

We say thanks to both reviewers for their detailed and constructive comments, which most of them have been used to improve the paper.

One basic idea of Referee #1 was to make a clear distinction between “desert dust” and “mineral particles”. So we decided even to modify the title of our manuscript. The new title is:

“Technical Note: Optical properties of desert aerosol with non-spherical mineral particles: data incorporated to OPAC”

In the following we discuss each point of the remarks in detail, with the reviewer comment partly repeated (in italics).

Referee#1

I.17 I ... would use rather Mineral dust or Desert dust, not both...

We mentioned “mineral desert dust particles” since also particles besides the mineral components may be part of desert aerosol. However, in the new OPAC only the shape assumptions for the mineral particles have been changed. But we improved the manuscript with respect to this aspect, and even the title as mentioned at the beginning.

I.20 It is quite unusual to use references in the abstract

We agree. But in our case the paper is directly an improvement of the old OPAC paper, which therefor must be mentioned already in the abstract with detailed information.

I.23 It is an (of course quite reasonable) assumption that the T-matrix approach improves the phase function. Nevertheless...I would rather suggest... to be a bit more conservative here...

We changed the wording.

I.25 ff It would be good to provide the corresponding changes in asymmetry parameter here also....

We added the information on the asymmetry parameter, since its small change is of special interest in comparison the large phase function deviations.

I.40 For full reliable optical properties you also need an absorption theory

Mie theory takes absorption into account, as well as T-matrix theory does. But we skipped the words scattering theory.

II.42ff ... another reason is that particles have no preferential direction...

Even under the assumption that the particles have no preferential direction the particle shape will have influence on the scattering function. Thus we agree with the referee that it is a good idea to advance beyond Mie theory for dust optical properties.

I.51 Is the largest fraction meant with biggest part?

Yes, we agree and changed the diction.

II 54 I do not agree with this statement.....

We eliminated the statement.

II 67ff That is too much simplification.... Passive remote sensing also includes infrared methods, which not so much rely on the scattering phase function

We changed the text

II 70ff You should clarify somewhere above that your major concern is on solar wavelengths and define your spectral region of interest.....

OPAC covers the broad spectral region from 0.25 to 40 μm , and thus the improved assumptions on the shape of mineral particles are taken into account also in the thermal infrared. That the effect of non-spherical particles is largest in the solar spectral range is one point of the results, mentioned in the text and shown in the figures, but nevertheless it is also considered up to 40 μm .

I 88show that T-Matrix really improves....

The improvement of the scattering properties of non-spherical particles using T-matrix instead of Mie-theory in the solar spectral range has been shown by references mentioned in the paper.

I 92 ...physical reasoning for that?

The variation of the aspect ratio distributions with particle size is fact, found be electron microscope measurements. Physical reason may be the particle formation.

I 106campaigns showed abundance of much larger particles....effective radius around 5 µm or larger is not covered by OPAC...

OPAC takes the variability of mineral dust size distributions into account by providing the possibility to mix 3 different mineral components as required (e.g. using Eq. 2 – 4). When comparing with the SAMUM measurements we refer to the pre-defined mixture “OPAC desert”. The flexibility of OPAC with respect to large particles is limited by the coarse mode mineral component (MICM). This component has an effective radius of 8.1 µm and a maximum particle size of 60 µm (see Tab. 1), which means that OPAC covers mineral dust radii up to these values.

I 187 ...“mineral component” sounds like you are ...taking into account variable dust composition..
The three mineral components used in OPAC have the same refractive indices, as mentioned in the manuscript. The possibility of their individual mixture makes it possible to take into account variable dust compositions with respect to the size distribution.

I 197 ...physical reasoning for assuming prolate particles, i.e. from microscopic imagery?....

With electron microscopy generally the projection of the particle is analyzed. Thus it is not possible to detect whether the individual particle is oblate or prolate. As a consequence, the selection of the form with the better fit is a reasonable decision.

I 274 be more specific on spectral regions here...

and

I 275 ... dust also has significant longwave radiative forcing...

The referee is right that both the SW and the LW spectral range are essential for radiation budget and for remote sensing of desert dust. But, as mentioned, our improvement for the scattering properties of mineral particles holds for both spectral regions. Nevertheless we have corrected this paragraph.

I 306 It is not true that solar wavelength generally is use for aerosol remote sensing...

We have corrected the sentence.

I 313 ...very large particles also in transported dust... results of SALTRACE campaign ..

We agree with the referee that the size dependent loss of particles during transport is an assumption that no longer may be valid for desert dust. Since our institute took part and thus we are informed about the results of the SALTRACE campaign, we will consider this aspect carefully in future aerosol modelling. However, in the actual manuscript the assumption is used only to test the effect of non-sphericity for mixtures of particles with different size distribution. (As mentioned, OPAC has the advantage that any user can decide for an individual composition of the given components and thus for the size distribution of the mixture.) However, we added an explanation.

I 376 ... comment a bit that only one specific set of refractive index is used...

The referee is right that the refractive index is important for the optical properties of particles. But this manuscript, as a technical note, strictly focusses on the particle shape of mineral aerosol and thus leaves the other properties of OPAC unchanged. However we add a sentence belonging to the question of the uncertainty of the refractive indices in the conclusion.

I 429 ... spectral resolution in the different wavelength ranges...

The data in OPAC are available for the wavelengths that can be chosen from the data base. The spectral resolution is not given specifically since it is assumed that the spectral properties of aerosol particles vary rather weak, in contrast to gaseous absorption. Nevertheless, for some specific applications the spectral resolution may be too low. Here improvements will be discussed in future versions of OPAC.

Referee #2

3997 10 ... more representative publications...

Thank you for the suggested references.

4000 1additional modern accounts of the T-matrix method...

We wanted to give credit to Waterman and his original paper. The used updated accounts of the TMM are mentioned in the text. Nevertheless we added the Mishchenko reference, but not Doicu, because we did not use his advanced method.

4000 4 und 13 ..distinction between the aspect ratio and the axial ratio ..

We agree that the definition of the aspect ratio in our text was incorrect and emended it in the revised manuscript.

General commentthe effects of non-sphericity are well known to depend on the imaginary part of the refractive index..... include a table showing the refractive indices used.... different types of dust with different origin...

The dependence of the effects of the particle shape on the refractive index, and especially on its imaginary part, is known and partly considered in the answer to referee #1 and mentioned in the improved conclusion of the manuscript. We prefer not to add a table or figure with the refractive index of the mineral components because it is referenced and the data can be looked up in the ASCII files of the OPAC package. The refractive index used in OPAC for the mineral particles is an average value, for an “average” mineralogical composition. We agree that mineral aerosol originating from different deserts may have different chemical composition and thus different refractive index. But considering a large variation of individual aerosol components is far beyond the idea of OPAC, which will be easy, to be used without too detailed information on the actual aerosol properties.

Nevertheless, for a future version of OPA C, we plan to add an additional component with stronger absorbing mineral particles.