

Review of: Spatiotemporal Distributions of Icebergs in a Temperate Fjord: Columbia Fjord, Alaska

General comments:

This manuscript presents a study of icebergs in the Columbia Fjord, Alaska during March-November 2013. The authors use high resolution satellite images to look at iceberg distribution and size, applying common scaling factors to estimate volume and keel depth. Based on these iceberg metrics, the authors speculate on the influence of icebergs on fjord water properties and note differences and similarities with studies of Greenland fjord icebergs.

The research has succeeded at a basic characterization of Columbia Fjord icebergs. However, the paper falls short on several important fronts.

- The research is motivated (page 2, lines 8-21) by noting an interest in icebergs exiting Columbia Fjord, a topic that is not raised again. A second motivation is that the authors point to Alaska fjords as a proxy for Greenland fjords. However, the discussion of this potential relationship is only vague, failing to provide a reader with a sense of where and when this relationship might hold true.
- The study uses a small sample size, examining only one year. The authors need to provide more information on why only 8 months of data are used. Are images not available from other years? And, if only one year is used, what is the context of this year within the longer periods of observation. Are there reasons to think that this year is dis/similar to other years (e.g., from other published data re: ice discharge, fjord conditions, etc.)? Basing conclusions on such a limited sample provide a weak foundation, so the authors must put in extra work either to increase data or to better contextualize the data that is used.
- Overall, the explanation and discussion does not provide a detailed account of the implications of the study and the meaning of the results. The paper would benefit from more references to existing work, providing context for the study conclusions and discussion. For example, section 4.1 mentions ocean circulation and ocean temperatures, but doesn't provide any of the detail needed for the reader to understand what is known about Columbia Fjord circulation or temperatures. In another example, the discussion in section 4.4 fails to show an appreciation for the wide range of variables and conditions present across Greenland fjords or the many variables involved in the interactions between icebergs and ocean waters. As a result, the discussion is shallow and the conclusions are too general (e.g., see last paragraph in section 4.4).

Specific comments (by page/line number):

1/19-21. This is a broad and vague statement regarding Columbia Fjord as a proxy for future Greenland fjords. Given the wide range of variables influencing the role of icebergs in fjords and

the wide variation in physical environments of Greenland, such a general statement is not particularly useful or well substantiated.

2/8. Given how few times Prince Williams Sound is referred to in the paper, it is preferable to use the full phrase rather than an acronym. In general, acronyms make the reader's job more difficult and should be avoided unless for a phrase used widely throughout the paper.

2/19. Here, the authors mention that Columbia Fjord represents a potential analog for future Greenland conditions. Given the wide range of fjord types and conditions in Greenland – and that this is mentioned as a main motivation for the paper – the authors need to be more detailed here. What areas of Greenland might be good candidates? Are there any projections (e.g., of near-Greenland ocean temperatures) that suggest when these analog conditions might occur? As a general statement, it's not very useful.

2/30. What is "Mean Lower Low Water"? This is not something that most glaciologists will be familiar with. This is also another case when the acronym is unnecessary since it's rarely used.

2/35 to 3/1. This sentence does not make sense. Please revise for clarity.

3/15. Instead of "in all but two cases", go ahead and give the information on which cases. The authors are dealing with a relatively small number of images, so it's best to be specific.

3/29. Snow does not float on top of water. Ice mélange is usually considered a conglomerate of icebergs, bergy bits, and growlers, sometimes including sea ice. For the most part, the authors use the phrase correctly, but not in this case. Please correct.

4/9. Introduce the definition of 'mélange' when it is first used. It's also odd to discuss bergy bits and growlers in the preceding sentence and then 'tiny chunks of ice' in this sentence.

4/23-28. At no point do the authors explain the use of 'a' and 'b' images. Is there standard area covered by 'a' v. 'b' images? Are they always made into a mosaic? Are areas double counted? A more important point is also raised in this paragraph – the authors attempt to change the threshold for the Nov. 19a image, but are unsuccessful as alleviating the problem. Nevertheless, the authors then continue to include this data in plots and tables. Knowingly poor data should not be included in analysis. The authors have several options – use manual methods to properly characterize the image, remove the data completely, treat this data separately with additional errors, etc.

4/30. In this paragraph, the authors should point to all pertinent figures. For example, point the reader to Fig. 4 for a visual of the 500 m x 500 m squares. Same is true for the first paragraph on page 5.

5/13. Perhaps 'subdividing at 10, 25...'. The current sentence is confusing.

5/30. Need to define waterline cross-sectional area at its first use, which is earlier in the paper.

5/30. As best I can tell, the authors do not use waterline cross-sectional area as a proxy for iceberg volume. Instead, they use two methods for determining iceberg volume from waterline cross-sectional area. Later in the paper, they also refer iceberg volume calculated from 'two methods'. Using waterline cross-sectional area would be a third method (and also a worse method than the other two used).

6/7-11. It's not clear why the authors would apply this method for calculating albedo when, I assume, albedo products are available.

6/20-23. The discussion of uncertainty here is an awkward add on to the paragraph. This would be better as a separate section, perhaps combining overall discussion of uncertainty. At minimum, the authors need to discuss the implications of the uncertainties – for example, what percent of the fjord coverage is *mélange*? Currently, there's no metric for the reader to understand the implications of the numbers given.

6/25. The first half and second half of this sentence say the same thing. Please revise.

7/3. Explain the implications of these numbers.

7/21-25. With such warm water, it seems that iceberg melt would be a substantial component. Is there any published information or other method that the authors can apply to give a sense of the potential magnitude of iceberg melt and its influence?

8/1. The sentence says “evidence *for this*”, but the sentence before mentions two possibilities. “This” must be specified.

9/12. What is the area of interest for “all of Columbia Fjord”? Please show on a figure.

Section 4.3. This is a shallow discussion of iceberg influence on freshwater. As some points the authors mention temperature changes, at others they mention salinity. Both are likely affected, but this is not well discussed.

11/2. How can the authors conclude that winter-time capture of ice fragments aren't important when they did not examine winter-time data? The overall discussion in this paragraph also fails to recognize that iceberg residence time is only one factor in how icebergs change ocean water characteristics. For example, ocean water temperature, salinity, and current velocity and direction are also important.

11/19. Why would the icebergs not be significantly rougher than the calving front?

12/4. What evidence is there to attribute the iceberg size change to increased crevasse hydro-fracture? Can the authors cite literature on this or point to observations that suggest this (even qualitatively)?

12/6. How can the authors identify a correlation between anything and average annual calving rate given that they have less than 1 year of data?

12/17. Alaska glaciers contributing to sea level rise is poor justification for studying icebergs in and of itself. I feel the authors need to think more deeply about what is unknown and the most important implications of their work.

Figure 1. It would be useful to label Heather Moraine in the image. ‘PWS’ label in c. is unnecessary. Is it possible to add the outline of the region in d. to the c. panel?

Figures 4 and 8. It would be nice to put this data on a map/image background.

Figure 5. Why not show data from all periods? Also, it would be preferable to list the class sizes in the captions.

Figure 6. Bad data should not be included in the plot.

Table 2. What is the source of these errors? What does this error represent?

Tables 3 and 4. Again, bad data should not be included in plots or tables. Either fix it or remove it.

Technical corrections (by page/line number):

2/20. Please remove “in order” for all cases of “in order to”. It is unnecessary.