https://doi.org/10.5194/egusphere-2025-1207
Preprint. Discussion started: 16 April 2025

Imprints of Sea Ice, Wind Patterns, and Atmospheric Systems on Summer Water Isotope Signatures at Hercules Névé, East Antarctica

Songyi Kim[1,2], Yeongcheol Han[2], Jiwoong Chung[2], Seokhyun Ro[2,3], Jangil Moon[2], Soon Do Hur[2] and Jeonghoon Lee[1]

[1]Department of Earth Science Education, Ewha Womans University, Seoul, 03760, Republic of Korea
[2]Division of Glacier & Earth Science, Korea Polar Research Institute, Incheon, 21990, Republic of Korea
[3]Department of Ocean Sciences, Inha University, Incheon, 22212, Republic of Korea

Correspondence to: Jeonghoon Lee (jeonghoon.lee@gmail.com)

Abstract. This study investigated the interactions between atmospheric and oceanic conditions during the austral summer based on an analysis of water isotopes ($\delta^{18}O$, $\delta^{2}H$, and deuterium excess[dexc]) in a Hercules Névé ice core from Antarctica. The primary objective was to evaluate the complex influence of temperature, precipitation, wind patterns (v- and u-winds), ocean environmental (sea ice concentration [SIC] and sea surface temperature [SST]), and atmospheric systems (Amundsen Sea Low [ASL] and Zonal Wave-3 [ZW3]) on the variability of these water isotopes using high-resolution ERA5 reanalysis data from the austral summer months between 1979 and 2015. The results indicated that higher temperatures and precipitation increased $\delta^{18}O$ levels, while wind patterns contributed in a complex manner to variation in the isotopes. Specifically, southerly winds (positive u-wind anomalies) increased $\delta^{18}O$ values, whereas westerly winds (positive v-wind anomalies) tended to decrease them as a result of reflecting moisture characteristics. Additionally, the dexc showed positive correlations with SIC and negative correlations with SST, providing valuable insights into moisture source processes in the study region during austral summer. The ASL and ZW3 were thus found to play significant roles in atmospheric circulation, affecting the transport of heat and moisture and leading to isotopic variation.

1 Introduction

Water isotopes ($\delta^{18}O$ and $\delta^{2}H$) have served as crucial proxies for paleoclimatic reconstructions due to their systematic relationship with temperature, making ice cores invaluable archives of past climatic information (Dansgaard, 1964; Jouzel et al., 1997). Recent advancements, such as refined surface temperature reconstructions using advanced modeling approaches (Markle and Steig, 2022) and analyses of isotopic diffusion in snow layers for estimating past temperatures (Holme et al., 2018), highlight the progression from observational studies toward sophisticated modeling. Despite these advancements, accurately interpreting isotopic records from ice cores remains challenging, particularly due to regional variability in the temperature-isotope relationship. In polar regions, and especially across Antarctica, local climatic and atmospheric conditions significantly influence this relationship, creating spatial differences in isotopic signals (Masson-Delmotte et al., 2008; Sime et al., 2009). Therefore, detailed regional investigations are essential for bridging these gaps in understanding and ensuring accurate interpretations of paleoclimatic conditions from ice core isotope records.

https://doi.org/10.5194/egusphere-2025-1207
Preprint. Discussion started: 16 April 2025

Victoria Land in East Antarctica offers unique advantages for understanding climatic processes due to its transitional position between the high interior plateau and the coastal regions. Previous research in this area has utilized ice cores from locations such as Styx Glacier, Talos Dome, Whitehall Glacier and Hercules Névé to study regional climate dynamics (Bertler et al., 2011; Emanuelsson et al., 2023; Masson-Delmotte et al., 2008; Nyamgerel et al., 2024; Sime et al., 2009; Stenni et al., 1999, 2002; Thomas et al., 2017). Each of these sites has contributed distinctive insights: Styx Glacier provides detailed records of local temperature trends (Nyamgerel et al., 2024; Thomas et al., 2017), while Talos Dome captures long-term climatic signals influenced by marine-continental air mass interactions (Frezzotti et al., 2007). Research at Whitehall Glacier has emphasized its role in documenting snow accumulation patterns and their relationship to atmospheric dynamics (Sinclair et al., 2012). These studies have collectively advanced our understanding of isotopic variability and its relationship to atmospheric processes. Among these locations, Hercules Névé is distinguished by its location near the Ross Sea, enabling it to capture isotopic signals influenced by both coastal and interior atmospheric systems. The high snow accumulation rates in this region allow for the preservation of detailed isotopic records, which are essential for investigating Antarctic climate variability and its broader global impacts (Masson-Delmotte et al., 2003; Sinclair et al., 2012) .

Isotope-enabled general circulation models demonstrate that sea ice extent and concentration influence the isotopic composition of polar coastal precipitation by altering moisture source locations and transport pathways, ultimately shaping the isotopic signatures recorded in precipitation (Faber et al., 2017; Noone and Simmonds, 2004). Reduced sea ice increases evaporation from open ocean areas, enriching atmospheric isotopic composition due to shorter transport distances and distinct moisture sources (Noone and Simmonds, 2004). In contrast, expanded sea ice shifts moisture sources to colder regions, resulting in isotopic depletion and altering precipitation patterns. These interactions highlight the complex interplay between sea ice variability and atmospheric circulation, where changes in sea ice extent influence moisture transport and isotopic signatures in precipitation, driven by regional atmospheric dynamics (Faber et al., 2017; Song et al., 2023).

The relationship between sea ice and moisture transport is shaped by various atmospheric circulation features, with the Amundsen Sea Low (ASL) being particularly influential in the Ross Sea region due to its role in directing moisture transport and modulating wind patterns (Hosking et al., 2013; Raphael et al., 2016). Another critical pattern is Zonal Wave 3 (ZW3), which significantly affects the distribution of air masses and precipitation in coastal Antarctica, amplifying the influence of regional circulation dynamics. (Goyal et al., 2022). While ASL and ZW3 modulate these interactions, regional cyclonic activity also contributes to shaping the isotopic composition of precipitation in coastal Antarctica. This modulation affects regional precipitation isotopes and links sea ice variability with broader atmospheric processes (Emanuelsson et al., 2023; Sinclair et al., 2013).

The Austral summer months of December, January, and February (DJF) are particularly suitable for sea ice research because of the climatic and environmental dynamics observed during this period. For example, Antarctica experiences higher solar radiation levels during DJF, leading to dynamic changes in the extent and structure of sea ice. Strong, cold katabatic winds that flow downward from the interior ice sheets also promote the expansion of sea ice and the formation of polynyas, which are areas

https://doi.org/10.5194/egusphere-2025-1207
Preprint. Discussion started: 16 April 2025

of open water surrounded by sea ice (Dale et al., 2020; Turner et al., 2016). These polynyas facilitate the exchange of heat and moisture between the ocean and atmosphere, influencing local and regional climate patterns (Stammerjohn et al., 2015). Additionally, higher precipitation rates in DJF lead to the greater preservation of isotopic signals, allowing for more detailed analysis of seasonal variation. The primary objective of this study was to analyze how water isotopes (particularly $\delta^{18}O$) in the Hercules Névé region respond to various climatic drivers during the Austral summer months. In particular, the relationship between isotopic signals and climatic factors was assessed by determining the influence of temperature, precipitation, and u- and v-wind components on isotopic variability. We also evaluated the impact of atmospheric–ocean systems on Hercules Névé by examining the effects of drivers such as the ASL and ZW3 on the isotopic composition and sea ice variability. By focusing on climatic patterns and isotopic signals during the DJF period, it was possible to identify the impact of seasonal processes on isotopic records. Finally, we aimed to interpret isotopic data from ice cores in order to contribute to the reconstruction of the past climate of Antarctica. To achieve these goals, we used ERA5 reanalysis data from 1979 to 2015 to evaluate climatic patterns and compare these with isotopic data taken from an ice core from the Hercules Névé region.

2 Materials and methods

2.1 Study Area

The research area is located at Hercules Névé, Victoria Land, Antarctica, at 73°03'S, 165°25'E (Figure 1). Situated at an altitude of 2,864 m and approximately 80 km inland from the sea, the climatic conditions of this mountainous area are affected by its position near the northern edge of the Transantarctic Mountains, which strongly influence atmospheric circulation by acting as a barrier to the flow of air masses (Tewari et al., 2021). Because the interaction between the mountains and the prevailing winds generates various microclimates at Hercules Névé, it has become an area of interest for understanding the complex interactions between the local geography and climate (Maggi and Petit, 1998).

