Update on the physical oceanography of the RUSALCA region

Robert S. Pickart (WHOI)

Professor Khromov
Canada Basin, Sep 2009
(Photo by D. Torres)

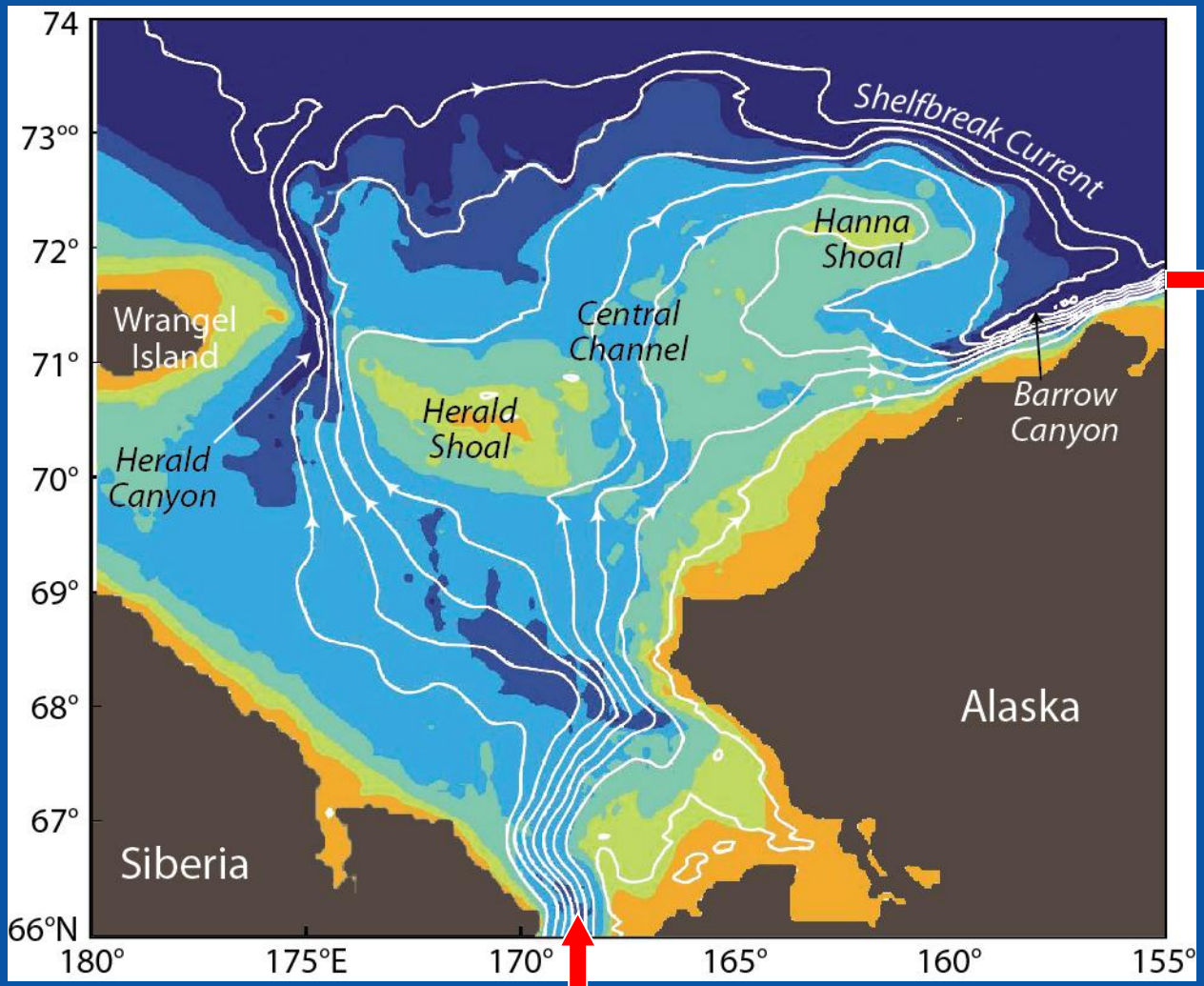
Outline

1. Review of RUSALCA 2004 and RUSALCA 2009 hydrography and circulation.

2. A revised circulation scheme for the Chukchi Sea.

3. Aspects of changing ice cover in the study region and and potential issues to focus on.

Pacific water inflow to the Arctic

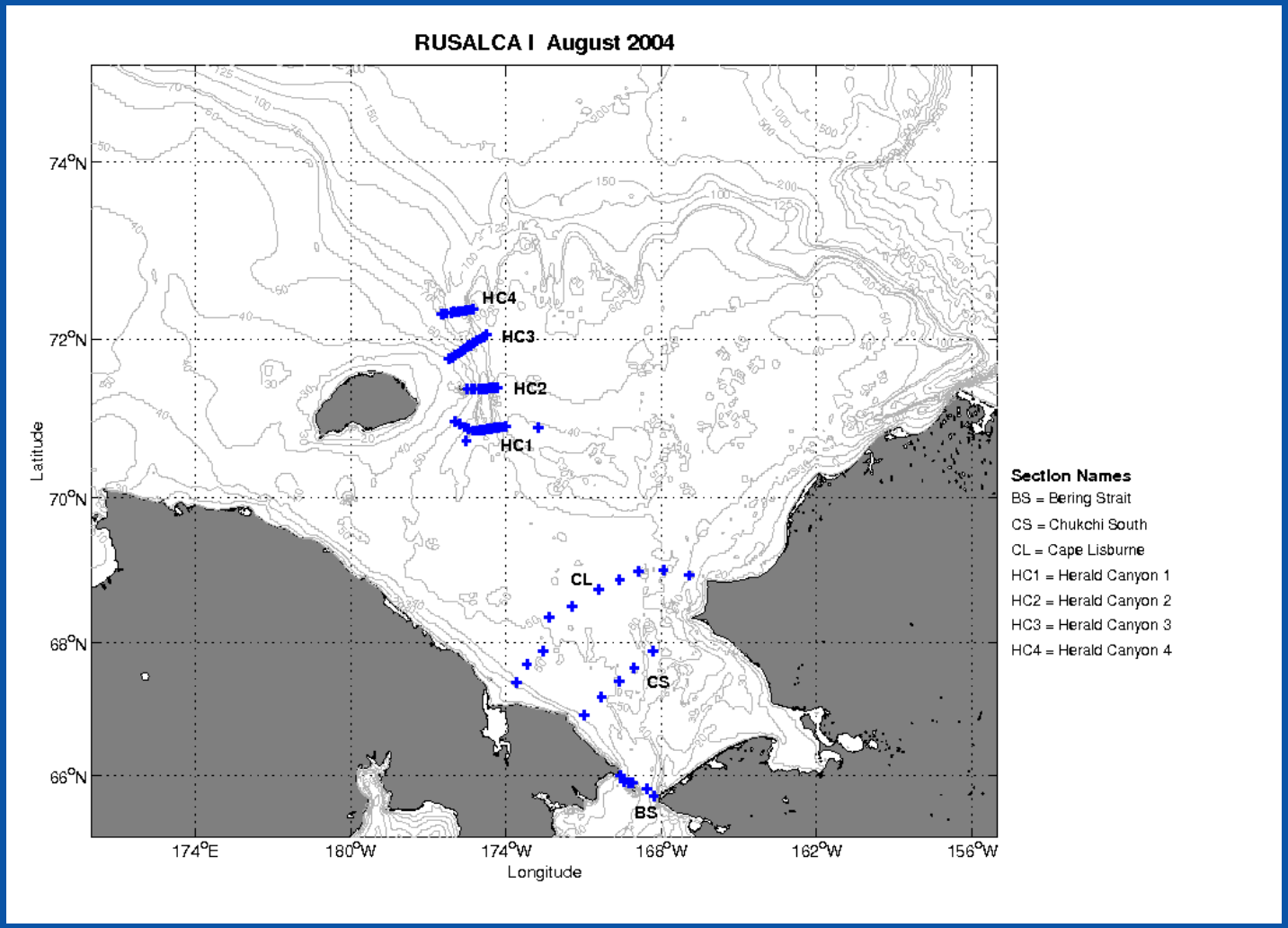


Shelfbreak Current

0.8 Sv

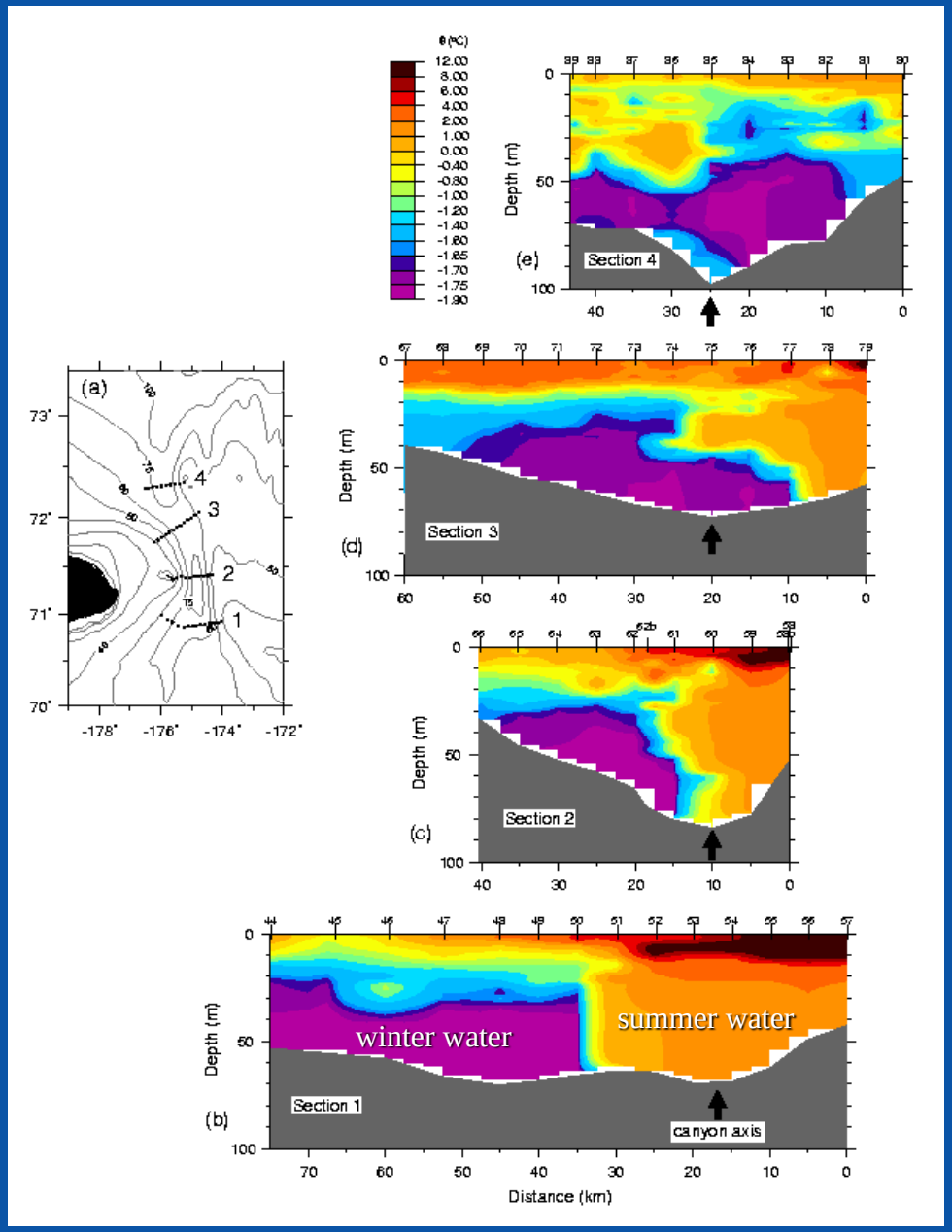
Barotropic streamlines from Spall (2007)

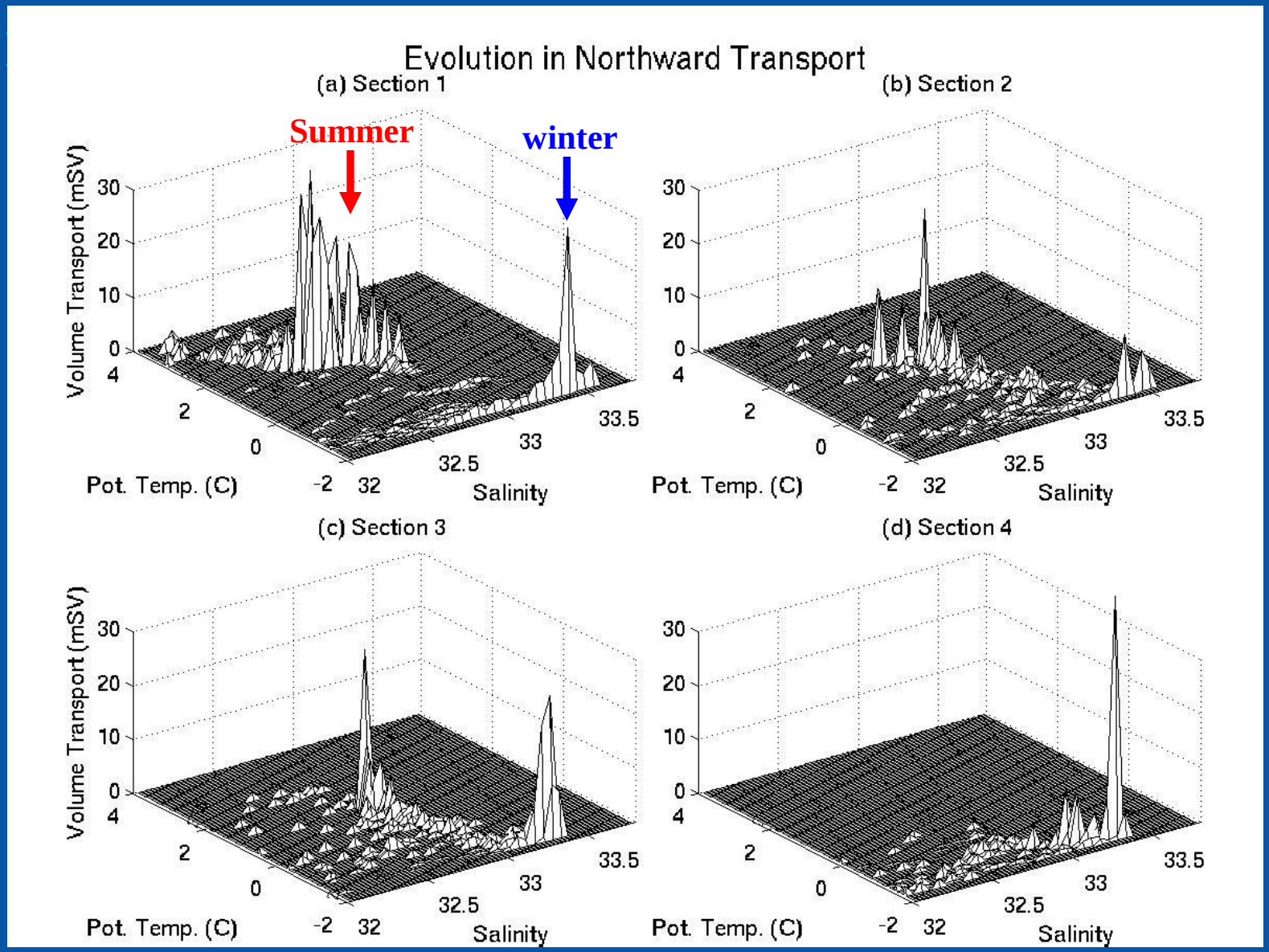
CTD Survey 2004

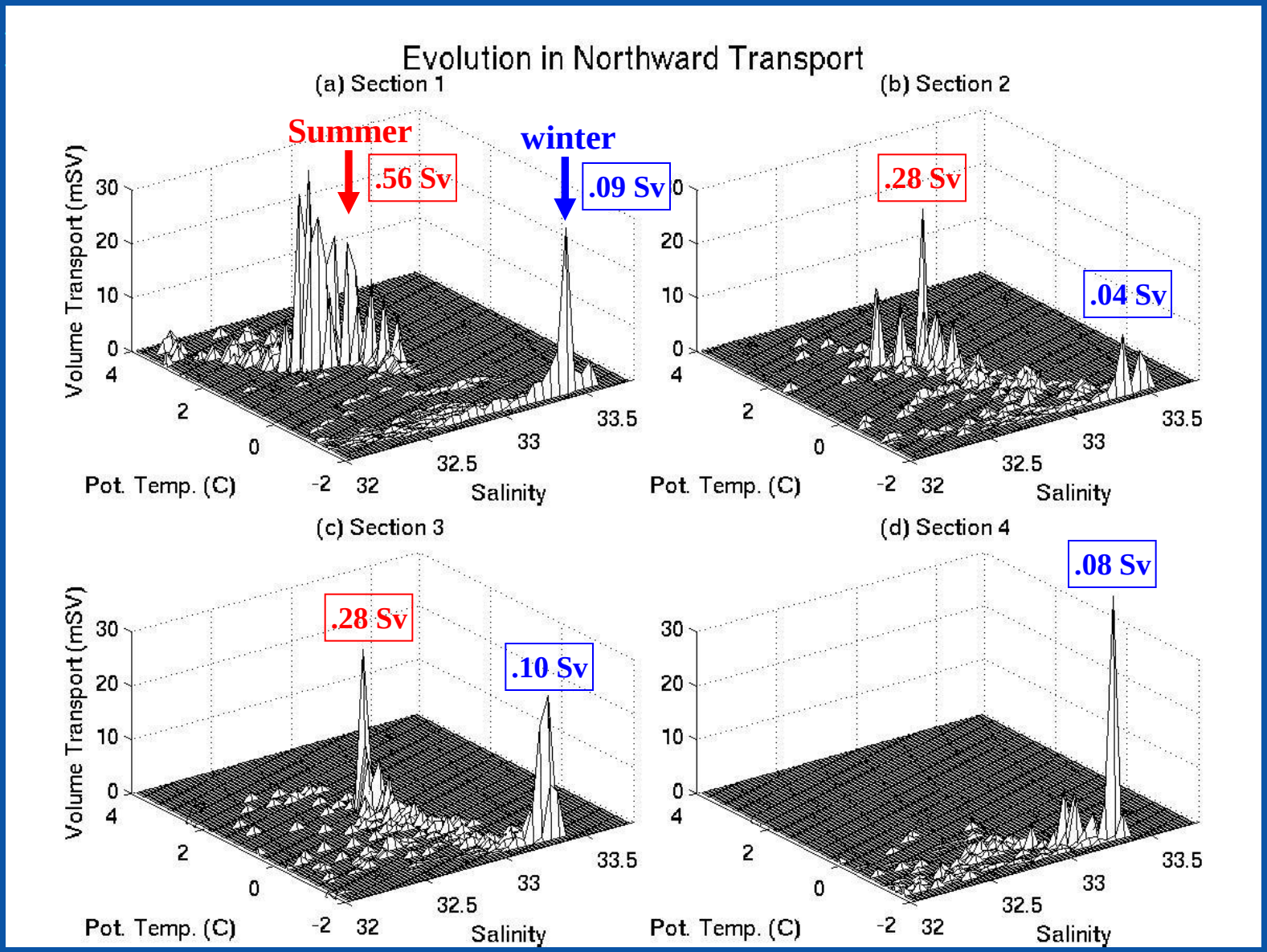


Evolution of flow through Herald Canyon 2004

Potential temperature (°C, color)




Evolution in Northward Transport
(a) Section 1
Summer
winter
(b) Section 2
(c) Section 3
(d) Section 4
Volume Transport (mSV)
30
20
10
0
Pot. Temp. (C)
4
2
0
-2
Salinity
32
32.5
33
33.5


Evolution in Northward Transport
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Summer
.56 Sv
winter
.09 Sv
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Volume Transport (mSV)
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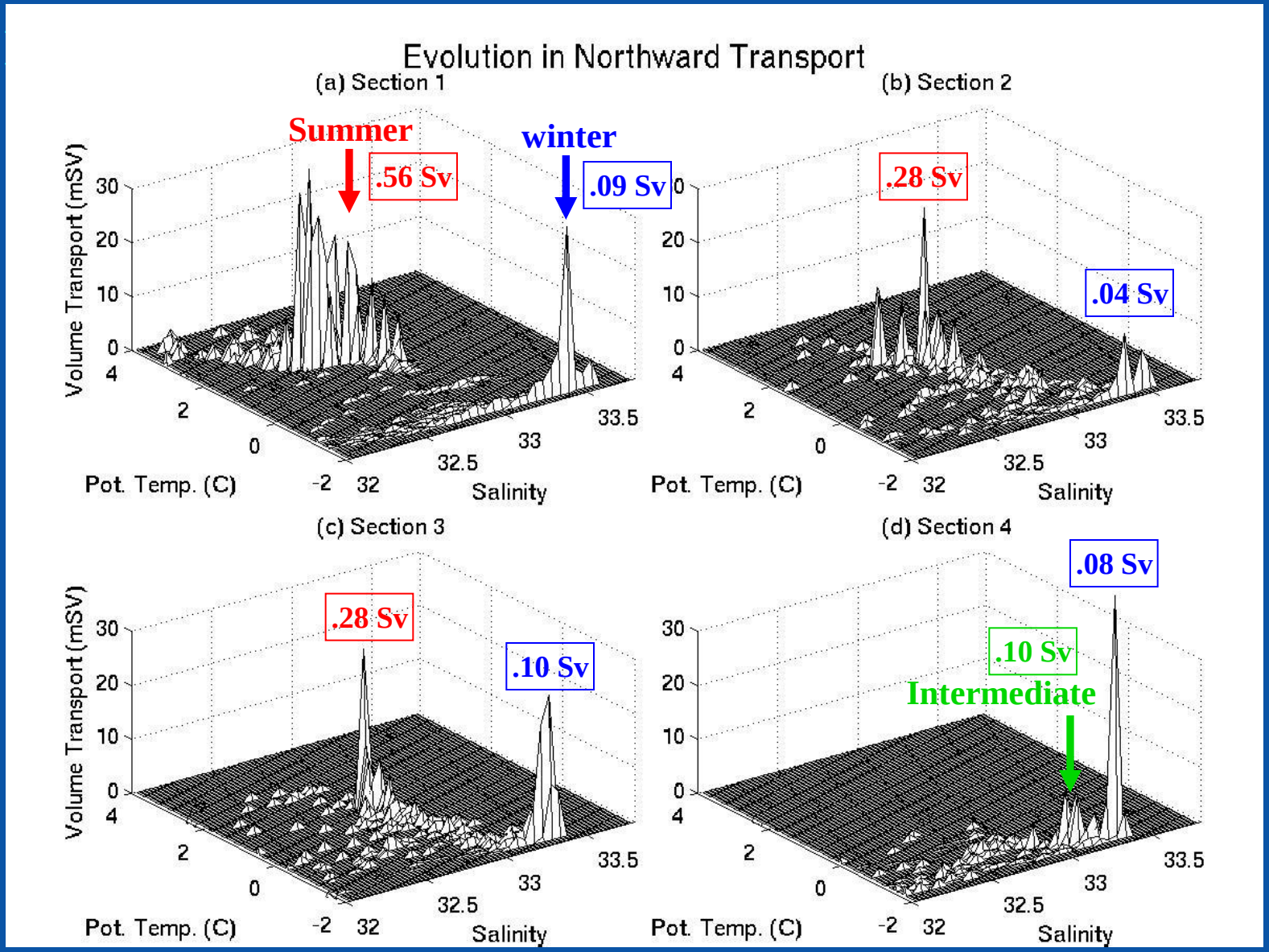
Salinity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Intermediate
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Pot. Temp. (C)
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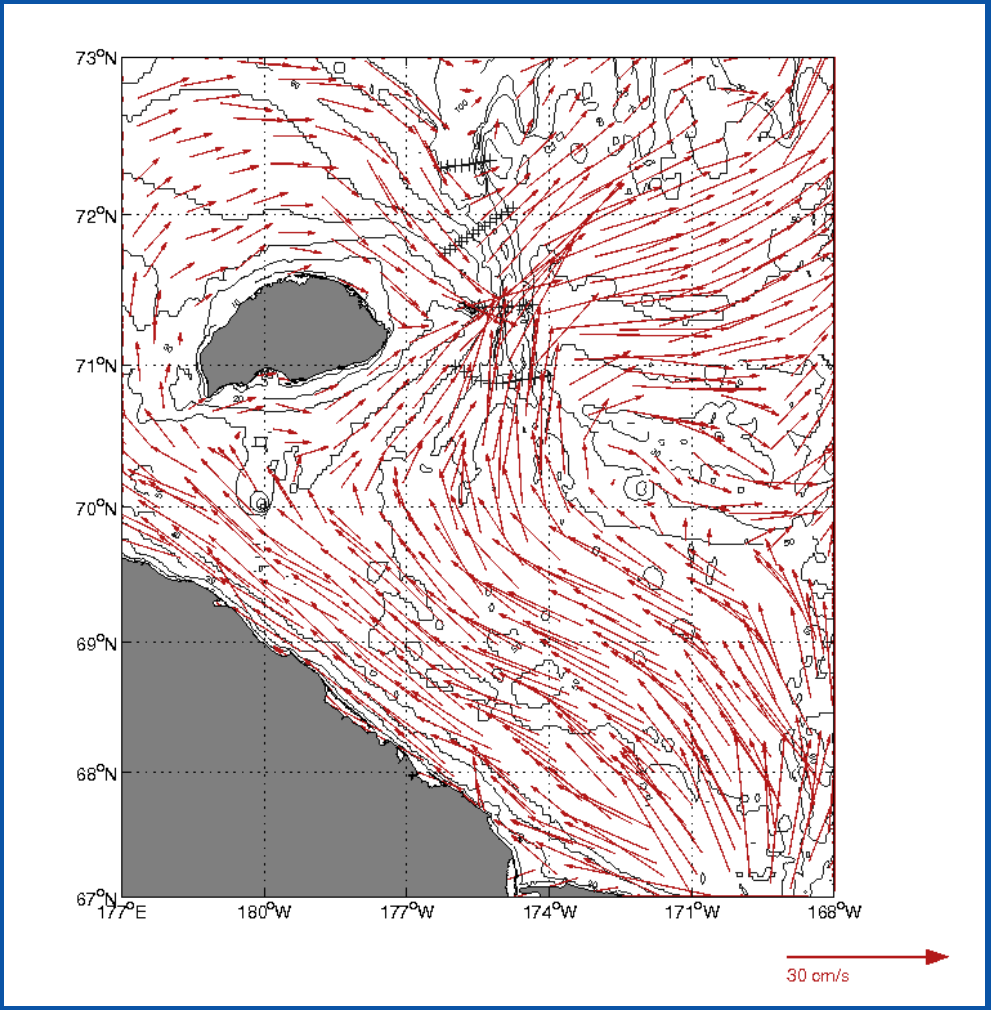
30
20
10
0
4
2
0
-2
32
32.5
33
33.5

