Modeling Harmful Algal Blooms in Lake Ontario by Inclusion of Algal Ecology and Nutrient Dynamics

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Phosphorus (P) and nitrogen (N) are crucial nutrients for algal growth, and P is generally considered as the limiting nutrient. Most of the efforts for modeling, management, and restoration of lakes have been focused on P. However, there is a growing body of research that indicates some freshwater resources can experience stages of N limitation or N-and-P co-limitation of algal growth. This paper is an attempt to improve the modeling and prediction of harmful algal blooms (HABs) through the inclusion of insights into phytoplankton ecology and the effect of N and P species in controlling different phytoplankton species growth. An integrated three-dimensional hydrodynamic-ecological modeling framework is applied to simulate HABs dynamics in Lake Ontario, which is the last lake in the chain of Laurentian Great Lakes. Environmental Fluid Dynamics Code (EFDC) is a state-of-the-art model that simulates hydrodynamic behavior, and it is linked to an ecological model, Advanced Aquatic Ecosystem Model (A2EM), which simulates water quality, sediment diagenesis, and interactions in lower-food-web, including four phytoplankton species (diatom, green, blue-green, and none-nitrogen-fixing algae), three zooplankton species (cladocerans, copepods, and microzooplankton), benthic algae (Cladophora), and invasive dreissenid mussels. This work seeks to address N:P dynamics and the role of N in driving differences in spatiotemporal dynamics of phytoplankton and HABs in a large lake.