Double haloclines in the Canada Basin under the warming climate

Jiuxin Shi , Jinping Zhao and Shujiang Li

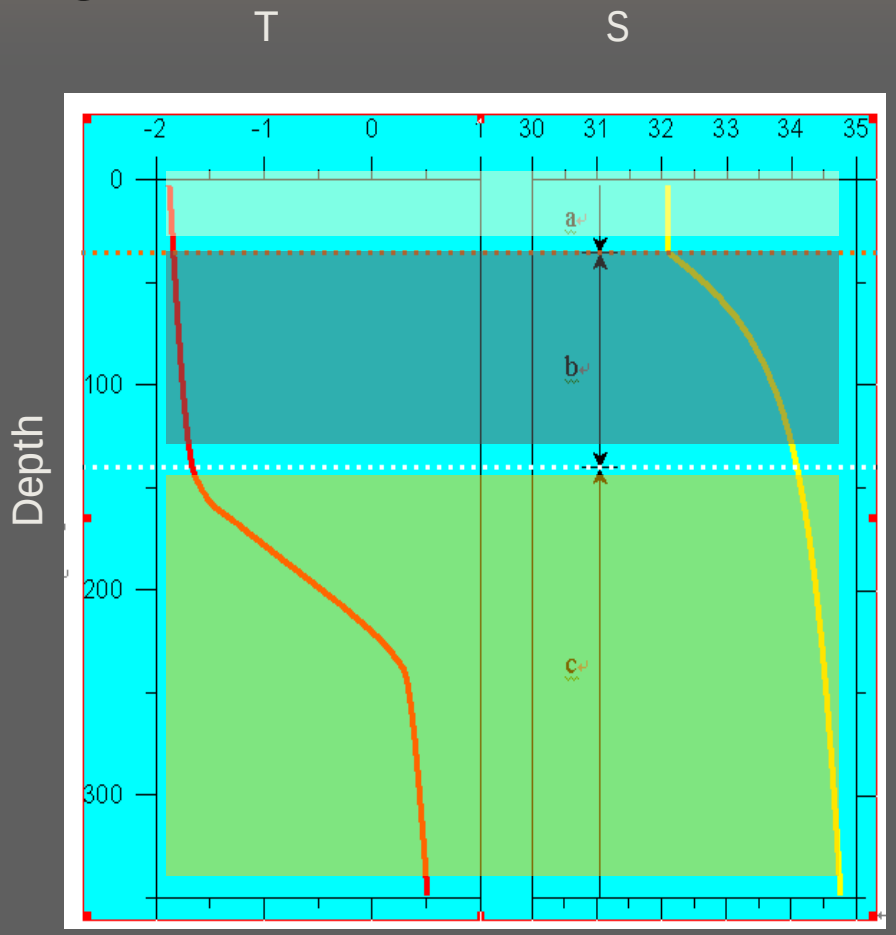
Key Lab of Polar Oceanography and Global Change
( )
Ocean University of China

Outline

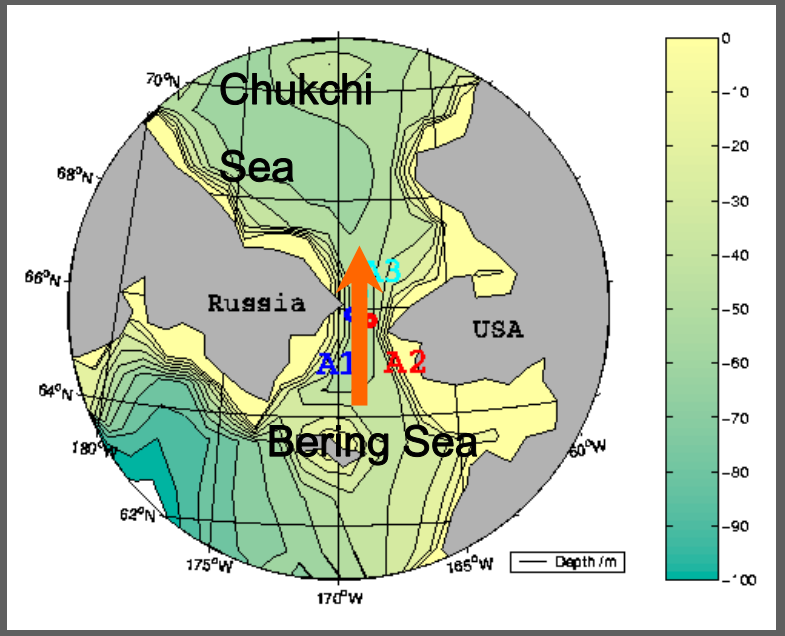
- Background
  - Arctic Ocean halocline
  - Pacific inflow to the Arctic Ocean
- Double haloclines in Canada Basin
  - Spatial distribution
  - Annual cycle
  - Inter-annual variations: 2003~2008
- Summary

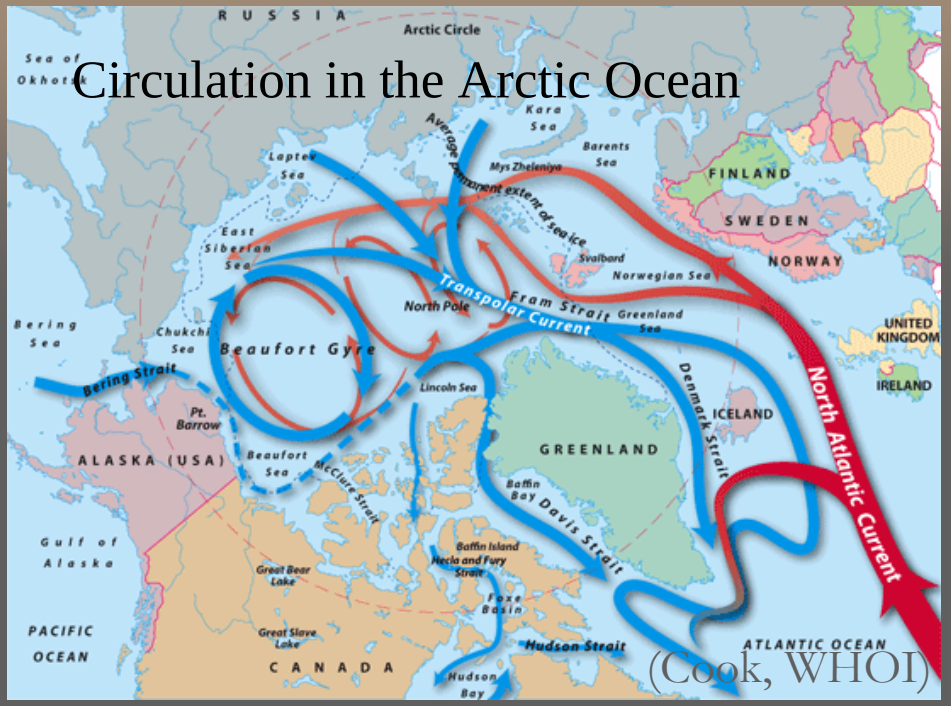
Arctic Ocean Halocline

- a. Mixed layer
  - Cold and fresh
- b.Cold Halocline Layer (CHL)
  - T~ freezing point
  - S increase from 32 to 34
- c. Atlantic Layer
  - Warm and saline



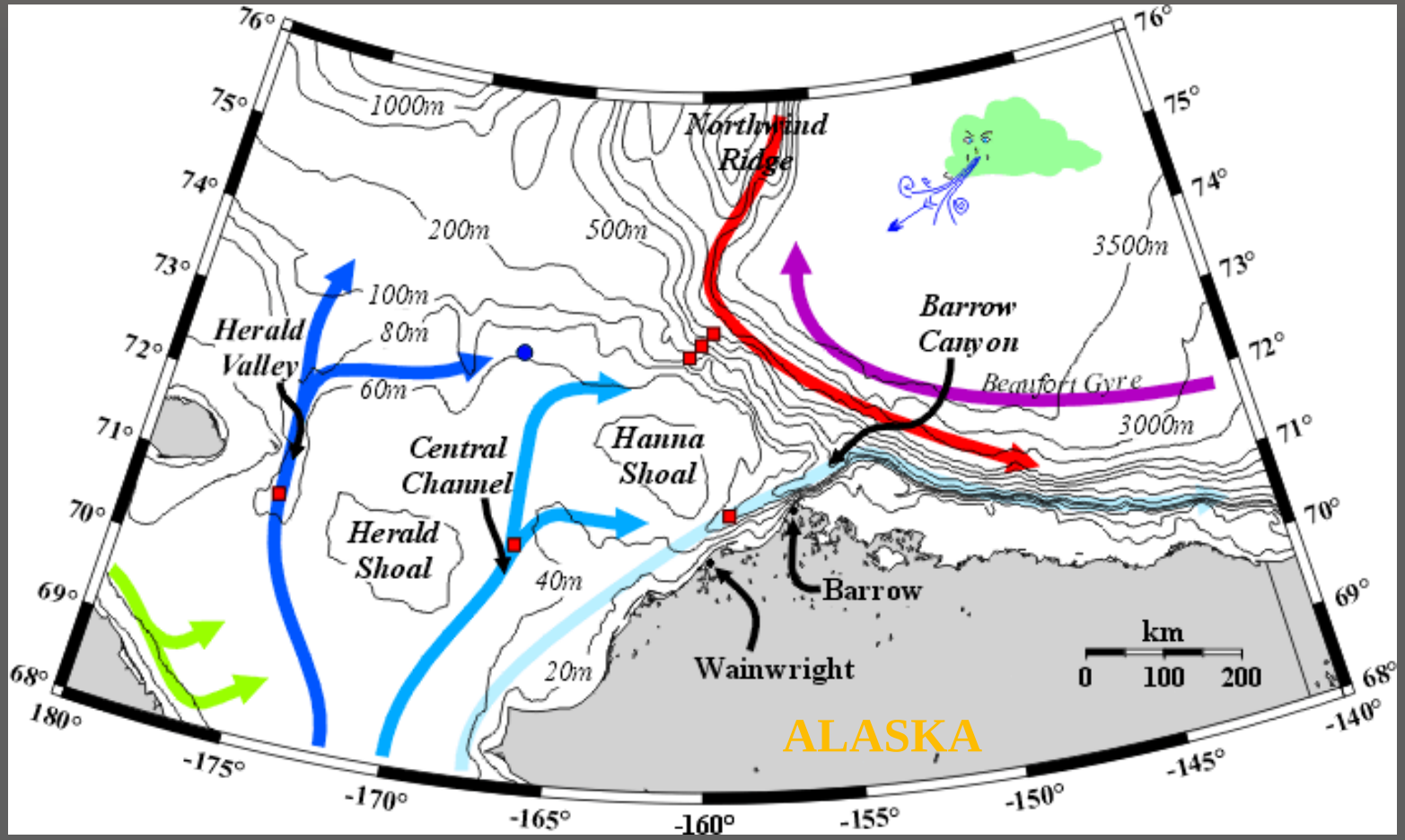
Pacific inflow in the Bering Strait



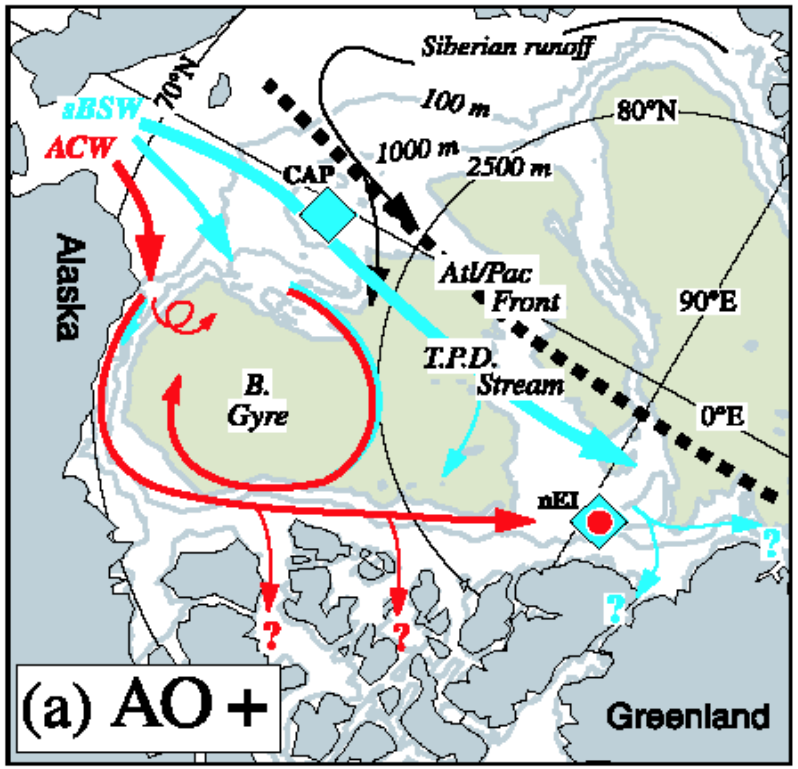


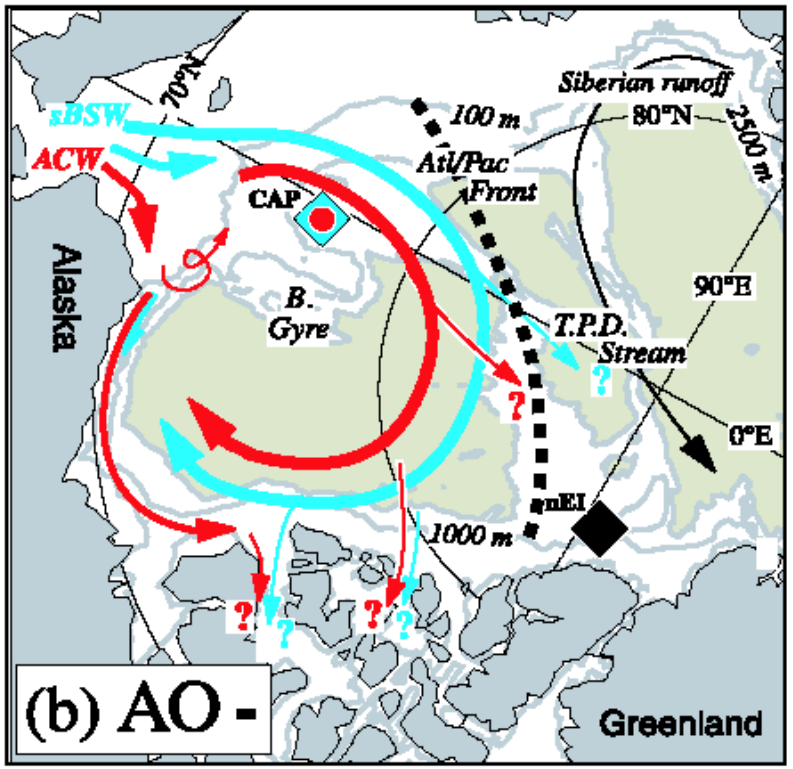
- Transport volume: 0.8Sv , Northward
- Fresher and warmer

