Review of Meinander et al

This paper provides an overview of the state of knowledge of high latitude dust sources, identifies new sources, and provides new data on the physicochemical properties of these particles. The paper is certainly timely and a good fit for ACP; however, the paper needs major revisions to make the points clearer and more concise. A lot of information regarding the methodology used to determine the physicochemical properties of HLD is missing making it difficult to assess the quality of the work presented in this paper. My comments below are meant to be additive to the points made by the 1st reviewer.

Major Comments:

1. The paper needs to be revised to improve the clarity and readability of the work. The paper feels a bit jumbled without a clear goal of what the authors want to convey—e.g., some parts get into remote sensing, others get into detailed chemical knowledge, there is a section on impacts on clouds. I suggest making the changes suggested by Reviewer 1 regarding the modeling, shortening the sections 7.5-7.8 and providing the impacts of this dust in the introduction to motivate the work. The authors can then provide the new information learned about these impacts in the Implications at the end.

2. I also found it very difficult to tease apart what new knowledge the authors were presenting as opposed to previous findings. I was confused by the fact that the authors showed figures from previous papers yet put their own new figures in the SI. For instance, new figures on the properties of particles from high latitude dust emitted from Russia is in the SI while reprints of already published work are in the main manuscript.

3. A lot of key references and definitions are missing that would help the reader digest the new information presented.

4. The introduction needs major work. It has lots of redundancies, does not clearly articulate the goals of this work, and is missing key information needed to understand the impact of high latitude dust. Similarly, the methods section needs more information regarding the key measurements performed at each site discussed in the paper.

Specific Comments:

Introduction:

1. The Introduction needs a section on mechanisms that describe how high latitude dust is formed and how these processes differ from low latitude dust emission.

2. The introduction also needs a section on how climate change is affecting the intensity and seasonality of HLD and how, in turn, HLD is affecting climate. This last point can draw upon a very shortened version of sections 7.5-7.8.

Methods:

1. The method section needs an overview of which sites discussed have what measurement capabilities. This will help the reader interpret the information given regarding PM loadings as well as the physical and chemical information reported.

Results:

1. Figures 1-3 can be improved to more clearly show the regions described in this work. The figures have a lot of white space and are hard to read, especially figures 1 and 3.
2. Line 251 about Sr and Rb needs a citation.
3. Lines 271-272 reference new measurements but do not show the data
4. Line 352 and elsewhere in this section, what do the No.s refer to? The numbers in Figure 1?
5. Line 419: are those units correct for the dust storms of 7 mg/m3 (milligram not microgram??)
6. Section 5.7.1 presents what I believe to be new data, but all of the data is in the SI instead of in the actual manuscript and none of the data is described. The authors need to present their data here.
7. Section 5.7.3 are these measurements of sediment or aerosols? If aerosols, the KCl could also be from biomass burning rather than sylvite and more evidence is needed to prove the assignment of this particle class.
8. Line 566: how were these minerals characterized? Again, a lot of methodology is missing in this paper that needs to be provided in order to assess the quality of the work presented.
9. Lines 728-729 make a good point about the heterogeneous nature of HLD that should be emphasized in other parts of the manuscript.
10. Lines 885-886 require a reference for this statement.
11. Line 995: cite (Jickells and Moore, 2015)
12. Line 997, cite (Mahowald, 2011)

Minor Comments

1. In general, the paper needs to be carefully reviewed before resubmission. There are a lot of awkwardly worded sentences that are hard to read. I pointed out a few examples here but there were too many to point them all out in this review.
2. Line 58: “retrieval” should be “retreat”
3. Line 69: bio productivity should be biological productivity
4. Several definitions are missing in the paper such as SI, UNCOR, UNEP, etc
5. Line 128 describes “the best productive surfaces”. This needs to be rephrased.
6. Lines 143-144, define the terms given “gleysols, retisols”
7. Line 148, remove an “in”
8. Line 186-187: “minimum values dust productive surface areas” needs to be rephrased.
9. Line 188: “dependable” should be “dependent” and “comprehend” should be “contain”
10. Line 222: change “glacial sediment carrying major rivers” to “major rivers carrying glacial sediment”
11. Line 301: change “roundly” to “round”

12. Line 305: change “heat supply” to “supply heat”
13. Line 375: change “south easter” to “southeastern”

REFERENCES

Jickells, T., Moore, C.M. (2015). The Importance of Atmospheric Deposition for Ocean Productivity. Annu. Rev. Ecol. Evol. Syst. 46, 481–501. https://doi.org/10.1146/annurev-ecolsys-112414-054118

Mahowald, N. (2011). Aerosol indirect effect on biogeochemical cycles and climate. Science (80-. ). 334, 794–796.