Personal ‘Arctic’ Observations

Science is both a social and individual activity.

~Henry Stommel (1987) in “A View of the Sea”

Travails of a Sailor in a Changing Climate

Andreas Muenchow

Greenland, Canada, Alaska

Oceanography + Glaciology

Ships + Remote Sensing

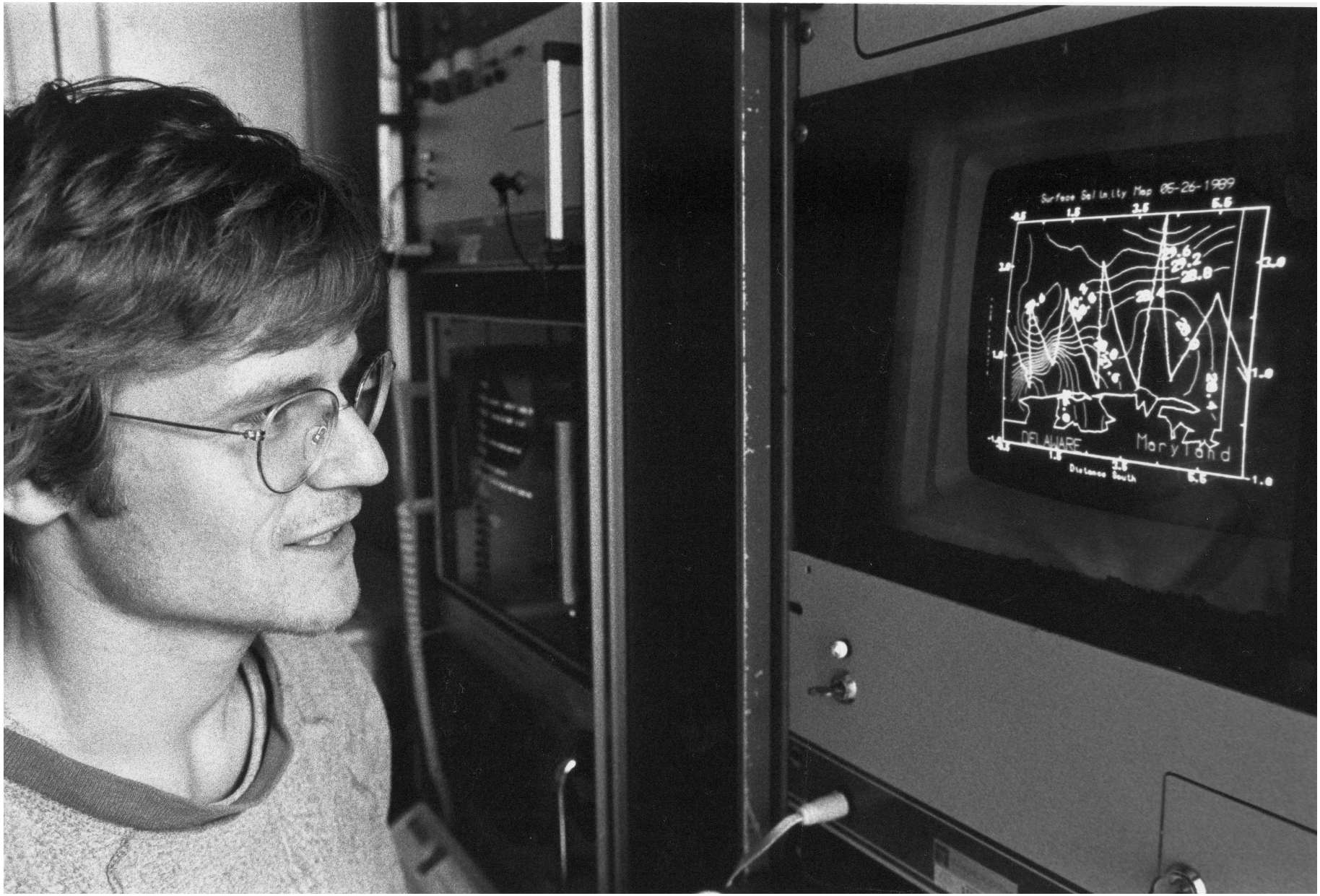
Glaciers + Icesheets

Blogging + Communities

Climate Politics + Media

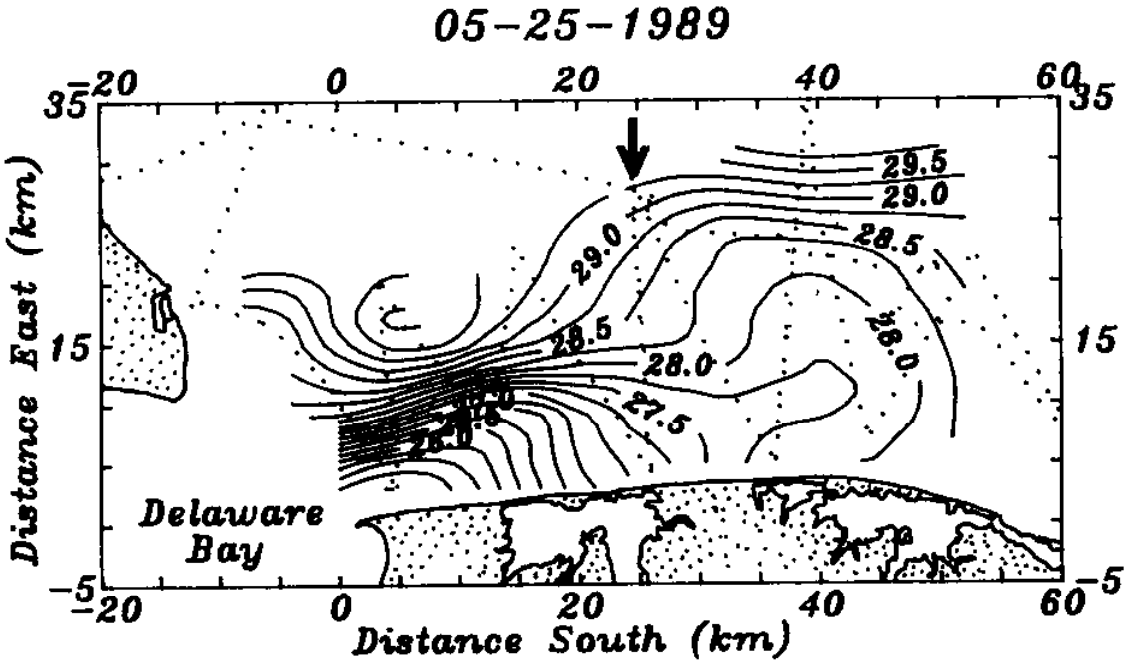
Getting started

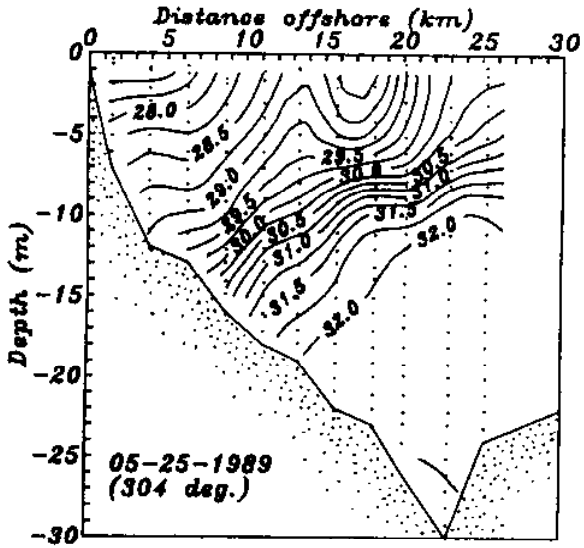
PhD and PostDoc 1987-1994



R/V Cape Henlopen May-25, 1989

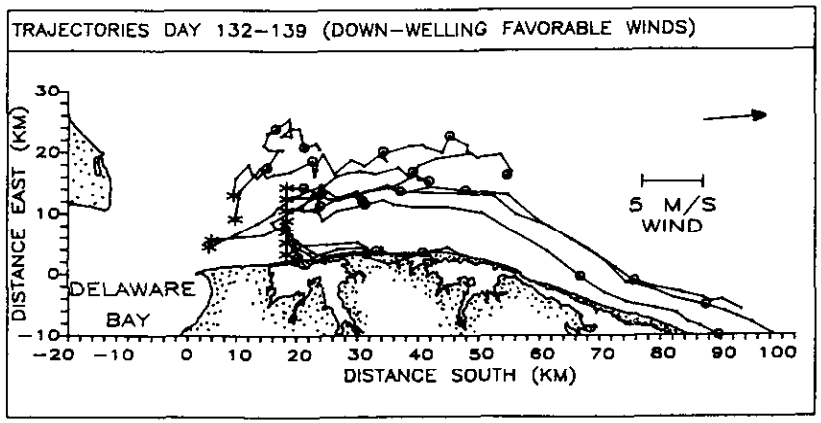
Buoyancy and Wind Forcing of a Coastal Current





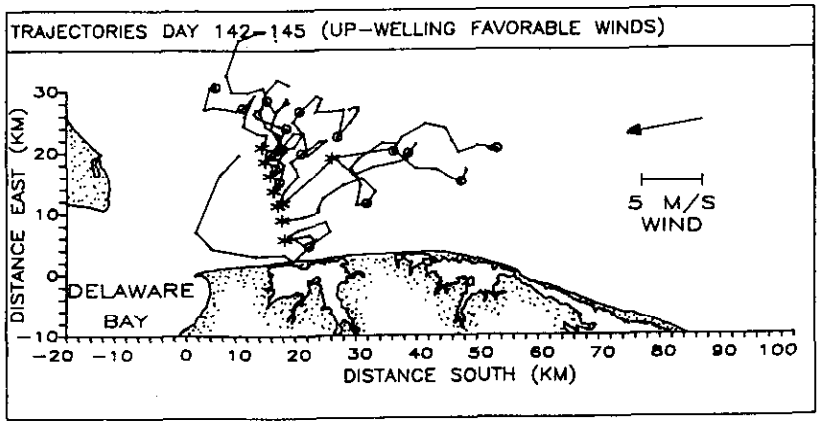
Muenchow & Garvine (1993)

A



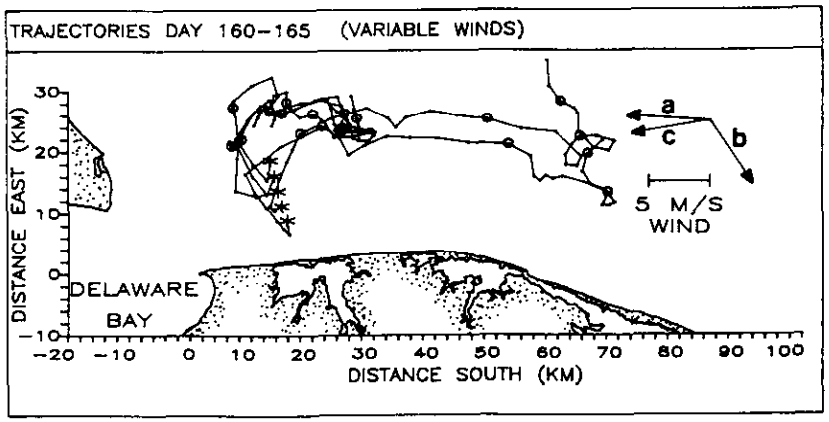
Down-welling Winds

B



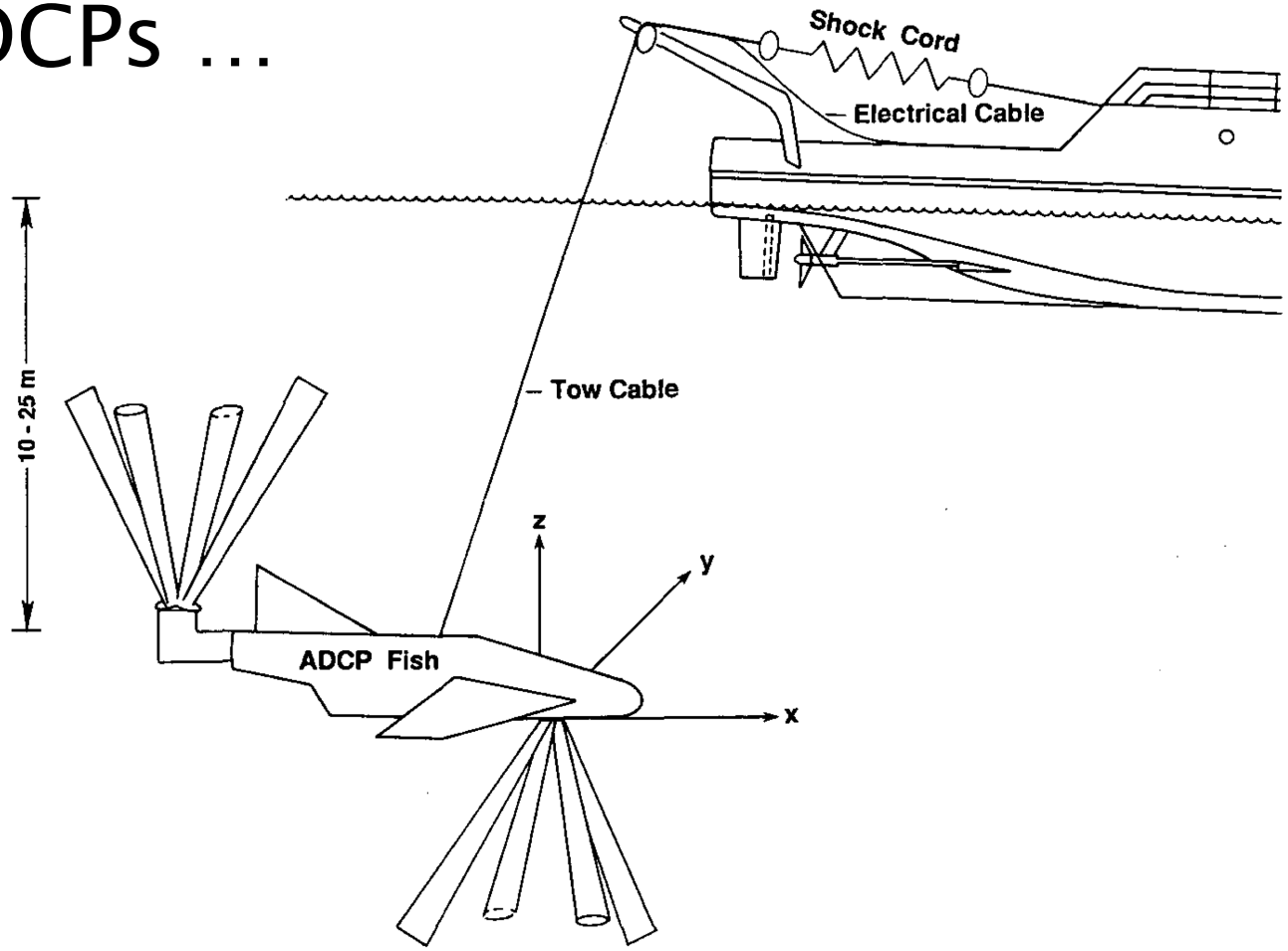
Up-welling Winds

C



Variable Winds

Towed ADCPs …

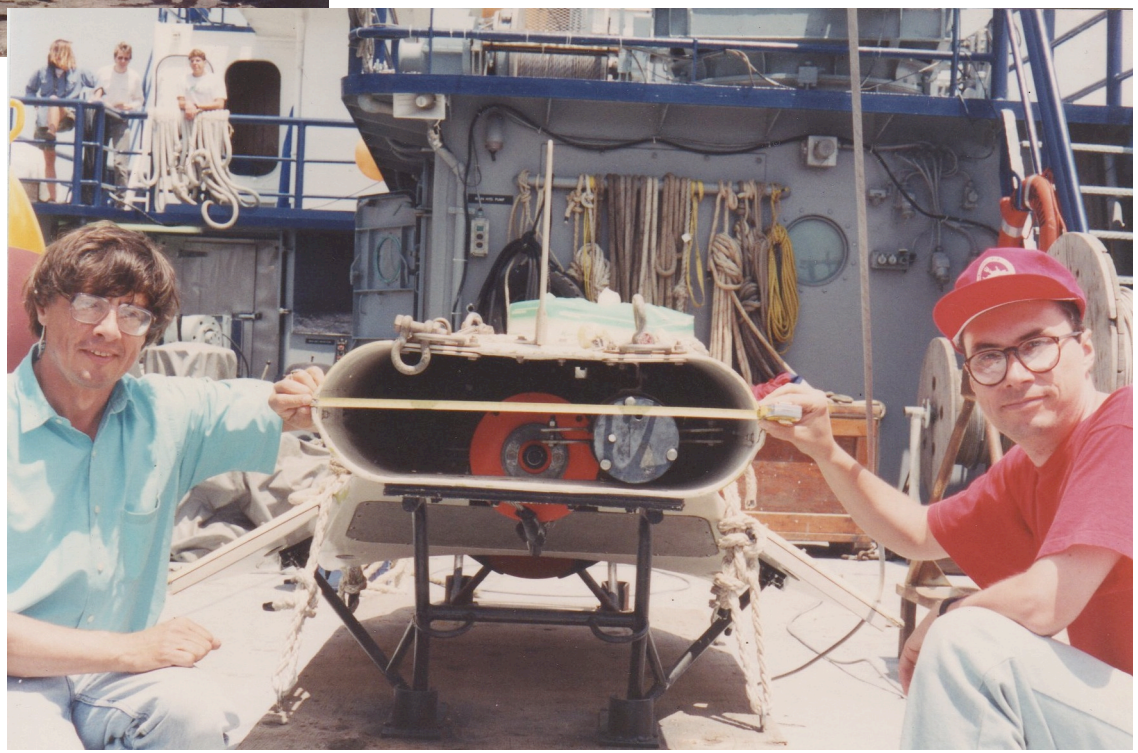


… good idea …

… but too fickle.

