## Response to Referee #1

We thank to Referee #1 for his/her positive and constructive comments. The responses to every question and comment are shown below.

***Q1. Page 1-2. In the introduction of aerosol properties, it would be better to cite some new references such as related studies e.g. SKYNET, CARSNET, WMO-PFR, etc.***

The authors agree with the referee comment. These networks have been referenced in page 2 line 26.

***Q2. Page 3 line 34. "…with AOD values < 0.15." Which wavelength of AOD here?***

We are referring to 675 nm. We have included the wavelengths.

***Q3. Page 9 line 28. "In case of AOD≈0.5 …". which wavelength of AOD you used in this study?***

We are referring to 500 nm. Included

***Q4. Page 11 line 15. "…it can be said that AOD is mostly underestimated by the ZEN-LUT method." What's the probable reason?***

As we pointed out in the sensitivity study, the cause of the observed ZSR differences might come from the instrumental side or from the RTM inputs. We discard stray light as a possible explanation as the CE318 collimator performs a $10^{-5}$ stray light rejection for scattering angles=$3^{o}$ (Holben et al. 1998). Other instrument-related errors, as dirtiness over lenses or a calibration offset normally produce a systematic ZSR overestimation or underestimation at all scattering angles what does not agree with the observed positive ZSR differences for SZA below 20° and negative differences for SZA larger than 20°. For the same reason, we also discard a wrong input albedo as a possible cause.

We suspect that the main cause of the systematic AOD underestimation might be found in the aerosol optical properties derived from the aerosol model chosen to produce the look-up tables of Zenith Sky Radiances (ZSRs). To illustrate this hypothesis we have performed a comparative analysis of the measured ZSR with several simulated ZSR performed for the sample days, using the actual lookup table and the 4 individual OPAC mineral components (MINM, MITR, MIAM and MICM) with phase functions and single scattering albedos (SSA) taken from the LibRadtran spheroids components (see table 1 for the SSA values). In figure 2, the relative differences between measured and computed ZSR for the different cases, are represented against SZA. It can be seen larger differences for the extreme cases, i.e. supposing we only have fine mineral particles (MINM) or large mineral particles (MICM), but smaller when intermediate size mineral particles are employed (MITR and MIAM). The lookup table for Izaña is composed by a mix of WASO (fine particles), MINM (fine particles) and MITR (intermediate size particles) and it shows slightly larger negative differences (especially for 675 and 870 nm wavelengths) than considering just the presence of MITR or MIAM components. It might indicate that chosen mix of components to generate the lookup table has an excess of fine particles.

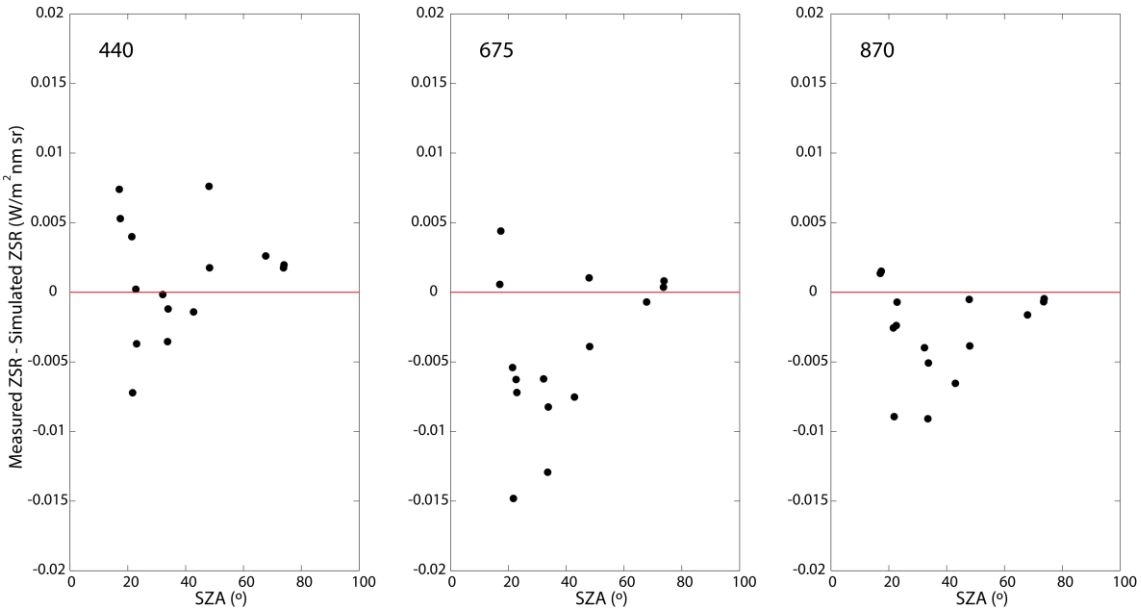


Figure 1. Difference between measured and computed ZSR (lookup table) at three wavelengths (440(a), 675(b) and 870(c)) for two days (23$^{rd}$ and 24$^{th}$ of August 2013) with similar and stable AOD conditions (<$AOD_{440}$>≈0.3).

