

Review of "Aerosol radiative impact during the summer 2019 heatwave produced partly by an inter-continental Saharan dust outbreak – Part 2: Long-wave and net dust direct radiative effect" by M. Sicard et al., 2021. The submitted manuscript, companion of ACP-21-6455, assesses, in radiative terms, the impact of a dust outbreak paired with an abnormal heatwave. The manuscript is scientifically interesting because those events will be more and more frequent because of climate change. The following issues should be addressed before publication:

Reply: Thank you very much. We greatly appreciate the reviewer positive feedback.

1) From MPLNET data, it looks like that the dust contribution drops drastically after 27 June 2019 at noon. How can the authors be sure that this is dust and not a mixture of dust and local aerosols? How this impacts the refractive index choice used as input in Mie code? This is a source of possible uncertainty.

Reply: On 27 June the dust outbreak intensity decreases but the changes are not drastic. The MPL data of both BCN and LPZ are indeed represented in Figure 5 of the companion paper in terms of volume depolarization ratio (VDR). According to the color bar it is true that the VDR seems smaller after 27 June, which reflects that the dust is not as pure as before 27 June. However, the application of POLIPHON takes this aspect into account, and the lower the VDR, the lower the concentration of the dust coarse mode. In these conditions the fine mode retrieval is representative of a mixing (fine background or local + fine dust). Since the fine-to-total ratio of LW DRE is not larger than 5 %, this aspect does not represent a relevant source of uncertainty.

2) The longwave contribution is computed just from 5 to 19 UTC. Is there any reason for this time interval? Longwave radiation is not depending on sunlight.

Reply: The code computes the LW radiation from the sun, among other radiation sources, and thus can only be run during the sun hours, i.e. from 5 to 19 UTC during summertime at the longitudes of Central European Time and mid-latitudes. In the revised manuscript in the last paragraph before section 3.1 we have added this explanation "as it computes the sun LW component".

3) The strength of this paper is paring the dust outbreak with a heatwave in terms of radiative effects. This should be better highlighted.

Reply: We have made a general effort to highlight this especially in the abstract, introduction and conclusion.

4) English should be revised because some sentences are not clear.

Reply: The sentences highlighted in the attached file have been reformulated and/or completed, when possible. We have also gone through a full reading and spelling revision of the paper.

Specific comments can be found in the attached file.

Reply: All comments have been addressed in the revised manuscript, and are marked in the version with “Change control” activated. Below we are giving an answer to the comments which require an answer:

RC2, page 1: this expression is too colloquial. I would say "coincident with one of the strongest heatwaves"

Reply: The prefix “mega” is not colloquial. Numerically it quantifies a unit being multiplied by 10^6 . It has been applied peer-review articles such as Barriopedro et al. (2011) or Xu et al. (2020b); see the paper. Barriopedro et al. (2011) give this definition of a mega heatwave:

The concept of mega-heatwave is herein used to refer to regional mean temperature anomalies (over ~ 1 million km^2) of extraordinary amplitude (approximately ≥ 3 SDs relative to the 1970–1999 period) at subseasonal scales (of at least 7 days), thus differing from the classic local heatwave definition.

In the recent years the prefix has been misused commonly in a colloquial way as a superlative. This may be the reason why it sounds too colloquial to the referee, but in its original meaning the prefix mega is not colloquial.

RC2, page 3: why exactly from 5 to 19? Longwave can be computed all over a day

RC2, page 8: why not on the whole day?

Reply: See answer to Comment #2.

RC2, page 3: Notation should be uniform. Before cm^{-1} was used.

Reply: Before (line 79–80 of the same page) we give the spectral limits in cm^{-1} because it is the way they are defined in the code but we also convert them to longwave to the readers who are more familiar with wavelength than wavenumbers. The referee will note that the spectral limits in wavenumber are only given in the Section 2 about the description of the RTM.

RC2, page 11: I suggest to add a plot for BCN with DD in x-axis s and NET DD in y-axis

Reply: We would like to know the idea of the referee for making this suggestion, and also whether he/she suggests to plot NET DRE vs. DOD or vs. LW DRE of the total dust (DD). It is not clear from the comment alone. For the time being, since the paper already includes 13 figures, and since we think this could be out of the scope of the paper, such a plot has not been included in the revised manuscript.

RC2, page 17: it would be much more interesting the other way-round, the effects of dust outbreak on the heatwave

Reply: It is clear that the study the other way around would also have an interest. However as the primary focus of the paper is on the dust direct radiative effect, the sensitivity study is made to analyze the effect of the heatwave on the dust direct radiative effect.

The other way around would require to be able to compute an aerosol radiative effect caused by the heatwave first and a background aerosol load, and then add the mineral dust. At first sight it is conceptually a little more difficult to conceive.