



Fisheries and Oceans
Canada

Pêches et Océans
Canada

Canadian Arctic Marine Science 2022

Pacific Arctic Group Fall Meeting

Victoria, Canada

5-6 December, 2022

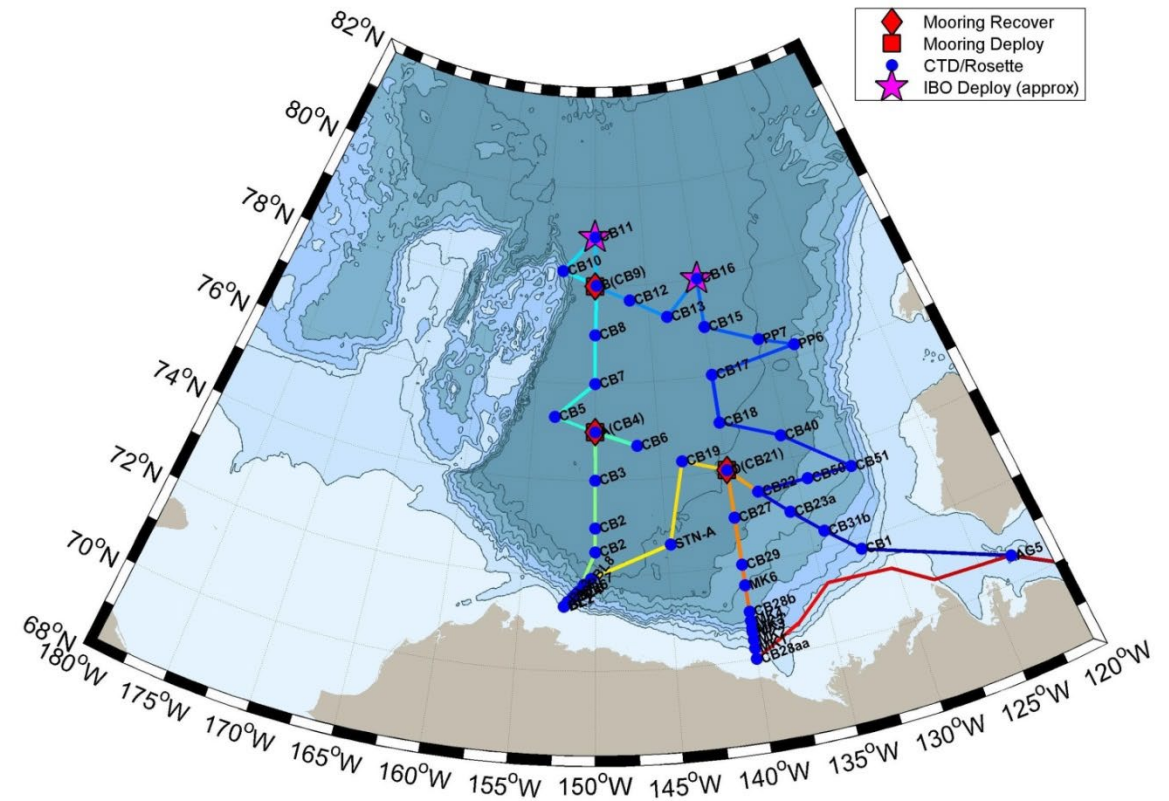
Bill Williams, Fisheries and Oceans Canada



Canada

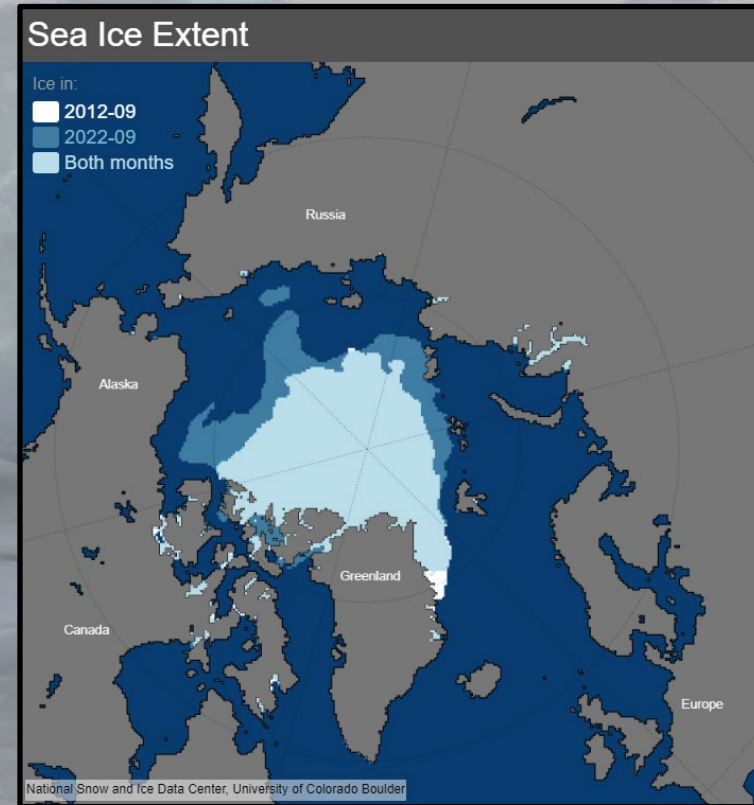
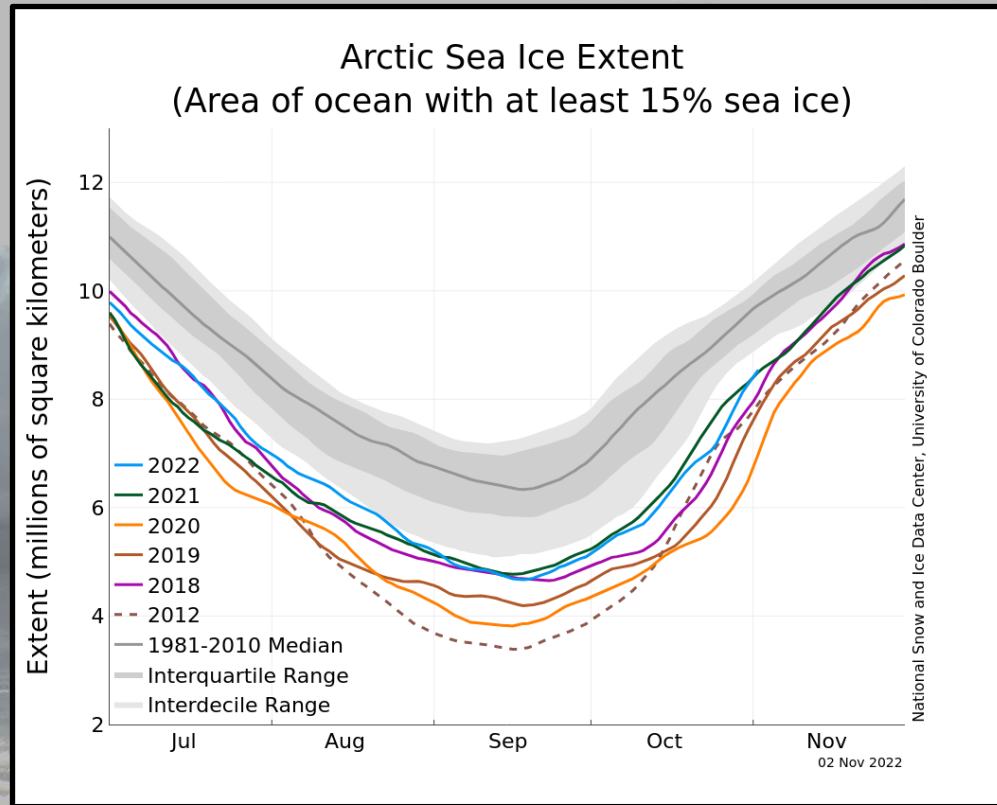
2022 Joint Ocean Ice Study / Arctic Observing Network - Beaufort Gyre Observing System CCGS Louis S. St-Laurent

- A USA-Canada collaboration aboard the *CCGS Louis S. St-Laurent*
- Created and supported by the National Science Foundation, Fisheries and Oceans Canada, Woods Hole Oceanographic Institution (Isabela Le Bras, Andrey Proshutinsky) and Yale (Mary-Louise Timmermans).
- 2022 is our 20th year! Funded until 2024.

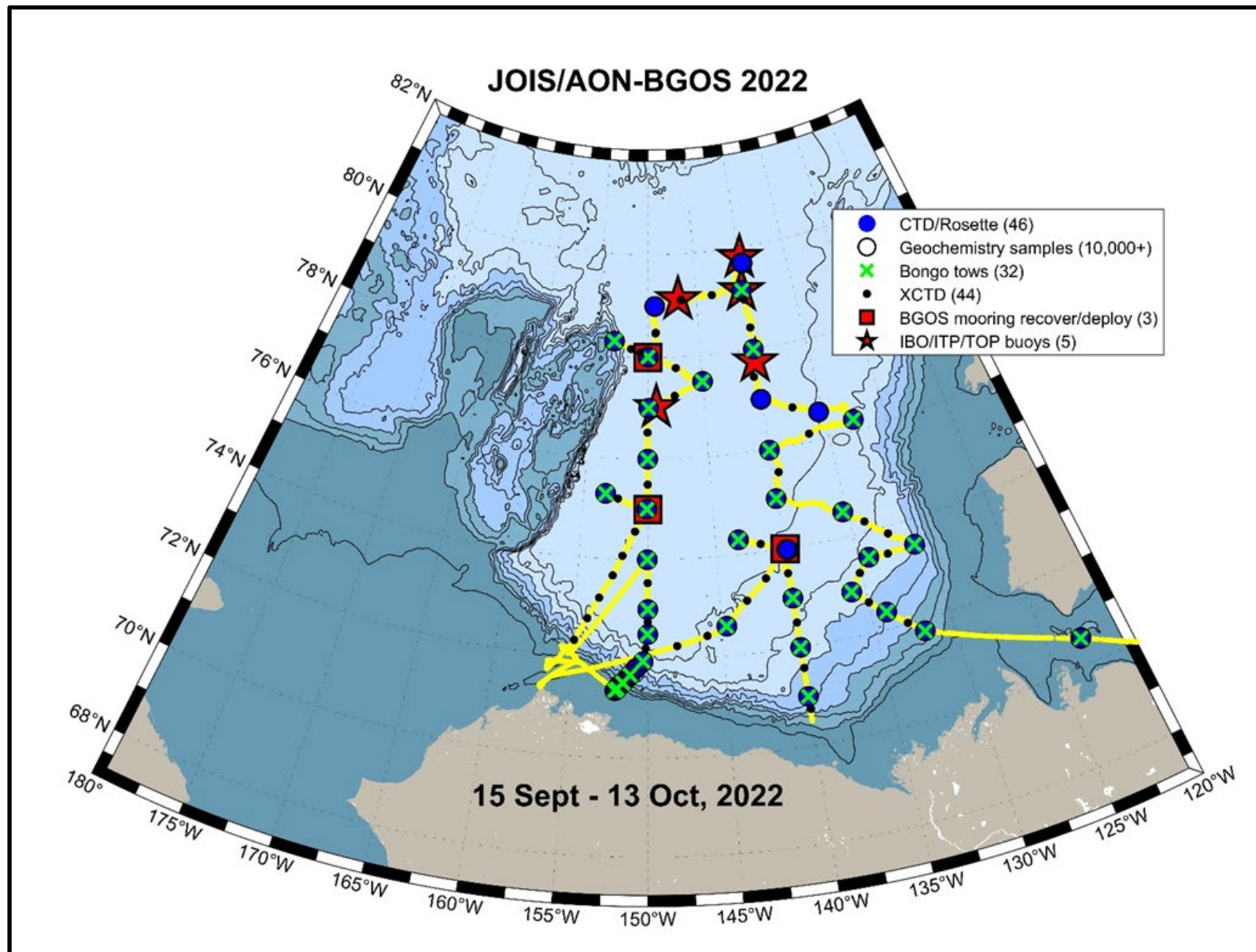




2022 compared to 2012



2022 Joint Ocean Ice Study / Arctic Observing Network - Beaufort Gyre Observing System
CCGS Louis S. St-Laurent



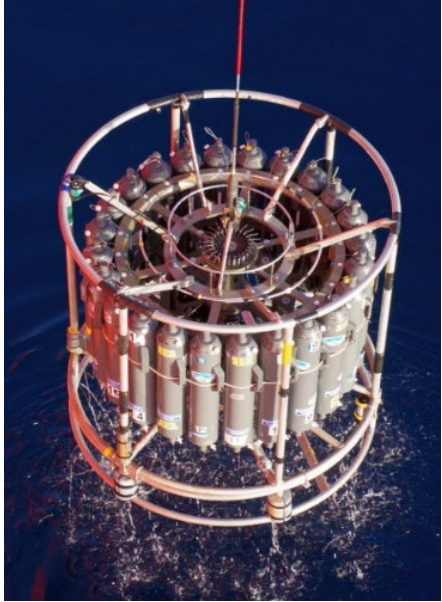


2022 Joint Ocean Ice Study / Arctic Observing Network - Beaufort Gyre Observing System

Louis S. St. Laurent, September 15 – October 13, 2022 (20+ science days during a 28-day operation)

- 46 CTD/Rosette casts at 41 Stations (DFO) with 1028 X 10L Niskin water samples collected
- 32 Zooplankton Vertical Net (“Bongo”) casts at CTD/Rosette stations (100 m)
- 46 XCTD (Expendable temperature, salinity and depth profiler) casts typically to 1,100 m
- 3 Mooring Recoveries and Re-deployments in the deep basin
- 4 Ice-Tethered Profiler w/ SAMI-CO2 (3 ice stations, 1 open water)
- 3 Tethered Ocean Profilers (2 ice stations, 1 open water)
- 1 Arctic Ocean Flux Buoy (ice station)
- 2 Seasonal Ice Mass Balance Buoy (ice station)
- Continuous ice monitoring using a multi-camera system with additional observations
- Continuous ice thickness measurements using an electro-magnetic sensor
- On-ice thickness measurements/transects and coring
- Continuous TSG (surface temperature & salinity) measurements while underway

Observations and Sampling:



