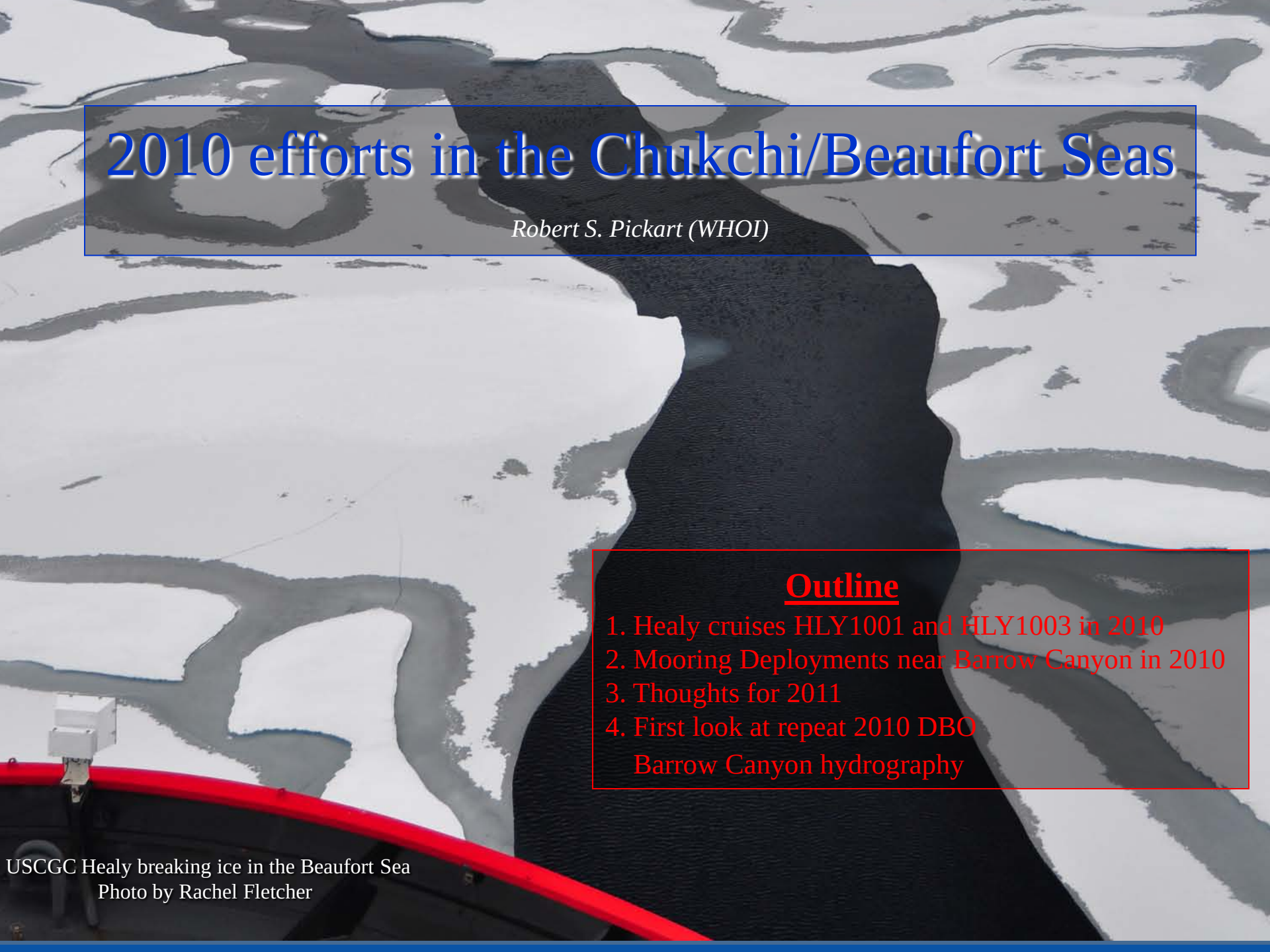
2010 efforts in the Chukchi/Beaufort Seas

Robert S. Pickart (WHOI)

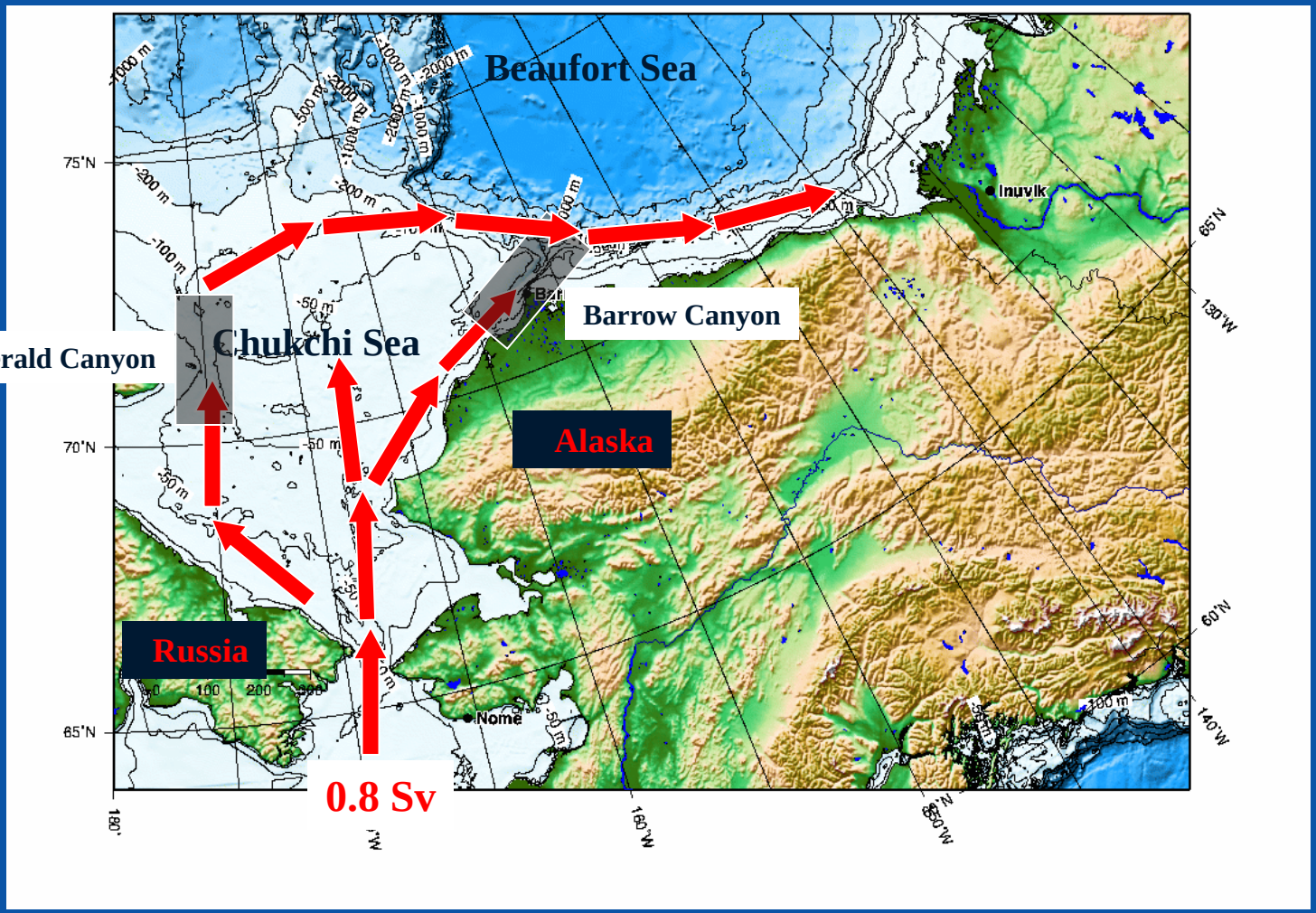


Outline

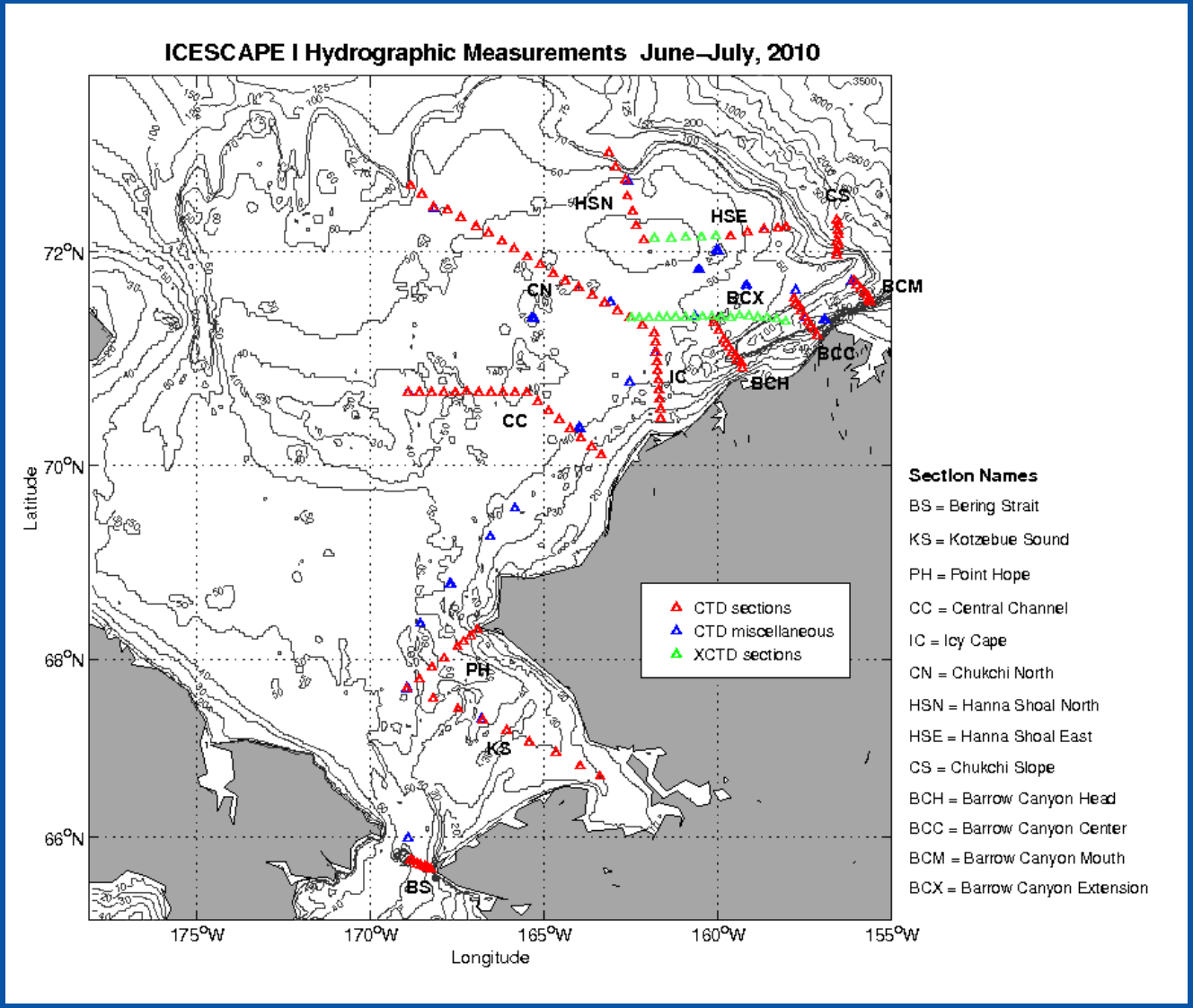
1. Healy cruises HLY1001 and HLY1003 in 2010
2. Mooring Deployments near Barrow Canyon in 2010
3. Thoughts for 2011
4. First look at repeat 2010 DBO Barrow Canyon hydrography

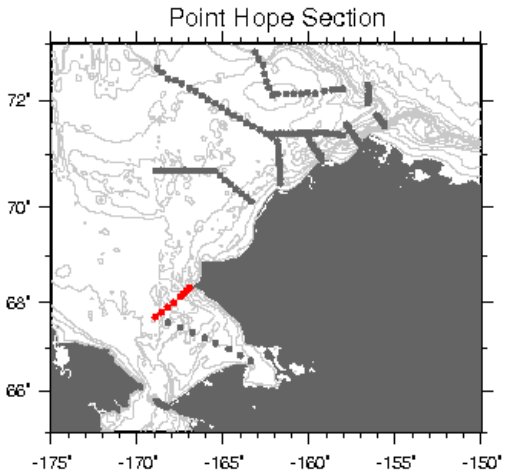
USCGC Healy breaking ice in the Beaufort Sea
Photo by Rachel Fletcher

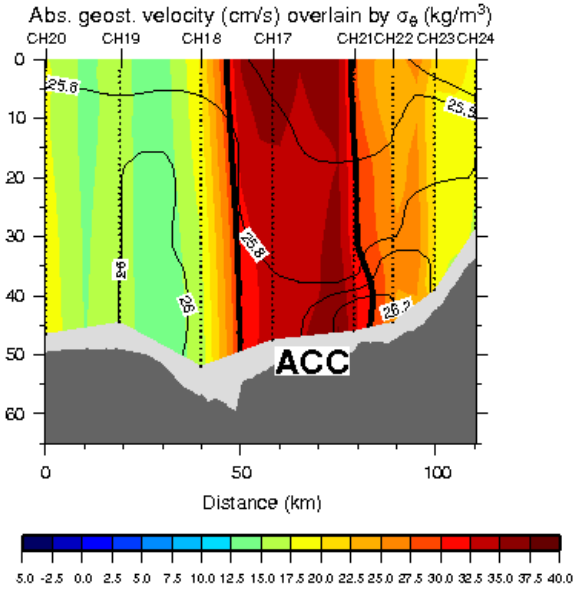
Pacific water inflow to the Arctic

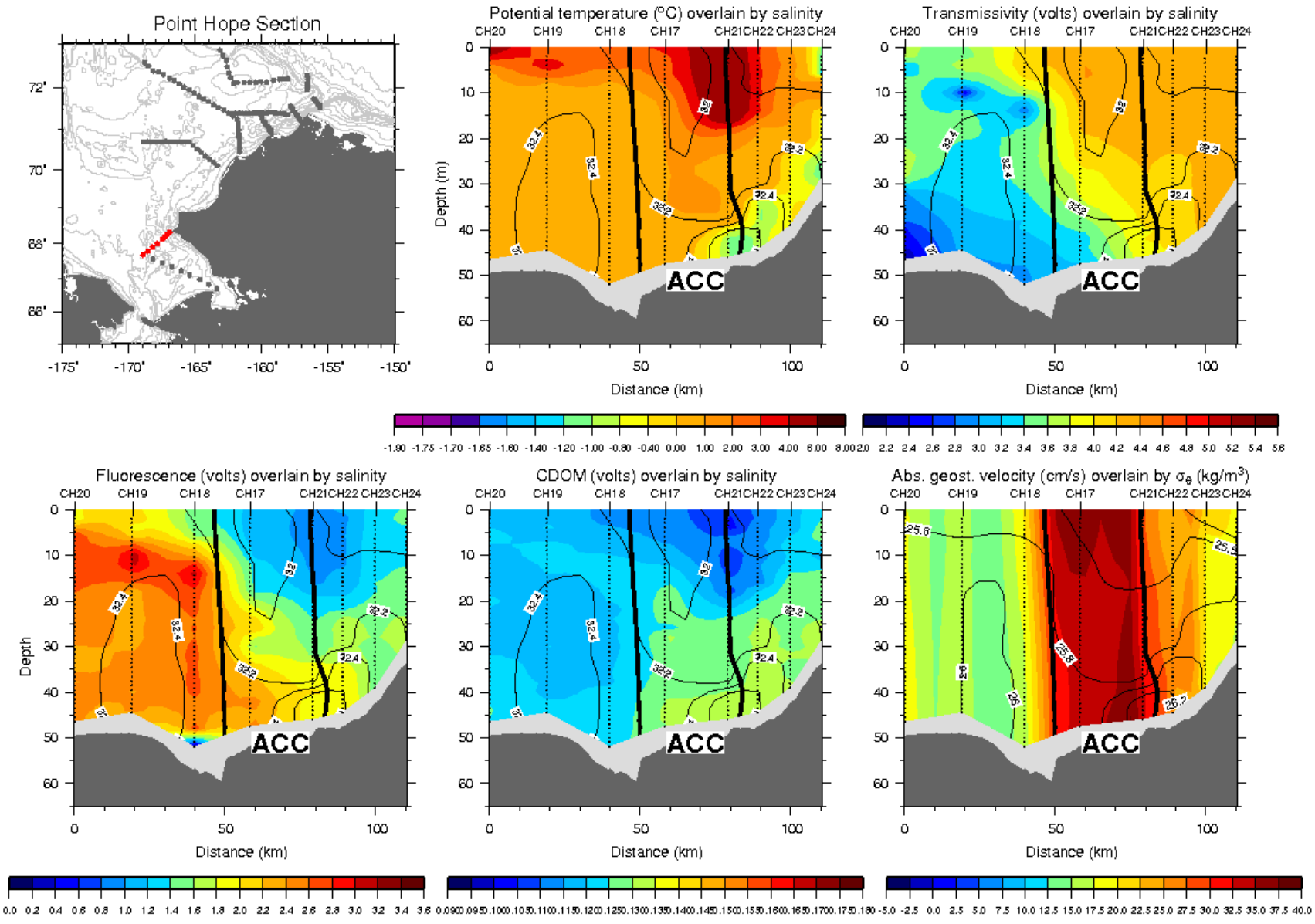


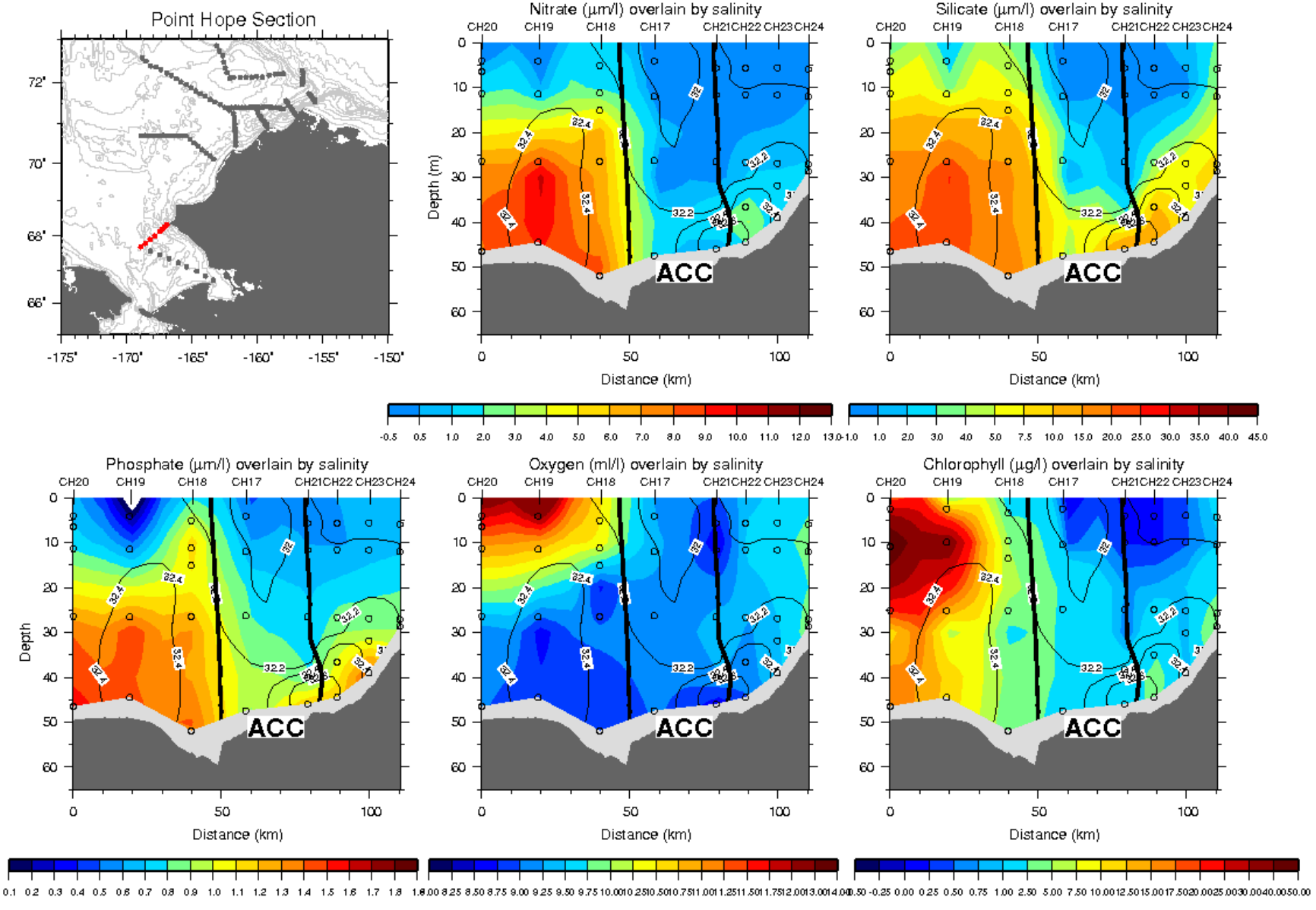
HLY1001: ICESCAPE *(Impacts of climate on ecosystems and chemistry of the Arctic Pacific environment)*




Point Hope Section
72°
70°
68°
66°
-175°
-170°
-165°
-160°
-155°
-150°


Abs. geost. velocity (cm/s) overlain by σθ (kg/m3)
CH20
CH19
CH18
CH17
CH21
CH22
CH23
CH24
0
10
20
30
40
50
60
25.6
25.8
25.7
25
ACC
0
50
100
Distance (km)
5.0 -2.5 0.0 2.5 5.0 7.5 10.0 12.5 15.0 17.5 20.0 22.5 25.0 27.5 30.0 32.5 35.0 37.5 40.0


Point Hope Section
72°
70°
68°
66°
-175°
-170°
-165°
-160°
-155°
-150°
Potential temperature (°C) overlain by salinity
Transmissivity (volts) overlain by salinity
Fluorescence (volts) overlain by salinity
CDOM (volts) overlain by salinity
Abs. geost. velocity (cm/s) overlain by σθ (kg/m3)
CH20 CH19 CH18 CH17 CH21 CH22 CH23 CH24
Depth (m)
Depth
Distance (km)
ACC
0 50 100
0 10 20 30 40 50 60
-1.90 -1.75 -1.70 -1.65 -1.60 -1.40 -1.20 -1.00 -0.80 -0.40 0.00 1.00 2.00 3.00 4.00 6.00 8.00
2.0 2.2 2.4 2.6 2.8 3.0 3.2 3.4 3.6 3.8 4.0 4.2 4.4 4.6 4.8 5.0 5.2 5.4 5.6
0.0 0.2 0.4 0.6 0.8 1.0 1.2 1.4 1.6 1.8 2.0 2.2 2.4 2.6 2.8 3.0 3.2 3.4 3.6
0.090 0.095 0.100 0.105 0.110 0.115 0.120 0.125 0.130 0.135 0.140 0.145 0.150 0.155 0.160 0.165 0.170 0.175 0.180
-5.0 -2.5 0.0 2.5 5.0 7.5 10.0 12.5 15.0 17.5 20.0 22.5 25.0 27.5 30.0 32.5 35.0 37.5 40.0


Point Hope Section
72°
70°
68°
66°
-175°
-170°
-165°
-160°
-155°
-150°
Nitrate (µm/l) overlain by salinity
Silicate (µm/l) overlain by salinity
Phosphate (µm/l) overlain by salinity
Oxygen (ml/l) overlain by salinity
Chlorophyll (µg/l) overlain by salinity
CH20 CH19 CH18 CH17 CH21 CH22 CH23 CH24
Depth (m)
Depth
Distance (km)
ACC
0 10 20 30 40 50 60
0 50 100
32
32.2
32.4
-0.5 0.5 1.0 2.0 3.0 4.0 5.0 6.0 7.0 8.0 9.0 10.0 11.0 12.0 13.0
1.0 2.0 3.0 4.0 5.0 7.5 10.0 15.0 20.0 25.0 30.0 35.0 40.0 45.0
0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0 1.1 1.2 1.3 1.4 1.5 1.6 1.7 1.8
1.800 8.25 8.50 8.75 9.00 9.25 9.50 9.75 10.00 10.25 10.50 10.75 11.00 11.25 11.50 11.75 12.00 13.00 14.00
0.50 -0.25 0.00 0.25 0.50 0.75 1.00 2.50 5.00 7.50 10.00 12.50 15.00 17.50 20.00 25.00 30.00 40.00 50.00

