Interactive comment on "Impact of mineral dust on shortwave and longwave radiation: evaluation of different vertically-resolved parameterizations in 1-D radiative transfer computations" by Maria José Granados-Muñoz et al

Anonymous Referee #1

We would like to thank the reviewers for their efforts and thorough review of our manuscript. We realize that the notes and suggestions made will improve the quality of the paper. Hereafter, the reviewers' comments are presented in bold font and the text included in the manuscript is marked in italics. Line numbering is referred to the new version of the manuscript.

The paper presents an analysis of the optical and microphysical properties of dust particles observed from ground and from airplane on 16-17 June 2013 above southeastern Spain during the ChArMEx/ADRIMED campaign. The observations were conducted during a moderate Saharan dust event. Using a 1-D radiative transfer model, the author makes comparison of the output results obtained with different input data. They consider both shortwave and longwave radiation for the calculations. They concluded that the dust produces a cooling effect both at the surface and at the top of the atmosphere, as expected.
The paper in well written, the methodology and the results are clearly presented. The discrepancies coming from the different parametrizations are well analyzed. The authors conclude that global model estimate needs to consider the complete radiation spectrum to avoid an overestimation of the cooling effect produced by dust.
I have just one major concern. The same dust event was observed are almost the same location and at the same time by a balloon borne aerosol counter LOAC (Renard et al., Atmos. Chem. Phys., 18, 3677-3699, 2018, https://doi.org/10.5194/acp-18-3677-2018). Such counter measurements can be considered here for the estimate of the vertical distribution of the dust plume, and for the size distribution of the particles.

The ballon borne measurements included in Renard et al., (2018) were performed at the stations of Minorca and Ile du Levant. These locations are around 700 km away from Granada, therefore, no data are available at Granada station where the current study is performed.

The paper can be published if the comments below are considered.

1. **Abstract: A sentence must be added on the cooling effect found by the authors.**

Done.
Page 2, lines 6-7: *"The three parameterization datasets produce a cooling effect due to mineral dust both at the surface and the top of the atmosphere."*

2. Instrument and data: Perhaps a map of the ground-based and airplane locations could be added.

The map is already included in Benavent-Oltra et al., 2017 (Figure 1), as indicated in the manuscript (Page 6, line 24).

3. Page 8 line 25: Such observation were also reported by Renard et al. 2018.

The study by Renard et al. (2018) is included as a reference in the manuscript where appropriate.

4. Page 10 line 9: The authors say that the concertation profiles of the main absorbing gas were taken from the US standard atmosphere. Nevertheless, real profiles can exhibit a significant variably from the standards for several reasons (local event, perturbed atmosphere. . .). Can you evaluate the effect of this variability on your results?

Variations in the concentration of the main absorbing gases have a low impact on the radiative fluxes profiles and much lower impact in the ARF, since only the effect of the aerosol is accounted for. As an example, we performed a sensitivity test varying the ozone profiles up to double concentrations. Comparing the obtained results with those obtained for DS1 using the standard concentration, we observe differences lower than 4 W·m^{-2} in the $^{\downarrow}F_{SW}$ and lower than 2 W·m^{-2} in the case of the $^{\uparrow}F_{SW}$. For the LW, differences lower than 1.5 W·m^{-2} in the $^{\downarrow}F_{LW}$ and lower than 3.6 W·m^{-2} in the case of the $^{\uparrow}F_{LW}$ are obtained. For the ARF differences are negligible (below 0.2 W·m^{-2}).

