Review to: "Atmospheric ^{10}Be from Talos Dome (East Antarctic) ice core records geomagnetic dipole intensity from 170 to 270 ka BP"

Comments from reviewer are in black / answers to the comments are in blue / suggested modified sections are in orange, with the specific modifications in **bold**

Reviewer 2:

Atmospheric ^{10}Be from Talos Dome (East Antarctic) ice core records geomagnetic dipole intensity from 170 to 270 ka BP by Lamothe et al.

This study presents a long-term ^{10}Be record from the Talos Dome ice core (TALDICE) in East Antarctica, spanning a period from 170 to 270 thousand years before present (ka BP). After removing some potential post-depositional "noise", the 3-kyr smoothed ^{10}Be flux profile appears to faithfully represent the broad variations in the atmospheric ^{10}Be production signal. These variations are likely sufficient to serve as a proxy for relative paleointensity (RPI). The smoothed profile shows the ^{10}Be maxima caused by three geomagnetic dipole moment lows: the Iceland Basin excursion (IBE), the Pringles Fall excursion (PFE), and the Mamaku excursion (ME). The characteristic ^{10}Be variations of the largest low, the IBE, are also evident. These maxima and variations could serve as useful tie-points for paleo-archives. Ice core data is especially valuable for the 200–270 ka interval, for which no data has been published yet. Furthermore, I generally agree with their interpretations and conclusions. However, I have the following concerns, which, in my opinion, should be properly addressed before this work is published in GChron.

1. Earlier studies' findings are disregarded
Comprehensive research on the IBE period (170–200 ka BP) has already been conducted by Horiuchi et al. (2016). They presented unprecedented, high-resolution ^{10}Be data from the Antarctic Dome Fuji (DF) ice core and western equatorial Pacific sediments. They also discovered the following: (i) a 7-kyr plateau of the ^{10}Be maximum at the IBE, (ii) a twofold enhancement in ^{10}Be production (i.e. cosmic ray intensity), (iii) an asymmetric pattern of the ^{10}Be peak that is opposite to that of geomagnetic reversals, and (iv) an apparent age offset of several kyr between the ice core and the marine sediments, mainly due to uncertainty in the chronology of the sediments. I found that all of these findings are confirmed using independent data sets by Lamothe et al. in this preprint. This is truly wonderful. However, this preprint does not refer to the earlier findings. It should properly indicate what is known from the earlier research and what new findings were obtained in this study.

We thank the reviewer for this comment. We agree that our results are in excellent agreement with Horiuchi et al., 2016, which therefore would support more mentions of Horiuchi et al., 2016. We also notice that while many of the results discussed in our work are discussed in Horiuchi et al., 2016 dataset, we propose new elements like the twofold enhancement with respect to polar bias, the influence of marine age model uncertainties on the 3 ka delay, or the different asymmetric patterns between excursions and inversions. We have corrected our manuscript to better show these elements and what was already present and discussed in Horiuchi et al., 2016.

Revision:

L384: "Based on the TALDICE ^{10}Be flux data, a flux enhancement factor of 1.59 to 2.08 is observed, depending on the reference background (see section 4. Results)**, similar to the twofold enhancement reported in Dome F (Horiuchi et al., 2016). In comparison, we calculate an enhancement ratio between 1.90 with the ^{10}Be flux calculated with the revised age of Dome Fuji, assuming a background calculated between 170 and 180 ka BP and a low-GDM plateau between 185.5 and 191 ka BP**"

L487: "A systematic time offset between the oceanic and the ice core records is observed (Figures 5, S4.A). **A similar 3 to 4.5 ka offset between oceanic and Dome F ice core records was previously reported by Horiuchi et al., (2016), and interpreted it primarily in terms of magnetic lock-in depth associated with post-depositional remanent magnetization acquisition in marine sediments. Our results confirm the existence of a comparable offset using independent marine and ice core datasets, but extend the comparison to ice core ^{10}Be fluxes, which are not affected by magnetization processes.** When comparing authigenic ^{10}Be/^{9}Be from core MD05-2920 to the TALDICE ^{10}Be flux, the best correlation is obtained when the oceanic record is shifted 3 ka younger (R^2 = 0.37, Figure S4), which remains within the uncertainties of the marine core age model (Tachikawa et al., 2014). **Unlike comparisons involving RPI, a phase shift between ice core and oceanic ^{10}Be records cannot be attributed to magnetic lock-in effects. Potential physical causes would instead involve atmospheric or oceanic transport and mixing processes.** Nevertheless, does this 3 ka offset result from age model uncertainties or reflect a physical lag in the system, thereby limiting the possibility to use paleomagnetic events as chronostratigraphic horizons?

A phase shift linked to mixing processes would result in a delayed and attenuated ^{10}Be signal. Although excursion amplitudes are consistent between the two archives (Figure 5), this depends on complex processes that can be involved such as polar bias linked to incomplete atmospheric mixing (Adolphi et al., 2023), oceanic circulation and transport (Jeromson et al., 2025; Savranskaia et al., 2021) and bioturbation in sediments (Raisbeck et al., 1985). Nevertheless, if a physical phase shift occurred, we would expect the ice core signal to lead the oceanic record due to various oceanic mixing effects, thereby resulting in a delayed (and attenuated) marine authigenic ^{10}Be/^{9}Be signal.

To investigate the delay, we can examine the cross-correlation between the ^{10}Be/^{9}Be from core MD05-2920 and the ^{10}Be flux from TALDICE**, similar to the approach of Horiuchi et al., (2016)**. Such analysis (Figure S4.B) shows the highest correlation when MD05-2920 is shifted by 3 to 3.7 ka earlier. Another approach consists in examining the evolution of the delay between well-defined paleomagnetic events identified in both records (marked with stars in Figure 5). If major changes in oceanic circulation influenced the sedimentation of oceanic ^{10}Be, the lag would vary between glacial and interglacial periods (Savranskaia et al., 2024). However, we observe no variation in the lag across glacial–interglacial variations (Figure S4.C), indicating a consistent phase relationship between atmospheric and authigenic ^{10}Be signals. This approach yields a mean offset of 2.3 ka (Figure S4.C). Taken together, these results suggest that the observed delay is the result of age model uncertainty in the marine core, and that ^{10}Be production events are likely recorded synchronously in both oceanic and ice core archives. This conclusion is consistent with previous findings that suggest a limited reservoir effect and minimal climatic bias in ^{10}Be-based chronologies (Ménabréaz et al., 2012). These findings reinforce the value of ^{10}Be as a reliable synchronizing tool across sediment and ice archives. In the context of the Beyond EPICA project, they emphasize the role of ^{10}Be in refining chronologies and investigating climatic transitions, particularly across complex intervals such as the Mid-Pleistocene Transition (1.2 – 0.9 Ma, Fischer et al., 2013; Parrenin et al., 2017; Wolff et al., 2022)."

L510: "**During IBE, the TALDICE ^{10}Be flux record closely follows variations in oceanic authigenic ^{10}Be/^{9}Be from a global compilation (Frank et al., 1997) (Figure 5). In particular, the timing, duration, and stepped structure of the collapse and subsequent recovery of the GDM are consistent between the ice cores and marine records (Figure 5). For instance, the ≈7 ka plateau of elevated ^{10}Be flux**

observed in TALDICE has also been observed in Dome F ice core (Horiuchi et al., 2016) and is in agreement with oceanic records (Knudsen et al., 2008). Besides, the good overall agreement between the TALDICE and Dome F records with global geomagnetic field model of the IBE (Lanci et al., 2008) further supports the global record of Antarctic ice cores.

