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Dear Editor Gabriele Messori,

We are pleased to resubmit the further revised version of our manuscript entitled "Climate-related signals in the GV7-C ice core from East Antarctica for 1782–2013 CE: Potential relevance to climate and teleconnections between the tropics and Antarctica" for consideration in *Earth System Dynamics*.

We sincerely appreciate the careful and constructive comments provided. In preparing this revision, we undertook a reassessment of the manuscript and devoted effort to addressing the remaining concerns. In particular, we have strengthened the physical and climatological interpretation of our results, clarified the datasets and analytical methods, added further analyses and discussion where appropriate, corrected inaccuracies, and revised statements that were not sufficiently supported by the available evidence. We carefully considered each comment and have documented corresponding changes in the detailed point-by-point response and the marked-up manuscript.

We believe that this revision has substantially improved the scientific robustness, clarity, and overall contribution of the manuscript. We hope that the revised version is now suitable for publication in *Earth System Dynamics*.

Report #1 Anonymous referee #3

Reply to the comments by Referee #3

Comment 1	The manuscript presents annual records spanning 1782–2013 CE of water isotopes ($\delta^{18}O$ and d-excess) and snow accumulation from the GV7-C ice core obtained from a coastal East Antarctic site. The authors compare these records with large-scale climate indices and reanalysis datasets (ERA5, Niño 3.4, SOI, SAM, IOD, and SST-SEIO) to investigate possible climatic connections. The Authors argue that the GV7-C record represents regional climate variability and provides evidence for potential teleconnections between coastal East Antarctic climate and tropical ocean variability. However, the strength of these interpretations requires careful evaluation considering the representativeness of the GV7-C core, the spatial limitations of the comparisons, and the influence of local atmospheric and geographic factors

Response 1	Thank you for all comments and suggestions. We have carefully revised the manuscript and believe that these revisions have substantially improved the manuscript. Please see the detailed responses provided below and the marked-up manuscript file.
Comment 2	The study compares the GV7-C ice core mainly with distant East Antarctic ice cores (such as Mount Brown South, RICE, and Victoria Glacier Lower) rather than with nearby ice cores (GV7 trench, GV7, GV7-B, GV5, Talos Dome) that could better evaluate whether the snow accumulation record is representative at local and regional scales (see Stenni et al., 2001; Frezzotti et al., 2007; Caiazzo et al. 2017, Nardini et al. 2021).
Response 2	Thank you for the pointful comment. We have edited/added results from previous studies (nearby ice cores) as supporting evidence, particularly for explaining variations in snow accumulation and air-mass sources. The edited parts are shown below. **Lines 200-202, Section 3.1** *"The mean SA in the GV7-C ice core was comparable to previously reported records nearby (205–252 mm w.e. yr^{-1}) (Frezzotti et al., 2007; Caiazzo et al., 2017; Khan, 2019; Nardin et al., 2019) and in other coastal regions across East Antarctica (Table 3)."* **Lines 394-401, Section 3.4** *"The variations in SA data from the GV7-C ice core showed significant interannual variations, and show only a weak correlation with IOD (for the period 1957–2013) (Table 4). The Indian Ocean and western Pacific Ocean were identified as the moisture source regions, together contributing approximately 95% of snowfall at GV7 site, with the western Pacific accounting for 65% (147 mm) of total snowfall (Caiazzo et al., 2017). This likely indicate the presence of influence of Indian Ocean variability on snow accumulation at the GV7-C site. It was also reported that snowfall from the western Pacific Ocean sector was associated with a few intense snowfall events (Caiazzo et al., 2017). It is expectable that the variability in SA of the GV7-C ice core is assumed to be affected by the coupled influence of large-scale atmospheric circulation, moisture-transport pathways and transport efficiency, as well as short-lived synoptic-scale events such as intense precipitation associated with atmospheric rivers (Thomas et al., 2008; Cohen et al., 2012; Turner et al., 2019; Udy et al., 2021; Wille et al., 2021).*
Comment 3	Although the study recognises issues such as wind-driven snow redistribution and stratigraphic noise, the analysis uses annual value and statistical methods without adequately addressing these limitations. The analysis are presented at 5 years average (fig. 2) or analysed the spatial correlation analyses between annual GV7-C records and annual/seasonal ERA5 reanalysis fields. The PCA results conducted on annual mean values were selected and presented in this study. The Authors claim evidence for connections between low-latitude ocean variability and coastal East Antarctic climate, but the critique argues that these conclusions rely mainly on statistical correlations and lack a sufficient geographical and environmental interpretation, including consideration of Antarctic geography, atmospheric circulation patterns, air-mass sources

