This study focuses on intra- and interannual trends of GHG emissions from 4 small urban ponds and also addresses their underlying drivers. I believe that the study is a great addition to inland water studies, especially since long-term data on small pond GHG emissions is currently scarce. I commend the authors for curating such a comprehensive dataset. However, the current structure of the paper needs to be revised to make it easier for the reader to follow and also for possible final publications to Biogeosciences. Below are my brief and detailed comments for each subsection for possible improvement of the manuscript.

Reply: We warmly thank the reviewer for the positive evaluation of our work and for the detailed and useful comments for improvement.

Brief comments

Abstract and introduction

While the introduction was well compiled with the key motivation of the study, the end part did not include clear objectives and hypotheses for the work, which would have guided the reader better throughout the whole manuscript. I suggest that the authors include this and also adjust the intro to highly key gaps that would be addressed later on in the manuscript

Reply: The reviewer is right; we have revised the text providing objectives and working hypotheses at the end of the discussion. Text now reads L137: "We test the hypothesis that the two alternative states in shallow lakes (a clear-water state dominated by macrophytes, or a turbid-water state dominated by phytoplankton) drive differences in the $CO_2$, $CH_4$, and $N_2O$ dissolved concentration and diffusive emissions from the four studied artificial ponds, that have similar depth, surface area, and catchment urban coverage, and that mainly differ by the phytoplankton-macrophyte dominance. We also test the hypothesis that the two alternative states in shallow lakes drive differences in the ebullitive $CH_4$ emissions, water column MOX, and sedimentary methanogenesis pathway (acetoclastic or hydrogenotrophic) in the four studied ponds. The final objective of the present work is to determine the relative contribution of $CO_2$, $CH_4$, and $N_2O$ to the total GHG emissions in $CO_2$-eq and to test the hypothesis that the relative contribution of each GHG differs according to the two alternative states in shallow lakes."

Materials and methods

Although the description of the analysis of the GHG and associated parameters was well done, the statistical analysis part was too short and lacked enough detail. For example, the authors said they used a one-way ANOVA, yet they had a two-factor problem. i.e., seasonal and also pond-type influences. Also, what post hoc tests were used, what correlative analyses were used, and the main aims of this analysis are either lacking or not clearly stated. I suggest that more details should be added addressing the points above.

Reply: The reviewer is right; we have revised the text to provide additional information of the statistical treatment of the data. Text now reads L307: "Statistical analysis was conducted with R version 4.4.1. Pearson's linear correlation coefficients and the $r^2$ coefficient were used to assess relationships between log-transformed variables within each pond and across the dataset, to identify potential pond-specific and overall direct relationships between variables and GHGs. Statistical significance was determined using Fisher's F test and the associated *p*-value. This approach was also applied to study the relationships between $\delta^{13}C$-$CH_4$, FOX and MOX with Chl-*a* and TSM. To assess the impact of Chl-*a* concentration, macrophyte cover in summer, water depth, and lake surface area on diffusive and ebullitive $CH_4$ fluxes, the ratio of ebullitive $CH_4$ to total $CH_4$ flux, and $CO_2$ and $N_2O$ fluxes, both linear and quadratic relationships were applied to log-transformed averaged data. This approach allowed for the observation of trends between explanatory and dependent variables. For $N_2O$ fluxes, additional explanatory variables included $NO_2^-$, $NO_3^-$, $NH_4^+$, and DIN concentrations.

A two-way repeated measures analysis of variance (ANOVA) was used to test for differences in categorical variables, with the four seasons and the four ponds serving as independent factors, pond was set as a random effect to account for repeated measurements. A one-way repeated measures ANOVA was used to test for differences in $\delta^{13}C$-$CH_4$ from "perturbed sediments" with the four ponds serving as independent factors. After conducting an ANOVA and establishing significant differences among at least two groups ($p<0.05$), Tukey's Honestly Significant Difference (HSD) post-hoc test was employed to perform pairwise comparisons across all groups. Statistical outcomes are visually represented on boxplots, where upper- and lower-case letters are used to denote significant differences ($p<0.05$). Different lower- and upper-case letters indicate significant differences between groups."

Results and discussion

While combining the results and discussion is an acceptable practice, it sometimes leads to sectors of the manuscript that are not well described. For example, the trends of CO2 and N2O were only mentioned as results and not well substantiated by findings from other studies. In contrast, CH4 trends were well described by the authors, with proper discussions also related to other studies. I suggest either sticking to methane alone or giving also equal focus to the other GHGs.

Reply: The reviewer is right that there is more emphasis on $CH_4$ than $CO_2$ and $N_2O$ in the manuscript. This reflects the amount of collected data and variables that was different for each of the three GHGs. For $CO_2$ and $N_2O$ only dissolved concentrations were collected; for $CH_4$ additional variables were collected (ebullitive fluxes, $^{13}C/^{12}C$ ratios in water column, and in sedimentary bubbles). As such, we do not see how to provide an equivalent amount of discussion for each of the three GHGs. However, we think that $CO_2$ and $N_2O$ data bring invaluable added value to the manuscript because it allows us to quantify the relative importance of $CH_4$ emissions in $CO_2$ equivalents compared to the other two gases, in the context of the two alternative states, as well as at seasonal and inter-annual scales (former Fig. 14 = new Fig. 13). We feel this is a major outcome of our work, because there are relatively few studies that report simultaneously the diffusive emissions of three GHGs and even fewer with the addition of ebullitive $CH_4$ fluxes. So, we preferred to keep the data-set of the three GHGs in the paper.

But we followed the reviewer's suggestion, and we have expanded the description of the variations of $CO_2$ and $N_2O$ diffusive fluxes with new supplemental figures (Figs. S12, S13, S14). The corresponding text now reads L645: "The annual averaged diffusive fluxes of $CO_2$ ($F_{CO2}$) and $N_2O$ ($F_{N2O}$) in the four ponds in the city of Brussels were also plotted against Chl-*a* concentration, total macrophyte cover in summer, water depth, and lake surface area, as well as DIN for $N_2O$ fluxes (Figs. S12, S13, S14). Annual $F_{CO2}$ did not show significant differences between the four studied ponds (Tukey's HSD test: $p>0.05$ for each comparison), and $F_{CO2}$ did not significantly correlate to the other variables (Chl-*a* concentration, total macrophyte cover, water depth, and lake surface area). This might be surprising since other studies have reported lower $CO_2$ fluxes in more productive lentic systems (*e.g.* Sand-Jensen and Staehr 2007; Borges et al., 2022). We hypothesize that given that the four systems were either phytoplankton-dominated or macrophyte-dominated, in both cases, the ponds had an important submerged productivity resulting in a relatively invariant $F_{CO2}$ as function of either Chl-*a* or macrophyte cover. Annual mean $F_{CO2}$ was also uncorrelated to water depth and lake area (Fig. S12). This might have resulted from the relative similarity of depth and surface area of the four studied ponds, as it is well established that $CO_2$ emissions strongly increase with decreasing size of ponds (Holgerson and Raymond, 2016). Annual $F_{N2O}$ was not significantly different between clear-water and turbid-water ponds. $F_{N2O}$ was significantly lower in the slightly deeper Pêcheries pond than the two slightly shallower Leybeek and Silex ponds (Fig. S13) (Tukey's HSD test $p=0.0012$ for Pêcheries versus Leybeek, and $p=0.0052$ for Pêcheries versus Silex), and $F_{N2O}$ showed a significant negative relationship with water depth (Fig. S13). We hypothesize that this might reflect a larger dilution of $N_2O$ diffusing from sediments in the deeper systems. $F_{N2O}$ did not correlate to DIN, $NH_4^+$, $NO_2^-$, and $NO_3^-$ (Fig. S14). We hypothesize that this reflects the rather narrow range of annual DIN average values in the four studied ponds (~24 to ~29 µmol $L^{-1}$), as DIN, $NH_4^+$, $NO_2^-$, and $NO_3^-$ were not statistically different between ponds (Tukey's HSD test $p>0.05$ for every comparison)."