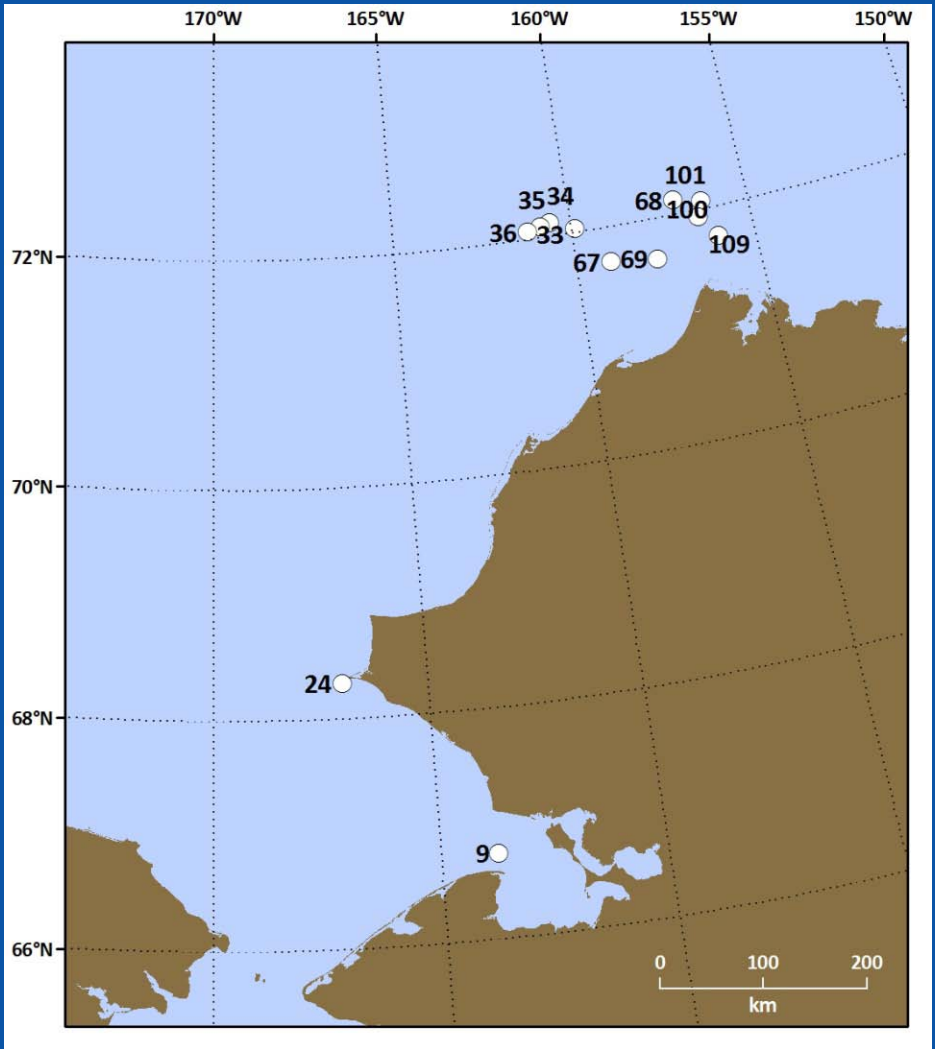
HLY1001: ICESCAPE

Biological, Chemical, Optical studies

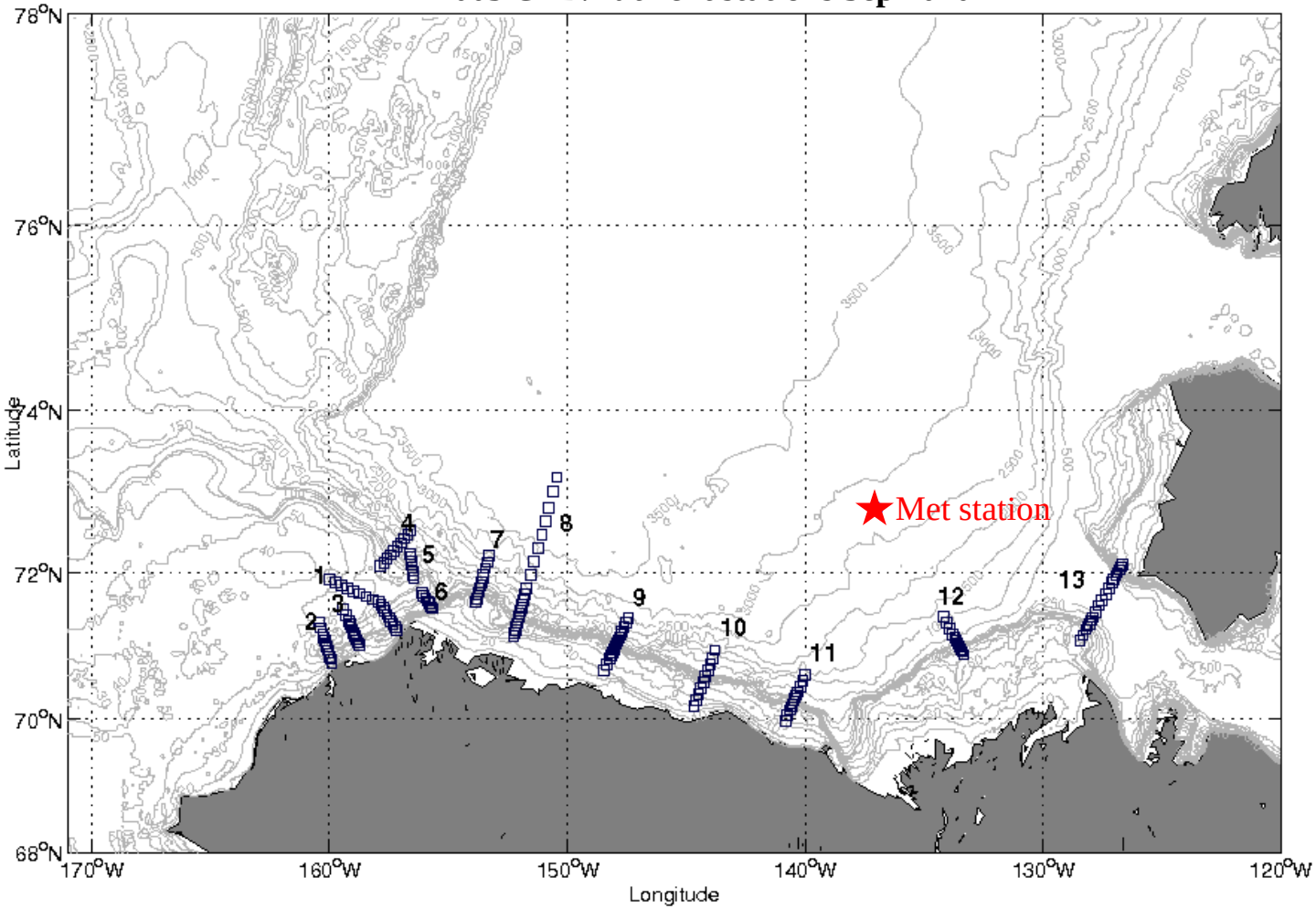
Nutrients
DIC and Alkalinity
Chlorophyll a
POC, POP, TPP, DOP, BSi, HPLC-pigments
Algal physiology bio-assay experiments
IOP and AOP (via small boat deployments)
Microplankton assemblage composition
aCDOM, TSM
Bacterial Production
CDOM absorption
Biogeochemical cycling of dissolved organic matter

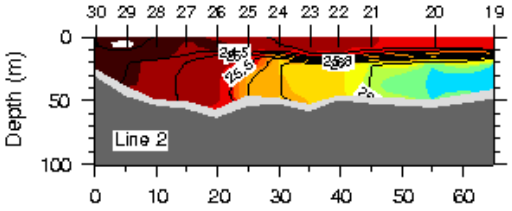
HLY1001: ICESCAPE

Ice Stations

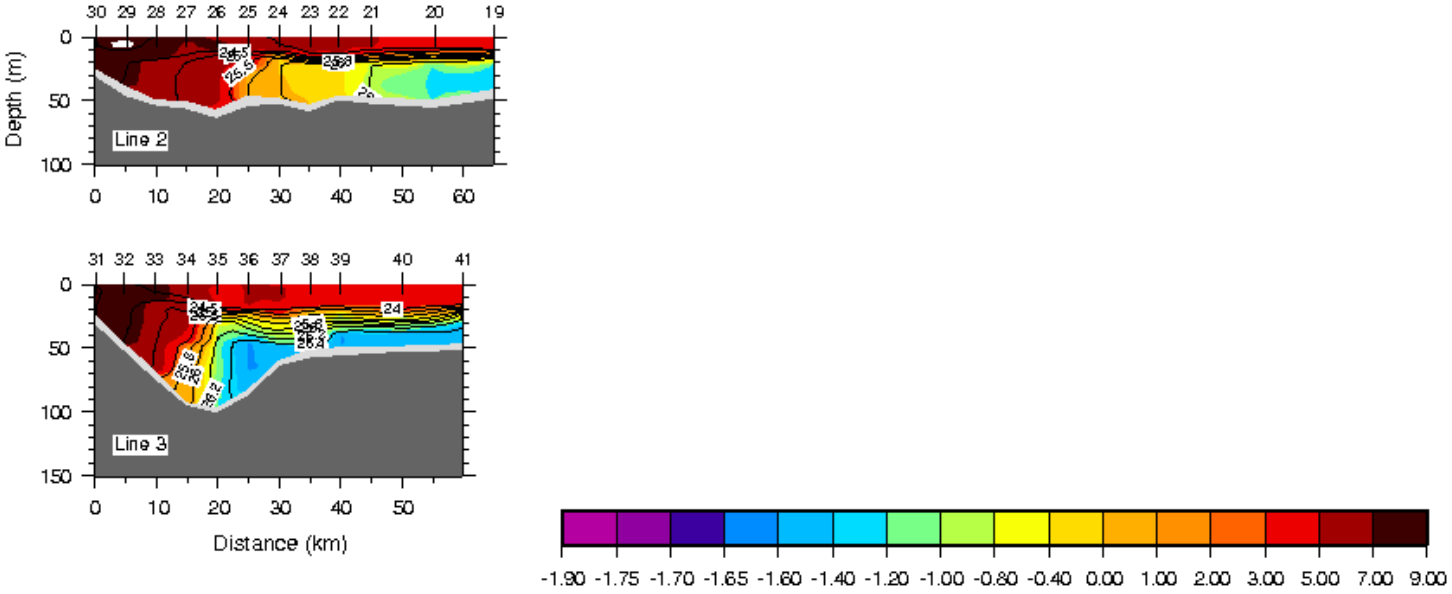


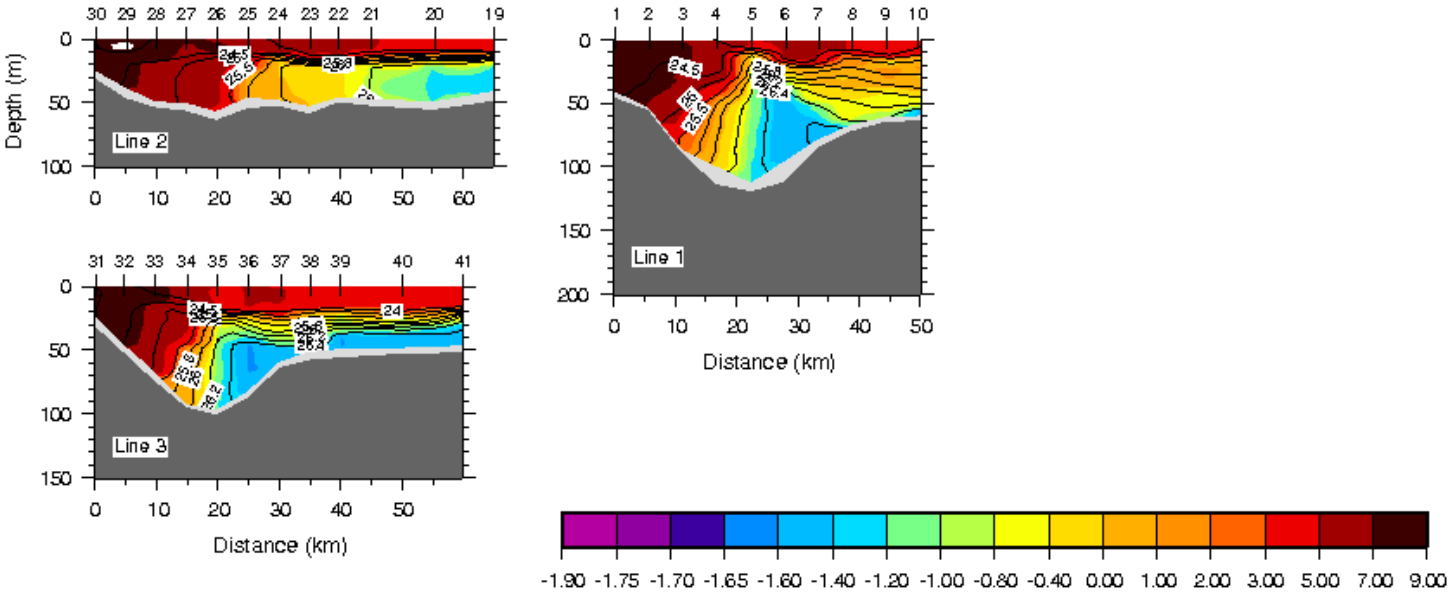
HLY1003: Arctic Observing Network *(Assessing the Western Arctic boundary current and its role in the Arctic ecosystem and climate change)*




30 29 28 27 26 25 24 23 22 21 20 19
0
50
100
Depth (m)
Line 2
0 10 20 30 40 50 60


-1.90 -1.75 -1.70 -1.65 -1.60 -1.40 -1.20 -1.00 -0.80 -0.40 0.00 1.00 2.00 3.00 5.00 7.00 9.00


30 29 28 27 26 25 24 23 22 21 20 19
0
50
100
Depth (m)
Line 2
0 10 20 30 40 50 60
31 32 33 34 35 36 37 38 39 40 41
0
50
100
150
Line 3
0 10 20 30 40 50
Distance (km)
-1.90 -1.75 -1.70 -1.65 -1.60 -1.40 -1.20 -1.00 -0.80 -0.40 0.00 1.00 2.00 3.00 5.00 7.00 9.00


Depth (m)
Line 2
Line 1
Line 3
Distance (km)
Distance (km)
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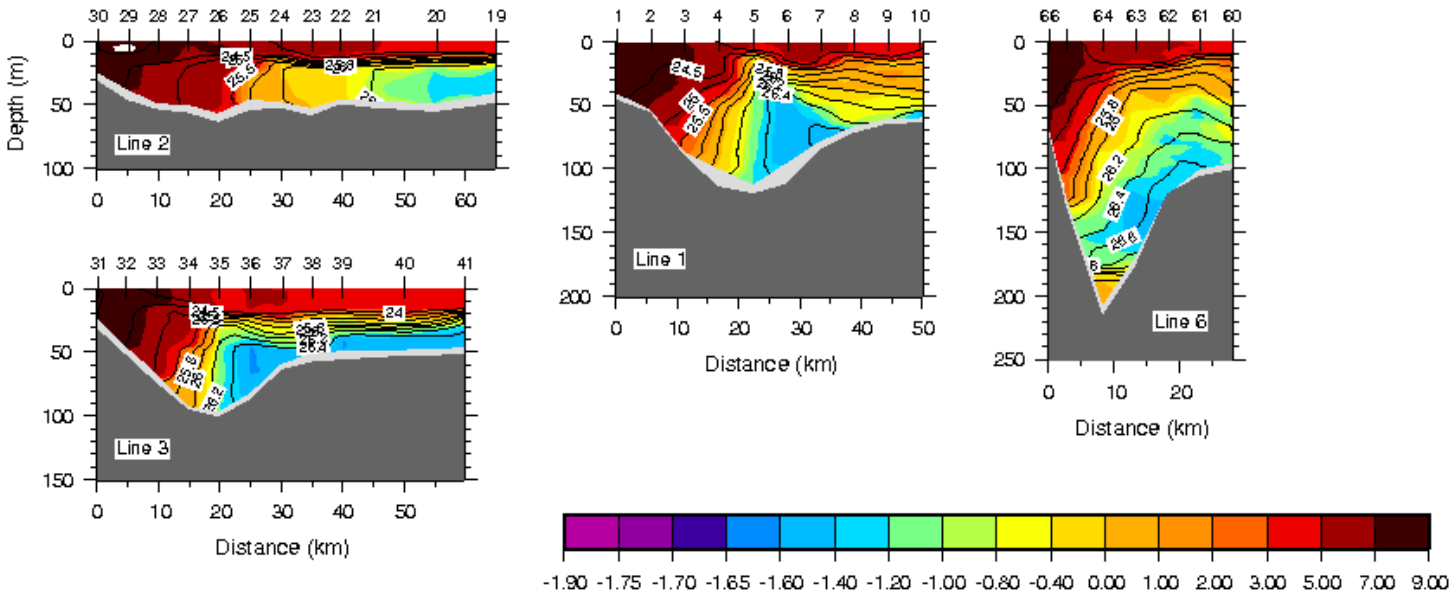
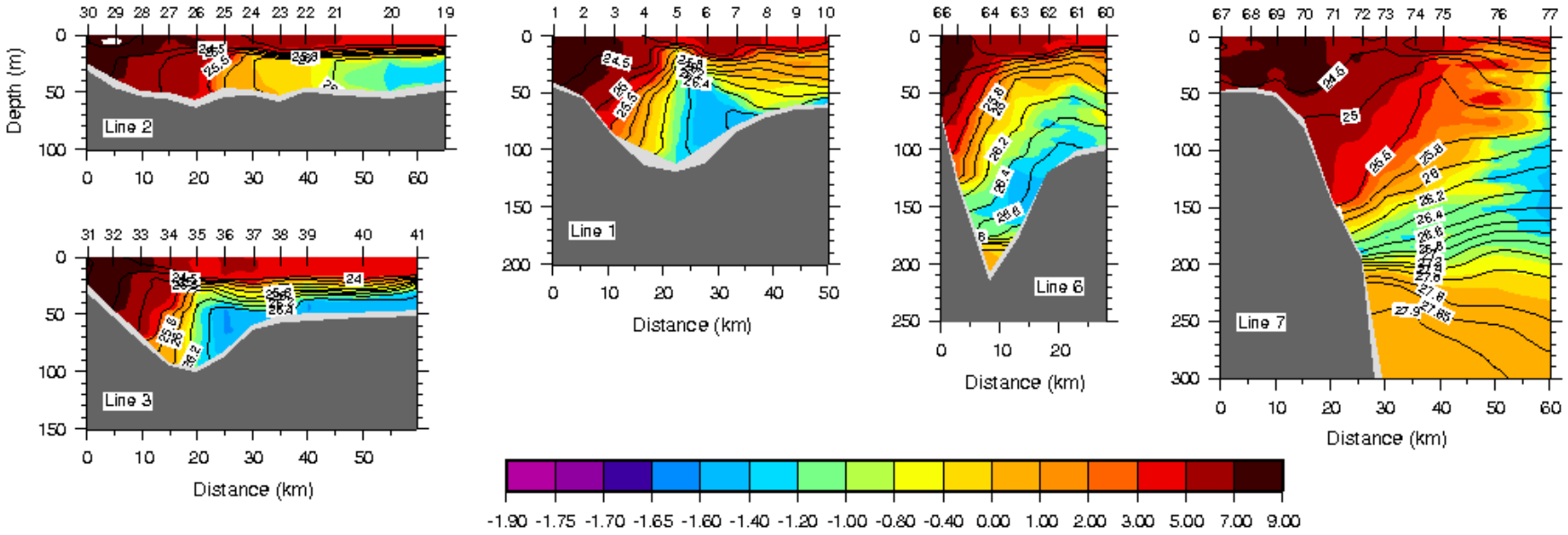

Depth (m)
Line 2
Line 1
Line 6
Line 3
Distance (km)
Distance (km)
Distance (km)
-1.90 -1.75 -1.70 -1.65 -1.60 -1.40 -1.20 -1.00 -0.80 -0.40 0.00 1.00 2.00 3.00 5.00 7.00 9.00