Because of this broad **global** agreement, a comparison of ^{10}Be production calculated from RPI-based VADM and authigenic $^{10}Be/^{9}Be$ with ice core ^{10}Be fluxes is possible."

L406: "The structure of the ^{10}Be flux anomaly during IBE is also noteworthy. **An asymmetric pattern, characterized by a rapid increase in ^{10}Be flux associated with dipole collapse followed by a slow and three-step dipole moment recovery was already identified in the Dome Fuji ice core record by Horiuchi et al., (2016) (Figure 4). Similar asymmetric dynamics have also been reported for the Laschamps excursion in ^{10}Be records from both ice cores (Muscheler et al., 2005; Raisbeck et al., 2017, Figure 4) and sediment cores (Ménabréaz et al., 2012; Simon et al., 2016, 2020).** Interestingly, this asymmetric pattern **is opposite, in a temporal sense, to that observed** for polarity reversals (e.g., Valet and Meynadier, 1993; Valet et al., 2005): **reversals are characterized by** a slow decrease of the dipole moment in the initial polarity followed by an abrupt recovery of the dipole moment in the new opposite polarity. After long and intensive debates (Kok and Tauxe, 1996; Mazaud, 1996; Meynadier et al., 1998; Meynadier and Valet, 1996), the hypothesis was recently tested on authigenic $^{10}Be/^{9}Be$ records reconstructed from sediment cores (Simon et al., 2018; Valet et al., 2024, 2025) which suggested that the asymmetric patterns were not convincingly reproduced for any of the reversals of the last 4 Ma. However, the consistent asymmetry of the dipole moment collapse and recovery observed for Iceland Basin and Laschamps excursions might reveal a fundamental difference between the dynamics of excursions and reversals, and should be carefully considered in future geodynamo modeling efforts."

2. Ocean ^{10}Be records on the IBE

In addition to the aforementioned concern, it is also strange that only the ice core record was picked up from Horuichi et al. (2016). The ^{10}Be records from the two marine sediment cores (KR0515-PC4 and KR0515-PC2) remain the highest-resolution ocean records available for the IBE period. I recommend using these records for comparison, at least to discuss the fine features of the ^{10}Be variations in the IBE period.

We thank the reviewer for this suggestion and for highlighting the importance of the KR0515-PC2 and KR0515-PC4 sediment cores presented in Horiuchi et al. (2016), which indeed represent the highest-resolution marine ^{10}Be records available for the IBE interval. In the initial version of the manuscript, we restricted the comparison to oceanic authigenic ^{10}Be records spanning the full 170–270 ka BP interval, which is why the KR cores were not included.

We agree that these records are valuable for discussing the detailed structure of the IBE. We therefore examined the KR0515-PC2 and KR0515-PC4 $^{10}Be/^{9}Be$ records in comparison with TALDICE and with the MD05 sediment cores used in this study. As noted by the reviewer, the KR cores show fine-scale features similar to those observed in other western equatorial Pacific records. However, because these cores originate from the same region and display patterns comparable to the MD records already included, their addition does not significantly alter or clarify the main conclusions regarding the timing, duration, and structure of the IBE.

We have nonetheless revised the manuscript to explicitly discuss the consistency between TALDICE, the MD records, and the KR cores reported by Horiuchi et al. (2016), and we now emphasize that the fine-scale structure of the IBE observed in Antarctic ice cores is also supported by these high-resolution marine sediment records.

__**Revision:**__

L480: "The comparison between atmospheric ^{10}Be fluxes from ice cores and authigenic $^{10}Be/^{9}Be$ ratios from marine sediments reveals overall agreement (Figure S4.A), supporting the reliability of both archives in recording geomagnetic events. Previous studies have highlighted the close correspondence between atmospheric and authigenic ^{10}Be records (e.g., Czymzik et al., 2020; **Horiuchi et al., 2016**). For IBE, high-resolution alignment is observed between ice cores (TALDICE and Dome Fuji, see section 5.3.1) and marine sediment cores (Figure 5). In particular, MD05-**2920 (Simon et al., 2016) and KR0515-PC2 (Horiuchi et al., 2016)** captures the same three ^{10}Be peaks at 174, 182, and 187 ka BP. PFE is also identified in both MD05-2920 and MD05-2930, while ME is not detected in MD05-2930, likely due to the core's lower temporal resolution (ca. 4 ka around 240 ka BP), which may not resolve the short 2–3 ka duration of the event."

3. Data processing

The descriptions of the statistical analyses and criteria are sometimes lacking or insufficient. A careless mistake was made when correcting the ^{10}Be flux data of the DF ice core. See the specific comments and questions below for details.

We thank the reviewer for this general comment. We agree that we did not clearly understand the chronology of Dome F which led to mistakes. All points raised regarding the description of statistical criteria and the correction applied to the Dome Fuji ^{10}Be flux have been carefully addressed in the detailed responses to the specific comments below, and the manuscript has been revised accordingly.

Specific comments and questions are as follows:

Lines 162–163. Why is there a sampling gap between 1499 and 1505 m? Please clarify.

We did not sample this section. We clarified this in the manuscript.

__**Revision:**__

L162: "The ice core was continuously sampled in sections of 20 cm (when possible) between 1470 m and 1499 m and between 1505 m and 1531 m**, with a non-sampled section between 1499 and 1505 m**."

Lines 203–204. When the data was merged, did the authors account for the systematic differences (if any) between laboratories? What are the criteria for removing outliers? Please clarify.

We thank the reviewer for this comment. No dedicated inter-laboratory comparison was performed on the TALDICE ice cores. However, all laboratories involved in the ion chromatography analyses followed the same analytical protocols and procedures that were previously applied to the EPICA Dome C and EPICA Dronning Maud Land ice cores. For these EPICA cores, a formal intercomparison exercise was conducted, demonstrating very good agreement between laboratories (Littot et al., 2002). Given the identical analytical conditions and procedures, systematic inter-laboratory offsets are therefore expected to be negligible for the TALDICE samples.

Regarding data screening, outliers were identified and removed following standard quality-control criteria applied to ion chromatography measurements (e.g., values affected by contamination, analytical artifacts, or failing internal consistency checks). These criteria are now clarified in the manuscript.

Revision:

L199: "**No inter-laboratory comparison was performed, and each laboratory analyzed a distinct subset of samples. However, all laboratories followed the same ion chromatography analytical protocols and procedures as those applied to the EPICA Dome C and EPICA Dronning Maud Land ice cores, for which inter-laboratory comparisons demonstrated very good agreement (Littot et al., 2002). Systematic inter-laboratory differences are therefore expected to be negligible for the TALDICE dataset.**The ions measured by each laboratory on the discrete samples were 5 anions (Cl^-, $CH_3SO_3^-$ (methane sulfonic acid, MSA), F^-, NO_3^-, and SO_4^{2-}) and 5 cations (Na^+, NH_4^+, K^+, Mg^{2+}, and Ca^{2+}). Measurements were made with a mean resolution of 8 cm (maximum 17 cm). Details about blanks and calibrations are reported in Morganti et al. (2007).

