Quantification of iron-rich volcanogenic dust emissions and deposition over ocean from Icelandic dust sources (Arnalds, Olafsson and Dagsson-Waldhauserova)

Responses to referee comments

First of all: we are thankful for the constructive comments made by the referees, which we have attempted to answer below and to improve the paper accordingly.

Referee #1

GENERAL COMMENTS

1. **Is mostly concerned with lack of descriptions.** We have addressed this issue as is outlined under the items below.

SPECIFIC COMMENTS

2. **Recent eruptions.** This is an interesting subject, of course. We mention that there are sometimes spikes in dust activity following eruptions and floods associated with eruptions, and of course if tephra is deposited directly on oceanic waters. We provide relevant citations, but otherwise this not the subject of this paper, as we focus on continuous average dust production.
3. **Error estimates and difference between studied events.** The errors of the individual meteorological and dust-related parameters are discussed at the beginning of Ch.5. They are expected to be high for each event. This discussion is now summarized with a statement of error of estimation of the dust transport being 50 to 100% for each storm in the new version of the paper.
4. **Is the visibility the same as in Sahara**. There is bound to be some difference given the same dust concentration, which relates to the light absorbance of the materials, but the severity of the storm is the main factor controlling the visibility.
5. **What were the numerical calculations for dust storms.** The numerical simulations are only used to estimate the height of the atmospheric boundary-layer and the winds inside the boundary-layer. This is now stated clearly in the new version of the paper.

TECHNICAL CORRECTIONS

6. **Abstract, mention river discharge**. River discharge is discussed in the text, but due to the number of words limitations, we could not fit discussion of river discharge there (would have to consider both amount and the extent of spread).

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7. **l4. MODIS questions; is there MODIS available?** There were MODIS images available for the storms presented in the paper. Dust storms in Iceland are commonly captured by MODIS. The respresentativity was compared to other MODIS images (we have >50 downloaded, but they have not been systematically collected). It should be noted, however, that only a minority of the dust storms that occur in Iceland are captured by MODIS. The sentence now reads: "(iii) the repetitiveness of the visibility observations were confirmed by comparing MODIS images of the storms to other typical storms captured by MODIS."
8. l25. **What was the average storm duration.** The average duration of the dust storms was 17.3 hours. This is now stated in Ch. 3.2
9. l25. **Which are occurring 135 times a year**. There is a large variability in storm sizes, as can be expected, and this is addressed in table 2, which indicates that the majority of the storms are minor.
10 l26. **How amount calculated.** The equation used for the estimation of the mass transport is now given and explained in Ch. 3.2

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11. L4. **What are "main dry winds".** We mean dry wind directions. In a given area some wind directions are primarily wet, others dry, depending on location within the country. Amended with wind directions.
12. L15. **Map presented in Fig. 3** . Amended accordingly.
13. L22 **Where does the log distribution figure come from and how corresponds with theory**. It comes from using the data from Arnalds (2010) from dust sources, but this time out to the ocean from the southern shore. It corresponds to theory as far as we know; more coarse materials are deposited closer to sources (and overall larger amount over smaller unit areas) while finer materials are spread over much larger areas (hence less deposition per unit area).
14. L25 Typo, corrected.

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15. **L14. What is the error estimate for the numbers of dust storms**. This number is based on observations at weather stations. The error is therefore presumed to be low. The observations are made regularly by well trained observers and it is not reasonable to expect many dust plumes to pass without being detected by the observational network. This does however not account for some of the dust storms at the south and SE coast where dust is blown directly out on the sea. This is now mentioned at the beginning of section 4.1.
16. L20. **How is the split between major, medium and minor dust storms decided**. And **Emission during major storm.** This is based on classification presented by Dagsson-Waldhauserova et al. 2013 of visibility at weather stations. Added a line thereabout in the Methods section (3.1). The amount per storms is given in Table 2, and is 1 million t per major event (which are very few). Added more info to L 21 for reiteration.
17. L23. **Grammar**: adjusted.

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18. L22-23. I**s a factor of 3 comparable?** Actually factor of 2.5. Yes, in this case we believe so. Taking into consideration annual variability and other uncertainties; the same order of magnitude.
19. **Section 4.2. is unclear.** We assume this refers to the first part. The section explains that each area or section of the map expands with distance from the country or the source (land), and therefore the 25% percentile was used instead of the average number for each area of the map (from boundary to the next boundary) We attempted to make this clearer.

DISCUSSION

20. **Is it likely that Icelandic sources are 21% of North African dust?** We are comparing our numbers for Iceland with published numbers for North Africa, which result in 1.9-21%. We are careful not to indicate an opinion here.

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21. L27. **How old is the material being blown out to sea, has it been washed and what would the solubility of the iron be then**. The age is going to be quite variable, but lot of the material has been washed in glacial rivers while deposited. But we are not aware of Fe solubility results per se, but we think it is vital to start experiments with solubility of the different dust materials in Iceland.
22. **Fig. 1 How are major plume areas defined.** They were defined by Arnalds 2010. Areas characterized by excessive frequency of dust events (hence, low threshold velocities), dust carried vast distances, easily identified by scanning and monitoring MODIS images several years back. In addition they have certain geomorphological features, such as fine silt sediments, frequent reloading of the sediments (by glacial river flooding etc). Mostly, however defined by the frequency and amount of dust, overshadowing other dust sources (and the other 15 000 km^2 of sandy deserts).
23. Fig 3. **Would like to know a little more how it is generated.** The map generation is further explained in section 3.3, where we added a sentence to amend the text.

<u>Referee #1</u>

Has few comments, with the major one covered with responses to Referee #1 with more detailed descriptions of methods. **Regarding MODIS**: The MODIS data is used to support / confirm the map generation (sentence added to section 3.3).