Baroclinic structure in the subarctic gyre of the North Pacific from the Argo Float CTD Data

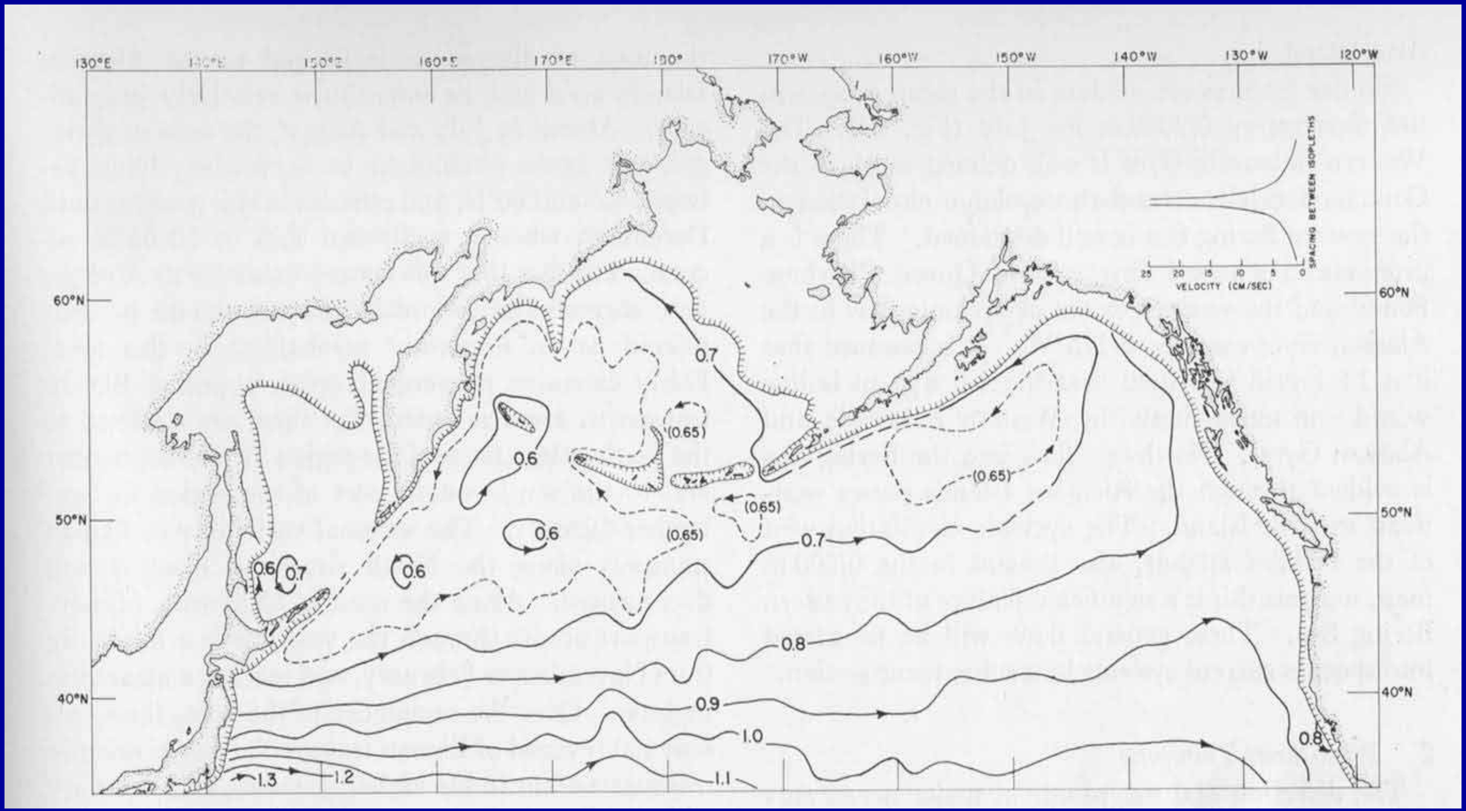
1. Introduction
2. Purpose
3. Method
4. Result
5. Summary

○Masatoshi Sato[1)]・ Tokihiro Kono[1)]

1:Hokkaido Tokai University

1. Introduction

The mean structure by using Historical **data**.



(Favorite et al., 1976)

Seasonal variation of Dynamic height using the **historical data**.

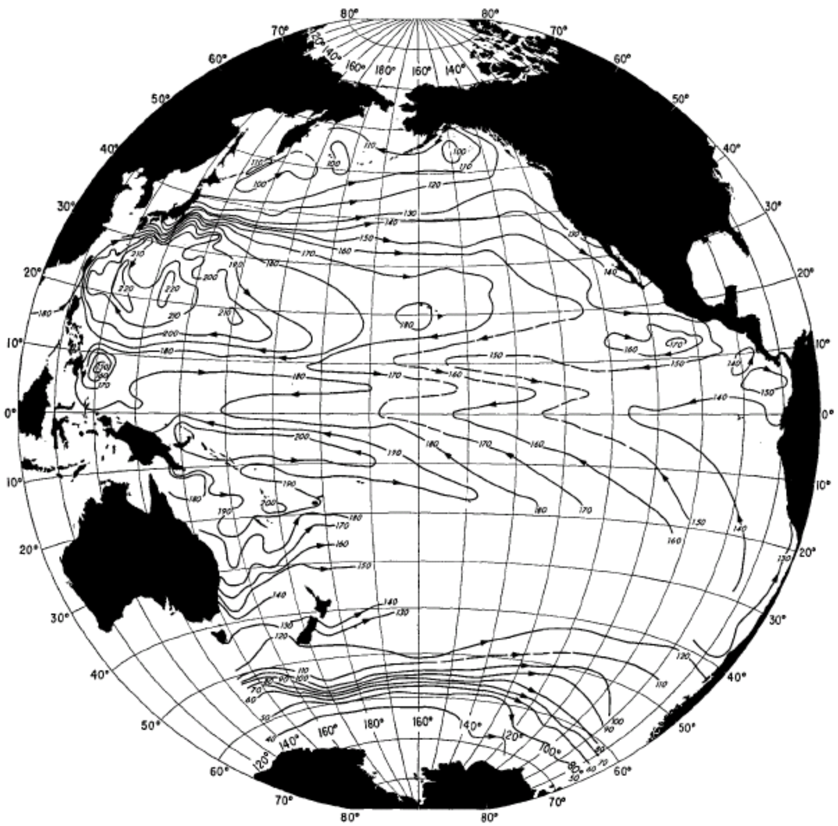


FIG. 2. Mean dynamic topography (dyn-cm) of the sea surface relative to 1000 db for the period March–April: 5,742 observations.

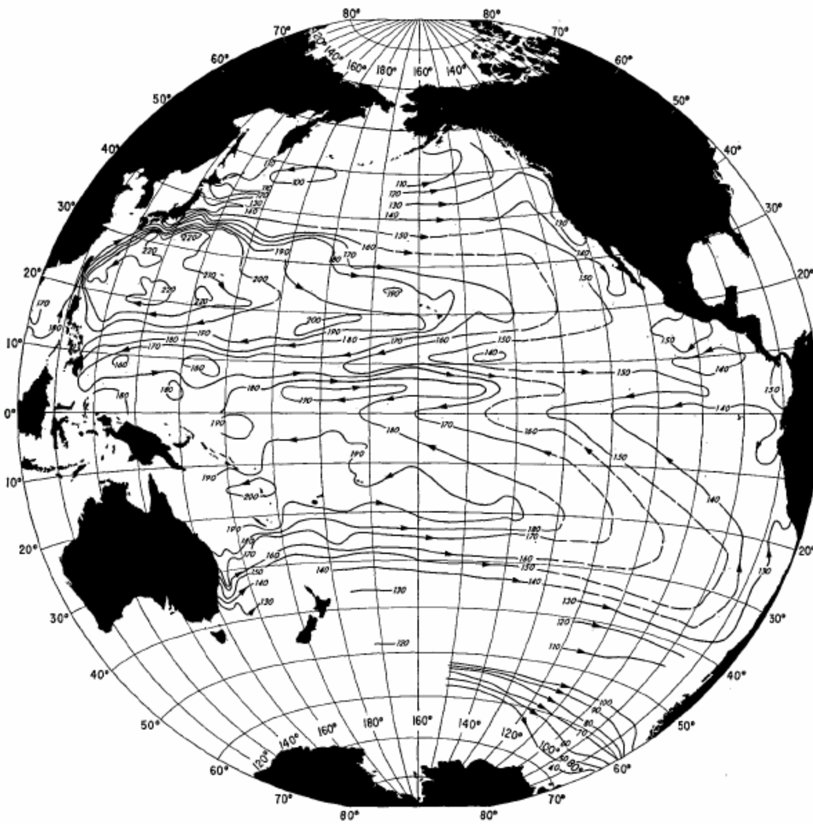
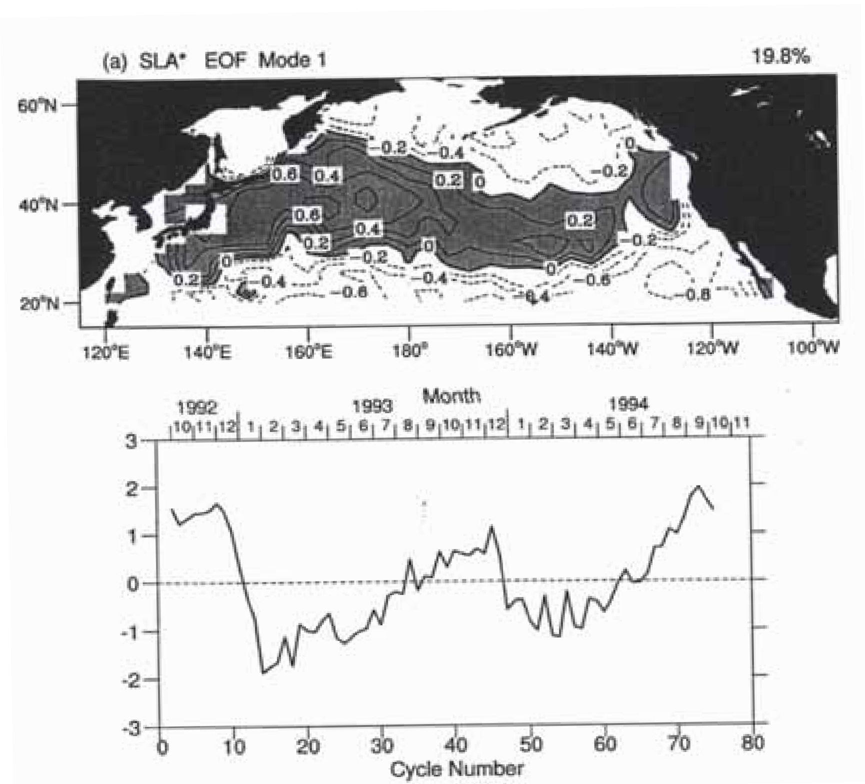


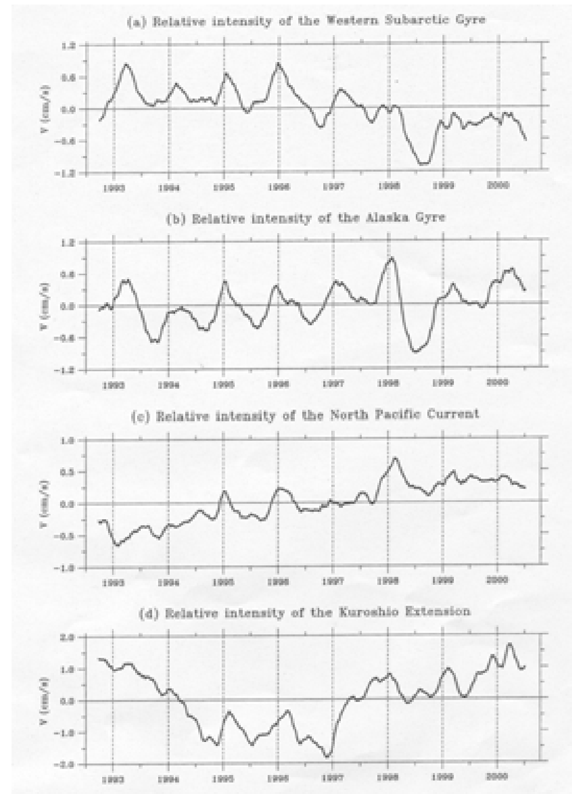
FIG. 3. Mean dynamic topography (dyn-cm) of the sea surface relative to 1000 db for the period November–December: 4,060 observations.

