The authors would like to sincerely thank Reviewer #3 for their insightful comments and their time for reviewing this manuscript. We have addressed their comments below and believe their feedback has strengthened the science of this manuscript.

Reviewer 3

L18: Was evidence provided in the text? It seems to be speculation.
This is mostly speculative as we do not have a robust age scale or flow model, but given the high age densities discussed in this paper and other papers cited (e.g., Marks-Peterson et al., 2026), we know these high age densities must correspond to strong layer thinning.

L21: The abstract should be presented as a single paragraph.
We condensed the abstract into one paragraph.

L24: How can we identify the discontinuities?
This is shown in Figure 5 and we do not have the space to describe it in the abstract as it is currently written.

L26: The EDC core would serve as a good benchmark for CH_4, whereas ice core records from Victoria Land would provide more appropriate references for stable water isotopes and particle concentrations.

We included additional clarity in Section 2.4 regarding our decision to compare it to EDC. We do use offsets to account for regional differences and therefore are mainly comparing the shapes of the distributions, but a key point is that our CFA ages overlap better with EDC than Victoria Land cores and we believe this is important for understanding glacial-interglacial variability in our records. Additionally, TALDICE does not have a comparable dust record in that the concentrations were measured with a Coulter Counter and not continuously with an Abakus. Simonsen et al., 2018 (cited in paper) found these make comparisons between the two measurements challenging.

We have added this paragraph in Section 2.4 to clarify our justification for using EDC as a benchmark:

"The purpose of the EDC comparison is to assess whether discontinuous blue ice at Allan Hills reliably preserves environmental signals and glacial-interglacial variability. ALHIC 2201 and 2302 do not have a robust age scale due to discontinuous stratigraphy in conjunction with limited discrete ^{40}Ar dates. Therefore, the EDC comparative analyses are conducted with all EDC data resampled on a 1 m binned depth scale rather than an age scale. Comparison between these two records on a depth scale allows for interpretation of the distribution of environmental variability and the depth binning of the EDC record limits the influence of sampling resolution biases as a result of uneven depth sampling in the EDC datasets. The continuous 800 kyr EDC record is an appropriate benchmark for the ALHIC CFA records in that most of the estimated ages fall within this age range (see Section 3.1) and the distributional comparison of the environmental variables is independent of the continuity of the record. Due to regional differences between Victoria Land and the East Antarctic Plateau, a mean offset is applied to the Allan Hills water isotope and dust values for better comparison to EDC."

L35: Marine sediments preserve records spanning hundreds of millions of years.

We added this distinction to highlight the deep-time capability of marine sediment records and now reads as follows:

“Marine and terrestrial sediment records have revealed major aspects of our Earth’s climate history, extending hundreds of millions of years into the past. “

L36: We should better constrain the paleoclimate intervals corresponding to the last several million years to address the two MPT and mPWP.
We added the following sentence to enhance the logical flow of the paragraph:

“Strengthening and constraining paleoclimate records from these intervals is therefore essential for improving our understanding of Earth’s climate system.”

L60: update reference
We updated the reference from (in press) to its full 2026 citation.

L177:180 Moving figure caption information to Section 2.2.2 and 2.2.3
Due to the complexity of the figure, we believe keeping this figure caption as is allows readers who are interested in the functionality of the CFA system, to have a clear picture and explanation without having to go to the main text for details that are a part of the figure. The figure is unclear without these explanations, and we prefer to have the figure be understandable without having to refer to the main text.

L193: The alteration processes occurring near the surface have not yet been clearly understood. If the authors wish to mention the potential causes, they should cite appropriate references.
We now cite Baggenstos et al., 2017 Clim. Past that discusses surface cracking at Taylor Glacier blue ice area and Turney et al., 2013, Journal of Quat. Sci. that discusses gas contamination in the surface of blue ice at Patriot Hills. We also can clearly see the effects in our methane data when we see these fractures in the ice. They result in high methane values (> 700) but no instrumentation errors (e.g., spike in cavity pressure) that would be indicative of an air intrusion that occurred during melting.

L213: Was "d" defined earlier? If not, it should be defined here.
Yes, it is defined in Line 148-149:

“Deuterium excess, d, is defined as the deviation from the linear meteoritic water line: $d = \delta^2H - 8 \times \delta^{18}O$.”