Evolution of flow through Herald Canyon

Averaged for the week-long period prior to the 2004 Herald Canyon survey

Depth-averaged flow vectors from Proshutinsky model



Wrangel Island Polynya

Number of days that polynya was present, winter 2003-4 (from AMSR-E)

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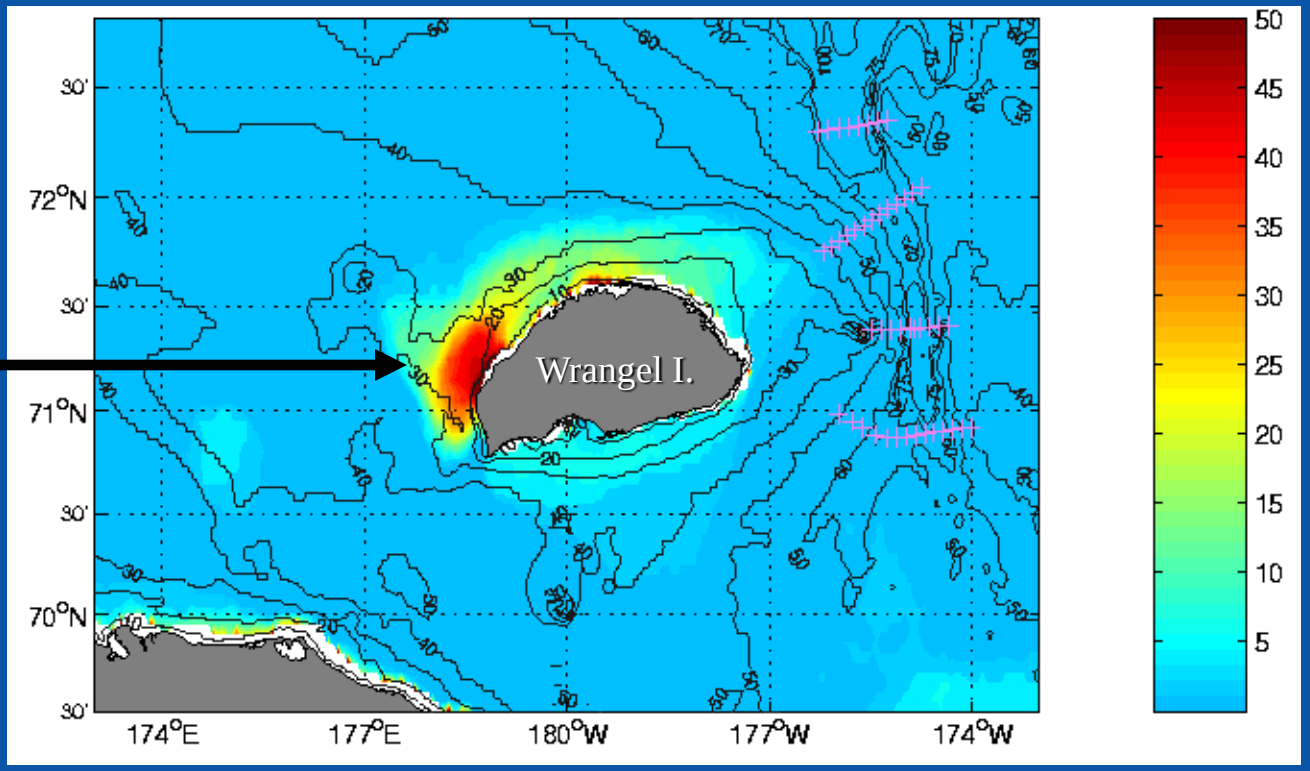

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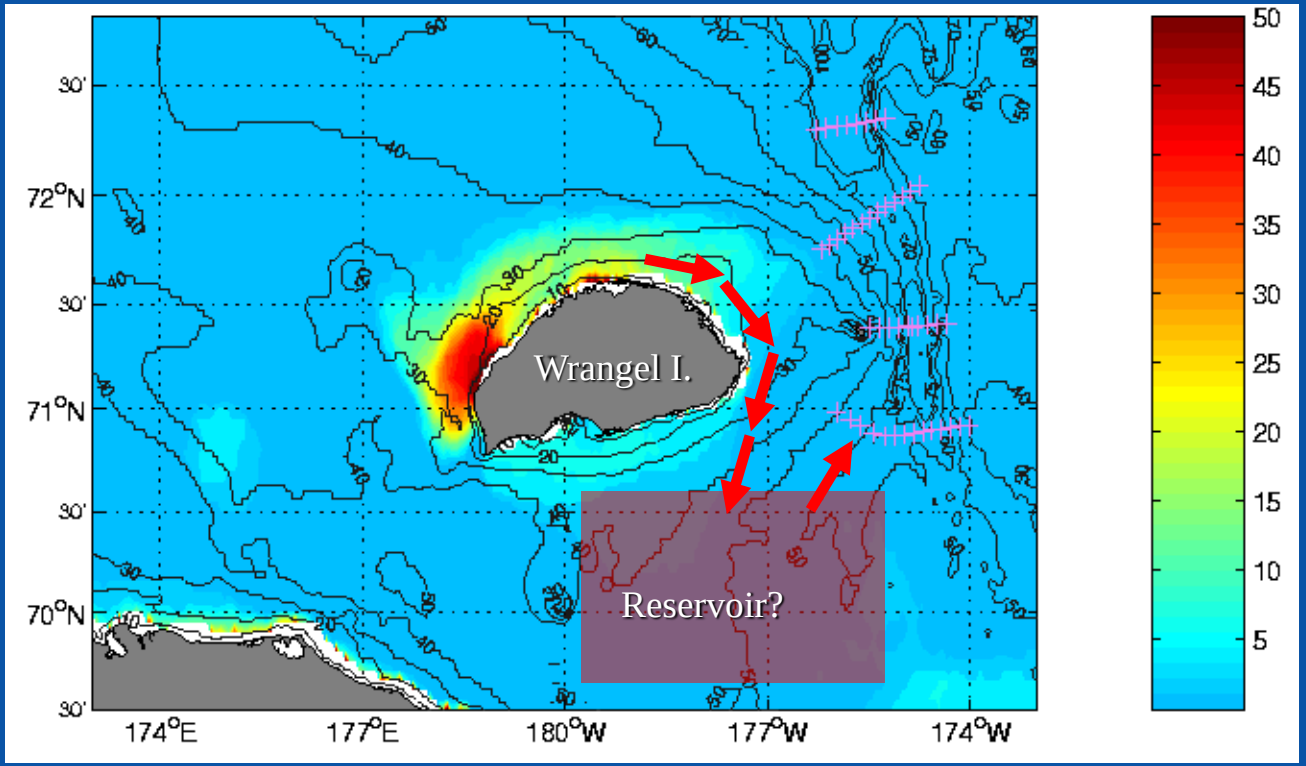

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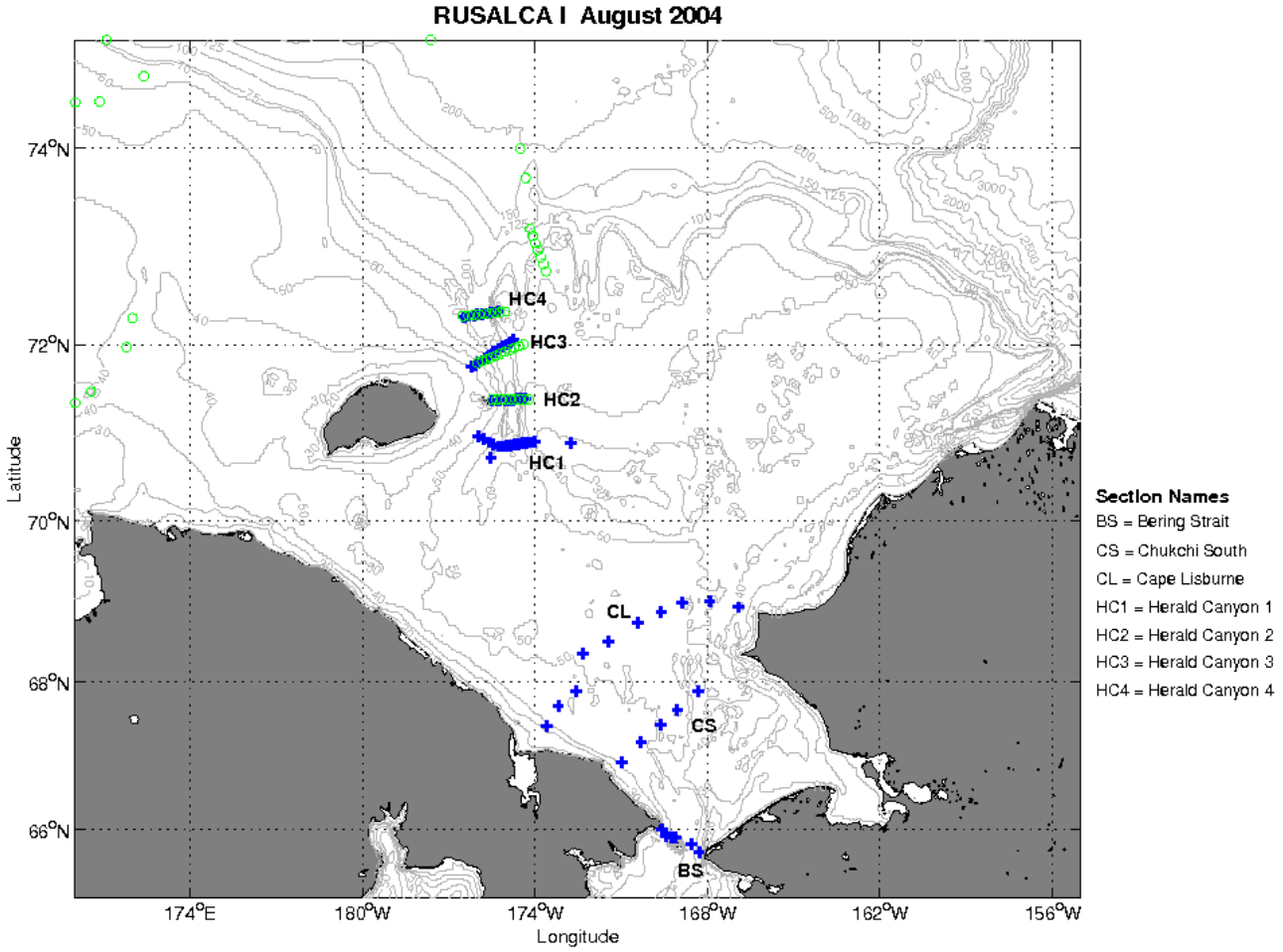
Important Points

1. Herald Canyon is a major conduit for summer and winter Pacific waters into the Arctic Basin, where they meet Atlantic water.

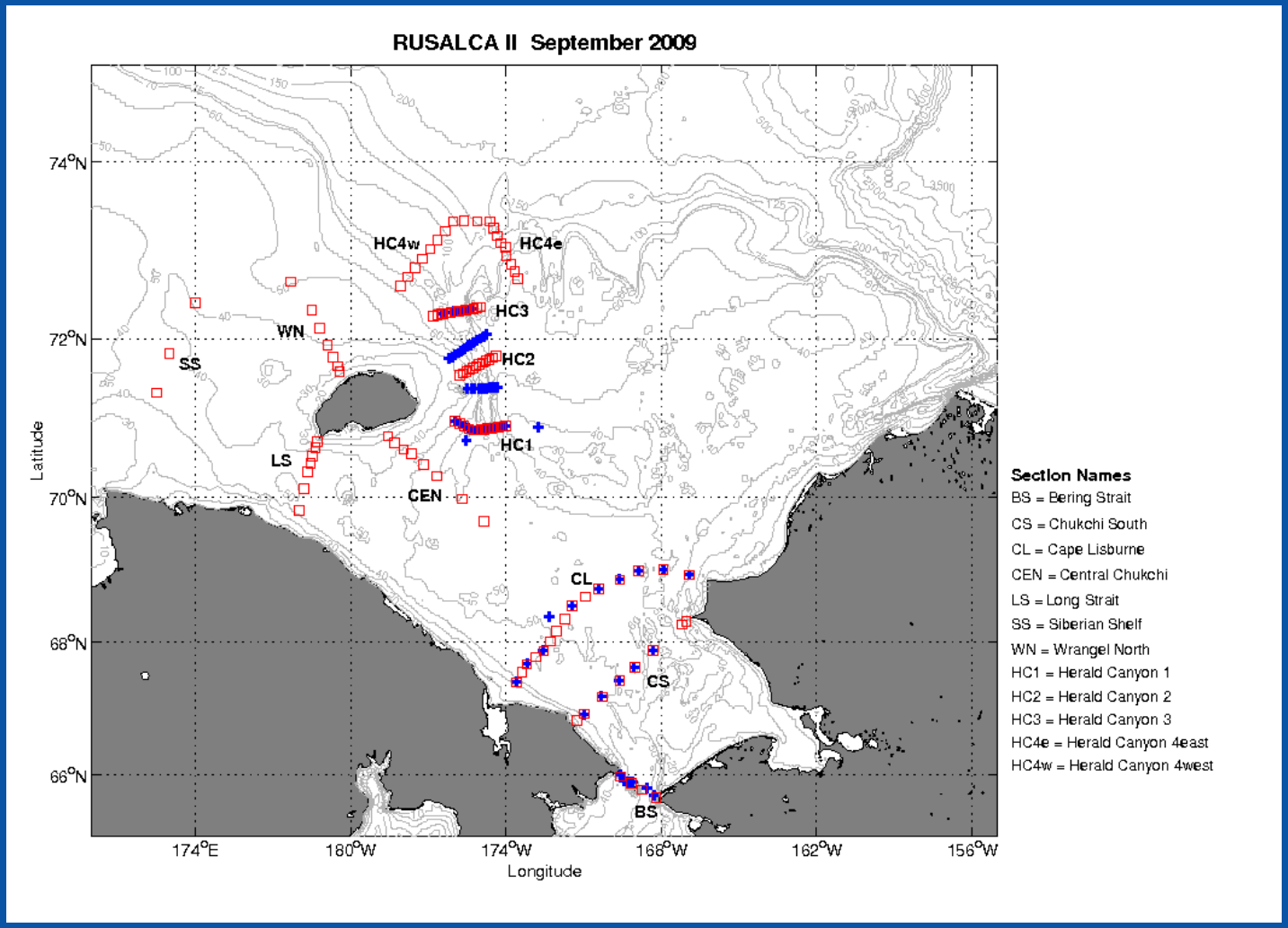
2. Dynamical processes in the canyon impact the transport, characteristics, and fate of the exiting water.

3. The winter water comes from two sources: Bering Strait and the Wrangel Island polynya.

2008 Swedish Survey of Herald Canyon



CTD survey 2004 (blue) and 2009 (red)



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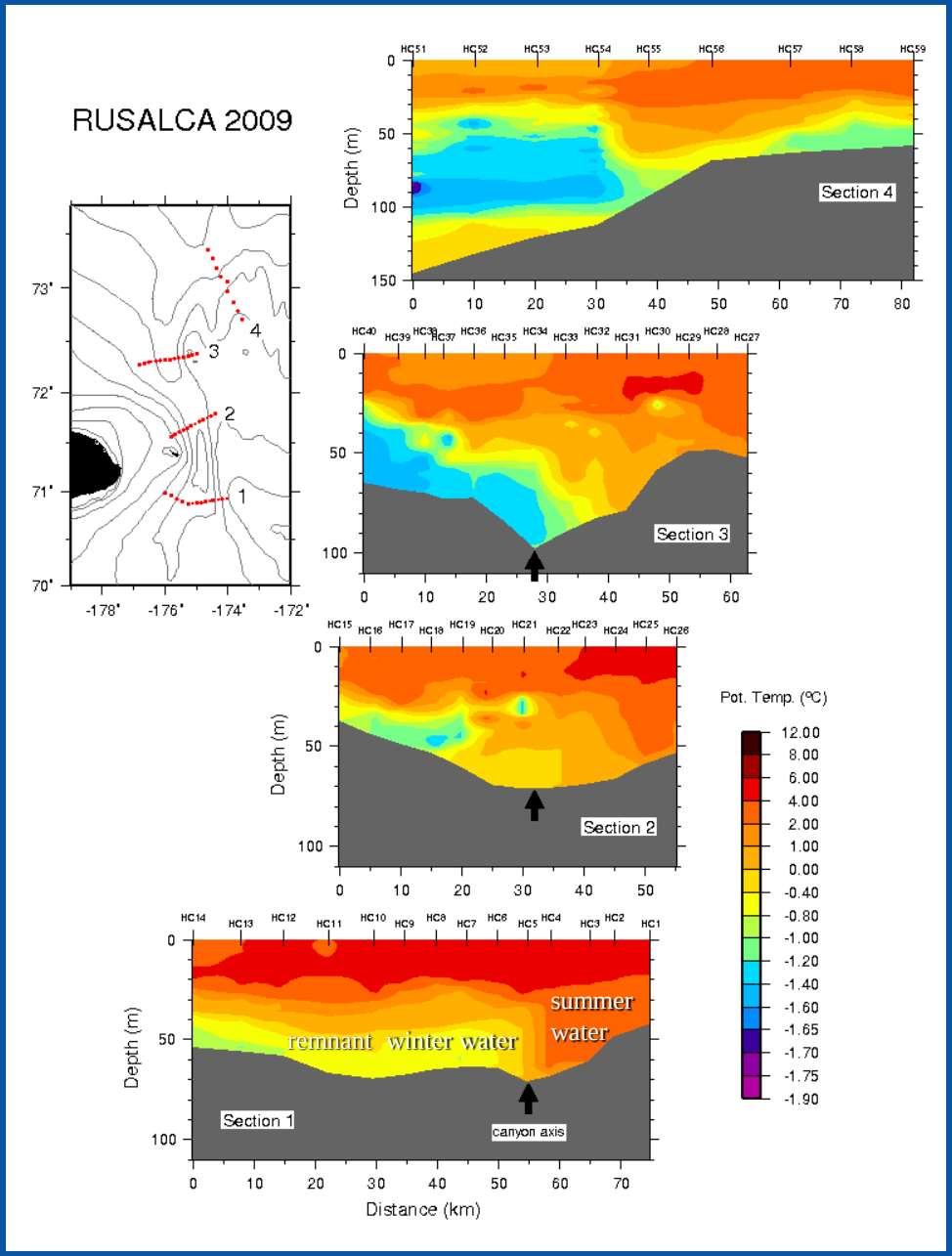
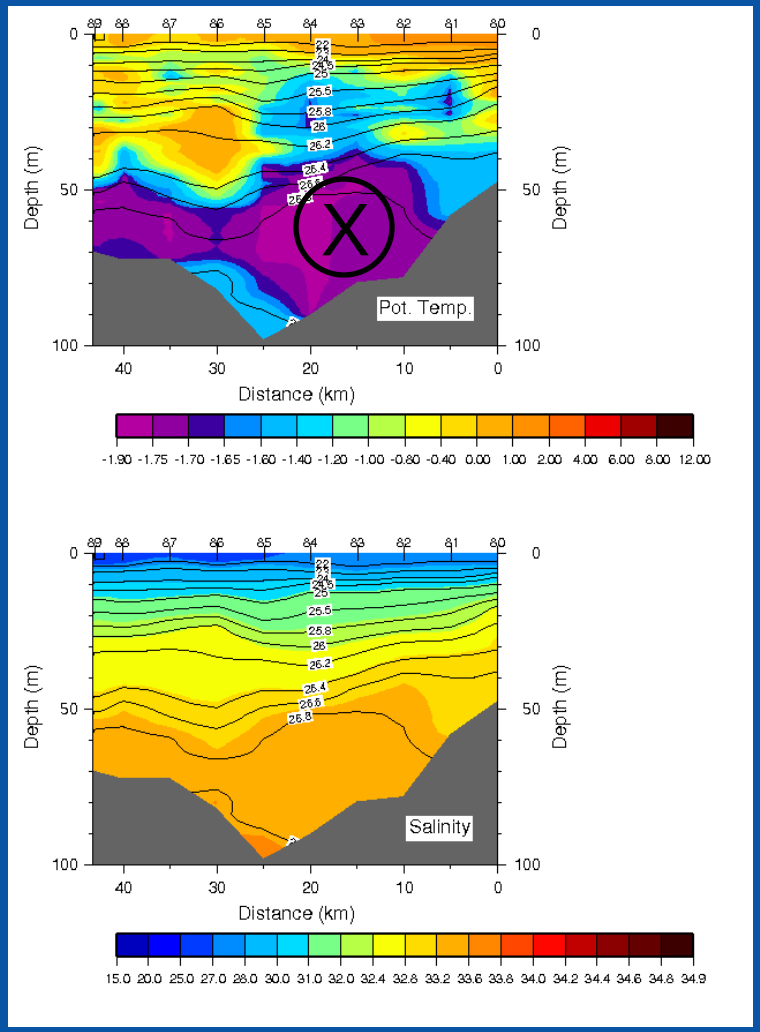


