

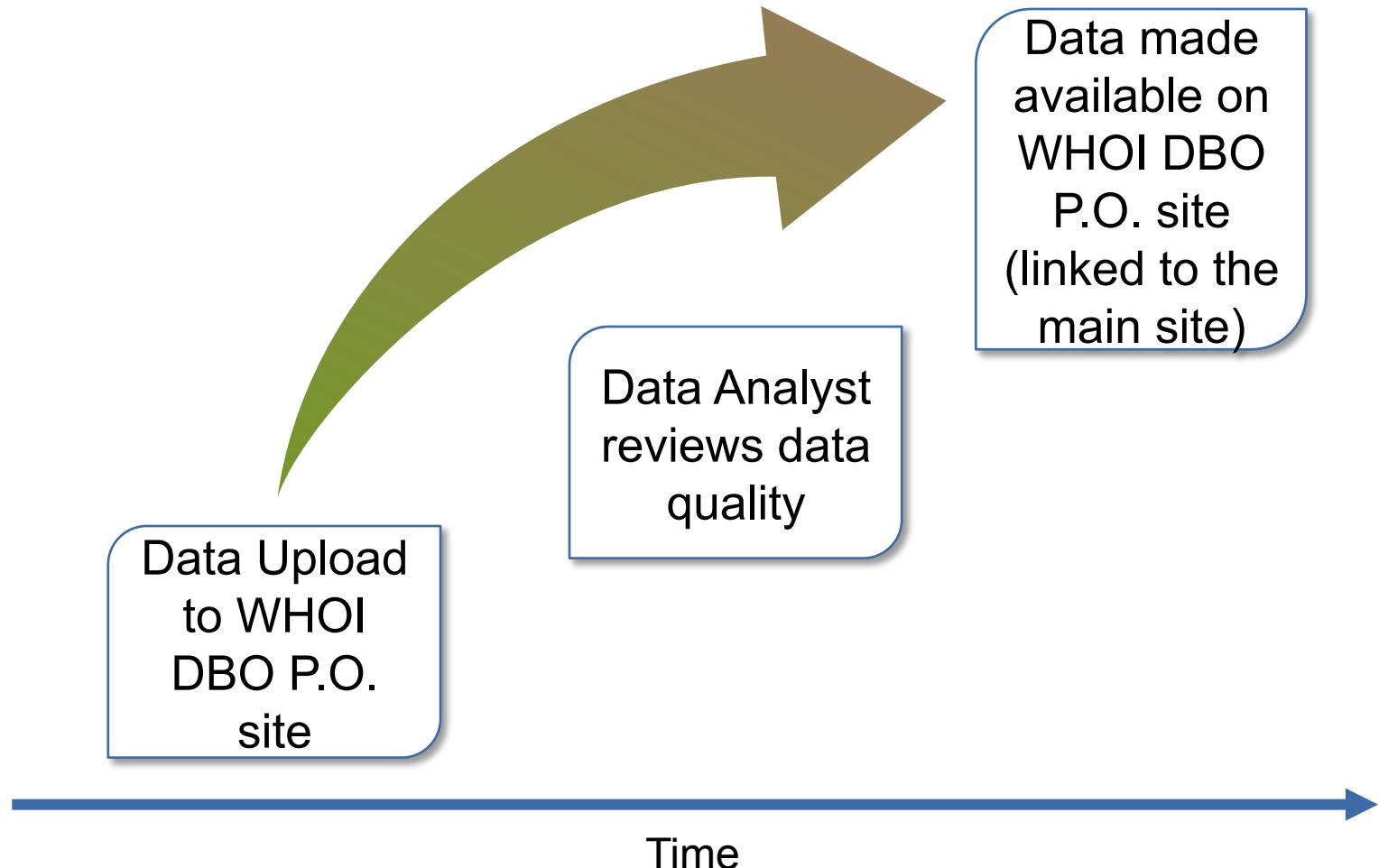
DBO PHYSICAL OCEANOGRAPHY

1. ROBERT PICKART AND CAROLINA NOBRE

Who's Who

Lead	Role	Contact information
Bob Pickart	P.O Lead	rpickart@whoi.edu
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Andree Ramsey	ADCP Data	aramsey@whoi.edu

The Assembly Line

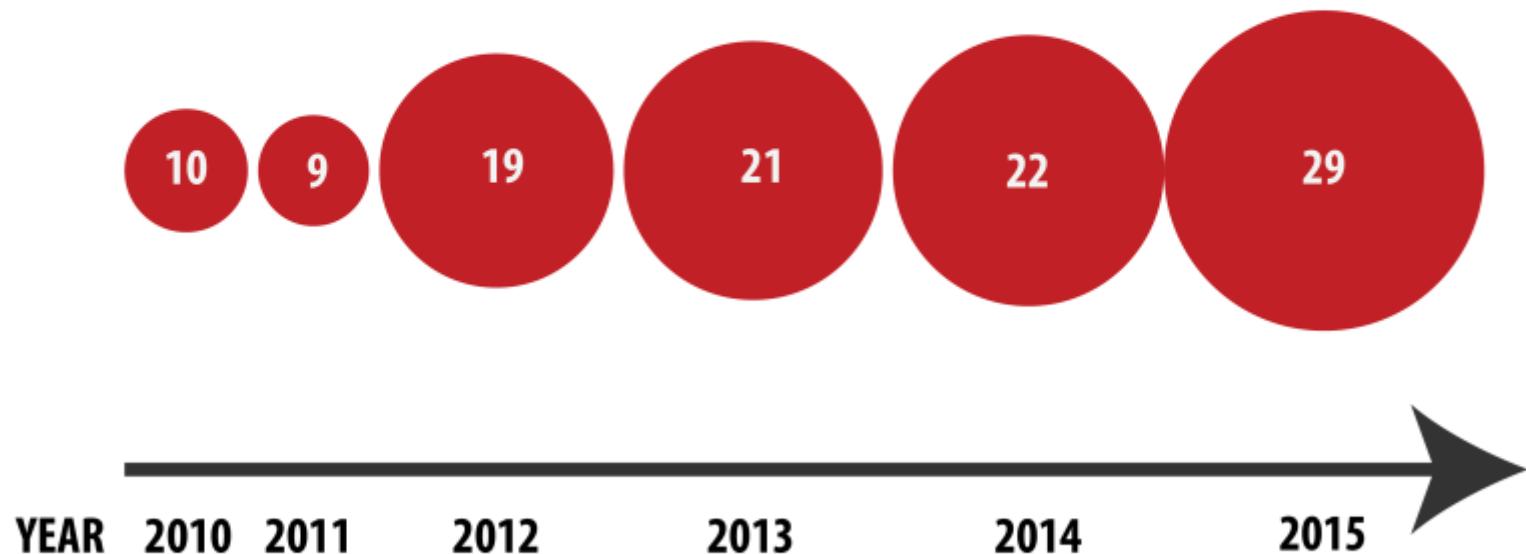


Data Coverage



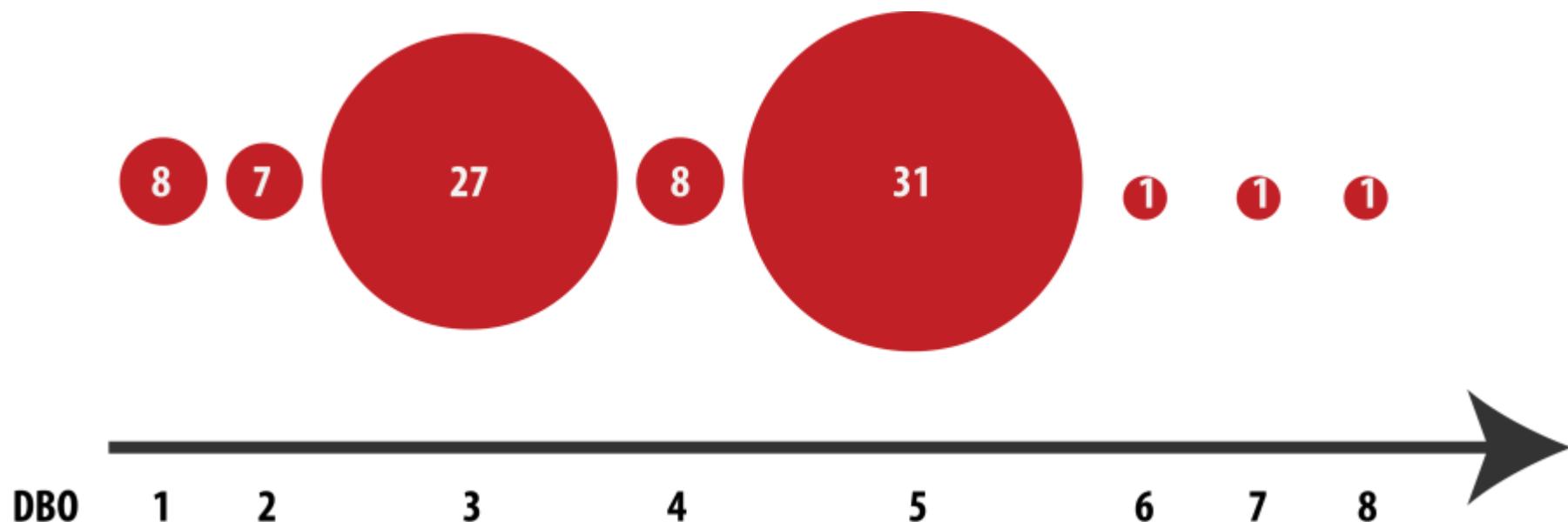
Data Coverage - CTD

All ctd crossings per year



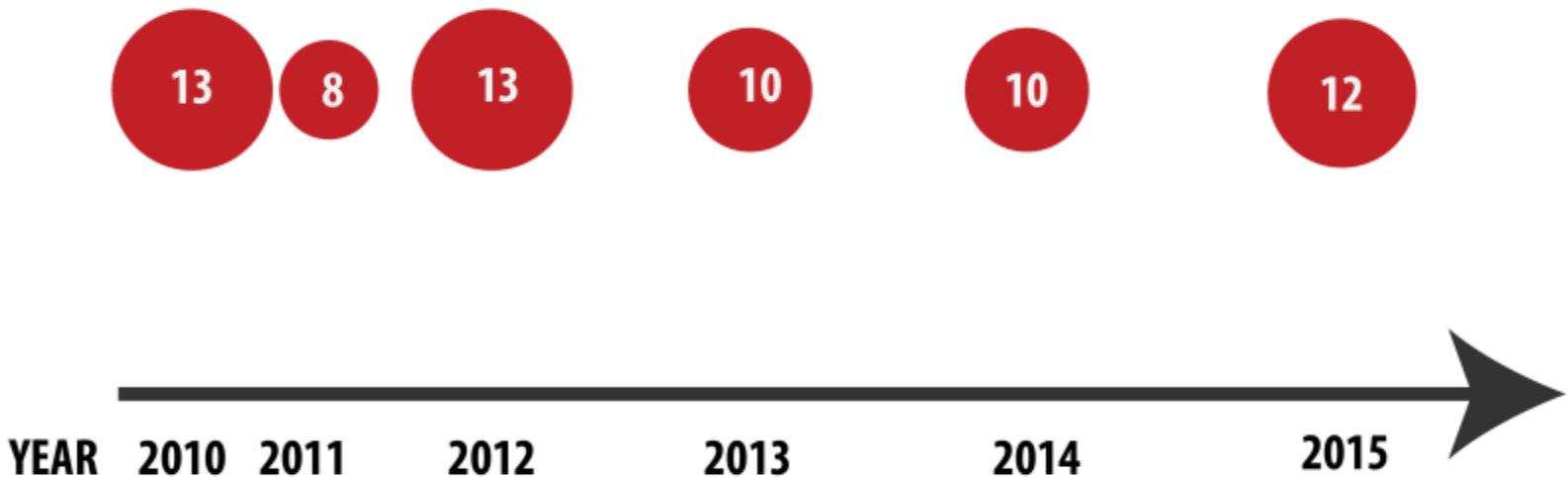
Data Coverage - CTD

All ctd crossings per line



Data Coverage - ADCP

All adcp crossings per year



Science Highlights



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Deep-Sea Research I

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Water properties, heat and volume fluxes of Pacific water in Barrow Canyon during summer 2010



Motoyo Itoh ^{a,*}, Robert S. Pickart ^b, Takashi Kikuchi ^a, Yasushi Fukamachi ^c, Kay I. Ohshima ^c, Daisuke Simizu ^{c,d}, Kevin R. Arrigo ^e, Svein Vagle ^f, Jianfeng He ^g, Carin Ashjian ^b, Jeremy T. Mathis ^b, Shigeto Nishino ^a, Carolina Nobre ^b

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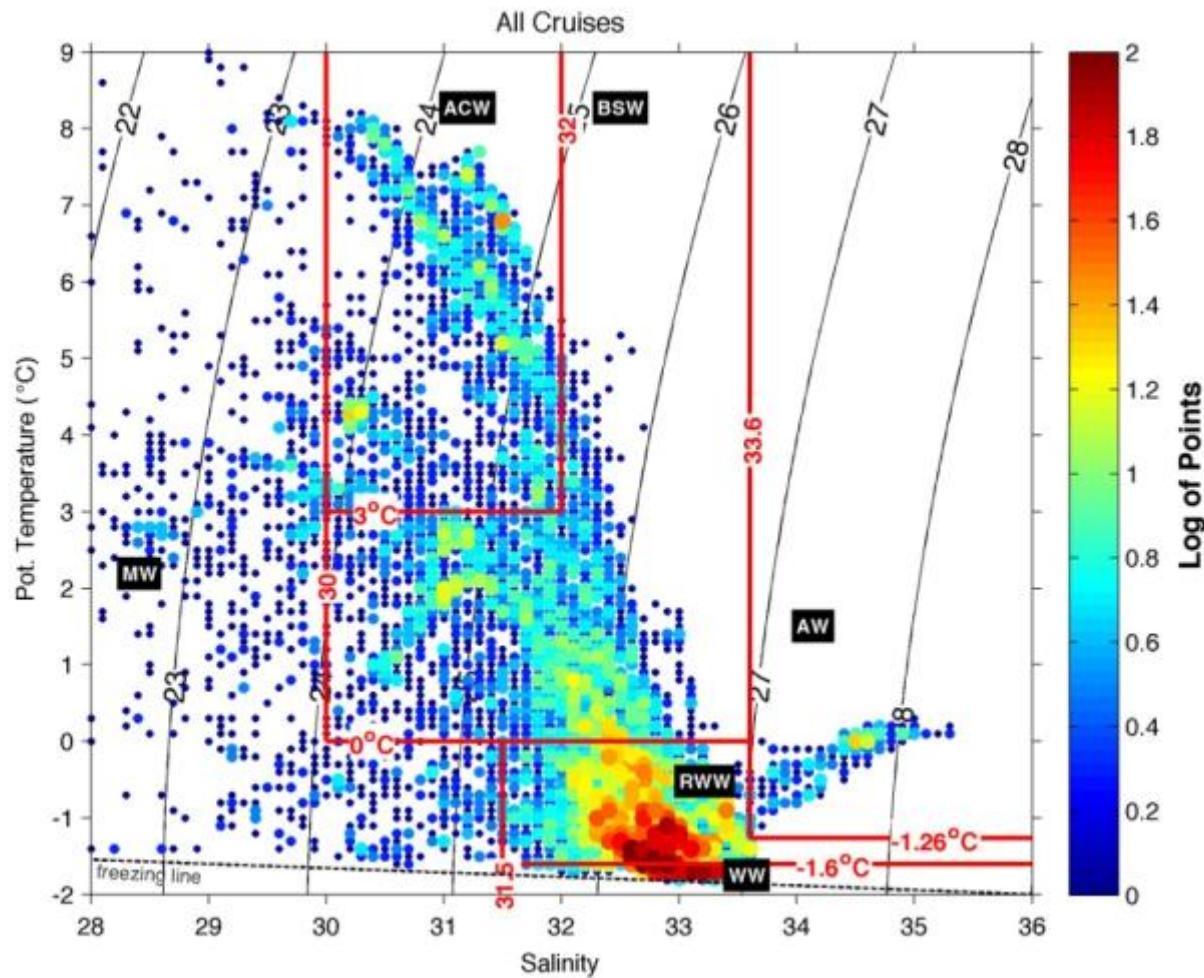
Volume transports

Water properties

ABSTRACT

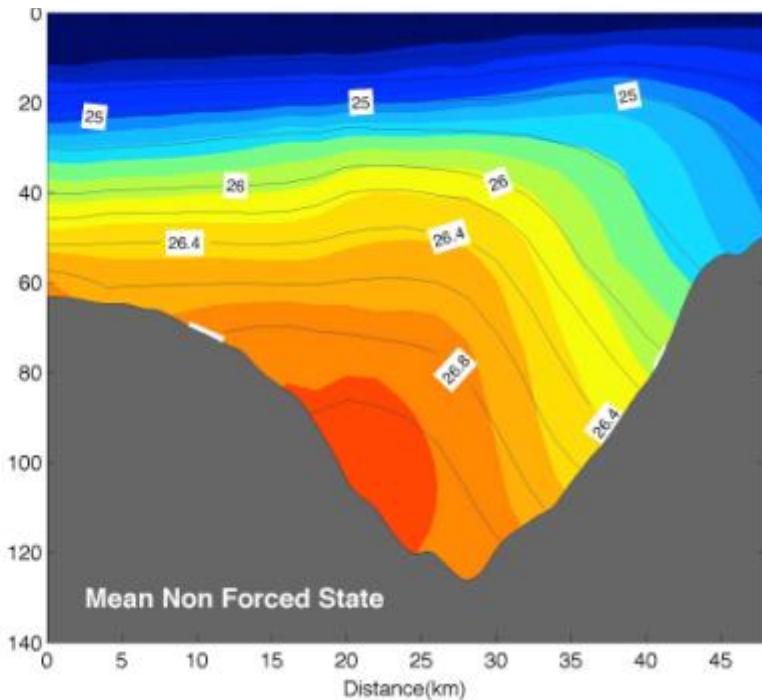
Over the past few decades, sea ice retreat during summer has been enhanced in the Pacific sector of the Arctic basin, likely due in part to increasing summertime heat flux of Pacific-origin water from the Bering Strait. Barrow Canyon, in the northeast Chukchi Sea, is a major conduit through which the Pacific-origin water enters the Arctic basin. This paper presents results from 6 repeat high-resolution shipboard hydrographic/velocity sections occupied across Barrow Canyon in summer 2010. The different Pacific water masses feeding the canyon – Alaskan coastal water (ACW), summer Bering Sea water (BSW), and Pacific winter water (PWW) – all displayed significant intra-seasonal variability. Net volume transports through the canyon were between 0.96 and 1.70 Sv poleward, consisting of 0.41–0.98 Sv of warm Pacific water (ACW and BSW) and 0.28–0.65 Sv of PWW. The poleward heat flux also varied strongly, ranging from 8.56 TW to 24.56 TW, mainly due to the change in temperature of the warm Pacific water. Using supplemental mooring data from the core of the warm water, along with wind data from the Pt. Barrow weather station, we derive and assess a proxy for estimating heat flux in the canyon for the summer time period, which is when most of the heat passes northward towards the basin. The average heat flux for 2010 was estimated to be 3.34 TW, which is as large as the previous record maximum in 2007. This amount of heat could melt 315,000 km² of 1-meter thick ice, which likely contributed to significant summer sea ice retreat in the Pacific sector of the Arctic Ocean.