Dynamic height could not change between summer and winter(Wyrtki, 1975)

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



Isoguchi et al., 1997



Qiu 2002

However, the temporal change in the dynamic Structure of the gyre has not been clarified yet.

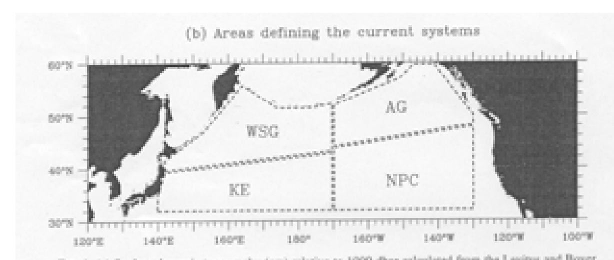


FIG. 1. (a) Surface dynamic topography (cm) relative to 1000 dbar calculated from the Levitus and Boyer (1994) and Levitus et al. (1994) climatology. (b) Areas defining the four current systems: the Kuroshio Extension (KE), the North Pacific Current (NPC), the Alaska Gyre (AG), and the Western Subarctic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

2. Purpose

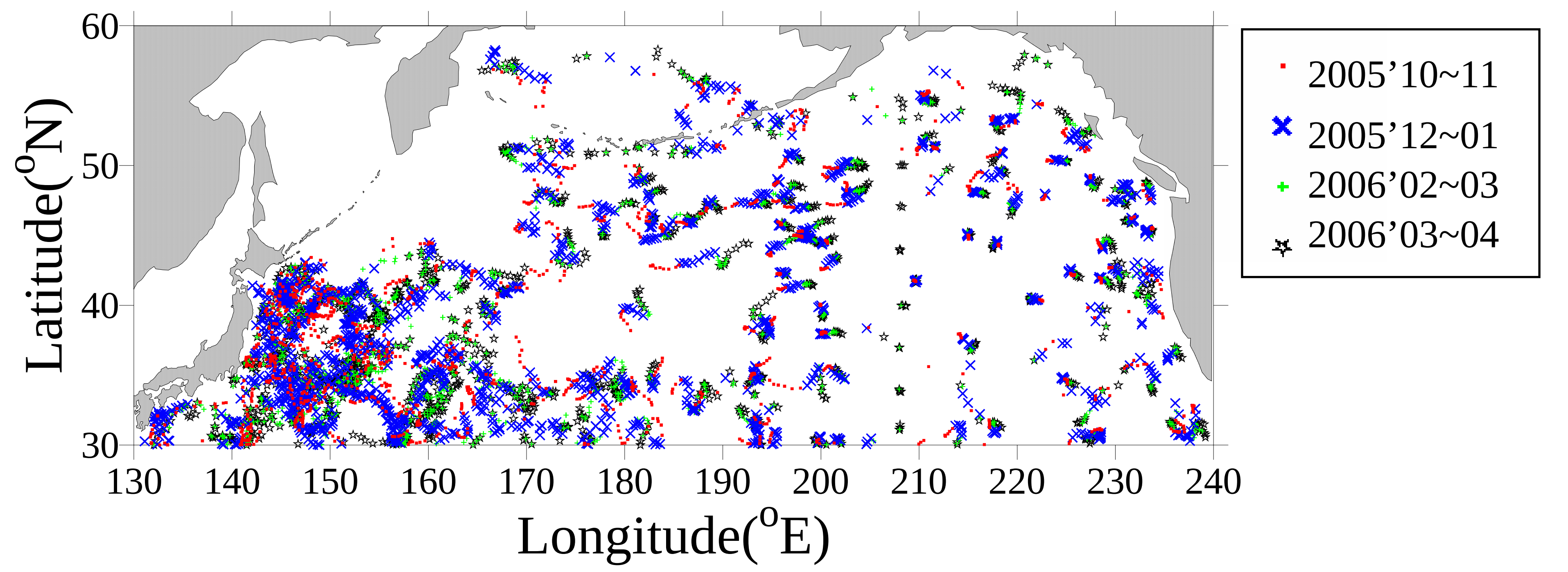
In this study, we analyzed

high resoluted synoptic data from Argo floats

to clarify mean Baroclinic Structure
and it's Seasonal Variation.

3. Method

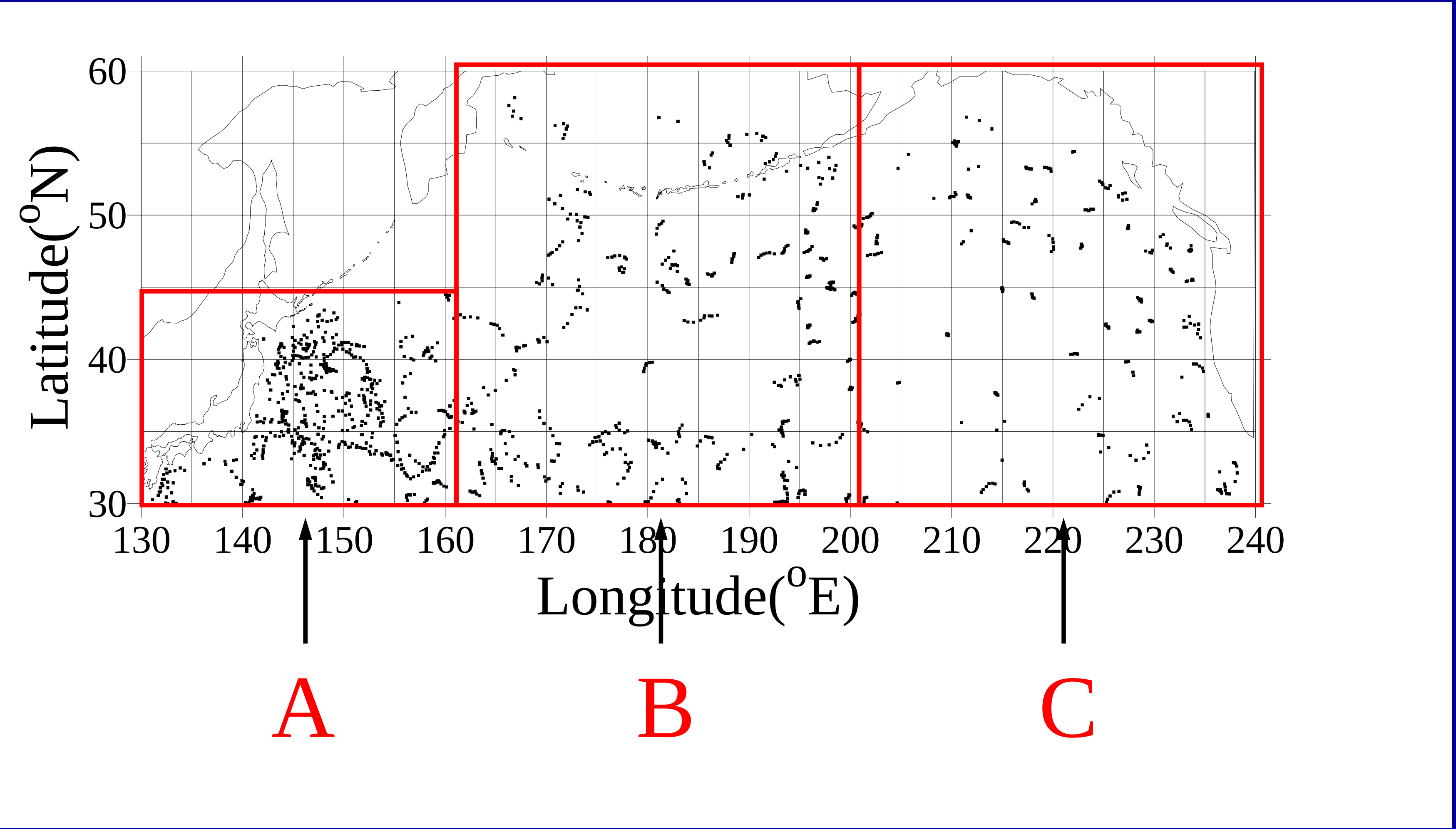
Profile location plot



Data every two months were analyzed.
e.g.
Oct-Nov Nov-Dec ……. Aug-Sep

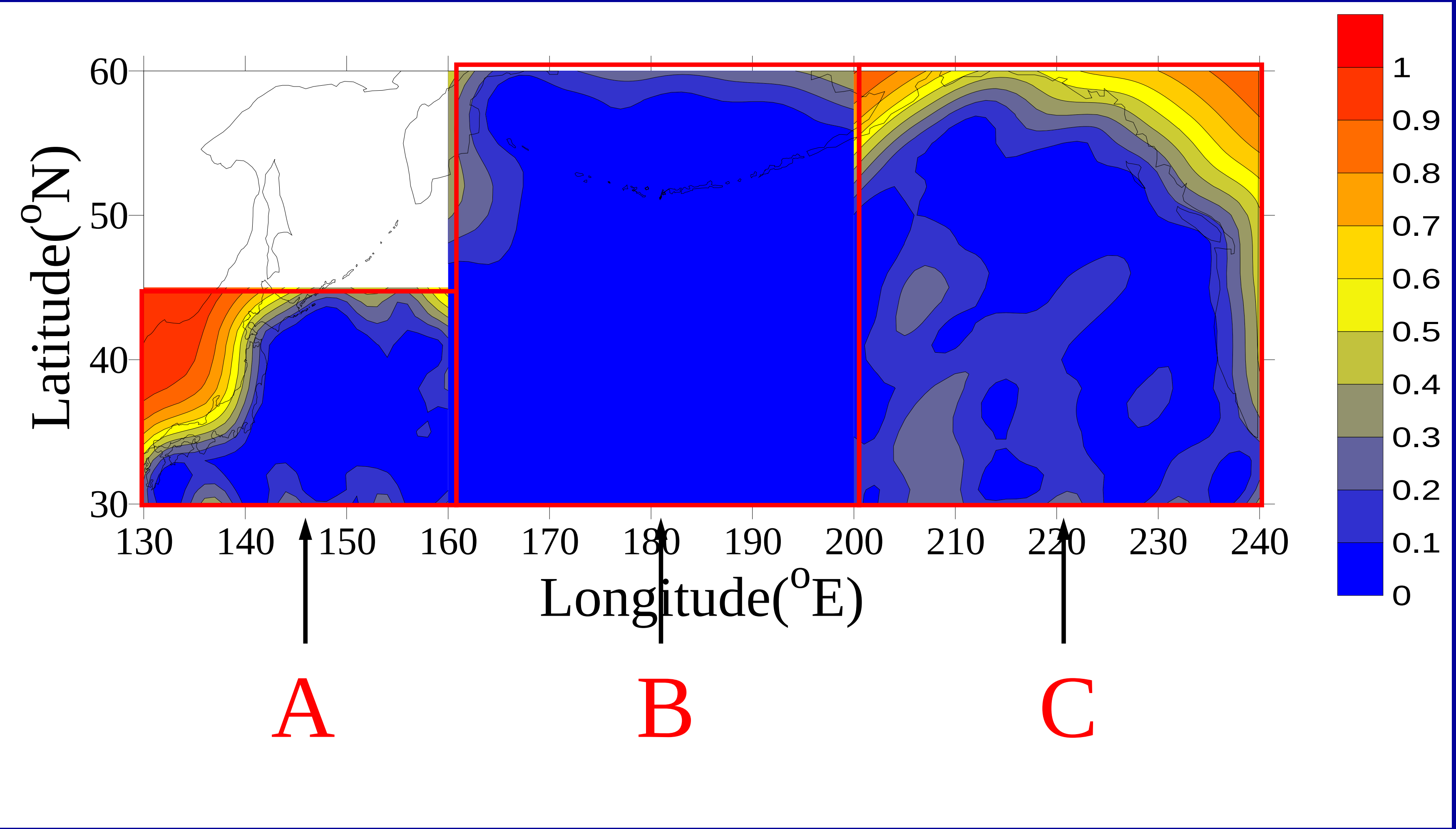
(GODAE ：http://www.usgodae.org/cgi-bin/argo_select.pl)