	responsible for snowfall at the GV7 site. The use of large-scale climate indices and hemispheric-scale sea surface temperature correlations is criticized because they are not sufficiently constrained by location or regional climate processes. The Authors are quoted of citing previous studies from the region without properly incorporating their findings. The critique argues that earlier research already established: the limited contribution of snowfall from the Antarctic Plateau to the site, relationships between isotope variations, temperature, and elevation along the GV7 ice divide. The GV7-C study overinterprets statistical relationships and does not adequately consider local Antarctic geography, atmospheric processes, previous regional research, or nearby ice-core evidence needed to validate its conclusions.
Response 3	We thank the reviewer for these important and constructive comments. We have carefully reconsidered the methodological, geographical, and climatological limitations and have revised the relevant parts of Sections 2.1, 2.3, 3.2, 3.3, and 3.4. We have clarified the datasets and analytical procedures, expanded the seasonal analyses, provided a more complete account of the variables and seasons examined, strengthened the regional and moisture-source context using previous studies, and revised interpretations. We have also adopted more cautious language where the observed relationships are weak or mechanistically uncertain and have explicitly acknowledged the limitations. We believe that these revisions have improved the methodological transparency, physical interpretation, and robustness of the manuscript. The corresponding changes are detailed below. **Lines 69-74, Section 2.1.** *"Snow accumulation ranges from 205 to 252 w.e yr^{-1} (>200 w.e yr^{-1}) (Frezzotti et al., 2007; Magand et al., 2004; Nardin et al., 2021), which is relatively high compared with that at other inland Antarctic sites (e.g., Ekaykin et al., 2004; Stenni et al., 2002) and some coastal sites (Stenni et al., 1999; Nyamgerel et al., 2020), and is expected to provide better preservation of the seasonal signals and facilitate annual-layer identification (Frezzotti et al., 2007). Moreover, post-depositional effects are expected to be limited due to the low intensity of katabatic winds along the ice divide (Frezzotti et al., 2007; Magand et al., 2004).* **Lines 123-168, Section 2.3.** *"For the 1957–2013 CE period, the following climate indices, expressed as annual means (January–December) were compared with the annual means of the GV7-C ice core records: station-based SAM index (Marshall, 2003; Marshall G and National Center for Atmospheric Research Staff, 2018), the Southern Oscillation Index (SOI) obtained from the National Centers for Environmental Information (NCEI) (available at https://www.ncei.noaa.gov/access/monitoring/enso/soi), Niño3.4 index (5°S–5°N and 170°–120°W) (Rayner et al., 2003; available at https://psl.noaa.gov/gcoswgsp/Timeseries/Nino34), Indian Ocean Dipole (IOD) index is the Dipole Mode Index, representing the SST gradient between the western (50°E–70°E and 10°S–10°N) and southeastern equatorial IO (90°E–110°E and 10°S–0°N) (available at https://psl.noaa.gov/gcos_wgsp/Timeseries/DMI), SST anomaly in the southeastern IO (SST-SEIO) (90°E–110°E and 10°S–0°N) (available at https://psl.noaa.gov/gcos_wgsp/Timeseries/Data/dmieast.had.long.data), and*

reconstructed sea ice extent (SIE) over the Ross–Amundsen Sea sector (SIE-RA) (162°E–250°E) and the East Antarctic sector (SIE-EA) (71°E–162°E) (Fogt et al., 2023). Moreover, for the 1957–2013 CE period, spatial correlation analyses (at 95% confidence interval) were conducted between annual GV7-C records and gridded ERA5 reanalysis data produced by the European Centre for Medium-Range Weather Forecasts (ECMWF) (air temperature, SST, sea ice concentration [SIC], 10-m wind speed, zonal [u] and meridional [v] wind components, and total precipitable water) using Climate Reanalyzer developed by the University of Maine, USA (https://climatereanalyzer.org/). ERA5 shows better performance than its predecessor, ERA-Interim, owing to its higher spatial and temporal resolution, improved model physics and core dynamics, and data assimilation (Hersbach et al., 2020), and overall good performance can be found compared with other reanalysis products (Caton Harrison et al., 2022; Marshall et al., 2022). ERA5 effectively represents temperature variability over Antarctica, particularly for annual and seasonal mean temperatures and at higher-elevation sites (>1000 m a.s.l), although some biases and regional differences have been reported (Tetzner et al., 2019; Zhu et al., 2017). We acknowledge that ERA5 has been widely used for the satellite era (from 1979 onward), when observational coverage was better than during the pre-satellite period, particularly over Antarctica and the Southern Ocean (Hersbach et al., 2020), and has been used in Antarctic ice-core studies (Kim et al., 2025; Leroy-Dos Santos et al., 2023; Thomas et al., 2024). There are also studies based on ERA5 on the pre-satellite period (1950–1979), showing good performance (Marshall et al., 2022; Xie et al., 2023). In this study, we used ERA5 reanalysis data for the period 1957–2013 CE in the spatial correlation analyses. Since ice-core signals reflect a broad range of thermodynamic and dynamic influences, this spatial correlation analyses were conducted for physically plausible scenarios to help identify potential moisture supply regions over a longer time period (1957–2013 CE) than previous studies (Caiazzo et al., 2017; Khan, 2019). As it mentioned before, 1957–2013 CE period was selected based on data availability (e.g., SAM indices) and to provide a relatively longer temporal coverage than previous studies. Spatially coherent and physically interpretable patterns are selectively presented and used as supportive evidence in the interpretation of climate-related signals from the GV7-C ice core. Principal component analysis (PCA), a linear dimensionality reduction technique, was employed to investigate potential similarities in variability between the annual means of the ice-core records and seasonal and annual means of climate datasets (IOD, SST-SEIO, SAM, SOI, Niño3.4, SIE-EA, SIE-RA) for 1957–2013 CE. The PCA results conducted on annual mean values were selected and presented in this study.

For the 1872–2013 CE period, the GV7-C ice core data were compared with the climate indices, expressed as annual means (January–December), including the Indian Ocean Dipole (IOD) index is the Dipole Mode Index, representing the SST gradient between the western (50°E–70°E and 10°S–10°N) and southeastern equatorial IO (90°E–110°E and 10°S–0°N) (available at https://psl.noaa.gov/gcos_wgsp/Timeseries/DMI), SST anomaly in the southeastern IO (SST-SEIO) (90°E–110°E and 10°S–0°N) (available at https://psl.noaa.gov/gcos_wgsp/Timeseries/Data/dmieast.had.long.data), reconstructed SST anomaly over the Southern Hemisphere (SST-SH) (available at https://www.ncei.noaa.gov/access/monitoring/climate-at-a-glance/global/time-series) (Huang et al., 2017), reconstructed SAM index from the NOAA-CIRES-DOE Twentieth Century Reanalysis (20CR)

(https://psl.noaa.gov/data/20thC_Rean/timeseries/monthly/SAM), and Niño3.4 index (5°S–5°N and 170°–120°W) (Rayner et al., 2003; available at https://psl.noaa.gov/gcoswgsp/Timeseries/Nino34). SAM and ENSO are considered key modes potentially affecting Antarctic climate variability (Turner et al., 2009; Cohen et al., 2012; Pohl et al., 2021; Wille et al., 2021), and the SOI and Niño3.4 indices describe Pacific variability that can influence the climate of the Southern Ocean and Antarctica (Meyerson et al., 2002; Bertler et al., 2004).”