Transports of the Pacific-origin water in the Chukchi Sea



Two patterns of the Pacific-origin water circulation in the Arctic Ocean: Summer



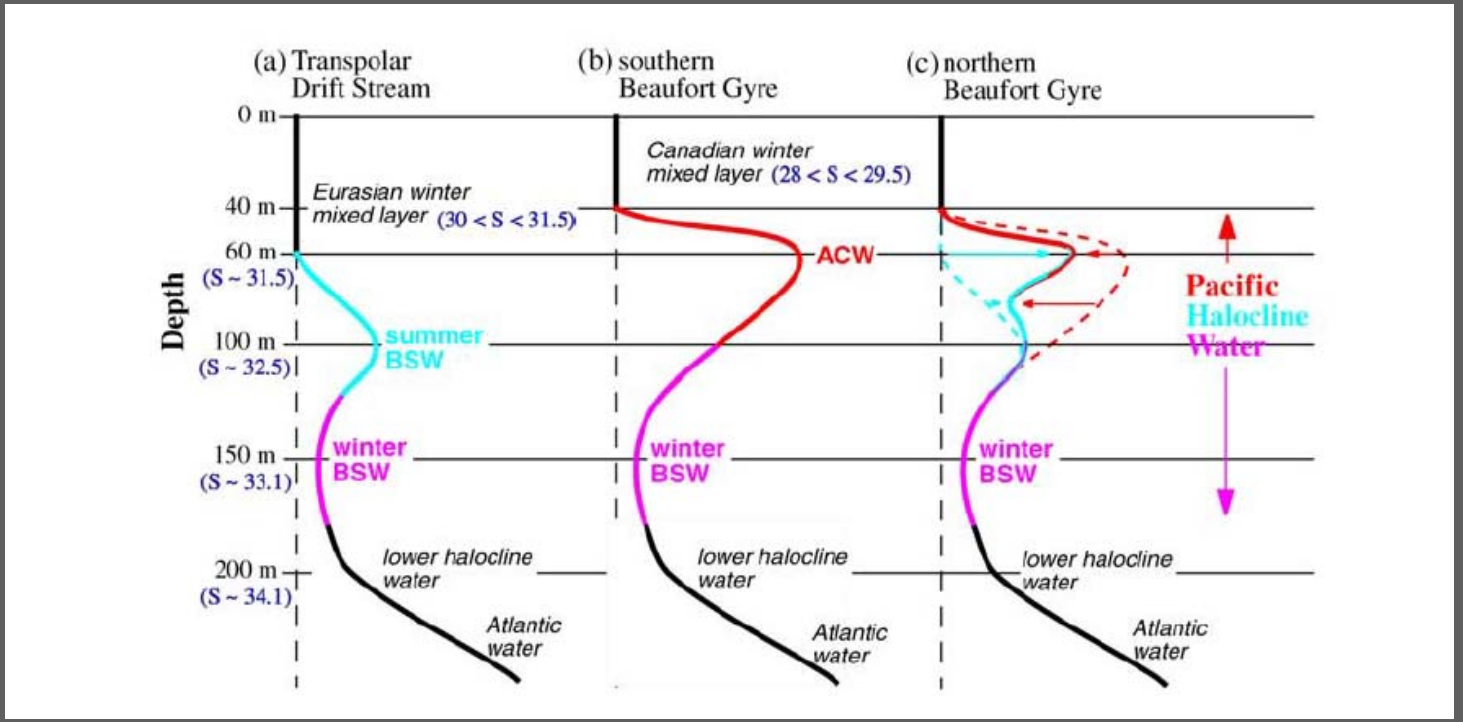


(Steele et al., 2004)

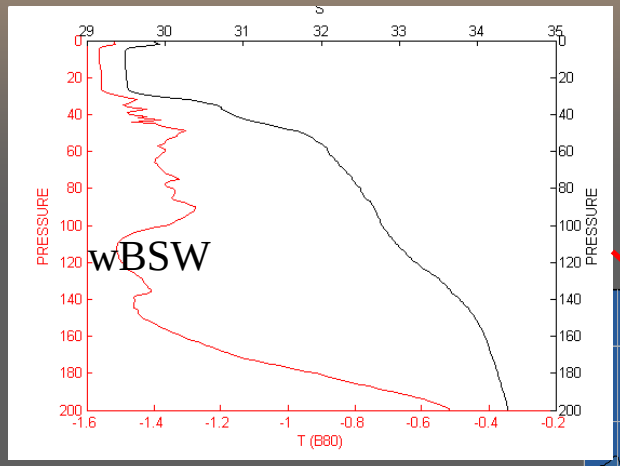
Pacific-origin watermasses

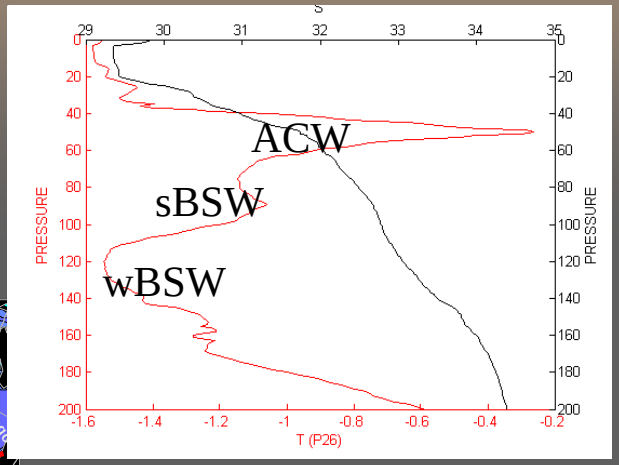
- Alaskan Coastal Water (ACW): θ_{max}, $31 < S < 32$
- summer Bering Sea Water (sBSW): θ_{max}, $32 < S < 33$
- winter Bering Sea Water (wBSW) θ_{min}, $S \sim 33.1$

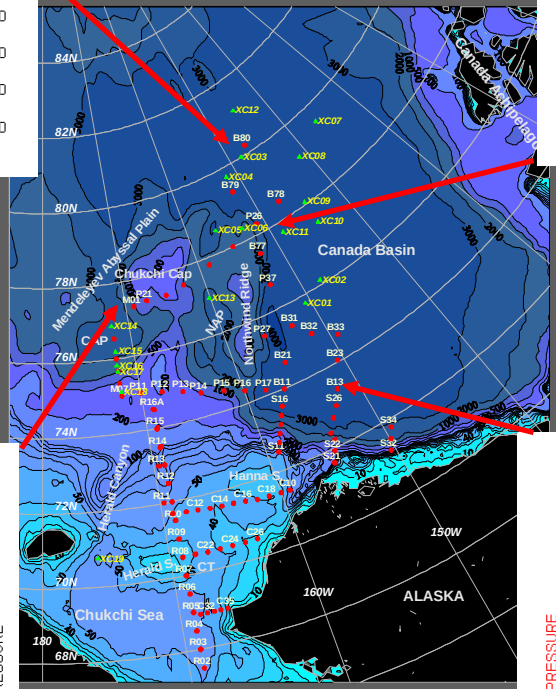
(Steele et al., 2004)