OI was carried out for the three separated areas



Because of resolution is different between these areas as shown in the previous slide.

Error of geopotential anomaly at 20db in Nov-Dec 2005



The error is very small almost all over the areas.

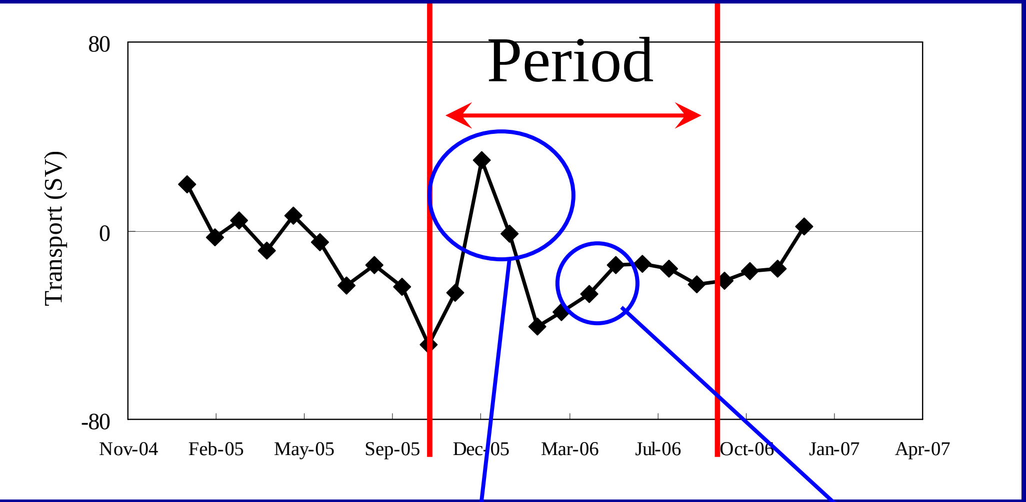
4. Result

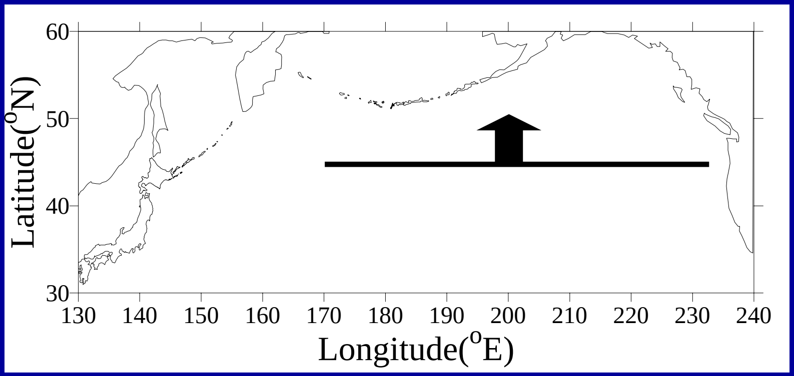
Seasonal Variation of

1.Wind Stress Curl and
Baroclinic structure of
Interior
Southern Boundary
of the Subarctic Gyre

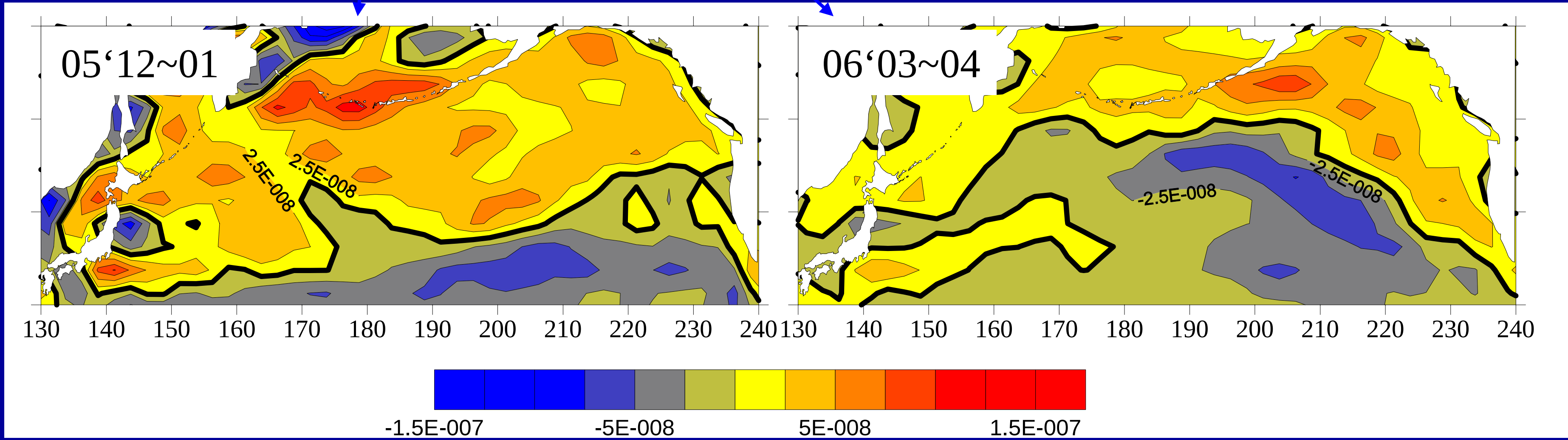
2.1000km-scale variation
of the Surface Dynamic Height

Seasonal variation of Sverdrup transport



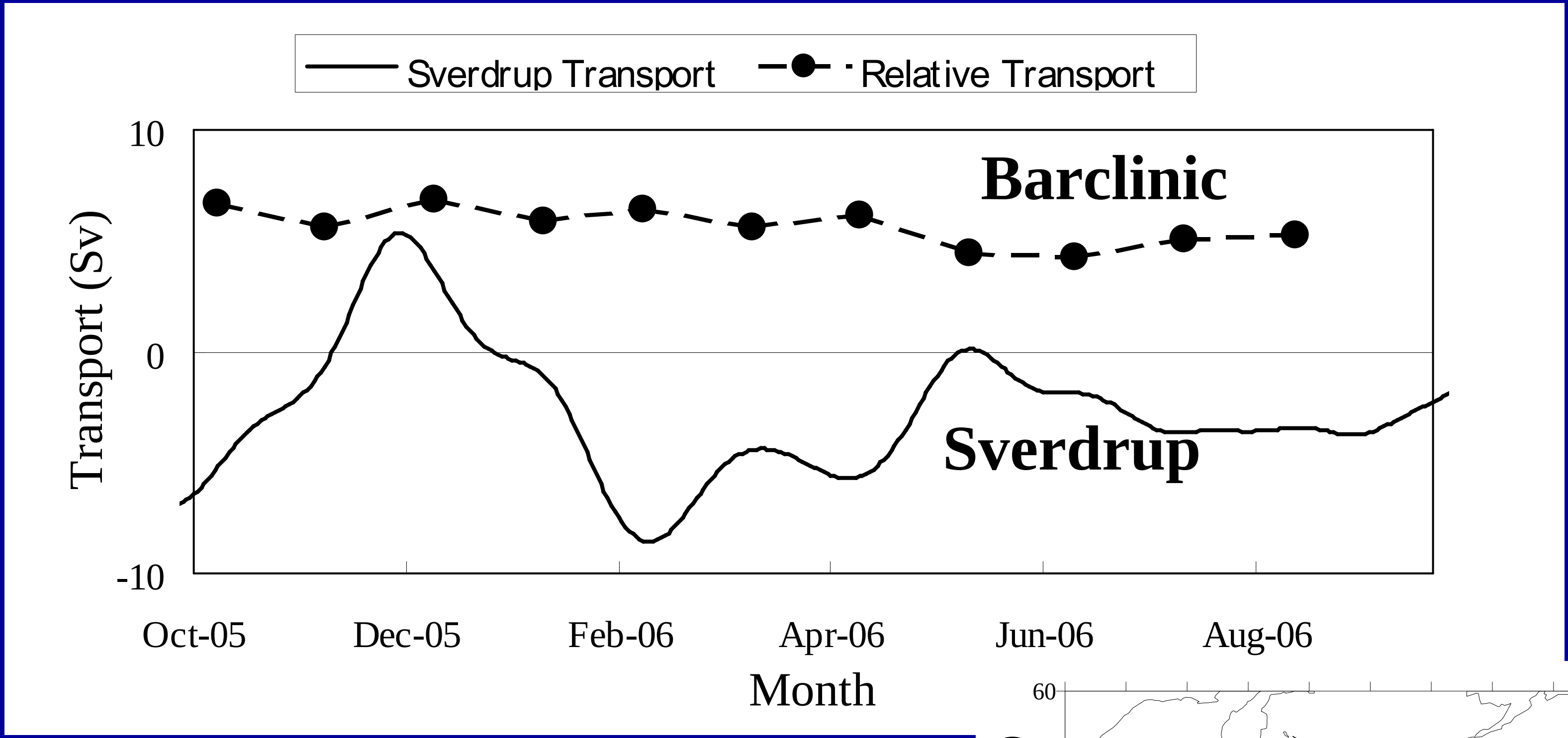


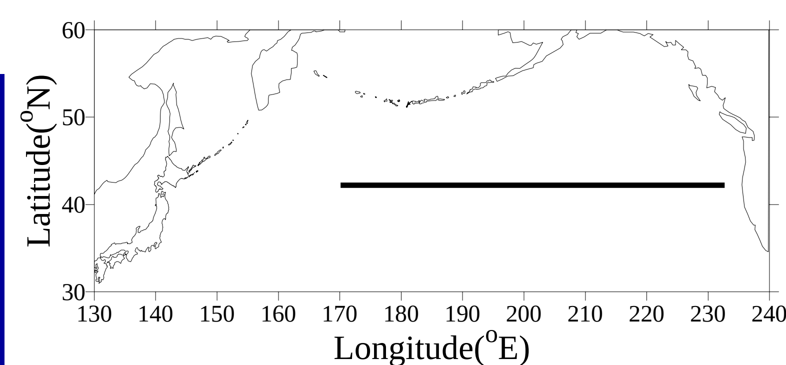
Northward Sverdrup transport crossing the parallel of 45ºN from NCEP



