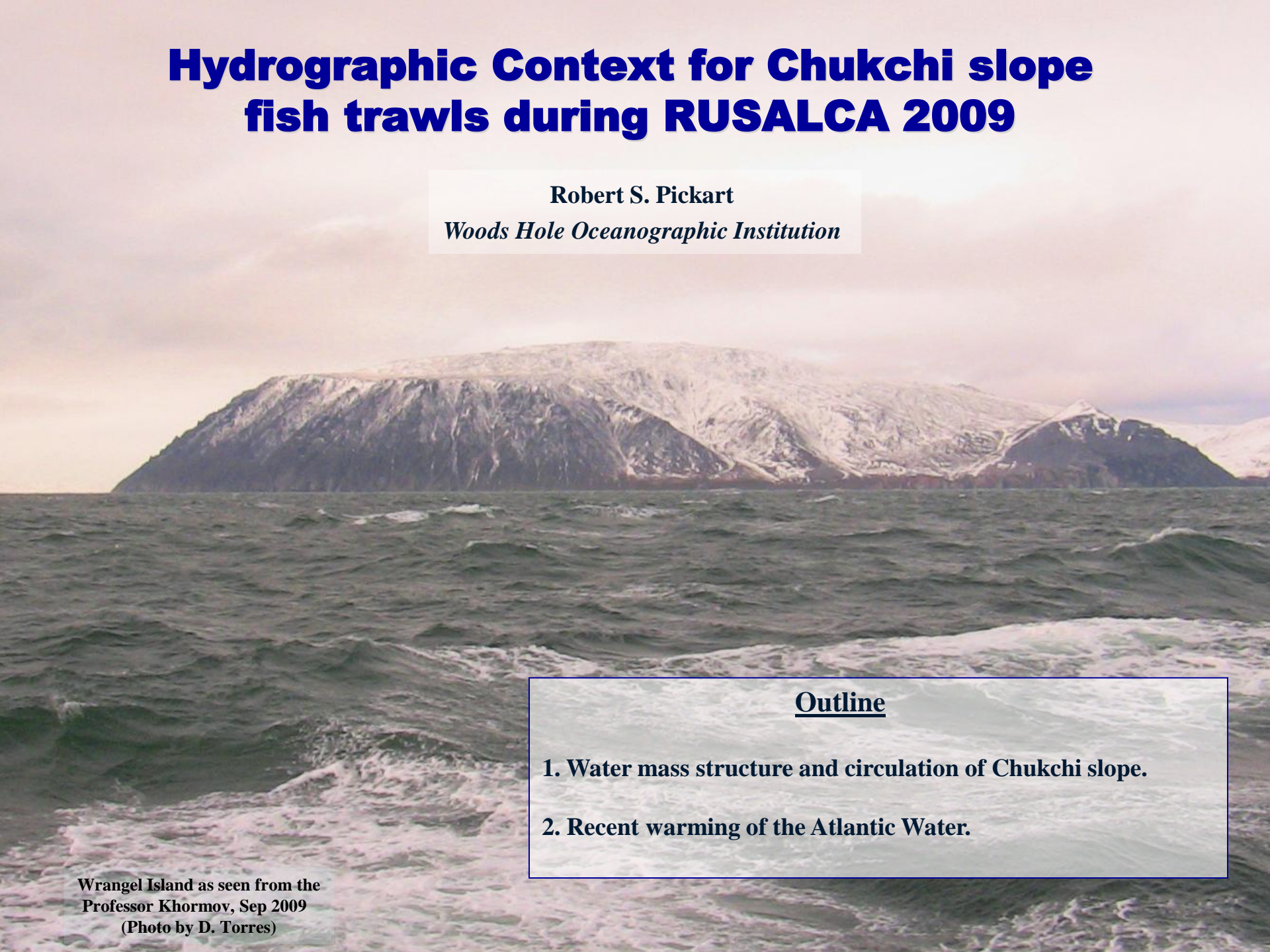


# Hydrographic Context for Chukchi slope fish trawls during RUSALCA 2009

Robert S. Pickart

*Woods Hole Oceanographic Institution*



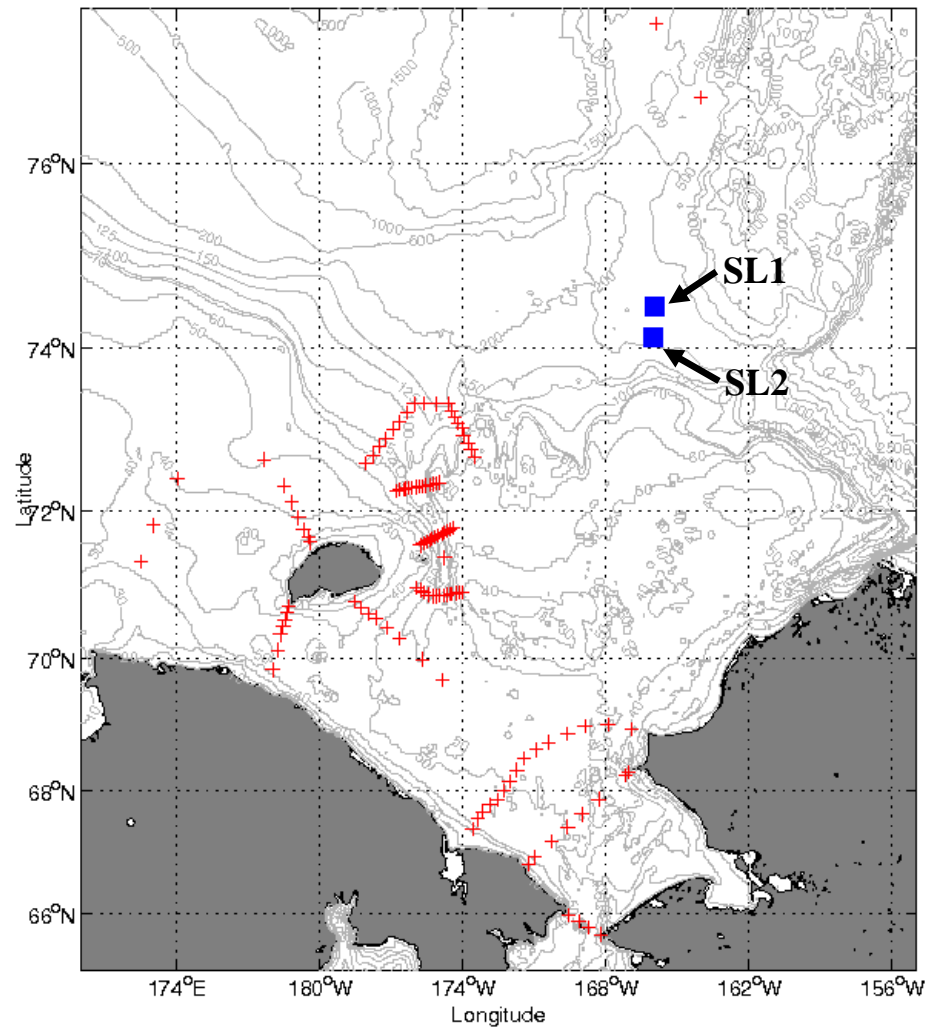
## Outline

1. Water mass structure and circulation of Chukchi slope.
2. Recent warming of the Atlantic Water.

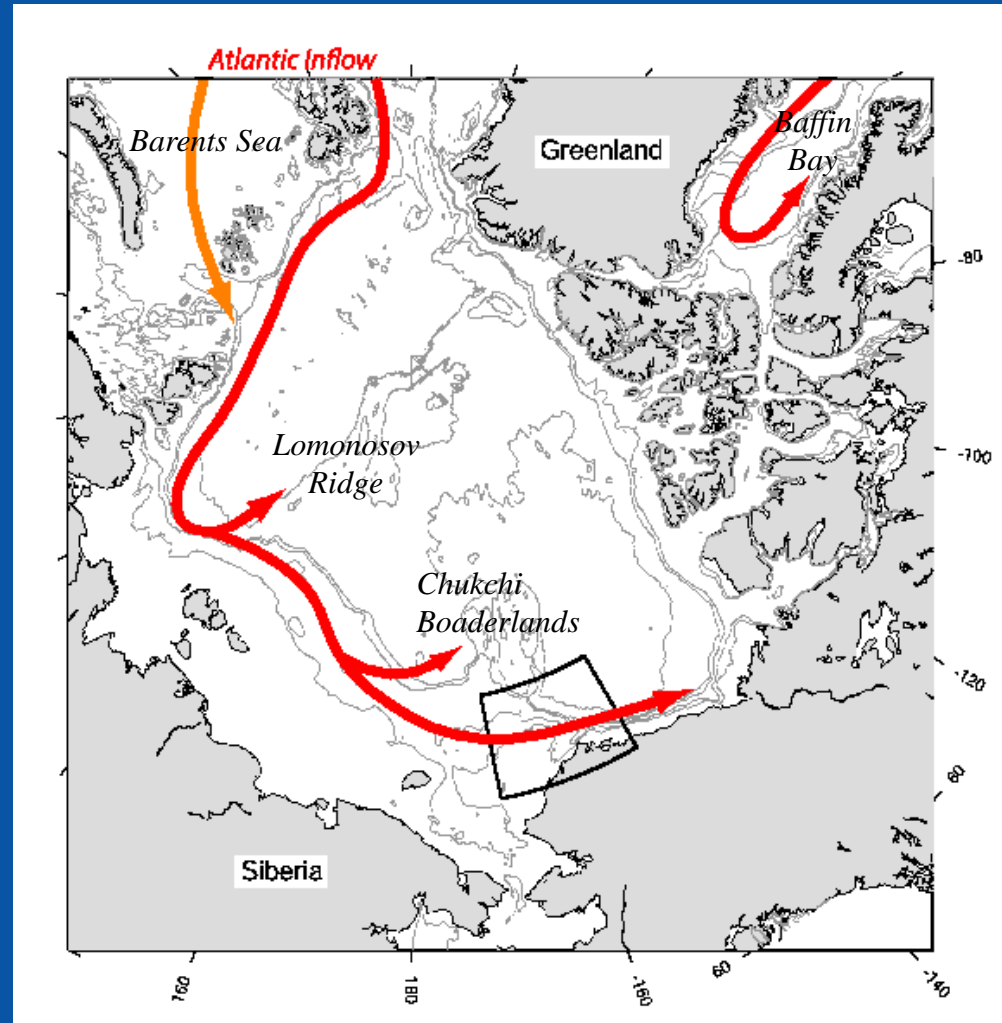
Wrangel Island as seen from the  
Professor Khormov, Sep 2009  
(Photo by D. Torres)



