Journal of Marine Systems 115–116 (2013) 33–39

Contents lists available at SciVerse ScienceDirect

Journal of Marine Systems

journal homepage: www.elsevier.com/locate/jmarsys

Role of wind stress in causing maximum transport through the Korea Strait in autumn

Yang-Ki Cho [a], Gwang-Ho Seo [a,*], Chang-Sin Kim [a,b], Byoung-Ju Choi [c], Dinesh Chandra Shaha [d]

[a] School of Earth and Environmental Sciences/Research Institute of Oceanography, Seoul National University, Republic of Korea
[b] Department of Oceanography, Chonnam National University, Republic of Korea
[c] Department of Oceanography, Kunsan National University, Republic of Korea
[d] Department of Fisheries Management, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Bangladesh

ARTICLE INFO

Article history:
Received 1 August 2012
Received in revised form 11 December 2012
Accepted 5 February 2013
Available online 16 February 2013

Keywords:
Tsushima Current
Korea Strait
Transport
Seasonal variation
Wind stress
Ekman transport

ABSTRACT

Observations show that the maximum transport for the Tsushima Current (TC) through the Korea Strait occurs in autumn. For the TC, variation in transport changes the physical properties of the water as well as the distribution of nutrients, plankton, and other materials in the Japan/East Sea. Despite the importance of the TC, research is yet to unravel the cause of the maximum transport for the TC in autumn. In this study, observational data and numerical modeling data were analyzed in an effort to explore this phenomenon. The maximum transport through the Korea Strait was determined to be the result of the maximum onshore transport crossing the shelf break in the East China Sea (ECS); this transport is driven by strong northeasterly wind stress. Ekman transport driven by wind in the ECS is the primary cause of the maximum transport for the TC through the Korea Strait in autumn.

© 2013 Elsevier B.V. All rights reserved.

1. Introduction

Current systems and their variabilities are important to the marginal seas of the Northwest Pacific (NWP) Ocean because these systems are instrumental in distributing heat, salt, and other materials through the straits connecting the neighboring marginal seas (Cho and Kim, 2000; Moriyasu, 1972; Senjyu et al., 2006; Yanagi, 2002). The Tsushima Current (TC) flows into the Japan/East Sea (JES) through the Korea Strait (Fig. 1) and then flows out to the Pacific Ocean through the Tsugaru and the Soya straits (Moriyasu, 1972; Teague et al., 2003).

It is widely accepted that the TC has two sources (Cho et al., 2009; Guo et al., 2006; Isobe, 2008; Kim et al., 2005). One is a branch of the Kuroshio Current, southwest of Kyushu Island, Japan; this current flows onshore across the shelf break in the East China Sea (ECS) (Lie et al., 1998; Nitani, 1972; Uda, 1934). The other source is a continuation of the Taiwan Warm Current (TWC) that originates in the Taiwan Strait and enters the Korea Strait as the TC (Beardsley et al., 1985; Fang et al., 1991; Zhu et al., 2004). Cho et al. (2009) suggested that the volume transport in the Korea Strait is dominated by the Kuroshio Current in winter (83%) and by the TWC through the Taiwan Strait in summer (66%).

* Corresponding author at: School of Earth and Environmental Sciences, Seoul National University, 599 Gwanak-ro, Gwanak-gu, Seoul 151-742, Republic of Korea. Tel./fax: +82 2 880 6749.
E-mail address: seogwangho@gmail.com (G.-H. Seo).