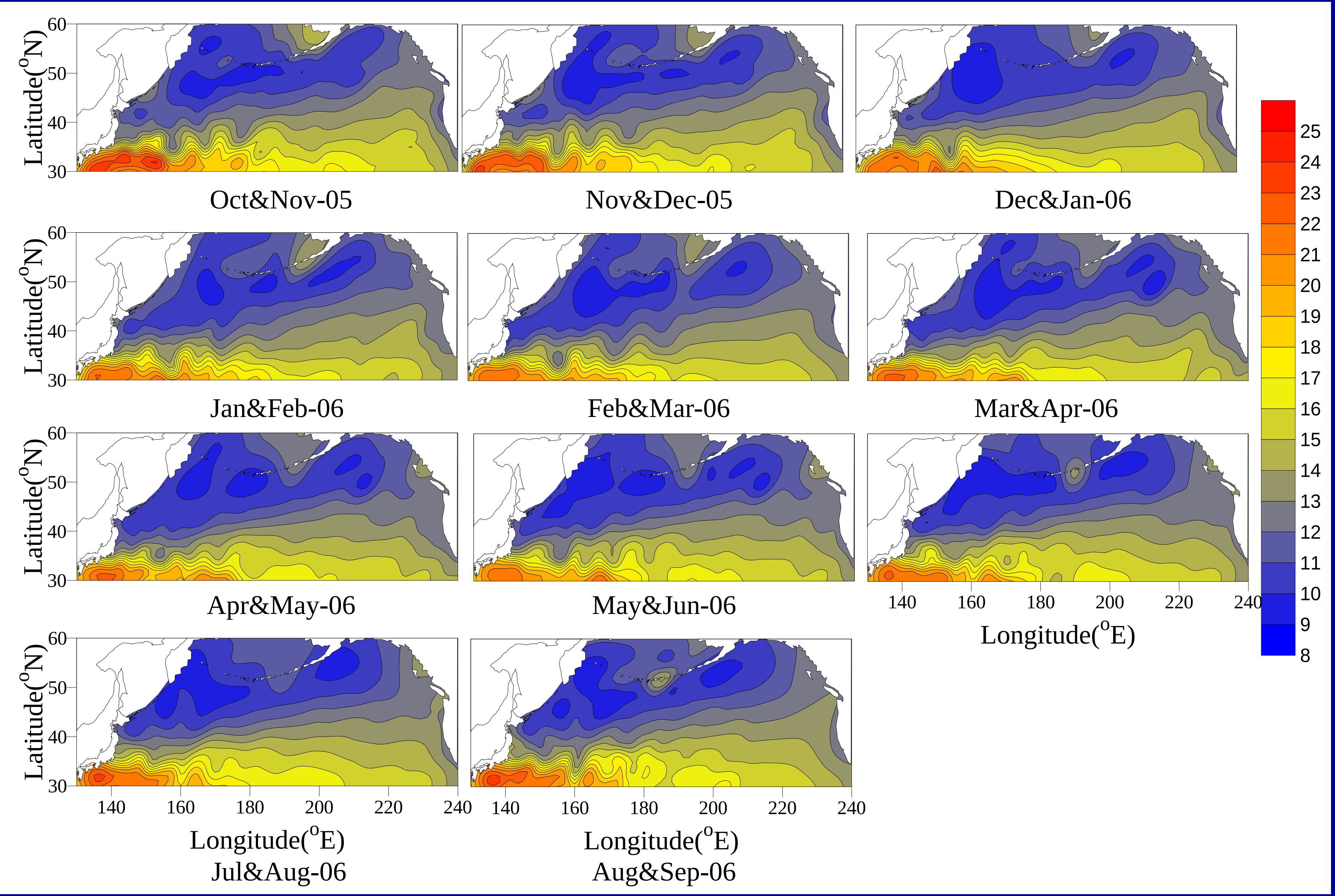
The horizontal distribution of Curl τ

Temporal changes of Baroclinic transport and Sverdrup transport from 20db to 1000db.

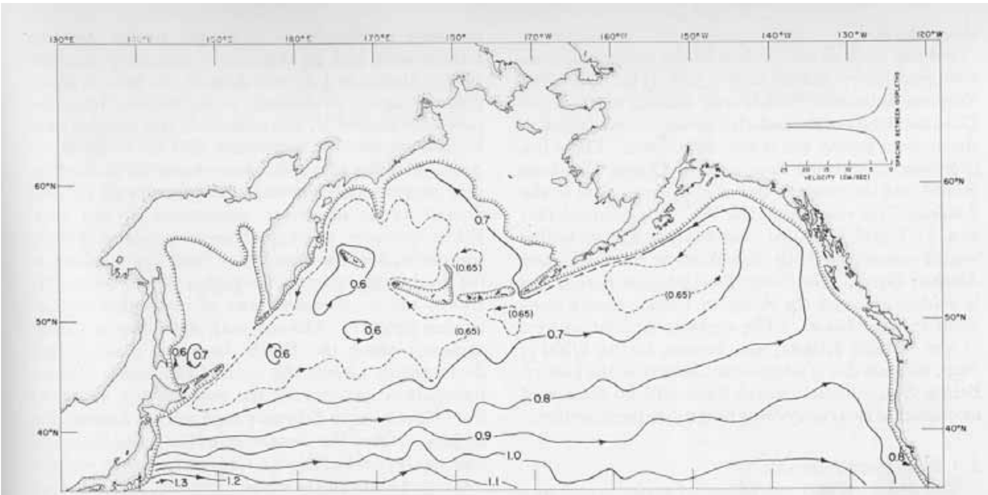




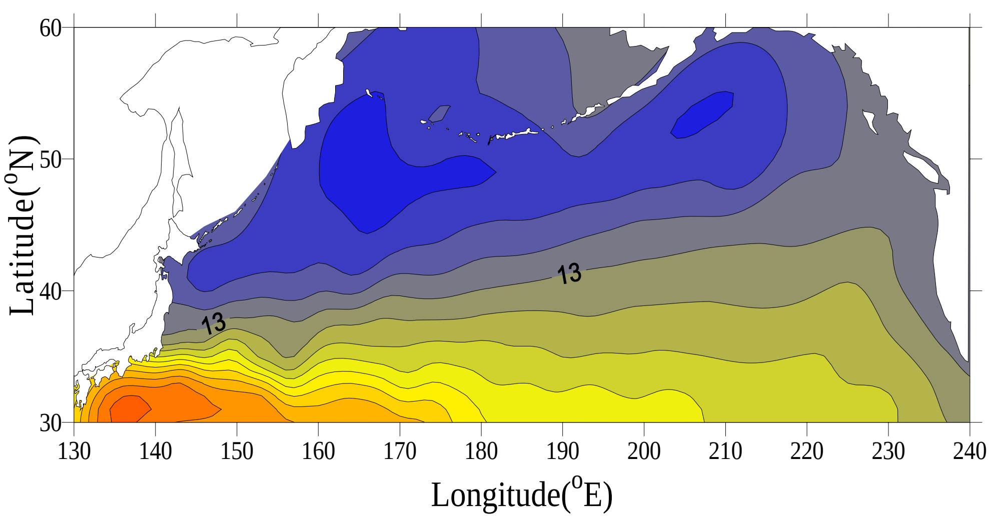
Geopotential Anomaly at 20db (m^2/s^2) [refer to 1000db]



Comparisons of the climatological data with the Argo float data.



(Favorite et al., 1976)



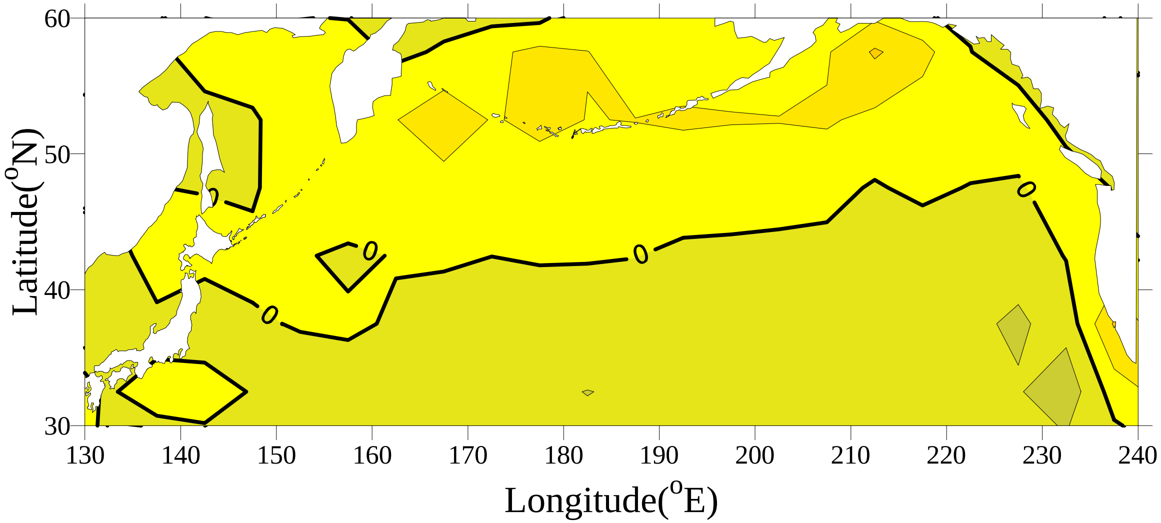
Climatological

The southern most latitude by Argo locates similarly to the climatological.

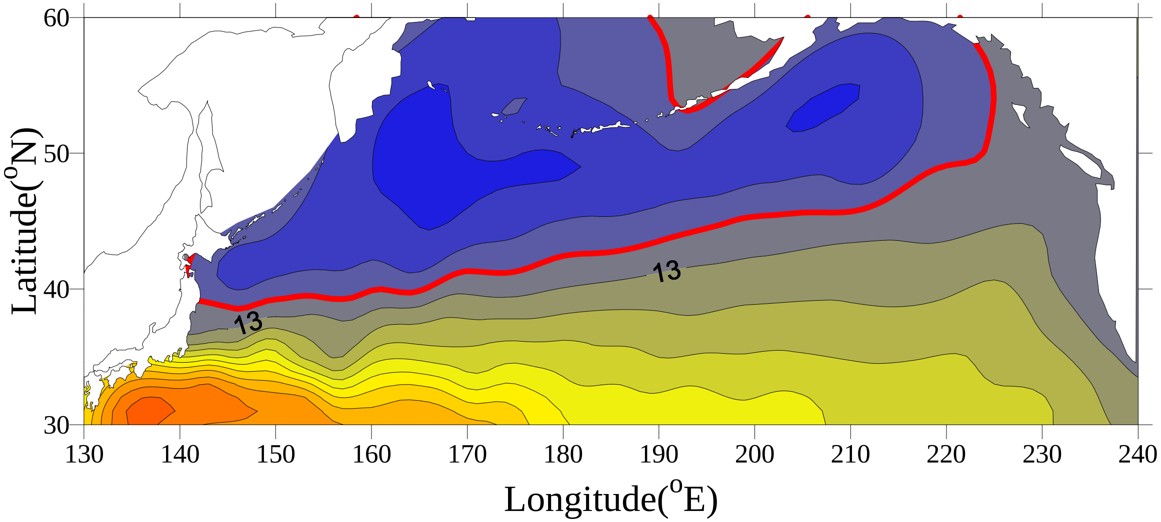
Argo Float Mean

Then how dose the structure differs from or similar to the mean curl tau?

