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Three-dimensional structure of a standing meander in the Antarctic Circumpolar Current

Jan Jaap Meijer (1,2), Helen E. Phillips (1,2), Stephen R. Rintoul (3,4,5), Nathaniel L. Bindoff (1,2,3)

(1) Institute for Marine and Antarctic Studies, University of Tasmania, Hobart, Tasmania, Australia, (2) ARC Centre of Excellence in Climate Extremes, Hobart, Tasmania, Australia, (3) CSIRO Oceans and Atmosphere Flagship, Hobart, Tasmania, Australia, (4) Antarctic Climate and Ecosystems Cooperative Research Centre, University of Tasmania, Hobart, Tasmania, Australia, (5) Centre for Southern Hemisphere Ocean Research, Hobart, Tasmania, Australia

Most theories of the Southern Ocean and more specifically the Antarctic Circumpolar Current (ACC) are based on zonally symmetric models that lack information about the complexity of the ACC's frontal structure and the presence of several significant topographic obstructions to the flow. When the current interacts with strong topography standing meanders, or stationary Rossby waves, can occur. Standing meanders steepen in response to a stronger current as a result of increasing wind stress upstream that steepen the isopycnals. This leads to instabilities in the flow generating more eddies, that flatten the isopycnals, slow down the ACC and lead to stronger poleward heat fluxes. This has implications for warming of the waters around Antarctica, leading to melting of sea ice and basal melt of ice shelves. We surveyed a standing meander in the Subantarctic Front downstream of the Southeast Indian Ridge with 11 cross-frontal transects, comprising 99 CTD profiles to ~ 1500 dbar, to examine the alongstream change of watermass properties in the upper ocean. We describe the change in properties relative to gravest empirical mode (GEM) mean fields of temperature and salinity. Over the ridge and upstream of the meander, streamlines converge speeding up the flow and merging inter-frontal zones. Into the trough, warm and salty anomalies relative to the GEM mean field are shown in the intermediate waters ($\gamma_n < 27.6$ kgm^{-3}) and cold and fresh anomalies in the upper deep waters ($27.2 < \gamma_n < 27.8$). In between the trough and the crest, the flow is decelerated allowing for mixing of the frontal zones, which leads into the trough to warmer and saltier anomalies over the water column down to ~ 1500 dbar. The meridional gradient in the temperature suggests a net poleward heat transport, also referred to as 'eddy stirring', and explains the warm anomalies in the upper water column in both the trough and the crest of the meander. The cyclonic rotation of the trough suggests upwelling, according to the 'eddy pump' mechanism, and explains the cold anomaly in the lower water column, whereas the anticyclonic rotation suggests downwelling and explains the warm anomaly in the lower water column of the crest.