Response to reviewer comments on "Physico-chemical properties of the top 120 m of two ice cores in Dronning Maud Land (East Antarctica)…..**" by Wauthy et al.**

We would like to warmly thank both referees for their very constructive comments which have greatly improved the quality of the manuscript. We provide here below detailed "one to one" response to all their comments and a separate version of the new manuscript with related track changes.

Referee 1

Wauthy et al. provided the ice cores data of density, water stable isotopes (δ18O, δD and derived deuterium excess), ions concentrations (Na+, K+, Mg+, Ca+, MSA, Cl-, SO4 2- and NO3 -), and the continuous electrical conductivity measurement Primary data), as well as the derived data records of age models and surface mass balance from the top 120 m of two ice cores (FK17 and TIR18) drilled on two adjacent ice rises located in coastal Dronning Maud Land, east Antarctica. The authors propose that the datasets presented here offer numerous development possibilities for interpreting the different paleo records and addressing the mechanisms behind the spatial and temporal variability observed at the regional scale in East Antarctica. Since the article is data-based, my comments are restricted to the suitability of data for ESSD and its benefits to the scientific community.

Major comments

My primary concern is not providing the complete data for longer climate records of the entire ice core. Here, the authors provide only the ice cores data of the upper 120 m of two adjacent ice rises (Hammarryggen and Lokeryggen) located on the coastal Dronning Maud Land (cDML) along the Princess Ragnhild Coast, East Antarctica. The ice core data profiles provide a time scale to the past 200 to 250 years of ice core data. Several high-resolution ice cores records for similar data profiles have been available from the cDML region for the past 100 to 250 years (e.g. Graf et al., 2002; Naik et al., 2010; Vega et al., 2018; Ejaz et al., 2021; Dey et al., 2022). What is missing from the cDML region is longer climate records from CDML, where westerlies and sea ice extends variabilities were well influenced by the region in the past. The authors claim that the total length of the two ice cores available is 208 m from the Lokeryggen and 268 m from the Hammarryggen ice rises, which maybe provide climate profiles for the past 500 to 700 years data profiles. Hence, I strongly recommend that the authors provide the entire data records for a long time scale, which will be useful to understand past climate variability for a longer time and validate regional/global model results.

Response:

We agree with Referee 1 that it would be ideal to reconstruct past climate profiles on the whole available profiles. However, we can only provide, at this stage, analyses of the upper 120 m for both ice cores because our laboratory is not equipped with a CFA instrument and the acquisition of the entire datasets (5000 samples multiplied by the number of measured parameters) took more than three years. We believe these results are already worth publishing since they cover the whole Anthropocene transition and document the strong spatial and temporal variability at those spatial and temporal time scales. Aware of the need for longer ice core records, we plan the complete analyses of these ice cores in the coming years.

Regarding the papers mentioned by Referee 1, three of these are already used to support our discussion (i.e. Naik et al., 2010, Vega et al., 2018 and Ejaz et al., 2021). The Graf et al., (2002) paper focuses on the DML plateau and we therefore do not consider it as relevant for our coastal DML focus. As for Dey et al., (2022), we acknowledge the interest of the visual stratigraphy method obtained from line-scan images presented in that paper for the chronology and melt features but this subject is far from our main topic. Note that now we use the results of our detailed “classical” visual inspection of the cores to discuss the potential impact of melt layers in response to one of Referee 2 comments. We would also like to emphasize that most of the mentioned papers either focus on one parameter (Graf et al., 2002 and Naik et al., 2010) or are complementary to another paper (Vega et al., 2018 and Ejaz et al., 2021). Here we present complete datasets (with multiple parameters) for the two ice cores, which have consequences timewise.

As the authors pointed out, accurate dating for shallow cores is tricky. Especially identifying annual layers using water isotopes/major ions was sometimes challenging because of the high noise and background levels due to the coastal location of the ice cores and the post-depositional process. Even the same can be reflected in the nssSO42-, which identifies volcanic peaks. Hence, I suggest using a proxy that is not influenced by sea supply and does not have many post-depositional effects, such as tritium isotopes (the well-known tritium peak of the largest nuclear bomb testing "Tsar Bomba" in 1961 observed in all compiled tritium records ranges between 1961 and 1962), which were well recorded in the several cDML ice cores. However, the age-depth model and the automatic dating from StratiCounter further improved the uncertainties from the present coastal ice core data.

Response:

Thank you for the suggestion of using tritium isotopes. These are not “standard” measurements and were not used in many other similar studies. They were thus not planned in our analyses schedule. We do not have the possibility to measure these in our laboratory, and the option to do the analyses in another dedicated laboratory would incur considerable delays. However, this will certainly be taken into account when planning for future ice cores projects. As underlined by the referee, the uncertainties are constrained by our age-model and the automatic dating from StratiCounter. Moreover, we have now developed an appendix (Appendix D) to describe our dating procedure step-by-step and added a full description of the error calculations in section 3.2 as well as error estimates in the figures and tables presenting SMB results.

Specific comments

Section 2.2.2

Instead of only representing the standard deviation of each ion at line 185, please include a table on precision and accuracy/ any error corrections/SD for all the major ions measurements.

Response:

We replaced the sentence by a table presenting the standard deviation (which measures precision) and added accuracy values (Table 1 in the new version of the manuscript).

Section 2.4.1

Since the reconstructed surface mass balance (SMB) from ice cores can be associated with significant uncertainties, especially at the top parts of the ice core, if authors have a shallow radar profile/Radargram from the region, use it for better SMB reconstruction from the ice core and along with other chronological markers/density profile. The same may be included in the text.

Response:

As stated in the paper, Cavitte et al., 2022 showed that our ice cores are representative for a small surface area of the ice rises (~200-500 m radius) but are good representative of the temporal variability. They used shallow radar observations to conclude this. We already mentioned in the original manuscript that: "(SMBs) are systematically 0.08-0.16 m i.e. a^{-1} lower (at the drilling site) than the mean SMB value calculated for the whole ice rise". A potential user of the dataset, interested in estimates of the SMB at the whole ice rise scale can then apply these correction factors to our calculated SMBs. We prefer to keep the values at the core location for comparison to other ice cores. It should also be noted that thse radar SMB estimations rely on dating the ice core.

Overall comments

The authors presented new data from two adjacent ice cores from the cDML region, and the data will be helpful for future comparison of paleoclimate data on regional/global time scales. As mentioned in the above comments, a few additions will improve the data quality/ in the methods and materials sections. Also, additional references/citations to other data sets or missing articles may be incorporated in the comments. The data set is usable in its current format and size, and the article's length is appropriate. All the figures and tables are correct and of high quality. However, the article needs to be improved based on the suggested comments for publication in ESSD.

The abovementioned issues can be addressed with reasonable additions and extra analysis. Hence, I leave it to the Editor to decide whether to recommend modifications and resubmit or leave them all.

References

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