L215: What is "Abakus"? Abakus instrument? Please clarify.
We clarify this sentence that an Abakus instrument (Markus Klotz GmbH) in Section 2.2.1 where it is first defined. Additionally, we have modified this sentence in Section 2.2.2 as follows:

“We did not calibrate dust measurements, but dust concentrations on ALHIC 2302 were replicated (also using an Abakus instrument) during a CFA campaign at Dartmouth College (DC), providing a useful inter-lab comparison.”

L261: It is not clear whether the increased CH_4 originated from the intrusion of modern air. Although this possibility is assumed, the extent to which this process affects the CH_4 concentration has not been clearly investigated.

We clarified our interpretation of the methane data that led us to this conclusion as noted above from the comment in L193.

L274: Does "adjacent" refer to samples at different depths or at the same depth? Please clarify.
We clarified that adjacent means from the ~same depth interval. The sentence now reads as follows:

"The samples used for dating were from an adjacent (i.e., approximately the same depth interval) piece of ice from the BID core using an ~800 g sample."

L277 and 380: For comparisons of water isotopes and dust concentrations, it would be better to use ice core records from Victoria Land.
Please see response to comment #4 (L26). We expanded this section to include a deeper justification for our choice to compare it to EDC.

L315: Kirkpatrick et al. (2025)
Thank you for noticing this. We updated the formatting.

L350: This paragraph can be moved to the Introduction section.
As this is a long paper, we would like to retain this introductory section to help guide readers and provide expectations for this section.

L360: The authors should clearly describe how the variance was calculated. Were the data collected at regular time intervals or at constant depth intervals for the EDC core?
Thank you for this note. We have addressed this in our modification of Section 2.4 as noted above in response to comment #4 (L26).

L384: We should also consider how far is the ice from the underlying bedrock or sediments?
The distance from bedrock is discussed in Section 3.4 (Figure 10). Rocks are found throughout the ice column, not just near bedrock. The origins of dust and particulates is an ongoing challenge at the Allan Hills. CFA for ALHIC 2302 was only on the upper 46 m while 2201 was the upper 69 m, therefore this does not appear to be an explanation for the higher dust concentration. We added this discussion in Section 3.2 and have included the following sentences:

"The distance from bedrock does not explain the enhanced particle concentrations in the ALHIC 2302 CFA data as the analyses depths ranged from 186 to 140 m above bedrock while ALHIC 2201 was analysed to 90 to 20 m above the bed. Bed entrainment of particles is a potential process in these cores (Choi and Carter et al, in review), but unfortunately, the CFA analyses precede the depths in which this likely becomes relevant."

L391: How about if we compare with Victoria Land ice cores?
We modified this paragraph to provide clarity and expand on the discussion of *d* in Victoria Land:

"The average ALHIC water isotope values (including *d*) resemble those of other Victoria Land ice cores, such as Talos Dome, Taylor Dome, and S27 (Baggenstos et al., 2018; Crotti et al., 2022; Landais et al., 2015; Steig et al., 2000; Yan et al., 2021) reflecting the warmer site conditions and a closer proximity to moisture sources than those of the East Antarctic interior, such as EDC (Table 1; Landais et al., 2021; Markle & Steig, 2026). Both ALHIC 2201 and ALHIC 2302 exhibited lower average *d* in comparison to

EDC, and ALHIC 2201 showed a particularly wide range, with some higher values comparable to EDC (Table 1, Fig. A4). This wide range of values for *d* may imply that the Allan Hills ice incorporates material from multiple accumulation zones, such that the water isotope signal reflects a mixture of ice formed under different temperature and elevation conditions, and at varying distances from the coast. Additionally, Victoria Land ice cores may be more influenced by large changes moisture source, thus exhibit anomalous *d* values that also dampen $\delta^{18}O$ variability (Markle & Steig, 2026). Sublimation (which lowers *d* values) and complex post-depositional regimes may have implications for interpreting water isotope data at this site (Hu et al., 2022). Neither ALHIC 2201 nor 2302 capture the full range of expected glacial–interglacial variability in $\delta^{18}O$, with the range representing ~72% for ALHIC 2201 and ~45% for ALHIC 2302 to that of EDC (Fig. 6, Table 1)."

