Chukchi/Beaufort Physical Oceanographic Overview

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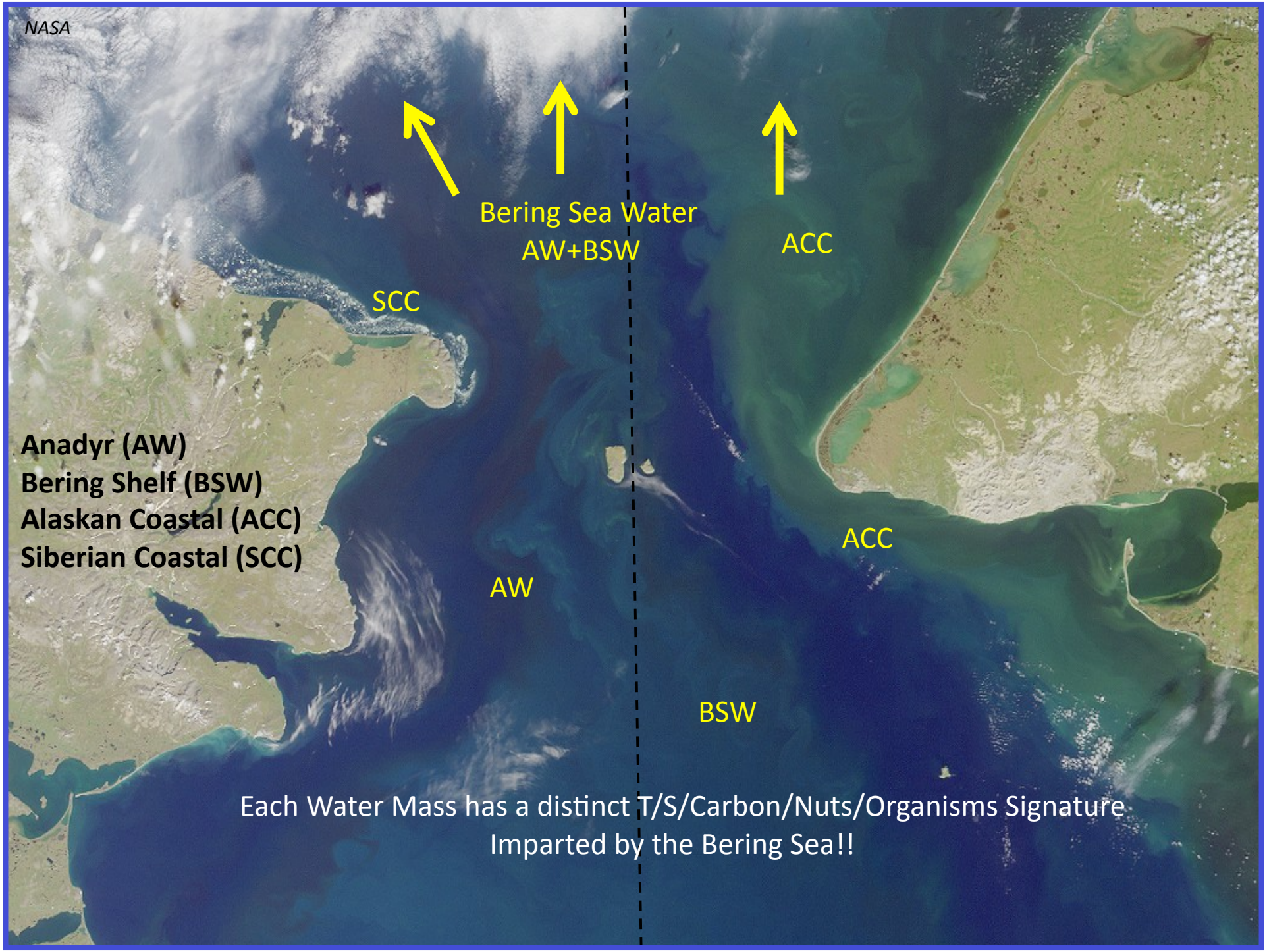
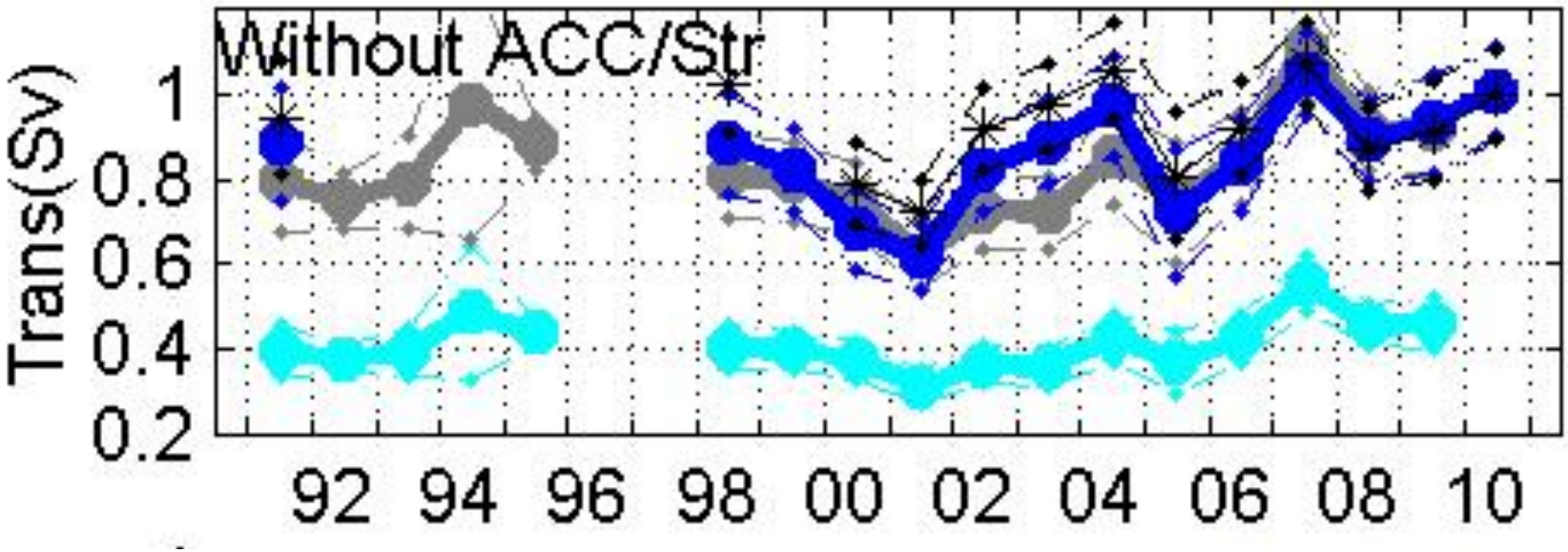
Overview

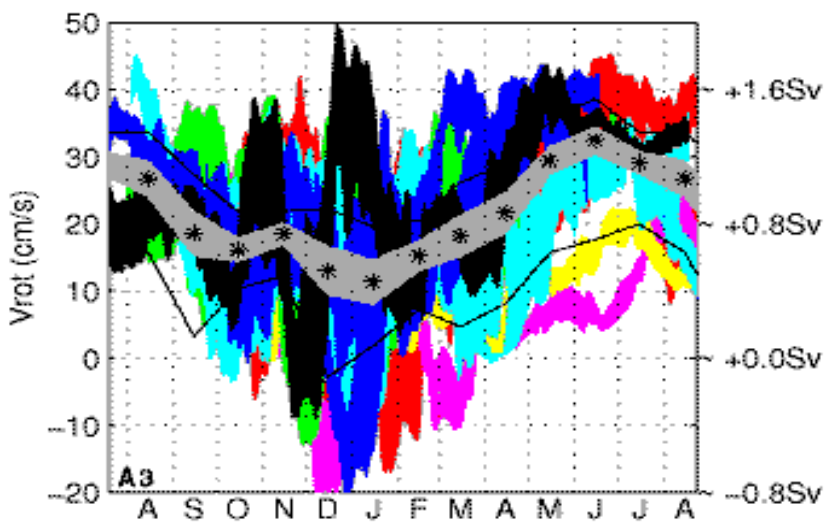
Bering Strait

Chukchi Shelf

Beaufort Shelf

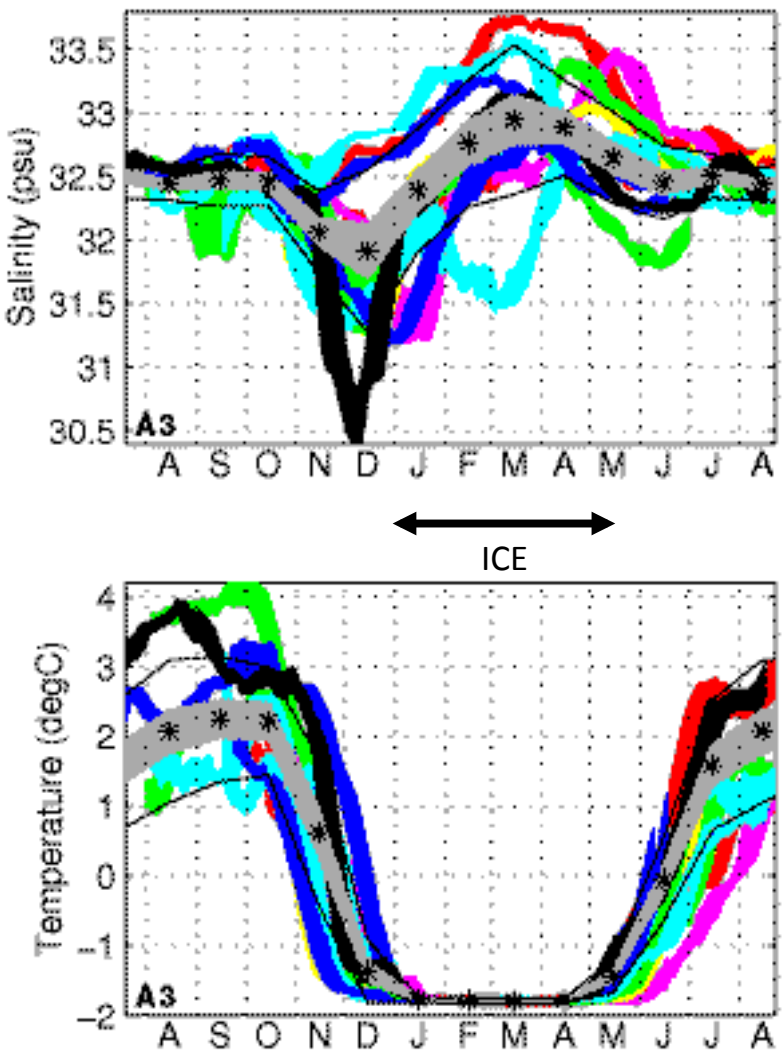

NASA
Bering Sea Water
AW+BSW
ACC
SCC
Anadyr (AW)
Bering Shelf (BSW)
Alaskan Coastal (ACC)
Siberian Coastal (SCC)
ACC
AW
BSW
Each Water Mass has a distinct T/S/Carbon/Nuts/Organisms Signature
Imparted by the Bering Sea!!





TRANSPORT
0.4 to 1.2 Sv

(Woodgate et al, 2005 and Unpub.)

