We thank the editor and the reviewers for their time evaluating this paper. Based on their recommendations, we have made significant changes to the manuscript.

Firstly, we have undertaken additional analysis to support the age-scale. We have identified crypto-tephra-like shards believed to originate from the Puyehue-Cordón Caulle eruption in 2011. In addition, we have expanded the section on melt, to highlight the good agreement between annual melt and positive degree days which further supports the age-scale. Finally, we have removed the pseudo core data, to avoid the circular argument of comparing reanalysis data.

We hope that this additional information, and more conservative interpretation approach, will alleviate the reviewers concerns and make this acceptable for publication in Climate of the Past.

Detailed response below, with reviewer comments in italics.

Reviewer 1:

- *My main concern remains with the presentation of the dating section. Given the short record, it requires a more detailed explanation and justification. Specifically, there is a lack of direct comparison of this record to other firn/ice/snow samples (cores) obtained in the Antarctic Peninsula.*

We were cautious about making comparison with such short records that are more than 600km from the site. However, for the benefit of the reviewers below is a comparison between Peter 1st and the closest continental site, Rendezvous. While the overlap between the two records is just 10-years, and arguably too short to determine meaningful correlations, the seasonal deposition of SO_4^{2-} does provide some supporting evidence for our age-scale.

- *According to Koffman et al., 2017(https://doi.org/10.1002/2017JD026893) deposition and transport of the ash from Puyehue-Cordón Caulle in 2011 happened during 2-3 weeks in June. On Fig.2 this peak is partly located in 2012. Could that be just a seasonal SO4? How this peak is different to the peak in e.g. 2005 (Fig.2). Please clarify.*

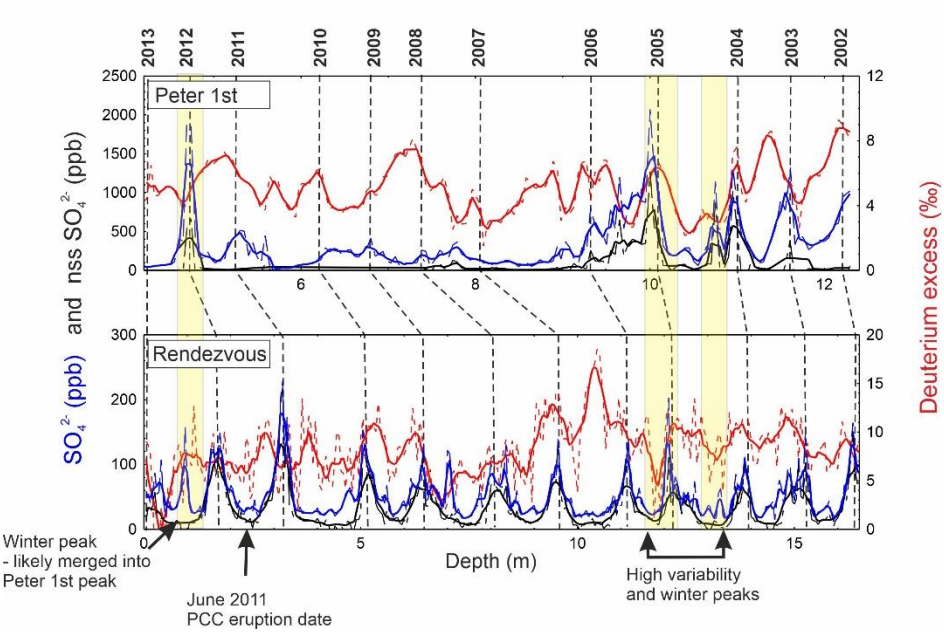

Figure R1. Comparison of SO_4^{2-} (blue), nss SO_4^{2-} (black) and deuterium excess data (red) in Peter 1st (top) and Rendezvous (bottom), which are located ~600 km apart.