from Muenchow et al (1997)

Dr. Meryl Hendershott
and presenter
Santa Barbara Channel
1992/93



Drs. Meryl Hendershott
and Mirlo Orlic
Santa Barbara Channel
1992/93

Synoptic Flow and Density Observations near an Arctic Shelf Break

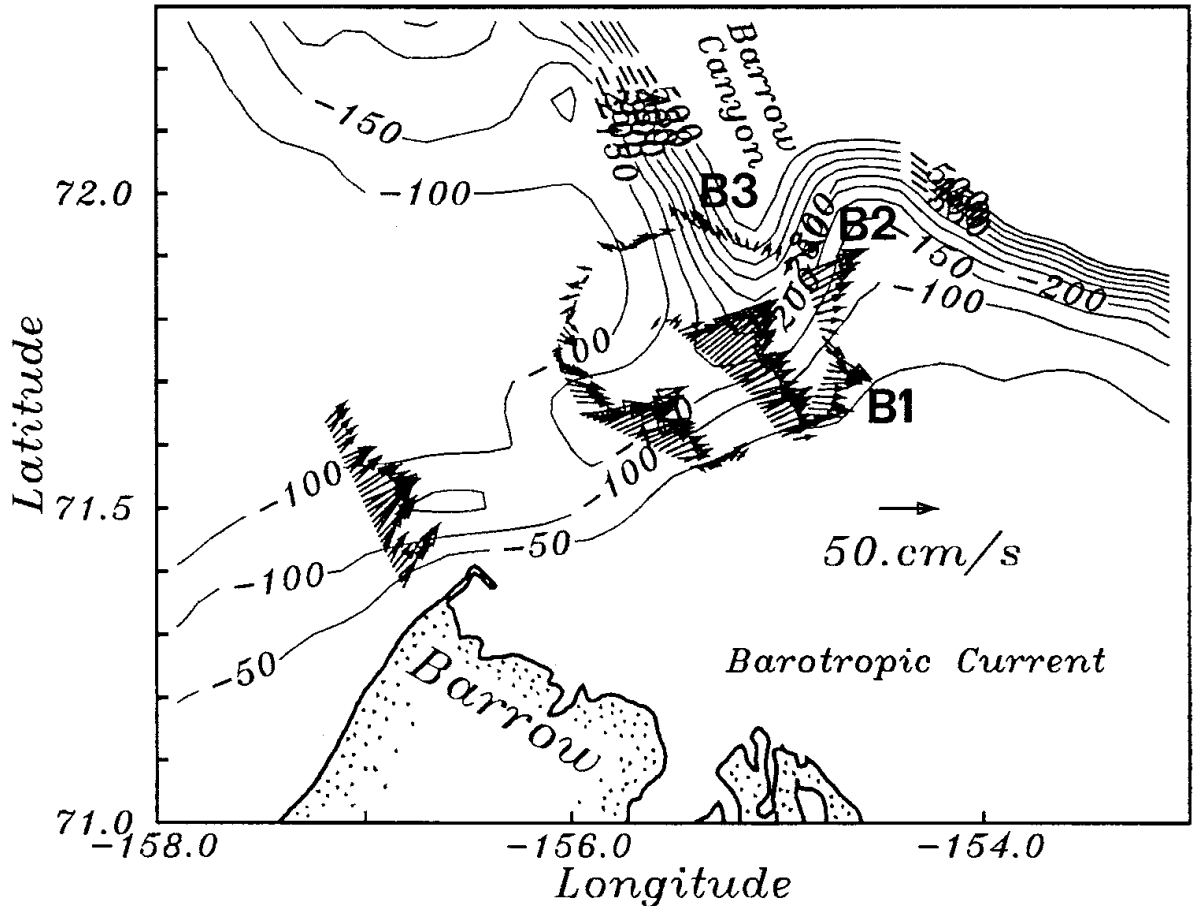
ANDREAS MÜNCHOW

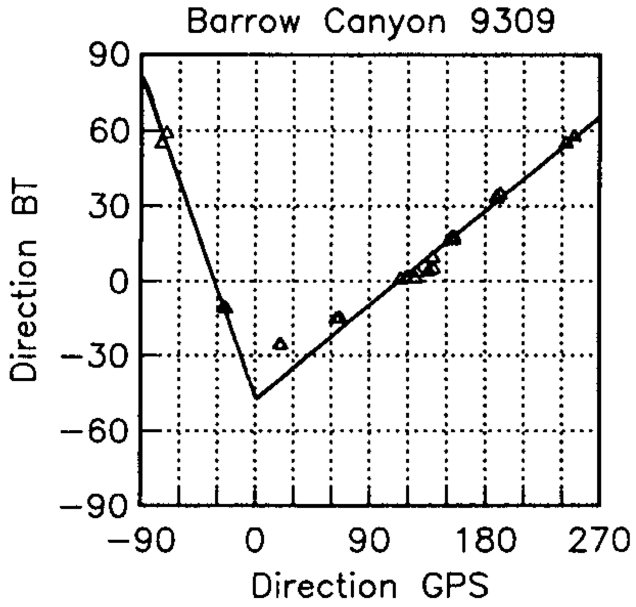
Institute of Marine and Coastal Sciences, Rutgers University, New Brunswick, New Jersey

EDDY C. CARMACK

Institute of Ocean Sciences, Sidney, British Columbia, Canada

(Manuscript received 8 July 1996, in final form 14 January 1997)



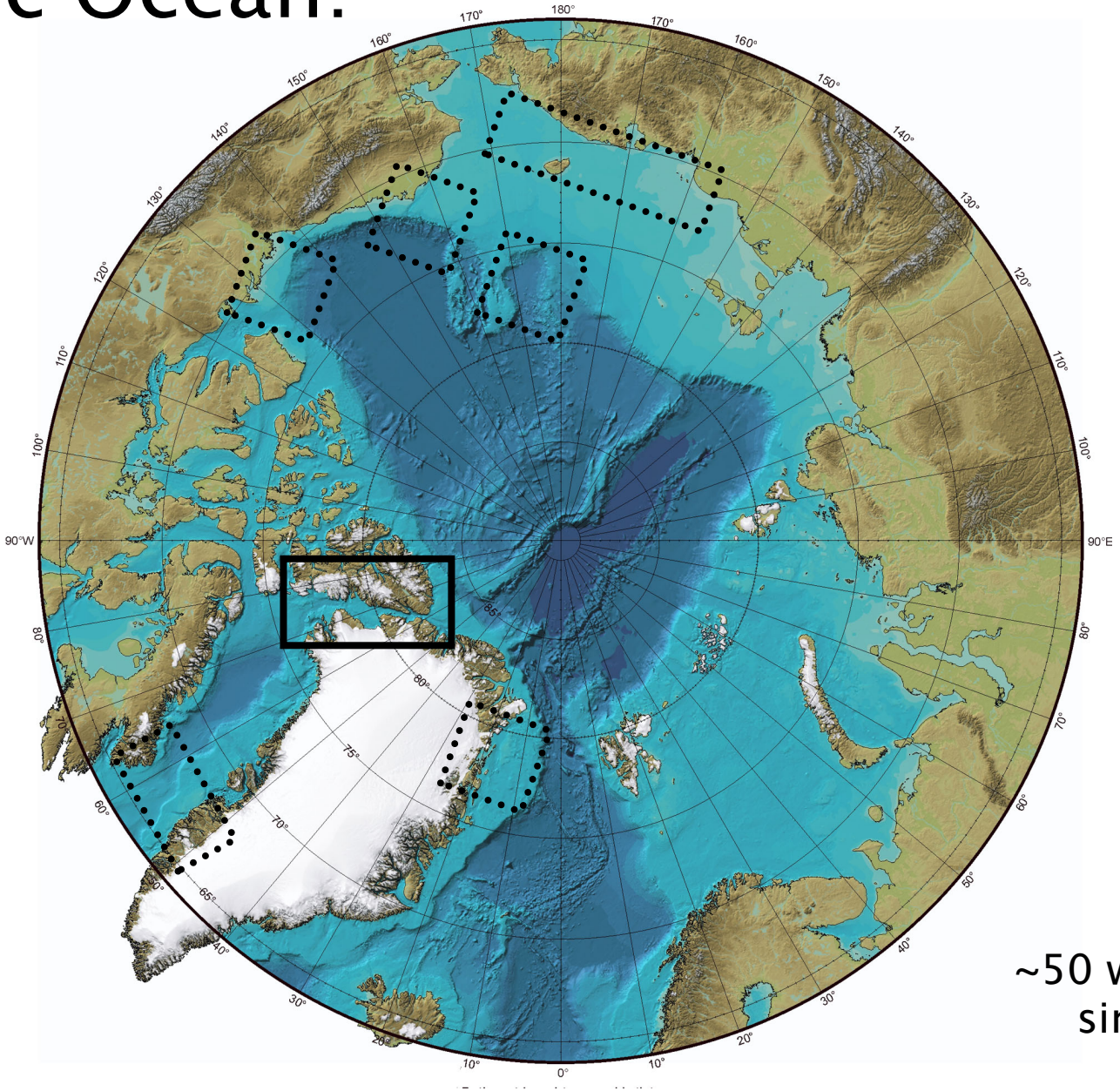


Compass needle stuck to magnetic icebreaker; JTech 1997

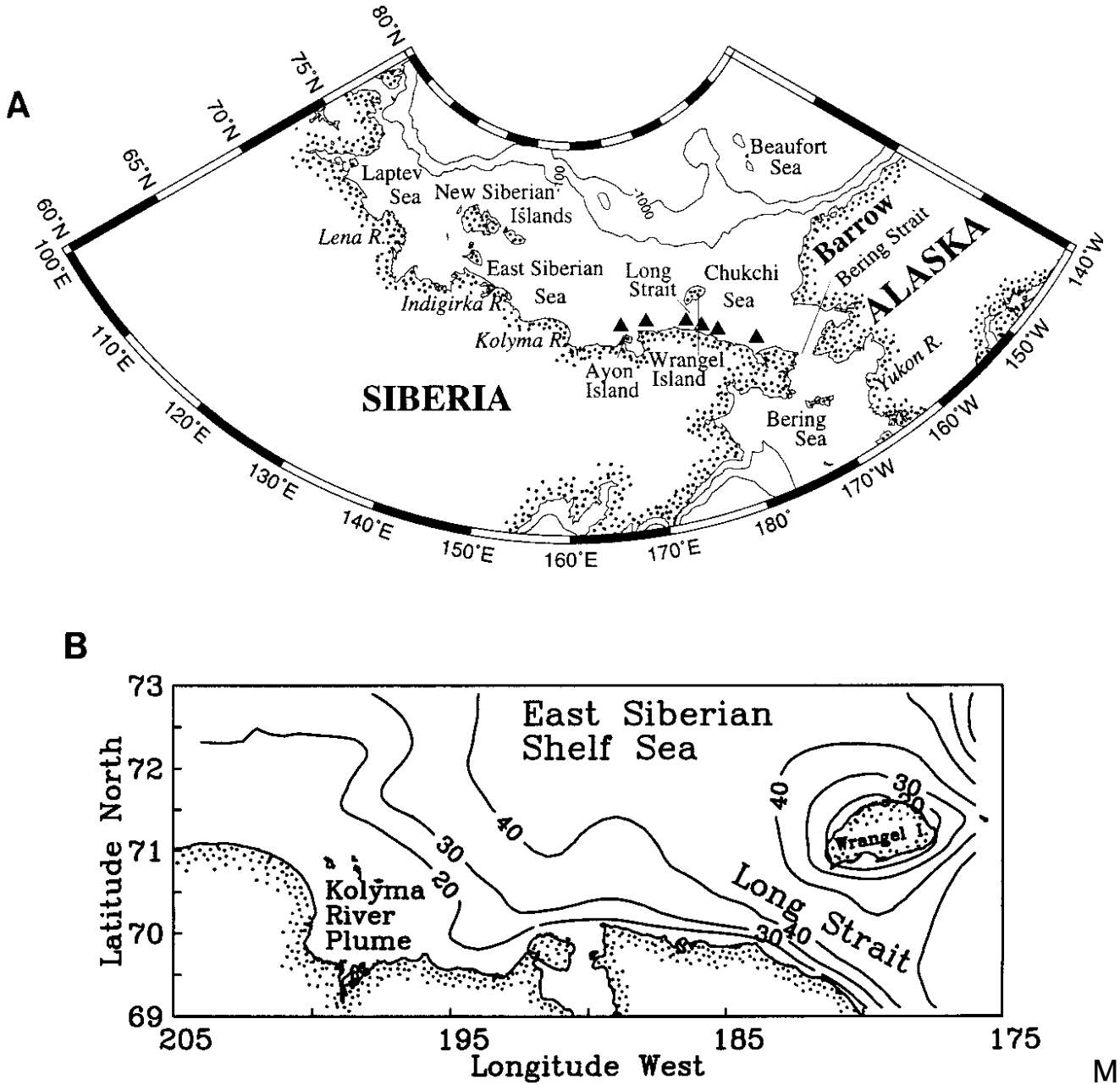
Early Wanderings

Rutgers faculty 1994-1998

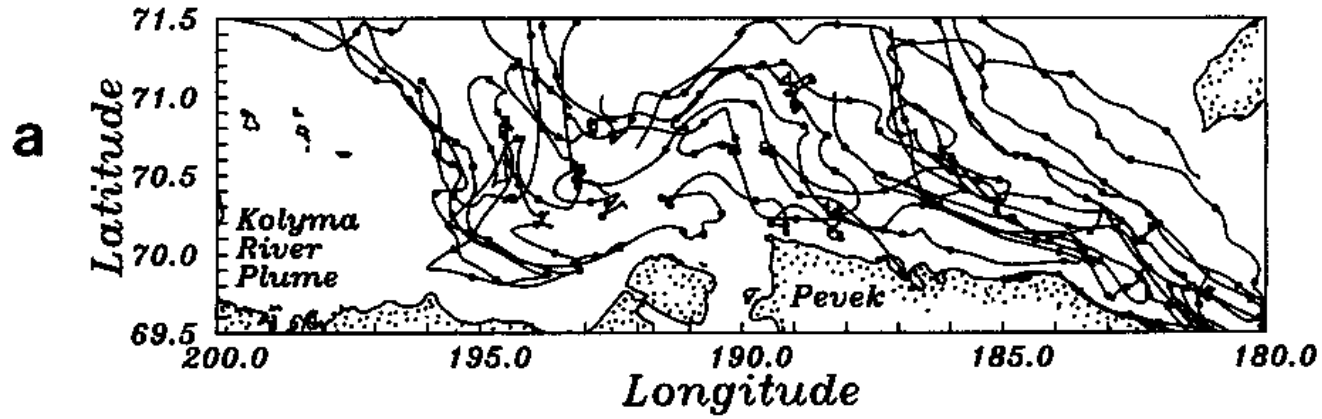
Arctic Ocean:

