**Manuscript summary**

Zaninetti et al. report newly collected field observations of thick blue layers in freshly calved icebergs from Sermeq Kujalleq, Greenland, collected in July 2023 and other unspecified dates in the autumn. This follows on the interesting analysis begun by Luthi et al. (2009), which was a popular correspondence paper that raised the interesting question that Zaninetti et al. advance here. The observations are interesting and well documented, but the manuscript's current conclusions are too wishy-washy. I believe that with the ingestion of the new hypothesis by Reviewer 1, which I find quite compelling, this manuscript would be significantly strengthened and would make a very nice contribution to the literature on Sermeq Kujalleq.

**Major points**

I find myself largely in agreement with Reviewer 1, at least as far as my expertise goes (he knows much more about the optical properties of ice than I do). What I mean by my agreement is that I am largely satisfied by the observations and their documentation / presentation in figures -- these are nicely done! -- but I think that the inferences and conclusions laid out are too tentative, speculative, and don't explain the observations strongly enough. I believe that Reviewer 1's idea of clathrate release provides a better explanation and that the authors should scrutinize, adopt, and incorporate it. Many of my points here stem from implications and second-order effects of this new hypothesis that I would encourage the authors to address in a revision.

Line 83-85 - "blue ice is visible during almost all major calving events and appears to be independent of the position of the iceberg along the calving front, indicating that it exists across the entire width of the ice stream." If the clathrate hypothesis is correct, ice thickness of at least ~1600 m would be required along the entire calving front in order to support this statement / observation. This may not be the case, as the trough becomes shallower away from the centerline. The authors should present evidence from BedMachine (or an accepted ice thickness dataset of their choice) that this is indeed the case, or discuss the limits of the position along the calving front where blue ice should be present. A problematic deduction is that of Luthi et al. (2009): that the calving front was "only" 900 meters thick at the time. This may have changed as the front retreated into deeper water over the past 15 years -- but still, the blue ice was observed then, too. Could or should their methods for estimating local ice thickness be revisited or revised? Or perhaps the transit time from a location where H>1600 m to the 2009 calving front is sufficiently short (~days) that clathrates would not yet decompress? → **discussed in clathrates**

Line 96 - "Temperature is not absolute but on all profiles, the blue ice is relatively colder than the white ice." This is in conflict with Reviewer 1's hypothesis that all basal ice could/should be blue, regardless of whether it is temperate or cold. A solution would be if blue ice (with clathrates) has different thermal emissivity than white ice (without). I recommend that the authors please investigate this. **I also ask that in the revision, they take care to distinguish between the observation (infrared emission) and the derived quantity (inferred temperature),** since they differ by the emissivity which may be uncertain -- this uncertainty should be better discussed too.

→ **it lacks literature about thermal emissivity of various types of ice (line 247-249)**

→ **lines 255-262: we compute what would be the blue ice emissivity if its temperature were 0°C (and also if it were at the temperature of the adjacent white ice)**

→ **Through the sensor, blue ice emits less infrared radiation than white ice. With emissivity set to 0.98 for both ice types, the inferred temperature of blue ice is colder than that of white ice.**

**Difference emphasized at several other places.**

Figure 5c shows that blue ice can re-emerge ~20 hours after calving if the ice fractures and exposes its interior. This observation is also problematic for Reviewer 1's hypothesis, as the iceberg is no longer under the pressure required to maintain clathrates. I have no good suggestions for this apparent contradiction, aside from the timescale (mentioned above) of clathrate release (which should be reported) and very weak speculation about some chemical interaction with air (N2 or O2) or mechanical wind action. The apparent contradiction should be discussed. → **addressed**

Line 162-163 - "Englacial liquid water seems to be a plausible explanation of a highly absorbing substance that drains out of the ice by gravity". A test of this hypothesis would be whether a whiteness gradient from top to bottom was observed during the period of reflectance change. It is not evident from the observations presented here, but I would like to know if this was in fact observed. Of course, the iceberg is tipping around in the fjord as it melts, which changes its orientation, so "down" is not always in exactly the same direction in the iceberg's reference frame.

