

Data Paper

Keiko Konya, Go Iwahana, Tetsuo Sueyoshi, Tomoaki Morishita and Takahiro Abe. Methane flux around the Gulkana Glacier terminus, Alaska summer 2019. Polar Data Journal. 2022, 6, p. 32–42. <https://doi.org/10.20575/00000040>.

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1st submission

Editor Start Date: 9/3/2021

Editor Stop Date: 9/27/2021

Reviewer #1 (9/8/2021–9/26/2021)

Reviewer #2 (9/9/2021–9/27/2021)

Editor comments to the Author: Ryu Uemura

The ratings of the two reviewers were very negative (between rejection and major revision). However, the reviewers kindly provided very detailed comments. Thus, I think that the paper could be revised if you revise the manuscript according to the following comments/suggestions. As Reviewer#2 suggested, this manuscript lacks fundamental information (instrument names, precision, protocol etc.). Please read the journal guideline and also read the papers published in PDJ before submitting the revised manuscript. You use the section titles of the Word format file as it is. Please revise appropriate section name or remove unnecessary words (e.g., Location (or Observation) should be Location or Location and observation etc ; For "Usage note (optional)", remove "optional".)

Reviewer #1: Anonymous

Please provide the manuscript with the line numbers to reviewers. It would help a lot in commenting. This time I could manage from the manuscript in Word file.

The dataset is quite unique, so it is worth while listing them. However, the number of measurements were only seven, and there is no explanation in the manuscript why the sampling location were chosen, and how they would become valuable in future.

My specific comments follows: please refer the file attached for the line numbers.

1. L25 "18 locations" is not precise. At 3 sites, totally 18 locations.
2. L38 "square": missing "meter."
3. L45 Is "globally" correct?
4. L47 Why did you choose this glacier?
5. L48 Why is the data set of methane around a temperate small-scale mountain glacier important for the global CH₄ cycle?

6. L58 It would be more kind to mention how much and when the glacier was "retreated in recent years."
7. L82 All item in the Table 1 must be explained including symbols such as "-".
8. L89 Needs more explanation in order to make readers trust the data set.
9. L91 This is an important information, and should be written in "2. Location and observation."
10. L118 The time and date for the methane sampling should be included in this table.
11. L118 "sediment" is not suitable for describing the ground condition, Should be "sand" or "gravel" etc..
12. L118 Nothing in the box of A1 and "Air/water temperature." Is it correct?
13. L118 "-" in this Table has two meanings. One is "No measurement", and another "The measurement was done but the value was negligibly small." It is recommended to use different symbols.
14. L135 Not in the manuscript.
15. L147 Not in the manuscript.
16. L170 Not in the manuscript.

Reviewer #2: Anonymous

General comments

This manuscript presents measurement results of methane (CH₄) flux near the Gulkana Glacier, Alaska. The topic and data are well within the scope of the journal. However, I must point out that information on the data is unfortunately incomplete, for which I cannot recommend publication of the present manuscript. I suggest the authors major revision to consider the following comments.

What types of data/variables are presented in this study should be clearly described in abstract. The authors should write every variable, so that readers can easily understand list of the data. They should not write scientific interpretation the data unless it is clearly explained in the text.

Background & summary section should allow readers understand why the authors obtained the data. Insufficient is scientific context of why the Gulkana Glacier in Alaska was selected for a measurement site. Unknown is not a reason of a scientific study. If contribution of such a small glacier to the global CH₄ cycle is insignificant, this study cannot help better understanding of the future CH₄ dynamics, contradictory to what the authors state. Please more specifically describe how this study could have potential contribution significantly. The second paragraph of the section should be reformulated and much enriched.

Methods section lacks necessary information on methodologies that were used to obtain the data presented in Table 1. The authors describe measurement methods for CH₄ flux and stable isotope ratios. However, methods/instruments for the measured variables in the other columns (e.g. electric conductivity, air/water temperature, ground-surface conditions and CO₂ concentration) are not given.

It is important to describe uncertainties of the individual measurements. The authors argue that CH₄ fluxes at some locations are negligibly small, but without measurement uncertainty and associated detection limit, presence/absence of CH₄ flux is not justified. Uncertainties of the individual CH₄ flux estimates should also be calculated and presented

in Table 1.

For $\delta^{13}\text{C}$ of CH_4 data, corresponding CH_4 concentration data should be provided. Although the authors argue that the $\delta^{13}\text{C}$ of CH_4 data indicate influence of CH_4 oxidation in abstract, I could not understand adequate reasoning for the interpretation. I surmise that the measured $\delta^{13}\text{C}$ values higher than in the background atmosphere (about -47 per mil in general) might have been ascribed to oxidation of CH_4 . If so, those samples with higher $\delta^{13}\text{C}$ should have lower CH_4 concentration, but it should not be the case for positive CH_4 flux was calculated. Please provide more detailed measurement results and consistent interpretation.

Technical Validation section does not play a role. It reads just like subjective opinion of the authors. They should specifically provide the range of realistic values, if they argue reliability of their data in such a manner. Likewise, the authors should carefully read the journal guideline again (for other sections, too) and reformulate the manuscript accordingly.

Specific comments

Title: Given that this manuscript has been written for a data paper, it is more appropriate to leave out "preliminary investigation of" and change it to "Methane fluxes around..."

L1 Abstract: I would move "to assess the carbon cycle on the proglacial land surface of temperate mountain glaciers" to the beginning. But this purpose sounds a bit exaggerated. Measurement of CH_4 flux would be far from complete to assess the carbon cycle, because major part of carbon is stored in chemical forms different from CH_4 .

L4 Abstract: In Table 1 and Figure 2, CH_4 flux values are given at 7 locations. The term "negligibly small" is inappropriate. I think that the results showed insignificantly different from zero. As my earlier comment, clear description of the measurement uncertainties is needed.

L5 Abstract: As my earlier comment, I could not find reasoning of this sentence throughout the manuscript.

L1 Section 1: IPCC assessed the GWP of CH_4 and other greenhouse gases. It is an estimate value and thus it is strange to say "methane exhibits a GWP of 28".

L2 Section 1: CH_4 concentration has increased globally since the beginning of the industrial era.

L4 Section 1: Leave out "emissions"

L6 Section 1: Leave out "emissions"

L6 Section 1: per square "meter" per day or " $\text{mmol CH}_4 \text{ m}^{-2} \text{ day}^{-1}$ "

L7 Section 1: "existence of active methanogenic activity" or "presence of biologically active wetlands"

L13 Section 1: This paragraph lacks why the authors consider small-scale mountain glacier important, as my earlier comment.

L3 Section 2: Probably the latitude is typo.

L3 Section 2: "the farthest" to "250 m distant"

Section 3: As in my earlier comment, method for every variable presented in Table 1 should be sufficiently explained.

L4 Section 3: "at 0, 10,..." could be move to the beginning.

L6 Section 3: "The samples were analyzed for CH_4 concentration by using..." and replace "following" to "according

to". As in my earlier comment, measurement uncertainty of CH₄ concentration and how it is translated to the calculated uncertainty of CH₄ flux should be given. Calibration of the CH₄ concentration measurement should be also explained.

L9 Section 3: Was the oven temperature maintained at 120°C throughout the analysis? If so, it could be more simply written like "...with a 2-m Unibeads C column maintained at 120° C."

L10 Section 3: Provide the purity of the carrier helium gas.

L11 Section 3: Was the only small aliquot (5 mL) used for sample analysis or were multiple analyses made from the original sample (40 mL)?

L11 Section 3: "uptake or emission rate" or "uptake/emission rate". Were there any case where uptake was estimated? It would better help readers if the equation by the reference is given here.

L13 Section 3: "The stable carbon isotope ratio ($\delta^{13}\text{C}$) of CH₄" as this is the first appearance place. Provide a reference that describes measurement method of $\delta^{13}\text{C}$ of CH₄ used at UC Davis Stable Isotope Facility. Provide measurement uncertainty and to which international scale the measurement is traceable.