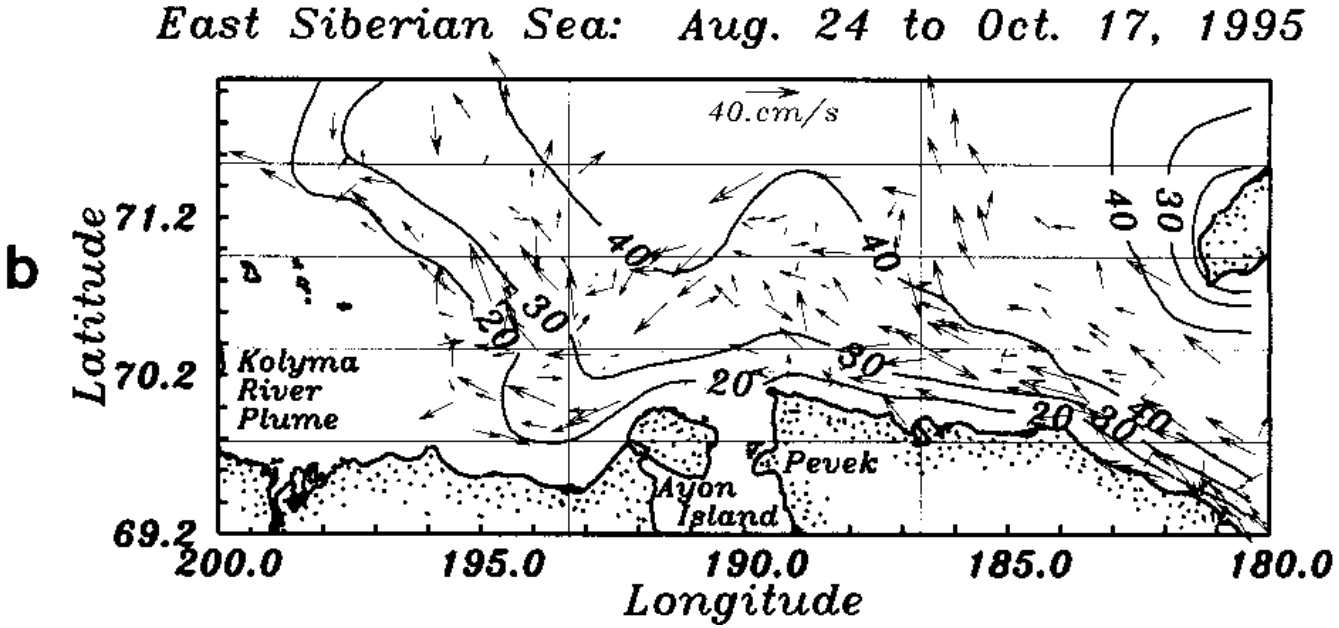


~50 weeks @ sea
since 1992

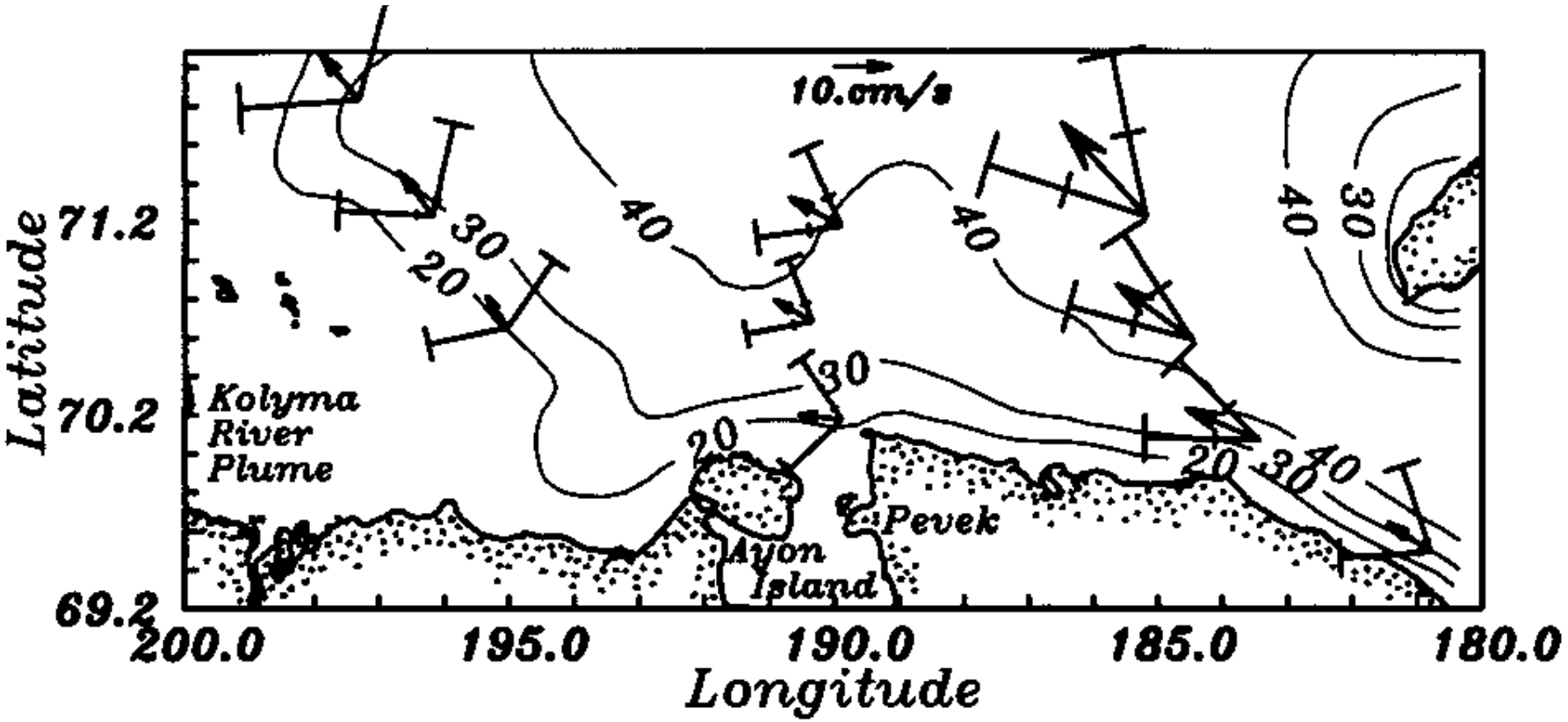


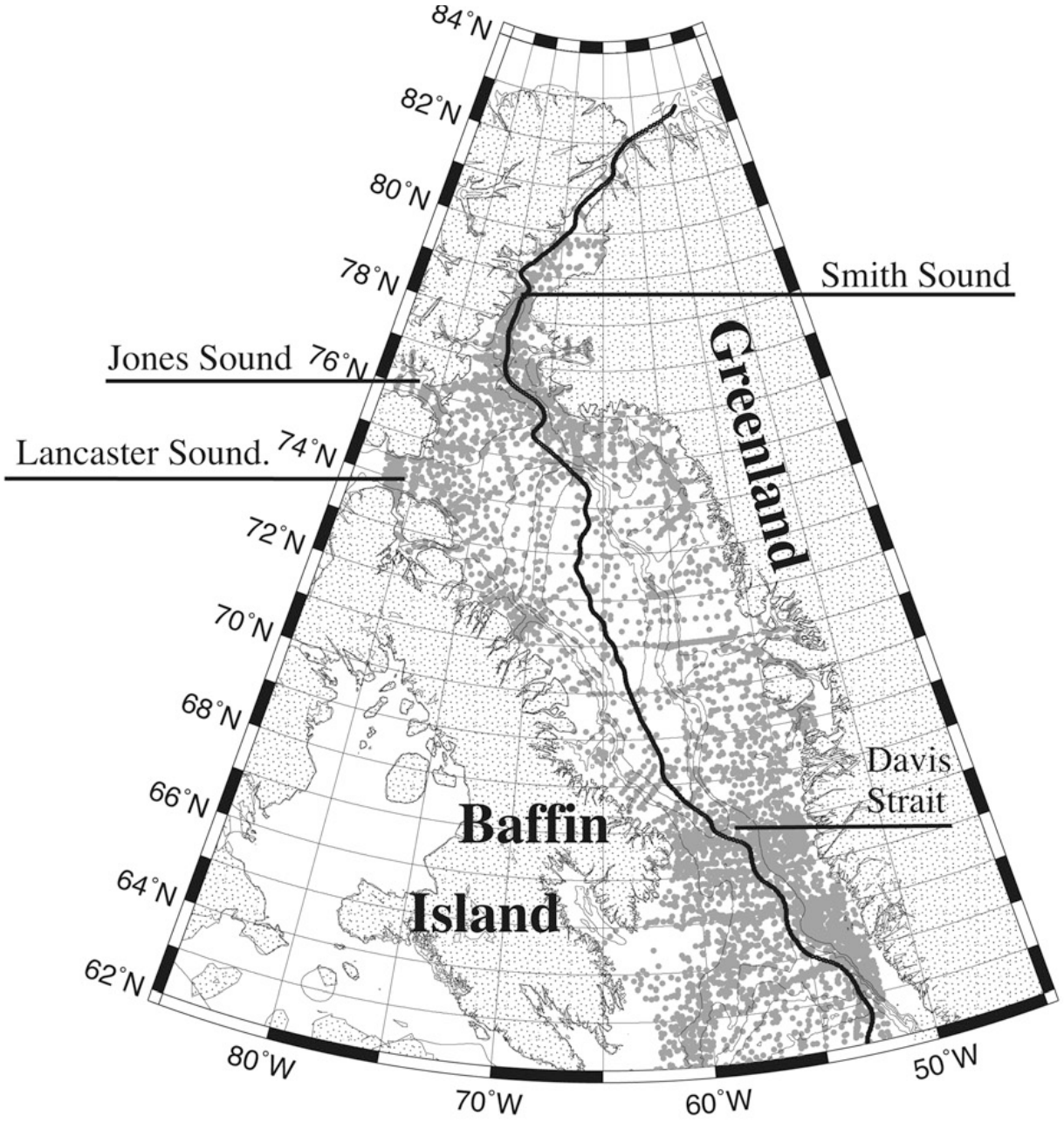
Muenchow et al. (1999)


a
71.5
71.0
70.5
70.0
69.5
Latitude
Kolyma
River
Plume
Pevek
200.0
195.0
190.0
185.0
180.0
Longitude

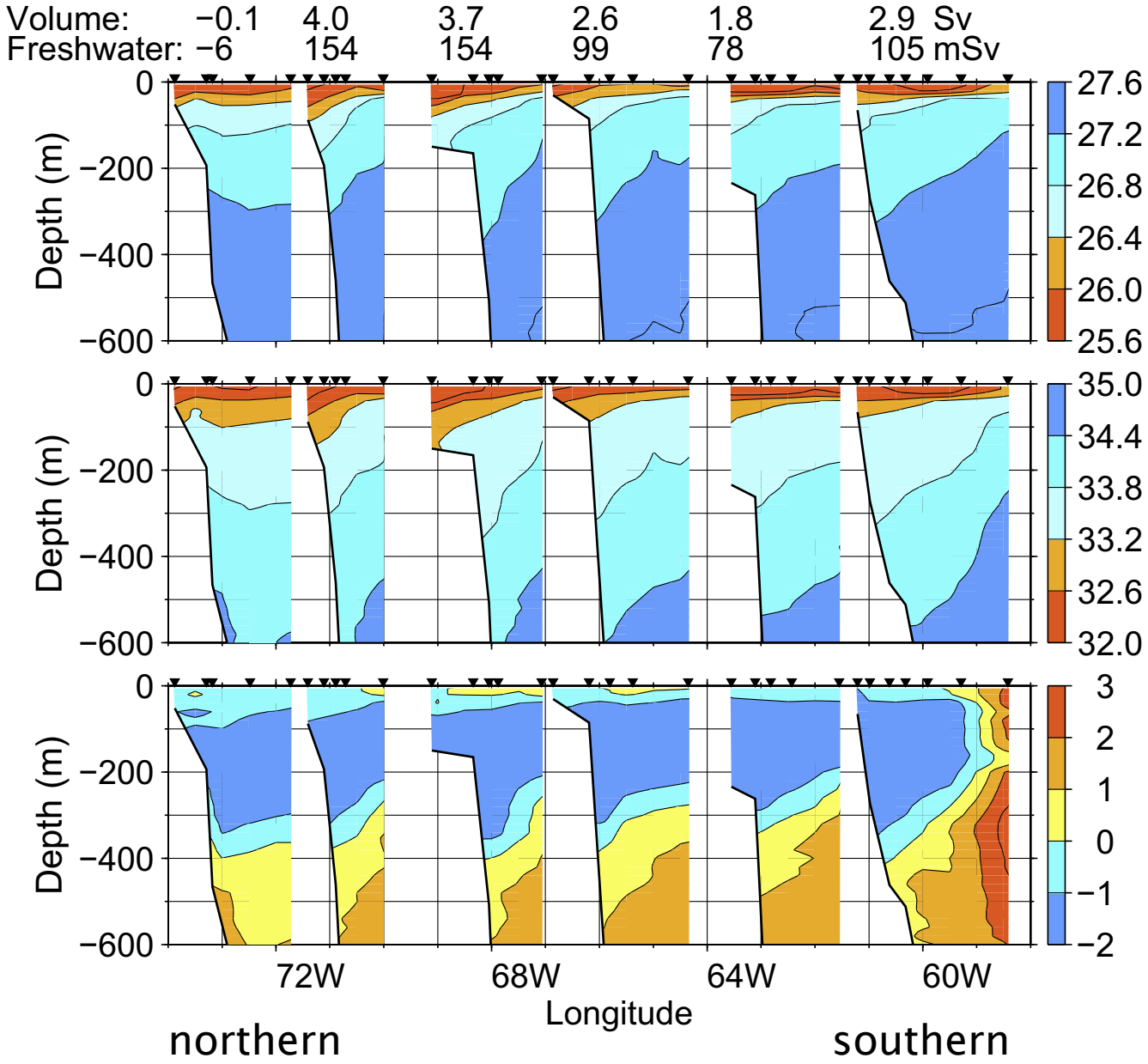

East Siberian Sea: Aug. 24 to Oct. 17, 1995
b
40 cm/s
71.2
70.2
69.2
Latitude
Kolyma
River
Plume
Pevek
Ayon
Island
40
30
20
200.0
195.0
190.0
185.0
180.0
Longitude