46 Stations using SBE911+ CTD
with Pressure, Temperature, Salinity,
Dissolved Oxygen, Chl Fluorometer, CDOM
Fluorometer, PAR, Transmissometer.
Rosette has 24 x 10L Niskins

Water Samples:

All full depth stations:

- Salinity
- Dissolved O₂
- Nutrients (NO₃, PO₄, SiO₄)
- ¹⁸O isotope in H₂O
- Alkalinity
- Dissolved Inorganic Carbon (DIC)
- Chlorophyll-a
- Bacteria (Connie Lovejoy, U. Laval)
- Fluorescent Dissolved Organic Matter (FDOM) (Celine Gueguen, U. Sherbrooke)



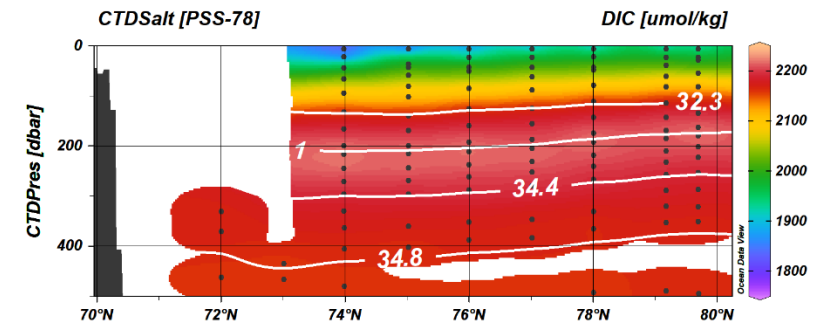
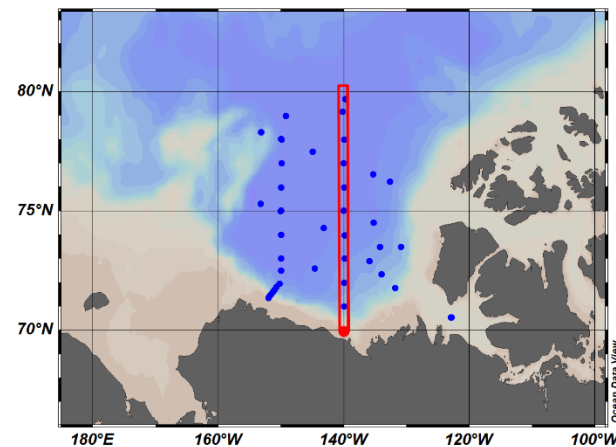
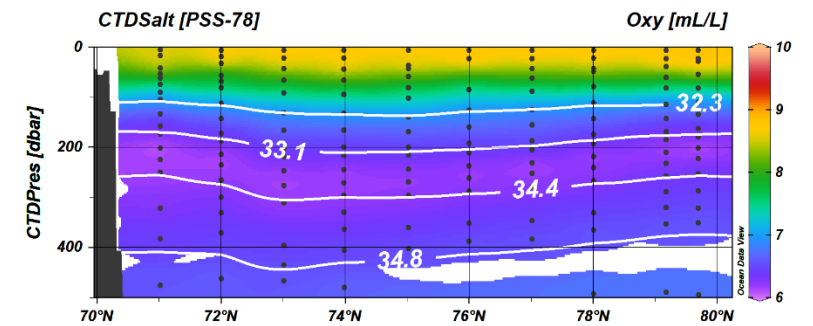
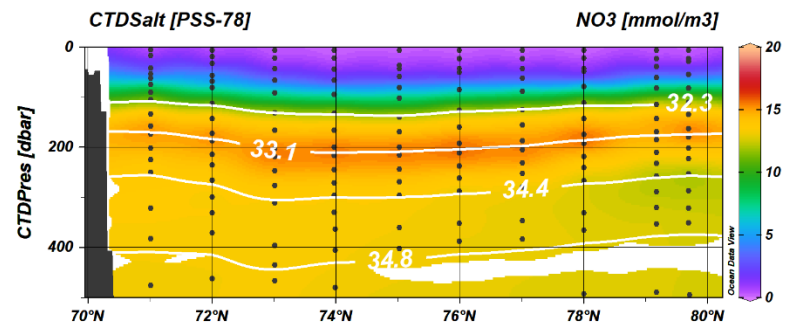
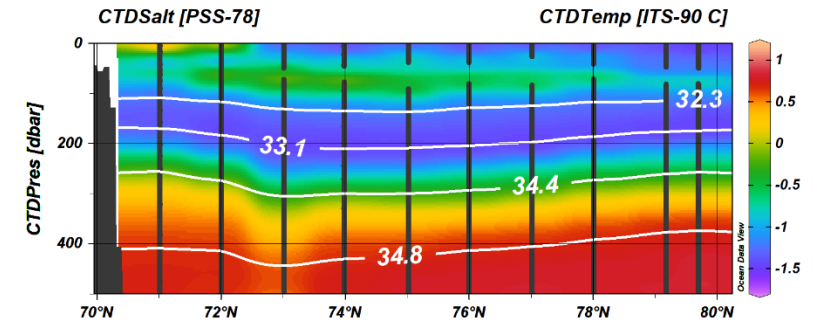
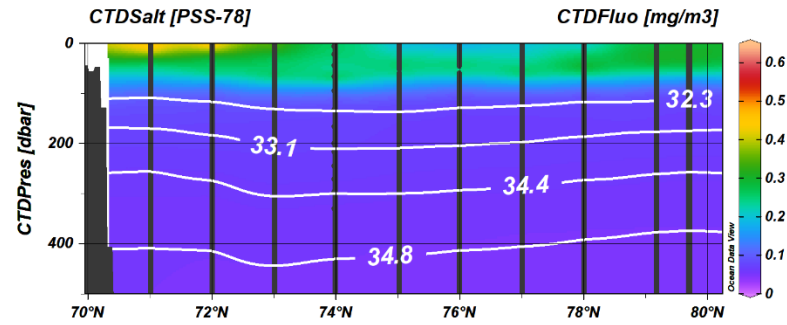
32 Zooplankton Net casts to 100m depth

Water samples at select stations:

- Microbial Diversity (Connie Lovejoy, U. Laval, David Walsh, Concordia)
- Dissolved Organic Material (DOM), Lignin and Phenols, Barium (Celine Gueguen, U. Sherbrooke)
- ¹²⁹I, ²³⁶U, ³⁹Ar, ¹⁴C, Nd, Hf (John Smith DFO, Nuria Casacuberta ETH Zurich)

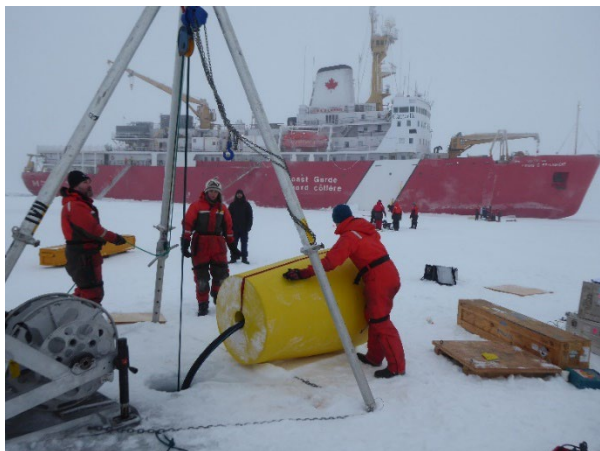
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140W Section



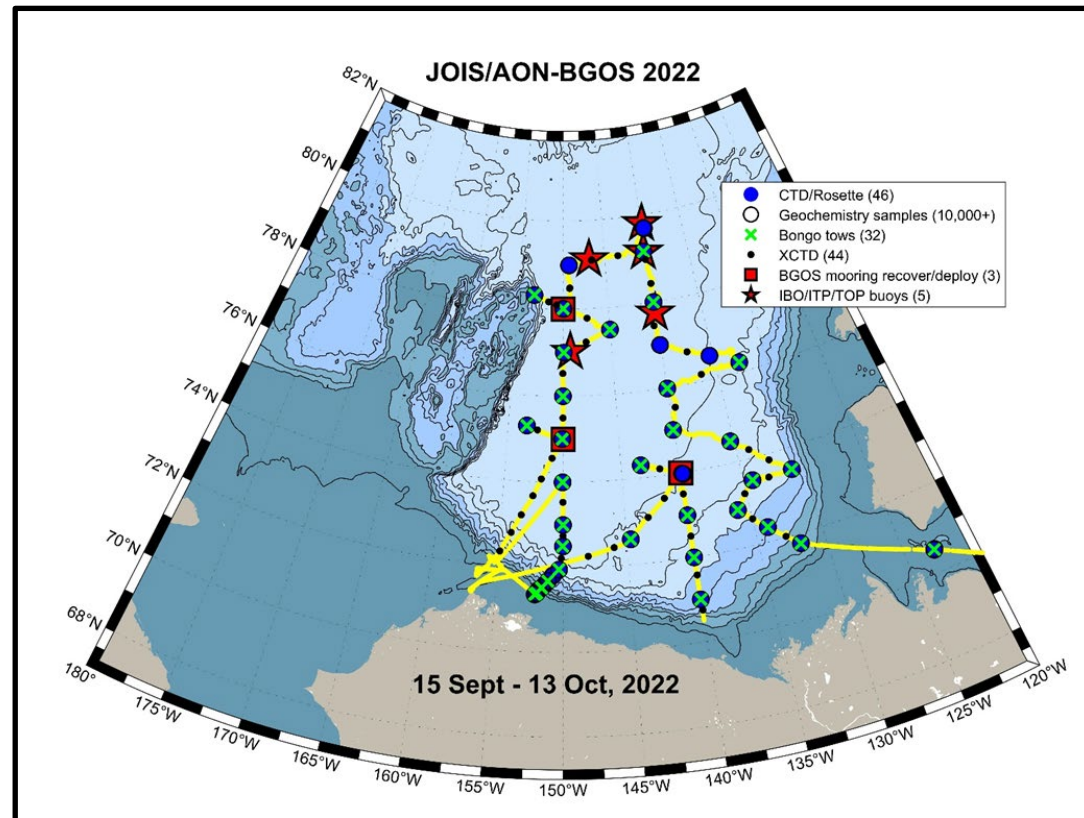
2022 Joint Ocean Ice Study / Arctic Observing Network - Beaufort Gyre Observing System

Buoy Deployments:



5 Buoy Stations, 3 Ice Stations:

- 4 Ice Tethered Profilers
- 2 Seasonal Ice Mass Balance Buoys
- 3 Tethered Ocean Profilers
- 1 Arctic Ocean Flux Buoy



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Underway Measurements:

Surface water measurements:

- Thermosalinograph with Chl-a and FDOM Fluorometers
- pCO₂ system (Mike DeGrandpre, U Montana)
- Water samples for Salinity, Chlorophyll, Nutrients, DIC/Alkalinity, FDOM (Celine Gueguen, U Sherbrooke)

Meteorological data: AVOS weather station

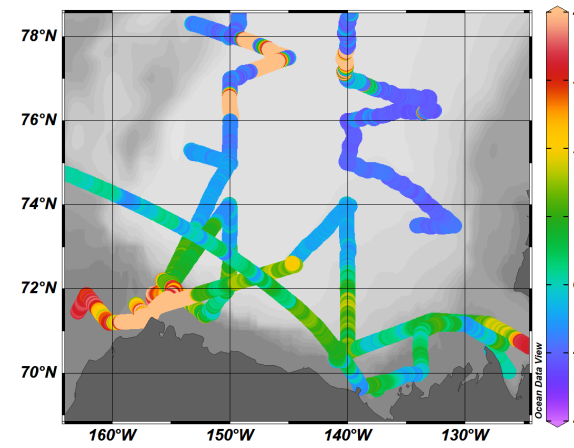
Sea-Ice Observations: (Kazutaka Tateyama, Kitami Institute of Technology; Canadian Ice Service)

Expendable CTDs (XCTD) deployed between Rosette Stations (DFO, WHOI, JAMSTEC)

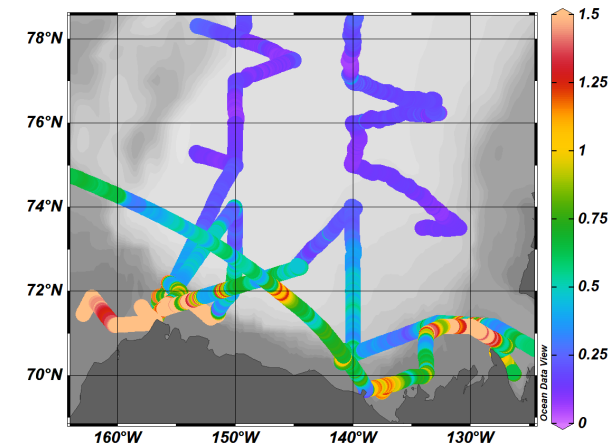
Data and Dispatches (2003-2022):

Project	Website/Email
AON-BGOS/JOIS	https://www2.who.edu/site/beaufortgyre/
Ice-Tethered Profilers	https://www2.who.edu/site/itp/
Ice Mass Balance Buoys	http://imb-crrel-dartmouth.org/
JOIS	Bill.Williams@dfo-mpo.gc.ca
Dispatches	https://www2.who.edu/site/beaufortgyre/

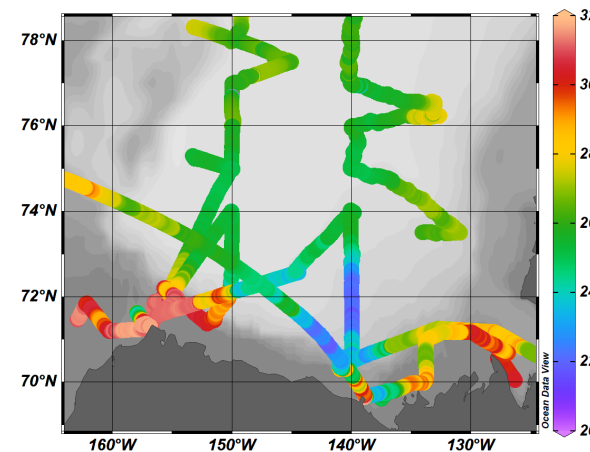
Temperature, 2 [ITS-90, deg C]