Victoria Land has long been used as a research site to study the impact of atmospheric and oceanic variability on snow accumulation and ice core records (Maggi and Petit, 1998; Nardin et al., 2020; Nyamgerel et al., 2024; Yan et al., 2021; Yang et al., 2018). This region is characterized by austral summer-dominant precipitation patterns influenced by easterly winds that bring moist air from the ocean onto the continent (Scarchilli et al., 2011). Significant katabatic wind-driven sublimation occurs due to the cold, dense air descending from the plateau, which can affect surface snow layers and influence the isotopic composition of the accumulated snow (Nyamgerel et al., 2024). Broader climatic drivers such as the Southern Annular Mode and sea ice variability also impact regional weather patterns and precipitation (Yang et al., 2018). Hercules Névé is thus a useful site for the analysis of how regional climate variability influences snow deposition and ice core records, which can be used to reconstruct past climate conditions. Furthermore, previous studies have reported a high snowfall rate in the

https://doi.org/10.5194/egusphere-2025-1207
Preprint. Discussion started: 16 April 2025

surrounding area (Maggi and Petit, 1998; Nyamgerel et al., 2020; Stenni et al., 1999, 2000), making this region particularly suitable for ice core drilling during the austral-summer season.

2.2 Data Acquisition

2.2.1 Sampling and Water Isotope Data

To acquire water isotope data from Hercules Névé in northern Victoria Land, an ice core was drilled according to the method described by Han et al. (2015). The ice core was extracted to a depth of approximately 80 m. Frozen sections of the core were immediately stored in plastic bags, logged, and packaged in insulated containers to prevent temperature fluctuations during transport to a laboratory at the Korea Polar Research Institute (KOPRI).

In the laboratory, the ice core was carefully segmented into 5 cm sections based on analytical needs to assess seasonal variability, yielding approximately 2,000 segments. This segment size was selected to ensure data representativeness and ease of handling by providing a balance between resolution and sample manageability. Each segment was processed in a clean environment to prevent contamination. The ice was melted at room temperature in sealed containers to avoid isotopic fractionation via physical processes such as evaporation and sublimation. After melting, the samples were filtered using a 0.45 µm syringe filter to remove fine particles and prevent contamination from impurities. The filtered water was transferred into 2 ml high-density polyethylene vials with airtight caps to prevent evaporation and isotopic exchange with the atmosphere. The samples were stored at temperatures below 4 °C until analysis to preserve their original isotopic ratios and prevent degradation over time. The liquid samples were analyzed using a Picarro L2130-i water isotope analyzer, which employs cavity ring-down spectroscopy (CRDS) for high-precision measurements. The analyzed water isotope results were expressed using delta notation, as shown in Eq. (1):

$$\delta\ (‰) = \left({R_{standard}}/{R_{sample}} - 1 \right) \times 1000 \quad (1)$$

The secondary parameter deuterium excess (dexc), defined according to Dansgaard, (1964), was also determined as shown in Eq. (2):

$$\text{dexc} = \delta\,^{2}H - 8 \times \delta^{18}O \quad (2)$$

The Picarro L2130-i water isotope analyzer has a measurement accuracy of ± 0.07 ‰ for $\delta^{18}O$ and ± 0.1 ‰ for $\delta^{2}H$, making it suitable for detecting variation in isotopic composition. The measurements were calibrated using the international standards VSMOW, Greenland Ice Sheet Precipitation (GISP), and Standard Light Antarctic Precipitation (SLAP), as well as the laboratory standard RS (–34.69 ± 0.07 ‰ for $\delta^{18}O$, –272.4 ± 0.6 ‰ for $\delta^{2}H$).

https://doi.org/10.5194/egusphere-2025-1207
Preprint. Discussion started: 16 April 2025

2.2.2 Utilization of ERA5 Data and ZW3 Data

In this study, we utilized ERA5 reanalysis data provided by the European Centre for Medium-Range Weather Forecasts (ECMWF, covered on a 31 km grid) (Hersbach et al., 2020). ERA5 has been widely validated for use in Antarctica due to its high temporal and spatial resolution and strong correlation with observational data (Tetzner et al., 2019). The dataset includes a wide range of atmospheric variables, including air temperature, precipitation, wind speed and direction, and sea ice concentration. During the ice core sampling, we installed an automatic weather station (AWS) at the Hercules Névé site to collect meteorological data over the span of one year. The AWS recorded parameters such as air temperature, relative humidity (RH), wind speed, wind direction, and atmospheric pressure at regular intervals. This AWS data was then compared with the ERA5 outputs to assess the accuracy of the reanalysis model in representing local atmospheric conditions at Hercules Névé (Figure S1). It was found that ERA5 effectively captured temperature and wind patterns, confirming its reliability for climate analysis in this region.

We also incorporated new data for ZW3 taken from recent research (Goyal et al., 2022) because it has a higher temporal and spatial resolution compared to previous datasets. ZW3 is characterized by three large-scale ridges and troughs in the mid-latitudes of the Southern Hemisphere, influencing atmospheric circulation and sea ice distribution around Antarctica (Goyal et al., 2022; Raphael, 2007). The inclusion of the new ZW3 data allows for a more detailed assessment of its impact on the climatic conditions at Hercules Névé via isotopic signatures.

2.3 Data Processing

2.3.1 Age Dating

Manual layer counting is widely used for the age dating of ice cores, with the identification of annual layers relying on variation in proxies such as stable water isotopes ($\delta^{18}O$, $\delta^{2}H$, and dexc), ion concentrations, dust deposition, and electrical conductivity method (ECM) (Johnsen et al., 2001; Masson-Delmotte et al., 2003; Sigl et al., 2016; Sinclair et al., 2012). Previous studies have demonstrated that, in regions with abundant snowfall, particularly along coastal areas, water isotope signals are well-preserved and exhibit clear seasonal cycles, allowing for the precise manual counting of annual layers. Seasonal variation in $\delta^{18}O$, $\delta^{2}H$, and dexc from the Hercules Névé ice core, characterized by higher $\delta^{18}O$ and $\delta^{2}H$ values during warmer months and lower values during colder periods, were thus used to establish annual layers for age dating (Figure 2B–D). This method provides a high-resolution chronological framework for correlating isotopic and chemical variations with specific years and climatic events.

Radioactive isotopes resulting from atmospheric nuclear testing, such as plutonium-239 (^{239}Pu) and tritium, can be utilized to validate the accuracy of the manual layer counting method (Hwang et al., 2019; Stenni et al., 1999). In this study, ^{239}Pu concentrations were measured at various depths within the Hercules Névé ice core, and ^{239}Pu peaks corresponding to known periods of atmospheric nuclear testing in the late 1950s and early 1960s were employed as absolute time markers (Figure 2A). By matching

https://doi.org/10.5194/egusphere-2025-1207
Preprint. Discussion started: 16 April 2025

these peaks with the historical records for nuclear testing, we confirmed the age of specific layers and validated the annual layer counting method. The uncertainty for the age dating of the ice core was assumed to be less than a year.

In this study, we successfully determined the ice core ages back to 1950s at a depth of approximately 25 m. In particular, we accurately used the top 16 m of the ice core, which represented around 40 years of ice accumulation (highlighted in green in Figure 2). To achieve precise age dating, we utilized ERA5 isotope data from the polar regions over the 1979–2015 period. The clear seasonal patterns in the isotopic data provided a reliable basis for constructing a high-resolution chronology. From the age dating results, we estimated a snowfall amount of 204.5 kg m^{-2} y^{-1} ± 54.5. After determining the age, we analyzed climate patterns during the DJF period from 1979 to 2015 using the ERA5 reanalysis data. These data provided additional context for interpreting the isotopic variation in the core and examining its relationship with temperature, precipitation, and wind patterns.

2.3.2 Spatial Correlation Analysis

Spatial correlation analysis using ERA5 reanalysis data was conducted to examine the relationship between the isotopic variation and temperature, precipitation, wind patterns (i.e., u- and v-wind components), and sea ice concentration in the Hercules Névé region. The analysis aimed to identify which climatic factors had the most significant influence on the isotopic composition of the ice core. For this, we utilized ZW3 index data from recent studies (Goyal et al., 2022), which better represent the temporal and spatial variation in ZW3. Pearson correlation and multiple regression were employed to determine the strength and significance of the relationships between the isotopic and ZW3 data. Special attention was given to evaluating the influence of the ASL and the updated ZW3 on the isotopic signatures. The ASL is a significant low-pressure system affecting weather patterns in West Antarctica, and its interactions with ZW3 can influence temperature and precipitation in the region (Coggins and McDonald, 2015; Goyal et al., 2022).

