Abstract View

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A Criterion for Thermal Stratification in a Wind-Mixed System

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ABSTRACT

The onset of thermal stratification in an isohaline, wind-mixed water body is shown, by a simple model and observations, to be determined by the parameter u_*^3/hB', where u_* is the friction velocity of the air just above the water surface, h the water depth and B' a buoyancy flux. Defined as $B' = g\alpha(\rho C_p)^{-1} \times [Q_0 - 2Q_1(ch)^{-1}]$, where g is gravitational acceleration, α the coefficient of thermal expansion, ρ the density of water, C_p, the specific heat of water at constant pressure, Q_0 the not surface heat input, Q_1 the solar radiation that penetrates the water column and c the extinction coefficient for Q_1, in the water, this buoyancy flux is the net buoyancy input to the water, less an amount due to solar radiation penetrating the water column. The transition from the well-mixed to stratified regime occurs when u_*^3/hB' falls below a value of approximately 6700. This is supported by observations from a lagoon 3 m deep where the complete formation and breakdown cycle of thermal stratification occurs over several hours. A value of 1.8 is found for the ratio of the rate of increase in potential energy of the water column due to wind mixing, over νv_*, where ν is the surface wind stress and v_* the friction velocity in the water near the air-water interface. The value of this ratio was obtained from measurements made in the lagoon where the effects of water beating were considered, as well as wind mixing, on changing the potential energy. The development of the simple stratification criterion allows some predictions to be made of the influence of turbidity on the thermal structure of a water body.

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