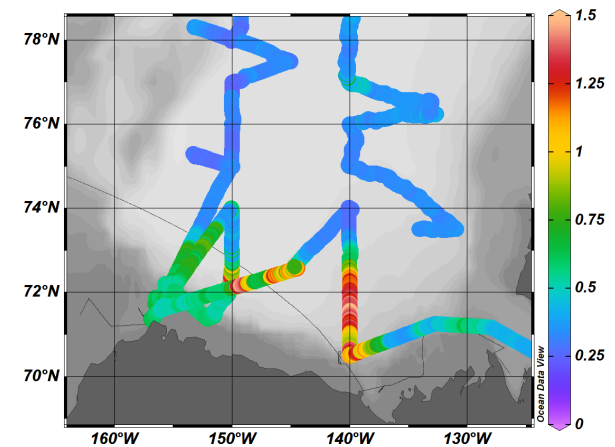
Fluorescence, Seapoint



Salinity, Practical [PSU]



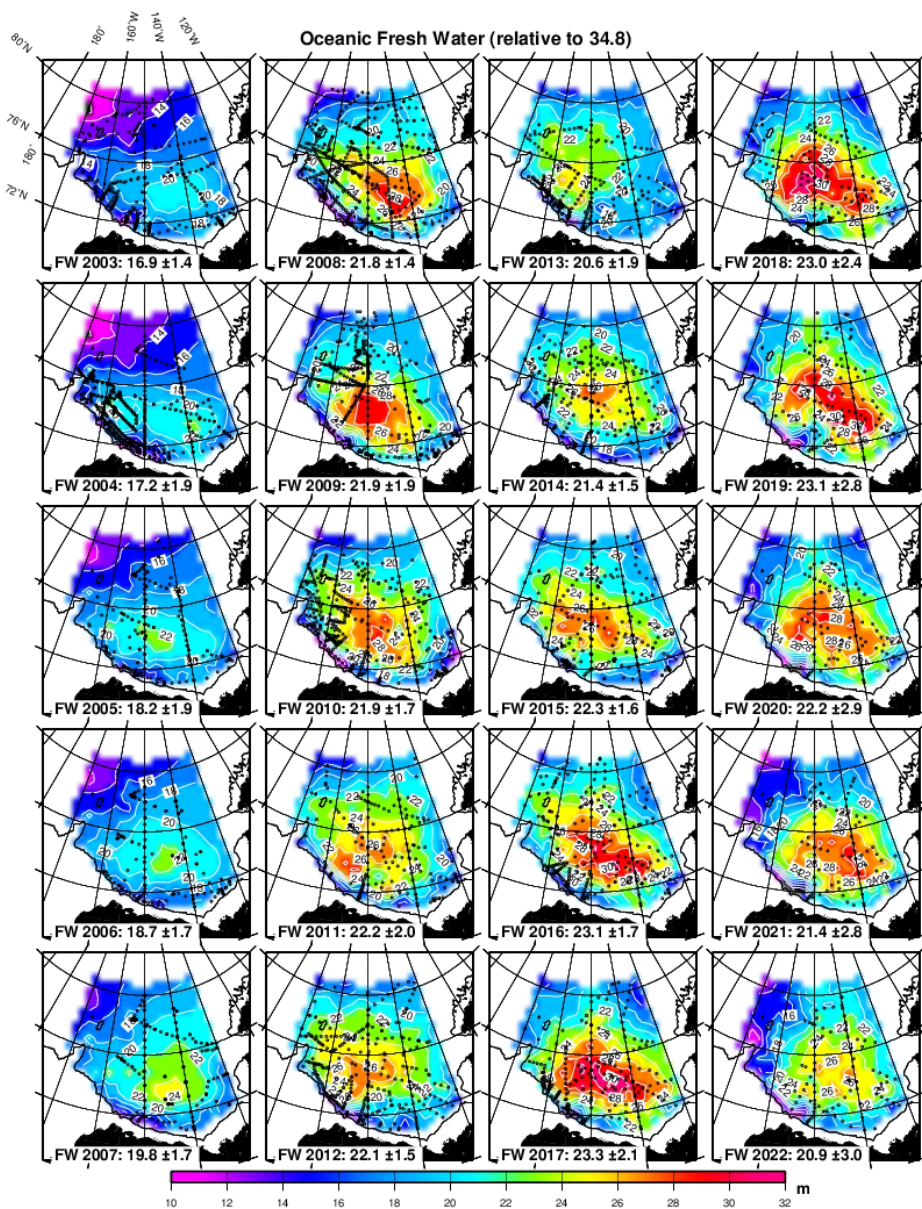
Fluorescence, WET Labs CDOM [mg/m^3]



Mackenzie River Water traced by salinity, CDOM, Alkalinity

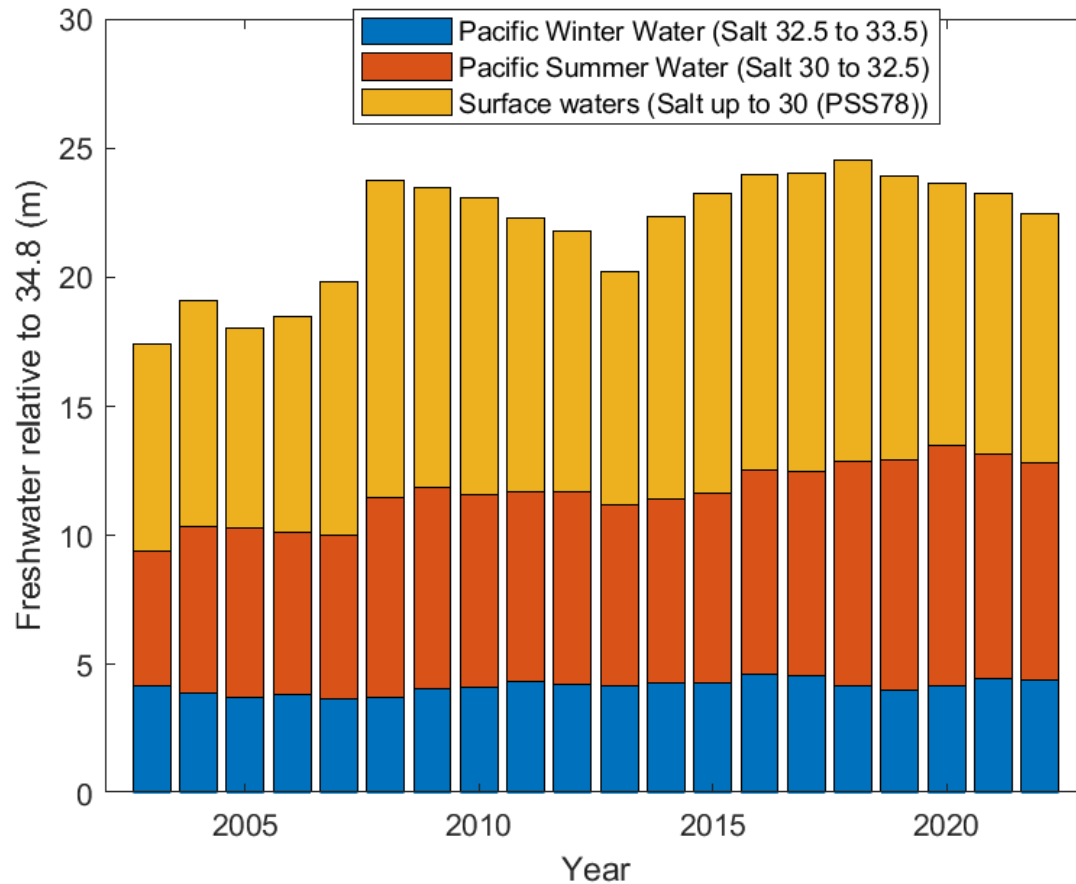
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Monitoring of the Beaufort Gyre since 2003: Freshwater content



Ocean freshwater relative to S = 34.8

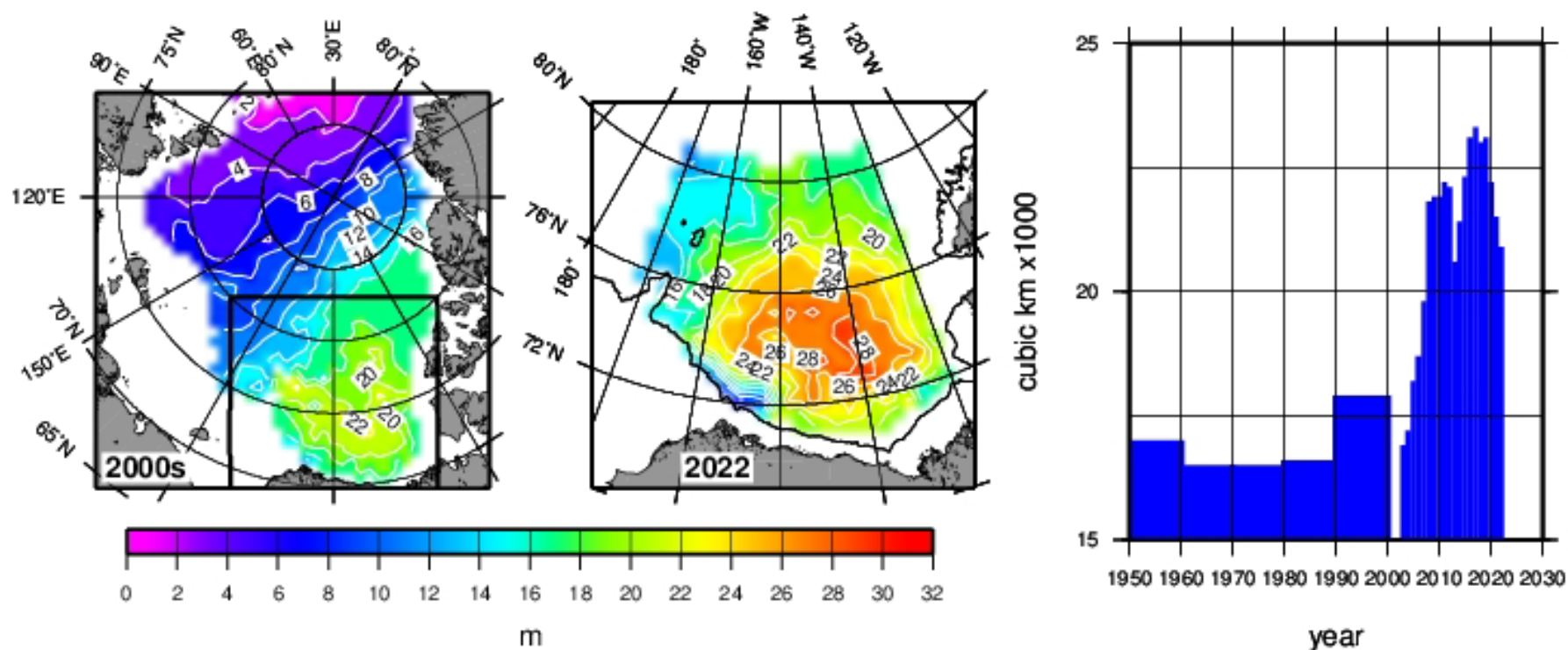
(from Rick Krishfield, WHOI)



(from Sarah Zimmermann, DFO)