L393: I wonder whether these data could be interpreted differently. It would be helpful to compare them with other ice core records from Victoria Land.
As stated above, we added discussion of expectations of these values regarding d values in Victoria Land versus the plateau here. Additionally, we add additional discussion points in this section. We include the following in Section 3.2

Notably, ALHIC 2201 shows a comparable reduction in $\delta^{18}O$ variance relative to EDC as TALDICE does (for the same age ranges as S27; Table 1), suggesting that reduced isotopic variability ALHIC 2201 retains this regional feature. The reduced variance in water isotopic values observed in the Allan Hills ice cores may therefore be partially attributed to regional characteristics of Victoria Land, rather than being solely a consequence of stratigraphic mixing or other post-depositional processes.

L396: It would be useful to compare these values with those reported for ice cores from Victoria Land.
These are in Table 1.

We would also like to highlight the discussion later in the manuscript in Section 3.3.2 starting at L558 that discusses Victoria Land comparisons more in-depth and is accompanied by Figure 9.

L398: The comparison between the Victoria Land cores and EDC suggests that δD is influenced by local conditions. Is the same true for the d-excess and particle concentration values?
In addition to d-excess stated above, we add the following sentence citing work from Albani et al., 2012 that addresses local dust deposition in Talos Dome:

"For the ALHIC cores, the proximity of the local accumulation area to ice-free regions of the Transantarctic Mountains may contribute to regional dust inputs whereas dust at EDC is derived from remote sources, resulting in differences in dust concentration distributions (Albani et al., 2012; Carter et al., 2026)."

We do not want to draw too many conclusions between these dust records as they are measured using different methods.

L409: The depths of the studied ice cores should also be considered. How far is the analyzed ice from the underlying bedrock or basal sediments?

The ice is 90 to 20 m above the bedrock for ALHIC2201, and 186 to 140 m for ALHIC2302. The analysed sections and full core lengths are mentioned in Section 2.1.

Additionally, we added the following to discuss its relevance to particle concentrations in the CFA data:

“The distance form bedrock does not explain the enhanced particle concentrations in the ALHIC 2302 CFA data as the analyzed depths ranged from 186 to 140 m above bedrock while ALHIC 2201 was analyzed to 20 m above the bed.”

L421: I wonder whether the dip is consistent throughout each core.
The dip is mostly consistent throughout the core with a slight decrease in dip with depth. Not varying typically by ~10 degrees. See citation Kirkpatrick et al., 2025. We added the following detail into this paragraph:

“Dip angles resolved by three-dimensional multitrack electrical conductivity measurements (3D-ECM) find fairly consistent (with depth) average dip angles of ~69° in ALHIC 2302 as compared to ~29° in ALHIC 2201 (Kirkpatrick et al., 2025).”

L469: EDC on the time domain?
It is the 1 m binned depth. We clarified this this in the modified Section 2.4 discussed above.

L512: What about alteration caused by basal rocks or sediments?
Post-depositional effects in general should be considered. We updated the sentence to read as follows:

“Deviations between the artificial EDC and ALHIC distributions suggest the presence of sampling bias, likely driven by complex ice flow, stratigraphic disruption, or post-depositional alteration.”

L528: It would be better if the authors specify the core name and location studied by Yan et al. (2021).
Thank you for this suggestion. We will specify this core, S27. We changed the sentence to read as:

“Note that both estimates are smaller than the ten-fold IG-G accumulation contrast estimated for S27 (Yan et al., 2021).”

L531: What does KDE stand for?
Kernel density estimation. We updated this to explicitly state this in the figure caption.

L583: It would be better to report the depth range or the distance of the samples from the base.
Thank you for this note, now include the distance from bed:

“Signal attenuation and averaging effects are more pronounced with depth as evidenced by the transition to only long snapshots below 140 m (~20 m above the bedrock) in ALHIC 1901 (Marks-Peterson et al., 2026).”

L589: It would be helpful to specify the distance from the bed.
We specified the distance from bed in the section. See above comment for modification.

L616: variation?
This should read "...reduce the preservation of glacial-interglacial variation" and has been updated.