NGA LTER & Gulf Watch Alaska
Cruise NUQ2019-01S

Northern Gulf of Alaska Freshwater Pathways Cruise
23 July to 2 August 2019

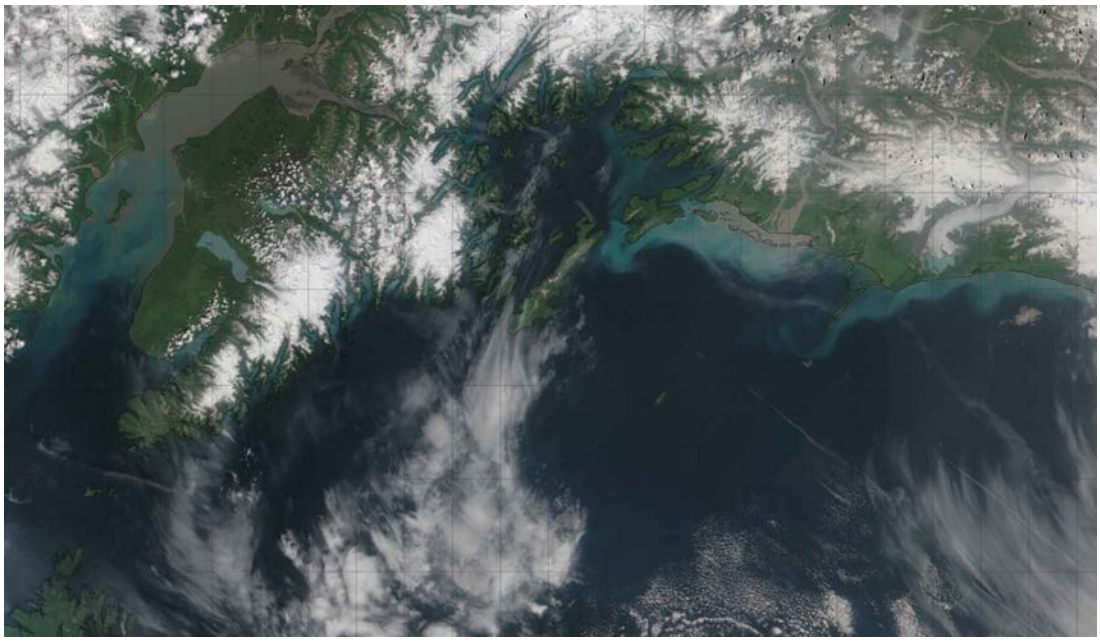
Funding Sources: NSF

Cruise Personnel: Seth Danielson, Chief Scientist, sldanielson@alaska.edu
Hank Statscewich, Acrobat Specialist, hank.stats@alaska.edu
Brian Mulally, Captain, R/V Nanuq

College of Fisheries and Ocean Sciences
University of Alaska Fairbanks
Fairbanks, AK 99775
Phone: 907-474-7834
Mobile 907-388-7088

Synopsis and Objectives:

The scientific purpose of this research is to map the nearshore fresh water system of the Northern Gulf of Alaska. Weather permitting, we will work offshore of the Copper River delta, towing an undulating CTD in and out of the frontal systems between the fresh river water and the salty waters offshore. Inclement weather will re-direct operations into Prince William Sound. This cruise will attempt to re-occupy transects covered by R/V Sikuliaq in early July 2019, seeking information on the temporal evolution of the fresh water distribution and freshwater pathways.



Satellite image of the plume study area from 17 July 2019.

Cruise Narrative:

Monday, July 22: The science party arrives in Seward on Monday afternoon. We found R/V Nanuq in the small boat harbor at X-dock and proceeded to ferry science gear from the SMC Warehouse and Mooring Loft to the boat. We affixed the Mobile Marine Meteorological station to the port ladder that provides access to the roof. (A better location would be attached to the antenna frame aloft; this should be accomplished on future missions now that we know the aloft configuration.)

Tuesday, July 23: We provision for ca. 5-6 days, with the expectation that we will likely refuel in Cordova by the end of the week. We continue to set up science gear, pump grey water at the Seward harbor, take on fresh water and are ready to sail by mid-afternoon. We head into Resurrection Bay for a test of the Acrobat system. We rig the tow and operate the A-frame hydraulics and winch in synchrony. After a successful test, the weather is still good so we head for Prince William Sound. In order to keep the day from being too extended, we change our transit target from Port Etches and instead anchor in Hanning Bay, with a plan of beginning science on the following morning.

Wednesday July 24:
First day of science. Before departing our anchorage we rig up the ADCP tow sled and execute a slowly ramped-up speed tow test from the davit, using a 3/8" spectra stabilizer line going forward to an eye on the house forward port side. We find that the davit is flexing downward even under moderate speeds (3-5 kts) and determine that the davit is not suitable for towing the ADCP sled in anything but flat calm conditions at very low speed. Recommend an alternate method for mounting acoustics. Recommend strengthening the davit if anything but very light gear will be towed or hauled. Weather is decent and we accomplish a first Acrobat tow outside of Hinchinbrook Entrance along the eastern edge of the tanker lane, back toward Point Steele and then back offshore again, for about 7 hours of towing at a speed of 7 kts. We anchor in Port Etches for the night across the bay from the spill response vessels.

Thursday, July 25:
Generator refuses to turn over when the starter is engaged though we can hear it try. Turning the motor over by hand loosens up whatever was binding the starter motor and we are back in business. Learning about the new vessel. What caused the lockup? Excellent weather conditions prompts us to repeat the Middleton Island transect that was accomplished by R/V Sikuliaq in early July. We steam all the way from Port Etches to Middleton Island, arrive near 11 AM and manage a 50-mile tow from station MID6 to MID1. We deploy Microstar satellite tracked drifters (SN #30 and #32) near stations MID2i and MID1i. This day provided our first indication of the great value in Nanuq's speed: being able to run so far offshore and still accomplish 7 hours of science in a day. At the end of the day we beat back into Port Etches. An extremely successful day for the science.

Friday, July 26:
Poor weather offshore brings us into Prince William Sound for work. We accomplish two Acrobat transects: one across Hinchinbrook Entrance on its north side (Point Zaikof to Point Johnstone) and then one across the mouth of Orca Bay (Point Johnstone to Point Knowles). The need to refuel brings us to Cordova late in the day, where we tie up at G Float transient dock.

Saturday, July 27:
We remain in Cordova over Saturday, with small craft advisory conditions out in Prince William Sound (25 kts from the east, with gusts higher reported at the buoy in the middle of the Sound). We re-provision, take on water and fuel, and spend time talking to local fishermen and boat operators about transiting through Egg Island passage, Strawberry Passage, and the Cutoff. Our discussions are fruitful and we are given a lot of pointers, some tracklines and some maps that will be useful for this trip and for future work in the Copper River region. Fuel onboarded: 322 gallons. Water onboarded: 15 gallons.

Sunday, July 28:
Forecast still calls for 5-6' seas in our operating area so we steam to western Prince William Sound to repeat the April 2018 Acrobat tow accomplished on SKQ201810S. We get into the southern reach of College Fjord, where a seine fishery is taking place. We tow through Port Wells, Wells Passage, Perry Passage and finish at station KIP2 in southern Knight Island Passage. We anchor in Drier Bay after deploying a thermistor mooring (sensors across the thermocline and at the anchor). Anchor is a shrimp pot borrowed from Cordova gillnetter Erik Kokborg.

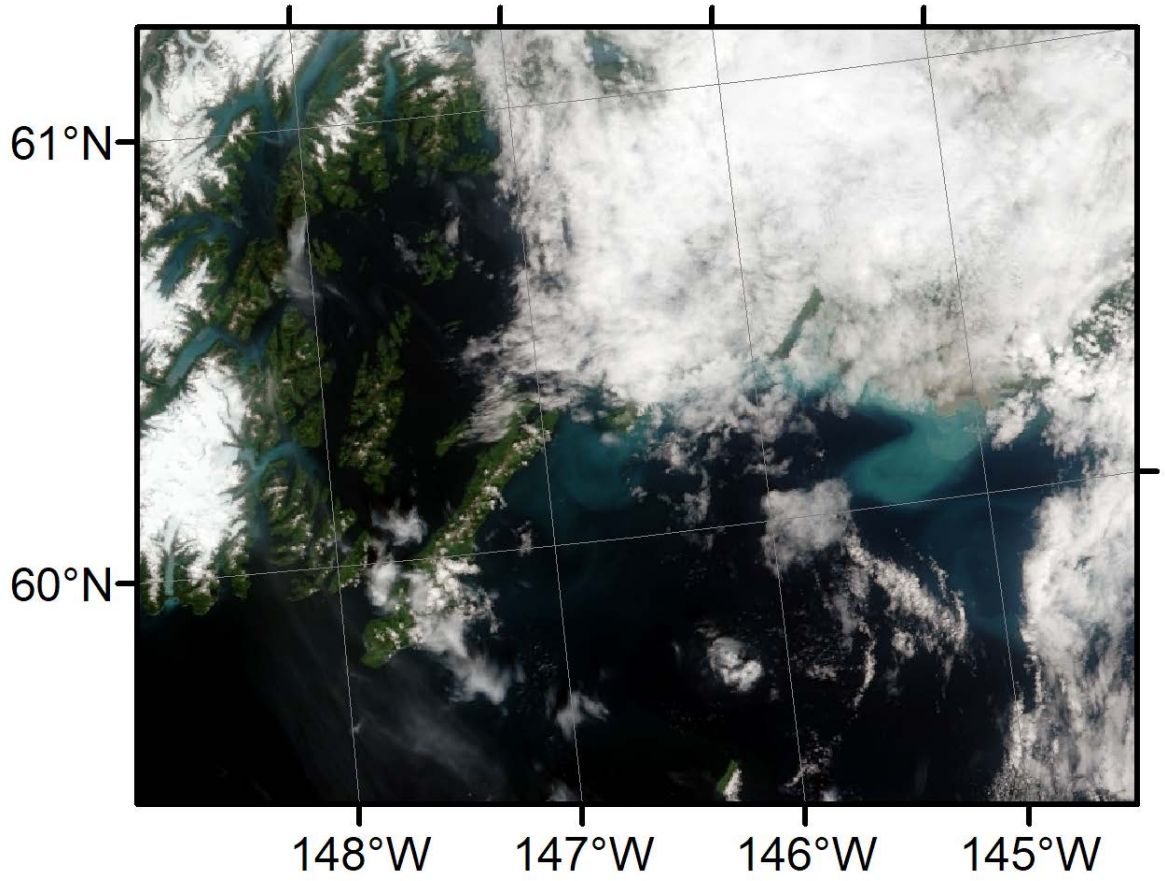
Monday, July 29:
Recovery of the mooring returns excellent high-resolution data records with indications of the semi-diurnal tide, many internal motions, and suggestions of mixing or advection. The shrimp pot mooring anchor returns two dozen shrimp, mostly spot prawns and a few tiger-stripes. These are pan-fried at supper in butter. We test our ability to launch and recover the skiff and take the opportunity to get a few photographs of Nanuq at anchor and maneuvering. A motor electronics alarm prompts a call to the Volvo mechanic in Seward and concerns for the motor are laid to rest after a linkage nut or two are snugged up and whatever voltage error caused the alarm is cleared. During the day, the weather still calls for 15 kts and 4' seas so we complete the tow through southern Knight Island Passage and into Montague Strait, covering the LTER MS line.

