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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 #3

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This paper presents the results of several modeled and empirical estimates of the depth difference between ice and gas for the same age, along the Dome C deep ice core. This depth difference is useful for constraining firn thickness and ice thinning (and validating the models to estimate them), which are important for constructing the timescales of ice and gas. The authors found overestimation of the depth difference in purely model-based estimates in the last glacial period, likely due to errors in the firn densification model. They also confirmed irregular thinning in the deep part of the core. The topics are well suited for the scope of the journal and the paper represents important contribution toward solving the issues around timescales of ice and gas. However, there are several points that need to be addressed/clarified before the paper can be accepted for publication.

Major problems: (1) The paper uses EDC3 chronology but there is a more accurate (at least for the last glacial period) chronology for this core by Lemieux-Dudon (2010). Because an accurate chronology is necessary for the analyses in this paper, the latter timescale should be used in this study.

(2) Section 3.2 presents wrong observations. From fig. 8, the TD-synchro yields delta-depth which is systematically larger than the results from EDML-synchro and seesaw, and in consistent with model-based estimate, for the depths above around 800 m (latter part of the last glacial period). The differences between TD-synchro and EDML-synchro are larger than the error bars. These need to be described and possible causes should be discussed.

Minor problems: P1091, L10. There are several definitions for COD in the past literature. More than one definition are used in this paper so the readers will be confused. Here it is stated "the Close Off Depth (COD), where it is not possible to pump air". But in p1096, L22 it is stated, "at Close-Off, 37% of the pores are closed". Please clarify the definition of COD employed in this study.

L13-17. There are more recent papers for the temperature-CO2 timing for the last termination, and they suggest almost no lag of CO2 relative to Antarctic temperature.

Loulergue, L., F. Parrenin, T. Blunier, J. Barnola, R. Spahni, A. Schilt, G. Raisbeck, and J. Chappellaz (2007), New constraints on the gas age-ice age difference along the EPICA ice cores, 0-50 kyr, Clim. Past, 3, 527.

Pedro, J. B., T. D. van Ommen, S. O. Rasmussen, V. I. Morgan, J. Chappellaz, A. D. Moy, V. Masson-Delmotte, and M. Delmotte (2011), The last deglaciation: timing the bipolar seesaw, Clim. Past, 7(2), 671-683.

P1097, L7. Is this a section title?

P1097, L11-12. References presenting concept and evidence of convective zone are missing. Following papers should be cited.

Sowers, T., M. Bender, D. Raynaud, and Y. S. Korotkevich (1992), δ15N of N2 in air trapped in polar ice: a tracer of gas transport in the firn and a possible constraint on ice age-gas age differences, J. Geophys. Res., 97(D14), 15683-15697.

Bender, M. L., T. Sowers, J. Barnola, and J. Chappellaz (1994), Changes in the O2/N2 ratio of the atmosphere during recent decades reflected in the composition of air in the firn at Vostok Station, Antarctica, GRL, 21(3), 189-192.

Kawamura, K., J. P. Severinghaus, S. Ishidoya, S. Sugawara, G. Hashida, H. Motoyama, Y. Fujii, S. Aoki, and T. Nakazawa (2006), Convective mixing of air in firn at four polar sites, EPSL, 244, 672.

P1098, L7. Eq (15) has error (as pointed out by other reviewers).

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