L14 Section 3: Same comment as above for δD and $\delta^{18}\text{O}$ of water.

L17 Section 3: Provide the instruments used to measure these variables. The pH values could be also included in the dataset.

Section 4: The authors should refer to the journal guideline. "Describe the data files and their formats so that other researchers can reuse them by reading this section." This is not given.

L1 Section 4: CH₄ flux seems to have been detected only at 7 locations among 18. This should be explicitly written.

L2 Section 4: The pH values could be also listed in Table 1.

L2 Section 4: According to WMO (2020), which the authors refer to, the global mean CO₂ concentration was 410.5 ppm in 2019. In general, CO₂ concentration at northern high latitudes is higher on annual average, but could be lower in summer (the period of measurement). In any case, without measurement uncertainty of CO₂ concentration provided, the argument "at the same level of the ambient air" cannot be justified.

L4 Section 4: "separated" to "distinct"

Section 5 should be rewritten. The present form does not validate methodologies of the authors.

Section 6: I could not understand why this content is written independently in this section. This sentence could be moved to section 2.

Figure 2 caption: "emissions" to "fluxes".

Figure 3: The authors should explain usefulness of these isotope data from the water samples and how this type of scatterplot helps, probably in section 1. Where are these isotope data are available?

Table 1: Please provide what "-" does mean. It seems that at some places it means below detection limit and at other places not measured.

Data Citations: I do not understand availability of the dataset. Is Table 1 the whole dataset corresponding to this manuscript or has the dataset been made open at an independent repository?

Authors Response:

Response to the editor and reviewers,

We thank the editor for the comments. We have corrected the manuscript as the editor and reviewers pointed out. We believe that the manuscript was improved in describing the necessary information as a data paper. We hope the revised manuscript to be considered for publication in Polar Data Journal. Since we have additional data for this manuscript, new data was registered on ADS.

Response to Editors' comments;

The ratings of the two reviewers were very negative (between rejection and major revision). However, the reviewers kindly provided very detailed comments. Thus, I think that the paper could be revised if you revise the manuscript according to the following comments/suggestions. As Reviewer#2 suggested, this manuscript lacks fundamental information (instrument names, precision, protocol etc.). Please read the journal guideline and also read the papers published in PDJ before submitting the revised manuscript. You use the section titles of the Word format file as it is. Please revise appropriate section name or remove unnecessary words (e.g., Location (or Observation) should be Location or Location and observation etc ; For "Usage note (optional)", remove "optional".)

We thank the editor for the comments. We have corrected the manuscript as the editor and reviewers pointed out. We have changed the format following to the guidelines.

Response to reviewer #1;

Please provide the manuscript with the line numbers to reviewers. It would help a lot in commenting. This time I could manage from the manuscript in Word file. The dataset is quite unique, so it is worth while listing them. However, the number of measurements were only seven, and there is no explanation in the manuscript why the sampling location were chosen, and how they would become valuable in future.

We thank the reviewer #1 for the valuable comments and suggestions.

We corrected the manuscript and added line numbers. We wrote the criteria and reasons to choose the observation sites in section 2. Also, we wrote the usefulness by the measurement of the methane flux in section 1.

My specific comments follows: please refer the file attached for the line numbers.

1. L25 "18 locations" is not precise. At 3 sites, totally 18 locations.

We corrected as "At 3 sites, totally 18 locations".

2. L38 "square": missing "meter."

We added "meter" in the text.

3. L45 Is "globally" correct?

We meant that mountain glaciers exist many places in the world. However, "many in high latitude and high altitude" is better sentence. We have corrected the sentence.

4. L47 Why did you choose this glacier?

The motivation of our study is to examine how generally does the methane emission at the glacier terminus occurs. Therefore, it should be a typical mountain glacier, also with relatively easy access as the measurement requires many tools and heavy devices. Gulkana Glacier is a small mountain glacier and has good access from the traffic road. In choosing from many glaciers in Alaska, accessibility is an important factor. We added this information in the updated manuscript.

5. L48 Why is the data set of methane around a temperate small-scale mountain glacier important for the global CH₄ cycle?

Glacier area in the cryosphere in the Arctic is important for methane flux study. Methane emission in the Arctic is not fully understood. Therefore, we think the emission rate from glacier areas needs to be understood. We assessed the methane emission from the typical glacier area.

6. L58 It would be more kind to mention how much and when the glacier was "retreated in recent years."

The area of Gulkana glacier shrunk 14 % from 1967 to 2016. We wrote that in the text.

7. L82 All item in the Table 1 must be explained including symbols such as "-".

"-" meant "no data available". However, we rewrote "no measurement" and "not detected" as you pointed in another comment.

8. L89 Needs more explanation in order to make readers trust the data set.

The technical validation section was rewritten and described the measurement and precision.

9. L91 This is an important information, and should be written in "2. Location and observation."

This sentence was moved to "2. Location and observation".

10. L118 The time and date for the methane sampling should be included in this table.

The time and date were filled in the table.

11. L118 "sediment" is not suitable for describing the ground condition, Should be "sand" or "gravel" etc.

We rewrote as the surface condition was "sand". Since we put the chambers on the flat surface, we avoid gravel area.

12. L118 Nothing in the box of A1 and "Air/water temperature." Is it correct?

The A1 of Air/water temperature was missing. We filled "n/m", meaning no measurement, in that box.

13. L118 "-" in this Table has two meanings. One is "No measurement", and another "The measurement was done but the value was negligibly small." It is recommended to use different symbols.

We used n/m for "no measurement" and n/d for "not detected", which is under the detection limit.

14. L135 Not in the manuscript.

We have omitted that reference.

15. L147 Not in the manuscript.

We have omitted that reference.

16. L170 Not in the manuscript.

We have omitted that reference.

Response to reviewer #2;

Thanks for the valuable and useful comments on our manuscript. We made some corrections
102 through your comments as follows.

General comments

This manuscript presents measurement results of methane (CH₄) flux near the Gulkana Glacier, Alaska. The topic and data are well within the scope of the journal. However, I must point out that information on the data is unfortunately incomplete, for which I cannot recommend publication of the present manuscript. I suggest the authors major revision to consider the following comments.

What types of data/variables are presented in this study should be clearly described in abstract. The authors should write every variable, so that readers can easily understand list of the data. They should not write scientific interpretation the data unless it is clearly explained in the text.

We have described types of data in the abstract.

Background & summary section should allow readers understand why the authors obtained the data. Insufficient is scientific context of why the Gulkana Glacier in Alaska was selected for a measurement site. Unknown is not a reason of a scientific study. If contribution of such a small glacier to the global CH₄ cycle is insignificant, this study cannot help better understanding of the future CH₄ dynamics, contradictory to what the authors state. Please more specifically describe how this study could have potential contribution significantly. The second paragraph of the section should be reformulated and much enriched.

We described our objective in the background section. We think the glacier area in the cryosphere in the Arctic is important for methane flux study. Methane emission in the Arctic is not fully understood. Therefore, we think the emission rate from glacier areas needs to be understood. We assessed the methane emission from the typical glacier area. The “background and summary” section changed to the “background” section.

Methods section lacks necessary information on methodologies that were used to obtain the data presented in Table 1. The authors describe measurement methods for CH₄ flux and stable isotope ratios. However, methods/instruments for the measured variables in the other columns (e.g. electric conductivity, air/water temperature, ground-surface conditions and CO₂ concentration) are not given.

Method of CH₄ flux and other factors measurement were filled in method section.

It is important to describe uncertainties of the individual measurements. The authors argue that CH₄ fluxes at some locations are negligibly small, but without measurement uncertainty and associated detection limit, presence/absence of CH₄ flux is not justified. Uncertainties of the individual CH₄ flux estimates should also be calculated and presented in Table 1.

Uncertainties for measurements were written in the section of technical validation. The limit of flux detection was also written in that section as $-1.0 < F \text{ (}\mu\text{g CH}_4\text{-C m}^{-2} \text{ h}^{-1}\text{)} < 1.0$.