Mean CurlTau (1970~2006) and Mean Geopotential Anomaly(Nov.05~Sep.06)

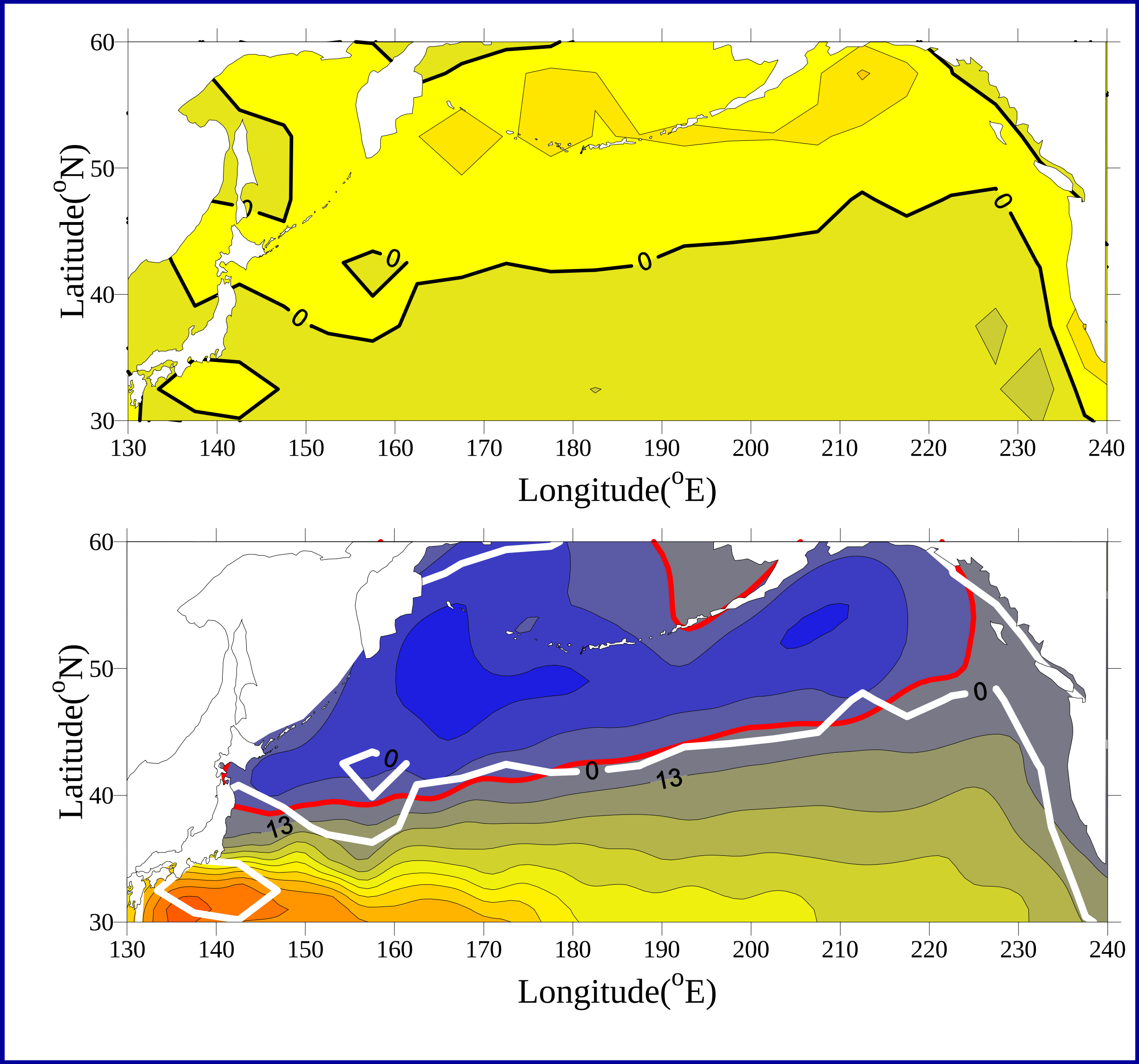


CurlTau



Geopotential Anomaly

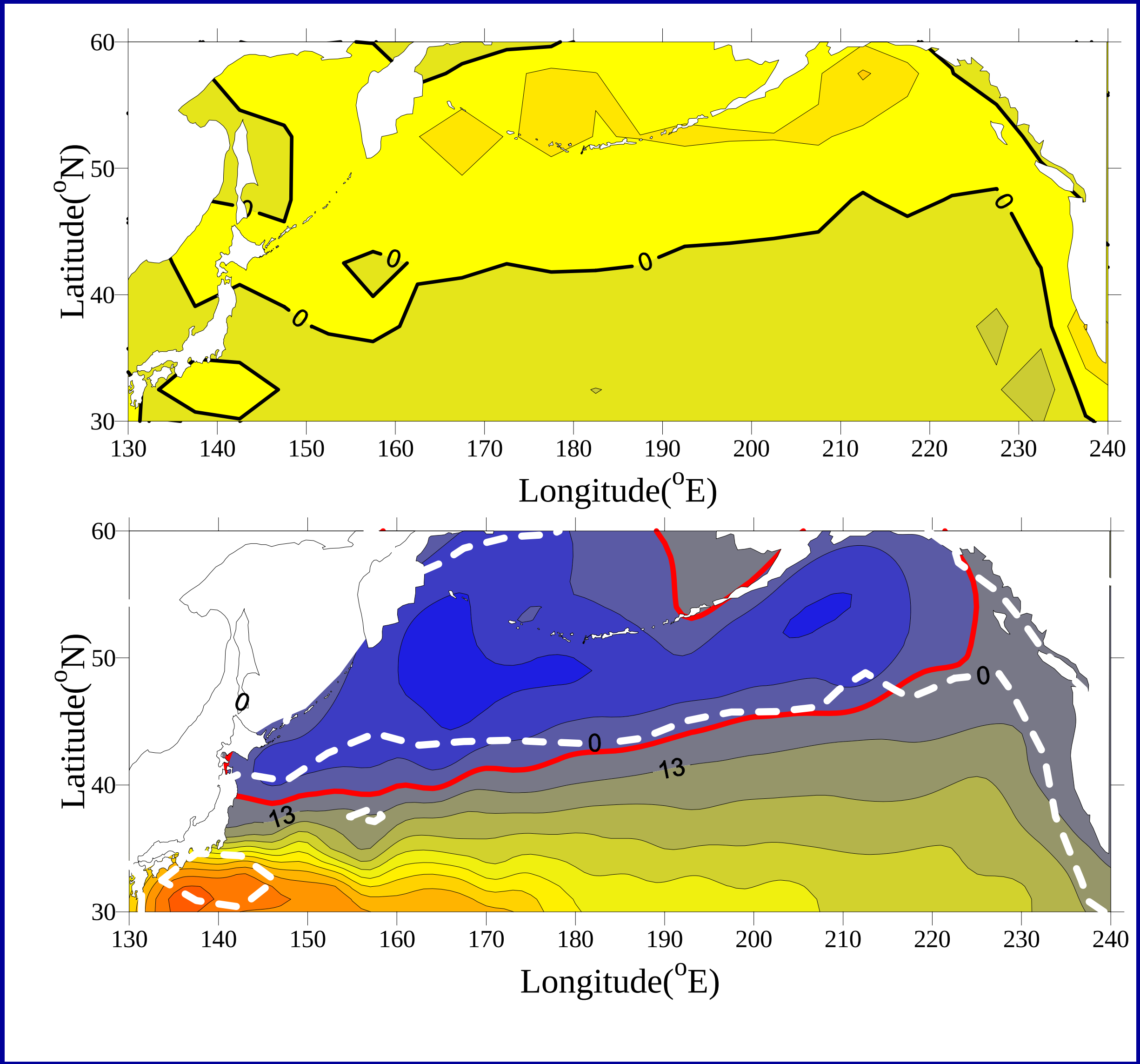
Mean CurlTau (1970~2006) and Mean Geopotential Anomaly(Nov.05~Sep.06)



Geopotential Anomaly

Wihte line: Curl Tau is Zero

Mean CurlTau (1970~2006) and Mean Geopotential Anomaly(Nov.05~Sep.06)

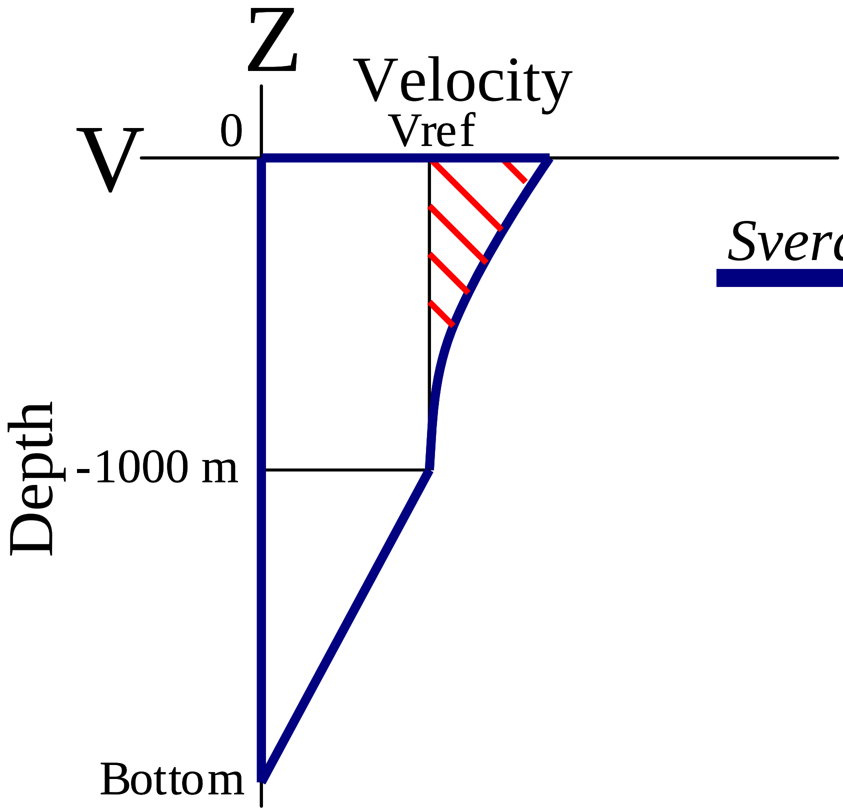


The line shifts north from Curl 0 line.
But not different so far.

