Response to the editor, Prof. Kaitlin Keegan

We would like to thank Prof. Kaitlin Keegan for her thoughtful and helpful reviews of our paper. The comments have helped us to clarify many important points. Editor's comments are in blue; our responses are in black. *Extracts from the revised manuscript are in italics.*

R.1.1 Response R 1.2: Description of '(3) use ice as an analogue to understand the annealing of minerals at their melting temperatures.', as mentioned in the response to referees, is missing in the manuscript.

We apologise for the mistake. We have made five rounds of revisions before submitting our manuscript for a second review. Describing the use of ice as an analogue for other minerals has been included in the first round of revision. However, this specific part was removed before the final revision, but we forgot to update the document of 'response to reviewer'. The reasons for us to remove the description of using ice as an analogue for other minerals are:

1. The original motivation of this study is to assess the growth rate of natural ice at extreme conditions. The data that come out from this study is expected to be used for assessing the dynamics of ice flows at where melting is common.

2. Using the grain growth of data of ice to understand the grain growth of rock-forming minerals is a good idea. However, thoroughly discussing this topic might require another paper, which should rigorously compare the microstructural data between ice and other minerals, and it is beyond this paper's scope.

R.1.2 Line 71: remove one of the 'and's, for example: '…at the base of many glaciers and ice sheets (Schmidt et al., 2023; Davis et al., 2023) as well as ice shelves (Schodlok et al., 2016, Pritchard et al., 2012), and is predicted…'

We apologise for the mistake. We have corrected the writing.

R.1.3 Line 141: should be '… 'A' and 'B' refer to…'

We apologise for the mistake. We have corrected the writing.

R.1.4 Line 420: should be 'field campaigns' instead of 'field strips'

We apologise for the mistake. We have modified the sentence to:

Temperature records that span from January 2020 to November 2022 show…

R.1.5 Table 1: The last row on Page 6 is missing the Sample Type (sample 12_P_A); the first row on Page 7 is missing the Annealing Time, Initial Median Grain Size, Measuring Grain Size – Combined Sections, Number of Ice Grains – Combined Sections (sample 12_P_B). If that's intentional, place a '-' or 'N/A' to indicate that these blank boxes are intentional.

We suggest this should be a display error while the Word software tries to display vertically merged cells. We have applied modification so that the information of 12_P_A and 12_P_B can be correctly displayed.

R.1.6 Section 2.4.3: I respectfully disagree that the broad readership of The Cryosphere will understand what the M-index is from what is included in this Methods section. As referee Stoll points out, it would be useful to include how the M-index calculates CPO intensity for the non-expert reader.

We apologise that our previous reply was not considering enough. We have added the following statement to describe the calculation of M-index:

The calculation of M-index is based on the distribution of misorientation angles calculated from random pairs of pixels indexed as ice from a given EBSD map (Skemer et al., 2005).

R.1.7 Section 3.3: You refer to a Section 3.3 in your response to referee Stoll (R 1.49), referee Wilson (R 2.5), and on lines 250, 285, 356, 358, 390, 395, 396, and 418, but it does not exist. Please check your Section numbering references throughout the text.

We apologise for this mistake. We merged sections based on comments from Prof. Chris Wilson. In detail, we have (1) removed Sect. 3.2.1, (2) merged Sects. 3.2.1 and 3.2.2 as the new Sect. 3.1, and (3) merged Sects. 3.3.1 and 3.3.3 as the new Sect. 3.2.1, and (3) changed Sect. 3.3.2 as the new Sect. 3.2.2.

However, we forgot to update the referenced section number in the second submission. The previous section 3.3 should be the current section of 3.2. We have corrected this mistake throughout the whole manuscript.

R.1.8 R 1.67 – this modified statement is not present in the present version of the manuscript.

We apologise for this mistake. These statements were firstly added based on Dr Stoll's comments. However, we removed statements, including the statement on the impact of CPO on grain growth, after accepting Prof. Wilson's comments. This is because our data is insufficient to evaluate the impact of CPO on grain growth; discussing the impact of CPO can be misleading. We have honestly addressed such shortage in the modified manuscript:

Evaluating the impact of impurities, CPO, and strain energy on grain growth would require additional data input and extensive modelling that are beyond the scope of this paper. In the following paragraphs, we will focus on evaluating the impact of bubbles on the inhibition of grain growth.

Unfortunately, we forgot to update the change, i.e., remove the statement about the comparison of CPO patterns between synthetic and Priestly ice, in the reply to the first reviewer, Dr Stoll.

R.1.9 R 1.71 – I agree that the bubble density does not appear to be 'relatively stable' in the data presented in Figure 8d. Explaining the jump from time 0 to 100 hours for each bubble size, and the difference in trend between the largest bubbles (orange squares) and the smaller bubbles would be helpful.

We apologize that our previous interpretation of the evolution of bubble statistics is not robust enough. We have thus separately described and interpreted the evolution of statistics for bubbles on grain boundaries and bubbles within grains:

For bubbles within ice grains, the density of relatively bigger bubbles (bubble size ≥300 μm) increases with time, whilst the density of relatively smaller bubbles (bubble size <300 μm) remains relatively stable during ~800 hours of annealing (square marks, Fig. 8(c)). This observation indicates the growth of some of the bubbles, probably driven by surface energy. Before ~400 hours of annealing, the density of bubbles on grain boundaries gradually increases (triangle marks, Fig. 8(d)). This observation suggests that more bubbles pin at grain boundaries probably during the migration of grain boundaries. By ~800 hours of annealing, the density of bubbles on grain boundaries has decreased (triangle marks, Fig. 8(d)). This observation suggests that some grain boundaries have swept through bubbles.

To match the sequence of the description of figures in the text, we also switched Fig. 8(c) and 8(d), i.e., the previous Fig. 8(c) is the current Fig. 8(d); the previous Fig. 8(d) is the current Fig. 8(c).