Goldschmidt 2023 Abstract
https://doi.org/10.7185/gold2023.16765

Acidification of northern New England lakes from rising anthropogenic-sourced atmospheric carbon dioxide concentrations

KAREN H. JOHANNESSON[1], JAXON DII HORNE[2], ANANT MISRA[2], CATHERINE ALIPERTA[2], ORPHEUS V. MELETIS[2], CHRISTOPHER D. WHITE[2], GEORGIA MAVROMMATI[2] AND DAVID J BURDIGE[3]

[1]School for the Environment, University of Massachusetts Boston

[2]University of Massachusetts Boston

[3]Old Dominion University

Presenting Author: karen.johannesson@umb.edu

We evaluated the impact of rising atmospheric CO_2 (i.e., pCO_2^{atm}) due to anthropogenic activities on pH, alkalinity, and acidity of 18 lakes from the north-eastern United States, including Champlain, Winnipesaukee, and Moosehead lakes, using a polythermal, sliding activity/fugacity reaction path model. Atmospheric CO_2 was forced assuming two scenarios from the IPCC's Sixth Assessment Report: 1) scenario SSP2-4.5 in which pCO_2^{atm}attains a concentration of 600 ppm in 2100; and 2) scenario SSP5-8.5 in which pCO_2^{atm} attains 1100 ppm in 2100 [1]. Equilibrium modelling suggests that most of the studied lakes are supersaturated with respect to CO_2 and are thus local sources of CO_2 to the atmosphere. Nonetheless, as pCO_2^{atm} increases, the pCO_2^{water} will also increase proportionally to maintain steady-state in the lakes and keep the lake-to-air CO_2 flux constant [2]. Consequently, the lakes will therefore acidify. The modelling suggests that pH will decrease, on average, 0.15 pH units under scenario SSP2-4.5 and 0.32 pH units for scenario SSP5-8.5. These changes correspond to a 31% and 65% increase in the hydrogen ion activity, respectively. Furthermore, the activity of CO_3^{2-} is predicted to decrease, on average, by 24% and 49%, respectively for SSP2-4.5 and SSP5-8.5, whereas the saturation state with respect to aragonite would decrease by 21% and 45%, respectively. The predicted changes are like those expected for the Great Lakes [2] and the ocean [3], and consequently may impact lacustrine calcifying organisms. Changes in aluminium (Al) speciation resulting from lake acidification are also evaluated and discussed within the context of Al toxicity to aquatic organisms.

[1] Arias et al. (2021) 6th Assessment Report, IPCC, 33-144 [2] Phillips et al. (2015) Oceanography 28 136-145. [3] Orr et al. (2005) Nature 437, 681-686.