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The Transfer of Energy and Momentum by the Wind to the Surface Mixed Layer

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ABSTRACT

During the initial stages of the deepening of the surface mixed layer, the rate of increase of potential energy is proportional to the input of energy to the mixed layer by the wind. In an attempt to reconcile an apparent discrepancy between the rate of deepening in laboratory experiments (Kato and Phillips,1969) and in the ocean (Denman and Miyake, 1973), a simple model for the momentum and energy transfer by the wind to surface waves and the mixed layer is suggested. The net transfer of momentum τ_{ml} is the wind stress τ less the local growth of surface wave momentum and the divergence of the surface wave momentum flux, and the net energy transfer $\dot{E}_{ml}$ is the work $\dot{E}$ done on the waves by the wind less the local growth of surface wave energy, the divergence of the surface wave energy flux and the viscous dissipation of the waves. Using the JONSWAP wave observations, the net momentum transfer is 0.97τ (Hasselmann *et al.*, 1973). Using a. simple momentum transfer function, allowing direct generation of long gravity waves and capillary-gravity waves, to estimate work done on the waves, the energy actually transferred to the mixed layer is a few percent of ${}_{\tau}U_0$, where U_{10} is the 10 m wind speed. The oceanic and laboratory rates of deepening of the mixed layer appear roughly consistent. In addition, the flow in the mixed layer apparently adjusts itself so that the surface flow is $\dot{E}_{ml}/\tau_{ml}$.

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