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Comment

## ***Interactive comment on “Long-term variability of dust events in Iceland (1949–2011)” by P. Dagsson-Waldhauserova et al.***

**P. Dagsson-Waldhauserova et al.**

pavla@lbhi.is

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Anonymous Referee #1

General comments This manuscript presents long-term records of dust events in Iceland and discusses a topic relevant for ACP. Although there is overlap with a previous publication of the authors (Dagsson-Waldhauserova et al., 2013), the manuscript extends the data presented earlier with observations in S Iceland. Especially the comparisons of visibility and PM10 measurements in S Iceland have not been discussed earlier. However, they are discussed only briefly in this manuscript. This type of comparison has been done previously in other regions and the results should therefore be discussed in relation to earlier studies such as Wang et al. 2008. Possible explanations

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for deviations to earlier findings should be discussed. Moreover, I would suggest to also discuss previous model attempts of the authors based on these new fit functions that deviate from the model used earlier for NE Iceland (Dagsson-Waldhauserova et al., 2013). The differences between NE Iceland and S Iceland could be discussed more thoroughly and appear to be partly caused by the difference in measurement method. The distance between stations and nearest dust sources probably affects the results in Table 2 and section 3.2.3 and should therefore be discussed in the manuscript. Conclusions mentioned in the abstract and/or conclusions section, specifically the use of 04-06 codes and the influence of the SLP oscillation pattern, are not clear from the presented data. The data should preferably be shown in the manuscript, or otherwise these statements, currently presented as conclusions, can only be points of discussion. Conclusions appear to focus on the occurrence of dust events at low temperatures in S Iceland (and high temperatures in NE Iceland). More attention, however, could be given to the wind direction and speed (and subsequent temperature), as this probably is the driving factor of the dust events. In the current version of the manuscript one may get the impression that temperature foremost affects dust events, but the responsible processes are not discussed.

ANSWER: We would like to thank the reviewer for the suggestions, corrections and comments, which have improved the paper considerably. We carefully read through the comments and reworked large parts of the manuscript. Particularly, we extended the discussion part of the manuscript, especially regarding the PM analysis and differences in dust frequency between NE and S Iceland. The observation methods for dust day frequency in S and NE Iceland were the same – synoptic codes reported by the observer at the stations. This dust frequency study follows the methods from the dust studies of the major desert areas of the world – Africa, Australia, Mongolia, China, Iran, and USA. We decided to use exactly the same synoptic codes as these studies to be able to compare our results with them. However, a very important outcome of this study is that active volcanic and glacial deserts such as Iceland differ from the crustal deserts, because of permanent input of volcanic materials and frequent resuspension

of these materials. We did not include the synoptic codes for this into the dust-day frequency study, but it needs to be stated, that dust event frequency is significantly higher in Iceland due to its volcanic and glacial character than conventional crustal deserts. We extended the discussion part also on these codes (04-06), emphasizing the PM concentrations were elevated for these codes, and reworded the conclusions and abstract parts. We excluded the SLP oscillation conclusions from the abstract and conclusions. We agree that more attention should be given to the wind direction, wind speed and responsible processes of dust events. More on this was added to the manuscript.

### Specific comments

17332L7 concerning SLP: this is hardly shown in the manuscript and could be ignored in the abstract, or an analysis of SLP influence should be added. ANS 17332L7 concerning SLP: Text was changed.

17332L12-L15 Prevailing wind direction and wind speed should also be mentioned, as these probably influence dust event occurrence and temperature. ANS 17332L12-L15: Added.

17335L26/27 This could be mentioned in the methods/analysis section rather than data. ANS17335L26/27: We agree, but the sentence "Daily dust concentrations were correlated with the minimum visibility during dust observations during the preceding 24 h." is related to the HVFA sampler in previous sentence. We have not found a relevant place for this in the section analysis. Therefore, we suggest it is better to keep it as it is.