Line 215, Figure 2.

For Figure 2, we have changed/applied to “3-year smoothing”. The purpose of smoothing here in Figure 2 was primarily for visualization, so either 3 or 5-year smoothing can be shown. We have changed to 3-year smoothing for a consistency with the other sections of the manuscript.

Lines 224-231, Section 3.2.

“Because ice-core signals reflect a broad range of influencing factors, the analyses were conducted at both annual and seasonal timescales and at different pressure levels, considering several physically plausible variables, including air temperature, sea surface temperature, sea ice concentration, wind speed, zonal and meridional wind components, and total precipitable water. These analyses were primarily intended to highlight potential relationships and provide supporting evidence for potential moisture source regions based on the spatial coherence of different climate variables over the longer 1957–2013 CE period. Significant ($|r| > 0.3$ at 95% confidence interval) and physically interpretable patterns were selected and are presented in the Supplement (Figs. S1–S3) as supporting evidence for the interpretation of potential climate-related signals in the GV7-C ice core.”

Lines 290-300, Section 3.3.1.

“Considering the seasonality of Niño3.4 and the IOD, their relationships with the GV7-C ice core records were also examined at the seasonal scale (not shown). Niño3.4 showed positive correlations only with $\delta^{18}O$ in all seasons ($r = 0.33–0.43$, $p < 0.01$, $n = 55$), with the strongest correlation occurring in MAM, for the three-year averaged time series. In contrast, the IOD showed negative correlations with d-excess during JJA ($r = −0.53$, $p < 0.001$, $n = 55$) and MAM ($r = −0.51$, $p < 0.001$, $n = 55$), for the three-year averaged time series. Moreover, the IOD showed weak positive correlations with SA in MAM ($r = 0.31$, $p < 0.05$, $n = 55$) for the annually averaged time series, and in JJA ($r = 0.36$, $p < 0.05$, $n = 55$) and SON ($r = 0.36$, $p < 0.05$, $n = 55$) for the three-year averaged time series. These seasonal relationships are gently consistent with the results of the spatial correlation analysis (Section 3.2). Although this study is primarily based on annual climate indices, further investigation using seasonally resolved climate indices and event-based analyses would be valuable for better understanding the seasonal mechanisms linking climate indices to the GV7-C ice core records.”

Lines 304-315, Section 3.3.1.

“This reflected the importance of both thermodynamic and dynamic effects on the decrease (increase) in $\delta^{18}O$ with an increase (decrease) in the SIE, stronger (weaker) westerly winds associated with positive (negative) SAM conditions,

lower (higher) SOI values and lower (higher) SST anomalies in the Niño3.4 region, corresponding to El Niño (La Niña)-like conditions. In PC 2, d-excess and SA were clustered with IOD, SAM, SIE, and particularly strong signal of SST-SEIO. This can represent the increasing (decreasing) d-excess with increased (decreased) evaporation with warm (cold) SSTs particularly over the southeastern IO. Moreover, there could be a weak relevance with enhanced (weakened) air mass transport with strong (weak) westerlies associated with the positive (negative) SAM conditions, consequent wind-induced increase (decrease) in SIE over East Antarctica and relatively cooler temperature over the eastern IO (decreasing IOD). It is ambiguous to explain the negative correlation between the SA and SST-SEIO in PC 2. In contrast to the expected positive influence of warmer source-region SSTs on moisture availability and precipitation, the observed negative relationship may reflect the combined effects of atmospheric circulation, moisture transport pathways, and precipitation efficiency, rather than a direct thermodynamic response to SST solely.."

Lines 394-403, Section 3.4.

"The Indian Ocean and western Pacific Ocean were identified as the moisture source regions, together contributing approximately 95% of snowfall at GV7 site, with the western Pacific accounting for 65% (147 mm) of total snowfall (Caiazzo et al., 2017). This likely indicate the presence of influence of Indian Ocean variability on snow accumulation at the GV7-C site. It was also reported that snowfall from the western Pacific Ocean sector was associated with a few intense snowfall events (Caiazzo et al., 2017). It is expectable that the variability in SA of the GV7-C ice core is assumed to be affected by the coupled influence of large-scale atmospheric circulation, moisture-transport pathways and transport efficiency, as well as short-lived synoptic-scale events such as intense precipitation associated with atmospheric rivers (Thomas et al., 2008; Cohen et al., 2012; Turner et al., 2019; Udy et al., 2021; Wille et al., 2021). Such processes are particularly important for Antarctic coastal snowfall and have been identified in the ice core records from coastal regions (Servettaz et al., 2020; Jackson et al., 2023)."

Lines 407–424, Section 3.4.