Science Highlights



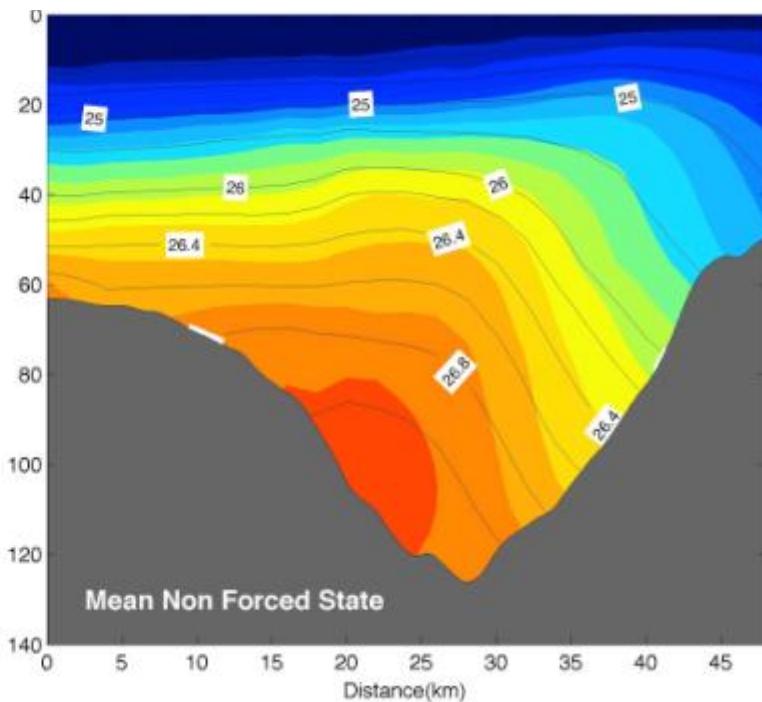
Science Highlights

Mean unforced salinity

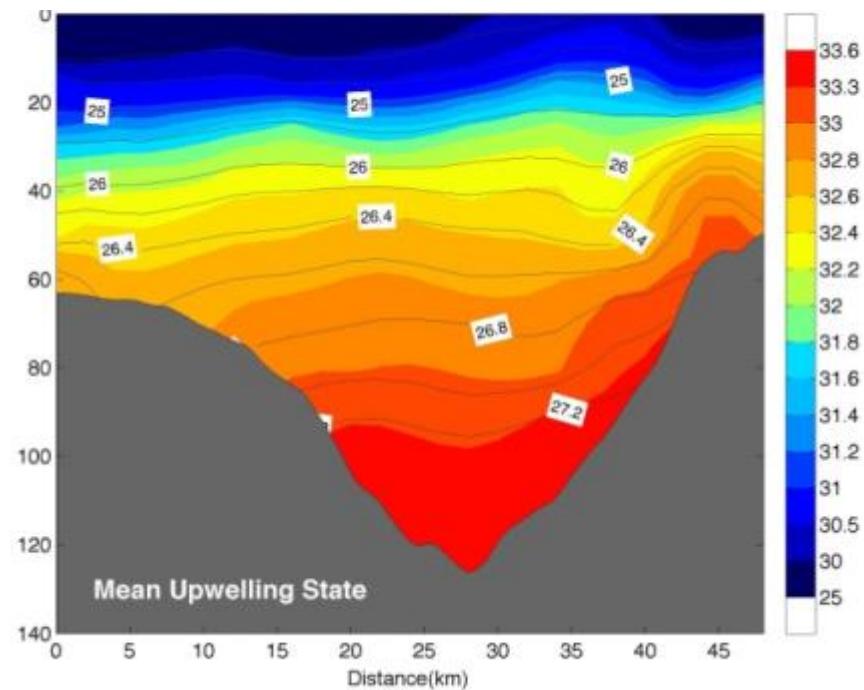


Science Highlights

Mean unforced salinity



Mean upwelling salinity



2. SVEIN VAGLE

CCGS SIR WILFRID LAURIER

EVERY JULY 2008-2015

VICTORIA, BC – BARROW ALASKA



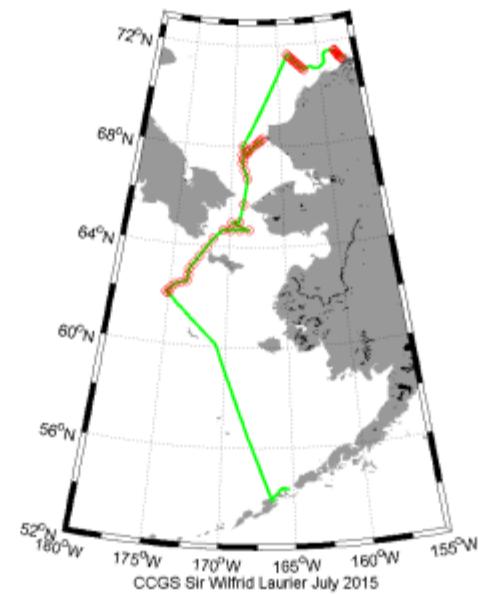
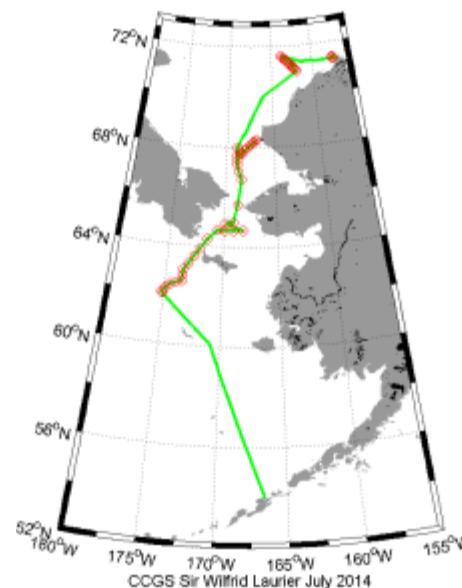
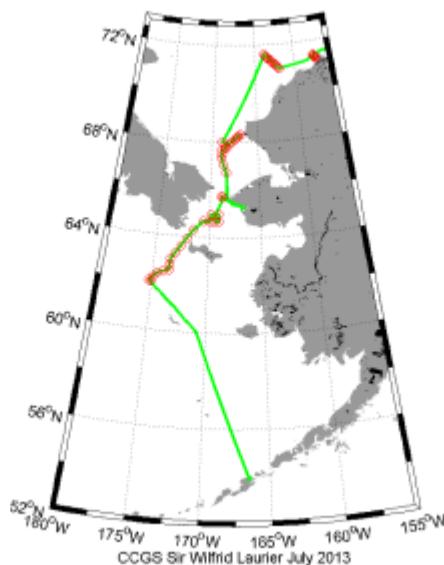
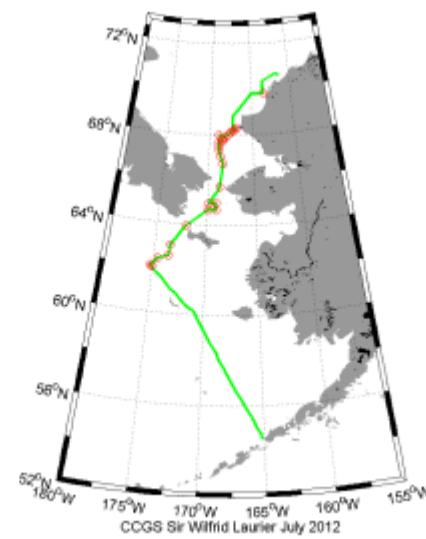
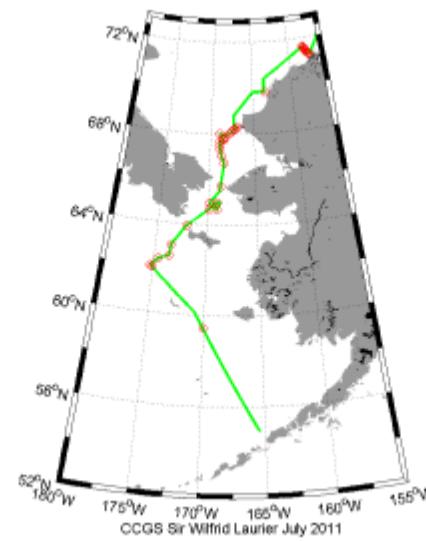
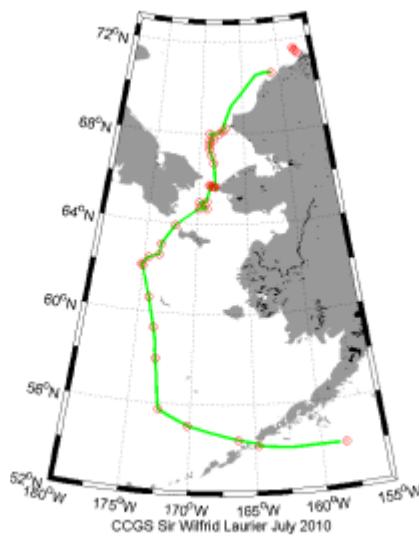
SWL DBO Science: Dutch Harbor to Barrow

July 12 to July 23, 2015

Science:

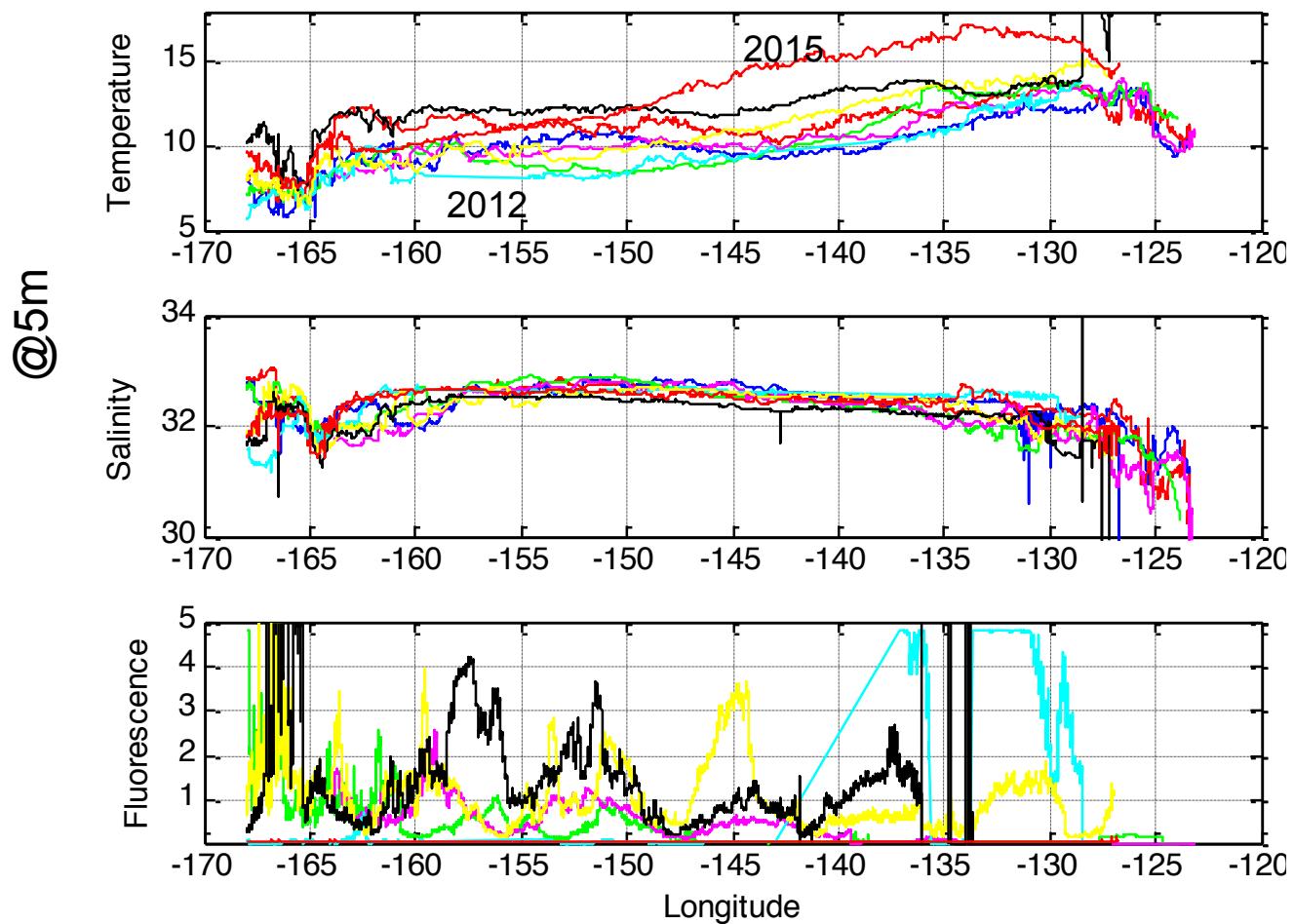
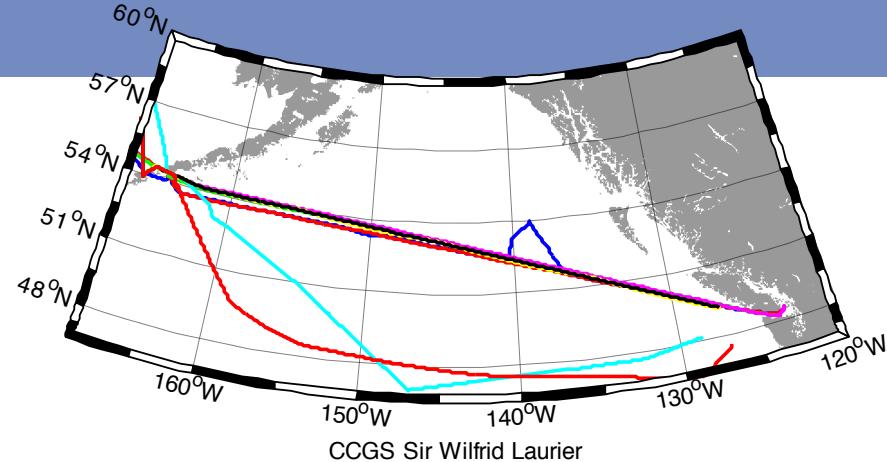
- Continuous sea surface water monitoring (T,S,F,O₂,weather)
- Bird and mammal observations (Mammals from Victoria)
- 54 CTD science stations (All planned stations completed this year)
- 41 Rosette casts (Nutrients, Ba, O18, DIC/Alk, Chlorophyll)
- 41, 150 kHz ADCP over the side deployments (Backscatter and currents)
- 41 Bongo plankton net hauls to 100 m or 10 m above seafloor (Stantek)
- 40 Benthic sampling stations (U. of Maryland)
- 12 C-OPS stations (Clark University)
- 4 Phytoplankton incubation experiments (UVIC)
- 20 Stations where water was collected for Methane and C13 analysis.

Ship tracks and sampling stations, Sir Wilfrid Laurier, July 4-24 2010-2015



Sir Wilfrid Laurier NE Pacific transects from Victoria BC to Dutch Harbor

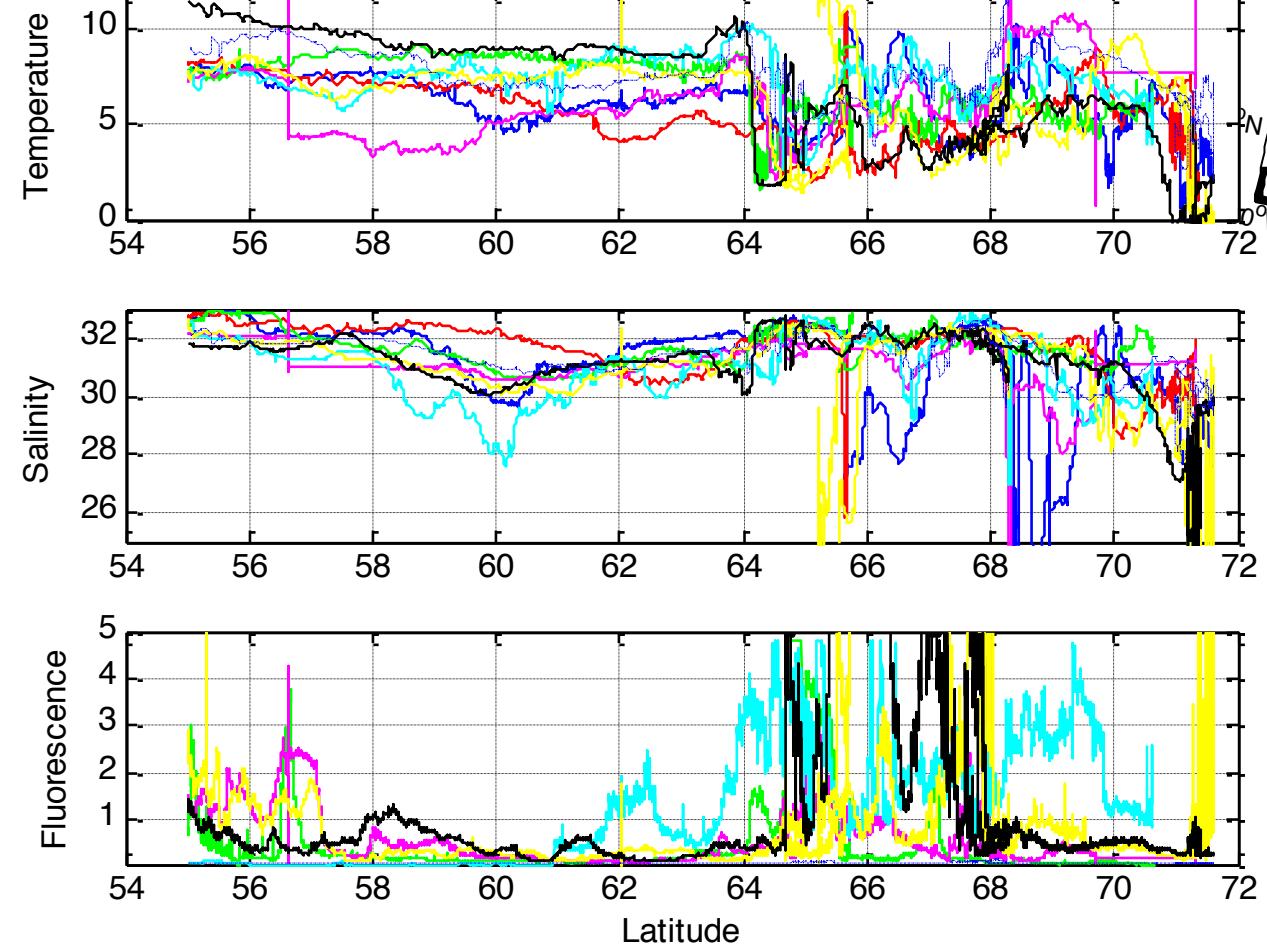
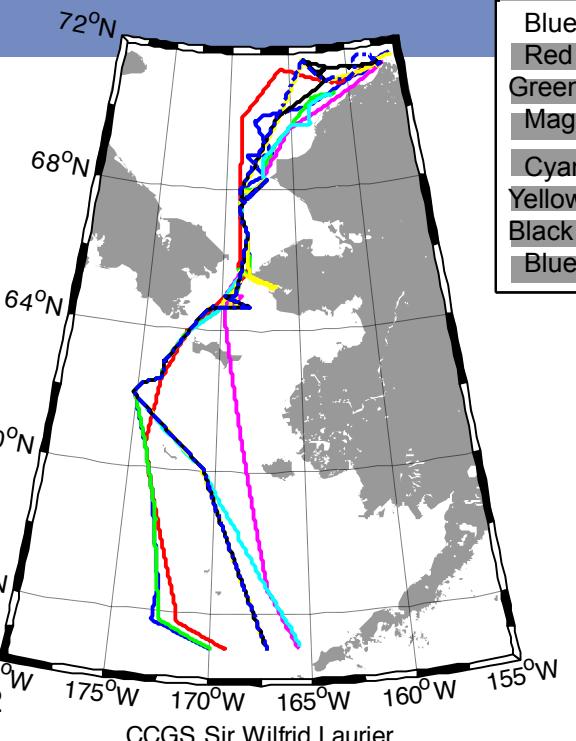
July 2008-2015

