Response to Referee #2

Many thanks to referee for take in time to evaluate and improve this manuscript. Thank also for your recommendation of publication. Please find below point by point responsive to comments.

1) The author go through great detail deriving the new inversion technique and testing the sensitivity of the retrieval to both theoretical and real scenarios, however, the manuscript would greatly benefit from a more detailed discussion on the applications and limitations of this approach. For example, theoretical testing was performed for range r = 100 m. Is this approach applicable at r=200 m? What is your definition of "short range"?

Short range means herein measurement which are made at distance less than 1 km. The inversion formalism and the method for finding the lidar ratio described in this manuscript are applicable as soon as the surface echo is present on the lidar signal. Applications at 200 m 500 m or 1 km are therefore possible.

Sentence added (p14. Line243-246): *"Note that the formalism and methodology adopted here to retrieve the lidar ratio are efficient as long as the peak backscattering of the SRT is present on the lidar signal. The method has been evaluated, in this manuscript, for short range around 100 m because our research focus on application at this range. However, the algorithm developed does not present any limit with respect to the range provided that measurements are made below 1 km of range (this value depends of the power of laser sources) with respect to our applications. However, at first sight there is no limit to the application of the method to measurements at longer ranges such as more than 1 km measurements."*

2) The authors mention that this approach has the potential to be applied to airborne lidar observations, however, I do not see how this would be possible without a) flying low in the atmosphere and b) knowing the varying underlying surface BRDF.

When we talk about airborne lidar observation, we are indeed considering low-level flights operated from aircraft such as helicopters or small planes. Precisely, measurements must be made at 1 km of altitude maximum. We suggest coupling the measurements with those of a spectrometer imager in order to deduce the reflectance of the surface target.

Sentence revised (P19. line 322-324): *"The new inversion technique presented in this paper suggests new airborne lidar applications operated at low altitude from aircraft (helicopters, airplanes), but requires a priori knowledge of the reflectance of the SRT."*

Paraph revised (p19. line 324-328): *"Even if some models exist for the BRDF of surfaces (Bréon et al., 2002; Lobell and Asner, 2002; Mishchenko et al., 1999), their use seems difficult to implement because of the diversity of encountered surfaces during airborne measurements. Nevertheless, it may be possible to identify the reflectance of the ground surface by means of a spectroradiometer imager (Josset et al., 2018; Miesch et al., 2005; Poutier et al., 2002). The combination of these results measurements with the herein proposed inversion method would be a priori complementary to establish new methods of calibration for downlooking lidar measurements (spaceborne or airborne lidars)."*

3) Line 11 – Consider omitting the 3 dots following "ocean"

The three dots have been deleted (p1. Line11).

4) Line 54-55– This limitation is only applicable for ground-based lidar systems.

Sentence revised (p3. line 64-65): *"Another limitation of ground-based lidar measurements is related to the overlap function that strongly impacts (and prevents) observation close to the instrument, i.e. in the lowest layers of the troposphere where aerosols are emitted."*

5) Equation 1 – Please provide a definition of Fcor in the equation description and also consider adding some text explaining the BRDF component (f).

Fcor is now defined (p4. Line 99).

Sentence revised (p.3 line 85-86): *"In our approach, we propose to use a SRT of known bidirectional reflectance distribution function (BRDF) $f_{r,\lambda}$ (in sr^{-1}) (Kavaya et al., 1983; Nicodemus, 1965)."*

Sentence added (p4. Line94-96): *"It should be noted that in the particular case of a Lambertian surface $f_{r,\lambda}(r_s, \theta_i)$ can be easily expressed by spectral bidirectional reflectance factor ρ_λ from $\rho_\lambda \cos\theta_i/\pi$ (Haner et al., 1998; Josset et al., 2010, 2018). However, the general form of BRDF ($f_{r,\lambda}$) will be considered later in this work in order to not restrict the approach to specific cases."*

6) Line 123 – Typo - "mentioning"

Sentence revised (p.6 line 140): *"It is worth mentioning that $LR_a(r_s)$ is the lidar ratio just before the SRT and $Y(r_s) = 0$ (only surface target)."*

7) Line 139-140 – "A prioris: : :". Consider adding justification/references for this sentence.

We understand that this sentence is a bit confusing. Also, it is not necessary for the scientific content. We have therefore deleted it.