Comment on bg-2022-220

Anonymous Referee #2

Referee comment on "Methane emissions from Arctic landscapes during 2000–2015: an analysis with land and lake biogeochemistry models" by Xiangyu Liu and Qianlai Zhuang, Biogeosciences Discuss., https://doi.org/10.5194/bg-2022-220-RC2, 2023

The manuscript of Liu and Zhuang covers an interesting topic appropriate for Biogeosciences. The authors addressed the importance of accounting for the methane emissions from wetlands and lakes using two processed-based models, with a few different wetland and lake extent products. The methodology is sound and the results are interesting. However, more in-depth discussions and some clarifications are needed. I have the following main questions:

1. Since reducing the uncertainties from 'double accounting' is one of the main focus for this manuscript, I wonder how large the amount was 'double accounted' and how large the estimate was improved by your approach. Could you elaborate in the abstract and main text?

2. The Lake with a size < 10 ha is the central component that affects estimating wetland and lake CH_4 emissions simultaneously. It is unclear how you treat this since the HydroLakes doesn't cover the extent for small lakes?

3. The statistical analysis needs to be improved. I am surprised to see shortwave radiation has a much higher correlation with CH_4 emissions than the temperature for the Arctic wetlands and lakes on the annual basis. What's the underlying mechanism for this? Also, these climate variables often co-vary over time. the analysis done in its current way may not reflect the 'true' sensitivity of CH_4 fluxes to the climate variables.

4. The description of the sensitivity test is not clear. How did you treat the increasing temperature by 5 deg C and increasing precipitation by 15%? Was the increased temperature or precipitation evenly allocated to each month or proportional to its seasonal cycle? This is important because the added precipitation and temperature to different seasons would have different effects on CH_4 emissions. Also, how the threshold for

temperature and precipitation were chosen.

Specific comments:

Table 2. The way its presented is confusing. As I said, your might want to consider a multiple regression or partial correlation to analyze the sensitivity.

Figure 3. It is difficult to read as it is currently presented. Could you minimize the duplicated information by plotting the time series by different groups? Say Ch4 emissions and climate variables as two groups?

Discussion 4.1 it is not clear to me how your number narrows down the double counting.

4.2 is confusing. If analyzing yearly values can not capture the 'true' relationship as the authors said. Why present it in results? To me it looks like you are analyzing the driving variables for different time scales, The 4.2 is for seasonal cycle and the annual analysis is for interannual variations.

Section 4.2 Why vapor pressure has the highest correlation for monthly results. This needs an explanation for the mechanisms of dominant control by humidity and vapor pressure. Are the mechanisms differ with wetlands and lakes?

Line 304 Correlation of 0.77 for short-wave radiation is still high.