Depth (m)
Line 2
Line 1
Line 6
Line 7
Line 3
Distance (km)
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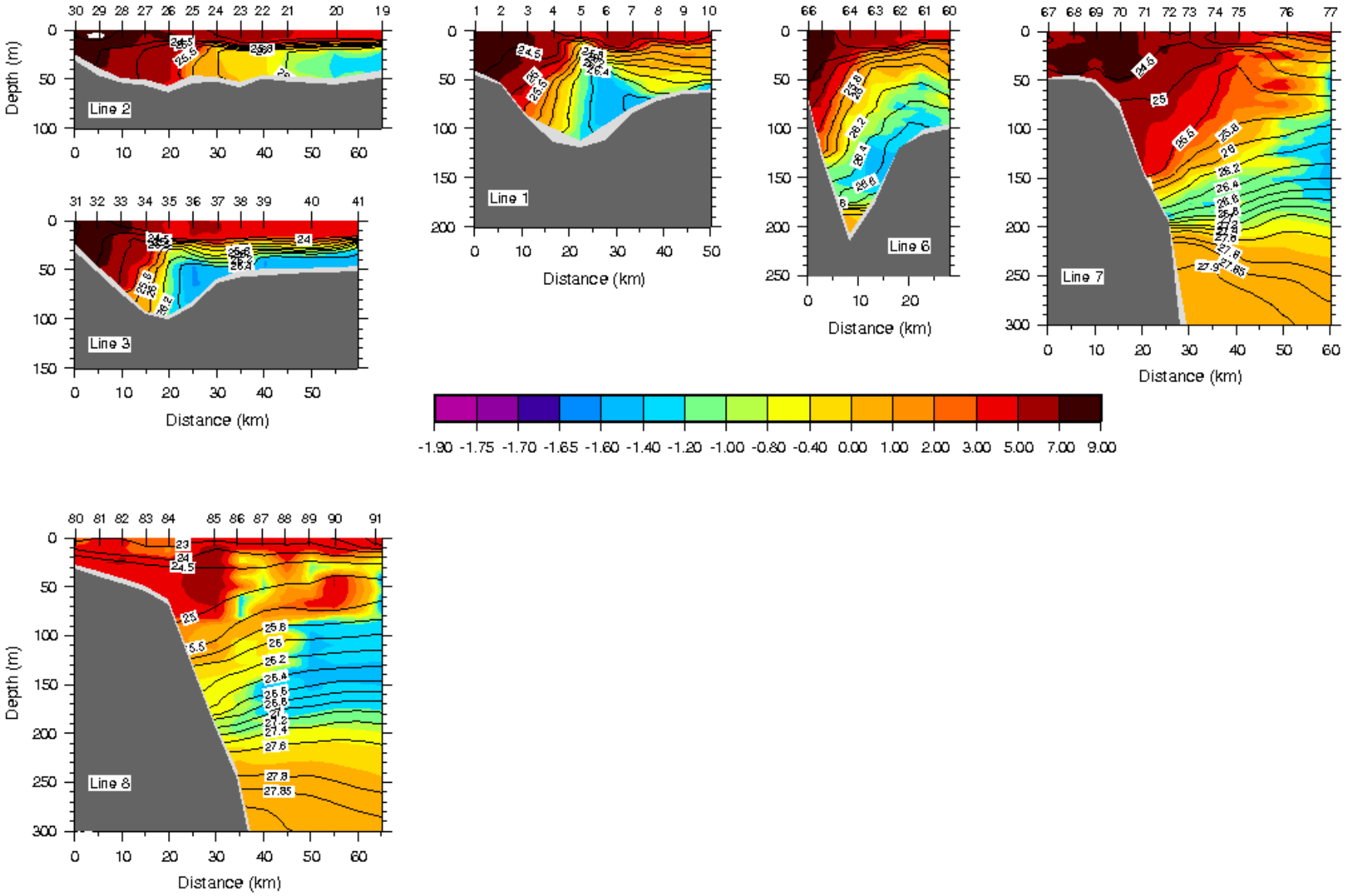
Line 2
Line 1
Line 6
Line 7
Line 3
Line 8
Depth (m)
Distance (km)
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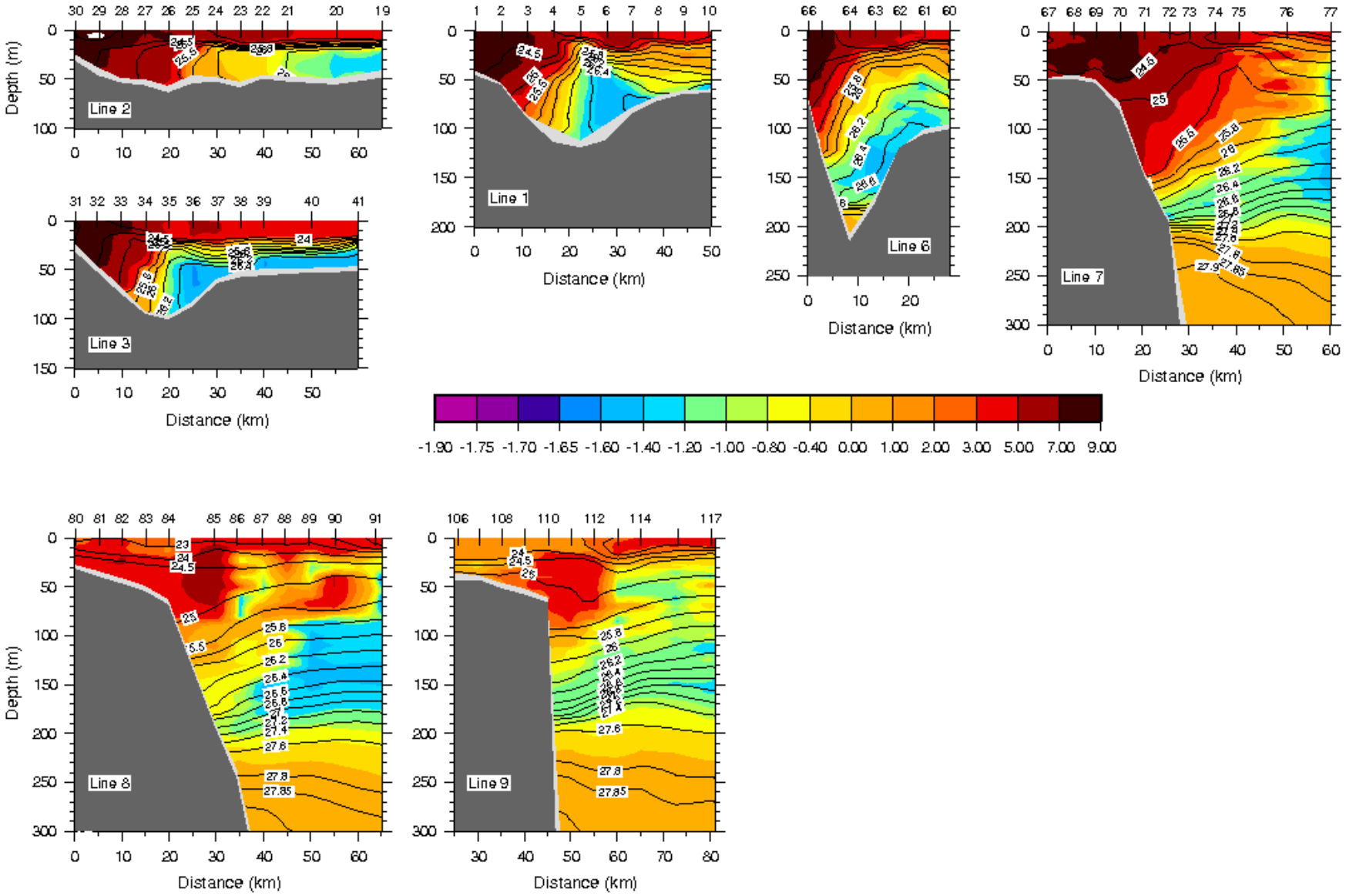
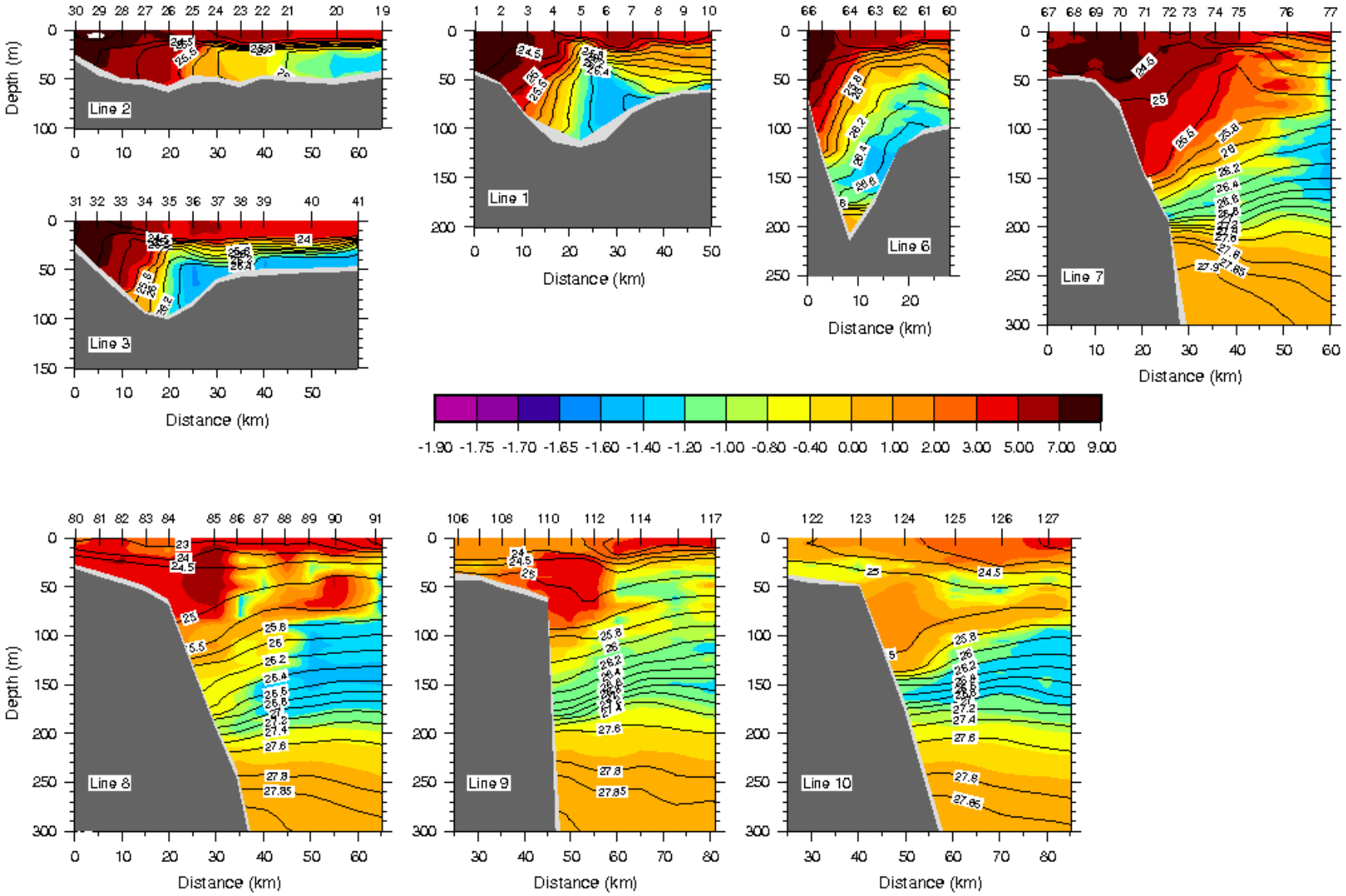
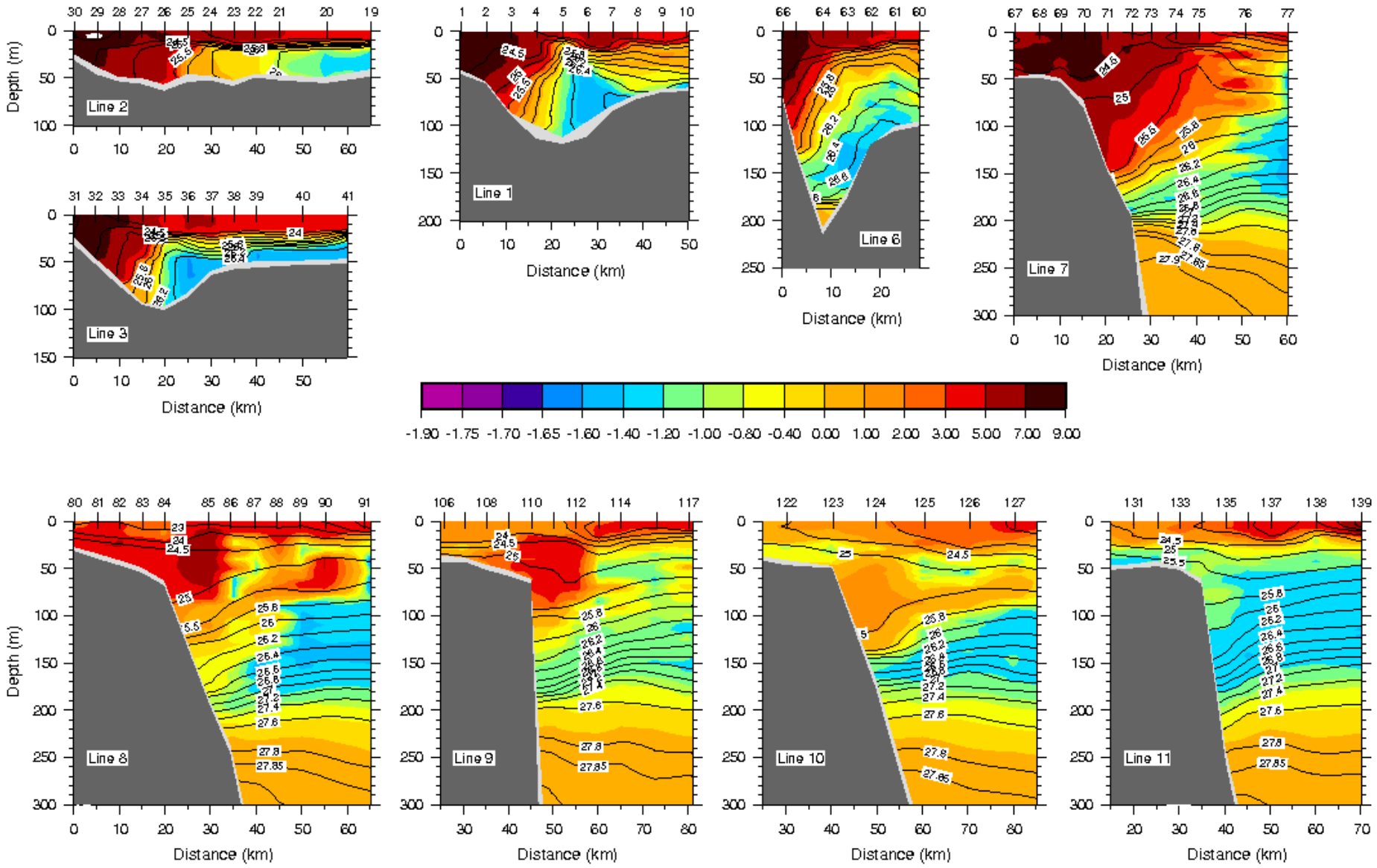

Depth (m)
Line 2
Line 1
Line 6
Line 7
Line 3
Distance (km)
-1.90 -1.75 -1.70 -1.65 -1.60 -1.40 -1.20 -1.00 -0.80 -0.40 0.00 1.00 2.00 3.00 5.00 7.00 9.00
Line 8
Line 9

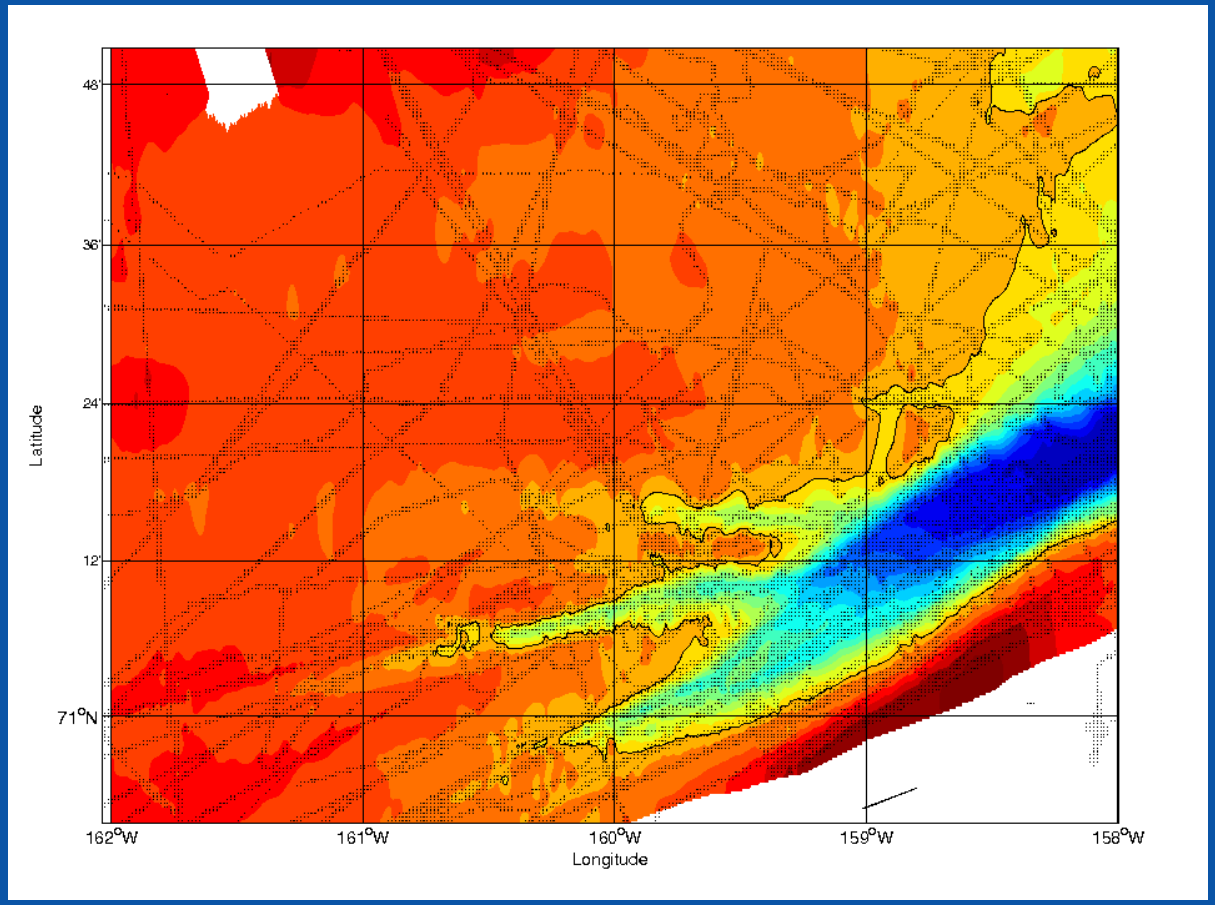

Depth (m)
Line 2
Line 1
Line 6
Line 7
Line 3
Distance (km)
-1.90 -1.75 -1.70 -1.65 -1.60 -1.40 -1.20 -1.00 -0.80 -0.40 0.00 1.00 2.00 3.00 5.00 7.00 9.00
Line 8
Line 9
Line 10


Depth (m)
Line 2
Line 1
Line 6
Line 7
Line 3
Distance (km)
-1.90 -1.75 -1.70 -1.65 -1.60 -1.40 -1.20 -1.00 -0.80 -0.40 0.00 1.00 2.00 3.00 5.00 7.00 9.00
Line 8
Line 9
Line 10
Line 11

Barrow Canyon 2010

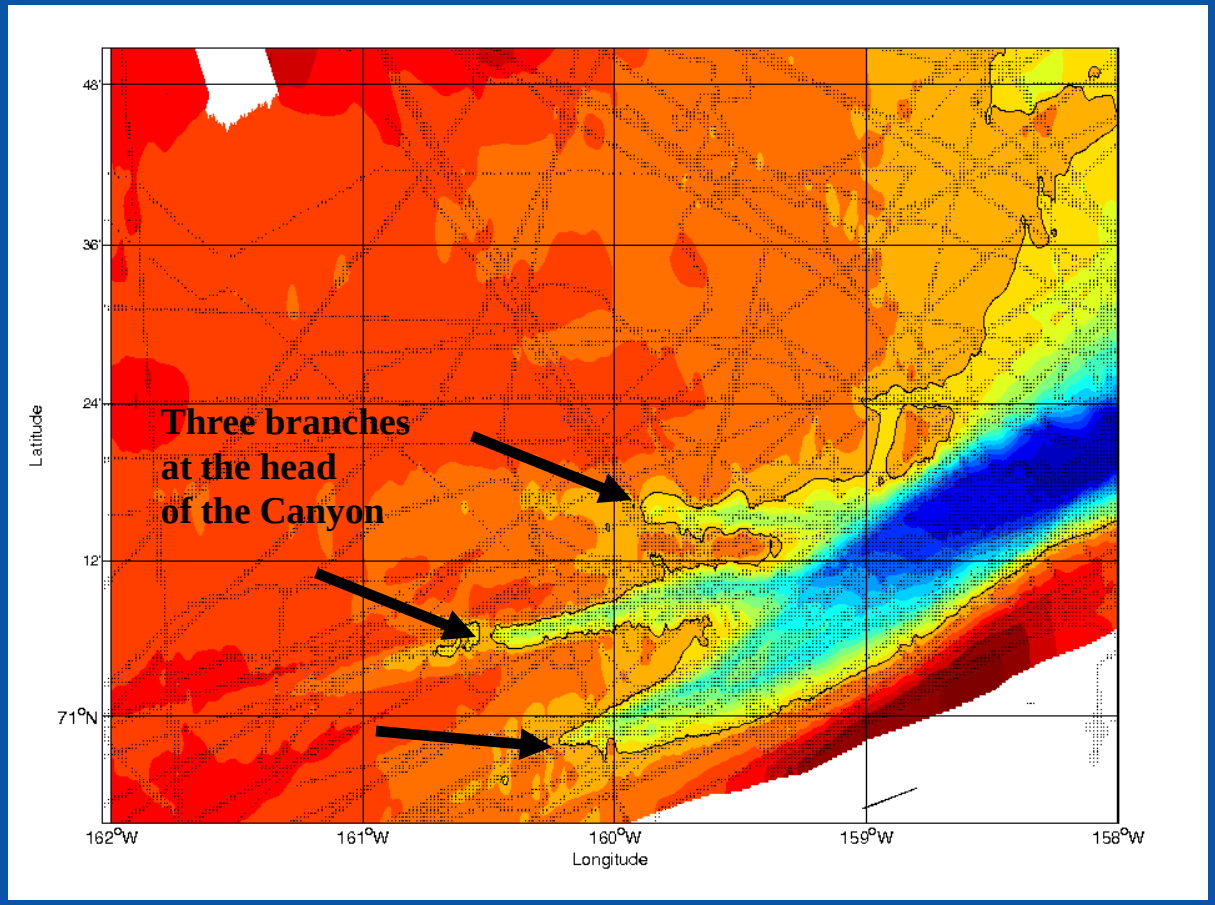
Barrow Canyon bathymetry

Multi-beam data up to September 2010



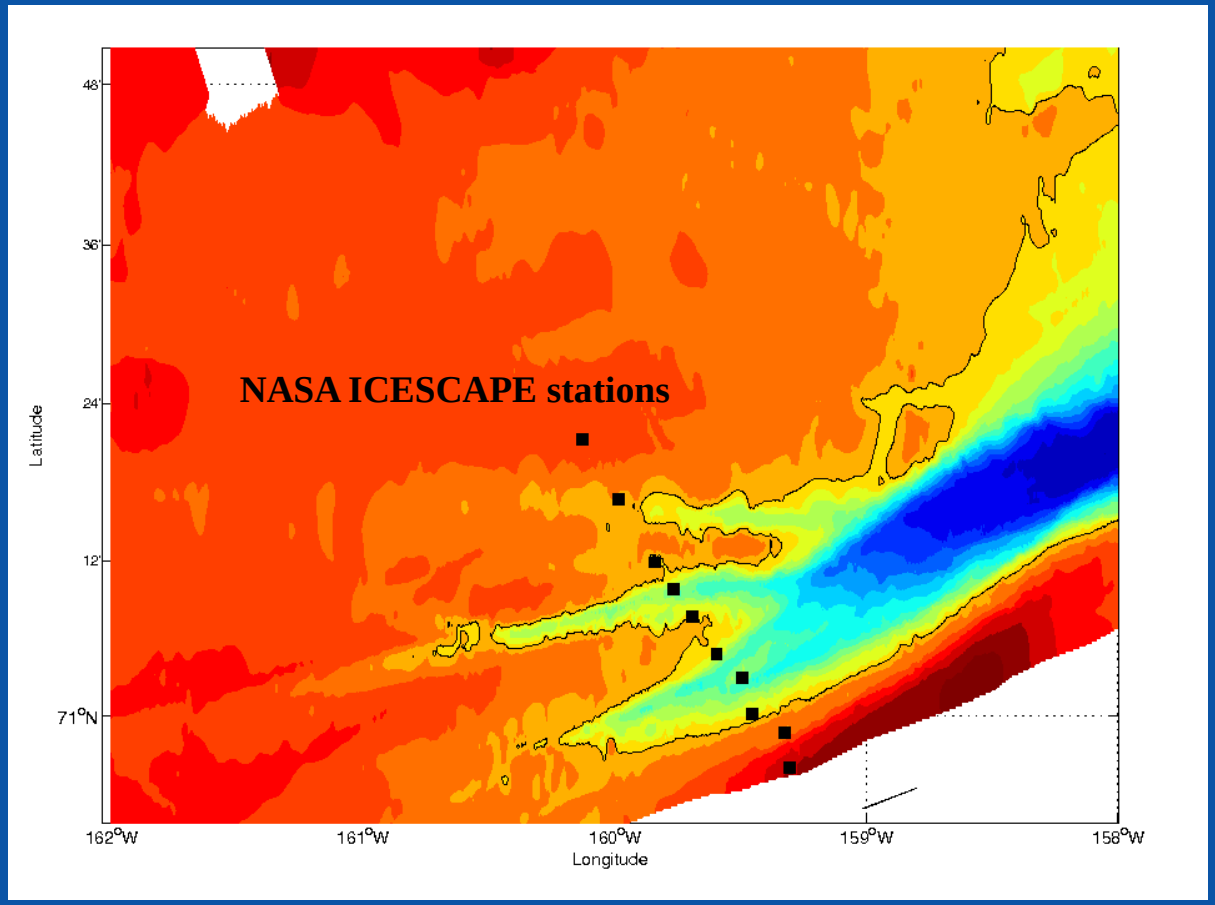
Barrow Canyon bathymetry

Multi-beam data up to September 2010



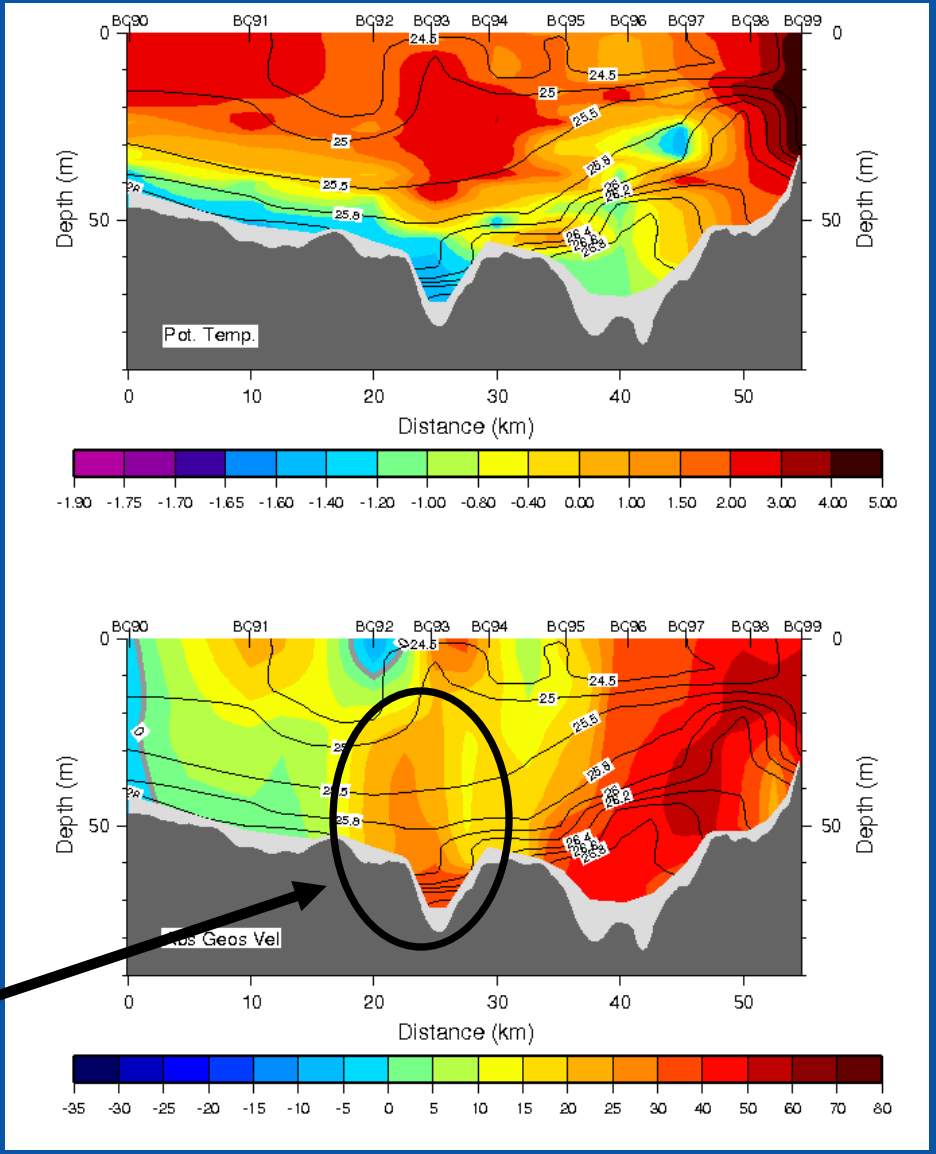
Barrow Canyon bathymetry

Multi-beam data up to September 2010



NASA hydrographic sections

Properties overlaid on density (contours, kgm^{-3})