For $\delta^{13}\text{C}$ of CH₄ data, corresponding CH₄ concentration data should be provided. Although the authors argue that the $\delta^{13}\text{C}$ of CH₄ data indicate influence of CH₄ oxidation in abstract, I could not understand adequate reasoning for

the interpretation. I surmise that the measured $\delta^{13}\text{C}$ values higher than in the background atmosphere (about -47 per mil in general) might have been ascribed to oxidation of CH_4 . If so, those samples with higher $\delta^{13}\text{C}$ should have lower CH_4 concentration, but it should not be the case for positive CH_4 flux was calculated. Please provide more detailed measurement results and consistent interpretation.

The $\delta^{13}\text{C}$ of CH_4 data was provided in table 1. The interpretation about oxidation was originally from previous studies. However, we have omitted the sentences for interpretation about oxidation since we can only show the isotope data and methane concentration. We also rewrote that sentence in the abstract.

Technical Validation section does not play a role. It reads just like subjective opinion of the authors. They should specifically provide the range of realistic values, if they argue reliability of their data in such a manner. Likewise, the authors should carefully read the journal guideline again (for other sections, too) and reformulate the manuscript accordingly.

We rewrote this section. We wrote about the precision and limit of each measurement.

Specific comments

Title: Given that this manuscript has been written for a data paper, it is more appropriate to leave out "preliminary investigation of" and change it to "Methane fluxes around..."

We have left out the first three words and changed the title to "Methane flux around..."

L1 Abstract: I would move "to assess the carbon cycle on the proglacial land surface of temperate mountain glaciers" to the beginning. But this purpose sounds a bit exaggerated. Measurement of CH_4 flux would be far from complete to assess the carbon cycle, because major part of carbon is stored in chemical forms different from CH_4 .

We have corrected the words to "to understand the methane flux".

L4 Abstract: In Table 1 and Figure 2, CH_4 flux values are given at 7 locations. The term "negligibly small" is inappropriate. I think that the results showed insignificantly different from zero. As my earlier comment, clear description of the measurement uncertainties is needed.

We described it as n/d (not detected) when the methane was not detected. Then, we have corrected it to "not detected" and also wrote the uncertainties and lower limitations of the measurements in "5. Technical validations".

L5 Abstract: As my earlier comment, I could not find reasoning of this sentence throughout the manuscript.

This sentence has been omitted and described about isotope analysis in the table 2 for the data usefulness.

L1 Section 1: IPCC assessed the GWP of CH_4 and other greenhouse gases. It is an estimate value and thus it is strange to say "methane exhibits a GWP of 28".

We have corrected the sentence to "was assessed global warming potential of 28".

L2 Section 1: CH_4 concentration has increased globally since the beginning of the industrial era.

We have corrected as the reviewer#2 pointed out.

L4 Section 1: Leave out "emissions"

We made leave out "emission" from this sentence.

L6 Section 1: Leave out "emissions"

We made leave out "emission" from this sentence.

L6 Section 1: per square "meter" per day or "mmol CH₄ m⁻² day⁻¹"

We corrected to "mmol CH₄ m⁻² day⁻¹".

L7 Section 1: "existence of active methanogenic activity" or "presence of biologically active wetlands"

We corrected to "presence of biologically active wetlands" to fit what we meant.

L13 Section 1: This paragraph lacks why the authors consider small-scale mountain glacier important, as my earlier comment.

We rewrote background section.

L3 Section 2: Probably the latitude is typo.

We have corrected from 53 to 63.

L3 Section 2: "the farthest" to "250 m distant"

We have corrected to "250 m distant".

Section 3: As in my earlier comment, method for every variable presented in Table 1 should be sufficiently explained.

Method section was expanded with explanations of every factor.

L4 Section 3: "at 0, 10,..." could be move to the beginning.

"at 0, 10,..." was moved to the beginning of the sentence.

L6 Section 3: "The samples were analyzed for CH₄ concentration by using..." and replace "following" to "according to". As in my earlier comment, measurement uncertainty of CH₄ concentration and how it is translated to the calculated uncertainty of CH₄ flux should be given. Calibration of the CH₄ concentration measurement should be also explained.

We have replaced "following" to "according".

Measurement uncertainty is affected from chamber size, air temperature and measurement time period as shown in the equation (1). Uncertainty of chamber size is 0.005 since height and diameter of the chamber was measured by 0.005 m interval and the flux was calculated with V/A. Uncertainty of air temperature is 0.1-degree C. Uncertainty of measurement time effect on the extrapolation line to calculated flux rate in an hour. We did not statistical processing for the plot and fitting line in this study. We have collected the air sample in the chambers every time just after starting of measurement (0 minutes after the lid closed). Standard CH₄ gas (1.981 ppmv) was used for calibrations. As written in the manuscript, the limitation of the measurement is $-1.0 < F (\mu\text{g CH}_4\text{-C m}^{-2} \text{ h}^{-1}) < 1.0$.

L9 Section 3: Was the oven temperature maintained at 120°C throughout the analysis? If so, it could be more simply written like "...with a 2-m Unibeads C column maintained at 120° C."

The oven temperature was maintained at 120 °C, we rewrote as "...with a 2-m Unibeads C column maintained at 120° C."

L10 Section 3: Provide the purity of the carrier helium gas.

The purity of helium gas was 99.9999 %.

L11 Section 3: Was the only small aliquot (5 mL) used for sample analysis or were multiple analyses made from the original sample (40 mL)?

Yes, 5 ml was used for analysis.

L11 Section 3: "uptake or emission rate" or "uptake/emission rate". Were there any case where uptake was estimated?

It would better help readers if the equation by the reference is given here.

The equation was quoted from Morishita et al. (2004) as follows.

$$\text{CH}_4 \text{ uptake rate } (\mu\text{g CH}_4 \text{ C m}^{-2} \text{ h}^{-1}) = -\rho \times V/A \times \Delta c/\Delta t \times 273/T \quad (1)$$

Where ρ is the density of CH_4 ($0.716 \times 10^9 \mu\text{g m}^{-3}$) under standard conditions; $V(\text{m}^3)$ and $A(\text{m}^2)$ area the volume and bottom area of the chamber, respectively; $\Delta c/\Delta t$ ($10^{-6} \text{ m}^3 \text{ m}^{-3} \text{ h}^{-1}$) is the rate of the CH_4 concentration in the chamber during a given period; and T is the absolute temperature.

L13 Section 3: "The stable carbon isotope ratio ($\delta^{13}\text{C}$) of CH_4 " as this is the first appearance place. Provide a reference that describes measurement method of $\delta^{13}\text{C}$ of CH_4 used at UC Davis Stable Isotope Facility. Provide measurement uncertainty and to which international scale the measurement is traceable.

Stable isotope was measured at UC Davis, and the measurement method is in their site (<https://stableisotopefacility.ucdavis.edu/methane-ch4-gas>).

Their reference is

C. Yarnes. 2013 $\delta^{13}\text{C}$ and $\delta^2\text{H}$ measurement of methane from ecological and geological sources by gas chromatography-combustion/pyrolysis-isotope-ratio mass spectrometry. *Rapid Commun. Mass Spectrom.* 27, 1036–1044. DOI: 10.1002/rcm.6549.

Limit of quantitation and standard deviation for $^{13}\text{C}-\text{CH}_4$ and $^2\text{H}-\text{CH}_4$ are 0.8 nanomoles and 0.2 ‰, and 2 nanomoles and 2 ‰, respectively.

L14 Section 3: Same comment as above for δD and $\delta^{18}\text{O}$ of water.

The δD and $\delta^{18}\text{O}$ values were measured using a pyrolysis-elemental analyzer EA-IRMS. This method utilizes a ThermoScientific high-temperature element analyzer (TC/EA) and a ConFlo III interface with a Delta XP mass spectrometer. Stable isotope ratios were reported in δ notation as parts per thousand (‰) deviations from international standards, V-279 SMOW (Standard Mean Ocean Water). Instrument precision is better than 1.2‰ for hydrogen and 0.2‰ for oxygen. Analysis was performed by the Alaska Stable Isotope Facility at the UAF Water and Environmental Research Center (WERC). In the manuscript, we wrote about the instrument precision.