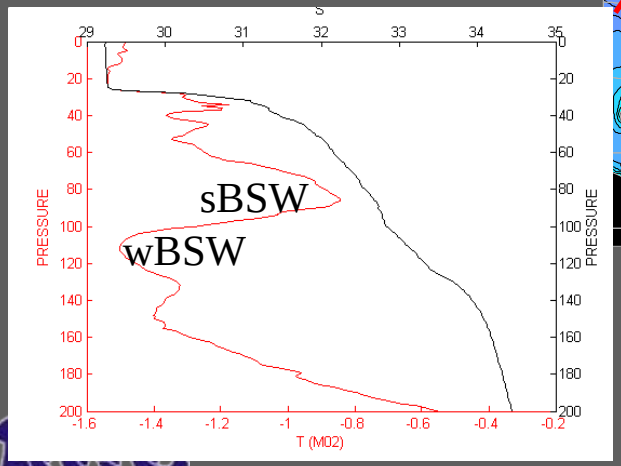


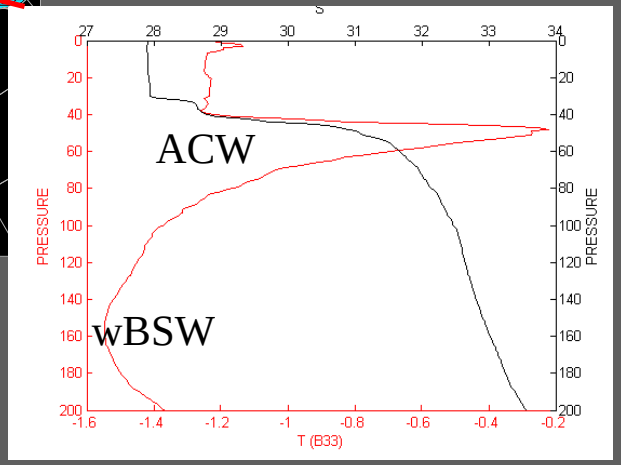
CHINARE 2003



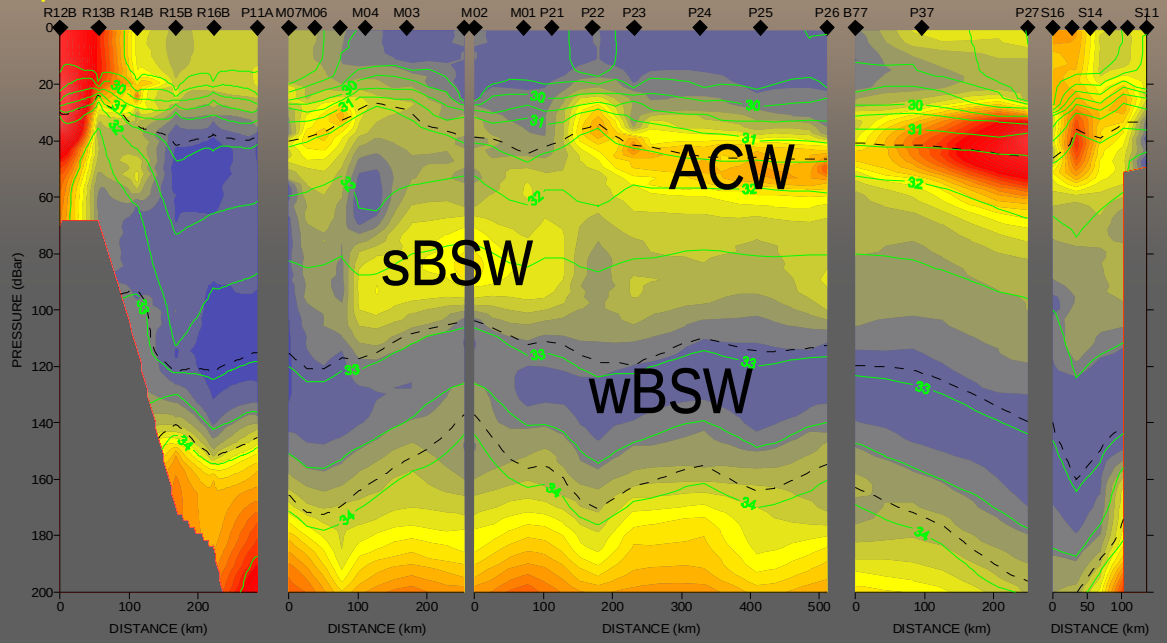


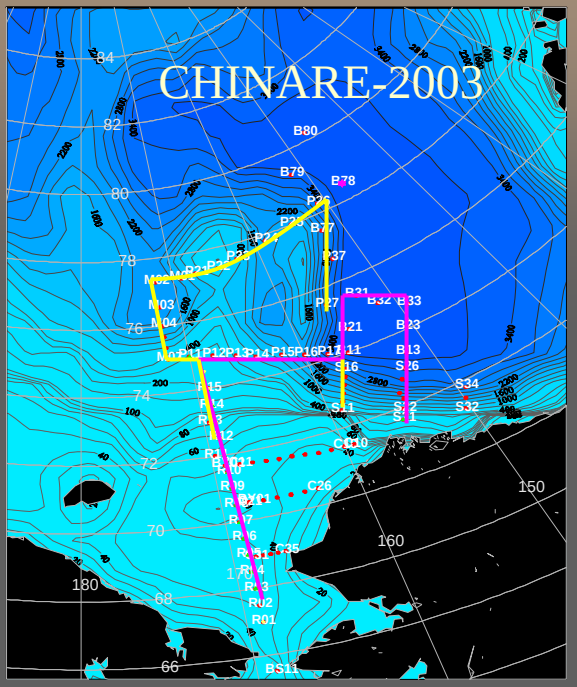




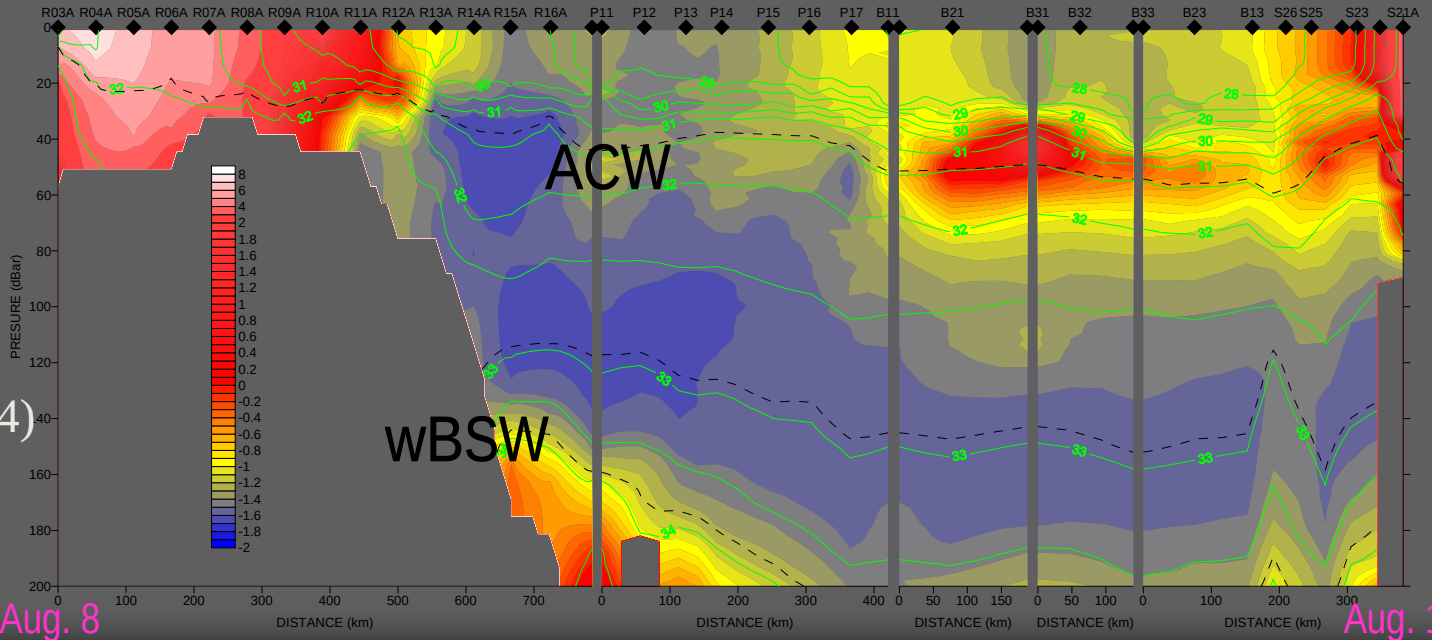


Sept. 8 Sept. 4 Aug. 19 Aug. 17





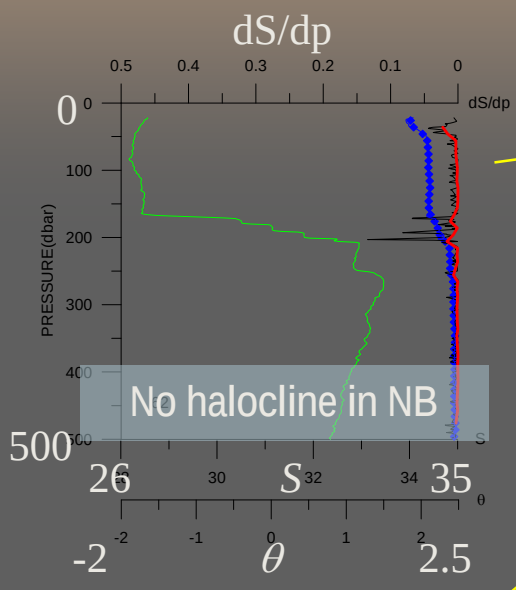
- σ_θ 25.25,26.5,27.25 (Mclaughlin et al., 2004)

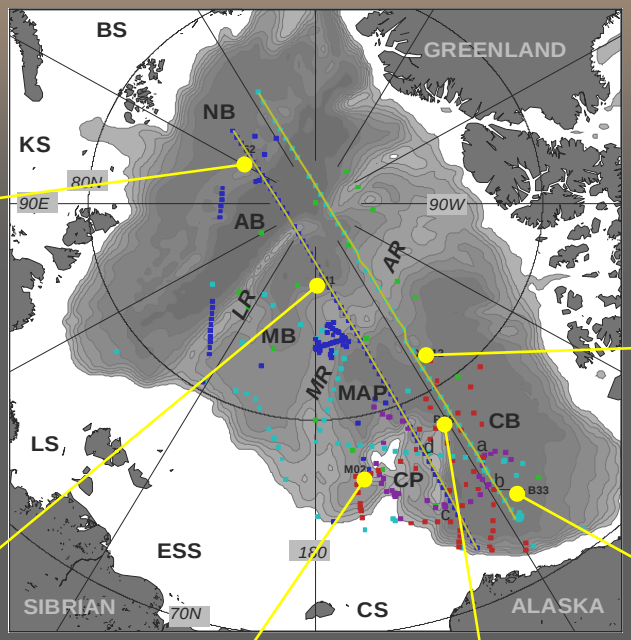


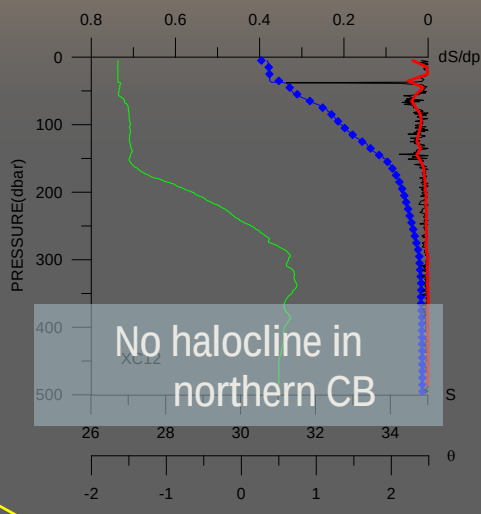
Aug. 8 Aug. 15

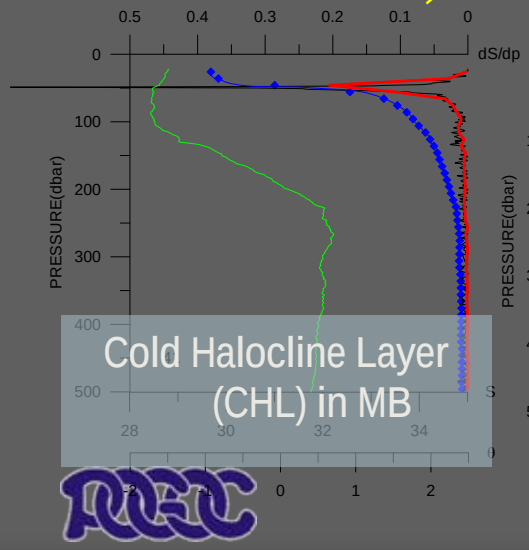
Halocline: Ds/dp

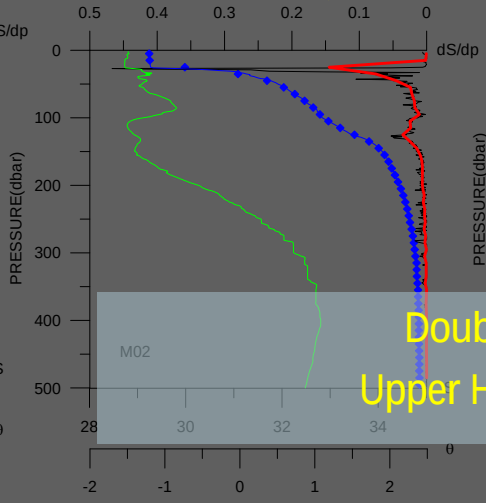
Data: SCICEX93 97 98
SHEBA CHINARE2003

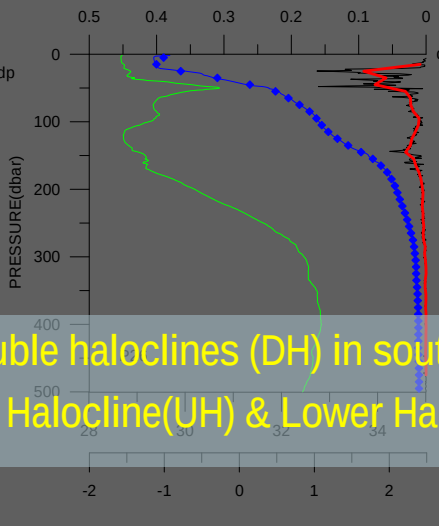


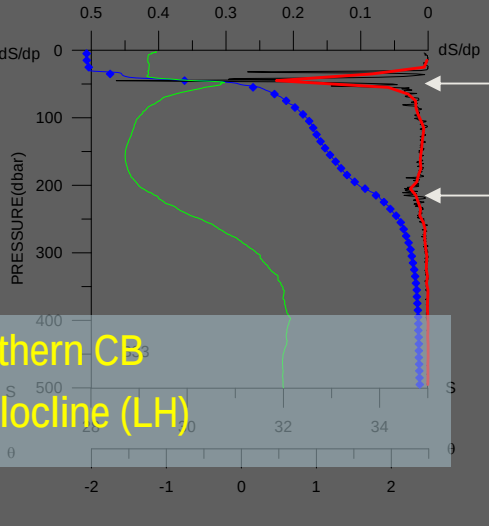






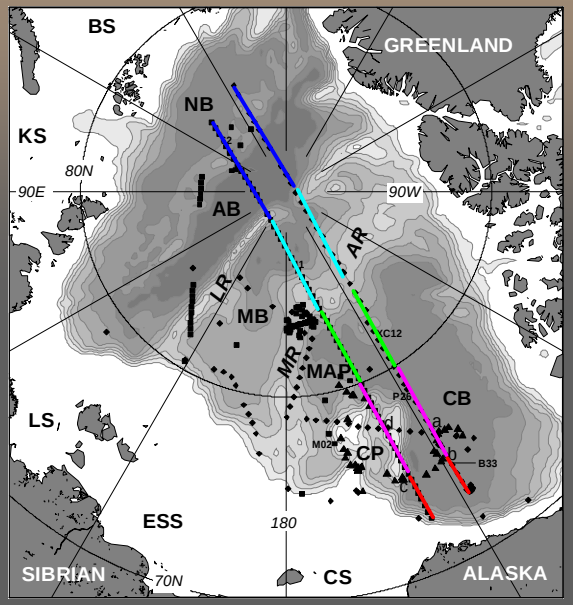


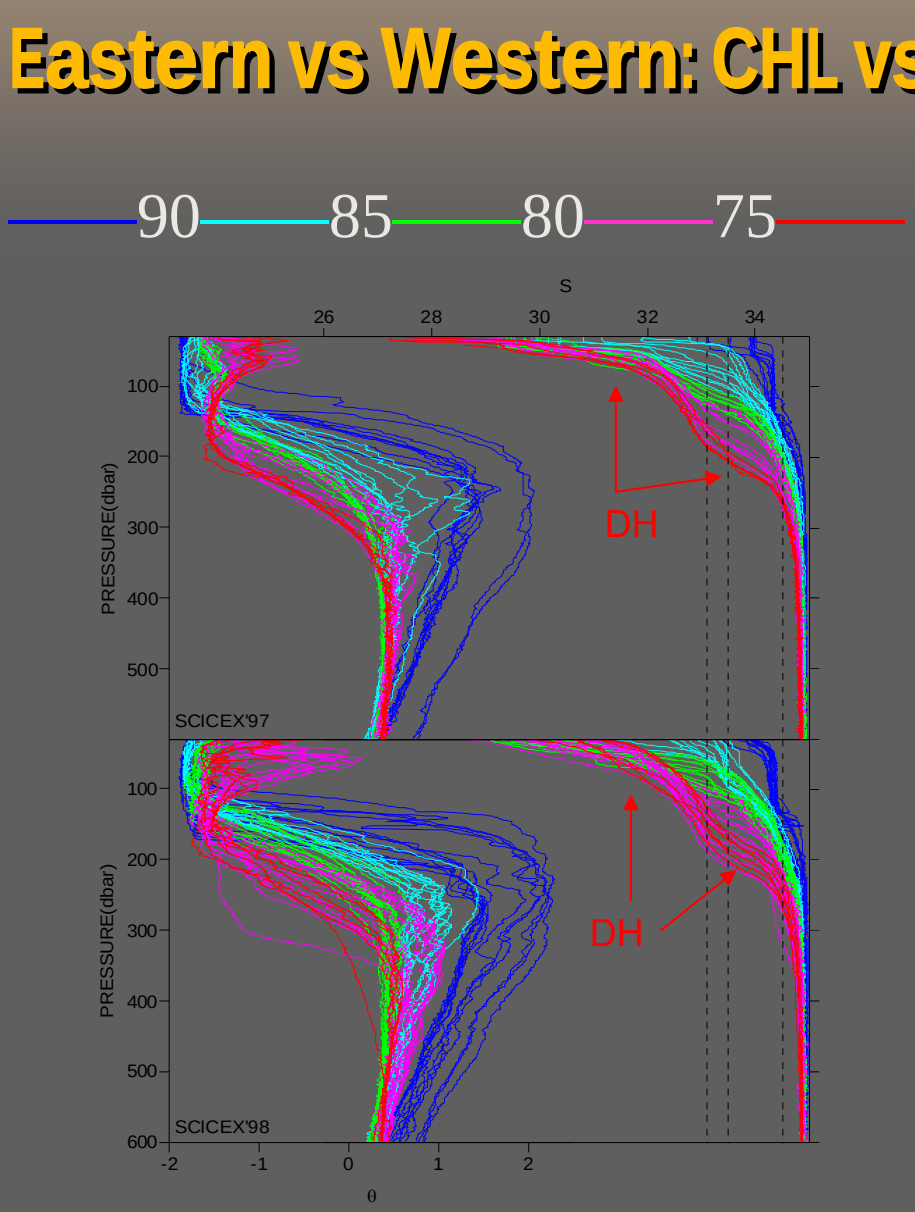




Double haloclines (DH) in southern CB
Upper Halocline(UH) & Lower Halocline (LH)

