Central Indian Ocean mixed layers and upper layer transports

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WOCE I8N CTD and IMET measurements are used to study the surface layer structures and their driving mechanism from 6N to 25S along 80E. SST (SSS) increases sharply (~0.4°C/100km, 0.6 psu/100km) from 5N to 3N. SST is above 29.5°C in the equatorial zone (4N to 4S) with a large amplitude diurnal cycle (of 0.8°C). In contrast, south of the equatorial zone, the diurnal cycle is much less pronounced and SST/SSS change with strong fronts. Correspondingly, there are two regimes in the mixed layer (ML) structure. In the tropics, there is net heat gain and weak wind (~2m/s), resulting in a strong diurnal cycle and a shallow ML (above 10m), A 1-D ML model using observed atmospheric forcing shows that the depth and magnitude of the diurnal cycle in both regimes are consistent with observations. The ML must warm up in such a 1-D model, but warming above 30°C is rarely observed. The balance may be due to advection/upwelling. Away from the equatorial region, the surface layer is well mixed to the pycnocline. This is caused by strong wind forcing (~7m/s) and associated large latent heat loss (~210W/m^2). The model shows a SST diurnal cycle of only about 0.12°C. The daily-mean heat is roughly balanced for the ML, and the ML depth remains about 3m at mid-day, 15m at evening, 40 m at midnight, and 49m at dawn.

The permanent pycnocline north of 12S is intense and coincident with the strong halocline separating fresh surface waters of northeastern Indian ocean/Indonesian throughflow origin from much more saline water of Arabian Sea origin. The lowest salinity surface water is found outside the equatorial band, within which the halocline is more intense. Both suggest equatorial upwelling. The maximum ML depth is set by this halocline/pycnocline; waters above the pycnocline are fully saturated with oxygen. The pycnocline depth variations are determined by the large scale circulation which includes: a narrow westward coastal jet off Sri Lanka (40 cm/sec, 6Sv); a pronounced equatorial undercurrent domain (70 cm/sec based on ADCP); a strong equatorial countercurrent just south of the equator (70 cm/sec near the surface, flow extending to 1100m depth, 55 Sv eastward transprot0< and the westward jet between 10S and 14S which carries Indonesian throughflow water (30 to 70 cm/sec surface flow, 21 Sv westward transport extending over 1500 m depth).