2022 Joint Ocean Ice Study / Arctic Observing Network - Beaufort Gyre Observing System

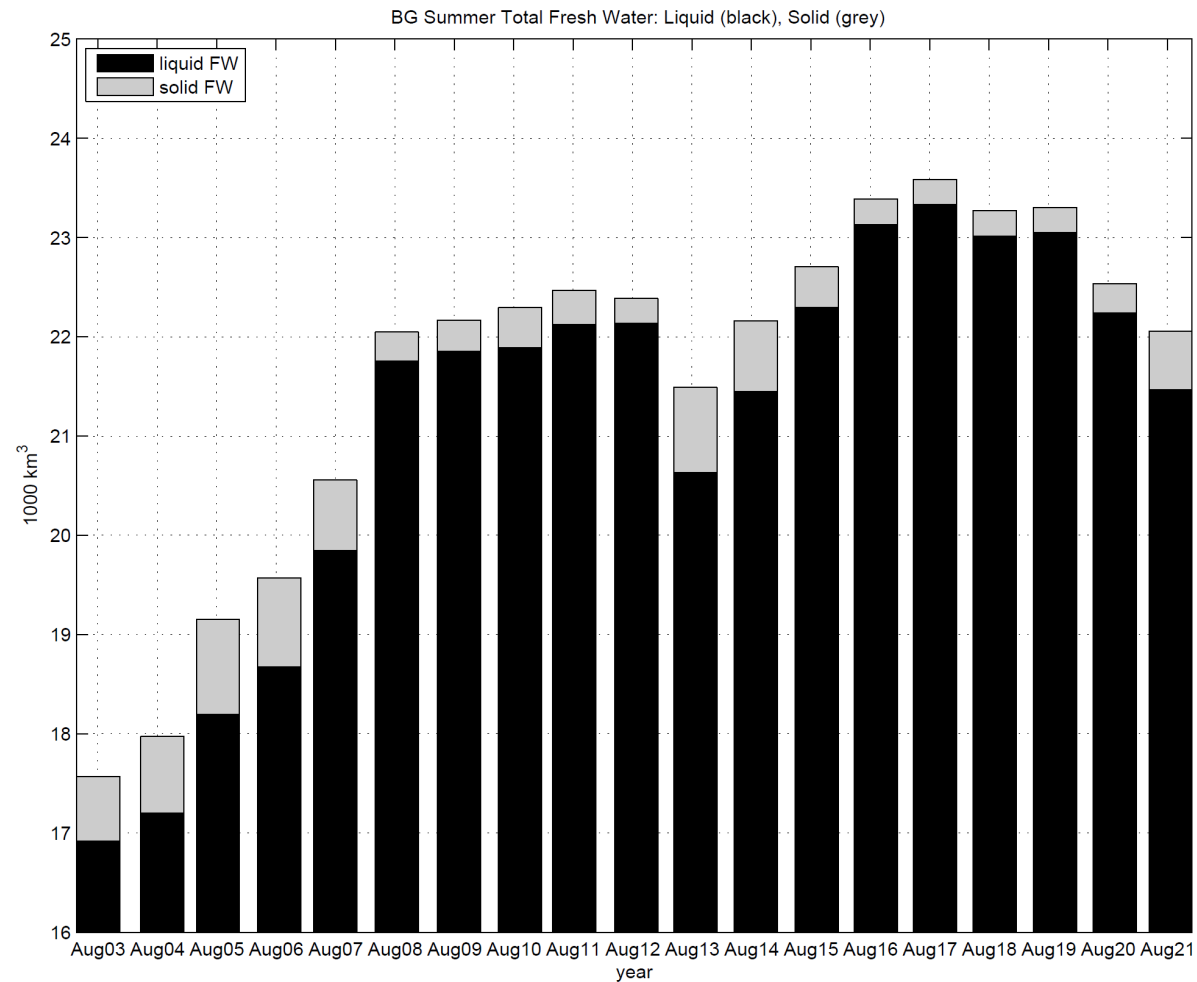
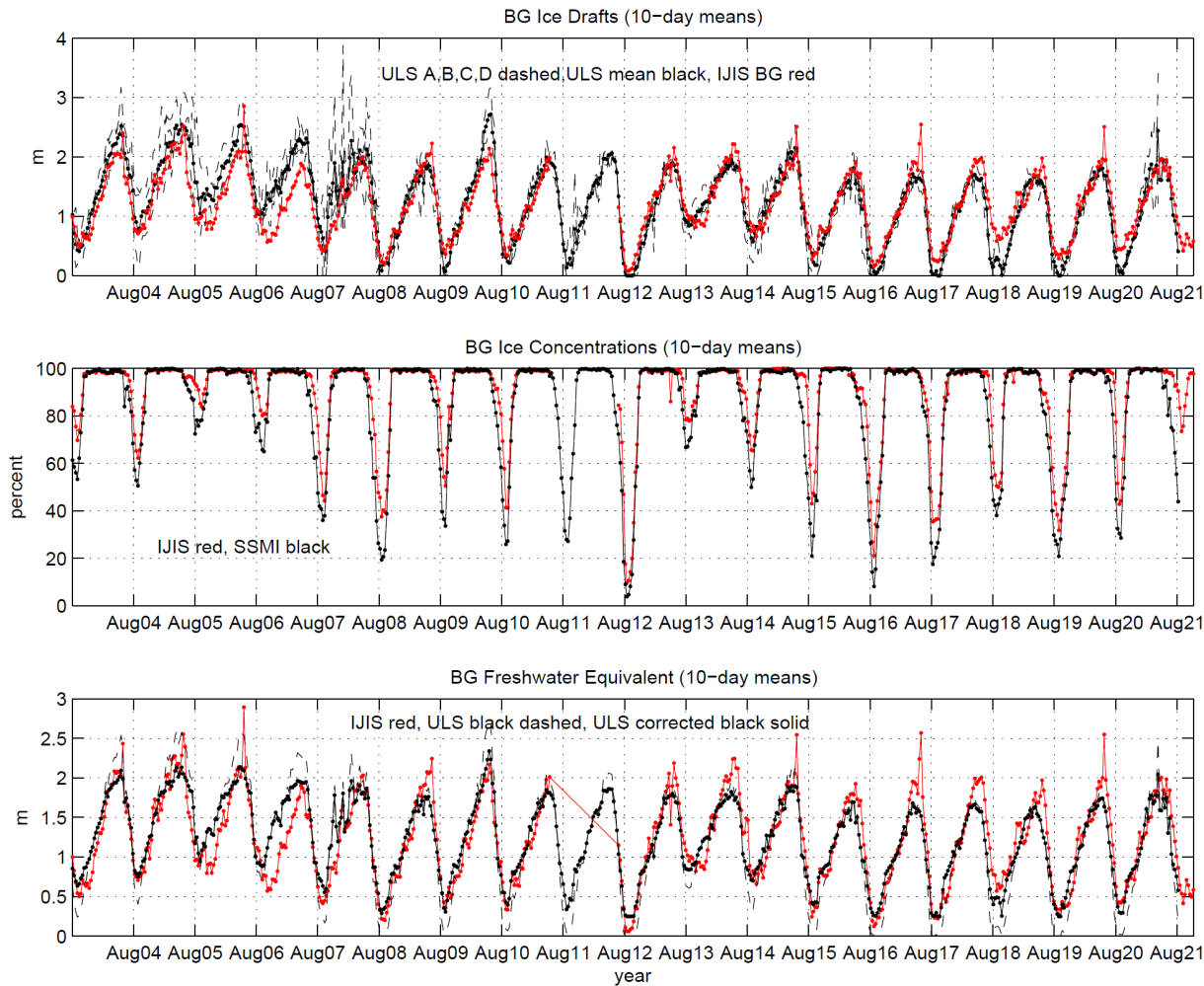
Monitoring of the Beaufort Gyre since 2003: Freshwater content



(from Rick Krishfield, WHOI)

2022 Joint Ocean Ice Study / Arctic Observing Network - Beaufort Gyre Observing System

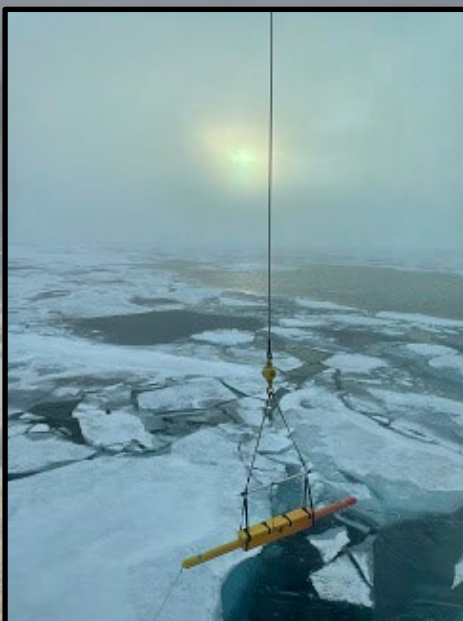
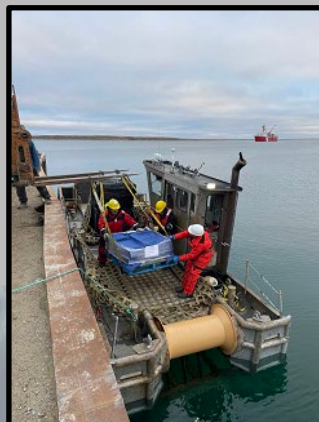
Monitoring of the Beaufort Gyre since 2003: Freshwater content



(from Rick Krishfield, WHOI)



2022 Joint Ocean Ice Study / Arctic Observing Network - Beaufort Gyre Observing System





2022 Joint Ocean Ice Study / Arctic Observing Network - Beaufort Gyre Observing System – Moorings (WHOI)





Joint Ocean Ice Study & Arctic Observatory Network 2022

CCGS Louis S. St-Laurent: Sept. 15th—Oct. 13th



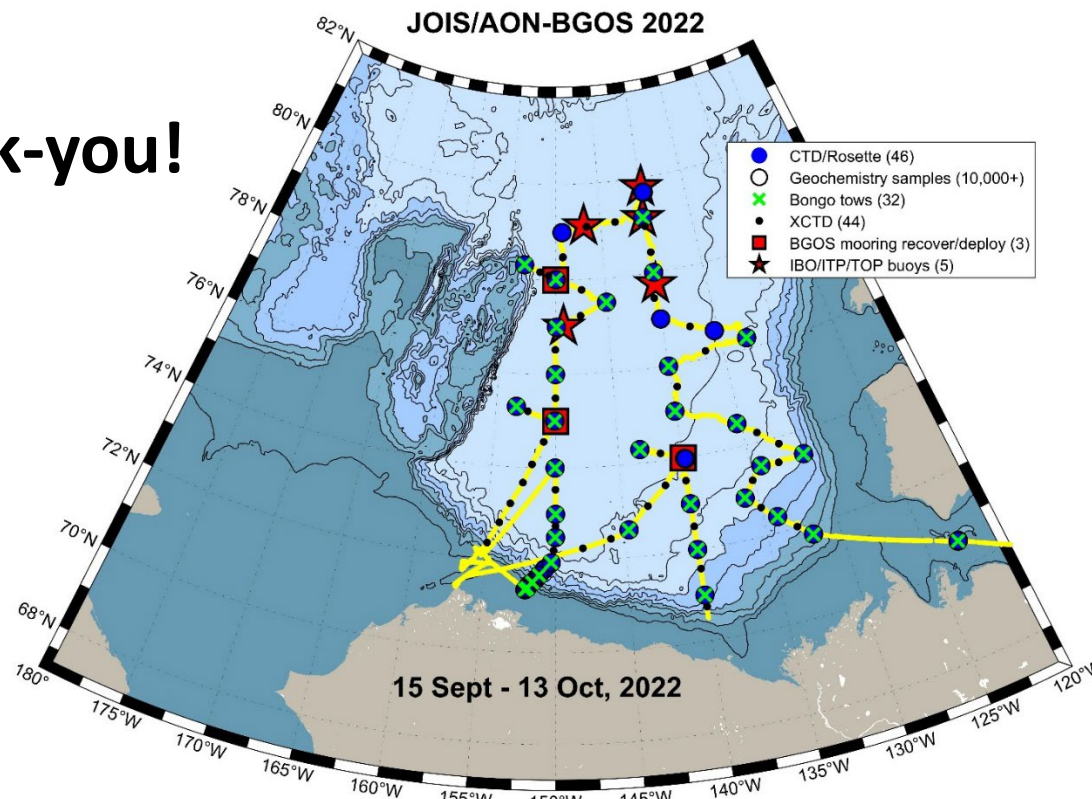
20th

Joint Ocean Ice Study &

Arctic Observing Network – Beaufort Gyre Observing System



Thank-you!



CCGS Sir Wilfrid Laurier





Canada's Three Oceans / Distributed Biological Observatory

CCGS Sir Wilfrid Laurier, July 6 – 25 (6 science days during a 20-day operation)

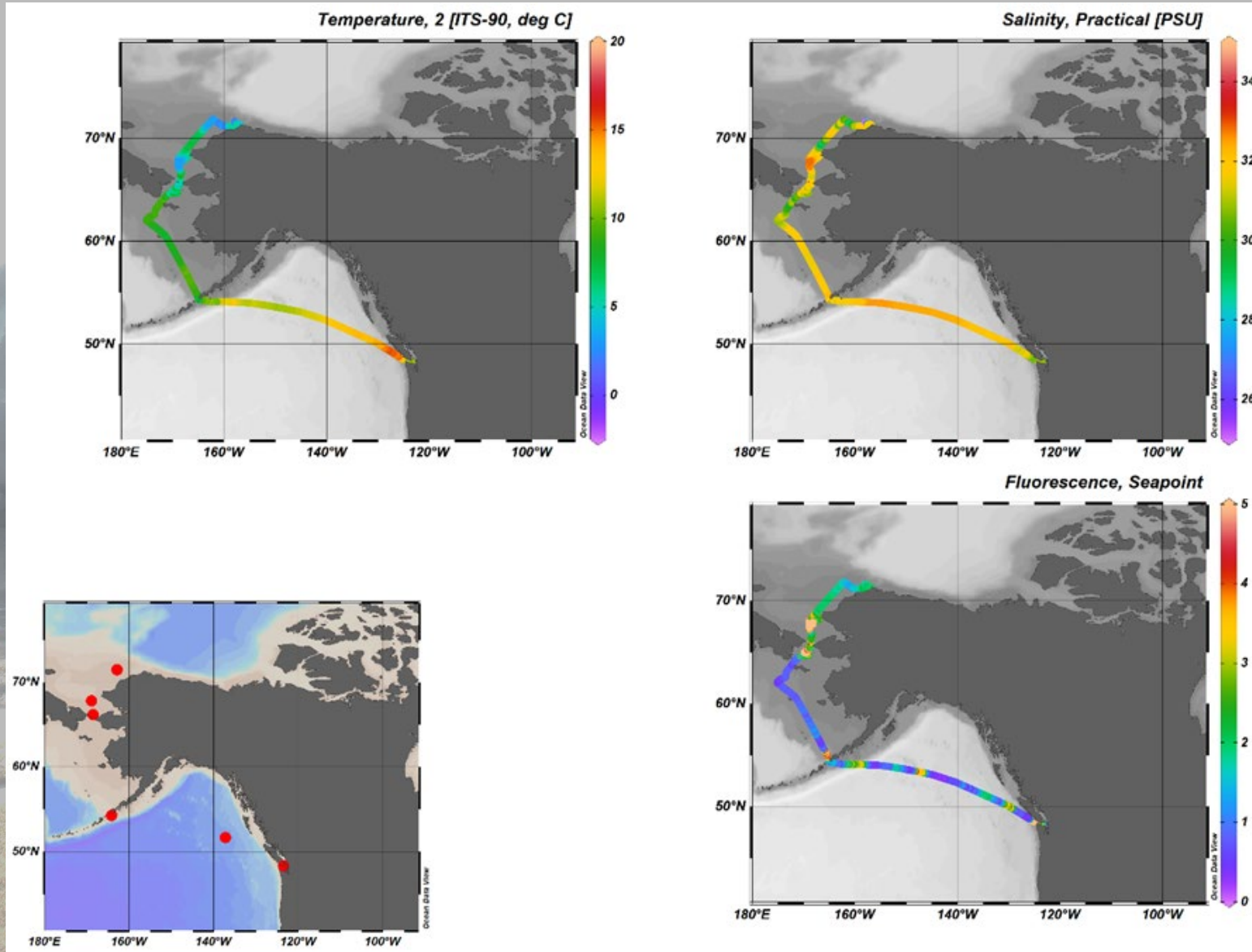


- 15 scientists (IOS, UVic, USFW, UMCES, ClarkU)
- 54 CTD/Rosette casts in the Pacific, Bering, Chukchi
- 16 UCTD casts/tows conducted in NE Pacific
- 1 Argo Float deployed in the NE Pacific
- 31 ADCP transects conducted
- 39 Bongo net hauls
- 26 Benthic stations with many grabs
- 23 Benthic camera recordings
- 22 Irradiance/Radiance profiles
- 2 long deployments of the continuous plankton recorder, total towing distance **817 nm**
- Continuous TSG measurements while underway
- Seabird observations throughout



