Goldschmidt 2022 Abstract
https://doi.org/10.46427/gold2022.11493

Global trends in timing and rates of chlorophyll-*a* increase in cold-temperate and temperate lakes

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Cold region lakes are key ecosystems which act as sentinels of climate change and contribute to carbon and nutrient cycling and greenhouse gas storage and emissions. However, environmental controls on the primary productivity of lakes, including surface temperature, ice phenology, nutrient loads, and mixing regime, are increasingly altered by climate warming and land-use changes. To better understand the controls on algal primary productivity in lakes, we compiled time series of *in situ* chlorophyll-*a* concentrations, as well as contemporaneous associated water quality parameters and surface solar radiation, collected between 1964 and 2019 in 357 lakes. We then developed a novel approach to identify seasonal periods of rapid and detectable chlorophyll-*a* increase (*increase periods*) and to compute the corresponding net chlorophyll-*a* increase rates (NCIR) during these periods. We applied this approach to the assembled dataset. The temporal trends show that, with ongoing climate warming, the onset of the increase periods has been occurring increasingly earlier in the year, thus potentially extending the algal growth season, and increasing the annual productivity of cold region lakes. We also observe that lakes of higher trophic status exhibit a higher sensitivity to solar radiation, especially at moderate radiation values during spring. The lower sensitivity of NCIR to surface solar radiation of oligotrophic lakes likely reflects the more dominant role of nutrient limitation. This variation in response between lakes of different trophic status is important to consider when predicting the sensitivity of lake productivity to climate change and the associated regional variations in cloud cover and incident solar radiation. Overall, the metrics of NCIR and the timing of the chlorophyll-*a* increase period presented here provide novel insight into how algal primary productivity may be responding to anthropogenically-altered environmental drivers.