

**Review of the paper “Variability of the infrared complex refractive index of African mineral dust: experimental estimation and implication for radiative transfer and satellite remote sensing” by Di Biagio et al.**

**Submitted for publication on ACPD**

Comments in black, answers in red

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At first, we would like to thank the reviewer for having carefully read the paper and provided valuable comments which helped to improve the quality of the manuscript. We have taken into consideration all the questions raised by the reviewer, and changed the paper accordingly. The details of our changes are highlighted in the text. The point by point answers are provided in the following.

**Referee 1**

Di Biaggio et al. present a very interesting study on the infrared refractive index of desert dust. The manuscript is well structured and the work is precisely described. As the presented work might be of very high value for many researchers I strongly recommend publication of the manuscript after some minor revisions.

I have only one major comment which the authors might wish to think about. I would strongly encourage the authors to provide the refractive index data of their study, either as table or in the form of harmonic oscillator parameters. Potentially the data can be provided online as supplementary material along with the online version of the manuscript, if the authors wish to not add an additional table. As they correctly describe, many applications rely on at best inappropriate descriptions of the optical constants of mineral dust. So providing the new set of dust refractive indices would potentially be extremely beneficial for a whole range of applications.

We thank the reviewer for its suggestion. Refractive index data are already available as supplementary material to this paper.

**Minor comments:**

l. 94: Chlorite is not really a clay mineral.

Clay minerals are divided into four main groups: Kaolinite, Illite, Smectite, and Chlorite groups. Chlorite is sometimes considered as a separate group, however formally it should be included among clay species.

l. 95: I know that iron oxides locally strongly contribute to mineral dust. What would be typical fractions of titanium oxides? Are they important on large scales?

Recent works performed near source areas suggest the contribution of titanium oxides to be of the order of 1-2% in mass, so a little lower than iron oxides which are estimated at about 4-5% of the dust mass (e.g., Formenti et al., 2014). At the large/global scale they are thus

expected to contribute for a little fraction of the dust mass. However, there are several works highlighting the importance of these components in several chemical reactions in which dust particles take part (e.g., Gustaffson et al., 2006).

l. 223: Ryder et al. (2013) found particles up to 100 $\mu$ m during the Fennec campaign. Given the OPC measurements, how likely is it that the large / giant particle fraction is underestimated in the size distributions?

As discussed in Ryder et al. (2013), the occurrence of very large/giant particles depends on the distance from the source and the aerosol load. In their study, they sampled very large particles in correspondence of heavy dust loads (aerosol optical depth > 2) in proximity of fresh dust sources. In our study, dust events were characterized by a lower optical depth (<1.30) and corresponded to low/medium range transported plumes (with the exception of the SOP1-8 case for which the highest content of coarse particles is observed). This may explain why we did not observe significant fractions of giant particles in our data.

l. 291: I understood that the particles have diameters smaller than 20  $\mu$ m, which would be about the Mie-scattering particle size. How realistic then is the assumption, that scattering effects can be neglected? It would be worth to comment a bit more on this assumption.

As discussed in the paper, since dust constitute only the 0.1% of the mass of the pellet, its scattering signal is negligible compared to that of KBr, which instead constitutes the 99.9% of the pellet mass. This is corroborated by observations, since the measured dust spectra (Figure 1) do not show a detectable scattering signal but only absorption. The reviewer is right and this is undoubtedly an important point, since the fact of not measuring dust scattering with the pellet approach strongly limits the applicability of the results. A discussion on that point has been added in the Introduction (lines 145-151).

Section 5.3: OPAC (and other older databases) have a quite coarse spectral resolution in the thermal infrared window. It would potentially be worth to discuss this point, especially in the light that a couple of spectral features are not represented in the OPAC optical properties.

We thank the reviewer for this very useful comment. We rewrote the following sentence in Section 4.3 (587-590) as: *“The spectral signatures from the different clay species appear smoothed in the curves taken from literature, mainly because of the rather coarse spectral resolution of these datasets. Only a major single peak between 9 and 10  $\mu$ m is observed, compared to our data where multiple clay peaks are detected in the 8-12  $\mu$ m spectral interval.”*.

l. 660: Which algorithm for calculating the Mie-scattering functions has been used? Especially for the small ( $x < 1$ ) particles described here, how stable is this algorithm when approaching the Rayleigh limit? For the Rayleigh limit itself, has there any other approximation been used, which is not original Mie theory? If so, which one?

Concerning the Rayleigh limit, we did not perform specific approximations, but we used the original Mie theory. Calculations have been performed by using the mie\_single.pro IDL routine ([http://www.atm.ox.ac.uk/code/mie/mie\\_single.html](http://www.atm.ox.ac.uk/code/mie/mie_single.html)), which does not show any instability issues when approaching the Rayleigh limit.

## References

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- Gustafsson, R. J., Orlov, A., Griffiths, P. T., Cox, R. A., and Lambert, R. M.: Reduction of NO<sub>2</sub> to nitrous acid on illuminated titanium dioxide aerosol surfaces: implications for photocatalysis and atmospheric chemistry, *Chem. Commun.*, 5, 3936–3938, 2006.
- Ryder, C. L., Highwood, E. J., Rosenberg, P. D., Trembath, J., Brooke, J. K., Bart, M., Dean, A., Crosier, J., Dorsey, J., Brindley, H., Banks, J., Marsham, J. H., McQuaid, J. B., Sodemann, H., and Washington, R.: Optical properties of Saharan dust aerosol and contribution from the coarse mode as measured during the Fennec 2011 aircraft campaign, *Atmos. Chem. Phys.*, 13, 303-325, doi:10.5194/acp-13-303-2013, 2013.