The final dataset, obtained by merging the data from the four laboratories, was finally reprocessed by hand, removing outliers resulting from probable contamination events. **Specifically, outliers were removed when values were affected by probable contamination events or analytical artifacts, such as isolated spikes inconsistent with adjacent samples.** In the end, between 1470 and 1531 m, post-processing resulted in the withdrawal of 0 %, 19 %, 3 %, 0 %, 0 %, 2 %, 1 %, 0 %, 0 %, and 0 % of the total sample depths for Na^+, NH_4^+, K^+, Mg^{2+}, Ca^{2+}, Cl^-, MSA, F^-, NO_3^-, and SO_4^{2-}, respectively."

Lines 214–234. I agree with the authors' statement that the uncertainty of the raw ^{10}Be flux is overestimated due to the feature of Paleochrono for SAR estimation, which reflects the large prerequisite uncertainty of SAR. However, I have my doubts about the validity of the uncertainty correction for SAR performed here. According to equation 1, if a given SAR value is equal to the mean of all SAR values, then it has no uncertainty. Is that reasonable? All measurements and estimations are subject to some degree of uncertainty.

We thank the reviewer for this important comment and agree that, in a strict sense, all measurements and model-derived quantities, including snow accumulation rates, are associated with non-zero uncertainties, even when their value equals the mean. The issue raised here was also carefully considered during our analysis.

The approach adopted in Equation (1) does not aim to quantify the absolute uncertainty of the ^{10}Be flux at a given time, but rather to estimate the uncertainty associated with *relative variations* of the flux over time. This distinction is essential for the objectives of this study, which focus on identifying and interpreting temporal variations in ^{10}Be flux related to geomagnetic field changes.

If the absolute ^{10}Be flux at a specific time were of interest, propagating the full accumulation-rate uncertainty provided by the Paleochrono framework would indeed be required, as no other constrain currently exists. However, when investigating relative variations, applying the full ±20 % accumulation uncertainty uniformly would artificially inflate the uncertainty envelope and obscure meaningful variability.

We therefore use the ±20 % accumulation uncertainty as a relative uncertainty applied to deviations from the mean accumulation rate, which we now explicitly define as a 'variation uncertainty'. We have clarified this point in the Methods section to avoid ambiguity and to clearly state the scope and limitations of this approach.

Revision:

L228: "In order to avoid artificial inflation of the uncertainty associated with ^{10}Be flux variations, we propose a dedicated uncertainty propagation aimed at tracking relative **changes through time rather**

than absolute flux values. Rather than **propagating** the full absolute uncertainty of the **snow** accumulation rate, we use the 20 % accumulation rate uncertainty from AICC2023 as a relative uncertainty (0.2) applied only to deviations from the mean accumulation rate (Equation 1).

With this formulation, accumulation rates equal to the mean have no associated uncertainty in terms of variability, although they remain subject to absolute uncertainty. This approach therefore does not represent the total uncertainty of the accumulation rate, but rather a 'variation uncertainty' that reflects how uncertainty in accumulation affects the amplitude of ^{10}Be flux fluctuations. This corrected uncertainty reflects the fact that variability in ^{10}Be flux is primarily driven by changes in accumulation over time rather than by its absolute range of uncertainty. On average, the corrected uncertainty, used when interpreting ^{10}Be flux variations as in Figure 15, is 22 % (min 0.2 %; max 53 %) lower than the raw uncertainty."

[we moved one comment to gather with other comments that refer to a similar point]

Lines 239–241, and 280. If the authors used objective statistical criteria, why did they focus only on low values and not high ones? If the reason is related to concurrent peaks of certain ions, why were low ^{10}Be values unrelated to those peaks excluded from the final rolling average? Please clarify.

We thank the reviewer for this comment and for the opportunity to clarify this point. Although objective statistical criteria were used to identify anomalous values, the analysis focused primarily on low ^{10}Be values because they represent the dominant and recurrent feature affecting the rolling-average signal. Sharp and isolated minima are frequent in the ^{10}Be concentration record and can significantly distort the rolling average, particularly when they are related to post-depositional processes rather than to changes in ^{10}Be production.

In contrast, high ^{10}Be values do not display the same behavior. Apart from a single isolated high value at 1473.2 m, very few maxima satisfy the same statistical criteria applied to minima. Applying an equivalent detection procedure to high values identifies only one additional case to 1473.2 m, at 1521.2 m, which corresponds to a broader, multi-sample Gaussian-shaped feature rather than an isolated outlier. Such smooth maxima are unlikely to result from contamination or depositional artifacts and therefore do not significantly bias the rolling average.

For this reason, the analysis focused on identifying and evaluating the origin of low ^{10}Be values. Low values that were not associated with concurrent peaks in major ion concentrations were excluded from the final rolling average because they are interpreted as non-climatic artifacts that disproportionately affect the smoothed signal. In contrast, maxima were retained, as they represent features for which no clear mechanisms can support to discard them.

Revision:

L240: "**The outlier analysis was intentionally focused on minima, as low ^{10}Be values are far more frequent and have a strong impact on the rolling average than high values.**"

Line 263. Does 52 refer to the number of minima or the number of data points included? In Fig. 3, I see 24 shaded lines that I think represent the minima. So, isn't the number of minima 24? Please specify.

We thank the reviewer for this comment. We realized that we have made a mistake. Only 40 minima are identified in the section 1470 – 1531 m. The 52 minima mentioned in the previous version included other sections that have been removed from the manuscript, in order to mainly focus on the 170-270 ka BP period. Figure 2 correctly shows the section with the 40 minima. We corrected the new section 4.2. dedicated to ^{10}Be minima and the caption of Figure 3.

Revisions:

*"**Figure 3: M**inima in ^{10}Be concentration (black **line**) **identified at the measurement resolution (≈20 cm) are highlighted by shaded areas. Orange shading indicates ^{10}Be minima that are concomitant with macima in major ion concentrations, whereas grey shading indicates minima without concomitant major ion maxima.** The resolutions are the measurement resolution, i.e. ≈20 cm for ^{10}Be. **Because minima are defined at the ^{10}Be sampling resolution, a low-concentration interval extending over 40 cm is counted as two distinct minima. Only the 40 minima identified within the 1470–1531 m depth interval (corresponding to 170–270 ka BP) and retained for the present analysis are shown.** The major ion **(Na^+, Cl^-, MSA, SO_4^{2-}, Ca^{2+}, Mg^{2+}, NO_3^-, and H^+)** concentration profiles are in high resolution (8 cm). Acidity profile (H^+) is calculated from an ionic balance (see section 3.2.2)."*

L263: "4.2. ^{10}Be minima

A total of **40** minima in ^{10}Be concentration were identified across the TALDICE record studied in this work, which appear to coincide with maxima in the concentrations of major ions (Figure 3). This association is statistically significant (permutation test's *p*-value = 0.0001), though no direct quantitative relationship can be established. The major ions involved originate from a variety of sources, including oceanic sea spray (Na^+, Cl^-, Mg^{2+}, MSA, SO_4^{2-}), crustal dust (Ca^{2+}, Mg^{2+}), and volcanic (SO_4^{2-}) sources. In addition to ion concentration peaks, many of the ^{10}Be minima are also associated with decreases in the Cl^-/Na^+ ratio which is typically used to study changes in the relative contributions of marine aerosols or alterations in transport processes (Legrand et al., 2017).

