



LES of an Ocean Mixed Layer and its Application to the Parameterization of the Vertical Mixing Process

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We performed LES of the ocean mixed layer under the surface heat flux, in which both wave breaking (WB) and Langmuir circulation (LC) were realized (Noh et al, JPO 2004). Based on the LES data, we investigated the effects of the surface heat flux on the structure of the ocean mixed layer, and examined the parameterization used in the ocean mixed layer model by Noh (Noh & Kim JGR 1999, Noh et al. JPO 2002). LC is weakened under the surface heating, and ultimately broken down if the intensity of the surface heating becomes sufficiently strong, but the effect of surface cooling is more subtle. Under the influence of WB and LC, turbulence production in the upper ocean mixed layer is dominated by the TKE flux, contrary to the case of the atmospheric boundary layer, and the balance between the TKE flux and buoyancy flux leads to the formation of a thermocline under the surface heating. The depth of a thermocline is determined by both the Monin-Obukhov length scale and the Ekman length scale. Analysis of the LES data reveals that the effect of stratification must be parameterized in terms of the Richardson number based on TKE, rather than the Richardson number based on mean velocity shear, and the Prandtl number must increase with increasing stratification. The entrainment rate for the deepening of the mixed layer under the influence of surface cooling and wind stress was also parameterized.