Response to Reviewer 2

The paper describes the meteorological and blowing snow dataset collected at Col du Lac Blanc (2720 m a.s.l.) in the French Alps. This data consists of wind speed and direction, air temperature, snow depth, blowing snow fluxes and occurrence periods, spanning the period from 2000/2001 until 2015/2016. The data is complemented with local atmospheric reanalysis from SAFRAN, and a digital terrain model with 20 cm resolution. All data are now available for the public, the dog's are given. The paper is a very welcome contribution for the ESSD Special Issue: Hydrometeorological data from mountain and alpine research catchments, and for the scientific community of snow scientists. However, I recommend some improvements prior to final publication.

We thank Reviewer 2 for his comments that greatly helped us improving the quality of the paper. We answered below to all his points. His comments are in normal font while our answers appear in blue. Changes made to the original version of the paper appear in blue italic.

General aspects:

- my major concern is that in the way it is presented, the comparison of the database of blowing snow occurrence and the SPC is not meaningful (2.3.1, 2.3.2 and 2.3.3). Both data sources make use of more or less empirical thresholds to classify a period as blowing snow occurrence, or to count the percentage of time during which particles are detected by the SPC, respectively. There is no better or worse of the two methods, they are only different and, due to the threshold values chosen, provide different results. Why do you choose thresholds in a way that the results become such different? The possibilities for improvement that I see here are (i) just present the two datasets "as is" without comparison, (ii) explicitely justify the choice of all thresholds, and explain the difference in the results, (iii) calibrate one method with the other, or (iv) leave the empirical database out und just provide a reference. In any case, always distinguish clearly physical processes from empirical estimates. Finally, it is not clear who the original author of the database methodology is, Guyomarc'h and Merindol (1998) or Vionnet et al. (2013)?

Following the recommendations of Reviewer 1, we have added a new section 3 dedicated to blowing snow data with new comments and we have split Table 3 in two tables. We hope that this revised presentation will help the potential readers:

- Section 3.1 describes the empirical database of blowing snow events. The choice of the minimum duration of 4 hours is better explained (see below our answer to this specific point)

- Section 3,2 describes the SPC measurements. The last paragraph of this section (L 231) has been fully rewritten to better explain the impact of the threshold value applied on the particle flux. Such discussion is important since SPC data are not widely used in the community

"Figure 4 shows an overview of the inter-annual variability of blowing snow occurrence and intensity derived from the SPC-S7. They measured non-zero snow flux during a percentage of time ranging from 43 % in 2010-2011 to 63 % in 2013/2014 corresponding to an average blowing snow transport quantities between 0.2 and 1.2 m per linear meter during 30 days ranging from 2547 kg in 2010-2011 to 10331 kg in 2013/2014. Overall, for the period 2010-2016, SPC-S7 provided a non-zero-value during 50% of time and an average quantity of snow transported between 0.2 and 1.2 m per linear meter and per 30 days of 6245 kg. However, SPC-S7 can detect individual snow particles and can report a positive signal (particle number larger than 20 particles cm-² during 10 min) even during very light snowfall event with low wind. Such period is considered as a blowing snow period even if it does not significantly contribute to the total amount of transported snow. For this reason, we quantified the sensitivity of the estimations of blowing snow occurrence and amount to the threshold value used to set flux to zero. Results are presented on Table 2. Three threshold values were tested: (i) the initial value of 20 particles per cm² per 10 minutes used to remove to electronic noise, (ii) a threshold value 1200 particles cm-² per 10 minutes as in Naaim-Bouvet et al. (2014) and (ii) a value of 9600 particles cm-² per 10 minutes. Table 2 shows that the estimation of blowing snow occurrence

is highly dependent on the threshold values whereas blowing snow quantities remain quite stable in the chosen range. It is therefore essential to provide the chosen threshold value to end-users when determining blowing snow occurrence from SPC-S7. In general, it might be better to use blowing snow fluxes for characterizing blowing snow events".

- Sections 3.3 (L 312) describes the comparison between the empirical database of blowing snow occurrence and the SPC. This section has been rewritten to provide a more accurate analysis of the results presented in Table 3. We decided to maintain this comparison because, from our point of view, it is useful for end-users. They need to be aware of the advantages and disadvantages of each method to use the data in the most efficient way. Moreover the depth of data available is greater for empirical data base at Col du Lac Blanc: 11 additional years are provided (2000-2010). We therefore add a new paragraph dealing with the potential use of data.