3 Results

3.1 Water Isotope Records in the Ice Core from Hercules Névé

Figure 2 presents the water isotope data for the 1979–2015 period from Hercules Névé. The $\delta^{18}O$ values in the Hercules Névé ice core ranged from –42.29 ‰ to –29.67 ‰, with a standard deviation of 1.69 ‰, while those for $\delta^{2}H$ ranged from –334.5 ‰ to –226.1 ‰, with a standard deviation of 11.75 ‰. To better understand the regional variability of stable isotopes, we compared our results with data from several nearby ice cores (see Table S1). The Styx–M ice core (1979–2014) has a mean dexc of 3.91 ± 3.72‰ and a mean $\delta^{18}O$ of −33.49 ± 3.05 ‰, while Whitehall Glacier exhibits mean dexc values of 9.5‰ (1980–1993) and 4.6‰ (1993–2004) along with a $\delta^{2}H$ of −202.965 ± 14.179 ‰. Approximately 10 km away, in the Hercules Neve region (1770–1992), $\delta^{18}O$ averages −35.37 ± 1.55 ‰, whereas at Talos Dome (1217–1996), $\delta^{18}O$ and $\delta^{2}H$ reach −37.1 ‰ and −286 ‰, respectively. These values are comparable to those observed in other near-coastal mountainous ice cores, such as Styx–M and

https://doi.org/10.5194/egusphere-2025-1207
Preprint. Discussion started: 16 April 2025

Hercules Névé, but are depleted than those reported from coastal low-elevation site like Whitehall Glacier, and are slightly enriched than those from further inland site Talos Dome (Table S1). The Hercules Névé values are broadly similar to those at Styx–M, which is also a near-coastal, mountainous site, but they are more depleted compared to the lower-elevation coastal site at Whitehall Glacier. Conversely, they show slightly more enriched values than those found further inland, such as at Talos Dome.

Using the annual mean $\delta^{18}O$ and $\delta^{2}H$ in Hercules Névé core, we derived a local meteoric water line (LMWL) with a slope of 8 and an intercept of 8.2 (R^2=0.99). While there slope and intercept are higher than those of the Antarctica meteoric water line (AMWL, slope = 7.75 and intercept = –4.93 Masson-Delmotte et al., 2008), they are similar to the global meteoric water line (GMWL, slope = 8 and intercept = 10; Craig, 1961). The result indicates that that the Hercules Névé region, being relatively close to the coast, experiences moisture conditions more akin to oceanic sites, possibly leading to a steeper $\delta^{18}O$–$\delta^{2}H$ relationship (Fernandoy et al., 2010; Goursaud et al., 2018; Nyamgerel et al., 2024). Seasonally, the $\delta^{18}O$-$\delta^{2}H$ relationship in the Hercules Névé core range from 8 to 8.3 and 7.8 to 18 (Figure S2). Notably, the austral summer, the slope is 8 and the intercept is 7.8, matching closely with the annual mean LMWL. This suggests that the annual isotope signal is largely determined by processes occurring in the summer, when post-depositional effects are relatively reduced, and accumulation rates are higher. Indeed, according to ERA5 reanalysis, total precipitation minus evaporation during DJF accounts for approximately 23–40 % (mean 35%, standard deviation 4%) of the annual total precipitation in this region. Consequently, the summer season can provide a representative signal for interpreting the overall isotopic composition in the Hercules Névé core.

3.2 Impact of Summer Climate Patterns on Water Isotope in the Antarctic Hercules Névé

Using ERA5 climate reanalysis data from 1979 to 2015, we conducted a spatial correlation analysis to examine how temperature, precipitation, and the v- and u-wind components relate to $\delta^{18}O$ variations during the austral summer in the Hercules Névé region (Figure 3).
When considering annual mean temperature (1979–2015), $\delta^{18}O$ shows a weak correlation (r = 0.13), possibly due to the combined effects of varying moisture sources, complex atmospheric circulation, and precipitation processes. In contrast, during the austral summer, a more pronounced correlation was observed, with a correlation coefficient of 0.32 ($p < 0.05$) and a slope of 0.59 ‰ °C^{-1}. Although slightly lower than the Styx site (0.66 ‰ °C^{-1}; Nyamgerel et al., 2024), this summer slope is comparable to other East Antarctic locations such as Whitehall Glacier (0.62 ‰ °C^{-1}; Sinclair et al., 2012), Taylor Dome (0.50 ‰ °C^{-1}; Steig et al., 2000) and Talos Dome (0.60 ‰ °C^{-1}; Stenni et al., 2002) (Figure S3). Several factors may account for this stronger summer correlation: (1) reduced post-depositional processes in warmer conditions, (2) simplified moisture transport pathways, and (3) a higher frequency of precipitation events, leading to more direct incorporation of local climatic signals into the ice. These conditions imply that $\delta^{18}O$ in summer snowfall is a more robust indicator of surface air temperature. Precipitation shows a strong positive correlation with $\delta^{18}O$ during summer (r=0.6; Figure 3B), exceeding its annual mean correlation (r=0.3, not shown). This pattern suggests that that precipitation in

https://doi.org/10.5194/egusphere-2025-1207
Preprint. Discussion started: 16 April 2025

coastal Antarctica is often isotopically enriched during periods of heavy snowfall, reflecting moisture sourced from the nearby ocean (Servettaz et al., 2020 and Jackson et al., 2023).

Regarding wind components, the austral summer v-wind (southerly) and u-wind (westerly) are generally negative values, indicating predominant southerly and westerly winds flows. A positive correlation was observed between $\delta^{18}O$ and v-wind, suggesting that stronger southerly winds are associated with higher $\delta^{18}O$ values (Figure 3C). Conversely, $\delta^{18}O$ is negatively correlated with the u-wind (Figure 3D), suggesting that more intense westerly winds bring colder, isotopically depleted air. There results underscore the dynamic interplay between temperature, precipitation, and wind directions, all of which collectively modulated $\delta^{18}O$ variations in the Hercules Névé region.

In summary, the combination of temperature, precipitation, and wind patterns during austral summer exerts a marked influence on $\delta^{18}O$. Such findings provide a framework for interpreting how coastal Antarctic ice cores can record regional climatic conditions, highlighting the importance of focusing on the season (DJF) that captures a clearer signal of local temperature and marine moisture influx.

4. Discussion

4.1. Relationship between the dexc and SIC/SST during the DJF Period

A significant positive correlation between austral summer SIC and dexc is detected in the Hercules Névé ice core (Figure 4A). This relationship can be attributed to dynamic interactions among local atmospheric conditions, katabatic winds, and polynya formation near the sea-ice edge during the austral summer can be attributed to the dynamic interactions between local atmospheric conditions and moisture source processes (Figure 4A). High SIC conditions, driven by katabatic winds originating from the Antarctic interior, promote the formation of polynyas along the sea ice edge. Polynya formation increases local evaporation but can produce low dexc vapor due to kinetic fractionation during evaporation (Merlivat and Jouzel, 1979). However, mixing with continental air masses–often enriched in dexc–elevates the resultant dexc observed in the precipitation (Noone and Simmonds, 2004). Moreover, extensive sea-ice concentration serves as a barrier that limits moisture transport from distant oceanic sources, which are generally more ^{18}O-depleted, thereby reducing their overall contribution (Kurosaki et al., 2020; Noone and Simmonds, 2004). As a result, polynya-derived and continental air masses dominate the regional isotopic composition, leading to a net increase in dexc. Such a mechanism is consistent with observations in polar regions where local sea-ice dynamics strongly modulate isotopic signals (Kurosaki et al., 2020). In contrast, lower SIC in summer exposes a larger open-sea area, thereby enhancing kinetic fractionation and reducing dexc (Bertler et al., 2018; Kurosaki et al., 2020). These contrasting processes underscore the importance of local moisture source variability in controlling isotopic signatures in Antarctic coastal regions.

In theory, SST changes can exert a strong influence on dexc through kinetic and equilibrium fractionation processes (Gat et al., 2003; Merlivat and Jouzel, 1979).. However, our results reveal a negative correlation between dexc and SST (Figure 4B), which diverges from the expected positive

https://doi.org/10.5194/egusphere-2025-1207
Preprint. Discussion started: 16 April 2025

relationship (Merlivat and Jouzel, 1979). We hypothesize that complex ocean–atmosphere interactions in polynya regions—where sea-ice dynamics, variable SST, and atmospheric circulation converge—modify the typical SST–d-excess linkage. Further numerical modeling that includes both SST and humidity variability would be necessary to elucidate these processes more precisely (Pfahl and Sodemann, 2014; Uemura et al., 2008).

Overall, the strong positive correlation between SIC and dexc, together with the observed negative correlation between SST and dexc, suggests that local moisture sources in the Ross Sea polynya region drive the d-excess variability during DJF. This highlights the sensitivity of coastal Antarctic ice cores to sea-ice extent and sea surface conditions and underscores the need to account for localized ocean–atmosphere processes when interpreting dexc records.