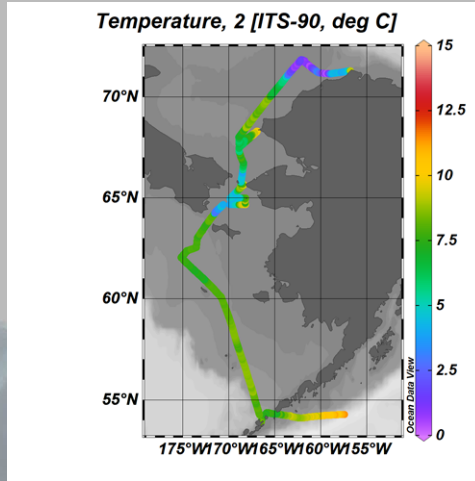


C30/DBO – 2022 TSG data

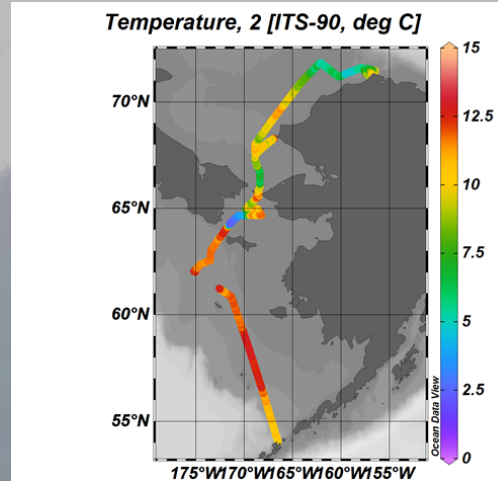




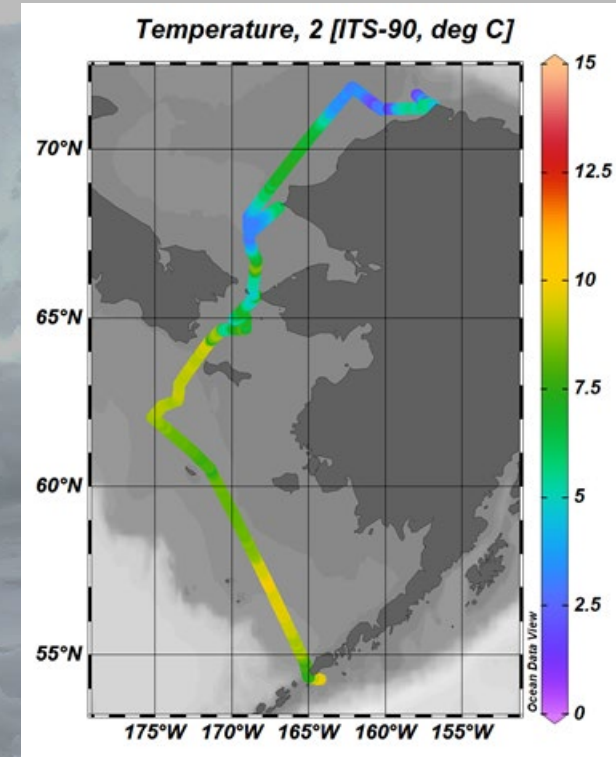
C30 / DBO Near Surface Temperature



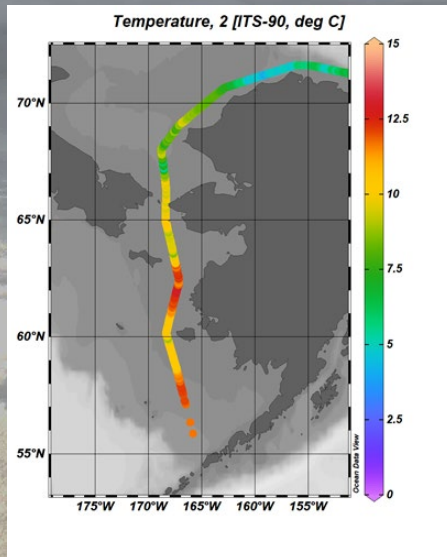
2018



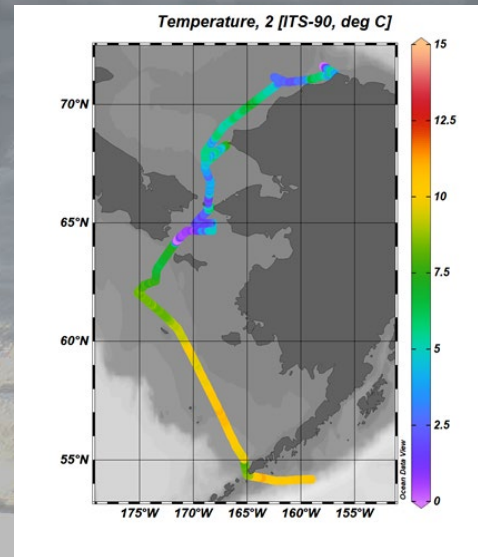
2019



2022



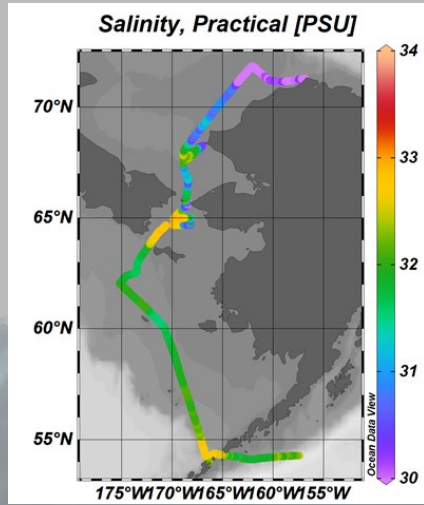
2020



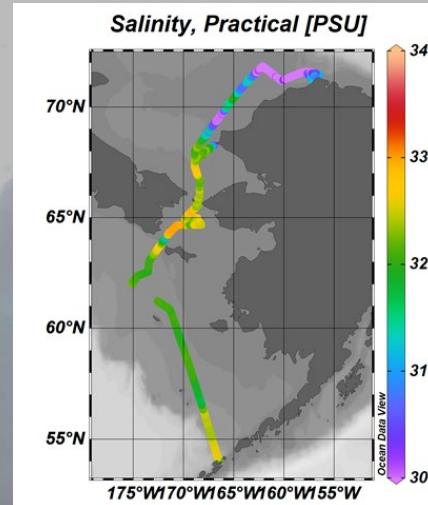
2021



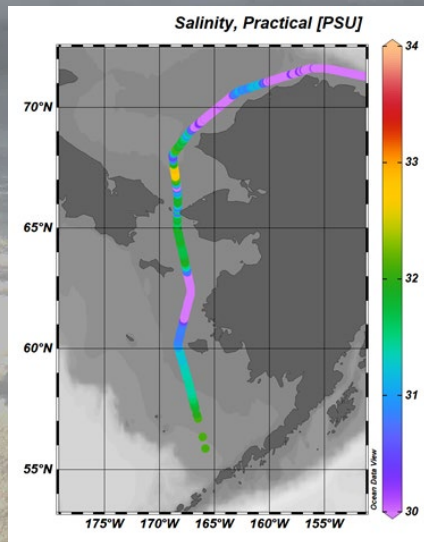
C30 / DBO Near Surface Salinity



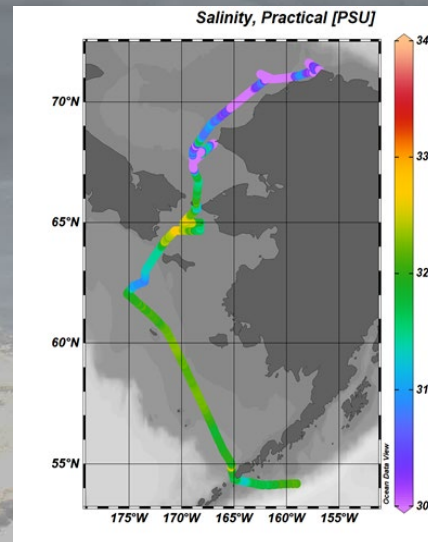
2018



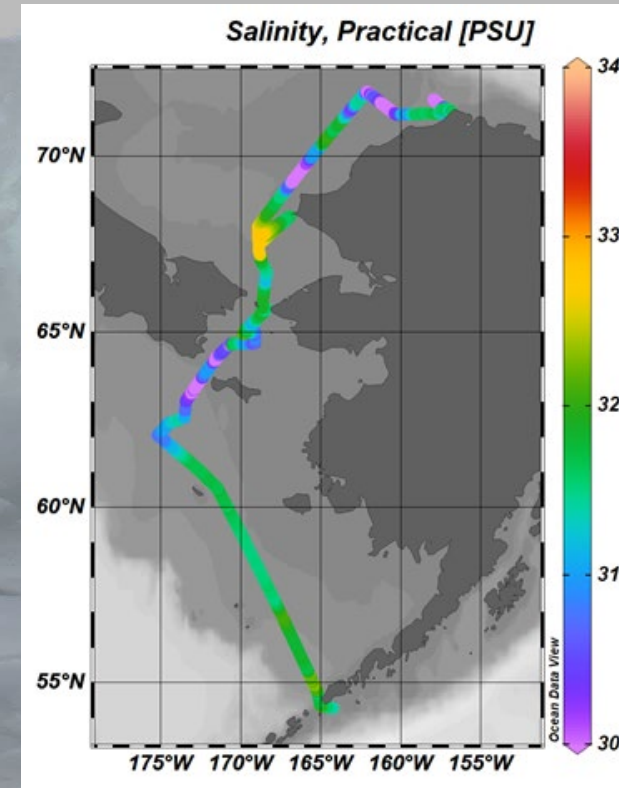
2019



2020



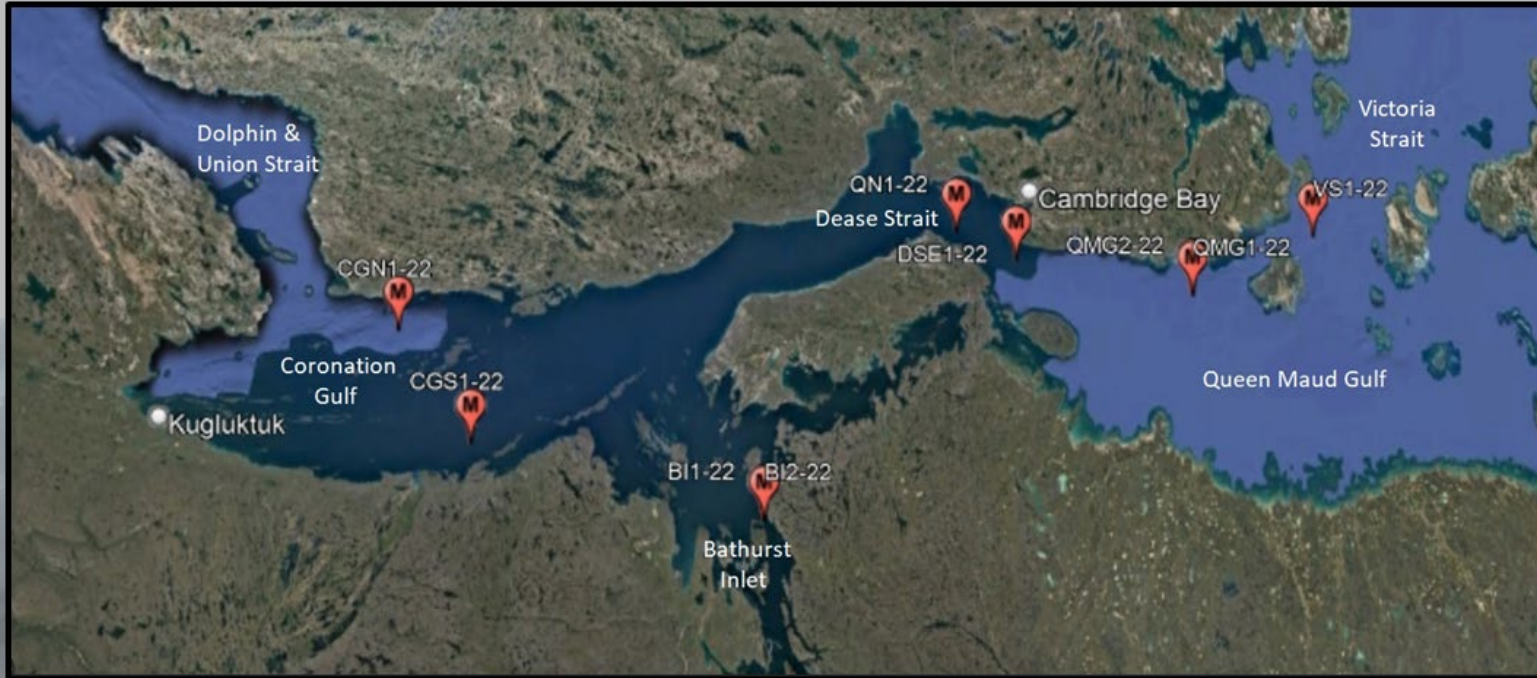
2021



2022



Kitikmeot Sea Science Study (K3S) – The Kitikmeot Sea

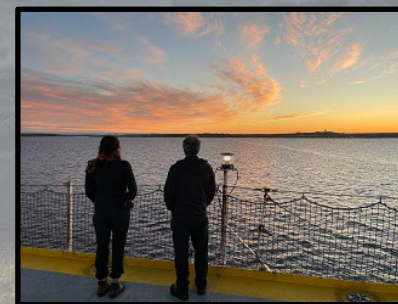
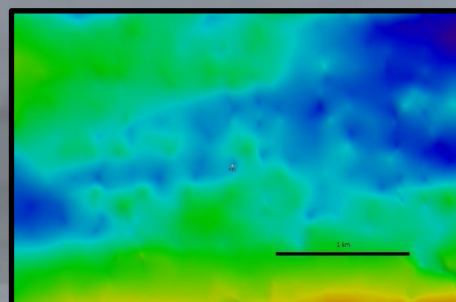


CCGS Sir Wilfrid Laurier, August 15-30 (4 science days during a 14-day operation)

