Geophysical Research Abstracts
Vol. 14, EGU2012-10681, 2012
EGU General Assembly 2012
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The Deep Meridional Overturning Circulation in the Indian Ocean Inferred from the GECCO Synthesis

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The meridional overturning circulation in the Indian Ocean and its temporal variability in the GECCO ocean synthesis are being investigated. An analysis of the integrated circulation in different layers suggests that, on time average, 2.1 Sv enter the Indian Ocean in the bottom layer (>3200m) from the south and that 12.3 Sv leave the Indian Ocean in the upper and intermediate layers (<1500m), composed of the up-welled bottom layer inflow water, augmented by 9.6 Sv Indonesian Throughflow (ITF) water. The GECCO time-mean results differ significantly from those obtained by box inverse models, which, being based on individual hydrographic sections, are susceptible to aliasing.

The GECCO solution has a large seasonal variation in its meridional overturning caused by the seasonal reversal of monsoon-related wind stress forcing. Associated seasonal variations of the deep meridional overturning range from -7 Sv in boreal winter to 3 Sv in summer. In addition, the upper and bottom transports across 34°S section show pronounced interannual variability with roughly biennial variations superimposed by strong anomalies during each La Niña phase as well as the ITF, which mainly affect the upper layer transports. On decadal and longer timescale, the meridional overturning variability as well as long-term trends differ before and after 1980. Notably, our analysis shows a rather stable trend for the period 1960-1979 and significant changes in the upper and bottom layer for the period 1980-2001.

By means of a multivariate EOF analysis, the importance of Ekman dynamics as driving forces of the deep meridional overturning of the Indian Ocean on the interannual timescale is highlighted. The leading modes of the zonal and meridional wind stress favour a basin-wide meridional overturning mode via Ekman upwelling or downwelling mostly in the central and eastern Indian Ocean. Moreover, tropical zonal wind stress along the equator and alongshore wind stress off the Sumatra-Java coast contributes to evolution of IOD events.