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

1. Introduction
2. Purpose
3. Method
4. Result
5. Summary

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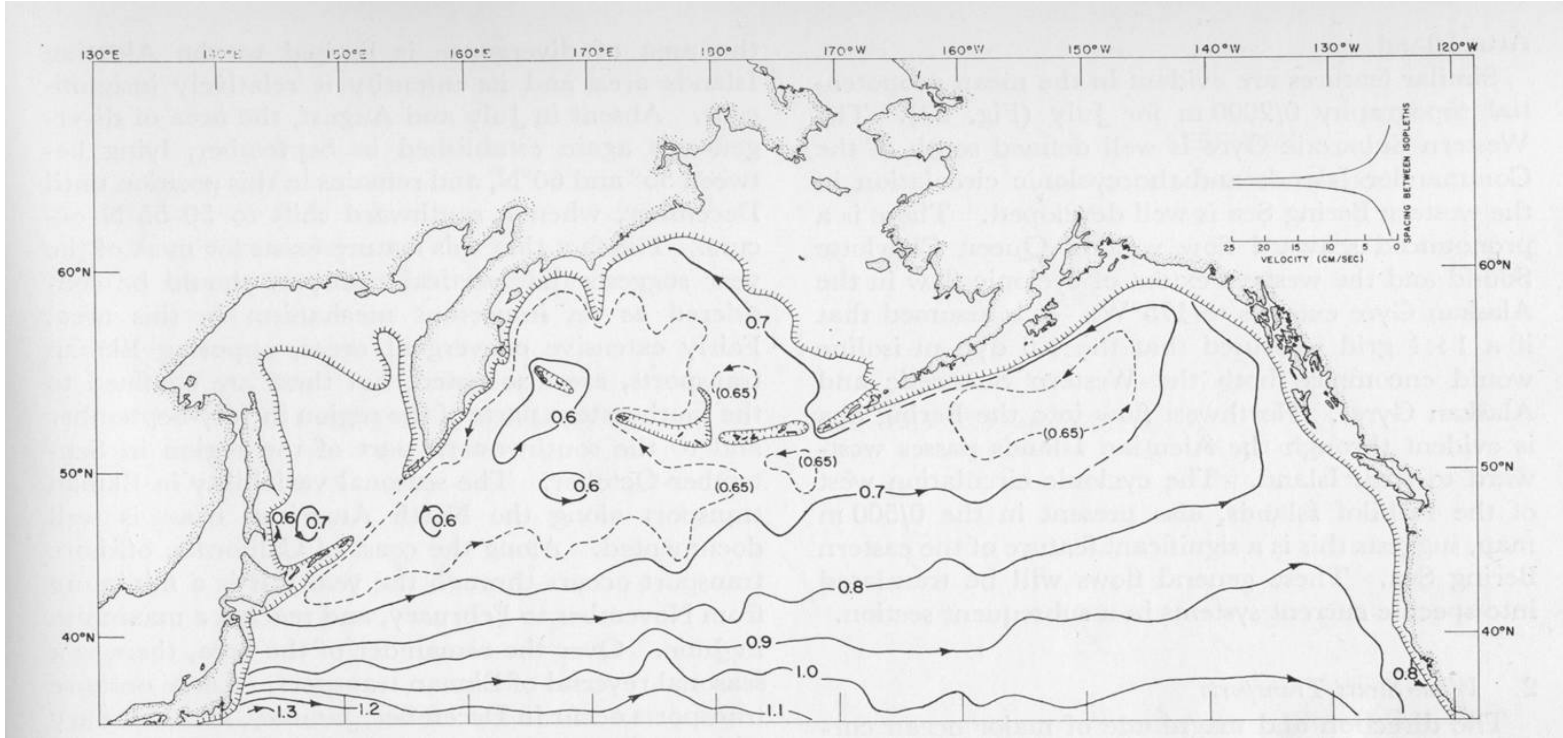
1. Introduction



(Favorite et al., 1976)

The mean structure of the subarctic gyre
has been investigated mainly using the climatological data.

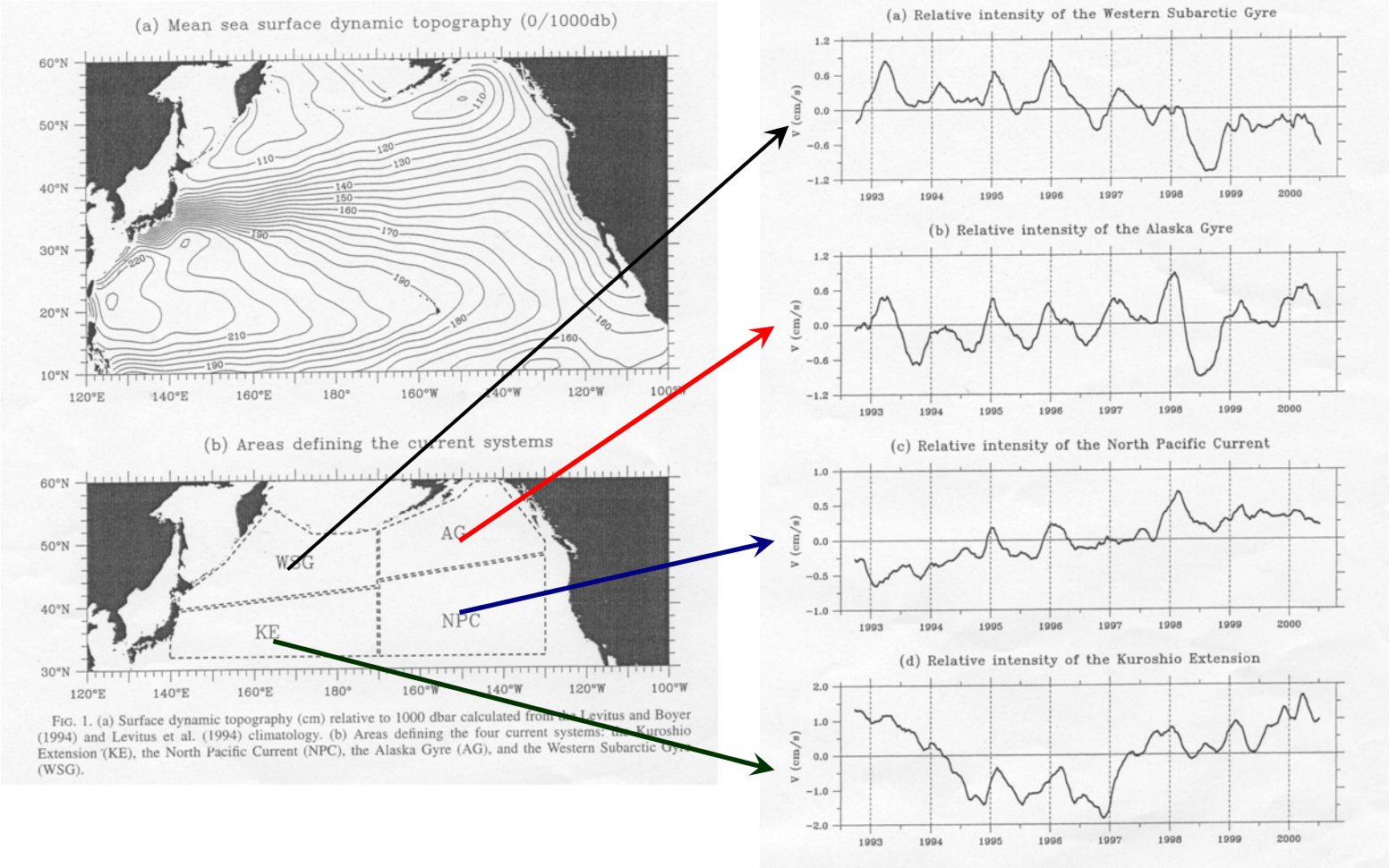
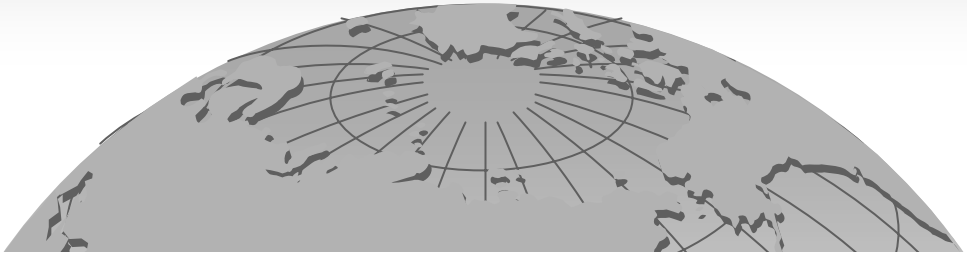


FIG. 1. (a) Surface dynamic topography (cm) relative to 1000 dbar calculated from the Levitus and Boyer (1994) and Levitus et al. (1994) climatology. (b) Areas defining the four current systems: the Kuroshio Extension (KE), the North Pacific Current (NPC), the Alaska Gyre (AG), and the Western Subarctic Gyre (WSG).

