Long-term perspective on current changes in lake-water organic carbon levels in Ontario:

linking monitoring data and paleolimnological reconstructions

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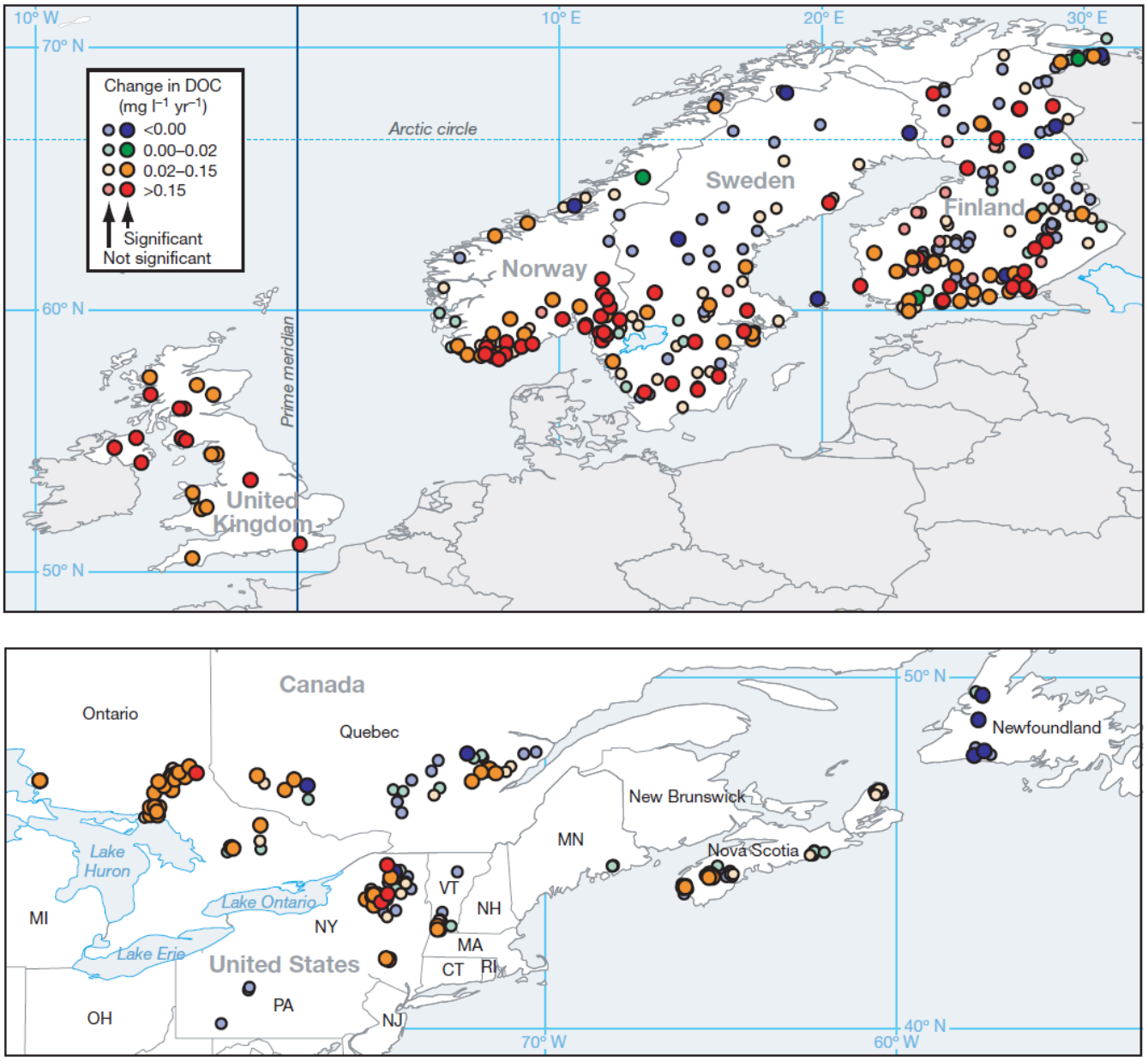
PEARL
Paleoecological Environmental Assessment & Research Laboratory

Queen's UNIVERSITY

Recent increase of organic C concentrations in surface waters in NE North America and N Europe



Monteith et al. 2007, Nature

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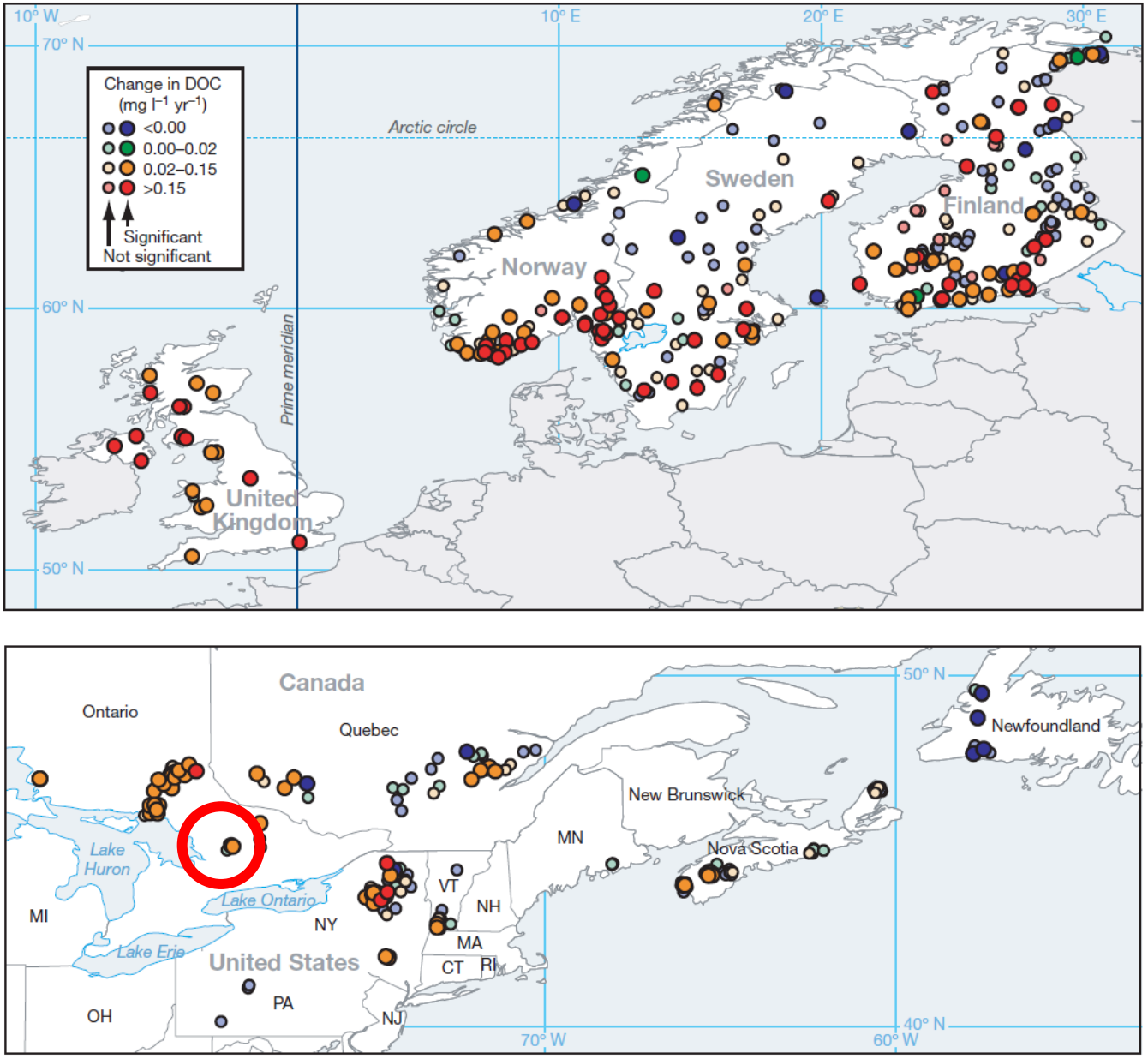

Monteith et al. 2007, Nature

Implications of changing lake-water organic C levels

- **Alteration of lake-ecosystem functioning**
  - Organic C influences:
    - Water acidity
    - Light conditions
    - Food web structures
    - Transport of pollutants
- **Global C cycle**
- **Drinking water treatment**

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DOC = dissolved organic carbon