4.2 Influence of the ASL on Water Isotopes and Wind Patterns

The ASL has a profound impact on both both $\delta^{18}O$ variability and local wind dynamics in the Ross Sea and Victoria Land (Coggins and McDonald, 2015; Turner et al., 2013). In this study, we find a significant negative correlation was observed between the mean sea level pressure related to the ASL and $\delta^{18}O$ values in the Hercules Névé region (Figure 5A). When the ASL intensifies (i.e., its central pressure drops), cold and dry air from the Antarctic continent intrudes into the Hercules Névé region, depleting $\delta^{18}O$ in precipitation (Emanuelsson et al., 2023).. This agrees with prior findings that a stronger ASL enhances cold-air advection, thereby lowering the isotopic content of snowfall (Hosking et al., 2013; Raphael et al., 2019).

Wind fields also play a pivotal role in isotopic dynamics. As discussed in Section 3.2, $\delta^{18}O$ exhibits a positive correlation with the v-wind (southerly) but a negative correlation with the u-wind (westerly). Strong southerly winds can carry warmer or isotopically enriched air, elevating $\delta^{18}O$, whereas westerly winds often import colder, more depleted air from offshore regions. The ASL's variability modulates these wind patterns, so that when the ASL weakens, relatively warmer air masses penetrate farther inland, enriching $\delta^{18}O$ (Figure 5B; Clem et al., 2017).

These findings highlight the essential role of the ASL in regulating isotopic signatures in coastal Antarctica. Nonetheless, it is important to note that correlation alone does not imply a direct causality; the actual isotopic outcome likely reflects the net effect of multiple atmospheric pathways modulated by ASL fluctuations. Future work, possibly involving coupled climate models, could improve our mechanistic understanding of ASL-driven changes in Antarctic precipitation and isotopic composition.

4.3. Relationship between ZW3 and Water Isotopes

This study identified a significant positive correlation between the strength of ZW3 and $\delta^{18}O$ ($r=0.47$, $p<0.01$) in the Hercules Névé region. ZW3 modulates the influx of warm, moisture-laden air masses; in particular, when ZW3 becomes more intense, it facilitates the transport of warmer, isotopically enriched air masses into the Hercules Névé region, resulting in higher $\delta^{18}O$ values. This observation supports

https://doi.org/10.5194/egusphere-2025-1207
Preprint. Discussion started: 16 April 2025

findings from earlier studies indicating that a stronger ZW3 increases warm air advection, thereby enhancing isotopic enrichment in precipitation (Raphael, 2007).

While a strong correlation was observed between the strength of ZW3 and $\delta^{18}O$ variability, the phase of ZW3 did not exhibit a significant relationship with $\delta^{18}O$ in this region, despite the fact that it is known to impact the spatial distribution of atmospheric effects across the Southern Hemisphere. The strength of ZW3 has a notable impact on local climate conditions because it affects the transport of heat and moisture, both of which are associated with $\delta^{18}O$ variability. Notably, the strength of ZW3 correlates with significant sea ice anomalies in the Southern Hemisphere (Goyal et al., 2022), indicating that it influences broad climatic patterns, including variation in surface temperature and moisture availability. Therefore, the strengthening of ZW3 not only drives increased $\delta^{18}O$ in this region but may also impact broader atmospheric and oceanic conditions that influence isotopic composition in polar precipitation.

The interaction between ZW3 and the ASL adds further complexity to the climatic influence on $\delta^{18}O$. Previous studies have highlighted that, when ZW3 is more intense, ASL activity often also increases, resulting in an enhanced influx of cold, dry air masses from the continental interior into the Ross Sea region (Cohen et al., 2013). This process can lead to lower $\delta^{18}O$ values, counteracting the warming effects of ZW3 and introducing isotopically depleted air masses. This complex dynamic suggests that $\delta^{18}O$ variability is influenced by multiple, sometimes opposing, atmospheric factors, including warm air advection from ZW3 and cold air influx associated with ASL activity, indicating that concurrent atmospheric influences need to be considered when interpreting isotopic records.

Furthermore, the combined effects of ZW3 and ASL on $\delta^{18}O$ indicate the presence of a broader climatic mechanism across the Antarctic. For example, when ASL weakens together with strong ZW3 activity, the enhanced warm air transport driven by ZW3 is likely to dominate, leading to enriched $\delta^{18}O$ values in precipitation. Conversely, during periods of strong ASL activity coupled with intense ZW3, cold air incursions may deplete $\delta^{18}O$ despite the usual warming influence of ZW3.

5. Conclusion

This study analyzed a Hercules Névé ice core to investigate the factors influencing water isotope composition in eastern Antarctica. By examining the upper 15 m of the 80-m ice core, we identified clear seasonal variation in the isotopic composition, allowing for a high-resolution chronological reconstruction of approximately 40 years of ice accumulation. This timeline allowed us to trace changes in climate patterns over this period. We concentrated on the effects of water isotopes in the austral summer months, which are crucial for comprehending polynya formation and the atmospheric processes that govern them. Our findings demonstrate that variation in water isotopes, particularly $\delta^{18}O$, is primarily driven by the combined effects of temperature, precipitation, and wind patterns, with significant interactions involving atmospheric pressure systems such as the ASL and ZW3.
Notably, our analysis revealed how specific wind patterns affect isotopic composition. Southerly winds were found to enrich $\delta^{18}O$ values, while westerly winds resulted in relatively depleted $\delta^{18}O$ values. This highlights the complex interactions between atmospheric dynamics and isotopic composition, with the

https://doi.org/10.5194/egusphere-2025-1207
Preprint. Discussion started: 16 April 2025

wind direction potentially affecting local climate conditions. Furthermore, the dexc from the ice core exhibited a positive correlation with SIC and a negative correlation with the SST. This suggests that the katabatic winds contributing to the formation of polynyas were a significant source region for the observed isotopic signals. Overall, the intensity of the winds originating from Antarctica and the range of the SIC are believed to significantly influence precipitation in the study area, thus impacting local climate conditions.

Additionally, we explored the effects of the ASL and ZW3 on atmospheric circulation and isotope variability in the Antarctic region. Changes in the ASL intensity were shown to significantly influence wind direction and strength, leading to measurable changes in $\delta^{18}O$ values. ZW3 played a critical role in transporting warm, moisture-rich air into the area, thereby enriching the isotope composition. These findings highlight the interconnectedness of atmospheric systems and their strong impact on local climate dynamics. However, the processes determining the water isotopes in atmospheric circulation are complex, thus future research should aim to incorporate additional climatic factors to provide a more comprehensive understanding of their collective impacts on isotopic records.

In conclusion, the variability of water isotopes in the Hercules Névé region is primarily driven by the combined effects of temperature, precipitation, and wind patterns, alongside complex interactions with atmospheric pressure systems such as the ASL and ZW3. These results confirm that multiple atmospheric and oceanic drivers need to be considered when interpreting climate and isotopic records from the Antarctic. In addition, the insights gained from this research enhance the understanding of past climate conditions and can also contribute to the development of predictive models for future climate scenarios.

https://doi.org/10.5194/egusphere-2025-1207
Preprint. Discussion started: 16 April 2025

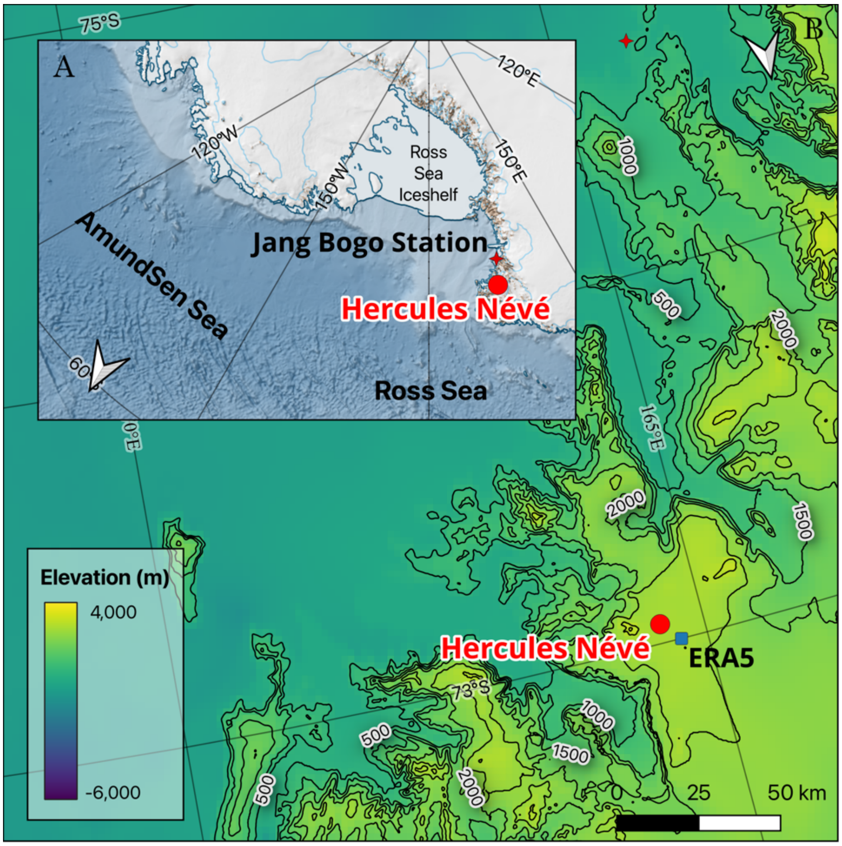


Figure 1 (A) Map of the West and East Antarctica regions showing the Ross Ice Shelf, the Ross Sea, and Hercules Névé. (B) Topographic map of Northern Victoria Land. The red circles indicate the location of the Hercules Névé ice core. The maps were created using Quantarctica 3.2 on QGIS.