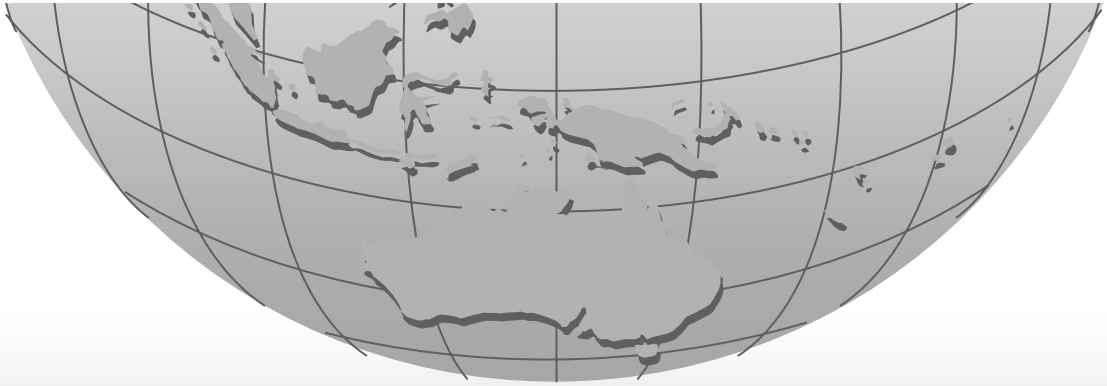
(Qiu 2002)

The seasonal variation and interannual variation were clarified from the satellite altimetry data

2. Purpose

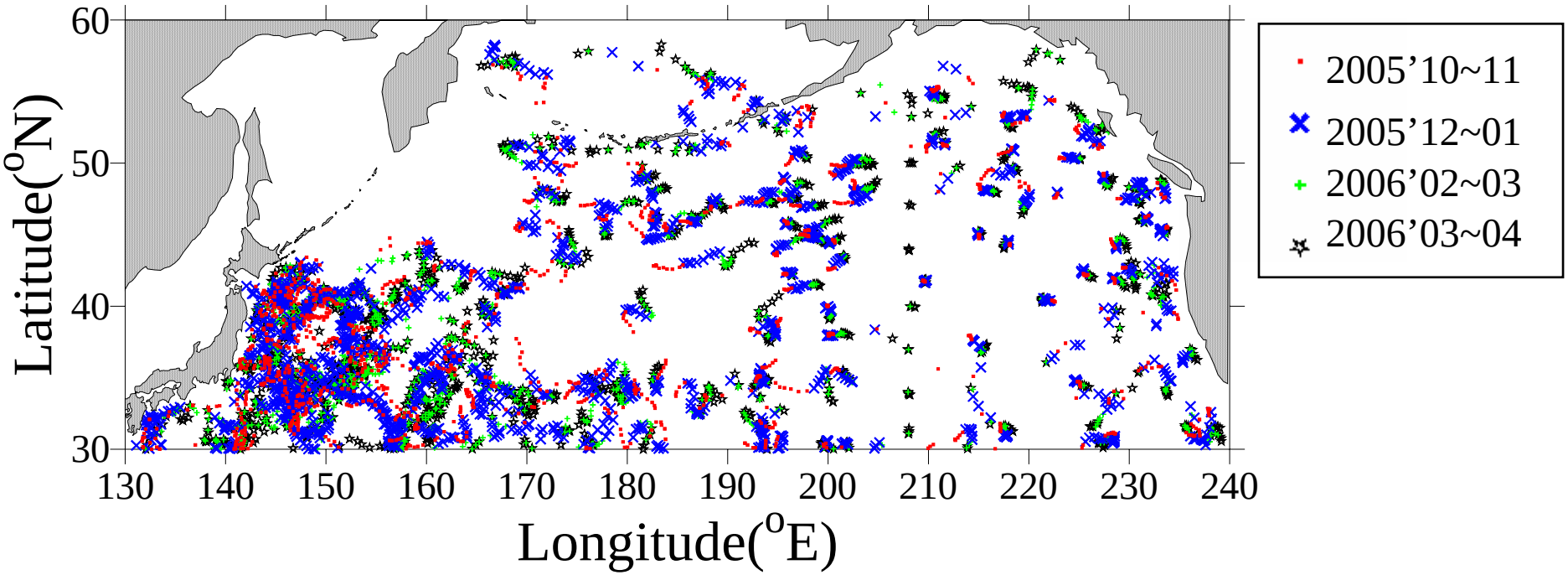


In this study, we analyzed synoptic data from Argo floats drifting in the subarctic North Pacific from October 2005 to April 2006 to show bimonthly variation in current structure.



3. Method

Argo float profile

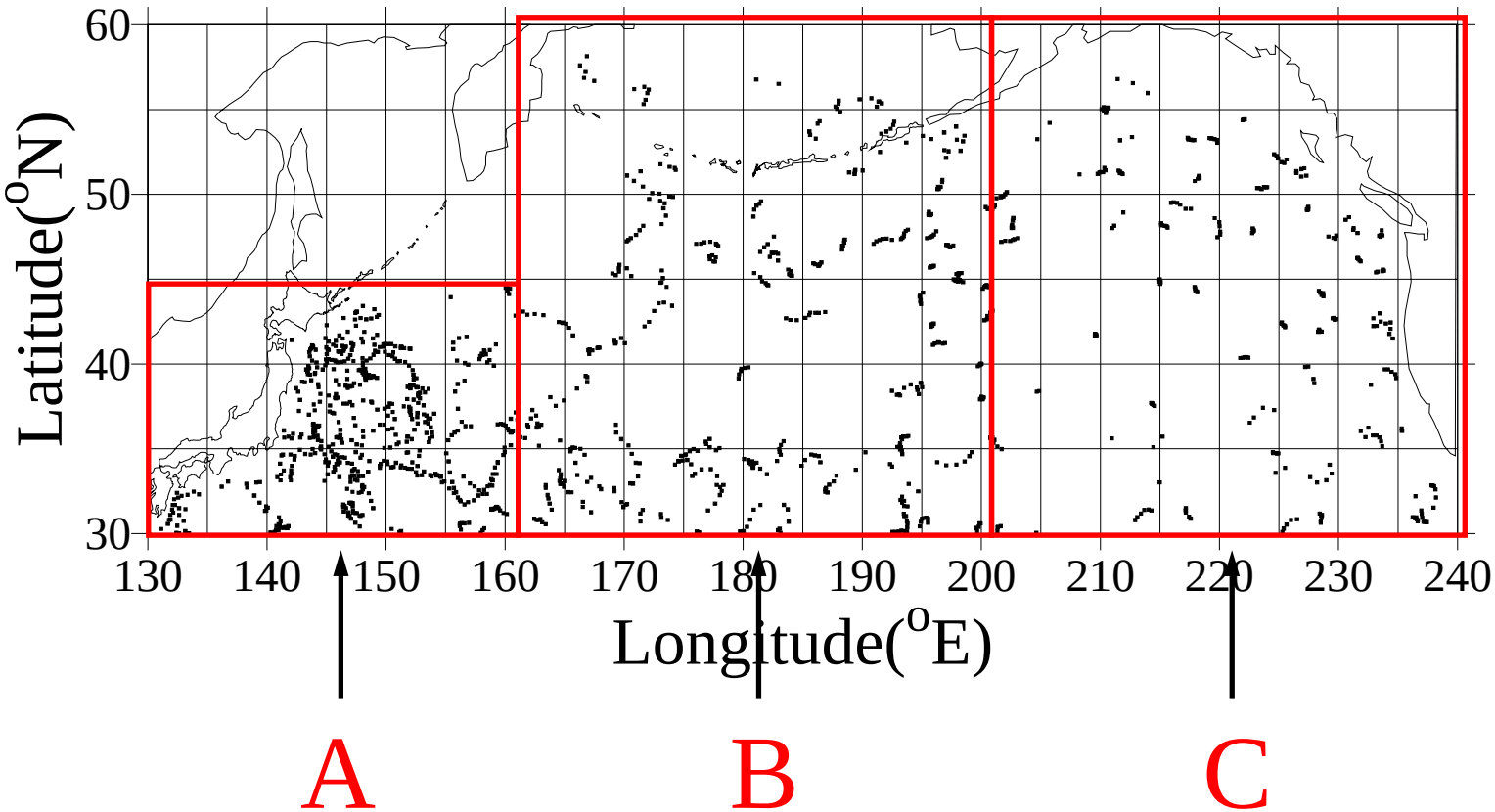


Data in observation period was divided by every two months.

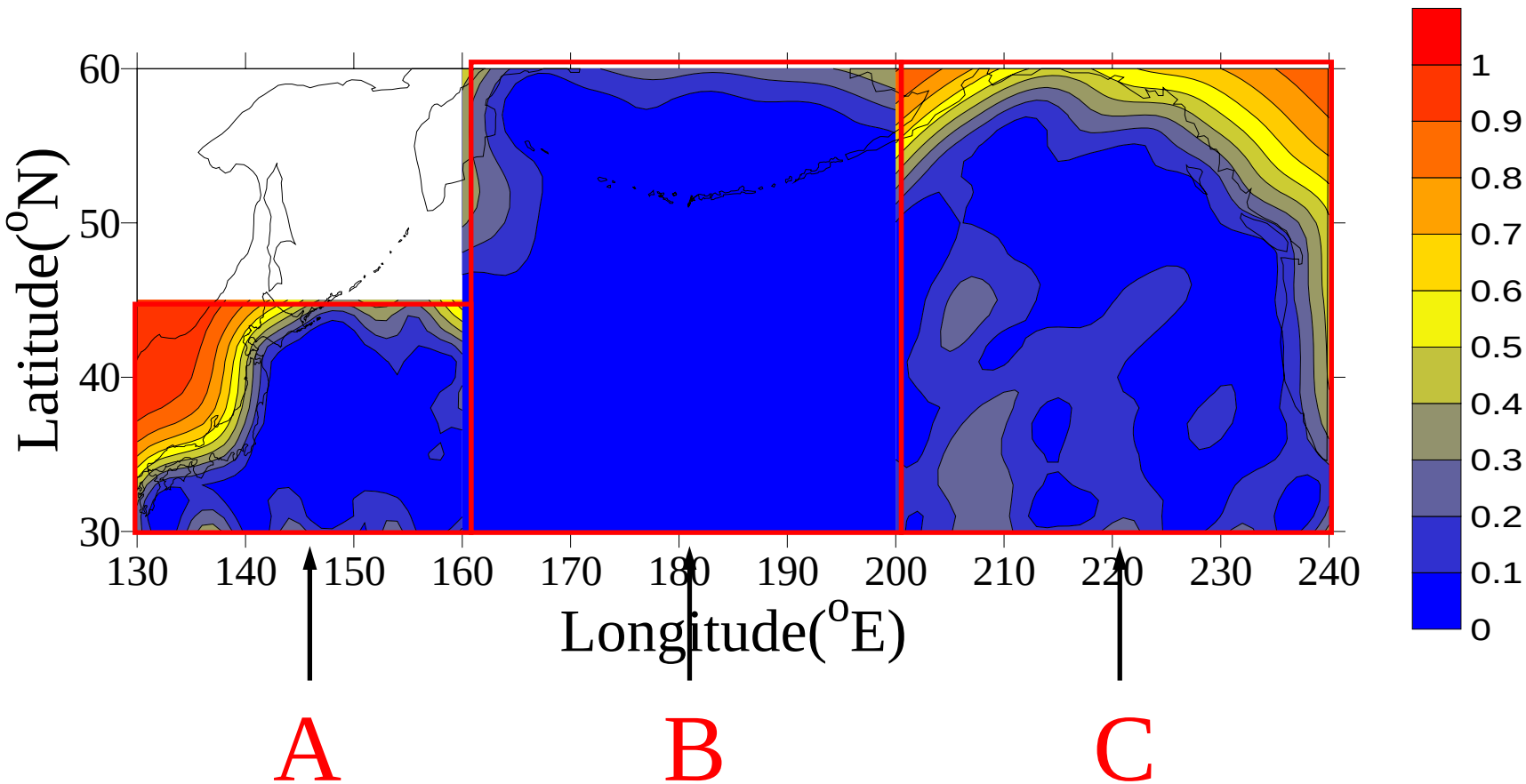
Oct-Nov Nov-Dec ……. Mar-Apr

(GODAE : http://www.usgodae.org/cgi-bin/argo_select.pl)

