LakeMIP Kivu: Evaluating the representation of a large, deep tropical lake by a set of 1-dimensional lake models

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The African great lakes are of utmost importance for the local economy (fishing), as well as being essential to the survival of the local people. During the last decades, these lakes experienced fast changes in ecosystem structure and functioning and their future evolution is a major concern. In this study, for the first time a set of one-dimensional lake models are evaluated for Lake Kivu (2.28 °S; 28.98 °E), East-Africa. The unique limnology of this meromictic Lake, with the importance of salinity and subsurface springs in a tropical high-altitude climate, presents a worthy challenge to the seven models involved in the Lake Model Intercomparison Project (LakeMIP). Meteorological observations from two automatic weather stations are used to drive the models, whereas a unique dataset, containing over 150 temperature profiles recorded since 2002, is used to assess the model's performance. Since some lake models do not account for salinity and its effect upon lake stratification, simulations are performed over the freshwater layer only (60 m) and over the average lake depth (240 m). All models are able to reproduce the mixing seasonality in Lake Kivu, as well as the magnitude and seasonal cycle of the lake enthalpy change. Differences between the models can be ascribed to variations in the treatment of the radiative forcing and the computation of the turbulent heat fluxes, while fluctuations in wind velocity and solar radiation explain inter-annual variability of observed water column temperatures. The good agreement between the deep simulations and the observed meromictic stratification also shows that a subset of models is able to account for the salinity- and geothermal-induced effects upon deep water stratification. Finally, based on the strengths and weaknesses discerned in this study, an informed choice of a one-dimensional lake model for a given research purpose becomes possible.