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Climate of the Past Discussions

Interactive comment on "The EDC3 chronology for the EPICA Dome C ice core" *by* F. Parrenin et al.

F. Parrenin et al.

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Reviewer's comments are in a normal font.
Answers are in a **Bold** font.

General comments: In this paper the authors present the new EDC3 time scale for the EPICA Dome-C deep ice core. The authors provide us initially with a very useful discussion on the different types of accuracies involved i.e. absolute, relative and the duration of climatic events. The dating is based on several steps and actions including: 1. A highly advanced accumulation rate driven ice flow model for the Dome-C area. 2. Independent age markers are defined and used to constrain the model parameters using Monte Carlo inversion methods. The age markers are based on a wide variety of data and applications of novel methods; the related discussions make up the most important part of the paper. 3. Corrections of the oldest 400-800 kyr BP age scale are introduced in order to cope with deformation anomalies not captured by the ice flow model below 2700 meters or so. The age scale is further more tuned into the

new Greenland GICC05 absolutely counted age scale back to 41 kyr BP. Several submitted papers and papers in preparation make out the back bone of this dating effort, unfortunately these papers are not available for inspection. We must assume that the results applied from these papers are based on solid data and equally solid scientific argumentation.

A large part of these works are submitted in the same Climate of the Past special issue. The corresponding manuscript can be freely downloaded from CP's website for evaluation. The main exception is the air content work by Raynaud et al.. It has been submitted to EPSL and currently is in revisions.

The resulting chronology is compared with other independent chronologies from ice cores and deep ocean sediment cores. This comparison suggests that the final glaciological flow model is highly accurate back to 400 kyr BP. Amazing when we consider the small number of parameter defining the model. The accuracies of the new time scale is finally estimated from the discrepancies found between the different time scales which seems to give quite reasonable estimates. This most impressive dating effort presented in the paper is based on input from a large number of specialists that have provided a wealth of unique data and ideas. Having followed this effort from a distance, it looks as if the group leader started out with a "soup stone" and the group then provided all the ingredients needed for a most "delicious" outcome.

We thank you for the flavorful metaphor. :-)

Several ice cores in Antarctica and Greenland have quite early on been dated using related methods. This historic background, which the work described in the paper is built on top of, is totally missing implying that all the methods and ideas employed in the paper are new.

It was not our spirit to claim our methods and ideas were new. Actually, previous ice flow modelling works are referenced in the companion manuscript '1D-ice flow modelling at EPICA Dome C and Dome Fuji', also submitted to Climate

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of the Past. Moreover, the number of articles related to ice core dating huge, and it is why we chose to summarize it by just describing the main categories. We nevertheless tried to add a 'historical background' paragraph in the revised manuscript.

Below I am including some key references the authors should consider to include as a part of such a discussion, to be embedded into the text where appropriate. Camp Century was dated with a new flow model with reduced strain rates below a kink depth [Dansgaard and Johnsen, 1969]. A general discussion on the then state of the art methods for dating ice cores was given in [Hammer, et al., 1978]. The CC and the Dye-3 cores were also correctly dated/interpreted by matching the stable isotopes to the SPECMAP stack [Dansgaard, et al., 1985]. The GRIP core was dated with a CC type ice flow model by introducing partial bottom sliding, exponential delta accumulation dependency and delta sea corrections, furthermore two fix points were used for tuning model parameters [Johnsen, et al., 1992; Johnsen, et al., 2001; Johnsen and Dansgaard, 1992]. The GISP2 core was dated with annual layer counting and matching with SPECMAP through del18Oatm [Alley, et al., 1997; Bender, et al., 1994; Meese, et al., 1994]. In Antarctica we have the partly successful dating of the Byrd ice core with full bottom sliding 2D flow models [Johnsen, et al., 1972]. Counting of annual ECM layers was also done back to the LGM [Hammer, et al., 1994]. The Vostok core was originally dated using an advanced 2D flow model and acc. rate dependency for the delta values [Lorius, et al., 1985; Ritz, 1989] (or other possibly more appropriate references). Also matching the Vostok del18Oatm record to the orbital SPECMAP scale has been employed by [Bender, et al., 1994].

We thank you for this input, that we took into account in a 'historical background' paragraph in the revised manuscript.

In general the paper is very well written and organized, the advanced methods employed are very well explained and the scientific level is fully matching CP standards. Thus the paper should be published with the few changes proposed. Finally let me

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congratulate the authors for a job well done in a perfect team effort that undoubtedly will set the standard for accurate dating of low accumulation rate Antarctic ice cores for years to come.

Thank you. :-)

Specific comments: Page 583, line 17. The 4200 yr BP date stated should be closer to 42000 yr BP.

Corrected.

Page 590, lines 2 and 3. “shorten in EDC3, while duration.....” should read “shortened in EDC3, while the duration.....”.

Corrected.

In “Acknowledgements” a mention of the drilling consortium responsible for the recovery of the EDC and EDML ice cores is “loudly” missing.

Corrected.

The green age difference curve in Fig. 3 does not comply with the discussion in the paper.

It was a bug in the graph which has now been corrected.

References: Alley, R. B., et al. (1997), Visual-stratigraphic dating of the GISP2 ice core: Basic, reproducibility, and application, Journal of Geophysical Research, 102, 26367-26381. Bender, M., et al. (1994), Climate correlations between Greenland and Antarctica during the last 100,000 years, Nature, 372, 663-666. Dansgaard, W., et al. (1985), Dating and climatic interpretation of two deep Greenland ice cores, in Greenland Ice Core: Geophysics, Geochemistry, and the Environment, edited by C. C. J. Langway, et al., pp. 71-76, American Geophysical Union (AGU), Washington D.C. Dansgaard, W., and S. J. Johnsen (1969), A flow model and a time scale for the ice core from Camp Century, Greenland, Journal of Glaciology, 8, 215-223. Hammer, C.

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U., et al. (1978), Dating of Greenland ice cores by flow models, isotopes, volcanic debris, and continental dust, Journal of Glaciology, 20, 3-26. Hammer, C. U., et al. (1994), Electrical conductivity method (ECM) stratigraphic dating of the Byrd Station ice core, Antarctica, Annals of Glaciology, 20, 115-120. Johnsen, S. J., et al. (1992), Irregular glacial interstadials recorded in a new Greenland ice core, Nature, 359, 311-313. Johnsen, S. J., et al. (2001), Oxygen isotope and palaeotemperature records from six Greenland ice-core stations: Camp Century, Dye-3, GRIP, GISP2, Renland and NorthGRIP, Journal of Quaternary Science, 16, 299-307. Johnsen, S. J., and W. Dansgaard (1992), On flow model dating of stable isotope records from Greenland ice cores, in The Last Deglaciation: Absolute and Radiocarbon Chronologies, edited by E. Bard and W. S. Broecker, pp. 13-24, Springer-Verlag, New York. Johnsen, S. J., et al. (1972), Oxygen isotope profiles through the Antarctic and Greenland ice sheets, Nature, 235, 429-434. Lorius, C., et al. (1985), A 150,000-year climatic record from Antarctic ice, Nature, 316, 591-596. Meese, D. A., et al. (1994), Preliminary depth-age scale of the GISP2 ice core, CRREL Special Report, 94-1, 66pp. Ritz, C. (1989), Interpretation of the temperature profile measured at Vostok, East Antarctica, Annals of Glaciology, 12, 138-144.

We thank you for your constructive review.

Interactive comment on Clim. Past Discuss., 3, 575, 2007.