**Figure 5 shows the evolution of an iceberg, but there does not appear to be a color gradient based on height. We lack further examples to test this hypothesis. Furthermore the icebergs topography is complicated, which certainly has an impact on how fast the liquid water would drain out.**

Line 227 - "The vertical position of the blue ice is not necessarily at the bottom of the ice stream (Lüthi et al., 2009)." This would be inconsistent with Reviewer 1's hypothesis, unless temperate ice for some reason cannot form clathrates. Could the interstitial liquid water get in the way of the intra-granular clathrate? This should be investigated and commented on.

**→ The blue ice is not necessarily at the bottom of the ice stream, but still in the lower half or third, which is still in the pressure ranges to form clathrates.**

**In terms of P-T, the ice at the bottom, if temperate, would require a higher overburden pressure to form clathrates, because its temperature is higher. But this is not a problem at such depth. Interstitial water content would rather favour the gas diffusion. Thus, it remains an open question.**

**Minor points**

Line 19 - "these colors already exist within the ice stream." I can deduce that the authors mean that the ice stream is fast-moving and grounded so there is no possibility of marine ice accretion, but this should be better specified. **→ The situation at SKK does not allow for freeze-on ice formation. The ice stream is grounded and fast-moving such that the processes leading to blue ice formation take place at depth within the ice stream**

Line 38 - "From extrapolation of measured temperature profiles it was concluded that the fast flow is caused by the enhanced deformation of a thick basal layer of temperate ice within the trough." This needs citation or rephrasing, because modeling studies in the past decade have shown that despite significant deformation (as found by Iken et al. 1993 and Funk et al. 1994), the fast flow is still accommodated mostly by sliding (Poinar et al. 2017, Shapero et al. 2016).

**From modeled extrapolation of measured temperature profiles (Funk et al., 1994), it was concluded that a very thick layer of temperate ice resides within the trough. Together with convergent ice flow (Iken et al.,1993) the temperate ice contributes considerably to the observed fast flow. However, recent modeling studies demonstrated that the fast flow can also be explained by significant sliding (Shapero et al., 2016; Bondzio et al., 2017; Poinar et al., 2017)**

Line 49 - "shaded" - Refer to this as "in shadow" instead. **→ done**

Line 86 - "For icebergs that rise vertically out of the water, the upper part emerging out of the water disintegrates, leaving the lower portion presenting blue ice rising by buoyancy." I am not sure what this description of the icebergs means. Does it refer to tabular icebergs, which present in their "natural" orientation, rather than the vast majority of icebergs that flip immediately as they calve? I think I must misunderstand which icebergs are being discussed here; please clarify.

**→ There are two main ways to see blue ice appear during calving events. First, when an iceberg calves as a vertical slab and rotates backward, it horizontally exposes the formerly vertical cross-section of the ice stream, and blue ice is visible at its foot. Secondly, other icebergs, tabular or not, do not rotate immediately. First, they rise above the calving front due to buoyancy. Then, the part emerging from the water, which does not show blue ice, disintegrates. Next, still due to buoyancy, the deeper part of the iceberg rises to the surface, and that is where the blue ice is visible. The observations of these calving events allow us to affirm that blue ice was only observed in the bottom half of the glacier thickness.**

Line 120 - "long-term evolution" - a different term is recommended, as 12 days is not likely to be thought of as a long period in glaciology

**→ Evolution of iceberg color between 1 and 12 days**

Line 130 - What are the autumn observation dates? Also, the summer dates should also be specified; I have assumed that they are the July 2023 field dates, but this may not be the case.

**The images come from Sentinel-2 satellite. There is no relation with the July 2023 field.**

**→ "corresponding to satellite images acquired in summer (May-mid August) and autumn (mid-September)"**

**→ also already specified in Section 2.2 in the first version.**

Line 138 - the BIA are referred to here as "well studied", which is in contradiction to the single reference repeatedly used for them (Hui et al., 2014). Additional references would bolster this claim, or simply remove the descriptor "well studied".