Hydrographic changes between 2004 and 2009

August 2004

Section 3



Potential temperature (color) and salinity (color) overlaid by potential density (contours)

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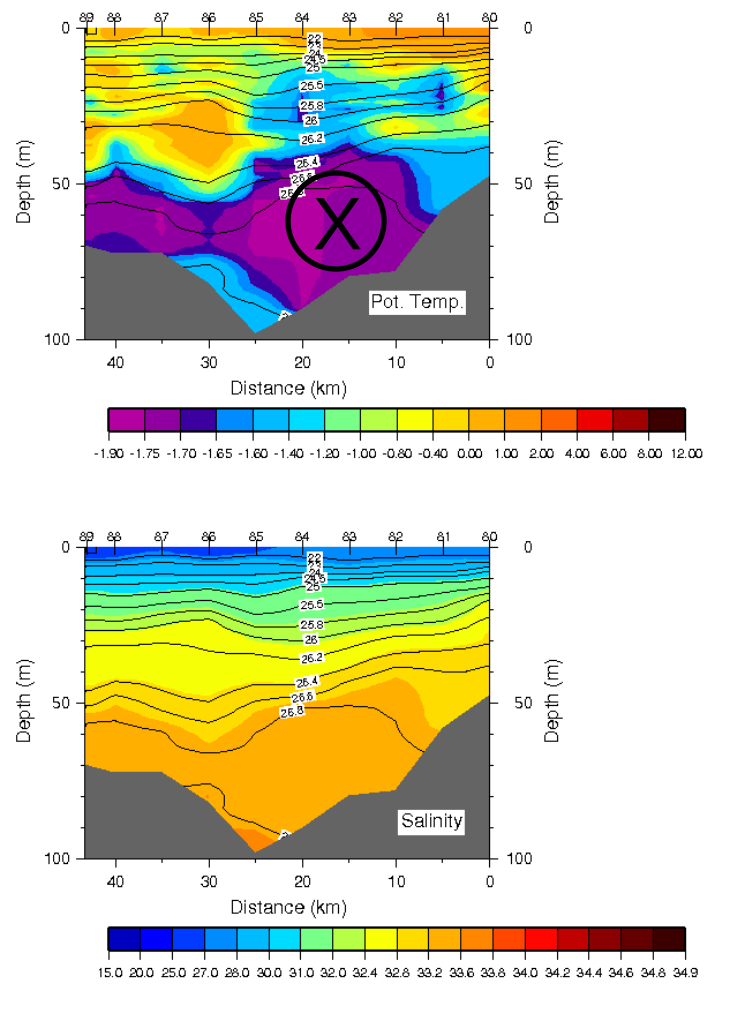

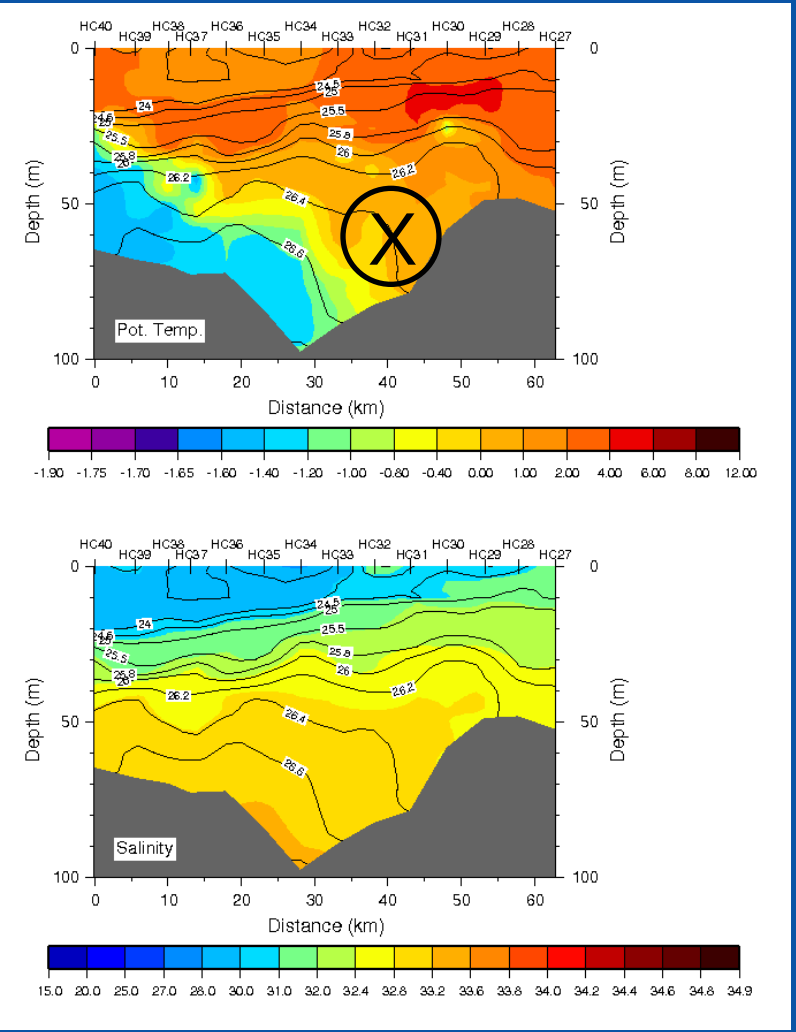

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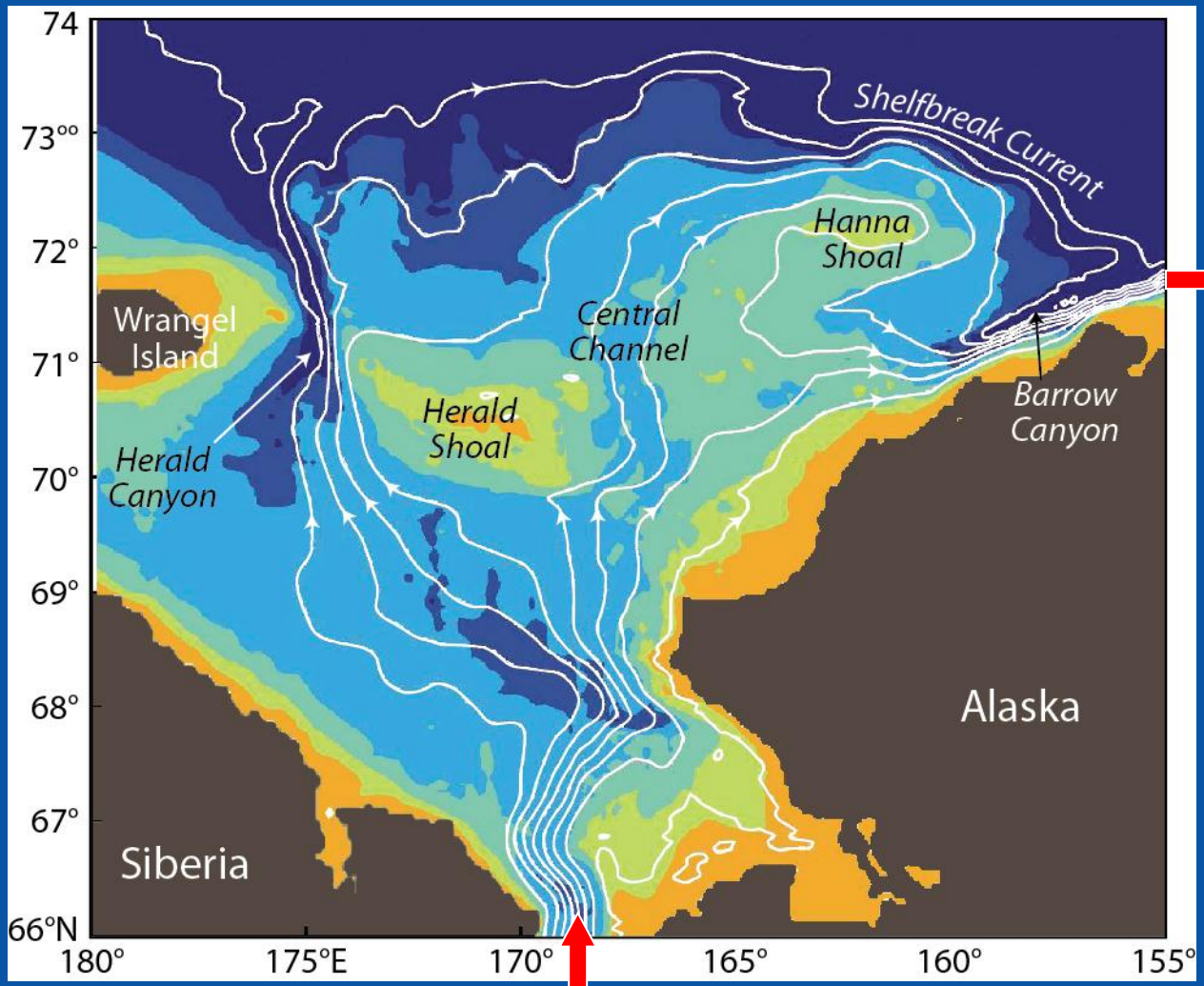

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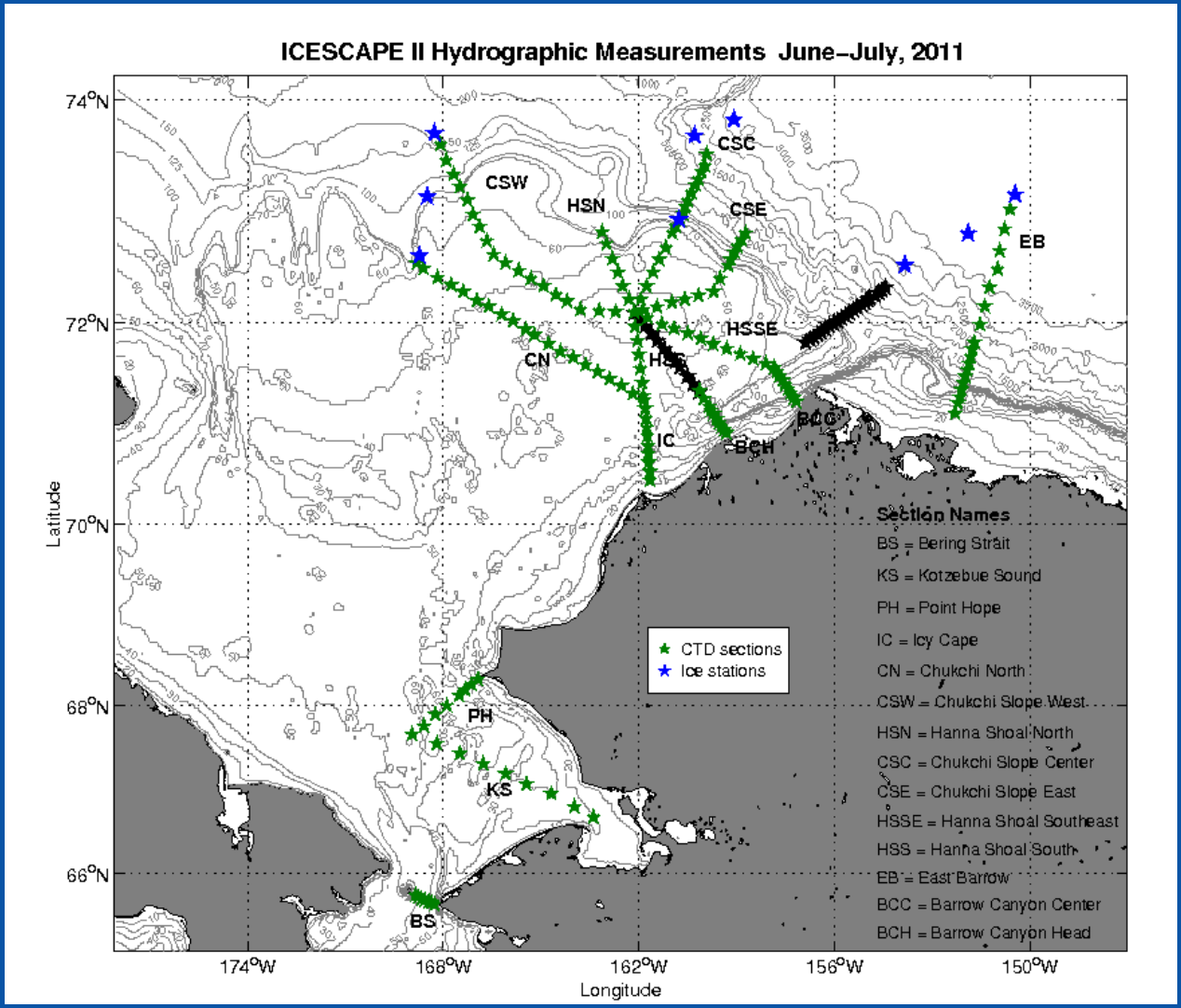

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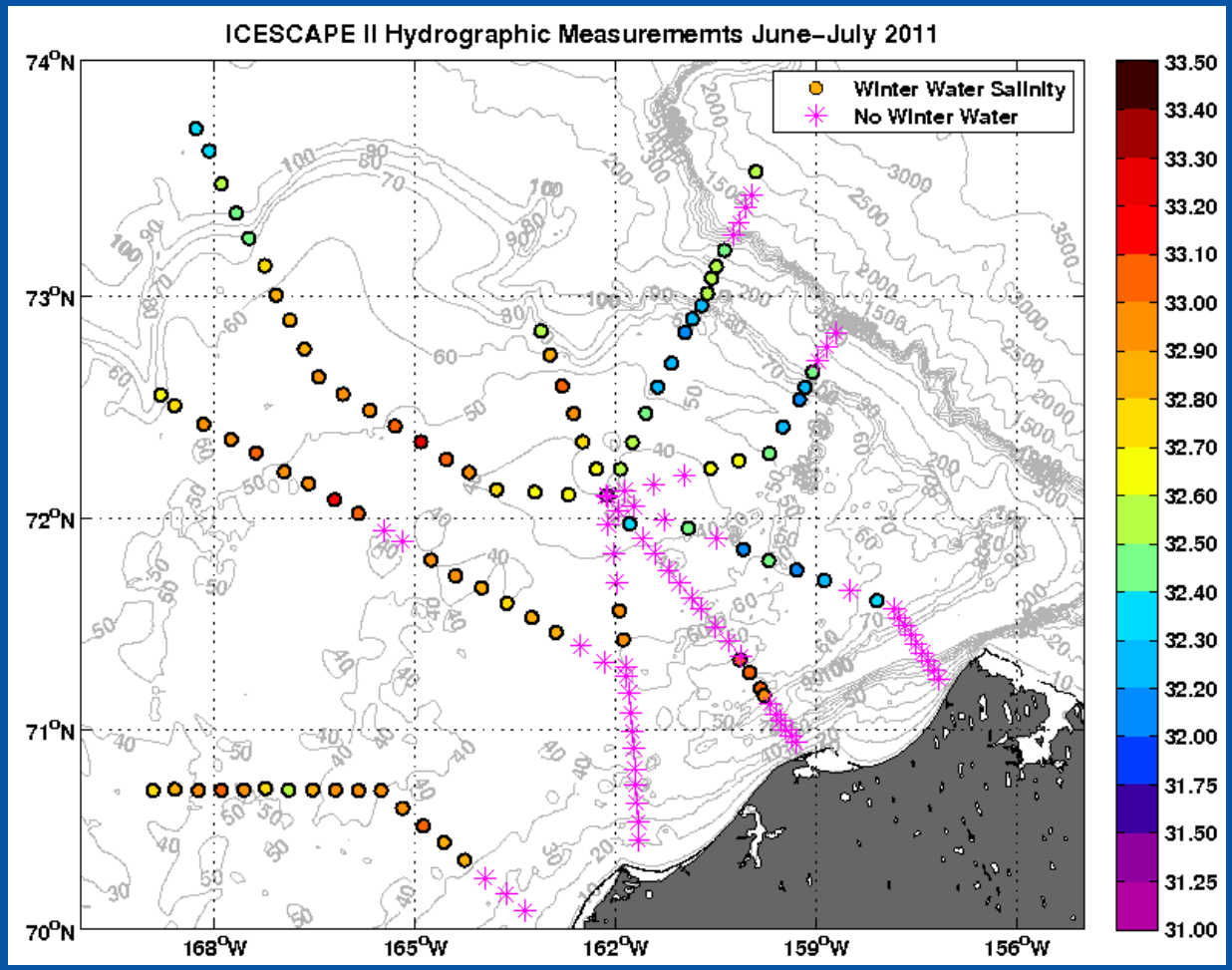

Mao et al. (in prep)

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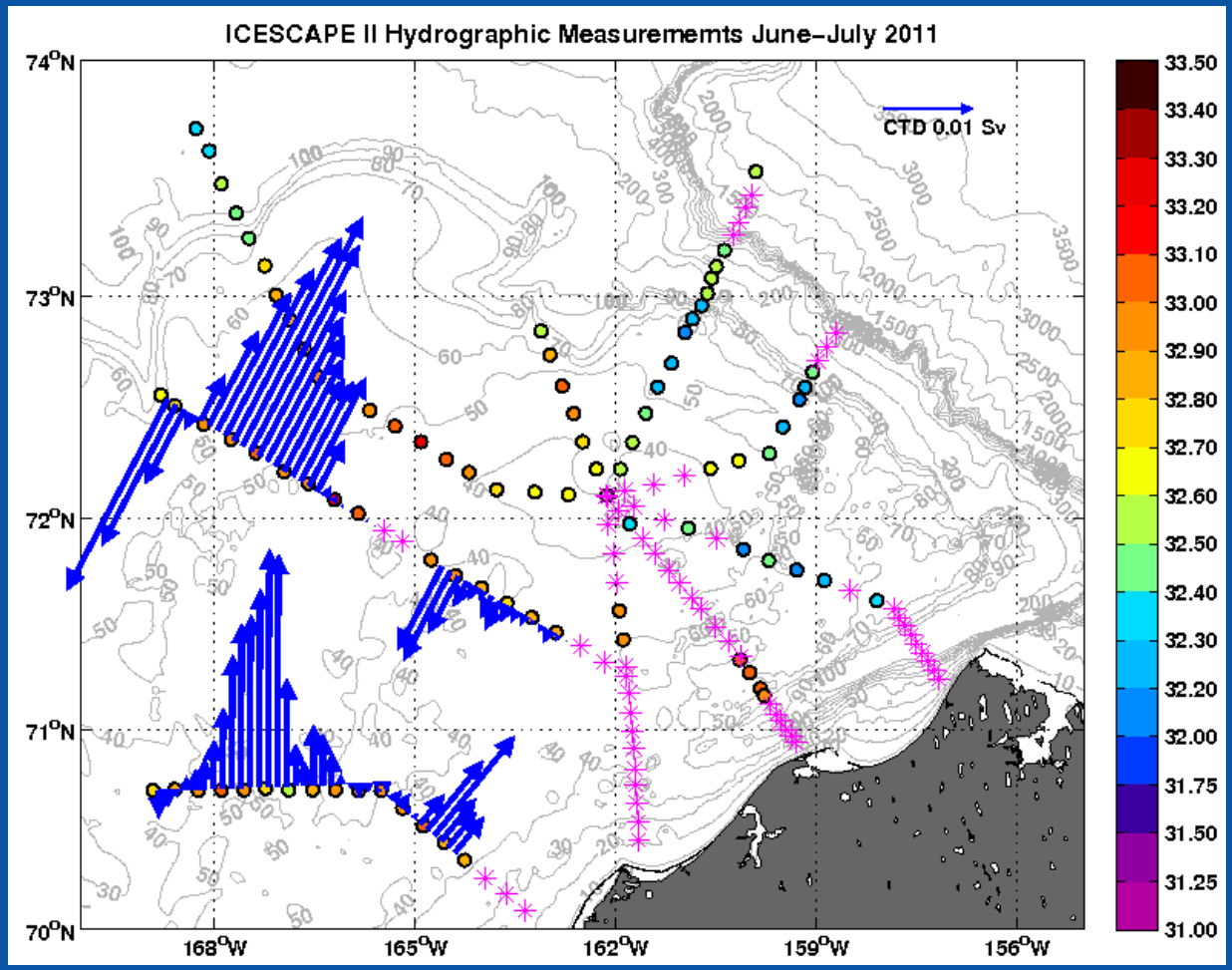

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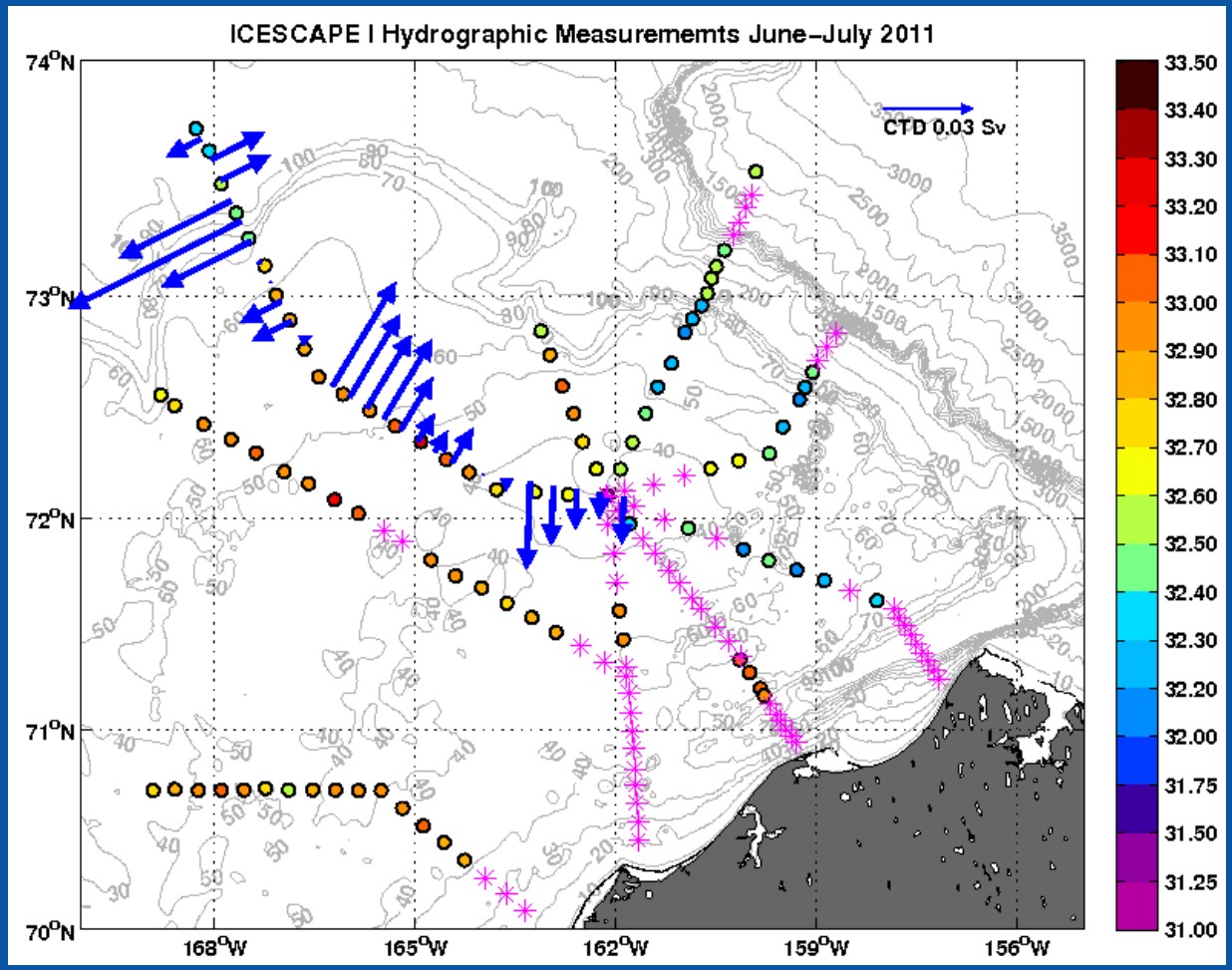

