Anonymous Referee #2

- Some comments related to the scientific content:

Line 64: The expression of the molecular lidar ratio Sm = 8π/3 sr is an approximation, whereas it depends on depolarization and refractive index at each wavelength (see Bucholtz A., Rayleigh-scattering calculations for the terrestrial atmosphere, APPLIED OPTICS, Vol. 34, No. 15, 1995). Which is the influence of this assumption on the overlap estimation?

We have modified the formulas to include this dependence of molecular lidar ratio. Its effect (very small) is illustrated in fig. B1 of appendix B

Line 98-99: About the sentence "we neglect the difference between the aerosol extinction coefficients at λ0 and λR". This assumption could be acceptable in the case of the pure rotational Raman, but not in general, like for 532 nm in this paper, where the vibro-rotational Raman at 607 nm is used. The authors should explain better.

An appendix (B) has been added to the paper to address this issue.

Line 164-165: see previous comment.

An appendix (B) has been added to the text to address this issue.

Lines 169-173: The authors say that "the 355-nm has a sudden fall below approximately 400m. For this reason, in this particular case of optical alignment we should distrust the overlap function retrieval below that height". Why did not the authors try to improve the alignment and use a better measurement?

This undesired feature in the system was discovered while preparing this work and we are still finding out the cause of the issue.

Figs. 2 and 3:

Did the authors performed a comparison with the overlap functions obtained from the Wandinger and Ansmann method?

Although using a different formulation, the method presented in this paper relies on the same basis than the one by Wandinger and Ansmann and results are indistinguishable. We have added a sentence in the paper stating this fact (Lines 258ss):

"Although using a different, explicit, non-iterative formulation, the method presented in this paper relies on the same basis as the one given by Wandinger and Ansmann. The reader can check that, for the same measured data and assumed lidar ratio, both methods, for a sufficient number of iterations in (Wandinger and Ansmann 2002), yield indistinguishable results"

The overlap function should not be higher than 1, contrary to what the figures show, suggesting that the overlap function contains further kind of corrections. This behaviour is present also in low aerosol load conditions that should be used to retrieve the overlap function, so affecting the extinction and backscatter retrieval that, as known, is particularly critical at low range. In this context, how the authors use the overlap function, especially at low range, if the overlap function presents the reported dependence on the lidar ratio?

Because we have arbitrarily normalized the profile to the reference height, where the overlap function has reached a stable value, values greater than one, as shown in figs. 3 and 4, at lower ranges are possible below the region where profiles stabilize to unity and reveal a non-perfect alignment, in particular, a slight crossing between the laser beam and the receiver field-of-view axes, leading to a loss of energy from the far range.

This overlap function corrects overestimated (because of less than perfect alignment) signal values at low ranges.

We have added a clarifying paragraph (lines 249ss):

"Because we have arbitrarily normalized the profile to the reference height, where the overlap function has reached a stable value, values greater than one, as shown in figs. 2 and 3, at lower ranges are possible and reveal a non-perfect alignment, in particular, a slight crossing between the laser beam and the receiver field-of-view axes, leading to a loss of energy from the far range (see for example fig 1(a) in (Kokkalis 2017) with laser tilt A_{tilt}, half-width laser beam divergence LBD and receiver field of view $RFOV$ fulfilling the conditions $A_{tilt} + LBD > RFOV$ and $A_{tilt} - LBD < RFOV$)".

In addition throughout the document we have replaced the term "full overlap" by "stable overlap" and emphasized that the stable overlap value is normalized to 1:

"We assume as well that at that range the overlap function has attained a constant value that we set conventionally to 1" (line 80)

Which is the full overlap altitude of the system used by the authors in the paper?

We prefer talking about "stable overlap". Right now, according to our calculations, the altitude for stable overlap is around 4 km. Below that range the overlap has a small enhancement (see response to previous question).

- Some suggestions related to the text:

Line 31: I suggest replacing "To overcome" with "To reduce", because the problem is not removed.

Done

Line 71: In eq. (2), maybe, it should be O(Rm) instead of O(R).

We have eliminated $O(R_m)$ (O(R) in the original).