	4	188	13.5	41.2	KK	0.5	0	2	
20240912	757	11	**41**	1	22.5	66	28.723	168	1.915 %	AL25	1			8.4	340.4	KK	0.5	0	2	bottle #5 intially was fine, but then water flow did not stop (as if it were leaking). Sample taken from spare bottle (#7)
20240912	802	11	**41**	2	22.4	66	28.806	168	1.793 %	AL25	1	5	193	11.6	27.8	KK	0.5	0	2	
20240912	805	5	**9**	1	22.4	66	28.859	168	1.728 %	AL25 Laramie						KK				
20240912	813	5	**9**	2	22.3	66	28.992	168	1.53 %	AL25 Laramie						KK				
20240912	822	1	**42**	1	21.7	66	29.025	167	59.841 %	AL25.5	1			12.8	5.5	KK	0.5	0	2	
20240912	825	1	**42**	2	21.8	66	29.073	167	59.766 %	AL25.5	1	3	196	12.2	5.3	KK	0.5	0	2	
20240912	835	1	**43**	1	21.4	66	29.38	167	57.745 %	AL26	1			5.9	0.5	KK	0.5	0	2	
20240912	838	1	**43**	2	21.4	66	29.409	167	57.645 %	AL26	1	3	199	7	345.1	KK	0.5	0	2	
20240912	847	1	**44**	1	21.6	66	29.769	167	55.759 %	AL26.5	1			6.5	2.1	KK	0.5	0	2	
20240912	850	1	**44**	2	21.6	66	29.798	167	55.63 %	AL26.5	1	3	202	5	323	KK	0.5	0	2	
20240912	859	1	**45**	1	21.7	66	30.084	167	53.552 %	AL27	1			8.5	343.7	KK	0.5	0	2	
20240912	903	1	**45**	2	21.8	66	30.083	167	53.441 %	AL27	1	4	206	9.7	9.1	KK	0.5	0	2	
20240912	914	1	**46**	1	22	66	30.416	167	51.421 %	AL27.5	1			7.1	176.1	KK	0.5	0	2	
20240912	917	1	**46**	2	22.1	66	30.428	167	51.309 %	AL27.5	1	3	209	5.1	213.2	KK	0.5	0	2	END OF AL LINE
20240912	1615	9	**NaN**	NaN	46	67	18.567	168	37.07 %	near AS15	NaN	NaN		9.5	41	ACPF	0.3	0	3	Monica sample #2 - light measurements = 0.12, 0.13, 0.13 uMol

20240912	1615	9	**NaN**	NaN	46	67	18.567	168	37.07 %	near AS15	NaN	NaN	209	9.5	41	ACPF	0.3	0	3	
20240912	1829	13	**NaN**	NaN	43.5	67	22.684	168	11.551 %	Monica 3	NaN	NaN		7.8	310.9	RW	0.1	0		Monica sample #3 [Large] - marine snow at ice edge with whales, light measurements = 4.8, 4.8, 4.9,
20240912	1829	13	**NaN**	NaN	43.5	67	22.684	168	11.551 %	Monica 3	NaN	NaN	209	7.8	310.9	RW	0.1	0		nutrients taken FROM SAME BUCKET (one filtered, one unfiltered) about 30 minutes after sample taken
20240912	2107	11	**47**	1	47.8	67	34.884	168	36.028 %	SCS10	1			0.8	203.6	KC	0.1	0	8	CTD here, blocked by sea ice ahead
20240912	2119	11	**47**	2	47.8	67	34.939	168	35.93 %	SCS10	1	12	221	3.5	262	KC	0.1	0	8	Saw chl max around 12, took Monica Chl samples below/at/above max (20/10/0 m).
20240912	2123	5	**10**	1	47.8	67	34.96	168	35.889 %	SCS10 Laramie						KC				
20240912	2132	5	**10**	2	47.7	67	34.996	168	35.797 %	SCS10 Laramie						KC				
20240912	2136	10	**2**	1	47.6	67	35.01	168	35.763 %	SCS10 Bella						KC				
20240912	2144	10	**2**	2	47.7	67	35.041	168	35.693 %	SCS10 Bella						KC				Wrongly numbered 3 at sea. This is Bells's 2nd large station
20240912	2255	6	**48**	1	47.1	67	40.849	168	21.908 %	SCS11	1			6.6	253.1	KC	0	0	3	
20240912	2304	6	**48**	2	47.4	67	40.879	168	21.709 %	SCS11	1	9	230	1	172.1	KC	0	0	3	Lots of jellyfish, Monica samples below/at/above Chl max (20/10/0 m), 5 leaked (did not set properly), sampled from 7
20240912	2306	5	**11**	1	47.4	67	40.888	168	21.685 %	SCS11 Laramie						KC				
20240912	2314	5	**11**	2	47.1	67	40.913	168	21.57 %	SCS11 Laramie						KC				ICE
20240913	48	6	**49**	1	51.8	67	48.578	168	4.991 %	SCS12	1			14.9	318.3	KC	0	0	2.5	
20240913	59	6	**49**	2	51.8	67	48.565	168	4.919 %	SCS12	1	11	241	14.3	322.9	KC	0	0	2.5	Another chlorophyll max, Monica samples taken below/at/above (20/9/0 m), SUNA battery 12.4 (starts at 12.7)
20240913	101	5	**12**	1	51.7	67	48.561	168	4.907 %	SCS12 Laramie						KC				NO ICE
20240913	109	5	**12**	2	51.7	67	48.552	168	4.85 %	SCS12 Laramie						KC				
20240913	316	12	**50**	1	52.9	67	56.219	167	47.545 %	SCS13	1			14.8	342.1	KK	0	0		Late here as doing ship rudder calibration
20240913	325	12	**50**	2	52.9	67	56.307	167	47.649 %	SCS13	1	9	250	15.2	336.5	KK	0	0		
20240913	327	5	**13**	1	53	67	56.321	167	47.676 %	SCS13 Laramie						KK				
20240913	334	5	**13**	2	52.9	67	56.381	167	47.759 %	SCS13 Laramie						KK				
20240913	450	6	**51**	1	51.7	68	3.558	167	30.22 %	SCS14	1			20.1	344.6	KK	0	0		
20240913	502	6	**51**	2	51.4	68	3.574	167	30.518 %	SCS14	1	12	262	16.2	364.6	KK	0	0		
20240913	502	5	**14**	1	51.6	68	3.581	167	30.562 %	SCS14 Laramie						KK				Start time estimated
20240913	512	5	**14**	2	51.7	68	3.581	167	30.735 %	SCS14 Laramie						KK				
20240913	624	6	**52**	1	46.4	68	10.26	167	14.8 %	SCS15	1			22	11.3	KK	0	0	2	
20240913	631	6	**52**	2	46.3	68	10.25	167	14.91 %	SCS15	1	7	269	19.3	12.5	KK	0	0	2	
20240913	632	5	**15**	1	46.3	68	10.248	167	14.934 %	SCS15 Laramie						KK				
20240913	643	5	**15**	2	46.1	68	10.232	167	15.05 %	SCS15 Laramie						KK				End time estimated
20240913	723	6	**53**	1	42.2	68	13.555	167	7.259 %	SCS16	1			17.5	33	KK	0	0		
20240913	730	6	**53**	2	42.6	68	13.544	167	7.392 %	SCS16	1	7	276	19.8	37.1	KK	0	0		
20240913	733	5	**16**	1	42.7	68	13.537	167	7.458 %	SCS16 Laramie						KK				
20240913	744	5	**16**	2	42.5	68	13.52	167	7.73 %	SCS16 Laramie						KK				
20240913	821	6	**54**	1	35.8	68	16.819	166	59.827 %	SCS17	1			7.9	19	KK	0	0		
20240913	828	6	**54**	2	35.7	68	16.838	167	0.061 %	SCS17	1	7	283	14.5	54.7	KK	0	0		
20240913	831	5	**17**	1	35.7	68	16.855	167	0.154 %	SCS17 Laramie						KK				
20240913	839	5	**17**	2	35.7	68	16.913	167	0.21 %	SCS17 Laramie						KK				Depth taken from start of pumping
20240913	902	6	**55**	1	32.2	68	18.352	166	56.049 %	SCS18	1			12.4	26.8	KK	0	0	2	
20240913	907	6	**55**	2	32.2	68	18.386	166	56.109 %	SCS18	1	5	288	12.3	10.3	KK	0	0	2	
20240913	909	5	**18**	1	32.2	68	18.39	166	56.159 %	SCS18 Laramie						KK				
20240913	918	5	**18**	2	32.2	68	18.442	166	56.286 %	SCS18 Laramie						KK				
20240913	1013	11	**56**	1	25.6	68	19.897	166	52.437 %	SCS19	1			6.2	112.5	KK	0	0	2	
20240913	1017	11	**56**	2	25.8	68	19.899	166	52.688 %	SCS19	1	4	292	5.6	123.4	KK	0	0	2	
20240913	1017	5	**19**	1	25.8	68	19.899	166	52.688 %	SCS19 Laramie						KK				Start time estimated
20240913	1029	5	**19**	2	26.6	68	19.907	166	53.092 %	SCS19 Laramie						KK				
20240914	552	1	**57**	1	45.4	65	48.306	168	56.011 %	BS11	2			17.9	125.7	KK	0	0	6	
20240914	557	1	**57**	2	45.9	65	48.417	168	55.848 %	BS11	2	5	5	24	62.4	KK	0	0	6	
20240914	609	11	**58**	1	45.9	65	47.772	168	53.882 %	BS11.5	2			22	99.3	KK	0	0	4	
20240914	616	11	**58**	2	46.3	65	47.803	168	53.91 %	BS11.5	2	7	12	21.3	91.6	KK	0	0	4	
20240914	622	5	**20**	1	46.1	65	47.797	168	53.935 %	BS11.5 Laramie						KK				
20240914	633	5	**20**	2	46	65	47.79	168	53.93 %	BS11.5 Laramie						KK				
20240914	643	1	**59**	1	43.2	65	47.235	168	51.557 %	BS12	2			23.9	78.7	KK	0	0	4	
20240914	648	1	**59**	2	43	65	47.243	168	51.623 %	BS12	2	5	17	22.3	116.8	KK	0	0	4	
20240914	659	1	**60**	1	47.8	65	46.832	168	49.668 %	BS12.5	2			11.8	53.9	KK	0	0	4	
20240914	703	1	**60**	2	47.5	65	46.862	168	49.728 %	BS12.5	2	4	21	6.2	45.2	KK	0	0	4	
20240914	716	6	**61**	1	50.2	65	46.365	168	47.574 %	BS13	2			9.7	50.9	KK	0	0	4	
20240914	723	6	**61**	2	50.3	65	46.544	168	47.538 %	BS13	2	7	28	7.2	57.2	KK	0	0	4	
20240914	725	5	**21**	1	50.2	65	46.616	168	47.49 %	BS13 Laramie						KK				
20240914	731	5	**21**	2	50.1	65	46.795	168	47.424 %	BS13 Laramie						KK				
20240914	746	14	**62**	1	51	65	45.88	168	45.54 %	BS13.5	2			12.6	52.1	KK	0	0	4	Got internet back momentarily. Off transiting from Diomedes
20240914	753	14	**62**	2	51.1	65	46.028	168	45.524 %	BS13.5	2	7	35	12.4	43.2	KK	0	0	4	
20240914	806	1	**63**	1	50.9	65	45.314	168	43.292 %	BS14	2			8	141.2	KK	0	0		
20240914	810	1	**63**	2	51.1	65	45.414	168	43.182 %	BS14	2	4	39	7.9	29	KK	0	0		
20240914	820	6	**64**	1	50	65	44.85	168	41.58 %	BS14.5	2			8.5	118	ACPF	1-1.5	0	4.5	
20240914	827	6	**64**	2	50.4	65	44.99	168	41.56 %	BS14.5	2	7	46	2.2	32	ACPF	1-1.5	0	4.5	Bottle 12 leaked - surface bottle.
