In my review I focus on the area I am mostly familiar with: retrieval of aerosol properties from the photometric data through computer modeling of light scattering by non-spherical particles. Although the manuscript is well organized and clearly written, there are some concerns which I describe below.

The discussion of the modeling parameters is not sufficient. What was the minimum and maximum size of particles considered? What kind of spheroids (prolate? oblate? aspect ratio?) was used to describe "aspherical particles"? It is also not clear the role of the roughness in the modeling. Importance of roughness is discussed in Section 3 and also presented as one of the parameters of the modeling. However, smooth or rough particles were considered at the modeling is not clear. If smooth, then need to be explained why this assumption was selected. If rough, then characteristics of the roughness should be discussed. Also, what does "severe roughness" mean quantitatively? As I know, Dubovik's kernels were calculated not for severe roughness but for small roughness parameter equal to 0.2 in the case of spheres and spheroids; for spheres, also the kernels for medium roughness equal to 0.5 were calculated.

The term "aspherical" means a slight deviation from sphericity. As I mentioned above, the characteristics of the spheroids, which represent "aspherical particles" were not mentioned in the paper. However, if spheroids of aspect ratio large than 1.2 were considered, the particles cannot be called "aspherical" and need to be called "non-spherical", although I would highly prefer to replace the word "aspherical" by the word "spheroids" to avoid misunderstandings. If really "aspherical", i.e. particles with aspect ratio close to unity were considered, such a constraint should be justified.

Absolutely not sufficient description is provided for the retrieval procedure and results for size distribution. I could not find any discussion of how this was done, i.e. how the type and parameters of the size distribution were selected and justified. I am also surprised not to see any characteristics of the size distribution in Table 1. As I remember, Dubovik's package works with log-normal size distribution, whereas the plots presented in Fig. 4., left panel, look more like power-law size distribution, moreover, the plots in Fig.4 look like a combination of several power-law distributions, different for different ranges of particles. A more detailed discussion on selecting the size distribution and its final characteristics (size ranges, types and quantitative parameters of the size distribution) is necessary.

I find the discussion about the refractive index insufficient as it considers only its real part. I would expect to see a discussion of the imaginary part of the refractive index too. Is the imaginary part also consistent with the particles of porosity 18-35% ? For this, I would expect the authors to provide the complex refractive index of the material used for the Maxwell Garnett calculations and its justification. Is it consistent with the composition of volcanic aerosols?

I was also confused by the discussion regarding asymmetry (g) parameter. For example, in page 4 the authors claim "Generally, the *g*-value decreases with increasing asphericity of the particles (Gayet et al., 2002; Gayet et al., 2012)." However, values of asymmetry parameter depend mostly on the size of particles (see, e.g., Asano and Sato, Appl. Optics, 19, 962-974, 1980; or check the plots in http://www.meteo.physik.uni-muenchen.de/~seppg/spheroids.html) , thus, a discussion of g values and associated with them "asphericity" without identifying the range of particle size is not very useful.

At the end of Section 3.1 a vectorial form of the formula for the principal component analysis is presented. I see it as unnecessary complication which is more confusing than useful. Leaving the

parameters in the form $\xi_l(\theta_i)$, $\ln[\sigma_j(\theta_i)]$ will make them more evident and do not make any conflict with Fig.3, where parameters ξ_1, ξ_2, ξ_3, appeared to be undefined if the vectorial representation is used. Also, please, define parameter λ used in Fig. 3.

Minor comments.

Page 3, top line. I highly recommend to add a reference to Mishchenko et al. (Optics Letters, 39, 3935, 2014). Moreover, I think, this paper deserves discussion in the manuscript (e.g., in page 14) as it provides good estimates what is important in modeling heterogeneous particles using effective medium approach. Also, please, fix the typo "Gustafsonm"

Page 9, line 15. What does it mean that the size distribution is not negative?

Page 15, top line, "inertia effect" – what is this ?