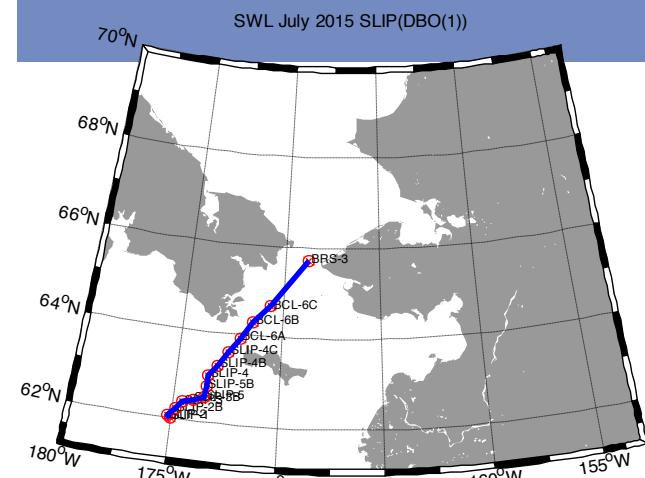
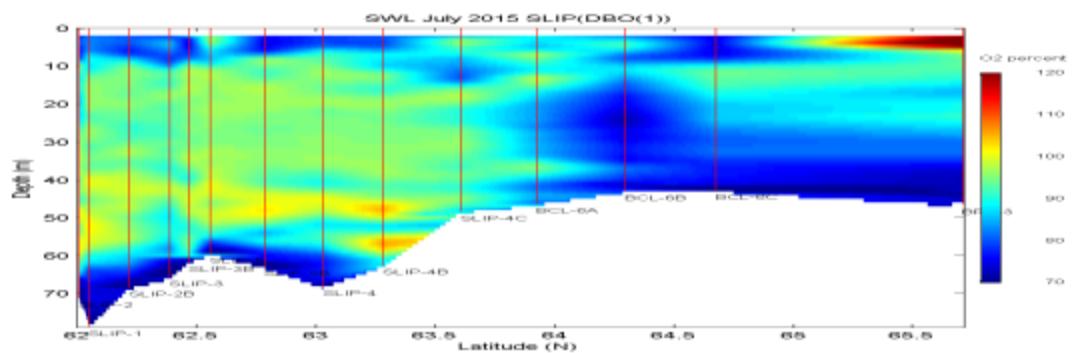
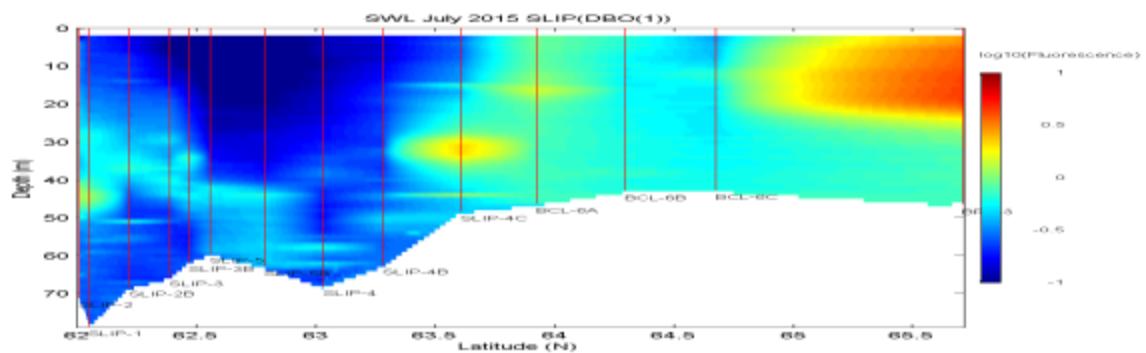
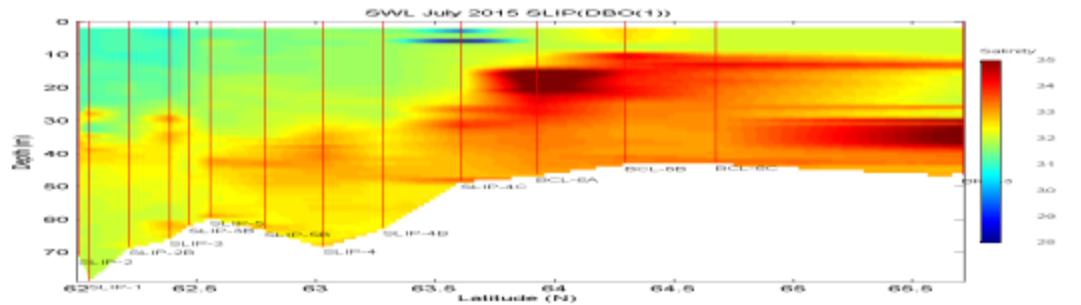
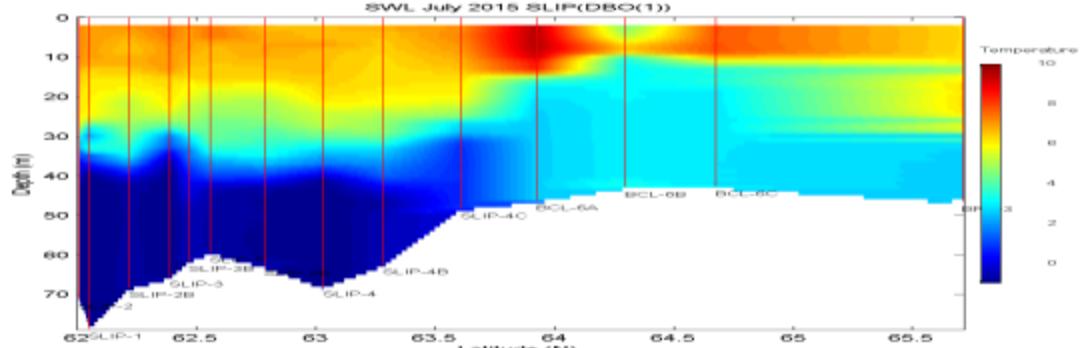


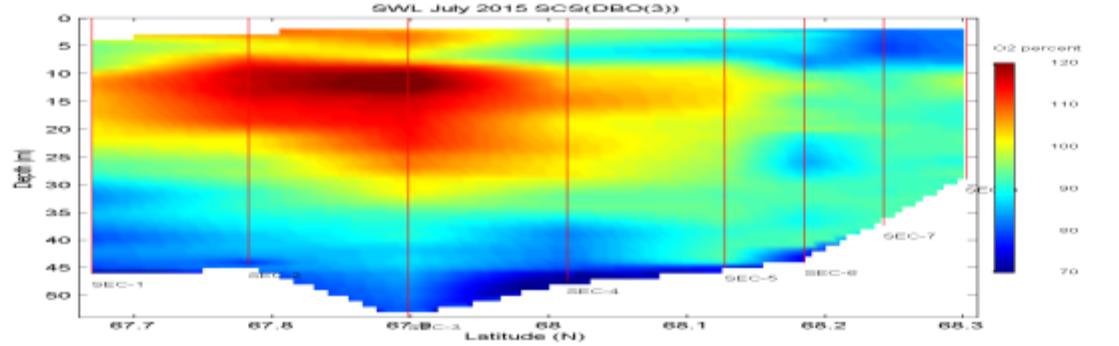
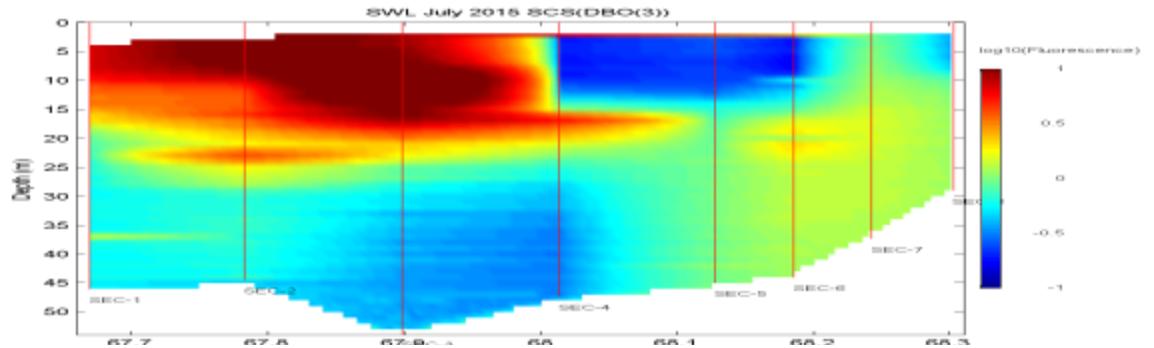
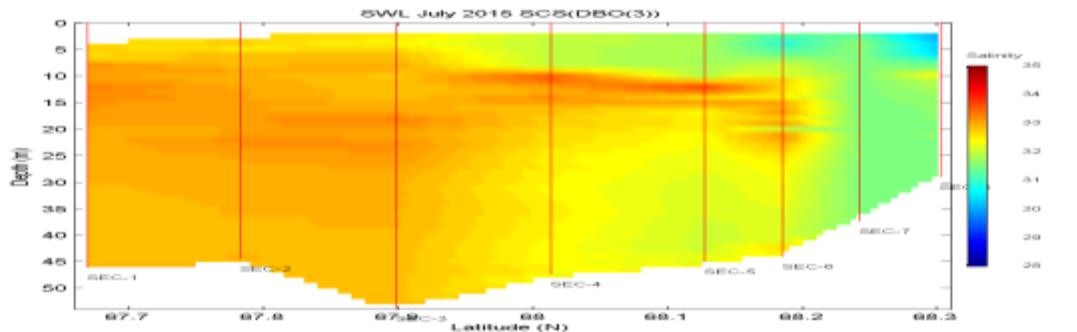
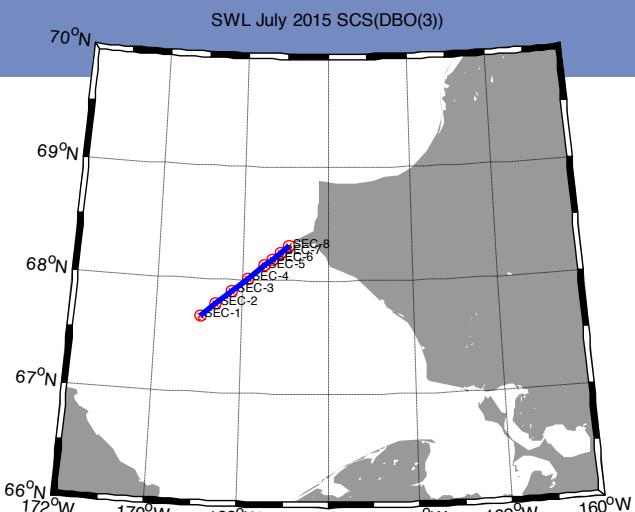
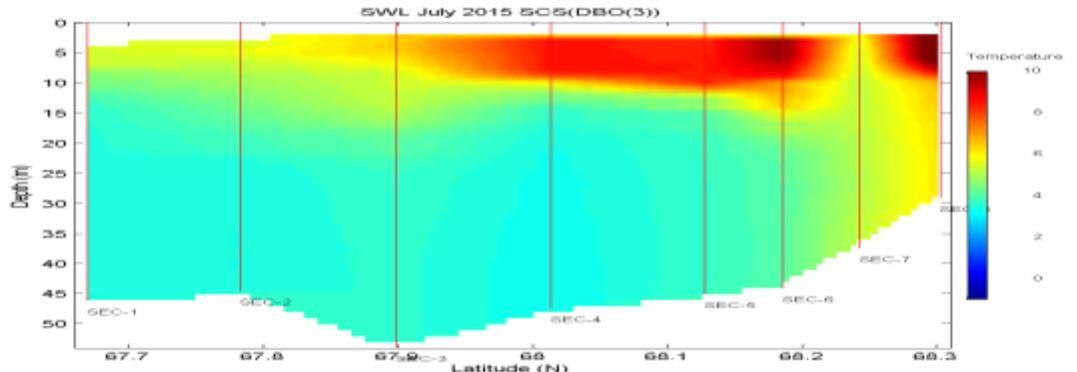
Sir Wilfrid Laurier DBO transects from Dutch Harbor to Barrow

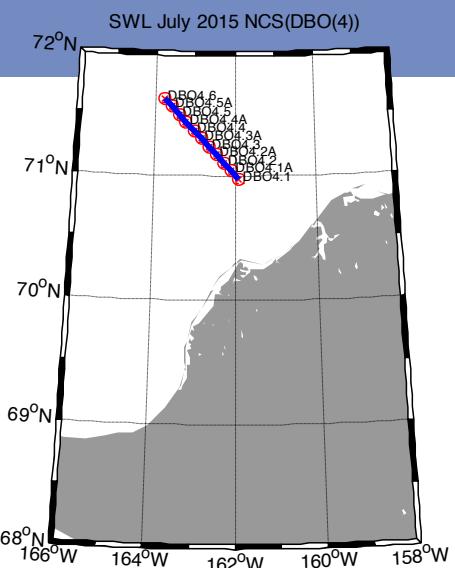
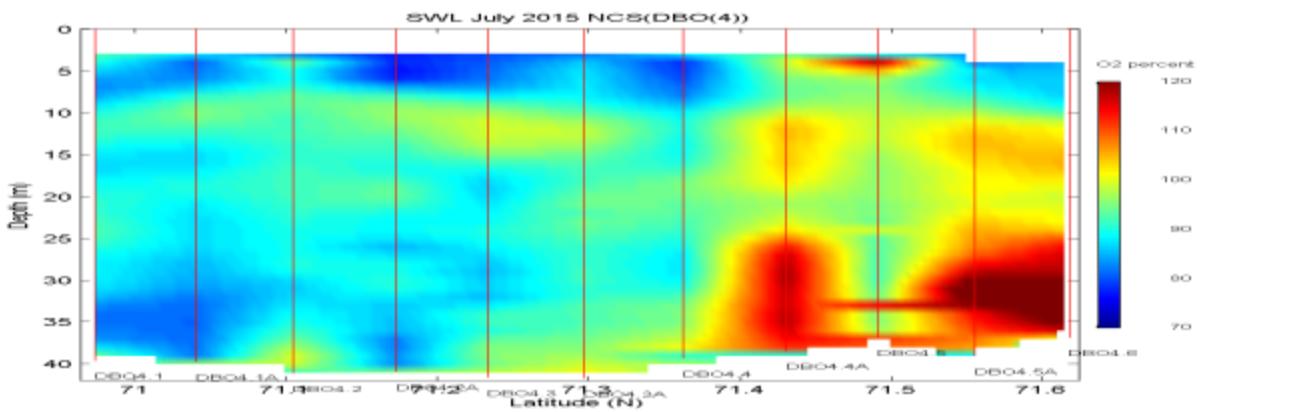
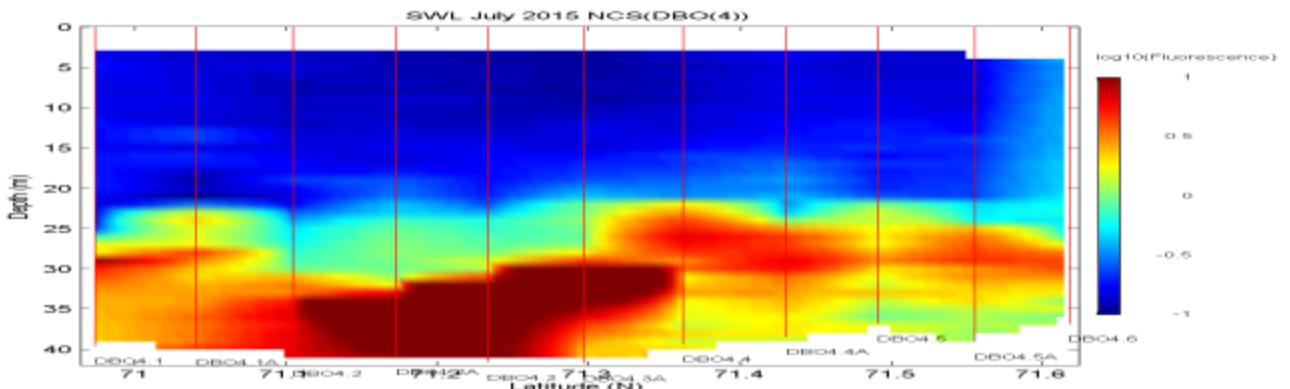
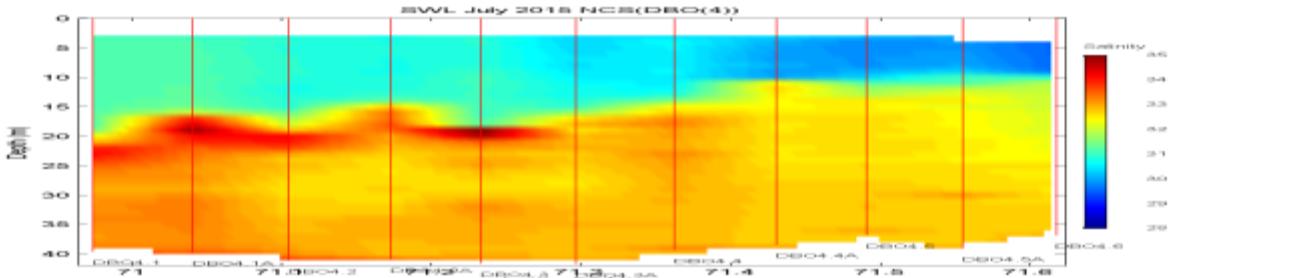
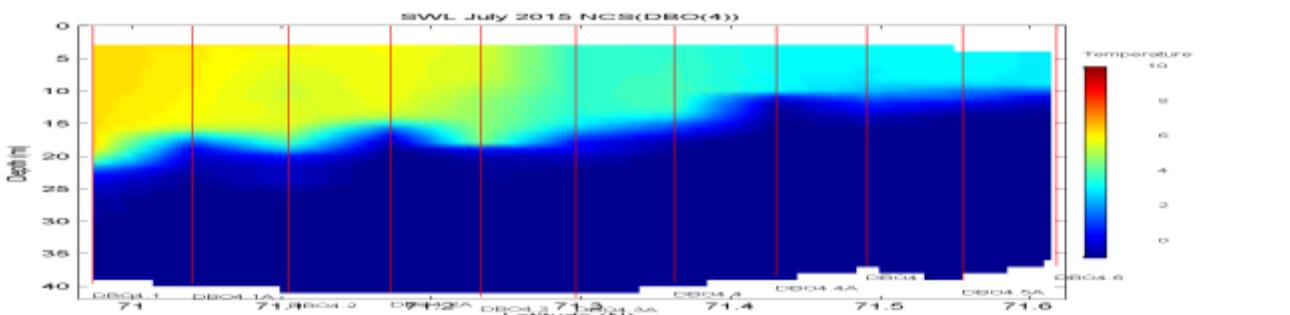
July 2008-2015

