

A process-based modelling study of the subtropical front in the south-east Indian Ocean.

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Abstract

A series of process-based numerical modelling experiments were employed to understand mixing processes at the Subtropical Front (STF) in the southeast Indian Ocean. In this region, the STF is characterised by strong density compensation in and below the seasonal mixed layer, and thermohaline intrusions at the base of the seasonal mixed layer. The first series of experiments modelled the formation of the seasonal mixed layer, to examine the mechanisms that maintain the front during the summer period. The second series of experiments modelled the displacement of the surface Ekman layer during synoptic wind events, and was used to determine whether intrusions develop due to wind alone. The final series of experiments extended the second model in a zonal direction, hence allowing the unstable front to evolve over time. Simulations were run both with and without wind forcing. This model was used to determine whether frontal instabilities may lead to the development of thermohaline intrusions. For all models, simulated intrusions were compared with intrusions observed in high-resolution Seasoar transects.

Model results indicate that the maintenance of the front at depth depends on the degree of density compensation, whereas the maintenance of the front within the seasonal mixed layer depends on entrainment of water from below. Synoptic winds were found to influence the development of intrusions in two ways. Higher salinity intrusions were found to develop if the wind stress magnitude varies between successive wind events, provided that the surface Ekman layer is first displaced poleward. Lower salinity intrusions were found to develop due to convective mixing, if the surface Ekman layer is first displaced equatorward. Both forced and unforced instabilities lead to the development of lower salinity intrusions at the base of the mixed layer. Experiments that considered both wind-driven mixed layer dynamics and frontal dynamics together, resulted in simulated lower salinity intrusions that best resembled the observed structures.