Field verification on high gross nitrification in the surface soils using oxygen isotope of nitrate in a temperate forest in Japan

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In order to elucidate the intensity and mechanism of the impact of atmospherically derived nitrate on the soil nitrogen dynamics, dual isotope measurements on nitrate ($d^{15}N$ and $d^{18}O$) in soil waters were conducted in a forested watershed in central Japan. The $d^{18}O$ of nitrate in rainwater is generally higher than that produced by nitrifying bacteria in soils. Accordingly, the $d^{18}O$ can often be used as an index of the impact of the atmospherically derived nitrate. While soil waters within less than 20cm in depth had a strong signal of the atmospheric nitrate, the $d^{18}O$ of nitrate in soil water decreased in the deeper soil horizons, indicating that the dominant source of nitrate in this soil profile was nitrification. The net nitrification rate of this soil profile was separately measured, and was about 18 kg-N $ha^{-1}year^{-1}$, and deposited nitrate was about 6 kg-N $ha^{-1}year^{-1}$. Assuming that the annual mean $d^{18}O$ of deposited nitrate was 60 permil, and the mean value of bacterially produced nitrate in soil was about 0 permil, the average value for soil nitrate pool could be ˜15 permil. However, the observed $d^{18}O$ of the soil and groundwater was 0 to 6 permil, and was remarkably smaller than the above estimation based on annual mass balance. This may suggest that the gross nitrification was sufficiently higher than net nitrification rate, and the major portion of nitrate produced in soil was reused quickly by microbes. Previous studies using isotope dilution method usually conducted in laboratories that the gross nitrification in soils was several times higher than net nitrification. We could verify this phenomenon from our $d^{18}O$-nitrate measurements of the field samples.