Geopotential Anomaly

Wihte broken line: Sverdrup Transport +Ekman Transport

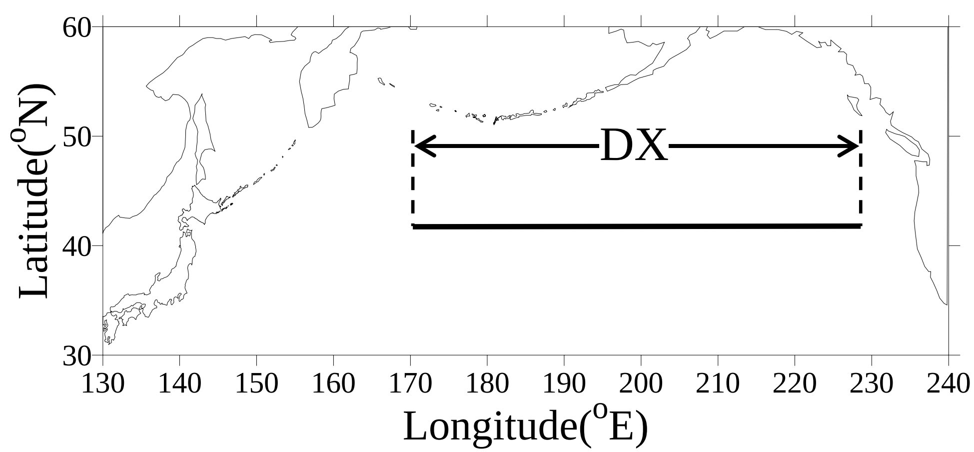
Estimation of reference velocity from Sverdrup Transport and Geopotential



$$SverdrupTransport + EkmanTransport$$

$$= \int_{-1000}^{0}\int_{0}^{DX} (V_{baroclinic} + V_{ref})\,dxdz$$

$$+ \frac{V_{ref}}{2} DX\,(Bottom - 1000)$$

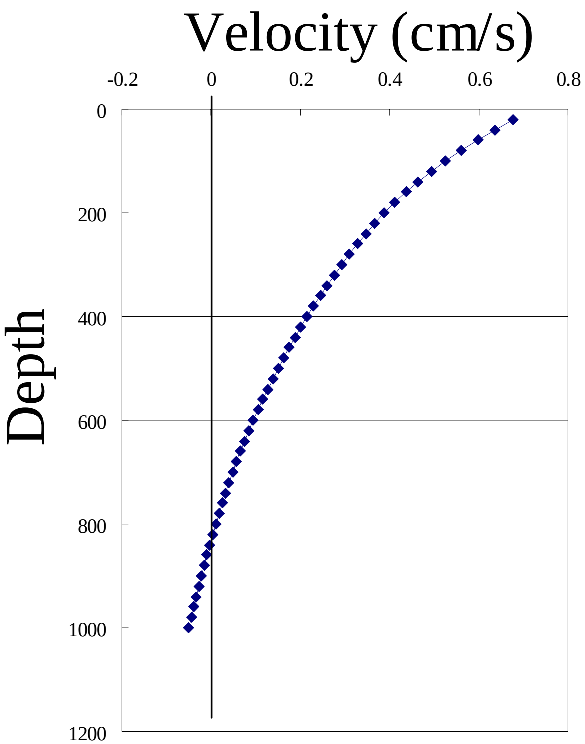


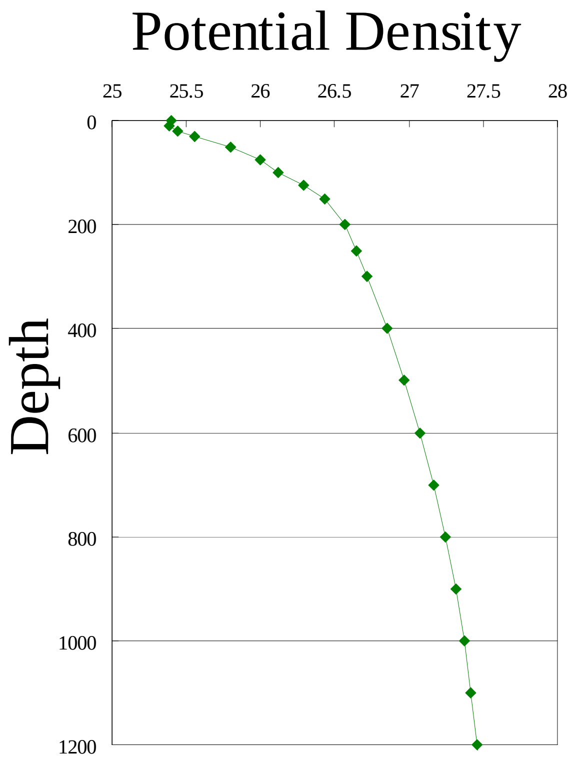
Results

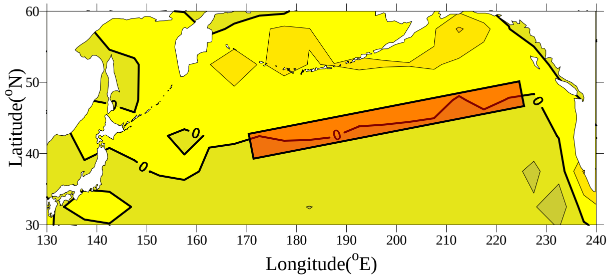
47.5^{o}N : **0.02cm/s**

42.5^{o}N : **-0.08cm/s**

To estimate the mean northward velocity profile Along the curl tau zero line





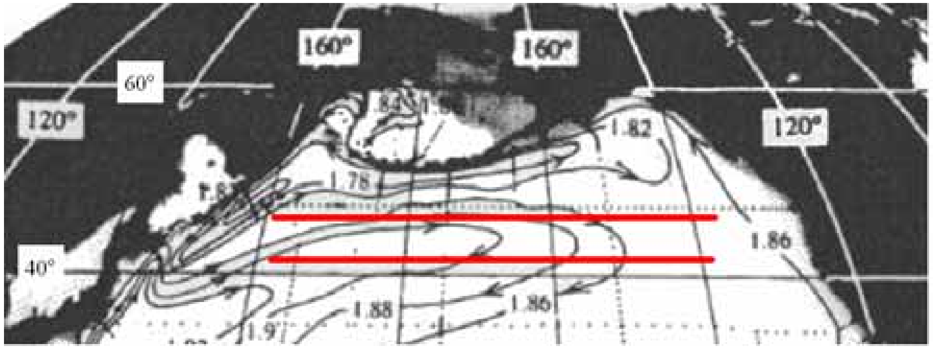


Southern boundary of the upper gyre locates almost similarly to the mean wind driven gyre.

Compared with steric height at 1000db by the historical data.

(Cm/s)

	Estimation	Reid(1997)
47.5°N	0.02	0.05
42.5°N	- 0.08	- 0.16



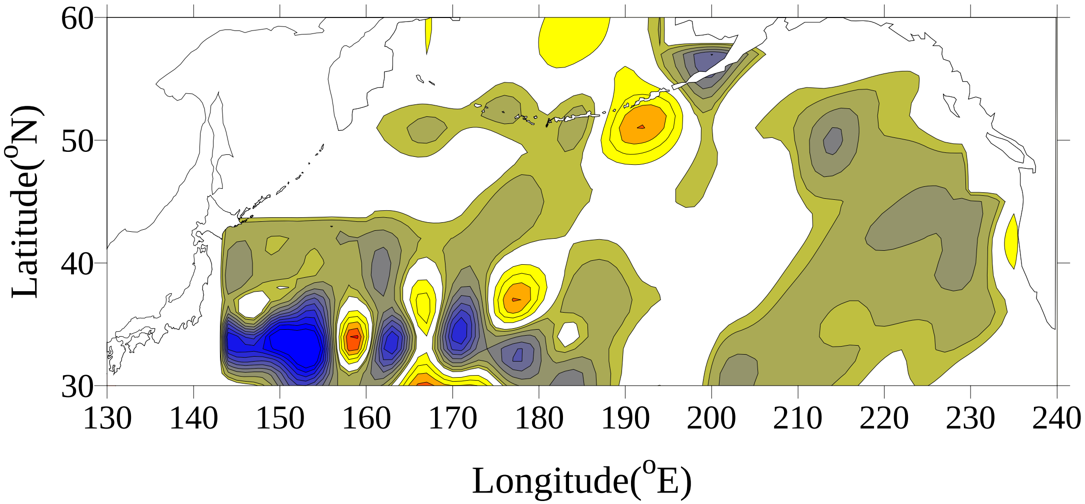
Reid (1997)

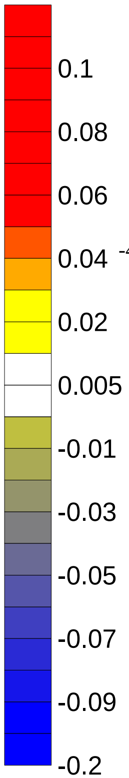
Velocity at the 1000db 47.5°N is directed **Northward**.
42.5°N is directed **Southward**.

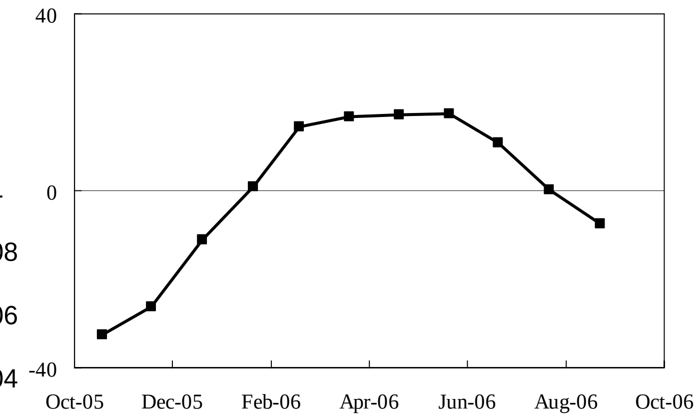
The Sverdrup balance is supported, therefore.

We will investigate the pattern of the seasonal change in the geopotential.

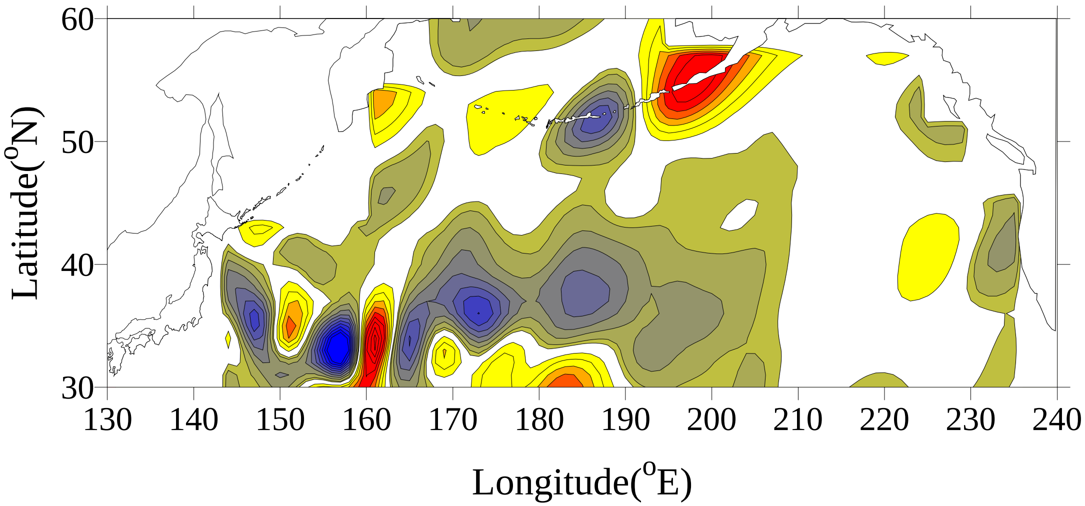
EOF analysis of geopotential anomaly at 20db.