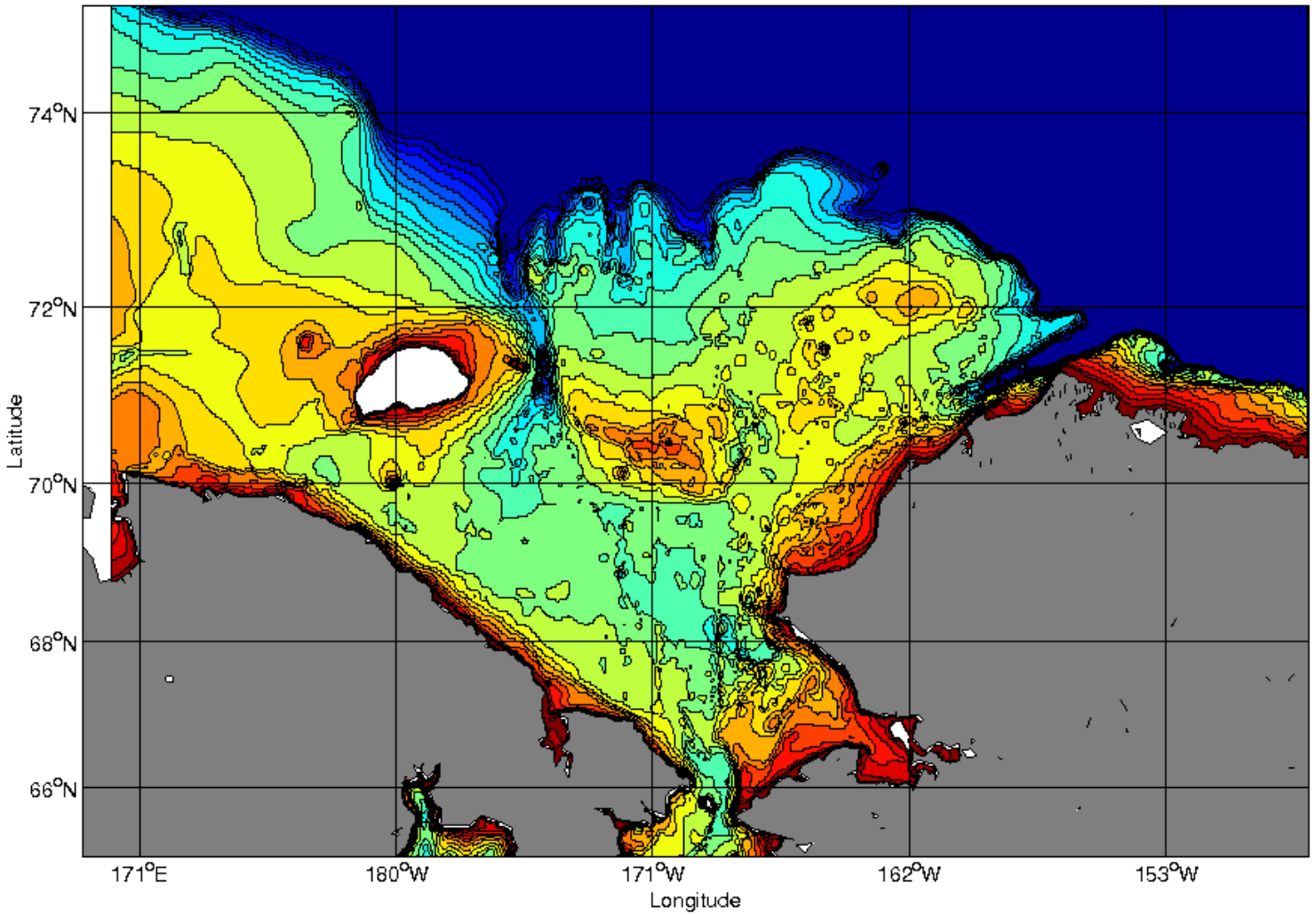


Potential temperature (°C)

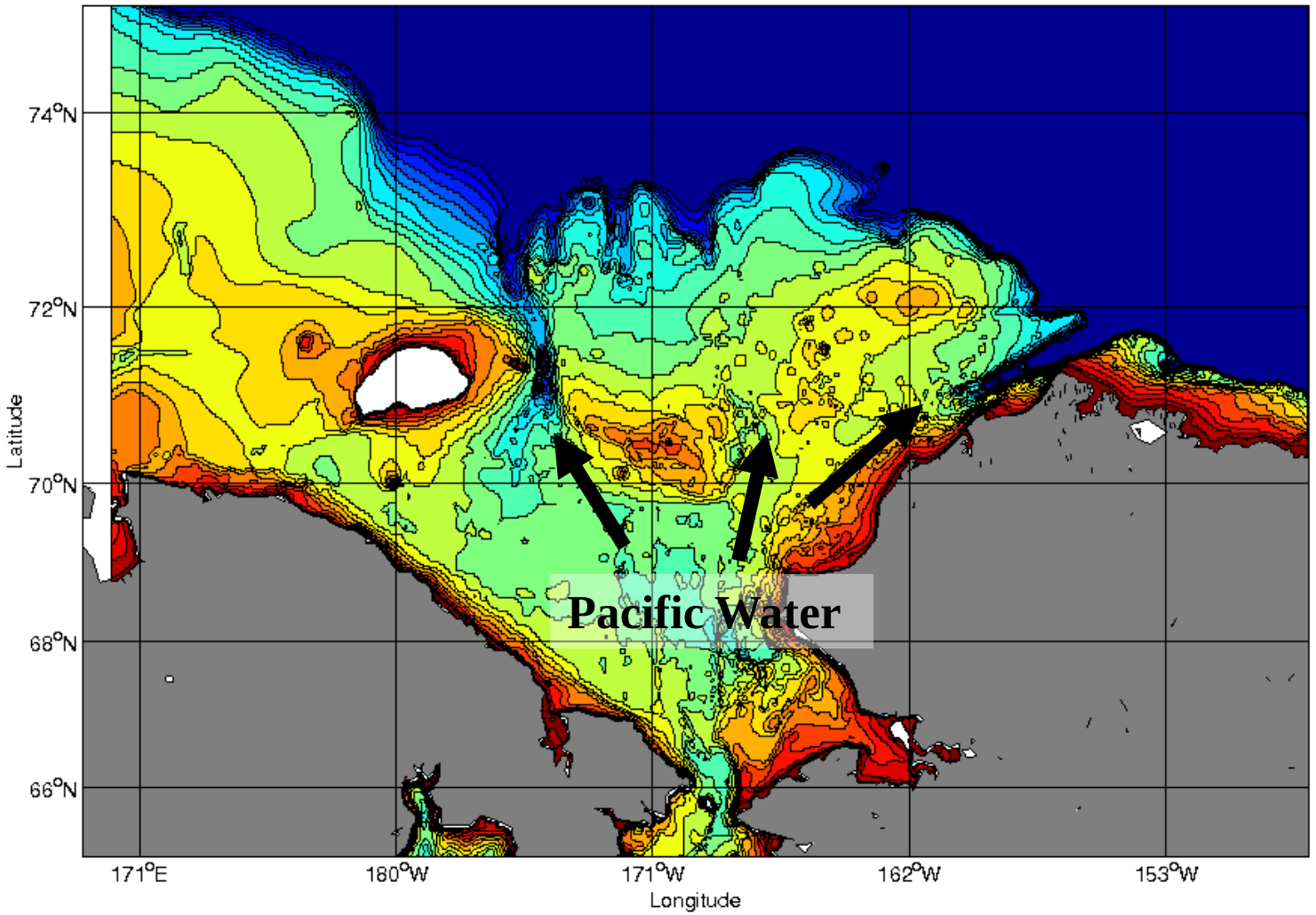
Absolute Geostrophic velocity (cm/s)

Jet advecting dense water at bottom of center branch

Pathways

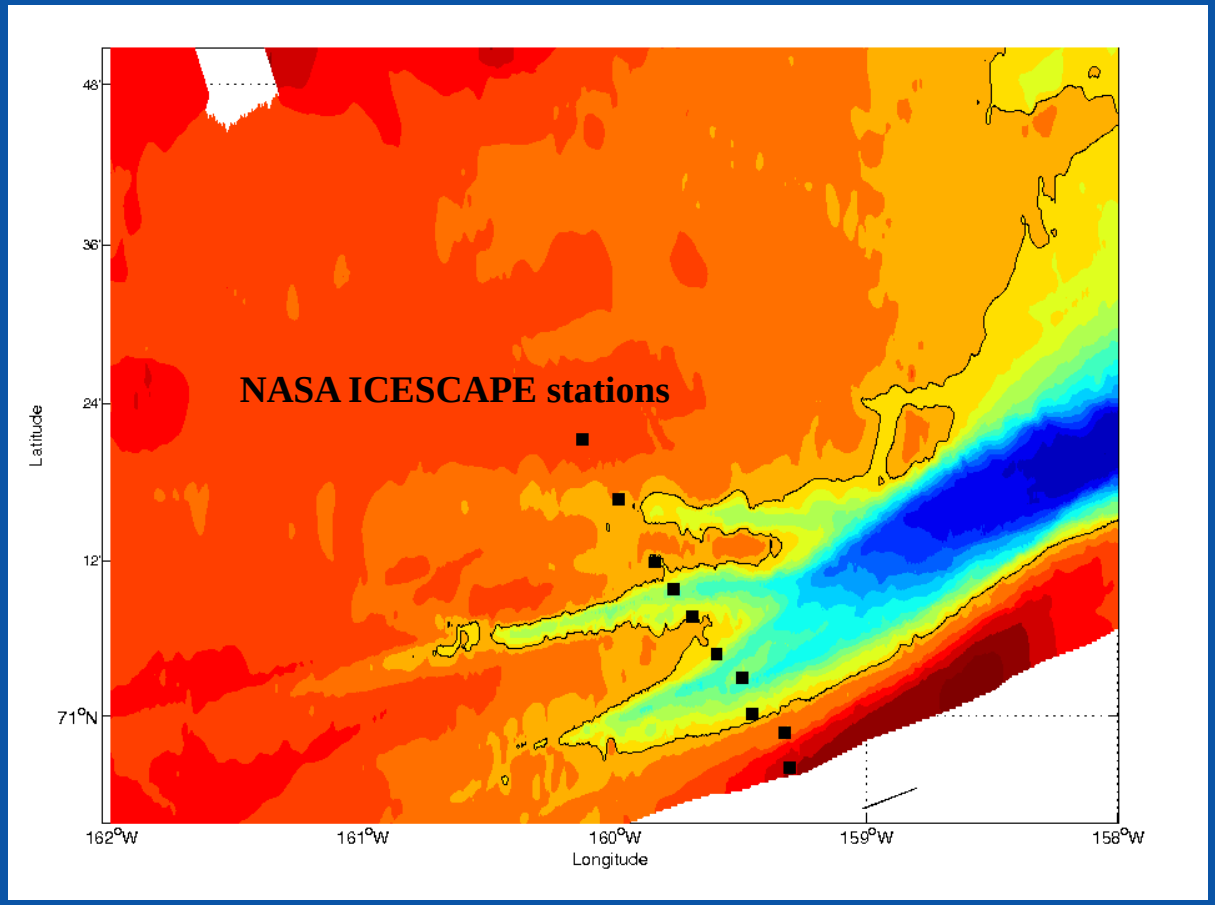

74°N
72°N
70°N
68°N
66°N
Latitude
171°E
180°W
171°W
162°W
153°W
Longitude

Pathways


74°N
72°N
70°N
68°N
66°N
Latitude
171°E
180°W
171°W
162°W
153°W
Longitude
Pacific Water

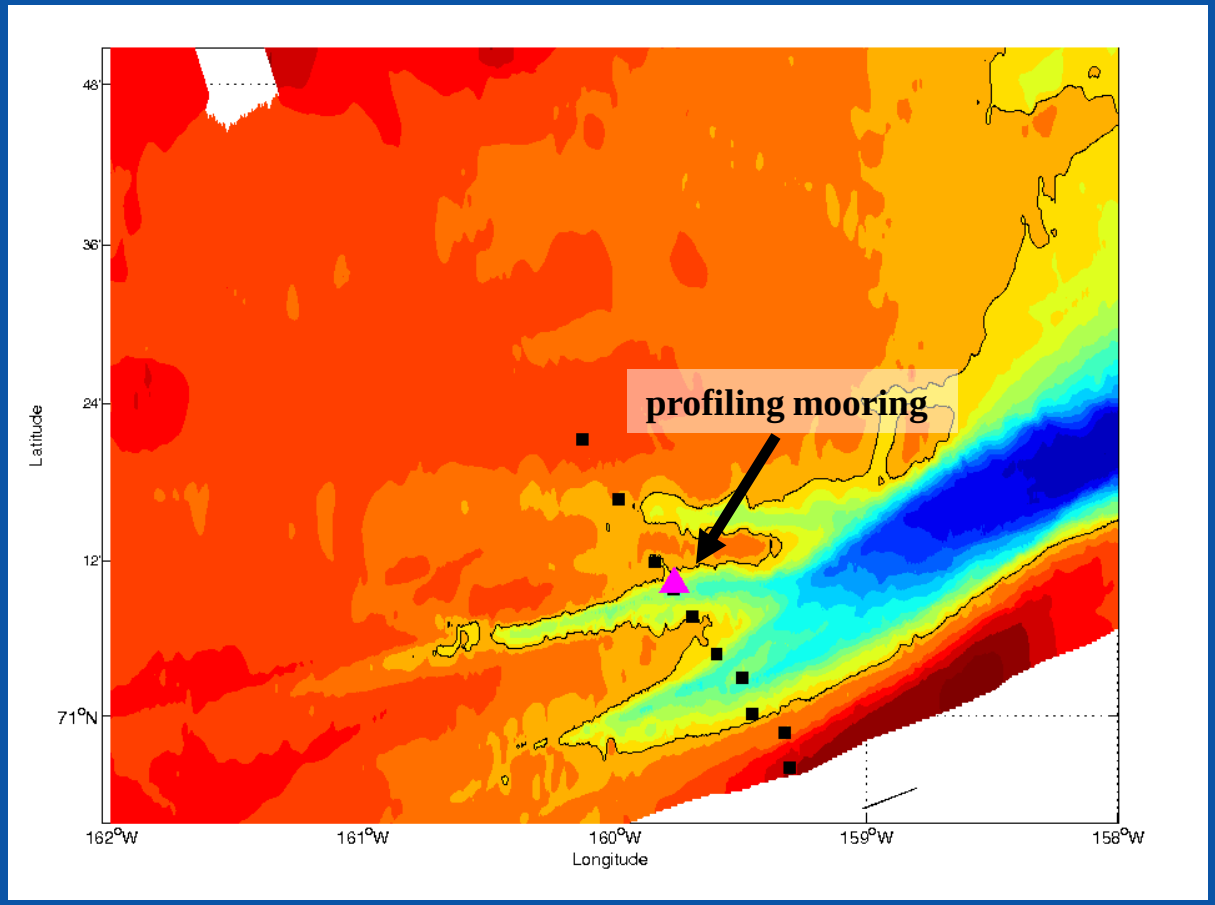
Barrow Canyon bathymetry

Multi-beam data up to September 2010



Barrow Canyon bathymetry

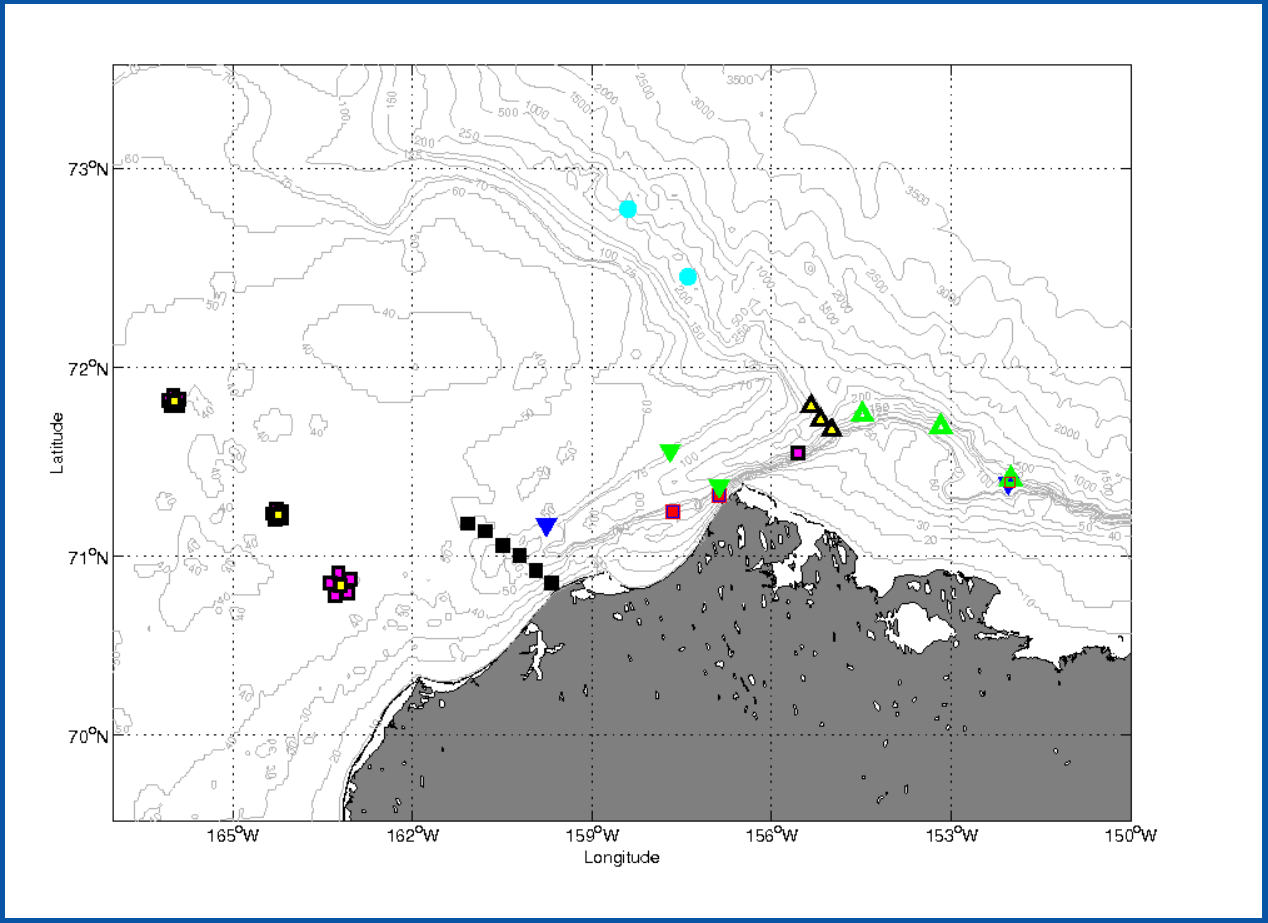
Multi-beam data up to September 2010



39 moorings deployed in vicinity of Barrow Canyon in summer 2010!

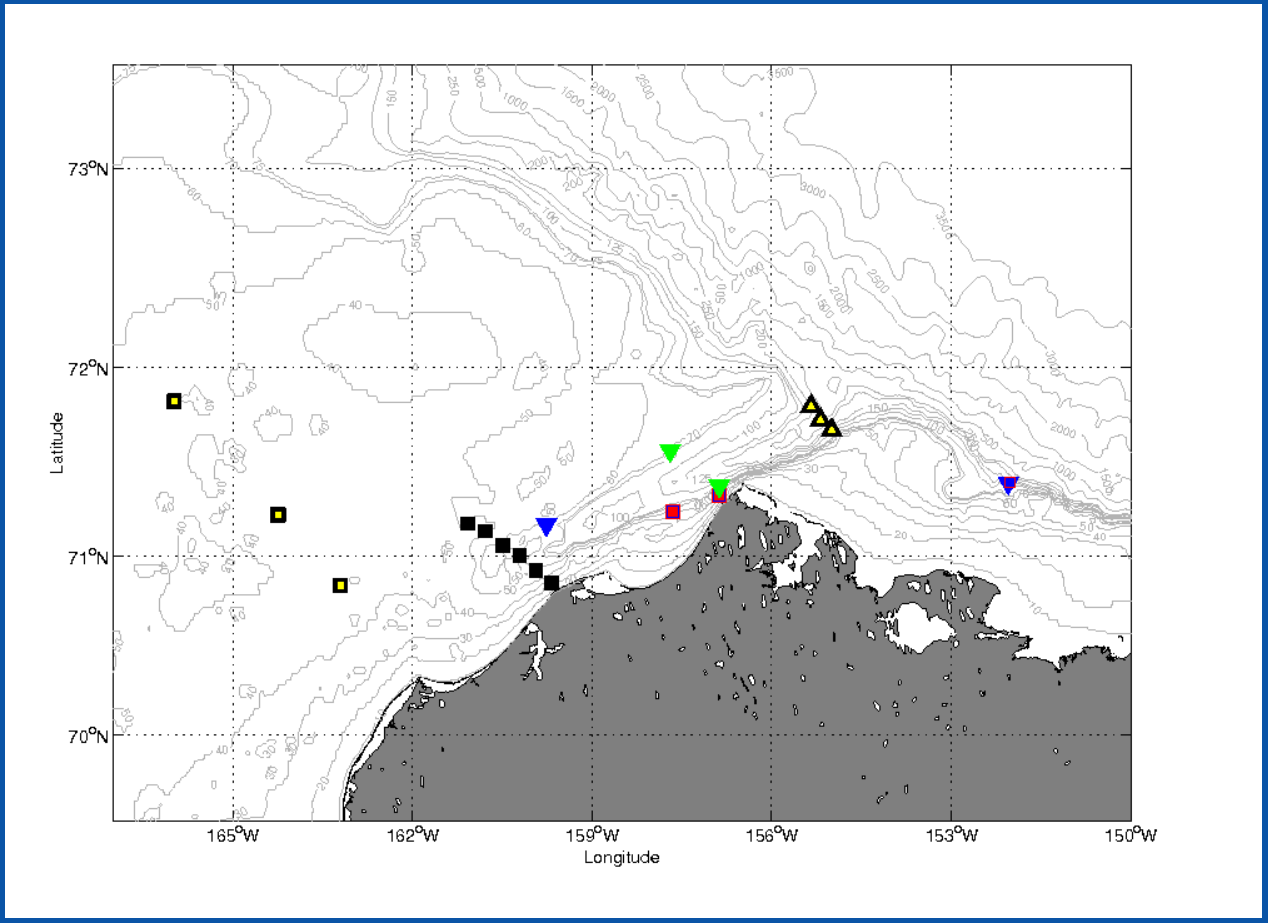
Institutions

Hokkaido University (SIZONet)
JAMSTEC
Univ. Alaska, Fairbanks (MMS)
WHOI (NSF-AON)
Univ. Washington (NSF-AON)
WHOI (Bowfest)
Univ. Washington (NOAA)
NOAA (CHAOZ)
SCRIPPS



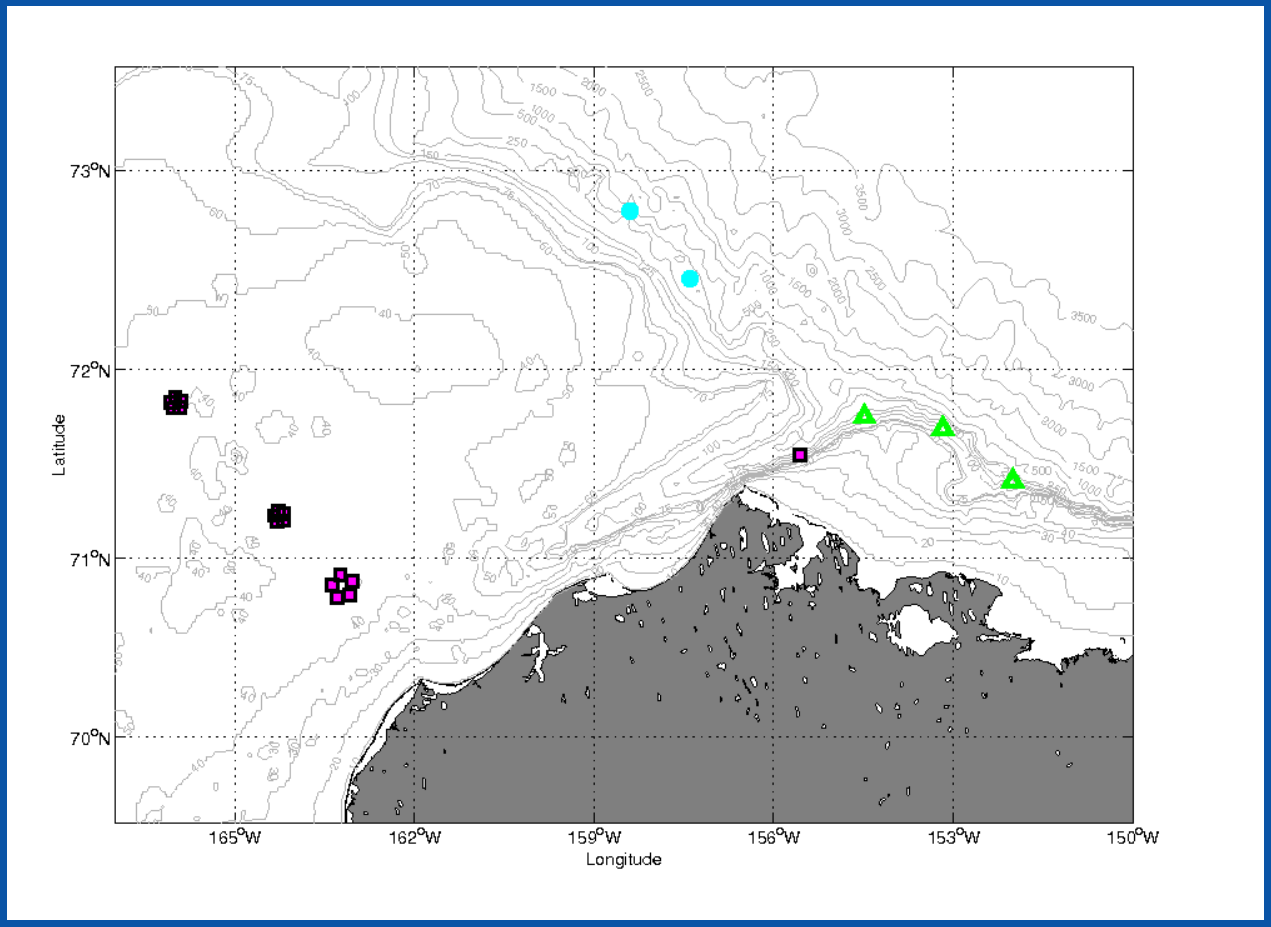
Moorings deployed in vicinity of Barrow Canyon in summer 2010

