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Velocity and transport of the Falkland Current at 46° S

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Abstract. The structure of the Falkland Current is studied on the basis of a CTD/LADCP and SADCP hydrographic section across the current carried out along 46°S in November 2016. In the upper 200 m, the maximum velocities based on LADCP reach 57 cm/s, and they are as high as 60 cm/s based on SADCP data. The current is directed to the northeast. At 1500 m the velocities decrease to 10 cm/s. The transport measured by LADCP is 30.9 Sv in the water column up to the bottom. The SADCP transport between 0 and 600 m is 20.7 Sv. It is shown that different means of estimating the velocities of the current result in close values.

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Introduction

The Falkland Current is one of the strongest currents in the Southwest Atlantic [*Gordon, Greengrove*, 1986]. This flow originates as a branch of the Antarctic Circumpolar Current (ACC), which flows around the Falkland Islands after passing the Drake Passage. Then it flows along the coast of South America. At a latitude of approximately 38°S, the Falkland Current separates from the continental slope zone and turns clockwise. Here, a confluence zone with the Brazil Current is formed with strong horizontal temperature and density gradients. After reorientation of the meridional velocity component of the Falkland Current from north to south, this flow is transformed into a SE-oriented countercurrent (Falkland Return Current) [*Legeckis, Gordon*, 1982]. Satellite images show that the Falkland Current is a relatively cold water band 70–100 km wide.

Observation Results

Our previous research was based on 140 hydrographic sections across the current carried out along 46°S during the period from 1982 to 1996 up to 1000 m depth and two CTD sections to the bottom in 2004 and 2005

[*Remeslo et al.*, 2004]. It was shown that the transport of the current correlates with the atmospheric pressure difference in the latitudinal zone 50°–60°S and it increases in April and September–October. An intensification of the current is accompanied by a water temperature increase in the bottom layer over the continental slope west of the current. A scheme of the Falkland and Brazil currents is shown in Figure 1.

In November 2016, we occupied a CTD/LADCP section across the current with simultaneous ADCP measurements from the R/V "Akademik Sergey Vavilov" using ship mounted SADCP Teledyne RD Instrument (TRDI) Ocean Surveyor – OS-75. This section is important for squid fishing in the region of the Southwest Atlantic and forecasting the resources of fishery.

The cores of the currents at mid-latitudes are well determined from the maximum temperature gradients at the ocean surface across the flow. The eastern boundary of the current is formed as a result of the interaction between cold waters of the current and warmer Subantarctic surface waters in the southwestern Argentine Basin. The thermohaline characteristics of its waters are identified with those of the Polar Frontal Zone [*Fedulov et al.*, 1990]. The core of the Falkland Current corresponds to the surface temperature minimum

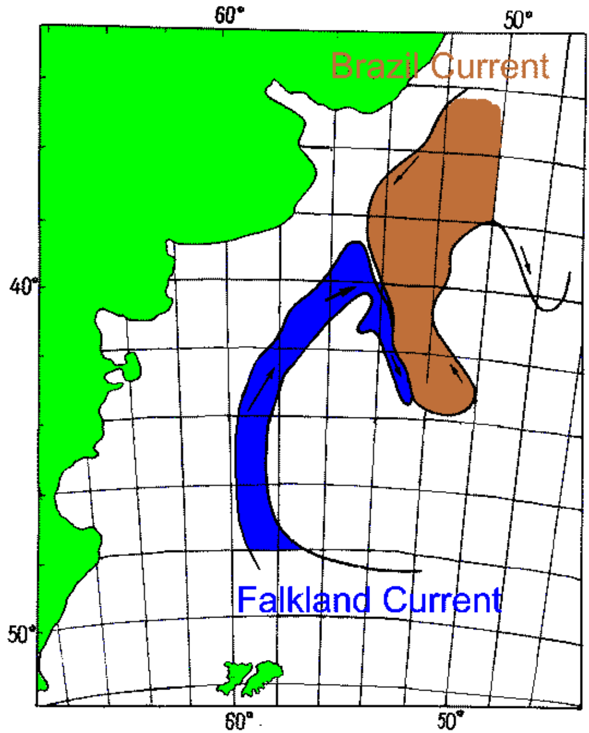

Figure 1. Scheme of the Falkland and Brazil currents and their confluence zone.

and the maximum temperature and density gradient at levels of 200–400 m. The maximum geostrophic velocities of the Falkland Current at 46°S are confined to the upper 200-meter layer where they reach 35 cm/s. At depths of 250–400 m, velocities decrease approximately by a factor of two [*Remeslo et al.*, 2004; *Matano et al.*, 1993].

In the previous research [*Remeslo et al.*, 2004], we calculated the geostrophic velocities and transports relative to the 800-dbar isobaric surface along the 46°S section. The calculations showed that the main water transport over the section occurs between 58°30'W and 60°00'W. The maximum monthly average transport is observed in August–October and April; the minimal transport, in November–February and May–July. The maximum geostrophic transport of currents along the section over the entire period of observations relative to 1000 m reference depth was recorded in April 1982 and was equal to 12.4 Sv (1 Sv $= 106$ m^3/s), while the minimal transport (3.4 Sv) in this month was recorded in 1987.

