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Glacial/Interglacial changes of southwest Pacific intermediate- and deep-water circulation over the last 350,000 years

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On glacial/interglacial timescales, Southern Ocean air-sea gas exchange is considered to be an important factor, driving the variability of atmospheric CO_2 concentrations. To understand the role of oceanic variability in the global carbon cycle, it is necessary to reconstruct changes in deep- and intermediate-water circulation and chemistry of Southern Ocean water masses. In this context, our study aims on the reconstruction of glacial/interglacial changes in the vertical expansion of southwest Pacific Antarctic Intermediate Water. For our study, we compared isotope records (δ13C and δ18O) measured on the epibenthic foraminifera Cibicidoides wuellerstorfi from the Antarctic Intermediate Water and the Upper Circumpolar Deep Water (943 – 2066 m water depth) off New Zealand. We used two sediment cores from the Tasman Sea (MD06-2990 and MD06-2986), retrieved during R/V Marion Dufresne cruise MD152, and three sediment cores from the Bounty Trough east of New Zealand (MD97-2120, SO 213-82-1 and SO 213-84-1). Comparing these records, we can monitor changes in southwest Pacific water mass circulation over the past 350,000 years. Over this time period, we record a significant shoaling of the boundary between Antarctic Intermediate Water and Upper Circumpolar Deep Water during all glacial stages. We propose that freshwater input by melting sea ice into the glacial intermediate-water increased the buoyancy difference to underlying deep-waters, thus hampering the downward expansion of southwest Pacific Antarctic Intermediate Water during glacials. This interpretation is consistent with our modeling results, based on the Community Climate System model version 3, which also indicate a shoaling of glacial intermediate waters due to the input of meltwater. The glacial upward displacement of the water mass boundary significantly increased the vertical extent of circumpolar deep-waters, consequently extending the volume of the proposed glacial deep-water carbon pool.