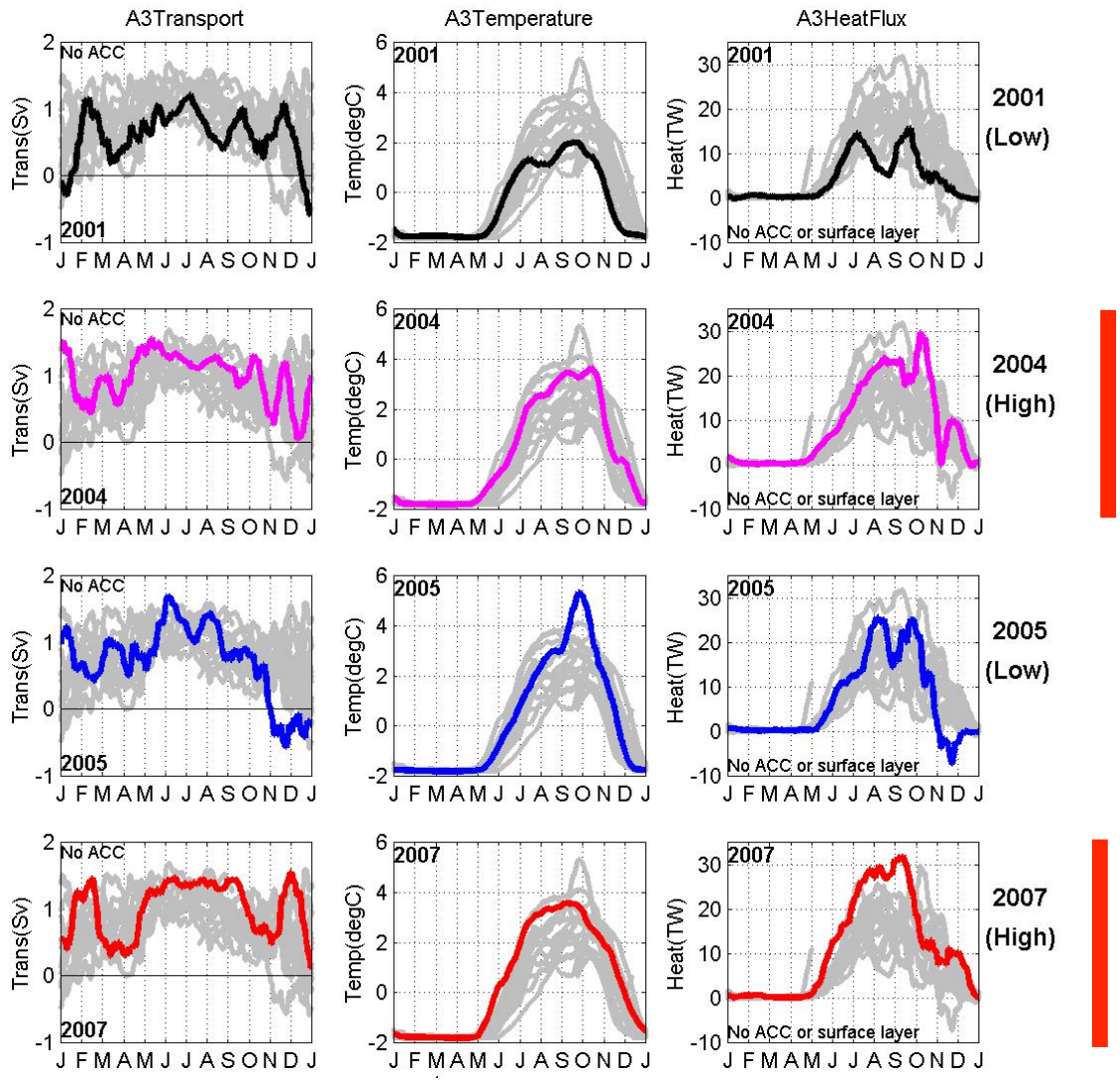


Near-Bottom
SALINITY
31.9 to 33

Near-Bottom
TEMPERATURE
-1.8 to 2.3C

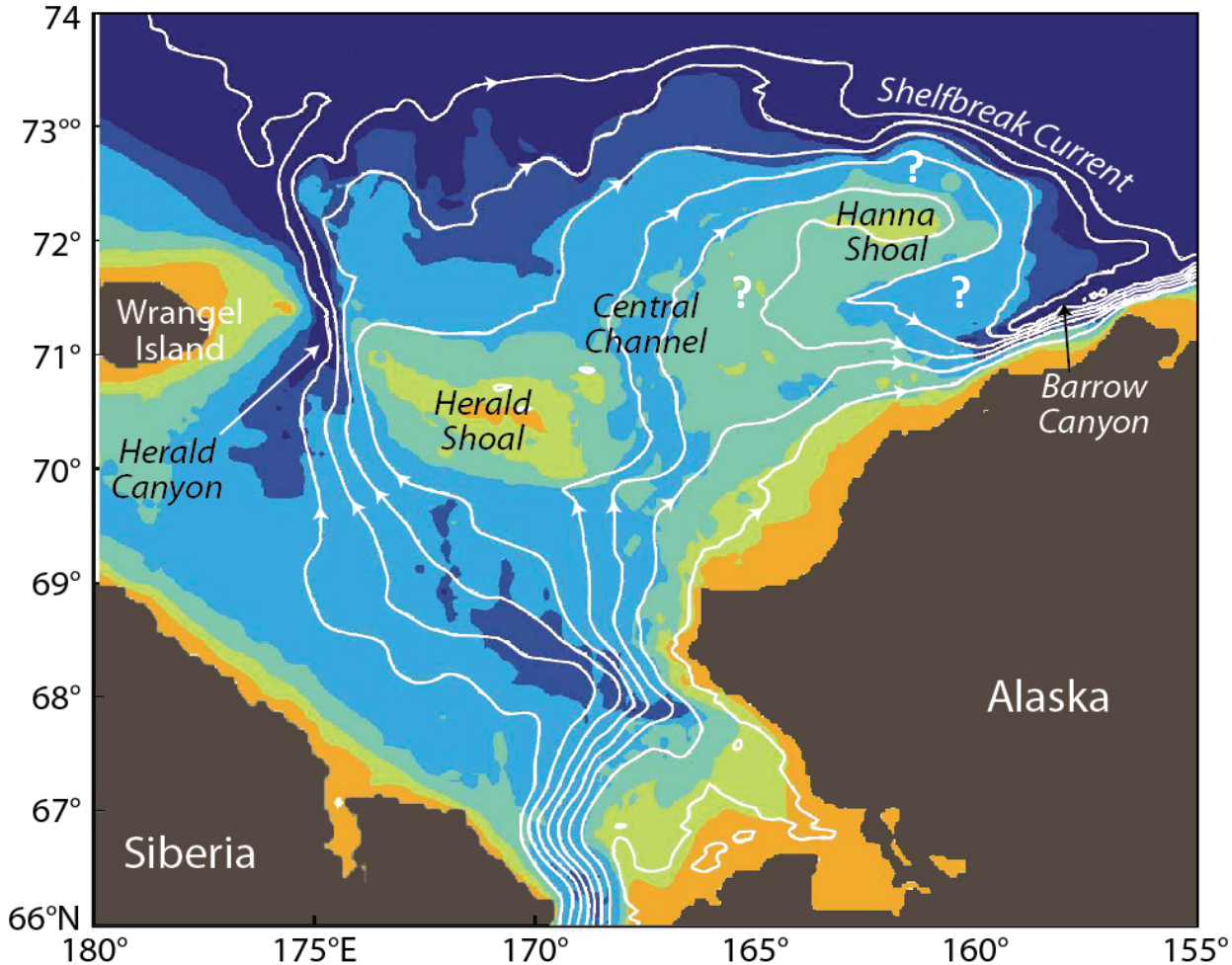
(Woodgate et al, 2005)

Ex: Interannual Variability in Heat Flux
(Heat and Salt Fluxes controlled by flow *and* constituent)



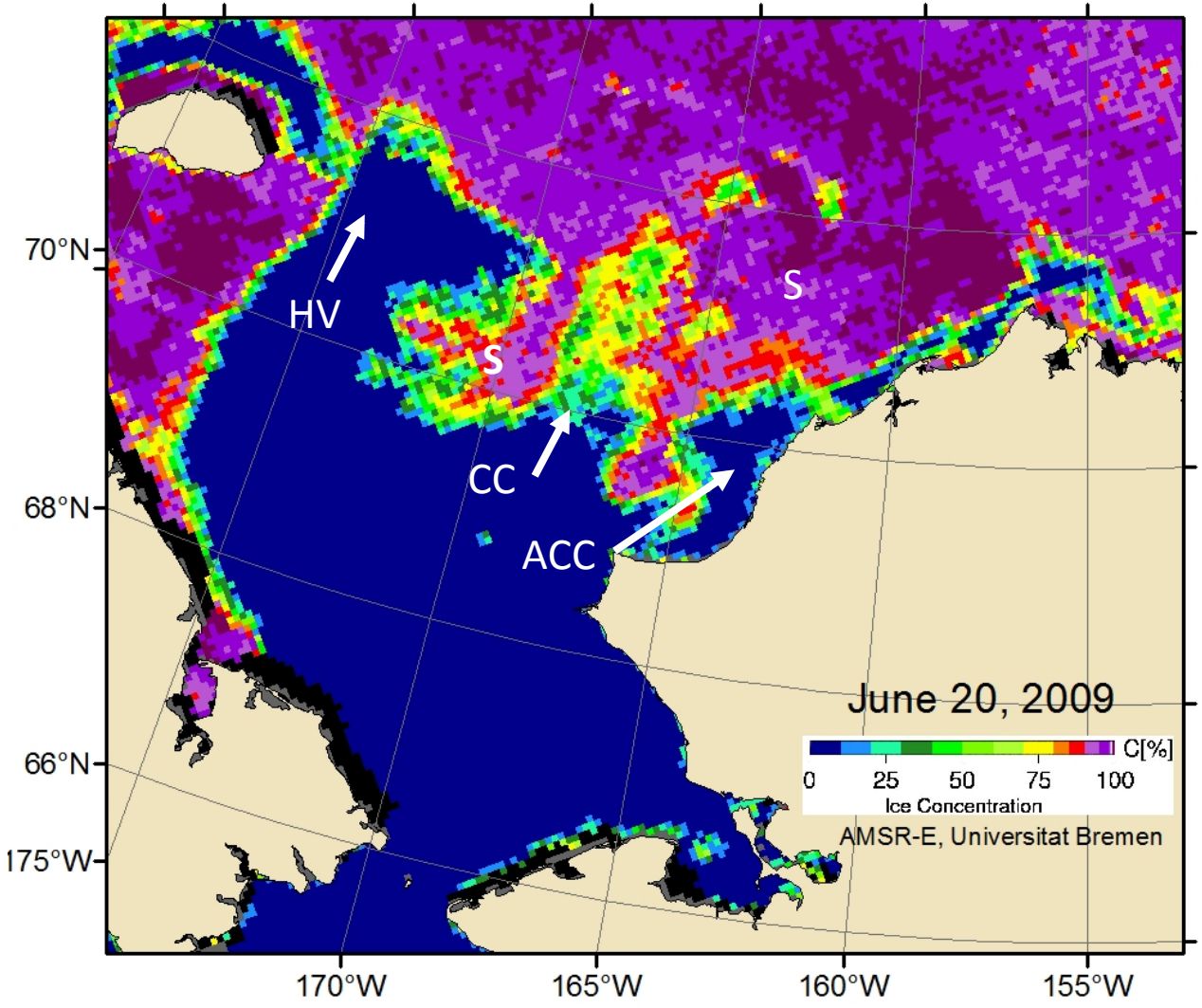
Chukchi Sea Circulation:
Flow influenced by bathymetry (important ecosystem implications)

Outflows feed the shelfbreak and head EAST

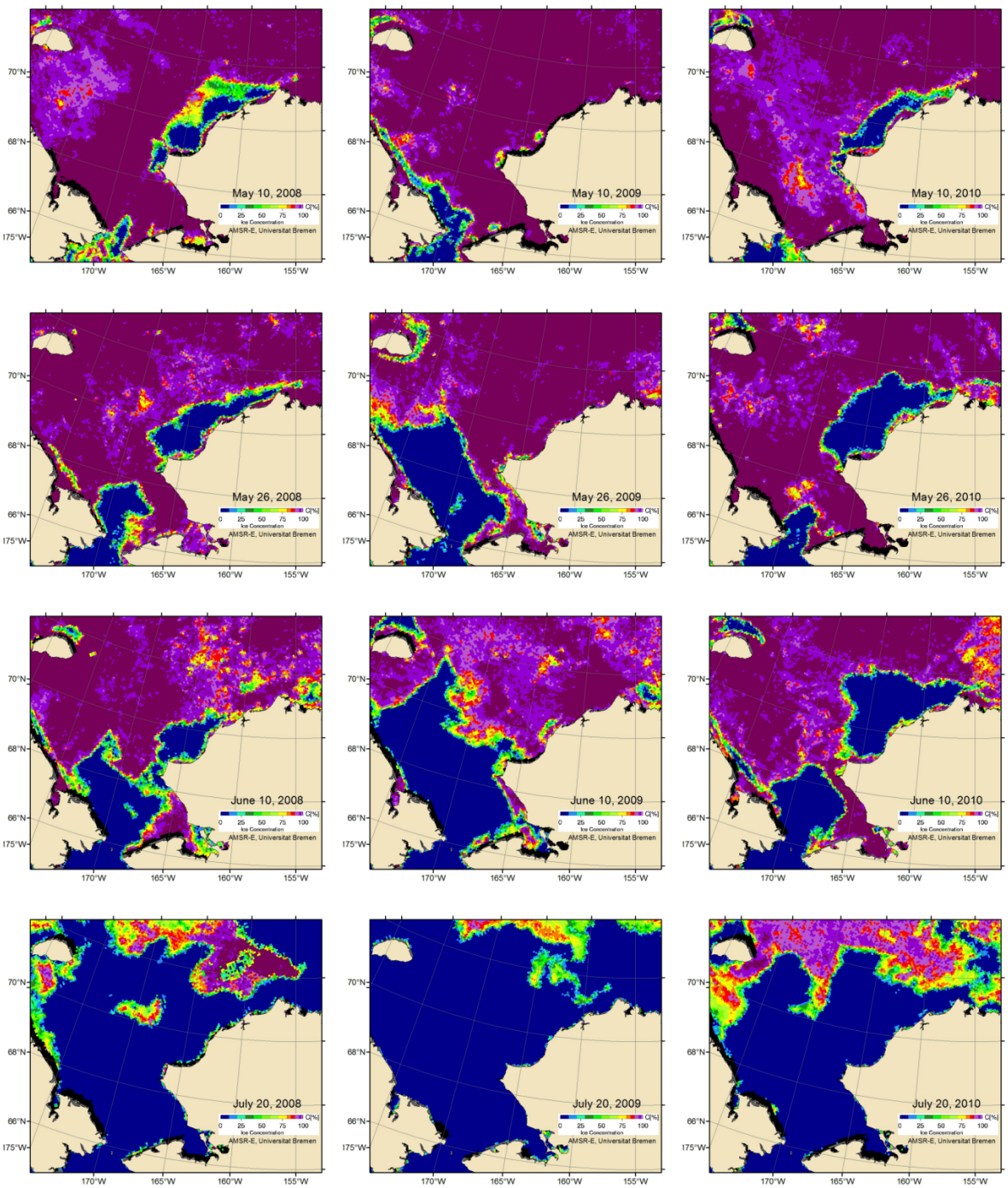


(*Spall, 2007*)