"Atmospheric rivers could generate extreme snowfall and pronounced isotopic anomalies over Antarctica, potentially contributing disproportionately to the isotope signals preserved in ice cores (Wille et al., 2022; Dutrievoz et al., 2026). Wille et al. (2021) estimated that atmospheric rivers contribute approximately 10–20% of annual snowfall across broad regions of East Antarctica and can substantially influence interannual snowfall variability. Based on the lower-bound estimate of a 10% contribution, we applied a 10% increase to the mean annual accumulation of the GV7-C ice core, yielding a threshold value of 245 mm w.e. yr^{-1}. Years exceeding this value were classified as high-accumulation years. The mean summer maximum $\delta^{18}O$ values during these high-accumulation years were −28.23 ± 1.70‰ (n = 83), compared with −28.71 ± 1.63‰ (n = 149) during the remaining years, representing a statistically significant enrichment of 0.48‰ (p = 0.037) in $\delta^{18}O$ during high-accumulation years. Similarly, the mean DJF $\delta^{18}O$ values ($\delta^{18}O$ = –28.40 ± 1.69 ‰, n = 196) were also higher during high-accumulation years than during the remaining years ($\delta^{18}O$ = –28.81 ± 1.60 ‰, n = 251). These results suggest that years with higher snowfall accumulation may be associated with potentially increased

	contributions from atmospheric river events. We acknowledge that the contribution of atmospheric rivers to snowfall and associated $\delta^{18}O$ variability at the GV7-C site merits further investigation. *Based on the correlation of $\delta^{18}O$ in the GV7-C ice core with Nino 3.4, SOI, SAM, and SIE over the Ross-Amundsen Sea sector for 1957–2013 CE (Fig.3), the increasing (decreasing) $\delta^{18}O$ can be partly explained by the intrusion of warm (colder) and moist (dry) air mass mainly through the PO sector of the Southern Ocean. This likely suggests that ENSO and SAM related atmospheric circulation variability may modulate the transport of air masses from the PO sector toward the GV7-C site, contributing to the observed $\delta^{18}O$ variability."* **Lines 468-477, Section 3.4.** *"We note that the 3-year smoothing was used to examine persistent or low-frequency variability in the GV7-C ice-core records and their relationships with large-scale climate modes. The ice-core records integrate signals from multiple influencing factors, which may reinforce, weaken, or obscure one another's signals. Therefore, correlations after smoothing are likely to reflect an averaged climate signal and may also represent the signal-preservation characteristics of the GV7-C ice core. Thus, the results are interpreted cautiously as indicating the dominant or more detectable component of multi-year climate variability recorded in the ice core. Moreover, the correlations discussed for the 1957–2013 CE and 1872–2013 CE periods represent relationships averaged over the respective study periods and may vary over time. Temporal variations in the relationships have been reported (Casado et al., 2026; Jouzel et al., 1997; Turner et al., 2020; Udy et al., 2026), and we acknowledge that further investigation using sub-period correlation analyses would help to better assess their temporal stability and potential evolution of the relationships."*
Comment 4	The critique points out geographical errors in the study, such as incorrect locations and distances of referenced ice cores (for example, the position of Victoria Lower Glacier, the core is on Dry Valley 700 km far from GV7 and not 55 km and as reported on Fig. 1).
Response 4	Thank you for the clear comment. We have corrected the location of the Victoria Lower Glacier ice-core site in Figure 1 and revised its distance from GV7-C in Table 3. Please see the revised Figure 1 and Table 3.
Comment 5	The dataset presented is novel, highly valuable, and potentially of significant interest to the scientific community. However, the study is affected by several methodological and geographical/climatological limitations. The analytical approach and statistical comparisons appear limited and, in some cases, contradictory, reducing the strength of the interpretations and insufficiently developed.
Response 5	We thank the reviewer for recognizing the novelty and scientific value of the GV7-C ice-core record. We have carefully reconsidered, re-examined the analytical framework and revised the relevant sections. Specifically, we have clarified the datasets and analytical procedures in the Materials and Methods section, corrected the geographical information, added seasonal analyses, expanded the presentation of the results, and revised the discussion in Sections 3.2–3.4 (see our detailed response to Comment 3). We note that this work basically aims to reveal the potential signals by comparing/considering several/pre-expected-relevant variables in temporal and spatial resolution,

	considering the broad range of influencing factors reflected on ice-core signals. We primarily based/reported on annual timescale, but considered the seasonal values as well, and reported selectively and incorporated them into the discussion. We have revised the manuscript by carefully linking the interpretations to our results and previous studies, also adopting cautious interpretations where relationships are weak/uncertain and highlighting directions for further investigation. We hope that these revisions have substantially improved the methodological transparency, internal consistency, and overall scientific robustness of the manuscript.

General comments by referee #1

Thank you to the authors for revising the manuscript. The overall structure and presentation have improved, and the updates have addressed several of the issues raised previously. However, I still have some concerns regarding the physical interpretation of several relationships between the annual climate variability indices and the ice core records. I believe further analysis, clarification and discussion would strengthen the manuscript and provide greater confidence in the interpretations.

Response to general comments:

Thank you again for the careful and constructive assessment of our revised manuscript. The remaining comments prompted us to re-examine the physical interpretation of the relationships between the climate indices and the GV7-C ice-core records. In response, we have conducted additional analyses, clarified the datasets and analytical methods, expanded the discussion of the relevant physical mechanisms and limitations, and revised interpretations that were not sufficiently supported by the available evidence. We hope that these changes have improved the scientific robustness and clarity of the manuscript. Detailed point-by-point responses are provided below, and all corresponding changes can be seen in the marked-up manuscript file.