The manuscript also has 13 figures. While this is fine, readers may end up missing the most crucial part of the results. The unwritten rule of thumb is 6 to a maximum of 8 graphics, which include both tables and figures. I suggest the authors reevaluate the key figures guided by the objectives of the study and then reduce the current number and keep the rest in the suplimentary.

Reply: The reviewer is right that the manuscript has a large number of figures. *Biogeosciences* does not impose a size limit (text and figures) to submissions; the Associate Editors of *Biogeosciences* are required to carefully evaluate the manuscript before they are published in the *Biogeosciences Discussion* forum, which is an indication that for our present submission the Associate Editor decided that the length of text and number of figures were acceptable for an article in *Biogeosciences*. The larger than usual number of figures of our submission reflects the size of the data-set. However, we feel that the length of the manuscript and the number of figures of our submission justifies the scientific merit of keeping the data of the three GHGs in a single manuscript, rather than slicing the data-set into several papers and going down the path of "salami science". As mentioned above, there are relatively few studies that report simultaneously the diffusive emissions of the three GHGs and even fewer with the addition of ebullitive $CH_4$ fluxes. We feel this justifies the scientific merit of keeping this large data-set together in a single manuscript. As suggested by the reviewer, we have carefully reconsidered the usefulness and value of each of the figures, and we have moved former Figure 13 to the supplementals, reducing by one the number of figures in the main text. The other figures were kept because we feel they meet the objectives and hypotheses of the paper that have been added at the end of the Introduction.

Most of the results also lacked tests of significance and I suggest that this should be included in the revised drafts. If differences are not significant, its always acceptable to refer to them as trends

Reply: Most of differences presented in the previous version of the submitted manuscript had been tested, but the related statistical tests were in the supplementary tables and were only referenced in the legends of the figures. We have revised the manuscript to mentioned statistical significance in L357, L366, L368, L370, L371, L386, L388, L389, L413, L437, L464, L493, L553, L554, L576, L577, L578, L596, L598, L599, L611, L623, L625, L647, L657, L661, L672, L676, L694, L734, L735, L736, L737, L738, L739, L745, L767, L771, L772, L790, L793, L796, L797.

Conclusion

It needs to be focused on the objectives of the study and also to have a general outlook on the potential of urban ponds of inland water GHG dynamics.

Reply: We have now listed the objectives and hypotheses of the paper at the end of the Introduction section, and we feel that the Conclusions section addresses these objectives. We do not think that it would be appropriate to provide here, based on only four systems, a general outlook on the potential of urban ponds of inland water GHG emissions. This was to some extent addressed in a previous publication from our group based on a larger data-set in 22 ponds in the city of Brussels (but with more sparse temporal coverage) by a comparison of the urban ponds GHGs emissions with other emissions of GHGs from the city of Brussels (Bauduin et al. 2024; https://doi.org/10.1016/j.watres.2024.121257).Additionally, there are several synthesis papers that extensively address this issue, for example:

- Holgerson and Raymond (2016, https://doi.org/10.1038/ngeo2654)
- Peacock et al. (2021; https://doi.org/10.1111/gcb.15762)
- Deemer and Holgerson (2021, https://doi.org/10.1029/2019JG005600)
- Ray et al. (2023, https://doi.org/10.1002/lno.12362)

We prefer not to repeat the content of these papers, and we feel that the Conclusions reflect the main findings based on our data-set and addresses the objectives stated at the end of the Introduction section.

Detailed comments

Abstract and introduction

Line 15,16: Consider mentioning the direction of the relationship.

Reply: We have removed this sentence because this information was already given elsewhere in the abstract

Line 20: Consider adding a statement relating light availability in the clear ponds to enhance macrophyte growth. The current statement may be unclear at first read.

Reply: Text was modified and now reads L28: "Clear-water (macrophyte-dominated) ponds exhibited higher values of annual ebullitive $CH_4$ fluxes compared to turbid-water (phytoplankton-dominated) ponds, most probably in relation to the delivery to sediments of organic matter from macrophytes."

Line 21: Trim down the statement about pond methane fluxes, for instance, 'Pond methane fluxes to the atmosphere… '.

Reply: Text was modified and now reads L30: "At seasonal scale, $CH_4$ emissions exhibited a temperature dependence in all four ponds, with ebullitive $CH_4$ fluxes having a stronger dependence to temperature than diffusive $CH_4$ fluxes."

Line 37: Consider rephrasing: Greenhouse gas emissions from inland waters to the atmosphere….

Reply: Text was modified and now reads L50: "Greenhouse gas (GHG) emissions from inland water (rivers, lakes, and reservoirs) to the atmosphere such as carbon dioxide ($CO_2$), methane ($CH_4$) and nitrous oxide ($N_2O$) are quantitatively important for global budgets (Lauerwald et al., 2023)."

Line 39: GHG emissions from lakes….

Reply: Text was modified and now reads L52: "GHG emissions from lakes are lower than from rivers for $CO_2$ (Raymond et al., 2013) and $N_2O$ (Lauerwald et al., 2019; Maavara et al., 2019)."

Line 44: Remove the …. You can replace it with such as, which indicates that these are just examples and there could be more.

Reply: Text was modified and now reads L60: "The emissions of GHGs from artificial water bodies such as agricultural reservoirs, urban ponds, and storm-water retention basins could be higher than those from natural systems (Martinez-Cruz et al., 2017; Grinham et al., 2018; Herrero Ortega et al., 2019; Gorsky et al., 2019; Ollivier et al., 2019; Peacock et al., 2019, 2021; Webb et al., 2019; Bauduin et al., 2024)."

Line 46: Noun required after the word this…for example, this finding, this conclusion….check here and everywhere in the manuscript.

Reply: Text was modified and now reads here and elsewhere:

L63: "These higher emissions seem to result from higher external inputs of anthropogenic carbon and nitrogen in artificial systems such as rainfall runoff that brings organic matter and dissolved inorganic nitrogen (DIN), but might also reflect other differences compared to natural systems such as in hydrology (Clifford and Heffernan, 2018)."

L429: "The slopes of these correlations were not significantly different between ponds and were not correlated with surface area, depth, or dominance of type of primary producers (phytoplankton or macrophyte) (Table S6)."

L535: "The resulting calculated ebullitive $CH_4$ fluxes allowed to compare and integrate seasonally both components of $CH_4$ emissions to the atmosphere, and to calculate the relative contribution of ebullition to total (diffusive+ebullitive) $CH_4$ emissions."

L555: "This finding is consistent with other studies showing that ebullitive $CH_4$ fluxes can account for more than half of total $CH_4$ emissions in small and shallow lentic systems (*e.g.* Wik et al., 2013; Deemer and Holgerson, 2021; Ray and Holgerson, 2023; Rabaey and Cotner, 2024)."

L602: "The higher ebullitive $CH_4$ emissions from the clear-water ponds would suggest that the delivery of organic matter to sediments from macrophytes sustained a larger methane production than from phytoplankton."

L604: "This finding is consistent with the notion that vegetated littoral zones of lakes are hot spots of $CH_4$ production and emission (*e.g.* Hyvönen et al., 1998; Huttunen et al., 2003; Juutinen et al., 2003; Desrosiers et al., 2022)."

L615: "An increase in methane production with phytoplankton biomass in turbid-water ponds has also been reported by other studies in lakes (*e.g.* Yan et al., 2019; Bartosiewicz et al., 2021)."