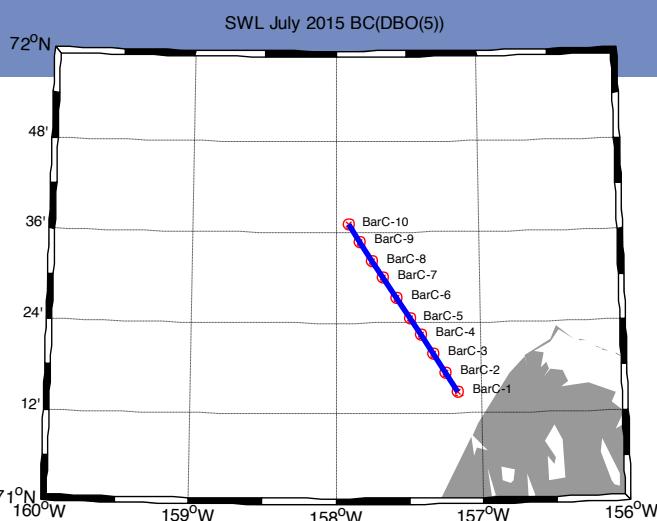
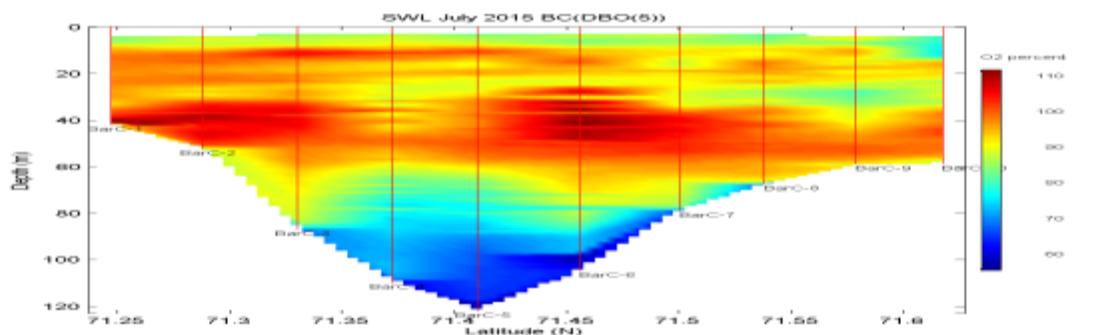
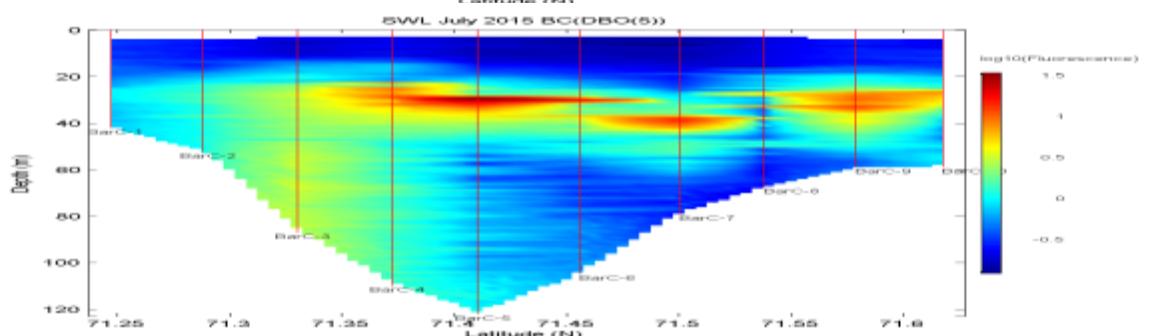
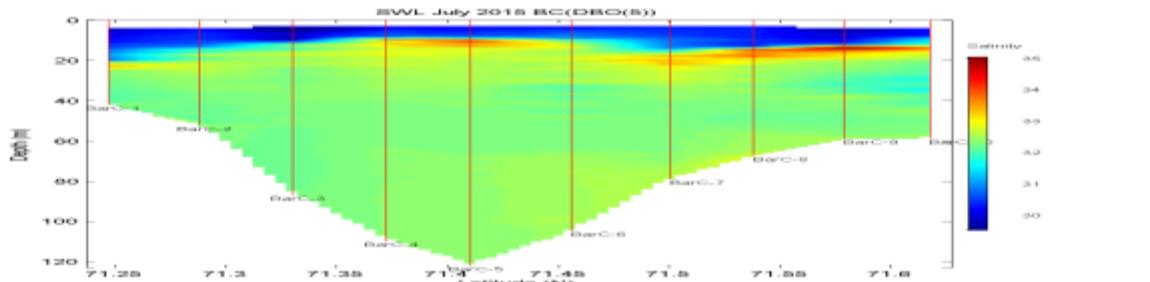
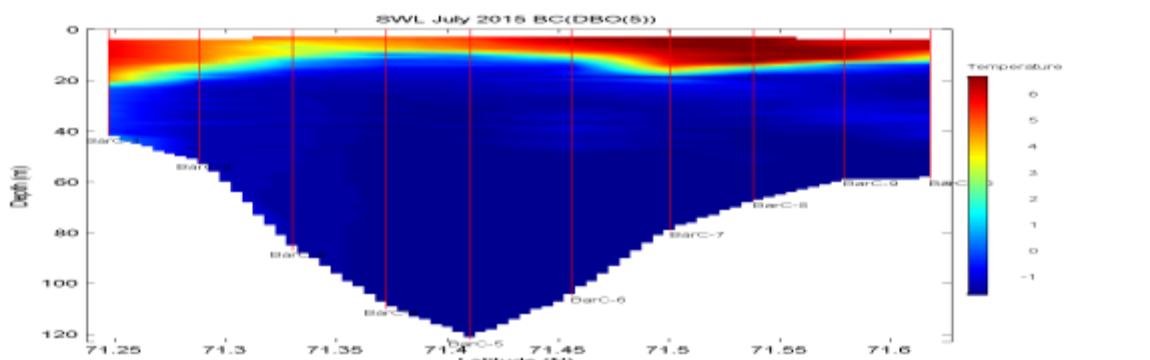
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Red	2009
Green	2010
Magenta	2011
Cyan	2012
Yellow	2013
Black	2014
Blue	2015

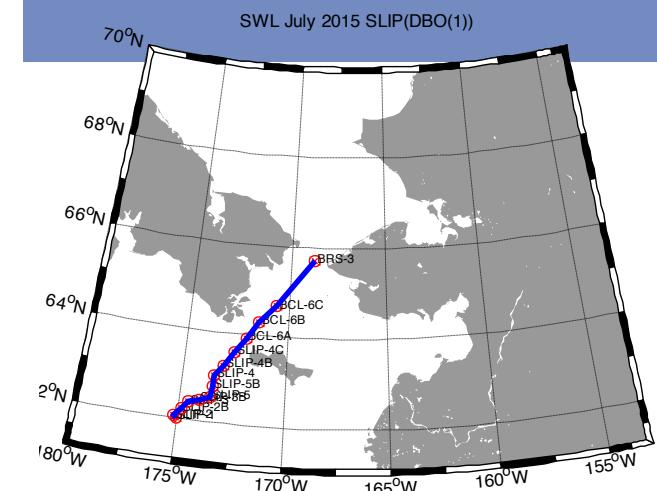
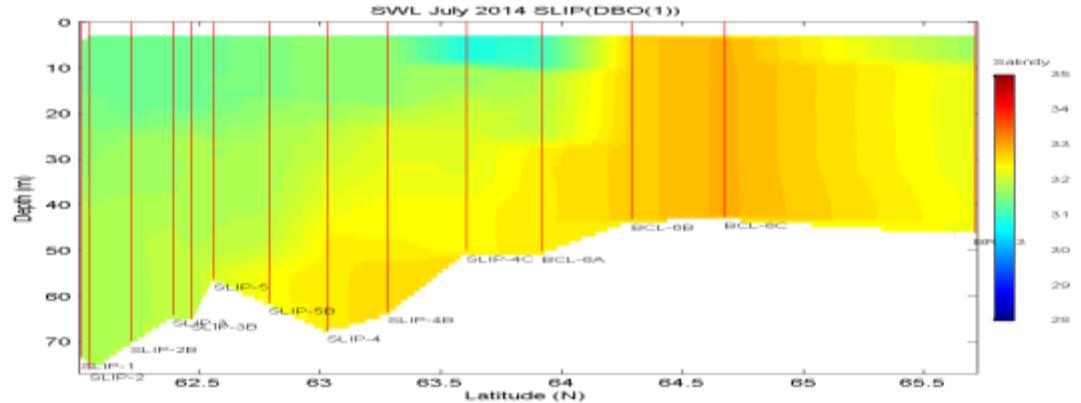
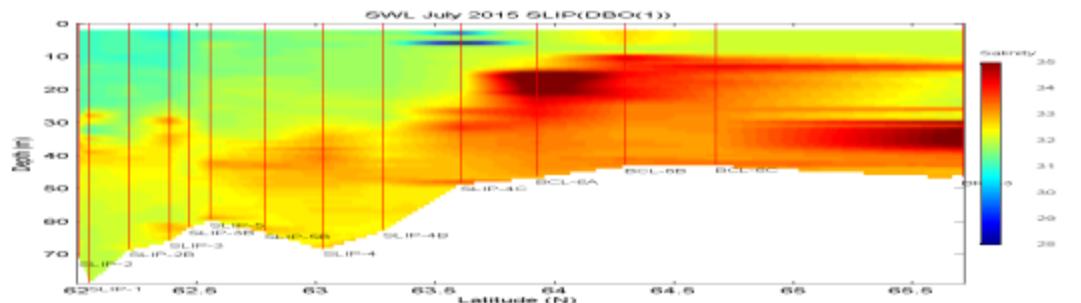
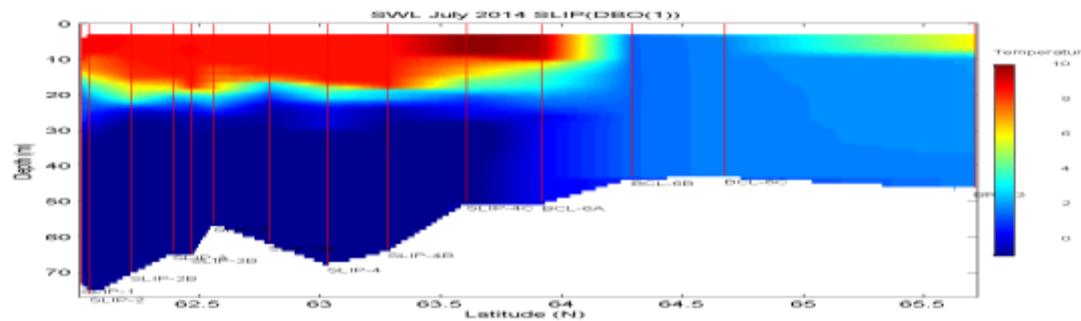
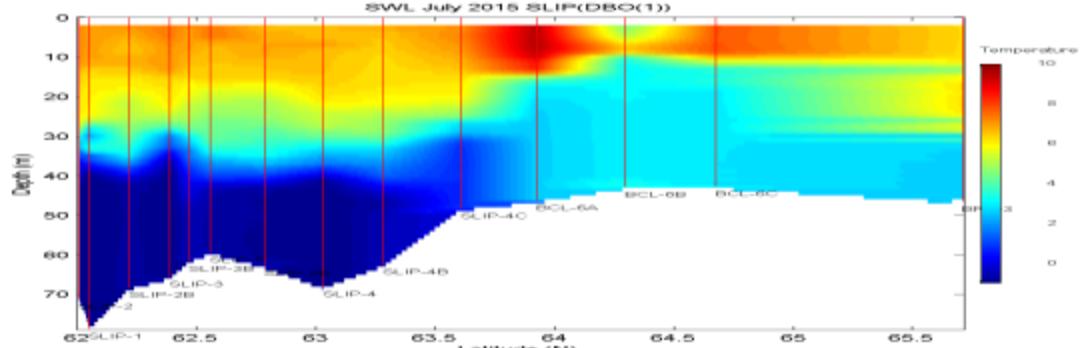


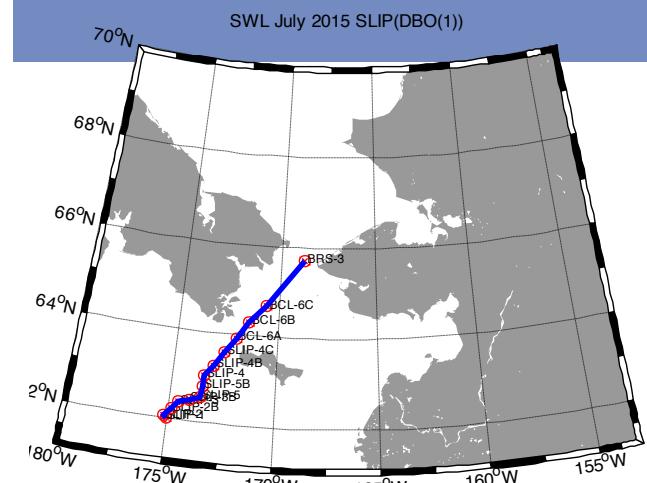
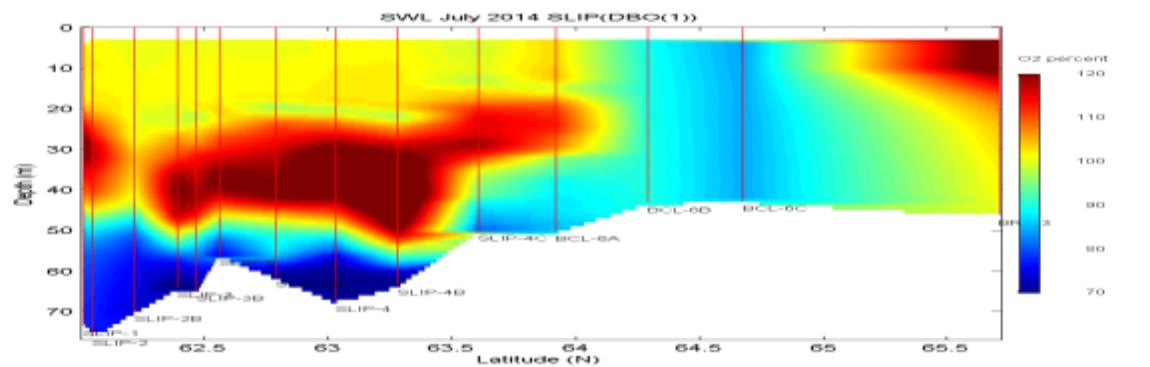
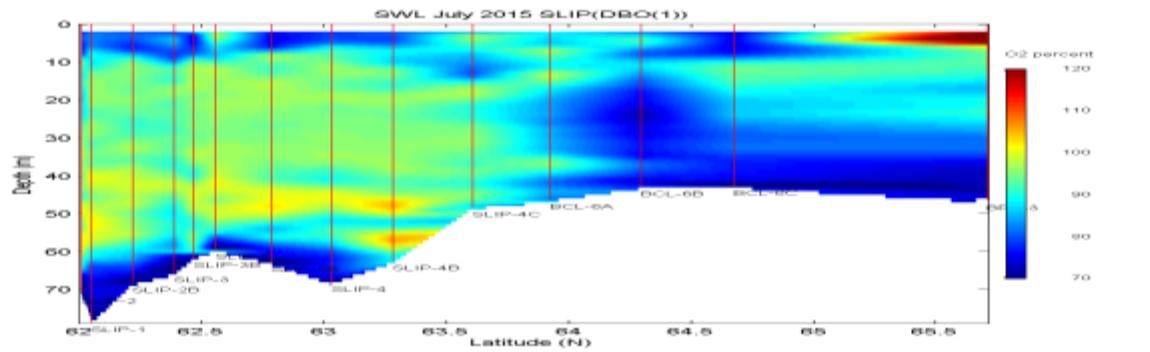
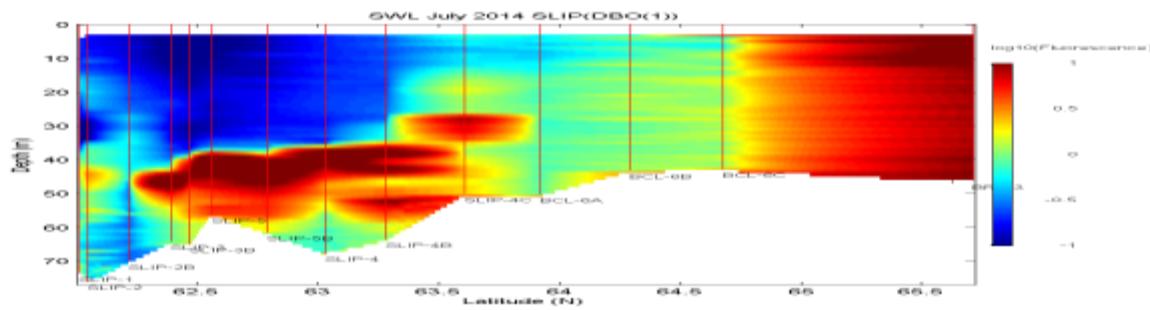
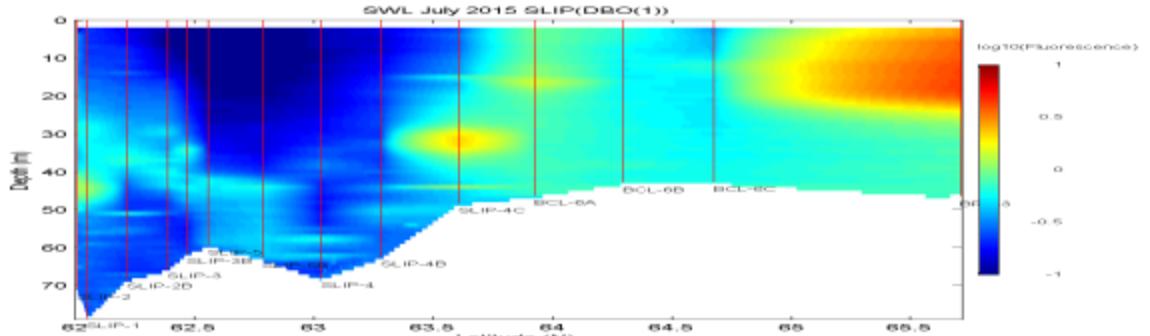