Tuesday, July 30: Back to the Copper River Plume. A nearly cloudless sky and good cell phone coverage prompts us to look for satellite images. R. Potter from UAF delivers two good images from July 29 and we make a plan to tow east of the plume as an upstream boundary condition. We accomplish five crossings of the plume front; if the plume has not changed too much from yesterday's satellite image we will have a good set of transects to compare against the imagery. We deploy an experimental (concrete) Surface Circulation Tracker (SCT) drifter at the end of our transect, slightly east of station MID2i. We anchor in Port Etches for the night.

Wednesday July 31: Fuel tank at ¼. We head to Cordova to refuel one last time. We take on fuel, water and a few last food items. Fuel onboarded: 376 gallons. Water onboarded: 0 gallons. Forecast calls for 15 kt winds and seas of 3' coming up to 4', with 10 kt winds forecast for the following day. An Acrobat tow west of our prior work would provide some valuable downstream data so we decide to see if the forecast conditions are workable. We find ourselves pounding along Montague Island and though we are able to deploy the Acrobat the action of the pitching vessel is too much for the tow cable and we are not able to collect any usable data at even 5 kts. We recover the Acrobat and steam into Patton Bay, which provides a good lee from the westerly winds. Hank catches sharks.

Thursday August 1: We depart Patton Bay and although the wind has abated some overnight we find that sea and wind conditions off Cape Cleare will require a long 6-hour, 10 kt transit of banging into the swell to get back to the mouth of Resurrection Bay. Based on the conditions and forecast models, it appears that nearer to the coast will offer a much better ride so we transit NE into Hinchinbrook Entrance, down Montague Strait and through Elrington Passage. We make good progress across Port Bainbridge, despite still being somewhat slowed by a still sizeable swell. We spend less than an hour slowed significantly by the conditions while exposed. By the time we pass Cape Fairfield it is obvious that we are getting good protection from the Chiswell Islands and we make it back to Seward by mid-afternoon.

Approaching the nearshore silt-laden portion of the Copper River outflow plume.

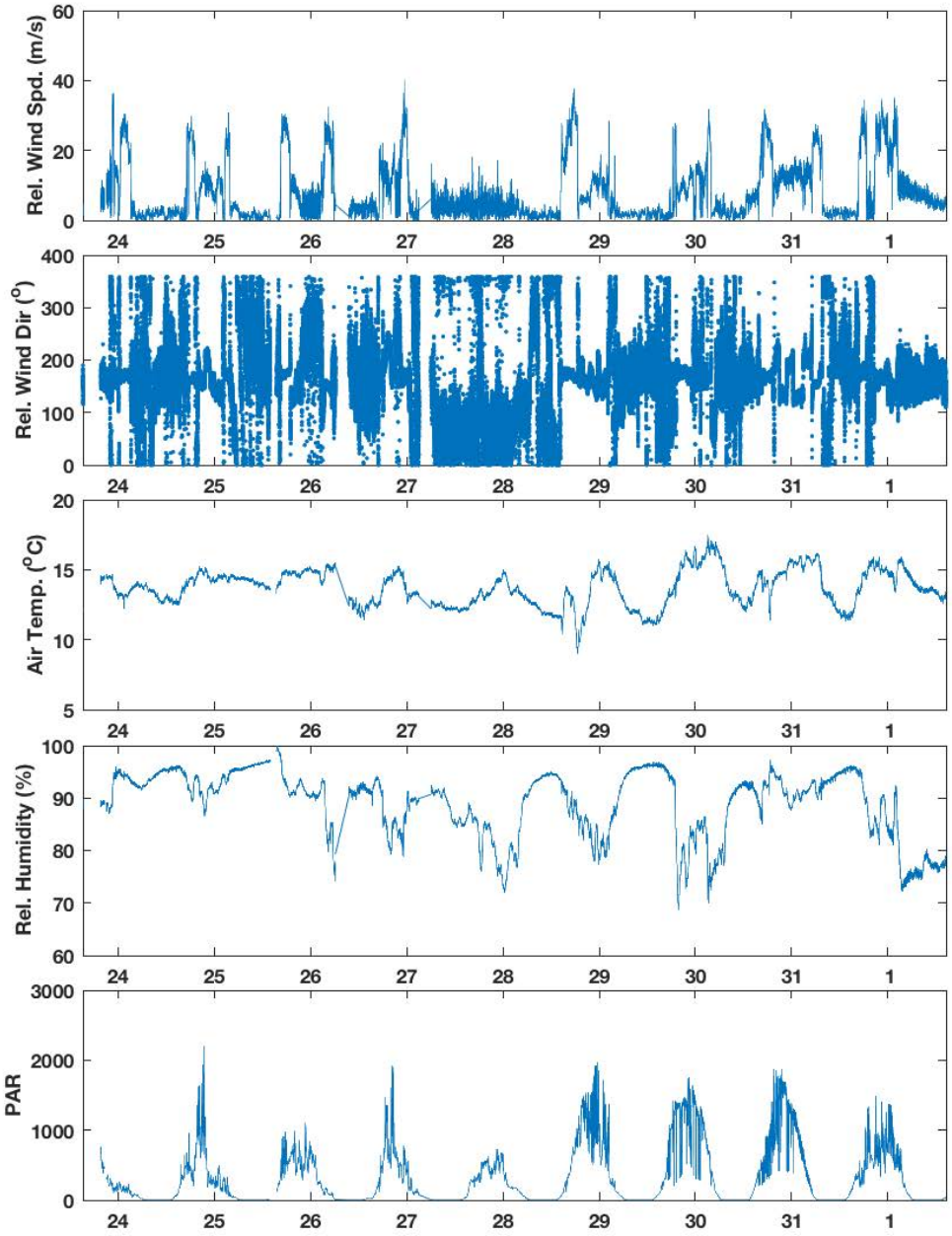


Satellite image from 29 July 2019

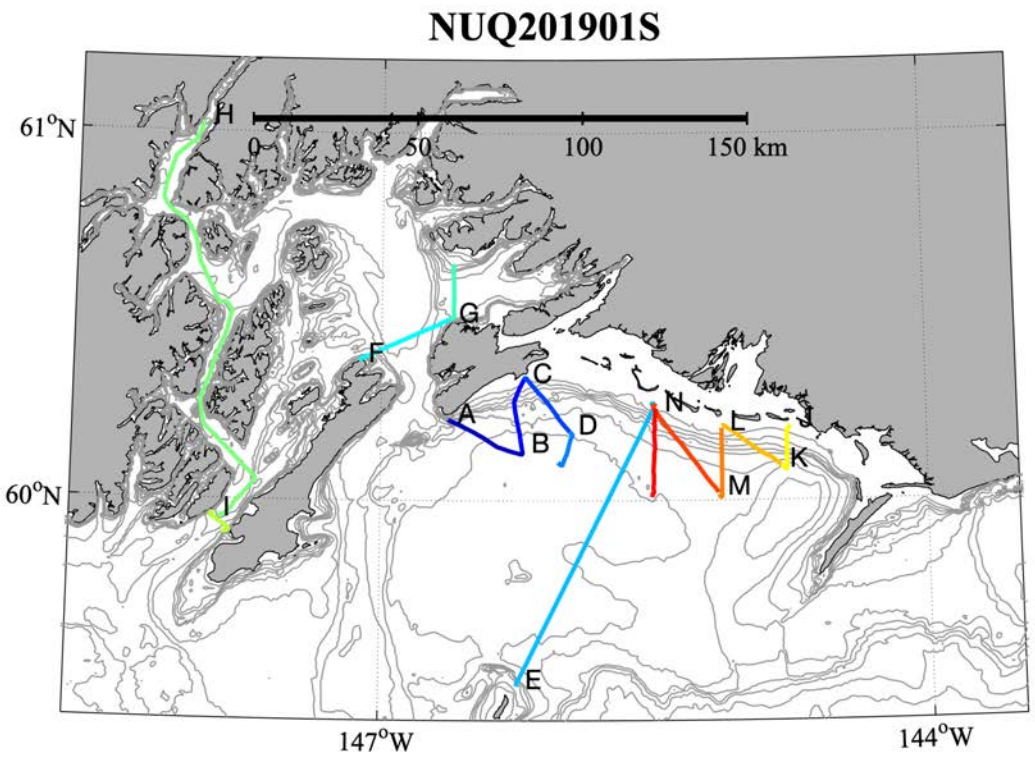
Deck, met station, rigging, and lab bench layouts:

UAF COLLEGE OF FISHERIES AND OCEAN SCIENCES
University of Alaska Fairbanks
NGA LTER
GULF WATCH ALASKA
LTER NETWORK
NORTH PACIFIC RESEARCH BOARD
Exxon Valdez Oil Spill Trustees
U.S. FISH & WILDLIFE SERVICE
NSF

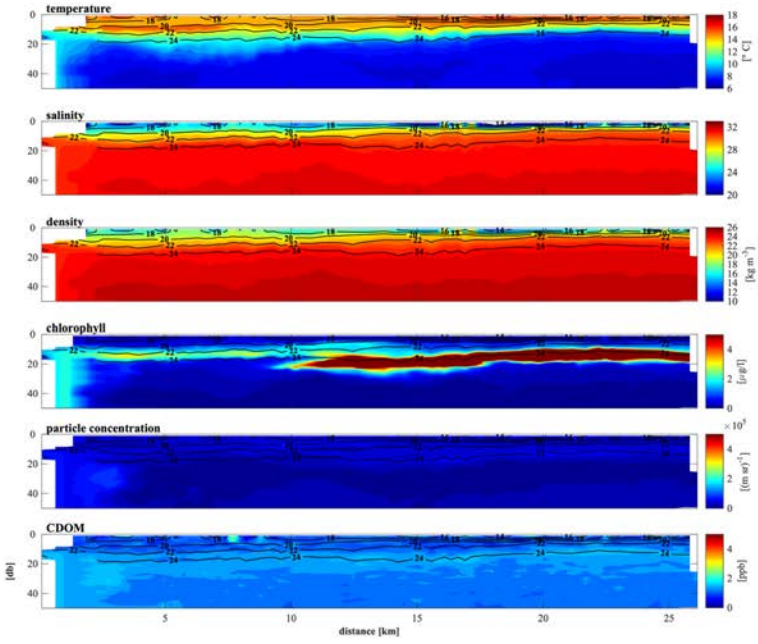
Summary Plots of Data Collected

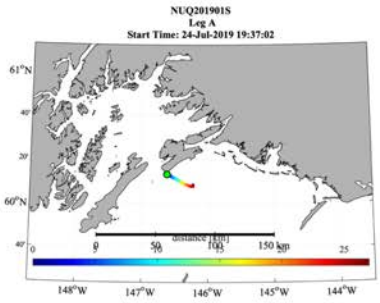


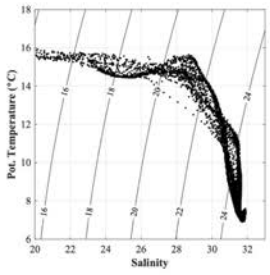
Time series data of underway meteorological data from July 23 to August 1.