Major revisions	
Data selection requiring further clarification	
Comment 1	**1) SST-SEIO index** The manuscript currently links SST-SEIO to the Dipole Mode Index (DMI), which is the index commonly used to represent the Indian Ocean Dipole (IOD) (line 128). Suggest revisiting this to ensure the correct dataset is referenced. It would also be helpful to provide the latitude and longitude bounds used to define this index. More generally, a figure showing the regions associated with all climate indices used in the study would improve clarity for readers.
Response 1	We thank for this clear and helpful comment. We have rechecked/edited the reference for SST-SEIO as well as other variables, and added latitude and longitude bounds. **Lines 123-133, Section 2.3.** "*For the 1957–2013 CE period, the following climate indices, expressed as annual means (January–December) were compared with the annual means of the GV7-C ice core records: station-based SAM index (Marshall, 2003; Marshall G and National Center for Atmospheric Research Staff, 2018), the Southern Oscillation Index (SOI) obtained from the National Centers for*

	Environmental Information (NCEI) (available at https://www.ncei.noaa.gov/access/monitoring/enso/soi), Niño3.4 index (5°S–5°N and 170°–120°W) (Rayner et al., 2003; available at https://psl.noaa.gov/gcoswgsp/Timeseries/Nino34), Indian Ocean Dipole (IOD) index is the Dipole Mode Index, representing the SST gradient between the western (50°E–70°E and 10°S–10°N) and southeastern equatorial IO (90°E–110°E and 10°S–0°N) (available at https://psl.noaa.gov/gcos_wgsp/Timeseries/DMI), SST anomaly in the southeastern IO (SST-SEIO) (90°E–110°E and 10°S–0°N) (available at https://psl.noaa.gov/gcos_wgsp/Timeseries/Data/dmieast.had.long.data), and reconstructed sea ice extent (SIE) over the Ross–Amundsen Sea sector (SIE-RA) (162°E–250°E) and the East Antarctic sector (SIE-EA) (71°E–162°E) (Fogt et al., 2023).”
Comment 2	**2) Use of ERA5 in the Southern Ocean** The use of ERA5 over the longer analysis period to identify moisture source regions is understandable. However, given the sparse observational coverage in the Southern Ocean prior to the satellite era, it would be beneficial to include some discussion of ERA5 performance in this region and period. While a full evaluation is beyond the scope of this study, references that assess ERA5 skill in data-sparse Southern Ocean environments would help readers interpret the results appropriately.
Response 2	We thank the reviewer for this clear comment. We have added a more balanced discussion of ERA5 performance and its limitations over Antarctica and the Southern Ocean, with particular attention to the pre-satellite period. We hope this will improve the readability and clarify the use of ERA5 in this study. **Lines 137-153, Section 2.3.** *“ERA5 shows better performance than its predecessor, ERA-Interim, owing to its higher spatial and temporal resolution, improved model physics and core dynamics, and data assimilation (Hersbach et al., 2020), and overall good performance can be found compared with other reanalysis products (Caton Harrison et al., 2022; Marshall et al., 2022). ERA5 effectively represents temperature variability over Antarctica, particularly for annual and seasonal mean temperatures and at higher-elevation sites (>1000 m a.s.l), although some biases and regional differences have been reported (Tetzner et al., 2019; Zhu et al., 2017). We acknowledge that ERA5 has been widely used for the satellite era (from 1979 onward), when observational coverage was better than during the pre-satellite period, particularly over Antarctica and the Southern Ocean (Hersbach et al., 2020), and has been used in Antarctic ice-core studies (Kim et al., 2025; Leroy-Dos Santos et al., 2023; Thomas et al., 2024). There are also studies based on ERA5 on the pre-satellite period (1950–1979), showing good performance (Marshall et al., 2022; Xie et al., 2023). In this study, we used ERA5 reanalysis data for the period 1957–2013*

	CE in the spatial correlation analyses. Since ice-core signals reflect a broad range of thermodynamic and dynamic influences, this spatial correlation analyses were conducted for physically plausible scenarios to help identify potential moisture supply regions over a longer time period (1957–2013 CE) than previous studies (Caiazzo et al., 2017; Khan, 2019). As it mentioned before, 1957–2013 CE period was selected based on data availability (e.g., SAM indices) and to provide a relatively longer temporal coverage than previous studies. Spatially coherent and physically interpretable patterns are selectively presented and used as supportive evidence in the interpretation of climate-related signals from the GV7-C ice core."
Comment 3	**a. Selection of ERA5 results** The manuscript presents selected seasonal and spatial correlation results from ERA5. It would be useful to clarify what additional variables and seasons were examined but not shown. As currently presented, it is difficult to determine whether the selected results provide a comprehensive picture or primarily highlight relationships that exhibit stronger correlations. Some discussion of the full analysis would help reduce the potential for perceived selection bias and strengthen confidence in the interpretation.
Response 3	Thank you for the clear comment. We have edited/included this in the section 3.2. Considering a broad range of influencing factors (variables at the deposition site or source region; combined effects of multiple variables rather than a single dominant factor), we have checked various results *(annual and seasonal; at different pressure levels; various variables, including air temperature, sea surface temperature, sea ice concentration, wind speed, zonal and meridional wind components, and total precipitable water*) from the spatial correlation analyses and primarily intended to highlight potential relationships and provide supporting evidence for the interpretation of climate signals in the GV7-C ice core. **Lines 224-231, Section 3.2.** **"***Because ice-core signals reflect a broad range of influencing factors, the analyses were conducted at both annual and seasonal timescales and at different pressure levels, considering several physically plausible variables, including air temperature, sea surface temperature, sea ice concentration, wind speed, zonal and meridional wind components, and total precipitable water. These analyses were primarily intended to highlight potential relationships and provide supporting evidence for potential moisture source regions based on the spatial coherence of different climate variables over the longer 1957–2013 CE period. Significant (|r| > 0.3 at 95% confidence interval) and physically interpretable patterns were selected and are presented in the Supplement (Figs. S1–S3) as supporting evidence for the interpretation of potential climate-related signals in the GV7-C ice core."*
Comment 4	**3) Description of datasets spanning 1872–2013**