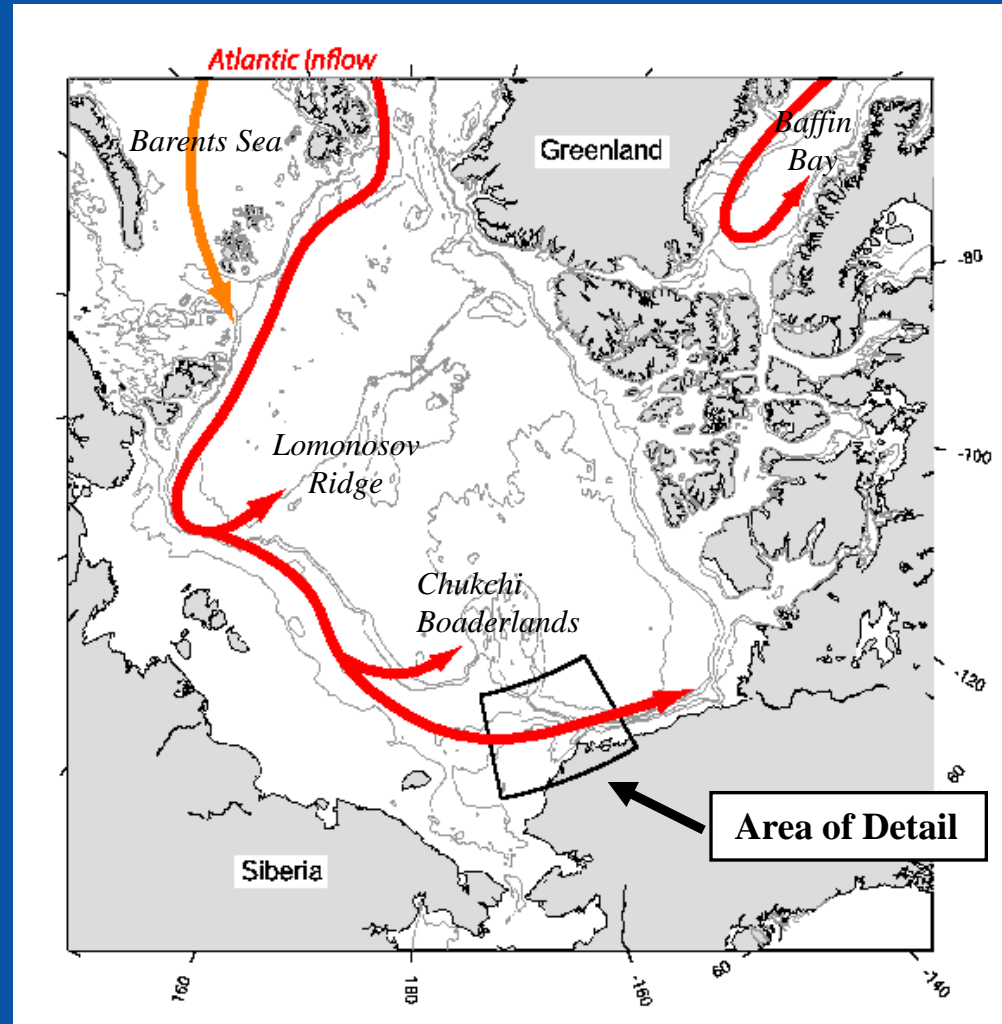
## Chukchi slope fish trawl sites



# Atlantic Water Circulation

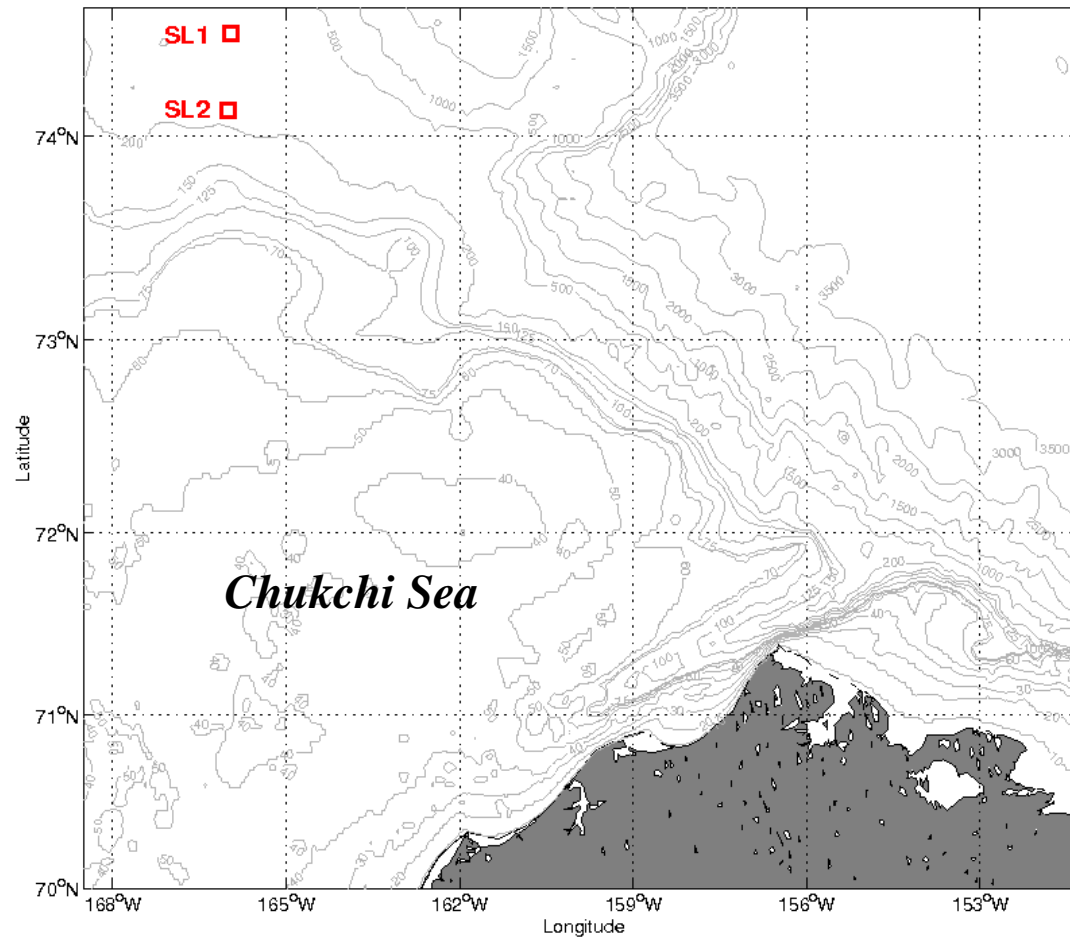


# Atlantic Water Circulation



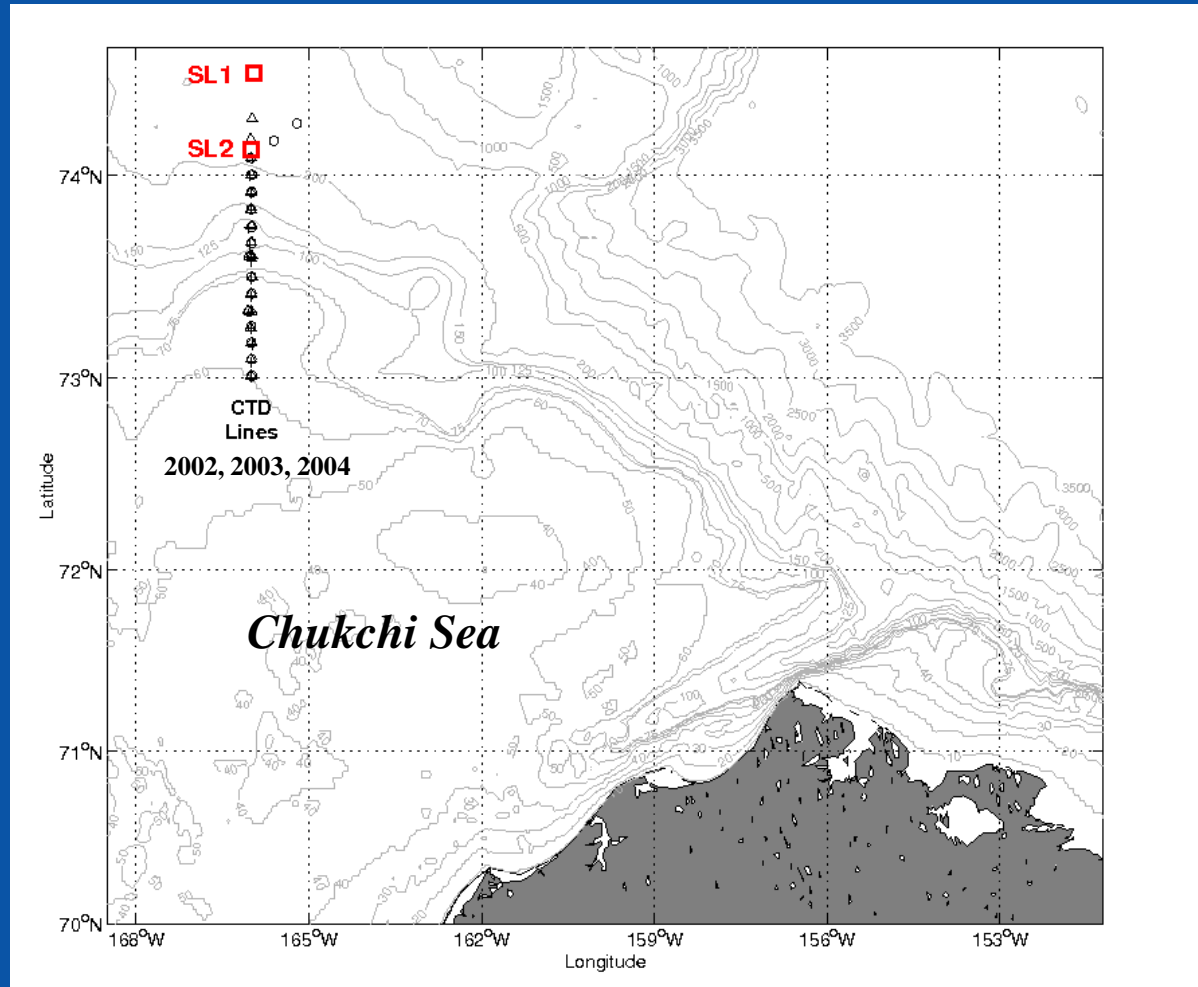


## Supporting information





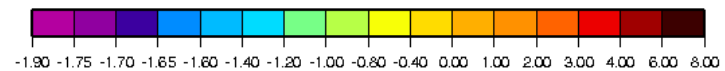
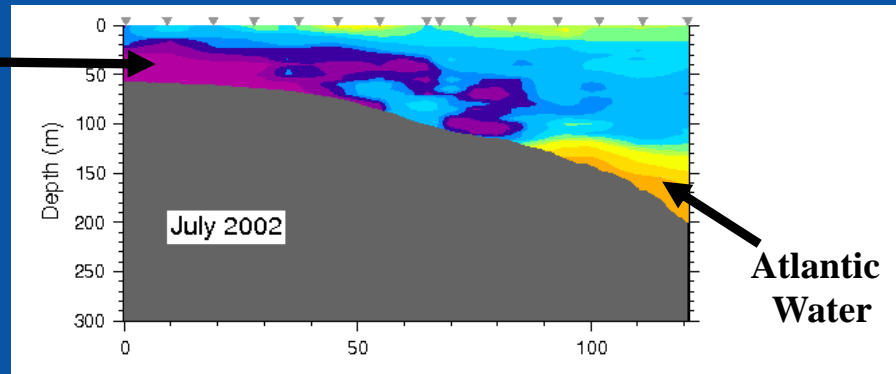
## Supporting information





## 166°W hydrographic sections during SBI

Pacific Winter Water

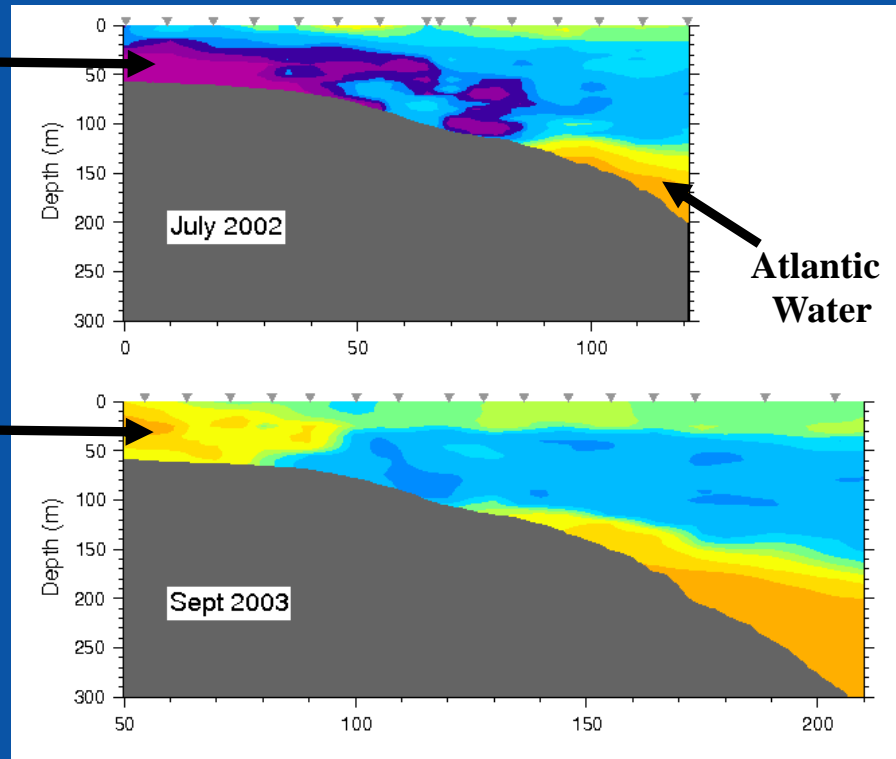




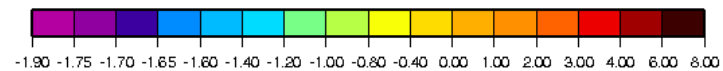
## 166°W hydrographic sections during SBI

Potential temperature (°C)

Pacific Winter Water



Pacific Summer Water





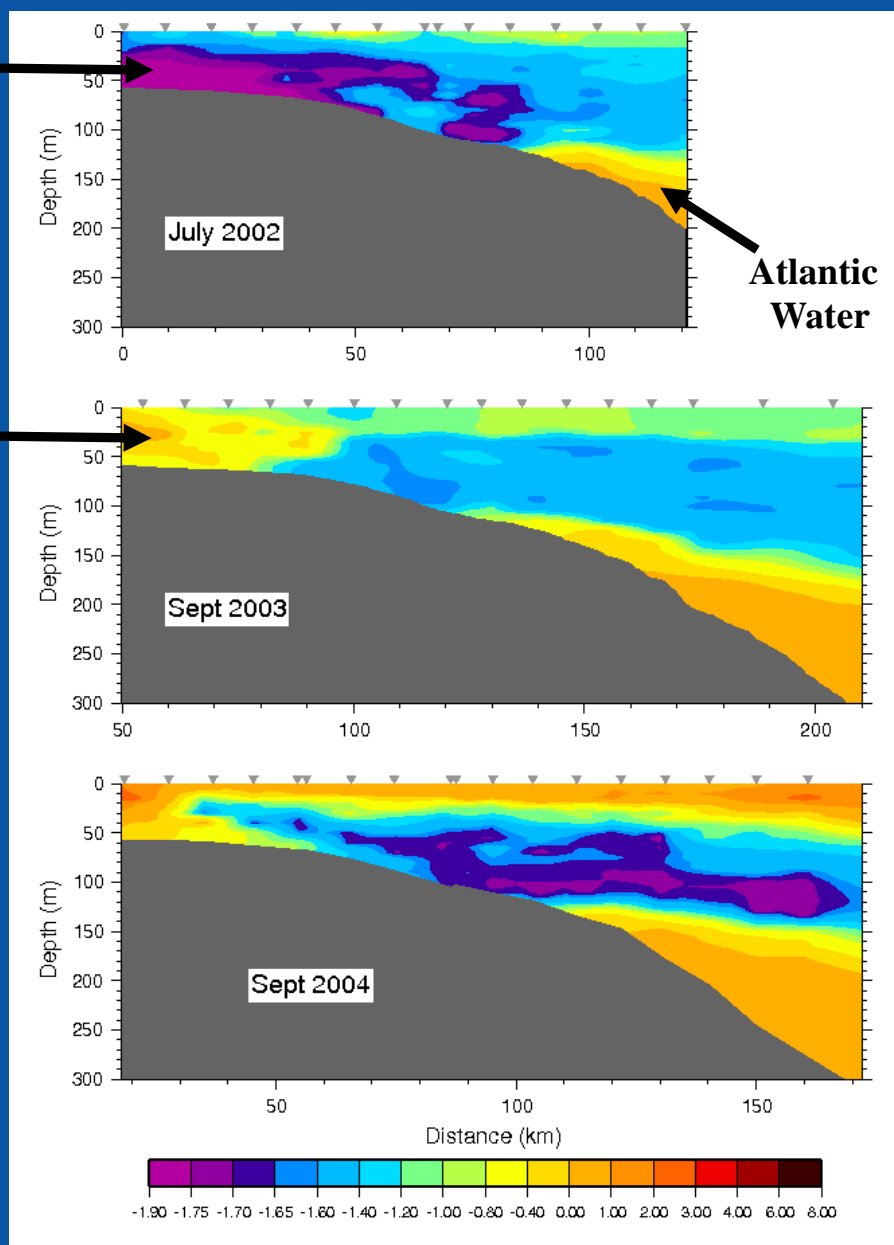


## 166°W hydrographic sections during SBI

Pacific Winter Water

Pacific Summer Water

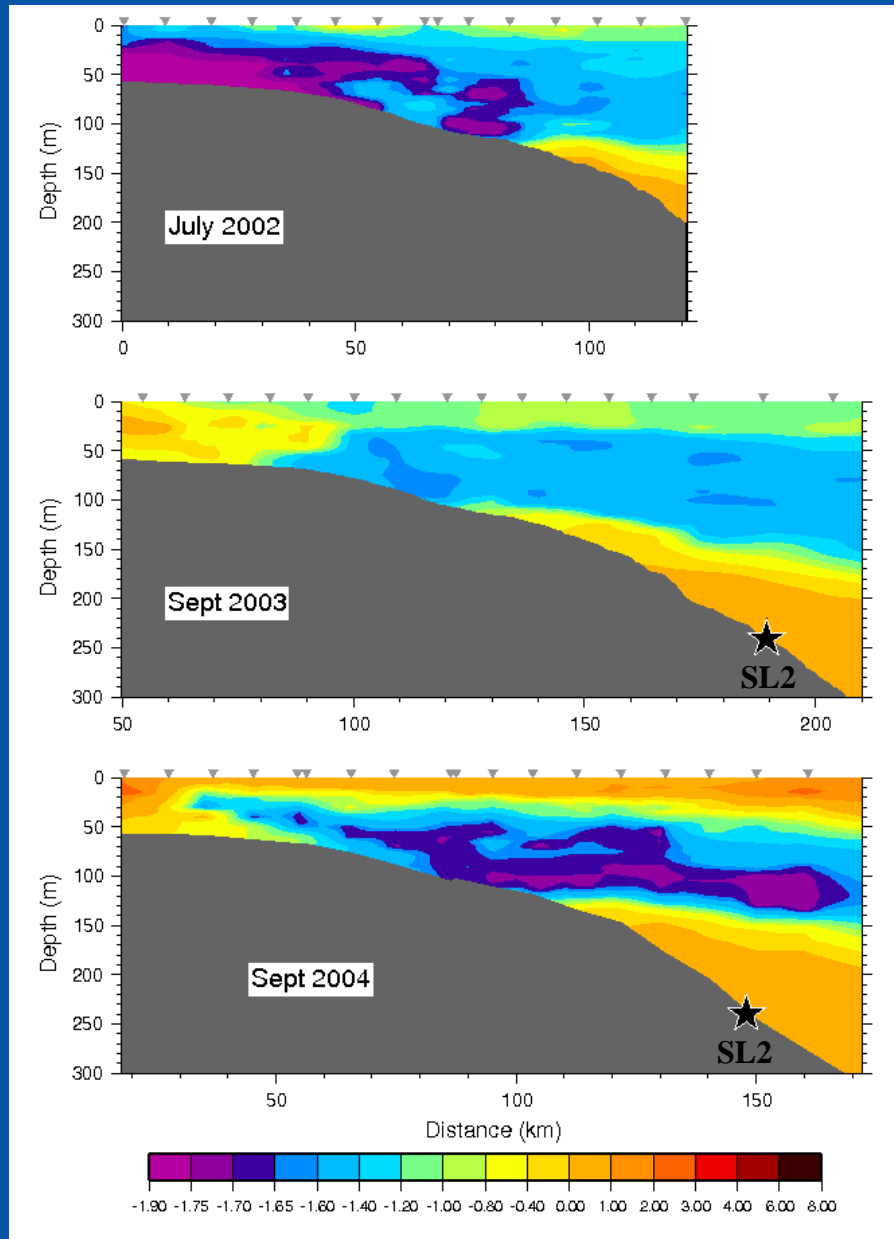
Potential temperature (°C)