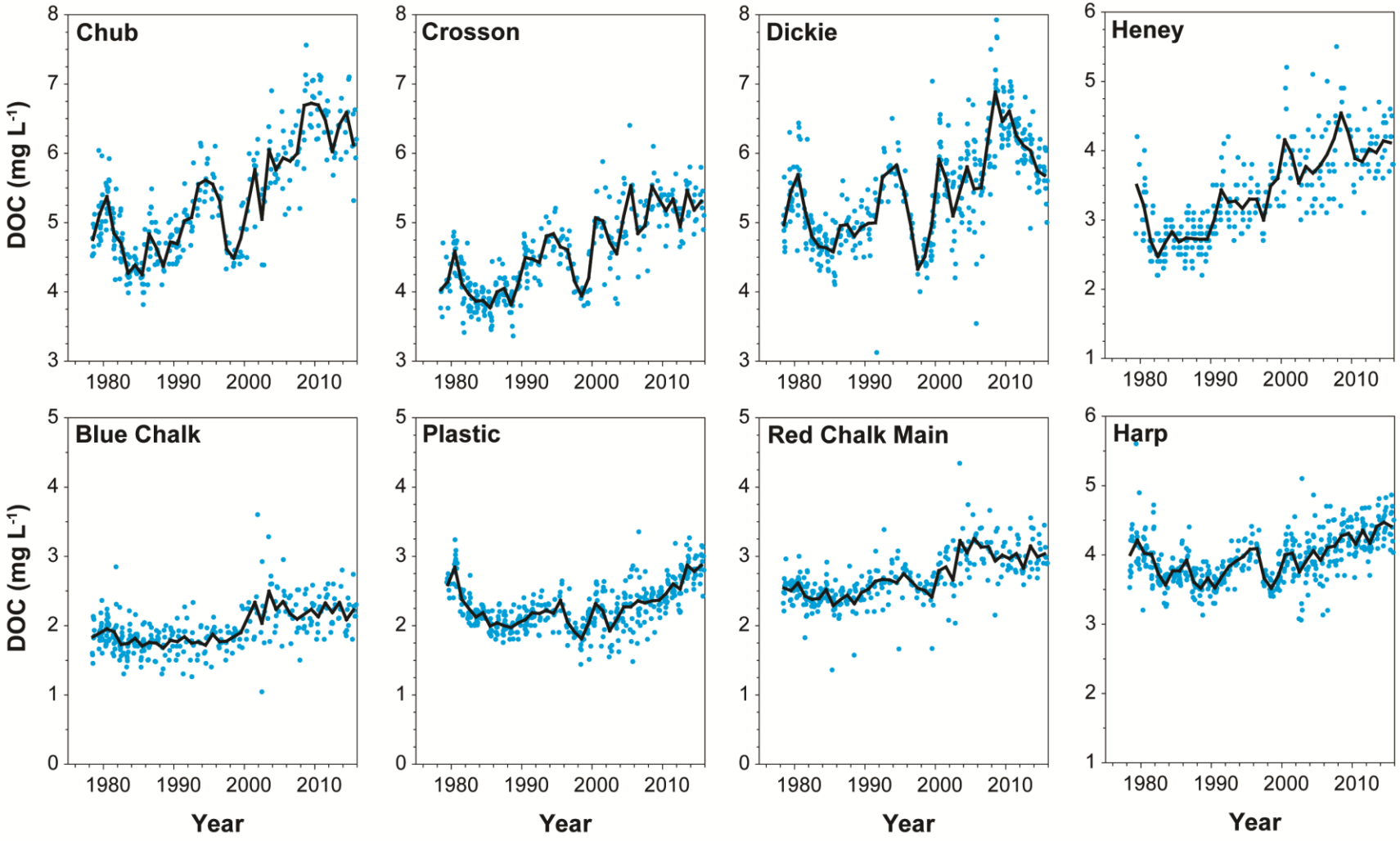
TOC = total organic carbon (~90% DOC)

OM = organic matter

Recent increase of organic C concentrations

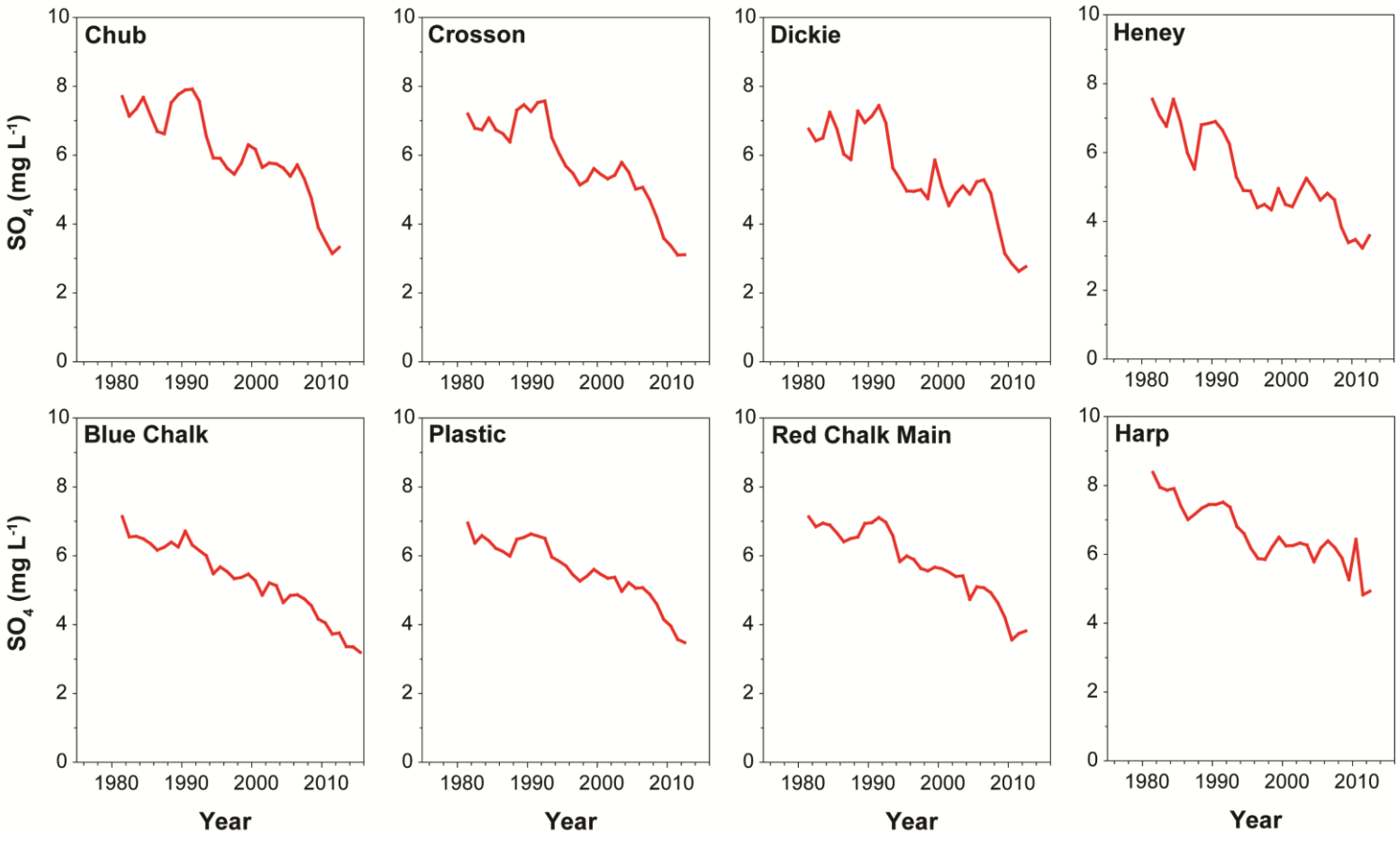
- **<u>Identified drivers:</u>**
  - Climate change
  - Recovery from acidification/atmospheric mineral acid deposition
  - Land use
  - Atmospheric nitrogen deposition
  - CO_2 concentration

