Biogeosciences Discussions

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Comment on bg-2021-167

Carsten Vogt (Referee)

Referee comment on "Hydrogen and carbon isotope fractionation factors of aerobic methane oxidation in deep-sea water" by Shinsuke Kawagucci et al., Biogeosciences Discuss., https://doi.org/10.5194/bg-2021-167-RC1, 2021

General comments

The global methane cycle is in view of climate change an important biogeochemical topic, hence the study addresses relevant scientific questions within the scope of BG. The presented concept of two-dimensional stable isotope analysis of methane for describing methane removal processes is not new but has been applied for the first time in a marine water body, hence the data are novel and original and of relevance. The used scientific methods and assumptions are valid and clearly outlined. The reasons for analysing stable isotopes of N2O becomes not clear, however (see comments below). The data are sufficient to support the interpretation and conclusions. The reasons for lacking aerobic methane biodegradation in the ANA site are not clear however and might be discussed in more detail. The results are traceable, experiments, methods and calculations are described in detail and sufficient. The authors give overall proper credit to related work and indicate their own/ new contribution. The title reflect the content of the paper. The summary is concise and complete except the missing N2O stable isotope data, which should be either indicated in the abstract and explained in more detail in the main manuscript, or deleted. The overall presentation is well structured, the language is precise and fluent. Mathematical formulae, symbols, abbreviations, and units are correctly used. The N2O part of the paper should be clarified or eliminated. Number and quality of references is fine. The supplementary material is an excel sheet containing raw data which should be explained in more detail (e.g., units the for shown data are not given in the head of the respective data column) to facilitate the understanding of the data.

Specific comments

L 37-38: Isotope fractionation factors are not always coupled to a ‘series of multi-step enzyme-catalyzed reactions’, this statement is slightly misleading. Indeed, stable isotopes of methane analyzed to describe methanotrophic pathways are linked to single reactions catalysed by single enzymes (methane monooxygenase for aerobic methane oxidation or the first step of reversed methane oxidation for anaerobic methane oxidation). Actually,

what I miss in the introduction is a brief description of the biochemical background of aerobic methane oxidation to clarify the mechanism of isotope fractionation upon methane oxidation.

L 38: 'Fluctuate' is in my view not the precise word to describe changing isotope fractionation factors of a distinct (bio)chemical reaction due to changing conditions. Each reaction is characterized by a distinct isotope fractionation factor, which can be however **masked** due to abiotic, non-destructive 'dilution' effects.

L 175: By using a 0.2 µM pore-size filter, ultra-small bacterial cells which may represent a substantial fraction of the total cell counts, will not be counted. This should be discussed.

L 196-197: Temperature units are not given in Figure 2,

Figure 2: Units for temperature are between 0°C and 0.3°C? Unclear.

Figure 3: Why no Λ value for the isotope data of the ANA site is given?

L 290-292: Lower but measurable (and constantly available) concentrations of methane should allow methanotrophs to grow, I do not understand the argumentation here. Please explain.

L 292-294: the 16S rRNA gene data indicate that inorganic sulfur compounds are the main electron donors in both investigated systems. It would be excellent if the authors could provide additional data on, e.g. concentrations of inorganic sulfur compounds 8and integrate them into Figure 2), to support this hypothesis

L 294-299: I wonder why the results about N_2O stable isotopes were not mentioned in the abstract, since the data seem to be exceptional. In this context, I also wonder why the N_2O topic has not been briefly described in the introduction. The background and goal of the N_2O stable isotope analyses becomes not clear. Thus, I suggest either deleting these data to streamline the methane story, or to integrate the N_2O story into the manuscript by explaining the aims of this study in more detail.

L 335-339: The lower absolute fractionation for carbon and hydrogen upon aerobic methane oxidation point to a considerable masking of isotope fractionation in the water column, e.g. due to limited mass-transfer of methane to the methane monooxygenase inside the cells, or a considerable decrease of methane concentrations in the water column

due to abiotic, non-fractionating processes (e.g., dispersion, dilution). Notably, similar differences in absolute isotope fractionation for carbon and hydrogen were observed for anaerobic benzene degradation at laboratory and field scale by Fischer et al. (2009) Rapid Communications in Mass Spectrometry 23: 2439-2447, this study might be discussed here for comparison.

Technical comments

L 20-21: 'Although the isotope fractionation factors associated with methanotrophy been examined under various conditions, ….' – have been examined

L 566: Mehtane – change to Methane