Ice retreat linked to Bering Strait influx and flow paths
(most of the time. . .)
Configures ice-edge ecosystems and habitats



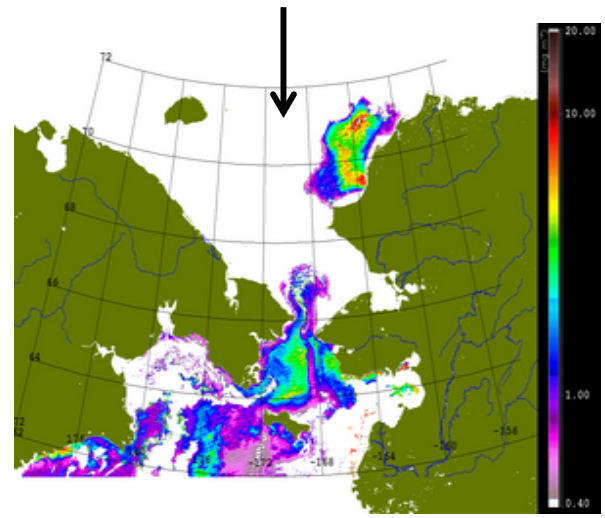
S= Herald and
Hanna Shoal



Easterly winds can "open"
NE Chukchi early in some years
A polynya without freezing?

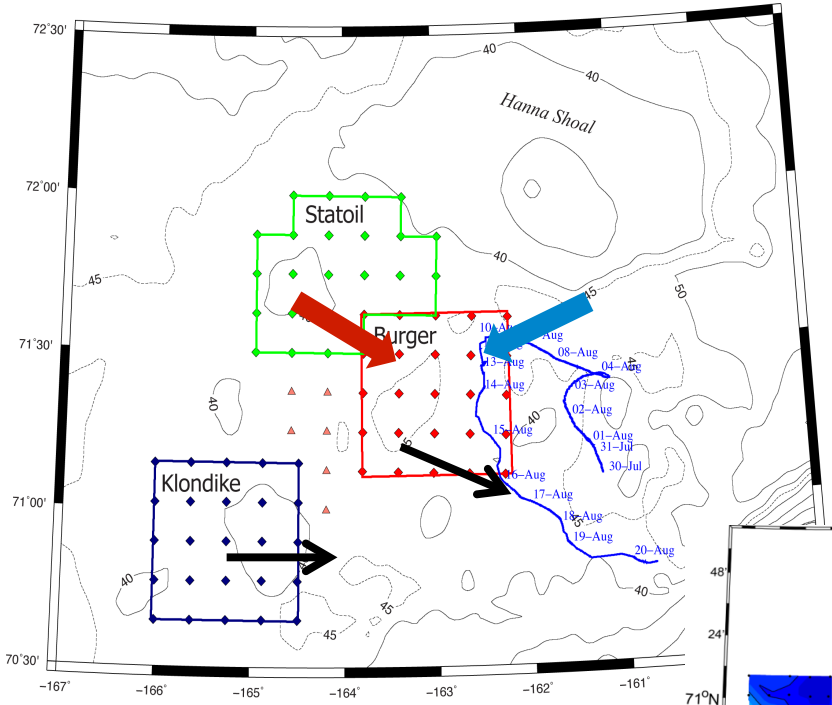
Epontic vs. pelagic production

May 10 , 2010



Note ice "trapping" over shoals
a "persistent" source of
meltwater

[Weingartner et al., in prep.]



Small (~50 km) spatial scale variations in hydrography

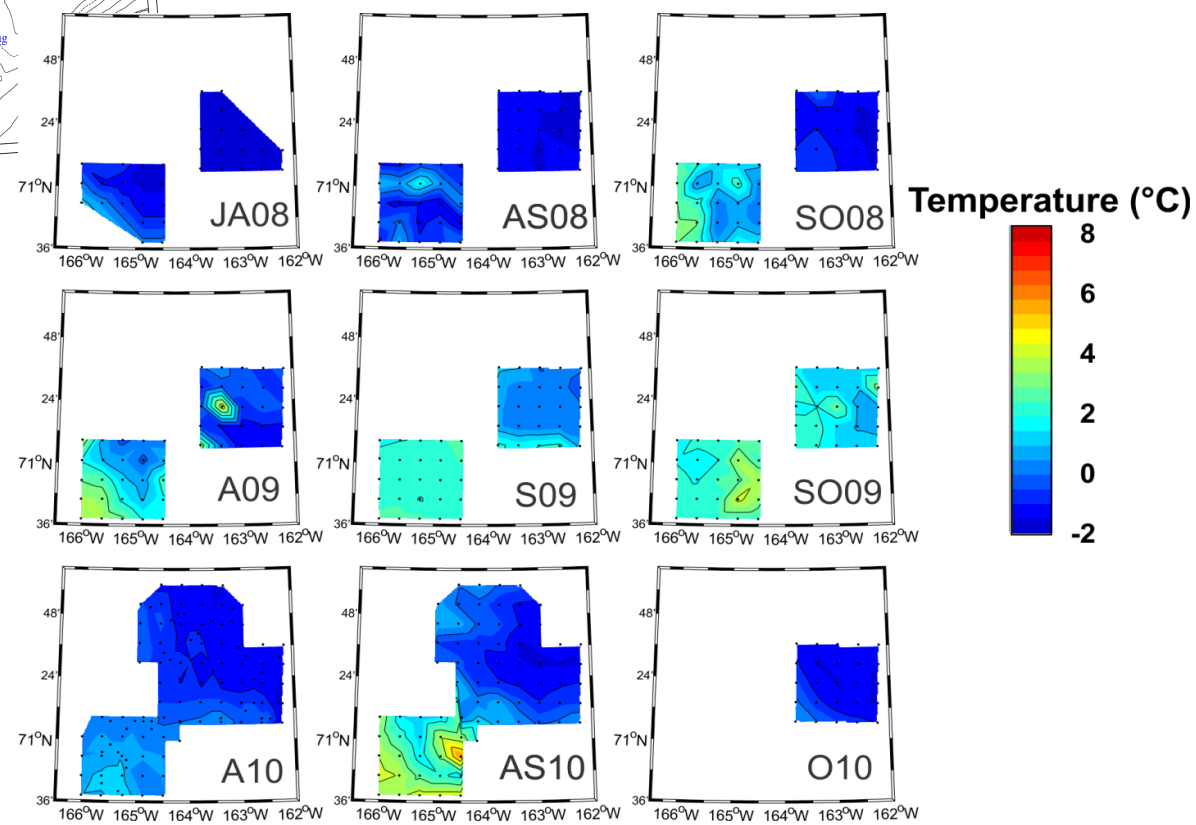
-influence bio. and chem. distributions

-linked to bathymetry

Interannual variability

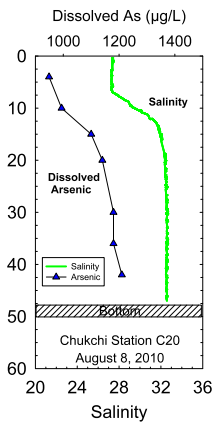
remote (Bering Strait)

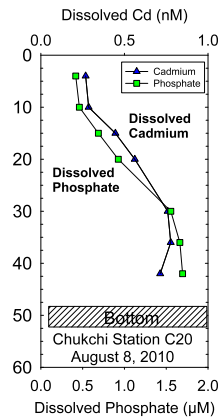
local (winds, ice history, $Q_{air\text{-}sea}$)



[Weingartner et al., in prep.]

Bottom Temperatures

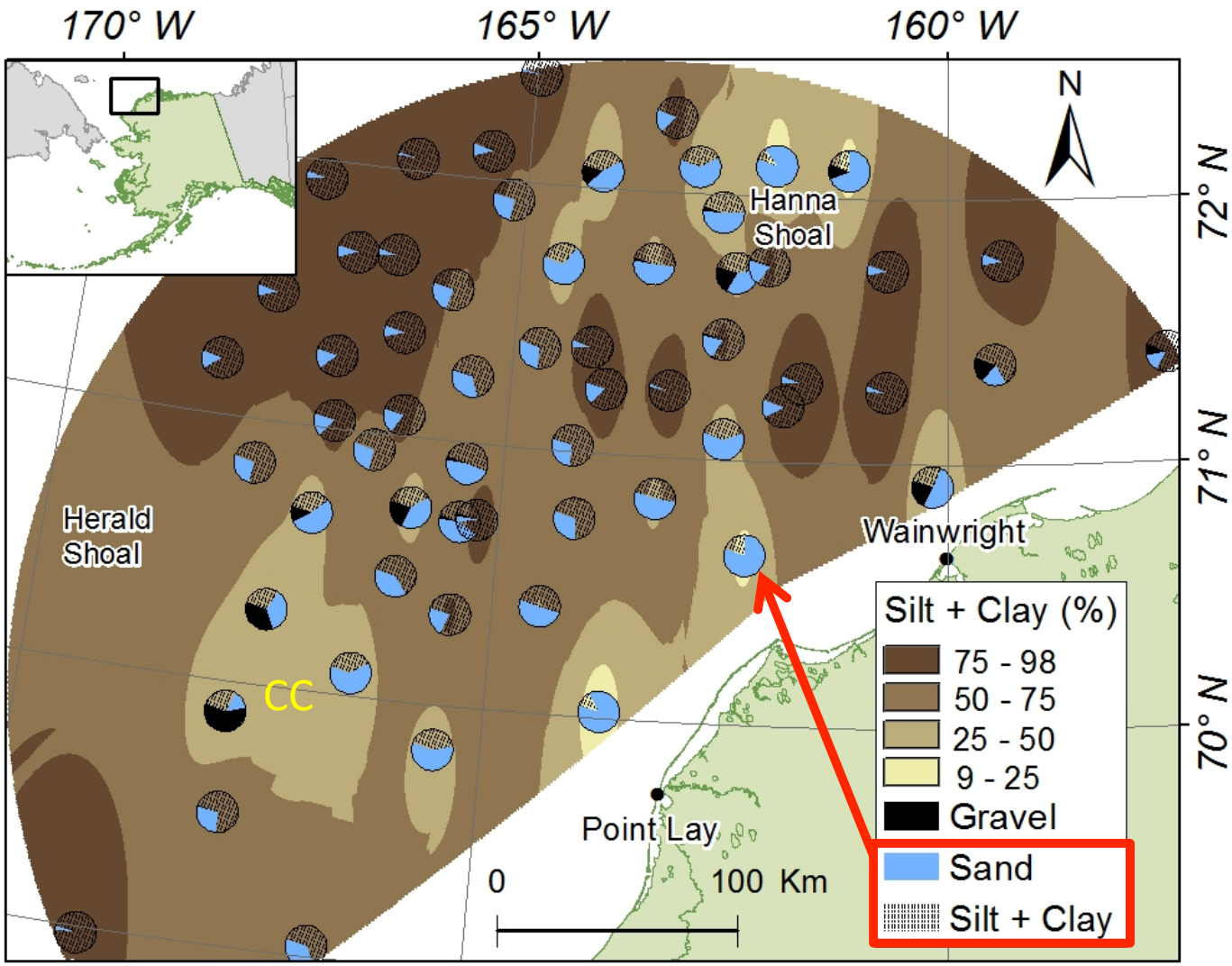




NE Chukchi Sea is like a mini-ocean with some of the familiar distinctions between surface and "deep" water.
Sediment regeneration versus advection?