"The estimation of blowing snow occurrence determined with the SPC-S7 reported on Table 2 differs from the results obtained with the empirical database (Fig. 3). To gain more understanding on these differences, we determined the quantity of snow transported between 0.2 and 1.2 m per linear meter during the periods identified as blowing snow periods in the empirical database and we compared this value with the total quantity of snow transported between 0.2 and 1.2 m per linear meter derived with the SPC-S7 for the same winter season. The result is expressed as a percentage in Table 3. It shows that the empirical database of blowing snow occurrence detects 55 % of the total transported snow mass measured by the SPC-S7. This results from the non-detection of blowing snow events of low to moderate intensity with the empirical method as discussed in Vionnet et al. (2013). This method only reports the main blowing snow events. This mainly results from assumptions made in the method: the minimal event duration is set to 4 hours and only period with wind speed greater than 6 m s-1 are included during snowfall. Therefore, the estimation of blowing snow occurrence with the empirical method (12.0 % of the time for the period 2010-2016; Table3) constitutes a lower bound for the estimation of blowing snow occurrence at CLB. SPC-S7 provides estimations ranging between 23 and 50 % of the time, depending on the threshold value used when filtering the SPC-S7 data as discussed in the previous section.
The empirical database of blowing snow events and the SPC-S7 data are two sources of information on blowing snow occurrence and intensity at CLB. We recommend the use of SPC-S7 data for the study of blowing snow processes and the evaluation of models at fine temporal scales whereas the empirical database of blowing snow events can be used to evaluate reanalysis or output of regional climate models on a longer term. Compare to the SPC-S7 data, the empirical database covers a longer time period (11 additional years: 2000-2010). It also provides continuous hourly estimations of blowing snow occurrence whereas about 25 % of the SPC-S7 data can be considered as invalid or missing over the period 2010-2016 (Fig. 4)".

The empirical method to determine blowing snow occurrence has been developed by Guyomarc'h and Merindol (1998) and used in Vionnet et al. (2013). It is now clearly stated in the revised version of the paper (L215)

- my second major concern is a thorough discussion of the (very important) scale effects of blowing snow, and which ones are observed at Col du Lac Blanc. This should be an original paragraph in the introduction

The introduction has been rewritten to mention the different scale effects of blowing snow. Rather than writing an original paragraph, we included it at 2 different stage of the introduction.

- In the first paragraph, when presenting in general the effects of blowing snow on snow cover variability:

"Snow deposition is affected by wind-induced snow transport at the slope scale in a wide scale range of few meters to hundreds of meters (e.g. Mott et al., 2010). Snow tend to be deposited in the lee of ridges or local depressions leading to the formation of snow dunes and drifts and the smoothing of the land-surface roughness (Schirmer and Lehning, 2011). Blowing snow also affects the surface roughness of the snow cover at sub-meter scale creating a large variety of Aeolian snow forms such as ripples or sastrugis (e.g. Filhol et al., 2015)."(L32)

- In the second paragraph, when describing the effects observed at CLB:

"Wind-induced snow transport strongly modifies the spatial variability of the snow cover around the site for scales ranging approximately from 1 m to 50 m (Vionnet et al., 2014; Schön et al, 2015, 2018). The roughness of the snow surface is also continuously evolving throughout the winter as a function of the occurrence of snowfall and blowing snow events (Naaim Bouvet et al. 2017)." (L47)

- the fact that the data collection continues and new measurements will follow and be made available should be mentioned in the beginning of the paper, not at the end (in section 4).
It is now also mentioned in the introduction section. (L61)

- in figure 1 (the maps) the color scheme/contour lines should be improved: certain altitudes should be associated with a contour line, not with a color. The latter should be associated with an altitudinal range. In this map figure, the typeface and size should be harmonized. In the legend, "Automatic stations" should be "Automatic weather stations", or simply "AWS"
New versions of Maps (b) and (c) on Figure 1 have been produced during the review process. They include an updated color scheme, updated contour lines as well as harmonized font size and type. The term "AWS" is now used on Figure 1. The figure caption has been modified accordingly.

