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Biogeosciences Discussions

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

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Author's Response to Comments by Referee #1

We thank the reviewers for their thoughtful comments, which we think have led to substantial improvements in the manuscript. Below we provide a detailed list of responses.

Anonymous Referee #1 Received and published: 18 April 2016

Referee #1: This study presents a comparison of different proxies for assessing the nitrogen status of terrestrial ecosystems. Such proxies are essential if we are to assess the influence of nitrogen on these ecosystems, but various proxies exist and it is yet unclear which proxies are to preferred above others, and how the different proxies relate to one another. The current study addresses primarily the latter. Although I

find this a useful effort, I think especially the analyses require revisions to improve the quality of this study.

General comments: As the study is now it is only indicative of the relationship between different proxies of nitrogen availability, and although differences between biomes are discussed, I think additional analyses are required to be able to draw firm conclusions regarding the difference among e.g. boreal, temperate and tropical systems. So, I suggest that the authors test statistically if for example the relationship between soil d15N soil and foliar d15N differs between temperate and tropical systems (as suggested on l. 167-168).

Response: We thank you for this suggestion and agree with the idea. Although we lack statistical power in boreal regions to test how these relationships change, we do discuss how they differ between temperate and tropical ecosystems in lines 179-185. We have also included the following text to address the way in which these relationships change:

Lines 179-185: "Some relationships between proxies differed with latitude. Soil and foliar δ15N were more tightly correlated in the tropics (n=24, τ=0.68, p<0.0001) than in the temperate zone (n=49, τ=0.23, p=0.02). Soil δ15N was correlated with net nitrification in tropical (n=17, τ=0.39, p=0.03), but not temperate regions. Conversely, soil δ15N was correlated with net N mineralization (n=44, τ=0.34, p=0.001) in temperate but not tropical areas. Stream DIN:DON was correlated with net nitrification (n=10, τ=0.63, p=0.01) and N mineralization (n=10, τ=0.78, p=0.002) in temperate zone, and not in the tropics (n=4, p>0.05)."

Lines 244-253: "While most observed correlations were consistent across latitudes, a few differed between the tropics and the temperate zone. The correlations of soil 15N with foliar 15N, foliar 15N with net nitrification, and net nitrification with N mineralization were consistent across both tropical and temperate regions. Net nitrification and N mineralization were correlated with stream DIN:DON only in temperate re-

gions. These data suggest that while terrestrial proxies may be a useful across biomes, stream DIN:DON requires further research to understand the extent of its applicability across space. The correlation between foliar and soil δ15N also differs across latitudes, in that the correlation in the tropics was much tighter than in the temperate zone. Bias in the literature towards natural abundance isotopic data from the temperate zone may explain why previous research looking at this relationship has been noisy (Craine et al., 2009)."

Finally, we note that we did not test these relationships using regression, rather non-parametric correlation. Other than comparing the strength of the correlation, this makes it difficult to determine statistically whether the nature of the relationships vary with biome.

Referee #1: Although I understand that the potential proxies are numerous and choices need to be made, I wonder why authors did not include soil C:N ratio. This ratio is often considered a good indicator of soil nutrient status (see e.g. Alberti et al 2015, iForest 8, 195-206). It is also an easy measurement to make so I advocate to include this ratio in the study.

Response: We agree, soil C:N would be another useful proxy, since as the reviewer notes it is commonly measured, and is highly correlated with soil and plant δ15N (Craine et al. 2015, Plant and Soil, (369): 1-26). However, at this stage including C:N would require us to withdraw the manuscript and revisit the literature, an exercise that might prove useful but our suspicion is would not change the conclusion of this manuscript. We have however updated the sentence in lines 92-96 to say: "We chose these metrics because 1) other authors have suggested that they are indicative of soil nutrient status (Martinelli et al., 1999, Amundson et al., 2001, Brookshire et al., 2012; Figure 1), and 2) they are thought to integrate N fluxes on different timescales (e.g. soil δ15N integrates N losses over decades while net N mineralization rates integrate inorganic N production over days; Binkley and Hart, 1989, Hogburg 1997)."

Referee #1: I wonder if the authors could test for the influence of the distance between watershed and stream in the analysis of the correlation between soil proxies versus stream DIN:DON (perhaps with a subset for which this info is available).

Response: Unfortunately distance from the stream is rarely reported, especially when terrestrial metrics are gathered from different papers than that of water-based metrics (which was typical). We have updated the text to include this point in lines 125-126: "Terrestrial metrics were typically gathered from different papers than that of water-based metrics, requiring validation of congruent watershed location."