https://doi.org/10.5194/egusphere-2025-1207
Preprint. Discussion started: 16 April 2025

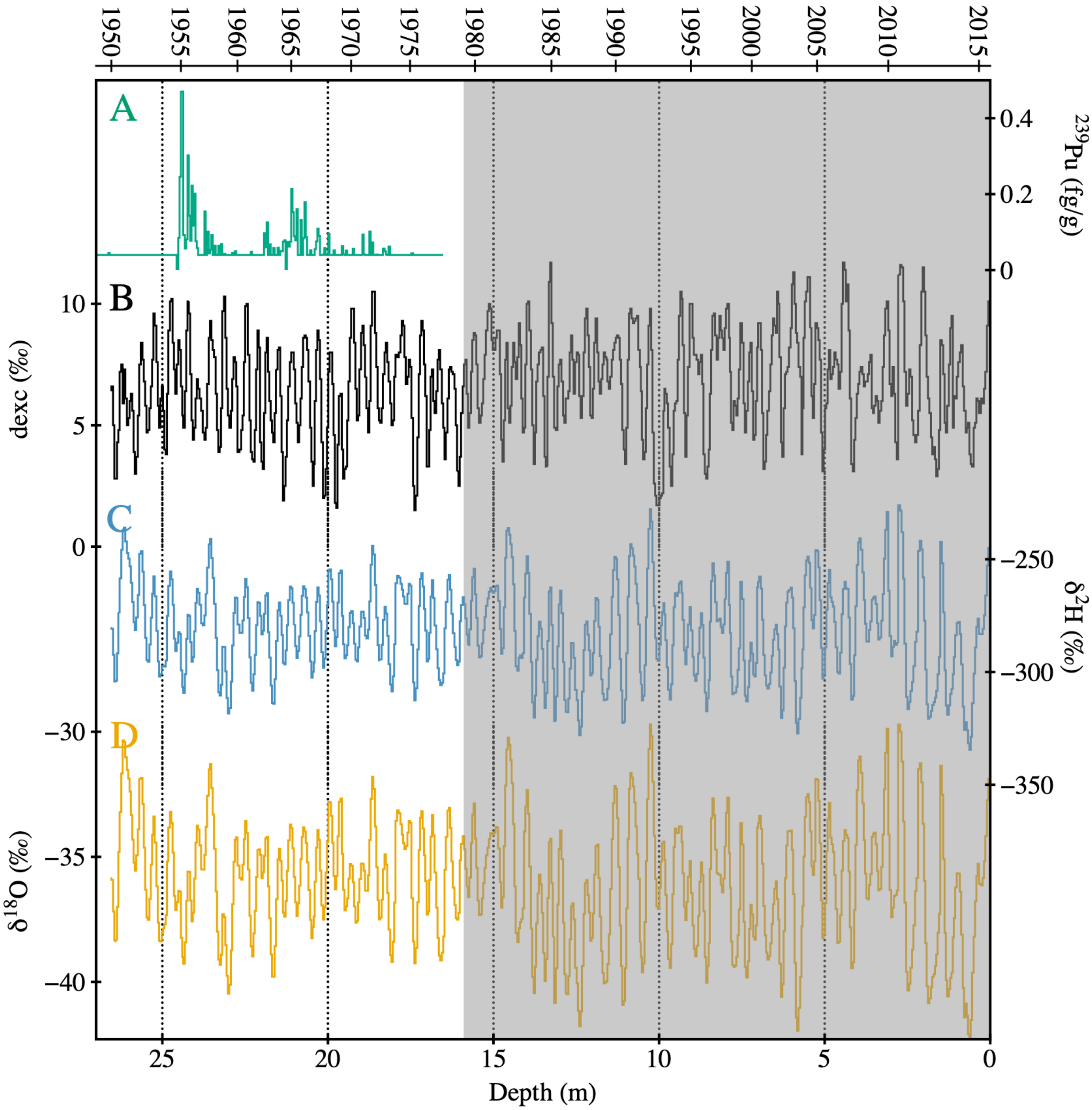


Figure 2: Depth profiles of various parameters from the surface to a depth of 26 m taken from the Hercules Névé ice core. A: ^{239}Pu concentration for the period 1950–1975. B–D: Water isotopes (dexc, δ^2H, and δ^{18}O) for the period 1950–2016. Data from 1979–2015 (highlighted in green) were used in this study.

395

https://doi.org/10.5194/egusphere-2025-1207
Preprint. Discussion started: 16 April 2025

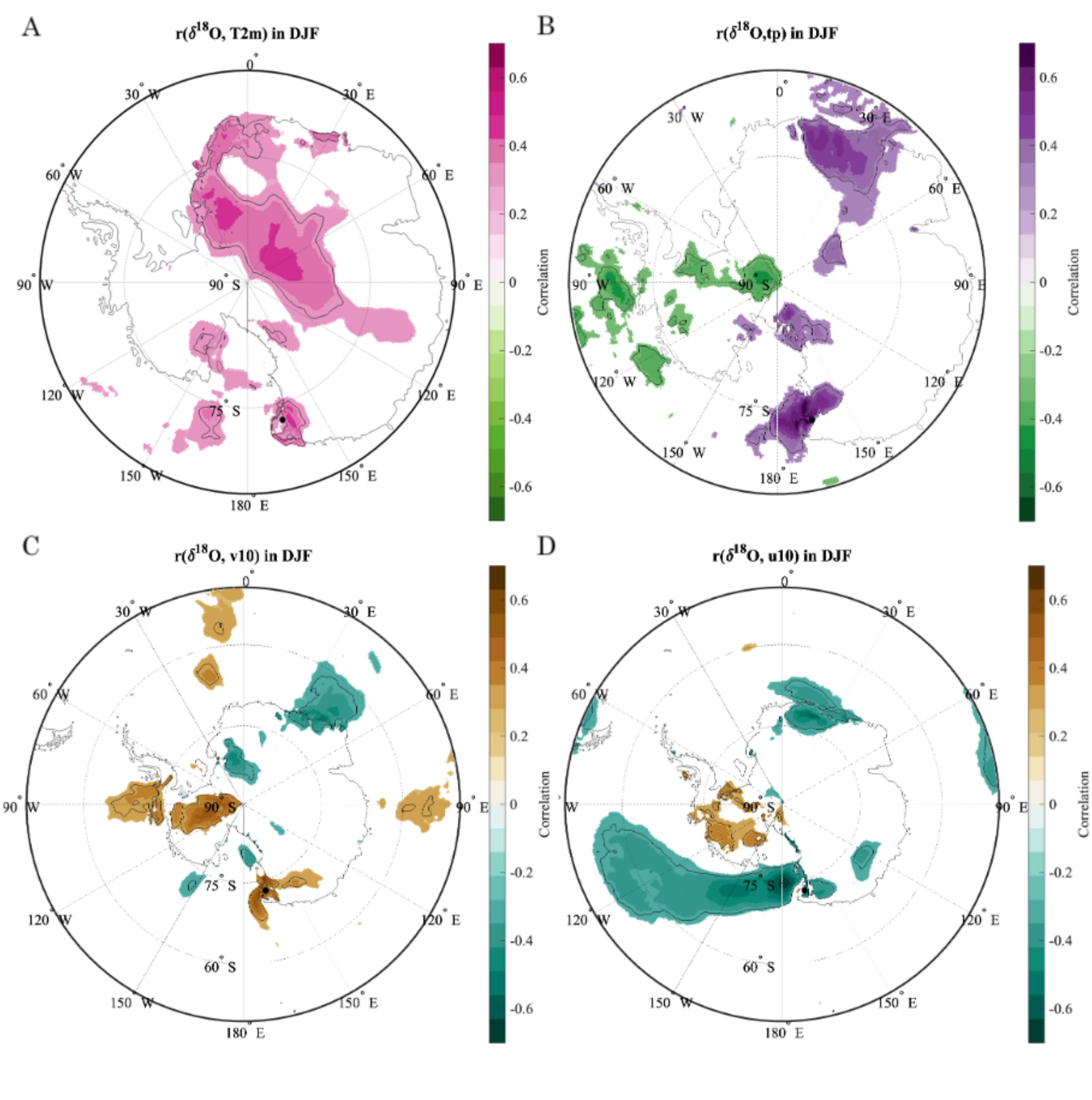
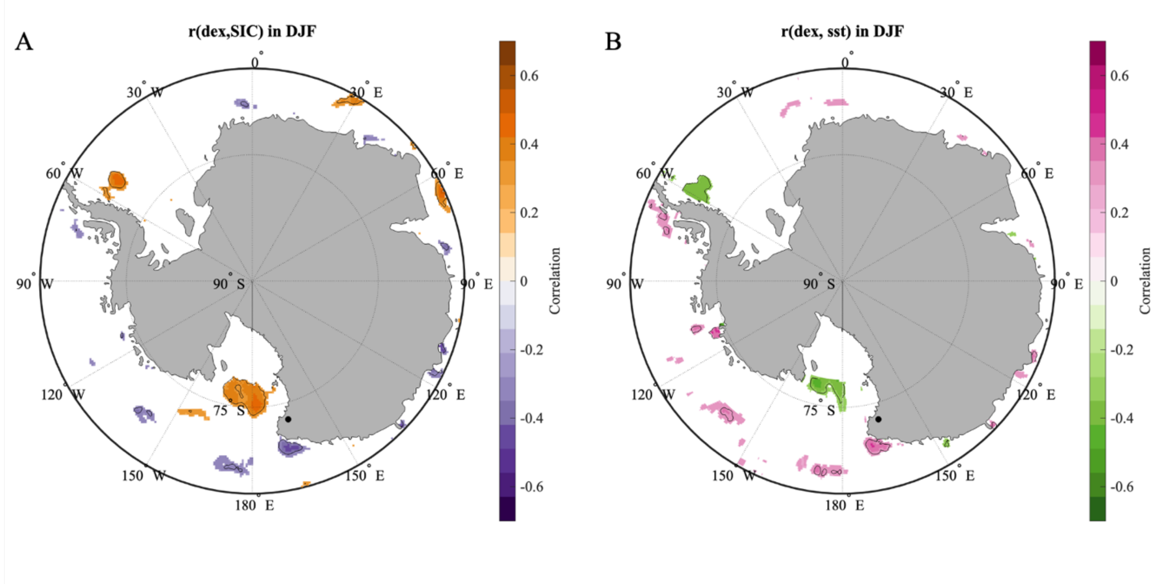