- 6 scientists, shared program (3 from IOS, 3 from CHS)
- 7 CTD/Rosette casts in the Kitikmeot Sea (Coronation Gulf, Bathurst Inlet, Dease Strait, Queen Maud Gulf and Victoria Strait)
- 10 Moorings deployed (variety of CTD/ADCP configurations)
- Continuous TSG measurements while underway



Kitikmeot Sea Science Study (K3S)





Beaufort Shelf Marine Observatories (BSMO) – Location Map

Sir Wilfrid Laurier: September 27 – October 13



Collaborators include:

- Wildlife Conservation Society Canada
- Environment & Climate Change Canada
- Freshwater Institute, Fisheries and Oceans
- National Oceanic and Atmospheric Administration



Beaufort Shelf Marine Observatories (BSMO) – By the numbers

Sir Wilfrid Laurier. September 27 – October 13 (5 science days during a 17-day operation)

- 5 in-situ ADCP compass calibrations on land to correct for local declination
- 15 deployments of oceanographic moorings at 12 locations between Dolphin and Union Strait and the Chuckchi Plateau
- Instrumentation includes ice profilers (IPS), acoustic current meters (ADCP), Zooplankton profilers (AZFP) and CTDs.
- 16 recoveries of oceanographic moorings at the same 12 locations, including AIM mooring deployed in 2020
- 7 CTD/Rosette casts in the vicinity of each mooring location
- Water samples for ECCC at selected stations for microplastic contamination
- 500 nm+ transects towing Continuous Plankton Recorder (CPR) Herschel Island to AIM and AIM to Bering Strait
- 16 Drift bottle deployments between Herschel Island and AIM sites
- 11 XCTD casts between Herschel Island and AIM sites
- Continuous TSG (surface temperature & salinity) measurements while underway

Year-round data document marine climate and hazards: Norms, natural variation, extremes, progressive change

Sea ice

Thickness, drift, hazardous features

Sea surface

Storm waves, storm surge

Ocean current – surface to seabed

Seawater pathways (e.g. nutrient delivery, pollutant dispersal),
dangerous currents

Ocean water masses – temperature, salinity

Identify properties, origins of seawater

Sediment in seawater

Suspension, transport & deposition

Organic contaminants in seawater

Biological enhancers

Nutrient upwelling, zooplankton variation

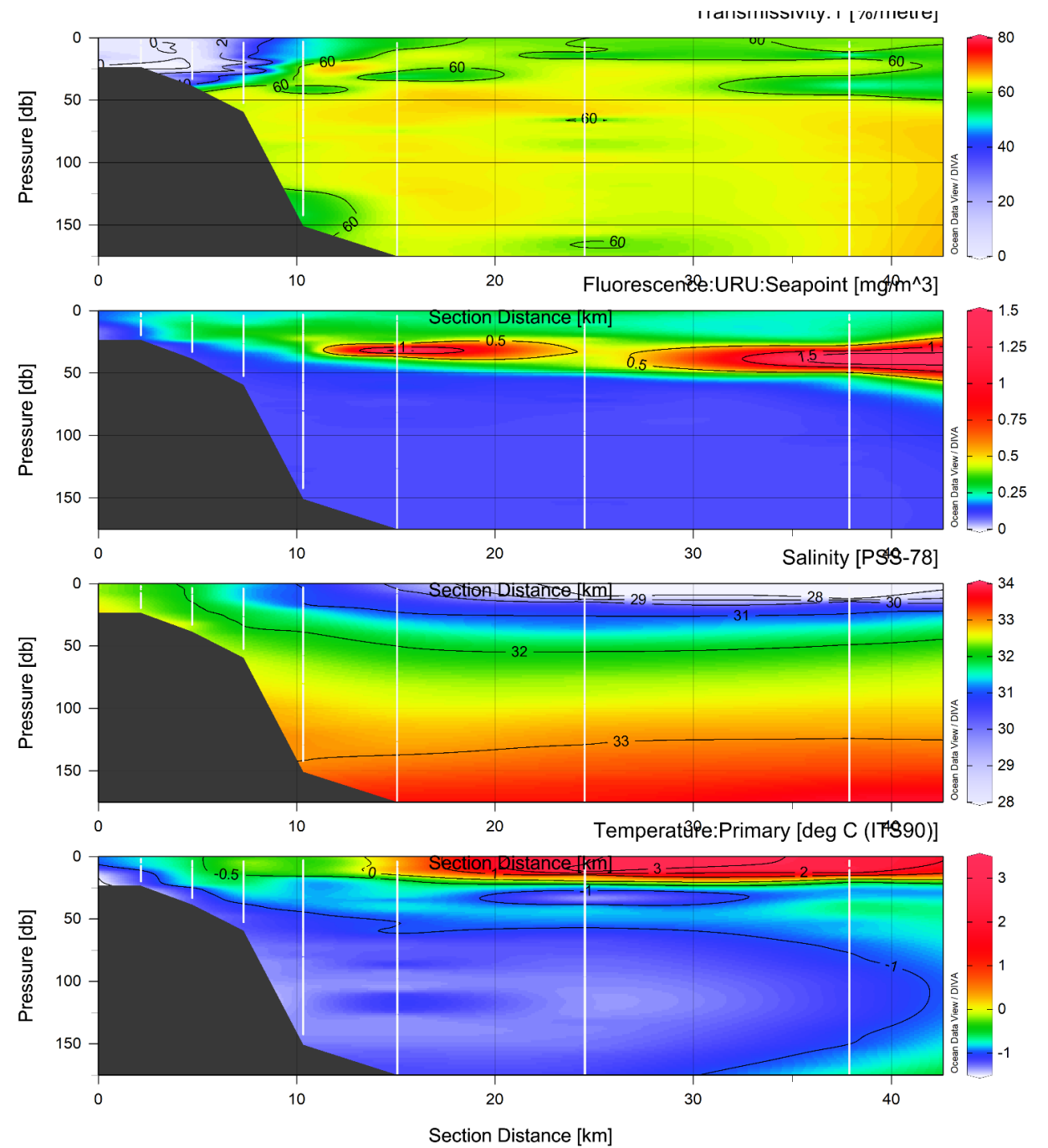
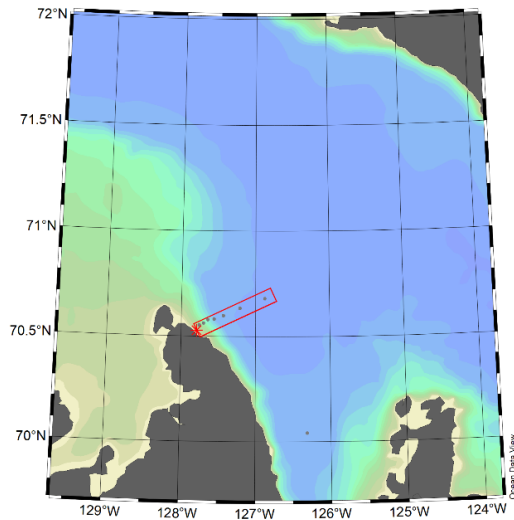
Ambient sound

Mammal's vocalization, species presence, natural sound, seismic
surveys, ship noise

Ocean and ice dynamics

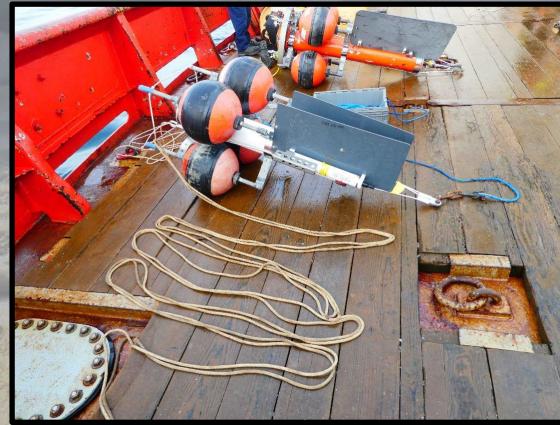
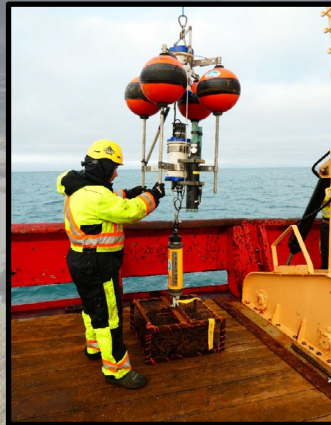


Up-welling and down-welling at DBO-8:





Beaufort Shelf Marine Observatories (BSMO)



Canadian Beaufort Sea - Marine Ecosystem Assessment (CBS-MEA)

02-30 August, 2022



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F/V Frosti (41m commercial fishing trawler)

Photo by Jane Eert



Offshore ecosystem research in support of marine conservation and co-management priorities in the Inuvialuit Settlement Region.

Focus on:

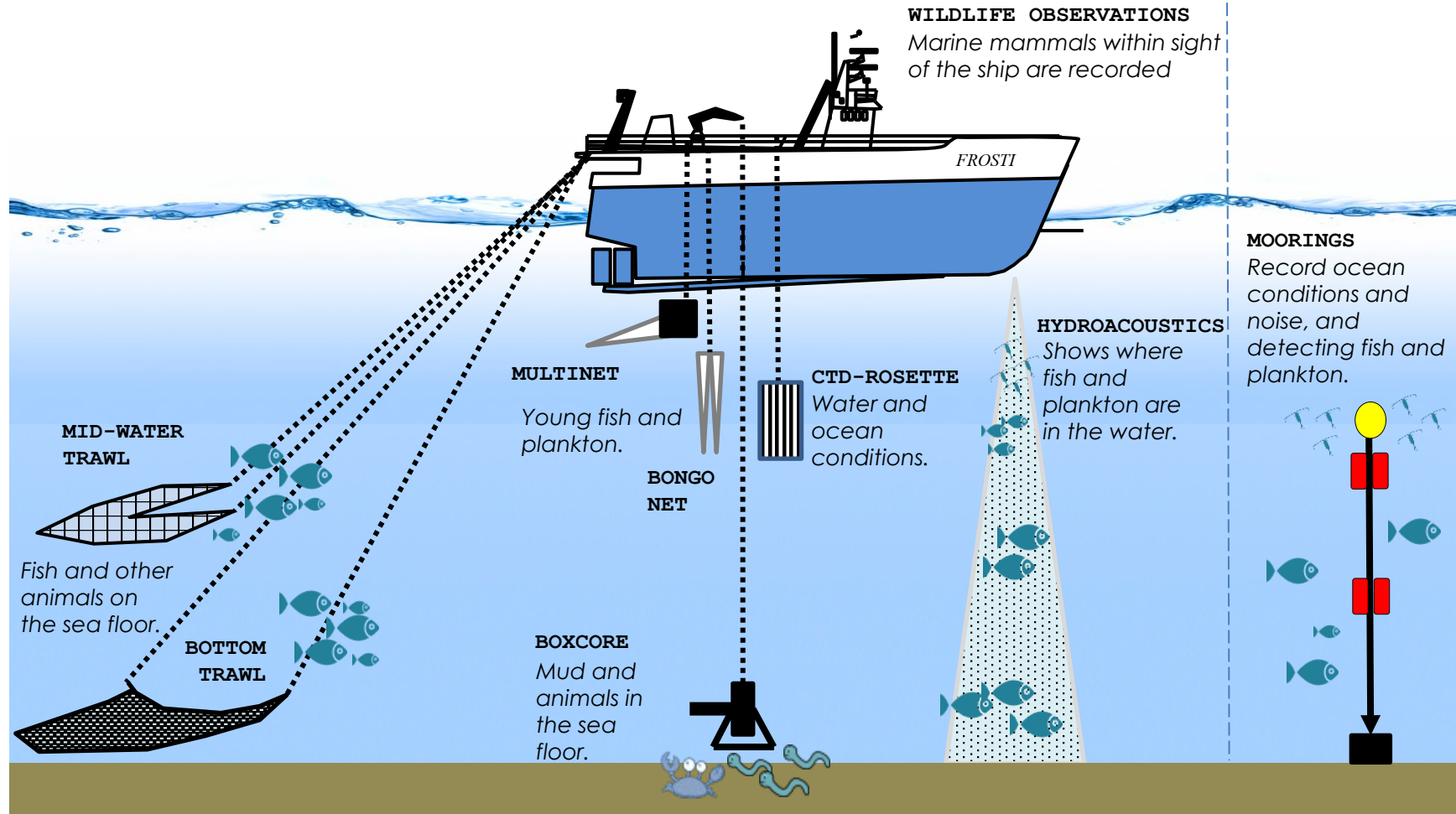
- Offshore-coastal linkages
- Ecosystem stressors - acidification, plastics, contaminants, noise ...
- Marine Protected Areas