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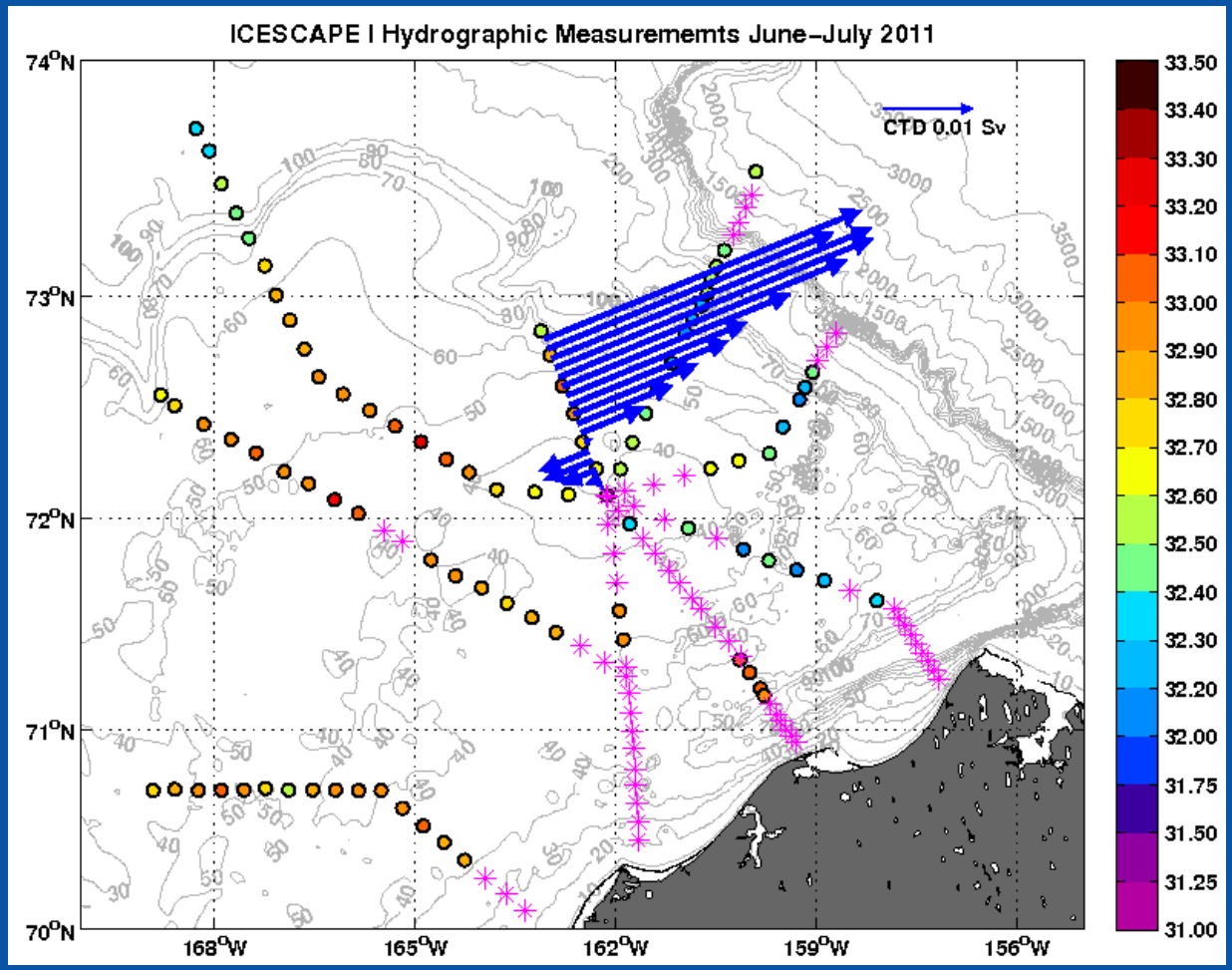

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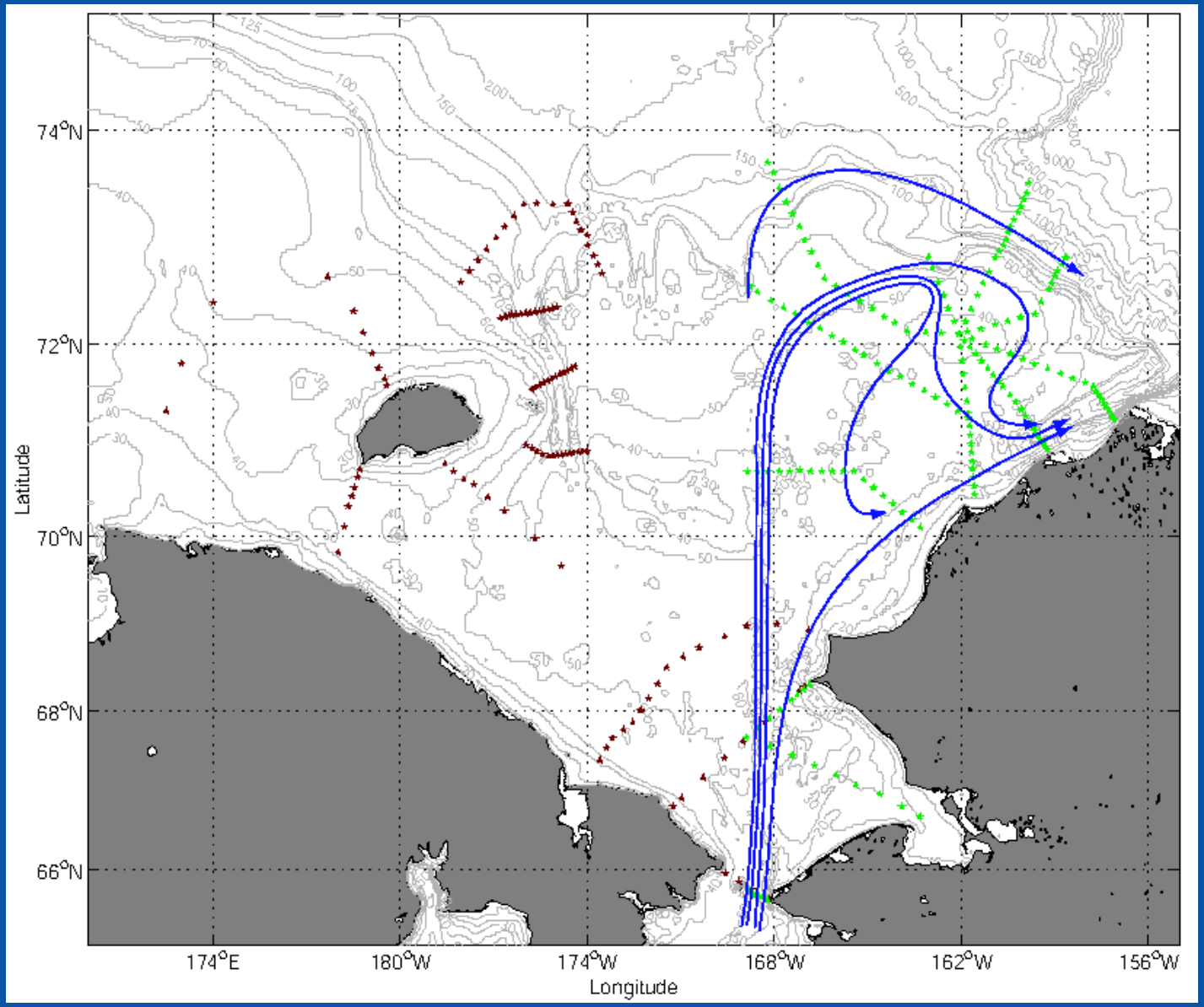
Revised winter water circulation scheme



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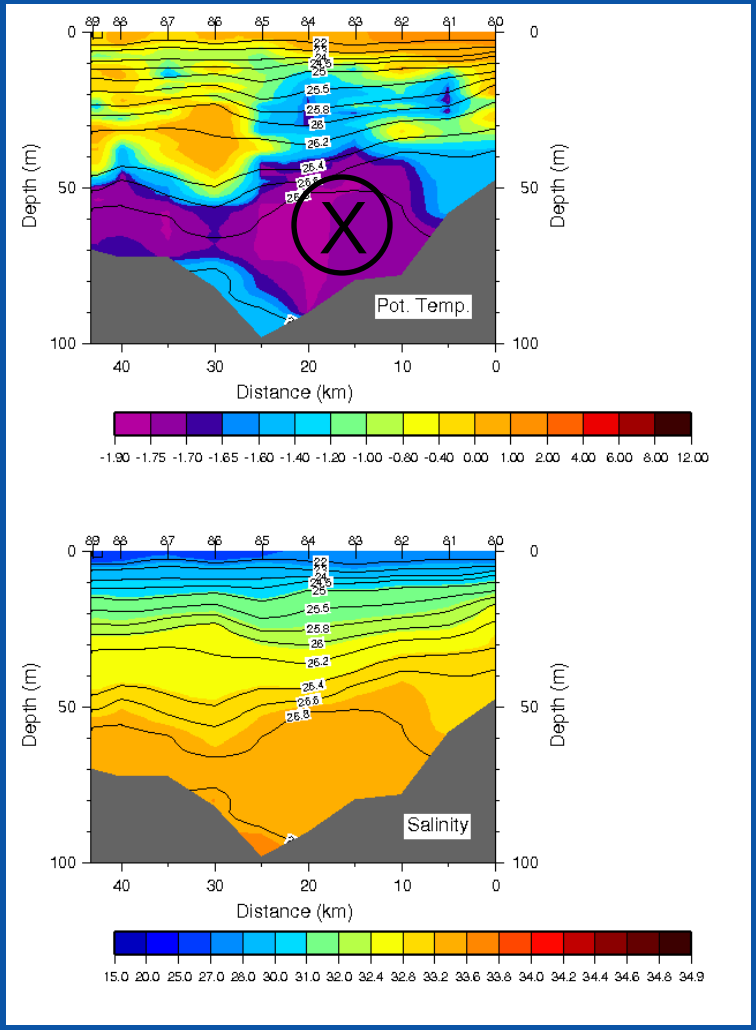

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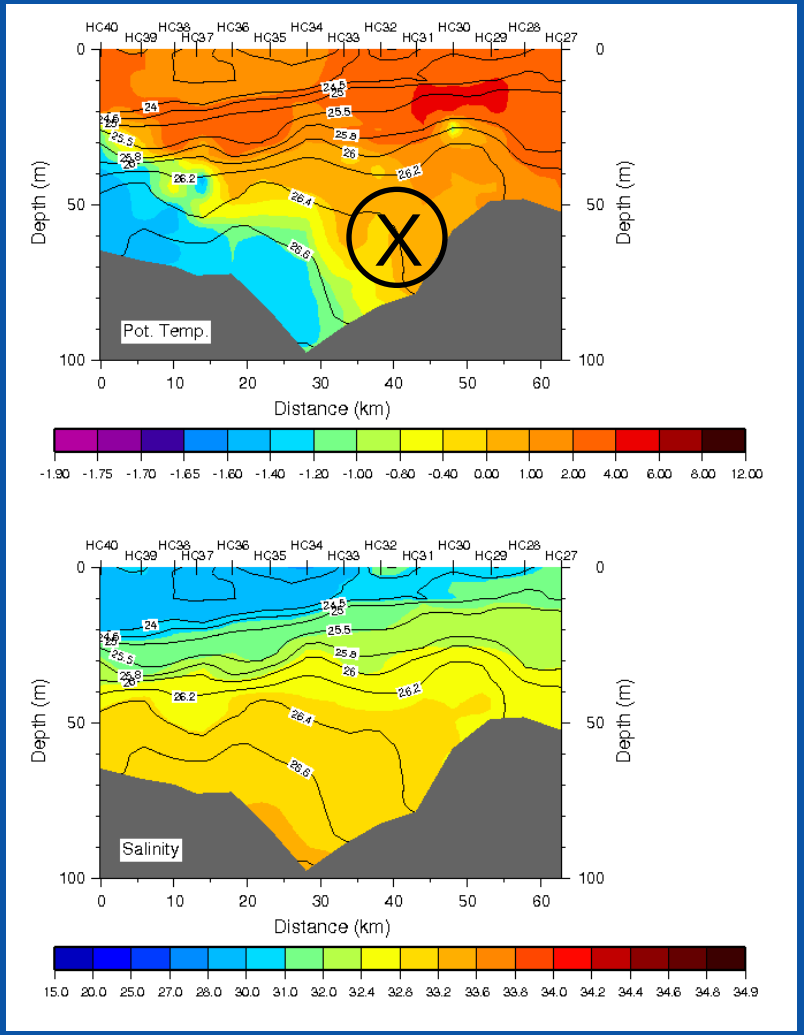

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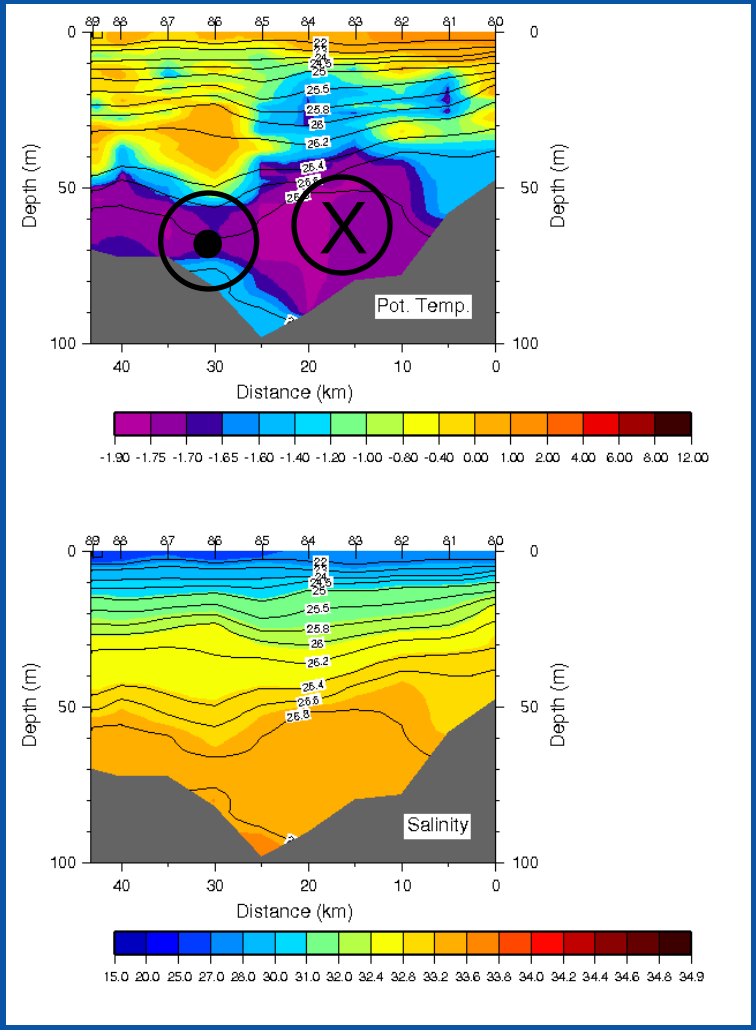

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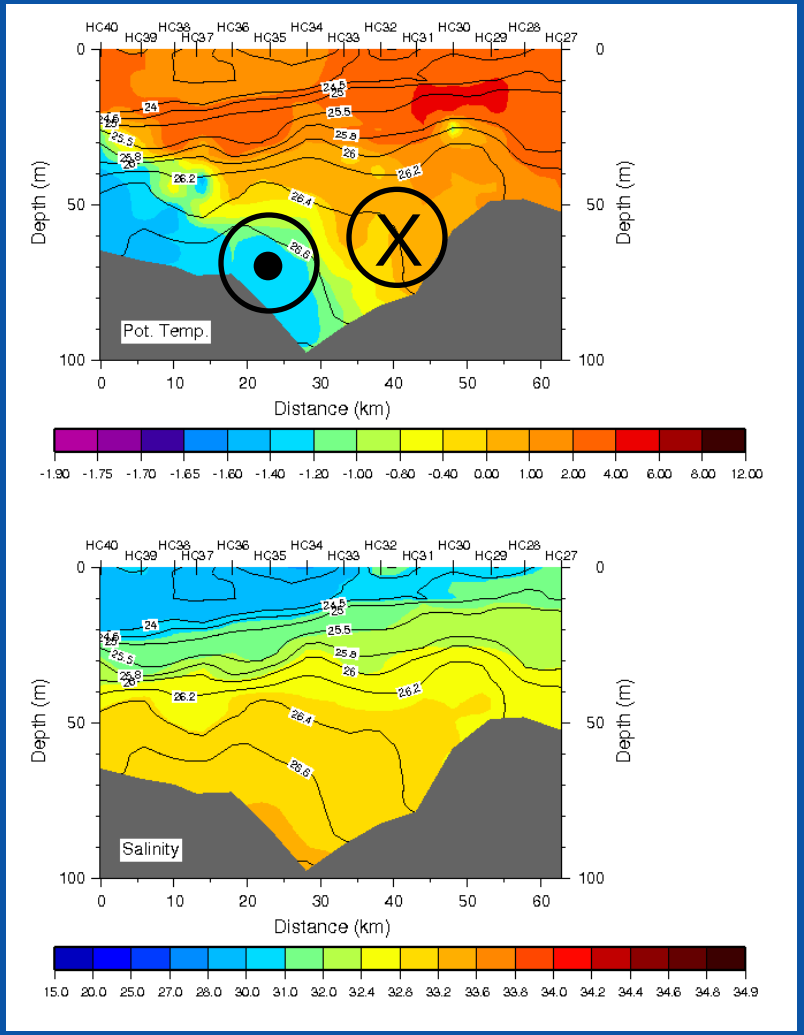

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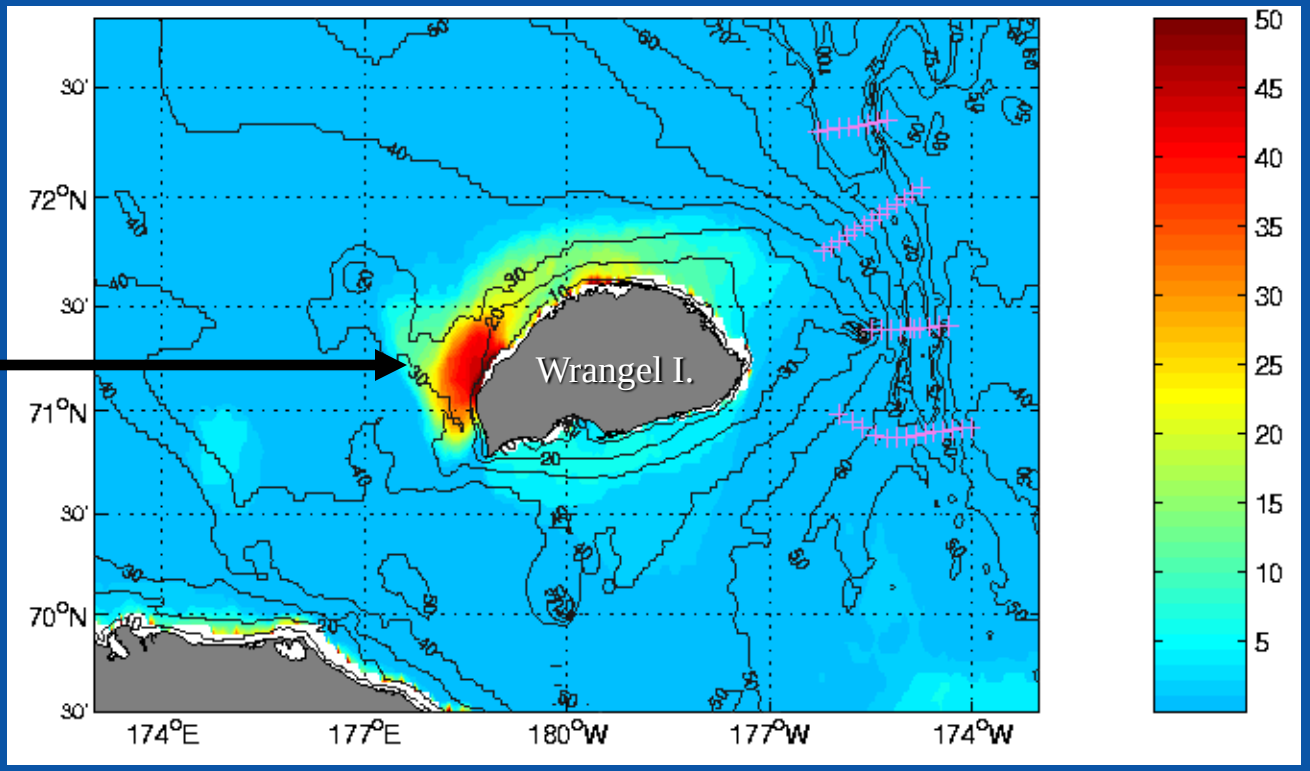

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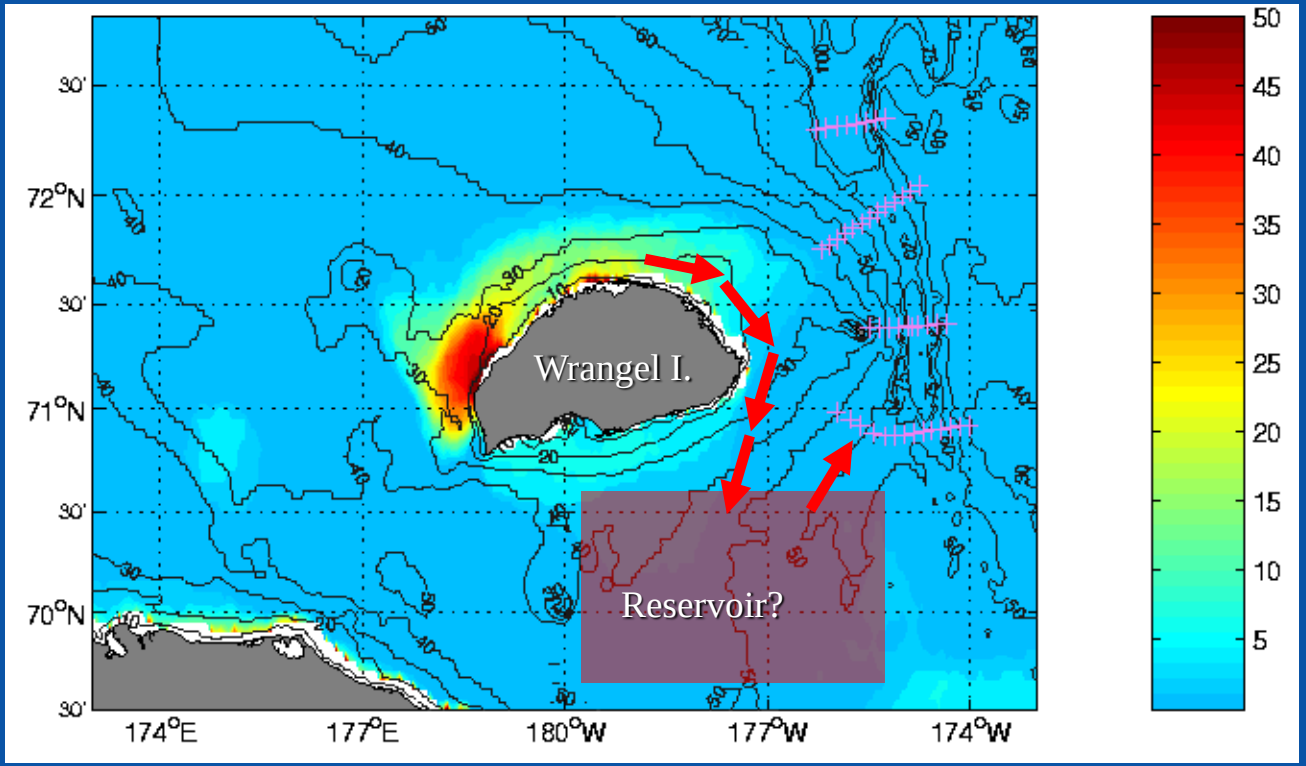