Figure 3: Spatial correlation analysis of (A) the 2 m temperature (T2m), (B) total precipitation (tp), (C) 10 m v-wind (v10), and (D) 10 m u-wind (u10) across Antarctica based on ERA5 data with δ^{18}O in HN ice core (black symbol) from 1979 to 2015 during DJF. The $p < 0.01$ confidence level is indicated by black contours.

https://doi.org/10.5194/egusphere-2025-1207
Preprint. Discussion started: 16 April 2025



405 **Figure 4: Spatial correlation analysis results between the secondary parameter dexc from the HN ice core (black symbol) and (A) the sea ice concentration (SIC) and (B) sea surface temperature (SST) from ERA5 data during DJF for 1979–2015. The $p < 0.01$ confidence level is indicated by black contours.**

https://doi.org/10.5194/egusphere-2025-1207
Preprint. Discussion started: 16 April 2025

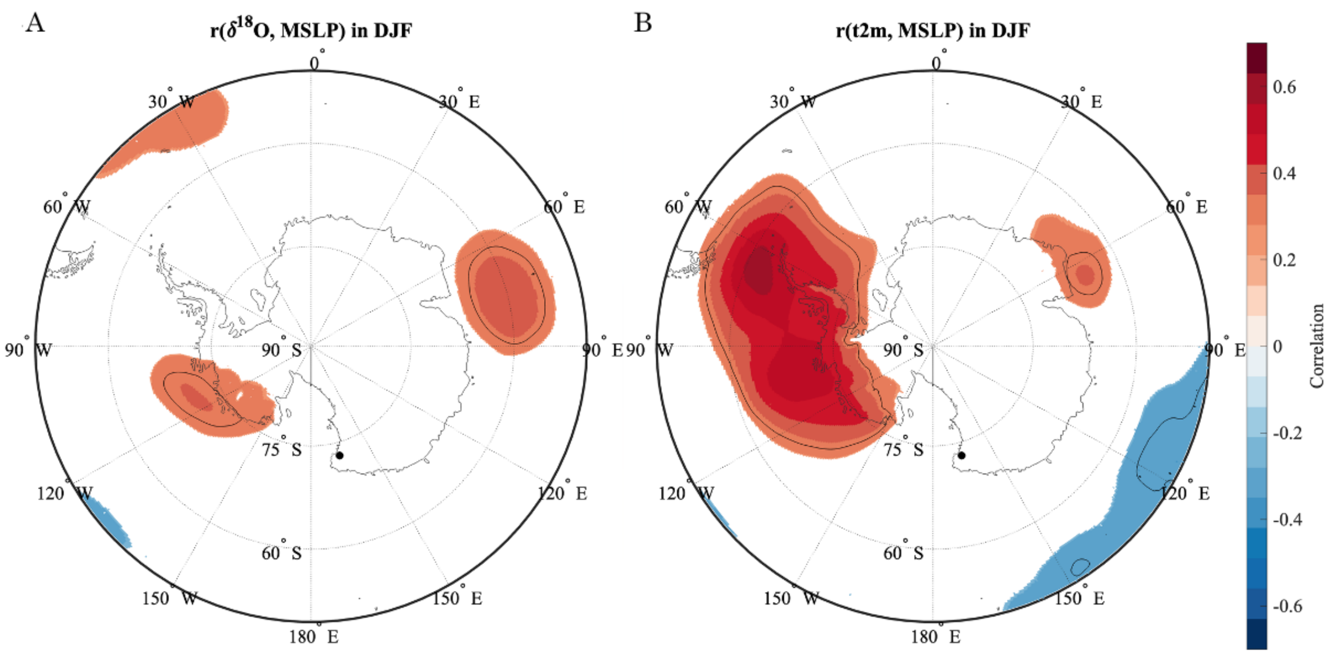


Figure 5: Spatial correlation analysis for (A) δ18O from the HN ice core (black symbol) and (B) the 2 m temperature (t2m) from ERA5 data with the mean sea level pressure (MSLP) from 1979 to 2015 in DJF. Contour plots are used for 410 $p < 0.05$ and black lines for $p < 0.01$.

https://doi.org/10.5194/egusphere-2025-1207
Preprint. Discussion started: 16 April 2025

References

Bertler, N. A. N., Mayewski, P. A., and Carter, L.: Cold conditions in Antarctica during the Little Ice Age — Implications for abrupt climate change mechanisms, Earth and Planetary Science Letters, 308, 41–51, https://doi.org/10.1016/j.epsl.2011.05.021, 2011.

Clem, K. R., Renwick, J. A., and McGregor, J.: Large-Scale Forcing of the Amundsen Sea Low and Its Influence on Sea Ice and West Antarctic Temperature, https://doi.org/10.1175/JCLI-D-16-0891.1, 2017.

Coggins, J. H. J. and McDonald, A. J.: The influence of the Amundsen Sea Low on the winds in the Ross Sea and surroundings: Insights from a synoptic climatology, JGR Atmospheres, 120, 2167–2189, https://doi.org/10.1002/2014JD022830, 2015.

Cohen, L., Dean, S., and Renwick, J.: Synoptic Weather Types for the Ross Sea Region, Antarctica, Journal of Climate, 26, 636–649, https://doi.org/10.1175/JCLI-D-11-00690.1, 2013.

Craig, H.: Isotopic Variations in Meteoric Waters, Science, 133, 1702–1703, https://doi.org/10.1126/science.133.3465.1702, 1961.

Dale, E. R., Katurji, M., McDonald, A. J., Voss, P., Rack, W., and Seto, D.: A Comparison of AMPS Forecasts Near the Ross Sea Polynya With Controlled Meteorological Balloon Observations, JGR Atmospheres, 125, e2019JD030591, https://doi.org/10.1029/2019JD030591, 2020.

Dansgaard, W.: Stable isotopes in precipitation, Tellus, 16, 436–468, https://doi.org/10.1111/j.2153-3490.1964.tb00181.x, 1964.

Emanuelsson, B. D., Renwick, J. A., Bertler, N. A. N., Baisden, W. T., and Thomas, E. R.: The role of large-scale drivers in the Amundsen Sea Low variability and associated changes in water isotopes from the Roosevelt Island ice core, Antarctica, Clim Dyn, 60, 4145–4155, https://doi.org/10.1007/s00382-022-06568-8, 2023.