L627: "These patterns are consistent with the idea of an increase of ebullition relative to diffusive $CH_4$ emissions in vegetated sediments compared to unvegetated sediments (e.g. Desrosiers et al., 2022; Ray et al., 2023; Theus et al., 2023)."

L639: "This hypothesis is consistent with the two clear-water ponds in Brussels having higher ebullitive fluxes than in the ponds compiled by Deemer and Holgerson (2021) at equivalent Chl-*a* values (Fig. S11)."

L695: "This pattern of $\delta^{13}C$-$CH_4$ of perturbed sediments could suggest a higher contribution of the hydrogenotrophic methanogenesis pathway compared to the acetoclastic pathway in the clear-water ponds where organic matter for methanogenesis was assumed to be mainly related to macrophytes rather than phytoplankton."

L865: "Years 2022 and 2023 were abnormally dry and wet, respectively, and consequently, the GHG emissions were higher in 2023 mainly due to an increase in the relative contribution of $CO_2$ emissions, probably in response to a strong El Niño event."

Line 52-54. The sentence on runoff comes from nowhere. Did you mean the rainfall runoff gets into the ponds? Consider revising it to make it clearer.

Reply: Text was modified and now reads L63: "These higher emissions seem to result from higher external inputs of anthropogenic carbon and nitrogen in artificial systems such as rainfall runoff that brings organic matter and dissolved inorganic nitrogen (DIN), but might also reflect other differences compared to natural systems such as in hydrology (Clifford and Heffernan, 2018)."

Materials and methods

Line 99. Did you mean the institute laboratory? The use of a home may imply a laboratory located in a personal house/apartment.

Reply: Text was modified and now reads L175: “A 2 liter polyethylene water container was filled with surface water for conditioning the samples for other variables at the laboratory in Université Libre de Bruxelles. ”

Line 109. Consider revising from “consistent in” to “consisted of”

Reply: Text was modified and now reads L181: The bubble traps consisted of inverted polypropylene funnels (diameter 23.5 cm) mounted with 60 ml polypropylene syringes, with three way stop valves allowing to collect the gas without contamination from ambient air.”

Line 111. The statement is a bit confusing. Consider revising it to make it clearer. How were the gases measured with 60ml syringes?

Reply: Text was modified and now reads L184: “The volume of gas collected in the funnels was sampled with graduated polypropylene 60 ml syringes every 24 hours. The value of the collected volume of gas was logged, and the gas was transferred immediately after collection to pre-evacuated 12 ml vials (Exetainers, Labco, UK) that were stored at ambient temperature protected from direct light prior to the analysis of $CH_4$ concentration and $\delta^{13}C-CH_4$ in the laboratory.”

Line 113. Consider revising the statement. Did you mean that the measurements at Silex were of a longer frequency?

Reply: Text was modified and now reads L188: “The time-series of measurement were longer at the Silex pond than the other three ponds, because the Silex pond is closed to the public during the week, while the other three ponds are open to the public all the time.”

Line 210-211. How were seasonality and pond type considered in your ANOVA analysis? The current statement is too short and lacks details. Was the ANOVA a repeated measures ANOVA as you sampled on the same pond multiple times?

Reply: The reviewer is right; we have expanded the description of the statistical tests, and text now reads L316: “A two-way repeated measures analysis of variance (ANOVA) was used to test for differences in categorical variables, with the four seasons and the four ponds serving as independent factors, pond was set as a random effect to account for repeated measurements. A one-way repeated measures ANOVA was used to test for differences in $\delta^{13}C-CH_4$ from “perturbed sediments” with the four ponds serving as independent factors. After conducting an ANOVA and establishing significant differences among at least two groups ($p<0.05$), Tukey's Honestly Significant Difference (HSD) post-hoc test was employed to perform pairwise comparisons across all groups. Statistical outcomes are visually represented on boxplots, where upper- and lower-case letters are used to denote significant differences ($p<0.05$). Different lower- and upper-case letters indicate significant differences between groups.”

Results and discussion

Line 223. Wetter and colder

Reply: Text was modified and now reads L338: “Year 2021 had warmer and drier months in June and September, colder and wetter months in July and August, and was overall wetter and colder than 2022 (Fig. 2).”

Line 228-229. Consider adding the reference period at first mention and not at the end of the statement

Reply: Text was modified and now reads L345: “Figure 2: Temperature anomaly (difference between the average annual temperature and the normal annual temperature for the reference period 1991-2020 (11 °C), in °C) plotted against precipitation anomaly (ratio between annual precipitation and normal annual precipitation for the reference period 1991-2020 (837 mm), in %) from 2003 to 2023.”

Line 233. Missing article; “with the silex pond”

Reply: Text was modified and now reads L353: “The four sampled ponds are situated in the periphery of the city of Brussels, with the Silex pond bordered by the Sonian Forest (Fig. 1).”

Line 244. In Figure 3, I suggest adding letters to the boxplots to indicate significant differences from the ANOVA test. This will help the reader quickly follow the graphs and avoid looking at an extra table in the supplementary.

Reply: The figures were modified accordingly.

Line 252. Are you reporting significant differences or trends? Check here and everywhere where you report comparisons of means. Also, indicate the level of significance as the information is currently missing in the results.

Reply: We have revised the manuscript to mentioned statistical significance in L357, L366, L368, L370, L371, L386, L388, L389, L413, L437, L464, L493, L553, L554, L576, L577, L578, L596, L598, L599, L611, L623, L625, L647, L657, L661, L672, L676, L694, L734, L735, L736, L737, L738, L739, L745, L767, L771, L772, L790, L793, L796, L797.

Line 253. I would move the explanations to the discussion, i.e., owing to primary production…

Reply: We preferred to keep the format of a joint "Results and Discussion" section. We have contemplated extensively how to present and discuss our data-set that is quite large and varied. We concluded that a joint "Results and Discussion" section was a better option than separated "Results" and "Discussion" sections. We feel that the text was articulated in a logical way that was relatively straightforward to follow by readers, going from relatively simple variables (meteorological and dissolved concentrations) to processes related to $CH_4$ dynamics (ebullition and MOX), and ending an integrative issue with the overall emissions in $CO_2$ equivalents.

Line 256. Consider using low instead of minimal

Reply: Text was modified and now reads L394: "Low values of $pCO_2$ were generally observed in spring and summer probably due to uptake of $CO_2$ by primary production from either phytoplankton or submerged macrophytes."

Line 257. Same comment as 253

Reply: We preferred to keep the format of a joint "Results and Discussion" section, refer to justification given above.

Line 258. Replace Maximal to High

Reply: Text was modified and now reads L396: "High values of $pCO_2$ were observed in fall in the four ponds and probably reflect the release of $CO_2$ from degradation of organic matter due to the senescence of phytoplankton or macrophytes (Fig. 3)."

Line 259-263. Correlation results are important for GHG process information as also discussed in this paragraph. I suggest moving them to the main text and, if possible, using scatterplots for the main relationships and indicating the correlation coefficients in the graphs. Also, always include the direction of the relationship, i.e., how was pco2 related to precipitation? Was it a negative or positive correlation?

Reply: We have added several new supplemental figures (Figs. S3, S4, S5, S6, and S7) showing the correlations for each pond and for the whole data set. Text was modified and now reads L403: "In all four ponds, $pCO_2$ strongly correlated positively to precipitation (Table S3; Figs S3, S4, S5, S6) suggesting a control of external inputs of carbon either as organic carbon sustaining internal degradation of organic matter or as soil $CO_2$ (*e.g.* Marotta et al., 2011)."