To test whether the identified ^{10}Be concentration minima preferentially occur under particular conditions, we compared their distribution against δD and [Ca^{2+}]. Of the **40** minima identified, **31** occurred during glacial intervals (δD < -300 ‰), which is proportional to the fraction of the record spent in glacial conditions (**77** %). A χ^2 test confirms no significant increase in the number of minima during glacials (p = **1.00**), and δD values at ^{10}Be minima are statistically indistinguishable from non-minima levels (Mann-Whitney U test, p = **0.889**). In contrast, [Ca^{2+}] concentrations are systematically higher at ^{10}Be minima. While median [Ca^{2+}] is only slightly elevated at minima compared to the background (Mann–Whitney U p = **0.53**), contingency tests using thresholds show strong enrichment: for example, **32** % of ^{10}Be minima exceed 15 ppb Ca^{2+} compared to **13** % of the background (**χ^2 = 8.0, p = 0.005**), and **7** ^{10}Be minima exceed 30 ppb compared to only **9** out of **221** non-minima samples (**χ^2 = 8.4, p = 0.005**). This suggests that short-lived ^{10}Be minima preferentially coincide with dust-rich conditions."

Lines 264–265. Please describe the details about the statistical analysis in either the Materials and Methods or the Supplemental Information.

We thank the reviewer for this comment. The statistical tests applied in this section are standard non-parametric methods commonly used to compare distributions and proportions in paleoclimate studies. While the paper is not focused on statistical methodology, we agree that the rationale for using these tests should be made more explicit. We have therefore clarified in the manuscript how each test was applied and what hypothesis it was designed to evaluate. Additional details on the statistical approach are now provided in a new sub-section of the methodology.

Revisions:

L239: "**3.4. Statistical analyses**

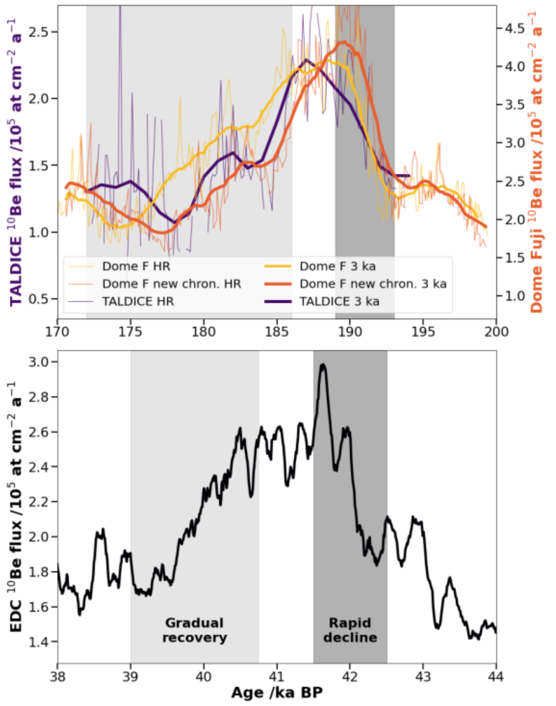
To identify anomalously low ^{10}Be fluxes, which could bias the interpretation of geomagnetic intensity, we applied an objective statistical criterion. **These ^{10}Be minima were identified when the concentration fell below the mean minus one standard deviation, both calculated using a 3 ka rolling window. The outlier analysis was intentionally focused on minima, as low ^{10}Be values are far more frequent and have a strong impact on the rolling average than high values.**

Statistical analyses were designed to test whether ^{10}Be concentration minima are randomly distributed with respect to climatic and geochemical conditions. A permutation test was used to assess whether the observed coincidence between ^{10}Be minima and major ion concentration peaks could arise by chance. Differences between distributions at minima and non-minima were evaluated using the Mann–Whitney U test, a non-parametric test appropriate for non-Gaussian data. Contingency tables and χ^2 tests were used to test for enrichment of ^{10}Be minima above selected thresholds (e.g., Ca^{2+} concentration), allowing us to assess whether minima preferentially occur under dust-rich conditions."

Figs. 4 and 5. In these figures, the ^{10}Be flux profile of the DF ice core appears to have been smoothed using a 5-point rolling average or a similar procedure. I recommend showing the data at its original resolution. In any case, the authors should clearly indicate in the captions and text that the profile is smoothed.

We thank the reviewer for this comment. The Dome Fuji ^{10}Be flux record shown in Figures 4 and 5 is indeed smoothed using a 3 ka rolling average to be consistent with other 3 ka-averaged records, improve readability, and facilitate comparison with other records. We have now explicitly stated the smoothing procedure in the figure captions. We now also show the high-resolution DF ^{10}Be flux in Figure 4.

Revisions:



*"**Figure 4:** **C**omparison of Dome Fuji (**high resolution and 3 ka rolling mean average,** yellow, Horiuchi et al., 2016) and TALDICE (purple, this study) ^{10}Be flux records for IBE. The revised Dome Fuji record is also presented based on chronology revision, which modifies snow accumulation rate (orange, Oyabu et al., 2022). **The dark (resp. light) grey shaded area represents the period of rapid decline (resp. slow recovery) of the GDM. For comparison, the same periods can be identified during the Laschamps excursion in the ^{10}Be flux record from EPICA Dome C ice core (Raisbeck et al., 2017)"***

Lines 333–335. I understand that the extraction protocol is essentially the same for both EDC in Raisbeck et al. (2006) and TALDICE in the present preprint. However, the appearance of ^{10}Be anomalies in the deep parts of the two cores is opposite: increasing spikes in the EDC core and minima in the TALDICE core. The authors argue that the minima may be caused by the incorporation of ^{10}Be into large aggregates that are not released by the extraction protocol. I don't understand how the mechanism keeps only ^{10}Be and releases other major ions for TALDICE only. What is it? I agree with the authors that future studies are needed to clarify this issue. Nevertheless, some trials using a strong leaching method could support the authors' hypothesis and are not difficult to attempt.

We thank the reviewer for raising this very important point that we now clarify. A key point is that the extraction protocols used in Raisbeck et al. (2006) and in the present study are not identical. In particular, Raisbeck et al. (2006) did not use ion-exchange columns, whereas our protocol involves loading the melted ice sample onto a cation-exchange resin prior to Be purification.

Major ions are measured independently on a separate ice stick, thus being not affected by the ion exchange resin step. In contrast, ^{10}Be measurements rely on chemical separation steps that may not quantitatively recover Be incorporated into large mineral aggregates or particle-bound phases. Under deep-ice conditions characterized by large grain sizes and enhanced impurity relocation at grain boundaries, ^{10}Be may become associated with dust or mineral aggregates that are not efficiently released by our extraction protocol, resulting in apparent ^{10}Be minima despite elevated major ion concentrations.

This difference in analytical treatment provides a plausible explanation for why post-depositional perturbations manifest as ^{10}Be maxima in EDC but as minima in TALDICE. We agree with the reviewer that further experimental work is needed to directly test this hypothesis, and such investigations, including stronger leaching protocols and inter-method comparisons, are currently underway.