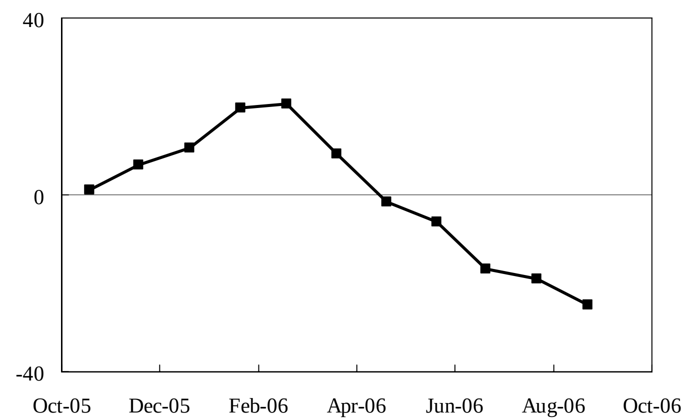




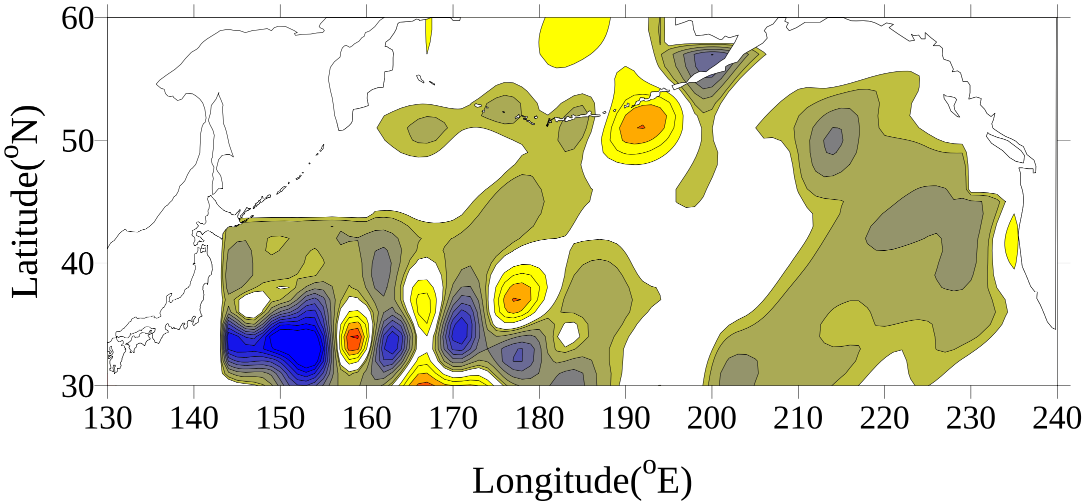


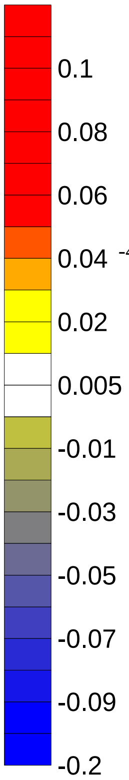
	Contribution
First	43%
Second	32%

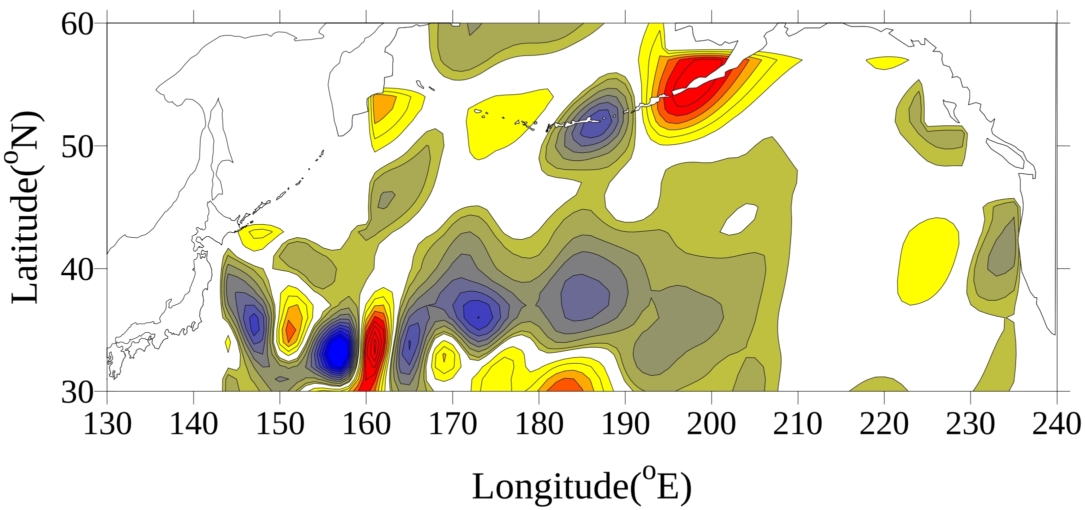




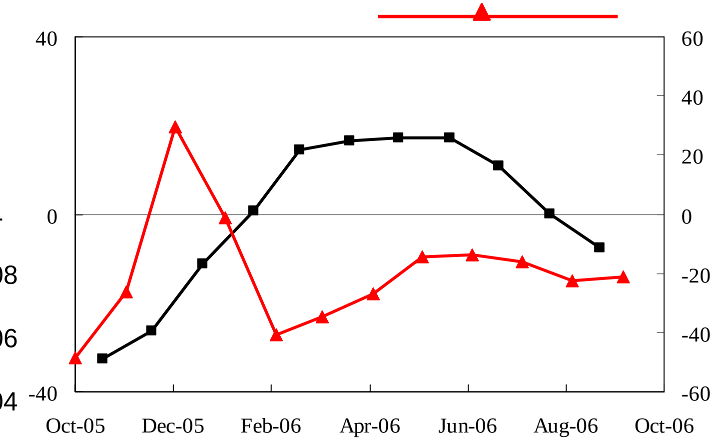
EOF analysis of geopotential anomaly at 20db.



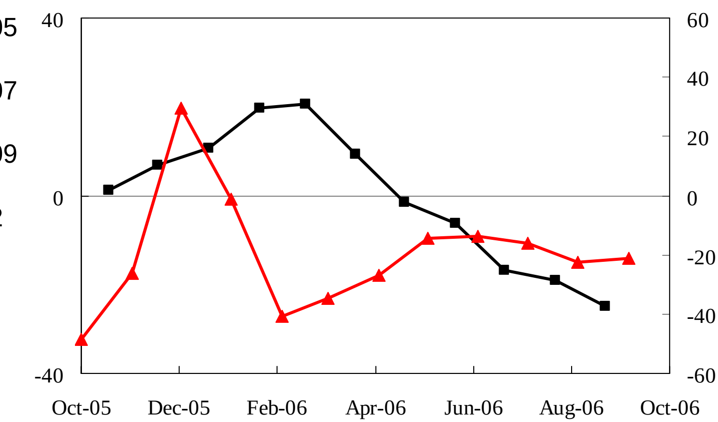




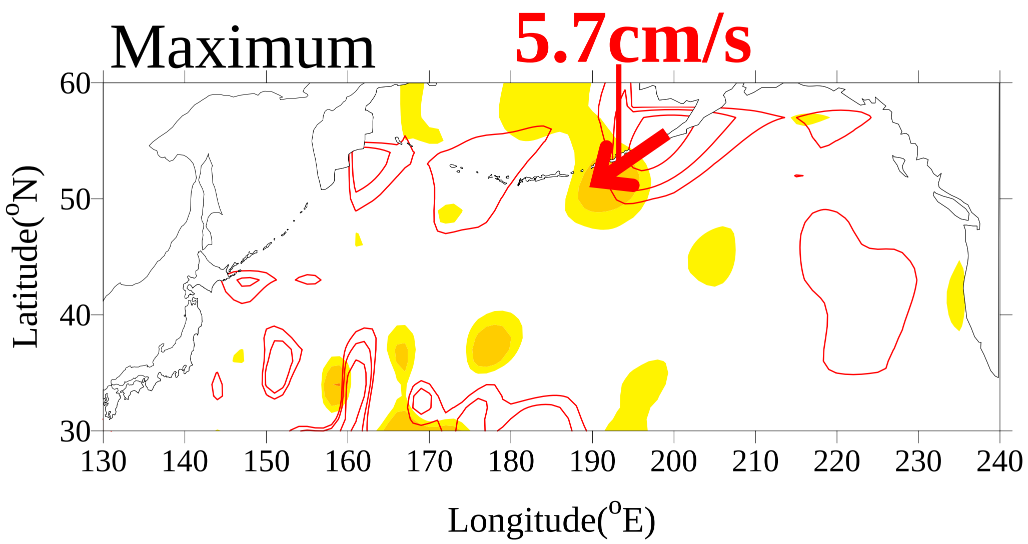
Sverdrup Transport



	Contribution
First	43%
Second	32%

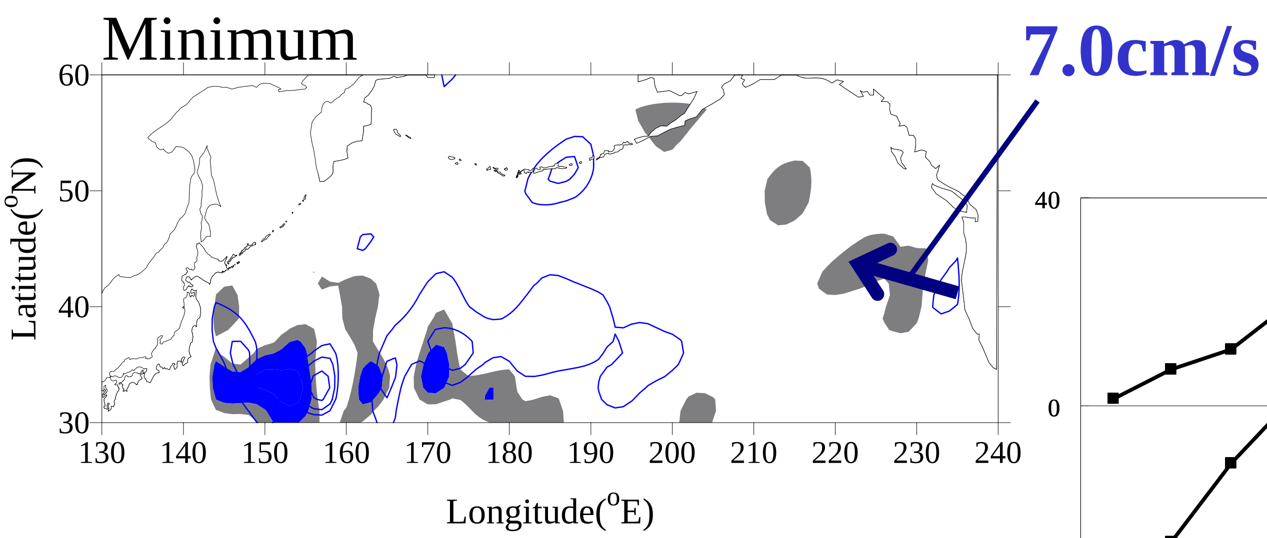


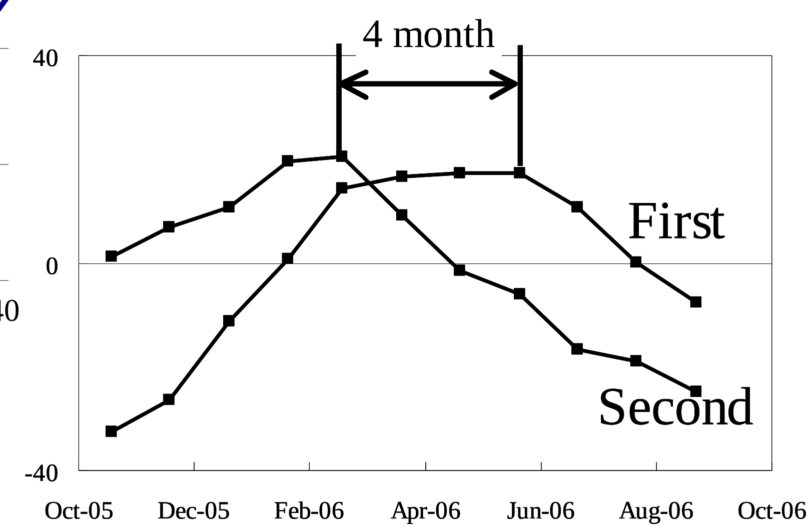
Maximum and Minimum amplitudes of EOF First and Second modes.