Physical/Chemical Moorings



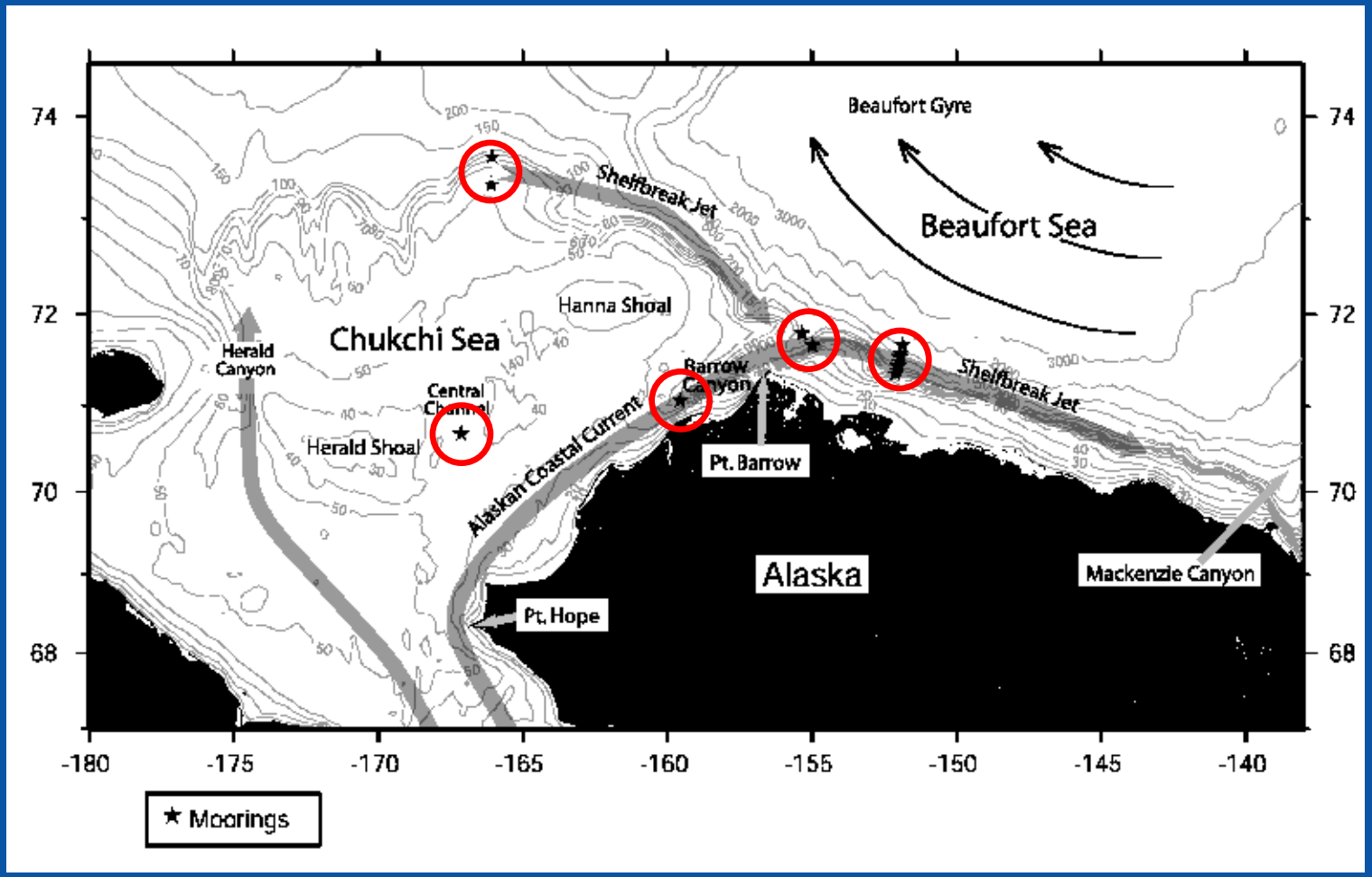
Moorings deployed in vicinity of Barrow Canyon in summer 2010

Marine Mammal Moorings

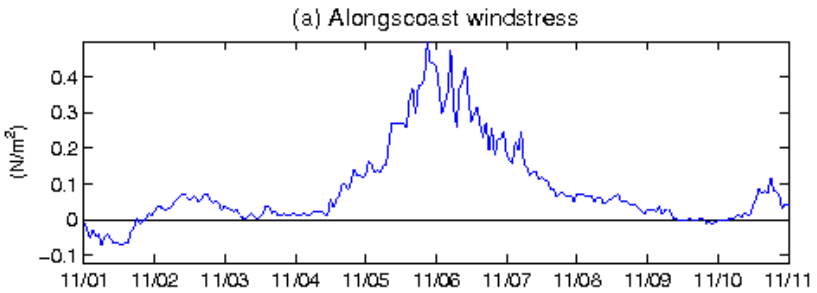


Example of synergy with moorings

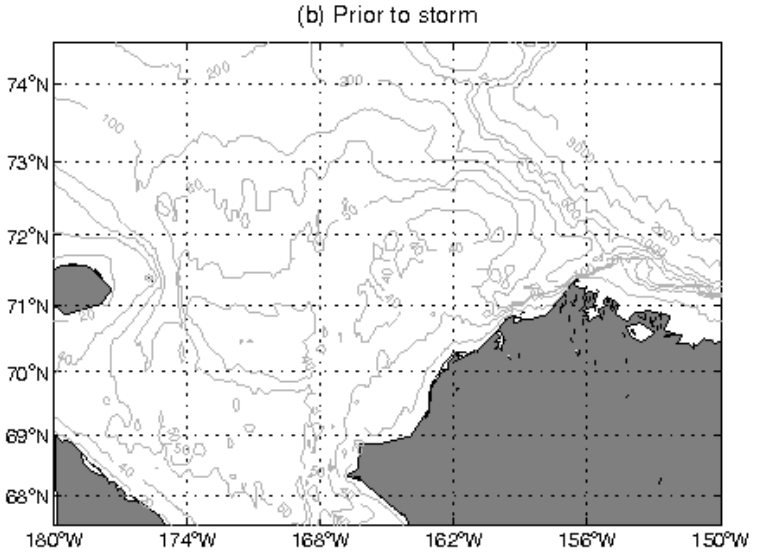
Five mooring arrays during 2002-4

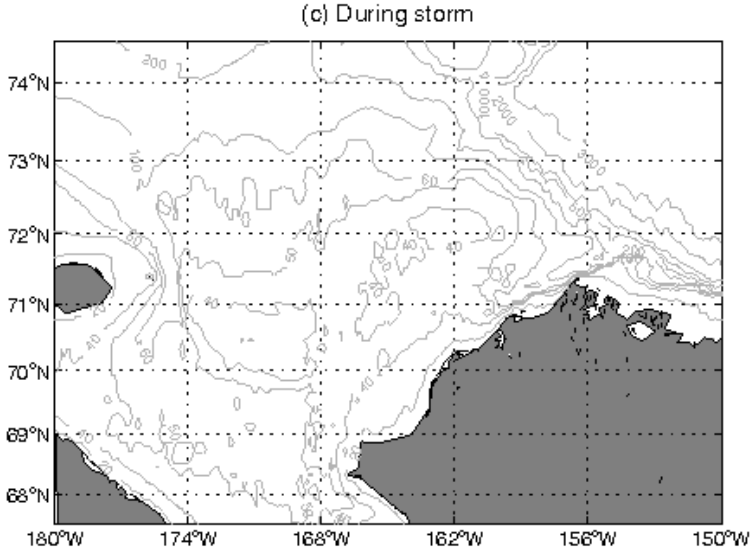


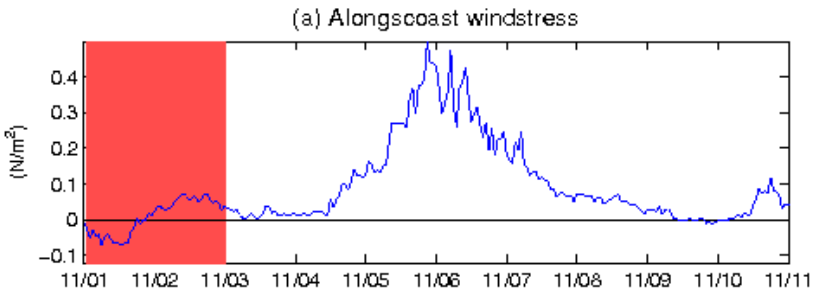
Storm Event in Nov 2002

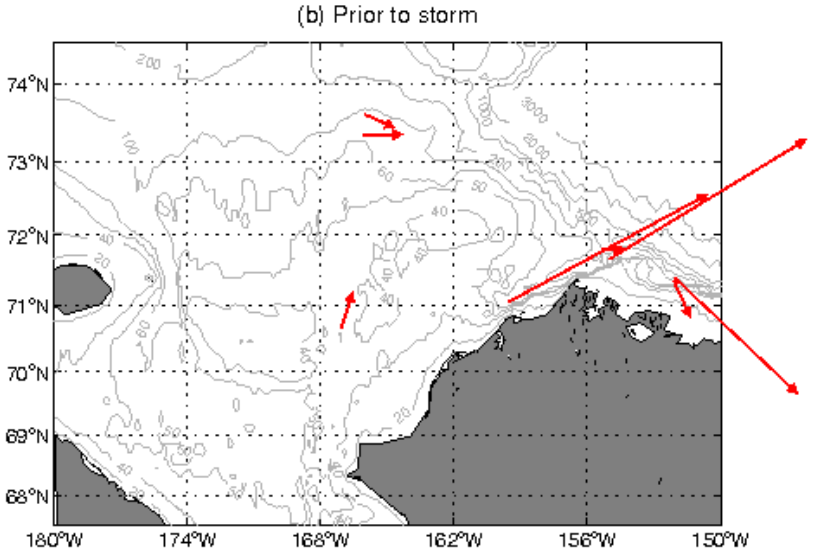


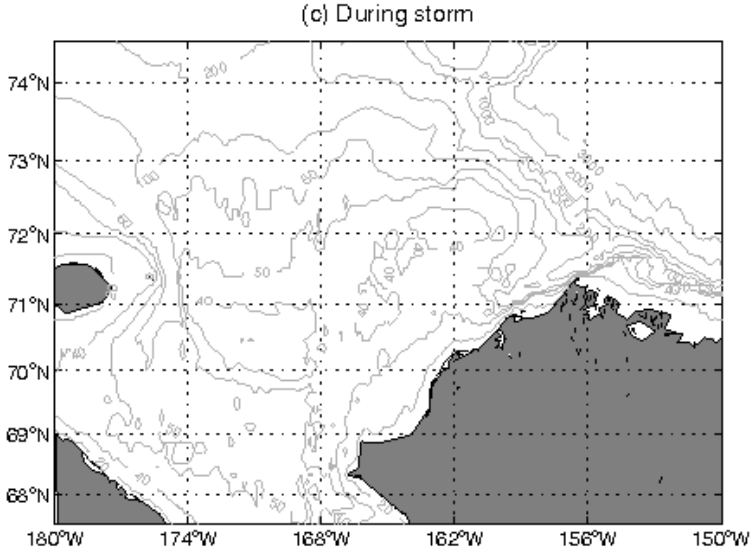
Pt. Barrow Winds



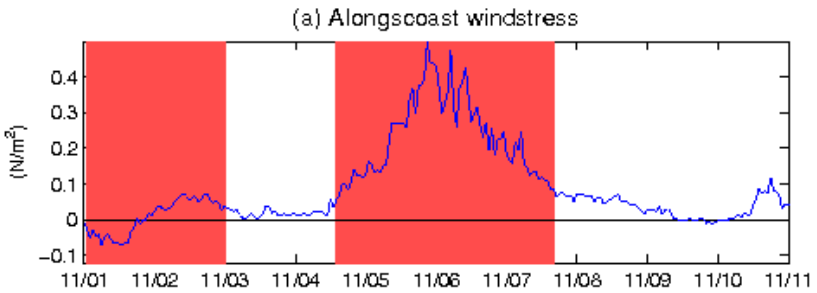


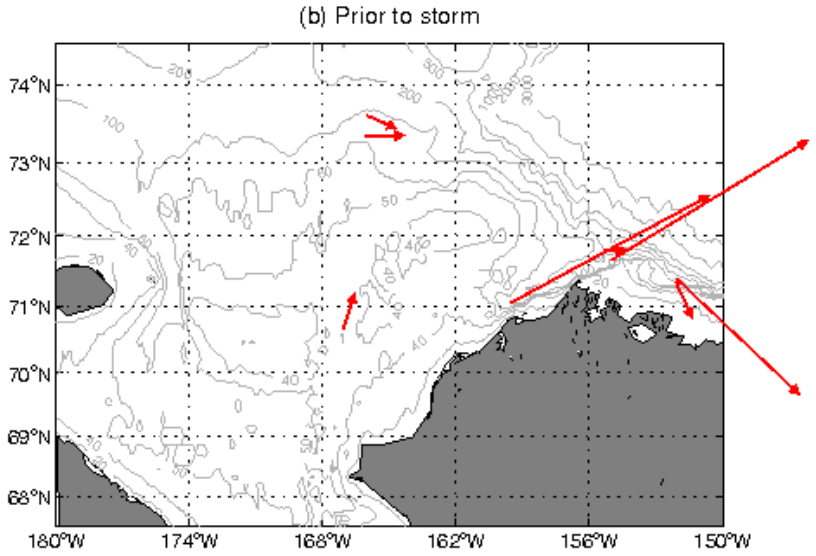


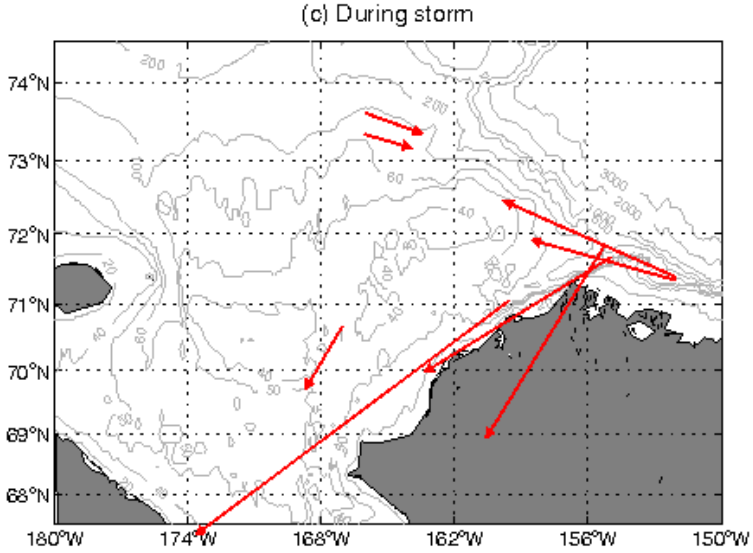




Pickart et al. (2010)





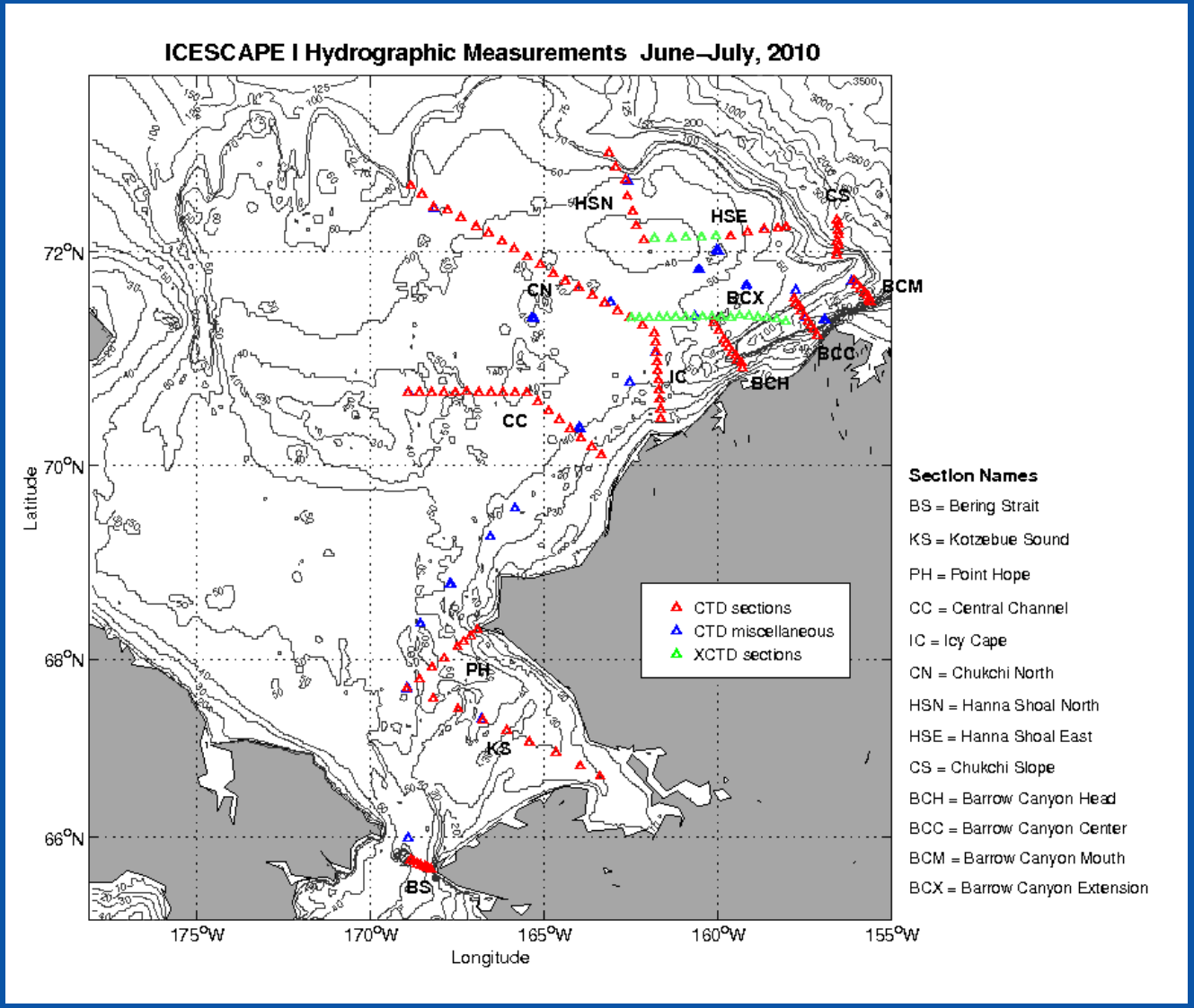


Pickart et al. (2010)

Thoughts for 2011

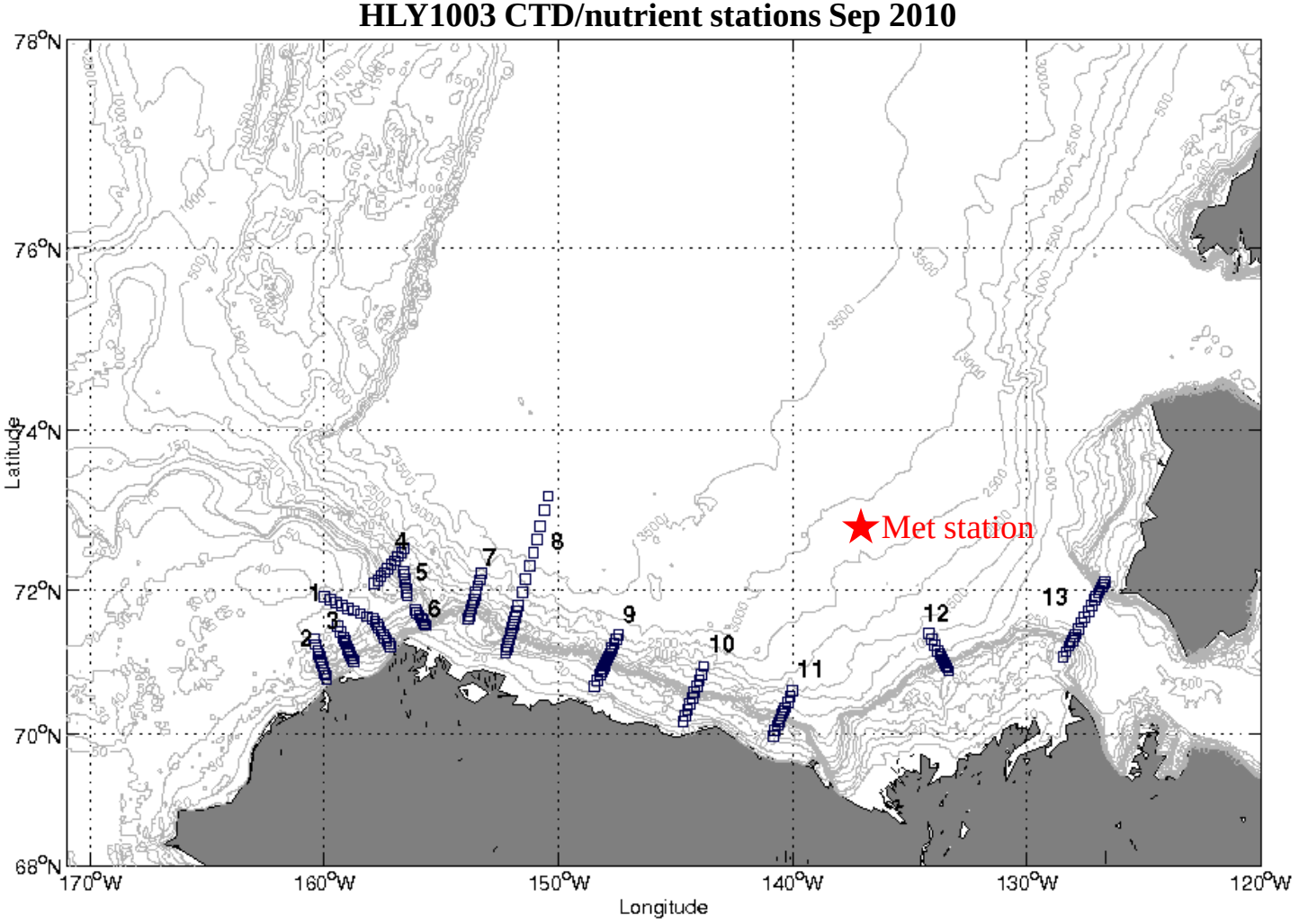
HLY1101 ICESCAPE *(Impacts of climate on ecosystems and chemistry of the Arctic Pacific environment)*

HLY1101 ICESCAPE *(Impacts of climate on ecosystems and chemistry of the Arctic Pacific environment)*

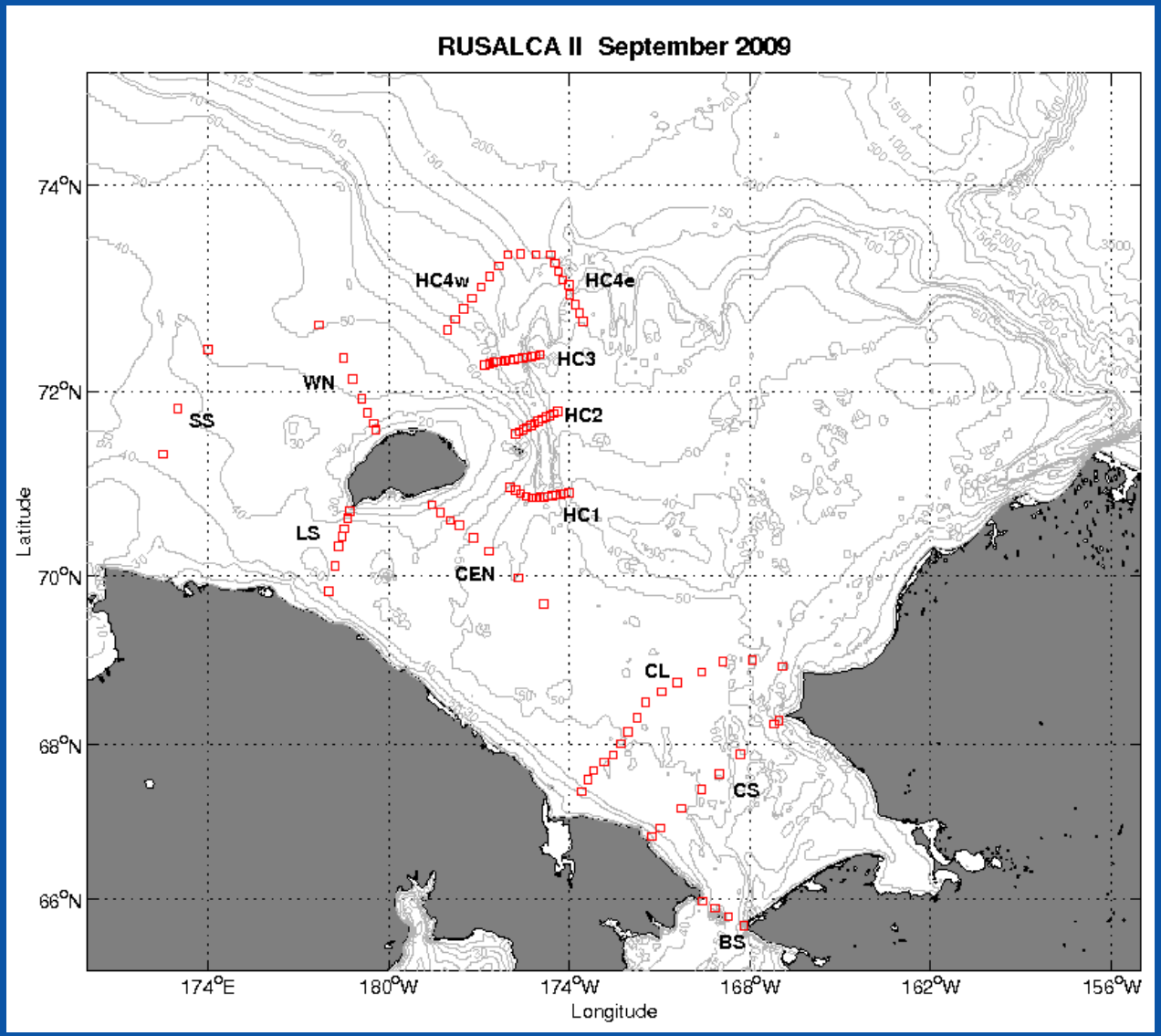


HLY1103 Arctic Observing Network *(Assessing the Western Arctic boundary current and its role in the Arctic ecosystem and climate change)*