Revisions:

L310: "These ^{10}Be minima co-occur with sharp maxima in major ion concentrations (e.g., Na^+, Cl^-, Ca^{2+}), yet the ions originate from diverse sources. This rules out scenarios similar to single-source volcanic fallout (Baroni et al., 2011), terrestrial dust input (Baumgartner et al., 1997), or irregular snow redistribution (Poizat et al., 2024) and extreme atmospheric events such as atmospheric rivers (Wille et al., 2021). Instead, the inverse relationship between ^{10}Be and major ions suggests a post-depositional control. Spikes in the concentration of major ions have been observed in the deep section of EDC that had been linked to impurities migration in the ice crystal boundaries (Traversi et al., 2009). **Anomalous ^{10}Be signals were also reported in the deepest parts of the EDC core (>700 ka; >3,100 m) (Raisbeck et al., 2006), documenting ^{10}Be maxima in EDC rather than minima as in TALDICE. This apparent contrast with TALDICE likely reflects differences in analytical protocols. In particular, the EDC study did not involve ion-exchange resin, unlike the present study.** As reported in Kappelt et al. (2025), horizontal migration of Be was proposed to explain these maxima, as "smoothing over several thousands of years does not yield a distribution resembling the expected production signal smoothed by a vertical migration" (Kappelt et al., 2025). **Under deep-ice conditions characterized by large grain sizes and enhanced impurity relocation, ^{10}Be may become incorporated into dust-rich aggregates or mineral phases at grain boundaries. Such particle-bound Be may not be quantitatively recovered by the ion-exchange protocol, leading to apparent ^{10}Be minima despite elevated concentrations of major ions.** However, it is worth noting that some of the EDC ^{10}Be maxima were also concomitant with spikes in other species, including dust (Raisbeck et al., 2006). Similarly, major ion spikes in EDC were associated with low acidity (Raisbeck et al., 2006), which is different from the high acidity observed in TALDICE.

Baumgartner et al. (1997) proposed another mechanism to explain the covariations between ^{10}Be and dust. Indeed, in the deepest and warmest ice of the GRIP core (Greenland), up to 40–50 % of ^{10}Be become dust-bound – higher than the <5 % seen in Holocene ice – due to ice metamorphism. The migration of ^{10}Be and dusts at the ice grain boundaries would result in higher local concentrations and thus favour the adsorption of ^{10}Be onto dust particles. Although such effects are expected to be less pronounced in low-dust Antarctic settings, deeper sections of ice cores, where ice crystals are large, may promote localized enrichment of major ions and ^{10}Be adsorption onto grain-boundary dust, muting the dissolved-phase signal. This mechanism is also in agreement with higher relocations and reactions of dusts in deep TALDICE (Baccolo et al., 2021). The significant connection between ^{10}Be minima occurrence and elevated Ca^{2+} concentrations, particularly above 30 ppb, suggests that extreme, non-atmospheric conditions are the main drivers of these ^{10}Be minima. The absence of a significant relationship with the glacial/interglacial state, as defined by δD, reinforces the idea that these anomalies are not controlled by large-scale atmospheric changes in production or transport, but instead reflect in-ice processes. In this way, **while further experimental work is needed to directly test this hypothesis, including stronger leaching protocols,** ion remobilisation associated with ice grain metamorphism**, leading** to ^{10}Be incorporation into larger mineral aggregates that are not released by our extraction protocol**, provides a plausible mechanism for the observed ^{10}Be minima**."

[comment which has been moved is added here]

Lines 236–238. Correcting the previously published ^{10}Be flux data based on the most recent DF chronology (DF2021) is an excellent attempt. However, this preprint incorrectly uses the DF2 depth for SAR estimation (I verified this by recalculating the updated 10Be flux myself.). Since the DF2021 chronology is associated with the DF1 ice core, the equivalent DF1 depth (see Horiuchi et al.'s (2016) supplementary data file) must be used instead of the DF2 depth. Additionally, it appears that the previous chronology (DFO-2006) is still being used for the age model in this preprint (Figs. 4 and 5). To maintain consistency, I recommend that the authors use the DF2021 chronology for the age model of the corrected ^{10}Be flux of DF. As a result, the r-squared values shown in lines 355–356 (and the relevant discussion?) will change.

Lines 363–365. The ^{10}Be record from the DF ice core over the last millennium (Horiuchi et al., 2008) was normalized using the previous nominal value of the ICN ^{10}Be standard. Additionally, the ^{10}Be flux was calculated using an earlier SAR estimation based on the simple empirical relationship between SAR and d^{18}O in surface snowpacks (Satow et al., 1999) (for more details, see Horiuchi et al., 2008). Then, the average of the last millennium's ^{10}Be flux was updated in Horiuchi et al. (2016) using a revised standard value and the formulation of Parrenin et al. (2007) (i.e. using the same methodology as the published ^{10}Be record for the IBE) (see the Supplementary Material of Horiuchi et al. (2016)). Although it is still just about 1.3 times higher, the updated value of 2.07 ×10^{5} at cm^{-2} a^{-1} should be compared to the EDC value.

Lines 368–370. As mentioned above, the DF ^{10}Be flux is not twice as high as the EDC ones, but rather, just 1.3 times higher for the last millennium. Therefore, the difference of two times between the DF and TALDICE is not persistent, but has been observed (so far) only during the IBE. Although this seems enigmatic, I agree with the authors that data from other cores is necessary to resolve this issue.

We thank the reviewer for this detailed and very helpful comment. We acknowledge that, in the previous version of the manuscript, the description of the Dome Fuji ^{10}Be flux recalculation was not sufficiently clear and may have led to confusion. We confirm that the revised flux has now been recalculated using the DF1 depth scale consistently associated with the DF2021 chronology (Oyabu et al., 2022). The resulting flux have been corrected accordingly.

We also revised Figures 4 and 5 using the recalculated Dome Fuji flux based on the DF2021 age model. The revised comparison yields an improved agreement between TALDICE and Dome Fuji when using the DF2021 chronology (R^2 = 0.44) compared to the older DFO-2006 chronology (R^2 = 0.37). The relevant text has been updated accordingly.

Regarding the comparison with last-millennium values, we have substantially modified this discussion. We note that a recent independent compilation combining measurements and atmospheric modelling (Jouzel et al., 2026) confirms that Dome Fuji exhibits systematically higher ^{10}Be fluxes than EPICA Dome C (by 67 %) over the last millennium, supporting the conclusion that the Dome Fuji enhancement is not an artefact of accumulation or standardisation choices. We therefore clarify that the larger Dome Fuji / TALDICE contrast observed during the IBE is specific to that interval, but occurs within a broader context of persistent inter-site differences across East Antarctica. We also now discuss this difference in relationship with climate variations during MIS7, and show that this difference does not differ between glacial and inter-glacial conditions.

Finally, we emphasize that this systematic offset does not affect the interpretation of geomagnetic dipole moment variations, which relies exclusively on relative changes in ^{10}Be flux within each archive.

Revisions:

L 349: "For the period 170–270 ka BP, the mean 3 ka rolling ^{10}Be flux in TALDICE**, including the background and the geomagnetic events,** is 1.44 × 10^{5} at cm^{-2} a^{-1}, which slightly increases to 1.56 × 10^{5} at cm^{-2} a^{-1} when the identified ^{10}Be minima are excluded. For the overlapping period 170–190 ka BP, the TALDICE ^{10}Be flux relative variations are in good agreement with the Dome Fuji **(DF)** record

(Horiuchi et al., 2016) (Figure 4). This coherence not only highlights the homogeneous ^{10}Be deposition over East Antarctica, but also indicates that accumulation changes are well captured in both age models**,** AICC2023 for TALDICE (Bouchet et al., 2023) and the Dome Fuji DFO-2006 chronology (Kawamura et al., 2007). This agreement is further improved when the recent Dome Fuji chronology from Oyabu et al. (2022) is applied (R^2 = 0.**44**, with DF values calculated on TALDICE timestep), compared to the older DFO-2006 chronology (R^2 = 0.**37**). The consistent temporal evolution of ^{10}Be fluxes across these independent ice cores supports the reliability of these datasets for investigating variations in the GDM.

