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Decadal variations of the South Tropical Countercurrent and Eddy Kinetic Energy in the South Pacific

Jan Klaus Rieck, Claus W. Böning, and Richard J. Greatbatch
GEOMAR Helmholtz Centre for Ocean Research Kiel, FB1, Kiel, Germany (jrieck@geomar.de)

A series of eddying global ocean-sea ice models is used to assess the low-frequency variability of Eddy Kinetic Energy in the world ocean. The models with horizontal resolutions ranging from 1/4°-1/12° are driven by the atmospheric CORE.v2 forcing for a period of 1958-2009. A region located between 25°-33°S and 153°-175°W stands out globally, having a high variance of EKE, relative to the mean EKE, at decadal timescales.

This region is characterized by the shallow, eastward South Tropical Countercurrent (STCC). The STCC, restricted to the upper 200m, forms a vertically sheared current system with the westward South Equatorial Current (SEC) below. While there are only minor changes to the SEC on decadal timescales, velocities of the STCC vary with a magnitude of >50% of the mean. The induced variations in vertical shear (du/dz) are at a maximum during the 1970s, followed by a minimum from the mid 1980s to mid 1990s and a subsequent increase. Decadal EKE changes are driven by these variations in du/dz and an associated strengthening of the reversal of the meridional gradient of potential vorticity with depth.

Increased du/dz between the STCC and SEC is related, through the thermal wind balance, to sub-surface temperature anomalies, with a maximum >1°C at ∼300m depth. Sensitivity studies reveal this decadal variations to be driven by changes in the wind stress τ. A combination of local and remote anomalies of curl(τ) drives sub-surface temperature changes that either emerge locally or propagate in to the STCC region from the east and south. These temperature anomalies steepen (flatten) the isopycnals and increase (decrease) du/dz.