Eddy Variability from Direct Current Measurements in the Southwestern East/Japan Sea

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Kim et al. (2008)
Schematic Upper Circulation

TC: Tsushima Current
EKWC: East Korean Warm Current
NB: Nearshore Branch
LCC: Liman Cold Current
NKCC: North Korean Cold Current

W: Warm eddies
C: Cold eddies

Naganuma (1977)
Surface Eddy Kinetic Energy


$EKE = 200 \sim 600 \text{ cm}^2/\text{s}^2$; Lee & Niiler (2005)

EKE at 0 m & 100 m based on a two-year-long PIES data set during the period of June 1999 – June 2001
Eddies in the Ulleung Basin

Quasi-permanent eddies in the Ulleung Basin
- Ulleung Warm Eddy
- Dok Cold Eddy

*Shin et al. (2005); Mitchell et al. (2005)*

Mean geopotential height anomaly at surface relative to 500 dbar (Mitchell et al., 2005)

Surface signature (Chang et al., 2004)
The Ulleung Warm Eddy

Zonal sections of temperature, salinity, and geostrophic velocity

Shin et al. (2005)
Moored Current Meter Observation

Nov.2002 ~ Apr. 2004

Ulleungdo
Ulleung Basin
EC1
Dokdo

[Map showing the location and depth of the moored current meter observation sites]

- Argos-Beacon
- ADCP
- RCM-7
- RCM-8

EC1
37° 19.370' N,
131° 24.686' E

Weight

[Diagram showing the mooring setup and data collection intervals]

Looking upward
4-m intervals

153m
60 min

200m
30 min

360m
30 min

1000m
30 min

1360m
30 min

1690m
30 min

2240m
30 min
1. Gradual warming at 200 m from mid-Aug. to mid-Oct. (but a sharp T increase at 160 m) concomitant with the development of strong northwestward currents in the upper 200 m in Sept. & Oct. 2003, the core of which occurred at 152 m.

2. Development of thermostad during mid-Oct. and the end of Nov. with the weakening of currents

3. Sharp T decrease at 200 and more gradual cooling at 160 m between the end of Nov. and the end of Dec. with strong southward currents with max. speed at 40 m.

Currents and Temperature during Warm Event

(a) SST from NOAA-16
2003.10.30

(b) Currents and Temperature

- 153m
- 200m
- 360m

Month in 2003

(a)

(b)
## Mean Currents & EKE

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<th>Mooring depth (m)</th>
<th>Velocity comp. (cm/s)</th>
<th>Mean (cm/s)</th>
<th>SD (cm/s)</th>
<th>Vector (mean)</th>
<th>Mean speed (cm/s)</th>
<th>Max. speed (cm/s)</th>
<th>MKE (cm²/s²)</th>
<th>EKE (cm²/s²)</th>
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### Diagrams

- **(d)**: Mean speed (cm/s) with labels for record-length, first half, and second half.
- **(e)**: Eddy kinetic energy (cm²/s²) with three labels for different depth ranges.
Stream coordinate
100 m vs 360 m; Phillips & Rintoul (2000)

East-west comp.

North-south comp.

Along-stream dir.

Temperature

Along-stream currents

Cross-stream currents
Bimonthly Temperature Distribution at 200 m
Vertical Sections of Temperature

(a) Aug. 2003

(b) Oct. 2003

(c) Dec. 2003

(d) Feb. 2004
Translational speed of an eddy: $\sim 2.0 \text{ cm/s}$

Horizontal distance between $5^\circ$ isotherms at 200m: $\sim 123 \text{ km}$

Duration of $T > 5^\circ$ at 200 m: 71 days

$Ro = \frac{U}{fL} \sim 0.1$
High NIW energy at 360 m

NIW amplitude \( \left( \sqrt{u^2 + v^2} \right) \)

Generated by Typhoon Maemi
Summary

• A 16.5-month-long moored current observation between Nov. 2002 and Apr. 2004 captured a westward migrating anticyclonic warm eddy feature during the second half of the observation period.

• Eddy kinetic energy in the upper 200 m during the second half (~400 cm²/s² at 40 m) is about three to forty times higher than the EKE during the first half.

• An increase in the subsurface temperature was observed during this period down to at least 360 m. The temperature increased to about 6 °C at 160 m. Upper currents responded to the passage of the eddy, and an intensification of northwestward (> 51 cm/s) and southwestward (> 78 cm/s) upper currents occurred when EC1 was placed near the western and eastern periphery of the eddy feature.

• When EC1 was close to the center of the eddy, a thermostat developed and upper currents became weak. An amplification of the NIW energy occurred during this period.

• Fluctuations of upper and deep currents are poorly related.
Power spectra

First half (cold period)  Second half (warm period)

(a)  

Period (days)

(cm²/s²)

(b)  

Period (days)

(cm²/s²)

(f)  

Period (days)

(cm²/s²)

(g)  

Period (days)

(cm²/s²)