Thank you for the thoughtful and helpful reviews to strengthen the paper.

Reviewer comment 1

In this paper by Winton and co-authors the results achieved from a 120 m deep ice-core are presented. The ice-core was drilled in the DML region (close to Kohnen Station) in 2017 in the framework of the ISOL-ICE project. The main results shown and described in the paper can be summarised in: production of a chronology for the last 1349 years, the history of the accumulation rate at the site along this period and the chemical profiles of selected markers (mainly nitrate, MSA and sea spray species). The chronology was built via annual layers counting with the aid of selected accurate age markers to be used as tie points (volcanic eruptions). The authors clearly write that this work is just the first part of the full job to be done in the framework of the project and I agree with them that the reconstruction of the accumulation rate is very important to better understand the nitrogen isotopes variations in nitrate. We all agree on the importance of the study of the TCO variations in the past but, in this paper, this topic is not studied at all and some sections of the Abstract and of the Introduction should be "cleared" at least in part since they are a bit misleading. I think that especially the Abstract should not give all those details about TCO, UV radiation and nitrogen isotopes. The discussion about the importance of this topic is properly described in section 4.2.

In the abstract and introduction, we have reduced the background information about the ozone layer and UV radiation. We have left the information in the abstract and introduction about the accumulation rate-nitrate isotope relationship as quantifying the accumulation variability and the implications for nitrate isotope interpretation at the site is one of the motives of the study. We have addressed the comments of reviewer 2 about explaining where the work presented here fits within the development of a UV (ozone) proxy in the introduction and a final sentence explaining where the results of this manuscript fit towards the eventual quantification of natural ozone variability in the abstract.

Regarding the chronology, the authors declare an estimated uncertainty at the bottom of the core of 3 years. I have two questions for this point:

1. How was the uncertainty estimated? Is it a sum of the "uncertain" annual layers?

   Yes, it was the sum of uncertain annual layers counting from the previous volcanic age marker.

2. Since you have several well-known volcanic age markers, I would expect the maximum uncertainty in the middle of the largest interval enclosed between volcanic peaks. Which is the maximum uncertainty along the core? Does it coincide with the bottom uncertainty?

   Thank you for this important comment. We agree that reporting the uncertainty over the largest interval between dated volcanic peaks is more appropriate. A maximum uncertainty of 3 years was estimated based on the largest difference in the number of years between a documented eruption date and ISOL-ICE deposition date. To determine this, we compared dates of volcanic deposition horizons with documented eruption dates (Pinatubo, Tambora, Krakatoa, Huaynaputina, Komaga-Take, Kuwae, Samalas). These

eruptions are the most established and well-known volcanic markers observed in Antarctic ice cores over this period.

L250-251 *"A maximum age uncertainty in our layer counting of ± 3 years is estimated between 48-61 m corresponding to about 150 yr (1453-1601 AD), which is one of the largest intervals enclosed between documented volcanic peaks in Antarctic ice cores (Table A2) ."*

All along the manuscript the authors use Na and Mg but from time to time they use the ionic form. I know that the authors measured the "total" content of the two species but, as stated at line 139, the total is assumed to represent mostly the ionic specie. The same thing holds true for chloride which is sometimes Cl- and other times Cl. I think that the ionic forms would be to be preferred all along the text.

We have updated the manuscript with the ionic form throughout.

Figure 3 (a) shows an interesting "dip" a few years before 2000 but this feature is not discussed in the text. Do the authors have a possible explanation for this section? Such significant variations in the accumulation rate will be basic in correctly interpret the N-nitrate isotopic changes and thus past surface-UV and TCO implications.

Thank you for pointing out this interesting feature in the record. The ISOL-ICE snow accumulation rate decreases between 1950-1980 and increases between 1979 and 1991. Figure A below shows the running 13-year trends for the accumulation rate and shows that the 1979-1991 period had the strongest accumulation increase on this decadal time scale. The increase in accumulation over the period is consistent with a composite accumulation record from ice cores in the region (Oerter et al., 2000). Reanalysis data prior to this is less reliable over Antarctica and the Southern Ocean as this is a data spare region and the satellite sounder data were assimilated from 1979 onward. Thus, we examined the 1979-1991 period further.

