

## ***Interactive comment on “The impact of ice layers on gas transport through firn” by K. Keegan et al.***

**Anonymous Referee #1**

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The authors present new results on how small ice layers formed by percolating superficial melt water affect air permeability of polar firn. I am in favor of concise articles, and this one complies with that criterion. The method and results are clearly presented. However the interpretations are kept a bit too simplistic. The mixing of air in the firn is clearly a 3-dimensional issue. I realize that the authors are aware of this, but the difference between a sample-size effect of an ice layer and the effect on the overall firn air profile and the composition of the air that is finally recorded in the ice should be discussed more extensively. For example melt layers of about 1 cm thickness do not extend over large horizontal distances and thus do generally not substantially affect the firn air profile. Then the bias induced by bubbles in the melt-layers on the age of the air should be discussed by taking into account that the air in those bubbles has not atmospheric composition, but is affected by the melt refreezing process, thus being somewhere between atmospheric and equilibrium composition of air dissolved in water

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at the melting point.

Specific comments.

p. 1100, l. 6: "Adolph et al., 2014" is "Adolph and Albert, 2014" in references.

p. 1101, l. 18-21: "under steady state conditions": What is meant here? Is it e.g. the gravitational effect on 15N? Generally all gases are affected in a similar way by anomalies in permeability/diffusivity, whether steady state or time-varying. It is rather a question on the size of the signal one aims to discern, whether an effect is judged important or not. I advise the authors to be more specific.

p. 1101, l. 19: " a laterally-extensive ice layer at 27m may be expected to cause some variation within the concentration profile " As this is a very important issue for the whole ice core community this discussion should not be left with such simple statement. Of course it is correct but without any quantitative information this statement remains purely academic: Is there a relation between melt-layer thickness and its lateral extension? How does lateral extension quantitatively affect the firn air profile?

p. 1102, l. 5: "..few pores in the both ..": delete "the"

p. 1102, l. 10: ".. the refreezing process that layer .." -> " the refreezing process of that layer"

p. 1102, l. 12: ".. much older than bubbles .." This is correct, but the composition in those bubbles should be considered (see general comment above).

p. 1103, l. 7-11: As 1 cm = 10 mm, CFA analysis would see the full signal and thus be significantly affected!

p. 1103, l. 19: "These air bubbles probably contain .. ". The air IS older but of different composition. See comments above.

p. 1103, l. 20-22: "and significantly biasing the ice core record at that depth. Nevertheless, these ice layers were relatively thin and are therefore not expected to significantly

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alter the gas record because of the spatial resolution of current gas records." See comment p. 1103, l. 7-11.

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Interactive comment on The Cryosphere Discuss., 8, 1095, 2014.