

Interactive comment on “Photolytic control of the nitrate stable isotope signal in snow and atmosphere of East Antarctica and implications for reactive nitrogen cycling” by M. M. Frey et al.

Anonymous Referee #2

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The manuscript by Frey et al. presents new nitrate data (concentration, N and O isotopes) from Antarctica. Year round atmospheric samples from Dome C and Dumont d’Urville are presented as well as pit studies from Dome C and a transect between Dumont d’Urville and Dome C. As observed earlier there is a severe loss of nitrate in the uppermost firn layer which is inversely proportional to the accumulation rate among others. Along go a heavy fractionation in nitrogen and oxygen isotopes and a small fractionation in D17O. I would like to congratulate the authors to the beautiful dataset. The combination of atmospheric measurements and pit studies will ultimately lead to a full understanding of the processes and potentially to a climatic interpretation of the nitrate record. However, we are not quite there yet. The interpretation of the records

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is based on a lot of speculations. Especially analogies to water isotope fractionation processes seem unreasonable to me. All in all I would like to see the data published but some of the theoretical speculations removed from the manuscript.

Detailed comments:

It is a mystery to me how the annual signal in D17O can be completely removed in the firn while the ~2.7 year signal is preserved. Any idea why this is happening?

p 12569 line 1-9: I do not understand what the authors try to explain here. Is it that the fractionation is not occurring during initial deposition?

p 12572, line 9 – 12573, line 4: The theoretical approach to isotope fractionation by evaporation is extremely speculative and I doubt that all the assumptions in that paragraph will hold. I suggest removing it completely. As stated in the end McCabe et al., 2005 show that evaporation is not the main effect. However, I wonder if this experiment has been made with fresh snow. Also a few hours of exposure is relatively short and natural snow undergoes temperature stress (day/night, and winter/summer) which the snow in the experiment has probably not experienced. To me the question of evaporation vs. photolysis is not completely settled yet.

4.2.2. Photolysis: Again I am not sure that the analogy between NO₃⁻ and N₂O using the study by Miller and Yung is justified. A better way than bending theory would be to repeat the experiment of Blunier et al. 2005 by using a light source which is better representing natural light. I suggest removing that analogy since it can not serve as prove or disprove of the following interpretation.

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