Our researches were continued in November 2004 and March 2005. Sections of eight CTD stations were occupied across the current at 46°S from 60°30'W to 57°30'W using a Sea-Bird 19 plus profiler. In 2016 we occupied a section across the Falkland Current from 58°00'W to 60°00'W using a Sea-Bird 19 plus profiler, Workhorse Sentinel 300 kHz LADCP, and ship mounted SADCP Teledyne Ocean Surveyor OS-75. We occupied three stations on this section with measurements to the bottom.

Direct measurements of velocity indicate that during the period of measurements the maximum velocities based on LADCP data were as high as 57 cm/s. At 1500 m the velocities decrease to 10 cm/s and the direction of the current becomes almost northerly. The location of the station occupied in the middle of the section (58°55'W) appeared approximately in the core of the current with maximum velocities. However, the maximum velocities measured by the ship mounted ADCP were at 58°44'W. The sections of velocity measured by different instruments are shown in Figure 2, Figure 3. and Figure 4.

Velocities based on the ship mounted ADCP at 58°44'W are as high as 60 cm/s. Similarly to the measurements using LADCP, the current is directed to the northeast. Vertical profiles of velocity in the core of the current with maximum velocities show that different means of estimating the velocities of the current result in close values (Figure 5).

The transport measured by LADCP is 30.9 Sv in the water column up to the bottom. Since reliable velocity data measured by ship mounted ADCP are collected in the layer not deeper than 600 m, the SADCP transport between 0 and 600 m is 20.7 Sv, which is smaller than

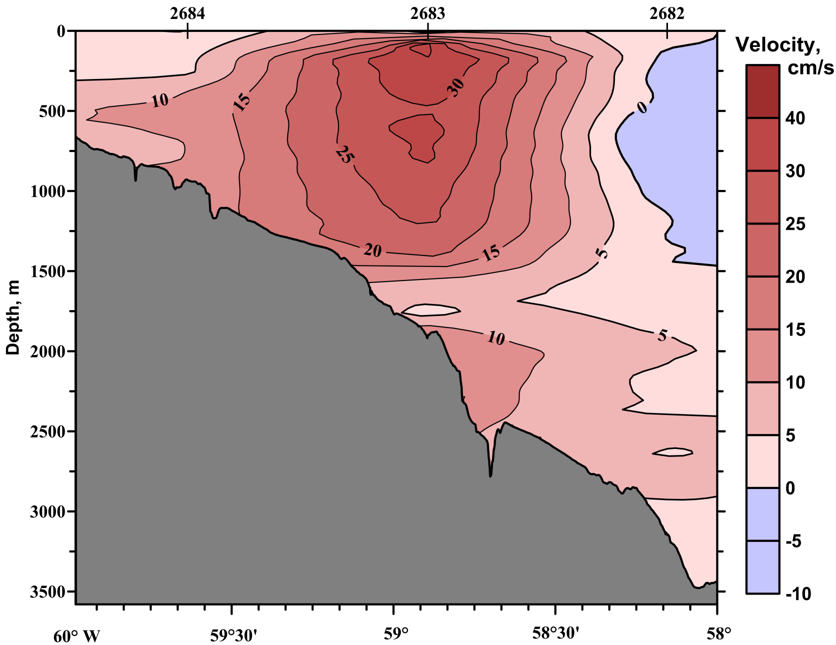

Figure 2. Meridional velocity section based on the lowered ADCP data. The gray color shows the ocean bottom.

in the entire water column. It is seen in Figure 3 and Figure 4 that the current exists below the level reached by the SADCP signal. However, SADCP data allow us to obtain a detailed pattern of the horizontal structure of the current.