Another issue along the same lines it that other land-uses in the greater watershed are rarely reported either, which can potentially influence the relationship between soil and stream metrics. We revised the text to raise this point in lines 240-243: "varied land-use (e.g. pasture, N fixing plant species, etc.) upstream of undisturbed sites is typically not reported in the literature, but is another possible explanation for the break down between terrestrial and water-based proxies."

Referee #1: Finally, I suggest that the authors make their dataset available. At minimum, a list of sites and coordinates should be given, but I hope authors can also provide the associated data for the various proxies.

Response: Along with the manuscript, we submitted a supplementary zip file with the complete data set, including a list of sites and complete citations for papers we extracted data from. We apologize if this was not made available and will inquire with the editor about its status. We also plan to include an additional figure that outlines the approximate location of our sites (see Fig. 2b).

Referee #1: Specific comments: l. 9: bracket after 'correlate' should come before 'correlate' l. 46: remove 'in solution' (dissolved is obviously in solution) l. 70: I suggest to rephrase 'we asked which were correlated'

Response: We corrected these. Thank you.

Referee #1: l.181-182: I disagree with this statement that category 1 and 2 proxies showed a robust relationship. In a dataset with huge variation (like this one), a significant correlation between 2 metrics does not necessarily imply a robust relationship, and visual inspection of the relationships in Fig. 3 does not support the statement. There is some correlation, but there is a lot of unexplained variance.

Response: We agree this statement was misleading as stated. We have adjusted the text to point out the statistical significance and removed the word "robust". The sentence (lines 193-194) now reads: "Our data suggest that category 1 and 2 metrics are correlated".

Referee #1: l.194- 198: How is d15N of soil (and plants) influenced by N deposition? If N deposition influences soil and plant d15N, the use of these proxies globally may not be ok because similarly rich sites would differ in d15N depending on the N source.

Response: This is a good point. Our data show no evidence of N deposition on plant or soil δ15N, but many of our sites do not have N deposition data. We have revised the text to reflect this in lines 208-2011: "In our dataset, N deposition was not correlated with stream DIN:DON (τ=0.03, p>0.05), or any other metric. Thus our data do not support the idea that N deposition is responsible for the lack of correlation between these two long-term proxies."

Referee #1: l.211: 'that' after 'seem' and 'to' after 'used

Response: We corrected this. Thank you.

Please also note the supplement to this comment:
http://www.biogeosciences-discuss.net/bg-2016-43/bg-2016-43-AC1-supplement.zip

Interactive comment on Biogeosciences Discuss., doi:10.5194/bg-2016-43, 2016.

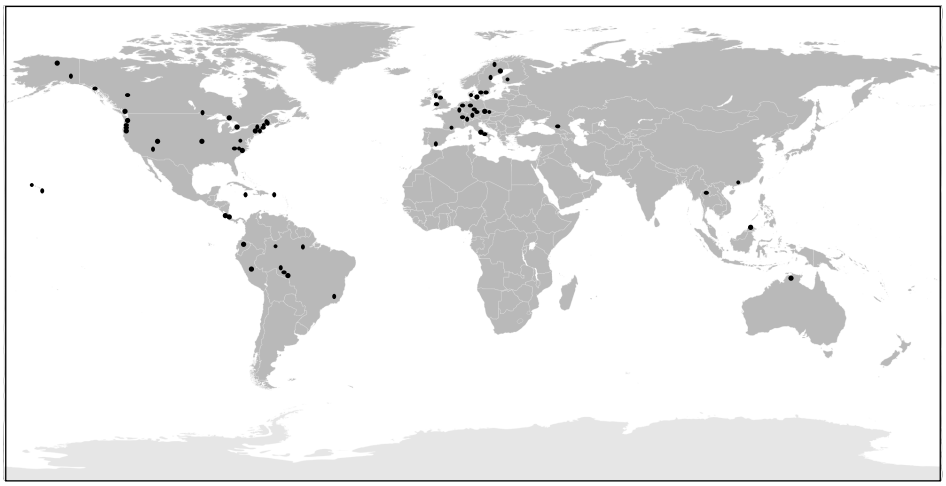

Fig. 1. Figure 2. a) Distribution of grassland (grey) and forest (black) watershed mean annual temperature (MAT; °C) and mean annual precipitation (MAP; mm yr-1) included in meta-analysis (left). b) Location