

Biogeochemistry of nitrous oxide in the suboxic zone in Lake Kizaki elucidated by isotopomer analysis

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Biogeochemistry of nitrous oxide (N₂O) was investigated in Lake Kizaki, Japan where accumulation of N₂O in the water column had been observed. We found greatly high peaks of N₂O concentrations in Oct. and Nov. 2008 in the suboxic hypolimnion. In this suboxic hypolimnion, NO₃⁻ concentration rapidly decreased with seasonal change followed by the increase in nitrogen and oxygen isotope ratios (d¹⁵N(NO₃⁻) and d¹⁸O(NO₃⁻)), indicating the occurrence of denitrification. Then, the ratio of isotopic fractionation factors for ¹⁵N and ¹⁸O (1.04) was nearly equal to the intrinsic ratio of 1 for denitrification. But there is paradox that slightly accumulating NO₂⁻ is implying the occurrence of nitrification. We can explain about this paradox and N₂O accumulation with analysis of the intramolecular distribution of ¹⁵N (site preference; SP) and nitrogen isotope ratio of N₂O (d¹⁵N_{bulk}) combined with isotopic data of NO₃⁻ and ammonium (NH₄⁺). This analysis strongly suggests the both denitrification and nitrifier-denitrification were the sources for the N₂O, and strong N₂O reduction occurred simultaneously in this deep hypolimnion. This study illustrated the powerfulness of isotope and isotopomeric analysis of NH₄⁺, NO₃⁻ and N₂O to elucidate the complex biogeochemistry of N₂O in an intact ecosystem.

Keywords: nitrous oxide, lake water, suboxic zone, stable isotope ratio, N₂O isotopomers (SP), nitrifier-denitrification