Organic C increase in lakes of the Muskoka watershed



Analysis of monitoring data

Recovery from acidification



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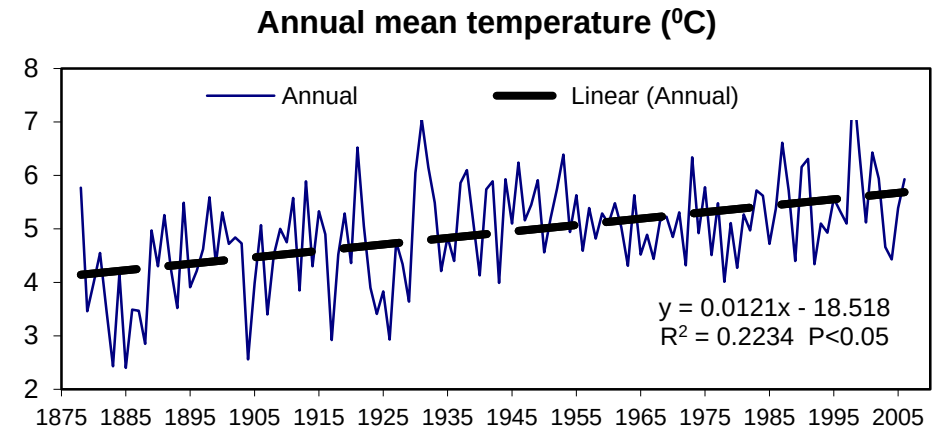
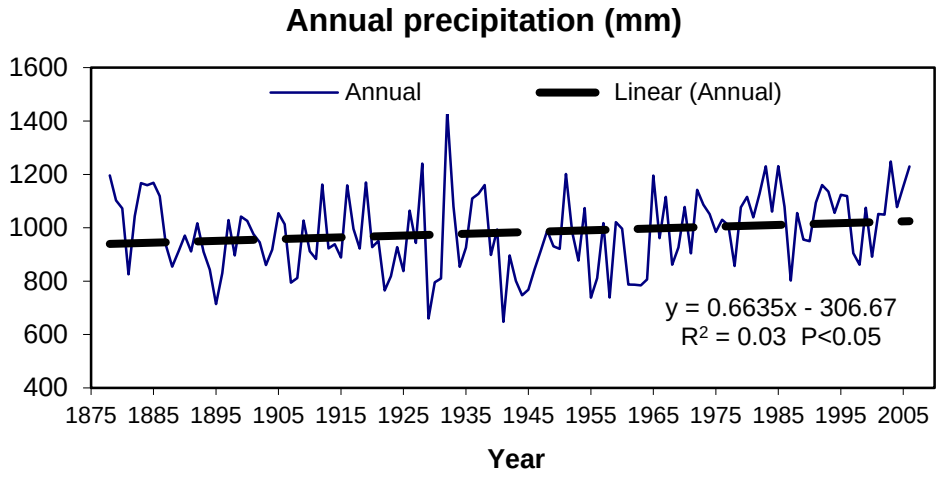




Huntsville weather station

Yao et al. 2009, Hydrol Process

Recovery from acidification

+

Temperature

+

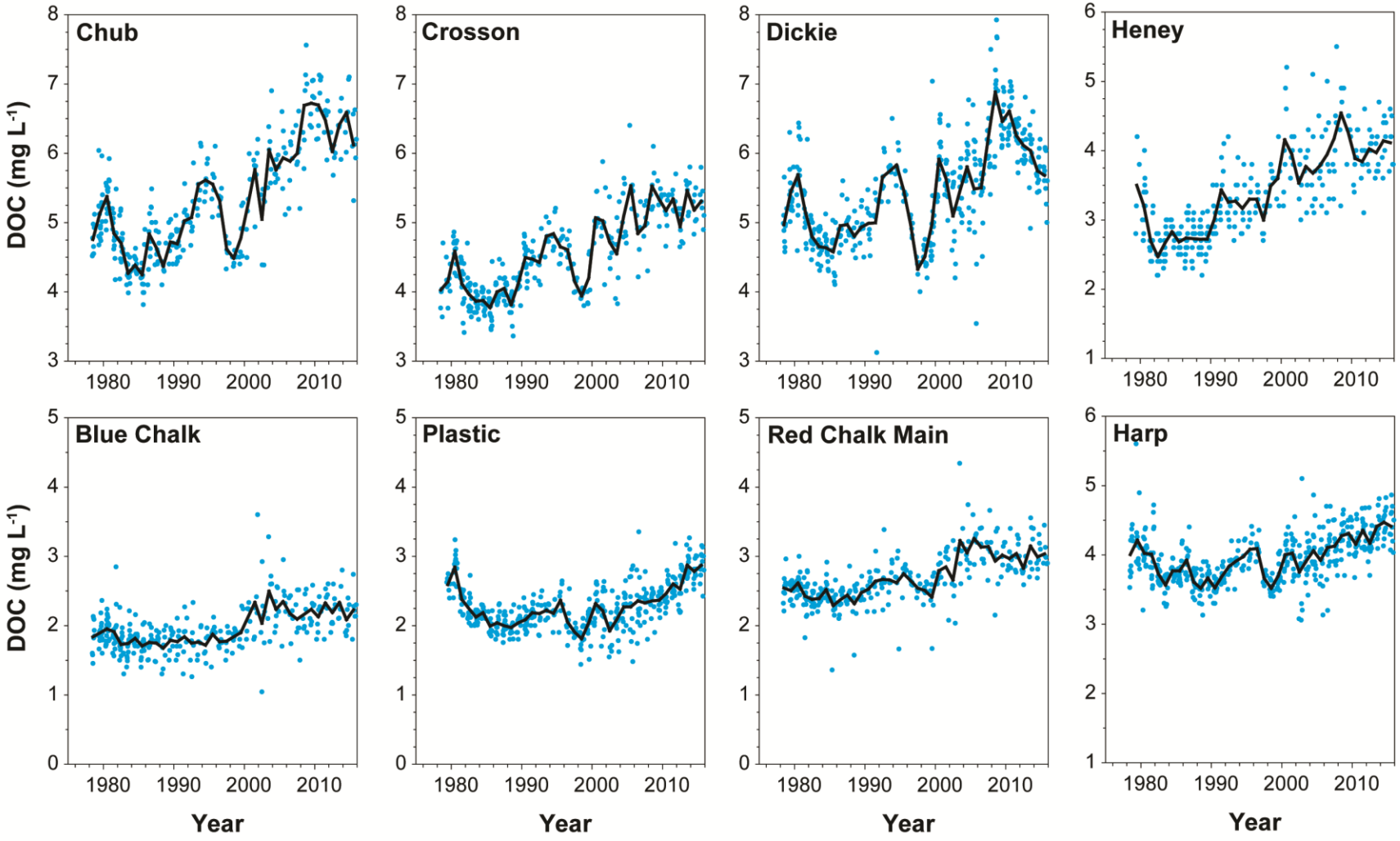
Precipitation

=

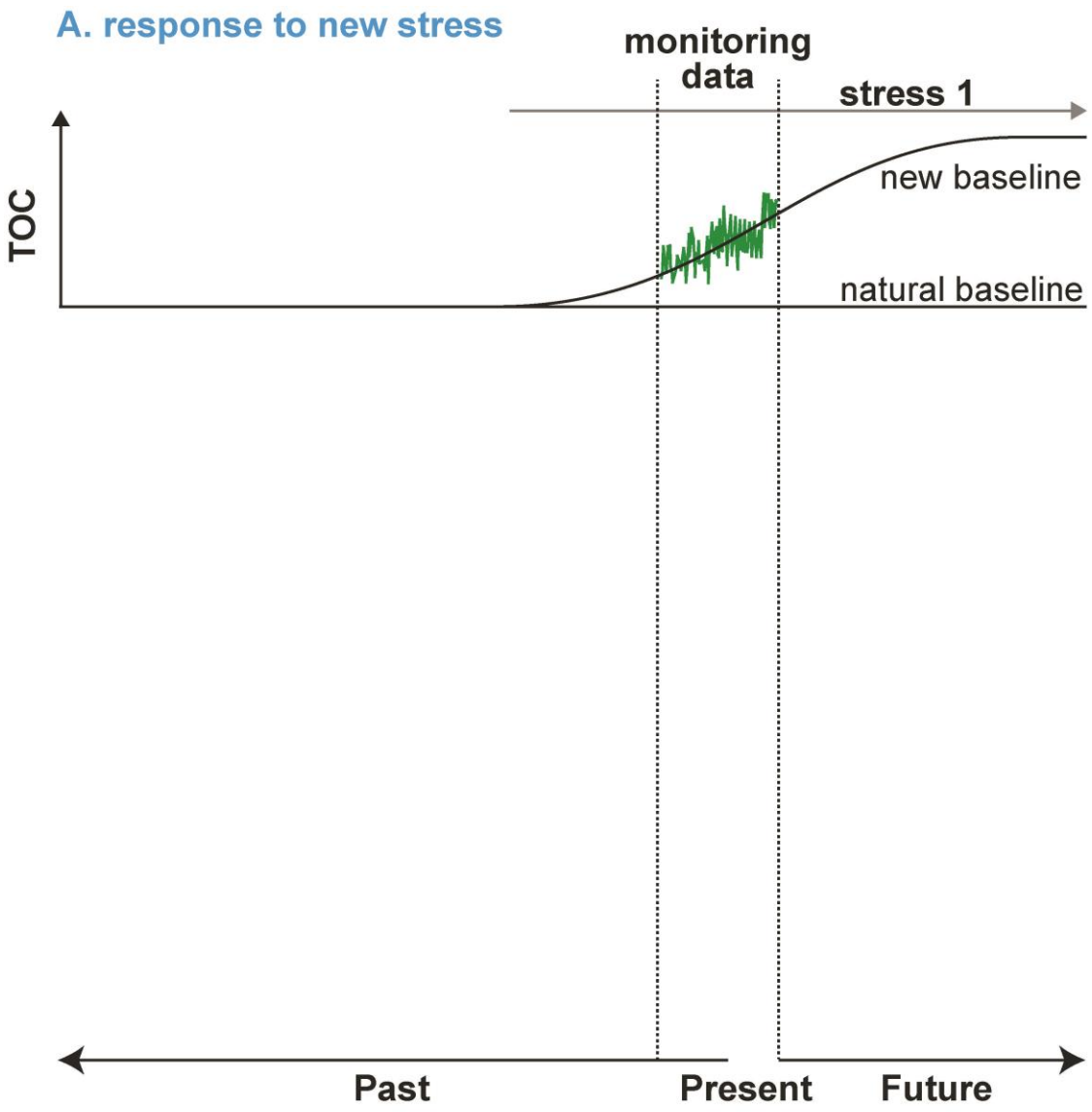
41-75% of variability in organic C (1978-2003)