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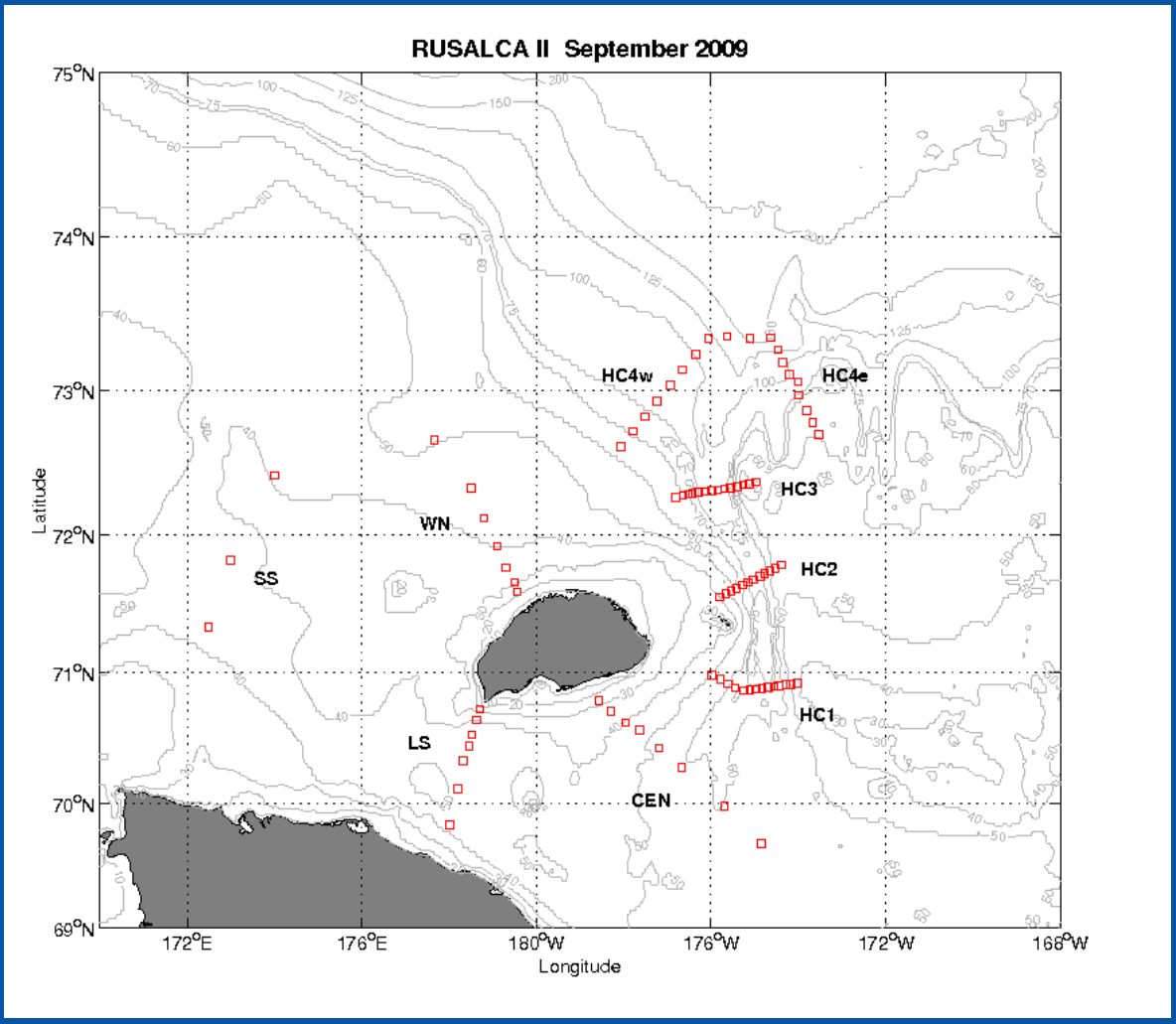
Another pathway of winter water

Unchartered canyon?



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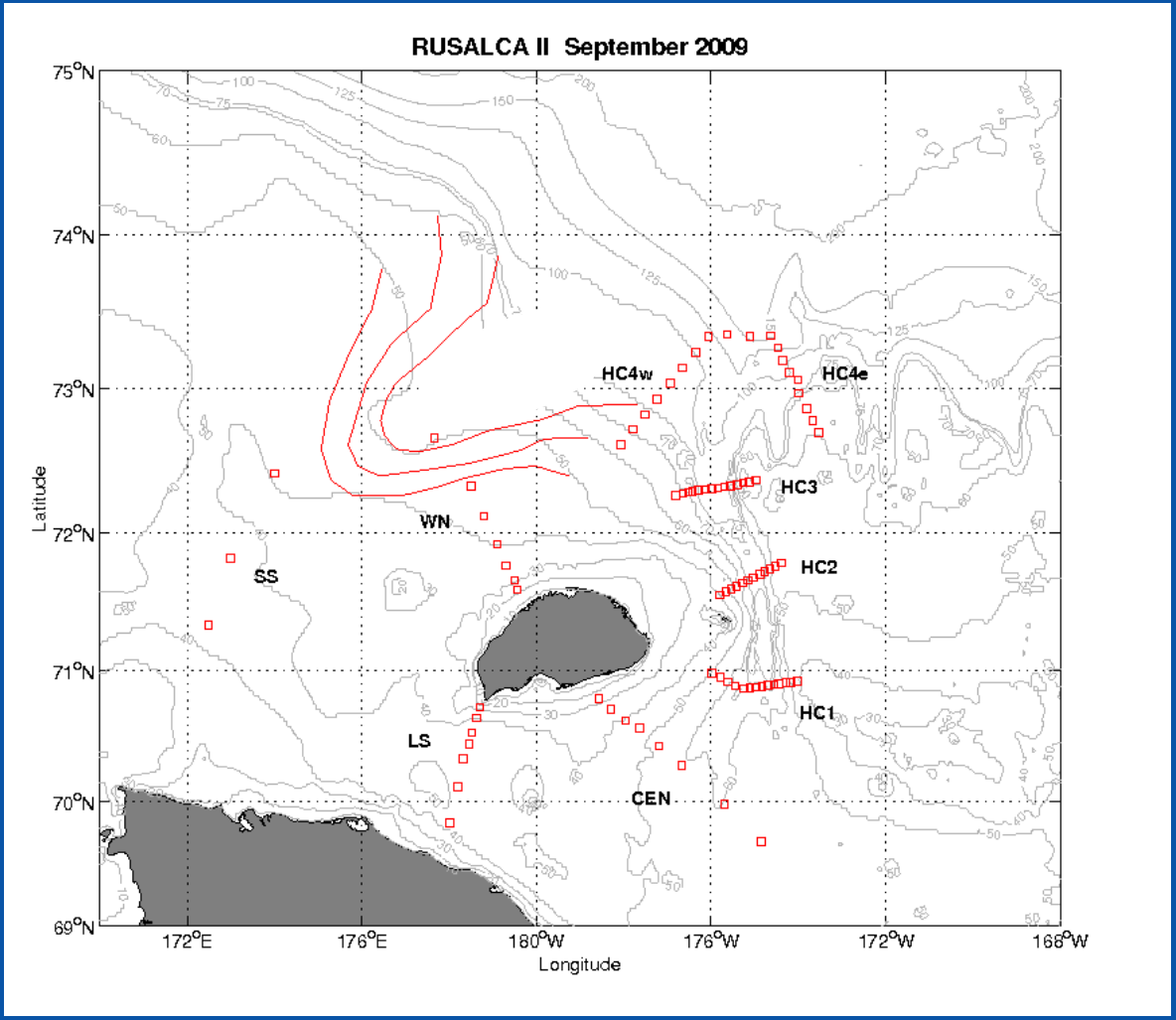

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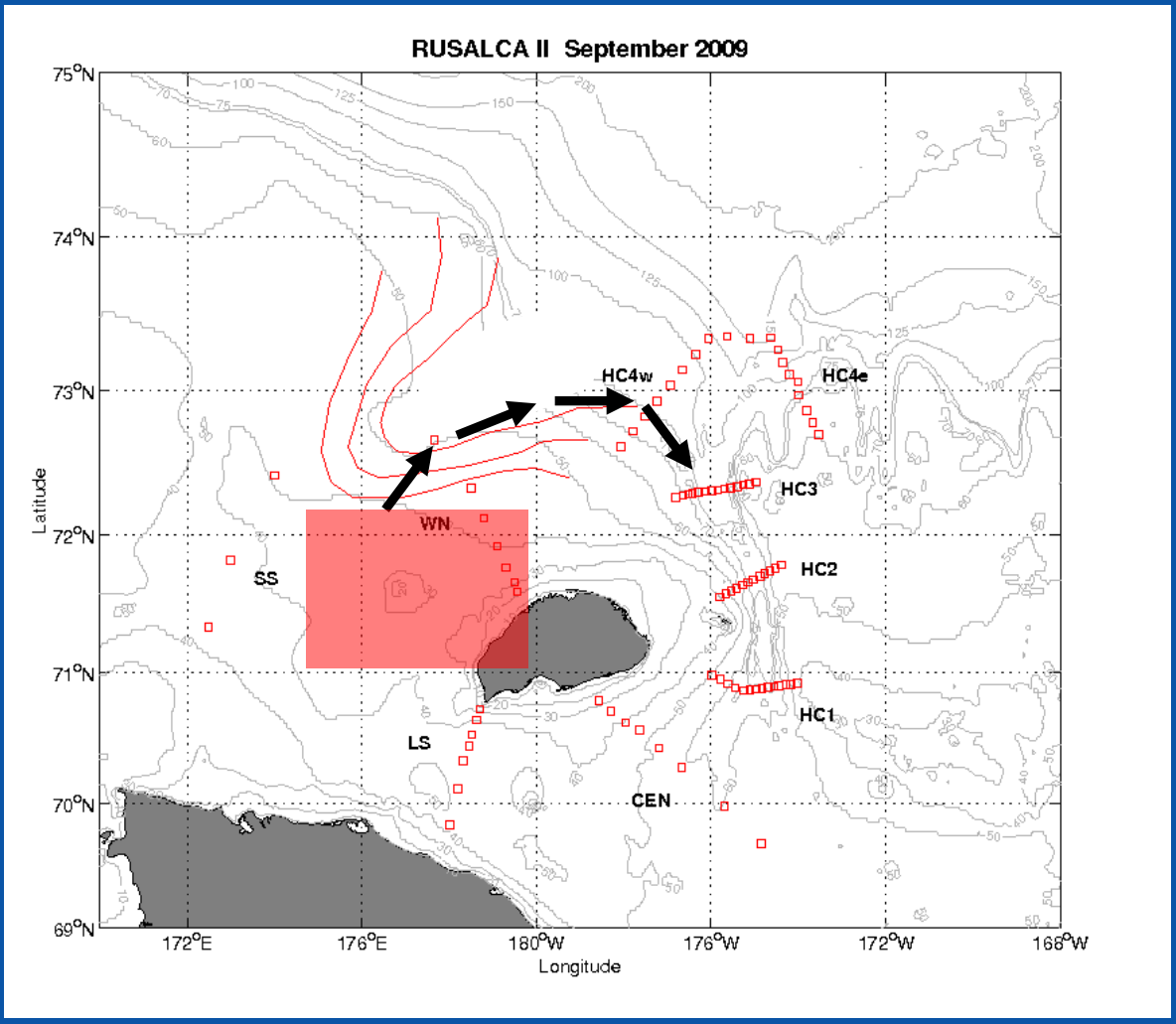

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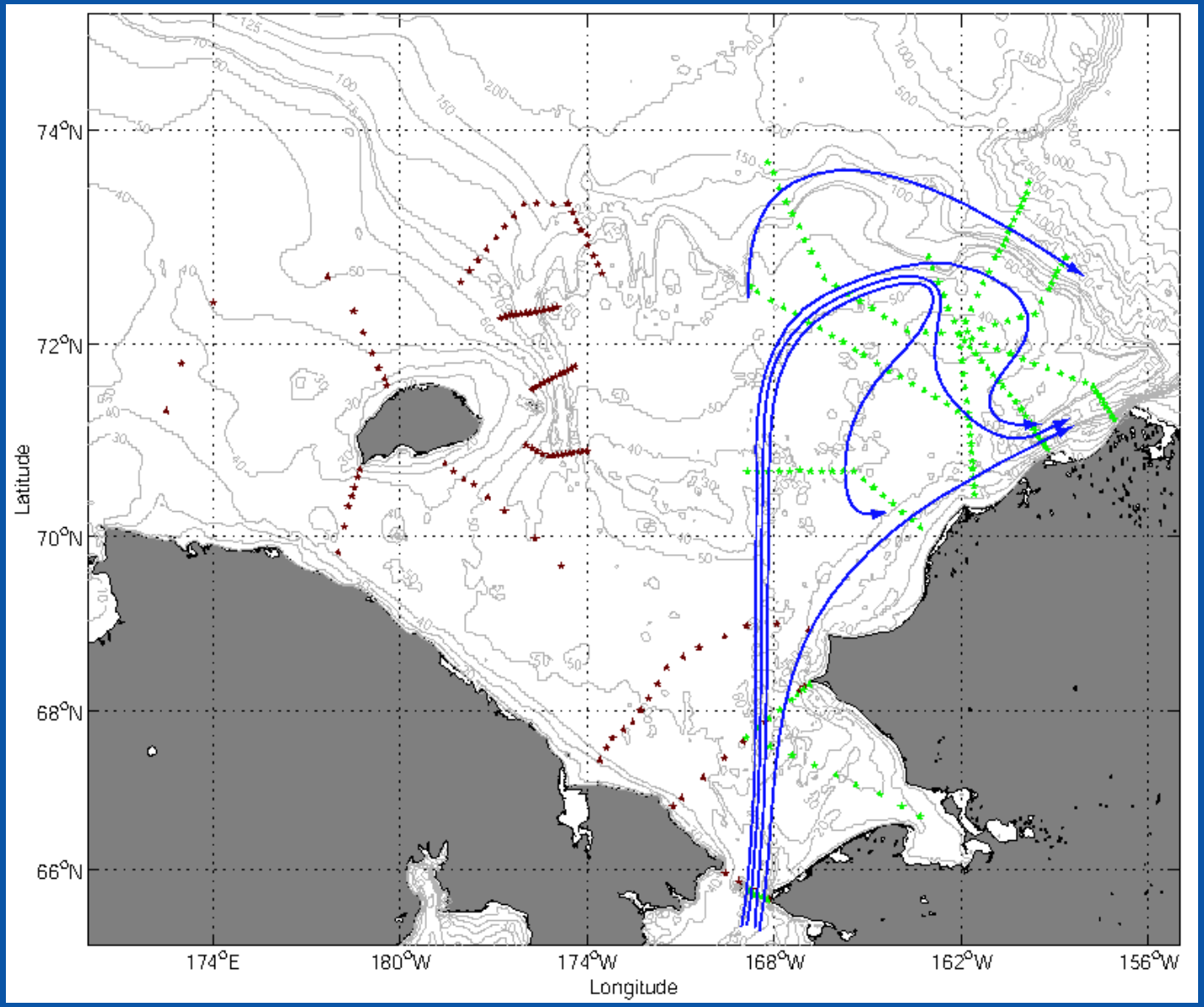

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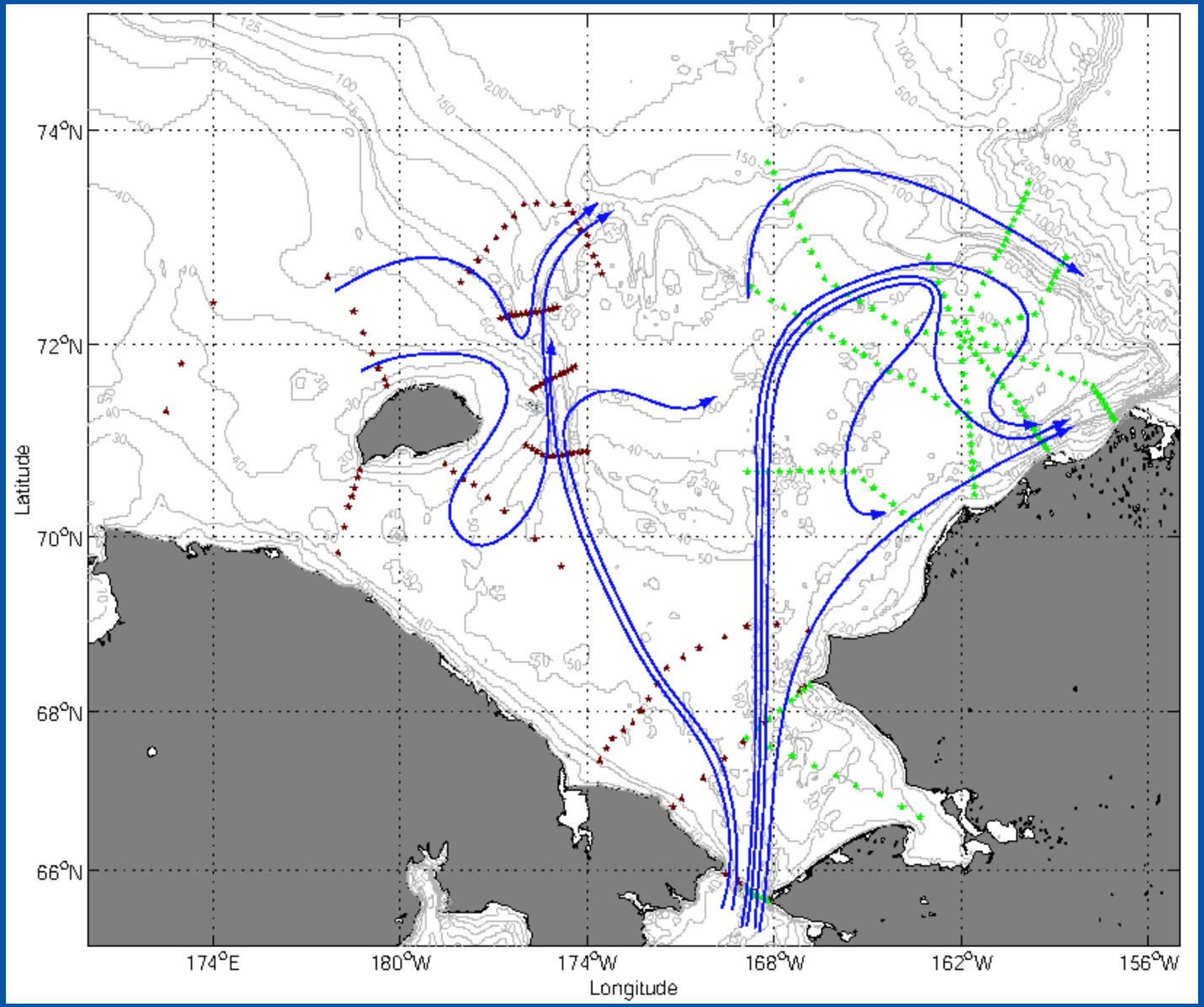

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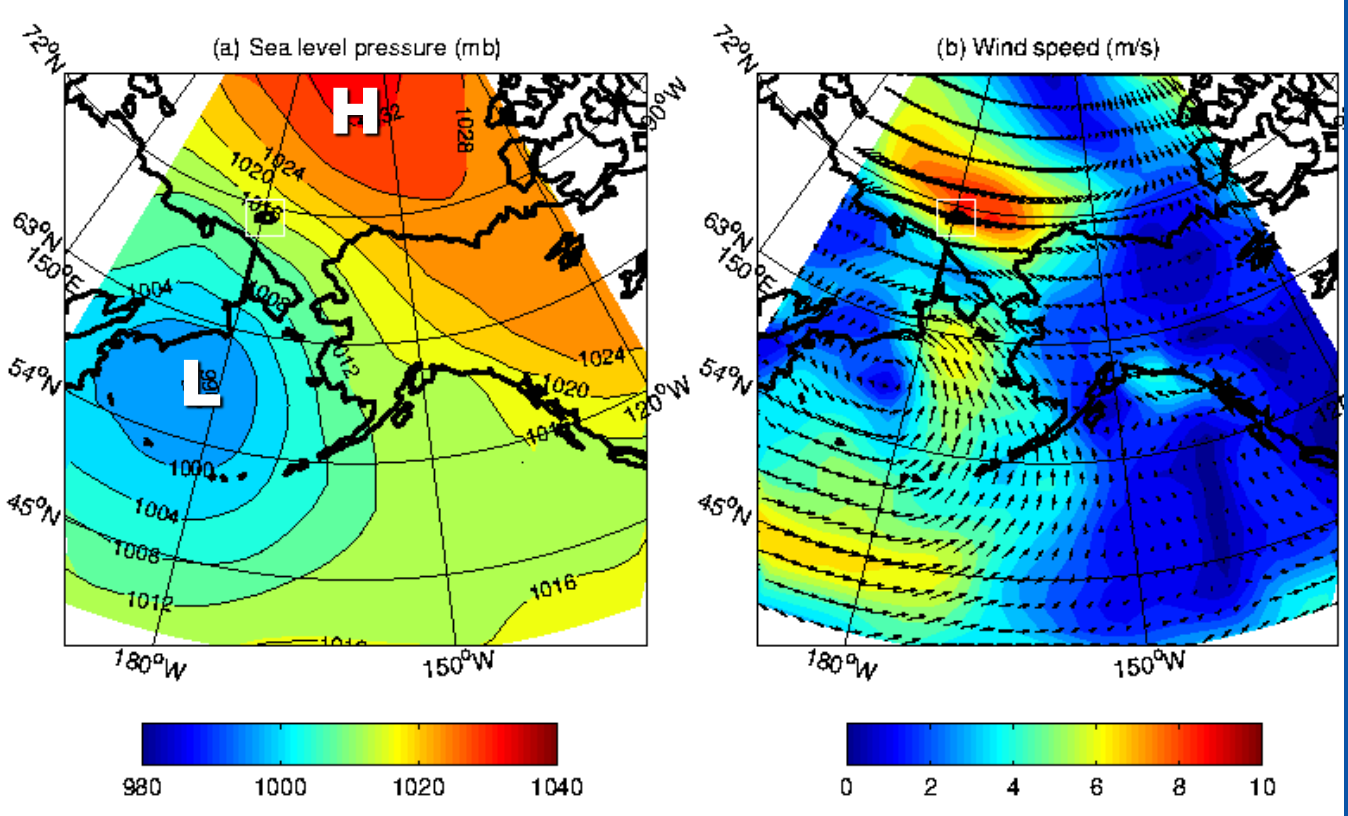
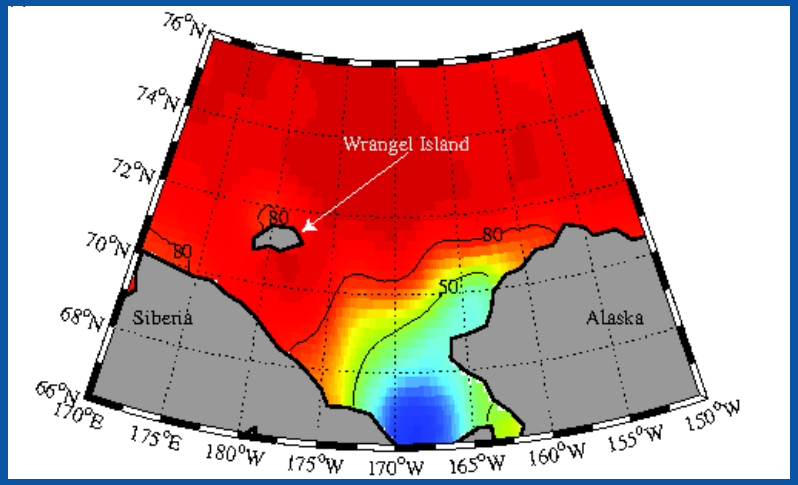
Meteorological conditions causing the polynya

