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Transport and structure of the Weddell Gyre

E. Fahrbach, G. Rohardt, M. Schröder, V. Strass

Alfred-Wegener-Institut für Polar- und Meeresforschung, Postfach 120161, D-27515 Bremerhaven, Germany

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Abstract. A cyclonic gyre controls the advection of source waters into the formation areas of bottom water in the southern and western parts of the Weddell Sea and the subsequent transport of modified water masses to the north. Determination of the structure of the Weddell Gyre and of the associated transports was one of the objectives of the "Weddell Gyre Study" which began in September 1989 and ended in January 1993. The collected data set comprises records of moored current meters and profiles of temperature and salinity distributed along a transect between the northern tip of the Antarctic Peninsula and Kapp Norvegia. The circulation pattern on the transect is dominated by stable boundary currents of several hundred kilometers width at the eastern and western sides of the basin. They are of comparable size on both sides and provide nearly 90% of the volume transport of the gyre which amounts to 29.5 Sv. In the interior, a weak anticyclonic cell of 800 km diameter transports less than 4 Sv. Apart from the continental slopes, the near-bottom currents flow at some locations in an opposite direction to those in the water column above, indicating a significant baroclinic component of the current field. The intensity of the boundary currents is subject to seasonal fluctuations, whereas in the interior, time scales from days to weeks dominate. The large-scale circulation pattern is persistent during the years 1989 to 1991. The heat transport into the southern Weddell Sea is estimated to be 3.48×10^{13} W. This implies an equivalent heat loss through the sea surface of 19 W m^{-2}, as an average value for the area south of the transect. The derived salt transport is not significantly different from zero; consequently, the salt gain by sea ice formation has to compensate almost entirely the fresh water gain from the melting ice shelves and from precipitation. Estimation of water mass formation rates from the thermohaline differences of the inflow and outflow through the transect indicates that 6.0 Sv of Warm Deep Water are transformed into 2.6 Sv of Weddell Sea Bottom Water, into 1.2 Sv of Weddell Sea Deep Water, and into 2.2 Sv of surface water.

Correspondence to: E. Fahrbach

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