Despite this coherence in temporal evolution, Dome Fuji exhibits systematically higher absolute ^{10}Be fluxes than TALDICE (about 70 % more, Figure 4). While the mean ^{10}Be flux in TALDICE is 1.56 × 10^5 at cm^{-2} a^{-1} **over 170–190 ka BP** (accounting for the minima), the DF ice core shows significantly higher values, reaching 2.**74** × 10^5 at cm^{-2} a^{-1} (Horiuchi et al., 2016), or 2.**68** × 10^5 at cm^{-2} a^{-1} when recalculated with the revised Dome Fuji chronology (Oyabu et al., 2022). The TALDICE values, however, are consistent with those from other Antarctic sites, such as EDC, which reports mean fluxes of approximately 1.44 × 10^5 at cm^{-2} a^{-1} for the period 200–300 ka BP (Cauquoin, 2013).

This pattern persists over the last millennium, **b**etween **918 and 1893** CE, the mean ^{10}Be flux was **1.64** × 10^5 at cm^{-2} a^{-1} at Dome C **(Jouzel et al., 2026)**, and approximately twice as high at Dome Fuji (3.08 × 10^5 at cm^{-2} a^{-1}, Horiuchi et al., 2008). Although no ^{10}Be measurements are available for the last millennium at Talos Dome, comparison of recent century data shows similar mean fluxes between Talos Dome (1.49 × 10^5 at cm^{-2} a^{-1}**,** Supplementary Table 1) and Dome C (1.**69** × 10^5 at cm^{-2} a^{-1}, **Jouzel et al., 2026**). **Independent evidence from the last millennium further indicates that Dome Fuji generally exhibits higher ^{10}Be fluxes than other East Antarctic sites. A recent multi-site compilation and modelling study (Jouzel et al., 2026) reports that measured ^{10}Be fluxes at Dome Fuji exceed those at EPICA Dome C by c. 70 %, consistent with earlier observations.** These lower fluxes relative to the last millennium **may be the result of** the occurrence of solar minima during this interval **corresponding to enhanced ^{10}Be production (Wolf, 1280 – 1350 CE; Spörer, 1420 – 1570 CE; Maunder 1645 – 1715 CE; Dalton 1790 – 1830 CE, Bard et al., 2000; Berggren et al., 2009; Horiuchi et al., 2008). These results suggest that persistent differences in ^{10}Be flux over Antarctica likely reflect regional deposition or atmospheric processes rather than artefacts of accumulation estimates or chronological treatment.**

Jouzel et al. (2026) further suggest that this persistent contrast reflects regional atmospheric and depositional processes specific to the high-elevation interior of East Antarctica, including a transition from predominantly wet deposition north of 75°S to dry-dominated deposition south of this boundary, as well as enhanced stratosphere-troposphere exchanges over the highest Antarctic domes. While current global aerosol-climate models remain limited in their ability to resolve such sharp spatial gradients over Antarctica (Golubenko et al., 2024; Zheng et al., 2024; Jouzel et al., 2026)**, these mechanisms provide a physically grounded explanation for the systematically elevated ^{10}Be fluxes observed at Dome Fuji.**

Importantly, we find no significant relationship between the Dome Fuji / TALDICE ^{10}Be flux ratio and δD (Spearman test, p = 0.46), indicating that differences in ^{10}Be flux over Antarctica is not modulated by glacial-interglacial climate variability. This result implies that the atmospheric and depositional mechanisms responsible for the DF/TALDICE ratio either remain stable through time or compensate one another across climate states. Consequently, while absolute ^{10}Be fluxes may differ between Antarctic sites, their relative temporal variations primarily reflect changes in cosmogenic production. This reinforces the use of Antarctic ice cores as robust records of global ^{10}Be production (modulo hemispheric polar bias; Adolphi et al., 2023) and supports their application to reconstruct variations in the geomagnetic dipole moment."

Lines 383–393. Horiuchi et al. (2016) clearly described the twofold enhancement of ^{10}Be production for IBE by comparing the high-resolution ^{10}Be flux record from DF with the updated ^{10}Be flux for the past millennium (see above). This earlier work should be referenced appropriately here.

We are sorry for not having been complete. As mentioned earlier in response to the major comment, we now appropriately refer to Horiuchi et al., 2016.

Revisions:

L384: "Based on the TALDICE ^{10}Be flux data, a flux enhancement factor of 1.59 to 2.08 is observed, depending on the reference background (see section 4. Results)**, similar to the twofold enhancement reported in Dome F (Horiuchi et al., 2016). In comparison, we calculate an enhancement ratio between 1.90 with the ^{10}Be flux calculated with the revised age of Dome Fuji, assuming a background calculated between 170 and 180 ka BP and a low-GDM plateau between 185.5 and 191 ka BP**"

Lines 406–417. Horiuchi et al. (2016) clearly pointed out both the asymmetric pattern and its opposite sense to reversals based on the DF record and twin, unprecedented, high-resolution ^{10}Be ocean records from the western equatorial Pacific (This preprint makes no mention of the ocean records, for reasons that are not clear). While it is notable that the authors provide a more comprehensive discussion, they should properly reference the earlier work here.

We are sorry for not having been complete. As mentioned earlier in response to the major comment, we now appropriately refer to Horiuchi et al., 2016.

Revisions:

L406: "The structure of the ^{10}Be flux anomaly during IBE is also noteworthy. **An asymmetric pattern, characterized by a rapid increase in ^{10}Be flux associated with dipole collapse followed by a slow and three-step dipole moment recovery was already identified in the Dome Fuji ice core record by Horiuchi et al., (2016) (Figure 4). Similar asymmetric dynamics have also been reported for the Laschamps excursion in ^{10}Be records from both ice cores (Muscheler et al., 2005; Raisbeck et al., 2017, Figure 4) and sediment cores (Ménabréaz et al., 2012; Simon et al., 2016, 2020).** Interestingly, this asymmetric pattern **is opposite, in a temporal sense, to that observed** for polarity reversals (e.g., Valet and Meynadier, 1993; Valet et al., 2005): **reversals are characterized by** a slow decrease of the dipole moment in the initial polarity followed by an abrupt recovery of the dipole moment in the new opposite polarity. After long and intensive debates (Kok and Tauxe, 1996; Mazaud, 1996; Meynadier et al., 1998; Meynadier and Valet, 1996), the hypothesis was recently tested on authigenic $^{10}Be/^{9}Be$ records reconstructed from sediment cores (Simon et al., 2018; Valet et al., 2024, 2025) which suggested that the asymmetric patterns were not convincingly reproduced for any of the reversals of the last 4 Ma. However, the consistent asymmetry of the dipole moment collapse and recovery observed for Iceland Basin and Laschamps excursions might reveal a fundamental difference between the dynamics of excursions and reversals, and should be carefully considered in future geodynamo modeling efforts."

L480: "The comparison between atmospheric ^{10}Be fluxes from ice cores and authigenic $^{10}Be/^{9}Be$ ratios from marine sediments reveals overall agreement (Figure S4.A), supporting the reliability of both archives in recording geomagnetic events. Previous studies have highlighted the close correspondence between atmospheric and authigenic ^{10}Be records (e.g., Czymzik et al., 2020; **Horiuchi et al., 2016**). For IBE, high-resolution alignment is observed between ice cores (TALDICE and Dome Fuji, see section 5.3.1) and marine sediment cores (Figure 5). In particular, MD05-**2920 (Simon et al., 2016) and KR0515-PC2 (Horiuchi et al., 2016)** captures the same three ^{10}Be peaks at 174, 182, and 187 ka BP. PFE is also identified in both MD05-2920 and MD05-2930, while ME is not detected in MD05-2930, likely due to the core's lower temporal resolution (ca. 4 ka around 240 ka BP), which may not resolve the short 2–3 ka duration of the event."