Composite average from NCEP for the major Wrangel Island polynya events



Ice concentration in late spring



1979 to 1995

Moore and Pickart (2012)

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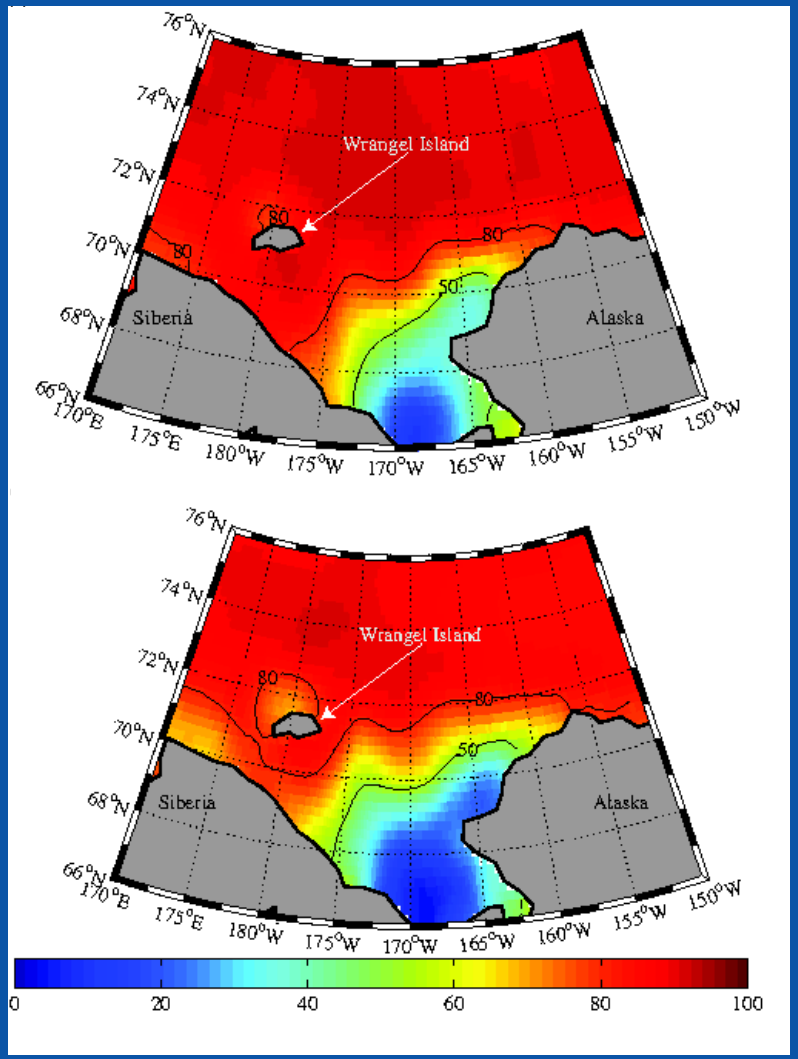

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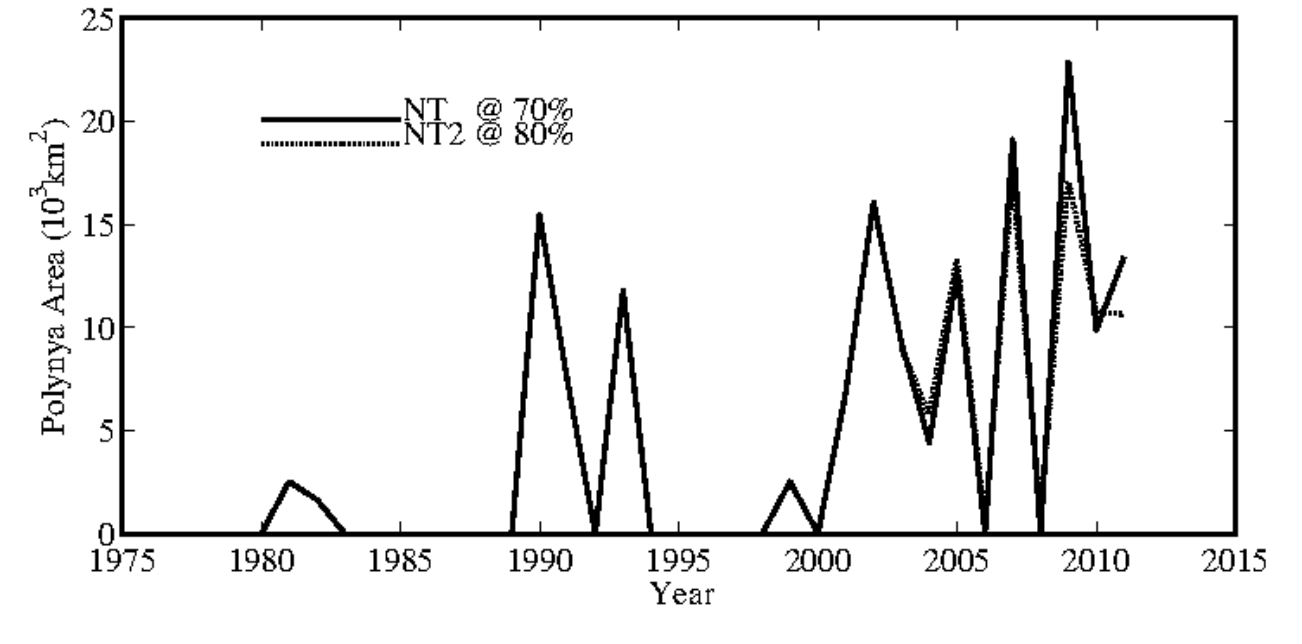
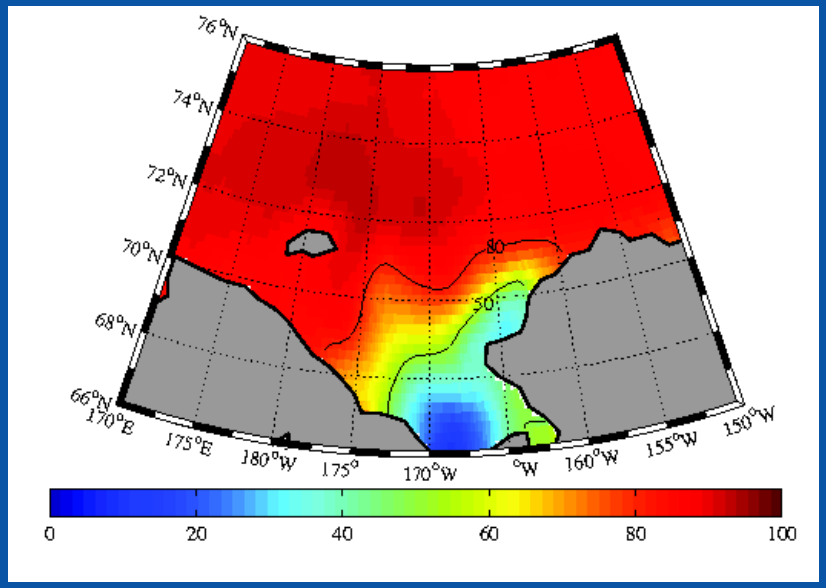


Mean polynya size in late-spring

Moore and Pickart (2012)

Ice concentration composites in late spring



Years when there is small polynya activity

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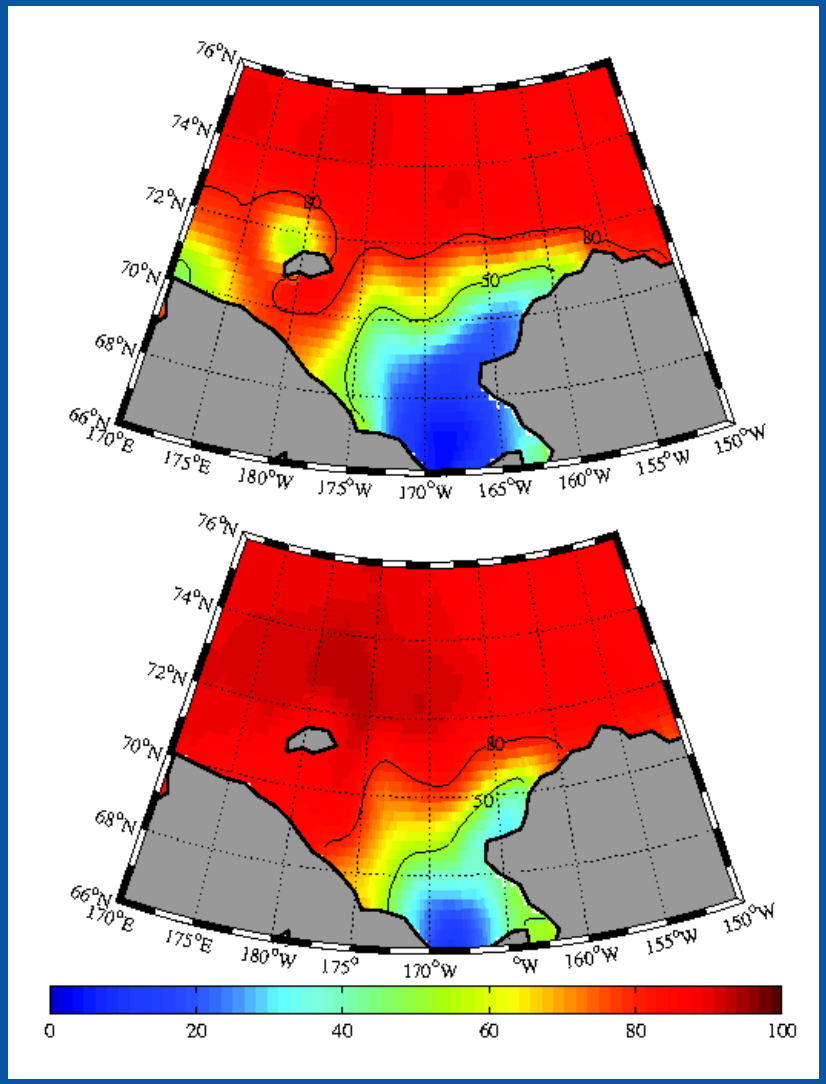

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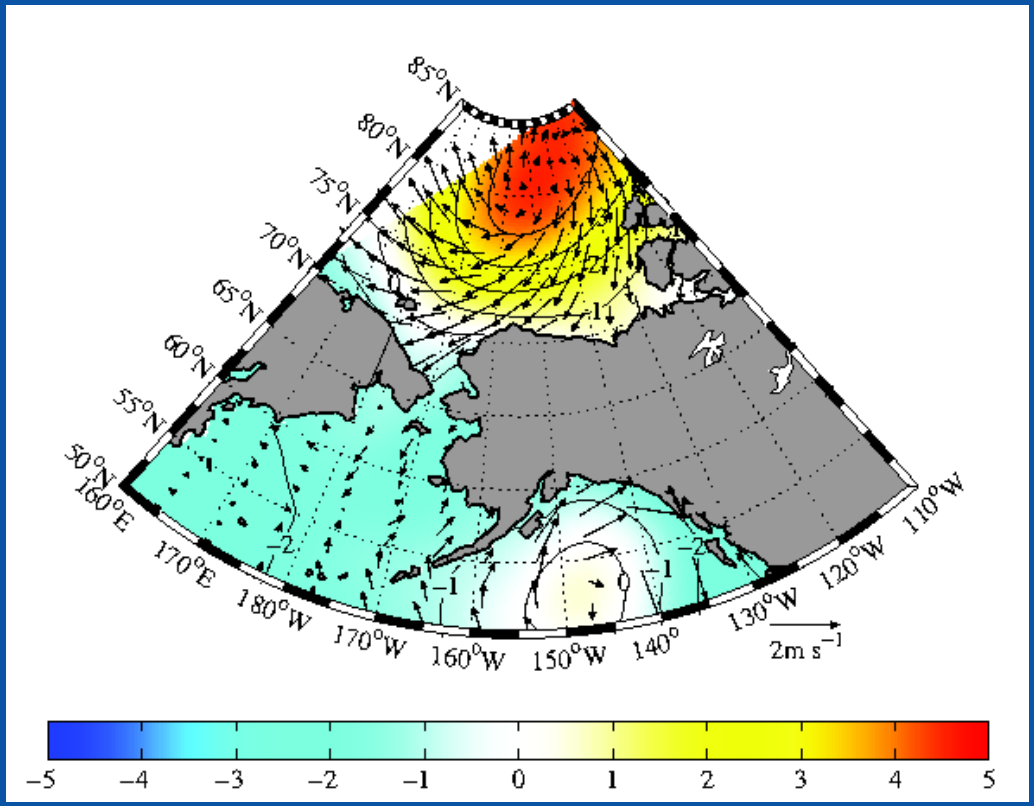
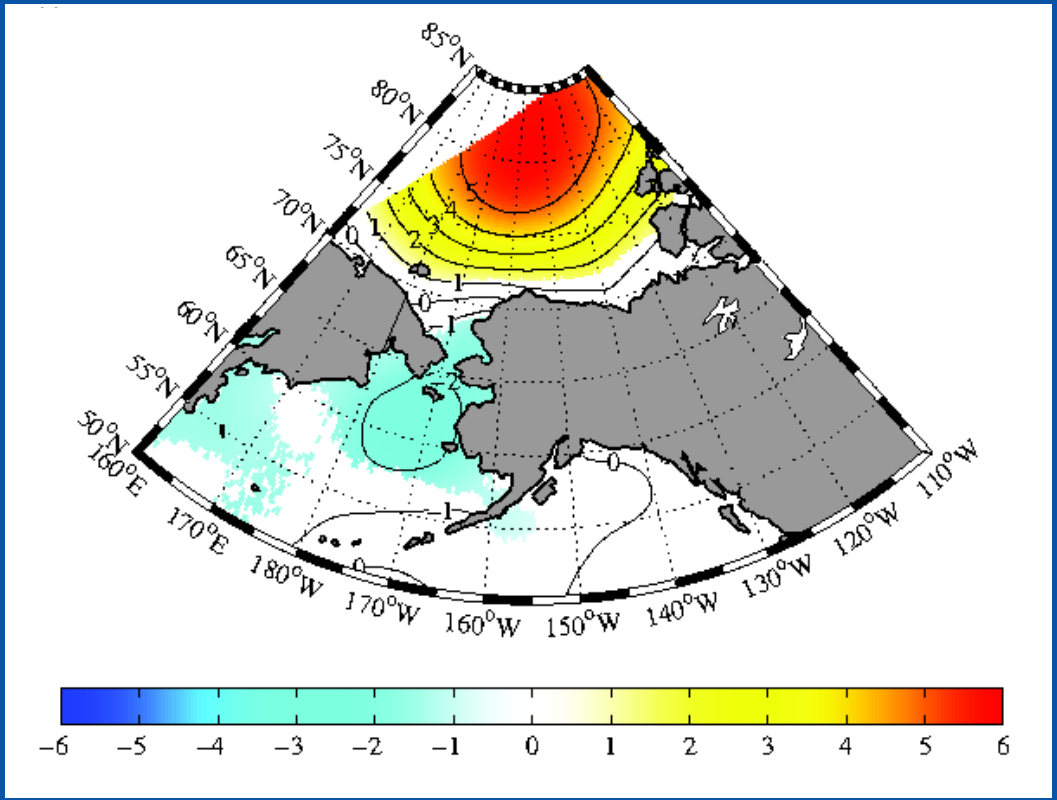
Atmospheric conditions



Moore and Pickart (2012)

Difference in Sea level pressure (color) and 10m wind vectors for high polynya years – low polynya years

Atmospheric trends from 1995 – 2001



Trend in Sea level pressure (mb/decade)

Moore and Pickart (2012)

Monthly mean air temperature 1979 – 2011

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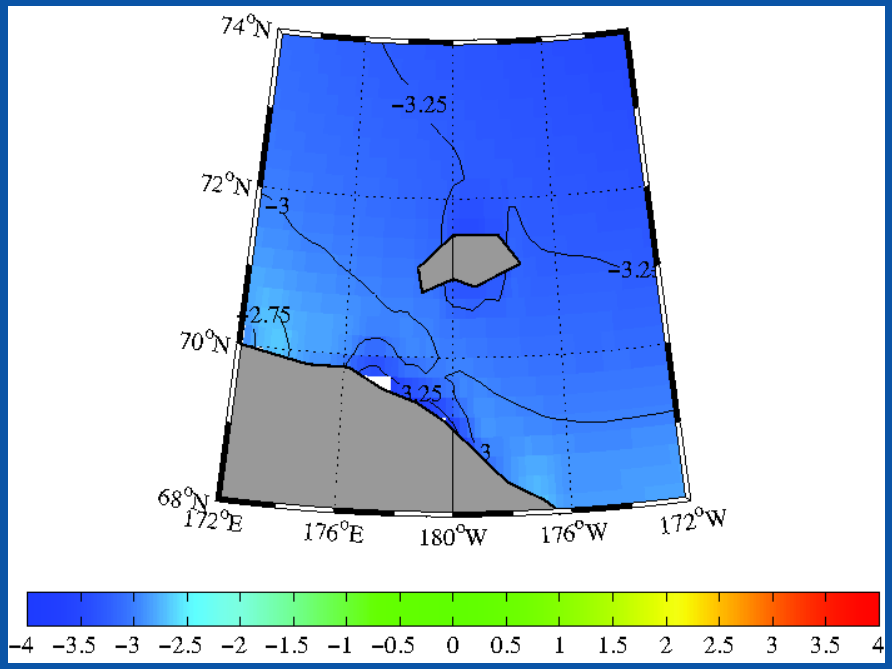

From K. Moore

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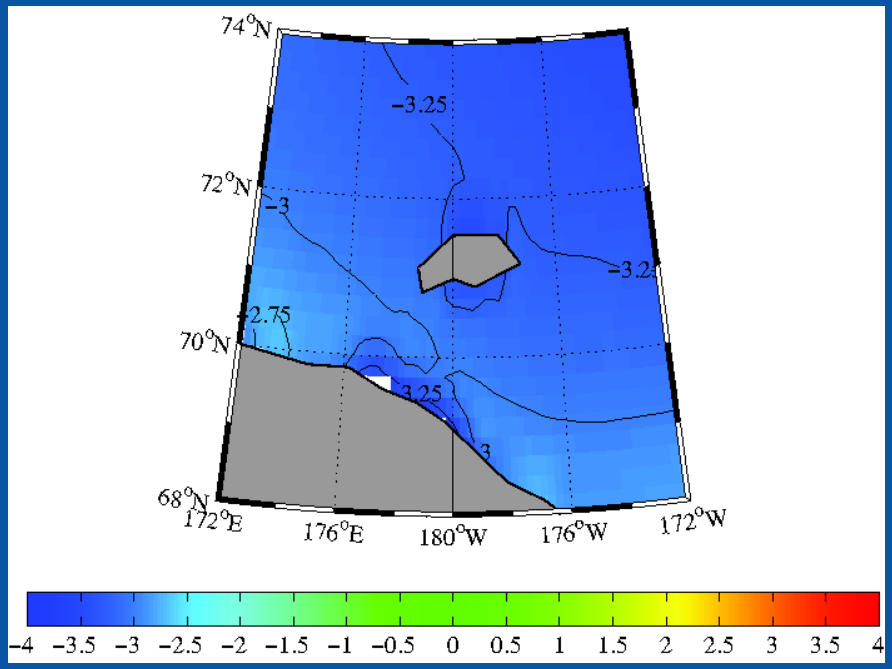

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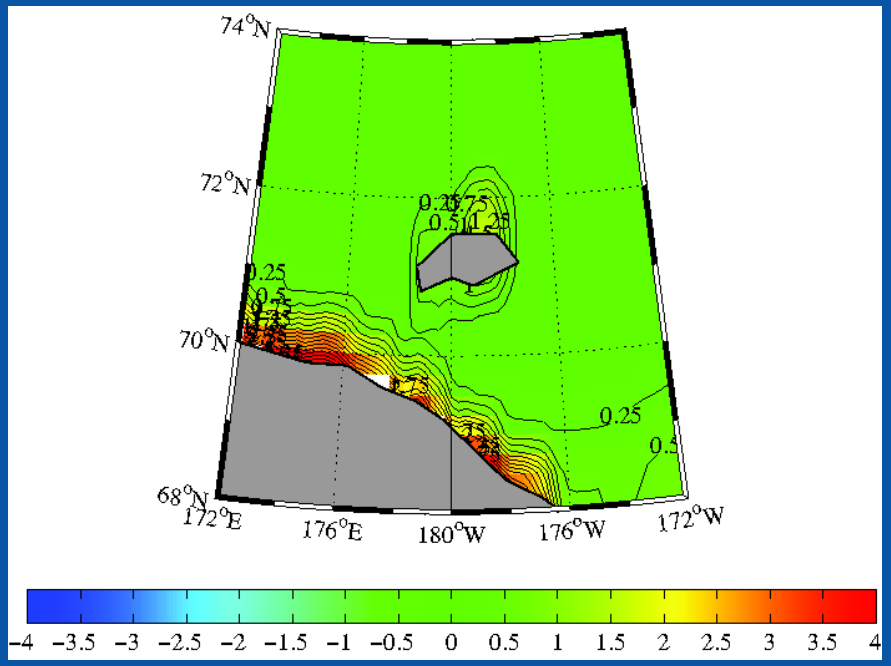

