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Improvement of Lake Thermal Process Simulations with the Community Land Model

Qunhui Zhang (1,2), Jiming Jin (1,2), Phaedra Budy (2,3), Nicholas Barrett (2), and Xiaochun Wang (4)

(1) Northwest A&F University, College of Water Resources and Architectural Engineering, Xianyang, China (qunhui_zhang321@163.com), (2) Department of Watershed Sciences, Utah State University, Logan, Utah, USA (Jiming.Jin@usu.edu; nbarrett1992@gmail.com), (3) US Geological Survey, Utah Cooperative Fish & Wildlife Research Unit, USA (phaedra.budy@usu.edu), (4) Jet Propulsion Laboratory, California Institute of Technology, Pasadena, California, USA (xiaochun.wang@jpl.nasa.gov)

In this study, we improved upon our ability to simulate lake thermal process by coupling the K profile parameterization (KPP) into the Community Land Model (CLM) version 4.5 developed by the National Center for Atmospheric Research. Vertical mixing of the water column significantly affects heat transfer and vertical temperature profiles. However, many lake models, including the lake scheme in the CLM, produce large simulation biases in water temperatures due to unrealistic mixing that is mainly a function of wind stress. This study aims to improve the CLM lake scheme by coupling it with the KPP, where vertical mixing of the water column is driven by both wind stress and surface thermal forcing. We tested the newly coupled model in lakes in arctic Alaska and the Tibetan Plateau. The results demonstrated the new mixing scheme was capable of reproducing observed lake water mixing and improved lake temperature simulations when compared to the original scheme. Such improvements resulted from more realistic simulations of the transition between stratification and turnover due to surface thermal forcing. This newly coupled CLM-KPP model has great potential for broader applications in climate, hydrology, and ecosystem studies including predicting the effects of warmer climates on lake ecosystems.