"Changes in Antarctic Circumpolar Current deep and bottom waters from a 23-year time series"

The Antarctic Circumpolar Current (ACC) is a crucial site for the formation and transformation of water masses, including the Antarctic Bottom Water (AABW) that fills the global abyssal ocean. Widespread warming and freshening of Southern Ocean deep and bottom waters detected using decadal repeat hydrographic sections (e.g. Purkey and Johnson, 2013, J. Clim.; Desbruyeres et al., 2017, J. Clim.) prefigure global changes in abyssal heat and salinity, but the spatiotemporal variability of the ACC leaves large uncertainties on the magnitude and drivers of these changes. Here we examine 22 occupations of GO-SHIP line SR1b in eastern Drake Passage conducted near-annually since 1993. Using a neutral density framework to decompose changes into components due to isopycnal displacement (heave) and to isopycnal property changes distinguishes a significant isopycnal cooling trend from the additional cooling, and substantial year-to-year variability, due to movements of the ACC fronts. The isopycnal cooling and freshening is found throughout the Antarctic Bottom Water (AABW) density class as well as much of the Lower Circumpolar Deep Water (LCDW) range, while warming and salinification characterises Upper Circumpolar Deep Water (UCDW). An analysis of volume changes in thermohaline coordinates is used to distinguish the origins of these contrasting trends.