Eastern vs Western: CHL vs DH



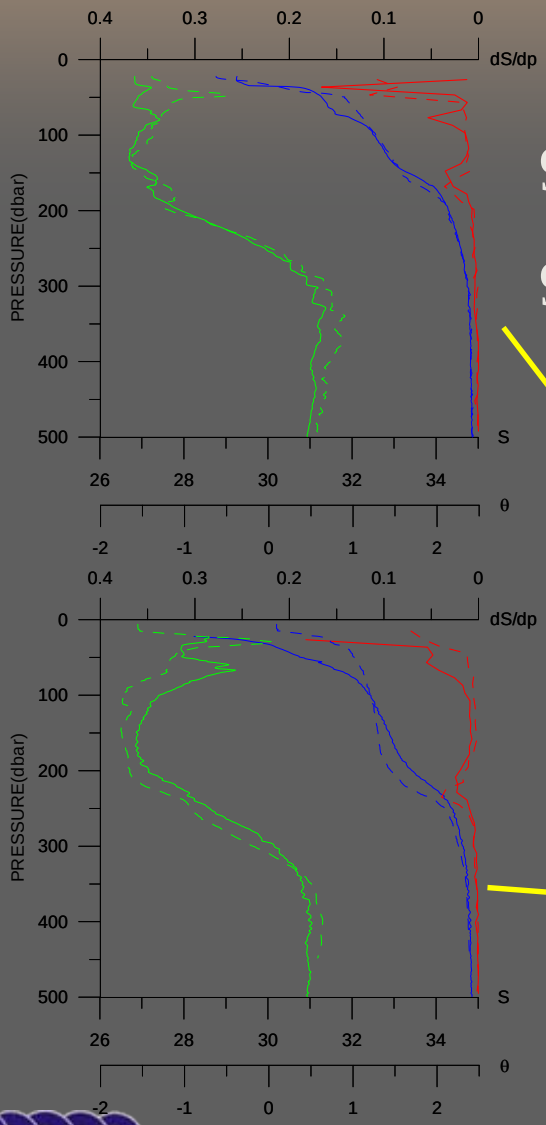


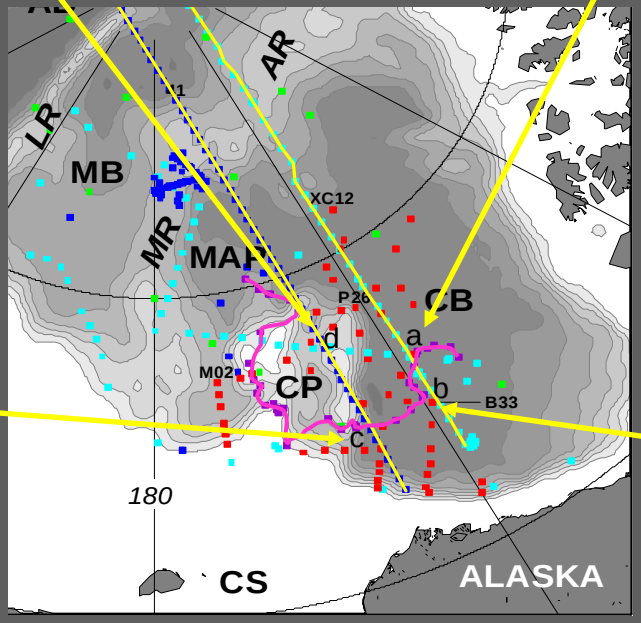
- SCICEX97
- SCICEX98

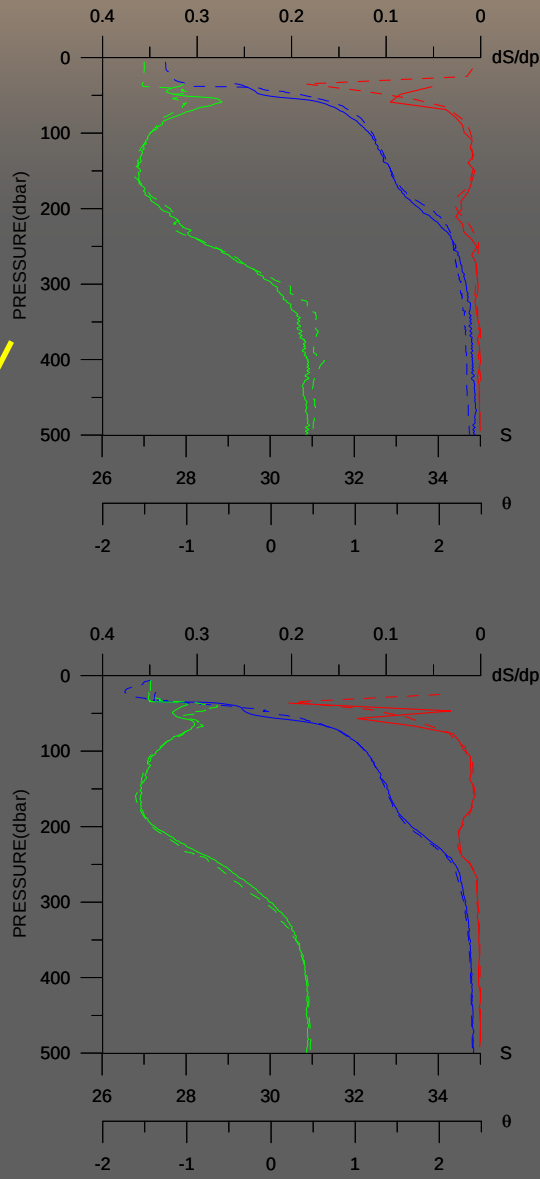
Annual Cycle

9708-9808 9708-9711

9808-9802 9708-9801



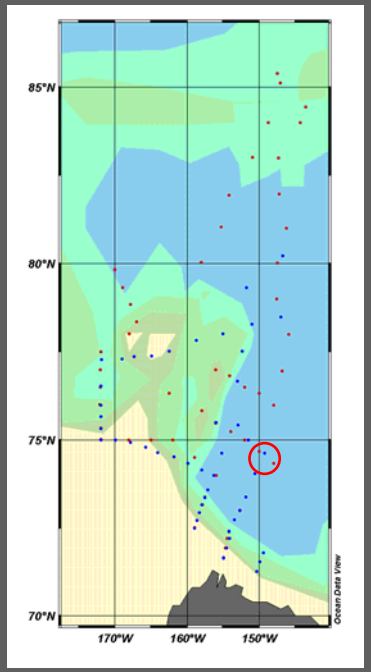


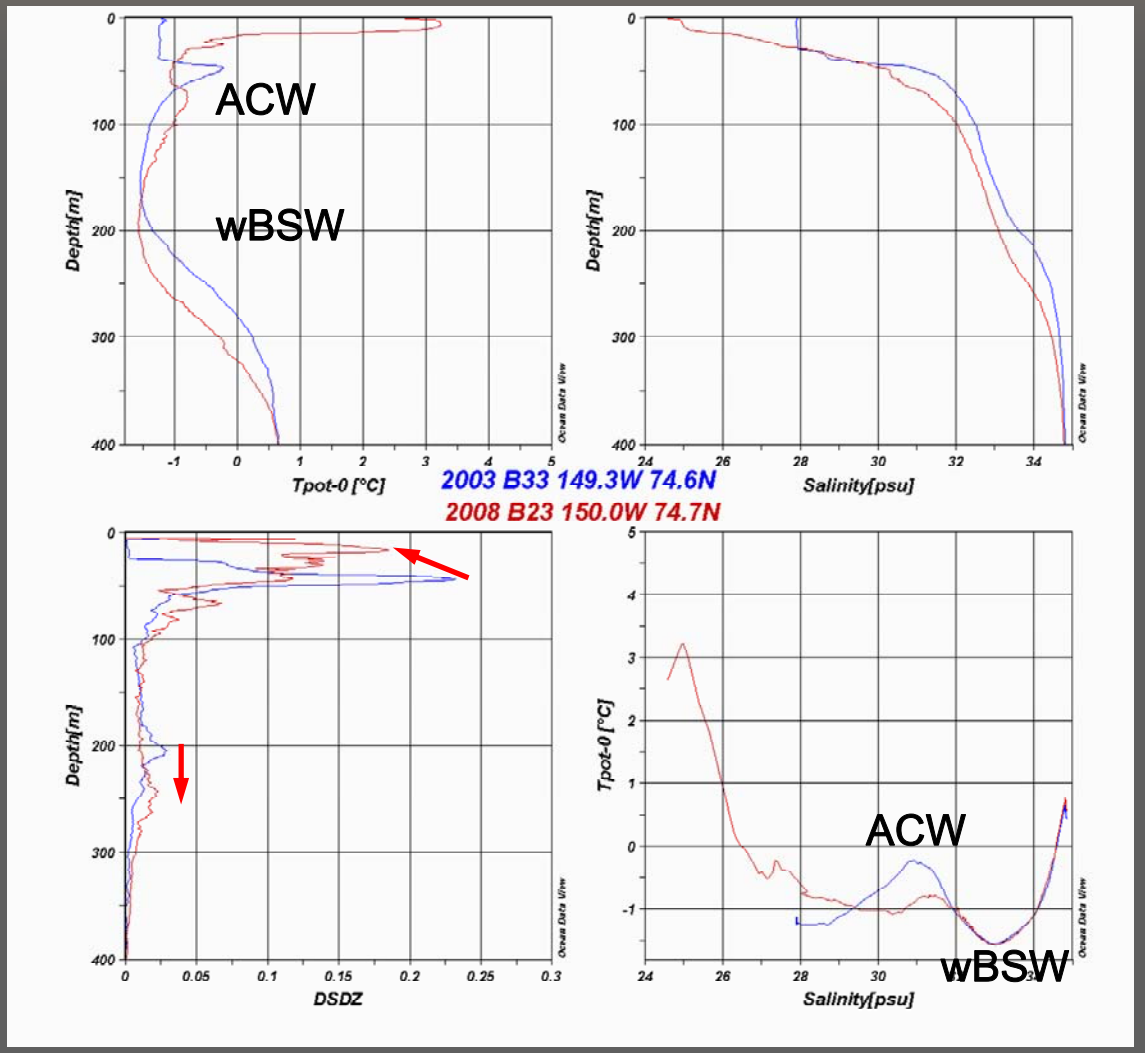


Data: SCICEX93 97 98 SHEBA (97.10~98.9)

Inter-annual variaitons: 2003 vs 2008:

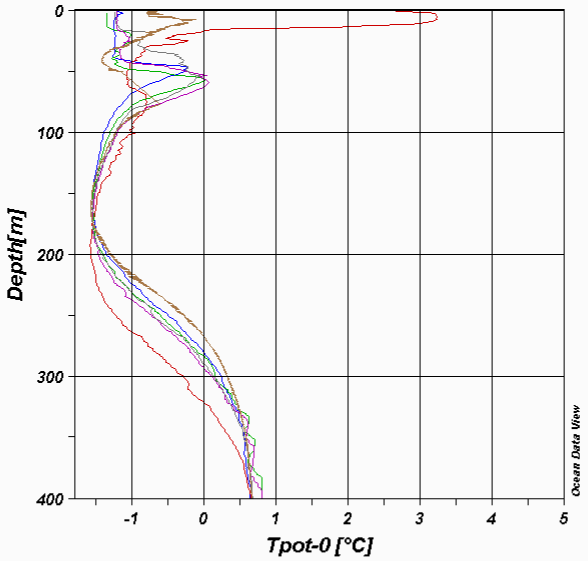
- dS/dz
- Southern CB

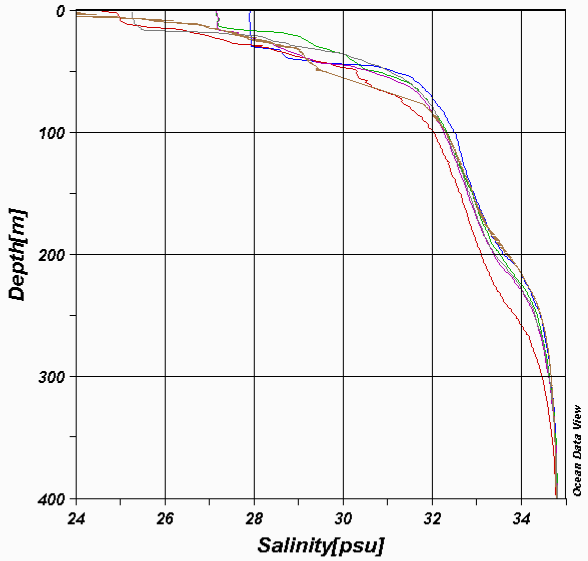




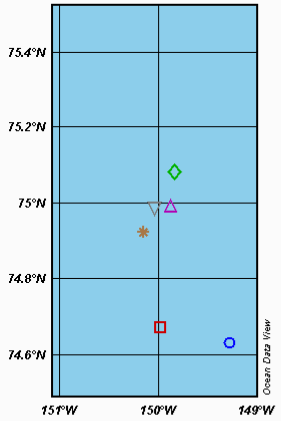
2003 ~2008

LH deepens ~40m
(200m→240m)