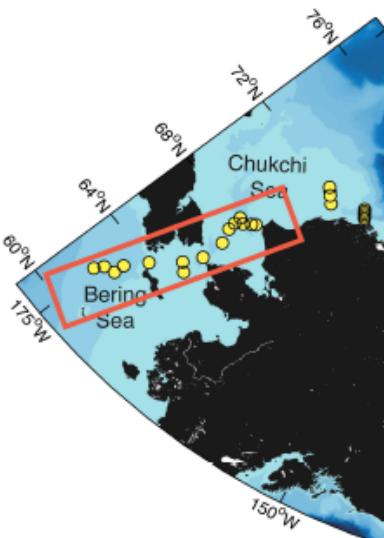




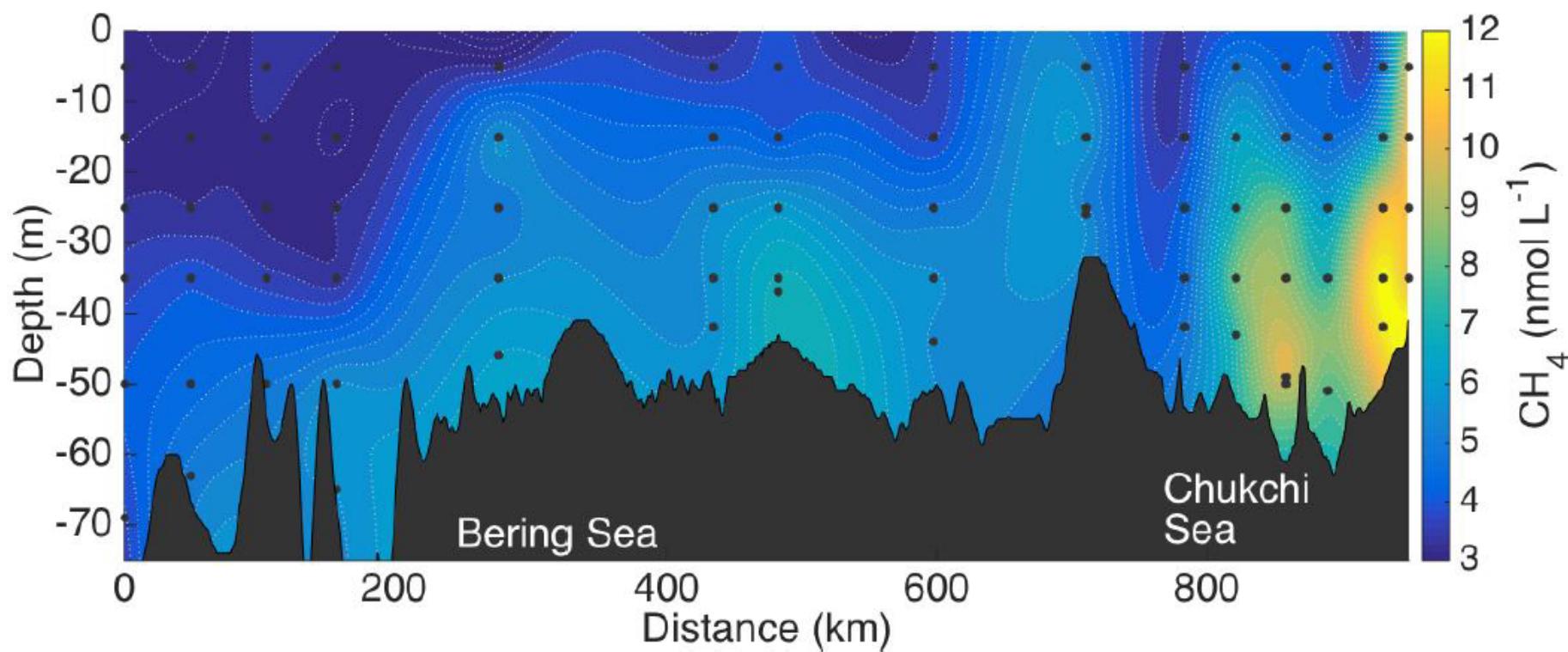
Survey of Arctic methane and nitrous oxide distributions w/ Lindsay Fenwick and Philippe Tortell (UBC)

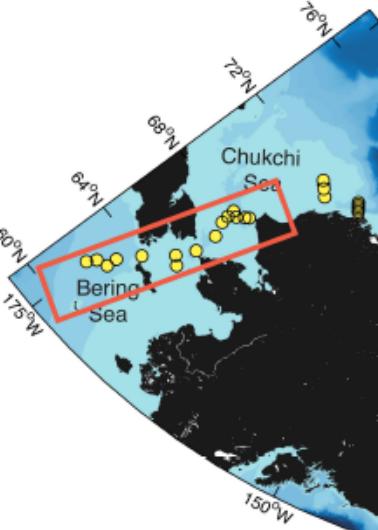
CH_4 is produced by methanogenesis in anaerobic sediments and consumed by oxidation.

N_2O is produced by nitrification (aerobic) and denitrification (suboxic) and consumed by denitrification

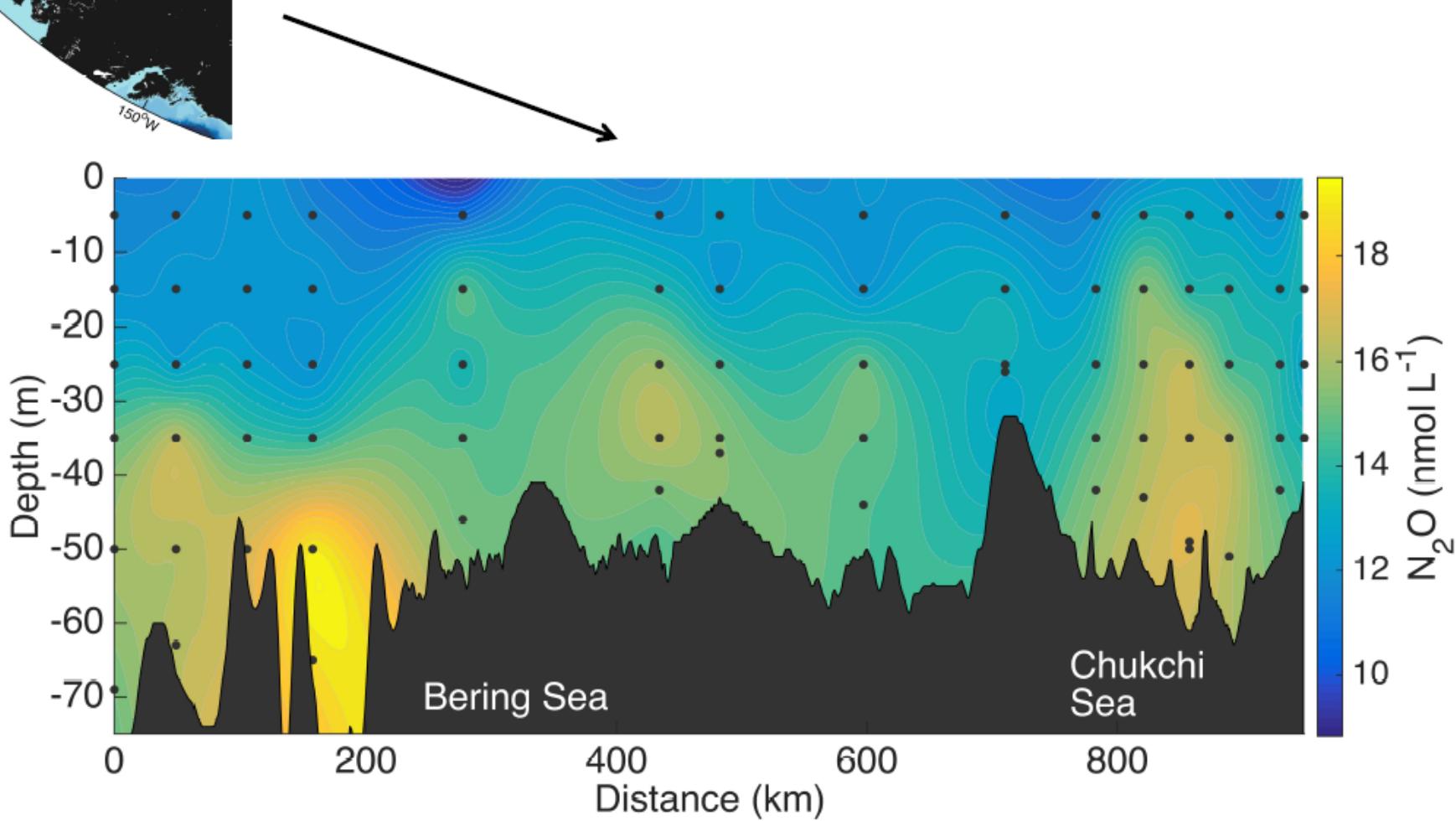


Methane is present in high concentrations in the Chukchi Sea



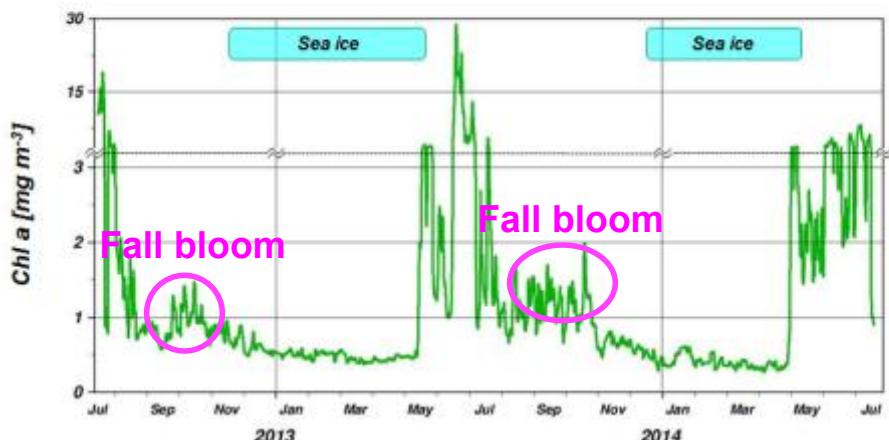
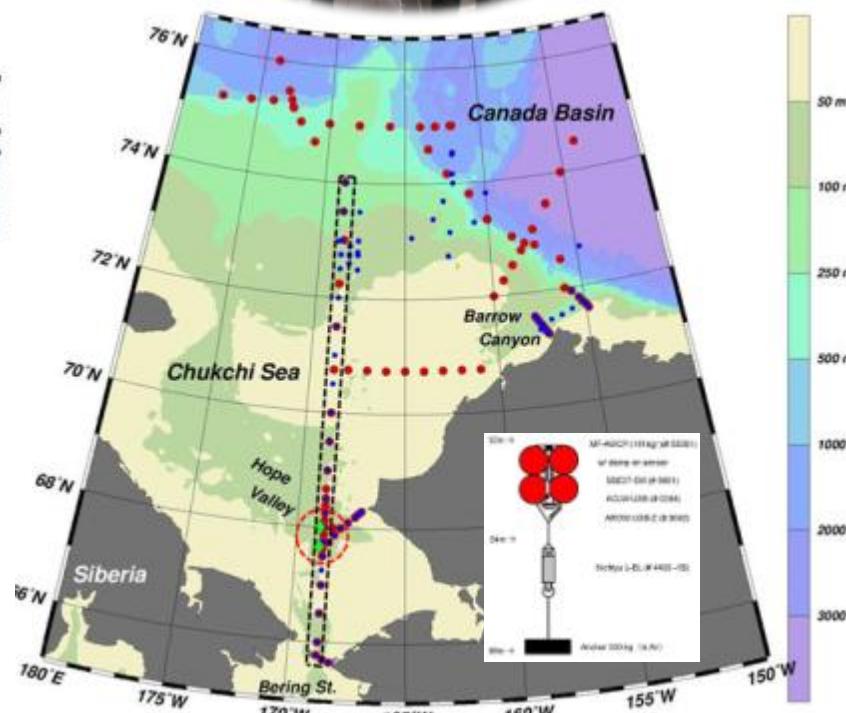
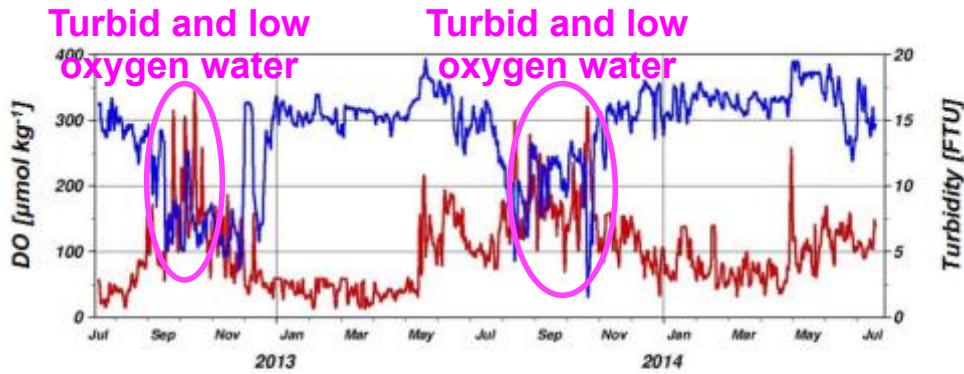
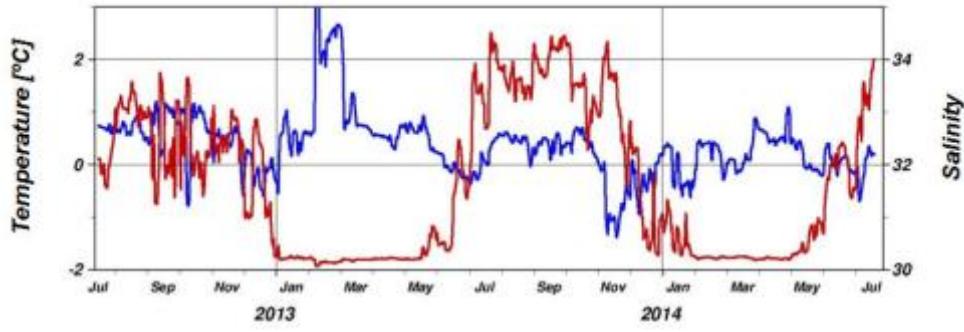


Nitrous oxide is present in high concentrations near the sediments of the Bering and Chukchi Seas



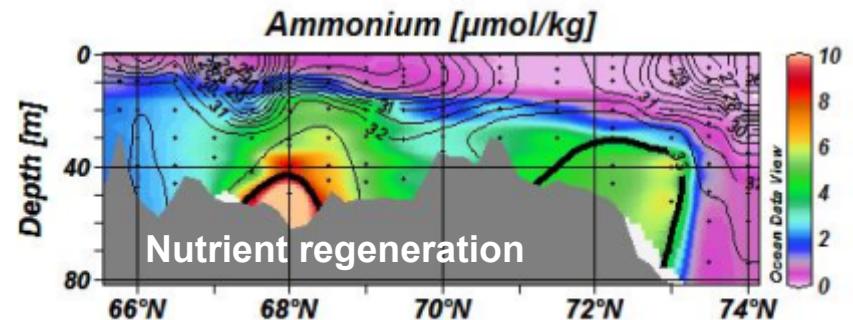
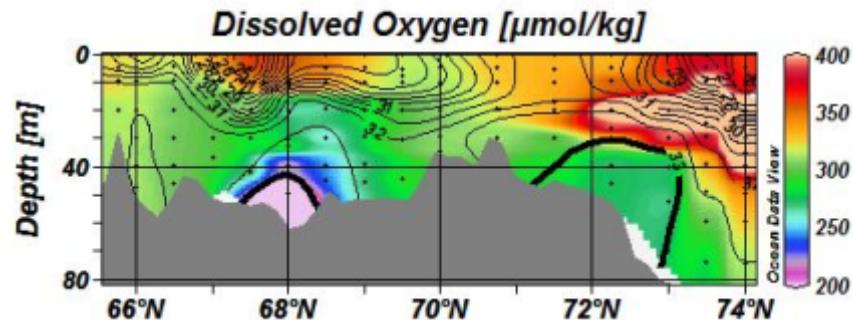
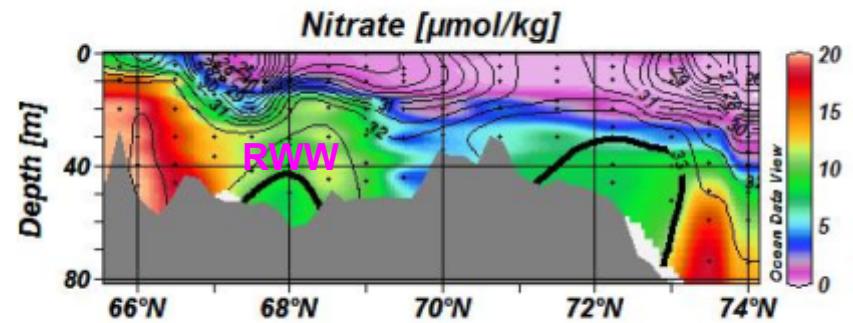
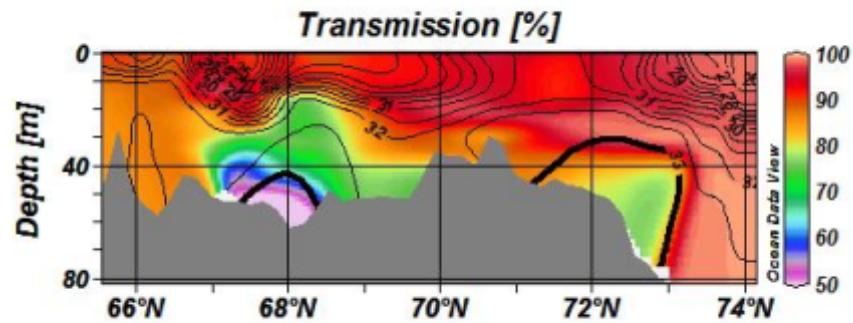
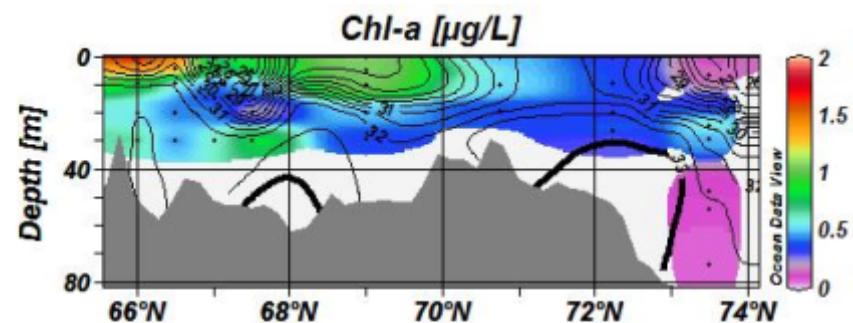
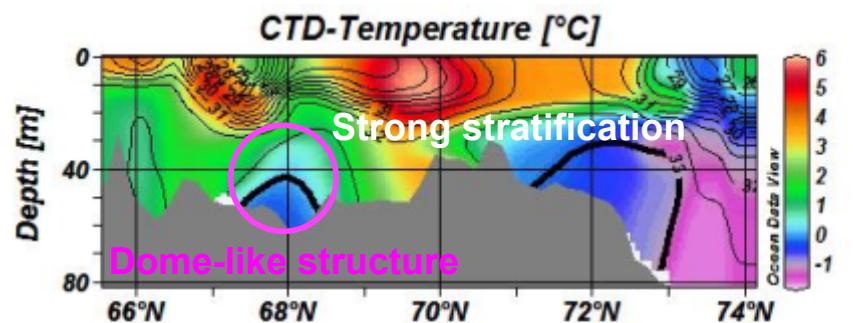
3. SHIGE NISHINO