Surface Velocity off Siberia 1995




84°N
82°N
80°N
78°N
76°N
74°N
72°N
70°N
68°N
66°N
64°N
62°N
80°W
70°W
60°W
50°W
Smith Sound
Jones Sound
Lancaster Sound.
Greenland
Davis
Strait
Baffin
Island

Current Surveys off Baffin Island 1979

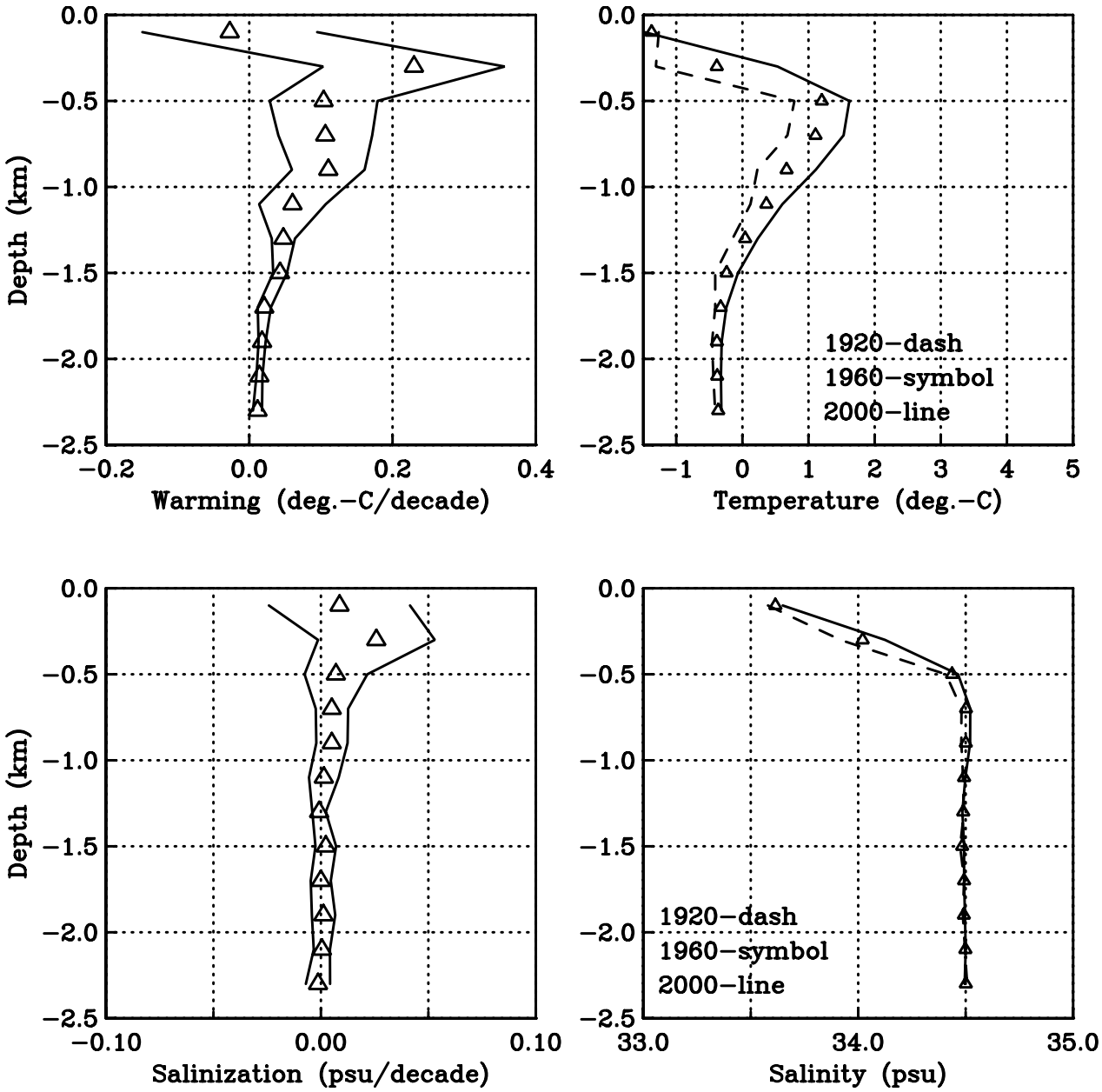


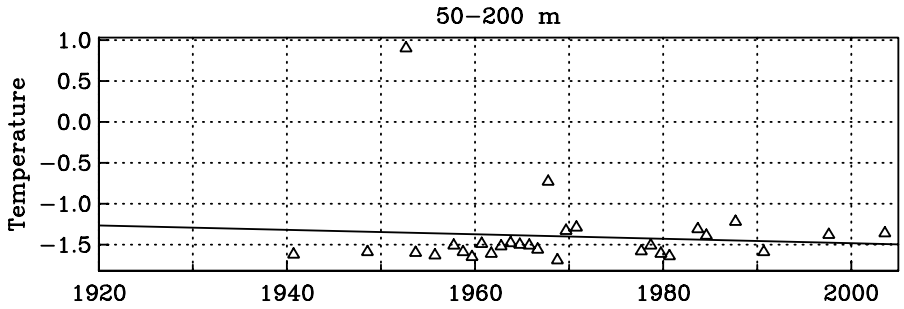
Density

Salinity

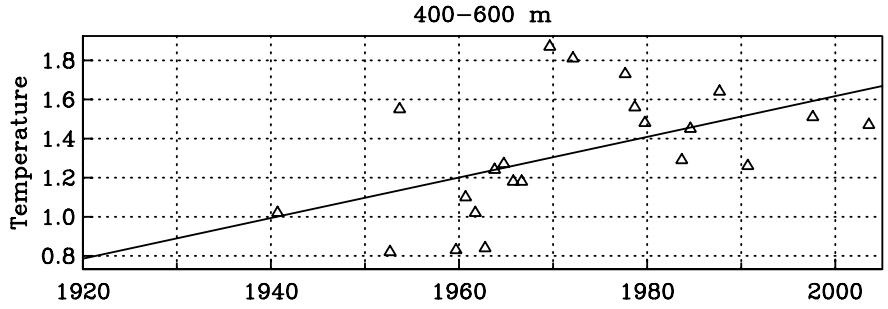
Temperature

northern sections southern

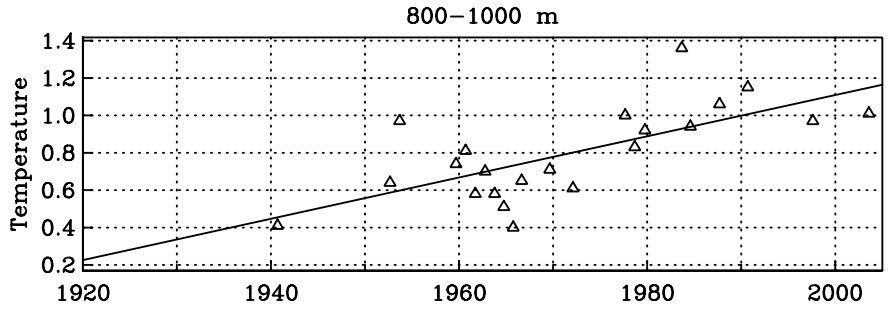

0.0
−0.5
−1.0
−1.5
−2.0
−2.5
Depth (km)
−0.2
0.0
0.2
0.4
Warming (deg.−C/decade)
−1
0
1
2
3
4
5
Temperature (deg.−C)
1920−dash
1960−symbol
2000−line
−0.10
0.00
0.10
Salinization (psu/decade)
33.0
34.0
35.0
Salinity (psu)



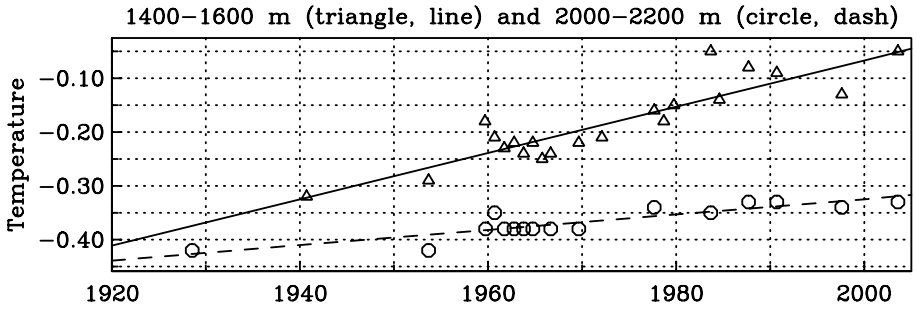
Surface Layer Temperature



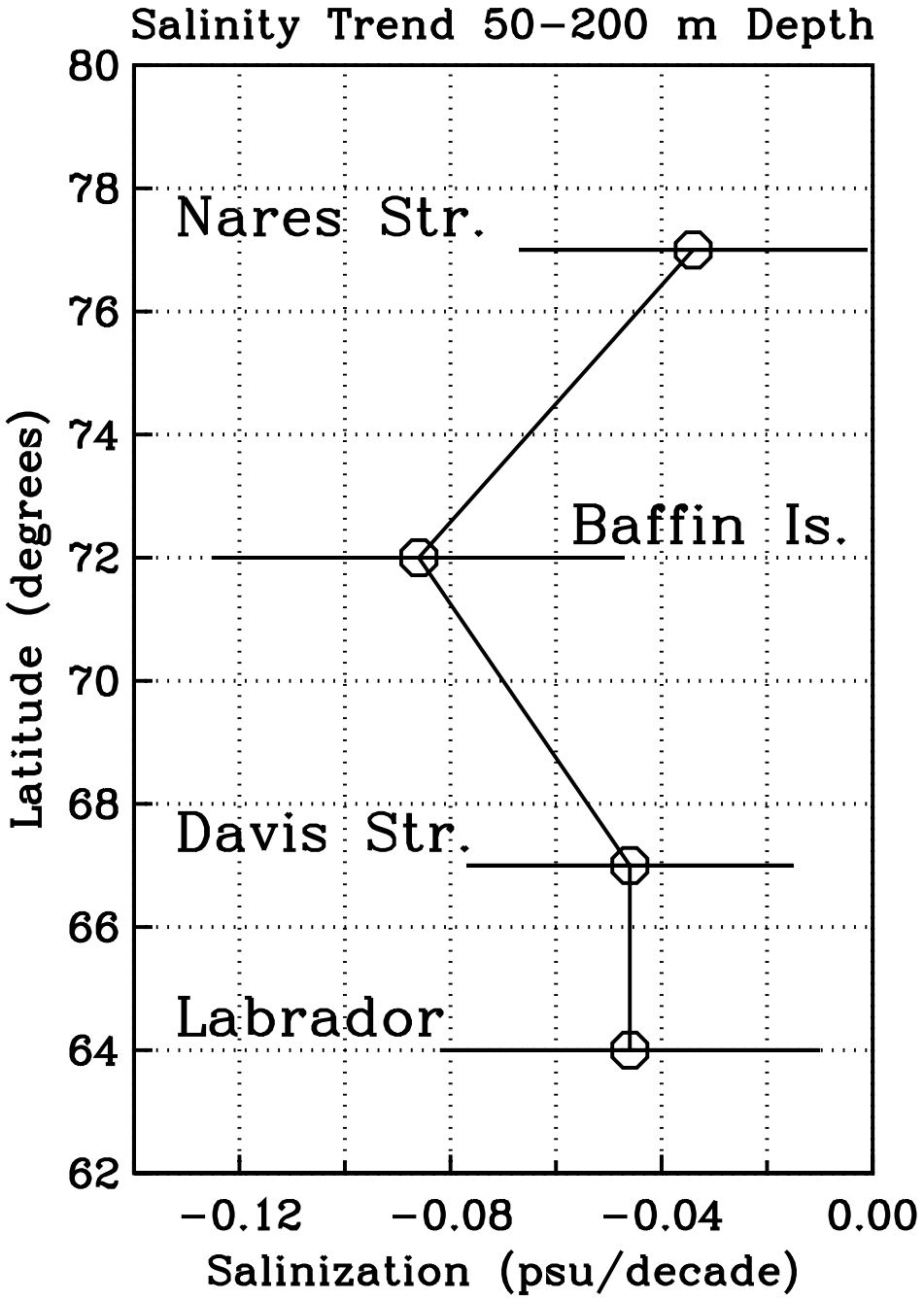
Upper Atlantic Layer Temperature



Lower Atlantic Layer Temperature



Deep Basin Layer Temperature



Surface Layer Waters

become fresher

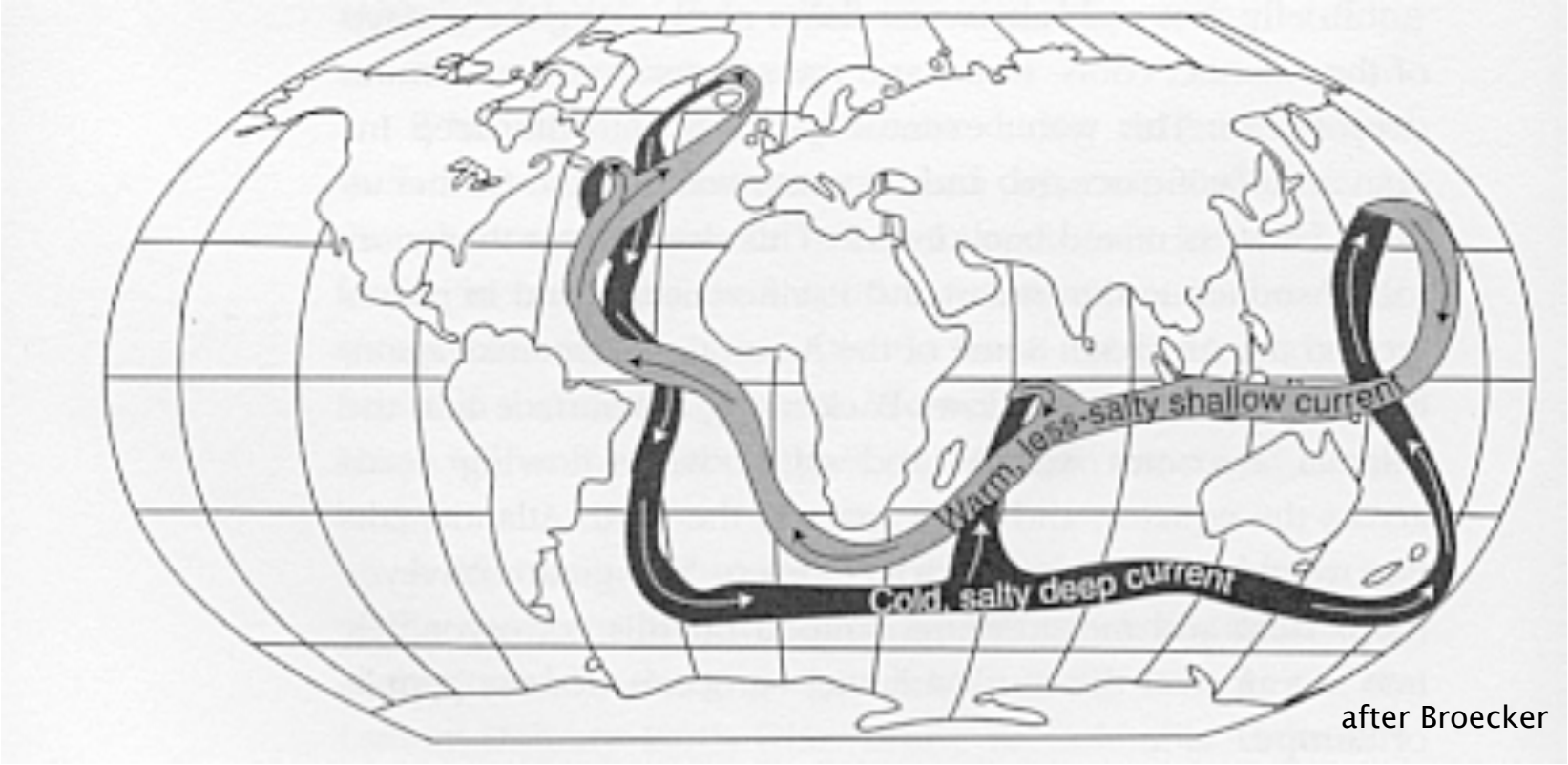
West of Greenland

Why this fascination with freshwater?