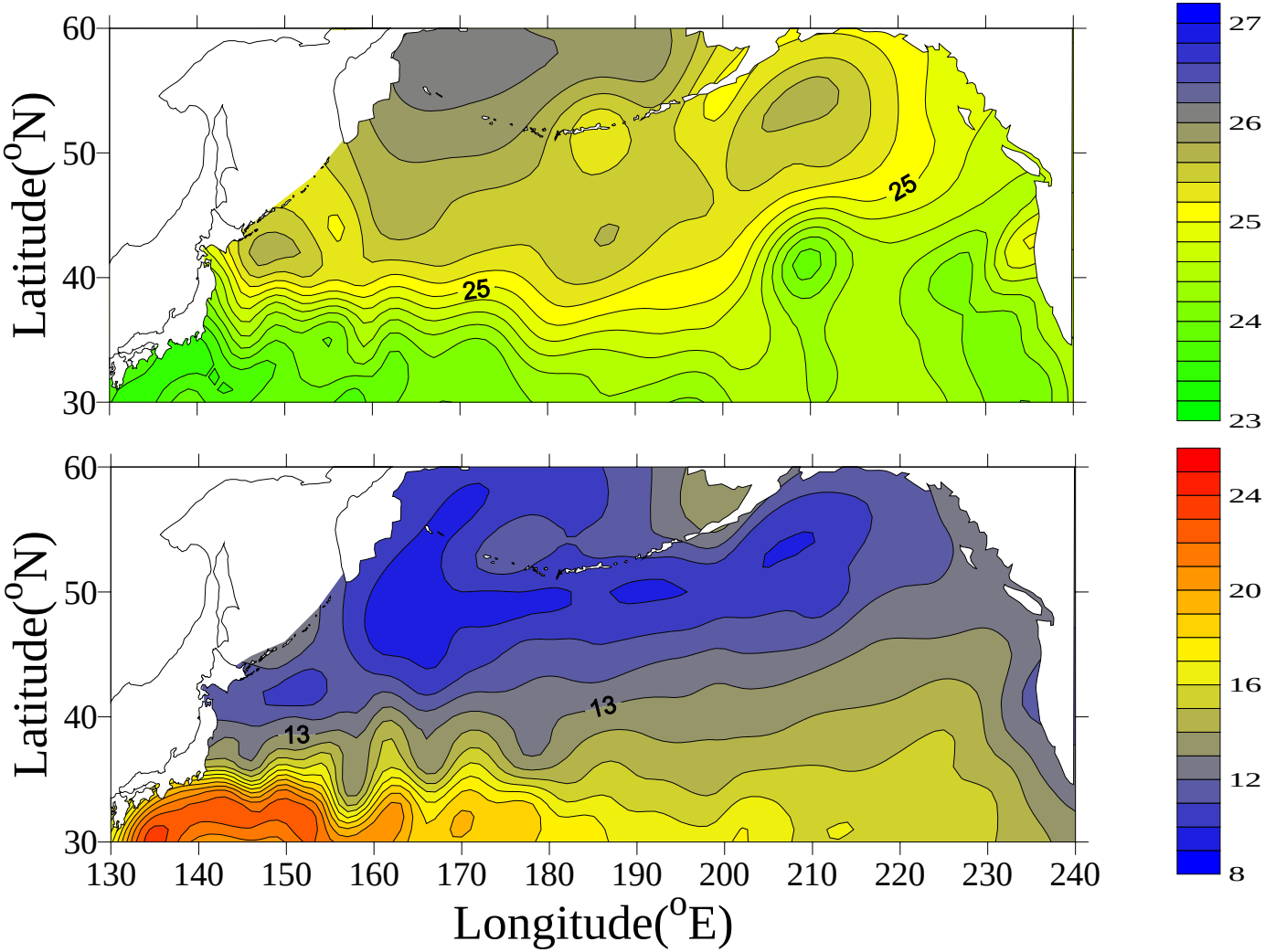
To make the maps



To make the maps



Error of density (σ_θ) on 20db in Nov-Dec 2005



e.g (top) potential density and (bottom)geopotential anomaly(m^2/s^2) on 20db in Nov-Dec 200

The data(1°×1°) of every 20db was made between 20db and 1000db.

4. The Result

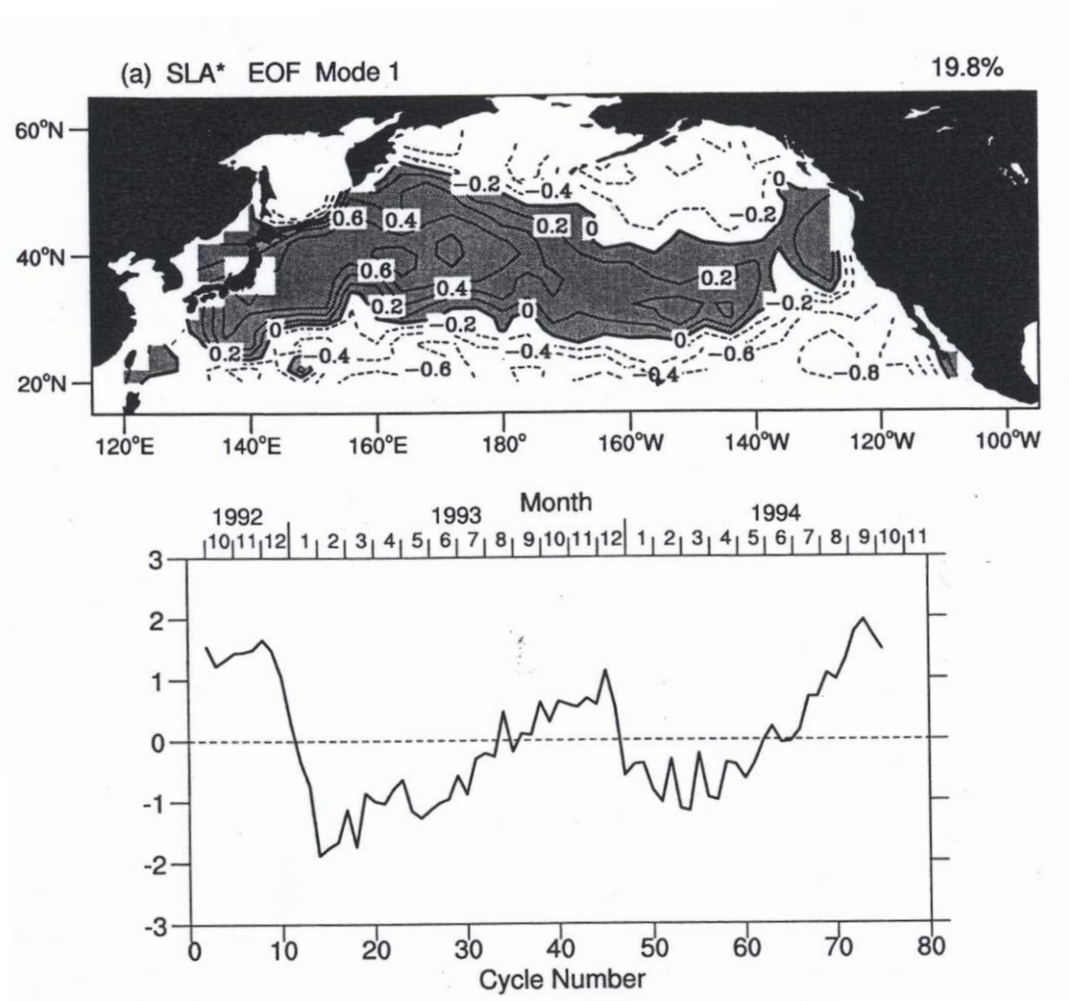
Variation of Sverdrup transport

Variation of relative geostrophic transport

Variation of vertical current-structure

Estimation of velocity at 1000db
by inverse analysis

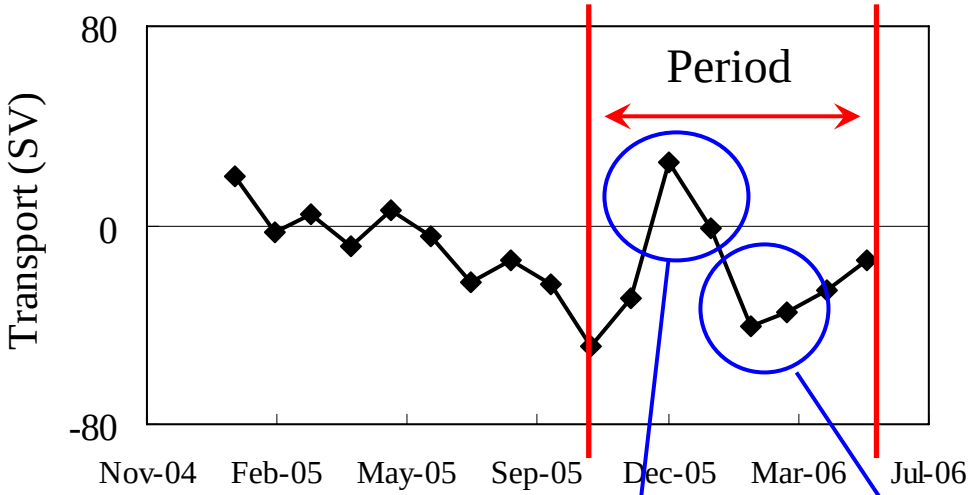
Wind stress curl

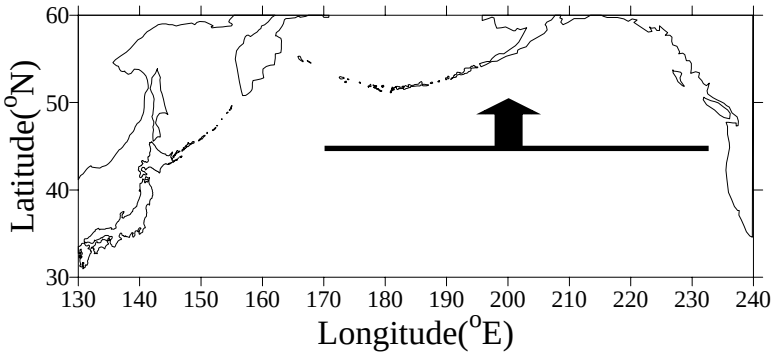


(Isoguchi et al., 1997)

