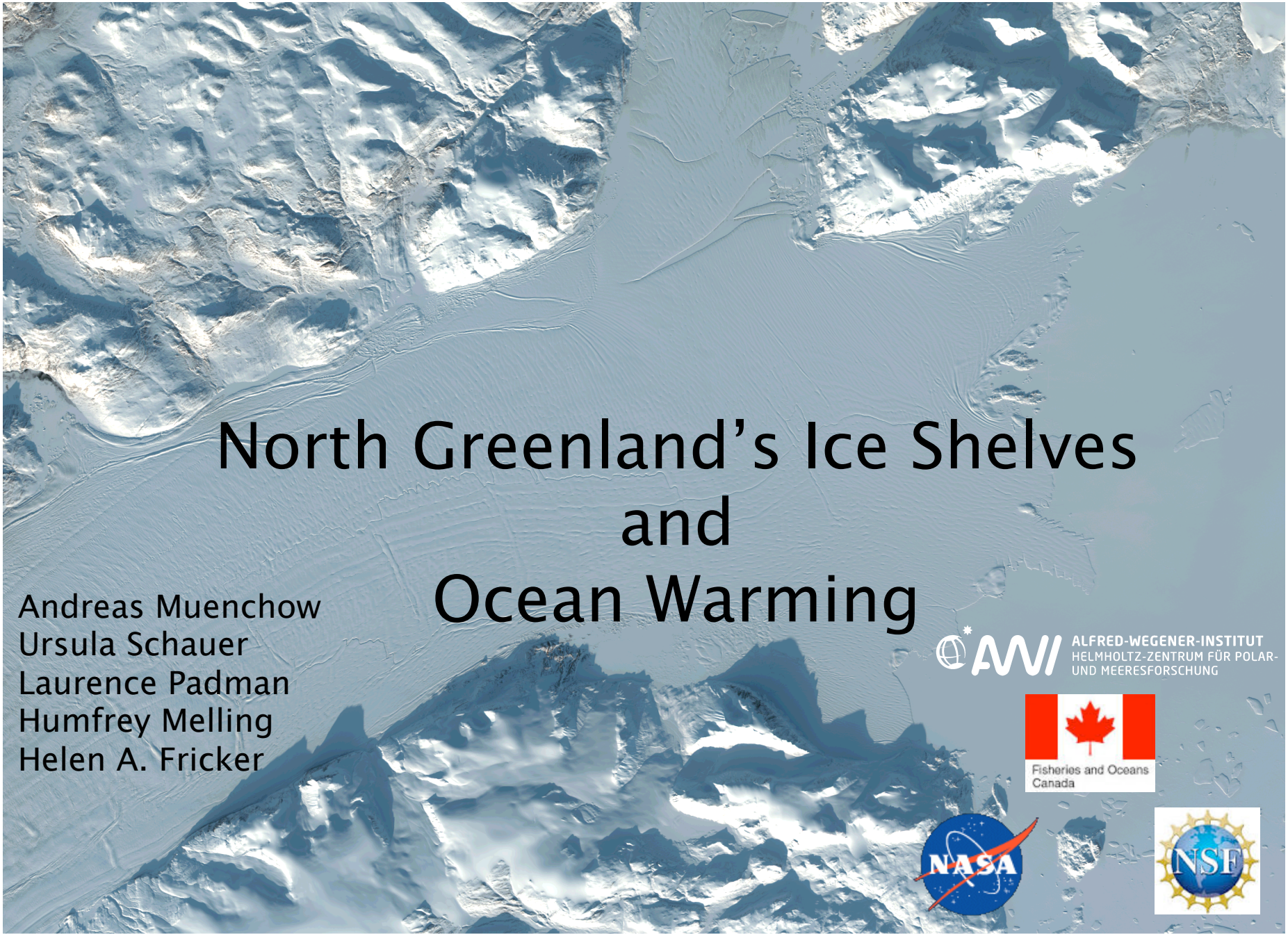
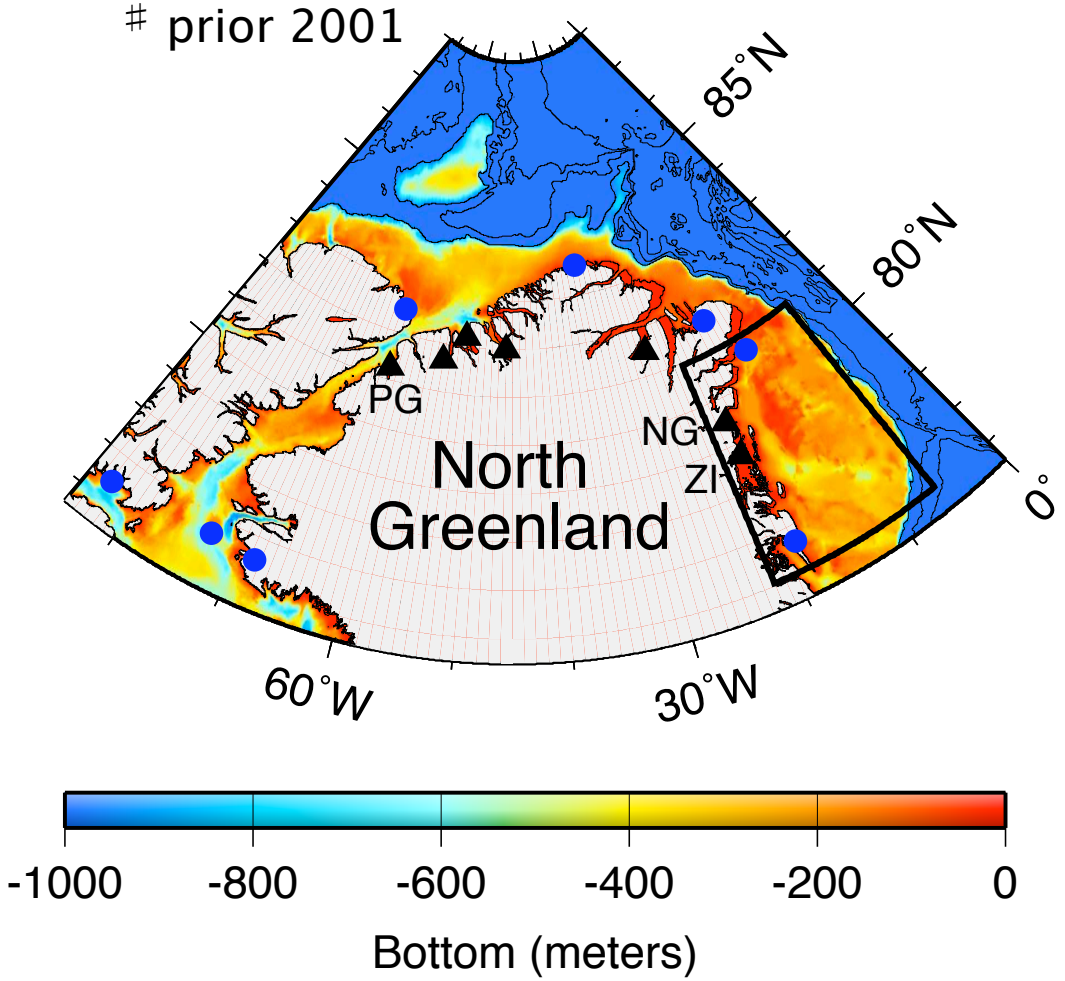