L17 Section 3: Provide the instruments used to measure these variables. The pH values could be also included in the dataset.

More instruments and precisions were described in section 3. pH values were included in Table 1.

Section 4: The authors should refer to the journal guideline. "Describe the data files and their formats so that other researchers can reuse them by reading this section." This is not given.

We wrote the data file name and format in section 4.

L1 Section 4: CH_4 flux seems to have been detected only at 7 locations among 18. This should be explicitly written.

We rewrote as "A small CH_4 flux was detected at 7 locations among 18" for the first sentence in Section 4.

L2 Section 4: The pH values could be also listed in Table 1.

The pH values were listed in Table 1.

L2 Section 4: According to WMO (2020), which the authors refer to, the global mean CO₂ concentration was 410.5 ppm in 2019. In general, CO₂ concentration at northern high latitudes is higher on annual average, but could be lower in summer (the period of measurement). In any case, without measurement uncertainty of CO₂ concentration provided, the argument "at the same level of the ambient air" cannot be justified.

In this sentence, we have meant that CO₂ flux was very small. However, the sentence about ambient air may make the readers misunderstand. Therefore, we have deleted this sentence and rewrote the first sentence that "A small CH₄ and CO₂ flux were detected at 7 locations among 18".

L4 Section 4: "separated" to "distinct"

We have corrected to "distinct".

Section 5 should be rewritten. The present form does not validate methodologies of the authors.

We have rewritten section 5 and showed the accuracy and measurement ranges.

Section 6: I could not understand why this content is written independently in this section. This sentence could be moved to section 2.

This content has moved to sections 2.

Figure 2 caption: "emissions" to "fluxes".

"emissions" has changed to "fluxes".

Figure 3: The authors should explain usefulness of these isotope data from the water samples and how this type of scatterplot helps, probably in section 1. Where are these isotope data are available?

The data were listed in Table 1. The isotope data were analyzed in University of Alaska as written in the text.

Table 1: Please provide what "-" does mean. It seems that at some places it means below detection limit and at other places not measured.

"-" meant "no data available". However, we rewrote "no measurement" and "not detected".

Data Citations: I do not understand availability of the dataset. Is Table 1 the whole dataset corresponding to this manuscript or has the dataset been made open at an independent repository?

The data was registered to ADS. We wrote the DOI in the text as follows.

Konya, K., G. Iwahana, T. Morishita, T. Sueyoshi, T. Abe, 2021, Methane flux observation at Gulkana Glacier terminus, Alaska in July 2019., 0.00, Arctic Data archive System (ADS), Japan, <https://ads.nipr.ac.jp/dataset/A20210720-001>

2nd submission

Editor Start Date: 10/21/2021

Editor Stop Date: 11/28/2021

Reviewer #1 (10/21/2021–11/28/2021)

Reviewer #2 (10/21/2021–11/20/2021)

Editor in Chief comments to the Author: Akira Kadokura

Considering the comments from two reviewers and handling editor, I recommend a major revision in which the authors should consider seriously their every comment, especially on the treatment of the "n/d" data and evaluation of the uncertainties of measured CH₄ fluxes.

My additional comments are as follows:

1. Please explain about Figure 2 in the text.
2. Please describe why and how you selected the 6 locations at the 3 sites (A, B, C) in the "2. Location" section.
3. Please include words such as "2019 summer" in the title.
4. ALL co-authors must check the technical and editorial details before resubmitting.

(Do NOT use reviewers' valuable and dedicated effort for editorial checks.)

Editor comments to the Author: Ryu Uemura

In spite of the previous major revision, two reviewers again judged it as a major revision close to reject. The reviewers also expressed concerns about the reliability of the data itself. I myself regret that there are still many mistakes (as suggested by reviewers) in the revised manuscript. These should have been corrected before submitting the revised version. Unfortunately, I recommend that this manuscript be rejected. I believe that the following reviewer's comments will be useful for improving the quality of future manuscript.

Reviewer #1: Anonymous

I judge this manuscript as "major revision", which is very closed to "reject." The reason is as follows.

1. L114-115, it said "For the flux measurement, the range of $-1.0 < F < 1.0$ is out of measurement in this study." It is absolutely wrong, because, when the change of the measured methane concentrations is very small (no matter how the methane concentration is detectable or not), we normally treat it as zero flux, not "out of measurement."
2. There are 11 "n/d" in the CH₄ flux measurement. The authors did not treat them as zero flux in Fig.2 and Table 1, and never explained why they were "not detected."
3. If the measurements of CH₄ concentrations (4 times in 40 minutes after the lid of chamber closed), are under the limit of detection of the instrument and unchanged in the 4 measurements, the flux can be regarded as zero, not "n/d." However, the authors treated as "n/d," and excluded from Fig.2.

I speculate they thought there might have been something wrong in the measurement. If so, the flux values shown in Fig.2 might also include "something wrong" and are not reliable.

Therefore, you must explain why more than half of the measurement were "n/d", and why the same reason does not apply to the CH₄ flux values shown in Fig.2.

Specific comments

L73 40mL, but at L115, it is "50mL."

L83 area ->are

L84 What is "10-6"?

L86 "The in the" cut out.

L101 What are D717, B-771 or B-712?

L101 The temperature and the hight (V/A) inside the chamber should be included in Table 1.

L106 No " CO2 flux" were written in Table 1.

L135 What "The number attached with each sample location" means?

L141

L139-143 The caption for Table 1 should be re-written. They are not accurate. E.g. " CO2 flux"?, Ta and Tw?, etc.

Reviewer #2: Anonymous

General comments

This manuscript has been improved by incorporating comments from reviewers including myself. However, even with the revised manuscript, it is difficult for me to agree to publication of the study.

It is regrettable that the authors do not provide measurement uncertainties of CH₄ concentration and uptake rate, the main data of this study. In their response to one of my comments, the authors explain uncertainties relevant for flux estimation. Moreover, although they wrote that "We did not statistical processing for the plot and fitting line in this study," I am sure that they could evaluate uncertainty associated with regression for $\Delta C/\Delta t$ estimation. The authors therefore have all information to make a simple calculation of error propagation. They should provide uncertainties of CH₄ flux in a style of $X \pm Y \mu\text{g CH}_4 \text{ m}^{-2} \text{ h}^{-1}$. In my opinion, it is the authors' responsibility to sufficiently provide uncertainty of a reported dataset so that readers can clearly judge and understand reliability of the data.

In addition, there are many careless mistakes that must have been resolved by the authors. The authors should realize that they force reviewers make unnecessary efforts.

Specific comments

P1 L28: An incomplete sentence which lacks a verb. It is written that CO₂ flux data are provided, but, in Table 1 and the ADS dataset, only CO₂ concentrations are given, not flux. The authors may misunderstand definitions of flux and concentration, which is a serious mistake that could make readers question quality of this study.

P2 L29: "Stable carbon isotope ratio of CH₄" and "Stable hydrogen and oxygen isotope ratios of water". "Water from river water" sounds strange.

P2 L34: "...and its global warming potential is assessed to be 28."

P2 L35: "The atmospheric concentration of CH₄" or "The CH₄ concentration in the atmosphere". The first clause reads wrongly. For instance, CH₄ concentration in an Arctic area remote from strong sources could be lower than that in a

tropical wetland area. This sentence needs a reference.

P2 L39: Here the positive number fluxes seem to indicate emission to the atmosphere, but later the authors seem to indicate uptakes in positive numbers. It is very confusing. Be consistent throughout the manuscript.

P2 L46: "at high latitudes, have been". I would suggest to delete the next sentence, because it does not give any information. Almost everything in the earth system is not fully understood, so the sentence cannot explain motivation of the work, in my opinion.