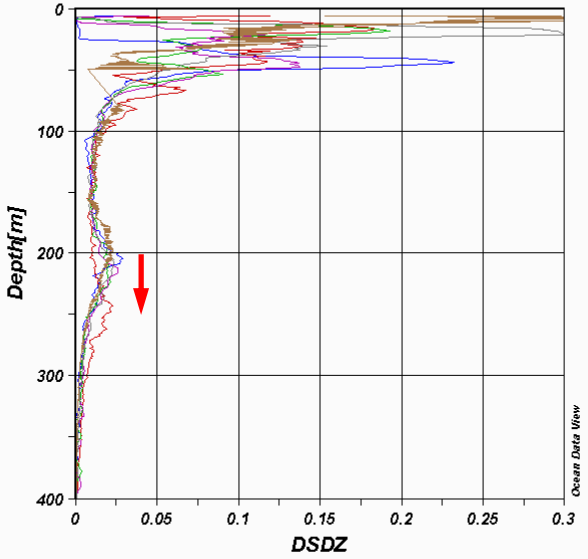


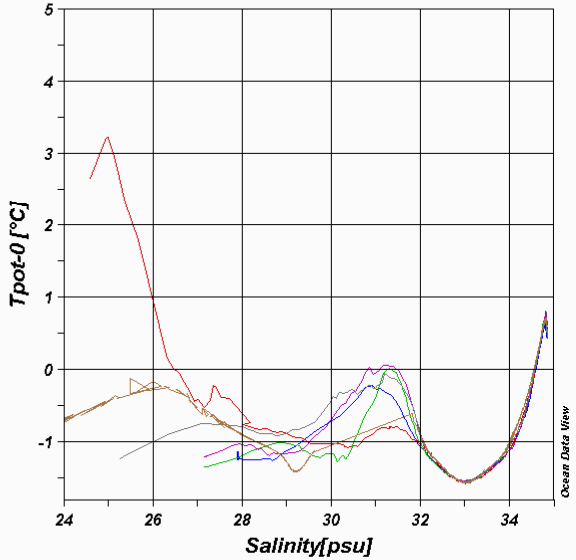


(Data: CHINARE2003,2008
& LSSL2003~2007)



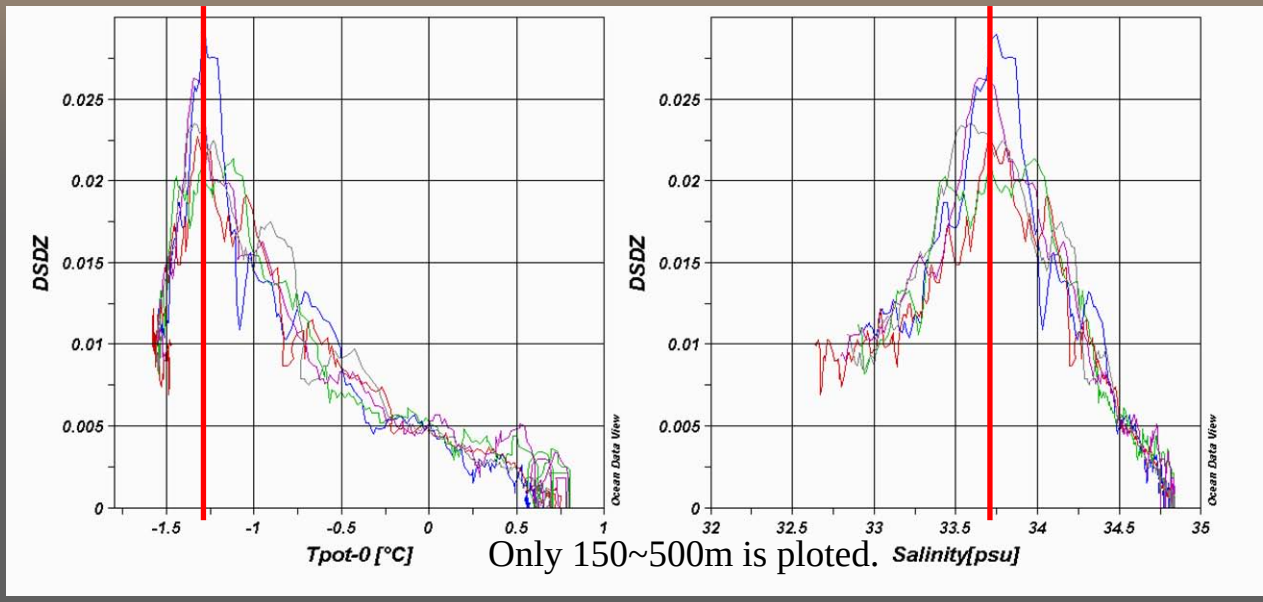
~150W 75N



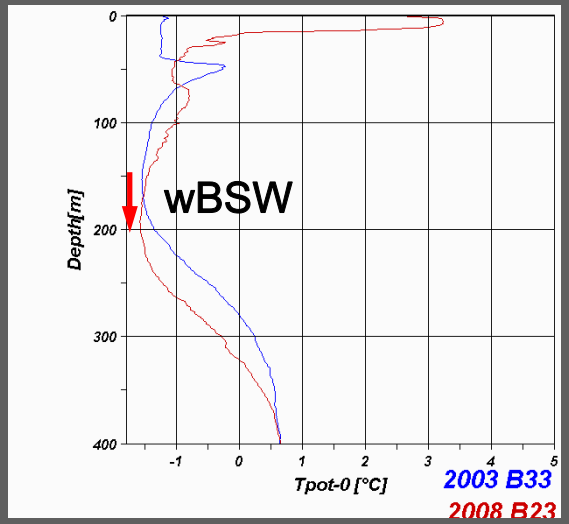


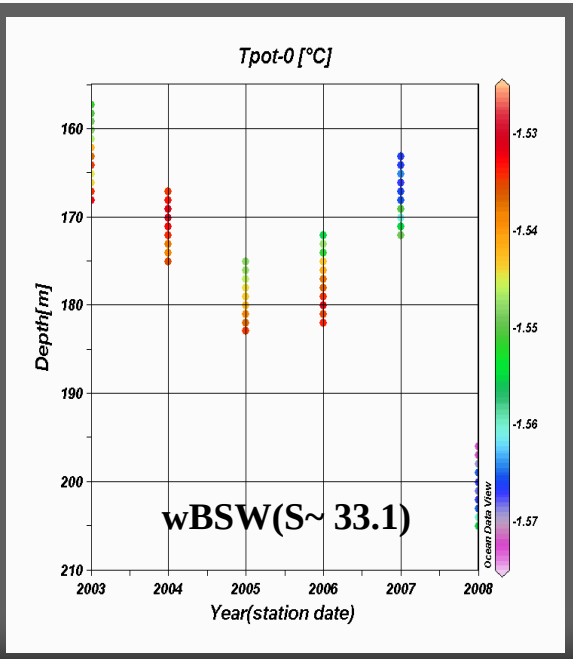
θ=-1.3 S=33.7

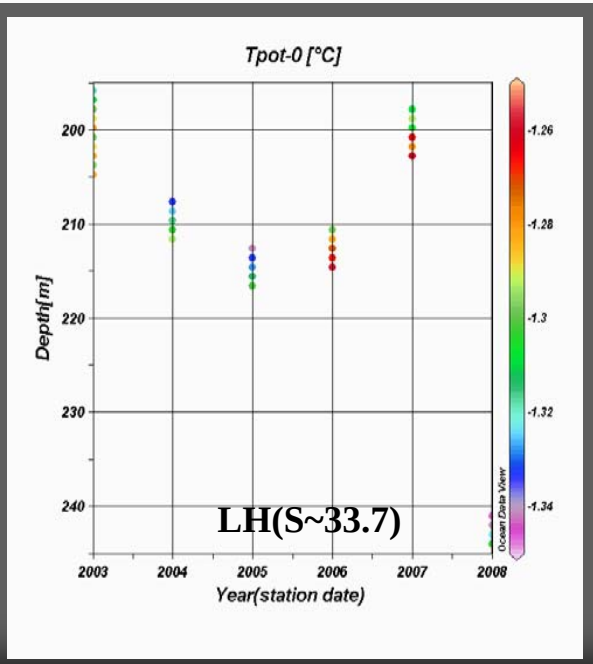
- No obvious changes in θ, S of LH
- In 2008:
  LH deepens greatly



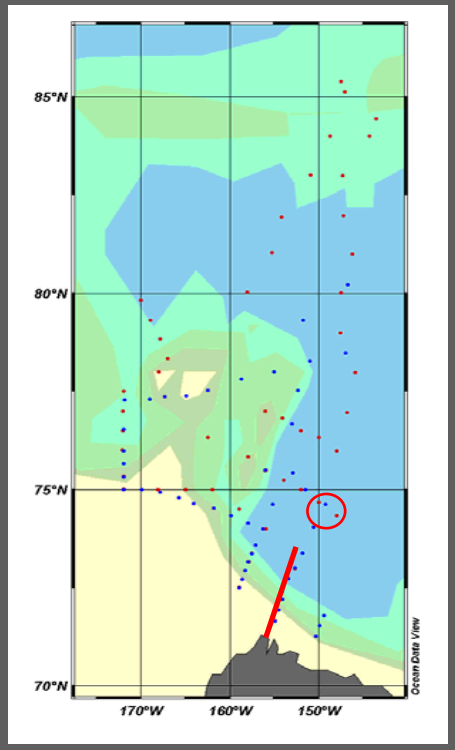
Only 150~500m is ploted.

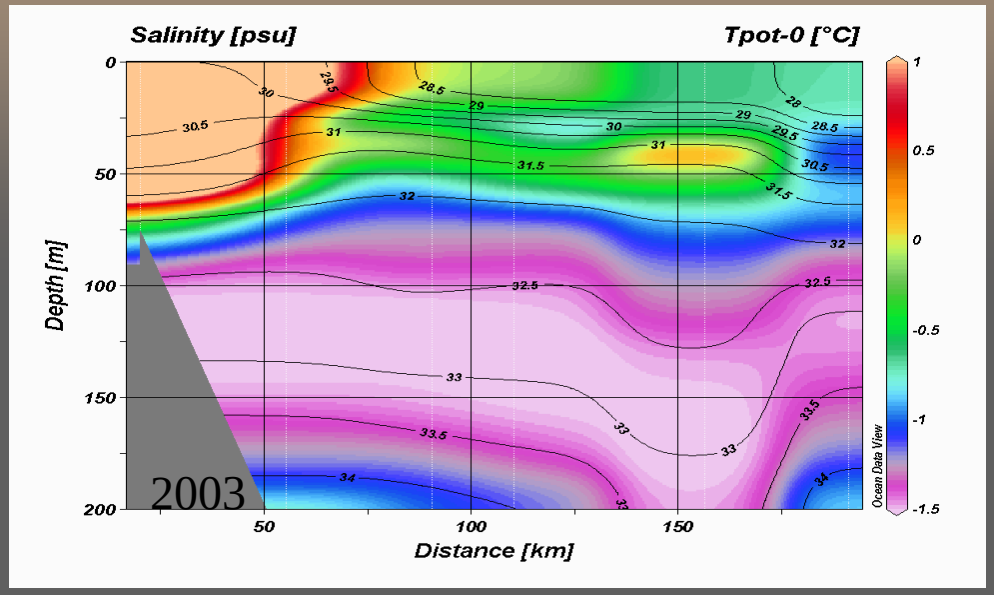


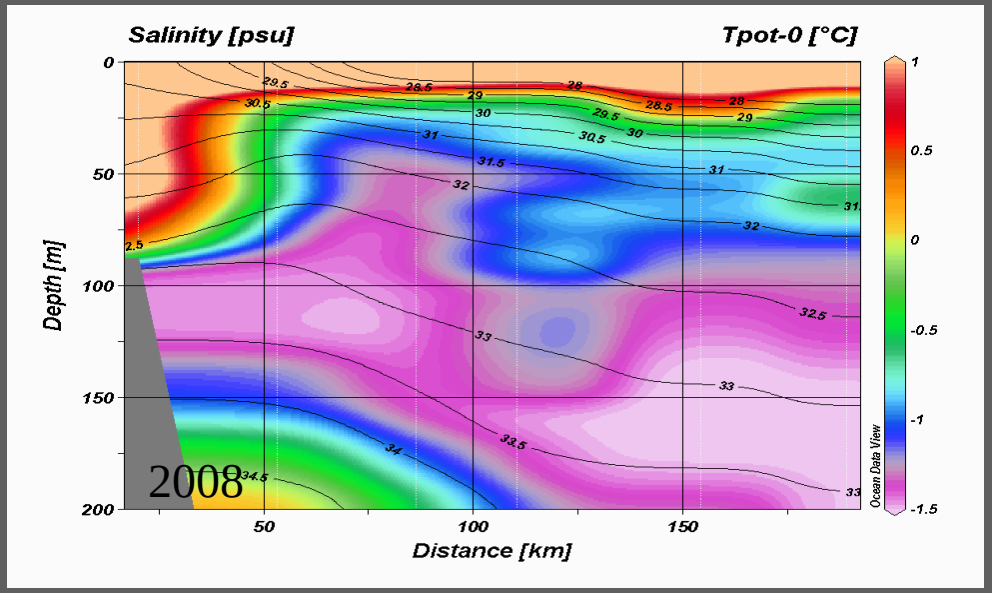




- wBSW deepens

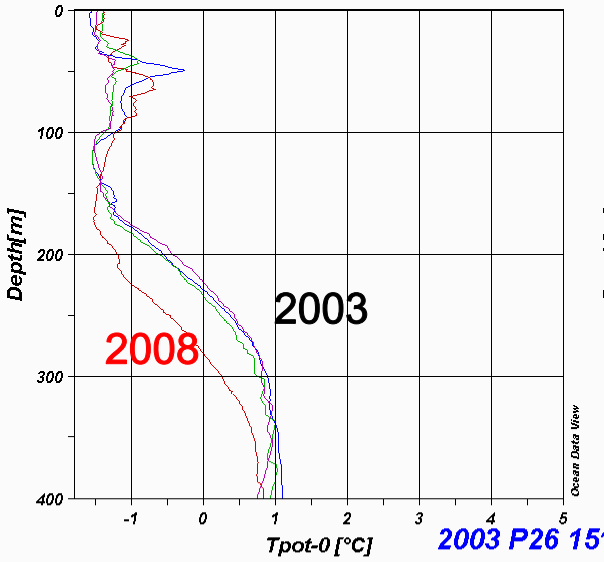


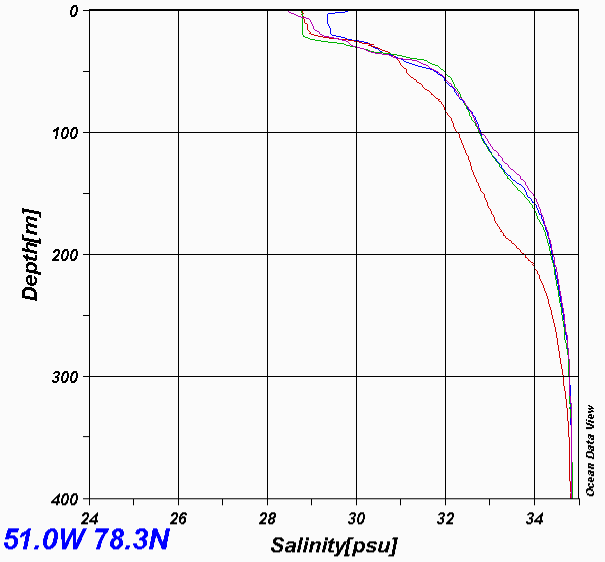




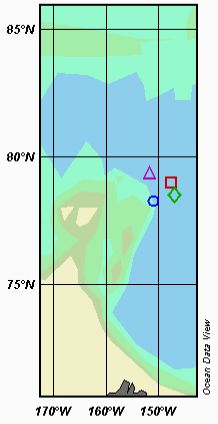
2003 vs 2008: northeast of Chukchi Plateau

