

Interactive comment on “On the gas-ice depth difference (Δ depth) along the EPICA Dome C ice core” by F. Parrenin et al.

F. Parrenin et al.

parrenin@ujf-grenoble.fr

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original text is plain, answer is bold

In this paper the discussion about dating uncertainties of climate records from polar ice cores is stimulated by a comparison study of different methods to calculate the gas-ice depth difference (Δ depth) along the EPICA Dome C ice core. It is a compilation of approaches including pure firn and ice flow modelling, a d15N based estimation, ice and gas synchronisation techniques and the thermal bipolar seesaw hypothesis. One of the main conclusion is that the ice-gas cross synchronisations (using GRIP, TALDICE and EDML) give general support for the bipolar seesaw anti-phase relationship. A further interesting aspect is that the d15N estimates for the Δ depth of EDC in the last Glacial period are in a better agreement with the estimates from synchronisation

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methods than Δ depth estimates using recent firn densification models. As one future strategy to improve the EDC age scales precise and highly resolved measurements of d15N and CH₄ are suggested. In my opinion the paper is relevant and appropriate for publication in CP. Some minor revisions should be considered:

Specific comments: 1) page 1091; lines 18-28 Advantages and drawbacks of Δ depth approach: The sentences about the advantages and drawbacks of Δ depth and dage approaches in the introduction imply that only the Δ age approaches have the disadvantage to be strongly depended on the accumulation rate which is poorly constrained for the past. But actually this is also true for Δ depth approaches when there are make use of flow or firn densification modelling because both models need accumulation rates as input. This is done in method 1 (flow and densification modelling) and 2 (flow modelling) as well as in method 3 (flow and firn densification modelling for EDML and TALDICE).

Δ depth is only weakly dependent on accumulation rate because both the LID and the thinning function are only weakly dependent on accumulation rate. We stated this more clearly in the introduction.

An additional disadvantage of the Δ depth approach lies in the difficulty to judge the dating uncertainty in terms of years (what is needed) because a certain bias in Δ depth means increasing uncertainties in Δ age with absolute depth.

This is true. We added a corresponding sentence in the introduction.

2) page 1092ff; lines 12ff: Re-structuring of the method section: The sub-division of the method section is a little bit confusing. I would suggest that it would be more clear if the section is divided into the different Δ depth methods that are discussed (2.1 Δ depth from ice flow and densification methods, 2.2 Δ depth from ice flow modelling and d15N based estimates of firn thickness, 2.3 Δ depth from ice and gas synchronisations, 2.4. Δ depth from the thermal bipolar seesaw hypothesis)

This was exactly the organisation of our original manuscript but some mistakes went through during the typesetting phase and we did not check carefully enough. The problem will be corrected in the next version.

3) page 1095; lines 15-25: There is no explanation of $f(z)$ given in eq (9), in general it is difficult to follow the quantification of the uncertainty on the modelled thinning function

There was a mistake in eq (9) (but not in our calculations) which is now corrected.

4) page 1096; line 2: Reference Figure 2 instead Figure 7.

Corrected.

5) page 1096; line 23 and page 1101; line 7: Definition of LID: 20(at EDML) of closed pores? What is the reason for the discrepancy?

Here we are just describing what has been done/used in past studies (mainly Louergue et al., 2007) but was not fully described. These are observations of the closed porosity proportion at the LID, the latest being given by the start of the N15 plateau. These observations of the closed porosity have unfortunately never been completely published but we have some plan to do so.

6) page 1097; line 2: The interpretation of the differences in Δ depth derived from the 4 methods is really a difficult task due to the different level of inner-dependency. However with focus on the $d_{15}N$ estimates of Δ depth in the glacial period (which is one of the interesting results) it might be instructive to compare the simulated Δ ages (or LID) in an accumulation-temperature graph as it is shown in Figure 3 only for the densification model.

It is not very appropriate to plot the LID inferred from N15 in an accumulation/temperature diagram since both temperature and accumulation are linked with an exponential relationship (we would therefore only define a curve in the accumulation/temperature diagram).

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Otherwise I would skip Fig.3 because there is no link to the discussion.

Figure 3 is indeed not mandatory but useful for starters and we think it is not a problem to keep it in the manuscript.

7) page 1098; line 7: $d_{15}N$ -estimate: Equation (15), probably it is only a mistake in writing and not in thinking. Otherwise the $d_{15}N$ estimates have to recalculate. It should be: $h = h_{conv} + d_{15}N / ((T) * G + \Delta mg * 1000 / RT)$

Indeed it is a mistake introduced in the typesetting phase (we did not check carefully enough) and it will be corrected in the revised version.

We wish to warmly thank the reviewer for his careful review.

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