Winton et al report observations of the nitrogen isotopic composition of nitrate in Antarctic (DML) in the atmosphere, snow "skin layer", and depth profiles in snow pits. They use these observations combined with a snow chemistry model to understand what controls the variability in the nitrogen isotopes and nitrate concentrations and to assess the utility of such observations in ice cores as a proxy for past surface UV radiation. They conclude that although photolytic driven recycling and loss of reactive nitrogen is what determines the nitrate isotopes and abundances at this location, that variability in parameters such as snow accumulation rate have a large enough impact on the nitrogen isotopes so as to preclude the influence of variability in surface UV in determining the nitrogen isotopic composition of snow nitrate.

The observations and model-based interpretation are robust and important as it would be useful to have a paleo-UV proxy. As the authors state, it is important to assess the sensitivity of nitrogen isotopes at particular locations in order to determine its usefulness as a proxy for any given process. Unfortunately, the paper is frustrating to read because it is it so repetitive and spends so much time on introductory material throughout the manuscript that it is hard to find the actual interpretation of the results. It is as if the authors are afraid to state their interpretation. I suggest moving (and condensing) the introductory material that is spread throughout the manuscript (especially in section 4) to the introduction and making sure that the actual interpretation is presented up front instead of hidden. Because of this, it's sometimes hard to determine if the results support their conclusions. The paper as is reads as a first or second draft, not a final manuscript ready for submission for publication. This is particularly evident in the conclusions, which is not even written in paragraph form.

Additional comments:

I find the concept of the number of times nitrate is recycled difficult to wrap my head around. Does this mean that each molecule of nitrate is recycled on average three times before being archived? Is this averaged over the depth of the photic zone? I would imagine some molecules (like those that are close to the surface in summer) are recycled more than others, so that there is actually some distribution of recycling events on a molecule per molecule basis so as to average around the number 3. Is this interpretation correct? I suggest elaborating on this in the methods section.

Second paragraph of the introduction: It seems strange to say that the primary sources of nitrate are transport of nitrate from the stratosphere and transport of alkyl nitrates in the troposphere without mentioning transport of inorganic nitrate in the troposphere. Where is the evidence that inorganic nitrate is not transported in the troposphere to Antarctica? A model study suggests that it is certainly possible (Lee et al., 2014). Also, soil NOx should be mentioned as a NOx source in the troposphere.

Page 2 lines 61 – 62: Reprase to: "Model results from Zatko et al. (2016) suggest that…"

Page 4 line 116: Are you referring to skin layer nitrate here? Since you are measuring nitrate in three different locations, you should always be specific about which location you are talking about and not just say "nitrate".

Page 4 line 128: Perhaps you should say that you are referring to the e-folding depth of the snow photic zone, UV radiation, or something less vague.

Page 5 line 157: If you remove the word "While" from the beginning of this sentence it will be grammatically correct.

Page 8 line 259: By “lower” do you mean “shallower”? Lower could also mean deeper, so it would be better to use words like deeper and shallower when referring to the depth in the snow beneath the surface.

Section 2.7: It seems quite important to state what value you assume for the N-isotopic composition of primary nitrate, before it is impacted by photolysis.

Page 12 line 371: “values” of what? Concentration? Isotopes? Both? Since you measured more than one thing you need to be specific.

Page 13 Section 3.5: You should probably note that gas phase HNO3 and particulate nitrate have different dry deposition rates.

Section 3.6: I think you should elaborate on the difference between the actual (from photolysis) and apparent fraction factor. The latter is lower than the actual due to recycling. Also, related to this, can the difference between the actual and apparent fractionation factor be used to calculate fractional loss?

Page 15 line 455: Is this at DML?

Page 15 line 459: Which results? Concentration? Isotopes? Both?

Page 15 lines 472 – 473: Does the model simulate the influence of hoar frost and diamond dust on nitrate deposition? The way this sentence is written it seems that it does, but this is surprising to me as I didn’t think the model was a meteorological/snow model that calculated such things. It seems that you are saying that diamond dust and hoar frost explain the difference between the model and the observations, and that the model has these things but they didn’t happen in reality.

Section 4.2: This is a perfect example of the section 4 having lots of introductory material without any results. The entire first paragraph reads like an introduction except for the very last sentence. However, the very last sentence of the first paragraph is not specifically supported by your observations. By the time I finished the 5 pages of section 4.2, I have no idea what you learned or what you are concluding from your new observations.

Section 4.1: Again, I have no idea what you are concluding in this section.

Page 17 line 540: “is no exception” to what?

Page 18 lines 547 – 551: It seems that if you are collecting both gas and particulate phase nitrate that you cannot conclude that sea salt promotes conversion of HNO3 to nitrate. I’m sure that it does, however, I don’t see how your observations provide evidence of this.

Page 18 lines 558-559: I suggest rephrasing this as “…Dome C where the underlying snowpack is the dominant… skin layer via photolytic recycling and redeposition.

First paragraph of section 4.3: Need a reference for this statement.

Page 20 line 617: It could also be transported away as nitrate, not just NO2.

Page 21 line 648: “The contribution ***to what?*** of natural sources”

Page 21 lines 659-660: If you say that denitrification causes O-isotopes to increase, then you need cite a paper that provides evidence of this. However, I would delete this sentence since this paper does not address O-isotopes.

Page 22 line 690: How was the apparent fractionation factor calculate? There should be an equation for this in the methods section.

Page 22 line 706: are these FNO2 values a daily mean, a daily maximum?

Page 24 lines 742 – 746: What is the difference between the grain size and impurity concentrations at these two locations? The N-isotopes may be sensitive to something, but if that something shows no significant difference between these two locations than it won't be able to explain the differences in N-isotopes.

Page 25 lines 786-787: The e-folding depth is 20 years yet the nitrate is archived after 5-6 years. This seems conflicting. Why is nitrate archived when it is still in the photic zone?

Page 25 lines 792 and 796: Are you referring to observed or modeled values here?

Page 25 line 807: Snow optical properties are part of what determines the depth of the photic zone, so it seems weird to mention these two things separately here as if they aren't related.

Page 26 Line 821: "lower" than what?

Page 28, last sentence of section 4.5.3: Explicitly state here why the sensitivity is greater at Dome C than at DML.

Page 28 line 899: What would cause a change in the e-folding depth?

Page 29 line 919: What does "unpicking" mean in this context? Perhaps choose a better word.

Page 29 line 931: This is percent. Should it be permil?

Figure 1 caption: State the difference between HiVol 2 and 3.

Figure 2: The boxes in this figure are totally unclear to me. What are the gray boxes trying to convey?

Figure 4: Mark the seasons (e.g., shade winter) in c) and f). It's hard to see the seasonal cycles.

Figure 4: Why does the x-axis scales to all the way to 1500 and 300 when the observations are much lower than this? The axes should be scaled by the range of the data.

Figure 5: Why is "recycling factor" listed as a process occurring below the snow photic zone? How is "tropospheric input" different from "net lateral advection"?

Figure 7: Why are these values for accumulation rates chosen as sensitivity studies in the model? What is the base case that you are changing each parameter around?

Figure 8: This is showing the change in TCO around what value?

Reference:

Lee, H.-M., Henze, D. K., Alexander, B., and Murray, L. T.: Investigating the sensitivity of surface-level nitrate seasonality in Antarctica to primary sources using a global model, Atm. Env., 89, 757-767, 10.1016/j.atmosenv.2014.03.003, 2014.