Firstly, there is no evidence of a significant SO_4^{2-} peak in the winter layer immediately following the Puyehue-Cordón Caulle eruption in Rendezvous. In contrast to snow pit observations in West Antarctica (Koffman et al., 2017). Instead, we observe a broader SO_4^{2-} peak during the spring and summer 2012 layer at Rendezvous. The Rendezvous core was drilled in January 2013, so we have confidence that the June 2011 eruption does not generate a significant winter peak at this site. We conclude that the lower sampling resolution (and potential influence of melt at Peter 1st), likely account for the differences between the West Antarctic snow pit and the ice core records. Therefore, we maintain that the peak in SO_4^{2-} occurs during summer 2012, likely from a combination of volcanic SO_4^{2-} (deposited during early spring 2011) overlain on the summer biogenic SO_4^{2-} deposition.

In addition, as observed at Peter 1st, the Rendezvous record contains elevated SO_4^{2-}, between years 2004 and 2006. The increased variability at both sites further supports our age-scale and suggests a similar (yet unknown) source. As observed previously, the pattern of variability, magnitude, and exact timing of SO_4^{2-} peaks in Antarctic ice cores may vary (e.g. [Emanuelsson et al., 2021]). This is especially true when trying to compare sites which are separated by over 600 km of open ocean and contain relatively high background biogenic SO_4^{2-}.

- *Additionally, more clarification is needed on the criteria used for annual layer placement, particularly for years such as 2012/2013!, 2009/2010, or 2007/2008. In Figure 2, some lines do not align with any peaks. Without additional evidence, the annual layer counting could yield results ranging from 7 to 16 years. It is crucial to provide independent evidence to support the assumed correct dating. Alternatively, you can try to provide different possible dating of the core and then check the results and correlations (in supplementary).*

We have now included the deuterium excess in figure 2, to further demonstrate our selection of individual years. We hope that the revised figure 2 helps to explain our depth horizon choice.

We have also undertaken a more in-depth evaluation of potential volcanic eruptions, to further constrain the age-scale (see below). We now have evidence for crypto tephra in the layer corresponding to 2011/2012. This independently supports our age-scale, providing a reference horizon for the Puyehue-Cordón Caulle eruption in 2011.

- *Can you please present nssSO4 and nssCa data to compare with other records?*

Given the maritime location, the contribution of marine SO_4^{2-} is high. Traditional equations for nssSO_4 (e.g. [nss SO_4^{2-}] =[SO_4^{2-}] -(0.25*[Na^+])) result in a largely negative record. The nss SO_4^{2-} peak is shown in Fig R1 (black), for the reviewers. However, we remain unconvinced that extracting the nss SO_4^{2-} component from such a low elevation maritime location is very informative.

- *While the authors correlate the record with meteorological data, these data are not presented. It would be helpful to include, for example, PDD temperatures over the entire period to demonstrate notable years such as 2013 and 2006.*

We have now included a more detailed comparison of the meteorological data. We present the annual melt thickness alongside the number of positive degree days (PDD) and daily maximum temperature. This highlights the close agreement between melt and temperature (r=0.73), which further supports our age-scale. The data is presented in a revised, which now also includes the line scanned image of the melt feature previously presented as a supplementary figure.

- *Regarding sulfate peaks, authors suggest volcanic eruption as a potential source, but additional evidence is needed. Given the low concentrations and the presence of high calcium levels (suggesting that this layer is alkaline and not acidic), it is important to consider other independent data such as cryptotephra.*

To independently validate our assigned volcanic reference horizons, we have now scanned the particulate material from this core. The presence of several cryptotephra particles in the layer corresponding to 4.6-4.9 m confirm the volcanic origin of the sulphate peak at this depth, and further support our assignment that this is the 2011 Puyehue-Cordón Caulle eruption.

We have referenced the work of Koffman et al., 2017 as supporting evidence that this material was likely deposited after June 2011.

- *Regarding snow accumulation, the reasoning for accounting for annual layer thinning for the 14 m firn core should be explained. If such corrections are necessary, references, formulas, and the calculated effect should be provided. It is worth noting that snow and firn compaction does not alter the water-equivalent of layer thickness since there is no lateral extension (Nye, 1963 DOI:https://doi.org/10.3189/S0022143000028367). Please clarify.*

We have used the Nye model to account for thinning at this site, failing to cite the appropriate paper was an oversight. It has now been included.

