

Atmos. Chem. Phys. Discuss., referee comment RC1  
<https://doi.org/10.5194/acp-2021-519-RC1>, 2021  
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## Comment on acp-2021-519

Anonymous Referee #1

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Referee comment on "The importance of alkyl nitrates and sea ice emissions to atmospheric NO<sub>x</sub> sources and cycling in the summertime Southern Ocean marine boundary layer" by Jessica M. Burger et al., Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2021-519-RC1>, 2021

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Review of The importance of alkyl nitrates and sea ice emissions to atmospheric NO<sub>x</sub> sources and cycling in the summertime Southern Ocean marine boundary layer. by Burger et al.

### General Comments

In this paper, the authors present stable nitrogen and oxygen isotope measurements of aerosol nitrate collected on filter samples during 2018 and 2019 in the Southern Ocean between South Africa and Antarctica, and in the Weddell Sea. The measurements are then analyzed based on previous literature-based fractionation and isotope information on both nitrate nitrogen and oxygen sources in the different key study regions, including anthropogenic NO<sub>x</sub>, lightning NO<sub>x</sub>, emissions of RONO<sub>2</sub>, and snow-NO<sub>x</sub> emission, as well as O<sub>3</sub> and other oxygen sources and equilibrium impacts. The introduction is thorough and well-written, and presents a clear context for the findings described in following sections. I find this paper and its findings compelling, and certainly worthy of publication, but there are a number of issues that need to be addressed prior to publication.

As well, there are a fair number of typographical errors and style guide recommendations that need to be addressed, and I would encourage the authors to take greater care in the future to address these details prior to manuscript submission, in particular for journals where there is no typesetting prior to the review process.

### Specific Comments

Line 95 – Technically,  $\epsilon = (KIE - 1) \times 1000\text{‰}$ , where KIE, the kinetic isotope effect is the ratio of the rates,  $= k_{\text{(primary N isotopologue)}}/k_{\text{(stable }^{15}\text{N isotopologue)}}$ , so  $\epsilon$  is the ratio  $- 1 \times 1000\text{‰}$ .

Line 142 – the date range could be simplified by writing 7-19 December 2018. Similarly, on Line 143, you could write 4 January to 21 February 2019. Also, at some point, and this is probably the ideal time, it should be stated what time zone (UTC? local time? South Africa Standard Time?) is being used to describe the dates for the legs and the times for the filter sample collections.

Lines 161-162 – Were the samples that were taken for less than 24 hours due to stagnant conditions due to unusual ship manoeuvres? Or was it a combination of both stagnant conditions and unusual ship manoeuvres? Also, Table S1 lists “Daylight (hrs)” (which should be “hours” or “h”) but not total sampling duration times. So the reader isn’t left doing their own calculations based on the location and time of year relative to the equinox, perhaps the authors could include both “total daylight hours sampled” and “total sampling duration” in Table S1. It would also be good to include sampling start and end times (with a reference time zone) in the table, rather than just the start day and stop day, to demonstrate consistency with the 13-88 hours reported in Line 162.

Line 168 – for consistency with line 164 “field blank”, you could write “field blank filters” or “field blank set of filters”.

Lines 175-183 – I have questions about the filters. What is the precision of the IC system analysis? Is it  $0.3 \mu\text{mol/L}$ ? What was the reasoning behind the other analysis, and why was this only done on a subset of the filters? In line 183, the authors suggest the average  $[\text{NO}_3^-]$  is “reported”, but where? Maybe point to it here? And why not report both? And are they labeled as this or that or both? There should be a notation in Table S3 for the samples that were analyzed using both methods.

Line 198 – Where are the seawater samples provided? If you’re not providing a table or documentation on the seawater sample data, it would be prudent to provide a link at this point, and not just at the end of the manuscript. Also, what depth does “position at depth  $\pm 5 \text{ m}$ ” imply? Was the depth location actually uncertain to within a 10 m range? Lastly, the reported data repository on line 500 is an incomplete link that goes nowhere, so this needs to be sorted out prior to publication, or a final review of the paper.

