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Deep and bottom water formation in the western Weddell Sea - results from hydrographic and tracer observations

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Deep and bottom water formation in the Weddell Sea, particularly formation rates, locations, involved processes, and exit pathways, are still under consideration. During Ice Station POLarstern (ISPOL, Polarstern cruise ANT XXII/2, 2004/2005) hydrographic, noble gas, and chlorofluorocarbon (CFC) measurements were obtained while drifting in the western Weddell Sea along the slope of the Antarctic Peninsula.

From our observations we found Weddell Sea Bottom Water, which contains significant contributions of glacial melt water in its upper, and High Salinity Shelf Water in its lower layer. The formation of this recently ventilated bottom water can not be related to the known sources in the southern Weddell Sea, the Filchner-Ronne Ice Shelf. There is clear evidence that this bottom water is formed in the western Weddell Sea, most likely in interaction with the Larsen C Ice Shelf. We estimated fractions of glacial melt water of more than 0.1% in the bottom water by applying an Optimum Multiparameter analysis (OMP) using temperature, salinity, helium isotopes, and neon. On sections further north across the Weddell Gyre melt water fractions were still in the order of 0.04%.

We deduced mean transit times between the western source and the bottom water found on the slope toward the north (9 year), and between the southern source and the bottom water off the slope in the inner basin (22 years) using chlorofluorocarbons (CFCs) as age tracers. These transit times are larger and the inferred transport rates smaller compared to previous findings. But accounting for a loss of bottom water due

to upwelling and renewal of Weddell Sea Deep Water, initial formation rates of 1.1 +/- 0.5 Sv in the western Weddell Sea and 3.9 +/- 1.2 Sv in the southern Weddell Sea are plausible. From these numbers we inferred basal melt rates of 35 Gt/year at the Larsen Ice Shelf and 123 Gt/year at the Filchner-Ronne Ice Shelf.

The bottom water formed partly due to ice shelf interaction in the western Weddell Sea is shallow enough to leave the basin trough gaps in the South Scotia Ridge and contribute to Antarctic Bottom Water (AABW) spreading northwards. These findings emphasize the role of the western Weddell Sea in AABW formation, particularly in view of changing environmental conditions due to climate variability, e.g., enhanced melting of ice shelves or their disintegration.