

We thank Prof. Cole-Dai for his helpful and constructive remarks on the manuscript. Here below is reported our point-to-point reply to each stressed issue starting with “Reply”.

“Dating of an East Antarctic ice core (GV7) by high resolution chemical stratigraphies” Nardin et al. (2021)

Climate of the Past

Public comment: Jihong Cole-Dai

- This discussion paper details how annual layer counting is used to date an shallow ice core from a coastal region in East Antarctica. The paper gets into many specifics of how annual/seasonal cycles in measured ice core chemical content originate and are identified. This is good because these specifics are important to the accuracy and precision of ice core dating.
- Seasonal cycles in ice core parameters depend on the seasonal variations of the chemical species at their source. The Introduction section of the paper seems to imply that as long as there is a source seasonal variation, seasonal cycles can be found in ice cores. However, that is not the only dependency that may determine whether seasonal cycles can be identified and utilized for dating. Two other factors are also important in determining whether a seasonal cycle in a parameter can be found in ice cores. One is the transport process from the source area to the ice core site. Seasonal variations in source may be moderated or even erased by differences in transport efficiency during different time periods of a year. One example is sea-salt components such as Na and Mg ions. Sea-salt aerosols may not be particularly more abundant in winter to many Antarctic locations; but stronger winds in winter and spring may bring higher levels of sea-salt aerosols to a site, resulting in a winter-high and summer-low seasonal pattern. The second factor is preservation of seasonal signals in snow. Water oxygen isotope composition is an example: vapor diffusion can gradually even out the difference between summer and winter, eventually smoothing out seasonal cycles completely. Another such example is nitrate: Even though nitrate is primarily produced in summer with photochemical reactions in the atmosphere, significant post-depositional change (reemission of nitrate as NO_x) make the nitrate annual cycle in snow or ice unrecognizable, such that nitrate is not a good annual layer indicator in many places in Antarctica.
So, when discussing using seasonal cycles for dating in general, it may be important to point out the limitations such as those mentioned above and caution against unrealistic optimism.

Reply: Thank you for your comment and for pointing this out. The points raised by Prof. Cole-Dai are actually very relevant when studying seasonal patterns and would deserve an extensive discussion that, although very interesting, is beyond the scope of this paper. Nevertheless, we will try to summarize and briefly discuss in the revised Introduction the source, transport and preservation issues of sea salt and nitrate.

- I have some difficulty understanding the significance of the equations in (2) (lines 172-175). The first two are simply stating the facts (total is equal to the sum of sea-salt fraction and the non-sea-salt fraction). In the other two, $ssNa$ and $nssCa$ are supposed to be calculated from measured ion concentrations. However, calculation of $ssNa$ requires the knowledge of $nssCa$, while the calculation of $nssCa$ requires the knowledge of $ssNa$. How could ion measurement lead to $ssNa$ and/or $nssCa$, if each requires one to know the other first?

Reply: Thank you for your comment. As previously done in other Antarctic ice cores (e.g. Roethlisberger et al., GRL 2002; Wolff et al., Nature, 2006; Benassai et al., Ann. Glaciol., 2005), to evaluate terrestrial and marine contributions to Ca^{2+} and Na^+ , we just solved the equation system (2) reported in the manuscript. From IC analysis we achieve the concentration of total Na^+ and total Ca^{2+} and, by applying the sea water and crustal ratios of these ions we derive the sea salt Na^+ and non-sea salt Ca^{2+} content.

- A significant part of the paper or the outcome of dating the ice core by annual layer counting is an accumulation history of some 960 years. Analysis of this history by the authors shows a slight increasing trend for most parts of this period. I did not see any mention in the paper about the effect of layer thinning due to ice flow. While layer thinning in the top 10% of the ice sheet thickness is usually negligibly small, thinning in and of itself could generate or contribute to a trend, albeit small. Could the authors do a calculation based on a simple flow model to determine if layer thinning may be responsible for part of the increasing trend in accumulation? Another factor to consider is the effect of snow/ice density, for calculation of layer thickness/accumulation rate in water equivalent depends on density which could vary widely. The paper gives only a superficial description of how density was measured and how the measured density was used to be part of the calculation of annual layer thickness.

Reply: Thank you for pointing this out. Ice thinning was taken into account when calculating and discussing the snow accumulation rate. More details will be added in the main text (in the methodology section, together with further information on the density of the ice core and how it was evaluated on site), but to summarize, we assumed a constant thinning function (assuming an ice thickness of 1530 m).