Line 264-266. I now see that the results and discussion are combined. While this is fine, the way it's currently written includes a lot of speculative statements that have not been substantiated by the findings of other studies. I suggest taking a closer look at all statements made and trying to support them with other studies. Putting a citation at the end without stating where the authors found similar results is also not encouraged. You can use (e.g., ……) in the citation to make clear that these authors found similar findings.

Reply: We agree and we have carefully revised the text to mention when relevant references with similar results and we have use "e.g." when relevant. Text was amended L114, L399, L405, L500, L507, L509, L517, L530, L551, L556, L581, L582, L605, L607, L618, L628, L643, L650, L834.

Line 269. See comment on line 253

Reply: We preferred to keep the format of a joint "Results and Discussion" section, refer to justification given above.

Line 277. See the comment on the use of "this" above

Reply: Please refer to the reply above, the text was modified in several places (including here) following the above comment.

Line 278. Add a comma between ponds and the

Reply: The comma was added.

Line 279. Were these differences based on the other factors also tested, i.e., the effect of the size of the pond? This analysis would validate the statement. At the moment, it's a bit speculative

Reply: We tested whether the slopes of the relationships differed between ponds (based on an analysis of covariance (ANCOVA)), and whether these slopes showed a relationship to surface area, depth, chl-*a* concentration and macrophyte cover (based on Pearson's linear correlation coefficients, with Fisher's F test and the associated p-value), and added the statistical results in a new supplementary Table S6. Text was modified and now reads L429: "The slopes of these correlations were not significantly different between ponds and were not correlated with surface area, depth, or dominance of type of primary producers (phytoplankton or macrophyte) (Table S6). These results suggest that the effect of precipitation on $pCO_2$ and the impact of temperature on dissolved $CH_4$ concentration outweigh other factors in explaining seasonal variations."

Line 282. Citation of figure or table needed here.

Reply: Text was modified and now reads L436: "The $\%N_2O$ values did not show significant seasonal variations in any of the four sampled ponds (ANOVA $F(3,174)=1{,}127$, $p=0.4091$) (Fig. 3). In individual ponds, $\%N_2O$ correlated negatively to temperature in the Tenreuken pond and Chl-*a* in the Silex pond, and positively to SRP in the Silex pond and TSM concentration in the Tenreuken pond (Table S3; Fig S3, S4)."

Line 284. Were surprising…

Reply: Text was modified and now reads L440: "The correlations with Chl-*a* and TSM were surprising since they were observed in the two clear-water ponds and might indirectly reflect seasonal variations (with minimal values of these two quantities in summer)."

Line 291-295. This paragraph is a bit confusing. I know what the authors mean, but I suggest it be rephrased in order to explain better the lack of correlation between N2O and DIN and its link to nitrogen deposition. How much is the nitrogen deposition in the region and how does it decrease from the edges of the city to the inner parts? Without this data, the current statement is somehow speculative

Reply: Following the reviewer's comment we have added a new supplemental figure showing the relation between $\%N_2O$ and DIN/atmospheric $NO_2$/distance from the city center (Fig. S8). We have also modified text that now reads L450: "A lower atmospheric nitrogen deposition in the periphery than in the city center is consistent with the correlation between $\%N_2O$ and atmospheric nitrogen dioxide ($NO_2$), and the correlation between $\%N_2O$ and the distance from the city center (Fig. S8)."

Line 297 -298. How do these bubble fluxes compare with other values from similar studies? Are they on the higher end or lower end? I suggest adding a few comparison studies in all fluxes reported to give an idea of where your study stands in terms of the magnitude of the fluxes.

Reply : We compared our data with those of Wik et al (2013), Delsontro et al (2016), and Ray and Holgerson (2023), and we have modified text that now reads L465: "The bubble flux values in the four sampled ponds in the city of Brussels were within the range of values reported in lentic systems of equivalent size by Wik et al. (2013) (0 to 2772 mL $m^{-2}$ $d^{-1}$), Delsontro et al. (2016) (11 to 748 mL $m^{-2}$ $d^{-1}$) and Ray and Holgerson (2023) (0 to 2079 mL $m^{-2}$ $d^{-1}$). The mean $CH_4$ content of the bubbles in the four sampled ponds in the city of Brussels was 31±21%, and comparable to the values obtained by Wik et al. (2013) (35±25%), Delsontro et al. (2016) (58±25%) and Ray and Holgerson (2023) (25±13%) in lentic systems of equivalent size."

Line 304. I suggest adding the equation of the fit on the graph.

Reply: We preferred not to overcrowd the figure (and for consistency we should have added equations in all the figures). But following the reviewer's comment, we have added the equation in the legend of the figure so that it is easy to access by the readers. Text now reads L477: "Figure 4: Bubble flux (ml $m^{-2}$ $d^{-1}$) as a function of water temperature (°C) and the relative $CH_4$ content in bubbles ($\%CH_4$, in %) in four urban ponds (Leybeek, Pêcheries, Tenreuken, and Silex) in the city of Brussels (Belgium). Bubbles fluxes were measured with three bubble traps in spring, summer, and fall of 2022 and 2023, totalling 8 days in the Leybeek, Pêcheries, and Tenreuken ponds and 24 days in the Silex pond. Given the shallowness of the sampled systems (<1.5 m, Fig. 1) we assume that sediments experience the same temperature as surface waters. Solid lines represent exponential regression fit of bubble flux as function of temperature ($Y = 28 \cdot e^{0.14 \cdot X}$, n=139), and as function of relative $CH_4$ content in the bubbles ($Y = 164 \cdot e^{0.0.3 \cdot X}$, n=123) (Table S11)."

310-312. This is what I mean by referencing of other studies to support your findings/

Reply: We agree with the reviewer and we have referenced other studies elsewhere in the manuscript (L390, L407, L435, L465, L470, L507, L530, L551).

Line 337. I suggest always using, e.g.,…. Or "similar to what was found…" for every citation quoted in the discussion, particularly those that involve specific findings. This form of citing guides the reader better

Reply: Text was amended L114, L399, L405, L500, L507, L509, L517, L530, L551, L556, L581, L582, L605, L607, L618, L628, L643, L650, L834.

Line 338. I suggest adding the equations of the relationships to Figure 6, which may be useful for future comparisons with other studies and also allow them to be potentially used to estimate ebullition methane fluxes where temperature data is available, as this study has done.

Reply: We preferred not to overcrowd the figure (and for consistency we should have added equations in all of the figures). But following the reviewer's comment, we have added the equation in the legend of the figure so that it is easy accessed by the readers. Text now reads L519: "Figure 6: Measured ebullitive $CH_4$ fluxes (mmol $m^{-2}$ $d^{-1}$) as function of water temperature (°C) in four urban ponds (Leybeek, Pêcheries, Tenreuken, and Silex) in the city of Brussels (Belgium), in spring, summer, and fall of 2022 and 2023, totalling 8 days in the Leybeek, Pêcheries, and Tenreuken ponds and 24 days in the Silex pond, with three bubble traps. Solid lines represent exponential fit for the Leybeek ($Y = 0.01 \cdot e^{0.32 \cdot X}$, n=22), Pêcheries ($Y = 0.16 \cdot e^{0.15 \cdot X}$, n=22), Tenreuken ($Y = 0.10 \cdot e^{0.23 \cdot X}$, n=19), Silex ($Y = 0.54 \cdot e^{0.18 \cdot X}$, n=72) ponds (Table S7) dashed lines represent exponential fit established in similar systems: four small ponds in Québec ($Y = 0.06 \cdot e^{0.25 \cdot X}$) (DelSontro et al., 2016) and a small urban pond in the Netherlands ($Y = 0.51 \cdot e^{0.17 \cdot X}$) (Aben et al., 2017). Each exponential curve allows to determine a $Q_{10}$ of $CH_4$ ebullition, plotted against water depth, solid line represents exponential regression fit ($Y = 92 \cdot e^{-0.02 \cdot X}, n = 6$) (Table S11)."