Lines 219 and 222 – The authors should state the calculated p-values, and not just state that the values are or aren’t significant. Moreover, are p-values really appropriate for this data set? I encourage the authors to think about this article: <https://link.springer.com/article/10.1007/s10654-016-0149-3> Perhaps a simple comparison of the data would be more insightful than a “significant/not significant” binary outlook.

Figure 1 – the points in this figure are rather coarse, and it might be easier to see the points and error bars with thinner lines for both.

Figure 2 - It might make it somewhat more complicated, but it would be helpful to, rather than colour all the back trajectory lines the same tone of grey, to have them coloured by the date of the sample, even if it were done using an ombre (monotone) effect. In particular, this would be helpful for the Weddell Sea legs, because there is a significant amount of overlap in the back trajectories. Alternatively, individual or grouped back trajectories could be shown in a Supplemental Figure, to complement the complete regional back-trajectory version that is in this figure. Also, "AMBTs" doesn't need an apostrophe in the figure caption (and in the caption for Figure 3.)

Figure 4 - the back trajectory lines are again quite thick – if possible, it might be better to show the back trajectory lines with a slightly finer point size. Also, in the caption, lines 304-305 – "AMBTs" x2. Line 306 – "sea ice" (ice is a noun), and in line 307 "sea-ice concentration" (sea-ice is an adjective.) As well, "AMSR2 ASI programme" needs to be defined, either here or in the main text. Finally, "the white region represents the location..." of the sea ice identified by the AMSR2 ASI programme in the Antarctic study region, not "at the southernmost extent of each transect".

Line 310 – many of the transects have two shades of orange, indicating that they originated in one region, and then continued through a different region before being sampled. Were these samples treated differently in your statistics than the ones that were modeled to be entirely in one region throughout the entire 72 hours? This needs to be clarified.

Lines 318-319 – "end of the low-latitude zone" – this is still somewhat ambiguous.

Lines 363-370 – While I certainly appreciate the methodology being used here, there should be a discussion about the uncertainties inherent from putting so much of the analysis on the accuracy of the back trajectories. There needs to be a discussion about the reliability and uncertainties in the HYSPLIT AMBTs, and the resultant uncertainties in the calculated isotopic impacts on  $\delta^{15}\text{N}$  of aerosol nitrate.

Technical comments

Title – The period at the end of the title is unnecessary

Line 31 – here and throughout the paper, per the EGU style guide, use “and” instead of &, both in in-text citations and in the reference list. Similarly, per the style guide, for Figure panel labels, use lower case letters, i.e., (a), (b), etc. Also, “Coordinates need a degree sign and a space when naming the direction (e.g. 30° N, 25° E)”, and “Common abbreviations to be applied: hour as h (not hr), kilometre as km, metre as m”. Also, Figure captions should be numbered “Figure 1...”, not “Fig. 1...”, and Figures, Equations, and Sections should be referred to as “Fig. #”, “Eq. (#)”, and “Sect. #” when not at the beginning of a sentence. Likewise, reactions should be referenced in the text in parentheses: e.g., (R10).

Line 31 – “Earth’s”

Line 38 – probably out to put “Southern Ocean (SO)” here, so later references to SO are defined.

Line 39 and throughout – references with “et al., YYYY” should not have a comma following the first author’s last name.

Line 53 – “(Jones et al., 2000, 2001).”

Line 80 – remove the word “both” (three things are listed, so “both” doesn’t make sense”).

Line 86 – “R” should be italicized.

Line 94 – “(Berhanu et al., 2014, 2015)”.

Line 179 – Probably ideal to use the same notation for pooled standard deviation here and in Table S2, either  $s_p$  (with subscripted p), or  $SD_p$  (with a subscripted p.)

Line 190 – “BÓšhlke et al.”

Line 198 – “ship’s”

Line 201 – This should probably be section 2.3, not 2.6. Also, the numbering notation of the section notation should be consistent throughout the manuscript for each type of heading: 1), 2), etc., or 1.1 Secondary Heading, 2.2 Another Secondary Heading, etc.