	Additional information is needed regarding all datasets used in the long-term comparison period. For example, no reference or description is provided for the Niño3.4 dataset. It would be helpful to clarify whether this record is derived from reconstructions, ship-based observations, blended datasets, or another source, and to provide appropriate citations.
Response 4	We thank the reviewer for this pointful comment. We have edited/added information for all datasets as suggested. Please see the edited parts below. **Lines 157-165, Section 2.3.** *"For the 1872–2013 CE period, the GV7-C ice core data were compared with the climate indices, expressed as annual means (January–December), including the Indian Ocean Dipole (IOD) index is the Dipole Mode Index, representing the SST gradient between the western (50°E–70°E and 10°S–10°N) and southeastern equatorial IO (90°E–110°E and 10°S–0°N) (available at https://psl.noaa.gov/gcos_wgsp/Timeseries/DMI), SST anomaly in the southeastern IO (SST-SEIO) (90°E–110°E and 10°S–0°N) (available at https://psl.noaa.gov/gcos_wgsp/Timeseries/Data/dmieast.had.long.data), reconstructed SST anomaly over the Southern Hemisphere (SST-SH) (available at https://www.ncei.noaa.gov/access/monitoring/climate-at-a-glance/global/time-series), reconstructed SAM index from the NOAA-CIRES-DOE Twentieth Century Reanalysis (20CR) (https://psl.noaa.gov/data/20thC_Rean/timeseries/monthly/SAM), and Niño3.4 index (5°S–5°N and 170°–120°W) (Rayner et al., 2003; available at https://psl.noaa.gov/gcoswgsp/Timeseries/Nino34). HadISST1.1 is a globally complete monthly SST dataset that combines bias-adjusted in situ marine observations with satellite-derived SST observations from 1982 onward and uses reduced-space optimal interpolation to reconstruct data-sparse regions and periods. Consequently, the earlier parts of these records depend more strongly on sparse ship-based observations and statistical reconstruction. The SST-SH record was obtained from NOAA NCEI Climate at a Glance and was based on the Extended Reconstructed Sea Surface Temperature dataset (Huang et al., 2017)"*
Additional analysis and/or clarification to discussion points	
Comment 5	**4) Annual layer identification and snowfall seasonality** Please clarify whether the summer snowfall maximum could influence the identification of annual layers using isotopes. For example, could large snowfall events associated with atmospheric rivers influence the positioning of annual isotope peaks from year to year? If so, it would be useful to discuss whether this could affect the derived interannual variability.
Response 5	Thank you for the helpful comment. We have edited/added a discussion in 3.4 section. **Lines 407-419, Section 3.4.**

	"Atmospheric rivers could generate extreme snowfall and pronounced isotopic anomalies over Antarctica, potentially contributing disproportionately to the isotope signals preserved in ice cores (Wille et al., 2022; Dutrievoz et al., 2026). Wille et al. (2021) estimated that atmospheric rivers contribute approximately 10–20% of annual snowfall across broad regions of East Antarctica and can substantially influence interannual snowfall variability. Based on the lower-bound estimate of a 10% contribution, we applied a 10% increase to the mean annual accumulation of the GV7-C ice core, yielding a threshold value of 245 mm w.e. yr^{-1}. Years exceeding this value were classified as high-accumulation years. The mean summer maximum $\delta^{18}O$ values during these high-accumulation years were −28.23 ± 1.70‰ (n = 83), compared with −28.71 ± 1.63‰ (n = 149) during the remaining years, representing a statistically significant enrichment of 0.48‰ (p = 0.037) in $\delta^{18}O$ during high-accumulation years. Similarly, the mean DJF $\delta^{18}O$ values ($\delta^{18}O$ = –28.40 ± 1.69 ‰, n = 196) were also higher during high-accumulation years than during the remaining years ($\delta^{18}O$ = –28.81 ± 1.60 ‰, n = 251). These results suggest that years with higher snowfall accumulation may be associated with potentially increased contributions from atmospheric river events. We acknowledge that the contribution of atmospheric rivers to snowfall and associated $\delta^{18}O$ variability at the GV7-C site merits further investigation. "
Comment 6	**5) Stability of correlations through time** The correlation analysis is conducted over 1957–2013. However, relationships between East Antarctic climate and large-scale modes of climate variability are known to vary through time. The d-excess results shown here appear broadly consistent with previously documented shifts in Antarctic temperature–SAM observed in Antarctic wide study using station data: Turner et al 2020 https://rmets.onlinelibrary.wiley.com/doi/10.1002/joc.6378 and Law Dome ice core study: Udy et al 2026 https://agupubs.onlinelibrary.wiley.com/doi/10.1029/2025JD045013. Recommend assessing the stationarity of the reported correlations or, at minimum, discussing this limitation.
Response 6	Thank you for the clear comment. We agree on this point and we edited/added a discussion of this limitation in the 3.4 section. **Lines 473-477, Section 3.4.** *"Moreover, the correlations discussed for the 1957–2013 CE and 1872–2013 CE periods represent relationships averaged over the respective study periods and may vary over time. Temporal variations in the relationships have been reported (Casado et al., 2026; Jouzel et al., 1997; Turner et al., 2020; Udy et al., 2026), and we acknowledge that further investigation using*

