Authors' response (in blue) to the Reviewer #1's comments (in black):

The authors thank Reviewer #1 for his/her comments and suggestions that definitely improved the manuscript. Required changes and modifications have been introduced in the text of the revised version of the manuscript by using the Word Track Changes tools. The manuscript has been revised and restructured in order to present more clearly the results and to implement the changes after answering the reviewer's comments. Authors think that the way they are introduced in the new version of the manuscript will improve the reading and understanding.
In addition, the following general changes have been addressed throughout the manuscript:

- The title has been slightly modified in order to highlight the main issue of the work (Part 1), i.e. the shortwave dust direct radiative effect, that is: "Aerosol radiative impact during the summer 2019 heatwave produced partly by an inter-continental Saharan dust outbreak. Part 1. Shortwave dust direct radiative effect".
- 'J' in the dates have been replaced by 'June' for avoiding confusion.
- Figure 2 has been removed (also taking into account the reviewers #2 and #3's comments) for a more fluent reading in overall, since this figure doesn't provide any crucial additional information to the current modelling analysis performed (see Fig. 1 and previous Fig. 3). The following figures have been renumbered.
- Figures 3-5 (previous 4-6), and 7-9 (previous 8-10) have been improved. In particular, error bars have been included in Fig. 3 in order to show uncertainties.
- A new Table (Table 2 now) has been added. The rest of Tables have been renumbered.
- Symbols used for the single scattering albedo (SSA), the asymmetry factor (asyF) and the surface albedo (SA) have been replaced by SSA, asyF and SA, respectively, for avoiding confusion, as in the text as in the Figures.

Next, the authors respond to the particular comments of the reviewer #1.

- Reviewer 1

Overall this paper contains very interesting work and demonstrates a useful way to use AeroNet and MPLNET measurements to study dust pathways. As with any data analysis, the uncertainty in the data and the results are important for the evaluation of the work and for comparison with other modeling efforts.

R1C1. While summary results are presented in the abstract, some indication of the uncertainty in the results should be presented.
Authors' response: We agree. Uncertainties in the data have been included and discussed in the revised version of the manuscript. See also the authors' response to the rest of comments next.

R1C2. Uncertainties start to be presented on line 276, the daily-averaged ML of 0.66 ± 0.42 g m-2 on 24J (24th of June) at BCN is provided. However, this is no discussion of the uncertainty and the level of confidence in the uncertainty. The paper lacks a discussion of the uncertainties and how they are obtained.

Authors' response: A new Table 2 has been included (the following ones have been renumbered), showing the relative uncertainties associated to the lidar-derived particle optical properties and mass features (see **page 5, lines 163-164**). The variables in the text include their uncertainty intervals (either as measurement errors or as standard deviation for time- and height-averaged variables). In addition, a discussion has been introduced in the revised version of the manuscript. In particular, regarding this R1C2 comment:

Page 12, lines 329-331: "That high dispersion found for $\overline{M_L}$ (~ 64%) is due to the high variability of the dust mass loading along this day, showing a pronounced M_L peak of 1.97 ± 0.6 g m^{-2} at 11UT (88 and 9% of that corresponding to the contribution of the Dc and Df particles, respectively)."

R1C3. Figure 7 shows different fits to the data. What is the uncertainty in the data? Again this figure calls out for the uncertainty in the results and the data. While the data uncertainties may be small, they should be stated. With an uncertainty shown, one can better compare the fits to the data.
Authors' response: In former Fig. 7 (now Fig. 6) no fit was performed. AERONET products are plotted as is. The uncertainty associated to AERONET products (AOD and AE in Fig. 5 and SSA and asyF in Fig. 6) are known from literature and have been added in the text (see revised version of the manuscript):

Page 14, lines 401-403: "AERONET AOD and Ångström exponent are given with an uncertainty of ± 0.02 (Eck et al., 1999), and ± 0.25, respectively, for AOD^{440} > 0.1 and in the order of 50% for AOD^{440} < 0.1 (Toledano et al., 2007). "

Page 16, lines 444-446: "AERONET SSA and asyF are given with an uncertainty of, respectively, ± 0.03 for AOD^{440} > 0.5 for dust and biomass burning, and ± 0.04 for desert dust particles (Dubovik et al., 2000; 2006)."