DBO3 moorings during July 2012 to July 2014

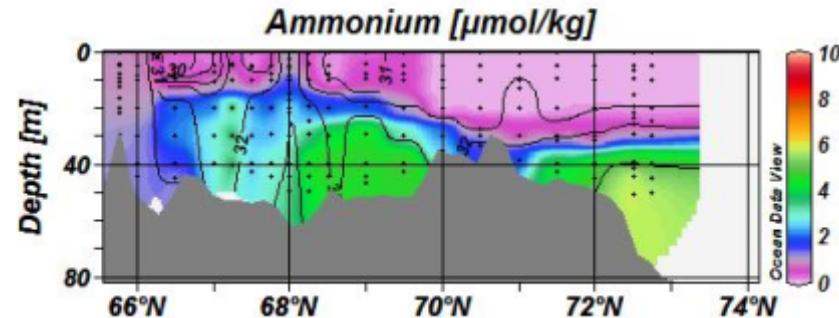
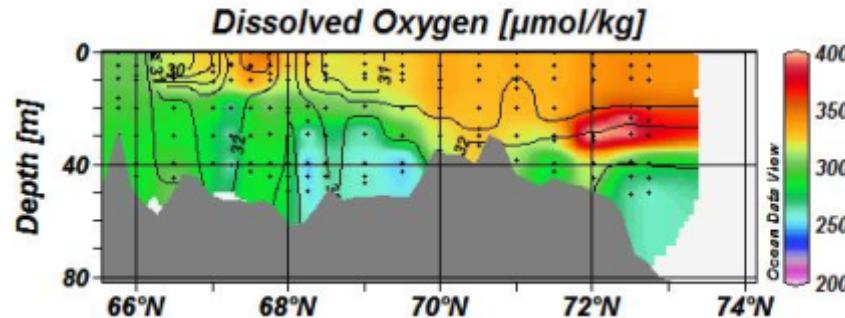
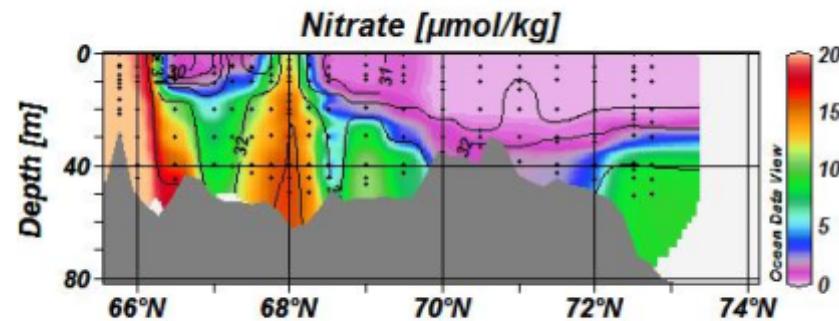
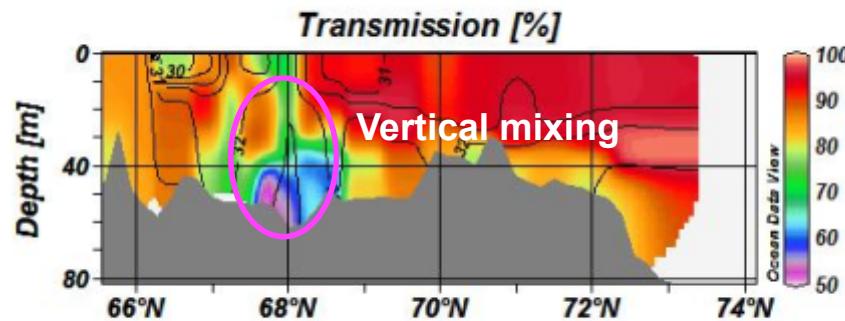
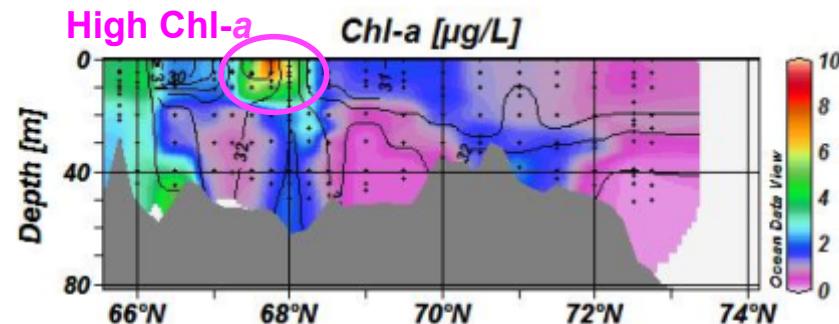
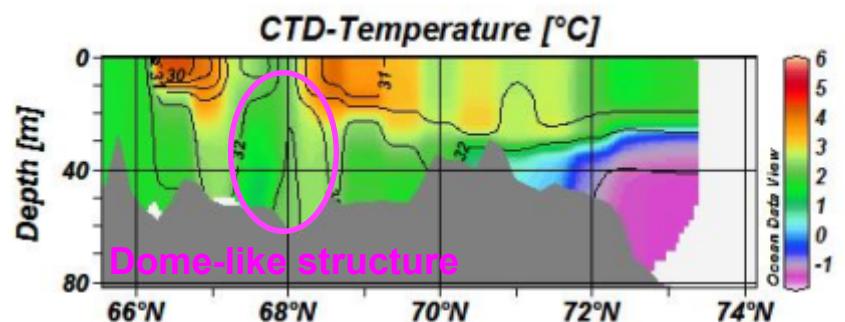


[Nishino et al., 2015b]

Southern Chukchi Sea hotspot sections during the 13–17 September 2012 R/V Mirai cruise

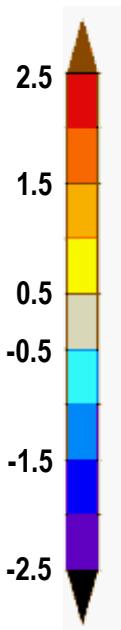
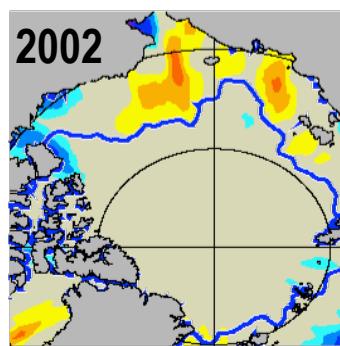
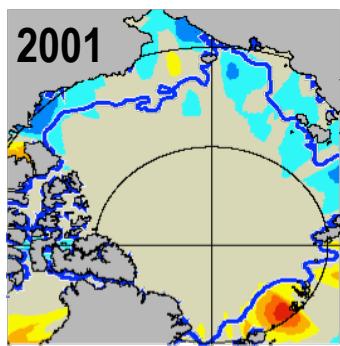
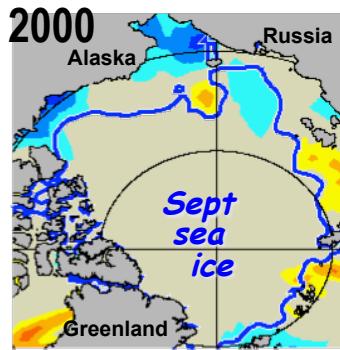


Southern Chukchi Sea hotspot sections during the 27 September–4 October 2013 R/V Mirai cruise

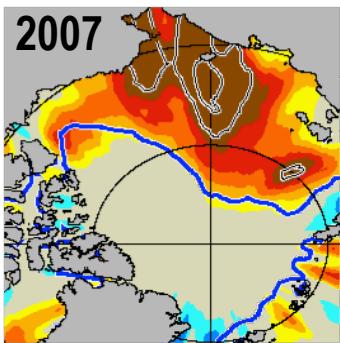
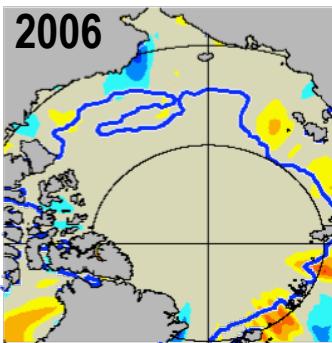
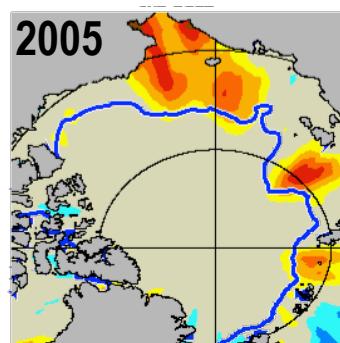
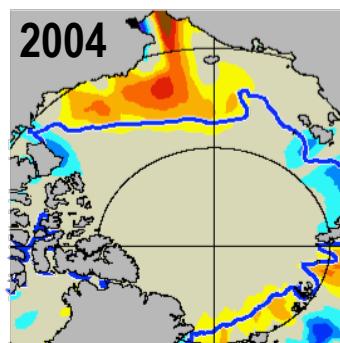
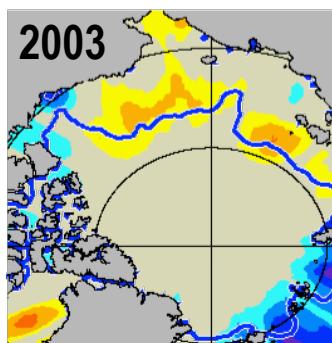


4. MIKE STEELE

Ice Retreat → Ocean Warming



from Steele et al., GRL 2008

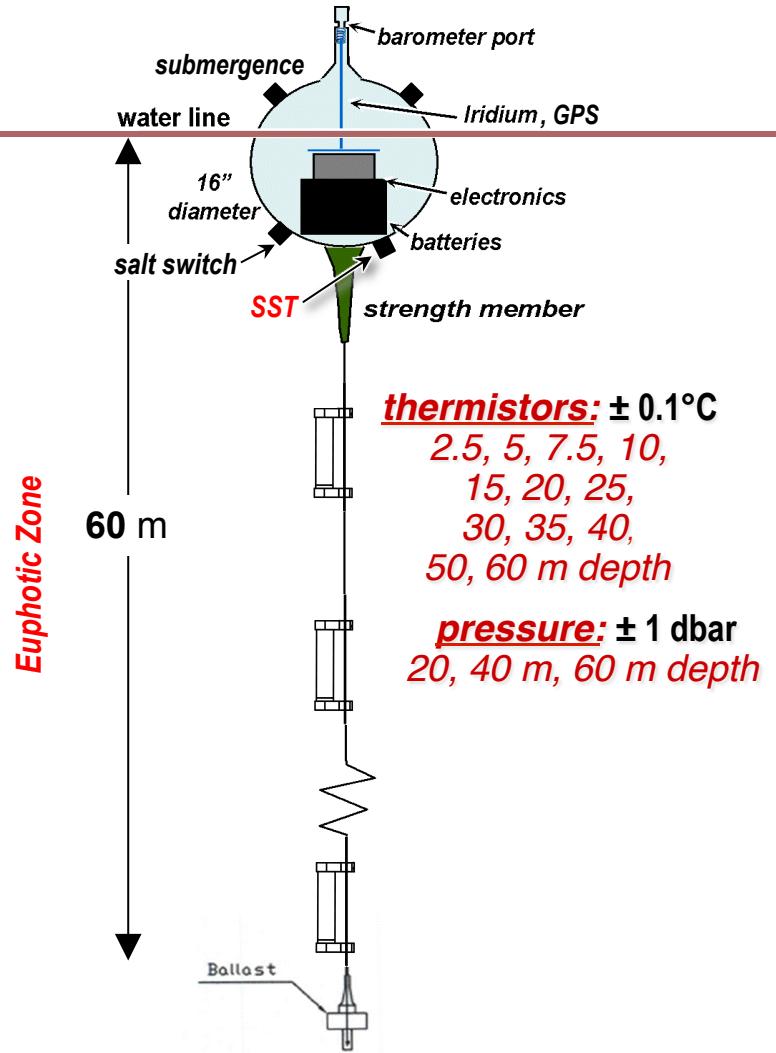


Anomalies of summer (JAS),
relative to 1982-2007 mean
daily NOAA OI.v2

Local solar + advection
Steele et al. JGR (2010)