Line 356. Add letters from posthoc tests to indicate seasonal differences to this figure, similar to my comment on Figure 3

Reply: The figures were modified accordingly.

Line 373. Than for diffusive fluxes…

Reply: Text was modified and now reads L562: "Other studies have also reported higher $Q_{10}$ for $CH_4$ ebullition than for $CH_4$ diffusion in lentic systems (DelSontro et al., 2016; Xun et al., 2024)."

Line 389. How do you explain the polynomial U fit in the first panel?

Reply: The cause of the U shape is discussed further down in the text.

Line 393. Was there a statistical test to show that the differences were significant? Judging by the error bars, which sometimes overlap, it may be that the differences were not significant, but I do agree that the trends are there. In cases where the relationships are not significant, I suggest sticking to … showed trends of being higher in…even though the difference was not significant.

Reply: The error bars reflect the seasonal variability. In order to analyze the differences among the 4 ponds as function of size and phyto/macrophyte dominance it is required to average the data and remove the seasonal variability. For transparency we have nevertheless shown the error bars.

Line 401. I now see the explanation for the polynomial fit, which also makes sense. However, this may not be so clear at first read. Hence, it may help to reference the result first and then link it to the explanation. Also, has the relationship with phytoplankton been found in other turbid pond studies. The current reference talks about lakes.

Reply: We feel that the text is structured conventionally were the results are presented first and the explanations given after. We have added comparison with other turbid ponds and text reads L615: "An increase in methane production with phytoplankton biomass in turbid-water ponds has also been reported by other studies in lakes (*e.g.* Yan et al., 2019; Bartosiewicz et al., 2021)."

Line 411. Where is the regression done in the results?

Reply: The figure was modified and now includes the results of the regression.

Line 421-423. Lakes and ponds are used as synonyms here, even thou they may have different characteristics. Check here and everywhere to ensure that references made on lakes are assumed to be related also to ponds.

Reply: We have modified text that now reads L642: "Consequently, global scaling of $CH_4$ fluxes in lentic systems using Chl-*a* as a predictor as used in lakes (*e.g.* DelSontro et al., 2018) might under-estimate ebullitive $CH_4$ emissions due to a misrepresentation of macrophyte-dominated clear-water ponds."

Line 472. "as" not "than"

Reply: We have replaced "than" by "as" (L731).

Line 485. Modify the graph to include posthoc tests showing significance across ponds and seasons

Reply: The figures were modified accordingly.

Conclusion

Line 557-562. Reads more like the results and discussion part. I suggest rewriting the conclusion part to focus more on what were the objectives, what were the main conclusions from each objective, and finally future perspectives on what can be done better.

Reply: We have now listed the objectives and hypotheses of the paper at the end of the Introduction section and we feel that the Conclusions section focusses on these objectives.

**Figure S3: Partial pressure of $CO_2$ ($pCO_2$, ppm), dissolved $CH_4$ concentration ($CH_4$, nmol $L^{-1}$) and $N_2O$ saturation level (%$N_2O$, %), versus water temperature (°C), oxygen saturation level (%$O_2$, %), concentration of soluble reactive phosphorus (SRP, µmol $L^{-1}$), concentration of dissolved inorganic nitrogen (DIN= $NH_4^+$ + $NO_2^-$ + $NO_3^-$ , µmol $L^{-1}$), concentration of chlorophyll-*a* (Chl-*a*, µg $L^{-1}$), and total suspended matter (TSM, mg $L^{-1}$) in the clear-water Tenreuken pond in Brussels, sampled from June 2021 to December 2023. Coefficient of determination, $r^2$, and associated *p*-value are indicated in boxes and solid lines indicate significative linear regression lines of the log-transformed data (*p*-value < 0.05).**

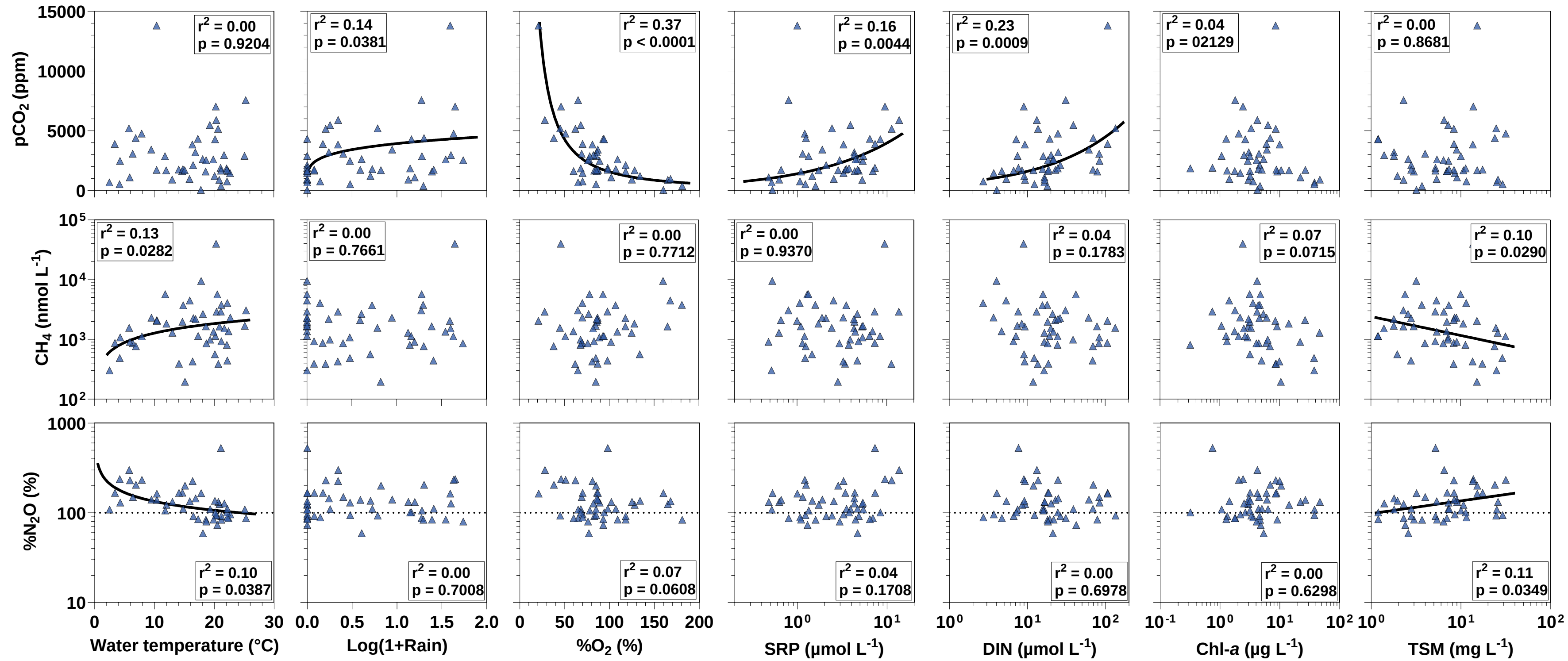

**Figure S4: Partial pressure of $CO_2$ ($pCO_2$, ppm), dissolved $CH_4$ concentration ($CH_4$, nmol $L^{-1}$) and $N_2O$ saturation level (%$N_2O$, %), versus water temperature (°C), oxygen saturation level (%$O_2$, %), concentration of soluble reactive phosphorus (SRP, µmol $L^{-1}$), concentration of dissolved inorganic nitrogen (DIN= $NH_4^+ + NO_2^- + NO_3^-$ , µmol $L^{-1}$), concentration of chlorophyll-*a* (Chl-*a*, µg $L^{-1}$), and total suspended matter (TSM, mg $L^{-1}$) in the clear-water Silex pond in Brussels, sampled from June 2021 to December 2023. Coefficient of determination, $r^2$, and associated *p*-value are indicated in boxes and solid lines indicate significative linear regression lines of the log-transformed data (*p*-value < 0.05).**