**→ "well studied" removed**

Line 138 - "no reference spectra were found for temperate ice" - Pope & Rees (2014) studied broadspectrum albedo on temperate Icelandic glaciers

**→ reference included**

**In the NIR, blue icebergs show similar reflectances to those of a reflectance spectra of saturated ice (which is certainly temperate) from Midtre Lovénbreen in Svalbard \citep{POPE201442}**

Line 148 - "It however appears in the mentioned literature" - Please cite it again, since I am not sure which specific references are meant if I want to look into this statement.

**→ sentence written again and moved right after the literature mentioned**

**Moreover, a larger grain size or lower air bubble content can significantly reduce reflectance and could make the ice appear blue, as water does \citep[e.g.][]{bohren1983colors, dadic2013effects}. However, it appears in these studies that the impact of larger grain size, lower porosity,...**

Line 150 - "surprisingly" - please remove this non-objective word

**→ Contrary to the intuition that BIA reflectance would resemble that of blue ice,**

**used to highlight that blue ice Antarctica does not show the same properties as SKK.**

Line 154-158 - I also found this paragraph to be muddled and needing improvement. I'd add to Reviewer 1's comments that "opaque" and "reflecting" are not antonyms.

**→ paragraph removed, shallow melt water pond only mentioned, no conclusions drawn from them**

Line 193-194 - That the icebergs "rose from the water 30 to 60 seconds later in a second phase after the disintegration of the upper part" should be moved to the Results as they are direct observations. The generation of the icebergs should be described more thoroughly overall.

**→ better described in the results now**

Line 200 - Within measurement uncertainty and additional uncertainty stemming from unknown emissivity, is the ice here in the cold core of B5 truly any colder than the white ice in B5? **→“However, relative temperature differences remain similar.”**

**this was tested. At a same distance, thus under the same biases, when the sensor feels different values, this means that both surfaces emit differently.**

Line 201 - The number 0.5 refers, I think, to the "halfway depth" of the ice stream. This should be better defined. **→ In contrast, on B5, the cold core of blue ice is situated almost at the bottom of the ice stream, much deeper than the cold minimum at a relative depth of 0.5 in the borehole.**

Reviewer 1 expects the ice to turn gray first and then white as the clathrates release. Why the gray phase, and was this transition observed? I recognize that the authors may not have an answer for this, as this is the Reviewer's idea (not theirs), but I am asking simply because I would like to know. **→ The gray color is part of the gradual transition from blue to white. Indeed, it is rather grey-blue. I don’t think there is an intermediate gray state. The blue-gray color is visible in Figure 5.**

Perhaps a related question to the above: What do the authors hypothesize to be the origin of the grayish-green layers? This observation is reported, but its cause never explored (it only appears in Section 4.6, "Pathways for further research"). **→ it could be a high dust content originating from the late Wisconsin period. I mention it only in this section because it is not the main topic of the article, but further methods for blue ice could help to answer the origin of the green ice.**

**Moreover, green ice occupies smaller areas on icebergs than blue ice. Thus, it was hard to investigate its properties with the methods of our study (satellites and thermal measurements).**

Figure 4 caption - Please fix the typo "in black line" and define "BIA" in the caption (it is defined in the text, but this was harder to find). **→ done**

Figure 5 caption - "except that water was trapped during calving (no melt water)" - What does this mean? Is it implied that this is seawater, not water sourced from the glacier? Please clarify. **→ In panel a, a pond is similar to those studied previously, except that here it is sea water trapped during calving, not melt water from the iceberg.**

**References**


Pope and Rees, 2014. “Using in Situ Spectra to Explore Landsat Classification of Glacier Surfaces.” International Journal of Applied Earth Observation and Geoinformation 27: 42–52. doi:10.1016/j.jag.2013.08.007.

Shapero, Joughin, Poinar, Morlighem, and Gillet-Chaulet, 2016. “Basal Resistance for Three of the Largest Greenland Outlet Glaciers.” Journal of Geophysical Research 121 (January): 1–13. doi:10.1002/2015jf003643.