OCCI Research Award: Final Report
Closing the North Atlantic Meridional Overturning Circulation: Mixing in the Southern Oceans

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The Ocean and Climate Change Institute (OCCI) Research Award was used to support an initial study into the spatial variability of mixing in the Southern Ocean and the adjacent South Atlantic, Indian and Pacific Oceans. Funds supporting the OCCI research objectives are gratefully acknowledged.

This study investigated the potential for mixing in the Southern Ocean. Techniques suggested by Kurt Polzin (WHOI, Physical Oceanography) were applied to WOCE CTD profiles in the Southern Ocean and subtropical Atlantic, Indian and Pacific Oceans (Fig. 1). Hydrographic data (temperature, salinity and pressure) were used to estimate the stretching or squashing of different water masses (i.e. North Atlantic Deep Water and Antarctic Bottom Water) along the given sections. The variability of this water mass stretching or squashing can be related to mixing - providing order of magnitude estimates of mixing.

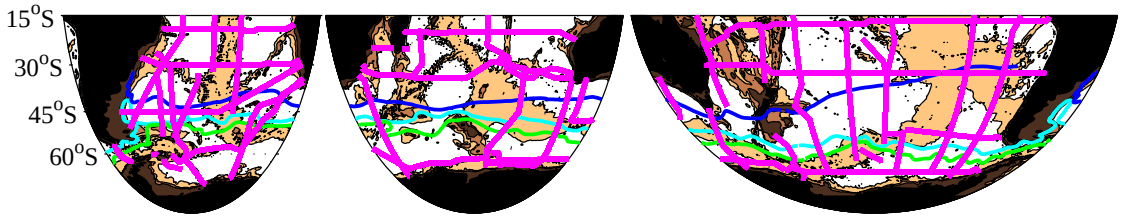

Figure 1: Map of the southern oceans WOCE 2 dbar CTD sections from which order of magnitude estimates of mixing have been calculated. The major frontal features of the Southern Ocean are also shown - Subtropical Front (blue), Subantarctic Front (light blue) and Polar Front (green). Topography above 4000 m is shaded.

A comparison of order of magnitude estimates of mixing from these hydrographic sections provides an indication of the size and spatial variability of mixing in the southern hemisphere oceans (Fig. 2). The hydrographic data in the Atlantic sector of the Southern Ocean, which from south to north occupies stations in the Weddell Sea, over the Scotia Ridge and the Argentine basin, indicates the large variability of mixing within this region. Intense mixing is found above the Scotia Ridge and in the Weddell basin, while north of the ridge in the Argentine Basin mixing is reduced. The meridional sections in the Indian and Pacific Ocean are at approximately 32°S . Both of these section shown higher mixing rates above topographic features and within the abyssal basin. Note that mixing 1000 m from the bottom in the deep basins is markedly reduced over mixing values close to the bottom, although the 32°S Pacific section shows a band of elevated mixing near 2000 m.

This initial study does suggest that mixing in the Southern Ocean is spatial non-uniform and potentially large in certain regions. Intense mixing is found over rough topography and associated with the Antarctic Circumpolar Current as it passes over topographic features. The results of this study provide a basic map of mixing variability in the Southern Ocean and will help to identify regions that may warrant further study.

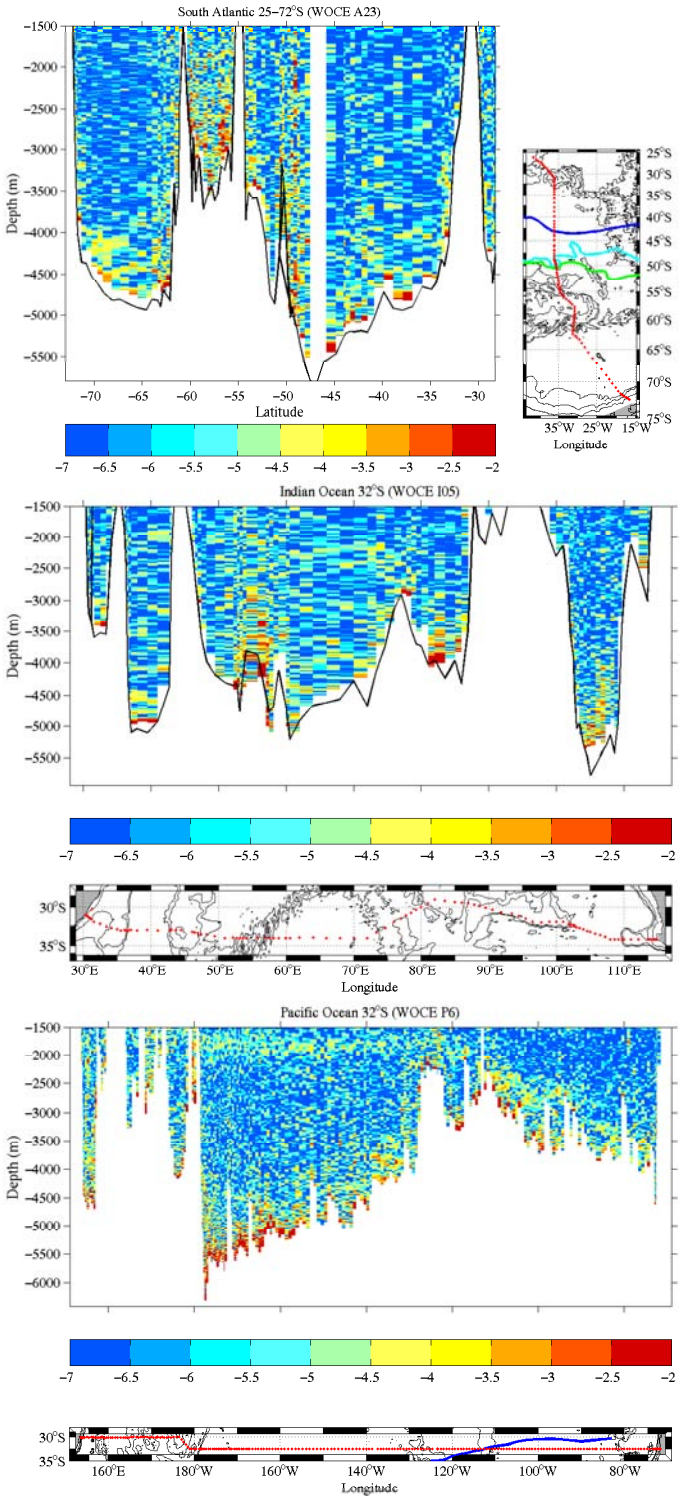

Figure 2: Order of magnitude estimates and spatial variability of mixing ($m^2\ s^{-1}$) in the southern oceans. Color scale is base $\log_{10}$. (Top) In the Atlantic sector of the Southern Ocean. (Middle) A meridional section across the Indian Ocean. (Bottom) A section across the Pacific Ocean. Section position in relation to topography and Southern Ocean frontal features is shown right of or below the mixing distribution, respectively.