Keller et al. 2008, Can J Fish Aquat Sci

Organic C increase in lakes of the Muskoka watershed



Driving factors and future implications

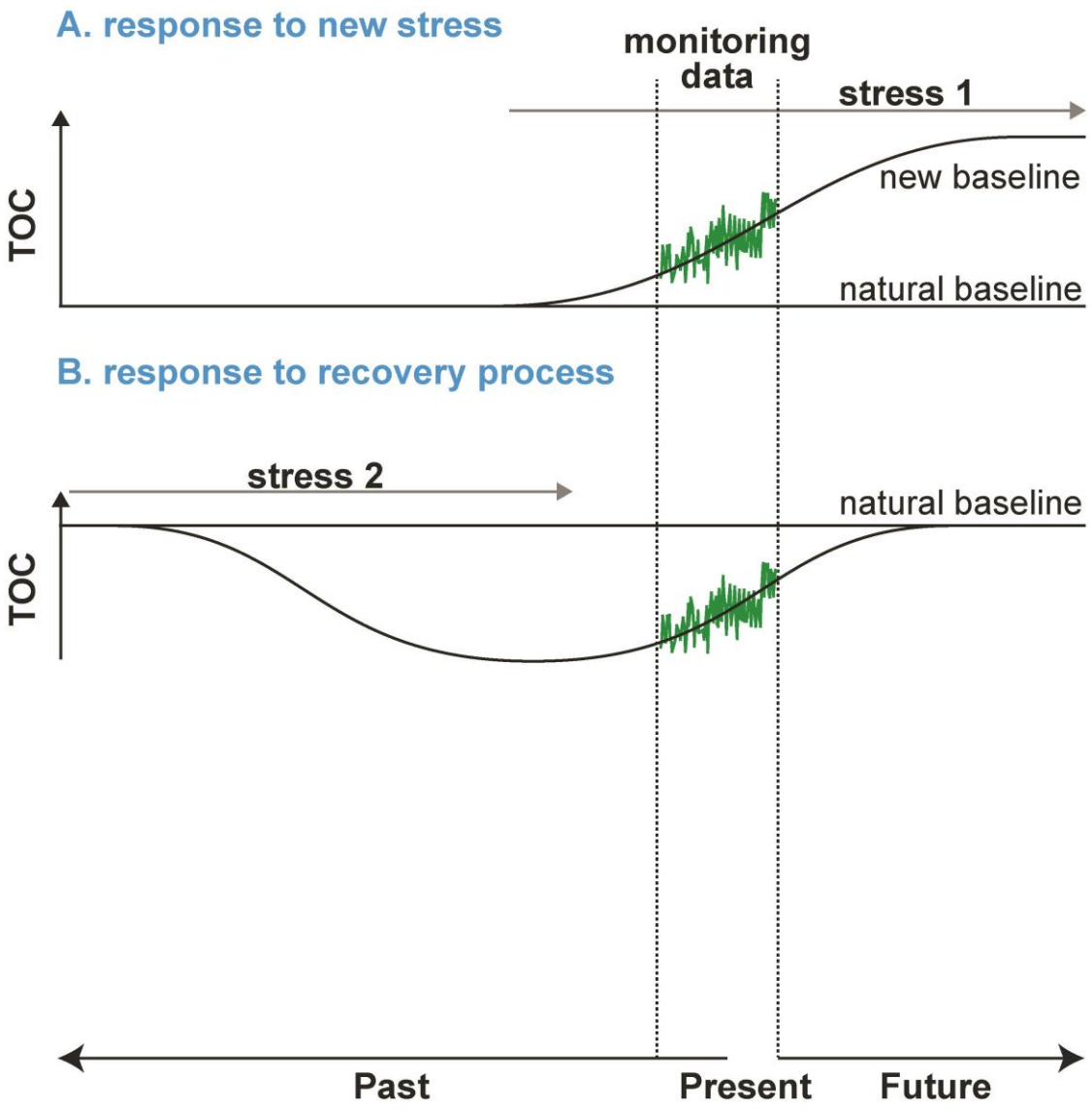


Unprecedented organic C increase

Climate change

modified from Battarbee 1999, Hydrobiologia; Battarbee et al. 2005, Freshwater Biol

Driving factors and future implications



Unprecedented organic C increase

Climate change

restoration of natural organic C level

Acidification recovery

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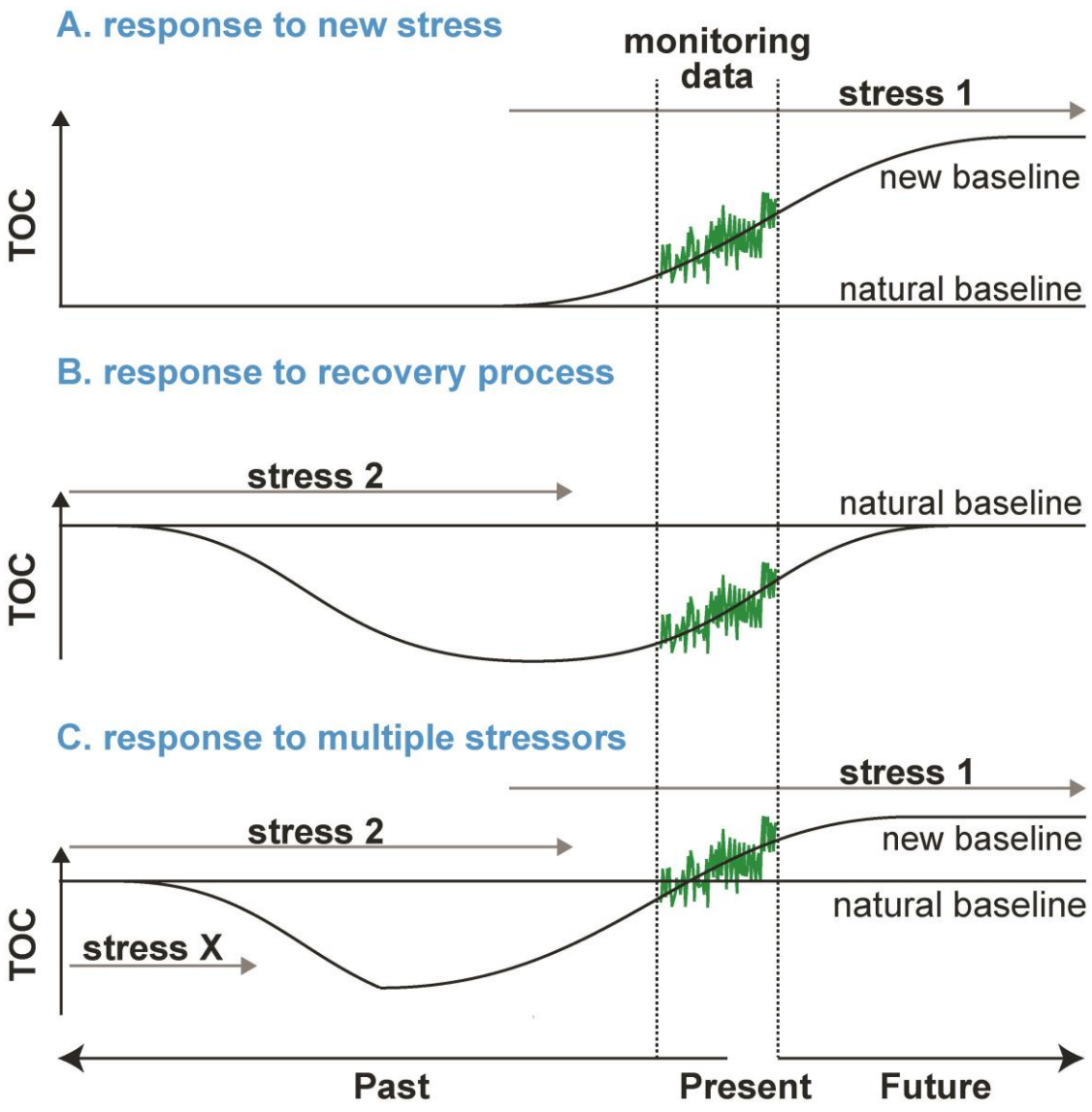