North Greenland's Ice Shelves
and
Ocean Warming
Andreas Muenchow
Ursula Schauer
Laurence Padman
Humfrey Melling
Helen A. Fricker
AWI
ALFRED-WEGENER-INSTITUT
HELMHOLTZ-ZENTRUM FÜR POLAR-
UND MEERESFORSCHUNG
Fisheries and Oceans
Canada
NASA
NSF
Landsat id: LC80080032014081LGN00 Date: 2014-03-22 SCENE_CENTER_TIME = 14:51 Natural Color 30m

Ice-Shelf Glaciers:

Petermann, Steensby, Ryder,Hagen, 79N, Ostenfeld[#] and Zachariæ[#]

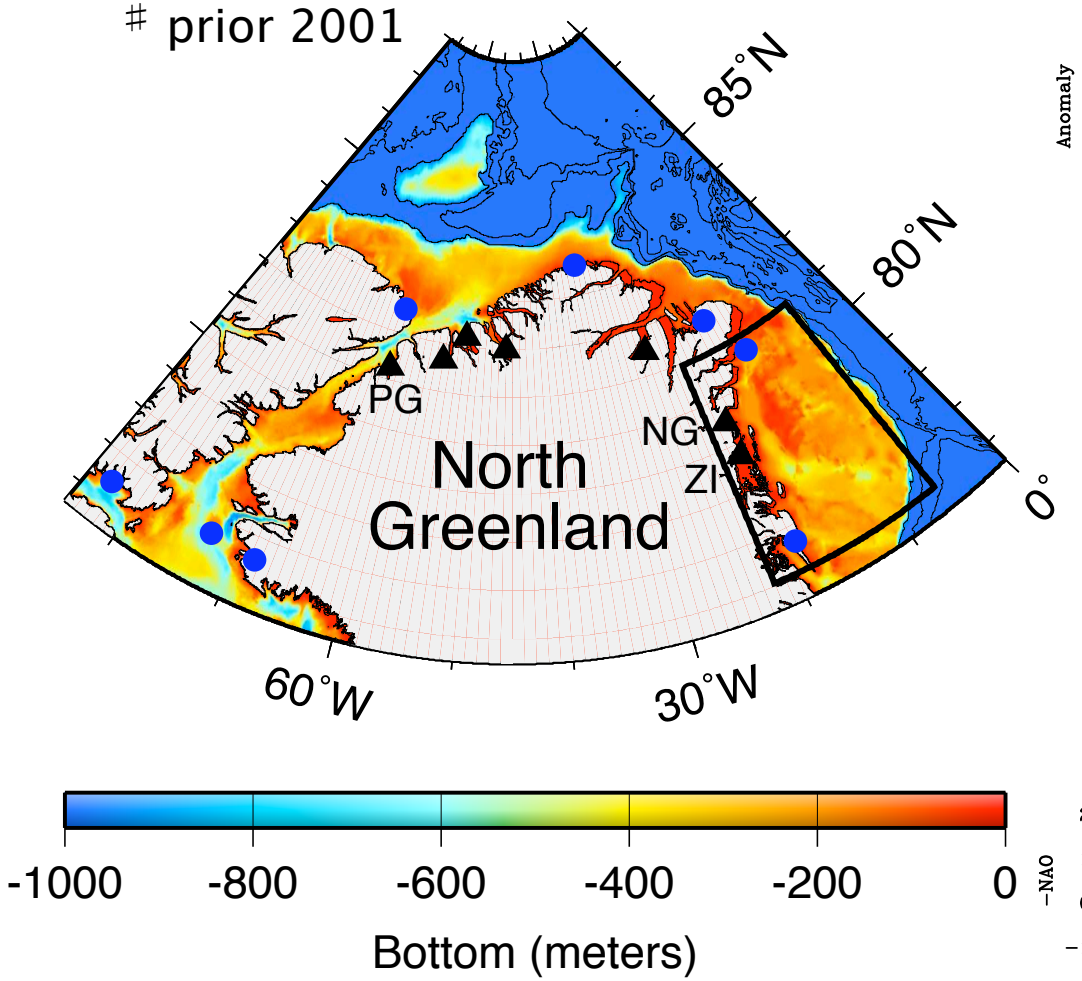
[#] prior 2001



Ice-Shelf Glaciers:

Petermann, Steensby, Ryder,Hagen, 79N, Ostenfeld[#] and Zachariæ[#]