20240914	829	5	**22**	1	50.4	65	45.06	168	41.52 %	BS14.5 Laramie						ACPF				
20240914	836	5	**22**	2	50.2	65	45.245	168	41.472 %	BS14.5 Laramie						ACPF				
20240914	851	1	**65**	1	50.1	65	44.39	168	39.754 %	BS15	2			10	40	ACPF	2	0	4	

20240914	856	1	**65**	2	49.8	65	44.484	168	39.963 %	BS15	2	5	51	10.7	55	ACPF	2	0	4	Lots of Jellies on the CTD
20240914	918	8	**66**	1	49.8	65	43.334	168	35.408 %	BS16	2			17	125	ACPF	1.5	0	3	
20240914	925	8	**66**	2	49.6	65	43.499	168	35.388 %	BS16	2	7	58	17	125	ACPF	1.5	0	3	S1 and S2 disagreed - Rinsed both sensors w Syringe and took 1 Salinity Sample
20240914	927	5	**23**	1	49.5	65	43.54	168	35.369 %	BS16 Laramie						ACPF				
20240914	934	5	**23**	2	49.8	65	43.75	168	35.24 %	BS16 Laramie						ACPF				
20240914	1004	11	**67**	1	51.9	65	41.688	168	29.187 %	BS17.5	2			19.2	116	ACPF	1.5	0	3	Salinities back to good.
20240914	1011	11	**67**	2	51.7	65	41.883	168	29.195 %	BS17.5	2	7	65	20.2	117	ACPF	1.5	0	3	
20240914	1013	5	**24**	1	51.8	65	41.947	168	29.199 %	BS17.5 Laramie						ACPF				
20240914	1021	5	**24**	2	51.6	65	42.166	168	29.235 %	BS17.5 Laramie						ACPF				Original log missed Bella station after this. Added here
20240914	1021	10	**3**	1	51.6	65	42.166	168	29.235 %	BS17.5 Bella										Position taken from station above; Likely took 10min to pump
20240914	1029	10	**3**	2	51.6	65	42.166	168	29.235 %	BS17.5 Bella										Position taken from station above; end time estimated
20240914	1111	6	**68**	1	50	65	40.365	168	23.611 %	BS19	2			17.6	100.2	ACPF	1	0	3	
20240914	1118	6	**68**	2	50.8	65	40.766	168	23.939 %	BS19	2	7	72	17	101	ACPF	1	0	3	
20240914	1122	5	**25**	1	50.8	65	40.895	168	24.035 %	BS19 Laramie						ACPF				
20240914	1129	5	**25**	2	51.2	65	41.279	168	24.29 %	BS19 Laramie						ACPF				
20240914	1201	1	**69**	1	49.1	65	39.999	168	21.383 %	BS19.5	2			17.9	115	ACPF	1	0	3	
20240914	1206	1	**69**	2	49.4	65	40.25	168	21.678 %	BS19.5	2	5	77	18	94	ACPF	1	0	3	
20240914	1230	1	**70**	1	47.3	65	39.319	168	19.211 %	BS20	2			22.3	104	ACPF	1	0	3	
20240914	1236	1	**70**	2	47.5	65	39.665	168	19.558 %	BS20	2			21	95	ACPF	1	0	3	
20240914	1259	6	**71**	1	44.8	65	39.017	168	17.163 %	BS20.5	2			16.2	115	ACPF	1	0	3	
20240914	1306	6	**71**	2	45.5	65	39.47	168	17.566 %	BS20.5	2	7	84	12	89	ACPF	1	0	3	
20240914	1309	5	**26**	1	46	65	39.605	168	17.698 %	BS20.5 Laramie						ACPF				
20240914	1318	5	**26**	2	46.9	65	39.605	168	17.952 %	BS20.5 Laramie						ACPF				End position minutes taken from start position
20240914	1350	1	**72**	1	41.1	65	38.68	168	15.116 %	BS21	2			17.9	115	ACPF	1	0	3	
20240914	1354	1	**72**	2	41.7	65	38.971	168	15.321 %	BS21	2	4	88	17.8	120	ACPF	1	0	3	
20240914	1420	1	**73**	1	31.1	65	38.098	168	12.767 %	BS21.5	2			10.4	120.2	KC	1	0	2	
20240914	1424	1	**73**	2	37.8	65	38.341	168	13.061 %	BS21.5	2	4	92	11.1	103.7	KC	1	0	2	
20240914	1445	11	**74**	1	29.9	65	37.553	168	10.625 %	BS22	2			12.5	68.4	KC	1	0	3	
20240914	1449	11	**74**	2	30.9	65	37.789	168	10.984 %	BS22	2	4	96	14.4	84.1	KC	1	0	3	
20240914	1452	5	**27**	1	31.5	65	37.933	168	11.183 %	BS22 Laramie						KC				
20240914	1500	5	**27**	2	34.7	65	38.362	168	11.599 %	BS22 Laramie						KC				
20240914	1504	10	**4**	1	35.8	65	38.523	168	11.757 %	BS22 Bella						KC				
20240914	1512	10	**4**	2	37.3	65	38.95	168	12.187 %	BS22 Bella						KC				END OF BS LINE HERE
20240914	1539	1	**75**	1	37.4	65	36.858	168	13.011 %	SBSnn 1.5	2			15.5	82.5	KC	1	0	2	START OF SBSnn LINE
20240914	1543	1	**75**	2	37.6	65	37.079	168	13.332 %	SBSnn 1.5	2	4	100	13.4	70.4	KC	1	0	2	
20240914	1603	1	**76**	1	44	65	35.569	168	17.43 %	SBSnn 2.5	2			9.8	86.1	KC	1	0	2	
20240914	1607	1	**76**	2	45	65	35.692	168	17.85 %	SBSnn 2.5	2	4	104	12.6	77.6	KC	1	0	2	
20240914	1625	1	**77**	1	47.1	65	34.307	168	21.523 %	SBSnn 3.5	2			9.1	54.1	KC	1	1	2	
20240914	1629	1	**77**	2	47.3	65	34.404	168	21.643 %	SBSnn 3.5	2	4	108	9.4	71	KC	1	1	2	Extremely homogenous T and S
20240914	1649	1	**78**	1	49.7	65	32.97	168	26.242 %	SBSnn 4.5	2			11.4	112.2	KC	1	1	4	
20240914	1653	1	**78**	2	49.7	65	33.08	168	26.329 %	SBSnn 4.5	2	4	112	8.1	173	KC	1	1	4	
20240914	1713	1	**79**	1	58.2	65	31.787	168	30.807 %	SBSnn 5.5	2			12.2	41.1	KC	1	0	3	
20240914	1718	1	**79**	2	57.7	65	31.874	168	30.963 %	SBSnn 5.5	2	5	117	9.4	124.3	KC	1	0	3	
20240914	1740	1	**80**	1	53.8	65	30.654	168	35.512 %	SBSnn 6.5	2			13.4	56.7	KC	1	0	3	
20240914	1745	1	**80**	2	54.8	65	30.824	168	35.609 %	SBSnn 6.5	2	5	122	9.5	87.2	KC	1	0	3	
20240914	1807	1	**81**	1	55.4	65	29.34	168	39.595 %	SBSnn 7.5	2			5.4	337.7	KC	1	0	4	
20240914	1811	1	**81**	2	55.1	65	29.39	168	39.609 %	SBSnn 7.5	2	4	126	0.2	90.9	KC	1	0	4	Lot of jellyfish
20240914	1831	1	**82**	1	56.4	65	28.137	168	44.386 %	SBSnn 8.5	2			16.7	15.5	KC	1	0	4	
20240914	1835	1	**82**	2	55.3	65	28.195	168	44.543 %	SBSnn 8.5	2	4	130	16.5	37.4	KC	1	0	4	
20240914	1853	1	**83**	1	54.4	65	26.858	168	48.521 %	SBSnn 9.5	2			7.6	335.2	KC	1	0	3	
20240914	1857	1	**83**	2	54.6	65	26.88	168	48.481 %	SBSnn 9.5	2	4	134	4.2	322.2	KC	1	0	3	Lots of jellyfish tentacles on CTD when recovered, faulty salinity at depth, flushed sensors to resolve issue, high nitrate
20240914	1919	6	**84**	1	56.5	65	25.717	168	53.295 %	SBSnn 10.5	2			9.1	343.1	KC	1	0	3	
20240914	1924	6	**84**	2	56.6	65	25.725	168	53.31 %	SBSnn 10.5	2	5	139	6	320.7	KC	1	0	3	Salinity sensor mismatch by 1PSU still, flushing sensors again to resolve issue, higher nitrate
20240914	1943	7	**85**	1	54.5	65	24.382	168	57.871 %	SBSnn 11.5	2			16.9	28.3	KC	1	0	4	
20240914	1948	7	**85**	2	55.1	65	24.491	168	57.987 %	SBSnn 11.5	2	5	144	6.7	78.5	KC	1	0	4	Salinity sensor mismatch by 1PSU still, flushing sensors again to resolve issue, salinity sample taken at bottom, even higher nitrate
20240914	2008	1	**86**	1	52.7	65	23.08	169	2.32 %	SBSnn 12.5	2			17.1	41.4	KC	1	0	4	
20240914	2012	1	**86**	2	52.6	65	23.124	169	2.369 %	SBSnn 12.5	2	4	148	19.1	50.7	KC	1	0	4	Salinity sensor seems better, nitrate at/above 15!