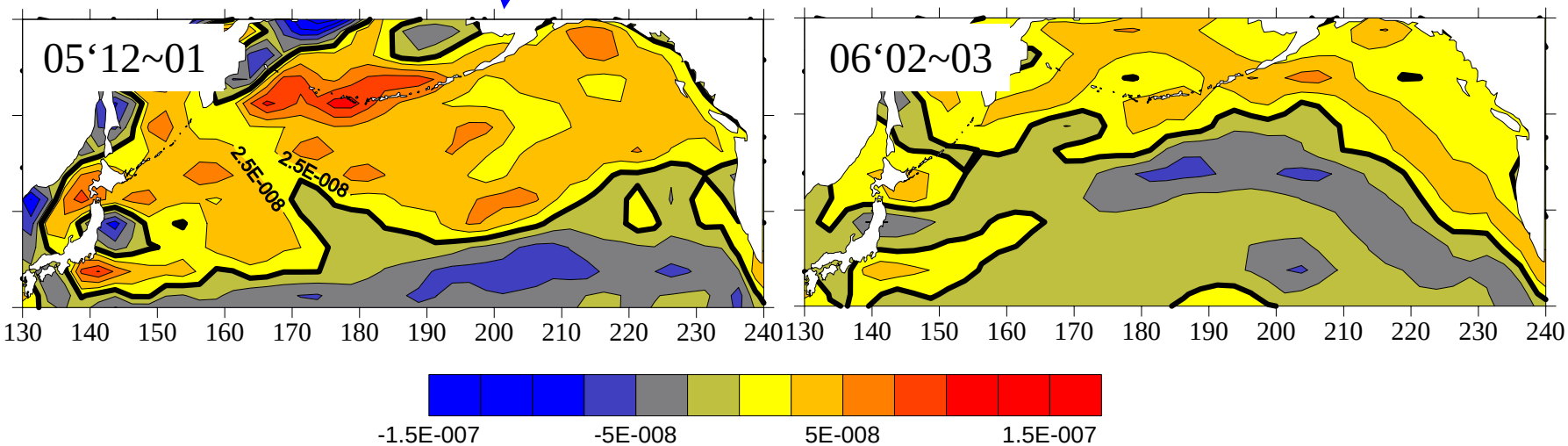
Several investigators in the past showed barotropic processe depends on the wind stress that becomes strong in winter is superior.

Seasonal variation of Sverdrup transport

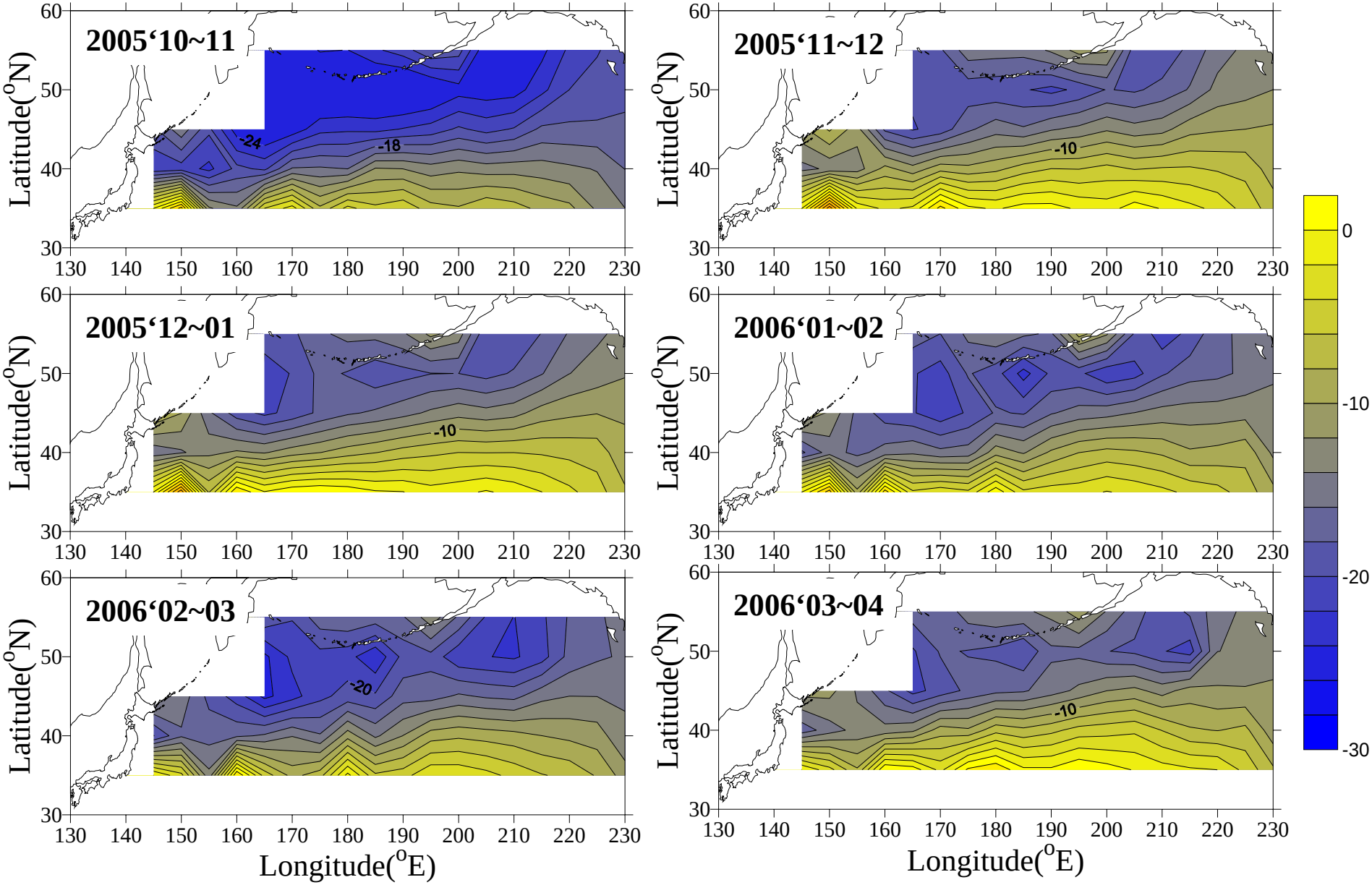




Northward Sverdrup transport crossing the parallel of 45ºN.
It was estimated from NCEP.



The horizontal distribution of Curl τ

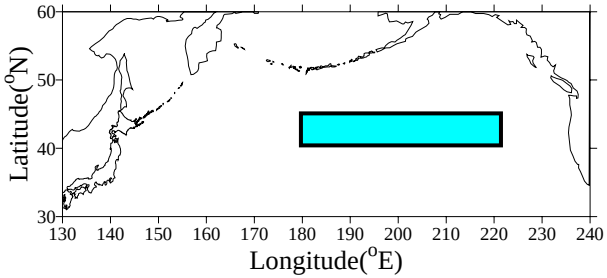


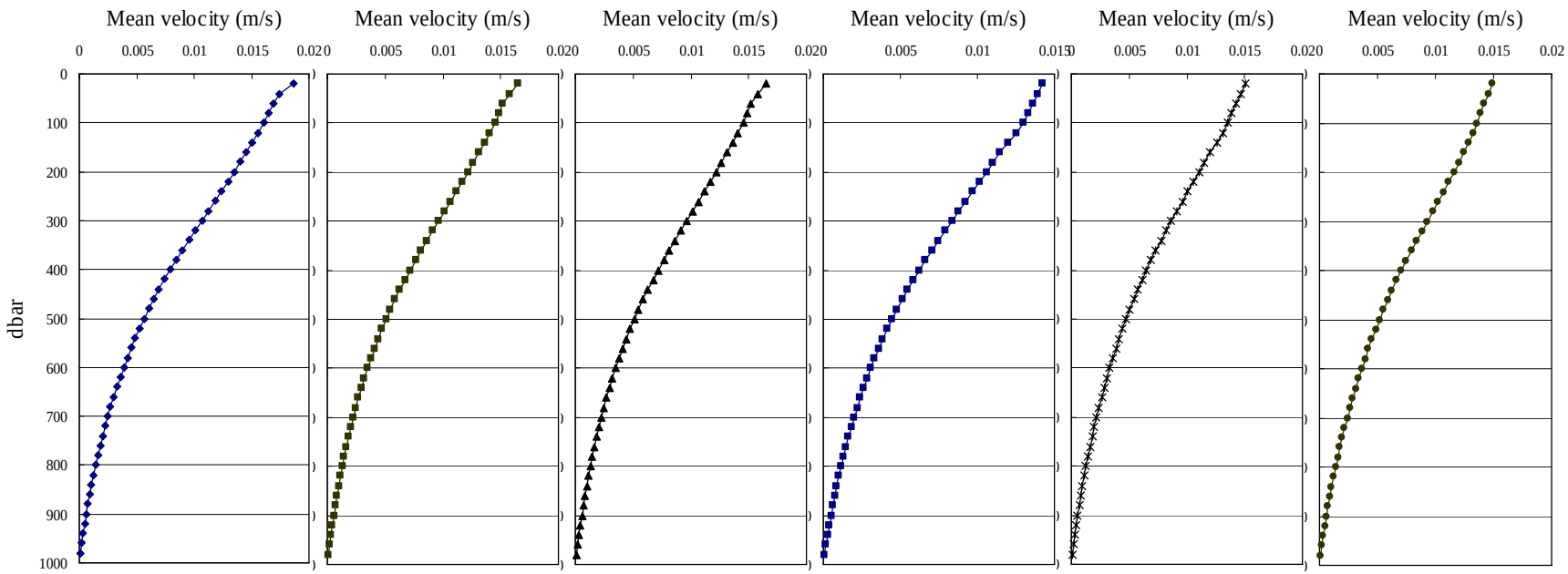
Relative transport referred to 1000db

(Contour units in 2 Sv)

