Seasonal variation of current structure in the subarctic North Pacific from Argo data

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1. Introduction

(Favorite et al., 1976)

The mean structure of the subarctic gyre has been investigated mainly using the climatological data.
The seasonal variation and interannual variation were clarified from the satellite altimetry data.
2. Purpose

In this study, we analyzed synoptic data from Argo floats drifting in the subarctic North Pacific from October 2005 to April 2006 to show bimonthly variation in current structure.
3. Method

Argo float profile

Data in observation period was divided by every two months.

Oct-Nov Nov-Dec ....... Mar-Apr

(GODAE : http://www.usgodae.org/cgi-bin/argo_select.pl)
To make the maps
To make the maps

Error of density ($\sigma_\theta$) on 20db in Nov-Dec 2005
The data (1°×1°) of every 20db was made between 20db and 1000db.

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e.g. (top) potential density and (bottom) geopotential anomaly (m²/s²) on 20db in Nov-Dec 200.
4. The Result

Variation of Sverdrup transport

Variation of relative geostrophic transport

Variation of vertical current-structure

Estimation of velocity at 1000db by inverse analysis
Several investigators in the past showed barotropic processes depend on the wind stress that becomes strong in winter is superior.

(Isoguchi et al., 1997)
Seasonal variation of Sverdrup transport

Northward Sverdrup transport crossing the parallel of 45°N. It was estimated from NCEP.

The horizontal distribution of Curl $\tau$
Relative transport referred to 1000db
(Contour units in 2 Sv)
Variation of vertical current-structure

Zonal-average profile of horizontal velocity in right box
Variation of vertical current-structure

Zonal-average profile of horizontal velocity in right box

Velocity shear did not change in the observation periods.
Comparison with Sverdrup transport

The Relative transport is always northward.

Northward relative transport referred to 1000db crossing the parallel of 45°N.
On the assumption of the Sverdrup balance, the reference velocity must be changed largely corresponding to the wind stress curl.
The inverse method we adopted is a hybrid of $\beta$-spiral and box.

(Ueno and Yasuda, 2003)
Estimate of velocity at 1000db by Inverse analysis

\[ \sum_{i=1}^{4} (v_{i,j,k} + b_{i,j})S_{i,j,k}q_{i,j,k} = 0 \]

- \( v_{i,j,k} \): Relative velocity referred to 1000db
- \( b_{i,j} \): Velocity at 1000db
- \( S_{i,j,k} \): Box area
- \( q_{i,j,k} \): Density
- \( i \): Box side number
- \( j \): Box number
- \( k \): Density layer number

Box inverse
\[ \omega_{ek} - \frac{\beta}{f} \int_{z}^{Z_{ek}} (v_{j} + b_{cvj}) dz = (u_{j, \kappa} + b_{cu j}) \frac{\partial Z_{j, \kappa}}{\partial x} + (v_{j, \kappa} + b_{cvj}) \frac{\partial Z_{j, \kappa}}{\partial y} \]

**Vertical velocity at isopycnal surface**

**Horizontal advection of isopycnal**

\( \beta \)-spiral \ (Ueno and Yasuda, 2003)
Levenburg-Marquardt analysis
(Joice et al., 1986)
We adopted weighting parameters $10^4, 10^5, 10^{5.75}, 10^6$, and $10^{6.25}$ from the box and the β-spiral reaction.
Contour line of streamfunction at 1000db
(Contour units in $5 \times 10^4 m^2/s$)

Dec-Jan 2005

May-Apr 2006

Contour line of streamfunction at 20db
(Contour units in $5 \times 10^4 m^2/s$)

Dec-Jan 2005

May-Apr 2006
(Ueno and Yasuda, 2000, 2001)

(Reid, 1997)
5. Summary

- Relative transport referred to 1000db did not change in the observation period.

- The Sverdrup transport changed largely.

- When the Sverudrup transport flowed northward, Velocity field at 1000db shows anticlockwise circulation.
  
  When the Sverudrup transport flowed southward, Velocity field at 1000db shows clockwise being reversed to the surface.
Future works

Variation
  Comparison with
  Transport of western boundary current (Oyashio)
  Velocity from the surface drifting floats
  (Intermediate velocities from Argo have much error from our estimation)

Thank you for your kind attention