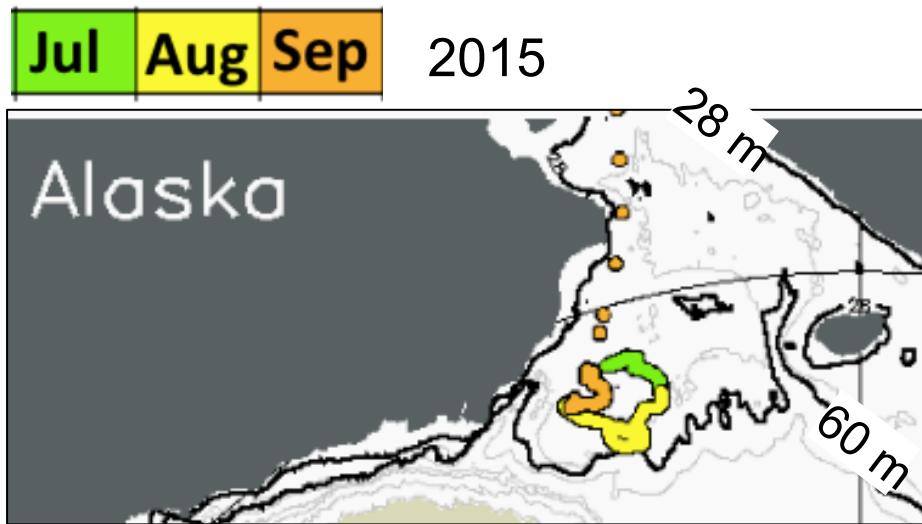
The UpTempO buoy

Upper Temperature of the polar Oceans



Deploy:
In ice or water by ship, ice camp, air

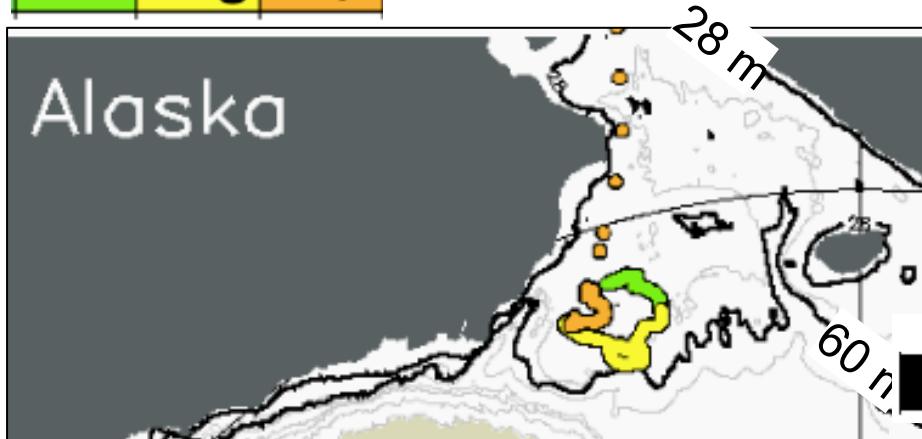
Chukchi UpTempO



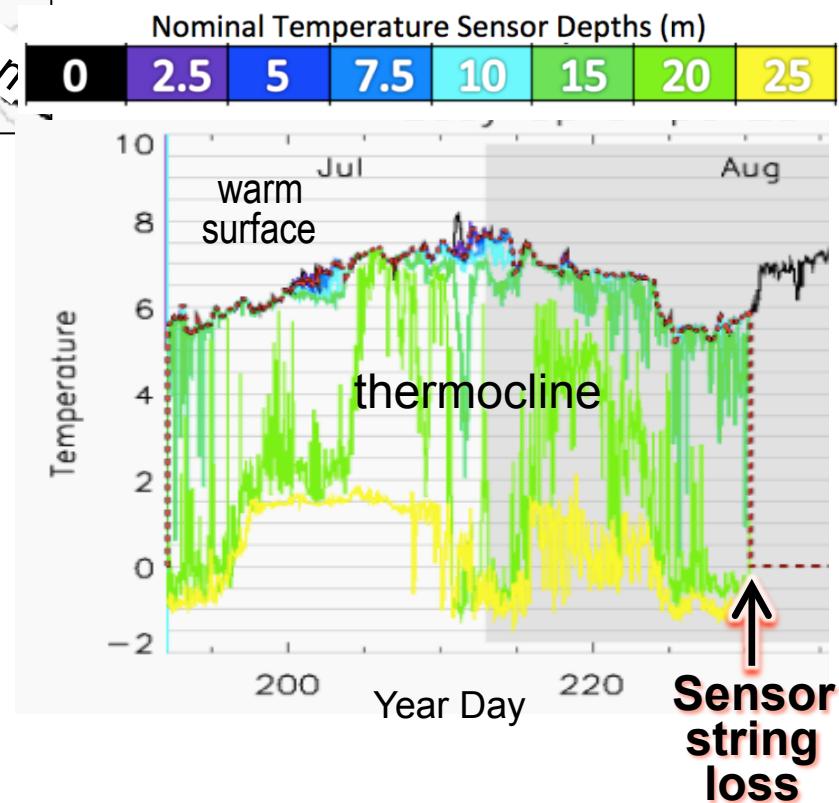
New: 25 m for shelves

Chukchi UpTempO

Jul Aug Sep 2015



New: 25 m for shelves



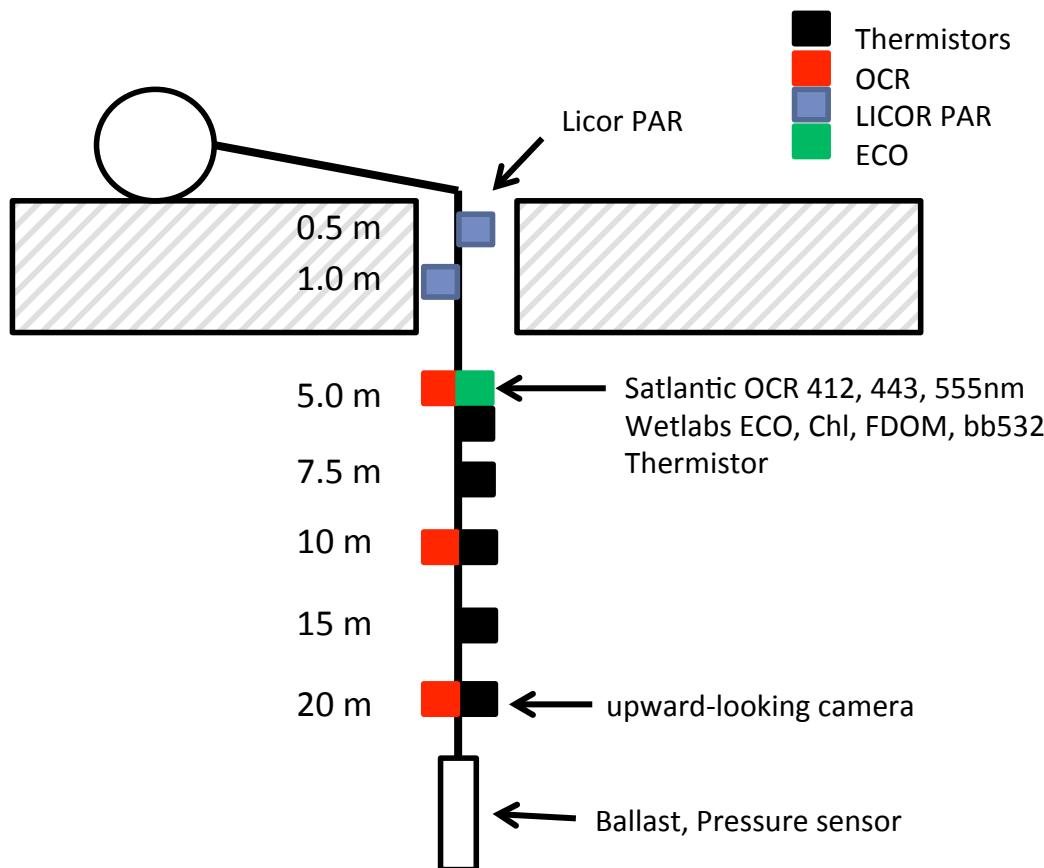
Also:

- 4 m **salinity** ~ 31.5
- Surface **winds**

UpTempO + bioOptics: The "**WARM**" buoy

WArming &
irRadiance Measurements

V. Hill, B. Light, M. Steele



Also:

- 50 m string for basins

Future:

- 3 x CT → S for stratification
- Incoming PAR sensor

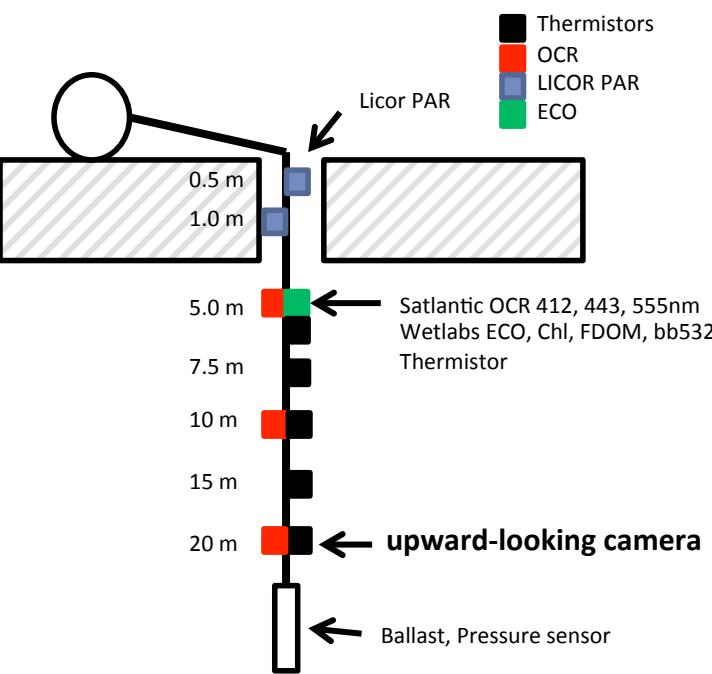
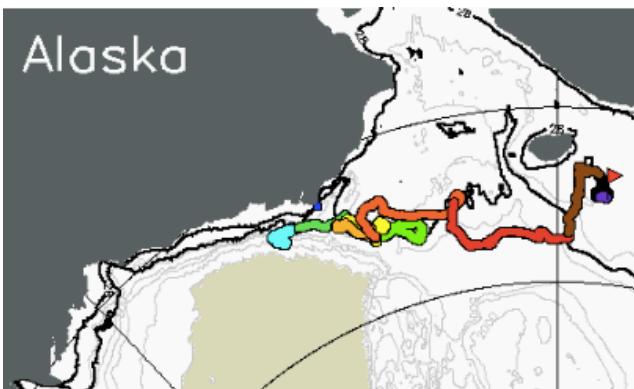
2014

May Jun Jul Aug Sep Oct Nov Dec

The "WARM" buoy

WArming &
irRadiance Measurements

V. Hill, B. Light, M. Steele



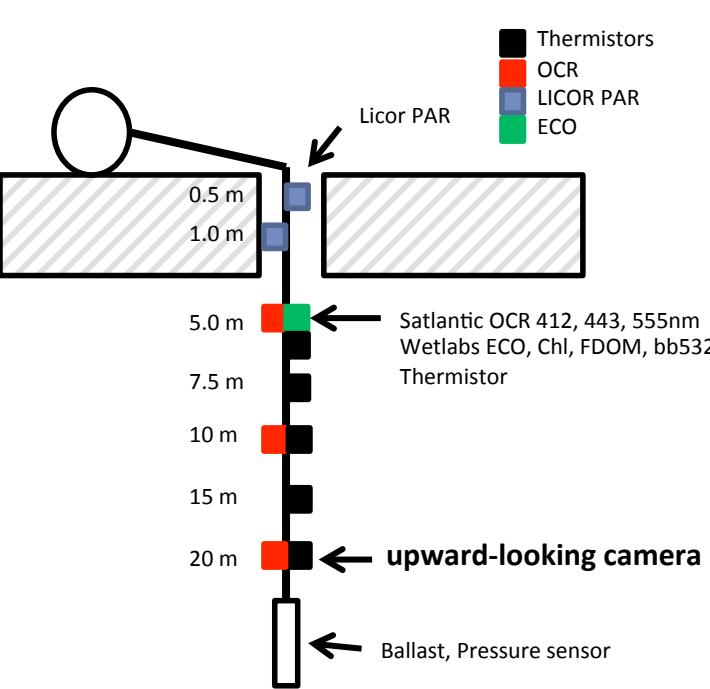
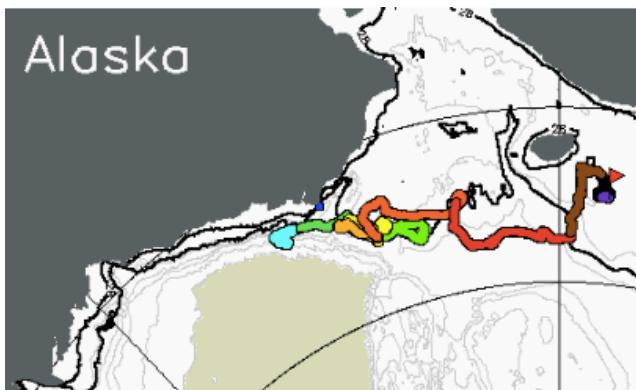
Heat budget:

warming \sim solar + advection

T \sim PAR + residual

2014

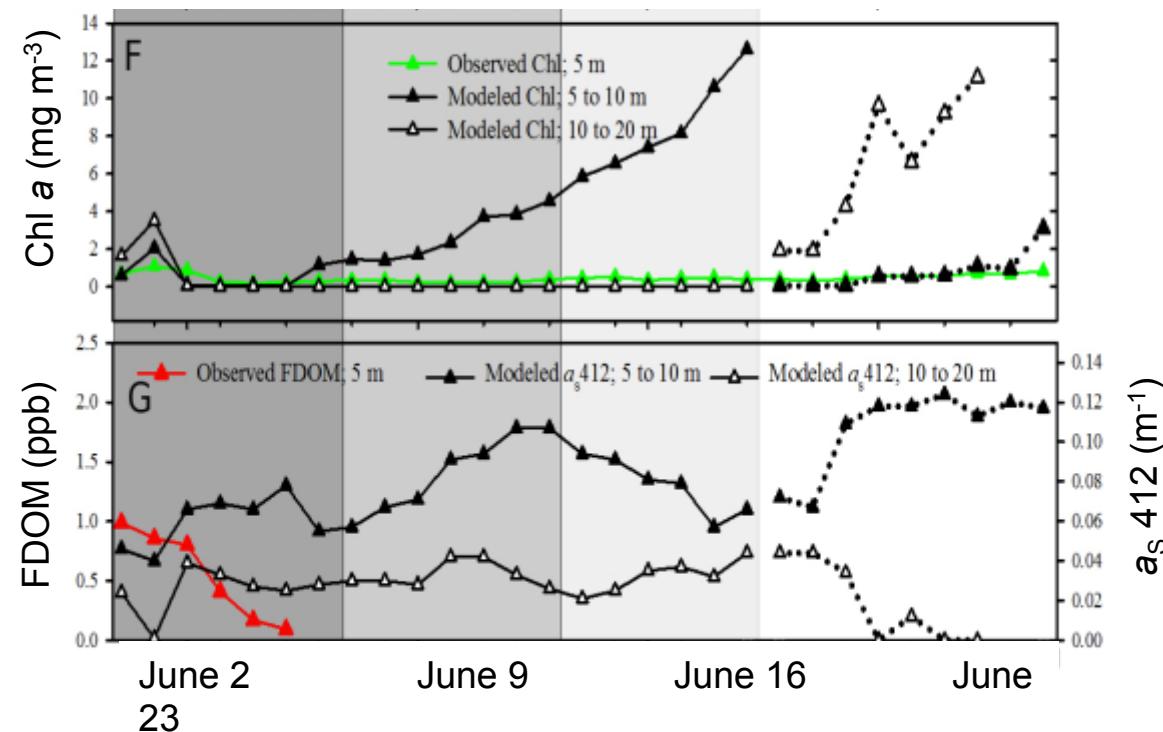
May Jun Jul Aug Sep Oct Nov Dec



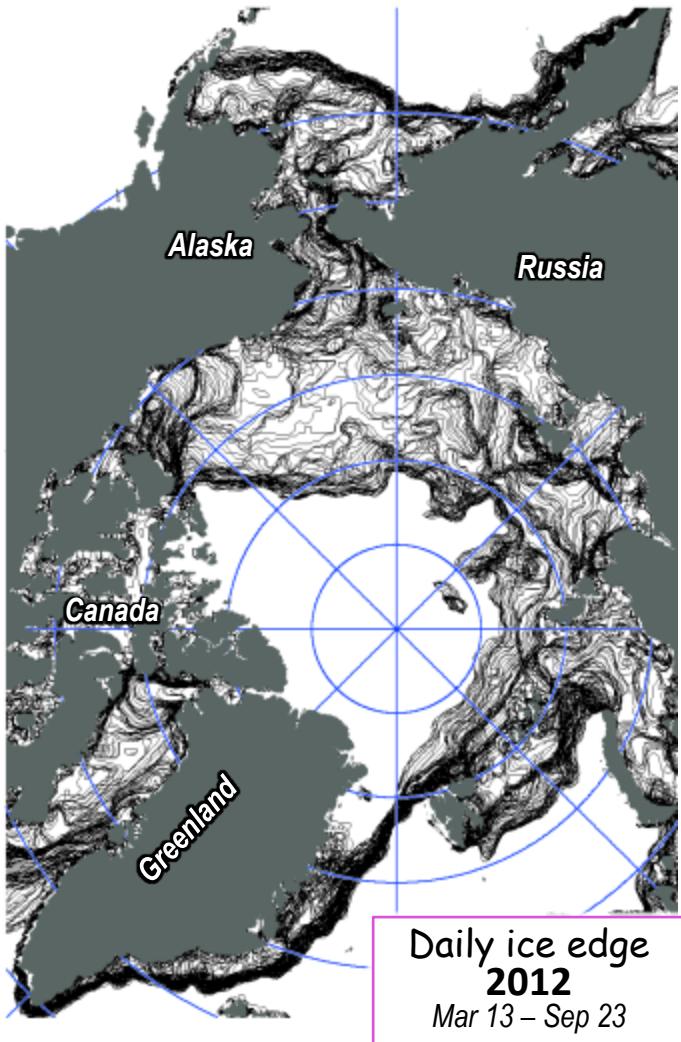
The "WARM" buoy

WA
rm
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irRadiance Measurements

