Effects of the wind forcing on a shallow lake associated with the lake size and stratification

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This study shows effects of the wind forcing on a shallow lake associated with the lake size and stratification. Mixing in lakes and reservoirs are frequently evaluated by using nondimensional parameters, for example the Wedderbrun number (W_e). W_e can be estimated for a steady state wind condition or computed by using time averaged wind data, however, winds largely vary within several hours or less. Time scales associated with mixing in a shallow lake were investigated using a two dimensional (x-z) numerical simulator, SUNTANS. Several conditions of the horizontal scale of the modeled lake, stratification and wind speed were used in simulations with W_e ranging 0.1–10. This study employees two time scales: (1) time scale required for a steady state temperature distribution estimated from the tilt of the thermocline, T_s, and (2) time scale required for complete vertical mixing, T_{mix}. T_{mix} is computed from change in the potential energy. Numerical results showed that T_s linearly decreases with decreasing in the stratification or increasing in the horizontal distance under a same W_e condition. T_{mix} also increased when the stratification decreased or the horizontal distance increased under a same W_e condition. A quarter of the internal seiche period (T_i) was calculated using a stratification and a horizontal distance. Numerical results showed a linear relationship between T_i and T_s. Moreover, a quarter of T_i was fundamentally shorter than T_{mix} under a same stratification and horizontal distance. This implies that the lower limit of the mixing time scale is determined by a quarter of T_i.

Keywords: Wind forcing, Stratification, Mixing

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