HLY1103 Arctic Observing Network *(Assessing the Western Arctic boundary current and its role in the Arctic ecosystem and climate change)*

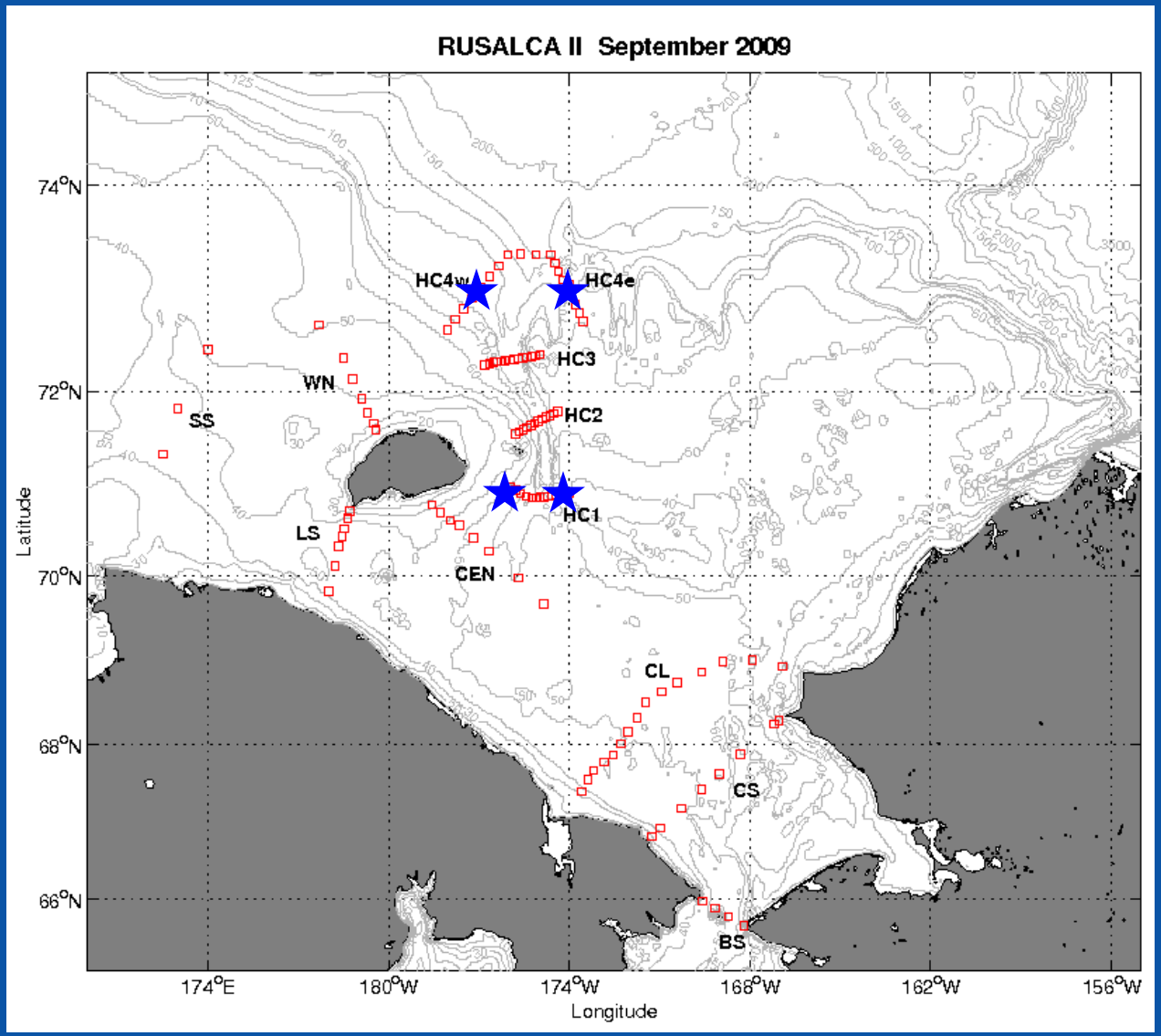


RUSALCA 2012



RUSALCA 2012

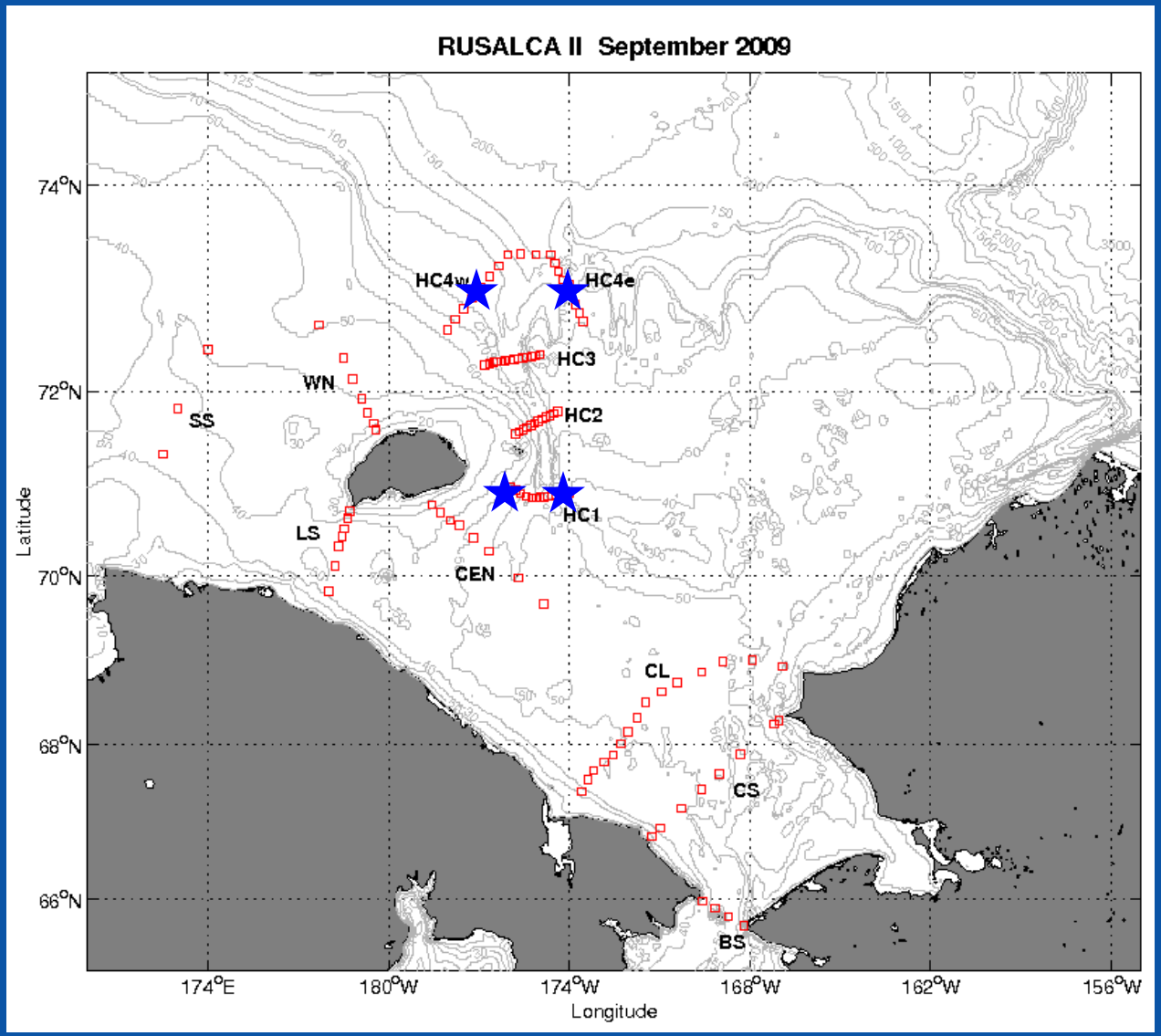
Possible Mooring Locations



RUSALCA 2012

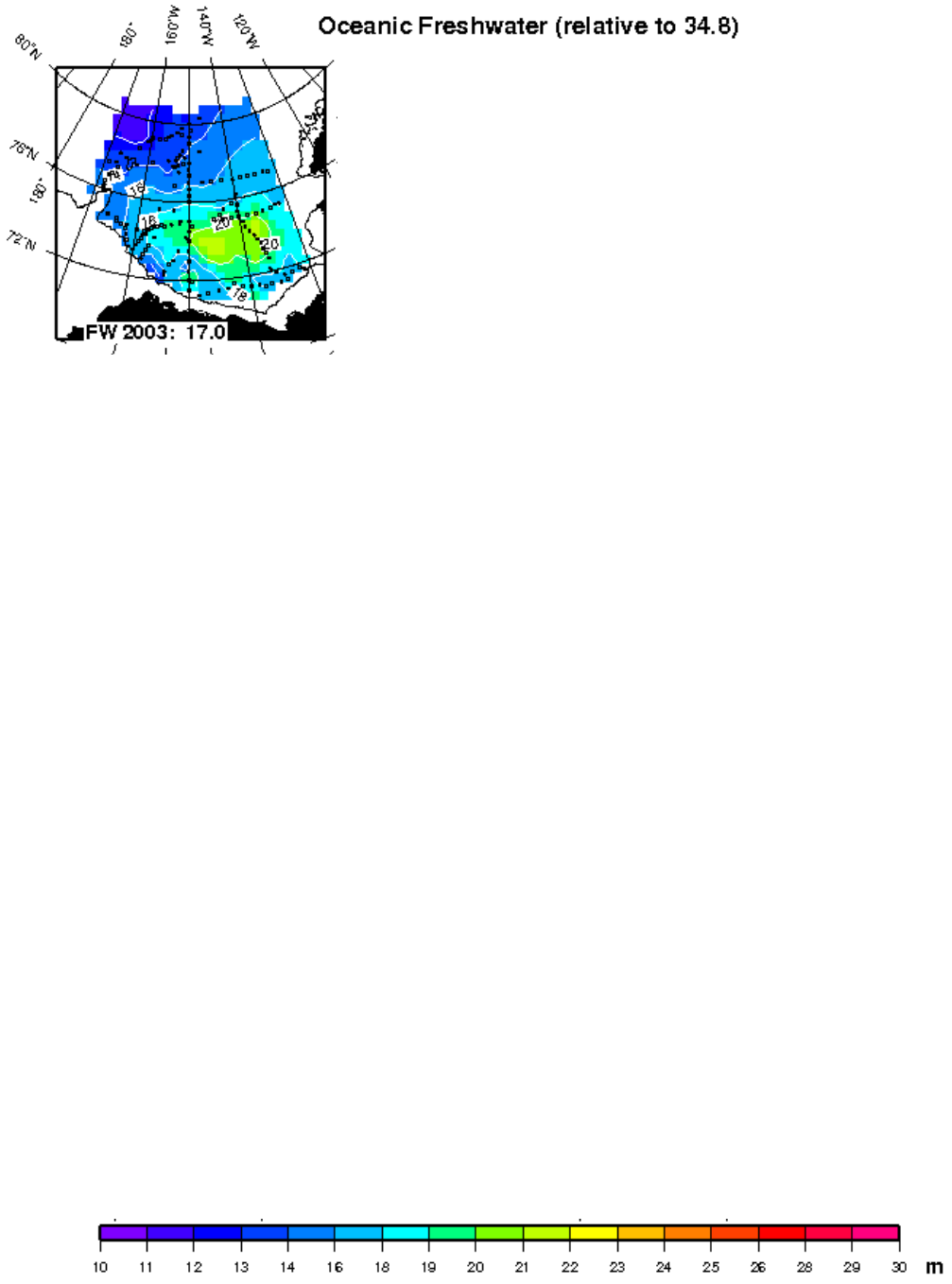
Possible Mooring Locations

Need recovery platform in summer 2013

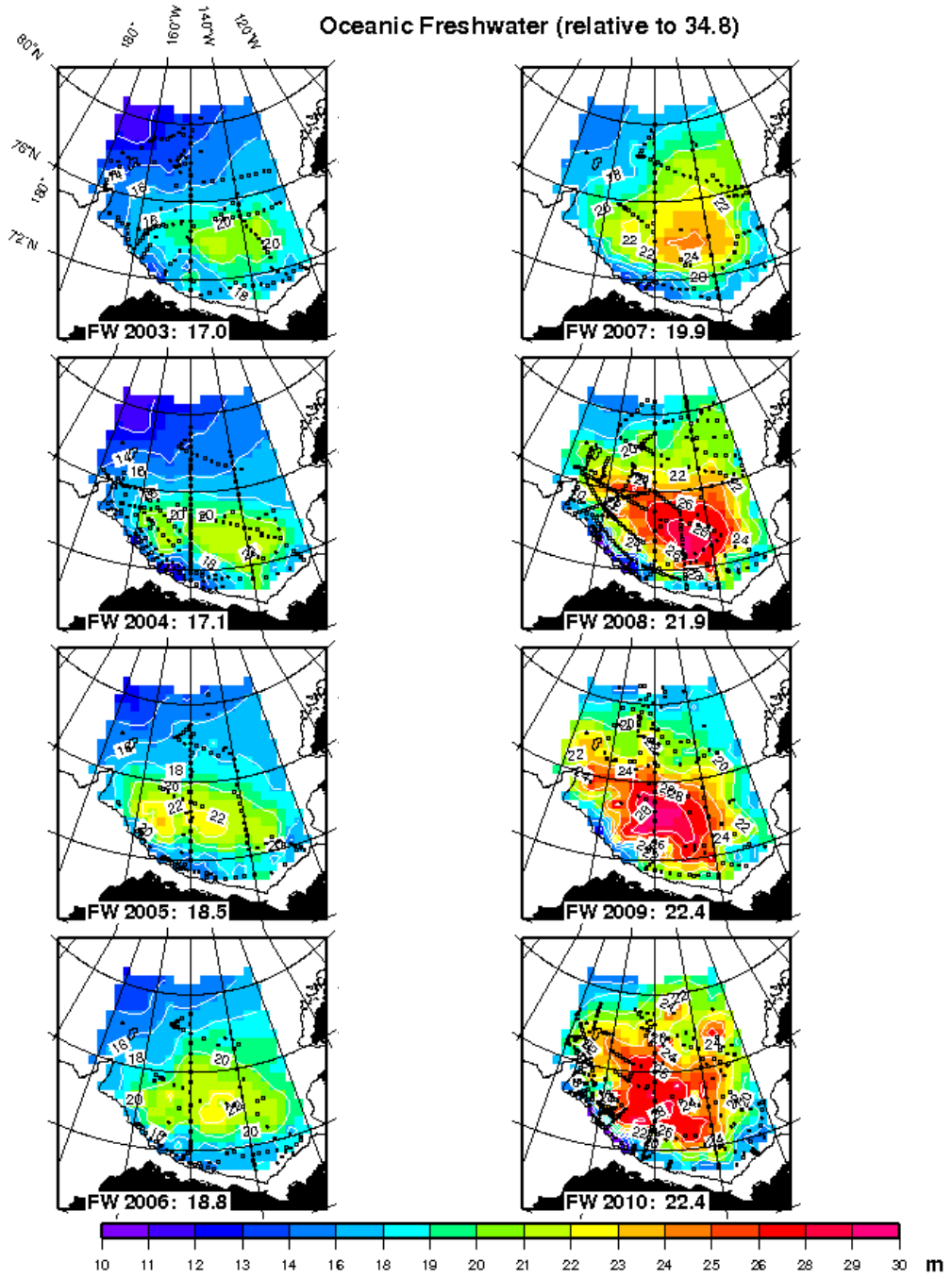


DBO Barrow Canyon Line
Pilot Study 2010

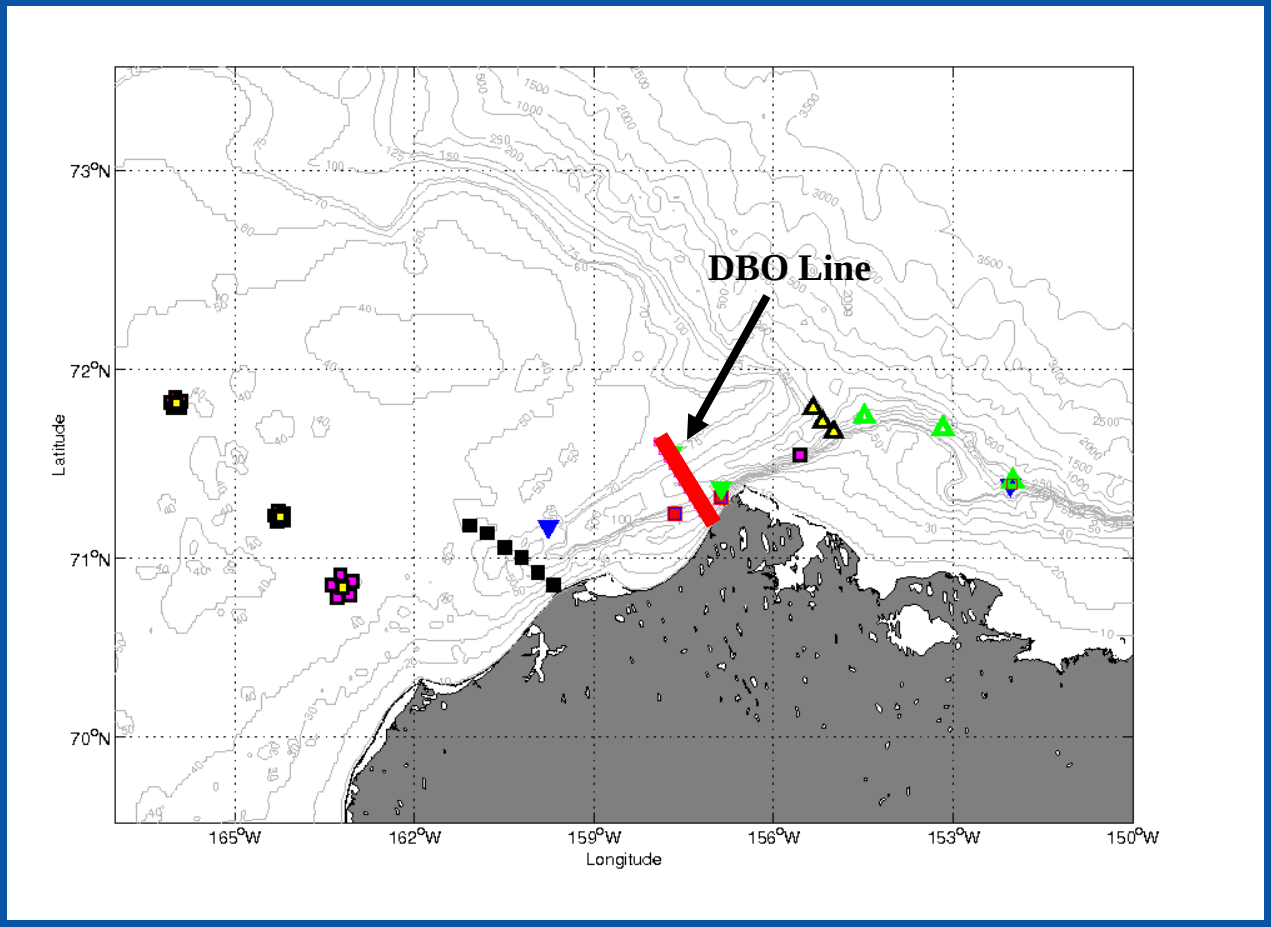
Status of Beaufort Gyre: How PAG can help



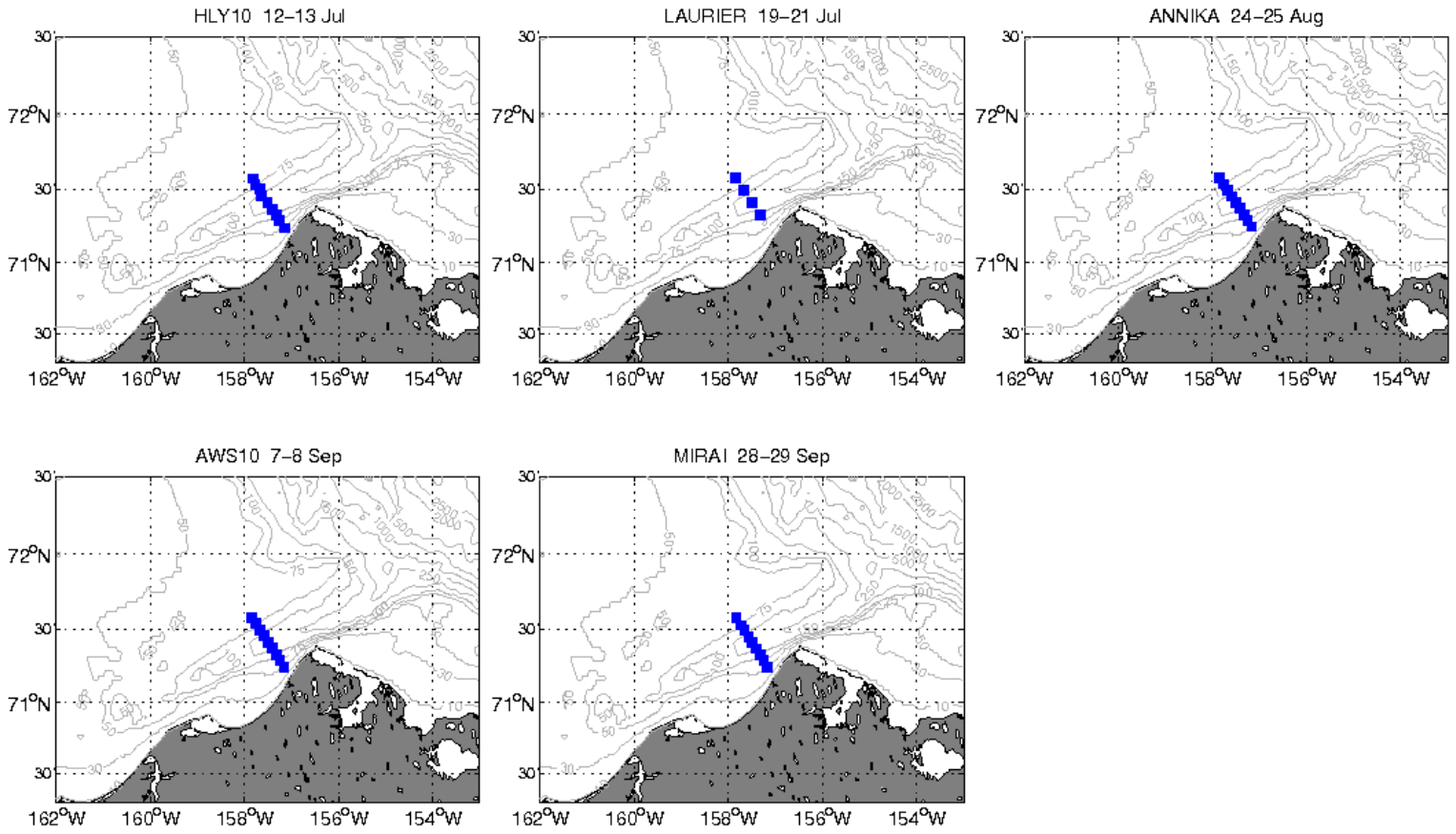
Status of Beaufort Gyre: How PAG can help