20240914	2032	6	**87**	1	50.4	65	21.604	169	6.515 %	SBSnn 13.5	2			19	23.2	KC	1	0	4	
20240914	2038	6	**87**	2	50.6	65	21.65	169	6.602 %	SBSnn 13.5	2	6	154	19.7	53.7	KC	1	0	4	END OF SBSnn LINE HERE
20240914	2157	6	**88**	1	52.2	65	14.928	168	51.448 %	BC12.5	2			19.4	72.3	KC	1	0	3	START OF BC
20240914	2203	6	**88**	2	52.3	65	15.003	168	51.593 %	BC12.5	2	6	160	19.9	85.5	KC	1	0	3	Monica chl samples taken below/at/above max
20240914	2206	5	**28**	1	52.3	65	15.034	168	51.654 %	BC12.5 Laramie						KC				Depth taken from CTD as not recorded at time
20240914	2212	5	**28**	2	52.3	65	15.164	168	51.822 %	BC12.5 Laramie						KC				Depth taken from CTD as not recorded at time
20240914	2225	1	**89**	1	50.1	65	15.593	168	48.716 %	BC12	2			11.1	27.6	KC	1	0	4	
20240914	2229	1	**89**	2	50	65	15.636	168	48.784 %	BC12	2	4	164	10.1	26.5	KC	1	0	4	
20240914	2241	1	**90**	1	53.4	65	16.09	168	46.157 %	BC11.5	2			17.8	116.4	KC	1	0	5	
20240914	2244	1	**90**	2	53.4	65	16.136	168	46.177 %	BC11.5	2	3	167	19	76.6	KC	1	0	5	nepheloid layer in the bottom
20240914	2255	1	**91**	1	53	65	16.698	168	43.777 %	BC11	2			15.5	100.2	KC	1	0	8	

20240914	2259	1	**91**	2	53	65	16.774	168	43.802 %	BC11	2	4	171	15.4	45.7	KC	1	0	8	
20240914	2312	6	**92**	1	52.5	65	17.292	168	40.996 %	BC10.5	2			3.4	71	KC	1	0	5	
20240914	2318	6	**92**	2	52.3	65	17.412	168	41.134 %	BC10.5	2			3.1	66.8	KC	1	0	5	
20240914	2320	5	**29**	1	52.3	65	17.444	168	41.178 %	BC10.5 Laramie						KC				Depth taken from CTD as not recorded at time
20240914	2336	5	**29**	2	52.3	65	17.581	168	41.347 %	BC10.5 Laramie						KC				Depth taken from CTD as not recorded at time
20240914	2340	1	**93**	1	53	65	17.977	168	38.735 %	BC10	2			17.1	108.1	KC	1	0	4	
20240914	2344	1	**93**	2	52.9	65	18.053	168	38.785 %	BC10	2	4	175	17.3	53.2	KC	1	0	4	
20240914	2355	6	**94**	1	50.7	65	18.561	168	36.212 %	BC9.5	2			9.2	0.3	KC	1	0	4	
20240915	0	6	**94**	2	50.9	65	18.596	168	36.33 %	BC9.5	2	5	180	3.4	44.8	KC	1	0	4	
20240915	12	1	**95**	1	50.2	65	19.207	168	33.831 %	BC9	2			18.4	8.2	KC	1	0	5	
20240915	16	1	**95**	2	50.4	65	19.243	168	33.949 %	BC9	2	4	184	17.7	31.4	KC	1	0	5	
20240915	28	1	**96**	1	50.8	65	19.828	168	31.292 %	BC8.5	2			10.5	56.5	KC	1	0	4	
20240915	31	1	**96**	2	50.8	65	19.865	168	31.375 %	BC8.5	2	3	187	12.8	51.5	KC	1	0	4	
20240915	43	6	**97**	1	53.3	65	20.476	168	28.744 %	BC8	2			9.7	322.8	KC	1	0	3	
20240915	47	6	**97**	2	53.3	65	20.522	168	28.822 %	BC8	2	4	191	17	352	KC	1	0	3	5 leaked, sample form 7 instead
20240915	49	5	**30**	1	53.1	65	20.542	168	28.873 %	BC8 Laramie	2					KC				
20240915	55	5	**30**	2	53.1	65	20.62	168	29.08 %	BC8 Laramie	2					KC				
20240915	109	1	**98**	1	52.3	65	21.085	168	26.299 %	BC7.5	2			9.4	301.5	KC	1	0	3	
20240915	113	1	**98**	2	52.3	65	21.118	168	26.342 %	BC7.5	2	4	195	16.2	335.4	KC	1	0	3	
20240915	125	1	**99**	1	53.8	65	21.729	168	23.696 %	BC7	2			10.6	322.4	KC	1	0	3	
20240915	128	1	**99**	2	53.9	65	21.773	168	23.693 %	BC7	2	3	198	18.7	326	KC	0.5	0	3	
20240915	141	1	**100**	1	56.3	65	22.383	168	21.073 %	BC6.5	2			17.8	341.9	KC	0.5	0	3	
20240915	145	1	**100**	2	56.1	65	22.422	168	21.115 %	BC6.5	2	4	202	16.8	346.3	KC	0.5	0	3	
20240915	156	1	**101**	1	57.5	65	22.95	168	18.718 %	BC6	2			3	31.9	KC	0.5	0	5	
20240915	201	1	**101**	2	57.4	65	22.992	168	18.746 %	BC6	2	5	207	6.4	351.5	KC	0.5	0	5	Salinity sensor 1 sucked up jellyfish, caused difference of 1PSU, flushed sensor
20240915	213	6	**102**	1	58.2	65	23.587	168	16.169 %	BC5.5	2			5.6	17.6	KC	0.5	0	5	
20240915	219	6	**102**	2	58.1	65	23.626	168	16.281 %	BC5.5	2	6	213	12.9	358.9	KC	0.5	0	5	
20240915	222	5	**31**	1	58	65	23.634	168	16.331 %	BC5.5 Laramie						KC				
20240915	228	5	**31**	2	58.5	65	23.669	168	16.53 %	BC5.5 Laramie						KC				
20240915	242	1	**103**	1	56.9	65	24.215	168	13.75 %	BC5	2			24	24	ACPF	1	0	5	
20240915	247	1	**103**	2	56.5	65	24.23	168	13.874 %	BC5	2	5	218	25	31	ACPF	1	0	5	
20240915	300	1	**104**	1	47.1	65	24.884	168	11.259 %	BC4.5	2			15	33	ACPF	1.5	0	5	
20240915	304	1	**104**	2	47.1	65	24.913	168	11.415 %	BC4.5	2	4	222	20.5	16	ACPF	1.5	0	5	
20240915	320	6	**105**	1	46	65	25.531	168	8.74 %	BC4	2			20.2	14	ACPF	1.5	0	4.5	
20240915	326	6	**105**	2	46.7	65	25.551	168	9.242 %	BC4	2	6	228	27.1	30	ACPF	1.5	0	4.5	5 leaked.. 8 leaked from the bottom after opening valve. So took surface sampled from 7
20240915	328	5	**32**	1	46.8	65	25.578	168	9.378 %	BC4 Laramie	2					ACPF				
20240915	336	5	**32**	2	46.9	65	25.605	168	9.678 %	BC4 Laramie	2					ACPF				
20240915	354	1	**106**	1	42.7	65	26.209	168	6.353 %	BC3.5	2			25	17	ACPF	1.5	0	4.5	
20240915	358	1	**106**	2	40.7	65	26.271	168	6.78 %	BC3.5	2	4	232	29.4	35.4	ACPF	1.5	0	4.5	
20240915	416	1	**107**	1	41.9	65	26.832	168	3.746 %	BC3	2			30	13	ACPF	1.5	0	4	
20240915	421	1	**107**	2	43.2	65	26.969	168	4.197 %	BC3	2	5	237	24	30	ACPF	1.5	0	4	
20240915	439	6	**108**	1	40.3	65	27.396	168	1.2 %	BC2.5	2			26.7	25	ACPF	1	0	4.5	very fresh top layer and visible current structure at surface shortly before cast
20240915	447	6	**108**	2	42	65	27.528	168	1.984 %	BC2.5	2	8	245	29.1	28.8	ACPF	1	0	4.5	
20240915	449	5	**33**	1	41.2	65	27.576	168	2.316 %	BC2.5 Laramie				16	40	ACPF				
20240915	457	5	**33**	2	41.2	65	27.705	168	3.243 %	BC2.5 Laramie				16	40	ACPF				
20240915	522	1	**109**	1	38.8	65	27.933	167	59.182 %	BC2	2			28	44	RW	1	0	2.5	very fresh top layer
20240915	527	1	**109**	2	39.1	65	27.984	167	59.63 %	BC2	2	5	250	24	25	RW	1	0	2.5	
20240915	546	1	**110**	1	30.5	65	28.681	167	56.135 %	BC1.5	2			28	28	RW	1	0	3	very fresh and upper layer more no3?
20240915	551	1	**110**	2	30.9	65	28.727	167	56.442 %	BC1.5	2	5	255	32	32	RW	1	0	3	
20240915	607	6	**111**	1	23.4	65	29.188	167	53.579 %	BC1	2			29	60	RW	1		2.5	
20240915	612	6	**111**	2	25.8	65	29.266	167	54.029 %	BC1	2	6	261	30	30	RW				bottle 11 didn't fire
20240915	614	5	**34**	1	25.8	65	29.273	167	54.085 %	BC1 Laramie						RW				
20240915	621	5	**34**	2	25.8	65	29.328	167	54.629 %	BC1 Laramie						RW				Depth taken from pump start; end time estimated
20240917	1039	1	**112**	1	45.3	65	48.294	168	55.864 %	BS11	2			18.9	316	KK	1	0	1	
20240917	1044	1	**112**	2	45.5	65	48.306	168	55.726 %	BS11	2	5	266	17.8	328.2	KK	1	0	1	
20240917	1054	1	**113**	1	46.2	65	47.83	168	53.842 %	BS11.5	2			16.7	314	KK	1	0	1	
20240917	1100	1	**113**	2	46.4	65	47.791	168	53.533 %	BS11.5	2	6	268	2.4	335.9	KK	1	0	1	
20240917	1102	5	**35**	1	46.5	65	47.796	168	53.436 %	BS11.5 Laramie						KK				
20240917	1108	5	**35**	2	46.8	65	47.796	168	53.209 %	BS11.5 Laramie						KK				
20240917	1119	1	**114**	1	42.9	65	47.235	168	51.671 %	BS12	2			18.1	333	KK	1	0	1	
20240917	1123	1	**114**	2	43.1	65	47.181	168	51.803 %	BS12	2	4	272	16.8	344.2	KK	1	0	1	
20240917	1135	1	**115**	1	47.7	65	46.864	168	49.673 %	BS12.5	2			20.3	332.2	KK	1	0	3	
20240917	1139	1	**115**	2	47.8	65	46.888	168	49.709 %	BS12.5	2	4	276	19.6		KK	1	0	3	lots of jellyfish stuck on the rossette
20240917	1151	1	**116**	1	50.4	65	46.357	168	47.622 %	BS13	2			11.2	337	KK	1	0	2	
20240917	1157	1	**116**	2	50.2	65	46.388	168	47.491 %	BS13	2	6	282	4.5	338	KK	1	0	2	even more jellyfish on rossette
20240917	1158	5	**36**	1	49.8	65	46.407	168	47.477 %	BS13 Laramie						KK				
20240917	1205	5	**36**	2	49.8	65	46.458	168	47.448 %	BS13 Laramie						KK				
20240917	1218	1	**117**	1	51	65	45.852	168	45.482 %	BS13.5	2			9.3	341.1	KK	1	0	2	

20240917	1222	1	**117**	2	51.1	65	45.877	168	45.415 %	BS13.5	2	6	288	12.6	31.2	KK	1	0	2	a lot of jellyfish, tons stuck on rossette
20240917	1234	1	**118**	1	50.8	65	45.273	168	43.306 %	BS14	2			20	341.7	KK	1	0	2	
20240917	1239	1	**118**	2	51.3	65	45.24	168	43.422 %	BS14	2	5	293	22.3	346.2	KK	1	0	2	a lot of jellyfish and tons stuck on rossette
20240917	1249	1	**119**	1	50.2	65	44.824	168	41.659 %	BS14.5	2			17	325.7	KK	1	0	2	
20240917	1254	1	**119**	2	50	65	44.759	168	41.631 %	BS14.5	2	5	298	6.3	8	KK	1	0	2	
20240917	1256	5	**37**	1	49.7	65	44.758	168	41.633 %	BS14.5 Laramie						KK				
20240917	1303	5	**37**	2	50.3	65	44.744	168	41.686 %	BS14.5 Laramie						KK				
20240917	1316	1	**120**	1	50	65	44.32	168	39.678 %	BS15	2			6.4	35	ACPF	1	0	2	O2 sensor #2 acting up... too many zigzags, but O2#1 seems good.