Lines 418–426. The ≈7-kyr plateau of the IBE cosmogenic anomaly is also an important finding by Horiuchi et al. (2016), follows Knudsen et al.'s (2007) suggestion based on their low-resolution data. Both of these earlier works should be properly cited in this paragraph, along with their original age estimations.

We are sorry for not having been complete. As mentioned earlier in response to the major comment, we now appropriately refer to Horiuchi et al., 2016.

Revisions:

L510: "**During IBE, the TALDICE ^{10}Be flux record closely follows variations in oceanic authigenic ^{10}Be/^{9}Be from a global compilation (Frank et al., 1997) (Figure 5). In particular, the timing, duration, and stepped structure of the collapse and subsequent recovery of the GDM are consistent between the ice cores and marine records (Figure 5). For instance, the ≈7 ka plateau of elevated ^{10}Be flux observed in TALDICE has also been observed in Dome F ice core (Horiuchi et al., 2016) and is in agreement with oceanic records (Knudsen et al., 2008). Besides, the good overall agreement between the TALDICE and Dome F records with global geomagnetic field model of the IBE (Lanci et al., 2008) further supports the global record of Antarctic ice cores.**

Lines 427–430. When discussing fine-scale features, the high-resolution ^{10}Be ocean records published by Horiuchi et al. (2016) should not be overlooked, as they remain the highest-resolution ^{10}Be records from marine sediments for the IBE interval.

We are sorry for not having been complete. As mentioned earlier in response to the major comment, we now appropriately refer to Horiuchi et al., 2016.

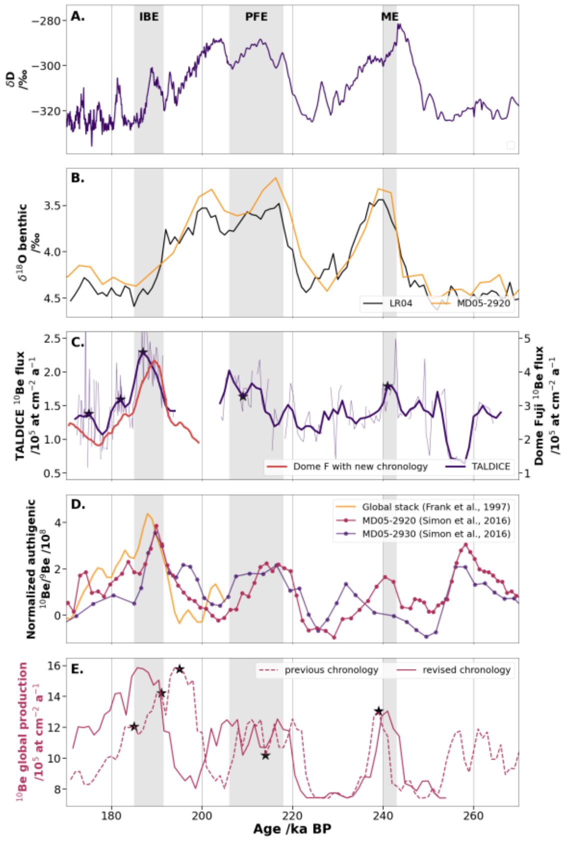
Revisions:

L480: "The comparison between atmospheric ^{10}Be fluxes from ice cores and authigenic ^{10}Be/^{9}Be ratios from marine sediments reveals overall agreement (Figure S4.A), supporting the reliability of both archives in recording geomagnetic events. Previous studies have highlighted the close correspondence between atmospheric and authigenic ^{10}Be records (e.g., Czymzik et al., 2020; **Horiuchi et al., 2016**). For IBE, high-resolution alignment is observed between ice cores (TALDICE and Dome Fuji, see section 5.3.1) and marine sediment cores (Figure 5). In particular, MD05-**2920 (Simon et al., 2016) and KR0515-PC2 (Horiuchi et al., 2016)** captures the same three ^{10}Be peaks at 174, 182, and 187 ka BP. PFE is also identified in both MD05-2920 and MD05-2930, while ME is not detected in MD05-2930, likely due to the core's lower temporal resolution (ca. 4 ka around 240 ka BP), which may not resolve the short 2–3 ka duration of the event."

Fig. 5. In the above discussion, what's important is not the value itself, but rather the variations in each index. Therefore, MD05-2930 should have a y-axis value of around 5 to 6 ×10^8 at the top, meaning a different y-axis should be used for MD05-2920 and MD05-2930. Otherwise, readers will not be able to effectively compare the ^{10}Be profiles. I also recommend adding data points using symbols for lower-resolution data, such as MD05-2920 and MD05-2930, to clarify the time resolution issue mentioned by the authors on lines 485–486.

We thank the reviewer. We have now normalized the data and add the data points on MD05-2920 and MD05-2930 to better see the differences in resolution.

Revisions:



Line 430 (and Fig. 5) . The criteria for adding the black star in Figure 5 are unclear. A more detailed explanation is necessary to convince audiences of the validity of the tie-point selection.

We agree that the criteria for selecting tie points should be clearly stated. We have revised the text to explicitly describe the criteria used for adding black stars in Figure 5, and we now emphasize that the feature around ca. 210 ka BP is tentative and associated with higher uncertainty, consistent with the comment of Reviewer 1.

Revisions:

L427: "Furthermore, fine-scale features in the IBE record, such as a short-lived recovery at 182 ka BP following a minimum at 183 ka BP, and a subsequent flux minimum around 178 ka BP with recovery by 174 ka BP, are visible in both TALDICE and DF cores as well as in oceanic cores (Figure 4). These well-resolved features are also mirrored in ocean sediment records (Black stars in Figure 5) and could serve as valuable tie points for synchronizing paleoclimate archives across different media. **In contrast, the feature tentatively identified around c. 210 ka BP is less well constrained and should be regarded as having a higher uncertainty in its assignment.**

