Estimating of the Small Lakes Heat Budget in Energy Balance Approach

Heat budget studies of small lakes and reservoirs are essential components of efficient lake water management. Estimating heat budget of water bodies such as small lakes and reservoirs needs temperature profile in water bodies.

A one-dimensional numerical model of the hydrodynamic and thermal structure of small lakes which includes vertical turbulent mixing in water and heat exchange between the lake and the overlying atmosphere is developed. The vertical temperature profiles were calculated by solving the 1-D heat transfer equation that takes into account the internal heat sources and sinks and the molecular and eddy diffusions. In this model eddy diffusions were assumed to be function of gradient Richardson number.

This physically based eddy diffusions model was well suited to simulate the formation and dynamics of vertical stratification and provide a basis for estimating heat budget of small lakes in energy balance models and in estimating evaporation from open water surfaces as well.

The governing equation was solved by a powerful and open-source finite-volume CFD solver (OpenFOAM), which a new solver(LakeH1D) was established for this model. The heat exchange between the lake and the atmospheric boundary layer(ABL) was formulated by using the energy balance equations and the bottom of the lake was considered to be insulated.

Because no lake-specified fitting of the parameters of the model is necessary, the model can be used to estimate evaporation in water resources management plans and lake hydrology in a variety of settings. The necessary data for running the model are only the standard meteorological measurements.

The results of the model has been compared with the field data on vertical temperature profile in (semi-) arid region lakes.