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Climate of the Past Discussions

Interactive comment on "On the gas-ice depth difference (△depth) along the EPICA Dome C ice core" *by* F. Parrenin et al.

Anonymous Referee #2

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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 (△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 △depth of EDC in the last Glacial period are in a better agreement with the estimates from synchronisation methods than △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 △depth approach: The sentences about the advantages and drawbacks of △depth and dage approaches in the introduction imply that only the △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 △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). An additional disadvantage of the △depth approach lies in the difficulty to judge the dating uncertainty in terms of years (what is needed) because a certain bias in △depth means increasing uncertainties in △age with absolute depth.

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 △depth methods that are discussed (2.1 △depth from ice flow and densification methods, 2.2 △depth from ice flow modelling and d15N based estimates of firn thickness, 2.3 △depth from ice and gas synchronisations, 2.4. △depth from the thermal bipolar seesaw hypothesis)

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

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

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

6) page 1097; line 2: The interpretation of the differences in △depth derived from the 4 methods is really a difficult task due to the different level of inner-dependency. However

with focus on the d15N estimates of Δdepth in the glacial period (which is one of the interesting results) it might be instructive to compare the simulated Δages (or LID) in a accumulation-temperature graph as it is shown in Figure 3 only for the densification model. Otherwise I would skip Fig.3 because there is no link to the discussion.

7) page 1098; line 7: d15N-estimate: Equation (15), probably it is only a mistake in writing and not in thinking. Otherwise the d15N estimates have to recalculate. It should be: h=hconv + d15N / (Ω(T)*G+ Δmg*1000/RT)

Interactive comment on Clim. Past Discuss., 8, 1089, 2012.