Responses to the Short Comment by Patrick Stegmann (Manuscript # acp-2019-812)

First of all, we would like to thank Dr. Stegmann for his valuable comments to the manuscript. In the revision, we have accommodated the suggested changes into consideration and revised the manuscript accordingly. All changes are highlighted in RED in the revision. In this point-to-point response, the reviewer's comments are copied as texts in BLACK, and our responses are followed in BLUE.

General comment:

This manuscript provides a good overview on the current state of mineral dust single scattering computations and addresses an important issue in the field of aerosol optics, namely the uncertainty in the particle refractive index.

Is there any specific justification for the Koch-fractal morphology compared to e.g. spheroids and super-ellipsoids? Is it more convenient or more accurate?
Response: In fact, there is no specific reason for the choice of the Koch-fractal morphology. Because this study focuses on the refractive index, and we simply consider a particular geometry that works. We considered the Koch-fractal particle because of its relatively accurate performance on representing dust optical properties (Liu et al., 2012; Jin et al., 2016). For example, Lin et al. (2018) revealed that neither spheroids nor super-ellipsoids can reproduce scattering matrix elements of red clay, whereas the Koch-fractal particles can (Jin et al., 2016). However, we think this study can also be performed using spheroids or super-ellipsoids, and we expect that they result in similar results. With respect to the scattering simulations, there is no difficulty for the PSTD and IGOM to consider Koch-fractal particles.

It would be interesting (but by no means necessary) to supplement this study with the derivatives of the phase matrices w.r.t. the refractive index.
Response: Thanks for the suggestion. We tried to present the derivatives, and the figure become difficult to read, as figure cover with each other and no clear trends are shown. Considering that the current Figures 3 and 4 are clear and can easily followed, we will not make the problem more complicated.

Specific Notes:

Page 1, line 10: Change "Dust" to "Mineral dust".
Response: Thanks. We have corrected it in the revision.

Page 1, line 14: "This study reveals the importance of the dust RI for the model development of dust optical properties"
Response: Thanks. We have corrected it in the revision.

Introduction in general: The IPCC has also identified aerosols as a major source of uncertainty in radiative forcing of the terrestrial climate. Maybe this can be added to the introduction with a suitable source to cite.
Response: Thanks, and we have include the following sentence in the revision:
"*According to the IPCC Fifth Assessment Report (IPCC, 2014), aerosol is still one of the largest sources of uncertainty in the total radiative forcing estimation.*"

P.2, l.4: "... mineral dust is widely distributed around the globe, ..."
Response: Corrected.

P.2, l.13: "For example, the measured phase functions of dust particles are distinctively different from the ...."
Response: Thanks. We have corrected it.

P.2, l.20: "a simplified but optically equivalent model is more convenient and easier to process"
Response: Thanks.

P.3, l.14f: "..., to which much less attention has been devoted during the model development."
Response: Thanks. We have corrected it in the revision.

P.5, l.15ff: Particle size distributions are a source of uncertainty as well. What is the reason for choosing the specific particle size distributions here?
Response: We consider simultaneous size distribution from the AGLSD, so there

should be less uncertainties from the size aspect. However, we completely agree with the reviewer, and think the size distribution can be a source of uncertainty, and this have been slightly investigated in previous studies, so we will not discuss it here. We just mentioned the potential further studies respect to uncertainties on particle size distribution.

P.6: The proposed method finds the optimal theoretical particle properties in terms of the phase matrix alone. What is the impact on the other properties, such as extinction coefficient, albedo etc.? Is a similarly good match achieved?

Response: Other optical properties are also sensitive to particle refractive index, whereas they are not measured simultaneously. We think this would be a great suggestion for future studies and instrument/observation design. We added the following sentence in the revision:

"Last but not least, to better constrain either particle RI or geometry for dust optical property studies, more observations on dust microphysical and optical properties should be considered."