P2 L48: "typical" - with this expression, I think the next section (Location) needs to explain why the glacier investigated in this study is considered to be typical.

P2 L52: It is unclear that what the fundamental factors are. By definition, flux is rate, unit $\text{m}^{-2} \text{s}^{-1}$, so the term flux rate sounds strange. Please elaborate why the CH_4 flux depends on surface conditions.

P3 L56-58: Figure 1 is mentioned twice in the middle and end of the sentence, but it is unclear where readers should look at in Figure 1. Both Gulkana Glacier and Alaska Range cannot be identified/labeled in the figure.

P3 L61: What is glacier influence?

P3 L63: "applied" to "used"

P3 L68ff: A method to measure CO_2 concentration (as well as measurement uncertainty) is not given.

P3 L74: Please provide measurement reproducibility of the GC-FID. Calibration of CH_4 concentration measurement is not provided. As in the response, if the standard gas (1.981 ppm) was used, the authors should explain the origin of the concentration value, which lab/company assigned/certified the number? This should be incorporated into the main text.

P3 L77: "of which purity is $>99.9999\%$ "?

P3 L77: How are the samples introduced into GC-FID?

P3 L78: This should be "uptake rate", if a positive value indicates uptake. It is also clearly given that positive values indicate uptake.

P3 L81: mistake of superscript and subscript

P4 L83: probably "9" of " 10^9 " is superscript

P4 L84: probably " -6 " of " 10^{-6} " is superscript

P4 L86: Correct the wording "the in the air samples". It is regrettable that only the samples collected 40 min after the chamber closure are analyzed for $\delta^{13}\text{C}$. If the initial samples had been measured, they could have possibly addressed oxidation of CH_4 . Why were those samples selected for $\delta^{13}\text{C}$ measurements? It should be explained.

P4 L88: "methane" to " CH_4 "

P4 L90: Are $\delta^{13}\text{C}$ and δD values reported respectively on the VPDB and VSMOW scales?

P4 L92: How much volume of water samples were collected?

P4 L96: "mass spectrometer" to "isotope ratio mass spectrometer"

P4 L97: Reports in δ notation are common for $\delta^{13}\text{C}$ of CH_4 . Just to be sure, is $\delta^{18}\text{O}$ also on the VSMOW scale?

P4 L99: "hydrogen" to " δD " and "oxygen" to " $\delta^{18}\text{O}$ "

P4 L101: Should be written like "a conductivity meter XX-YYY (Horiba...)"

P4 L106: Table 1 does not list CO₂ flux, but CO₂ concentration. Be sure that they have different units! " $\delta^{13}\text{C}$ " to " $\delta^{13}\text{C}$ of CH₄". Uncertainty of CH₄ flux should be provided together.

P5 L114: "chromatology" is probably "chromatography". Whether a measurement method is in general established does not justify validity of the present dataset. In this section, the authors should clearly state uncertainty and traceability of their own measurement methods. It is unclear that why the present measurements are restricted in the range. How the range was determined must be also explained.

P5 L115: I do not understand why the volume of syringe contribute to technical validation. If this is important information, the authors need more explanations.

P5 L117: Redundancy

P5 L119: How much is the full scale? Are the following numbers are those evaluated by the authors or certified by product providers?

Figure 1: Alaska Range and Gulkana Glacier should be labeled in the map.

Figure 1 caption: With many pictures used for panels d-f, the authors should add more sentences to explain what individual pictures show. Readers also wonder what circles indicate. There seems to be chambers circled but also those not circled.

Figure 2: After calculation of uncertainty, error bars can be added.

Figure 2 caption: "flux" to "fluxes"

Table 1 caption: "S and W in column Ground-surface conditions". Again it is not CO₂ "flux". Again I wonder how the authors determined "n/d". This is because they do not provide uncertainty of flux calculation.

Authors Response:

Dear Editors and reviewers,

We thank your support and comments on our manuscript. We have revised the manuscript following the suggestions.

Response to Editor in Chief comments;

Considering the comments from two reviewers and handling editor, I recommend a major revision in which the authors should consider seriously their every comment, especially on the treatment of the "n/d" data and evaluation of the uncertainties of measured CH₄ fluxes.

We seriously consider the reviewers' comments on these points. We have made clear the criteria for the rejection of the data, and "n/d" was changed to "0" as suggested by reviewer 2. The flux is shown as "0" when either the CH₄ concentration in the chamber does not change significantly or the correlation coefficient of the linear regression line to estimate the flux is too small. Uncertainty was estimated with the measurement errors and included in Table 1.

My additional comments are as follows:

1. Please explain about Figure 2 in the text.

The explanation of Figure 2 was added in section "4. Data Records." The figure caption was also updated.

2. Please describe why and how you selected the 6 locations at the 3 sites (A, B, C) in the "2. Location" section.

We have added descriptions in the text.

3. Please include words such as "2019 summer" in the title.

"summer 2019" was added in the title.

4. ALL co-authors must check the technical and editorial details before resubmitting.

(Do NOT use reviewers' valuable and dedicated effort for editorial checks.)

The manuscript was checked by co-authors. Also, we ordered to English editing service company.

Response to Editor comments;

In spite of the previous major revision, two reviewers again judged it as a major revision close to reject. The reviewers also expressed concerns about the reliability of the data itself. I myself regret that there are still many mistakes (as suggested by reviewers) in the revised manuscript. These should have been corrected before submitting the revised version. Unfortunately, I recommend that this manuscript be rejected. I believe that the following reviewer's comments will be useful for improving the quality of future manuscript.

We revisited the reviewers' comments and revised the manuscript, especially on the clarity of the data reliability. We have made clear the criteria for the rejection of the data. We add the explanation of uncertainties and errors.

Response to reviewer #1;

I judge this manuscript as "major revision", which is very closed to "reject." The reason is as follows.

1. L114-115, it said "For the flux measurement, the range of $-1.0 < F < 1.0$ is out of measurement in this study." It is absolutely wrong, because, when the change of the measured methane concentrations is very small (no matter how the methane concentration is detectable or not), we normally treat it as zero flux, not "out of measurement."

We have recalculated methane flux and conducted error estimation. We have made clear the criteria for the rejection of the data, and "n/d" was changed to "0" as suggested. The flux is shown as "0" when either the CH₄ concentration in the chamber does not change significantly or the correlation coefficient of the linear regression line to estimate the flux is too small.

2. There are 11 "n/d" in the CH₄ flux measurement. The authors did not treat them as zero flux in Fig.2 and Table 1, and never explained why they were "not detected."

We showed five flux values in Fig 2, Table 1 and 2. The data of Fig 2 is shown in Table 1. We changed "n/d" to "0" for flux. One of the reasons of undetected flux were very small value of concentration. The other reason is that the root mean square is too low for linear regression line of .

3. If the measurements of CH₄ concentrations (4 times in 40 minutes after the lid of chamber closed), are under the limit of detection of the instrument and unchanged in the 4 measurements, the flux can be regarded as zero, not

"n/d." However, the authors treated as "n/d," and excluded from Fig.2.

The very small number, which is close to zero, can be considered indeed. However, since we tried to measure small value, we thought the value less than $1.0 \mu\text{g C m}^{-2} \text{ h}^{-1}$ is not zero in our first and second draft. As you pointed out “ $-1 < F < 1$ ” is zero, we wrote 0 in Table 1 and Figure 2 for too small value and uncalculatable case.

I speculate they thought there might have been something wrong in the measurement. If so, the flux values shown in Fig.2 might also include "something wrong" and are not reliable.

Therefore, you must explain why more than half of the measurement were "n/d", and why the same reason does not apply to the CH₄ flux values shown in Fig.2.

Specific comments

L73 40mL, but at L115, it is "50mL."

We used 50 ml syringe to vacuum the sample from the chamber. However, we have omitted the sentence about syringe since it is not important information as pointed out.

L83 area ->are

We have corrected the mistake.

