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Climate of the Past Discussions

Interactive comment on "Post-depositional changes in snow isotope content: preliminary results of laboratory experiments" *by* A. A. Ekaykin et al.

Anonymous Referee #3

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The manuscript deals with post depositional processes, PDs, in the top of the firn like studied by Sokratov and Golubev (2009) (missing in the list of references) that are suspected to affect the isotopic levels in ice cores. Other processes like proposed by Neumann and Waddington (2004) are not considered. Ultimately these changes could affect reconstructions of past temperatures based on the isotope thermometer. These processes are so far not fully understood and need to be studied further. A sophisticated lab experiment was designed by the authors with the purpose to simulate sublimation on the top of the snow surface, and to reveal the resulting isotopic shifts. The conditions on top of the snow surface in the field are, however, only partly mimicked. Unfortunately the deuterium excess is not included which is an important player

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in reconstructing past temperatures. If the samples are still available deuterium data should be included in a revised version. The excess data could also help constrain any models designed to explain the results. Sections 1 and 2 are quite useful for the reader as they give a comprehensive overview of previous field, lab and theoretical evidence concerning PD processes. The description of their experiment is slightly misleading. In particular the schematics and picture of the set up are way too small to be fully understood. Several parameters are introduced for describing the mass and isotope balance. It would help to list these parameters separately. The various outcome of the experiment is an important contribution for helping our understanding of these processes in a qualitative way at least. On the other hand, to "briefly overview preliminary results" is not acceptable for readers of CP. The parameter "k" in equation 3 looks quite dubious when it is found in the range of 10 to 100. How can you separate "s" into + and - components unless you have a solid model explaining the isotope wave based on the nature of the interaction between the vapour in the box and the snow matrix. How do you estimate the isotopic signature of the two fluxes? Why is the bulk of the sublimation flux not just delivered from the top surface of the samples even with minimum fractionation. This possibility is supported by the following observations: i) the sample surface is simply being lowered during the runs and ii) no sign of reduced density is observed except possibly for the -5°C experiment. The important data in Fig. 5 deserves a much clearer presentation. Use a color code for the number of the sampling sequence and use clear markers as well. In my opinion, the documentation of the isotope wave is the most important finding of this work, even in spite of some discrepancies (cf. Exp. 1, 3 and 4). You should, if possible, also present the complete data set in the next version of the paper. For the benefit of the paelo-community also show a plot of the thickness and mean isotopic value for the isotope wave at the end of each experiment; relevant data for correcting ice core isotope profiles. The mixing in the box seems to be insufficient and unstable, e.g. depending on the free depth in the sample containers. For instance the final sublimation in Exp. 1, starting at snow height of 6.8 cm, is about double that of Exp. 3 and renders much stronger isotope

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enrichment (both runs at -35°C). Clearly the next version of this experimental set up needs serious modifications in order to give reproducible results independent of the geometry in the box, not the least due to the results in Exp. 4. In Fig. 6 a plot of the mean isotope values of the snow samples against the sublimation depth is shown. The nice linear relationship looks some how accidental; in any event the statement in the footnote on page 2254 can only be true if the sum of the sublimation loss and the depth of the isotope wave are much smaller than the depth of the sample box. Two data points from the work of Sokratov and Golubev (2009) are included in the plot supporting their findings. In fact their interesting work should be compared much more extensively with the present experiments. In Fig. 6 one data point is set close to 70 % relative sublimation which is not in line with Fig. 5, where the max mass loss observed is rather 50 %? The work presented in this paper renders some support to the notion that central Antarctic ice cores can be slightly affected by the PD processes discussed, an important conclusion not fully stated by the authors. The paper should be suitable for CP after revision when you have considered all published comments. The ice core palaeo community needs to be much more aware of these types of processes possibly affecting their isotopic records.

Interactive comment on Clim. Past Discuss., 5, 2239, 2009.