



EGUsphere, referee comment RC1

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Comment on egusphere-2022-549

Anonymous Referee #1

Referee comment on "Characterization of atmospheric methane release in the outer Mackenzie River delta from biogenic and thermogenic sources" by Daniel Wesley et al., EGU sphere, <https://doi.org/10.5194/egusphere-2022-549-RC1>, 2022

This manuscript aims to determine the contribution of biogenic and thermogenic methane (CH₄) to CH₄ fluxes from the Mackenzie River Delta (MRD) into the atmosphere.

Therefore, the authors collected surface air samples from several sampling sites in the MRD and analysed their CH₄ concentration and the $\delta^{13}\text{C}$ value of CH₄. To differentiate between thermogenic and biogenic CH₄ they used two thresholds, assuming that CH₄ with a carbon stable isotope value of $> -50\text{‰}$ is of thermogenic origin and CH₄ with a value $< -70\text{‰}$ of biogenic origin. Values between -50‰ and -70‰ would indicate a mixture of both sources. The main conclusions of the manuscript are based on this assumption, which is, however, a substantial oversimplification. There are numerous studies demonstrating carbon stable isotope signatures of biogenic CH₄ of $> -70\text{‰}$, in particular CH₄ from acetoclastic methanogenesis (see e.g. Bréas et al. (2001), Chanton & Smith (1993), Conrad (2005)), including from permafrost affected wetlands (Nakagawa et al., 2002). Furthermore, CH₄ emitted from highly heterogeneous wetlands as the one studied here are affected by microbial CH₄ oxidation, which causes the carbon stable isotope signature of released CH₄ to increase, also to values above -50‰ . There are many studies about the impact of CH₄ oxidation in northern wetlands on CH₄ fluxes and the carbon stable isotope signatures of released CH₄ (e.g. Happell et al. (1994), Vaughn et al. (2016)), but the effect of CH₄ oxidation on carbon stable isotope values of CH₄ is mentioned only very briefly. Since the carbon stable isotope values of released methane may vary strongly, e.g. due to different CH₄ production pathways, CH₄ transport and CH₄ oxidation, carbon stable isotope values between -42‰ and -88‰ , as presented in this manuscript, may be explained by biogenic sources alone and are also reported for northern wetlands not affected by fluxes of thermogenic methane. Hence, I do not see that carbon stable isotope values of released methane alone provide robust information to answering the central research question of this manuscript, the contribution of biogenic and thermogenic methane to methane release in the MRD. To give substantial information on this question, further data are needed, e.g. the δD signatures of CH₄, its ^{14}C age, or the concentration of further hydrocarbons.

Furthermore, methods of gas sampling and analysis and calculation of the source $\delta^{13}\text{C}$ value should be described in more detail. What was the gas flow while flushing the Synflex tube, how often was it flushed with the air sample to ensure that no contaminations remained? How was gas collected with the LI-7810, how often and at which positions? Why were gas samples collected in the Synflex tube, if they were not analysed for d^{13}C of

CH₄? How far is 'as close as possible'? Please clearly describe which samples were collected for which analysis. Particularly for the Keeling-plots and the calculation of the $\delta^{13}\text{C}$ source values it should be clearly explained from which collected sample the CH₄ concentrations and $\delta^{13}\text{C}$ values were analysed.

Finally I suggest restructuring the Results and Discussion section. In the current version of the manuscript a substantial part of the results are presented (or repeated) in the Discussion.

Specific comments:

L11: To my understanding, CH₄ is released but not produced from thermogenic sources. Please clarify

L30: What means 'conductive for biogenic CH₄ production'? Please clarify

L56f: This assumption is an oversimplification (see above)

L85: Do mixed sources contain other CH₄ than biogenic and thermogenic? Please clarify.

L159f: The sampling of surface gas with the aluminium tubing is unclear to me. How was the tube filled and how it was possible to analyse discrete samples from this tube? Please explain in more detail.

L 177: value not ratio

L 275f: This might just indicate a higher contribution of CH₄ oxidation in summer than in winter, when the surface soil is frozen.

L282f: Methane oxidation in permafrost-affected wetlands is most important in the ice-free summer. High CH₄ oxidation might even cause the lack of ebullition and explain the high $\delta^{13}\text{C}$ value of CH₄.

L306: It is unclear, which data indicate the multiple sources of CH₄. Please clarify.

L311 f: The second part of this sentence is unclear.

L318f: What are 'eddy covariance hotspot locations' and which data of this study verify these?

Cited literature:

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Happell JD, Chanton JP, Showers WS (1994) The influence of methane oxidation on the stable isotopic composition of methane emitted from Florida swamp forests. *Geochimica et Cosmochimica Acta*, **58**, 4377-4388.

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