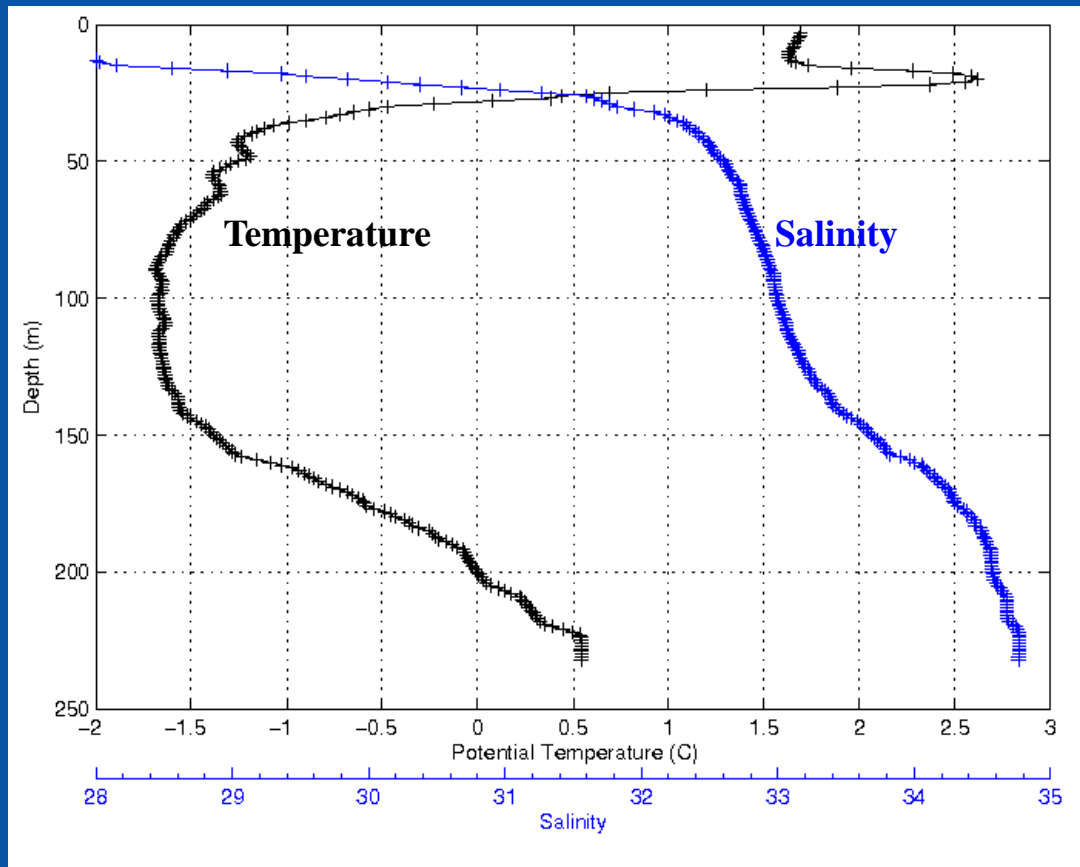
## 166°W hydrographic sections during SBI

Potential temperature (°C)



