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Biogeosciences Discussions

Interactive comment on "Geomorphic control on the δ^{15}N of mountain forest" *by* R. G. Hilton et al.

Anonymous Referee #1

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General comments

This paper deals with the N cycle in terrestrial forest ecosystems, using natural abundance stable nitrogen isotopes to track especially N export from mountainous forests in Taiwan. The paper uses relatively few measurements to inform model calculations that export of leaves can be important in controlling ecosystem N stocks. The leaves have low N isotope values, and export loss of leaves and particulate materials derived from leaves could lead to the observed high N isotope values in residual soil N pools, pools where most ecosystem N resides. The paper is broadly consistent with an early ecosystem N isotope model from the 1970s (Shearer et al. 1974). That model envisions the terrestrial N cycle as turning many times in a largely N-retentive way, with small losses at each turn having 14N-enriched (and 15N depleted) isotopic compositions. Those losses cumulate in higher 15N values observed in soils worldwide. The current study extends this modelling idea to explicitly consider export of particulate materials as the main vector of 14N-enriched export, calling attention to correlations of N isotope values in leaves and soils with slope (Fig. 6), correlations expected when export is strong.

Specific comments

The questions for this manuscript are mostly in the data and concepts, i.e., first was enough data collected to be convincing, and second is the proposed correlative export mechanism the most plausible among other explanations? The number of samples was relatively few across two transects, but enough to show interesting trends that seemed evident in other systems as well (Figures 3 and 6). Still, little consideration seemed to have been given to sampling along gradients of ecosystem age or succession that may influence these same N isotope patterns (Hobbie et al. 1999). Conceptually, inputs as well as outputs can be important is determining the average N isotope value of ecosystems, and input values might vary across the mountain ranges where for example fog and condensation might mean more atmospheric N deposition or wetter conditions favouring N fixation. Correlations with slope might be supported in such cases, but the mechanism of N isotope change would not be N export. Or, the export of particulates may be important, but only one mechanism among many, with the multi-loss scenario consistent with early thinking by Shearer and Kohl. That early thinking would also indicate that it is the number of times N is recycled, the biological cycling age, rather than the calendar age, that controls N isotope evolution in soils.

In this study, authors argue that the export of particulate organics accounts for the major N loss term in steep hillslope systems, and because these exports are likely to have low N isotope values, that this is the dominant process controlling N isotope distributions in the remaining soils. Authors show that the isotope difference between plants and soils is fairly constant across sites and slopes at about 4oo/oo, but it is the average of the ecosystem N (plants + soils) that is varying. Other work by Hobbie et al. (1998) give an explanation of these same patterns but invoke N inputs as important in setting isotope trends across time and space. The current study does not report

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Interactive Comment

N isotope values for inputs, and one wonders if the correlations related to slope are in fact driven by inputs and not losses. In this sense, the paper seems incomplete, especially, could slope conditions be forcing differences in input amounts and isotopes? The answer is uncertain. Also, the modelling emphasizes an overall cumulative loss based partly on anomalously low C/N ratios that may not be realistic (see technical comment below), and generally does not consider recycling in favour of a simpler first order unidirectional loss term. In sum, several pieces of the story seemed lacking and there was no experimental work validating the correlations, but the authors do make a reasonable and common-sense case that loss of PON with low N isotopes will, by difference, help drive up N isotope values in remaining ecosystem N pools.

Technical comments

There are relatively few (12) soil samples analysed and some have very low C/N ratios, so that 5 of the 12 samples have C/N ratios below 6. These seem anomalously low values for soils that usually have values >10. The low C/N values are used to guide the modelling, introducing the possibility that the modelling is based on poor data. However, the main results of soils with higher N isotope values than plants (Fig. 3) is the general pattern seen in many other studies, and the main subject of the paper. This pattern is the main focus of the modelling.

Literature Cited

Hobbie, E.A., S.A. Macko and H.H. Shugart. 1999. Patterns in N dynamics and N isotopes during primary succession in Glacier Bay, Alaska. Chemical Geology 152:3-11.

Shearer, G., J. Duffy, K.H. Kohl and B. Commoner. 1974. A steady-state model of isotopic fractionation accompanying nitrogen transformations in soil. Soil Science Society of America, Journal 38:315-322.

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