20240917	1320	1	**120**	2	49.8	65	44.314	168	39.67 %	BS15	2	4	302	4.3	25	ACPF	1	0	2	Tons of jellyfish
20240917	1330	1	**121**	1	49.8	65	43.848	168	37.739 %	BS15.5	2			21	350	ACPF	1	0	2	O2 sensor #2 is better now.
20240917	1335	1	**121**	2	49.8	65	43.82	168	37.889 %	BS15.5	2	5	306	19.3	2	ACPF	1	0	2	
20240917	1347	1	**122**	1	50.2	65	43.334	168	35.534 %	BS16	2			4	100	ACPF	1	0	2	O2 sensor #2 still zigzagging a lot.
20240917	1353	1	**122**	2	50.1	65	43.302	168	35.448 %	BS16	2	6	312	5.6	32	ACPF	1	0	2	
20240917	1355	5	**38**	1	49.9	65	43.296	168	35.45 %	BS16 Laramie						ACPF				
20240917	1403	5	**38**	2	50.1	65	43.257	168	35.54 %	BS16 Laramie						ACPF				
20240917	1415	1	**123**	1	50.1	65	42.786	168	33.375 %	BS16.5	2			3.5	12.2	KC	1	0	2	
20240917	1419	1	**123**	2	50	65	42.779	168	33.384 %	BS16.5	2	4	316	8.8	328.7	KC	1	0	2	SUNA communication ceased during cast, changing battery to (hopefully) resolve issue. Old battery 12.3V (out of 12.8V)
20240917	1431	1	**124**	1	53.4	65	42.275	168	31.282 %	BS17	1			5.4	15.7	KC	1	0	2	
20240917	1434	1	**124**	2	53.6	65	42.266	168	31.324 %	BS17	1	3	3	9.8	353.3	KC	1	0	2	SUNA starts okay, then ceases communication. Cleaned all three SUNA connections to (hopefullly) resolve issue.
20240917	1447	1	**125**	1	52	65	41.689	168	29.198 %	BS17.5	1			6	61.3	KC	1	0	2	
20240917	1451	1	**125**	2	52.1	65	41.679	168	29.282 %	BS17.5	1	4	7	15.6	10.3	KC	1	0	2	SUNA works well again!
20240917	1453	5	**39**	1	52.1	65	41.651	168	29.337 %	BS17.5 Laramie						KC				
20240917	1500	5	**39**	2	52.8	65	41.577	168	29.521 %	BS17.5 Laramie						KC				
20240917	1513	1	**126**	1	51.8	65	41.162	168	27.012 %	BS18	1			10.9	62.7	KC	1	0	3	
20240917	1517	1	**126**	2	52	65	41.159	168	27.07 %	BS18	1	4	11	11.5	3.1	KC	1	0	3	
20240917	1526	1	**127**	1	51.1	65	40.75	168	25.167 %	BS18.5	1			3.2	26.1	KC	1	0	3	
20240917	1531	1	**127**	2	51.3	65	40.764	168	25.251 %	BS18.5	1	5	16	5.5	27.5	KC	1	0	3	
20240917	1541	1	**128**	1	50.3	65	40.329	168	23.446 %	BS19	1			7.6	47.6	KC	1	0	2	
20240917	1545	1	**128**	2	50.2	65	40.355	168	23.526 %	BS19	1	4	20	9.2	29.9	KC	1	0	2	
20240917	1546	5	**40**	1	50.3	65	40.365	168	23.5757 %	BS19 Laramie						KC				
20240917	1553	5	**40**	2	50.4	65	40.407	168	23.758 %	BS19 Laramie						KC				
20240917	1606	1	**129**	1	48.8	65	39.807	168	21.209 %	BS19.5	1			9.5	51.2	KC	1	0	2	
20240917	1609	1	**129**	2	49.1	65	39.815	168	21.202 %	BS19.5	1	3	23	13.8	24.9	KC	1	0	2	
20240917	1620	1	**130**	1	47.1	65	39.322	168	19.07 %	BS20	1			9	82.9	KC	1	0	2	
20240917	1624	1	**130**	2	47.3	65	39.32	168	19.142 %	BS20	1	4	27	7.4	59.5	KC	1	0	2	
20240917	1634	1	**131**	1	44.6	65	38.92	168	16.981 %	BS20.5	1			11.3	109.6	KC	1	0	1	
20240917	1638	1	**131**	2	44.7	65	38.943	168	17.108 %	BS20.5	1	4	31	12	54.9	KC	1	0	1	
20240917	1639	5	**41**	1	44.8	65	38.955	168	17.172 %	BS20.5 Laramie						KC				
20240917	1646	5	**41**	2	45.1	65	38.986	168	17.474 %	BS20.5 Laramie						KC				
20240917	1700	1	**132**	1	40.6	65	38.494	168	14.91 %	BS21	1			11.1	112.1	KC	1	0	1	
20240917	1704	1	**132**	2	40.7	65	38.512	168	14.987 %	BS21	1	4	35	7.1	67.6	KC	1	0	1	
20240917	1715	1	**133**	1	37.3	65	38.014	168	12.652 %	BS21.5	1			13	52.4	KC	1	0	1	
20240917	1718	1	**133**	2	37.5	65	38.016	168	12.81 %	BS21.5	1	3	38	15.2	62.2	KC	1	0	1	
20240917	1730	1	**134**	1	30.1	65	37.473	168	10.52 %	BS22	1			13.1	45.3	KC	1	0	1	
20240917	1733	1	**134**	2	30.4	65	37.475	168	10.619 %	BS22	1	3	41	21.2	52.9	KC	1	0	1	END OF BS LINE
20240917	1734	5	**42**	1	30.6	65	37.486	168	10.672 %	BS22 Laramie						KC				
20240917	1739	5	**42**	2	31.3	65	37.512	168	10.83 %	BS22 Laramie						KC				END OF BS LINE
20240917	1751	1	**135**	1	37.3	65	36.818	168	13.011 %	SBSnn1.5	1			15.2	49.9	KC	1	0	2	START OF SBSnn LINE
20240917	1755	1	**135**	2	37.5	65	36.841	168	13.145 %	SBSnn1.5	1	4	45	8.9	62.5	KC	1	0	2	
20240917	1806	1	**136**	1	40.5	65	36.221	168	15.149 %	SBSnn2	1			9.6	94	KC	0.5	0	2	
20240917	1809	1	**136**	2	40.5	65	36.256	168	15.244 %	SBSnn2	1	3	48	16.4	47	KC	0.5	0	2	
20240917	1819	1	**137**	1	43.9	65	35.617	168	17.266 %	SBSnn2.5	1			16.7	44.9	KC	0.5	0	2	
20240917	1822	1	**137**	2	44	65	35.625	168	17.404 %	SBSnn2.5	1	3	51	15.7	45.8	KC	0.5	0	2	
20240917	1832	1	**138**	1	46.1	65	35.029	168	19.465 %	SBSnn3	1			13.3	55.8	KC	0.5	0	3	
20240917	1836	1	**138**	2	46.3	65	35.039	168	19.586 %	SBSnn3	1	4	55	15.4	30.3	KC	0.5	0	3	
20240917	1847	1	**139**	1	47.6	65	34.339	168	21.843 %	SBSnn3.5	1			9.6	49.2	KC	0.5	0	2	
20240917	1850	1	**139**	2	47.6	65	34.351	168	21.948 %	SBSnn3.5	1	3	58	18.9	33.7	KC	0.5	0	2	
20240917	1908	1	**140**	1	48.8	65	33.726	168	24.042 %	SBSnn4	1			11.4	33.4	KC	0.5	0	2	
20240917	1911	1	**140**	2	48.4	65	33.722	168	24.153 %	SBSnn4	1	3	61	12.7	29.8	KC	0.5	0	2	flipped fairleads on block so wire runs on pulleys
20240917	1922	1	**141**	1	49.7	65	33.114	168	26.215 %	SBSnn4.5	1			17.3	29.2	KC	0.5	0	2	
20240917	1925	1	**141**	2	50	65	33.092	168	26.302 %	SBSnn4.5	1	3	64	8.1	42.3	KC	0.5	0	2	
20240917	1936	1	**142**	1	51.6	65	32.527	168	28.287 %	SBSnn5	1			16.7	26.8	KC	0.5	0	2	
20240917	1940	1	**142**	2	52	65	32.516	168	28.43 %	SBSnn5	1	4	68	8	48.1	KC	0.5	0	2	
20240917	1953	1	**143**	1	57.9	65	31.92	168	30.78 %	SBSnn5.5	1			8.9	51.8	KC	0.5	0	2	
20240917	1957	1	**143**	2	57.8	65	31.906	168	30.877 %	SBSnn5.5	1	4	72	8.1	41.8	KC	0.5	0	2	
20240917	2008	1	**144**	1	56.8	65	31.277	168	33.291 %	SBSnn6	1			27.1	48.8	KC	0.5	0	2	
20240917	2012	1	**144**	2	56.2	65	31.29	168	33.428 %	SBSnn6	1	4	76	25.1	26.2	KC	0.5	0	2	Salinity sensors became off by about 2 PSU, flushing sensors to resolve the issue
20240917	2022	1	**145**	1	55.6	65	31.384	168	33.916 %	SBSnn6 redo	1			17.4	87.2	KC	1	0		Salinity sensors still not converging, did not complete cast. Brought on board and moved on to next station

20240917	2024	1	**145**	2	55.7	65	31.405	168	33.966	**%**	SBSnn6 redo	1	2	78	13.9	69.4	KC	1	0		CTD came up covered in jellyfish tendrils. Flushed both cells again with salt water and moved on, (Break for lunch)
20240917	2058	1	**146**	1	54.8	65	30.702	168	35.392	**%**	SBSnn6.5	1			18	64	rw	1.5	0	2	Going deeper on the soak to hopefully avoid jellyfish
20240917	2102	1	**146**	2	54.8	65	30.763	168	35.414	**%**	SBSnn6.5	1	4	82	17	52	rw	1.5	0	2	
20240917	2115	1	**147**	1	53.8	65	29.99	168	37.716	**%**	SBSnn7	1			16	60	rw	1.5	0	2	
20240917	2119	1	**147**	2	53.8	65	30.017	168	37.733	**%**	SBSnn7	1	4	86	21	51	rw	1.5	0	2	station name wrong in hex file,. Should be SBSnn7
20240917	2130	1	**148**	1	54.1	65	29.411	168	39.832	**%**	SBSnn7.5	1			27	60	rw	1	0	2	
20240917	2134	1	**148**	2	53.7	65	29.47	168	39.99	**%**	SBSnn7.5	1	4	90	34	40	RW	1	0	2	CHANGED TO low res as waves picking up
20240917	2153	1	**149**	1	58.3	65	28.179	168	44.3	**%**	SBSnn8.5	1			19	58	rw	1.5	0	3	
20240917	2156	1	**149**	2	58.5	65	28.214	168	44.3	**%**	SBSnn8.5	1	3	93	21	40	rw	1.5	0	3	
20240917	2217	1	**150**	1	54.7	65	26.908	168	48.81	**%**	SBSnn9.5	1			15	44	rw	1.5	0	3	
20240917	2220	1	**150**	2	54.8	65	26.937	168	48.781	**%**	SBSnn9.5	1	3	96	26	42	rw	1.5	0	3	
20240917	2240	1	**151**	1	56.9	65	25.716	168	53.258	**%**	SBSnn10.5	1			12	26	rw	1.5	0	3	