- Table 3 is more confusing than helpful; is there not better way of presenting these numbers?
Following the recommendation of Reviewer 1, we have split Table 3 into two tables and we delete lines which don't provide meaningful information. In such way, we believe the two new tables will provide valuable information to the readers.

- the reference section is full of type inconsistencies and mistakes. This entire section needs complete revision (should have been checked prior to submission).
The reference section has undergone a careful check to remove all inconsistencies and mistakes.

- the use of lowercase and uppercase letters needs revision in the entire manuscript

Details:

- line 20: "Snow Particle Counter" in uppercase: why? Is this the name of the device? I would recommend "snow particle counter (SPC)", and use "SPC" only in the following text.
Correction included. SPC-S7 is used in the rest of text.

- line 21/22: give the date when resolution changes Date included.

- line 28: avoid references in the abstract The reference was suppressed in the abstract.

- line 33: insert "atmospheric" between "concurrent" and "snowfall" Correction included.

- line 51: "SPC" SPC-S7 which is a commercial name is used in the text after the description of the sensor (Table 1)

- line 72: insert "weather" between "automatic" and "stations" Correction included.

- line 90: better "a" instead of "the" ("detailed view") Correction included.

- Table 1: remove the dot after "direction" Correction included.

- Table 2: remove the dots in the units, insert space in "4.8m" Correction included.

- line 133: the availability of the AWS Muzelle data given here does not match the one given in table 2
We thank Reviewer 2 for pointing out this inconsistency. Temperature and snow depth data are available at AWS Muzelle since December 2004 whereas wind data are available since December

2002. The text and the Table 2 have been modified to correct the inconsistency.

- line 1390: remove dot in "m.s-1“ Correction included.

- line 142: insert dot after "process“ Correction included.

- line 145: replace "Sect.“ We kept the term “Sect” following the recommendation for authors available on the ESSD website.

- line 162: better remove "but its power consumption is higher“ - this is another issue of no relevance here Sentence removed as recommended.

- entire section 2.2.4: make clear if the SAFRAN data presented here origins in an "analysis“, or in a "re-analysis“, and use the correct term then everywhere
The term reanalysis is now used everywhere.

- line 181: "SPC“ Correction included.

- line 183. insert "snow“ between "blowing“ and "occurrence“ Correction included.

- line 184: replace "of the period“ with "in the period“, and add at the end of the sentence where the sensor was established. Replace "consists in“ with "consists of“
The text was modified following this comment. The location of the sensor was not added since the database of blowing snow events is derived from a combination of sensors as explained at L 191-205 in the initial version of the manuscript.

- line 186: replace "was“ with "is“, make "event“ plural ("events“) Correction included.

- line 188: better "relies“ instead of "relied“, and "requires“ instead of "required“ Correction included.

- line 189: replace "datasets“ with "meteorological occurrences“
We think that the term "datasets“ is more appropriate in this case. Therefore we did not include the modification.

- line 191: better formulate "Periods of ground snow transport with concurrent snowfall are identified first“ Correction included.

- line 196: do you mean a logarithmic law? If yes, write the entire word and avoid abbreviations
We replaced “log-law” by “logarithmic law”.

- line 204: how did you choose the threshold of 4 hours? The results depend on it!
The empirical database of blowing snow occurrence has been developed to provide a full record of blowing snow occurrence that can be compared with the avalanche activity in the Grandes Rousses massif (Guyomarc’h et al., 2014). For this reason, the threshold of 4 hours has been selected to only keep in the database the main blowing events. We are totally aware that this is a strong limitation when compared to the occurrence of blowing snow measured by the SPC.
In the revised version of the manuscript, we better justify the choice of this 4-hour threshold:

- *“This database was initially developed to provide a full record of blowing snow occurrence that can be compared with the avalanche activity in the Grandes Rousses massif (Guyomarc’h et al., 2014).” L199 in the revised manuscript)*
- *« Only events of duration longer than 4 h were recorded in the database to only include the main blowing events.” (L 221 in the revised manuscript)“This method only reports the main blowing snow events. This mainly results from assumptions made in the method: the minimal event duration is set to 4 hours and only period with wind speed greater than 6 m s^{-1} are included during snowfall.”* (L 322 in the revised manuscript)