Faber, A.-K., Møllesøe Vinther, B., Sjolte, J., and Anker Pedersen, R.: How does sea ice influence δ18O of Arctic precipitation?, Atmospheric Chemistry and Physics, 17, 5865–5876, https://doi.org/10.5194/acp-17-5865-2017, 2017.

Fernandoy, F., Meyer, H., Oerter, H., Wilhelms, F., Graf, W., and Schwander, J.: Temporal and spatial variation of stable-isotope ratios and accumulation rates in the hinterland of Neumayer station, East Antarctica, Journal of Glaciology, 56, 673–687, https://doi.org/10.3189/002214310793146296, 2010.

Frezzotti, M., Urbini, S., Proposito, M., Scarchilli, C., and Gandolfi, S.: Spatial and temporal variability of surface mass balance near Talos Dome, East Antarctica, Journal of Geophysical Research: Earth Surface, 112, https://doi.org/10.1029/2006JF000638, 2007.

Gat, J. R., Klein, B., Kushnir, Y., Roether, W., Wernli, H., Yam, R., and Shemesh, A.: Isotope composition of air moisture over the Mediterranean Sea: an index of the air-sea interaction pattern, Tellus B, 55, 953–965, https://doi.org/10.1034/j.1600-0889.2003.00081.x, 2003.

Goursaud, S., Masson-Delmotte, V., Favier, V., Orsi, A., and Werner, M.: Water stable isotope spatio-temporal variability in Antarctica in 1960–2013: observations and simulations from the

ECHAM5-wiso atmospheric general circulation model, Climate of the Past, 14, 923–946, https://doi.org/10.5194/cp-14-923-2018, 2018.

Goyal, R., Jucker, M., Gupta, A. S., and England, M. H.: A New Zonal Wave-3 Index for the Southern Hemisphere, https://doi.org/10.1175/JCLI-D-21-0927.1, 2022.

Han, Y., Jun, S. J., Miyahara, M., Lee, H.-G., Ahn, J., Chung, J. W., Hur, S. D., and Hong, S. B.: Shallow ice-core drilling on Styx glacier, northern Victoria Land, Antarctica in the 2014-2015 summer, jgsk, 51, 343, https://doi.org/10.14770/jgsk.2015.51.3.343, 2015.

Hersbach, H., Bell, B., Berrisford, P., Hirahara, S., Horányi, A., Muñoz-Sabater, J., Nicolas, J., Peubey, C., Radu, R., Schepers, D., Simmons, A., Soci, C., Abdalla, S., Abellan, X., Balsamo, G., Bechtold, P., Biavati, G., Bidlot, J., Bonavita, M., De Chiara, G., Dahlgren, P., Dee, D., Diamantakis, M., Dragani, R., Flemming, J., Forbes, R., Fuentes, M., Geer, A., Haimberger, L., Healy, S., Hogan, R. J., Hólm, E., Janisková, M., Keeley, S., Laloyaux, P., Lopez, P., Lupu, C., Radnoti, G., de Rosnay, P., Rozum, I., Vamborg, F., Villaume, S., and Thépaut, J.-N.: The ERA5 global reanalysis, Quarterly Journal of the Royal Meteorological Society, 146, 1999–2049, https://doi.org/10.1002/qj.3803, 2020.

Holme, C. T., Gkinis, V., and Vinther, B. M.: Molecular diffusion of stable water isotopes in polar firn as a proxy for past temperatures, Geochimica et Cosmochimica Acta, 225, 128–145, https://doi.org/10.1016/j.gca.2018.01.015, 2018.

Hosking, J. S., Orr, A., Marshall, G. J., Turner, J., and Phillips, T.: The Influence of the Amundsen–Bellingshausen Seas Low on the Climate of West Antarctica and Its Representation in Coupled Climate Model Simulations, https://doi.org/10.1175/JCLI-D-12-00813.1, 2013.

Hwang, H., Hur, S. D., Lee, J., Han, Y., Hong, S., and Motoyama, H.: Plutonium fallout reconstructed from an Antarctic Plateau snowpack using inductively coupled plasma sector field mass spectrometry, Science of The Total Environment, 669, 505–511, https://doi.org/10.1016/j.scitotenv.2019.03.105, 2019.

Jackson, S. L., Vance, T. R., Crockart, C., Moy, A., Plummer, C., and Abram, N. J.: Climatology of the Mount Brown South ice core site in East Antarctica: implications for the interpretation of a water isotope record, Climate of the Past, 19, 1653–1675, https://doi.org/10.5194/cp-19-1653-2023, 2023.

Johnsen, S. J., Dahl-Jensen, D., Gundestrup, N., Steffensen, J. P., Clausen, H. B., Miller, H., Masson-Delmotte, V., Sveinbjörnsdottir, A. E., and White, J.: Oxygen isotope and palaeotemperature records from six Greenland ice-core stations: Camp Century, Dye-3, GRIP, GISP2, Renland and NorthGRIP, J Quaternary Science, 16, 299–307, https://doi.org/10.1002/jqs.622, 2001.

Jouzel, J., Alley, R. B., Cuffey, K. M., Dansgaard, W., Grootes, P., Hoffmann, G., Johnsen, S. J., Koster, R. D., Peel, D., Shuman, C. A., Stievenard, M., Stuiver, M., and White, J.: Validity of the temperature reconstruction from water isotopes in ice cores, J. Geophys. Res., 102, 26471–26487, https://doi.org/10.1029/97JC01283, 1997.

Kurosaki, Y., Matoba, S., Iizuka, Y., Niwano, M., Tanikawa, T., Ando, T., Hori, A., Miyamoto, A., Fujita, S., and Aoki, T.: Reconstruction of Sea Ice Concentration in Northern Baffin Bay Using Deuterium Excess in a Coastal Ice Core From the Northwestern Greenland Ice Sheet, Journal of

Geophysical Research: Atmospheres, 125, e2019JD031668, https://doi.org/10.1029/2019JD031668, 2020.

Maggi, V. and Petit, J.-R.: Atmospheric dust concentration record from the Hercules Névé firn core, northern Victoria Land, Antarctica, A. Glaciology., 27, 355–359, https://doi.org/10.3189/S0260305500017729, 1998.

Markle, B. R. and Steig, E. J.: Improving temperature reconstructions from ice-core water-isotope records, Clim. Past, 18, 1321–1368, https://doi.org/10.5194/cp-18-1321-2022, 2022.

Masson-Delmotte, V., Delmotte, M., Morgan, V., Etheridge, D., van Ommen, T., Tartarin, S., and Hoffmann, G.: Recent southern Indian Ocean climate variability inferred from a Law Dome ice core: new insights for the interpretation of coastal Antarctic isotopic records, Climate Dynamics, 21, 153–166, https://doi.org/10.1007/s00382-003-0321-9, 2003.

Masson-Delmotte, V., Hou, S., Ekaykin, A., Jouzel, J., Aristarain, A., Bernardo, R. T., Bromwich, D., Cattani, O., Delmotte, M., Falourd, S., Frezzotti, M., Gallée, H., Genoni, L., Isaksson, E., Landais, A., Helsen, M. M., Hoffmann, G., Lopez, J., Morgan, V., Motoyama, H., Noone, D., Oerter, H., Petit, J. R., Royer, A., Uemura, R., Schmidt, G. A., Schlosser, E., Simões, J. C., Steig, E. J., Stenni, B., Stievenard, M., Van Den Broeke, M. R., Van De Wal, R. S. W., Van De Berg, W. J., Vimeux, F., and White, J. W. C.: A Review of Antarctic Surface Snow Isotopic Composition: Observations, Atmospheric Circulation, and Isotopic Modeling*, Journal of Climate, 21, 3359–3387, https://doi.org/10.1175/2007JCLI2139.1, 2008.

Merlivat, L. and Jouzel, J.: Global climatic interpretation of the deuterium-oxygen 18 relationship for precipitation, J. Geophys. Res., 84, 5029–5033, https://doi.org/10.1029/JC084iC08p05029, 1979.

Nardin, R., Amore, A., Becagli, S., Caiazzo, L., Frezzotti, M., Severi, M., Stenni, B., and Traversi, R.: Volcanic Fluxes Over the Last Millennium as Recorded in the Gv7 Ice Core (Northern Victoria Land, Antarctica), Geosciences, 10, 38, https://doi.org/10.3390/geosciences10010038, 2020.

Noone, D. and Simmonds, I.: Sea ice control of water isotope transport to Antarctica and implications for ice core interpretation, Journal of Geophysical Research: Atmospheres, 109, https://doi.org/10.1029/2003JD004228, 2004.

Nyamgerel, Y., Han, Y., Kim, S., Hong, S.-B., Lee, J., and Hur, S. D.: Chronological characteristics for snow accumulation on Styx Glacier in northern Victoria Land, Antarctica, J. Glaciol., 66, 916–926, https://doi.org/10.1017/jog.2020.53, 2020.

