Biogeosciences Discuss.,
https://doi.org/10.5194/bg-2017-111-AC1, 2017

Biogeosciences Discussions

Interactive comment on "Ice Acidification: A review of the effects of ocean acidification on sea ice microbial communities" *by* Andrew McMinn

A. McMinn

andrew.mcminn@utas.edu.au

Received and published: 3 July 2017

Author's final comments

I agree with all comments made by RC1 and have followed all suggestions. Of the larger changes, I have;

1. included a final section '5. Discussion and summary', where I have added most of the requested additional discussion.

2. Changed the Table to include extra studies and a column indicating positive/negative or no change

3. Figure 1, I have added to the caption to better explain the role of nutrients

Anonymous Referee #1

Andrew McMinn has done a good job summarizing the (relatively scarce) literature that is available about effects of ocean acidification on sea ice microorganisms. I think this is an important topic, and I am generally in favor of the publication of this type of synthesis paper. However, I do believe that the author needs to elaborate the review paper before it is ready for publication. I feel like the manuscript summarizes the main findings from the studies quite well, but I am lacking key points and overall conclusions from the synthesis of these papers. I would like to see more emphasis on general conclusions that can be drawn from reviewing the literature, other than a collection of findings (albeit solid and worth publishing). More specifically, my key points are:

I am lacking a section about future directions on the topic (and perhaps an overall summary in the end of the review). What are the key points lacking in the field of sea ice acidification and how should we best approach them? For instance, the author discusses strong pH fluctuations in sea ice – how can we best address these fluctuations experimentally?

I would also like to see that the author comments on the technical issues working with ocean acidification in sea ice – is there a "best practice" approach for doing it? The author lists a number of approaches (e.g. cultures, brine communities, in situ experiments). Ocean acidification experiments are relatively complicated to perform by themselves, considering the effort needed to control the CO2-system well. Doing it in sea ice may be intimidating for scientists new to sea ice work. I believe that suggestions for a best practice approach would be very helpful to our community to increase the scientific effort on the topic (especially in the Arctic).

RESPONSE: I agree with all the above comments and have now added an extra section '5. Discussion and Summary' at the end of the manuscript where I address all these points. In this section I discuss future directions, technical issues and best practice, and a summary

Why do you think everything is performed in the Southern Ocean? Would you expect to see differences in the Arctic, considering the differences in sea ice characteristics? I would also be happy to hear about the author's opinion about the importance of ice acidification in relation to planktonic acidification. By the limited number of published studies available on ice algae, can you draw any conclusions about the sensitivity of sea ice algae compared to phytoplankton? Is ocean acidification more important in the water mass than in sea ice?

RESPONSE: There are currently no published studies based on the Arctic. However, I have a added a sentence to indicate Arctic bottom communities are expected to respond in a similar manner to Antarctic communities.

I am also a bit reluctant about Figure 1. It describes a highly generalized seasonal cycle of pH and nutrients. Why are nutrients there, and what type of nutrients is the author referring to (I am assuming inorganic macronutrients)? Nutrients are never discussed in relation to Figure 1 in the text, so please elaborate on this. Some nutrients (mainly phosphourous) are accumulated in the brine before the melt in summer (Fripiat et al 2017, Elementa), so I think it is important to note that this figure is quite generalised.

RESPONSE: I like this diagram and want to leave it in. I accept the reviewer's comments, however, and have expanded the caption to better explain its meaning. I have also added a sentence to the introduction describing the expulsion of nutrients during ice formation (p2, ln 16).

I would also like to bring some additional papers to the author's attention, which are not discussed in the review but could perhaps be relevant for the discussion. The main papers that I am referring to are Barr et al (2017, Limnology and oceanography: Methods), Søgaard et al (2011, Polar Biology) and Torstensson et al (2013, Biogeosciences).

RESPONSE: Added Barr et al. 2017 and Torstensson et al. 2013 to refs, Torstensson et al. 2013 is now also in Table 1. I haven't added Sogaard et al. 2013 as they only looks at elevated pH, i.e ocean alkalination not acidification.

Minor points:

Title: Please revise the title so that it starts with "Reviews and synthesis:", according to the journal's instructions.

RESPONSE: Changed as suggested

P3, L31: Please clarify "ice water interface (surface communities)". This term might be confusing for a reader who lacks knowledge about surface flooding (if that is what the author is referring to). I believe that many readers could misinterpret the "ice-water interface" as the bottom community.

RESPONSE: Changed to snow-ice interface

P4, L7-11: This section needs some elaboration. Please explain how it relates to ocean acidification studies and the context of this review.

RESPONSE: I have added some extra context here, emphasizing that different groups have differing physiological responses depending on whether they have a CCM or the type of RuBisCo present (p4, Ln 15-24)

P5, L6-8: Please elaborate this statement. I would imagine that temperature would affect sea ice thickness, melt pond formation and less multiyear ice (in the Arctic at least), which definitely have large impacts on the environment in sea ice.

RESPONSE: I am trying to focus on physiological responses here. Phytoplankton will need to respond to increased temperatures, sea ice algae will not. I have restructured this paragraph to make this clearer. I agree that there will be impacts on the physical and chemical structures.

P7, L6-12: What about indirect physiological effects on bacterial communities from changes in algal physiology? Engel et al (2013, Biogeosciences) reported elevated bacterioplankton growth due to shifted nutrient stoichiometry and DOC production in Arctic phytoplankton.

RESPONSE: I have added some general comments about bacteria and phytoplankton but there is very little specific information about sea ice. I have also added the Engel reference, although it relates to polar phytoplankton. Table 1: Would a column with a short summary of the results (e.g. positive/negative/no effect) be in place in this table? That way this could be a central Table summarizing the whole review quite well.

RESPONSE: I have added the extra column ad included a more detail Table caption

---

Interactive comment on Biogeosciences Discuss., https://doi.org/10.5194/bg-2017-111, 2017.