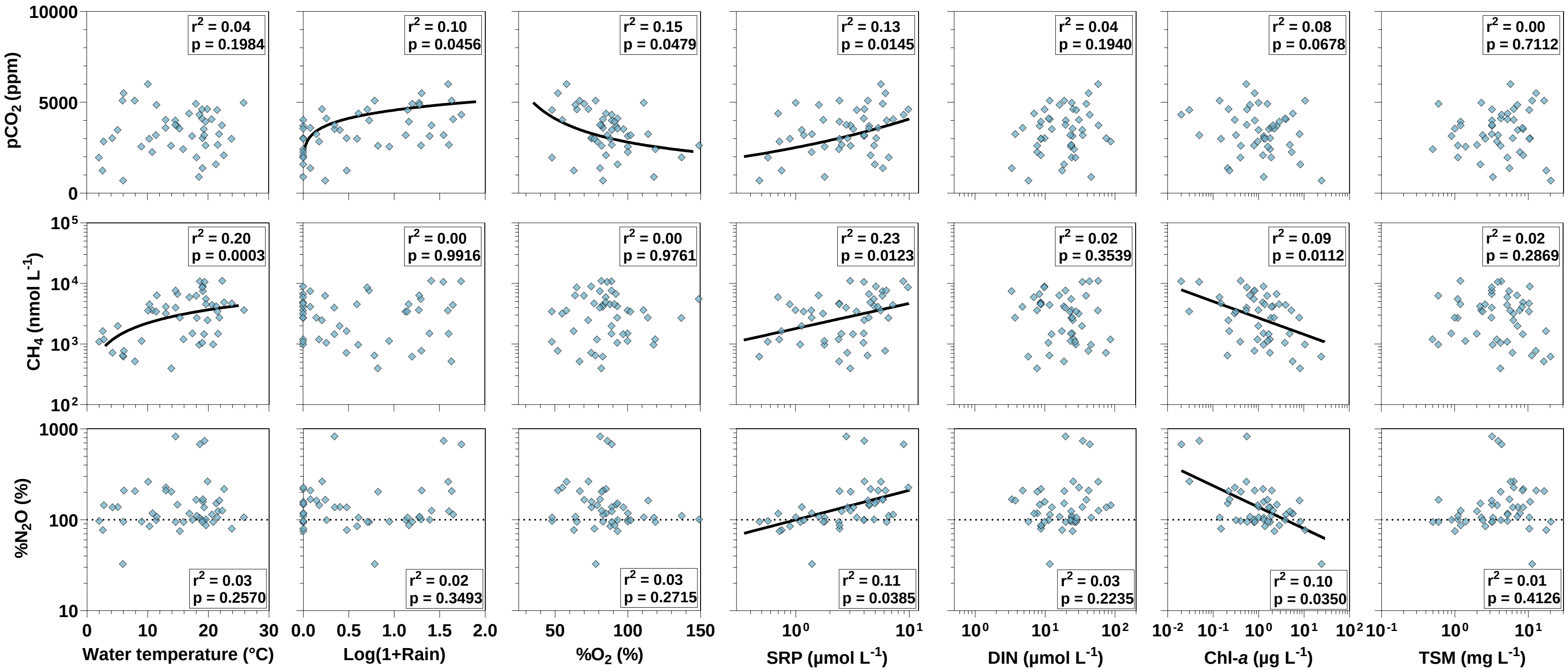

**Figure S5: Partial pressure of $CO_2$ ($pCO_2$, ppm), dissolved $CH_4$ concentration ($CH_4$, nmol $L^{-1}$) and $N_2O$ saturation level (%$N_2O$, %), versus water temperature (°C), oxygen saturation level (%$O_2$, %), concentration of soluble reactive phosphorus (SRP, µmol $L^{-1}$), concentration of dissolved inorganic nitrogen (DIN= $NH_4^+$ + $NO_2^-$ + $NO_3^-$ , µmol $L^{-1}$), concentration of chlorophyll-*a* (Chl-*a*, µg $L^{-1}$), and total suspended matter (TSM, mg $L^{-1}$) in the turbid-water Leybeek pond in Brussels, sampled from June 2021 to December 2023. Coefficient of determination, $r^2$, and associated *p*-value are indicated in boxes and solid lines indicate significative linear regression lines of the log-transformed data (*p*-value < 0.05).**