Variation of vertical current-structure

Zonal-average profile of horizontal velocity in right box

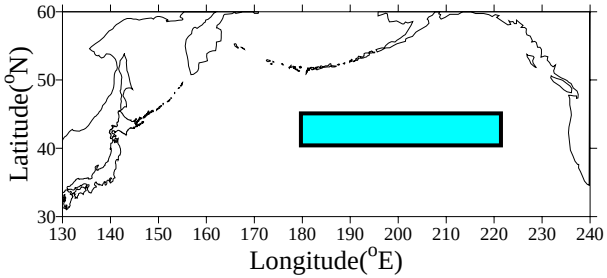


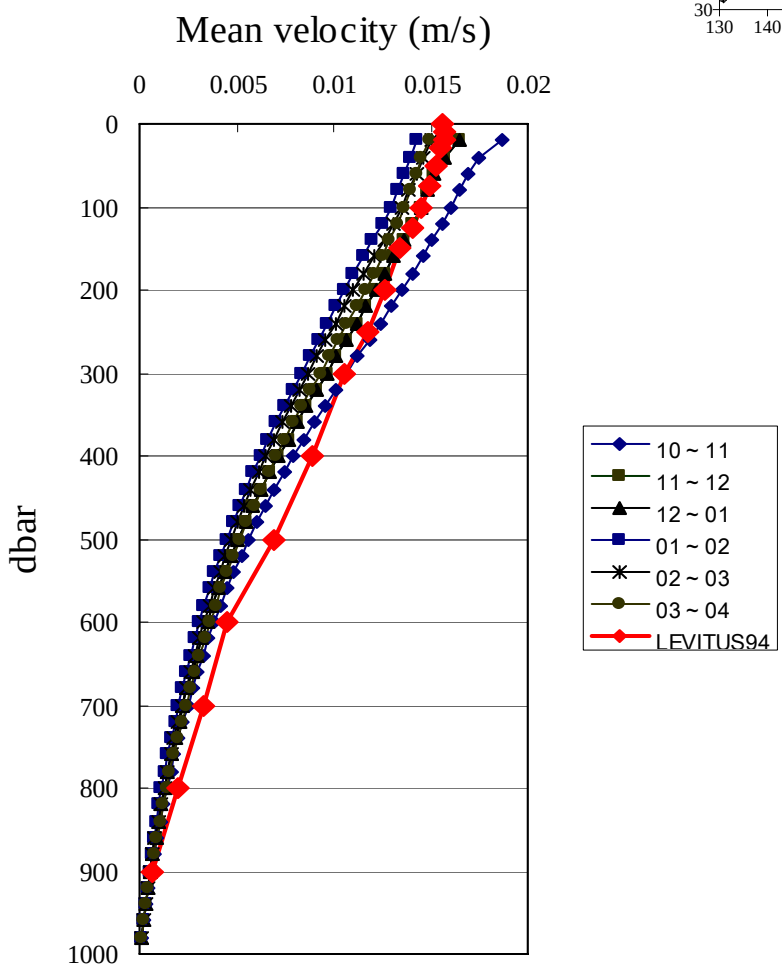


2005‘10~11 **2005‘11~12** **2005‘12~01** **2006‘01~02** **2006‘02~03** **2006‘03~04**

Variation of vertical current-structure

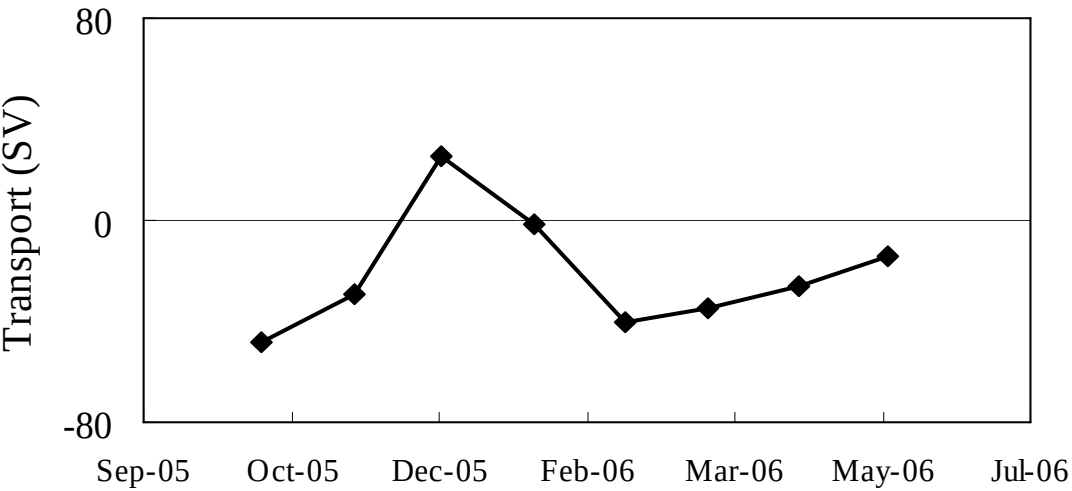
Zonal-average profile of horizontal velocity in right box

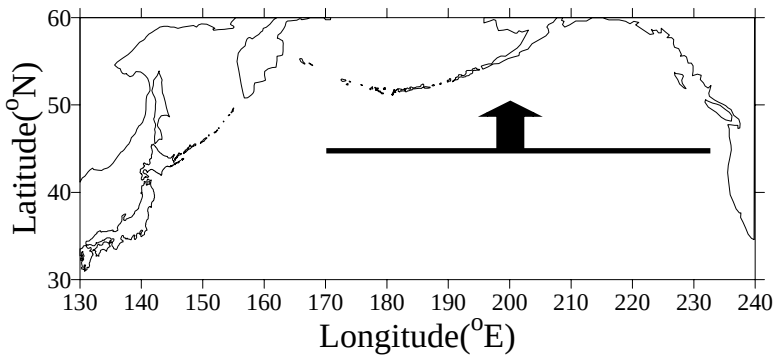


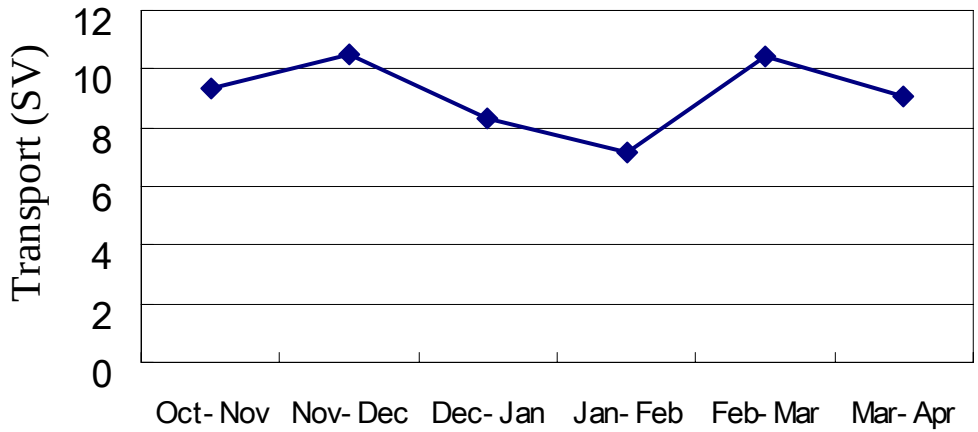


Velocity sheer did not change in the observation periods.

Comparison with Sverdrup transport

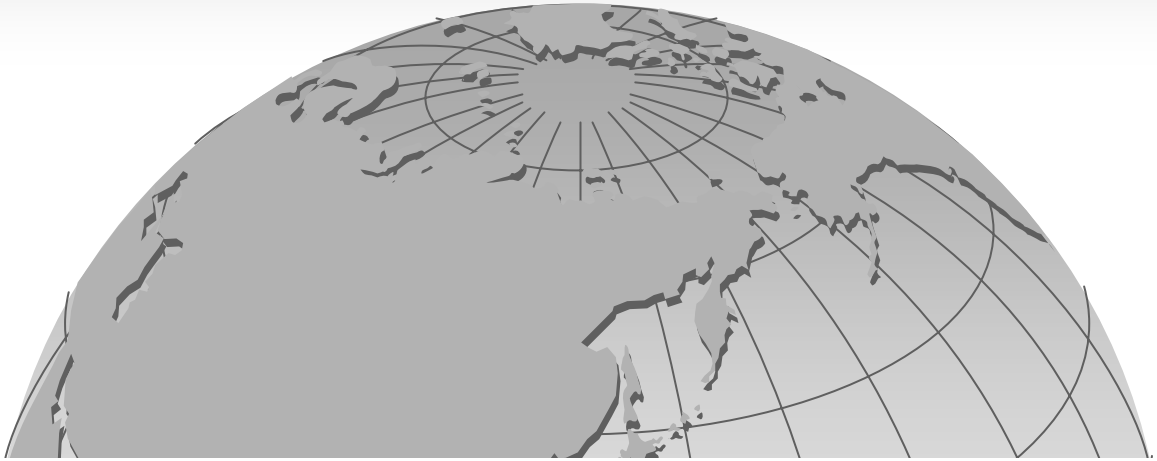




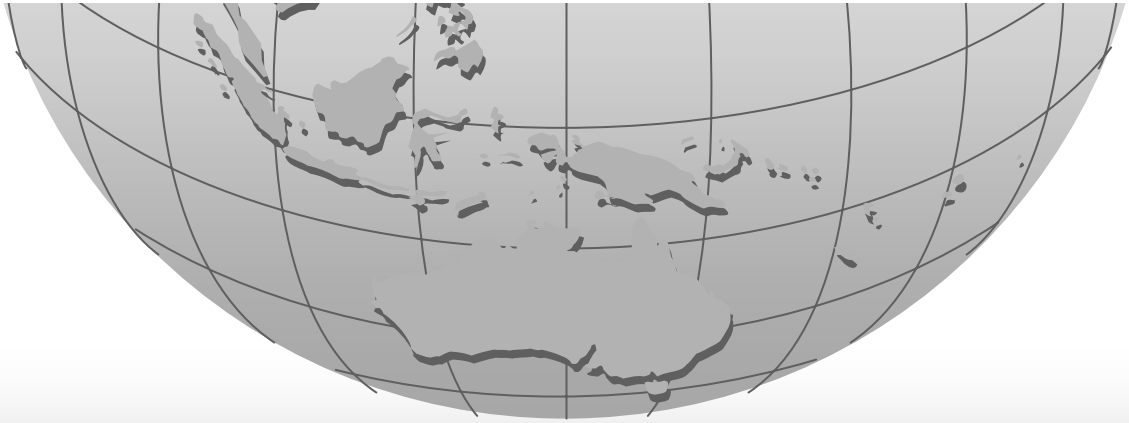


The Relative transport is always northward.