- line 207: does this correspond to the sum of the two columns in a winter season? Indicate this in the text. Avoid to write "blowing snow occurred“ in the context of the empirical method with the threshold, since the process of blowing snow probably occurred much more often! (i.e., write something like "blowing snow periods were classified : : :“)
Yes, the values correspond to the sum of the 2 values reported on Fig 3. It is now described in the revised version of the manuscript:
“These values correspond to the sum of blowing occurrence with and without concurrent snowfall reported on Fig. 3.” (L226 in the revised manuscript)
The sentence “blowing snow occurred” has been removed from the text and we now use:
“Using this method, blowing snow periods were identified during 11.7 % of time at Col du Lac Blanc over the period 2000-2016. 36.7 % of time blowing snow periods were classified with concurrent snowfall.” (L 227 in the revised manuscript)

- line 209: why only "are similar“, should these estimations not be the same as in Vionnet et al. (2013)? What is different, and why?
We used “are similar” since the estimations in Vionnet et al. (2013) covered the period 2000-2011 whereas the database presented in this paper contains 5 more years and covers the period 2000-2016. We used in the revised version of the paper:
“These estimations for the period 2001-2016 are similar to those reported in Vionnet et al. (2013) for the period 2001-2011.” (L 228 in the revised manuscript)

- line 214: better write "Data from SPC devices“ Correction included.

- line 215: "SPC“ Correction included.

- line 216: insert "a“ between "on“ and "photodiode“ Correction included.

- line 216/217: better make two sentences out of the one Sentence modified

- line 226: "SPC“ Correction included.

- line 227: delete "and risked burying the sensors“ Sentence deleted.

- line 228: better of "the“ SPC Correction included.

- line 229: delete "being made“. Better write full words, i.e. "That is why“ Correction included.

- line 235: insert "the“ between "approximate“ and "averaged“ Correction included.

- line 338: correctly align the minus in the formula Correction included.

- line 244: delete "case of“, add "speed“ (?) after "wind“ Correction included.

- line 248: delete the "s“ at the end of "particles“ (-> singular) Correction included.

- line 258: better "the mean horizontal fluxes“ Correction included.

- line 261: "the“ SPC data Correction included.

- line 263: "The“ SPC Correction included.

- line 265: "in“ the period Correction included.

- line 266: "the“ SPC Correction included.

- line 266: : : : able to "identify trace“ precipitation : : : ? Please clarify!
The term “trace precipitation” is generally used to describe a very small amount of precipitation that results in no measurable accumulation using a rain gauge, snow stick, or any other weather instrument. (http://glossary.ametsoc.org/wiki/Trace). As SPC-S7 is able to detect one snowflake, it is able to detect trace precipitation. The expression “trace precipitation” has been deleted in the text to facilitate reader comprehension *(L 299 in the revised manuscript)*
“However, SPC-S7 can detect individual snow particles and can report a positive signal (particle number larger than 20 particles cm-² during 10 min) even during very light snowfall event with low wind”.

- Figure 4: add unit to y-axis and format typesetting properly.
We added the unit to the y-axis.

In the figure caption, better write "during“ the period, and "delivered by the SPC“: Corrections included

- line 279: this "calls“ for Correction included.

- line 281: better "That is why“ Correction included.

- line 282: "applied for the raw data“, with "a particle flux smaller : : :“ (singular) Correction included.

- line 283: "Then a similar data processing: : :“, and: why "similar“, and not "the same“. Explain the difference, if it exists! It is not similar, it is the same. Correction is included.

- line 284: "a“ direction threshold. Delete "parameters“ Correction included.

- line 285: "with different thresholds“ Correction included.

- line 293: "to the SPC“ Correction included.

- line 295: "blowing snow occurrence“ Correction included.

- line 309: site "for the last six snow seasons“ Correction included.

- line 334: better "of“ the different stations Correction included.

- line 341: "The data of the winters: : :“ Correction included.

- line 350: "SPC“ Correction included

- line 358: delete comma Correction included.

- line 359: better "who“ instead of "which“ Correction included.

Good luck, a very nice peace of work! Thanks!