Trefey et al.

NE Chukchi Sea: Sediment chemistry and biology strongly linked to sediment texture (grain size).

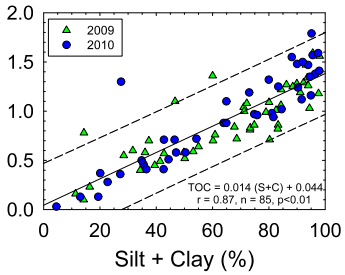


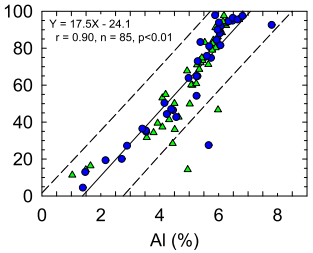
Sand and gravel long known to be abundant on Hanna Shoal and nearshore along the path of ACC.

COMIDA CAB 2009-10

Trefry, Trocine, Cooper (2012)

NE Chukchi Sea: **Sediment Total Organic Carbon (TOC) patchy distribution, follows texture, subject to future shifts from coastal erosion and changes in primary productivity. Sediment concentrations of Aluminum and trace metals follow sediment texture (grain size) and TOC**

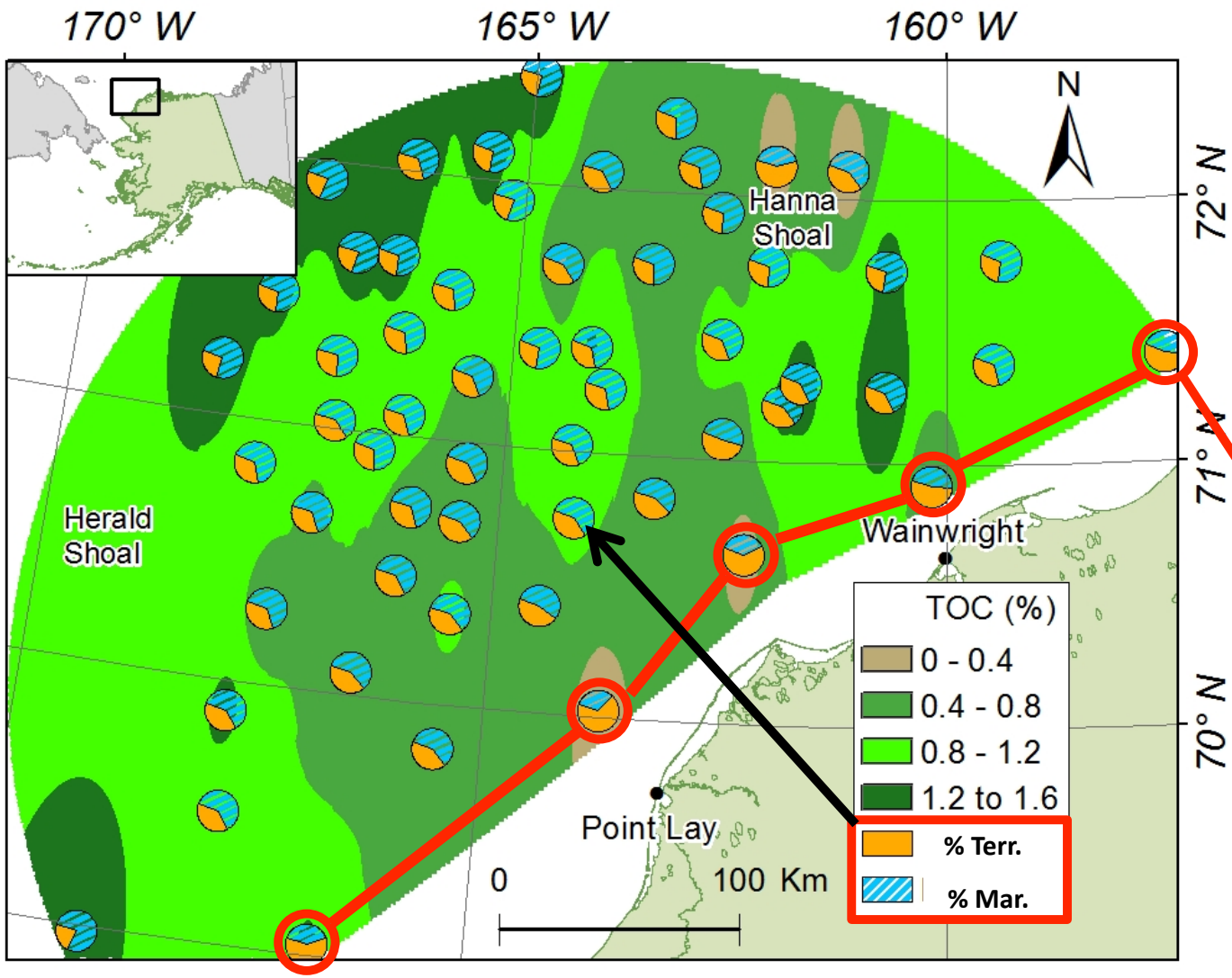




Coastal Beaufort Sea: **Very patchy sediment texture; however, good correlations among sediment chemical (TOC, metals, organic substances) and biological parameters as for the NE Chukchi Sea.**

Trefry, Trocine, Cooper (2012)

NE Chukchi Sea: Based on stable C isotope data for OC (organic carbon) in sediment, we can calculate the % terrestrial and % marine organic matter.

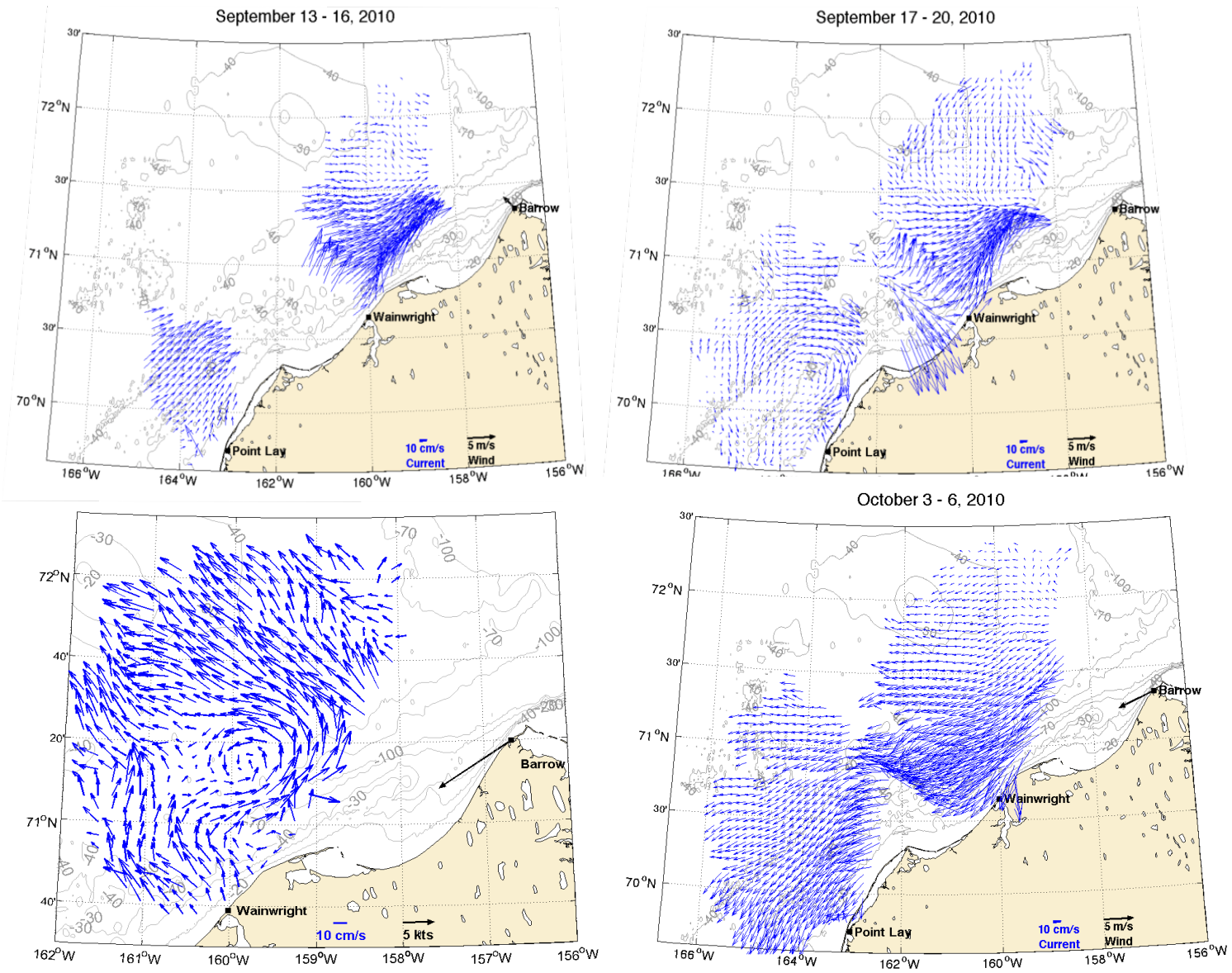


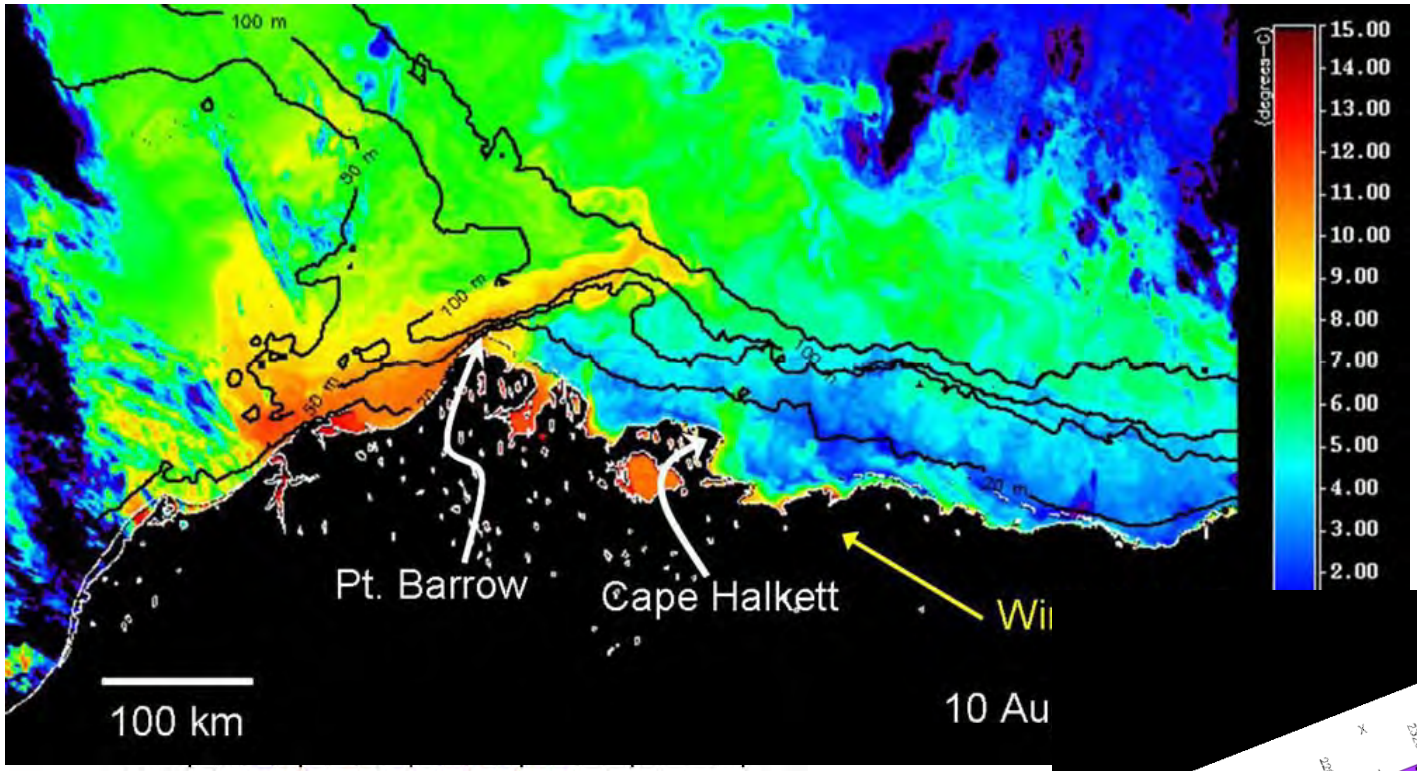
Only stations nearshore have >50% terrestrial organic carbon.

