Responses to the comments made by Reviewer#1

Dear Reviewer:

Thank you very much for helping us to handle the manuscript entitled "Response patterns of moss to atmospheric nitrogen deposition and nitrogen saturation in an urban-agro-forest transition" (egusphere-2023-2718). I am writing a response to the reviewer's comments. The detailed revisions are highlighted in yellow in the manuscript, and the responses to the comments are listed as follows:

Q1: Lines 27-28: It is not clear that a better estimation. How to evaluate sampling period? Similar to the lines 28-29, it is not clear about "better indicate"

A: Thank you very much for your comments. We changed "*a better estimation*" to "*a more accurate estimation*" on page 2, Line 27. Besides, we modified the sentence "*In addition, the moss N content could better indicate total N deposition than the deposition of specific N species.*" to "*In addition, the moss N content serves as a more reliable indicator of total N deposition compared to the deposition of specific N species.*" on page 2, Line 28-29.

Q2: Line 31: Remove "by using mosses"

A: We deleted "*by using mosses*" on page 2, Line 32.

Q3: Line 40: Atmospheric deposition is not the only way for the anthropogenic N go back to the surface ecosystem. It is better to introduce all the major pathways for anthropogenic N that are input to the earth surface and then highlight the role of atmospheric deposition.

A: Thank you for your comments. We modified the sentences "*Several pathways of anthropogenic N input into earth surface, including deposition, manure, fertilizer and so on (Gu et al., 2015). Atmospheric transport, deposition, and circulation facilitate the conveyance of excess N to nearby or distant terrestrial and aquatic habitats (Erisman et al., 2007; Schlesinger, 2009). Atmospheric N deposition is an important component of the human-accelerated global N cycle and a serious form of*

atmospheric pollution (Xu et al., 2019), which results in adverse ecological effects, such as water eutrophication, soil acidification, and biodiversity loss, have been reported due to excessive N deposition in some areas (Clark and Tilman, 2008; Elser et al., 2009; Storkey et al., 2015). Atmospheric N deposition has climbed by three-to-five-fold over the course of the 20th century (IPCC 2013). Global N deposition was estimated at 119 Tg N in 2010 (land, 60%; seas, 40%) (Liu et al., 2022)." to "*Anthropogenic perturbations have dramatically influenced the nitrogen (N) cycle on the earth's surface (Vitousek et al., 1997; Galloway et al., 2008). Several pathways of anthropogenic N input into earth surface, including deposition, manure, fertilizer and so on (Gu et al., 2015). Atmospheric transport, deposition, and circulation facilitate the conveyance of excess N to nearby or distant terrestrial and aquatic habitats (Erisman et al., 2007; Schlesinger, 2009). Atmospheric N deposition is an important component of the human-accelerated global N cycle and a serious form of atmospheric pollution (Xu et al., 2019), which results in adverse ecological effects, such as water eutrophication, soil acidification, and biodiversity loss, have been reported due to excess N deposition in some areas (Clark and Tilman, 2008; Elser et al., 2009; Storkey et al., 2015). Atmospheric N deposition has climbed by three-to-five-fold over the course of the 20th century (IPCC 2013). Global N deposition was estimated at 119 Tg N in 2010 (land, 60%; seas, 40%) (Liu et al., 2022).*" on page 3, Line 37-49.

Q4: Line 55: What is the retention time of mosses for N deposition? Do you mean the time duration that the N accumulated in mosses?

A: Thanks for your comments. We modified the sentence "*The sampling frequency option will be based on the retention time of mosses for N deposition.*" to "*The sampling frequency option will be based on the time duration that the N deposition accumulated in the mosses.*" on page 3, Line 59-60.

Q5: Lines 55-56: How about the assimilation of N by moss? Is this amount could be ignored with the N accumulated from deposition?