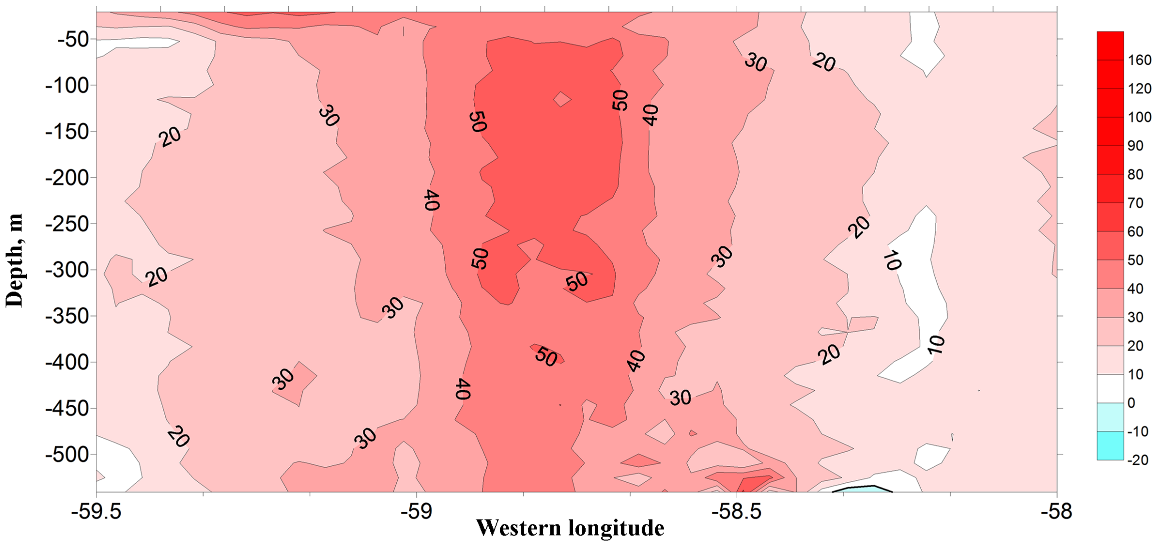

Figure 3. Meridional velocity section based on the ship mounted ADCP data.

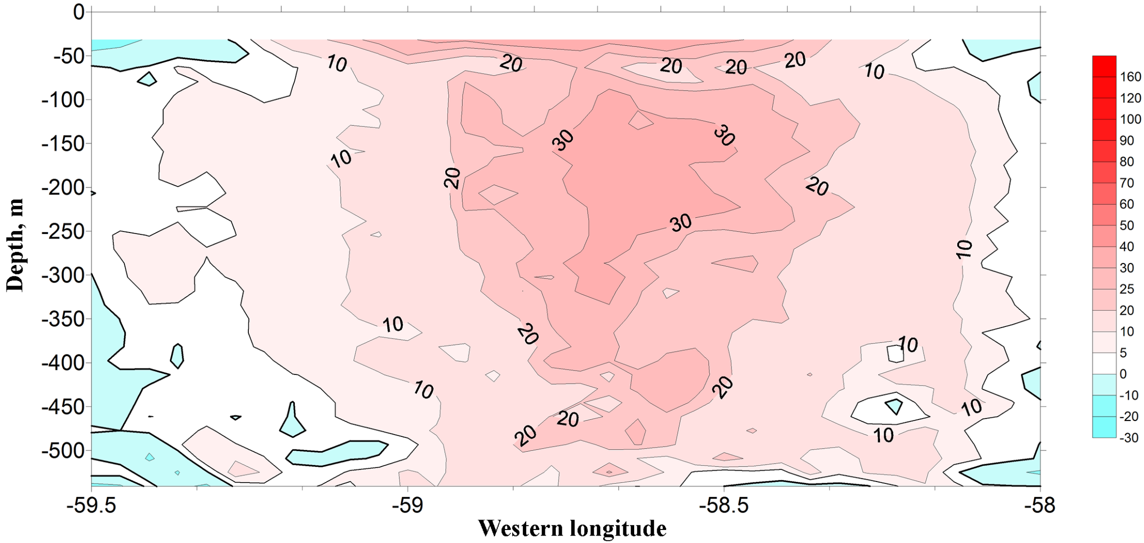

Figure 4. Zonal velocity section based on the ship mounted ADCP data.

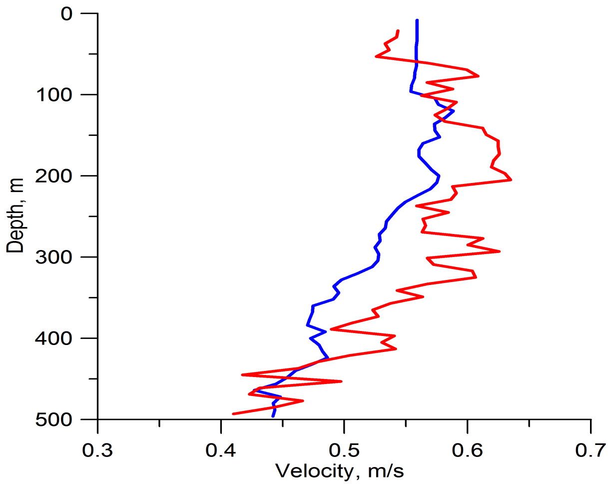

Figure 5. Vertical profiles of the absolute value of velocity (m/s) based on the LADCP data (blue) and SADCP data (red).

Conclusions

We estimated the structure of the Falkland Current at 46°S using direct measurements of velocity by the LADCP and SADCP instruments in November 2016. In the upper 200 m, the maximum velocities based on LADCP data reach 57 cm/s, and they are as high as 60 cm/s based on SADCP data. Both instruments indicate that the current in the upper layer is directed to the northeast, while in the deeper layers it becomes almost northerly. At 1500 m the velocities decrease to

10 cm/s. The transport measured by LADCP is 30.9 Sv in the water column up to the bottom. The SADCP transport between 0 and 600 m is 20.7 Sv.

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