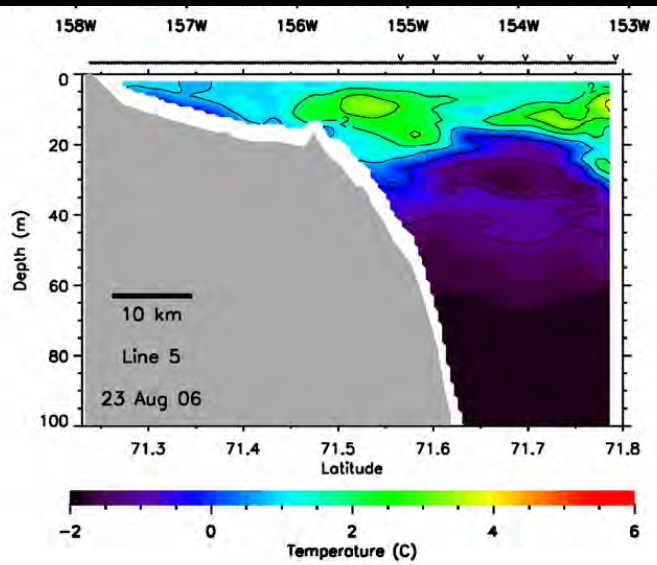
COMIDA CAB 2009-10

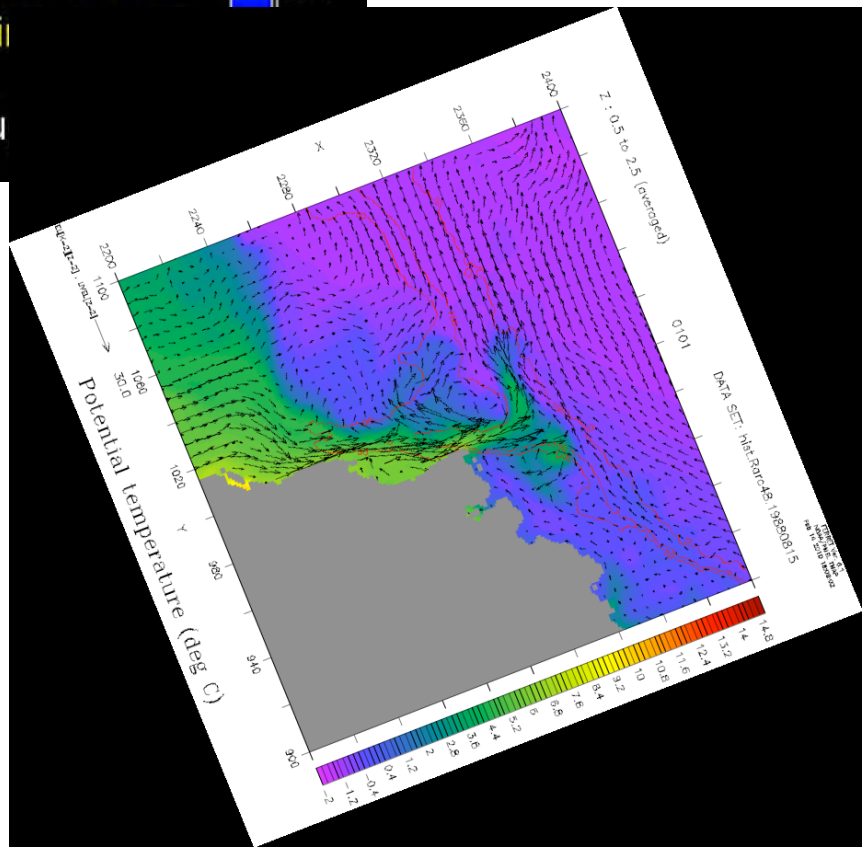
Trefry, Trocine, Cooper (2012); $\delta^{13}C$ data from Dunton et al. (2012)

More Mesoscale Variability Than I thought

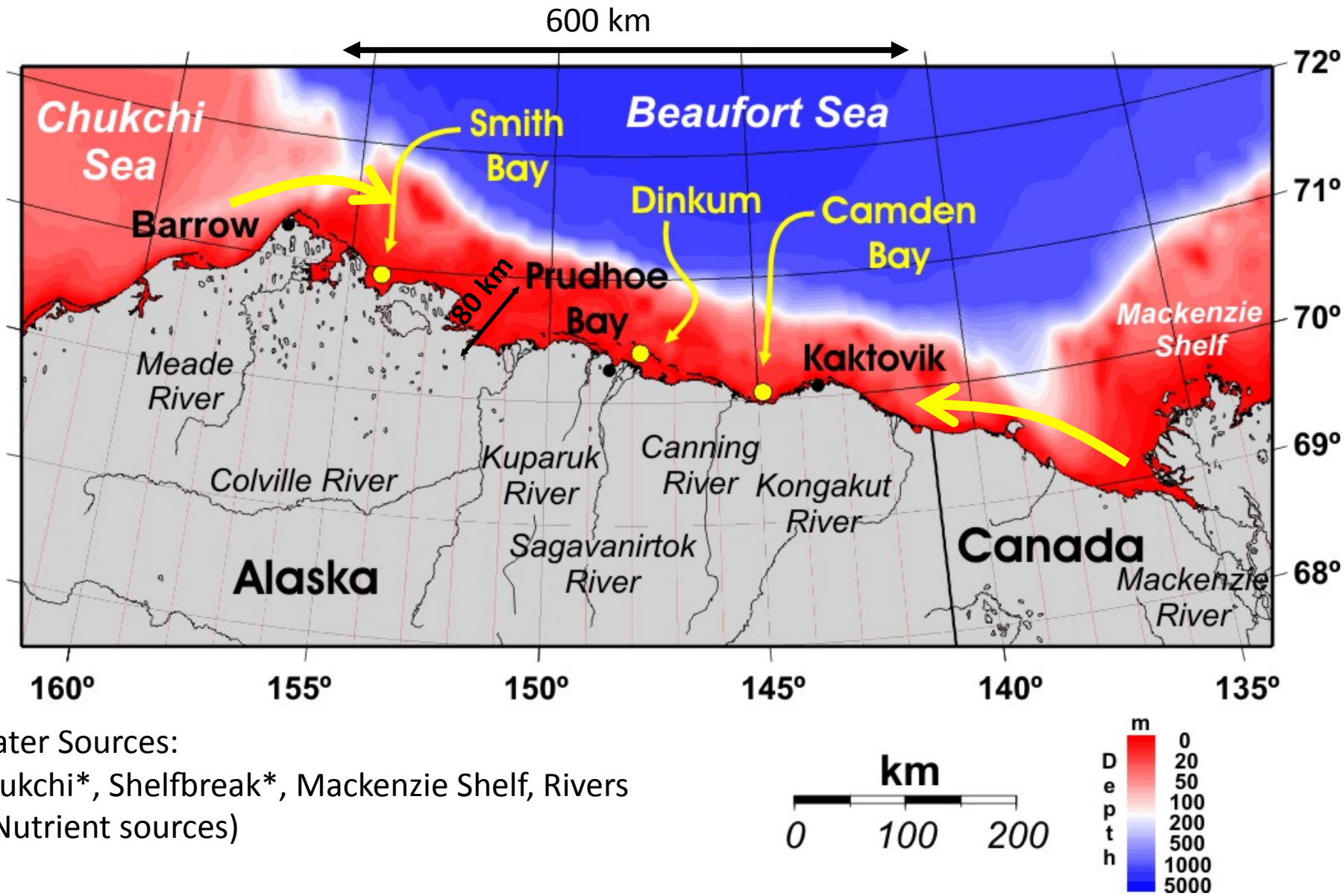



100 m
50 m
100 m
50 m
20 m
Pt. Barrow
Cape Halkett
Wi
100 km
10 Au
(degrees-C)
15.00
14.00
13.00
12.00
11.00
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00


158W
157W
156W
155W
154W
153W
Depth (m)
0
20
40
60
80
100
10 km
Line 5
23 Aug 06
71.3
71.4
71.5
71.6
71.7
71.8
Latitude
−2
0
2
4
6
Temperature (C)


Z : 0.5 to 2.5 (averaged)
0101
DATA SET: hist.Barc48.1989b15
Potential temperature (deg C)
X
Y
2400
2360
2320
2280
2240
2200
1100
1060
30.0
1020
980
940
900

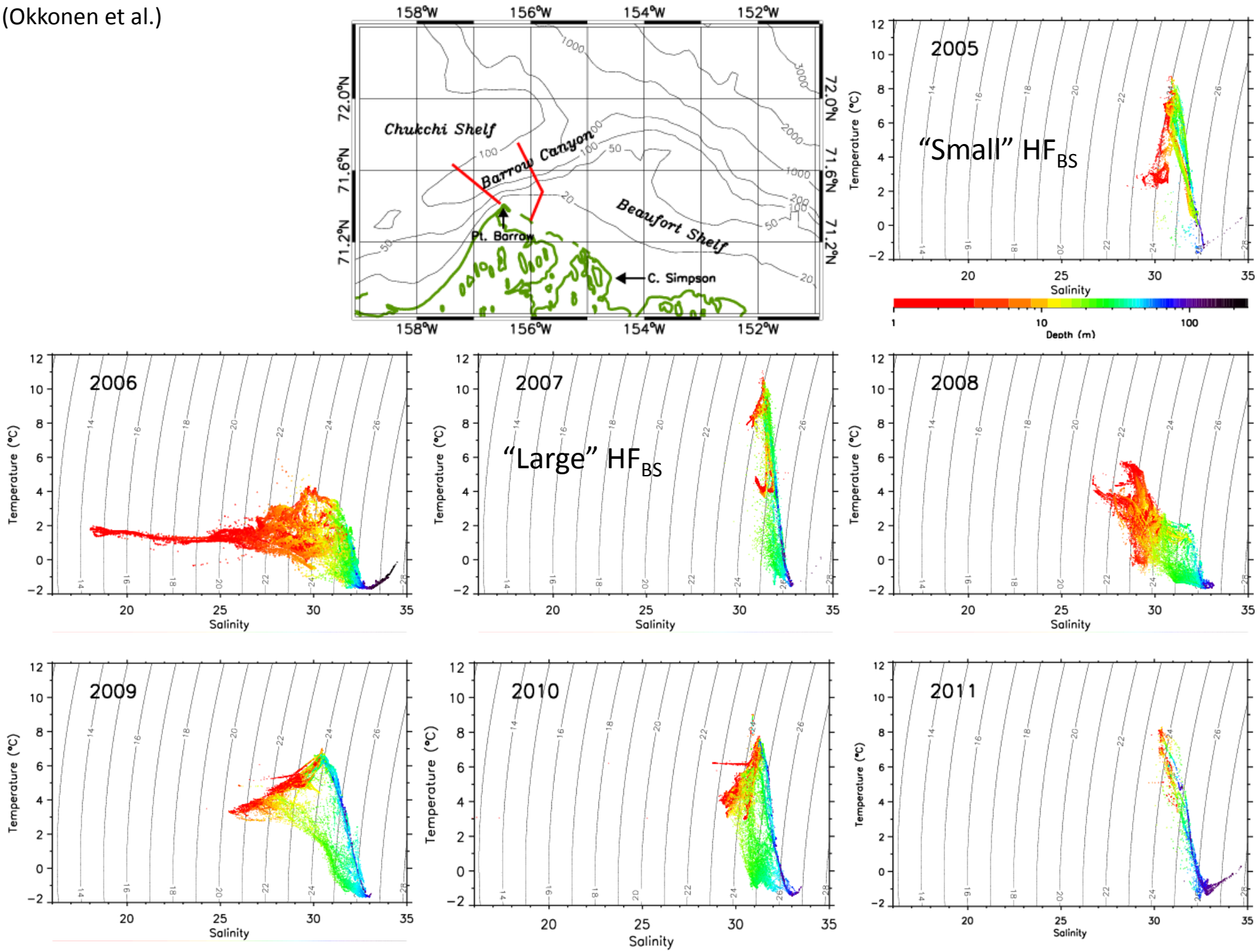
The Alaskan Beaufort Shelf (ABS)