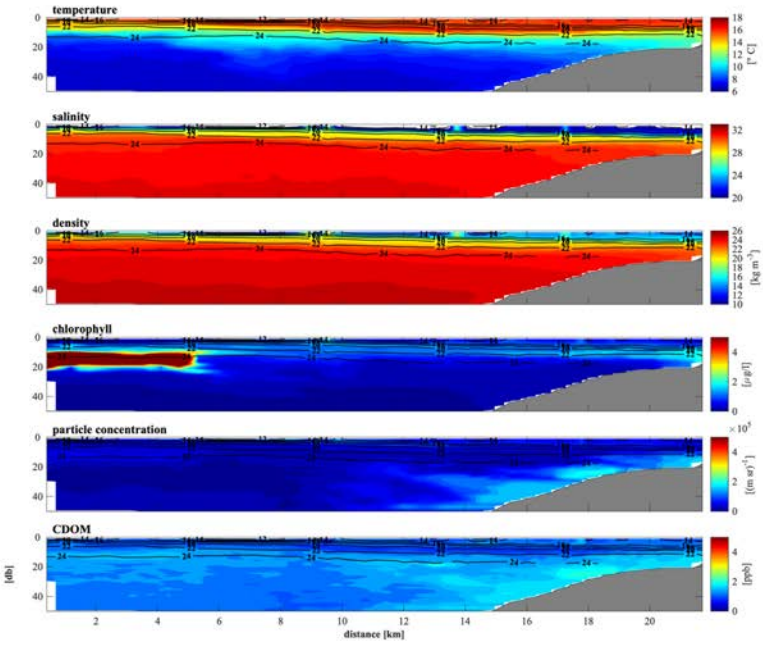


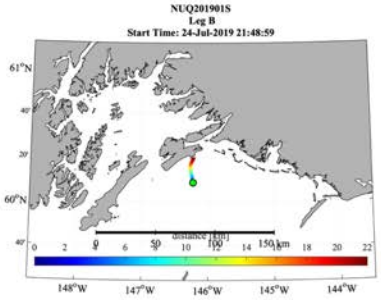
Acrobat transects

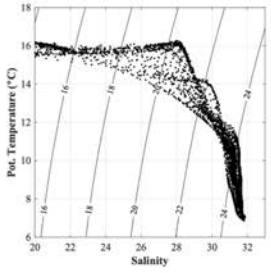


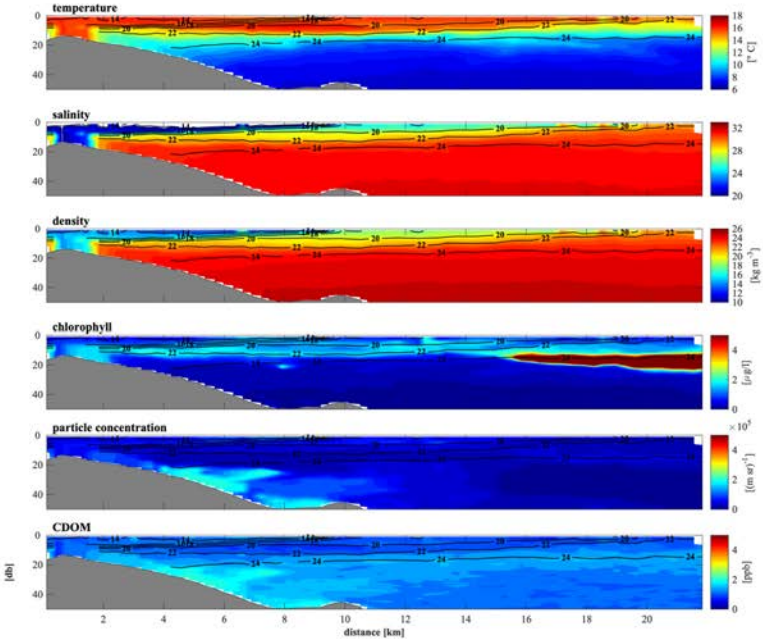


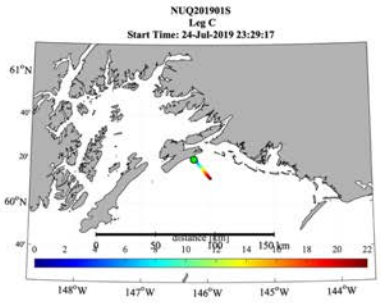


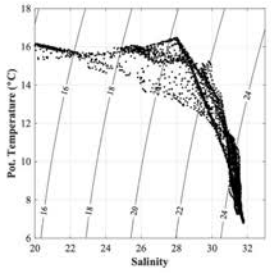

temperature
salinity
density
chlorophyll
particle concentration
CDOM
[db]
distance [km]

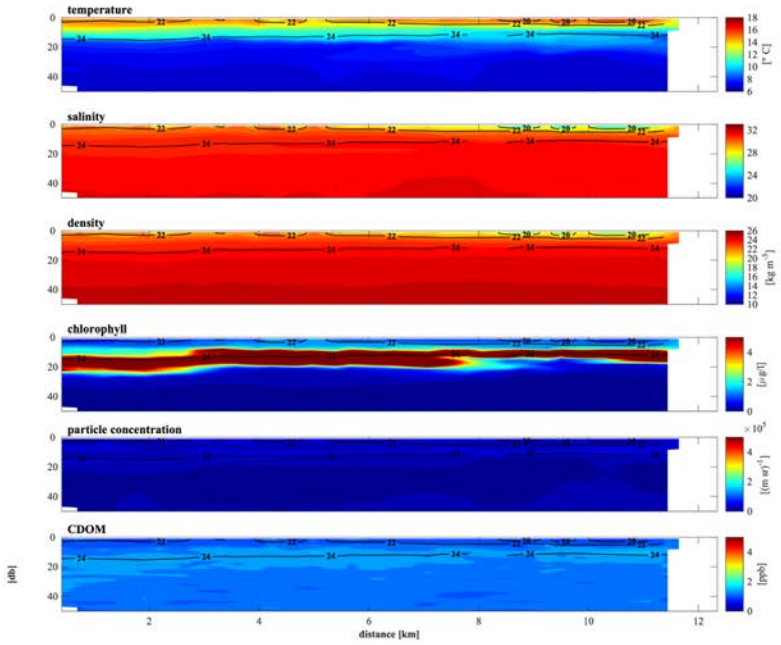

NUQ201901S
Leg B
Start Time: 24-Jul-2019 21:48:59
61°N
60°N
148°W
147°W
146°W
145°W
144°W

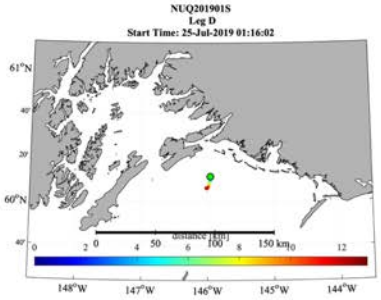

Pot. Temperature (°C)
Salinity

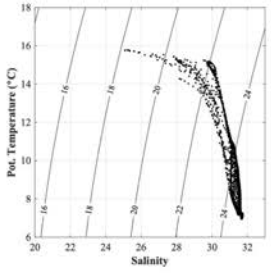

temperature
salinity
density
chlorophyll
particle concentration
CDOM
[db]
distance [km]

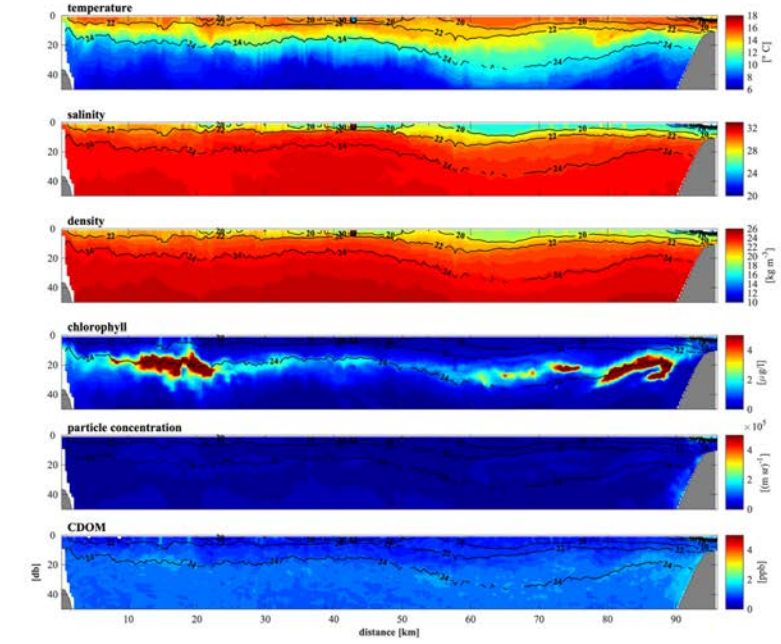

NUQ201901S
Leg C
Start Time: 24-Jul-2019 23:29:17
61°N
60°N
148°W
147°W
146°W
145°W
144°W

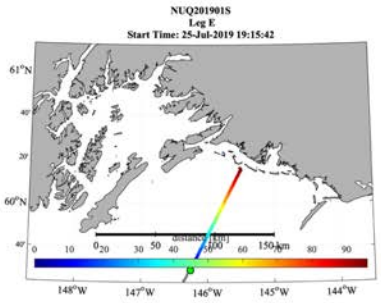

Pot. Temperature (°C)
Salinity

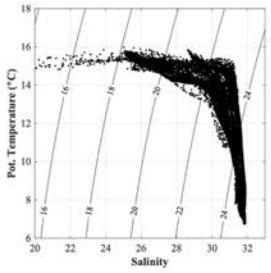

temperature
salinity
density
chlorophyll
particle concentration
CDOM
[db]
distance [km]