- *L.296. Regarding the removal of the two most melt-affected years (2013 and 2006 CE), further clarification is needed on the correlation with winter average 2m temperature. It's unclear what "respectively" refers to, and the correlation value of r=0.66 is not presented in Table 1.*
- *Additionally, the rationale for correlating annual isotopic composition with winter temperature should be justified, considering precipitation distribution. By removing two years, you make the record even shorter and it is not clear that 2006 isotopic record was affected that much by melting so it should be removed.*

Firstly, we have decided to only include correlations with the annual average data. This has now been revised in figure 6. We also no longer remove the most melt effected years from our comparisons or corelations. While we think the melt has impacted the record, we agree that removing them makes the record too short to draw meaningful significance. Accordingly, we have removed table 1 which is no longer required.

Reviewer 2:

Minor:

Lines 25-27 and 65-72, Introduction and Discussion: This sentence would fit better within the abstract if the clauses were flipped.

Lines 65 to 72 demonstrate that evaluating the skill of ERA5 on Peter 1st Island and comparing the firn core proxies with ERA5 data are two goals of the paper.

Thank you for the suggestion, we have updated the abstract text with the revised sentence to better reflect the goals of this study.

Line 32 and section 2.1: How do these crevasses influence the ice cap as a possible drilling location? Is there a location that is above the crevasses and may not be interrupted by these weak points that can influence the ice layers? If one of the main goals is to establish the suitability of the site for future deep ice core drilling, how often does this heavy cloud cover occur? Obviously, drilling in such a remote location with difficult logistics can influence the site location. Is the site of the short core a possibility for drilling the longer core?

In section 2.1, we present a geographical setting for the firn core presented in this study. Based on the data we collected from the firn core, and the short GPR transects, we suggest there is potential for future deep drilling. However, any future deep drilling would be subject to a far more extensive geophysical survey to identify a site free from crevassing.

Lines 31 and 32: Include the coordinates of the island or refer to the map with the location (Figure 1).

Added.

Line 40 and throughout the paper: The use of the acronym "AP" for the Antarctic Peninsula hinders rather than helps the reader. Please use the full name throughout the paper, rather than relying on the acronym.

All changed.

Line 44: How long did this pause in warming occur? Are the temperatures at a record level, or is the rate of warming at records levels (or both options)?

The temperatures are at record levels. This has been clarified in the text.

Line 69: I think you wish to complete this sentence with "provide a unique opportunity to …." Rather than "unique op."

Corrected.

Lines 94-125: Did the samples melt at any time during the transit? How were the samples distributed between the teams? Were all samples brought back to the British Antarctic Survey?

The samples remained frozen. The ice cores were transported in a -25°C shipping container to the BAS laboratories. All samples were sub-sampled at BAS.

Line 330: As you are using brackets, the word "concentration" is not necessary. If you choose to keep this word, then change it to the plural "concentrations".

Removed.

Section 3.7: Substantially more information on how the "pseudo core" was derived is necessary and/or omitting the entire section that uses the pseudo core data. While the authors are clear that the pseudo core can create circular reasoning, the pseudo core does not grant sufficient gains in understanding that outweigh this circular reasoning.

Based on this, and other reviewer comments, we have decided to remove the section relating to pseudo cores. We feel that the potential circular reasoning is detracting from the aim of the study. Discussion section 4.4 has been shortened to just provide an overview of expect drivers of variability based on current literature.

Technical corrections:

Line 28: Why say "invaluable" when you can simply state "valuable"?

Line 32: Replace "islands'" with "island's".

Line 57: Change "last Glacial Maximum" to "Last Glacial Maximum".

Line 228: Change "when temperature have exceeded" to "when temperatures have exceeded".

Line 230: Change "To test this" to "To test this discrepancy".

Line 260: Change "However, this suggest" to "However, this suggests".

Line 315: Change "reference" to "references".

Lines 462, 535, 555 and 636: Change "Peter 1st island" to "Peter 1st Island".

Line 569: Change "This is corroborated" to "This warming is corroborated".

Line 578: Change "Mean annual temperature of" to either "Mean annual temperatures of" or "A mean annual temperature of".

All technical corrections have been made.