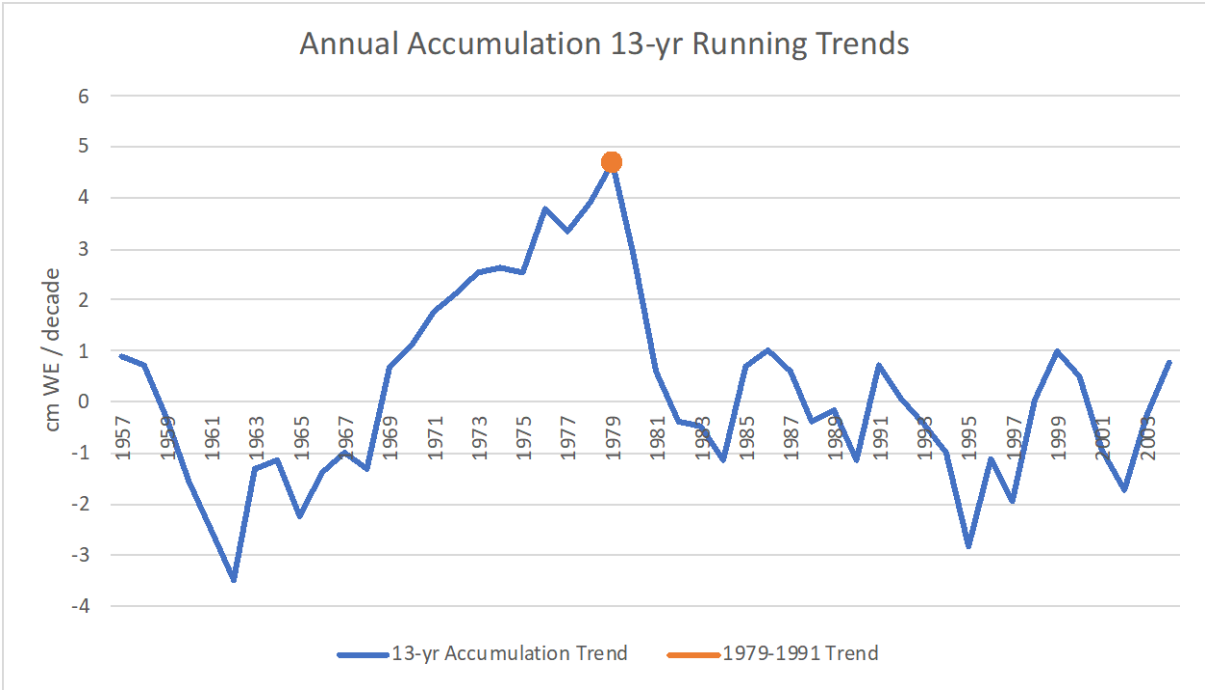

Figure A: Running 13-yr trends of the ISOL-ICE accumulation rate, showing the 1979-1991 period has the strongest accumulation increase on this decadal time scale.

Figure B shows the 500 hPa geopotential height and wind annual and seasonal trends for the 1979-1991 period. In terms of annual trends, there was stronger cyclonic circulation. There was also increased northerly flow to the site in certain seasons. Figure B shows more northerly flow coming in from the Weddell Sea to the west of the ISOL-ICE site in autumn (MAM) tied to increased pressure/anticyclonic circulation along the coast of DML near 0° longitude. This can explain the higher accumulation in MAM and thus dominating the increase in the annual accumulation rate. In addition, there was more northerly flow to the ISOL-ICE site from the northeast in summer (DJF) tied to a decrease in pressure/cyclonic circulation offshore of DML between 0-15°E. Both circulation trends in DJF and MAM reflect a trend toward a more prominent zonal wave 3 pattern (three high-low pressure pairs surrounding Antarctica), especially in MAM.

The finding over the 1979-1991 period reinforces the correlations observed for annual accumulation in Figure 4a and our conclusions that higher annual snow accumulation is associated with anomalous low pressure over the Weddell Sea and northly flow from the South Atlantic bringing marine airmasses to the ice core site. While we did not find any significant changes with temperature, ENSO or SAM over this period, other periods of decade long accumulation increases occur elsewhere in the record. For example, between 1840 and 1849 which could be tied to synoptic circulation assuming the snow accumulation-geopotential heigh relationship did not change.

Text added to L505-516 *"The ISOL-ICE snow accumulation rate increased between 1979 and 1991 consistent with a composite accumulation record from ice cores in the region (Oerter et al., 2000). The increased accumulation rate is tied to local increases in northerly flow to the DML region associated with regional circulation changes along/offshore the DML coast during the austral summer (December to February) and austral autumn (March to May) seasons. The broader circulation pattern trend in these two seasons resembles a zonal wave 3 pattern, especially in austral autumn. Thus, while we don't find a significant*

relationship between accumulation and ENSO/SAM, zonal wave 3, a well-known and prominent internal feature of the Southern Hemisphere atmospheric circulation (e.g. Goyal et al., 2022; Raphael, 2004), may be an important mechanism for producing localised northerly flow to the site that can influence accumulation variability. Also, these results reinforce earlier findings from Figure 4a and highlight the likely importance of sub-annual, seasonal circulation changes and variability in driving annual accumulation variability. Furthermore, other periods of decade long accumulation increases occur elsewhere in the record, e.g., between 1840 and 1849 which could also result from stronger synoptic circulation assuming the snow accumulation-geopotential height relationship did not change."

