

## ***Interactive comment on “Impact of dust deposition on the albedo of Vatnajökull ice cap, Iceland” by Monika Dragosics et al.***

### **Anonymous Referee #1**

Received and published: 17 October 2016

#### Summary:

The paper by Dragosics et al. applies modeling and field observations to determine the impact of mineral dust deposition on the radiative properties of Vatnajökull's ice cap in Iceland. Field observations, gathered during 2013, and AWS data are compared with model simulations of FLEXPART and HIRHAM5 parameterized on Iceland's land cover and meteorology. The authors state that dust depositions have a strong impact on the mass balance of the ice cap, which is a novel and interesting conclusion.

#### General comments:

The paper is rather well structured and its hypotheses are relevant with respect to the impact of light-absorbing impurities (LAI) on the cryosphere. The referencing is quite complete and state of art knowledge is developed in the introduction.

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The comparison between observed and simulated dust depositions showed quite big differences. For example, in Figure 2 I cannot see the "similar pattern" (line 208-209) the authors refer to. Furthermore, any direct correlation between observed and simulated data is not provided. I suggest to expand the discussion about this comparison, highlighting possible causes of the differences (e.g. the timing of the field campaigns).

The choice of the year 2012 should be strengthened. I don't understand why the authors did not use 2013 as a test year, since they have field data for that year. If I understand well, they are comparing field observation from 2013 with simulations of 2012. In my opinion, this needs a stronger justification. Here they are assuming that the spatial patterns of dust deposition on the ice cap are equivalent from year to year.

I suggest to delete the part on MODIS data, since they are not used quantitatively in the study. In Figure 6, I cannot recognize any dust plume or deposited dust on the ice cap. If anything, other satellite (e.g. Landsat) and model products can be used to represent dust plumes and/or depositions. If you want to keep MODIS data, I suggest to compare data from the AWS with MODIS snow albedo time series (MOD10A1, MYD10A1), which could be very interesting from a remote sensing perspective.

I suggest to add in the introduction a description of the "state" of Vatnajökull ice cap (e.g. mass balance data), in order to ensure a broader impact of the paper. Why is it important to study the impact of LAI on Vatnajökull? Is there any missing link between the temperature increase and ice melting? In the introduction, reference to the impact of LAI on Greenland (e.g. Tedesco et al. 2016 TC, Dumont et al. 2014 Nat. Geo.) could also be helpful to describe the process on ice sheets, which is more interesting for climate analysis.

The Appendix is more suitable as Supplementary Information.

The dust mobilization scheme (FLEXDUST) is based on a paper that was submitted to JGR (Groot Zwaaftink et al.). I suggest to expand the description of this scheme, since at the moment the reader cannot have details on it.

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I'm not an expert in mass balance modeling, so I don't have specific comments on it. In any case, the impact on mass balance is evaluated using only two AWS dataset. Is it possible to extrapolate this information to the whole Vatnajökull ice cap? or the impact of mineral dust could be limited to some areas of the glacier?

I think that the paper can be published in TC once these comments are addressed and discussed. Specific comments are reported below.

Specific comments:

Figure 1: It is very small and labels are difficult to read. I suggest to enlarge Fig.1A and to remove Fig.1B since the details are not relevant for this study. As far as I understand, only data from B13 and B16 (+ the firn core) are used in this work.

Figure 2: I suggest to use a linear scale bar palette for dust deposition.

line 56 Here briefly describe the impact of LAI on Greenland Ice sheets.

line 76: delete "want".

line 77: please rephrase this sentence.

line 92: "Snow cover inhibits the dust emission": explain better or remove this sentence

line 111: Why did you choose this threshold? Please explain.

line 116-117: here some references are needed. 2012 was an extreme year in the northern hemisphere, with strong melting in Greenland (e.g. Nghiem et al. 2012 GRL).

line 118-121: here I don't understand why you chose 2012 as a test year.

line 120: replace "spacial" with "spatial".

line 128-130: remove this part on MODIS data.

line 154: "Albedo is a key variable in the surface energy balance and used to calculate melting", change with : "Albedo is a key variable in the surface energy balance and it

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is used to calculate ice melting"

line 160: delete "may then be" and replace with "it is"

line 163-165: please rephrase this sentence

line 173: I personally don't like reference to paper in preparation.

line 181: delete "seemed" and replace with "is assumed to be"

line 181- 183: did you remove these data? please explain

line 188: delete "seemed" and replace with "was"

line 188-190 Unsupported statements. Add some reference or lose the phrase

line 194: delete "(not ice)"

line 194: add more details on this point, what do you mean with "extreme year"?

line 194-195: this is a fundamental aspect. Decoupling the effect of dust and other meteoroclimatic forcing is a big issue. Explain better possible influence on your estimations

line 198-205: these are results, integrate in Section 3.

line 208-209: I can't see this "similar pattern". It looks like observational points don't show a marked spatial correlation, which is present in model simulations. This is supported by the IDW map showed in Figure 6 of Dragosics et al. 2016 (Arab. J. Geosci.), which shows "bull's eye" that are typical errors of spatial interpolation of uncorrelated data. I would expect that on a large ice cap such as the Vatnajökull, dust concentration on surface snow should in theory feature some spatial structure. Probably the impact of snow falls, melting and run off can redistribute the dust concentration. Only 16 samples on a large area (8000 km<sup>2</sup>) are too few to capture these complex processes of deposition and redistribution. Please discuss these aspects in the paper.

line 226: Confused sentence. Please rephrase

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line 232: delete "however, the order of magnitude was captured correctly", you already said that in line 229

line 259: I don't see the dust cloud, nor the dust deposition from Figure 6.

line 284: use "from .. to .." in both parenthesis

line 306: replace "precipitation" with "deposition"

line 324: confused sentence, please explain.

line 328-331: This should be better explained. BC cannot be excluded since its impact on snow is hardly visible with naked eyes (Warren 2013 JGR).

line 370: delete the "s" from "supper"

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