Our Approach

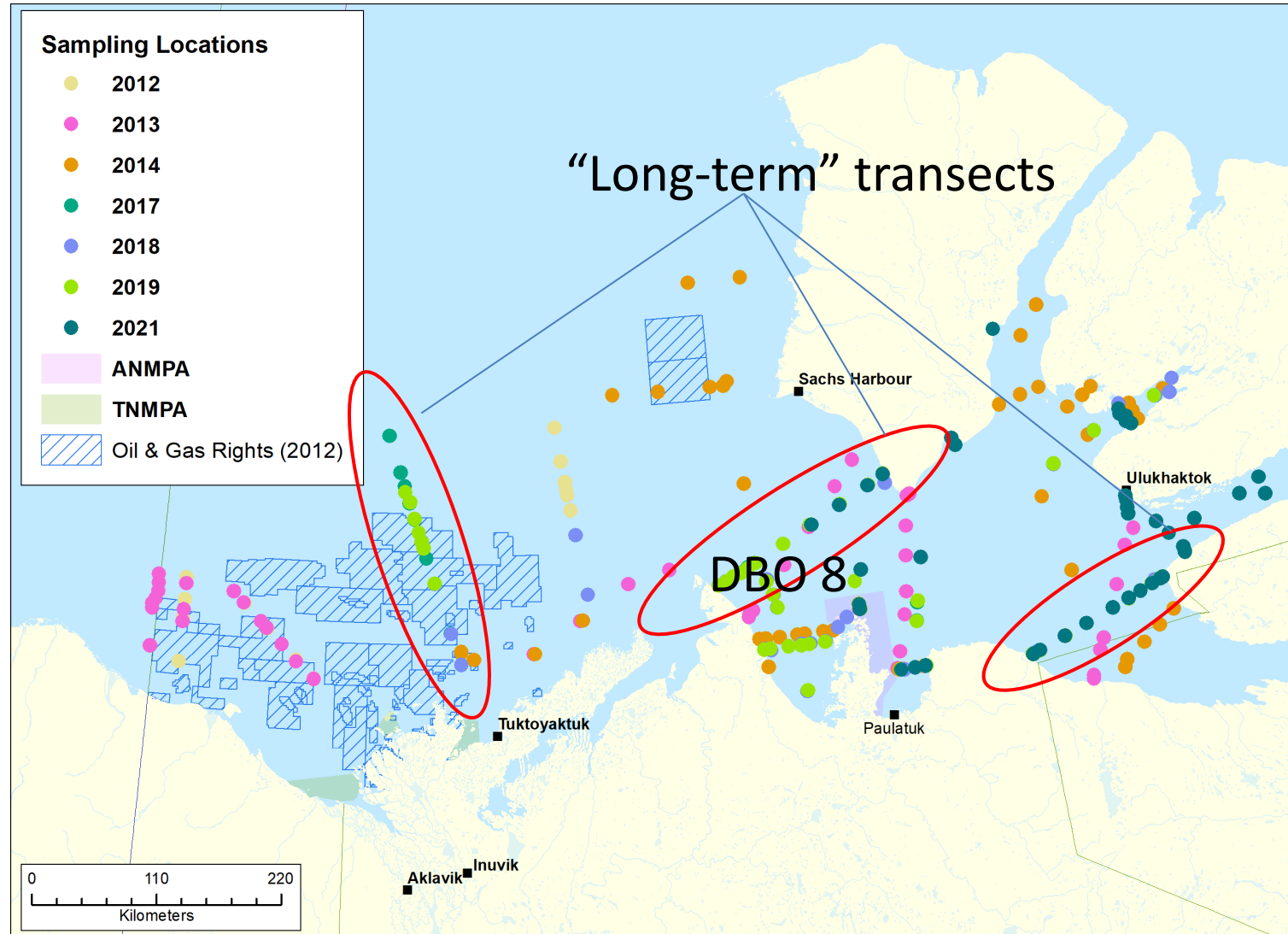


SUMMER

YEAR-ROUND



Project Evolution – BREA to CBS-MEA

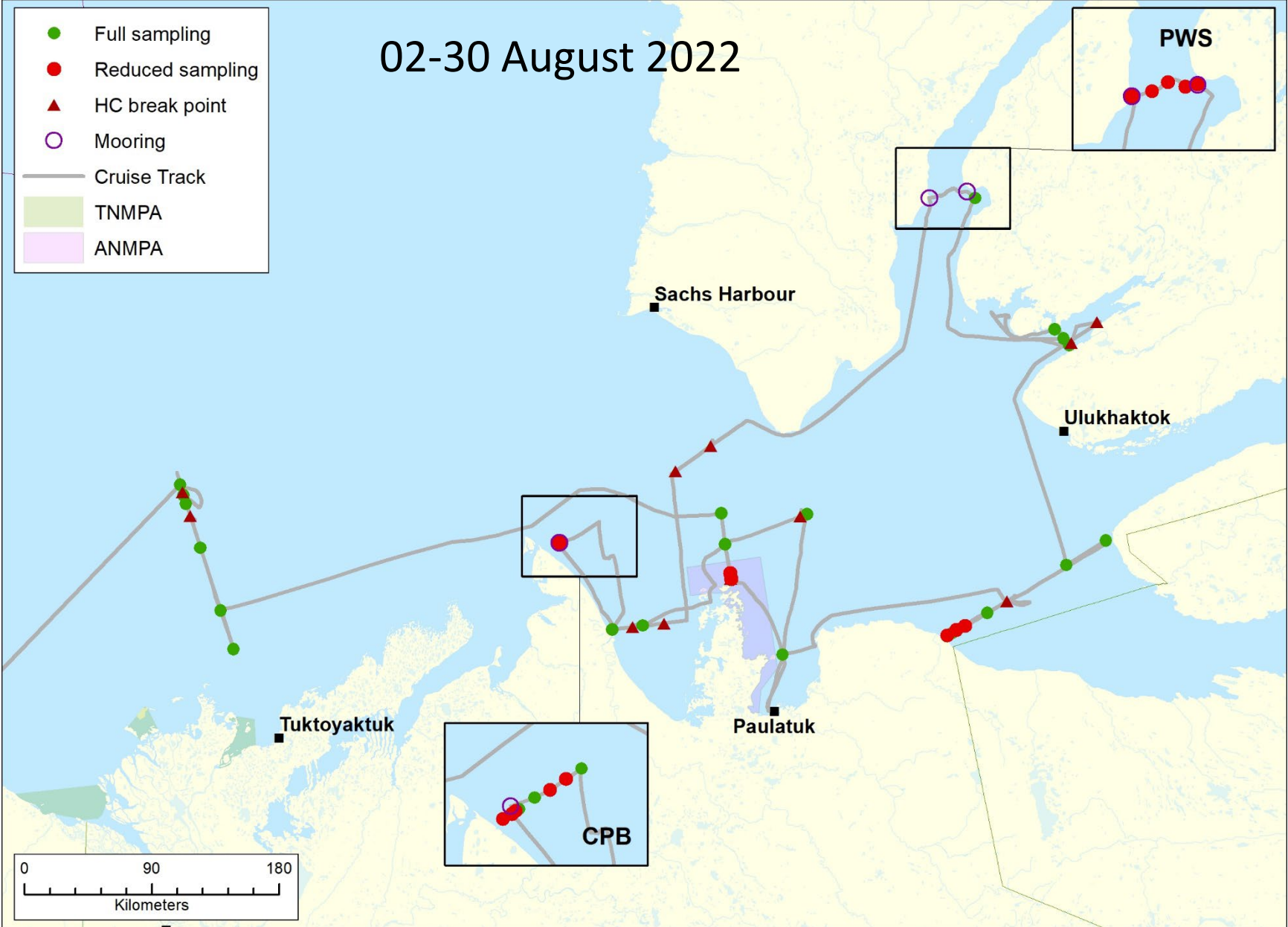
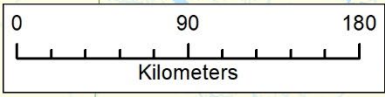


02-30 August 2022

- Full sampling
- Reduced sampling
- ▲ HC break point
- Mooring
- Cruise Track
- TNMPA
- ANMPA

PWS

CPB



Inuvialuit Consultation and Engagement



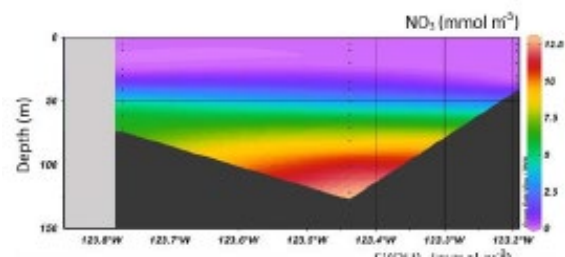
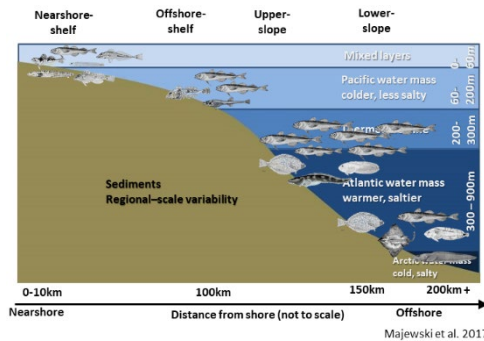
Annual consultations:

- Inuvialuit Game Council – Dec, Mar, Jun
- FJMC – Annually, January meeting
- HTC's – Community-based concerns/updates
- Annual Activity Application to WAMPA
- Annual onboard Inuvialuit participation, community ship tours, open houses/community dinners

Providing the regional context: baselines to mechanisms

Baselines

- Community composition
- Food web structure
- Key habitat variables

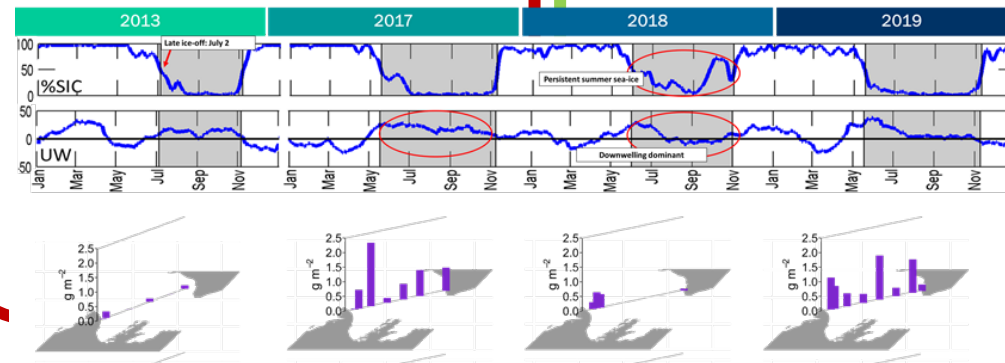
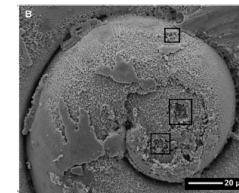


Mechanisms

- Beluga prey studies
- Year-round moorings
- Feeding traits
- Biodiversity hotspots
- Influence of upwelling/downwelling

Stressors

- Underwater noise (WCS)
- Ocean acidification (NOAA)
- Microplastics in sediments (ECCC)
- Mercury in key benthic and zooplankton prey (ECCC)



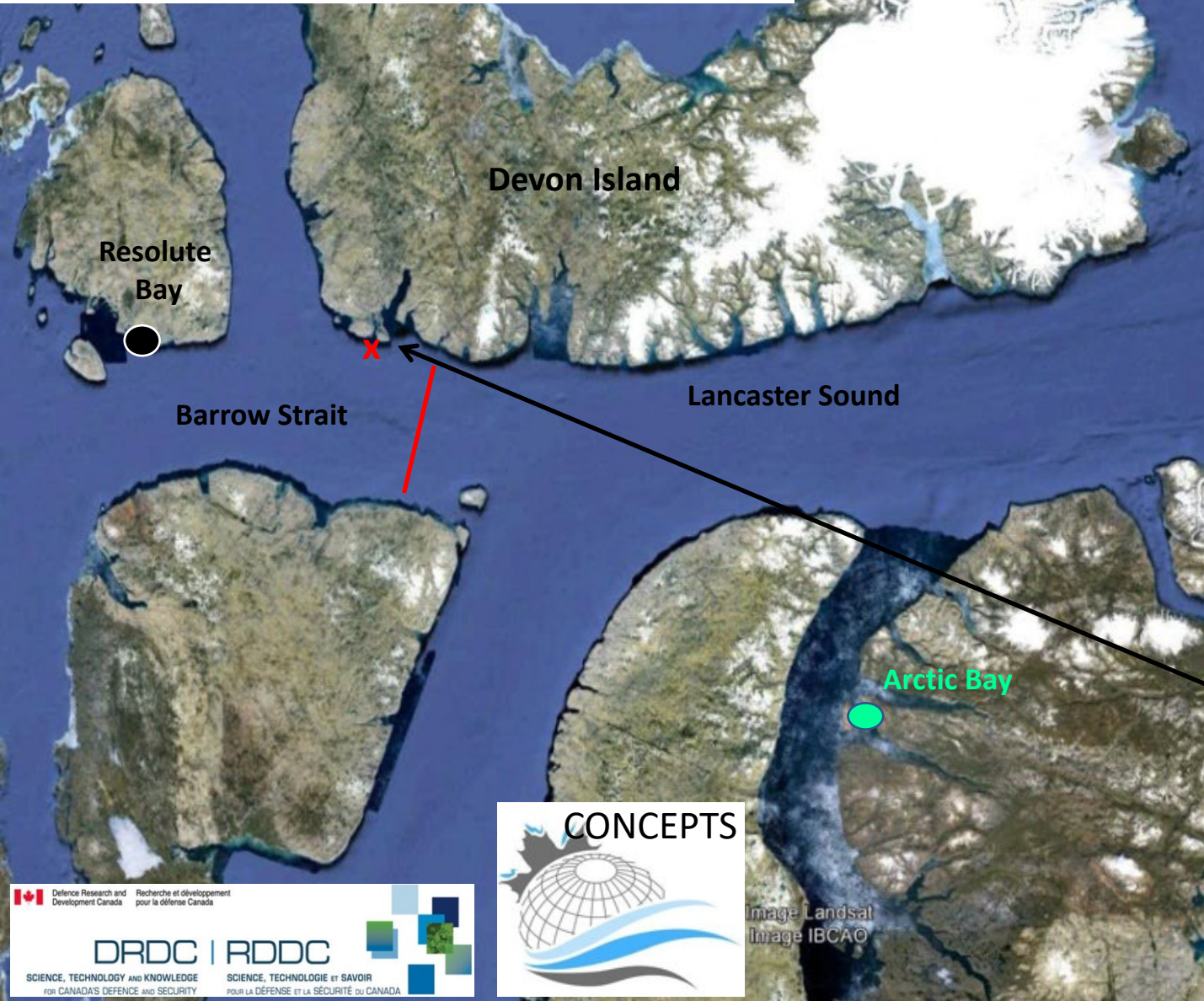
The Barrow Strait Monitoring Program and Real-time ocean observatory