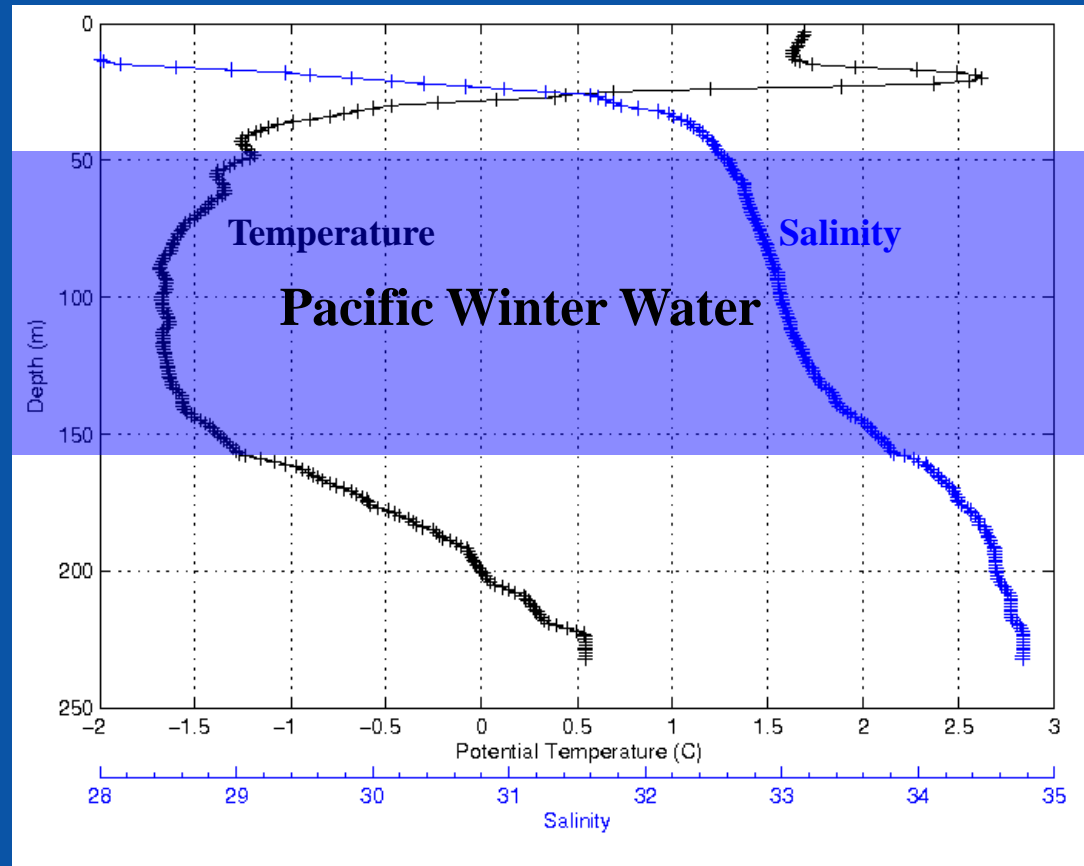


# Hydrographic profiles at fish trawl site SL2



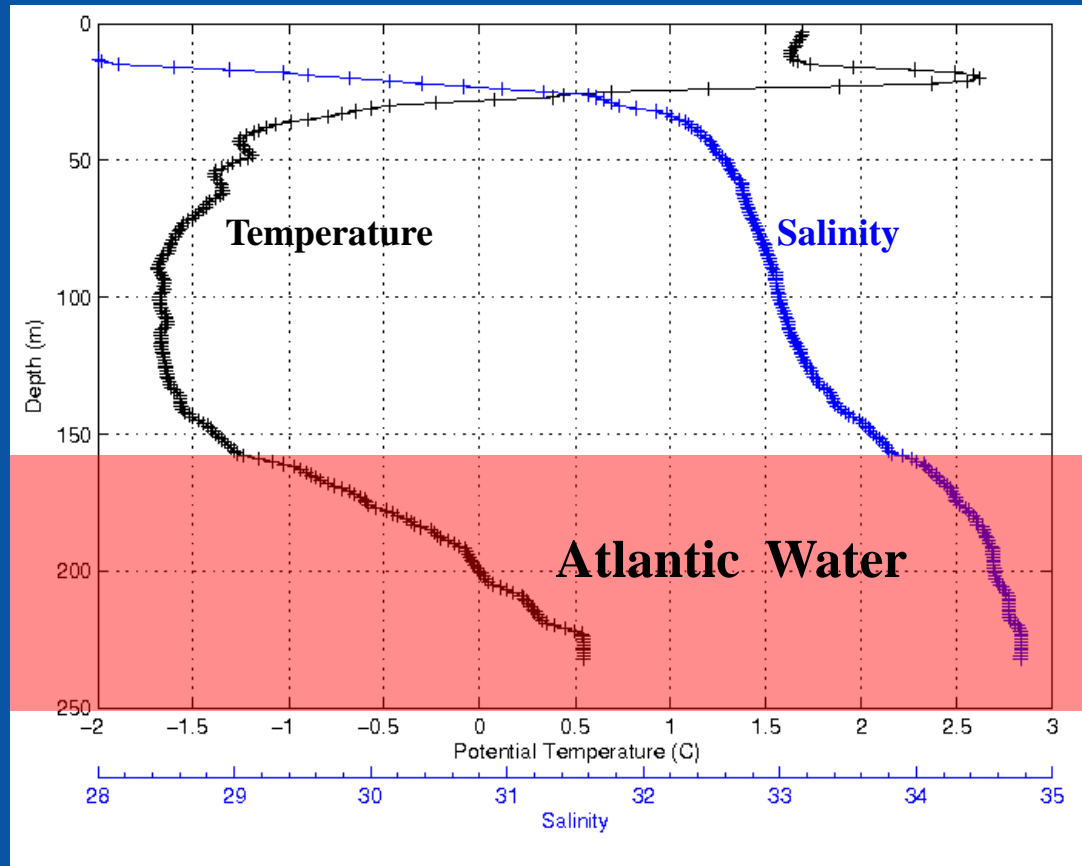


# Hydrographic profiles at fish trawl site SL2

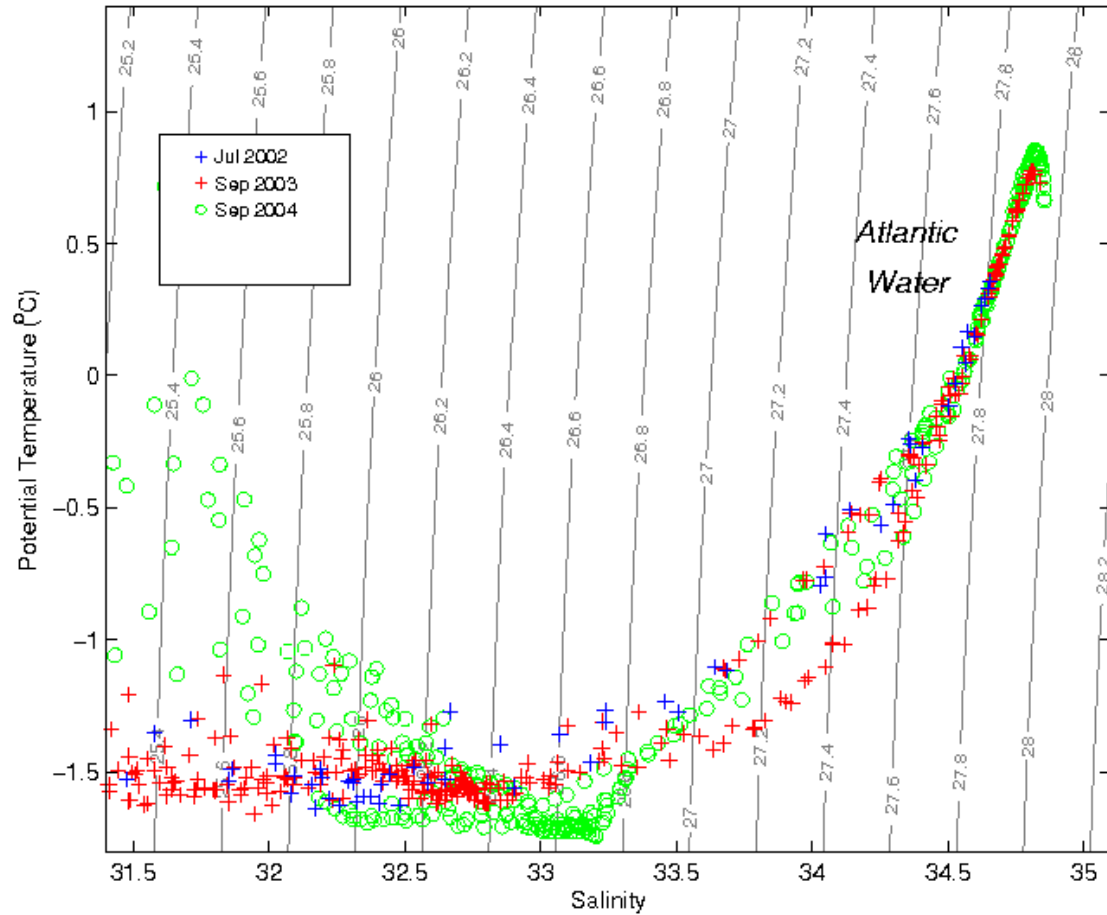




# Hydrographic profiles at fish trawl site SL2

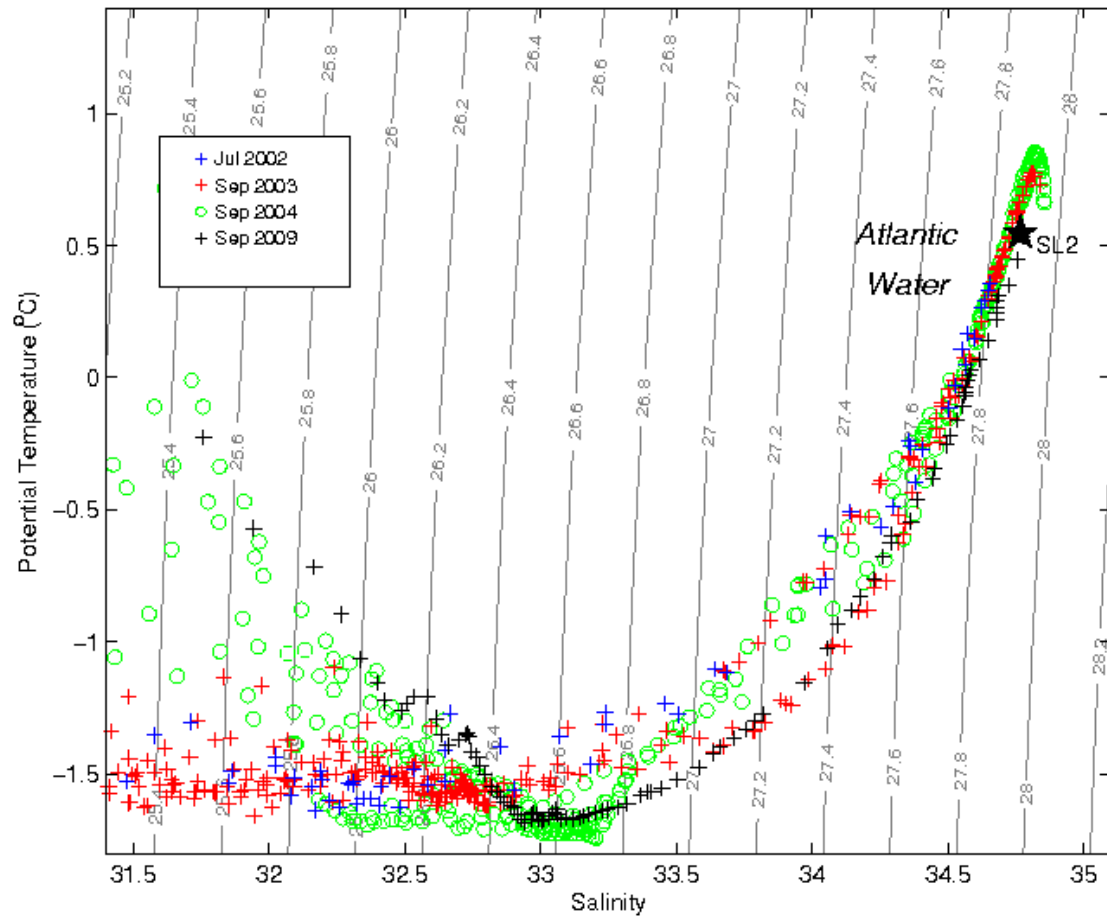


# Temperature/Salinity Diagrams



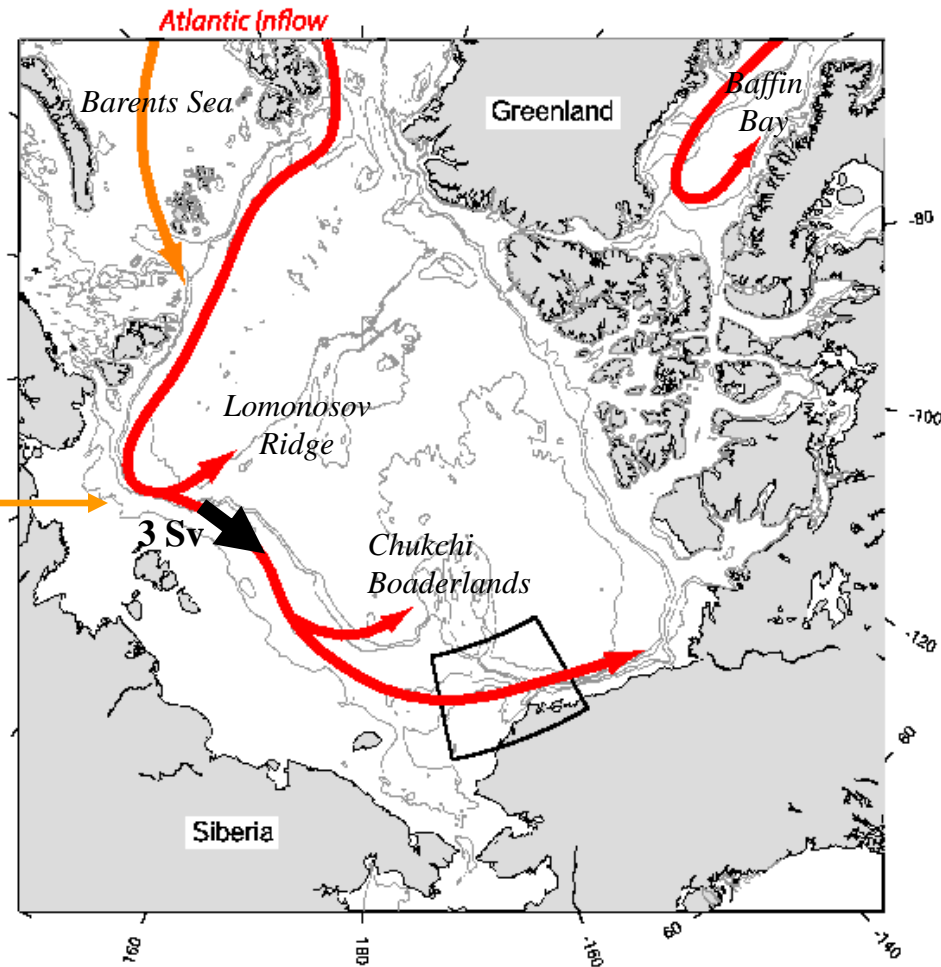


# Temperature/Salinity Diagrams

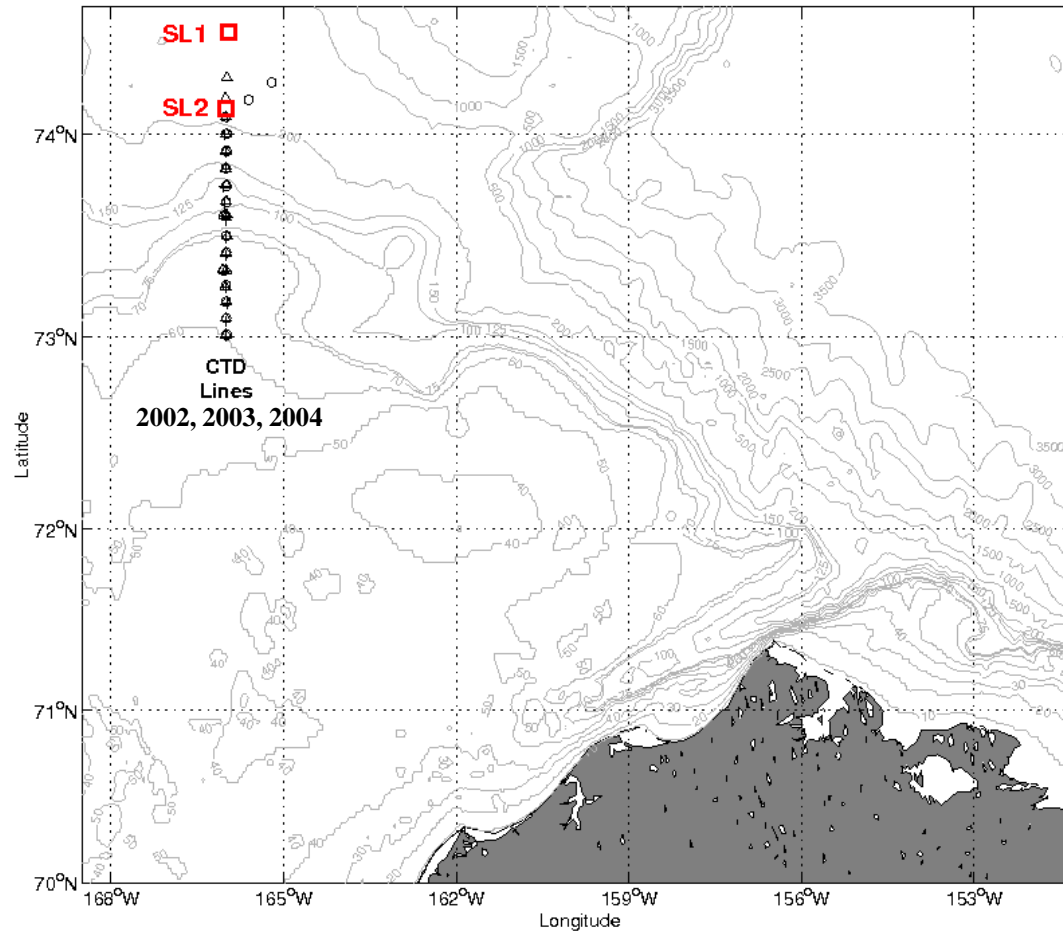


# Atlantic Water Circulation

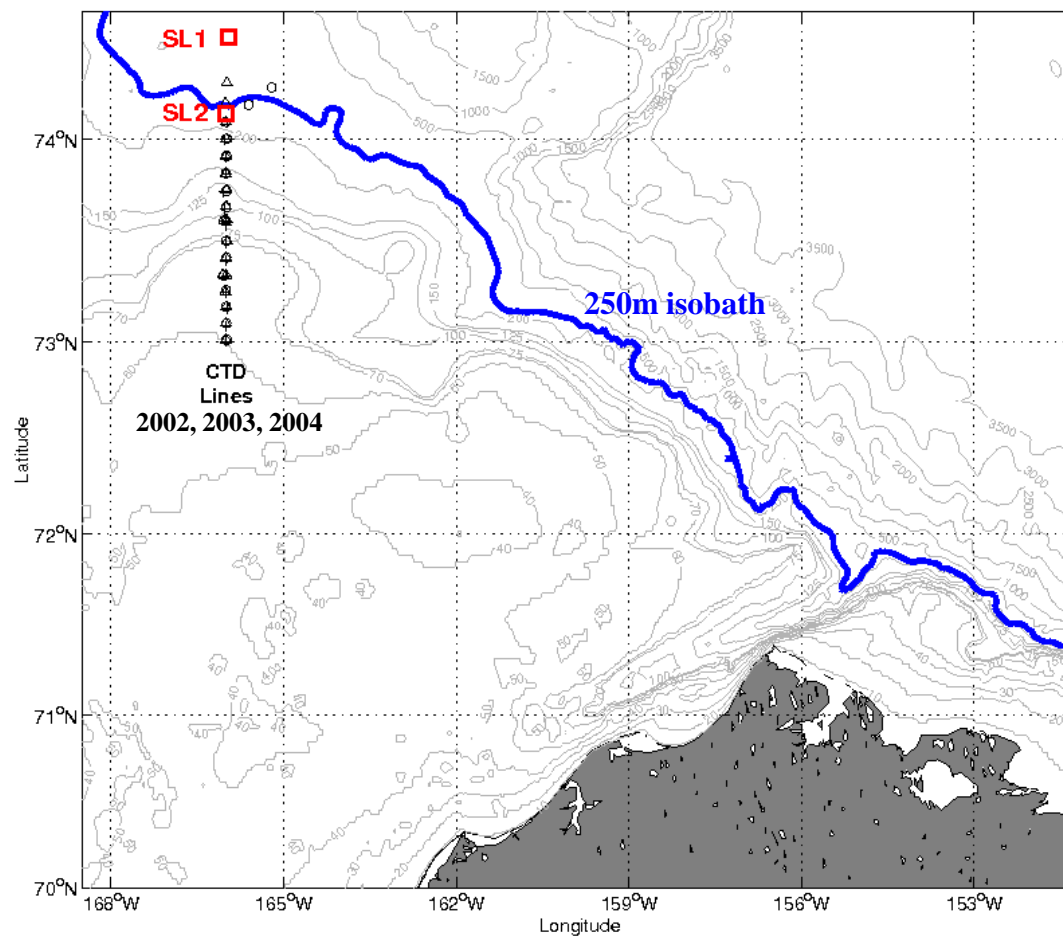
According to  
Woodgate et al. (2001)  
using a single mooring



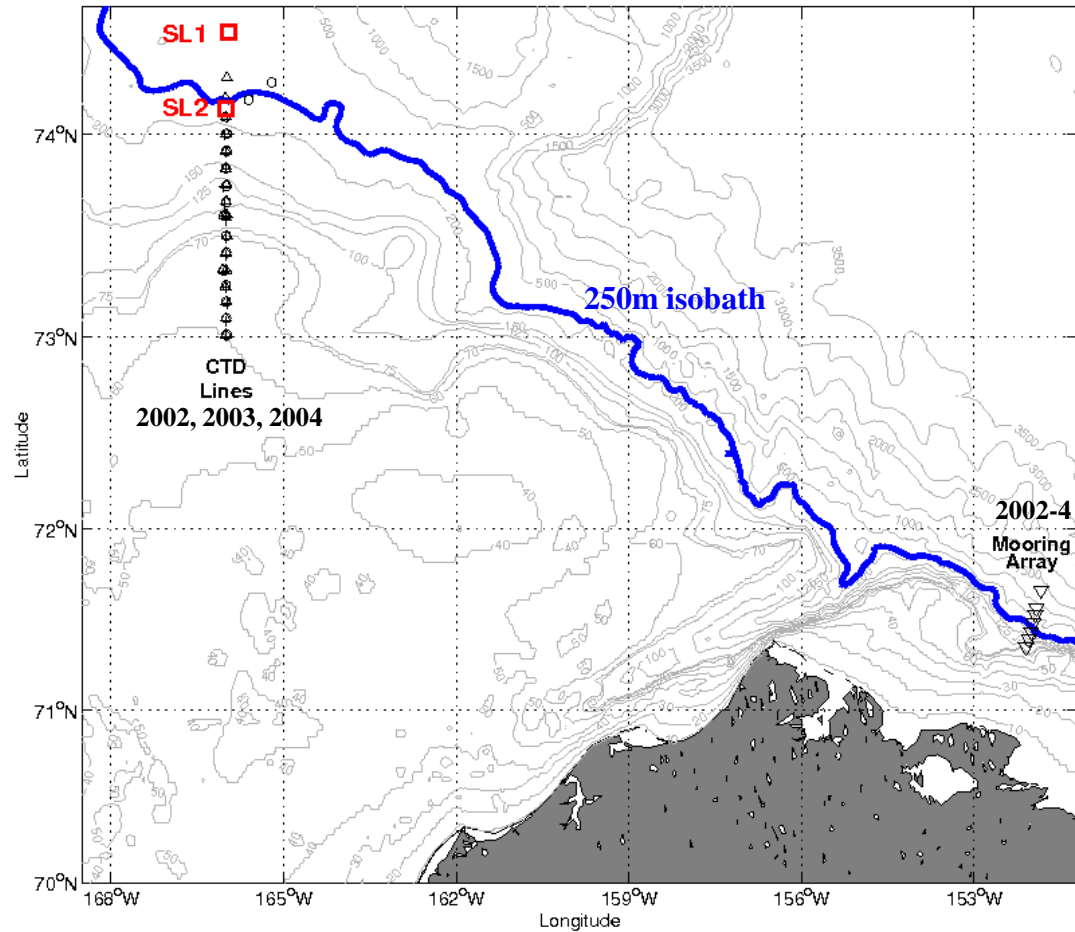
## Supporting information



## Supporting information



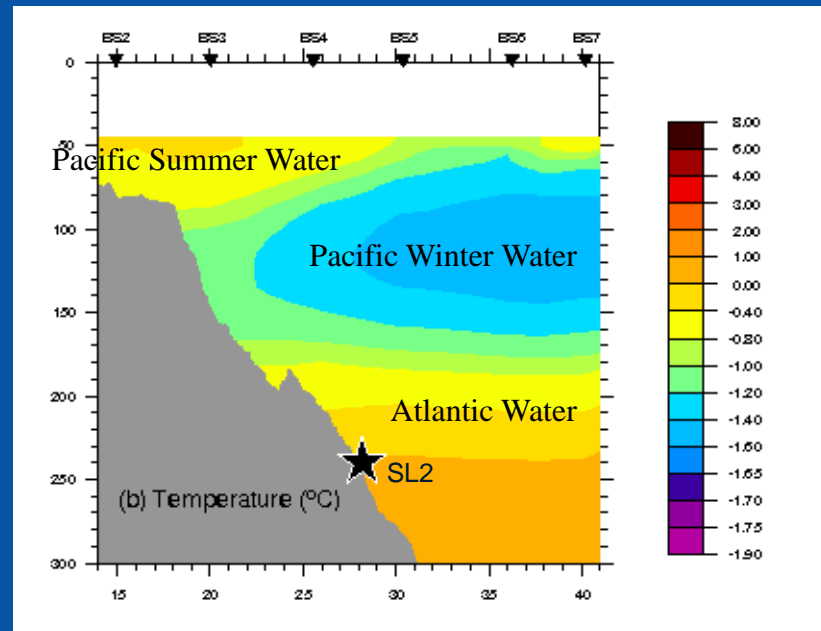
## Supporting information





# Circulation

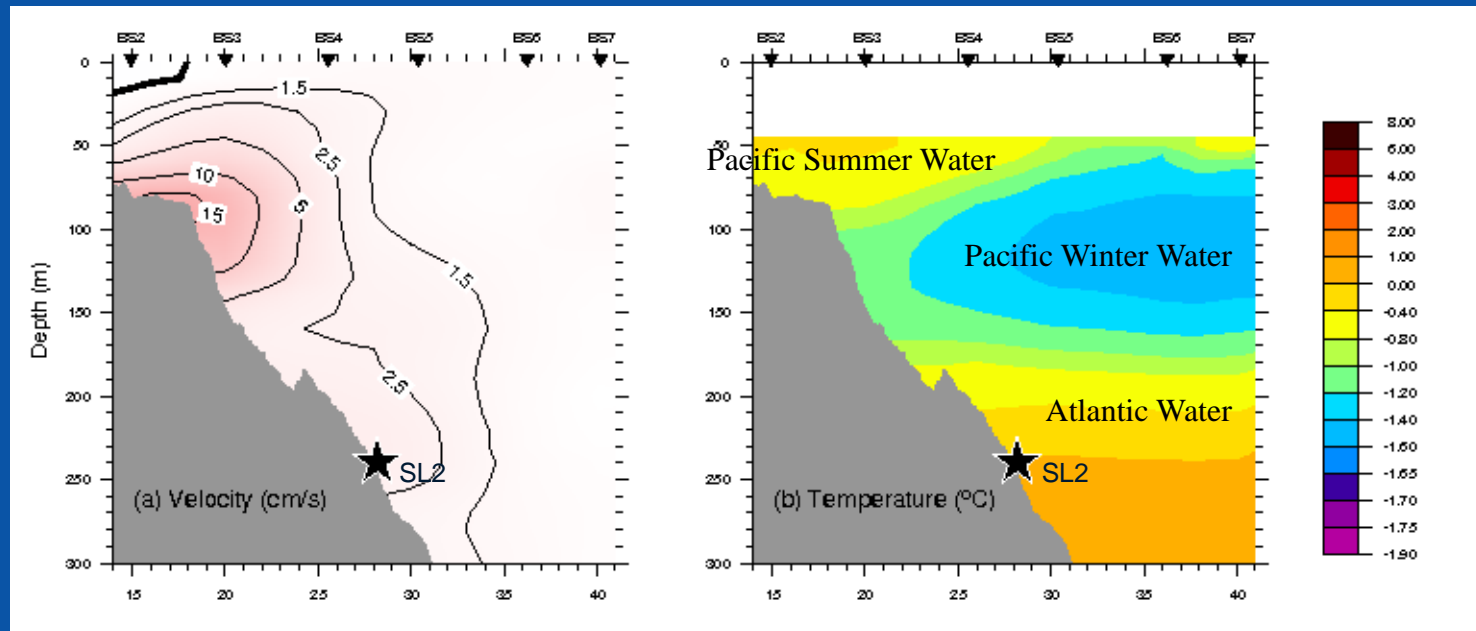
## Year-long Mean fields from SBI 152°W Mooring Array





