

Interactive comment on “Optical properties of laboratory grown sea ice doped with light absorbing impurities (black carbon)” by Amelia A. Marks et al.

Anonymous Referee #1

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General overall comments:

Positive: The work presented here by Marks et al. is both novel and an excellent fit for The Cryosphere. It is very timely with some of the biogeochemistry sea-ice models currently looking to expand and incorporate a more complex radiative-transfer component for light propagation, and black carbon on sea-ice is topical given the possibility of further opening of Arctic shipping lanes. If the data in here is picked up by the relevant modelling teams I could envisage this being highly citable. The paper also serves as a successful demonstration of the creation of a new sea-ice laboratory, and I would anticipate that this paper will be well utilised in forming the basis for many future experiment

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designs.

I have no major concerns over the methodology used, it is clear that the research group have a long history of these kind of experiments in snow and ice and have cited the previous work that this builds on. The use of TUV-snow for the modelling aspects appears to be an entirely valid use of the model given previous publications.

Negative: The abstract feels rushed and confused compared to the rest of the paper and does not do the paper justice.

Much of the modelling community will be put off / not find this paper due to the terminology used. I suggest also quoting e-folding depths as extinction coefficients as these are the terms currently used by the majority of sea-ice models.

The laboratory description feels short and underplayed, this is a new facility and it is very difficult to visualise with the current amount of information provided. I suggest significantly increasing the information provided about the facility, although some could go in the supplementary section. I feel this is important, especially if the authors plan on using this paper as a background reference point to further papers using the facility. Some of the broad comments here are brought up in more detail in the specific comments.

Specific Comments: (Format for reference, e.g 5.4: refers to Page 5, line 4.)

1.3: Question the use of “simulated” throughout, it gives an initial impression of modelling rather than experimental. Could this be altered to laboratory or artificial or something similar?

Abstract General: It is not clear from the abstract what the focus of the paper truly is, and it feels rushed leaving more questions than useful data in its current form. I would suggest removing discussion of algae (as this is barely mentioned in the main manuscript) and refocussing the abstract on the less technical aspects. The mention of measuring e-folding and reflectance and then later calculating e-fold and reflectance

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from absorption and scattering values sounds confusing in an abstract and is confusing to the reader. I would remove technical detail in favour of adding extinction coefficients which may be of more value to the readership.

3.9: I would argue that it is a medium sized facility, as somewhere like SERF is a large facility. Could this be phrased in a more impressive way? E.g. “sea-ice simulator designed to reproduce polar sea-ice growth conditions under UV and Visible lighting”

3.14: What is the temperature stability of the cold room?

4.Fig1. Is there wind shear across the tank? It'd be good to have it added to the Figure.

4.General. It'd be really nice to see the facility description fleshed out more, with some more technical details of what the chamber is capable of (especially as this appears to be the first paper to come out from the laboratory). Some suggestions would be how temp / salinity of the ocean vary through time of an experiment as the ice grows, lighting consistency at the ice surface, room temperature vs time during ice growth. These are just suggestions, but it would be good to have more technical facility description. Could some annotated photos be added to go alongside the figures? This would not only allow a much better visualisation, but could well encourage potential collaborators.

5.14: Model # for the thermocouples? Details on precision / calibration if possible?

6.7: Again, could an annotated photo be added for the set up or an extra figure? It may not be implicit for non experimentalists to imagine.

7.7: Clarify, is the tank emptied at this point or is bleach added?

7.27. Can the authors clarify whether this is a range, or the result of two experiments? Is there any way of knowing where the differences in result occur from?

8.Table 1: No mention of sigmascatt in the caption. Please add details.

9. Figure 2. Caption is not sufficient and needs fully re-composing.

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11. Fig 3: It could be due to black and white printing, but the contrast seems very off. It is a really nice Figure to have, but it currently is not as clear as it could be.

11.5: The authors should be commended here for using a secondary method to calculate an important parameter for the work. This sort of thing is often overlooked and should be done much more in many fields of science.

14.3 Is there any way of further discussing the fabrics of the ice? Is there any information in the cores that could be used? Currently the images in the SI are too small to really ascertain anything structural but maybe there is information within those images which could be enhanced to help interpret the variability?

15.Fig 7: Please add a scaled absorption of algae (and what type of algae) be added here.

17.16: (and 19.10:) How does the uncertainty in the e-fold fitting procedure propagate through? There is much discussion about the other parameters but I feel that this is overlooked and that there are sources of error which are not propagated from the experimental side? Is there an easy way to estimate this?

20.25: Would the extra ice at the side have any impact on the e-folding depth?

21.4: It is my feeling that if light is being reflected back from the base of the tank, then there would be excess light within the ice at depth, which would result in the e-folding depth becoming longer and not shorter.

I would also disagree with the authors comparison to the blue ice seen in Grenfell and Maykut (1977) as this is described as “ice saturated, but not covered, with melt water”. The ice created here is fresh, “dry” ice and has not been subjected to melt metamorphism and structural change such as the one described in Grenfell and Maykut 1977, and should not be compared as such.

Technical Comments: 2.26 Unclear, are these the first experiments or just the first experiments using TUV-snow? 2.30 Personal preference, and may be disagreed by

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the editorial team, but this list of aims feels very wordy. Could it be bulleted? 7.13 Extra space needed. 9.8: Sentence currently doesn't make sense, too many "for smalls"? 10.9 "with a", not in a?

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