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Trends and variability in Antarctic Circumpolar Current properties and transports

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The Antarctic Circumpolar Current (ACC) is a crucial site for the formation and transformation of water masses; widespread warming and freshening of Southern Ocean 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 deep ocean heat and salinity, but the spatiotemporal variability of the ACC leaves large uncertainties on the magnitude and drivers of these trends. Changes in properties and transports of ACC water masses are examined using a 26-year time series consisting of 24 occupations of GO-SHIP hydrographic line SR1b in eastern Drake Passage. 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 and freshening in both the Antarctic Bottom Water (AABW) and Lower Circumpolar Deep Water (LCDW) density classes, while Upper Circumpolar Deep Water (UCDW), in contrast, warms and salinifies. For Antarctic Intermediate Water (AAIW) the net effect of isopycnal and heave-driven changes is warming and freshening. The trends in average properties are associated with intensification of the temperature maximum characteristic of UCDW and weakening of both LCDW and AAIW salinity minima. The origins of these changes, as well as cruise-to-cruise variability, are examined in terms of both boundary fluxes and interior transformations. Salt transport by the ACC, meanwhile, is decreasing on average, with the AAIW density range providing the only exception; the implications of these trends for the Atlantic freshwater budget are discussed.