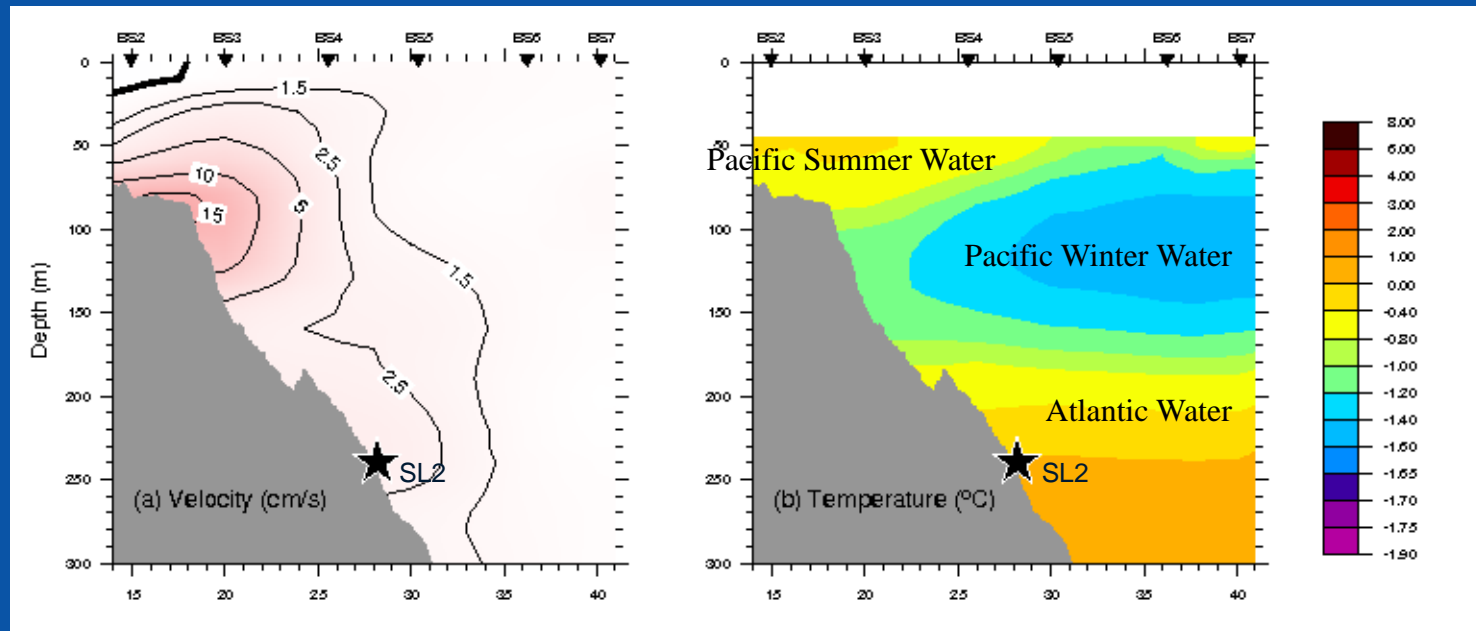
# Circulation

## Year-long Mean fields from SBI 152°W Mooring Array



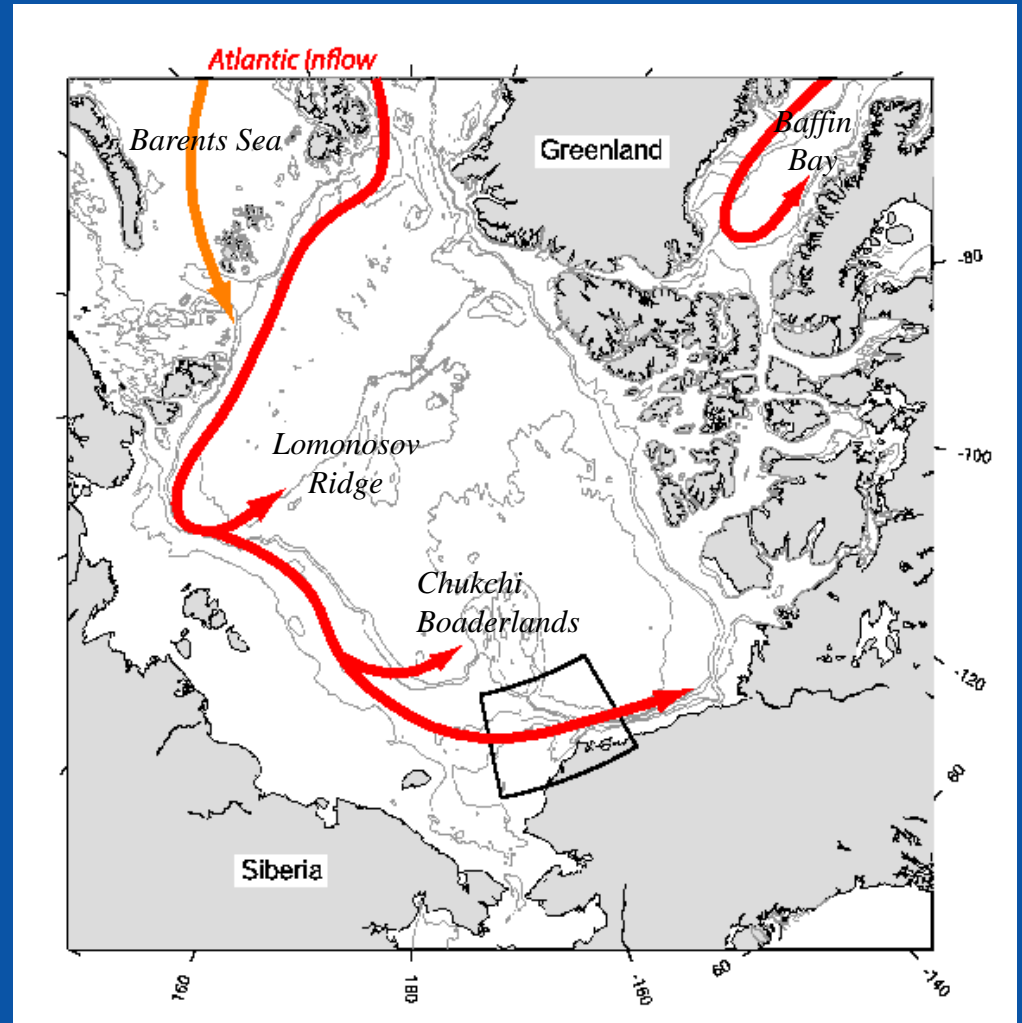
# Circulation

## Year-long Mean fields from SBI 152°W Mooring Array



**Conclusion: Site SL2 is within an eastward current of Atlantic Water**

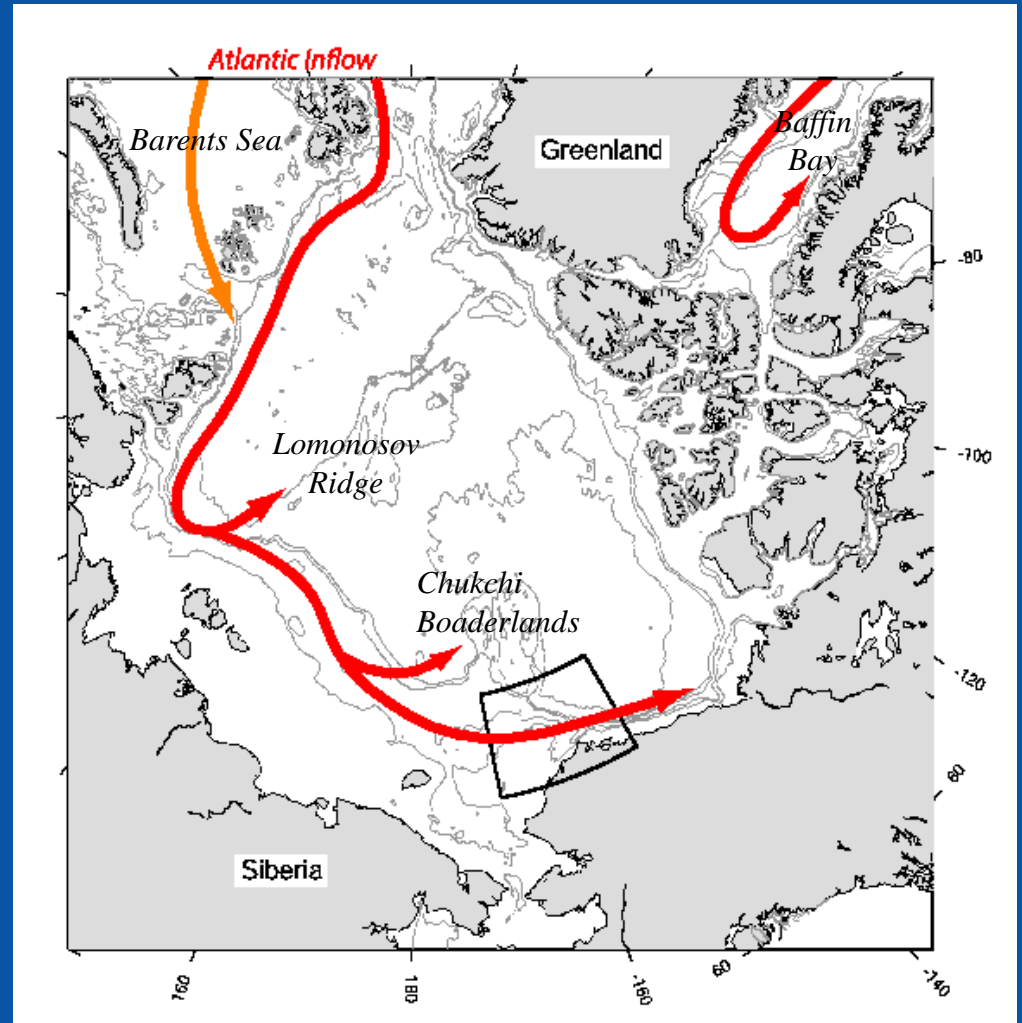
# Role of Atlantic Warming





# Role of Atlantic Warming

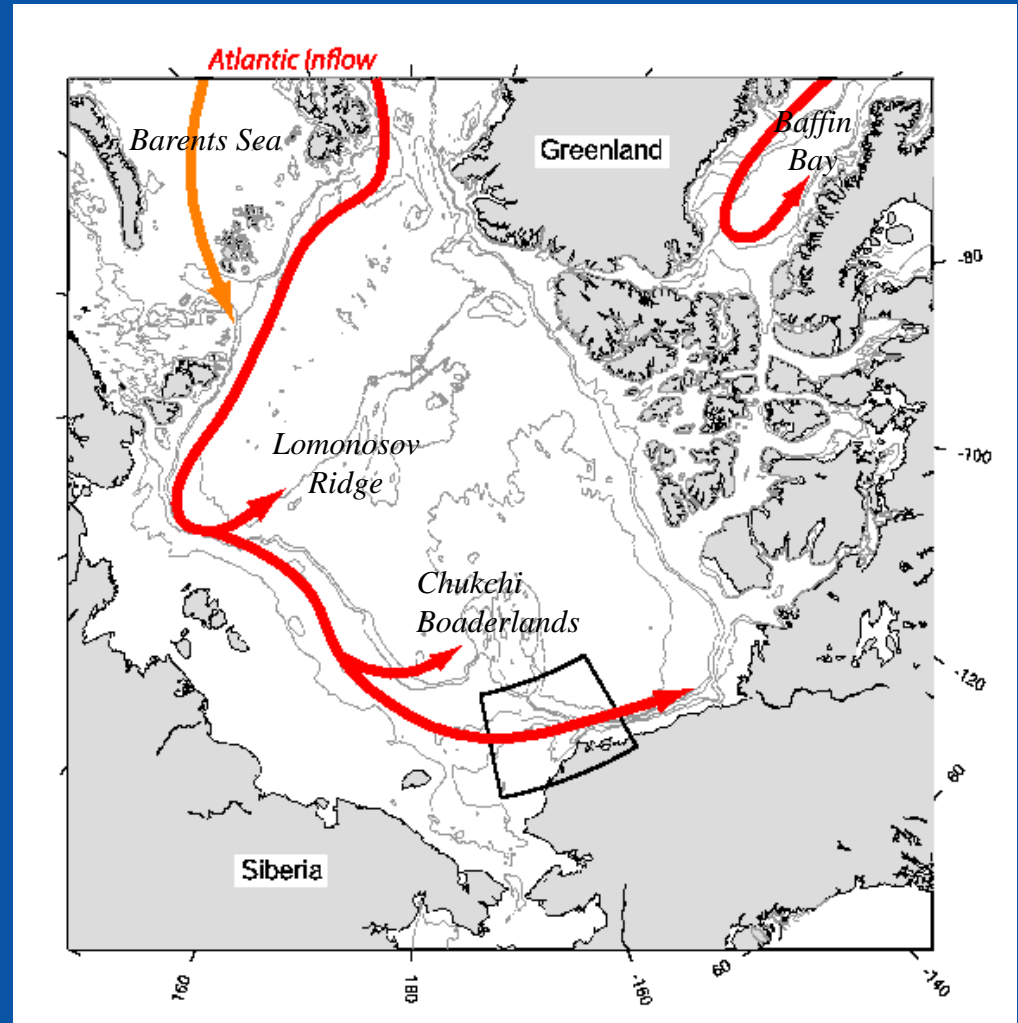
- Warming of AW inflow since 1980.





# Role of Atlantic Warming

- Warming of AW inflow since 1980.
- Two pronounced pulses: one around 1990 and the other around 2000, tracked by hydrographic sections and mooring data.

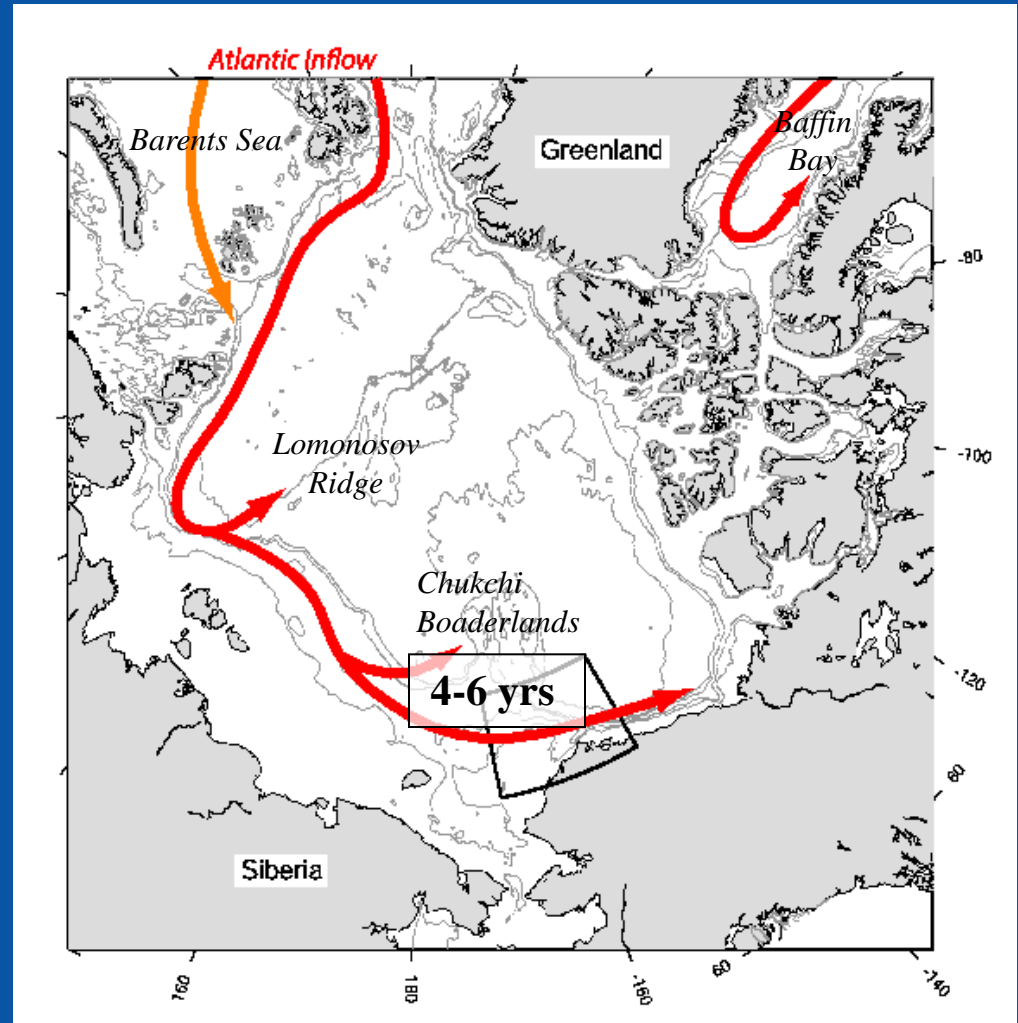




# Role of Atlantic Warming

## First pulse:

- Shimada et al. (2004) deduced that it reached the Beringlands in 4-6 years.