Unprecedented organic C increase

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restoration of natural organic C level

Acidification recovery

Restoration + Unprecedented organic C increase

Acidification recovery; Climate change

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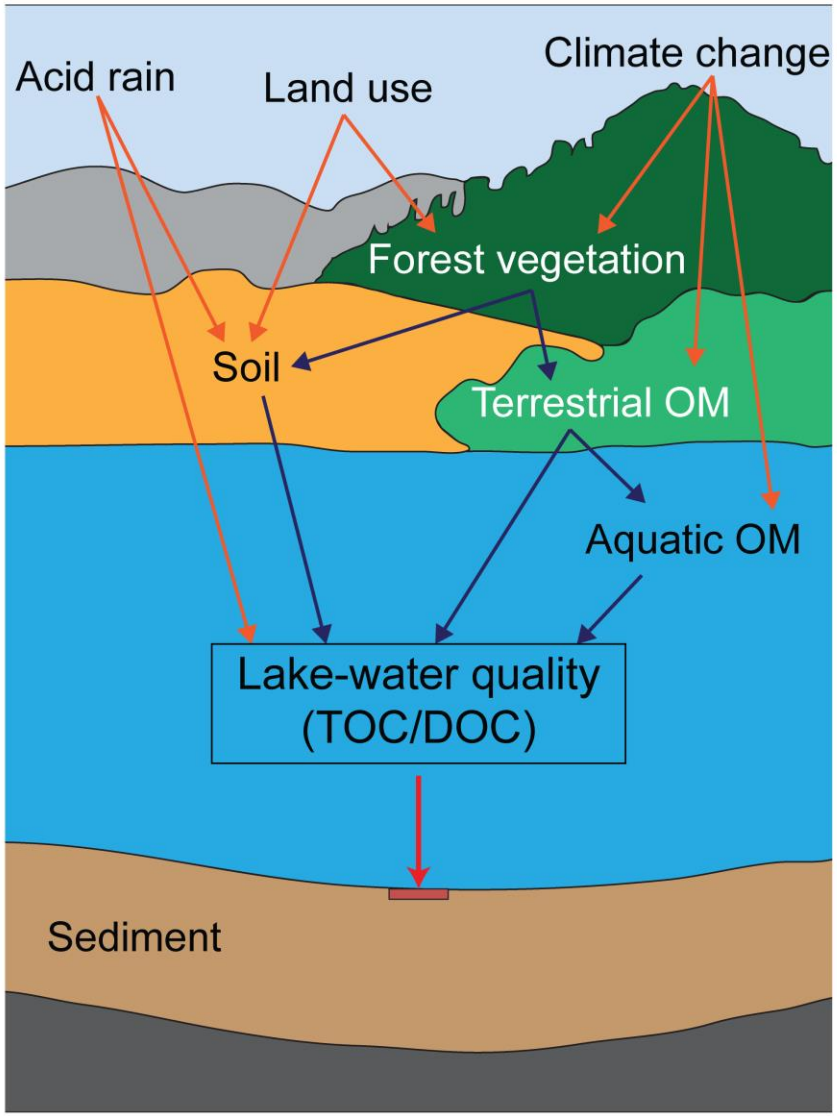
Reconstruction of past lake-water organic C levels



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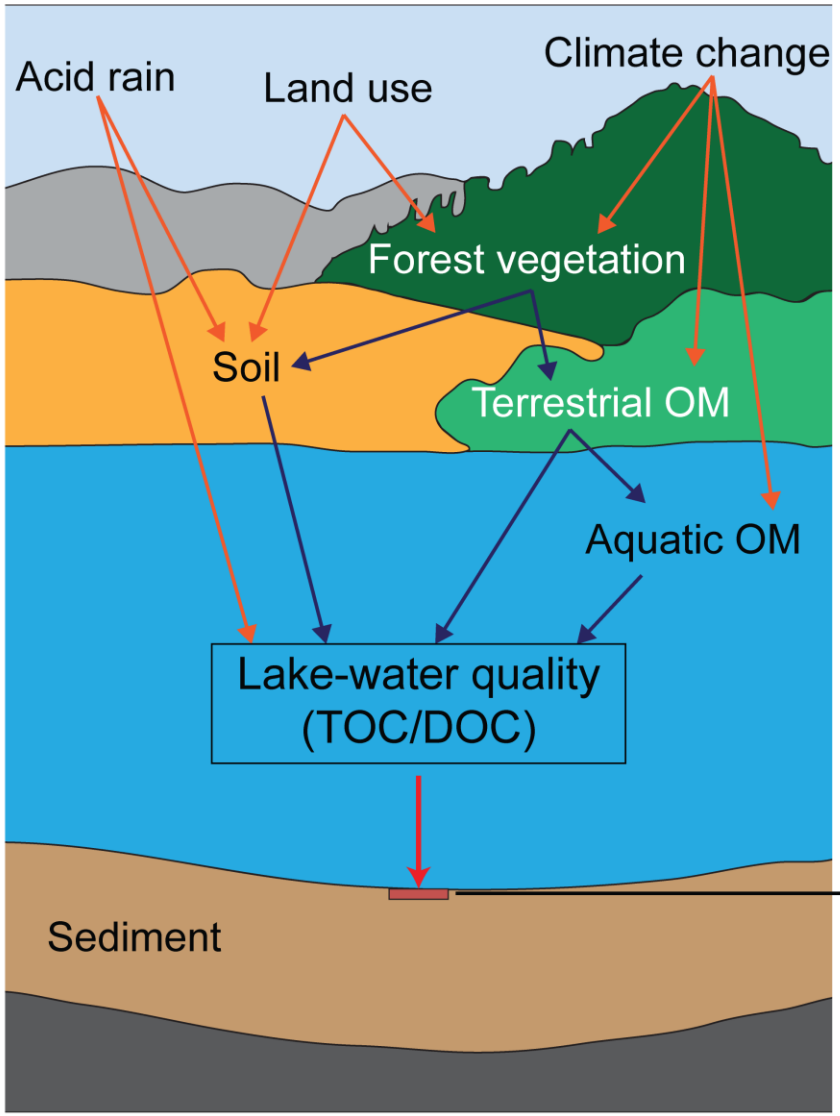
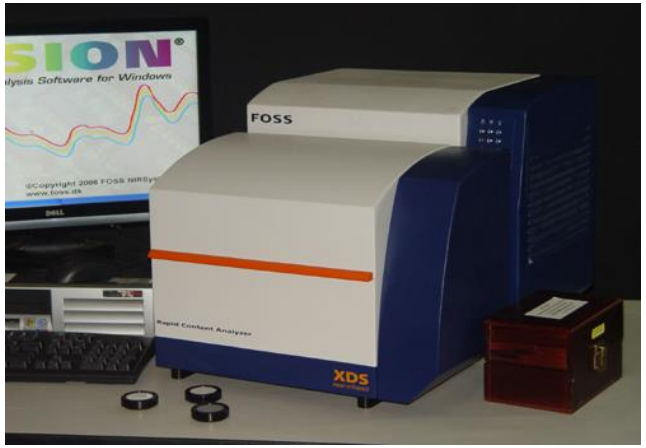
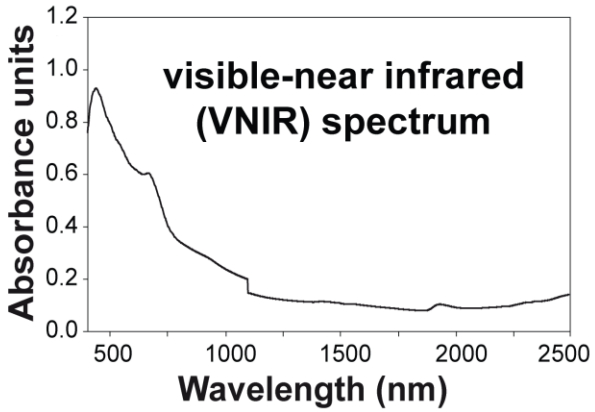
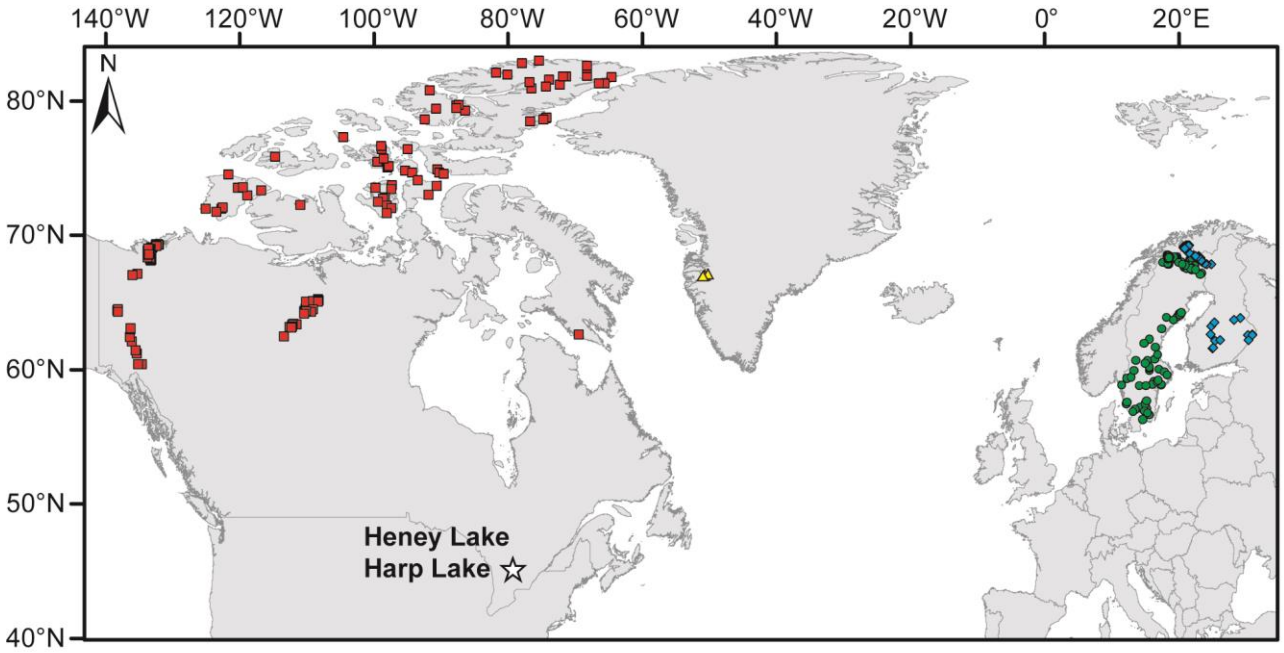


