# A theoretical modeling framework for motile and colonial harmful algae

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**Abstract**

1. Harmful algal blooms are increasing in both severity and frequency across the globe. Many bloom-forming species are capable of vertical motility and colony formation. The cyanobacterium *Microcystis aeruginosa* is a common example of such a species, yet current models poorly predict vertical distributions of *M. aeruginosa*. 2. To couple the hydrodynamics, buoyancy, and the colony dynamics of *Microcystis*, we present a system of one-dimensional advection-diffusion-aggregation equations with Smoluchowski aggregation terms. 3. Results indicate Smoluchowski aggregation accurately describes the colony dynamics of *M. aeruginosa*. Further, transport dynamics are strongly dependent on colony size, and aggregation processes are highly sensitive to algal concentration and wind-induced mixing. Both of these findings have direct consequences to harmful algal bloom formation. 4. While the theoretical framework outlined in this manuscript was derived for *M. aeruginosa*, both motility and colony formation are common among bloom-forming algae. As such, this coupling of vertical transport and colony dynamics is a useful step for improving forecasts of surface harmful algal blooms.

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