

The manuscript by K.A. Casey describes a new data set about measurements of geochemical components in dust and debris taken at four different glaciers. These glaciers are located in Svalbard, southern Norway, Nepal, and New Zealand and should therefore represent four different glacier types with the following characteristics.

- The Svalbard glaciers are located in a mild polar climate with high rates precipitation in close proximity to the ocean, where marine aerosols are emitted.
- The Norway temperate and marine glaciers also receive high accumulations rates but are located “in” the downdraft path from industrialized regions of the northern European Union.
- The Nepal glaciers are the highest elevated glaciers in this study and are subject to a continental climate with enhanced summer accumulation. In contrast to the others these glaciers receive also a considerable amount of dust and debris load.
- The New Zealand glaciers at the outer flanks of the stratovolcano Mt. Ruapehu are subject to high precipitation rates in a temperate marine climate and to aerosols from the adjacent volcano and acidic crater lake.

The manuscripts informs after the introduction about the characteristics of the four glaciers and its environment. Afterward the utilized data collection protocol and the analysis technique are represented. The main part of the manuscripts are the descriptions of the abundances of the numerous analyzed major, trace, and rare earth elements in the ice and snow probes and the debris samples. Some of the measured concentrations are related to signatures of the surrounding environmental conditions, such as the aerosol contributions from the neighboring ocean, trace abundances of the upper continental crust, or anthropogenic pollutants transported by atmospheric circulations to the glaciers. The discussion and conclusions close the manuscript. The manuscript's structure needs to be improved. In addition it would immensely benefit from some professional language editing.

The selected journal “Earth System Science Data” aims to foster the publication of reference data of benefit to the earths system science community. Since no data set of such quality is to my knowledge freely available, *I recommend the publications of the manuscript after minor revisions.*

## **Minor comments about the text**

In an enumeration within the text, I personally prefer a comma in front of the final “and”. But I guess there are other views out there about this particular point.

I have not collect all problems in language and grammar. Therefore the following list might not be complete. I strongly recommend to double-check grammar and phrasing. Also the structure need to be streamlined.

Since reference data might not only be of interest for a selected group dealing with the specific problems related to undertake the measurements, I would strongly suggest to introduce even common abbreviations in the field like LHREE.

## **Specific comments**

In the following text, the given page and line numbers refer to the printer-friendly version of the manuscript.

Page 108, Line 21-23: In the abstract ablation add satellite relevance is from my point of view quite vague. Would you consider to delete these lines? Please comment this point.

Page 108, Line 25-26: I disagree about the strong statement, that the factor of increase glacier melt is primarily driven by the lowered albedo. I admit, it might be a strong contributor in some regions, but I think that some glaciers in polar regions, where due to polar amplification the temperature rises stronger than the global average, the related higher longwave radiation might be of high importance. Therefore I would suggest at least a more cautious phrasing like: “There is indication that one of the primary factors ... “

Page 109, Line 22-24: What is the meaning of this sentence “In this study were collected from ... glaciers speculated to maximize ... composition diversity.”?

Page 111, Line 23: “ ... to the ocean as well as a local ... source.” Would you like to replace it against “ ... to the ocean that act as a local emission source.” ?

Page 112, Line 22: “... upper outer flanks and in the summit”. Do you need the “and”?

Page 113, Line 2: “such” do you need this word here?

Page 113, Line 11, 12, 13: I miss some verbs in the list describing the handling of the bottles.

Page 114, Line 4: measurements instead of measurement.

Page 114, Line 9-10: Please clarify for what the standard spike was utilized, for example by phrasing :”An internal standard spike of ... was utilized to ....”

Page 114, Line 24/28: Are the devices fully described by “Philips XPERT diffractometer” and “Philips PW2400 XRF”? Might you be able to cite references about these particular devices describing their abilities and limitations.

Page 115 and Page 116: I would like to see separate paragraphs for each for the described glacier and its elements distributions, such as

- Page 115, Line 14: ... element glaciochemistry. (New paragraph) Jostedalbreen ...
- Page 115, Line 21: ... as well as slight marine influence (Pacyna and Pacyna, 2001). (New paragraph) Khumbu Himalayan ...
- Page 116, Line 2: ... concentrations (e.g. Kang et al., 2007). (New paragraph) Mt. Ruapehu winter ...