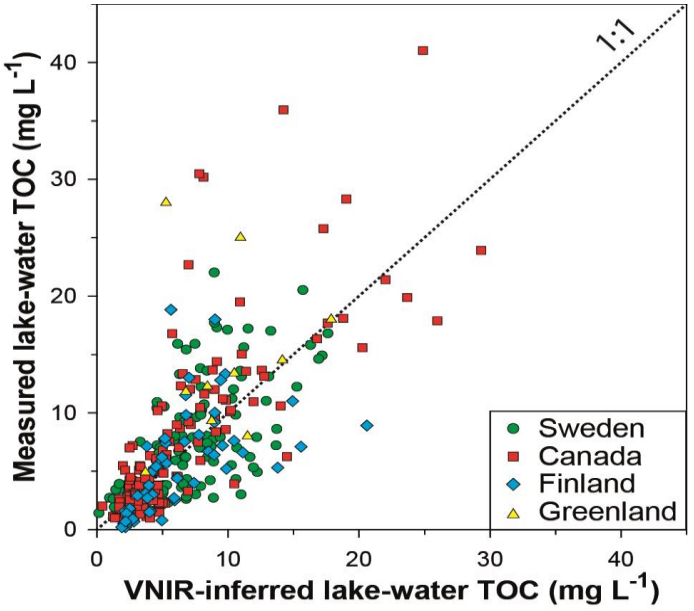


Visible-near infrared spectroscopy



Unified lake-water organic C model for northern lakes



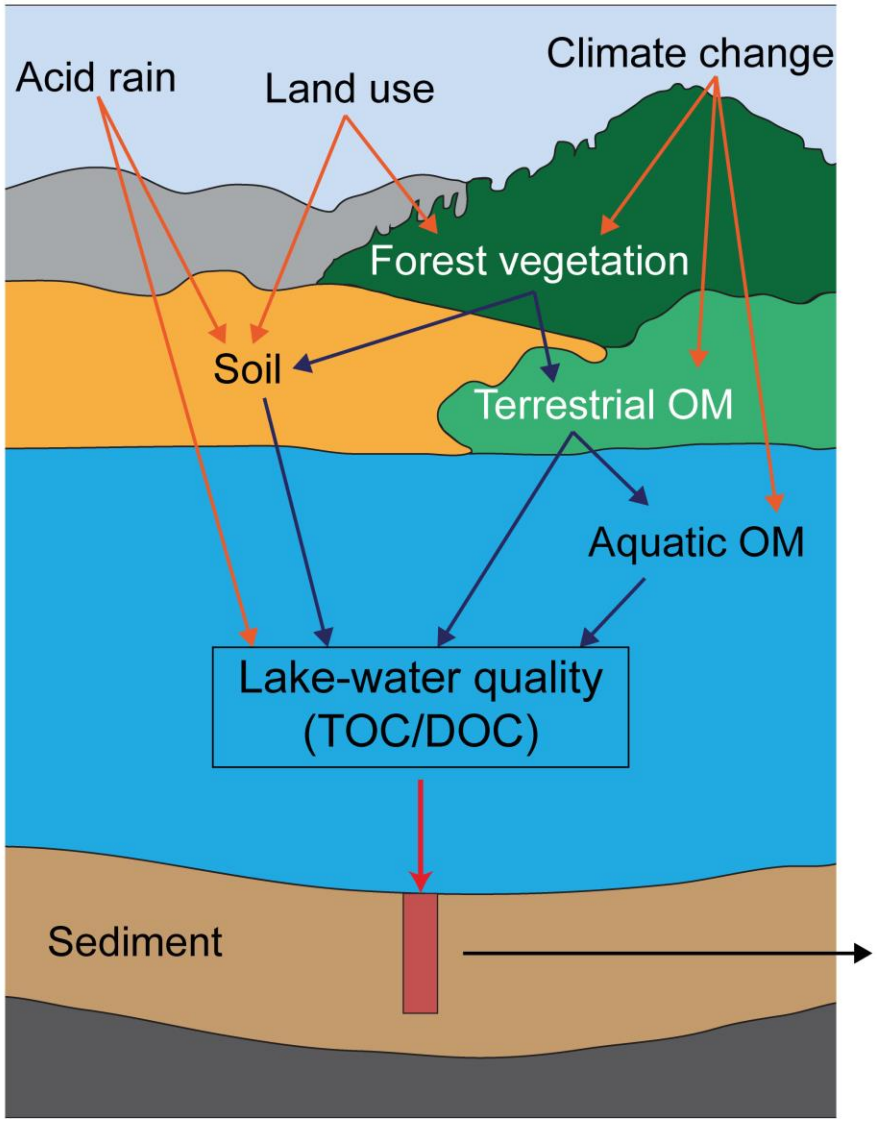


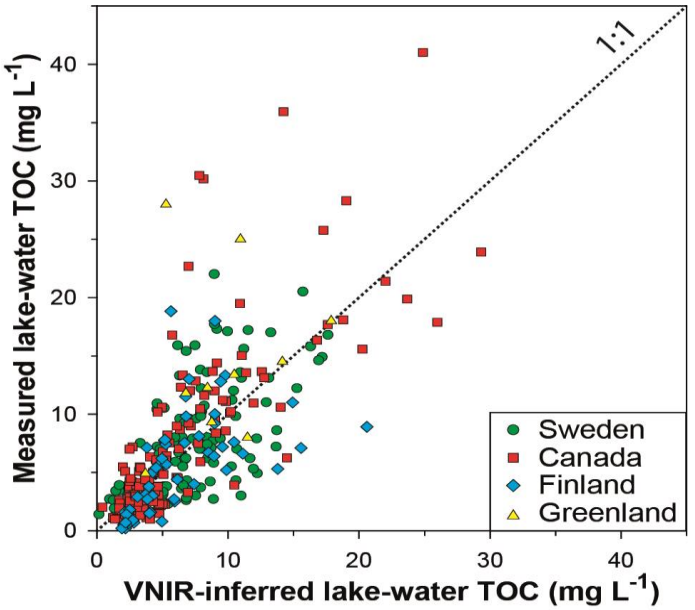
350 lakes from Canada, Greenland, Sweden and Finland

