acp-2016-212, “Near-surface and columnar measurements with a Micro Pulse Lidar of atmospheric pollen in Barcelona, Spain” by Sicard et al.

General comments from the authors: First of all, we want to thank the two referees of our paper for their time and revision of our work. There is a small change in the paper that we would like to indicate to the referees. We noticed that the pollen on the last day of the event, on March 31st, after 18UT is not removed from the atmosphere (as it was said in the initial submission). A look at Figure 2b evidences it: a strong volume depolarization ratio persists in the ABL after 18UT but not below 0.5 km where it comes down to values typical of the local, background aerosol in Barcelona. This non-depolarizing plume (< 0.5 km) is at the same time associated with high values of the backscatter coefficient (Figure 2a). We checked that the detection of the pollen plume height was erroneously found at the first range bin shown (near 0.16 km), and not near the top of the ABL as it should be. We corrected our script and ran it again for the last hours of March 31st. This re-run results in changes in h_{pol} and thus on all integrated parameters (AOD_{pol}, AOD_{pol} / AOD, $\overline{\delta^V}$ and $\overline{\delta^p}$) only for March 31st after 18UT. We updated the following figures: 5, 6 and 8 and all four tables, as well as the discussion related to March 31st. We insist that these little changes only affect the data from March 31st after 18 UT, and do not change anything to the conclusions of the paper.

Answers to Referee#1’s comments

Overall comment:
The object of this paper is to analyze relationships between direct surface measurements of pollen and MPL data simultaneously observed, and also meteorological parameters including solar radiation for continuous pollination events in Barcelona.
The results are shown with many figures and tables, and discussed in detail on the phenomena. The results and discussion may be a little lengthy, e.g., as mentioned in the “P15, L20-L27”. And the reviewer feels that the discussion is not satisfactory for readers because of less physical aspects of the relationships analyzed. For example, in section 5, they analyze and discuss the correlation with solar radiation. It is interesting that the correlation coefficients have been better when introducing the time-delay(t). They show better results of correlation coefficient, when t > 0 and t < 0 for different days. What is the physical meaning of the time-delay ? Also why do these values show positive and negative in neighboring two days?
Authors’ reply: The idea behind the correlation analysis between the quantity of pollen dispersed in the atmosphere (parametrized by δV or δp) and the solar radiation was to see if the solar radiation, which during daytime creates convective ascendant motion of air masses, is a major factor of the vertical motion of pollen during daytime. This idea is also reinforced by the fact that during nighttime, i.e. without solar radiation, pollen is usually not detected in the PBL. The objective of the correlation analysis is well introduced in the first paragraph of Section 5.
The convective ascendant motion of air masses produced by the solar radiation reaching the ground is not instantaneous; it occurs with a determined time delay. The time delay introduced in the paper has the exact same meaning, and the question that we want to answer is: what is the time phase difference between the variations of the solar radiation and the ones of δV or δp? We find that the time delay is between 0 and -1, which indicates a time phase difference between 0 and 60 minutes. However on 28 march we have a surprising result: the δV or δp variations are ahead of time (t is positive) w.r.t. the solar radiation. The probable explanations for it, and expressed in the text, are that 28 March is one of the days with nocturnal pollen near-surface activity and with the highest wind speeds. On that particular day, the transport of pollen in the atmosphere was already occurring before (and without) the morning solar radiation.

Minor comments:
P2, L22: Do authors have any reasons of two kinds of character types, normal and italic when written in the following manner, e.g., "Ambrosia, Alnus, Artemisia, Betula, Corylus, Chenopodiaceae, Cupressaceae/Taxaceae" Such expression is also shown in other places. If these are common in this field, it is Okay, but if not, please change these into one type.
Authors' reply: This is related to botanical terms and the taxonomy nomenclature rules. The names of genus have to be written in italics or underlined, the names of families are written with the normal letter type. You can recognize the names of the families by the termination –aceae. It is necessary to maintain the types indicated in the submitted version in order to be correct from the botanical point of view of the paper.

P6, L23: "In the second half of March 2015 a strong anticyclone positioned in the Atlantic Ocean west of the Portuguese coast generated southeasterly winds in the northeastern part of the Iberian Peninsula." Is the wind direction correct? It must be northwesterly (not southeasterly) ?
Authors' reply: The referee is right. That was a mistake from our part. "southeasterly" has been replaced by "northwesterly" in the revised manuscript.

P7, L8 ant other places: The unit for counting the number concentration of pollen even for the daily mean should be "m-3", not "m-3 day-1". This expression is physically wrong. So in this case they should express in the following manner, the daily mean concentration of pollen is xxx "m-3". Also the unit of "m-3 h-1" is wrong, shown in other sentences and figures. These should be changed.
Authors' reply: Initially "day-1" and "h-1" were added in order to indicate clearly if we were talking of daily or hourly averages. However we agree with the referee that it makes the units of concentration not fully correct, since the concentration numbers are not assessed by dividing by a unit of time (day or hour). So all pollen concentrations have been expressed in m-3 in the revised manuscript.

P8, L28: Is "Figure 3b" correct? It looks like "Figure 5."
Authors' reply: Figure 3b is correct. In Fig. 3b, as mentioned in the caption, the red and grey vertical lines indicate the time of the maximum pollen concentration and pollen optical depth, respectively, on each day.