New Learning --> Kelly Falkner --> Climate Science

Global thermohaline circulation:

--->nonlinear dynamical system with multiple equilibria

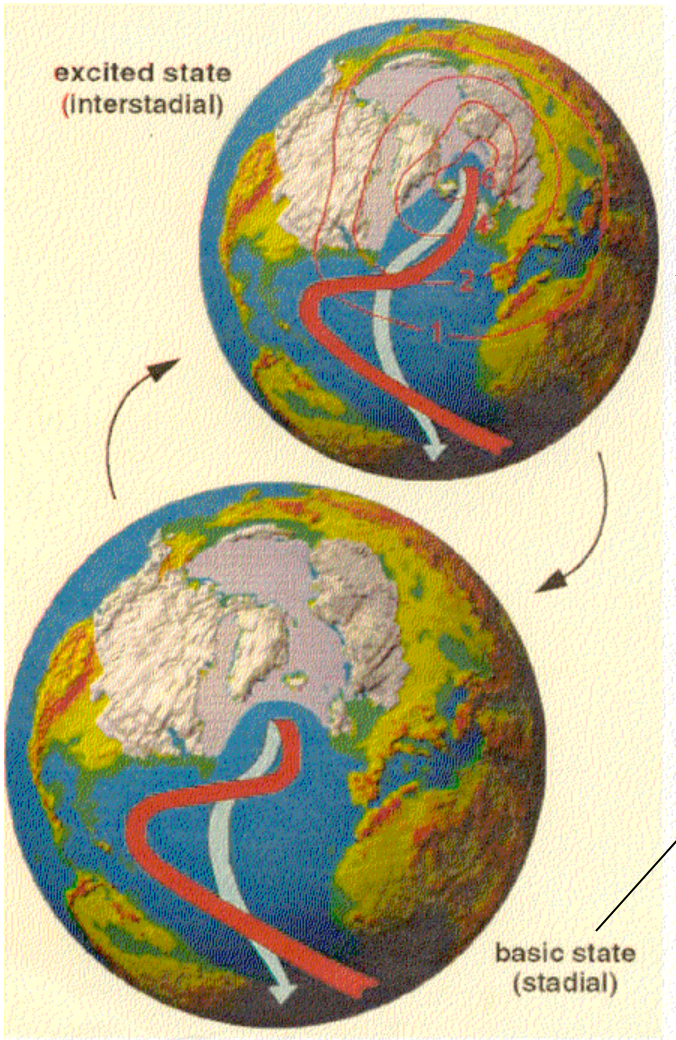


How to turn this on and off?

Add Freshwater.

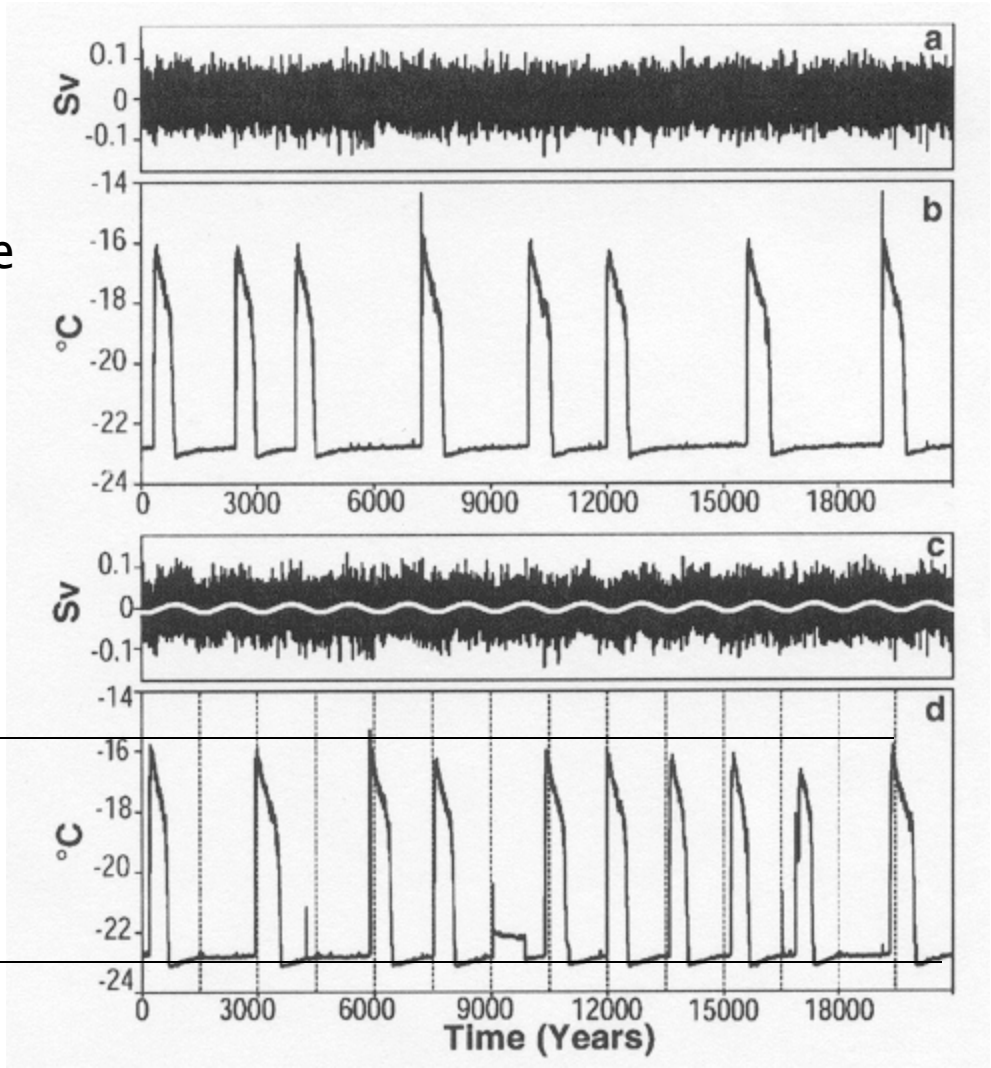
Freshwater Flux Forcing:

Response



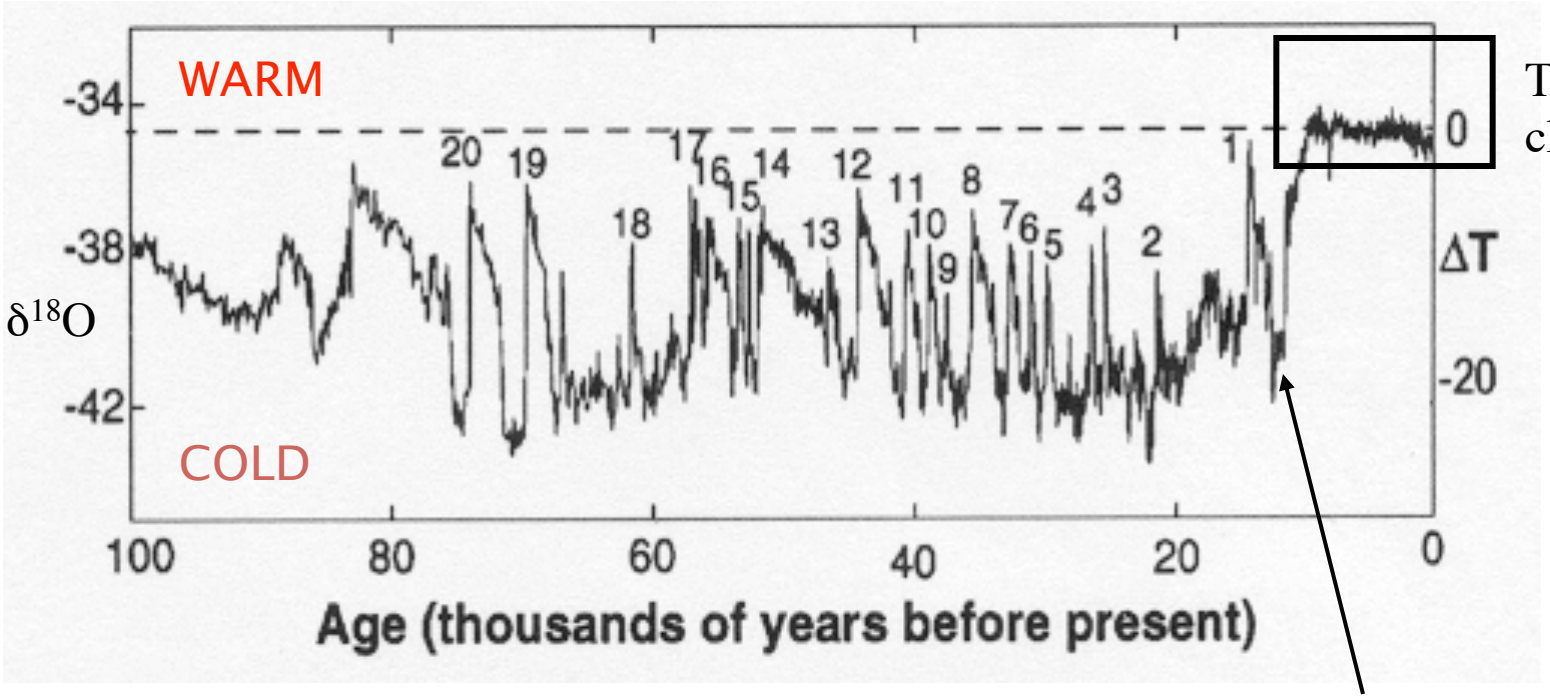
warm

cold



From Ganopolski and Rahmstorf (2002)
Physics Review Letters

Greenland Ice Core Data
oxygen isotopes $\delta^{18}O \sim \Delta T$ temperature



Today's climate

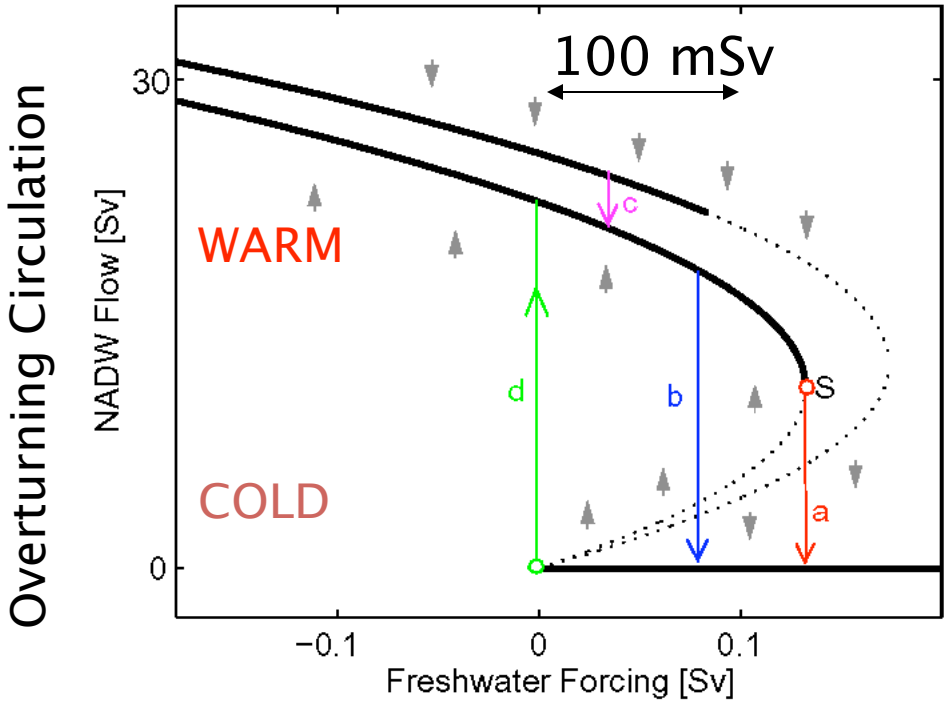
Younger Dryas

Climate of last 10,000 years appears most anomalous.

Figure from Alley et al. (2001)

Hysteresis Loop of Climate Change

Stommel (1961)



Rahmstorf (2000)

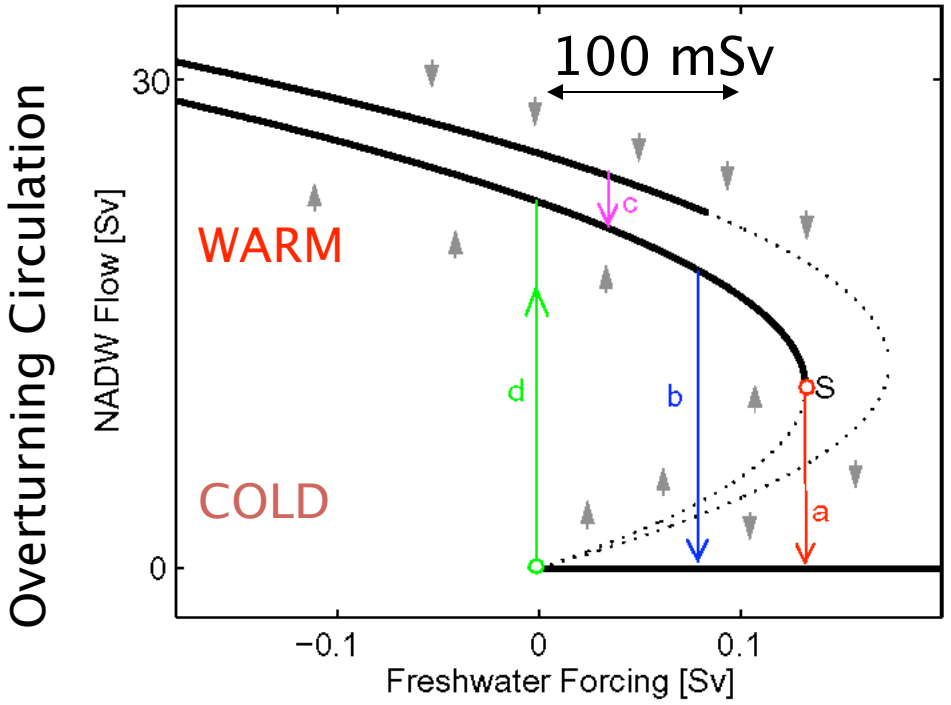
Nonlinear response of thermohaline circulation to freshwater pertubations

Caveats:

