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Ocean Science Discussions

Interactive comment on "Automated gas bubble imaging at sea floor – a new method of in situ gas flux quantification" *by* K. Thomanek et al.

Anonymous Referee #3

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This is a well-written paper covering an important topic. The gas flux and bubble size distributions from methane seeps on the seafloor represent important unknowns in understanding the release of this potent greenhouse gas. This paper describes an image-based method for measuring these quantities and includes a comprehensive error analysis of the resulting data. It contains a comprehensive literature review and both laboratory and field data.

I have some general and specific comments, detailed here.

General comments.

1. I found the literature review to be excellent, except in one regard: they have not compared the advantages and disadvantages of using optical probes against their chosen

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Discussion Paper

imaging method (see, for example, A. Cartellier, "Simultaneous void fraction measurement, bubble velocity and size estimate using a single optical probe in gas-liquid two-phase flows", Review of Scientific Instruments , vol. 63, pp. 5442-5453, 1992.). A hybrid method, where a camera is used to image the plume dimensions and an optical probe is used to obtain bubble size distributions, void fraction of air, and rise velocity may offer some interesting trade-offs in terms of illumination, power consumption and processing power.

1. I think more discussion is required on the topic of the measured bubble rise velocity. Given the large bulk fluid velocity implied by the data (it is the same order as the bubble rise velocity in still water, which is to say around 20 cm/s), it is reasonable to expect the bulk fluid velocity to be a strong function of gas flux. But changing the gas flux by a factor of two had very little effect on the bulk water velocity. As the authors state, a decreasing velocity gradient profile (in the horizontal) in the bulk fluid of the plume could explain this. However, were this the case, I would expect the shape of the bubble velocity probability density distribution (PDF) to become more narrow as the gas flux rate increased. A decrease in the velocity gradient profile implies that more bubbles throughout the plume horizontal cross-section are moving at the same speed. However, Fig. 7 does not show any particular indication of a change in the shape of the bubble rise velocity PDF as a function of gas flux. An alternative explanation is that the additional drag introduced by the increased number of bubbles in the higher flux case goes into entraining more fluid into the two-phase plume, rather than an increase in the plume velocity across the entire plume width. Did the authors observe the overall cross-section of the plume (at a fixed height) to increase with increasing gas flux?

2. The authors have done an excellent job of assessing the efficacy of their processing algorithm to identify and track bubbles. One of the methods they used was to analyze the derivative of the major and minor diameter as a function of frame number. They could apply the same reasoning to identify bubble clusters, by looking at the derivative of the bubble size distribution at the large end of the bubble spectrum. Since these

OSD

7, C132–C135, 2010

Interactive Comment

clusters contribute a significant fraction of their total error, they may be able to identify and remove bubble clusters and so improve their estimates of gas flux.

3. Is there any way to assess the contribution of bubbles cut-off at the edge of the images to the overall gas flux and bubble size distribution errors?

Specific Comments:

p. 298. '...changes in the inductive capacity while submerged'. I'm not sure what is meant by 'inductive capacity'.

p.302, l. 13: 'The advantage of this approach is that the memory size and the structure of the output file are predetermined regardless of how many images and bubbles may be processed.' This seems a minor point with the current capacity of computer storage.

p.304, l.28 'Brake' should read 'break'.

p.304, l.14. Use of the term 'rate' implies a measure of how quickly or how often something happens relative to a time unit. I think the authors mean the proportion or fraction of successful assignments.

p. 305, l. 9. I'm not sure what is meant by 'differential diameter'.

p. 305, l. 22. Note that breakup and coalescence processes are sensitive to the presence of salt. Since coalescence tends to be inhibited in salt water, it may be that the bubble assignment tests, if made in fresh water, represent a worst-case scenario.

p. 306, l. 8. 'Barely move' should be replaced with an estimate of the number of pixels moved (At 500 fps, I estimate around 5 pixels between frames, depending on bubble size).

Figure 8. Replace 'Bubble Size' with 'Bubble Diameter' since both bubble radius and diameter are used in the literature to signify bubble size.

p. 311, l. 8: 'tab' should probably read 'tap'.

OSD

7, C132–C135, 2010

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Discussion Paper

p. 312, l. 14. Bubbles smaller than about 1.5 mm diameter in water rise in rectilinear paths. See, for example, Fan and Tsuchiya "Bubble Wake Dynamics in Liquids and Liquid-Solid Suspensions", p.54.

Interactive comment on Ocean Sci. Discuss., 7, 291, 2010.

OSD

7, C132–C135, 2010