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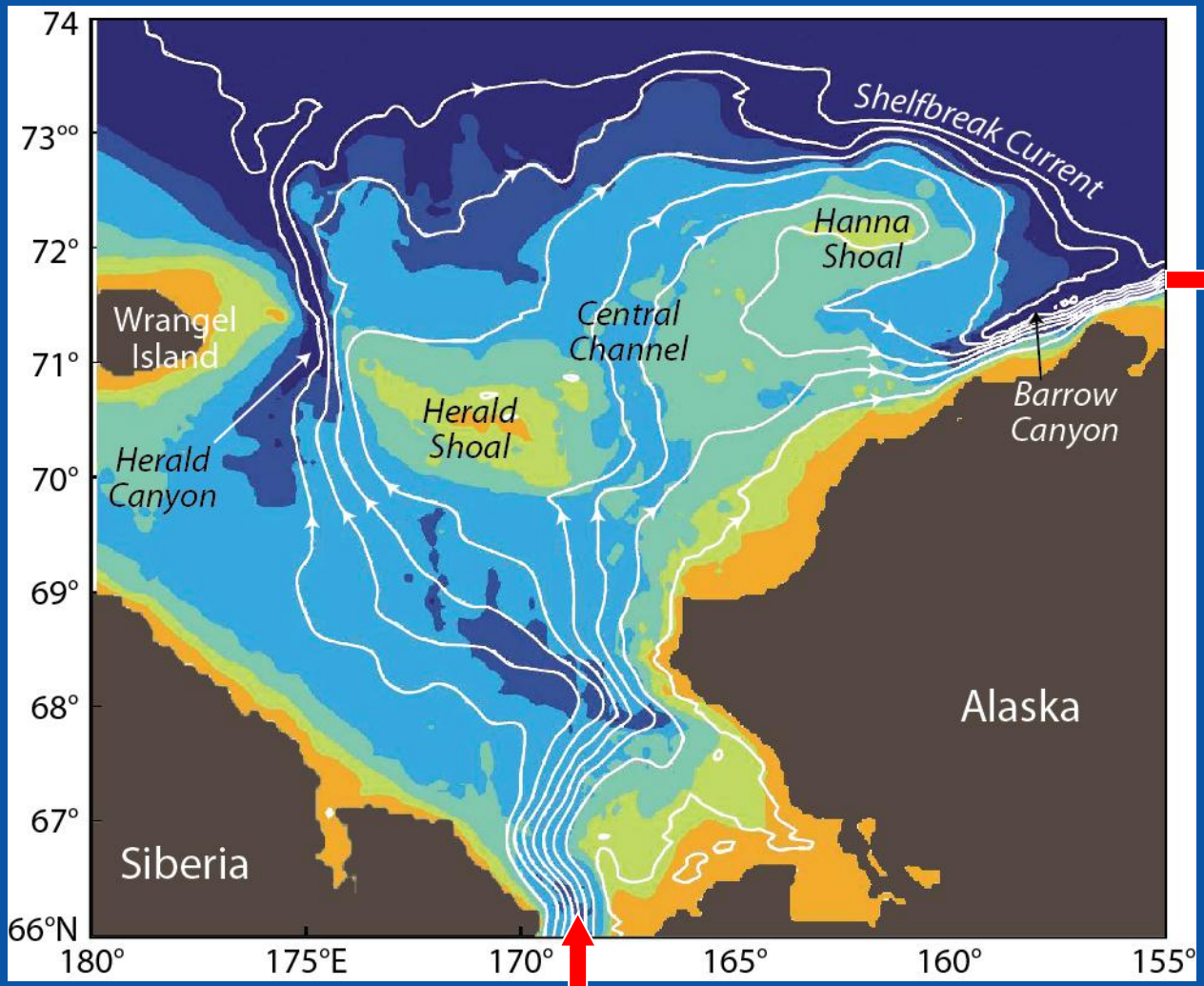
2. **Dynamical processes in the canyon impact the transport, characteristics, and fate of the exiting water.**

3. **The winter water comes from two sources: Bering Strait and the Wrangel Island polynya. The latter source is likely changing due to decreases in ice cover and the changing atmospheric conditions.**

Thank You

Pancake ice as seen from the Professor Khromov
Chukchi Sea, September 2009 (Photo by D. Torres)

Pacific water inflow to the Arctic



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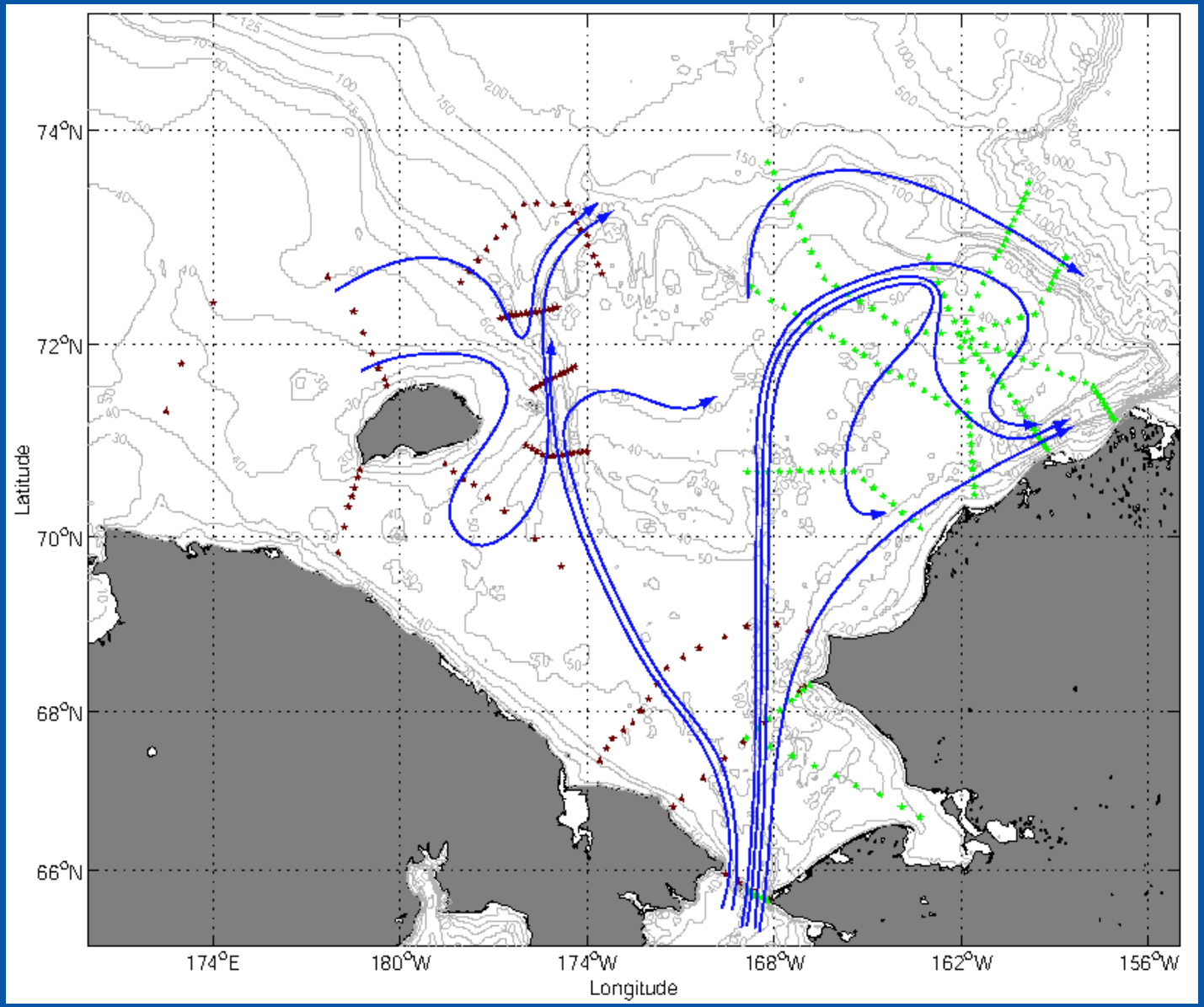

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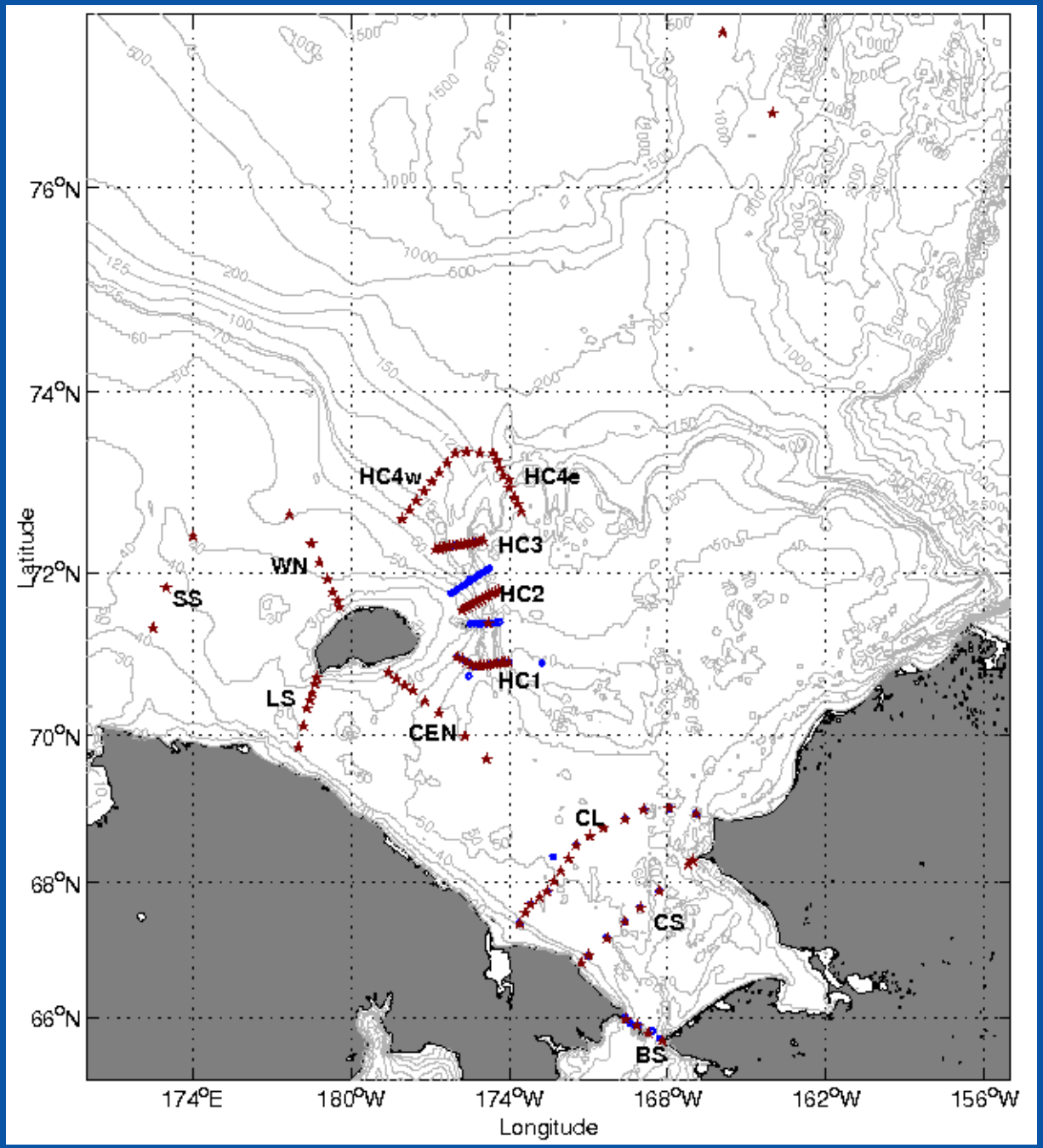

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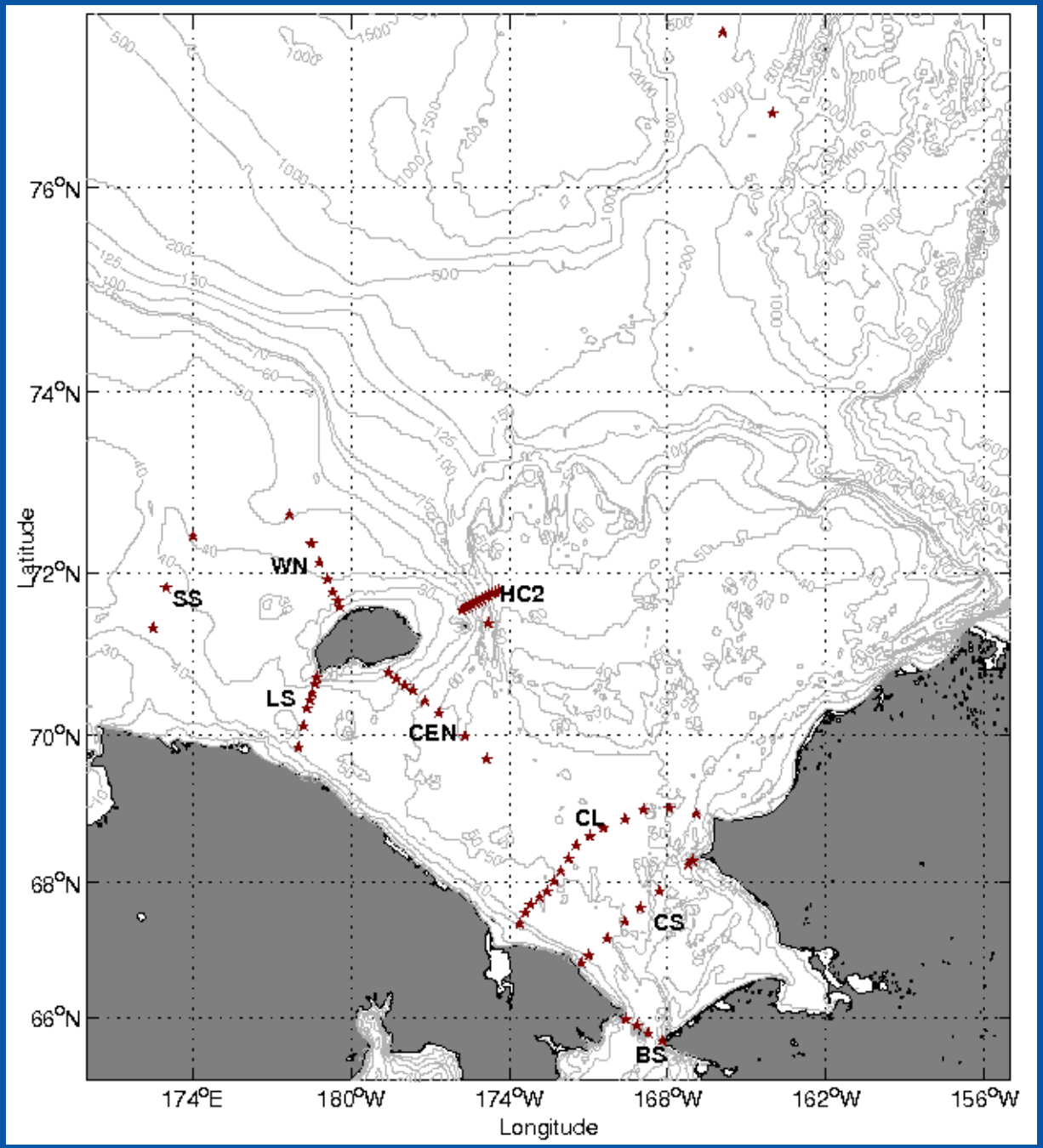

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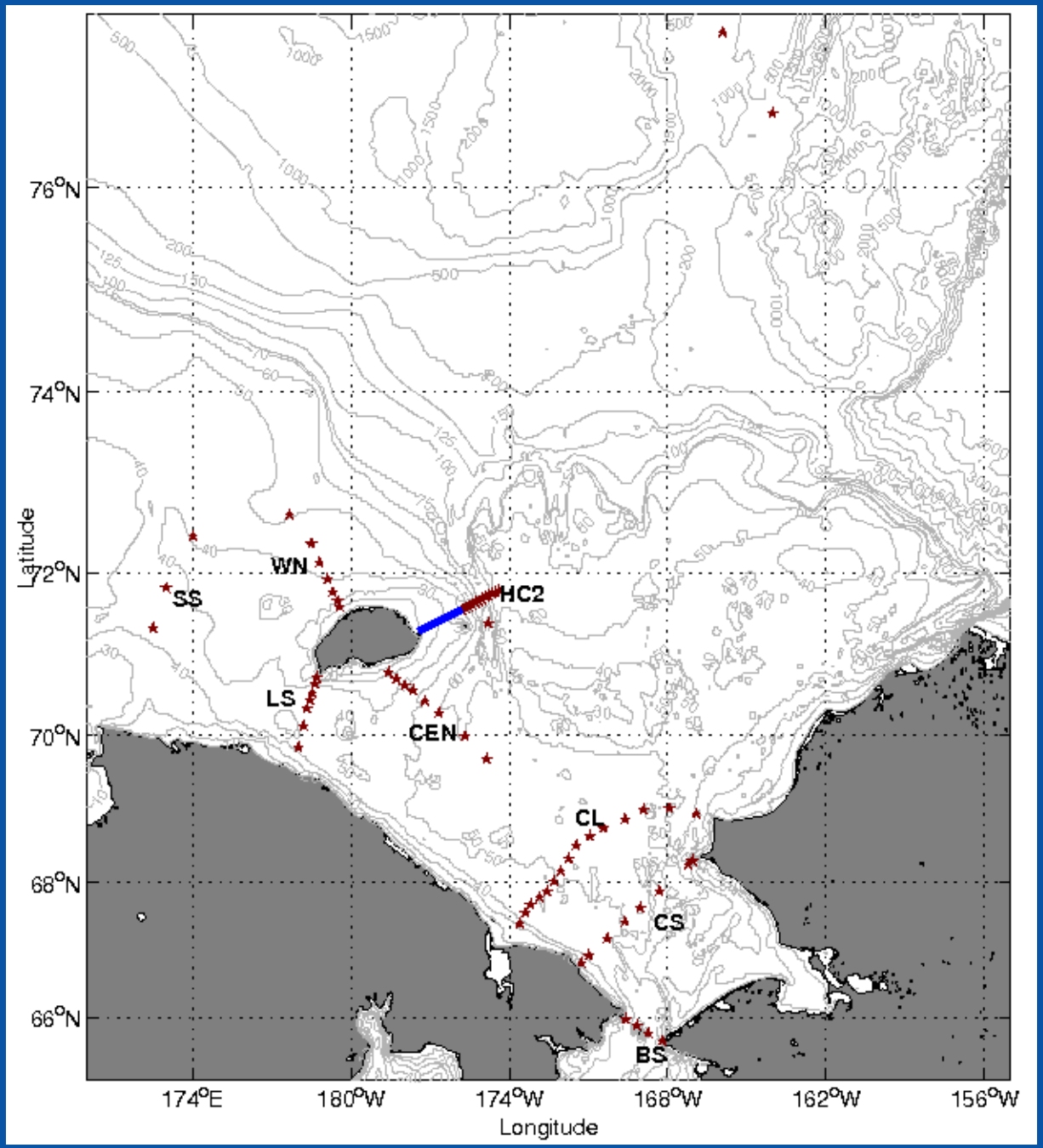
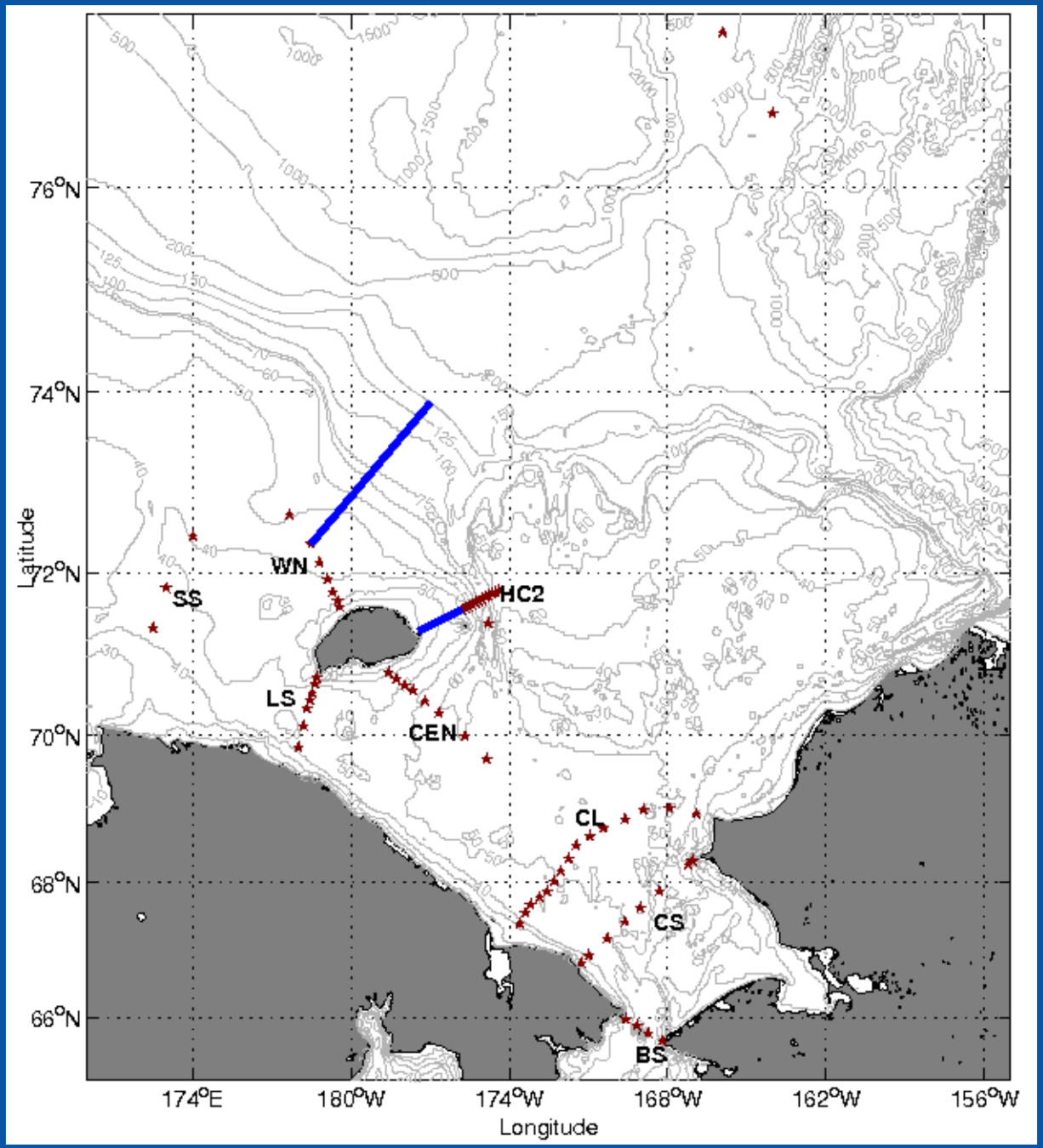
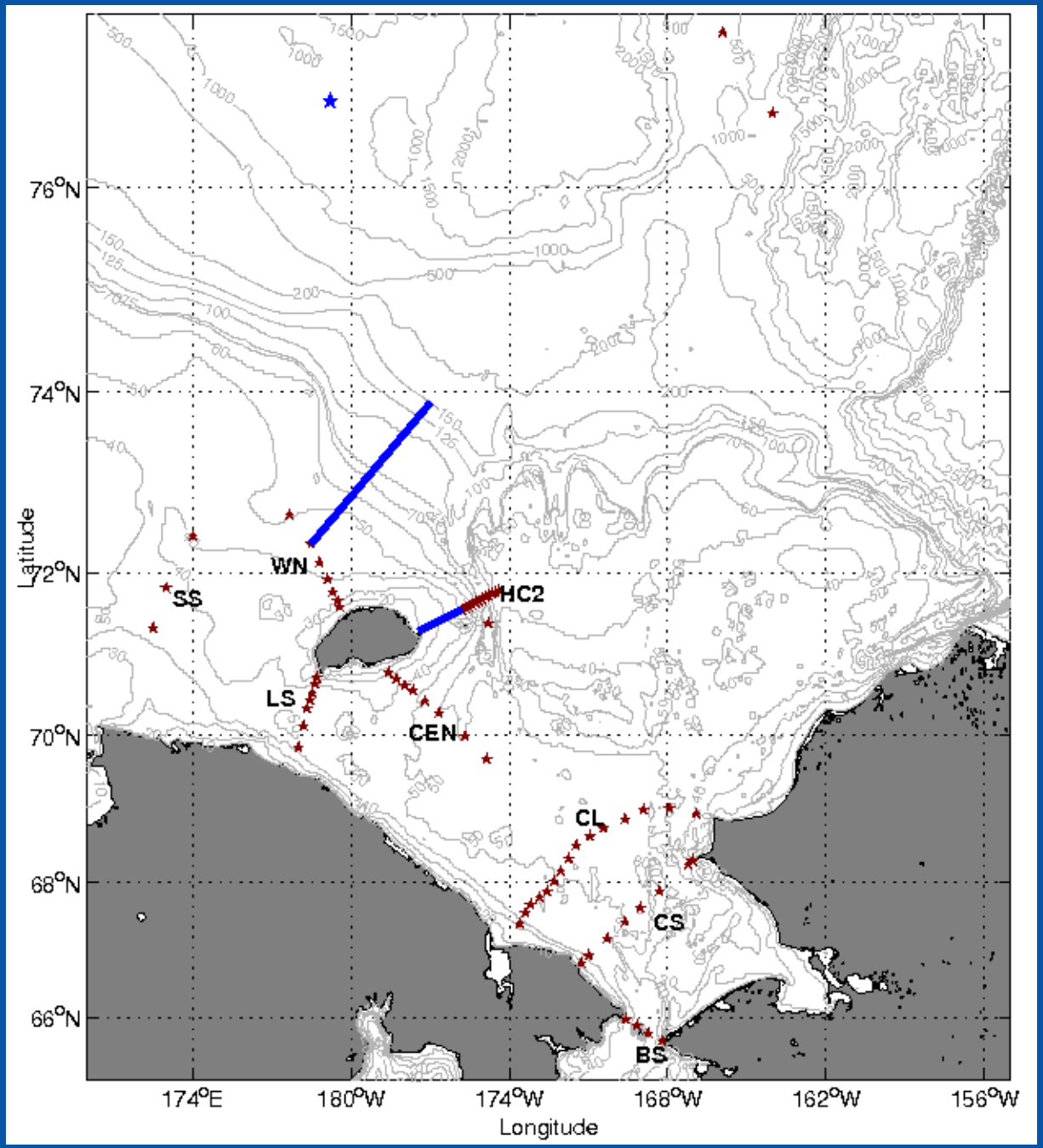


