Evaluating Regional Patterns in Nitrogen Sources to Watersheds in National Parks of the Rocky Mountains using Nitrate Isotopes

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Abstract

In the western United States, anthropogenic emissions of NO_x (nitrogen oxides) and NH_3 (ammonia) from energy generation activities, transportation, industry, and agricultural activities contribute to nitrogen (N) deposition in high-elevation watersheds. There is considerable uncertainty in the source areas and emission types that contribute to N deposition, which can adversely affect sensitive aquatic habitats of high-elevation lake basins. In this study, the spatial variability in nitrate isotopes was evaluated at sites across National Parks of the Rocky Mountains, including 37 lakes and 7 precipitation sites. Results for lakes sampled in 2004 during late summer indicate that nitrate concentrations ranged up to 38 μeq/L, $\delta^{18}O$ (NO_3) values ranged from -5.7 to +21.3 permil, and $\delta^{15}N$ (NO_3) values ranged from -6.6 to +4.6 permil. $\delta^{18}O$ (NO_3) in precipitation ranged from +71 to +78 permil. $\delta^{15}N$ (NO_3) in precipitation and high-elevation lakes overlap, however, the precipitation samples are lighter ranging from -5.5 to -2.0 permil. Regional patterns indicate that $\delta^{15}N$ (NO_3) values are heaviest in high-elevation lakes and precipitation collected from National Parks in the Southern Rockies and are lighter in the Northern Rockies. $\delta^{15}N$ (NO_3) values are significantly related (r-squared = 0.6) to deposition estimates of inorganic N, sulfate, and acidity, suggesting that the spatial variability of $\delta^{15}N$ (NO_3) over the Rocky Mountains is related to sources. There is a significant positive correlation (r-squared = 0.8) between $\delta^{15}N$ (NO_3) and total stationary source NOx emissions from electrical power generation plants within a 300 km buffer of the National Parks. This suggests a contribution of both local and regional sources, and may indicate a greater contribution of NO_x emissions from coal combustion in electric generating units to N deposition in Colorado parks than in the Northern parks.

Keywords: Atmospheric Deposition, Nitrate Isotopes, Alpine Lakes, Rocky Mountains