P9, L21-L24: "Logically a strong release of … are gathered." It is a little hard to understand it. Please modify the sentence into much easier expression.
Authors' reply: This sentence and the previous one were replaced by the following: "As expected, every day the AOD_{pol} peak follows the total pollen concentration peak. Logically, in the case of pollen of local origin, not long-range transport, a peak of the amount of pollen in the atmosphere (parameterized by AOD_{pol}) can only happen if previously a strong release of pollen at the ground level (parametrized by the pollen concentration) has occurred.".

P13, L11-L13: "… is not from local origin." Please show and explain some evidences/reasons of "not from local origin."
Authors' reply: We have considerably modify the hypothesis related to the sudden removal of pollen on 31 March at 18h. The decrease of the pollen layer top height is associated with a strong increase of AOD, a strong increase of β^p in the first 0.5 km, a decrease of $\overline{\delta^V}$ and $\overline{\delta^p}$, an increase of RH but with no significant variation of the near-surface PM_{10} level. The characteristics of the layer below 0.5 km are thus not from sea salt (because we have low depolarization ratios), they are also not directly from the aerosols formed at ground level (PM

levels are unchanged). We conclude to a water uptake (hygroscopic growth) of the already lofted particles and put it as a hypothesis in the text:

"Finally the sharp decrease of h_{pol} on 31 March at 18 UT is an indication of the sudden removal of the pollen from the ABL. This decrease of h_{pol} is associated with a strong increase of AOD due to high values of β^p (> 5 Mm^{-1} sr^{-1}) in the first 0.5 km (see ¡Error! No se encuentra el origen de la referencia.**), a decrease of $\overline{\delta^V}$ and $\overline{\delta^p}$, an increase of RH (see** ¡Error! No se encuentra el origen de la referencia.**b) but with no significant variation of the near-surface PM_{10} level. All in all these results suggest that the removal of the pollen from the ABL on 31 March at 18 UT may have been accompanied by a possible hygroscopic growth of lofted particles, probably from local origin, below 0.5 km."**

P14, L14: It is not so familiar with the following equation, "Pinus (0.09 <δV r -values < 0.70 and 0.25<δV r -values < 0.68),". Is it possible to change other expression for better understanding?
Authors' reply: "R-values" are correlation coefficients (their definition is given the first time they appear in the manuscript in Section 4) and "XX R-values" are the correlation coefficients measured between the parameter XX and another parameter. We have used this notation in order to synthetize the discussion as "XX R-values" is much shorter than "the correlation coefficients of XX". This notation also allows to treat "XX r-value" as a parameter and include it in equations like the one taken as example by the referee (0.09 < δ_V r -values < 0.70). In the absence of a standard notation to express in a more concise way the "correlation coefficient of XX" the authors have decided to leave the notation "r-values" as is the manuscript.

P15, L20-L27: The reviewer supposes that the content of detailed cloud conditions is not necessarily needed in this context, because the cloud type such as medium or high might be not directly related with pollination events.
Authors' reply: The most important for our analysis is that no low cloud was present during the pollination event (which could have made difficult the inversion of the lidar signals). The referee is right that the details on the medium and high clouds for the two cloudy days (29 and 30 March) are not necessary and they have been deleted in the revised manuscript. In turn the details have been kept for the three clear-sky days because we believe it is important to keep the detailed time of the presence of clouds (before 09:30UT on 27 March, before 10 and after 17UT on 28 March and after 17UT on 31 March) for the validation of the solar fluxes.

P17, L35: The sentence of "Otto et al.(2011) … " may not be needed in this conclusion because the authors do not discuss on the radiative forcing in the main sections.
Authors' reply: The effect of large pollen grains on the aerosol direct radiative forcing is only mentioned in the conclusions because it is a potential perspective that the authors would like to further investigate (in another paper). A small sentence "Large pollen grains may behave the same." has been added at the end of the conclusions to get back to our topic: pollen (and not mineral dust).

Figure 1: The unit of "m-3day-1" should be changed into "m-3".
Authors' reply: All concentration units have been changed.

Figure 2: The notation of decimal point should be unified, such as "0.005" from 0,005". Also "km-1sr-1" should be unified into "Mm-1sr-1" because "Mm-1sr-1" is used in the text.
Authors' reply: The dot (.) decimal separator has been used in the whole manuscript. The units of the backscatter coefficient have been unified as Mm-1 sr-1.

Figure 7: The colours of lines for 27th and 31st might be confused. These should be changed with other colours for discriminating clearly.
Authors' reply: The authors have a different opinion and thought that the colours were rather well chosen. To satisfy the referee, we have kept the very different colours dark blue, brown, green and violet and changed the light blue by black. For homogeneity, the same colour change was applied to Figure 7.

Figure 8: The colour "red" is used for both of δP and time-delay. In order to understand these figures easily, the colours of δP and δV should be modified from "red" and "blue" into others.
Authors' reply: δp is actually brown while the scatter plot with t=0 is effectively red. We have not applied the same line style as in Figure 4 (blue solid (δp) and dotted (δV) lines) because the symbols (solid circles) of Figure 8 would make difficult to differentiate them.