Nyamgerel, Y., Han, Y., Hwang, H., Han, C., Hong, S.-B., Do Hur, S., and Lee, J.: Climate-related variabilities in the Styx-M ice core record from northern Victoria Land, East Antarctica, during 1979–2014, Science of The Total Environment, 935, 173319, https://doi.org/10.1016/j.scitotenv.2024.173319, 2024.

Pfahl, S. and Sodemann, H.: What controls deuterium excess in global precipitation?, Clim. Past, 10, 771–781, https://doi.org/10.5194/cp-10-771-2014, 2014.

Raphael, M. N.: The influence of atmospheric zonal wave three on Antarctic sea ice variability, Journal of Geophysical Research: Atmospheres, 112, https://doi.org/10.1029/2006JD007852, 2007.

Raphael, M. N., Marshall, G. J., Turner, J., Fogt, R. L., Schneider, D., Dixon, D. A., Hosking, J. S., Jones, J. M., and Hobbs, W. R.: The Amundsen Sea Low: Variability, Change, and Impact on

Antarctic Climate, Bulletin of the American Meteorological Society, 97, 111–121, https://doi.org/10.1175/BAMS-D-14-00018.1, 2016.

Raphael, M. N., Holland, M. M., Landrum, L., and Hobbs, W. R.: Links between the Amundsen Sea Low and sea ice in the Ross Sea: seasonal and interannual relationships, Clim Dyn, 52, 2333–2349, https://doi.org/10.1007/s00382-018-4258-4, 2019.

Scarchilli, C., Frezzotti, M., and Ruti, P. M.: Snow precipitation at four ice core sites in East Antarctica: provenance, seasonality and blocking factors, Clim Dyn, 37, 2107–2125, https://doi.org/10.1007/s00382-010-0946-4, 2011.

Servettaz, A. P. M., Orsi, A. J., Curran, M. A. J., Moy, A. D., Landais, A., Agosta, C., Winton, V. H. L., Touzeau, A., McConnell, J. R., Werner, M., and Baroni, M.: Snowfall and Water Stable Isotope Variability in East Antarctica Controlled by Warm Synoptic Events, JGR Atmospheres, 125, e2020JD032863, https://doi.org/10.1029/2020JD032863, 2020.

Sigl, M., Fudge, T. J., Winstrup, M., Cole-Dai, J., Ferris, D., McConnell, J. R., Taylor, K. C., Welten, K. C., Woodruff, T. E., Adolphi, F., Bisiaux, M., Brook, E. J., Buizert, C., Caffee, M. W., Dunbar, N. W., Edwards, R., Geng, L., Iverson, N., Koffman, B., Layman, L., Maselli, O. J., McGwire, K., Muscheler, R., Nishiizumi, K., Pasteris, D. R., Rhodes, R. H., and Sowers, T. A.: The WAIS Divide deep ice core WD2014 chronology – Part 2: Annual-layer counting (0–31 ka BP), Climate of the Past, 12, 769–786, https://doi.org/10.5194/cp-12-769-2016, 2016.

Sime, L., Wolff, E., Oliver, K., and Tindall, J.: Evidence for warmer interglacials in East Antarctic ice cores, Nature, 462, 342–345, https://doi.org/10.1038/nature08564, 2009.

Sinclair, K. E., Bertler, N. A. N., and Ommen, T. D. van: Twentieth-Century Surface Temperature Trends in the Western Ross Sea, Antarctica: Evidence from a High-Resolution Ice Core, https://doi.org/10.1175/JCLI-D-11-00496.1, 2012.

Sinclair, K. E., Bertler, N. A. N., Trompetter, W. J., and Baisden, W. T.: Seasonality of Airmass Pathways to Coastal Antarctica: Ramifications for Interpreting High-Resolution Ice Core Records, Journal of Climate, 26, 2065–2076, https://doi.org/10.1175/JCLI-D-12-00167.1, 2013.

Song, W., Liu, Z., Lan, H., and Huan, X.: Influence of seasonal sea-ice loss on Arctic precipitation δ18O: a GCM-based analysis of monthly data, Polar Research, 42, https://doi.org/10.33265/polar.v42.9751, 2023.

Stammerjohn, S. E., Maksym, T., Massom, R. A., Lowry, K. E., Arrigo, K. R., Yuan, X., Raphael, M., Randall-Goodwin, E., Sherrell, R. M., and Yager, P. L.: Seasonal sea ice changes in the Amundsen Sea, Antarctica, over the period of 1979–2014, Elementa: Science of the Anthropocene, 3, 000055, https://doi.org/10.12952/journal.elementa.000055, 2015.

Steig, E. J., Morse, D. L., Waddington, E. D., Stuiver, M., Grootes, P. M., Mayewski, P. A., Twickler, M. S., and Whitlow, S. I.: Wisconsinan and Holocene Climate History from an Ice Core at Taylor Dome, Western Ross Embayment, Antarctica, Geografiska Annaler: Series A, Physical Geography, 82, 213–235, https://doi.org/10.1111/j.0435-3676.2000.00122.x, 2000.

Stenni, B., Caprioli, R., Cimino, L., Cremisini, C., Flora, O., Gragnani, R., Longinelli, A., Maggi, V., and Torcini, S.: 200 years of isotope and chemical records in a firn core from Hercules Névé,

https://doi.org/10.5194/egusphere-2025-1207
Preprint. Discussion started: 16 April 2025

northern Victoria Land, Antarctica, Ann. Glaciol., 29, 106–112, https://doi.org/10.3189/172756499781821175, 1999.

Stenni, B., Serra, F., Frezzotti, M., Maggi, V., Traversi, R., Becagli, S., and Udisti, R.: Snow accumulation rates in northern Victoria Land, Antarctica, by firn-core analysis, Journal of Glaciology, 2000.

Stenni, B., Proposito, M., Gragnani, R., Flora, O., Jouzel, J., Falourd, S., and Frezzotti, M.: Eight centuries of volcanic signal and climate change at Talos Dome (East Antarctica), Journal of Geophysical Research: Atmospheres, 107, ACL 3-1-ACL 3-13, https://doi.org/10.1029/2000JD000317, 2002.

Tetzner, D., Thomas, E., and Allen, C.: A Validation of ERA5 Reanalysis Data in the Southern Antarctic Peninsula—Ellsworth Land Region, and Its Implications for Ice Core Studies, Geosciences, 9, 289, https://doi.org/10.3390/geosciences9070289, 2019.

Tewari, K., Mishra, S. K., Dewan, A., and Ozawa, H.: Effects of the Antarctic elevation on the atmospheric circulation, Theor Appl Climatol, 143, 1487–1499, https://doi.org/10.1007/s00704-020-03456-1, 2021.

Thomas, E. R., van Wessem, J. M., Roberts, J., Isaksson, E., Schlosser, E., Fudge, T. J., Vallelonga, P., Medley, B., Lenaerts, J., Bertler, N., van den Broeke, M. R., Dixon, D. A., Frezzotti, M., Stenni, B., Curran, M., and Ekaykin, A. A.: Regional Antarctic snow accumulation over the past 1000 years, Climate of the Past, 13, 1491–1513, https://doi.org/10.5194/cp-13-1491-2017, 2017.

Turner, J., Phillips, T., Hosking, J. S., Marshall, G. J., and Orr, A.: The Amundsen Sea low, Intl Journal of Climatology, 33, 1818–1829, https://doi.org/10.1002/joc.3558, 2013.

Turner, J., Hosking, J. S., Marshall, G. J., Phillips, T., and Bracegirdle, T. J.: Antarctic sea ice increase consistent with intrinsic variability of the Amundsen Sea Low, Clim Dyn, 46, 2391–2402, https://doi.org/10.1007/s00382-015-2708-9, 2016.

Uemura, R., Matsui, Y., Yoshimura, K., Motoyama, H., and Yoshida, N.: Evidence of deuterium excess in water vapor as an indicator of ocean surface conditions, J. Geophys. Res., 113, 2008JD010209, https://doi.org/10.1029/2008JD010209, 2008.

Yan, Y., Spaulding, N. E., Bender, M. L., Brook, E. J., Higgins, J. A., Kurbatov, A. V., and Mayewski, P. A.: Enhanced moisture delivery into Victoria Land, East Antarctica, during the early Last Interglacial: implications for West Antarctic Ice Sheet stability, Climate of the Past, 17, 1841–1855, https://doi.org/10.5194/cp-17-1841-2021, 2021.

Yang, J., Han, Y., Orsi, A. J., Kim, S., Han, H., Ryu, Y., Jang, Y., Moon, J., Choi, T., Hur, S. D., and Ahn, J.: Surface Temperature in Twentieth Century at the Styx Glacier, Northern Victoria Land, Antarctica, From Borehole Thermometry, Geophysical Research Letters, 45, 9834–9842, https://doi.org/10.1029/2018GL078770, 2018.