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SURFACE CIRCULATION IN THE BELLINGSHAUSEN SEA ESTIMATED FROM SATELLITE-TRACKED DRIFTING BUOYS

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1. INTRODUCTION

The Bellingshausen Sea, located West of the Antarctic Penninsula, is a region whose circulation is still incompletely understood. More complete information on the surface and subsurface currents will clarify the nature of formation and the degree of interaction of Bellingshausen water with those of the South Pacific and the Drake Passage.

This report describes surface circulation in the central and eastern regions of the Bellingshausen Sea, using satellite-tracked, drifting buoys. These modern drifters offer oceanographers a new and powerful research tool that can be applied to circulation studies on a regional to global basis.

2. DATA AND METHODS

Two data sets were used. Positional data were selected for three drifting buoys, deployed in the central and eastern parts of the Bellingshausen in early 1979, as part of the First GARP Global Experiment (FGGE) (Garrett, 1980; Keeley and Taylor, 1981). The second data set was collected from two (ARGOS compatible) Brazilian drifting buoys, tracked during January-April 1986/87, as part of the Vth Brazilian Antarctic Expedition.

Positional data for the FGGE drifters were available about two times per day, compared to 10-12 times per day, for the Brazilian buoy data. Brazilian buoy data were decimated in frequency to twice a day, to correspond to the FGGE data. Positional data for FGGE data were given to the nearest 0.01° latitude (1.1 km), while positional data for the Brazilian buoys were provide by Service ARGOS to the nearest 0.001° latitude (111 m).

Each trajectory was divided into 10-day periods, for which mean meridional and zonal velocities were calculated, using the linear regression method. The goodness of fit parameter (r^2) (Davis, 1973) was used for each of these time periods to determine the percentage of variation attributable to uniform (mean) motion. The remaining percentage was assumed to be largely due to eddy-like motion. It was also assumed that the surface circulation in the Bellingshausen was in general similar for the two austral summers, 8 years apart.

3. RESULTS AND CONCLUSIONS

Due to limited space, the results and conclusions are summarized as follows:

1. Surface currents calculated for January-February averaged 11 cm s^{-1} toward 112° in the region bounded by 64° 30'-67°S and 90°-75°W. As the current moved eastward, its speed decreased and averaged 4 cm s^{-1} toward 123° in the region of 64° 30'-68°S by 80°-71°W, during the same period of time. For the interval of January-April, in the region of 66°-69°S by 77°-74°W, the surface advection was only about 1 cm s^{-1} toward 160°. In the region 63° 30'-64°S by 66°-64°W, 100 km from the coast, during January-February (8 years later), the speed averaged 2 cm s^{-1} toward 134°. Within 50 km of the west coast of the Antarctic Penninsula, a coastal current averaged 4 cm s^{-1} toward 183°, from January through 15 April. The general large scale circulation of this gyre is clockwise, as variously noted in the literature (e.g., Gordon, 1971).

2. Statistical examination of 10-day intervals for the 5 trajectories showed the highest average speed (27 cm s^{-1}) occurring in the central part of the Bellingshausen. In moving from the central to eastern part of the Sea, average velocities ⩾ 15 cm s^{-1} decreased from 54% of the time to 25% of the time. Within 100 km of the Penninsula, mean velocities were equal/greater 10 cm s^{-1} 17% of the time and increased to 30% of the time, within the coastal current. Previously published results, using FGGE drifters for 5 degree grid spacing, shows the mean surface flow near 65°S, 70°-90°W to be eastward at 10-15 cm s^{-1} (Patterson, 1985).

3. Using the goodness of fit parameter (r^2) for the 10-day periods, it was found that the percentage of the total meridional flow attributable to uniform (mean) advection was 64% in the central part of the Sea, with eddy-like motion present within the remaining 36% of the variation. The percentage of uniform flow decreased progressively to only 39% about 100 km West of the Penninsula. Within the coastal current, the percentage for uniform advection increased to 42%. By comparison, in the Central part of the Sea, mean zonal flow accounted for 50% of the total zonal advection and subsequently increased to 67% within 100 km of

the Penninsula. Within the eastern boundary current, the mean zonal flow accounted for 60% of the total variation in zonal flow. Knowledge about the contribution of mean and eddy-like flows to the overall circulation is important in a general understanding of the dominant physical processes at work in the formation and advection of water masses in the region.

4. It has been shown that there is an eastward flow across the central and eastern parts of the Bellingshausen Sea near 64°-65°S. There is strong evidence that this zonal flow becomes southerly in proximity to the Penninsula and merges with or forms the coastal current. Some of this zonal flow, however, may turn northward near the coast and enter the Strait of Bransfield. Results from the 1985 and 1986 Brazilian drifter experiments (Stevenson et al, 1989a, 1989b) and earlier hydrographic work conducted in the Strait (Ikeda et al, 1986), show that there is a northeast flow into the Strait, at least part of the time. It is reasonable then, to conclude that there is a divergence or bifurcation in this eastward flowing current, with some of the water turning northward and into the Strait; the rest of the transport turns southward and becomes the eastern boundary current. We estimate that this bifurcation occurs North of 63° 30'S, because South of this latitude, the nearshore water is already flowing southward. Further studies in this region will better determine the location and character of this bifurcation, South of the Bransfield Strait.

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