The Cryosphere Discuss.,
doi:10.5194/tc-2017-35-AC3, 2017

The Cryosphere Discussions
Open Access
EGU

Interactive comment on "Constraints on post-depositional isotope modifications in East Antarctic firn from analysing temporal changes of isotope profiles" *by* Thomas Münch et al.

Thomas Münch et al.

thomas.muench@awi.de

Received and published: 31 May 2017

We thank the editor for his comments for which our author comments (AC) are given below.

O_____When you say that diffusion and condensation 'only smooth and compress the original signal', you should precise that you are talking about vapor diffusion against isotopic gradients. AC: It is indeed a good point to precise to which diffusion process we refer here. However, to our knowledge the term "against isotopic gradients" is not common in the literature. Diffusion rather acts "down" the (concentration) gradients. We will change the sentence to "The isotope ratios of buried snow are affected by firn densification (...) and by diffusion of interstitial water vapour driven by gradients in the

Printer-friendly version

Discussion paper

isotopic composition (...)".

EC: Sorry but I don't understand the statement "by diffusion of interstitial water vapour driven by gradients in the isotopic composition (...)". It appear to me that the sentence is claiming that isotopic gradient is a driving force of change. Vapour diffusion in snow is driven by T gradients not by isotopic composition. The isotopic gradient will drive the diffusion only if the system under consideration was isothermal, purely diffusional. In the present situation, the change of enthalpy induced by the T gradient is orders of magnitude greater than the change of enthalpy induced by the isotopic gradient. Isotopic composition change is thus a result, not a driving force. Please rephrase so that the reader is not confused by which process is responsible for the change in the isotopic composition.

AC:

We thank the editor for clarifying this issue. It is indeed true that only for isothermal firn diffusion is driven alone by the different isotopic composition of the layers. For non-constant temperatures, the main driver of diffusion are temperature gradients since the temperature directly affects the vapour concentration above the ice and thus also the concentration of heavy and light isotopologues in the vapour. In this case, the diffusion does not necessarily lead to a pure smoothing of the isotopic composition in the firn. This is probably also what referee #1 referred to in the original comment. We overlooked this fact in our answer since we approximate the effect of diffusion in our study assuming isothermal firn even at the trench depth scale. We will add a respective note to the revised manuscript in section 2.4 where the diffusion model is described in order to clarify this and the fact that pure smoothing only occurs for isothermal firn. Regarding the introduction, since in polythermal firn the effect of diffusion may not be a pure Gaussian-like smoothing and not only driven by different isotopic composition of the layers, we suggest to rephrase the cited sentence to a more general statement: "The isotopic composition of buried snow and firn is affected by diffusion of interstitial water vapour (...) and by densification (...); however, these processes do not lead to a

Printer-friendly version

Discussion paper

net change in the isotopic composition."

EC: Regarding the shift of the curves in fig4. I will suggest to keep the original plot. Eventually, the curves can be x-axis shifted for taking into account the accumulation between the two samplings but no superposition is required in my view.

AC:

Thank you for your comment on this. We will keep the original plot in the revised mansucript.

Interactive comment on The Cryosphere Discuss., doi:10.5194/tc-2017-35, 2017.