Abstract View

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The classification of Mixed-Layer Dynamics of Lakes of Small to Medium Size

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ABSTRACT

An analysis of the time scales of processes relevant to wind mixing in lakes indicates that the response of a lake to wind may be classified into four regimes with respect to thermocline deepening behavior, depending on the relative sizes of the parameters describing wind strength, basin size and stratification. The dependence is described in terms of a mixed layer Richardson number and the aspect ratio of the mixed layer thickness to length. The classification is used to explain the diversity of phenomena reported in the literature for wind events in a number of different lakes and laboratory tanks which are either short enough or narrow enough for rotational effects to be unimportant. The classification is derived with reference to a two-layer, rectangular basin in the absence of Coriolis forces and surface heating. The classification is exended in a simple way to more realistic stratifications and basin shapes to predict the overall mixing features of a wind event. Response to wind varies from one in which entrainment proceeds very slowly and has negligible effect on baroclinic motions to one in which any stratification is rapidly destroyed by wind before baroclinic motions can occur. Between these two extremes entrainment and mean motions interact through the production of turbulent kinetic energy by velocity shear at the base of the mixed layer. The nature of this interaction is investigated, and scales for velocity shear, stable interface thickness, and times for internal seiching, internal wave decay and vertical and longitudinal mixing are developed. A computer algorithm parameterizing the effects of shear production on mixed layer deepening is described, based on the analysis presented. By incorporating this algorithm in a more comprehensive reservoir simulation model, DYRESM, effects of surface heating, realistic stratification, and complicated basin shape may be accounted for. Interaction between these effects and the wind deepening mechanism is described explicitly by the program logic. Results of a successful simulation by DYRESM for a season in the Wellington Reservoir, Western Australia, are discussed.

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