

Reply to interactive comment on “Imbalanced phosphorus and nitrogen deposition in China’s forests” by Anonymous Referee #2

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Review:

This is an interesting paper, discussing a previously not available dataset on phosphorus and nitrogen deposition fluxes on forests (through fall and bulk deposition). The paper is well written, and the context and relevance are well explained. The issue of increasing dis-balance of phosphorous to nitrogen ratios may further worsen, if fire from coal and biofuel use in China will be reduced, and/or particulate emissions will be better controlled. This issues could warrant some further discussion.

Reply: Thank you very much. In the revised manuscript, we will include a short discussion on future changes in the imbalance of P and N deposition in the ending paragraph.

I see some major weaknesses of this study:

1) The assumption that bulk minus through equals dry deposition is rather challenging. Throughfall measurements are easily compromised by input from the canopy, it is not clear what was done to prevent this. For N bulk deposition may not capture input potential significant input from gaseous nitric acid- and may in this sense not be a good proxy for total deposition. Some discussion on the specific situation in China is warranted. I guess the applicability of the approach to estimate phosphorus deposition is even less well known. At any rate a better quantification of errors is needed.

Reply: Thanks for this useful and correct comment. Canopy-captured dry deposition accumulates during periods without precipitation and it is washed down during precipitation events. Therefore, we calculated canopy-captured dry

deposition as the difference between bulk deposition and the estimated total deposition. On an annual basis, total deposition can be estimated as the sum of N/P fluxes in throughfall and stemflow as well as canopy exchange. In the revised manuscript, we approximate total deposition by multiplying the volume-weighted mean N/P concentration in throughfall with the sum of throughfall and stemflow water fluxes because of a lack of measured data on canopy exchange and stemflow concentrations. We realize that our results generally underestimate total deposition because concentrations in throughfall usually are lower than those in stemflow (underestimate of N/P fluxes in stemflow) and tree foliage can take up a small proportion of soluble N and P in rainwater and gaseous N (part of dry deposition) (Reddy and Majmudar, 1983; Draaijers et al., 1996; Sparks, 2009). We also realize that our estimate of canopy-captured dry deposition is lower than total dry deposition because a proportion of dry deposition is already included in bulk deposition and the total deposition is likely underestimated due to the neglect of canopy uptake (Reddy and Majmudar, 1983; Draaijers et al., 1996; Sparks, 2009) and the underestimate of stemflow N/P fluxes. More detailed information on the method and uncertainty will therefore be included in the revised manuscript to answer your concerns.

2) the constraint of only using bulk deposition and throughfall observations (where both are available), is providing a very limited amount of observations, and raises questions about representativity for larger regions. I understand that a wider dataset of deposition measurements are available in other ecosystems (e.g. the authors mention that N-dep is relatively well known), and I would recommend to analyse also these in the context of this core set of depositions over forests. To what extent are the forest observation consistent with nearby depositions over other regions? Are the same urban-rural decay of depositions observable also in other datasets? What would wet-versus bulk versus throughfall tell?

Reply: Thank you very much for your suggestions. The database used in this study has included most of the forest sites where nutrient deposition has been observed. Moreover, these sites are evenly distributed in the forested areas in China (Figure S1). We believe that the datasets used in this study currently is the best to represent the observations of N and P deposition in China's forest. As indicated by the title, our analysis has been focused on China's forest ecosystems where the response of C sequestration to atmospheric nutrient deposition currently is a core topic. In addition, our estimates of total deposition are based on throughfall N/P concentrations and annual precipitation and this method is not applicable in other types of ecosystem. Nevertheless, a previous analysis on wet N deposition across China has also indicated an urban-rural decay of N deposition (Du, E.Z. and Liu, X.J.: High rates of wet nitrogen deposition in China: A synthesis. In: Sutton, M. A., Mason, K. E., Sheppard, L. J., Sverdrup, H., Haeuber, R., Hicks W. K. (eds.) *Nitrogen Deposition, Critical Loads and Biodiversity*. Springer, Netherlands, pp 49–56, 2014.).

3) As the motivation of the study is to point to a dis-balance in P:N ratios- I wonder how the numbers in this study compare to published and modeled deposition maps of N and P, used as input to vegetation models. For instance p6/13 mentions a number of 4.6 Tg N/yr deposition on Chinese forests. In my impression this is not very different from model estimates, but this can be corroborated. How would the estimate of P deposition compare to current estimates (e.g. Wang 2015; Mahowald; 2008). Nevertheless, altogether an important dataset and analysis, which I would recommend to publish in ACP, after duly accounting for these comments.

Reply: There have been rare literatures which focus on total N and P inputs into China's forests. This hinders the comparison between our estimates with others. Nevertheless, our results in China's forests are comparable to the ranges of modelled P deposition in China (Wang et al., 2015). This is now indicated in the text. Unfortunately, the modelling results by Mahowald et al (2008) have a very coarse resolution and are not suitable for comparison with our datasets.

Minor comment:

P 3/1 9: what is taken city-centre or city-boundary? How defined?

Reply: The distance between the sampling site and the centre of the nearest large city (non-agricultural population > 0.5 million) was derived using Google Earth for Microsoft Windows. The city centre is defined as the geometric centre of the city area. We have included the information in the revised manuscript.

p. 6 l 24 were is this number coming from?

Reply: The number 63% is the percentage that bulk N deposition ($16.5 \text{ kg N ha}^{-1} \text{ yr}^{-1}$) accounts for the total N deposition ($26.2 \text{ kg N ha}^{-1} \text{ yr}^{-1}$) estimated based on annual precipitation and total N concentrations in throughfall. In the revised manuscript, we re-estimated total deposition by multiplying the volume-weighted mean N/P concentration in throughfall with the sum water flux of throughfall and stemflow (see replies above). The updated results indicate that bulk N deposition ($16.5 \text{ kg N ha}^{-1} \text{ yr}^{-1}$) accounts for 76% of the total N deposition ($21.5 \text{ kg N ha}^{-1} \text{ yr}^{-1}$).