Dear Dr. Veselovskii,

First of all, we would like to thank you for the positive and very interesting comments that certainly are very helpful to improve the manuscript. Please, find the detailed answers below. The original text of your comments is highlighted in blue color.

Authors provide very detailed description of application of GRASP algorithm to the Sun photometer data inversion, and to the combination of this instrument with multiwavelength lidar as well. The main goal of this study is estimation of uncertainties of inversion, which is definitely very important scientific task. The manuscript is very well written, though is rather long with large amount of illustrations. On another hand, it provides the reader with all necessary information to understand the inversion technique and expected retrieval uncertainties. So, I think such length is acceptable.

I general, I think that this is very deep research, which is suitable for publishing in AMT. I have just several technical comments, concerning combining the lidar and Sun photometer.

We thank for the very positive and encouraging evaluation of our paper.

Regarding the questions, we have concluded that all questions below related to Section 3.3 are caused by the lack of introductory explanations for the considered retrievals from the combined co-incident measurement by Sun/sky-radiometer and lidar. In fact, this section considered the approach developed earlier by Lopatin et al. (2013) and widely used for joint processing of AERONET radiometer and lidar data. In frame of this approach the aerosol is modelled as external mixture of two components. These components are characterized by height independent microphysical properties in including size distribution (represented by several size bins) and spectrally dependent complex refractive index. Also, each component is described by the detailed vertical profile of volume concentration. Therefore, the retrieval provides height independent columnar properties of each component (size distribution and complex refractive index) and two profiles of fine and coarse mode volume concentrations. It is expected that this model is sufficient to adequately describe both radiometric and lidar observations.

The above explanations are added in the introduction of Section 3.3 of the revised manuscript (p. 19).

1) **Section 3.3. It would be useful to provide modal radii of the fine and coarse modes for aerosol types used in the model. Modal radii depend on the relative humidity and may change with height. Can it influence the uncertainty?**

We have added more information about the table containing the parameters of modelled size distributions and complex refractive indices in the text of the revised paper. Regarding the effects of the humidity and hygroscopic growth, we fully agree that this presents in the reality and may result in the vertical variability of both size and refractive index. Our model doesn't allow such variability for properties of each mode. This is certainly a limitation. At the same time, we expect that the model is sufficient for adequate mimicking of all lidar measured parameters such high and spectrally dependent extinction, lidar ratios, etc. Certainly, this concept will evolve in future, but for now our studies were based on this concept, especially is widely used by lidar communities such as ACTRIS.

2) **Fig.9. I am a bit confused. What is height distribution of particle concentration used in this modeling? For what height the results are shown? Does uncertainty depend on height?**

As explained above, the approach assumes that the microphysical properties of each mode (size distribution, complex refractive index and shape) are height independent, while vertical profiles of concentrations vary with altitude as is shown in Figure 12. Correspondingly, Figure 9 and 11 show only the column integrated properties while Figure 12 illustrates the vertical profile concentration which vary with the altitude for the two modes, fine and coarse mode.

3) **Fig.11. The height distributions for dust and smoke are the same? In real situation these are always different, so would be good to discuss how it will influence the modeling. Again, for what height lidar ratios are shown?**

Once again, Fig. 11 shows the column LR for fine and coarse modes independently that are assumed vertically constant. The height distribution for fine and coarse mode are not the same as they are illustrated in the Figure 12. The fine mode represents the background aerosol with specific vertical distribution, while coarse mode distribution had a thick layer approximately at 2.5 km. As a result, the total lidar ratio certainly changes vertically.

4) **Fig.12. The results are shown for the mixture of two components. Any chance to retrieve the profiles of two components separately?**

The Figures 9, 11 and 12 were simultaneously retrieved and they represent the columnar properties for two aerosol modes (Fig. 9 and 11) and the aerosol vertical profiles of each modes (Fig. 12). In the tests, we generated sun/sky photometer and lidar measurements and we retrieved simultaneously different aerosol properties, such us, SD, RRI, IRI, sphericity fraction and also the aerosol vertical distribution for both, fine and coarse mode separately (once again, these properties of each mode are assumed vertically constant). In addition, we provided the derived parameters, SSA and LR, for fine and coarse mode. With no doubts, total SSA and LR are strongly vertically dependent, as illustrated by the figure below for one example of the real case (Fig. 38) where we can clearly identify this dependency.

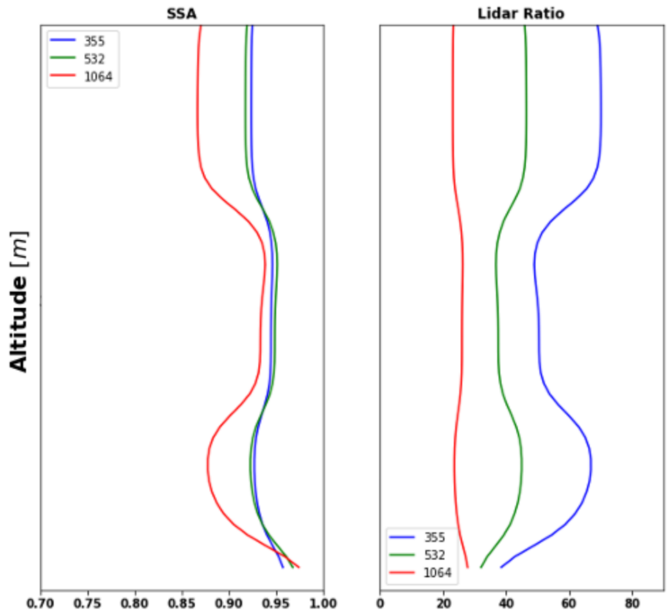

Figure: The vertical profiles of SSA and lidar ratios for total (fine + coarse modes) aerosol for the case illustrated by Fig. 38.