Dynamics of phytoplankton size-structure as explained by bio-physical principles and ecological history: a trait based adaptive dynamics modeling approach

Summary

Impacts of multiple stressors on plankton are not well understood. Previous research have suggested that these effects can be modulated by the systematic differences in vulnerabilities to any given stressor across a trait space and the degree of overlap in the trait-specific vulnerabilities to multiple stressors. In this project, we employed a trait-based model framework to better understand and quantify these relationships in phytoplankton communities. Specifically, we had three objectives:

1. to establish a mechanistic understanding of changes in phytoplankton traits driven by different forms of stressors
2. to identify the mechanistic origins of changes in trait diversity in phytoplankton communities
3. to test the relevance of the ecological history for the dynamics of traits and trait diversity as observed in multiple stressor environments

The project has reached first conclusions in addressing the first objective by establishing and applying a size-based plankton model that includes sensitivities to different forms of stressors and that was entirely built on mechanistic knowledge on the eco-physiology of unicellular autotrophs (Taherzadeh et al., 2017, 2019, Fig.1-3). These capabilities also allowed a first assessment of the 2nd objective (Taherzadeh et al 2017, Fig.1b), which, however, could not be further elaborated in isolation. As was necessitated by the 3rd objective, we elaborated the interactions between multiple stressors as mediated by the changes in the traits. Here, we employed the adaptive trait based modeling framework developed in the previous workpackages of the project, and considered the nutrient limitation and zooplankton grazing as the specific stressors (Taherzadeh et al 2019, and Fig. 4). Our results suggested that the interaction type between these stressors change over time, being antagonistic at the beginning, and transitioning to synergistic later. We proposed a mathematical framework for the investigation of the time dependence of interaction type (Taherzadeh et al. 2019).