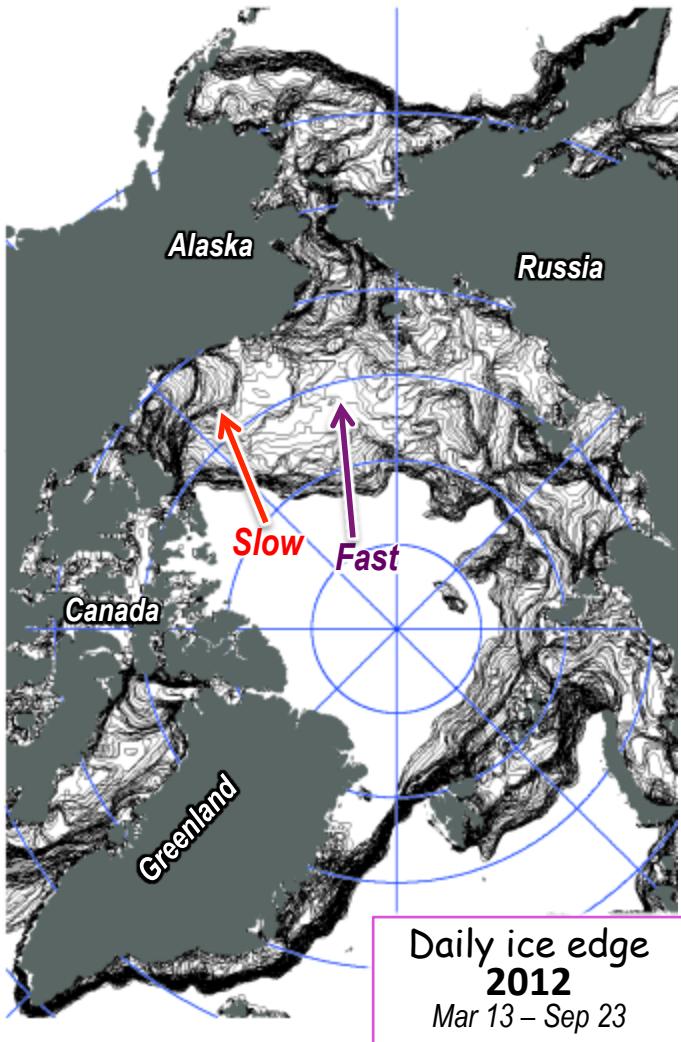
V. Hill, B. Light, M. Steele



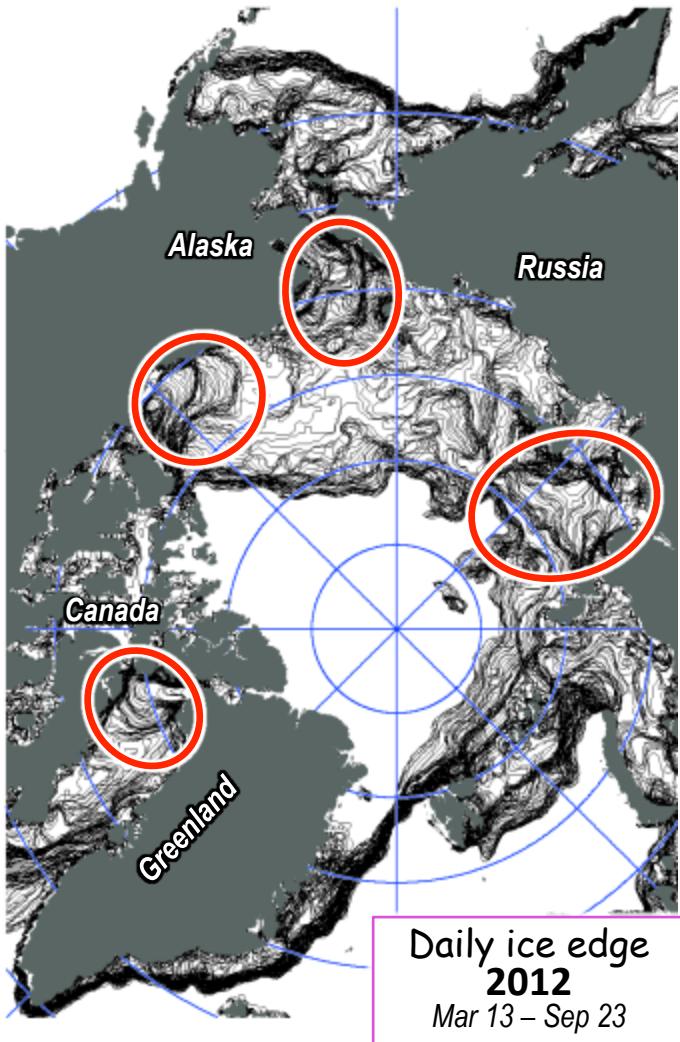
Ice Retreat ← Ocean Warming



Ice Retreat ← Ocean Warming



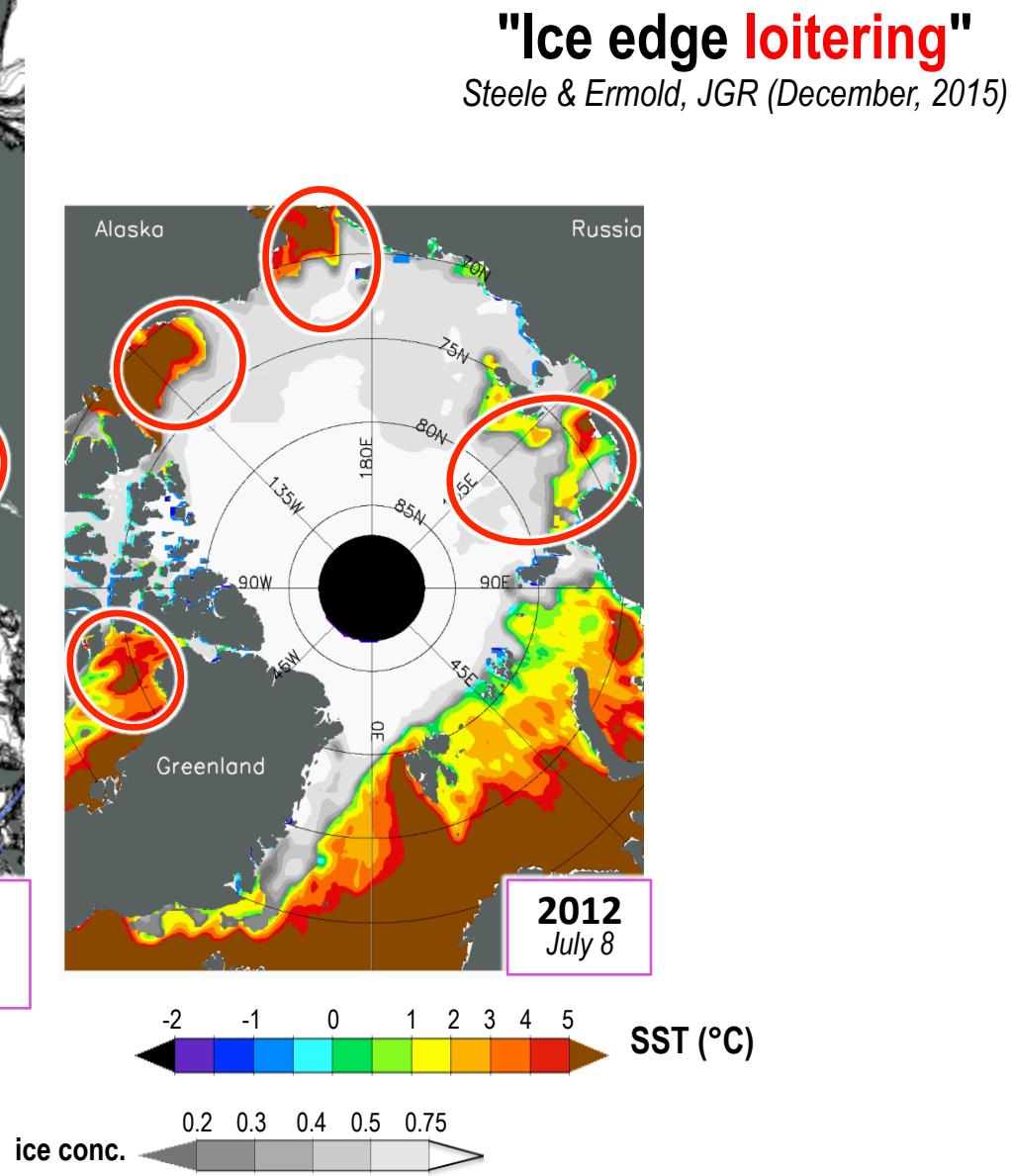
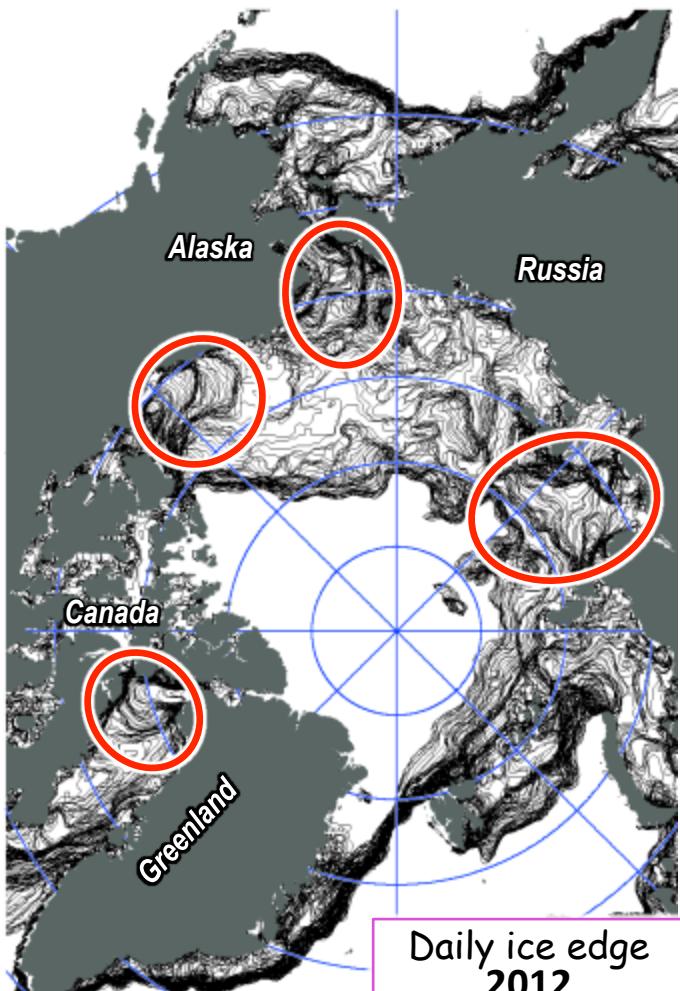
Ice Retreat ← Ocean Warming



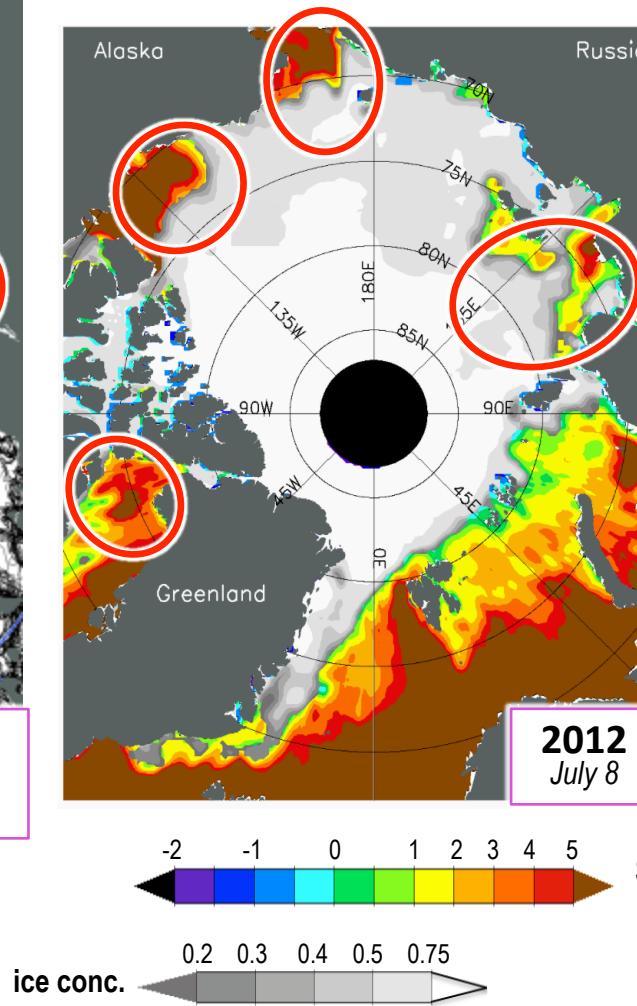
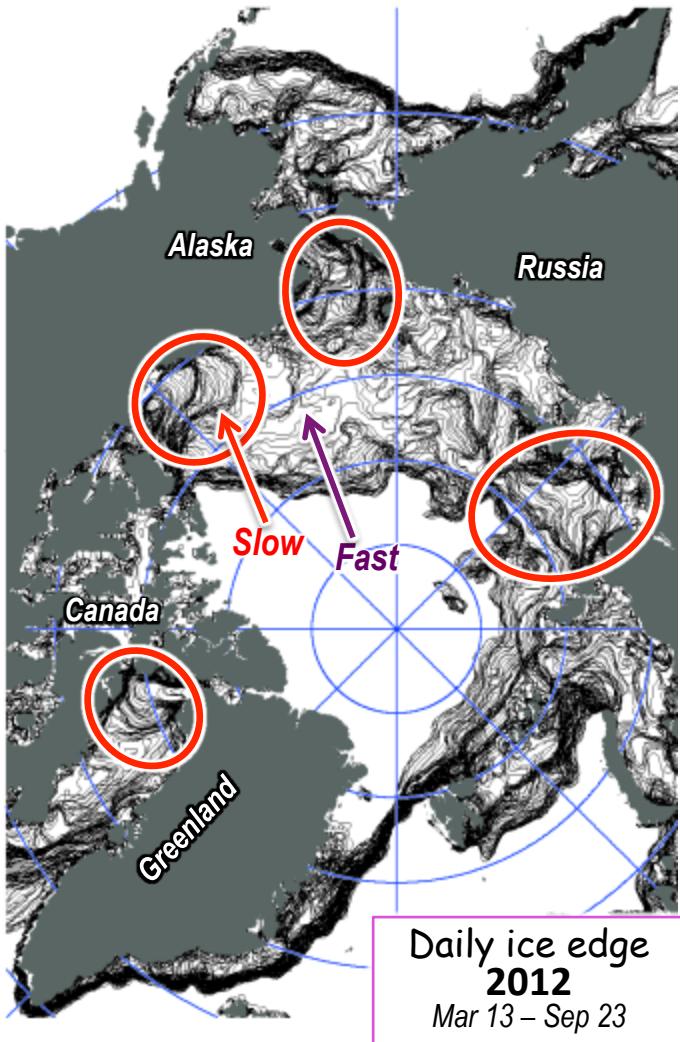
"Ice edge loitering"

Steele & Ermold, JGR (December, 2015)

Ice Retreat ← Ocean Warming



Ice Retreat ← Ocean Warming



"Ice edge loitering"

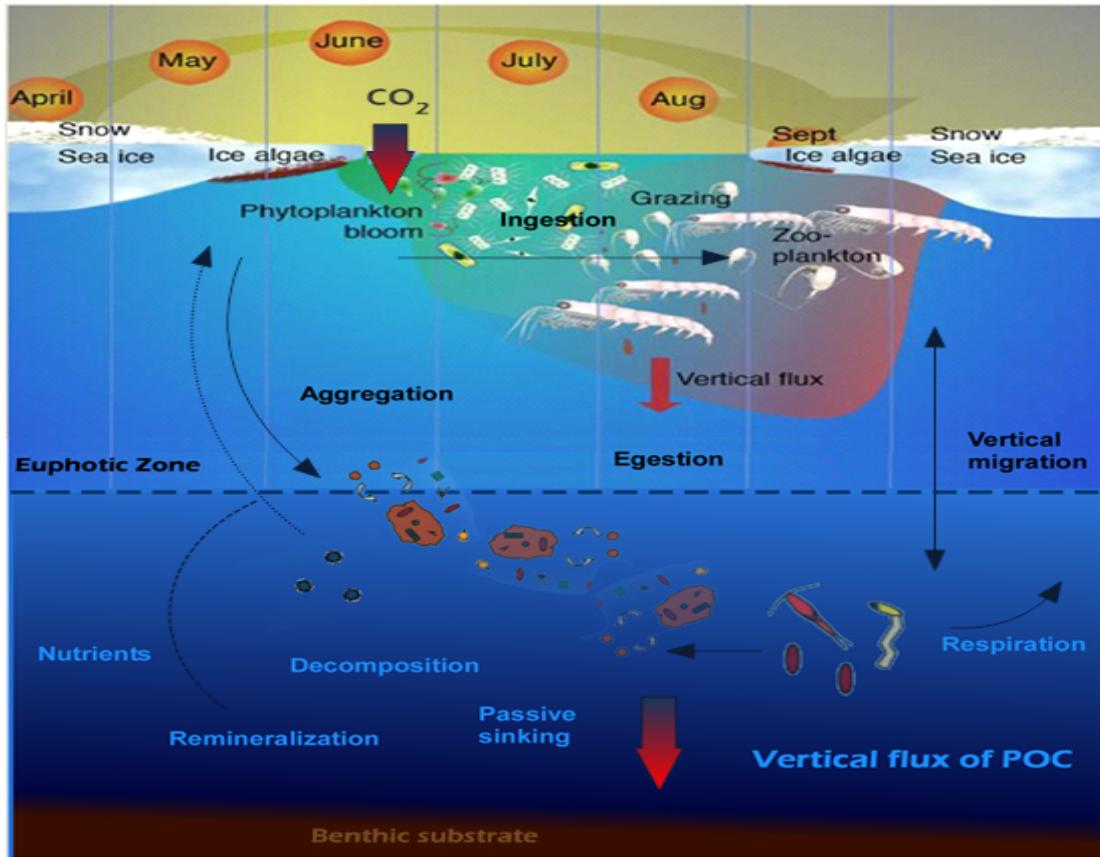
Steele & Ermold, JGR (December, 2015)

Explanation?

Off-ice winds +
warm SSTs

~ 4-10 day time scale

Ice edge ecosystem time scales: A proposal



← A slow **seasonal** progression

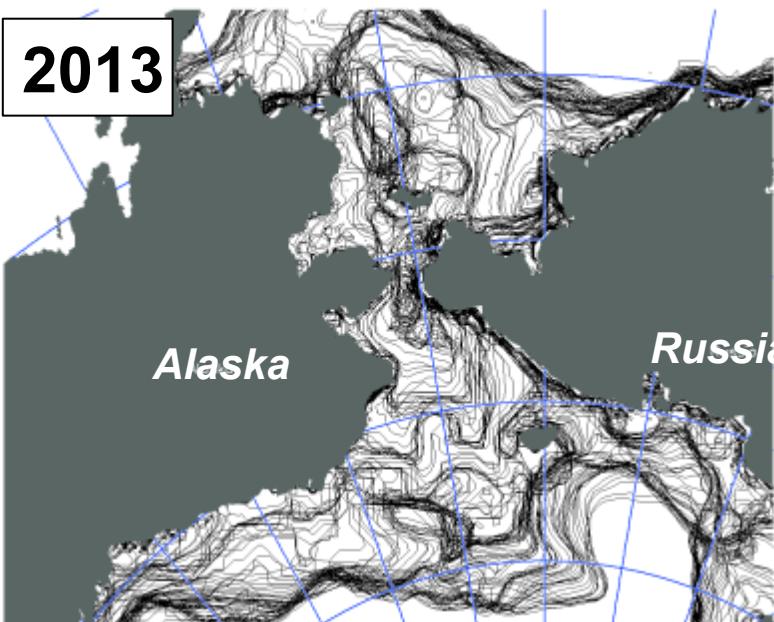
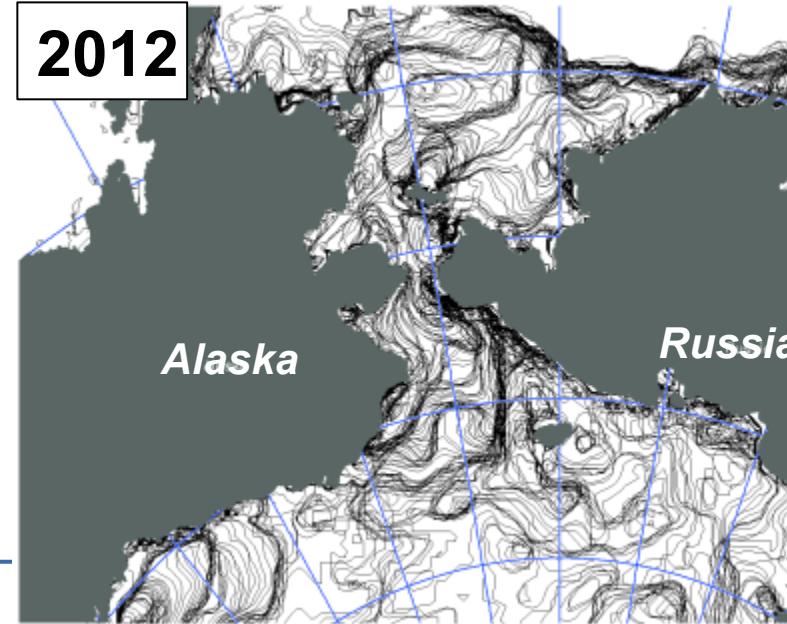
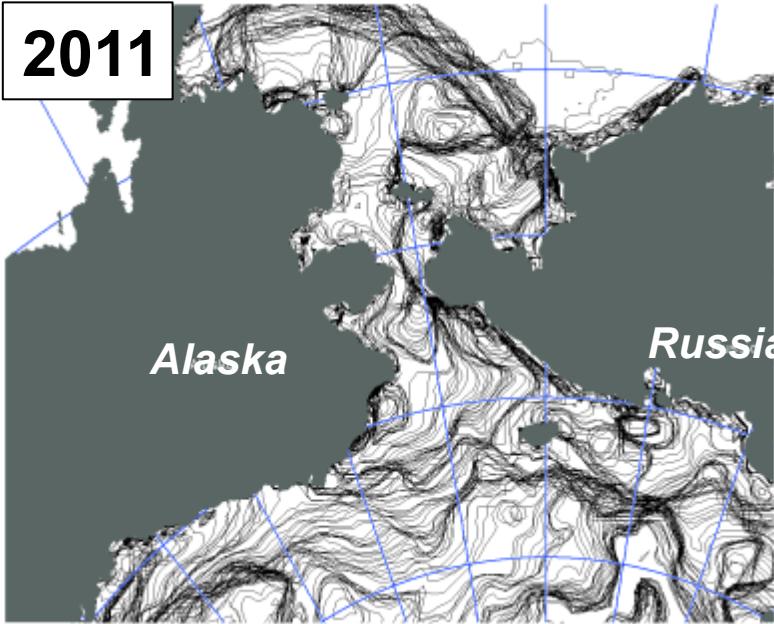
+

~ Weekly “reset” from:

(i) **Highly stratified loitering MIZ**

to:

(ii) **Less stratified, mixed MIZ retreating rapidly northward**



DBO Loitering

Loitering Frequency (1989-2013)

