Double haloclines in the Canada Basin under the warming climate

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Outline

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  - 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)**
  - $T \sim$ 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): \( \theta_{\text{max}}, \ 31 < S < 32 \)
- summer Bering Sea Water (sBSW): \( \theta_{\text{max}}, \ 32 < S < 33 \)
- winter Bering Sea Water (wBSW): \( \theta_{\text{min}}, \ S \sim 33.1 \) (Steele et al., 2004)
$\sigma_\theta$

25.25, 26.5, 27.25

(McLaughlin et al., 2004)
Halocline: $dS/dp$

- No halocline in NB
- Cold Halocline Layer (CHL) in MB
- Double haloclines (DH) in southern CB
- Upper Halocline (UH) & Lower Halocline (LH)

Data: SCICEX93 97 98
SHEBA CHINARE 2003
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 variations: 2003 vs 2008:

- $dS/dz$
- Southern CB
2003 ~ 2008

LH deepens ~40m (200m → 240m)


~150W 75N
No obvious changes in $\theta$, $S$ of LH

In 2008:
LH deepens greatly

\[ \theta = -1.3 \]
\[ S = 33.7 \]

Only 150~500m is plotted.
wBSW deepens
2003 vs 2008: northeast of Chukchi Plateau

LH deepens ~60m (140m → 200m)
2003 ~ 2008

LH deepens ~60m (140m → 200m)

2004 2005

2006 2007
No obvious changes in $\theta$, $S$ of LH

LH became deeper and deeper gradually from 2003 to 2008.
2003 vs 2008: east of Chukchi Plateau

LH deepens ~50m (120m→170m)
Depth of the Atlantic Layer
Upper halocline

Complex variations

156W 75.5N

2003

2008
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 \(\rightarrow\) 2100 km\(^3\)/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!