New references have been added to the reference list.

References

Dubovik, O., Smirnov, A., Holben, B. N., King, M. D., Kaufman, Y. J., Eck, T. F., and Slutsker, I.: Accuracy assessment of aerosol optical properties retrieval from AERONET sun and sky radiance measurements, J. Geophys. Res., 105, 9791–9806, https://doi.org/10.1029/2000JD900040, 2000.

Dubovik, O., Sinyuk, A., Lapyonok, T., Holben, B. N., Mishchenko, M., Yang, P., Eck, T. F., Volten, H., Muñoz, O., Veihelmann, B., van der Zande, W. J., Leon, J.-F., Sorokin, M., and Slutsker, I.: Application of spheroid models to account for aerosol particle nonsphericity in remote sensing of desert dust, J. Geophys. Res., 111, D11208, https://doi.org/10.1029/2005JD006619, 2006.

Eck, T. F., Holben, B. N., Reid, J. S., Dubovik, O., Kinne, S., Smirnov, A., O'Neill, N. T., and Slutsker, I.: Wavelength dependence of the optical depth of biomass burning, urban and desert dust aerosols, J. Geophys. Res., 104, 31333–31349, https://doi.org/10.1029/1999JD900923, 1999.

Toledano, C., Cachorro, V. E., Berjon, A., de Frutos, A. M., Sorribas, M., de la Morena, B. A., and Goloub, P.: Aerosol optical depth and Ångström exponent climatology at El Arenosillo AERONET site (Huelva, Spain), Q. J. Roy. Meteor. Soc., 133, 795–807, https://doi.org/10.1002/qj.54, 2007.

R1C4. Some spread in the data points and the fit to the data points is shown in Figure 9. It would be helpful to provide the uncertainty to the fits and clearly state the nature of this uncertainty (i.e. is it a standard deviation, a U95 level of uncertainty. How was it obtained?) The data points in the plot should also have information about their uncertainty.

Authors' response: The standard deviation of the cloud of points around the best linear fit has been calculated and included in the legend of the former Figure 9 (now Fig. 8). However, for the sake of clarity of the figure (each of the plot contains 4 fittings), the information has not been added to the plots. The following texts have been either included or modified in the revised version of the manuscript:

Page 18, lines 524-525: "Note the small deviation of the cloud of points from the linear fitting (± 2.9 and ± 1.4 W m^{-2} for the coarse and fine mode, respectively)."

Page 20, lines 569-570: "Note again the small deviation of the cloud of points from the linear fitting (± 0.8 and ± 0.5 W m^{-2} for the coarse and fine mode, respectively)."

Page 22, lines 639-643: "In BCN the daily $DREff_{Dc}(TOA)$ and $DREff_{Df}(TOA)$, as averaged over the whole dust event, are -43.9 ± 4.2 and -98.6 ± 2.0 W m^{-2} τ^{-1}, respectively, showing a deviation of the cloud of points from the linear fitting still low for both the coarse and fine mode, but higher than at the surface (± 2.9 and ± 1.4 W m^{-2}, respectively)."

In addition, the caption of the Fig. 8 has been slightly modified as follows:

Page 21, lines 581-584: "Figure 8: Dust direct radiative effect (DRE) (a) on surface (SRF) and (b) at TOA as a function of DOD at 532 nm (DOD^{532}), as shown separately for the dust coarse (Dc, circles, solid lines) and dust fine (Df, crosses, dashed lines) components at both BCN (23-30 June) (in red) and LPZ (29-30 June) (in blue). Corresponding $DREff$ values (slope of the linear fitting: DRE vs. DOD) are included in the legend, as well as their standard deviation (i.e., the standard deviation of the points from the best linear fit)."

R1C5. The analysis of the information is well done and shows a meaningful understanding of the data. A minimal about of uncertainty information is presented without a clear discussion of the significance of the uncertainty and how it was obtained. To better convey the usefulness and accuracy of the methodology a discussion of the uncertainties is required.

Authors' response: We really thank the useful suggestions of the reviewer. In general, uncertainties of the optical and mass variables and those associated to the radiative analysis as performed in this work has been included and discussed in the revised version of the manuscript. Please, see also the response to the previous reviewer's comments.