

Submitted to Deep Sea Research:

Surface mixed layer deepening by stationary vortices: a model of mixing by Langmuir circulation

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Abstract:

Though Langmuir circulation occurs in the mixing layer of oceans and lakes for relatively low wind speeds, its relevance to mixed layer deepening is still an open question. In order to estimate the influence of mixing by Langmuir vortex cells relative to shear induced mixing, we employ results on entrainment rate obtained from laboratory experiments, and use the analogy between the mixing by Taylor vortex cells and the mixing by Langmuir vortices. Relating the vortex flow and the shear across the mixed layer to a surface friction-velocity u^* , we show that up to a Richardson number of $Ri^* = h\Delta b/u^{*2} \leq 80$ layer deepening is dominated by shear turbulence, whereas it is taken over by Langmuir circulation for $Ri^* > 80$. This result confirms the observation that shear turbulence dominates during initial layer deepening under relatively weak buoyancy effects, and that subsequently Langmuir cell mixing causes the principal layer deepening.