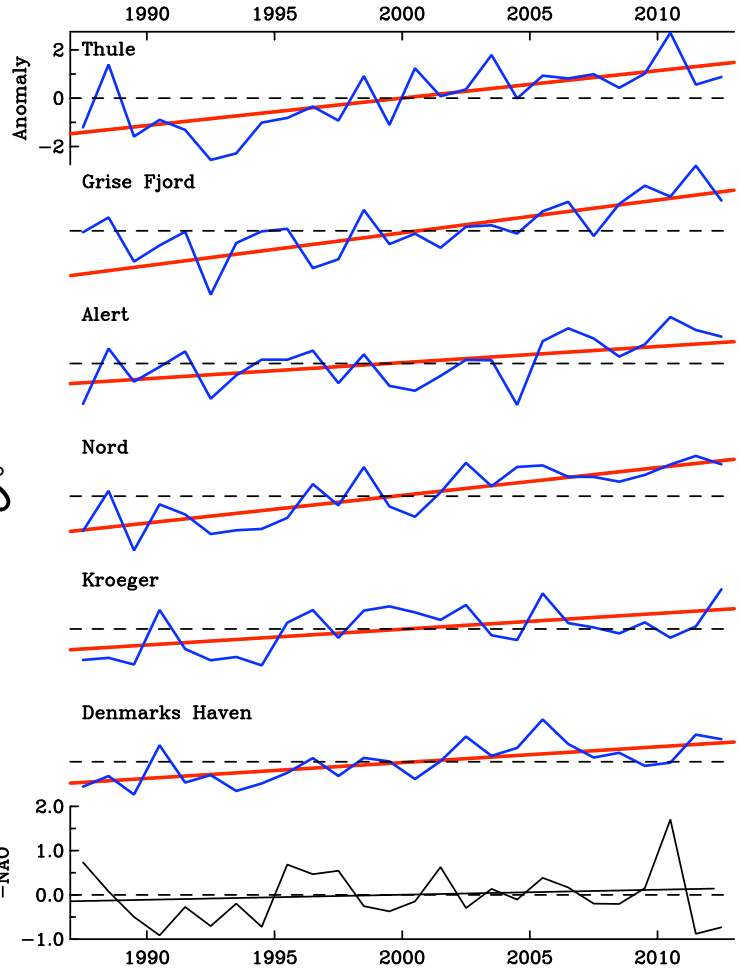
[#] prior 2001



Coastal Air Temperatures

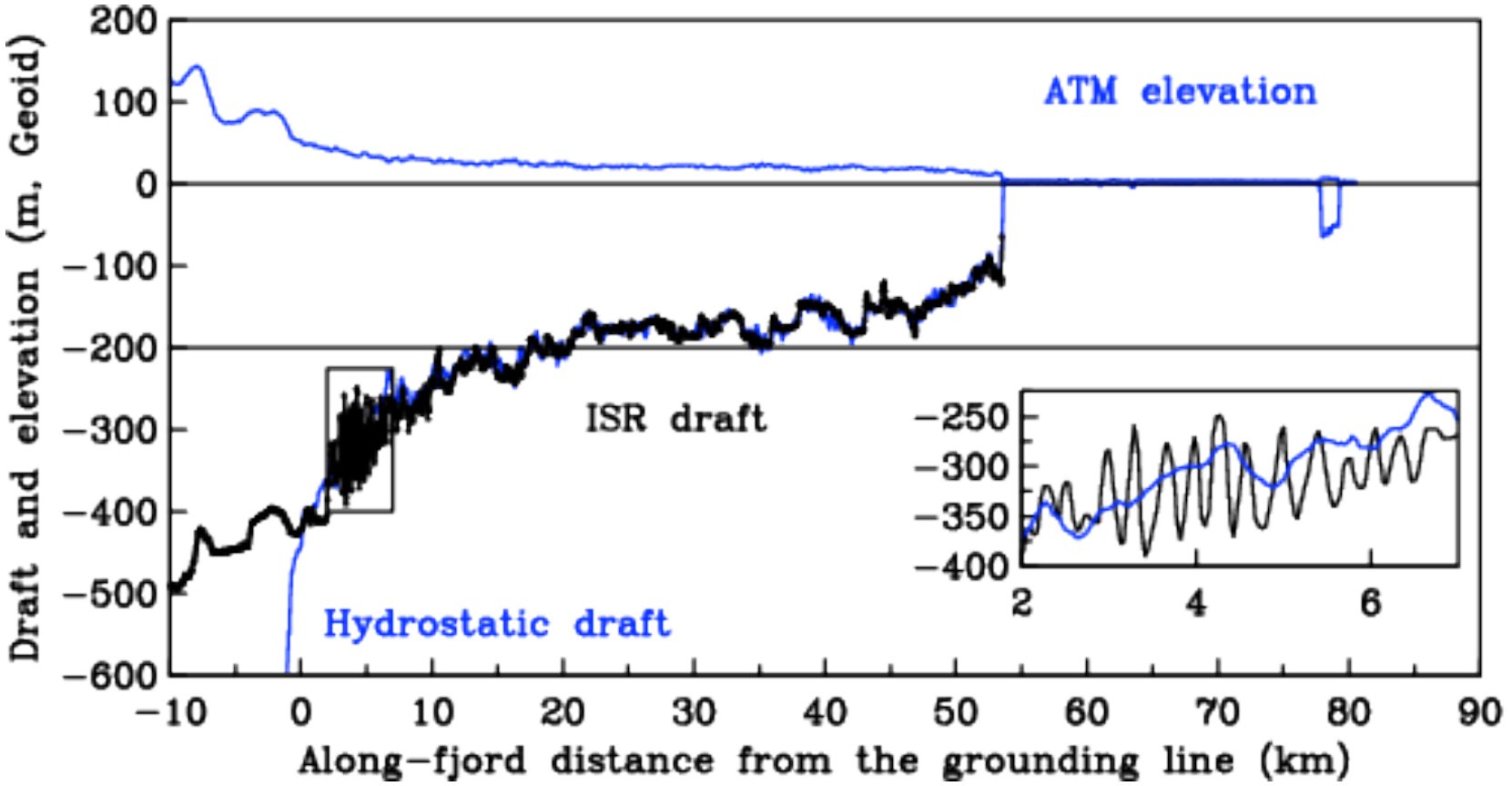
North Greenland:

0.9 ± 0.18 °C/decade

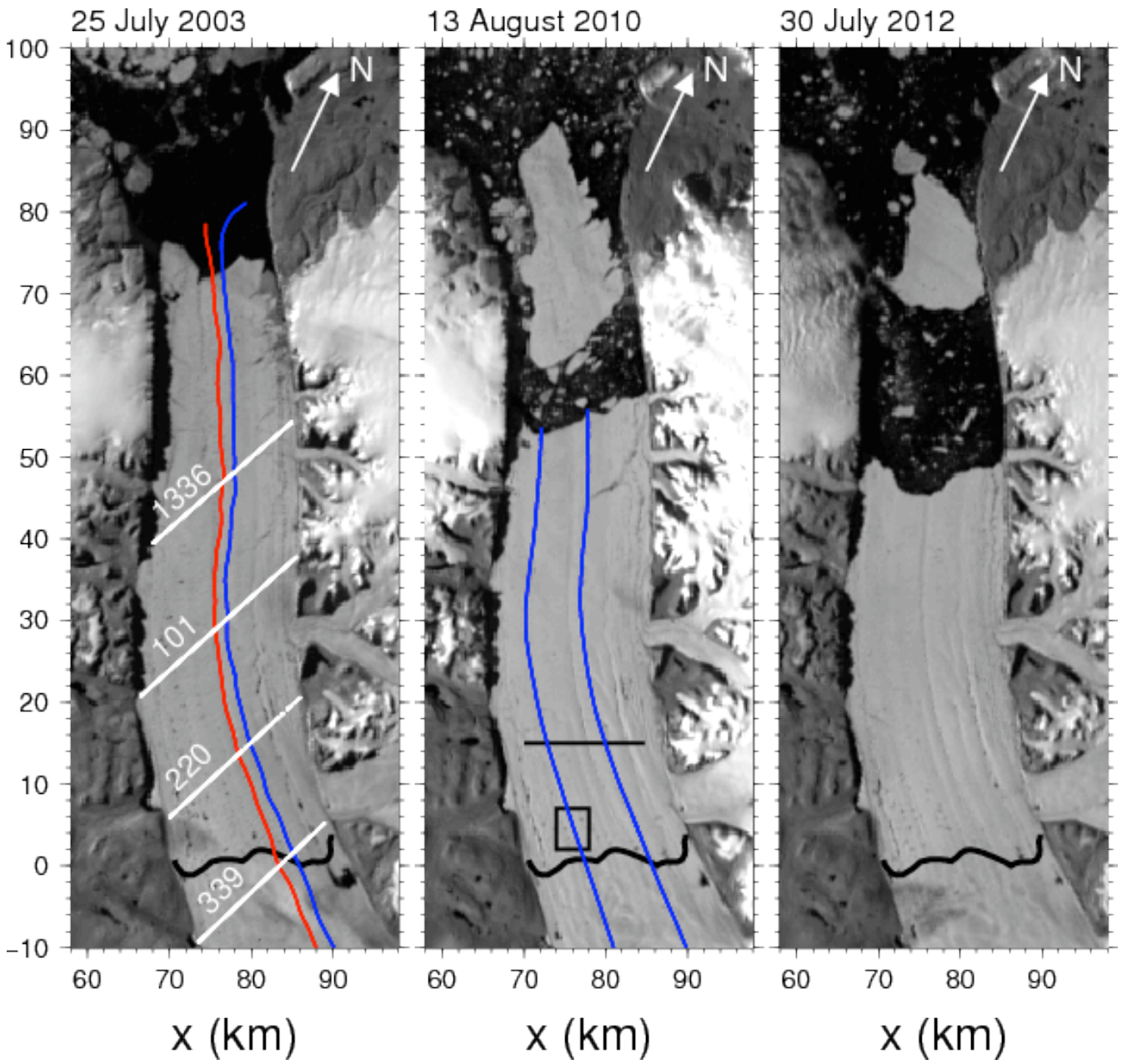


Petermann Gletscher, May 7, 2011:

ATM Airborne Topographic Mapper
ISR Ice Sounding Radar



Münchow et al. (2014)



Petermann Gl. 2010–12 Calving Events:

18 ± 2 Gt each

White – ICESat

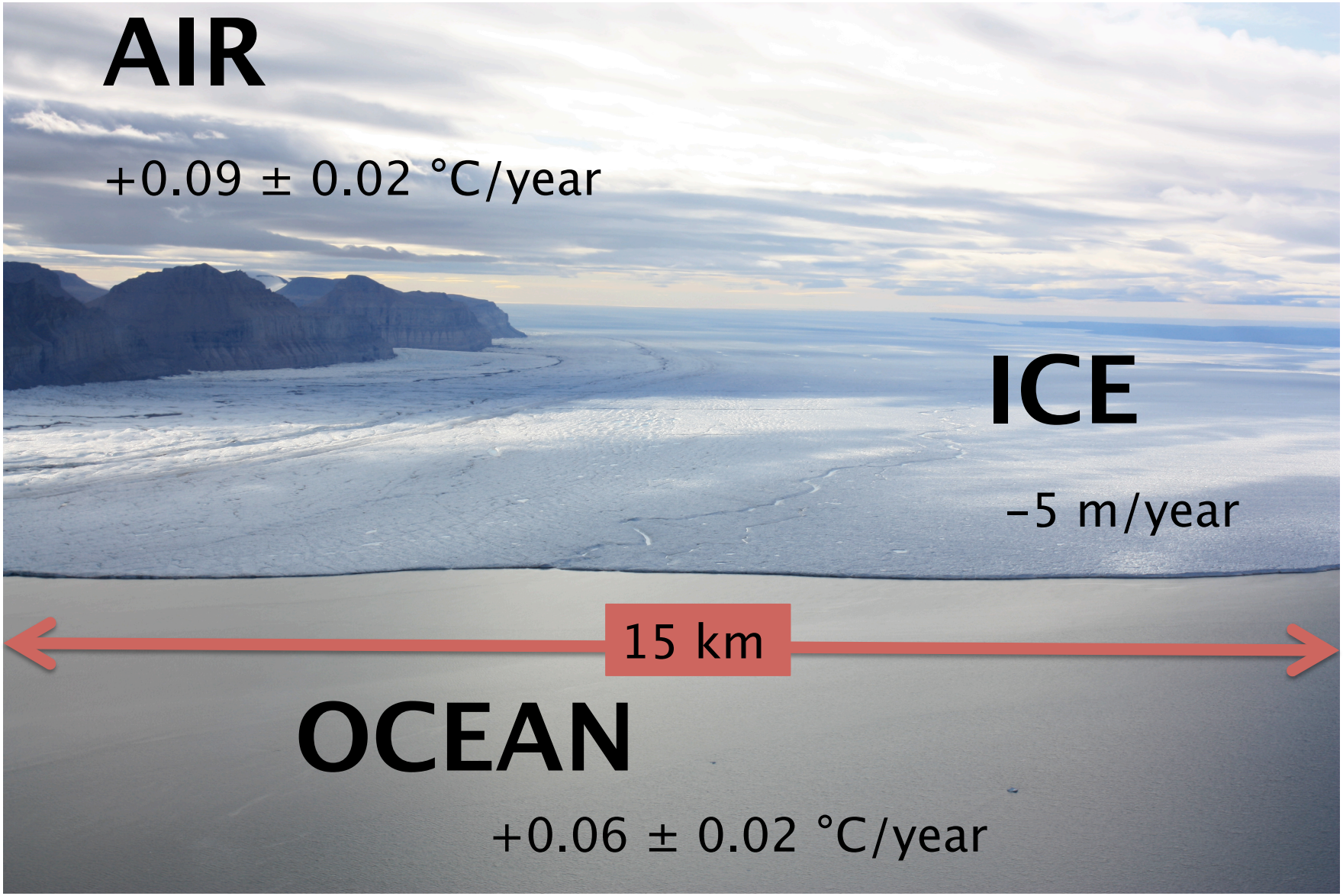
Operation Icebridge repeat

Red – ambient ice shelf

Blue – central channel

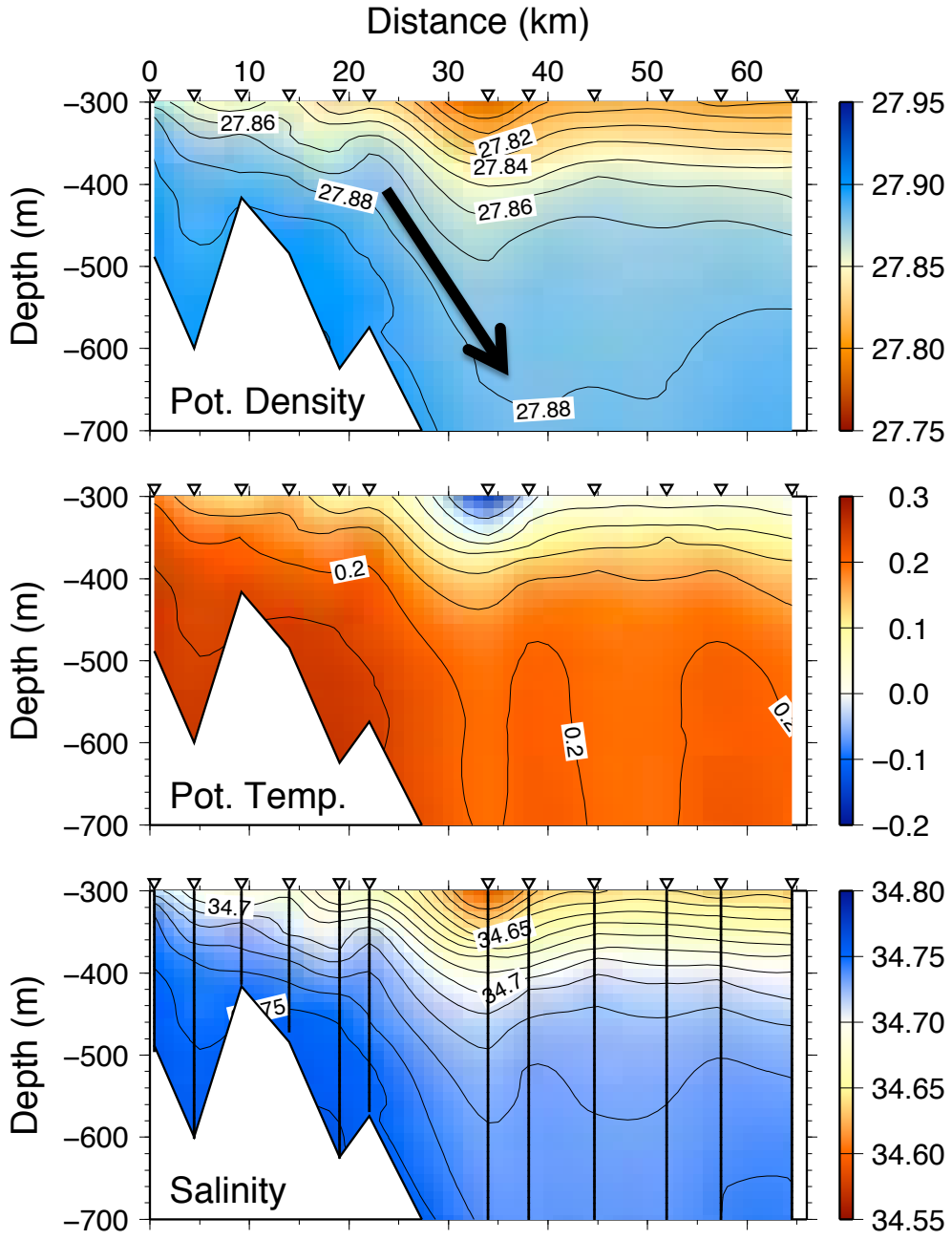
Münchow et al. (2014)