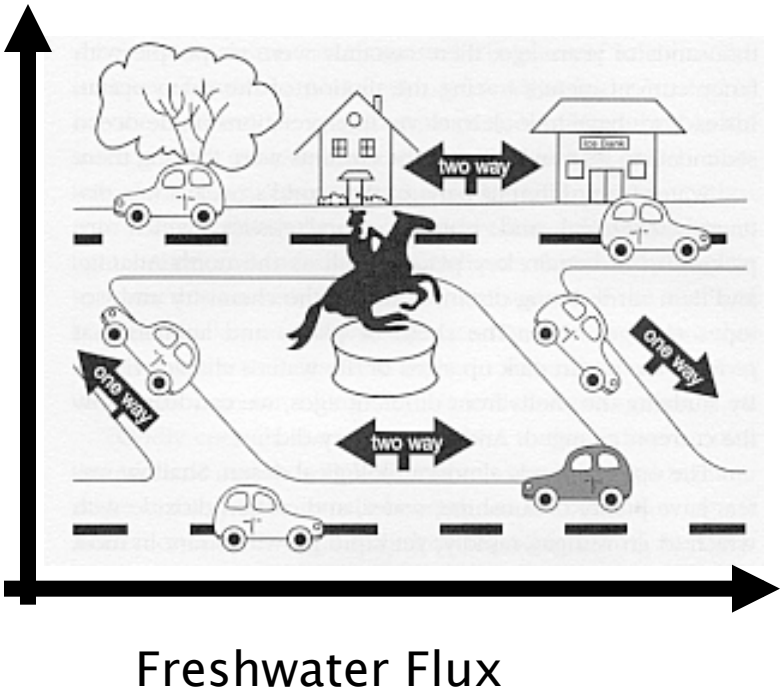
- Location of current climate?
- 100-500 year duration
- Distance to convection sites

Hysteresis Loop of Climate Change

Stommel (1961)



Rahmstorf (2000)



Freshwater Flux

Alley (2001)

The Times are a Changing:

$$\partial \bullet / \partial t \neq 0$$

"Steady State" may not exist

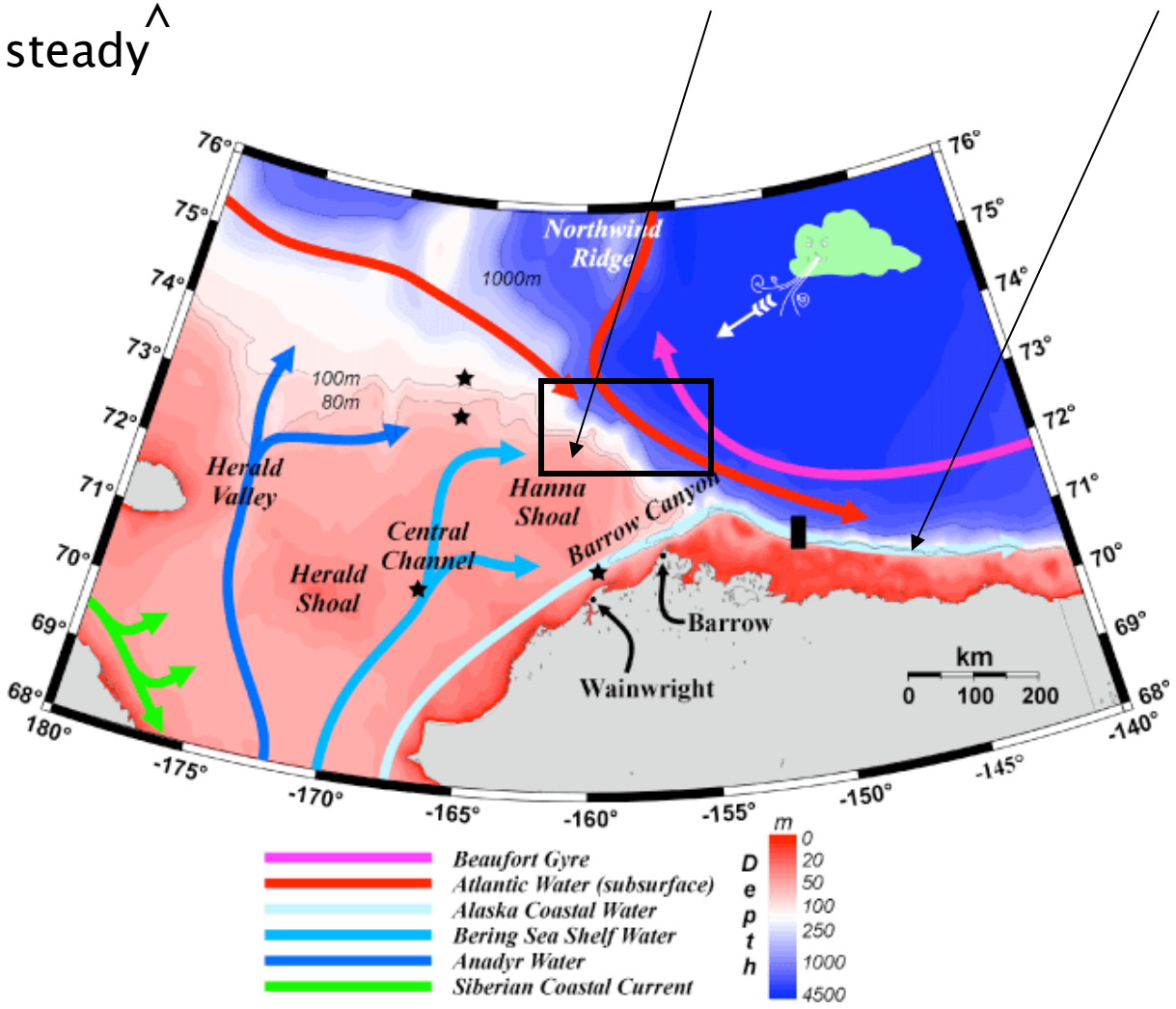
Understanding a more dynamic Arctic Ocean circulation requires more modern observational tools

Lost Years of too much Field Work

1998 – 2005

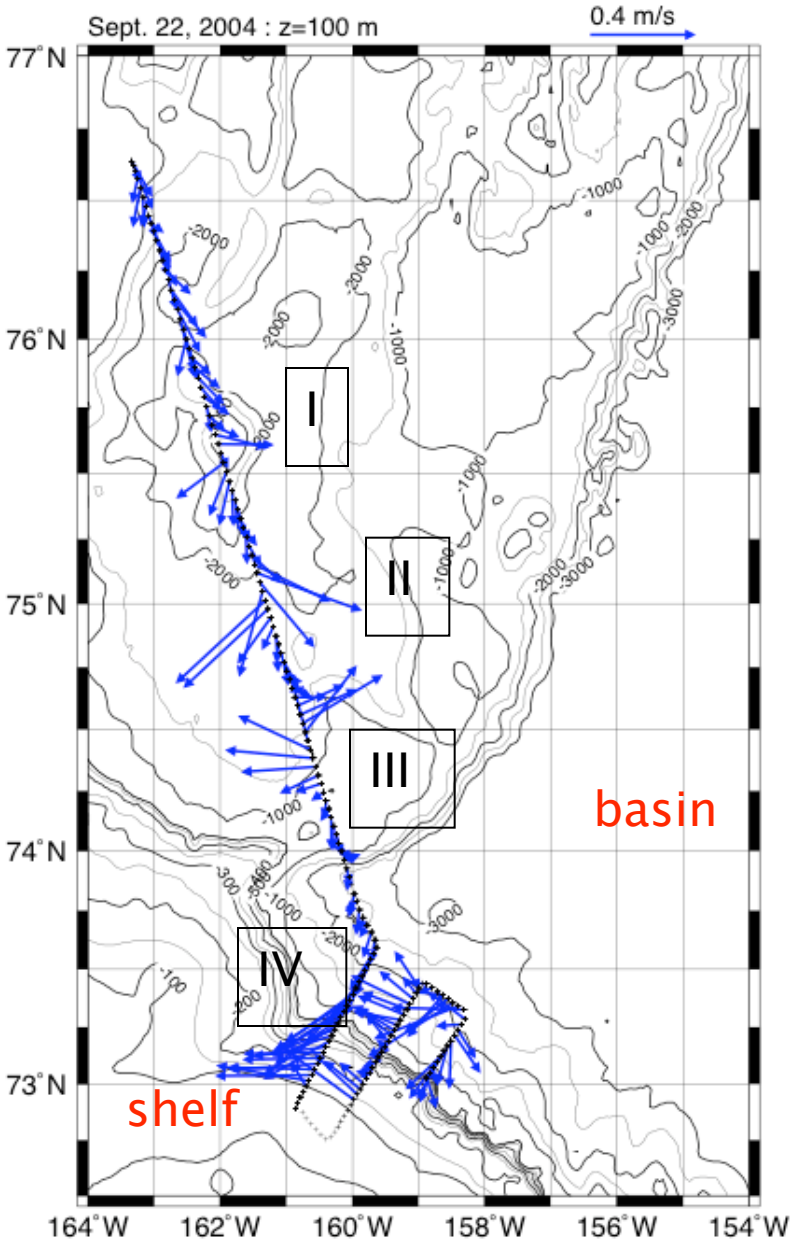
Sketch of the Circulation over the Chukchi and Beaufort Seas

steady^

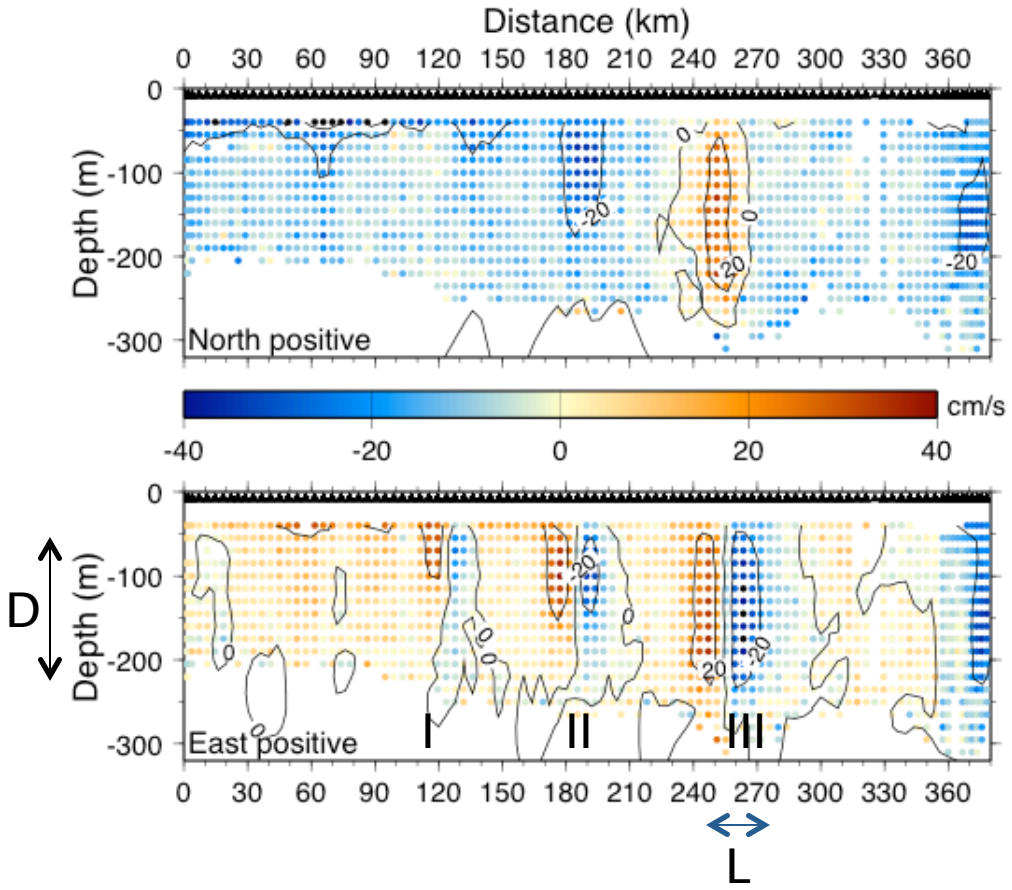


Eddies in the Arctic

Sept.-21/22, 2004



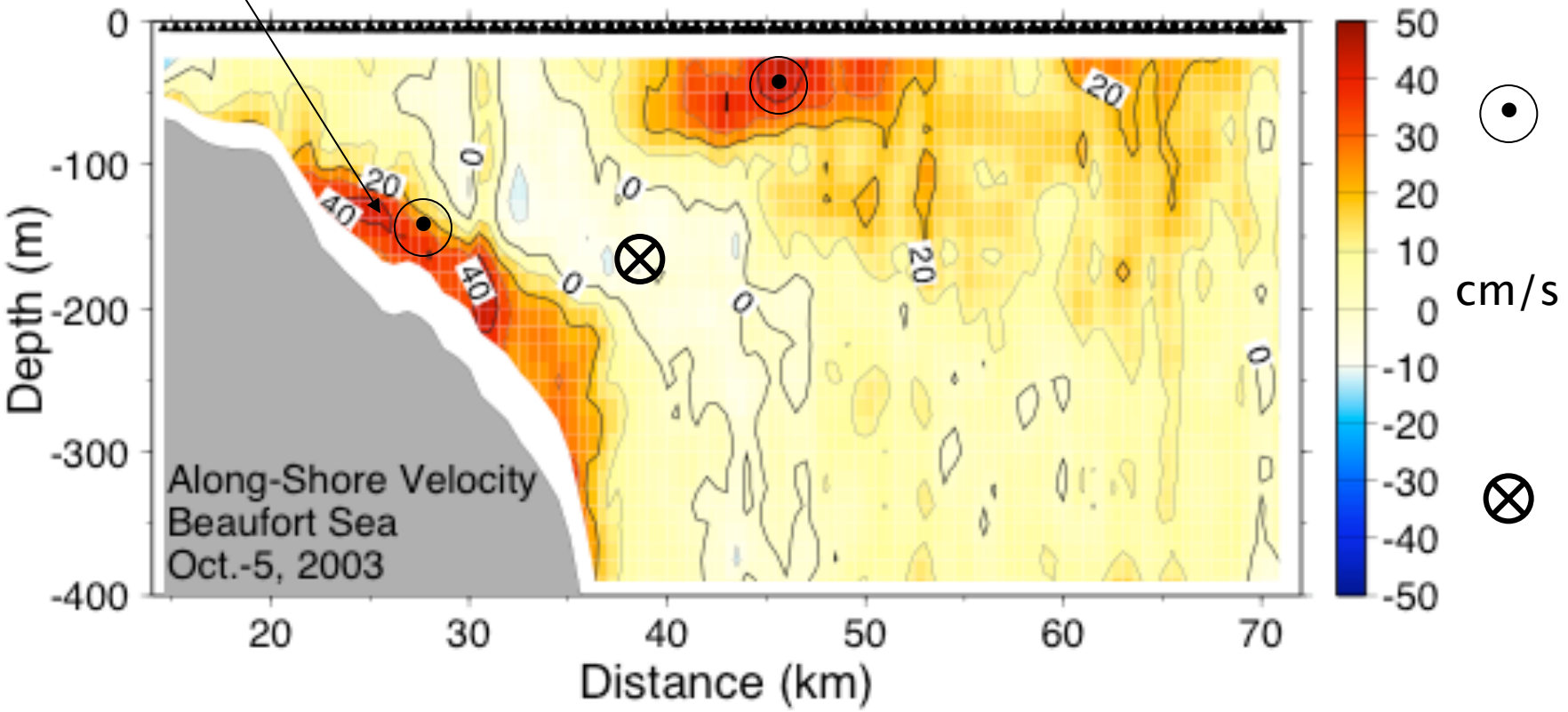
4 clock-wise rotating (anti-cyclonic) vortices



