

OBSERVED SUBSURFACE WARMING & SOUTHERN OCEAN SEA LEVEL RISE

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Satellite altimetry data show a strong increase in sea level in various parts of the Southern Ocean over the 1990s. In this paper we examine the causes of the observed sea level rise in the region south of Australia, using 13 years of repeat hydrographic data from the WOCE-SR3 sections, and the SURVOSTRAL XBT and surface salinity data. The hydrographic data show a **poleward shift in the position of the Subtropical and the Subantarctic Fronts** over the period. In the Antarctic Zone, the Antarctic Surface Water has become warmer and fresher, and the Winter Water tongue has become warmer, fresher, thinner and shallower. **Increased freshening south of the Polar Front is linked to increased precipitation over the 1990s.** Temperature changes over the upper 500 m account for only part of the altimetric sea level rise. The CTD sections show that the **deeper layers are also warmer and slightly saltier** and the **observed sea level can be explained by steric expansion over the upper 2000 m.** ENSO variability impacts on the northern part of the section, and a simple Sverdrup transport model shows how large-scale changes in the wind-forcing, related to the Southern Annular Mode, may contribute to the deeper warming to the south.

Fig. Mean XBT temperature structure over 0-500 m depth averaged over the summertime SURVOSTRAL sections for the period a) 1992-1996, b) 2000-2004 and c) the temperature difference between these two mean summer periods. The SAZ and AZ are delimited by the vertical black lines. The position of the STF and SAF are marked.