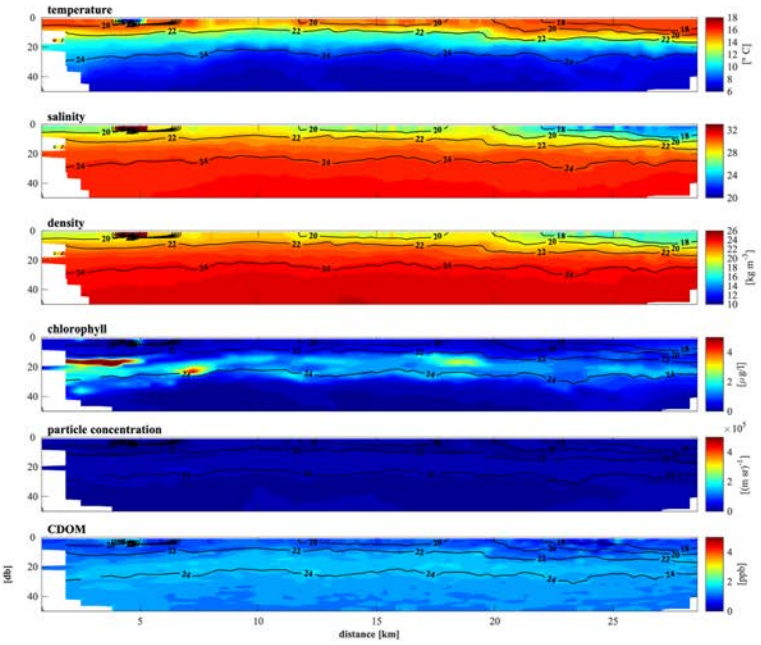

NUQ201901S
Leg D
Start Time: 25-Jul-2019 01:16:02
61°N
60°N
148°W
147°W
146°W
145°W
144°W

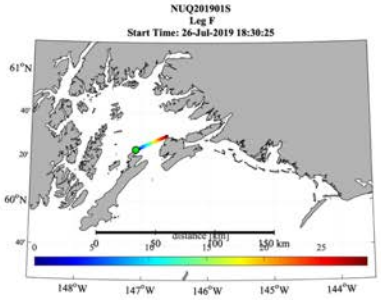

Pot. Temperature (°C)
Salinity

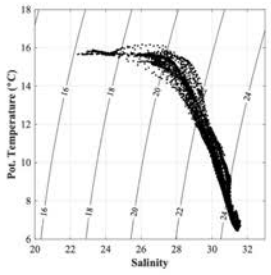

temperature
salinity
density
chlorophyll
particle concentration
CDOM
[db]
distance [km]

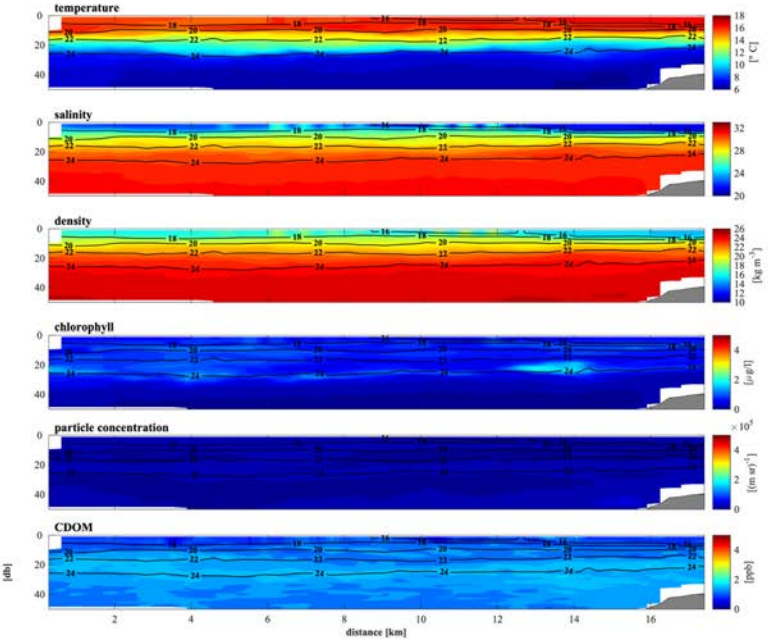

NUQ201901S
Leg E
Start Time: 25-Jul-2019 19:15:42
61°N
60°N
148°W
147°W
146°W
145°W
144°W

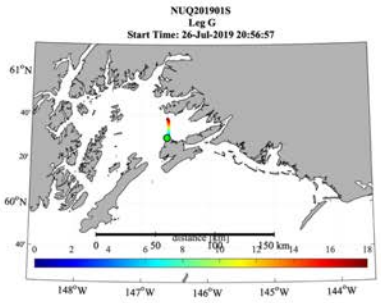

Pot. Temperature (°C)
Salinity

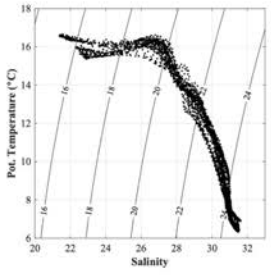

temperature
salinity
density
chlorophyll
particle concentration
CDOM
[db]
distance [km]

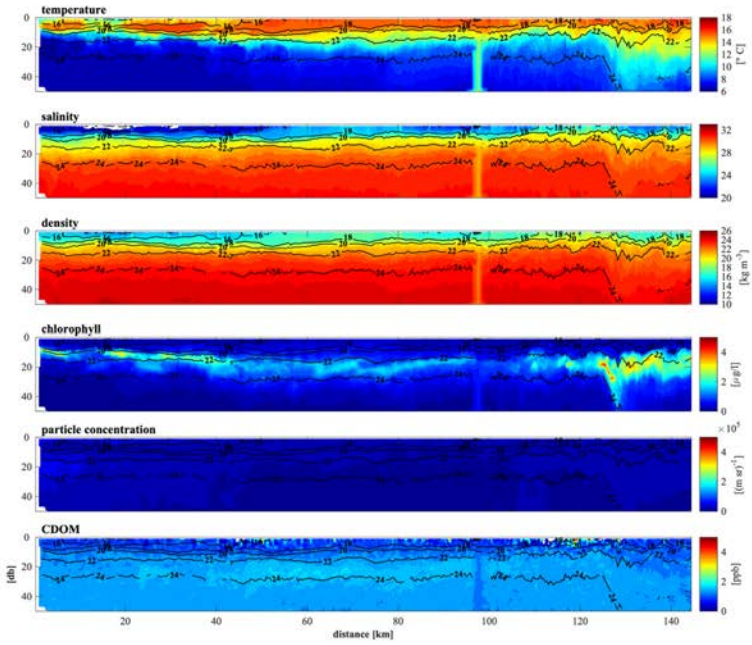

NUQ201901S
Leg F
Start Time: 26-Jul-2019 18:30:25
61°N
60°N
148°W
147°W
146°W
145°W
144°W
distance [km]

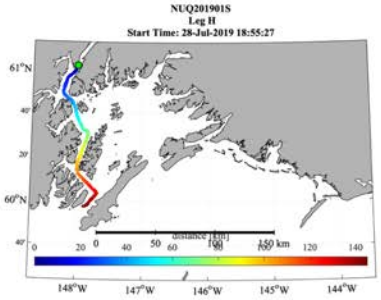

Pot. Temperature (°C)
Salinity

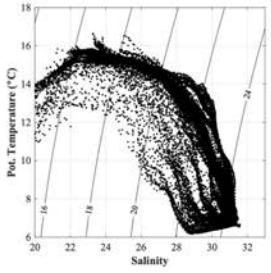

temperature
salinity
density
chlorophyll
particle concentration
CDOM
[db]
distance [km]

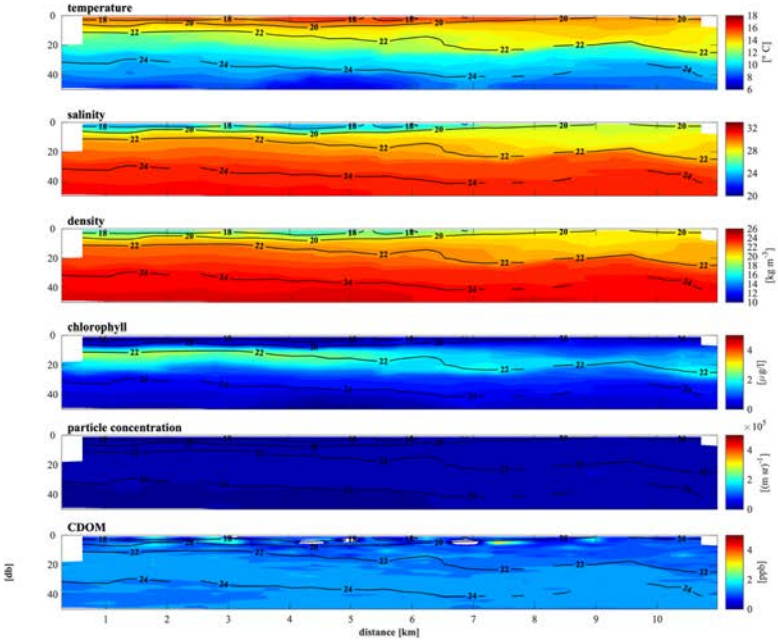

NUQ201901S
Leg G
Start Time: 26-Jul-2019 20:56:57
61°N
60°N
148°W
147°W
146°W
145°W
144°W
distance [km]

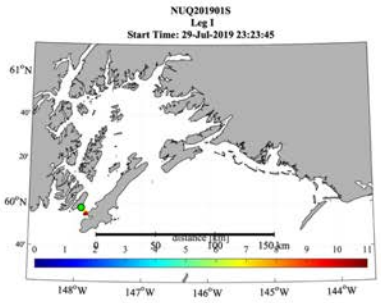

Pot. Temperature (°C)
Salinity

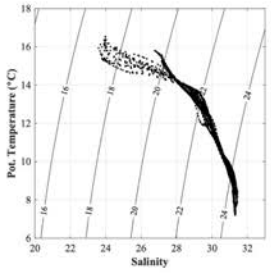

temperature
salinity
density
chlorophyll
particle concentration
CDOM
[db]
distance [km]