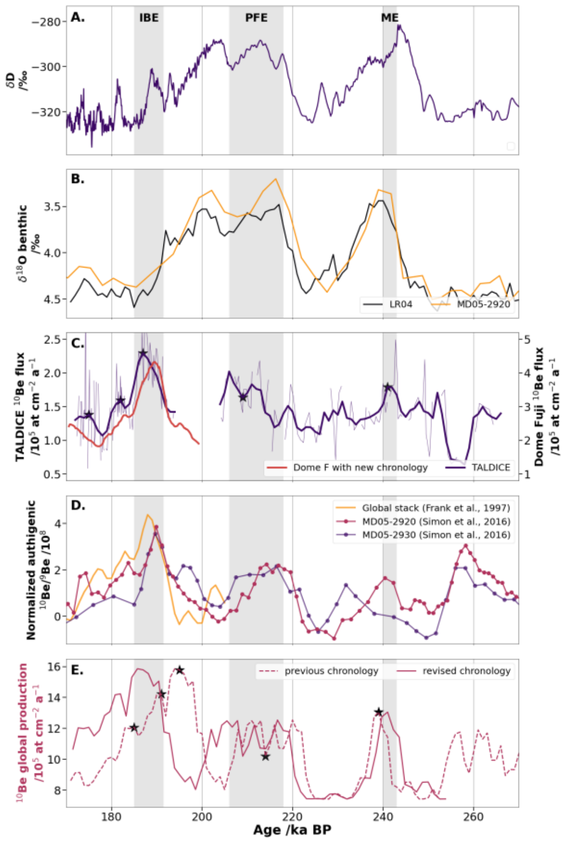


Figure 5**: Comparison of ^{10}Be and climate records from ice cores and marine sediments over 170–270 ka BP with: **A.** TALDICE δD (/‰), **B.** benthic δ^{18}O (/‰) from LR04 stack (Lisiecki and Raymo, 2005) and MD05-2920 (Tachikawa et al., 2014), **C.** TALDICE and Dome Fuji ^{10}Be (in purple and red respectively, /at cm^{-2} a^{-1}), **D.** authigenic ^{10}Be/^{9}Be from **global stack reconstruction (yellow, Frank et al., 1997), MD05-2920 (red), and MD05-2932 (purple) (Simon et al., 2016),** and **E.** the ^{10}Be global production (/at cm^{-2} a^{-1}; Poluianov et al., 2016) calculated from RPI-based VADM (Channell et al., 2009). Grey bars highlight the main geomagnetic excursions discussed in the text (IBE, PFE, ME). Timing of identifiable geomagnetic features (black stars in TALDICE and RPI-based VADM) is used to obtain a revised chronology of RPI-based VADM used for calculating the ^{10}Be production**, noting though a lower confidence on the star around 210 ka BP.”

Lines 481–484. This type of study has already been conducted by Horiuchi et al. (2016) for IBE. At the very least, this earlier work should be referenced here. Furthermore, their ocean records should also be compared with the ice core records.

We are sorry for not having been complete. As mentioned earlier in response to the major comment, we now appropriately refer to Horiuchi et al., 2016.

Revision:

L480: “The comparison between atmospheric ^{10}Be fluxes from ice cores and authigenic ^{10}Be/^{9}Be ratios from marine sediments reveals overall agreement (Figure S4.A), supporting the reliability of both archives in recording geomagnetic events. Previous studies have highlighted the close correspondence between atmospheric and authigenic ^{10}Be records (e.g., Czymzik et al., 2020; **Horiuchi et al., 2016**). For IBE, high-resolution alignment is observed between ice cores (TALDICE and Dome Fuji, see section 5.3.1) and marine sediment cores (Figure 5). In particular, MD05-**2920 (Simon et al., 2016) and KR0515-PC2 (Horiuchi et al., 2016)** captures the same three ^{10}Be peaks at 174, 182, and 187 ka BP. PFE is also identified in both MD05-2920 and MD05-2930, while ME is not detected in MD05-2930, likely due to the core's lower temporal resolution (ca. 4 ka around 240 ka BP), which may not resolve the short 2–3 ka duration of the event."

Lines 485–486. What is the authors' opinion on the clear maximum observed around 232 ka in the MD05-2930 record? Please clarify.

We thank the reviewer for drawing attention to the specific pattern around ca. 232 ka BP in the MD05-2930 record. We agree that this feature is noticeable. However, it is not observed consistently in other marine records nor in the ice core ^{10}Be fluxes, which prevents a robust attribution at this stage.

Several explanations should be considered, including uncertainties in the marine age model, which could potentially shift this feature toward the age of the Mamaku Excursion, although such a reinterpretation would affect the δ^{18}O-based alignment to the LR04 stack. Alternatively, this maximum may reflect local depositional or sedimentary processes, transient perturbations of the authigenic ^{10}Be signal, or changes in sediment circulation or scavenging efficiency.

Given the absence of corroborating evidence from independent archives, we consider this feature as tentative and do not interpret it further. Additional high-resolution marine records would be required to assess its origin and potential geomagnetic significance.

Revision:

L449: **"Around 232 ka BP, a maximum in authigenic ^{10}Be/^{9}Be in MD05-2930 is observed. However, as this feature is not clearly reproduced in other marine records or in TALDICE ^{10}Be flux, we do not assign a geomagnetic origin to this signal."**

Lines 487–490. Horiuchi et al. (2016) found apparent lags of 3 and 4.5 kyr in the ^{10}Be record of an ice core (DF) compared to two ^{10}Be records from western Pacific sediment cores (KR0515-PC4 and KR0515-PC2) during the IBE period (170–200 ka). They attributed this discrepancy primarily to the uncertainty of the age model for marine sediments. This should be referenced as an earlier study here. Interestingly, an independent examination of this preprint, which used the TALDICE ice core and the MD05-2930 core, yielded a similar result: a lag of 3 kyr. This implies a systematic difference between ice and sediment chronologies (the latter of which essentially relies on marine isotope chronostratigraphy) for this period.

We thank the reviewer for this comment. As answered earlier, we agree that Horiuchi et al. (2016) reported a multi-ka offset between ice core and marine records during the IBE. However, in that study the offset was primarily interpreted in terms of magnetic lock-in depth affecting sedimentary paleomagnetic records, rather than as a consequence of marine age-model uncertainty. We have revised the manuscript to clarify this distinction and to explicitly state how our ice core to marine ^{10}Be comparison, which is not affected by magnetization processes, provides complementary constraints on the origin of the observed offset.

L487: "A systematic time offset between the oceanic and the ice core records is observed (Figures 5, S4.A). **A similar 3 to 4.5 ka offset between oceanic and Dome F ice core records was previously reported by Horiuchi et al., (2016), and interpreted it primarily in terms of magnetic lock-in depth associated with post-depositional remanent magnetization acquisition in marine sediments. Our results confirm the existence of a comparable offset using independent marine and ice core datasets, but extend the comparison to ice core ^{10}Be fluxes, which are not affected by magnetization processes.** When comparing authigenic ^{10}Be/^{9}Be from core MD05-2920 to the TALDICE ^{10}Be flux, the best correlation is obtained when the oceanic record is shifted 3 ka younger (R^2 = 0.37, Figure S4), which remains within the uncertainties of the marine core age model (Tachikawa et al., 2014). **Unlike comparisons involving RPI, a phase shift between ice core and oceanic ^{10}Be records cannot be attributed to magnetic lock-in effects. Potential physical causes would instead involve atmospheric or oceanic transport and mixing processes.** Nevertheless, does this 3 ka offset result from age model uncertainties or reflect a physical lag in the system, thereby limiting the possibility to use paleomagnetic events as chronostratigraphic horizons?"

The following are suggestions for technical corrections:

Line 49. Replace "concomittent" with "concomitant."

Sorry for this mistake we corrected accordingly.

Lines 140–141. Shouldn't it be 210 and 220 ka BP instead of 200 and 215 ka BP? Around 205 ka, there is a local maximum (minimum) of PRI (^{10}Be) in PISO (MD05-2920/2930).

Sorry for this mistake we corrected accordingly.

Line 192. Add $\times 10^4$ to the mean concentration value.

Sorry for this mistake we corrected accordingly.

Line 195. What is "the latter"? Please clarify.

We clarified that we were referring to the discrete samples.

Line 271. I see no data below 1570 m in this preprint. Is it 1520 m instead?

As mentioned in one previous comment, we made a mistake. The previous version included other sections that have been removed from the manuscript, in order to mainly focus on the 170-270 ka BP period.