USCGC Healy 75-kHz ADCP

Beaufort Slope Currents 2003

Bottom-intensified



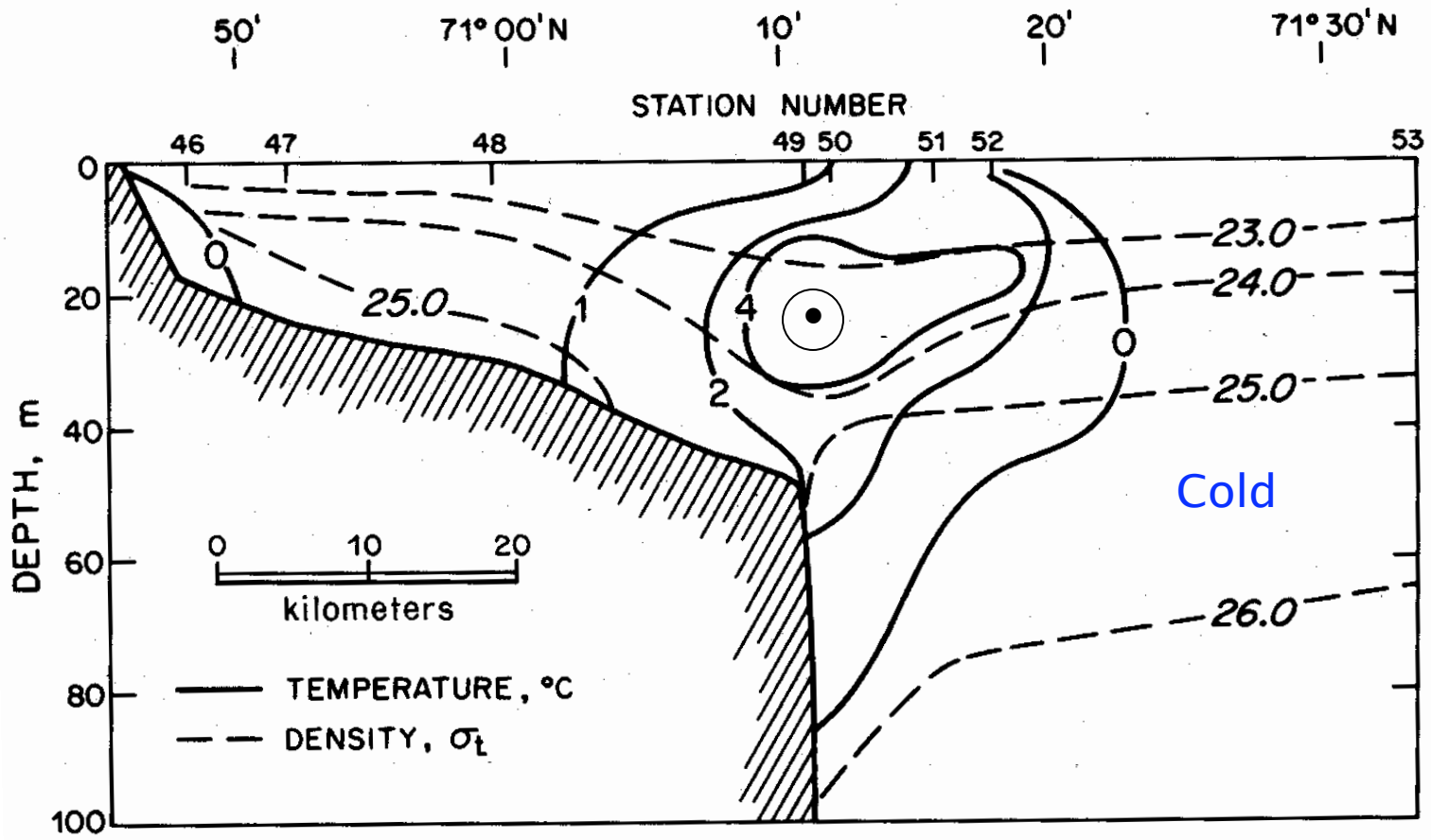
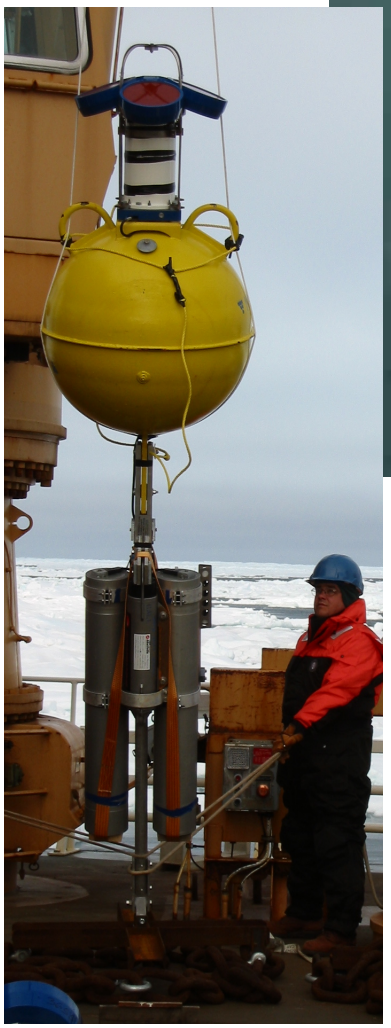
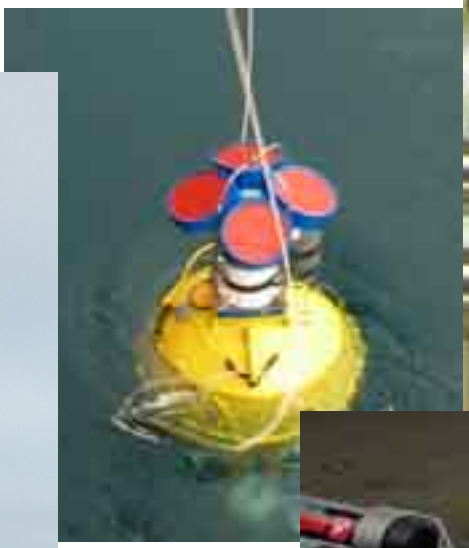


FIGURE 4. Summer temperature and density section across the shelf and upper slope at 150°W. Adapted from Mountain (1974).

Aagaard (1984)

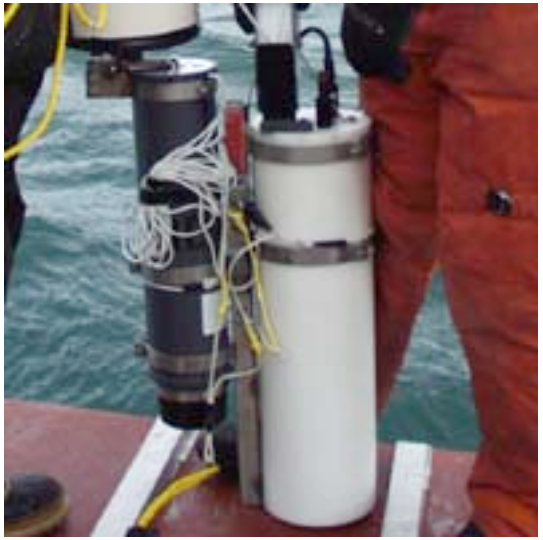
Arctic Instrumentation





75 kHz ADCP,
velocity profiles

Temperature, salinity,
and pressure sensors

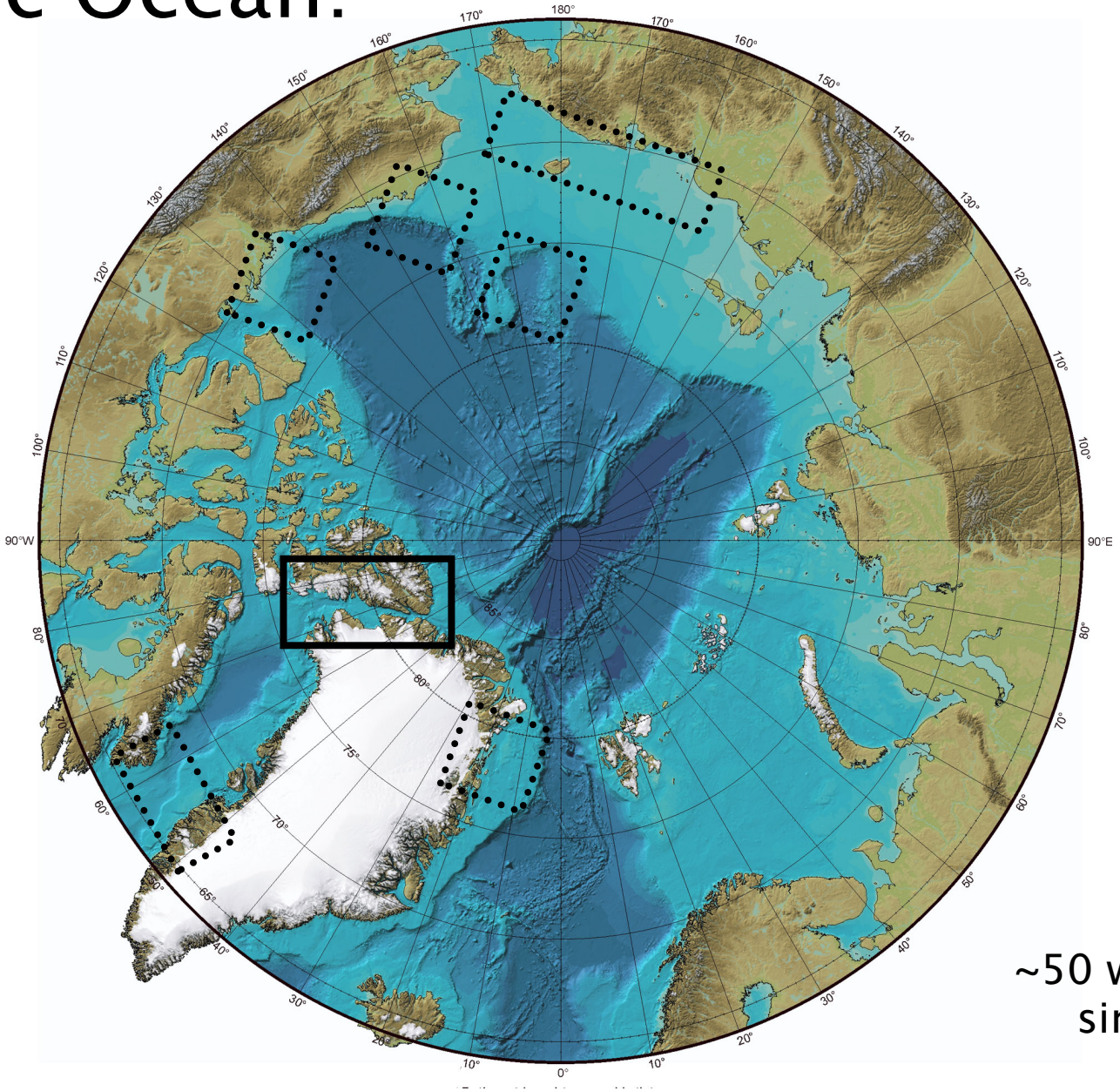


Bottom pressure,
tide gauge

First Focus

Nares Strait 2002-2012

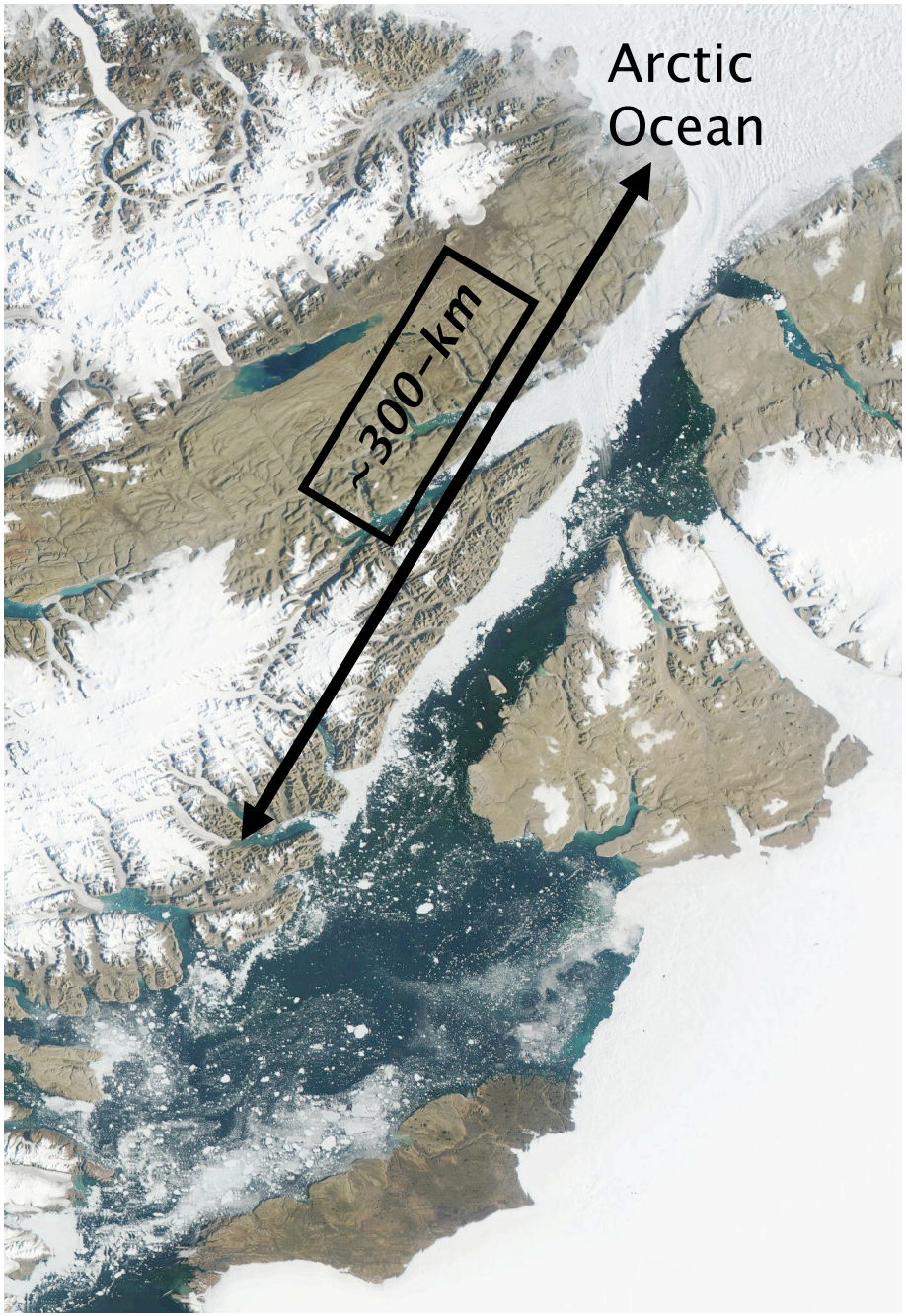
Arctic Ocean:



