Review on “**A sensitivity study on radiative effects due to the parameterization of dust optical properties in models”** by **Fountoulakis et. al.**

This paper presents a sensitivity study on radiative effects due to Saharan dust aerosols. The parameter tested in the sensitivity study are 1) optical properties of aerosols under three different spectral-resolved refractive indexes (WMO 2023, OPAC: Köpke et al. 1998, 2015 and Balkanski et al. 2007). 2) Size range of aerosol size are: 0.1 - 10 µm (as done in most of former and current models) and 0.1 - 50 µm. 3) Shape form (spherical or spheroidal shapes) Calculations are made over the desert and over the ocean. The sensitivity is first led on macroscopic aerosol radiation properties (extinction, scattering and absorption coefficients), then thanks to simulations with the MYSTIC radiative transfer model (Mayer, 2009) on radiative fluxes, and at the end, the sensitivity on radiative forcing is computed and analysed.

The paper has to be understood and evaluated as an advance for radiative transfer simulations in atmospheres containing dust aerosols but not about generalities concerning dust aerosol DRE, in contrary to the wrong understanding of anonymous author of RC2 comment. In this way, the paper answers and quantifies some open questions of radiative transfer in atmosphere containing dust aerosols, a domain that needs such kind of detailed and structured studies, since the difficulty of parametrizing the radiative transfer equation in radiative transfer models for the case of dust aerosol is contained in the lack of order of magnitude and on the unknowledge about the influence of the different parameters (especially RI, size distribution and shape). Therefore, this study is a significant advance in this topic thanks to the clarifications and the quantifications that it brings. Thus, this paper is worth to be published in Atmospheric Chemistry and Physics. The paper is welled structured, the radiative transfer simulations selected are relevant, the method and the results are well explained and well presented. The paper itself is well presented, and very clear, as well from a didactic as from a linguistic aspect. Figures and tables, are presented in a clear and ergonomic way, and the results of the simulations shown in the figures are analysed in the text of the manuscript in a meticulous way.

For all these reasons, I kindly recommend to accept this article in Atmospheric Chemistry and Physics, after the minor corrections I suggest, and after the authors briefly answer the few questions here below.
If the paper will be (as I suggest it) accepted with minor corrections, please give some explanations in answers to my comments

Major comments/questions

1) Please add an acronym table to define and summarize in the same place the main used acronyms (RI, TOA, BOA, AOD, DRE, IRE, SRE, SW, LW, etc...) this can really help the readers of the paper.

2) Why did you restrict the simulation in UV to a spectral range >350 nm? Especially for scattering, the UVB (290 – 315 nm) and UVA (315 – 400 nm) are very interesting, and a non-negligible part of the radiation reaching the earth and absorbed in the atmosphere is part of this spectral domain. It is a pity not to consider the 290 – 350 nm band.

3) It is a bit difficult to isolate the ocean impact and the desert impact on the radiation due to the only albedo of the ocean and of the desert with this study. The reason of this is that in this study, you consider another aerosol mixture (and extinction profile) over the ocean than the one over the desert: The aerosol mixture (and extinction profile) you consider over the ocean, is an older aerosol mixture, with less large particles. It should be valuable to make a second set of simulations over the ocean with the same aerosol mixture (and extinction profile) as the one you used for the simulation over the desert.

4) At one point (during the presentation of the database or later during the analysis of the simulation results) you need to write something about the relative quality of the three RI spectral databases (Balkanski et al., OPAC and WMO): Which one is the more modern one? Which is the more realistic one? Which one suits better to which aerosol mixture (over desert and over ocean) and why? This commented analysis would be very welcome, since the results show that for some cases and situations, the choice of the RI database is a crucial source of differences on the radiative fluxes and on the radiative forcing.

-> I definitively argue that this paper has to be accepted with only minor corrections, but if the editor decides to force you to resubmit or to make major changes, upgrading the simulations taking point 2) into account and adding a set of simulations taking point 3) into account would be a real quality gain.

Minor comments/questions:

1. Introduction
L101: "account" and "RI" written twice

2. Data and method
L111-112 Since we are at the beginning of a new part, please detail in the text the acronyms "DRE", "SD" and "RI"

L145 and Figure 2: Please explain very clearly about the aerosol mixture over ocean and over desert. There are different aerosol mixtures, this is clear. But do you consider a "Lagrange approach" = these are aerosol of the same plume, that is consider at a later timestamp over the ocean, or is it an "Euler approach" = you look at the mixtures at the same moment and the ocean mixture shown at this moment was former over the desert with probably at this time the same properties as the desert mixtures?

L155-159 and Figure 3: Here you can make the comments/analysis that I suggest in my comment number 4 concerning the differences of quality between the three RI datasets.

L170-171 and L175 (Figure 4): Explain better what is the aspect ratio. Is it something with the axis ratio of the ellipses of the ellipsoid? And explain the figure: If aspect ratio = 1 it is a sphere? And which aspect ratio did you use for the impact of shape further in the manuscript? The denomination "aspect ratio" will not be used anymore in the rest of the paper, therefore we do not understand why you show this graphic.

L189: simulations are done on the spectral range 0.35 – 40 micrometres. At least explain why you do not consider the main part of UV spectral range (290 – 400 nm) -> See my major comment/question number 2)

L233: You mention "the effect of the shape in the optical properties of dust" -> is the shape quantify with the "aspect ratio" mentioned in L170-171 and in Figure 4?

Table 1:
- Why did you split SW / LW at 2,5 micrometres? A rational border value is 3,5 micrometres because below 3,5 micrometres there are still solar radiation and only negligible atmospheric (thermal) emission of radiation.
- Do you have some values of the albedo (SW broadband, LW broadband, ore some values at given wavelength: 500 nm and 10 micrometres for instance)?

L275: TCWV = 10 mm over the desert: Isn't it too much? I would never expect ore than 5 mm over the desert

L289-290: A graphic with the vertical distribution of the extinction profile over ocean and atmosphere you used would be welcome

3. Results

L324-331: In the analysis of the results shown in Figure 9, maybe you should in the discussion compare the differences between the results to the noise: A trend seen that is below the noise should be consider with caution.

L369 (and Figure 10): “the smallest absolute differences were found for the RI used in OPAC” -> Can you explain why OPAC leads to such different results than the results obtain with the other databases. Same question for Balkanski on graphic d (TOA desert) between 500 and 2000 nm?
-> Here also it would be a good moment to discuss the what I asked in Point 4 of the major comments/questions above concerning the differences of quality between the three RI datasets.

L439: “For more realistic aerosol properties the DRE is less negative over the desert (by up to 25% for the RI of Balkanski et al. …” -> Should we understand that Balkanski is the most realistic RI description? If yes explain why.

L469: Here maybe also the real place to make the comments concerning the quality of RI database (major comments/questions point 4) above)