The authors would like to thank the referee for the helpful comments and suggestions. Our point-to-point response to each comments is detailed below.

Response to Anonymous Referee #2

1a) *The non-sphericity of aerosol particles and multi-scattering effects are mentioned as a source of uncertainty, however, this is not quantified. In particular with respect to the test cases and the case study presented later in the paper it would be important to have an estimate of the uncertainty introduced by those effects because the case studies consider mineral dust layers where this is most significant. Quantifying those uncertainties would also make the comparisons of model results to observed data more meaningful.*

We would like to thank the referee for pointing out the importance of including the uncertainty evaluation. A section *(3.1.4)* dedicated to these uncertainties has been added to the paper.

In order to estimate the variability of the simulated lidar parameters (notably R′ and χ′) associated with these uncertainties, we have conducted a sensitivity test based on the configuration of the presented academic case study. We show that differences in the values of the backscattering phase function (which is primarily affected by the shape of the particles) can result in large differences, reducing both R′ and χ′. On the other hand, multiple scattering was found to be of smaller importance for the simulated parameters. More specifically it was found to slightly increase R' while the differences in χ' are depend on the size of the particles.

1b) *The formula for the molecular scattering cross section given in Eq 8 is outdated and should not be used anymore because the accuracy of modern lidar observations is better than the accuracy of this fit. Check e.g, Adam (2012), Applied Optics, 51, 2135 for updates.*

Following the reviewer's recommendation we have updated the formula used for calculating the molecular cross-section.

In order to remain consistent with the observations, we implemented in OPTSIM the same equation as the one used to derive the molecular backscattering coefficient for producing the CALIOP attenuated backscatter profiles (Hostetler et al. 2006). The new equation takes into account two factors that were neglected in the

simplified equation of Collins and Russell (1976) used until now:

- The dispersion of the refractive index and King factor of air, which is quantified by k_{bw}.
- The spectral variation of King factor

The results are presented in Fig. 2. We notice a decrease in the simulated molecular backscattering coefficients (for both wavelengths). More specifically, at 532 *nm* the difference is -4.25% while at 1064 *nm* it reaches -10.34%.

The corresponding figures have been updated.

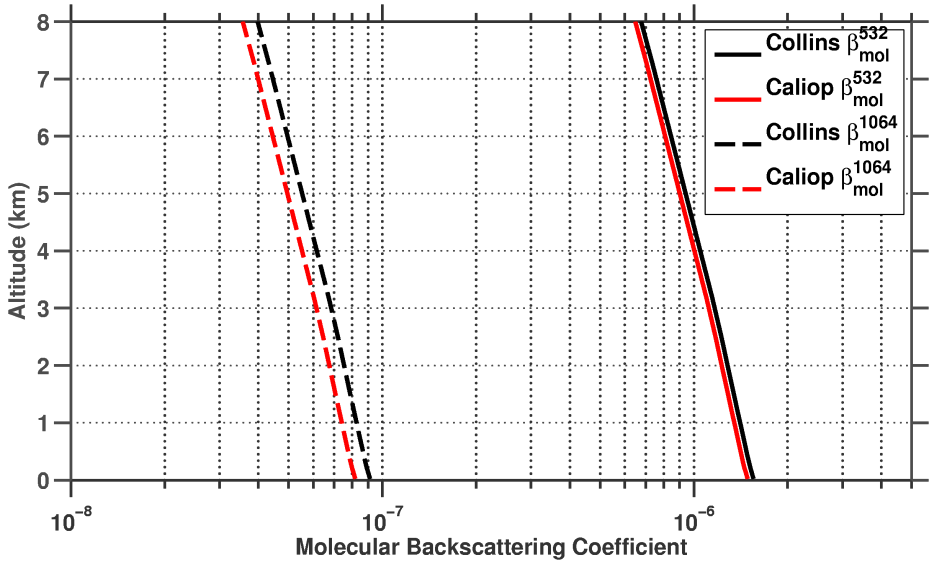

Fig.2: Molecular backscattering coefficient ($sr^{-1}\,m^{-1}$) calculated following Collins (black) and Hostetler (for the CALIPSO data, in red).

Section 3

The description of the case study setup in 3.1 is not clear. What is the difference between size sections and size bins? Does "log-normal interpolation" mean that a log- normal parameterization is assigned to the size distribution? How is this done, what are the uncertainties introduced by that parameterization? If the test cases are run with just one size bin populated, what does the interpolation make of this "mono-disperse" aerosol? Possibly a plot a size distribution might be helpful to interpret Fig 3-5. Also, the different symbols those figures are difficult to distinguish – the plots might benefit from using different colors for the lines.