Petermann Gletscher 2012



Sill

Depth



Nares Strait Sill Fjord Glacier

Along-Fjord Section
August 2012

1. Density:

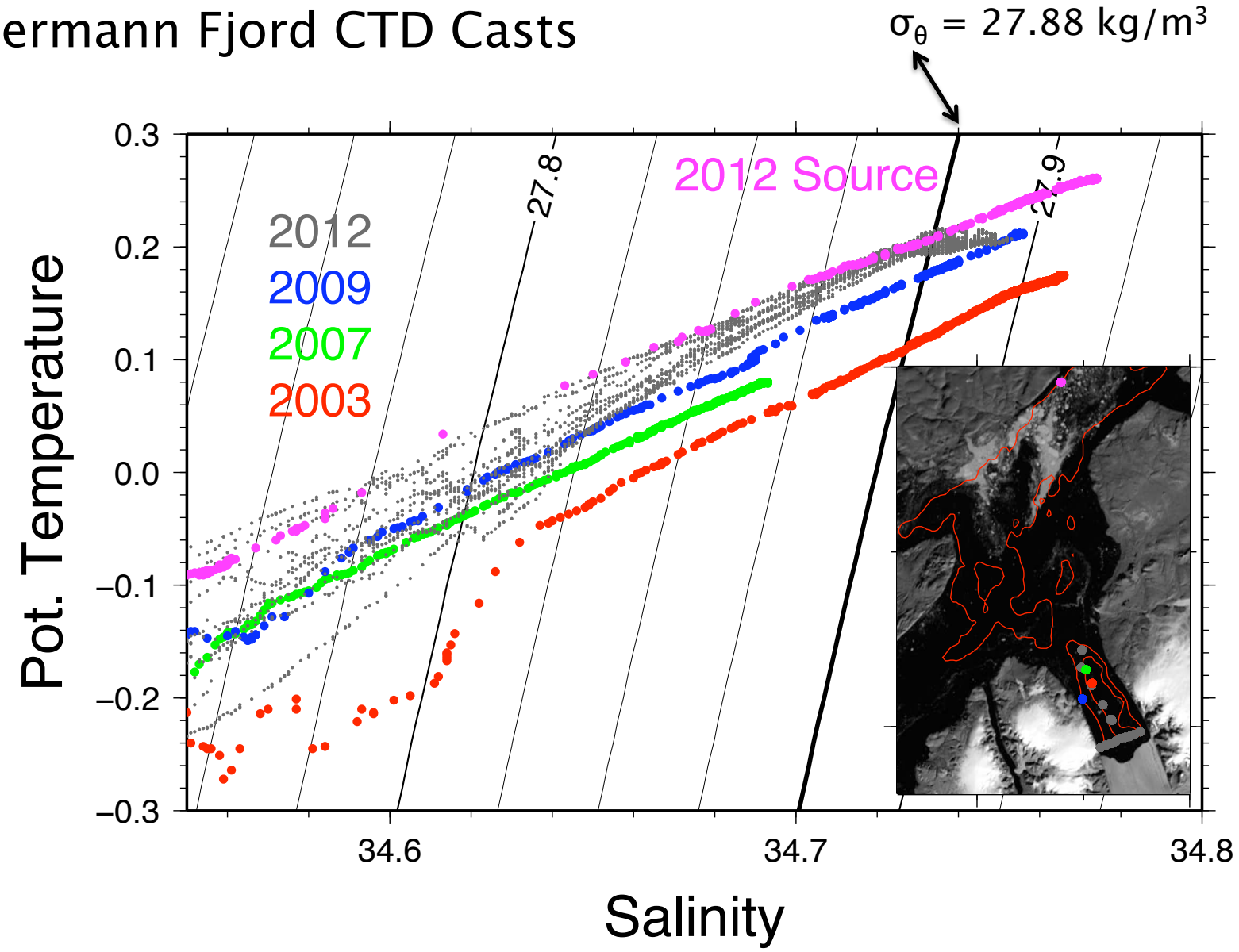
400-m plunge of
deep isopycnals

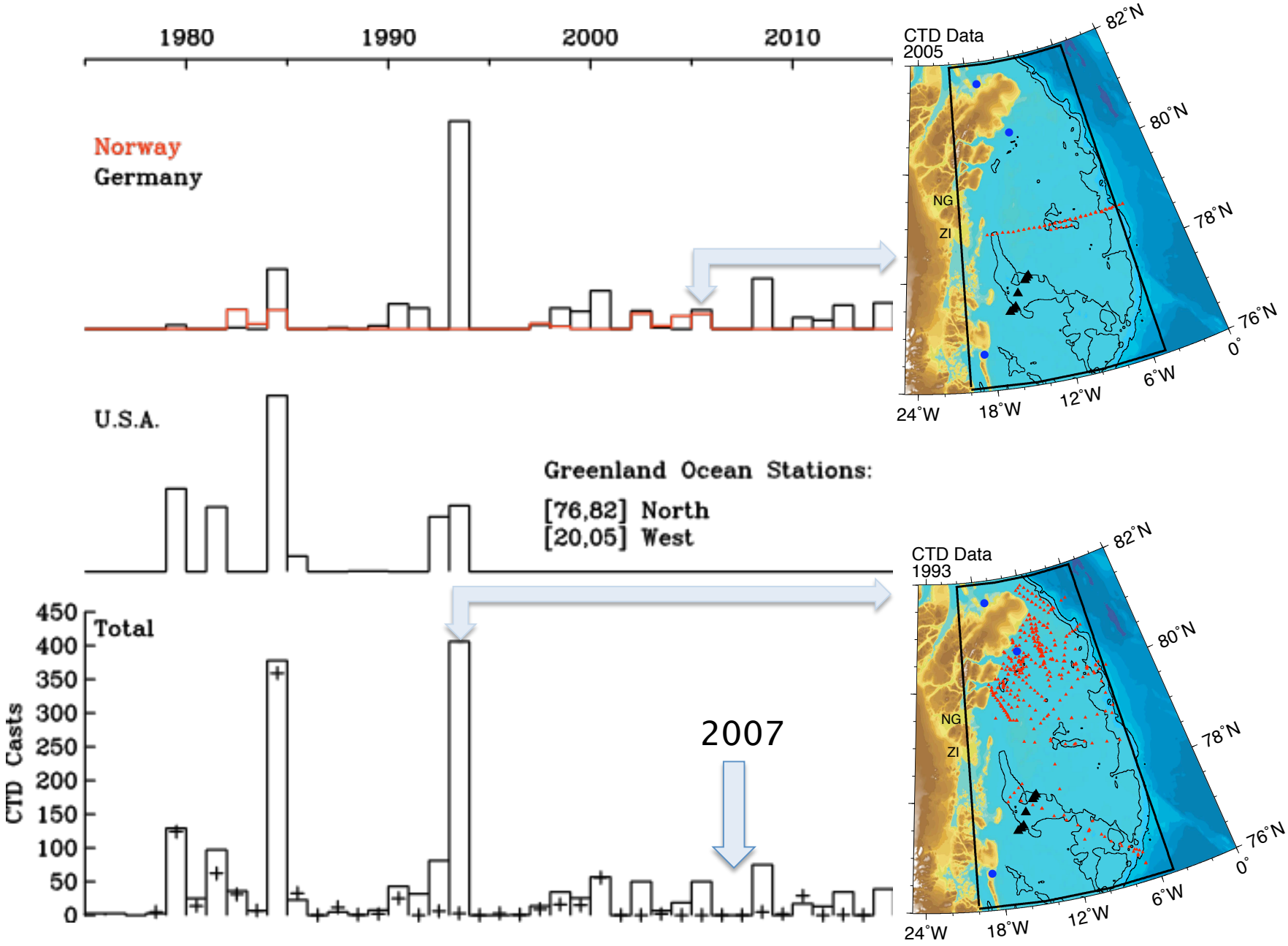
2. Temperature:

Enough Heat
to melt ice shelf

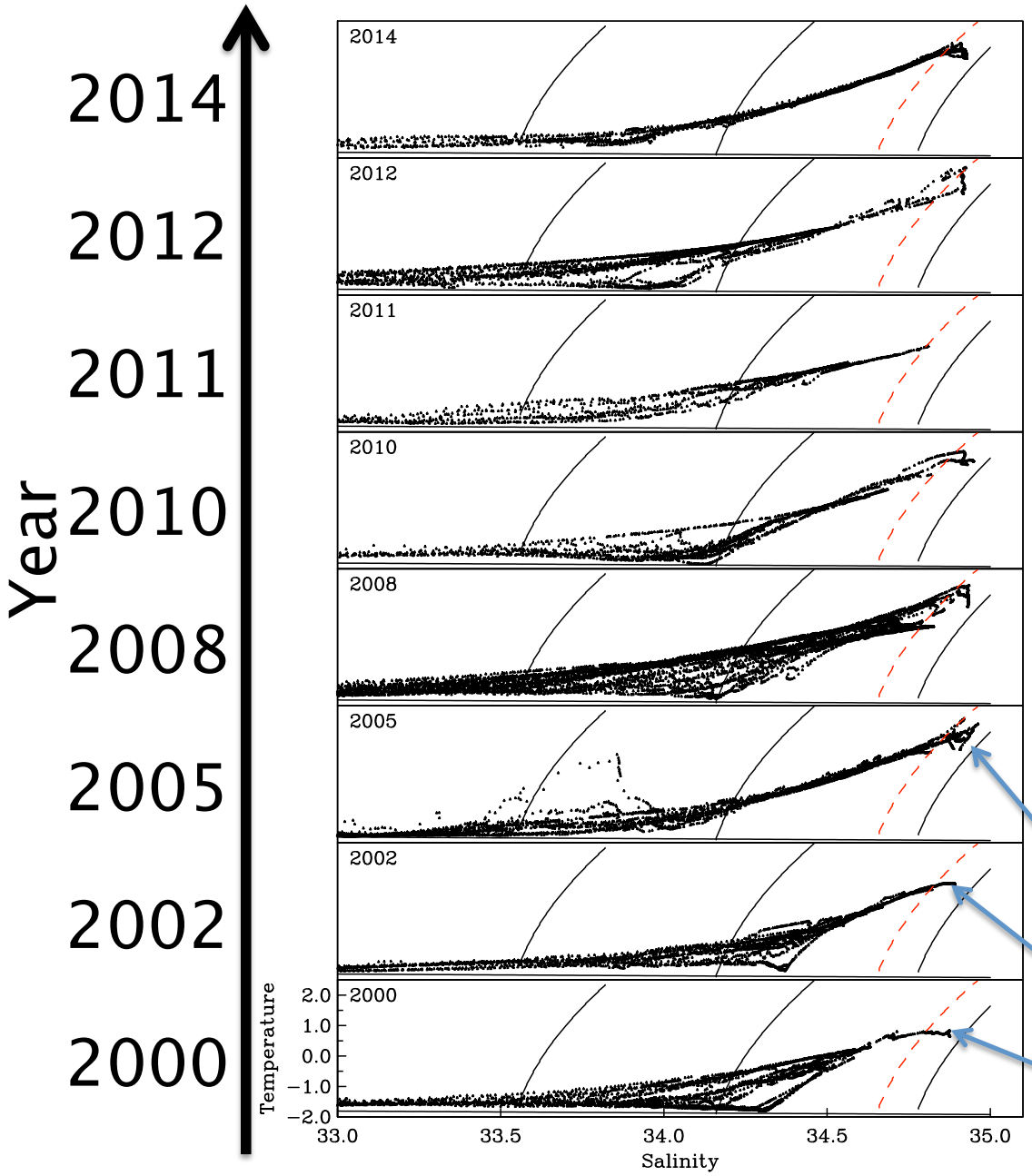
3. Salinity ~ Density

Petermann Fjord CTD Casts




1980
1990
2000
2010
Norway
Germany
U.S.A.
Greenland Ocean Stations:
[76,82] North
[20,05] West
Total
CTD Casts
450
400
350
300
250
200
150
100
50
0
2007
CTD Data
2005
CTD Data
1993
NG
ZI
82°N
80°N
78°N
76°N
0°
6°W
12°W
18°W
24°W