	sub-period correlation analyses would help to better assess their temporal stability and potential evolution of the relationships."
Comment 7	**6) Annual means for ENSO and IOD indices** The response to reviewers acknowledges concerns raised regarding the use of annual ENSO and IOD indices, but these limitations are not clearly reflected in the revised manuscript (Section 2.3). As a result, readers may not fully appreciate the challenges associated with interpreting annual-average values for climate modes that have strong seasonal characteristics and have events split by the January-December year. For example, the relationship reported in line 248 is based on annual IOD values, yet the physical relevance of annual averaging for this mode is unclear in the manuscript. While annual indices can be calculated, their interpretation unlikely reflects the known IOD dynamics and teleconnections. At minimum, the manuscript should explicitly discuss these limitations. My preference would be to see the analysis revised to better account for the seasonality of the relevant climate mechanisms and the way signals are recorded in the ice core. This issue is particularly important given that the ERA5 results presented in Section 3.2 demonstrate clear seasonal dependencies. Crockart et al. (2021) - CP - El Niño–Southern Oscillation signal in a new East Antarctic ice core, Mount Brown South may provide a useful example of an approach that considers both seasonal climate variability and annual ice-core records.
Response 7	Thank you for the clear comment. We have specified "annual means" where appropriate to make this point clearer. We have also added/included the results obtained using seasonal values (we note that, for the DJF mean of the IOD and Niño3.4 indices, December values from the preceding year were used). These seasonal relationships are generally consistent with the results of the spatial correlation analysis (Section 3.2) and also support the results from the annual-scale data and showing no substantial deviations. We have also noted the need for future studies to further investigate these relationships using seasonally resolved climate indices and event-based analyses. **Lines 290-300, Section 3.3.1.** *"Considering the seasonality of Niño3.4 and the IOD, their relationships with the GV7-C ice core records were also examined at the seasonal scale (not shown). Niño3.4 showed positive correlations only with $\delta^{18}O$ in all seasons (r = 0.33–0.43,* p *< 0.01, n = 55), with the strongest correlation occurring in MAM, for the three-year averaged time series. In contrast, the IOD showed negative correlations with* d*-excess during JJA (r = −0.53,* p *< 0.001, n = 55) and MAM (r = −0.51,* p *< 0.001, n = 55), for the three-year averaged time series. Moreover, the IOD showed weak positive correlations with SA in MAM (r = 0.31,* p *< 0.05, n = 55) for the annually averaged time series, and in JJA (r = 0.36,* p *< 0.05, n = 55) and SON (r = 0.36,* p *< 0.05, n = 55) for the three-year averaged time series. These seasonal relationships are gently consistent with*

	the results of the spatial correlation analysis (Section 3.2). Although this study is primarily based on annual climate indices, further investigation using seasonally resolved climate indices and event-based analyses would be valuable for better understanding the seasonal mechanisms linking climate indices to the GV7-C ice core records."
Comment 8	**7) Interpretation of climate-index phases** In the paragraph beginning at line 260, I recommend referring explicitly to the phases of the climate modes rather than their associated variables. For example: • Lower SSTs in Niño3.4: is this referring to an anomaly and La Nina conditions? • Strong westerlies associated with SAM: which SAM phase is being referenced? Positive SAM? • The negative correlation between accumulation and SST-SEIO is described as "ambiguous." If this relationship differs from expectations based on previous studies, it would be helpful to state this more directly and explain why.
Response 8	Thank you for the clear and pointful comment. We have added/detailed the phases of the climate modes, and hope this makes the discussion clearer. **Lines 304-315, Section 3.3.1.** *"This reflected the importance of both thermodynamic and dynamic effects on the decrease (increase) in $\delta^{18}O$ with an increase (decrease) in the SIE, stronger (weaker) westerly winds associated with positive (negative) SAM conditions, lower (higher) SOI values and lower (higher) SST anomalies in the Niño3.4 region, corresponding to El Niño (La Niña)-like conditions. In PC 2, d-excess and SA were clustered with IOD, SAM, SIE, and particularly strong signal of SST-SEIO. This can represent the increasing (decreasing) d-excess with increased (decreased) evaporation with warm (cold) SSTs particularly over the southeastern IO. Moreover, there could be a weak relevance with enhanced (weakened) air mass transport with strong (weak) westerlies associated with the positive (negative) SAM conditions, consequent wind-induced increase (decrease) in SIE over East Antarctica and relatively cooler temperature over the eastern IO (decreasing IOD). It is ambiguous to explain the negative correlation between the SA and SST-SEIO in PC 2. In contrast to the expected positive influence of warmer source-region SSTs on moisture availability and precipitation, the observed negative relationship may reflect the combined effects of atmospheric circulation, moisture transport pathways, and precipitation efficiency, rather than a direct thermodynamic response to SST solely."*
Comment 9	**8) Physical interpretation of the 3-year smoothing**

	The manuscript would benefit from further discussion of the physical meaning of the 3-year smoothing applied to the data. While smoothing is commonly used in ice-core studies to reduce noise and often increases correlation strength, it is not always clear what climatological process the smoothed signal represents when applying to modes of climate variability that have a strong seasonal influence. For example, Table 6 shows cases where no significant annual correlation is present, yet significance emerges after applying a 3-year running mean. It would be helpful to discuss how such results should be interpreted from a climate perspective and whether they imply persistence, low-frequency variability, or another process.
Response 9	Thank you again for the very pointful comment. The smoothing was applied primarily to highlight persistent or low-frequency variability in the ice-core records and to examine whether the relationships with large-scale climate modes. We agree on the points mentioned, and we edited/added/mentioned this in the 3.4 discussion section. **Lines 468-473, Section 3.4.** *"We note that the 3-year smoothing was used to examine persistent or low-frequency variability in the GV7-C ice-core records and their relationships with large-scale climate modes. The ice-core records integrate signals from multiple influencing factors, which may reinforce, weaken, or obscure one another's signals. Therefore, correlations after smoothing are likely to reflect an averaged climate signal and may also represent the signal-preservation characteristics of the GV7-C ice core. Thus, the results are interpreted cautiously as indicating the dominant or more detectable component of multi-year climate variability recorded in the ice core."*
Comment 10	**9) Interpretation of Figure 5** The d-excess correlations with SST shown in Figure 5 do not appear to exhibit strong anomaly patterns associated with major Pacific or Indian Ocean climate modes. I recommend expanding the discussion of this result and considering its implications for the proposed mechanisms and links with the correlation findings of this study.
Response 10	Thank you for the clear comment. We have edited/clarified this part in section 3.4. **Lines 363-370, Section 3.3.2.** *"The spatial correlation of d-excess with the reconstructed SST dataset was also shown for two periods: 1957–2013 CE, and 1854–2013 CE (Fig. 5). Weak positive correlations were observed over the remote IO sector during the 1957–2013 CE period (Fig. 5a) while in the period from 1854 to 2013 CE, the correlation was observed over a larger area in the southern sector of the IO (Fig. 5b). Although the correlations are weak and do not show clear anomaly*

