

## RESPONSE TO REFEREE 1, cp-2019-89:

We are thankful to the referee for their useful and constructive comments.

A point by point response to the review is detailed below. The text in blue is the text of the review, and the corresponding responses follow in black. The typos pointed-out by the referee will be corrected in the article, and are not specifically addressed in this response.

P1, Line 21 The bubbles contain air from the time of formation. Also rather write that so far the past atmosphere has been measured back to 820kyr BP.

The articles we found studying gases in the oldest part of the EDC ice core are Bereiter et al 2014 (806kyr, doi:10.1002/2014GL061957) and Tison et al 2015 (potentially 840kyr, doi:10.5194/tc-9-1633-2015). Perhaps the referee had a particular study in mind, that we unfortunately did not find. As the exact dating of the EDC ice core is not crucial for this article we propose to modify the article with the sentence: *“In particular, the bubbles enclosed in polar ice contain air that dates back their time of formation, and their analysis can be used to reconstruct the atmospheric composition history over more than 800kyr (Bazin et al 2012, Veres et al 2012, Bereiter et al 2014, Tison et al 2015)”*

P3, L3 there are plans to retrieve oldest ice in Antarctica based on the site selection from EU, Japan, China, Australia. . . Cite one of the site selection papers.

We will add a reference to the current research for oldest ice with the sentence. *“There is currently an effort to retrieve a more than a million year-old ice core on the East Antarctic plateau (Fischer et al 2013, Sutter et al 2019)”*

P3, L25 Please give the ball park of the present Vostok and DC accumulation rates.

We will add the modern-day accumulation rates at Dome C and Vostok with the sentence *“Hence, “Lock-In” has a similar temperature but a higher accumulation rate than Vostok and Dome C, that respectively have accumulation rates of 2.2 and 2.5 cm we yr-1 (Lipenkov et al 1997, Gautier et al 2016)”*

P16, L23 instead of "8%" write "corresponding to  $\alpha = 0.92$ "

The 8% value corresponds to the difference in driving pressure difference between closed and open pores, not to the difference in compressibility. The article will be made clearer with the sentences *“The driver of pore compression in the firn is  $\Delta P$ , the difference between the overburden pressure of the ice and the air pressure of the pores (Lipenkov et al., 1997). As reported by Martinerie et al. (1992), the  $\Delta P$  of open and closed pores differ by less than 8%, and it is not clear how this  $\Delta P$  difference translates in terms of bubble compressibility difference.”*

Figure 6 The color for 80.65m and 101.45m are not very well distinguishable. If possible please chose a different color.

We will modify the figure to make it more readable

P24, L9 Sentence is unclear

This and the following sentences will be modified to *“Either, this less dense layer is due to the absence of ice-softening impurities, but still contains enough conductive (non-softening) ions for the liquid conductivity no to drop. In this case the density variability is still related to a variability of ice-softening ions, but is simply not reflected in the liquid conductivity.”*

Best Regards,

Kévin Fourteau on behalf of all co-authors