Available online at www.sciencedirect.com
SCIENCE DIRECT®
Deep-Sea Research I 52 (2005) 1121–1137
DEEP-SEA RESEARCH PART I
www.elsevier.com/locate/dsr

Variations of the deep western boundary current in Wake Island Passage

Masaki Kawabe[a,*], Daigo Yanagimoto[a], Shoji Kitagawa[a], Yoshifumi Kuroda[b]

[a]*Ocean Research Institute, The University of Tokyo, 1-15-1 Minamidai, Nakano-ku, Tokyo 164-8639, Japan*
[b]*Japan Marine Science and Technology Center (currently Japan Agency for Marine-Earth Science and Technology), 2-15 Natsushima-cho, Yokosuka City, Kanagawa 237-0061, Japan*

Received 26 September 2003; received in revised form 12 November 2004; accepted 30 December 2004
Available online 25 April 2005

Abstract

Two moorings were deployed at 168°30′E (Sta. WPW) and 169°30′E (WPE) on 18°20′N in Wake Island Passage (WIP) to measure the velocity of the eastern branch of the deep western boundary current (DWBC) in the North Pacific. We obtained hourly velocity data from eight current meters located at depths of 3020, 4020, 5020, and 5120 m (near-bottom) at WPW and 2000, 4000, 5000, and 5300 m (near-bottom) at WPE, and analyzed daily mean velocity data for 374 days from 10 February 1999 to 18 February 2000. The velocity of the DWBC and its variations are large near the ocean floor, at depths of 5000 m and more. The DWBC at WPE increases exponentially with depth, with the near-bottom mean velocity being 3.5 cm s^{-1}, whereas the DWBC at WPW is almost uniform at the bottom layer with the mean velocity being 1.9 cm s^{-1}. The direction of the DWBC in WIP is dominant between 15 and 55°T with a mean of approximately 35°T. This orientation is due to the direction of the bottom topography around 5000-m depth. The velocity and its variations decay markedly at 4000 m, indicating the characteristics of the eastern branch current of the DWBC, which is formed primarily by the portion of the DWBC below 4500 m. A peculiar property is that the velocity and its variations of the DWBC are much less in the western part (WPW) than in the eastern part (WPE) of WIP. The presence of several seamounts may decrease the velocity and modify the structure of the DWBC in the western half of WIP. On the other hand, the eastern half of WIP is deep and has no significant seamounts, which may enable the DWBC to flow smoothly there. The volume transport of the DWBC in WIP is estimated to be 3.6 ± 1.3 Sv (10^6 m^3 s^{-1}) northward on average, with a range of −5.3–14.8 Sv, although the uncertainty of the mean value must be larger than 1.3 Sv because of the estimation from just two moorings. The mean volume transport of the eastern branch current of the DWBC is found to be a little more than 3.6 Sv by adding the transport in the passages west of WIP. The velocity and volume transport of the DWBC vary markedly with a period of approximately four months. A pause of the DWBC occurs in relation to the four-month variation. At WPW, the velocity and its variations at 4020 m are similar to those at 3020 m. The variations are sinusoidal with a four-month period, being almost out of phase with those at WPE. These

*Corresponding author. Fax: +81 3 5351 6418.
E-mail address: kawabe@ori.u-tokyo.ac.jp (M. Kawabe).

0967-0637/$ - see front matter © 2005 Elsevier Ltd. All rights reserved.
doi:10.1016/j.dsr.2004.12.009

are interpreted to be an eddy that may be propagated by Rossby waves and trapped in WIP. The four-month variations of the DWBC may be due to interaction with the eddy.
© 2005 Elsevier Ltd. All rights reserved.

Keywords: Wake Island Passage; Deep western boundary current; Moored current meters; Current velocity; Volume transport

1. Introduction

The deep western boundary current (DWBC) in the Pacific Ocean originates in the Southwest Pacific Basin near the Campbell Plateau and the Chatham Rise, separating from the Antarctic Circumpolar Current. It proceeds northward along the western edge of the Southwest, Central, and Northwest Pacific Basins, and eventually reaches the Northeast Pacific Basin by passing through the passages in the meridional seamount chains in the central North Pacific (Fig. 1) (Mantyla, 1975; Warren, 1981; Mantyla and Reid, 1983; Reid, 1997).

The DWBC in the South Pacific flows east of New Zealand and along the Tonga-Kermadec Ridge, and passes through the Samoan Passage at 10°S, 170°W, carrying the Lower Circumpolar Water (LCPW) that is characterized by salinity maximum and silica minimum, which are remnants of the North Atlantic Deep Water (Reid, 1986; Taft et al., 1991; Tsimplis et al., 1998). Except for the 19 Sv by Warren (1973), the geostrophic transport of the DWBC was estimated to range from 12 to 14 Sv ($10^6\,m^3\,s^{-1}$) by Warren and Voorhis (1970), Wunsch et al. (1983), Taft et al. (1991), Banks et al. (1995), Roemmich et al. (1996), and Tsimplis et al. (1998).

To the north of the Samoan Passage, the DWBC is divided into eastern and western branch currents, as inferred by Johnson and Toole (1993), Kawabe (1993), and Kawabe and Taira (1995). Kawabe et al. (2003) analyzed hydrographic data obtained at low latitudes in the North Pacific with a conductivity-temperature-depth-oxygen profiler ($CTDO_2$), and clarified the exact route of the branch currents; the eastern branch current passes through the Mid-Pacific Seamounts between 162°10′E and 170°10′E, not only in Wake Island Passage (WIP) around 18°N, 169°E but also in further western passages.

Johnson and Toole (1993) estimated that the geostrophic transports of the eastern and western branch currents at 10°N are 8.1 and 5.8 Sv, respectively. The former transport, however, was surmised to include a recirculation gyre of 4.7 Sv. When the recirculation component is removed, the geostrophic transport of the eastern branch current is reduced to 3.4 Sv. As a result, the total volume transport of the DWBC is estimated to be 9.2 Sv. This is the same as the total DWBC transport at 24°N estimated by calculating geostrophic transport below the isopycnal of $\sigma_4 = 45.885$ ($\theta = 1.06\,^{\circ}C$) between the Izu Ridge and 175°W with a least-squares inversion procedure (Roemmich and McCallister, 1989). The transpacific hydrographic date at 24°N gave geostrophic transport of 4.8 Sv for below the isotherm of $\theta = 1.05\,^{\circ}C$ in the central basin (Bryden et al., 1991), and 5.4 Sv for depths of 4800–5800 m between 160°E and 175°W (Roemmich et al., 1991). Considering the location, these values must indicate the volume transport of the eastern branch current of the DWBC. In terms of the western branch current of the DWBC, Kawabe et al. (2003) estimated that the volume transport is 4.1 Sv at the East Mariana Basin. Thus, most of the geostrophic calculations have shown the geostrophic transport with a small range of 12–14 Sv for the DWBC in the South Pacific, and around 9 Sv for the DWBC and 3–6 Sv for the respective branch currents in the tropical North Pacific.

However, the large variability in the volume transport of the DWBC has been pointed out by mooring observations. The volume transport of the DWBC at 32°S northeast of New Zealand has large variability: the transport is nearly zero or even southward occasionally (Whitworth et al., 1999). Rudnick (1997) showed that the volume transport in the Samoan Passage varies largely between 1.1 and 10.7 Sv with a mean of 6.0 Sv.

Download English Version:

https://daneshyari.com/en/article/9479775

Download Persian Version:

https://daneshyari.com/article/9479775

Daneshyari.com