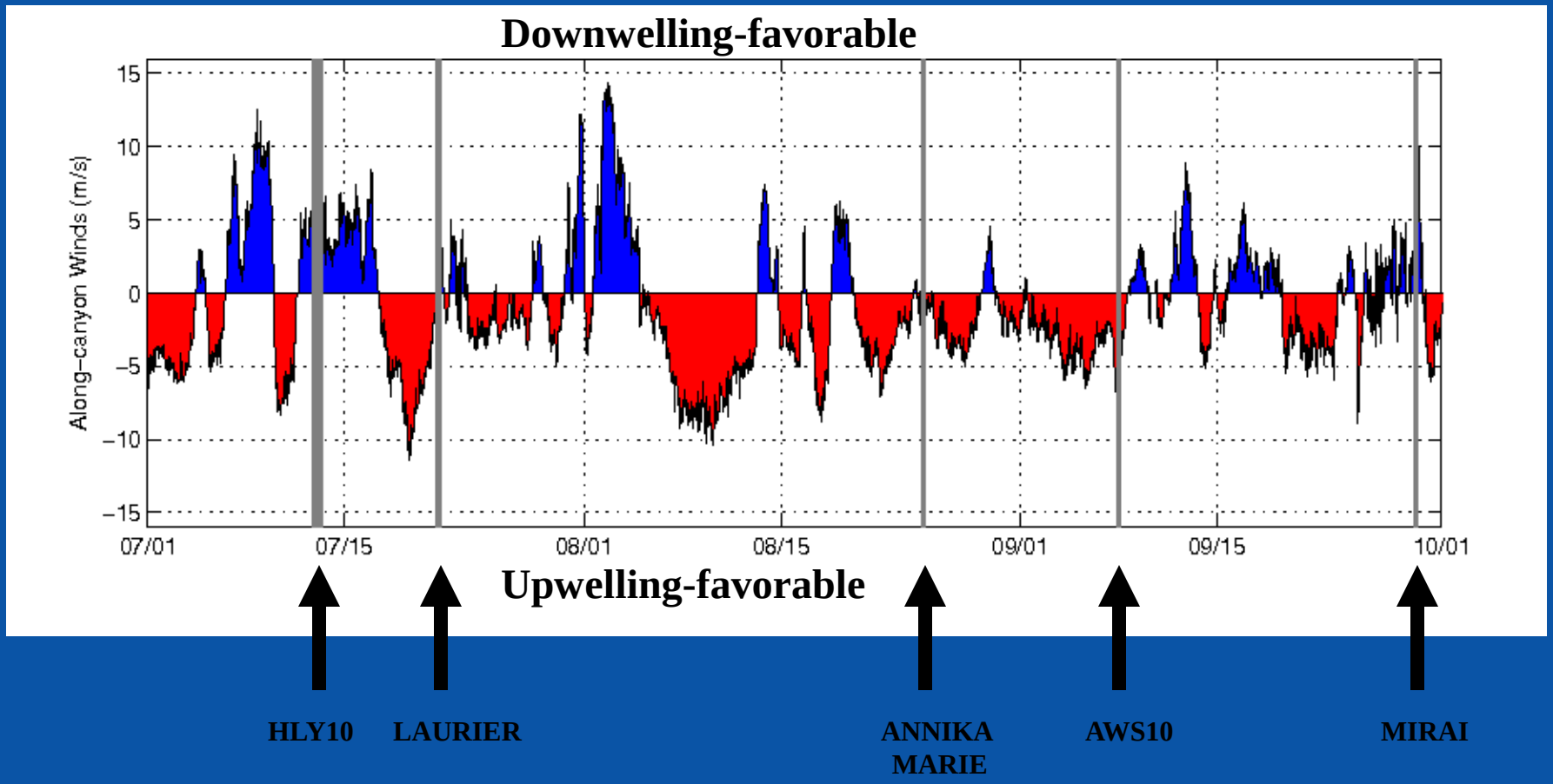
DBO Barrow Canyon Line Pilot Study 2010



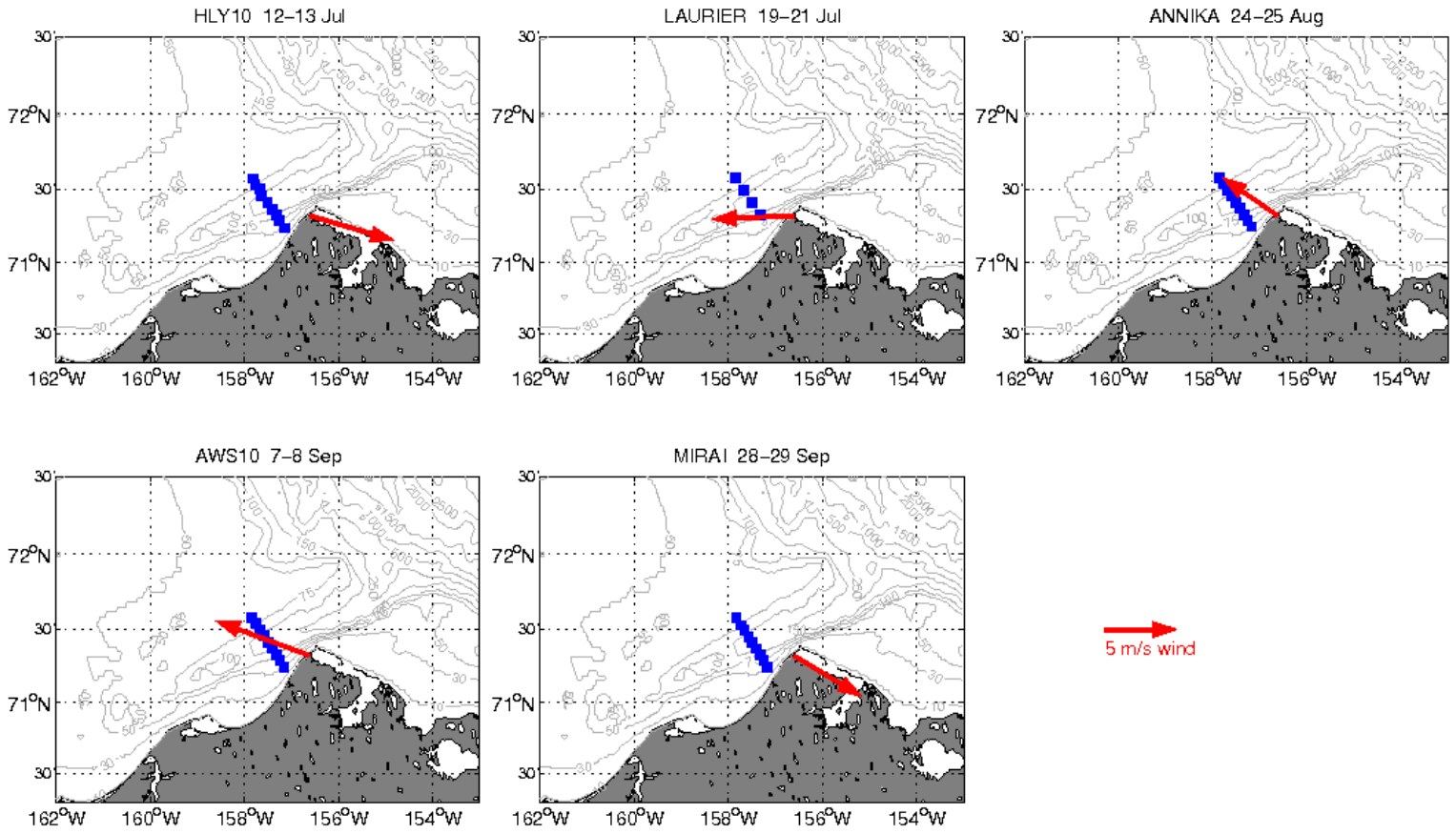
DBO Sections: 5 hydrographic/velocity occupations in 2010

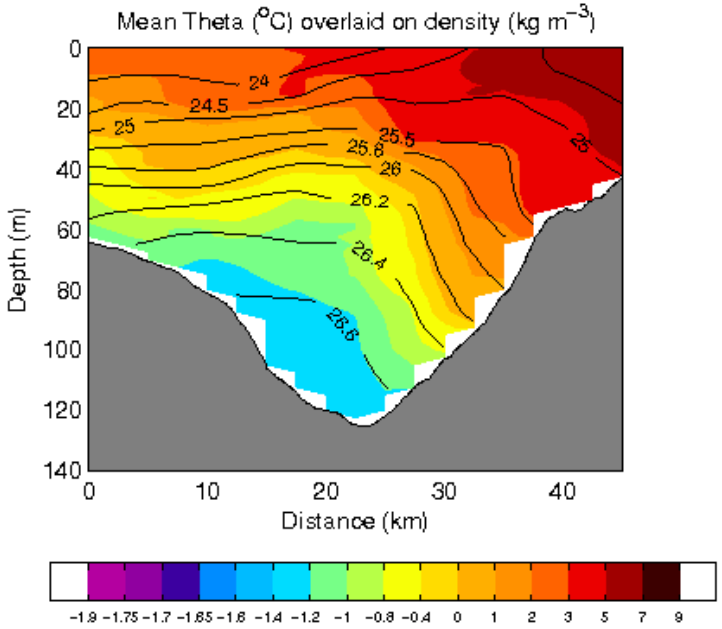


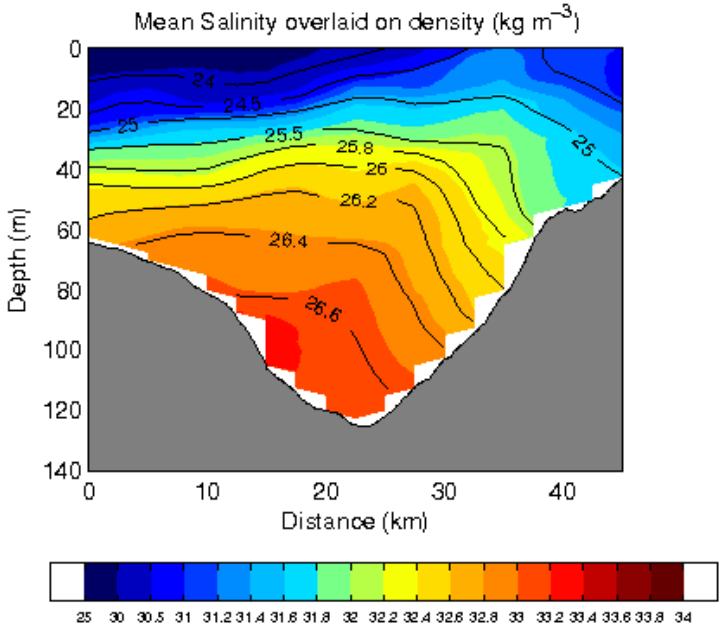
Along-canyon winds Summer 2010



DBO Sections Composite winds during each occupation



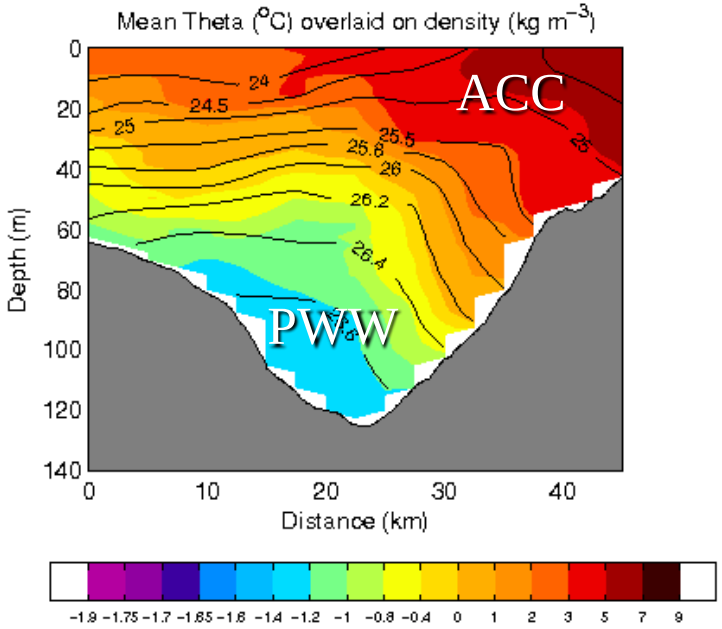


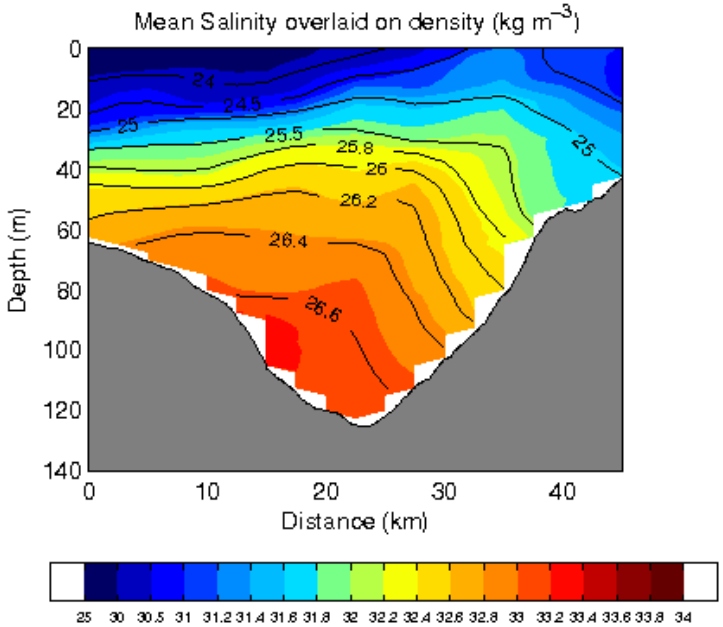


Temperature (color)

Mean Sections

Salinity (color)

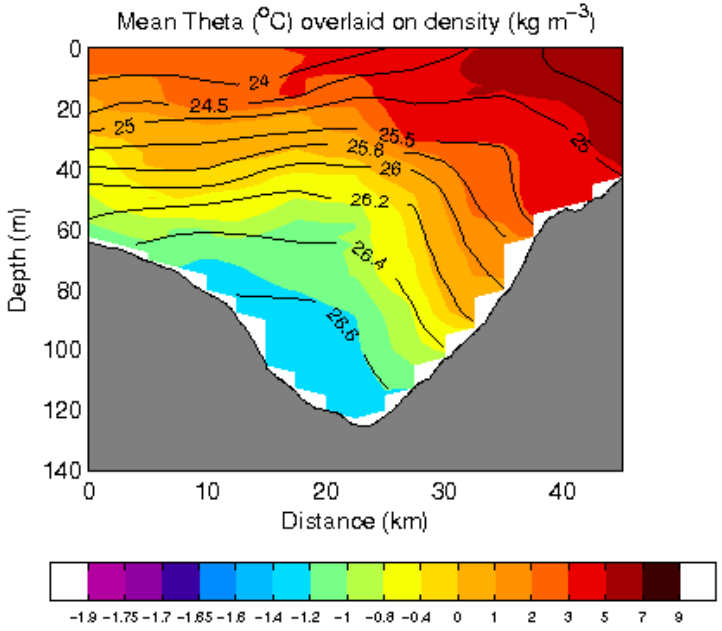




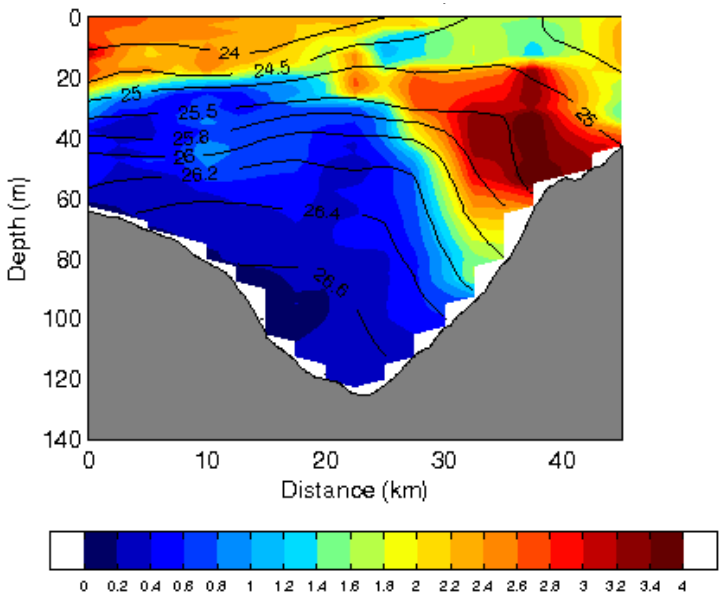
Temperature (color)

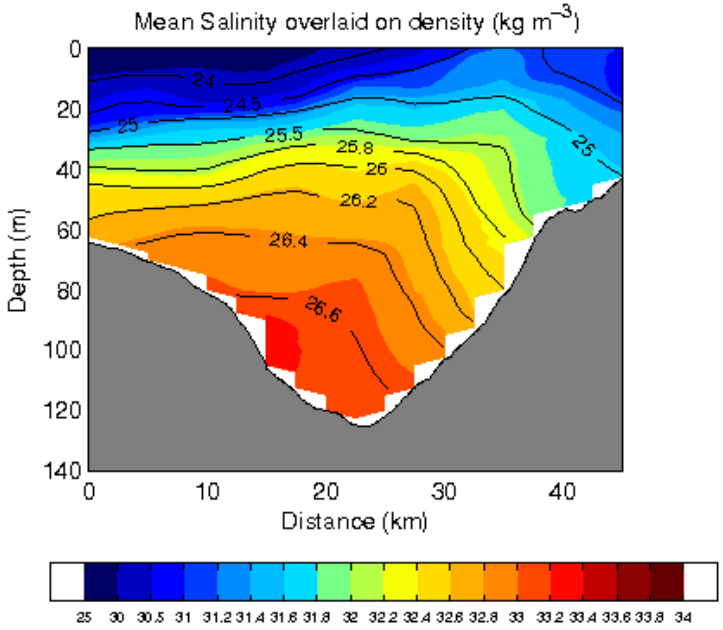
Mean Sections

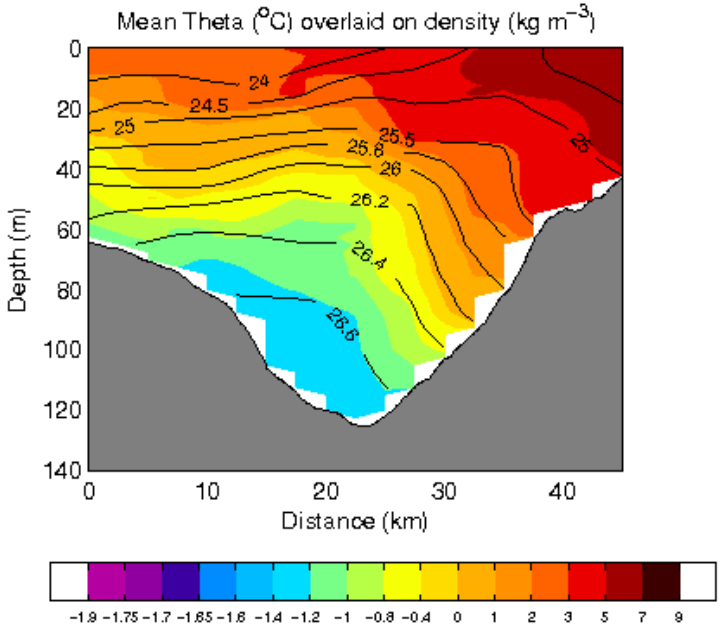
Salinity (color)

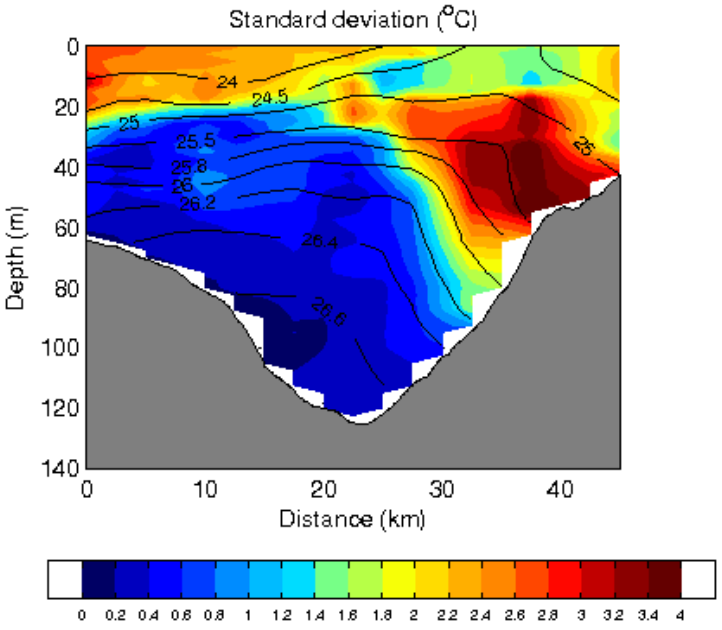


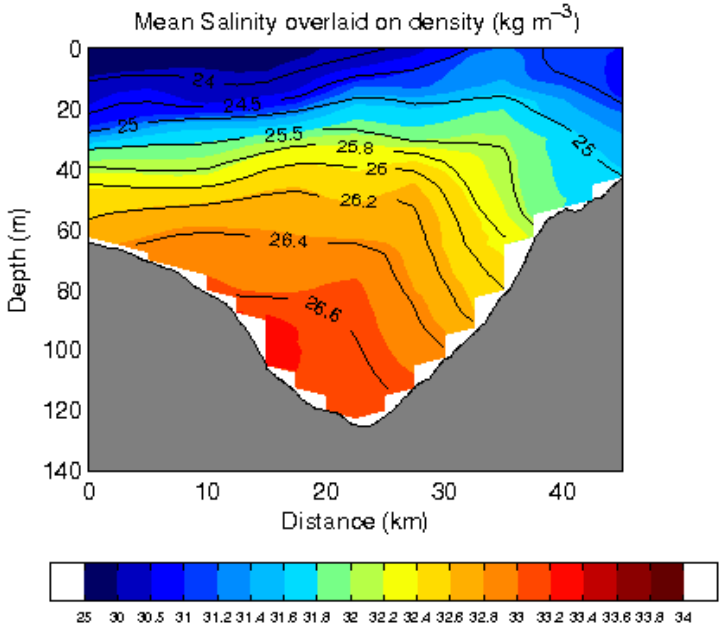
Standard Deviation

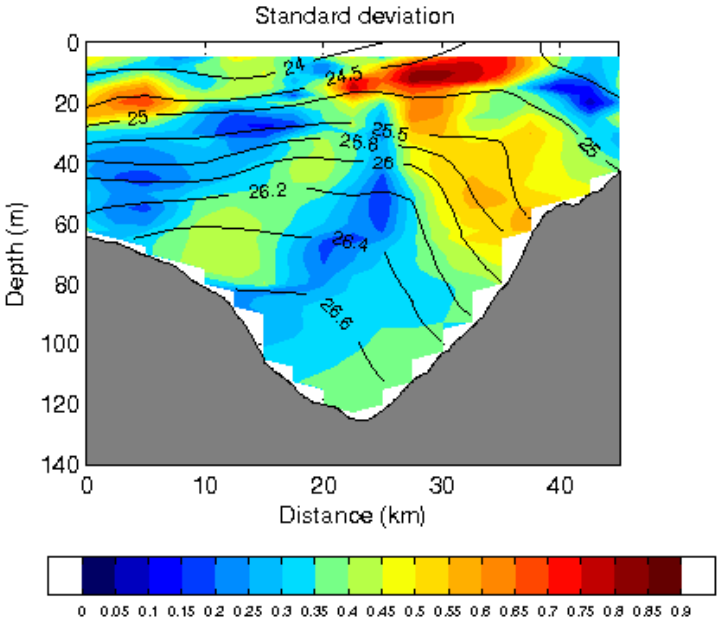




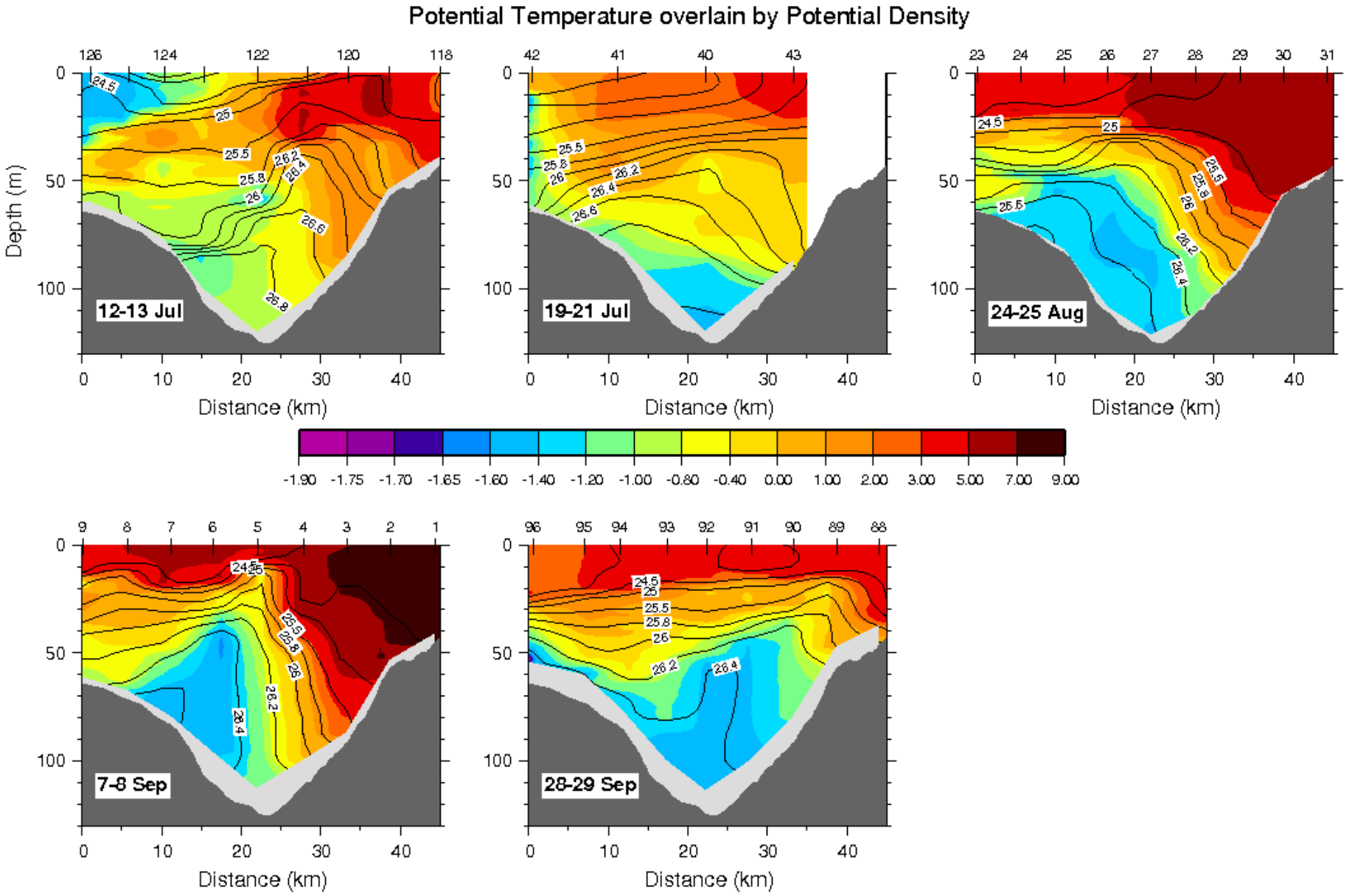

Mean Theta (°C) overlaid on density (kg m^{-3})
Depth (m)
Distance (km)
24
24.5
25
25.5
25.6
26
26.2
26.4
26.6
−1.9 −1.75 −1.7 −1.65 −1.6 −1.4 −1.2 −1 −0.8 −0.4 0 1 2 3 5 7 9