0924-7963/$ – see front matter © 2013 Elsevier B.V. All rights reserved.
http://dx.doi.org/10.1016/j.jmarsys.2013.02.002

The hydrography in the Korea Strait exhibits strong seasonal variations attributed to the monsoon (Cho et al., 2009; Isobe, 2008). The maximum and minimum temperatures in the Korea Strait are observed in summer and winter, respectively, whereas the minimum and maximum salinities appear in summer and winter, respectively (Fig. 2). Fukudome et al. (2010) observed that transport through the Korea Strait is at a maximum in autumn and shows an asymmetric seasonal variation (Fig. 3), whereas the transport in the Taiwan Strait, one of the sources of the TC, reaches a maximum in summer and has a symmetric seasonal variation (Cho et al., 2009; Isobe, 2008; Jan et al., 2006). Little observational data are available to explain the seasonal variation in the onshore flow of the Kuroshio branch across the shelf break in the ECS, though several numerical experiments have been performed to examine the onshore flow of the Kuroshio (Guo et al., 2006; Lee and Matsuno, 2007; Yang et al., 2012). The transport variations in the Korea Strait may be affected by surface forcing such as wind stress, heat flux, atmospheric pressure, sea level difference, and river discharge. In contrast, temperature and salinity variations (Fig. 2) have little significant relationship with the seasonal variation in transport.

Despite the importance of transport variability in determining the physical properties of the water, in addition to the distribution of nutrients, plankton, and other materials in the JES, research has not yet provided any clear explanation for the occurrence of maximum transport in the TC in autumn and its asymmetric seasonal variation.

In this study, we propose the cause of the autumn maximum transport for the TC through the Korea Strait based on data analysis and

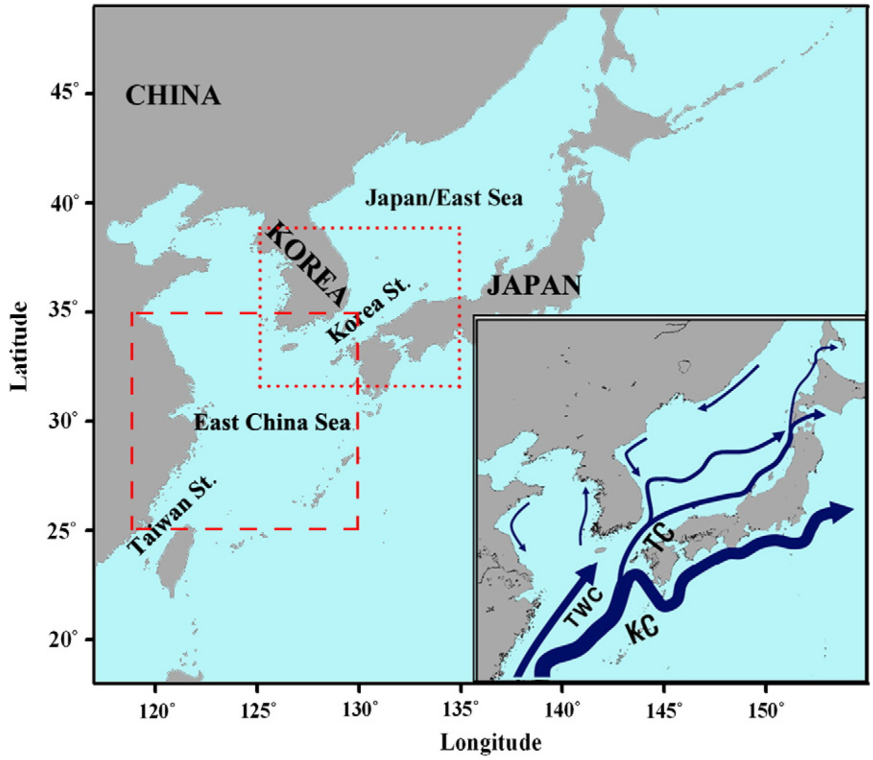

Fig. 1. The current system in the study area. KC, TWC, and TC represent the Kuroshio, Taiwan Warm Current, and Tsushima Current, respectively. Dashed and dotted boxes represent the areas from which the mean wind stress for the East China Sea and the Korea Strait were calculated, respectively.

numerical modeling. Numerical modeling successfully simulates the asymmetric seasonal variations in volume transport, with maximum transport for the Korea Strait observed in the autumn. Our modeling reveals the relationships between transport variations and seasonal wind fields in the ECS.

