

## ***Interactive comment on “Sonar Gas Flux Estimation by Bubble Insonification: Application to Methane Bubble Fluxes from the East Siberian Arctic Shelf Seabed” by Ira Leifer et al.***

**Anonymous Referee #1**

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The manuscript aims to contribute to an improved understanding of methane emission from the East Siberian Arctic Shelf (ESAS), and presents results from investigations and analysis of engineered bubble fluxes and in situ observed bubble fluxes. Quantification of such fluxes can be made using acoustic techniques and devices, however, there are challenges associated it.

For instance, significant bubble-bubble interactions, which require the derivation of a calibration curve, as this interaction is not captured by theoretical calibration functions. Therefore, such calibration curves are derived for engineered (nitrogen) bubble plumes, and are then applied to in situ observed (methane) bubble plumes, for which results are reported and discussed.

C1

While I believe quantification of gas fluxes from the ESAS to be a topic of interest and relevant to the audience of the SI “Climate–carbon–cryosphere interactions in the East Siberian Arctic Ocean: past, present and future” in “The Cryosphere”, I can not recommend publication of this manuscript in its present form. The manuscript needs major revision before it can be considered for publication. This is mainly because the material is not presented in a sufficiently streamlined and focused way, making it difficult for the reader to follow. Some equations introduced lack complete and concise description, and many figures come in too low resolution and with insufficient explanations in the figure captions. Together, this implies that its is difficult to assess whether results and conclusions reached are substantial, and whether their interpretation and discussion is sufficiently complete.

Therefore, I recommend major revision of the manuscript, and include below some specific comments that might be of help during a revision.

The introduction comprises extensive subsections on Arctic methane and climate change, Study motivation, Marine seepage, Seep bubble measurements, and Sonar seep bubble measurements and is too broad, too long and too general to serve as a concise introduction to the topic presented in the manuscript. In view of the geographical focus of the SI, the inclusion of the pre-study carried out in the coastal waters of California would deserve a better justification, or could be removed in the interest of streamlining and shortening the manuscript. Equations (1) and (2) presented in Sect. 1.4. are ambiguous and not understandable from the information given in the text.

The methodology section briefly describes the three field-work moments (including field sites, weather conditions, technical description of experiment-set up) on which this manuscript is based: a pre-study in coastal waters of California, calibration experiments in the Kara Sea, and the major field campaign in the Laptev Sea. Given the contents of this section, a more natural label for this section would be e.g. “Field sites” or, “Field sites and experimental set-up”.

C2

However, a new methodology section could be introduced, where modeling and visualization methodologies could be discussed, and example of which are now found at eg lines 370 and onward, and lines 456-472 (that is, part of Sec. 3.2, containing now the description of the numerical bubble plume model, the use of which is necessary to account for differences in the engineered nitrogen plumes and the measured methane plumes).

In the results section, numbering of subsections is incorrect: there are e.g. two subsections labelled 3.1, the first one referring to results from the pre-study, the second one to results from the calibration tests.

Parts of what is contained in the results section does not belong there thematically. For instance, the first paragraph of (the second) Sect. 3.1 (lines 350-255) does rather belong to the "field sites and experimental set-up" section. Lines 360-366 do not describe results, neither do lines 370 until ca 374. Lines 395-399, 420-424, and 447-454, e.g., seem more of discussion nature.

Results presented e.g. in Fig 7. lack complete description as no information regarding the geographical location of the profiles is given. If the specific geographic location is not important, because the profiles are considered representative for a larger area, then this should be stated. Do both panels in Figure 8 show data acquired with an SBES? In the text, mention is made that MBES addresses deficiencies related to geometric uncertainty when using SBES- could a figure be added that shows SBES vs MBES? Does Figure 9 show data from SBES or MBES, cf. also line 383? F

The discussion section is very extensive, with 8 subsections including discussion of broader implications and future directions. Similar to the introductions, the discussion section would benefit from shortening and streamlining, and a clearer link to the central results presented (Figures 13 and 15?).

Figures: Throughout the manuscript, figures appear to have too low resolution. Figure captions are often not explanatory and specific enough. For instance: What specifically

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is presented in Fig 1.b? What do the colors mean? Does "red" indicate bubbles/seeps? What is shown in Fig 5? Existing annotations are hard /impossible to read and make understanding difficult.

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