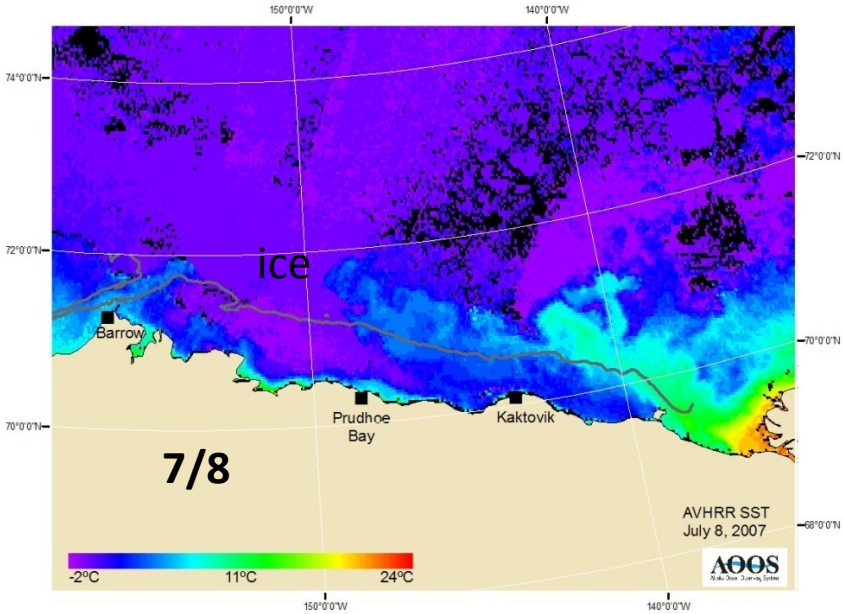


Water Sources:
Chukchi*, Shelfbreak*, Mackenzie Shelf, Rivers
(*Nutrient sources)

Exchange Mediated by Winds, Ice, Rivers,
Shelbreak density/velocity structure

(Okkonen et al.)





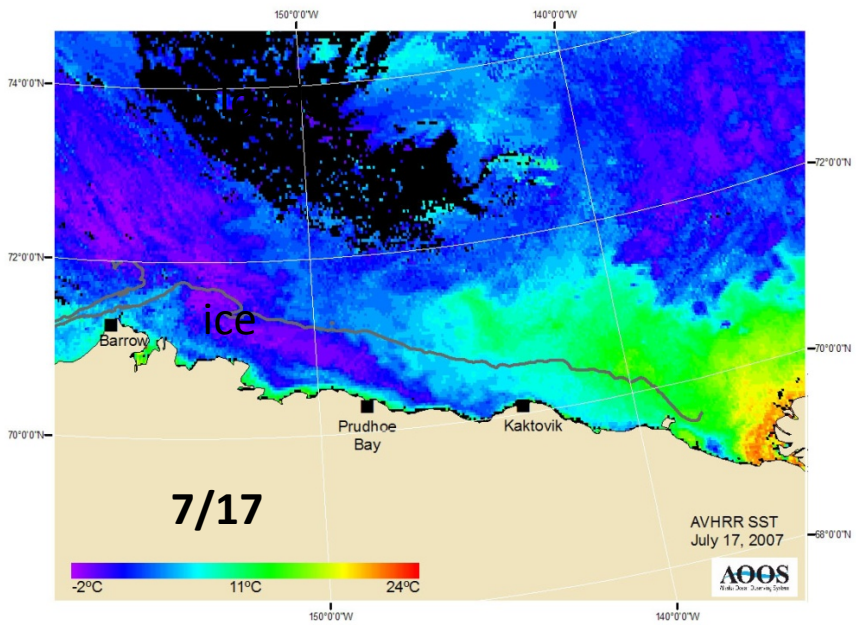
July 2007

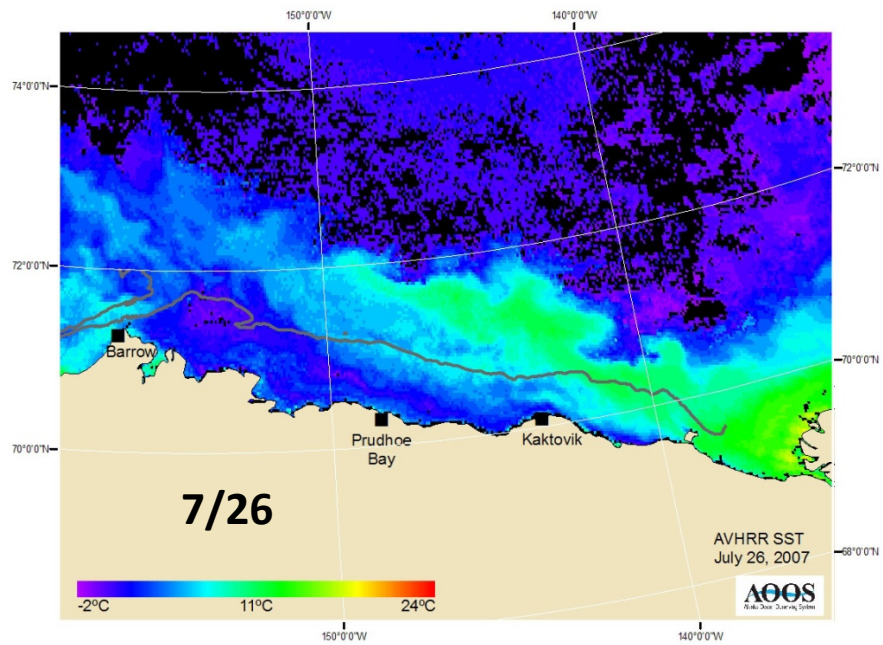
Plume Spreading Speed: 8 cm/s

Heat Flux: ~100 Wm^{-2} (2.5cm d^{-1})

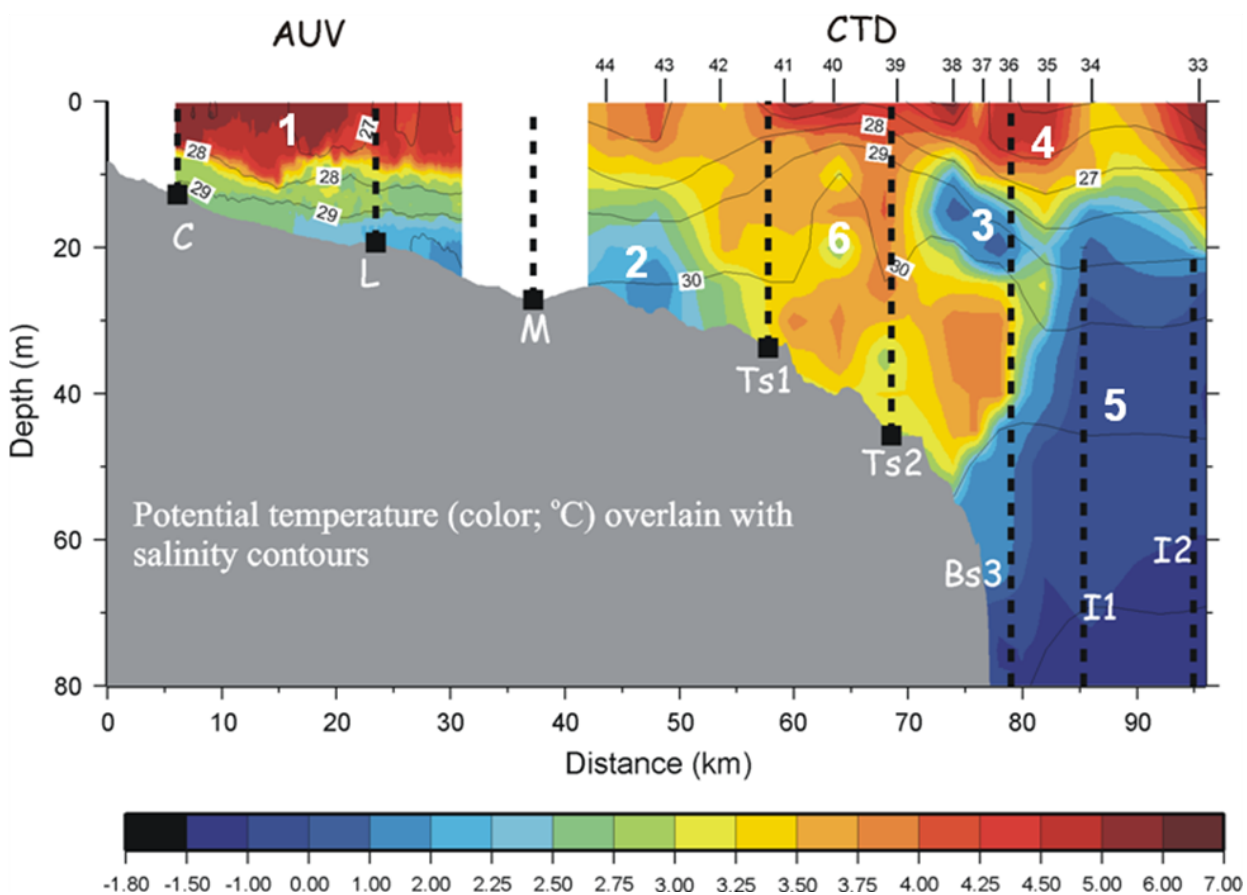
Solar Radiation: ~200 W m^{-2}

Are these plumes self-sustaining?





Summer is complex!!!

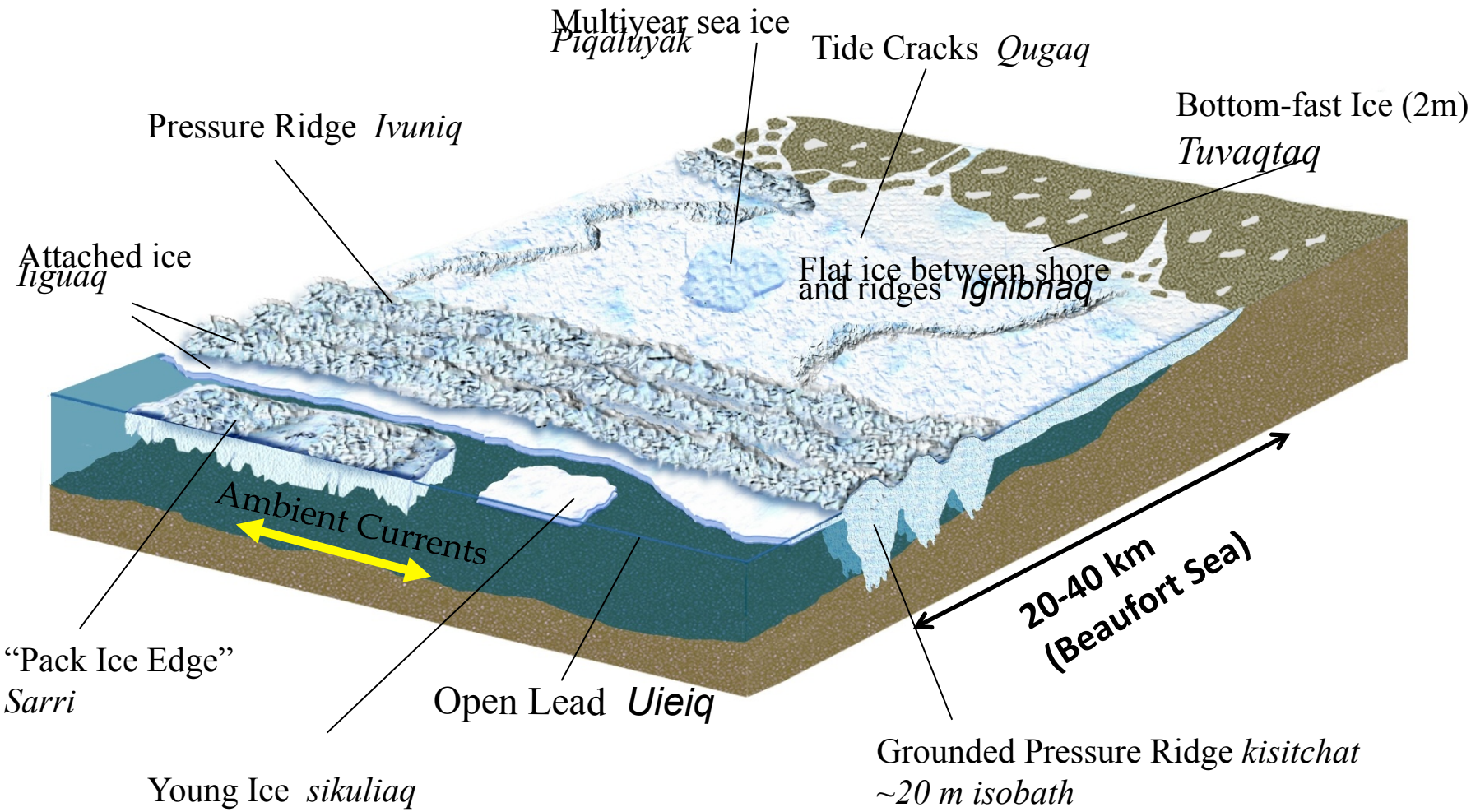


1. warm, fresh, river water
2. mid-shelf cold pool, winter remnant
3. shelfbreak eddy of Chukchi winter water
4. Mackenzie River plume spreading westward;
5. cold Chukchi winter water
6. warmer Chukchi summer water.