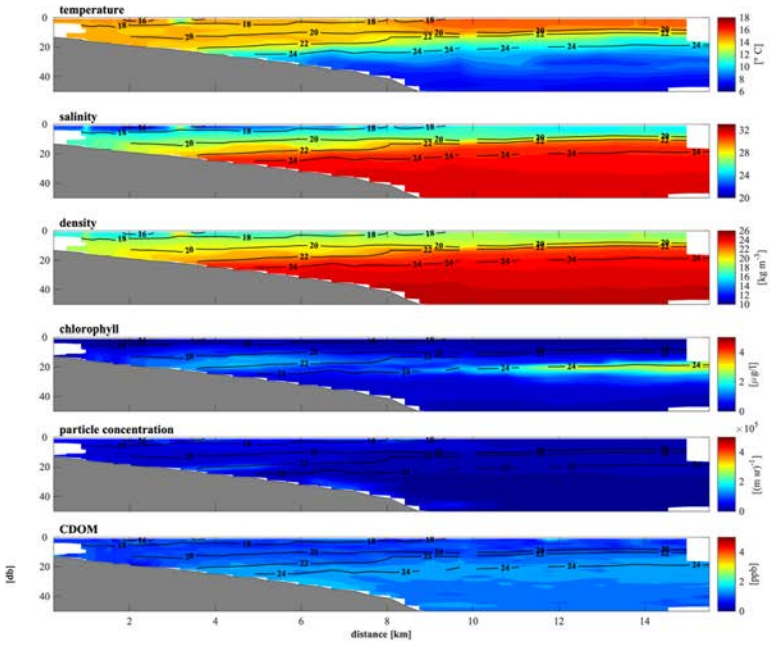

NUQ201901S
Leg H
Start Time: 28-Jul-2019 18:55:27
61°N
60°N
148°W
147°W
146°W
145°W
144°W

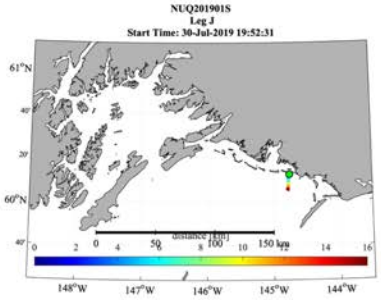

Pot. Temperature (°C)
Salinity

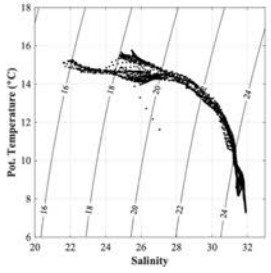

temperature
salinity
density
chlorophyll
particle concentration
CDOM
[db]
distance [km]

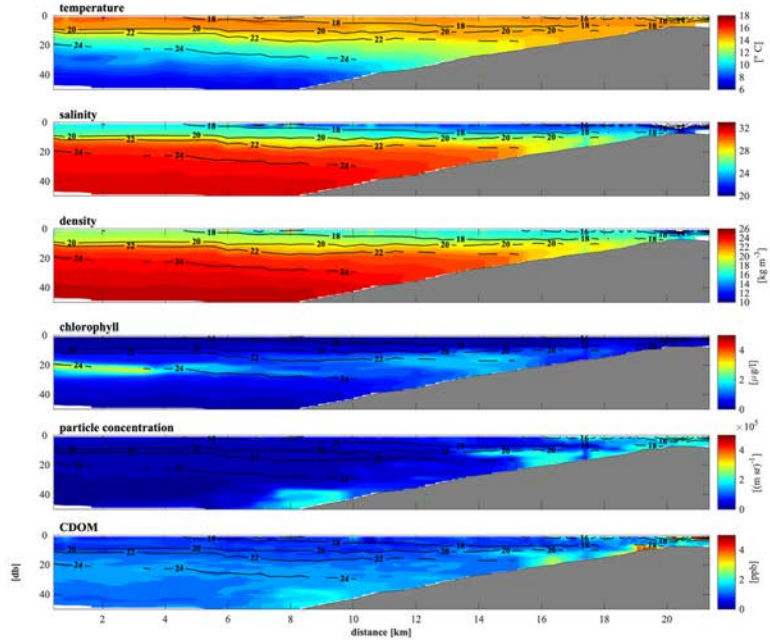

NUQ201901S
Leg I
Start Time: 29-Jul-2019 23:23:45
61°N
60°N
148°W
147°W
146°W
145°W
144°W

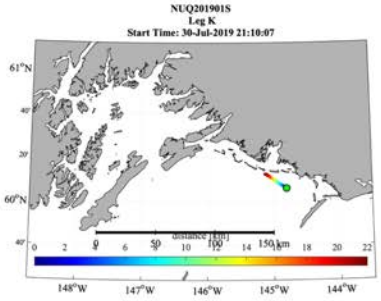

Pot. Temperature (°C)
Salinity

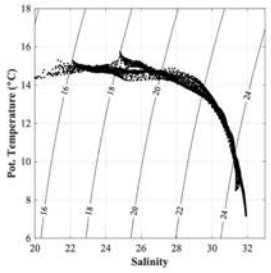

temperature
salinity
density
chlorophyll
particle concentration
CDOM
[db]
distance [km]

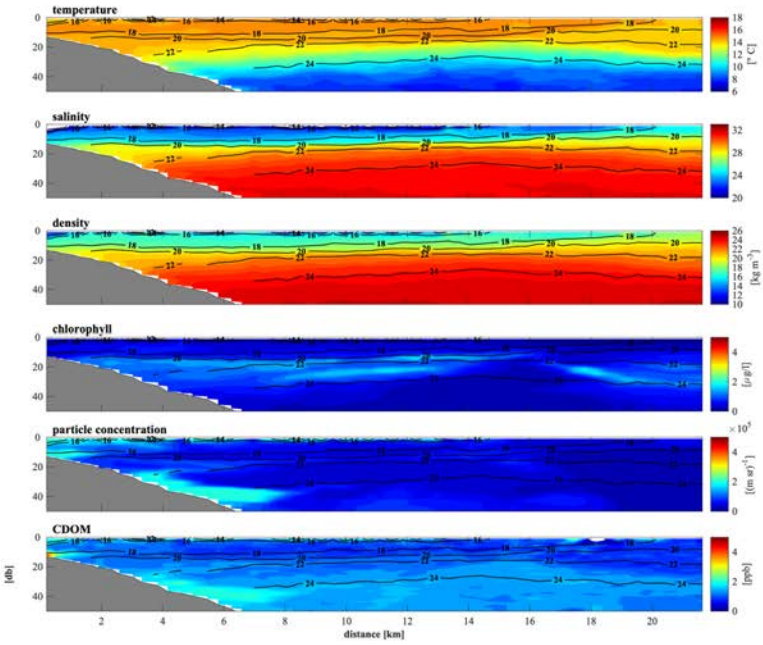

NUQ201901S
Leg J
Start Time: 30-Jul-2019 19:52:31
61°N
60°N
148°W
147°W
146°W
145°W
144°W

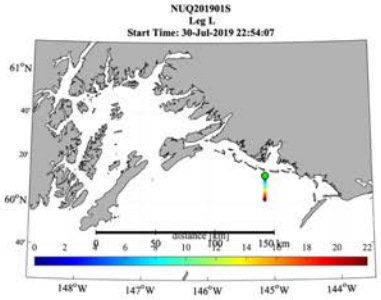

Pot. Temperature (°C)
Salinity

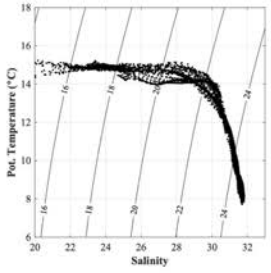

temperature
salinity
density
chlorophyll
particle concentration
CDOM
[db]
distance [km]

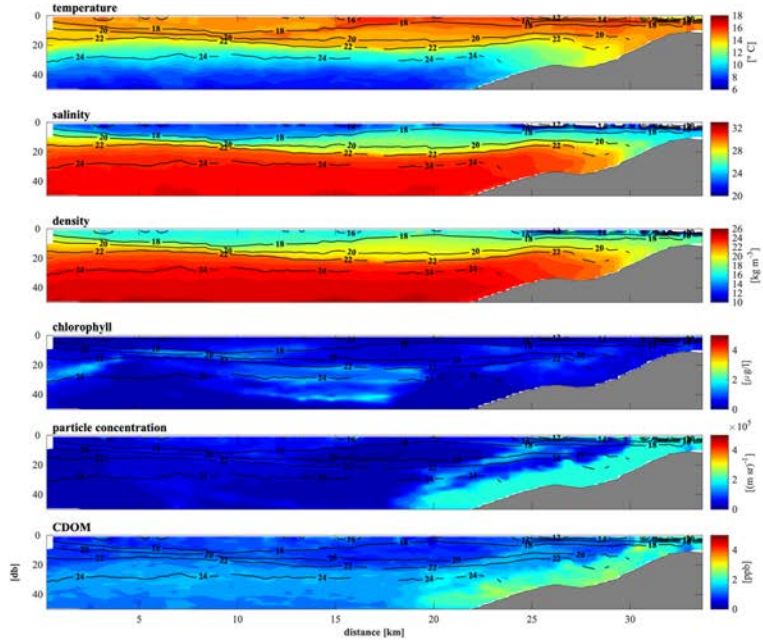

NUQ201901S
Leg K
Start Time: 30-Jul-2019 21:10:07
61°N
60°N
148°W
147°W
146°W
145°W
144°W

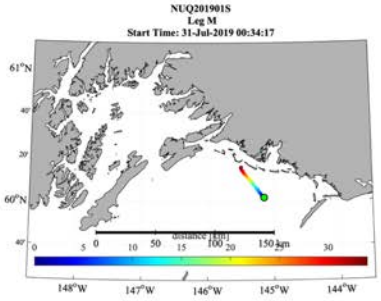

Pot. Temperature (°C)
Salinity

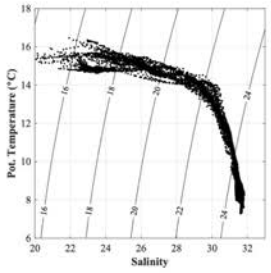

temperature
salinity
density
chlorophyll
particle concentration
CDOM
[db]
distance [km]

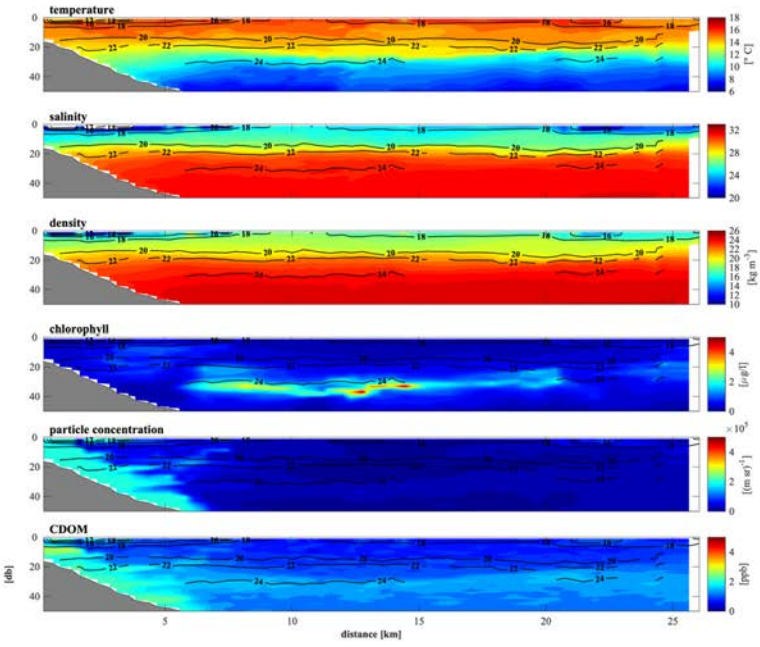

NUQ201901S
Leg L
Start Time: 30-Jul-2019 22:54:07
61°N
60°N
148°W
147°W
146°W
145°W
144°W
distance [km]