The terms “bins” and “size sections” are equivalent. In the revised version of the paper, the terminology will be homogenized for more clarity.

The term lognormal interpolation doesn’t refer to a parameterization. It means that the concentration in each size section is interpolated following a lognormal progression of the mean mass median diameters.

For the academic case study presented, we place the concentration in only one size section at a time, and we simply re-distribute it into 5 new equally sized sections, while ensuring mass conservation. This is done for higher accuracy in the calculation of the optical properties.

Section 4

The discussion of AERONET and MODIS observations seems somewhat off-topic for this paper since so far the discussion was primarily focused on lidar observations. The problem I see here is, that the aerosol optical properties derived from different observing techniques, such as sun photometers and lidar, will not necessarily agree with each other, especially if the measurements involve different wavelengths (see. e.g., Müller et al, 2012 doi:10.1029/2011JD016825). Neither MODIS nor AERONET measure the AOD directly, therefore one would not necessarily expect to obtain the “true“ answer derived by the model from a measurement. It might be better to focus this work on lidar instruments where the results of the simulator are directly comparable with observed quantities and cut all sections discussing other measurements.

Following both reviewer’s suggestions the sections dedicated to passive remote sensing and modeling have been rewritten in a more concise way (cf. section 4.1)

Section 5

This section could probably be shortened in some places since most of this is published elsewhere.

Following the reviewer's suggestion this section has been shortened in the revised version of the paper.

Section 6

Choosing a case with mineral dust is interesting to test the model performance under conditions where some of the approximations made in the model are questionable (non-sphericity and multi scattering effects). It would, however, be important to quantify the uncertainty introduced by those assumptions in the comparisons.

Answered before (1st comment).

Other comments:

- *p 1692, l 23: might be good to also cite a review paper about aerosol transport and effects on atmospheric composition*

A review paper has been added (Monks et al. 2009: Atmospheric composition change – global and regional air quality, Atmospheric Environment, 43, 5268–53504).

- *p 1693, l 9-10: This sentence does not seem to make sense.*

The sentence is now corrected as follows:

The simulation of the long-range transport of aerosol plumes requires an accurate representation 30 of their vertical structure (e.g. location, spread). It affects aerosol lifetime (e.g. Keating and Zuber, 2007), and as a result surface concentrations. Moreover, it has an impact on aerosol-clouds interactions (e.g. Waquet et al., 2009, and references therein) and on aerosol radiative forcing (e.g. Zarzycki and Bond, 2010; Zhu et al., 2007).

- *p 1693, l 17: MODIS is on AQUA and TERRA*

The sentence is modified accordingly.

- *p 1694, l 15-16: The difference of "aerosol layer" and "aerosol type" is not obvious. Rephrase this sentence for clarity.*

The sentence is rephrased for more clarity as follows:

More specifically, the accuracy of these products depends to a large extent on the uncertainties of each step (algorithm) in the processing chain. For example, the estimated values may diverge from the correct values, if the identified layer is wrongly classified (e.g. dense smoke aerosol layers can be misclassified as clouds, Liu et al., 2009) or incorrect estimates of the aerosol type (e.g. dust misclassified as polluted dust, Omar et al., 2010) and thus lidar ratio are used (Young and Vaughan, 2009).

- *p 1696, l 5: Start a new sentence after (λ)*

The sentence is modified accordingly.

- *p1696,l10: an→a*

Corrected.

- *p1696 l24: "finer distribution" should probably read "finer resolution"*

The sentence is modified accordingly.

- *p 1697, Eq 4: η has been used for the refractive index earlier. Please assign a different symbol to either of the quantities.*

Corrected. The symbol *η'* is now used to express the multiple scattering parameter.

- *p 1698, l 13: Parenthesis in citation is in the wrong place.*

Corrected.

- *p1700,l25: "onFig2"→"inFig2"*

Corrected.

- *p 1701, l 1: particle optical properties*

Corrected.

- *p 1701, l 21: write out "1st"*

Corrected.

- *p 1713, l 4: "plume's vertical extent" → vertical extent of the plume*

Corrected.

- *Fig. 1: The caption should state what "ASR" stands for.*

Corrected.

- *Fig. 4: spell out what ATB stands for at least in the figure caption or use the same symbol as in the text.*

Corrected.