Standard deviation (°C)
Depth (m)
Distance (km)
24
24.5
25
25.5
25.8
26
26.2
26.4
26.6
0 0.2 0.4 0.6 0.8 1 1.2 1.4 1.6 1.8 2 2.2 2.4 2.6 2.8 3 3.2 3.4 4


Mean Salinity overlaid on density (kg m^{-3})
Depth (m)
Distance (km)
24
24.5
25
25.5
25.8
26
26.2
26.4
26.6
25 30 30.5 31 31.2 31.4 31.6 31.8 32 32.2 32.4 32.6 32.8 33 33.2 33.4 33.6 33.8 34

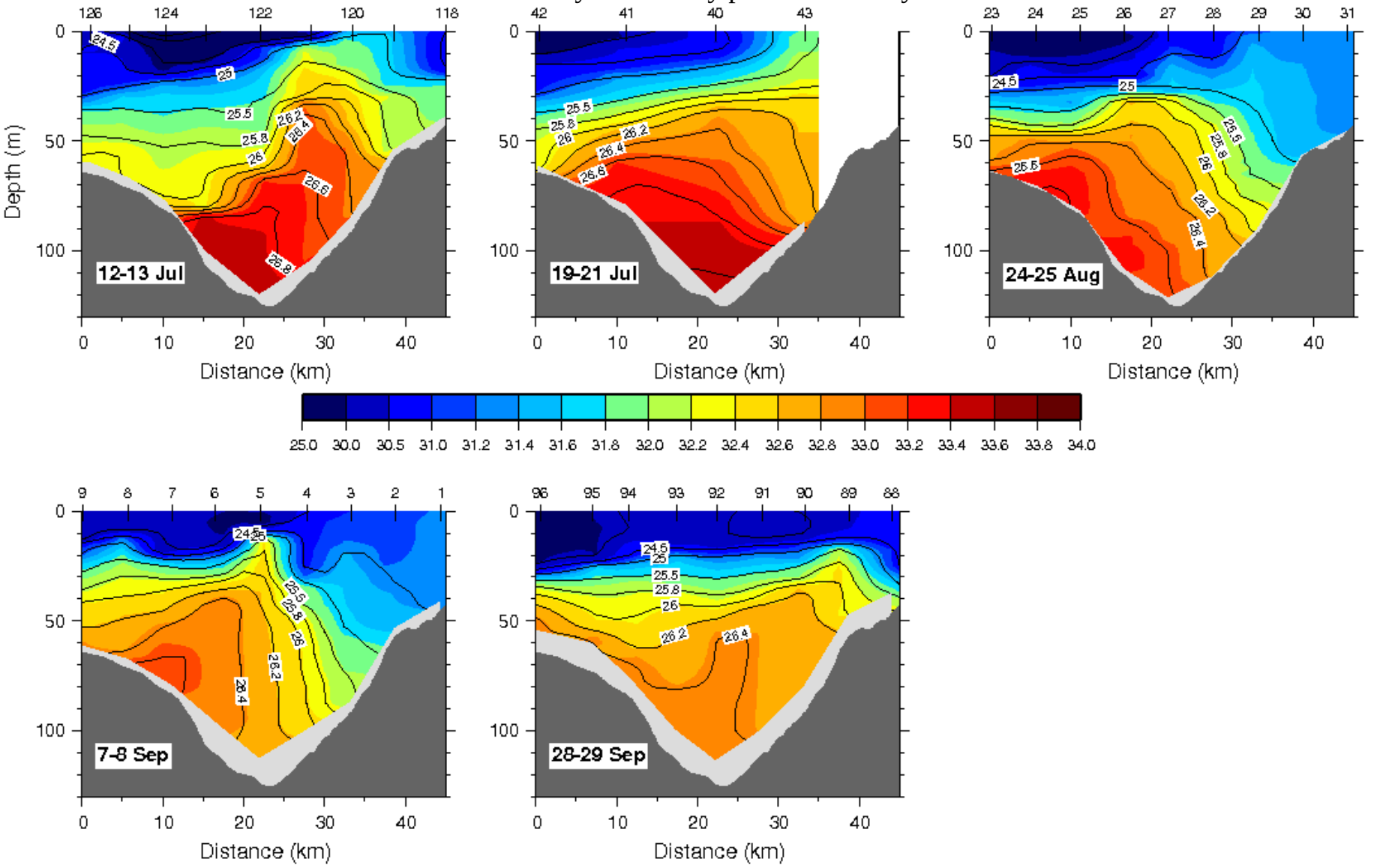

Standard deviation
Depth (m)
Distance (km)
24
24.5
25
25.5
25.8
26
26.2
26.4
26.6
0 0.05 0.1 0.15 0.2 0.25 0.3 0.35 0.4 0.45 0.5 0.55 0.6 0.65 0.7 0.75 0.8 0.85 0.9

Individual Sections

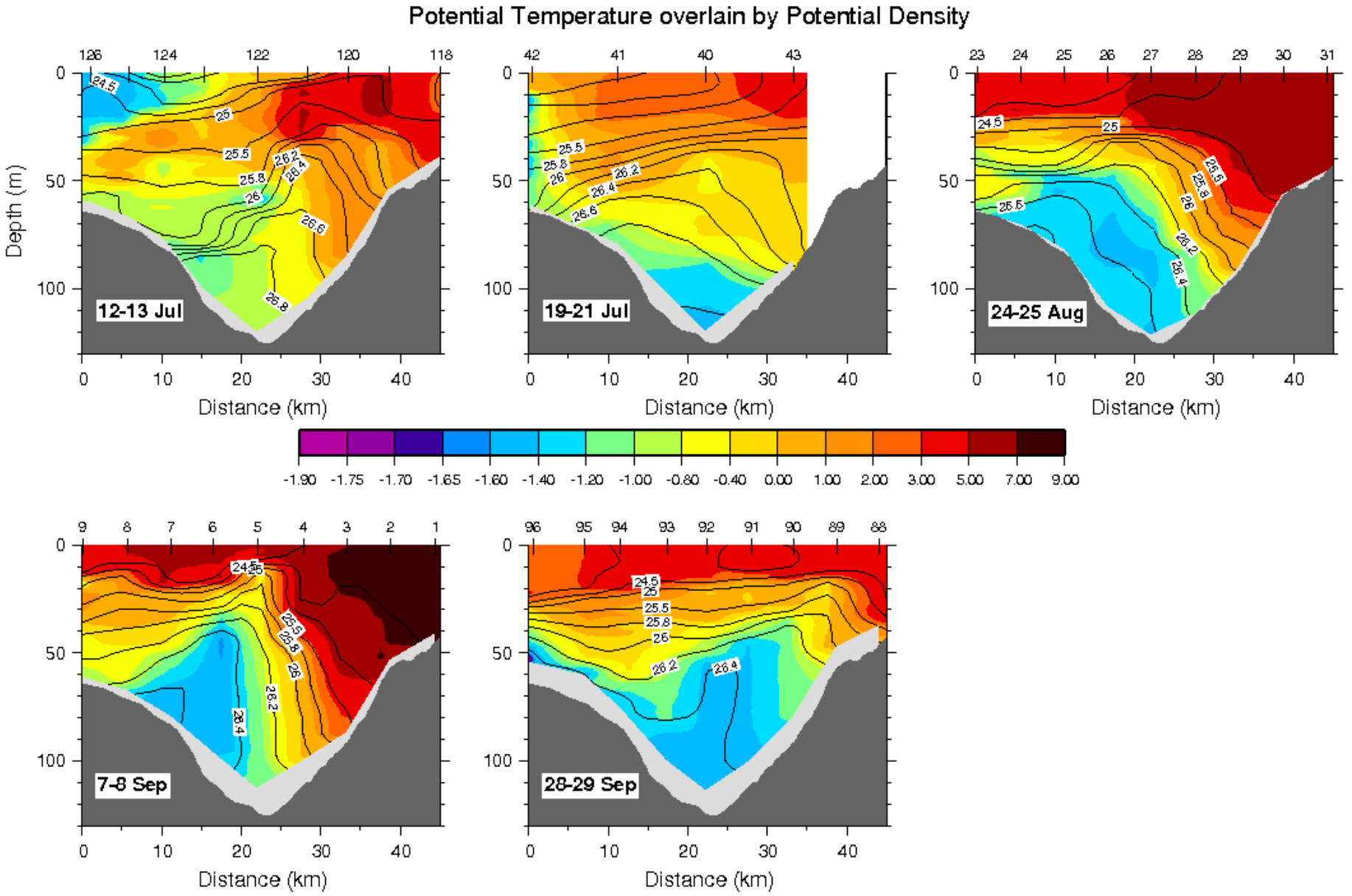


Individual Sections

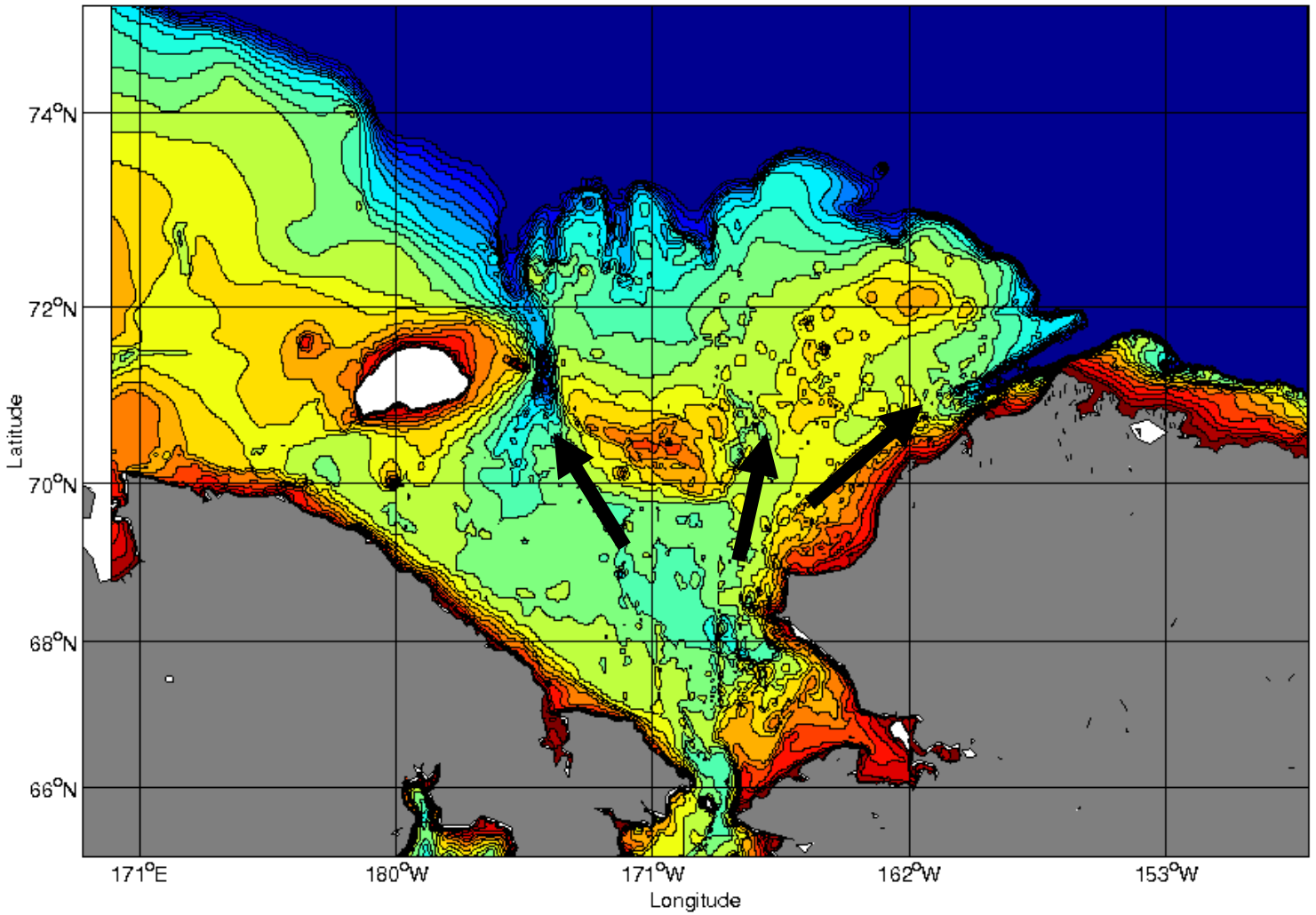
Salinity overlain by potential density



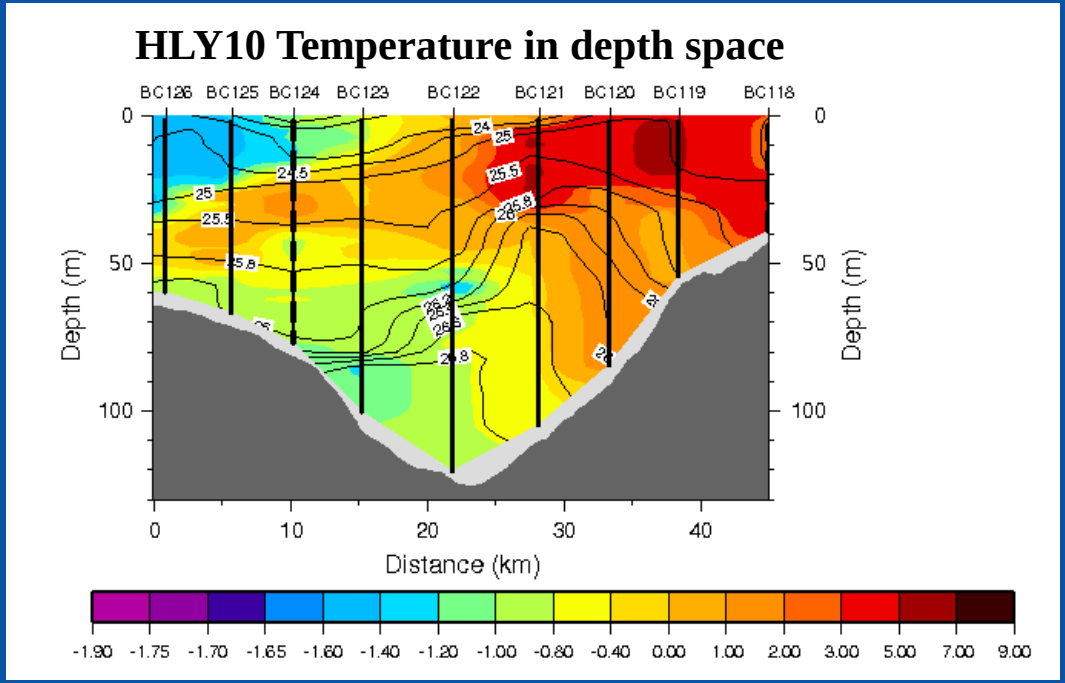
Individual Sections



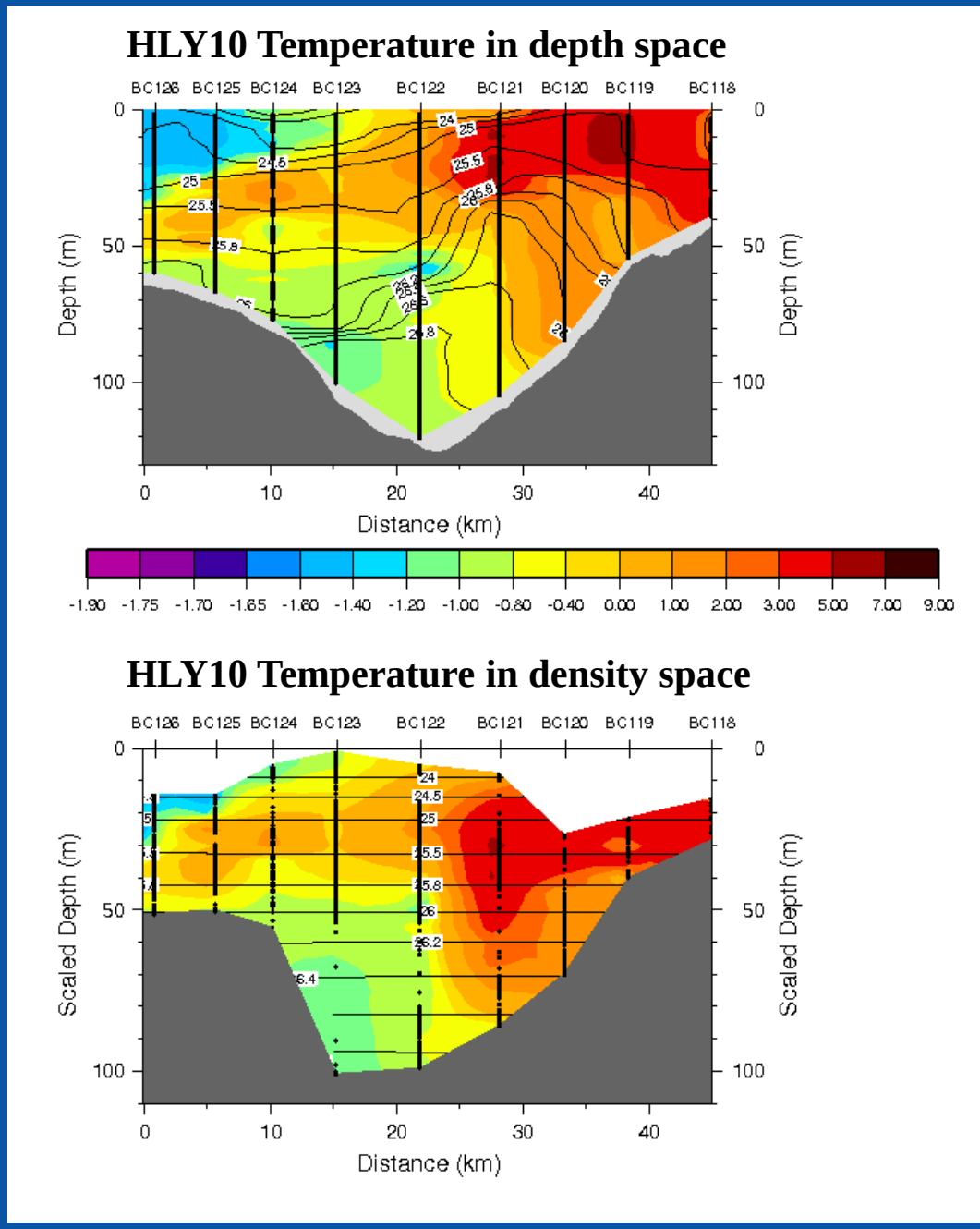
Pathways


74°N
72°N
70°N
68°N
66°N
Latitude
171°E
180°W
171°W
162°W
153°W
Longitude

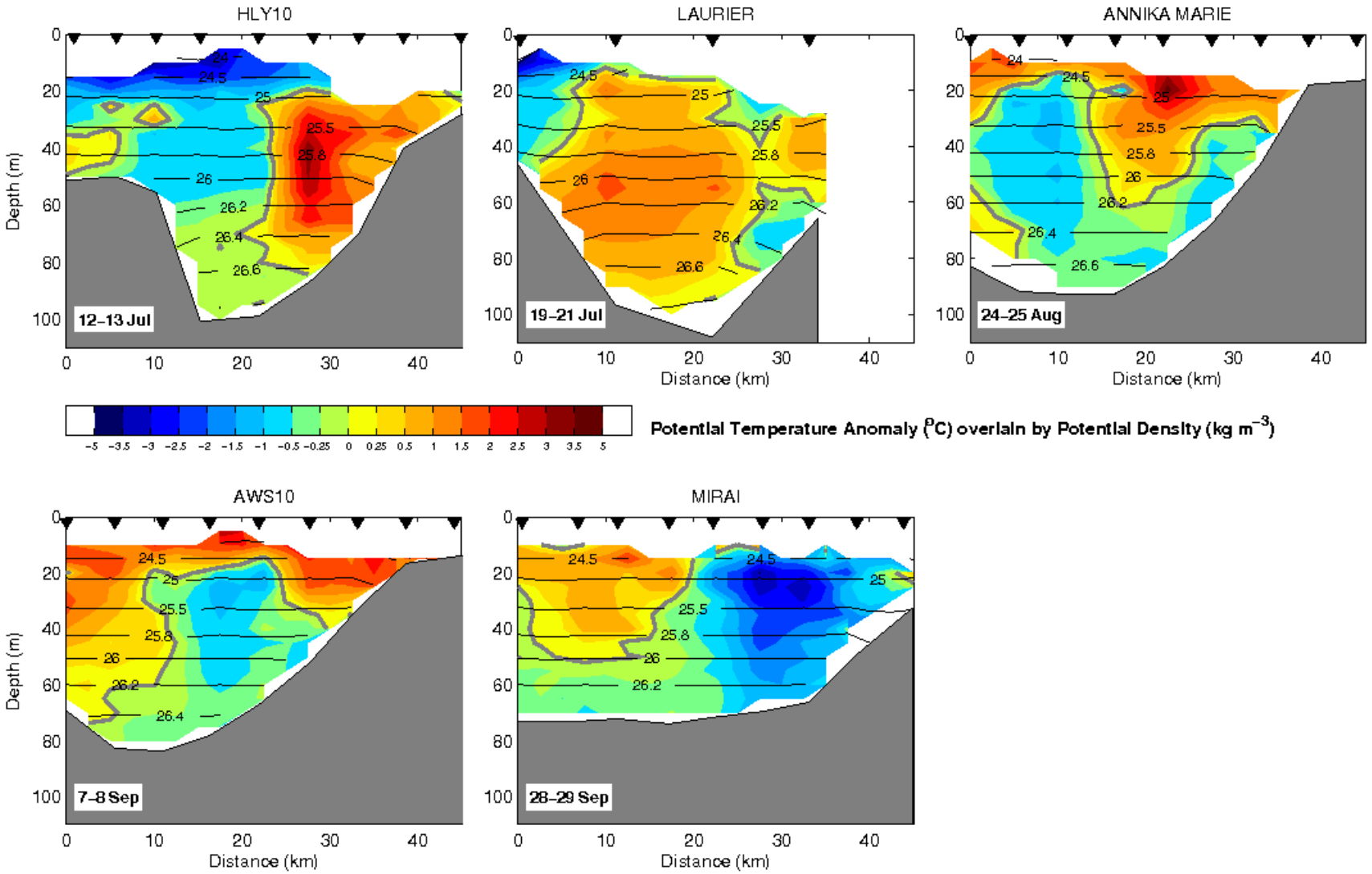
Advantages of repeat sections: Working in density space



Advantages of repeat sections: Working in density space



Temperature anomaly in density space



What have we learned from the DBO Pilot Study?

Positives

The concept can work! (5 cruises by 3 nations in 2010).

Immediate data sharing is advantageous.

The more occupations the better to help sort out seasonal versus interannual variability.

The information can help with the interpretation of individual studies by providing temporal context.

What have we learned from the DBO Pilot Study?

Challenges

Requires coordination and commitment (e.g. might have had 8 occupations in 2010) .

Data quality and processing.

Dedicated funding for incremental shiptime, data processing, analysis.