

## ***Interactive comment on “Acoustic mapping of mixed layer depth” by Christian Stranne et al.***

### **Anonymous Referee #2**

Received and published: 11 March 2018

This paper presents an interesting and concise account of an innovative acoustic method to detect with high spatial resolution the depth of the ocean mixed layer, or mixed layer depth (MLD), a quantity that is of interest for a number of practical applications in oceanography. It is shown, using acoustic mapping, in combination with CTD profiles, that reliable estimates of the MLD may be obtained using the former method. The main obstacles to reliable MLD estimates are very shallow MLDs (lower than 10 m), or the existence of excessive biological scatterers, which confuse the vertical distribution of the reflection coefficient, by introducing noise. The paper appears to be scientifically sound, and is clearly written, reporting novel results that are worthy of publication in Ocean Science. There are a few non-critical points (listed below) that I would like to see addressed before I can recommend acceptance. Therefore, at this point I recommend that the paper undergoes minor revisions.

Minor comments

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1. Page 1, line 20: "These prerequisites [MLD well-defined and absence of biological scatterers] are often met in the open ocean". Given that the study focuses on the Arctic Ocean, can the authors be sure that this remark is of general applicability, and not limited to that ocean? If not, then the necessary cautions should be noted.
2. Page 1, lines 27-28: "generated by wind stress and buoyancy fluxes at the air-sea interface", and lines 41-42: "The MLD is controlled primarily by surface stress (exerted by wind or sea-ice), buoyancy fluxes (heating/cooling, ice melt/formation, or precipitation/evaporation), and dissipation". In this picture, the effect of waves is missing. It has been established that surface waves, through their interaction with the wind stress and generation of Langmuir circulations, exert a decisive control on MLD growth (e.g. Thorpe, 2004, Ann. Rev. Fluid Mech.). This should be recognized.
3. Page 2, line 26: "ensonified". This word is probably unfamiliar to the readership of Ocean Science. Consider providing its significance on its first mention.
4. Page 3, Figure 1: This figure looks somewhat fuzzy (I am not sure if this only occurs in the version available for review, as that happens in some journals). The green dots (particularly on the yellow track), and especially the blue dots, mentioned in the caption, have very limited visibility. Consider using different colours with a better contrast with the blue background.
5. Page 4, line 13: "attitude", and line 23: "match-filtered": again, this terminology may not be familiar to the readers (it is perhaps over-technical), so provide a clarification of its meaning the first time it appears in the text.
6. Page 4, line 35: "Demer et al.", and page 5, line 2: "Lurton & Leviandier". These parts of the citations should not appear between brackets, as the corresponding references are incorporated in sentences. Please correct.
7. Page 6, caption of figure 2: "Vertical magenta lines". These lines are rather difficult to discern in the blue background. Consider improving this aspect.

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8. Page 6, paragraph between lines 20 and 27: The authors note that the criterion for detecting the MLD using CTD of using a temperature variation threshold of 0.2 degrees failed in the Central Arctic Ocean. Can they advance a physical interpretation for this behaviour, i.e., why in the Central Arctic Ocean and not elsewhere?

9. Page 7, figure 3: The horizontal scale of panel b in this figure appears no to be similar to that of panel a, but is not indicated. Please add that information.

10. Page 7, table 2: "rmsd". Not much is said in the text about how this quantity is defined and how it differs from the standard deviations in the two columns to the left. Please add that information.

11. Page 8, lines 19-20: "The acoustic method enables the study of internal waves propagating on the layer interface at the base of the mixed layer". What might generate these waves? Is there a possibility that the MLD measurements could be contaminated by waves generated by the remote interaction between the ship and the density interface at the bottom of the mixed layer (often called pycnocline)? It would be a good idea to discuss this aspect, as it might affect the proposed method in general (although not necessarily in the examples presented here).

12. Page 9, line 11: "splitting/merging of layers". Can the authors be a bit more specific about what physical processes might cause this splitting/merging?

13. Page 10, figure 6: This figure is presented as an example of measurements contaminated by biological scatterers, which makes it difficult (or even impossible) to reliably determine the MLD using the proposed acoustic method. However, in the reflection coefficient graph shown in figure 6c it is still possible to distinguish the MLD as the depth below which the reflection coefficient starts to have a large variability. I wonder whether it would be still possible to usefully determine the MLD by appropriately exploiting that property?

14. Page 10, line 12: "rosette". This word is not used elsewhere in the manuscript, so

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consider replacing it by another, more standard word.

15. Page 10, line 28: "lower success rate in coastal areas". Could this also be related to the greater abundance of biological scatterers in those regions? If yes, please add a comment explaining this.

16. There are a number of figures (S1-S5) referenced in the text (page 6, lines 24-25; page 7, lines 3 and 11-12; page 8, line 44; page 10, lines 20 and 34), but not included in the manuscript. Is this just a referencing problem, or are those figures really omitted, in which case allusions to them would need to be removed, with some detriment to a few justifications in the text?

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Interactive comment on Ocean Sci. Discuss., <https://doi.org/10.5194/os-2017-103>, 2018.

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