North-East Greenland Continental Shelf Water Properties

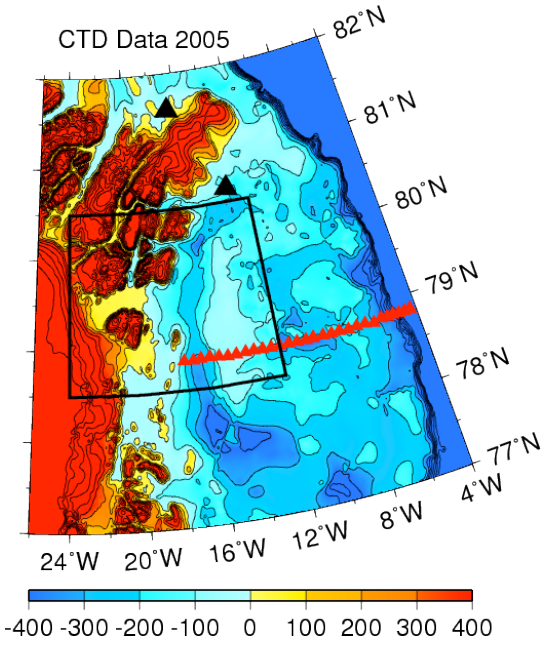


Temperature
vs.
Salinity

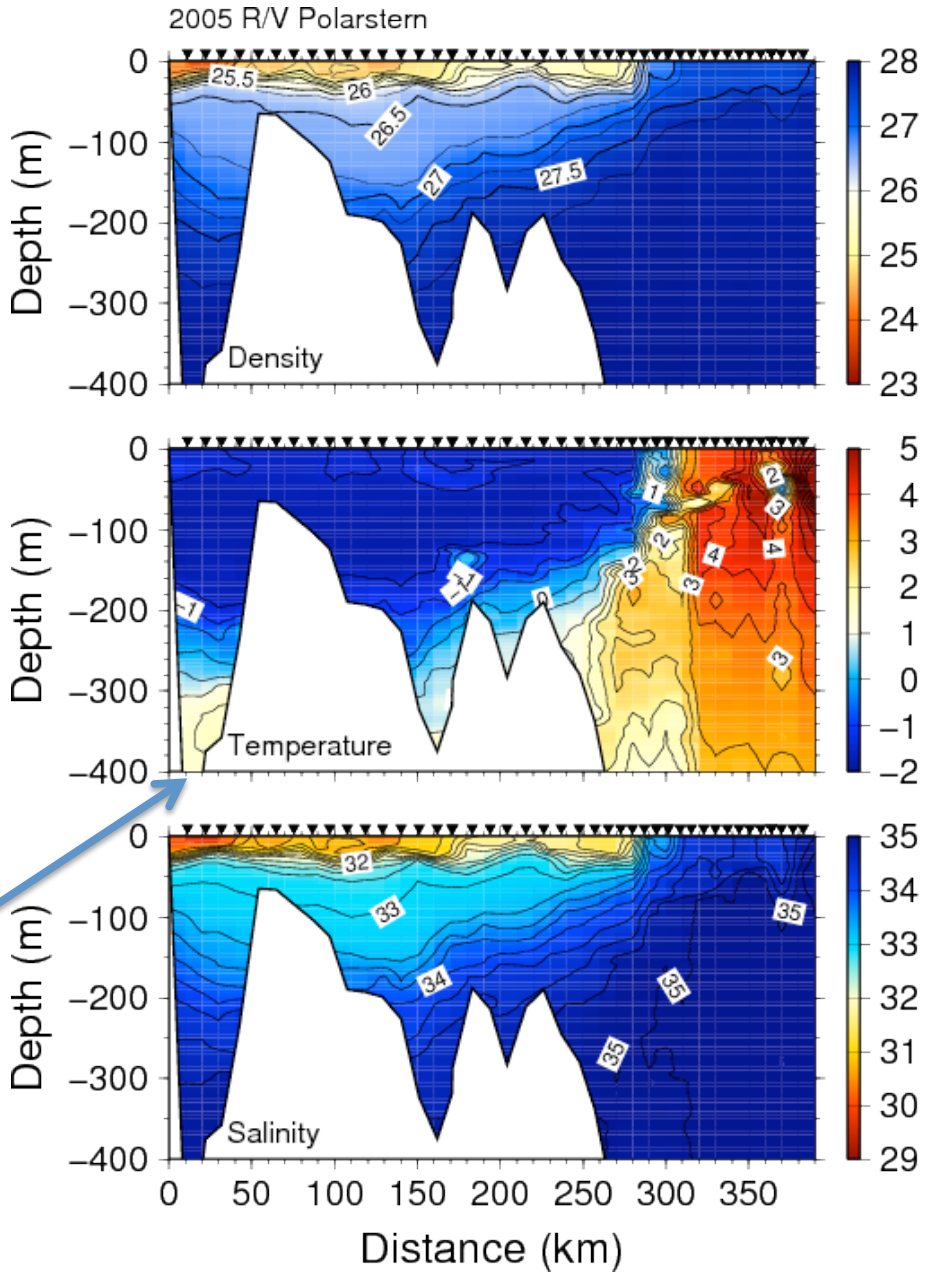
over density contours
1027.0 kg/m^3
1027.5 kg/m^3
1027.9 kg/m^3
1028.0 kg/m^3