20240917	2244	1	**151**	2	57.3	65	25.731	168	53.228	**%**	SBSnn10.5	1	4	100	14	33	rw	1.5	0	3	
20240917	2303	1	**152**	1	54.7	65	24.471	168	57.841	**%**	SBSnn11.5	1			20	2	rw	1.5	0	3	Monica small samples, waves building
20240917	2311	1	**152**	2	54.6	65	24.546	168	57.846	**%**	SBSnn11.5	1			23	4	rw	1.5	0	3	20uM in raw suna at bottom
20240917	2334	1	**153**	1	53.3	65	23.071	169	2.366	**%**	SBSnn12.5	1			21	6	rw	1.7	0	3	
20240917	2338	1	**153**	2	53.3	65	23.086	169	2.276	**%**	SBSnn12.5	1			24	4	rw	1.7	0	3	
20240917	2357	1	**154**	1	50.8	65	21.601	169	6.53	**%**	SBSnn13.5	1			28	352	rw	1.7	0	3	
20240918	2	1	**154**	2	51	65	21.623	169	6.541	**%**	SBSnn13.5	1			18	0	rw	1.7	0	3	
%			END OF CTDS .. 4pm local							**%**											

BSTRAIT 2024 - SUMMARY OF ALL WATER SAMPLES FROM CTD OR SURFACE BUCKETS (NOT TRACE METAL PUMP)

Station	Station description	Date (UTC)	Time (UTC)	Cast	Bottom depth (m)	Lat deg	Lat min	Latitude (degrees)	Long deg	Long min	Longitude (degrees)	Bottle #	Target Depth (db	Nut Sample	Sampler	Notes and other samples taken
A2-23	A2-23 recovery	10/09/2024	15:10	**4**	53.4	65	47.072	65.78453333	168	34	168.5666667	1	bottom		LJ+ACPF	Duplicate salinities taken (0261, 0262) for CTD calibration check
A2-23	A2-23 recovery	10/09/2024	15:10	**4**	53.4	65	47.072	65.78453333	168	34	168.5666667	3	50	1030A	LJ+ACPF	These samples for SUNA check - A2-23 recovery
A2-23	A2-23 recovery	10/09/2024	15:10	**4**	53.4	65	47.072	65.78453333	168	34	168.5666667	3	50	1031A	LJ+ACPF	
A2-23	A2-23 recovery	10/09/2024	15:10	**4**	53.4	65	47.072	65.78453333	168	34	168.5666667	5	48	1032A	LJ+ACPF	
A2-23	A2-23 recovery	10/09/2024	15:10	**4**	53.4	65	47.072	65.78453333	168	34	168.5666667	5	48	1033A	LJ+ACPF	
A2-24	A2-24 deploy	10/09/2024	02:18	**9**	53.9	65	47.138	65.78563333	168	33.631	168.5605167	1	50	1034A	LJ+ACPF	These samples for SUNA check - A2-24 deploy
A2-24	A2-24 deploy	10/09/2024	02:18	**9**	53.9	65	47.138	65.78563333	168	33.631	168.5605167	1	50	1035A	LJ+ACPF	
A2-24	A2-24 deploy	10/09/2024	02:18	**9**	53.9	65	47.138	65.78563333	168	33.631	168.5605167	3	48	1036A	LJ+ACPF	
A2-24	A2-24 deploy	10/09/2024	02:18	**9**	53.9	65	47.138	65.78563333	168	33.631	168.5605167	3	48	1037A	LJ+ACPF	
A3-23	A3-23 recovery	11/09/2024	15:05	**11**	54.7	66	19.708	66.32846667	168	57.024	168.9504	2	47	1038A	KC+ACPF	These samples for SUNA check - A3-23 recovery
A3-23	A3-23 recovery	11/09/2024	15:05	**11**	54.7	66	19.708	66.32846667	168	57.024	168.9504	2	47	1039A	KC+ACPF	
A3-23	A3-23 recovery	11/09/2024	15:05	**11**	54.7	66	19.708	66.32846667	168	57.024	168.9504	3	45	1040A	KC+ACPF	
A3-23	A3-23 recovery	11/09/2024	15:05	**11**	54.7	66	19.708	66.32846667	168	57.024	168.9504	3	45	1041A	KC+ACPF	Leaks on bottles 1, 3 and 4
A3-24	A3-24 deploy	11/09/2024	22:58	**14**	54.6	66	19.694	66.32823333	168	56.813	168.9468833	1	47	1042A	KC+ACPF	These samples for SUNA check - A3-24 deploy
A3-24	A3-24 deploy	11/09/2024	22:58	**14**	54.6	66	19.694	66.32823333	168	56.813	168.9468833	1	47	1043A	KC+ACPF	
A3-24	A3-24 deploy	11/09/2024	22:58	**14**	54.6	66	19.694	66.32823333	168	56.813	168.9468833	7	45	1044A	KC+ACPF	
A3-24	A3-24 deploy	11/09/2024	22:58	**14**	54.6	66	19.694	66.32823333	168	56.813	168.9468833	7	45	1045A	KC+ACPF	Leaks on bottle 11
AL12.5	near A3	11/09/2024	23:22	**15**	54.6	66	20.06	66.33433333	168	55.374	168.9229	1	54.6	1046A	KC+ACPF+RW+AP	Also sampled for 129I and 236U (see Payne report)
AL12.5	near A3	11/09/2024	23:22	**15**	54.6	66	20.06	66.33433333	168	55.374	168.9229	3	40	1047A	KC+ACPF+RW+AP	
AL12.5	near A3	11/09/2024	23:22	**15**	54.6	66	20.06	66.33433333	168	55.374	168.9229	5	30	1048A	KC+ACPF+RW+AP	
AL12.5	near A3	11/09/2024	23:22	**15**	54.6	66	20.06	66.33433333	168	55.374	168.9229	8	20	1049A	KC+ACPF+RW+AP	
AL12.5	near A3	11/09/2024	23:22	**15**	54.6	66	20.06	66.33433333	168	55.374	168.9229	10	10	1050A	KC+ACPF+RW+AP	
AL12.5	near A3	11/09/2024	23:22	**15**	54.6	66	20.06	66.33433333	168	55.374	168.9229	12	0	1051A	KC+ACPF+RW+AP	Also sampled for 129I and 236U (see Payne report)
				16												Cast 16 was sampled for phytoplankton (see Orellana report) but not nutrients
AL14	AL line	12/09/2024	00:38	**18**	53.8	66	21.188	66.35313333	168	49.96	168.8326667	1	53.8	1052A	KC+RJD	
AL14	AL line	12/09/2024	00:38	**18**	53.8	66	21.188	66.35313333	168	49.96	168.8326667	3	40	1053A	KC+RJD	
AL14	AL line	12/09/2024	00:38	**18**	53.8	66	21.188	66.35313333	168	49.96	168.8326667	5	30	1054A	KC+RJD	
AL14	AL line	12/09/2024	00:38	**18**	53.8	66	21.188	66.35313333	168	49.96	168.8326667	8	20	1055A	KC+RJD	
AL14	AL line	12/09/2024	00:38	**18**	53.8	66	21.188	66.35313333	168	49.96	168.8326667	10	10	1056A	KC+RJD	
AL14	AL line	12/09/2024	00:38	**18**	53.8	66	21.188	66.35313333	168	49.96	168.8326667	12	0	1057A	KC+RJD	
AL15.5	AL line	12/09/2024	01:32	**21**	50.4	66	22.139	66.36898333	168	42.916	168.7152667	1	50.4	1058A	RJD+AP	
AL15.5	AL line	12/09/2024	01:32	**21**	50.4	66	22.139	66.36898333	168	42.916	168.7152667	3	40	1059A	RJD+AP	
AL15.5	AL line	12/09/2024	01:32	**21**	50.4	66	22.139	66.36898333	168	42.916	168.7152667	5	30	1060A	RJD+AP	
AL15.5	AL line	12/09/2024	01:32	**21**	50.4	66	22.139	66.36898333	168	42.916	168.7152667	8	20	1061A	RJD+AP	
AL15.5	AL line	12/09/2024	01:32	**21**	50.4	66	22.139	66.36898333	168	42.916	168.7152667	10	10	1062A	RJD+AP	
AL15.5	AL line	12/09/2024	01:32	**21**	50.4	66	22.139	66.36898333	168	42.916	168.7152667	12	0	1063A	RJD+AP	
AL17	AL line	12/09/2024	02:28	**24**	54.2	66	23.34	66.389	168	36.638	168.6106333	1	54.2	1064A	RW+RJD	
AL17	AL line	12/09/2024	02:28	**24**	54.2	66	23.34	66.389	168	36.638	168.6106333	3	40	1065A	RW+RJD	
AL17	AL line	12/09/2024	02:28	**24**	54.2	66	23.34	66.389	168	36.638	168.6106333	5	30	1066A	RW+RJD	
AL17	AL line	12/09/2024	02:28	**24**	54.2	66	23.34	66.389	168	36.638	168.6106333	8	20	1067A	RW+RJD	
AL17	AL line	12/09/2024	02:28	**24**	54.2	66	23.34	66.389	168	36.638	168.6106333	10	10	1068A	RW+RJD	
AL17	AL line	12/09/2024	02:28	**24**	54.2	66	23.34	66.389	168	36.638	168.6106333	12	0	1069A	RW+RJD	
AL18.5	AL line	12/09/2024	03:25	**27**	52.2	66	24.38	66.40633333	168	30.068	168.5011333	1	52.2	1070A	RJD+KC	Also sampled for 129I and 236U (see Payne report)
AL18.5	AL line	12/09/2024	03:25	**27**	52.2	66	24.38	66.40633333	168	30.068	168.5011333	3	40	1071A	RJD+KC	
AL18.5	AL line	12/09/2024	03:25	**27**	52.2	66	24.38	66.40633333	168	30.068	168.5011333	5	30	1072A	RJD+KC	
AL18.5	AL line	12/09/2024	03:25	**27**	52.2	66	24.38	66.40633333	168	30.068	168.5011333	8	20	1073A	RJD+KC	
AL18.5	AL line	12/09/2024	03:25	**27**	52.2	66	24.38	66.40633333	168	30.068	168.5011333	10	10	1074A	RJD+KC	
AL18.5	AL line	12/09/2024	03:25	**27**	52.2	66	24.38	66.40633333	168	30.068	168.5011333	12	0	1075A	RJD+KC	Also sampled for 129I and 236U (see Payne report)
AL20	AL line	12/09/2024	04:27	**30**	51.2	66	25.422	66.4237	168	23.558	168.3926333	1	51.2	1076A	RJD+AP	
AL20	AL line	12/09/2024	04:27	**30**	51.2	66	25.422	66.4237	168	23.558	168.3926333	3	40	1077A	RJD+AP	
AL20	AL line	12/09/2024	04:27	**30**	51.2	66	25.422	66.4237	168	23.558	168.3926333	5	30	1078A	RJD+AP	
