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Interactive comment on "Chemical footprints of anthropogenic nitrogen deposition on recent soil C : N ratios in Europe" *by* C. Mulder et al.

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R[eviewer's] C[omment]: Reactive nitrogen (Nr) deposition certainly has an impact on soil C:N ratio, but the extent of this impact is difficult to assess. The approach chosen here is a statistical analysis of large datasets on C:N ratio and atmospheric Nr deposition in Europe. Results of the study reveal intuitively correct relationships. My concern is that the statistical approach may not have taken into account that regions with productive soils (C:N ratio mostly around 10) historically provided for a higher population density than elsewhere.

A[uthors'] C[omment]: Indeed, the concentration of human activities leads to low C:N ratios in agricultural areas, mostly due to the input of manure and (in more 'recent' times) artificial fertilisers. However, low soil C:N ratios did not cause a concentra-

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tion of human activities, but are the result of increased human activities. Statistically, this allows to run a model where nitrogen deposition is the independent predictor that causes/describes changes in the soil C:N ratios, regardless of the productivity of the soils.

RC: Our large cities and agricultural production centres are located in these regions and are the source of chronic (excessive) Nr deposition. Perhaps, I did not understand the analysis correctly.

AC: Good point, large human settlements and agricultural production centres (human impacts) surely cause chronic/excessive Nr deposition and global deposition patterns. However, we did not take the soils of any urban park into account, but we focused on managed ecosystems (as land under agricultural management) vs. unmanaged ecosystems (as land close to nature). We fully agree that agriculture plays a major role and we used the variables 'croplands' and 'nature' in the mixed GLMs and the Mantel tests. As introduced in our Material & Methods (BGD 12 (2015): page 4318 and C2060): "We have selected 19,458 locations with complete categorical site description: 8,010 locations were assigned in situ to 'croplands' (cereal fields, winter farms with annual or permanent crops, orchards, vineyards, etc.), twelve locations could not be assigned to one specific land use/cover (incomplete documentation), and all the remaining locations (including two organic soil outliers with C:N > 200) were assigned in situ to either unmanaged woodlands, shrublands, or grasslands (lumped together as 'nature')." According to us, you are referring in particular to our Figure 3 (BGD 12 (2015): page 4330), where we emphasize the signal for nature (9888 sites of Deposition Cluster VI + 1546 sites of Deposition Cluster VII equals 19,458 – 8010 – 12 – 2 = 11,434) and we discussed the croplands only in the text because "we were not able to extract a significant deposition for managed ecosystems". Hence, agricultural areas are not included in this latter analysis (in contrast to Figures 1 and 2), since their soil C:N ratios are not only influenced by N deposition but also (probably to a much greater extent) by the input of N in fertilisers. However, the influence of N emissions (mostly ammo-

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nia) from agriculture on (nearby and remote) non-agricultural ecosystems is taken into account in the atmospheric transport model used. At one hand, the “global” influence of agriculture is embedded in the model for each grid cell (please see our extended supplement at http://www.biogeosciences-discuss.net/12/C2059/2015/bgd-12-C2059-2015-supplement.pdf) and at the other hand the “local” influence of land management is far too patchy to be predictable by continental modelling spanning over 130 years (1880–2010). Statistically, the inverse cause-effect relationship will then be lower soil C:N ratios caused by higher (chronic) Nr deposition and the opposite.

RC: Could the authors please explain, whether, and if so how, they considered this cause-effect relationship (low soil C:N (causing [AC: caused by] a concentration of human activity) causing [AC: caused by] chronic Nr deposition)? As it looks to me now, only the other direction of the relationship is discussed (chronic Nr deposition causing low C:N ratio).

AC: In Figure 3 we are addressing both the chronic Nr deposition (upper panel) and the excessive Nr deposition (lower panel). The direction of the two relationships is the same. It is interesting to point out that despite the low Nr deposition rates also in lacustrine sediments from remote regions a comparable signal was detected (Holtgrieve et al., 2011). These authors already stated that (too) little attention was given to effects of low-level chronic Nr deposition, as most studies on environmental pollution were on densely populated regions.

Holtgrieve, G. W., Schindler, D. E., Hobbs, W. O., Leavitt, P. R., Ward, E. J., Bunting, L., Chen, G., Finney, B. P., Gregory-Eaves, I., Holmgren, S., Lisac, M. J., Lisi, P. J., Nydick, K., Rogers, L. A., Saros, J. E., Selbie, D. T., Shapley, M. D., Walsh, P. B., and Wolfe, A. P.: A coherent signature of anthropogenic nitrogen deposition to remote watersheds of the northern hemisphere, Science, 334, 1545–1548, 2011.

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