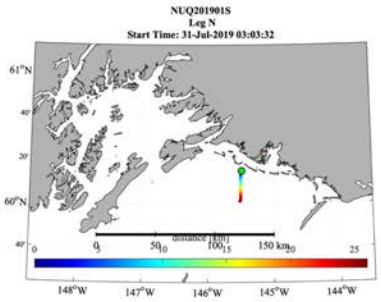

Pot. Temperature (°C)
Salinity

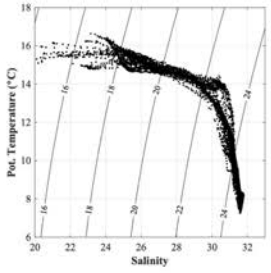

temperature
salinity
density
chlorophyll
particle concentration
CDOM
[db]
distance [km]

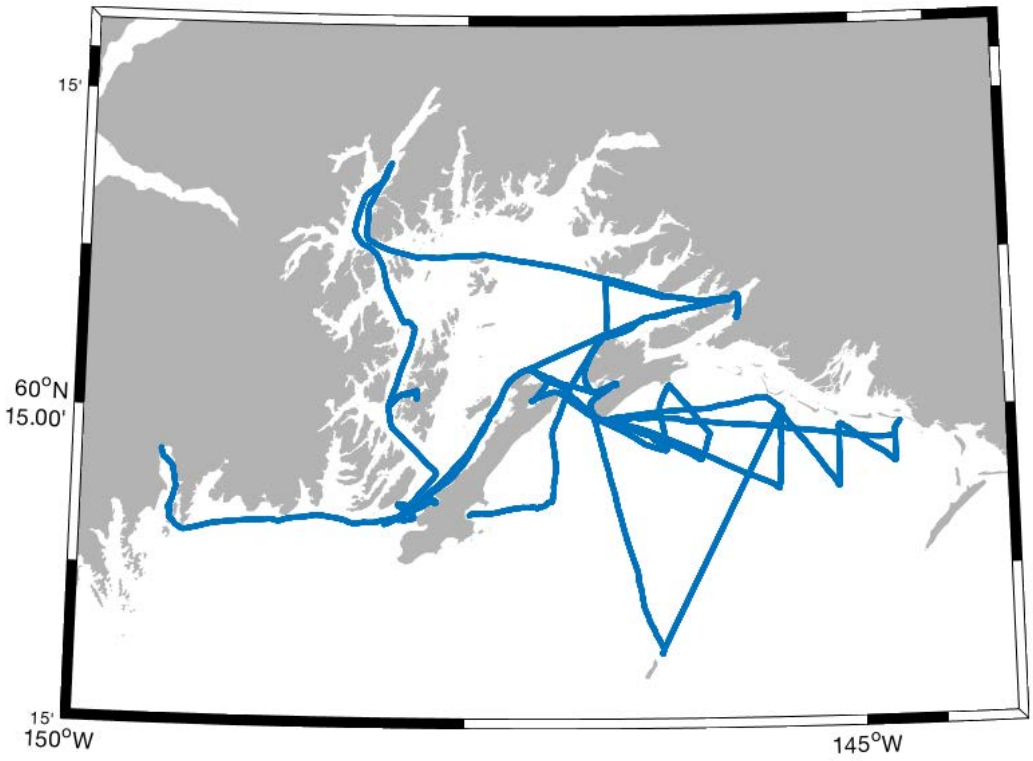

NUQ201901S
Leg M
Start Time: 31-Jul-2019 00:34:17
61°N
60°N
148°W
147°W
146°W
145°W
144°W
distance [km]


Pot. Temperature (°C)
Salinity

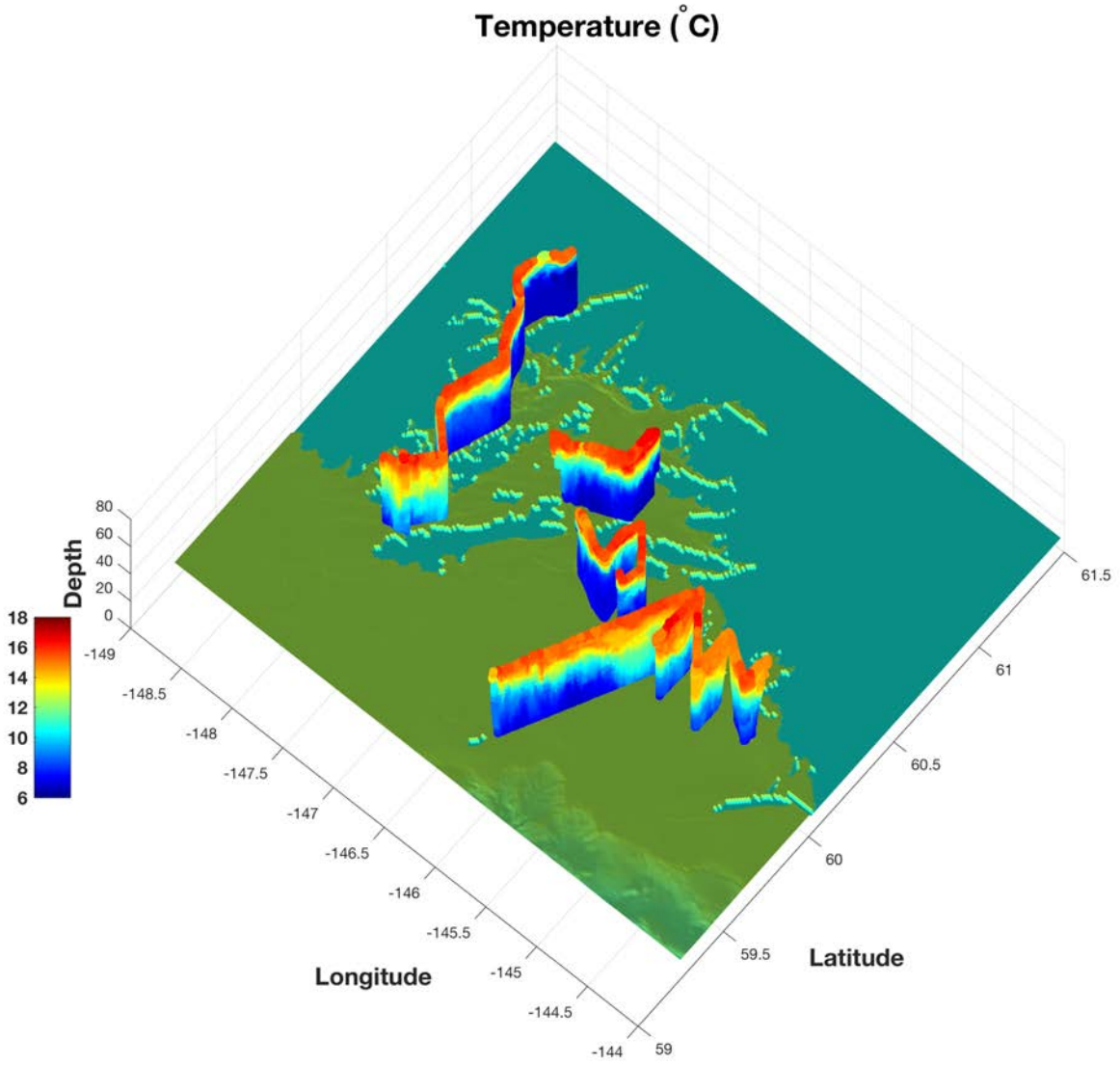

temperature
salinity
density
chlorophyll
particle concentration
CDOM
[db]
distance [km]


NUQ201901S
Leg N
Start Time: 31-Jul-2019 03:03:32
61°N
60°N
148°W
147°W
146°W
145°W
144°W
distance [km]
150 km


