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Interactive Comment

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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Isotope diffusion in firn and then in ice is an important process in the context of the interpretation of water isotope profiles (δD, δ18O and more recently $\Delta\delta$17O) measured in ice cores). Based on the pioneering theoretical approach of Johnsen (1977) back diffusion corrections are applied to reconstruct the original isotopic signal while, based on Johnsen et al. (2000), differential diffusion between HDO and H218O is used to infer the temperature signal (e.g. Gkinis et al., 2014).

The experimental approach conducted by van der Wel and colleagues specifically aimed to check the Johnsen' diffusion model at a Greenland site (Summit) which is better suited than previous experimental studies conducted in the laboratory. This is particularly interesting as back diffusion has been essentially applied for isotopic pro-

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files measured along Greenland firn or ice cores. The conclusion of this well designed field experiment clearly points to a lower diffusivity than expected from the Johnsen' theoretical framework. The various assumptions able to explain the data – model discrepancies are fully explored and such a conclusion appears firmly established.

I will add that the same type of conclusion probably applies for Antarctica. In an unpublished paper (F.Denux, J.P.Benoist, J.Jouzel and M.Stievenard, 1997) based on the PhD work of Françis Denux dealing with a comparison of Antarctic and Greenland observed isotopic profiles with Johnsen (1977) and Whillans and Grootes (1985) diffusion models, we conclude Âń The impetus for the study presented in this article largely comes from the fact that models describing the smoothing of the isotopic signal in firn and ice were not fully satisfying to explain relevant datailed isotopic data we have obtained over the last few years in East Antarctica (South Pole, Dome C and Vostok). In particular, both models existing for firn predict excessive smoothing with respect to what is observed at those sites. We have modified the Whillans and Grootes model in such a way that it accounts for ice crusts (and density variability) and for the well marked temperature gradient in the upper part firn. This new version satisfyingly explains our Antarctic data wherever seasonal cycles are present at the surface (South Pole) or lacking (Vostok and Dome C). It also leads to an improvement of model data comparison for higher accumulation Greenland sites Âż. The manuscript of van der Wel et al. is well written and I recommend to publish it without modification.

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