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Interactive comment on "Constraints on the δ^2H diffusion rate in firn from field measurements at Summit, Greenland" *by* L. G. van der Wel et al.

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This is an informative study based on a well-designed field experiment. The strategy and patience displayed by the authors are admirable. The comparison of the field realization of diffusion to the predictions of firn diffusion theory is useful and important. The main conclusion is that diffusion occurs more slowly in the top few meters of firn than expected from theory. The paper can be published after minor revision.

I have always viewed the upper few meters of firn as problematic because of the large temperature fluctuations and the potential for convection driven by pressure gradients ("wind pumping"). I would have guessed that diffusion proceeds more rapidly than expected because of both effects. It is important to see that my guess was wrong.

The presence of small layers of high density can block vapor transport and slow diffusion. Another possibility, emphasized by the authors, is incomplete isotopic mixing of grains by solid diffusion. The analysis by Whillans and Grootes includes an Appendix that addresses this issue. Their calculations indicate that grains should mix in less than a year, hence the assumption that the process is not rate-limiting. The important point in the present context is that the timescale for solid diffusive mixing of grains depends strongly on grain size. Larger grains slow the overall firn diffusion. What is known about grain sizes in the layers adjacent to the experimentally created enriched zone? I also wonder if the frequency distribution of grain sizes could be important; how much of the ice mass is caught in the larger grains? I think the paper can be published as is, but the authors should tell us what they know, if anything, about grain sizes, and how they compare to the grain sizes addressed in Appendix A of Whillans and Grootes (1985).

Interactive comment on The Cryosphere Discuss., 9, 817, 2015.