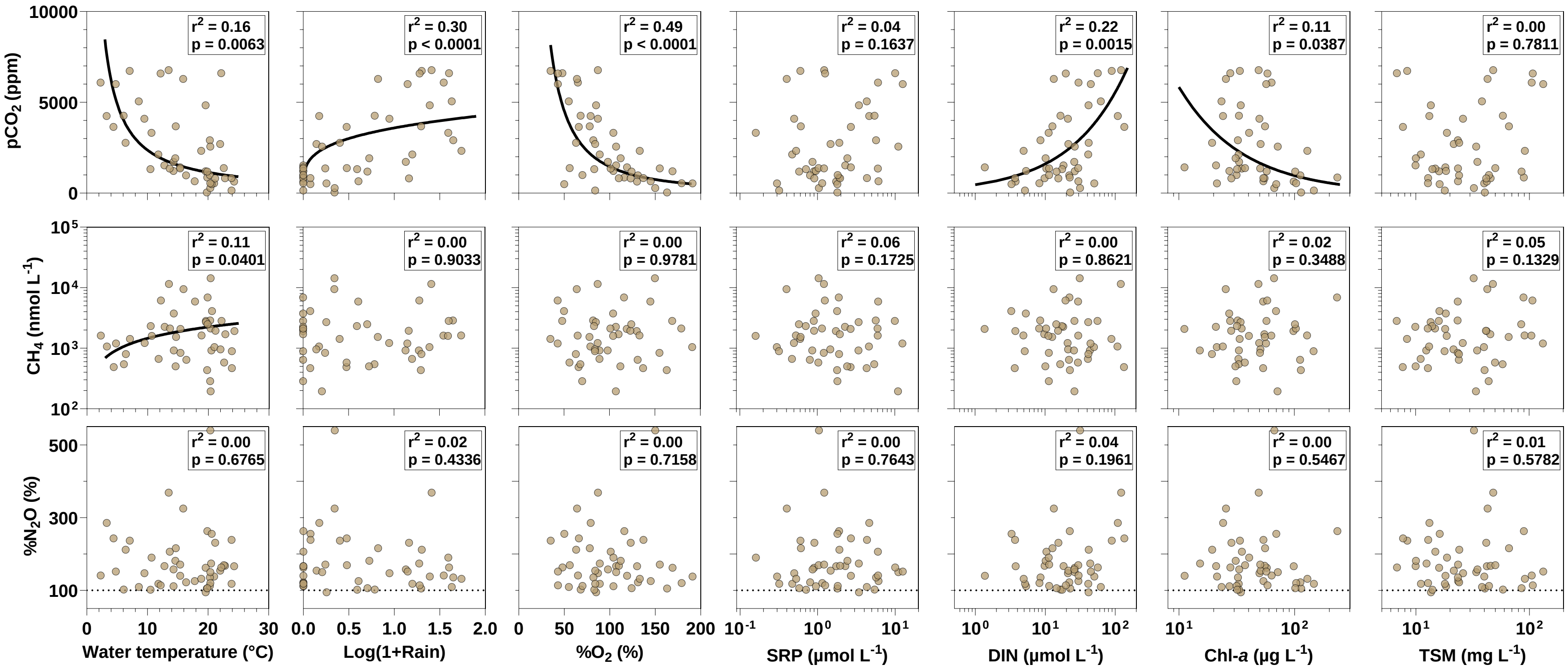

**Figure S6: Partial pressure of $CO_2$ ($pCO_2$, ppm), dissolved $CH_4$ concentration ($CH_4$, nmol $L^{-1}$) and $N_2O$ saturation level (%$N_2O$, %), versus water temperature (°C), oxygen saturation level (%$O_2$, %), concentration of soluble reactive phosphorus (SRP, µmol $L^{-1}$), concentration of dissolved inorganic nitrogen (DIN= $NH_4^+ + NO_2^- + NO_3^-$ , µmol $L^{-1}$), concentration of chlorophyll-*a* (Chl-*a*, µg $L^{-1}$), and total suspended matter (TSM, mg $L^{-1}$) in the turbid-water Pêcheries pond in Brussels, sampled from June 2021 to December 2023. Coefficient of determination, $r^2$, and associated *p*-value are indicated in boxes and solid lines indicate significative linear regression lines of the log-transformed data (*p*-value < 0.05).**

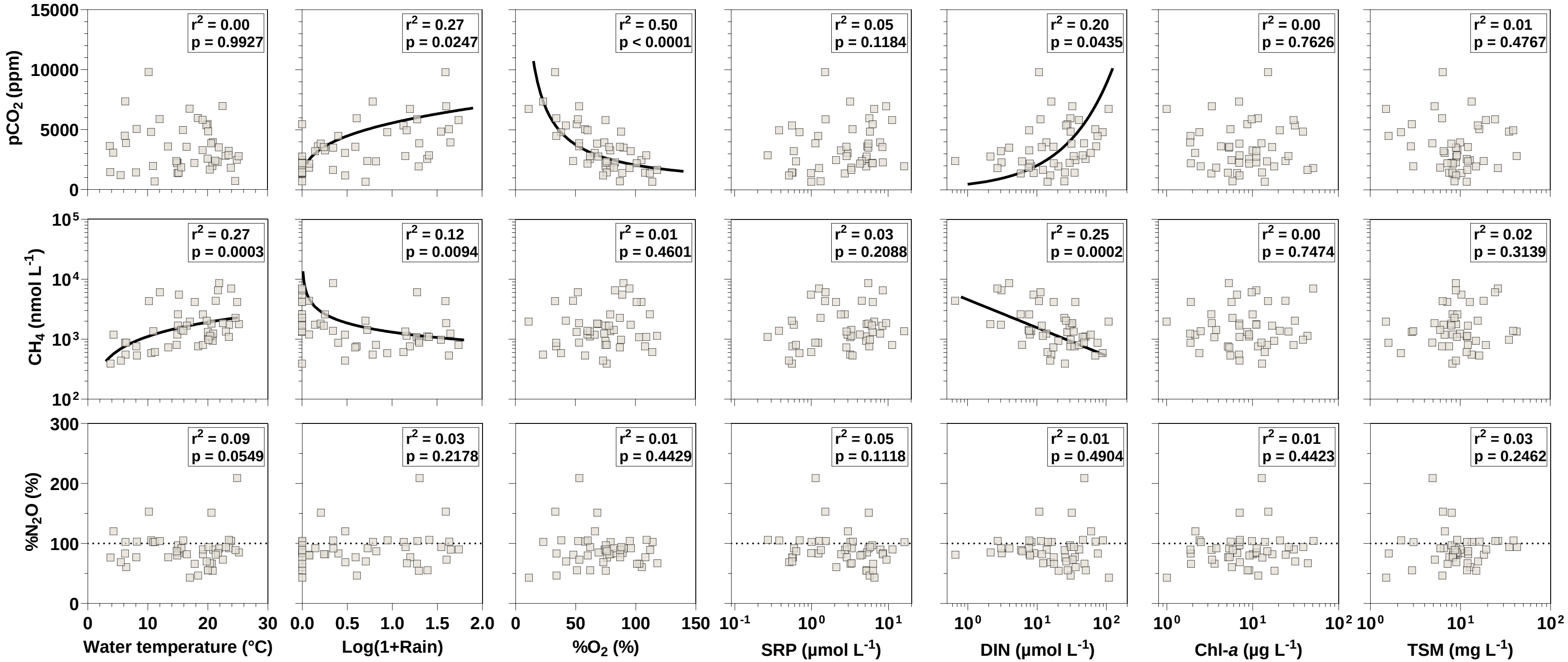

**Figure S7: Partial pressure of $CO_2$ ($pCO_2$, ppm), dissolved $CH_4$ concentration ($CH_4$, nmol $L^{-1}$) and $N_2O$ saturation level (%$N_2O$, %), versus water temperature (°C), oxygen saturation level (%$O_2$, %), concentration of soluble reactive phosphorus (SRP, µmol $L^{-1}$), concentration of dissolved inorganic nitrogen (DIN= $NH_4^+$ + $NO_2^-$ + $NO_3^-$ , µmol $L^{-1}$), concentration of chlorophyll-*a* (Chl-*a*, µg $L^{-1}$), and total suspended matter (TSM, mg $L^{-1}$) in four ponds in Brussels sampled from June 2021 to December 2023 (Leybeek, Pêcheries, Tenreuken, and Silex). Coefficient of determination, $r^2$, and associated *p*-value are indicated in boxes and solid lines indicate significative linear regressions lines of the log-transformed data (*p*-value < 0.05).**