Text added L497-499 *"As local deposition influences the accumulation rate in the DML region as shown through multiple ice core accumulation records (e.g., Oerter et al., 2000; Sommer et al., 2000), a site-specific accumulation record is required for the interpretation of the ISOL-ICE $\delta^{15}N(NO_3^-)$ record."*

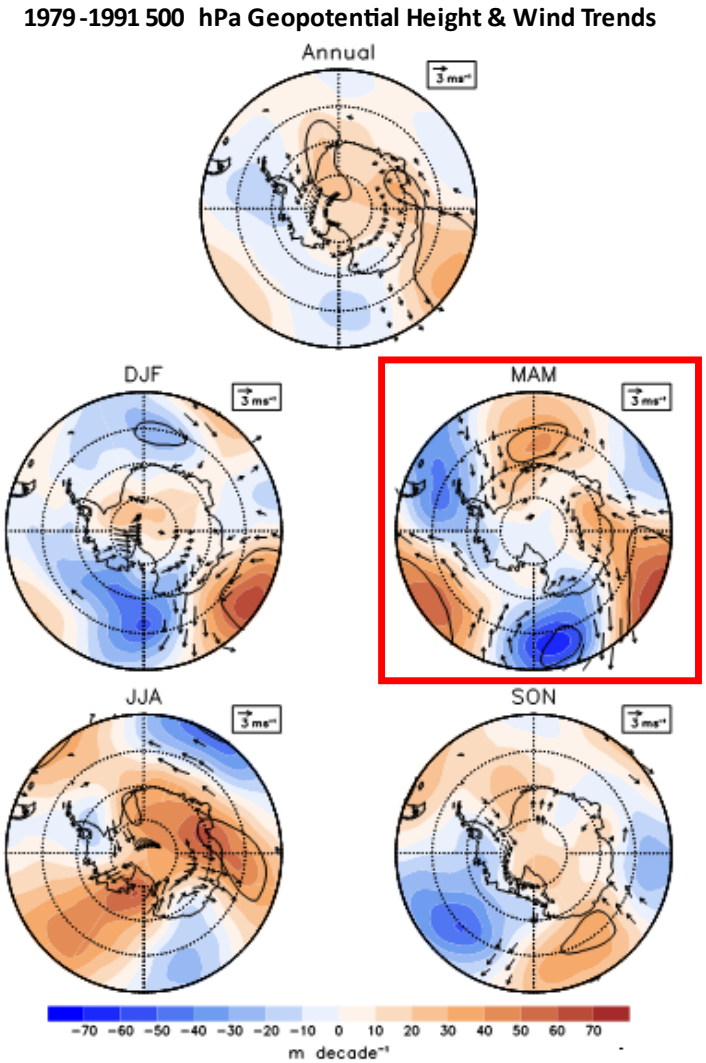

Figure B: The 500 hPa geopotential height and wind trends for annual and seasonal periods between 1979 and 1991. Bold contours outline 10 % significance level trends, and wind vectors are plotted only if at least one wind component trend is significance at the 10 % level.

Minor comments:

Line 19: when the authors speak about an extension of the previous records by two decades, I guessed that was an extension back in time but I understood later that it's an extension towards more recent years. Elsewhere in the manuscript this was correctly said. I invite the authors to correct this expression in the abstract in order to clarify this point.

Text added L20 "…towards the present."

Line 132: insert a space between Cl- and "was".

Done.

Line 139: change to "are assumed"

Done.

Line 263: change "with SAM …" to "between SAM…"

Done.

Line 488: change the full stop before "While" in a comma.

We have left the sentences as two separate sentences combining them results in a very long sentence.

Figure A3: bottom panels: y-axes add + to Na in both panels

Done.

Table A2: I would prefer "Deposition date" instead of "Arrival date" in the title of the third column.

Done.

Table A3: the SAM/accumulation R should be bold
Done.

References

Goyal, R., Jucker, M., Gupta, A. S., and England, M. H.: A new zonal wave-3 index for the Southern Hemisphere, Journal of Climate, 35, 5137-5149, 2022.
Oerter, H., Wilhelms, F., Jung-Rothenhäusler, F., Göktas, F., Miller, H., Graf, W., and Sommer, S.: Accumulation rates in Dronning Maud Land, Antarctica, as revealed by dielectric-profiling measurements of shallow firn cores, Annals of Glaciology, 30, 27-34, 2000.
Raphael, M.: A zonal wave 3 index for the Southern Hemisphere, Geophysical Research Letters, 31, 2004.