Pot. Temperature (°C)
Salinity



Cruise Track



UAF COLLEGE OF FISHERIES AND OCEAN SCIENCES
University of Alaska Fairbanks

NGA LTER

GULF WATCH ALASKA

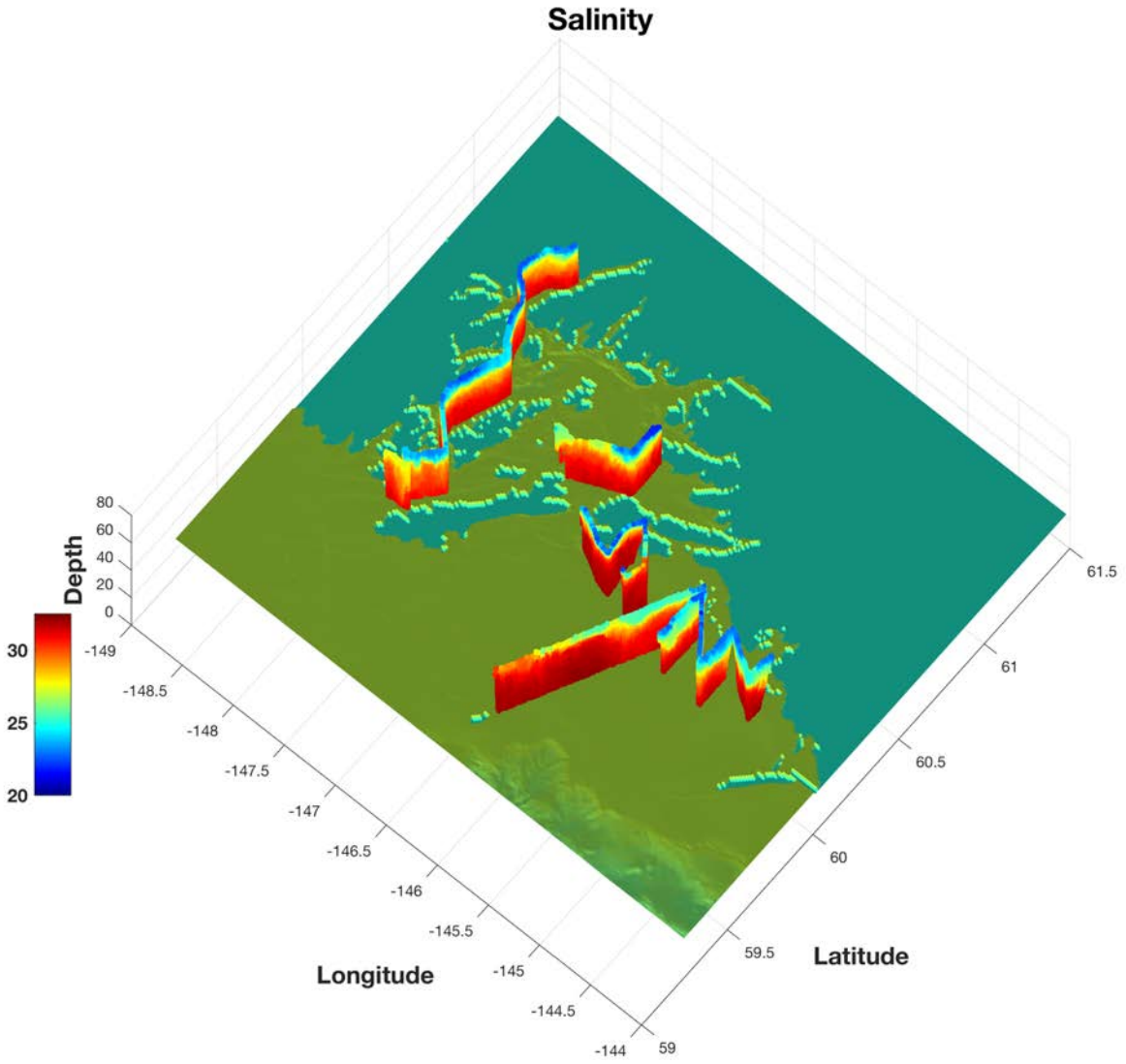
LTER NETWORK

NORTH PACIFIC RESEARCH BOARD

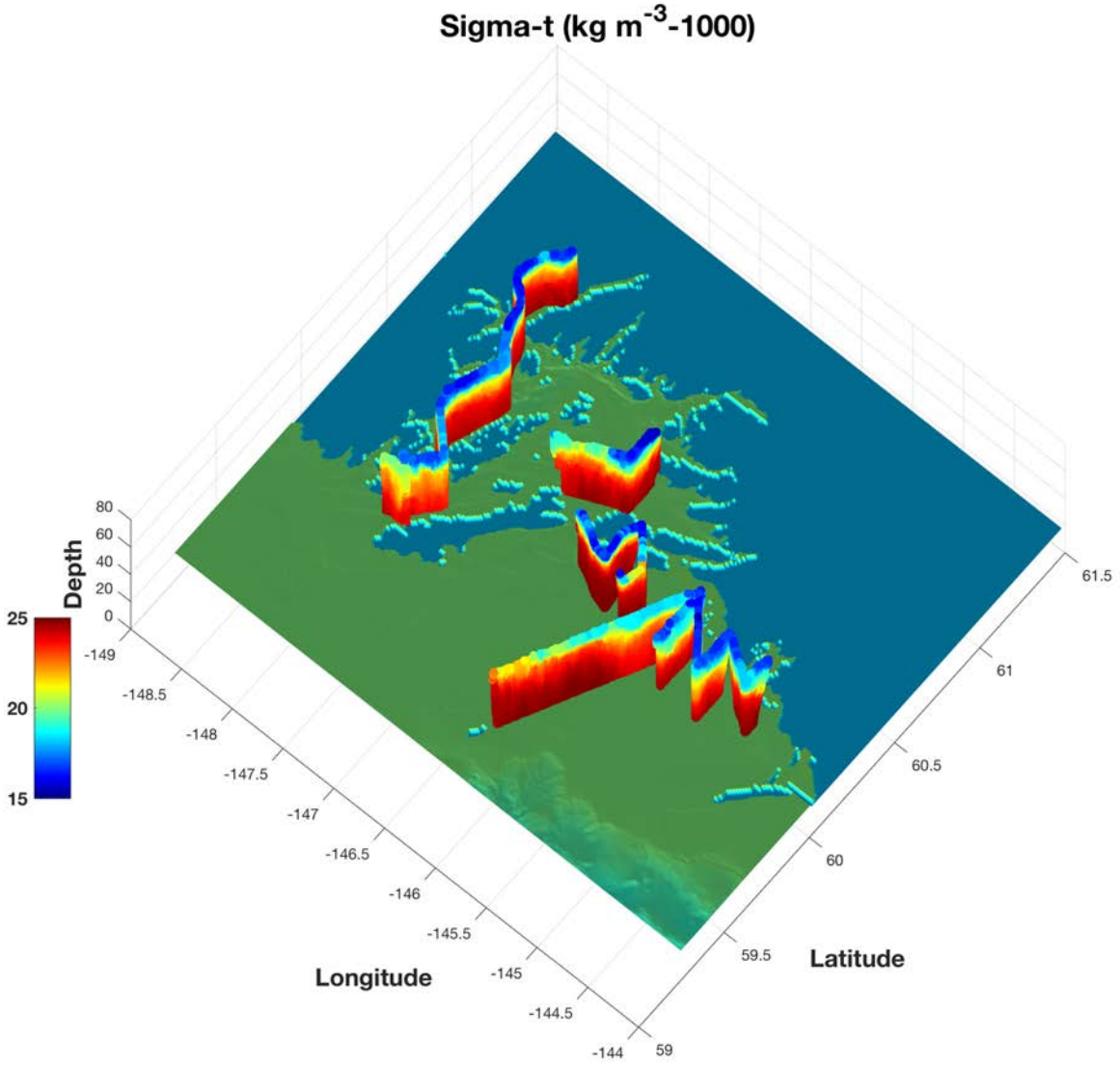
Exxon Valdez Oil Spill Trustees

U.S. FISH & WILDLIFE SERVICE

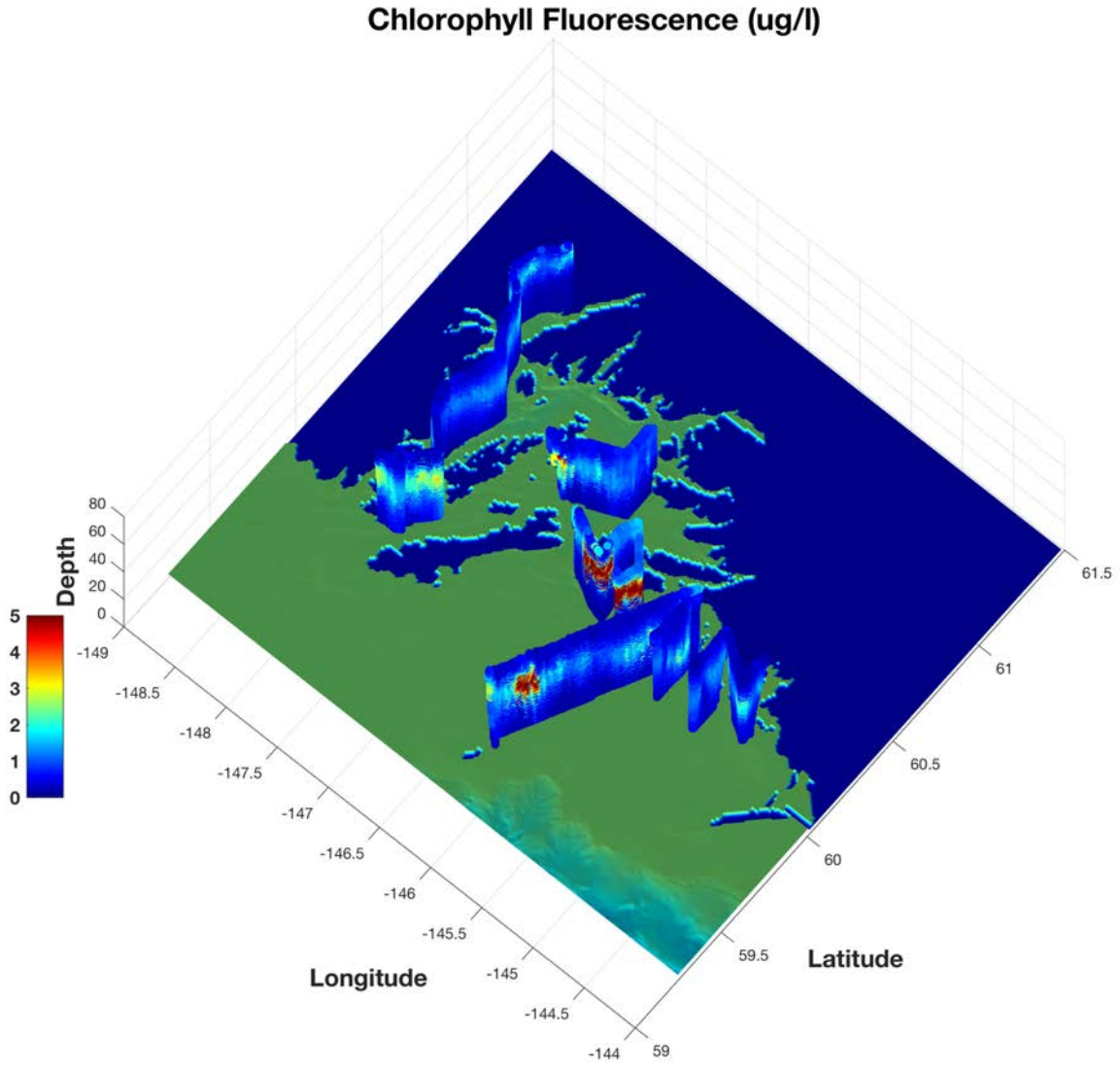
NSF



UAF COLLEGE OF FISHERIES AND OCEAN SCIENCES
University of Alaska Fairbanks
NGA LTER
GULF WATCH ALASKA
LTER NETWORK
NORTH PACIFIC RESEARCH BOARD
Exxon Valdez Oil Spill Trustees
U.S. FISH & WILDLIFE SERVICE
NSF



UAF COLLEGE OF FISHERIES AND OCEAN SCIENCES
University of Alaska Fairbanks
NGA LTER
GULF WATCH ALASKA
LTER NETWORK
NORTH PACIFIC RESEARCH BOARD
Exxon Valdez Oil Spill Trustees
U.S. FISH & WILDLIFE SERVICE
NSF



