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Biogeosciences Discussions

Interactive comment on "Interactions between leaf nitrogen status and longevity in relation to N cycling in three contrasting European forest canopies" *by* L. Wang et al.

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We thank Referee #2 for the positive comments, stating that our paper makes a significant contribution to the field of forest ecology (biogeochemistry and N cycling) and the physiological ecology of trees. In the revision we have been able to address all the questions and to incorporate all the suggestions of Referee #2 as explained below:

Referee comment #1: 1. Are the results sufïňĄcient to support the interpretations and conclusions? Yes, but it would be highly interesting to see how foliage longevity scales with the ratio of tree internal versus ecosystem N cycling. Is there a trade-off between both? Is the description of experiments and calculations sufïňĄciently complete and

precise to allow their reproduction by fellow scientists (traceability of results)? Yes. I only could not trace how the ratio between the fraction of tree internal N cycling and ecosystem internal N cycling was calculated based on data presented in Table 2. This should be clariïňĄed, either in the text or the numbers given in the table with a footnote on how the authors performed this estimation.

Response: The Referee points to the statement 'The ratios between the fraction of tree internal N cycling (Fi, i.e. N re-translocation) and ecosystem internal N cycling (Fe , i.e. the N ïňĆux in total aboveground litter), was calculated as 60 %, 50 % and 89 % for the beech, the ïňĄr and the pine forests, respectively (Table 2).' We facilitated the understanding by adding the following statement: 'The ratios between the fraction of tree internal N cycling (Fi, i.e. N re-translocation, see Table 2, row 6) and ecosystem internal N cycling (Fe , i.e. the N ïňĆux in total aboveground litter, see Table 2 row 5), was calculated as 60 %, 50 % and 89 % for the beech, the ïňĄr and the pine forests, respectively.'

Referee comment #2. p. 9761, line 8: It is not only atmospheric deposition of NH3 but also of NOx and wet deposition that caused the critical N loads to be exceeded in many European forests. Values for total N deposition (wet and dry deposition) should also be presented in Table1. p. 9763, lines 10-12: total N deposition estimates should also be presented here and in Table 1.

Response: We agree with the referee and have revised the text by inserting dry N deposition estimates from the NitroEurope denuder network (Flechard et al., 2011). The dry deposition of total inorganic N that was deposited via gasses and particles was 30, 15 and 4 kg N ha-1 yr-1 for the forest sites in The Netherlands, Denmark and Finland, respectively.

Referee comment #3. p. 9762, line 13: what does it mean that "deciduous species will distribute N more closely: : :". The meaning is not clear.

Response: The sentence has been changed to: "The vertical N distribution within deciduous canopies is more closely related to the actual needs for photosynthesis than is the case for longer-lived conifer needles. . .".

Referee comment #4. p. 9762, line 16: the hypothesis that N pollution may lead to an opening of the N cycle is impossible to be tested with the approach and study design. Atmospheric NH_3 concentrations varied across sites but with that as well tree species and major climate parameters changed. The hypothesis could only be tested based on the same species across an N deposition gradient with largely the same climate and soil type.

Response: The referee is right pointing to the limitation of a site intercomparison rather than a fertilisation experiment. We take care that this is not a hypothesis that we can test with the data but a plausible explanation for the data we found.

Referee comment #5. p. 9772, lines 1-end: it is a pity that (bulk) ÐŞ were not compared to (apoplastic) ÐŞ in the same material though the former is easier to measure, or that no measurements of foliar NH_3 exchange were performed to set ÐŞbulk in relation to NH_3 exchange. Moreover, measuring bulk tissue NH_4^+ and H^+ leaves the question open of the subcellular localization of both. The authors should shortly discuss this. I guess that the major part of both, NH_4^+ and H^+, is stored in vacuoles, e.g. Wang et al. (1993) reporting 72-92% of root NH_4 in rice being located in the vacuole, Lee and Ratcliffe (1991) showing 5-10 mM NH_4 in cytosol of maize roots and 15 mM vacuolar, and ïňĄnally Kronzucker et al. (1995) demonstrating 0.05-8 mM NH_4 in the apoplast, and 2-33 mM in the cytoplasm. Given the co-localization of both would be advantageous for using this proxy.

Response: We fully agree with the referee that more information about the compartmentalization of both NH_4^+ and H^+ would be very valuable. Such measurements are technically highly demanding and implementing them in an ecophysiological approach will be difficult. There are indications though, that bulk tissue values may be important bio-indicators for N turnover processes, particularly during incipient senescence where

concentrations of NH_4^+ may increase in parallel in both leaf tissue and apoplastic solution (Mattsson and Schjoerring, 2003). There is also evidence that bulk leaf litter NH_4^+ and H^+ concentrations may be more important for the NH_3 exchange than the corresponding apoplastic value (Nemitz et al., 2000). Bulk tissue values therefore still have some relevance for characterization of nitrogen pools and their relation to overall nitrogen dynamics during the growth season. These aspects have now been clarified in the text.

Referee comment #6. p. 9774, line 8: canopy enrichment probably refers to throughfall N enrichment, but sounds strange. Please change.

Response: We agree and have changed "canopy enrichment" to "throughfall N enrichment".

Referee comment #7. p. 9774, line 23: I would not term NO losses as volatilization but rather as gaseous losses, and include N_2O and N_2 as well which are more important quantitatively as gaseous N losses.

Response: We agree and have changed "volatilization (NO)" to "gaseous losses of NO, N_2O and N_2".

Referee comment #8. chapter 4.4: The paper would further increase in signiïňĄcance given that the authors could demonstrate a trade-off between leaf longevity and the partitioning between N re-translocation (tree internal N cycling) and litterfall N (ecosystem internal N cycling), on basis of the ratio between the respective N rates (g N m^{-2} a^{-1}). If possible the authors should compile data for this from the literature (only litterfall N data are missing) and present the relationship as Figure 5B.

Response: It has unfortunately not been possible to compile the relevant data from the literature. The Referee also expresses doubt about the feasibility of the suggestion and this doubt has turned out to be correct. We have therefore not been able to add the suggested extra Figure.

Referee comment #9. Conclusion: p. l 9778, line 3: How was soil fertility as mentioned here indicated. Probably not by N deposition, soil N cycling, soil N concentration, but by canopy Nc? The term “the most fertile stand” is not suitable since not mentioned or discussed or based on data. Please rewrite this part.

Response: The sentence has been changed to: “In the stand with the highest canopy N content, i.e. the Douglas fir stand, the amount of N in foliage litter was largest, potentially leading to higher turnover in the ecosystem N cycle and implying higher risks of N losses via leaching and gaseous emissions”.

Referee comment #10. Technical corrections

p. 9761, line 25: please spell out nitrogen if at the beginning of a sentence. p. 9774, line 11-12: please rewrite to “at least part of this enrichment can be accounted for by dry deposition”.

Response: All technical corrections have been implemented.

References Flechard, C. et al.:Dry deposition of reactive nitrogen to European ecosystems: a comparison of inferential models across the NitroEurope network. Atmos. Chem. Phys., 11, 2703-2728, 2011.

Mattsson, M. and Schjoerring, J.K.: Senescence-induced changes in apoplastic and bulk tissue ammonia concentrations of rye-grass leaves. New Phytol., 160, 489-499, 2003. Nemitz, E., Sutton, M.A., Gut, A., San Jose, R., Husted, S. and Schjoerring, J.K.: Sources and sinks of ammonia within an oilseed rape canopy. Agr. Forest Meteorol. 105, 385-404, 2000.

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