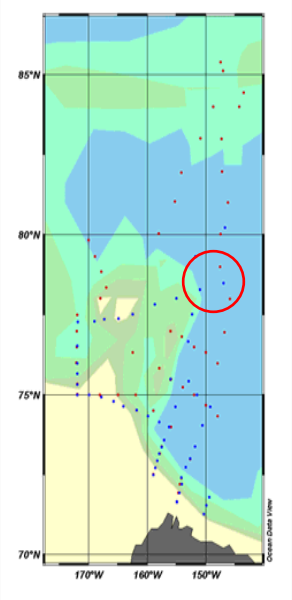
LH deepens ~60m
(140m→200m)

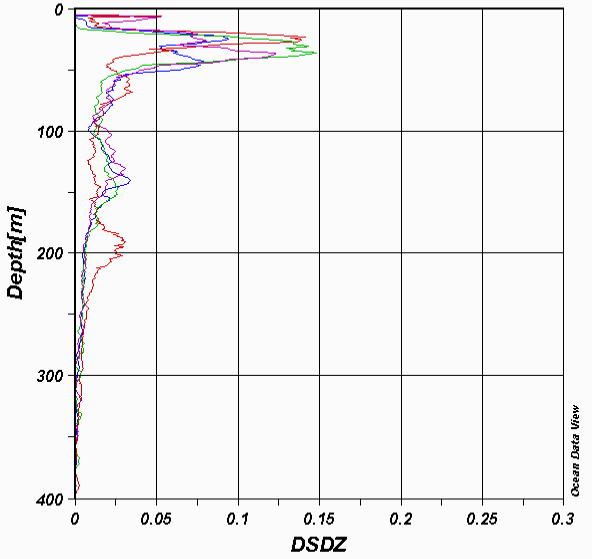


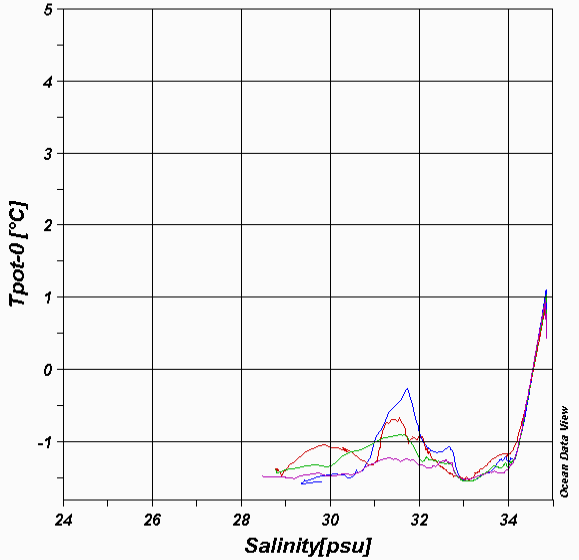


2003 P26 151.0W 78.3N
2008 B79 147.6W 79.0N







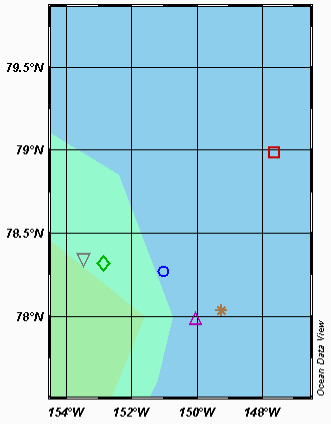


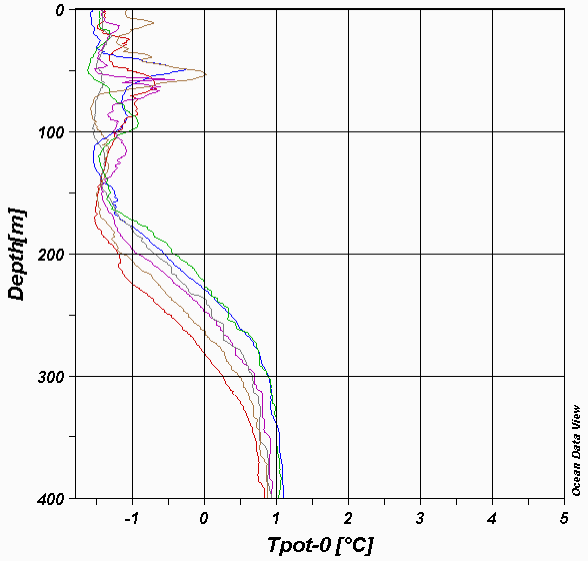
2003 ~2008

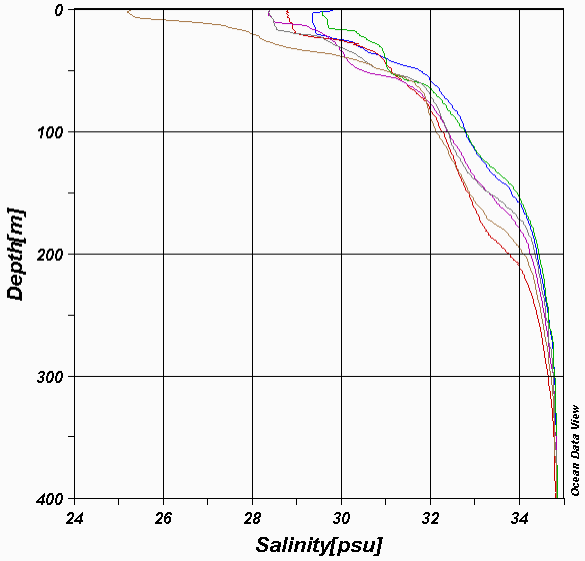
LH deepens ~60m (140m→200m)

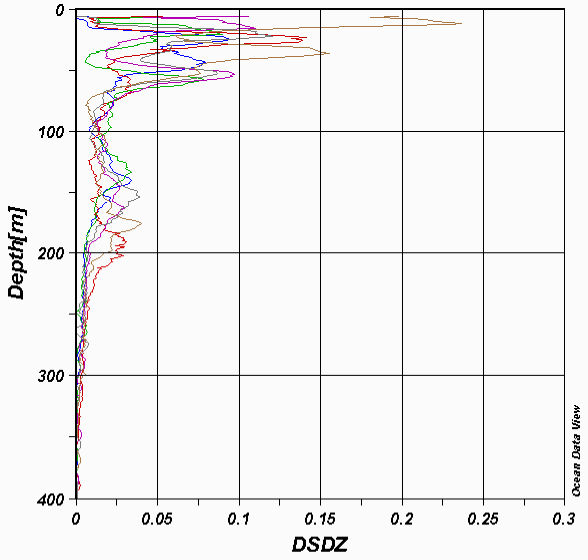
2004 2005

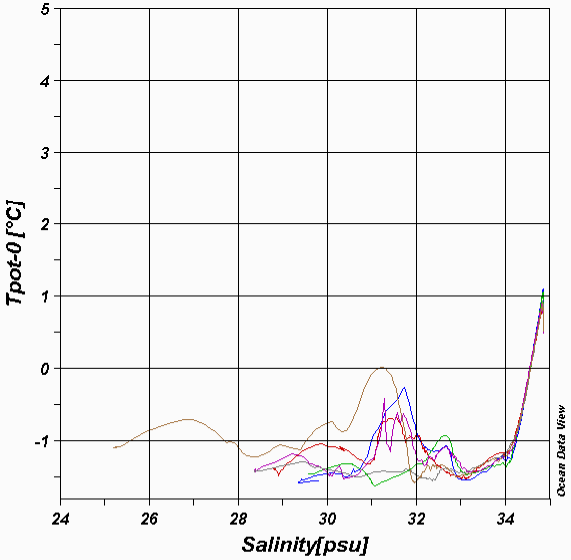
2006 2007





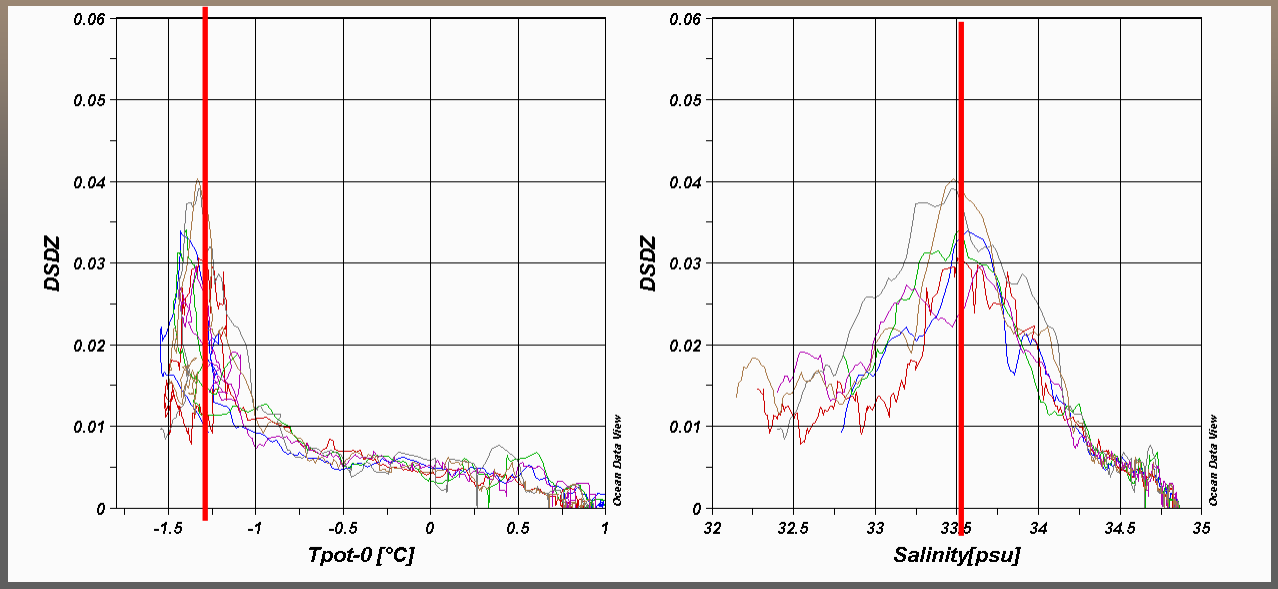


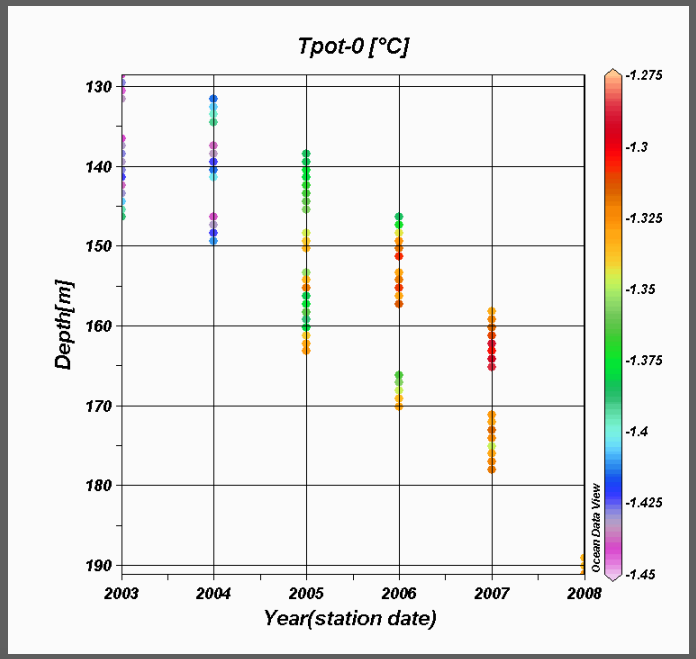


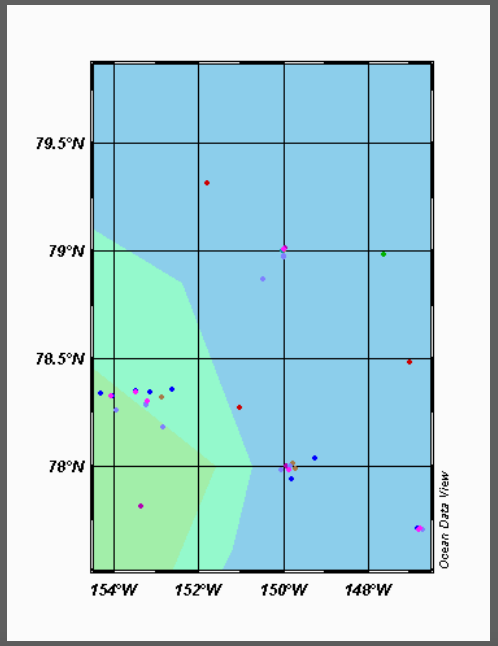


θ=-1.3 S=33.5

- No obvious changes in θ, S of LH
- LH became depper and deeper gradually from 2003 to 2008.