AL20	AL line	12/09/2024	04:27	**30**	51.2	66	25.422	66.4237	168	23.558	168.3926333	8	20	1079A	RJD+AP	
AL20	AL line	12/09/2024	04:27	**30**	51.2	66	25.422	66.4237	168	23.558	168.3926333	10	10	7192A	RJD+AP	
AL20	AL line	12/09/2024	04:27	**30**	51.2	66	25.422	66.4237	168	23.558	168.3926333	12	0	7193A	RJD+AP	
AL21.5	AL line	12/09/2024	05:36	**34**	43.1	66	26.41	66.44016667	168	17.229	168.28715	1	43.1	7194A	RJD+KC	
AL21.5	AL line	12/09/2024	05:36	**34**	43.1	66	26.41	66.44016667	168	17.229	168.28715	3	40	7195A	RJD+KC	
AL21.5	AL line	12/09/2024	05:36	**34**	43.1	66	26.41	66.44016667	168	17.229	168.28715	5	30	7196A	RJD+KC	
AL21.5	AL line	12/09/2024	05:36	**34**	43.1	66	26.41	66.44016667	168	17.229	168.28715	8	20	7197A	RJD+KC	
AL21.5	AL line	12/09/2024	05:36	**34**	43.1	66	26.41	66.44016667	168	17.229	168.28715	10	10	7198A	RJD+KC	
AL21.5	AL line	12/09/2024	05:36	**34**	43.1	66	26.41	66.44016667	168	17.229	168.28715	12	0	7199A	RJD+KC	
AL23	AL line	12/09/2024	06:34	**37**	32.4	66	27.452	66.45753333	168	10.672	168.1778667	1	32.4	7210A	KK+CP	
AL23	AL line	12/09/2024	06:34	**37**	32.4	66	27.452	66.45753333	168	10.672	168.1778667	3	30	7211A	KK+CP	
AL23	AL line	12/09/2024	06:34	**37**	32.4	66	27.452	66.45753333	168	10.672	168.1778667	5	20	7212A	KK+CP	
AL23	AL line	12/09/2024	06:34	**37**	32.4	66	27.452	66.45753333	168	10.672	168.1778667	8	10	7213A	KK+CP	
AL23	AL line	12/09/2024	06:34	**37**	32.4	66	27.452	66.45753333	168	10.672	168.1778667	10	0	7214A	KK+CP	
AL25	AL line	12/09/2024	08:05	**41**	22.5	66	28.723	66.47871667	168	1.915	168.0319167	1	20	7201A	KK+CP	
AL25	AL line	12/09/2024	08:05	**41**	22.5	66	28.723	66.47871667	168	1.915	168.0319167	3	10	7202A	KK+CP	
AL25	AL line	12/09/2024	08:05	**41**	22.5	66	28.723	66.47871667	168	1.915	168.0319167	5	0	7203A	KK+CP	Bottle 5 leaked, but was sampled anyway as was surface bottle
AL25	AL line	12/09/2024	08:05	**41**	22.5	66	28.723	66.47871667	168	1.915	168.0319167	8	0		KK+CP	Sampled for 129I and 236U (see Payne report)
				NaN								Bucket	0			Near AS15, sampled for phytoplankton (see Orellana report), but not nutrients
Ice edge 67N	Monica Station	12/09/2024	18:59	**NaN**	43.5	67	22.684	67.37806667	168	11.551	168.1925167	Bucket	0	7200A	LJ	Near ice-edge, for phytoplankton (see Orellana report) with nutrients sampled ~30min later

Ice edge 67N	Monica Station	12/09/2024	18:59	**NaN**	43.5	67	22.684	67.37806667	168	11.551	168.1925167	Bucket	0	7204A	LJ	**UNFILTERED**
SCS10	South of CS line due to ice	12/09/2024	21:07	**47**	47.8	67	34.939	67.58231667	168	35.93	168.5988333	1	47.8	6178	KC+RJD	Also sampled for 129I and 236U (see Payne report)
SCS10	South of CS line due to ice	12/09/2024	21:07	**47**	47.8	67	34.939	67.58231667	168	35.93	168.5988333	3	40	6179	KC+RJD	Still in ice
SCS10	South of CS line due to ice	12/09/2024	21:07	**47**	47.8	67	34.939	67.58231667	168	35.93	168.5988333	4	30	6180	KC+RJD	
SCS10	South of CS line due to ice	12/09/2024	21:07	**47**	47.8	67	34.939	67.58231667	168	35.93	168.5988333	5	20	6181	KC+RJD	This cast also sampled for phytoplankton (see Orellana report)
SCS10	South of CS line due to ice	12/09/2024	21:07	**47**	47.8	67	34.939	67.58231667	168	35.93	168.5988333	10	10	6182	KC+RJD	
SCS10	South of CS line due to ice	12/09/2024	21:07	**47**	47.8	67	34.939	67.58231667	168	35.93	168.5988333	12	0	6183	KC+RJD	Also sampled for 129I and 236U (see Payne report)
SCS11	South of CS line due to ice	12/09/2024	22:55	**48**	47.4	67	40.879	67.68131667	168	21.709	168.3618167	1	47.4	6168	KC+AP	
SCS11	South of CS line due to ice	12/09/2024	22:55	**48**	47.4	67	40.879	67.68131667	168	21.709	168.3618167	3	40	6169	KC+AP	Still in ice; bottle 5 leaked
SCS11	South of CS line due to ice	12/09/2024	22:55	**48**	47.4	67	40.879	67.68131667	168	21.709	168.3618167	4	30	6170	KC+AP	
SCS11	South of CS line due to ice	12/09/2024	22:55	**48**	47.4	67	40.879	67.68131667	168	21.709	168.3618167	7	20	6171	KC+AP	This cast also sampled for phytoplankton (see Orellana report)
SCS11	South of CS line due to ice	12/09/2024	22:55	**48**	47.4	67	40.879	67.68131667	168	21.709	168.3618167	10	10	6172	KC+AP	
SCS11	South of CS line due to ice	12/09/2024	22:55	**48**	47.4	67	40.879	67.68131667	168	21.709	168.3618167	12	0	6173	KC+AP	
SCS12	South of CS line due to ice	13/09/2024	00:48	**49**	47.1	67	48.565	67.80941667	168	4.919	168.0819833	1	47.1	6174	KC+RJD	
SCS12	South of CS line due to ice	13/09/2024	00:48	**49**	47.1	67	48.565	67.80941667	168	4.919	168.0819833	3	40	6175	KC+RJD	Still in ice
SCS12	South of CS line due to ice	13/09/2024	00:48	**49**	47.1	67	48.565	67.80941667	168	4.919	168.0819833	4	30	6176	KC+RJD	
SCS12	South of CS line due to ice	13/09/2024	00:48	**49**	47.1	67	48.565	67.80941667	168	4.919	168.0819833	7	20	6177	KC+RJD	
SCS12	South of CS line due to ice	13/09/2024	00:48	**49**	47.1	67	48.565	67.80941667	168	4.919	168.0819833	8	10	6184	KC+RJD	This cast also sampled for phytoplankton (see Orellana report)
SCS12	South of CS line due to ice	13/09/2024	00:48	**49**	47.1	67	48.565	67.80941667	168	4.919	168.0819833	12	0	7205A	KC+RJD	
SCS13	South of CS line due to ice	13/09/2024	03:16	**50**	52.9	67	56	67.93333333	167	47.545	167.7924167	1	52.9	7206A	KK+ACPF+RW	Salts (249, 250) taken for CTD calibration; Also sampled for 129I and 236U (see Payne report)
SCS13	South of CS line due to ice	13/09/2024	03:16	**50**	52.9	67	56	67.93333333	167	47.545	167.7924167	3	40	7207A	KK+ACPF+RW	
SCS13	South of CS line due to ice	13/09/2024	03:16	**50**	52.9	67	56	67.93333333	167	47.545	167.7924167	5	30	7208A	KK+ACPF+RW	
SCS13	South of CS line due to ice	13/09/2024	03:16	**50**	52.9	67	56	67.93333333	167	47.545	167.7924167	8	20	7209A	KK+ACPF+RW	
SCS13	South of CS line due to ice	13/09/2024	03:16	**50**	52.9	67	56	67.93333333	167	47.545	167.7924167	10	10	7215A	KK+ACPF+RW	
SCS13	South of CS line due to ice	13/09/2024	03:16	**50**	52.9	67	56	67.93333333	167	47.545	167.7924167	12	0	7216A	KK+ACPF+RW	Also sampled for 129I and 236U (see Payne report)
SCS14	South of CS line due to ice	13/09/2024	04:50	**51**	51.7	68	3.558	68.0593	167	30.22	167.5036667	1	51.7	7217A	CP+KK	
SCS14	South of CS line due to ice	13/09/2024	04:50	**51**	51.7	68	3.558	68.0593	167	30.22	167.5036667	3	40	7218A	CP+KK	
SCS14	South of CS line due to ice	13/09/2024	04:50	**51**	51.7	68	3.558	68.0593	167	30.22	167.5036667	4	30	7219A	CP+KK	
SCS14	South of CS line due to ice	13/09/2024	04:50	**51**	51.7	68	3.558	68.0593	167	30.22	167.5036667	5	20	7220A	CP+KK	
SCS14	South of CS line due to ice	13/09/2024	04:50	**51**	51.7	68	3.558	68.0593	167	30.22	167.5036667	8	10	7221A	CP+KK	This cast also sampled for phytoplankton (see Orellana report)
SCS14	South of CS line due to ice	13/09/2024	04:50	**51**	51.7	68	3.558	68.0593	167	30.22	167.5036667	12	0	7222A	CP+KK	
SCS15	South of CS line heading to coast	13/09/2024	06:24	**52**	46.4	68	10.26	68.171	167	14.8	167.2466667	1	46.4	7223A	CP+KK	
SCS15	South of CS line heading to coast	13/09/2024	06:24	**52**	46.4	68	10.26	68.171	167	14.8	167.2466667	3	30	7224A	CP+KK	
