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Interactive comment on "Global scale variability of the mineral dust longwave refractive index: a new dataset of in situ measurements for climate modelling and remote sensing" *by* Claudia Di Biagio et al.

Anonymous Referee #1

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Review of the manuscript by Di Biagio et al. submitted to ACPD.

Di Biagio et al. have studied the longwave refractive index of mineral dust and how it varies depending on the source region. This is an important topic, especially for climate modelers who need accurate information on the optical properties of mineral dust. The research is done conscientiously using well documented methods. The manuscript is very well written and all the relevant things are discussed. However, some parts of the text should be clarified. My specific comments are given below:

P3L88: What is the net radiative effect (SW+LW) of dust?

P4L115: What processes are you referring to? Oxidation, condensation, accumulation, water uptake?

P8L222-223: Could you give the spectral resolution also in μm?

P8L229: Could you give the spectral resolution also in cm-1?

P10L291: The usage of Mie theory for non-spherical particles causes errors. For example, the T-matrix method would a more suitable method. Could you estimate how large errors the usage of Mie theory causes?

P12L331: The combining of different size distribution measurements is difficult because different methods produce slightly different results. Did you check how well the SMPS, SkyGrimm and WELAS agreed on the overlapping size ranges and were there large differences? Why did you use the instruments separately for different size ranges? You could have also calculated a combined size distribution for the overlapping size ranges.

P14L394: Again, I'm a bit worried that you use Mie theory for non-spherical particles. It could cause large errors. You should at least discuss the magnitude of the possible uncertainties.

P14L399: What is Ω?

P15L427: Mention here that the uncertainties caused by this choice are discussed in section 3.1.

P16L454: Estimate the magnitude of the uncertainty caused by the use of Mie theory.

P17L483-484: Not sure what this sentence means. Please, clarify.

P17L485: Couldn't you estimate the uncertainty in the refractive index by calculating it using the size distribution and absorption data with maximum uncertainties? So, basically you add the uncertainties to the size and absorption data and see how much they change the calculated refractive index?

P17L488: The uncertainty of 10-20% in the refractive indices sounds surprisingly small when the uncertainty in the number concentration can be as high as 70 %. Why the uncertainty is so small?

P18L499: If the effect of the measured size distribution for the sizes larger than 8 μm was only 10 % why did you decide to use extrapolated data?

P19L523-525: This is a confusing sentence because you only mention 15 samples. What about the rest of the 19 discussed earlier?

P21L584: Doesn't this complication with the composition reflect also to the representativity of the refractive index results reported?

P21L592: What are the uncertainties here? They would help the comparison.

P21L599: The Eq. 5 has a number distribution. Why are you using surface size distribution here?

P22L623: Why Algeria and Atacama were selected for the comparison with Northern Africa data?

P22L631: I wouldn't say that the particle fractions are comparable for the particles smaller than $\sim$0.4 μm.

P22L632: This sentence is a bit confusing regarding the size ranges. Please, clarify.

P22L636: Could the extrapolation of the size data have an effect on the difference in deposition? It also started from 8 μm.

P24L679: Again, why were Algeria and Atacama chosen as examples?

P25L705: You mention standard deviations here. What about the uncertainties? I think they should also be considered. Do the refractive indices within the regions differ more than their uncertainties?

P25L709: Is the variability in the refractive indices larger between the regions than

within the regions? I just interested to know that could the modelers use a single refractive index for a region or do they have to also consider the variability within the regions?

P26L746: Just a comment regarding the linear fits shown in Fig. 11. You don't mention what kind of a fit you used but I hope it wasn't OLS because it is known to cause biases. See the paper by Pitkänen et al. (2016) for more details: http://onlinelibrary.wiley.com/doi/10.1002/2016GL070852/full

P26L758: "short or medium ranges" - What do these mean in km or time in the atmosphere?

P27L765: In this section I would like to see more discussion on the effect of these differences between the reported refractive indices for modelling and remote sensing applications. Are the differences large enough to have a significant effect, for example, on radiative transfer.

P28L814: Source-specific values for the source regions or even within the source regions?

P29L823: This could challenging due to atmospheric absorption. For example, ozone is a strong absorber at 9.6 μm.

P30L851: Are the regional differences larger than the uncertainties in the LW refractive index?

Table 1: SkyGrimm: Are the particles assumed spherical and if so, what is the uncertainty due to it?

Figure 6: This is a busy figure. What is min and max based on? Sometimes the min is larger than the corresponding max. Shouldn't the CESAM average include only the African and Asian data for a more direct comparison with the previous studies?

Figure 8: The scale for the Northern Africa subplot is different from the others. Same

scale would make comparisons easier.

References: Both Perlwitz papers have the same title.

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