~50 weeks @ sea
since 1992

Nares Strait Ocean Moorings 2003-12

Physics-in-Action: Shear Instabilities in Kennedy Channel, Aug.-2003



Ellesmere Island and
Greenland, Aug. 12, 2005

New Beginnings

Ocean-Glacier Interactions 2010-present

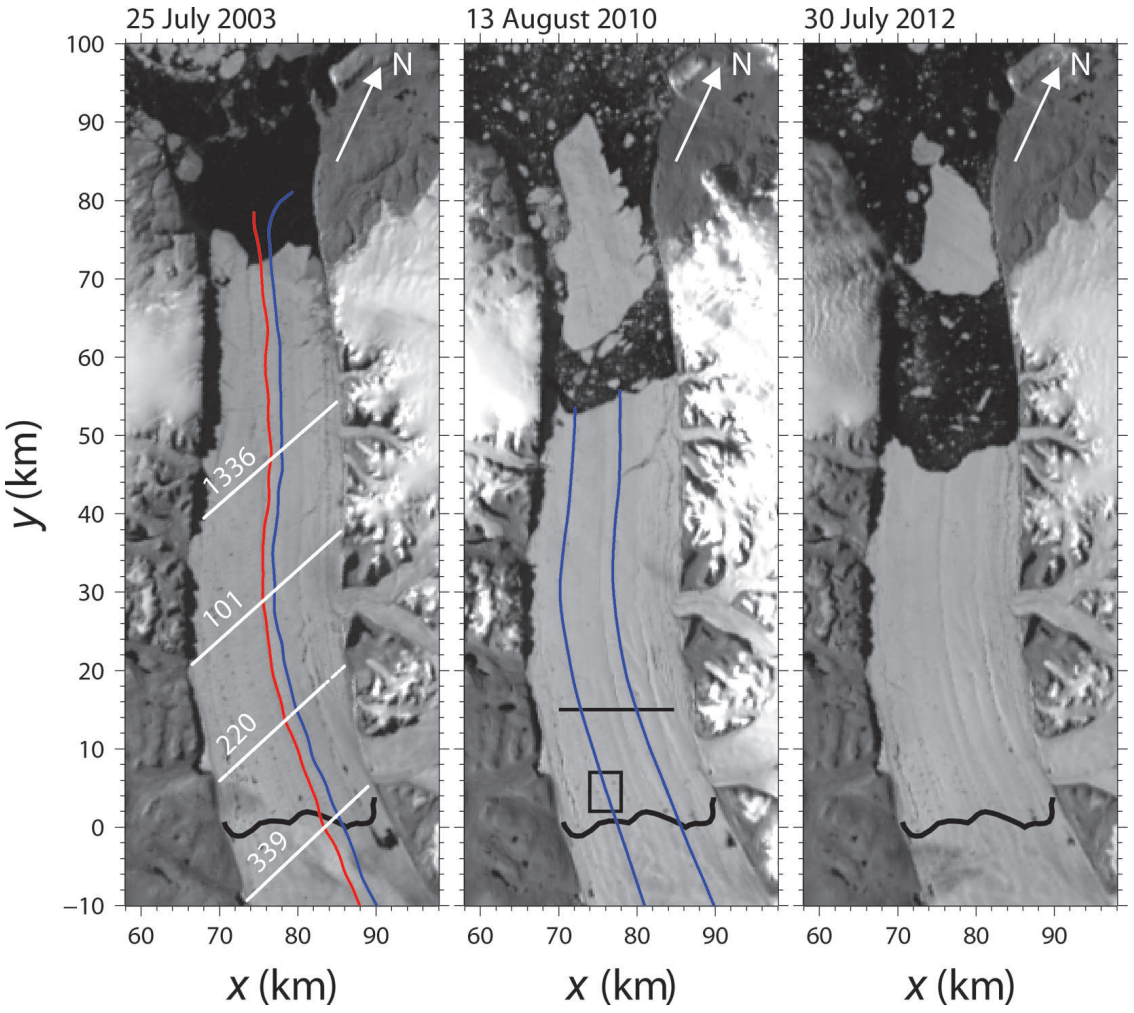
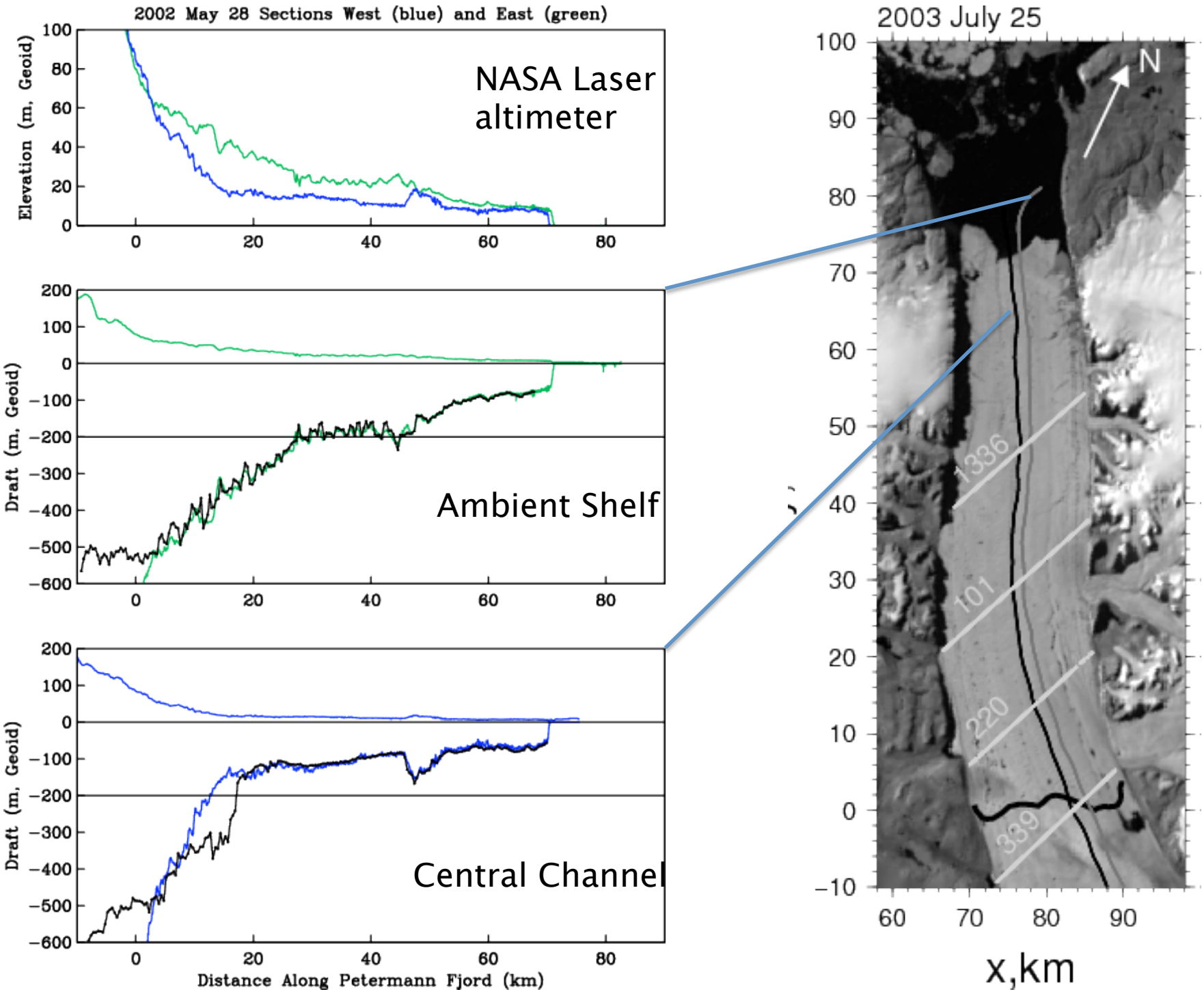
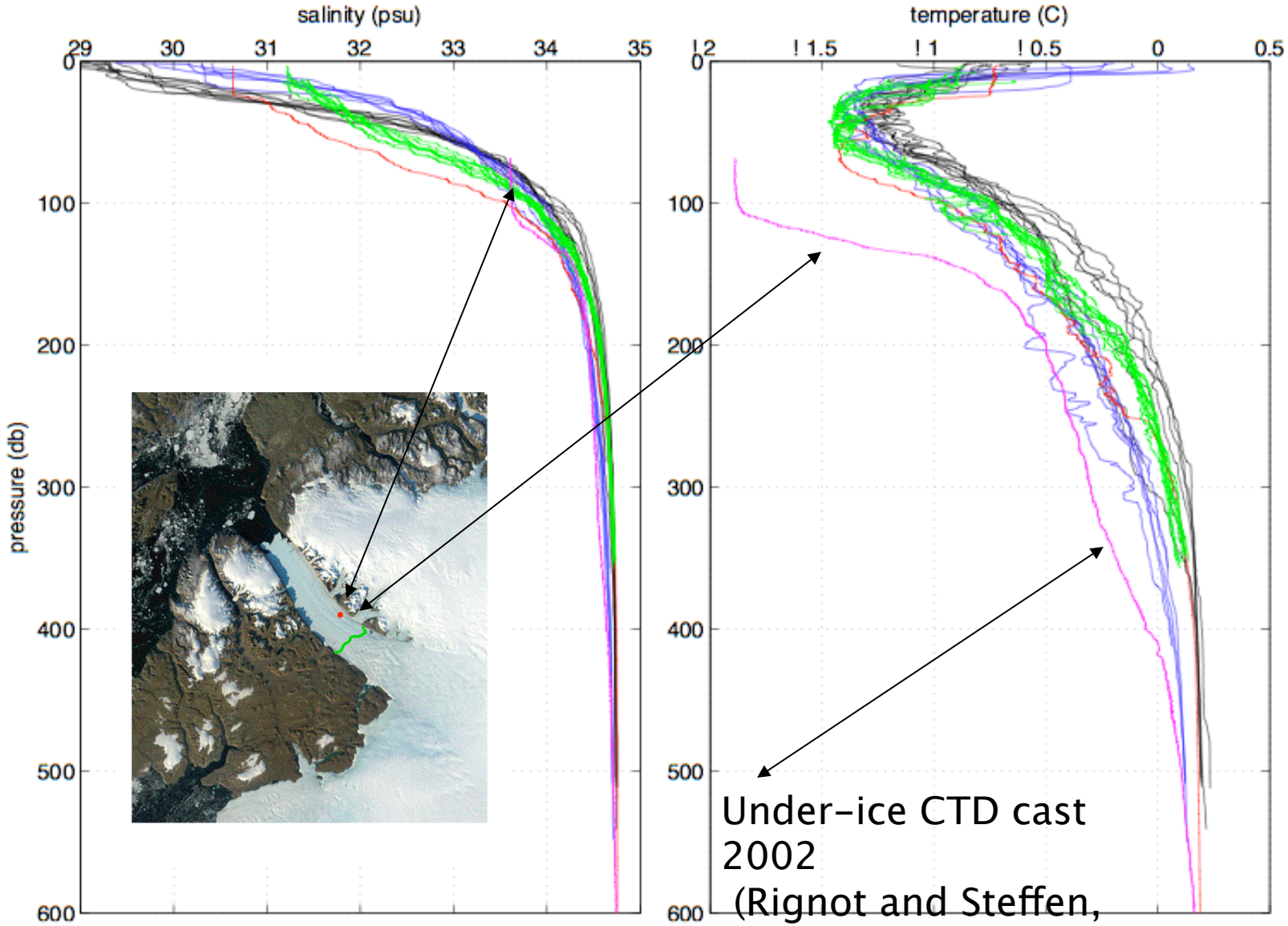


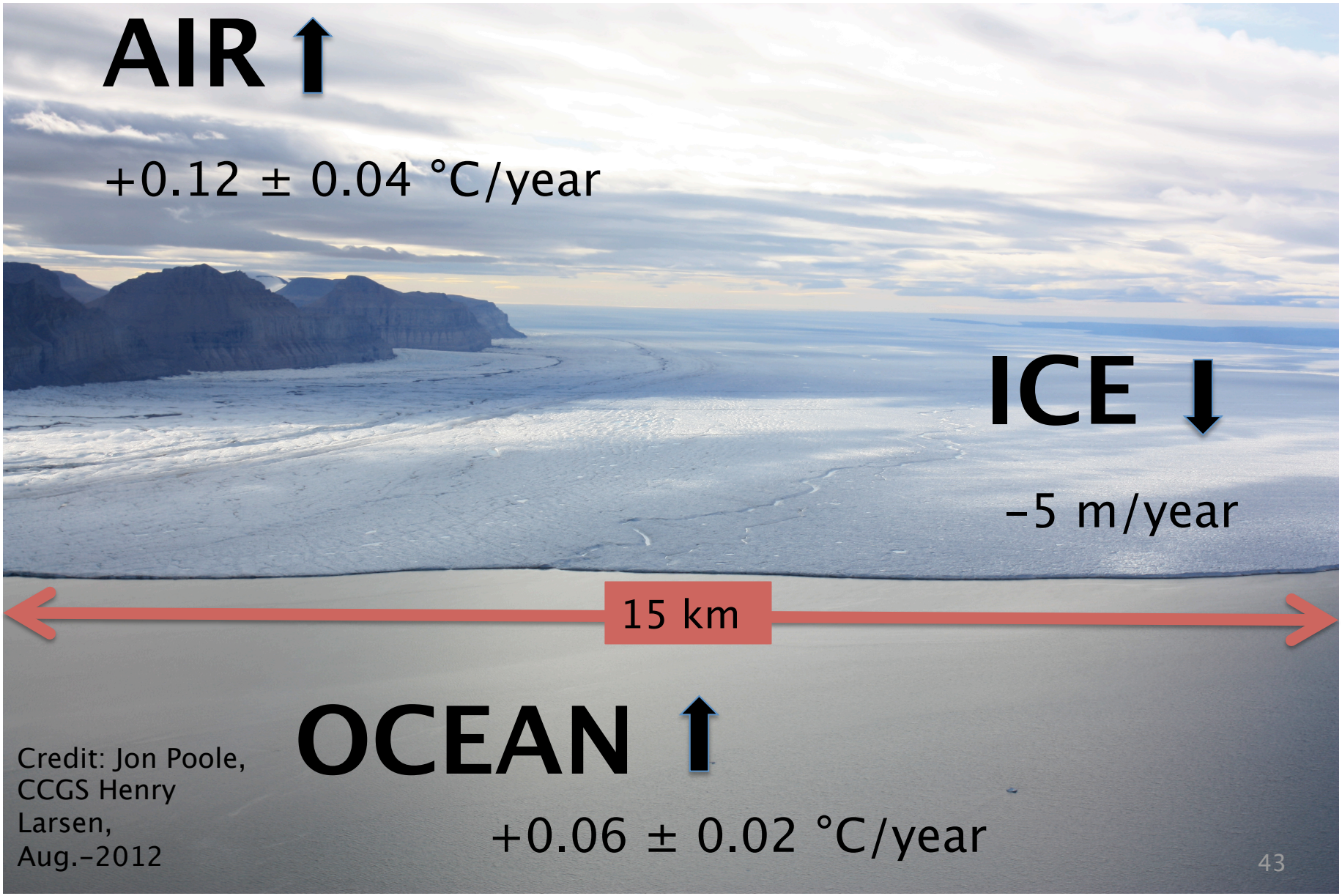
Fig. 1. MODIS images acquired over Petermann Gletscher on 25 July 2003 (left), 13 August 2010 (center) and 30 July 2012 (right). White lines on the left image are ICESat tracks, labeled by track number. Blue and red curves on the left panel are survey lines flown by NASA in 2002, 2003 and 2007. Blue curves in the center panel show the 2011 flight lines. Red indicates flight lines along the central channel, while blue marks flight lines along the ambient ice shelf. The thick black curve across the glacier near $y = 0$ km is the grounding-line location of Rignot and Steffen (2008). The horizontal black line near $y = 15$ km in the middle panel shows the location of MODIS surface reflectance profiles presented in Figure 6. The black rectangle shows an area of large and non-hydrostatic crevasses shown in Figure 10. Dark areas within 2 km of the western wall ($x \sim 70$ km) are shadows cast by high terrain, not ice-free water.


2002 May 28 Sections West (blue) and East (green)
Elevation (m, Geoid)
NASA Laser altimeter
Draft (m, Geoid)
Ambient Shelf
Draft (m, Geoid)
Central Channel
Distance Along Petermann Fjord (km)
2003 July 25
N
1336
101
220
339
x,km



Under-ice CTD cast 2002
(Rignot and Steffen, 2008)

Decadal Variability of Petermann Gletscher, North Greenland from Observations of Ice, Ocean, and Atmosphere



Did I ever see a polar bear?