Increased photoreactivity of DOC by acidification: Implications for the carbon cycle in humic lakes

Anesio, Alexandre Magno, Wilhelm Granéli

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ABSTRACT: Effects of ultraviolet (UV)-B radiation and acidification on pelagic carbon flux in a humic lake (dissolved organic carbon [DOC] ~15 mg C L21) were studied in a mesocosm experiment during the summer of 2000. Triplicate tanks (107 liters volume, 1 m high) were exposed to natural solar radiation, a daily extra dose of UV-B radiation, or kept dark. One set of tanks was submitted to a decrease in pH (from 5.7 to 4.7), and one set was kept at the natural pH level. During 70 d, water samples were taken regularly from the mesocosms for measurements of DOC, absorbance, dissolved inorganic carbon (DIC), and pH. Additionally, we regularly incubated samples to measure photooxidation rates, primary production, and community respiration. We found an increase in the photooxidation rates in the acidified mesocosms relative to ambient pH. The greater abiotic production of DIC (i.e., photooxidation) in acidified conditions could explain ~27% of the decline in DOC in the same conditions. Laboratory experi ments were done to test the effects of pH on the dissolved organic matter (DOM) photoreactivity. At lower pH values, we found both higher abiotic DIC production and specific absorbance fading, relative to neutral pH values in water from a humic lake. In a separate experiment, samples were exposed to prolonged irradiation under laboratory conditions, resulting in complete loss of absorptivity in the wavelengths between 290 and 400 nm. Decreases in DOC in the long-term exposure caused by photochemical mineralization were ~45 and 55% of the initial pool for natural pH and acidified samples, respectively, at the end of the experiment. An increase in the dissolved organic matter photoreactivity by acidification could be an important mechanism to explain the increased water transparency and in-lake DOC removal in acid lakes found in several previous studies.