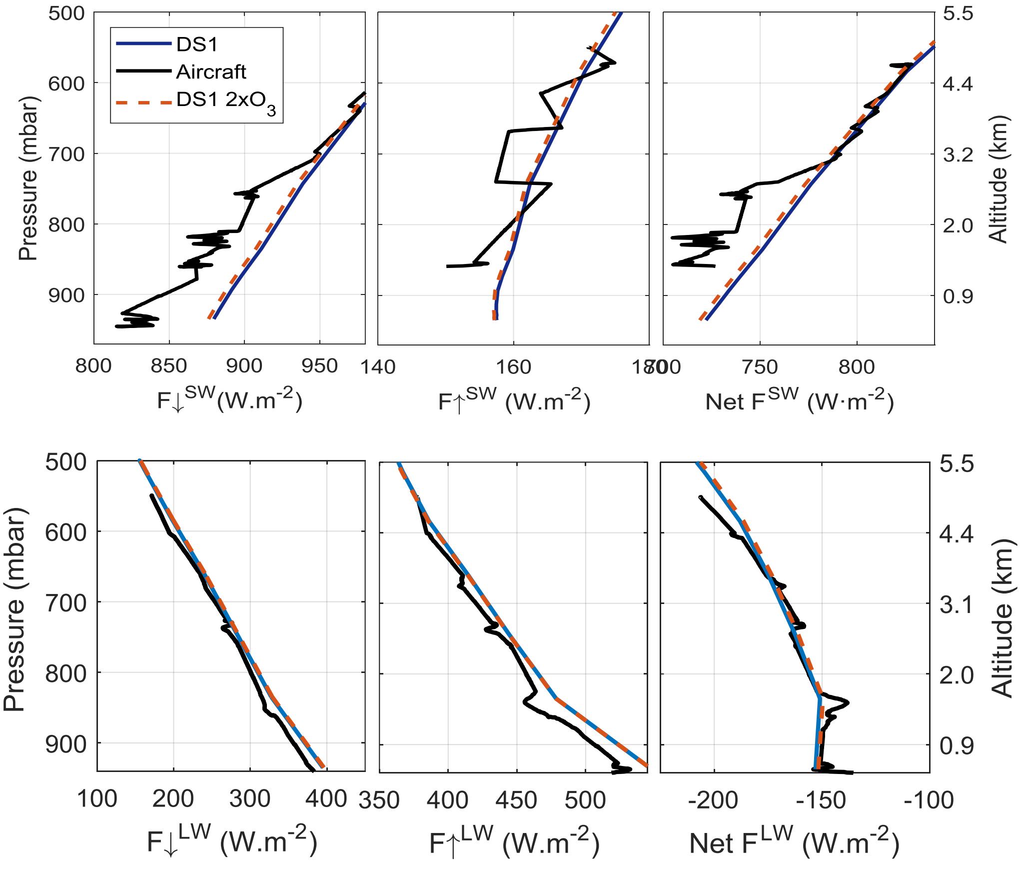

Figure. Radiative fluxes for the SW (top) and LW (bottom) spectral range for June 16 simulated with GAME using DS1 (in blue) and DS1 with double ozone concentration (orange dashed line). The black lines are the aircraft in situ measurements.

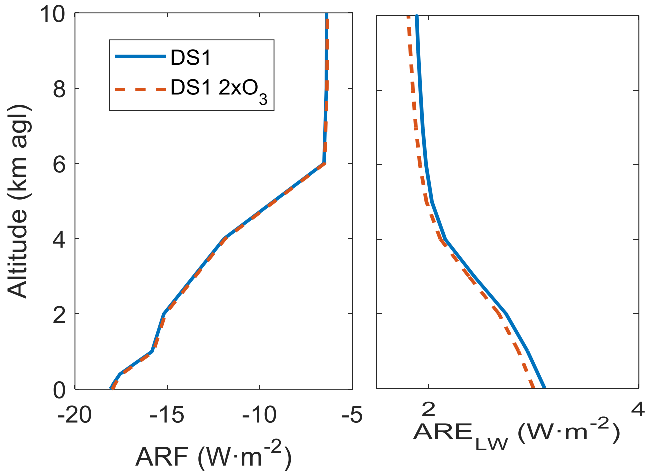

Figure. ARE profiles in the SW (right) and LW (left) spectral ranges simulated using DS1 (blue line) and DS1 with double ozone concentration (orange dashed line) as input data in GAME for June 16.

5. Page 10 line 15: The authors could consider the LOAC measurements, and the detection of large particles that produce a third mode.

We agree with the reviewer that the LOAC would provide very valuable information for our study. Nonetheless, no LOAC measurements are available above Granada site.

6. Page 13 line 10:
The author say that the refractive index of the dust are assumed to be constant with altitude. I understand that it is difficult to detect a possible variation of the index with altitude. Nevertheless, the authors must discuss the limit of this assumption, and how a variation of the refractive index can affect their results. They can consider the variability of the refractive index for different natures of dust and for the possible presence of pollution particles.

For our study we assumed the refractive index provided by Di Biagio et al., (2017) for the Moroccan source, which we consider as the most appropriate for our case studies. By using the refractive index provided for the Algerian and Mauritanian sources from the same database we observe variations in the ARF at the BOA of 0.8 W·m^{-2} and 0.3 W·m^{-2} at the TOA. These results come to confirm the importance of having an accurate aerosol database for the retrieval of the ARF and the reduction of the uncertainties. They have been reported in the new version of the manuscript:
Page 14, lines 20-25: *"This assumption is not exempt of uncertainty, since the refractive index present a certain variability associated to the different nature of mineral dust properties. For example, the use of the refractive index provided for the Algerian and Mauritanian sources from Di Biagio et al., (2017) leads to variations in the ARF of 0.8 and 0.3 W·m^{-2} at the BOA and the TOA respectively. Additionally, vertical variations of the refractive index are also a source of uncertainty in the obtained radiative fluxes."*

7. Page 13 line 12: Is it "interpolation" or "extrapolation"?

Text has been modified. Interpolation has been replaced by extrapolation.

8. Page 13 line 23: The authors must also consider the LOAC balloon borne aerosol counting data.

See our previous responses on this topic.

9. Page 17 line 26: Do you think that the presence of large dust particles, not always detected from aircraft instruments, could partly explain the large differences you observe?

We agree that the presence of large particles may partly explain the differences observed in the longwave radiative fluxes. As stated in the introduction, large particles are especially relevant for the aerosol radiative forcing in the longwave range. Therefore, it is important to consider the presence of these large particles in the aerosol measurements required to feed radiative transfer models. As an example, we performed a simulation with our model considering a third mode with similar characteristics to the one observed during this dust event in Minorca. On June 16, by adding this third mode (assuming that the number concentration is a 15% of the coarse mode) we observe an increase in the ARF_{LW} of $0.5 W\cdot m^{-2}$ at the BOA and $0.25 W\cdot m^{-2}$ at the TOA. This increase in the ARE due to the presence of a third mode is significant, but it does not fully explain the differences observed here.