	patterns associated with SST changes over the PO and IO, the observed positive correlations over the southern IO sector provide some qualitative support for the possibility that the d-excess signal from the GV7-C ice core may partly reflect thermodynamic variability (i.e., SST changes) over the IO sector of the Southern Ocean, at least over the 1872–2013 CE period. ”
Comment 11	**10) Discussion of warm intrusions (line 344)** It would be helpful to clarify how the warm intrusions discussed are linked to the climate modes identified in the analysis. In addition, some discussion statements (e.g., lines 344 and 351) would benefit from explicit figure references so that readers can more easily connect the discussion to the presented results.
Response 11	Thank you for the comment. First, we excluded the term “relatively”, which was not appropriate. We added reference for figure (Fig. 3) and added explanatory sentence after that. **Line 420-424, Section 3.4.** *“Based on the correlation of $\delta^{18}O$ in the GV7-C ice core with Nino 3.4, SOI, SAM, and SIE over the Ross-Amundsen Sea sector for 1957–2013 CE (Fig.3), the increasing (decreasing) $\delta^{18}O$ can be partly explained by the intrusion of warm (colder) and moist (dry) air mass mainly through the PO sector of the Southern Ocean. This likely suggests that ENSO and SAM related atmospheric circulation variability may modulate the transport of air masses from the PO sector toward the GV7-C site, contributing to the observed $\delta^{18}O$ variability.”*
Comment 12	**11) Significance of the ice-core record** The concluding paragraph at the end of Section 3.4 would benefit from additional emphasis on the broader significance of this ice-core record for climate research. At present, the section reads primarily as a summary of existing literature. Expanding the discussion of the unique contribution of this record would strengthen the overall conclusions.
Response 12	Thank you for the clear comment. We have added this at the end of the section. **Lines 489-492, Section 3.4.** *“Thus, understanding the response of the Antarctic climate to ocean variability, particularly in the IO sector, is important for better assessing past and future Antarctic climate variability. In this context, the GV7-C ice-core record provides a valuable proxy for investigating the links between oceanic variability, atmospheric circulation, and Antarctic precipitation and isotope variability.”*
Minor revisions	

Comment 13	In the study area description, please clarify what is meant by "relatively high snowfall" by providing quantitative values in the text. These values are currently available in Table 3 but would be useful to include in the main text.
Response 13	We have edited the text by mentioning the accumulation values and comparative references to clarify the use of the term “relatively”. **Lines 69-74, Section 2.1.** *“Snow accumulation ranges from 205 to 252 w.e yr^{-1} (>200 w.e yr^{-1}) (Frezzotti et al., 2007; Magand et al., 2004; Nardin et al., 2021), which is relatively high compared with that at other inland Antarctic sites (e.g., Ekaykin et al., 2004; Stenni et al., 2002) and some coastal sites (Stenni et al., 1999; Nyamgerel et al., 2020), and is expected to provide better preservation of the seasonal signals and facilitate annual-layer identification (Frezzotti et al., 2007). Moreover, post-depositional effects are expected to be limited due to the low intensity of katabatic winds along the ice divide (Frezzotti et al., 2007; Magand et al., 2004).”*
Comment 14	2. In all figure and table captions, please define acronyms in full (e.g., Southern Annular Mode (SAM)) to improve accessibility for readers.
Response 14	We have edited/defined acronyms in the captions (Figures 2-5, Figures S1-S3, Tables 4-6).
Comment 15	3. For Figure 2, please explain why a 5-year smoothing is applied, whereas 3-year smoothing is used in the correlation analyses.
Response 15	Thank you for the clear comment. We have changed/applied to “3-year smoothing”. The purpose of smoothing here in Figure 2 was primarily for visualization, so either 3 or 5-year smoothing can be shown. We have changed to 3-year smoothing for a consistency with the other sections of the manuscript.
Comment 16	4. Ensure all result statements include reference to relevant figures. E.g. paragraph beginning at line 232 - please include references to the relevant figures from this study where appropriate to assist with cross-referencing and clarity.
Response 16	We have included the reference here and checked/included throughout the manuscript.
Comment 17	5. Please clarify the meaning of "transport pathways." I assume this refers to moisture transport pathways, but more consistent language would improve clarity.

Response 17	We have edited as “moisture transport pathways”.
Comment 18	6. In Section 3.4, "atmospheric river events" and "atmospheric rivers" appear to be used interchangeably. Consider using a single consistent term throughout.
Response 18	We thank the reviewer for this suggestion. We have standardized the terminology throughout Section 3.4 and now consistently use the term “atmospheric rivers.”

Thank you very much for your time, effort, and patience in handling our manuscript. We look forward to your favorable consideration and to the opportunity for publication in Earth System Dynamics.

Sincerely,

Jeonghoon Lee