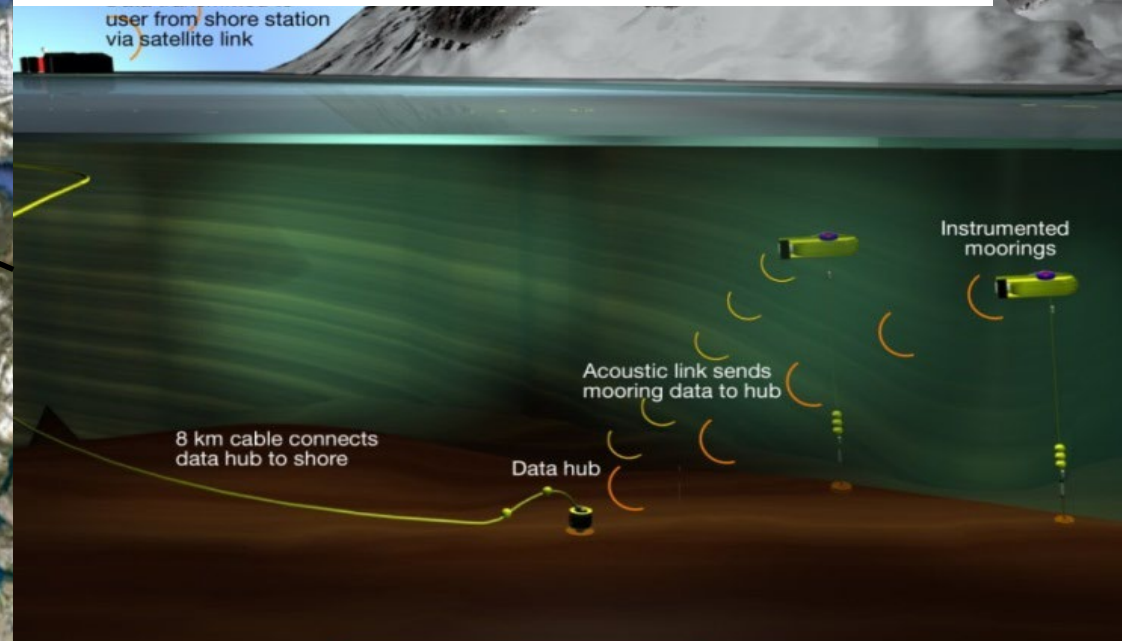
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Clark Richards,
Bedford Institute of Oceanography



- Originally maintained from 1998 to 2011.
- **Re-deployed in August 2017.**
- **Turned-around August 2019 for 2 years**
- **Field program cancelled in 2021 (COVID)**
- **All moorings and observatory turned around in Aug. 2022**
- **Principle objective:** To quantify freshwater and volume transports into the NW Atlantic.
- Measurements of water properties, currents, and ice draft, passive acoustics.

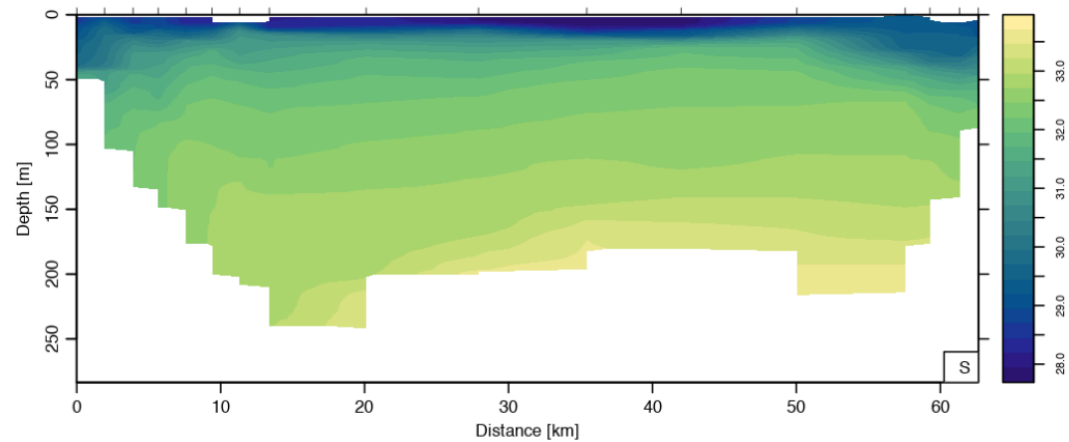
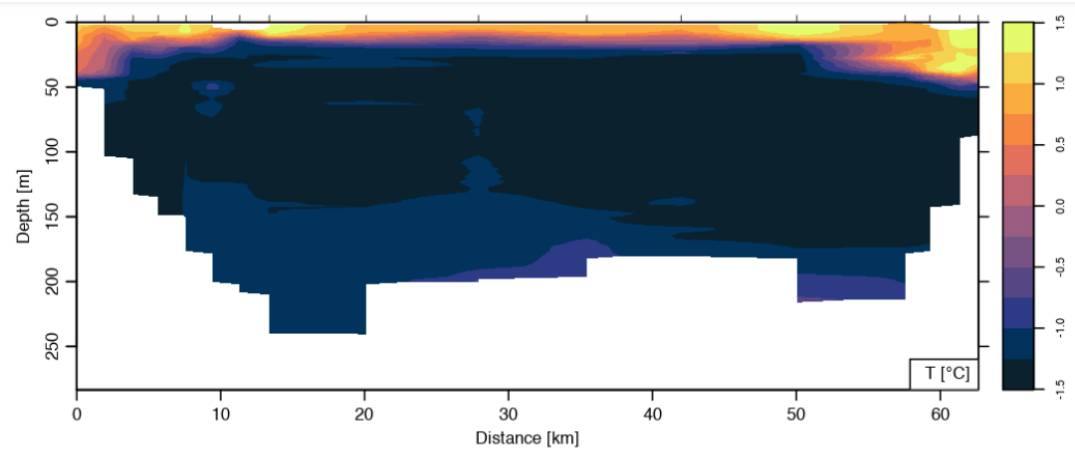


2022 program highlights (on board the NGCC Pierre Radisson)

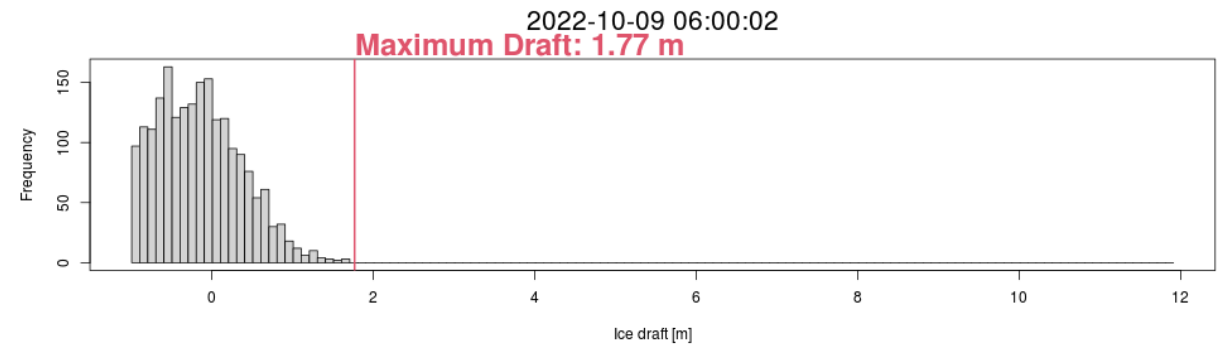
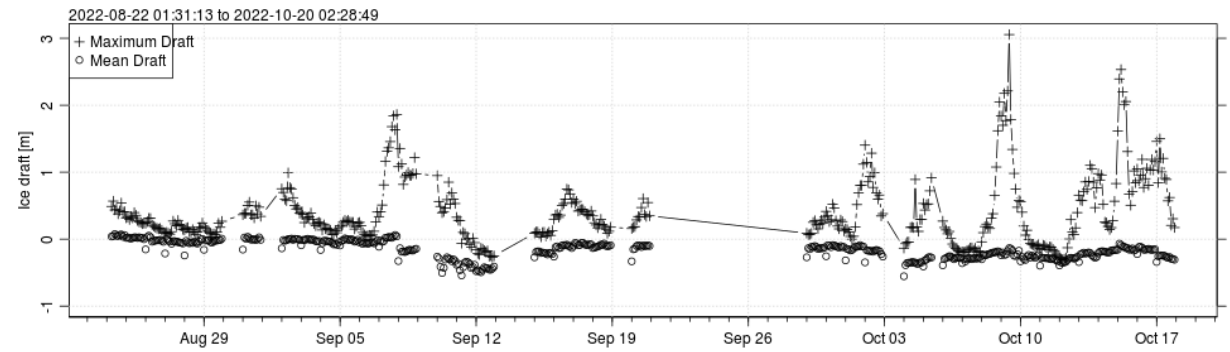
- All moorings successfully recovered (6) and all planned moorings (9) deployed
- Approximately 90% data recovery for 2019-2022
- New instruments being tested:
 - Nortek Signature 250 ADCP (combined water, ice, and echosounder)
 - Lowell and StarOddi compasses
 - BGC mooring with CTD+O₂+pH+nutrients
- Full CTD survey across the straight (17 stations), with water samples. First time since 2010

Some results:

2022 CTD survey



Real-time ice draft (Observatory)



2,500+

research days at sea since 2003

300,000+

nautical miles travelled since 2003

3,000+

scientists from 25+ countries

2,100+

publications and datasets

140+

teams in 45+ programs since 2003

\$45M+

of state-of-the-art scientific equipment

Part 1 - Vessel Life Extension Dry Dock



Vessel Life Extension Dry Dock & Schedule of the CCGS *Amundsen* in 2022

Vessel Life Extension Refit Phase II - Dry dock

- 15 November 2022 to summer 2022: VLE phase 2 (dry dock)
 - New dynamic positioning system
 - New multibeam sonar, new SADCP, new arctic box (EK80)
 - Long list of several systems under refit

Schedule received from the CCG used to plan the 2022 mission

		06-Jun-22	13-Jun-22	20-Jun-22	27-Jun-22	04-Jul-22	11-Jul-22	18-Jul-22	25-Jul-22	01-Aug-22	08-Aug-22	15-Aug-22	22-Aug-22	29-Aug-22	05-Sep-22	12-Sep-22	19-Sep-22	26-Sep-22	03-Oct-22	10-Oct-22	17-Oct-22	24-Oct-22	31-Oct-22	07-Nov-22	14-Nov-22	21-Nov-22
Amundsen																										
Primary program - Programme principal													26 - Science mobilisation	9	Arctic				19	Demob	24	Alongside maintenance				
Secondary program - Programme secondaire		Dry dock				Contingency + Alongside maintenance/ certification + training + transit + mob																				
Crew Change - Changement d'équipage		A16				B14				A11				B8				A13				B3				

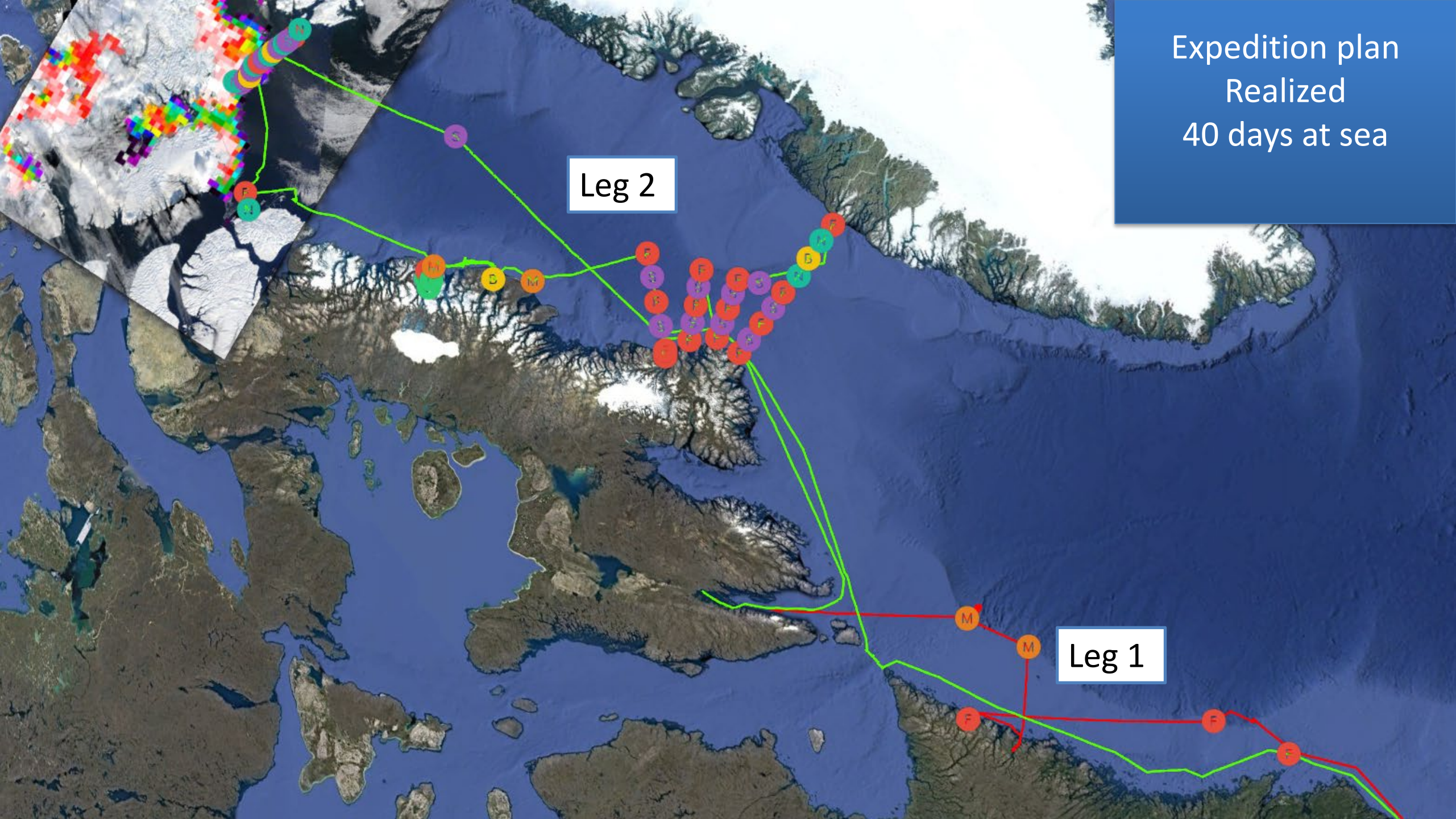
Part 2 - 2022 Scientific Expedition



Expedition plan
Realized
40 days at sea

Leg 2

Leg 1



Thank-you!