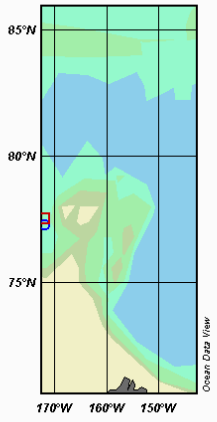


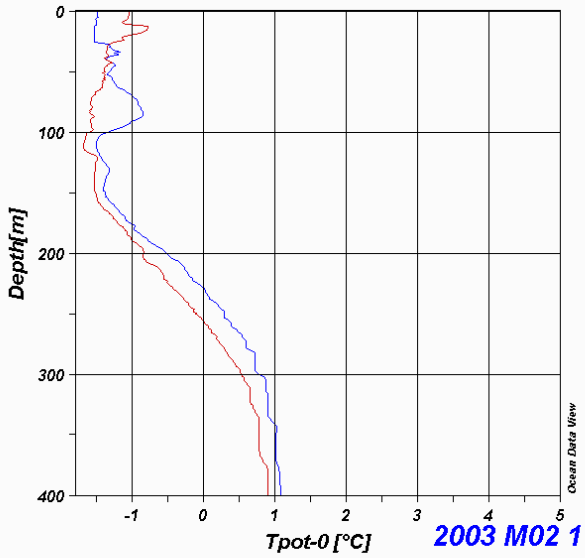


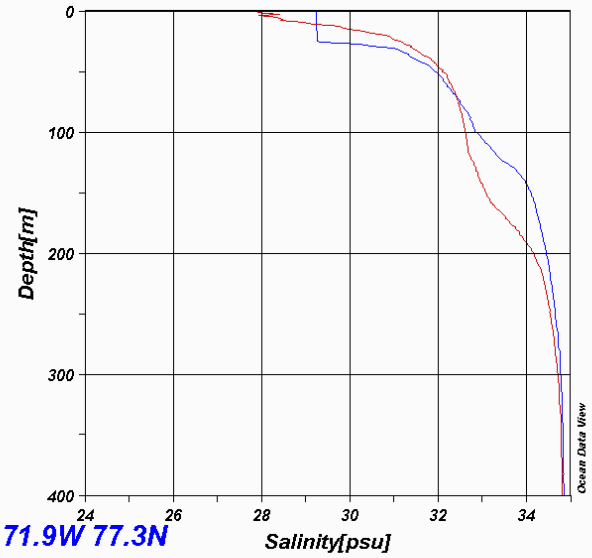


2003 vs 2008: east of Chukchi Plateau

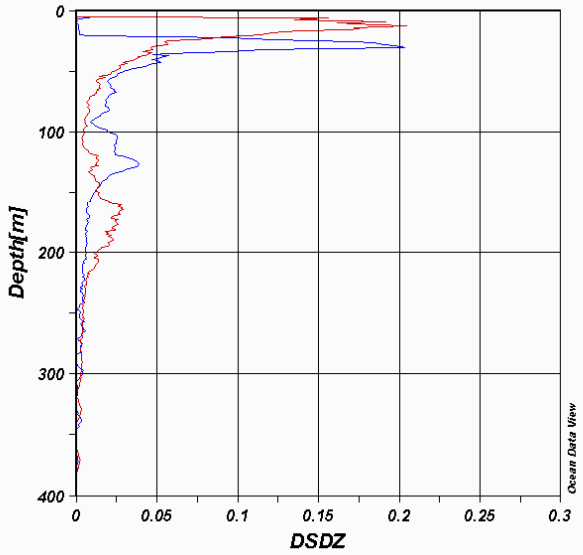
LH deepens ~50m
(120m→170m)

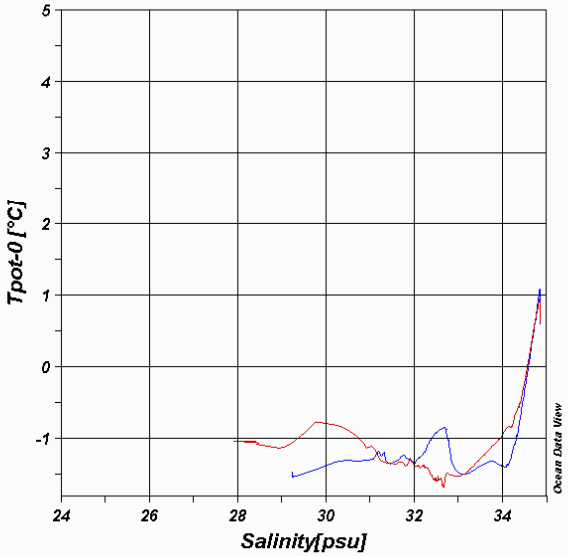




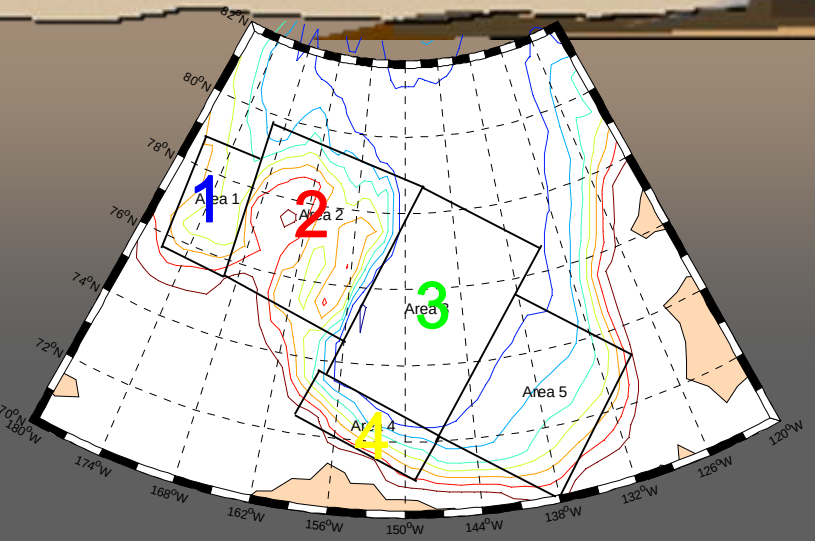


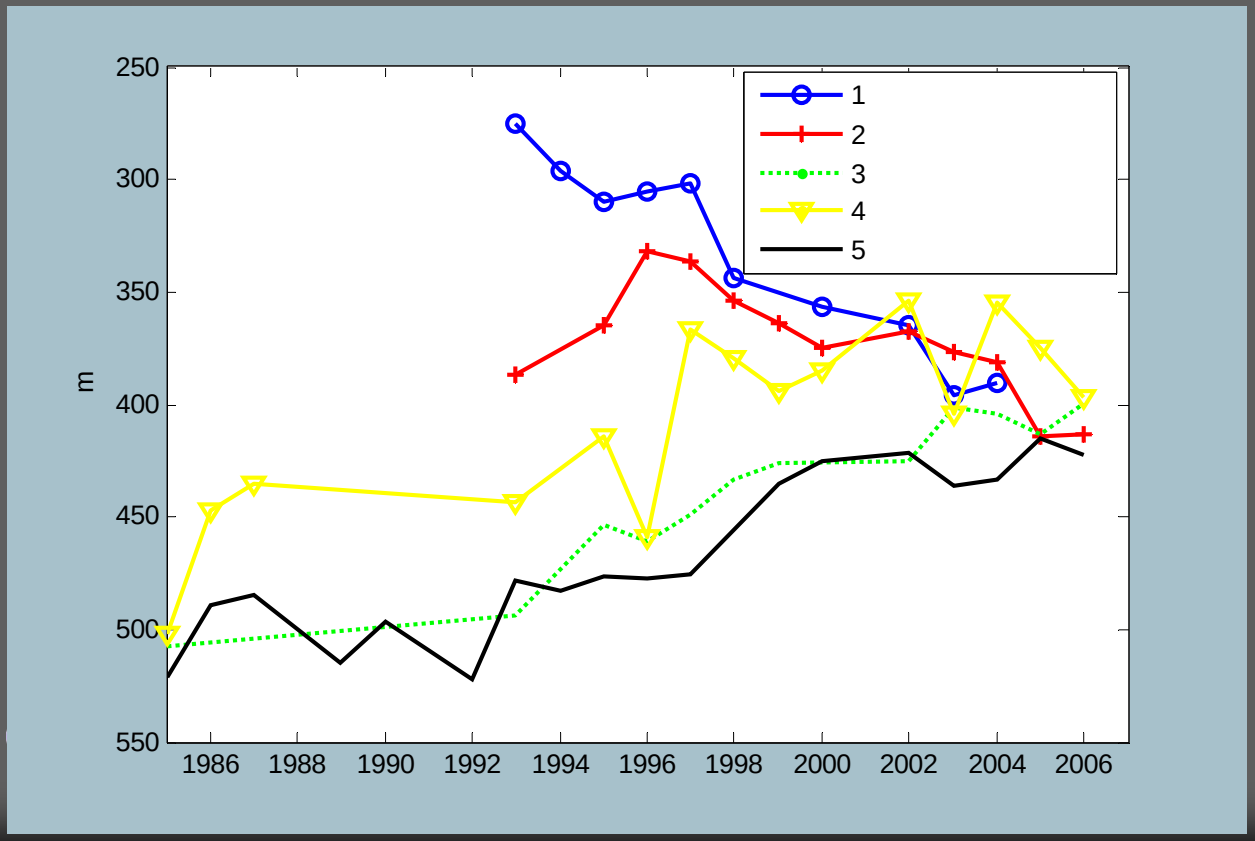
2003 M02 171.9W 77.3N
2008 M01 172.0W 77.5N





