Carbon cycling in the epilimnion of Lake Kivu (East Africa): surface net autotrophy and emission of CO_2 to the atmosphere sustained by geogenic inputs

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We report organic and inorganic carbon distributions and fluxes in Lake Kivu, acquired during four field surveys, that capture the seasonal variations. Surface waters of the main basin were a net source of CO_2 to the atmosphere at an average rate of 5.9 mmol m^{-2} d^{-1} which is lower than the global average for freshwater, saline and volcanic lakes. Based on dissolved inorganic carbon whole-lake mass balance of bulk concentrations and of stable isotope data, we show that the epilimnion of Lake Kivu was net autotrophic. This is due to the modest river inputs of organic carbon owing to the small ratio of catchment area to lake surface area. Our carbon budget implies that the CO_2 emission to the atmosphere must be sustained by DIC inputs of geogenic origin from deep geothermal springs. Based on metabolic rate measurements and mass balance considerations, we show that bacterial respiration was not solely sustained by particulate primary production, but also by dissolved primary production.