Winter is too and largely related to ice distribution

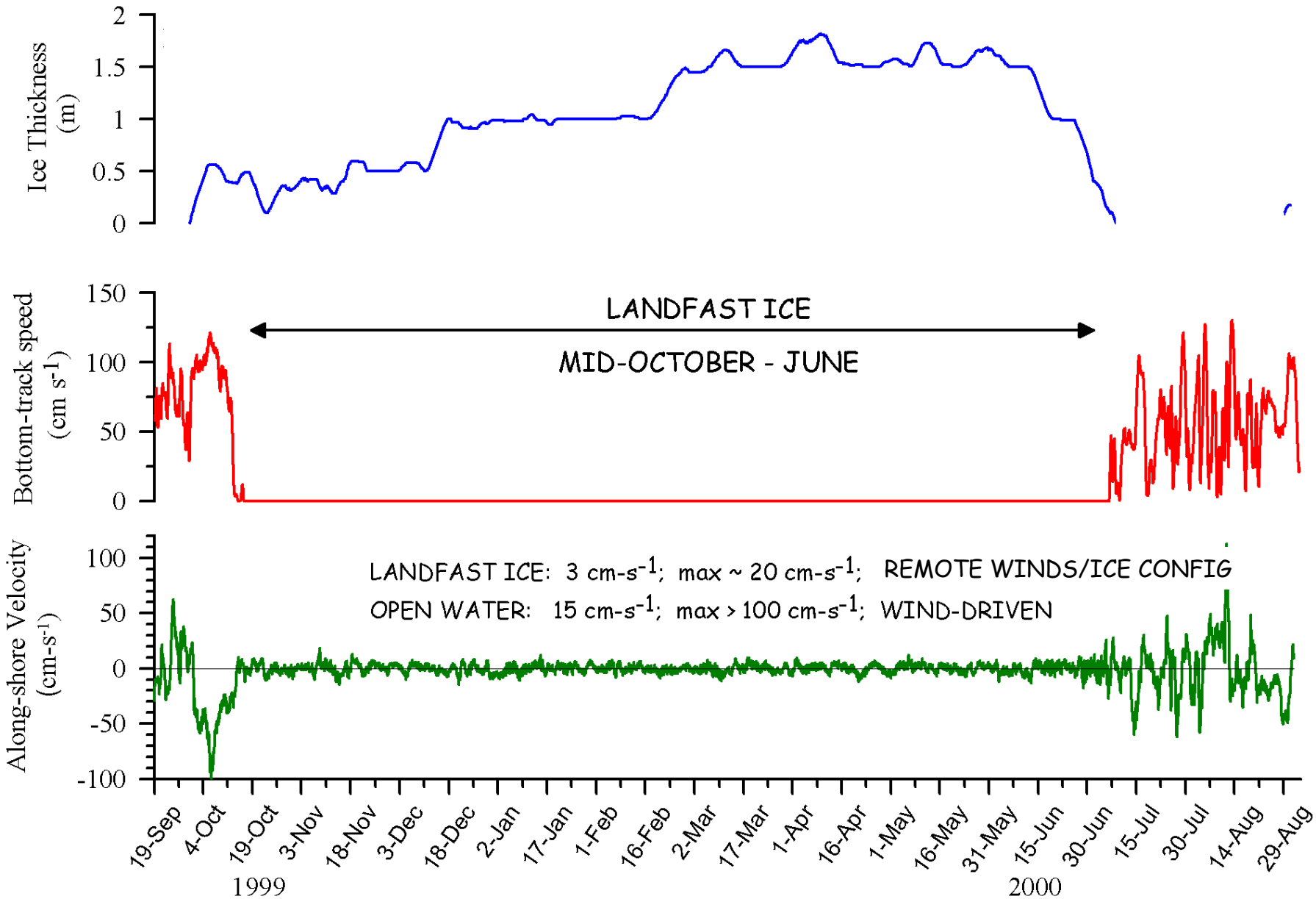
Landfast Ice (immobile)
Partial Ice Cover (“free drift”)
Total Ice Cover

Landfast ice or *Tuvaq* – occupies 20% of 'interior' shelf area

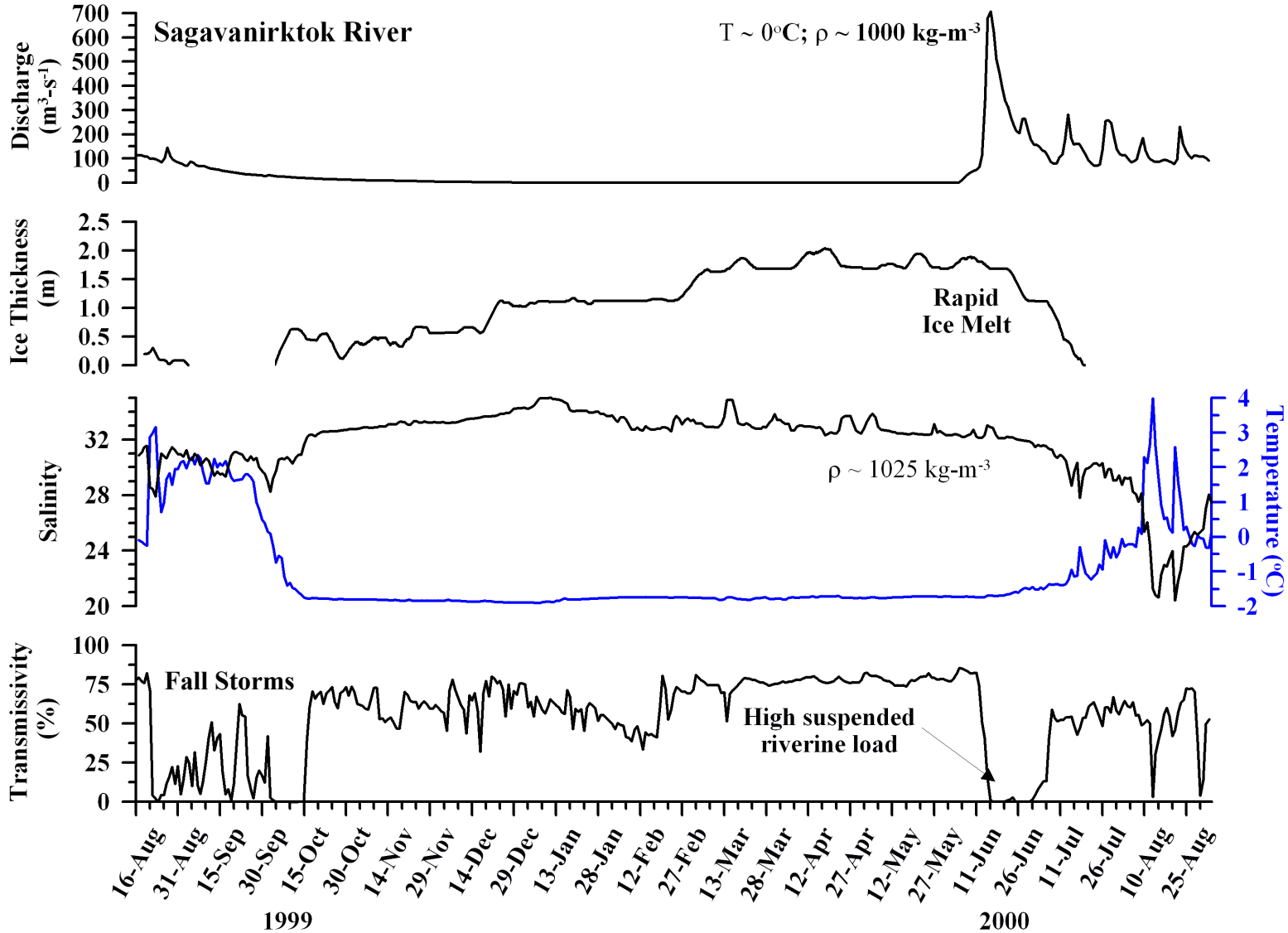


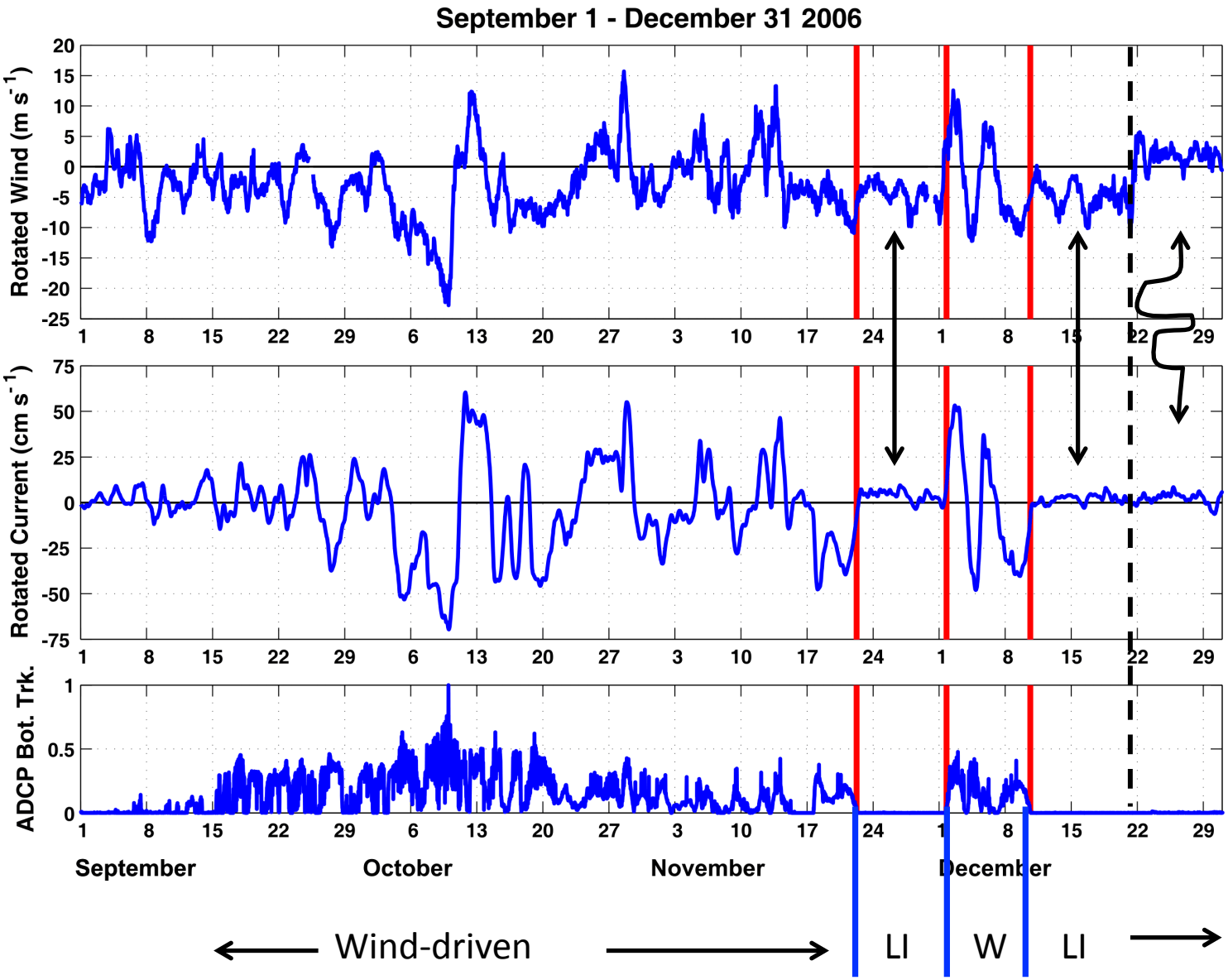
(Craig George, pers. comm.)