2. Data and numerical model

Hydrographic data in the Korea Strait were obtained from the World Ocean Atlas (WOA; www.nodc.noaa.gov). Fukudome et al. (2010) reported and analyzed the monthly mean transport through the Korea Strait from February 1997 to February 2007. Their volume transport data were derived from observations recorded by an acoustic Doppler current profiler (ADCP) mounted on a vessel that crossed the Korea Strait thrice in a week. Isobe (2008) calculated a sinusoidal variation in the transport based on all ADCP observations recorded in the Taiwan Strait. Wind data from February 1997 to February 2007 from the European Centre for Medium-Range Weather Forecasts (ECMWF) were analyzed.

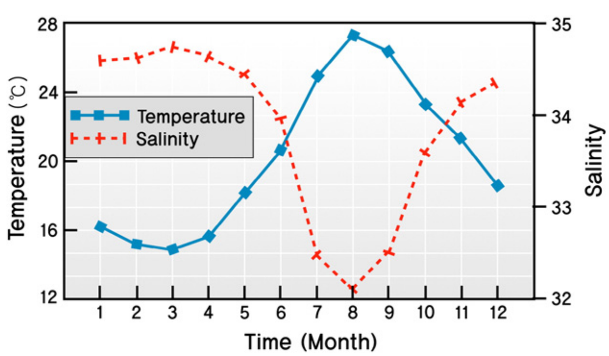

Fig. 2. Mean seasonal variation in temperature (solid line) and salinity (dashed line) in the Korea Strait. Temperature and salinity data for the Korea Strait were obtained from the World Ocean Atlas (WOA).

The model domain ranges from 18.5° N to 48.5° N in latitude and from 117.5° E to 154.5° E in longitude, and includes the ECS, Yellow Sea (YS), JES, and the northwestern region of the Pacific. The horizontal grid has a nominal resolution of 0.1° with 20 vertical sigma levels.

The open boundary data of the model were provided from a regional NWP model (Cho et al., 2009). The NWP model has a resolution of 0.25° and the domain ranges from 15° N to 53° N and from 115° E to 160° E. The NWP model is nested within a data assimilative global model known as Estimating the Circulation and Climate of the Ocean (ECCO; www.ecco-group.org).

The initial data for temperature, salinity, velocity, and sea surface height were obtained from the NWP model (Cho et al., 2009) from January 1996. The monthly mean data of the ECMWF reanalysis were used for the surface forcing, and bulk-flux formulae (Fairall et al., 1996) were used for the calculation of surface flux and wind stress.

Tidal forcing was applied along the open boundaries using 10 major tidal components in order to include the tidal mixing effect on sea surface temperature (Egbert and Erofeeva, 2002). Vertical mixing was calculated by the Mellor–Yamada turbulence closure scheme (Mellor and Yamada, 1974). Chapman, Flather, and clamped boundary conditions were used for free surface elevation, barotropic momentum, and baroclinic momentum, respectively (Marchesiello et al., 2001). The horizontal viscosity coefficient was set to 300 m^2/s. Further details on the model can be found in Cho et al. (2009).

A two-year spin-up run was performed using climatological monthly mean atmospheric forcing, which were obtained from monthly mean ECMWF reanalysis data from February 1997 to February 2007. The wind forcing was then changed in the third year. One simulation was performed with realistic wind and the other simulation without wind for one year. Wind speed was set to zero over the whole model domain for the no-wind simulation.

Given the uncertainty in the observed transports through the Korea Strait, the amplitude and phase of its seasonal variations were comparable in the simulation and observations (Fig. 4). A sinusoidal variation curve (dashed line) of transport through the Taiwan Strait was fitted

Download English Version:

https://daneshyari.com/en/article/4548117

Download Persian Version:

https://daneshyari.com/article/4548117

Daneshyari.com