

6th June 2023

Dear *Editor* Dr. Casado:

Please find attached my revised manuscript – both its final and track-change versions.

Following the suggestions of Reviewer 1 and Reviewer 2, respectively, I have extended the *Discussion* to include two passages to

- (i) explain [on Lines 575-583] that the diffusivities  $D_v$  and  $D_s$  are subject to uncertainty and potentially influenced by other factors, to let the reader know that the recipes currently used for them are not necessarily accurate nor comprehensive [the long paragraph containing the passage has also been edited for flow and concision];
- (ii) outline the need to establish whether the theorised phenomenon really operates [Lines 623-629], including Reviewer 2's idea about studying existing ice-core records for any displacement of isotopic signals due to the signal migration predicted by the theory.

These revisions follow what I agreed to do in my author responses during the interactive open discussion.

With regard to (i), Reviewer 1 kindly provided various details and examples (with references) on what can affect the diffusivities and fractionation factors. However, I have decided not to add such details to *Appendix A*, because I find I can't add one without adding all of them, yet the whole set of details remains highly fragmentary, given the state of current understanding.

Here and there, minor corrections have been made to the text to improve clarity and emphasis or remove redundancy/clutter. Where previously I used the wrong unit  $\text{m yr}^{-1}$  for the initial signal wavelength  $\lambda_0$  (e.g. on Lines 406 and 446), the unit has been corrected to metre (a length). This correction has been made also to the units inside the key in Fig. 9e.

Fig. 10 has been replaced with a new version without the spurious grey "0" (next to the vertical axis) in panel 10d.

The DOIs of the data/code repository and supplementary material are now known. I indicate them on Lines 645, 648 and 730.

Following an open-access requirement by my university, in the *Acknowledgements* I have added a statement on Lines 641-643 to declare the CC-BY licence for any Author Accepted Manuscripts, using the precise wording given by my university.

On the next page, I outline some changes that I wish to make to improve the "*Short Summary*" on the TC webpage of the manuscript. Please kindly ask the editorial office to update the summary.

Thank you for your attention and for handling my manuscript.

Kind regards,  
Felix Ng

# Isotopic diffusion in ice enhanced by vein-water flow

## Short Summary

Original version, with edits in red:

The stable isotopes of oxygen and hydrogen in ice cores ~~from Greenland and Antarctica~~ are routinely analysed for the climate signals which they carry. ~~It~~ has long been known that the system of water veins in ice facilitates isotopic diffusion. Here, mathematical modelling shows that water flow in the veins strongly accelerates the diffusion and ~~thus~~ the decay of climate signals. The process hampers methods that use the variations in signal decay with depth to reconstruct past climatic temperature.

Corrected version:

The stable isotopes of oxygen and hydrogen in ice cores are routinely analysed for the climate signals which they carry. It has long been known that the system of water veins in ice facilitates isotopic diffusion. Here, mathematical modelling shows that water flow in the veins strongly accelerates the diffusion and the decay of climate signals. The process hampers methods that use the variations in signal decay with depth to reconstruct past climatic temperature.

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