0-41 mg TOC L^{-1}

R_{cv}^2 = 0.56
$RMSE_{cv}$ = 4.5 mg L^{-1}

Reconstruction of past lake-water organic C levels

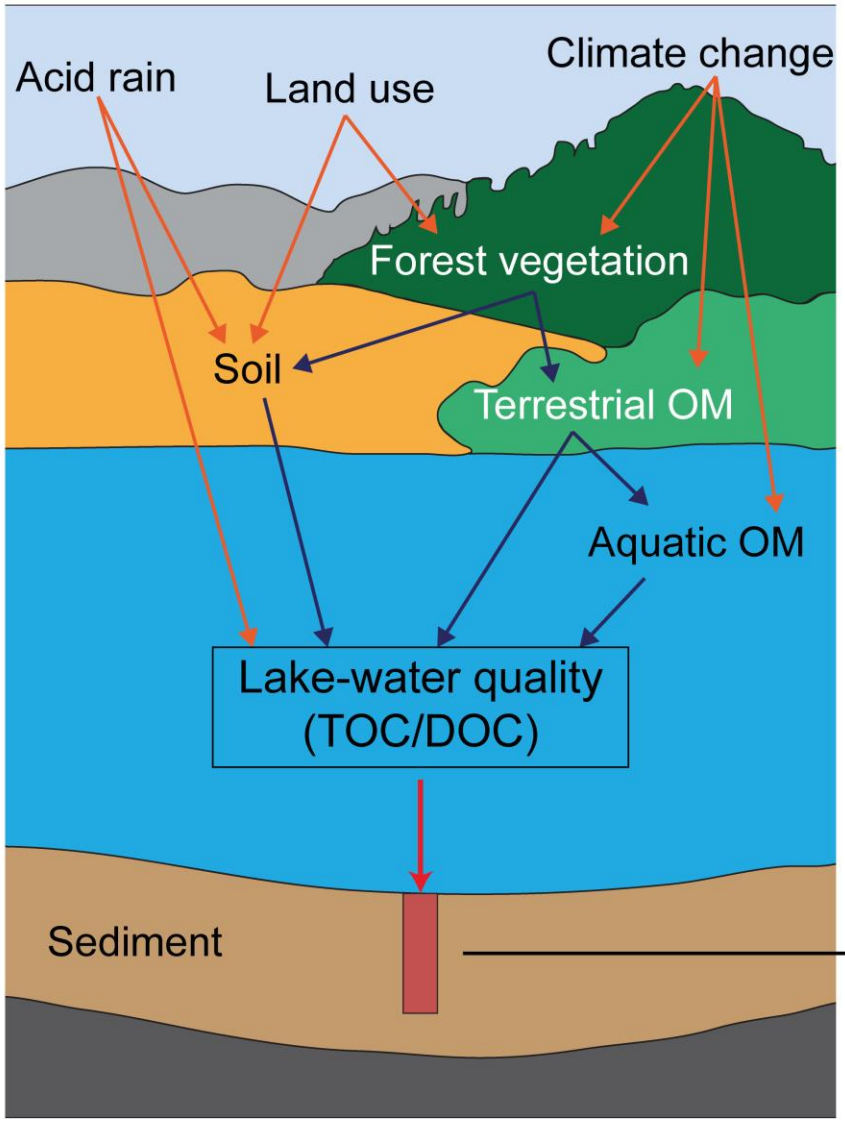


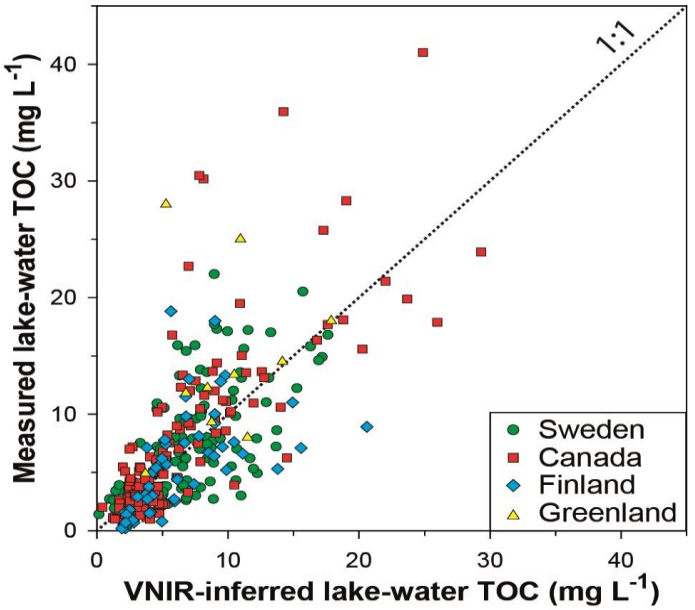


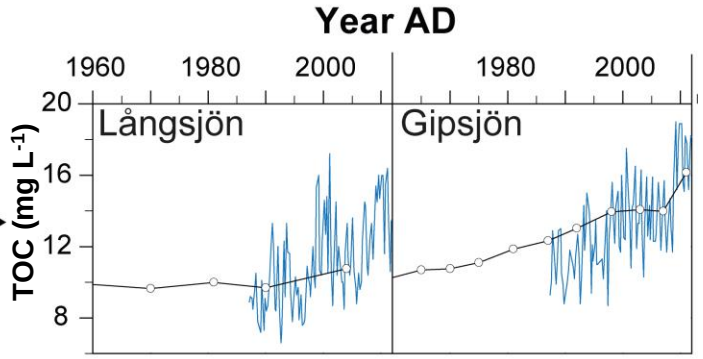
Surface sediment: recent lake environment

Past lake environment

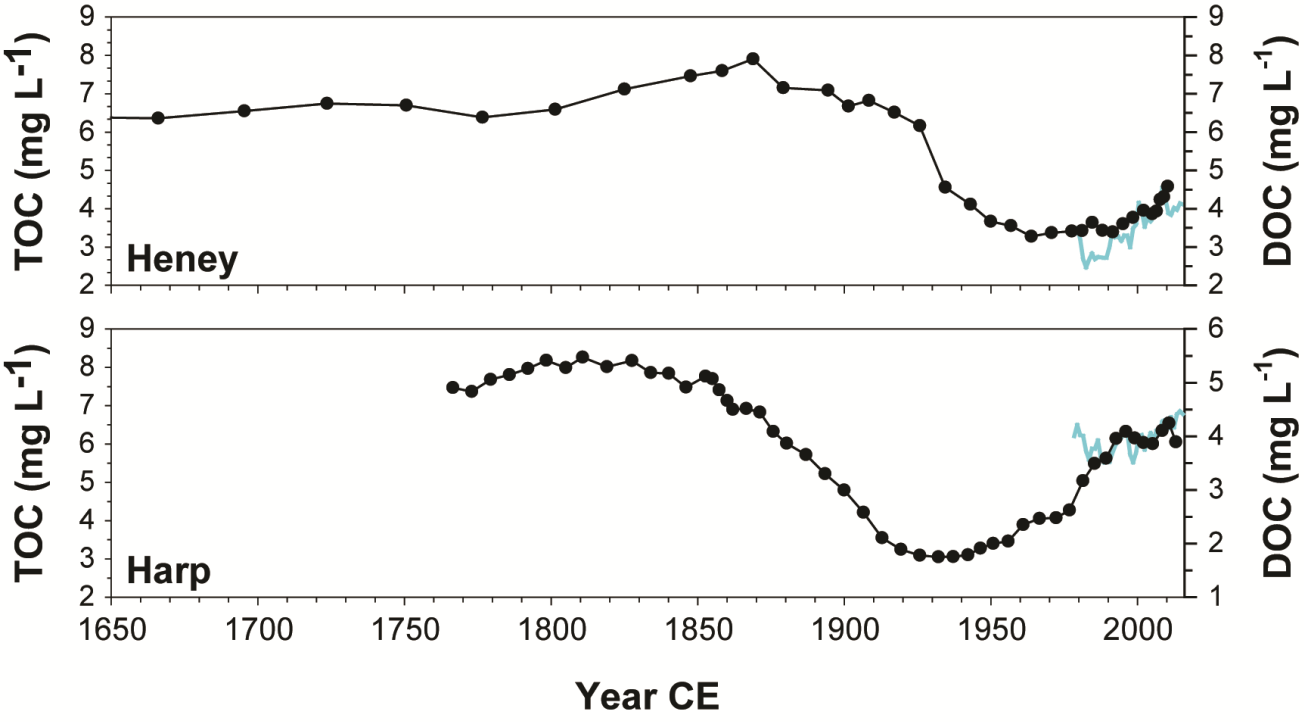
Reconstruction of past lake-water organic C levels