SCS15	South of CS line heading to coast	13/09/2024	06:24	**52**	46.4	68	10.26	68.171	167	14.8	167.2466667	5	20	7225A	CP+KK	
SCS15	South of CS line heading to coast	13/09/2024	06:24	**52**	46.4	68	10.26	68.171	167	14.8	167.2466667	8	10	7226A	CP+KK	
SCS15	South of CS line heading to coast	13/09/2024	06:24	**52**	46.4	68	10.26	68.171	167	14.8	167.2466667	10	0	7227A	CP+KK	Bottle 11 sampled for delta O18 (2679A, not 7228A as recorded in paper logs) (unfiltered)
SCS16	South of CS line heading to coast	13/09/2024	07:23	**53**	42.2	68	13.555	68.22591667	167	7.259	167.1209833	1	42.2	7228A	CP+KK	
SCS16	South of CS line heading to coast	13/09/2024	07:23	**53**	42.2	68	13.555	68.22591667	167	7.259	167.1209833	3	30	7229A	CP+KK	
SCS16	South of CS line heading to coast	13/09/2024	07:23	**53**	42.2	68	13.555	68.22591667	167	7.259	167.1209833	5	20	7230A	CP+KK	
SCS16	South of CS line heading to coast	13/09/2024	07:23	**53**	42.2	68	13.555	68.22591667	167	7.259	167.1209833	8	10	7231A	CP+KK	
SCS16	South of CS line heading to coast	13/09/2024	07:23	**53**	42.2	68	13.555	68.22591667	167	7.259	167.1209833	10	0	7232A	CP+KK	Bottle 11 sampled for delta O18 (2681A) (unfiltered)
SCS17	South of CS line heading to coast	13/09/2024	08:21	**54**	35.8	68	16.838	68.28063333	167	0.061	167.0010167	1	35.8	7233A	CP+KK	
SCS17	South of CS line heading to coast	13/09/2024	08:21	**54**	35.8	68	16.838	68.28063333	167	0.061	167.0010167	3	30	7234A	CP+KK	
SCS17	South of CS line heading to coast	13/09/2024	08:21	**54**	35.8	68	16.838	68.28063333	167	0.061	167.0010167	5	20	7235A	CP+KK	
SCS17	South of CS line heading to coast	13/09/2024	08:21	**54**	35.8	68	16.838	68.28063333	167	0.061	167.0010167	8	10	7236A	CP+KK	
SCS17	South of CS line heading to coast	13/09/2024	08:21	**54**	35.8	68	16.838	68.28063333	167	0.061	167.0010167	10	0	7237A	CP+KK	Bottle 12 sampled for delta O18 (2683A) (unfiltered)
SCS18	South of CS line near Point Hope	13/09/2024	09:02	**55**	32.2	68	18.386	68.30643333	166	56.109	166.93515	1	32.2	7238A	CP+KK	
SCS18	South of CS line near Point Hope	13/09/2024	09:02	**55**	32.2	68	18.386	68.30643333	166	56.109	166.93515	3	20	7239A	CP+KK	
SCS18	South of CS line near Point Hope	13/09/2024	09:02	**55**	32.2	68	18.386	68.30643333	166	56.109	166.93515	5	10	7240A	CP+KK	
SCS18	South of CS line near Point Hope	13/09/2024	09:02	**55**	32.2	68	18.386	68.30643333	166	56.109	166.93515	8	0	7241A	CP+KK	Bottle 9 sampled for delta O18 (2685A) (unfiltered)
SCS19	South of CS line near Point Hope	13/09/2024	10:13	**56**	25.6	68	19.899	68.33165	166	52.688	166.8781333	1	25.6	7243A	CP+KK	
SCS19	South of CS line near Point Hope	13/09/2024	10:13	**56**	25.6	68	19.899	68.33165	166	52.688	166.8781333	3	10	7244A	CP+KK	
SCS19	South of CS line near Point Hope	13/09/2024	10:13	**56**	25.6	68	19.899	68.33165	166	52.688	166.8781333	5	0	7245A	CP+KK	Bottle 10 sampled for 129I and 236U (see Payne report)
BS11.5	BS line near Little Diomede	14/09/2024	06:09	**58**	45.9	65	47.803	65.79671667	168	53.91	168.8985	1	45.9	7242A	KC + ACPF	Also sampled for 129I and 236U (see Payne report)
BS11.5	BS line near Little Diomede	14/09/2024	06:09	**58**	45.9	65	47.803	65.79671667	168	53.91	168.8985	3	40	7246A	KC + ACPF	
BS11.5	BS line near Little Diomede	14/09/2024	06:09	**58**	45.9	65	47.803	65.79671667	168	53.91	168.8985	5	30	7247A	KC + ACPF	
BS11.5	BS line near Little Diomede	14/09/2024	06:09	**58**	45.9	65	47.803	65.79671667	168	53.91	168.8985	8	20	7248A	KC + ACPF	
BS11.5	BS line near Little Diomede	14/09/2024	06:09	**58**	45.9	65	47.803	65.79671667	168	53.91	168.8985	10	10	7249A	KC + ACPF	This cast also sampled for phytoplankton (see Orellana report)
BS11.5	BS line near Little Diomede	14/09/2024	06:09	**58**	45.9	65	47.803	65.79671667	168	53.91	168.8985	12	0	7250A	KC + ACPF	Bottle 11 &/or 12 sampled for 129I and 236U (see Payne report)
BS13	BS line near Little Diomede	14/09/2024	07:16	**61**	50.2	65	46.365	65.77275	168	47.574	168.7929	1	50.2	7251A	CP+BP	
BS13	BS line near Little Diomede	14/09/2024	07:16	**61**	50.2	65	46.365	65.77275	168	47.574	168.7929	3	40	7252A	CP+BP	
BS13	BS line near Little Diomede	14/09/2024	07:16	**61**	50.2	65	46.365	65.77275	168	47.574	168.7929	5	30	7253A	CP+BP	
BS13	BS line near Little Diomede	14/09/2024	07:16	**61**	50.2	65	46.365	65.77275	168	47.574	168.7929	8	20	7254A	CP+BP	
BS13	BS line near Little Diomede	14/09/2024	07:16	**61**	50.2	65	46.365	65.77275	168	47.574	168.7929	10	10	7255A	CP+BP	This cast also sampled for phytoplankton (see Orellana report)
BS13	BS line near Little Diomede	14/09/2024	07:16	**61**	50.2	65	46.365	65.77275	168	47.574	168.7929	12	0	1409	CP+BP	
				62												This cast sampled for phytoplankton (see Orellana report)
BS14.5	BS line moving to Alaska	14/09/2024	08:20	**64**	50	65	44.99	65.74983333	168	41.56	168.6926667	1	50	1410	RW+KK	
BS14.5	BS line moving to Alaska	14/09/2024	08:20	**64**	50	65	44.99	65.74983333	168	41.56	168.6926667	3	40	1411	RW+KK	
BS14.5	BS line moving to Alaska	14/09/2024	08:20	**64**	50	65	44.99	65.74983333	168	41.56	168.6926667	5	30	1412	RW+KK	
BS14.5	BS line moving to Alaska	14/09/2024	08:20	**64**	50	65	44.99	65.74983333	168	41.56	168.6926667	9	20	1413	RW+KK	
BS14.5	BS line moving to Alaska	14/09/2024	08:20	**64**	50	65	44.99	65.74983333	168	41.56	168.6926667	10	10	1414	RW+KK	
BS14.5	BS line moving to Alaska	14/09/2024	08:20	**64**	50	65	44.99	65.74983333	168	41.56	168.6926667	12	0	1415	RW+KK	Bottle 12 leaking, but sampled anyway as surface bottle
BS16	BS line moving to Alaska	14/09/2024	09:18	**66**	49.8	65	43.54	65.72566667	168	35.369	168.5894833	1	49.8	1416	RW+KK	Salinity sample (255) taken to resolve disagrement between CTD sensors

BS16	BS line moving to Alaska	14/09/2024	09:18	**66**	49.8	65	43.54	65.72566667	168	35.369	168.5894833	3	40	1417	RW+KK	
BS16	BS line moving to Alaska	14/09/2024	09:18	**66**	49.8	65	43.54	65.72566667	168	35.369	168.5894833	5	30	1418	RW+KK	
BS16	BS line moving to Alaska	14/09/2024	09:18	**66**	49.8	65	43.54	65.72566667	168	35.369	168.5894833	8	20	1419	RW+KK	
BS16	BS line moving to Alaska	14/09/2024	09:18	**66**	49.8	65	43.54	65.72566667	168	35.369	168.5894833	10	10	1420	RW+KK	
BS16	BS line moving to Alaska	14/09/2024	09:18	**66**	49.8	65	43.54	65.72566667	168	35.369	168.5894833	12	0	1421	RW+KK	
BS17.5	BS line moving to Alaska	14/09/2024	10:04	**67**	52	65	41.883	65.69805	168	29.195	168.4865833	1	52	1422	RW+KK	Also sampled for 129I and 236U (see Payne report)
BS17.5	BS line moving to Alaska	14/09/2024	10:04	**67**	52	65	41.883	65.69805	168	29.195	168.4865833	3	40	1423	RW+KK	
BS17.5	BS line moving to Alaska	14/09/2024	10:04	**67**	52	65	41.883	65.69805	168	29.195	168.4865833	5	30	1424	RW+KK	
BS17.5	BS line moving to Alaska	14/09/2024	10:04	**67**	52	65	41.883	65.69805	168	29.195	168.4865833	7	20	1425	RW+KK	
BS17.5	BS line moving to Alaska	14/09/2024	10:04	**67**	52	65	41.883	65.69805	168	29.195	168.4865833	9	10	1426	RW+KK	
BS17.5	BS line moving to Alaska	14/09/2024	10:04	**67**	52	65	41.883	65.69805	168	29.195	168.4865833	11	0	1427	RW+KK	Bottle 12 sampled for 129I and 236U (see Payne report)