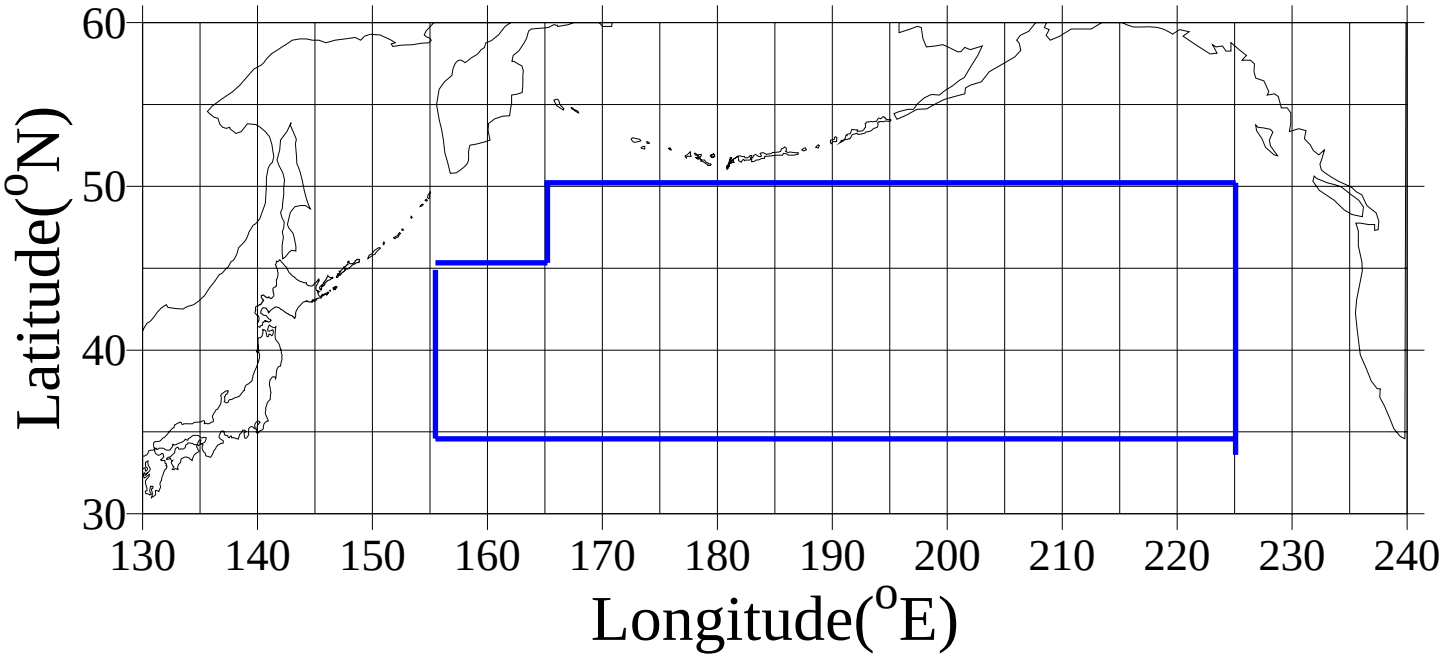
Northward relative transport referred to 1000db crossing the parallel of 45ºN.



On the assumption of the Sverdrup balance, the reference velocity must be changed largely corresponding to the wind stress curl.



Estimate of velocity at 1000db by Inverse analysis



The inverse method we adopted is a hybrid of β-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

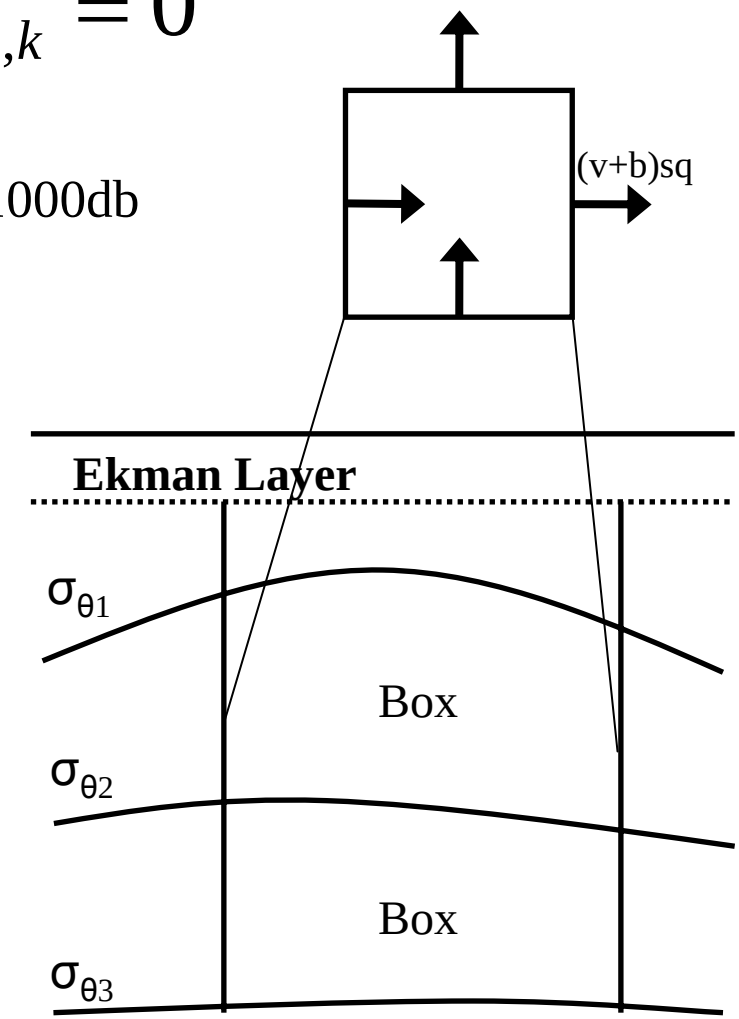
$S_{i,j,k}$: Box area

$q_{i,j,k}$: Density

i : Box side number

j : Box number

k : Density layer number



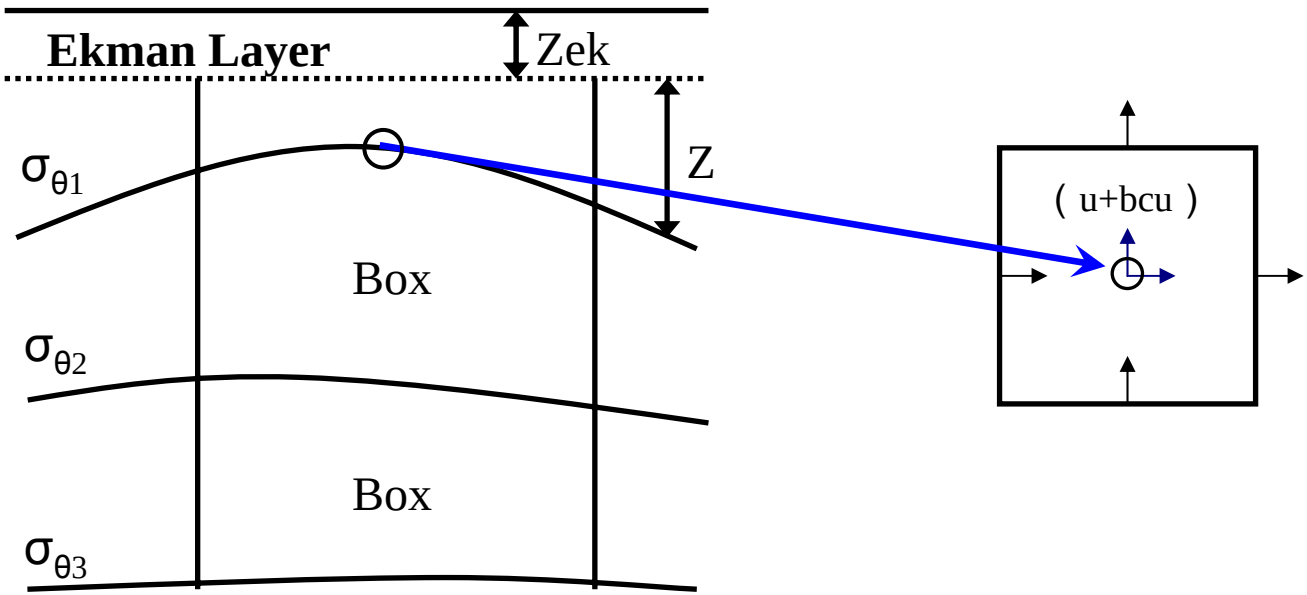
Box inverse

β-spiral (Ueno and Yasuda, 2003)