17336L4-6 Could you show this in a figure? ANS17336L4-6: We plotted all available PM10 measurements for codes 04-06 in the graph here bellow. Left graph – all measurements, right graph – focused on PM10 concentrations < 100  $\mu\text{gm}^{-3}$  (please note that the X-axis shows the number of the observation - all stations  $n=533$ ). However, the important information on the percentage (how many of these 04-06 codes matched

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with elevated PM10) is stated in the text and we do not see why this graph should be added to the manuscript. If the reviewer insists we would include it.

17336L6/7 Rephrase for clarity. We included .. in case : : : ANS17336L6/7: Rephrased.

17337L14 What was the mean visibility during dust events in NE Iceland? ANS17337L14: Added.

17337L15 Are the stations placed closer to major dust sources? ANS17337L15: Yes, the stations in the South are located closer to the dust sources. We have made this clearer in the text.

17337L24-25 How often do dust events occur in NE and S Iceland simultaneously? (e.g. as a percentage of total number of dust events) ANS17337L24-25: Such situation is very rare. If we consider NE Iceland and S Iceland without Westfjords (NW Iceland) and station Hveravellir, it is about 0%. The passage of the cyclonic system usually takes at least a day to change the wind directions from S to N. However, this study includes data from NW Iceland as part of S Iceland study and also the station Hveravellir (located in Central Iceland) reported minority of dust events also during S winds. Therefore, the total percentage of simultaneous events is 3.7%. We added sentence on this.

17338L9 Explain what is considered to be a dust event in this manuscript and how long it typically lasts. (DE defined in methods, add a link here) ANS17338L9: This is very good point. Dust event is considered here as dust observation (added to Chapter 2.2). The time resolution of dust event has been solved in the conventional dust studies with the new unit – the dust day. This is due to different time resolution between dust observations - some are made each 3 hours, some more, some less. If there is a dust observation reported, you do not really know if the event took one hour or three hours. The model calculated as average 17 h for Icelandic dust storm based on 4 representative storms. From our data, such precise information is hard to obtain.

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17338L10-15 You could add the mean air temperature in NE and S Iceland to give some insight if the mentioned differences are only related to dust events. ANS17338L10-15: Added.

17340L3-5 Possibly add “(not shown)”. ANS17340L3-5: Shown in Table 2. Added in text.

17340L13 What is “mean DE velocity”? ANS17340L13: Corrected.

17340L25 You could rephrase this sentence to clarify that this is the correlation between the modelled PM10 and measured PM10 values rather than a correlation between visibility and PM10. Furthermore, ‘higher correlation at station : : . than at station: : :’ may be more appropriate than good and considerable correlation. Moreover, add the number of data points at each station and show statistical significance. ANS17340L25: We are not sure we understand what the reviewer means by the “modelled PM10”. All PM10 concentrations and corresponding visibility were measured. We agree that rewording in the second part of the sentence was needed. Number of data points (n) was added.

17341L2 What does “visibility of all available dust codes” mean? Not many codes available, therefore we used one graph for all the stations. ANS17341L2: As we stated in the Chapter 2.2 Analysis – “Dust concentration measurements can be compared to the weather observations at few stations in South Iceland and for a short time period.” Yes, we combined all available data in one graph (n = 533) to obtain the relationship for all stations, similarly as in Wang et al. (2008). We emphasize here that these are the first results, we need more observations for detailed study.

17341L17-18 Dust day frequency including codes 04-06 can only be compared to studies that also include codes 04-06. ANS17341L17-18: We agree, sentence removed.

17343L2-5 This should already be mentioned in the measurements description. ANS17343L2-5: Added.

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17343L24-25 How is this related to the observed dust events? ANS17343L24-25: The dust events in S were mostly cold and frequently observed in winter. This trend is unusual and hard to find in the literature. The study from Mongolia is the only study found where dust events occurred in sub-zero temperatures and in winter.

17344L4-13 Compare the results to earlier studies on this topic. ANS17344L4-13: We appreciate that the reviewer noticed that this important part of the discussion was missing. New paragraph was added.

17344L14-25 This appears to be a topic for the introduction rather than discussion. ANS17344L14-25: We agree, the paragraph was rephrased.