A: Nitrogen utilization by plants encompasses both nitrogen uptake and assimilation processes. Moss assimilation occurs through the uptake of nitrogen from nitrogen deposition (mainly NH_4^+-N, NO_3^--N and DON), which is subsequently assimilated into usable amino acids. It was detailed explained by article titled "*Ammonium first: natural mosses prefer atmospheric ammoniumbut vary utilization of dissolved organic nitrogen depending onhabitat and nitrogen deposition*", authored by Liu et al., in 2013.

Line 57-58: Why limited? Depend on the moss species?

A: We modified the sentence "*It is generally accepted that mosses can preserve the N deposited from the atmosphere for more than one year (Schröder et al., 2011). Some studies have also documented that the preservation period of N by mosses is limited (i.e., weeks to months) (Pavlíková et al., 2016).*" to "*It is generally accepted that mosses can preserve the N deposited from the atmosphere for more than one year. While some studies have also shown that the preservation period of N by mosses is limited by land use types and moss species, making it possible to maintain N for only a few weeks or months (Schröder et al., 2011; Pavlíková et al., 2016).*" on page 3, Line 60-64.

Line 59: change "can" to "usually"

A: We modified "*can*" to "*usually*" on page 3, Line 65.

Line 61: various forms of N from deposition.

A: We modified "*various forms of N deposition*" to "*various forms of N from deposition*" on page 4, Line 68.

Line 64-67: This sentence is the explanation for the previous mentioned selective accumulation of N by moss. Please change "additionally"

A: We modified "*additionally*" to "*meanwhile*" on page 4, Line 70.

Line 68: This paragraph still talks about the uncertainties in using mosses as a bio-indicator to predict N deposition. It should be combined with previous paragraph.

A: Thank you very much for your comments. We have combined them into one paragraph on page 4, Line 73-74.

Figure 1: Major cities and any N emission hotspots should be marked on the map. The wind direction is also needed.

A: Thanks for your comments. We have reddened the names of the two sites with the highest deposition fluxes based on the levels at each atmospheric N deposition monitoring site, as indicated in Figure 1 on page 6, Line 116.

In addition, we want to clarify that the primary focus of this article is to optimize moss monitoring of atmospheric nitrogen deposition as a method, rather than to explore the sources of nitrogen emissions and their spatial variations.

Therefore, we have not listed the main sources of emissions at each point in detail. In addition, due to the constantly changing wind direction during the study period, we did not include wind direction information in the figure as it may not accurately reflect the monitoring time period.

Line 117: precleaned

A: We midified "*preclean*" to "*precleaned*" on page 6, Line 126.

Lines 121-122: Did you considered evaporation of prefilled pure water?

A: Thanks for your comments. We designed the experiment considering the evaporation of prefilled pure water. To address this issue, we developed a stainless-steel net that not only prevents disturbance from birds and crop stubble contamination but also helps reduce evaporation.

L142: Why did you chose "Haplocladium microphyllum (Hedw.) Broth. subsp. capillatum (Mitt.) Reim." as the only moss species? Is it the dominant species?

A: The primary reason for choosing "*Haplocladium microphyllum* (Hedw.) Broth. subsp. capillatum (Mitt.) Reim." As the only moss species is that, during the experimental design phase, we conducted a field study of moss species in the study area. Our findings revealed that this species is the predominant moss species in the study area, and its abundance provides a suitable foundation for our experiment.

Lines 159-162: Please combine these sentences.

A: We modified the sentences "*The moss samples were stored in polythene zip-lock bags. Dead branches, leaves, and debris attached to the mosses were removed in the lab. Separation of green and brownish parts from mosses for analysis. Only the green part was analyzed, and the brownish part was removed*" to "*The moss samples, stored in polythene zip-lock bags, had dead branches, leaves, and debris removed in the laboratory before separating green and brownish parts for analysis, with only the green part undergoing analysis and the brownish part being discarded.*" on page 8, Line 167-170.

Line 166: moss total N content?

A: We modified "*the moss N content*" to "*the moss total N content*" on page 8, Line 175.

L174-179: Why depositions and mosses sampling had different overall time scales, and how does this discrepancy impact the results?