Line 207 (and Line 699) – I believe it is <https://>

Line 214 – “high latitudes”

Line 228 (Table 1) –  $N_2$  should have a subscripted “2”.

Lines 228 (Table 1) and 230 (Figure 1 caption) – The convention for the standard notation, as you have on Line 87 and Table S2, is “VSMOW”, not “V-SMOW”.

Line 241 – “Our observations reveal...” would be sufficient.

Line 247 – “AMBTs”

Lines 265-266 – pptv and ppbv should be defined.

Line 287 – “high latitudes”

Lines 323, 324, 360 – “AMBTs”

Line 329 – “Dahl and Saltzman, 2008;”.

Line 342 – “NO<sub>x</sub>” should have a subscripted x.

Line 351 – There should be a comma before “i.e.,”

Lines 379-380 – recommend italicizing “*f*”, here and later.

Line 383 and 384 – add a comma prior to i.e.

Line 404 – “hypothesize” (or hypothesise for regional spelling consistency)

Line 418 – HCl should have a lower case L.

Line 449 – “AMBTs”, and the light blue lines aren’t dashed.

Line 454 – “ for 15 January 2019”.

Line 478 – “At the mid-latitudes, peroxy...” and “while in the”

Line 507 – “J.G.” (for consistency with other referenced (co-)authors.)

Line 514 – use <https://doi.org...> formatting throughout the references. Also, here and throughout the reference list, per the EGU ACP guide, Journal Abbreviations should be used.

Line 527 – “Journal of Geophysical Research Letters” should be “J. Geophys. Res. - Atmos.”, and “Ocean” should be capitalized.

Line 545 –  $C_1$  and  $C_4$  should have 1 and 4 subscripted. Also, “Letters” on the next line should also be “J. Geophys. Res. - Atmos.”

Line 550 – also JGR-A, not GRL. And the DOI link is <https://doi.org/10.1029/1999JD900238>.

Line 573 – “Saltzman, S. E.”

Line 575 – “Craig”, not “Graig”; this article is the ACP version, so remove “Discussions”

from line 577.

Line 579 – DOI citation: <https://doi.org/10.1023/A:1009738715891>

Line 580 – This should be “Elliott, E. M.” Also, in “United States,” (there is a space and a period where there should be a comma... likewise, in several other references, there is a period instead of a comma following the article title.)

Line 587 – “nitrogen”

Line 599 – there is a rogue comma detached from “Meteorology”.

Line 601 – “... Research: Atmospheres”, DOI: <https://doi.org/10.1029/93JD00874>

Line 606 – “aerosol”

Line 612 – “Atmospheric” is spelled incorrectly (although it should be “Atmos. ...” and this is not a discussion paper, so remove “Discussions” from line 613.

Line 614 – if this is a book, it should have more details.

Line 619 – there is a space missing in “... vapor at...”, Maida should be “Maïdo”, and the DOI citation is: <https://doi.org/10.1002/2017JD026791>

Line 628 - DOI citation: <https://doi.org/10.1029/1999RG000078>

Line 630 – DOI citation: [https://doi.org/10.1016/0016-7037\(57\)90021-2](https://doi.org/10.1016/0016-7037(57)90021-2)

Line 643 – “Peroxyacetyl”

Line 649 – The date for this citation (<https://doi.org/10.1029/97JD02075>) is in the wrong location.

Line 655 – in the reference, it is spelled "Oxidized". And "Atmos." is missing from the Journal title.

Line 660 – "formation"

Line 674 – "Lee, H.-M., ..." – the H is missing a period.

Line 684 – "Atmos." is missing.

Line 687 – "Müller"

Line 691 – "NO<sub>x</sub>" should have a subscripted x.

Line 705 – remove "Discussions."

Line 715 – "Galanter, M. and..."

Line 727 – "Atmos." is missing.

Line 747 – "Atmos." is missing.

Line 754 – "Comparisons" is spelled incorrectly, and it should be "Atmospheric Environment" (no 's'), but of course, "Atmos. Environ."

Line 754 – "NO<sub>x</sub>" should have a subscripted x.