Disappearance of the East Korean Warm Current in the southwestern East/Japan Sea

1Kyung-Il Chang, 2Yoon-Bae Kim

1Korea Ocean Research & Development Institute
2Seoul National University

PICES/POC
Flow patterns of the Tsushima (Warm) Current

Branching view (since Suda and Hidaka, 1932; Katoh, 1994; Hase et al., 1999):
  First branch (Nearshore branch, NB)
  Second branch (Offshore branch, OB)
  Third branch (East Korean Warm Current, EKWC)

Meandering view (since Tanioka, 1968; Moriyasu, 1972)

* Mostly based on 100 m T and/or dynamic topography at upper depths

Fig. 1. Schematic maps of the path of the Tsushima Current in the Japan Sea, proposed by the views of triple-branch and single-meander-path, adapted from Naganuma (1973).
Surface EKE in the East/Japan Sea

(Lee et al., 2001)

Eddy kinetic energy calculated from (a) TP/ERS sea level anomaly and (b) drifter observations. Colors are eddy kinetic energy and contours are Bottom topography.
Variability of the EKWC

   Hong et al. (1984) - summer 1981
Eddy intrusion process in spring and summer: Isoda and Saitoh (1993)
Variability of upper circulation in August


Fig. 13. Examples of patterns of the bifurcation into the second and third branches of the Tsushima Current. The first branch is shown as a fixed pattern, since it is thought to be steady (Katoh, 1994). Broken parts of paths indicate intermittent or transient bifurcations. The hatched section shows the area occupied by cold water. Pattern A is different from pattern B as explained by the following point: The second branch is shown to be over the continental shelf in pattern A, while in offshore area with water depth below 200 m in pattern B.

Disappearance of the EKWC
Bi-monthly variation of basin-averaged $T_{100}$
Mean temperature at 100 m between June 1999 and June 2001
from D. Mitchell
Five flow patterns observed between June 1999 and June 2001

Mitchell et al. (2003)

Zonal amplification of the UWE between P1 & P2

Transition from P2 to P3
EKWC and UWE

No EKWC
Flow patterns and transport variation

Zonal amplification of the UWE between P1 & P2

Lyu et al. (2003)
SLD Anomaly (SLD - monthly mean SLD)
3-month Moving Average

SLDA (Sasebo - Urakawa)
SLDA (Moji - Pusan) after removing steric effects

Figure 6.3. Long-term time series of 3-month moving averaged sea level difference anomalies (SLDA) between Sasebo and Urakawa (green line) and Moji and Pusan (blue line). SLDA is given by subtracting monthly mean SLD from monthly SLD after low-pass filtering with a half-power period of 90 days to remove seasonal variations. Baroclinic parts, which are calculated from hydrographic data across the Korea Strait (Lyu and Kim, 2003), are removed from SLD between Moji and Pusan before calculating SLDA.

From Lyu (2003)
Variability of Undercurrent
EKWC meander develops and begins to pinch off.

UWE separates from the TC and EKWC disappears.

EKWC is re-established and wraps the UWE.
Disappearance of the EKWC: The Tsushima Current through the Korea Strait turns to the east downstream of the strait and flows northeastward along the west coast of Japan. Isolated UWE remains in the Ulleung Basin.

Continuous IES observation for two years: the disappearance occurred during June ~ November, 2000 after merging of cold eddy with coastal cold water.

Abnormally cold upper layer temperature ($T_{100}<5^\circ$) in the UB that occurred in 1981 and 2000 arises from the disappearance of the EKWC. The basin-averaged $T$ showed its minimum in August or October.

The duration of the disappearance: ~5 months, sub-annual scale