A: Thanks for your comments. The time scale of the moss N content spans from October 2018 to September 2019, while the N deposition collection period extends beyond one year, from April 2018 to September 2019.

From the sampling period perspective, the collection of atmospheric N deposition began earlier than the collection of moss. This sequencing enhances the precision of our experimental results. If the period for collecting atmospheric deposition is shortened to match that of moss collection, moss samples collected in the initial stages would lack accumulated nitrogen deposition data for correlation analysis. For instance, in October 2018, when calculating the correlation between moss nitrogen content and atmospheric nitrogen deposition, data for the preceding 1, 3, and 6 months of nitrogen deposition could not be obtained, rendering the calculation impossible.

2: It is not clear about the plot f. Average for the 5 sites?

A: Plot f. in Figure 2. represents the average for the 5 sites. We added the sentence "*Additionally, the averages of atmospheric N deposition and moss N content across five sites were shown in Fig. 2f, providing an overview of temporal variations in the study area. It was found that the variation in the N content in moss highly matched the monthly fluctuation patterns of N deposition (all N species) in the study area.*" on page 10, Line 228-231.

Table 1. It is not clear that what kind of r was used? Pearson or spearman? The size of the dataset should be given for correlation. n=?

A: Pearson correlation analysis with a two-tailed significance test was used in Table 1. The correlations were performed with each result calculated from N deposition samples (n=60) and moss samples (n=60). We also added "*N deposition samples (n=60) and moss samples (n=60) for each correlation.*" on page 12, Line 251-252.

Figure 3: Each month?

A: The analysis for Figure 3 is explained in the sentences "*Furthermore, correlations between the moss N content and various species of N deposition were analyzed in each sampling months, which could obtain the optimal sampling time for moss response to atmospheric N deposition*." on page 8, Line 183-185.

L237: Please confirm whether you intend to express "more than six months per time" or "less than six months per time".

A: We are very sorry for our mistake. We had now changed "*more than six months per time*" to "*less than six months per time.*" on page 12, Line 253.

Line 256-257: No linear or logarithmic relationship.

A: As shown in Figure 4, "linear or logarithmic relationship" do exist. In our analysis, we considered a relationship to exist when the $P < 0.05$. Please see Figure 4. on page 14, Line 278-281.

L304-306: You found positive correlations in autumn (October and November) in L304, while absent in autumn in L306. Please double check.

A: We are very sorry for our mistake. We modified "*Autumn*" to "*Spring*" on page 16, Line 323.

Some minor edits for language

Line 40: excess N

A: We modified "*excessive N*" to "*excess N*" on page 3, Line 45.

Line 54: mosses

A: We modified "*moss*" to "*mosses*" on page 3, Line 59.

Line 77-78: in limiting the response of mosses

A: We modified "*in constraining the response of moss*" to "*in limiting the response of mosses*" on page 4, Line 83-84.

Line 122: maintained at approximately 10 cm

A: We modified "*kept at approximately 10 cm*" to "*maintained at approximately 10 cm*" on page 6, Line 130.

Line 129: dissolved organic nitrogen

A: We modified "*dissolved organic N*" to "*dissolved organic nitrogen*" on page 7, Line 135.

Line 160: laboratory

A: We modified "*lab*" to "*laboratory*" on page 8, Line 169.

Line 162: After the mosses were dried

A: We modified "*After drying the mosses*" to "*After the mosses were dried*" on page 8, Line 171.

Line 169: Change "this month" to "in the given month"

A: We modified "*in this month*" to "*in a given month*" on page 8, Line 178.

Line 210: change "displayed a notable similarity" to "moss samples from the five designated sites were notably similar"

A: We changed "*displayed a notable similarity*" to "*moss samples from the five designated sites were notably similar*" on page 10, Line 223-224.

Line 224: Correlations

A: We changed "*Correlation*" to "*Correlations*" on page 11, Line 239.

Line 319: Response patterns of mosses to various N species

A: We changed "*The response pattern of various species of N*" to "*Response patterns of mosses to various N species*" on page 16, Line 332.