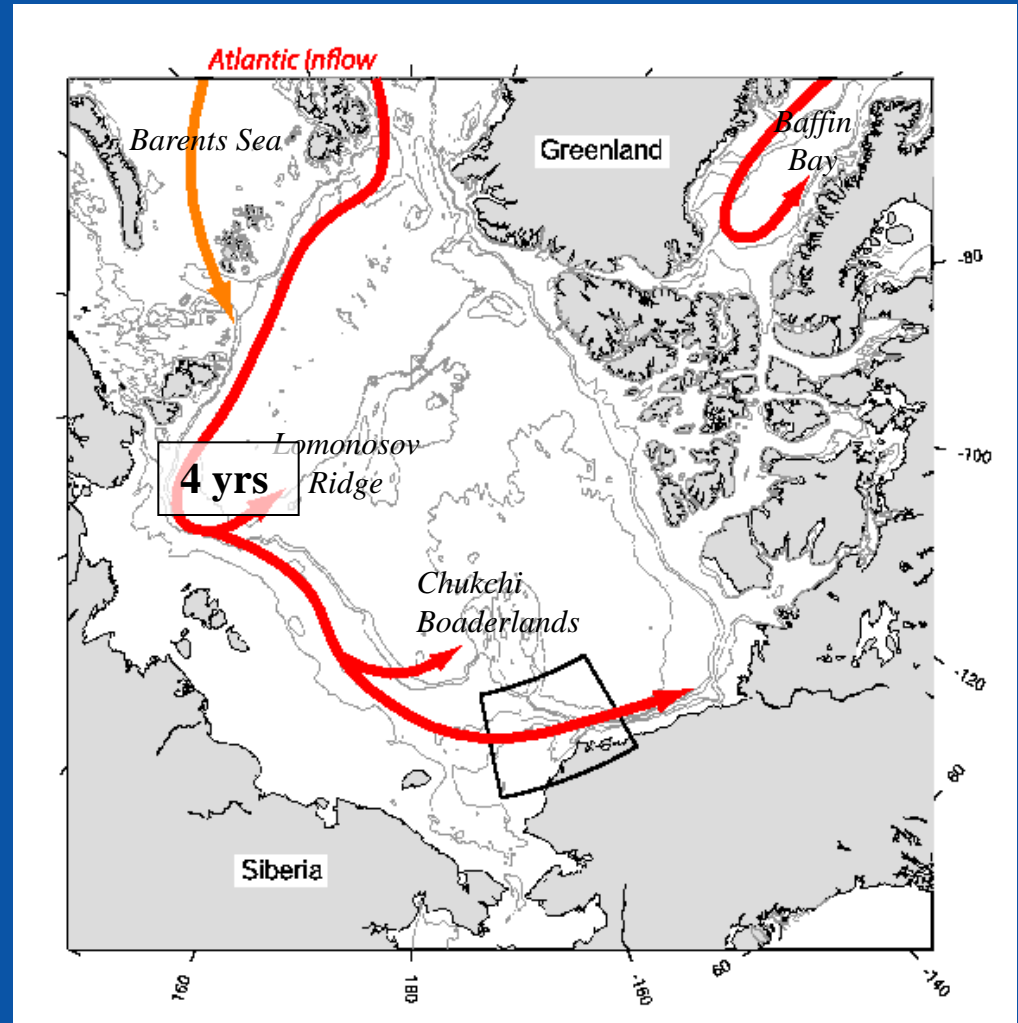




# Role of Atlantic Warming

## Second pulse:

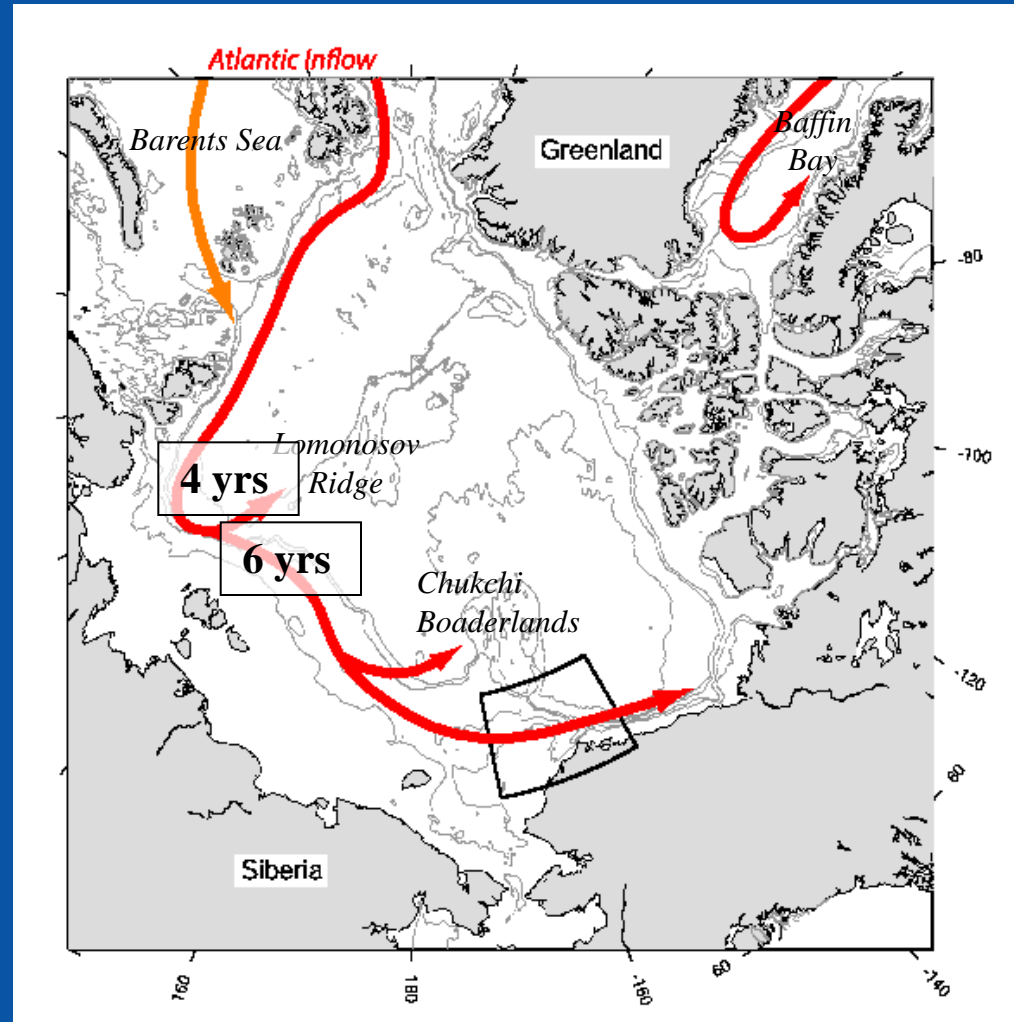
- Polyakov et al. (2005) argued that it took 4 yrs to reach the Northern Laptev Sea.



# Role of Atlantic Warming

## Second pulse:

- Polyakov et al. (2004) argued that it took 4 yrs to reach the Northern Laptev Sea.
- Dmitrenko et al. (2008) deduced that it took 2 more yrs to reach the other side of the Lomonosov Ridge [this pulse spread more effectively along the ridge.]

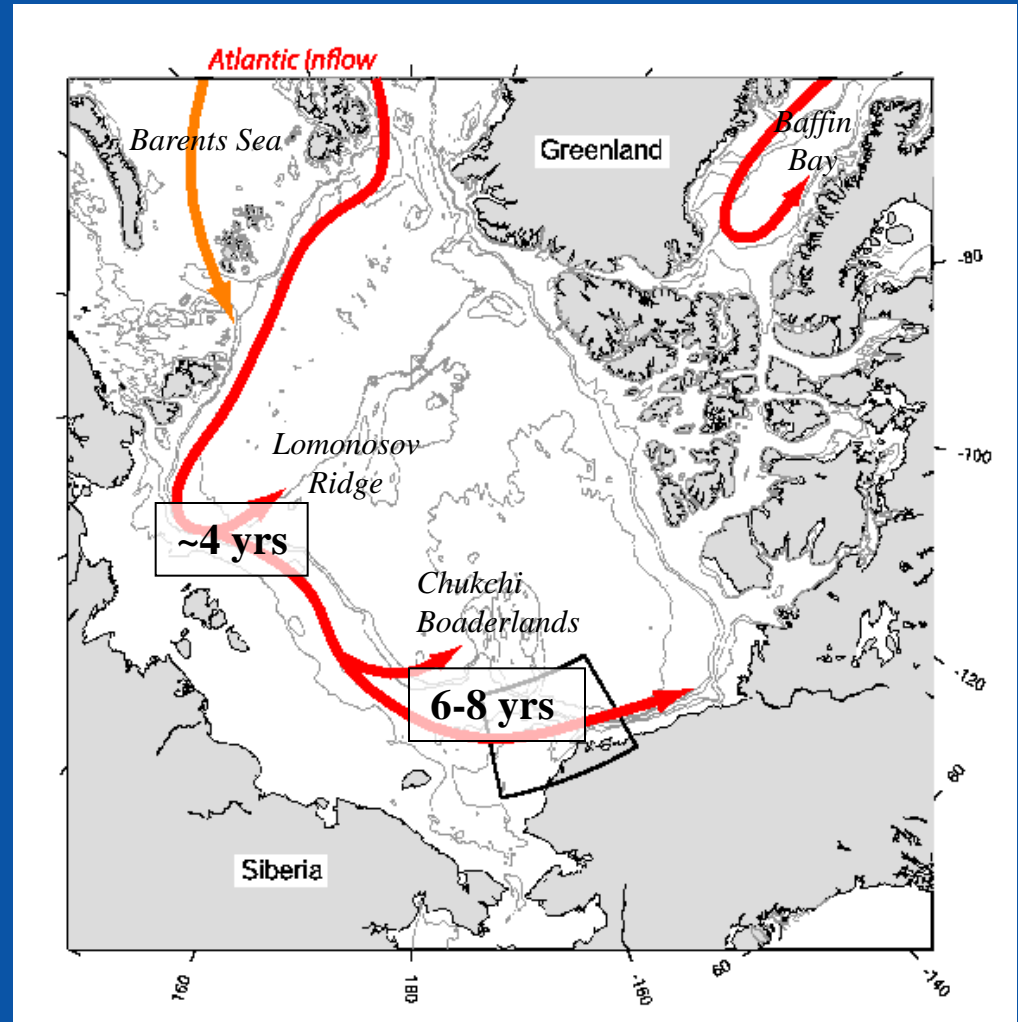




# Role of Atlantic Warming

## Overall:

Approximately 4 yrs to reach the ridge, and perhaps another 2-4 yrs to reach the Chukchi slope.