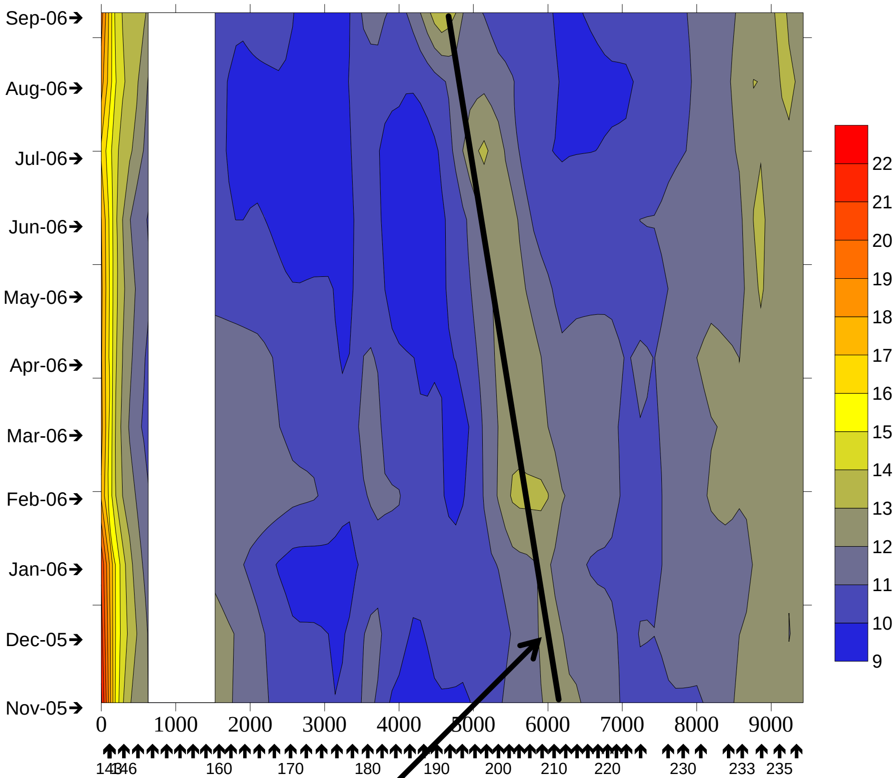
Shaded: First mode

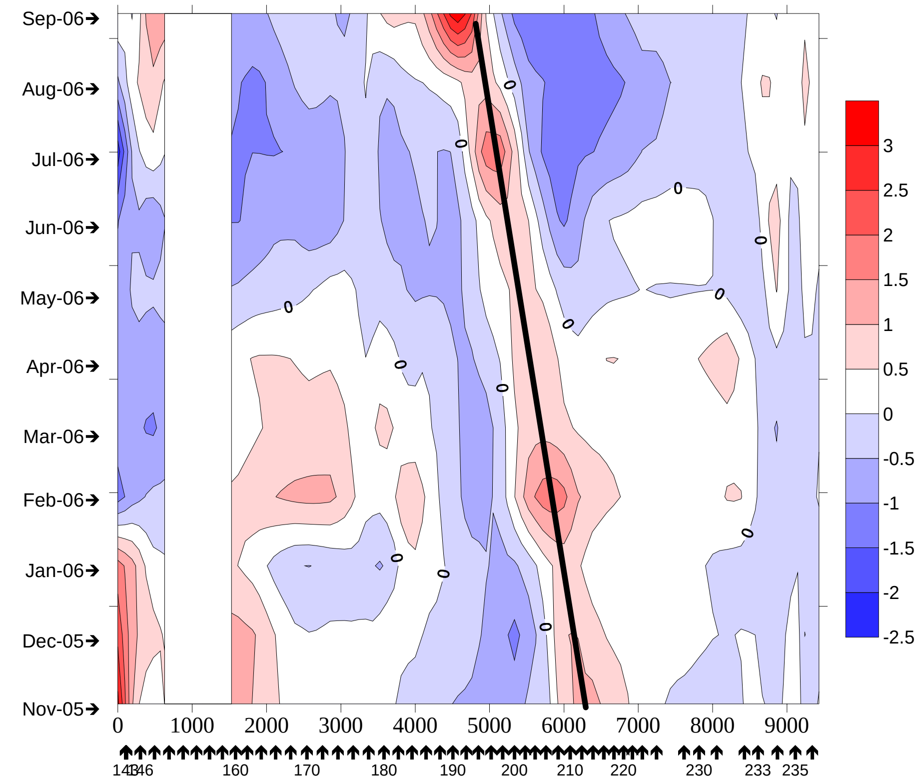
Contour : Second mode



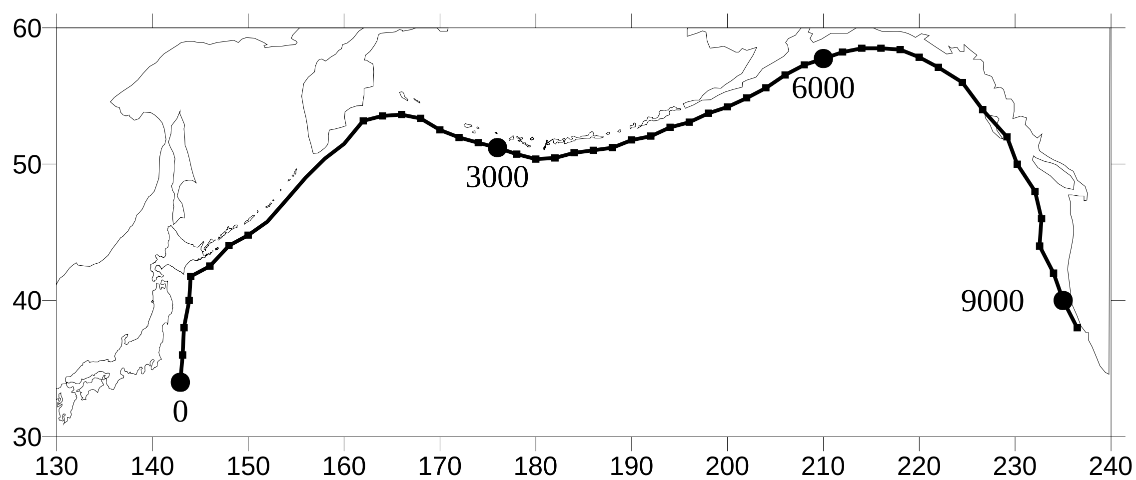


Time variation of Geopotential along the coast.

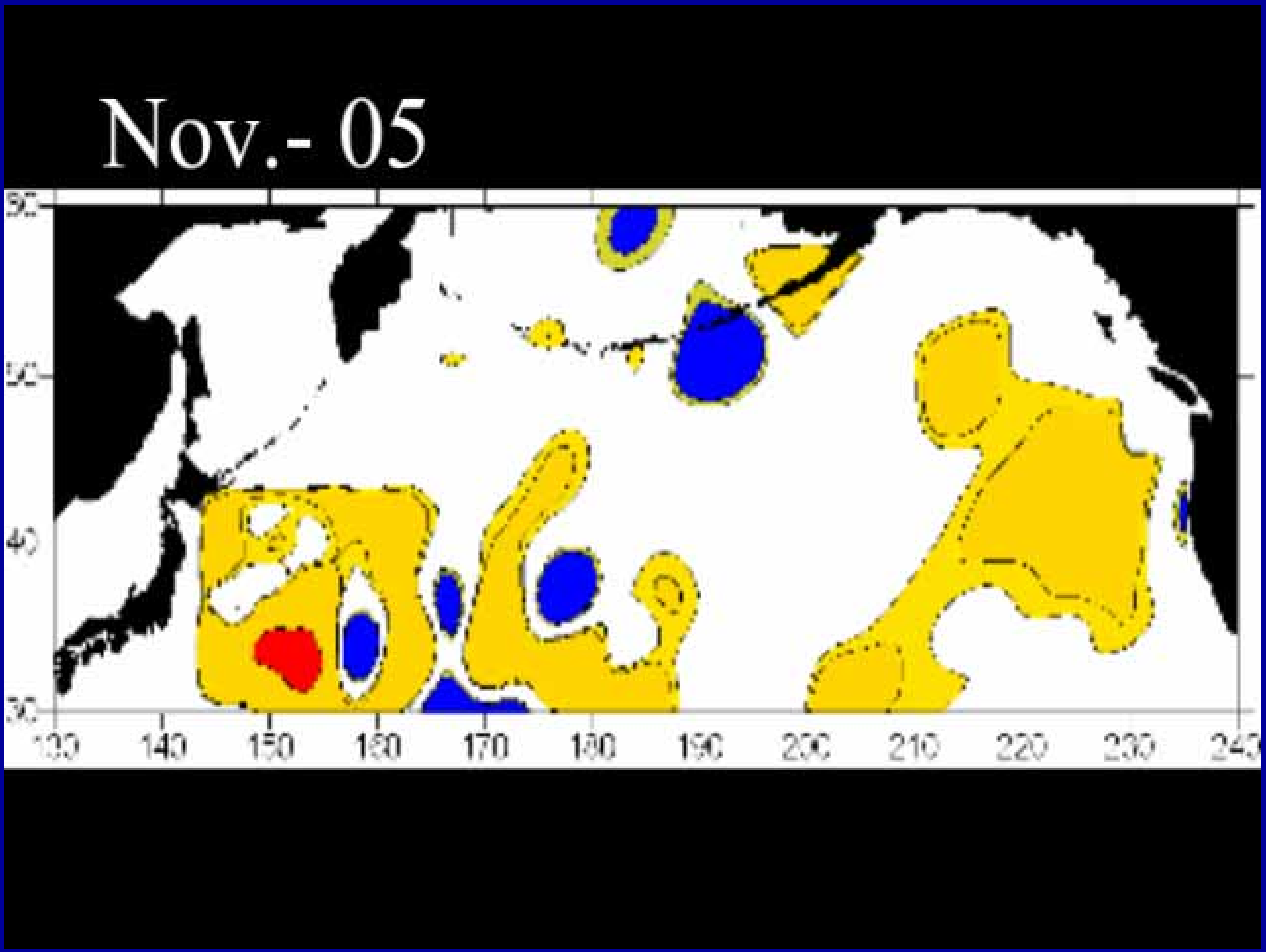




5.7cm/s



Time variation of composite First and Second modes



5.Summary

- Southern most latitude of the subarctic gyre estimated from geopotential did not change in the study period.

⇓

The latitude is the same as the mean zero wind stress curl.

⇓

The velocity at the 1000db is as small as 10% of the surface.

⇓

The surface subarctic gyre estimated from geopotential almost represent the mean barotropic gyre.

- 1 year signal is detected in the geopotential distribution.
  The amplitude is large on the coasts and the Kuroshio Front.