Traces of sunlight in carbon biochemistry of shallow subarctic lakes

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Sunlight fuels the drawdown and evasion of carbon in shallow northern lakes. Amplified polar warming is altering the sunlit transport and transformation of aquatic carbon at an alarming rate entailing potential for climate feedbacks. We combined experimental and retrospective approaches to explore the synoptic interlinks between underwater light, aquatic carbon biochemistry, landscape carbon cycling and climate change in two shallow subarctic lakes with divergent light and carbon regime (a clear lake low in organic carbon and a dark organic rich lake). In situ enclosures (treatments under full sunlight, sunlight without the ultraviolet [UV] spectrum, no light) were first deployed on the lakes to decipher the effect of photochemical alteration on the spectral, elemental and isotopic properties of lake water organic carbon pools under short term (four weeks) exposure. We then focused on elemental, isotopic and spectral fingerprints archived in the sediments of the lakes to trace coeval variability in aquatic primary production, terrestrial carbon transport, and underwater light under centennial climate fluctuations. We observed distinct differences in carbon biochemistry between the experimental treatments illustrating the importance of sunlight, and particularly the UV spectrum, in shaping the carbon pools of the lakes already over short time scales. Over the past centennia, sediment biogeochemical composition carried signatures of change in carbon origins (algal vs terrestrial) and shifting underwater light regime. The results shed light on how climate change and sunlight shape carbon flows in shallow northern lakes over short and long time scales.