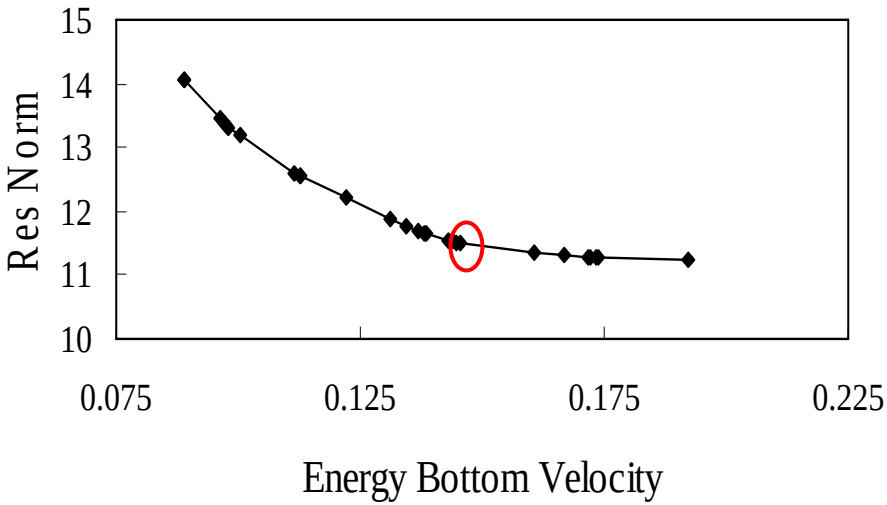
$$w_{ek} - \frac{\beta}{f}\int_{Z}^{Zek}(v_j + b_{cvj})dz = (u_{j,K} + b_{cuj})\frac{\partial Z_{j,K}}{\partial x} + (v_{j,K} + b_{cvj})\frac{\partial Z_{j,K}}{\partial y}$$

Vertical velocity at isopycnal surface

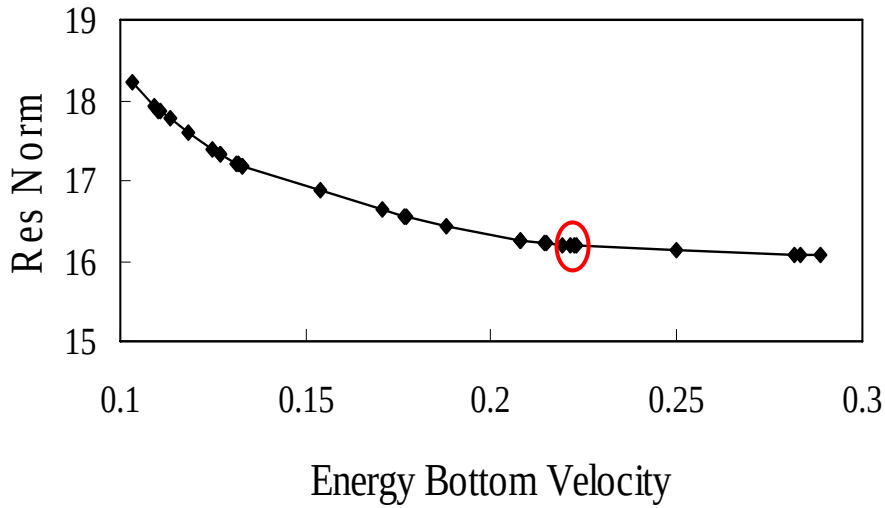
Horizontal advection of isopycnal



Nov-Dec 2005

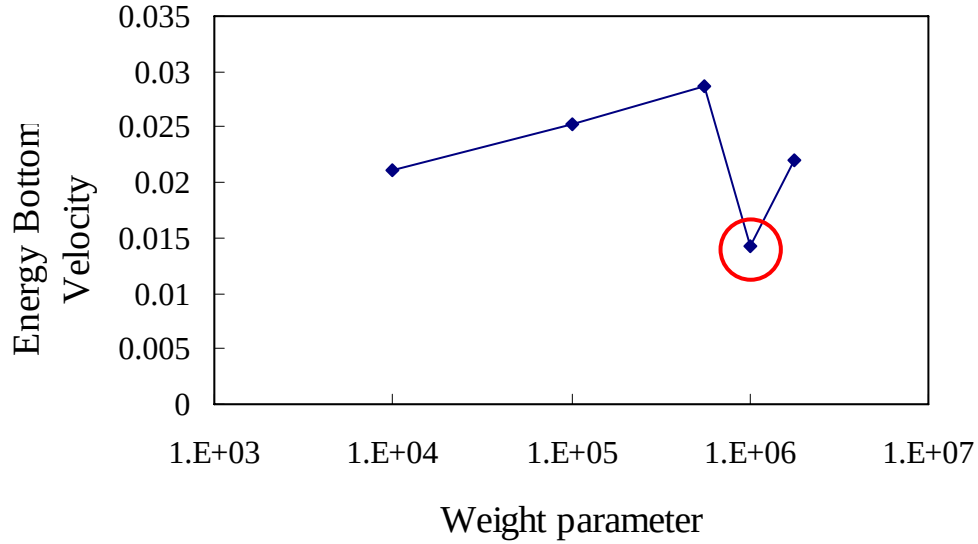


Dec-Jan 2005

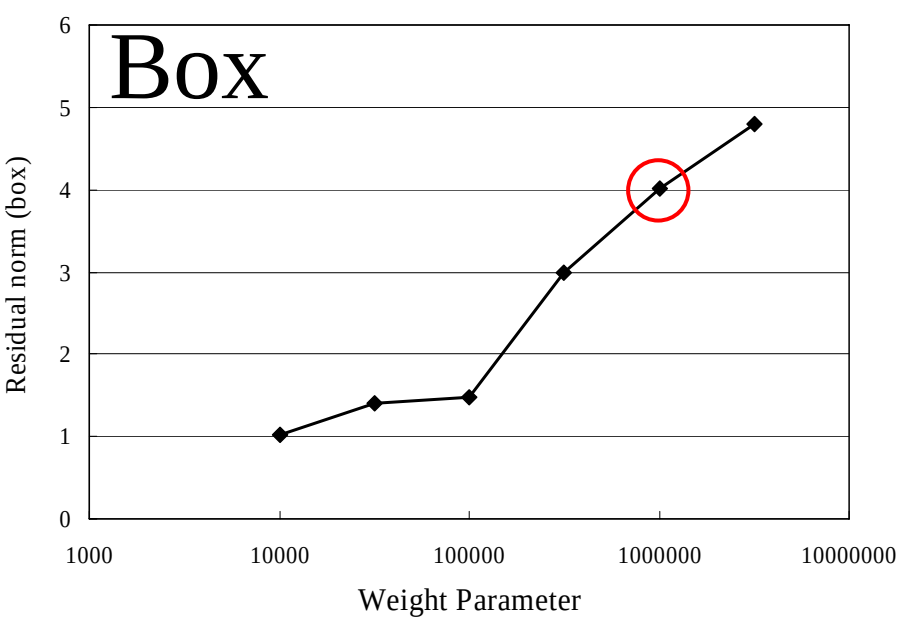


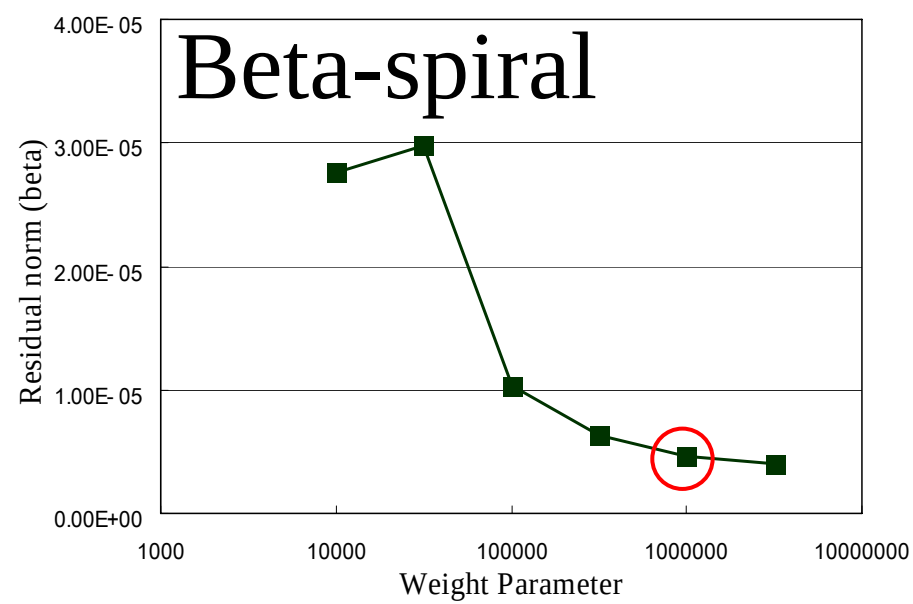
Levenburg-Marquartdt analysis

(Joice et al.,1986)



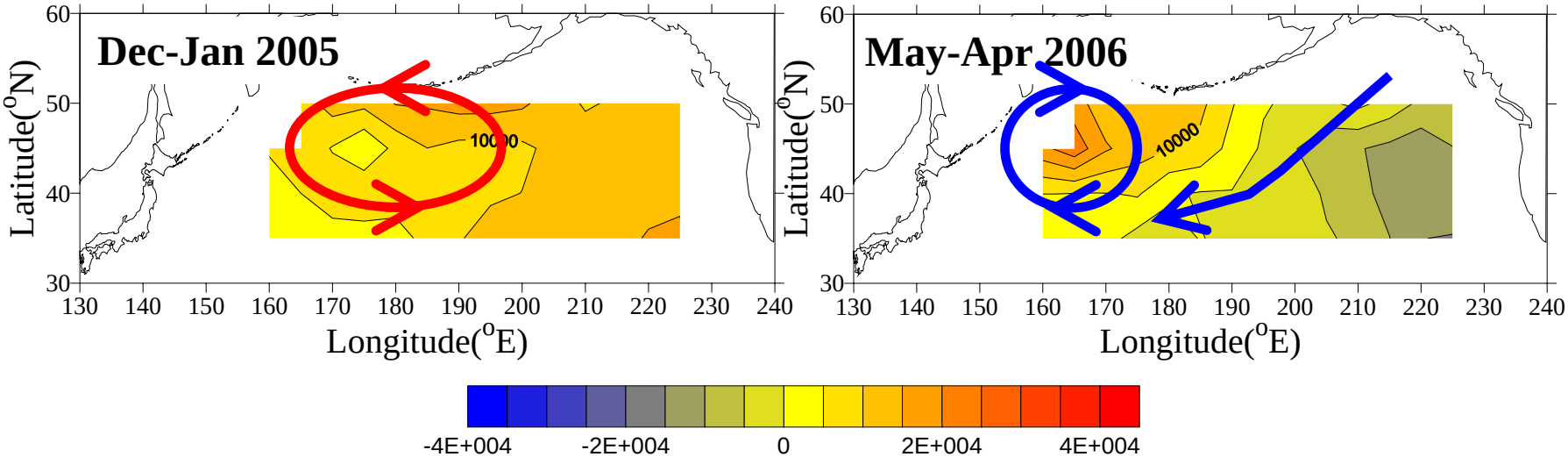
We adopted weighting parameters $10^{\wedge 4}$,$10^{\wedge 5}$,$10^{\wedge 5.75}$,$10^{\wedge 6}$,and $10^{\wedge 6.25}$ from the box and the β-spiral reation.