L84 What is "10-6"?

“-6” should have been super script. We have corrected that.

L86 "The in the" cut out.

We have cut “The in the “.

L101 What are D717, B-771 or B-712?

They are names of measurement sensors. We changed the sentence for the readers to understand sensors name.

L101 The temperature and the hight (V/A) inside the chamber should be included in Table 1.

Air temperature data is shown in Table 1. We considered the air temperature in the chambers are same as in the air.

Chamber height was added in Table 1.

L106 No " CO₂ flux" were written in Table 1.

CO₂ is shown in Table 1 as concentration (ppm), not as flux. We have omitted CO₂ concentration data.

L135 What "The number attached with each sample location" means?

The sentence has changed. Sample locations are indicated on the horizontal axis by letters and numbers.

L141

L139-143 The caption for Table 1 should be re-written. They are not accurate. E.g. “ CO₂ flux”?, Ta and Tw?, etc.

We have added some explanations for captions.

Response to reviewer #2;

General comments

This manuscript has been improved by incorporating comments from reviewers including myself. However, even

with the revised manuscript, it is difficult for me to agree to publication of the study.

It is regrettable that the authors do not provide measurement uncertainties of CH₄ concentration and uptake rate, the main data of this study. In their response to one of my comments, the authors explain uncertainties relevant for flux estimation. Moreover, although they wrote that "We did not statistical processing for the plot and fitting line in this study," I am sure that they could evaluate uncertainty associated with regression for $\Delta C/\Delta t$ estimation. The authors therefore have all information to make a simple calculation of error propagation. They should provide uncertainties of CH₄ flux in a style of $X \pm Y \mu\text{g CH}_4 \text{ m}^{-2} \text{ h}^{-1}$. In my opinion, it is the authors' responsibility to sufficiently provide uncertainty of a reported dataset so that readers can clearly judge and understand reliability of the data.

In addition, there are many careless mistakes that must have been resolved by the authors. The authors should realize that they force reviewers make unnecessary efforts.

We evaluated the uncertainty by checking the raw data and calculating the value again as we wrote in the text. Also, we have corrected English errors for this manuscript with the help of the English proofreading services.

Specific comments

P1 L28: An incomplete sentence which lacks a verb. It is written that CO₂ flux data are provided, but, in Table 1 and the ADS dataset, only CO₂ concentrations are given, not flux. The authors may misunderstand definitions of flux and concentration, which is a serious mistake that could make readers question quality of this study.

We have corrected English error. The data was CO₂ concentrations, we have corrected "flux" to "concentration".

P2 L29: "Stable carbon isotope ratio of CH₄" and "Stable hydrogen and oxygen isotope ratios of water". "Water from river water" sounds strange.

The last sentence of abstract change to "Stable isotope analysis has been conducted for CH₄ and water from puddle and river at the observation sites."

P2 L34: "...and its global warming potential is assessed to be 28."

The sentence has corrected to as suggested.

P2 L35: "The atmospheric concentration of CH₄" or "The CH₄ concentration in the atmosphere". The first clause reads wrongly. For instance, CH₄ concentration in an Arctic area remote from strong sources could be lower than that in a tropical wetland area. This sentence needs a reference.

We have corrected that sentence to "The CH₄ concentration in the atmosphere" as suggested. Also, the reference is written in the text.

P2 L39: Here the positive number fluxes seem to indicate emission to the atmosphere, but later the authors seem to indicate uptakes in positive numbers. It is very confusing. Be consistent throughout the manuscript.

We intended to show emission by positive flux number in the Table and figure. The word "uptake" in the equation (1) was corrected to "emission" since it is confusing.

P2 L46: "at high latitudes, have been". I would suggest to delete the next sentence, because it does not give any information. Almost everything in the earth system is not fully understood, so the sentence cannot explain motivation of the work, in my opinion.

We have omitted the sentence as you suggested.

P2 L48: "typical" - with this expression, I think the next section (Location) needs to explain why the glacier investigated in this study is considered to be typical.

We wrote that the typical glacier of recent receding, no surging (rapid advance) and land terminating in "Location" section.

P2 L52: It is unclear that what the fundamental factors are. By definition, flux is rate, unit $\text{m}^{-2} \text{s}^{-1}$, so the term flux rate sounds strange. Please elaborate why the CH_4 flux depends on surface conditions.

The fundamental factors for the emission were not understood in this study. The methane concentration was calculated by the equation (1) and that was calculated based on the chamber observations. Then, flux was calculated from the linear regression from the slope of linear regression made from the time series data of methane concentration.

We think the underground condition is reflected to the surface condition in this area. Therefore, different surface conditions were taken into account since the methane emission environment is related to the surface condition.

P3 L56-58: Figure 1 is mentioned twice in the middle and end of the sentence, but it is unclear where readers should look at in Figure 1. Both Gulkana Glacier and Alaska Range cannot be identified/labeled in the figure.

Former "Figure 1" was omitted from the sentence. Since Alaskan Range is now shown in the figure 1, we wrote "Alaska" instead of "Alaska Range". The caption of Figure 1 was corrected.

P3 L61: What is glacier influence?

We have omitted the words. Although we thought water is provided from the glacier, it is uncertain.

P3 L63: "applied" to "used"

We have corrected "applied" to "used". Then, we changed the sentence. "We measured CH_4 flux from the ground surfaces using a closed chamber technique."

P3 L68ff: A method to measure CO_2 concentration (as well as measurement uncertainty) is not given.

CO_2 was measured by the same method. However, we have omitted the data of CO_2 since it was difficult to calculate CO_2 flux from our data and we concentrate on methane in this paper. So that, we did not write about a method for CO_2 concentration.

P3 L74: Please provide measurement reproducibility of the GC-FID. Calibration of CH_4 concentration measurement is not provided. As in the response, if the standard gas (1.981 ppm) was used, the authors should explain the origin of the concentration value, which lab/company assigned/certified the number? This should be incorporated into the main text.

We wrote about gas chromatography in the text. The GC-FID is in the Forestry and Forest Products Research Institute, which one of co-authors belong to.

P3 L77: "of which purity is >99.9999 %"?

We added "carrier" in the text and rewrote this sentence.

P3 L77: How are the samples introduced into GC-FID?

2 ml of sample gas was taken from the rubber stopper of the sample bottle and injected into the GC.

P3 L78: This should be "uptake rate", if a positive value indicates uptake. It is also clearly given that positive values

indicate uptake.

In this study, positive values indicate “emission”. We corrected the text.

P3 L81: mistake of superscript and subscript

We have corrected subscript. “Uptake” changed to “emission”.

P4 L83: probably "9" of "109" is superscript

We have corrected superscript.

P4 L84: probably "-6" of "10-6" is superscript

We have corrected the superscript.

P4 L86: Correct the wording "the in the air samples". It is regrettable that only the samples collected 40 min after the chamber closure are analyzed for $\delta^{13}\text{C}$. If the initial samples had been measured, they could have possibly addressed oxidation of CH_4 . Why were those samples selected for $\delta^{13}\text{C}$ measurements? It should be explained.

We have corrected to “gas samples”.

We have used 40 min sample for isotope analysis since 40 min sample has been expected to have enough conductivity.

P4 L88: "methane" to " CH_4 "

We have corrected to CH_4 .

P4 L90: Are $\delta^{13}\text{C}$ and δD values reported respectively on the VPDB and VSMOW scales?

$\delta^{13}\text{C}$ and δD were measured in university of California. And, isotope analysis for water samples was conducted in the isotope center in University of Alaska. Both of them explain that both values were reported on VPDB and VSMOW scales.

P4 L92: How much volume of water samples were collected?

“10 ml” was added in the text.

P4 L96: "mass spectrometer" to "isotope ratio mass spectrometer"

We have added “isotope ratio” in the sentence.

P4 L97: Reports in δ notation are common for $\delta^{13}\text{C}$ of CH_4 . Just to be sure, is $\delta^{18}\text{O}$ also on the VSMOW scale?