Page 116, Line 22- 24: Might you consider to replace the brackets against a different type of brackets or dashes to guide more clearly the reader, since you might get lost to find immediately the begin and end of your thought placed in the brackets.

Page 117, Line 15-17: What would be needed to confirm/falsify the assumed relation between negative Zr anomalies and incomplete nitric acid digestion? Would you please clarify this point.

Page 118, Line 23: I do not completely understand what is meant by “ for all previous elements”. Do you might mean “for all remaining elements”?

Page 119, Line 6: Might you add to the name Ngozumpa also its region, so that the sentence is “ ... was found in Ngozumpa debris (Himalaja)”, because the jumping between the different regions, glacier names makes it sometimes hard to follow the text.

Page 120, Line 21: I might have missed it, but please introduce both acronyms LREE and HREE.

Page 121, Line 14-17: “The more silica-rich ... absorbs less solar radiation than the basaltic, silica-poor debris ... .” What point do you want to make here? Please clarify.

Page 121. Line 24-26: “In each region, 5-day transport paths were mapped ... meteorological input

data.” Which period does these estimates represent? Please clarify. In addition the related figure 6 suggests, that only the last month of the probe collection period has been used to determine the trajectories. Since glaciers also accumulate during the remaining period, I suggest to determine a probability density function (PDF) of trajectories that covers the climatological state in the year (years) before the measurements have been collected. This would give a more reliable picture of the different source contributions. Since you seem to be mostly interested in the ablation season you might weight differently the various seasons that go into the PDF.

Page 121-122, Paragraph 5.6: Supraglacial nutrient observations on Svalbard [*Hodson et al.*, 2009] suggest that sporadic inflow of pollutant-rich air masses might contribute significantly to observed pollutant concentrations. Do you account for this sporadic events that would also influence your reported concentrations? Are there also indications of such events for the other regions?

Page 122, Line 12-15. “Increased atmospheric deposition of dust ..... increase snow and ice mass loss, and ultimately contribution (better: contribute) to sea level rise.” It sounds like a clearly proven chain of processes that have a high significance. I agree in the assumptions but phrase them more cautious, such as “Increased atmospheric ... might amplify snow and ice melt rates, which increases snow and ice loss, and ultimately contributes to a faster rising sea level”

Page 122, Line 26-27: The sentence about ongoing improvements is an obvious statement. I do not think that it is necessary? Please consider to delete these lines with the exception you complete you thought about the consequences that goes beyond this general statement.

Page 123, Line 7-20 (last paragraph of discussion): I find this last paragraph a little bit vague. I will certainly gain power if you please the final conclusion (first sentence) at the end.

## Figures

Fig. 1, Caption: Please decipher REE printed in the figure legend in the figure caption.

Fig. 2, I personally like to see in photos how these areas look like. So I have a more clear picture about their characteristics. This is in particular important for people you might use your data and perform purely numerical model studies and have never seen such an environment.

Fig. 2-4, Caption: I would prefer to either place for example “a)”, “b)”, and “c)” in the figure panels and/or describe their figure position more clearly like “upper left” / “top left”, “upper right”, and “lower”.

Fig. 3: I've not seen the reason for the data gaps neither in the text nor the caption. Please clarify this point. At least you might phrase that data gaps are depicted as gaps in the lines or refer to the corresponding table.

Fig. 4: Gaps are related to .. Please clarify or mention at least the existence of the gaps.

Fig. 5: In the three figure panels, the slightly different color for identical symbols per plot make it hard to identify the groups immediately. Would you consider to use either more distinct colors, different symbols for the four glacier groups or place vertical “bold” lines that separate these groups in the plots.

## Tables

Tab. 5-7: Might you be able to use a different symbol for below detection limit and missing data, such for example “0” and “-”, respectively.

## References

Hodson, A., T. J. Roberts, A.-C. Engvall, K. Holmén, and P. Mumford (2009), Glacier ecosystem response to episodic nitrogen enrichment in Svalbard, European High Arctic, *Biogeochemistry*, 98(1-3), 171-184, doi:10.1007/s10533-009-9384-y. [online] Available from: <http://www.springerlink.com/index/10.1007/s10533-009-9384-y> (Accessed 8 September 2011)