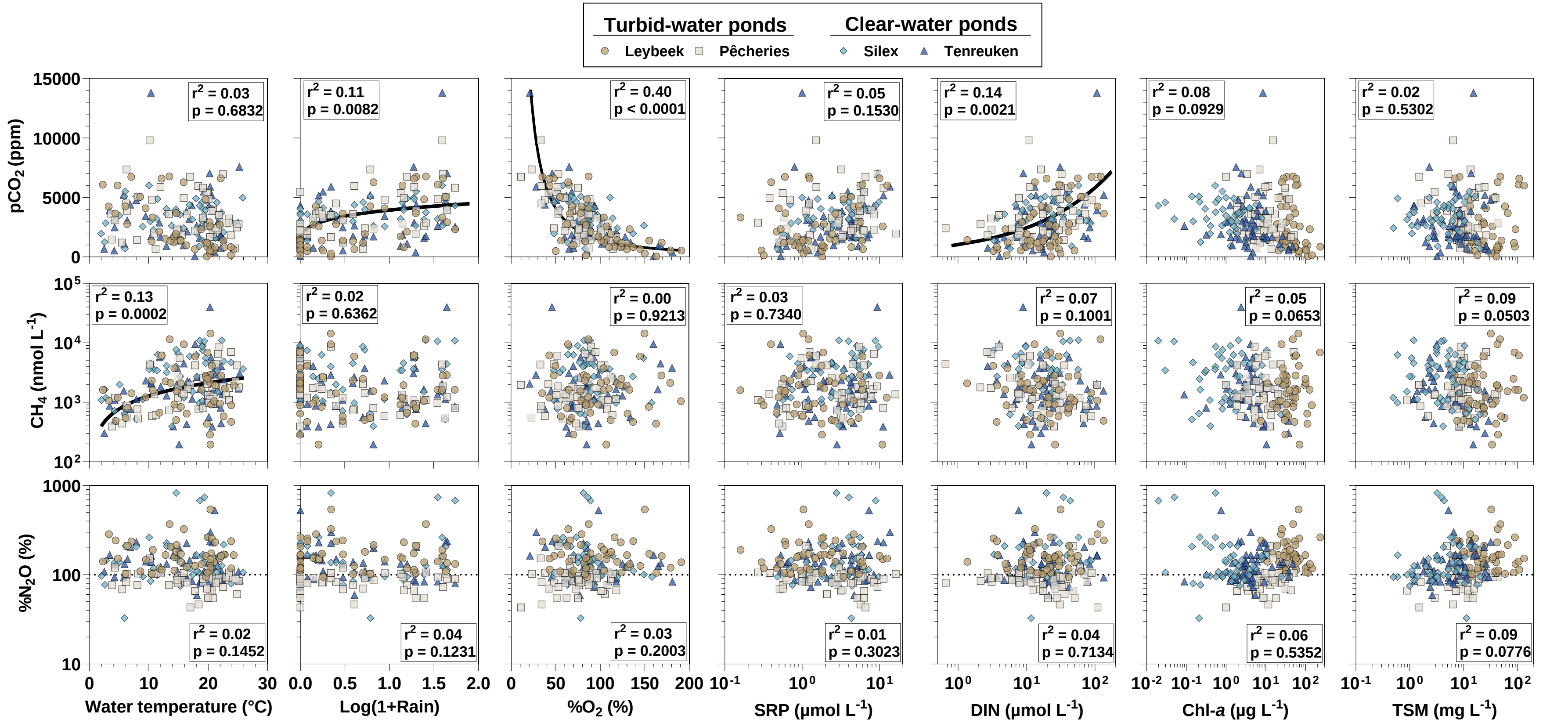

**Figure S8: Mean diffusive $N_2O$ saturation level (%$N_2O$, %) versus dissolved inorganic nitrogen (DIN= $NH_4^+$ + $NO_2^-$ + $NO_3^-$, in µmol $L^{-1}$), distance of the pond from city center (km), and atmospheric $NO_2$ (µg $m^{-3}$) in four ponds in Brussels sampled from June 2021 to December 2023 (Leybeek, Pêcheries, Tenreuken, and Silex), and in other ponds in the city of Brussels sampled in 2021 and 2022 from Bauduin et al. (2024). The atmospheric $NO_2$ concentration was extracted from the Curieuzenair initiative which analyzed 2483 air samples in September 2021 covering the whole of the city of Brussels with a homogeneous distribution (https://curieuzenair.brussels/en/the-results/). Coefficient of determination, $r^2$, and associated *p*-value for data from Bauduin et al. (2024) are indicated in boxes and solid lines indicate significative linear regression lines of the log-transformed data (*p*-value < 0.05).**

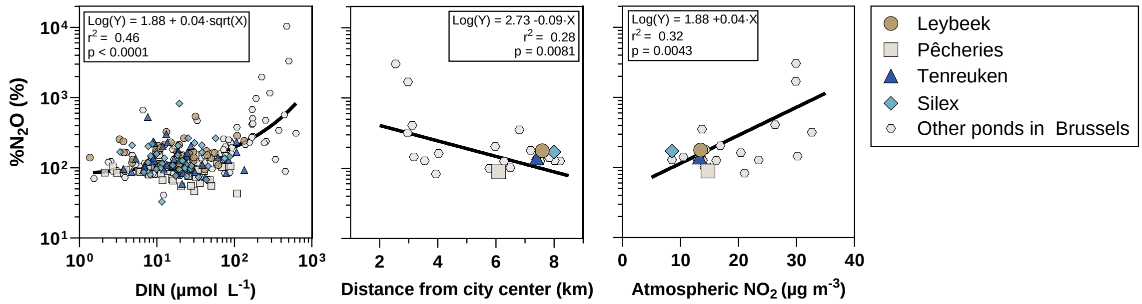


**Figure S12: Mean annual diffusive $CO_2$ flux ($F_{CO2}$ in mmol $m^{-2}$ $d^{-1}$) versus chlorophyll-*a* (Chl-*a*, µg $L^{-1}$), total macrophyte cover in summer (%), water depth (cm), and lake surface area (ha) in four ponds (Leybeek, Pêcheries, Tenreuken, and Silex) in the city of Brussels (Belgium) from June 2021 to December 2023. Error bars indicate the standard deviation.**

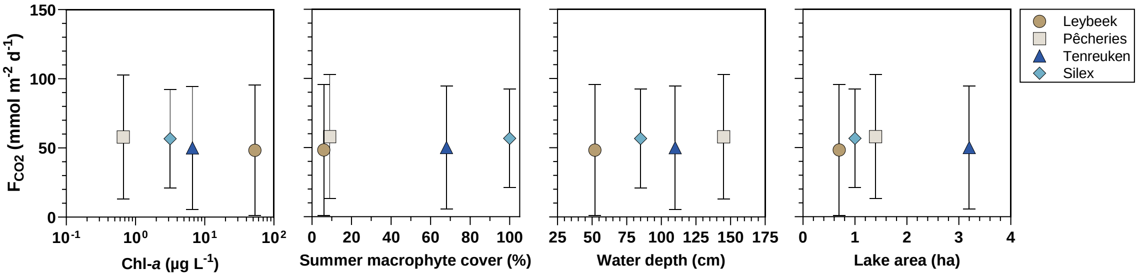


**Figure S13: Mean annual $N_2O$ flux ($F_{N2O}$, µmol $m^{-2}$ $d^{-1}$) versus chlorophyll-*a* (Chl-*a*, µg $L^{-1}$), total macrophyte cover in summer (%), water depth (cm), and lake surface area (ha) in four ponds (Leybeek, Pêcheries, Tenreuken, and Silex) in the city of Brussels (Belgium) from June 2021 to December 2023. Error bars indicate the standard deviation. Solid lines indicate trends in relationship between variables.**

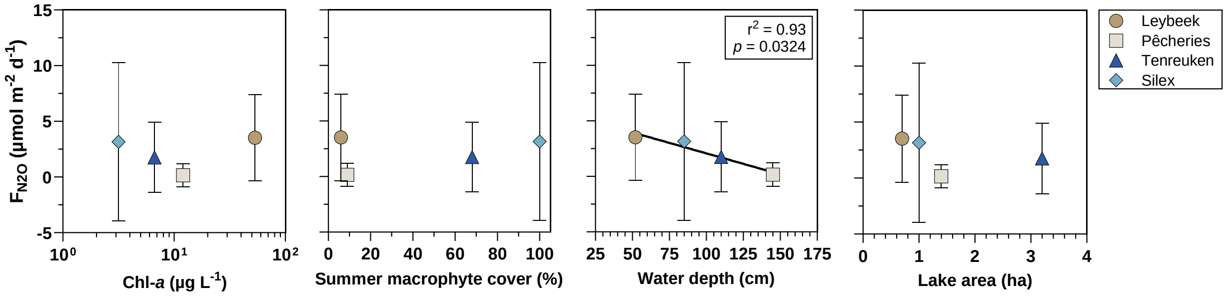


**Figure S14: Mean annual diffusive $N_2O$ flux ($F_{N2O}$, µmol $m^{-2}$ $d^{-1}$) versus dissolved inorganic nitrogen (DIN= $NH_4^+$ + $NO_2^-$ + $NO_3^-$ , µmol $L^{-1}$), ammonium ($NH_4^+$, µmol $L^{-1}$), nitrite ($NO_2^-$, µmol $L^{-1}$) and nitrate ($NO_3^-$, µmol $L^{-1}$) in four ponds (Leybeek, Pêcheries, Tenreuken, and Silex) in the city of Brussels (Belgium) from June 2021 to December 2023.**