Review for Du et al. ESSD by Cécile Blanchet

Potsdam, April 19th 2022

The authors present a data compilation for neodymium and strontium isotopes to trace dust deposition in the "three poles". In order to do that, the authors have assembled data from the literature as well as new measurements. I would recommend to reorganize the manuscript and better define the objectives of the study before this can be published. I have several comments, which I hope will help to improve the manuscript.

Main comments:

1) I am not entirely sure what the **main goal of the paper** is: is it to determine where dust deposited on the three poles comes from? Is it to determine how the three poles act as sources and/or sinks through time? Is it to determine the role of local dust sources to the sinks on the three poles? On line 106, it is not clear which are the "questions" the authors are aiming to answer. Clarifying the aim will help to understand the rationale of compiling data from soil surfaces, glacier, snow, and marine sediment cores, but not using more global databases that would allow to determine the contribution from other potential source areas.

2) If the aim of the paper is to describe the dataset, the authors need to **spend more time explaining their strategy for data collection**. Literature search? Use of previous compilations? Number of data from the literature versus samples measured and published in this paper. Needs to be clarified, esp. in lines 175-190, where it is quite confusing (although it is clearer in the abstract). Please separate in the methods the literature search from the sample collection and measurements.

3) Data file (excel spreadsheet): I struggle with the way the data are presented: I would recommend to use one template for all the data. In the attached spreadsheet, there are four different sheets with each a different template. **For the sake of being able to compare the data with each other, please follow a strict (and similar) order and include "NA"s when an information is missing**. If you want your data to be used by others, why not using the template that we published last year (version 3.0 of my database: https://dataservices.gfz-potsdam.de/panmetaworks/showshort.php?id=7124101c-d2a2-11eb-9603-497c92695674), with perhaps modifying the "water depth (m)" column into an "elevation (m)" column (with changing signs whether it is altitude (+, masl) or bathymetry (-, mbsl)? Also please **provide the locations in decimal degrees** as it allows most programs to plot the data (it is more difficult with locations in minute/second). Also please provide the metadata in the downloadable spreadsheet.

4) Data visualisation: I think that one of the powerful possibilities of compiling data and attributing precise locations is to explore the spatial variability of certain variables by plotting **isoscapes** (instead of plotting numbers on locations like in Fig. 5). In your case, it would be very interesting to compare the changes in Nd and Sr isotopes spatially in the three poles for the source material (soils) and for the sinks (snow, sediments). In general, the authors need to **better separate sources and sinks** throughout the manuscript.

5) Box and whiskers plots (Fig. 3 and 6): please indicate the number of samples used for each category. Please note that these analyses are best suited for >5 samples.

6) In general, the isotopic signature needs to be discussed in terms of lithologicak context, which is seldom mentioned in the manuscript. Perhaps use geological maps to contextualise the varying signatures observed?

7) There are way too many abbreviations and I must say, I got lost. Please use abbreviations only when necessary but otherwise use the full names.

Minor comments:
L. 29-30: "recognized and introduced": what do you mean here?

L. 115: what is "data augmentation"?

L. 122-123: it might be useful to clarify the expression "three poles" for the readers who might not be familiar with it. I knew the expression "third pole" but not "three poles". In lines 124-125, you cite Australia, Southern south America, Southern Africa and New Zealand: are these regions part of the three poles? I thought the third pole refers to the Himalayas? Please clarify.

L. 126: I don't think that the abbreviation TP has been introduced before.

L. 131: Please explain what a cryoconite sample is.

l. 182: Very pleased that you used the scheme I developed: it will be very useful to compare and compile datasets!

L. 218-219: I do not understand this sentence. The "acid leaching method" used is not given in the spreadsheets.

l. 220: "This feature validates" is a strange formulation, please clarify.

L. 221-222: how did you determine PSAs exactly? Based on which criteria?

L. 224-253: are these six regions the PSAs? How were they determined?

L. 301-306: belong to the methods. This happens repeatedly throughout the manuscript. Please all technical considerations should be put in the methods. However, the authors are often describing how other teams have sampled, which seems not really necessary.

It might be advisable to the authors to edit the paper: there are often redundancies or unclear sentences, which hinder a smooth reading and a comprehension of the paper.

L. 374-376: I do not understand this sentence. I cannot see any homogeneity/heterogeneity from Fig. 6. Please clarify or modify Fig. 6.

L. 377. Antarctica: there are a lot of new data for Antarctica assembled in the paper of Robinson et al. (2021) in Chemical Geology (Open Access, https://doi.org/10.1016/j.chemgeo.2021.120119). The accompanying database version is V 3.0: https://dataservices.gfz-potsdam.de/panmetaworks/showshort.php?id=7124101c-d2a2-11eb-9603-497c92695674)

L. 429-438: the separation in these different areas seems quite arbitrary. What is it based on? The authors mix sources and sink and it is not very helpful to understand the processes driving dust transportation I think.

L530-556. Conclusions

L. 540-543: I find this claim not really supported by the manuscript. The criteria were not used to determine which dust source was contributing to which sink. This needs to be better demonstrated, e.g., by separating sources and sink in the database or in the figures.

L. 554. A PSA should be defined based on present-day knowledge of dust generation, e.g., based on remote sensing or geomorphological evidence. At minima it needs to be defined by the dust produced: grain-size distribution, mineralogy, isotope signature as well as by its geographical location.

Figures:
I would encourage the authors to revise their figures to make them more informative.

Fig. 2: The numbers on the map (glaciers and deserts) need to be related to the names in a legend or in the caption.

Fig. 3: see my previous comment on box and whiskers plots.

Fig. 4: There needs to be a legend on this map to help the reader to identify the different sample sets.

Fig. 5: This figure would be much better is plotted as an isoscape (using interpolation between known values), and with maps for sources and maps for sinks. Actually, I think that Fig. 4 and 5 could be combined in isoscapes.

Fig. 6. See Fig.3. I struggle with the abbreviations: please put the full names.

Fig. 7: same as comment for Fig. 5.

Fig. 8: What are the A, B, C and D areas? Perhaps choose colour codes to distinguish the main areas?

Data: See main comment 3)