BS19	BS line moving towards Alaska	14/09/2024	11:11	**68**	50	65	40.766	65.67943333	168	23.939	168.3989833	1	50	1428	KK+AP	
BS19	BS line moving towards Alaska	14/09/2024	11:11	**68**	50	65	40.766	65.67943333	168	23.939	168.3989833	3	40	1429	KK+AP	
BS19	BS line moving towards Alaska	14/09/2024	11:11	**68**	50	65	40.766	65.67943333	168	23.939	168.3989833	5	30	1430	KK+AP	
BS19	BS line moving towards Alaska	14/09/2024	11:11	**68**	50	65	40.766	65.67943333	168	23.939	168.3989833	8	20	1431	KK+AP	
BS19	BS line moving towards Alaska	14/09/2024	11:11	**68**	50	65	40.766	65.67943333	168	23.939	168.3989833	10	10	1432	KK+AP	
BS19	BS line moving towards Alaska	14/09/2024	11:11	**68**	50	65	40.766	65.67943333	168	23.939	168.3989833	12	0	1433	KK+AP	Bottle 12 also sampled for delta O18 (1081A) (unfiltered)
BS20.5	BS line moving towards Alaska	14/09/2024	12:59	**71**	45	65	39.017	65.65028333	168	17.163	168.28605	1	45	1434	KK+AP	
BS20.5	BS line moving towards Alaska	14/09/2024	12:59	**71**	45	65	39.017	65.65028333	168	17.163	168.28605	3	30	1435	KK+AP	
BS20.5	BS line moving towards Alaska	14/09/2024	12:59	**71**	45	65	39.017	65.65028333	168	17.163	168.28605	5	20	1436	KK+AP	
BS20.5	BS line moving towards Alaska	14/09/2024	12:59	**71**	45	65	39.017	65.65028333	168	17.163	168.28605	7	10	1437	KK+AP	
BS20.5	BS line moving towards Alaska	14/09/2024	12:59	**71**	45	65	39.017	65.65028333	168	17.163	168.28605	9	0	1438	KK+AP	Bottle 9 also sampled for delta O18 (1083A) (unfiltered)
BS22	BS line near Wales	14/09/2024	14:45	**74**	29.9	65	37.789	65.62981667	168	10.625	168.1770833	1	29.9	1439	KC+RJD	
BS22	BS line near Wales	14/09/2024	14:45	**74**	29.9	65	37.789	65.62981667	168	10.625	168.1770833	3	20	1440	KC+RJD	
BS22	BS line near Wales	14/09/2024	14:45	**74**	29.9	65	37.789	65.62981667	168	10.625	168.1770833	5	10	1441	KC+RJD	
BS22	BS line near Wales	14/09/2024	14:45	**74**	29.9	65	37.789	65.62981667	168	10.625	168.1770833	8	0	1442	KC+RJD	Bottle 8 also sampled for delta O18 (1086A) (unfiltered); 8 or 9 sampled for 129I and 236U (see Payne report)
				83												This cast sampled for phytoplankton (see Orellana report)
SBSnn 10.5	SBS line near EEZ	14/09/2024	19:19	**84**	56.5	65	25.725	65.42875	168	53.31	168.8885	1	56.5	1443	RW	
SBSnn 10.5	SBS line near EEZ	14/09/2024	19:19	**84**	56.5	65	25.725	65.42875	168	53.31	168.8885	3	25	1444	RW	Interesting SUNA feature targeted at 25m
SBSnn 10.5	SBS line near EEZ	14/09/2024	19:19	**84**	56.5	65	25.725	65.42875	168	53.31	168.8885	5	0	1445	RW	
				85												Salinity sample (256) taken to resolve disagreement between CTD sensors
SBSnn 13.5	SBS line near EEZ	14/09/2024	20:32	**87**	50.6	65	21.65	65.36083333	169	6.602	169.1100333	1	50.6	1446	RW+RJD+KC	
SBSnn 13.5	SBS line near EEZ	14/09/2024	20:32	**87**	50.6	65	21.65	65.36083333	169	6.602	169.1100333	3	20	1447	RW+RJD+KC	This cast also sampled for phytoplankton (see Orellana report)
SBSnn 13.5	SBS line near EEZ	14/09/2024	20:32	**87**	50.6	65	21.65	65.36083333	169	6.602	169.1100333	5	0	1448	RW+RJD+KC	
BC12.5	BC line south of strait	14/09/2024	21:57	**88**	52.2	65	15.003	65.25005	168	52	168.8598833	1	52.2	1449	RW+RJD+KC	
BC12.5	BC line south of strait	14/09/2024	21:57	**88**	52.2	65	15.003	65.25005	168	52	168.8598833	3	25	1450	RW+RJD+KC	This cast also sampled for phytoplankton (see Orellana report)
BC12.5	BC line south of strait	14/09/2024	21:57	**88**	52.2	65	15.003	65.25005	168	52	168.8598833	10	0	1451	RW+RJD+KC	Bottle 5 leaked (and was not sampled)
BC10.5	BC line south of strait	14/09/2024	23:12	**92**	52.3	65	17.412	65.2902	168	41	168.6855667	1	52.3	1452	KC+AP	Bottle 2 also sampled for ????
BC10.5	BC line south of strait	14/09/2024	23:12	**92**	52.3	65	17.412	65.2902	168	41	168.6855667	3	23	1453	KC+AP	
BC10.5	BC line south of strait	14/09/2024	23:12	**92**	52.3	65	17.412	65.2902	168	41	168.6855667	9	0	1454A	KC+AP	
BC9.5	BC line south of strait	14/09/2024	23:55	**94**	50.9	65	18.596	65.30993333	168	36.33	168.6055	1	50.9	1455A	KC+LJ+AP	Marked A on logs, but I think that is wrong
BC9.5	BC line south of strait	14/09/2024	23:55	**94**	50.9	65	18.596	65.30993333	168	36.33	168.6055	3	25	1456A	KC+LJ+AP	
BC9.5	BC line south of strait	14/09/2024	23:55	**94**	50.9	65	18.596	65.30993333	168	36.33	168.6055	7	0	1457A	KC+LJ+AP	
BC8	BC line south of strait	15/09/2024	00:45	**97**	53.3	65	20.522	65.34203333	168	28.822	168.4803667	1	53.3	1458A	KC+AP	Filtered sample (Arco-200NN) for Trace Metals?? taken from Bottle 2 in possible benthic nephiloid layer
BC8	BC line south of strait	15/09/2024	00:45	**97**	53.3	65	20.522	65.34203333	168	28.822	168.4803667	3	25	1459	KC+AP	Marked A on logs, but I think that is wrong
BC8	BC line south of strait	15/09/2024	00:45	**97**	53.3	65	20.522	65.34203333	168	28.822	168.4803667	7	0	1460	KC+AP	Bottle 5 leaked (and was not sampled)
BC5.5	BC line south of strait moving to coast	15/09/2024	02:22	**102**	58.2	65	23.587	65.39311667	168	16.169	168.2694833	1	58.2	1461	KK	
BC5.5	BC line south of strait moving to coast	15/09/2024	02:22	**102**	58.2	65	23.587	65.39311667	168	16.169	168.2694833	3	25	1462	KK	
BC5.5	BC line south of strait moving to coast	15/09/2024	02:22	**102**	58.2	65	23.587	65.39311667	168	16.169	168.2694833	5	0	1463	KK	
BC4	BC line south of strait moving to coast	15/09/2024	03:20	**105**	46	65	25.551	65.42585	168	9.24	168.154	1	46	1464	ACPF+KK	
BC4	BC line south of strait moving to coast	15/09/2024	03:20	**105**	46	65	25.551	65.42585	168	9.24	168.154	3	23	1465	ACPF+KK	
BC4	BC line south of strait moving to coast	15/09/2024	03:20	**105**	46	65	25.551	65.42585	168	9.24	168.154	7	0	1466	ACPF+KK	Bottles 5 and 8 leaked (and were not sampled)
BC2.5	BC line south of strait moving to coast	15/09/2024	04:39	**108**	41.2	65	27.396	65.4566	168	1.2	168.02	1	41.2	1467	ACPF+KK	
BC2.5	BC line south of strait moving to coast	15/09/2024	04:39	**108**	41.2	65	27.396	65.4566	168	1.2	168.02	3	mid	1468	ACPF+KK	
BC2.5	BC line south of strait moving to coast	15/09/2024	04:39	**108**	41.2	65	27.396	65.4566	168	1.2	168.02	5	0	1469	ACPF+KK	Bottle 7 sampled for delta O18 (1087A) (unfiltered)
BC1	BC line next to coast	15/09/2024	06:07	**111**	25.8	65	29.266	65.48776667	167	54.029	167.9004833	1	25.8	1470	ACPF+KK	
BC1	BC line next to coast	15/09/2024	06:07	**111**	25.8	65	29.266	65.48776667	167	54.029	167.9004833	4	20	1471	ACPF+KK	Bottle 11 did not close even though fired
BC1	BC line next to coast	15/09/2024	06:07	**111**	25.8	65	29.266	65.48776667	167	54.029	167.9004833	9	0	1472	ACPF+KK	Bottle 9 also sampled for delta O18 (6142) (unfiltered)

TOTAL nutrient samples	195	(more nutrient samples taken with trace metal pumping)
TOTAL salinity samples	6	(see Nutrient and Salinity report (non-trace metal)
TOTAL delta O18 taken from CTD	9	(see trace metal report, more delta O18 samples taken with trace metal pumping)

To avoid duplication of nutrient sample numbers at UW, the following bottle ranges were marked with an A during this cruise
1025-1088, 1454-1458, 2625-2674, 2675-2688, 7192-7255, .