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Climate of the Past Discussions

Interactive comment on "The SP19 Chronology for the South Pole Ice Core – Part 1: Volcanic matching and annual-layer counting" *by* Dominic A. Winski et al.

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Review by Anders Svensson of manuscript entitled 'The SP19 Chronology for the South Pole Ice Core – Part 1: Volcanic matching and annual-layer counting' submitted to Climate of the Past by D. Winsky et al.

The manuscript (MS) introduces a stratigraphic chronology SP19 of the South Pole SPICE ice core based on 1) Holocene layer counting in high-resolution discrete chemistry samples and continuous records, and 2) a transfer of the WD2014 chronology based on identification of 251 common volcanic match points distributed over the last 54 ka. The layer counting is compared to a previously obtained independent layer

counting from the same core based on visual stratigraphy alone. Furthermore, the authors are introducing an accumulation rate profile for the SPICE core based on a kink model. The model is compared to upstream accumulation patterns, to nitrate concentration profiles and to a d15N of N2 profile that all seem to support the obtained accumulation profile.

Overall, the MS is well written, well referenced and the figures are clear and illustrative of the study. The MS is well structured, the language is clear and the conclusions are well argued for. I only have a few comments below for the authors to consider.

The authors perform multiple careful counting of annual layers of the Holocene using chemical parameters, continuous dust and conductivity. They then compare their resulting layer counting to an independent layer counting based on visual stratigraphy alone, and find an overall good agreement between the two approaches (Figure 9). Whereas this is a good test to see how well the two independent approaches are, it would probably have resulted in a better overall time scale, if all of the available high-resolution records (chemistry + visual stratigraphy) had been combined in a common dating exercise from the beginning?

Whereas I agree to the approach of transferring the WD2014 chronology to SPICE core rather than publishing a new independent time scale for SPICE core, it still seems like quite a large effort to do 4x independent layer counting of SPICE just to end up doing a transfer of time scale? Probably most of that time scale transfer could have been done based on a depth-depth matching alone (WDC – SPICE) similar to the approach taken in Figure 5?

There are certain depth intervals (228-275m and 626-687m), where all of the independent layer counting plus the automated Straticounter dating approach consistently count significantly fewer annual layers than suggested by the transfer of the WD2014 time scale. I understand that this consistent undercounting is associated with periods of exceptionally low accumulation (upstream) at SPICE. Are the authors convinced,

however, that their layer counting is wrong and that there is not a problem with the WD2014 counting in one or both of those periods? In other words, can the authors account for all of the 'missing' layers when they go back and recount the critical sections in SPICE core? I'm not suggesting that the authors should revise the WD2014 time scale, but independent checks are always useful, and considering the effort put into precise dating of SPICE, an outcome may be suggestions for future revisions of the WDC chronology?

112,843 samples were collected and analyzed individually for this project! Did the authors consider doing fewer discrete and more continuous sample analysis? A CFA system optimized for depth/time resolution should be able to resolve the annual layering throughout the Holocene period. Of course, I'm not suggesting to do that now, but for future projects it may be an alternative?

A depth-difference relation figure between the two synchronized ice cores (SPICE, WDC) is very good for evaluating the synchronization and/or to identify regions where accumulation/thinning of the two records deviate. See Figure 2 of Seierstad et al., QSR, 2014: 'Consistently dated records from the Greenland GRIP, GISP2 and NGRIP ice cores for the past 104 ka reveal regional millennial-scale d18O gradients with possible Heinrich event imprint'.

After having nicely synchronized the SPICE and WDC records, it would be nice to see the two climate profiles (water isotopes) in the same figure on their common time scale. If for whatever reason that is not possible, maybe the Calcium profiles of the two ice cores can be shown together? It is difficult for the reader to evaluate the quality of the volcanic matching without seeing a comparison of some parameter of the two ice core records.

Minor comments:

Accumulation mistakenly used in figure 7 caption, already mentioned by Frederic. In Figure 3 is shown the seasonal variability of four impurities but not including nitrate.

In section 4.5 and in Figure 11B the nitrate seasonality is discussed. Maybe it makes sense to include the seasonal variability of nitrate in Figure 3?

In Figure 7, the annual layer thickness appears to stay constant or even increase throughout the glacial part of the record. Wouldn't one normally expect a thinning of annual layering with depth?

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