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Summary

The cyanobacterial genus Microcystis commonly forms surface blooms that adversely impact aquatic ecosystems. The development and spatiotemporal distributions of blooms are governed by complex physical mixing and transport processes that interact with physiological processes affecting the growth and loss of bloom-forming species. Many modelling studies have attempted to simulate the vertical and temporal distributions of Microcystis colonies by using a fixed colony size whilst acknowledging that colony size has a significant effect on buoyancy and vertical distributions of populations. In this study, a novel individual-based model (IBM) was developed to examine how colony size changes under different environmental conditions and how colony size impacts Microcystis bloom development and spatiotemporal distributions. To simulate transport and mixing processes, the IBM was coupled to a three-dimensional hydrodynamic model. Based on relevant relationships from the literature, aggregation and disaggregation of colonies influenced by turbulent dissipation were incorporated into the IBM. In addition, the model considered the growth of cyanobacteria in relation to light, nutrients, and temperature. The IBM was applied to Forest Lake (Queensland, Australia) in the summer of 2020, when Microcystis concentrations calculated from phycocyanin fluorescence measurements exceeded 3.5×10 cells mL-1. The model results were compared with in situ high-frequency observations. The hydrodynamic model accurately reproduced the observed variation in water temperature and current speed. In addition, the IBM was able to capture the observed Microcystis colony accumulation at the water surface during diel stratification and redistribution during mixing events. It was found that including dynamic variations in colony size yielded more accurate predictions of the cyanobacteria blooms and could improve current models of colony-forming cyanobacteria.

Research Expertise

- Hydrology
- Climate change
- Landuse change
- Remote sensing
- Ecohydrology