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Interactive comment on "Numerical experiments on isotopic diffusion in polar snow and firn using a multi-layer energy balance model" *by* Alexandra Touzeau et al.

Anonymous Referee #2

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The posr-depositional modification is an important but poorly understood part of the "isotopic paleo-thermometer". After the solid precipitation is deposited on the top of the polar ice sheet snow surface, its isotopic content is changed drastically due to the water and mass exchange with the atmospheric water vapor and due to molecular diffusion in snow. These processes disturb or even completely erase the initial climatic signal recorded in the isotopic content of the precipitation. To solve this problem, different approaches are applied including modeling of the snow pack evolution during snow metamorphism.

This manuscript is an attempt to simulate the snow isotopic content of the polar snow in

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the course of the post-depositional processes. For the first time the snow-pack Crocus model is applied for this purpose.

The authors clearly understand that this work is a small step towards the full description of the isotopic post-depositional modifications. A lot of efforts still has to be done. However, this attempt deserves to be published as a separate paper in "Geoscientific Model Developement" journal. The manuscript is nicely structured and provides a good review of literature on the formation of the climatic signal in the snow isotopic composition. The authors make a nice attempt to describe in simple way a rather complicated process of the isotopic modifications in the snow thickness. I do not have major corrections, only a few minor comments or questions:

In your model you do not take into account the mechanical snow mixing by wind. This mixing erases the initial climatic signal (shorter than few years) in central Antarctica, and makes the vertical isotopic profiles in the upper part of snow thickness similar to white noise. Recent study by Thomas Laepple (https://www.the-cryosphere-discuss.net/tc-2017-199/) showed that the filtering of this noise by isotopic diffusion can create false cycles in the isotopic profiles. So, I suggest that in the further versions of you model you introduce random component of the initial isotopic composition of the precipitation (or of the upper snow layer if you wish) in parallel to the regular component given by precipitation events. You might mention this in section 4.4. and conclusion.

Other minor comments:

line 33 - better to write "1950s"

lines 352-353 - why condensation is without additional fractionation?

lines 502-503: the values (86% and 90%) are the remaining amplitudes, right?

section 4.2.3: how much snowfall have you added to the snow thickness in this simulation?

lines 582-583: this gives 10 cm / year, but above you said that the accumulation rate at

DC is 8 cm / year (snow equiv.).

Figure 2d is a bit misleading. From the first glance a reader may think that the seasonal amplitude is increasing with time. Then, it becomes clear that it is actually d18O change that is increasing with time. It would be nicer to show here the d18O values themselves (instead of d18O changes), so that the colors would nicely illustrate the fading isotopic variability.

The same comment is for Figures 3 and 12.

line 1055: December 2001.

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