17345L3 replace “cold high-latitude areas” with “Iceland” ANS17345L3: Replaced.

17345L11 The data that could show that “codes 04-06 should be considered in dust studies” were not shown in the manuscript and this can therefore not be stated as a main conclusion. Move to discussion ANS17345L11: We improved the discussion on these codes. The statement in the conclusions was changed. However, we are convinced that this is an important finding of this study. The dust studies from the crustal deserts require different codes than volcanic, glacial deserts. The percentage was stated in the manuscript and the codes were used in the PM-visibility analysis. The extra graph showing the PM exceeding of  $41 \mu\text{g m}^{-3}$  was not found necessary.

17349Table 1 Please indicate the distance to the nearest dust source for each station. What do the bold stations refer to? ANS17349: The distance of the stations from the dust sources can be seen on Figure 1. We added to the figure caption that the red areas are the major dust sources and a scale. Note that the same station can measure dust from different sources, making such distance statement a little complex. The “bold stations” were removed.

17356Figure 6 Add an explanation of the dashed circles. You could add a wind rose for the complete period (including dust events) for comparison. ANS17356: Explanation

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added. This is a complete period for all dust observations in South Iceland as defined in introduction. The wind rose for the NE Iceland was presented in the paper for the NE. The graph of all wind directions measured at all stations 1949-2011 is added here below for the reviewer.

17357 It would be informative to add the wind direction and show the relation between wind direction/speed and dust event occurrence and temperature. This could be an extension of the discussion about the effects of SLP pattern mentioned on page 17343. ANS17357: A figure with the monthly WD during dust events was added.

The changes in manuscript regarding the reviewer's comments were marked in red and are included to this answer as Supplement.

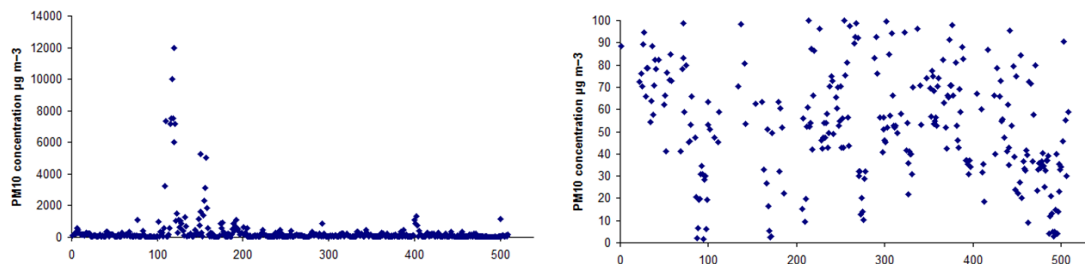
Please also note the supplement to this comment:

<http://www.atmos-chem-phys-discuss.net/14/C7671/2014/acpd-14-C7671-2014-supplement.pdf>

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Interactive comment on Atmos. Chem. Phys. Discuss., 14, 17331, 2014.

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**Fig. 1.** 17336L4-6 graph with PM observations

