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Multi-scale and qualitative analysis of a stoichiometric algae model in the absence or presence of bacteria

Algal blooms are becoming a global concern due to the increasing prevalence of eutrophication. Often, algae and bacteria interact, within the well-mixed epilimnion, in a loose commensalistic way. Here we analyze stoichiometric models for algal dynamics and for bacteria-algae dynamics. The algae-only dynamics exhibit rich transient behavior, and the driving biological mechanisms are studied and understood via a multiple time-scale analysis. We further perform global qualitative analysis of both models. There are three dynamical scenarios determined by the basic reproductive numbers of algae and bacteria. We use these models to make specific predictions about how the relative balance of algae and bacteria should change in response to varied nutrient and light availability. The bacteria-algae model successfully reproduces empirical respiration data.