Understanding and Predicting Algal Blooms Using In Situ Automated Monitoring

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Aquatic ecosystems are highly diverse and dynamic. They sustain globally important ecosystem processes, like the carbon and nitrogen cycles, and harbour a significant share of earth taxonomic and functional diversity. Plankton communities dominate open water environments and rest at the base of aquatic food-webs. Phytoplankton (microscopic algae), in particular, represent the most important primary producers in aquatic environments, and are very sensitive to human impacts like eutrophication, chemical pollution, and climate change. Algal blooms are, in fact, an emergent property of the complex planktonic food-web and are recognised as a threat for aquatic ecosystem services (water quality, fishery, farming, recreation) worldwide, with annual societal costs in the billions of dollars. Identifying the mechanisms and processes that govern plankton communities has important practical consequences in the management of aquatic ecosystems, particularly of lakes that provide vital services to human society. Still, our ability to predict plankton ecological dynamics is limited.
A naturally fluctuating environment and complex internal interactions among individuals and species make planktonic communities difficult to understand and fundamentally hard to predict. We can however shift our efforts from prediction (mechanism-based model) to probabilistic forecasting (statistical model able of making statements about the future based on the history of the system). Three main issues are crucial to afford effective forecasting: i) acquiring environmental data at the appropriated scale of space and time; ii) turn large and high dimensional datasets into information that can be used for forecasting, iii) apply the most appropriated forecast approach.
During this seminar, I will briefly review the above issues hindering the predictability of plankton communities, and show advantages and limitations of approaches based on environmental monitoring data (biological, physical and chemical) sampled at different scales, coupled with machine learning, to forecast phytoplankton dynamics across scales of time and space. I will particularly focus on how high-resolution monitoring, particularly by recently developed technology, can inform machine-learning tools and deliver targets ecological and data-driven models, helping elucidate the mechanisms underlying plankton dynamics and forecasting of algal blooms.