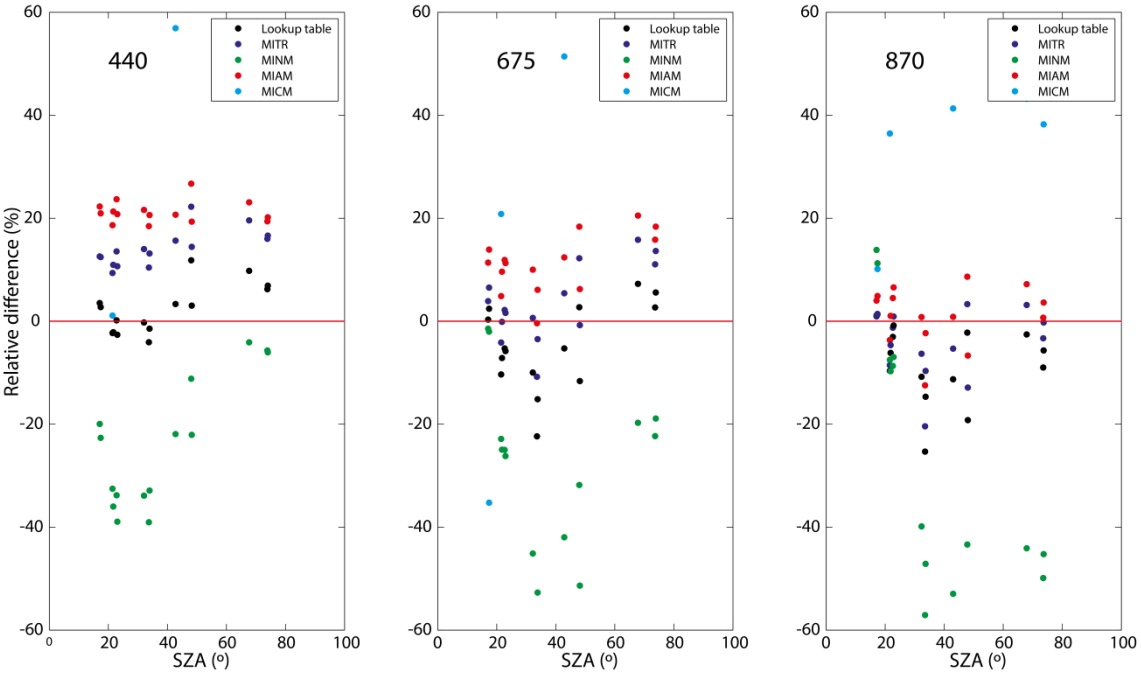


Figure 2. Relative difference between measured and computed ZSR at three wavelengths (440(a), 675(b) and 870(c)) for two days (23$^{rd}$ and 24$^{th}$ of August 2013) with similar and stable AOD conditions (<$AOD_{440}$>≈0.3). Every different mark represents the relative difference using different optical properties to compute the ZSR.

| | SSA(450nm) | SSA(650nm) | SSA(900nm) |
|---|---|---|---|
| **MINM** | 0.95 | 0.97 | 0.98 |
| **MITR** | 0.84 | 0.92 | 0.95 |
| **MIAM** | 0.81 | 0.91 | 0.94 |
| **MICM** | 0.61 | 0.71 | 0.76 |

Table 1. Single scattering albedo values for four mineral aerosol OPAC components (spheroids) taken from LibRadtran at three different wavelengths.

***Q5. Figure 3. The top major ticks of Fig (b) are different from other pictures, please revise it.***

Done.

## REFERENCES

Holben, B. N., Eck, T. F., Slutsker, I., Tanré, D., Buis, J. P., Setzer, A., Vermote, E., Reagan, J. A., Kaufman, Y. J., Nakajima, T., Lavenu, F., Jankowiak, I. and Smirnov, A.: AERONET- A federated instrument network and data archive for aerosol characterization, Rem. Sens. Environ., 66, 1-16, 1998.