The Annual Cycle: Ice Thickness, Ice Set-up & Alongshore Currents



Annual cycles: river runoff, ice, temperature, salinity, transmissivity

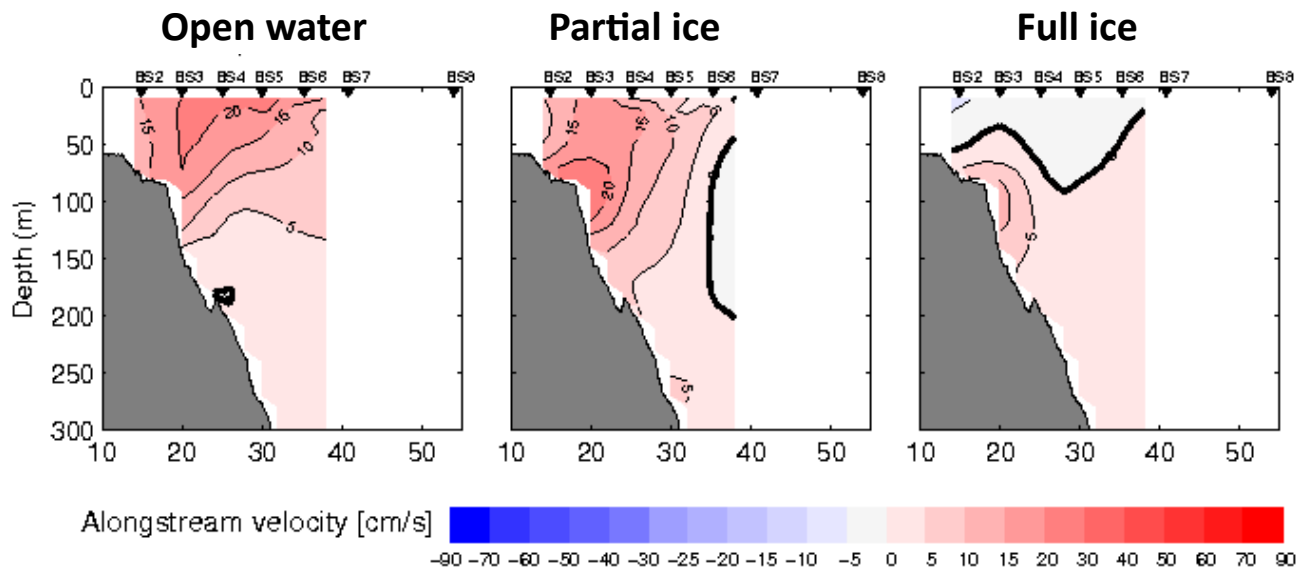




(Fast ice expanding seaward)

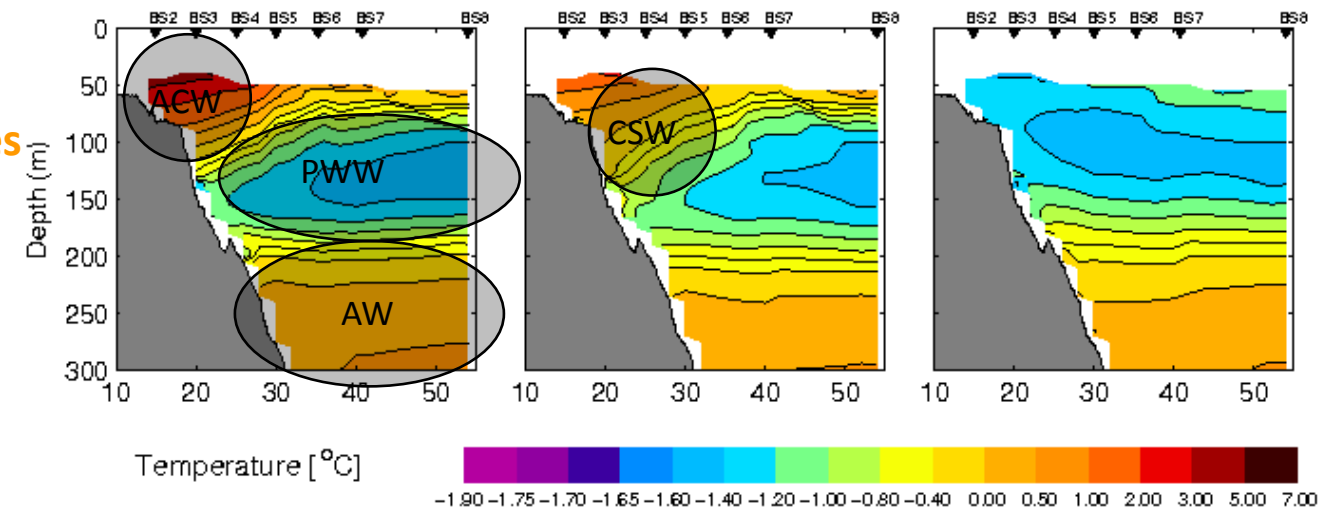
(Cross Island 17 m)

Undisturbed State



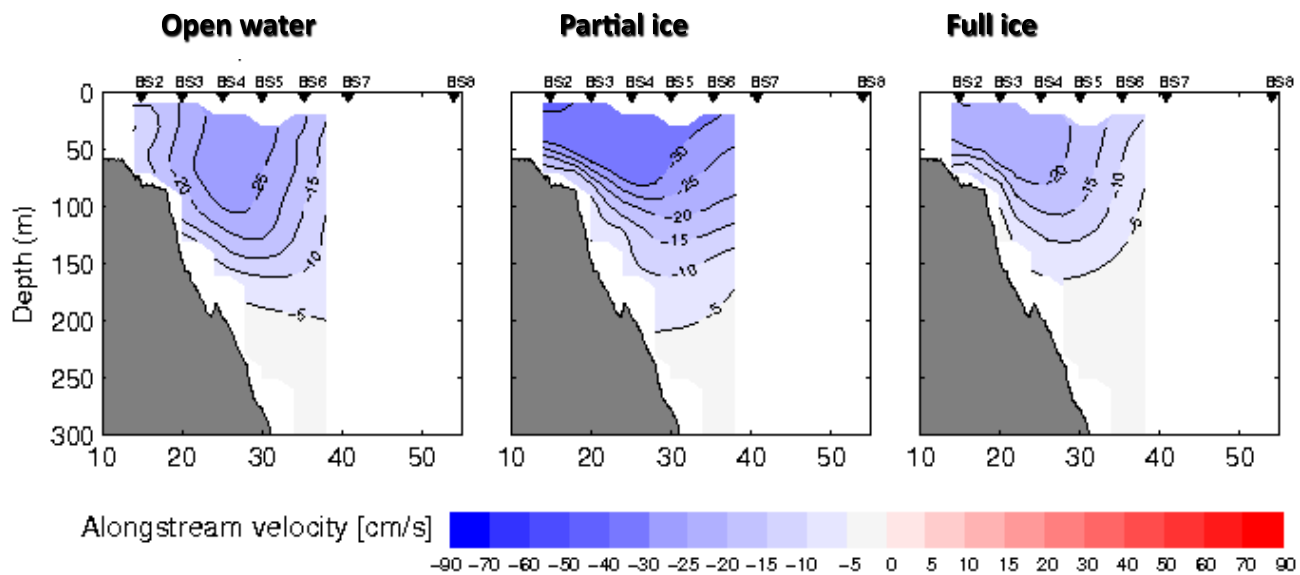
Alongstream Velocity

Water masses

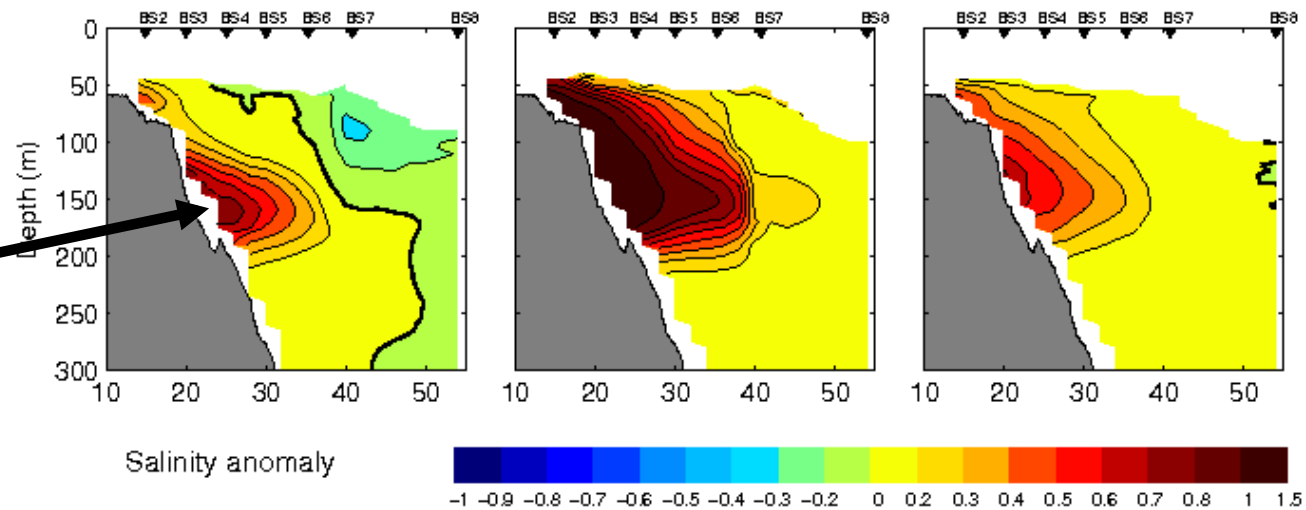


Temperature

Storm Composites



Wind-forced State

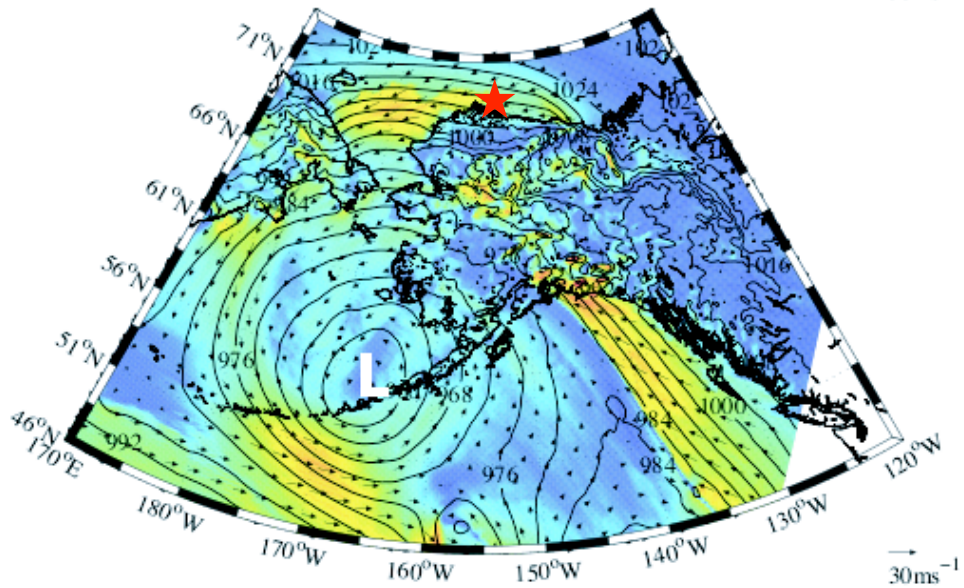


Salty, Nutrient-rich Upwelled Water

Wind-forced Salinity anomaly

Typical upwelling sequence:

1. Aleutian low results in easterly winds in the Beaufort Sea



2. Eight hours later the shelfbreak jet reverses

3. Ten hours after that upwelling commences

Upwelling response depends significantly on ice cover

Strongest for partial ice, weakest for full ice

4-5 storms can flush the entire Alaskan Beaufort shelf!!!!

Summary

1. Bering Strait & Sea (the Pacific Signature):
   Key to many of the physical and biological features of each shelf
   Chukchi and Beaufort an ecosystem continuum with the Bering

2. Chukchi Sea: bathymetry is crucial to the circulation, ice, and
   property distributions
   Mesoscale variability may be more important than we have thought.

3. Beaufort:
   Pacific influence imparted through exchange with Chukchi in the western
   Beaufort and along shelfbreak but sensitive to winds and ice distribution.

   Arctic rivers and Mackenzie Shelf (& river) important at least seasonally