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Atmospheric Chemistry and Physics Discussions

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.

Interactive comment on Atmos. Chem. Phys. Discuss., 9, 12559, 2009.