Blue-Green Red Alert?

Team Globolakes
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Questions

• What are the ‘background controls’ on phytoplankton growth around the world?
• How will climate change impact these controls?
Methodology

• Define an idealised lake with identical: area (4000 km$^2$), depth (13.9 m), light attenuation (1 m$^{-1}$), residence time (~1 year) and nutrient loading

• Use meteorological data from global 2$^\circ$ grid for current (1996-2005) and future (2090-2099) using GCM (HadGEM2-ES) output for RCP6.0 scenario

• Calibrate and validate lake physics model (FLake) with Globolakes lake surface temperatures

• Run FLake to generate present day and future daily temperature profiles

• Use two different nutrient loading scenarios: Low/High

• Run a phytoplankton model (PROTECH) using FLake temperature profiles to simulate phytoplankton community composition
Phytoplankton community modelling: PROTECH

PROTECH
Phytoplankton community simulation model

20 species of phytoplankton
Annual average mixed layer temperature 1996-2005

Temperature (°C)
Future-present difference annual mixed layer temperature

Temperature change (°C)
Present day total no. of ‘normally’ stratified days

No. of days

- 300
- 200
- 100
- 0

latitude

longitude
Future-present difference in start of normal stratification
Future-present difference in end of normal stratification

Days difference

Map showing the future-present difference in end of normal stratification with a color scale indicating days difference.
Present day average ‘normal’ mixed depth
Future-present difference in ‘normal’ mixed depth

Mixed depth change (m)
Present day annual phytoplankton biomass

Chlorophyll a (mg m\(^{-3}\))
Present day annual percentage Cyanobacteria
Present day no. of days Cyanobacteria > 50 mg m$^{-3}$
Future-present difference in annual phytoplankton biomass

Change in chlorophyll \( a \) (mg m\(^{-3}\))
Future-present difference in percent Cyanobacteria

Change in % Cyanobacteria
Future-present difference in no. of days with Cyanobacteria > 50 mg m$^{-3}$

Change in no. of days
Cyanobacteria > 50 mg m$^{-3}$
• Under present climate large geographical variation in algal biomass and species composition (for the same nutrient loading)
• Implies much less nutrient loading required to produce the same algal biomass in some parts of the world than others
• Lakes will stratify earlier and for longer, with shallower mixed depths
• Temperate-zone phytoplankton communities will be most affected by climate change
• Some increase in phytoplankton biomass
• Large increase in cyanobacterial blooms
Thank you

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