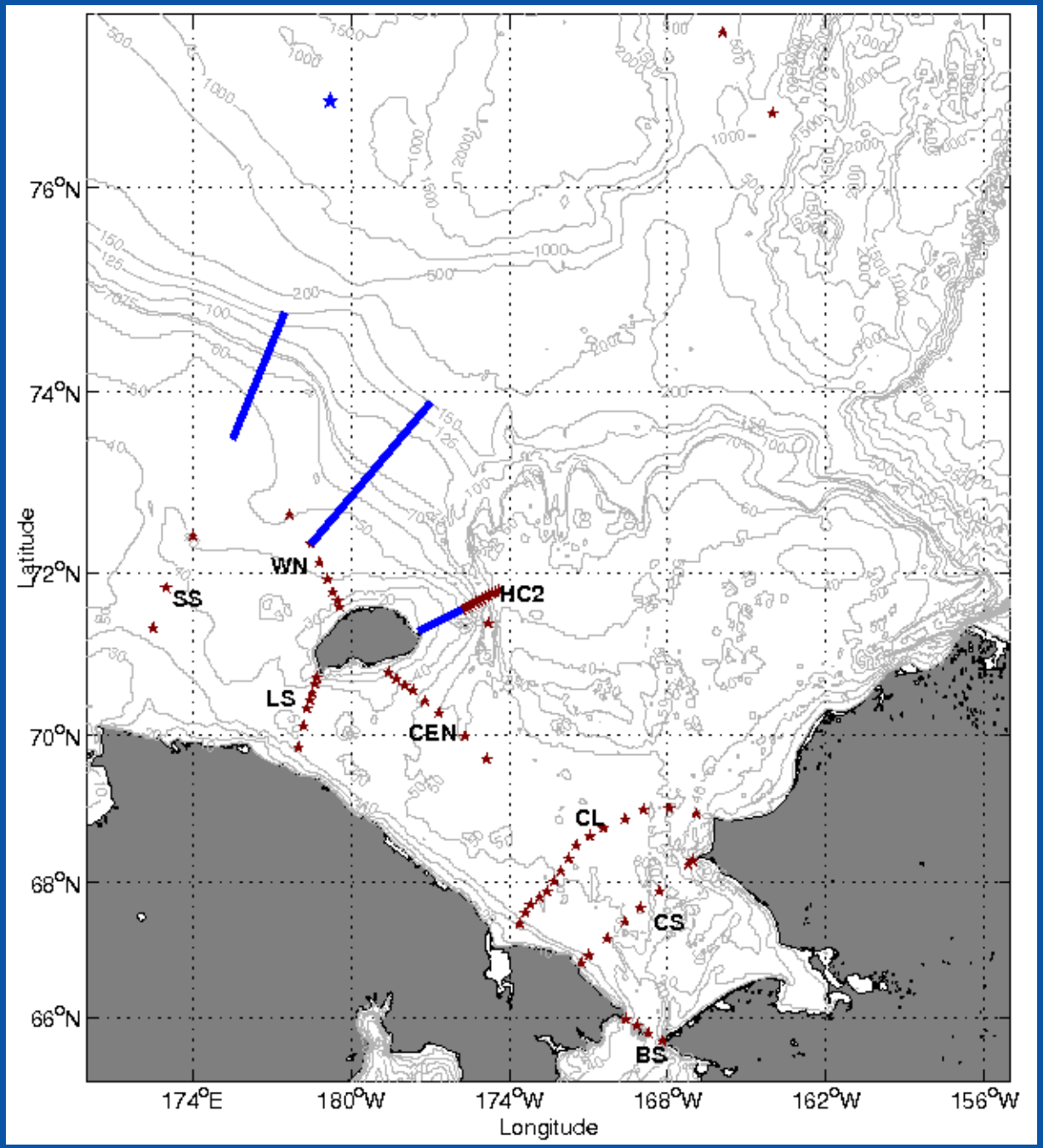
Considerations for 2012 sampling



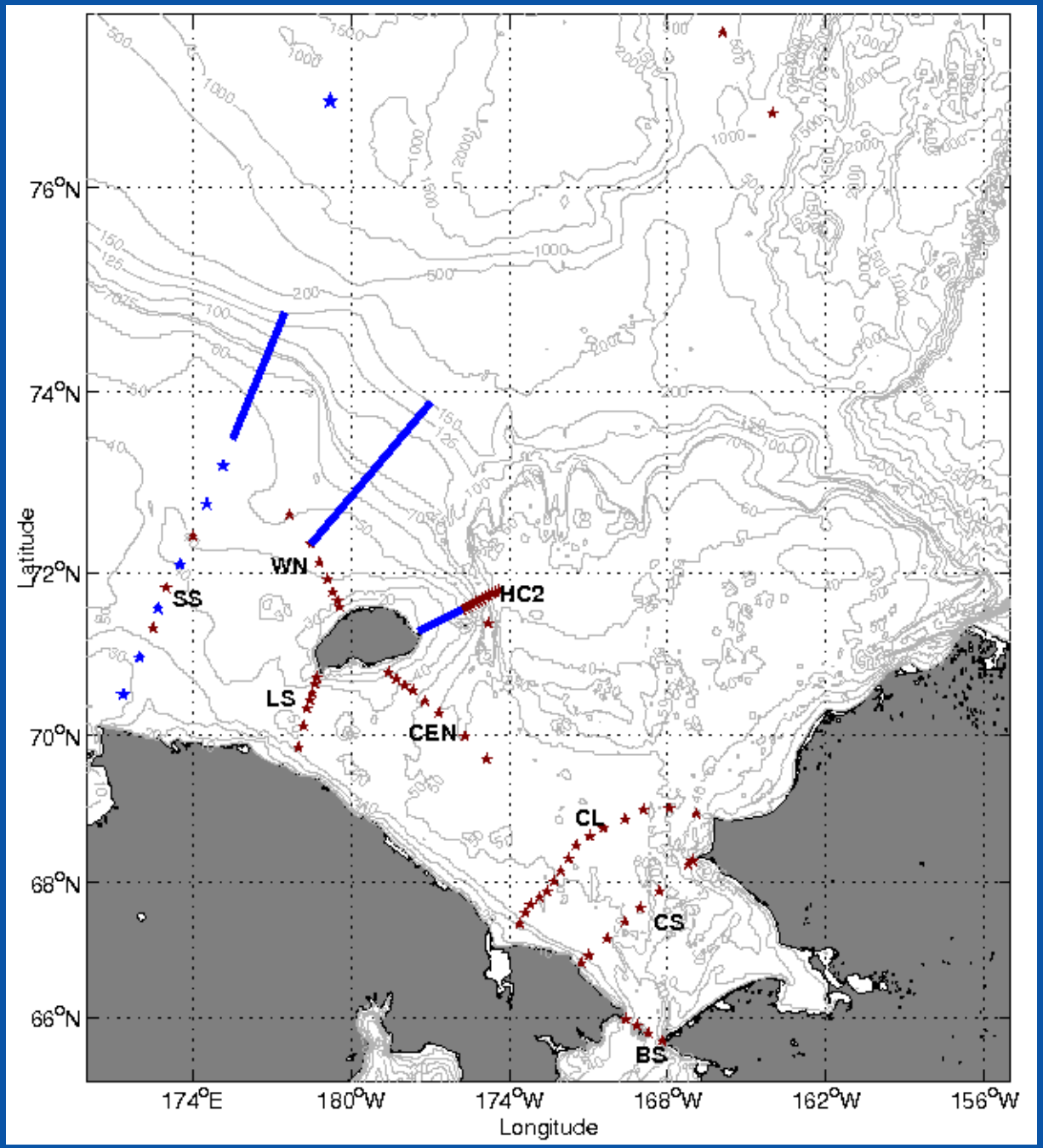
Considerations for 2012 sampling



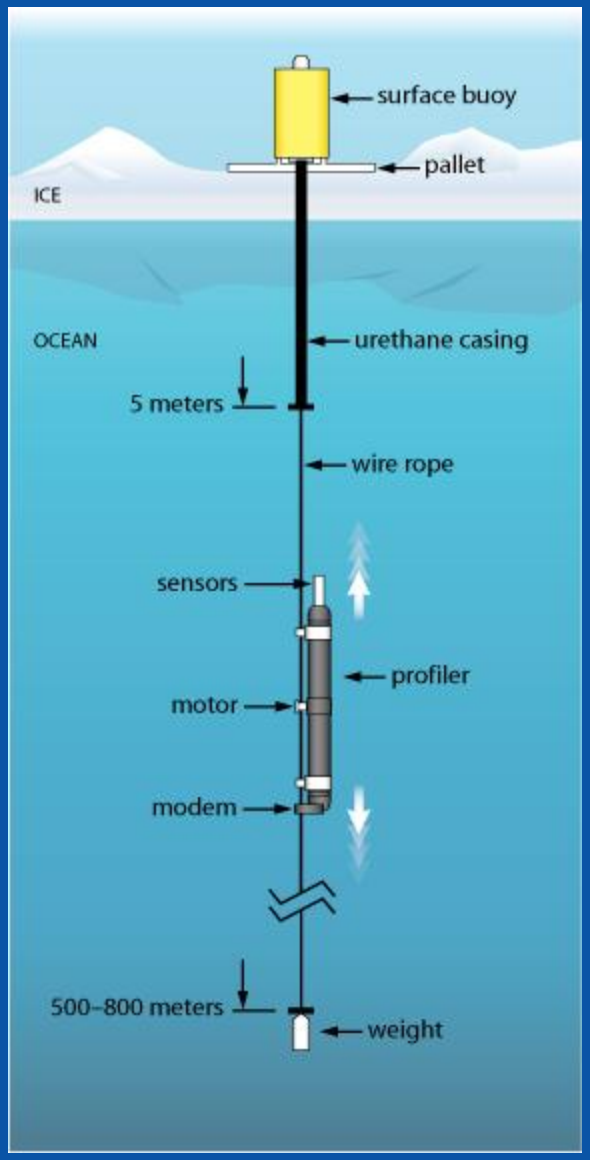
Considerations for 2012 sampling



Considerations for 2012 sampling



Ice-Tethered Profiler



Sensors: temperature, salinity and O2 now, prototypes with fluorometer, OBS, PAR, CDOM and MAVS current probe.

Data acquisition: 2-4 profiles per day between 10 and 760 m.

Real-time data telemetry:
Inductive modem profiler -> surface
Iridium from surface -> lab

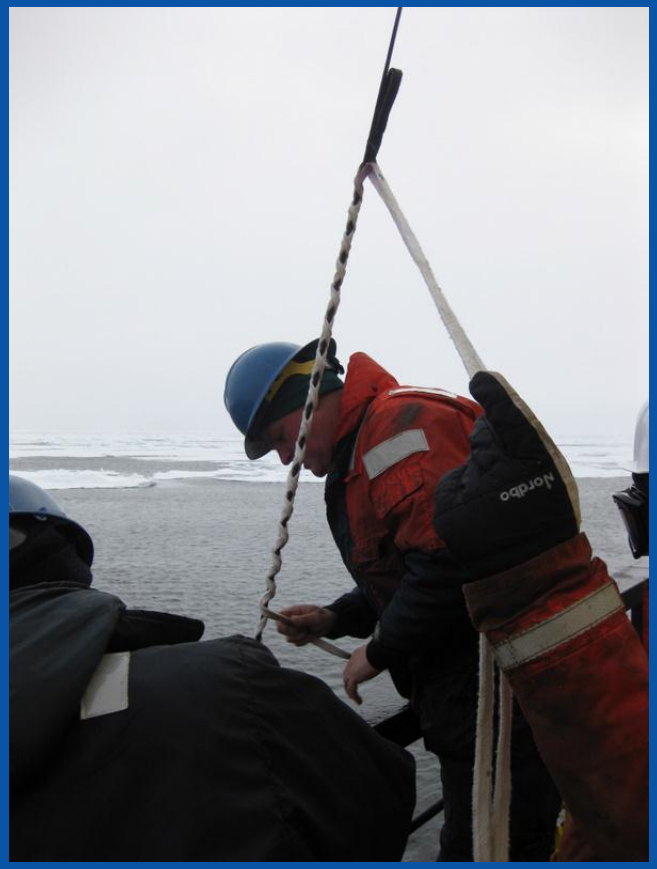
Duration: 3 years (1.5 million meters)

Open water deployment: Dranitsyn 2009

Specialized winch secured to deck with wire through block on ship's crane.

Attaching profiler to wire.

Lowering anchor and profiler.



Yale grip attached to wire to transfer load from winch.

Remove cable from winch, feed through float and attach bottom flange.

Make electrical connections, and secure flange to package.

Attach quick release to top float.

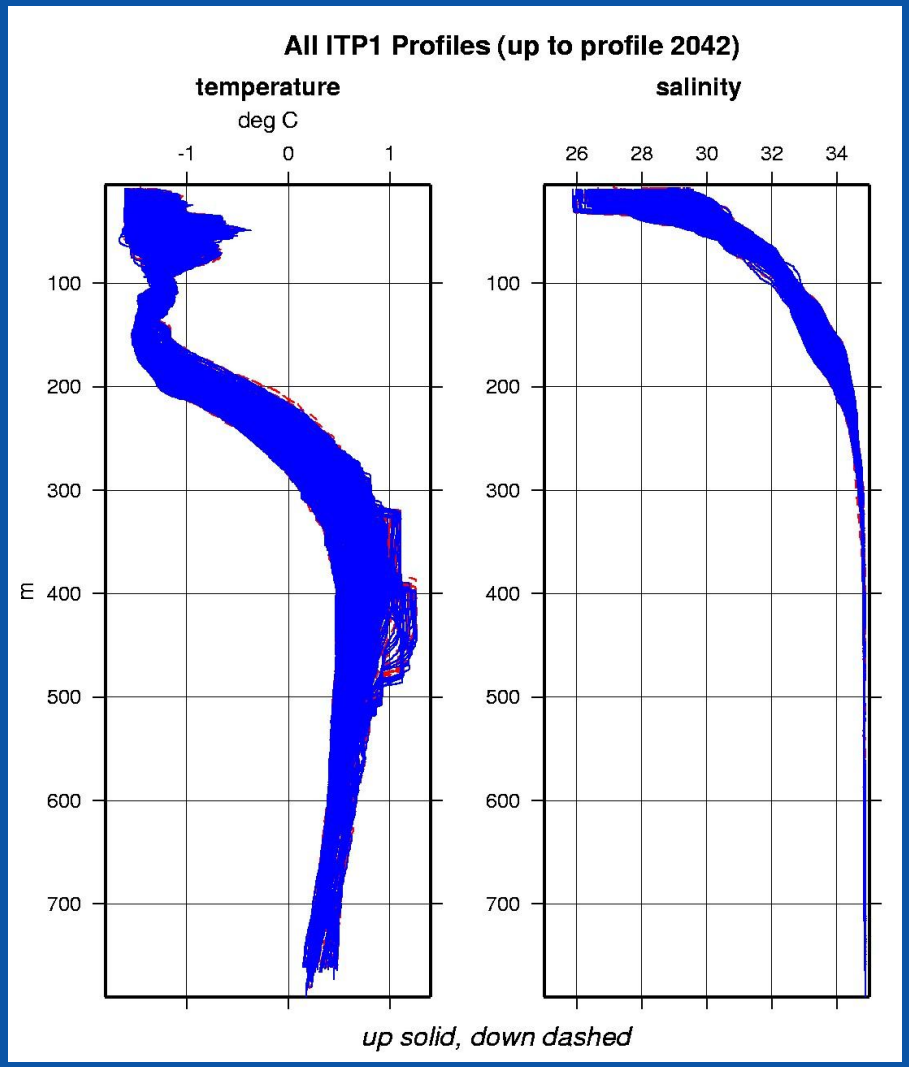
Test operation before lowering.

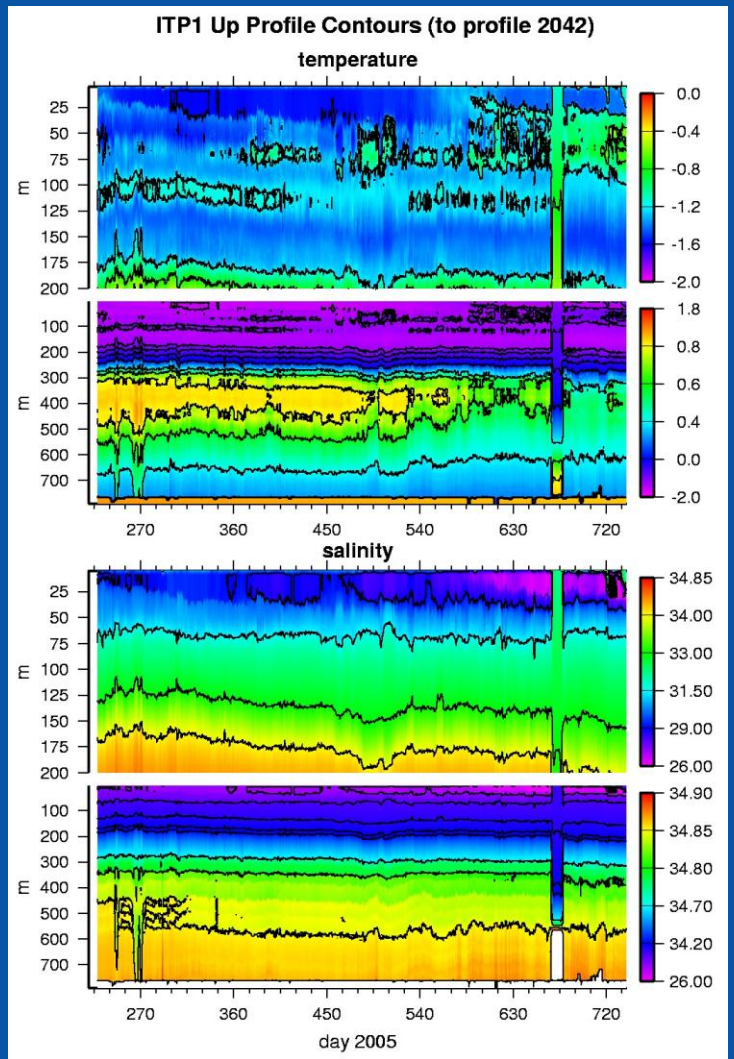
Entire deployment should take less than 2 hours.

Move top float outboard, take load from Yale grip, and remove grip.

Release buoy.

Representative Temperature and Salinity Profiles

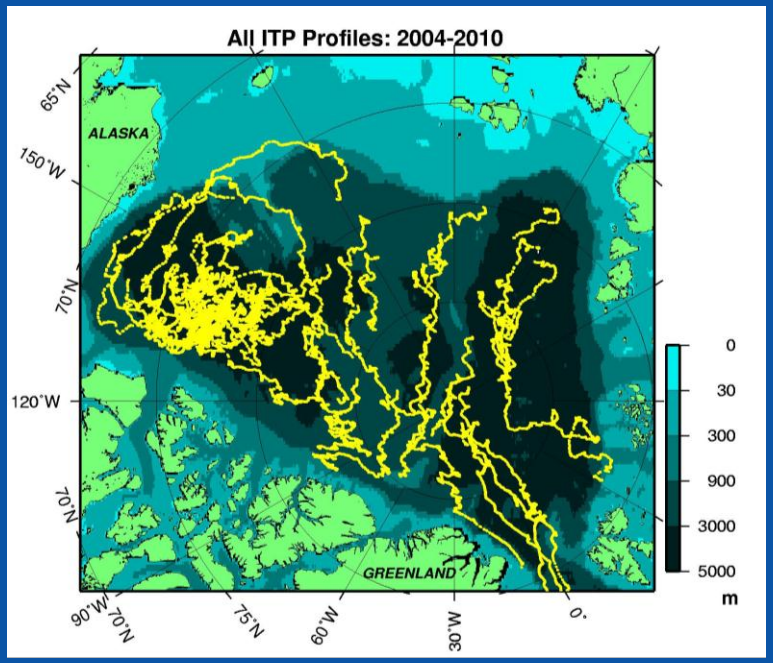


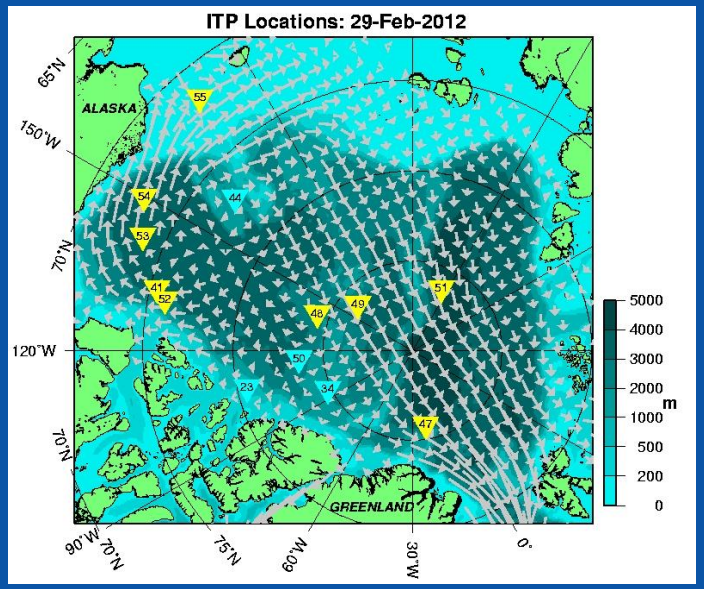


17 months of data from ITP 1

Status of ITP Program

- First prototype deployed August 2004
- 51 ITPs deployed in Arctic to date
- Over 36,000 CTD profiles obtained





- 6 complete + 4 partial ITPs recovered
- 3 still fully functioning + 6 partially
- Funded to build and deploy 6 ITPs in the Arctic per year through 2013.
- Continuing to collaborate with other investigators to field and maintain an array of multi-sensor Ice-Based Observatories

Data available in real time from www.whoi.edu/itp

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