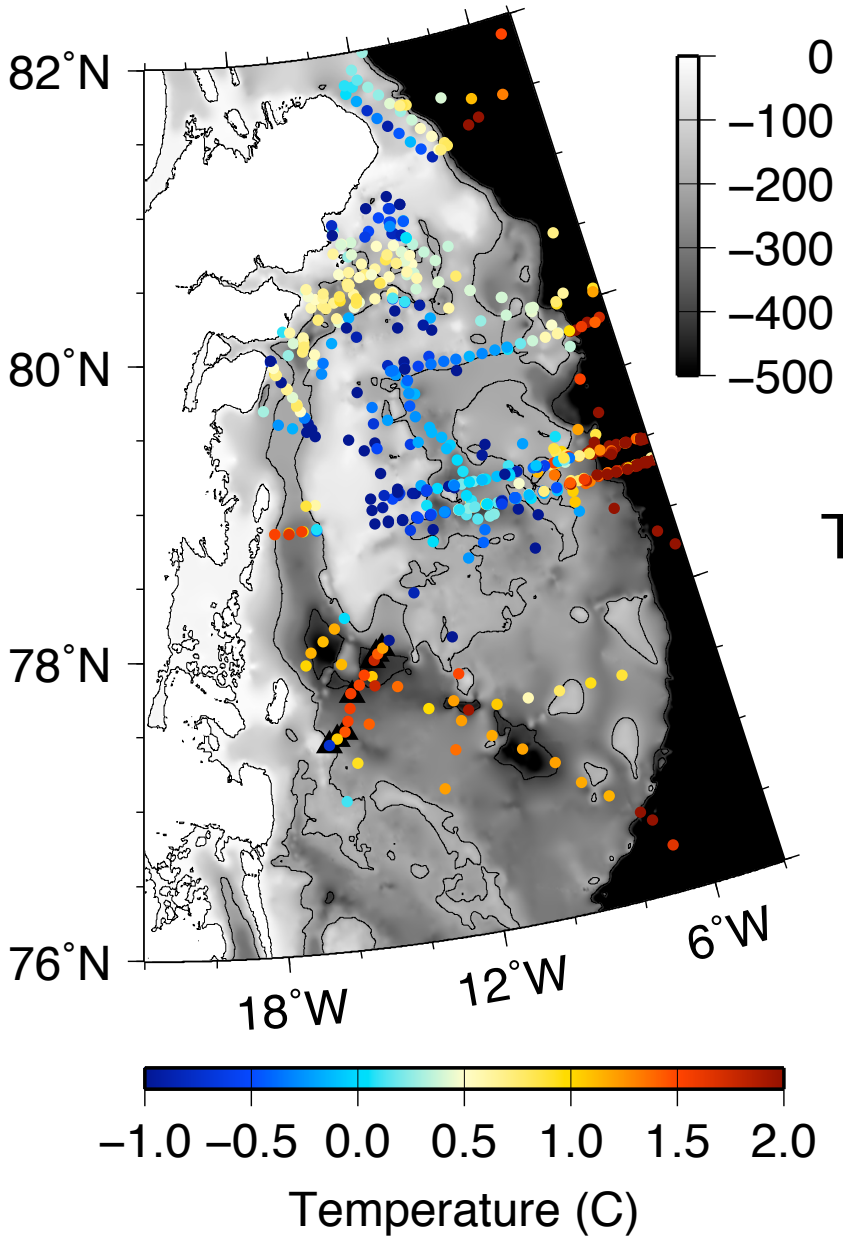
Atlantic Layer
T_{max} Intrusions

Section across East-Greenland Shelf, Trough, and Slope



Atlantic Layer T_{max} Intrusions

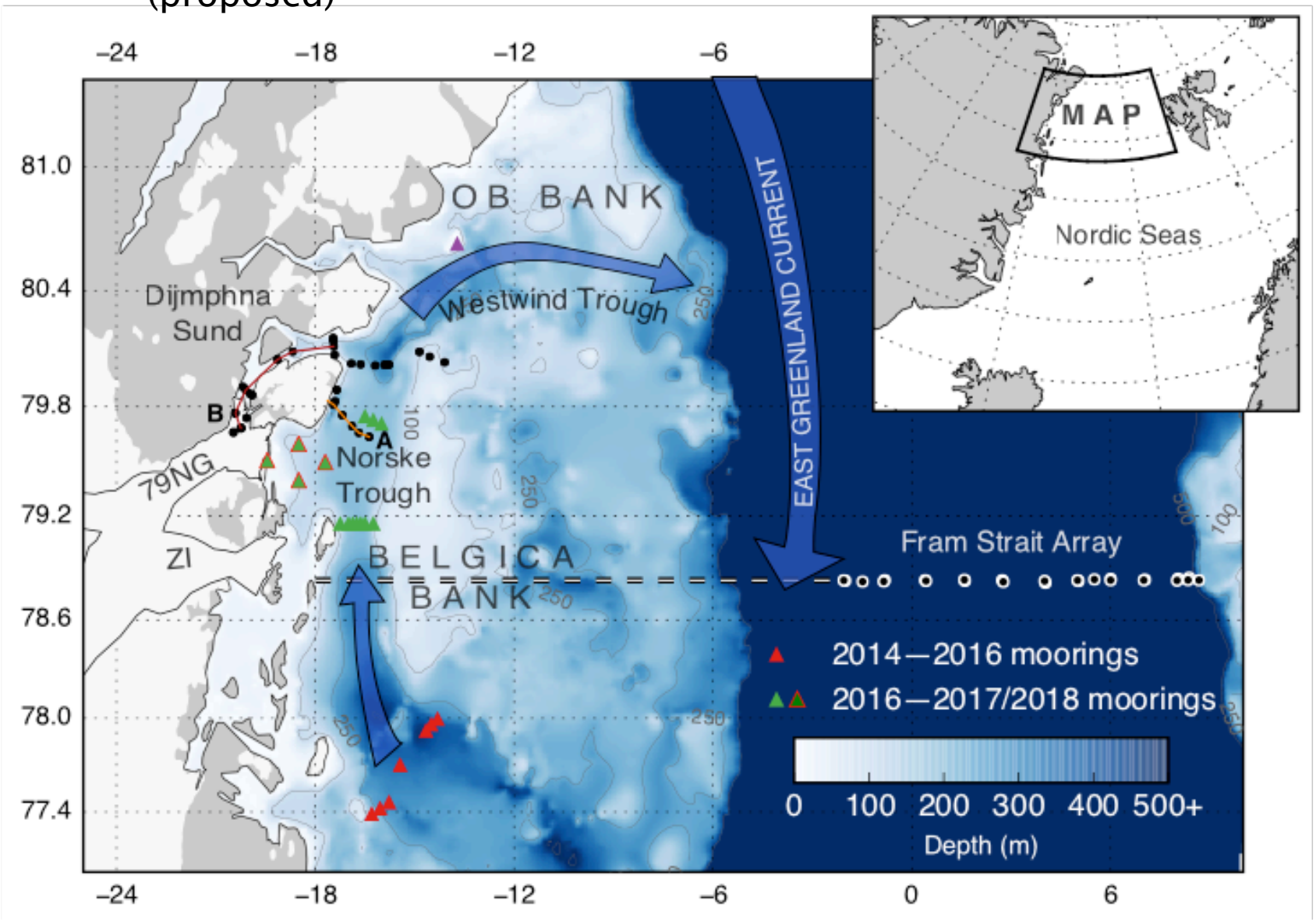




Temperature of subsurface Atlantic layer temperature maximum 1987–2014

Future work

(proposed)



Conclusions

North Greenland atmosphere warms 4-5 times global rate;

Greenland's glaciers melt and retreat (steady + non-steady);

Excellent surface (remotely sensed) data on glaciers;

Limited ocean data, often extrapolated and used incorrectly

(Nature Geoscience, 2014)

Poor models and predictions/projections

Need ocean data under and adjacent to ice shelves

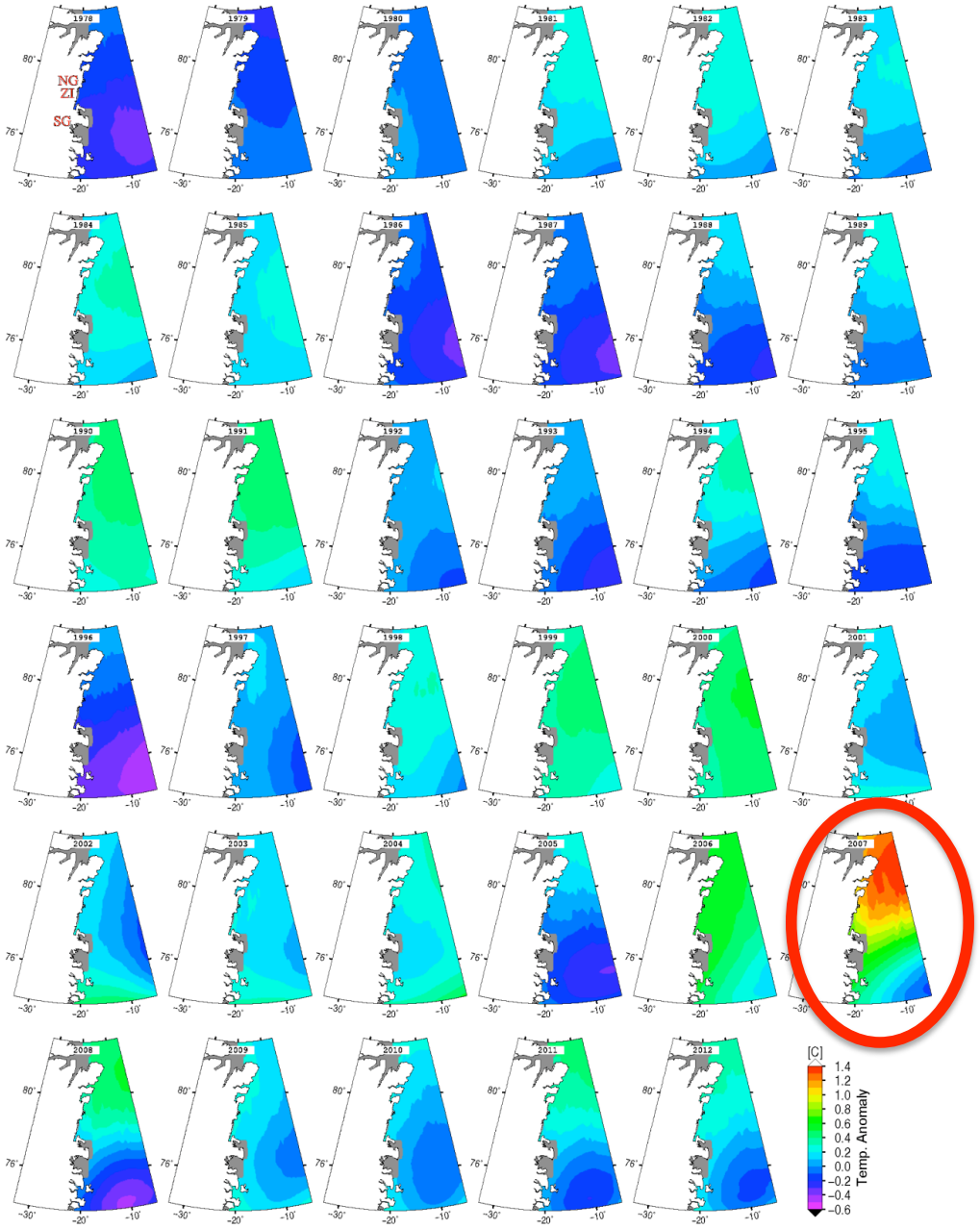


Figure S16: Mean annual subsurface ocean water temperature anomalies in degree °C at 315 m depth from 1978 to 2012.

Subsurface Ocean

Temperature Anomaly

at~300m depth

1978–2012

2007 has NO DATA !!!

Khan et al. (2014)