Review of Yan et al.

Yan et al. present atmospheric gas measurements from a blue ice core in the Allan Hills which spans the time period of approximately 110 ka to 250 ka. The atmospheric measurements are high resolution and high quality, and allow a reliable timescale for the gas phase to be developed. The ice-age timescale was previously developed by Spaulding et al., 2013. The primary interpretation in the paper is that there is an order of magnitude change in the gas-age/ice-age difference (dage) from termination II to the last interglacial. The dage drops from a few thousand years to a few hundred, which the authors interpret as being due to a large increase in snowfall in the region during the last interglacial, indicating a significant change in atmospheric circulation during this period of higher global sea level and possibly smaller Antarctic ice sheet volume.

A conclusion of a climatically different Last Interglacial would be interesting and important; however, the authors do not critically evaluate the ice timescale that was previously developed by Spaulding et al. (2013). It is worth noting that the low dage values at ~128 ka are not unique in this core. The authors point out the unphysical negative dage values at ~200 ka; however, the authors don't address that there is a second time period of near-zero dage at ~145 ka (see figure below) in additional to the one at ~128 ka. This is visible in Figure 6 where the ice (red) and gas (black) timescales nearly touch, and it is even more clear plotting up the supplemental data. This is just older than 115-140 ka time period that the authors zoom in on. It seems particularly relevant to the interpretation because an increase in accumulation in both the last interglacial and the previous glacial maximum would have different climatic implications than if it occurred during just the previous interglacial.

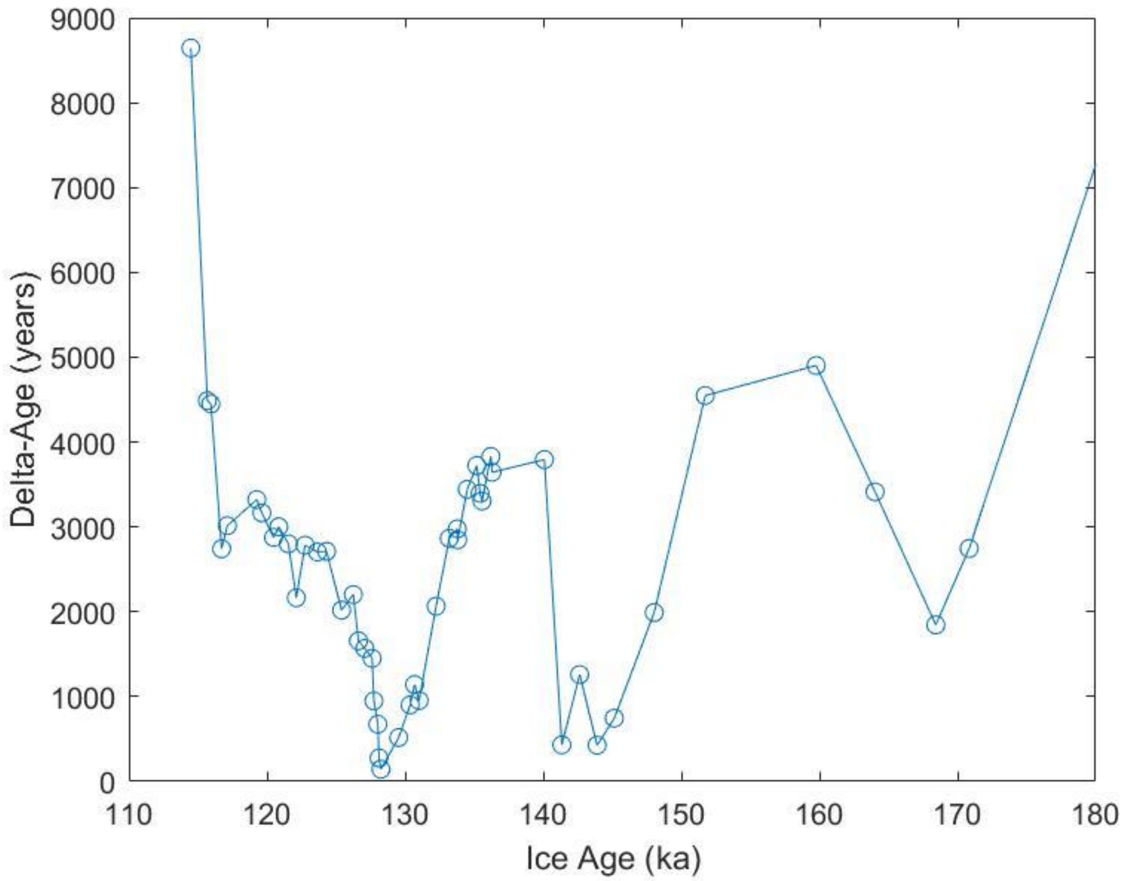
The authors accept that the Spaulding et al. tie points with the water isotope isotopes are accurate and precise, yet the Spaulding et al. tie points were not scrutinized for centennial-scale precision because that was not the purpose of that paper. Instead, Spaulding et al. sought to demonstrate an approximately continuous climate record from the core (S27), which they did. Water isotopes records are quite useful for matching broad climate events, but are rarely relied upon for precise synchronization. One of the features which varies substantially among cores is the peak of the Last Interglacial, which is of particular importance to this study. Visual inspection of the S27 and EDC (Figures 1 and 9) and Talos (Spaulding et al., 2013, Figure 7) show broad agreement, but also significant differences on centennial-to-millennial timescales - particularly at the peak Last Interglacial warmth. The authors write "L284-285 unambiguous feature matching (e.g. the distinct MIS5e peak around 128.2 ka)" was not unambiguous to me when I downloaded the S27 dD data (props to Spaulding et al. making it publicly available back in 2013). Trying to make this pick in depth-space, I had to accept a slow rise to the maximum, relative to the EDC dD on depth. This in turn causes sharp changes in the average annual layer thickness. Yes, this could be the result of a change in accumulation, but it can also be an indicator of incorrect tie points. My point here is not that the authors have the tie points wrong, but that to support their conclusion, they need to revisit the ice timescale and demonstrate that the tie points are accurate to a century. There needs to be an uncertainty on the water isotope tie points and the method for developing it described.