$\delta^{18}\text{O}$ was also in the VSMOW scale.

P4 L99: "hydrogen" to " δD " and "oxygen" to " $\delta^{18}\text{O}$ "

We have corrected both words.

P4 L101: Should be written like "a conductivity meter XX-YYY (Horiba...)"

We have corrected the sentence.

P4 L106: Table 1 does not list CO_2 flux, but CO_2 concentration. Be sure that they have different units! " $\delta^{13}\text{C}$ " to " $\delta^{13}\text{C}$ of CH_4 ". Uncertainty of CH_4 flux should be provided together.

CH_4 concentration (ppmv) is listed in Table 1. $\delta^{13}\text{C}$ is written as $\delta^{13}\text{C}_{\text{CH}_4}$ [‰]. Uncertainty of CH_4 flux is explained in the chapter of “Technical validation”.

P5 L114: "chromatology" is probably "chromatography". Whether a measurement method is in general established does not justify validity of the present dataset. In this section, the authors should clearly state uncertainty and traceability of their own measurement methods. It is unclear that why the present measurements are restricted in the

range. How the range was determined must be also explained.

“Gas chromatography” was corrected. Uncertainty of our method was explained in the section of “5. Technical Validation”. We also rewrote how to determine valid range.

P5 L115: I do not understand why the volume of syringe contribute to technical validation. If this is important information, the authors need more explanations.

We have omitted this sentence.

P5 L117: Redundancy

We have corrected the sentence for the readers to understand easily.

P5 L119: How much is the full scale? Are the following numbers are those evaluated by the authors or certified by product providers?

The observation scale is 0~19.9mS/cm, which is provided certificated by the product company.

Figure 1: Alaska Range and Gulkana Glacier should be labeled in the map.

Alaska Range is omitted from the sentence since it is too large. Gulkana Glacier was labeled in the map.

Figure 1 caption: With many pictures used for panels d-f, the authors should add more sentences to explain what individual pictures show. Readers also wonder what circles indicate. There seems to be chambers circled but also those not circled.

Figure 2: After calculation of uncertainty, error bars can be added.

Figure 1: We showed the individual pictures to help the readers understand the land surface condition of sampling locations. Also, we have added words in a sentence to help readers understand the local situation. We have omitted circles from the pictures since it is unnecessary as you pointed out. We added chamber names besides the chambers shown in the pictures. Figure 2: Uncertainty of methane measurement by gas chromatography was constantly 0.01 ppmv. Error bars on flux were added in fig 2.

Figure 2 caption: "flux" to "fluxes"

We have corrected the word to “fluxes”.

Table 1 caption: "S and W in column Ground-surface condntions". Again it is not CO₂ "flux". Again I wonder how the authors determined "n/d". This is because they do not provide uncertainty of flux calculation.

S and W is explained in the captions as “S and W indicate whether the surface were sand (S) or water (W), respectively.” CO₂ flux was not calculated in this study since it was difficult to calculate CO₂ flux and we concentrate on methane rather than CO₂ in this paper “n/d” in flux column was changed to zero.

3rd submission

Editor Start Date: 2/21/2022

Editor Stop Date: 4/8/2022

Reviewer #1 (2/21/2022–3/4/2022)

Reviewer #2 (2/21/2022–4/7/2022)

Reviewer #1: Anonymous

Since the manuscript has improved very much, I judge it "accept," after the corrections at the followings. I ask the Handling Editor to judge if they will be successfully corrected or not.

1. In Table2, how did you get ± 1.2 of CH₄ flux of 5.3 ± 1.2 at A1, where there is only one calculation result of the flux at a location? The same question is given to the values at A2, B1, B4, B5, C1, and C6.
2. At L26-27: Flux were measured using a closed chamber technique. Were ancillary environmental conditions also measured using a closed chamber technique? I guess not!
3. At L77-79: I think you used a syringe to take a sample from the chamber and injected into the bottle. Rewrite this sentence to make it clearer.

Reviewer #2: Anonymous

General comment

This manuscript has been considerably improved and become concise with acceptable amount of information. It is good that the authors have presented uncertainties of flux calculation, which I think is imperative for this manuscript being considered for publication as a data paper. Although my comments at this time go to the revised manuscript only, I should tell that I do not consider that the responses by the authors addressed all the questions and comments satisfactorily and I hope they should be revisited. Below I suggest some minor corrections.

Minor comments

P2 L36: Insert "in general" after "is". You should refer to my comments to the previous version of the manuscript.

Atmospheric CH₄ concentration is highly variable.

P2 L38: Delete "typically" but insert "major" before "sources" in the next line.

P2 L48: Insert "measurements" after "flux".

P3 L77: I would suggest to correct the sentence to "...using temporal gradient in the CH₄ concentration measured by gas chromatography." Note that gas chromatography itself does not calculate CH₄ flux.

P3 L80: "chromatographer" to "chromatograph"

P4 L84: "emission rate" to "flux". The term "emission rate (flux)" appears after equation (1), which looks fine.

P4 L94: I would suggest this sentence to "...were analyzed for gas samples collected 40 min after the chamber closure at 10 sampling locations."

P4 L102 & 103: "reference standard" to "scale" and "isotopic standard" to "scale". Note that Vienna reference materials are hypothetical standards and expressions like "V-PDB standard" sounds weird. All laboratories should use inhouse standards whose isotope ratio is traceable to that of reference materials with a certified value on the internationally recognized isotope ratio scale (e.g. VPDB).

P5 L118: "pH concentration" sounds strange.

P5 L126: The original sentence read like the detection limit was determined by precision, which is however strange. I

would suppose that the authors intend to write like "temporal changes in the CH₄ concentration less than 0.1 ppmv were considered to be undetected."

P5 L132: for instance "very low ($R^2 < 0.6$)" otherwise this sentence look very subjective.

P5 L133: "CH₄ fluxes at A6 and B6 were not considered to be detectable, ..."

P5 L135: I could not understand what this sentence means. Please elaborate.

P7 L147 Figure 1 caption: Start with e.g. "A map of..." or "A map showing..." for panel a). For panel d), e.g.

"Photographs of the six sampling locations at site A.". I suppose that the metal cylinders in the pictures are flux chambers, which should be also described in the caption.

P8 L163: "failure of the collecting gas sample in the gas chromatography devise" I cannot understand what this means.

The gas sample collections were from chambers and they were injected to GC, and GC was not on site, so gas collection in the GC is not understandable.

P8 L166: "correlation coefficient" to "coefficient of determination" or "squared correlation coefficient". The sentence should be conscious about difference of R and R².

Authors Response:

Dear Editors and Reviewers,

We wish to submit our revised manuscript titled, "Methane flux around the Gulkana Glacier terminus, Alaska summer 2019." We thank Editors and Reviewers for the supports and valuable comments on our manuscript. The manuscript has been rechecked and the necessary changes have been made in accordance with the suggestions. The responses to all comments have been prepared.

Thank you for your consideration.

Response to reviewer #1;

Since the manuscript has improved very much, I judge it "accept," after the corrections at the followings. I ask the Handling Editor to judge if they will be successfully corrected or not.

We appreciate your comments on the manuscripts. We corrected as you pointed out.

1. In Table2, how did you get ± 1.2 of CH₄ flux of 5.3 ± 1.2 at A1, where there is only one calculation result of the flux at a location? The same question is given to the values at A2, B1, B4, B5, C1, and C6.

There is only one calculation at a location. As flux values are calculated from the slope of $\Delta c / \Delta t$ using equation (1), the determining accuracy of the slope ($\Delta c / \Delta t$) gives the accuracy of the flux. The error of flux was derived from the standard error of determining the slope of $\Delta c / \Delta t$, i.e., the standard error of the regression line for the four data points.

2. At L26-27: Flux were measured using a closed chamber technique. Were ancillary environmental conditions also measured using a closed chamber technique? I guess not!

The ancillary environmental conditions were not measured. We have corrected the sentence.

