Review of the manuscript "Drivers of CO_2 emissions during the dry phase of Mediterranean and Temperate ponds" by Frutos-Aragón et. al for Biogeosciences:

The study examines CO_2 fluxes of dry sediments from 14 temperate and 16 Mediterranean ponds in Europe during their dry phase in summer and/or autumn of 2022. These fluxes were measured using chambers. Additionally, sediment and water analyses were conducted to characterize the sites and to investigate the differences.

I read the manuscript with great interest and believe that the study is promising, but that some improvements are necessary.

General comments or questions:

- In the abstract, the methodology for measuring CO_2 fluxes is missing.
- How exactly and to what extent does your study fill the knowledge gap you mentioned in the introduction?
- In the introduction, a concluding sentence on how the questions will be answered is missing.
- The coordinates of the sampling or measurement points within the sites, the sampling dates, and the names of the studied ponds are missing.
- The chamber description still lacks some information (see the detailed comments).
- For me, it is unclear how often or at what frequency the CO_2 measurements were conducted in each season. Were there temporal replicates?
- In the manuscript, there is no information on whether the data requirements for the statistical tests used (e.g., ANOVA or t-test) are met.
- I miss a conclusion chapter.
- The graphics are slightly pixelated, and the image quality could be improved.

Detailed comments and suggestions:

- Abstract: The methodology is missing
- L23ff: What do you mean by hydroperiod?
- L26: c.?
- L37f: It would be good to specify the CO_2 emission value of ponds.
- L104f: Instead of spanning latitudes or longitudes, it would be better to add the actual coordinates of some sites and refer to the appendix.
- Figure 1: Since graphs a) and b) are already zoomed in, it would be helpful to include an overview graph with all sites, countries, climate regions, etc.
- It would be interesting to categorize the sites in Figure 1 according to the dry or wet phase definition written in L109 ff.
- Method chapter: Please use the same description style for each instrument. Currently, it differs. You do not have to repeat it if the instrument is already mentioned.
- L117: What do you mean by "dry fluxes"? I also recommend using *N* instead of n for the number of observations/samples throughout the manuscript.
- L123ff: Why were 40-year averages of annual temperatures and precipitation used instead of the more common 30-year averages for the climatic description of sites?
- L130: You have finally defined what you mean by "hydroperiod length," although the term was already mentioned before. It would have been helpful to define it the first time it was mentioned.
- L157: Why did you use a filter size of 0.7 µm to obtain the dissolved fraction instead of, for example, 0.45 µm?

- L165ff: This subchapter is missing important information about the chamber measurement (e.g., whether it is a through-flow or static system), the chamber type (transparent or opaque), the chamber size (area, height, and volume), and the chamber material. In addition, did you use any additional materials during the measurement, such as tubes or a pump? What time of day did you conduct the chamber measurements at the four to eight spots per pond? How many measurement days were there per season at each pond, and how often were they conducted? Did you correct the measured CO_2 concentrations for water vapor?
- L167: I am not familiar with the mentioned sensor. What is its precision, compared to a Licor, Los Gatos, or Picarro gas analyzer, for example? At what frequency does this sensor measure during the five-minute closing time?
- L174f: Explain why one measurement had a different sampling technique and measurement time. Was it a one-hour measurement time or a one-hour closing time?
- L175: What was the size and the material of the vials or syringes? When during the one-hour closing time did you measure, and how much volume did you take? Were your chambers equipped with an overpressure valve?
- L175f: What did you measure with the gas chromatograph? This is unclear to me, as it was never mentioned again in the manuscript.
- L178: Why did the CO_2 sensor did not require a calibration?
- L178f: What data did you use for the 3-point average, and why was there background noise?
- L180: Why did you only use the last two to three minutes of each five-minute measurement period? What is the reference for Equation 1?
- L182: Why did you choose to use the carbon unit for the fluxes? Additionally, you used hourly units here, but daily units throughout the manuscript.
- L190: Milli-Q is a brand name, not a water type.
- L191: Why did you use 48 hours?
- L195: Please cite the references that used this as a proxy.
- L220: Table S2 is mentioned before Table S1. Please reconsider the order of the tables.
- L221f: This sentence could be moved to the next subchapter, “Statistical (or data) analysis”.
- L224ff: Have you had tested your data for normality?
- L259: The R version is important for repeatability.
- Figure 2: The unit in the y-axis label is missing a bracket. Why does the boxplots have different widths? Does the x-axis label mean Pond ID? To better illustrate the differences and support your results, I would reconsider the representation and categorize by other environmental variables.
- L263: Instead of "overall," I would say "on average" that all your ponds were a CO_2 source, as you have also measured a few negative CO_2 fluxes.
- L265: It would be better to call them CO_2 "fluxes" instead of "emissions" since you have measured some negative values.
- L270: Both are red lines. Please be more precise in the description. What is the mean value of?
- Table 2: I don't think the abbreviation T-FCO_2 is necessary or correct here. I would rather use the term "CO_2 fluxes" over the four columns on the right, including the unit. Where T-FCO_2 and the unit are now, I would put the mean ± SD. I also recommend including the number of observations.
- Figure 3: In the graph, you used n.s., but in the caption, you explained the abbreviation NS. In the supplementary figures, you wrote that an absence indicates no significance. Be consistent.
- L299: Here, you wrote ".01"; in L302, you wrote "0.01" for p. Be consistent throughout the entire manuscript.
- Figure 4: What are the R^2 values of the linear regression lines?

- L305: The caption of Figure 4 mentions a dashed line, but I cannot see one in the figure.
- Table 3: I miss the p values you mentioned in L302f.
- Figure 5: I'm not sure what to say about these trend lines. I don't trust them because they look like a point cloud with temperature differences and the influence of the edge effect.
- L345: Sometimes there is a space between the number and "Celsius," and sometimes there isn't. Be consistent throughout the manuscript.
- Table 5: In the text, you always used SD, but in the tables, you used sd. Please be consistent and explain every abbreviation in the table caption. Use the same rounding for all emission values shown here. Since seasonality affects CO_2 fluxes in your studied ponds and in most ecosystems outside the tropics, it would be helpful to know what season the reference values were measured.
- L485: The data cannot be reviewed because they are unavailable. I recommend that the authors make the data easily accessible to everyone, not just upon request, for reasons of repeatability and reusability.
- The information about the R packages used is missing and can be added to the references or the methods chapter.
- Why did you use two appendices (A and B)?
- Table A2: Could you add more lines to better separate the categories in the left column and put each variable name in its own row? This would make the table easier to read.
- Figure S1: Variable names, including units, are sometimes split into two lines. This makes the table difficult to read. Please reconsider this.
- Figure S2: In the manuscript, you called it "Pond ID"; here, on the x-axis, it is "Pond Code." Be consistent. The y-axis is missing a unit.
- Figure S3: Please include the number of observations for each box plot.
- Figure S4: There is a typo in the x-axis label: months.
- Figure S5. The sentence about the absence of an asterisk can be removed from the caption.