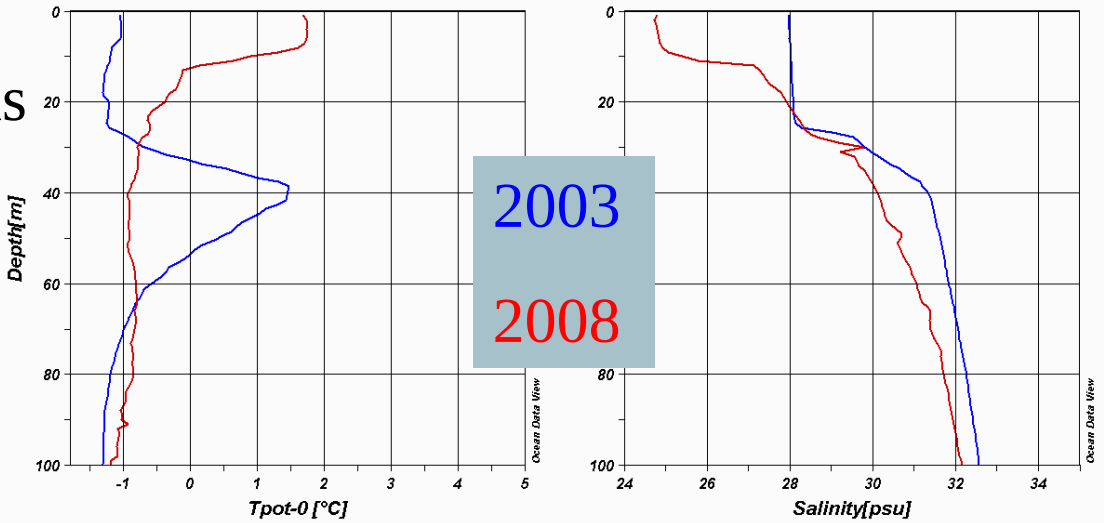
Depth of the Atlantic Layer

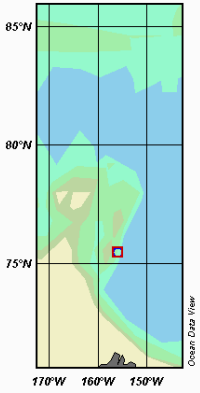




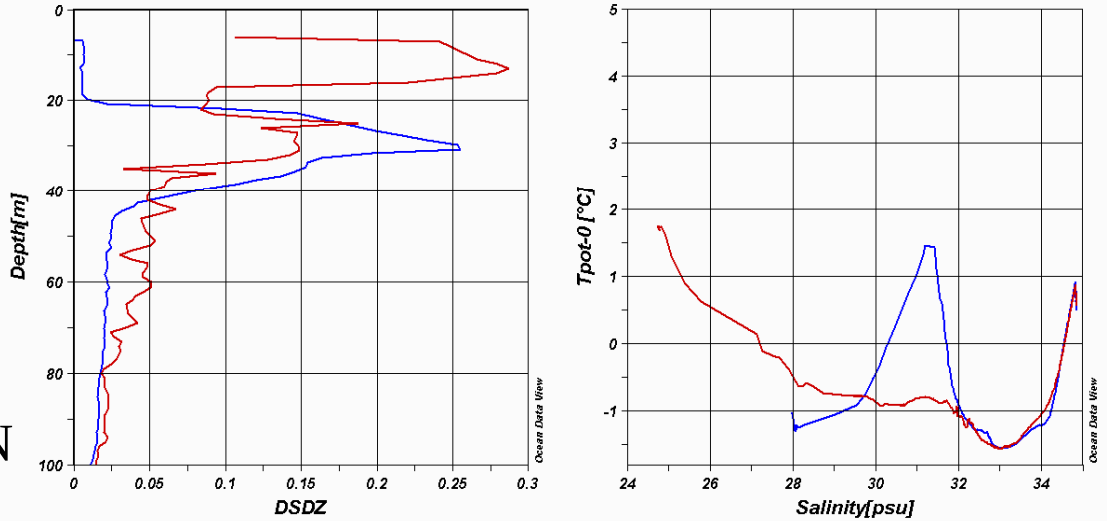
Upper halocline

- Complex variations

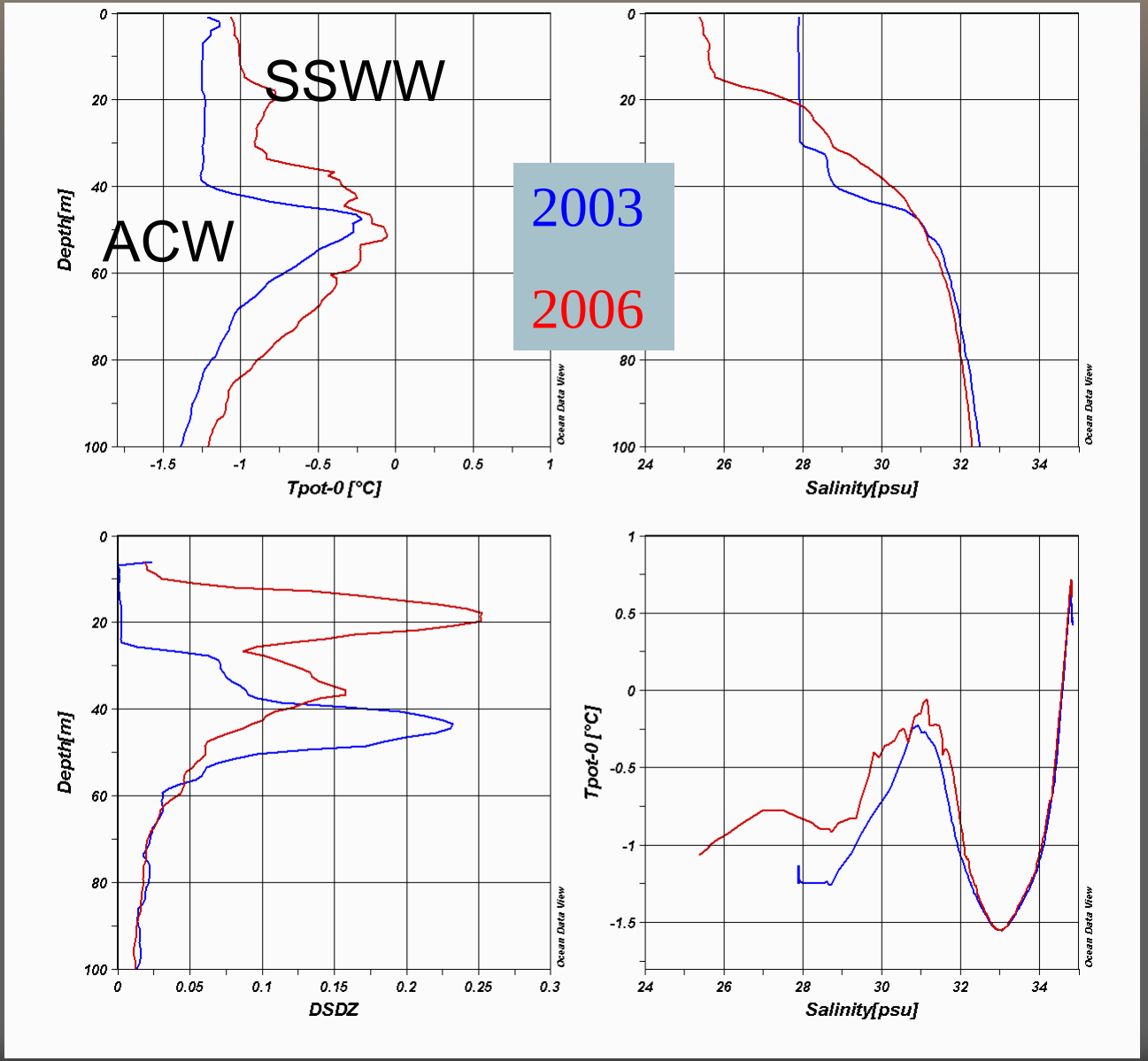




156W 75.5N

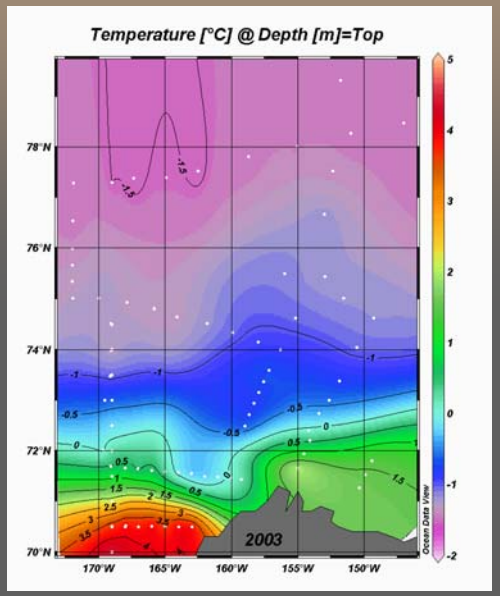


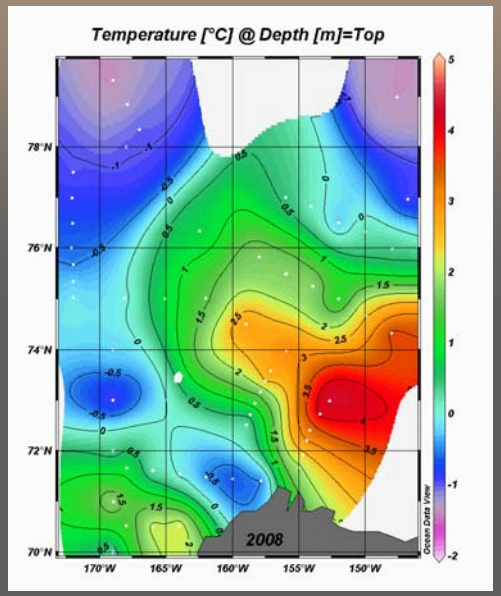
- Seasonal halocline associated with SubSurface Warm Water (SSWW)

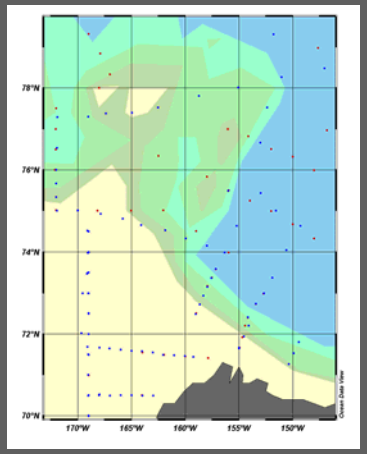


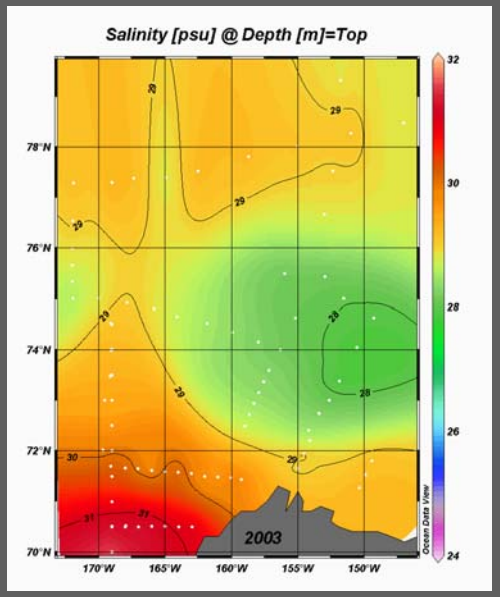
Surface of the Arctic Ocean

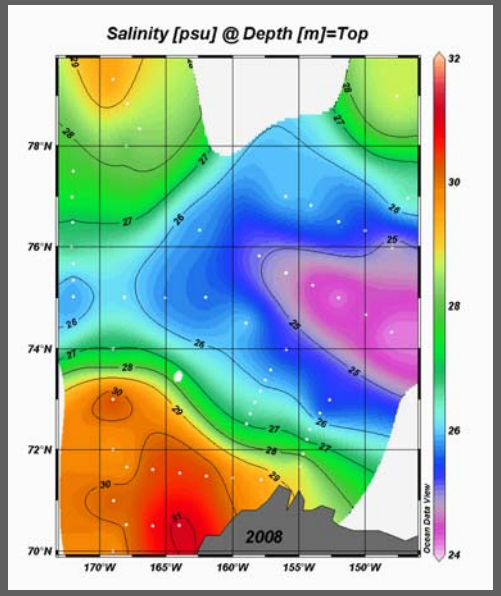
- Warmer
- Fresher



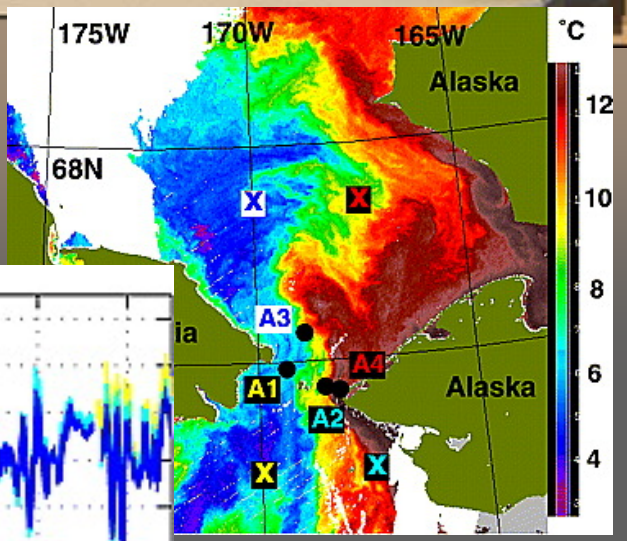


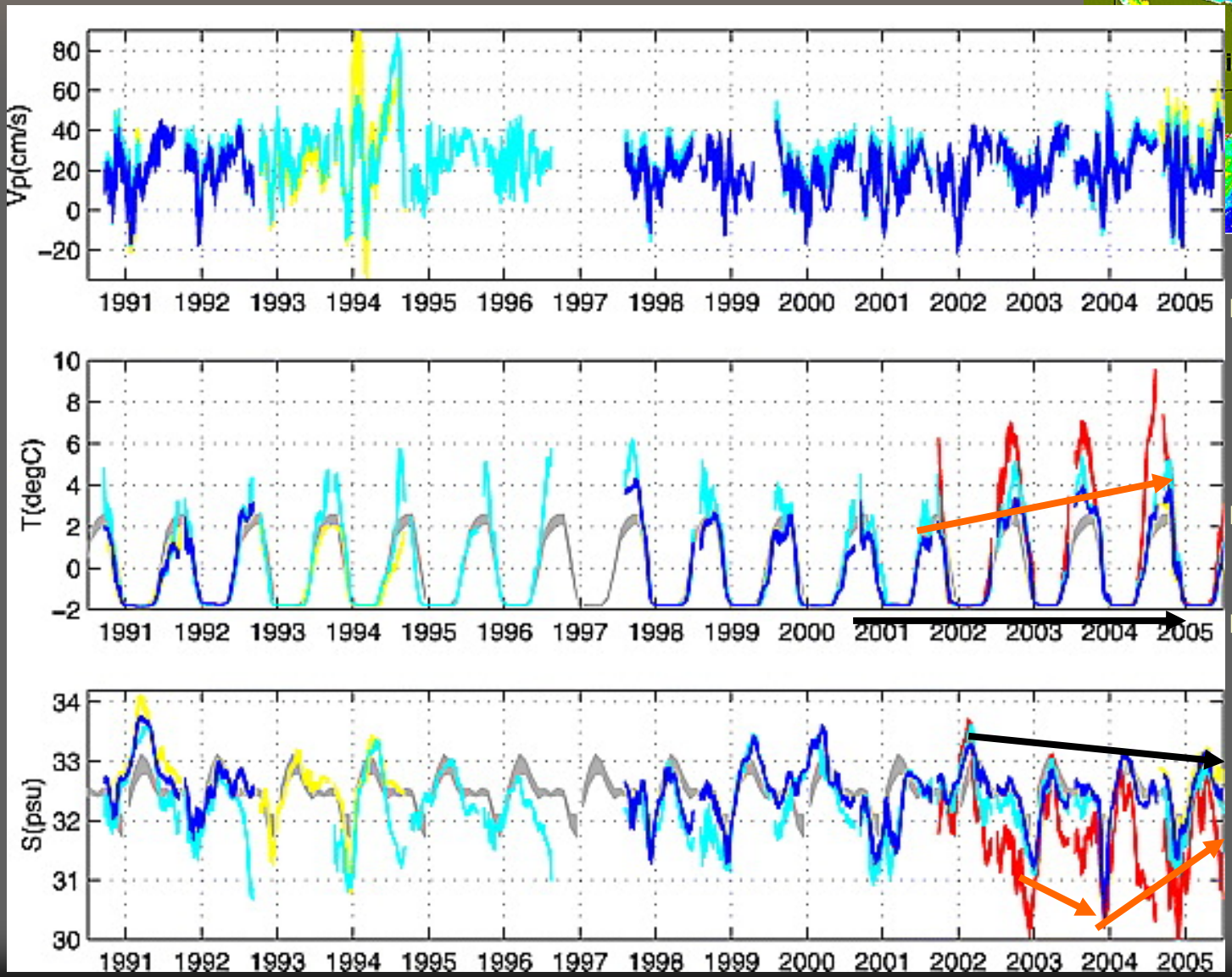






Interannual changes of inflow in the Bering Strait





- **Fluxes** are lowest in 2001 and **increase** to 2004.
- **Warmer** summer inflow since 2002
- The **increase in freshwater flux** since 2001 (1300 →2100 km3/yr, =1/4 total annual Arctic river run-off

Woodgate et al. , 2006

Summary

- Double-halocline structure exists in the southern Canada Basin where the Pacific-origin water existed, which is absolutely different from the CHL in the Eurasian Basin.
- The lower halocline is formed by the overlying of the Pacific-origin water (wBSW) upon the Atlantic-origin water, and the upper one is by the summer and winter modifications (ACW or sBSW to wBSW) of the Pacific-origin water.
- Both the haloclines are all the year-round, even though seasonal and inter-annual variations have been detected.

Thanks!