

## ***Interactive comment on “Measuring ecosystem nitrogen status: a comparison of proxies” by M. Almaraz and S. Porder***

**Anonymous Referee #2**

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BG review This paper poses an interesting and important question about whether different metrics used to characterize N availability (which represent different spatial and temporal scales) are correlated. This topic is of potential interest to a broad group of researchers who consider N availability in their studies. The paper attempts to evaluate some underlying assumptions that are included implicitly or explicitly in interpreting ecosystem N dynamics. The scope of the analysis is not really clear from the paper. It is a little surprising that the authors did not include several large syntheses of similar data (Aber et al. 2003, BioScience, Pardo et al. 2006 Biogeochemistry, the CANIF study in Europe, Schulze 2000 Springer). The scope of the analysis is important, because it can be difficult to make assertions about different climatic zones or life forms unless enough variation is included among the samples to represent that observed

Several issues should be addressed: Nitrate leaching is referred to as if it were

C1

the driver of the fractionation that would lead to  $^{15}\text{N}$ -enrichment of material remaining in the ecosystem (soil, foliage). In fact the elevated nitrification which leads to an increase  $\delta^{15}\text{N}$  of the plant available (including the nitrate that leaches to the stream) is the driver. The authors are, no doubt, well aware of this, but it is worth taking the trouble to be more precise for the reader less familiar with these dynamics. This should be addressed at several points in the paper. The isotope literatures is not as current as it could be I have given some examples of possible additional citations. I assume that when the authors talk about long-term patterns and measures that are invariant temporally, that they mean in undisturbed systems. This should be stated explicitly, since over the long term, at many of these study sites, various disturbances have occurred which disrupt that N cycle and which would affect the values of these metrics. Need to define what is meant by N status More explanation about the differences between observed correlations in tropical versus temperate systems would be useful (why were foliar and soil  $\delta^{15}\text{N}$  correlated in tropical, but not temperate?)

Abstract: 10 if space permit, include the region considered in this study

19 is there a ‘that’ missing? i.e., given that both. . .

27 why ‘Nevertheless’? what follows doesn’t not seem to contrast with what was said in the first sentence.

31 don’t really need ‘such’ on this line

32 I would suggest adding ‘rates’ after mineralization and nitrification, to make the comparison to another flux clearer. Also, the verb needs to agree with the subject is→are

33-4 This is an important point (basing annual budgets on short-term measures) and one that is often ignored.

34-6 There seems to be a word missing or a punctuation problem. Is ‘are relevant’ associated with scales or N status?

C2

47 when is it not true that DON is not accessible to plants? Are those situations relevant here?

53-4 Presumably, the assumption is that DIN:DON integrates well over time in the absence of disturbance of any sort that disrupts the N cycle.

59 soil  $\delta^{15}\text{N}$  'represents the cumulative loss of N' is a bit narrow as a definition—more broadly, it reflects the net of all biotic transformations (that are fractionating)

60 this text needs to be changed to be more precise. Nitrate leaching is not a fractionating process. I presume the authors are using 'nitrate leaching' as shorthand to represent nitrification followed by nitrate leaching. It is worthwhile being clear about this for readers less familiar with isotope dynamics.

61 the phrase 'remains in relative abundance' is an odd locution. There are many standard ways to express this:  $\delta^{15}\text{N}$  increased, the soil becomes enriched in  $^{15}\text{N}$ , etc.

62 insert comma after degree 62-3 see also Pardo et al 2006 for relationships between foliar and soil  $\delta^{15}\text{N}$

63 word missing after bulk→bulk soil

66 Additional more recent refs include: Cheng et al 2010 Plant and Soil 337:285-297; Pardo et al 2013 Biogeochemistry ; Templer et al. 2007 Oecologia, etc.

70 nitrification and mineralization measurements are not all short term. Buried bag measurements are often made over a year or longer. If the authors are referring only to short term lab incubations, they should call it net nitrification potential.

71 is foliar  $^{15}\text{N}$  temporally integrated?

80-82 do these numbers represent the number of sites included or do they include repeated measures at the same site? There should be some indication in the methods about the region and geographic extent of the sites included in the study. At the very least, mention should be made of the supplemental material.

C3

87-90 Is this level of detail necessary?

90 What is meant by 'intact'? does this mean 'not fragmented'? Or is it intended to include disturbance as well? And if so, only anthropogenic disturbance (e.g., harvesting) or also natural (fire, wind, ice or pest events, etc.)?

92 Is there a list of the sites in supplemental information? (cite supplemental material here)

101 Is it appropriate to lump net nitrification potential measures with measures of nitrification? This should be justified.

105-6 This level of detail is unnecessary.

107 Are these five watersheds identified somewhere? Supplemental material?

137 How is foliar  $\delta^{15}\text{N}$  on the same timescale as bulk soil  $\delta^{15}\text{N}$ ? The plant available portion of the soil pool is very small and is not what is measured by bulk soil. Foliar %N and  $\delta^{15}\text{N}$  can vary on very short time scales. Bulk soil  $\delta^{15}\text{N}$  may vary in response to disturbance, but the soil N pool is many orders of magnitude larger than the foliar N pool.

141 What does 'that' refer to in this sentence (that of water-based proxies)

144 Does the absence of a correlation between soil solution and stream DIN:DON suggest that stream DIN:DON does not reflect what is available in the terrestrial ecosystem?

155 Foliar  $^{15}\text{N}$  is not an integrator on the time scale of decades to centuries

160 It seems a fairly broad interpretation to say that these data suggest that correlations between categories 1 and 2 are robust—some of them may be, but not all of them. To what extent is it reasonable to extrapolate this finding?

171 I don't see why one would expect DIN:DON to be correlated with soil  $^{15}\text{N}$ , they are

C4

measuring very different things.

178 Is DIN:DON more sensitive to N deposition than DIN?

183 What does it tell you if soil solution DIN:DON is not correlated with stream DIN:DON?

198 Hydrologic flowpath and flowrate are also probably important.

2002-4 Work by K. Lohse et al. addresses these issues.

Figures and tables

Fig 2 there is a lot of useful information in Figure 2, but the graphs are too small and are illegible. The format, in the end, is more clever than useful. It would be better to enlarge the graphs a bit so that it is easier to resolve the patterns. (The quality of the figure in the paper I downloaded is fair, but I assume there is a high resolution version).

The size of the statistical info is fine and legible. It might be easier to follow if it were presented in the same triangle configuration as the figures (as opposed to flipped) or else in a table.

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