3. At L77-79: I think you used a syringe to take a sample from the chamber and injected into the bottle. Rewrite this sentence to make it clearer.

We have rephrased the sentence, accordingly.

Response to reviewer #2;

General comment

This manuscript has been considerably improved and become concise with acceptable amount of information. It is good that the authors have presented uncertainties of flux calculation, which I think is imperative for this manuscript being considered for publication as a data paper. Although my comments at this time go to the revised manuscript only, I should tell that I do not consider that the responses by the authors addressed all the questions and comments satisfactorily and I hope they should be revisited. Below I suggest some minor corrections.

We appreciate your question and apologize for unsatisfactory replied to your questions. As you wrote that we did not fully reply to your questions, we did not mention the calibration of CH₄. We added a sentence about calibration in the first paragraph of “3. Method” section.

Minor comments

P2 L36: Insert "in general" after "is". You should refer to my comments to the previous version of the manuscript.

Atmospheric CH₄ concentration is highly variable.

We have added the phrase “in general” in the sentence, as requested.

P2 L38: Delete "typically" but insert "major" before "sources" in the next line.

We have deleted the words “typically” and added “major”, as requested.

P2 L48: Insert "measurements" after "flux".

We have inserted the word “measurements” after “flux”, as requested.

P3 L77: I would suggest to correct the sentence to "...using temporal gradient in the CH₄ concentration measured by gas chromatography." Note that gas chromatography itself does not calculate CH₄ flux.

The sentence was corrected as you suggested.

P3 L80: "chromatographer" to "chromatograph"

We have corrected the word.

P4 L84: "emission rate" to "flux". The term "emission rate (flux)" appears after equation (1), which looks fine.

The term "emission rate" was changed to "flux".

P4 L94: I would suggest this sentence to "...were analyzed for gas samples collected 40 min after the chamber closure at 10 sampling locations."

The sentence was corrected as you suggested.

P4 L102 & 103: "reference standard" to "scale" and "isotopic standard" to "scale". Note that Vienna reference materials

are hypothetical standards and expressions like "V-PDB standard" sounds weird. All laboratories should use inhouse standards whose isotope ratio is traceable to that of reference materials with a certified value on the internationally recognized isotope ratio scale (e.g. VPDB).

Accordingly, the words were corrected to "scale".

P5 L118: "pH concentration" sounds strange.

I apologize for this error. The correct word was "CH₄".

P5 L126: The original sentence read like the detection limit was determined by precision, which is however strange. I would suppose that the authors intend to write like "temporal changes in the CH₄ concentration less than 0.1 ppmv were considered to be undetected."

Your assumption was correct. Accordingly, the sentence has been amended as suggested.

P5 L132: for instance "very low ($R^2 < 0.6$)" otherwise this sentence look very subjective.

"($R^2 < 0.6$)" was inserted in the sentence.

P5 L133: "CH₄ fluxes at A6 and B6 were not considered to be detectable, ..."

We have changed the word to "detectable".

P5 L135: I could not understand what this sentence means. Please elaborate.

We have added some sentences to clarify our analysis.

P7 L147 Figure 1 caption: Start with e.g. "A map of..." or "A map showing..." for panel a). For panel d), e.g.

"Photographs of the six sampling locations at site A.". I suppose that the metal cylinders in the pictures are flux chambers, which should be also described in the caption.

We have corrected some sentences in the caption. We have added "the metal cylinders in the pictures are flux chambers" in the sentence.

P8 L163: "failure of the collecting gas sample in the gas chromatography devise" I cannot understand what this means.

The gas sample collections were from chambers and they were injected to GC, and GC was not on site, so gas collection in the GC is not understandable.

We have added some sentence to explain the situation. Some of the gas samples were injected from the sample bottle to the gas chromatography system.

P8 L166: "correlation coefficient" to "coefficient of determination" or "squared correlation coefficient". The sentence should be conscious about difference of R and R².

We have changed the words to "squared correlation coefficient".

4th submission

Editor Start Date: 4/25/2022

Editor Stop Date: 5/31/2022

Reviewer #2 (5/5/2022–5/30/2022)

Editor comments to the Author: Ryu Uemura

Thank you for many revisions. The manuscript is finally close to acceptance. Please refer to the Reviewer's comments below and send us the revised version.

Reviewer #2: Anonymous

The manuscript has been improved after iteration of revisions and finally can be considered for publication. The following corrections can be also considered.

L82" "A" standard gas (1.981 ppmv) was used... However, regarding this, I have to mention that the authors did not provide the origin of the value (1.981 ppmv) (e.g. gas company or the scale the authors' measurements stand on) despite repeat of my earlier comments.

L99: The detection limits for "d"13C-CH4 and "d"2H-CH4 "measurements" were...

L109: "The" instrument precision was "smaller" than...

L131" "since the detection limit is 0.01 ppmv" could be deleted because this is redundancy.

L174-176: The sentence that start with "R2 < 0.6" reads strange. Maybe something like "Flux calculation was also rejected when the squared correlation coefficient between...was very low (<0.6)" could be replaced with the two sentences.

Table 2: Here "d13CCH4" with "CH4" as subscript is used while e.g. 13C-CH4 is used section 3. Be consistent for expression throughout the manuscript.

Table 3: "dD-VSMOW" is inconsistent with the way of expression like "d13C-CH4". For the latter the gas name follows after hyphen, while for the former the scale name. To me the former looks strange. The scale name should be used for instance "[‰ VSMOW]". For the same reason, "dD-std_dev" looks strange.

Authors Response:

Dear Editors and Reviewers,

We wish to submit our revised manuscript titled, "Methane flux around the Gulkana Glacier terminus, Alaska summer 2019."

We thank Editors and Reviewers for the supports and valuable comments on our manuscript. The manuscript has been rechecked and the necessary changes have been made in accordance with the suggestions. The responses to all comments have been prepared.

Thank you for your consideration.

Response to reviewer #2;

The manuscript has been improved after iteration of revisions and finally can be considered for publication.

The following corrections can be also considered.

We appreciate your comments on the manuscripts. We corrected as you pointed out.

L82" "A" standard gas (1.981 ppmv) was used... However, regarding this, I have to mention that the authors did not provide the origin of the value (1.981 ppmv) (e.g. gas company or the scale the authors' measurements stand on) despite repeat of my earlier comments.

The company is Saisan Co., Ltd, which is Japanese company. (<https://www.saisan.net/en/>) The gas information is provided in the following site in Japanese. (https://www.saisan.net/industry/hight_pur_gas.html)

L99: The detection limits for "d"13C-CH4 and "d"2H-CH4 "measurements" were...

We have added those words in the sentence.

L109: "The" instrument precision was "smaller" than...

We have corrected the sentence.

L131" "since the detection limit is 0.01 ppmv" could be deleted because this is redundancy.

We have omitted those words from the sentence.

L174-176: The sentence that start with "R2 < 0.6" reads strange. Maybe something like "Flux calculation was also rejected when the squared correlation coefficient between...was very low (<0.6)" could be replaced with the two sentences.

We have corrected the sentence.

Table 2: Here "d13CCH4" with "CH4" as subscript is used while e.g. 13C-CH4 is used section 3. Be consistent for expression throughout the manuscript.

The words have corrected to $\delta^{13}\text{C}_{\text{CH}_4}$ in consistence with other words.

Table 3: "dD-VSMOW" is inconsistent with the way of expression like "d13C-CH4". For the latter the gas name follows after hyphen, while for the former the scale name. To me the former looks strange. The scale name should be used for instance "[‰ VSMOW]". For the same reason, "dD-std_dev" looks strange.

The scale has put in the bracket and those have corrected to " δD [‰ VSMOW]" and " δD (stdev) [‰ VSMOW]".

5th submission

Editor Start Date: 6/9/2022

Editor Stop Date: 6/10/2022

Editor comments to the Author: Ryu Uemura

I believe that your manuscript is suitable for acceptance. Thank you for multiple revisions and submitting to PDJ.

Editorial Office's note

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