Understanding natural nitrogen enrichment in subtropical acid forest soils by examining nitrogen transformation dynamics

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Most temperate forest ecosystems appear to be N-limited, while many humid subtropical and tropical forests may be naturally N-enriched. The N status of relatively young temperate soils may differ markedly from that of highly weathered subtropical-tropical ecosystems. Humid subtropical and tropical forest soils are generally characterized by rapid N cycling rates and high N availability. However, to date, the mechanisms underlying the retention of inorganic N in humid subtropical forest soils have not been quantitatively investigated in detail based on N transformation dynamics. In this study, five typical temperate forest sites located in northern China (defined as northern soil) and four typical subtropical forest sites located in southern China (defined as southern soil) were selected (Lat. 47°35'N to 19°04'N and Long. 109°31'E to 133°31'E, Table 3). All sites were located in nature reserves. We used a combination of ^{15}N tracing experiments and full process-based N cycle models to quantify process-specific and pool-specific N transformation rates. Our results showed that compared to northern soils, the humid subtropical acidic forest soils of southern China had significantly higher gross rates of N mineralization (3.04±1.03 mg N kg^{-1} d^{-1} vs 1.80±0.50 mg N kg^{-1} d^{-1}; $p<0.05$) and a significantly higher turnover rate (554±307 d vs 2519±1419 d; $p<0.01$) (Fig. 1). However, southern soils had a much higher capacity for retaining inorganic N than northern soils, as indicated by their significantly lower ($p<0.05$) autotrophic nitrification rates (0.14 ± 0.17 mg N kg^{-1} d^{-1} vs 1.07 ± 1.57 mg N kg^{-1} d^{-1}) and significantly higher ($p<0.01$) rates of NO_3^- immobilization into organic N (0.65±0.41 mg N kg^{-1} d^{-1} vs 0.04±0.11 mg N kg^{-1} d^{-1}), which afforded them protection against N loss from leaching, runoff, and denitrification. We proposed that the mechanisms for retaining inorganic N in acidic forest soils in southern China is a combination of higher N production and much stronger capacities for the immobilization of inorganic N.

Acknowledgments

This work was supported by grants from the Priority Academic Program Development of Jiangsu Higher Education Institutions.