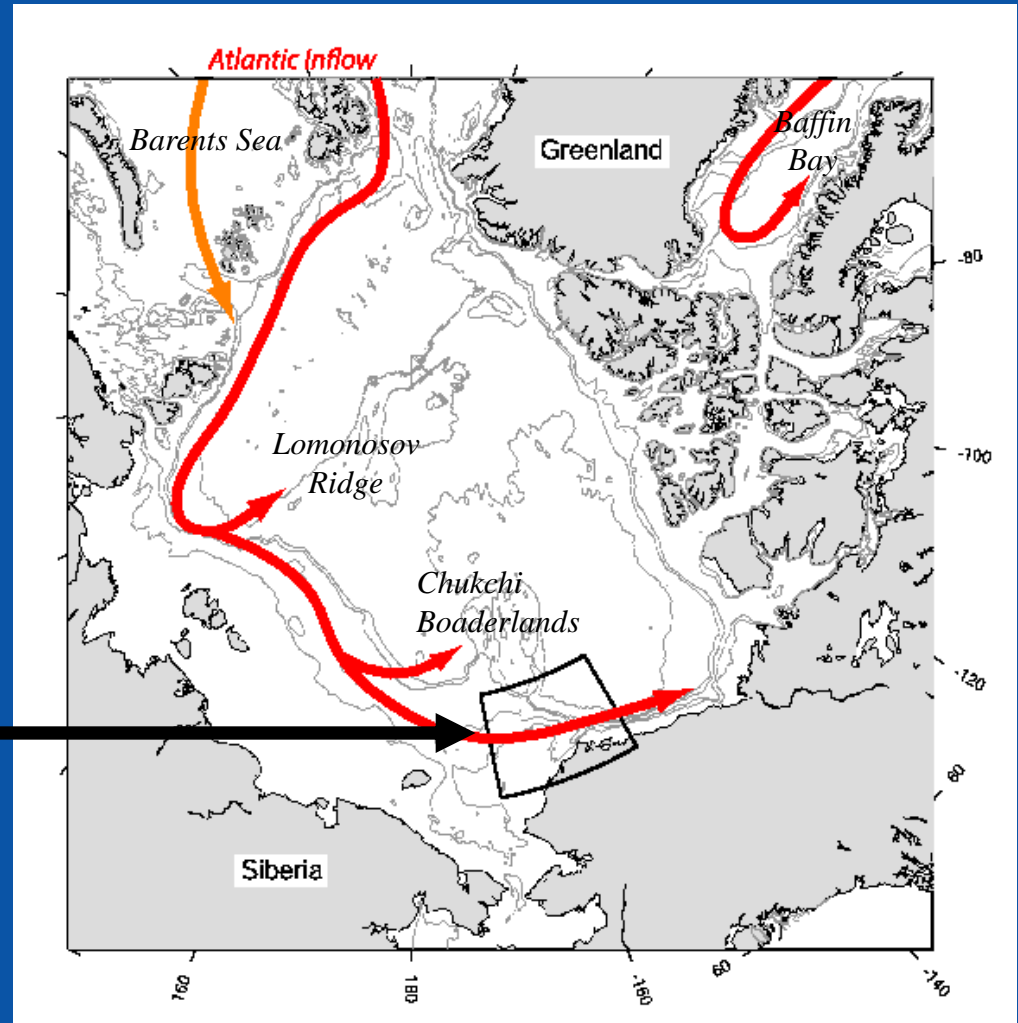




# Role of Atlantic Warming

## Crude Estimate of Arrival at Chukchi Slope

First pulse: ~1996  
Second pulse: ~2008



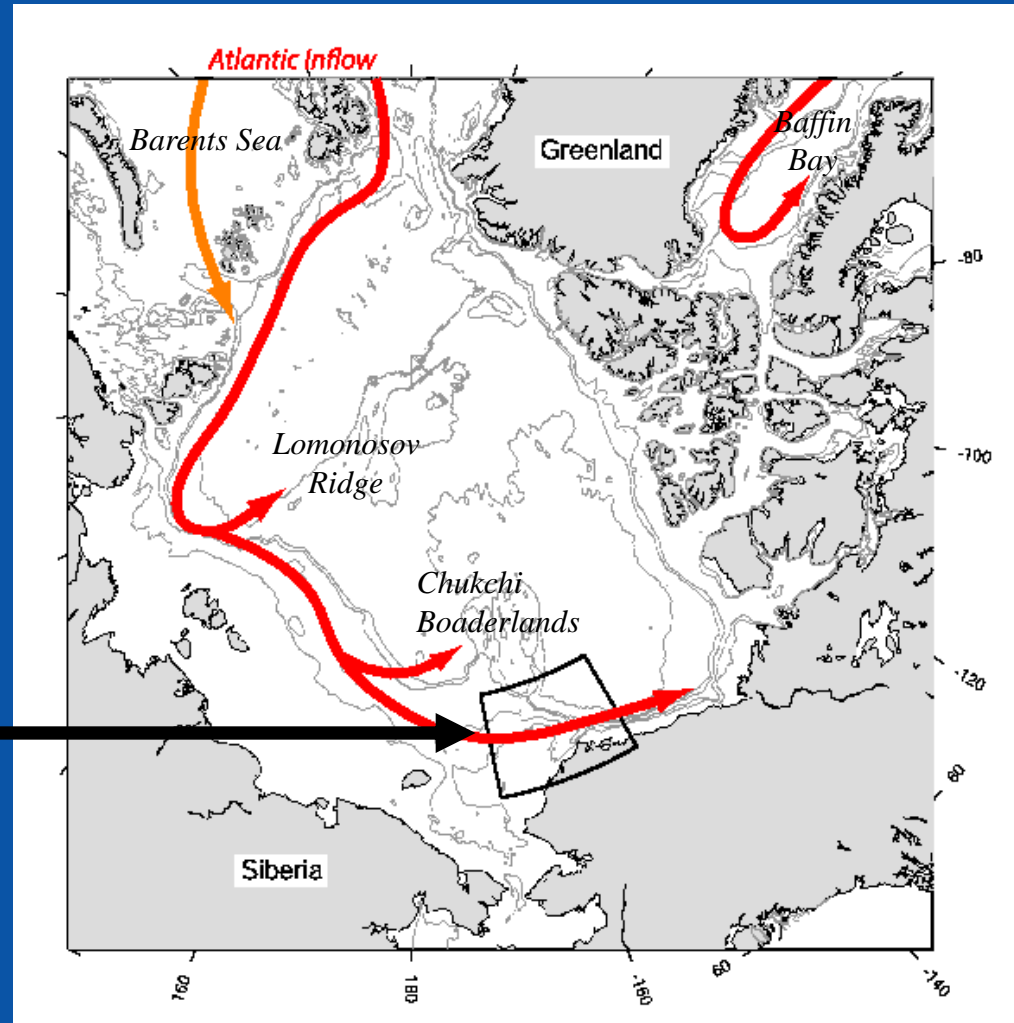


# Role of Atlantic Warming

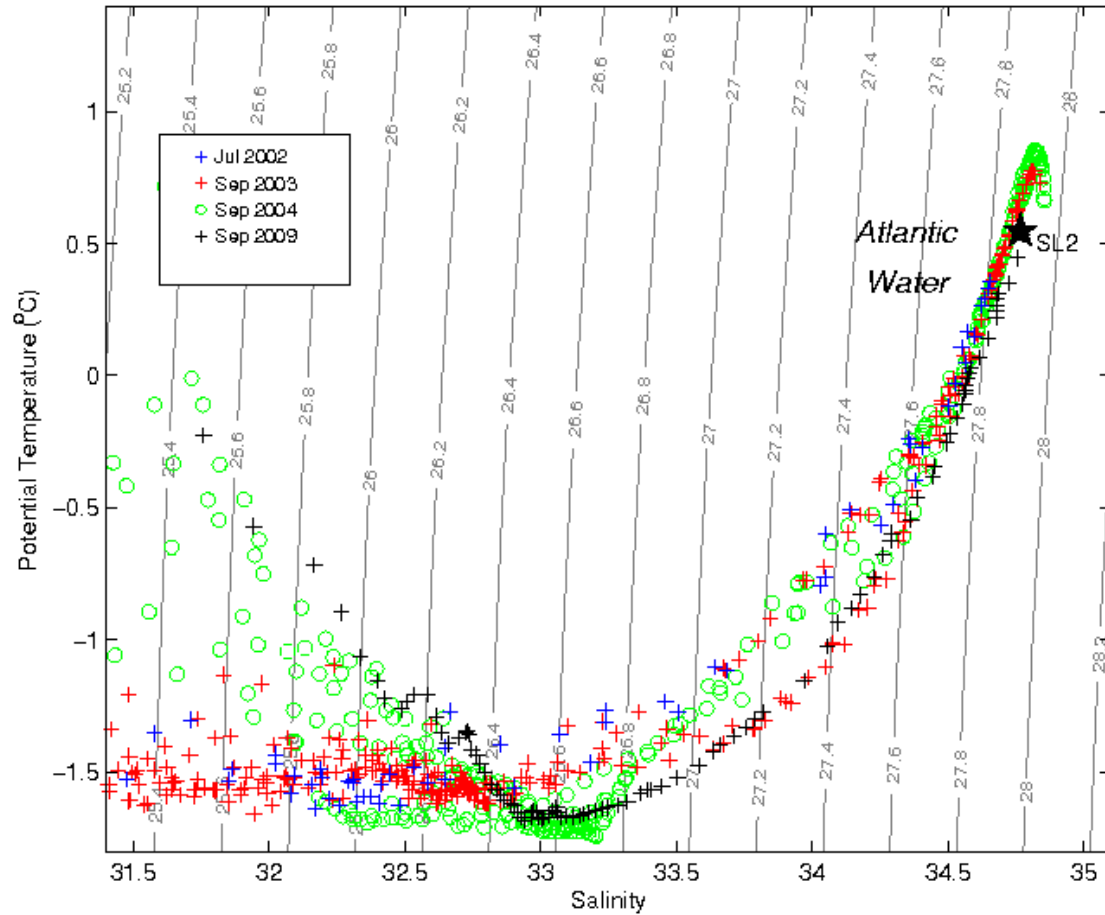
➔ Atlantic species measured by Khromov arrived in the second, warmer pulse?

➔ 2009 Atlantic Water should be warmer than 2002-4 Atlantic Water during SBI

**First pulse: ~1996**  
**Second pulse: ~2008**

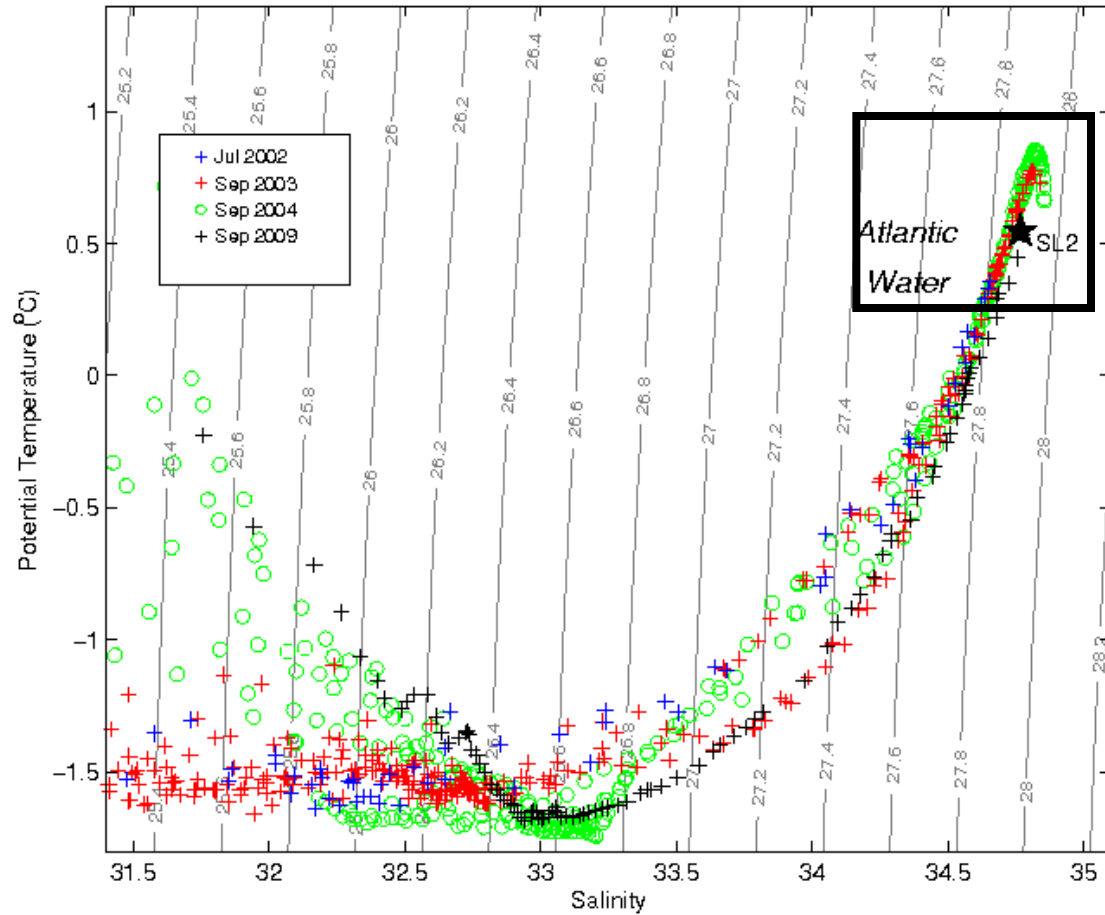


# Temperature/Salinity Diagrams

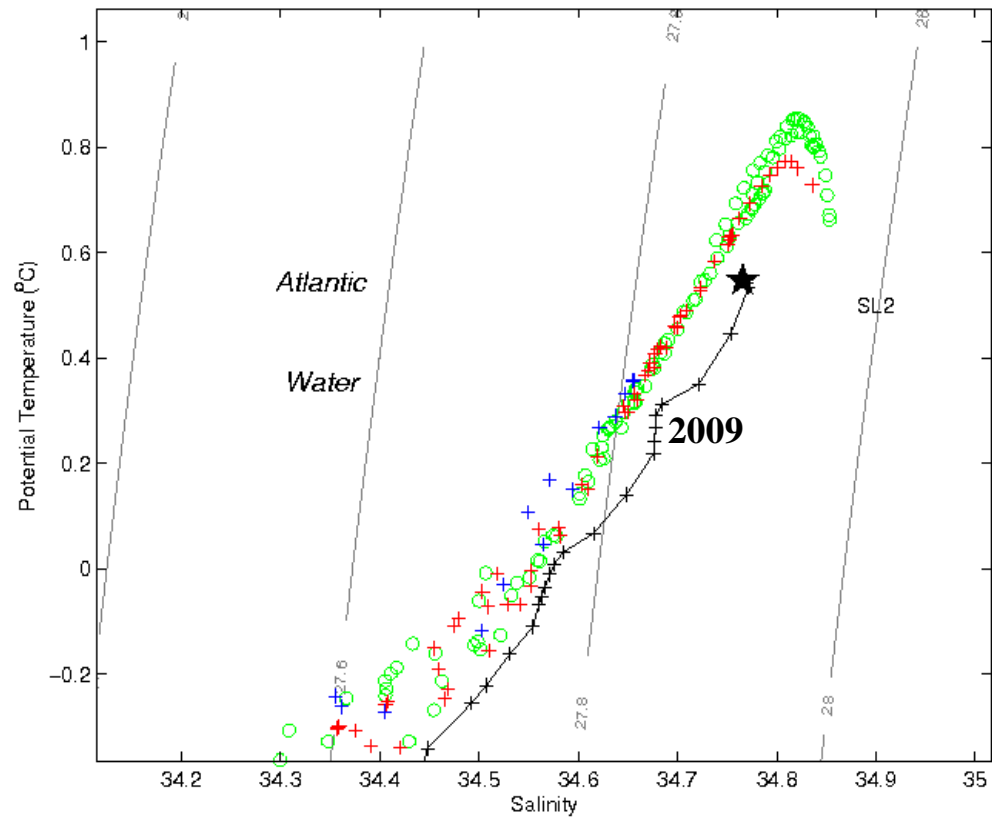




# Temperature/Salinity Diagrams

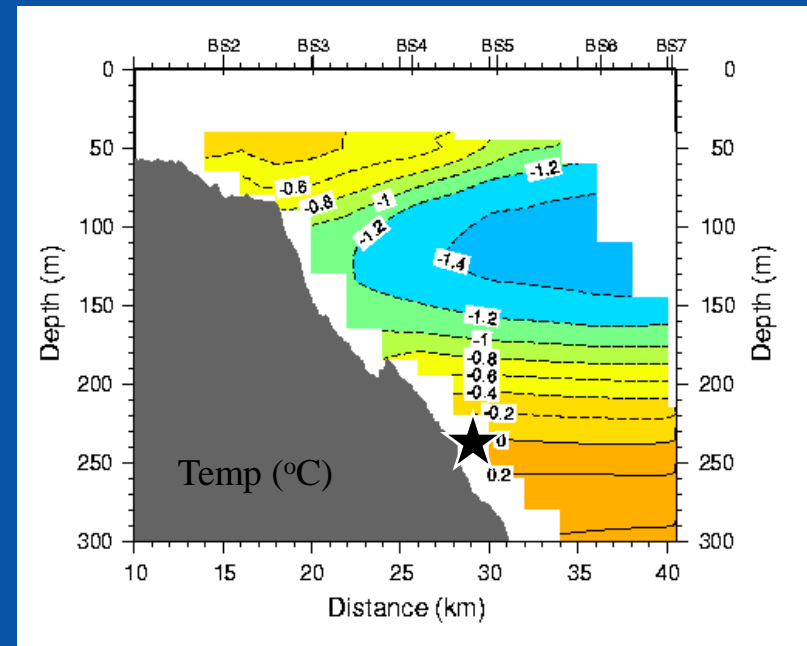
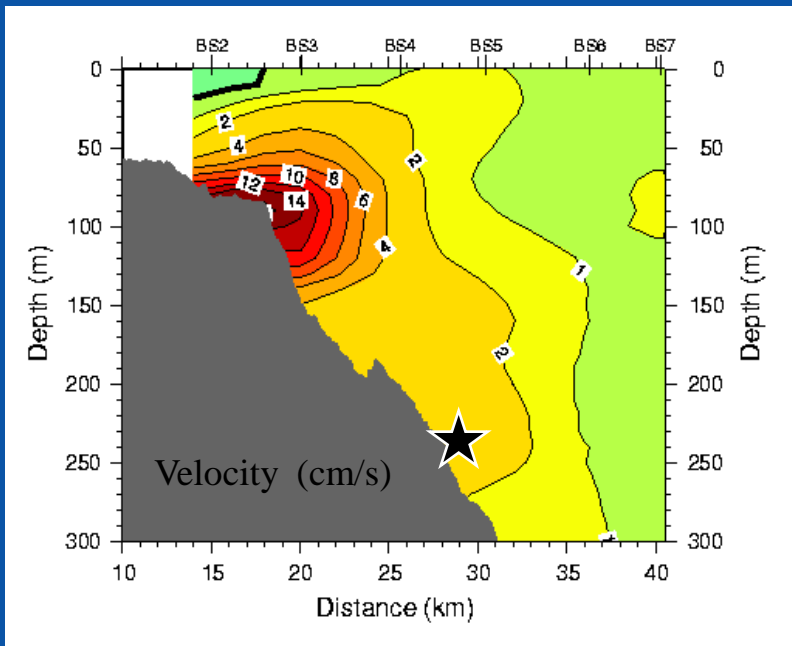


