

The Cryosphere Discuss., referee comment RC2  
<https://doi.org/10.5194/tc-2022-232-RC2>, 2023  
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## Comment on tc-2022-232

Anonymous Referee #2

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Referee comment on "A field study on ice melting and breakup in a boreal lake, Pääjärvi, in Finland" by Yaodan Zhang et al., The Cryosphere Discuss.,  
<https://doi.org/10.5194/tc-2022-232-RC2>, 2023

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The manuscript focused on the melting regime of lake ice, which has been seldomly investigated despite its crucial impacts on ice break-up, air-lake mass and heat exchange, and lake habitats and ecosystems. The manuscript, using varied technologies, investigated the melting rate, the evolutions of lake ice texture, pore, and crystalline structure, and the concurrent pH, EC, and Chl-a profiles with their relationships with the decaying ice. These observational results are quite important to understand the ice breakup regime and its effects on lake habitats and ecology.

However, the manuscript is too long and poorly-structured and is suffered to linguistic issues, so it is not easy to follow what the authors wanted to deliver to readers. E.g., there are a number of repetitions of sentences in the text, which can be removed or shortened. I am not sure of if the section 5.1 should be presented in *Results* or *Discussion*. I recommend that the manuscript should reorganized and carefully language-checked when revising.

Intuitively, the manuscript is more like a report presenting the techniques and straight results than a scientific paper. It should be more focused and tightly compact on what you found and why. In short, the authors observed the melting rate, internal texture with estimated porosity, and basic ice+water geochemistry. It would better if the manuscript directly present the methods and results and discuss what controls the surface, bottom and interior melting, how these melting are related to the evolution of pH\EC\chl-a, and how it expands/deepens our knowledge on lake ice decay and accompanying changes in lake environment, so the interannual variations of ice breakup date and bearing capacity discussion seem redundant and not closely related to the topics.

Below, I have some specific comments and suggestions, which can be considered by the authors during revision.

- L31: by/through altering the heat, mass...
- L36: the under-ice living conditions or the living conditions under the ice
- L43: please specify what the two major practical problems are.
- L53-54: I guess "by about one week over 100 years" is actually true for e.g. boreal lakes? Should be specific here.
- L67: the primary production
- L69: limits the proper assessment of the impacts of...
- L71-90: I suggest this paragraph can be divided to several short paragraphs according to their key points. At its current status, it is not easy to clearly understand what the authors want to tell to the readers.
- L91-98: I guess in this paragraph the authors should introduce briefly the scientific issues to be targeted, what work and analysis has been done, and what problems could be resolved. The snow and ice conditions may be better to be presented in the "2.1 study site".
- L125: delete "lateral"?
- L164: delete "*Measurements of ice density can be found in several studies (Timco and Frederking, 1996).*"
- L169-176: please add the measuring accuracy for each variable.
- Table 1: what did x and z denote?
- Figure 2: please add a scale to these maps.
- L221: due to
- (1): there must be mistakes in this equation since it was not consistent with the description below it and I cannot see  $L_f$  and  $\Delta t$  in the formula.
- L295-296: delete "*In practice it is difficult to determine the freeboard/draft ratio as it requires an order of one-millimetre accuracy for the freeboard.*"
- Table 5: It would be better if these data can be presented in a plot/plots (i.e., vertical profiles), which can show clearly the vertical structures and temporal variations of EC, pH, and Chl-a.
- L322: how did the data of EC on April 14 confirm the deposition of acidic substances from the atmosphere? And why did EC of ice increase after a snowfall?
- L333-334: "Algae can grow in a slush layer within snow-ice, but not in consolidated ice because of lack of liquid water for living organisms." However, Fig. 5b shows clearly the Chl-a content in congelation ice increases gradually as melting proceeds. The increase in Chl-a content within the ice is likely to result from the increasing solar radiation and/or the decreasing surface albedo rather than the thinning ice cover.
- (3): it would be better if you present briefly the physical meaning of each formula.
- L359:  $4 \text{ W m}^{-2}$  can not be a half of the incoming solar radiation in May.
- L363: does the bottom melting depend on the solar radiation?
- L367: what do you mean by " $\gamma$  represents the fraction of light in solar radiation"? I guess it is the fraction that penetrates through the ice surface.
- L368: by  $Q_{s0}=150 \text{ W m}^{-2}$ , is it the daily-averaged value? It looks like a daytime-averaged value in April. If this is true,  $Q_{s0}\approx 75 \text{ W m}^{-2}$ , the melt rate can be  $0.16 \text{ cm d}^{-1}$ , close the observed rate of  $0.18 \text{ cm d}^{-1}$ .
- (6): Could please give a brief physical background of this equation? What do the terms mean at the right-hand side?
- L389: the second "freezing" should be "melting"
- L397: what do you mean by "the ice freezing days"? freezing duration, or ice-covered duration?
- L433: after the net radiation becomes positive? The net radiation is always positive, I guess. And whether or not the surface, interior, and bottom melting take place depends on different conditions of heat balance.
- L467: "Yang et al. (2012) modelled...too late", what do you mean?
- L482: "Therefore, ... on the structures.", what do you mean?
- L527: a surge of phytoplankton under ice may indicate a positive net production, which uses CO<sub>2</sub> to produce oxygen and biomass, so why it results in an increase of CO<sub>2</sub>?

Could you explain on it a bit more? Maybe the inflow dominates the chemistry regime of the surface layer as is shown in Fig.9?

- Conclusions: Usually, in the conclusion section, notable technologies, results and findings should be presented as well as brief implications if any rather than research background and motivation. Key points that were found in present work were missed here. So I recommend to reorganize this section.
- L555: The present paper/investigation has filled...

Please also note the supplement to this comment:

<https://tc.copernicus.org/preprints/tc-2022-232/tc-2022-232-RC2-supplement.pdf>