COLLEGE OF FISHERIES AND OCEAN SCIENCES
University of Alaska Fairbanks

NGA LTER

GULF WATCH ALASKA

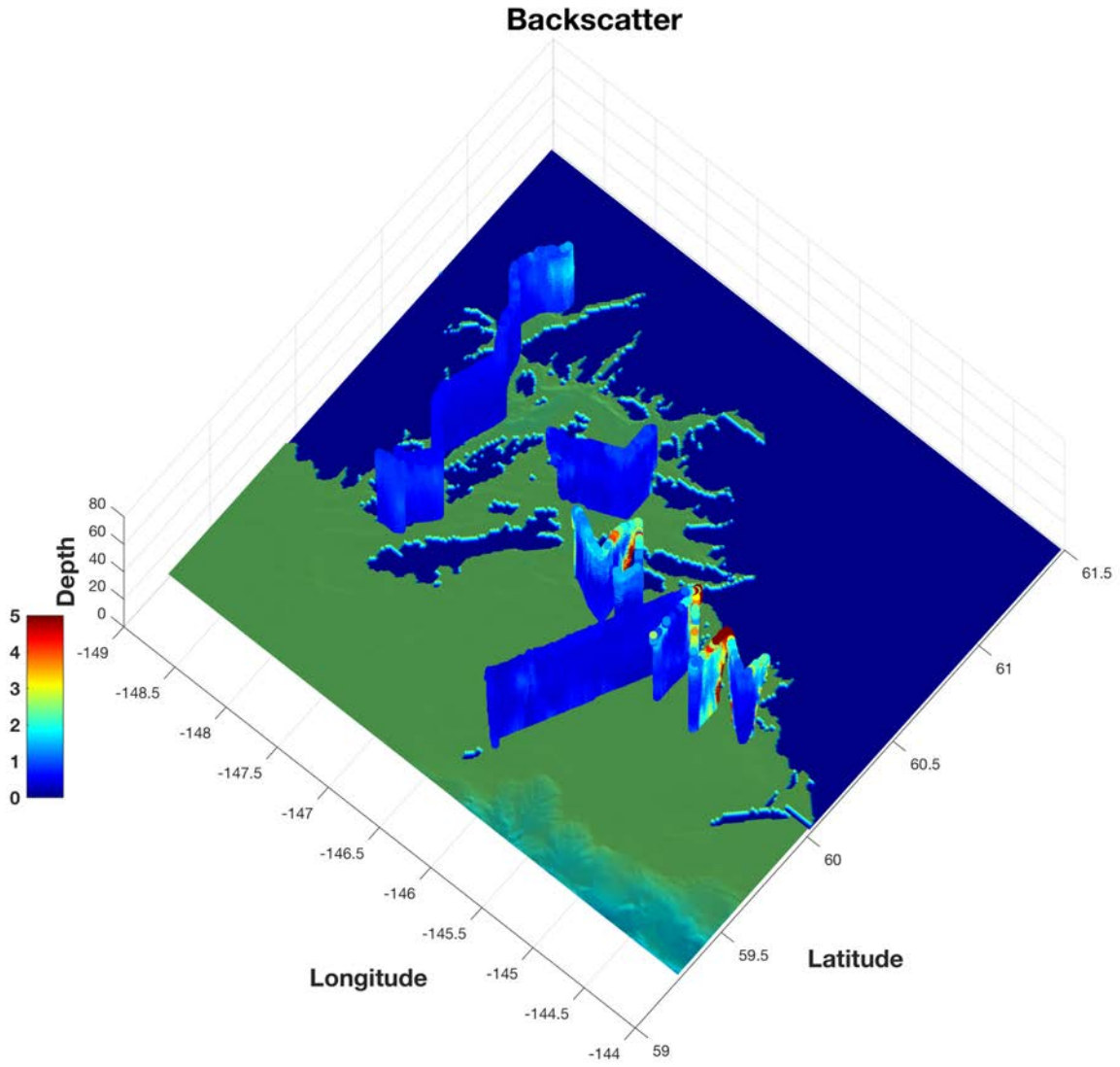
LTER NETWORK

NORTH PACIFIC RESEARCH BOARD

Exxon Valdez Oil Spill Trustees

U.S. FISH & WILDLIFE SERVICE

NSF



COLLEGE OF FISHERIES AND OCEAN SCIENCES
University of Alaska Fairbanks

NGA LTER

GULF WATCH ALASKA

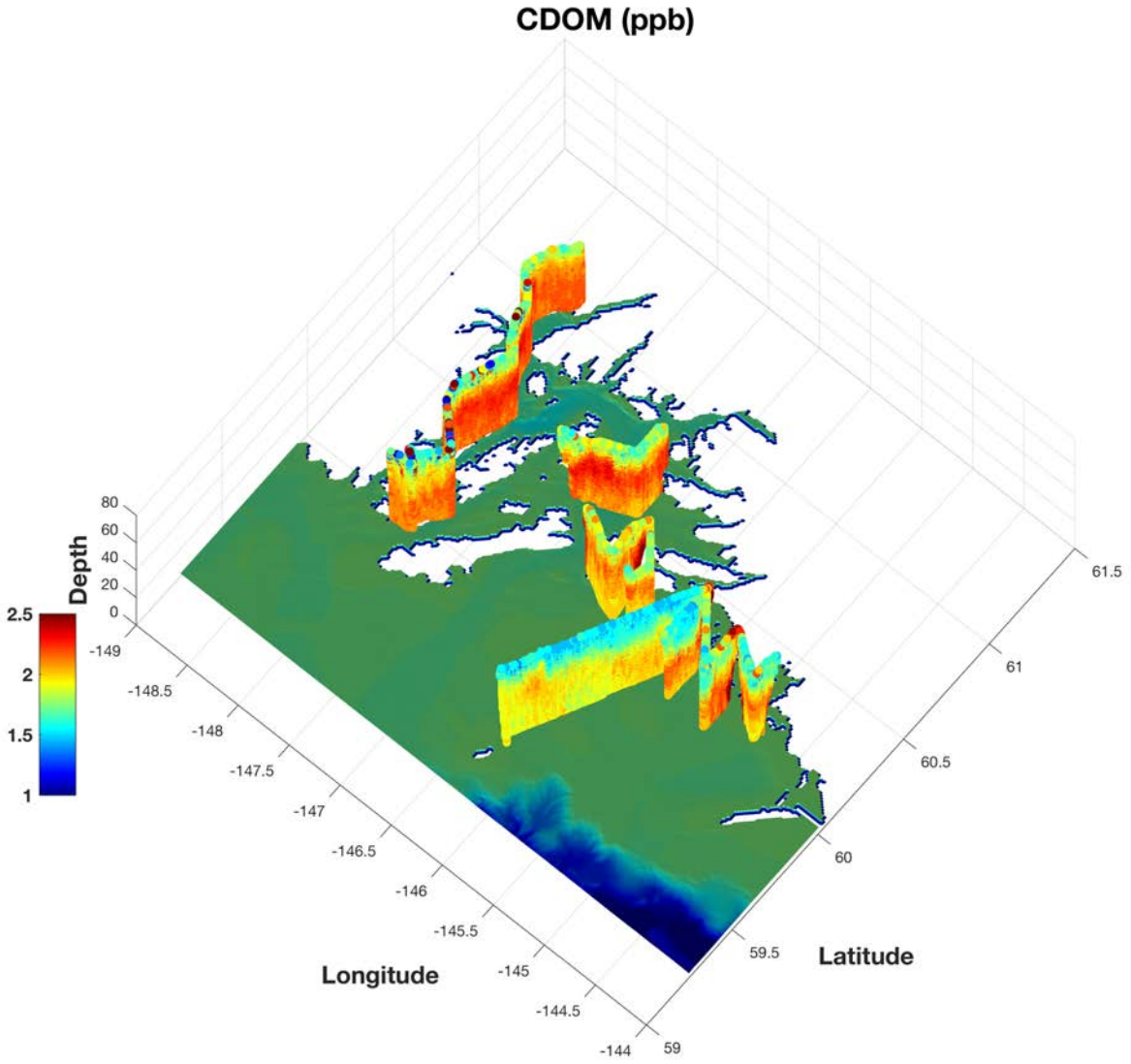
LTER NETWORK

NORTH PACIFIC RESEARCH BOARD

Exxon Valdez Oil Spill Trustees

U.S. FISH & WILDLIFE SERVICE

NSF



COLLEGE OF FISHERIES AND OCEAN SCIENCES
University of Alaska Fairbanks

NGA LTER

GULF WATCH ALASKA

LTER NETWORK

NORTH PACIFIC RESEARCH BOARD

Exxon Valdez Oil Spill Trustees

U.S. FISH & WILDLIFE SERVICE

NSF

Recommendations

In addition to the scientific goals of the cruise, the maiden voyage of R/V Nanuq was an opportunity to assess the capabilities of this brand-new vessel with an eye on operations, future mission planning and potential upgrades. In the course of the cruise we noted a number of additions that could improve the operational, safety, and scientific readiness of the vessel. In no order of priority, these include:

Operational & Safety Needs

- Autopilot
- Larger capacity house battery bank
- Access to generator power independent of inverter: kitchen appliances (e.g. heating elements and microwave) and some science equipment should have option of running directly off generator.
- Tie-down rails or cleats on roof
- Skiff & motor
- Stern deck squawk box
- Interior satellite phone antenna hookup
- Garmin inReach communicator
- More cleats: on deck between A-frame legs and hydraulic rams, near davit on railing
- Backup VHF radio
- Check existing VHF antenna
- Lights in hold spaces
- Light for stairs to below
- Ceiling panel dividers: insulate above to avoid condensation drips
- Fresh water alarm for low water condition
- Fuel tank sight level

Science Needs

- Acoustic pole and/or through-hull acoustic well
- Electronics rack: above stern-facing window
- TSG & underway meteorological & Nav./sounder data acquisition system
- Wire chase hole(s) through counter to power and data plugs below
- Brackets for scientific sensors on mast
- Shelving or storage bins in science hold. Need to keep bilge pump clear of shifting cargo

Amenities

- Hooks (galley items; coats; hats)
- AM/FM radio, sound system
- Kitchen Cabinet Shelves
- Bunk curtains
- Shop Vac

R/V Nanuq Operational Characteristics

To assist planning of future missions, we used the vessel's electronic fuel consumption readouts to assess the fuel efficiency of the vessel at different engine speeds. Please note these numbers will require derating for potential sensor and environmental errors that could impact the results. We conducted these tests as we returned to Resurrection Bay. Waters were calm but had unknown background currents, which can affect results. We took only one instantaneous reading at each engine speed. A more complete test would involve multiple measures at each speed and under documented and different wind, wave and current conditions. Nonetheless, the measurements are useful to show trade-offs associated with speed, distance and fuel consumption. Distance computations assume a 400 gallon fuel capacity. The transition from vessel on- and off-plane occurred as engine speed increased from about 2600 to 2800 rpm. Low idle measures should be repeated with one engine only.

Engine Speed (rpm)	Consumption (gal/hr)	Speed (kts)	Time (hrs)	Distance (n mi)
0	0	0	x	0
780 (	0.8	5	500	2500
1310	3.2	8	125	1000
2010	10	11.5	40	460
2510	16	16.5	25	412.5
2600	16.5	19.7	24.242	477.58
2810	19	22.2	21.053	467.37
2960	22	24.5	18.182	445.45
3140	25	27	16	432
3410	31	30.1	12.903	388.39

R/V Nanuq Fuel Curves