# Temperature/Salinity Diagrams



# Impact of upwelling

## Year-long Mean fields from SBI 152°W Mooring Array

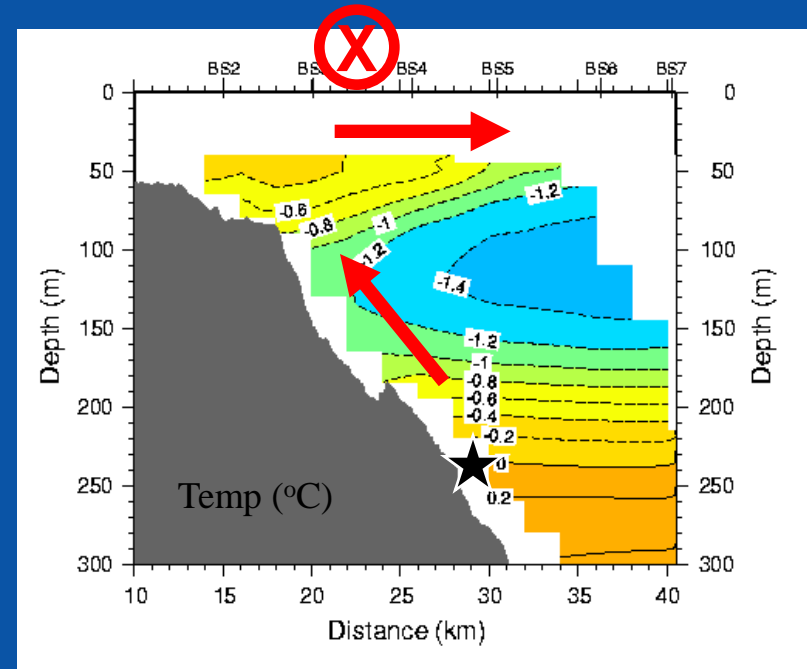
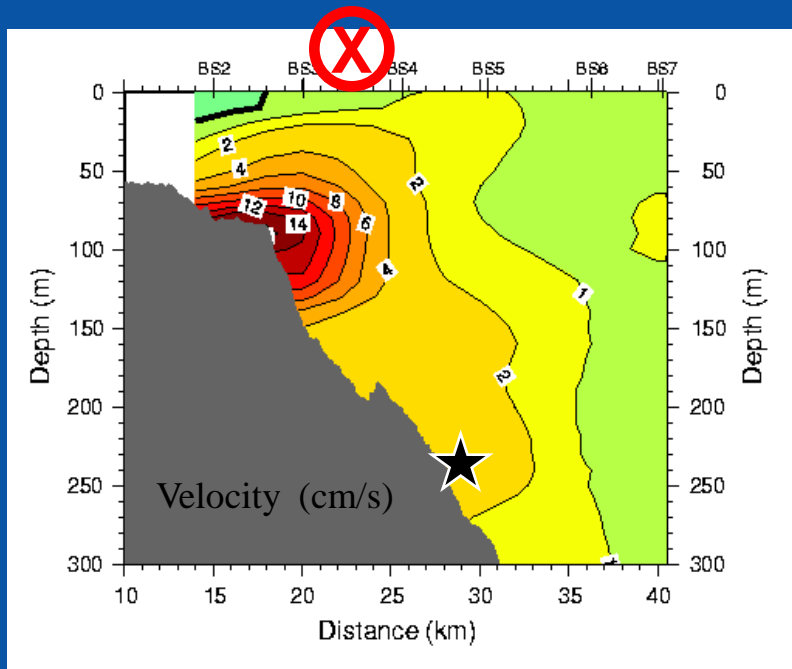


**SL2 site is subject to high mesoscale variability**



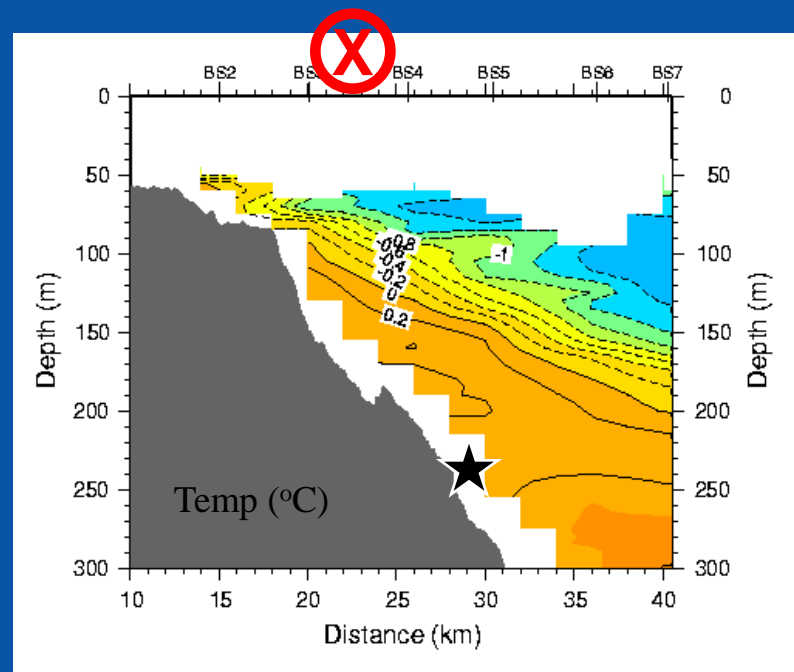
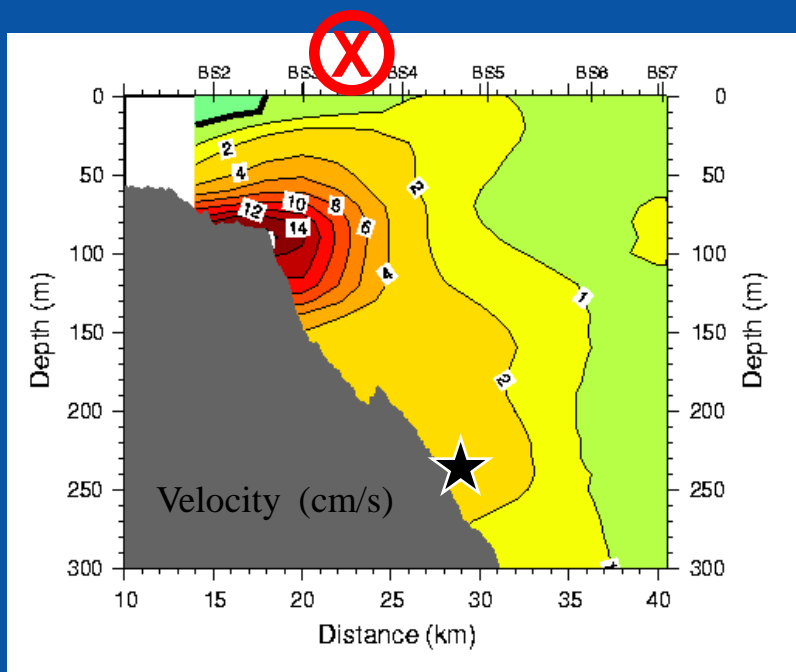
# Impact of upwelling

## Year-long Mean fields from SBI 152°W Mooring Array



Both the 2003 and 2004 SBI 166°W sections were occupied during/after enhanced easterly winds...

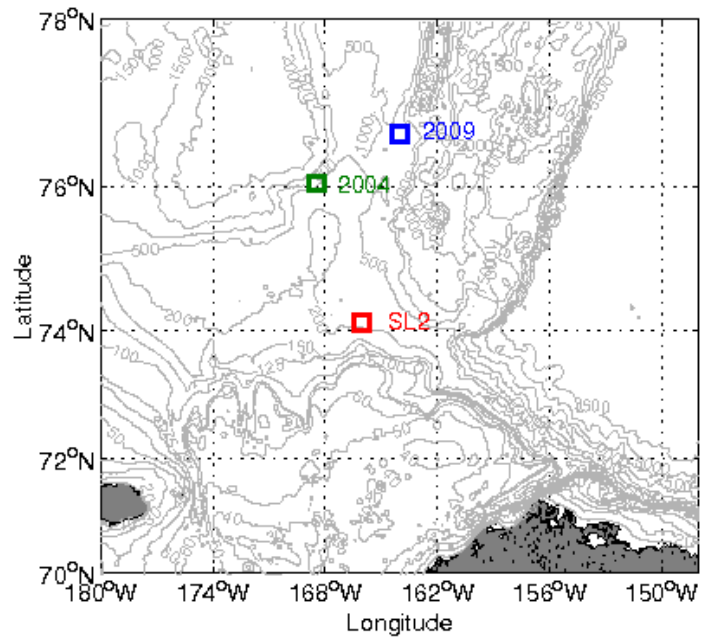
# Upwelling along the Beaufort slope



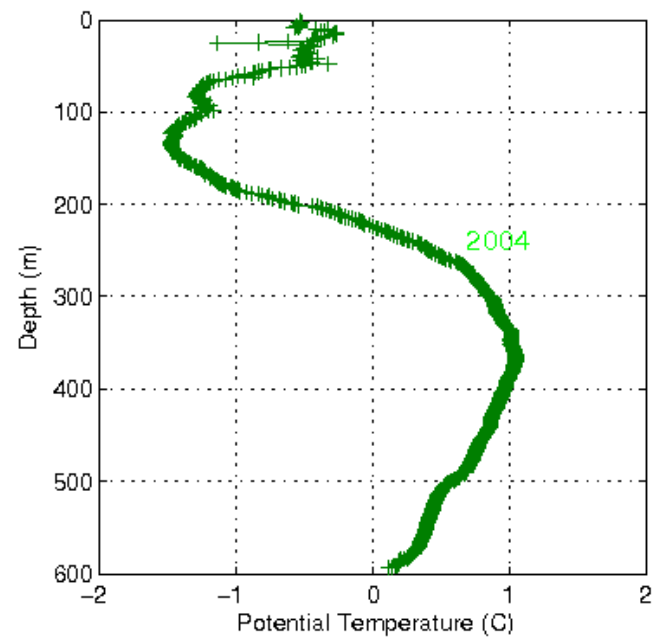
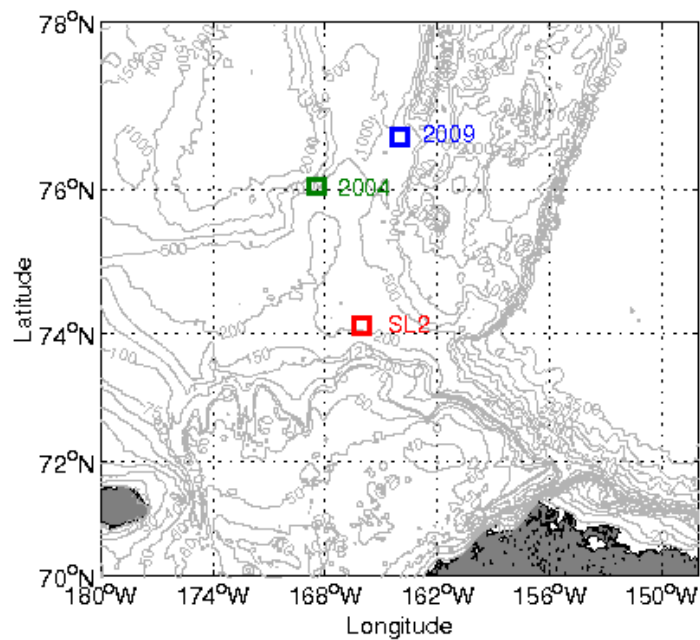
Upwelling storm in Nov 2002



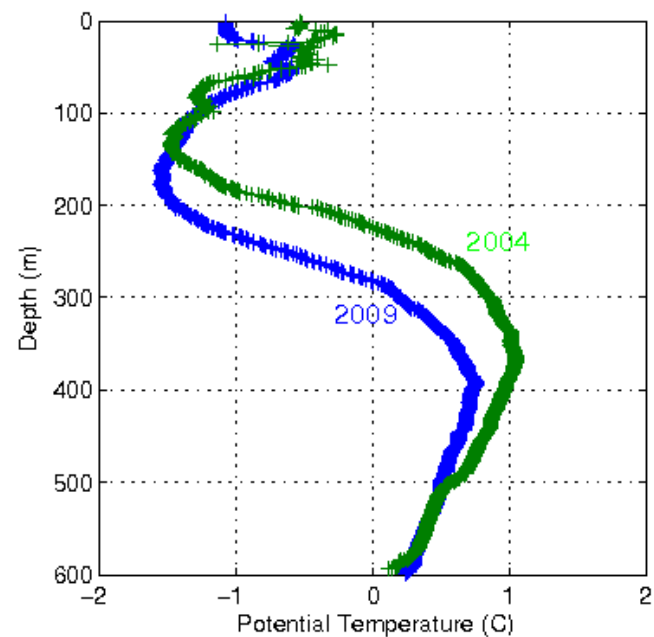
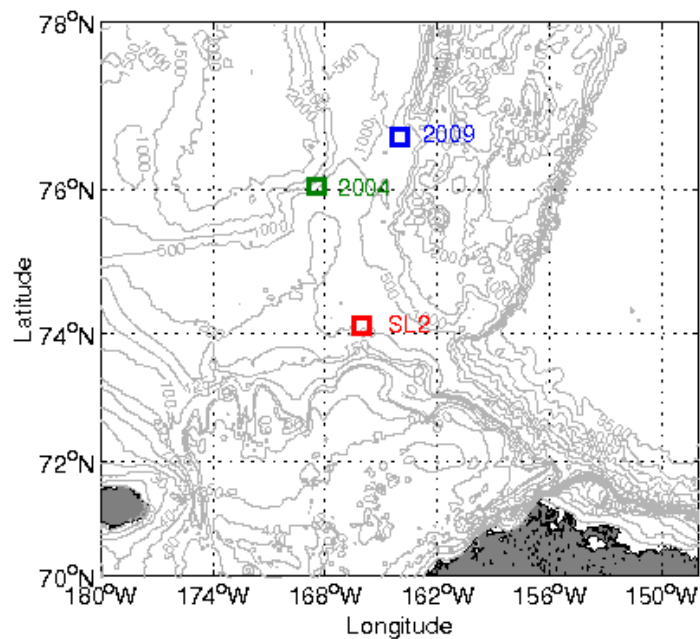
# Atlantic Water comparison



# Atlantic Water comparison

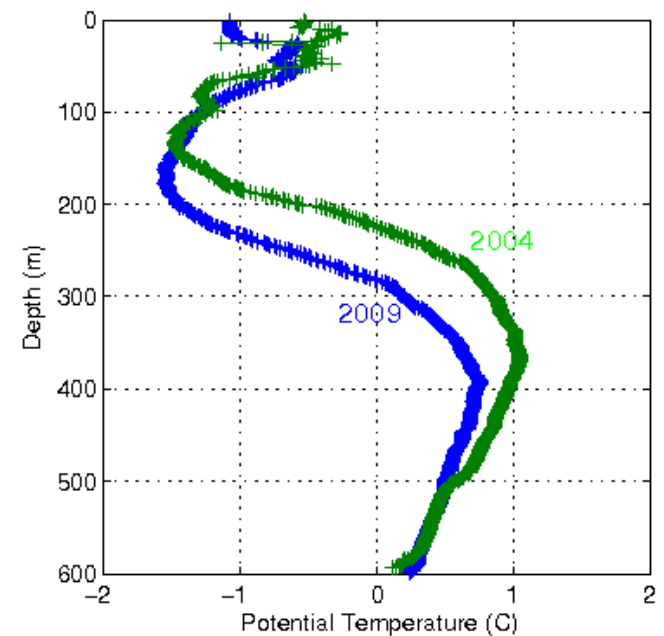
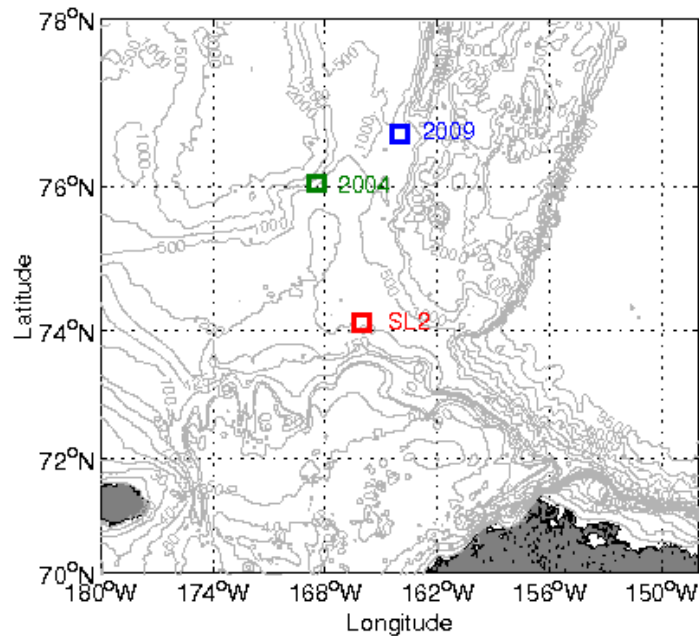


# Atlantic Water comparison





## Atlantic Water comparison



**Implication: 2004 was at tail end of first pulse; 2009 was in between pulses when the temperature had lowered.**



## Conclusions

- 1. The Atlantic species of fish caught at site SL2 (and probably SL1) were in the upper AW layer. If advected, they likely came from Fram St. via the AW boundary current.**
- 2. It is difficult to tie the presence of the fish to either of the recent pulses of warm AW (apparently between pulses).**
- 3. However, in light of the general warming of AW since 1980 it is possible that a threshold was reached allowing the fish to make the long transit to the western Arctic.**



Thank you

RUSALCA 2009  
(Photo by D. Torres)