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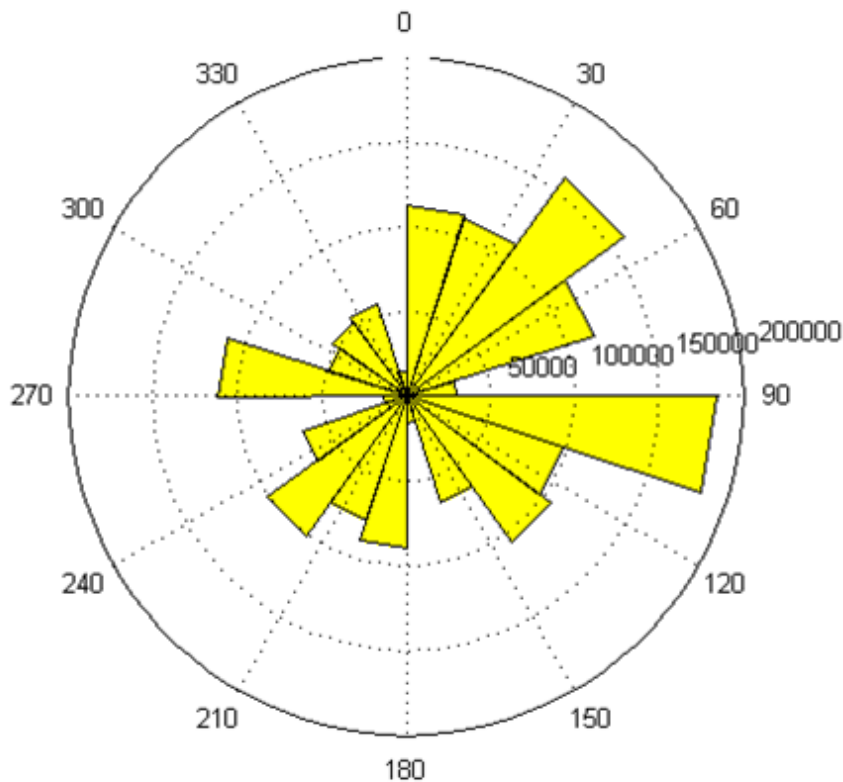


Fig. 2. 17356 - graph of total winds in S Iceland in 1949-2011 for reviewer

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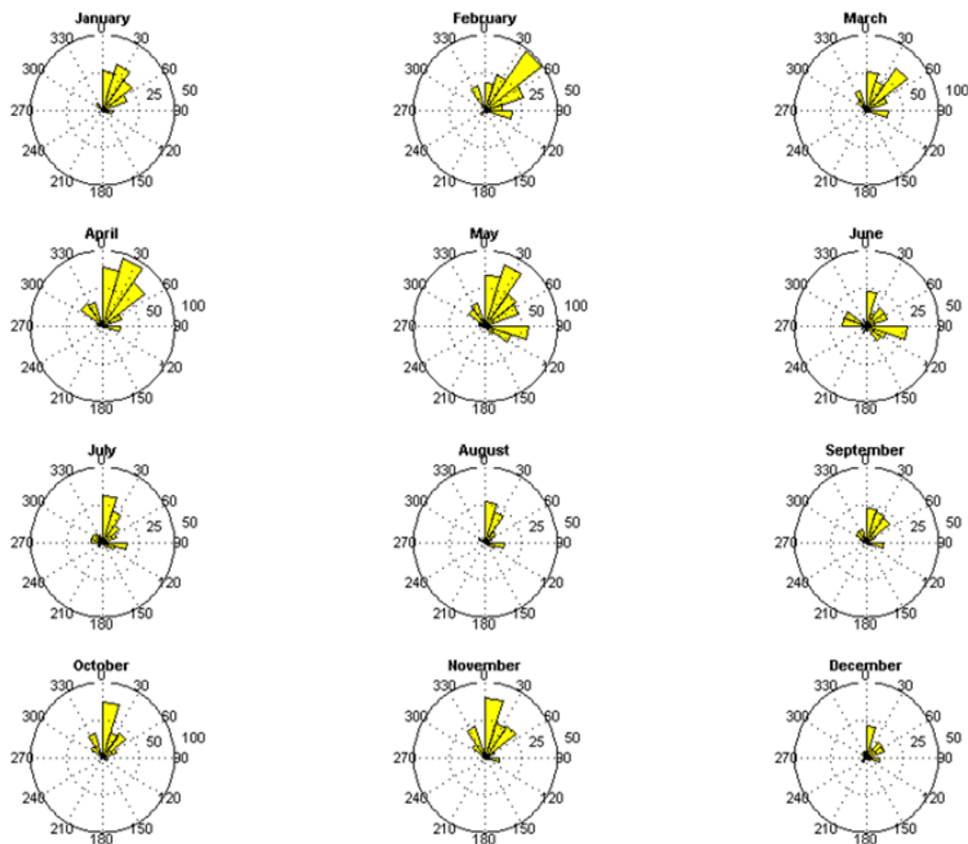


Fig. 3. new figure - monthly WD during DE in S Iceland