

Seasonal Variation of the Mixed Layer Depth at 60°S and its governing dynamics

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In this research, data from a yearlong M-TRITON type mooring system deployed in 2012 is used to study the seasonal variability of the dynamics governing the Southern Ocean and its influence on the mixed layer depth by measuring temperature, salinity and current velocity data. GHRSSST Satellite data and reanalysis ERA-interim wind data were used to complement the mooring, identifying spatial variation in wind and sea surface temperature (SST). This is relevant in the context of coupling readily available surface information (via satellite) and punctual information from ship CTD casts with corresponding subsurface phenomena.

A major factor of mixing was identified as the work on upper-ocean inertial motions (period $T=13.8186$ hours) associated with variable wind forcing, corroborating with the work of Alford (2001, 2003), Watanabe & Hibiya (2002) and Furuichi et al. (2008). Strong wind peaks, were observed to break stability, parametrized as the Buoyancy frequency N^2 , which varied from an order of 10^{-4} s^{-2} to 0 or negative values in the original mixed layer depth (MLD) at the period, while enhancing stability at deeper layers in the same proportion it decreases at the layer above. As a consequence, the MLD increases by around 25m during these events. Wind forcing was found to influence stability and MLD not only through the work of storm induced near-inertial motion but also through meso-scale meridional transport, modulating the frontal structure of the Antarctic Convergence. During winter, the system response to wind weakened as surface cooling induced large scale convection. In particular a cold front reached the mooring at May 28th, starting the convection process. MLD responded by deepening to as far as 150m, and upward salinity flux could be observed.

Strong shear could be observed, usually below the mixed layer and generally agreeing with other reports of momentum penetration beyond the scalar mixed layer (e.g. Johnston & Rudnick, 2009). Shear comparison could not be made throughout the year, however, as the mixed layer goes below the ADCP detection range during winter. The strong stratification at the base of the mixed layer was seen to generate a complex internal wave field, where shear instability dissipates through high frequency internal waves of period between 2 and 4 hours. These waves seem to become trapped at the stratified layer and evolve to inertial period oscillations, increasing in amplitude until they break, generating high frequency waves once again. This process was observed to repeat at every mixed layer deepening event, either in summer or winter. The relation between internal waves, mixing and MLD at the Southern Ocean is a step to understand nutrient availability and the formation of important water masses of global influence.

Keywords: Southern Ocean, Internal waves, Mixing