Regarding the ice timescale, it is surprising that there is no corroboration of the water isotope tie points with tephra or sulfate/ECM. Tephra matches are the gold standard, and pattern matching of sulfate peaks is the common currency for timescale synchronization. Narcisi et al. (2005; EPSL) found a distinct tephra at 1732.5m, now dated to ~131ka, which would seem to be an obvious candidate even if not perfectly timed to evaluate the dage minimum. Fujita et al. (2015, CP) were able to synchronize EDC and

Dome Fuji throughout this time period, so sulfate/ECM matches may be possible. The S27 average annual layer thickness is only about ½ that of EDC, with only a slightly lower inferred accumulation rate, so the potential for sulfate matching should at least be discussed – there may be something limiting it, but if so, it would be good to discuss what that is and whether that has its own implications for the integrity of the timescale.

The authors also need to discuss why this would indicate a regional signal instead of a local signal. Blue ice areas are particularly sensitive to small changes in climate. One can imagine a slight change in the wind and accumulation pattern could lead to an infinite change in accumulation – from net ablation to net accumulation. Therefore, the paper needs an extended description of the modern accumulation/ablation gradients in the source region. The reference of Kehrl et al. 2018 is provided for the source region, but it should be noted that no radar data have been collected from the actual source region, with the flowline needing to be extended ~10km to the local ice divide. It's also not clear that the position of this ice divide has been steady through time. Taylor Dome is a nearby ice divide for which the glaciological setting was studied extensively to support the ice core drilled there. The accumulation gradient across the dome spans an order of magnitude, 1cm/yr to 10cm/yr (Morse et al., 1999, Geografiska Annaler). And there are extreme km-scale gradients in accumulation rate (potentially 4cm/yr to 0.4cm/yr in 1 to 2 km; Morse et al., 1999, Figure 5). Advection through a gradient like this could produce the type of feature from 126-130 ka, with ice velocities of <1 m/yr. Also interestingly, the pattern of accumulation, based on ice penetrating radar, appears to have reversed between the Holocene and LGM (Morse et al., 1998, GRL).

In summary, the record from the blue ice core S27 is intriguing, but the main conclusion of an accumulation increase at the peak of the Last Interglacial is not sufficiently supported. Further development of the ice timescale is needed to ensure the dage determination is accurate.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