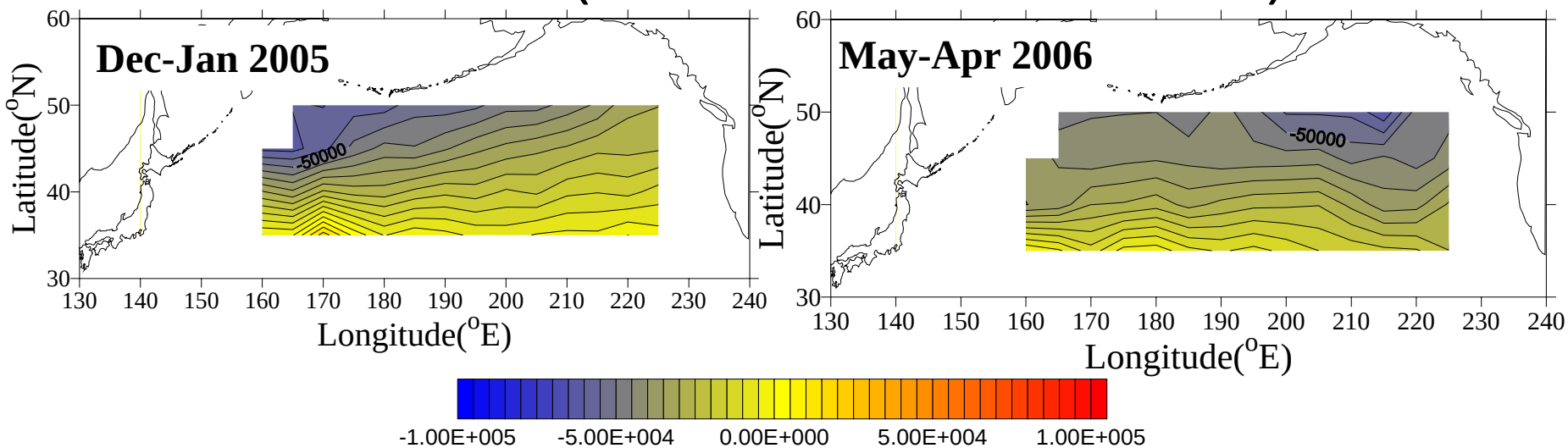
Contour line of streamfunction at 1000db

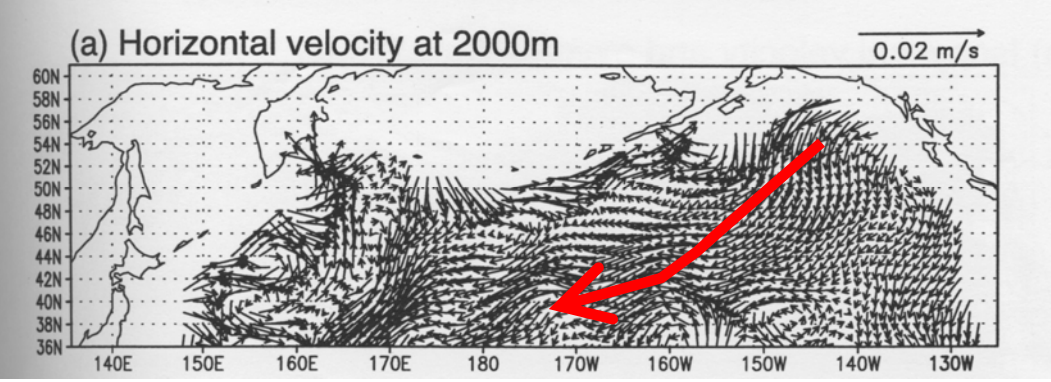
(Contour units in $5\times10^4 m^2/s$)



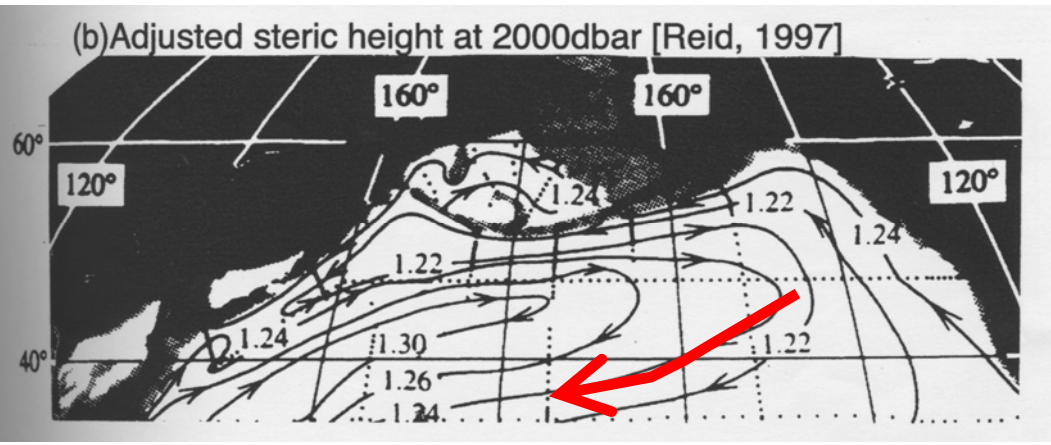
Contour line of streamfunction at 20db

(Contour units in $5\times10^4 m^2/s$)

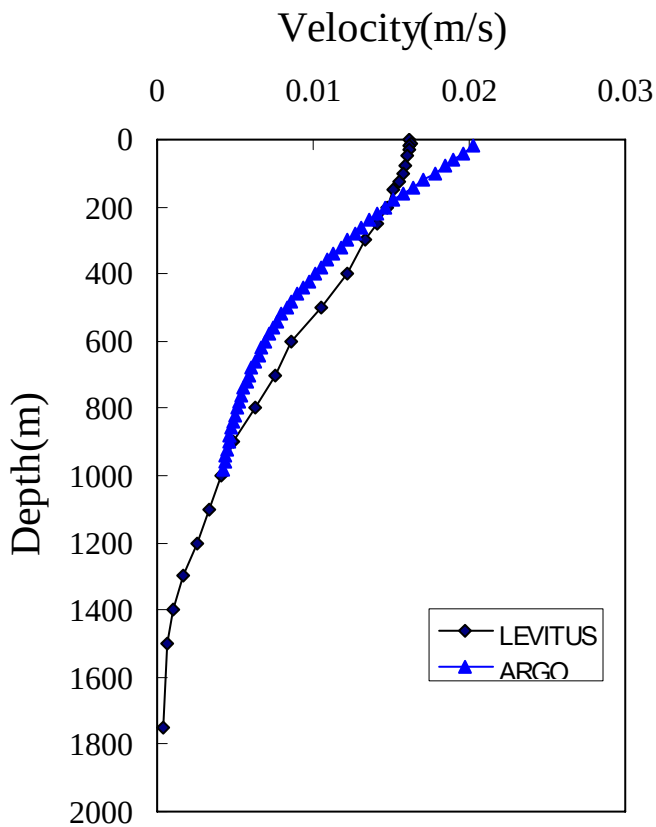


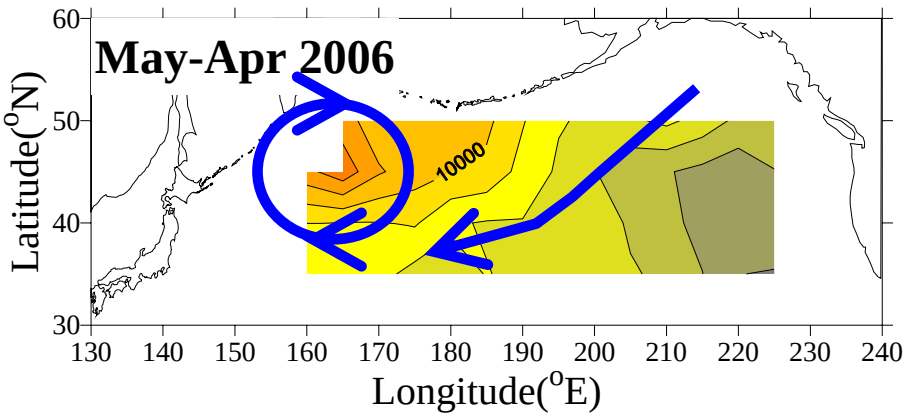


(Ueno and Yasuda, 2000,2001)



(Reid, 1997)





5.Summary

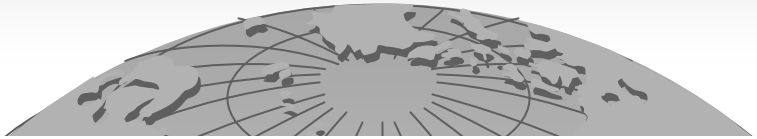
- Relative transport referred to 1000db did not change in the observation period.

- 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.

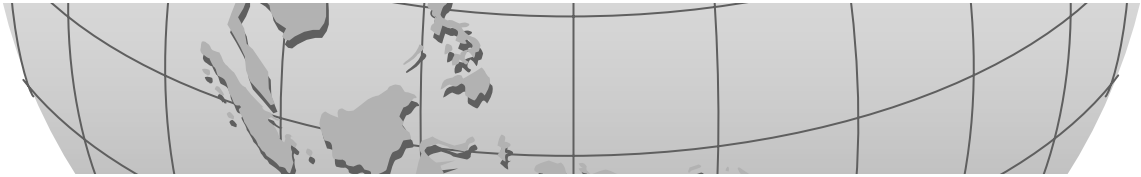
Future works



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