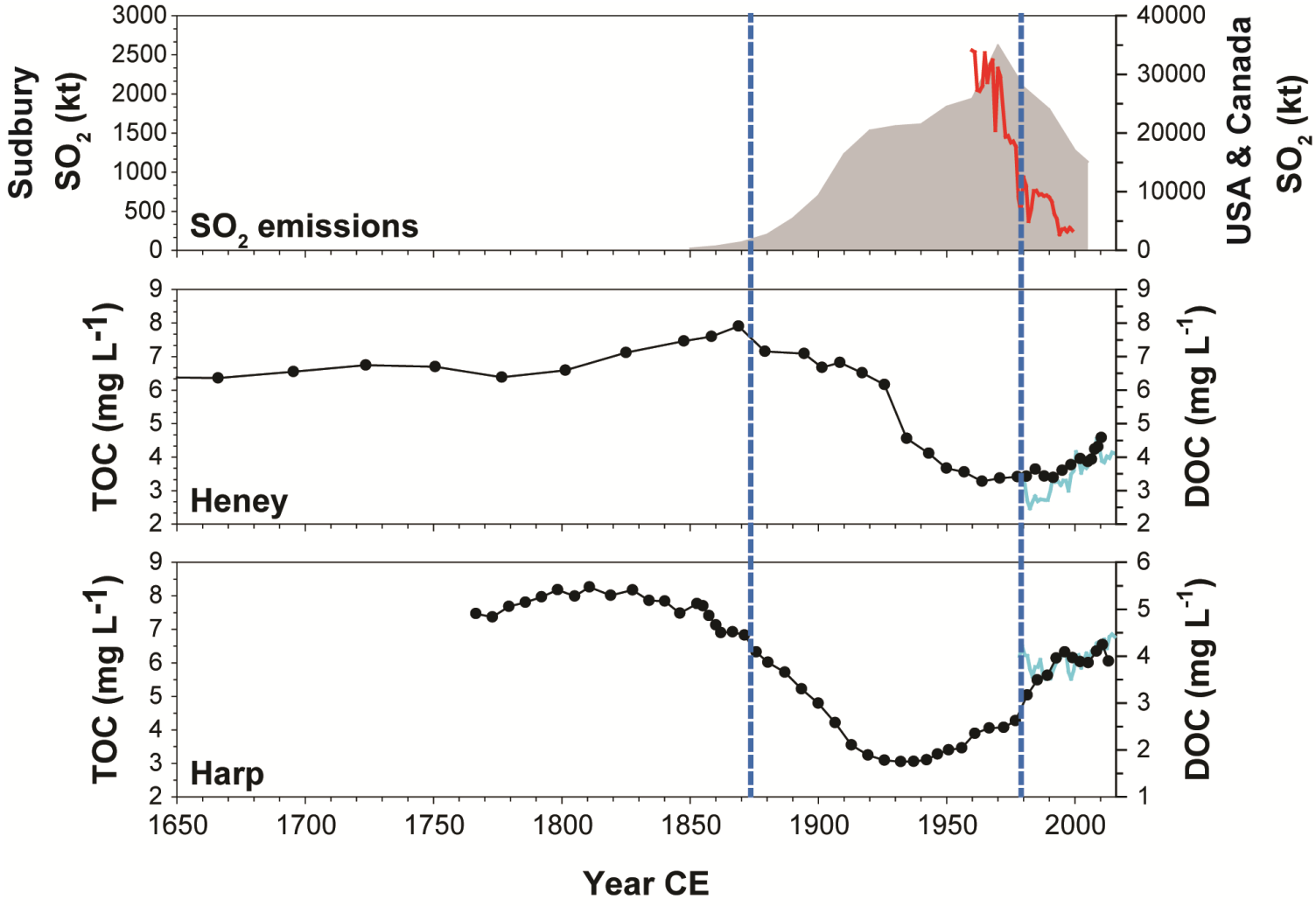




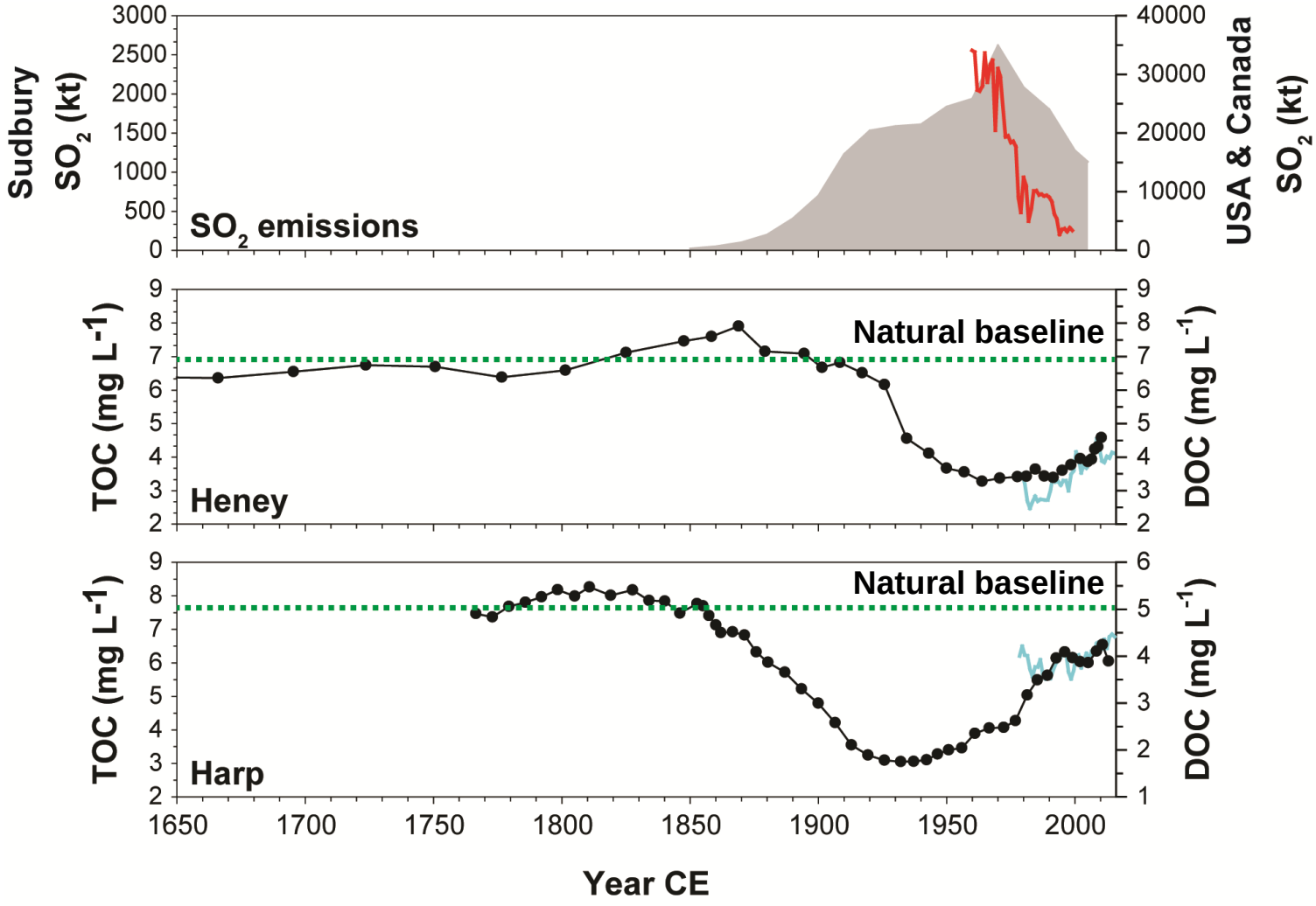
Lake-water organic C trends in the Muskoka watershed beyond the monitoring window



Response to atmospheric acid deposition



Return to pre-industrial organic C levels?



Conclusions

- Paleolimnological approach using VNIR spectroscopy allows to reconstruct past lake-water organic C trends beyond the monitoring window

  - Initial results for the Muskoka watershed:

    - Strong response to past and ongoing changes in atmospheric acid deposition

    - Lakes have not yet fully returned to pre-industrial organic C levels

Acknowledgements

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